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Compact Excavator

# TB125
# TB135
# TB145

BOOK No. CG4E004

# WORKSHOP MANUAL

Serial No.
TB125: 12510003~
TB135: 13510004~
TB145: 14510004~

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# FOREWORD

This manual is intended for persons who engage in maintenance operations, and explains procedures for disassembly and reassembly of the machine, check and maintenance procedures, maintenance reference values, troubleshooting and outline specifications, etc. Please use this manual as a reference in service activities to improve maintenance techniques.
Further, please be advised that items contained in this manual are subject to change without notice due to design modifications, etc.

## MACHINE FRONT AND REAR, LEFT AND RIGHT

The end where the dozer blade is mounted is the front and the end with the travel motors is the rear. Also the right and left sides of the operator when he is seated in the driver's seat are the right and left sides of the machine.

## MACHINE SERIAL NUMBER

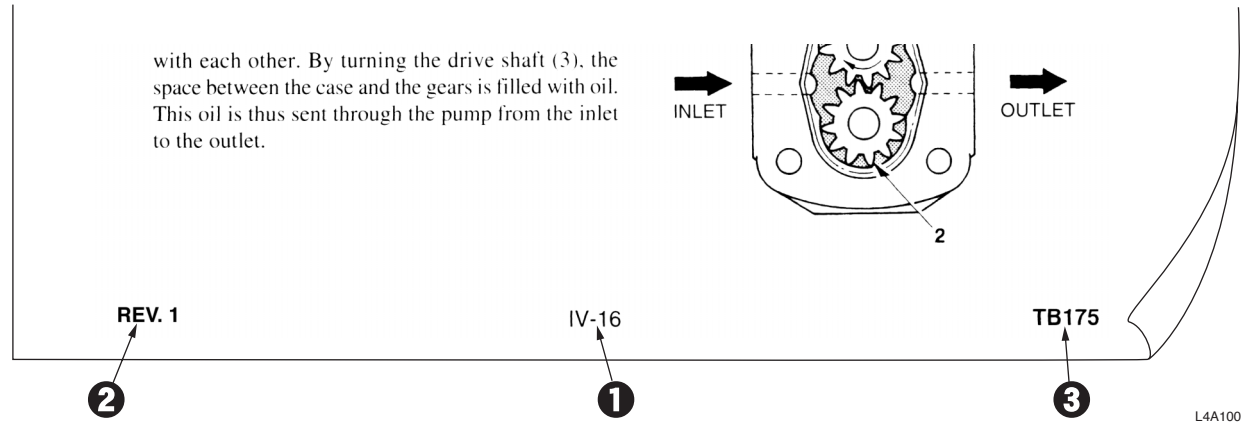
The machine serial number is stamped on the identification plate. When sending reports and inquiries, and when ordering parts, etc., be sure to include this number.

## MANUAL CONTROL

Information on those to whom this manual is distributed is recorded in the ledger in the section in charge at this company, so please decide on a person to be in charge of it and control it. When there are updates or additions, etc., we will notify the person in charge.

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## FOOT OF THE PAGE




1. Page number
   The following page numbers are assigned to each respective page. And if there are additional pages, an addition code is supplied. Please file the sheets in the order of the page numbers.

   Page No.
   X–XX
   → Page number within section
   → Section Number

   Page Addition
   X–XX–X
   → Addition Code

   Example: II-8
   II-9
   II-9-1 ..... A page is added between page 9 and page 10.
   II-10

   If a page has been revised, it is to be used in place of the page used before revision and it is not necessary to keep the old page.

2. Revision number
   Indicates the revision of this manual. This number is printed on the page that reflects this revision.

3. Model (s)

## SYMBOLS

☞ means “Please refer to the section quoted.”

Indicates the tightening torque at the specific section that requires special attention in designing.

Indicates the mass of a part or device.

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I . GENERAL
II . SPECIFICATIONS
III. MACHINE CONFIGURATION
IV. HYDRAULIC UNITS
V . TROUBLESHOOTING
VI. ENGINE

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# I. GENERAL

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## SAFETY PRECAUTIONS

### SAFETY ALERT SYMBOL

This symbol means Attention! Be Alert! Your Safety Is Involved.
The message that follows the symbol contains important information about safety.
Read and understand the message to avoid personal injury or death.

### ■ SIGNAL WORDS

Safety messages appearing in this manual and on machine decals are identified by the words “DANGER”, “WARNING” and “CAUTION”. These signal words mean the following:

**⚠ DANGER**

The word “DANGER” indicates an imminently hazardous situation which, if not avoided, can result in serious injury or death.

**⚠ WARNING**

The word “WARNING” indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.

**⚠ CAUTION**

The word “CAUTION” indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

**IMPORTANT:** The word “IMPORTANT” is used to alert against operators and maintenance personnel about situations which can result in possible damage to the machine and its components.

This manual is intended for trained and qualified personnel only. Warnings or cautions described in this manual do not necessarily cover all safety measures. For maintenance work, each person must take adequate safety precautions against possible hazards present in the respective working environment.

### Observe all safety rules

- Operation, inspection and maintenance of this machine must be performed only by a trained and qualified person.
- All rules, regulations, precautions and safety procedures must be understood and followed when performing operation, inspection and maintenance of this machine.
- Do not perform any operation, inspection and maintenance of this machine when under the adverse influence of alcohol, drugs, medication, fatigue, or insufficient sleep.


E3A040

### Wear appropriate clothing and personal protective equipment

- Do not wear loose clothing or any accessory that can catch on controls or in moving parts.
- Do not wear oily or fuel stained clothing that can catch fire.
- Wear a hard hat, safety shoes, safety glasses, filter mask, heavy gloves, ear protection and other protective equipment as required by job conditions. Wear required appropriate equipment such as safety glasses and filter mask when using grinders, hammers or compressed air, as metal fragments or other objects can fly and cause serious personal injury.
- Use hearing protection when operating the machine. Loud prolonged noise can cause hearing impairments, even the total loss of hearing.

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### Provide a fire extinguisher and first aid kit


E3A080

- Know where a fire extinguisher and first aid kit are located and understand how to use them.
- Know how to contact emergency assistance and first aid help.

### Attach a “DO NOT OPERATE” tag

Severe injury could result if an unauthorized person should start the engine or touch controls during inspection or maintenance.

- Stop the engine and remove the key before performing maintenance.
- Attach a “DO NOT OPERATE” tag to the starter switch or control lever.

### Use the correct tools


E3A530

Do not use damaged or weakened tools or tools designed for other purposes. Use tools suited for the operation at hand.

### Replace important safety parts periodically

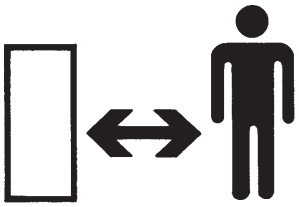
- Replace fuel hoses periodically. Fuel hoses become weaker over time, even if they appear to be in good shape.
- Replace important safety parts whenever an irregularity is found, even if it is before the normal time for replacement.

### Anti-explosive lighting


E3A550

Use anti-explosive electrical fixtures and lights when inspecting fuel, oil, coolant, battery fluid, etc. If lighting that is not anti-explosive should break, the substance could ignite, resulting in serious injury or death.

### Do not allow unauthorized personnel in the work area


E3A140

Do not allow unauthorized personnel in the work area. Chips or other debris can fly off machine parts when grinding, welding or using a hammer.

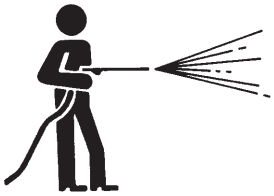
### Prepare the work area

- Select a firm, level work area. Make sure there is adequate light and, if indoors, ventilation.
- Clear obstacles and dangerous objects. Eliminate slippery areas.

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## Always clean the machine



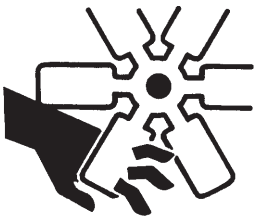
E3A580

- Clean the machine before performing maintenance.
- Cover electrical parts when washing the machine. Water on electrical parts could cause short-circuits or malfunctions.
  Do not use water or steam to wash the battery, sensors, connectors or the operator's seat area.

## Stop the engine before performing maintenance

- Avoid lubrication or mechanical adjustments with the machine in motion or with the engine running while stationary.
- If maintenance must be performed with the engine running, always work as a 2-person team with one person sitting in the operator's seat while the other works on the machine.
  - When performing maintenance, be sure to keep your body and clothing away from moving parts.

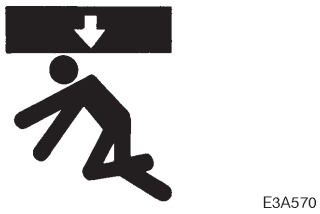
## Stay clear of moving parts



E3A630

- Stay clear of all rotating and moving parts. Wrapping or entanglement may result in serious injury or death.
- Keep hands, clothing and tools away from the rotating fan and running fan belts.

## Securely block the machine or any component that may fall



E3A570

- Before performing maintenance or repairs under the machine, set all working equipment against the ground or in the lowermost position.
- Securely block the tracks.
- If you must work beneath the raised machine or equipment, always use wood blocks, jack-stands or other rigid and stable supports. Never get under the machine or working equipment if they are not sufficiently supported. This procedure is especially important when working on hydraulic cylinders.

## Securely block the working equipment

To prevent unexpected movement, securely block the working equipment when repairing or replacing the cutting edges or bucket teeth.

## Secure the engine hood or cover when opened

Be sure to secure the engine hood or cover when opening it. Do not open the engine hood or cover on slopes or in strong wind.

## Cautions on tilting up the platform

- Raising or lowering the platform while the engine is running may cause the machine to move, and cause serious injury or death.
  Stop the engine before raising or lowering the platform.
- When the floor is tilted up, support it firmly with the stopper to prevent it from falling.

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### Place heavy objects in a stable position


E3A560

When removing or installing the hoe attachment, place it in a stable position so that it does not tip over.

### Use caution when fueling


E3A100

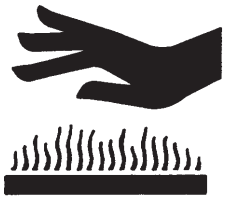
- Do not smoke or permit open flames while fueling or near fueling operations.
- Never remove the fuel cap or refuel with the engine running or hot. Never allow fuel to spill on hot machine components.
- Maintain control of the fuel filler nozzle when filling the tank.
- Do not fill the fuel tank to capacity. Allow room for expansion.
- Clean up spilled fuel immediately.
- Tighten the fuel tank cap securely. Should the fuel cap be lost, replace it only with the original manufacturer's approved cap. Use of a non-approved cap without proper venting may result in pressurization of the tank.
- Never use fuel for cleaning purposes.
- Use the correct fuel grade for the operating season.

### Handling of hoses

Fuel, oil or hydraulic fluid leaks can cause a fire.

- Do not twist, bend or hit the hoses.
- Never use twisted, bent or cracked hoses, tubes and pipes. They may burst.
- Retighten loose connections.

### Be careful with hot and pressurized components


E3A110

Stop the engine and allow the machine to cool down before performing inspection and maintenance.

- The engine, muffler, radiator, hydraulic lines, sliding parts and many other parts of the machine are hot directly after the engine is stopped. Touching these parts will cause burns.
- The engine coolant, oil and hydraulic fluid are also hot and under high pressure.
  Be careful when loosening caps and plugs. Working on the machine under these conditions could result in burns or injuries due to the hot oil spurting out.

### Be careful with hot cooling systems

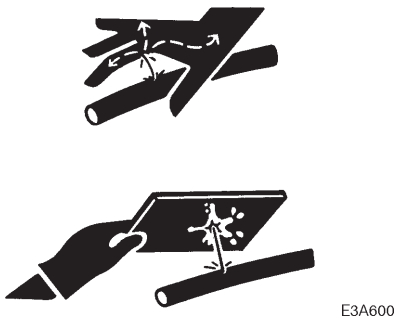

E3A540

Do not remove the radiator cap or drain plugs when the coolant is hot. Stop the engine, let the engine and radiator cool and loosen the radiator cap or drain plugs slowly.

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## Be careful with fluids under pressure



E3A600

Pressure can be maintained in the hydraulic circuit long after the engine has been shut down.

- Release all pressure before working on the hydraulic system.
- Hydraulic fluid under pressure can penetrate the skin or eyes and cause injury, blindness or death. Fluid escaping from a small hole can be almost invisible. Wear a safety goggles and heavy gloves and use a piece of cardboard or wood to search for suspected leaks.
  If fluid is injected into the skin, it must be removed within a few hours by a doctor familiar with this type of injury.

## Release all pressure before working on the hydraulic system

Oil may spurt out if caps or filters are removed or pipes disconnected before releasing the pressure in the hydraulic system.

- Gradually loosen the vent plug to relieve tank pressure.
- Move all the control levers and pedals several times in all directions to release the pressure from the working equipment circuitry. (For link type controls)
- When removing plugs or screws or disconnecting hoses, stand to the side and loosen slowly to gradually release the internal pressure before removing.

## Be careful with grease under pressure



E3A620

The track adjuster contains highly pressurized grease. If the tension is adjusted without following the prescribed procedure, the grease discharge valve may fly off, resulting in injury.

- Loosen the grease discharge valve slowly. Do not unfasten it more than one full turn.
- Do not put your face, arms, legs or body in front of the grease discharge valve.

## Disconnect the battery



E3A590

Disconnect the battery before working on the electrical system or doing any welding. Remove the negative (–) battery cable first. When reconnecting the battery, connect the negative (–) battery cable last.

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### Avoid battery hazards

- Batteries contain sulfuric acid which will damage eyes or skin on contact.
  - If acid contacts eyes, flush immediately with clean water and get prompt medical attention.
  - If acid is accidentally swallowed, drink large quantities of water or milk and call a physician immediately.
  - If acid contacts skin or clothing, wash off immediately with clean water.
- Wear safety glasses and gloves when working with batteries.
- Batteries generate flammable and explosive gases. Keep arcs, sparks, flames and lighted tobacco away.
- Use a flashlight to check battery electrolyte level.
- Stop the engine and shut off electrical equipment while inspecting or handling the battery.
- Do not short circuit the battery posts with metal items.
- Always unfasten the negative (–) battery cable first when disconnecting the battery cable. Always connect the negative (–) battery cable last when fastening the battery cable.
- Loose battery terminals may result in sparks. Be sure to fasten terminals tightly.
- Make sure the vent caps are tightened securely.
- Do not charge a battery or jump-start the engine if the battery is frozen. Warm to 15°C (60°F) or the battery may explode.

### Have a Takeuchi service agent repair welding cracks or other damage

Ask a Takeuchi service agent to repair any welding problems which are detected. If not feasible, make sure the welding is done by a qualified person in a properly equipped workplace.

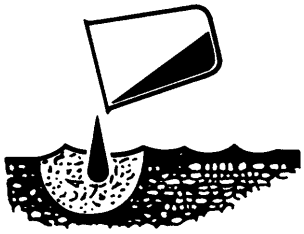
### Safety signs

- Keep all safety signs clean and legible.
- Replace all missing, illegible or damaged safety and warning signs.

### Checks after maintenance

- Gradually raise the engine speed from a low idle to maximum speed and check that no oil or air is leaking from serviced parts.
- Move the controls and check that the machine is operating properly.

### Disposing of wastes



E3A640

- Funnel spent fluids from the machine into containers. Disposing of fluids improperly destroys the environment.
- Follow the prescribed regulations when disposing of oil, fuel, engine coolant, refrigerant, solvents, filters, batteries or other harmful substances.

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## CAUTIONS DURING DISASSEMBLY AND ASSEMBLY

1. Clean the machine before disassembly operation.

2. Before disassembly, check the machine conditions and record them.
   - Model, Machine Serial Number, Hourmeter
   - Reason for Repairs, Repair History
   - Dirtiness of Filters
   - Fuel and Oil Conditions
   - Damage to each parts, etc.

3. To make reassembly operations easy, make matching marks at the necessary points.

4. Clean all disassembled parts and new parts, then arrange them in the proper sequence.

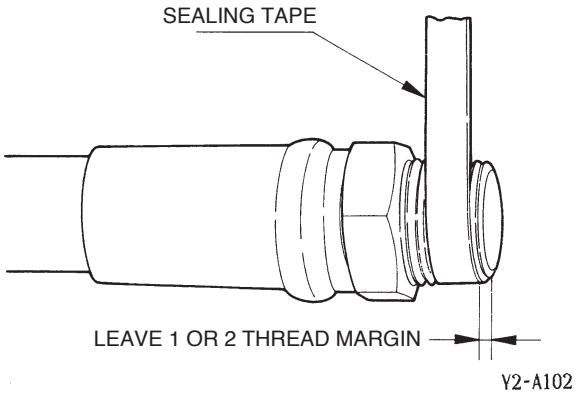
5. Be sure to replace all seals and cotter pins, etc., with new parts.

6. Keep parts which should not come in contact with oil and water separate from parts with oil on them.
   - Electrical Parts, Rubber, V-Belts, etc.

7. When installing bearings, bushings and oil seals, as a rule, use a press. When a hammer, etc., is used, it leaves bruises.

8. Wipe all joining surfaces clean so that there is no dirt or dust adhering to them.

9. Wrap seal tape from the front end, Wrapping it tight and leaving 1 or 2 threads bare, Overlap the tape by about 10 mm.




10. When fitting the snap rings, the bigger, rounder side of their circumferences should face the mating surfaces.

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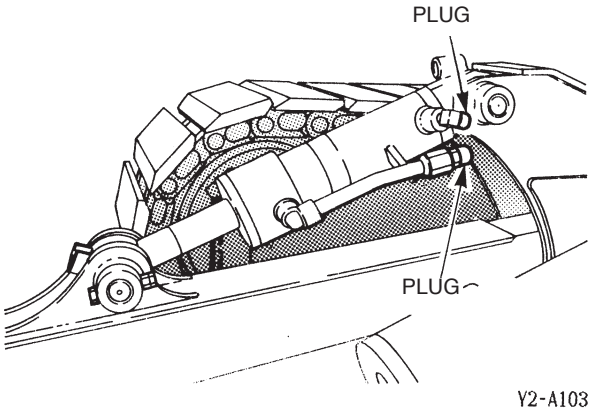


## CAUTIONS DURING REMOVAL AND INSTALLATION OF THE HYDRAULIC UNITS

1. Make sure that the hydraulic oil's temperature has dropped.

2. To prevent a loss of flow of the hydraulic oil, the residual pressure in the piping and the internal pressure in the hydraulic oil tank should be bled out.

3. Be sure to install caps or plugs on all openings in the hydraulic unit to prevent dirt from getting into the unit through the openings.




4. It is easy to mistake hydraulic oil adhering to the hydraulic unit for an oil leak, so wipe the unit off thoroughly.

5. Be sure that no damage is done to the plating on the rod in the hydraulic cylinder.

6. As a rule, removal and installation of the hydraulic cylinder should be done with the rod fully retracted.

7. Be sure to bleed the air after replacing the hydraulic oil or removing any of the hydraulic devices.
   ☞ "III. Machine Configuration, Hydraulic System"

8. After installation of the hydraulic unit, be sure to pressurize the hydraulic oil tank. If this operation is forgotten, it could cause cavitation of the hydraulic pump. Also, it could have a drastic effect on the life of the hydraulic pump.
   ☞ "III. Machine Configuration, Hydraulic System"

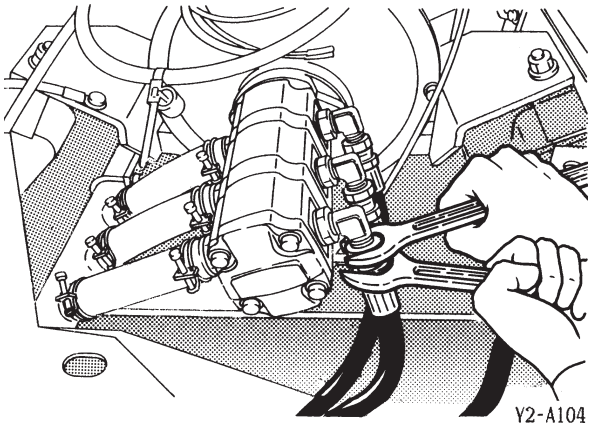
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## CAUTIONS DURING REMOVAL AND INSTALLATION OF PIPING

1. When hydraulic hoses are installed, tighten them once to the prescribed torque, then loosen them slightly and retighten them to the prescribed torque.
   - Tighten the fittings after the installation surfaces fit snugly together.
   - Pieces wrapped with seal tape are excluded.

2. Use 2 spanners, each on an opposite side, to remove and tighten fittings so that the hoses or steel pipes are not twisted.



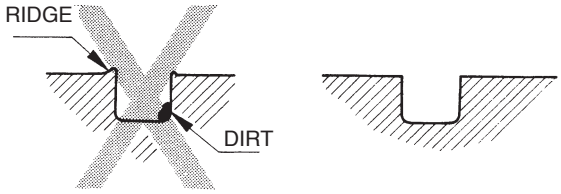

3. After installation of hydraulic hoses or steel pipes, apply the maximum working pressure 5 or 6 times and confirm that there is no leakage.

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## HANDLING OF SEALS

1. Clean the grooves for O-rings and if there is any ridge, etc., remove it.



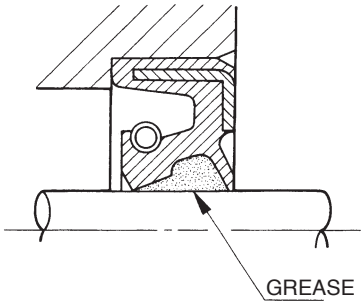

Y2-A105

2. Be careful not to twist O-rings. If an O-ring is twisted, remove the twist with the fingertips.

3. During insertion, be careful not to damage the seal.

4. Handling of Floating Seals
   - Wipe all oil off the O-ring and housing of the floating seal.
   - When assembling, apply a thin coating of gear oil to the contact surface of the housing.
   - After assembly, turn the seal 2 or 3 times to get it to fit snugly.

5. Apply grease to the lip of the oil seal.
   - This is to prevent wear when it is first started up after assembly.




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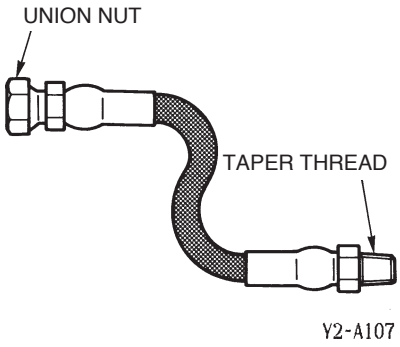
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## TIGHTENING TORQUES

### Hydraulic Hoses

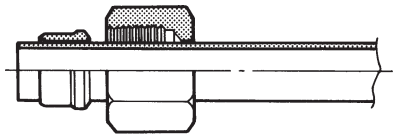
| Hose Fitting Size | Torque | | | |
|---|---|---|---|---|
| | Union Nut (G) | | Taper Thread (R) | |
| | N·m | ft-lb | N·m | ft-lb |
| 1/8 | 9.8 $^{+4.9}_{0}$ | 7.3 $^{+3.5}_{0}$ | 11.8 ±1.2 | 8.7 ±0.8 |
| 1/4 | 24.5 $^{+4.9}_{0}$ | 18.1 $^{+3.5}_{0}$ | 29.4 ±2.9 | 21.7 ±2.1 |
| 3/8 | 49 $^{+4.9}_{0}$ | 36.2 $^{+3.5}_{0}$ | 53.9 ±5.4 | 39.8 ±3.9 |
| 1/2 | 58.8 $^{+4.9}_{0}$ | 43.4 $^{+3.5}_{0}$ | 88.3 ±8.8 | 65.1 ±6.4 |
| 3/4 | 117.7 $^{+4.9}_{0}$ | 86.8 $^{+3.5}_{0}$ | 147.1 ±14.7 | 108.5 ±10.7 |
| 1 | 137.3 $^{+4.9}_{0}$ | 101.3 $^{+3.5}_{0}$ | 196.1 ±19.6 | 144.7 ±14.3 |



Y2-A107

### Bite Type Pipe Fitting for Steel Pipe

| Pipe Outer Diameter (mm) | Torque | |
|---|---|---|
| | N·m | ft-lb |
| 8 | 34.3 ±4.9 | 25.3 ±3.5 |
| 10 | 41.7 ±2.5 | 30.7 ±1.7 |
| 12 | 58.8 ±4.9 | 43.4 ±3.5 |
| 15 | 88.3 ±4.9 | 65.1 ±3.5 |
| 16 | 93.2 ±4.9 | 68.7 ±3.5 |
| 18 | 132.4 ±4.9 | 97.6 ±3.5 |
| 22 | 205.9 ±9.8 | 151.8 ±7.2 |
| 27.2 | 245.2 ±9.8 | 181.0 ±7.2 |
| 28 | 313.8 ±19.6 | 231.4 ±14.3 |
| 32 | 313.8 ±19.6 | 231.4 ±14.3 |
| 35 | 411.9 ±19.6 | 303.7 ±14.3 |

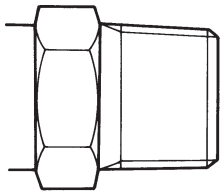

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### Joints for Piping

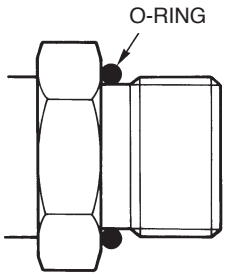
| Nominal Thread Diameter (R) | Torque | | | |
|---|---|---|---|---|
| | Steel | | Cast Steel | |
| | N·m | ft-lb | N·m | ft-lb |
| 1/8 | 11.8 ±1.2 | 8.7 ±0.8 | 10.8 ±1.1 | 8.0 ±0.7 |
| 1/4 | 29.4 ±2.9 | 21.7 ±2.1 | 24.5 ±2.5 | 18.1 ±1.7 |
| 3/8 | 53.9 ±5.4 | 39.8 ±3.9 | 49 ±4.9 | 36.2 ±3.5 |
| 1/2 | 88.3 ±8.8 | 65.1 ±6.4 | 73.5 ±7.4 | 54.3 ±5.3 |
| 3/4 | 147.1 ±14.7 | 108.5 ±10.7 | 127.5 ±12.7 | 94.1 ±9.3 |
| 1 | 196.1 ±19.2 | 144.7 ±14.3 | 171.6 ±17.2 | 126.6 ±12.5 |



Y2-A109

### Joints for Piping (O-ring Seal Type)

| Nominal Thread Diameter (G) | Torque | |
|---|---|---|
| | N·m | ft-lb |
| 1/8 | 19.6 ±2.0 | 14.5 ±1.4 |
| 1/4 | 34.3 ±4.9 | 25.3 ±3.5 |
| 3/8 | 53.9 ±4.9 | 39.8 ±3.5 |
| 1/2 | 63.7 ±4.9 | 47.0 ±3.5 |
| 3/4 | 93.2 ±4.9 | 68.7 ±3.5 |
| 1 | 107.9 ±9.8 | 79.5 ±7.2 |
| 1-1/4 | 117.7 ±9.8 | 86.8 ±7.2 |
| 1-1/2 | 137.3 ±9.8 | 101.2 ±7.2 |




Y2-A110

| Nominal Thread Diameter (UNF) | Torque | |
|---|---|---|
| | N·m | ft-lb |
| 7/16–20 | 16.7 ±2.0 | 12.3 ±1.4 |
| 1/2–20 | 22.6 ±2.0 | 16.6 ±1.4 |
| 9/16–18 | 31.4 ±2.9 | 23.1 ±2.1 |
| 3/4–16 | 59.8 ±4.9 | 44.1 ±3.5 |
| 1-1/16–12 | 102.0 ±5.9 | 75.2 ±4.4 |
| 1-5/16–12 | 135.3 ±7.8 | 99.8 ±5.8 |
| 1-5/8–12 | 181.4 ±9.8 | 133.8 ±7.2 |

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**Bolts and Nuts (for ISO Strength Category 10.9)**

| Thread | Size × Pitch | Torque | | | | | |
|---|---|---|---|---|---|---|---|
| | | General Tightening Points | | | Special Tightening Points | | |
| | | N·m | kgf·m | ft-lb | N·m | kgf·m | ft-lb |
| Coarse | M 6 × 1.0 | 9.8 ±0.5 | 1.0 ±0.05 | 7.2 ±0.4 | 11.8 ±0.6 | 1.2 ±0.06 | 8.7 ±0.4 |
| | M 8 × 1.25 | 22.6 ±1.1 | 2.3 ±0.11 | 16.6 ±0.8 | 26.5 ±1.3 | 2.7 ±0.13 | 19.5 ±0.9 |
| | M10 × 1.5 | 47.1 ±2.4 | 4.8 ±0.24 | 34.7 ±1.7 | 54.9 ±2.7 | 5.6 ±0.28 | 40.5 ±2.0 |
| | M12 × 1.75 | 83.4 ±4.1 | 8.5 ±0.42 | 61.5 ±3.0 | 97.1 ±4.8 | 9.9 ±0.49 | 71.6 ±3.5 |
| | M14 × 2.0 | 134.4 ±6.7 | 13.7 ±0.68 | 99.1 ±4.9 | 155.9 ±7.7 | 15.9 ±0.79 | 115.0 ±5.7 |
| | M16 × 2.0 | 207.9 ±10.4 | 21.2 ±1.06 | 153.3 ±7.7 | 241.2 ±12.1 | 24.6 ±1.23 | 177.9 ±8.9 |
| | M20 × 2.5 | 410.9 ±20.5 | 41.9 ±2.09 | 303.1 ±15.1 | 475.6 ±23.7 | 48.5 ±2.42 | 350.8 ±17.5 |
| Fine | M 8 × 1.0 | 24.5 ±1.2 | 2.5 ±0.12 | 18.1 ±0.9 | 28.4 ±1.4 | 2.9 ±0.14 | 21.0 ±1.0 |
| | M10 × 1.25 | 50.0 ±2.5 | 5.1 ±0.25 | 36.9 ±1.8 | 58.8 ±2.9 | 6.0 ±0.30 | 43.4 ±2.2 |
| | M12 × 1.5 | 87.3 ±4.3 | 8.9 ±0.44 | 64.4 ±3.2 | 102.0 ±5.1 | 10.4 ±0.52 | 75.2 ±3.8 |
| | M14 × 1.5 | 135.3 ±6.8 | 13.8 ±0.69 | 99.9 ±5.0 | 157.9 ±7.8 | 16.1 ±0.80 | 116.5 ±5.8 |
| | M16 × 1.5 | 220.6 ±11.0 | 22.5 ±1.12 | 162.7 ±8.1 | 256.0 ±12.7 | 26.1 ±1.30 | 188.8 ±9.4 |
| | M20 × 1.5 | 452.1 ±22.6 | 46.1 ±2.30 | 333.4 ±16.6 | 524.7 ±26.1 | 53.5 ±2.66 | 387.0 ±19.2 |

1. General Tightening Points (Non-lubricated)
   - All securing points other than the special tightening points.

2. Special Tightening Points (Grease with molybdenum disulfide applied.)
   - Points where particularly necessary due to function.
     Special tightening positions and associated instructions are given in the text.

3. Points where thread-locking compound is used (Three Bond #1324 is applied.)
   Thread-locking compound positions and associated instructions are given in the text.

4. If tightening torque values are provided in this manual, then tightening should be done according to those values.
   (This indicates that the tightening torque differs from the values given in this table.)

5. In order to tighten bolts and nuts evenly, they should be tightened alternately top, bottom, left, right.

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# II . SPECIFICATIONS

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### In regard to Standard Values and Allowable Values

The terms used in the items “Servicing Standards” and “Standards for Judging Performance” have the following meanings.

Standard Value ..... This indicates the standard value for the new machine at the time of shipping from the factory. It should be used as the target value for maintenance work after operation.

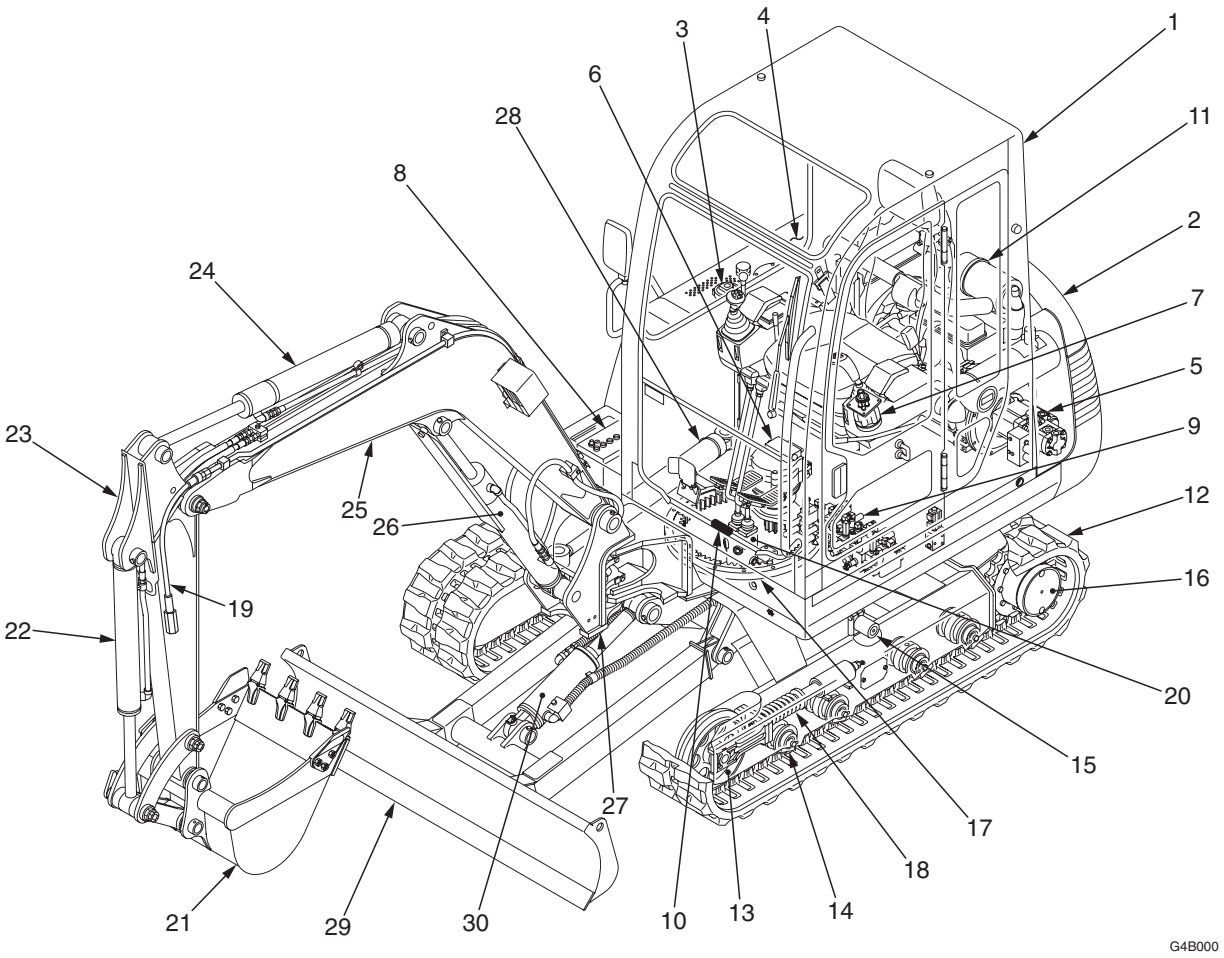
Allowable Value ..... The dimensions of parts change during use because of wear and deformation. Also, the performance of pumps, motors, and other hydraulic equipment drops, and this is the estimated value indicating the use limit for the respective part. It is decided under reference to the standard at the time of shipping, the results of various tests, etc. As the use conditions, the degree of repairs, etc., differ for each machine, these should be combined and used as reference for servicing standards and standards for judging performance.

* Do not use the standard values and the allowable values as standards for customer claims.

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## NAMES OF COMPONENTS




The above figure shows the components of the TB135.

1. Cab
2. Engine hood
3. Fuel tank
4. Hydraulic tank
5. Hydraulic pump
6. Slew motor
7. Pilot valve
8. Battery
9. Control valve
10. Lever lock cylinder
11. Engine
12. Crawler belt
13. Idler
14. Track roller
15. Carrier roller
16. Travel motor
17. Slew bearing
18. Track adjuster
19. Auxiliary line
20. Swivel joint
21. Bucket
22. Bucket cylinder
23. Arm
24. Arm cylinder
25. Boom
26. Boom cylinder
27. Swing bracket
28. Swing cylinder
29. Dozer blade
30. Dozer blade cylinder

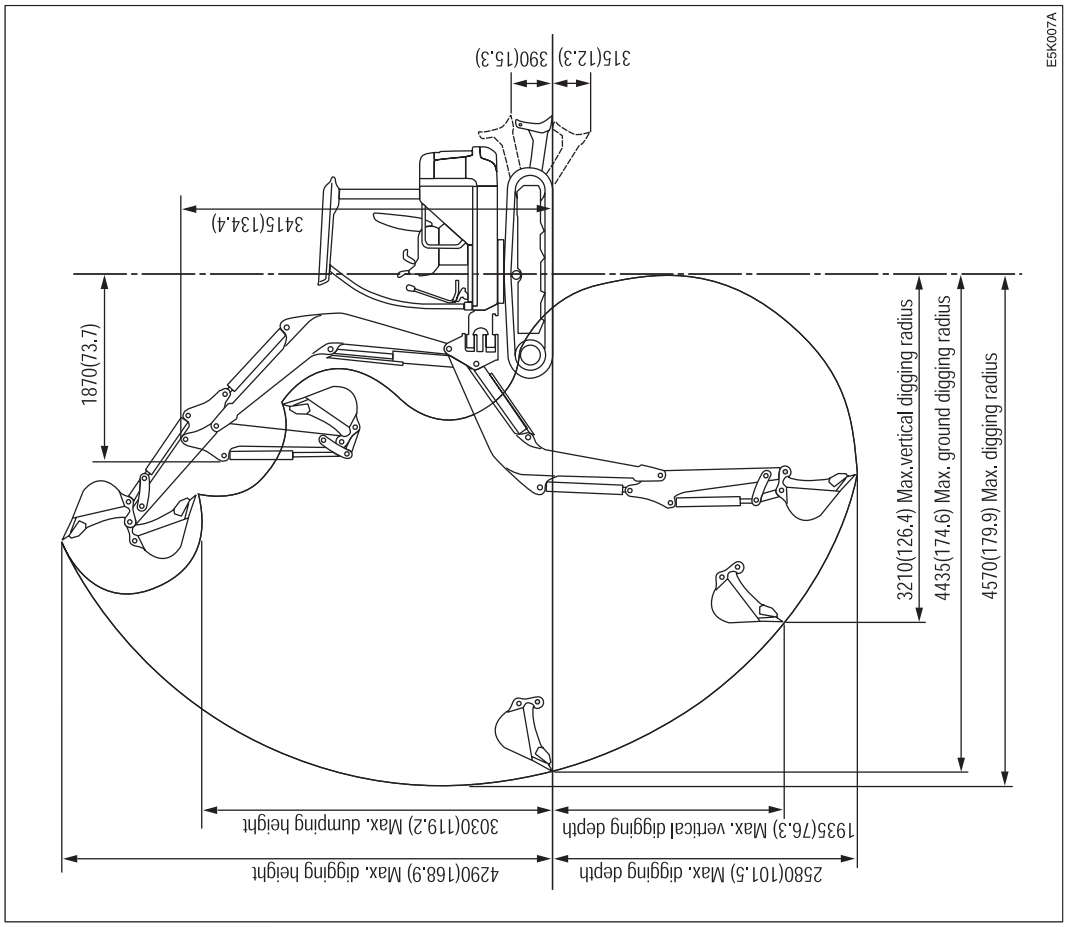
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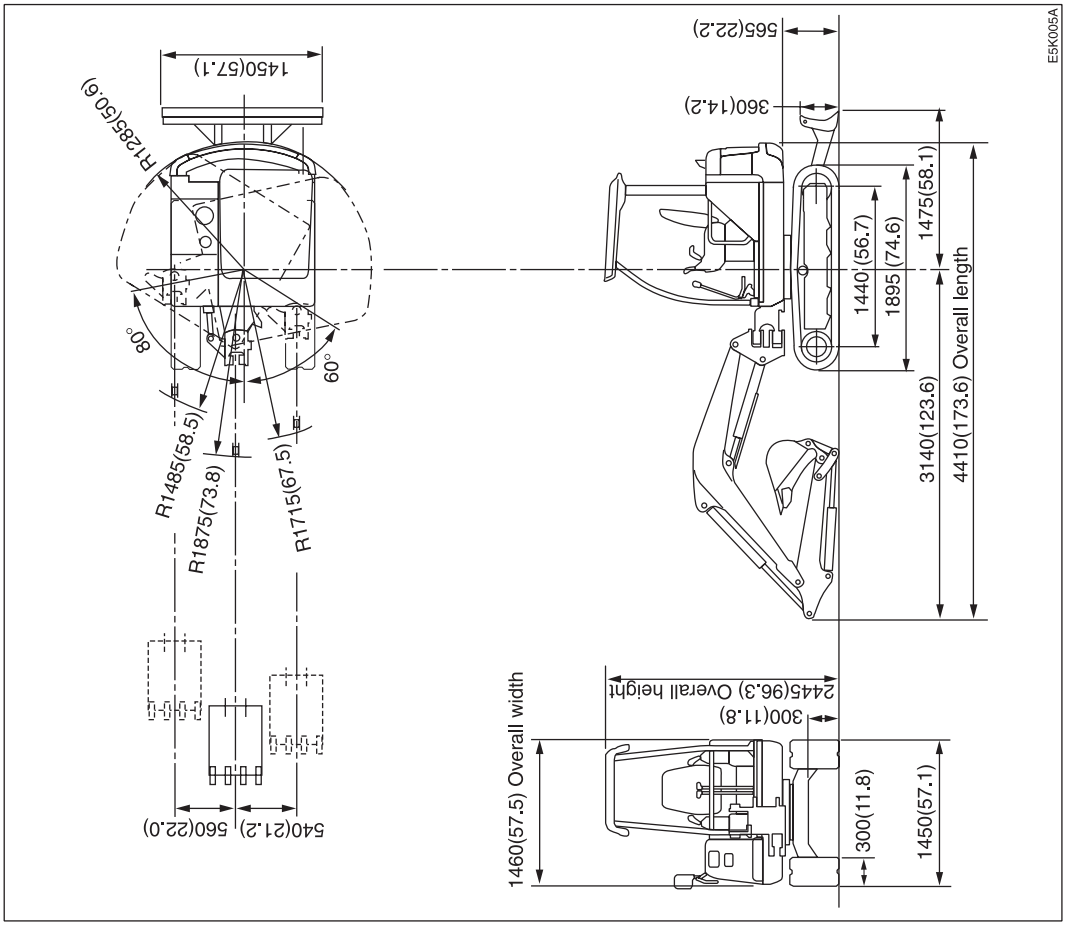


# DIMENSIONS

## ■ TB125
### Equipped with Canopy and Rubber Crawlers

Unit: mm (inches)



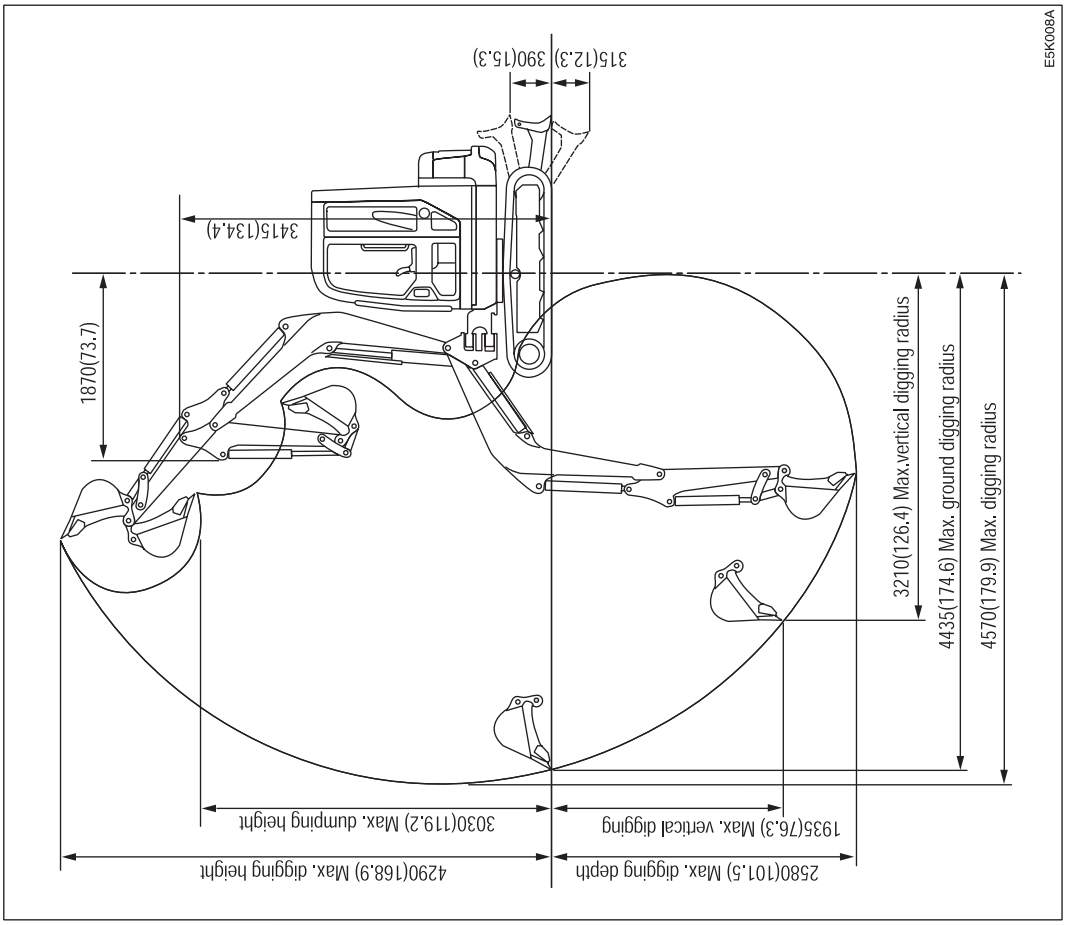



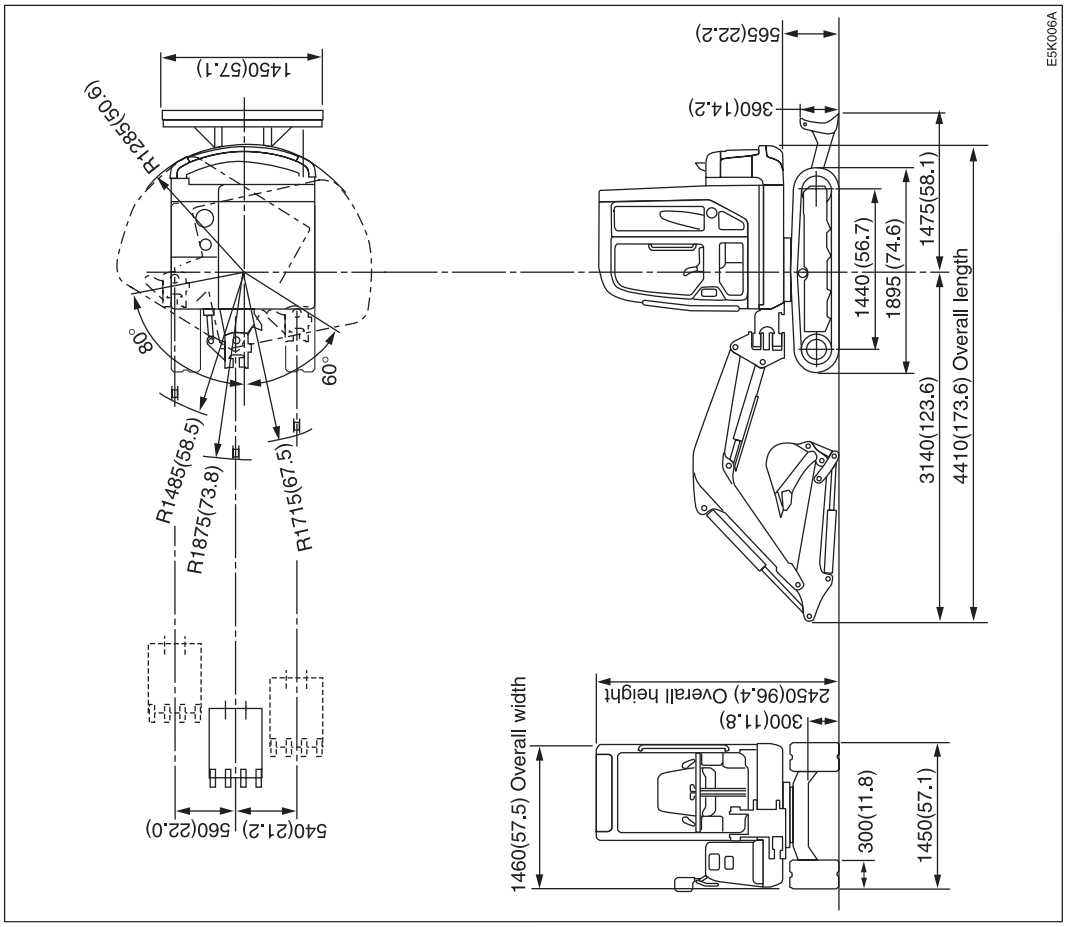
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Unit: mm (inches)

## ■ TB125
## Equipped with Cab and Rubber Crawlers



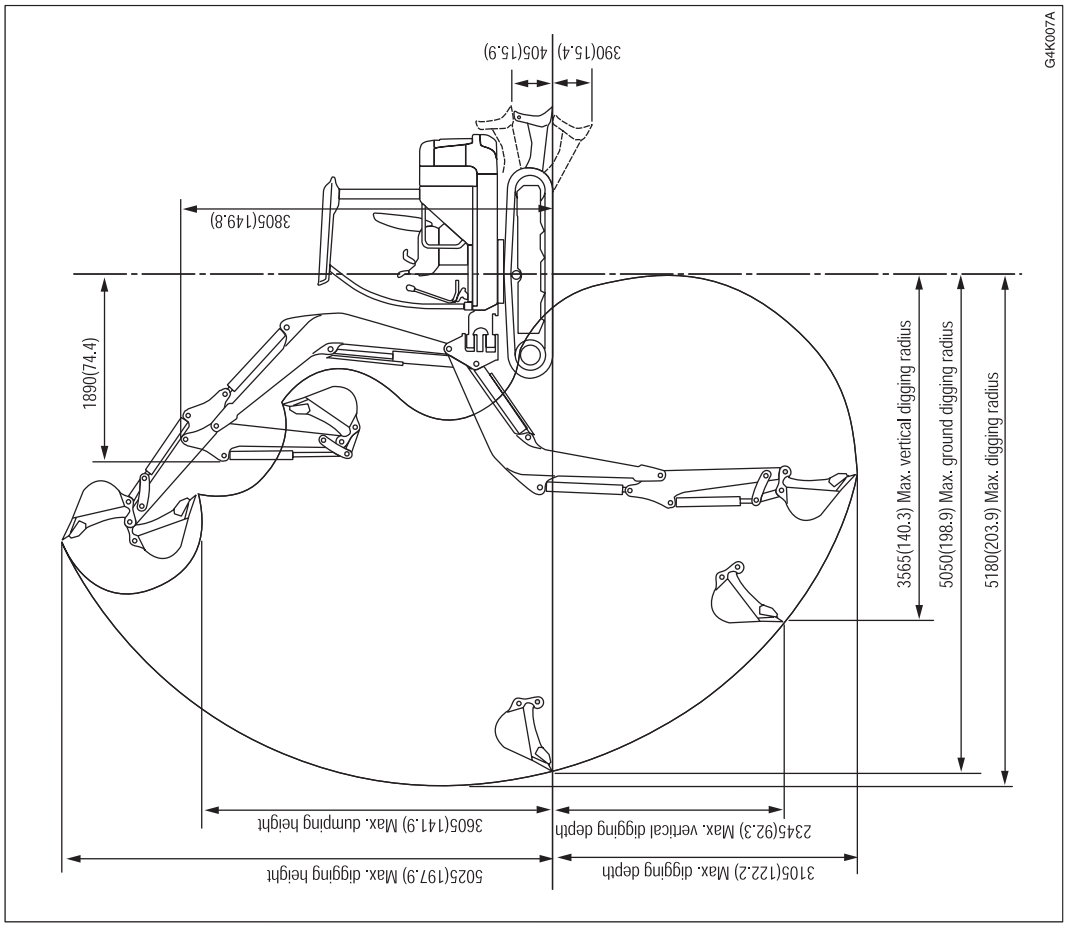



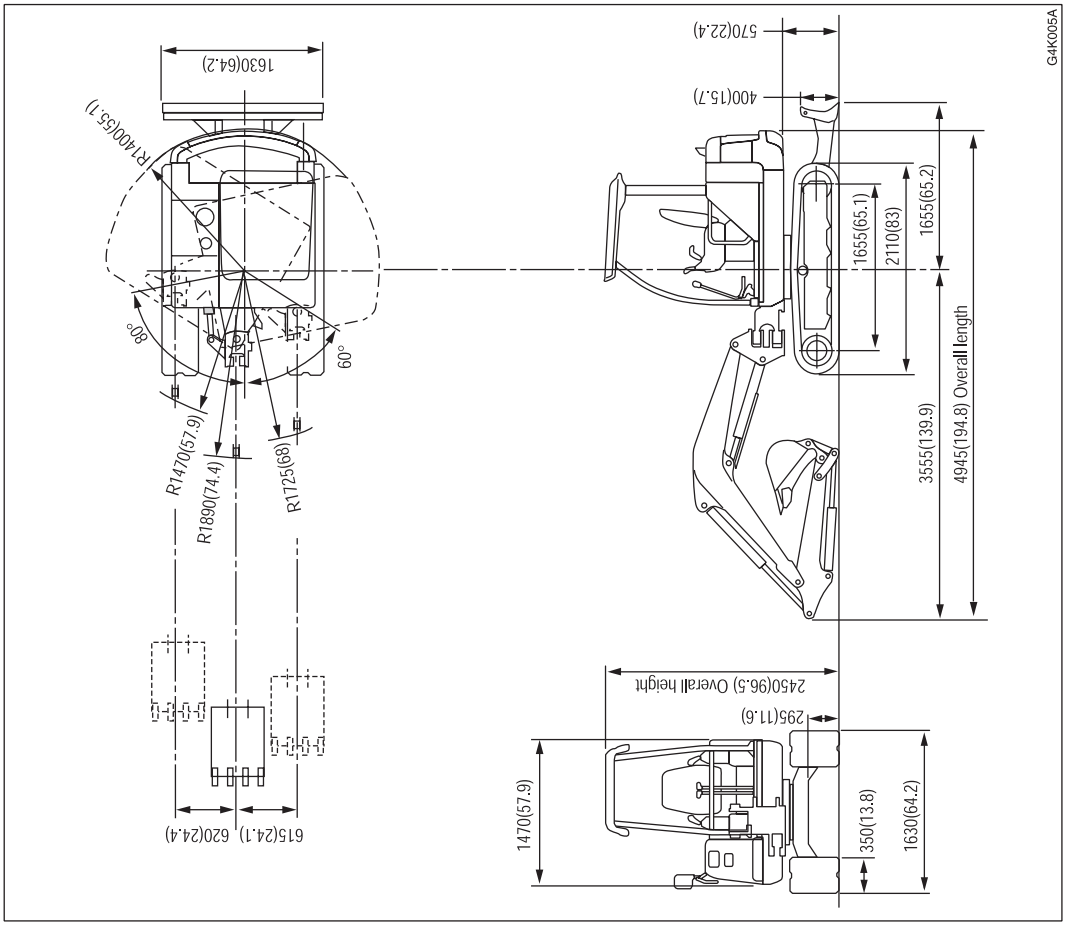
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Unit: mm (inches)

■ **TB135**
**Equipped with Canopy and Rubber Crawlers**



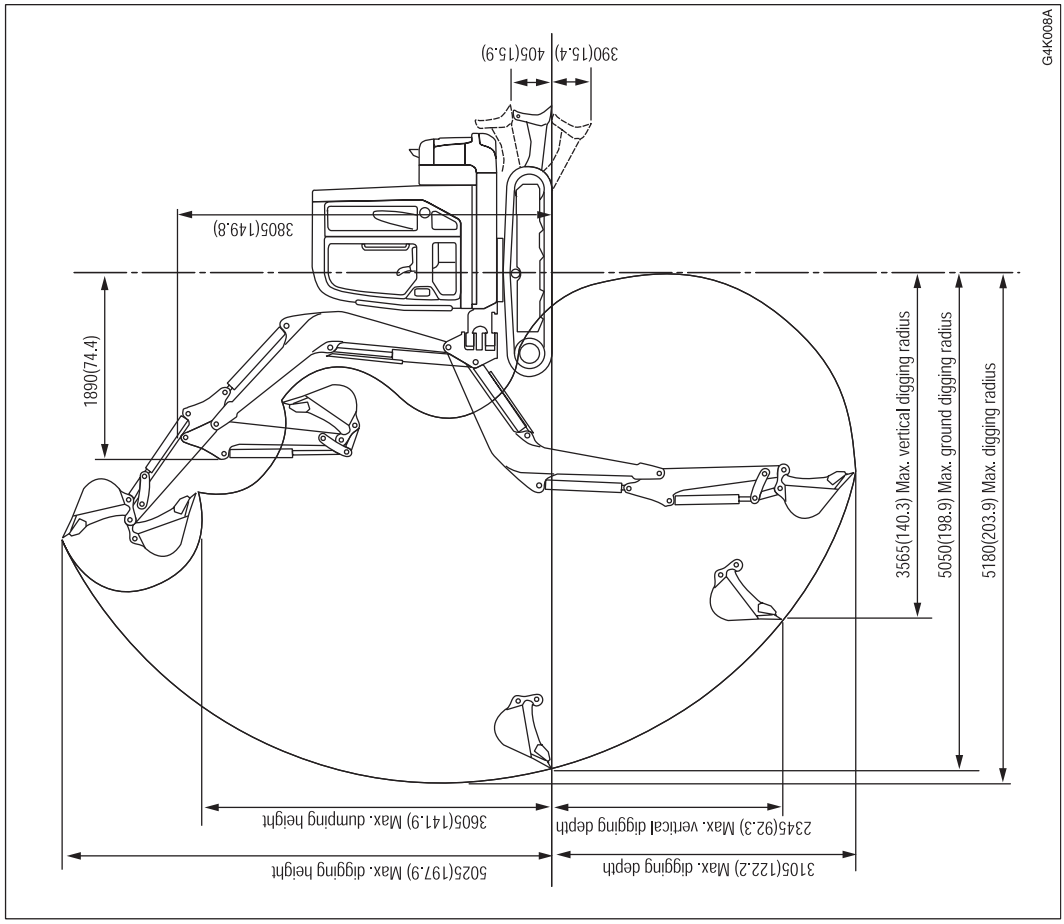



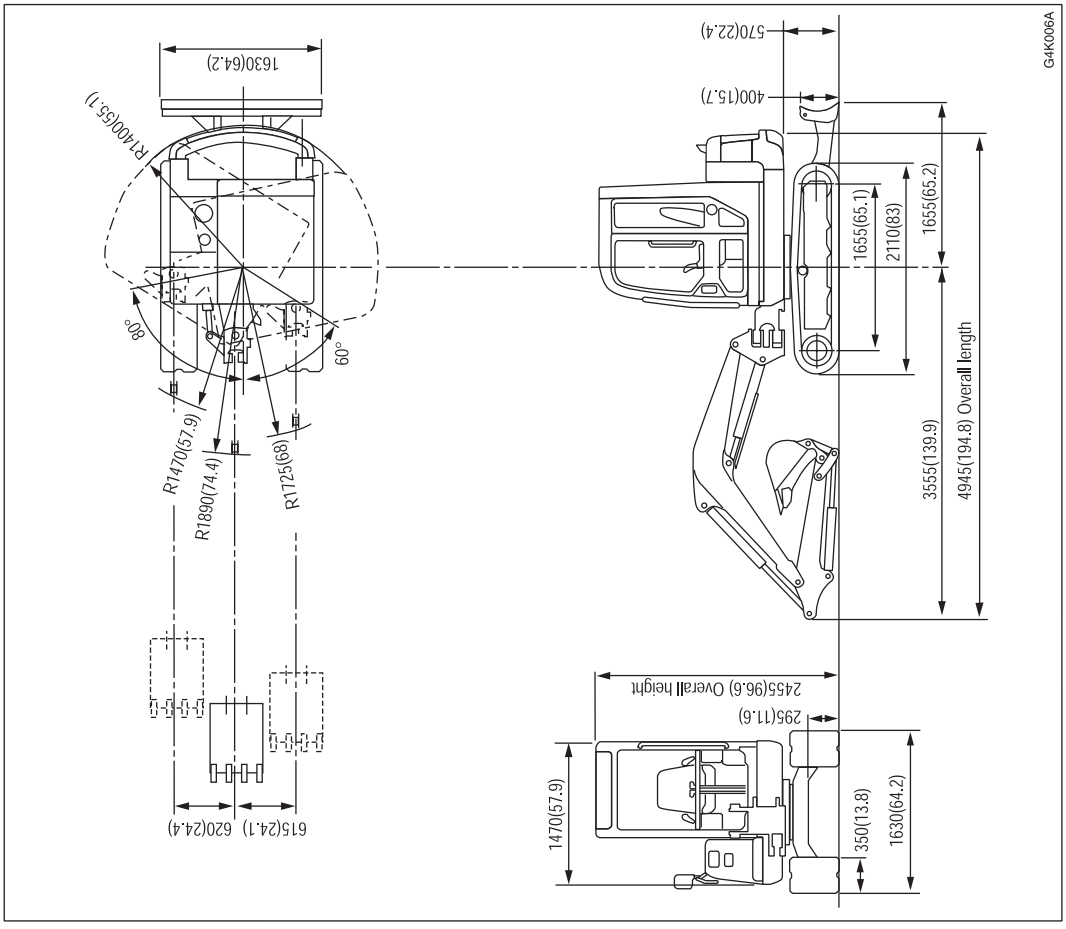
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Unit: mm (inches)

## ■ TB135
## Equipped with Cab and Rubber Crawlers



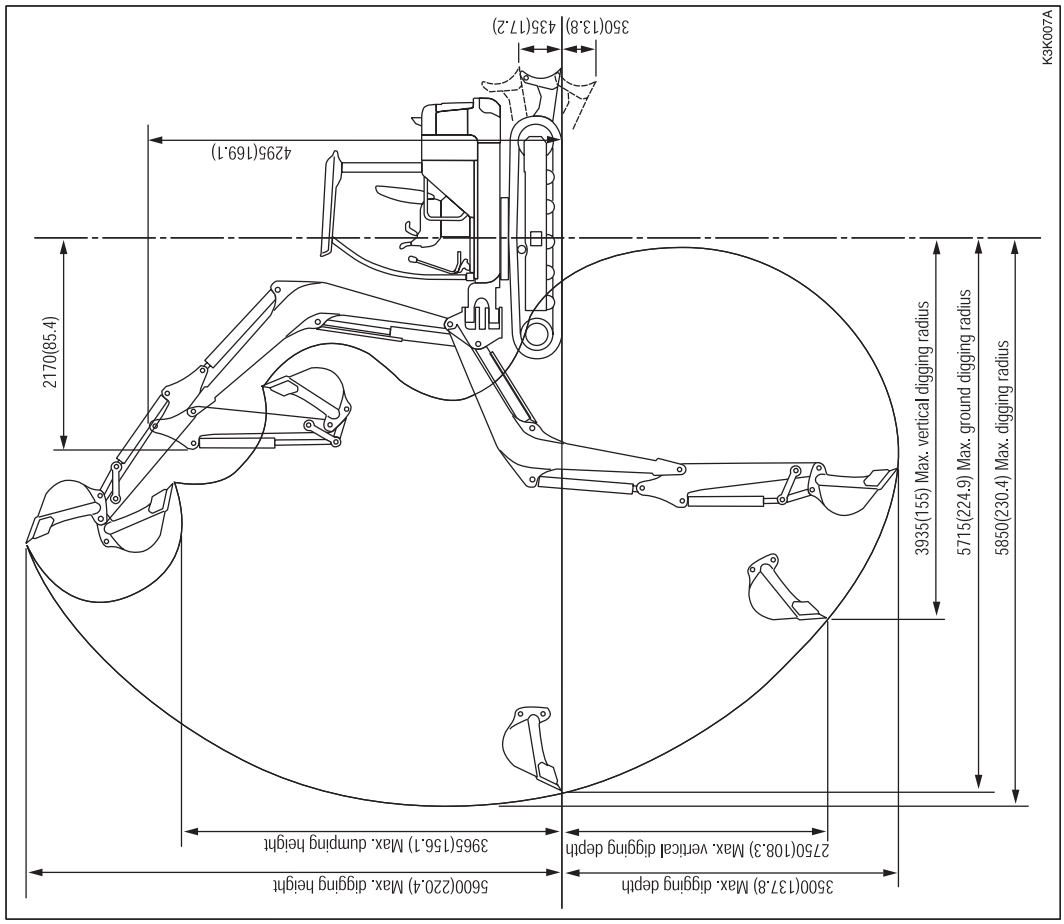



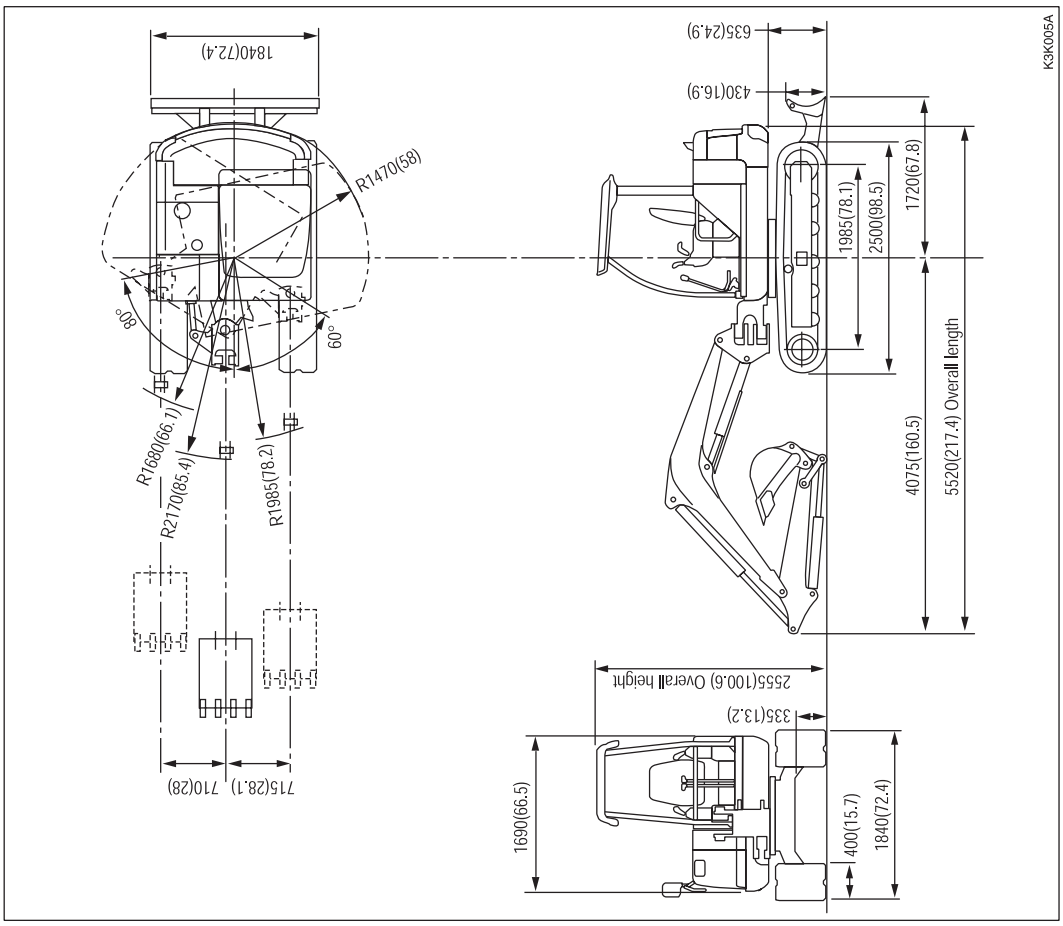
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Unit: mm (inches)

■ **TB145**
**Equipped with Canopy and Rubber Crawlers**



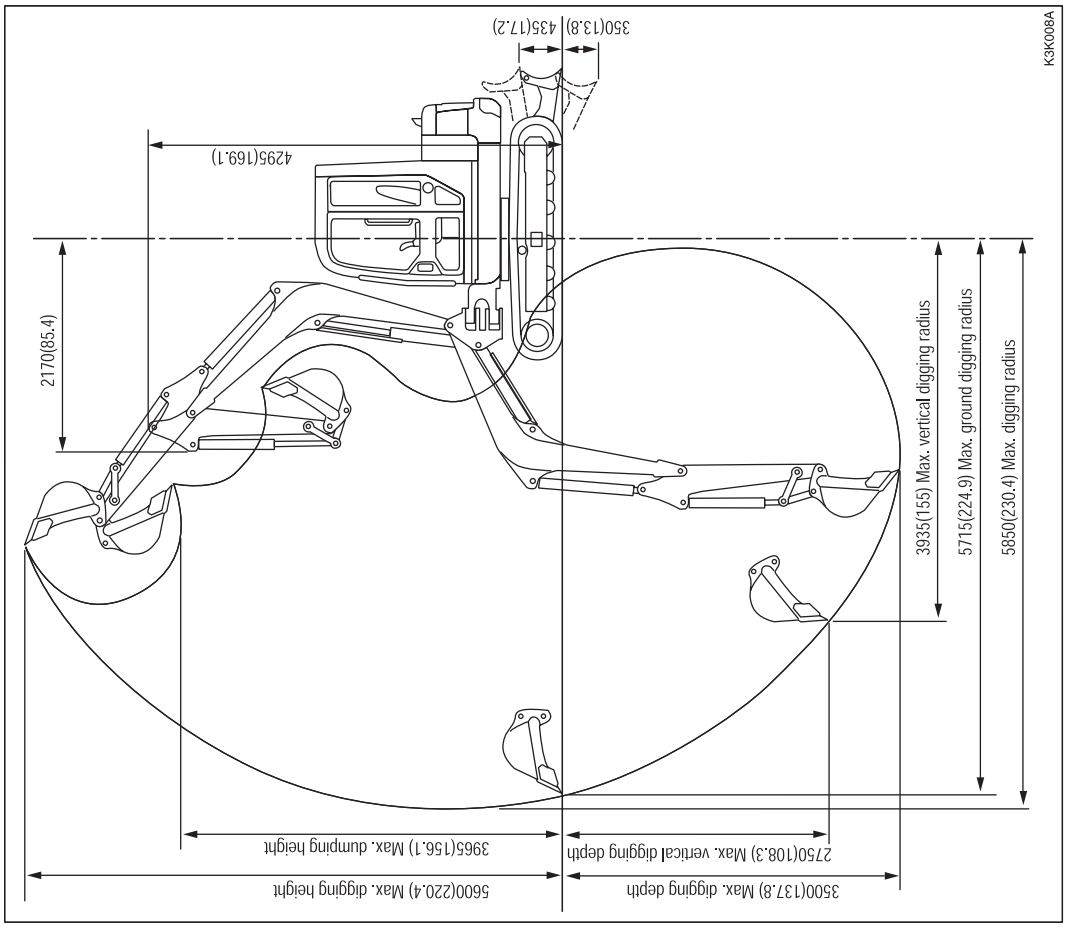



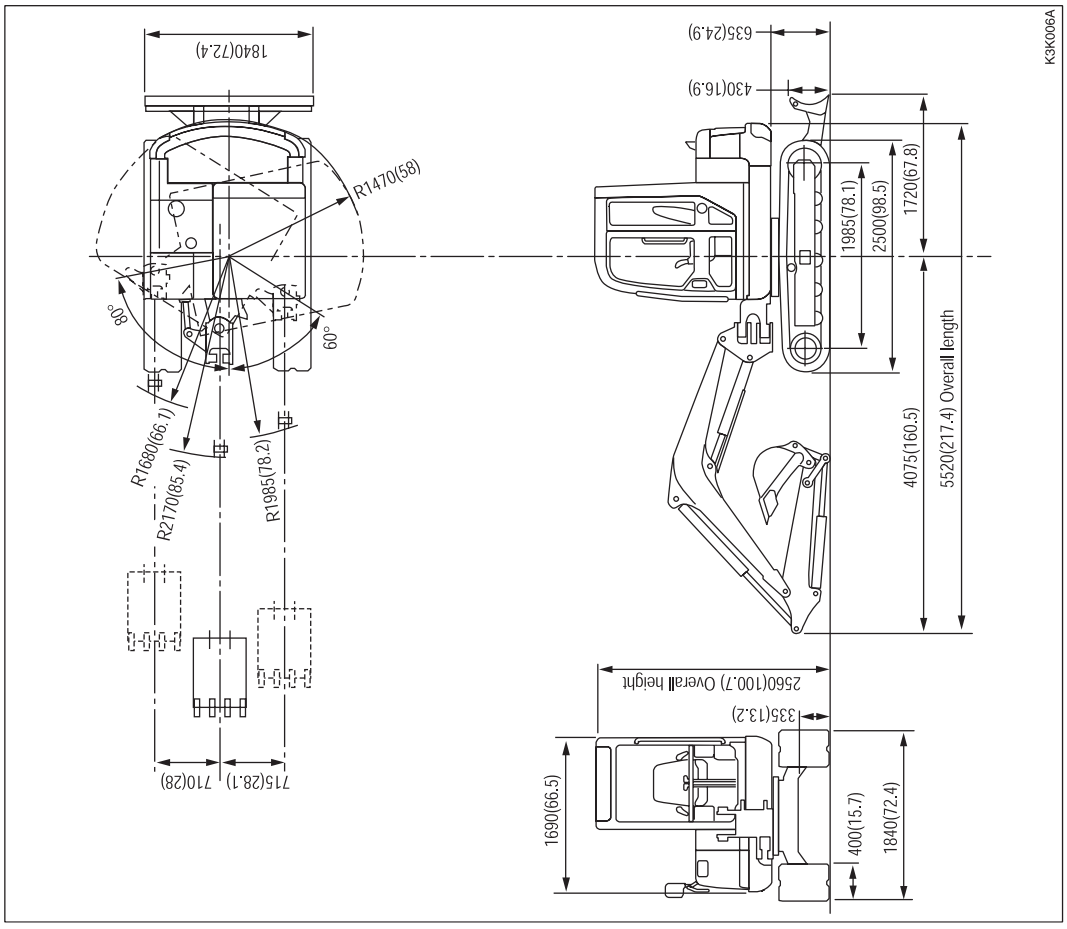
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Unit: mm (inches)

■ **TB145**
**Equipped with Cab and Rubber Crawlers**

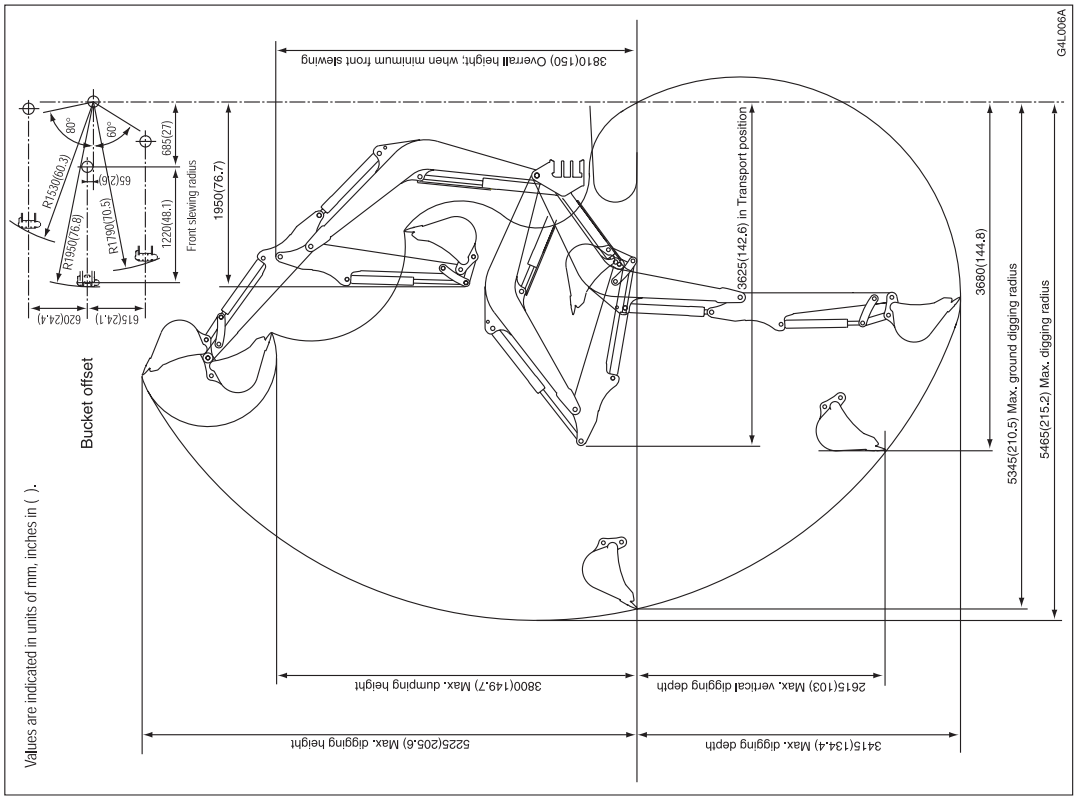


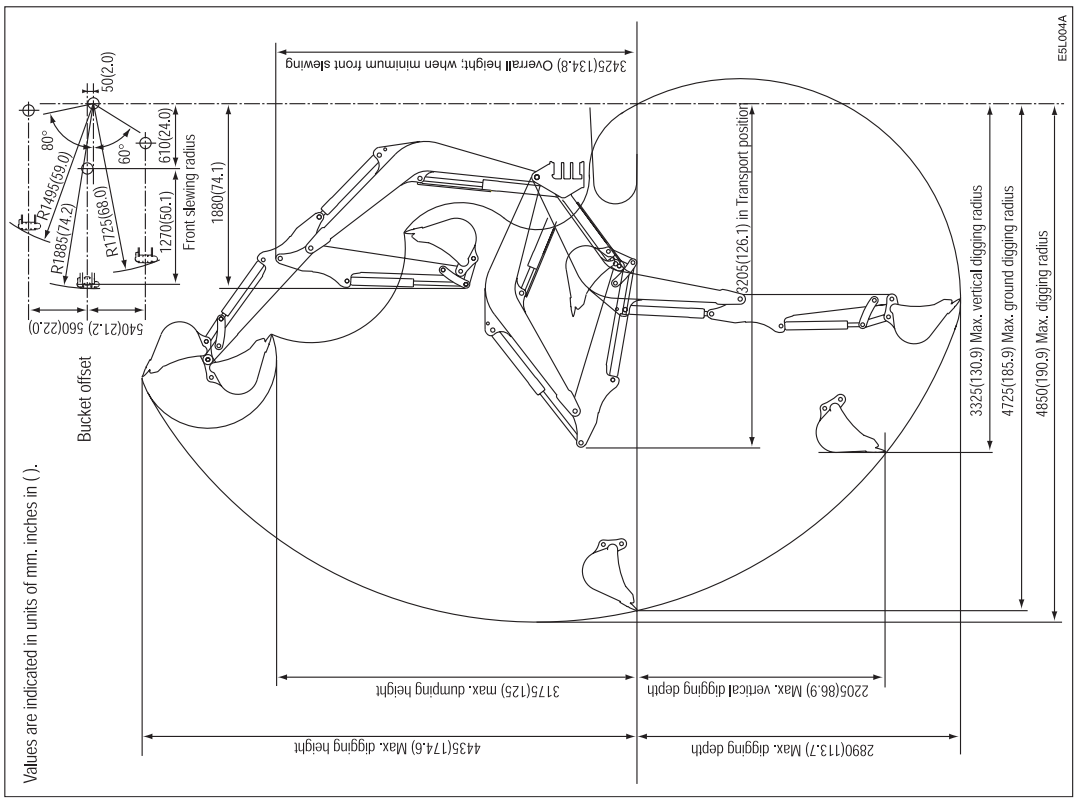
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## ■ TB135 Long Arm



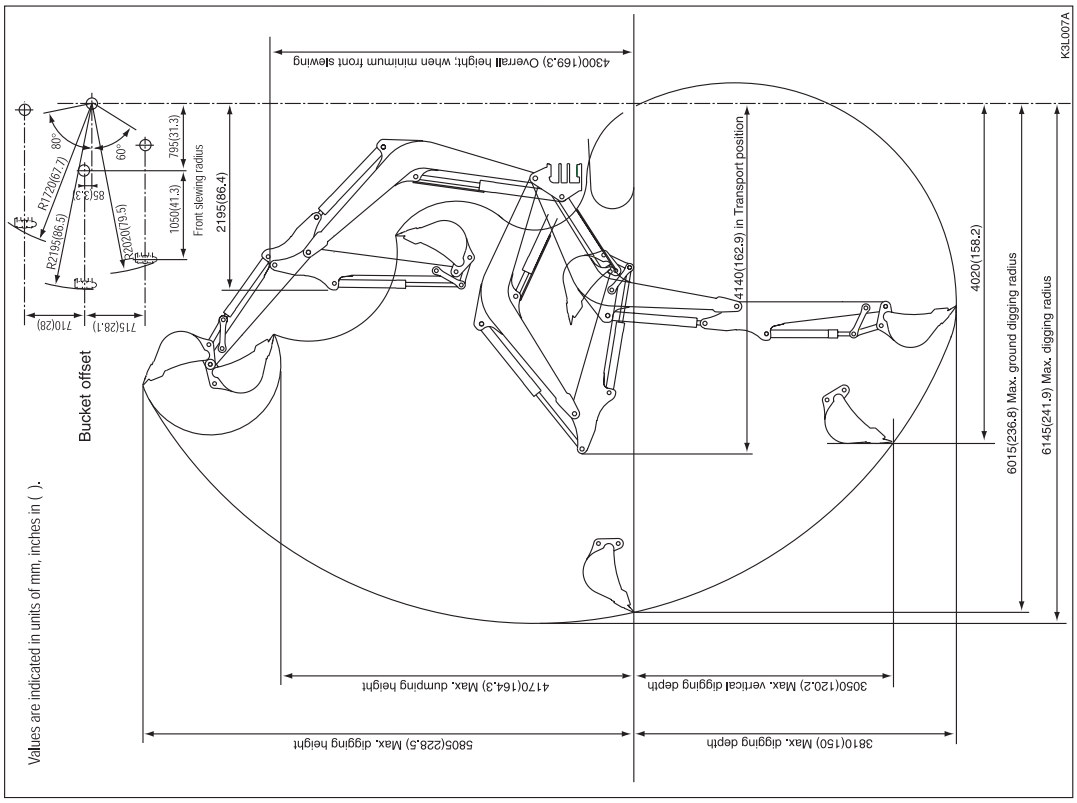

## ■ TB125 Long Arm



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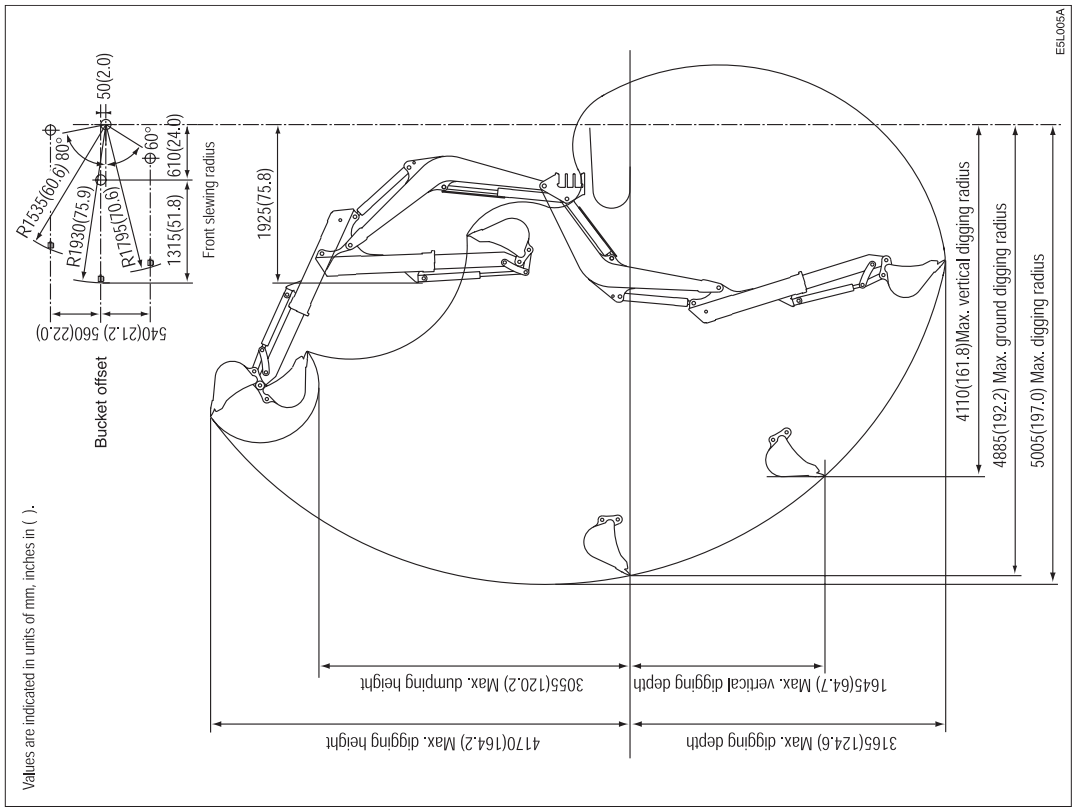
■ **TB145**
**Long Arm**



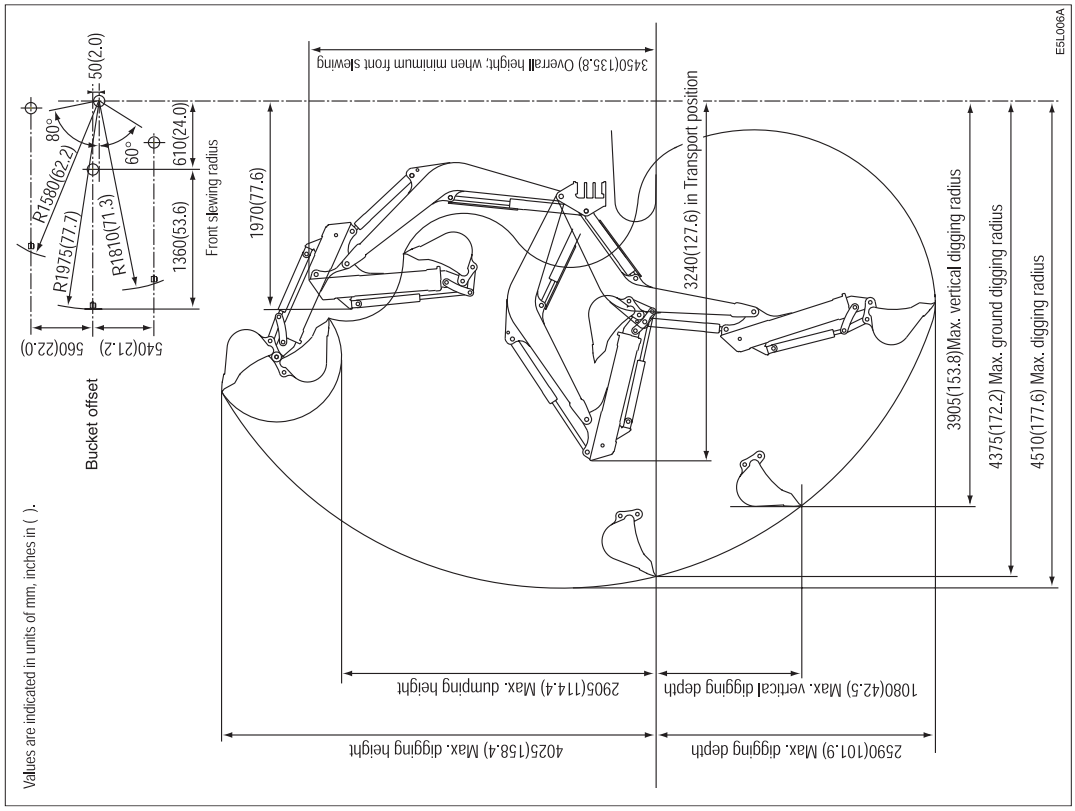
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## ■ TB125
## Telescopic Arm (Fully Extended)



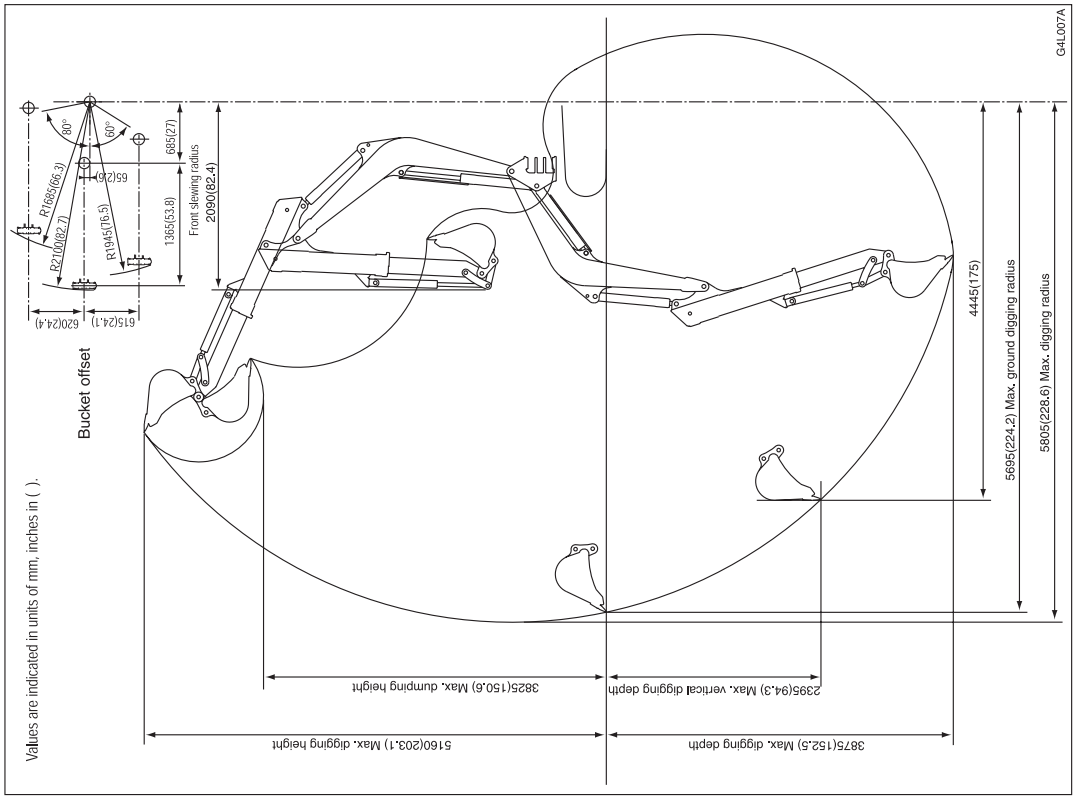

## Telescopic Arm (Fully Retracted)



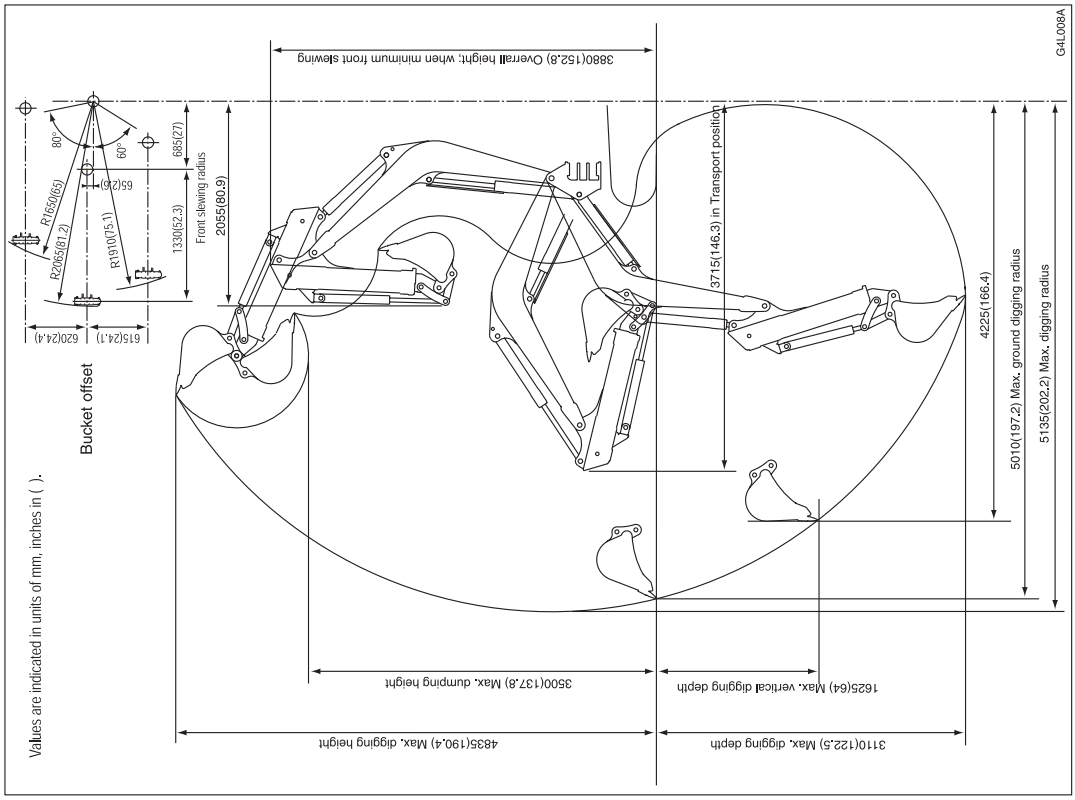
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## ■ TB135
## Telescopic Arm (Fully Extended)




## Telescopic Arm (Fully Retracted)

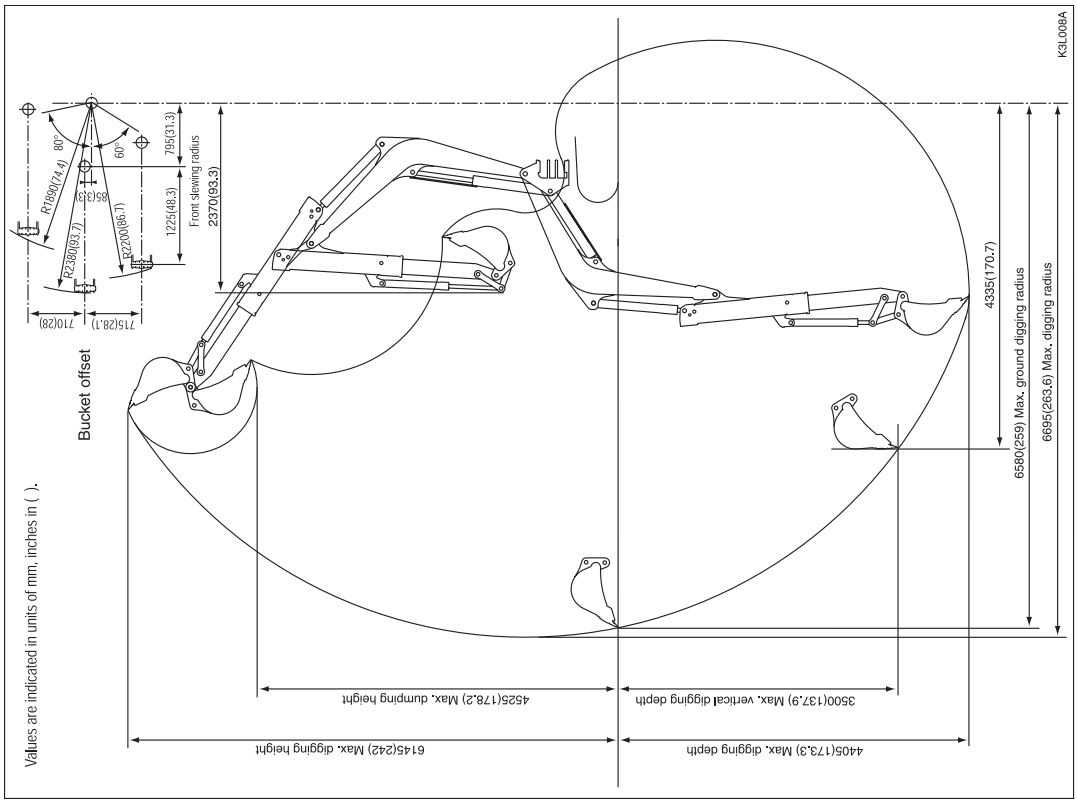


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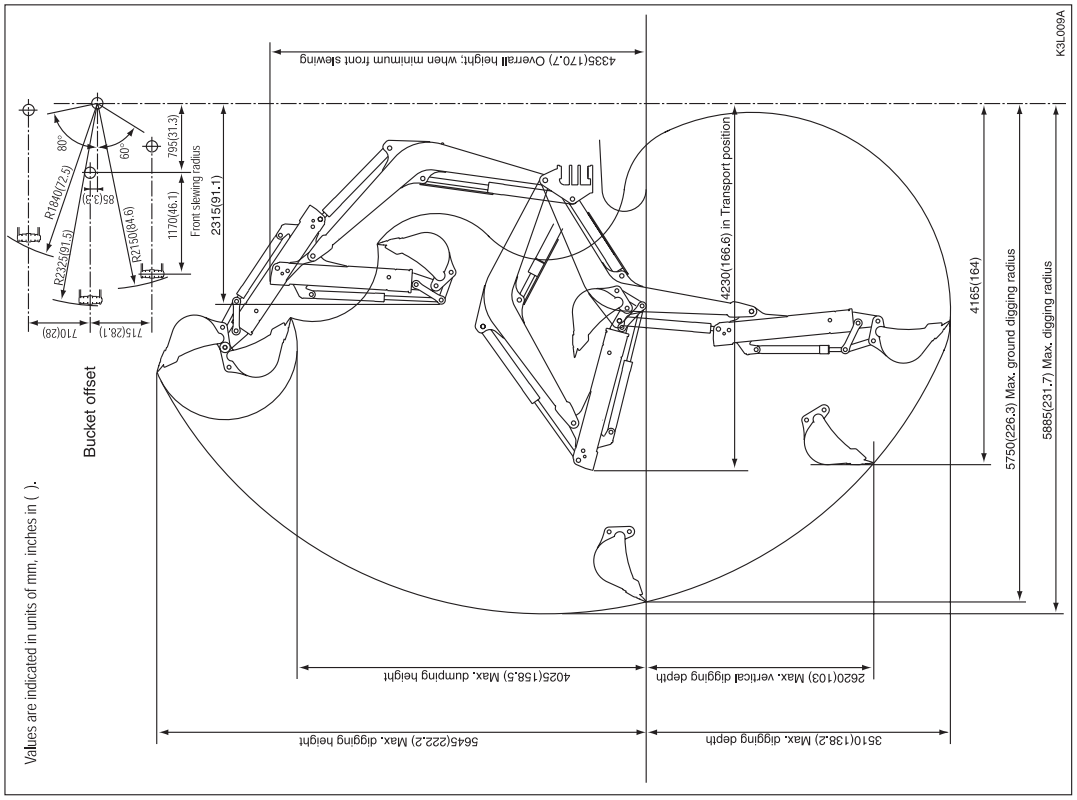


## ■ TB145

### Telescopic Arm (Fully Extended)




### Telescopic Arm (Fully Retracted)



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# SPECIFICATION TABLES

## SPECIFICATIONS

| Machine Model | | TB125 | | | |
|---|---|---|---|---|---|
| Serial Number | | 12510003~12514525 | | 12514526~ | |
| Machine Type | | Canopy | Cab | Canopy | Cab |
| Machine Mass (not including operator) | | | | | |
| Rubber Crawler | kg | 2675 | 2790 | 2675 | 2790 |
| Steel Crawler | kg | 2735 | 2850 | 2735 | 2850 |
| Engine Rated Output | kW/min$^{-1}$ | 16.8/2300 | ← | ← | ← |
| Bucket Capacity (Standard Bucket) | | | | | |
| Rated Capacity | m$^3$ | 0.068 | ← | ← | ← |
| Struck Capacity | m$^3$ | 0.051 | ← | ← | ← |
| Performance | | | | | |
| Slew Speed | min$^{-1}$ | 9.6 | ← | ← | ← |
| Travel Speed: Rubber Crawler 1st / 2nd | km/h | 2.7/4.8 | ← | ← | ← |
| Steel Crawler 1st / 2nd | km/h | 2.6/4.7 | ← | ← | ← |
| Gradeability | % (degree) | 58 (30) | ← | ← | ← |
| Ground Pressure: Rubber Crawler | kPa | 28.1 | 29.3 | 28.1 | 29.3 |
| Steel Crawler | kPa | 29.4 | 30.7 | 29.4 | 30.7 |
| Noise Level: Sound-power level | dB (A) | $L_{WA}$94 | ← | $L_{WA}$93 | ← |
| Sound-pressure level | dB (A) | $L_{PA}$78 | $L_{PA}$77 | $L_{PA}$74 | ← |
| Auxiliary Hydraulic Flow Rate | L/min | 48.8 | ← | ← | ← |
| Dimensions | | | | | |
| Overall Length in Transport Position | mm | 4410 | ← | ← | ← |
| Overall Width | mm | 1460 | ← | ← | ← |
| Overall Height | mm | 2445 | 2450 | 2445 | 2450 |
| Dimensions of Base Machine | | | | | |
| Tail Swing Radius | mm | 1285 | ← | ← | ← |
| Distance of Rearmost Upper Structure from Axis of Rotation | mm | 1270 | ← | ← | ← |
| Clearance Height under Upperstructure | mm | 565 | ← | ← | ← |
| Crawler Base | mm | 1440 | ← | ← | ← |
| Crawler: Overall Length | mm | 1895 | ← | ← | ← |
| Overall Width | mm | 1450 | ← | ← | ← |
| Crawler Shoe Width | mm | 300 | ← | ← | ← |
| Minimum Ground Clearance | mm | 300 | ← | ← | ← |

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| Machine Model | | TB135 | | | | | |
|---|---|---|---|---|---|---|---|
| Serial Number | | 13510004~13510348 | | 13510349~13514050 | | 13514051~ | |
| Machine Type | | Canopy | Cab | Canopy | Cab | Canopy | Cab |
| Machine Mass (not including operator) | | | | | | | |
| Rubber Crawler | kg | 3340 | 3430 | 3340 | 3430 | 3340 | 3430 |
| Steel Crawler | kg | 3440 | 3530 | 3440 | 3530 | 3440 | 3530 |
| Engine Rated Output | kW/min$^{-1}$ | 20.7/2300 | ← | ← | ← | 20.9/2300 | ← |
| Bucket Capacity (Standard Bucket) | | | | | | | |
| Rated Capacity | m$^3$ | 0.105 | ← | ← | ← | ← | ← |
| Struck Capacity | m$^3$ | 0.078 | ← | ← | ← | ← | ← |
| Performance | | | | | | | |
| Slew Speed | min$^{-1}$ | 9.2 | ← | ← | ← | ← | ← |
| Travel Speed: Rubber Crawler 1st / 2nd | km/h | 2.7/4.8 | ← | 2.5/4.6 | ← | ← | ← |
| Steel Crawler 1st / 2nd | km/h | 2.6/4.7 | ← | 2.4/4.5 | ← | ← | ← |
| Gradeability | % (degree) | 58 (30) | ← | ← | ← | ← | ← |
| Ground Pressure: Rubber Crawler | kPa | 26.4 | 27.1 | 26.4 | 27.1 | 26.4 | 27.1 |
| Steel Crawler | kPa | 27.9 | 28.6 | 27.9 | 28.6 | 27.9 | 28.6 |
| Noise Level: Sound-power level | dB (A) | $L_{WA}$96 | ← | ← | ← | ← | ← |
| Sound-pressure level | dB (A) | $L_{PA}$78 | $L_{PA}$75 | $L_{PA}$78 | $L_{PA}$75 | $L_{PA}$80 | ← |
| Auxiliary Hydraulic Flow Rate | L/min | 59.2 | ← | ← | ← | ← | ← |
| Dimensions | | | | | | | |
| Overall Length in Transport Position | mm | 4945 | ← | ← | ← | ← | ← |
| Overall Width | mm | 1630 | ← | ← | ← | ← | ← |
| Overall Height | mm | 2450 | 2455 | 2450 | 2455 | 2450 | 2455 |
| Dimensions of Base Machine | | | | | | | |
| Tail Swing Radius | mm | 1400 | ← | ← | ← | ← | ← |
| Distance of Rearmost Upper Structure from Axis of Rotation | mm | 1395 | ← | ← | ← | ← | ← |
| Clearance Height under Upperstructure | mm | 570 | ← | ← | ← | ← | ← |
| Crawler Base | mm | 1655 | ← | ← | ← | ← | ← |
| Crawler: Overall Length | mm | 2110 | ← | ← | ← | ← | ← |
| Overall Width | mm | 1630 | ← | ← | ← | ← | ← |
| Crawler Shoe Width | mm | 350 | ← | ← | ← | ← | ← |
| Minimum Ground Clearance | mm | 295 | ← | ← | ← | ← | ← |

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| Machine Model | | TB145 | | | | | |
|---|---|---|---|---|---|---|---|
| Serial Number | | 14510004~14512498 | | 14512499~14513260 | | 14513261~ | |
| Machine Type | | Canopy | Cab | Canopy | Cab | Canopy | Cab |
| Machine Mass (not including operator) | | | | | | | |
| Rubber Crawler | kg | 4650 | 4740 | 4650 | 4740 | 4650 | 4740 |
| Steel Crawler | kg | 4735 | 4825 | 4735 | 4825 | 4735 | 4825 |
| Engine Rated Output | kW/min$^{-1}$ | 27.9/2300 | ← | ← | ← | 27.3/2300 | ← |
| Bucket Capacity (Standard Bucket) | | | | | | | |
| Rated Capacity | m$^3$ | 0.141 | ← | ← | ← | ← | ← |
| Struck Capacity | m$^3$ | 0.102 | ← | ← | ← | ← | ← |
| Performance | | | | | | | |
| Slew Speed | min$^{-1}$ | 9.9 | ← | ← | ← | 9.7 | ← |
| Travel Speed: Rubber Crawler 1st / 2nd | km/h | 3.0/5.2 | ← | 2.8/4.7 | ← | ← | ← |
| Steel Crawler 1st / 2nd | km/h | 2.8/4.8 | ← | 2.6/4.3 | ← | ← | ← |
| Gradeability | % (degree) | 58 (30) | ← | ← | ← | ← | ← |
| Ground Pressure: Rubber Crawler | kPa | 26.8 | 27.3 | 26.8 | 27.3 | 26.8 | 27.3 |
| Steel Crawler | kPa | 29.8 | 30.3 | 29.8 | 30.3 | 29.8 | 30.3 |
| Noise Level: Sound-power level | dB (A) | LWA97 | ← | ← | ← | ← | ← |
| Sound-pressure level | dB (A) | LPA79 | LPA78 | LPA79 | LPA78 | LPA82 | ← |
| Auxiliary Hydraulic Flow Rate | L/min | 55.9 | ← | ← | ← | ← | ← |
| Dimensions | | | | | | | |
| Overall Length in Transport Position | mm | 5520 | ← | ← | ← | ← | ← |
| Overall Width | mm | 1840 | ← | ← | ← | ← | ← |
| Overall Height | mm | 2555 | 2560 | 2555 | 2560 | 2555 | 2560 |
| Dimensions of Base Machine | | | | | | | |
| Tail Swing Radius | mm | 1470 | ← | ← | ← | ← | ← |
| Distance of Rearmost Upper Structure from Axis of Rotation | mm | 1445 | ← | ← | ← | ← | ← |
| Clearance Height under Upperstructure | mm | 635 | ← | ← | ← | ← | ← |
| Crawler Base | mm | 1985 | ← | ← | ← | ← | ← |
| Crawler: Overall Length | mm | 2500 | ← | ← | ← | ← | ← |
| Overall Width | mm | 1840 | ← | ← | ← | ← | ← |
| Crawler Shoe Width | mm | 400 | ← | ← | ← | ← | ← |
| Minimum Ground Clearance | mm | 335 | ← | ← | ← | ← | ← |

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| Machine Model | | TB125 | | TB135 | | TB145 | |
|---|---|---|---|---|---|---|---|
| Serial Number | | 12510003~ | | 13510004~ | | 14510004~ | |
| Machine Type | | Canopy | Cab | Canopy | Cab | Canopy | Cab |
| Working Equipment (Hoe Attachment) | | | | | | | |
| Boom Swing Angle: L.H. | degree | 80 | ← | ← | ← | ← | ← |
| R.H. | degree | 60 | ← | ← | ← | ← | ← |
| Maximum Reach | mm | 4570 | ← | 5180 | ← | 5850 | ← |
| Maximum Reach at GRP | mm | 4435 | ← | 5050 | ← | 5715 | ← |
| Minimum Level Cut Radius with Bucket Flat on GRP | mm | 1400 | ← | 1655 | ← | 1845 | ← |
| Maximum Digging Depth | mm | 2580 | ← | 3105 | ← | 3500 | ← |
| Radius at Maximum Digging Depth | mm | 1990 | ← | 2060 | ← | 2400 | ← |
| Vertical Digging Depth | mm | 1935 | ← | 2345 | ← | 2750 | ← |
| Maximum Digging Height | mm | 4290 | ← | 5025 | ← | 5600 | ← |
| Radius at Maximum Digging Height | mm | 2785 | ← | 2650 | ← | 3095 | ← |
| Maximum Dumping Height | mm | 3030 | ← | 3605 | ← | 3965 | ← |
| Radius at Maximum Dumping Height | mm | 2510 | ← | 2460 | ← | 2850 | ← |
| Minimum Dumping Height | mm | 1275 | ← | 1440 | ← | 1570 | ← |
| Minimum Front Swing Radius | mm | 1875 | ← | 1890 | ← | 2170 | ← |
| Minimum Front Swing Radius at Boom Offset | mm | 1485 | ← | 1470 | ← | 1680 | ← |
| Overall Height at Minimum Front Swing Radius | mm | 3415 | ← | 3805 | ← | 4295 | ← |
| Overall Height at Minimum Front Swing Radius at Boom Offset | mm | 3415 | ← | 3805 | ← | 4295 | ← |
| Maximum Bucket Offset Volume: Left | mm | 540 | ← | 615 | ← | 715 | ← |
| Right | mm | 560 | ← | 620 | ← | 710 | ← |
| Digging Force: Bucket | kN | 20.6 | ← | 26.5 | ← | 36.5 | ← |
| Arm | kN | 14.7 | ← | 18 | ← | 24.3 | ← |
| Working Equipment (Dozer Blade) | | | | | | | |
| Dozer Blade: Width | mm | 1450 | ← | 1630 | ← | 1840 | ← |
| Height | mm | 360 | ← | 400 | ← | 430 | ← |
| Dozer Blade: | | | | | | | |
| Maximum Lifting Range above Ground Level | mm | 390 | ← | 405 | ← | 435 | ← |
| Maximum Lowering Range below Ground Level | mm | 315 | ← | 390 | ← | 350 | ← |

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## SPECIFICATIONS OF DEVICES

| Machine Model | | TB125 | | TB135 | | TB145 | |
|---|---|---|---|---|---|---|---|
| Serial Number | | 12510003~ 12510451 | 12510452~ 12514525 | 13510004~ 13510183 | 13510184~ 13514050 | 14510004~ 14510108 | 14510109~ 14513260 |
| Engine | | | | | | | |
| Manufacturer | | Yanmar | ← | ← | ← | ← | ← |
| Model: Canopy | | 3TNE82A-TB | 3TNE82A-ETB | 3TNE88-TB1 | 3TNE88-ETB1 | 4TNE88-TB1 | 4TNE88-ETB1 |
| Cab | | 3TNE82A-TB | 3TNE82A-ETB | 3TNE88-TB | 3TNE88-ETB | 4TNE88-TB | 4TNE88-ETB |
| Type | | 4-cycle, vertical, water-cooled, in-line, 3-cylinder diesel engine | | 4-cycle, vertical, water-cooled, in-line, 3-cylinder diesel engine | | 4-cycle, vertical, water-cooled, in-line, 4-cylinder diesel engine | |
| No. of Cylinders – Bore × Stroke | mm | 3 – 82 × 84 | | 3 – 88 × 90 | | 4 – 88 × 90 | |
| Maximum Torque | N·m | 80~84 | | 99~107 | | 133~145 | |
| Total Displacement | L | 1.331 | | 1.642 | | 2.190 | |
| Compression Ratio | | 18.0 : 1 | | ← | | ← | |
| Specific Fuel Consumption | g/kW·h | ≤238 | | ≤245 | | ← | |
| Maximum No-load R.P.M. | $min^{-1}$ | 2480 ±25 | | ← | | ← | |
| Minimum No-load R.P.M. | $min^{-1}$ | 1100 ±25 | | 1150 ±25 | | ← | |
| Starter Output | V – kW | 12 – 2.0 | | ← | | 12 – 2.3 | |
| Alternator Output | V – kW | 12 – 0.48 | | ← | | ← | |
| Battery | | | | | | | |
| Type | | 95D31R | | ← | | 130E41R | |
| Capacity | V – A·h | 12 – 64 (5HR) | | ← | | 12 – 92 (5HR) | |
| Serial Number | | 12514526~ | | 13514051~ | | 14513261~ | |
| Engine | | | | | | | |
| Manufacturer | | Yanmar | | ← | | ← | |
| Model: Canopy | | 3TNV82A-QTB1 | | 3TNV88-QTB1 | | 4TNV88-QTB1 | |
| Cab (w/Air Conditioner) | | 3TNV82A-QTB | | 3TNV88-QTB (2) | | 4TNV88-QTB | |
| Type | | 4-cycle, vertical, water-cooled, in-line, 3-cylinder diesel engine | | 4-cycle, vertical, water-cooled, in-line, 3-cylinder diesel engine | | 4-cycle, vertical, water-cooled, in-line, 4-cylinder diesel engine | |
| No. of Cylinders – Bore × Stroke | mm | 3 – 82 × 84 | | 3 – 88 × 90 | | 4 – 88 × 90 | |
| Maximum Torque | $N·m/min^{-1}$ | 85.2/1380 | | 104.9/1380 ±100 | | 138.3/1380 | |
| Total Displacement | L | 1.331 | | 1.642 | | 2.189 | |
| Compression Ratio | | 19.2 : 1 | | 19.1 : 1 | | ← | |
| Specific Fuel Consumption | g/kW·h | ≤249 | | ≤250 | | ≤253 | |
| Maximum No-load R.P.M. | $min^{-1}$ | 2485 ±25 | | 2510 ±25 | | ← | |
| Minimum No-load R.P.M. | $min^{-1}$ | 1100 ±25 | | 1150 ±25 | | ← | |
| Starter Output | V – kW | 12 – 2.3 | | ← | | ← | |
| Alternator Output | V – kW | 12 – 0.48 | | ← | | ← | |
| Battery | | | | | | | |
| Type | | 95D31R | | ← | | 130E41R | |
| Capacity | V – A·h | 12 – 64 (5HR) | | ← | | 12 – 92 (5HR) | |

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| Machine Model | | | TB125 | | TB135 | | TB145 | |
|---|---|---|---|---|---|---|---|---|
| | Serial Number | | 12510003~ 12512125 | 12512126~ | 13510004~ | | 14510004~ | |
| Hydraulic Pump | | | | | | | | |
| Model | | | AP2D18LV1RS7 | PVD-1B-25BP-8AG5 | PVD-15B-32B(C)P-9AG5 | | AP2D25LV1RS7 | |
| Type | | | Variable displacement type double axial piston plus double gear | | ← | | ← | |
| Delivery: | P1 | L/min | 29.0 | | 37.3 | | 55.9 | |
| | P2 | L/min | 29.0 | | 37.3 | | 55.9 | |
| | P3 | L/min | 19.8 | 19.6 | 21.9 | | 37.3 | |
| | P4 | L/min | 10.4 | | ← | | ← | |
| Rated Pressure: | P1 | MPa | 20.6 | | ← | | ← | |
| | P2 | MPa | 20.6 | | ← | | ← | |
| | P3 | MPa | 19.6 | | ← | | ← | |
| | P4 | MPa | 3.4 | | ← | | ← | |
| Pilot Relief Valve Pressure Setting | | MPa | 3.4 | | ← | | ← | |
| | Serial Number | | 12510003~ | | 13510004~ | | 14510004~ | |
| Control Valve | | | | | | | | |
| Model | | | BCV35-GB10 | | BCV35-GA10 | | KVSE-70-10/11 | |
| Number of Circuits | | | 10 Circuits | | ← | | ← | |
| Main Relief Valve Pressure Setting: | | | | | | | | |
| P1 | | MPa | 20.6 | | ← | | ← | |
| P2 | | MPa | 20.6 | | ← | | ← | |
| P3 | | MPa | 19.6 | | ← | | ← | |
| Port Relief Valve Pressure Setting | | MPa | 23.5 | | ← | | ← | |
| | | | 25.5 | | ← | | ← | |
| Solenoid Valve (Aux. Hydraulics) | | | | | | | | |
| Model | | | GA-1787B | | ← | | ← | |
| Rated Pressure | | MPa | 3.43 | | ← | | ← | |
| Rated Flow Rate | | mL/min | 10.4 | | ← | | ← | |
| | Serial Number | | 12510003~ 12514525 | 12514526~ | 13510004~ 13514050 | 13514051~ | 14510004~ 14513260 | 14513261~ |
| Pilot Valve | | | | | | | | |
| Model | | | 07509-0000B | PV48M2051A | 07509-0000B | PV48M2051A | 07509-0000B | PV48M2051A |
| Primary Pressure | | MPa | 3.4 | | ← | | ← | |
| Operating Angle: Ports 1, 3 | | degree | 19 | | ← | | ← | |
| Ports 2, 4 | | degree | 25 | | ← | | ← | |
| Leakage: Non-operating | | mL/min | 300 or less | | ← | | ← | |
| Operating | | mL/min | 600 or less | | ← | | ← | |
| Pilot Valve (Aux. Hydraulics) | | | | | | | | |
| Model | | | PV6P1013A | | ← | | ← | |
| Primary Pressure | | MPa | 3.43 | | ← | | ← | |
| Operating Angle | | degree | 15 | | ← | | ← | |

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| Machine Model | | TB125 | TB135 | TB145 |
|---|---|---|---|---|
| Boom Cylinder | | | | |
| Bore Diameter × Rod Diameter | mm | 75 × 40 | 85 × 45 | 100 × 55 |
| Stroke | mm | 480 | 590 | 690 |
| Fully Retracted Length (Pitch) | mm | 795 | 930 | 1053 |
| Cushion Mechanism | | Rod End | ← | ← |
| Arm Cylinder | | | | |
| Bore Diameter × Rod Diameter | mm | 70 × 40 | 80 × 45 | 90 × 50 |
| Stroke | mm | 560 | 600 | 750 |
| Fully Retracted Length (Pitch) | mm | 835 | 910 | 1146 |
| Cushion Mechanism | | — | Head End | Both Ends |
| Bucket Cylinder | | | | |
| Bore Diameter × Rod Diameter | mm | 60 × 35 | 70 × 40 | 80 × 45 |
| Stroke | mm | 465 | 490 | 585 |
| Fully Retracted Length (Pitch) | mm | 705 | 765 | 915 |
| Cushion Mechanism | | — | — | — |
| Bucket Cylinder (for Telescopic Arm) | | | | |
| Bore Diameter × Rod Diameter | mm | — | 70 × 40 | 80 × 45 |
| Stroke | mm | — | 490 | 585 |
| Fully Retracted Length (Pitch) | mm | — | 765 | 915 |
| Cushion Mechanism | | — | — | — |
| Swing Cylinder | | | | |
| Bore Diameter × Rod Diameter | mm | 75 × 40 | 80 × 45 | 90 × 50 |
| Stroke | mm | 440 | 470 | 620 |
| Fully Retracted Length (Pitch) | mm | 790 | 820 | 1014 |
| Cushion Mechanism | | Both Ends | ← | ← |
| Dozer Blade Cylinder | | | | |
| Bore Diameter × Rod Diameter | mm | 85 × 45 | 100 × 55 | 110 × 60 |
| Stroke | mm | 140 | 140 | 175 |
| Fully Retracted Length (Pitch) | mm | 480 | 615 | 540 |
| Cushion Mechanism | | — | — | — |

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| Machine Model | | TB125 | | TB135 | | TB145 | |
|---|---|---|---|---|---|---|---|
| Telescopic Arm Cylinder | | | | | | | |
| Bore Diameter × Rod Diameter | mm | — | | 65 × 40 | | 70 × 45 | |
| Stroke | mm | — | | 800 | | 900 | |
| Fully Retracted Length (Pitch) | mm | — | | 1080 | | 1170 | |
| Cushion Mechanism | | — | | — | | — | |
| Tensioning Cylinder | | | | | | | |
| Bore Diameter × Rod Diameter | mm | — | | — | | 80 × 50 | |
| Stroke | mm | — | | — | | 146 | |
| Fully Retracted Length (Pitch) | mm | — | | — | | 376 | |
| Cushion Mechanism | | — | | — | | — | |
| Lever Lock Cylinder | | | | | | | |
| Bore Diameter × Rod Diameter | mm | 25 × 12.5 | | ← | | ← | |
| Stroke | mm | 10 | | ← | | ← | |
| Spring Set Load | N | 98 | | ← | | ← | |
| Serial Number | | 12510003~ 12514525 | 12514526~ | 13510004~ 13510348 | 13510349~ | 14510004~ 14512498 | 14512499~ |
| Travel Motor | | | | | | | |
| Model | | MAG-18VP-230E | MAG-18VP-230F | PHV-300-53B-1S1 | | PHV-500-48B-1S1 | |
| Type | | 2-Speed Piston Motor | | ← | | ← | |
| Total Displacement: | | | | | | | |
| 1st | $cm^3/rev$ | 810 | | 1017 | 1091.5 | 1626 | 1735 |
| 2nd | $cm^3/rev$ | 437 | | 548 | 569.5 | 908 | 1012 |
| Motor Displacement | | | | | | | |
| 1st | $cm^3/rev$ | 18.0 | | 19.3 | 20.7 | 34.2 | 36.5 |
| 2nd | $cm^3/rev$ | 9.7 | | 10.4 | 10.8 | 19.1 | 21.3 |
| Reduction Gear Ratio | | 1/45.0 | | 1/52.73 | | 1/47.53 | |
| 2-Speed Control Pressure | MPa | 0.6 | — | 1.5 | | ← | |
| Parking Brake Torque | N·m | 1720 | 1421 | 2067 | | 3261 | 3589 |
| Parking Brake Release Pressure | MPa | 1.1 | 1.3 | 2.0 | | 2.0 | 2.2 |
| Amount of Reduction Gear Lubricant | L | 0.5 | | 0.6 | | 0.8 | |

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| Machine Model | | TB125 | | TB135 | TB145 | |
|---|---|---|---|---|---|---|
| Serial Number | | 12510003~ | | 13510004~ | 14510004~ 14513260 | 14513261~ |
| Slew Motor | | | | | | |
| Model | | MSG-27P-10E | | MSG-27P-16E | MSG-33P-19 | MSG-27P-23E |
| Type | | Piston Motor | | ← | ← | ← |
| Total Displacement | $cm^3/rev$ | 238 | | 321 | 559 | 570 |
| Motor Displacement | $cm^3/rev$ | 24.0 | | 20.7 | 29.4 | 25.1 |
| Redution Gear Ratio | | 1/9.9 | | 1/15.5 | 1/18.9 | 1/22.7 |
| Relief Valve Pressure Setting | MPa | 15.7 | | 18.1 | 18.6 | ← |
| Parking Brake Torque | N·m | 775 | | 1230 | 1863 | ← |
| Parking Brake Release Pressure | MPa | 2.0 | | ← | ← | ← |
| Serial Number | | 12510003~ 12514525 | 12514526~ | 13510004~ | 14510004~ | |
| Swivel Joint | | | | | | |
| Model | | YV-7104 | YV-7225 | YV-7090A | YV-7095 | |

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# MASS TABLES

## UNIT MASS (DRY MASS)

Unit: kg

| Machine Model | TB125 | | TB135 | | TB145 | |
|---|---|---|---|---|---|---|
| Serial Number | 12510003~12514525 | | 13510004~13514050 | | 14510004~14513260 | |
| Machine Type | Canopy | Cab | Canopy | Cab | Canopy | Cab |
| Upper Machinery | | | | | | |
| Engine | 128 | ← | 155 | ← | 170 | ← |
| Radiator | 6 | ← | ← | ← | 11.4 | ← |
| Hydraulic Pump | 28 | ← | 24 | ← | 36 | ← |
| Hydraulic Tank | 57 | ← | ← | ← | 74 | ← |
| Fuel Tank | 26 | ← | ← | ← | 32 | ← |
| Control Valve | 24 | ← | ← | ← | 42 | ← |
| Pilot Valve | 4.7 | ← | ← | ← | ← | ← |
| Slew Motor | 32 | ← | 39 | ← | 56 | ← |
| Canopy/Cab | 103 | 200 | 103 | 200 | 103 | 200 |
| Counterweight | 137 | 138 | 365 | ← | 490 | ← |
| Swing Bracket | 63 | ← | 74 | ← | 115 | ← |
| Swing Cylinder | 28 | ← | 30 | ← | 37 | ← |
| Lower Machinery | | | | | | |
| Swivel Joint | 11 | ← | 22 | ← | ← | ← |
| Slew Bearing | 40 | ← | ← | ← | 84 | ← |
| Crawler Belt: Rubber/Steel | 124/153 | ← | 149/199 | ← | 219/259 | ← |
| Travel Motor | 36 | ← | 49 | ← | 57 | ← |
| Carrier Roller | 3.1 | ← | ← | ← | 4 | ← |
| Track Roller: Rubber/Steel Crawler | 6.8/7.9 | ← | ← | ← | 11.6/12.1 | ← |
| Idler | 23 | ← | ← | ← | 28 | ← |
| Sprocket | 14.7 | ← | ← | ← | 15.4 | ← |
| Track Adjuster | 11 | ← | 14.7 | ← | 23.9 | ← |
| Dozer Blade | 126 | ← | 149 | ← | 196 | ← |
| Dozer Blade Cylinder | 21 | ← | 35 | ← | 41 | ← |
| Hoe Attachment | | | | | | |
| Boom | 98 | ← | 122 | ← | 188 | ← |
| Arm | 45 | ← | 66 | ← | 94 | ← |
| Bucket: Standard | 55 | ← | 73 | ← | 107 | ← |
| Boom Cylinder | 27 | ← | 40 | ← | 62 | ← |
| Arm Cylinder | 25 | ← | 33 | ← | 51 | ← |
| Bucket Cylinder | 16 | ← | 24 | ← | 34 | ← |

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Unit: kg

| Machine Model | TB125 | | TB135 | | TB145 | |
|---|---|---|---|---|---|---|
| Serial Number | 12514526~ | | 13514051~ | | 14513261~ | |
| Machine Type | Canopy | Cab | Canopy | Cab | Canopy | Cab |
| Upper Machinery | | | | | | |
| Engine | 128 | ← | 155 | ← | 170 | ← |
| Radiator | 2.3 | ← | 4.0 | ← | 3.3 | ← |
| Hydraulic Pump | 24 | ← | 24 | ← | 36 | ← |
| Hydraulic Tank | 57 | ← | ← | ← | 74 | ← |
| Fuel Tank | 26 | ← | ← | ← | 32 | ← |
| Control Valve | 24 | ← | ← | ← | 42/46 | ← |
| Pilot Valve | 1.6 | ← | ← | ← | 1.6/2.0 | ← |
| Slew Motor | 32 | ← | 39 | ← | 50 | ← |
| Canopy/Cab | 106 | 229 | 106 | 229 | 106 | 229 |
| Counterweight | 137 | 138 | 365 | ← | 490 | ← |
| Swing Bracket | 61 | ← | 73 | ← | 124 | ← |
| Swing Cylinder | 28 | ← | 30 | ← | 37 | ← |
| Lower Machinery | | | | | | |
| Swivel Joint | 9 | ← | 22 | ← | ← | ← |
| Slew Bearing | 40 | ← | ← | ← | 84 | ← |
| Crawler Belt: Rubber/Steel | 124/153 | ← | 149/199 | ← | 219/259 | ← |
| Travel Motor | 34 | ← | 49 | ← | 57 | ← |
| Carrier Roller | 2.9 | ← | ← | ← | 4.3 | ← |
| Track Roller: Rubber/Steel Crawler | 6.8/7.9 | ← | ← | ← | 11.6/12.1 | ← |
| Idler | 29 | ← | ← | ← | 28 | ← |
| Sprocket | 14.6 | ← | ← | ← | 15.4 | ← |
| Track Adjuster | 11 | ← | 14.7 | ← | 23.9 | ← |
| Dozer Blade | 117 | ← | 150 | ← | 202 | ← |
| Dozer Blade Cylinder | 20 | ← | 32 | ← | 41 | ← |
| Hoe Attachment | | | | | | |
| Boom | 98 | ← | 122 | ← | 189 | ← |
| Arm | 45 | ← | 66 | ← | 94 | ← |
| Bucket: Standard | 55 | ← | 73 | ← | 107 | ← |
| Boom Cylinder | 27 | ← | 36 | ← | 56 | ← |
| Arm Cylinder | 25 | ← | 33 | ← | 47 | ← |
| Bucket Cylinder | 16 | ← | 23 | ← | 32 | ← |

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## RECOMMENDED LUBRICANTS

Use different fuels, lubricants and greases according to the temperature, referring to the chart below.

- Change the lubricant earlier than as show in the table if it is extremely dirty or its performance has deteriorated severely.
- Whenever possible, use the same brand of lubricant as before. If changing with a different brand, replace the entire quantity – do not mix different brands.

| Part | Type | Type by temperature<br>-22 -4 14 32 50 68 86 104°F<br>-30 -20 -10 0 10 20 30 40°C | Replacement interval |
|---|---|---|---|
| Engine oil pan | Diesel engine oil API service CD | SAE 5W-20<br>SAE 10W-30<br>SAE 15W-40<br>SAE 10W | After first 50 hours<br>Every 250 hours |
| Hydlaulic tank | Antiwear hydraulic oil (Option: Biodegradable oil) | ISO VG68<br>ISO VG46<br>ISO VG32 | Every 2000 hours |
| Fuel tank | Diesel fuel | Use a clean, Quality fuel for performance and optimum engine life.<br>• To prevent fuel flow problems in cold weather, use diesel fuel with a pour point of at least -12°C (10°F) below the lowest expected ambient temperature.<br>• Minimum cetane number is 45. Low temperature or high altitude operation may require the use of fuel with a higher cetane number. | |
| Engine cooling system | Coolant (water**+Coolant***) | 30% coolant mixture<br>50% coolant mixture | Every 1000 hours |
| Travel reduction gear | Gear oil API-GL-4 | SAE 90 | After first 100 to 250 hours*<br>Every 1000 hours |
| Carrier Roller | | | — |
| Track Roller <TB125, TB135> | | | — |
| Track Roller <TB145> | Mobil gear SHC 680 | —— | — |
| Idler | Gear oil API-GL-4 | SAE 90 | — |
| Slew Grease Bath | Lithium grease EP-2 NLGI No. 2 | —— | — |
| Slew bearing | | —— | Every 50 hours |
| Working equipment | | —— | Daily or erery 10 hours |
| Levers | | —— | When required |

* If the percentage of the traveling time within the total operating time is high, replace the gear oil earlier than the specified time.
** For water, use tap water (soft). Do not use well or river water.
*** When the ambient temperature drops below 0°C, add coolant (antifreeze). Follow the coolant manufacture's instructions to determine the mixture ratio.

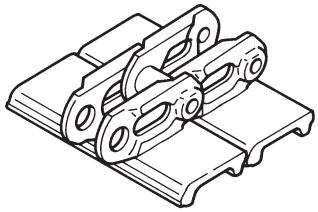
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## TYPES OF CRAWLER BELTS

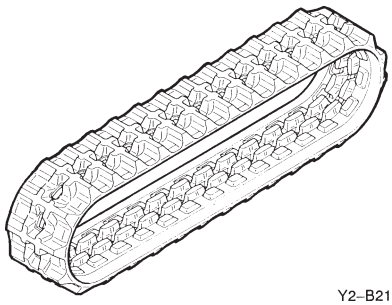
| Machine Model | Type | Shoe Width (mm) | Number of Links | Overall Crawler Width (mm) | Groud Pressure {kPa (kgf/cm$^2$)} | | Overall Mass (kg) |
|---|---|---|---|---|---|---|---|
| | | | | | Canopy | Cab | |
| TB125 | Rubber | 300 | — | 1450 | 28.1 (0.287) | 29.3 (0.299) | 124 |
| | Steel | 300 | 39 | 1450 | 29.4 (0.300) | 30.7 (0.313) | 153 |
| TB135 | Rubber | 350 | — | 1630 | 26.4 (0.269) | 27.1 (0.276) | 149 |
| | Steel | 350 | 43 | 1630 | 27.9 (0.285) | 28.6 (0.292) | 199 |
| TB145 | Rubber | 400 | — | 1840 | 26.8 (0.273) | 27.3 (0.278) | 219 |
| | Steel (Standard) | 380 | 38 | 1820 | 29.8 (0.304) | 30.3 (0.309) | 257 |
| | Steel (wide) | 460 | 38 | 1900 | 25.2 (0.257) | 25.7 (0.262) | 322 |

Steel



Y2–B211

Rubber



Y2–B210

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# TYPES OF ATTACHMENTS AND THEIR COMBINATIONS

## TYPES OF ATTACHMENTS

| Machine Model | Type | Specification | | | | |
|---|---|---|---|---|---|---|
| | | Outer Width (mm) | Capacity ($m^3$) | Teeth | | Mass (kg) |
| | | | | Type | Q'ty | |
| TB125 | Hoe Bucket | 300 | 0.043 (Heaped)<br>0.036 (Struck) | ESCO18S | 3 | 53 |
| | | 330 | 0.044 (Heaped)<br>0.037 (Struck) | ESCO18S | 3 | 55 |
| | | 460 (Std.) | 0.068 (Heaped)<br>0.051 (Struck) | ESCOV13 | 3 | 55 |
| | | 490 | 0.075 (Heaped)<br>0.058 (Struck) | ESCO18S | 3 | 65 |
| | | 530 | 0.084 (Heaped)<br>0.065 (Struck) | ESCO18S | 4 | 72 |
| | | 600 | 0.104 (Heaped)<br>0.079 (Struck) | ESCO18S | 4 | 77 |
| | | 3-Holes Bucket | 0.093 (Heaped)<br>0.075 (Struck) | ESCOV17S | 4 | 80 |
| | Arm | Length (mm) | Max. Digging Depth (mm) | Vertical Digging Depth (mm) | | Mass (kg) |
| | | 1135<br>1445 | 2580<br>2890 | 1935<br>2205 | | 45<br>57 |
| | Telescopic Arm | Max. Digging Depth (mm) | | Vertical Digging Depth (mm) | | Mass (kg) |
| | | 2590 (retracted)<br>3165 (extended) | | 1080<br>1645 | | 212 |
| | Dozer Blade | Height (mm) | Width (mm) | Lifting Range (mm) | | Mass (kg) |
| | | | | Above | Below | |
| | | 360 | 1450 | 390 | 315 | 126 |

https://truckmanualshub.com/



| Machine Model | Type | Specification | | | | |
|---|---|---|---|---|---|---|
| | | Outer Width (mm) | Capacity ($m^3$) | Teeth | | Mass (kg) |
| | | | | Type | Q'ty | |
| TB135 | Hoe Bucket | 310 | 0.042 (Heaped)<br>0.035 (Struck) | ESCO18S | 3 | 59 |
| | | 380 | 0.056 (Heaped)<br>0.045 (Struck) | ESCO18S | 3 | 65 |
| | | 400 | 0.061 (Heaped)<br>0.048 (Struck) | ESCO18S | 3 | 66 |
| | | 500 | 0.088 (Heaped)<br>0.067 (Struck) | ESCOV13 | 3 | 67 |
| | | 570 (Std.) | 0.105 (Heaped)<br>0.078 (Struck) | ESCOV13 | 4 | 73 |
| | | 3-Holes Bucket | 0.130 (Heaped)<br>0.100 (Struck) | ESCOV17S | 4 | 94 |
| | | 630 | 0.113 (Heaped)<br>0.082 (Struck) | ESCO18S | 4 | 86 |
| | | 680 | 0.123 (Heaped)<br>0.089 (Struck) | ESCO18S | 4 | 89 |
| | | 800 | 0.148 (Heaped)<br>0.102 (Struck) | ESCO18S | 5 | 101 |
| | Arm | Length (mm) | Max. Digging Depth (mm) | Vertical Digging Depth (mm) | | Mass (kg) |
| | | 1290<br>1600 | 3105<br>3415 | 2345<br>2615 | | 66<br>78 |
| | Telescopic Arm | Max. Digging Depth (mm) | | Vertical Digging Depth (mm) | | Mass (kg) |
| | | 3110 (retracted)<br>3875 (extended) | | 1625<br>2395 | | 241 |
| | Dozer Blade | Height (mm) | Width (mm) | Lifting Range (mm) | | Mass (kg) |
| | | | | Above | Below | |
| | | 400 | 1630 | 405 | 390 | 149 |

https://truckmanualshub.com/

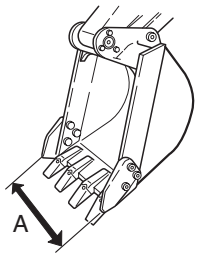


| Machine Model | Type | Specification | | | | |
|---|---|---|---|---|---|---|
| | | Outer Width (mm) | Capacity ($m^3$) | Teeth | | Mass (kg) |
| | | | | Type | Q'ty | |
| TB145 | Hoe Bucket | 360 | 0.064 (Heaped)<br>0.051 (Struck) | ESCO18S | 3 | 85 |
| | | 430 | 0.083 (Heaped)<br>0.065 (Struck) | ESCO18S | 3 | 92 |
| | | 530 | 0.113 (Heaped)<br>0.082 (Struck) | ESCOV17S | 4 | 97 |
| | | 3-Holes Bucket | 0.188 (Heaped)<br>0.149 (Struck) | ESCOV17S | 4 | 120 |
| | | 630 (Std.) | 0.141 (Heaped)<br>0.102 (Struck) | ESCO18S | 4 | 115 |
| | | 680 | 0.156 (Heaped)<br>0.112 (Struck) | ESCO18S | 5 | 123 |
| | | 730 | 0.171 (Heaped)<br>0.121 (Struck) | ESCO18S | 5 | 127 |
| | Arm | Length (mm) | Max. Digging Depth (mm) | Vertical Digging Depth (mm) | | Mass (kg) |
| | | 1450<br>1760 | 3500<br>3810 | 2750<br>3050 | | 94<br>112 |
| | Telescopic Arm | Max. Digging Depth (mm) | | Vertical Digging Depth (mm) | | Mass (kg) |
| | | 3510 (retracted)<br>4405 (extended) | | 2620<br>3500 | | 360 |
| | Dozer Blade | Height (mm) | Width (mm) | Lifting Range (mm) | | Mass (kg) |
| | | | | Above | Below | |
| | | 430<br>430 | 1840<br>1900 | 435<br>435 | 350<br>350 | 197<br>199 |

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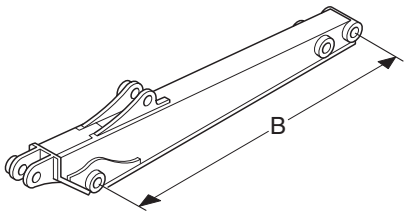
Hoe Bucket




G4B001

A: Outer Width

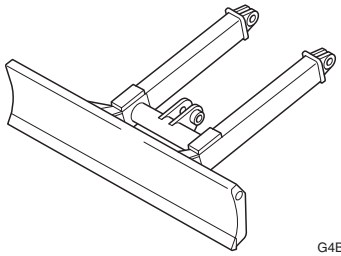
Arm




G4B002

B: Arm Length

Dozer Blade



G4B003

https://truckmanualshub.com/

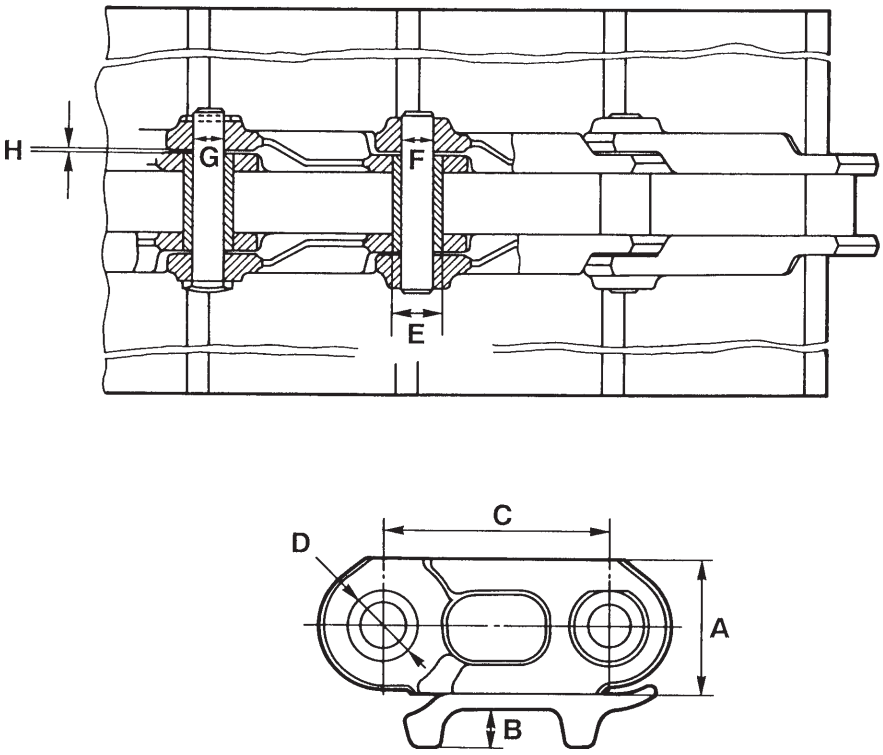


# SERVICE STANDARDS

## TRAVEL SYSTEM

### Steel Crawler Belt

■ TB125, TB135




G4B004

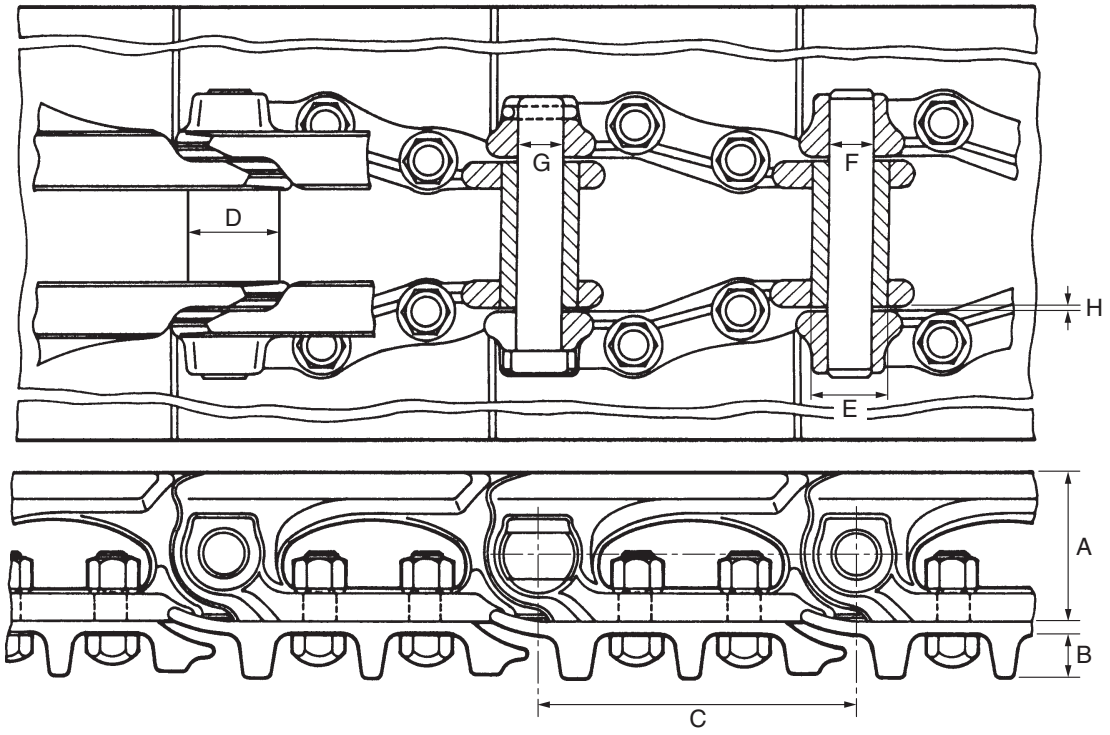
Unit: mm

| Code | Item | Designated Standard | | | | | Servicing Procedure |
|---|---|---|---|---|---|---|---|
| A | Link Height | Basic Dimension | | | Allowable Value | | Build up or replace. |
| | | 61 | | | 56 | | |
| B | Grouser Height | 16.5 | | | 8 | | |
| C | Link Pitch | 101.6 | | | 103.5 | | Replace |
| D | Bushing Outer Diameter | $32.2\ ^{0}_{-0.04}$ | | | 30.5 | | |
| E | Bushing and Link Interference | Basic Dimension | Allowable Tolerance | | Standard Fit | Allowable Fit | |
| | | | Shaft | Hole | | | |
| | | 32 | +0.20<br>+0.16 | +0.05<br>0 | 0.11~0.2 | 0.1 | |
| F | Regular Pin and Link Interference | 19 | +0.21<br>+0.17 | +0.05<br>0 | 0.12~0.21 | 0.1 | |
| G | Master Pin and Link Clearance | 19 | -0.07<br>-0.02 | +0.05<br>0 | 0.02~0.12 | 0.5 | Replace with oversize pin |
| H | Link Clearance | Standard Clearance (One Side) | | Standard Clearance (Both Sides) | | Allowable Clearance (Both Sides) | Replace |
| | | 0.6 | | 1.2 | | 6.0 | |

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■ TB145




Unit: mm

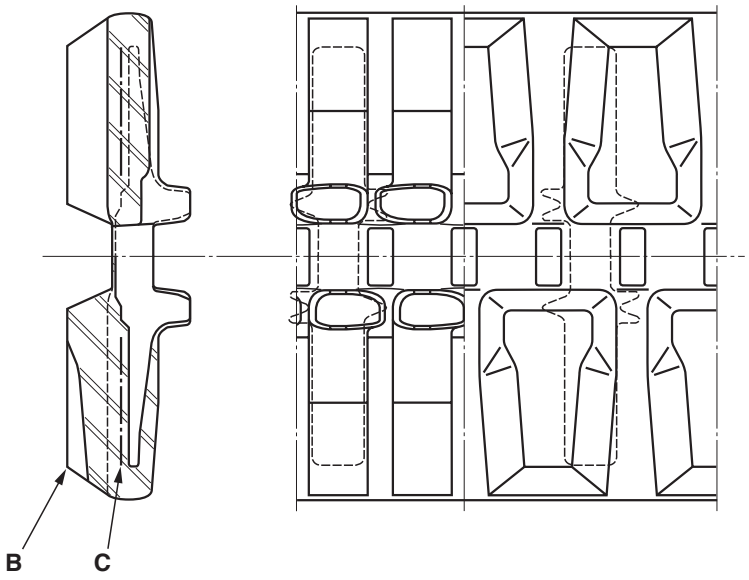
| Code | Item | Designated Standard | | | | | Servicing Procedure |
|---|---|---|---|---|---|---|---|
| A | Link Height | Basic Dimension | | | Allowable Value | | Build up or replace. |
| | | 65 ±0.1 | | | 60 | | |
| B | Grouser Height | 14 | | | 6.5 | | |
| C | Link Pitch | 135 | | | 137.5 | | Replace |
| D | Bushing Outer Diameter | $35.02^{+0.03}_{0}$ | | | 33.2 | | |
| E | Bushing and Link Interference | Basic Dimension | Allowable Tolerance | | Standard Fit | Allowable Fit | |
| | | | Shaft | Hole | | | |
| | | 35 | +0.05<br>+0.02 | -0.08<br>-0.13 | 0.1~0.18 | 0.1 | |
| F | Regular Pin and Link Interference | 22 | +0.06<br>+0.03 | -0.07<br>-0.12 | 0.1~0.18 | 0.1 | |
| G | Master Pin and Link Clearance | 22 | -0.12<br>-0.15 | -0.07<br>-0.12 | 0~0.08 | 0.5 | Replace with oversize pin |
| H | Link Clearance | Standard Clearance (One Side) | | Standard Clearance (Both Sides) | | Allowable Clearance (Both Sides) | Replace |
| | | 0.6 | | 1.2 | | 6.0 | |

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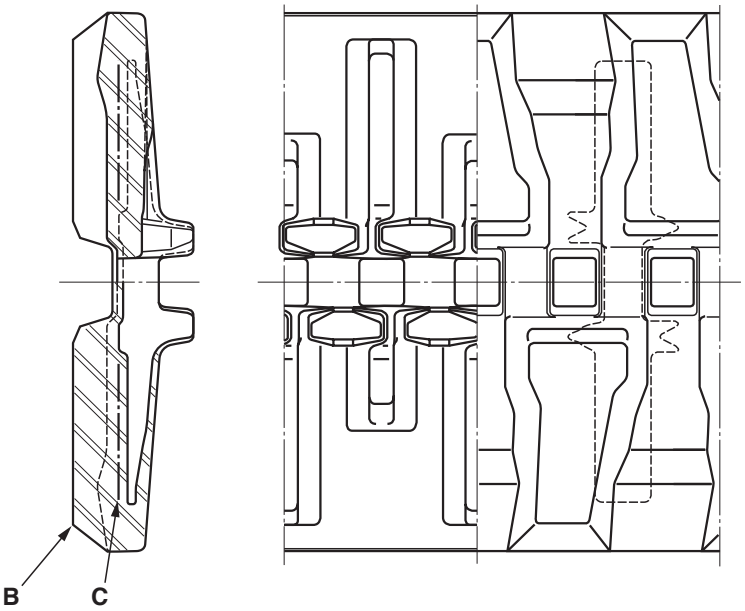
**Rubber Crawler Belt**

■ TB125, TB135




E5B005

■ TB145




K3B005

Unit: mm

| Code | Item | Designated Standard | | | Servicing Procedure |
|---|---|---|---|---|---|
| A | Crawler Tension* | Basic Dimension | | Allowable Value | Adjust or replace. |
| | | TB125, TB135 | TB145 | —— | |
| | | 77~87 | 108~118 | | |
| B | Crawler Cracks or Cuts | Steel cable is exposed. | | | Replace. |
| C | Steel Cable | Is severed. | | | |

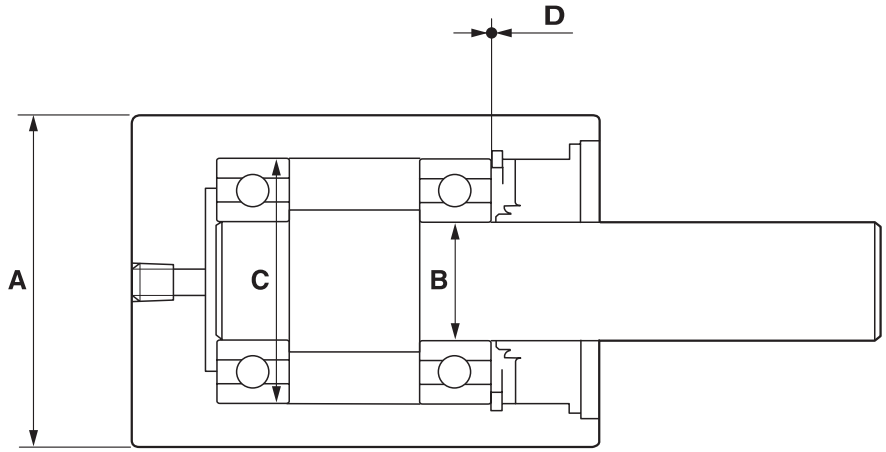
* : For the inspection method, refer to “II. Specifications, Standards for Judging Performance”.

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**Carrier Roller**

■ TB125, TB135




K3B028

Unit: mm

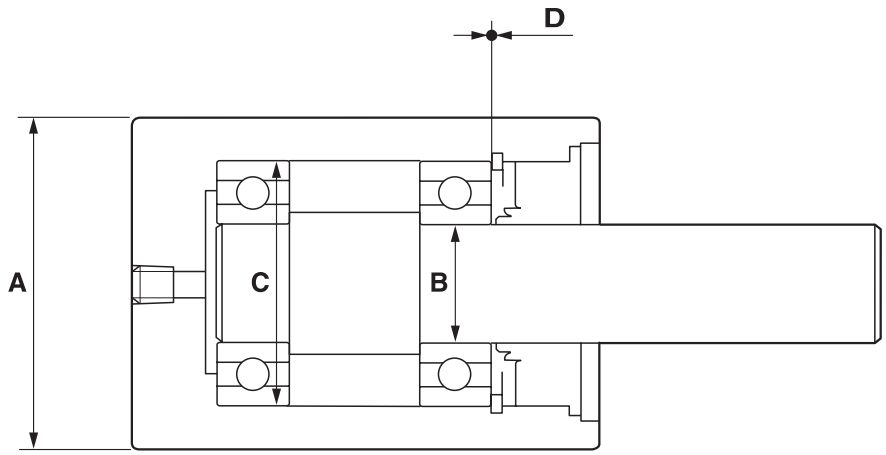
| Code | Item | Designated Standard | | | | | Servicing Procedure |
|---|---|---|---|---|---|---|---|
| A | Outer Diameter of Tread | Basic Dimension | | | Allowable Value | | Build up or replace. |
| | | 75 | | | 69 | | |
| B | Shaft and Bearing Bore Diameter Interfence | Basic Dimension | Allowable Tolerance | | Standard Fit | Allowable Fit | Replace |
| | | | Shaft | Hole | | | |
| | | 25 | +0.021<br>+0.008 | 0<br>-0.010 | 0.008~<br>0.031 | — | |
| C | Roller and Bearing Outer Diameter Fit | 52 | 0<br>-0.013 | -0.009<br>-0.039 | 0.004∗<br>0.039∗∗ | — | |
| D | Shaft End Play | Standard Value | | | Allowable Value | | |
| | | 0.6 | | | 1.1 | | |

∗ : Max. clealance ∗∗ : Max. interference

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■ TB145




K3B028

Unit: mm

| Code | Item | Designated Standard | | | | | Servicing Procedure |
|---|---|---|---|---|---|---|---|
| A | Outer Diameter of Tread | Basic Dimension | | Allowable Value | | | Build up or replace. |
| | | 84 | | 78 | | | |
| B | Shaft and Bearing Bore Diameter Interference | Basic Dimension | Allowable Tolerance | | Standard Fit | Allowable Fit | Replace |
| | | | Shaft | Hole | | | |
| | | 30 | +0.021<br>+0.008 | 0<br>-0.010 | 0.008~<br>0.031 | — | |
| C | Roller and Bearing Outer Diameter Fit | 62 | 0<br>-0.013 | -0.009<br>-0.039 | 0.004∗<br>0.039∗∗ | — | |
| D | Shaft End Play | Standard Value | | Allowable Value | | | |
| | | 0.6 | | 1.1 | | | |

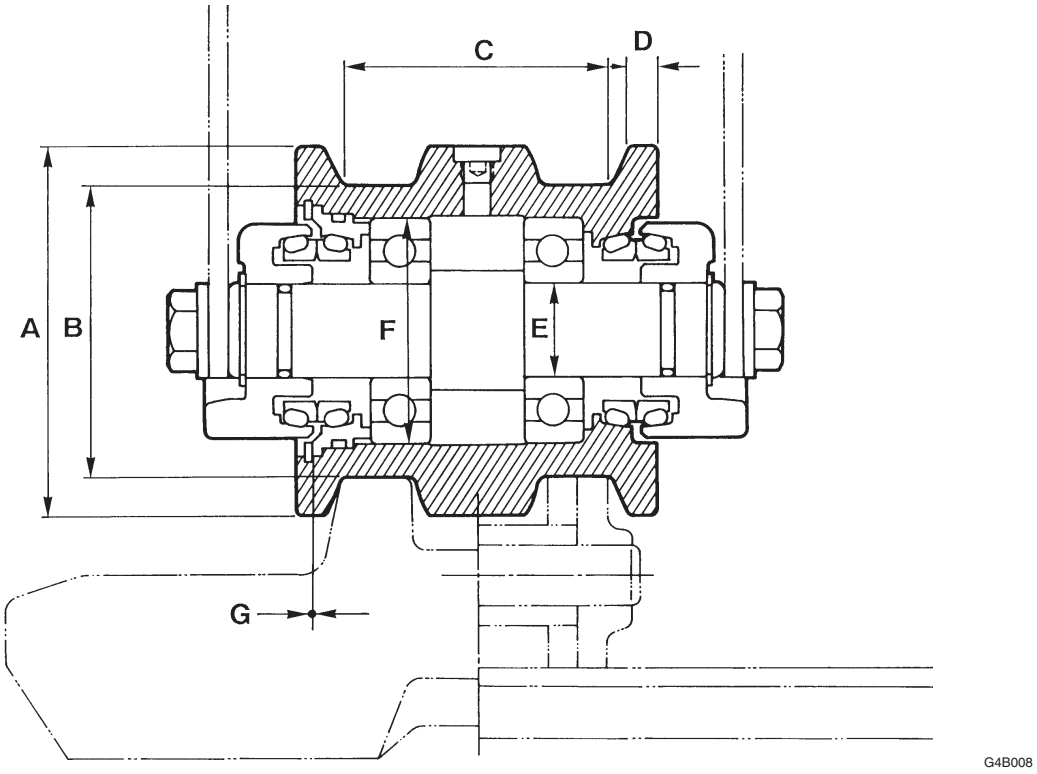
∗ : Max. clealance ∗∗ : Max. interference

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**Track Roller**

■ TB125, TB135




Unit: mm

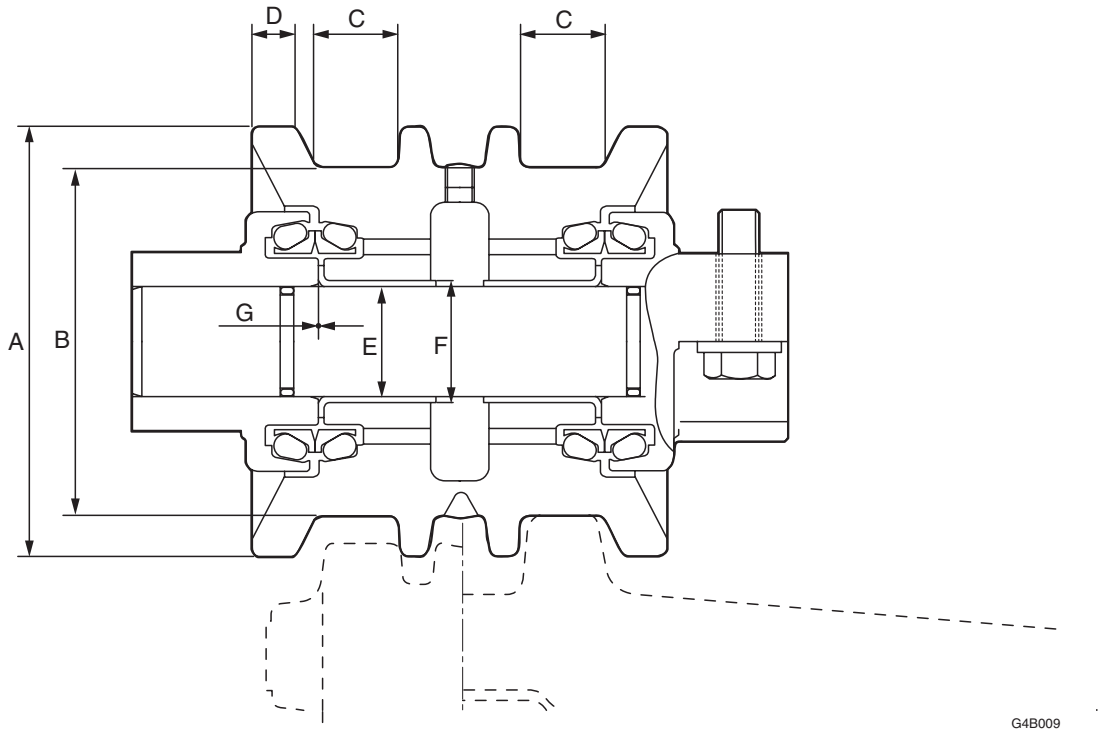
| Code | Item | Designated Standard | | | | | Servicing Procedure |
|---|---|---|---|---|---|---|---|
| A | Outer Diameter of Brim | Basic Dimension | | | Allowable Value | | Build up or replace. |
| | | 118 | | | 112 | | |
| B | Outer Diameter of Tread | 93 | | | 87 | | |
| C | Width of Tread | 86 | | | 90 | | Replace |
| D | Width of Brim | 8.7 | | | 6 | | |
| E | Shaft and Bearing Bore Diameter Interference | Basic Dimension | Allowable Tolerance | | Standard Fit | Allowable Fit | |
| | | | Shaft | Hole | | | |
| | | 30 | +0.021<br>+0.008 | 0<br>-0.010 | 0.08~0.031 | — | |
| F | Roller and Bearing Outer Diameter Fit | 72 | 0<br>-0.013 | -0.009<br>-0.033 | 0.004∗<br>0.033∗∗ | — | |
| G | Shaft End Play | Standard Value | | | Allowable Value | | |
| | | 0.7 | | | 1.2 | | |

∗ : Max. clealance ∗∗ : Max. interference

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■ TB145




Unit: mm

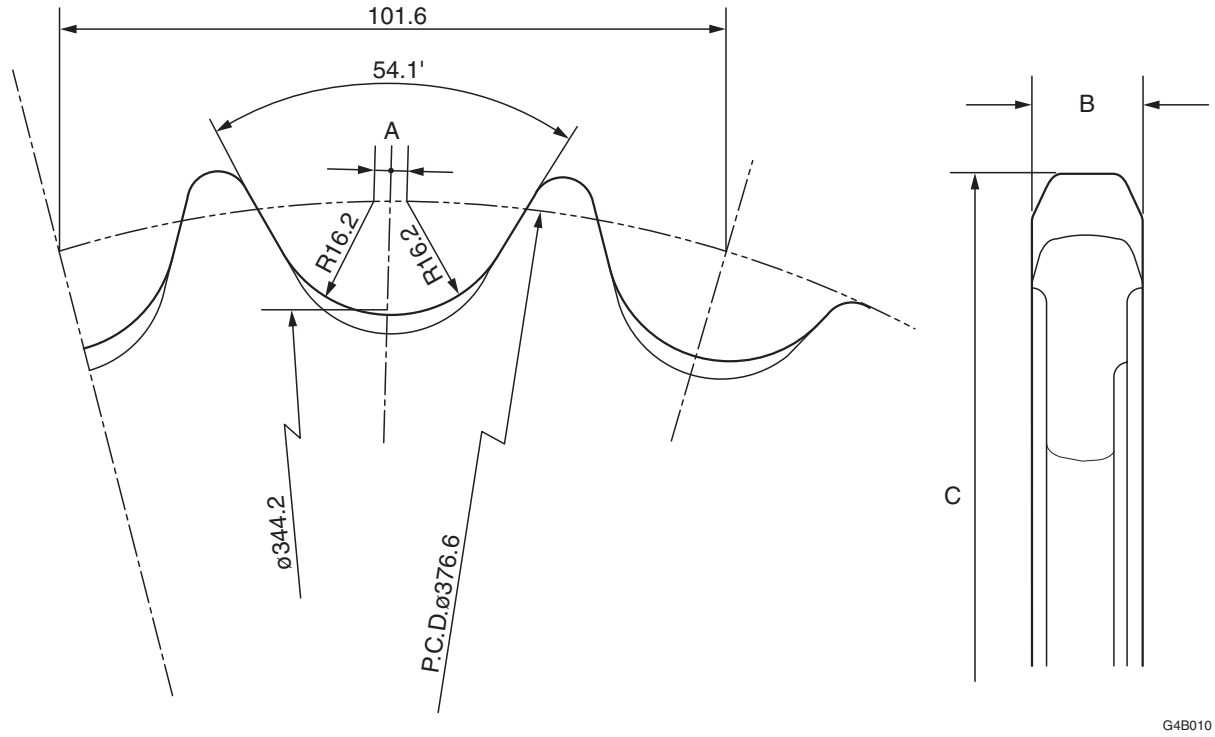
| Code | Item | Designated Standard | | | | | Servicing Procedure |
|---|---|---|---|---|---|---|---|
| A | Outer Diameter of Brim | Basic Dimension | | Allowable Value | | | Build up or replace. |
| | | 136 | | 130 | | | |
| B | Outer Diameter of Tread | 110 | | 106 | | | |
| C | Width of Tread | 26 | | 32 | | | |
| D | Width of Brim | 13.5 | | 10.5 | | | |
| E | Shaft and Bushing Bore Diameter Clearance | Basic Dimension | Allowable Tolerance | | Standard Fit | Allowable Fit | Replace |
| | | | Shaft | Hole | | | |
| | | 35 | 0<br>-0.025 | — | — | 0.8 | |
| F | Roller and Bushing Outer Diameter Interference | 39 | +0.12<br>+0.16 | +0.025<br>0 | — | 0 | |
| G | Shaft End Play | Standard Value | | Allowable Value | | | |
| | | 1.1 | | 1.65 | | | |

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**Drive Sprocket**

■ TB125, TB135



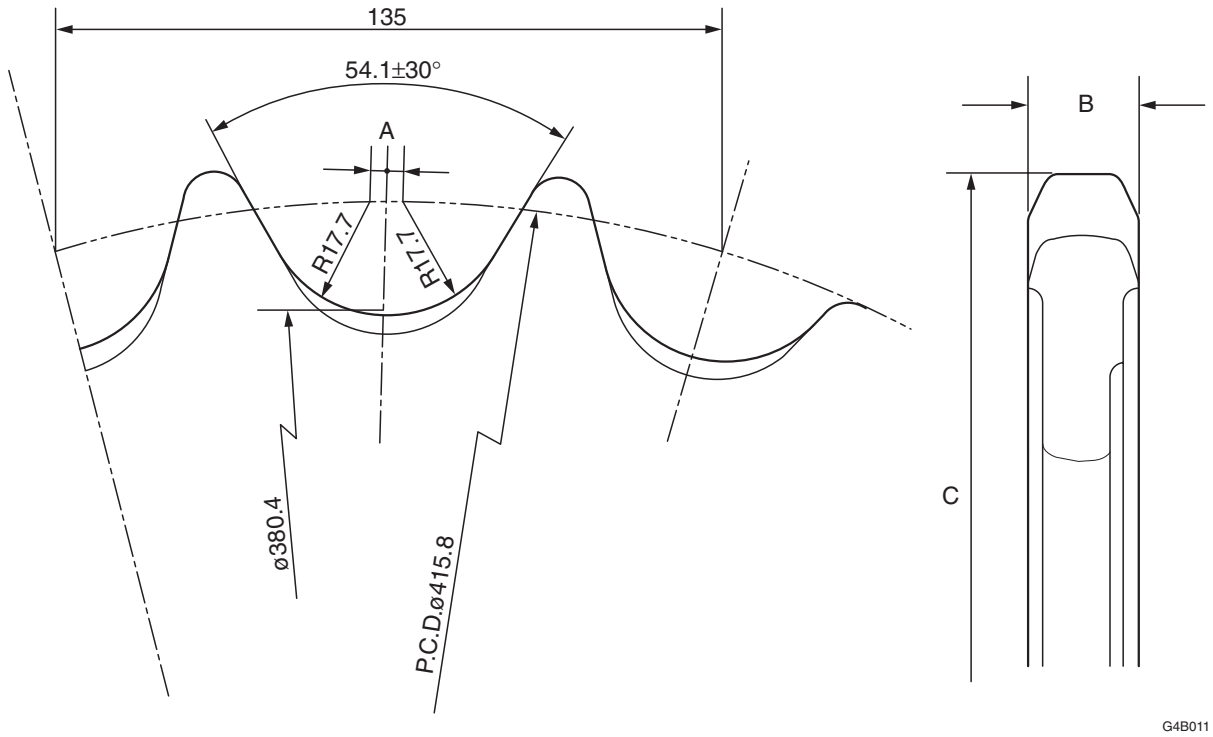

Unit: mm

| Code | Item | Designated Standard | | Servicing Procedure |
|---|---|---|---|---|
| A | Sprocket Teeth Profile Wear | Basic Dimension | Allowable Value | Build up or Replace |
| | | 4.8 | 8 | |
| B | Sprocket Teeth Width | 36 | 32 | |
| C | Sprocket Outer Diameter | 385.6 | 377 | |

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■ TB145




Unit: mm

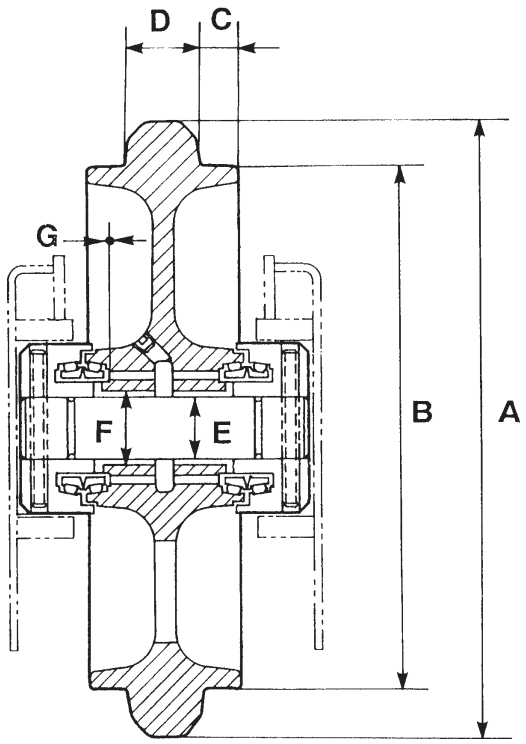
| Code | Item | Designated Standard | | Servicing Procedure |
|---|---|---|---|---|
| A | Sprocket Teeth Profile Wear | Basic Dimension | Allowable Value | Build up or Replace |
| | | 7 | 11.2 | |
| B | Sprocket Teeth Width | 32 | 28 | |
| C | Sprocket Outer Diameter | 435.8 | 427 | |

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**Idler**

■ TB125, TB135: S/N 13510004~13512646




G4B012

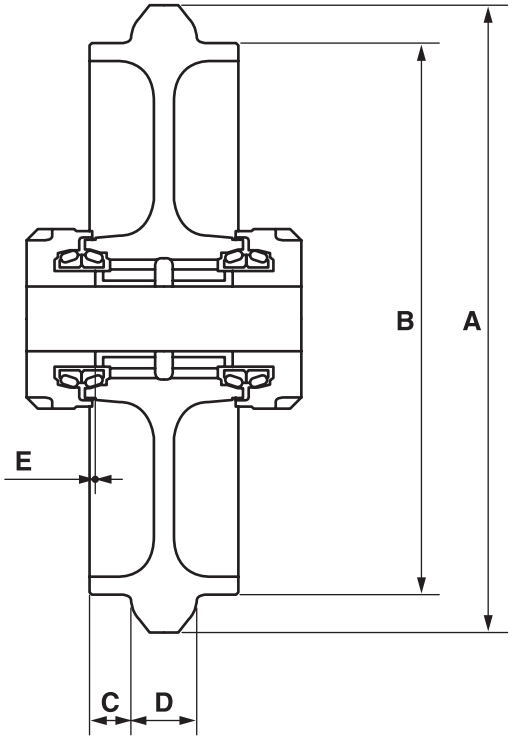
Unit: mm

| Code | Item | Designated Standard | | | | | Servicing Procedure |
|---|---|---|---|---|---|---|---|
| A | Outer Diameter of Brim | Basic Dimension | | | Allowable Value | | Build up or replace. |
| | | 347 | | | 341 | | |
| B | Outer Diameter of Tread | 305 | | | 299 | | |
| C | Width of Tread | 22.5 | | | 20.5 | | |
| D | Width of Brim | 40 | | | 36 | | |
| E | Shaft and Bushing Bore Diameter Clearance | Basic Dimension | Allowable Tolerance | | Standard Fit | Allowable Fit | Replace |
| | | | Shaft | Hole | | | |
| | | 35 | 0<br>+0.03 | +0.140<br>+0.285 | 0.315~0.140 | — | |
| F | Idler and Bushing Outer Diameter Interference | 42 | +0.120<br>+0.070 | +0.025<br>0 | 0.045~0.120 | — | |
| G | Shaft End Play | Standard Value | | | Allowable Value | | |
| | | 0.9 | | | 1.4 | | |

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■ TB135: S/N 13512647~




G4B026

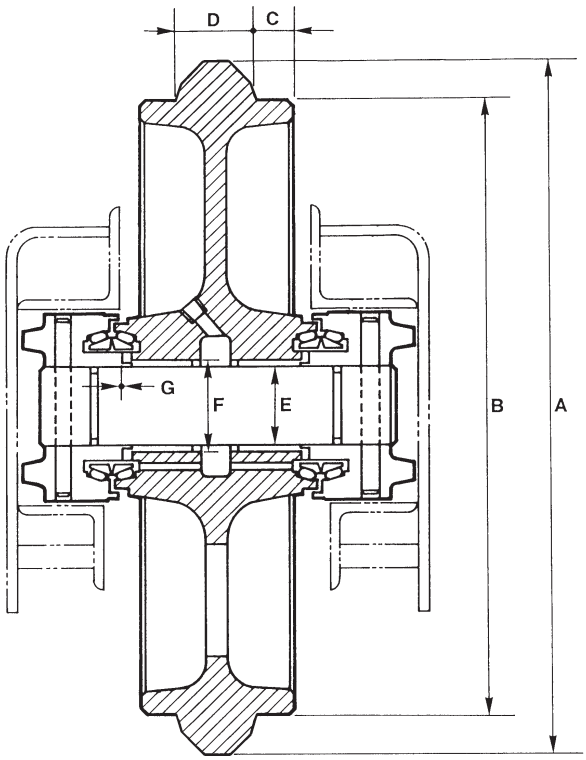
Unit: mm

| Code | Item | Designated Standard | | Servicing Procedure |
|---|---|---|---|---|
| A | Outer Diameter of Brim | Basic Dimension | Allowable Value | Build up or replace. |
| | | 347 | 341 | |
| B | Outer Diameter of Tread | 306 | 300 | |
| C | Width of Tread | 22.5 | 20.5 | |
| D | Width of Brim | 40 | 36 | |
| E | Shaft End Play | Standard Value | Allowable Value | Replace |
| | | 0.9 | 1.4 | |

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■ TB145




G4B013

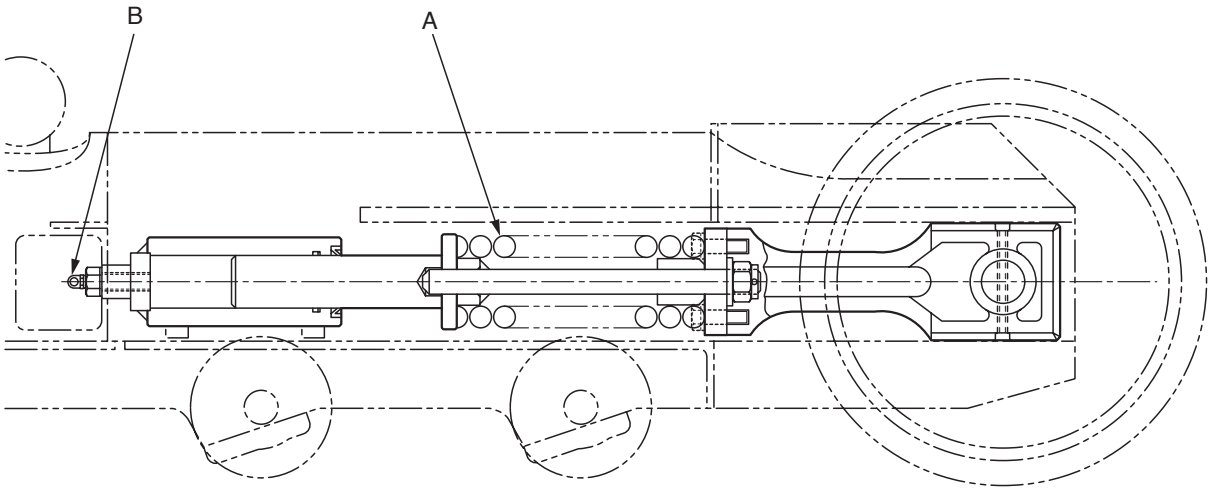
Unit: mm

| Code | Item | Designated Standard | | | | | Servicing Procedure |
|---|---|---|---|---|---|---|---|
| A | Outer Diameter of Brim | Basic Dimension | | | Allowable Value | | Build up or replace. |
| | | 395 | | | 389 | | |
| B | Outer Diameter of Tread | 350 | | | 344 | | |
| C | Width of Tread | 24 | | | 22 | | |
| D | Width of Brim | 38 | | | 34 | | |
| E | Shaft and Bushing Bore Diameter Clearance | Basic Dimension | Allowable Tolerance | | Standard Fit | Allowable Fit | Replace |
| | | | Shaft | Hole | | | |
| | | 45 | -0.050<br>-0.089 | — | — | 1.0 | |
| F | Idler and Bushing Outer Diameter Interference | 49 | +0.15<br>+0.10 | +0.02<br>-0.03 | — | — | |
| G | Shaft End Play | Standard Value | | | Allowable Value | | |
| | | 0.9 | | | 1.4 | | |

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### Track Adjuster




G4B0141

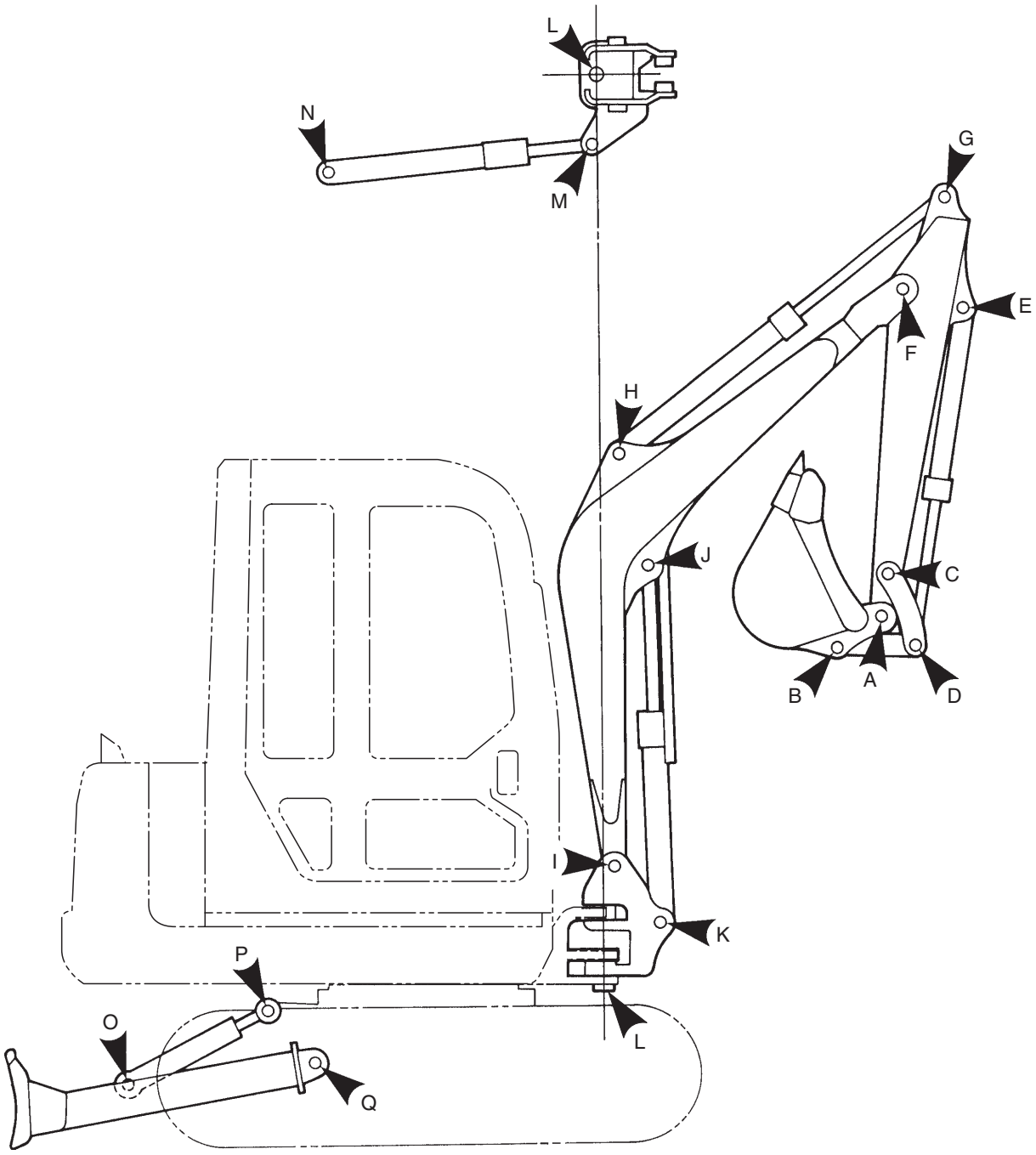
| Code | Item | | Designated Standard | | | Servicing Procedure |
|---|---|---|---|---|---|---|
| | | | Machine Model | Basic Value | Allowable Value | |
| A | Coil Spring | Length when free mm | TB125 | 235 | — | Replace |
| | | | TB135 | 256 | — | |
| | | | TB145 | 270 | — | |
| | | Length when installed mm | TB125 | 190 | — | |
| | | | TB135 | 212 | — | |
| | | | TB145 | 237 | — | |
| | | Set Load kN (kgf) | TB125 | 25.1 (2563) | — | |
| | | | TB135 | 23.3 (2376) | — | |
| | | | TB145 | 30.1 (3072) | — | |
| B | Grease discharge valve tightening torque N·m (kgf·m) | | TB125, TB135, TB145 | 177 (18) | — | Retighten |

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**ATTACHMENTS**

**Pin and Bushing Clearances**




G4B016

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■ TB125

Unit: mm

| Code | Connection Between | Designated Standard | | | | | Servicing Procedure |
|---|---|---|---|---|---|---|---|
| | | Basic Dimensions | Allowable Tolerance | | Standard Clearance | Allowable Clearance | |
| | | | Shaft | Hole | | | |
| A | Bucket & Arm | 35 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| B | Bucket & Link | 35 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| C | Arm & Link | 35 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| D | Bucket Cylinder & Link | 35 | -0.02<br>-0.05 | Link Side<br>+0.15<br>+0.10 | 0.12~0.20 | 1.0 | |
| | | | | Cylinder Side<br>+0.13<br>+0.05 | 0.07~0.18 | | |
| E | Bucket Cylinder & Arm | 35 | -0.02<br>-0.05 | +0.13<br>+0.05 | 0.07~0.18 | 1.0 | |
| F | Arm & Boom | 40 | -0.02<br>-0.05 | +0.15<br>+0.10 | 0.12~0.20 | 1.0 | |
| G | Arm Cylinder & Arm | 40 | -0.02<br>-0.05 | +0.15<br>+0.05 | 0.07~0.20 | 1.0 | |
| H | Arm Cylinder & Boom | 40 | -0.02<br>-0.05 | +0.15<br>+0.05 | 0.07~0.20 | 1.0 | Replace |
| I | Boom & Swing Bracket | 45 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| J | Boom Cylinder & Boom | 40 | -0.02<br>-0.05 | +0.15<br>+0.05 | 0.07~0.20 | 1.0 | |
| K | Boom Cylinder & Swing Bracket | 40 | -0.02<br>-0.05 | +0.15<br>+0.05 | 0.07~0.20 | 1.0 | |
| L | Swing Bracket & Turntable | 65 | -0.02<br>-0.05 | +0.19<br>+0.14 | 0.16~0.24 | 1.0 | |
| M | Swing Cylinder & Swing Bracket | 40 | -0.02<br>-0.05 | +0.16<br>+0.05 | 0.07~0.21 | 1.0 | |
| N | Swing Cylinder & Turntable | 40 | -0.02<br>-0.05 | +0.16<br>+0.05 | 0.07~0.21 | 1.0 | |
| O | Dozer Blade Cylinder & Dozer Blade | 45 | -0.02<br>-0.05 | +0.20<br>+0.05 | 0.07~0.25 | 1.0 | |
| P | Dozer Blade Cylinder & Lower Frame | 45 | -0.02<br>-0.05 | +0.20<br>+0.05 | 0.07~0.25 | 1.0 | |
| Q | Dozer Blade & Lower Frame | 40 | -0.02<br>-0.05 | ±0.05 | 0.07~0.10 | 1.0 | |

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■ TB135

Unit: mm

| Code | Connection Between | Designated Standard | | | | | Servicing Procedure |
|---|---|---|---|---|---|---|---|
| | | Basic Dimensions | Allowable Tolerance | | Standard Clearance | Allowable Clearance | |
| | | | Shaft | Hole | | | |
| A | Bucket & Arm | 40 | -0.02<br>-0.05 | +0.15<br>+0.10 | 0.12~0.20 | 1.0 | |
| B | Bucket & Link | 40 | -0.02<br>-0.05 | +0.15<br>+0.10 | 0.12~0.20 | 1.0 | |
| C | Arm & Link | 40 | -0.02<br>-0.05 | +0.15<br>+0.10 | 0.12~0.20 | 1.0 | |
| D | Bucket Cylinder & Link | 40 | -0.02<br>-0.05 | Link Side<br>+0.15<br>+0.10 | 0.12~0.20 | 1.0 | |
| | | | | Cylinder Side<br>+0.15<br>+0.05 | 0.07~0.20 | | |
| E | Bucket Cylinder & Arm | 40 | -0.02<br>-0.05 | +0.15<br>+0.05 | 0.07~0.20 | 1.0 | |
| F | Arm & Boom | 45 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| G | Arm Cylinder & Arm | 45 | -0.02<br>-0.05 | +0.20<br>+0.05 | 0.07~0.25 | 1.0 | |
| H | Arm Cylinder & Boom | 45 | -0.02<br>-0.05 | +0.20<br>+0.05 | 0.07~0.25 | 1.0 | Replace |
| I | Boom & Swing Bracket | 50 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| J | Boom Cylinder & Boom | 45 | -0.02<br>-0.05 | +0.20<br>+0.05 | 0.07~0.25 | 1.0 | |
| K | Boom Cylinder & Swing Bracket | 45 | -0.02<br>-0.05 | +0.20<br>+0.05 | 0.07~0.25 | 1.0 | |
| L | Swing Bracket & Turntable | 70 | -0.02<br>-0.05 | +0.19<br>+0.14 | 0.16~0.24 | 1.0 | |
| M | Swing Cylinder & Swing Bracket | 45 | -0.02<br>-0.05 | +0.25<br>+0.05 | 0.07~0.30 | 1.0 | |
| N | Swing Cylinder & Turntable | 45 | -0.02<br>-0.05 | +0.25<br>+0.05 | 0.07~0.30 | 1.0 | |
| O | Dozer Blade Cylinder & Dozer Blade | 55 | -0.02<br>-0.05 | +0.20<br>+0.05 | 0.07~0.25 | 1.0 | |
| P | Dozer Blade Cylinder & Lower Frame | 55 | -0.02<br>-0.05 | +0.20<br>+0.05 | 0.07~0.25 | 1.0 | |
| Q | Dozer Blade & Lower Frame | 40 | -0.02<br>-0.05 | ±0.05 | 0.07~0.10 | 1.0 | |

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■ TB145

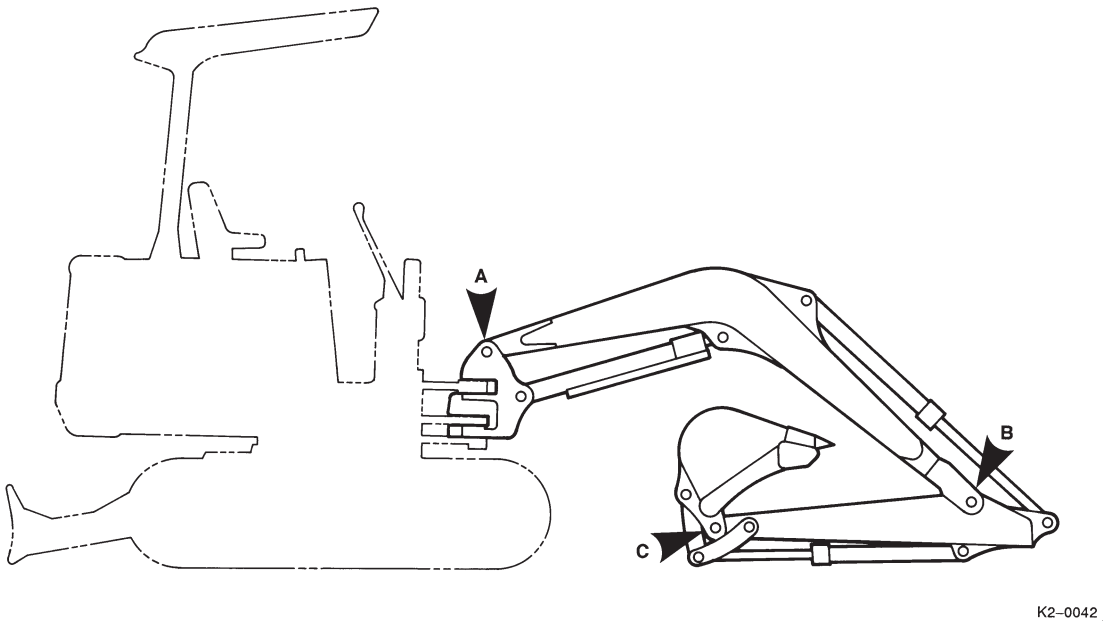
Unit: mm

| Code | Connection Between | Designated Standard | | | | | Servicing Procedure |
|---|---|---|---|---|---|---|---|
| | | Basic Dimensions | Allowable Tolerance | | Standard Clearance | Allowable Clearance | |
| | | | Shaft | Hole | | | |
| A | Bucket & Arm | 45 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| B | Bucket & Link | 45 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| C | Arm & Link | 45 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| D | Bucket Cylinder & Link | 45 | -0.02<br>-0.05 | Link Side<br>+0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| | | | | Cylinder Side<br>+0.1<br>0 | 0.02~0.15 | | |
| E | Bucket Cylinder & Arm | 45 | -0.02<br>-0.05 | +0.1<br>0 | 0.02~0.15 | 1.0 | |
| F | Arm & Boom | 50 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| G | Arm Cylinder & Arm | 50 | -0.02<br>-0.05 | +0.1<br>0 | 0.02~0.15 | 1.0 | |
| H | Arm Cylinder & Boom | 50 | -0.02<br>-0.05 | +0.1<br>0 | 0.02~0.15 | 1.0 | Replace |
| I | Boom & Swing Bracket | 55 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |
| J | Boom Cylinder & Boom | 50 | -0.02<br>-0.05 | +0.1<br>0 | 0.02~0.15 | 1.0 | |
| K | Boom Cylinder & Swing Bracket | 50 | -0.02<br>-0.05 | +0.1<br>0 | 0.02~0.15 | 1.0 | |
| L | Swing Bracket & Turntable | 85 | -0.02<br>-0.05 | +0.19<br>+0.14 | 0.16~0.24 | 1.0 | |
| M | Swing Cylinder & Swing Bracket | 45 | -0.02<br>-0.05 | +0.1<br>0 | 0.02~0.15 | 1.0 | |
| N | Swing Cylinder & Turntable | 45 | -0.02<br>-0.05 | +0.1<br>0 | 0.02~0.15 | 1.0 | |
| O | Dozer Blade Cylinder & Dozer Blade | 55 | -0.02<br>-0.05 | +0.12<br>0 | 0.02~0.17 | 1.0 | |
| P | Dozer Blade Cylinder & Lower Frame | 55 | -0.02<br>-0.05 | +0.12<br>0 | 0.02~0.17 | 1.0 | |
| Q | Dozer Blade & Lower Frame | 55 | -0.02<br>-0.05 | +0.17<br>+0.12 | 0.14~0.22 | 1.0 | |

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### Axial Clearances for Boom, Arm and Bucket

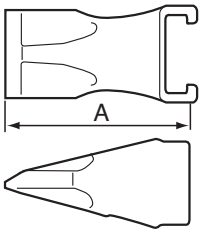



Unit: mm

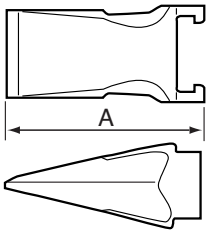
| Code | Item | Designated Standard | | Servicing Procedure |
|---|---|---|---|---|
| A | Side of Boom Foot | Standard Clearance | Allowable Clearance | Adjust shim |
| | | 0.2~0.5 | — | |
| B | Side of Arm Center | 0.2~0.5 | — | |
| C | Side of Arm Point | 0.2~0.5 | — | |

### Tooth

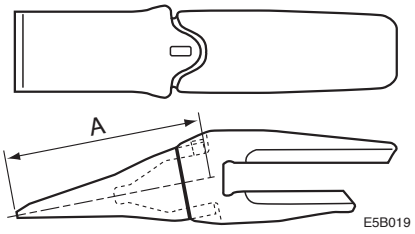
<ESCOV13>




<ESCOV17S>




<ESCO18S>




Unit: mm

| Code | Item | | Designated Standard | | Servicing Procedure |
|---|---|---|---|---|---|
| A | Wear of Tooth | Type | Basic Dimension | Allowable Values | Replace |
| | | ESCOV13 | 107 | 80 | |
| | | ESCOV17S | 117 | 85 | |
| | | ESCO18S | 135 | 100 | |
| | Damage to Point | | Even though small, if hole developes | | |

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# STANDARDS FOR JUDGING PERFORMANCE

## REFERENCE VALUE TABLE

| Machine Model | | | TB125 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Serial Number | | | 12510003~12511921 | | 12511922~12512125 | | 12512126~12514525 | | 12514526~ | |
| Item | | Unit | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values |
| Hydraulic Oil Pressure | | | | | | | | | | |
| Boom | | MPa | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — |
| Arm | | MPa | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — |
| Dozer Blade | | MPa | $19.6^{+1}_{-0.2}$ | — | $19.6^{+1}_{-0.2}$ | — | $19.6^{+1}_{-0.2}$ | — | $19.6^{+1}_{-0.2}$ | — |
| Slewing | | MPa | $17.6^{+2.5}_{0}$ | — | $17.6^{+2.5}_{0}$ | — | $17.6^{+2.5}_{0}$ | — | $17.6^{+2.5}_{0}$ | — |
| Pilot Pressure | | MPa | 3.3 ±0.4 | — | 3.5 ±0.3 | — | 3.6 ±0.3 | — | 3.6 ±0.3 | — |
| Travel | | | | | | | | | | |
| Travel Speed (5 rev.) | | | | | | | | | | |
| Steel Crawler | Low Speed | s | 27.2 ±1.5 | 31.4 | 27.2 ±1.5 | 31.4 | 27.9 ±1.5 | 32.2 | 28.3 ±1.5 | 32.6 |
| | High Speed | s | 15.4 ±1.2 | 18.8 | 15.4 ±1.2 | 18.8 | 15.6 ±1.2 | 19.0 | 15.7 ±1.2 | 19.1 |
| Rubber Crawler | Low Speed | s | 27.3 ±1.5 | 31.5 | 27.3 ±1.5 | 31.5 | 28.0 ±1.5 | 32.3 | 28.2 ±1.5 | 32.5 |
| | High Speed | s | 15.5 ±1.0 | 18.7 | 15.5 ±1.0 | 18.7 | 15.7 ±1.0 | 18.9 | 15.8 ±1.0 | 19.0 |
| Travel Speed (10 m) | | | | | | | | | | |
| Steel Crawler | Low Speed | s | 13.6 ±1.2 | 16.2 | 13.6 ±1.2 | 16.2 | 14.0 ±1.2 | 16.6 | 14.2 ±1.2 | 16.6 |
| | High Speed | s | 7.7 ±1.0 | 9.8 | 7.7 ±1.0 | 9.8 | 8.0 ±1.0 | 10.1 | 8.1 ±1.0 | 10.2 |
| Rubber Crawler | Low Speed | s | 13.4 ±1.0 | 15.7 | 13.4 ±1.0 | 15.7 | 13.8 ±1.0 | 16.2 | 13.8 ±1.0 | 16.2 |
| | High Speed | s | 7.6 ±0.6 | 9.3 | 7.6 ±0.6 | 9.3 | 7.8 ±0.6 | 9.5 | 7.8 ±0.6 | 9.5 |
| Travel Curve | | mm | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 |
| Natural Travel Drop | | mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Slew | | | | | | | | | | |
| Slew Time | | s | 12.4 ±1.0 | 14.6 | 12.4 ±1.0 | 14.6 | 12.2 ±1.0 | 14.4 | 12.2 ±1.0 | 14.4 |
| Overrun When Slewing Stops | | mm | 100 ±50 | 193 | 80 ±50 | 164 | 90 ±50 | 179 | 90 ±50 | 179 |
| Natural Slew Drop | | mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cylinders | | | | | | | | | | |
| Cylinder Speed | | | | | | | | | | |
| Boom | Extended | s | 2.4 ±0.5 | 3.1 | 2.4 ±0.5 | 3.1 | 2.4 ±0.4 | 3.0 | 2.4 ±0.4 | 3.0 |
| | Retracted | s | 2.5 ±0.5 | 3.3 | 2.5 ±0.5 | 3.3 | 2.5 ±0.4 | 3.2 | 2.5 ±0.4 | 3.2 |
| Arm | Extended | s | 3.2 ±0.4 | 3.9 | 3.2 ±0.4 | 3.9 | 3.1 ±0.4 | 3.8 | 3.1 ±0.4 | 3.8 |
| | Retracted | s | 3.1 ±0.4 | 3.8 | 3.1 ±0.4 | 3.8 | 3.2 ±0.4 | 3.9 | 3.2 ±0.4 | 3.9 |
| Bucket | Extended | s | 2.8 ±0.4 | 3.5 | 2.8 ±0.4 | 3.5 | 3.0 ±0.4 | 3.7 | 3.0 ±0.4 | 3.7 |
| | Retracted | s | 2.0 ±0.4 | 2.6 | 2.0 ±0.4 | 2.6 | 2.0 ±0.3 | 2.5 | 2.0 ±0.3 | 2.5 |
| Dozer Blade | Extended | s | 2.6 ±0.4 | 3.3 | 2.4 ±0.4 | 3.0 | 2.4 ±0.4 | 3.0 | 2.4 ±0.4 | 3.0 |
| | Retracted | s | 2.4 ±0.4 | 3.0 | 2.2 ±0.4 | 2.8 | 2.3 ±0.4 | 2.9 | 2.3 ±0.4 | 2.9 |
| Swing | Extended | s | 4.9 ±0.7 | 6.1 | 4.9 ±0.7 | 6.1 | 5.0 ±0.7 | 6.2 | 5.0 ±0.7 | 6.2 |
| | Retracted | s | 4.7 ±0.7 | 5.9 | 4.7 ±0.7 | 5.9 | 4.7 ±0.7 | 5.8 | 4.7 ±0.7 | 5.8 |

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| Machine Model | | | TB125 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Serial Number | | | 12510003~12511921 | | 12511922~12512125 | | 12512126~12514525 | | 12514526~ | |
| Item | | Unit | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values |
| Cylinders | | | | | | | | | | |
| Natural Cylinder Drop | | | | | | | | | | |
| Boom | | mm | $10^{0}_{-10}$ | 20 | $10^{0}_{-10}$ | 20 | $10^{0}_{-10}$ | 20 | $10^{0}_{-10}$ | 20 |
| Arm | | mm | $8^{0}_{-8}$ | 16 | $8^{0}_{-8}$ | 16 | $8^{0}_{-8}$ | 16 | $8^{0}_{-8}$ | 16 |
| Bucket | | mm | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 |
| Dozer Blade | | mm | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 |
| Swing | | mm | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 |
| Bucket Tip | | mm | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 |
| Levers | | | | | | | | | | |
| Lever Operating Force | | | | | | | | | | |
| Boom | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | |
| Arm | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | |
| Bucket | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | |
| Slew | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | |
| Travel | | N | 12 ±5 | | 12 ±5 | | 12 ±5 | | 12 ±5 | |
| Dozer Blade | | N | 30 ±8 | | 30 ±8 | | 30 ±8 | | 30 ±8 | |
| Swing | | N | 51 ±15 | | 51 ±15 | | 51 ±15 | | 51 ±15 | |
| Lever Play | | | | | | | | | | |
| Boom | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Arm | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Bucket | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Slew | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Travel | | mm | $15^{0}_{-15}$ | | $15^{0}_{-15}$ | | $15^{0}_{-15}$ | | $15^{0}_{-15}$ | |
| Dozer Blade | | mm | $25^{0}_{-25}$ | | $25^{0}_{-25}$ | | $25^{0}_{-25}$ | | $25^{0}_{-25}$ | |
| Slew Bearing | | | | | | | | | | |
| Backlash | | mm | 15 ±8 | 53 | 15 ±8 | 53 | 15 ±8 | 53 | 15 ±8 | 53 |
| Slew Bearing Play | | mm | 0.7 ±0.4 | 1.8 | 0.7 ±0.4 | 1.8 | 0.7 ±0.4 | 1.8 | 0.7 ±0.4 | 1.8 |
| Crawler | | | | | | | | | | |
| Crawler Tension | Steel | mm | 144~154 | — | 144~154 | — | 144~154 | — | 144~154 | — |
| | Rubber | mm | 77~87 | — | 77~87 | — | 77~87 | — | 77~87 | — |

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| Machine Model | | | TB135 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Serial Number | | | 13510004~13510348 | | 13510349~13512532 | | 13512533~13514050 | | 13514051~ | |
| Item | | Unit | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values |
| Hydraulic Oil Pressure | | | | | | | | | | |
| Boom | | MPa | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1.2}_{-0.3}$ | — |
| Arm | | MPa | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1.2}_{-0.3}$ | — |
| Dozer Blade | | MPa | $19.6^{+1}_{-0.2}$ | — | $19.6^{+1}_{-0.2}$ | — | $19.6^{+1}_{-0.2}$ | — | $19.6^{+1.2}_{-0.2}$ | — |
| Slewing | | MPa | $18.6^{+2}_{0}$ | — | $19.1^{+2}_{0}$ | — | $19.1^{+1.5}_{0}$ | — | $19.1^{+1.5}_{0}$ | — |
| Pilot Pressure | | MPa | 4.2 ±0.4 | — | 4.2 ±0.4 | — | 3.9 ±0.3 | — | 4.0 ±0.3 | — |
| Travel | | | | | | | | | | |
| Travel Speed (5 rev.) | | | | | | | | | | |
| Steel Crawler | Low Speed | s | 30.1 ±1.5 | 34.6 | 32.2 ±1.5 | 36.9 | 32.2 ±1.5 | 36.9 | 37.1 ±1.5 | 36.4 |
| | High Speed | s | 17.0 ±1.0 | 20.4 | 17.5 ±1.0 | 21 | 17.5 ±1.0 | 21 | 17.1 ±1.0 | 20.5 |
| Rubber Crawler | Low Speed | s | 30.1 ±1.5 | 34.6 | 32.2 ±1.5 | 36.9 | 32.2 ±1.5 | 36.9 | 32.0 ±1.5 | 36.7 |
| | High Speed | s | 17.0 ±1.0 | 20.4 | 17.5 ±1.0 | 21 | 17.5 ±1.0 | 21 | 17.4 ±1.0 | 20.8 |
| Travel Speed (10 m) | | | | | | | | | | |
| Steel Crawler | Low Speed | s | 14.5 ±1.2 | 17.2 | 15.6 ±1.2 | 18.6 | 15.6 ±1.2 | 18.4 | 14.8 ±1.2 | 17.5 |
| | High Speed | s | 8.3 ±0.6 | 10.1 | 8.6 ±0.6 | 10.4 | 8.6 ±0.6 | 10.4 | 8.1 ±1.0 | 10.2 |
| Rubber Crawler | Low Speed | s | 13.4 ±1.0 | 15.7 | 14.3 ±1.0 | 16.7 | 14.3 ±1.0 | 16.7 | 14.2 ±1.0 | 16.6 |
| | High Speed | s | 7.7 ±0.6 | 9.4 | 7.9 ±0.6 | 9.6 | 7.9 ±0.6 | 9.6 | 8.1 ±0.7 | 9.9 |
| Travel Curve | | mm | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 |
| Natural Travel Drop | | mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Slew | | | | | | | | | | |
| Slew Time | | s | 13.0 ±1.0 | 15.3 | 12.6 ±1.0 | 14.9 | 12.5 ±1.0 | 14.8 | 12.6 ±1.0 | 14.9 |
| Overrun When Slewing Stops | | mm | 100 ±50 | 193 | 100 ±50 | 193 | 90 ±55 | 184 | 90 ±55 | 184 |
| Natural Slew Drop | | mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cylinders | | | | | | | | | | |
| Cylinder Speed | | | | | | | | | | |
| Boom | Extended | s | 2.9 ±0.5 | 3.7 | 2.9 ±0.5 | 3.7 | 2.9 ±0.5 | 3.7 | 2.6 ±0.5 | 3.4 |
| | Retracted | s | 2.9 ±0.5 | 3.7 | 3.1 ±0.5 | 3.9 | 3.1 ±0.5 | 3.9 | 2.8 ±0.5 | 3.6 |
| Arm | Extended | s | 3.7 ±0.4 | 4.5 | 3.7 ±0.4 | 4.5 | 3.7 ±0.4 | 4.5 | 3.7 ±0.5 | 4.6 |
| | Retracted | s | 3.5 ±0.4 | 4.3 | 3.5 ±0.4 | 4.3 | 3.5 ±0.4 | 4.3 | 3.5 ±0.5 | 4.4 |
| Bucket | Extended | s | 3.4 ±0.4 | 4.1 | 3.4 ±0.4 | 4.1 | 3.4 ±0.4 | 4.1 | 3.2 ±0.4 | 3.9 |
| | Retracted | s | 2.3 ±0.4 | 2.9 | 2.3 ±0.4 | 2.9 | 2.3 ±0.4 | 2.9 | 2.3 ±0.4 | 2.9 |
| Dozer Blade | Extended | s | 3.4 ±0.4 | 3.9 | 3.3 ±0.4 | 4.0 | 3.0 ±0.4 | 3.7 | 3.2 ±0.4 | 3.9 |
| | Retracted | s | 3.2 ±0.4 | 3.9 | 3.3 ±0.4 | 4.0 | 3.0 ±0.4 | 3.7 | 3.2 ±0.4 | 3.9 |
| Swing | Extended | s | 4.8 ±0.7 | 6.0 | 4.8 ±0.7 | 6.0 | 4.8 ±0.7 | 6.0 | 4.7 ±0.7 | 5.9 |
| | Retracted | s | 4.8 ±0.7 | 6.0 | 4.8 ±0.7 | 6.0 | 4.8 ±0.7 | 6.0 | 4.7 ±0.7 | 5.9 |

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| Machine Model | | | TB135 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Serial Number | | | 13510004~13510348 | | 13510349~13512532 | | 13512533~13514050 | | 13514051~ | |
| Item | | Unit | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values |
| Cylinders | | | | | | | | | | |
| Natural Cylinder Drop | | | | | | | | | | |
| Boom | | mm | $10^{0}_{-10}$ | 20 | $10^{0}_{-10}$ | 20 | $10^{0}_{-10}$ | 20 | $10^{0}_{-10}$ | 20 |
| Arm | | mm | $8^{0}_{-8}$ | 16 | $8^{0}_{-8}$ | 16 | $8^{0}_{-8}$ | 16 | $8^{0}_{-8}$ | 16 |
| Bucket | | mm | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 |
| Dozer Blade | | mm | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 |
| Swing | | mm | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 |
| Bucket Tip | | mm | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 |
| Levers | | | | | | | | | | |
| Lever Operating Force | | | | | | | | | | |
| Boom | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | — | | — | |
| Arm | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | — | | — | |
| Bucket | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | — | | — | |
| Slew | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | — | | — | |
| Travel | | N | 10.8 ±4.9 | | 12 ±5 | | 12 ±5 | | 12 ±5 | |
| Dozer Blade | | N | 27.5 ±9.8 | | 30 ±8 | | 30 ±8 | | 30 ±8 | |
| Swing | | N | 49.0 ±14.7 | | 51 ±15 | | 51 ±15 | | 51 ±15 | |
| Lever Play | | | | | | | | | | |
| Boom | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Arm | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Bucket | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Slew | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Travel | | mm | $15^{0}_{-15}$ | | $15^{0}_{-15}$ | | $15^{0}_{-15}$ | | $15^{0}_{-15}$ | |
| Dozer Blade | | mm | $25^{0}_{-25}$ | | $25^{0}_{-25}$ | | $25^{0}_{-25}$ | | $25^{0}_{-25}$ | |
| Slew Bearing | | | | | | | | | | |
| Backlash | | mm | 20 ±13 | 73 | 21 ±10 | 73 | 21 ±10 | 73 | 21 ±10 | 73 |
| Slew Bearing Play | | mm | 0.8 ±0.5 | 2.0 | 0.8 ±0.5 | 2.0 | 0.8 ±0.5 | 2.0 | 0.8 ±0.5 | 2.0 |
| Crawler | | | | | | | | | | |
| Crawler Tension | Steel | mm | 144~154 | — | 144~154 | — | 144~154 | — | 144~154 | — |
| | Rubber | mm | 77~87 | — | 77~87 | — | 77~87 | — | 77~87 | — |

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| Machine Model | | | TB145 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Serial Number | | | 14510004~14512075 | | 14512076~14512498 | | 14512499~14513260 | | 14513261~ | |
| Item | | Unit | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values |
| Hydraulic Oil Pressure | | | | | | | | | | |
| Boom | | MPa | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1.2}_{-0.3}$ | — |
| Arm | | MPa | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1}_{-0.2}$ | — | $20.6^{+1.2}_{-0.3}$ | — |
| Dozer Blade | | MPa | $19.6^{+1}_{-0.2}$ | — | $19.6^{+1}_{-0.2}$ | — | $19.6^{+1}_{-0.2}$ | — | $19.6^{+1.2}_{-0.2}$ | — |
| Slewing | | MPa | $18.6^{+2}_{0}$ | — | $18.6^{+2}_{0}$ | — | $18.6^{+2}_{0}$ | — | $18.6^{+2.2}_{0}$ | — |
| Pilot Pressure | | MPa | 3.5 ±0.3 | — | 3.6 ±0.3 | — | 3.6 ±0.3 | — | 3.6 ±0.3 | — |
| Travel | | | | | | | | | | |
| Travel Speed (5 rev.) | | | | | | | | | | |
| Steel Crawler | Low Speed | s | 34.3 ±1.5 | 39.2 | 34.3 ±1.5 | 39.2 | 35.5 ±1.7 | 40.8 | 35.6 ±1.7 | 40.9 |
| | High Speed | s | 19.7 ±1.0 | 23.5 | 19.7 ±1.0 | 23.5 | 21.2 ±1.2 | 25.4 | 21.4 ±1.2 | 25.6 |
| Rubber Crawler | Low Speed | s | 33.4 ±1.5 | 38.2 | 33.4 ±1.5 | 38.2 | 34.4 ±1.5 | 39.3 | 34.5 ±1.5 | 39.5 |
| | High Speed | s | 19.2 ±1.0 | 22.9 | 19.2 ±1.0 | 22.9 | 20.3 ±1.0 | 24.1 | 20.5 ±1.0 | 24.4 |
| Travel Speed (10 m) | | | | | | | | | | |
| Steel Crawler | Low Speed | s | 13.3 ±1.2 | 15.8 | 13.3 ±1.2 | 15.8 | 13.7 ±1.3 | 16.4 | 13.8 ±1.5 | 16.7 |
| | High Speed | s | 7.8 ±1.0 | 9.9 | 7.8 ±1.0 | 9.9 | 8.4 ±1.0 | 10.6 | 8.6 ±1.2 | 11.0 |
| Rubber Crawler | Low Speed | s | 12.5 ±1.0 | 14.8 | 12.5 ±1.0 | 14.8 | 12.8 ±1.1 | 15.2 | 13.1 ±1.2 | 15.6 |
| | High Speed | s | 7.6 ±0.7 | 9.4 | 7.6 ±0.7 | 9.4 | 7.8 ±0.7 | 9.6 | 8.2 ±1.0 | 10.3 |
| Travel Curve | | mm | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 |
| Natural Travel Drop | | mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Slew | | | | | | | | | | |
| Slew Time | | s | 12.3 ±0.8 | 14.3 | 12.4 ±0.8 | 14.4 | 12.4 ±0.8 | 14.4 | 12.6 ±1.0 | 14.9 |
| Overrun When Slewing Stops | | mm | 200 ±60 | 346 | 160 ±60 | 289 | 160 ±60 | 289 | 160 ±60 | 289 |
| Natural Slew Drop | | mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cylinders | | | | | | | | | | |
| Cylinder Speed | | | | | | | | | | |
| Boom | Extended | s | 3.1 ±0.5 | 3.9 | 3.1 ±0.5 | 3.9 | 3.1 ±0.5 | 3.9 | 3.0 ±0.5 | 3.8 |
| | Retracted | s | 3.1 ±0.5 | 3.9 | 3.1 ±0.5 | 3.9 | 3.1 ±0.5 | 3.9 | 3.0 ±0.5 | 3.8 |
| Arm | Extended | s | 3.4 ±0.4 | 4.1 | 3.4 ±0.4 | 4.1 | 3.4 ±0.4 | 4.1 | 3.4 ±0.4 | 4.1 |
| | Retracted | s | 2.5 ±0.4 | 3.2 | 2.5 ±0.4 | 3.2 | 2.5 ±0.4 | 3.2 | 2.6 ±0.4 | 3.3 |
| Bucket | Extended | s | 3.4 ±0.4 | 4.1 | 3.4 ±0.4 | 4.1 | 3.4 ±0.4 | 4.1 | 3.2 ±0.4 | 3.9 |
| | Retracted | s | 2.4 ±0.4 | 3.0 | 2.4 ±0.4 | 3.0 | 2.4 ±0.4 | 3.0 | 2.3 ±0.4 | 2.9 |
| Dozer Blade | Extended | s | 2.9 ±0.4 | 3.6 | 2.8 ±0.4 | 3.5 | 2.8 ±0.4 | 3.5 | 2.8 ±0.4 | 3.5 |
| | Retracted | s | 2.6 ±0.4 | 3.3 | 2.4 ±0.4 | 3.0 | 2.4 ±0.4 | 3.0 | 2.4 ±0.4 | 3.0 |
| Swing | Extended | s | 5.1 ±0.8 | 6.4 | 5.1 ±0.8 | 6.4 | 5.1 ±0.8 | 6.4 | 5.2 ±0.8 | 6.5 |
| | Retracted | s | 5.1 ±0.8 | 6.4 | 5.1 ±0.8 | 6.4 | 5.1 ±0.8 | 6.4 | 5.2 ±0.8 | 6.5 |

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| Machine Model | | | TB145 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Serial Number | | | 14510004~14512075 | | 14512076~14512498 | | 14512499~14513260 | | 14513261~ | |
| Item | | Unit | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values | Standard Values | Allowable Values |
| Cylinders | | | | | | | | | | |
| Natural Cylinder Drop | | | | | | | | | | |
| Boom | | mm | $10^{0}_{-10}$ | 20 | $10^{0}_{-10}$ | 20 | $10^{0}_{-10}$ | 20 | $10^{0}_{-10}$ | 20 |
| Arm | | mm | $6^{0}_{-6}$ | 12 | $6^{0}_{-6}$ | 12 | $6^{0}_{-6}$ | 12 | $6^{0}_{-6}$ | 12 |
| Bucket | | mm | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 |
| Dozer Blade | | mm | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 |
| Swing | | mm | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 | $5^{0}_{-5}$ | 10 |
| Bucket Tip | | mm | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 | $125^{0}_{-125}$ | 500 |
| Levers | | | | | | | | | | |
| Lever Operating Force | | | | | | | | | | |
| Boom | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | | — | |
| Arm | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | | — | |
| Bucket | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | | — | |
| Slew | | N | 6.9 ±3.9 | | 6.9 ±3.9 | | 6.9 ±3.9 | | — | |
| Travel | | N | 12.7 ±4.9 | | 12.7 ±4.9 | | 12.7 ±4.9 | | 13 ±5 | |
| Dozer Blade | | N | 32.4 ±7.8 | | 32.4 ±7.8 | | 32.4 ±7.8 | | 32 ±8 | |
| Swing | | N | 54.9 ±14.7 | | 54.9 ±14.7 | | 54.9 ±14.7 | | 55 ±15 | |
| Lever Play | | | | | | | | | | |
| Boom | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Arm | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Bucket | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Slew | | mm | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | | $4.0^{0}_{-4}$ | |
| Travel | | mm | $15^{0}_{-15}$ | | $15^{0}_{-15}$ | | $15^{0}_{-15}$ | | $15^{0}_{-15}$ | |
| Dozer Blade | | mm | $25^{0}_{-25}$ | | $25^{0}_{-25}$ | | $25^{0}_{-25}$ | | $25^{0}_{-25}$ | |
| Slew Bearing | | | | | | | | | | |
| Backlash | | mm | 17 ±10 | 61 | 17 ±10 | 61 | 17 ±10 | 61 | 17 ±10 | 61 |
| Slew Bearing Play | | mm | 0.6 ±0.5 | 2.0 | 0.6 ±0.5 | 2.0 | 0.6 ±0.5 | 2.0 | 0.6 ±0.5 | 2.0 |
| Crawler | | | | | | | | | | |
| Crawler Tension | Steel | mm | 172~192 | — | 172~192 | — | 172~192 | — | 172~192 | — |
| | Rubber | mm | 108~118 | — | 108~118 | — | 108~118 | — | 108~118 | — |

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## METHODS FOR INSPECTING PERFORMANCE

### Hydraulic Oil Pressure (Main Relief Valve Set Pressure)

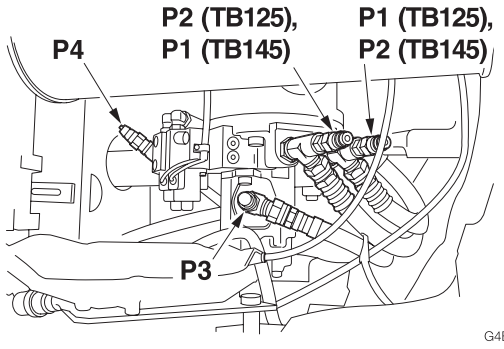
### Boom, Arm, Dozer Blade

Measuring Method

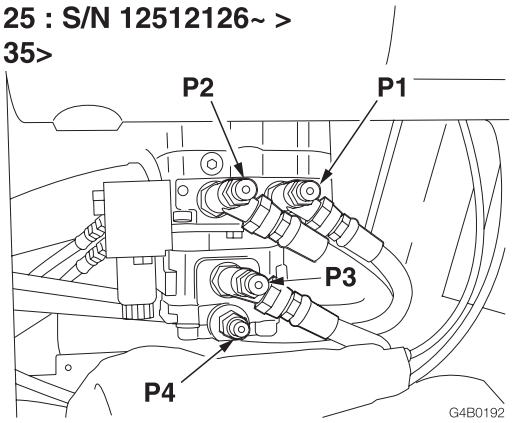
- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Mount the pressure gauge on the pressure detection port, operate the desired hydraulic circuit and measure the relief pressure.

| Circuit | Pressure Detection Port | | Relief Valve |
|---|---|---|---|
| | Port Position | Size | |
| Boom | P1 | G1/4 | R1 |
| Arm | P2 | G1/4 | R2 |
| Dozer Blade | P3 | G1/4 | R3 |

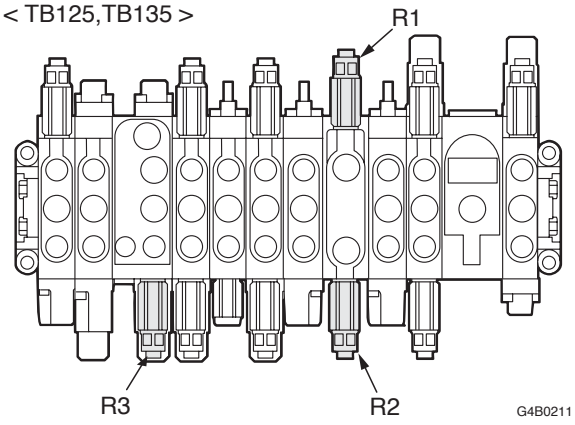
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**<TB145>**



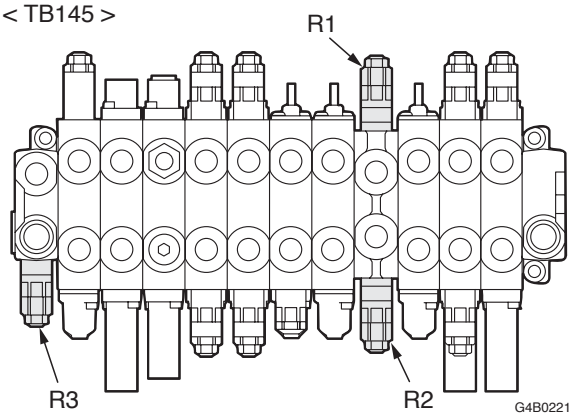

**<TB125 : S/N 12512126~ >**
**<TB135>**




< TB125,TB135 >




< TB145 >



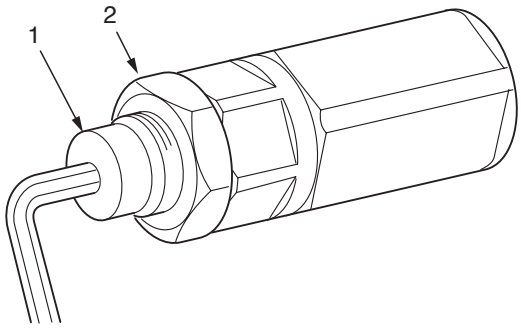
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### Adjusting Method

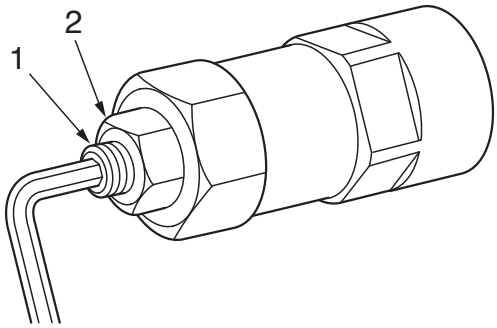
1. Loosen locknut (2), then begin adjusting pressure by turning setting screw (1).
   Turning clockwise ..... raises the set pressure.
   Turning counterclockwise .... lowers the set pressure.
2. In order to keep the setting screw from turning after pressure has been adjusted, tighten the locknut while at the same time holding the setting screw firmly in place.
   - Locknut tightening torque:
     20 N·m (2 kgf·m) .....TB125, TB135
     27~31 N·m (2.8~3.2 kgf·m) ...TB145
3. Operate the relief valve once more to confirm that the pressure that has been set it stabilized.

< TB125,TB135 >




G4B0231

< TB145 >




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**Hydraulic Oil Pressure (Slewing Relief Valve Set Pressure)**

Measuring Method

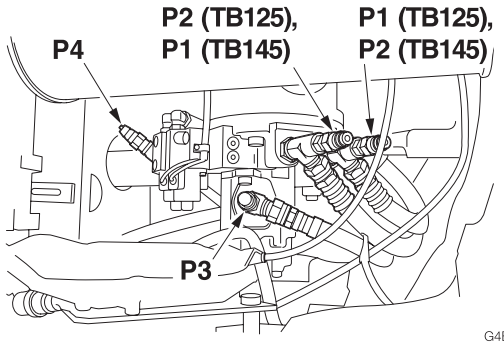
- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Mount the pressure gauge on the pressure detection port and set a solid obstacle so that the upperstructure cannot slew in the direction to be measured. Next, operate the circuit to be measured and measure the relief pressure.

| Circuit | Pressure Detection Port | | Relief Valve |
|---|---|---|---|
| | Port Position | Size | |
| Right Slew | P3 | G1/4 | R1 |
| Left Slew | | G1/4 | R2 |

Adjusting Method

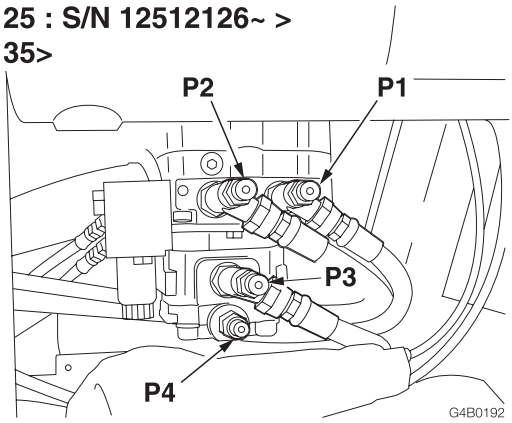
1. Loosen locknut (2), then begin adjusting pressure by turning setting screw (1).
   Turning clockwise ..... raises the set pressure.
   Turning counterclockwise .... lowers the set pressure.
2. In order to keep the setting screw from turning after pressure has been adjusted, tighten the locknut while at the same time holding the setting screw firmly in place.
3. Operate the relief valve once more to confirm that the pressure that has been set it stabilized.

**<TB125 : S/N 12510003~12512125>**
**<TB145>**



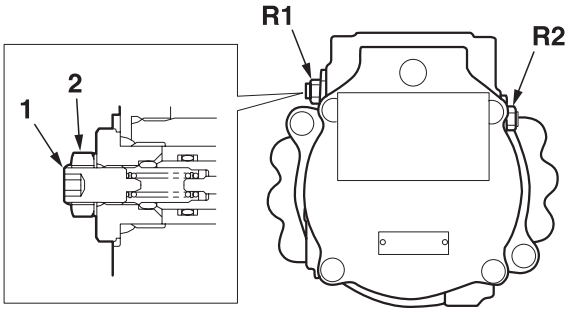
G4B0202

**<TB125 : S/N 12512126~ >**
**<TB135>**



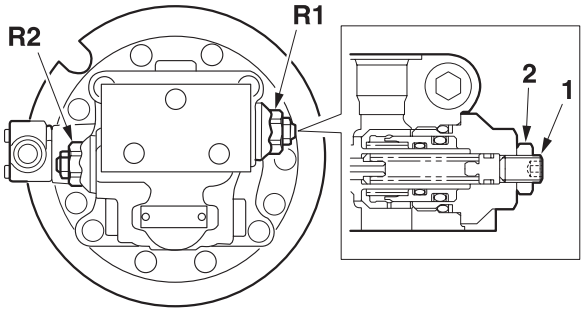
G4B0192

**<TB125, TB135>**
**<TB145 : S/N 14513261~ >**



E5B0261

**<TB145 : S/N 14510004~14513260>**



K3B0261

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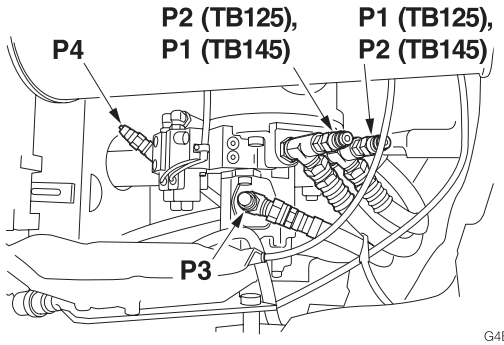
**Hydraulic Oil Pressure (Pilot Relief Valve Set Pressure)**

Measuring Method

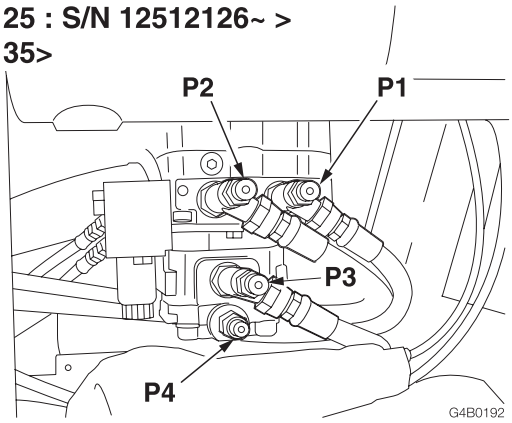
- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Mount pressure gauge on the pressure detection port and measure the pilot relief pressure.

| Pressure Detection Port | | Relief Valve |
|---|---|---|
| Port Position | Size | |
| P4 | G1/4 | R4 |

**<TB125 : S/N 12510003~12512125>**
**<TB145>**



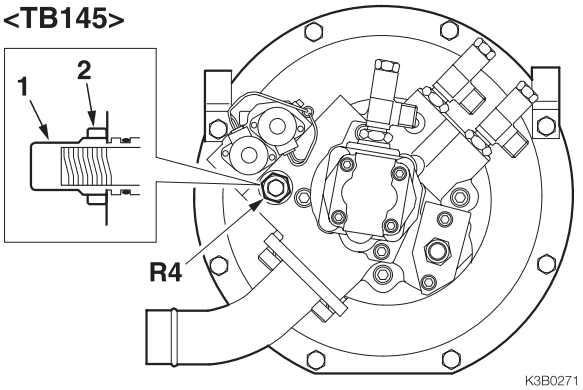

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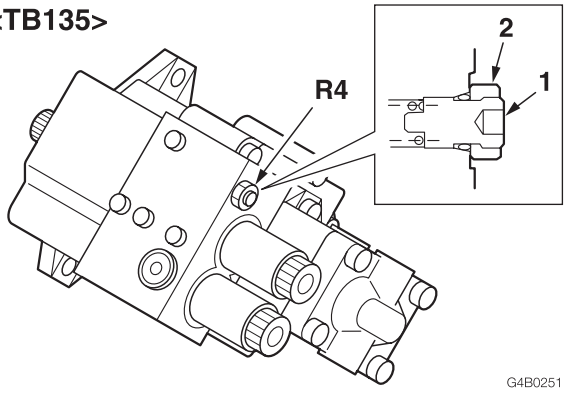

Adjusting Method

1. Loosen locknut (2), then begin adjusting pressure by turning setting screw (1).
   Turning clockwise ..... raises the set pressure.
   Turning counterclockwise .... lowers the set pressure.
2. In order to keep the setting screw from turning after pressure has been adjusted, tighten the locknut while at the same time holding the setting screw firmly in place.
3. Operate the relief valve once more to confirm that the pressure that has been set it stabilized.

**<TB125 : S/N 12510003~12512125>**
**<TB145>**




**<TB125 : S/N 12512126~ >**
**<TB135>**

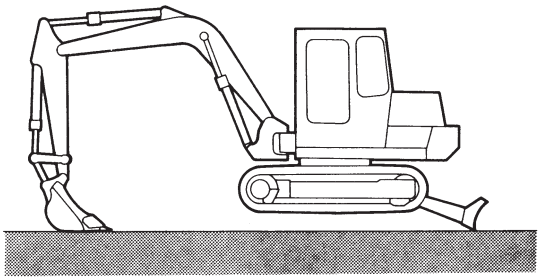


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**Travel Speed (5 Revolutions)**

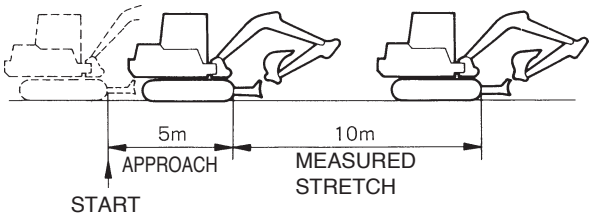
- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Measurement Posture : Excavator body raised using both hoe attachment and dozer blade.
- Set crawler belts in motion. Starting after one full revolution, measure the time required for 5 revolutions. (To measure speed after it has stabilized.)



Y2-B229

**Travel Speed (10m)**

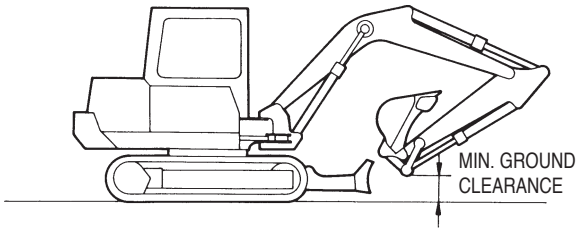
- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Measurement Posture : Travel Posture
- Set excavator in motion. Starting after a distance of 5 meters, measure the time required to travel 10 meters. Do this on level ground.




Y2-B230

■ Travel Posture

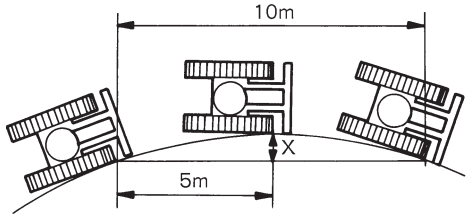
Fully extend the arm and bucket cylinders and adjust the hoe attachment so that its lowest part is even with the excavator's minimum ground clearance level. The hoe attachment, of course, should be in a no-load state and the dozer blade should not be touching the ground.




Y2-B231

**Travel Curve**

- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Measurement Posture : Travel Posture
- Starting after an approach of 5 meters, drive the excavator in a turn for 10 meters, then measure the distance of X (5 m point). Do this on level ground.



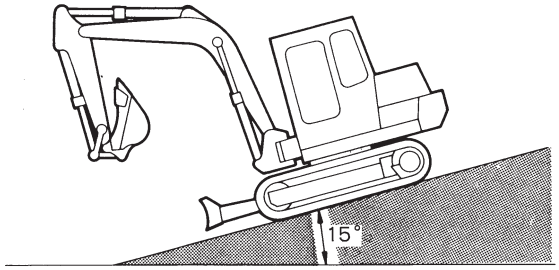

Y2-B232

https://truckmanualshub.com/



### Natural Travel Drop

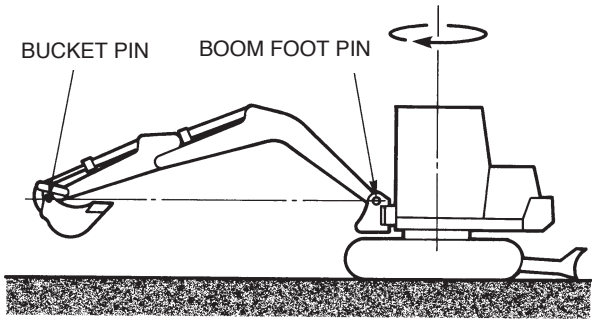
- Engine : Stopped
- Hydraulic Oil Temp. : 50~60°C
- Gradient : 15°
- Measurement Posture : Fully extend the boom, arm and bucket cylinders and completely retract the dozer blade cylinder.
- With the excavator parked at angle for 5 minutes, measure the extent of natural drop.




Y2–B233

### Slew Time

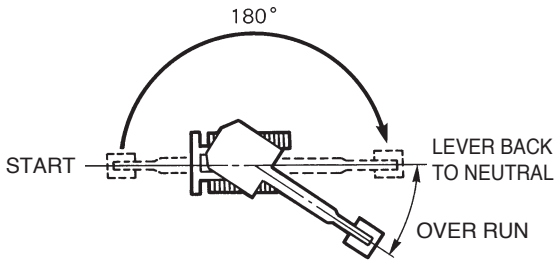
- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Measurement Posture : Completely retract the arm cylinder, fully extend the bucket cylinder and adjust so that boom foot pin and bucket pin are at matching height. Rest the dozer blade on the ground.
- With the hoe attachment in a no-load state, wait 1 rotation, then measure the time required for the next 2 rotations.




Y2–B234

### Overrun When Slewing Stops

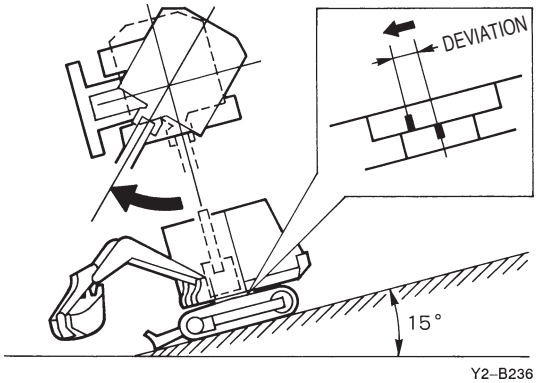
- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Measurement Posture : Same as that for measuring slew time.
- Draw matching marks on the outer race of the slew bearing and lower frame at an exactly 180 degrees rotation from the starting point. With the hoe attachment in a no-load state, rotate 180 degrees at, which point return the operation lever to neutral. Measure the differential between the position marks and the point the hoe attachment stops.




Y2–B235

### Natural Slew Drop

- Engine : Stopped
- Hydraulic Oil Temp. : 50~60°C
- Gradient : 15°
- Measurement Posture : Same as that for measuring slew time.
- Rotate the upper machinery so that it is directly abeam of the grade, then draw positional marks on the slew bearing's outer race and the lower frame. Then measure the distance that develops between the marks after 5 minutes.



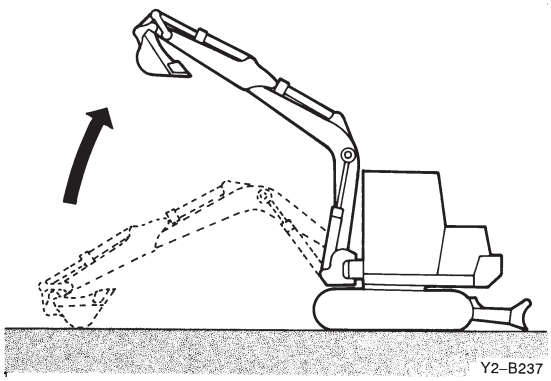

Y2–B236

https://truckmanualshub.com/



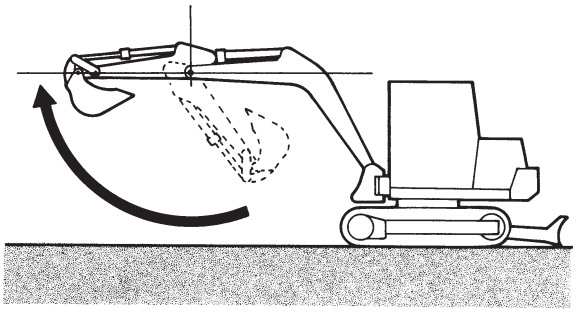
### Boom Cylinder Speed

- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Measurement Posture : Completely retract the arm cylinder, fully extend the bucket cylinder and rest the dozer blade on the ground.
- Then measure the time required for the bucket to reach its highest elevation point (lowest point) from its lowest point (highest point) resting on the ground. (Do not include the cushioning time.)



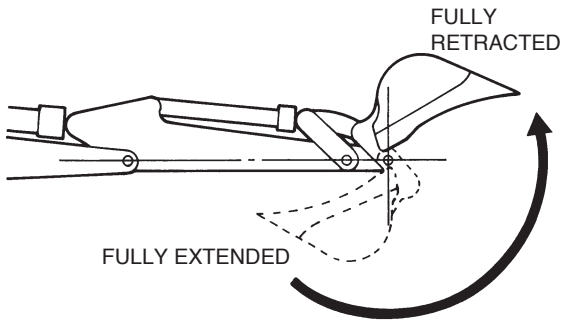

### Arm Cylinder Speed

- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Measurement Posture : Completely retract the arm cylinder, fully extend the bucket cylinder, position the arm horizontally and rest the dozer blade on the ground.
- Then measure the time required for the arm cylinder to completely retract (extend) from a fully extended state (retracted state).



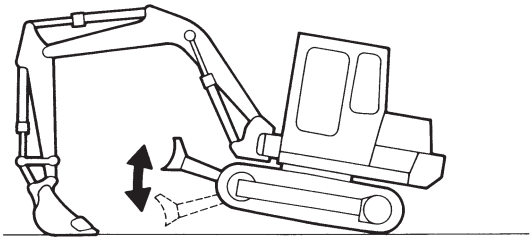

### Bucket Cylinder Speed

- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Measurement Posture : Completely retract the arm cylinder, position the arm horizontally and rest the dozer blade on the ground.
- Then measure the time required for the bucket cylinder to completely retract (extend) from a fully extended state (retracted state).




### Dozer Blade Cylinder Speed

- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Measurement Posture : Using the hoe attachment, lift up the dozer blade end of the excavator.
- Then, raising and lowering the dozer blade full stroke, measure the time required per stroke in each direction.

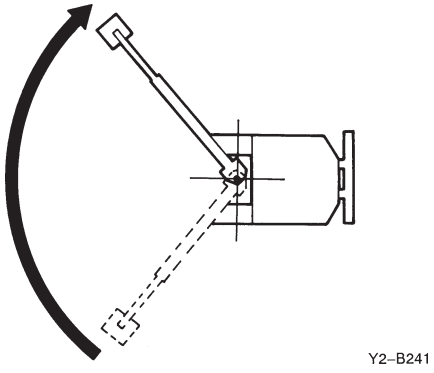


https://truckmanualshub.com/



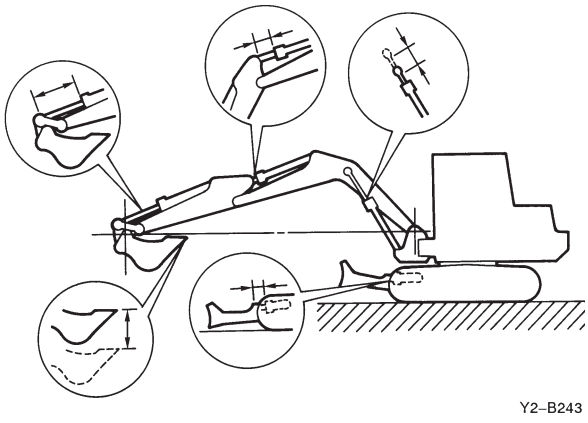
### Swing Cylinder Speed

- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Measurement Posture : Same as that for measuring slew time.
- While swinging the boom left (right) to right (left), measure the time required for a full stroke each way.
  (Do not include the cushioning time.)



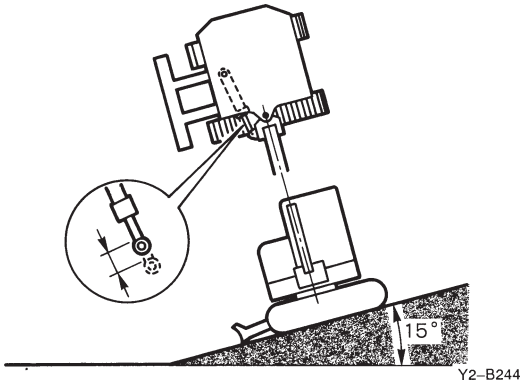

### Natural Cylinder Drop
### Boom, Arm, Bucket, Dozer Blade, Bucket Tip

- Engine : Rated r.p.m.
- Hydraulic Oil Temp. : 50~60°C
- Measurement Posture : Completely retract the dozer blade and arm cylinders, fully extend the bucket cylinder and adjust the bucket pin position to the same height as the boom foot pin.
- Maintain this position for 10 minutes, then measure the change in rod length and the distance the bucket tip falls.




### Swing Cylinder

- Engine : Stopped
- Hydraulic Oil Temp. : 50~60°C
- Gradient : 15°
- Measurement Posture : Same as that for measuring slew time.
- Rotate the upper machinery so that it is directly abeam of the grade, then measure the change in rod length after 5 minutes.

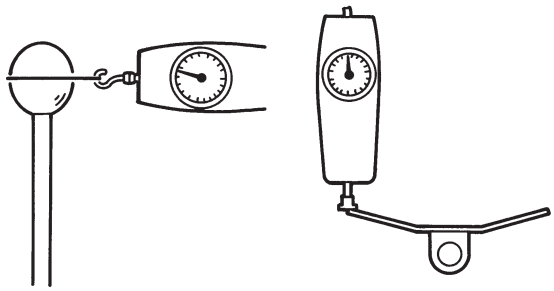


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### Lever Operating Force

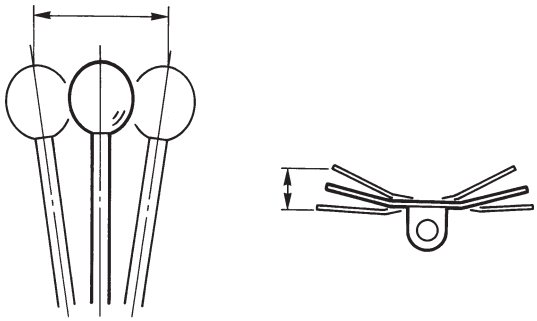
- With the engine stopped, attach a push-pull scale to the center of the operation lever's handle grip, or in the case of a pedal, position a push-pull scale to its tip and record the measurement at the point the lever/pedal reaches full stroke.



Y2–B245

### Lever Play

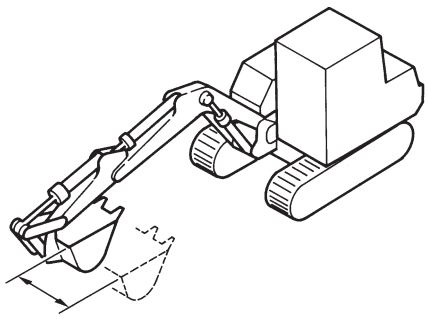
- Measure any discernible play at the tip of the lever (pedal).



Y2–B246

### Backlash

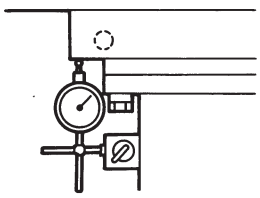
- Measurement Posture : Completely retract the arm cylinder and fully extend the bucket cylinder.
- Move the tips of the bucket teeth from side to side (left and right) and measure the play.

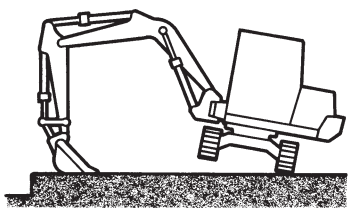


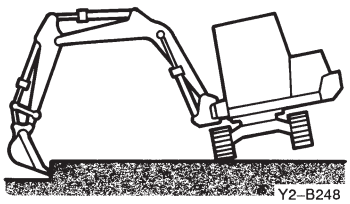
Y2–B247

### Slew Bearing Play

1. Attach a dial gauge to the bottom face of the slew bearing's race located near the front of the upper machinery.
2. Raise the crawler on one side off the ground and set the dial gauge to zero.
3. Then raise the opposite crawler and read the dial gauge.







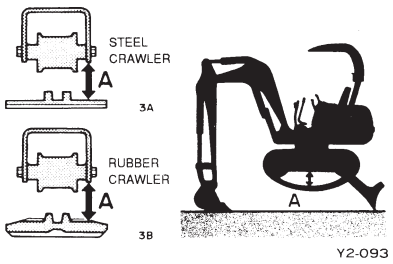
Y2–B248

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### Crawler Tension

- Raise the excavator completely off the ground using the hoe attachment and dozer blade.
  Then measure the distance (of droop) between the center point on the crawler frame and top of the crawler shoe.
  Note: For the rubber crawler, the measuring should be performed after placing the joint portion with “M” mark to the top center.



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# III. MACHINE CONFIGURATION

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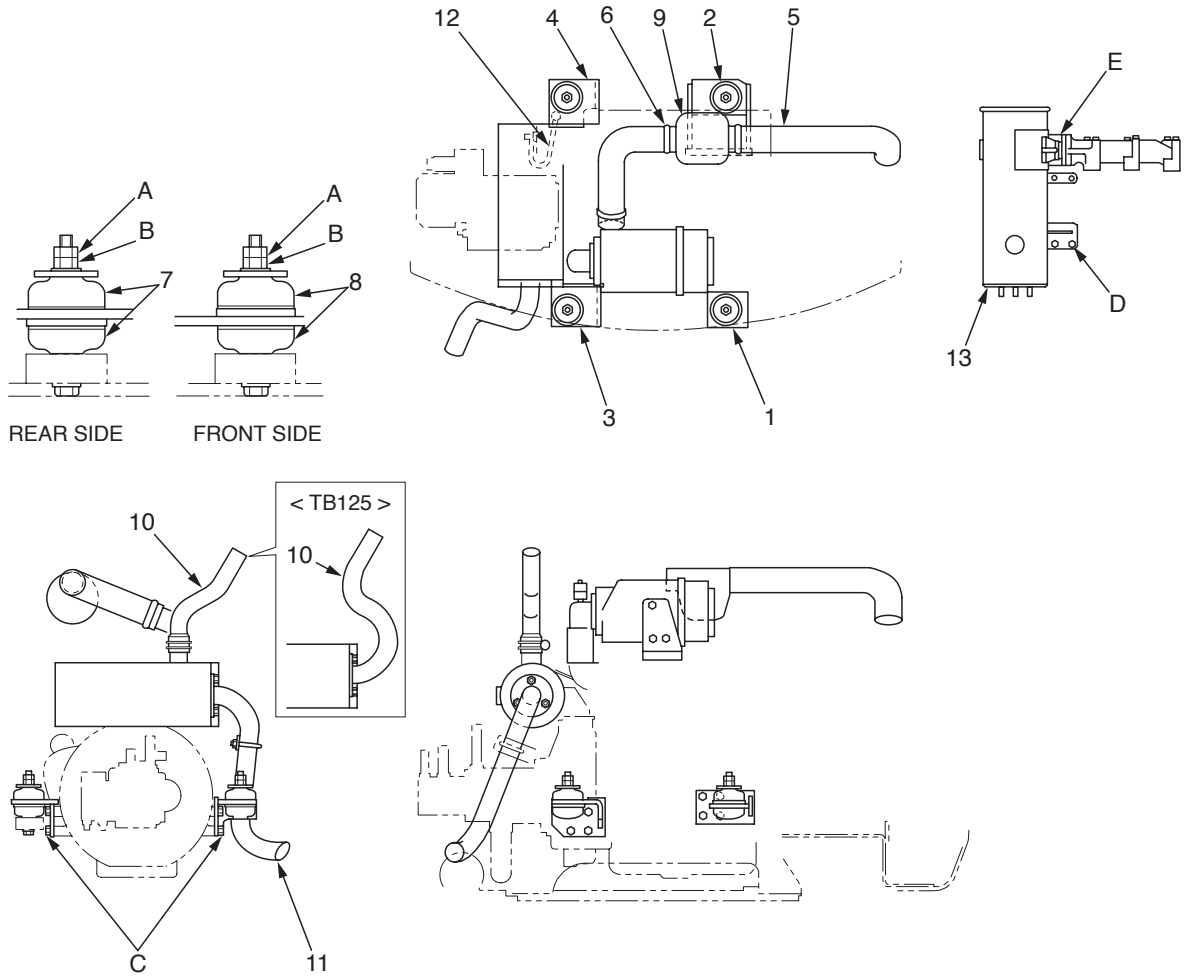


# DRIVE SYSTEM

## CONSTRUCTION

### Engine Mount

■ TB125: S/N 12510003~12514525, TB135: S/N 13510004~13514050




A: Tightening Torque: 102 N·m (10.4 kgf·m)
B: Tightening Torque: 81.4 N·m (8.3 kgf·m)
C: Tightening Torque: 54.9 N·m (5.6 kgf·m)
Apply thread lock.
D: Tightening Torque: 40.9 ±0.9 N·m (5.0 ±0.5 kgf·m)
E: Tightening Torque: 25.5 ±2.9 N·m (2.6 ±0.3 kgf·m)

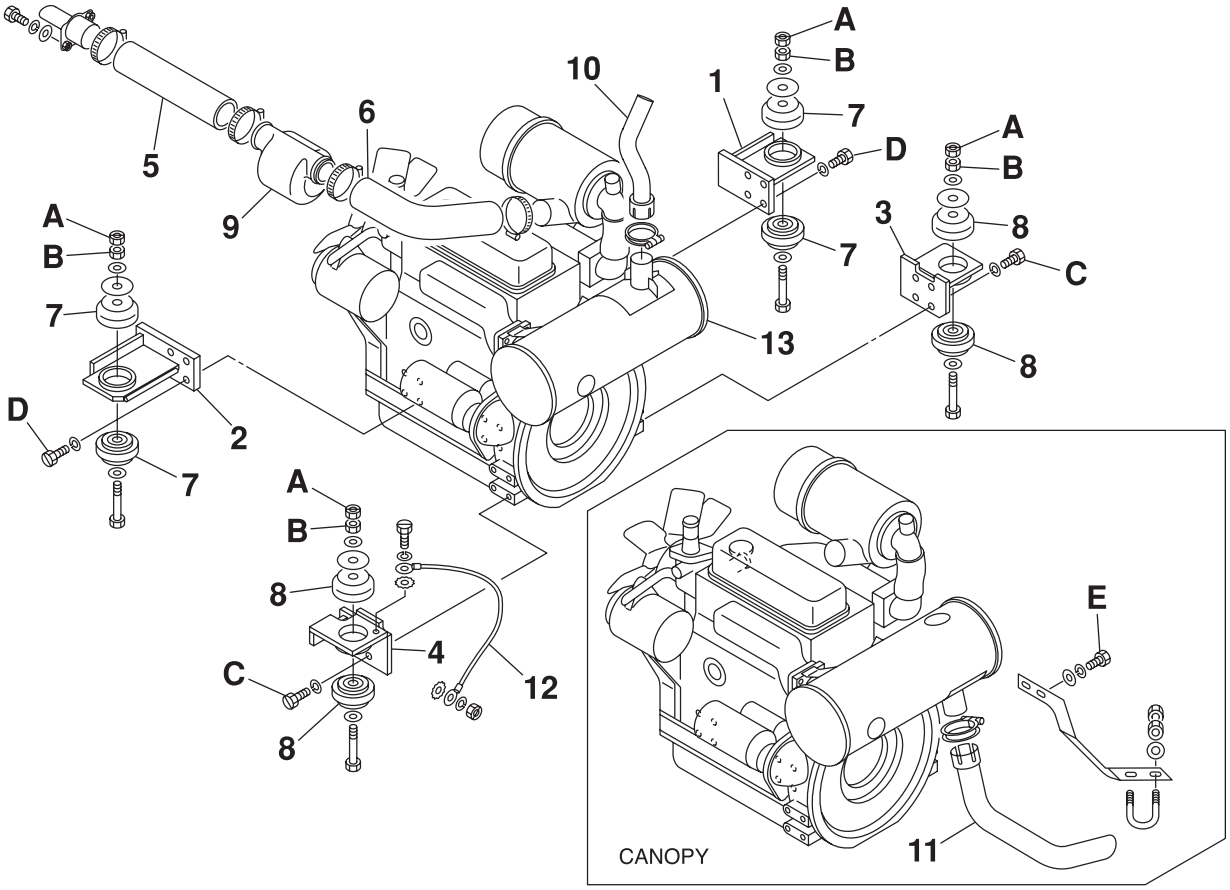
G4C100

1. Engine Foot FR
2. Engine Foot FL
3. Engine Foot RR
4. Engine Foot RL
5. Air Hose
6. Air Hose
7. Cushion Rubber
8. Cushion Rubber
9. Resonator
10. Exhaust Pipe (for Cab)
11. Exhaust Pipe (for Canopy)
12. Ground Cable
13. Silencer

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■ TB125: S/N 12514526~




E5C101E

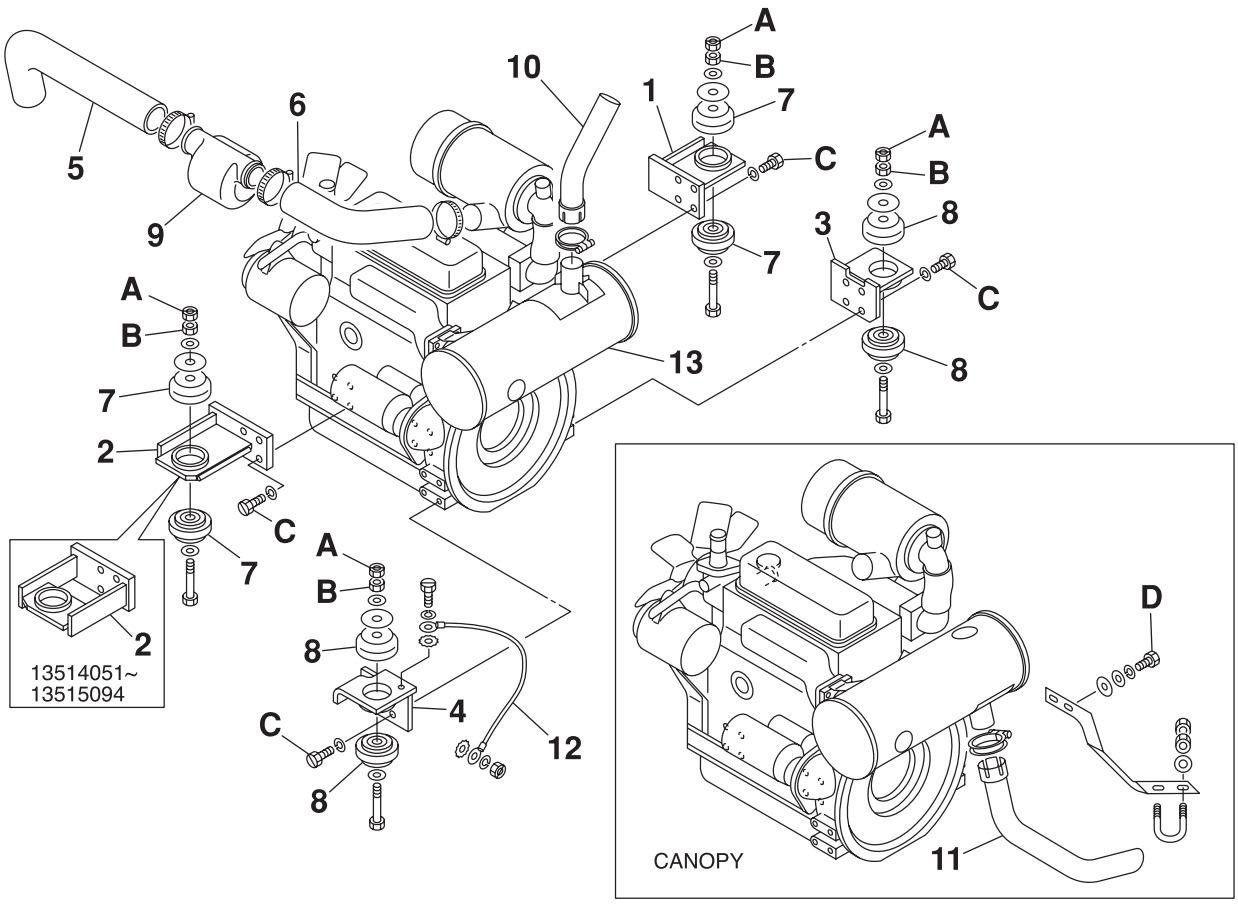
A: ⇨: 102 N·m
B: ⇨: 81.4 N·m
C: ⇨: 54.9 N·m; Apply thread-locking compound.
D: ⇨: 97.1 N·m; Apply thread-locking compound.
E: Apply thread-locking compound.

1. Engine Foot FR
2. Engine Foot FL
3. Engine Foot RR
4. Engine Foot RL
5. Air Hose
6. Air Hose
7. Cushion Rubber
8. Cushion Rubber
9. Resonator
10. Exhaust Pipe (for Cab)
11. Exhaust Pipe (for Canopy)
12. Ground Cable
13. Silencer

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■ TB135: S/N 13514051~




G4C117E

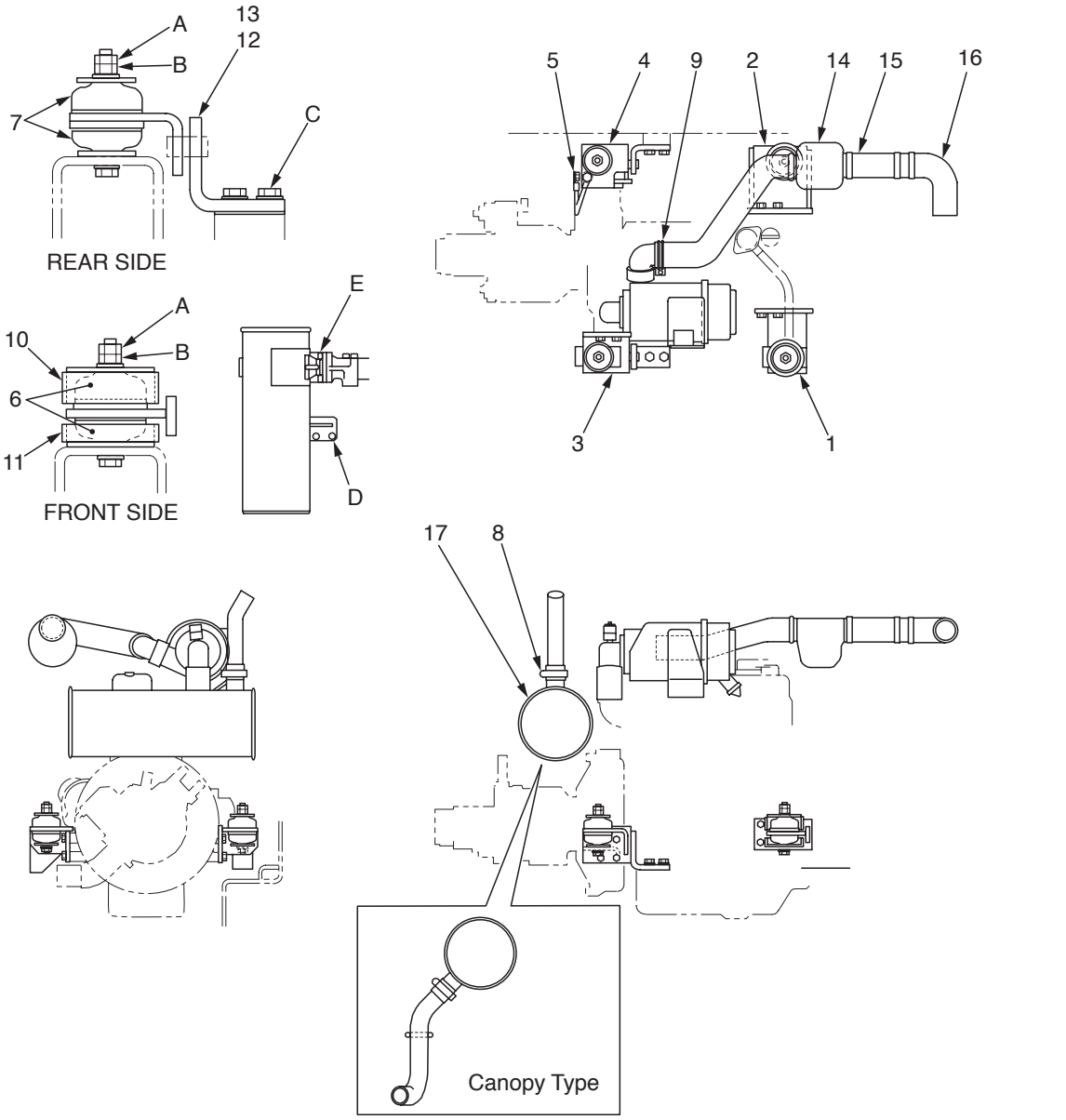
A: ⇔: 102 N·m
B: ⇔: 81.4 N·m
C: ⇔: 54.9 N·m; Apply thread-locking compound.
D: Apply thread-locking compound.

1. Engine Foot FR
2. Engine Foot FL
3. Engine Foot RR
4. Engine Foot RL
5. Air Hose
6. Air Hose
7. Cushion Rubber
8. Cushion Rubber
9. Resonator
10. Exhaust Pipe (for Cab)
11. Exhaust Pipe (for Canopy)
12. Ground Cable
13. Silencer

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■ TB145: S/N 14510004~14513260




K3C100

A: Tightening Torque: 102 N·m (10.4 kgf·m)
B: Tightening Torque: 81.4 N·m (8.3 kgf·m)
C: Tightening Torque: 102 N·m (10.4 kgf·m)
Apply thread lock.

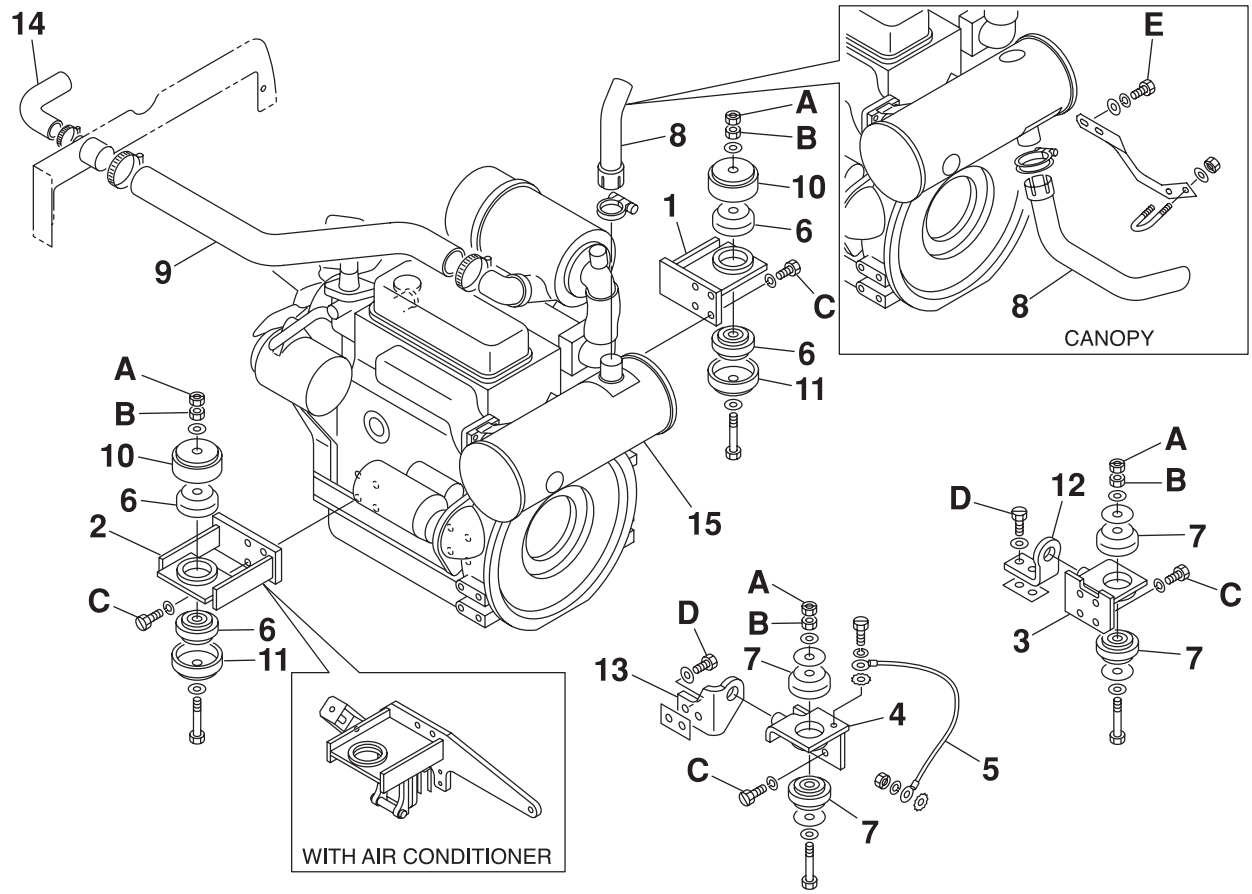
D: Tightening Torque: 40.9 ±0.9 N·m (5.0 ±0.5 kgf·m)
E: Tightening Torque: 25.5 ±2.9 N·m (2.6 ±0.3 kgf·m)

1. Engine Foot FR
2. Engine Foot FL
3. Engine Foot RR
4. Engine Foot RL
5. Ground Cable
6. Cushion Rubber
7. Cushion Rubber
8. Exhaust Pipe
9. Air Hose
10. Stopper
11. Stopper
12. Stopper
13. Stopper
14. Resonator
15. Air Hose
16. Air Hose
17. Silencer

https://truckmanualshub.com/



■ TB145: S/N 14513261~




A: 102 N·m
B: 81.4 N·m
C: 54.9 N·m; Apply thread-locking compound.
D: 102 N·m; Apply thread-locking compound.
E: Apply thread-locking compound.

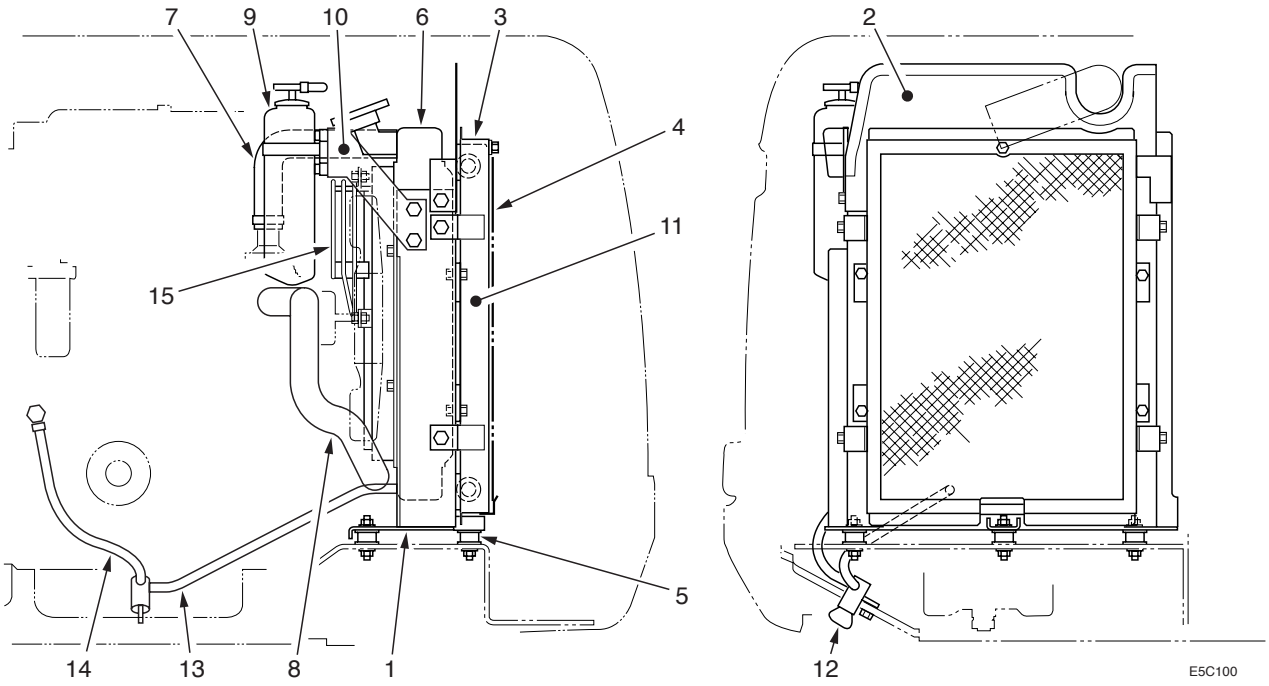
1. Engine Foot FR
2. Engine Foot FL
3. Engine Foot RR
4. Engine Foot RL
5. Ground Cable
6. Cushion Rubber
7. Cushion Rubber
8. Exhaust Pipe
9. Air Hose
10. Stopper
11. Stopper
12. Stopper
13. Stopper
14. Air Hose
15. Silencer

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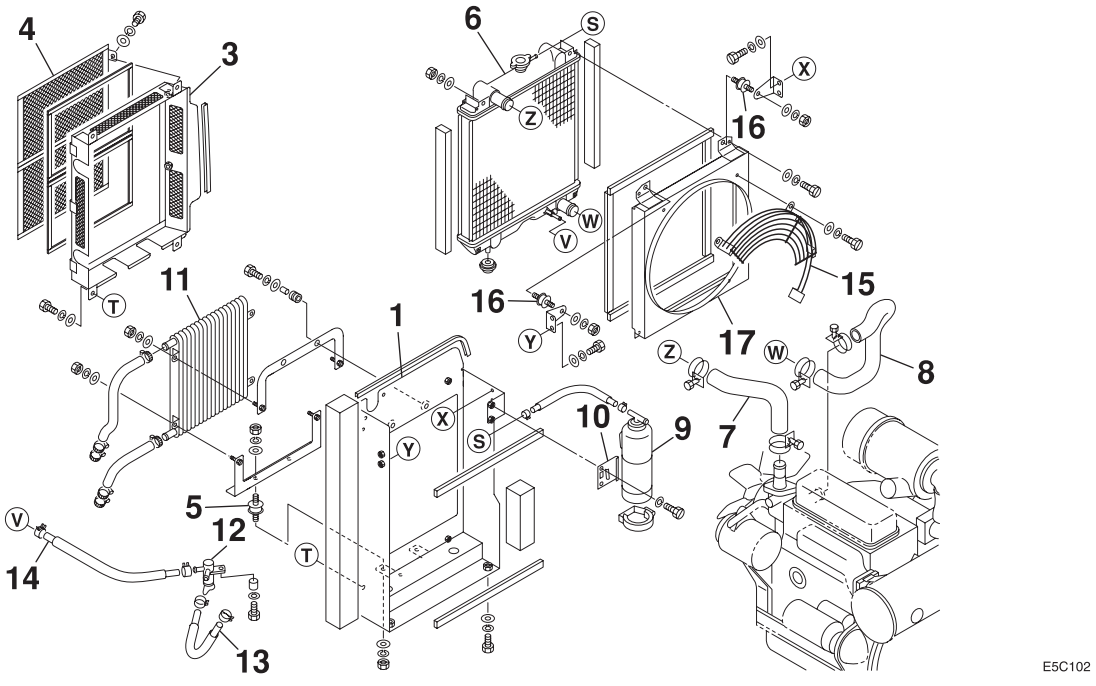


**Radiator and Oil Cooler**

■ TB125: S/N 12510003~12514525




■ TB125: S/N 12514526~

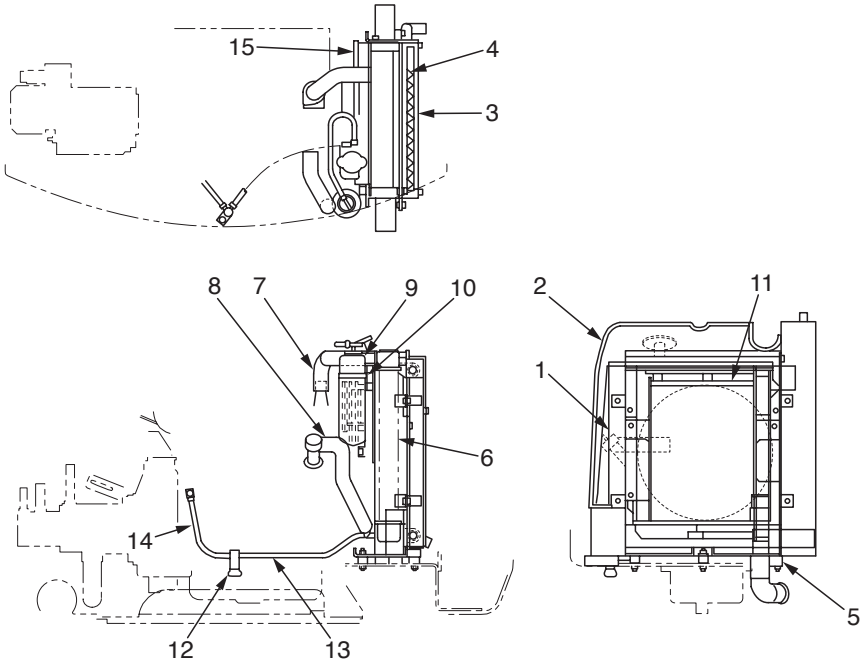



1. Bracket
2. Plate
3. Cover
4. Net
5. Cushion Rubber
6. Radiator
7. Radiator Hose (Top)
8. Radiator Hose (Bottom)
9. Sub Tank
10. Bracket
11. Oil Cooler
12. Drain Valve
13. Tube
14. Tube
15. Fan Guard
16. Cushion Rubber
17. Shroud

https://truckmanualshub.com/

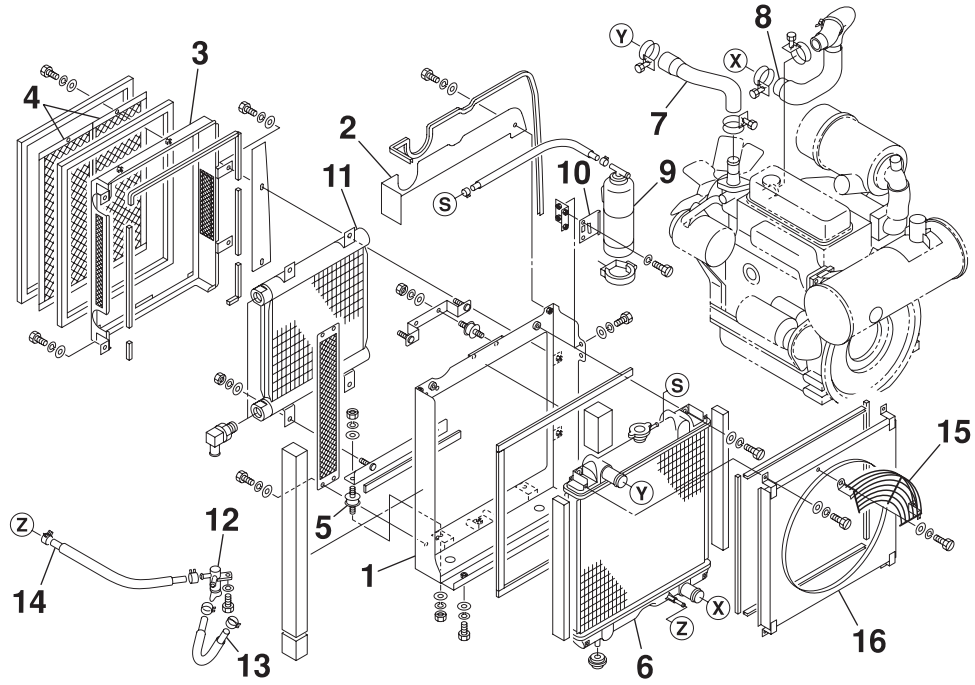


■ TB135: S/N 13510004~13514050




G4C101

■ TB135: S/N 13514051~



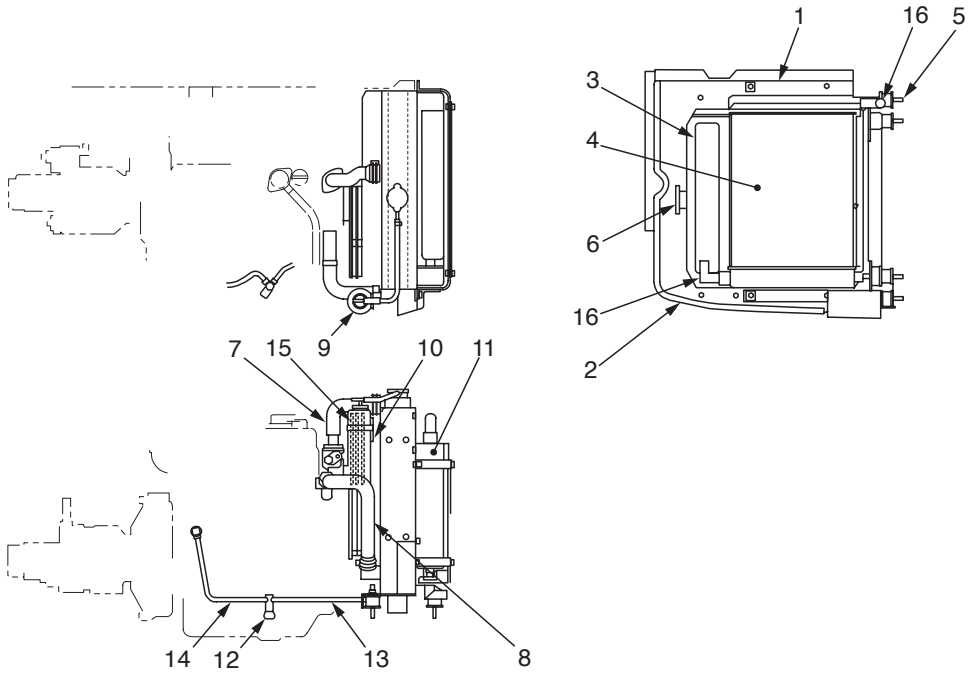

G4C118

1. Bracket
2. Plate
3. Cover
4. Net
5. Cushion Rubber
6. Radiator
7. Radiator Hose (Top)
8. Radiator Hose (Bottom)
9. Sub Tank
10. Bracket
11. Oil Cooler
12. Drain Valve
13. Tube
14. Tube
15. Fan Guard
16. Shroud

https://truckmanualshub.com/

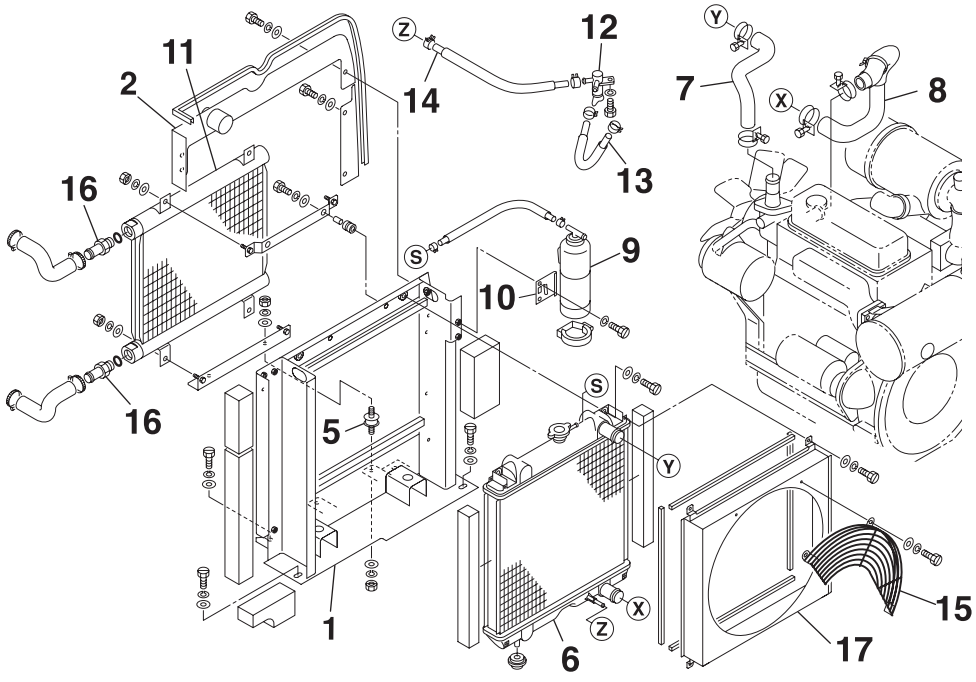


■ TB145: S/N 14510004~14513260




K3C101

■ TB145: S/N 14513261~




K3C108

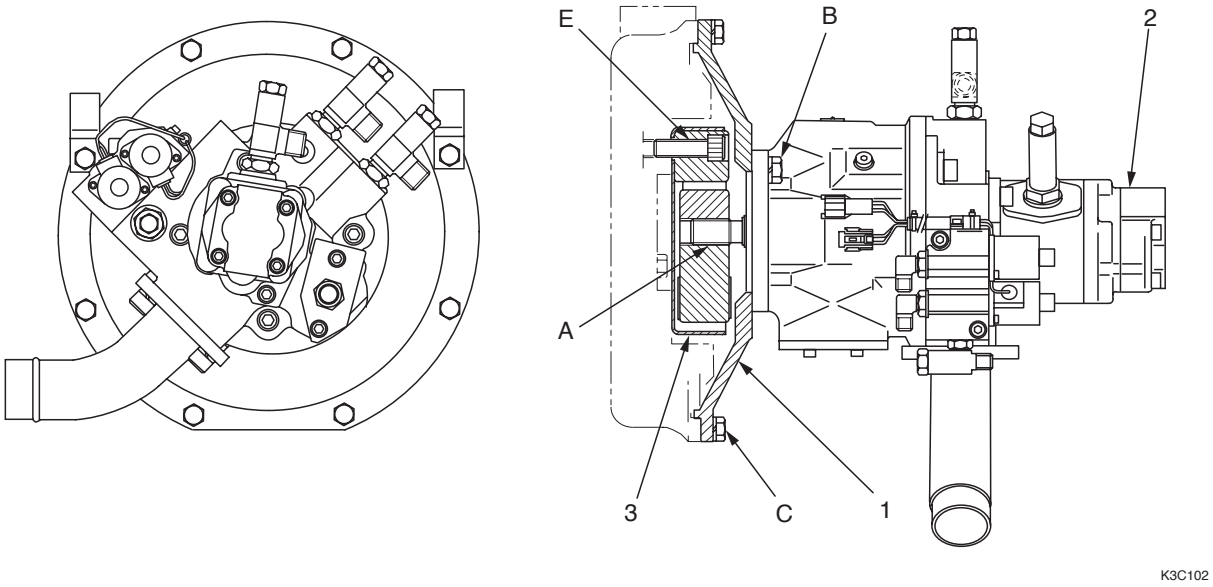
1. Bracket
2. Plate
3. Cover
4. Net
5. Cushion Rubber
6. Radiator
7. Radiator Hose (Top)
8. Radiator Hose (Bottom)
9. Sub Tank
10. Bracket
11. Oil Cooler
12. Drain Valve
13. Tube
14. Tube
15. Fan Guard
16. Hose Nipple
17. Shroud

https://truckmanualshub.com/

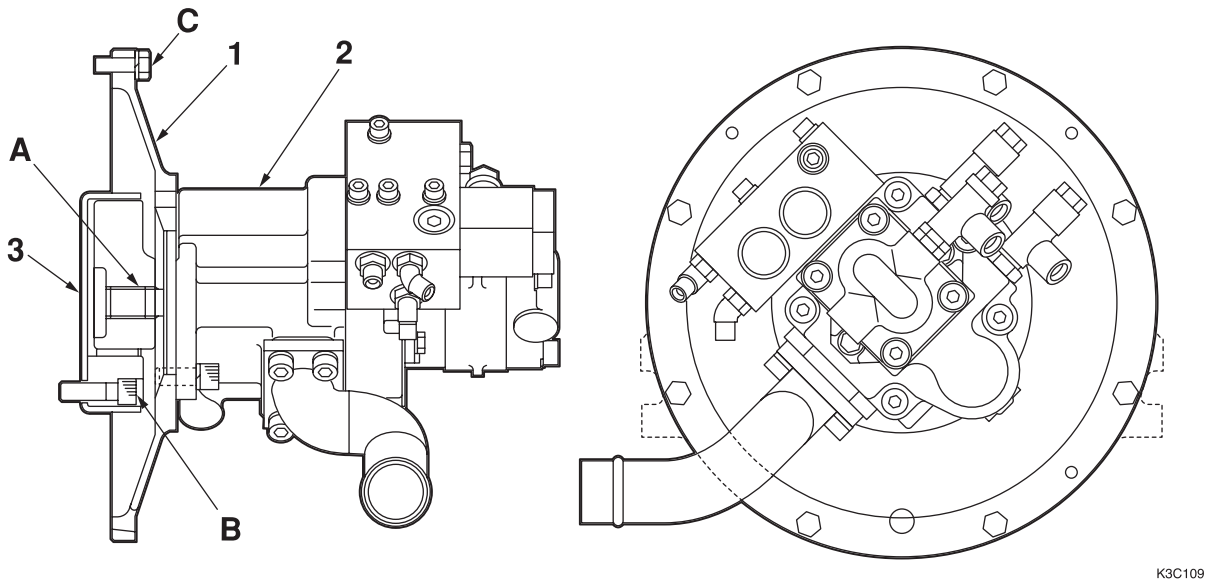


**Pump Coupling**

■ TB125: S/N 12510003~12512125, TB145




■ TB125: S/N 12512126~



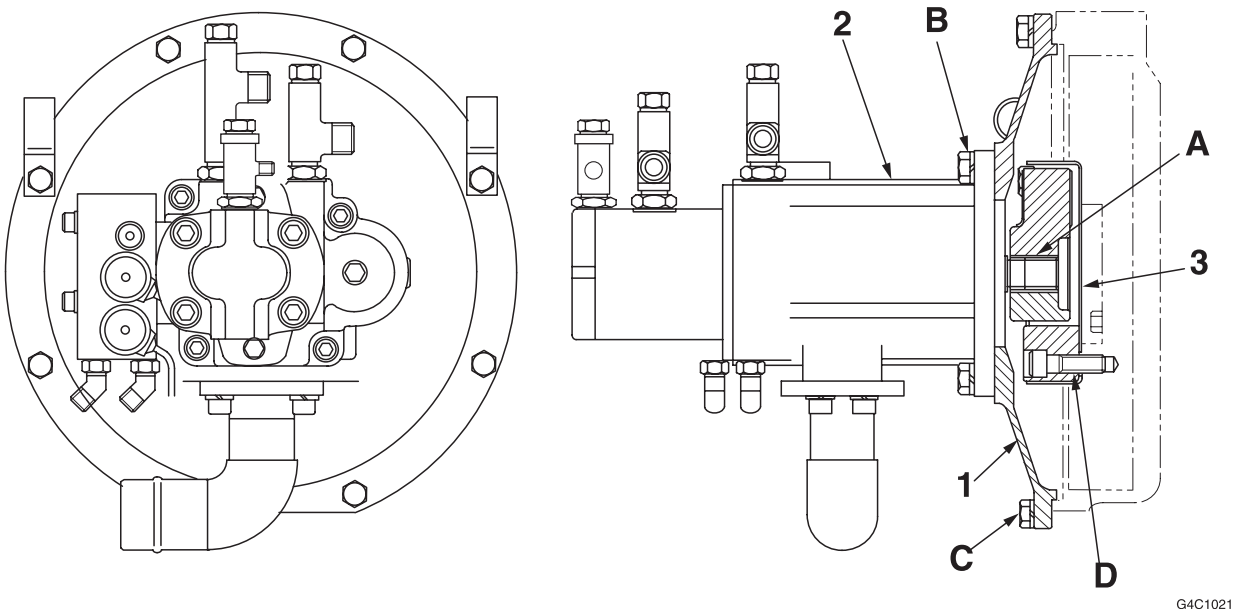

A: Apply molybdenum disulfide grease.
B: Tightening Torque: 102 N·m (10.4 kgf·m)
C: Tightening Torque: 54.9 N·m (5.6 kgf·m)
D: Tightening Torque: 88.3~112.8 N·m (9~11.5 kgf·m)
E: Tightening Torque: 147~176.4 N·m (15~18 kgf·m)

1. Engine Housing
2. Hydraulic Pump
3. Coupling

https://truckmanualshub.com/



■ TB135

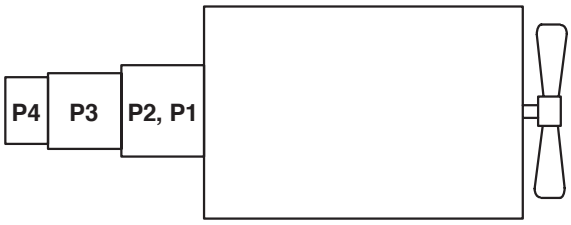



A: Apply molybdenum disulfide grease.
B: ⇔ 102 N·m
C: ⇔ 54.9 N·m
D: ⇔ 88.3~112.8 N·m (S/N 13510004~13512532)
⇔ 102 N·m (S/N 13512533~)

1. Engine Housing
2. Hydraulic Pump
3. Coupling

The pump coupling connects the engine flywheel and the hydraulic pump's drive shaft. It is constructed so that it absorbs vibrations, torsions, impact and out of center of the engine and hydraulic pump.

- Refer to the table concerning the responsibility of each of the pumps shown in the drawing at right.



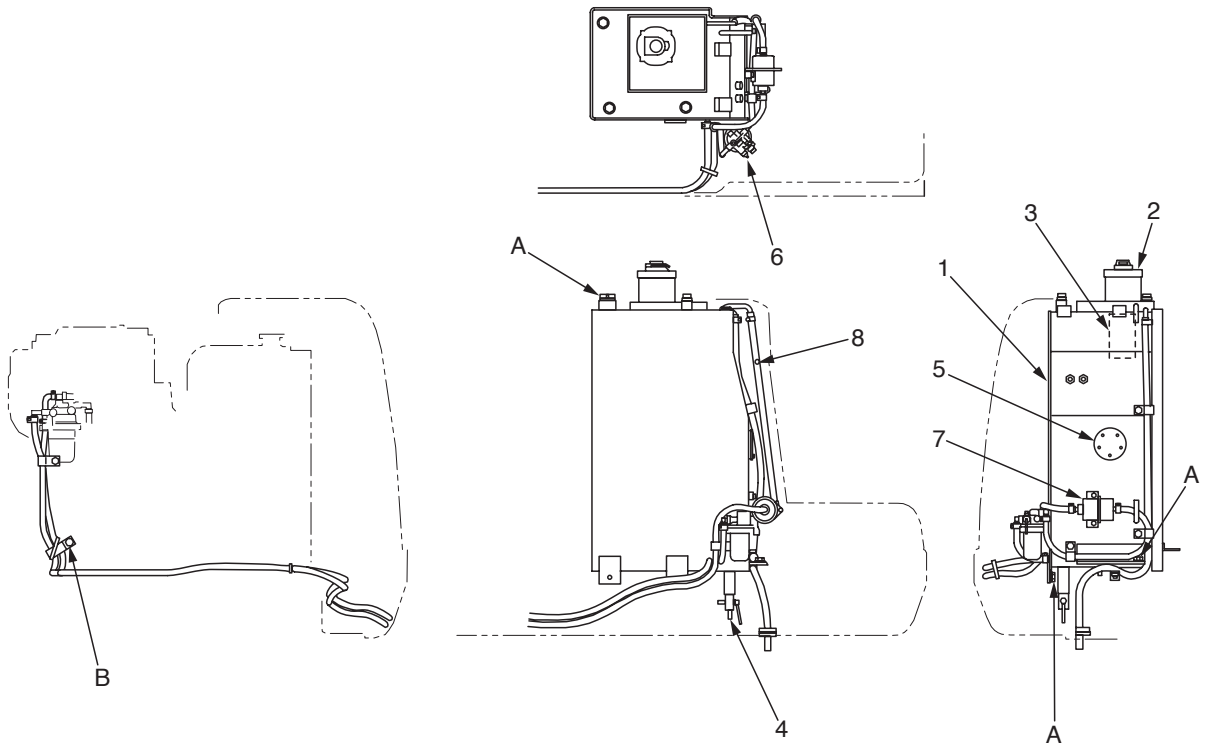

| | |
|---|---|
| P1 | Right Travel, Boom, Bucket |
| P2 | Left Travel, Arm, Swing, Auxiliary |
| P3 | Slew, Dozer Blade |
| P4 | Lever Lock<br>2nd Speed Travel<br>Slew P.B. Release |

https://truckmanualshub.com/



**Fuel Tank and Lines**

■ TB125, TB135




G4C104

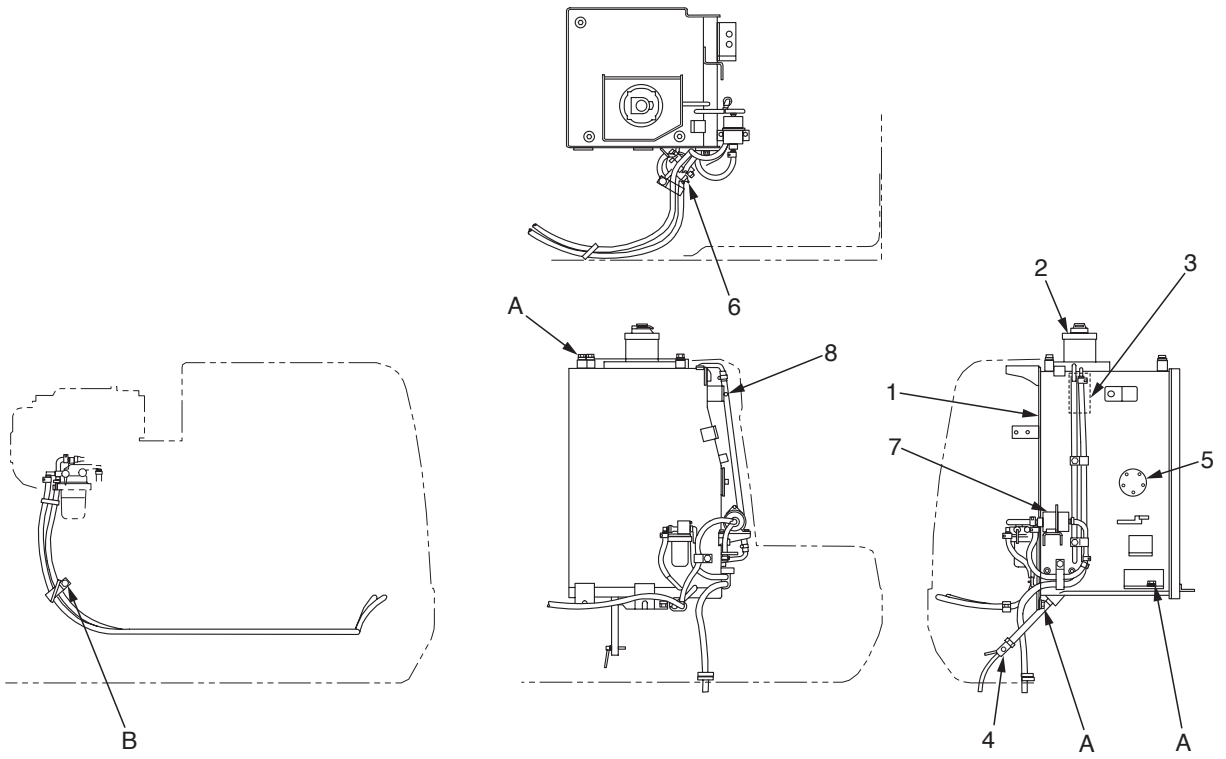
A: Tightening Torque: 47 N·m (4.8 kgf·m)
Apply thread lock.
B: Tightening Torque: 47 N·m (4.8 kgf·m)

1. Fuel Tank
2. Cap
3. Strainer
4. Drain Cock
5. Fuel Sender
6. Water Separator
7. Feed Pump
8. Float

https://truckmanualshub.com/



■ TB145




K3C103

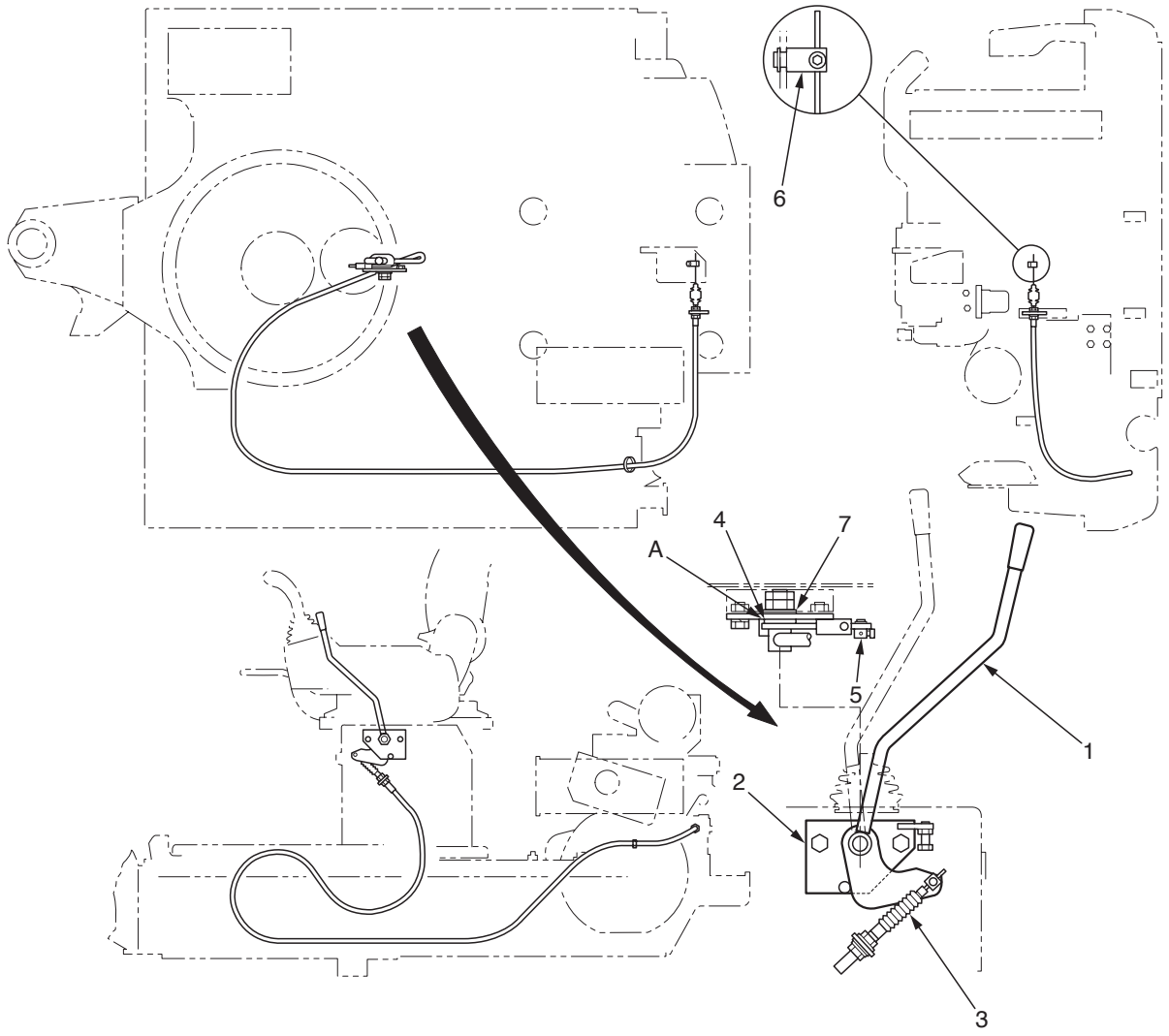
A: Tightening Torque: 47 N·m (4.8 kgf·m)
Apply thread lock.
B: Tightening Torque: 47 N·m (4.8 kgf·m)

1. Fuel Tank
2. Cap
3. Strainer
4. Drain Cock
5. Fuel Sender
6. Water Separator
7. Feed Pump
8. Float

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**Engine Control**



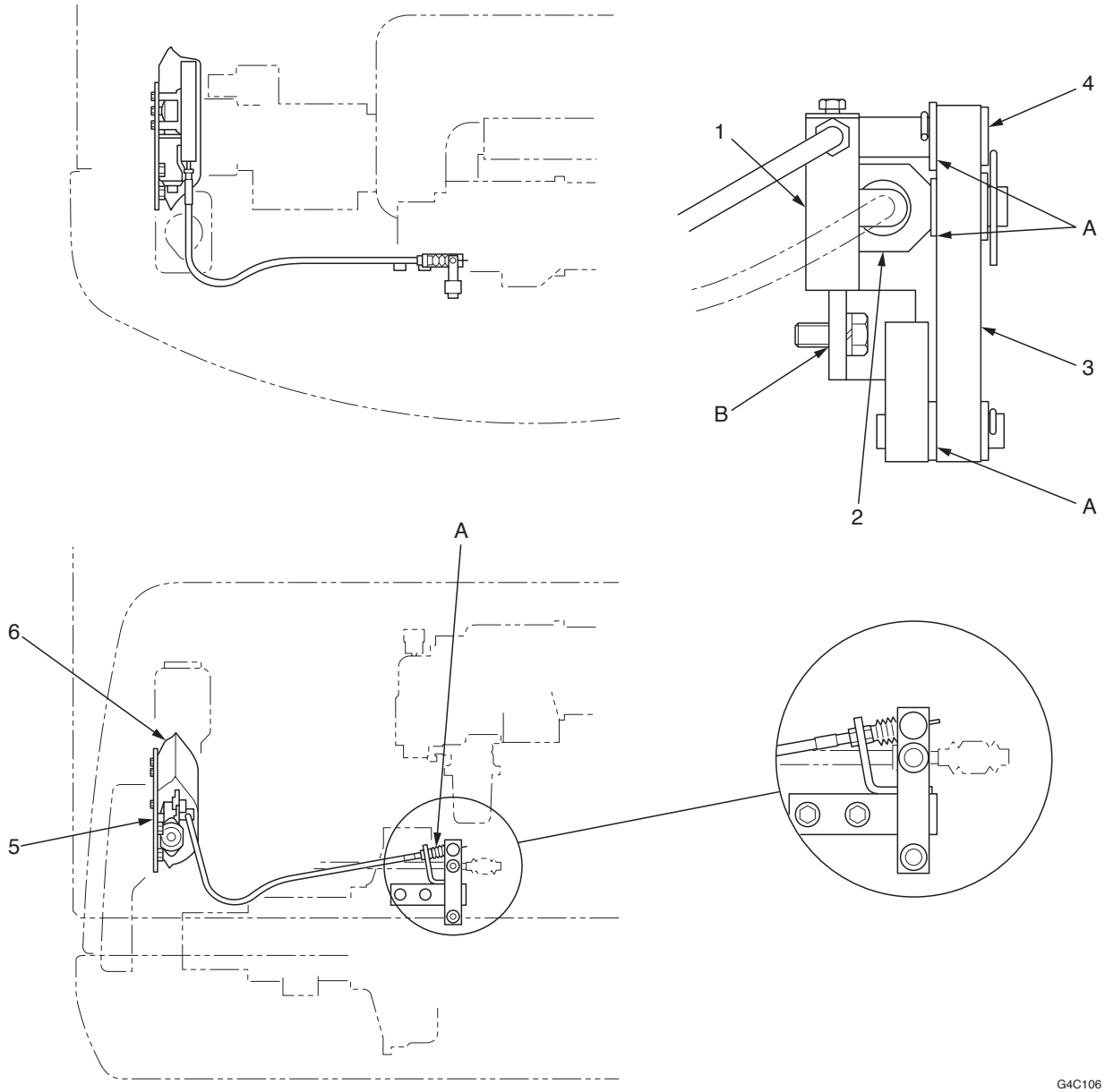

A: Apply molybdenum disulfide grease.

1. Lever
2. Bracket
3. Accelerator Wire
4. Washer
5. Wire Stopper
6. Wire Stopper
7. Conical Washer

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**Decelerator Unit**




A: Apply molybdenum disulfide grease.
B: Apply thread-locking compound.

1. Bracket
2. Bracket
3. Lever
4. Pin
5. Bracket
6. Motor

https://truckmanualshub.com/



## DISASSEMBLY AND ASSEMBLY

### Removing the Engine

1. Disconnect the battery ground cable (1) from the battery.

2. Remove the canopy or cab.
   ☞ "Removing the Cab"

3. Remove the engine hood, and engine cover.
   ☞ "Removing the Covers"

4. Remove the radiator and oil cooler.
   ☞ "Removing the Radiator and Oil Cooler"

5. Disconnect the coolant drain hose (2).

6. Remove the fuel tank.
   ☞ "Removing the Fuel Tank"

7. Remove the hydraulic pump.
   ☞ "Removing the Hydraulic Pump"

8. Disconnect the accelerator wire (3) and the decelerator wire (4) from the engine, then remove the bracket (5) together with the wires.

9. Disconnect the battery cable (6) and all the connections on the engine side of the electric wirings (7).
   - Attach identification labels to individual wirings.
   - Disconnect the wirings from the clamp and the band.

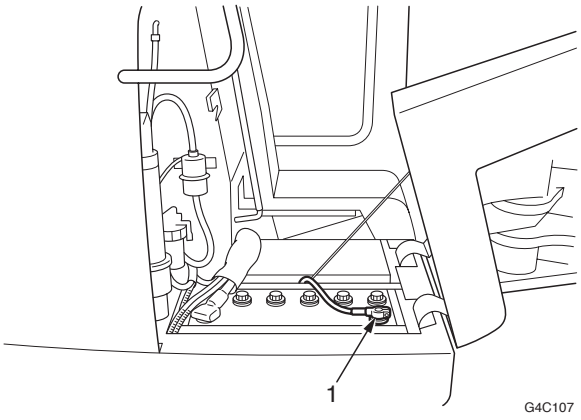
10. Disconnect the engine ground cable (8).

11. <TB145 only> Take out the securing bolts and remove the two stoppers (9).
    - Tightening torque:
      102 ±5.1 N·m (10.4 ±0.52 kgf·m)
    - Apply thread lock (Three Bond #1324) to the bolts.

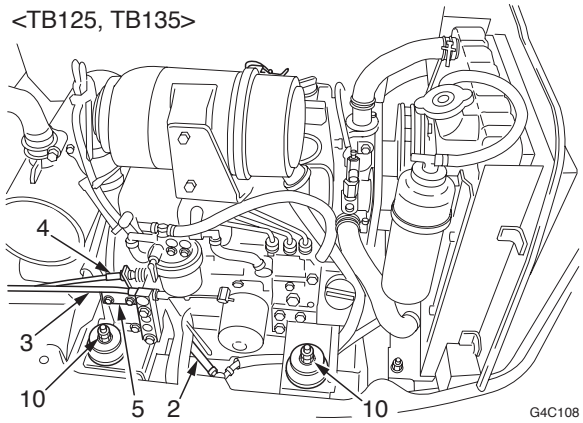
12. Remove the cushion rubber securing double nuts (10) on the four positions.
    - Tightening torque (upper): 102 N·m (10.4 kgf·m)
    - Tightening torque (lower): 81.4 N·m (8.3 kgf·m)

13. <TB145 only> Remove the two stoppers (11).

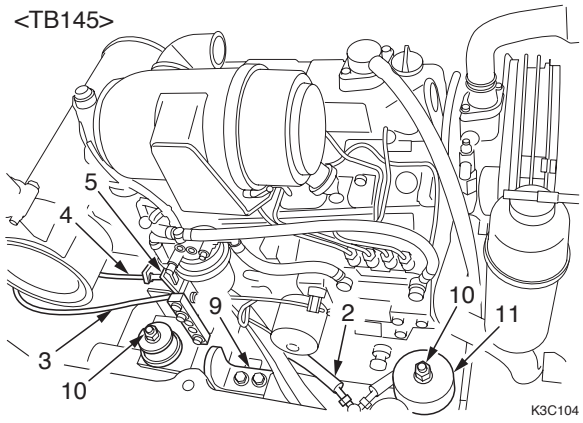
14. Remove the cushion rubbers.
    - Label each cushion rubber to identify for correct installation.

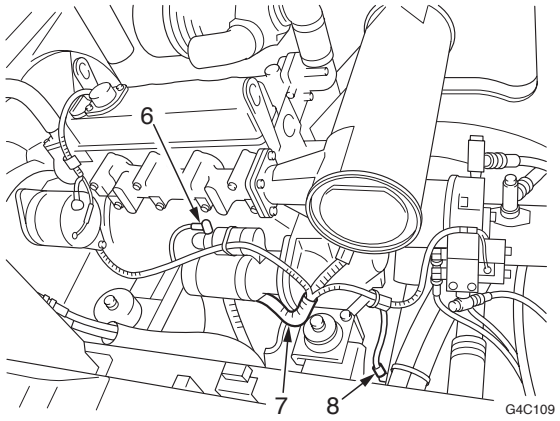



<TB125, TB135>




<TB145>



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15. Suspend the engine temporarily, and remove the mount and the engine.

### Installing the Engine

Follow the same procedure as for removal in the reverse order.

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### Removing the Radiator and Oil Cooler

1. Remove the canopy or cab.
   ☞ "Removing the Cab"

2. Remove the engine hood, and engine cover.
   ☞ "Removing the Covers"

3. Loosen the drain cock (1) to drain the engine coolant.
   - Coolant volume:
     TB125…4.5 *l*, TB135…5.4 *l*, TB145…6.7 *l*

4. Disconnect the coolant drain hose (2).

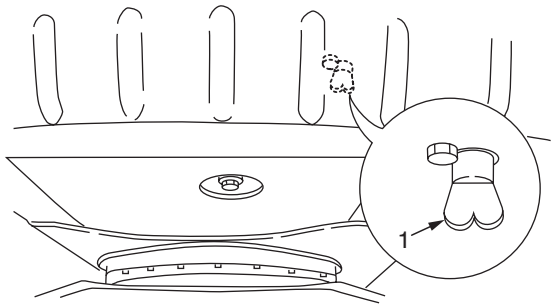
5. Disconnect the radiator hoses (3) and (4).

6. Disconnect the oil cooler hoses (5) and (6).
   - Prepare a plate to catch drips of the hydraulic oil.

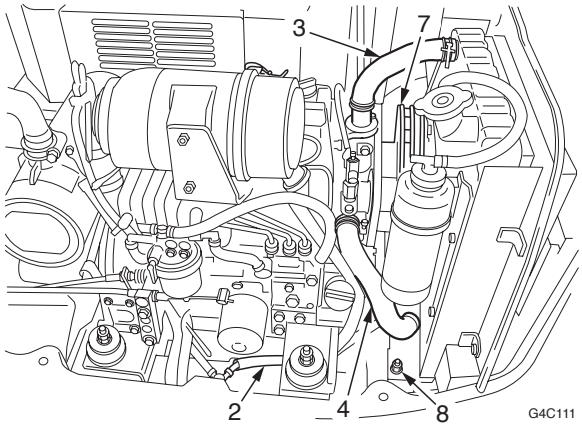
7. Remove the fan guard (7).

8. Remove the cushion rubber securing nuts (8).
   - TB125, TB135…3 nuts, TB145…4 nuts

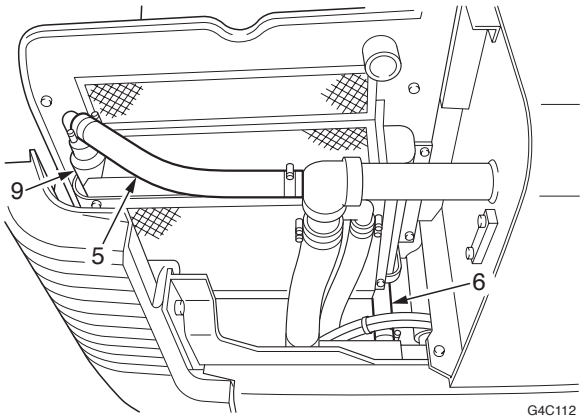
9. Suspend the radiator and oil cooler (9) together with the bracket.
   - Lift the radiator and oil cooler slowly, sliding it out forward so the shroud doesn't hit against the cooling fan.



G4C110



G4C111

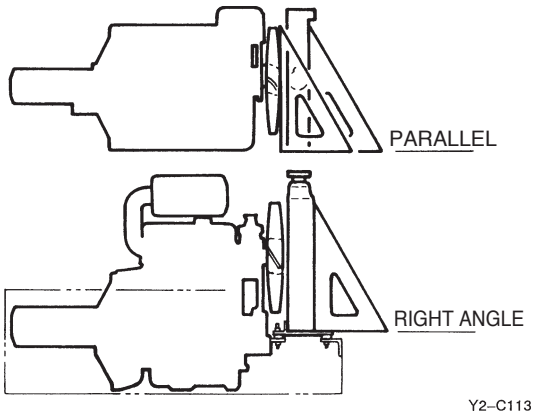


G4C112

### Installing the Radiator and Oil Cooler

Follow the same procedure as for removal in the reverse order.

- The radiator should be mounted at right angles to the main body frame and parallel to the cooling fan.



Y2–C113

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### Removing the Hydraulic Pump

1. Remove the canopy or cab.
   ☞ "Removing the Cab"

2. Remove the engine hood and engine cover.
   ☞ "Removing the Covers"

3. Remove the fuel tank.
   ☞ "Removing the Fuel Tank"

4. Drain out the oil from the hydraulic tank.
   ☞ "Removing the Hydraulic Tank"

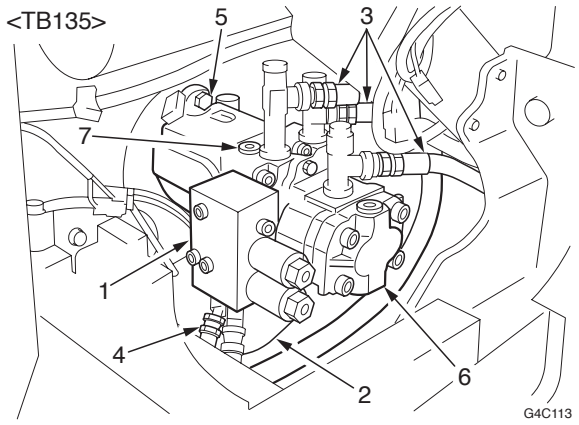
5. Disconnect the electric wirings from the Solenoid Valve (1).

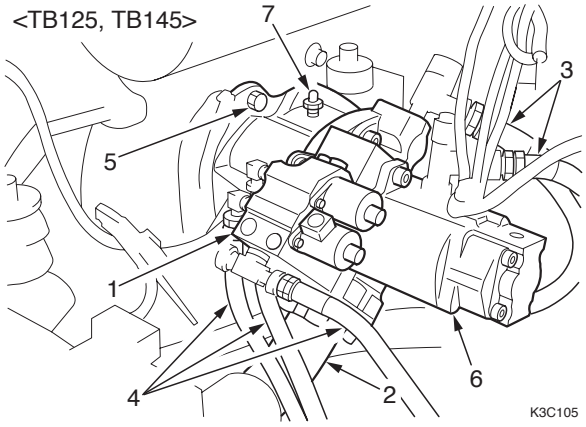
6. Disconnect the suction hose (2) from the pump.

7. Disconnect the discharge hoses (3) from the pump.

8. Disconnect the hoses (4) from Solenoid Valve (1).

9. Remove the fixing bolts (5) and take out the hydraulic pump (6).
   - Tightening torque: 102 ±5.1 N·m (10.4 ±0.52 kgf·m)
   - Apply molybdenum disulfide grease to the spline section (A).



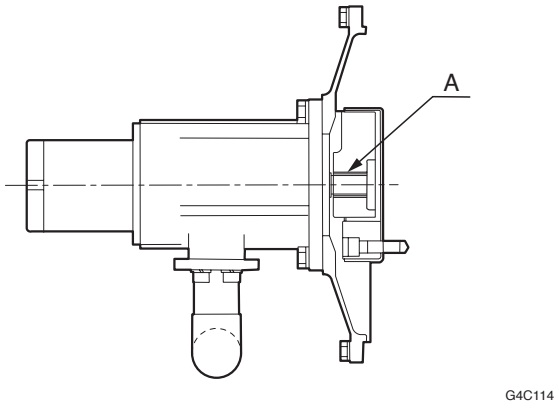

### Installing the Hydraulic Pump

Follow the same procedure as for removal in the reverse order.

#### Cautions when starting the hydraulic pump

1. Fill the pump housing with clean hydraulic oil before starting the pump.
   - Loosen the air release plug (7), fill in the oil through the opening until the oil overflows, and fasten the plug.

2. After starting the engine, let it run at a low idling speed for a while to completely bleed out the air within the circuit.



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### Removing the Fuel Tank

1. Remove the canopy or cab.
   ☞ "Removing the Cab"

2. Remove the covers around the tank.
   ☞ "Removing the Covers"

3. Loosen the drain cock (1) to drain out the fuel.
   - Fuel tank capacity:
     TB125, TB135…51 *l*, TB145…73 *l*

4. Remove the Hydraulic Tank.
   ☞ "Removing the Hydraulic Tank"

5. Disconnect the fuel sender wiring (2) and fuel pump wiring (3).

6. Disconnect the fuel hoses (4) and (5).

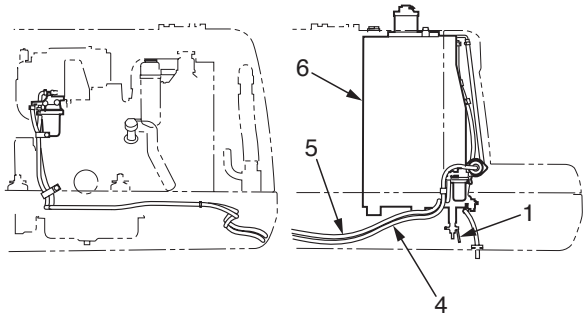
7. Suspend the fuel tank (6) temporarily and remove the fixing bolts (7).
   - Tightening torque:
     47.1 ±2.4 N·m(4.8 ±0.24 kgf·m)
   - Apply thread lock to the bolts.

8. Suspend the fuel tank (6) and remove it.
   - Fuel tank mass:
     TB125, TB135…26 kg, TB145…32 kg

### Installing the Fuel Tank

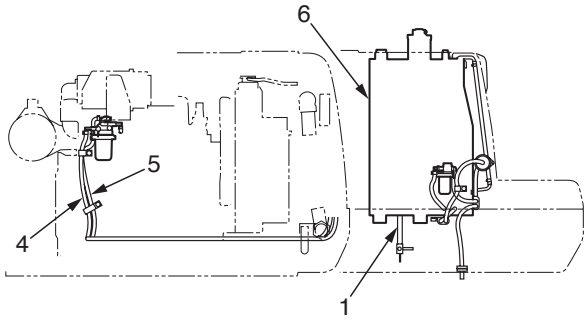
Follow the same procedure as for removal in the reverse order.

< TB125, TB135 >

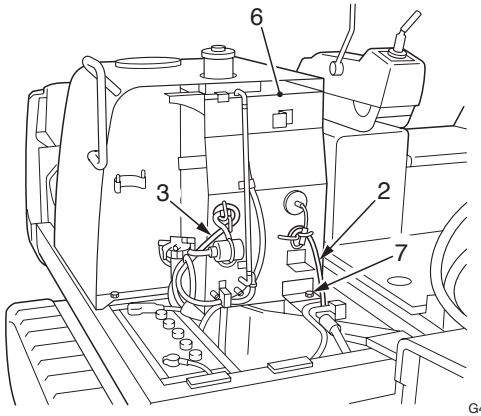



G4C115

<TB145>




K3C106




G4C116

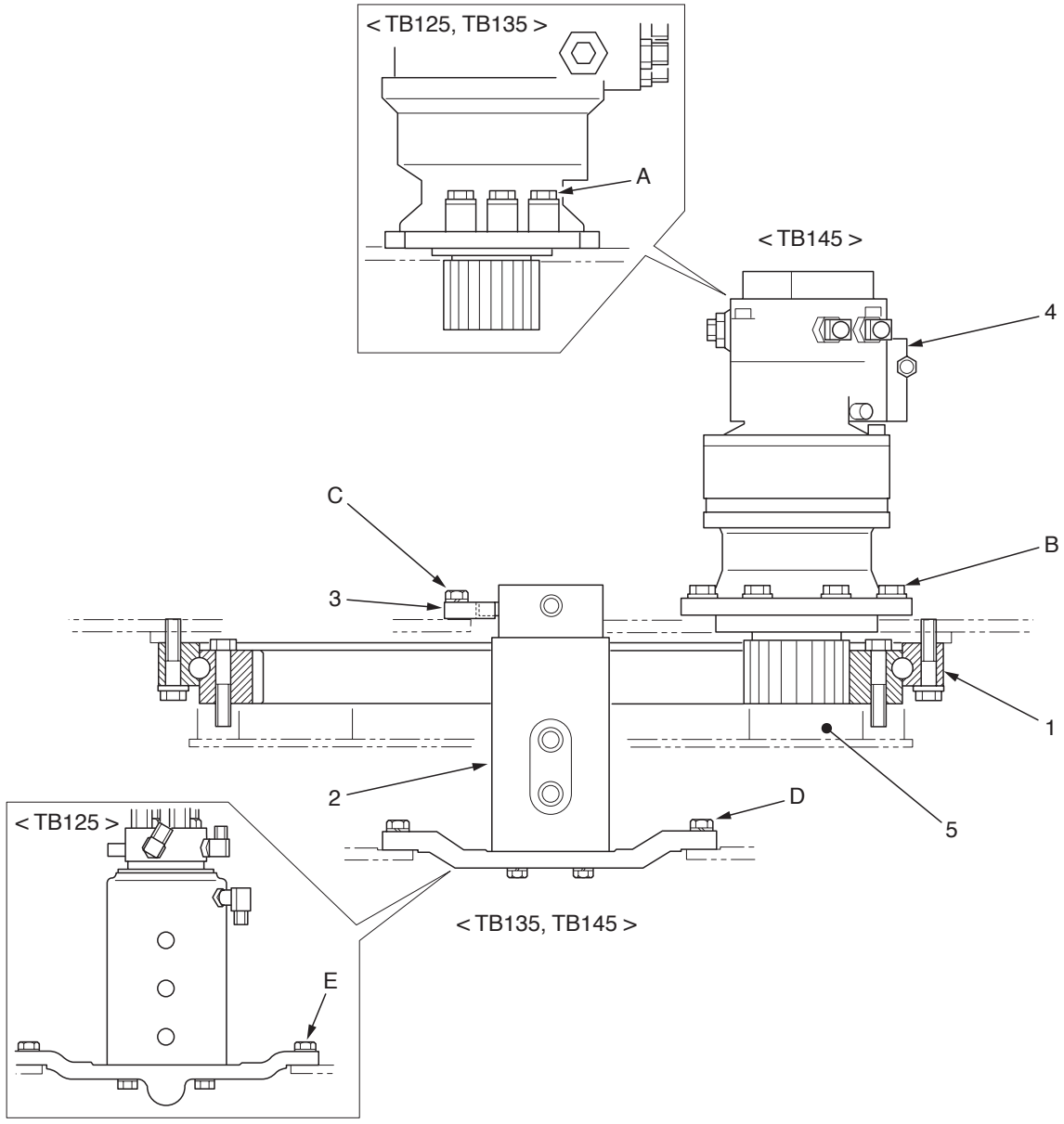
https://truckmanualshub.com/

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# SLEW SYSTEM

## CONSTRUCTION




E5C200

A: Tightening Torque: 157.9 N·m (16.1 kgf·m)
Apply thread lock.
B: Tightening Torque: 256 N·m (26.1 kgf·m)
Apply thread lock.
C: Tightening Torque: 102 N·m (10.4 kgf·m)
D: Tightening Torque: 102 N·m (10.4 kgf·m)
Apply thread lock.
E: Tightening Torque: 26.5 N·m (2.7 kgf·m)
Apply thread lock.

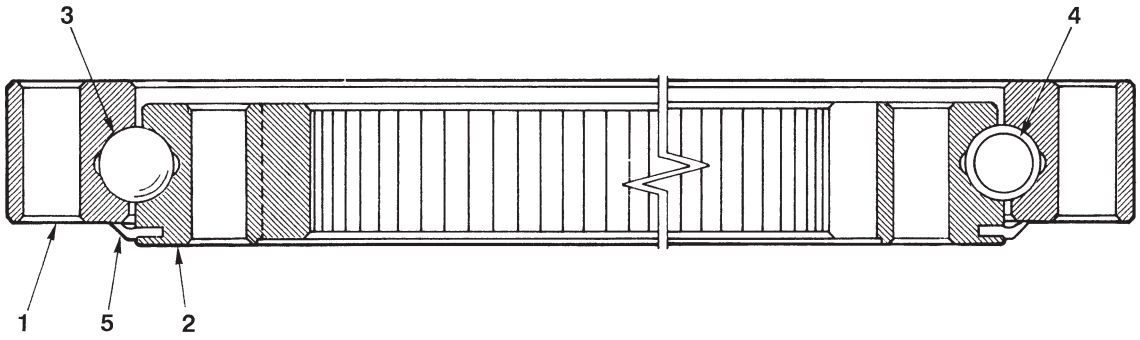
1. Slew Bearing
2. Swivel Joint
3. Stopper
4. Slew Motor
5. Grease Bath

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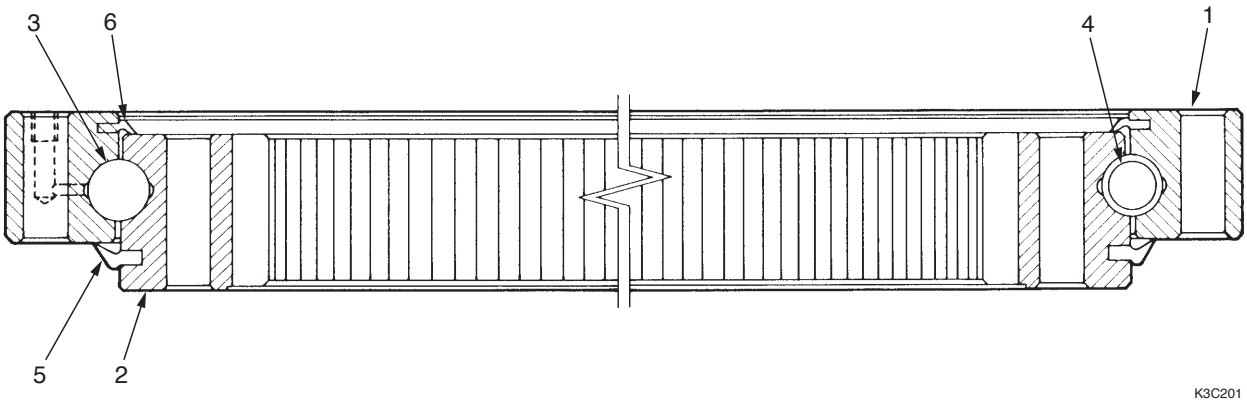
**Slew Bearing**

■ TB125, TB135




Y2–C201

■ TB145

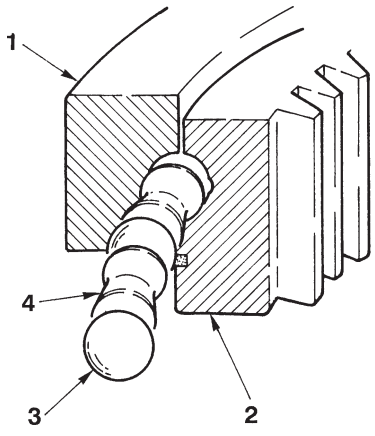



K3C201

1. Outer Race
2. Inner Race
3. Ball
4. Spacer
5. Seal
6. Seal

The slew bearing is a ball type bearing, with balls (3) and spacers (4) aligned alternately in the groove between the outer race (1) and inner race (2). The slew bearing is installed by attaching the outer race to the turntable and the inner race to the lower frame using hex bolts.

The slew speed reducer's pining, mounted on the turntable, engages with the gear formed on the inside of the inner race and rotates, slewing the machine's frame during operation.




Y2–C202

The above figure shows the components of the TB 135

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## DISASSEMBLY AND ASSEMBLY

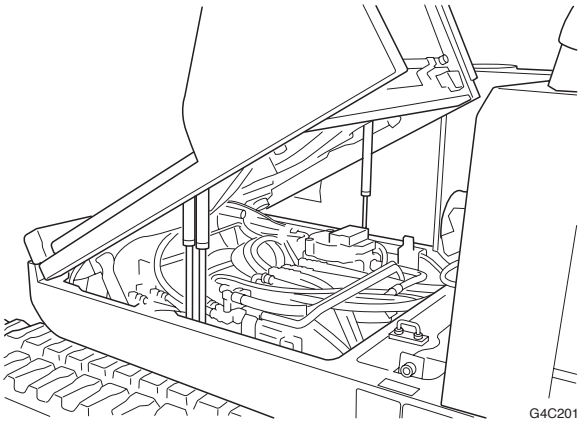
### Removing the Slew Motor

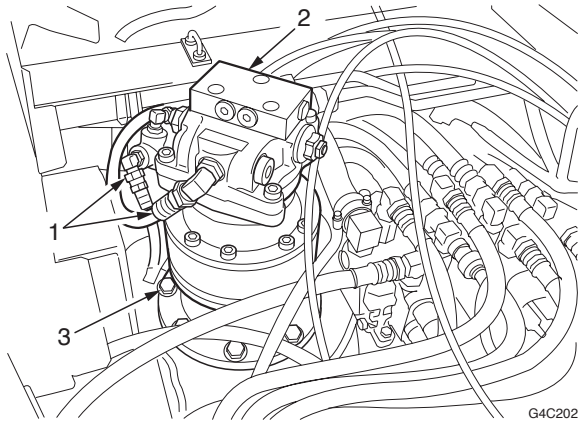
1. Remove the cab.
   ☞ "Removing the Cab"

2. Remove the floor frame.
   ☞ "Removing the Floor Frame"

3. Disconnect the hydraulic piping (1) from the slew motor (2).

4. Take out the installation bolts (3), suspend the slew motor and remove it.
   - Tightening torque:
     TB125, TB135…157.9 N·m (16.1 kgf·m)
     TB145…256 N·m (26.1 kgf·m)
     Apply thread lock to the bolts.
   - Slew motor mass:
     TB125…32 kg, TB135…39 kg, TB145…56 kg




### Installing the Slew Motor

Follow the same procedure as for removal in the reverse order.

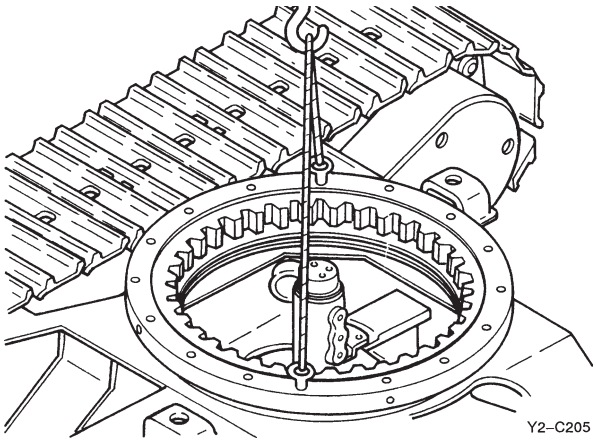
### Removing the Slew Bearing

1. Remove the hoe attachment
   ☞ "Attachments, Disassembly and Assembly"

2. Remove the upper frame.
   ☞ "Removing the Upper Frame"

3. Remove the inner race fixing bolts.
   - Tightening torque:
     TB125, TB135…102 N·m (10.4 kgf·m)
     TB145…256 N·m (26.1 kgf·m)
   - Apply thread lock to the bolts.

4. Suspend the slew bearing and remove it.
   - Slew bearing mass:
     TB125, TB135…40 kg, TB145…84 kg



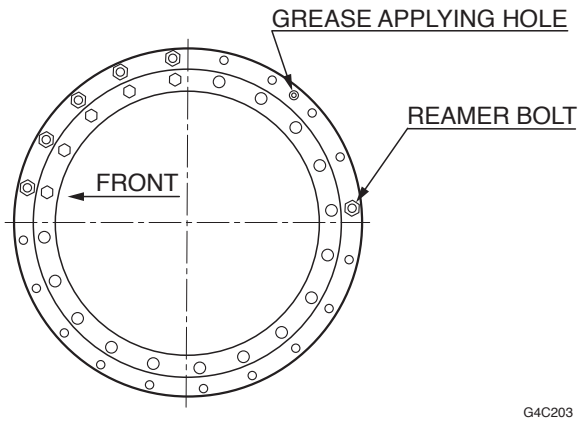
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### Installing the Slew Bearing

Follow the same procedure as for removal in the reverse order.

- When mounting the slew bearing on the upper frame, be sure to position the reamer bolts and the grease holes as illustrated in the right figure.
- Apply grease to the inner teeth of the slew bearing.




G4C203

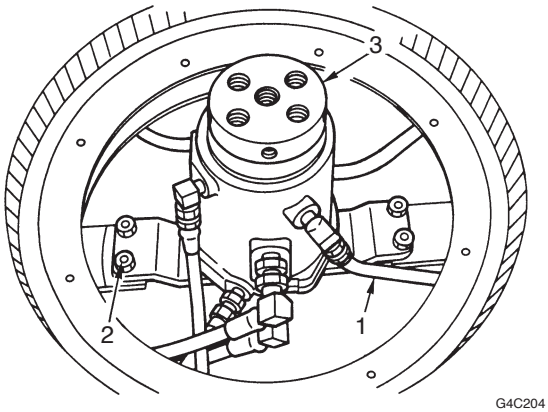
### Removing the Swivel Joint

1. Remove the upper frame.
   ☞ "Removing the Upper Frame"

2. Disconnect the hydraulic hoses (1) from the hub side of the swivel joint.
   - Make match marks at the connection positions of the hoses.

3. Remove the swivel joint fixing bolts (2).
   - Tightening torque:
     TB125…26.5 N·m (2.7 kgf·m)
     TB135, TB145…102 N·m (10.4 kgf·m)
   - Apply thread lock to the bolts.

4. Suspend the swivel joint (3) and remove it.
   - Swivel joint mass:
     TB125…11 kg
     TB135, TB145…22 kg

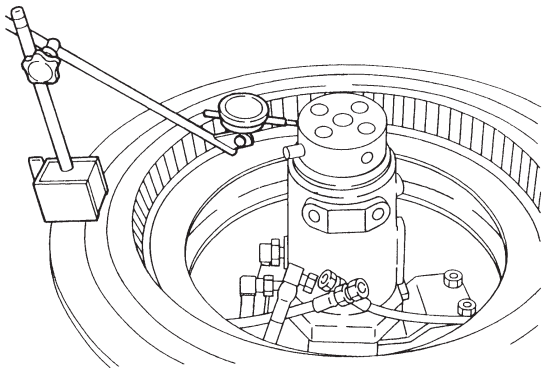



G4C204

### Installing the Swivel Joint

Follow the same procedure as for removal in the reverse order.

- When mounting the swivel joint, tighten it temporarily with the fixing bolts, and center the swivel joint by using a dial gauge.
- Adjust the centering so that the deviation from the center is within 0.25 mm.



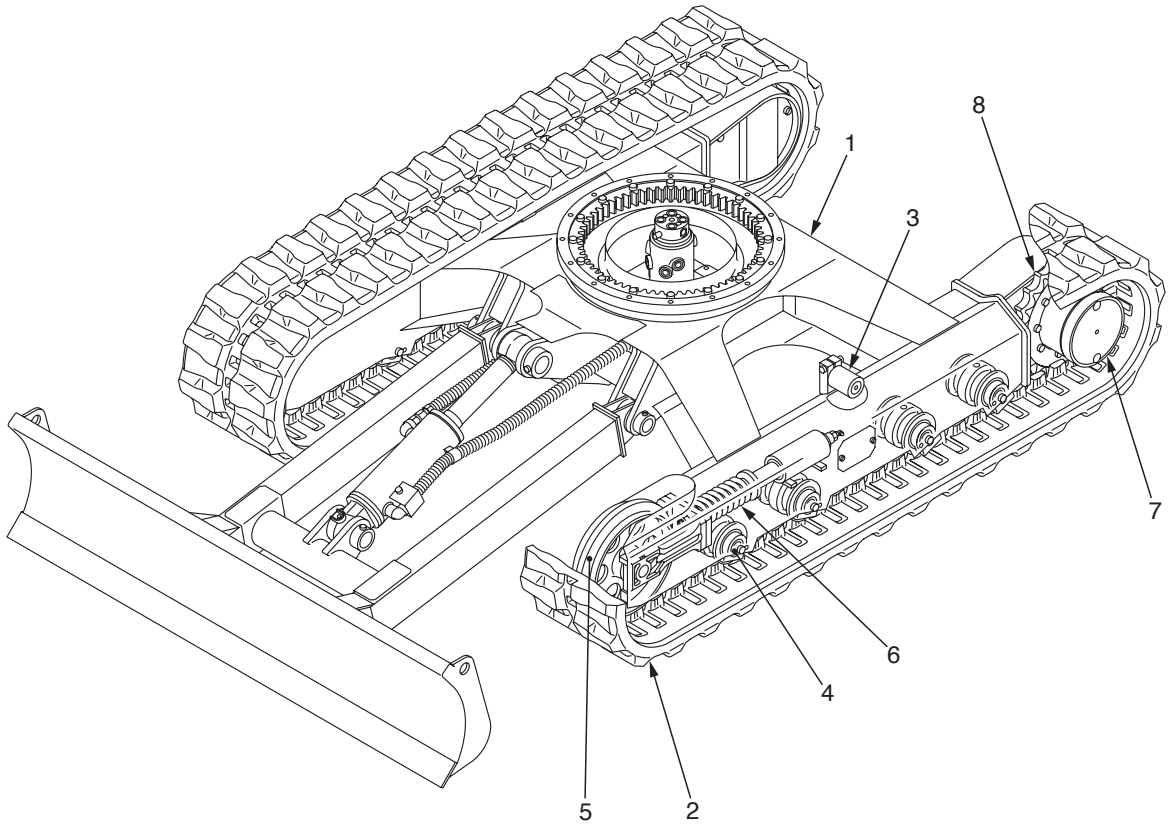
G4C205

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# TRAVEL SYSTEM

## CONSTRUCTION




G4C300

The above figure shows the components of the TB135.

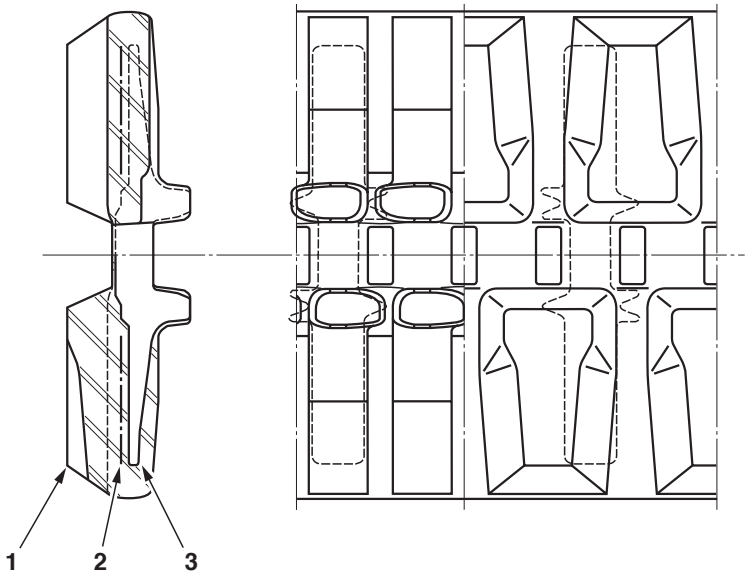
1. Lower Frame
2. Crawler Belt
3. Carrier Roller
4. Track Roller
5. Idler
6. Track Adjuster
7. Travel Motor
8. Sprocket

https://truckmanualshub.com/



**Rubber Crawler Belt**

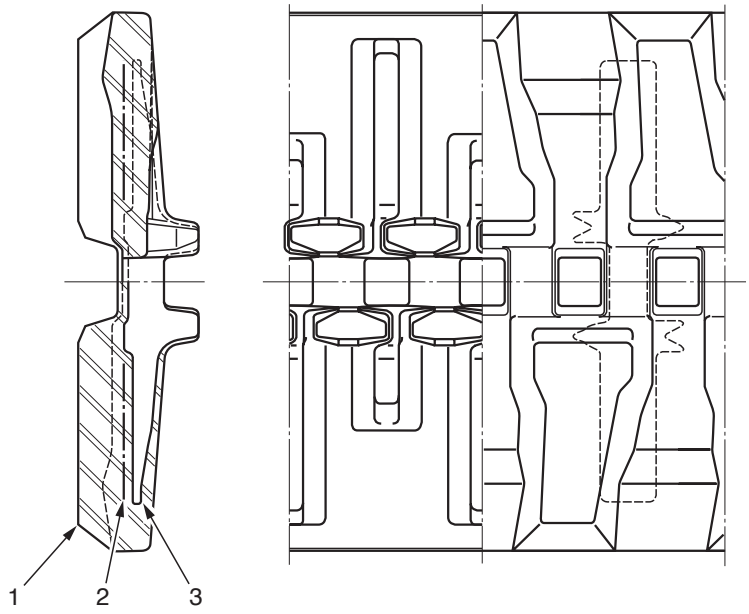
■ TB125, TB135




E5C300

1. Cover Rubber
2. Steel Cord
3. Core

■ TB145




K3C310

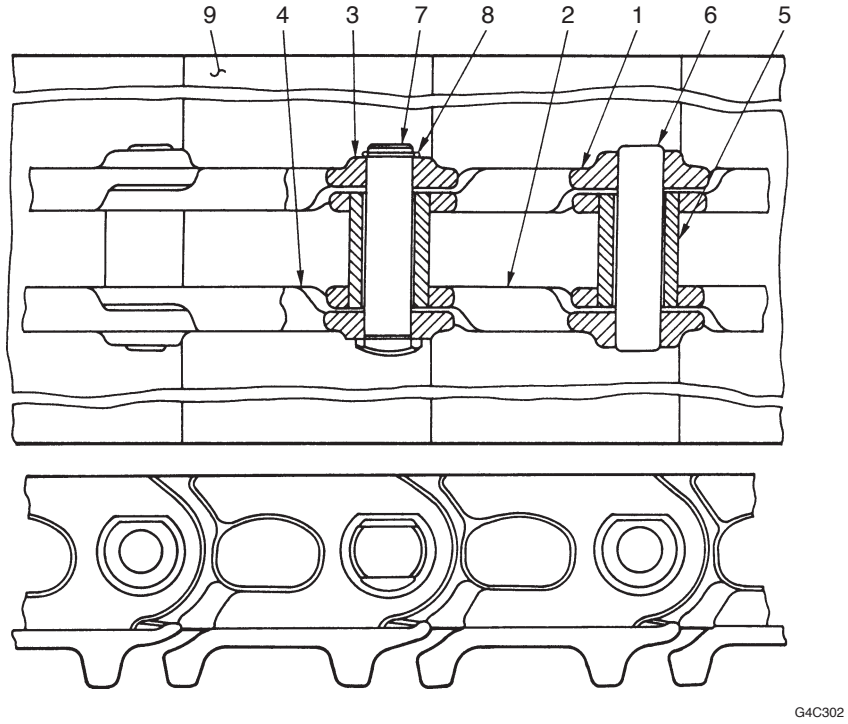
1. Cover Rubber
2. Steel Cord
3. Core

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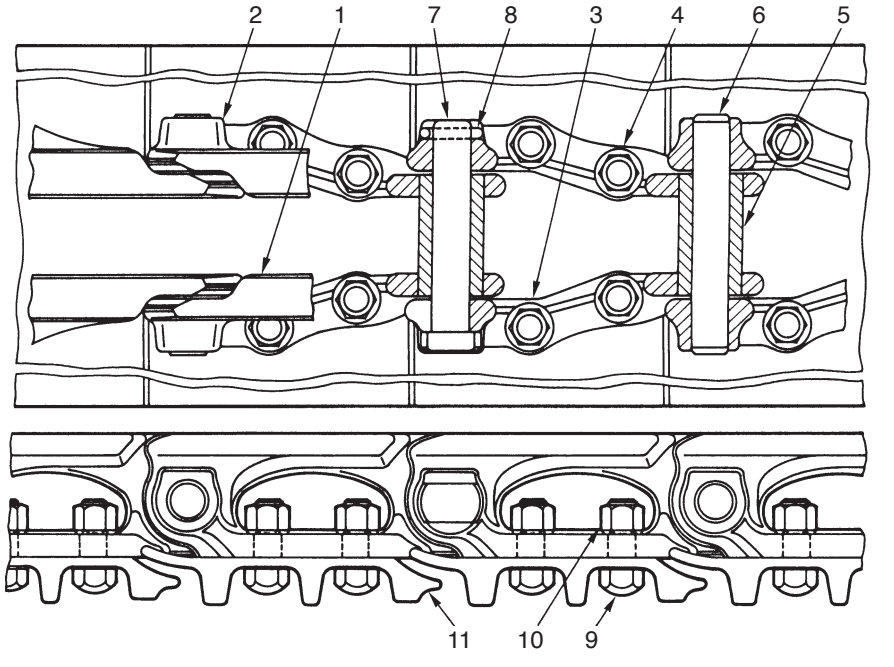
**Steel Crawler Belt**

■ TB125, TB135




1. Link R
2. Link L
3. Master Link R
4. Master Link L
5. Bushing
6. Track Pin
7. Master Pin
8. Spiro-lox
9. Shoe Plate

■ TB145



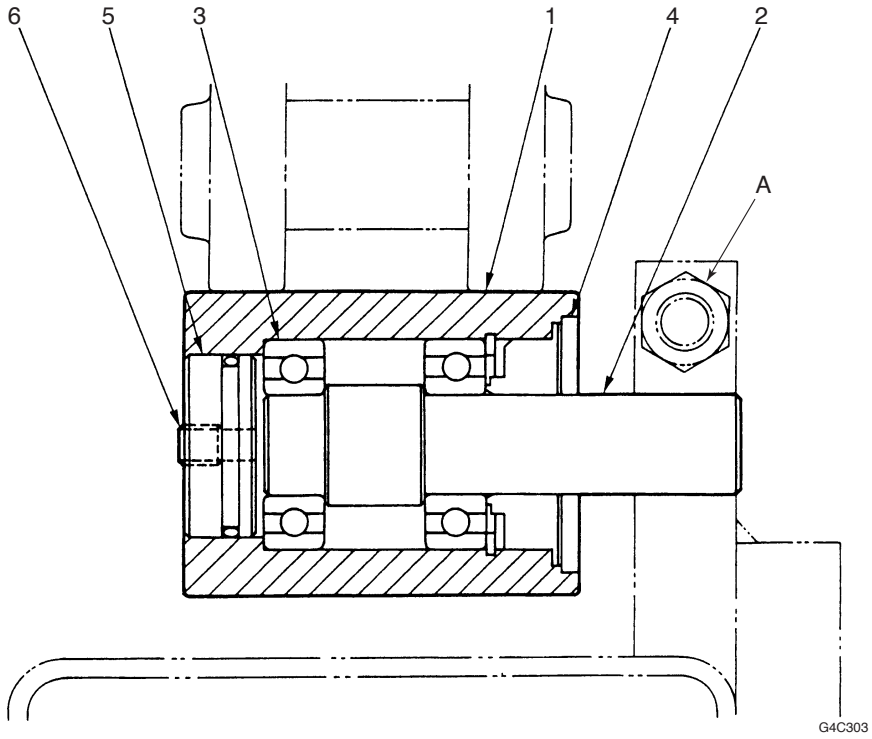

1. Link R
2. Link L
3. Master Link R
4. Master Link L
5. Bushing
6. Track Pin
7. Master Pin
8. Cotter Pin
9. Bolt
10. Nut
11. Shoe Plate

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**Carrier Roller**

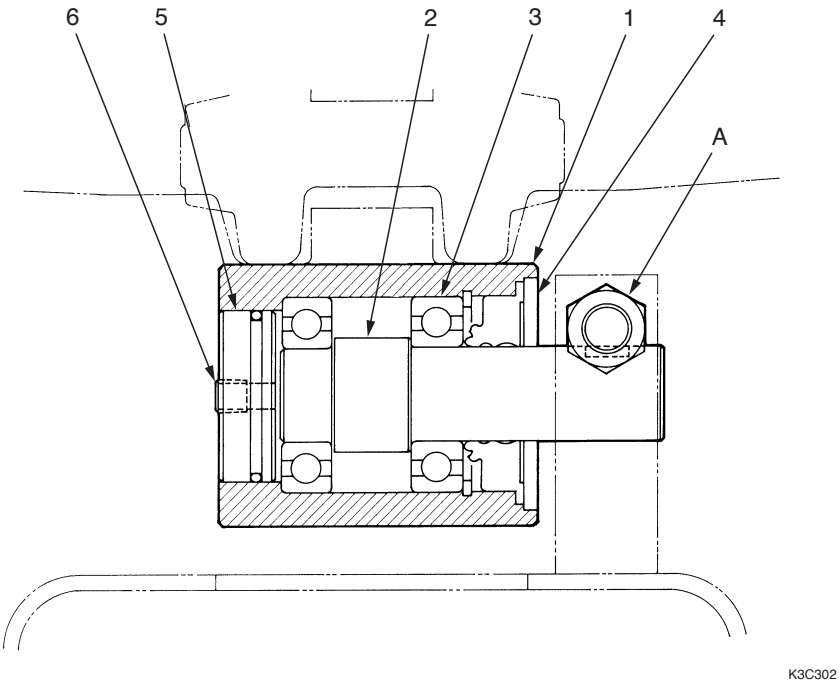
■ TB125, TB135




1. Roller
2. Shaft
3. Bearing
4. Cover
5. Cover
6. Oil Filler Plug

A: Tightening Torque: 65.7 N·m
Apply thread lock.
Lube oil capacity: 45 mL

■ TB145




1. Roller
2. Shaft
3. Bearing
4. Cover
5. Cover
6. Oil Filler Plug

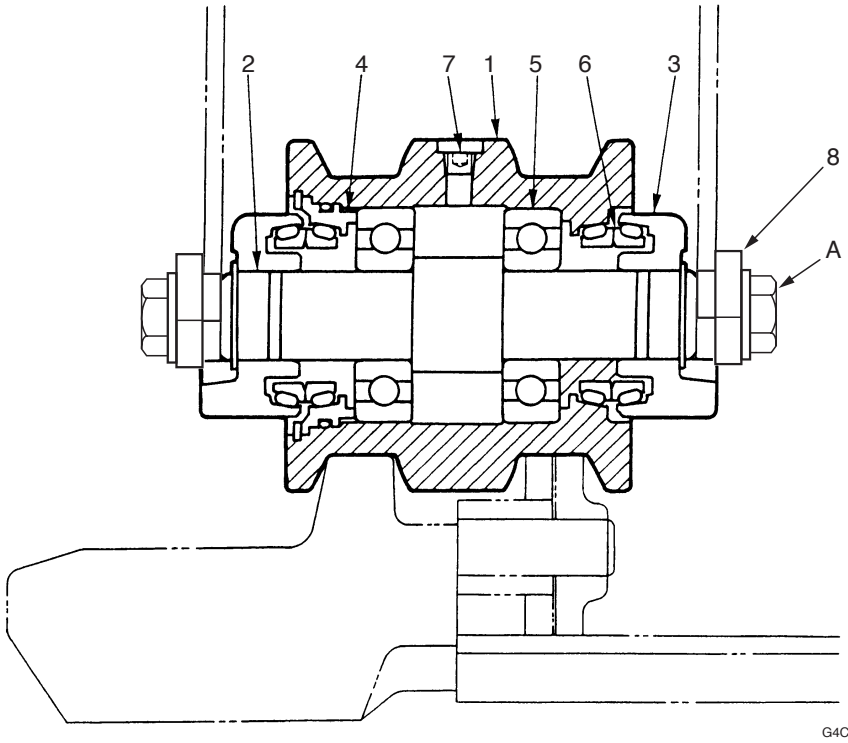
A: Tightening Torque: 256 N·m
Apply thread lock.
Lube oil capacity: 60 mL

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**Track Roller**

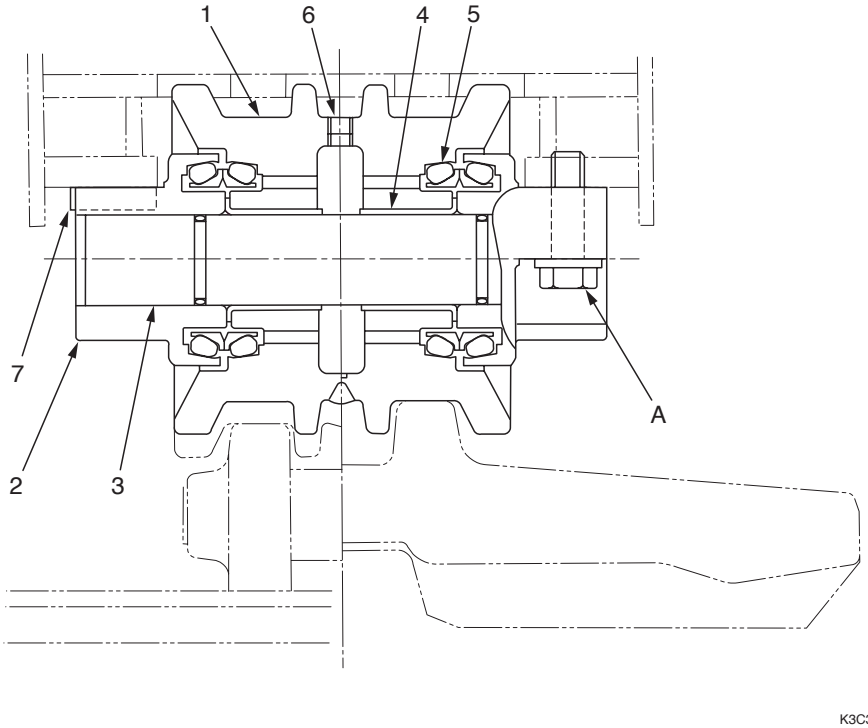
■ TB125, TB135




1. Roller
2. Shaft
3. Cover
4. Retainer
5. Bearing
6. Floating Seal
7. Oil Filler Plug
8. Stopper
   (for steel crawler)

A: Tightening Torque: 157.9 N·m
Lube oil capacity: 70 mL

■ TB145




1. Roller
2. Cover
3. Shaft
4. Bushing
5. Floating Seal
6. Oil Filler Plug
7. Spacer
   (for steel crawler)

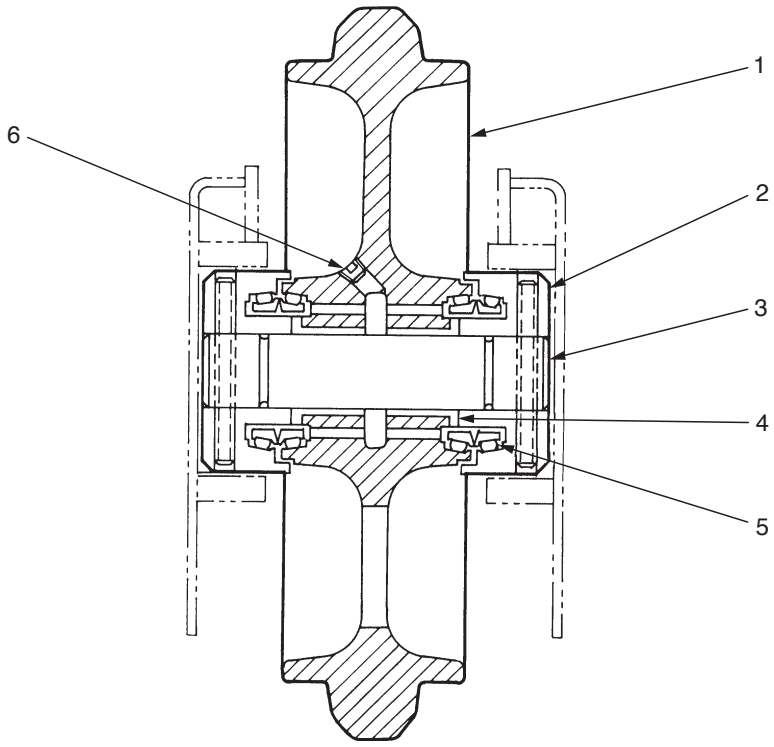
A: Tightening Torque: 102 ±5.1 N·m
Lube oil capacity: 65 mL

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**Idler**

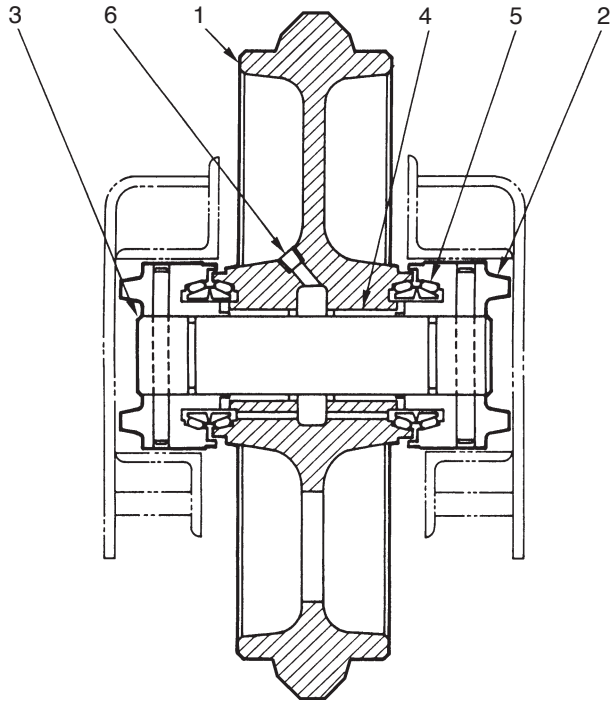
■ TB125, TB135




1. Idler
2. Slide
3. Shaft
4. Bushing
5. Floating Seal
6. Oil Filler Plug

Lube oil capacity: 50 mL

■ TB145




1. Idler
2. Slide
3. Shaft
4. Bushing
5. Floating Seal
6. Oil Filler Plug

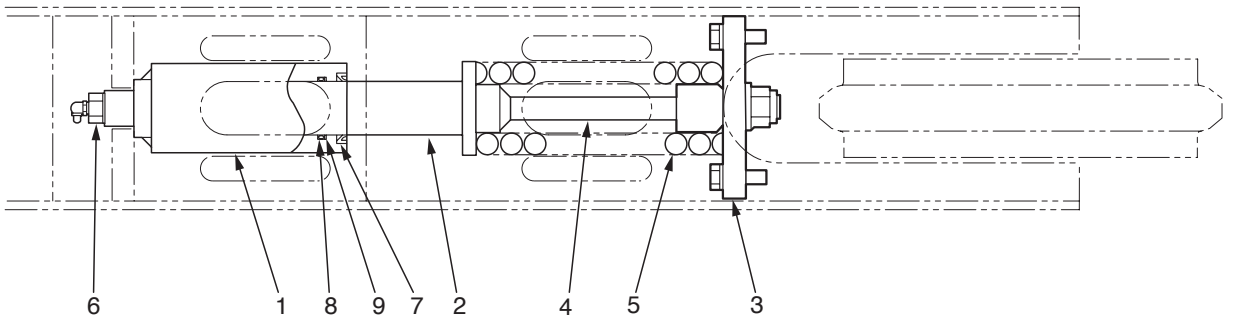
Lube oil capacity: 70 mL

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**Track Adjuster**

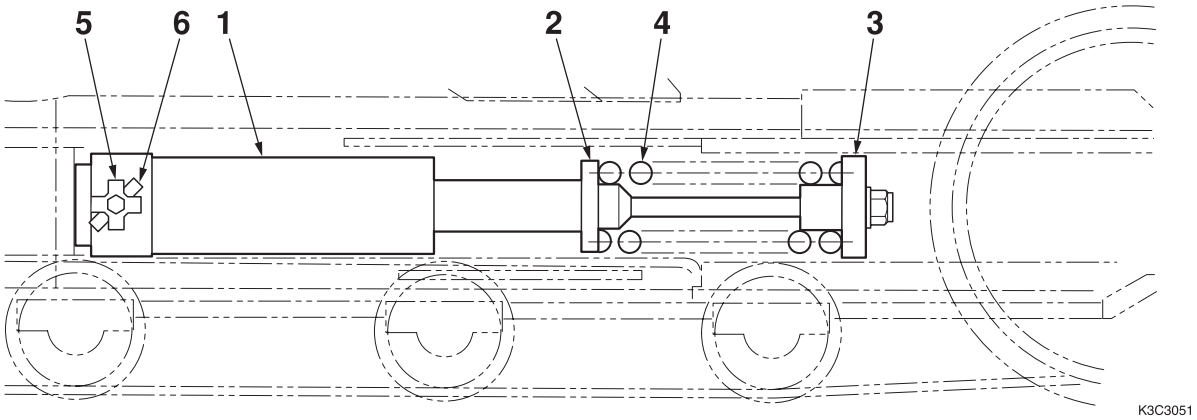
■ TB125, TB135, TB145 (Standard)




G4C306

1. Cylinder
2. Piston
3. Plate
4. Reach Rod
5. Spring
6. Check Valve Assembly
7. Oil Seal
8. O-ring
9. Backup Ring

■ TB145 (Automatic)




K3C3051

1. Cylinder
2. Reach Rod
3. Plate
4. Spring
5. Handle
6. Lock Plate

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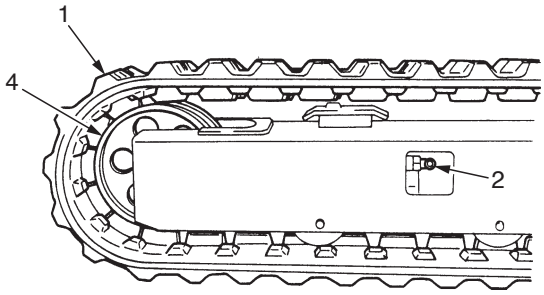


## DISASSEMBLY AND ASSEMBLY

### Removing the Rubber Crawler

■ TB125, TB135, TB145 (Standard)

1. Loosen the tension of the crawler (1).
   When loosening the check valve (2), turn it slowly. Do not loosen it beyond the point where grease starts to ooze out. If it is difficult for the grease to come out, move the machine forward and in reverse.
   • Check valve tightening torque:
   177 N·m (18 kgf·m)

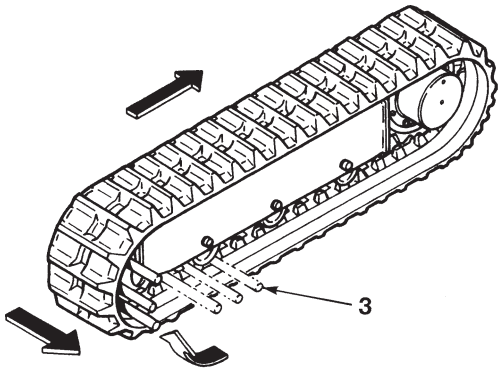


C4C308

2. Raise the body and after engaging pieces of iron pipe (3) in the crawler, rotate the sprocket in the reverse direction.

3. When the iron pipes reach a point just to the side of the idler (4), stop rotating the sprocket.

4. Slide the crawler to the side to remove it.
   • Rubber crawler mass: TB125…124 kg
   TB135…149 kg, TB145…219 kg



Y2–C307

### Installing the Rubber Crawler

■ TB125, TB135, TB145 (Standard)

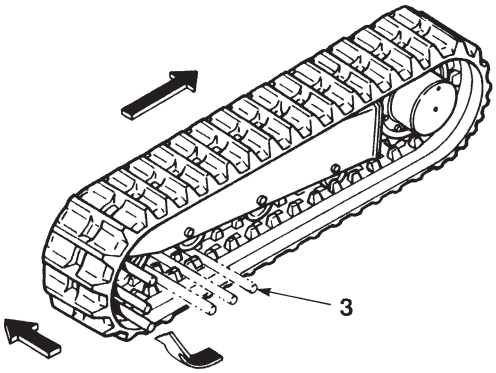
1. Raise the machine body and set the crawler (1) on the frame.
   • The Crawler should engage in the sprocket.

2. Engage pieces of iron pipe (3) in the crawler, then rotate the sprocket in the reverse direction.

3. When the iron pipes reach a point just to the side of the idler, stop rotating the sprocket.

4. Slide the crawler to a position where it will fit snugly with the idler.

5. Engage the crawler fully with the sprocket and the idler, then adjust the crawler tension.
   ☞ "II. Specifications, Standards for Judging Performance"



Y2–C308

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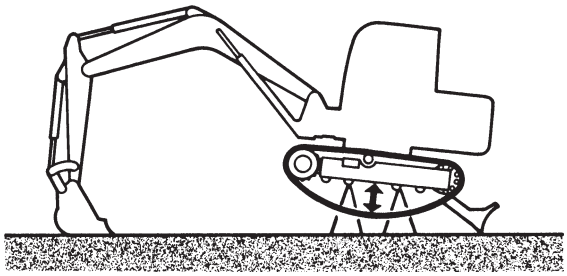


### Removing the Rubber Crawler

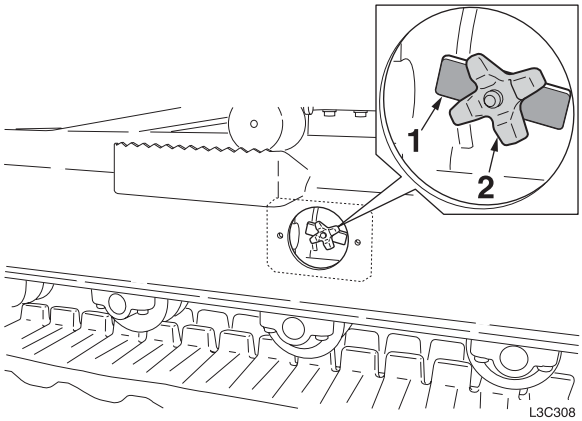
■ TB145 (Automatic)

When the travel speed switch is set to the 2nd speed side while the engine is running, the tensioning cylinder rods extend and the crawlers are tightened.
Always keep the switch at the 1st speed side except when tightening the crawlers.

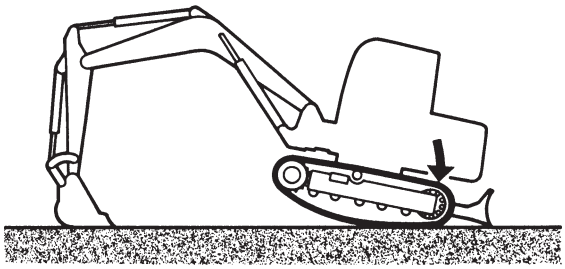
1. Start the engine and raise the machine body 500mm with the hoe attachment and dozer blade.
2. Stop the engine.
3. Remove the valve covers.
4. Turn the lock plate (1) counterclockwise to disengage the handle lock.
5. Turn the valve handle (2) counterclockwise to loosen the tension of the crawler. Do the same for the other side.
6. Close both the tensioning cylinder valves before removing the crawlers.
7. Slowly lower the dozer blade side of the machine body, by the dozer blade lever. (Do not start the engine.)
8. Ground the crawlers and lower the machine body so that the crawler slack is maximum.
9. When the crawlers come away from the idlers, slide the crawlers to the outside and remove them.
10. Disengage the crawlers and sprockets, then remove the crawlers from the crawler frames.



K3C306




L3C308

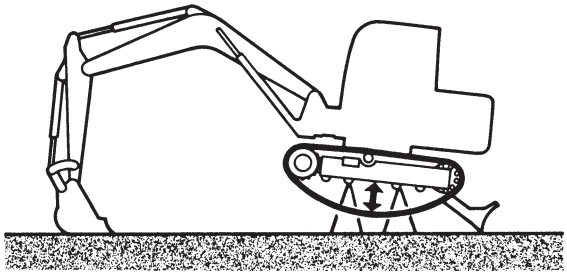


K3C308

### Installing the Rubber Crawler

■ TB145 (Automatic)

1. Engage the crawlers with the left and right sprockets.
2. Set the left and right crawlers on the idlers.
3. Start the engine.
4. Press the travel speed switch once and set it to the 2nd speed side. The left and right crawlers are tightened simultaneously.
5. Check that the crawlers are properly tightened.
   - ☞ "II. Specifications, Standards for judging performance" concerning adjustment dimensions and methods.



K3C306

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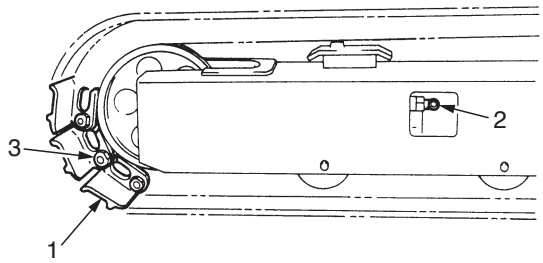


### Removing the Steel Crawler

■ TB125, TB135, TB145 (Standard)

1. Stop the machine so that master pin is front of the idler.

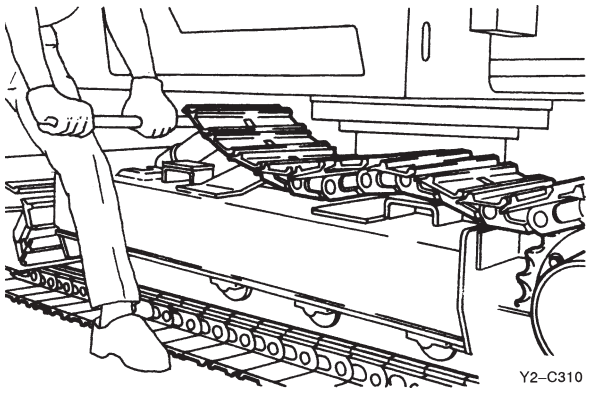
2. Loosen the tension of the crawler (1).
   When loosening the check valve (2), turn it slowly. Do not loosen it beyond the point where grease starts to ooze out. If it is difficult for the grease to come out, move the machine forward and in reverse.
   - Check valve tightening torque:
     177 N·m (18 kgf·m)



C4C309

3. Take out the master pin (3) and separate the ends of the crawler (1).

4. Raise the body, then open up the crawler (1) while running the travel motor slowly in reverse.
   - Use the dozer blade and hoe attachment to raise the body, It should be kept level as it is raised.
   - Steel Crawler mass: TB125…153 kg
     TB135…199 kg, TB145…259 kg

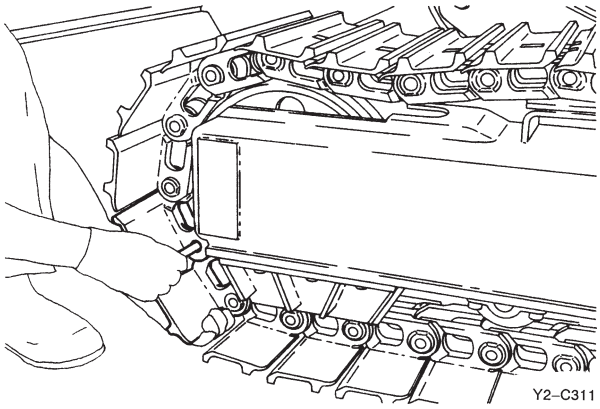

Y2–C310

### Installing the Steel Crawler

■ TB125, TB135, TB145 (Standard)

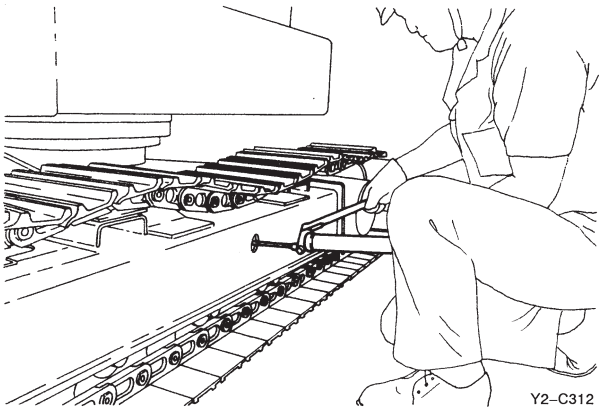
1. Raise the body and position the crawler beneath the frame.
   - Be careful not to mistake the installation direction of the crawler.

2. Engage the links in the sprocket, then run the travel motor slowly in the forward direction to wrap the crawler around the frame.


Y2–C311

3. After lowering the body, install the master pin to join the ends of the crawle.
   - After aligning the pin holes, insert a temporary pin before inserting the master pin.

4. Raise the body and adjust the crawler tension.
   ☞ "II, Specifications, Standards for judging performance"


Y2–C312

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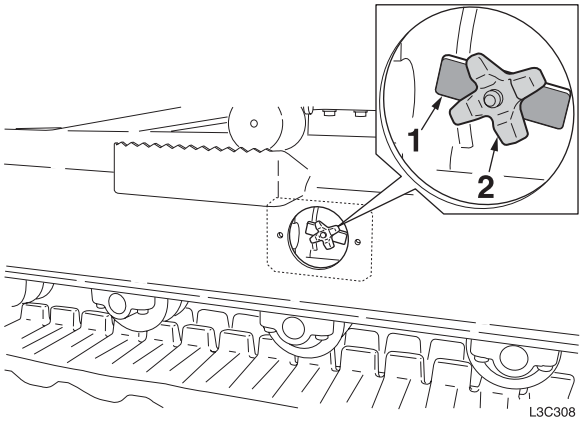


### Removing the Steel Crawler

■ TB145 (Automatic)

- Stop the machine so that the master pin is positioned at the front of the idler.

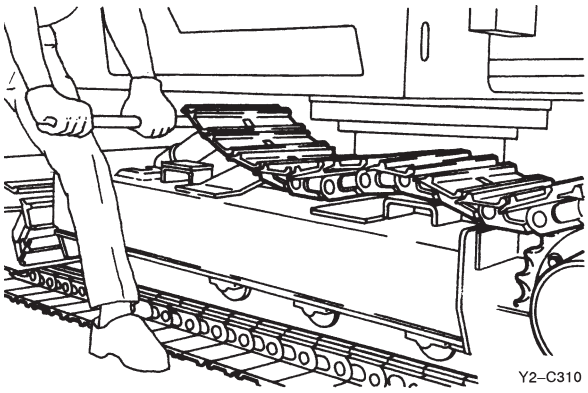
1. Raise the body.
2. Release the crawler tension.
   ☞ "Removing the Rubber Crawler"
3. Pull out the master pin and detach the crawler.
4. Slowly run the travel motor in reverse and gradually remove the crawler.
   - Steel crawler mass: 259 kg

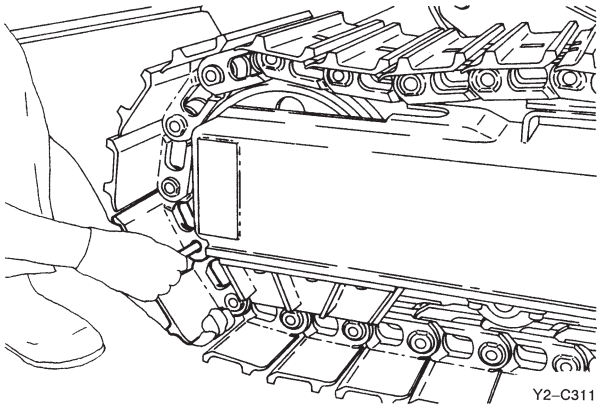



### Installing the Steel Crawler

■ TB145 (Automatic)

1. Raise the body and position the crawler under the frame.
   - Be careful to install the crawler belts in the proper direction.
2. Engage the links in the sprockets, then slowly run the travel motor in forward and wrap on the crawler.
3. Lower the body, then install the master pin and engage the crawler.
   - After lining up the pin hole, first insert the temporary pin.
4. Tension the crawler.
   - Turn on the travel speed switch and tension the crawler.
   - ☞ "II. Specifications, Standards for judging performance" concerning adjustment dimensions and methods.



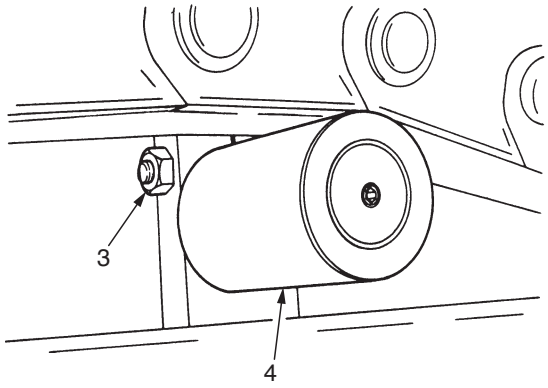



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### Removing the Carrier Roller

1. Loosen the tension in the crawler belt.
2. Using a hydraulic jack, push up the crawler belt.
3. Loosen the installation nut (3) and remove the bolt, then remove the upper roller (4).



G4C307

### Installing the Carrier Roller

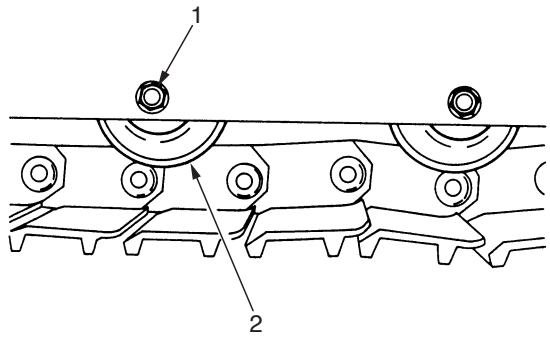
Follow the procedure used for removal in reverse order.

- When tightening the installation nut, apply thread lock to the threads.
- Installation nut tightening torque:
  TB125, TB135…65.7 N·m (6.7 kgf·m)
  TB145…256 N·m (26.1 kgf·m)

### Removing the Track Roller

1. Loosen the crawler tension.
2. Loosen the roller installation bolt (1) slightly (approximately 1 turn).
3. Raise the machine body, take out the installation bolt (1) and remove the roller (2).

< TB125, TB135 >

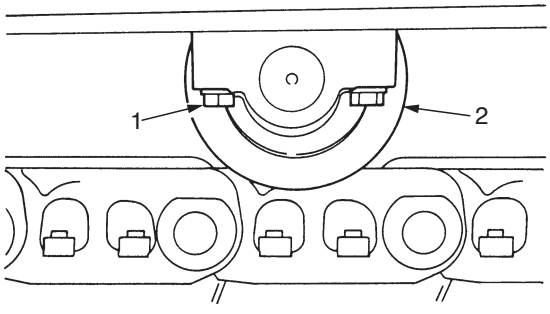


G4C308

### Installing the Track Roller

1. Tighten the roller (2) installation bolt (1) temporarily.
2. Bring the machine body in full contact with the ground, then tighten the bolt.
   - Tightening torque:
     TB125, TB135…157.9 N·m (16.1 kgf·m)
     TB145…102 ±5.1 N·m (10.4 ±0.52 kgf·m)
   - Apply thread lock to the threads of the installation bolt.
3. Raise the machine body, then adjust the tension of the crawler.
   Raise the machine body, then adjust the tension of the crawler.

<TB145>



K3C309

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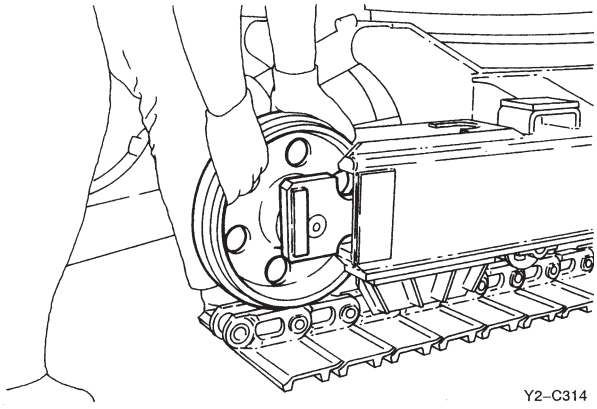


### Removing the Idler and Track Adjuster

1. Remove the Crawler.
   ☞ "Removing the Crawler"

2. <TB145 (Automatic) only> Remove the cover, then disconnect the hydraulic hoses from the tensioning cylinder.

3. Take out the idler and track adjuster.
   - Mass of idler + Track adjuster:
   - TB125, TB135…38 kg, TB145…52 kg




### Installing the Idler and Track Adjuster

Follow the procedure used for removal in reverse order.

- Apply grease to the rubbing surfaces of the track adjuster piston and cylinder.

### Removing the Travel Motor

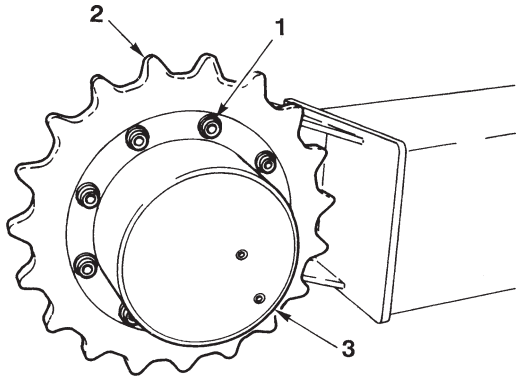
1. Remove the crawler.
   ☞ "Removing the Crawler"

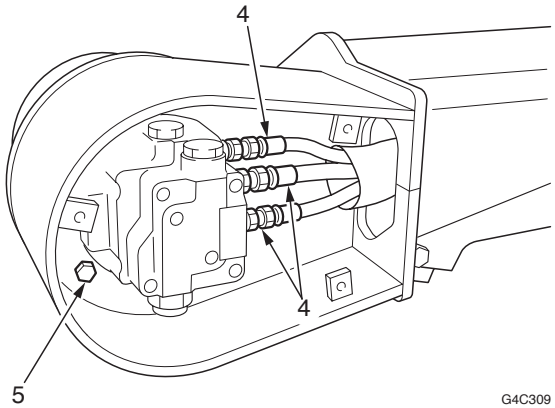
2. Remove the installation bolts (1) and remove the sprocket (2).
   - Tightening torque:
     TB125, TB135…97.1 ±4.8 N·m (9.9 ±0.49 kgf·m)
     TB145…155.9 ±7.7 N·m (15.9 ±0.79 kgf·m)
   - Apply thread lock to the bolts.

3. Remove the motor cover and disconnect the hydraulic piping (4).

4. Suspend the travel motor (3) temporarily and remove the fixing bolts (5).
   - Tightening torque:
     TB125, TB135…97.1 ±4.8 N·m (9.9 ±0.49 kgf·m)
     TB145…155.9 ±7.7 N·m (15.9 ±0.79 kgf·m)
   - Apply thread lock to the bolts.

5. Suspend the travel motor (3) and remove it.
   - Travel motor mass: TB125…36 kg,
     TB135…49 kg, TB145…57 kg




### Installing the Travel Motor

Follow the procedure used for removal in reverse order.

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**Replacing the Rubber Crawlers with the Steel Crawlers**

Supplementary Parts

| Item | Part Number | Description | Quantity | | |
|---|---|---|---|---|---|
| | | | TB125 | TB135 | TB145 |
| 1 | 03713-00100 | STOPPER | 12 | 16 | – |
| 2 | 11010-51450 | BOLT | 12 | 16 | – |
| 3 | 03913-00400 | SPACER | – | – | 20 |
| 4 | 11010-51255 | BOLT | – | – | 40 |

| Item | Part Number | Description | Quantity | | |
|---|---|---|---|---|---|
| | | | TB125 | TB135 | TB145 |
| 5 | 04610-00700 | GUIDE | – | – | 4 |
| 6 | 11010-41230 | BOLT | – | – | 12 |
| 7 | 11400-20012 | WASHER | – | – | 12 |

**⚠WARNING**

If you must work beneath the raised machine or equipment, always use wood blocks, jack-stands or other rigid and stable supports. Never get under the machine or working equipment if they are not sufficiently supported.

Refer to the previous pages for removing and installing the crawler belts.

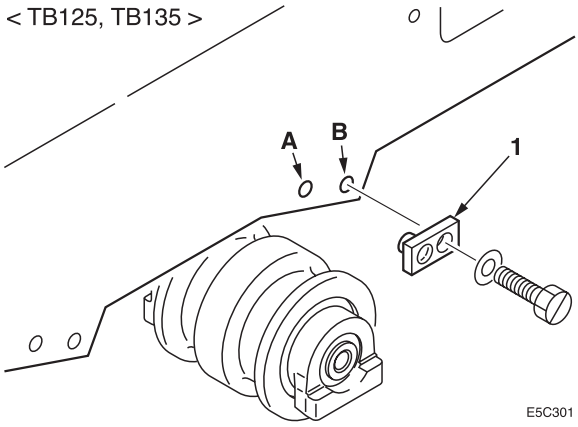
■ TB125, TB135

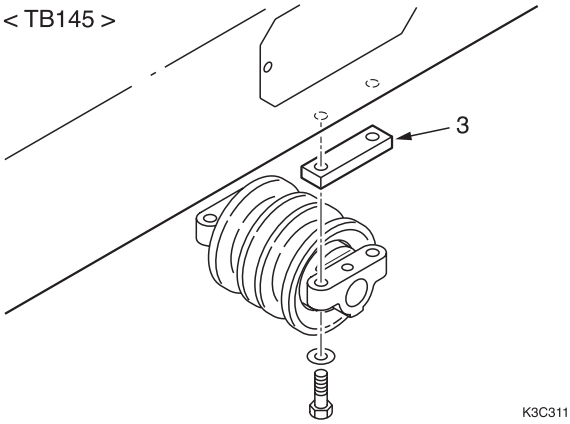
1. Remove the track roller.
   ☞ "Removing the Track Roller"

2. Change the track roller fitting position to the lower hole (B).
   - A (upper hole): fitting hole for rubber crawler
   - B (lower hole): fitting hole for steel crawler.

3. Fit the track roller with the stopper (1) added.
   - Insert the boss of the stopper into the upper hole (A).

   ☞ "Installing the Track Roller"



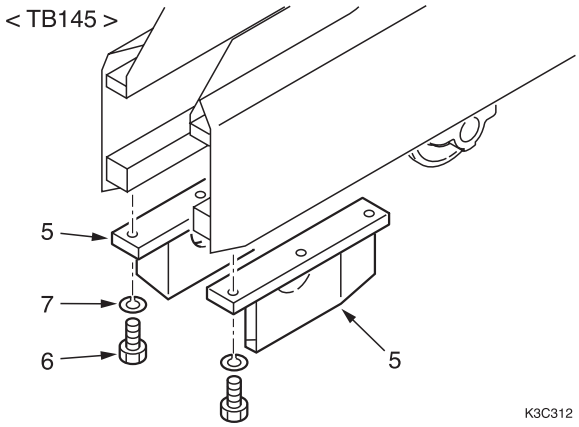




■ TB145

1. Remove the track roller.
   ☞ "Removing the Track Roller"

2. Fit the track roller with the spacer (3) added between the frame and the roller bracket.
   ☞ "Installing the Track Roller"

3. Attach the guide (5) to the bottom of the frame on the idler side, and fix them with a washer (7) and a bolt (6).



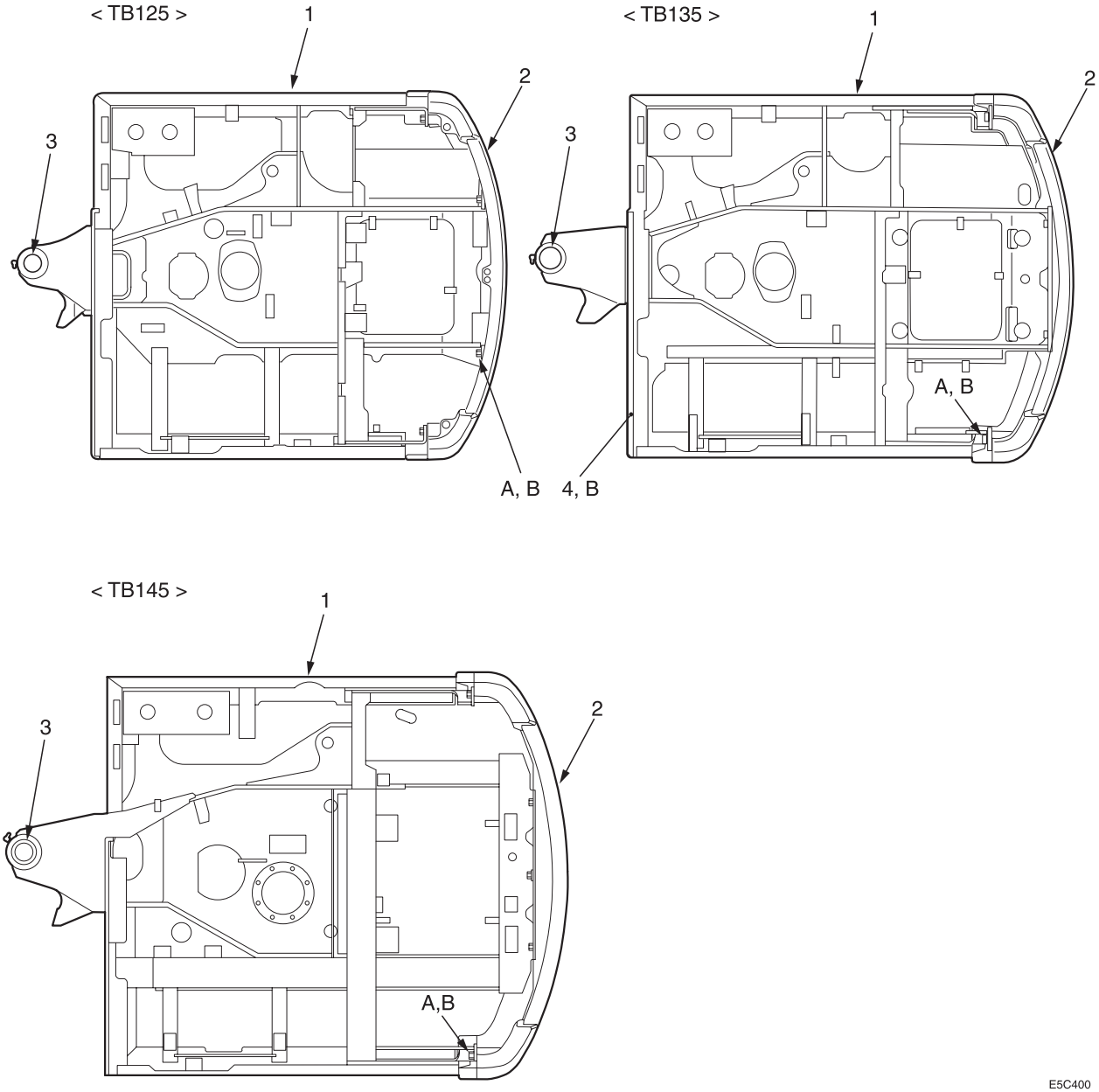
https://truckmanualshub.com/



# UPPER FRAME

## CONSTRUCTION

### Turntable



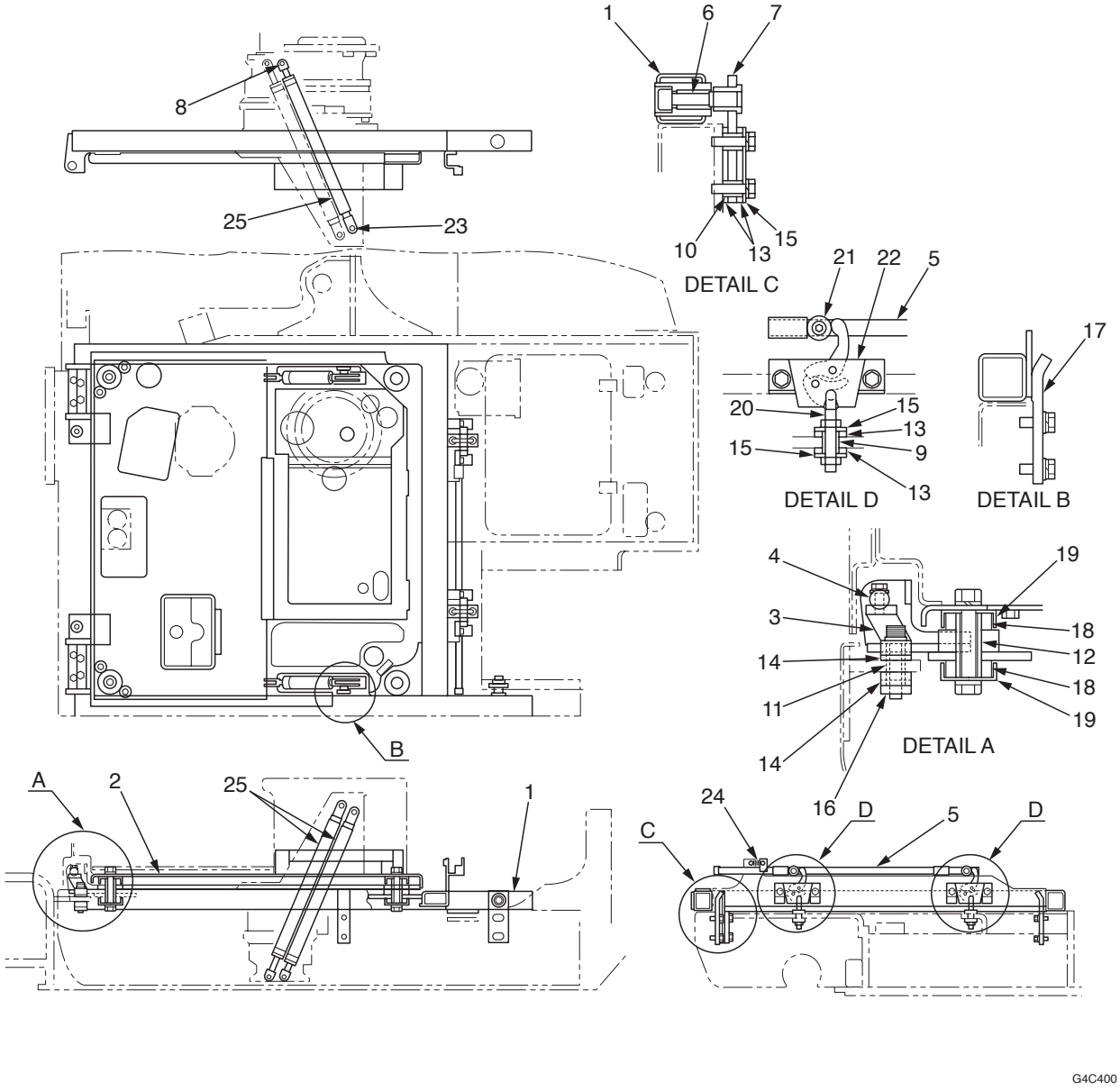

A: Tightening Torque:
TB125…157.8 N·m (16.1 kgf·m)
TB135, TB145…256 N·m (26.1 kgf·m)
B: Apply thread lock.

1. Turntable
2. Counterweight
3. Bushing
4. Rubber (TB135 only)

https://truckmanualshub.com/



**Floor Frame**



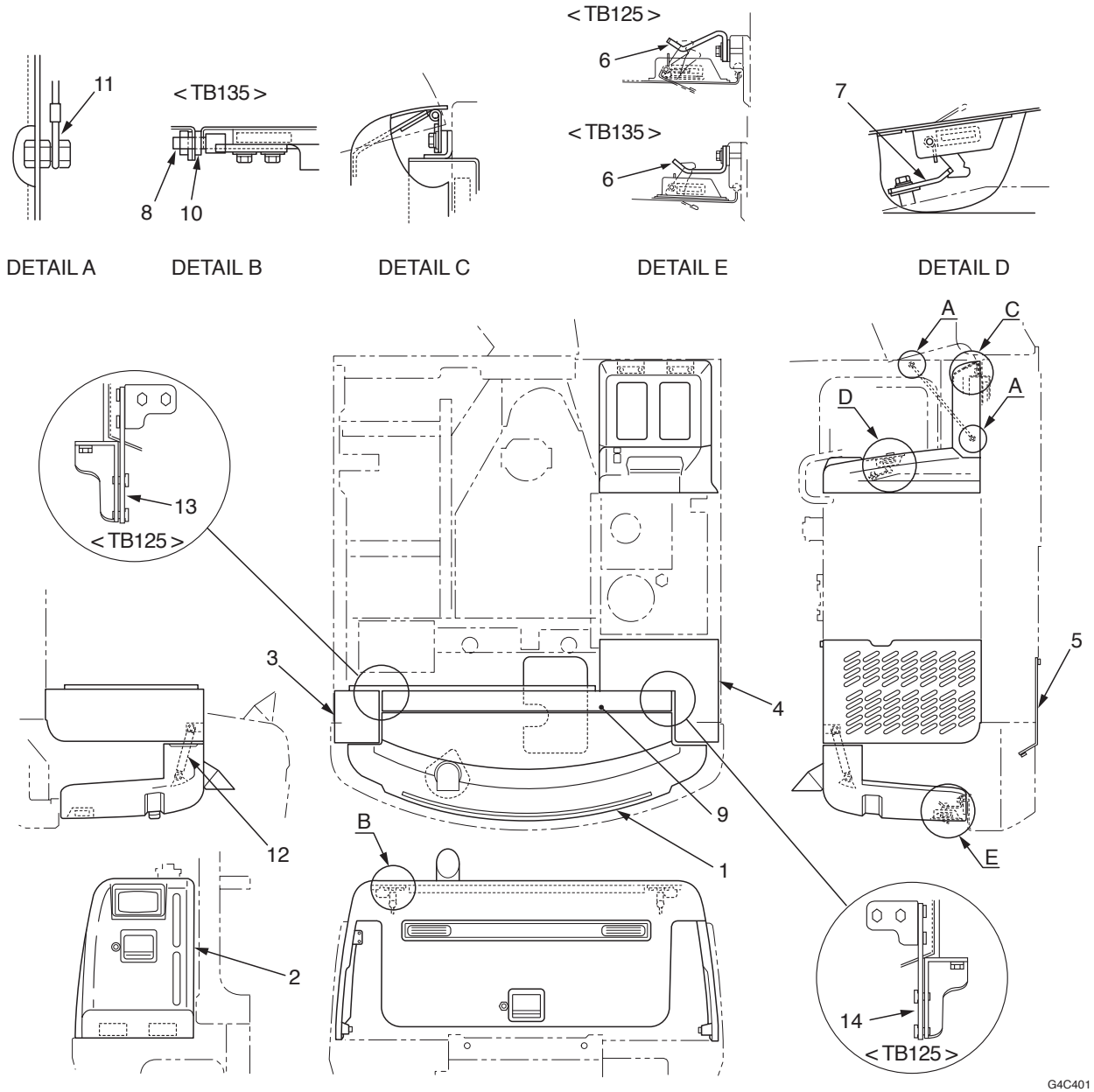

1. Floor Frame
2. Floor Plate
3. Hinge
4. Shaft
5. Rod
6. Lock Bolt
7. Nut Plate
8. Pin
9. Spacer
10. Spacer
11. Spacer
12. Spacer
13. Cushion
14. Cushion
15. Washer Plate
16. Nut Plate
17. Side Stopper
18. Rubber
19. Cover
20. Hook
21. Collar
22. Lock Assembly
23. Pin
24. Spring
25. Stay Damper

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**Covers**

■ TB125, TB135

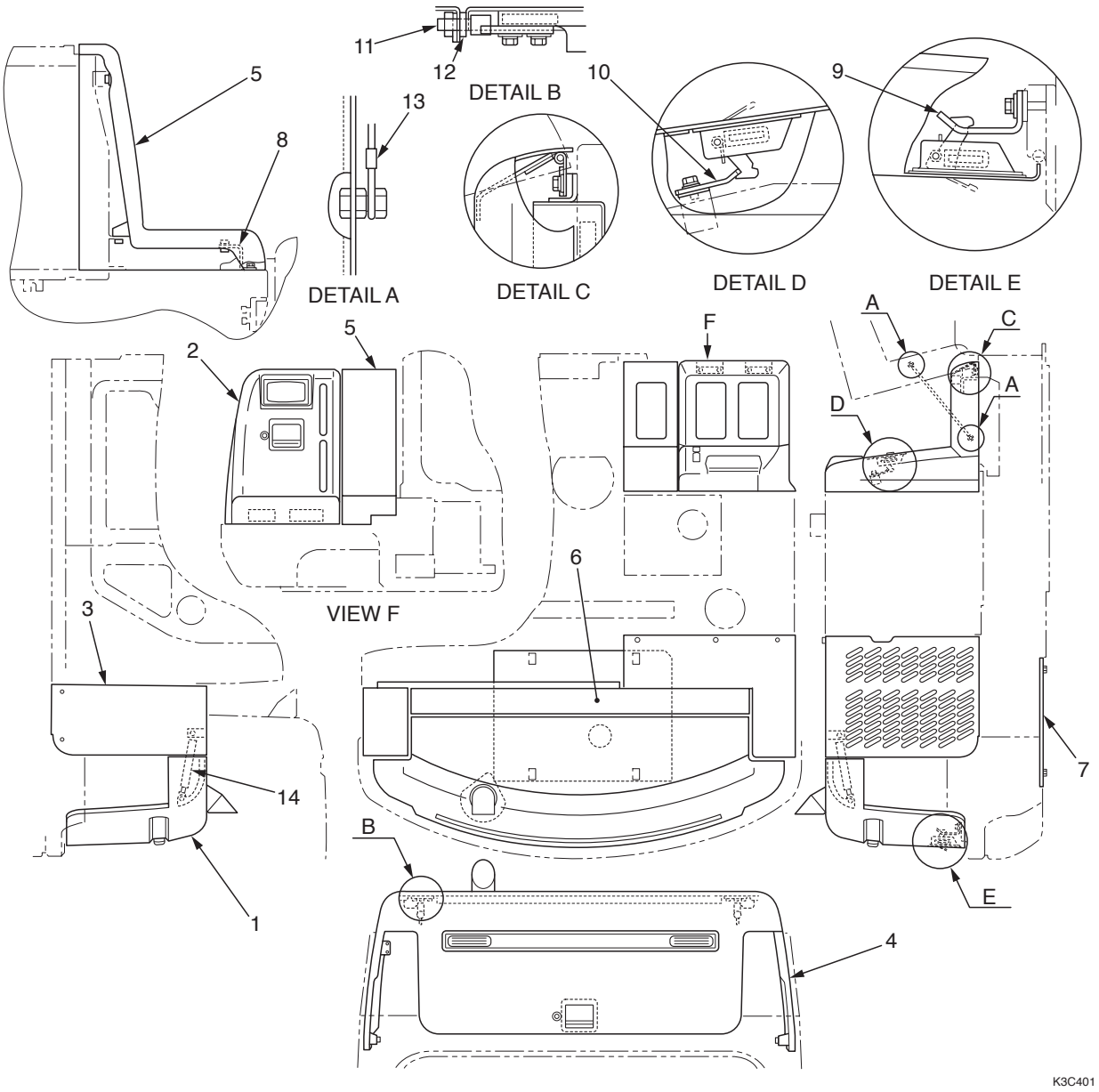



1. Engine Hood
2. Front Cover
3. Side Cover L
4. Side Cover R
5. Under Cover
6. Bracket
7. Bracket
8. Hinge Pin (TB135 only)
9. Center Cover (TB135 only)
10. Collar
11. Wire
12. Stay Damper
13. Link (TB125 only)
14. Link (TB125 only)

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■ TB145

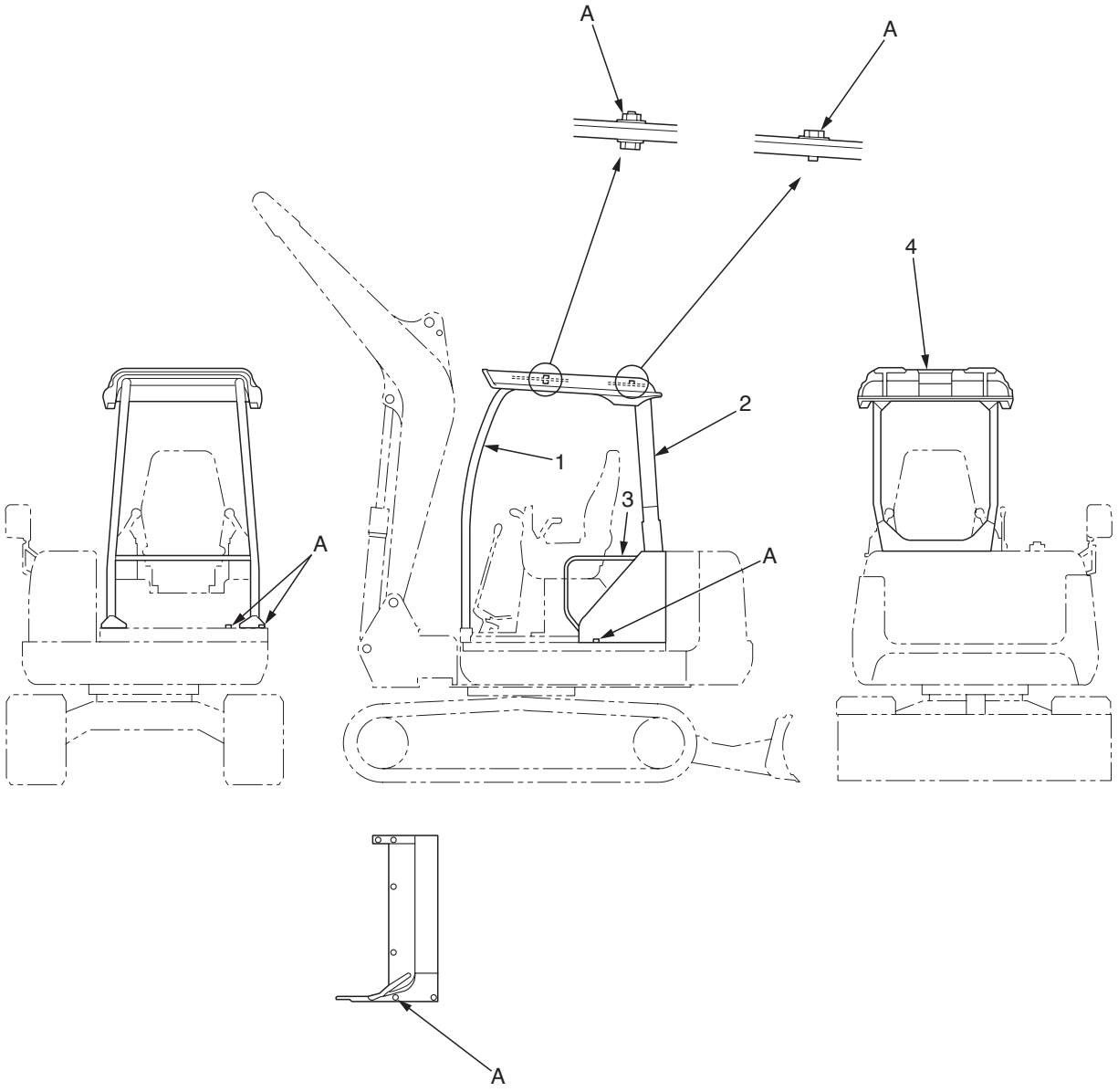



1. Engine Hood
2. Front Cover
3. Side Cover L
4. Side Cover R
5. Front Cover L
6. Center Cover
7. Under Cover
8. Bracket
9. Bracket
10. Bracket
11. Hinge Pin
12. Collar
13. Wire
14. Stay Damper

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**Canopy**




G4C402

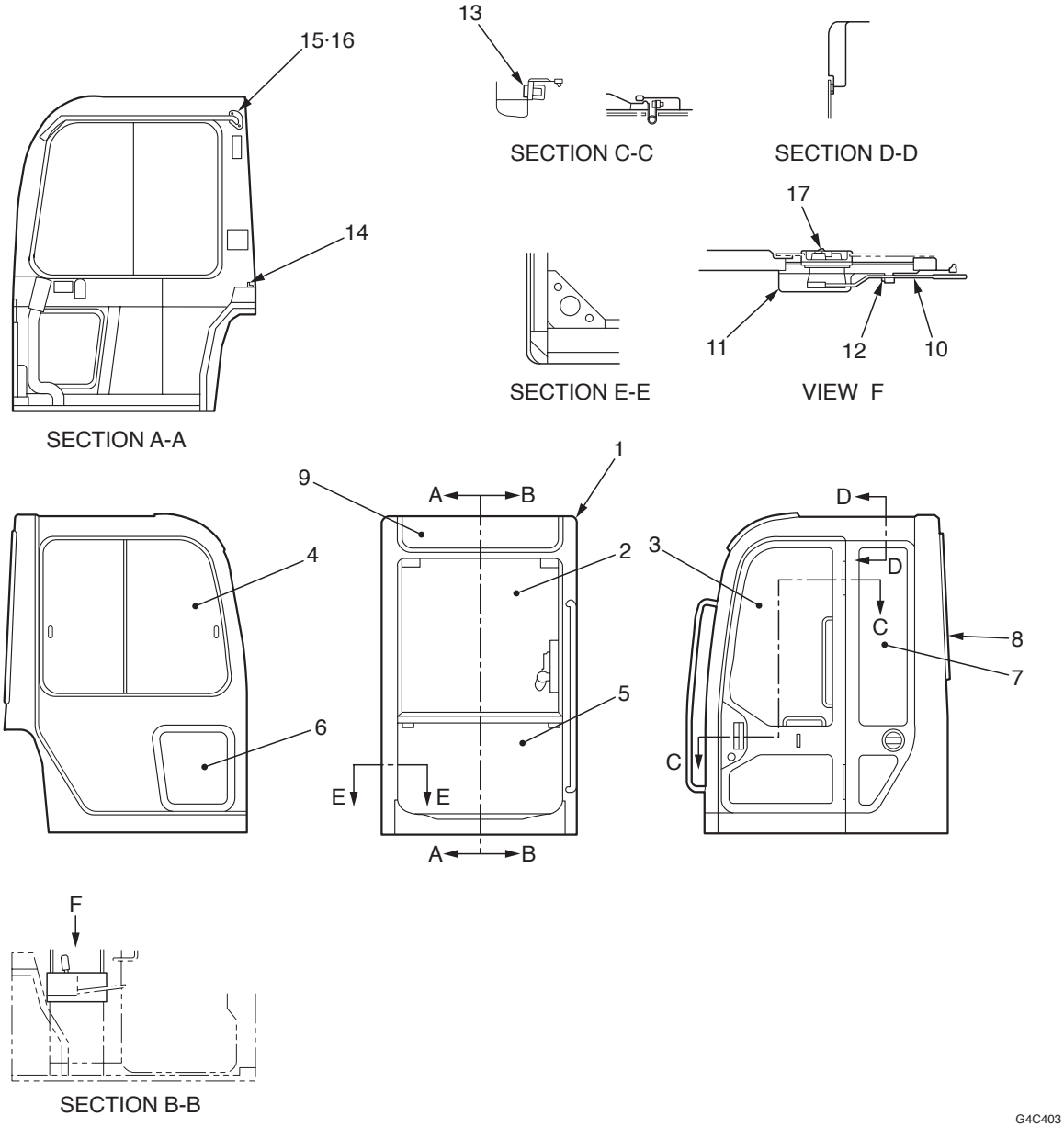
A: Apply thread lock.

1. Front Pole
2. Rear Pole
3. Engine Cover
4. Roof

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**Cab**




1. Main Body
2. Front Sash
3. Door
4. Side Sash
5. Front Glass
6. Glass R
7. Glass L
8. Rear Glass
9. View Roof
10. Plate
11. Cover
12. Plate
13. Plate
14. Plate
15. Stopper R
16. Stopper L
17. Lock Assembly

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## DISASSEMBLY AND ASSEMBLY

### Removing the Upper Frame

1. Remove the hoe attachment.
   ☞ "Attachments, Disassembly and Assembly"

2. Remove the canopy or cab.
   ☞ "Removing the Cab"

3. Remove the engine hood, front cover, and side cover R, L.
   ☞ "Removing the Covers"

4. Tilt the floor and install safety stoppers.

5. Disconnect the hydraulic hoses (1) from the swivel joint.
   - Make match marks on the installation position of the hoses before disconnecting them.

6. Take out the fixing bolts and remove the stopper (2).
   - Tightening torque:
     102 ±5.1 N·m (10.4 ±0.52 kgf·m)
   - Apply thread lock to the bolts.

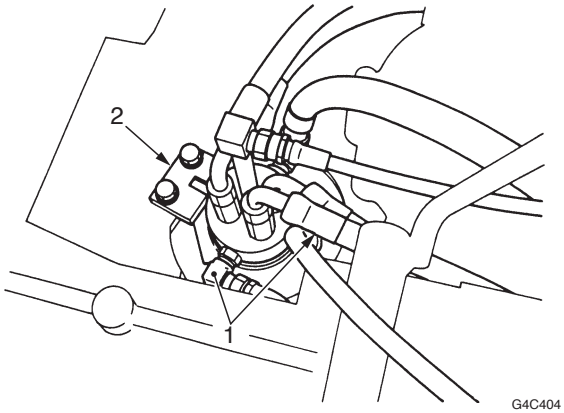
7. Disconnect the grease pipe (3) from the slew bearing.

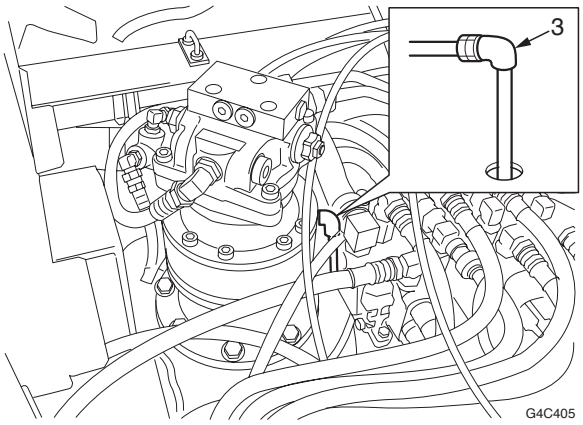
8. Remove the safety stoppers and lower the floor frame.

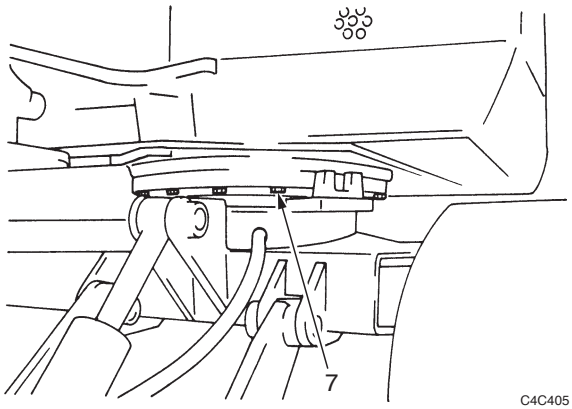
9. Remove the fixing bolts (7) from the outer race of the slew bearing, leaving only two bolts each on the front and the rear of the machine.
   - When mounting the slew bearing, be careful of the positions of the grease hole and reamer bolts.
     ☞ "Installing the Slew Bearing"
   - Tightening torque:
     TB125, TB135…102 ±5.1 N·m (10.4 ±0.52 kgf·m)
     TB145…256 N·m (26.1 kgf·m)
   - Apply molybdenum disulfide grease to the threads and the bolt holes.

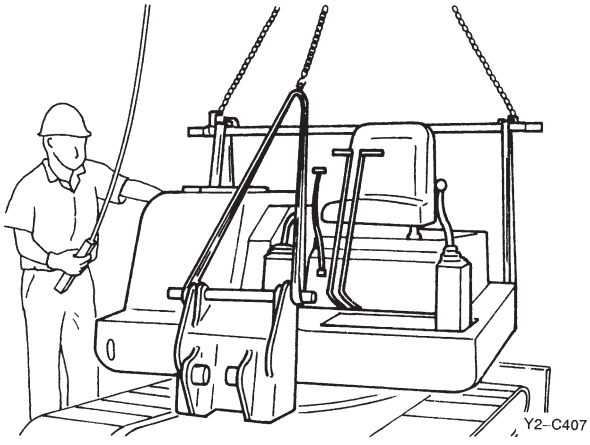
10. Suspend the upper frame temporarily and remove the remaining fixing bolts while keeping the frame well balanced.

11. Suspend the upper frame and remove it.



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### Installing the Upper Frame

Follow the same procedure as for removal in the reverse order.

https://truckmanualshub.com/



### Removing the Floor Frame

1. Disconnect the battery ground cable from the battery.

2. Remove the canopy or cab.
   "Removing the Cab"

3. Disconnect the accelerator wire (2) on the engine side.
   - After disconnecting the wire end from the wire stopper, loosen the fastening nut and take it out of the bracket.

4. Tilt up the floor frame and suspend it temporarily.

5. Disconnect the electric wiring from the control box L.
   ☞ "Removing the Lever Stand"

6. Remove the control unit (7).
   a. Remove two mounting bolts (8) from the top of the control unit.
   b. Remove the mounting bolts (9) and (10) from the plate (11) at the bottom of the control unit.
   c. Remove the mounting bolt (12) and then the clamp.
   d. Pull out the control unit (7) together with the plate (11), and disconnect the electric wiring.

7. Disconnect all hydraulic lines and electric wires passing through the floor at the turntable side.
   - Label all lines and wires to identify for correct installation.

8. Disconnect the control cable (3) on the swing pedal.
   - After disconnecting the wire end from the wire stopper, loosen the fastening nut and take it out of the bracket.

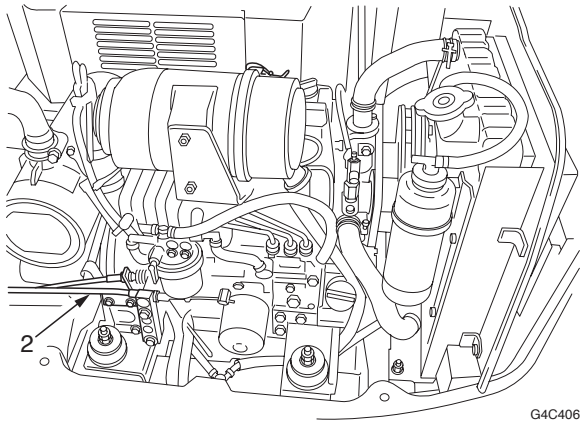
9. Remove the stay damper (4).

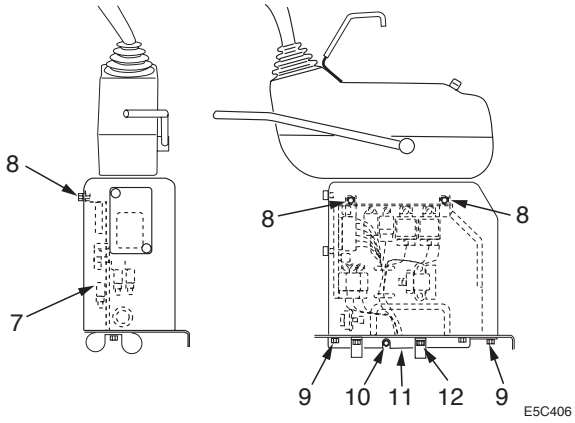
10. Take out the bolts, then take out the shaft (5).

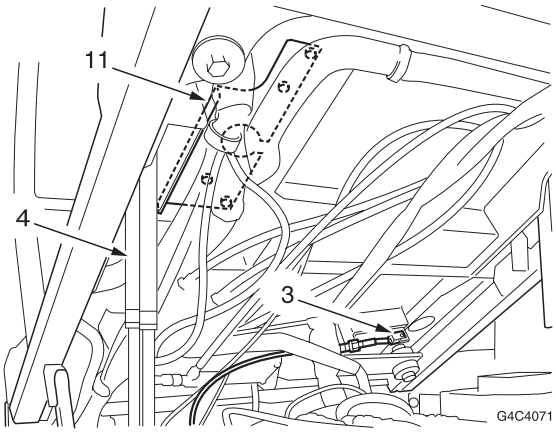
11. Suspend the floor frame (6) to remove it.

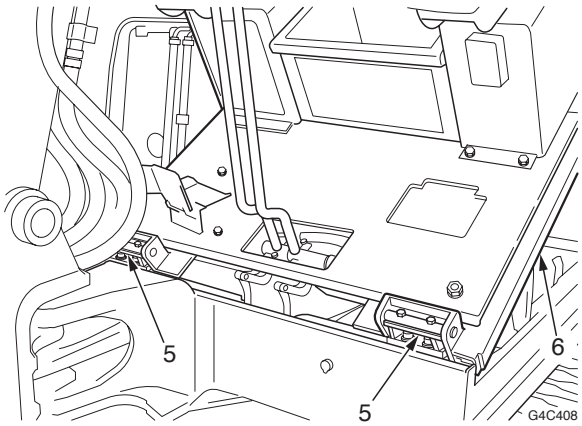
### Installing the Floor Frame

Follow the procedure used for removal in reverse order.



https://truckmanualshub.com/



### Removing the Covers

1. Disconnect the battery ground cable from the battery.

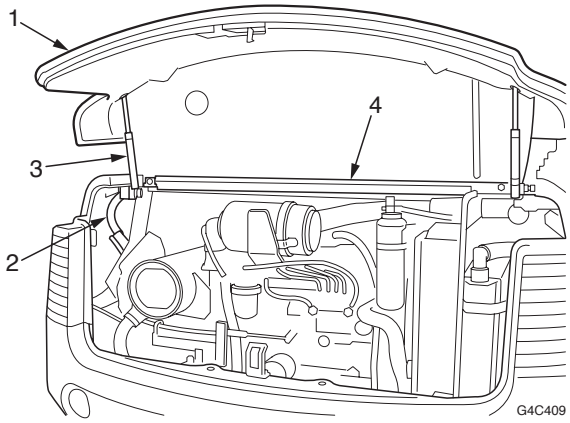
2. Remove the engine hood (1).
   a. Open the engine hood and suspend it temporarily.
   b. Disconnect the electric wiring (2) of the taillight.
   c. Remove the stay damper (3).

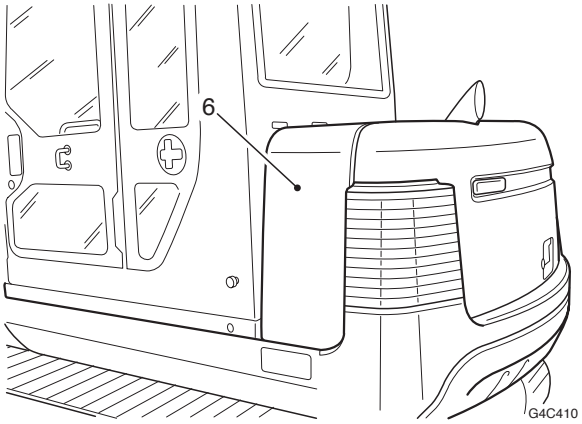
3. <TB135, TB145 only> Remove the center cover (4).

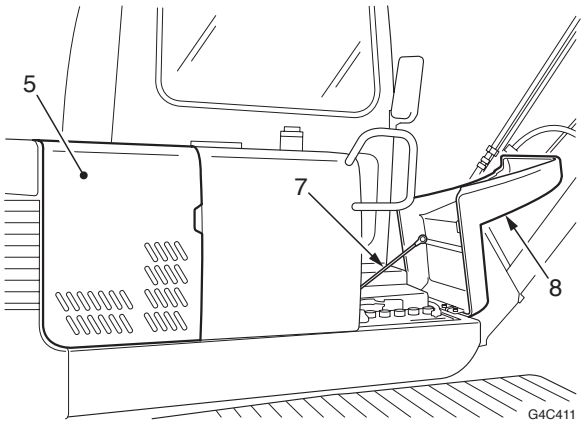
4. Remove the side cover R (5) and L (6).

5. Remove the installation bolts, disconnect the wire (7) and the light's electrical wiring, then remove the front cover (8).

6. Remove the undercover.




### Installing the Covers

Follow the same procedure as for removal in the reverse order.

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### Removing the Cab

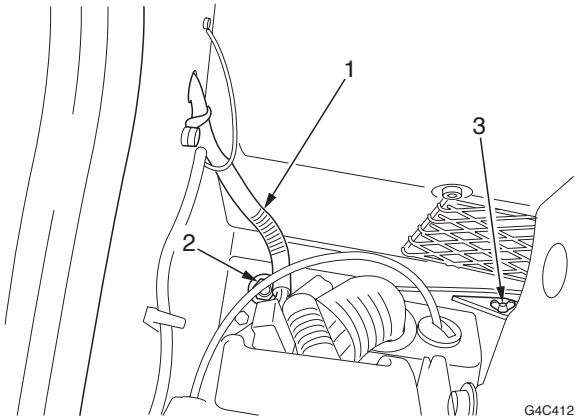
1. Disconnect the battery ground cable from the battery.

2. Disconnect the electric wiring (1) for the cab.

3. Remove the nuts (2) for installing the cab [at two places each on the front and rear].

4. Take out the wing bolts (3) and remove the cover.

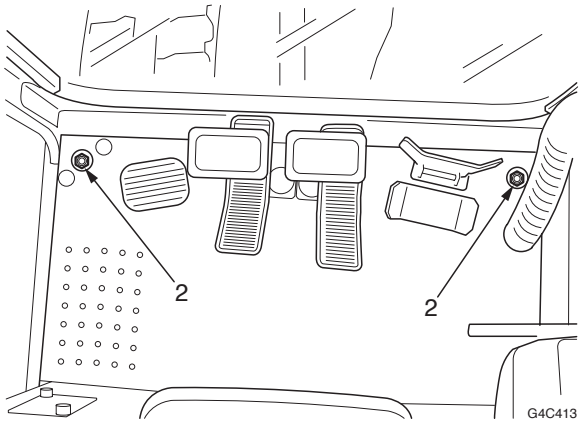
5. Suspend the cab and remove it.
   - Cab mass: Approx. 200 kg.

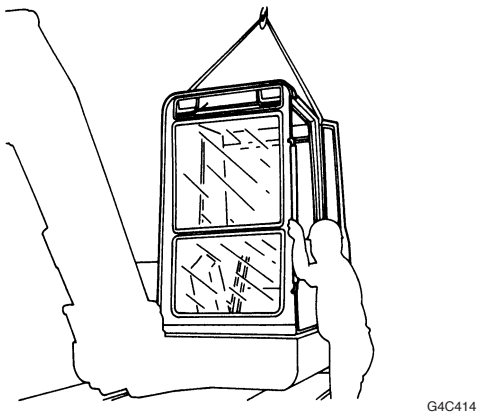


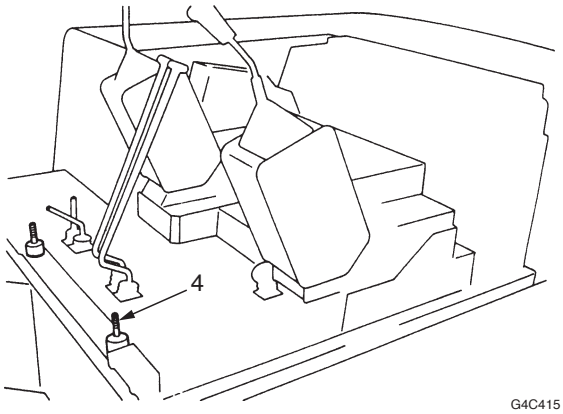

### Installing the Cab

Follow the procedure used for removal in reverse order.

- The cab installation bolts (4) should be set in the upper frame in advance.
- Suspend the cab temporarily, keeping it level, and fasten it temporarily while it is still suspended.



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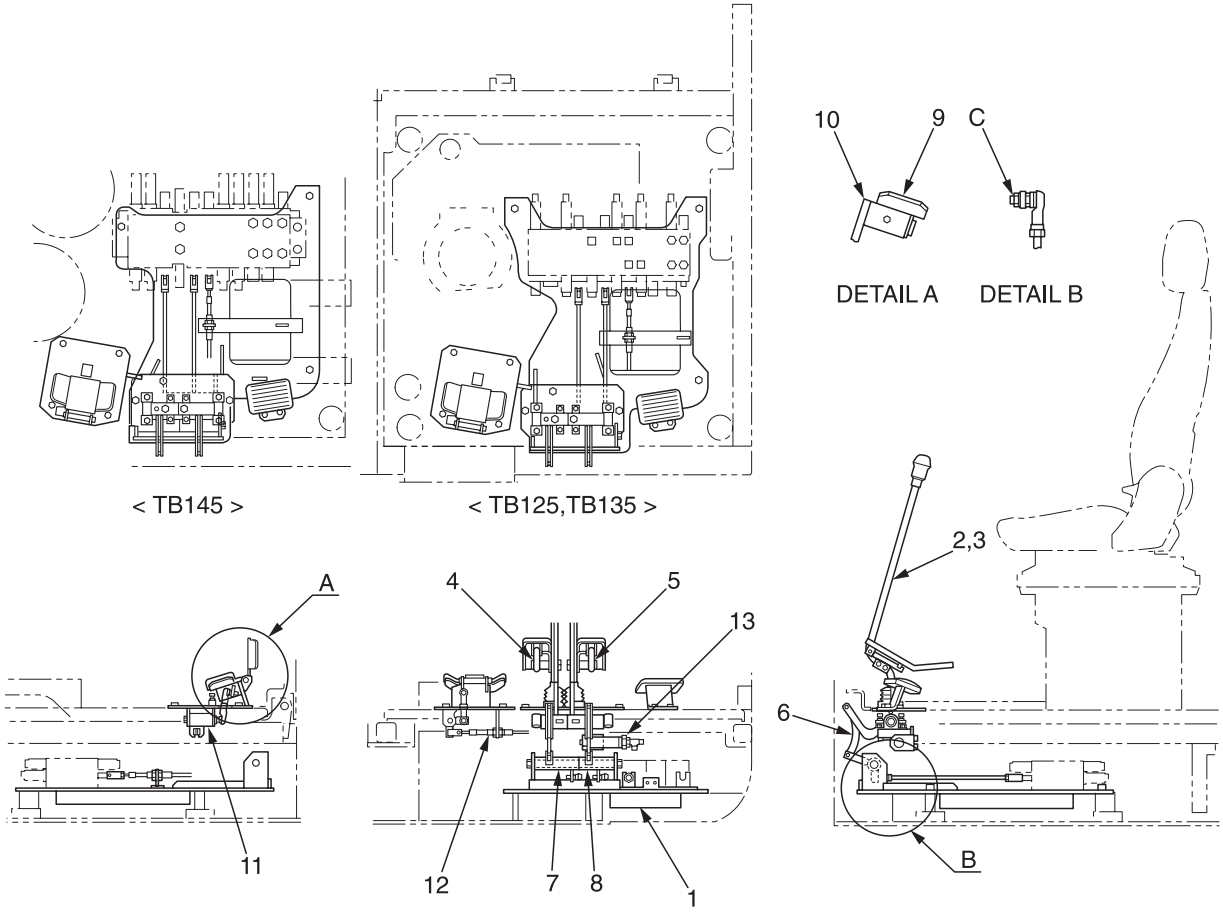
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# CONTROL SYSTEM

## CONSTRUCTION

### Travel, Swing Lever Unit




G4C500

NOTES:
- When assembling, apply grease to the inside of the DU bushing.
- Apply thread lock to the screws on the rod ends.

A: Details of the pedal mounting section
B: Details of the rod end tightening section
C: Applying thread lock

1. Lever Bracket
2. Right Travel Lever
3. Left Travel Lever
4. Bracket R
5. Bracket L
6. Plate
7. Lever
8. Lever
9. Swing Pedal
10. Bracket
11. Lever
12. Control Cable
13. Lock Cylinder

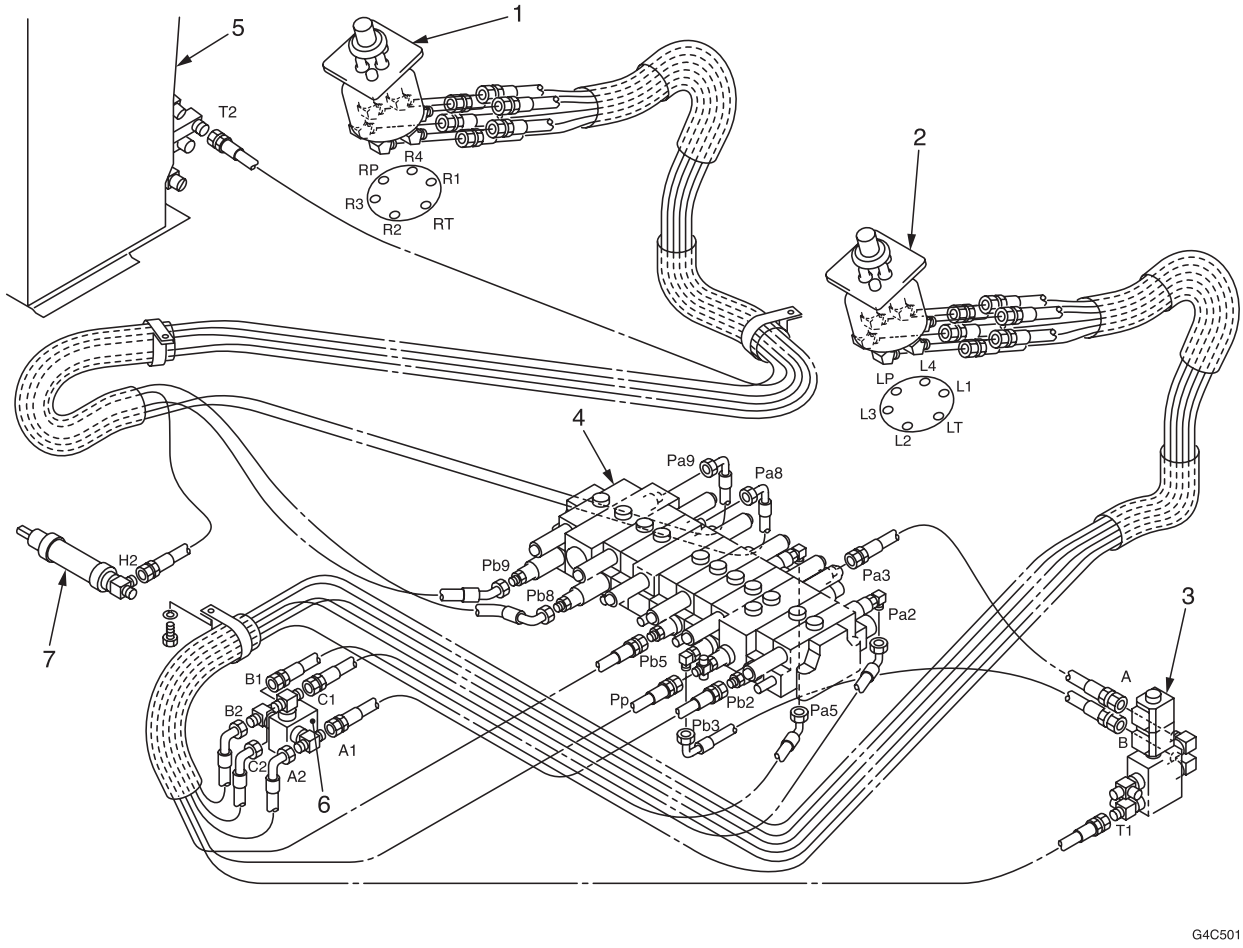
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**Hydraulic Pilot Unit**

■ TB125, TB135: S/N 13510004~13512532

A Type (ISO)




♦ Table of Connections ♦

| | | |
|---|---|---|
| Pilot Valve | R1 ↔ Pb9 | Control Valve |
| | R2 ↔ Pa8 | |
| | R3 ↔ Pa9 | |
| | R4 ↔ Pb8 | |
| | RP ↔ H2 | Lock Cylinder |
| | RT ↔ T2 | Tank |
| | L1 ↔ A2 | Shuttle Valve |
| | L2 ↔ Pb5 | Control Valve |
| | L3 ↔ C2 | Shuttle Valve |
| | L4 ↔ B2 | |
| | LP ↔ Pp | Control Valve |
| | LT ↔ T1 | Solenoid Valve |
| Shuttle Valve | C1 ↔ Pa2 | Control Valve |
| | A1 ↔ Pb2 | |
| | B1 ↔ Pa5 | |

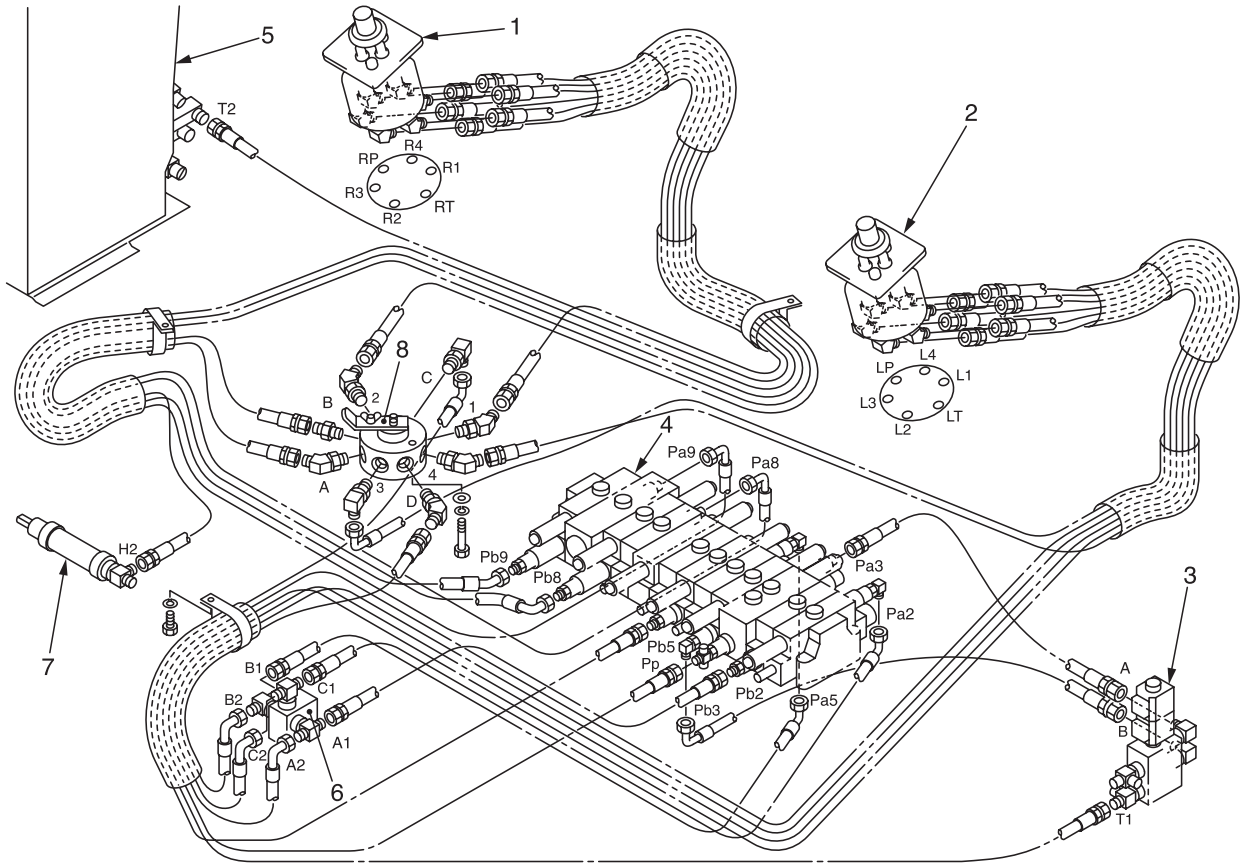
| | | |
|---|---|---|
| Solenoid Valve | A ↔ Pa3 | Control Valve |
| | B ↔ Pb3 | |

1. Right Pilot Valve
2. Left Pilot Valve
3. Solenoid Valve
4. Control Valve
5. Hydraulic Tank
6. Shuttle Valve
7. Lock Cylinder

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■ TB125, TB135: S/N 13510004~13512532
A Type (ISO) ↔ G Type (JCB)




G4C502

♦ Table of Connections ♦

| | | |
|---|---|---|
| Pilot Valve | R1 ↔ Pb9 | Control Valve |
| | R2 ↔ 1 | Selector Valve |
| | R3 ↔ Pa9 | Control Valve |
| | R4 ↔ 2 | Selector Valve |
| | RP ↔ H2 | Lock Cylinder |
| | RT ↔ T2 | Tank |
| | L1 ↔ A2 | Shuttle Valve |
| | L2 ↔ 3 | Selector Valve |
| | L3 ↔ C2 | Shuttle Valve |
| | L4 ↔ 4 | Selector Valve |
| | LP ↔ Pp | Control Valve |
| | LT ↔ T1 | Solenoid Valve |
| Shuttle Valve | C1 ↔ Pa2 | Control Valve |
| | A1 ↔ Pb2 | |
| | B1 ↔ Pa5 | |
| Solenoid Valve | A ↔ Pa3 | |
| | B ↔ Pb3 | |
| Selector Valve | A ↔ Pa8 | |
| | B ↔ Pb8 | |
| | C ↔ Pb5 | |
| | D ↔ B2 | Shuttle Valve |

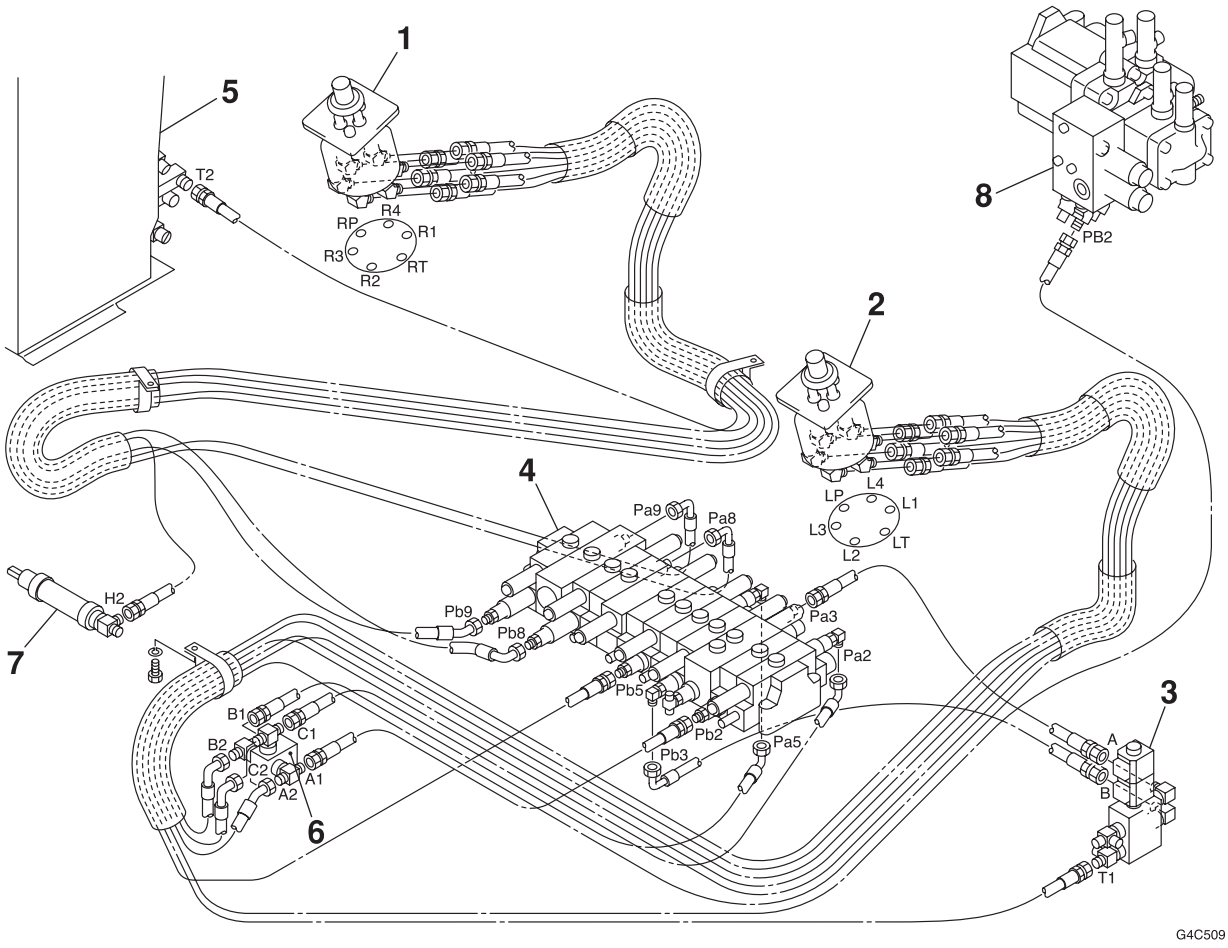
| | Selector Valve | | | |
|---|---|---|---|---|
| | Position A Type (ISO) | | Position G Type (JCB) | |
| Right Pilot Valve | | | | |
| Front | Boom | Lower | Arm | Dump |
| Rear | | Raise | | Load |
| Left | Bucket | Load | Bucket | Load |
| Right | | Dump | | Dump |
| Left Pilot Valve | | | | |
| Front | Arm | Dump | Boom | Lower |
| Rear | | Load | | Raise |
| Left | Slew | Left | Slew | Left |
| Right | | Right | | Right |

1. Right Pilot Valve
2. Left Pilot Valve
3. Solenoid Valve
4. Control Valve
5. Hydraulic Tank
6. Shuttle Valve
7. Lock Cylinder
8. Selector Valve

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■ TB135: S/N 13512533~
A Type (ISO)




♦ Table of Connections ♦

| | | |
|---|---|---|
| Pilot Valve | R1 ↔ Pb9 | Control Valve |
| | R2 ↔ Pa8 | |
| | R3 ↔ Pa9 | |
| | R4 ↔ Pb8 | |
| | RP ↔ H2 | Lock Cylinder |
| | RT ↔ T2 | Tank |
| | L1 ↔ A2 | Shuttle Valve |
| | L2 ↔ Pb5 | Control Valve |
| | L3 ↔ C2 | Shuttle Valve |
| | L4 ↔ B2 | |
| | LP ↔ PB2 | Solenoid Valve |
| | LT ↔ T1 | |
| Shuttle Valve | C1 ↔ Pa2 | Control Valve |
| | A1 ↔ Pb2 | |
| | B1 ↔ Pa5 | |

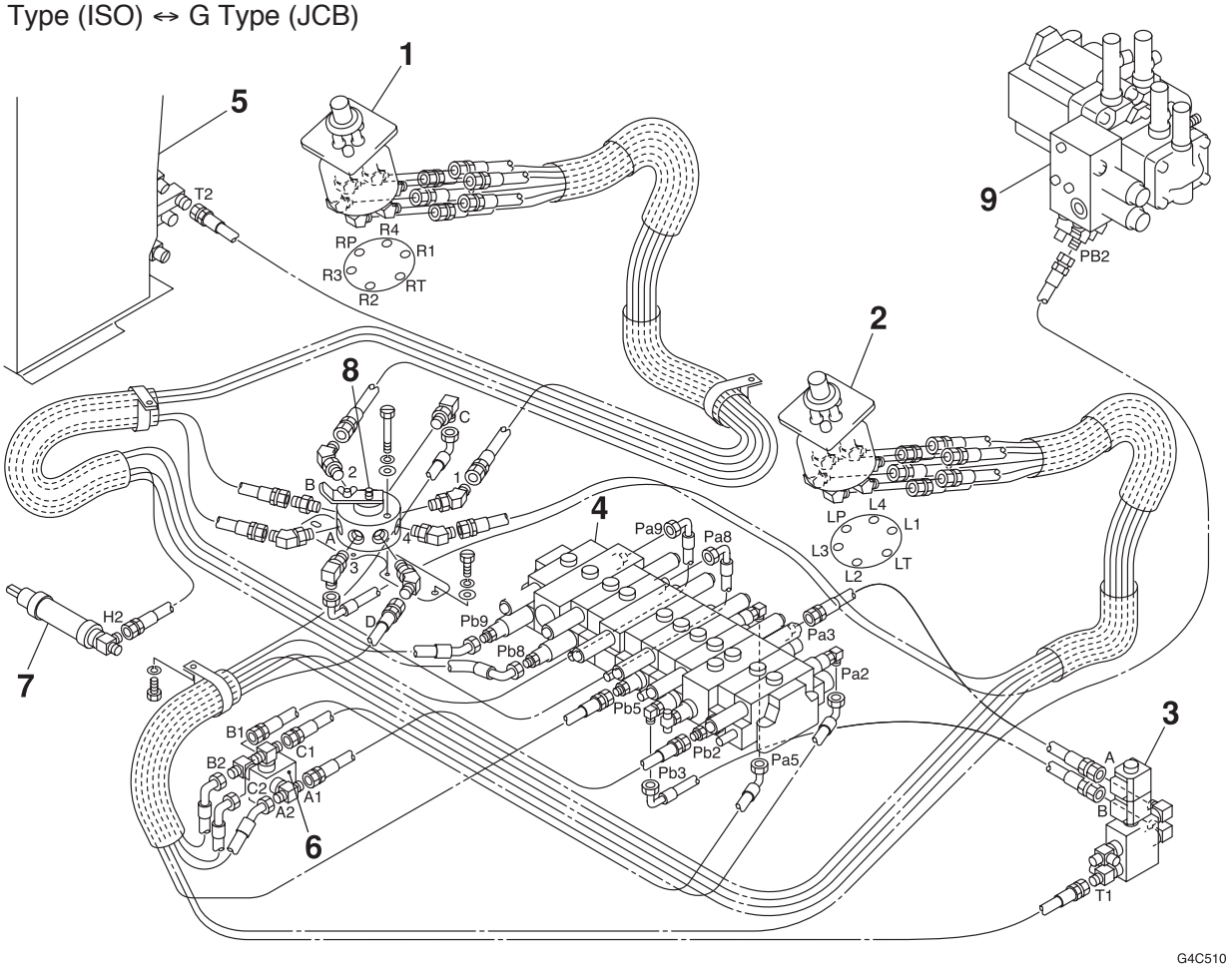
| | | |
|---|---|---|
| Solenoid Valve | A ↔ Pa3 | Control Valve |
| | B ↔ Pb3 | |

1. Right Pilot Valve
2. Left Pilot Valve
3. Solenoid Valve
4. Control Valve
5. Hydraulic Tank
6. Shuttle Valve
7. Lock Cylinder
8. Solenoid Valve

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■ TB135: S/N 13512533~
A Type (ISO) ↔ G Type (JCB)




♦ Table of Connections ♦

| | | |
|---|---|---|
| Pilot Valve | R1 ↔ Pb9 | Control Valve |
| | R2 ↔ 1 | Selector Valve |
| | R3 ↔ Pa9 | Control Valve |
| | R4 ↔ 2 | Selector Valve |
| | RP ↔ H2 | Lock Cylinder |
| | RT ↔ T2 | Tank |
| | L1 ↔ A2 | Shuttle Valve |
| | L2 ↔ 3 | Selector Valve |
| | L3 ↔ C2 | Shuttle Valve |
| | L4 ↔ 4 | Selector Valve |
| | LP ↔ PB2 | Solenoid Valve |
| | LT ↔ T1 | |
| Shuttle Valve | C1 ↔ Pa2 | Control Valve |
| | A1 ↔ Pb2 | |
| | B1 ↔ Pa5 | |
| Solenoid Valve | A ↔ Pa3 | |
| | B ↔ Pb3 | |
| Selector Valve | A ↔ Pa8 | |
| | B ↔ Pb8 | |
| | C ↔ Pb5 | |
| | D ↔ B2 | Shuttle Valve |

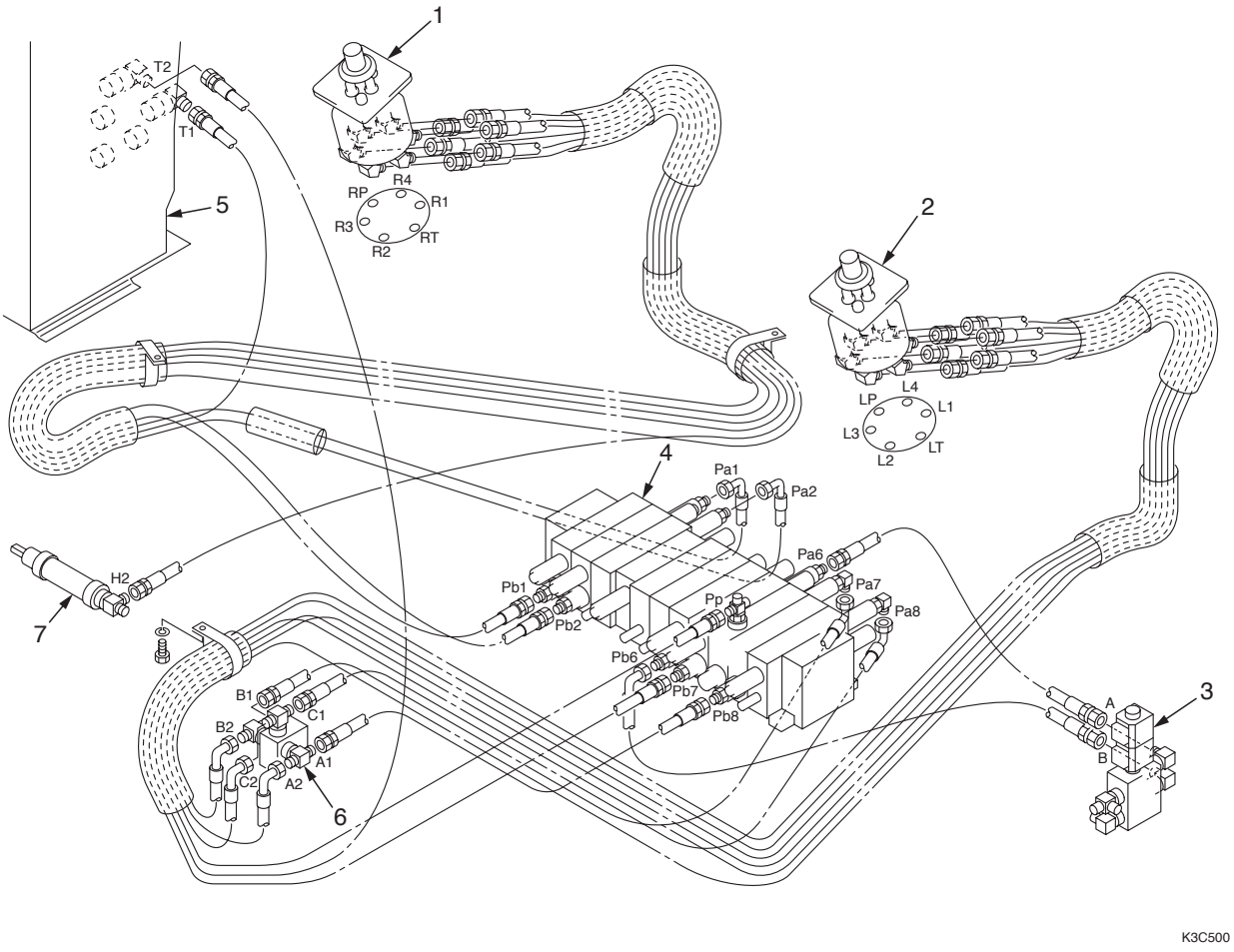
| | Selector Valve | | | |
|---|---|---|---|---|
| | Position A Type (ISO) | | Position G Type (JCB) | |
| Right Pilot Valve | | | | |
| Front | Boom | Lower | Arm | Dump |
| Rear | | Raise | | Load |
| Left | Bucket | Load | Bucket | Load |
| Right | | Dump | | Dump |
| Left Pilot Valve | | | | |
| Front | Arm | Dump | Boom | Lower |
| Rear | | Load | | Raise |
| Left | Slew | Left | Slew | Left |
| Right | | Right | | Right |

1. Right Pilot Valve
2. Left Pilot Valve
3. Solenoid Valve
4. Control Valve
5. Hydraulic Tank
6. Shuttle Valve
7. Lock Cylinder
8. Selector Valve
9. Solenoid Valve

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■ TB145
A Type (ISO)




♦ Table of Connections ♦

| | | |
|---|---|---|
| Pilot Valve | R1 ↔ Pb1 | Control Valve |
| | R2 ↔ Pa2 | |
| | R3 ↔ Pa1 | |
| | R4 ↔ Pb2 | |
| | RP ↔ H2 | Lock Cylinder |
| | RT ↔ T1 | Tank |
| | L1 ↔ C2 | Shuttle Valve |
| | L2 ↔ Pb7 | Control Valve |
| | L3 ↔ A2 | Shuttle Valve |
| | L4 ↔ B2 | |
| | LP ↔ Pp | Control Valve |
| | LT ↔ T2 | Tank |
| Shuttle Valve | C1 ↔ Pa8 | Control Valve |
| | A1 ↔ Pb8 | |
| | B1 ↔ Pa7 | |

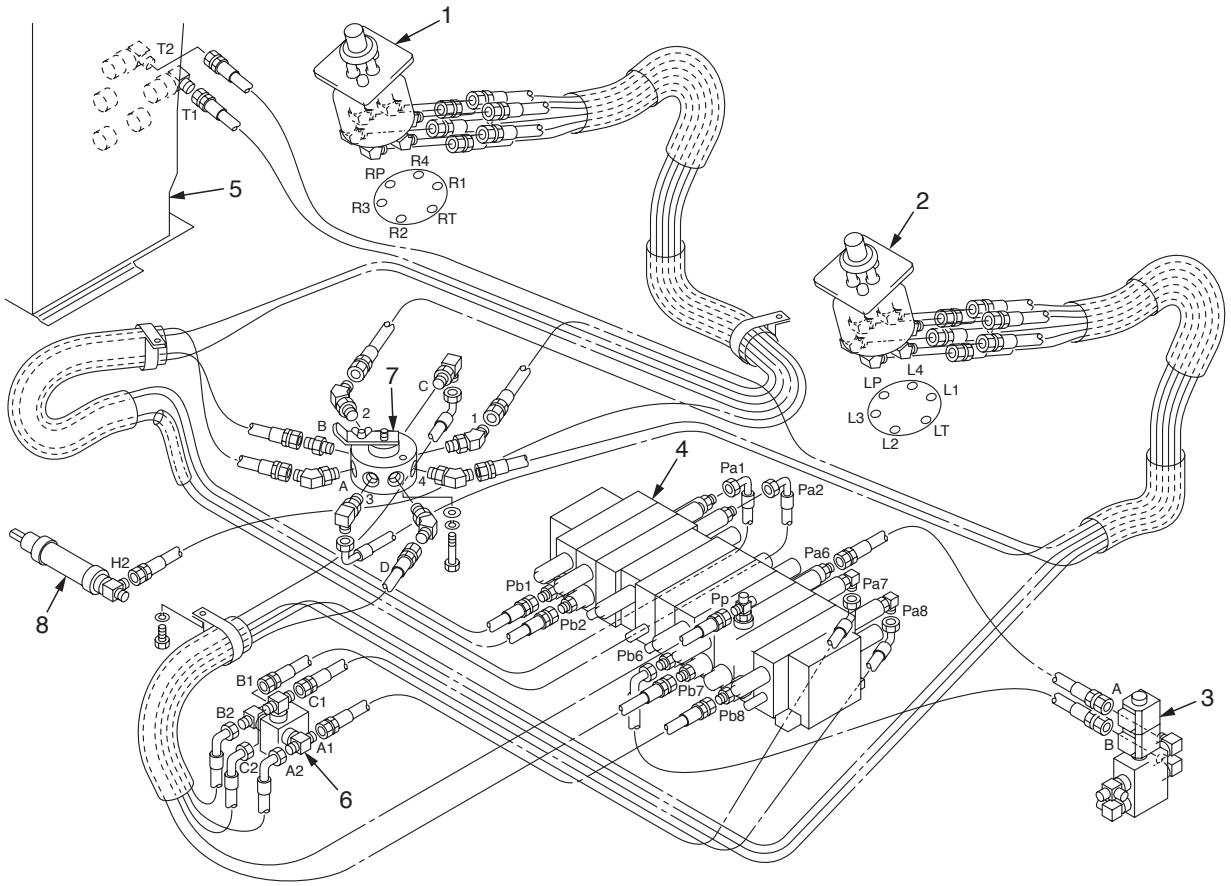
| | | |
|---|---|---|
| Solenoid Valve | A ↔ Pa6 | Control Valve |
| | B ↔ Pb6 | |

1. Right Pilot Valve
2. Left Pilot Valve
3. Solenoid Valve
4. Control Valve
5. Hydraulic Tank
6. Shuttle Valve
7. Lock Cylinder

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A Type (ISO) ↔ G Type (JCB)




K3C501

♦ Table of Connections ♦

| | | |
|---|---|---|
| Pilot Valve | R1 ↔ Pb1 | Control Valve |
| | R2 ↔ 1 | Selector Valve |
| | R3 ↔ Pa1 | Control Valve |
| | R4 ↔ 2 | Selector Valve |
| | RP ↔ H2 | Lock Cylinder |
| | RT ↔ T1 | Tank |
| | L1 ↔ C2 | Shuttle Valve |
| | L2 ↔ 3 | Selector Valve |
| | L3 ↔ A2 | Shuttle Valve |
| | L4 ↔ 4 | Selector Valve |
| | LP ↔ Pp | Control Valve |
| | LT ↔ T2 | Tank |
| Shuttle Valve | C1 ↔ Pa8 | Control Valve |
| | A1 ↔ Pb8 | |
| | B1 ↔ Pa7 | |
| Solenoid Valve | A ↔ Pa6 | |
| | B ↔ Pb6 | |
| Selector Valve | A ↔ Pa2 | |
| | B ↔ Pb2 | |
| | C ↔ Pb7 | |
| | D ↔ B2 | Shuttle Valve |

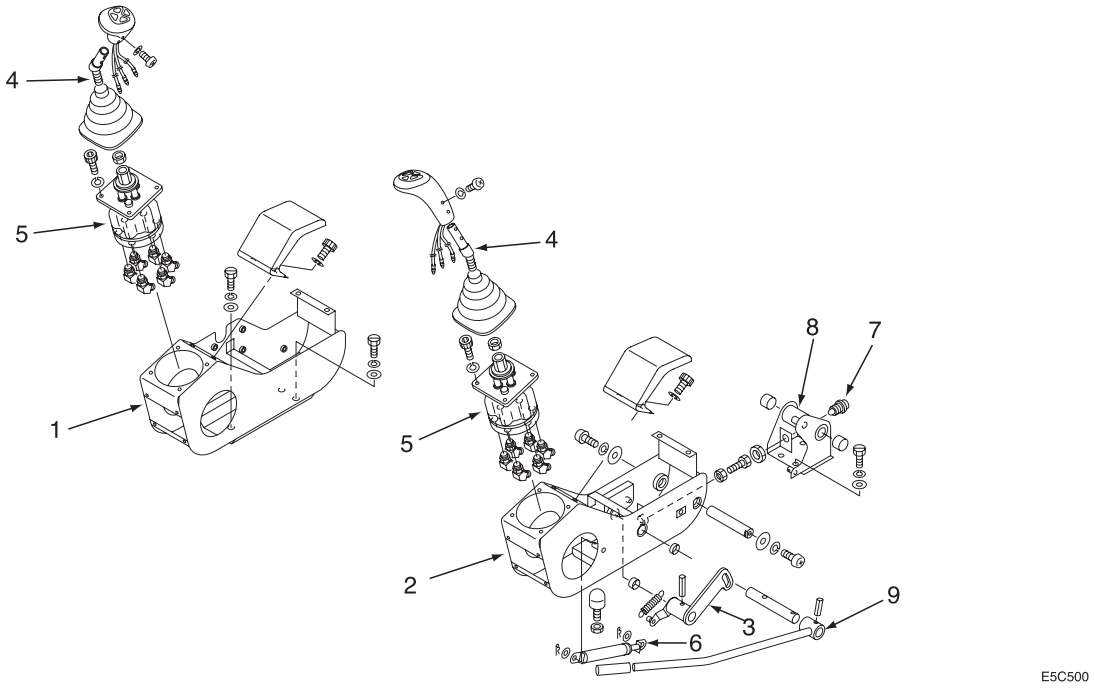
| | Selector Valve | | | |
|---|---|---|---|---|
| | Position A Type (ISO) | | Position G Type (JCB) | |
| Right Pilot Valve | | | | |
| Front | Boom | Lower | Arm | Dump |
| Rear | | Raise | | Load |
| Left | Bucket | Load | Bucket | Load |
| Right | | Dump | | Dump |
| Left Pilot Valve | | | | |
| Front | Arm | Dump | Boom | Lower |
| Rear | | Load | | Raise |
| Left | Slew | Left | Slew | Left |
| Right | | Right | | Right |

1. Right Pilot Valve
2. Left Pilot Valve
3. Solenoid Valve
4. Control Valve
5. Hydraulic Tank
6. Shuttle Valve
7. Selector Valve
8. Lock Cylinder

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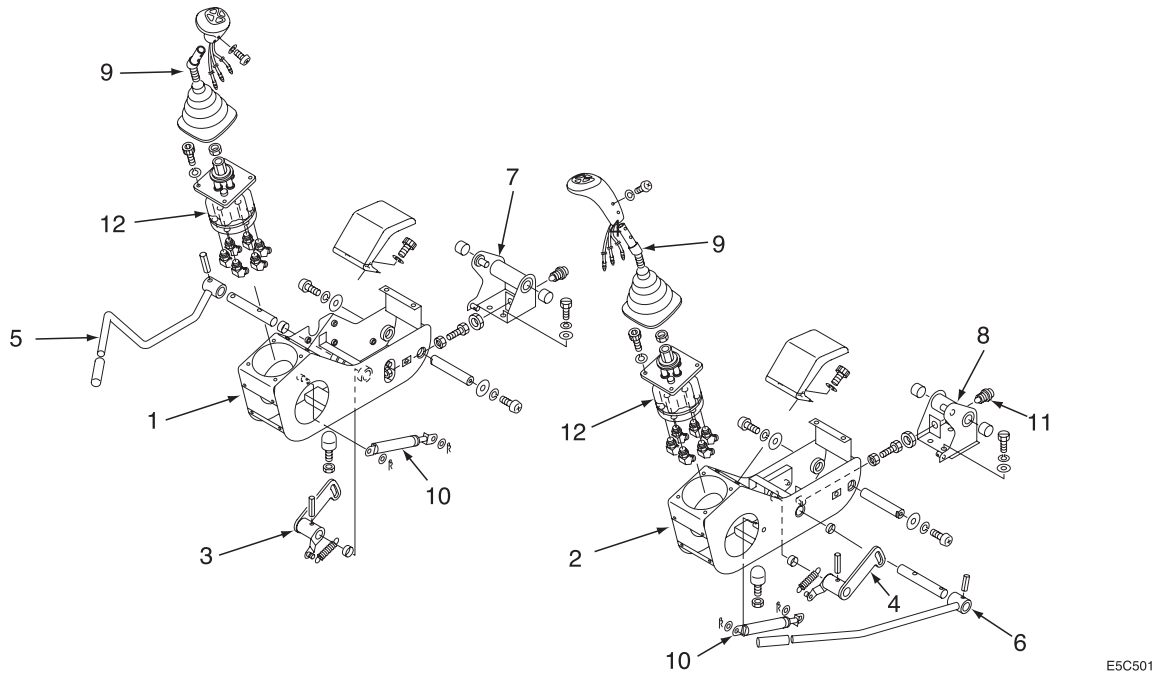


**Lever Stand (Cab)**




1. Control Box R
2. Control Box L
3. Plate
4. Lever
5. Pilot Valve
6. Gas Spring
7. Safety Switch
8. Bracket
9. Lever

**Lever Stand (Canopy)**

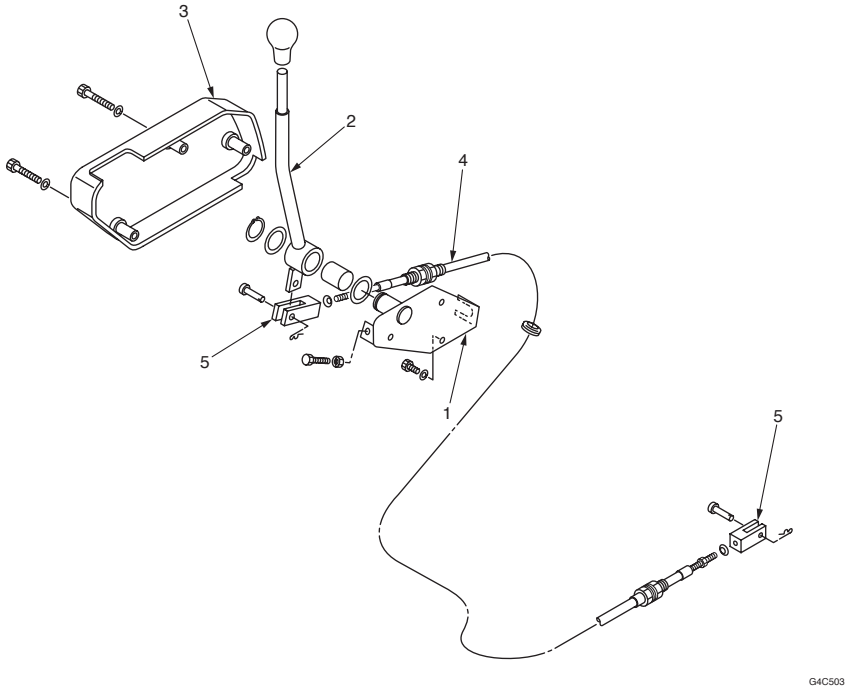



1. Control Box R
2. Control Box L
3. Plate
4. Plate
5. Lever
6. Lever
7. Bracket
8. Bracket
9. Lever
10. Gas Spring
11. Safety Switch
12. Pilot Valve

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**Dozer Blade Lever**




NOTES:
- When assembling, apply grease to the inside of the DU bushing.

1. Bracket
2. Lever
3. Cover
4. Control Cable
5. Yoke

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## DISASSEMBLY AND ASSEMBLY

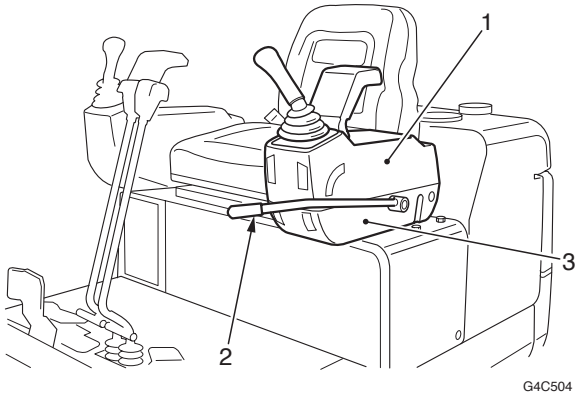
### Removing the Lever Stand

1. Disconnect the battery ground cable from the [-] terminal of the battery.

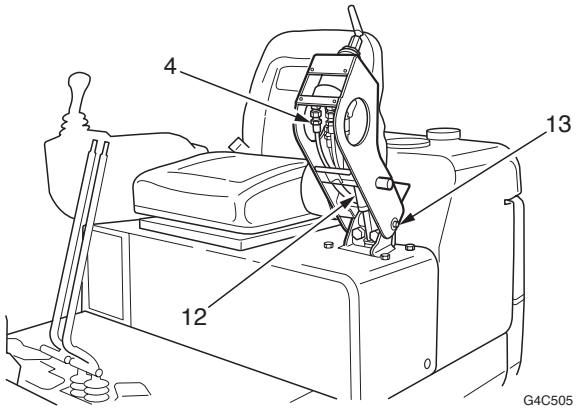
2. Remove the cab.
   ☞ "Removing the Cab"

3. Remove the lever stand L.
   a. Remove the cover (1).
   b. Pull up the lock lever (2) and raise the lever stand. Then pull off the pin and remove the lock lever (2).
   c. Remove the cover (3).
   d. Disconnect the hydraulic hoses (4) from the pilot valve.
      • Attach identification labels to individual hoses for correct reassembling.
   e. Disconnect the electric wiring of the limit switch.
   f. Take out the gas spring (12) and pin (13), and remove the control box.

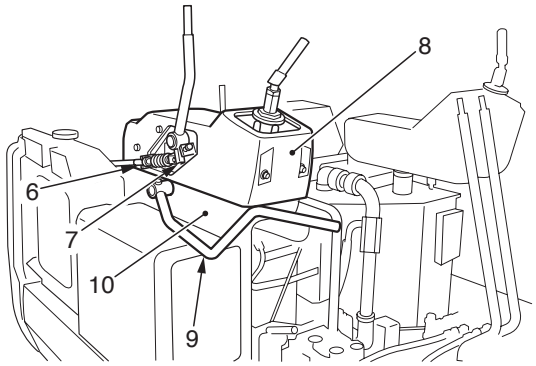
4. Remove the lever stand R.
   a. Remove the cover, and disconnect the control cable (6) from the blade lever.
   b. Remove the bracket (7) from the lever stand.
   c. Remove the covers (8).
   d. Pull up the lock lever (9) and raise the lever stand. Then pull off the pin and remove the lock lever (9). (For canopy type)
   e. Remove the cover (10).
   f. Disconnect the electric wiring.
   g. Disconnect the hydraulic hoses (11) from the pilot valve.
      • Attach identification labels to individual hoses for correct reassembling.
   h. Take out the gas spring (12) and pin (13), and remove the control box. (For canopy type)
   i. Take out the socket bolts, and remove the control box. (For cab type)



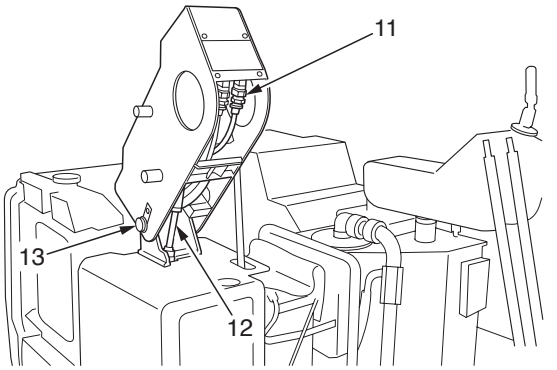
G4C504



G4C505



G4C506



G4C507

### Installing the Lever Stand

Follow the same procedure as for removal in the reverse order.

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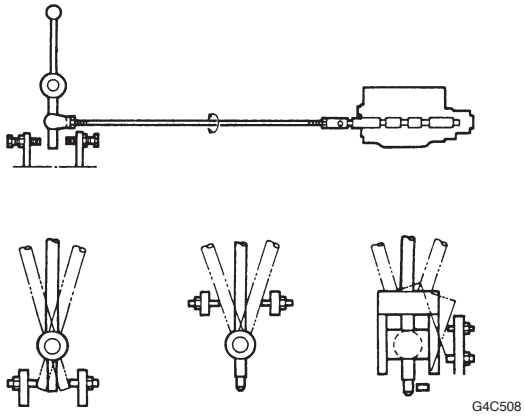


## INSPECTION AND ADJUSTMENT

### Adjusting Stroke

Adjust the lever's stroke to correspond to the control valve spool stroke using the setscrew.

1. The control valve's spool should be in the neutral position.
2. Turn the rod and position the lever in the center of the stroke, then fasten the rod with the nut.
3. Move the lever and hold it at the stroke end of the valve spool.
4. Set the setscrew.



G4C508

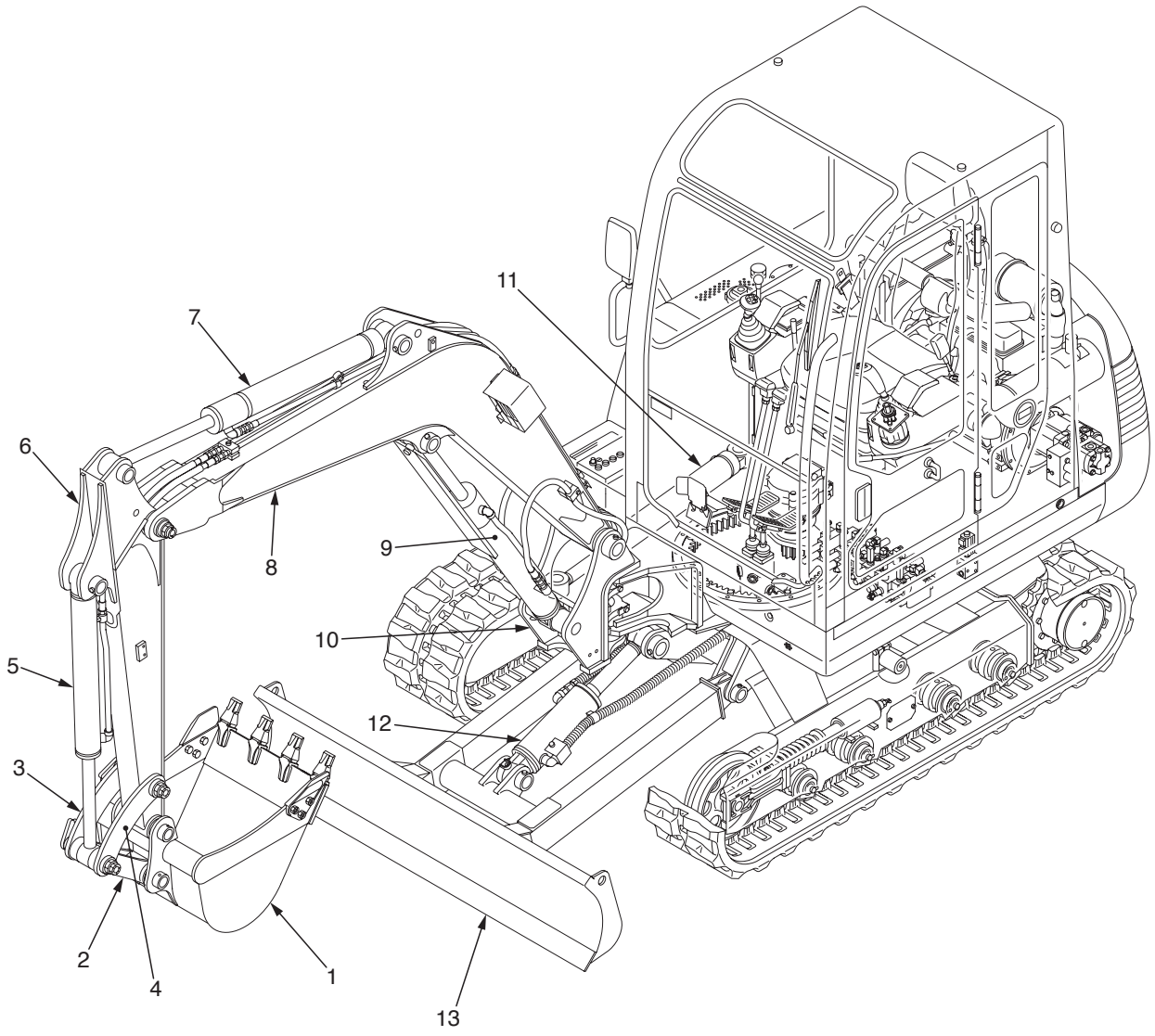
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# ATTACHMENTS

## CONSTRUCTION




G4C600

1. Bucket
2. Bucket Link
3. Guide Link R
4. Guide Link L
5. Bucket Cylinder
6. Arm
7. Arm Cylinder
8. Boom
9. Boom Cylinder
10. Swing Bracket
11. Swing Cylinder
12. Dozer Blade Cylinder
13. Dozer Blade

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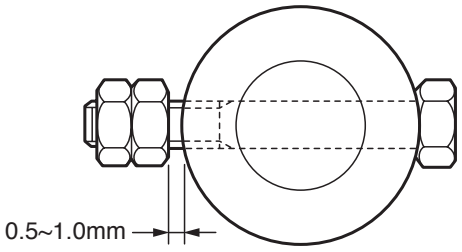
## DISASSEMBLY AND ASSEMBLY

### General Cautions

- When disconnecting hydraulic hoses, be sure to bleed off any residual pressure in the hoses and in the Hydraulic Tank.
- Plug openings which are opened up when piping is disconnected to prevent dust and mud, etc. from getting in.
- During assembly, be sure to adjust all the parts with shims so that there will be no looseness in the mounts.
- When aligning pin hole positions, absolutely do not insert a finger in any pin holes.
- When all the hydraulic equipment such as hydraulic cylinders and piping have been removed and the hydraulic cylinders are being operated for the first time after reassembly, be sure the bleed the air out of the hydraulic circuits by the following procedure.
- Keep the clearance at the pin connecting section to 0.5 mm or less by using the shim.

Air Bleeding Operation

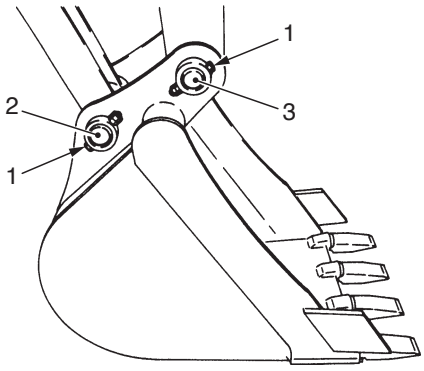
1. Start the engine and let it idle for about 5 minutes.
2. With the engine running at slow speed, extend and retract the cylinders 4 or 5 times.
   - Move the piston rods to a position 100 mm before the end of the stroke, taking care not to allow any relief whatsoever.
3. Perform the operation in (2) with the engine at top speed, then with the engine at slow speed, move the piston rods to the stroke end, allowing relief.




### Removing the Bucket

- Move the back side of the bucket so that it is down, then lower it fully to the ground.

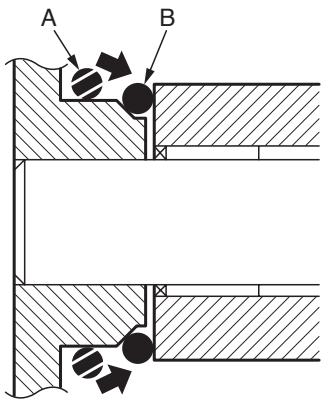
1. Take out the lock bolt (1) and remove the pin (2).
2. Take out the lock bolt (1) and remove the pin (3).
3. Remove the bucket.
   - Standard bucket mass:
     TB125…55 kg, TB135…73 kg, TB145…115 kg




### Installing the Bucket

Follow the procedure used for removal in reverse order.

- Position the O-ring at the “A” position on the outer perimeter of the bucket bush before mounting the bucket. Upon completion of the mounting, move the O-ring to the prescribed “B” position.



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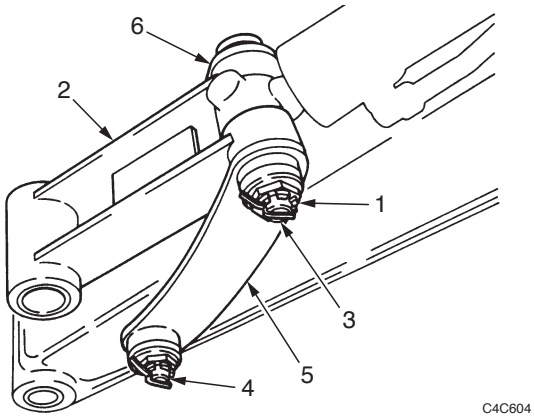
### Removing the Link

- Fully retract the bucket cylinder and lower the front end of the arm to the ground.

1. Take out the split pin, then remove the castle nut (1).

2. Suspend the bucket link (2) temporarily and take out the pin (3).
   - Place pillow blocks under the bucket cylinder to support it.
   - Since the end of the guide link will drop when the pin is taken out, exercise caution.

3. Take out the pin (4), then remove the guide link L (5), R (6).



C4C604

### Installing the Link

Follow the procedure used for removal in reverse order.

### Removing the Arm

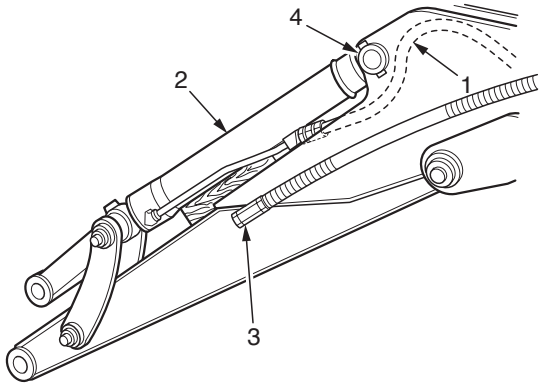
1. Disconnect the hydraulic hoses (1) from the bucket cylinder (2). Next, disconnect hydraulic hoses from the auxiliary ports (3).

2. Suspend the bucket cylinder (2) temporarily, take out the pin (4) and remove the bucket cylinder.
   - Bucket cylinder mass:
     TB125…16 kg, TB135…24 kg, TB145…34 kg

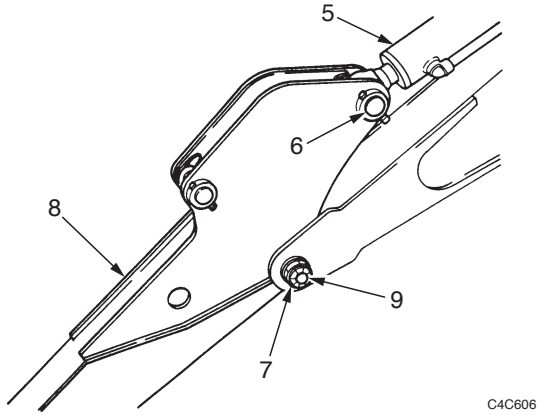
3. Place pillow blocks under the arm cylinder (5), then take out the pin (6).

4. Take out the split pin and remove the castle nut (7).

5. Suspend the arm (8) temporarily, take out the pin (9) and remove the arm.
   - Arm mass:
     TB125…45 kg, TB135…66 kg, TB145…94 kg



G4C602



C4C606

### Installing the Arm

Follow the procedure used for removal in reverse order.

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### Removing the Boom

- Lower the front end of the boom so that it is in full contact with the ground.

1. Disconnect the hydraulic hoses (1) from the arm cylinder (2).

2. Suspend the arm cylinder (2) temporarily, then take out the pin (3) and remove the arm cylinder.
   - Arm cylinder mass:
     TB125…25 kg, TB135…33 kg, TB145…51 kg

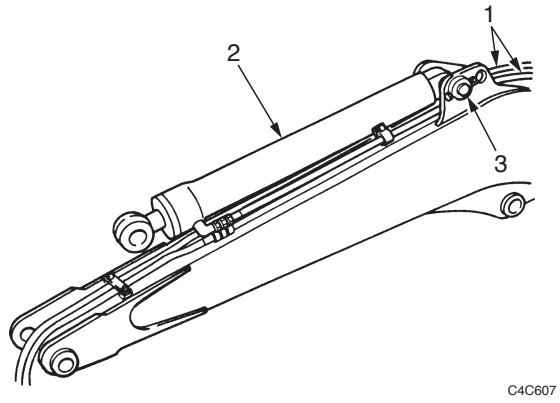
3. Remove the clamp (4) from the boom (5), and disconnect the hydraulic hose (6) from the boom cylinder (7).

4. Suspend the boom cylinder (7) temporarily and take out the pin (8).

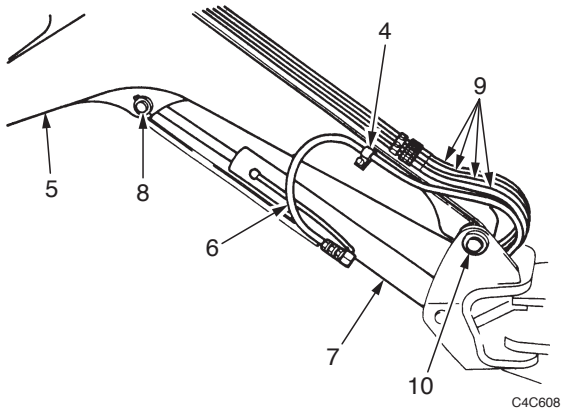
5. Disconnect the wiring to the boom light.

6. Disconnect the hydraulic hoses (9) from the pipes.

7. Suspend the boom (5) temporarily, take out the pin (10) and remove the boom.
   - Boom mass:
     TB125…98 kg, TB135…122 kg, TB145…188 kg



C4C607



C4C608

### Installing the Boom

Follow the procedure used for removal in reverse order.

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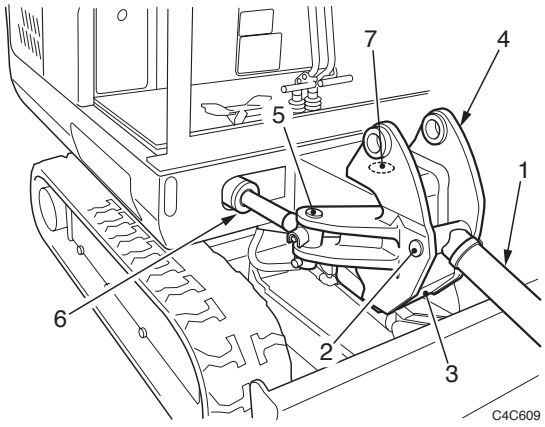
### Removing the Swing Bracket

1. Suspend the boom cylinder (1) temporarily, take off the pin (2) and remove the boom cylinder.
   - Boom cylinder mass:
     TB125…27 kg, TB135…40 kg, TB145…62 kg

2. Remove the cover (3) from the swing bracket (4).

3. Take out the pin (5) and disconnect the swing cylinder (6) from the swing bracket (4).

4. Suspend the swing bracket (4) temporarily, take out the pin (7), and remove the swing bracket.
   - Be careful not to damage the hoses.
   - Swing bracket mass:
     TB125…63 kg, TB135…74 kg, TB145…115 kg




### Installing the Swing Bracket

Follow the same procedure as for removal in the reverse order.

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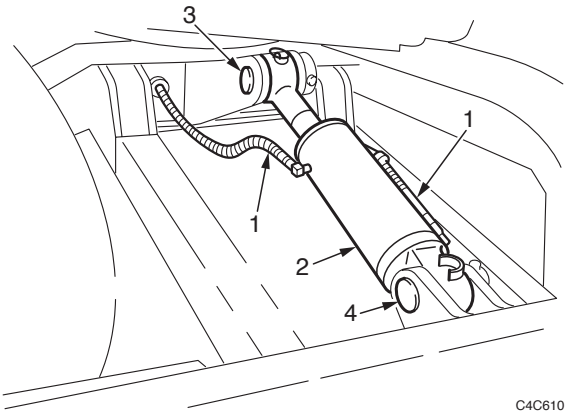
### Removing the Dozer blade

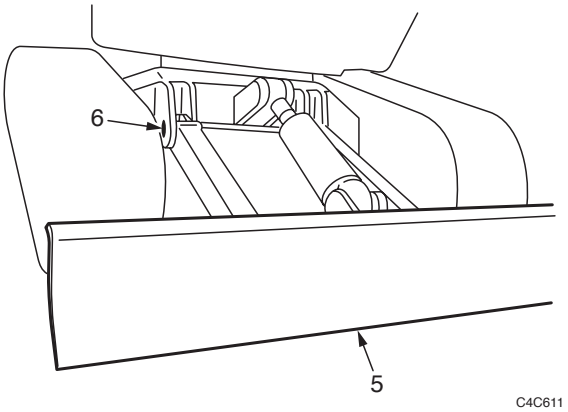
- Lower the dozer blade fully to the ground.

1. Disconnect the hydraulic hoses (1) from the dozer blade cylinder (2).

2. Suspend the dozer blade cylinder (2) temporarily, take out the pins (3), (4) and remove the cylinder.
   - Dozer blade cylinder mass:
     TB125…21 kg, TB135…35 kg, TB145…41 kg

3. Suspend the dozer blade (5) temporarily, take out the pins (6), and remove the dozer blade.
   - Dozer blade mass:
     TB125…126 kg, TB135…149 kg, TB145…196 kg




### Installing the Dozer Blade

Follow the procedure used for removal in reverse order.

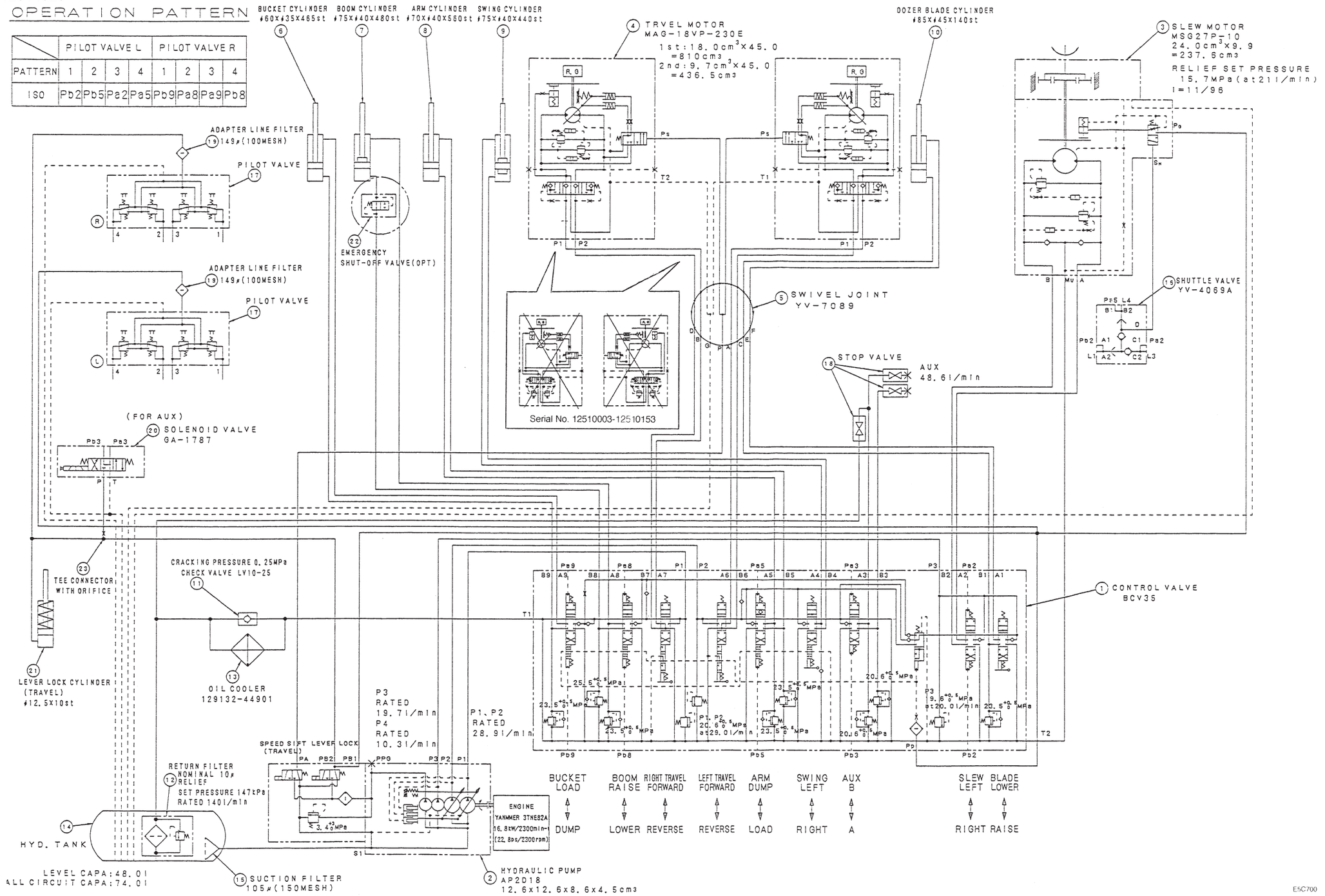
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# HYDRAULIC SYSTEM

## HYDRAULIC CIRCUIT DIAGRAM

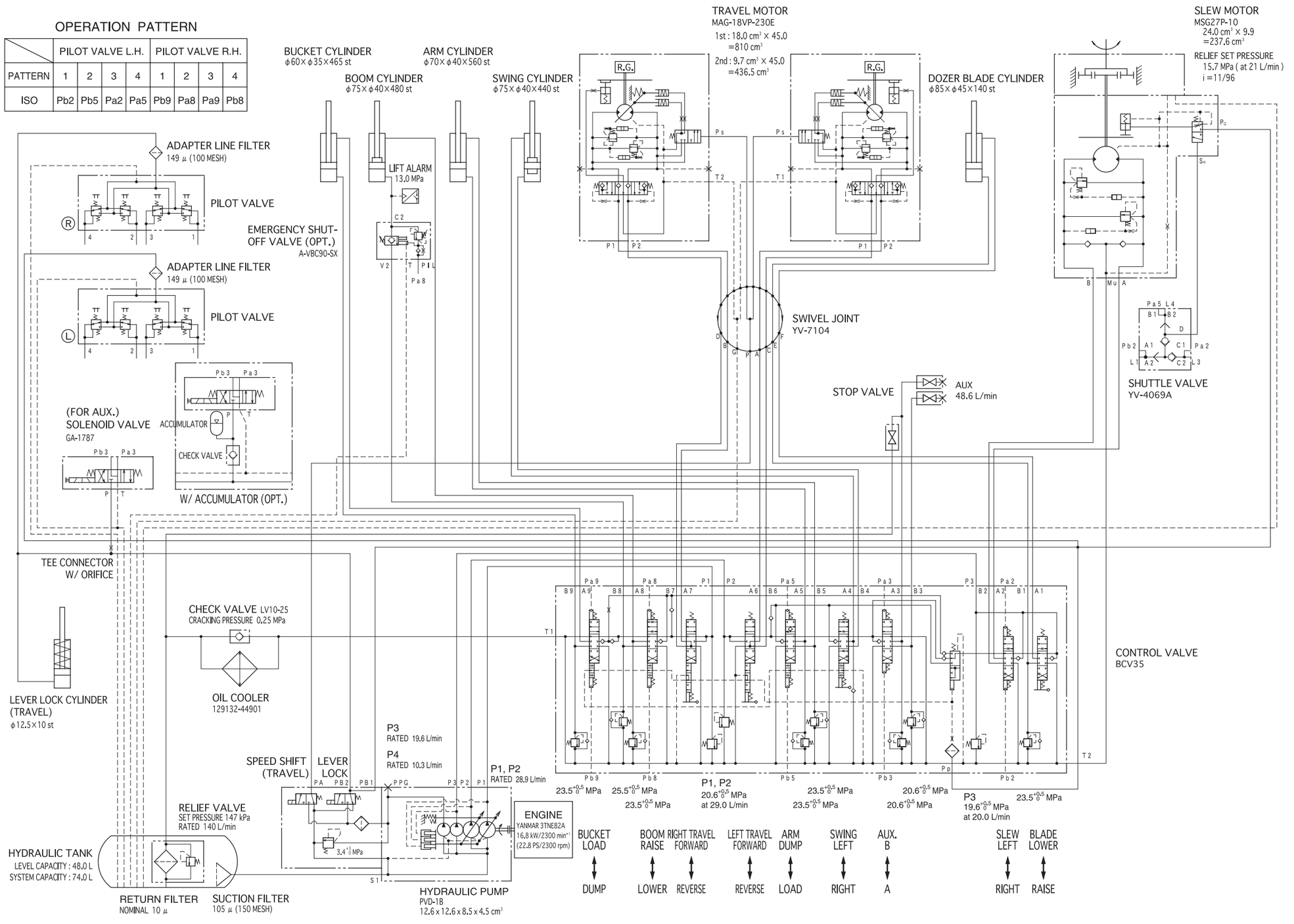
■ TB125: S/N 12510003~12514525



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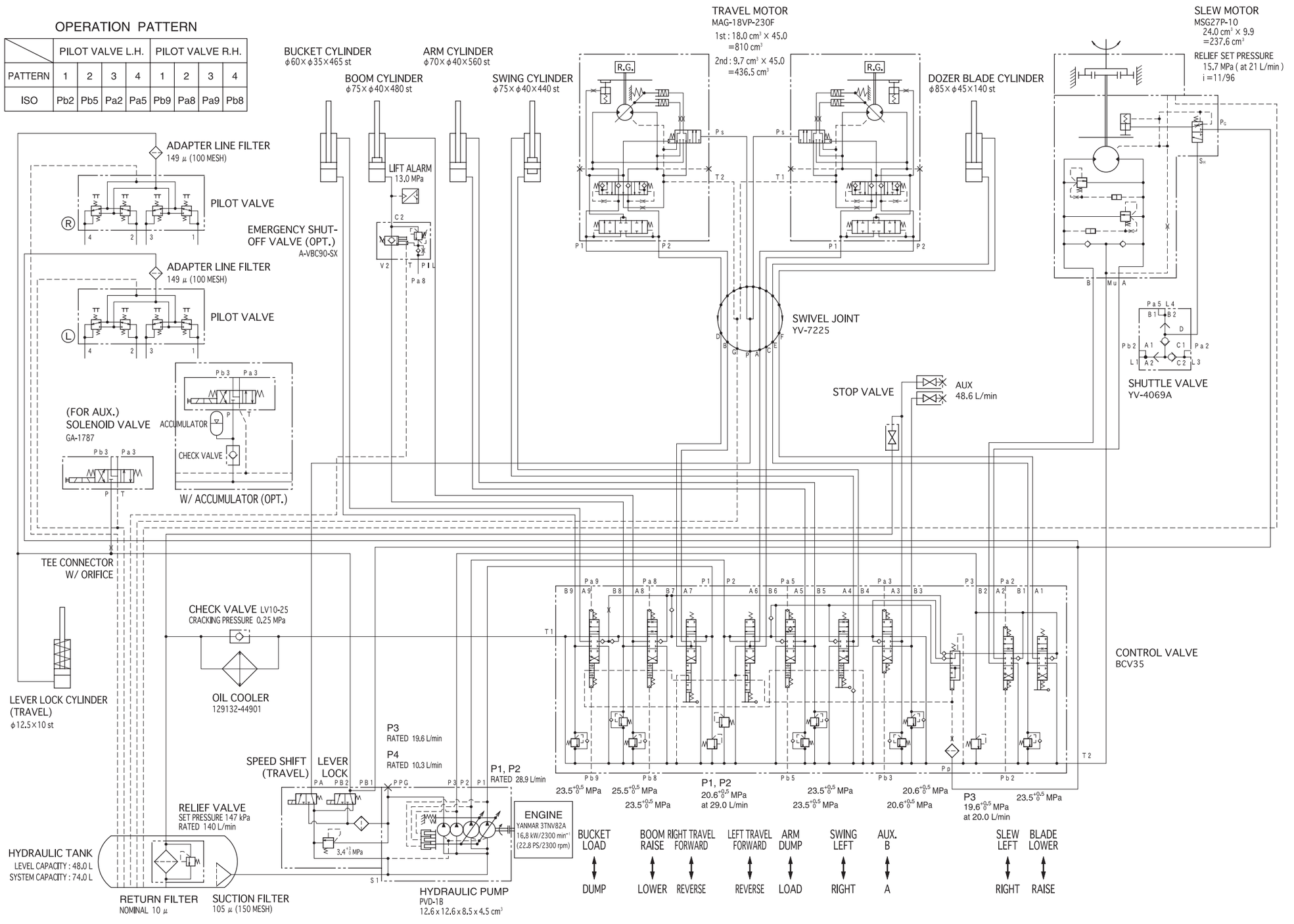
■ TB125: S/N 12510003~12514525



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■ TB125: S/N 12514526~

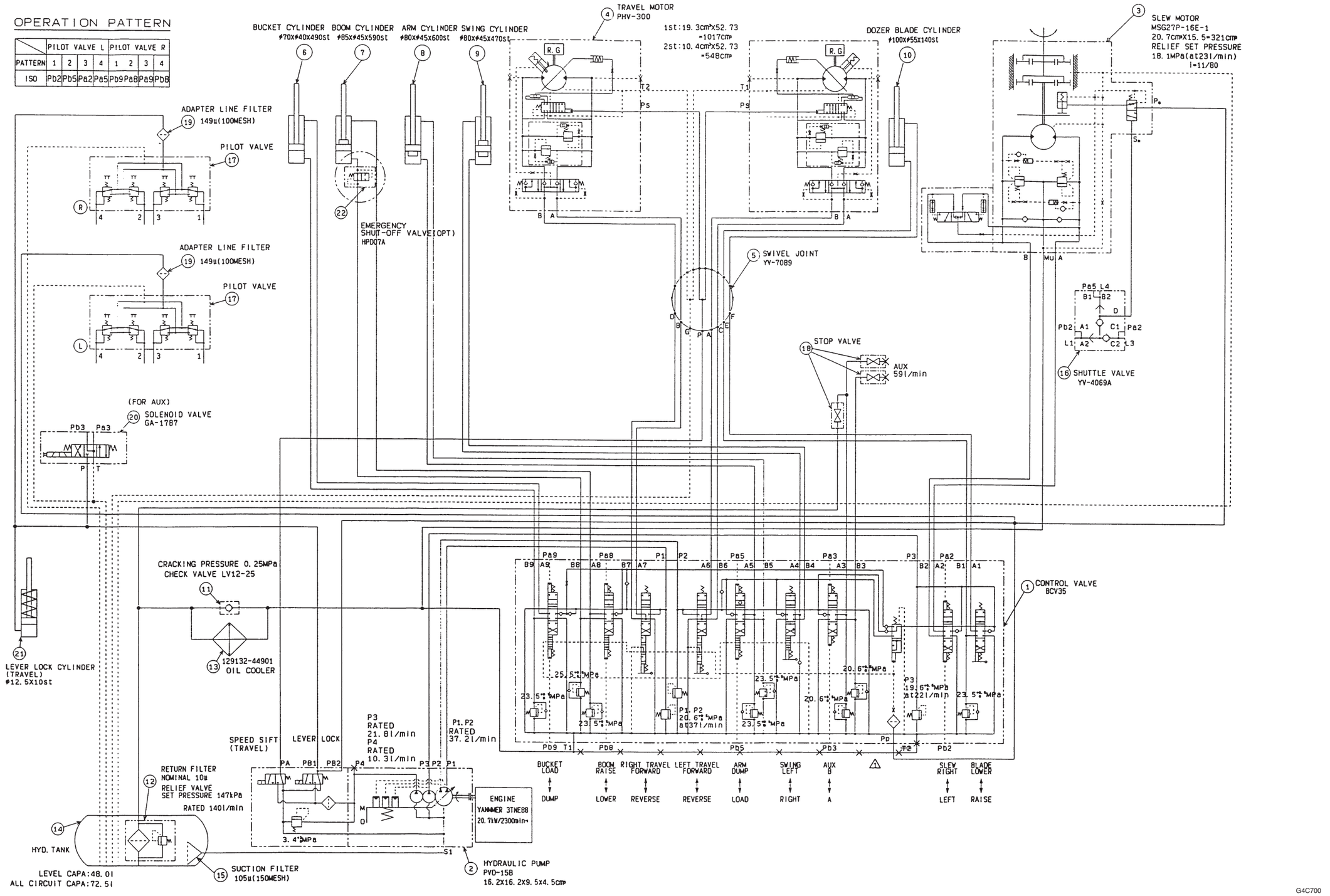



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■ TB135: S/N 13510004~13510348

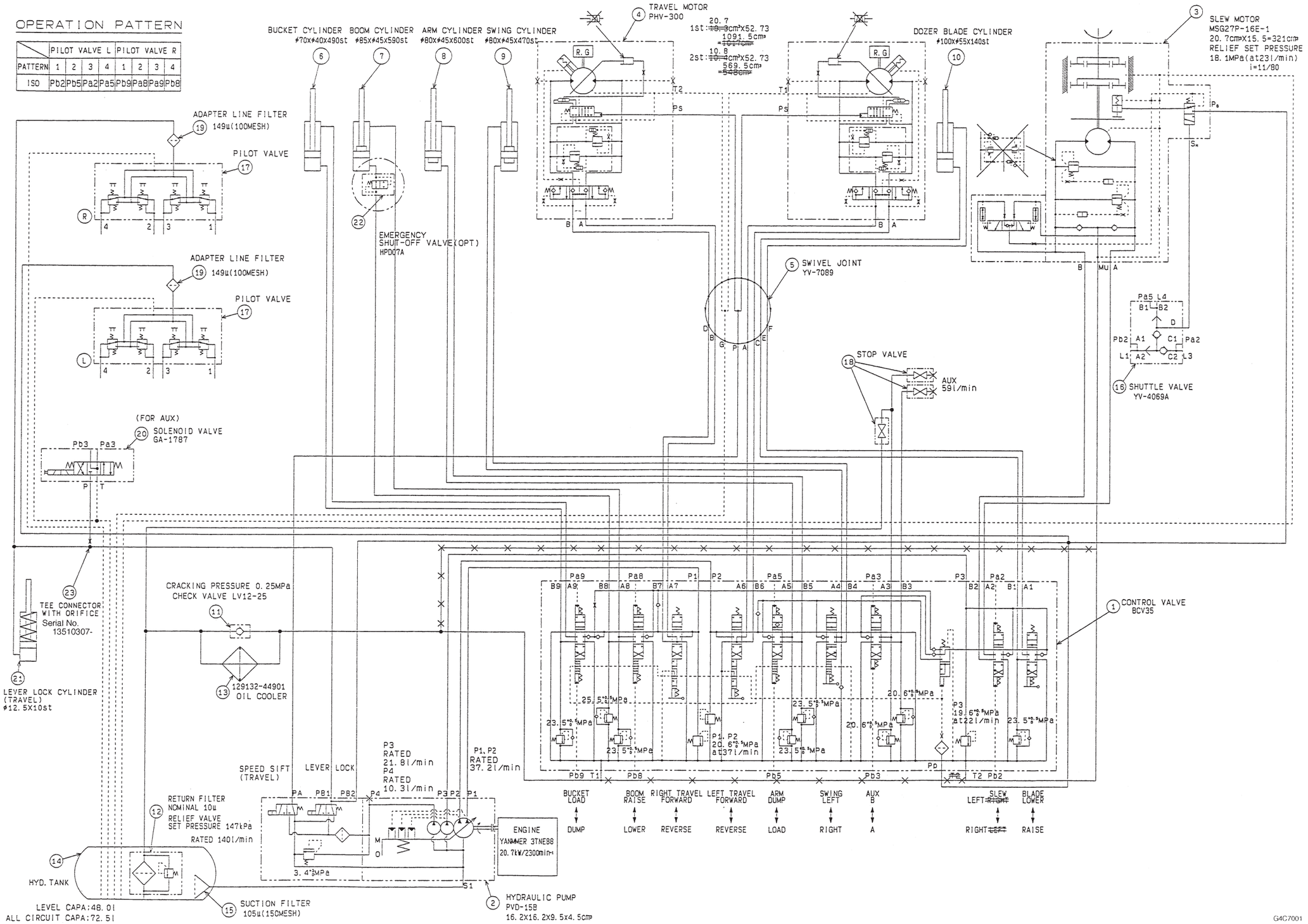



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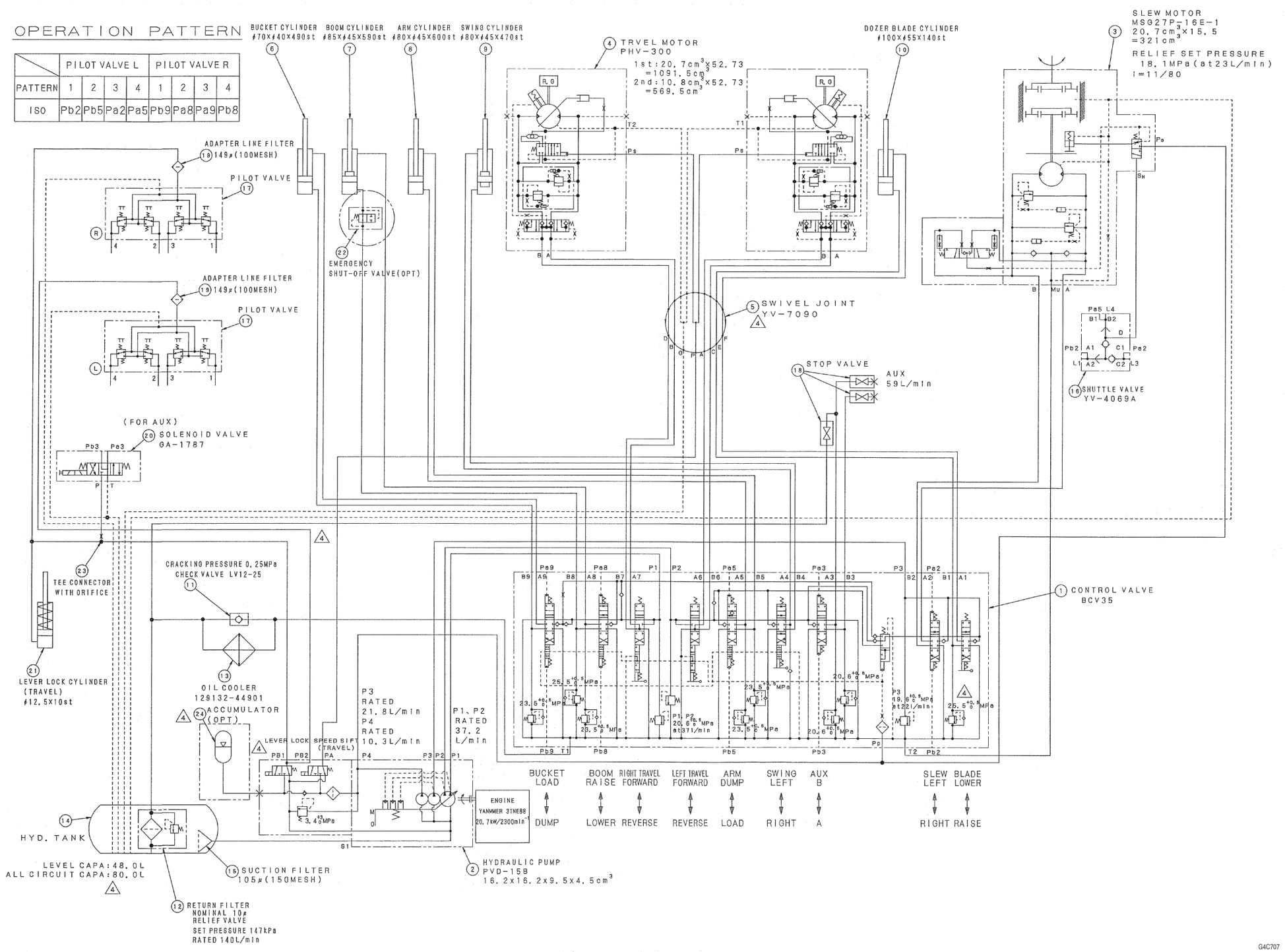
■ TB135: S/N 13510349~13512532



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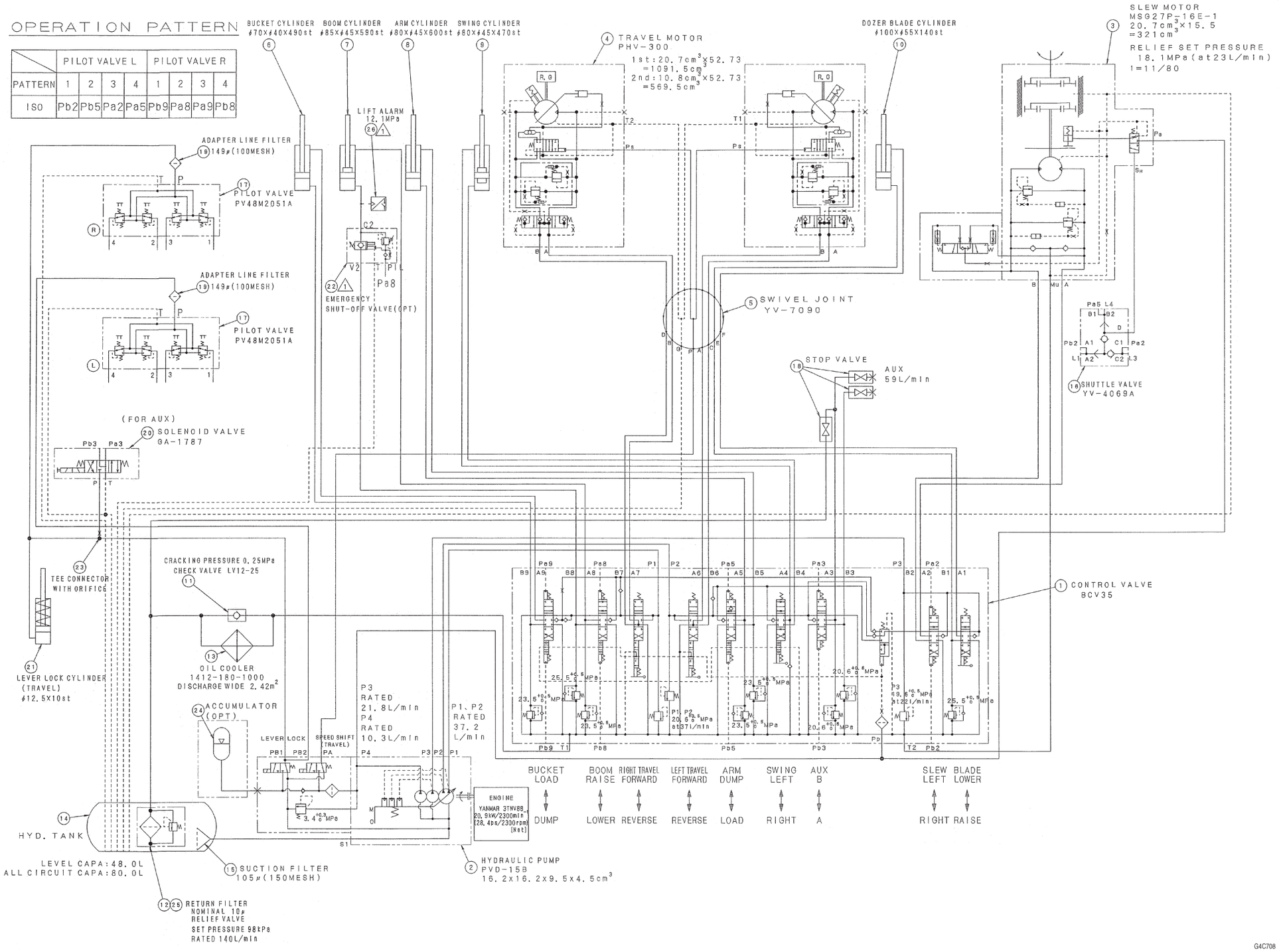
■ TB135: S/N 13512533~13514050



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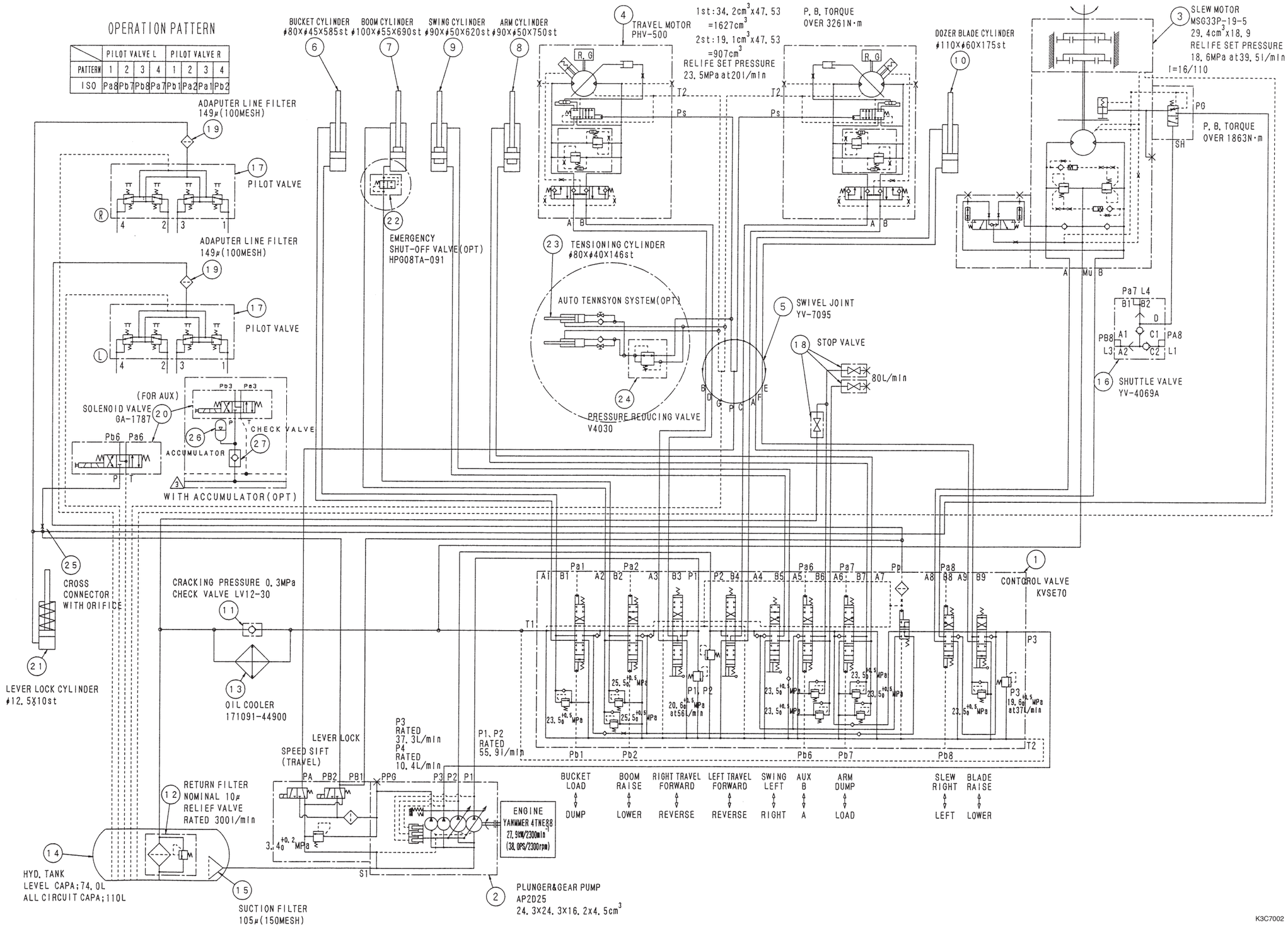
■ TB135: S/N 13514051~



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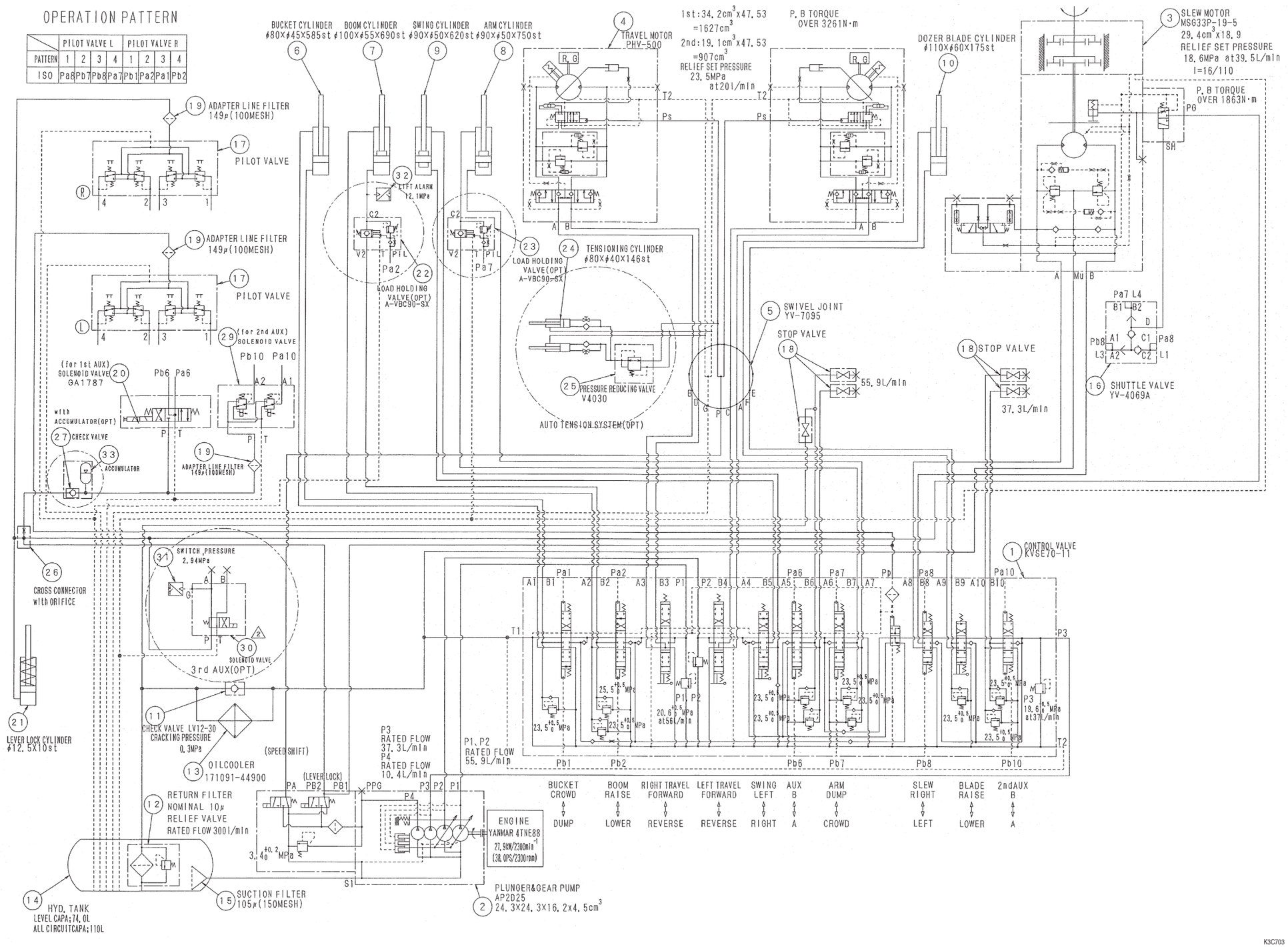
■ TB145: S/N 14510004~14513260



https://truckmanualshub.com/



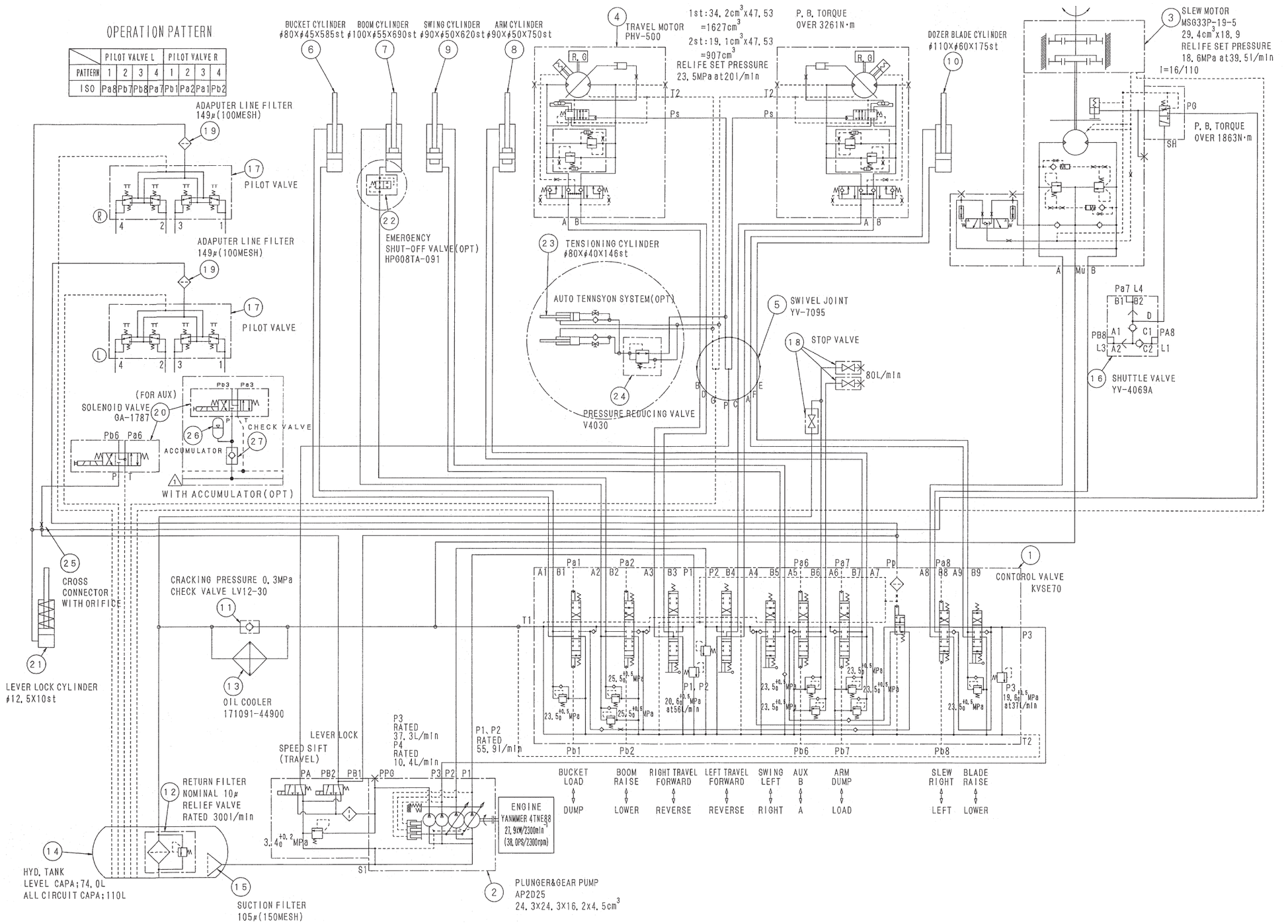
■ TB145: S/N 14510004~14513260
W/2nd auxiliary hydraulics



https://truckmanualshub.com/



■ TB145: S/N 14510004~14513260
W/high-flow hydraulics

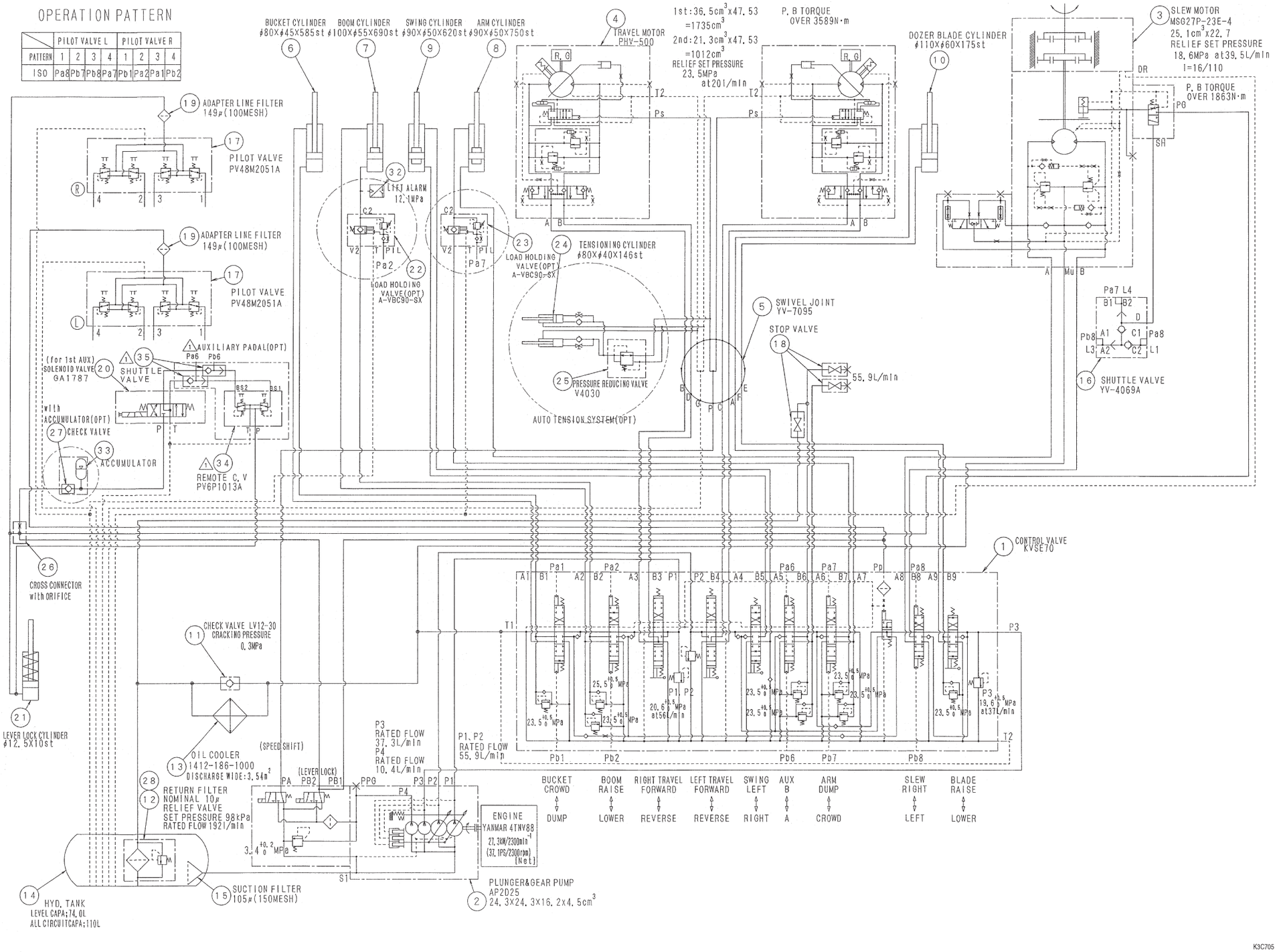



K3C704

https://truckmanualshub.com/



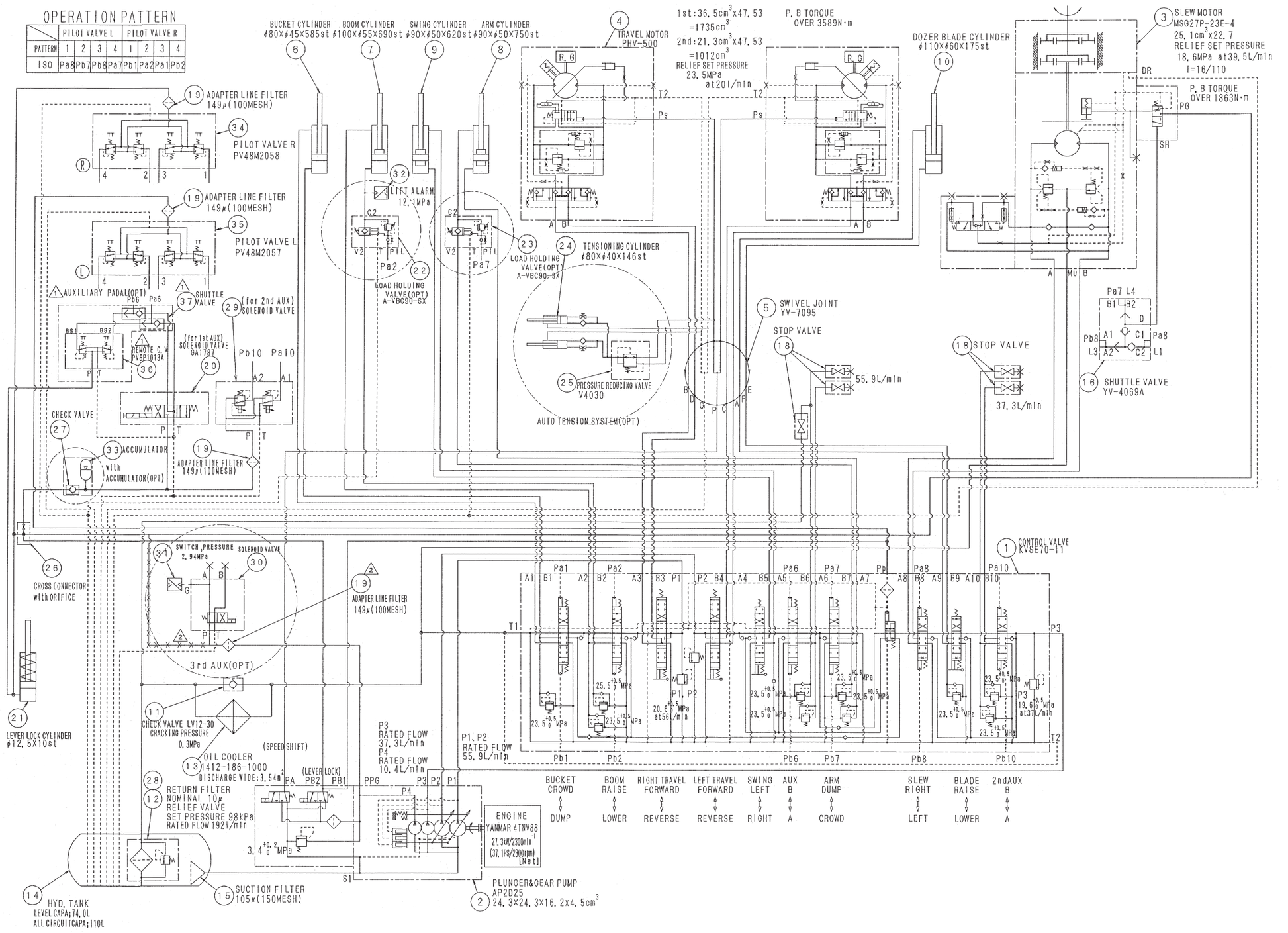
■ TB145: S/N 14513261~



https://truckmanualshub.com/



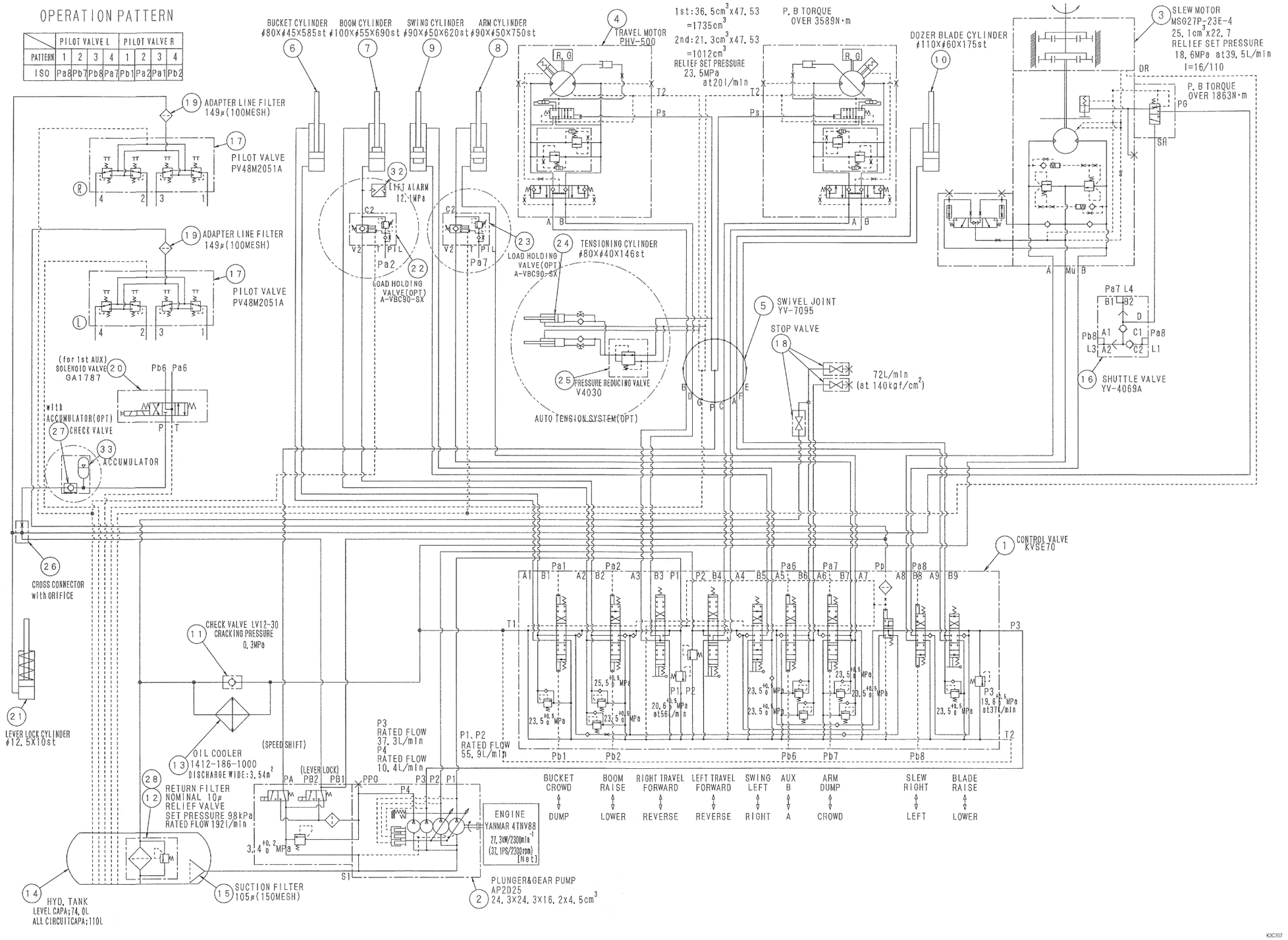
■ TB145: S/N 14513261~
W/2nd auxiliary hydraulics



https://truckmanualshub.com/



■ TB145: S/N 14513261~
W/high-flow hydraulics



https://truckmanualshub.com/

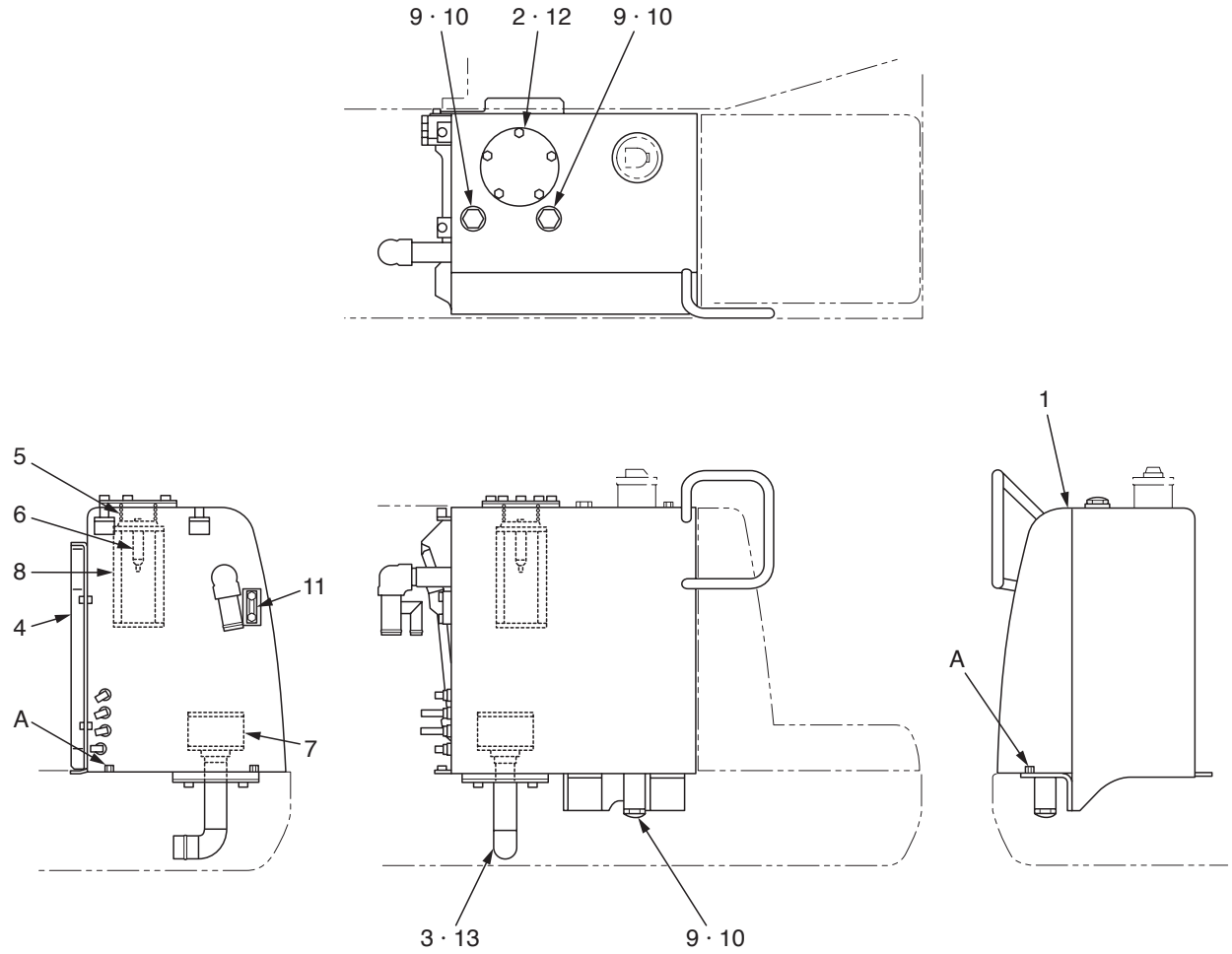
https://truckmanualshub.com/



## CONSTRUCTION

### Hydraulic Tank

■ TB125, TB135




G4C701

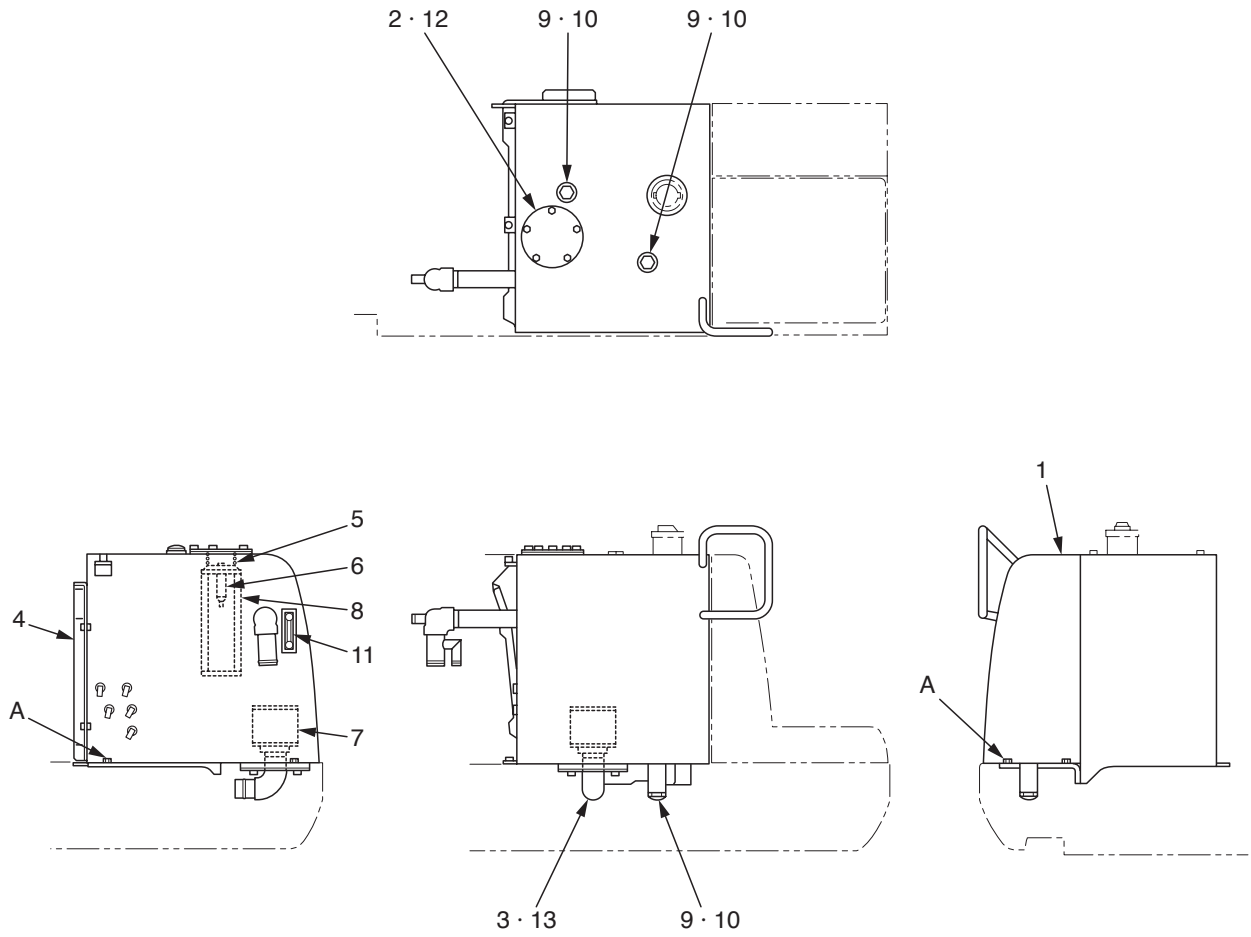
A: Tightening Torque: 47 N·m (4.8 kgf·m) [Apply thread lock]

1. Tank
2. Cover
3. Suction Pipe
4. Plate
5. Spring
6. Check Valve
7. Suction Filter
8. Return Filter
9. Plug
10. O-ring
11. Sight Gauge
12. O-ring
13. O-ring

https://truckmanualshub.com/



■ TB145




K3C701

A: Tightening Torque: 47 N·m (4.8 kgf·m) [Apply thread lock]

1. Tank
2. Cover
3. Suction Pipe
4. Plate
5. Spring
6. Check Valve
7. Suction Filter
8. Return Filter
9. Plug
10. O-ring
11. Sight Gauge
12. O-ring
13. O-ring

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**Function**

1. This tank stores the quantity of hydraulic oil necessary to operate the cylinders and hydraulic motors.

2. It keeps air, moisture and dirt out of the hydraulic oil.

3. It dissipates heat and lowers the oil temperature.

4. Volume of Hydraulic Oil.
   Check the oil level with the arm cylinder and bucket cylinder both fully retracted and with the bucket and dozer blade both lowered to the ground.

Reference

If the amount of hydraulic oil is insufficient, the disturbances in the flow of oil can not be calmed, and this will result in air bubbles getting in the hydraulic oil. If these bubbles are sucked into the hydraulic pumps, they could cause cavitation. Heat dissipation time would also become shorter and would result in a rise in the oil temperature.
If more than the specified amount of hydraulic oil is supplied, the amount of air in the tank will become small and changes in the oil level could cause the pressure fluctuation in the tank to become severe.

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## DISASSEMBLY AND ASSEMBLY

### Removing the Hydraulic Tank

1. Remove the cab or canopy.
   ☞ "Removing the Cab"

2. Remove the covers around the tank.
   ☞ "Removing the Covers"

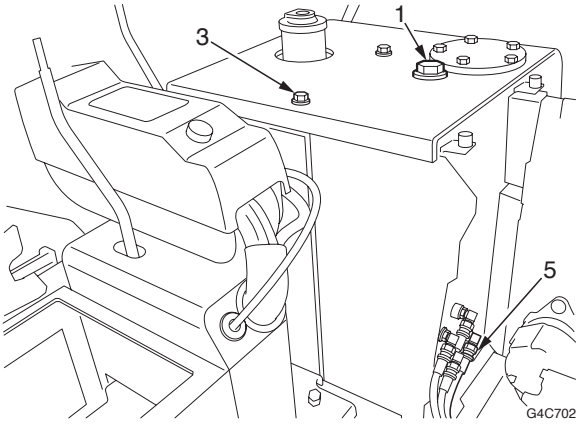
3. Drain the oil from the tank.
   a. Slowly loosen the plug (1) to release the tank's inner pressure.
   b. Loosen the drain plug (2) and drain out the oil.
      • Tank level capacity:
      TB125, TB135…48 *l*, TB145…74 *l*

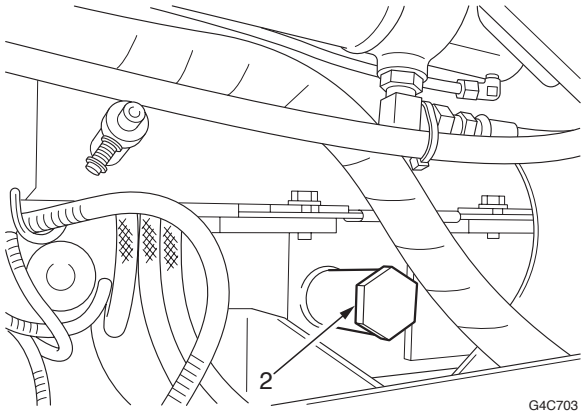
4. Remove the three bolts (3) securing the fuel tank to the hydraulic tank.

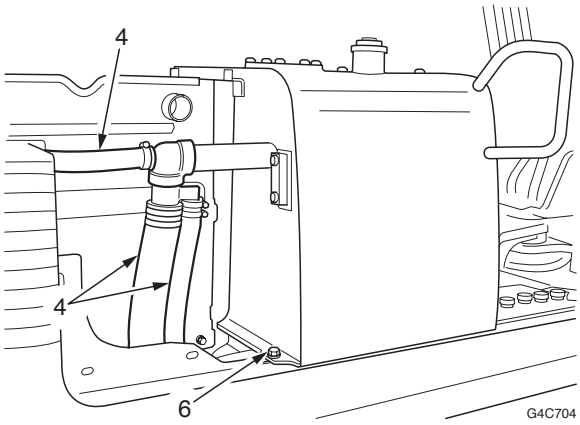
5. Disconnect the low pressure hoses (4) from the tank.
   • TB125, TB135…3 hoses, TB145…4 hoses

6. Disconnect the hydraulic hoses (5) from the tank.
   • TB125, TB135…4 hoses, TB145…5 hoses
   • Attach identification labels to individual hoses for correct reassembling.

7. Take off the fixing bolts (6), and suspend the tank and remove it.
   • Tank mass:
   TB125, TB135…57 kg, TB145…74 kg




### Installing the Hydraulic Tank

Follow the same procedure as for removal in the reverse order.

- Tank fixing bolt tightening torque: 47 N·m (4.8 kgf·m) [Apply thread lock to the bolt.]

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### Filling with Hydraulic Oil

1. Fill the tank with the specified amount of hydraulic oil through the filler inlet.

2. Bleed the air from the hydraulic pump.
   ☞ "Bleeding the air"

3. Run the engine for 2~3minutes at low speed.

4. Retract the arm and bucket cylinders fully, lower the boom and lower the bucket to the ground.

5. Lower the dozer blade to the ground.

6. Check if the oil level is proper using a level gauge.
   ☞ "I-12"

### Tank Pressurization

1. Extend all the cylinders fully, then in that condition, close the filler inlet. (The dozer blade should be lowered to the ground.)
   - When filling of the hydraulic tank is completed, be sure to pressurize the tank.

### Bleeding the Air

Bleed the air after replacing the hydraulic oil or reassembling hydraulic devices or hoses.

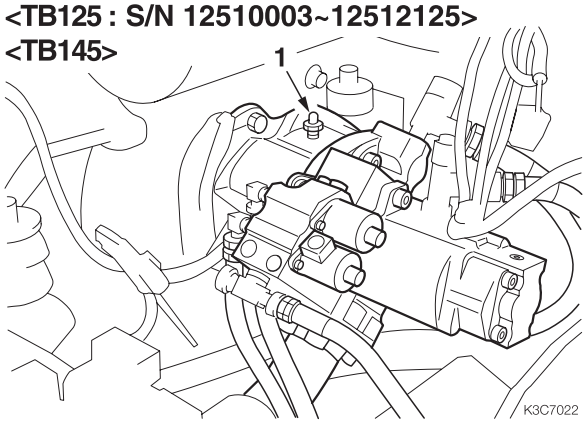
1. Remove the vent plug (1), on the hydraulic pump bleed the air from the housing, and tighten plug (1) once hydraulic oil begins to come out.
   - Be sure to stop the engine.

2. Start the engine and run the engine at low idle.

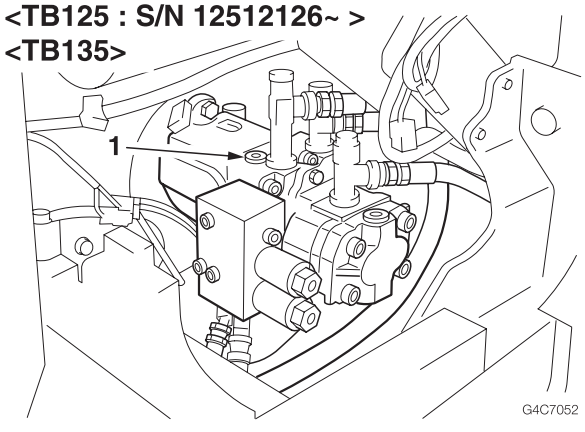
3. Slowly operate the cylinders until the air is bled.

4. Bleed the air from the cylinders.
   a. With the engine running at slow, extend and contract the cylinders 4 or 5 times.
      - Move the piston rods to 100 mm before the stroke end. DO NOT extend them completely.
   b. Repeat step "a" above with the engine running at full, then run it at slow and extend the piston rods completely to the stroke end.

**<TB125 : S/N 12510003~12512125>**
**<TB145>**




**<TB125 : S/N 12512126~ >**
**<TB135>**



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### Changing to Biodegradable Oil

When changing the hydraulic oil from mineral oil to biodegradable oil, be sure to flush it properly as described below to prevent mixing of oil, which will adversely affect the biodegradability and safety. When changing the hydraulic oil from biodegradable oil to mineral oil, flushing is not necessary.

#### Flushing

1. Drain the hydraulic tank.
   ☞ "Removing the Hydraulic Tank"

2. Disconnect the hoses from the cylinders and drain the disconnected hoses and cylinders.

3. Supply new biodegradable oil to the hydraulic tank.
   ☞ "Filling with Hydraulic Oil"

4. Bleed the air from the pump and cylinders and pressurize the hydraulic tank.
   ☞ "Bleeding the Air"

5 Operate the hydraulic actuators for 30 minutes.

6. Drain the tank and cylinders.

7. Replace return filter (2) with a new one.
   a. Remove cover (1).
   b. Remove filter (2) and replace with a new one.

8. Repeat steps 3 and 4.

9. Operate the hydraulic actuators for 30 minutes.

10. Drain the tank and cylinders.

11. Repeat steps 3 and 4.

12. Operate the hydraulic actuators for 1 hour.

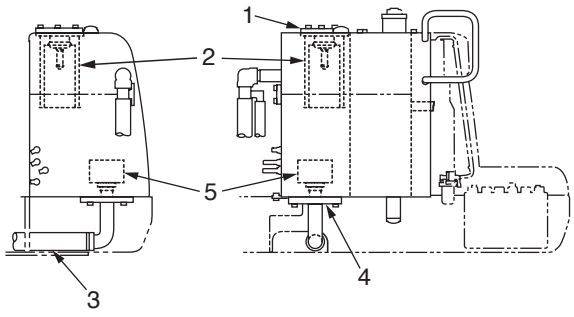
13. Drain the tank and cylinders.

14. Replace the return filter (2) with a new one.

15. Clean suction strainer (5).
   a. Loosen the hose clips and disconnect hose (3).
   b. Remove flange (4) together with strainer (5).
   c. Clean strainer (5).

16. Repeat steps 3 and 4.

17. Operate the hydraulic actuators, then check for oil leakage.




G4C706

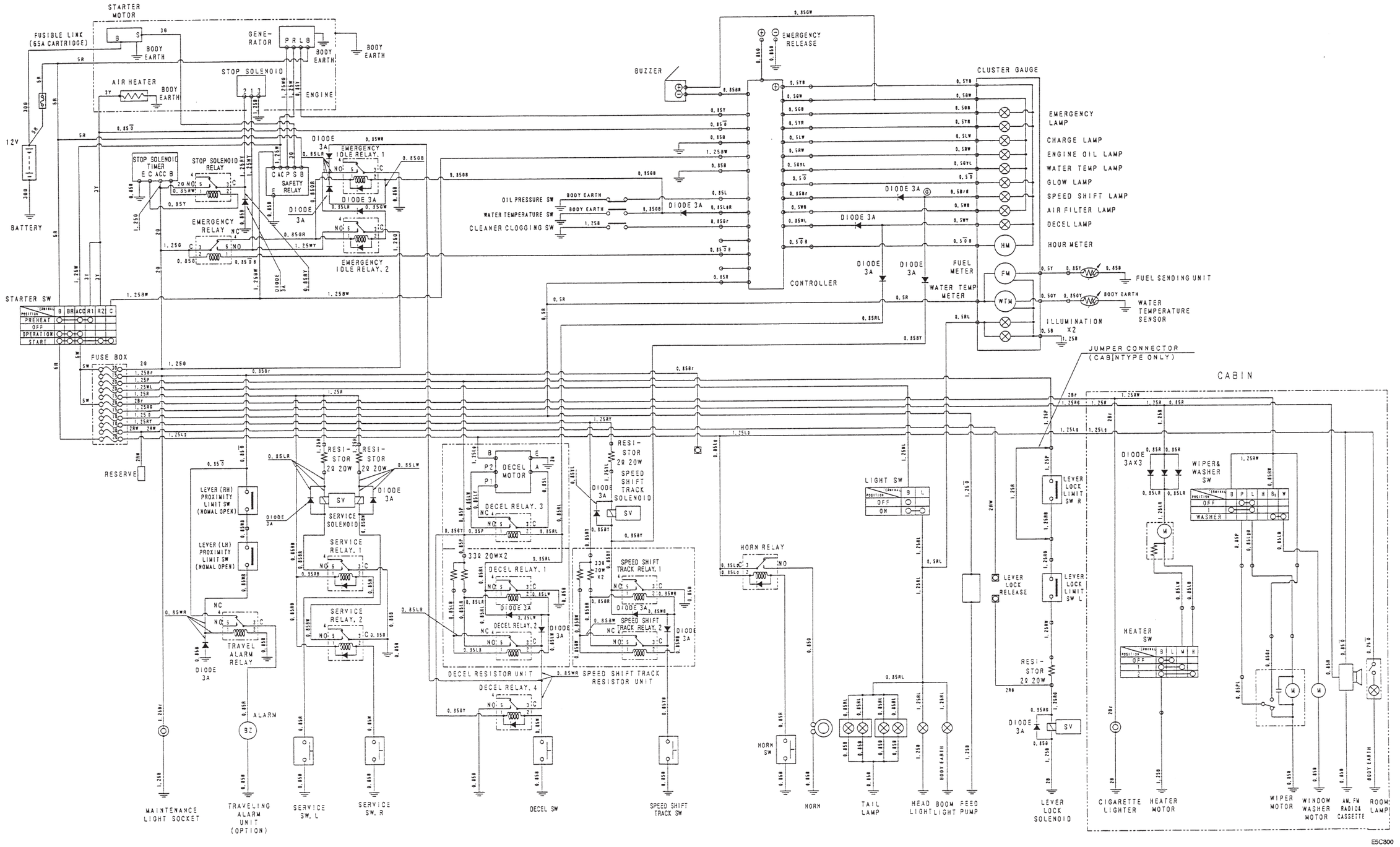
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# ELECTRICAL SYSTEM

## ELECTRICAL WIRING DIAGRAM

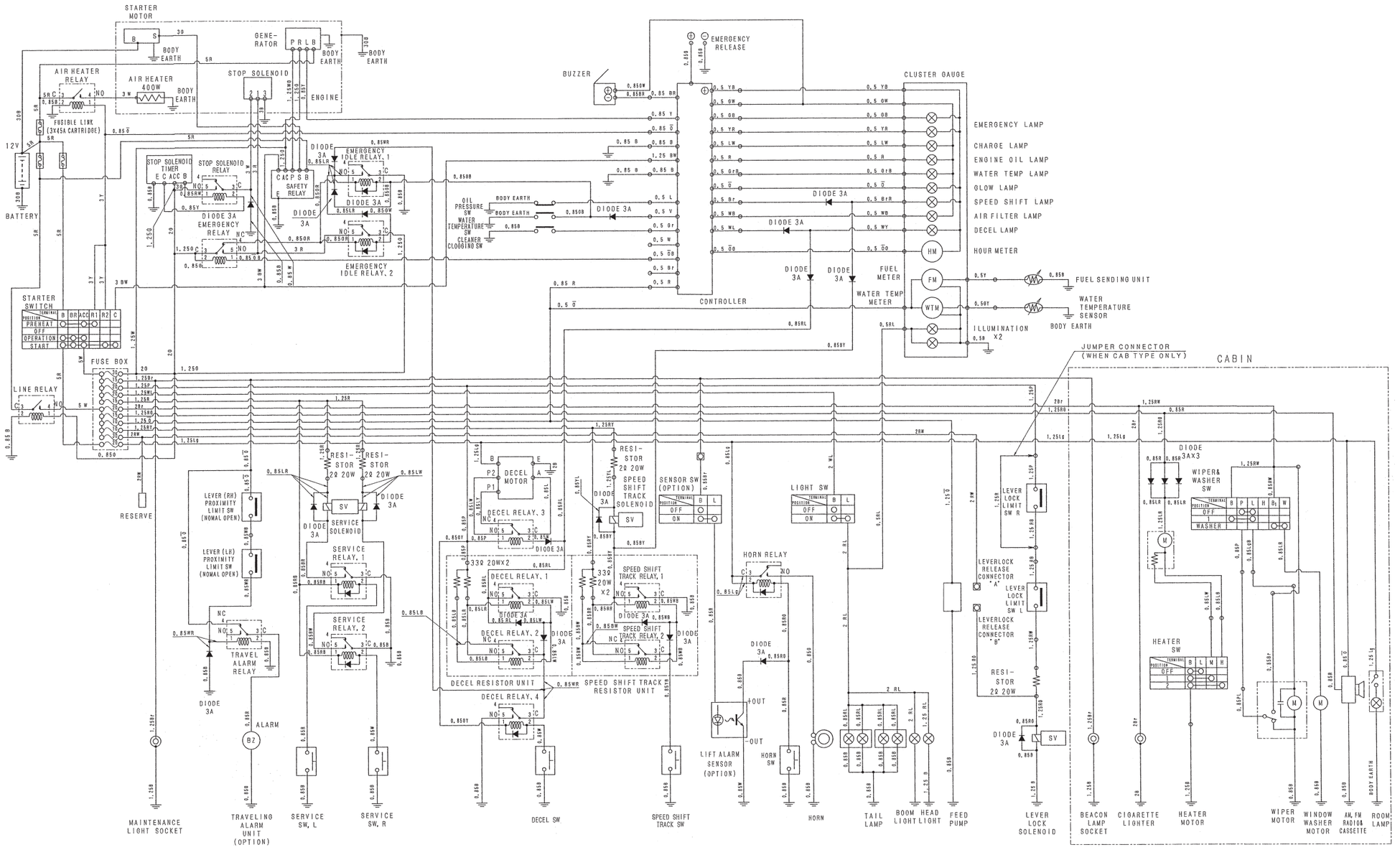
■ TB125: S/N 12510003~12514525



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■ TB125: S/N 12514526~




WIRING COLOUR EXAMPLE




WIRING COLOUR TABLE

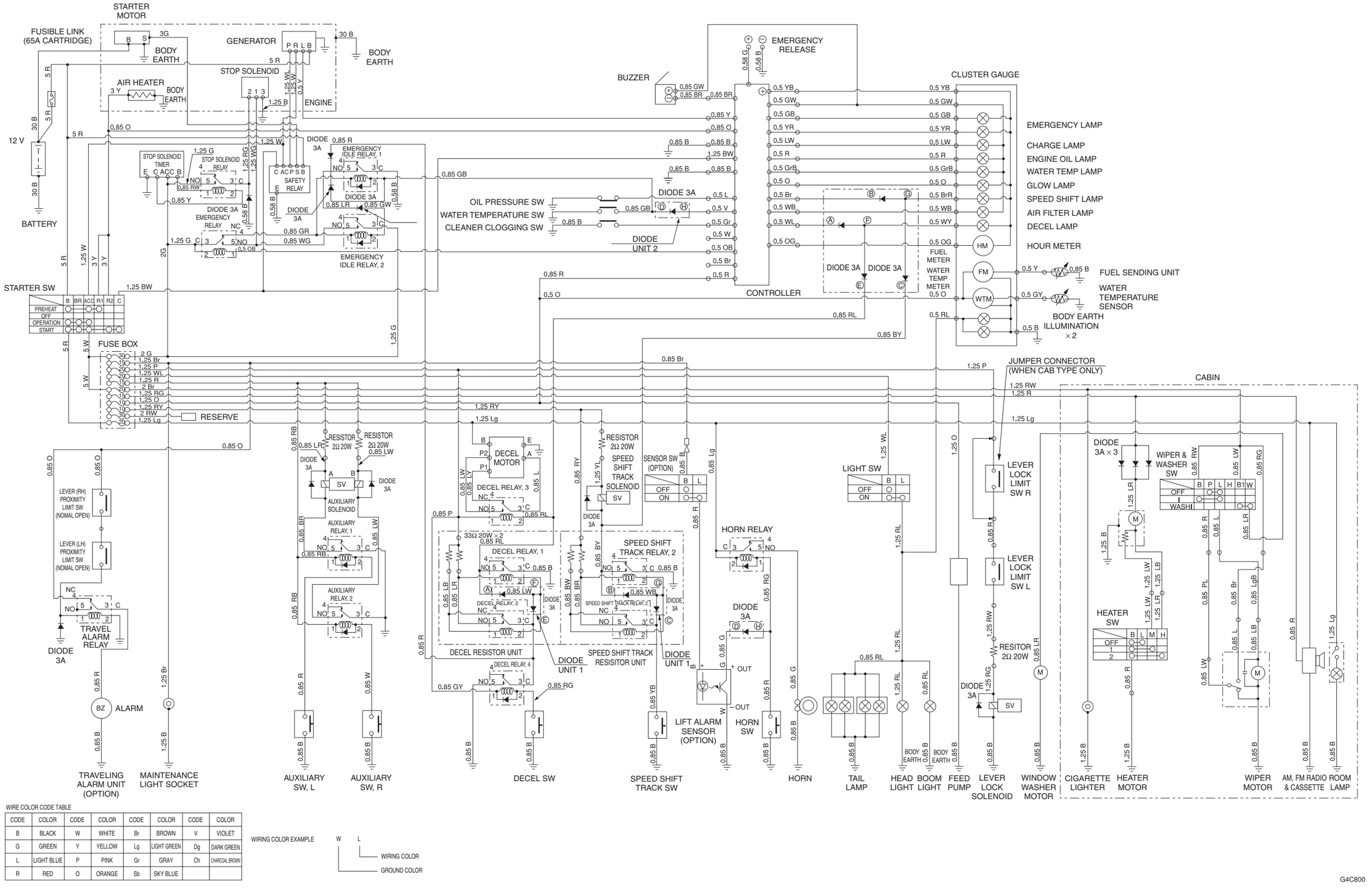
| CODE | COLOUR | CODE | COLOUR | CODE | COLOUR |
|---|---|---|---|---|---|
| B | BLACK | W | WHITE | Br | BROWN |
| G | GREEN | Y | YELLOW | Lg | LIGHT GREEN |
| L | BLUE | P | PINK | Gr | GREY |
| R | RED | O | ORANGE | Sb | SKY BLUE |
| V | VIOLET | Dg | DARK GREEN | Ch | CHOCOLATE |

ESC808

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■ TB135: S/N 13510004~13510420




WIRE COLOR CODE TABLE

| CODE | COLOR | CODE | COLOR | CODE | COLOR | CODE | COLOR |
|---|---|---|---|---|---|---|---|
| B | BLACK | W | WHITE | Br | BROWN | V | VIOLET |
| G | GREEN | Y | YELLOW | Lg | LIGHT GREEN | Dg | DARK GREEN |
| L | LIGHT BLUE | P | PINK | Gr | GRAY | Ch | CHARCOAL BROWN |
| R | RED | O | ORANGE | Sb | SKY BLUE | | |

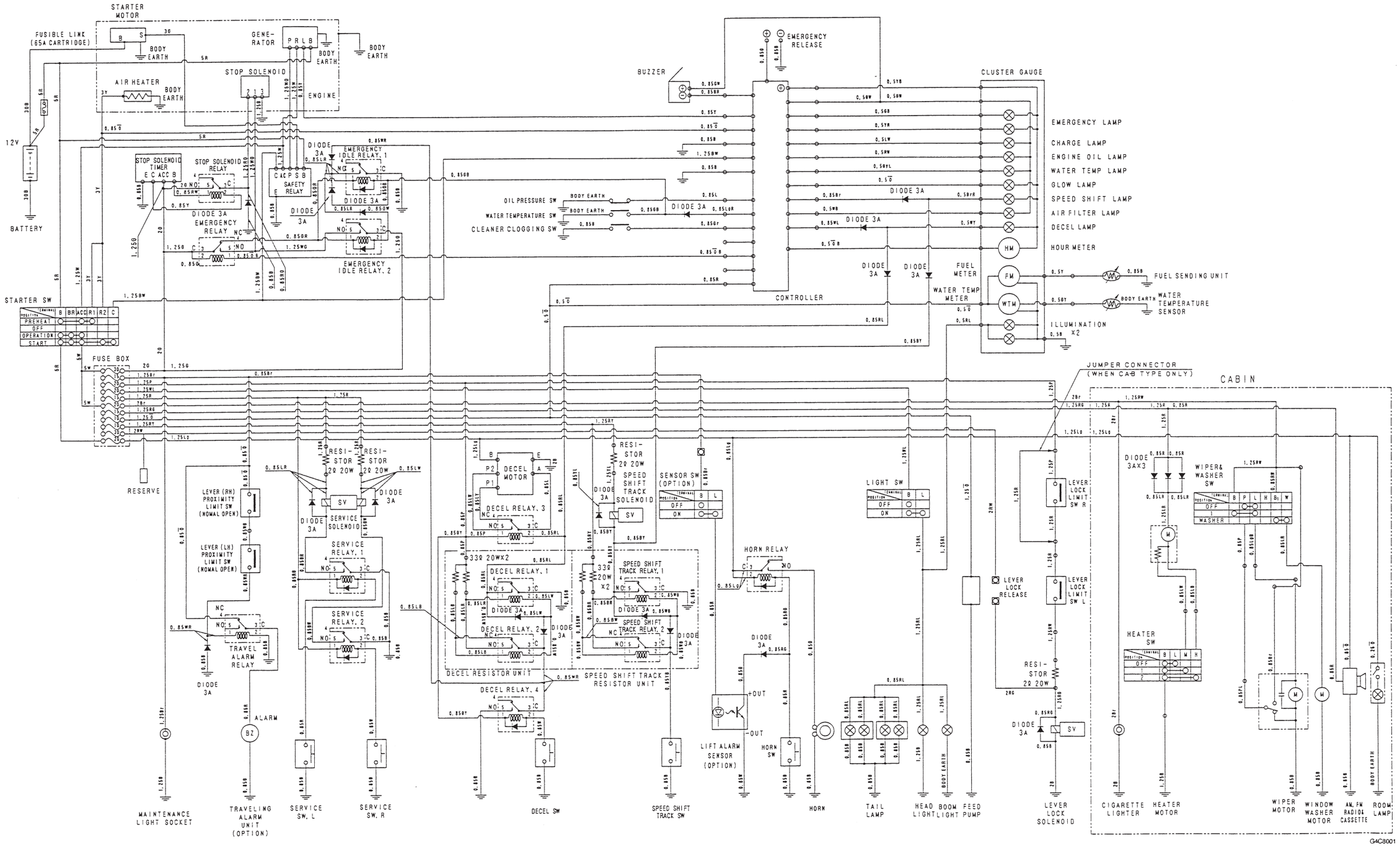
WIRING COLOR EXAMPLE W L — WIRING COLOR — GROUND COLOR

G4C800

https://truckmanualshub.com/



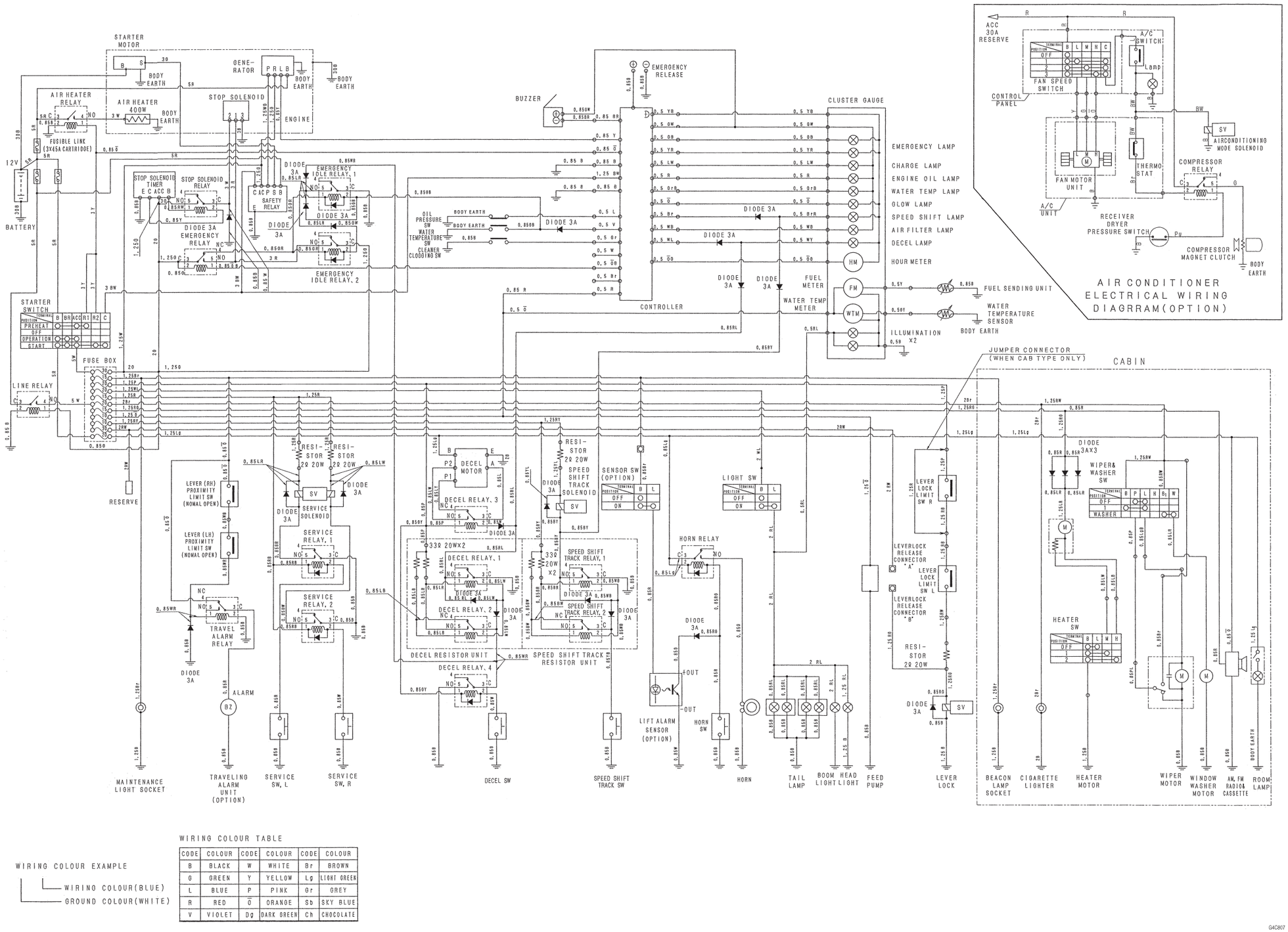
■ TB135: S/N 13510421~13514050



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■ TB135: S/N 13514051~




WIRING COLOUR EXAMPLE

WIRING COLOUR(BLUE)

GROUND COLOUR(WHITE)

WIRING COLOUR TABLE

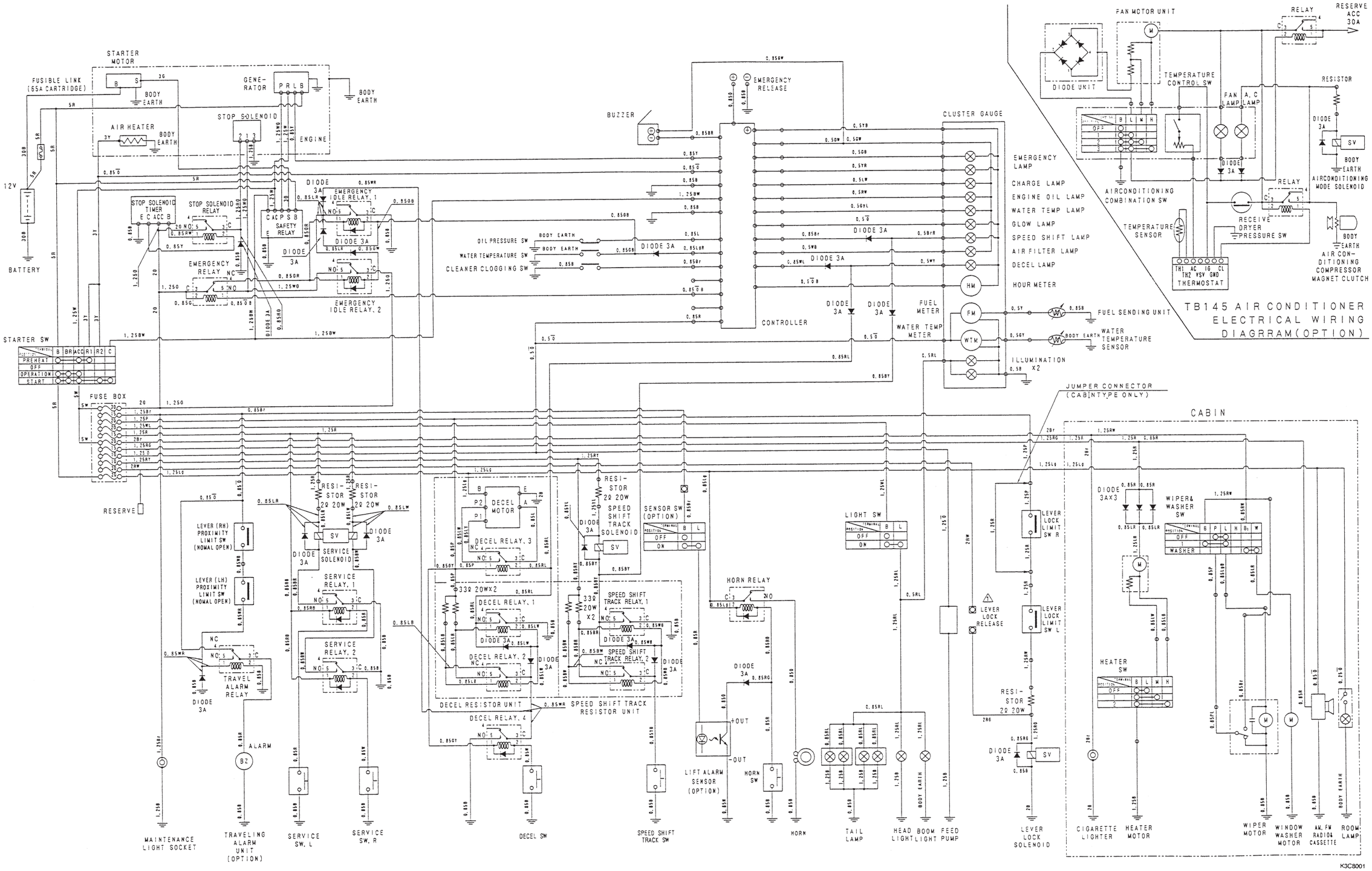
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|---|---|---|---|---|---|
| B | BLACK | W | WHITE | Br | BROWN |
| G | GREEN | Y | YELLOW | Lg | LIGHT GREEN |
| L | BLUE | P | PINK | Gr | GREY |
| R | RED | O | ORANGE | Sb | SKY BLUE |
| V | VIOLET | Dg | DARK GREEN | Ch | CHOCOLATE |

G4C807

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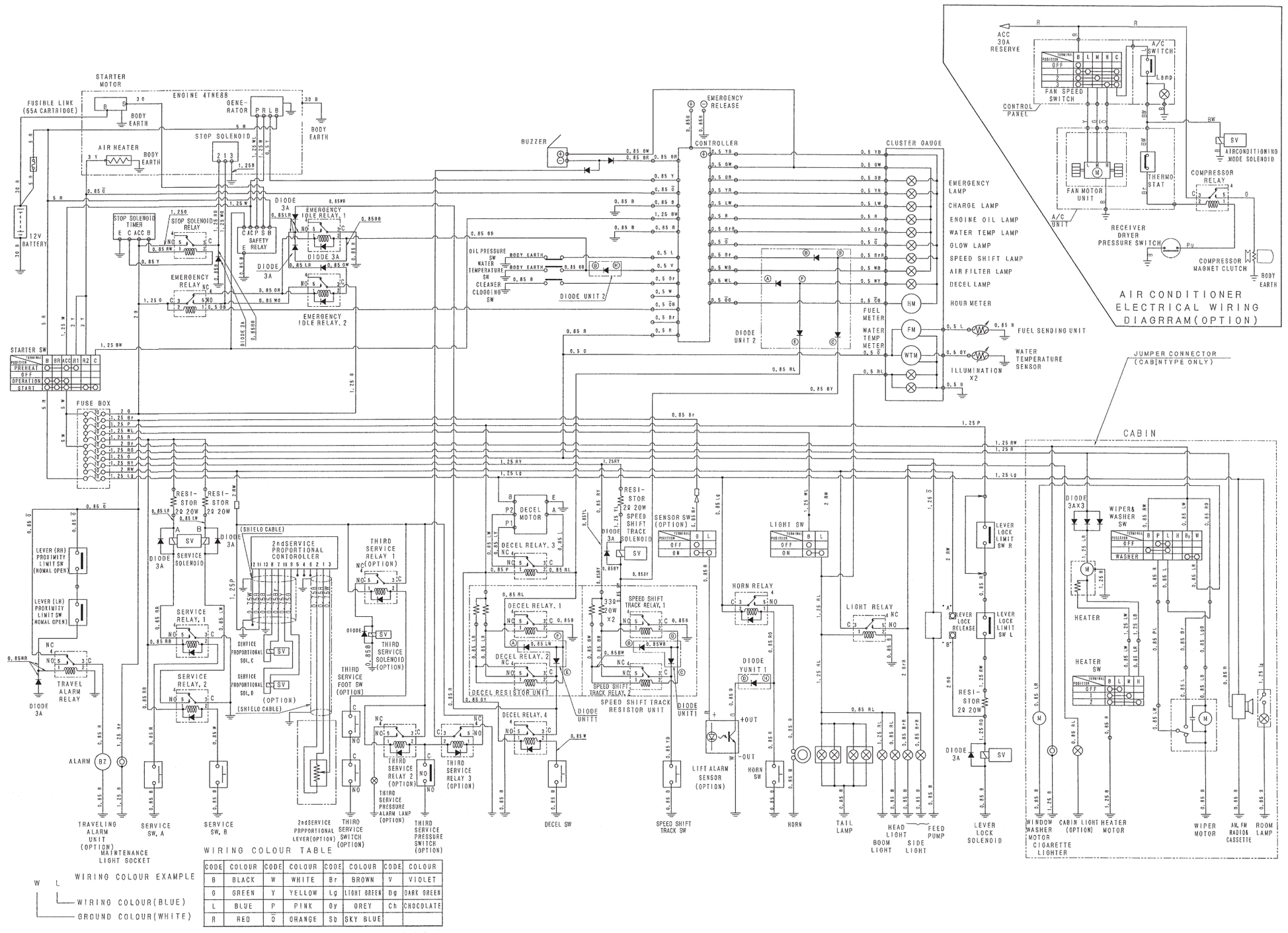
■ TB145: S/N 14510004~14513260
W/UNICLA air conditioner circuit



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■ TB145: S/N 14510004~14513260
W/RED DOT air conditioner circuit




WIRING COLOUR TABLE

| CODE | COLOUR | CODE | COLOUR | CODE | COLOUR | CODE | COLOUR |
|---|---|---|---|---|---|---|---|
| B | BLACK | W | WHITE | Br | BROWN | V | VIOLET |
| G | GREEN | Y | YELLOW | Lg | LIGHT GREEN | Dg | DARK GREEN |
| L | BLUE | P | PINK | Gy | GREY | Ch | CHOCOLATE |
| R | RED | O | ORANGE | Sb | SKY BLUE | | |

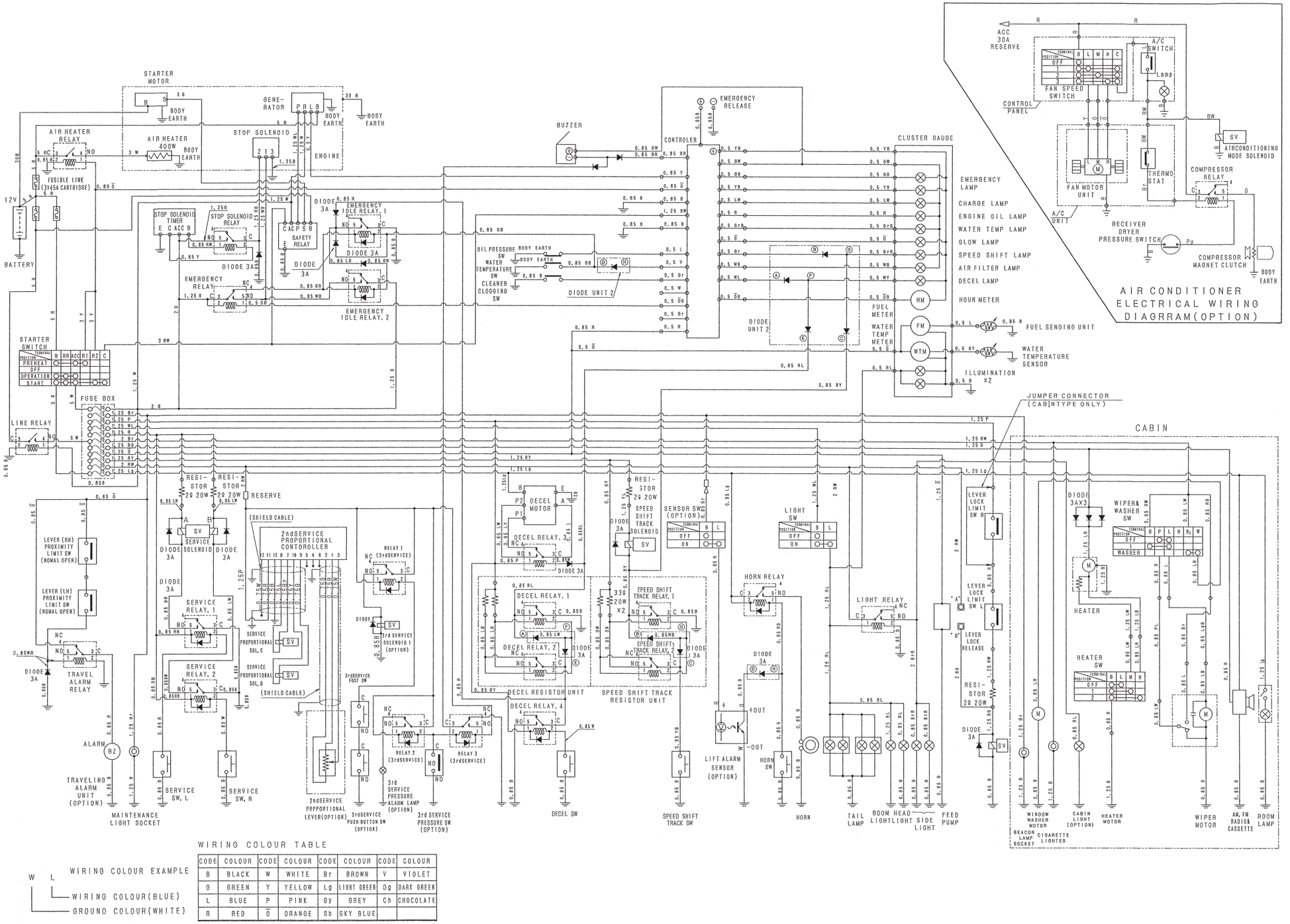
WIRING COLOUR EXAMPLE

W L
- WIRING COLOUR(BLUE)
- GROUND COLOUR(WHITE)

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■ TB145: S/N 14513261~




WIRING COLOUR TABLE

| CODE | COLOUR | CODE | COLOUR | CODE | COLOUR | CODE | COLOUR |
|---|---|---|---|---|---|---|---|
| B | BLACK | W | WHITE | Br | BROWN | V | VIOLET |
| G | GREEN | Y | YELLOW | Lg | LIGHT GREEN | Dg | DARK GREEN |
| L | BLUE | P | PINK | Gy | GREY | Ch | CHOCOLATE |
| R | RED | O | ORANGE | Sb | SKY BLUE | | |

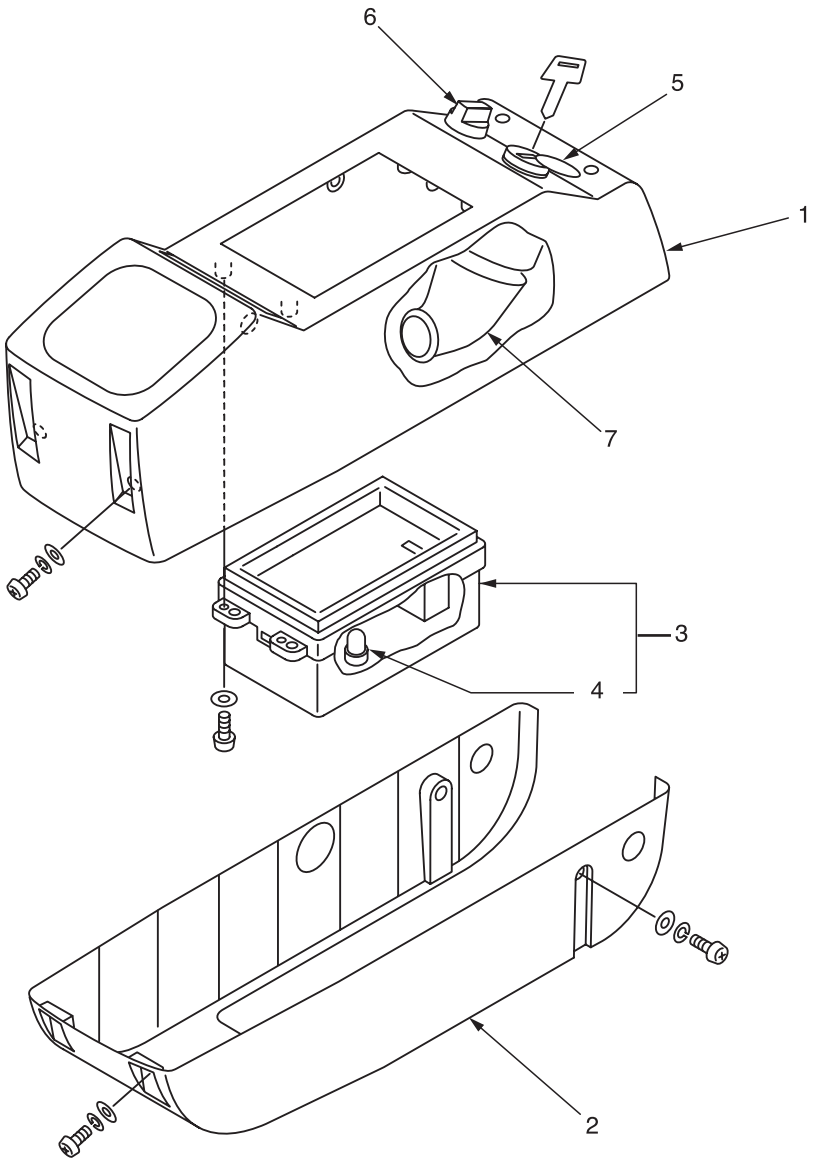
WIRING COLOUR EXAMPLE
W L
WIRING COLOUR(BLUE)
GROUND COLOUR(WHITE)

K3C804

https://truckmanualshub.com/



**Control Box R**



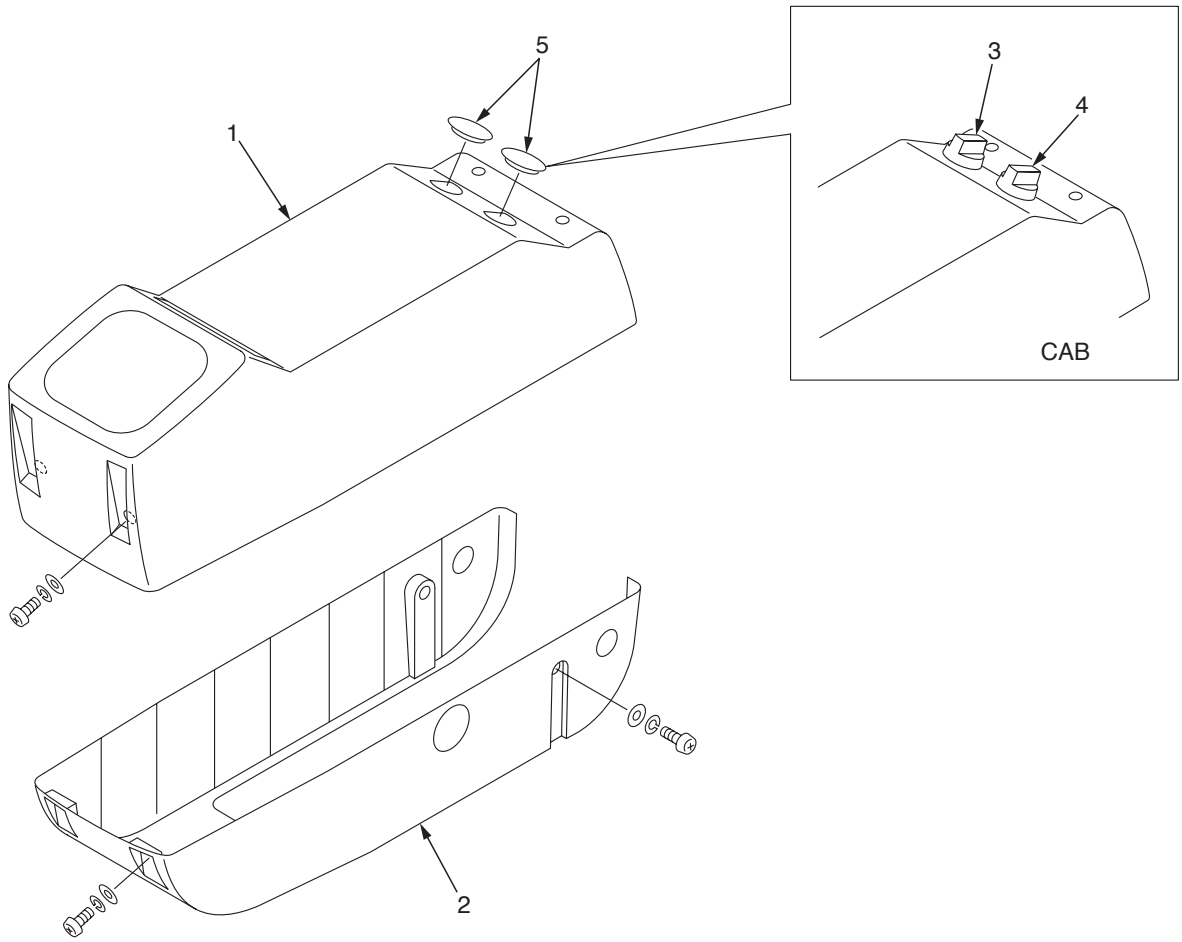

E5C802

1. Cover
2. Cover
3. Cluster Gauge
4. Bulb
5. Starter Switch
6. Lamp Switch
7. Cover

https://truckmanualshub.com/



**Control Box L**




C4C805

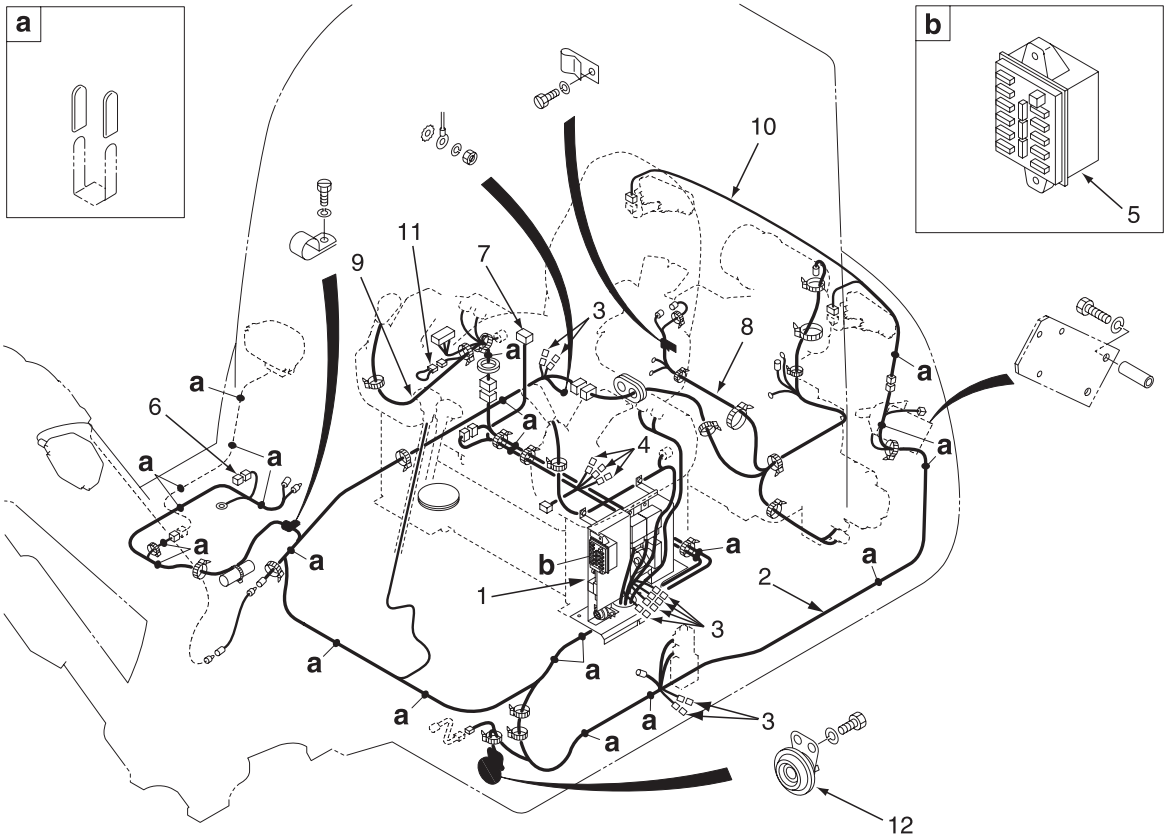
1. Cover
2. Cover
3. Wiper Switch
4. Heater Switch
5. Cap

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**Electrical Wiring (1/2)**

■ TB125

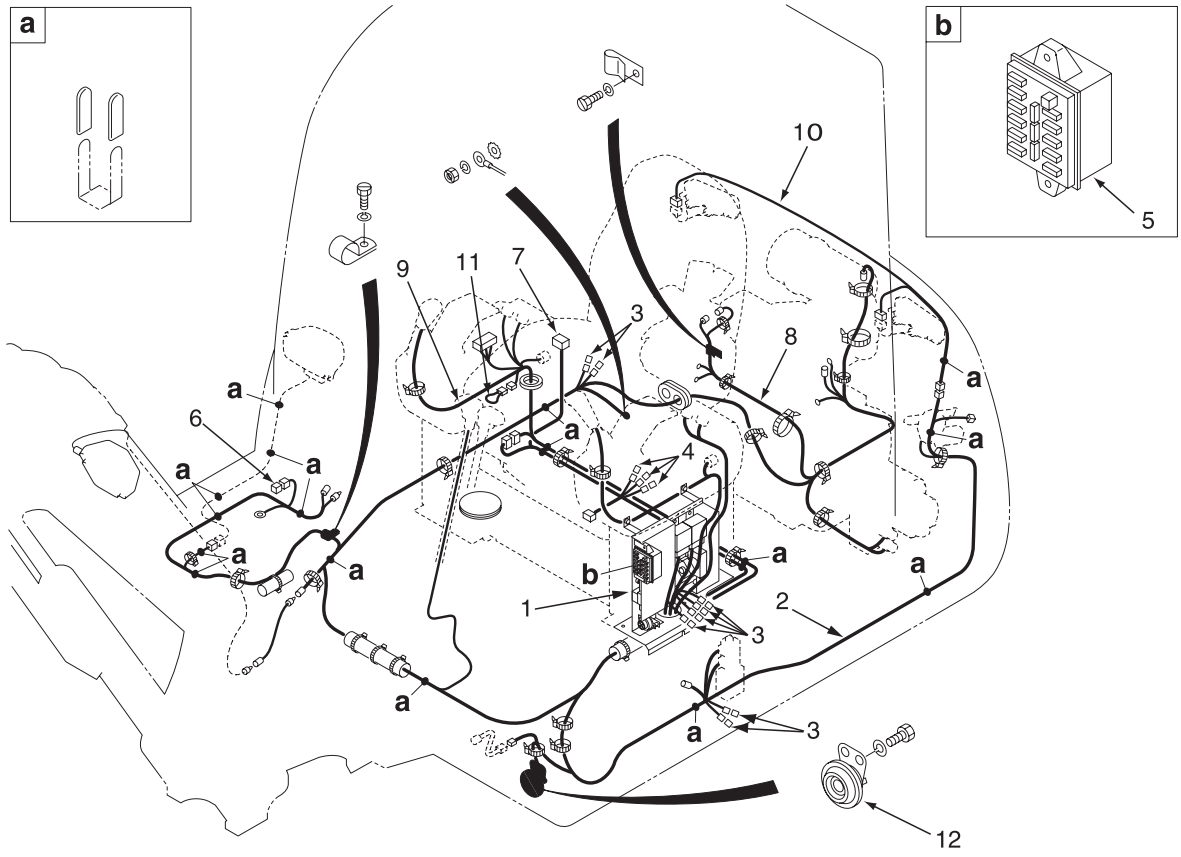



1. Control Unit
2. Wire Harness
3. Diode
4. Diode
5. Fuse Box
6. Fusible link
7. Wire Harness
8. Wire Harness
9. Wire Harness
10. Wire Harness
11. Connector
12. Horn

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■ TB135,TB145




G4C804

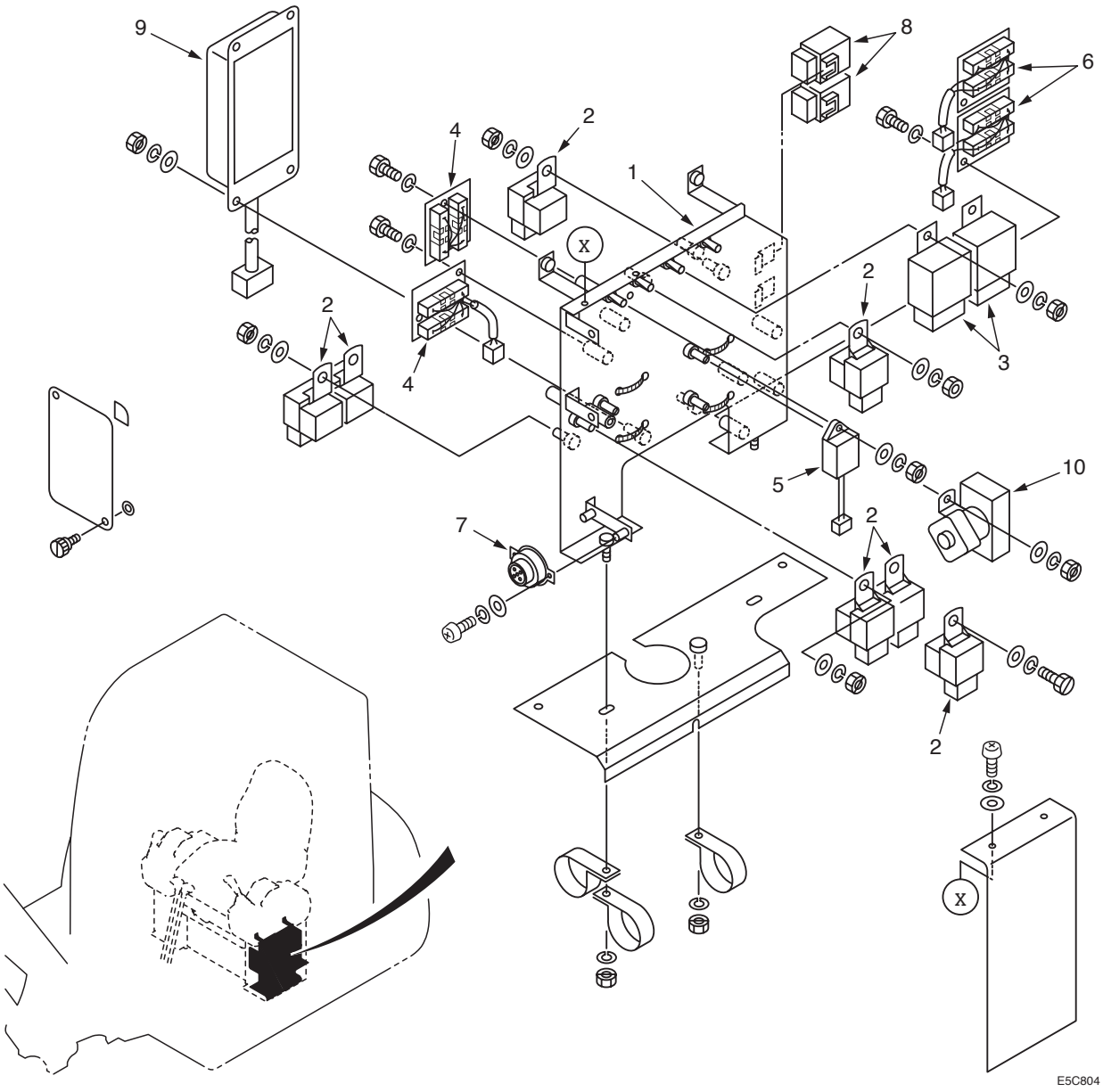
1. Control Unit
2. Wire Harness
3. Diode
4. Diode
5. Fuse Box
6. Fusible link
7. Wire Harness
8. Wire Harness
9. Wire Harness
10. Wire Harness
11. Connector
12. Horn

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**Electrical Wiring (2/2)**

■ TB125

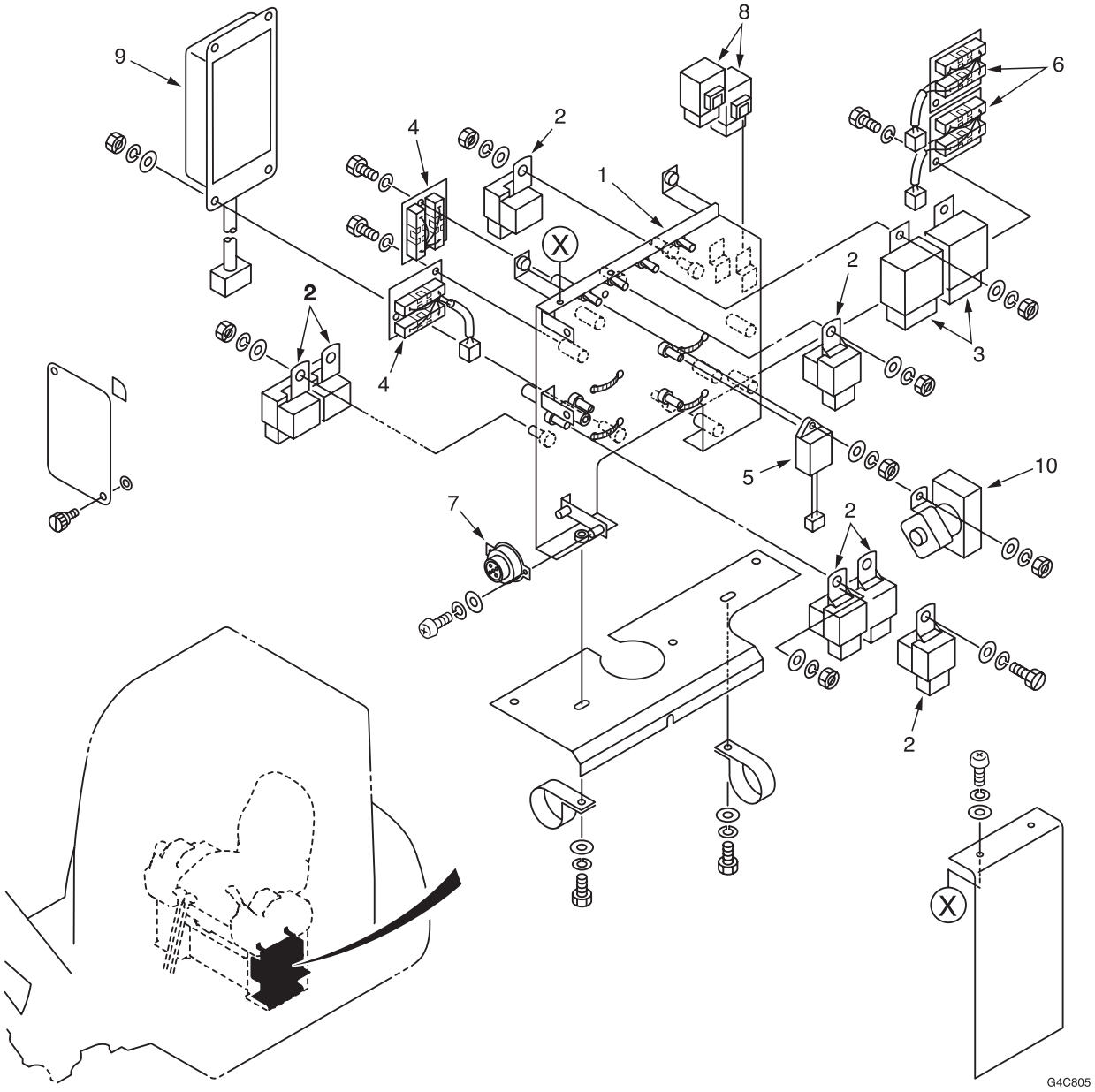



1. Plate
2. Relay
3. Relay
4. Resistor
5. Timer Unit
6. Resistor
7. Buzzer
8. Diode
9. Controller
10. Relay

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■ TB135, TB145

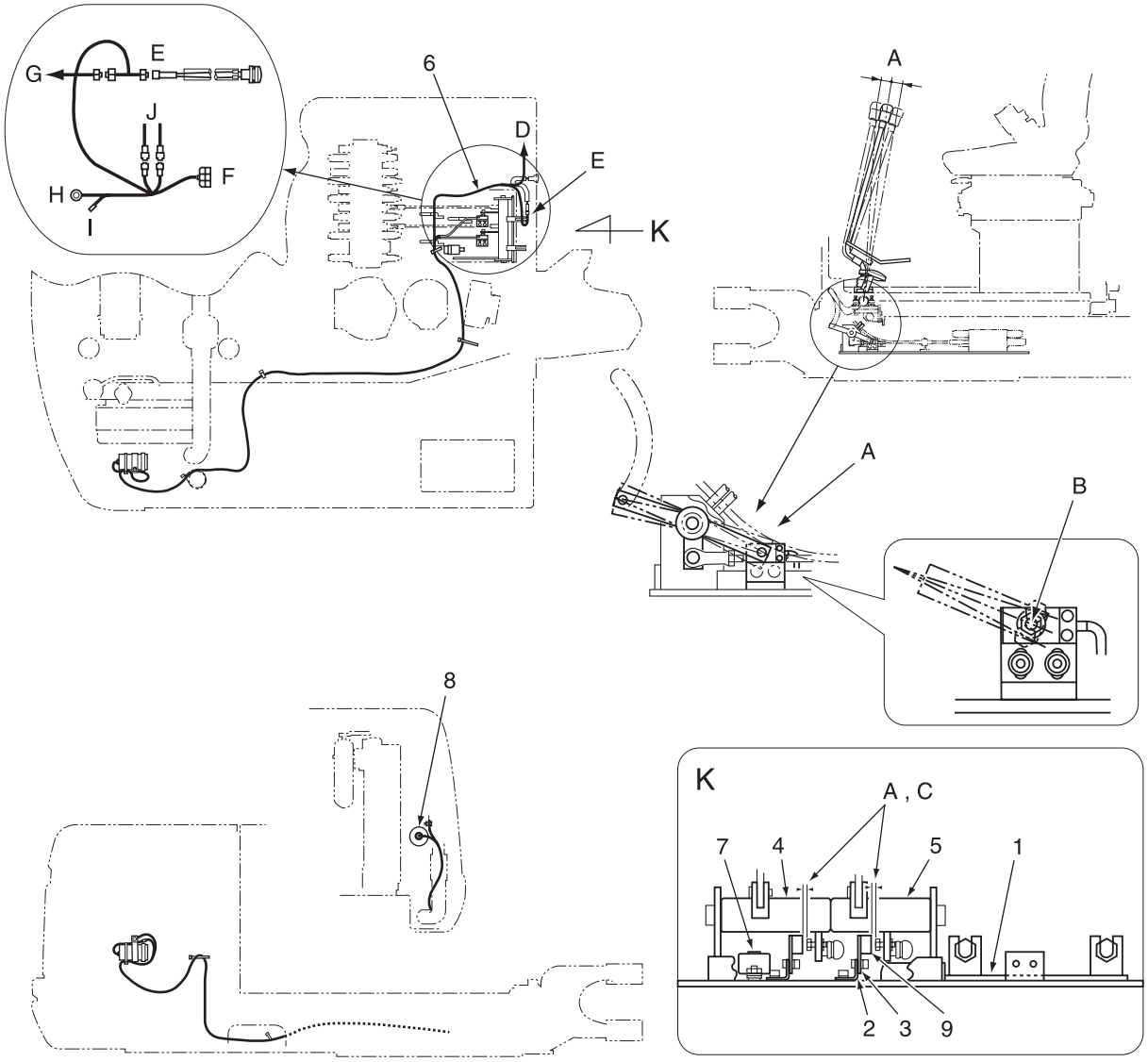



1. Plate
2. Relay
3. Relay
4. Resistor
5. Timer Unit
6. Resistor
7. Buzzer
8. Diode
9. Controller
10. Relay

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**Travel Alarm**




E5C805

A: Adjust the travel alarm so that it will sound when the lever grip is moved forward or backward by about 40 mm.
B: Adjust the lever so that the center of the proximity switch aligns with the center of the bolt when the lever is in the neutral position.
C: Do not allow the proximity switch to touch the adjustment bolt.
D: Connect to the power source (+) and the main harness.
E: Connect to the maintenance light socket.
F: Connect to the relay.
G: Connect to the main harness.
H: Connect to the buzzer earth.
I: Connect to the buzzer.

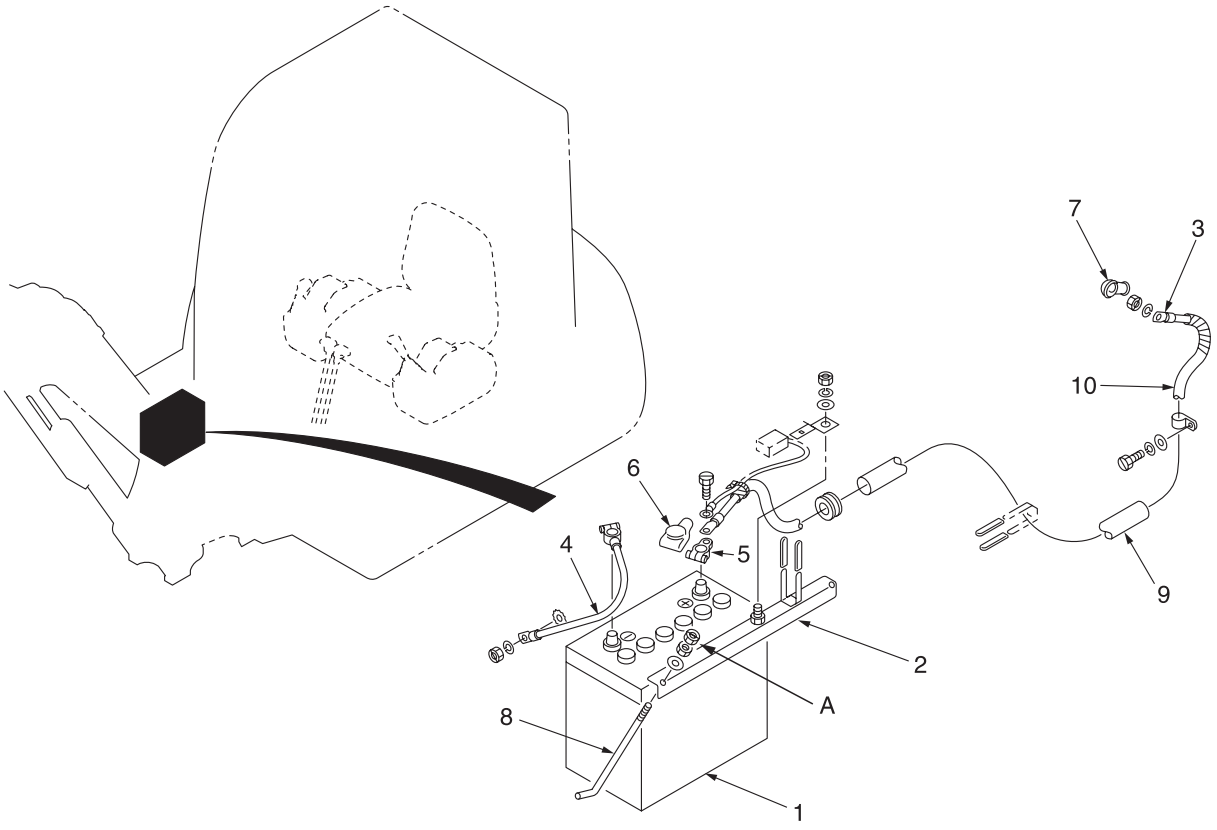
1. Lever Bracket
2. Bracket
3. Plate
4. Right Travel Lever
5. Left Travel Lever
6. Wire Harness
7. Relay Assembly
8. Buzzer
9. Proximity Switch

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**Battery**

■ TB125




A: Nut Tightening Torque 4.9 N·m (0.5 kgf·m)

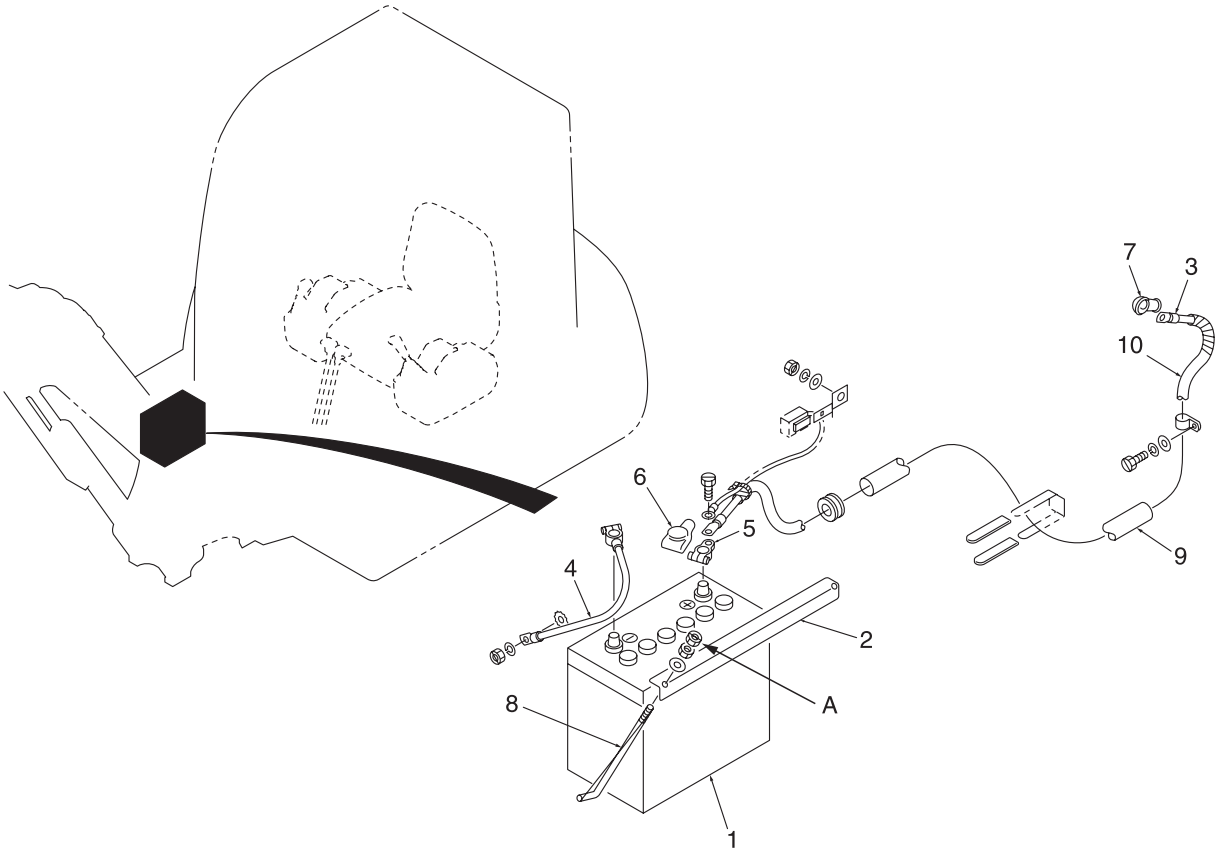
E5C806

1. Battery
2. Angle
3. Cable
4. Cable
5. Terminal
6. Cover
7. Cap
8. Bolt
9. Tube
10. Tube

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■ TB135




A: Nut Tightening Torque 4.9 N·m (0.5 kgf·m)

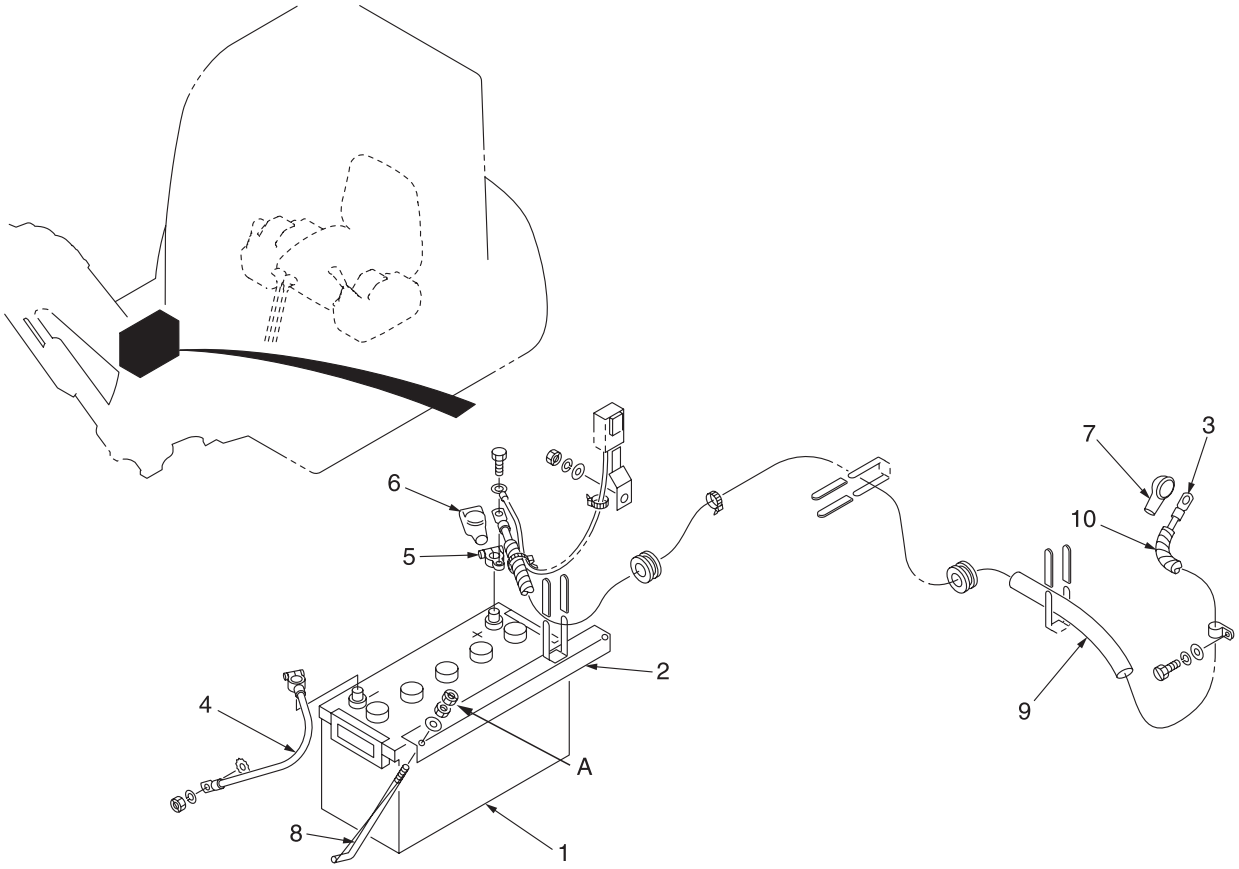
G4C806

1. Battery
2. Angle
3. Cable
4. Cable
5. Terminal
6. Cover
7. Cap
8. Bolt
9. Tube
10. Tube

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■ TB145




A: Nut Tightening Torque 4.9 N·m (0.5 kgf·m)

K3C803

1. Battery
2. Angle
3. Cable
4. Cable
5. Terminal
6. Cover
7. Cap
8. Bolt
9. Tube
10. Tube

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## ENGINE POWER

### Starting the Engine

1. When the key switch is turned on, the electric current from the battery passes through the cartridge type fusible link 65A to terminal B and terminal ACC of the key switch and then flows through the fuse.

   The ACC current through the fuse is applied to terminal ACC of the stop solenoid timer to turn on the stop solenoid relay for one second. The stop solenoid relay turns on the stop solenoid for one second and then turns it off.

   During this one second (while the stop solenoid is ON), the solenoid is switched to the holding circuit to keep the fuel being supplied while the key switch is turned on even when the stop solenoid relay is turned off.

   In addition, the ACC current that passed through the fusible link is also applied to the generator terminal R. The generator terminal R is a device that rectifies the current generated by the generator and adjusts the voltage to 14.5 V.
   The generator terminal L has a feature to detect power generation. When the engine stops with the key switch turned on, this feature will send the engine stop signal (ground signal) to the controller to turn on the charge lamp.
   Before the engine is started, the contact of the engine oil pressure switch is closed. This prompts the engine oil pressure warning signal (ground signal) to be sent to the controller, lighting up the engine oil pressure warning lamp.

2. The start signal from the terminal C of the key switch is applied to the coils through the terminal C of the safety relay. This activates the safety relay to shut terminals B and S, causing the voltage (+12 V) from the battery to be applied to the terminal S of the starter motor through the fusible link and the safety relay. This, in turn, causes the starter motor to start rotating.
   The start signal from the key switch terminal C is also applied to the controller to reset the timer circuit for the air preheater used in cold climates.

3. After the starter motor rotates, the engine starts and its rotational speed increases, and the generator starts generating power. At this time, the power-generating signal from the terminal P of the generator is applied to the terminal P of the safety relay to open the terminals B and S of the safety relay. This prevents the starter motor from overrunning.
   - If the starter switch is inadvertently turned to the start position while the engine is running, the generator signal is applied to the terminal P of the safety relay, turning off the safety relay. Therefore the starter motor will not rotate.
     Meanwhile, approximately 14.5 volts is generated from the terminal B of the generator (generating terminal) to charge the battery.
     Approximately 14.5 volts also is generated from the terminal L (for indicating purposes), sending a signal to the controller to turn off the charge lamp, thereby turning off the charge lamp.
     In addition, because the engine oil pressure increases, opening the contact of the engine oil pressure switch, a signal is sent to the controller to call off the engine oil pressure warning. This turns off the engine oil pressure warning lamp.
     Because the signal to call off the engine oil pressure warning also functions as a signal to activate the hour meter, the hour meter starts operating.

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**Engine Starter Auxiliary Unit (Pre-Heating Circuit)**

1. Operation of the Air Preheater
   In a cold climate, when you keep the key switch in the preheating position, the current from the battery is applied to both the preheater and the controller through the cartridge type fusible link 65 A and the terminals B and R1 of the key switch.
   In the controller, the timer is activated for 15 seconds to illuminate the glow indicator lamp of the cluster gauge for 15 seconds. As soon as the glow indicator lamp goes off after 15 seconds, turn the key switch to the start position at once.
   If the key switch is turned to the start position after maintaining it at the preheating position for less than 15 seconds, the timer in the controller is instantly reset, and the glow indicator lamp immediately goes off.
   The engine stop solenoid circuit also operates the same as when the terminal ACC of the key switch is used. This is because the circuit is simplified and is not an abnormal condition.

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## CLUSTER GAUGE AND CONTROLLER

### Cluster Gauge and Controller

1. Engine emergency stop circuit
   The engine oil pressure switch is used as a sensor. If the engine oil leaks due to a damaged engine oil pan or other cause, the engine oil pressure switch detects the pressure decrease and closes its contact.
   The engine oil pressure switch is connected to the controller's engine emergency stop circuit. This circuit turns off the emergency relay if the engine oil pressure is not restored within 15 seconds after the pressure decrease.
   As a result, the stop solenoid holding current is cut off, causing an emergency stop of the engine.
   At the same time, the emergency lamp of the cluster gauge flashes, and the buzzer sounds.

2. Engine emergency idling circuit
   The coolant temperature switch is used as a sensor. If the engine overheats, the coolant temperature switch closes its contact. The coolant temperature switch is connected to the controller's engine emergency idling circuit.
   This circuit turns on the emergency idling relays 1 and 2 if the coolant temperature switch remains activated for approximately 15 seconds.
   As a result, the decelerating relays 1 and 2 are activated to idle the engine rotation.
   At the same time, the emergency lamp of the cluster gauge flashes, and the buzzer sounds.

3. Second speed holding circuit and second speed indicator lamp
   When the speed switch on the travel lever is pressed once, the signal activates the holding circuit in the control unit installed below the lever stand to the left of the machine to retain the second speed.
   At this time, the second speed lamp of the cluster gauge goes on. When the speed switch is pressed again, the first speed is restored and retained.
   The second speed holding circuit drives the second speed electromagnetic valve by the relay. If the key switch is turned off while the second speed is retained, the second speed holding circuit is reset. When the key switch is turned on again, the first speed is restored. This prevents the engine from racing at the second speed when it is started.
   The holding circuit operates as follows:
   Pressing the second speed switch turns on the second speed relays 1 and 2. As a result, the contact of the second speed relay 1 is grounded, the current flows through the second speed relays 1 and 2 via a diode, and both relays are retained as activated. This excites the second speed solenoid connected to the contact of the second speed relay 1, and the second speed is retained.
   When the second speed switch is pressed again, the plus terminal of the second speed relay 1 is grounded via the contact of the second speed relay, the second speed relay 1 is turned off to open the contact, and the second speed relay 2 is turned off, restoring the initial state. The repetition of these operations constitutes the holding circuit, and a circuit having this function is called a flip-flop circuit.

4. Hour meter
   When the engine starts and the engine oil pressure switch is open, its open signal activates the hour meter drive circuit. The indicator lamp mounted on the hour meter flashes every two seconds.

5. Coolant temperature gauge
   The resistance of the coolant temperature sensor mounted on the engine is converted to the temperature and is displayed. In general, if the value is within the green range, it is normal.

6. Coolant temperature warning lamp
   The coolant temperature switch is used as a sensor. If the engine overheats, the coolant temperature switch closes the contact, the warning lamp is activated, and the buzzer sounds.The engine emergency idling circuit is also activated.

7. Cluster illumination lamp
   When the light switch on the control panel R is turned on, the panel illuminating lamp in the cluster gauge goes on.

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### Operation of the cluster gauge

1. When the key switch is turned on, the initial check circuit in the controller is actuated to turn on all the lamps of the cluster gauge and to sound the buzzer for about one second.
   - Confirm that all the lamps go on.

2. When about one second has elapsed after turning on the key switch, the lamps (except the charge lamp and the engine oil pressure lamp) go off and the buzzer stops. In this state, the cluster gauge is ready and waits for input. The coolant temperature gauge is also actuated.

3. When the engine is started, the charge lamp and the engine oil pressure warning lamp go off. The hour meter is also actuated and its indicator flashes.

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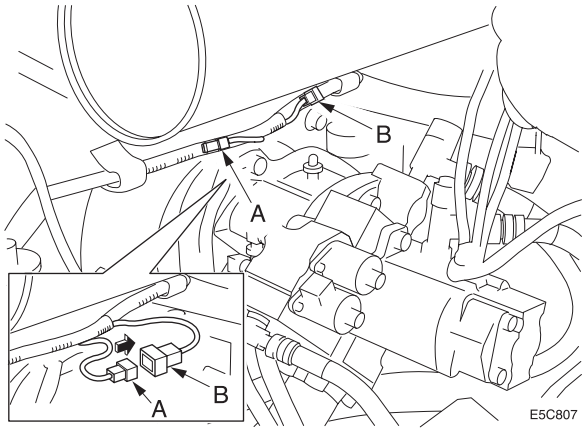


**Miscellaneous circuits relating to the ACC fuse**

**⚠WARNING**

To prevent serious accidents, never use the emergency lever lock release connectors during normal operations.

1. Lever lock circuit (for both cab and canopy types)
   The voltage (+12 V) from the ACC fuse is applied to the lever lock solenoid, through the limit switches R and L for the canopy type or through the limit switch L only for the cab type. During normal operation, the lever lock solenoid is turned on and the current flows. When the lever is locked, the lever lock solenoid is turned off.
   When the lever is locked, the lever lock solenoid turns off. If the lever lock limit switch should malfunction, the attachment is locked.
   If this happens and the attachment must be moved for repairs, this can be done using emergency lever lock release connectors A and B.
   The lever lock release connectors A and B for emergency use are taped on the main harness under the engine muffler. Connecting them will release the lever lock.




2. Water heater circuit (standard for the cab type, optional setting for the canopy type)
   The voltage (+12 V) from the ACC fuse is applied to the water heater unit through the diode that prevents the counterelectromotive force, and the minus terminal is grounded through the heater switch of the control panel L. The heater switch can be set to two stages for controlling the air volume of the heater: the first stage provides a small volume and the second stage provides a large volume.

3. Light circuit (for both cab and canopy types)
   The voltage (+12 V) from the ACC fuse is applied to the boom light, taillight and the illumination lamp of the cluster gauge through the light switch.

4. Windshield wiper circuit (for cab type)
   The voltage (+12 V) from the ACC fuse is applied to the windshield wiper motor and windshield washer motor through the windshield wiper and washer switch of the control panel L.

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5. Cigarette lighter socket circuit (for cab type)
   This circuit can be used to light a cigarette or as an optional power outlet. The maximum output is 120 watts.

6. Maintenance light socket circuit (for all models of European specifications)
   This circuit is a power socket for connecting a maintenance light. The maximum output is 60 watts.

7. Radio circuit (for cab type)
   The voltage (+12 V) from the ACC fuse is directly applied to the radio.

8. Travel alarm circuit (For all models: optional feature to be selected before shipment from the factory)
   The voltage (+12 V) from the ACC fuse is applied to the travel alarm relay through the travel alarm proximity switches (R) and (L) to activate the travel alarm buzzer.

9. Lift alarm sensor circuit (optional)
   When lifting loads using a boom, a load exceeding the stipulated weight may cause the lift to lose its balance and overturn. However, if the lift alarm sensor circuit is switched on, a horn will automatically sound when you attempt to lift a load that is too heavy, warning of the danger of the lift overturning.
   In usual excavating operations, this circuit should be switched off.

10. Auxiliary circuit
    If you press the push button switches A and B on the left control lever, you will be able to turn the circuit breaker and other auxiliary circuits on and off at your fingertips. The voltage (+12 V) from the ACC fuse is applied to the auxiliary relay through the push button switches on the left control lever to activate the solenoid valve of the auxiliary circuit.

11. Air conditioning circuit (for model TB145: optional feature to be selected before shipment from the factory)
    The voltage (+12 V) from the ACC fuse of 30 A is applied to the power terminal of the air conditioning unit.

**Miscellaneous circuits relating to the B+ fuse**

The circuits that cannot be turned off by the key switches are as follows:

1. Horn circuit
   The voltage (+12 V) from the B+ fuse is applied to the horn relay through the horn switch set on the control lever (R) to activate the horn.

2. Room light circuit (for cab type)
   The voltage (+12 V) from the B+ fuse is applied to the room light mounted on the cab.

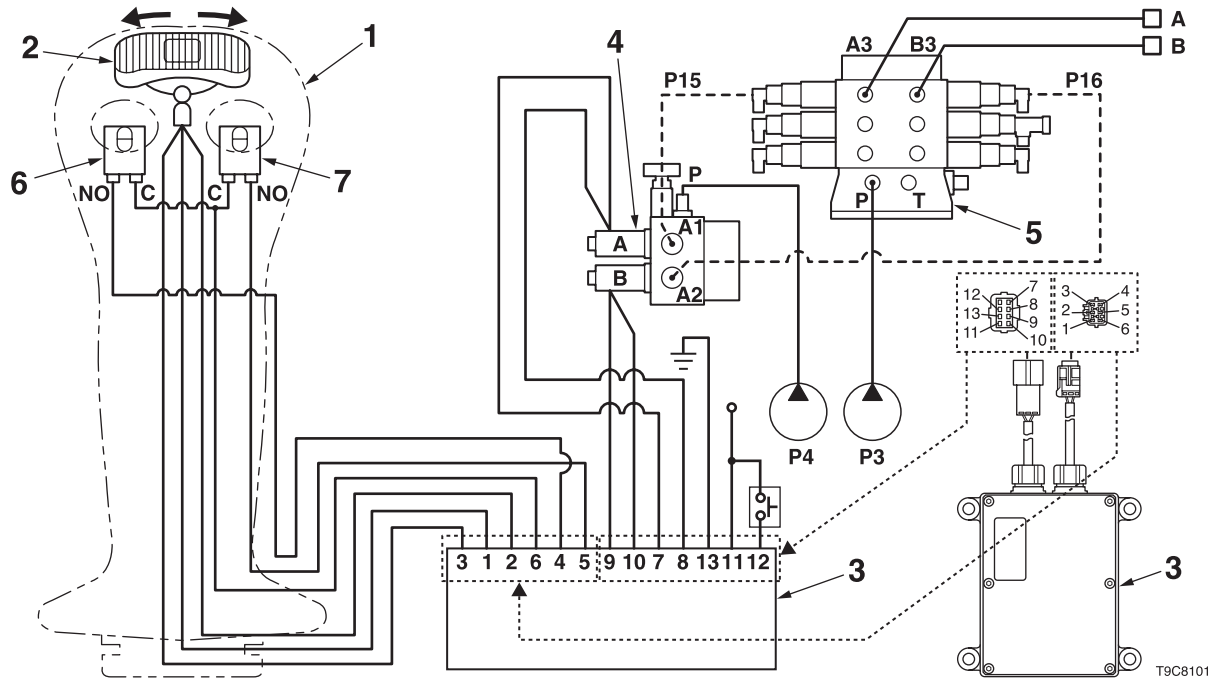
3. Radio circuit (for cab type)
   The voltage (+12 V) from the B+ fuse is applied to the station select memory circuit of the radio mounted on the cab. It also drives the clock mounted on the radio.

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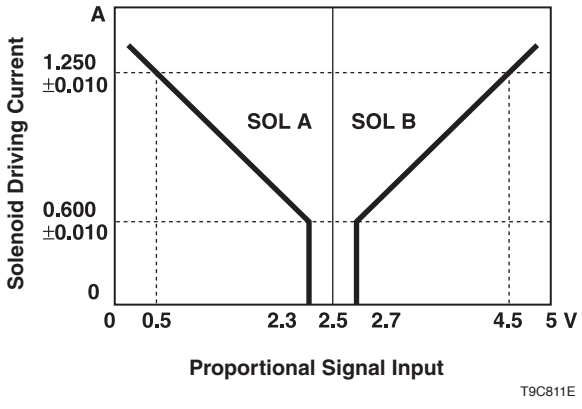


## PROPORTIONAL CONTROL

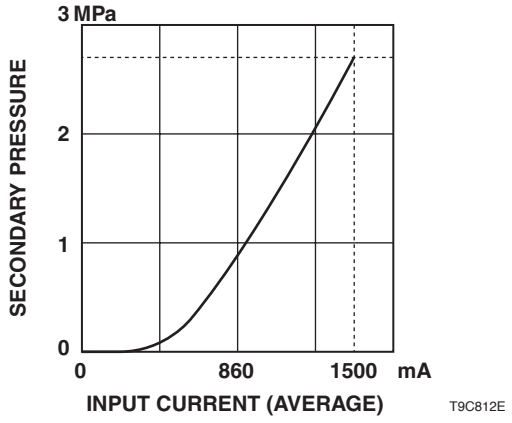
The driving current flowing through the proportional control solenoid valve (4) is controlled by the proportional control lever (2) of the left pilot valve (1) and the proportional controller (3), and the flow rate of the auxiliary piping is changed by the proportional control solenoid valve (4) controlling the pilot pressure of the control valve [auxiliary] (5).




By using the built-in current limiting circuit (PWM control), the proportional controller (3) controls the driving current of solenoids A and B of the proportional control solenoid valve (4) in response to the proportional signals input by the tilted proportional control lever (2), based on the driving current control diagram.



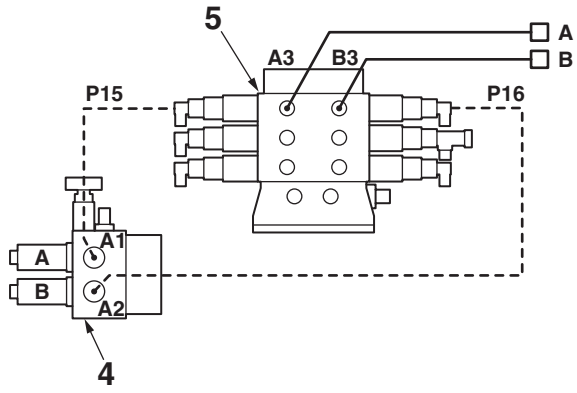

The force to move the spools of solenoids A and B is proportional to the driving current through the coil, thus the secondary pressure from ports A1 and A2 that are proportional to the driving current can be output, as shown in the figure.



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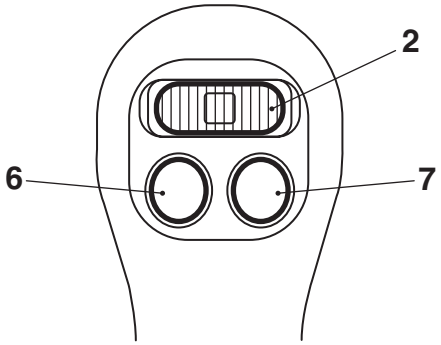


The secondary pressure from ports A1 and A2 enters the pilot port of the control valve [auxiliary] (5) to control the spool. Therefore, the desired flow rate of the auxiliary piping can be achieved by operating the proportional control lever (2) at certain angles.




T9C813

When button (6) or (7) of the left pilot valve is pressed, the maximum driving current can be output for the proportional control solenoid valve (4), despite the size of the signals input by the proportional control lever (2). Pressing button (6) outputs the maximum driving current for solenoid valve A. Pressing button (7) outputs the maximum driving current for solenoid valve B. At that time, the flow rate of the auxiliary piping A or B becomes maximum.



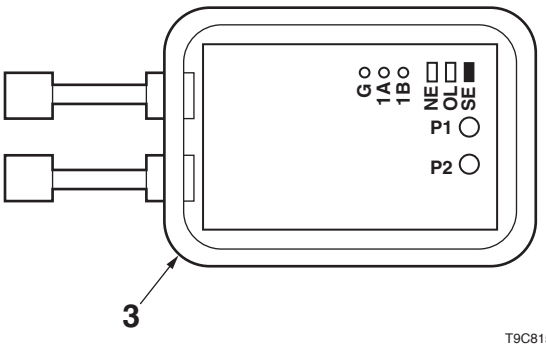

T9C814

**Inspection and Adjustment**

Checking the proportional controller

The proportional controller (3) has a built-in fault detection function, and thus shuts down the solenoid driving current output by the proportional control solenoid valve (4) when any of the events described below is detected. The fault detection function is self-retained until it is reset at power-up after the error has been eliminated.

1. Sensor error
   The proportional signals are continuously monitored with respect to range. When the signal falls outside the operating range due to a wire break or the like, a sensor error is detected. If this occurs, the "SE" LED on the controller lights up.
   - Repair the wiring connected to the proportional control lever (2), or replace the handle assembly of the pilot valve.

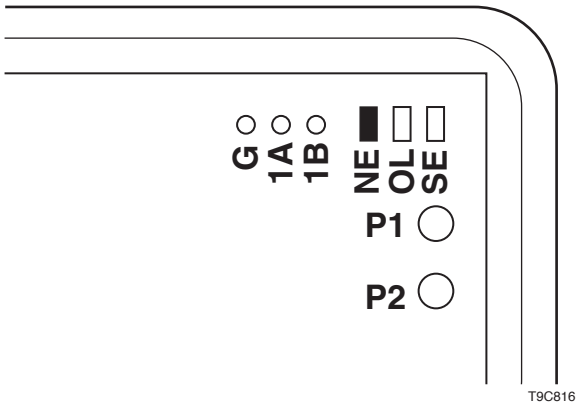



T9C815

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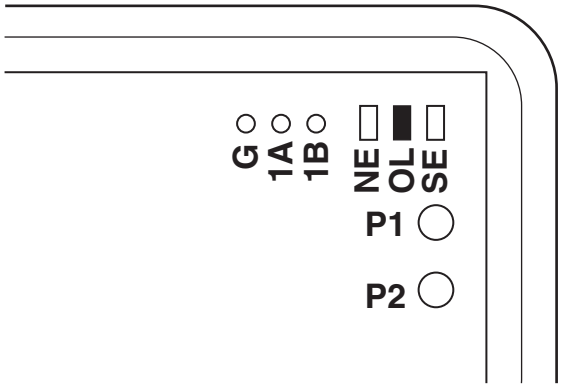


2. Neutral error
   When the solenoid driving current output by the proportional control solenoid valve (4) falls outside the neutral zone for a certain time (1 second) after the power is turned on, a neutral error is detected. If this occurs, the "NE" LED on the controller lights up.
   - Remove any foreign matter from the proportional control lever (2) and clean it, or replace the handle assembly.



T9C816

3. Overcurrent
   When the driving current output by either solenoid valve A or B exceeds the limit due to a short circuit or the like, an overcurrent error is detected. If this occurs, the "OL" LED on the controller lights up.
   - Repair the wiring between the controller and the proportional control solenoid valve A or B.



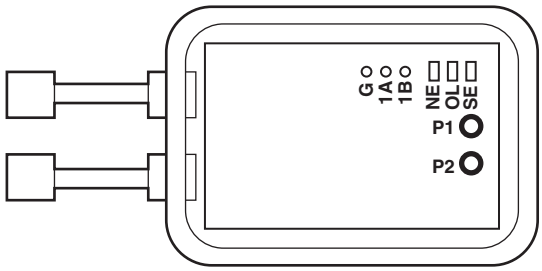
T9C817

### Adjusting the proportional controller

Although the adjusting trimmer is set for the maximum flow rate at the factory, the driving current for the proportional control solenoid valve (4) can be reduced by using the trimmer. Therefore, the flow rate can be controlled and the inching of the auxiliary piping A and B can be improved by dropping the pilot pressure of the control valve (auxiliary) (5).

1. Turn the starter switch on (ACC), and release the lever lock condition.

2. While checking the driving current of the proportional control solenoid valve (4) with the voltage of current monitor terminals G-1A and G-1B, turn trimmers P1 and P2 anticlockwise to reduce the driving current.
   - The driving current (maximum flow rate) is set to 1.25 A at the factory.
   - The relation between the voltage of the current monitor terminal and the driving current is 1 V = 1 A, where the voltage value and current value are equal.
   - The secondary pressure (pilot pressure) of the proportional control solenoid valve (4) drops by approximately 0.27 MPa per 0.1 A.



T9C818

| | Monitor terminal | Trimmer |
|---|---|---|
| Auxiliary piping A | G-1A | P1 |
| Auxiliary piping B | G-1B | P2 |

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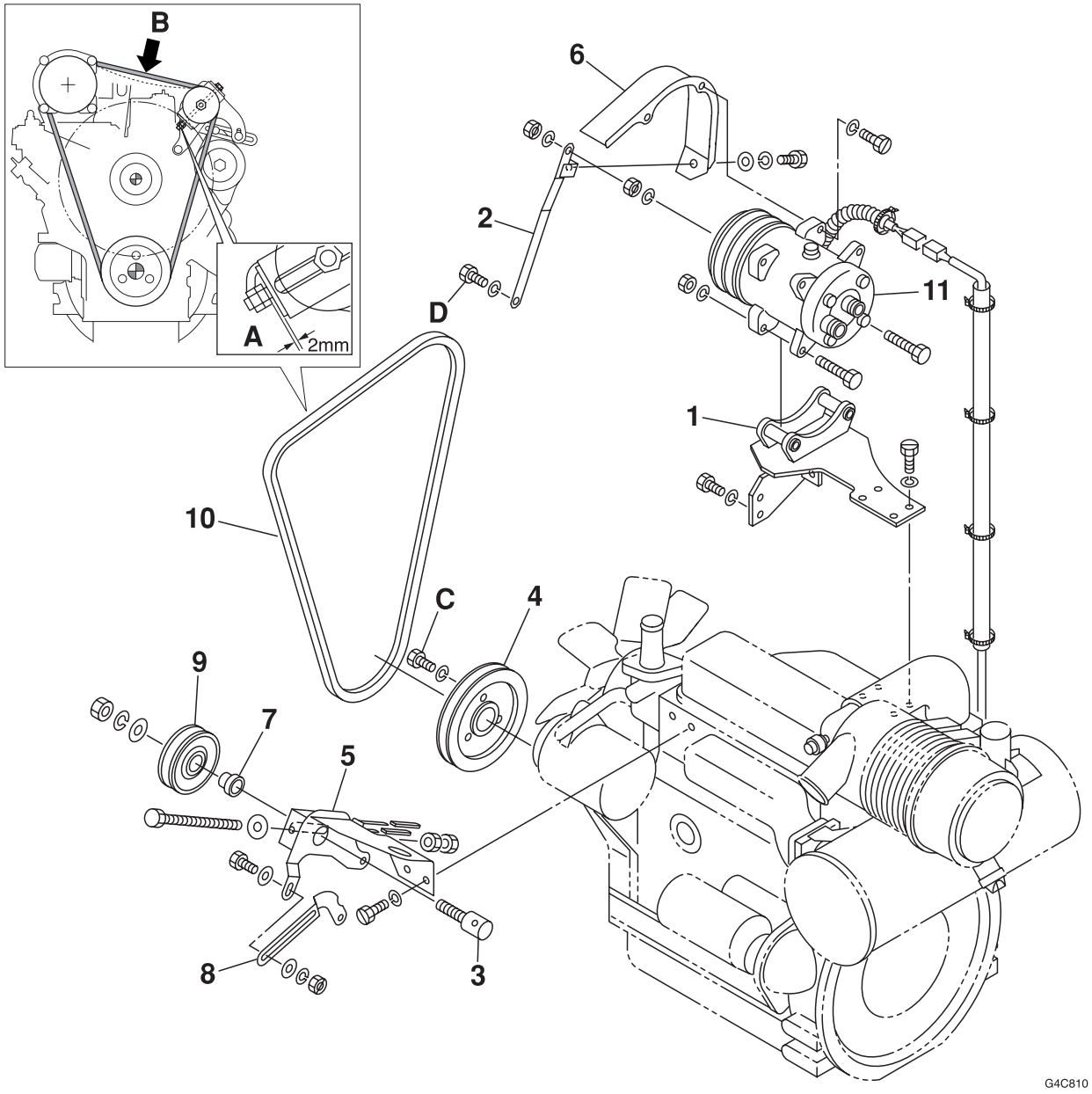


# AIR CONDITIONER SYSTEM

## CONSTRUCTION

### ■ TB135: S/N 13510004~13514050

### Compressor Assembly



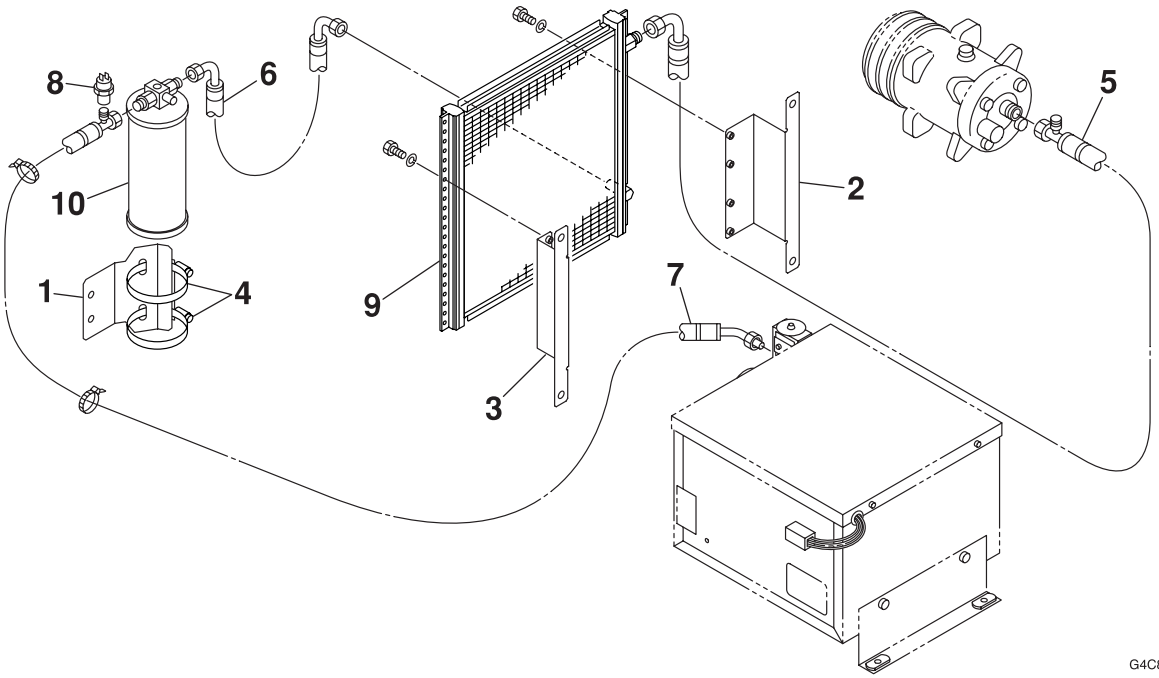

A: Allow a clearance.
B: Press on the center of the belt with a finger. The belt's tension is normal if it bends about 8 mm when pressed with a force of about 98N.
C: 54.9 N·m
D: 19.6 N·m
Apply thread-locking compound.

1. Bracket
2. Support
3. Shaft
4. Pulley
5. Bracket
6. Guard
7. Collar
8. Adjuster
9. Pulley
10. Belt
11. Compressor

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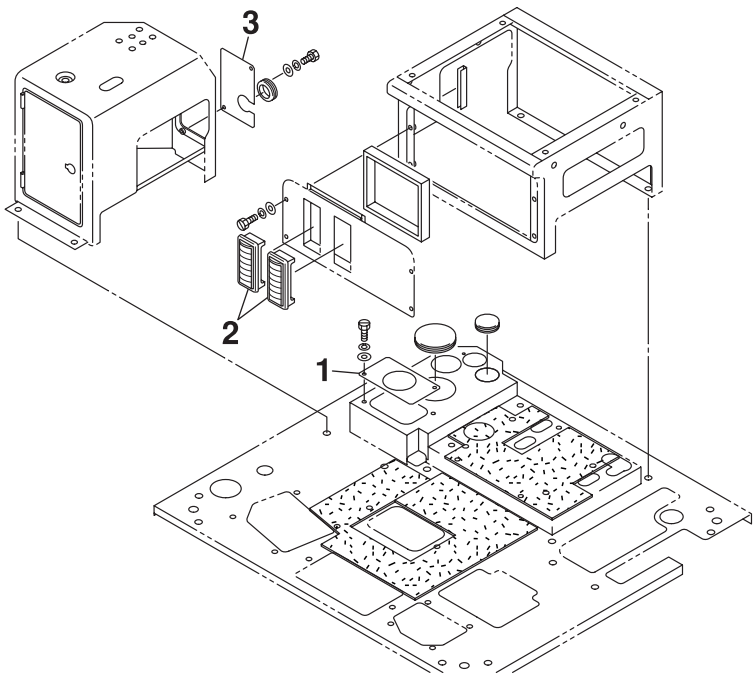


**Condenser Assembly**




1. Bracket
2. Bracket
3. Bracket
4. Bracket
5. Hose
6. Hose
7. Hose
8. Presser Switch
9. Condenser
10. Dryer

**Air Conditioner Unit (1/2)**

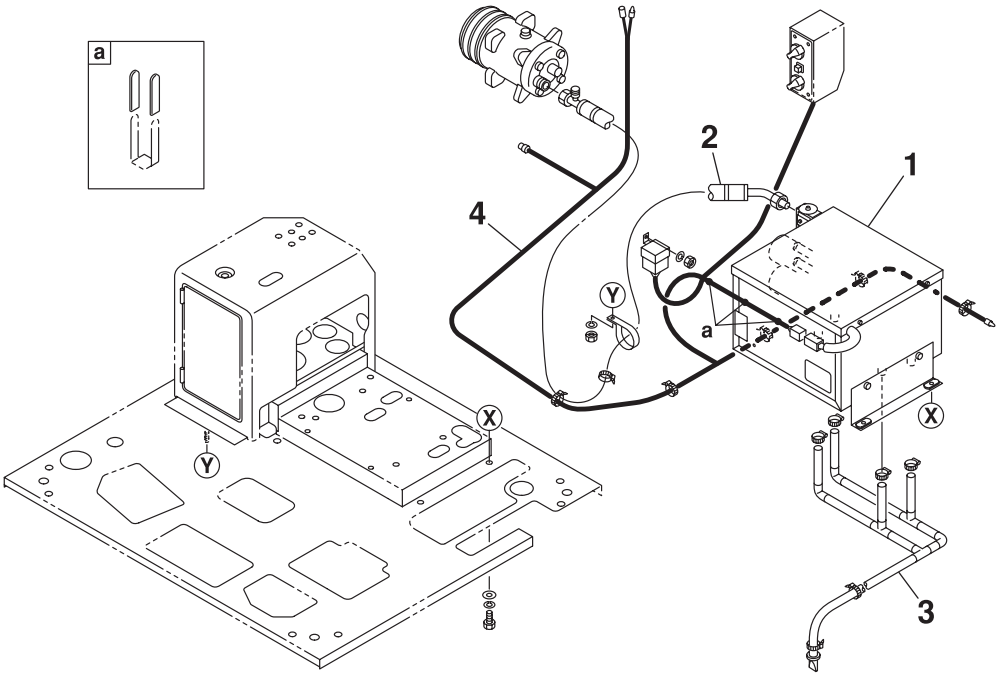



1. Cover
2. Louver
3. Cover

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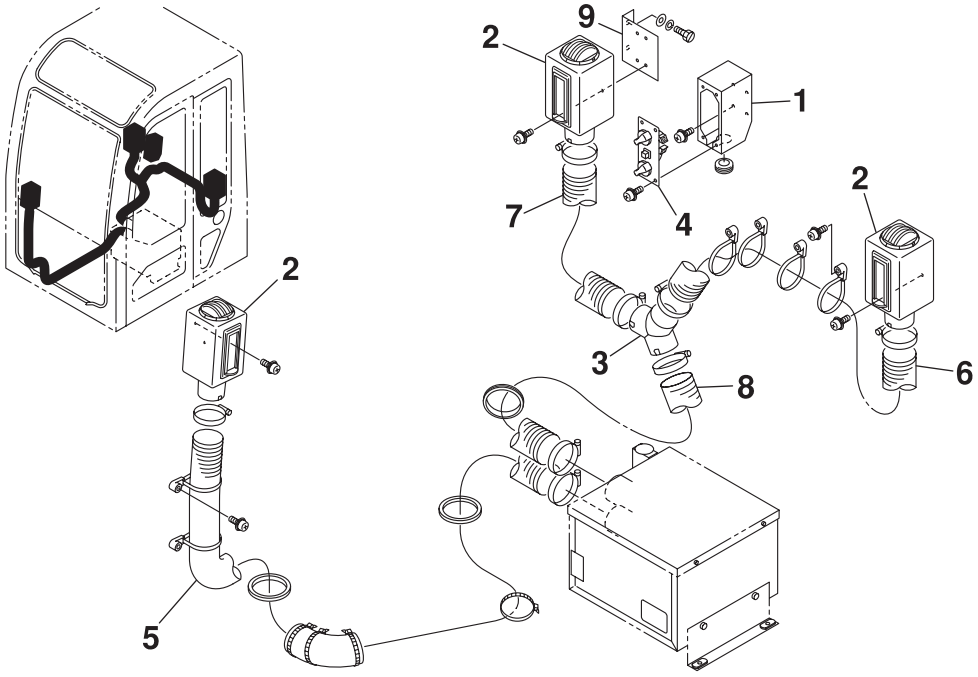


**Air Conditioner Unit (2/2)**




1. Air Conditioner Unit
2. Hose
3. Hose
4. Wire Harness

**Defroster Assembly**

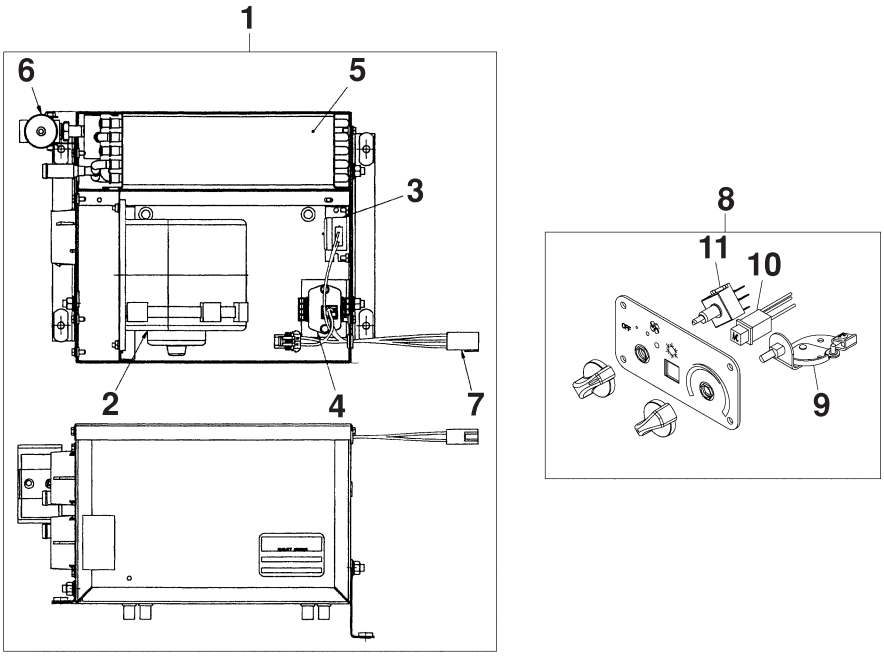



1. Cover
2. Duct
3. Connector
4. Control Panel
5. Hose
6. Hose
7. Hose
8. Hose
9. Bracket

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**Air Conditioner Unit, Control Panel**




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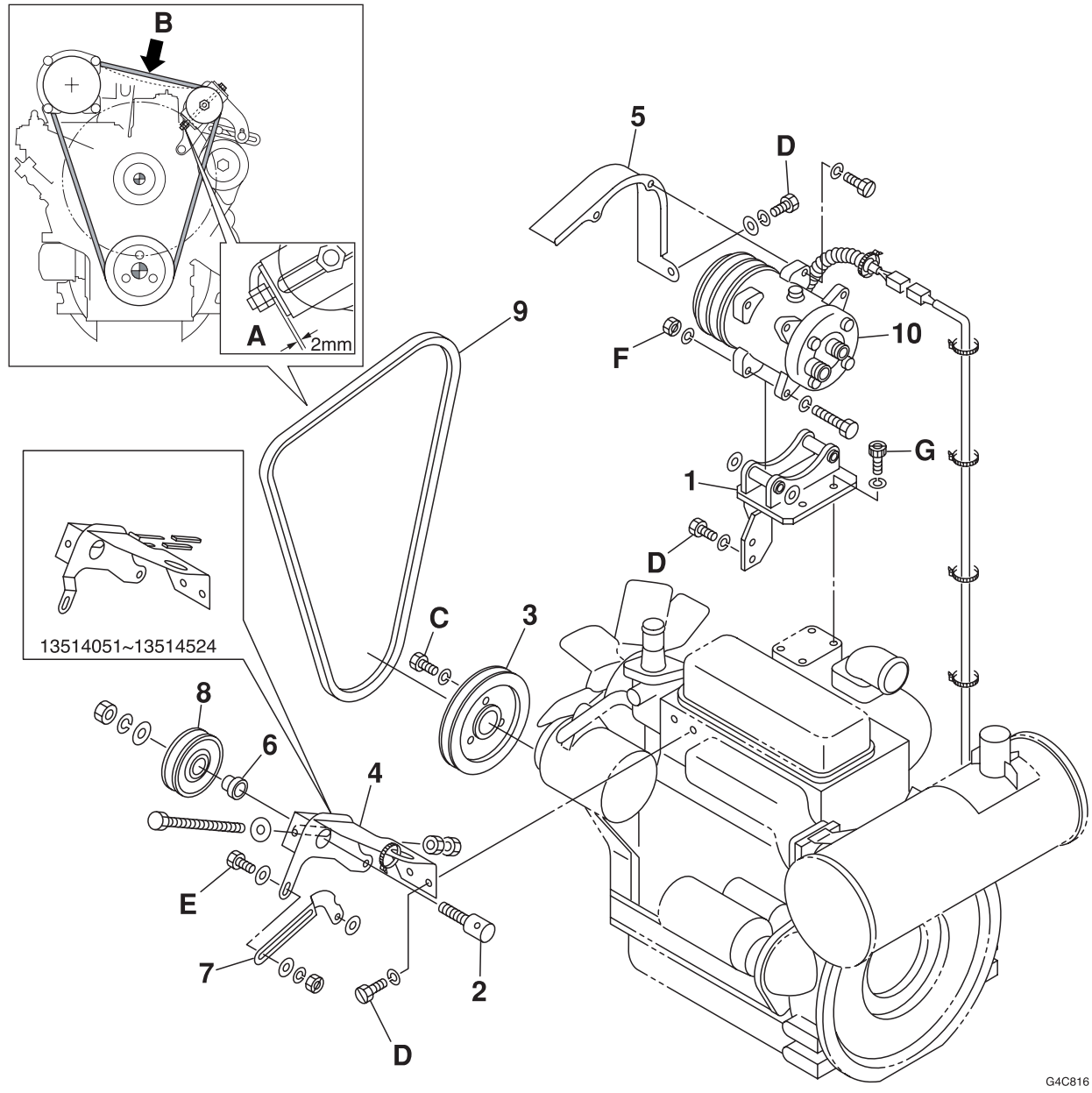
1. Air Conditioner Unit
2. Motor Assembly
3. Thermostat
4. Resistor
5. Core
6. Valve
7. Wire Harness
8. Control Panel
9. Control Cable
10. Switch
11. Rotary Switch

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## ■ TB135: S/N 13514051~

### Compressor Assembly



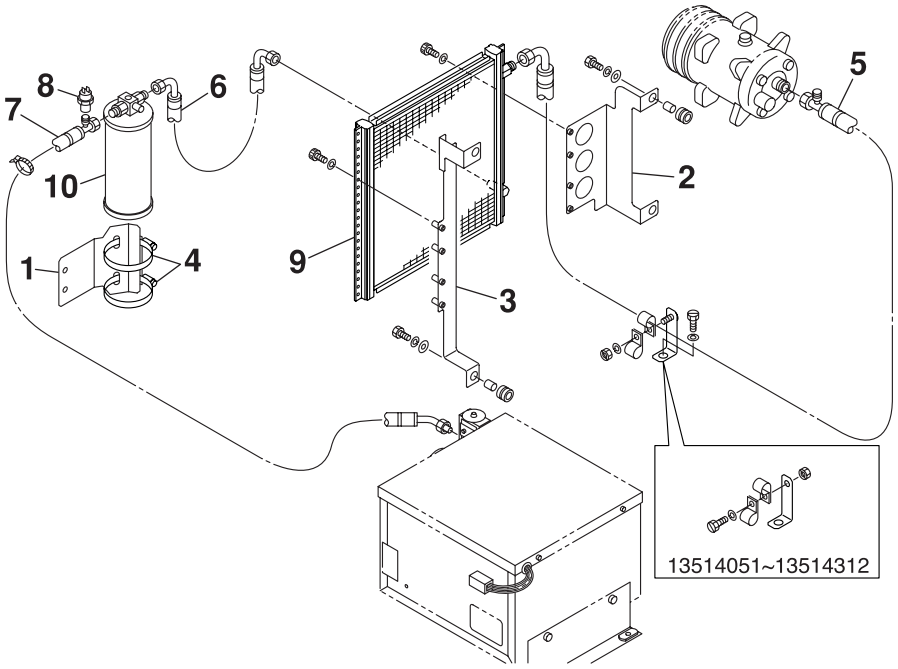

A: Allow a clearance.
B: Press on the center of the belt with a finger. The belt's tension is normal if it bends about 8 mm when pressed with a force of about 98N.
C: 54.9 N·m
Apply thread-locking compound.
D: 22.5 N·m
E: 19.6 N·m
F: 47.1 N·m
Apply thread-locking compound.
G: 19.6 N·m
Apply thread-locking compound.

1. Bracket
2. Shaft
3. Pulley
4. Bracket
5. Guard
6. Collar
7. Adjuster
8. Pulley
9. Belt
10. Compressor

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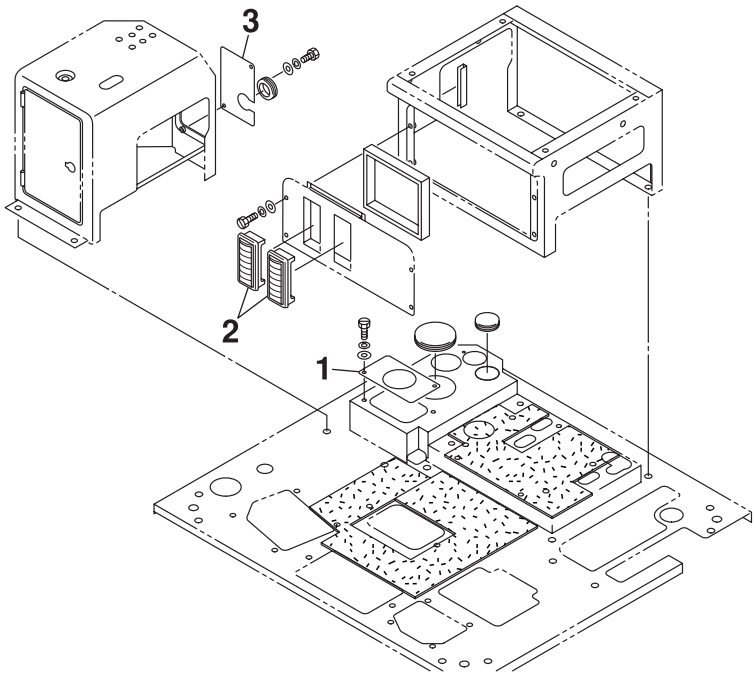


**Condenser Assembly**




1. Bracket
2. Bracket
3. Bracket
4. Bracket
5. Hose
6. Hose
7. Hose
8. Presser Switch
9. Condenser
10. Dryer

**Air Conditioner Unit (1/2)**

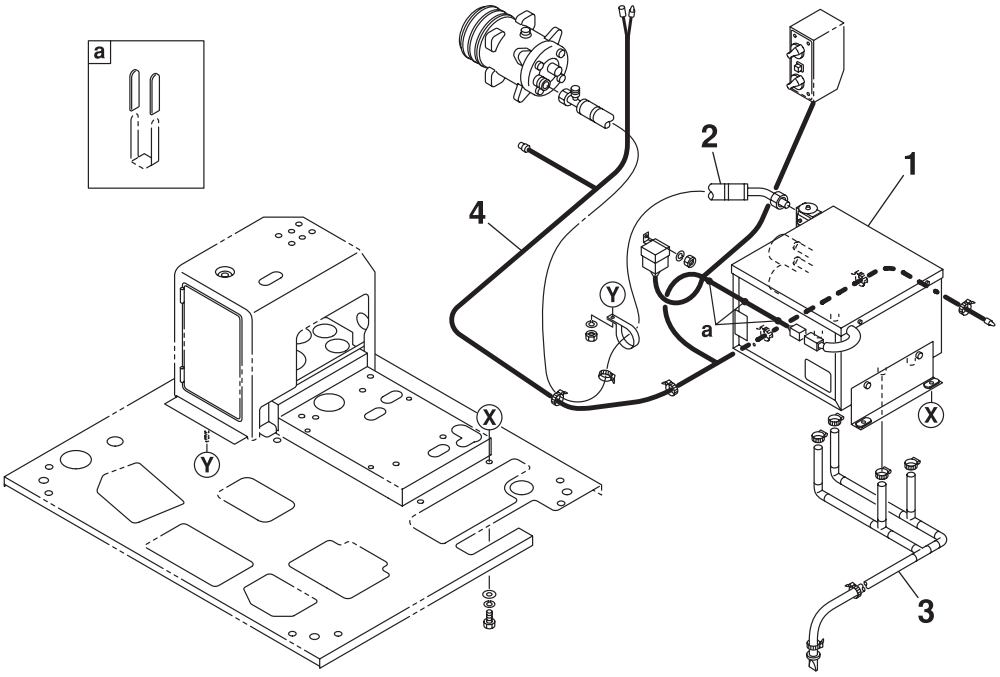



1. Cover
2. Louver
3. Cover

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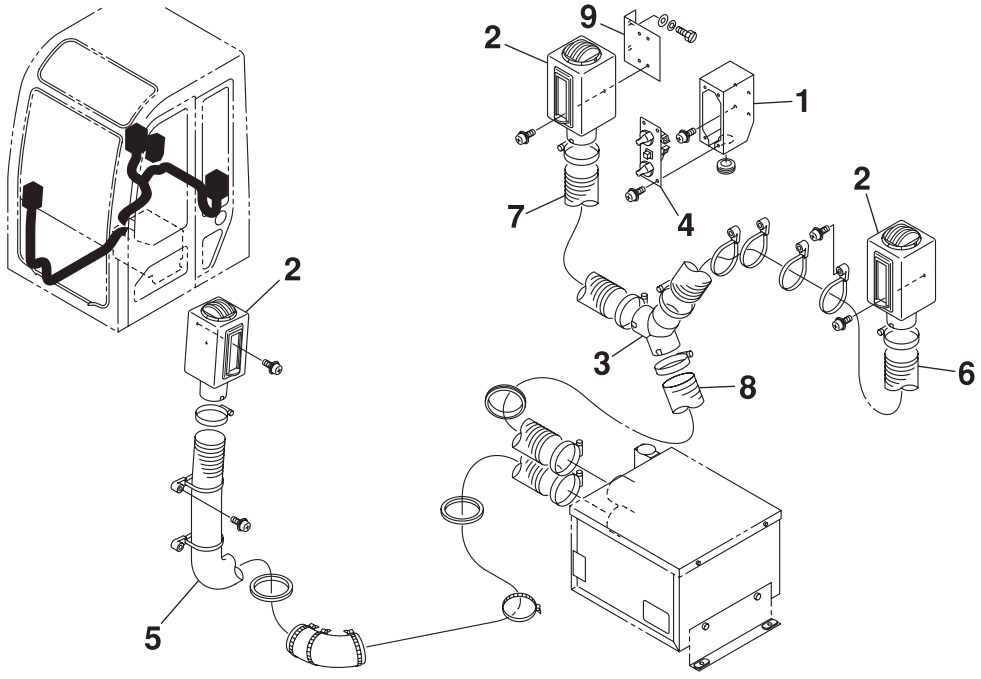


**Air Conditioner Unit (2/2)**




1. Air Conditioner Unit
2. Hose
3. Hose
4. Wire Harness

**Defroster Assembly**

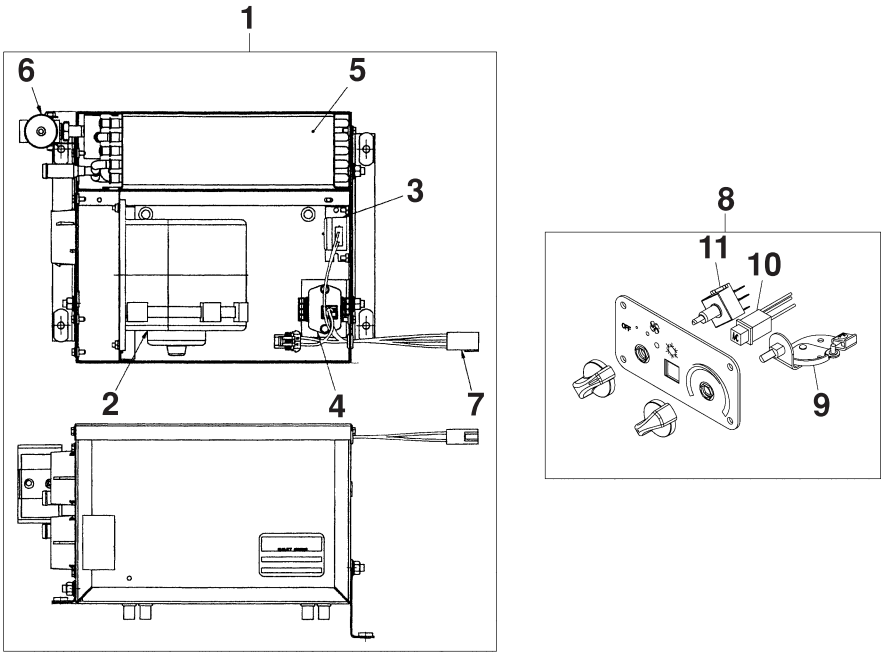



1. Cover
2. Duct Assembly
3. Connector
4. Control Panel
5. Hose
6. Hose
7. Hose
8. Hose
9. Bracket

https://truckmanualshub.com/



**Air Conditioner Unit, Control Panel**




G4C815

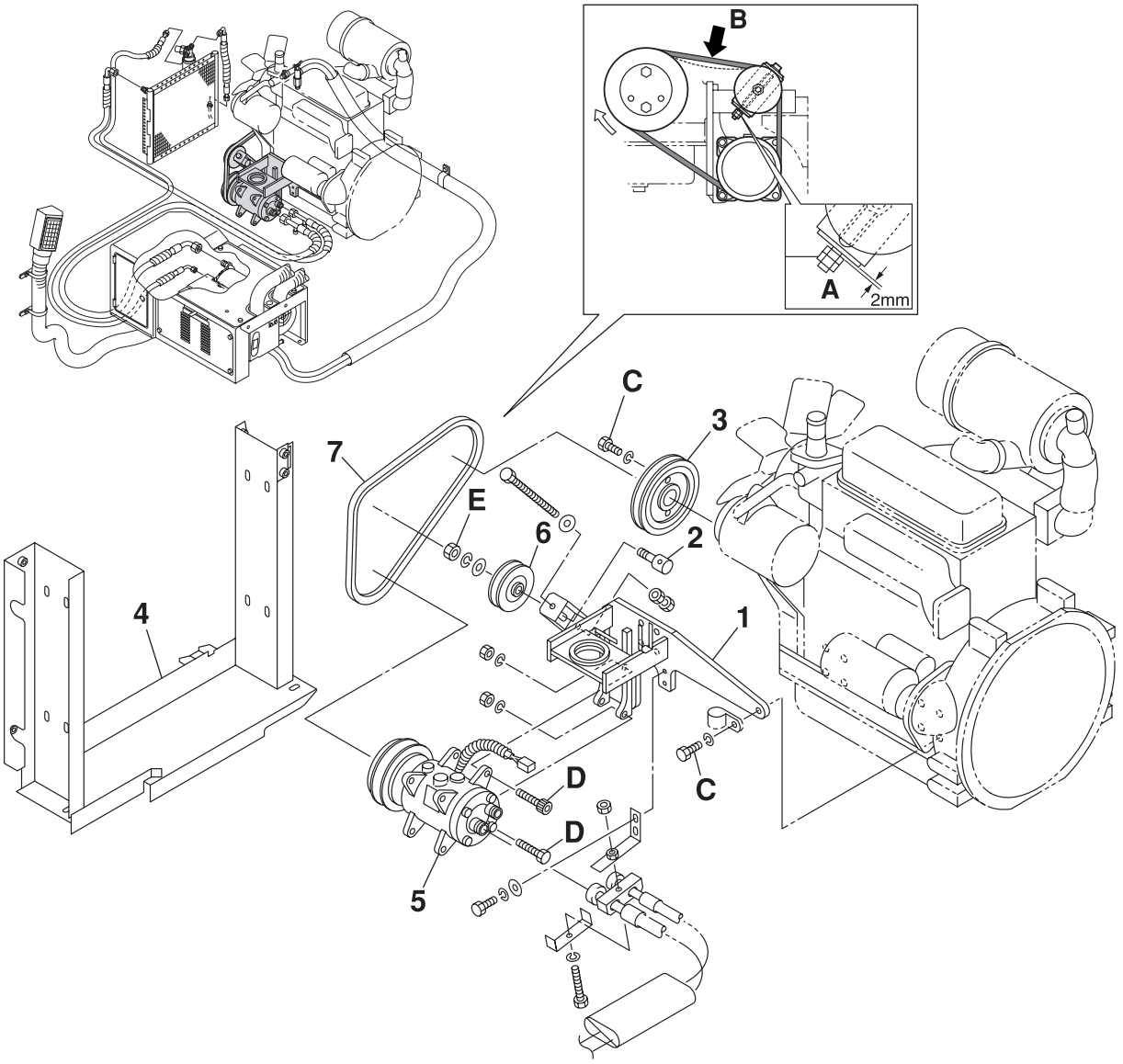
1. Air Conditioner Unit
2. Motor Assembly
3. Thermostat
4. Resistor
5. Core
6. Valve
7. Wire Harness
8. Control Panel
9. Control Cable
10. Switch
11. Rotary Switch

https://truckmanualshub.com/



■ **TB145: S/N 14510004~14511994**

**Compressor Assembly**




K3C805

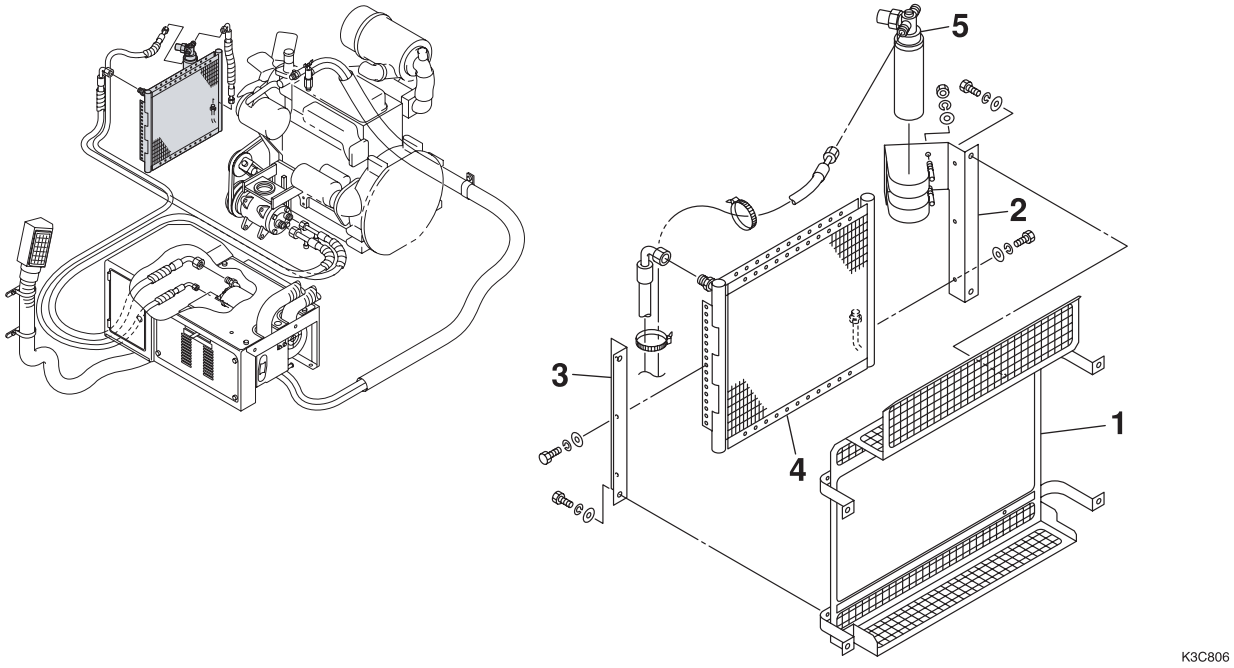
A: Allow a clearance.
B: Press on the center of the belt with a finger. The belt's tension is normal if it bends about 8 mm when pressed with a force of about 98N.
C: ⇔ 54.9 N·m
Apply thread-locking compound.
D: ⇔ 47.1 N·m
Apply thread-locking compound.
E: ⇔ 105.8 N·m

1. Engine Foot
2. Shaft
3. Pulley
4. Bracket
5. Compressor
6. Pulley
7. Belt

https://truckmanualshub.com/

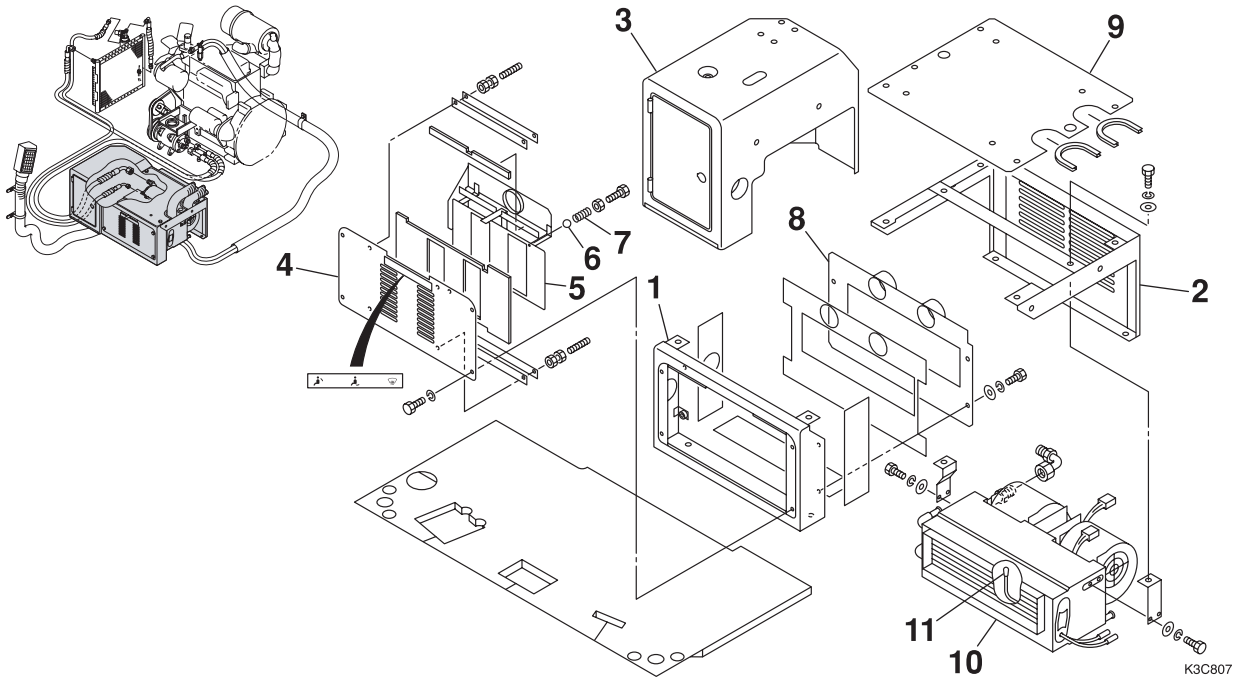


**Condenser Assembly**




1. Cover
2. Bracket
3. Bracket
4. Condenser
5. Dryer

**Air Conditioner Unit (1/4)**

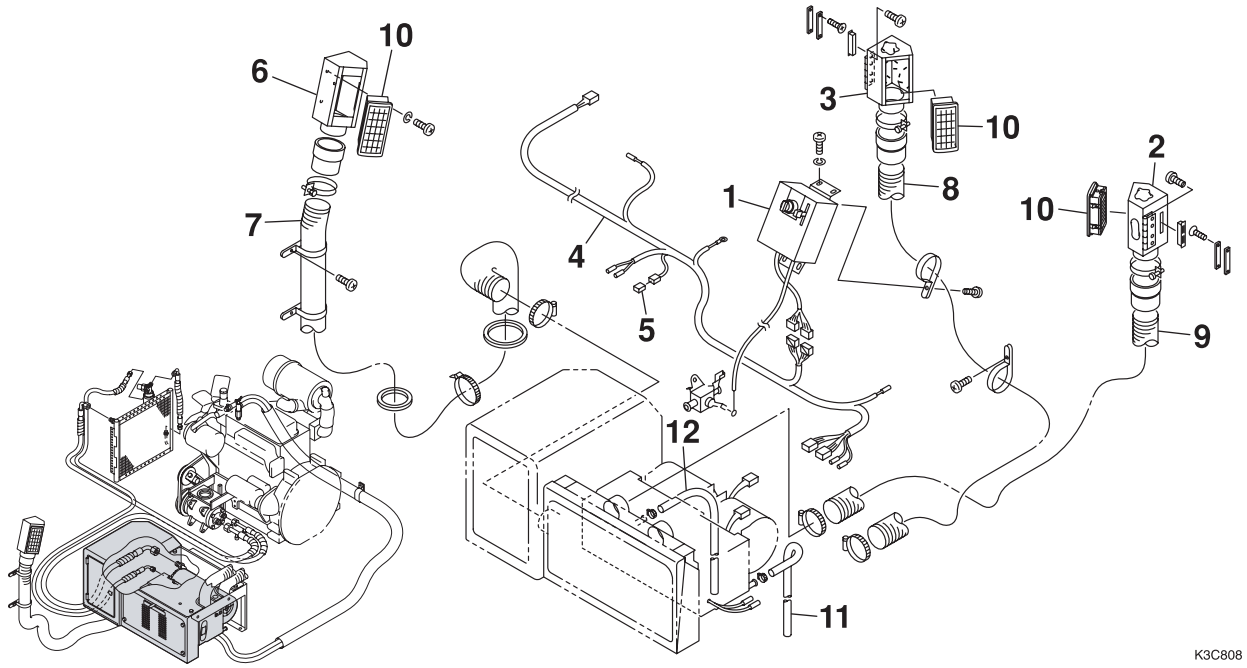



1. Box
2. Box
3. Box
4. Cover
5. Damper
6. Ball
7. Spring
8. Plate
9. Cover
10. Air Conditioner
11. Thermistor

https://truckmanualshub.com/

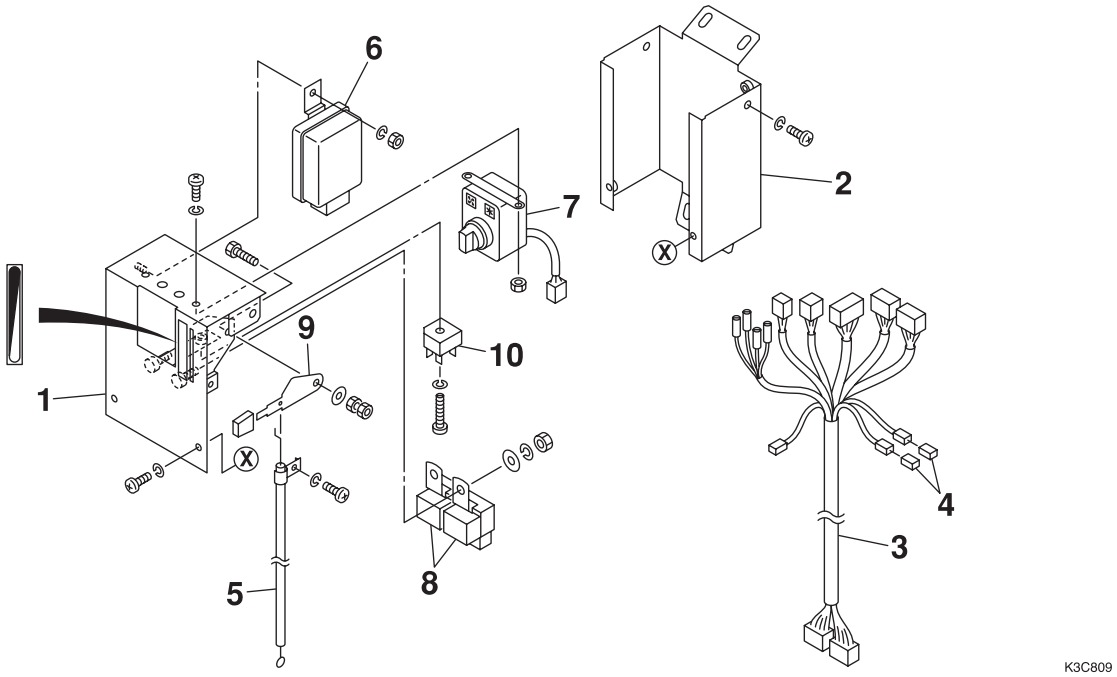


**Air Conditioner Unit (2/4)**




1. Control Assembly
2. Duct
3. Duct
4. Wire Harness
5. Diode
6. Duct
7. Hose
8. Hose
9. Hose
10. Louver
11. Hose
12. Hose

**Air Conditioner Unit (3/4)**

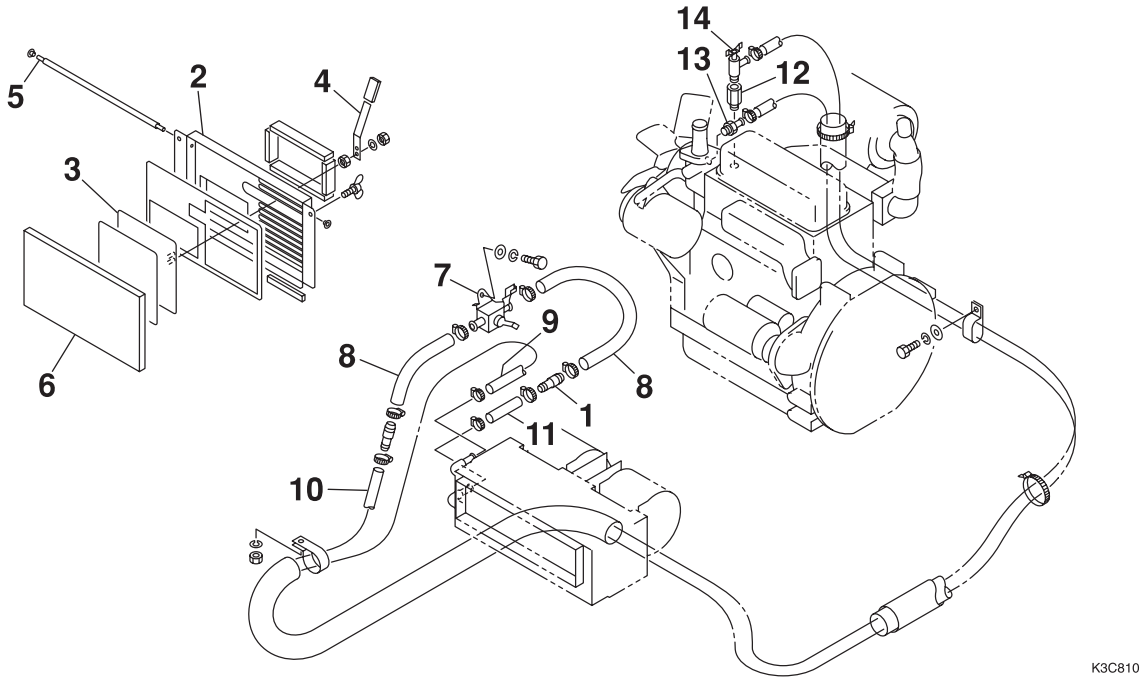



1. Cover
2. Plate
3. Wire Harness
4. Diode
5. Wire
6. Thermostat
7. Switch
8. Relay
9. Lever
10. Diode

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**Air Conditioner Unit (4/4)**



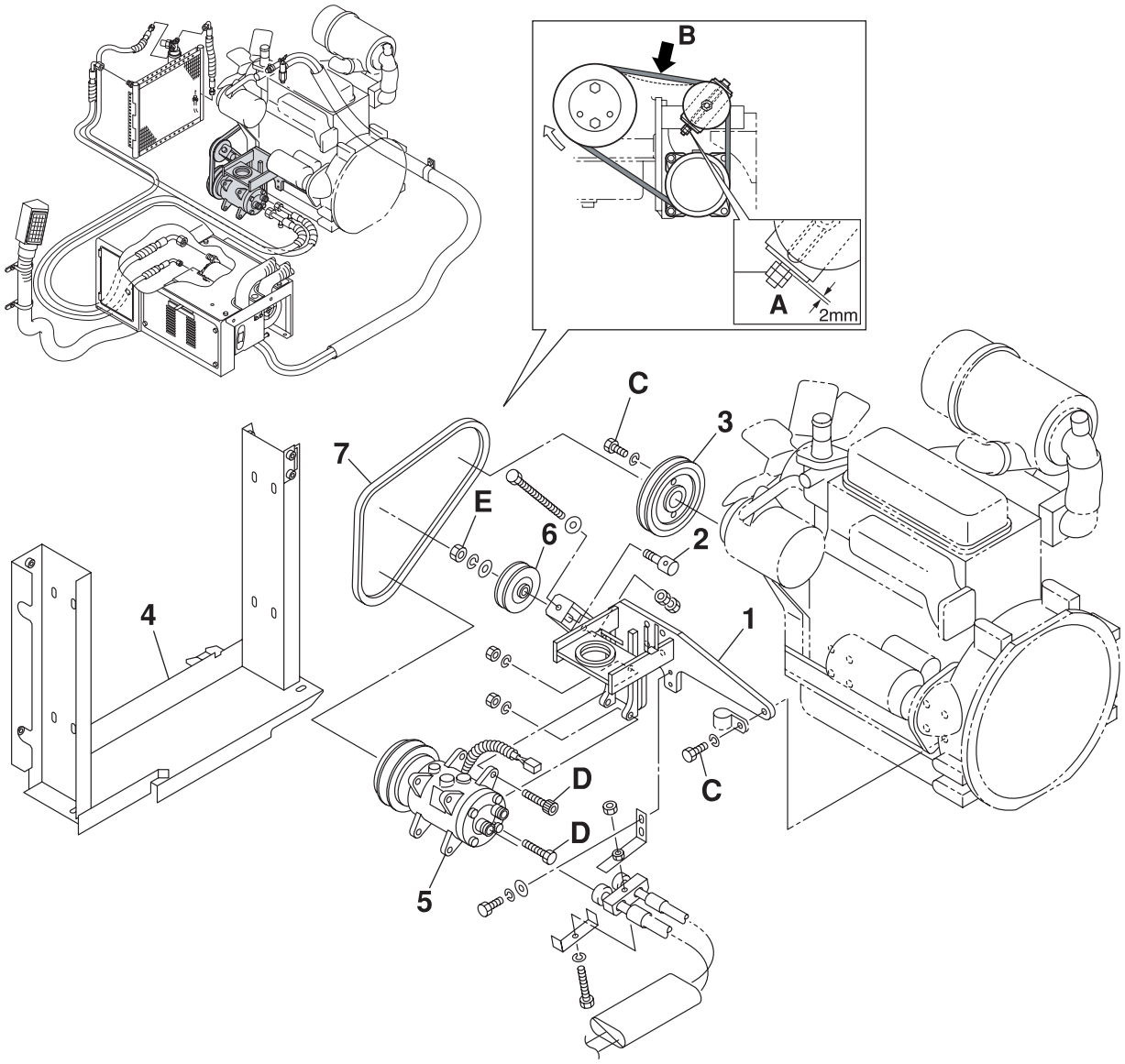

1. Joint
2. Cover
3. Plate
4. Lever
5. Boss
6. Filter
7. Valve
8. Hose
9. Hose
10. Hose
11. Hose
12. Bushing
13. Nipple
14. Valve

https://truckmanualshub.com/



■ **TB145: S/N 14511995~14512894**

**Compressor Assembly**




K3C811

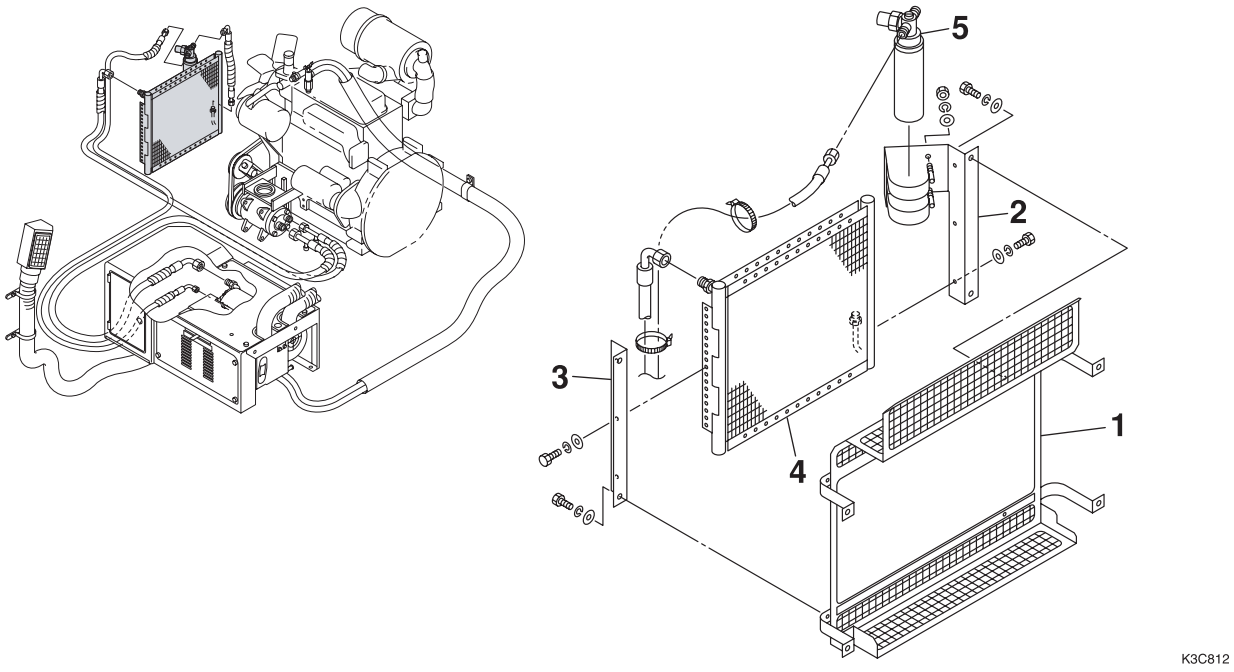
A: Allow a clearance.
B: Press on the center of the belt with a finger. The belt's tension is normal if it bends about 8 mm when pressed with a force of about 98N.
C: 54.9 N·m
Apply thread-locking compound.
D: 47.1 N·m
Apply thread-locking compound.
E: 105.8 N·m

1. Engine Foot
2. Shaft
3. Pulley
4. Bracket
5. Compressor
6. Pulley
7. Belt

https://truckmanualshub.com/

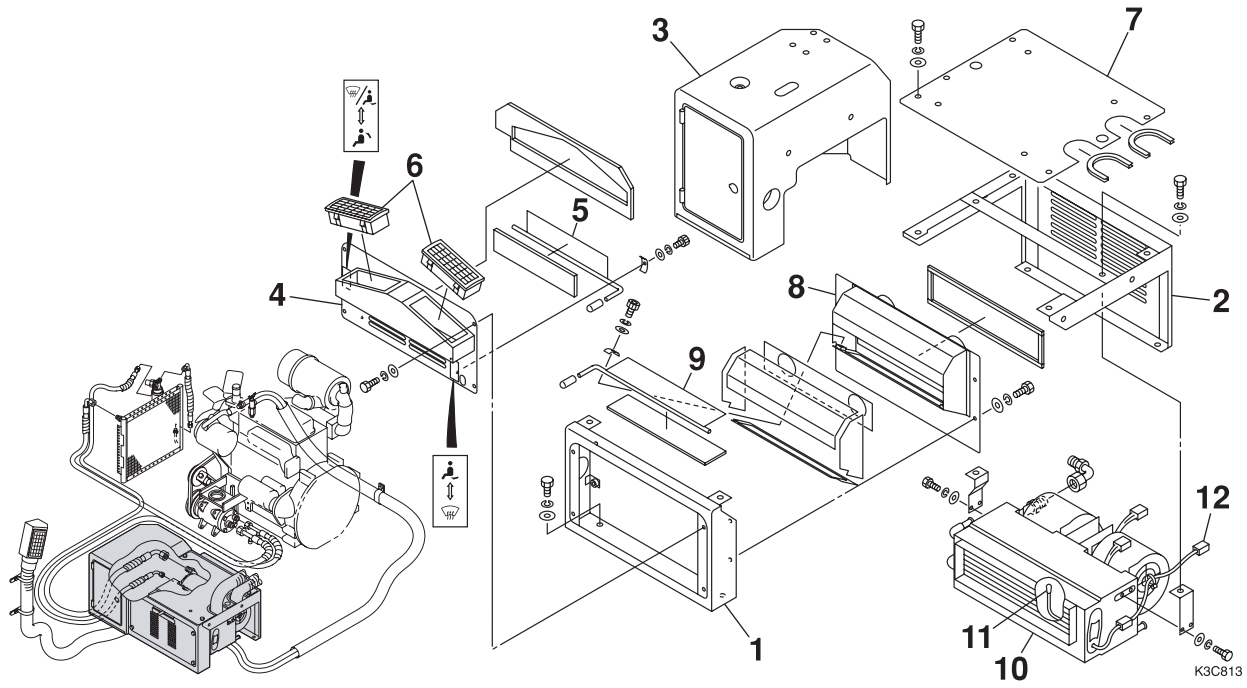


**Condenser Assembly**




1. Cover
2. Bracket
3. Bracket
4. Condenser
5. Dryer

**Air Conditioner Unit (1/4)**

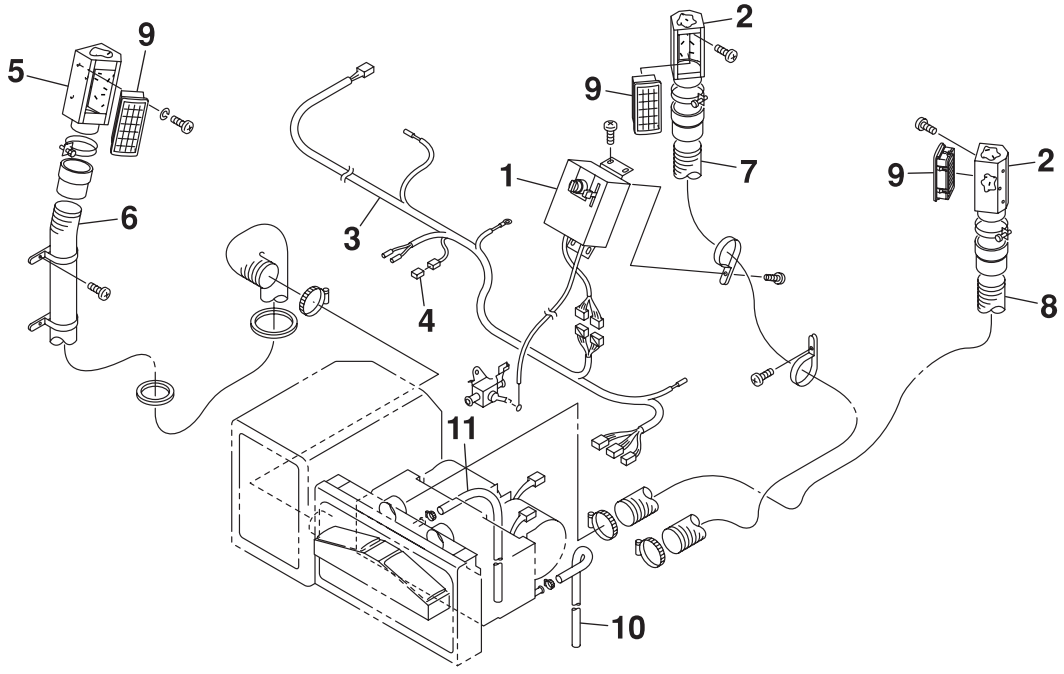



1. Box
2. Box
3. Box
4. Cover
5. Damper
6. Louver
7. Cover
8. Cover
9. Damper
10. Air Conditioner
11. Thermistor
12. Wire Harness

https://truckmanualshub.com/

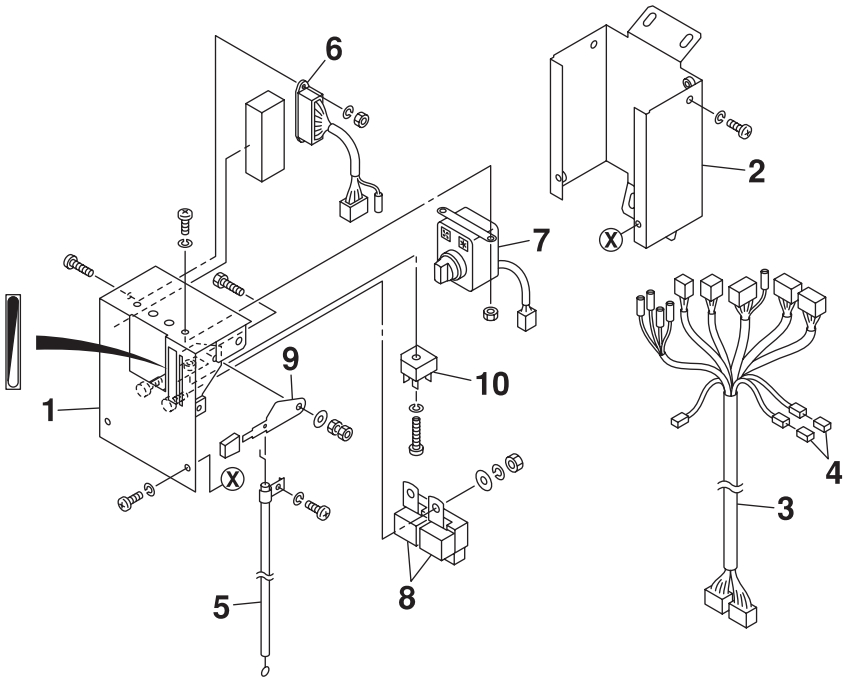


**Air Conditioner Unit (2/4)**




1. Control Assembly
2. Duct
3. Wire Harness
4. Diode
5. Defroster
6. Hose
7. Hose
8. Hose
9. Louver
10. Hose
11. Hose

**Air Conditioner Unit (3/4)**

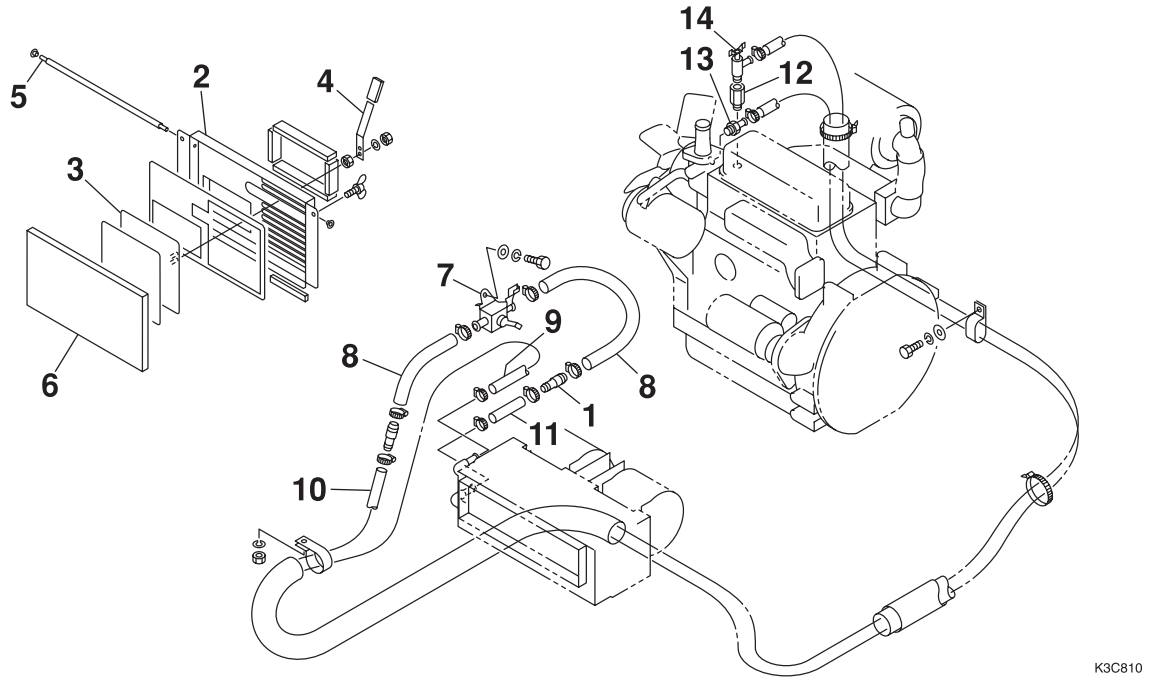



1. Cover
2. Plate
3. Wire Harness
4. Diode
5. Wire
6. Thermostat
7. Switch
8. Relay
9. Lever
10. Diode

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**Air Conditioner Unit (4/4)**



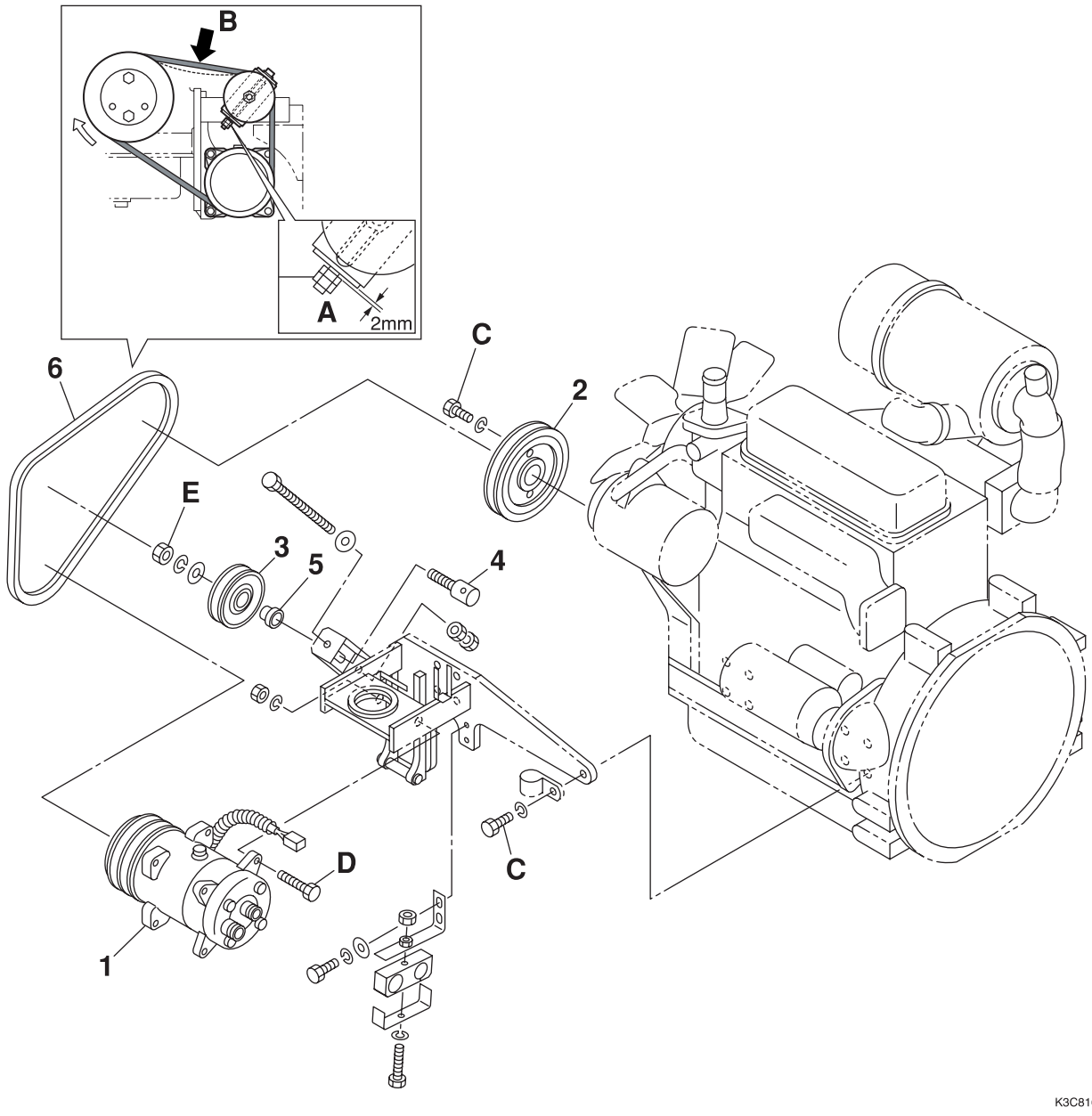

1. Joint
2. Cover
3. Plate
4. Lever
5. Boss
6. Filter
7. Valve
8. Hose
9. Hose
10. Hose
11. Hose
12. Bushing
13. Nipple
14. Valve

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■ **TB145: S/N 14512895~14513260**

**Compressor Assembly**



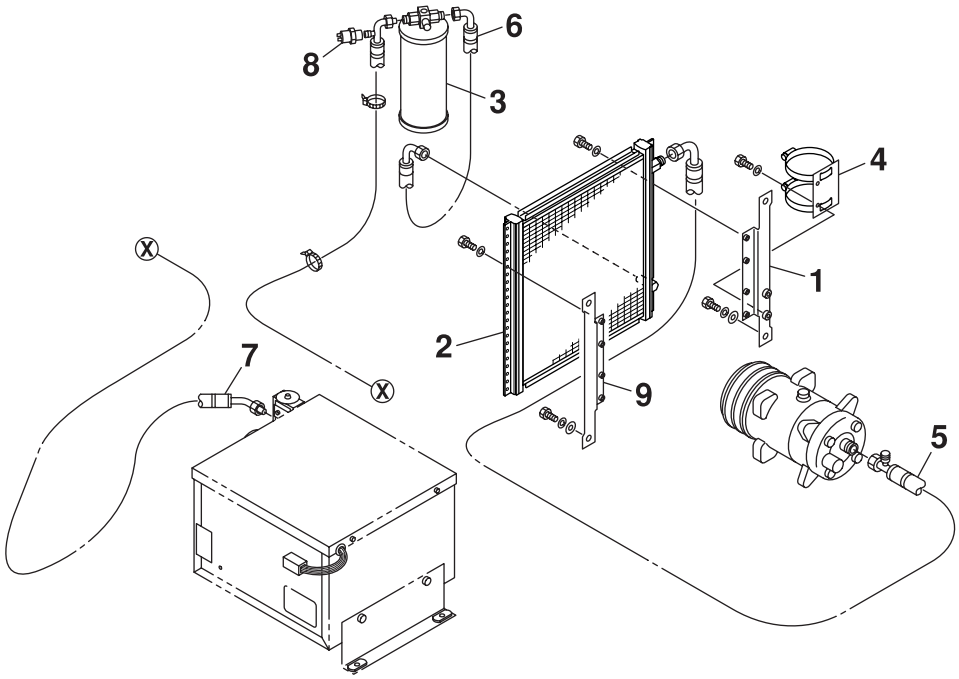

A: Allow a clearance.
B: Press on the center of the belt with a finger. The belt's tension is normal if it bends about 8 mm when pressed with a force of about 98N.
C: 54.9 N·m
Apply thread-locking compound.
D: 47.1 N·m
Apply thread-locking compound.
E: 105.8 N·m

1. Compressor
2. Pulley
3. Pulley
4. Shaft
5. Collar
6. Belt

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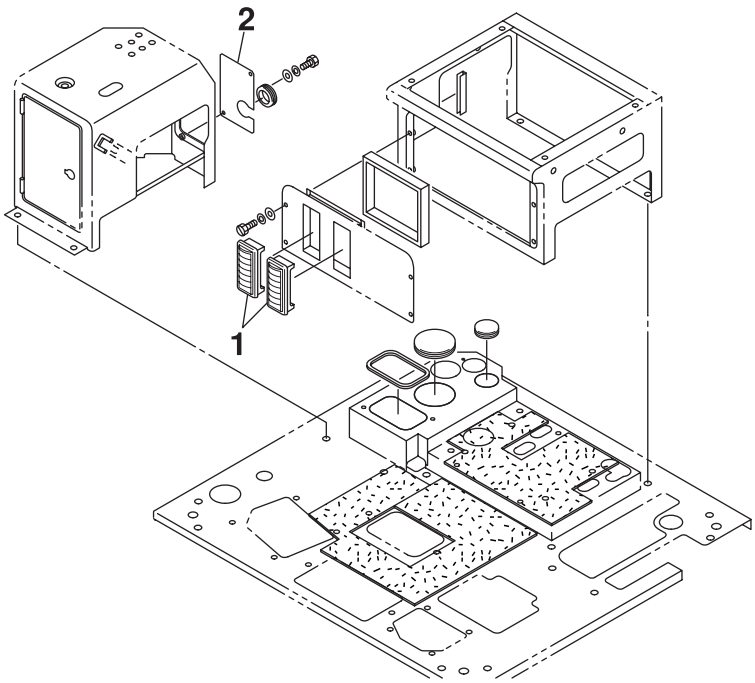


**Condenser Assembly**




1. Bracket
2. Condenser
3. Dryer
4. Bracket
5. Hose
6. Hose
7. Hose
8. Presser Switch
9. Bracket

**Air Conditioner Unit (1/4)**

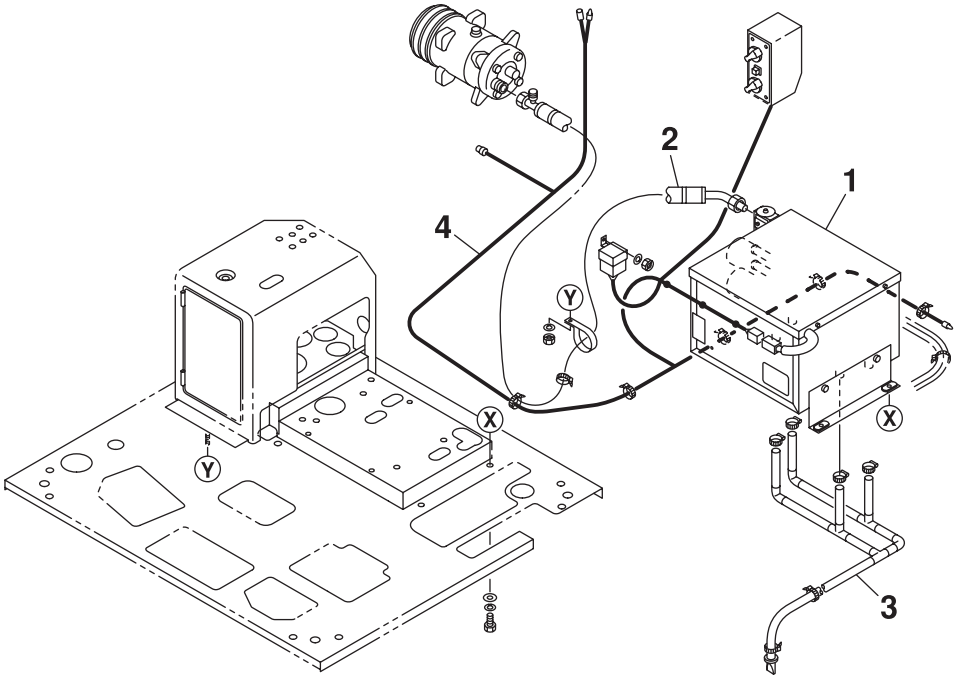



1. Louver
2. Cover

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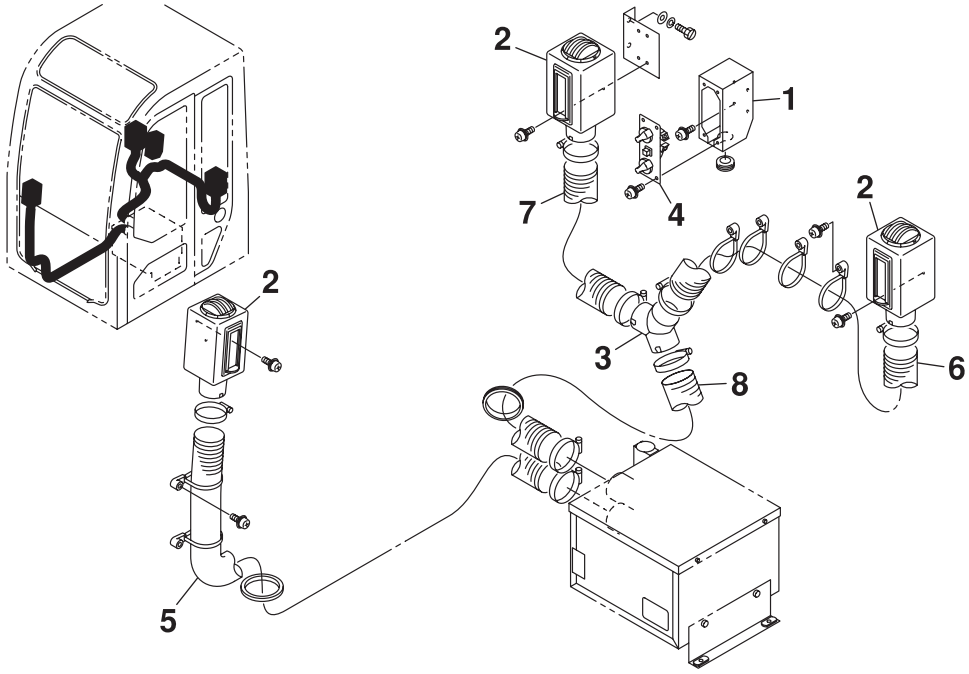


**Air Conditioner Unit (2/4)**




1. Air Conditioner unit
2. Hose
3. Hose
4. Wire Harness

**Air Conditioner Unit (3/4)**

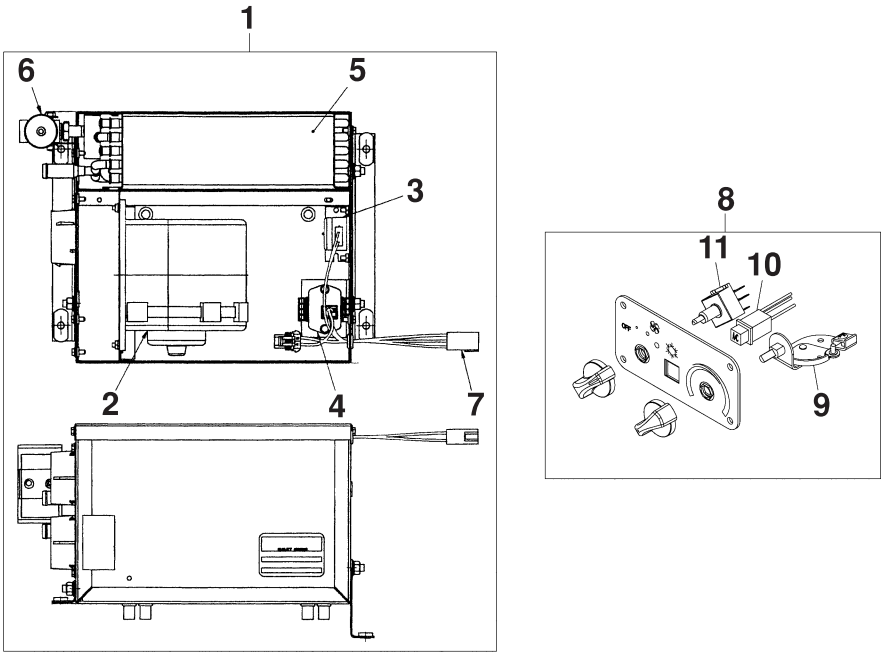



1. Cover
2. Duct
3. Connector
4. Control Panel
5. Hose
6. Hose
7. Hose
8. Hose

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**Air Conditioner Unit, Control Panel**




G4C815

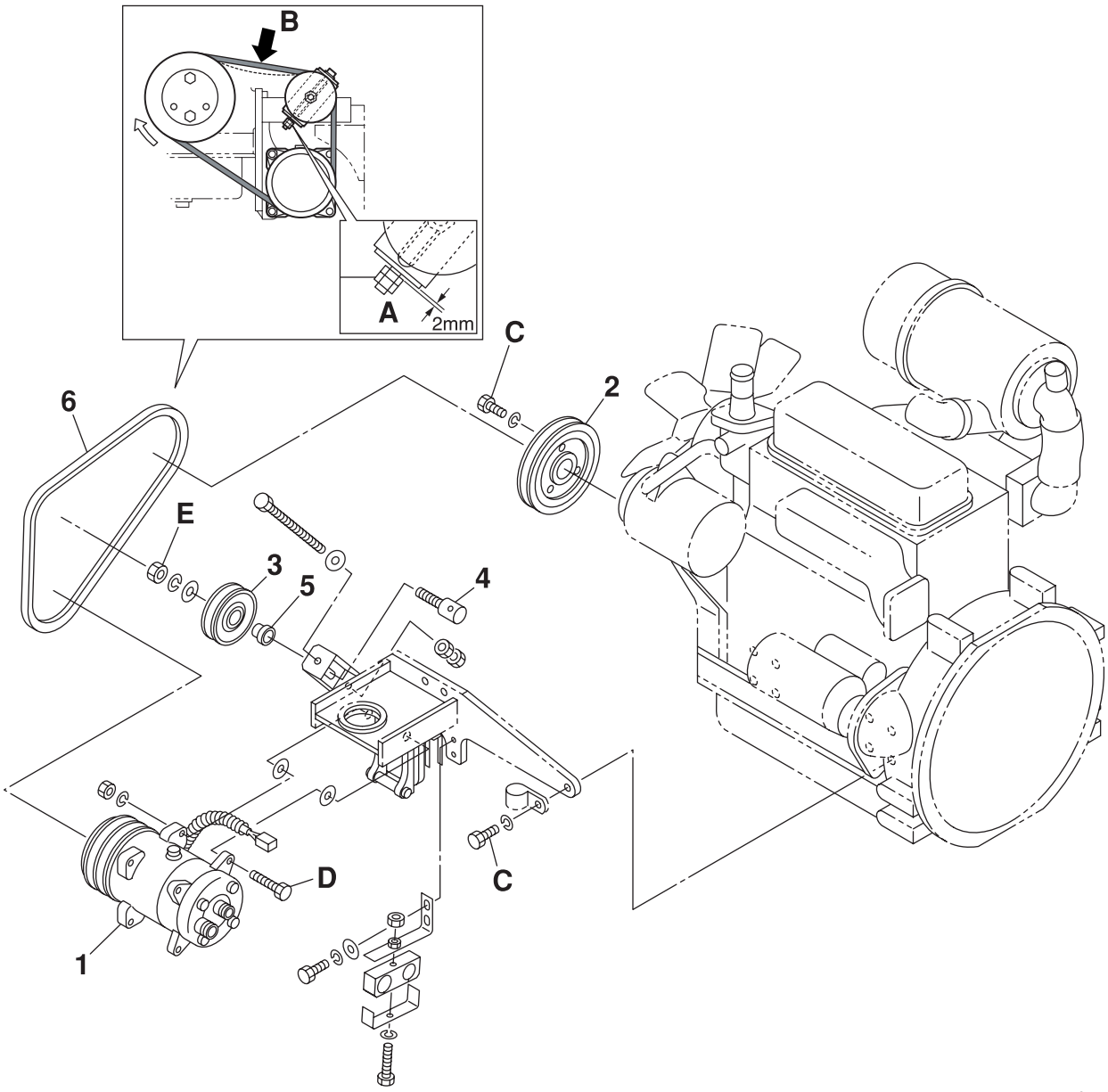
1. Air Conditioner Unit
2. Motor Assembly
3. Thermostat
4. Resistor
5. Core
6. Valve
7. Wire Harness
8. Control Panel
9. Control Cable
10. Switch
11. Rotary Switch

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■ **TB145: S/N 14513261~**

**Compressor Assembly**



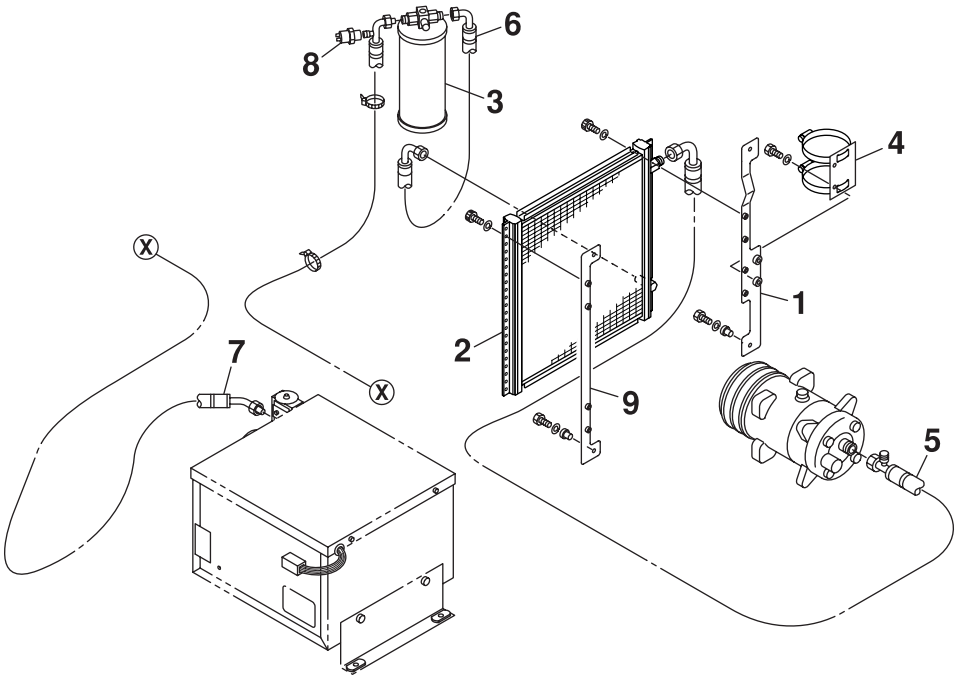

A: Allow a clearance.
B: Press on the center of the belt with a finger. The belt's tension is normal if it bends about 8 mm when pressed with a force of about 98N.
C: 54.9 N·m
Apply thread-locking compound.
D: 47.1 N·m
Apply thread-locking compound.
E: 105.8 N·m

1. Compressor
2. Pulley
3. Pulley
4. Shaft
5. Collar
6. Belt

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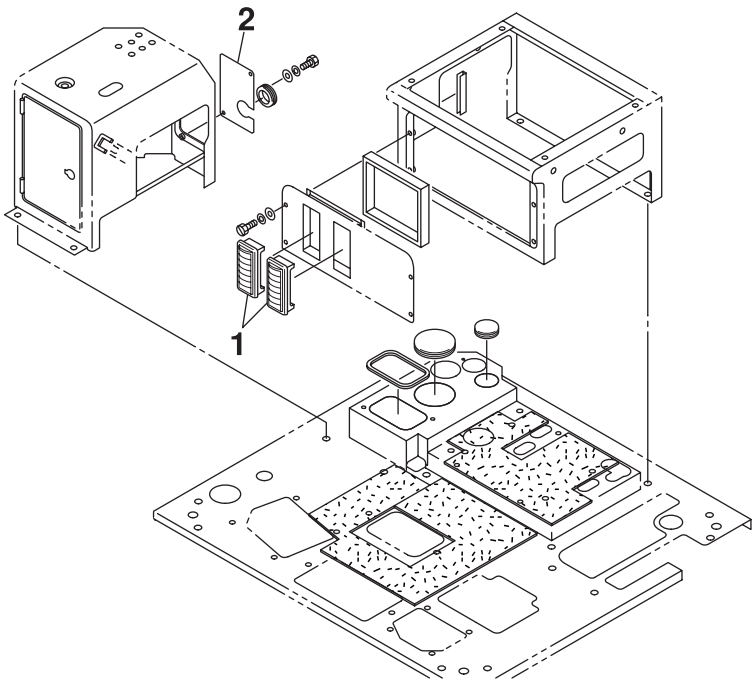


**Condenser Assembly**




1. Bracket
2. Condenser
3. Dryer
4. Bracket
5. Hose
6. Hose
7. Hose
8. Presser Switch
9. Bracket

**Air Conditioner Unit (1/4)**

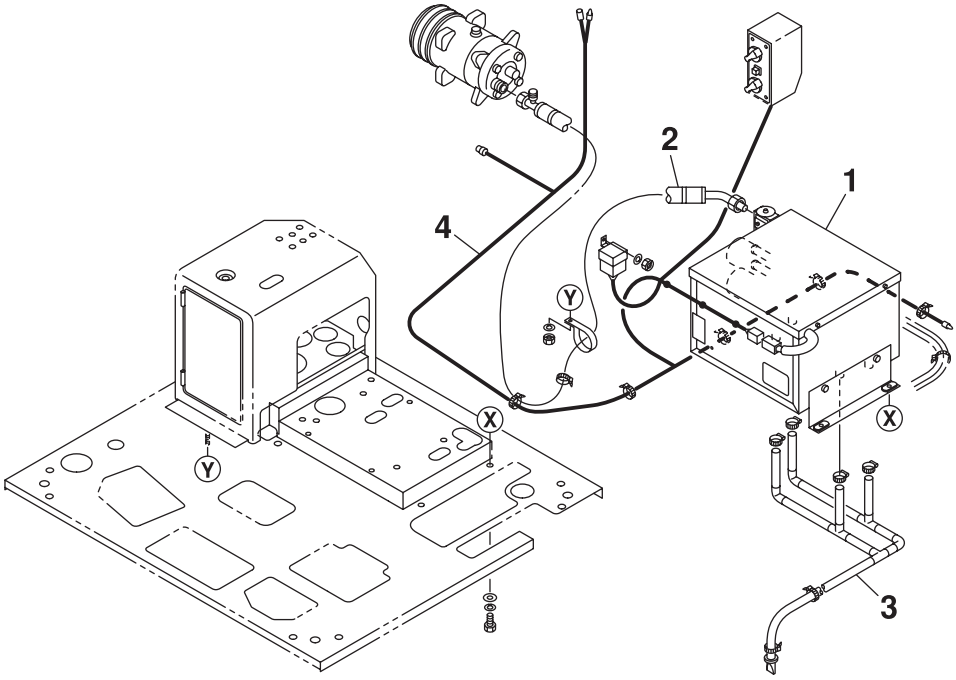



1. Louver
2. Cover

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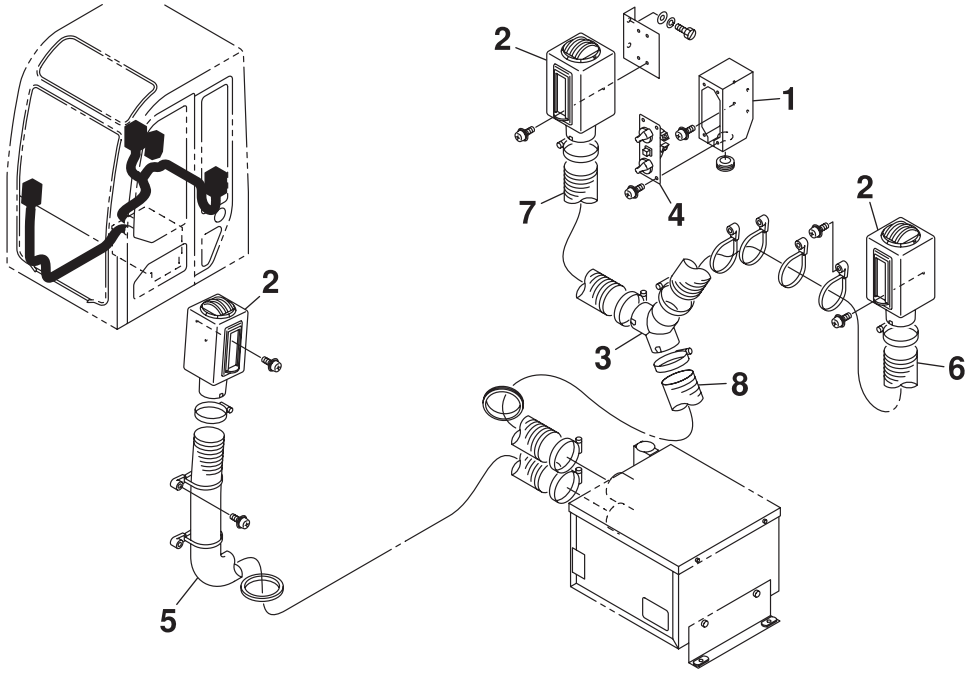


**Air Conditioner Unit (2/4)**




1. Air Conditioner unit
2. Hose
3. Hose
4. Wire Harness

**Air Conditioner Unit (3/4)**

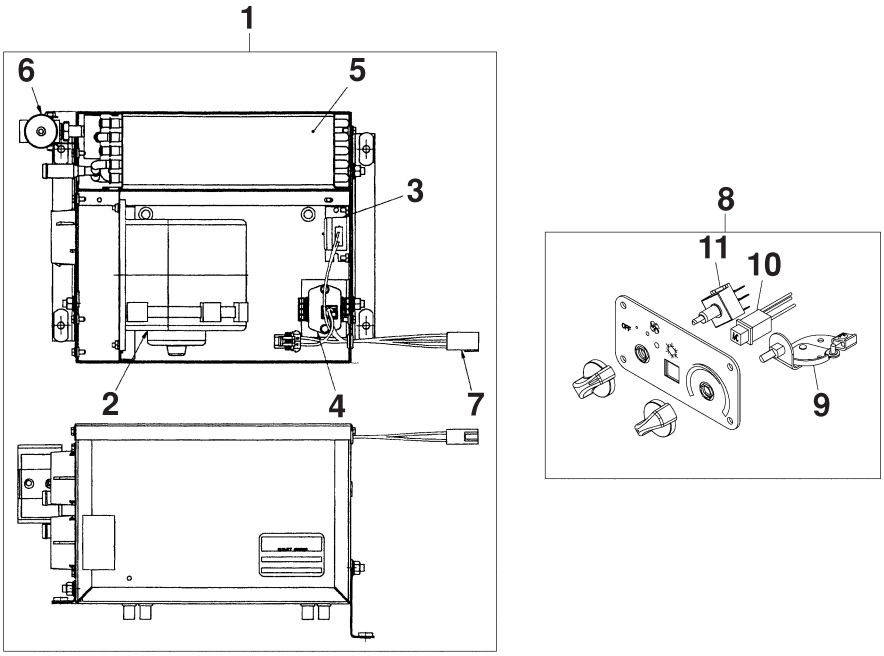



1. Cover
2. Duct
3. Connector
4. Control Panel
5. Hose
6. Hose
7. Hose
8. Hose

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**Air Conditioner Unit, Control Panel**




G4C815

1. Air Conditioner Unit
2. Motor Assembly
3. Thermostat
4. Resistor
5. Core
6. Valve
7. Wire Harness
8. Control Panel
9. Control Cable
10. Switch
11. Rotary Switch

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# Overview of System Operation

*Click on any of these subject headings to go directly to the page*


- Truck and Heavy Equipment Systems
- Air Conditioner-System Operation
- Heater System Operation
- Environmental Effects on System Operation
- Chapter Review


## Truck and Heavy Equipment Systems

A variety of HVAC systems are in use today, some old and some new. There are:

- Vehicle manufacturer installed systems
- Owner specified systems
- Add-on systems
- Retrofit systems

The system components come in different colors, shapes, and sizes. They may be mounted in or on the cab in varied locations. Owners or fleet maintenance people can modify systems by adding controls, auxiliary units or ducts. Major components are sometimes replaced due to damage or failure. All systems were, at least originally, designed and installed to meet the needs of an operator. Figure 2-1 includes illustrations of various AC and Heater systems. They illustrate system advantages and disadvantages explained in the paragraphs that follow.

The HVAC system includes both heater and air conditioner components, usually a common control, and air ducts. The system cools the cab by removing heat energy. It removes moisture from damp air in the cab and adds fresh outside air to the cab. In this way, the operator can work comfortably in all kinds of weather.

A sleeper unit, built in or added on, increases the air volumes in the cab. The air conditioner or heater must circulate and cool or heat a larger amount of air. This is accomplished by routing ducts and controls to the sleeper compartment as part of system design. Components may be increased in size to handle the larger cab air volume. A bigger heater core, air conditioning evaporator coil, condenser, blower or fan may be included. Often, on long haul trucks, auxiliary air conditioning and heater components and controls are added. The objective remains the same, to move heat energy and maintain occupant comfort.

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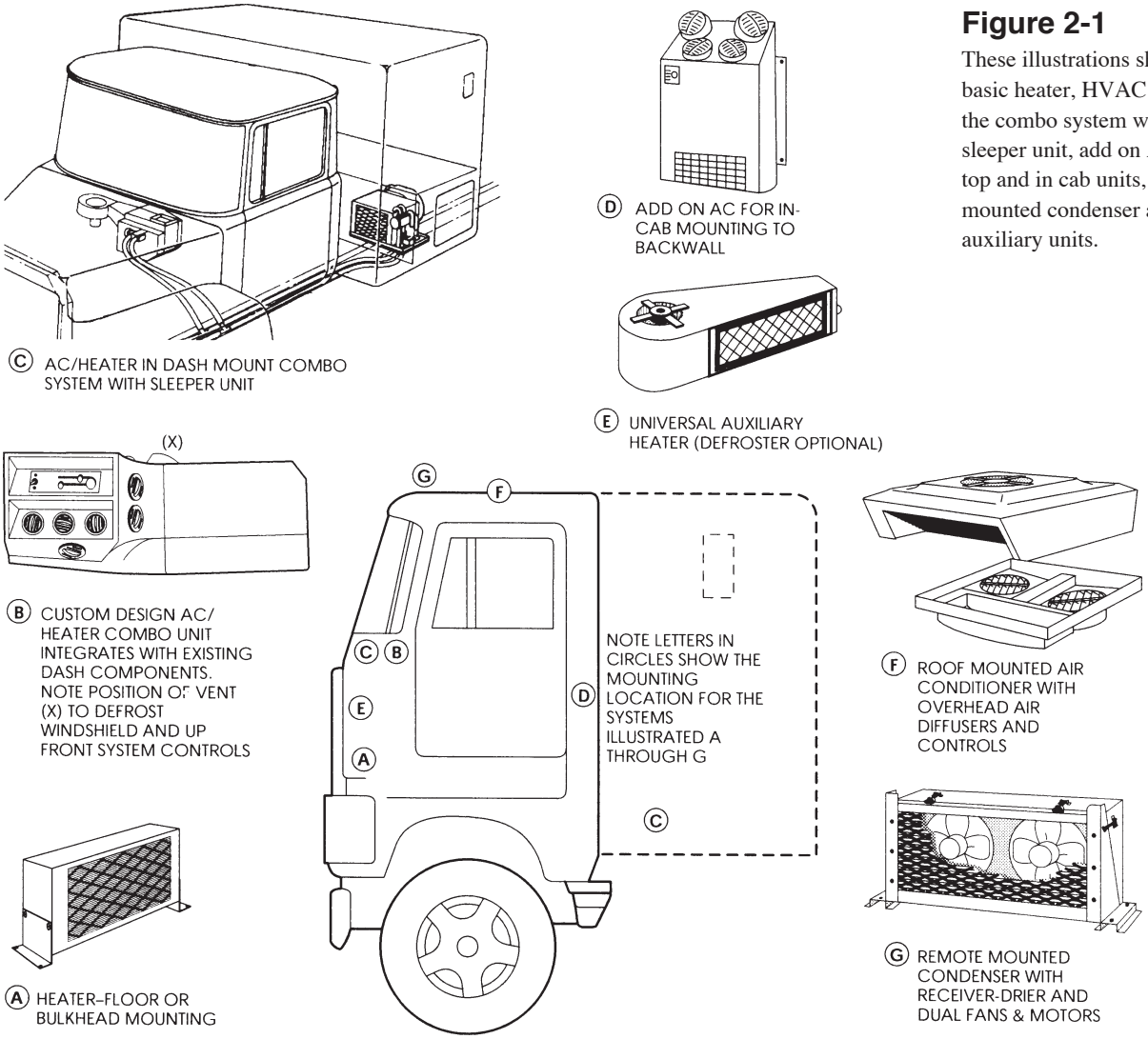



**Figure 2-1**
These illustrations show a basic heater, HVAC system, the combo system with sleeper unit, add on AC roof top and in cab units, roof mounted condenser and auxiliary units.

By law, all trucks have a heater/defroster as part of the standard equipment. When there is a reason to add air conditioning, there are options to meet different needs. The available space in the cab, operating environment, and owner preference can all play a part in the type of AC unit selected. You will probably encounter roof-mounted and in-cab add on systems, and even systems where the condenser is mounted on the roof and the evaporator is attached to the back panel or mounted under the dash. In cooler climates you may come across a cab with two heaters, the original and an auxiliary unit.

## Air Conditioner—System Operation

We have described the movement of heat energy and basic HVAC system function in Chapter 1. Now we will go into some detail on how an air conditioner operates. The system is sealed to keep out air and moisture. To operate properly, the inside of the system contains a measured amount of refrigerant and special refrigerant oil that keeps the system lubricated. Figure 2-2 is an illustration of system components without the cab outline, in-cab controls, component housing, and air ducts or vents. Please study it for a moment. Note the information printed next to each component. Remember that the components may be positioned and attached to the truck in various locations.

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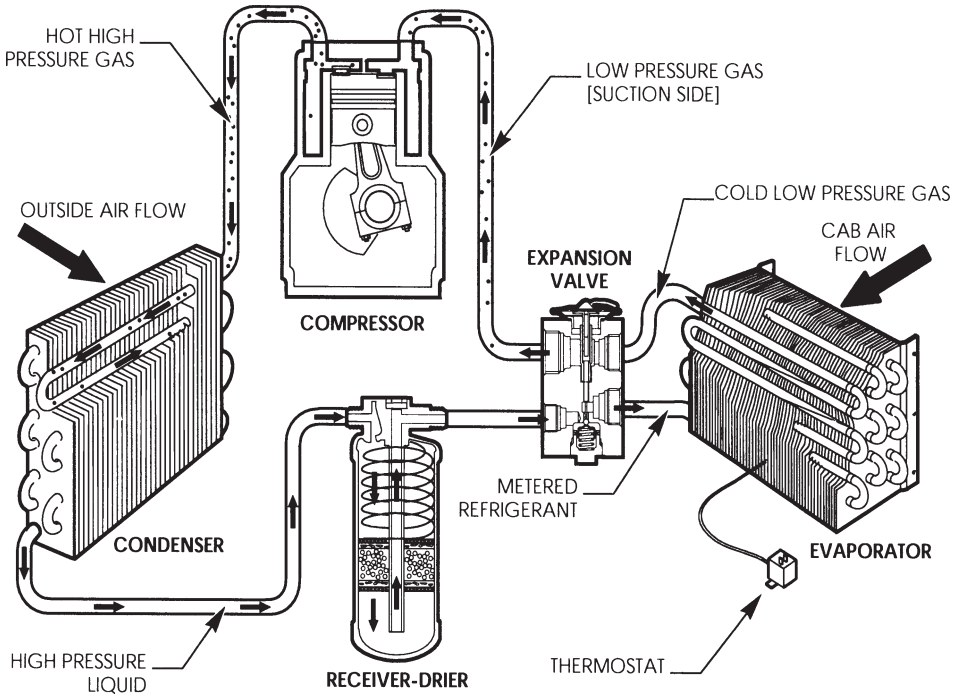


The following AC components are discussed in detail in this section:

1. Compressor/Clutch Assembly
2. Condenser
3. Receiver-Drier
4. Expansion Valve
5. Evaporator Coil

**Figure 2-2**

Air Conditioner components are connected together to illustrate system operation. The components shown are not to scale. The refrigerant and refrigerant oil are clear in color and not visible in this drawing. The small arrows inside the components and connecting hoses show the direction of refrigerant flow (refrigerant circuit).




## 1. Compressor/Clutch Assembly

The compressor/clutch assembly is the heart of the system. When the clutch is engaged, the compressor pumps refrigerant and oil around the system. It raises the temperature and pressure of the refrigerant gas, and forces it to the condenser where it changes state and becomes a liquid. The compressor also sucks the vaporized refrigerant out of the evaporator and back inside itself in the form of gas. One way valves inside the compressor separate the compressed gas (high pressure) side of the system from the suction (low pressure) side. Figure 2-3 shows a cutaway view of a compressor with the high and low pressure sides noted.

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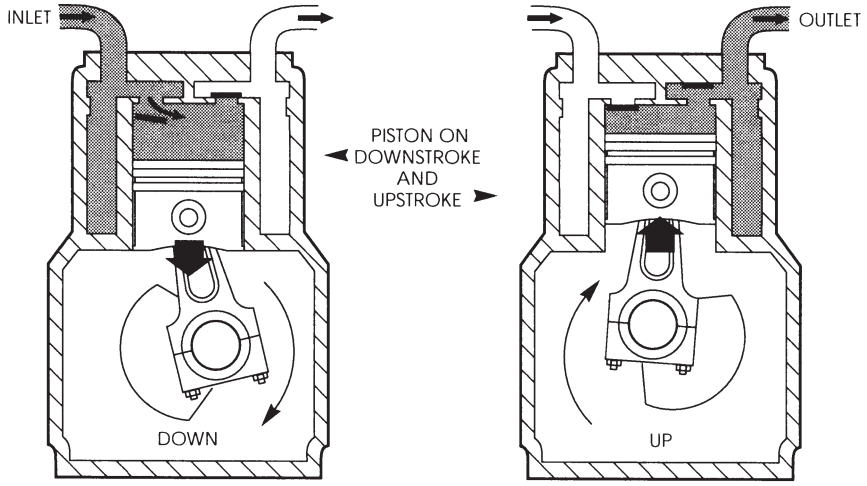



**Figure 2-3**
The compressor inlet is low pressure and the outlet is high pressure. The reed valves are one way. They open to allow refrigerant gas to enter the compressor on the down stroke and exit on the upstroke. Note the open valves in the illustrations.

The clutch is mounted on the shaft of the compressor and is engaged by electromagnetic action. Part of the clutch assembly is an electromagnetic wire coil. The coil is energized through a thermostat that senses the temperature in the evaporator coil. If the evaporator is too warm the electrical contacts close and allows power to flow to the clutch. The compressor shaft is engaged and moves the refrigerant around inside the system. Figure 2-4 is a cutaway view of the clutch mounted on the compressor.

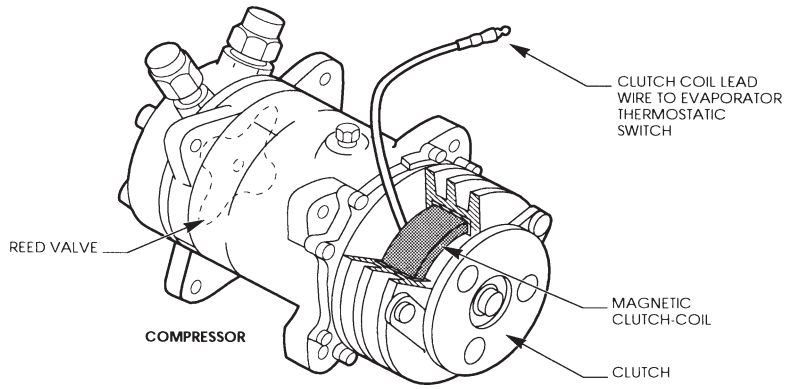



**Figure 2-4**
The clutch shown here has its electromagnetic coil mounted on the compressor body. When the coil is energized, magnetic force pulls the clutch drive plate into the pulley. This action locks the pulley to the compressor drive shaft and drives the compressor.

### 2. Condenser

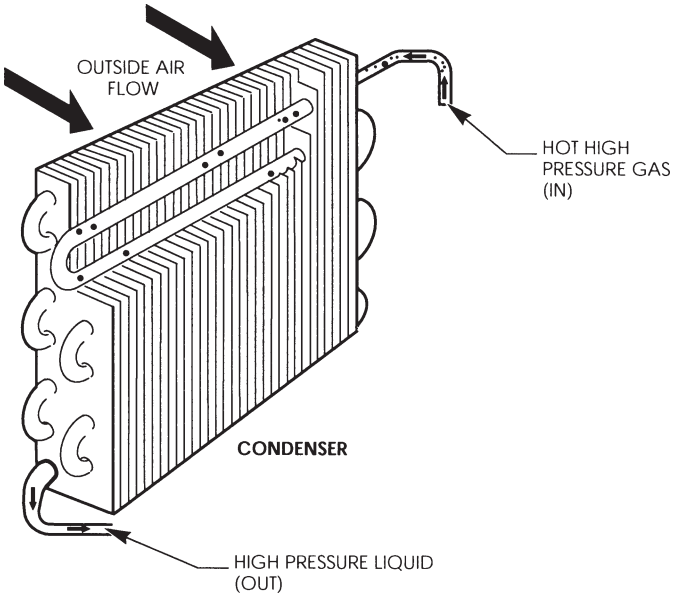
The refrigerant gas leaves the compressor and moves through a high pressure hose to the condenser. Inside the condenser the gas “changes state” and becomes a liquid. It is still hot and under pressure. Remember in Chapter 1 when we talked about water at 212 degrees Fahrenheit? Heat energy was involved in the “change of state,” but the temperature did not change. The same kind of action happens inside the AC system. The refrigerant gas gives up a lot of heat energy to the outside air as it “changes state” in the condenser. Figure 2-5 illustrates a condenser. Air moving through the condenser absorbs heat from the refrigerant. The amount of air flow through the condenser is the major factor in how well the condenser functions.

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**Figure 2-5**

As the refrigerant gas moves through the tubing coil from top to bottom, it condenses (changes state) into a liquid. For ease of installation, condenser fittings are often routed close together.

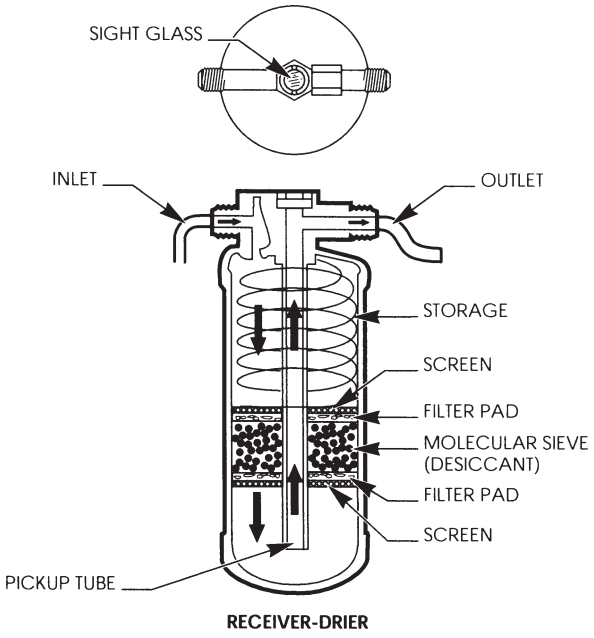



### 3. Receiver-Drier

The liquid refrigerant continues to move inside the system, out of the condenser through a tube or hose to the receiver-drier. The receiver-drier serves as a small storage tank and filter for the refrigerant. It is also a good location to mount pressure switches and often contains a sight glass (small window) used to view activity inside the system. The receiver-drier, Figure 2-6, also separates gas (bubbles) from the liquid with a pick-up tube as shown in this illustration. Some receiver-driers have a spring to preload the desiccant pack.

**Figure 2-6**

This cutaway view of a receiver-drier shows the filter elements, inlet, outlet and refrigerant path. The sight glass is a small window into the system used in diagnosis and when adding refrigerant (charging the system).



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### 4. Expansion Valve (Refrigerant Metering Device)

When refrigerant moves from the receiver-drier, it travels through another high pressure hose to a metering device at the inlet of the evaporator coil. The metering device can be an expansion valve, an expansion tube or a combination (multiple function) valve. Between the compressor and this point inside the system, the pressure is high and can range from 150 to 250 pounds per square inch. The expansion valve (TXV) is closely connected to the evaporator. A diaphragm opens the valve by exerting pressure on the spring. Pressure comes from gas inside the diaphragm housing on top of the valve and in the sealed sensing bulb. The sensing tube is located in the outlet of the evaporator and picks up heat from warm refrigerant leaving the evaporator. The gas in the valve diaphragm housing and sensing tube expands when it gets warmer and forces the expansion valve open at the metering orifice.

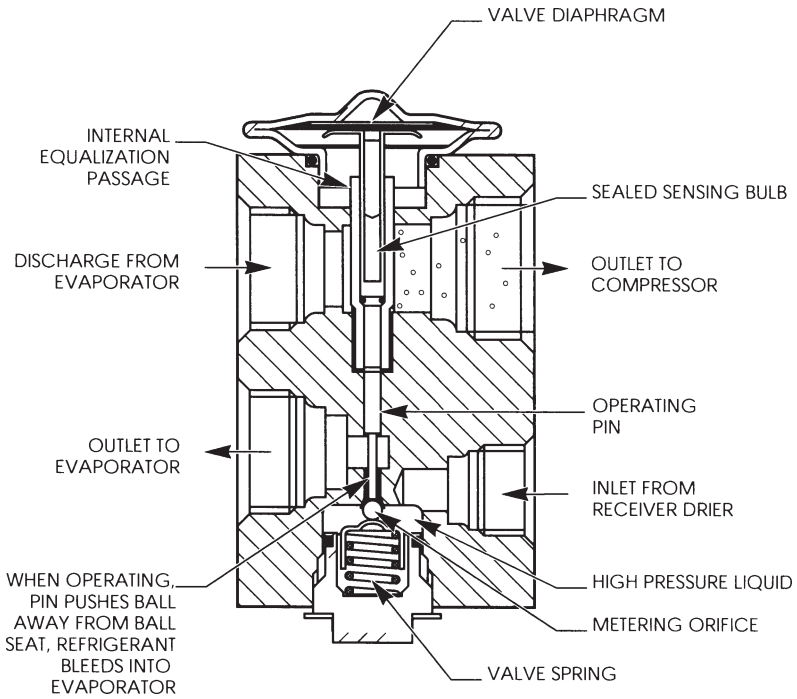



**Figure 2-7**

This block type expansion valve cutaway view will give you a better idea how these valves work. Spring pressure holds the valve closed.

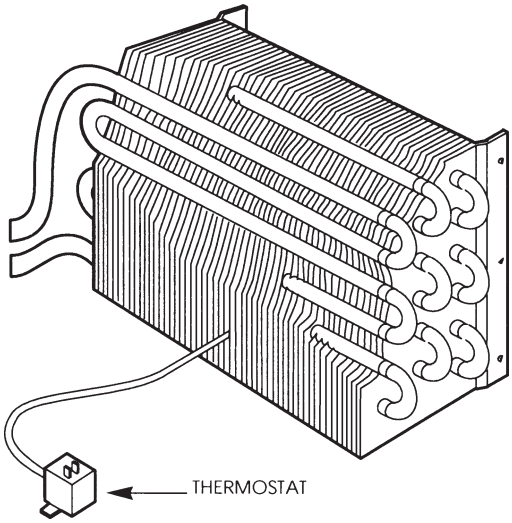
### 5. Evaporator Coil

The expansion valve or other type of metering device bleeds high pressure refrigerant into the evaporator coil, where the pressure is low. The refrigerant expands rapidly in this low pressure environment. When it expands it “changes state”. The sudden drop in pressure brings the refrigerant temperature down quickly inside the evaporator coil. Figure 2-8 shows an evaporator coil and thermostat. Refrigerant is sprayed into the evaporator by the high side pressure when the expansion valve opens. The refrigerant absorbs heat from the air when the blower forces the air through the fins. When the thermostat probe senses the upper limit of the thermostat heat setting, a circuit closes. The compressor clutch engages and the compressor operates and moves more refrigerant to the high side of the system.

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**Figure 2-8**
The evaporator coil as shown is of fin and tube construction. The thermostat probe is positioned in between the evaporator fins and senses the temperature.




**Note:** Moisture in the air (humidity) condenses on the fins of the evaporator as water droplets which drain out of the evaporator through a drain hose. This action dehumidifies the air in the cab as part of system operation, and contributes to operator comfort.

Cab air forced across the evaporator coil gives up heat energy to the cold refrigerant inside the coil. The cooled air circulates in the cab for occupant comfort. Refrigerant continues to expand and absorb heat energy in the evaporator coil. Refrigerant changes from liquid to gas before it leaves the evaporator on the way back to the compressor. The refrigerant gas moves to the compressor through a low pressure (suction) hose. When the compressor is operating, it sucks the refrigerant gas back inside, compressing and raising its temperature and pressure.

Some of AC system operation is controlled by the operator, and some is automatic. The operator can turn the system on and off, regulate the air velocity with the blower control, and in some designs adjust the thermostat control. The system and component operating range settings automatically cycle the clutch on and off. The operation of the expansion valve or other refrigerant metering device at the inlet to the evaporator is automatic.

Individual system features may differ, but the basic system function remains the same. Variations in components and controls are described in Chapters 4 and 5. The engine provides the power for both air conditioner and heater operation. It drives the AC compressor and the cooling system water pump. Engine RPM affects the efficiency of both the heater and air conditioner. The slower the engine RPM, the less capacity a heater or AC system will have.

**WARNING** When an AC system is operating, the high pressure side components, fittings and high pressure lines or hoses can be hot enough to burn your skin if you touch them. This includes the compressor, clutch, hoses, condenser, receiver-drier, and any control devices or metal tubing. The low pressure side will be cool to the touch. In operation the AC system is under load and high side pressures normally range between 150 and 250 pounds per square inch for R-12 and higher for some other refrigerants.

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## Heater System Operation

Heater and air conditioner systems both have the same basic function of moving heat. They take advantage of nature's laws where heat energy always moves from a warmer to a cooler area. In a heater system there is no "change of state" involved in system operation. The system is sealed and operates under pressure, but the pressure is low when compared to an air conditioner.

A heater system uses the engine coolant to carry excess heat energy to the cab air. The heart of the system is the water pump. The water pump forces hot coolant through a hose from the engine block and through the heater core. The coolant is returned to the engine cooling system either at the suction side of the water pump or to the radiator.

A control cable, attached to a water valve between the water pump and the heater inlet, is used to control the flow of coolant to the heater. The heater fan or blower forces cab air through the heater core where heat energy moves from the engine coolant to the air in the cab. Figure 2-9 illustrates the main heater system components. In-cab controls, component housing and air vents are not shown.

The following heater components are discussed in detail in this section:

1. Heater Core
2. Water Valves
3. Defrosters and Ducts
4. Blowers and Fans

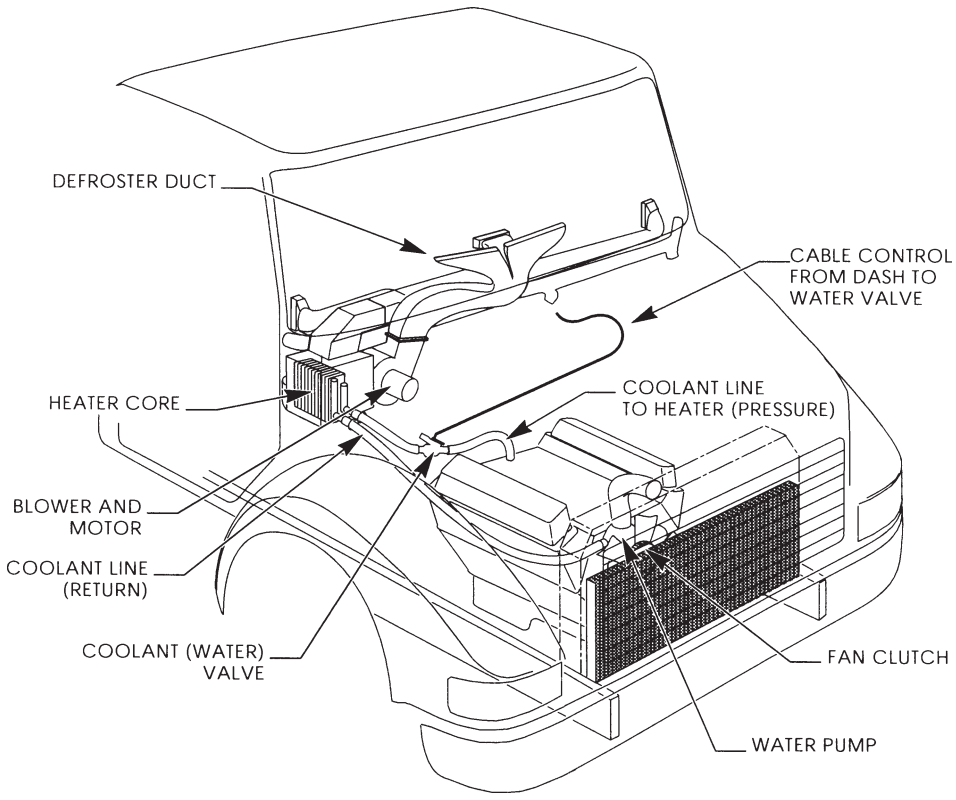



**Figure 2-9**
This view of a heater system shows the main components and how they are connected.

Additional heater controls, ducts, air vents, blend-air doors, temperature regulating devices and auxiliary heaters may be installed as part of a heater system. These may be air, vacuum, electrical or mechanically operated.

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### 1. Heater Core

Heater cores are like small radiators. The fin and tube construction is designed to route coolant flow for the best possible heat energy transfer from coolant to cab air. Hoses from and to the engine are connected to the core with clamps. The core outlet may be larger or the same size as the inlet.

### 2. Water Valves

Water valves may be cable, vacuum or air controlled. The valve can be either open, closed or set part way open. Some valves have a bypass design to return coolant to the engine. Most are manually controlled although electronic systems are now being installed.

### 3. Defrosters and Ducts

Defrosting is accomplished by directing heated dry air through ducts to the windshield. The heater system serves the dual purpose of defrosting and heating. Controls are used to route the air flow to the windshield and occupant areas by opening and closing duct doors. Controls may be manual, air or vacuum.

Many vehicles use a “defrost interlock” system which utilizes the air conditioner to dry the defrost air and clear the cab windows more quickly.

### 4. Blowers and Fans

Blowers or fans are used in the system to move cab air through the heater core and evaporator. Air can be pushed or pulled through the core depending on system design. Blower or fan speed is usually selected by the operator.

## Environmental Effects on System Operation

The environment outside the cab involves more than the weather. It may be hot and humid or cold and dry. That is only part of the condition the HVAC system must handle to maintain an ideal comfort range. A truck can be at idle, in traffic or moving along for hours on the Interstate at 65 M.P.H. The load condition on a trip can include going out full, coming home empty, or driving across the Rockies or Kansas plains during the day or night. The truck color and shape, the windows and angle of the sun are all variables that can increase or decrease the “load” on the system. The following are a few examples of environmental effect:

- A black cab-over (COE) with a dark color interior will be more difficult to cool than the same vehicle with white paint and a light colored interior. The black cab picks up and holds the radiant heat from the sun more easily than the white one.
- In Florida or Houston the humidity in mid summer can be very high with the temperature in the high 90’s or low 100’s. The AC unit must remove a lot of moisture from the air in the cab as the air moves through the evaporator fins. The more moisture on the fins, the less effective the transfer of heat is to the refrigerant inside the evaporator coil.

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- On a cold day the temperature can drop below zero. The engine may run cooler so the engine coolant is cooler when it circulates through the heater. The heat in the cab moves out of the cab faster (remember heat always moves to a cooler area until both are the same temperature—nature's law). To maintain cab comfort you have to increase the flow of coolant through the heater, increase coolant temperature, and/or move more air through the heater core.
- On a hot day, an off-road vehicle experiences cooling at a slower rate than an on-road vehicle. This is a result of high sun-load, large window area and often less insulation.

It is important for you to keep environmental effects in mind when you are servicing or diagnosing heater or air conditioner systems. If you work in Denver the altitude will affect system function and pressure. In Houston the heat and humidity may lower heat transfer to the air at the condenser and increase system operating pressures.

## Chapter Review

- HVAC systems range from simple cab heaters to multi-function combination systems. The multi-function system can heat and cool the cab and sleeper unit, and have separate auxiliary components and controls for driver and passenger comfort.
- Both heater (engine) coolant and air conditioner refrigerant circulate inside sealed, pressurized systems. The normal air conditioner operating pressure ranges from 150 to 250 pounds per square inch, sometimes higher with a different refrigerant.
- Air conditioners have a high and a low pressure side within the system. The compressor is the starting point of the high side. Pressure drops at the expansion valve opening to the evaporator.
- The basic components of an AC system are the compressorclutch assembly, high pressure lines, condenser, receiver-drier, expansion valve, evaporator, thermostat, blower assembly, and suction lines. There may be other controls installed for more complex systems.
- The basic components of a heater system are the inlet and outlet hoses, a water valve and valve control, heater core and fan or blower assembly. There may be other controls for more complex systems.
- An air conditioner system uses the "change of state" of refrigerant inside the system to move heat from the cab air to the outside air. Refrigerant changes from a gas to a liquid in the condenser, and back to a gas in the evaporator.
- A heater system uses the heat from the engine, carried to the heater core by the action of the water pump, to warm the air in the cab. There is no change of state within the heater system.
- Environmental conditions affect how both heaters and air conditioners work. Weather, driving conditions, color of the vehicle are factors. All contribute to heat gain or loss inside a cab and how much heat energy must be moved to maintain occupant comfort.

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# Inspection and Maintenance-without gauges

*Click on any of these subject headings to go directly to the page*


- Discussion of Inspection & Maintenance Survey Results
- Visual Inspection - System Off
- Electrical System Inspection
- Performance Inspection - Engine Running
- Heater System Inspection
- Preventive Maintenance Worksheet
- Chapter Review


## Discussion of Inspection & Maintenance Survey Results

There are three reasons for regular inspection and maintenance procedures:

1. They save money in the long run by reducing down time and often prevent more costly repairs.
2. They help to insure driver comfort and safety.
3. They add to your store of knowledge about these systems and maintain your level of efficiency.

About half of all heavy duty vehicles have air conditioners. Surveys of AC system owners find that over 30% of the systems are serviced every six months or less, and another 62% are serviced at least once a year.

The survey also covered how often the different components required maintenance. Figure 7.1 below shows survey finding percentages. Failure of any of the AC components listed in the survey could cause a system to malfunction or stop cooling.

**Figure 7-1**
This chart shows maintenance frequency, lists key parts and how often they require maintenance.

**INSPECTION & MAINTENANCE SURVEY**

| How often are your air conditioners serviced? | | | | |
|---|---|---|---|---|
| Average | 1 to 6 months 30% | 7 to 12 months 62% | More than 12 months 6% | Never 2% |

| Which AC components require frequent maintenance? | | | | | |
|---|---|---|---|---|---|
| Belts 32% | Compressor Clutch 26% | Condenser 12% | Add Refrigerant 12% | Refrigerant Lines 11% | Valves 7% |

**Note:** The above survey results may not apply to your situation. Actual operating conditions for the vehicles you service will determine or influence maintenance frequency and requirements.

The following inspection procedures should take about 15 to 20 minutes, longer if corrective steps, part replacement or adding refrigerant is necessary. There is a "Preventive Maintenance Worksheet" you may use at the end of this chapter, Figure 7-9

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## Visual Inspection - System Off

Your observations and the corrective measures you take may be different depending on circumstances. The following inspection procedures are explained in more detail below:

1. Observe the System
2. Inspect Parts
3. Check Hoses and Fittings
4. Check for Refrigerant Leaks

Use the following procedures as a general rule in performing a visual inspection with the AC system off:

### 1. Observe the System

Your first inspection step is to answer the following question if you can:

- Has the vehicle just come in off the road and has the HVAC system been in use?
- Did the operator or work order explain or describe any problems about the system?
- Did someone else work on the system yesterday, 700 miles down the road? Your first inspection step is to answer these questions if you can.

**CAUTION** Even when someone has told you what is wrong with an HVAC system, you should perform a visual inspection. Always make a visual inspection before you hook up the manifold gauge set. Never add refrigerant to a system until you have made a complete visual and performance inspection.

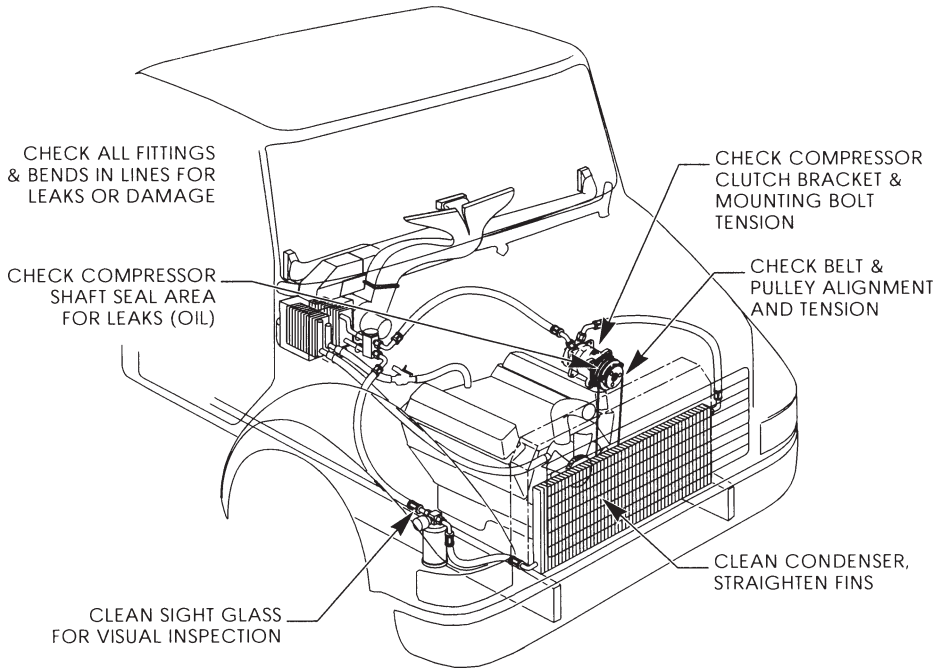
### 2. Inspect Parts

Look at the system for what might come loose, leak, wear out or become dirty and not function the way it should. The main points for visual inspection of the system are emphasized in Figure 7-2.

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**Figure 7-2**
This system illustration notes the main points for visual inspection.



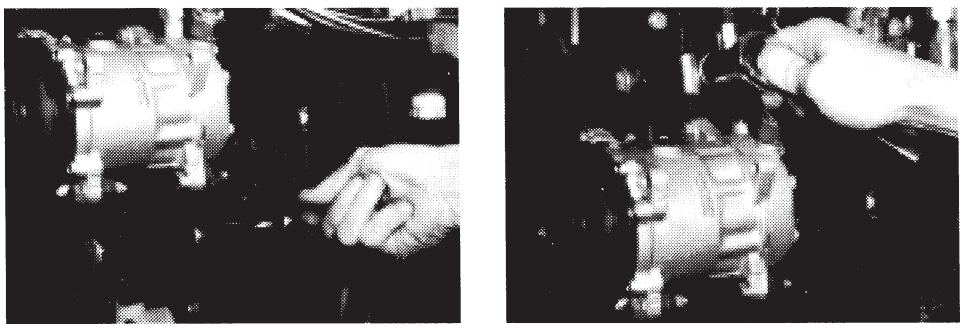

**A. Condenser** – Is it free of leaves, bugs, bird feathers or mud? The condenser must be relatively clean to work well as a heat exchanger. How you clean the condenser depends on where it is mounted. The condenser fin comb, air hose and nozzle, or soap and water may be used. Where possible, check condenser mounting bolts or screws and tighten them if necessary.

Condenser failure often results from loose hoses. Hose movement will cause fatigue failure of condenser tubing adjacent to the fittings. Make sure the hoses are securely clamped.

While inspecting the condenser check the receiver-drier sight glass and connections. Look to see if the sight glass has a moisture indicator that is showing moisture in the system.

**B. Components Under the Hood** – Tip the cab or raise the hood. Look at the compressor mounting bracket, compressor clutch assembly, drive belt and pulley alignment. The mounting bracket, compressor, clutch and drive pulley should be fastened securely, and a clutch groove (there may be two groves) should be in line with the drive pulley. Tighten all bolts shown in Figure 7-3, as you inspect.

**Figure 7-3**
Engine and compressor vibration can work mounting bolts loose. Tighten all mounting bolts as you inspect the system. Slots in the mounting bracket are used to move the compressor clutch assembly in order to adjust belt tension or alignment.



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**C. Drive Belt** – The drive belt should be tight and in good condition. Use a belt tension gauge to check tension (120 pounds maximum). With experience, you can feel belt tension by twisting the belt. Try feeling belt tension after using the gauge, when you know the tension is correct. Replace belts if they are frayed or look worn.

If the clutch pulley/belt alignment is obviously off, you need to loosen the compressor or mounting bracket, or both—and use the alignment bar to line up the clutch pulley with the drive pulley. Tighten compressor mounting bolts first, then the bolts holding the bracket. The mounting bracket should have slots or other means of adjustment to allow you to adjust the tension of the drive belt. When you use a pry bar to apply tension, be sure you do not pry against the compressor. Pry against the mounting bracket.

### 3. Check Hoses and Fittings

Check all hoses and fittings. Look for places where hoses flex when the cab is tilted. Any places the hoses or fittings are fastened, clamped, connected, bent or secured are potential wear points. This also applies to places where hoses are not clamped or supported but should be (often near the condenser). All of these spots are potential leak or damage points. Tighten, re-fasten, add, or replace as indicated by your inspection.

### 4. Check for Refrigerant Leaks

System refrigerant leaks can be anywhere but there are obvious places. You can spot some by looking for signs of refrigerant oil forced out with refrigerant leakage. One location leaks frequently occur is the compressor shaft seal. The shaft and seal are hidden behind the clutch assembly, but centrifugal force will throw the oil off the shaft and against the engine, bracket or whatever is close. Check these points when you examine the compressor clutch and mounting bracket. A solution of soap and water applied around potential leak points works well for detecting leaks. A leak in the evaporator may be indicated if you feel around the condensate drain hole and find oil present.

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**Note:** You can add inexpensive dry nitrogen gas to the system instead of R-12 if system pressures are low. Dispense the gas at no more than 200-250 PSI as this is sufficient pressure to cause or indicate a leak point in the AC system. AC service procedures for complete system recovering of refrigerant, evacuating, and recharging are covered and illustrated in *Chapter 9*.

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**Note:** A leaking heater core could also result in coolant at the condensate drain.

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You can feel for oil at the bottom of all connections (see Figure 7-4) if the system is not too hot. Of course, a few minutes with an electronic leak detector is the best way to check for leaks. Keep in mind that pressure is different in a system at rest, so small leaks may be hard to find. Pressure in a system at rest, will equalize at from 60 to 95 PSI, depending on outside air temperature. This means there is more pressure in the low side of the system at rest than during normal system operation. Just the opposite is true of the high side; at rest, high side pressure is lower. You may want to use the detector to check for leaks in the high side when the air conditioner is operating, if you suspect a leak and can't find it when the system is at rest.

**Figure 7-4**
This illustration shows a potential refrigerant leak point at the condenser fitting.



## Electrical System Inspection

The two stages of an electrical inspection are explained in more detail below:

1. Inspect Electrical Connections
2. Check Electrical Current Flow and Device Functions

Use the following procedures to perform an electrical system inspection:

### 1. Inspect Electrical Connections

First, while you are making your visual inspection under the hood (cab) and/or at the roof top condenser, take a moment and check all electrical connections visually and by feel. Look for any corrosion on leads or connectors and clean them. Make sure all leads and wires are properly supported and securely connected.

### 2. Check Electrical Current Flow and Device Functions

Perform the following steps to check current flow and electrical device functions:

**A. Turn the Ignition On** – To check current flow the ignition must be on.

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**B. Turn the AC System On** – This will power the thermostat and clutch. If it does not come on, use the AC mode switch to check the leads to the switch. You should be able to hear a "click" from the thermostat and hear the clutch drive plate "snap" against the clutch pulley. You can not check thermostat cycling on and off until you do the performance inspection. Figure 7-5 illustrates a typical AC electrical system and the places you should inspect.

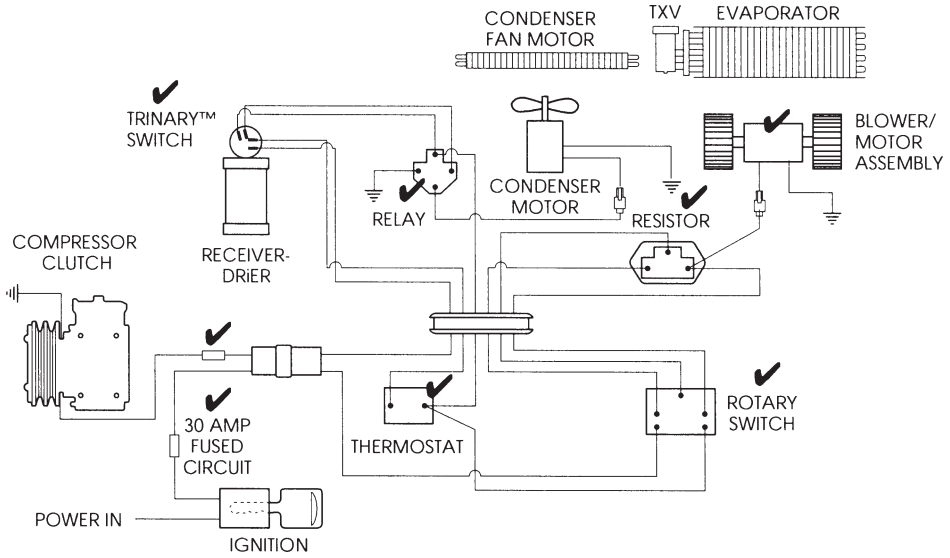



**Figure 7-5**
The electrical system inspection points are noted with check marks (✔) on this wiring diagram (electrical schematic).

**C. Check Fuses** – If there is a failure and you have made sure all connections are clean and tight, you need to check fuses—in-cab as well as in-line.

**D. Check Clutch Engagement** – Since you can't see and may not hear the clutch engage, get out and look at the clutch. If it's engaged, you will see that the drive plate is against the pulley and not slightly spaced from it. If you are not sure the clutch is engaged, look for the lead wire connector near the clutch. Break and close that connection. The clutch will disengage and engage again.

**E. Test Blower Speed Operation** – Some systems have a common switch that turns on the air conditioner and powers the blower motor. Test blower speed operation by adjusting this or the separate blower control switch. Feeling the air flow from the ducts or note blower sound (speed) changes.

**F. Inspect Roof Mounted Condensers** – Don't forget to inspect roof mounted condensers and AC systems for dirt and debris. Be sure the condenser fan(s) are working properly and all parts and electrical connections are securely fastened. The roof mounted condenser fans may come on when the system is turned on. Like the thermostat and most clutches, the normal on-off cycling action can not be observed until the engine is running with the AC system on.

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## Performance Inspection – Engine Running

The purpose of visual and electrical inspection is to detect obvious problems and assure AC system function for an accurate performance inspection. If you do the performance inspection first, you could be mislead. Problem areas discovered during the performance inspection can give you false clues or symptoms, and result in repair errors and come-backs. The following performance inspection procedures are explained in more detail below:

1. Inspect System Component Cycling and Cab Temperature Levels
2. Check Clutch Cycling Under Load
3. Check Sight Glass

The performance inspection does not cover pressure and temperature sensitive safety devices (cutout switches, fan control, Trinary etc.). Testing these devices requires the use of the manifold gauge set for observation of internal system pressures during tests. These are explained in *Chapter 8*.

Use the following procedures as a general rule in a performance inspection:

### 1. Inspect System Component Cycling and Cab Temperature Levels

**A. Turn On the Engine and Air Conditioner** – Inspect for system component cycling and cab temperature levels.

**Note: System performance testing will be much faster if all doors and windows in the cab are closed.**
The cab air must cool down to thermostat control setting levels before system components will cycle on and off, indicating correct function. This is called 'stabilizing the system' and takes about five minutes of operation. In very hot weather the system may not cycle.

**B. Check Thermometer Readings** – In the cab you can use your thermometer to measure air temperature at the vents. When the evaporator is easy to reach with a thermometer probe without removing some of the dash or duct work, use the probe to measure evaporator temperature. When the AC unit is on and working correctly, you can see the thermometer dial needle move down to about 32 degrees, then rise six to ten degrees and move back down again. The movement up and down indicates that the cycling clutch and thermostat, or orifice tube and accumulator pressure switch (to the clutch) are functioning correctly. In systems with a non-cycling clutch, this movement indicates correct function of the refrigerant metering device.

The needle movement is called "temperature swing." When you can adjust the thermostat setting, the range of swing should change. For example, from full cooling (cold) to moderate (between cold and warm), the swing may change from 32-38 to 32-42 degrees.

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These readings at the vents will be higher and temperature swing slower and not as obvious. Also blower speed will cause the temperature, levels to read higher (high air speed) or lower (low air speed) at the same thermostat setting. When you measure air temperature, an electronic thermometer/pyrometer is a great tool to have. You can easily measure cab air temperature at several locations quickly.

Swing temperatures vary depending on where you measure temperature, and on outside temperature, humidity and altitude. The chart in Figure 7-6, shows some examples of typical temperature variables. Don't forget that cab and sleeper area temperatures can vary within the same vehicle. Also, electronic controls used in newer HVAC systems often keep the temperature spread within a narrower range.

| AIR TEMP. DEGREES F. | 70° | | 80° | | 90° | | 100° | |
|---|---|---|---|---|---|---|---|---|
| AIR QUALITY | HUMID | DRY | HUMID | DRY | HUMID | DRY | HUMID | DRY |
| CENTER OUTLET AIR TEMP. DEGREES F. | 43° to 47° | 40° to 44° | 44° to 48° | 40° to 44° | 47° to 51° | 40° to 44° | 52° to 56° | 41° to 45° |
| | LEFT & RIGHT AIR OUTLET TEMPERATURE WILL VARY | | | | | | | |
| | LEFT | RIGHT | LEFT | RIGHT | LEFT | RIGHT | LEFT | RIGHT |
| OUTLET AIR TEMP. RANGE DEGREES F. | 40° to 41° | 41° to 44° | 41° to 45° | 43° to 47° | 46° to 52° | 47° to 54° | 48° to 55° | 50° to 56° |

**Figure 7-6**
The chart of AC system and cab temperature range shows you typical variables.

### 2. Check Clutch Cycling Under Load

The following operating inspections, visual and by feel, are done outside the cab while you wait for the system to stabilize.

**A. Lift hood** – With the hood up (or cab tilted) observe the clutch cycling under load.

**Note:** If the condenser is hood mounted you may not have adequate air flow through it.

**B. Touch suction and discharge lines** – Soon after system start up you can safely feel the suction and discharge lines and note their change in temperature. The discharge line will get hot (after a while it may be to hot to touch) and the suction line will get cooler.

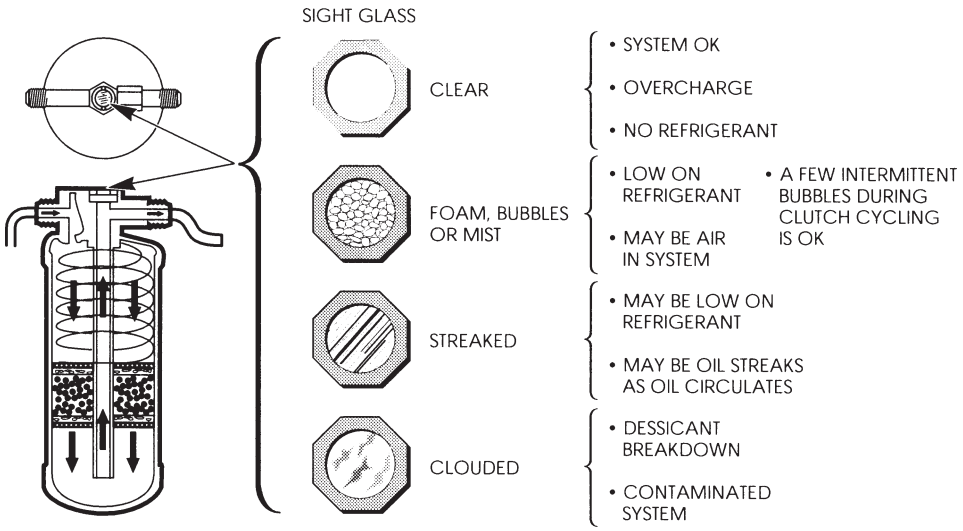
### 3. Check Sight Glass

The sight glass is the only point where you can actually see inside the air conditioner during operation. Check the sight glass through the window on the top of the receiver-drier (or the separate in-line sight glass). If the system is functioning properly and cooling the cab adequately, the sight glass should be clear (you will not see anything in it). If it is not clear when the system is first turned on, wait a few minutes for the system to stabilize, then look again. Figure 7-7 illustrates and explains what you may observe in the sight glass. Roof mounted condenser fans may run continuously or cycle on and off. If you can't tell by sound you may have to climb a ladder and observe the fan blades.

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**Figure 7-7**
These drawings illustrate conditions you may observe in the sight glass window.




**Note:** A roof mounted condenser or AC unit assembly often includes a roof mounted receiver-drier (and sight glass) close to the condenser.

## Heater System Inspection

A heater system inspection is really a combination engine cooling system and heater inspection. All heater/cooling system rubber parts deteriorate due to the air (ozone), heat, coolant and oils. They should be replaced at regular intervals to prevent breakdown on the road. Metal parts and gaskets are subject to malfunction or breakdown due to fatigue and corrosion.

Coolant has a limited life and should be replaced regularly. If it is dirty, the cooling system should be drained and flushed or back flushed (using special equipment) before refilling with clean water and anti-freeze. Coolant must be hot when using the hydrometer to check protection (freeze-up) level. The following inspection procedures are explained in more detail below:

1. Check Heater Control Valve Function
2. Inspect Other Functions

### 1. Check Heater Control Valve Function

Many air conditioner/heater systems depend on the heater control valve for temperature control and positive closure. You can easily check heater control valve function as follows.

**A. Cool engine** – Start with the engine cool, set the temperature to cold and leave the fan off. As the engine warms up, feel the heater return hose. If the hose feels warm or hot, the heater control valve is leaking internally. This type of leak can seriously reduce air conditioning performance.

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**B. Warm up engine** – Next, let the engine warm up to normal operating temperature and set both fan and temperature on high. Feel both heater supply and return hoses. If there is a noticeable difference in their temperature, it indicates a low flow of coolant through the heater core (a partially closed or blocked heater control valve). This could result in poor heating performance during cold weather conditions.

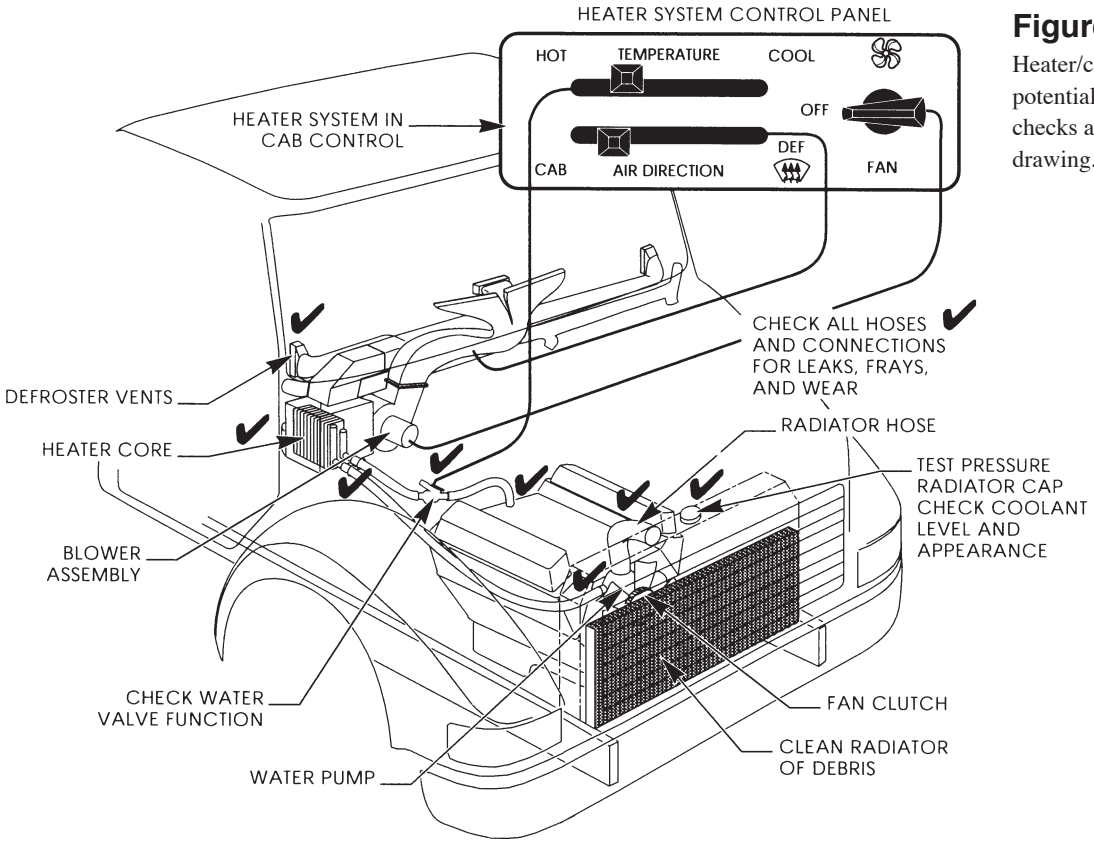



**Figure 7-8**
Heater/cooling system potential problem areas and checks are indicated in this drawing.

### 2. Inspect Other Functions

There are some things you can't see or feel when you inspect the thermostat, heater core, radiator pressure cap, electrical switch and control valve functions. Some of these can be checked with the pressure and thermostat testers as described in *Chapter 6*. A hand pump pressure tester can also be used to check for coolant leaks. This is done by using the pump to raise the pressure inside the system above normal operating pressure to force small suspected leaks to show up.

Heater/cooling electrical and valve component inspection is the same as air conditioner inspection. The controls are operated to see if they function correctly to maintain or vary cab temperature and air flow.

## Preventive Maintenance Worksheet

Please feel free to modify or copy the worksheet in Figure 7-9. Actual vehicle use, mileage, operating conditions and maintenance budget may influence service frequency.

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## Chapter Review

The purpose of these brief inspection procedures is for vehicle system maintenance and to determine if further, more detailed service is required. The uses of a manifold gauge set, system troubleshooting, recovery, flushing, evacuating and charging are explained in the next chapter.

High usage and operating condition variations are tough on air conditioning and heater components. You should establish and follow regular inspection and maintenance procedures to improve overall system function and component service life.

The typical inspection should not take more than 15 to 20 minutes unless component replacement and/or complete system evacuation and recharging is warranted. The survey results shown in Figure 7-1, indicate belts, compressor clutch assembly, condenser and the refrigerant lines are the most frequent problem areas. However, your own experience with service and maintenance may vary from survey results.

Inspection should first be visual and by feel. Some of your electrical system inspection will be done as you inspect other components (checking leads, connections and for loose wires). When you check the electrical circuit, begin with the engine off but ignition on. A system performance inspection with the engine running and system on really combines electrical and AC or heater system function.

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**Figure 7-9** Preventive Maintenance Schedule.

# PREVENTIVE MAINTENANCE SCHEDULE FOR AIR CONDITIONING SYSTEMS

**NOTE: Typical Maintenance Schedule:** 3 months or 15,000 miles, 6 Months or 30,000 miles, 12 Months or 60,000 miles

Installation Date: _____ Mileage: _____

Last Maintenance Check: _____ Mileage: _____

Checked by _____ Mileage: _____

| COMPONENT | MAINTENANCE INTERVAL (months) | | | DONE |
|---|---|---|---|---|
| | 3* | 6* | 12* | |
| **1. COMPRESSOR** | | | | |
| Check noise level | • | | | ❑ |
| Check clutch pulley | • | | | ❑ |
| Check oil level | • | | | ❑ |
| Run system 5 minutes | • | | | ❑ |
| Check belts for tension (120 lb max.) | • | | | ❑ |
| Inspect shaft seal (leakage) | | • | | ❑ |
| Check mounting bracket (tighten bolts) | | • | | ❑ |
| Check alignment to clutch w/crankshaft drive pulley | | • | | ❑ |
| Perform manifold gauge check | | | • | ❑ |
| Verify clutch is engaging | | | • | ❑ |
| **CONDENSER** | | | | |
| **2.** Clean dirt/bugs/leaves from coils (w/compressed air) | • | | | ❑ |
| Check inlet/outlet for obstructions/damage | • | | | ❑ |
| **RECEIVER-DRIER** | | | | |
| **3.** Check inlet line from condenser (hot to touch) | • | | | ❑ |
| Check sight glass (streaks or cloudiness) | • | | | ❑ |
| Replace if system is opened | | | • | ❑ |

| COMPONENT | MAINTENANCE INTERVAL (months) | | | DONE |
|---|---|---|---|---|
| | 3* | 6* | 12* | |
| **4. EXPANSION VALVE** | | | | |
| Inspect capillary tube (leakage/damage/looseness) | | | • | ❑ |
| **5. EVAPORATOR** | | | | |
| Clean dirt/bugs/leaves form fins/tubes (w/compressed air) | | | • | ❑ |
| Check solder joints on inlet/outlet tubes (leakage) | | | • | ❑ |
| Inspect condensate drain (R-12 or oil leak) | | | • | ❑ |
| **6. OTHER COMPONENTS** | | | | |
| Check discharge lines (hot to touch) | • | | | ❑ |
| Check suction lines (cold to touch) | • | | | ❑ |
| Inspect fittings/clamps/hoses | | • | | ❑ |
| Check thermostatic switch (proper operation) | | | • | ❑ |
| Outlets in cab (temperature check; 40 to 50°F) | | • | | ❑ |
| Check fan clutch (proper operation) | | • | | ❑ |
| Inspect all wiring connections | | • | | ❑ |
| Operate manual controls through full functions | • | | | ❑ |

**The following require monthly maintenance:**

*Compressor – run system at least 5 minutes (40 degrees Fahrenheit minimum outside temp.) in order to circulate oil and lubricate components.

**Maintenance notes:** _____

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# Troubleshooting & Service Procedures

*Click on any of these subject headings to go directly to the page*


- Troubleshooting Overview
- Understanding System Function
- A Troubleshooting Example
- Manifold Gauge Set Installation
- Troubleshooting by Manifold Gauge Set Readings
- Review of Frequent Problem Areas
- Conclusion


**Can you fix an air conditioner or heater system without finding and correcting the cause of the problem? You bet you can!** It happens every day and it's not good for business. Here is an example. A truck pulls in off the road and the operator asks to have his rig serviced in a hurry. He tells you the air conditioner isn't cooling like it should and dashes into the restaurant for lunch.

You tip the hood, and check the sight glass on top of the receiver-drier. You see bubbles, not a lot but a fairly constant stream of them. It is obvious the system is low on refrigerant so you hook up the manifold gauge set, purge the gauge set hoses of air, and add refrigerant until the sight glass clears. Then you check evaporator temperature and it's OK. **The air conditioner is repaired right?** Wrong! What you did is add refrigerant and the problem went away. You did not find and fix the cause of the problem.

Component failure in an air conditioning system may be the result of a problem elsewhere in the system. For example, a belt or clutch failure might be caused by a dirty condenser restricting air flow and increasing head pressures. High head pressures commonly create problems with other system components. **Take time to look beyond the obvious for a potential hidden problem**.

## Troubleshooting Overview

Troubleshooting includes collecting enough information to locate the cause of the problem, then correcting the problem and its cause by replacement, adjustment, and/or repairing. You begin by gathering information from the most to the least important sources.

Starting with the most important:

1. Your personal knowledge and experience with AC systems.
2. The vehicle operator's knowledge and experience—question him or her.
3. The work order.
4. Good test equipment and the HVAC system

The routine you follow when troubleshooting should proceed from the most to least productive way of locating the problem and fixing the cause.

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Experienced troubleshooters talk to the operator if they can, then personally verify the symptoms of the problem whenever possible. They attempt quick fixes on the basis of their knowledge of common system problems and causes when appropriate. They know where components are located, and make repairs when they have a good idea of what the problem is. They fix the cause or causes as well as the problem. They are confident of their knowledge and ability.

**Note:** **The best troubleshooters all know who to call when they get stuck.** They know someone who knows more than they do and are not too proud to ask for help or suggestions when needed. The key—understanding system function

## The Key–Understanding System Function

**Your complete understanding of AC and heater systems and how they work, plus what can go wrong, is the key to troubleshooting and repair.** We have talked about components and system function before. Now let's take a little different approach in describing what happens when the air conditioner is turned on. In Figure 8-1 we have used numbers on the illustration to track normal air conditioner function.

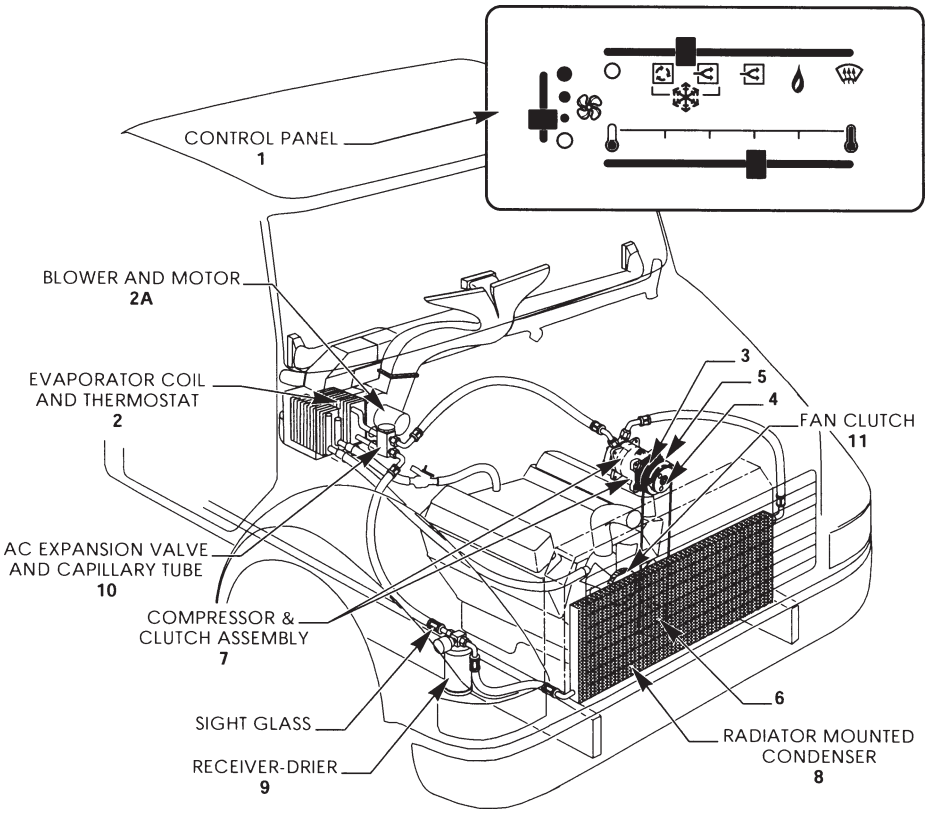



**Figure 8-1**
An illustration of the typical HVAC system. The numbers follow the action when the AC part of the system is working properly (moving heat out of the cab and into the outside air).

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When you turn on the air conditioner at the control panel (1), the thermostat (2), is supposed to sense a warm temperature at the evaporator. A circuit in the thermostat should close, allowing current to flow through the thermostat to the compressor clutch field coil (3). When this happens, the clutch field coil becomes an electromagnet and pulls the clutch drive plate (4) tight against the clutch pulley (5).

**Note:** The same AC switch (1) may also turn on the fan or blower motor (2a) to circulate air in the cab. The air feels warm at first but will cool quickly.

A belt connects the clutch pulley to a drive pulley (6) on the engine. The engine provides the power to turn the clutch pulley and drive the compressor (7) when the clutch is engaged. When operating, the compressor compresses and pushes refrigerant gas to the condenser (8), through the receiver-drier (9), and to the expansion valve (10) orifice. When it does, it puts a lot of pressure on the gas. The compressor raises the temperature and pressure of the refrigerant inside the high side of the system.

At the same time, the compressor is also sucking in low pressure refrigerant gas from the expansion valve orifice, evaporator and through the low side of the system. The movement of the refrigerant inside the system transfers heat energy from the cab to the outside air for occupant comfort.

The automatic functions of the thermostat (or the pressure valve on some accumulators), and the expansion valve, help maintain pressures and temperatures inside the system at safe and efficient operating levels. Pressure and temperature are constantly changing due to compressor and expansion valve action, the amount of heat energy being moved and the environment or weather conditions.

The engine cooling system fan and clutch (11), and the evaporator blower motor (2a), move a sufficient amount of air through the condenser and evaporator. On the road, vehicle speed provides most of the (ram) air required for the condenser to work right. In a parked or slow moving vehicle the engine fan (or roof or remote mounted condenser and fans) moves sufficient air through the condenser fins.

**Note:** Clean refrigerant and refrigeration oil should be inside the system in the amount specified by the manufacturer. Moisture, sludge (moisture combined with refrigerant oil or desiccant), or desiccant particles will prevent the correct performance of the system and may cause component damage.

## A Troubleshooting Example

Remember the story at the beginning of this chapter? The vehicle operator pulled in off the road and asked you to repair the rig. He was in such a hurry he didn't tell you anything except that the air conditioner wasn't cooling. Here is the best way to handle that kind of situation.

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Use your knowledge and experience. Ask yourself what could have caused a lack of cooling in that rig! Did the compressor drive belt break? Did a pressure switch or relief valve cutout the compressor because of high or low system pressure? Does the switch or valve in this type of system reset itself? Could there be a superheat switch and thermal limiter with a melted fuse. Did someone else service the system recently and put in too much refrigerant?

Could there be contaminants in the system blocking the expansion valve (expansion tube)? If there is a leak, why and how did refrigerant get out of the system? You know if refrigerant can get out, air and moisture may get inside as well, especially if the leak is on the suction side of the system. Could there be a restriction to refrigerant flow in one of the high pressure lines because of a kink? From your knowledge and experience, you already know about these possibilities and others when you talk to the operator (before he has the chance to leave).

The right kind of questions can speed up troubleshooting and your service work by pinpointing the problem(s) that needs fixing. Your conversation with the operator might be as follows:

- *How long ago did the AC system stop cooling?*
  **Answer:** About an hour ago.

- *What steps did you take when you noticed the lack of cooling?*
  **Answer:** I put it on maximum cool.

- *Then what did you do?*
  **Answer:** When it wouldn't cool, I opened the window and turned the air conditioner off.

- *Is this problem new or has it happened before, and when?*
  **Answer:** In the last few days I've had problems with cooling off and on—this is the first time it's happened when I was close to a place that did AC service.

- *Do you get any cooling at all?*
  **Answer:** Yes but it seems to quit after a while.

- *Do you still get air flow at the vents from the blower?*
  **Answer:** Yes.

- *When was your air conditioner checked thoroughly?*
  **Answer:** Before I bought the rig last May (a year ago).

- *Has the heater been used recently and did it work OK?*
  **Answer:** Yes.

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- *Have you had other service problems in the last few months?*
  **Answer:** No.

- *(If the answer was yes, you should ask—When? Where? What was fixed or replaced?).*

- *Finally, ask the operator if he or she has a wiring diagram for the system.*

Now let's look at the information you have gathered from the operator and what you know from experience. He believes the problem is that the AC system quits cooling after it has been on for a while! You know that the AC system has not been maintained since the rig was purchased a year ago. Because of that, there could be several causes for the problem (lack of cooling) and there may be other potential problems about to develop.

It is possible that some refrigerant has leaked. Moisture and other contamination may be inside the system. You have been told there are no heater problems, but that doesn't mean there are none that might affect AC system operation. The AC system has quit cooling several times in the last few days. The problem may have become more severe than when it quit cooling the first time.

If enough refrigerant or oil has leaked out, a low pressure cutout switch may have cut the circuit to the clutch, protecting the compressor. Because the system has not been maintained in a year, there may be other components that should be serviced. You could fix the probable causes, and the system might work and then break down again as the rig drives out of your place. From your knowledge and what the operator has just told you, you know this may not be a quick fix problem.

It's up to you to describe the service situation to the operator. Tell him you need to do a complete system maintenance inspection to find and correct the problem or other potential problems. He can give you the go ahead for full service and repair now, wait till you have inspected the system to determine cause and cost, or delay repair until he has some down time available.

Normally when the operator can tell you what the problem is, you would first operate the system to verify the problem. In this situation your troubleshooting (your own knowledge added to what the operator told you), indicates the next step. You need to do a complete maintenance inspection instead! Proceed as described in *Chapter 7*. Correct any obvious problems and check carefully for leaks. Leak testing should be visual, by feel and with a leak detector. Next, do your performance test with the engine running and the AC system on.

**Note:** Don't forget to check the heater system too! If the water valve is not closed, then hot engine coolant flowing through the heater core would warm the air at the same time the evaporator was trying to cool it. The result would be the appearance of an AC problem.

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If your AC and heater visual, electrical and leak inspections don't turn up any problems, save time by hooking up the manifold gauge set before you make the performance test. If you find a leak and can correct it easily by tightening a connection, do so. But if too much refrigerant leaked out, you may have to add some refrigerant to the system for an effective performance test. We will get into detail on troubleshooting with gauges after we explain manifold gauge set installation and adding refrigerant.

## Manifold Gauge Set Installation

**CAUTION** Never hook up the gauge set when the engine and air conditioner are running. Be sure all the valves on the manifold are closed all the way (turn them clockwise). Check the hose connections on the manifold for tightness.

Locate the low and high side system service fittings and remove their protective caps. Position or hang the manifold gauge set in a convenient location. Figure 8-2 illustrates a good example of manifold gauge set hookup in one service situation.

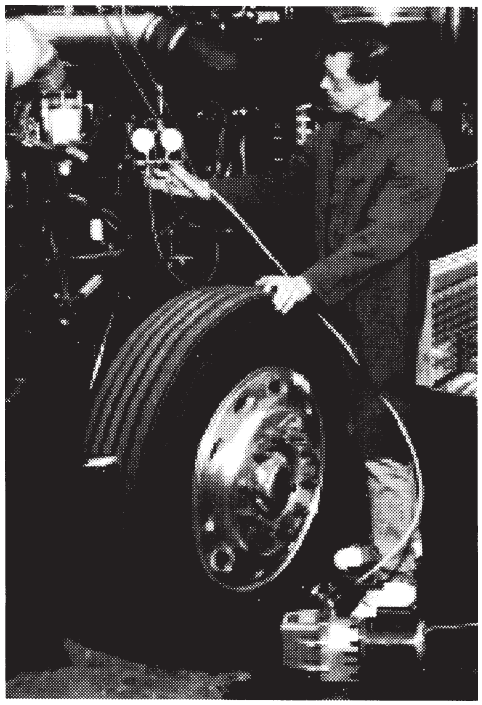


**Figure 8-2**
A typical manifold gauge set hookup is shown in this illustration. The center hose on the gauge set is connected to the vacuum pump.

The manifold gauge set is a necessary tool in troubleshooting AC system problems. The following steps are performed during and after installing the manifold gauge set:

1. Purging Air from the Gauge Set Hoses
2. Adding Refrigerant to the System
3. Stabilizing the AC System.

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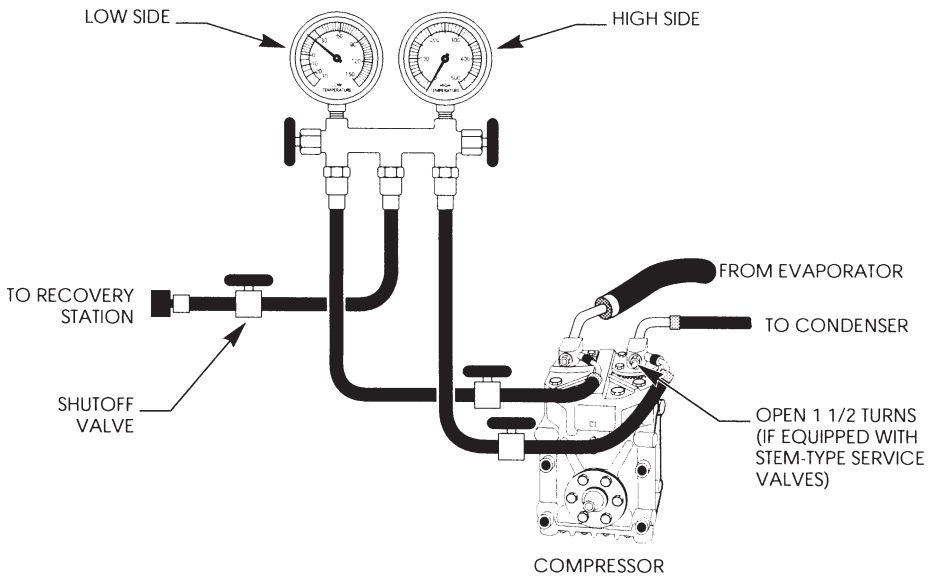
### 1. Purging Air From Gauge Set Hoses

Environmental regulations require that all service hoses have a shutoff valve within 12 inches of the service end. These valves are required to ensure only a minimal amount of refrigerant is lost to the atmosphere. R-12 gauge set hoses have a valve near the end of all three hoses. R-134a gauge sets have a combination quick disconnect and shutoff valve on the high and low sides. The utility (center) hose also requires a valve.

The initial purging is best accomplished when connected to recovery or recycle equipment. Figure 8-3 illustrates the gauge set connections for purging and refrigeration recovery.

**Figure 8-3**

The purging setup for manifold gauge set and compressor service valves are shown here.




**Note:** The manifold gauges read system pressure when the hand valves are closed if the hose end valves, and the stem type service valves (if included) are open.

### 2. Adding Refrigerant to the System

Now that the gauges are connected, you may need to add some refrigerant to the AC system before you can do an effective performance inspection. However, if leaks are obvious they should be repaired prior to adding refrigerant.

**Note:** Loss of some refrigerant is not unusual over an extended period of time. Adding refrigerant is a typical procedure when the AC system is maintained on a regular basis.

When adding refrigerant to the system, connect the center hose from the manifold gauge set to the refrigerant dispensing valve on the container. Figure 8-4 illustrates this connection.

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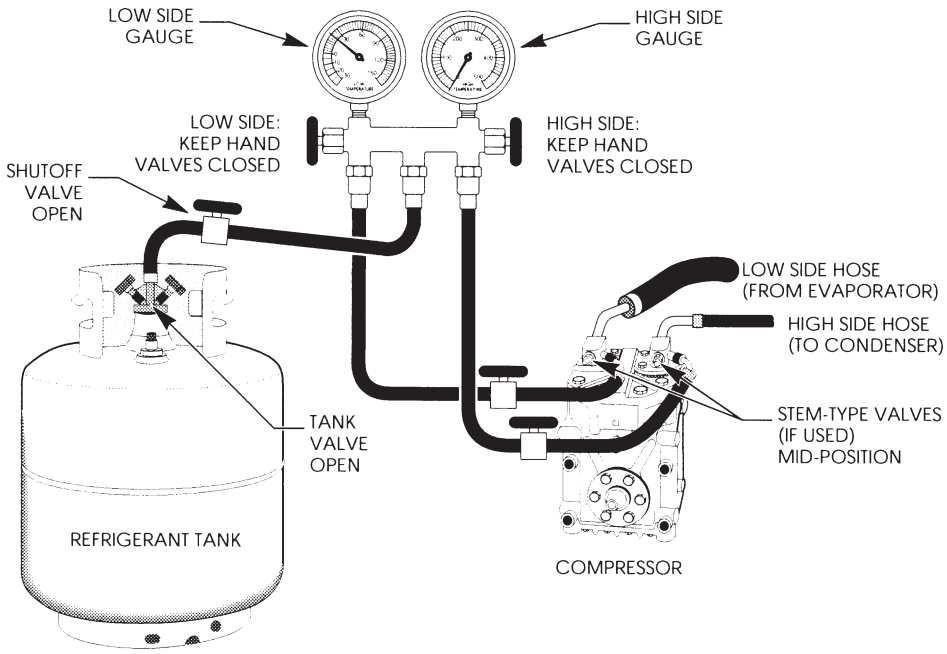



**Figure 8-4**
In this illustration we have noted how refrigerant is added to the air conditioner.

Before adding refrigerant to the system you should study the sight glass while the engine is running and the air conditioner is on. Even if you found a leak during the system inspection and corrected it, you have no way of knowing how much refrigerant has leaked. You will not be able to tell how much refrigerant is in there, but you can see if bubbles are present.

Then check the gauges for unusually high or low readings, or a lack of pressure. Following this procedure, and using your knowledge and experience, decide if it is safe and makes sense to add refrigerant in order to make your full performance inspection.

You are now ready to add refrigerant to the system. For your safety and to prevent system damage use the following procedure.

**1.** Turn on the engine and set the idle at 1200 to 1500 RPM and then turn on the air conditioner.

**CAUTION** Do not open the high pressure hand valve on the manifold gauge set. The compressor could pump refrigerant into the container and cause it to BURST. Be sure to keep the refrigerant container upright to prevent liquid refrigerant from entering the compressor.

**2.** Open the refrigerant dispensing valve on the container and then the low pressure hand valve on the manifold. This allows refrigerant to enter the system as a gas on the low pressure or suction side of the compressor. The compressor will pull refrigerant into the system.

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**3.** Add refrigerant until the gauges read in the normal range and the sight glass appears clear. The sight glass may not be clear for a moment just before or after the clutch cycles on and off but should generally be clear. Gauge readings will fluctuate as the compressor cycles on and off.

**Note:** Pressures within the air conditioning system vary with ambient temperature. A normal pressure range is defined as follows:

Low side 15–30 PSIG
High side 150–280 PSIG

If R-134a is used in place of R-12 the high side readings will be about 20 PSI higher. For this reason many OEMs are recommending an increase in condenser capacity when retrofitting to the new refrigerant, R-134a.

**CAUTION** If the gauges show any abnormally high or low pressures as you are adding refrigerant, stop and investigate for probable cause. Never add more than one pound of refrigerant. If the system is low enough on refrigerant to require more than that amount you should stop and check again for leaks. Then recover all of the refrigerant, repair, evacuate and recharge the air conditioner. (See *Chapter 9*). You may want to add dry nitrogen gas to the AC system instead of R-12 if pressures are below normal and a leak is suspected. Nitrogen gas is sold in cylinders under high pressure, 1800 to 2000 PSI. Be sure the cylinder has a pressure regulating valve to control the pressure when dispensing nitrogen gas. Dispose the gas at no more than 200-250 psi, as this is sufficient pressure to cause or indicate a leak point. See note under *Troubleshooting by Manifold Gauge Set Readings* in this chapter.

**4.** When the gauges show normal, close the hand valve on the manifold, the hose end shutoff valve, and the valve on the refrigerant container. You can now proceed with the performance inspection.

### 3. Stabilizing The AC System

For reliable gauge readings as an aid in troubleshooting, the AC system must be stabilized.

**CAUTION** Be sure your tools and test equipment are clear of all moving parts of the engine and air conditioner.

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Start the engine and set to a fast idle of 1200 to 1500 RPM. Turn on the air conditioner. After a quick in-cab performance test of control function, blower speeds and air flow, set the AC system controls to maximum cooling and blower speed on high. All windows must be closed. If cab temperature is hot (rig has been sitting in the sun with the windows closed), open the windows for a minute or so to let the hot air out. Run the engine and air conditioner about five minutes for the system to stabilize. In hot humid weather or where the AC condenser can't receive adequate air flow from the engine fan you may have to use a floor mounted fan to force sufficient air flow through condenser fins. This helps to stabilize the system by simulating ram air flow found under normal operating conditions.

When a vehicle has a tilt cab or hood and the condenser is part of the grill, you must use the floor fan to get air to the condenser. You could tilt the cab or hood back to normal position, carefully routing the manifold gauge set and hoses away from moving parts. Then place the gauges so you can read system pressure.

## Troubleshooting by Manifold Gauge Set Readings

The series of figures that follow (Figures 8-6 through 8-15) show gauges with typical readings indicating AC system problems. Each figure is followed by troubleshooting tips, probable causes for the gauge readings shown, and appropriate service and repair procedures.

### Low Refrigerant Charge in the System

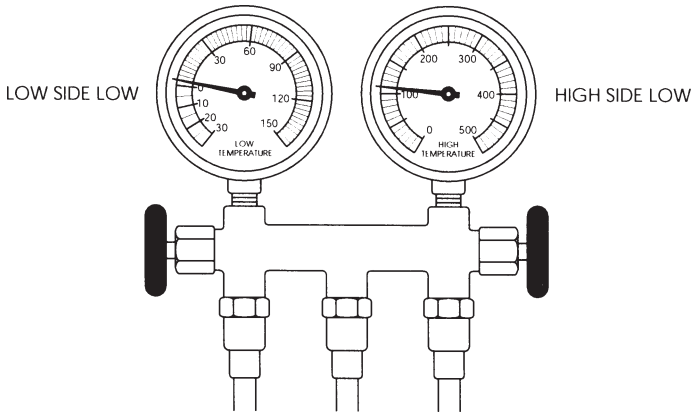



**Figure 8-5**
Gauge reading, low refrigerant charge in the system.

**Tip:** You see bubbles in the sight glass. The air from vents in the cab is only slightly cool.

**Cause:** Insufficient refrigerant (charge) in the system.

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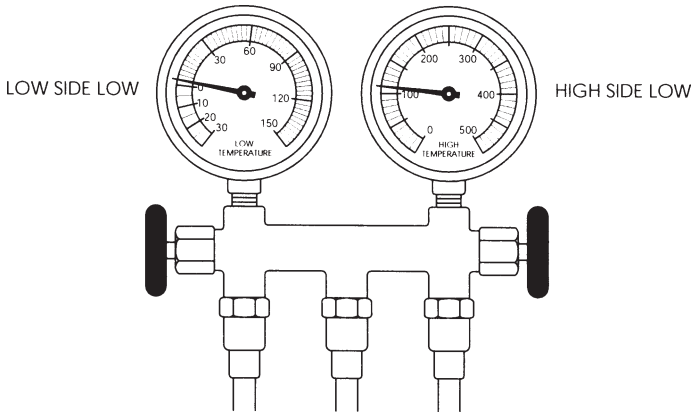
**Repair Procedure:**

Check for leaks with your leak detector. If you find a leak at a connection, tighten it then add refrigerant as necessary. If a component or line is leaking (defective), recover all refrigerant from the system. Replace the defective part and then check the compressor oil level and replace missing oil. Evacuate and recharge with refrigerant, then check AC operation and performance.

**Figure 8-6**

Gauge reading, extremely low refrigerant charge in system.

### Extremely Low Refrigerant Charge in the System




**Tip:** The sight glass is clear or shows oil streaks. The air from vents in the cab seems warm. If there is a low pressure or Trinary™ switch in the system it may have shut off the compressor (clutch).

**Cause:** Extremely low or no refrigerant in the system. There is a leak in the system.

**Repair Procedure:**

Add refrigerant to the system, at least half of the normal full charge amount. Then perform your leak test. As an alternative to a refrigerant, add dry nitrogen gas to the system and then test for leaks.

**Note:** It may be necessary to use a jumper wire to bypass some types of low pressure cutout switches to operate the compressor (clutch) when you add refrigerant to the system.

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After finding a leak, recover all refrigerant from the system and repair the leak. Check the compressor and replace any refrigeration oil lost due to leakage. Evacuate and recharge the system with refrigerant, then check AC operation and performance.

### Air and/or Moisture in the System

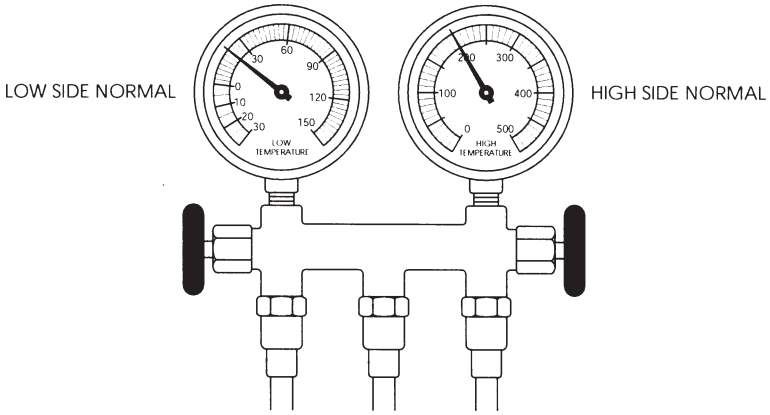



**Figure 8-7**
Gauge reading, air and/or moisture in the system.

**Tip:** The sight glass may be clear or show some bubbles. The air from vents in the cab is only slightly cool. In a cycling clutch type system with a thermostatic switch, the switch may not cycle the clutch on and off, so the low pressure gauge will not fluctuate.

**Cause:** Air and/or moisture in the system.

**RepairProcedure:**

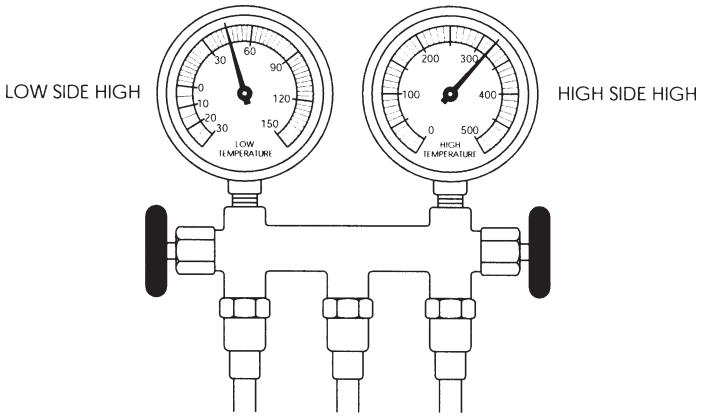
Test for leaks, especially around the compressor shaft seal area. When the leak is found, recover refrigerant from the system and repair the leak. Replace the receiver-drier or accumulator because the desiccant may be saturated with moisture (there is no way to tell). Check the compressor and replace any refrigeration oil lost due to leakage. Evacuate and recharge the system with refrigerant, then check AC operation and performance.

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**Figure 8-8**
Gauge reading, excessive air and/or moisture in the system.

### Excessive Air and/or Moisture in the System




**Tip:** There may be occasional bubbles in the sight glass. Air from vents in the cab is only slightly cool.

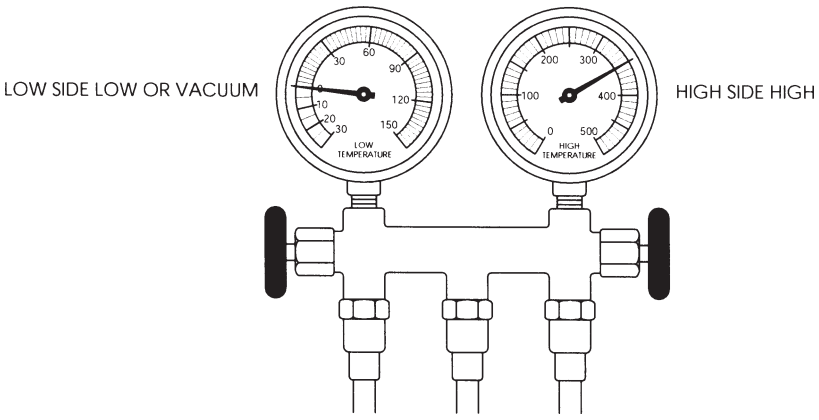
**Cause:** System contains excessive air and/or moisture.

**Repair Procedure:**

Test for leaks, recover refrigerant from the system and repair the leak. Depending on the type of system, replace the receiver-drier or accumulator. The desiccant is saturated with moisture. Check and replace any compressor oil lost due to leakage. Evacuate and recharge the system, then check AC operation and performance.

**Figure 8-9**
Gauge reading, expansion valve (TXV) stuck closed.

### Expansion Valve (TXV) Stuck Closed or Plugged




**Tip:** Air from vents in the cab is only slightly cool. The expansion valve body is frosted or sweating.

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**Cause:** An expansion valve malfunction could mean the valve is stuck in the closed position, the filter screen is clogged (block type expansion valves do not have filter screens), moisture in the system has frozen at the expansion valve orifice, or the sensing bulb is not operating. In vehicles where the TXV and sensing bulb are accessible, perform the following test. If not accessible, then proceed to *Repair Procedure*.

**Test:**

1. Warm diaphragm and valve body in your hand or carefully with a heat gun. Activate system and watch to see if the low pressure gauge rises.

2. Next, carefully spray a little nitrogen, or any substance below 32 degrees Fahrenheit, on the capillary coil (bulb) or valve diaphragm. The low side gauge needle should drop and read at a lower (suction) pressure on the gauge. This indicates the valve was part way open and that your action closed it. Repeat the test, but first warm the valve diaphragm or capillary with your hand. If the low side gauge drops again, the valve is not stuck.

3. Clean the surfaces of the evaporator outlet and the capillary coil or bulb. Make sure the coil or bulb is securely clamped to the evaporator outlet tube and the insulation is in place. Next proceed with recovering refrigerant from the system.

**Repair Procedure:**

Inspect the expansion valve screen (except block type valves). To do this you must recover all refrigerant from the system. Disconnect the inlet hose fitting from the expansion valve. Remove, clean and replace the screen, then reconnect the hose. Any signs of contamination will **require** flushing the system. Next, replace the receiverdrier. Then evacuate and recharge the system with refrigerant, and check AC operation and performance.

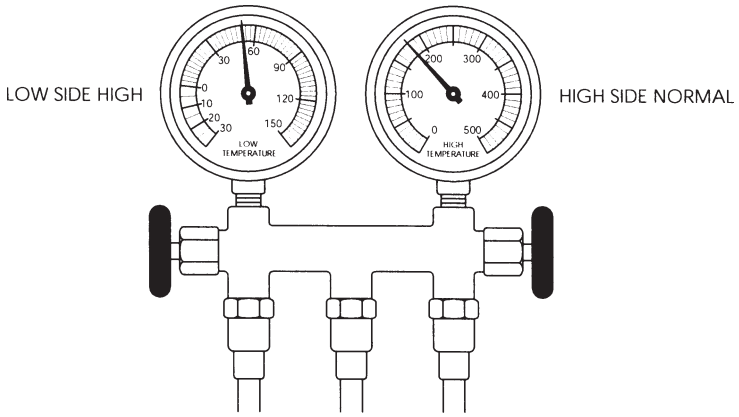
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**Note:** If the expansion valve tests did not cause the low pressure gauge needle to rise and drop, and if the other procedures described did not correct the problem, the expansion valve is defective. You must recover all refrigerant from the system again, and replace the expansion valve and receiver-drier. Evacuate and recharge the system with refrigerant, then check AC operation and performance.

**Figure 8-10**
Gauge reading, expansion valve (TXV) stuck open.

### Expansion Valve (TXV) Stuck Open




**Tip:** Air from vents in the cab is warm or only slightly cool.

**Cause:** The expansion valve is stuck open and/or the capillary tube (bulb) is not making proper contact with the evaporator outlet tube. Liquid refrigerant may be flooding the evaporator making it impossible for the refrigerant to vaporize and absorb heat normally. In vehicles where the TXV and sensing bulb are accessible, check the capillary tube for proper mounting and contact with the evaporator outlet tube. Then perform the following test. If the TXV is not accessible, then proceed to *Repair Procedure*.

**Test:**

1. Operate the AC system on it's coldest setting for a few minutes. Carefully spray a little nitrogen or other cold substance, on to the capillary tube coil (bulb) or head of the valve.

2. The low pressure (suction) side gauge needle should now drop on the gauge. This indicates the valve has closed and is not stuck open. Repeat the test, but first warm the valve diaphragm with your hand.

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3. If the low side gauge shows a drop again, the valve is not stuck. Clean the surfaces of the evaporator outlet and the capillary coil or bulb. Make sure the coil or bulb is securely fastened to the evaporator outlet and covered with insulation material. Operate the system and check performance.

**Repair Procedure:**

If the test did not result in proper operation of the expansion valve, the valve is defective and must be replaced. Recover all refrigerant from the system and replace the expansion valve and the receiver-drier. Evacuate and recharge the system with refrigerant, then check AC operation and performance.

### System High Pressure Side Restriction

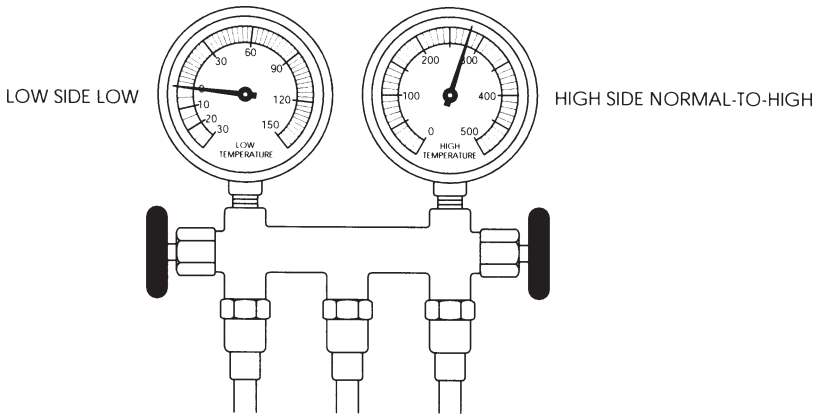



**Figure 8-11**
Gauge reading, system high pressure side restriction.

**Tip:** Air from vents in the cab is only slightly cool. Look for sweat or frost on high side hoses and tubing, and frost appearing right after the point of restriction. The hose or line may be cool to the touch near the restriction.

**Cause:** There could be a kink in a line, or other restriction in the high side of the system.

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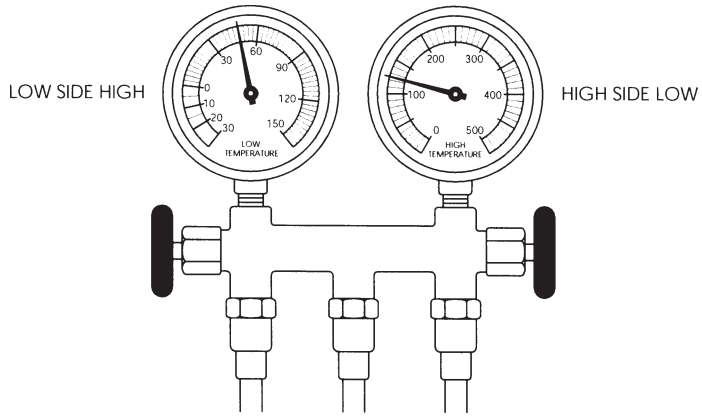


**Repair Procedure:**

After you locate the defective component containing the restriction, recover all of the refrigerant. Replace the defective component and the receiver-drier. Evacuate and recharge the system with refrigerant, then check AC operation and performance.

## Compressor Malfunction

**Figure 8-12**
Gauge reading, compressor malfunction.




**Tip:** The compressor may be noisy when it operates.

**Cause:** Defective reed valves or other compressor components. If the compressor is not noisy, there may be a worn or loose compressor clutch drive belt.

**Repair Procedure:**

If you find the belt worn or loose, replace or tighten it and recheck system performance and gauge readings. To inspect and service the compressor, you must isolate (front seat the stem type compressor service valves) and recover refrigerant, or fully recover R-12 from systems containing Schrader valves. Remove the compressor cylinder head and check the appearance of the reed valve plate assembly. If defective, replace the valve plate and install with new gaskets, or replace the compressor assembly.

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If you find particles of desiccant in the compressor, remove and replace it and the receiver-drier. Before doing so, back flush other system components (except the expansion valve) using a flushing kit. If there are stem type valves and you isolate the compressor, the rest of the system must be purged of refrigerant before you can disconnect and flush system components (*Chapter 9* describes the flushing procedure). After flushing, reassemble the components. Always check the oil level in the compressor, even if you install a new or rebuilt unit. Tighten all connections and evacuate the system. Recharge the air conditioner with refrigerant and check system operation and performance.

**Note:** Rotary compressors have a limited oil reservoir. Extra oil must be added for all truck installations

### Condenser Malfunction or System Overcharge

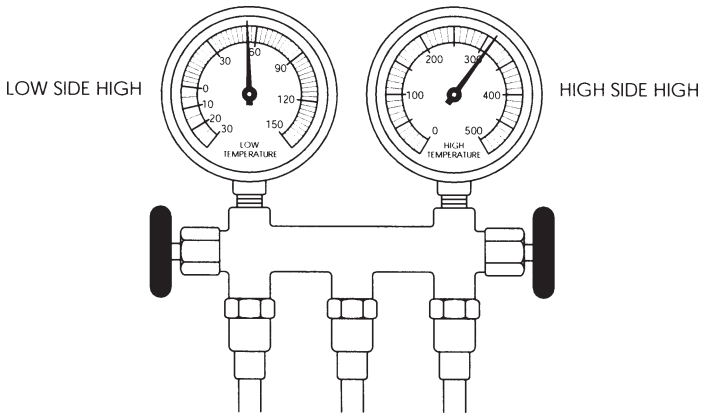



**Figure 8-13**
Gauge reading, condenser malfunction or system overcharge.

**Tip:** The air from vents in the cab may be warm. In R-12 systems there can be bubbles in the sight glass. The high pressure hoses and lines will be very hot. Don't forget to check the engine cooling system components—fan and drive belt, fan clutch operation, and the radiator shutter.

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**Cause:** The condenser is not functioning correctly or there may be an overcharge of refrigerant inside the system. Another possibility is lack of (ram) air flow through the condenser fins during testing. Engine cooling system component malfunction can cause high pressure by blocking air flow (radiator shutter) or not providing air flow (fan clutch) in sufficient quantity.

**Repair Procedure:**

Inspect the condenser for dirt, bugs or other debris and clean if necessary. Be sure the condenser is securely mounted and there is adequate clearance (about 1-1/2 inches) between it and the radiator. Check the radiator pressure cap and cooling system, including the fan, fan clutch, drive belts and radiator shutter assembly. Replace any defective parts and then recheck AC system operation, gauge readings and performance.

If the problem continues, the system may be over- charged (have too much refrigerant inside). Recover the system slowly until low and high pressure gauges read below normal, and bubbles appear in the sight glass. Then add refrigerant (charge the system) until pressures are normal and the bubbles disappear. Add another quarter to half pound of refrigerant and recheck AC system operation, gauge readings and performance.

If the high gauge readings do not change, you should recover all of the refrigerant and flush (it may be partially plugged) or replace the condenser. Also replace the receiver-drier or accumulator. Then connect the components and evacuate the system. Recharge the air conditioner with refrigerant and check system operation and performance.

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### Thermostatic Switch Malfunction

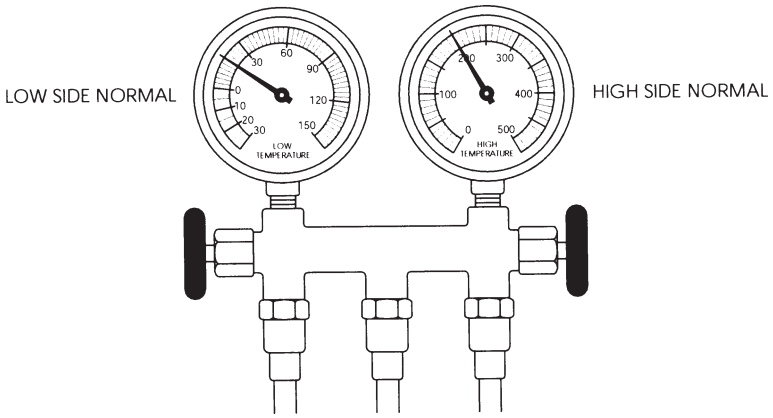



**Figure 8-14**
Gauge reading, thermostatic switch malfunction.

**Tip:** The low side gauge needle may fluctuate in a very narrow range compared to a normal range. The compressor clutch may be cycling on and off more frequently than it should.

The low side gauge needle may fluctuate in an above normal range as the clutch cycles. This may be an indication that the thermostat is set too high (someone may have attempted to adjust the factory setting). A new thermostat may have been installed incorrectly (capillary tube not inserted between the evaporator fins in the proper position).

**Cause:** The thermostatic switch is not functioning properly or at all.

**Repair Procedure:**

Replace the thermostatic switch. When you remove the old thermostat, replace it with one of the same type. (They operate in a factory preset temperature range.) Take care in removing and handling the thermostat and thin capillary tube attached to it. Don't kink or break the tube.

Position the new thermostat capillary tube at or close to the same location and seating depth between the evaporator coil fins as the old one. Connect the electrical leads.

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**Note:** See the *Thermostat* section in *Chapter 10*. Fan clutch, radiator shutter, condenser, compressor, and the newer air and water valve control systems are covered in *Chapter 10*.

## Review of Frequent Problem Areas

In HVAC systems a limited number of things can go wrong. Moving parts of the compressor, clutch, and expansion valve or refrigerant metering device can malfunction or break down from metal fatigue, contamination, abnormal pressure or lack of lubrication. Electrical connections may corrode, become disconnected or break. Fuses blow from shorts or overload. Belts slip or break.

Vibration from the engine or road surface can work bolts and air or vacuum lines loose, or rub and break or wear parts out. Motors may burn out. The inside of the system can become contaminated from moisture, air or desiccant material breakdown. Refrigerant may leak out of the system quickly or very slowly. Moisture in the system can combine with refrigerant to form acid and attack (corrode) metal parts from the inside. Moisture and refrigeration oil can combine to form sludge that may block refrigerant flow.

The following problems are discussed in more detail in this section:

1. Belts and Compressor Clutch
2. Condenser
3. Refrigerant Lines, Hoses, and Fittings
4. Refrigerant Metering Valves
5. Other Problems

### 1. Belts and Compressor Clutch

Let's review problem areas listed at the beginning of *Chapter 7*. The most frequent repairs are replacing belts and servicing or replacing the compressor or clutch. Heavy duty vehicle operation puts a lot of stress on these parts. There are several main reasons.

There is often continuous operation for long periods of time. There may be frequent sudden RPM variations when shifting gears up or down. For this reason the AC clutches used in heavy duty systems usually have double row ball bearings. Vibration and road shock contribute to loose or broken mounting brackets, electrical connections and fittings. Belts, bearings and compressor reed valves wear out.

Various compressor clutch cutout switches are used because the AC designers know about compressor operating conditions. System leaks, high operating pressures, malfunctioning engine cooling system components—all cause compressor problems and failures. When refrigerant and refrigeration oil leaks out of a system or there is contamination blocking oil flow, the compressor will be starved for oil and seize.

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### 2. Condenser

Condensers get dirty and the dirt reduces heat movement by insulating the condenser. The fittings come loose or break from stress if the condenser or connecting hoses are not secured properly to keep the effects of vibration at a minimum.

Heat transfer efficiency and pressure in the condenser are affected by the amount of outside air flowing through condenser fins. A lack of air flow can mean the refrigerant doesn't give up enough heat energy to the outside air (it doesn't change state). The refrigerant arrives at the evaporator as a gas and can't pick up any heat energy from cab air. In the cab, air from the vents is only slightly cool or warm.

One possible cause of condenser malfunction could be the engine cooling system. This is why fan clutches and radiator shutters are often controlled or overridden by AC switch function. In fact, we can add fan clutch, radiator shutters and also fan motors to condenser problems. If they don't function to allow sufficient air through the condenser, pressure inside the system may become dangerously high. A lack of air through the condenser fins can raise high side pressure and blow out the weakest point in a system, or damage the compressor.

### 3. Refrigerant Lines, Hoses and Fittings

Problems with these parts may be caused by normal deterioration, vibration damage, lack of maintenance or human error (improper installation or replacement). All rubber parts are attacked by ozone (oxygen) in the air. Rubber parts break down slowly and become more vulnerable to the effects of vibration with the passage of time.

Heavy duty vehicle vibration causes stress on all lines, fittings and connections. Regular maintenance includes checking and tightening any suspect line, or hose retainers, or grommet position where the grommet is protecting a line or hose from abrasion. Any insulating material wrapped around hoses must be in place and securely fastened.

### 4. Refrigerant Metering Valves

When you consider valve problems there are obvious differences in valve construction and what can go wrong. If a valve is clogged with sludge or other obstruction, the result is a valve problem but the cause is contamination in the system. Valves get stuck open or closed, although most often closed when the gas charge is lost from the diaphragm housing in a traditional TXV. The capillary tube can vibrate loose from the evaporator outlet tube. The capillary can break and the small quantity of temperature sensitive gas can escape. The diagnosis of a valve as defective calls for replacement.

### 5. Other Problems—Leaks, Moisture, and Adding Refrigerant

Before any refrigerant was put inside the AC system, someone used a vacuum pump to evacuate any air and moisture. Vacuum is really a force pulling against all hoses, fittings and components from the inside. When the system is charged with refrigerant, the pressure goes from minus (a vacuum) to plus pressure inside the hoses and all components. The refrigerant and refrigeration oil are trying to escape from the system at all times.

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Technicians frequently add refrigerant to a system, replacing refrigerant seepage through system connections or fittings. If the system has been maintained regularly (every three to six months), adding a small amount of refrigerant may result in normal system function. However, the best procedure is to check all connections and look for, find and repair any leaks before adding refrigerant.

When your leak detector indicates the presence of a leak, you can't tell how long the system has been leaking. Finding one leak doesn't mean there are not others. Until you have some AC system work experience, it will be hard to guess how much refrigerant may have leaked. If you have to top a system off with a half pound of refrigerant or more, adding refrigerant is not the answer.

Find the leak. Recover all of the refrigerant and repair the system. The moisture absorbing capacity of any desiccant material is limited and cannot be measured. For that reason, replace the receiver-drier or accumulator. Then evacuate the system for an hour and recharge with refrigerant.

When a compressor shaft seal has leaked oil and the refrigerant charge is a little low, the shaft seal may have leaked because the air conditioner was not used. The seal can get a little out of round from the weight of the crankshaft and leak above the shaft. Running the compressor may cause the seal to swell and close up the leak. The shaft rotation exerts force all around the seal and puts life back into it. To prevent this from happening, manufacturers recommend regular AC system operation a minimum of every couple of weeks even in cool weather.

Keep in mind that the compressor can cause a vacuum inside the system if there is a restriction in the system. That means it can suck air and moisture inside under some conditions. It will pull these contaminants in through the same space where refrigerant and refrigerant oil has leaked out.

## Conclusion

What could the air conditioning problem and it's cause have been at the beginning of this chapter? The operator was in a hurry, but you were able to start your troubleshooting with the answers he gave you. Problems your inspection may have turned up are a very low refrigerant charge, a contaminated system or defective compressor. Those are not quick fix jobs.

On the other hand, you might have found enough debris on the condenser fin surface to boost high side pressures to an abnormal level during the hottest part of the day. So the Trinary™ or high pressure switch would cut out from high pressure—but reset itself. You cleaned the condenser, added a half pound of refrigerant and AC system pressures and function returned to normal. Service and repair took a half hour. But there was no way to tell without using your knowledge and experience. By now you are pretty familiar with AC system problems, the reasons for some of them, troubleshooting and repair. In *Chapter 9* we will describe complete system purging, evacuation, flushing and recharging.

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# Security System

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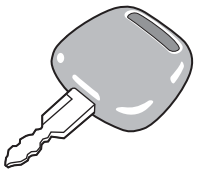
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# NOTES ON USE

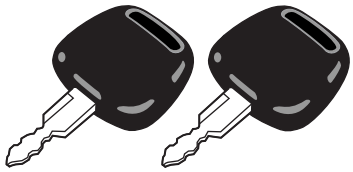
The Security System has a Registration Key and two Immobilizer Keys.

Registration Key (gray key grip): used for registration or de-registration of the key.



N0C950

Immobilizer Key (black key grip): used for everyday operation.

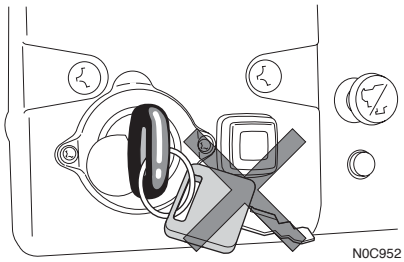


N0C951

Once this security system is implemented, the existing key(s) cannot be used to start the engine.
Use either the Registration Key or Immobilizer Key to start the engine.

## Important

- Although the system includes an anti-theft mechanism, it is not completely theft-proof as the mechanism itself could be removed. Take special caution while parking or storing the machine.
- Since the Registration Key is required for registration or de-registration, keep it safely to avoid losing it. If you lose it, the system may need to be replaced. Use the Immobilizer Key for everyday operation whenever possible.
- The Registration Key and Immobilizer Key(s) will work only for a specific machine (controller), and will not work on other machines. Keep these keys separate from keys of other machines.
- Do not use a key chain, etc. to hold more than one Registration or Immobilizer Key, otherwise the engine may fail to start due to an incorrect signal received by the machine from the key.



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- Keep metal away from the Registration or Immobilizer Key when starting the engine, otherwise the engine may fail to start due to an incorrect signal received by the machine from the key.

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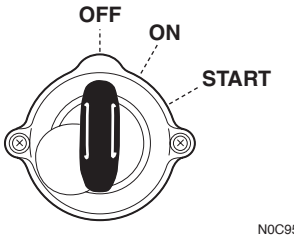
## OVERVIEW OF FUNCTIONS

1. Protection of Illegal Engine Startup
   Prevent illegal operation by limiting the engine startup with the Registration Key and Immobilizer Key (hereafter, "authorized key") registered to the controller on the machine.

2. Horn Alarm
   If an attempt to start the engine using a key other than the authorized key is made five times within three minutes, the warning horn will sound for four minutes and then stop.
   To stop the horn, use an authorized key to turn the starter switch position to ON.

**Notes**

- Starter switch (key switch) operation is counted as one when the switch position is changed from OFF to ON, then to START. Switching between ON and START is not considered as one operation.



N0C953E

- The illegal attempt count is reset if four subsequent illegal operations are not made within three minutes after the first one.

- If the battery is disconnected while the horn is sounding and then reconnected, the horn alarm will sound for four minutes from the time when the battery is connected.

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## LOSS OF AN IMMOBILIZER KEY

If you lose an Immobilizer Key, perform step 1 or 2 below to prevent the lost key from being misused.

1. De-register the lost Immobilizer Key (without purchasing a new Immobilizer Key)
   Delete the registration of the lost Immobilizer Key with the controller on the machine to prevent its use.

2. Re-register a new Immobilizer Key (purchasing a new Immobilizer Key)
   Re-register a new Immobilizer Key with the controller and delete the old registration of the lost key.

For details of registration or de-registration, refer to “De-registering or Re-registering an Immobilizer Key” on the next page.

## OBTAINING MULTIPLE IMMOBILIZER KEYS

You can register up to five Immobilizer Keys with one machine, provided the key has not been registered with another machine.

For adding a registration, please refer to “De-registering or Re-registering an Immobilizer Key” on the next page.

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## De-registering or Re-registering an Immobilizer Key

**Prepare the following:**

1. Registration Key of the machine you want to de-register/re-register with
2. All Immobilizer Keys that have been registered with the above machine (except the lost one)
3. A new Immobilizer Key you want to register (for re-registration only)
4. Clock/Timer (capable of counting 10 seconds): recommended for assured registration

**Checking before Registration:**

- Check that you can start the engine with the Registration Key of 1 above. If not, the key is probably the Registration Key of another machine. Prepare the correct Registration Key.

**Important:** You must use the authorized Registration Key to perform the registration.

- Check that you can start the engine with the Immobilizer Key of 2 above. If not, the key is probably the Immobilizer Key of another machine. Prepare the correct Immobilizer Key.

**Important:** Do not try to register an Immobilizer Key that has already been registered with a different machine.

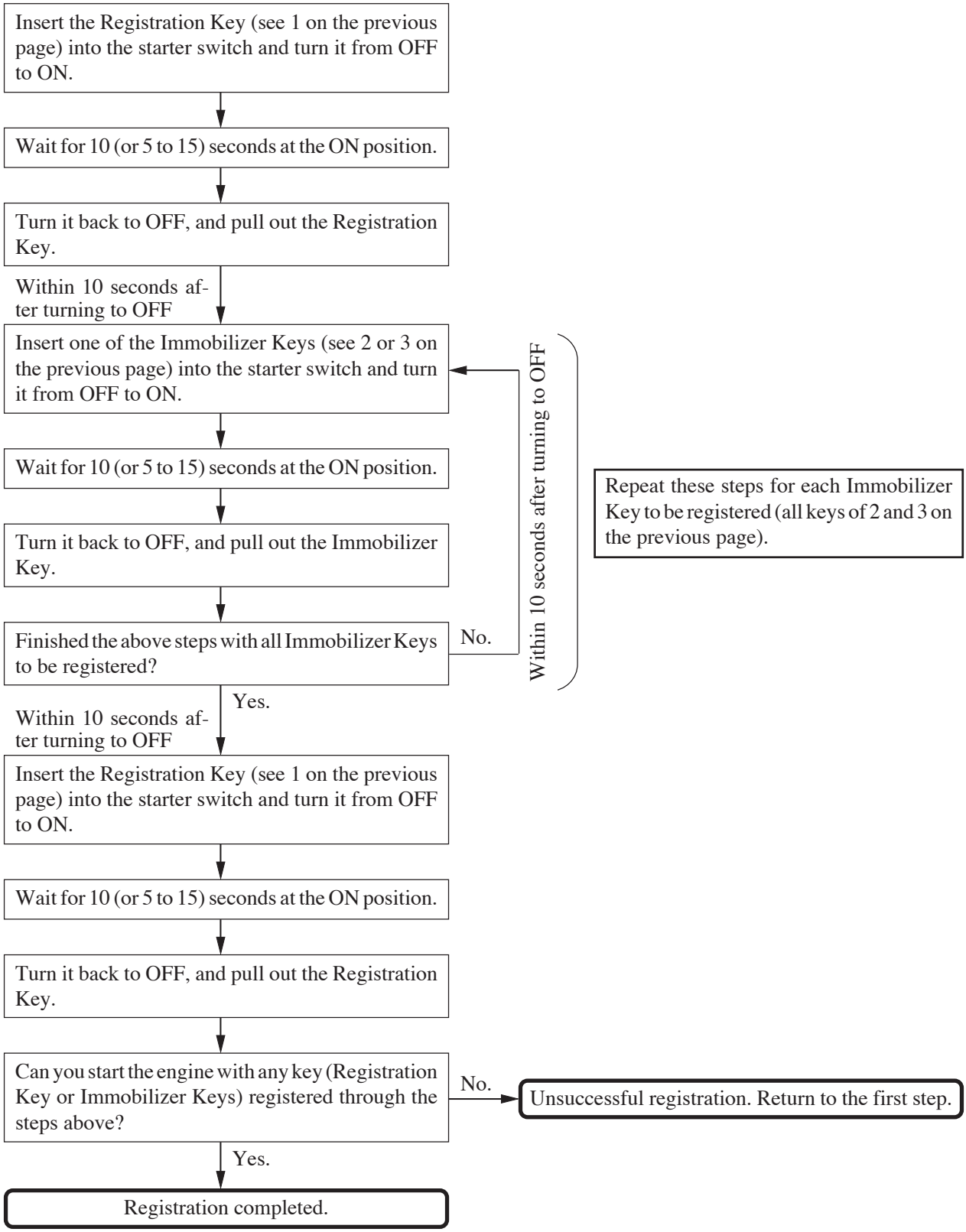
**Notes**

- You cannot start the engine with the Immobilizer Key of 3 above, as it is unregistered.
- Trying to start the engine with the wrong key five times for three minutes will activate the horn alarm for security.
- If a key fails to start the engine, do either of the following to prevent the horn alarm from being activated.
  (1) Use the Authorized Key (engine-starting key) to start the engine.
  (2) Pull out the key and wait for at least three minutes.
- If the horn starts sounding, turn the starter switch position from OFF to ON with an authorized key to stop the horn alarm.

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### Registration Procedure




## Important

During the registration procedure, you may find that the key you are trying to register is a wrong key or that you moved to a wrong step. If this happens, stop the registration where you are, wait for at least 30 seconds, then restart the procedure from the first step.

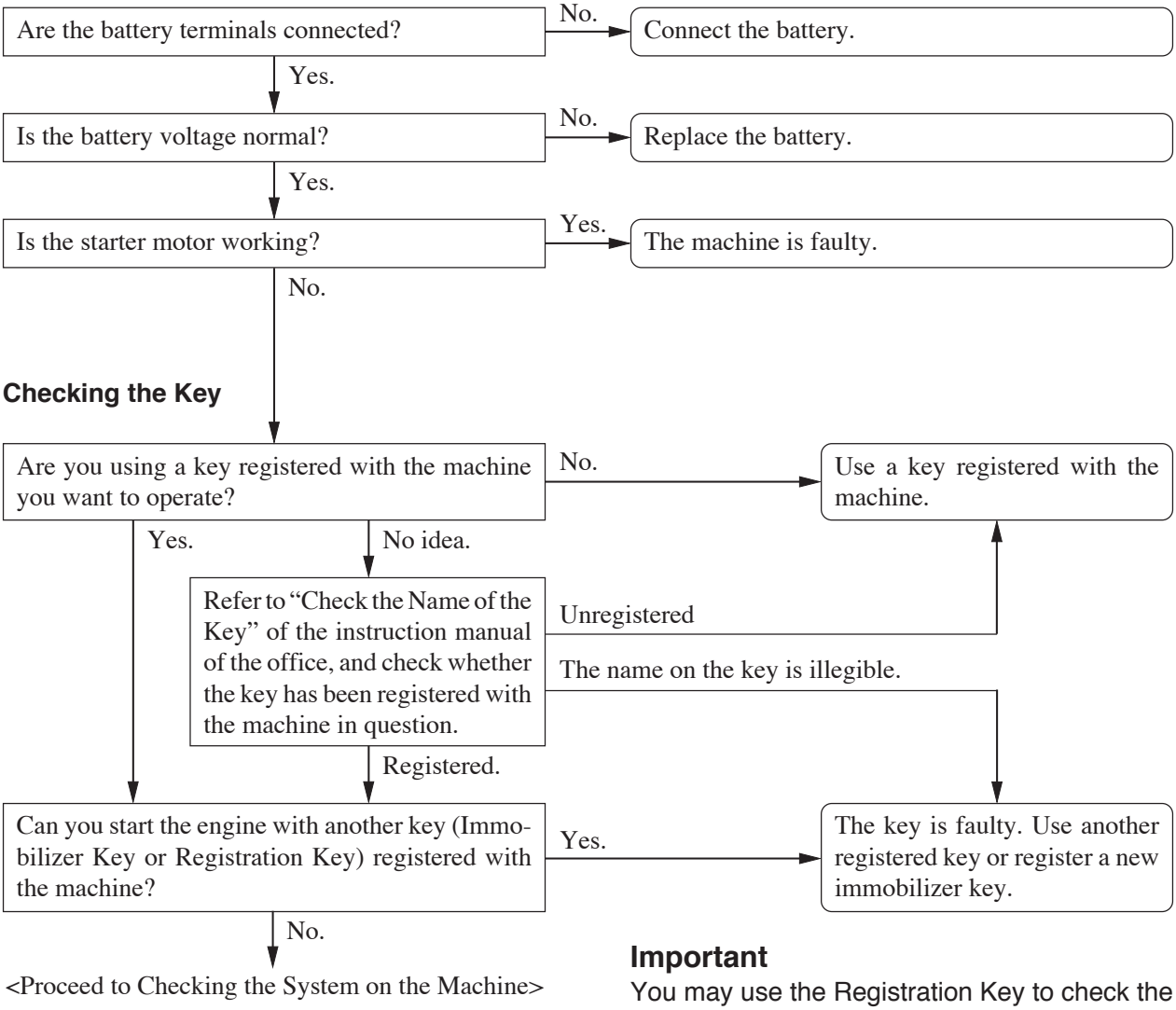
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# TROUBLESHOOTING

If the engine fails to start, check the following.

### Checking the Machine




### Checking the Key




<Proceed to Checking the System on the Machine>

**Important**

You may use the Registration Key to check the system, but take care because if you lose or damage it, the system may need to be replaced.

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### Checking the System on the Machine

Is the fuse on the main harness blown?
Yes. → Replace the fuse.
No.

Is the antenna in the starter switch section installed in the proper location?
No. → Install the antenna properly and restart the engine.
If the restarting fails
Yes.

Remove the connector (Pin 2) connecting the antenna and main harness, and measure the resistance between the two pins on the antenna side. Is the resistance value 1.2 ohms or less?
No. → Antenna is faulty. Replace the antenna.
No.

#### Checking the Connector Terminals

Check the continuity of the connector terminals connected to the controller on the machine and make sure the voltage is proper.

| Terminal No. | Function | Check | Condition | Normal value |
|---|---|---|---|---|
| 5 - earth *1 | Power | Voltage | Normal | Battery voltage |
| 7 - earth | ST | Voltage | Starter switch at “START” | Battery voltage |
| 8 - earth | ON | Voltage | Starter switch at “ON” | Battery voltage |
| 1 - earth | GND | Continuity | Normal | Continuity exists |
| 2 - 10 | Antenna | Resistance | Normal | 1.2 Ω or less |

*1: Connect the earth to the frame grounding.

Connector Terminal No.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | | | 3 | 4 |
| 5 | 6 | 7 | 8 | 9 | 10 |

Normal → Controller is faulty. Replace the system.

Abnormal → Check the connectors and their connections in the system according to the installation manual. If there is no problem with the connections, the harness may be faulty. Replace the harness.

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# IV. HYDRAULIC UNITS

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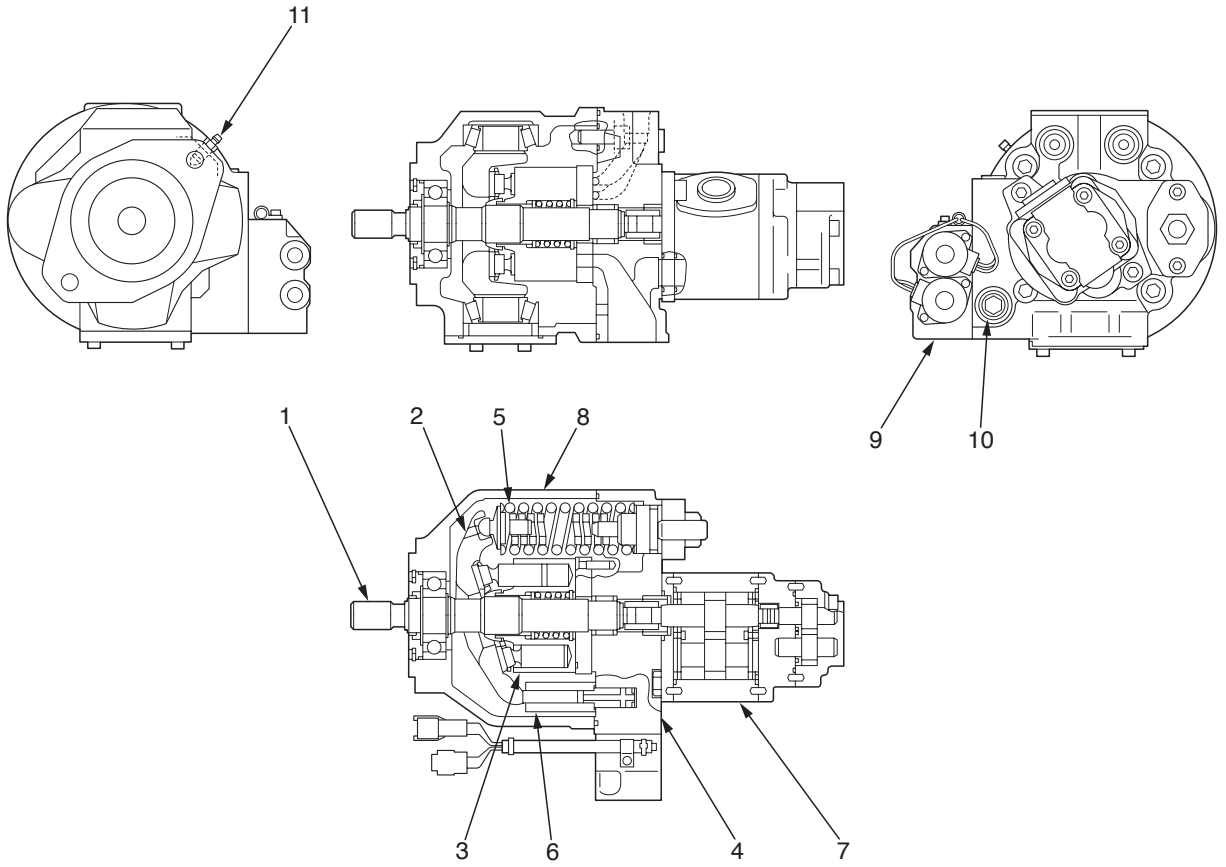
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## HYDRAULIC PUMP (TB125: S/N 12510009~12512125, TB145)

### CONSTRUCTION

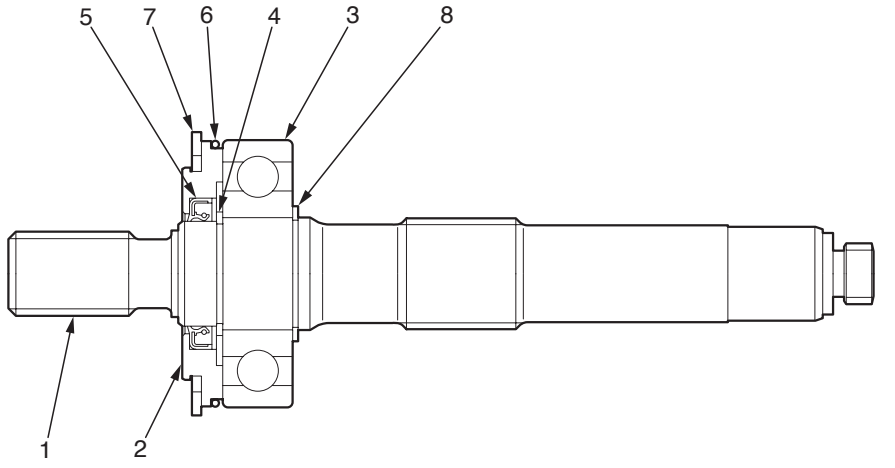



1. Shaft
2. Swash Plate
3. Cylinder Block
4. Cover
5. Control Spring
6. Control Piston
7. Gear Pump
8. Housing
9. Solenoid Valve
10. Relief Valve
11. Valve

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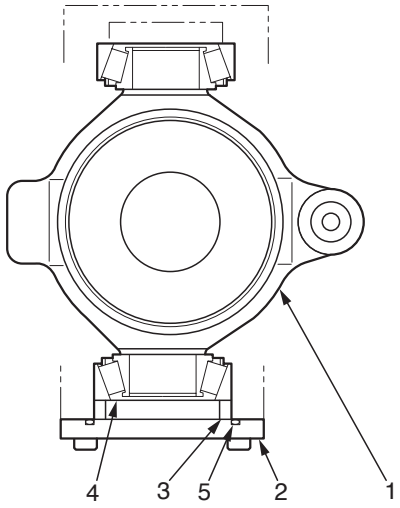
### Shaft




K3D101

1. Shaft
2. Seal Case
3. Bearing
4. Snap Ring
5. Oil Seal
6. O-ring
7. Snap Ring
8. Snap Ring

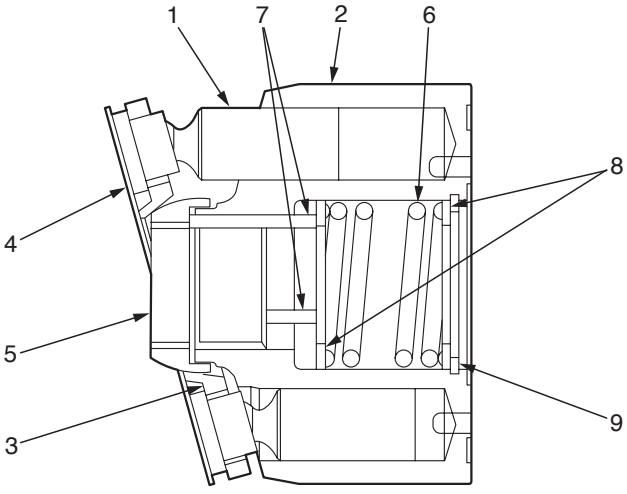
### Swash Plate




K3D102

1. Swash Plate
2. Plate
3. Distance Piece
4. Bearing
5. O-ring

### Cylinder Block




K3D103

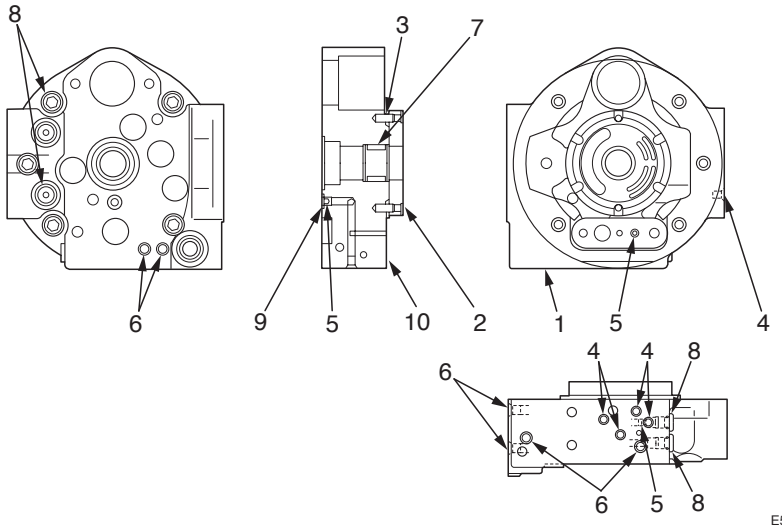
1. Piston
2. Cylinder Block
3. Retainer
4. Plate
5. Guide
6. Spring
7. Pin
8. Spring Seat
9. Snap Ring

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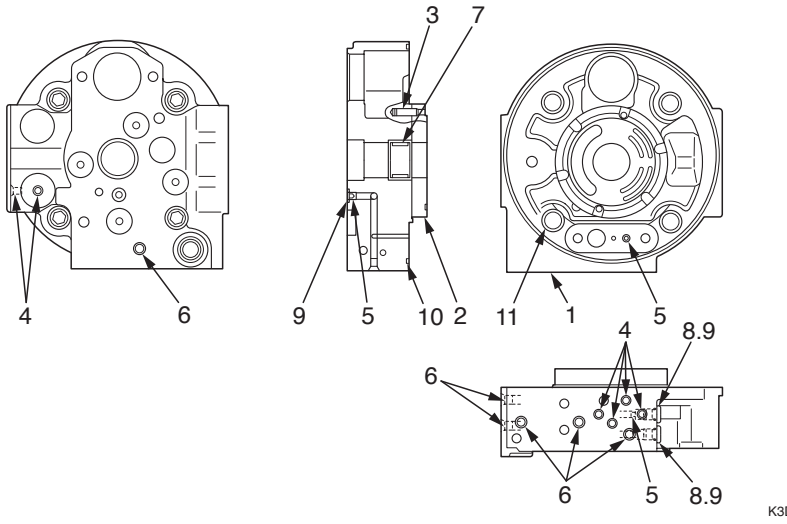
**Cover**

■ TB125



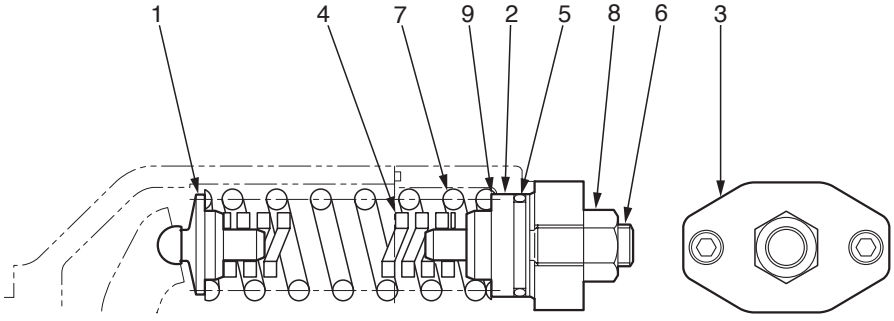

1. Cover
2. Valve Plate
3. Pin
4. Plug
5. Orientice
6. Plug
7. Bearing
8. Plug
9. O-ring
10. Packing

■ TB145




1. Cover
2. Valve Plate
3. Pin
4. Plug
5. Orientice
6. Plug
7. Bearing
8. Plug
9. O-ring
10. O-ring
11. O-ring

**Control Spring**

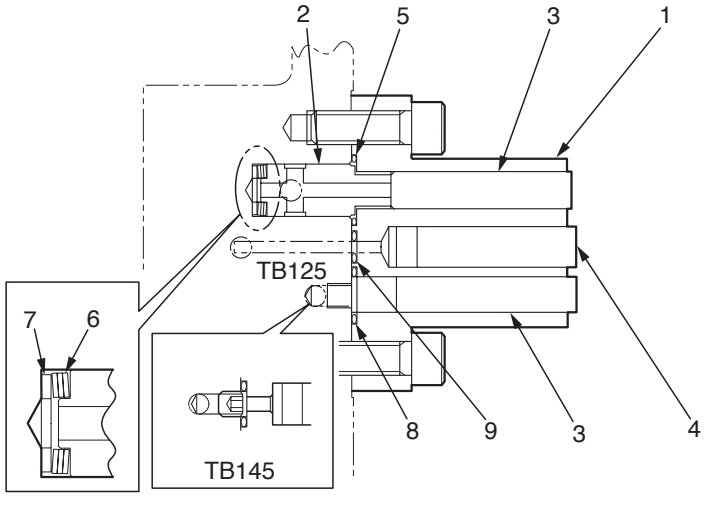



1. Spring Seat
2. Spring Seat
3. Cover
4. Spring
5. O-ring
6. Adjusting Screw
7. Spring
8. Nut
9. Shim

https://truckmanualshub.com/

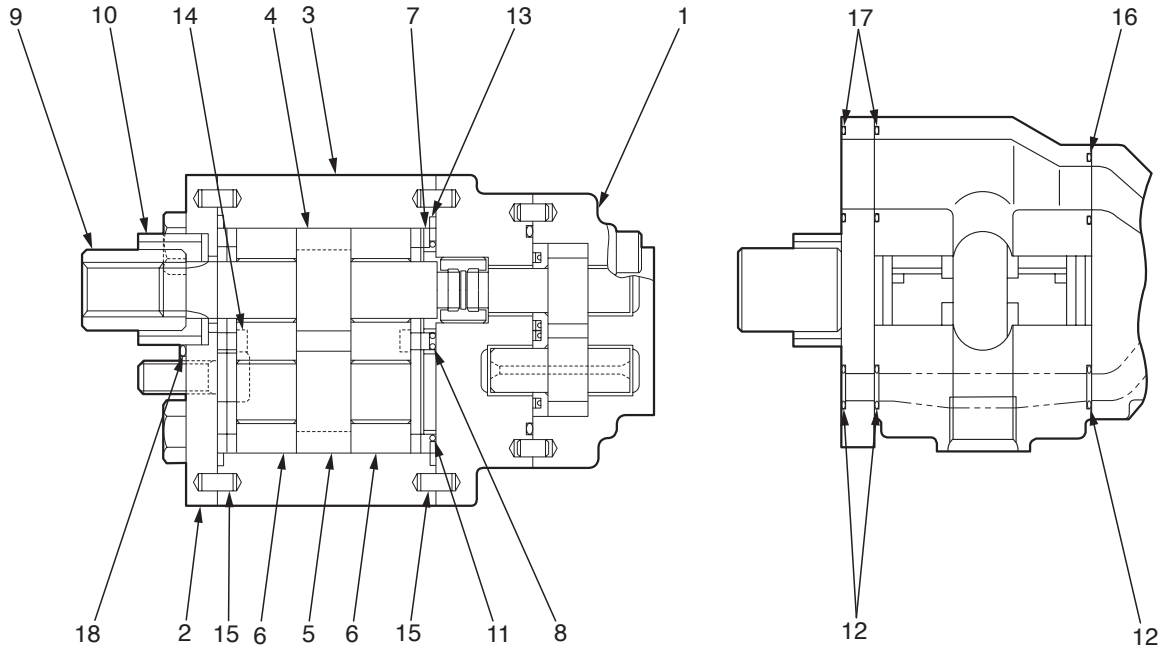


### Control Piston




1. Cylinder
2. Piston
3. Pin
4. Pin
5. O-ring
6. Conical Spring Washer
7. Spring Seat
8. O-ring
9. O-ring

### Gear Pump (P3)

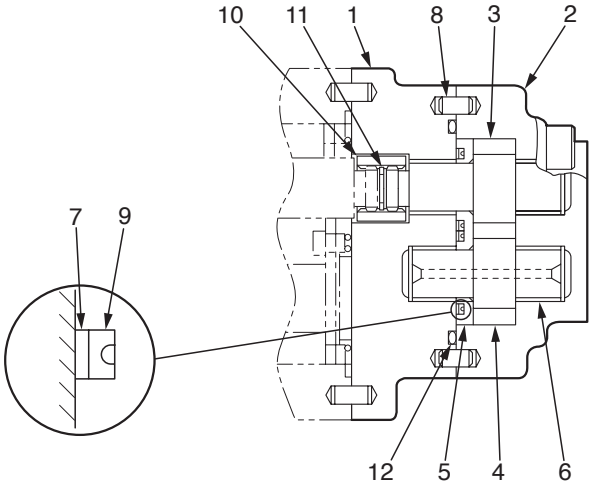



1. Gear Pump
2. Flange
3. Case
4. Drive Gear
5. Driven Gear
6. Bushing
7. Plate
8. Guide
9. Coupling
10. Bushing
11. O-ring
12. O-ring
13. Seal Ring
14. Angular Ring
15. Pin
16. O-ring
17 O-ring
18. O-ring

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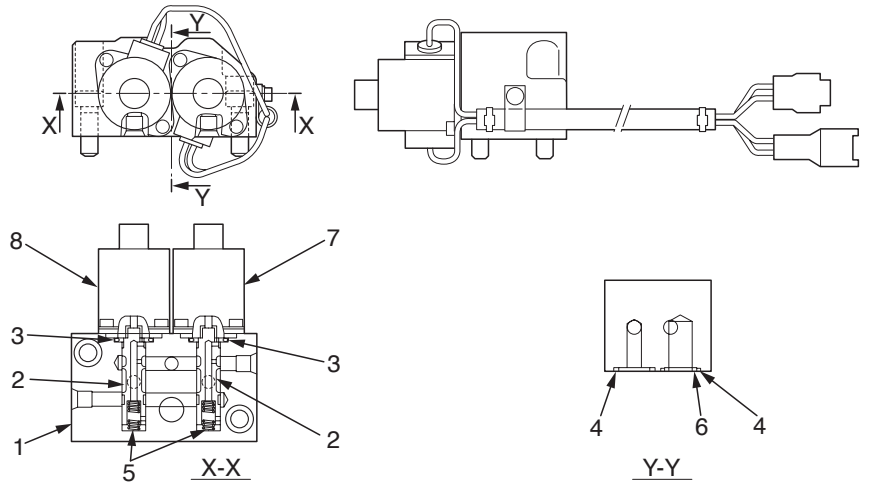
### Gear Pump (P4)




K3D108

1. Frame
2. Housing
3. Drive Gear
4. Driven Gear
5. Plate
6. Metal
7. Backup Ring
8. Pin
9. Seal Ring
10. Coupling
11. Snap Ring
12. O-ring

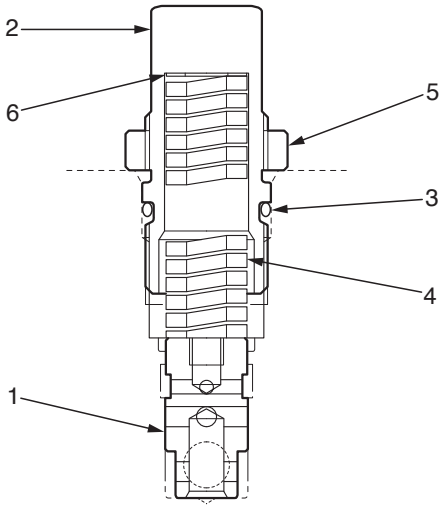
### Solenoid Valve




K3D109

1. Body
2. Spool
3. O-ring
4. O-ring
5. Spring
6. Filter Element
7. Solenoid A
8. Solenoid B

### Relief Valve




K3D110

1. Spool
2. Screw
3. O-ring
4. Spring
5. Nut
6. Shim

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## OPERATION

### Piston Pump

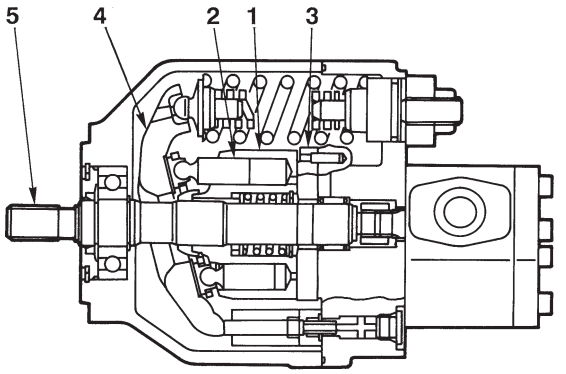
This pump is a variable displacement piston pump with a single cylinder block, which discharges two equal volumes.

Ten pistons (2) are installed in the cylinder block (1), and the end surface is in contact with the valve plate (3). The suction port C and the discharge port A of the pump P1 and the discharge port B of the pump P2 are arranged in the valve plate (3). On the other hand, the swash plate (4) is fastened to the housing at a given inclination, and the pistons (2) rotate along this swash plate (4).

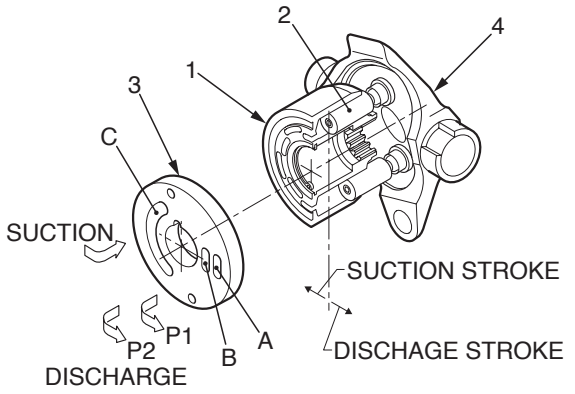
When the shaft (5) is rotated, the cylinder block (1) rotates, the pistons (2) in the cylinder block execute reciprocating movement along the swash plate (4), and the pump executes suction and discharge. At this time, the pistons in contact with the discharge port A of the valve plate (3) operate as the pump P1, while the pistons in contact with the discharge port B operate as the pump P2.

In this way, the ten pistons (2) execute one suction and discharge stroke with each revolution of the cylinder block (1), so that suction and discharge are executed continuously when the shaft (5) is rotated continuously.

As the piston stroke displacement depends on the inclination of the swash plate (4), the discharge flow quantity can be changed by changing the inclination of the awash plate (4).



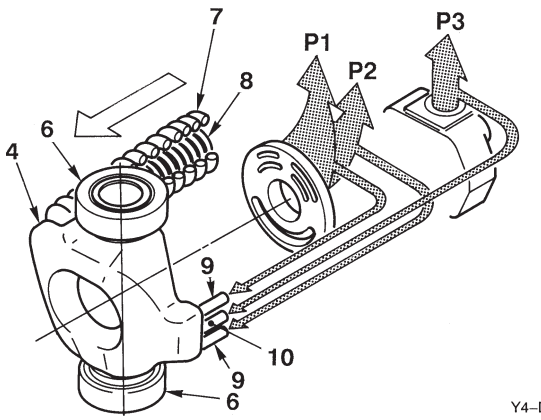

Y4–D100




K3D111

#### Discharge volume control

The swash plate (4) is equipped with the bearings (6) and is mounted on the housing at an inclination that can be varied. The swash plate (4) is loaded with the pistons (9) and the piston (10) in opposition to the spring (7). The discharge pressures from the pumps P1 and P2 work on the pistons (9). The discharge pressure from the pump P3 works on the piston (10). When the discharge pressure is below the value preset for the spring (7), the inclination of the swash plate (4) is fixed to the maximum value by the spring (7).

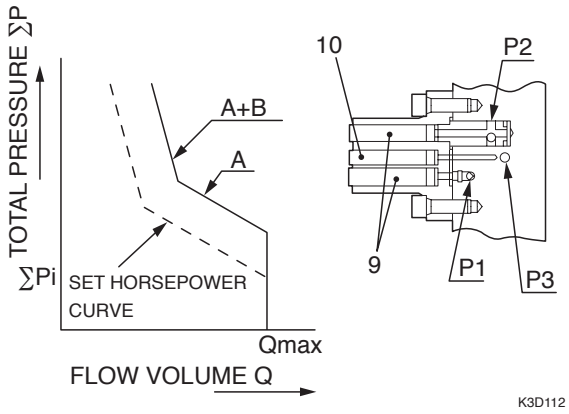



Y4–D102

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When the discharge pressure exceeds the set value of the spring (7), the swash plate (4) is pushed by the pistons (9) and (10), the inclination decreases, and the swash plate is kept at an inclination where the discharge pressure and the spring force are balanced.
When the pressure acting onto the pistons (9) and (10) increases still further, the inclination of the swash plate (4) becomes still smaller. The until now inactive spring (8) also becomes active, and a still higher discharge pressure will be required to counteract this spring force.
In this way, the inclination of the swash plate (4) is changed, the discharge quantity is controlled, the pump is supplied only with the pressure and the flow volume required for the load, and the pump loss pressure is reduced.
As the inclination of the swash plate (4) changes not only according to the operation pressure of the pumps P1 and P2, but also according to the operation pressure of the pump P3, the P-Q curve of the piston pump becomes a curve with effective use of the engine power (full power control).




**Gear Pump**
☞ "IV-36"

**Solenoid Valve**
☞ "IV-37"

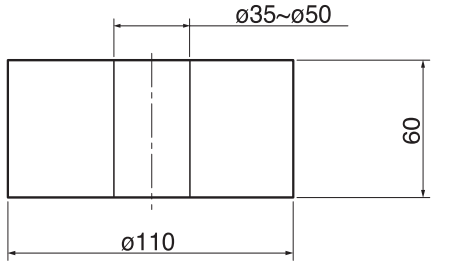
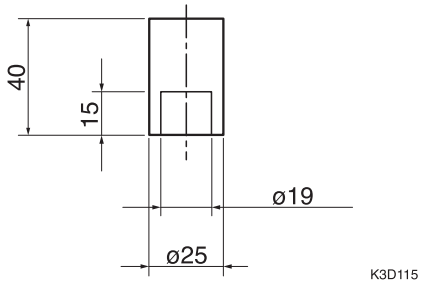
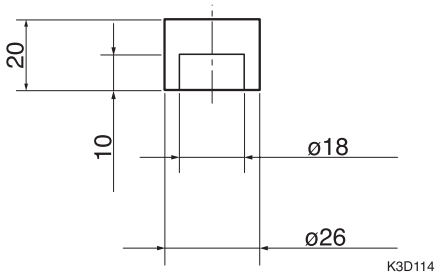
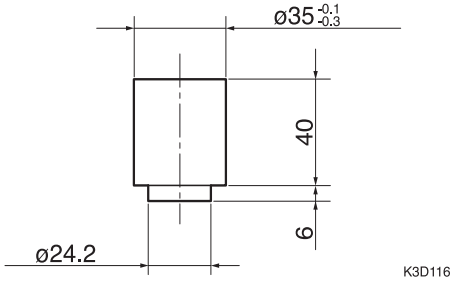
https://truckmanualshub.com/



## DISASSEMBLY AND ASSEMBLY

### Table of Special Tools

Unit: mm

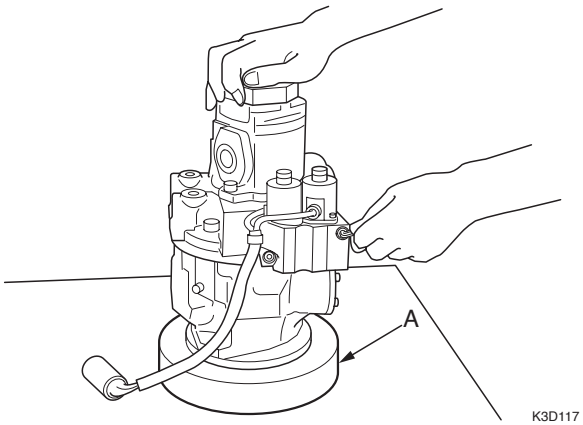
| | NAME, DIMENSIONS | | NAME, DIMENSIONS |
|---|---|---|---|
| 1 | JIG (A)<br>  | 3 | JIG (B) for TB145<br>  |
| 2 | JIG (B) for TB125<br>  | 4 | JIG (C) for TB125<br>  |

### General Cautions

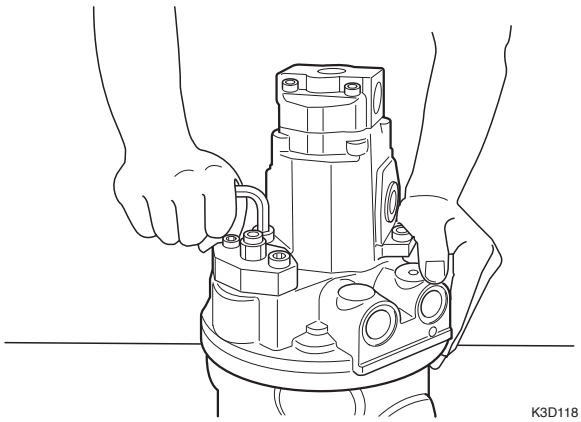
☞ “IV-37”

### Disassembly

1. Take out the cap screws and remove the solenoid valve from the pump.
   Place the pump with the shaft facing down onto the jig (A) so that the shaft end is not in contact with anything.



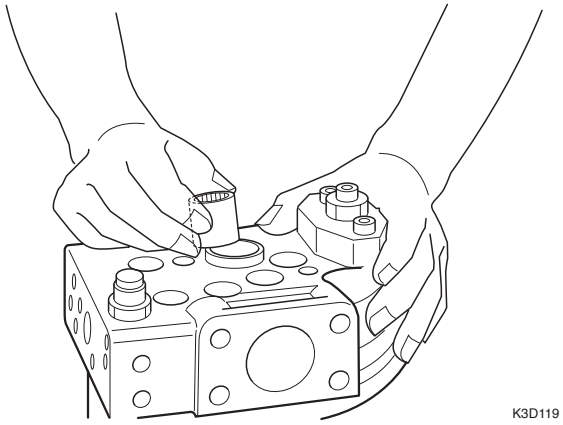

2. Remove the cap screws and remove the gear pump.



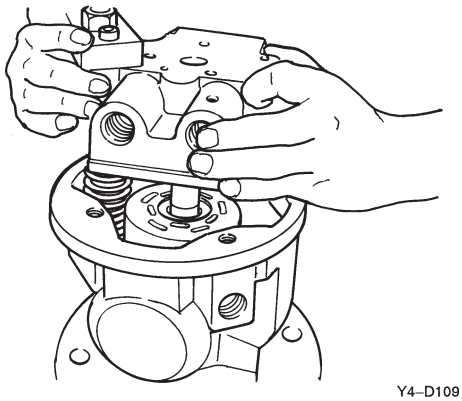
https://truckmanualshub.com/



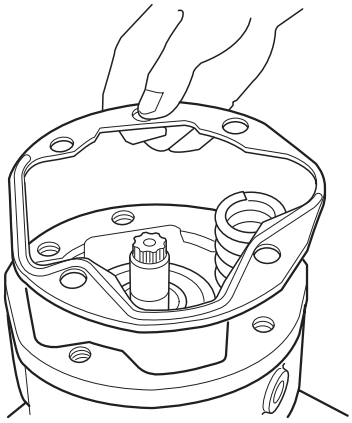
3. Remove the coupling.


K3D119

4. Remove the cap screws and remove the cover.
   - Remove the cover in horizontal condition.
   - Use care, as the valve plate is installed on the rear.
   - When the cover is difficult to remove, tap it with a plastic hammer.

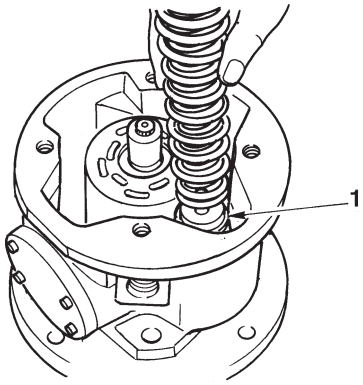

Y4–D109

5. <TB125> Remove the packing.


K3D120

6. Remove the two springs [inside, outside].

7. Remove the spring seat (1).

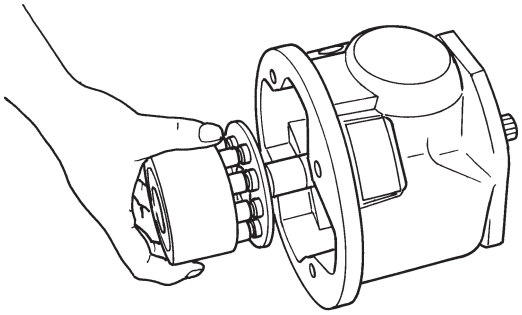


Y4–D111

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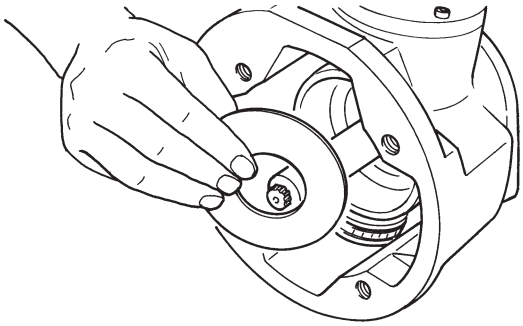


8. Disassemble the cylinder block.
   a. Remove the cylinder block from the shaft.



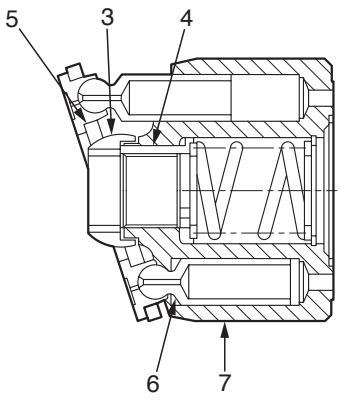
Y4–D112

   b. Remove the plate from the shaft.



Y4–D134

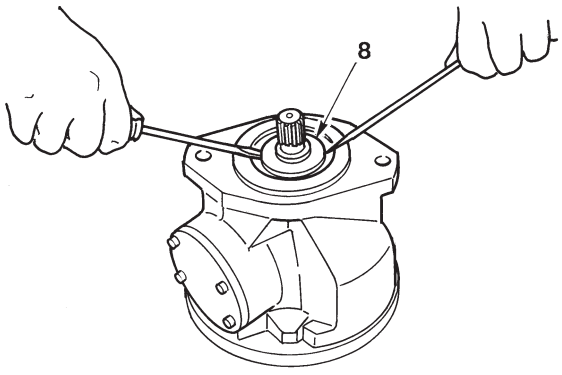
   c. Remove the guide (3), the pin (4), the retainer (5), and the piston (6) from the cylinder block (7).
      • Disassemble the inside of the cylinder block (7) only when required.




E5D101

9. Remove the snap ring and remove the oil seal case (8) and the O-ring.
   • Use two flat screwdrivers as shown in the figure to remove the oil seal case.

10. <TB125> Remove the oil seal from the removed oil seal case.

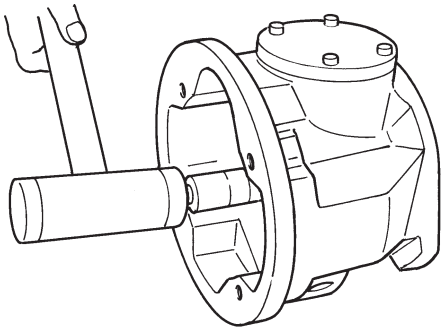



Y4–D114

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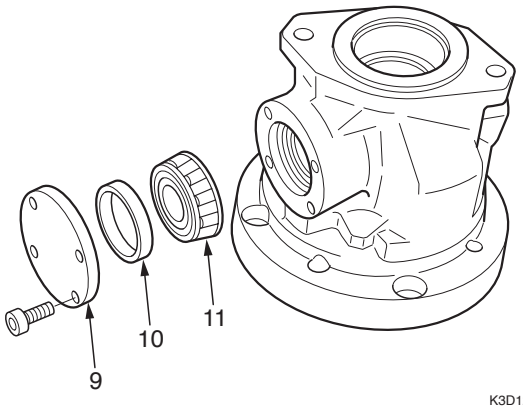


11. Remove the shaft while tapping its rear end with a plastic hammer.



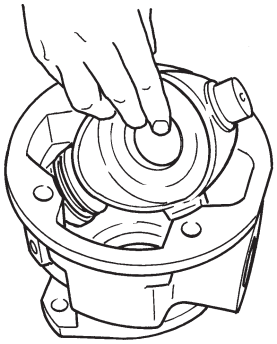
Y4–D115

12. Disassemble the swash plate part.
    a. Remove the cap screws and remove the plate (9).
    b. Remove the distance piece (10).
    c. Remove the bearing (11).



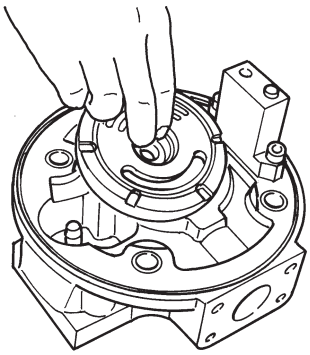

K3D121

    d. Remove the swash plate.



Y4–D117

13. Disassemble the cover part.
    a. Remove the valve plate.

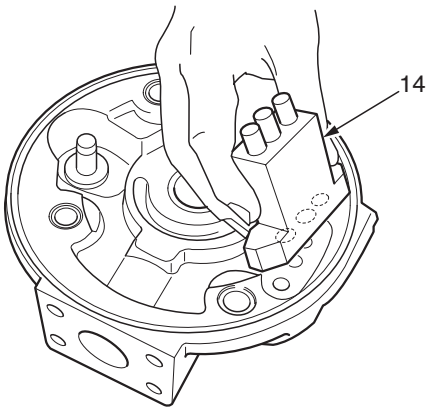


Y4–D118

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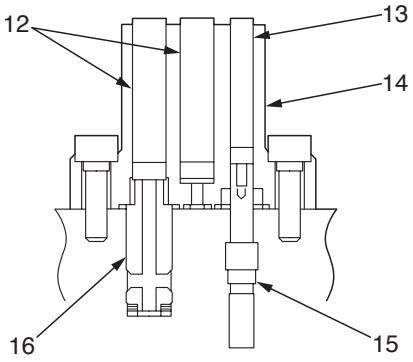


b. Remove the cap screws and remove the control piston part.
   - Disassemble the control piston part only when required.



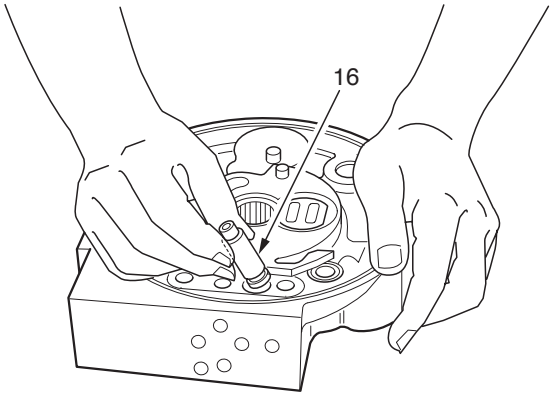

K3D122

c. Remove the pins (12), piston (13) from the cylinder (14).
d. Remove the piston (15) for the air-conditioner (if equipped).



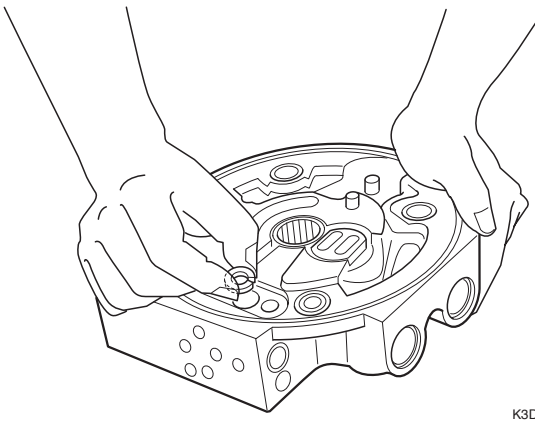

K3D123

e. Remove the piston (16).




K3D124

f. Remove the three conical spring washers and the spring seat.

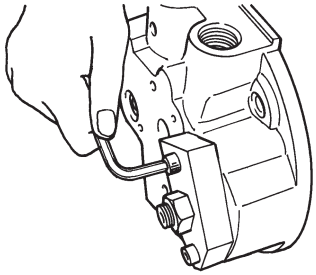


K3D125

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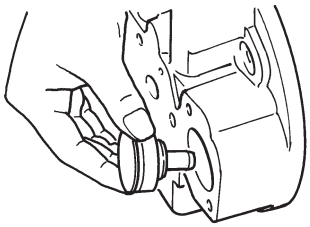


g. Remove the cap screws and remove the cover.



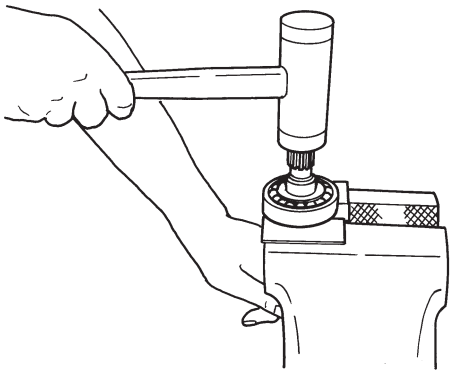
Y4–D121

h. Remove the spring seat, and remove the O-ring from the spring seat.



Y4–D122

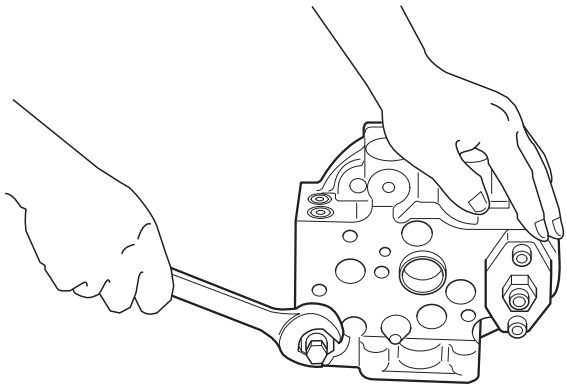
14. Disassemble the shaft part.
    a. Remove the snap ring.
    b. Remove the shaft while tapping it with a plastic hammer.



Y4–D123

15. Remove the relief valve.
    - The parts inside the relief valve should not be disassembled unless absolutely necessary.

    a. Remove the nut.
        - Record the length of the adjusting screw protrusion before starting the disassembly.

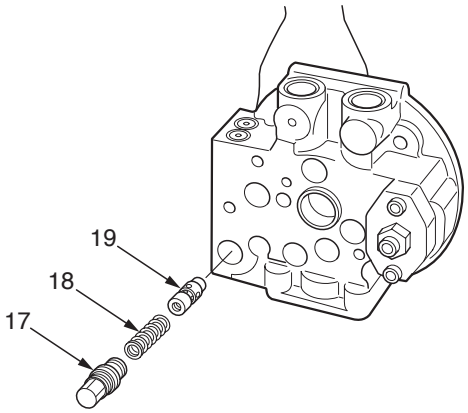


K3D126

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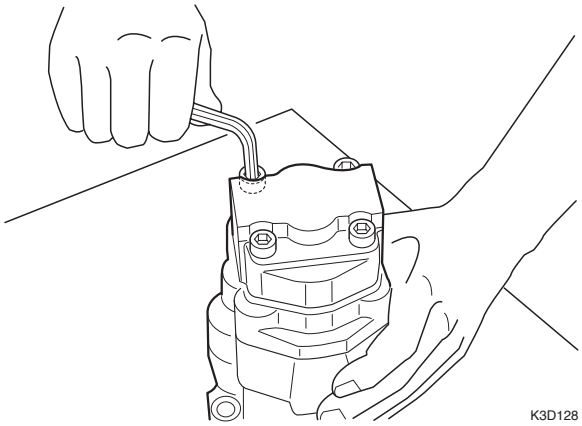


b. Remove the adjusting screw (17).
   • Be careful not to miss the shim.
c. Remove the spring (18).
d. Remove the spool (19).

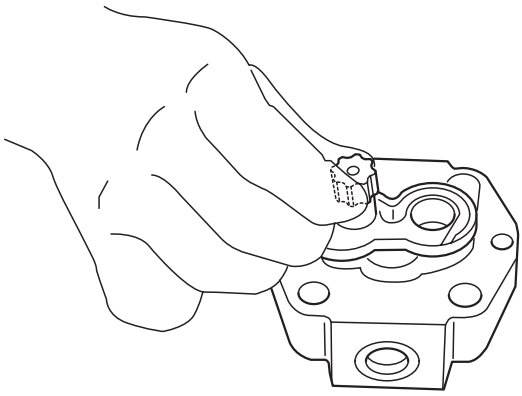


K3D127

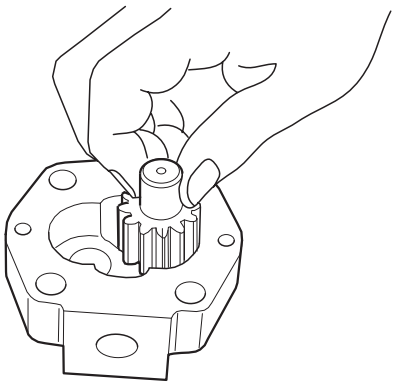
16. Remove the cap screws to disassemble the hydraulic pump into the pump P3 and the pump P4.


K3D128

17. Disassemble the pump P4.
    a. Remove the plate, backup ring and seal ring while pulling the drive gear.


K3D129

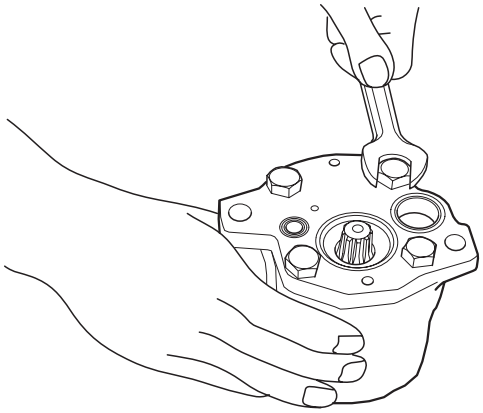
b. Remove the driven gear.


K3D130

https://truckmanualshub.com/

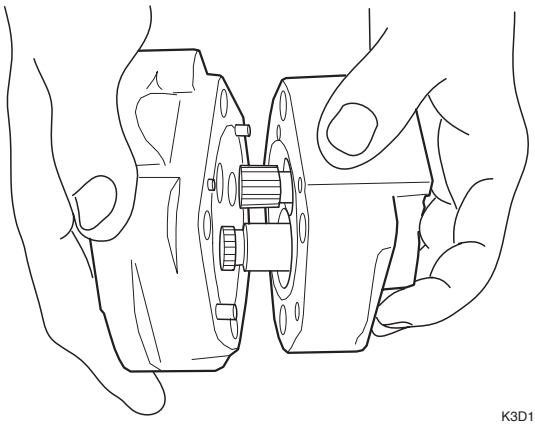


18. Disassemble the pump P3.
    a. Remove the bolts and then the flange.



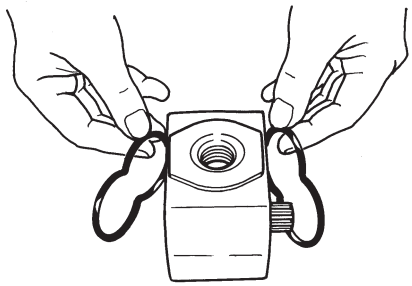
K3D131

    b. Remove the frame.



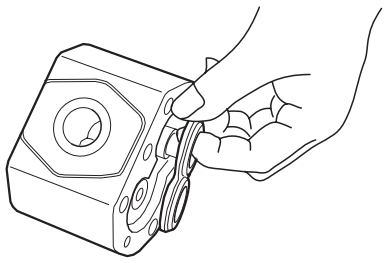
K3D132

    c. Remove the seal ring.



Y4–D125

    d. Remove the plate, guide and O-ring.

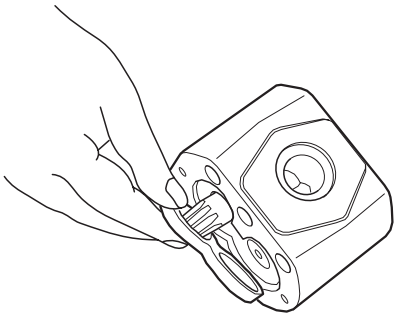


K3D133

https://truckmanualshub.com/

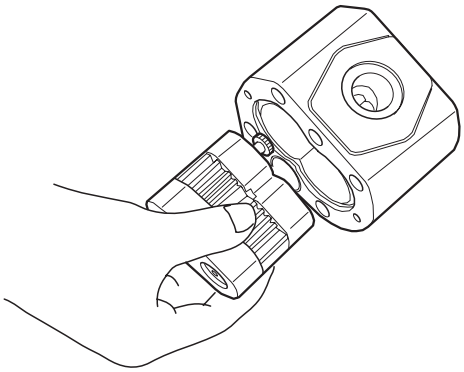


e. Remove the plate.



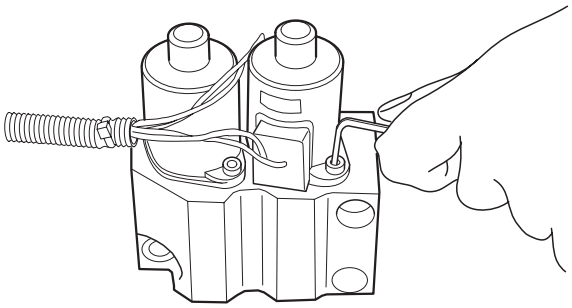
K3D134

f. Remove the drive gear, driven gear and bushing.



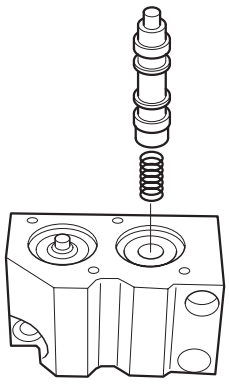
K3D135

19. Disassemble the solenoid valve.
    a. Remove the cap screws and then the solenoids.
       • Be careful not to miss the push rod in the solenoid valve.



K3D136

    b. Remove the spool and spring.
    c. Remove the O-ring.



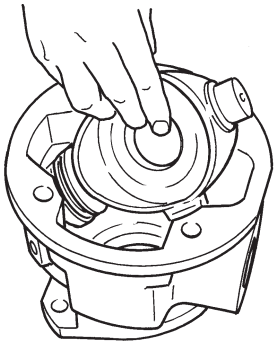
K3D137

https://truckmanualshub.com/



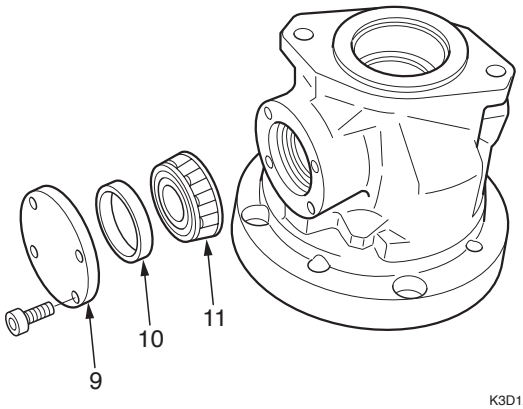
**Assembly**

1. Assemble the swash plate part.
   a. Install the swash plate in the housing.



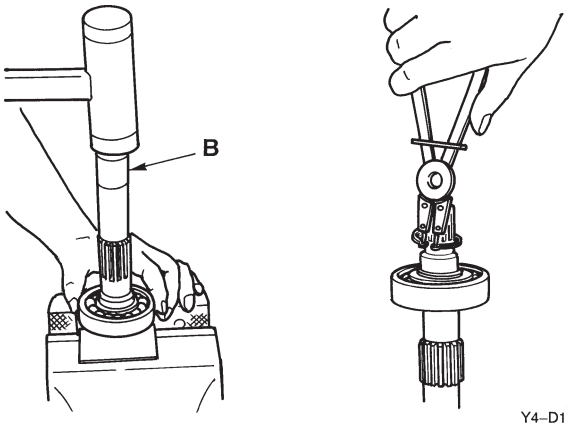
Y4–D117

   b. Install the bearing (11).
   c. Install the distance piece (10).
      • Bearing pre-load:
        TB125 .....0.045~0.085 mm
        TB145 .....0.08~0.12 mm
   d. Install the O-ring in the plate (9).
   e. Attach the plate (9) and fix it with the cap screws.
      • Cap screw tightening torque:
        12~15 N·m (1.2~1.5 kgf·m)



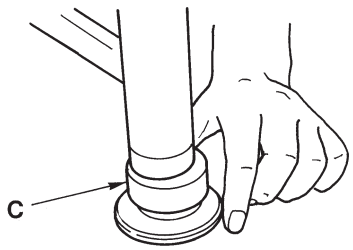

K3D121

2. Assemble the shaft part.
   a. Use the jig (B) to install the bearing on the shaft.
      • Use the bearing as the base, and use a press or a plastic hammer.
   b. Install the snap ring to fix the bearing.




Y4–D128

3. <TB125> Use the press jig (C) to install the oil seal in the oil seal case.
   • Tap with a plastic hammer.
   • Apply adhesive (Loctite #572) to the inside of the oil seal case.



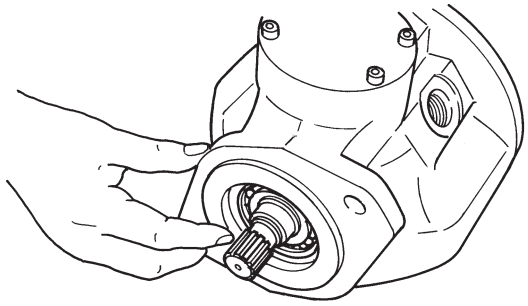

Y4–D129

https://truckmanualshub.com/



4. Install the shaft in the housing.
   - Tap the spline end with a plastic hammer to positively install the outer race of the bearing in the housing hole.

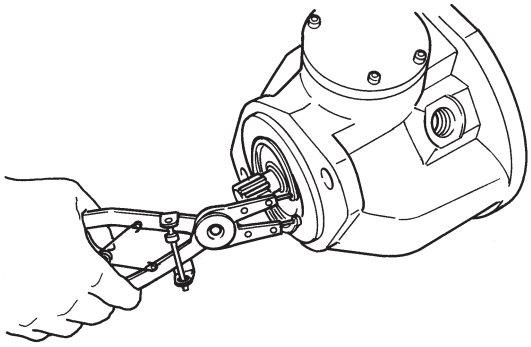
5. Install the O-ring.



Y4–D132

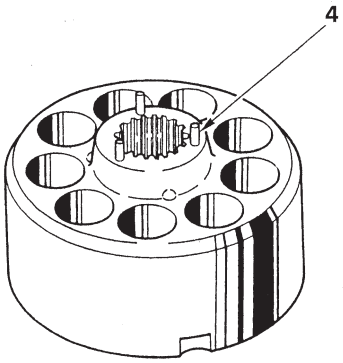
6. Install the oil seal case with installed oil seal.
   - Install the oil seal case so that it is straight.

7. Install the snap ring.



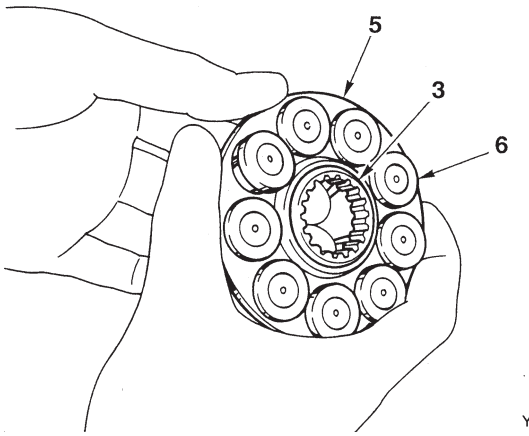
Y4–D133

8. Assemble the cylinder block.
   a. Install the pin (4) in the cylinder block.
      - Apply grease to the pin (4) to prevent its dropping off.




Y4–D130

   b. Install the guide (3) in the cylinder block.
      - Apply grease to the spherical part of the guide.
   c. Attach the piston (6) to the retainer (5), and install the retainer (5) in the cylinder block.

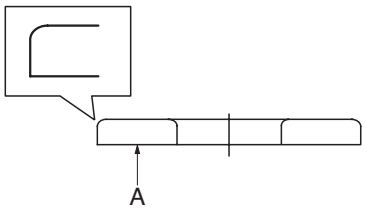



Y4–D131

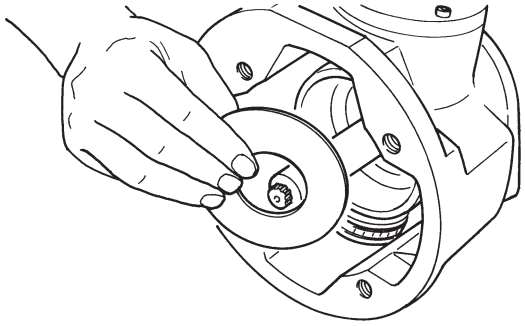
https://truckmanualshub.com/



9. Install the plate on the swash plate.
   - In order to prevent dropping off, apply grease at the rear (A) of the plate on the swash plate side.

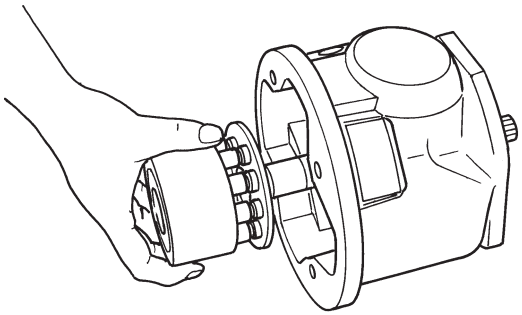



K3D138



Y4–D134

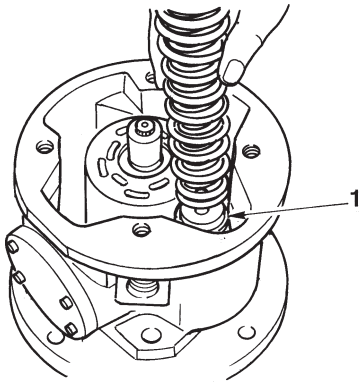
10. Install the cylinder block matching the spline of the shaft.
    - Apply grease to the sliding surfaces of the piston shoes and the plate.



Y4–D112

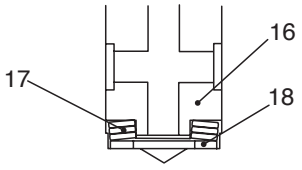
11. Install the spring seat (1).
    - Apply grease to the spherical part of the spring seat.

12. Install the two springs [inside, outside].

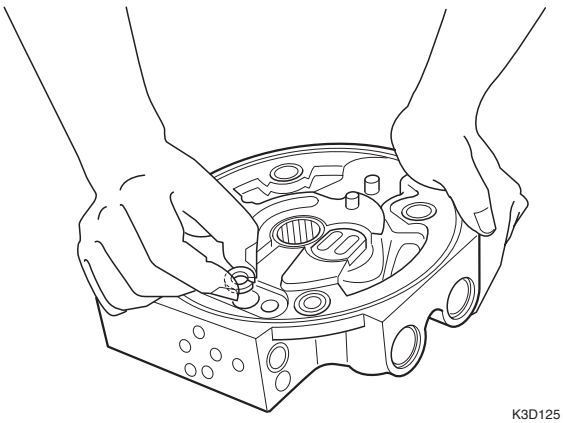



Y4–D111

13. Assemble the cover unit.
    a. Install the spring seat (18), the three conical spring washers (17).
       - Be careful of the installation direction of the washers.




K3D139

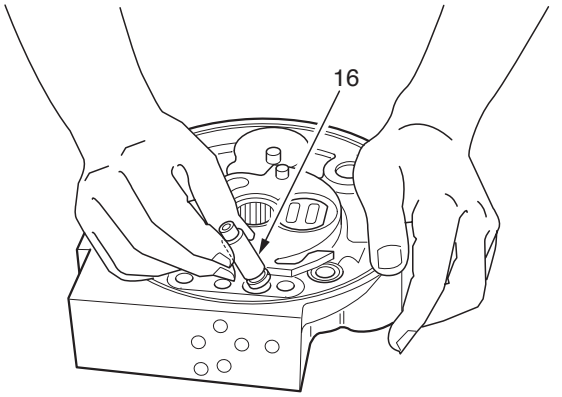


K3D125

https://truckmanualshub.com/

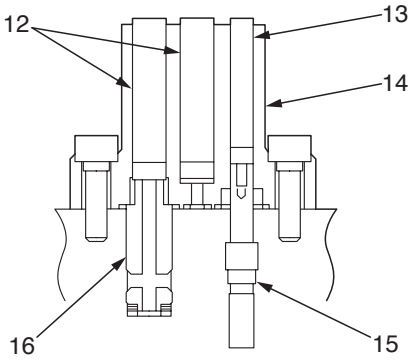


b. Install the piston (16).



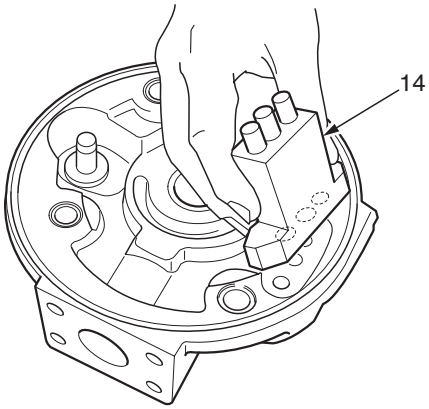

K3D124

c. Install the piston (15) for the air-conditioner (if equipped).
d. Fit the O-rings to the cylinder (14).
e. Apply grease to the two pins (12), the piston (13) and install them in the cylinder (14).



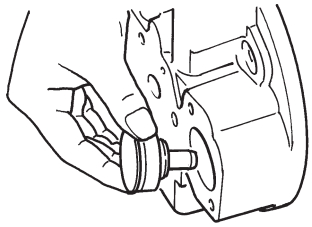

K3D123

f. Put the cylinder (14) in position and install the cap screws.
   - Cap screw tightening torque:
     28~35 N·m (2.9~3.5 kgf·m)
   - Apply Loctite #270.




K3D122

g. Fit the O-ring to the spring seat and install the spring seat.

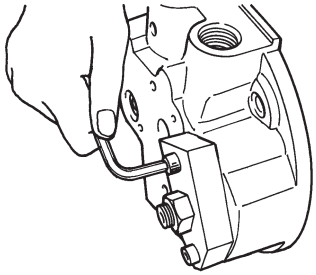


Y4–D122

https://truckmanualshub.com/

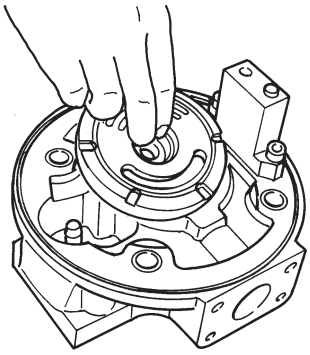


h. Put the cover in place and install the cap screws.
   - Cap screw tightening torque:
     28~35 N·m (2.9~3.5 kgf·m)



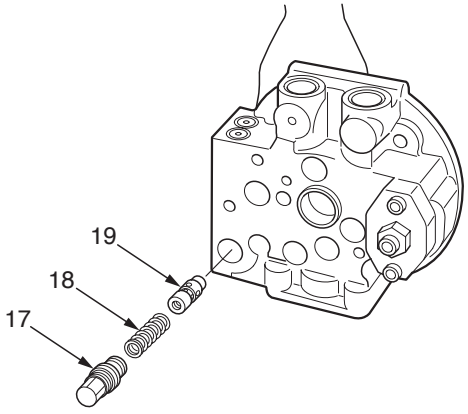
Y4–D121

i. Apply grease to the rear of the valve plate and install it to the cover, matching the knock hole.
j. Install a large and a small O-ring in the cover.



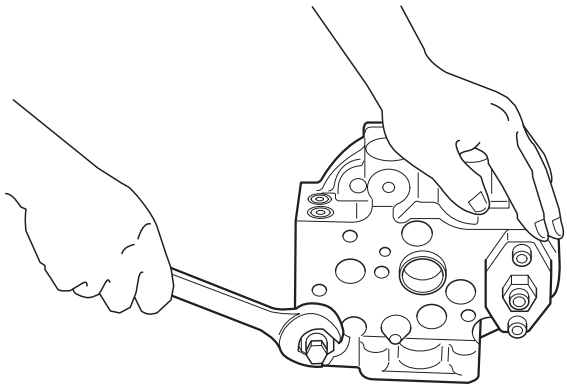
Y4–D118

14. Install the relief valve.
    a. Install the spool (19).
    b. Install the spring (18).
    c. Fit the shim to the adjusting screw (17) and install it in the cover.




K3D127

d. Install the nut.

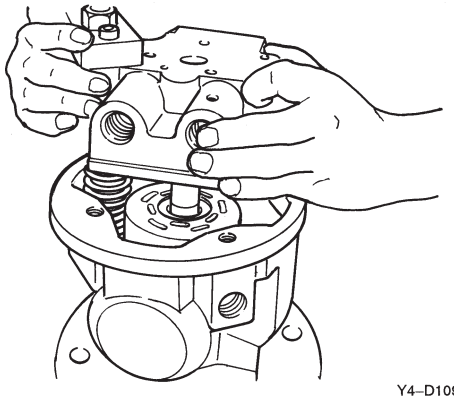


K3D126

https://truckmanualshub.com/

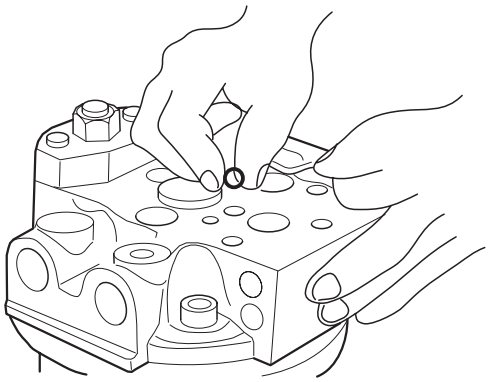


15. Install the cover and install the cap screws.
    - Install the cover parallel to the housing installation surface.
    - Cap screw tightening torque:
      55~69 N·m (5.6~7.0 kgf·m) ..... TB125
      98~123 N·m (10~12.5 kgf·m) ..... TB145



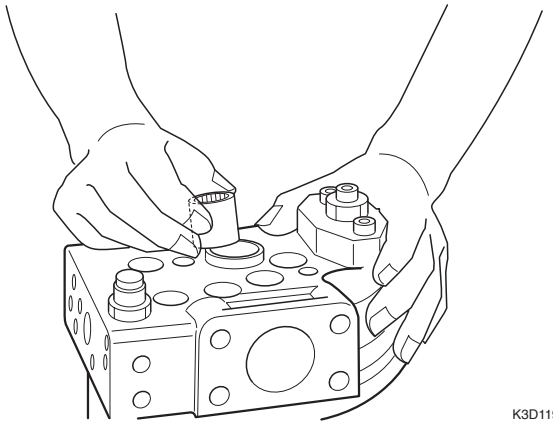
Y4–D109

16. Fit the O-rings to the cover.



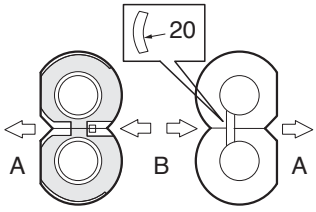
K3D140

17. Install the coupling on the end of the main pump shaft.



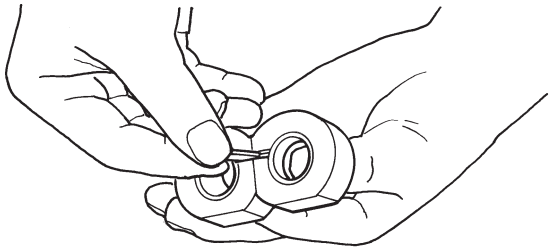
K3D119

18. Assemble the gear pump.
    a. Match the bushing and install the rectangular ring (20).
       - Pay attention to the installation direction.




K3D141

A: DISCHARGE SIDE
B: SUCTION SIDE

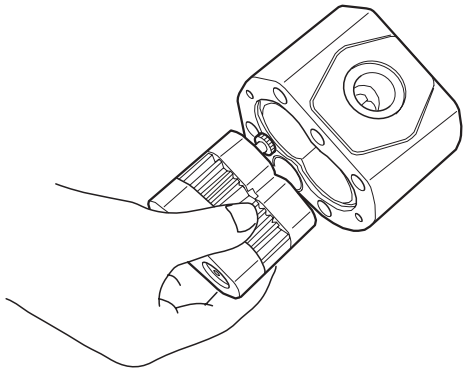


Y4–D137

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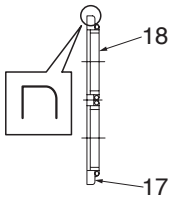


b. Install the bushings assembled as described above on both sides of the drive gear and the driven gear, and install them in the housing.

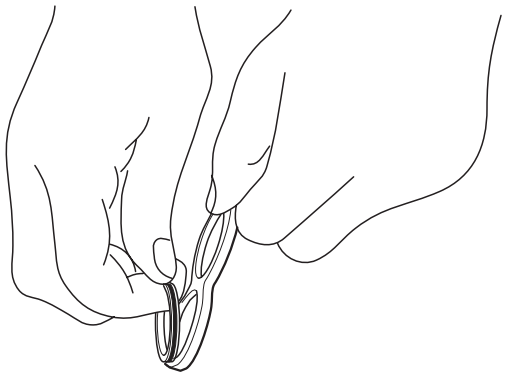


K3D135

c. Fit the O-ring to the guide (18) and mount them on the plate (17).
   - The O-ring on the guide should come to the largely-rounded side of the plate circumference.

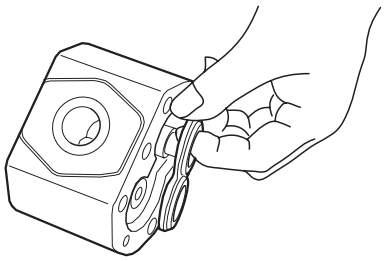



K3D143



K3D142

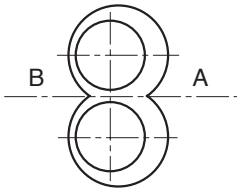
d. Install the plate assembled as described above in the housing.



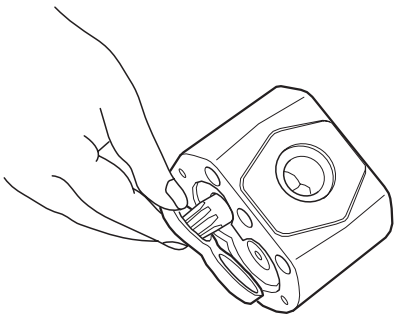
K3D133

e. Install two plates in the housing.
   - Be careful of the installation directions of the plates.

   A: DISCHARGE SIDE
   B: SUCTION SIDE




K3D144

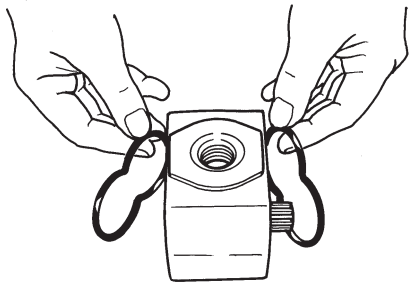


K3D134

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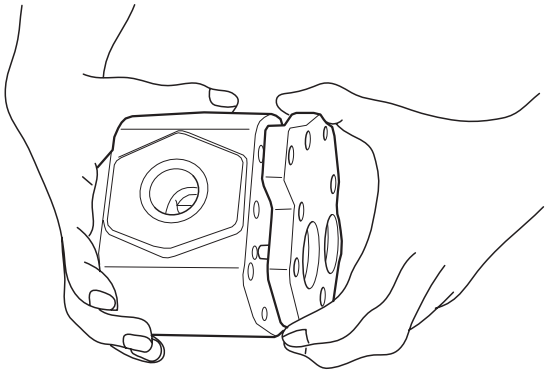


f. Mount the seal ring.



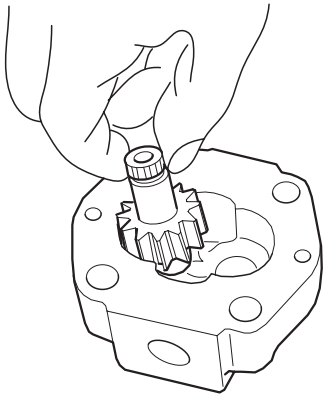
Y4–D125

g. Fit two parallel pins to the frame and mount them on the pump.



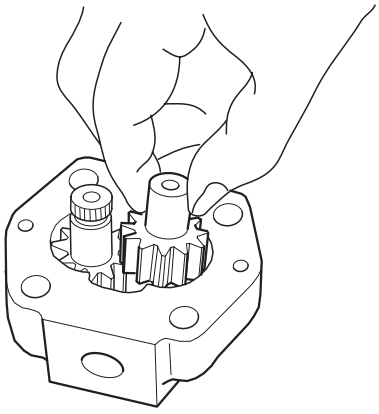
K3D145

19. Assemble the pump P4.
    a. Install the drive gear in the housing.



K3D146

b. Install the driven gear in the housing.

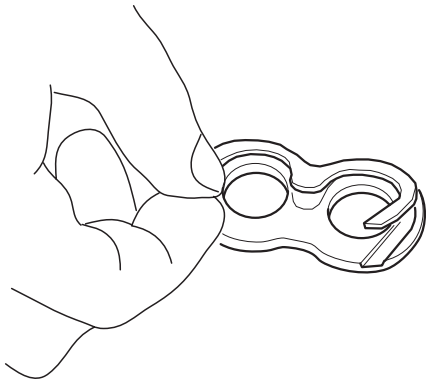


K3D147

https://truckmanualshub.com/

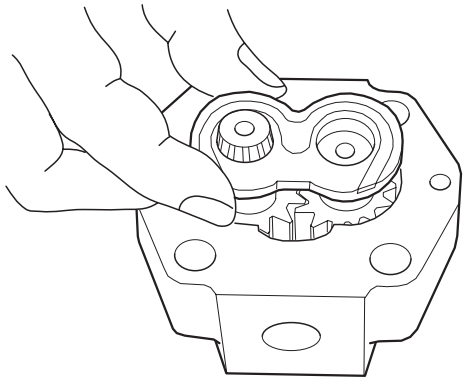


c. Fit the seal ring and backup ring to the plate.
   - Apply grease to the rings in advance to prevent them from dropping off.



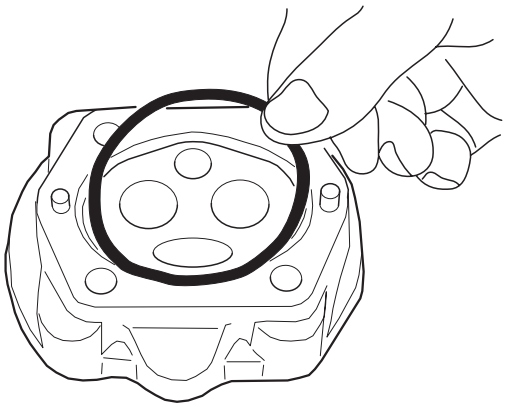
K3D148

d. Install the plate in the housing.



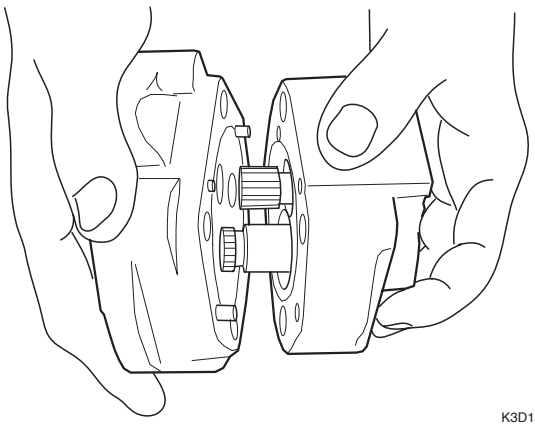
K3D149

e. Fit the pins and O-ring to the frame.



K3D150

f. Install the frame in the housing.

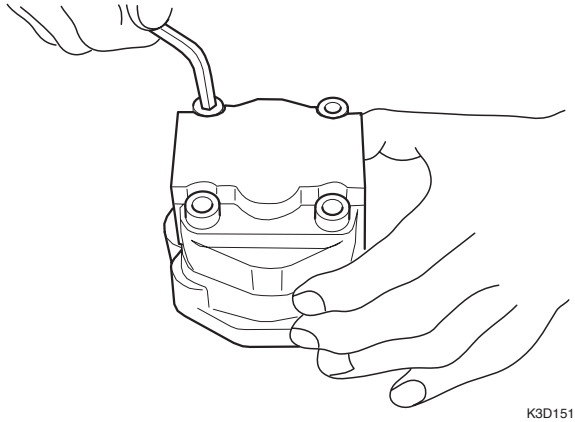


K3D132

https://truckmanualshub.com/

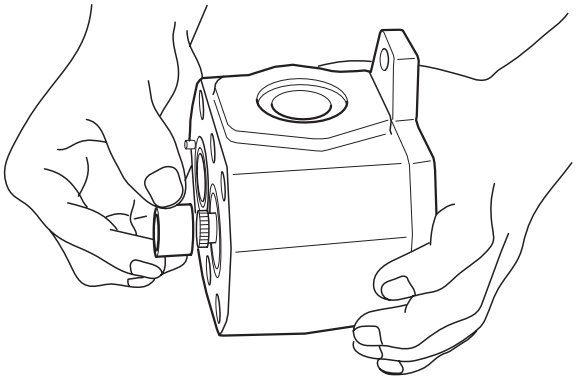


g. Fix the frame and the housing with the cap screws.
   - Cap screw tightening torque:
     29 N·m (3 kgf·m)



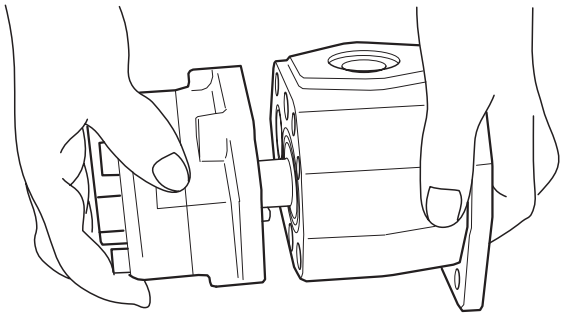
K3D151

h. Fit two pins to the frame and mount the coupling on the shaft end on the side of the pump P3.



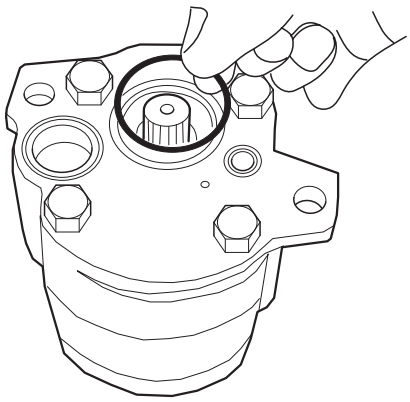
K3D152

20. Unite the pump P3 and the pump P4 and fix them with the bolt.
   - Bolt tightening torque: 59 N·m (6 kgf·m)



K3D153

21. Fit the O-ring to the frame.

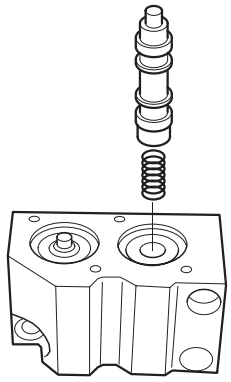


K3D154

https://truckmanualshub.com/

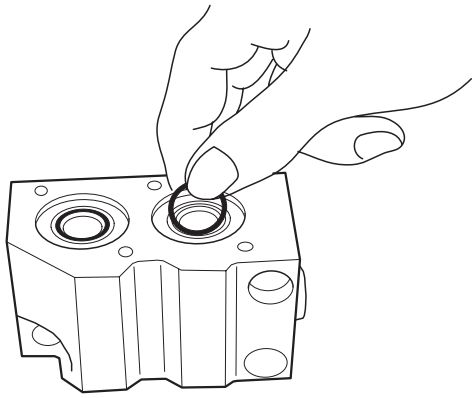


22. Assemble the solenoid valve.
    a. Mount the spring and spool on the body.



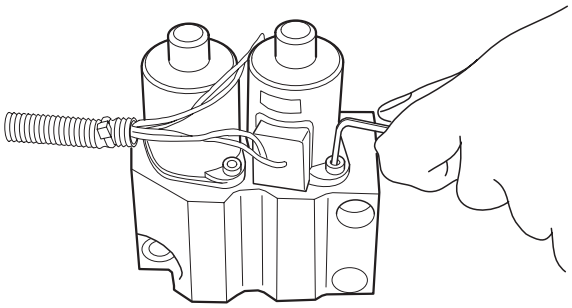
K3D137

    b. Mount the O-ring on the body.



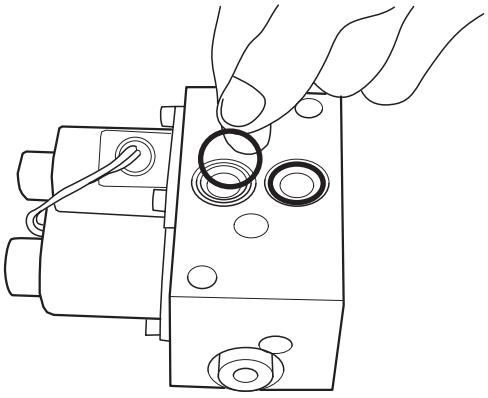
K3D155

    c. Mount the solenoids on the body and fix them with the cap screws.
       • Cap screw tightening torque:
         3.4~4.4 N·m (35~46 kgf·m)



K3D136

    d. Fit the O-ring to the body.

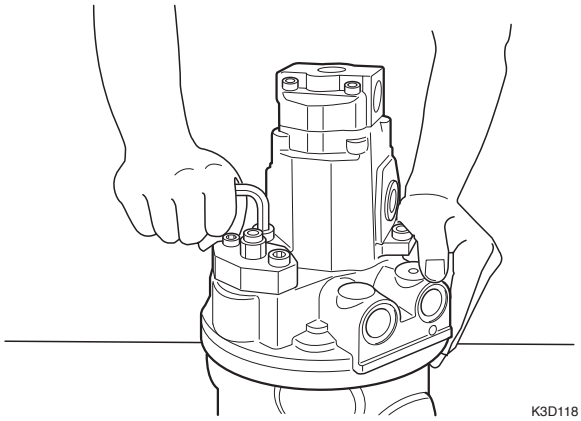


K3D156

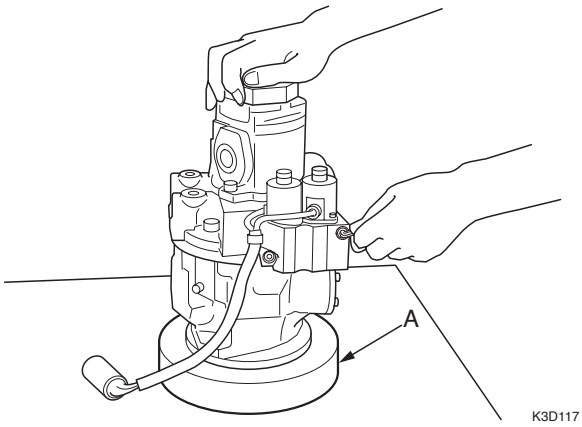
https://truckmanualshub.com/



23. Unite the main pump and gear pump and fix them with the cap screws.
    - Cap screw tightening torque:
      55~69 N·m (5.6~7.0 kgf·m)




24. Mount the solenoid valve on the pump and fix it with the cap screws.
    - Cap screw tightening torque:
      28~35 N·m (2.9~3.6 kgf·m)



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## INSPECTION AND ADJUSTMENT

### Checking the Parts
☞ "IV-45"

## TROUBLESHOOTING

☞ "IV-46"

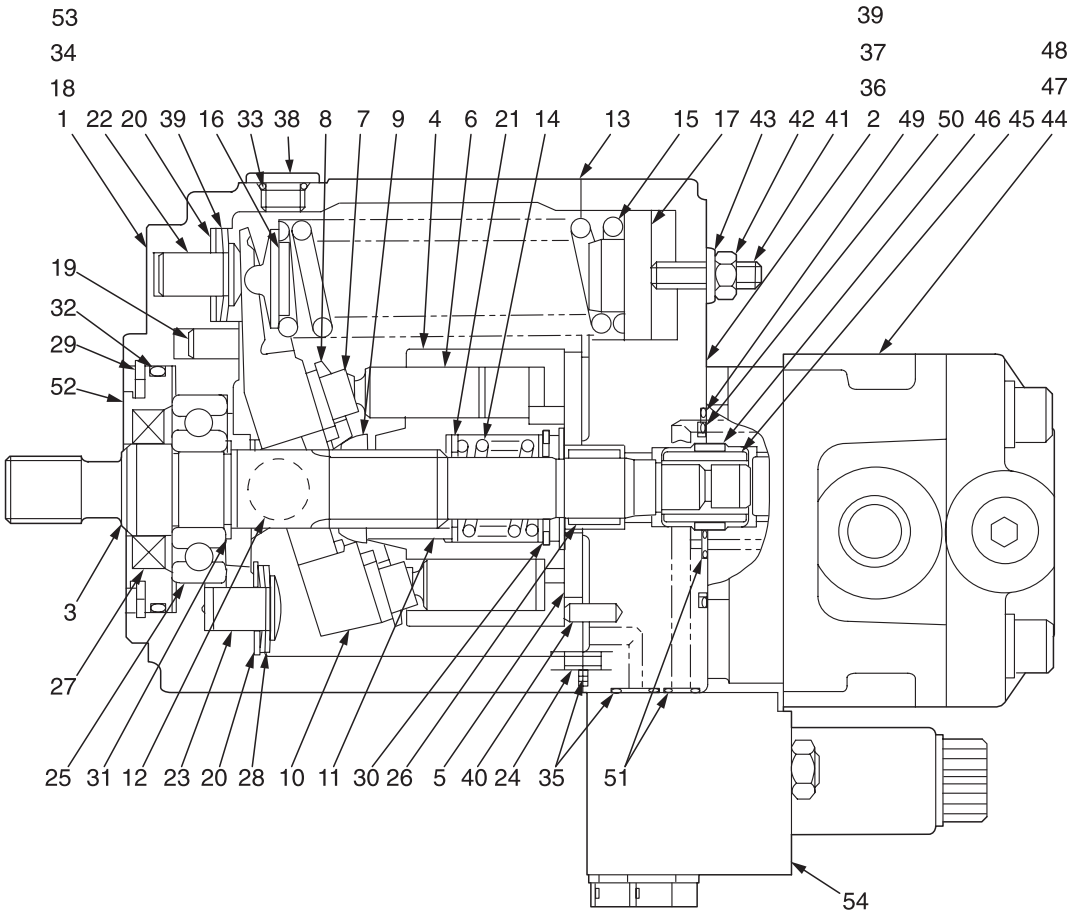
https://truckmanualshub.com/

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## HYDRAULIC PUMP (TB125: S/N 12512126~, TB135)

### CONSTRUCTION
**TB125: S/N 12512126~**
**TB135: S/N 13510004~13512532**

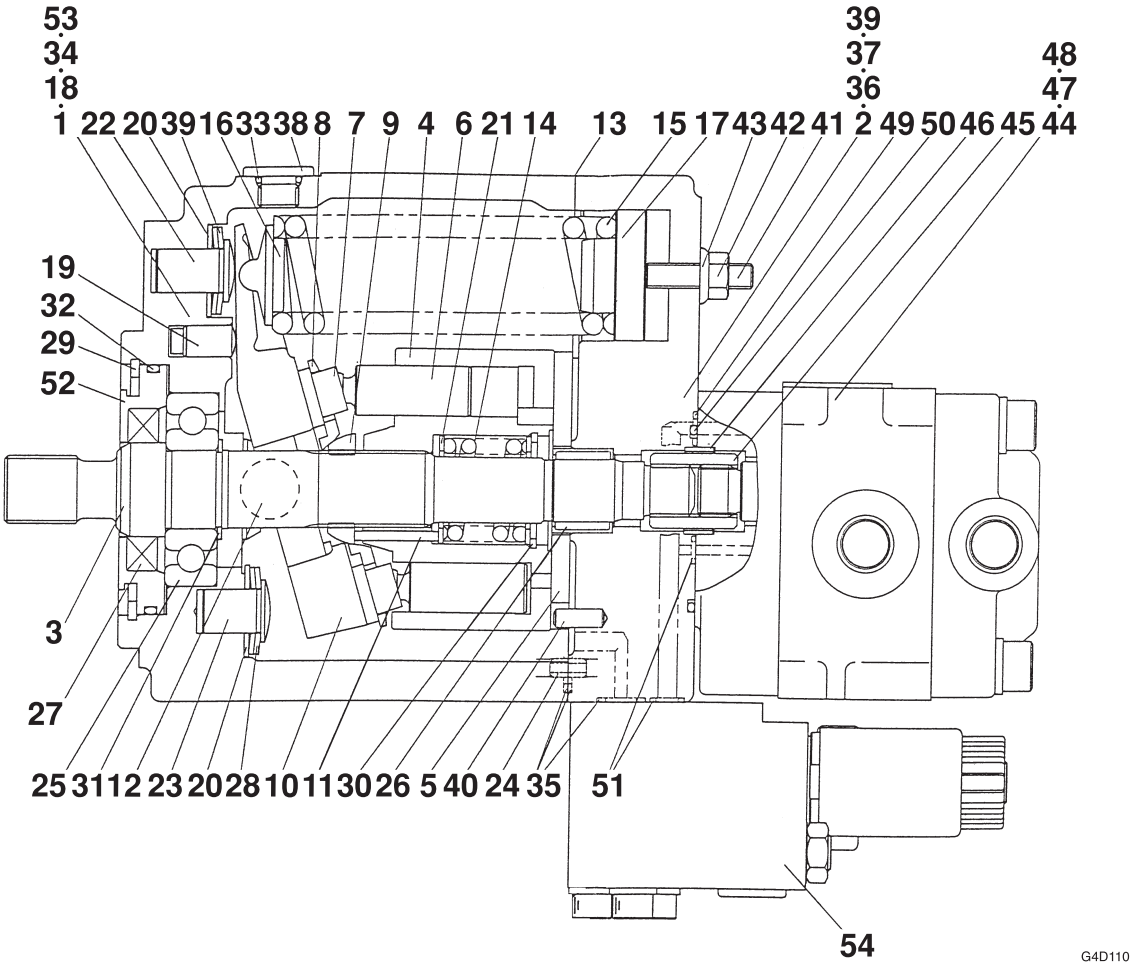



1. Body S
2. Body H
3. Shaft
4. Cylinder Block
5. Valve Plate
6. Piston
7. Shoe
8. Shoe Holder
9. Guide
10. Swash Plate
11. Pin
12. Pin
13. Packing
14. Spring C
15. Spring T1
16. Spring Holder
17. Spring Guide
18. Pin
19. Piston
20. Washer
21. Retainer
22. Stopper Pin A
23. Stopper Pin B
24. Pin
25. Ball Bearing
26. Needle Bearing
27. Oil Seal
28. Conical Spring Washer
29. Snap Ring
30. Snap Ring
31. Snap Ring
32. O-ring
33. O-ring
34. Plug
35. O-ring
36. Bolt
37. Plug
38. Plug
39. Spring Washer
40. Spring Pin
41. Set Screw
42. Nut
43. Seal Washer
44. Gear Pump
45. Coupling
46. Collar
47. Cap Screw
48. Washer
49. O-ring
50. O-ring
51. O-ring
52. Seal Holder
53. O-ring
54. Solenoid Valve

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**TB135: S/N 13512533~**




1. Body S
2. Body H
3. Shaft
4. Cylinder Block
5. Valve Plate
6. Piston
7. Shoe
8. Shoe Holder
9. Guide
10. Swash Plate
11. Pin
12. Pin
13. Packing
14. Spring C
15. Spring T1
16. Spring Holder
17. Spring Guide
18. Pin
19. Piston
20. Washer
21. Retainer
22. Stopper Pin A
23. Stopper Pin B
24. Pin
25. Ball Bearing
26. Needle Bearing
27. Oil Seal
28. Conical Spring Washer
29. Snap Ring
30. Snap Ring
31. Snap Ring
32. O-ring
33. O-ring
34. Plug
35. O-ring
36. Bolt
37. Plug
38. Plug
39. Spring Washer
40. Spring Pin
41. Set Screw
42. Nut
43. Seal Washer
44. Gear Pump
45. Coupling
46. Collar
47. Cap Screw
48. Washer
49. O-ring
50. O-ring
51. O-ring
52. Seal Holder
53. O-ring
54. Solenoid Valve

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## OPERATION

### Piston Pump

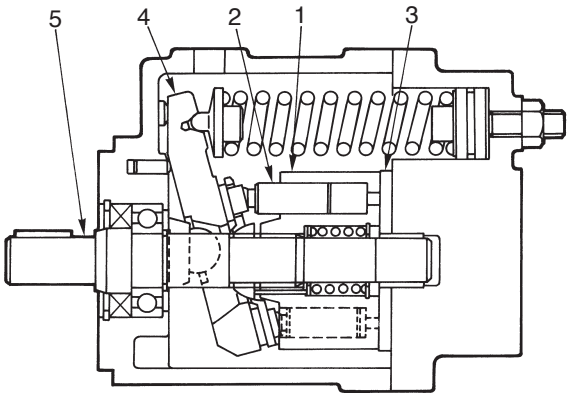
This pump is a variable displacement piston pump with a single cylinder block, which discharges two equal volumes.

Ten pistons (2) are installed in the cylinder block (1), and the end surface is in contact with the valve plate (3). The suction port C and the discharge port A of the pump P1 and the discharge port B of the pump P2 are arranged in the valve plate (3). On the other hand, the swash plate (4) is fastened to the housing at a given inclination, and the pistons (2) rotate along this swash plate (4).

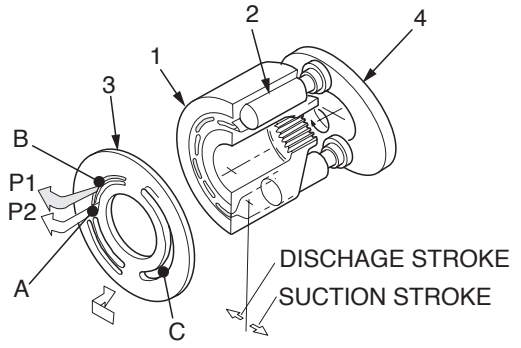
When the shaft (5) is rotated, the cylinder block (1) rotates, the pistons (2) in the cylinder block execute reciprocating movement along the swash plate (4), and the pump executes suction and discharge. At this time, the pistons in contact with the discharge port A of the valve plate (3) operate as the pump P1, while the pistons in contact with the discharge port B operate as the pump P2.

In this way, the ten pistons (2) execute one suction and discharge stroke with each revolution of the cylinder block (1), so that suction and discharge are executed continuously when the shaft (5) is rotated continuously.

As the piston stroke displacement depends on the inclination of the swash plate (4), the discharge flow quantity can be changed by changing the inclination of the awash plate (4).



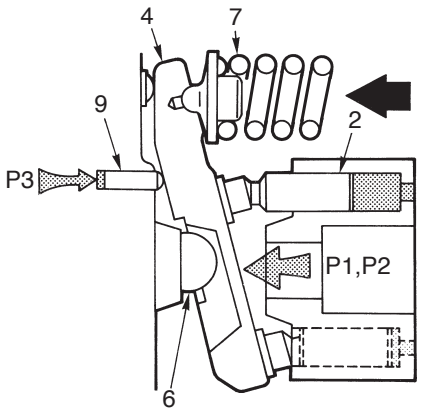

C4D101




G4D101

#### Discharge volume control

The swash plate (4) is equipped with the swing pins (6) and is mounted on the housing at an inclination that can be varied. The swash plate (4) is loaded with the pistons (2) of the cylinder block and the piston (9) in opposition to the spring (7). The discharge pressures from the pumps P1 and P2 work on the pistons (2). The discharge pressure from the pump P3 works on the piston (9). If the discharge pressure is below the value preset for the spring (7), the inclination of the swash plate (4) is fixed to the maximum value by the spring (7).

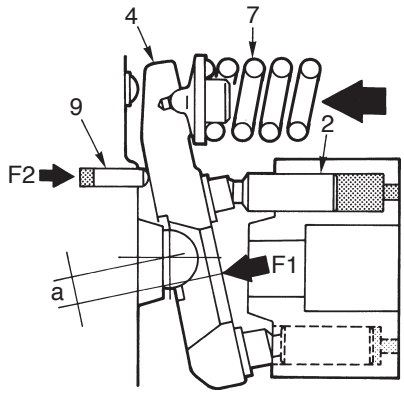



C4D102

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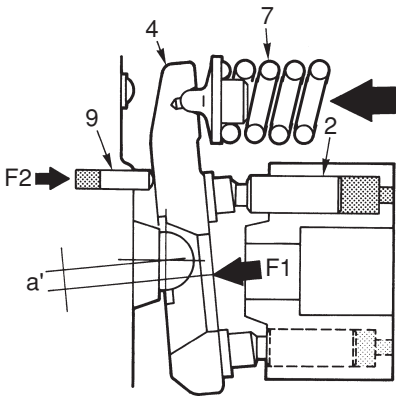


If the discharge pressure becomes larger than the preset value for the spring (7), the inclination of the swash plate (4) is made smaller by the resultant of the piston's force F1 x a and the piston's force F2. The swash plate (4) is kept at the inclination that balances the discharge pressure and the spring force.



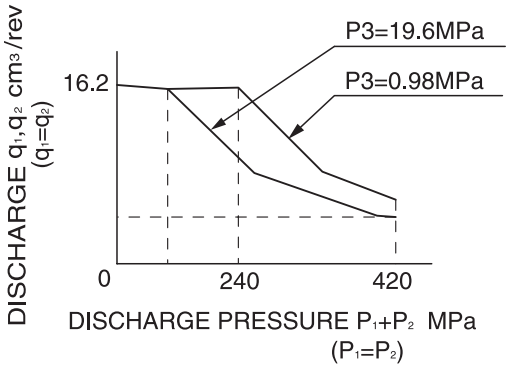

C4D103

If the discharge pressure further increases, the inclination of the swash plate (4) becomes much smaller. At this time, the arm length "a" on which the resultant of the piston's force F1 works decreases to "a' ". This means that a much larger force F1 is needed to keep the balance.




C4D104

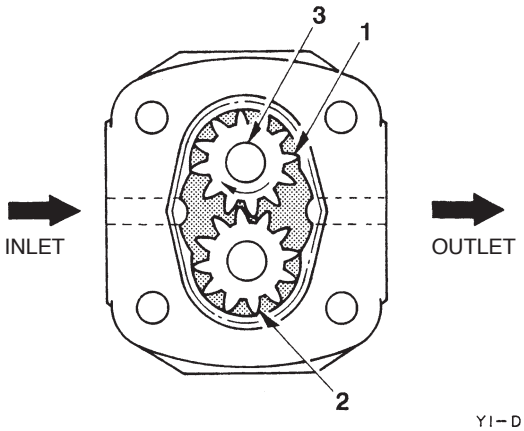
Thus, by changing the inclination of the swash plate (4) the discharge is controlled and only minimum pressure and flow required for the load are supplied from the pump. This minimizes the pressure loss of the pump. The inclination of the swash plate (4) varies depending on the operating pressures not only by the pumps P1 and P2 but also by the pump P3. Thus, the P-Q curve for the piston pumps shows that the engine's power is fully utilized (full horse power control).




G4D102

### Gear Pump

The gear pump consists of a single gear case, inside of which is a drive gear (1) and a driven gear (2) engaged with each other. By turning the drive shaft (3), the space between the case and the gears is filled with oil. This oil is thus sent through the pump from the inlet to the outlet.



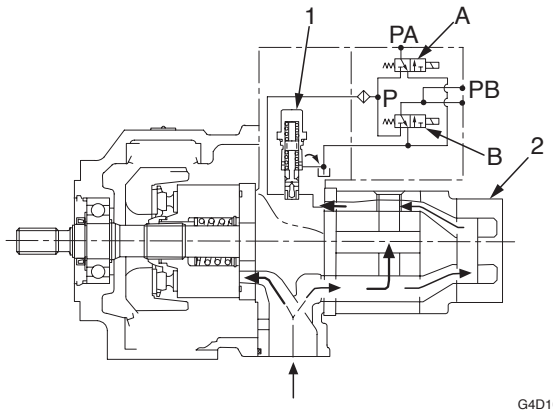

Y1-D101

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### Pilot Relief Valve and Solenoid Valve

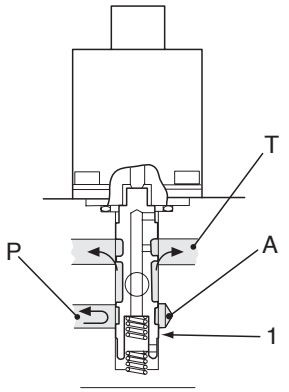
The pilot relief valve (1) keeps the pressure in the pilot circuit constant by releasing the oil into the tank passage when the discharged oil pressure from the pump P4 (2) exceeds the preset value.
This pilot pressure is switched by the solenoid valve A (that switches the second travel speed) and the solenoid valve B (that switches the lever lock).




G4D103

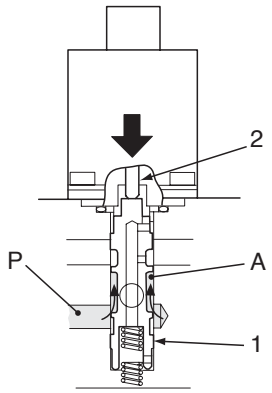
### Solenoid Valve

When Current is NOT Flowing
Oil at port P is blocked by the spool (1). Also, since port A and port T are connected, the pressure in the pilot circuit downstream becomes the same as the tank pressure.




G4D109

When Current is Flowing
A magnetic field is generated around the coil and the plunger (2) is pulled down. This pushes the spool (1) down. As a result, oil at port P flows into port A and pressure is transmitted to the pilot circuit at the bottom.




G4D108

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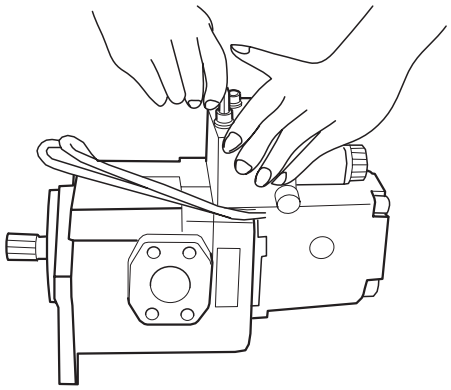
## DISASSEMBLY AND ASSEMBLY

### General Cautions

- Carry out disassembly and assembly operations in a clean place and provide clean containers to place the disassembled parts in.
- Before disassembly, clean around the ports and remove the paint from each joint using a wire brush.
- Clean each of the disassembled parts with a cleaning oil such as diesel fuel.
- Make match marks on each part so that they will be assembled in the same positions when assembled.
- Replace all seals with new ones each time the pump is disassembled, coating them lightly with grease.
- Check each part to make sure there is no abnormal wear or seizing and use sandpaper, etc. to remove any burrs, sharp edges, etc.
- Adjust adjustment screws only when required.

### Disassembly

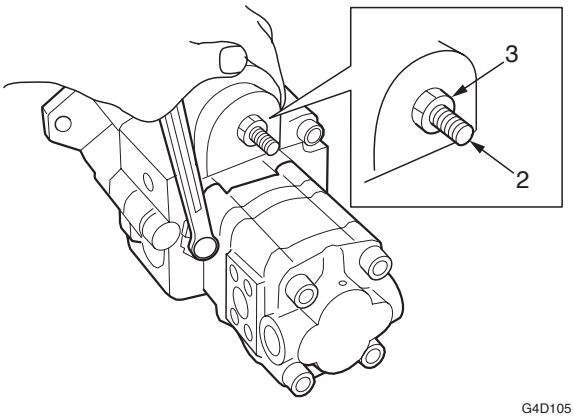
1. Remove cap screws and then the solenoid valve.



G4D104

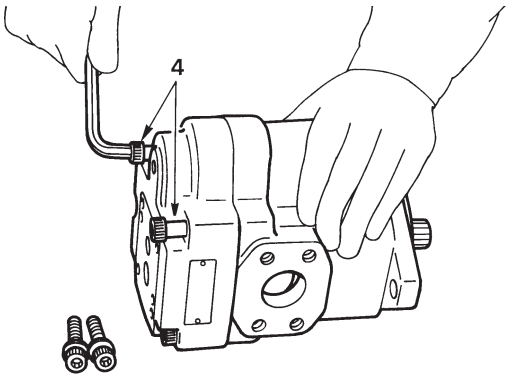
2. Remove the bolts and then the gear pump.

3. Loosen the lock nut (3) and remove the set screw (2).
   - Record the length of the set screw protrusion before starting the disassembly.




G4D105

4. Disassemble the body S and body H.
   a. Remove the upper two of the five cap screws (4), replace the two temporary cap screws (M10 × 65), and tighten them by about 10 mm.
   b. Slowly loosen the remaining three cap screws (4).
   c. Loosen the temporary cap screws (M10 × 65) and separate the body S from the body H.
      - Lightly tap the spring insert section of the body H with a plastic hammer.

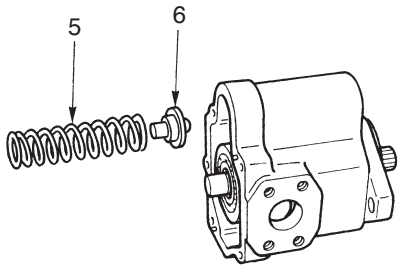



Y3–D107

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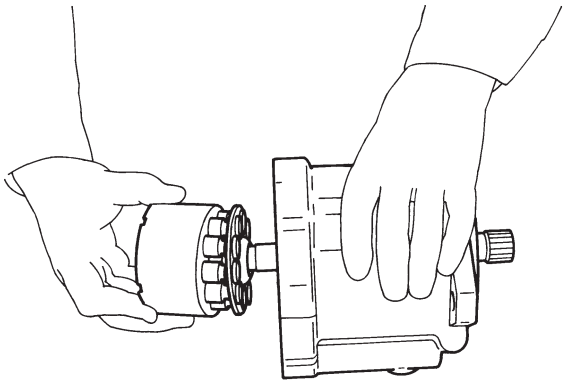


5. Remove the spring (5) and spring holder (6) of the body H from the body S.




C4D107

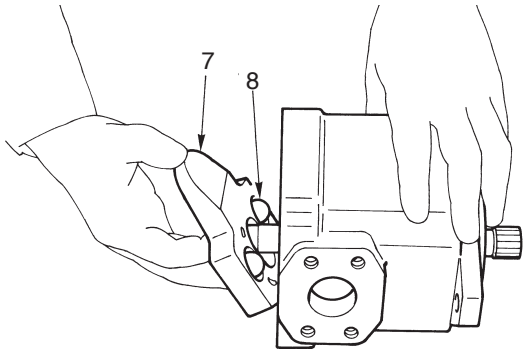
6. Remove the cylinder block from the body S.



Y3–D109

7. Remove the swash plate (7) and swing pins (8) from the body S.

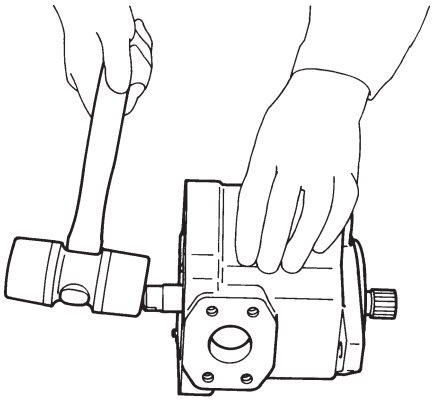
8. Remove the stopper pin A and the washers, then the stopper pin B and the washers and piston from the body S.
   - Parts should be stored so that they can be placed at the same positions when they are assembled.




C4D108

9. Remove the snap ring from the shaft side of the body S.

10. Remove the shaft assembly and oil seal from the body S.
    - Use a plastic hammer to take off the shaft assembly.

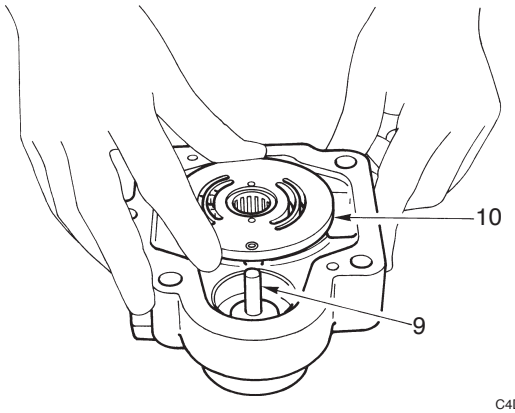


Y3–D111

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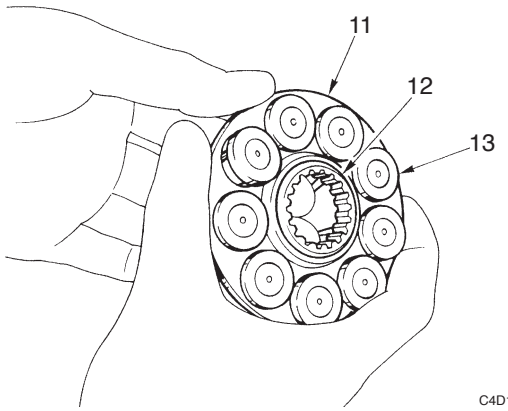


11. Remove the spring guide (9) and valve plate (10) from the body H.
    - To remove the spring guide, drive the set screw into the set screw hole of the body H and push out the spring guide.



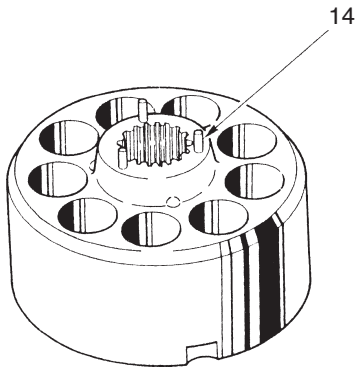
C4D109

12. Disassemble the cylinder block.
    a. Remove the shoe holder (11) and guide (12) from the cylinder block.
    b. Remove the shoe holder (11) from the pistons (13).



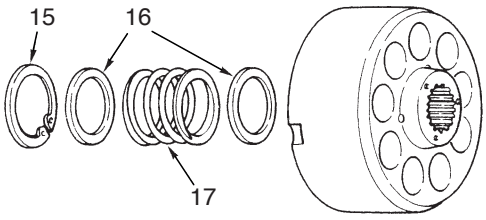
C4D110

    c. Remove the pins (14) from the cylinder block.

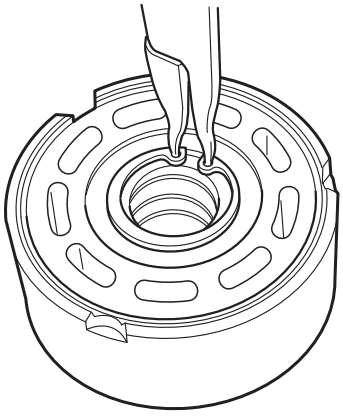


C4D111

    d. Remove the snap ring (15) first, and then the retainer (16), spring (17) and retainer (16) from the cylinder block.



C4D113

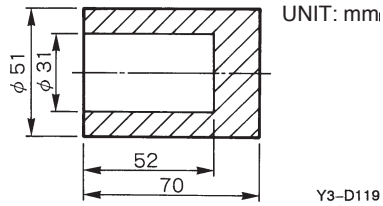

C4D112

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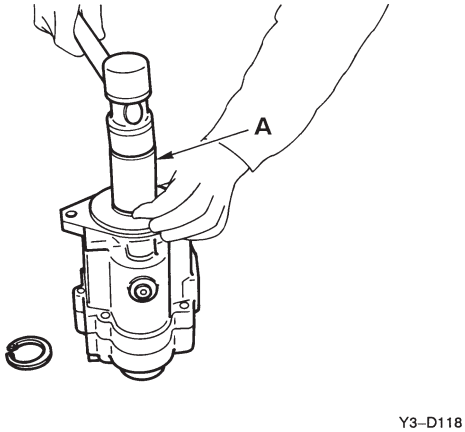


### Assembly

1. Mount the shaft assembly (18), oil seal (19) and snap ring (20) on the body S.
   - To mount the oil seal (19), use the insertion jig (A) (see Figure below) and tap the oil seal lightly with a hammer.
   - Temporarily mount the body S on the body H.



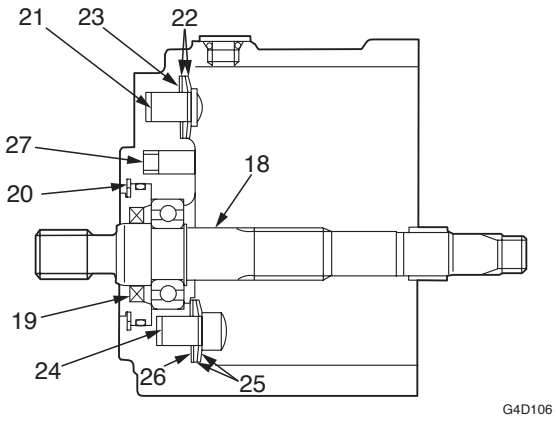

MATERIAL: S35C OR EQUIVALENT



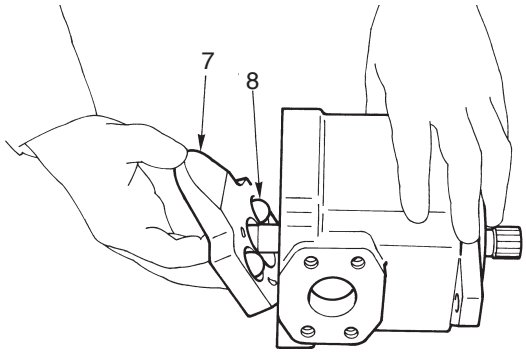

2. Fit two conical spring washers (22) and the washer (23) to the stopper pin A (21), and mount them on the body S.

3. Fit two conical spring washers (25) and the washer (26) to the stopper pin B (24), and mount them on the body S.

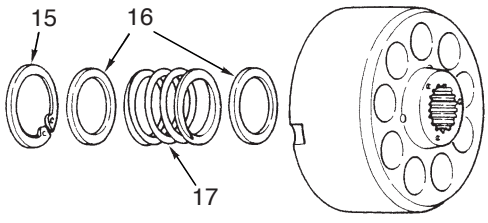
4. Mount the piston (27) on the body S.

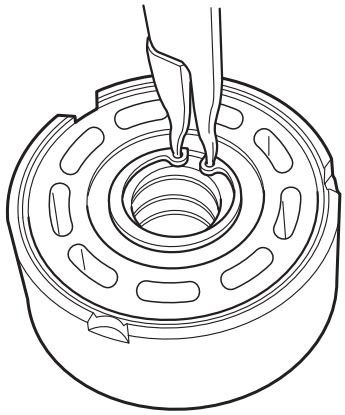



5. Fit the swing pins (8) to the swash plate, and install it into the ball orifice of the body S.




6. Assemble the cylinder block assembly.
   a. Install the retainer (16), spring (17), retainer (16) and snap ring (15).

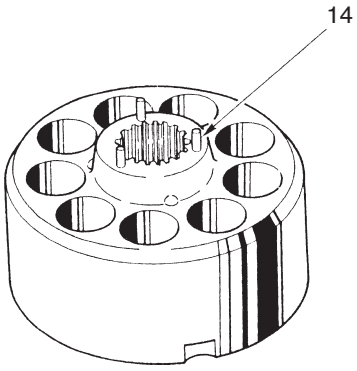


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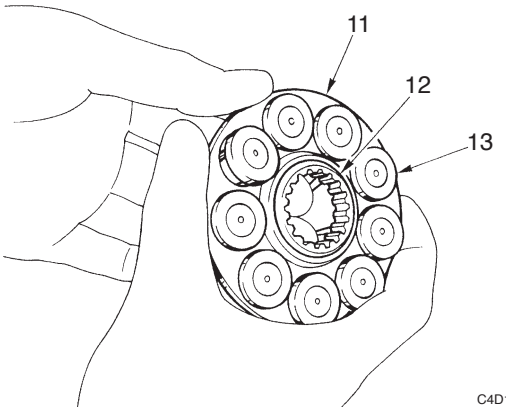


b. Fit the pin (14) to the cylinder block.



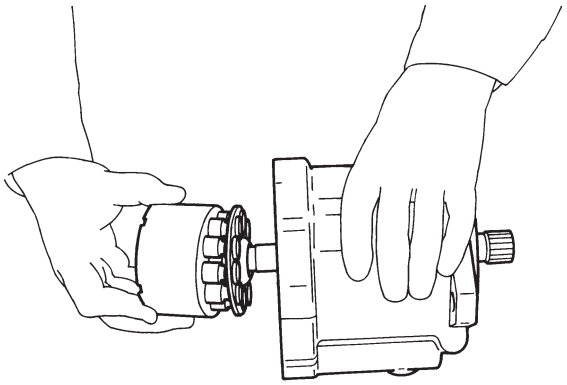

C4D111

c. Fit the guide (12) to the cylinder block.
d. Fit the pistons (13) to the shoe holder (11), and mount the shoe holder on the cylinder block.



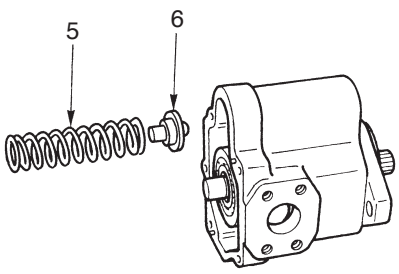

C4D110

7. Mount the cylinder block assembly on the body S.



Y3–D109

8. Fit the spring (5) to the spring holder (6). Then, install the ball-shaped section of the spring holder in the orifice of the swash plate.



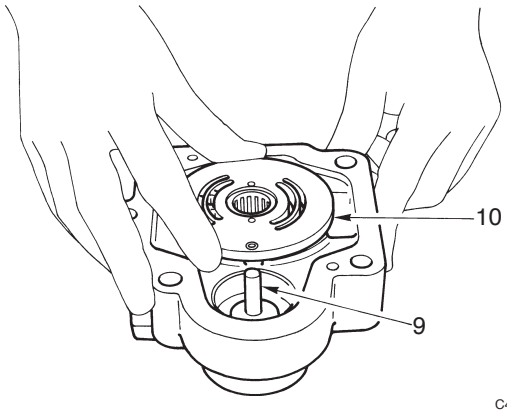

C4D107

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9. Mount the spring guide (9) on the body H.

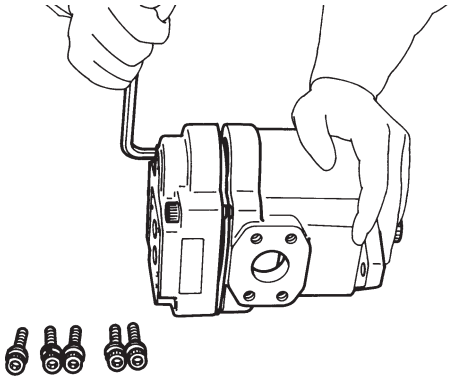
10. Position the valve plate (10) by the spring pin of the body H and gently fix it.
    - Be careful of the direction of the valve plate. The whiskered surface of the valve plate should be circled along the cylinder block.



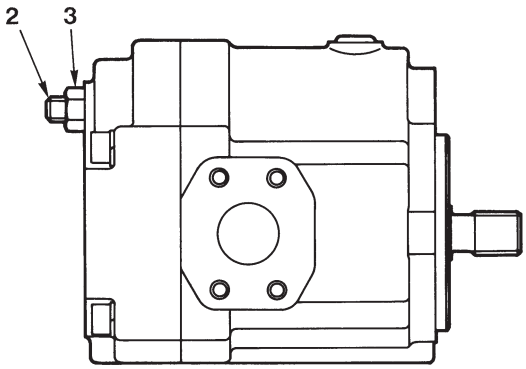
C4D109

11. Fit the packing to the mating surface of the body S.
    - The packing should be aligned with the positioning pin of the body S.

12. Fit two temporary cap screws (M10 × 65) to the upper side and tighten them slowly. When the clearance between the two surfaces becomes 5 mm to 10 mm, replace the temporary cap screws with five cap screws (M10 × 45) and fix them.
    Cap Screw: 51.0~64.7 N·m

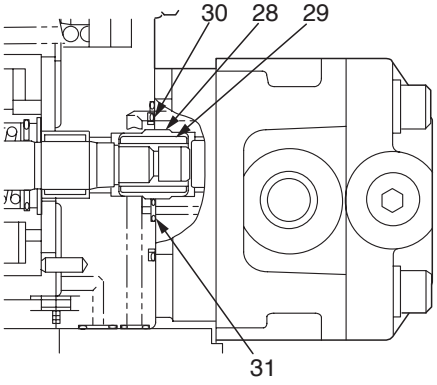

Y3–D221

13. Install the set screw (2).
    - Fix the set screw (2) to the same length as previously assembled using the lock nut (3).



Y3–D222

14. Fit the collar (28) and coupling (29) to the gear pump connection position of the piston pump, and fit the O-rings (30) and (31).

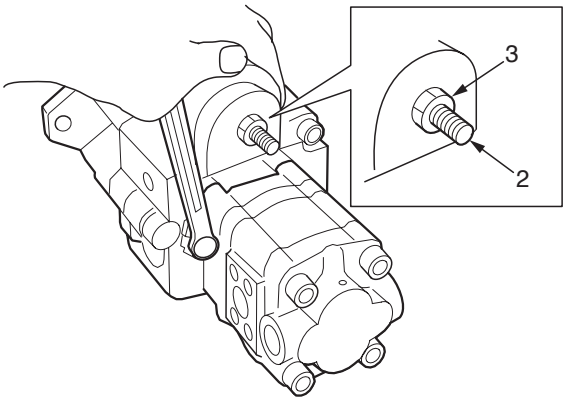


G4D107

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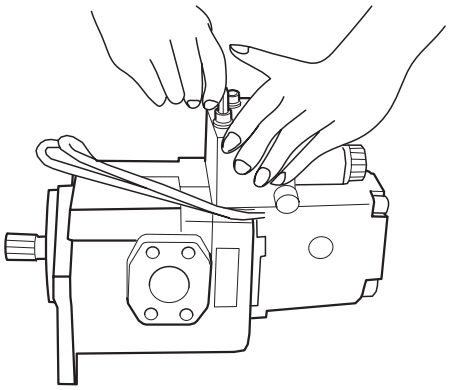


15. Install the gear pump by using two cap screws and washers.
    Cap Screw:
    <TB125> S/N 12512126~: 9.8~14.2 N·m
    <TB135>
    S/N 13510004~13512532: 9.8~14.2 N·m
    S/N 13512533~: 19.6~23.5 N·m

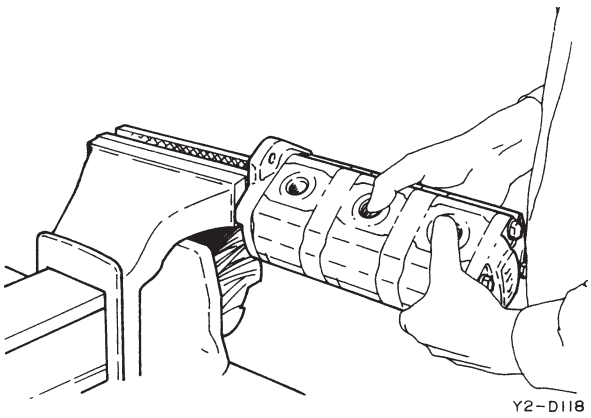


G4D105

16. Fit the O-rings to the solenoid valves and secure the solenoid valves to the pump using the cap screws and washers.
    Cap Screw: 20~25.5 N·m


G4D104

17. To check if the assembly is complete, lightly clamp the pump shaft in a vise and turn the pump. If the pump does not turn smoothly, reassemble it again.

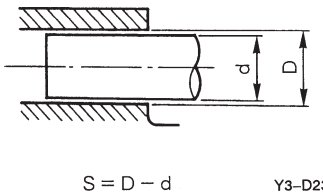
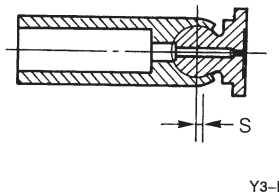
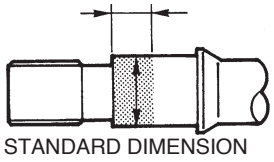

Y2-D118

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## INSPECTION AND ADJUSTMENT

### Checking the Parts

| Parts | | Judgment Criteria | Treatment |
|---|---|---|---|
| Piston and cylinder block assembly |  | • A clearance S of 0.05 mm or more between the piston and the cylinder block<br>• Occurrence of scratches, scoring, abnormal wear, etc. on sliding parts | • Exchange<br>• Exchange. |
| Slack of the piston shoe |  | • A slack S of 0.2 mm or more for the piston shoe | • Exchange |
| Shaft and oil seal installation part |  | • A wear amount of 0.025 mm at the installation part of shaft and oil seal | • Exchange |
| Valve plate | | • No abnormal scratches (0.02 mm or more), wear, or sticking for the sliding surfaces | • Correct by lapping or exchange. |
| Bushing | | • No abnormal wear or harmful scratches of the sliding surfaces | • Exchange |
| Seals and O-rings | | • At the time of reassembly after disassembly | • Exchange |
| Drive gear and driven gear | | • No abnormal scratches, wear, or flaking of the tooth surfaces | • Exchange |
| Ball bearings and needle bearings | | • No abnormal scratches, wear, or flaking of the rolling surfaces | • Exchange the shaft and the assembly. |

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## TROUBLESHOOTING

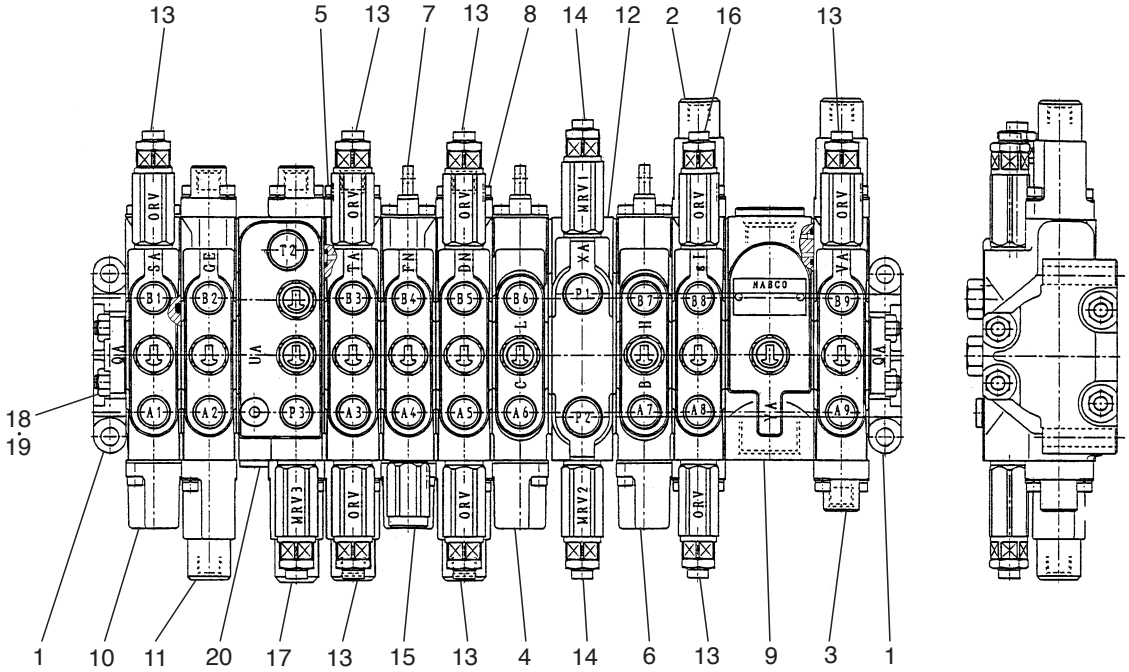
| Symptom | Probable Causes | Remedy |
|---|---|---|
| Noise is loud. Abnormal noise is generated. | • The suction hose is pinched or the suction filter is clogged.<br>• The suction side joint is loose and air is being sucked in.<br>• The hydraulic oil's viscosity is too high and cavitation is occurring.<br>• The pump is off center with respect to the engine.<br>• There are bubbles in the hydraulic oil.<br>• The engine's speed is higher than the specified speed.<br>• The drain back pressure is higher than the specified pressure.<br>• The bearing, etc. is mechanically damaged. | • Remove the dirt or eliminate the pinched condition of the hose.<br>• Retighten each joint.<br>• Replace the hydraulic oil with oil of the proper viscosity.<br>• Center the pump with respect to the engine.<br>• Investigate the cause of the bubbles and repair it.<br>• Operate the engine at the specified speed.<br>• Check and replace the drain piping.<br>• Replace the damaged parts or replace the pump. |
| Discharge is insufficient. | • The engine's speed is too low.<br>• The oil temperature is abnormally high.<br>• The hydraulic oil's viscosity is too high.<br>• The pump's volumetric efficiency has dropped.<br>• The horsepower setting adjustment screw is loose.<br>• The oil level in the tank is low.<br>• The suction side pipe or the suction filter is clogged.<br>• The amount of leakage from hydraulic devices other than the pump is increasing. | • Operate the engine at the specified speed.<br>• Stop the machine and let the oil cool off, then check again.<br>• Replace the hydraulic oil with oil of the proper viscosity.<br>• Replace the pump.<br>• Reset the screw and lock it.<br>• Replenish the tank with hydraulic oil to the specified level.<br>• Clean the piping.<br>• Repair the hydraulic device or replace it. |
| Pressure doesn't rise. | • The relief valve setting has dropped.<br>• The amount of leakage from hydraulic devices other than the pump is increasing.<br>• The pump's volumetric efficiency has dropped. | • Reset the relief valve setting.<br>• Repair the hydraulic device or replace it.<br>• Replace the pump. |
| The rotational speed drops when there is a dynamic load. | • The peak pressure is generated due to a drop in the relief valve's response.<br>• There is foreign matter trapped in the pilot line or foreign matter is caught in the sliding parts of the control equipment. | • Repair the relief valve or replace it.<br>• Remove the foreign matter and repair or replace the scratched parts. |
| Abnormal heat is generated. | • Leakage from the pump is increasing.<br>• The bearings, etc. are mechanically damaged.<br>• There is seizing of sliding parts. | • Replace the pump.<br>• Replace the damaged parts or replace the pump.<br>• Replace the damaged parts or replace the pump. |
| Hydraulic oil is leaking. | • Seals are damaged.<br>• The shaft surface which slides against the oil seal is worn.<br>• The plug or bolts are loose. | • Replace the seals.<br>• Replace the shaft or replace the pump.<br>• Tighten them or replace the seals. |

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## CONTROL VALVE (TB125, TB135)

### CONSTRUCTION



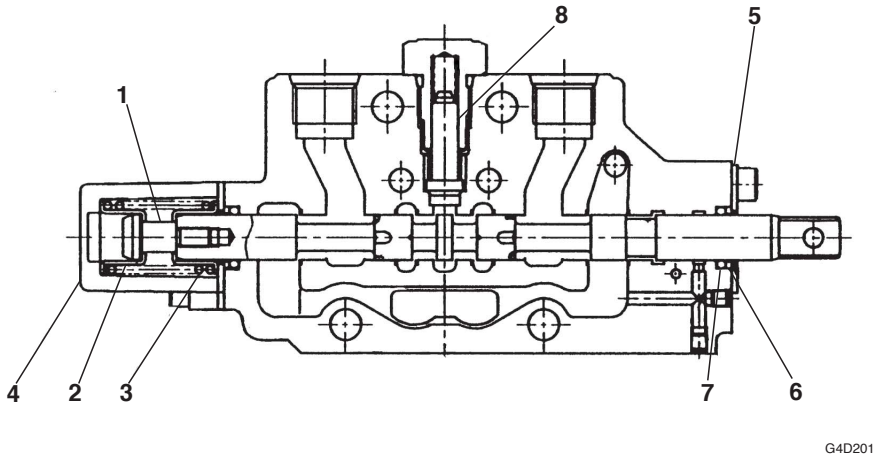

G4D200

1. End Cover
2. Boom Block Assembly
3. Bucket Block Assembly
4. Left Travel Block Assembly
5. Auxiliary Block Assembly
6. Right Travel Block Assembly
7. Swing Block Assembly
8. Arm Block Assembly
9. Outlet Housing
10. Dozer Blade Block Assembly
11. Slew Block Assembly
12. Inlet Housing
13. Port Relief Valve
14. Main Relief Valve
15. Anti Cavitation Valve
16. Port Relief Valve
17. Main Relief Valve
18. Tie Rod
19. Nut
20. Switch Valve

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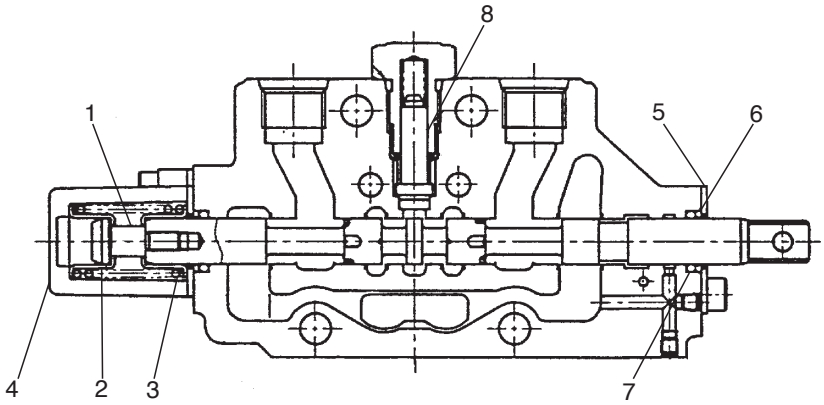
### Left Travel Block




G4D201

1. Screw
2. Spring Holder
3. Spring
4. Cover
5. Seal Holder
6. Backup Ring
7. O-ring
8. Poppet

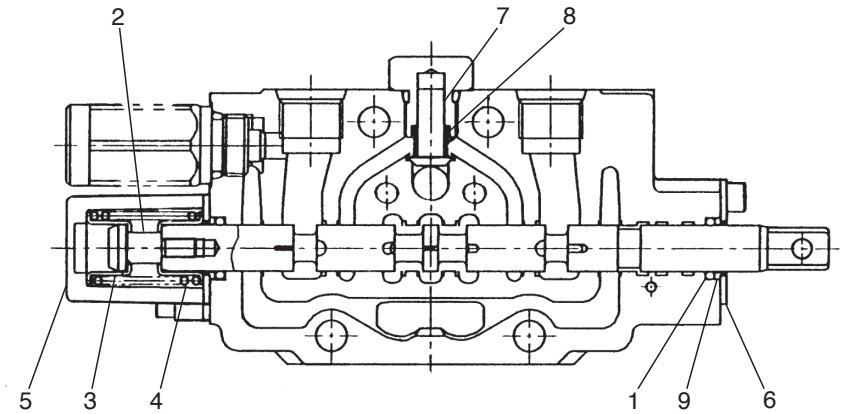
### Right Travel Block




G4D202

1. Screw
2. Spring Holder
3. Spring
4. Cover
5. Seal Holder
6. Backup Ring
7. O-ring
8. Poppet

### Swing Block



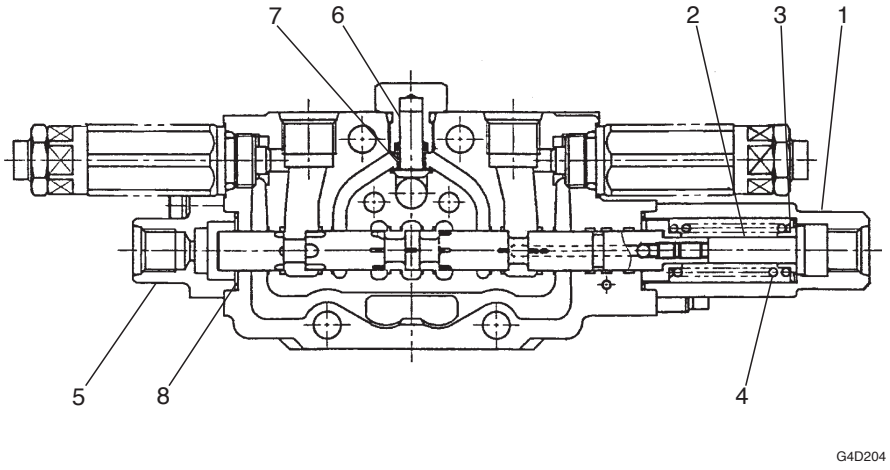

G4D203

1. O-ring
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Seal Holder
7. Poppet
8. Spring
9. Backup Ring

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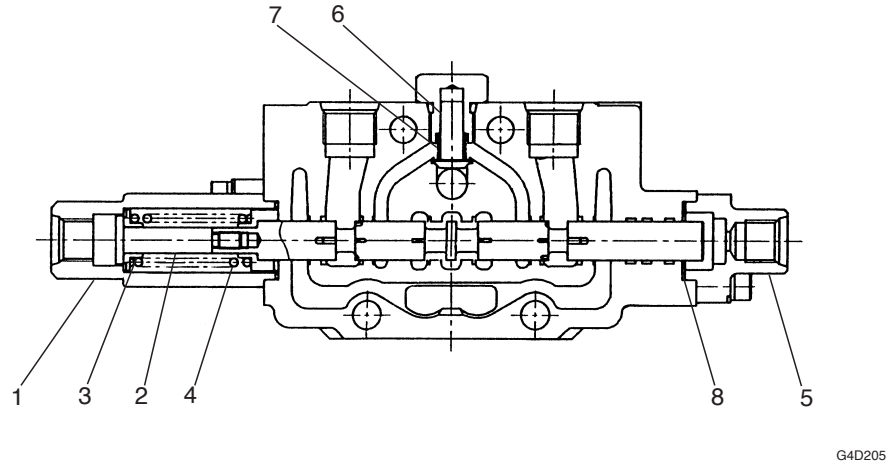


**Boom Block, Bucket Block**



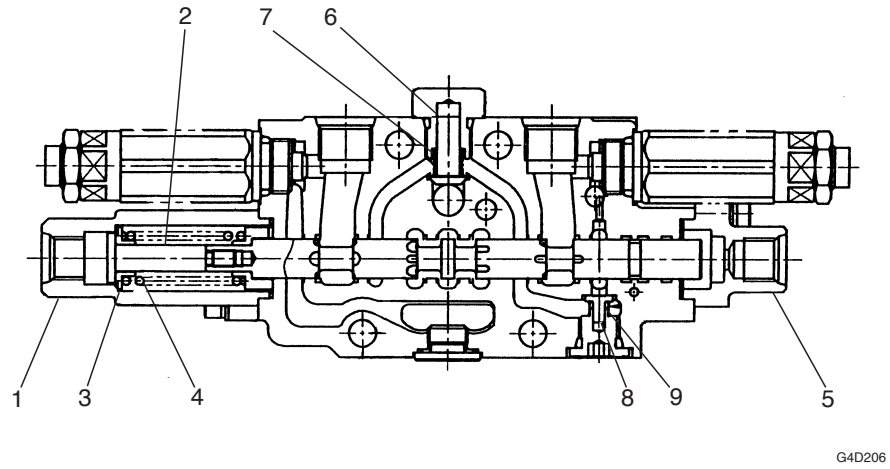

1. Cover
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Poppet
7. Spring
8. O-ring

**Slew Block**




1. Cover
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Poppet
7. Spring
8. O-ring

**Arm Block**

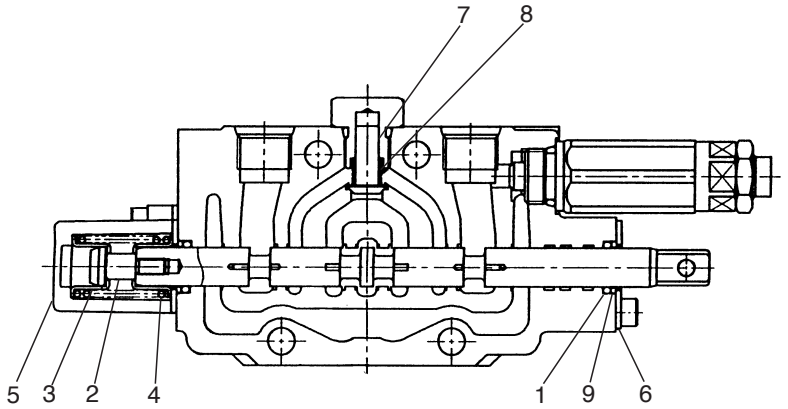



1. Cover
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Poppet
7. Spring
8. Poppet
9. Spring

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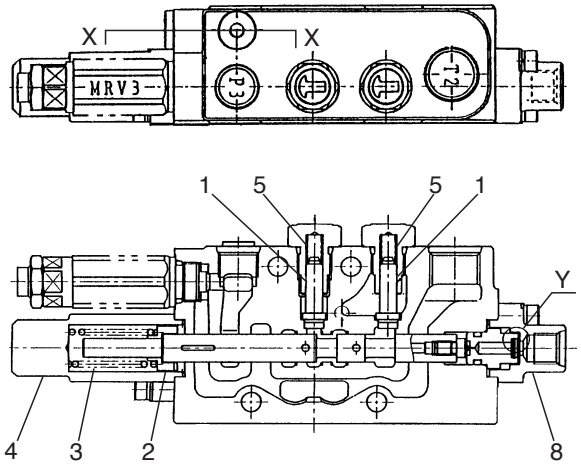
### Dozer Blade Block




G4D207

1. O-ring
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Seal Holder
7. Poppet
8. Spring
9. Backup Ring

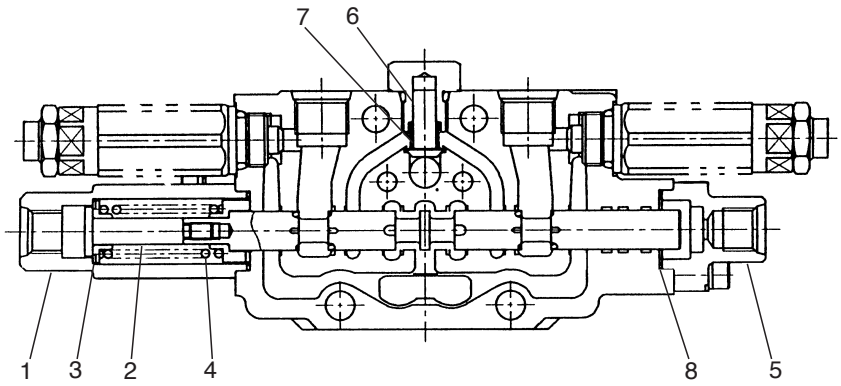
### Switch Valve




G4D208

1. Poppet
2. Spring Holder
3. Spring
4. Cover
5. Spring
6. Filter
7. Snap Ring
8. Cover

### Auxiliary Block



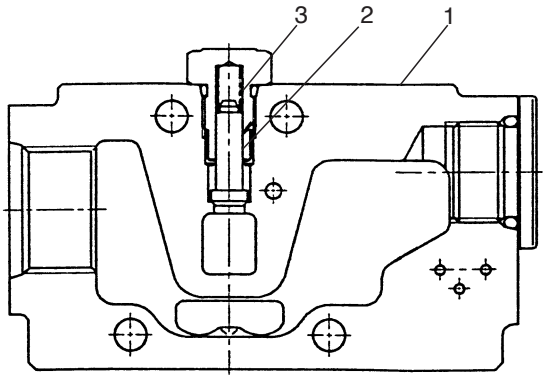

G4D209

1. Cover
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Poppet
7. Spring
8. O-ring

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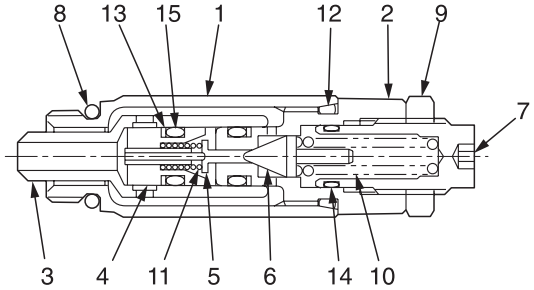
### Outlet Housing




G4D210

1. Housing
2. Poppet
3. Spring

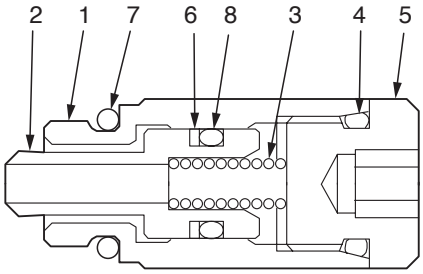
### Main Relief Valve, Port Relief Valve




G4D2111

1. Housing
2. Plug
3. Sleeve
4. Main Poppet
5. Piston
6. Needle Valve
7. Set Screw
8. O-ring
9. Lock Nut
10. Spring
11. Spring
12. O-ring
13. Backup Ring
14. O-ring
15. O-ring

### Anti-Cavitation Valve




G4D212

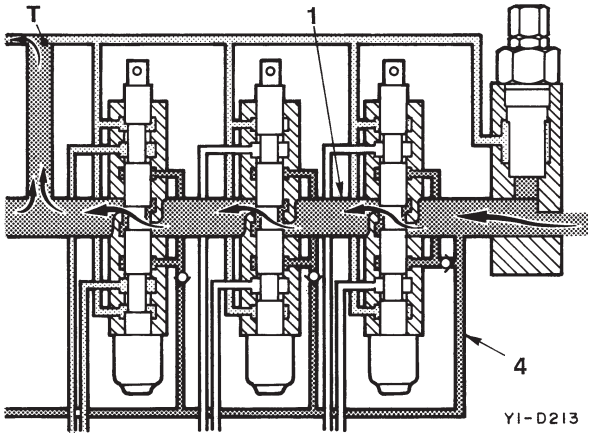
1. Sleeve
2. Poppet
3. Spring
4. O-ring
5. Plug
6. Backup Ring
7. O-ring
8. O-ring

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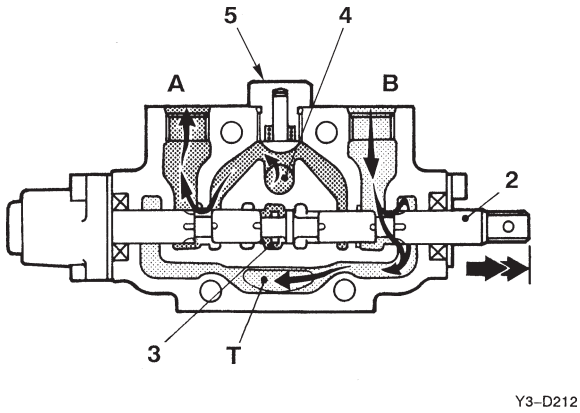


## OPERATION

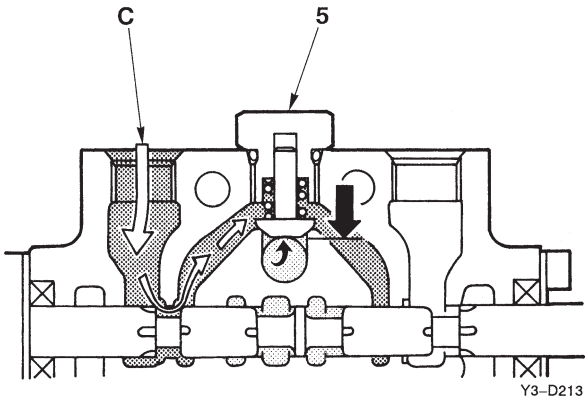
When the Spool is in the Neutral Position
When the control valve spool is not moving, hydraulic oil flows through the center bypass passage (1) and then through the tank passage (T) in the arrow direction, returning to the tank.




When the Spool is Actuated
Explanation is given for the case where the spool is moved to the right.
When the spool (2) is moved to the right, the center bypass passage (3) is closed and hydraulic oil entering from the pump passes through the load check valve (5) from the parallel passage (4), flowing from the A port to the actuator. On the other hand, oil returning from the B port flows through the tank circuit (T) and returns to the tank.




Load Check Valve
This valve prevents oil from flowing backward due to the load pressure (C) from the actuator port during switching of the spool.



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### Main Relief Valve, Port Relief Valve

A main relief valve is mounted between the pump circuit and tank circuit of each inlet housing and serves to maintain the circuit pressure at the set value.

A port relief valve is located between the actuator port and the tank circuit and when abnormal pressure due to shock pressure or external pressure generated when the actuator port is suddenly blocked by the spool or when there is an overload occurs, these valves act to protect the actuator.

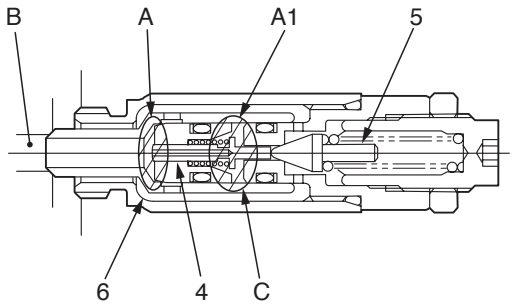
Relieving Operation

When the pressure in the circuit is low with respect to the set value, the relief valve is maintained at equilibrium. Pressure from the pump passes from chamber B to the orifice in piston (4), then reaches chamber C and the needle valve (5). On the other hand, forces F and F1 are acting in the arrow directions on both sides of the main poppet (6).

$F = P \times A$ $F1 = P \times A1$

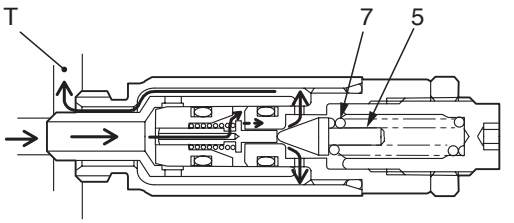
P: Pressure A,A1: Sectional Area

Since the sectional area of A is less than that of A1, the main poppet (6) is pushed by the force "F1-F" to the seat surface on the left side.



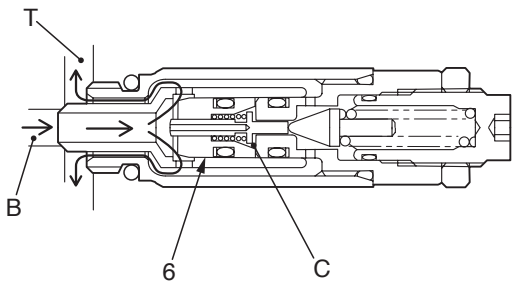

G4D214

If the pressure in the circuit becomes higher than the force of the spring (7), the needle valve (5) is pushed to the right by hydraulic pressure, opening. Oil then flows around the circumference of the needle valve (5) and passes through the slits, flowing into the tank passage (T).




G4D215

Compared to the chamber B side, the pressure in chamber C is low and there is no equilibrium in pressure. For this reason, the main poppet (6) opens and pressurized oil flows to the tank passage (T).




G4D216

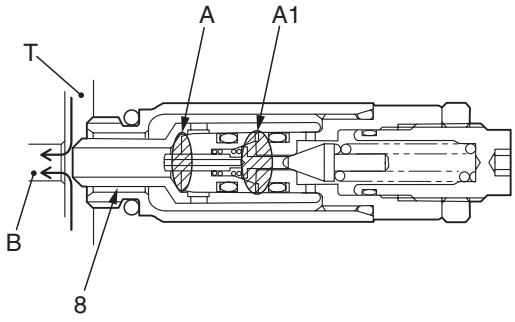
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Suction Operation

When the cylinder is operated at high speed, and the supply of oil cannot keep up with it, creating a vacuum in chamber B, oil is supplied from the tank side, preventing the occurrence of cavitation.

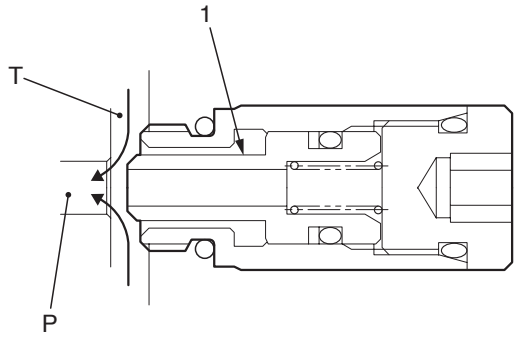
When the pressure in chamber B is lower than the pressure in the tank passage (T), the differences in the sectional areas A and A1 cause the main poppet (8) to open. Thus, sufficient oil from the tank passage (T) enters chamber B, filling the empty space.




G4D217

### Anti-Cavitation Valve

When a cylinder is operated at high speed and when the supply of hydraulic oil can't keep up with it, causing a vacuum to form at the cylinder port, this valve supplies oil from the tank, preventing cavitation from occurring. Normally in the cylinder port, pressure is brought to bear, so the poppet (1) is closed. If a vacuum is generated at the cylinder port (P), the oil in the tank passage (T) pushes on the poppet (1) and flows from the tank passage to the cylinder port.




G4D218

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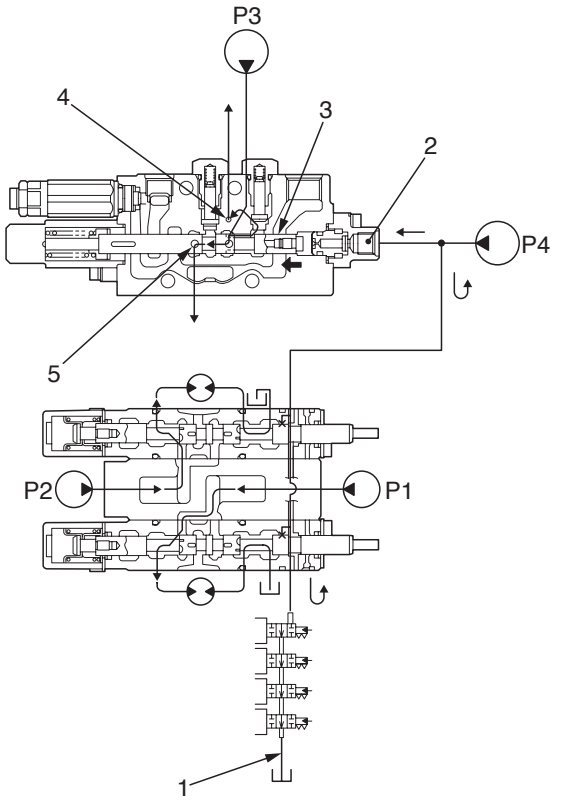
### Switch Valve

The switch valve is actuated only when the travel motor and hoe attachment are operated simultaneously.

When the Switch Valve is Actuated

When the spool of the hoe attachment is switched to block the pilot passage (1) connected to the tank passage, the pressure in the pilot chamber (2) is preserved.

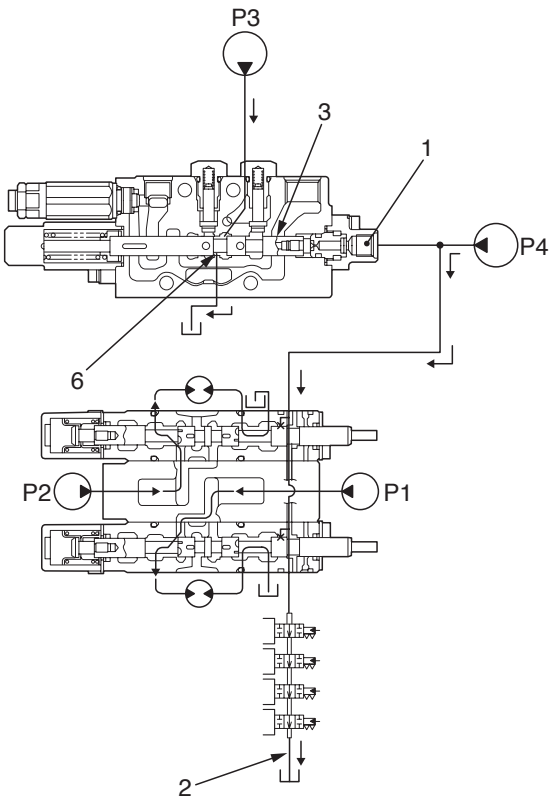
This switches the spool (3) to let the oil from the pump P3 flow into the passages (4) and (5) through the notch and hole provided on the spool (3). As the passage (4) is connected to the boom and bucket block while the passage (5) is connected to the arm block and swing block, the hoe attachment can be operated while the machine is traveling.




G4D219

When the Switch Valve is NOT Actuated

The pilot passage (1) is opened to the tank passage, making the pressure in the pilot chamber (2) equal to that in the tank, and the spool (3) is not switched. Therefore, the oil that has flowed into the switch valve from the pump P3 returns to the tank from the passage (6) through the center bypass passage of the auxiliary block.




G4D220

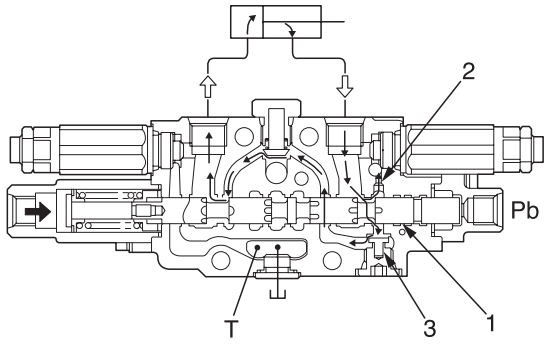
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### Arm Pulling Reclamation Function

At the time of arm pulling operation, the cylinder speed increases because of the increasing oil flow to the arm cylinder.

When the spool (1) of the arm section moves, the pressure oil from the pump P2 enters on the head side of the arm cylinder. On the other hand, the pressure oil discharged from the rod side enters into the spool (1), and a small quantity flows through the orifice (2) to the tank port (T). The remaining pressure oil opens the reclamation check valve (3) and is supplied (reclaimed) to the head side of the arm cylinder, so that the oil flow to the arm cylinder is increased.




G4D221

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## DISASSEMBLY AND ASSEMBLY

### General Cautions

- Since all parts in control valves are precision machined, carry out disassembly and assembly operations in a clean place.
- Before disassembly, clean the outside surfaces around the valves.
- Clean each of the disassembled parts and apply clean hydraulic oil to them.
- Apply hydraulic oil to sliding surfaces and apply a thin coating of grease to seals when assembling them.
- Replace all seals with new ones each time the valves are disassembled.
- Spools and section bodies are specially selected for a precise fit. Therefore, if any damage is found in either of these parts, replace the section assembly as a unit.
- Be sure to number each section and spool to avoid mistakes during assembly.

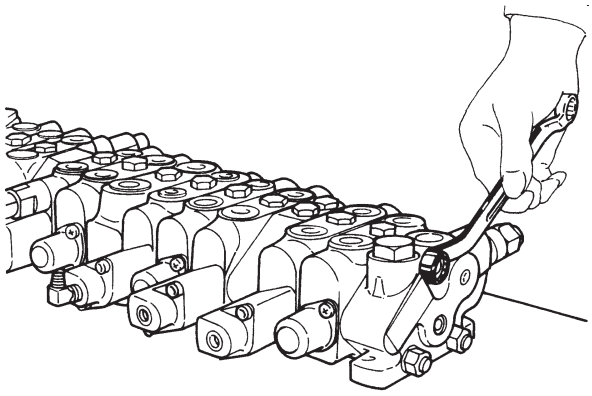
Following is an explanation of the control valve disassembly procedure.
Follow the procedure used to disassemble the control valve in reverse order when reassembling it.

- Before disassembly, number each section and spool.

### Disassembly

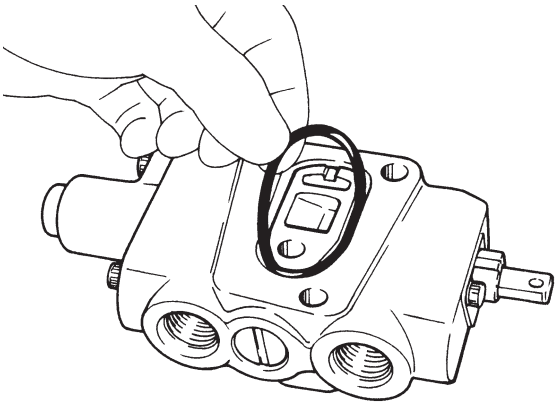
Valve Assembly

1. Loosen the nuts and remove the tie rods, then remove the sections.
   - Nut tightening torque:
     16.6~17.6 N·m (1.7~1.8 kgf·m)



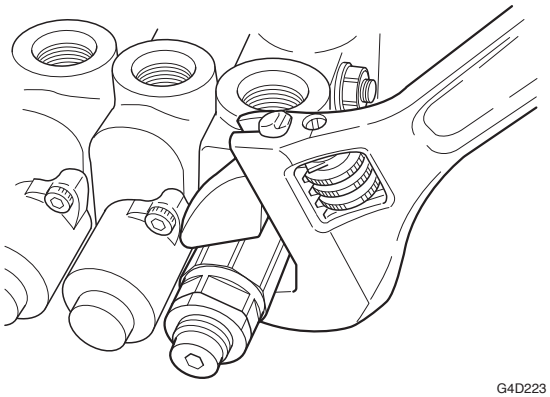
YI-D225

2. Remove the O-ring.
   - The mating surfaces are metal seals, so be careful not to scratch, bruise or otherwise damage them.
   - When assembling, do not apply any oil or grease to the O-rings used on the mating surfaces.



YI-D226

3. Remove the main relief valves and the port relief valves, then remove the O-rings from the relief valves.
   - Do not disassemble the relief valves unless it is necessary.
   - When using a spanner or adjustable wrench, be sure to attach it in the place shown in the figure at right.
   - Relief valve tightening torque:
     39 N·m (4 kgf·m)

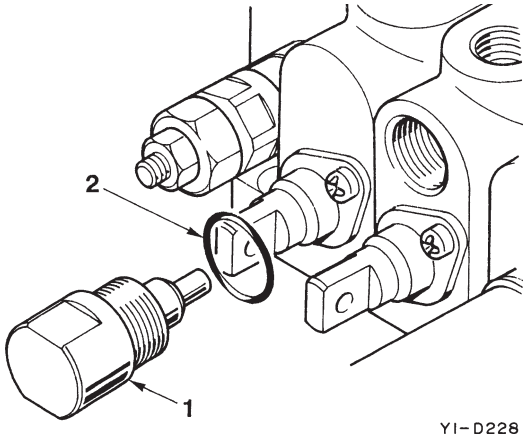


G4D223

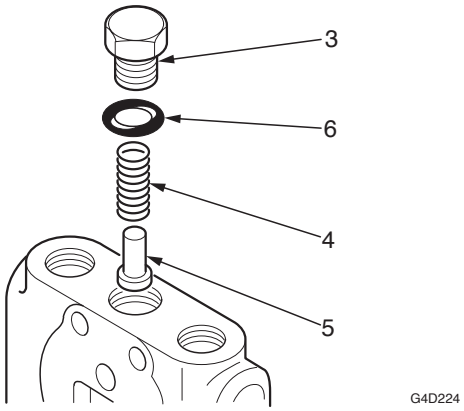
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4. Remove the anti-cavitation valve (1) and remove the O-ring (2) from the valve.
   • Plug tightening torque: 39 N·m (4 kgf·m)



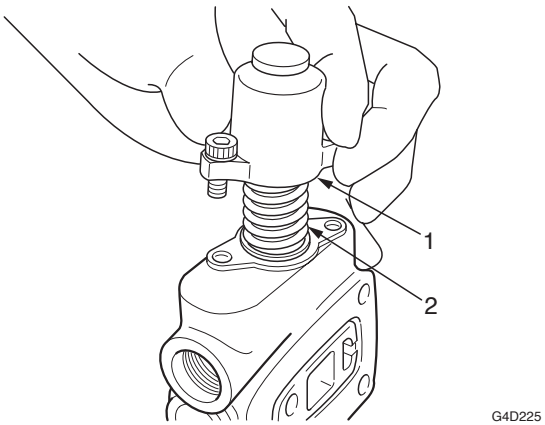

5. Remove the load check valve.
   a. Remove the plug (3) and the spring (4), then remove the poppet (5).
      • Plug tightening torque: 39 N·m (4 kgf·m)
   b. Remove the O-ring (6) from the poppet.



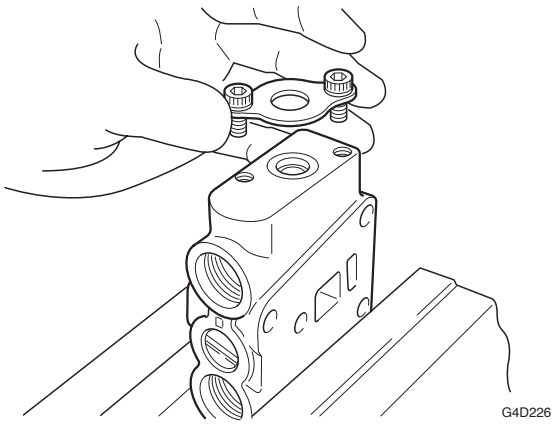

### Manually Operated Section

1. Remove the cap screws, the cover (1) and the spool assembly (2).
   • Cap screw tightening torque:
   5.8~6.8 N·m (0.6~0.7 kgf·m)

2. Remove the seal holder, backup ring and O-ring.




3. Remove the cap screws on the spool yoke end side of the section, then remove the seal holder, backup ring and O-ring.
   • Cap screw tightening torque:
   5.8~6.8 N·m (0.6~0.7 kgf·m)

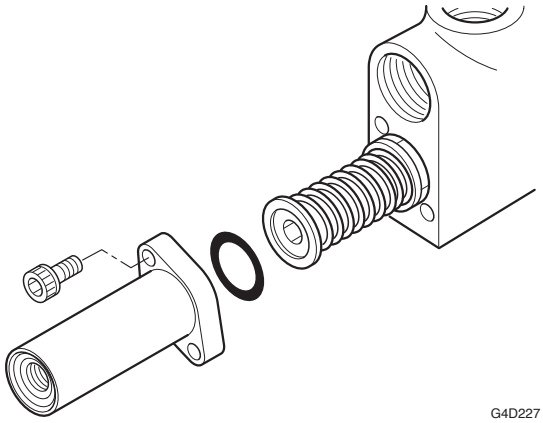


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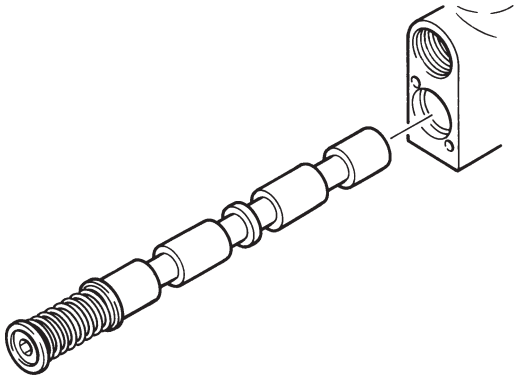


### Pilot Operated Section

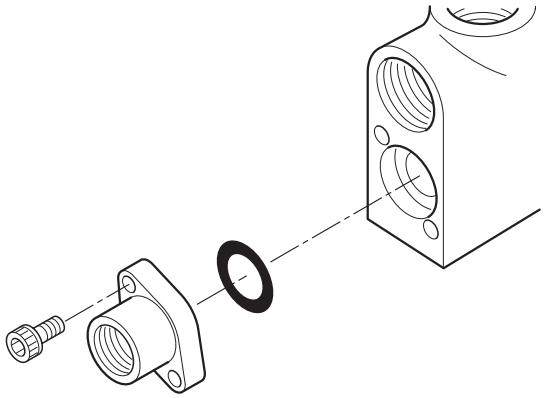
1. Take out the cap screws and remove the cover.
   - Cap screws tightening torque:
     5.8~6.8 N·m (0.6~0.7 kgf·m)
2. Remove the O-ring from the section.


G4D227

3. Remove the spool from the section.

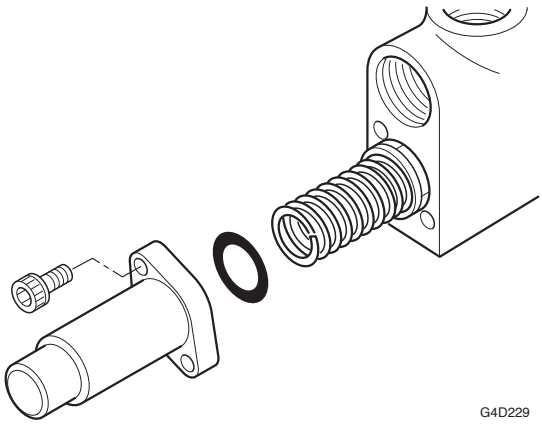

YI-D236

4. Take out the cap screws and remove the cover.
   - Cap screw tightening torque:
     5.8~6.8 N·m (0.6~0.7 kgf·m)
5. Remove the O-ring from the section.


G4D228

### Switch Valve

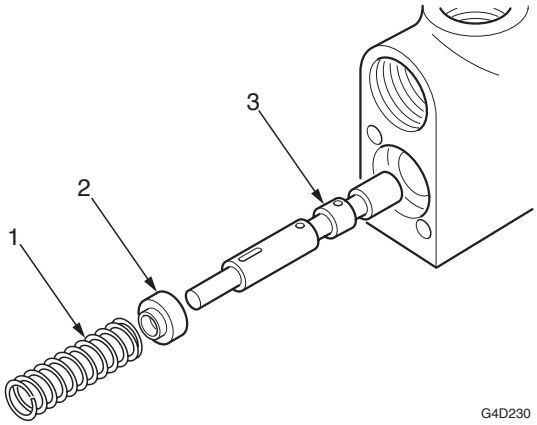
1. Take out the cap screws and remove the cover.
   - Cap screw tightening torque:
     5.8~6.8 N·m (0.6~0.7 kgf·m)
2. Remove the O-ring from the section.


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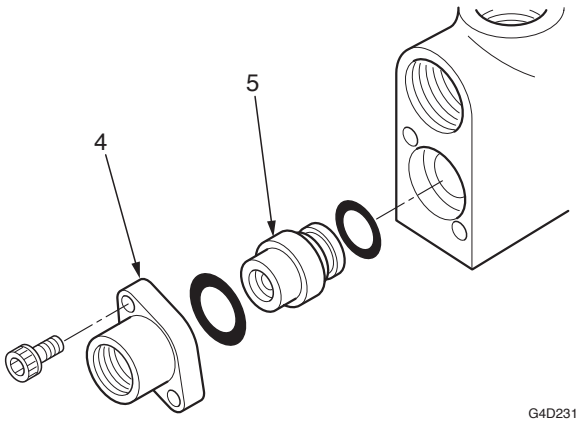
3. Remove the spring (1), spring holder (2) and spool (3).




4. Take out the cap screws and remove the cover (4).
   - Cap screw tightening torque:
     5.8~6.8 N·m (0.6~0.7 kgf·m)

5. Remove the O-ring from the section.

6. Take out the filter (5) and remove the O-ring from the filter (5).



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## INSPECTION AND ADJUSTMENT

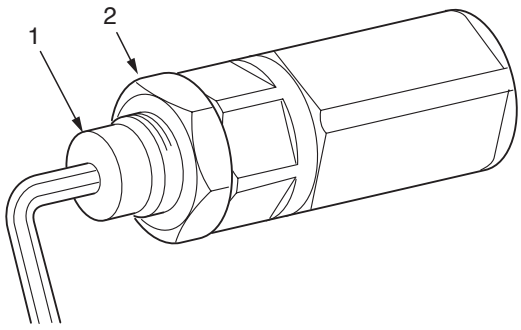
### Checking the Parts

| Parts | Judgment Criteria | Treatment |
|---|---|---|
| Housing, Section Body | • Scratches, rust, corrosion of the portion which slides against the spool. | • Replace |
| | • Scratches, rust, corrosion of the seal pocket portion of the part that enters the spool. | • Replace |
| | • Scratches, rust, corrosion of the port seal portion which is in contact with the O-ring. | • Replace |
| | • Scratches, rust, corrosion of the seal portion of the relief valve, etc. | • Replace |
| | • Other damage which could be a hindrance to correct function. | • Replace |
| Spool | • Scratch marks like being clawed around the outer circumference sliding portion. | • Replace |
| | • Scratches on the portion that slides against the seals on both ends. | • Replace |
| | • Spool not operating smoothly. | • Repair or replace. |
| Load Check Valve | • Imperfect sealing due to damage to the valve or spring. | • Repair or replace. |
| | • Does not catch, but operates lightly when inserted in the section body and operated. | • Normal |
| Around Springs | • Rust, corrosion, deformation, breakage or other marked damage to the spring, holder or cover. | • Replace |
| Around Spool Seal | • Oil leaking to the outside. | • Repair or replace. |
| | • Rust, corrosion or deformation of the seal holder. | • Repair or replace. |
| Main Relief Valve, Port Relief Valve, Anti-Cavitation Valve | • External rust, damage. | • Replace |
| | • Damage to valve seat contact surface. | • Replace |
| | • Damage to poppet contact surface. | • Replace |
| | • Abnormality in the spring. | • Replace |
| | • O-rings, backup rings, seals | • As a rule, all these should be replaced. |

### Adjusting the Main Relief Valve Pressure

1. Install a pressure gauge in the following pressure sensor port.
   - Control valve pressure sensor port.
     ☞ "II. Specifications, Standards for Judging Performance"
2. Run the pump at the rated speed.
3. Operate the control valve's cylinder spool over its full stroke and read the value indicated by the pressure gauge.
4. Turn the set screw (1) while watching the pressure gauge to adjust.
   Turning it to the right increases the set pressure.
   Turning it to the left decreases the set pressure.
5. After completing the pressure adjustment, tighten the lock nut (2) while holding the set screw (1) so it won't turn.
   Operate the relief valve again and check if the pressure is stabilized.

< TB125,TB135 >




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## TROUBLESHOOTING

The following items are a list of all the problems that might occur individually, but in actual practice, 2 or 3 of these problems might occur simultaneously to compound the trouble. It is therefore desirable to proceed so that the causes can be eliminated one at a time.

| Symptom | Probable Causes | Remedy |
|---|---|---|
| Oil leaks from spool seal. | • Seal is scratched or the seal lip is worn due to long use. | • Replace with a new part. |
| | • Spool's seal sliding portion was damaged by some external cause (bruise, scratch, etc.). | • Repair or replace the spool. |
| | • Seal bulged out and the cover was installed in a warped state. | • Return to the correct shape and check for eccentric wear of the seal lip. |
| | • Paint adhered to the sliding portion of the spool's seal portion during painting. | • Remove paint with paint thinner or remove it mechanically. However, at this time, be careful not to damage the spool surface or the seal lip. |
| | • Tank circuit's pressure became high and exceeded the pressure level that the seal was capable of withstanding. | • Eliminate the factors causing excessive flow resistance. |
| Spool's sliding is not smooth. | • Foreign matter is biting into the spool's sliding surface. | • Overhaul and repair or replace. |
| | • Oil film between the spool and body disappears due to abnormally high oil temperature. | • Use some method to lower the oil temperature or if the relief valve is operating frequently, investigate the cause and reduce the frequency. |
| | • Lubrication is improper due to deteriorating oil. | • This could be alleviated by simply replacing the hydraulic oil, or it could require an overhaul of the circuit. |
| | • Spool is worn from long use or due to pressure bearing on one side only. | • Check the spool's diameter and consider the necessity of replacement. |
| | • Spool is bent from externally applied pressure. | • Check the spool's straightness and other factors, then repair or replace. |
| | • Entire valve is strained due to strain in the installation face. | • Loosen the installation bolts, then cut the installation face and edge and check. |
| | • Valve was used at a pressure or a flow volume which was out of specification. | • In the case of pressure, check with a pressure gauge. In the case of flow volume, check by the actuator's speed of movement and the capacity. |
| | • Bolts used to assemble the valve were tightened excessively. | • Check if the assembly bolts are tightened to the specified torque. If the torque deviates markedly from the specified torque, tighten them again. |
| | • Oil is accumulating in the cover (the side with a spring or a detent) opposite the side where the spool operates. | • The spool is leaking oil, so when the spool moves, oil leaks from the cover. After confirming this, replace the seal. |
| Cylinder drops while shifting to a lift operation. | • Foreign matter is biting into the load check valve seat or large scratches were made by foreign matter biting into the valve's seat previously. | • Disassemble and check, then overhaul or replace. |

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| Symptom | Probable Causes | Remedy |
|---|---|---|
| Can't be held in the spool neutral position (cylinder drops). | • Could be mistaken for a great amount of leakage in the cylinder. | • Check if it isn't just the cylinder's natural drop when the cylinder is held. If the problem is in the cylinder, disassemble and repair it. |
| | • The gap between the spool and body is large, so the amount of oil leaking from the spool is great. | • Replace the spool or replace the valve block assembly. |
| | • Spool won't return completely to the neutral position. | • Manually Operated : Check if there is something interfering with the link mechanism. Pilot Operated: Check the pilot pressure. |
| | • Foreign matter is biting into the port relief valve seat or the anti-cavitation valve seat and oil is bypassing. Or a seat is damaged. | • Disassemble and check, then overhaul or replace. |
| The load won't move. (Pressure won't increase.) | • Foreign matter is biting into the relief valve seat and oil is bypassing. Or the seat is damaged. | • Disassemble and check, then overhaul or replace. |
| | • The relief valve's adjustment screw is loose. | • Try tightening the adjustment screw. If it is loose, correct the setting and tighten the lock nut securely. |
| | • Foreign matter is biting into the port relief valve seat or the anti-cavitation valve seat and oil is bypassing. Or a seat is damaged. | • Disassemble and check, then overhaul or replace. |
| | • Spool stroke is not the specified stroke. | • Manually Operated: Check if there is something interfering with the link mechanism. Check if a pin or a pin hole in the link connection is worn. Pilot Operated: Check the pilot pressure. |
| | • Pump is damaged and no oil is discharged. | • Check if the pump is abnormal or not. If the pump is bad, replace it. Check if the cause of the abnormality is air being sucked in, deterioration of hydraulic oil or shafts not centered, etc. |
| Load doesn't move. (Pressure rises.) | • The load is too heavy. | • Compare with an object of the specified weight. |
| | • Mechanical resistance of connecting parts is great regardless of the hydraulic pressure in the operating unit. | • Check and replenish hydraulic oil, etc., modify or repair. |
| | • A large piece of foreign matter is trapped in the circuit or a pipe is bent, causing great resistance. | • Find the affected place and repair it. |

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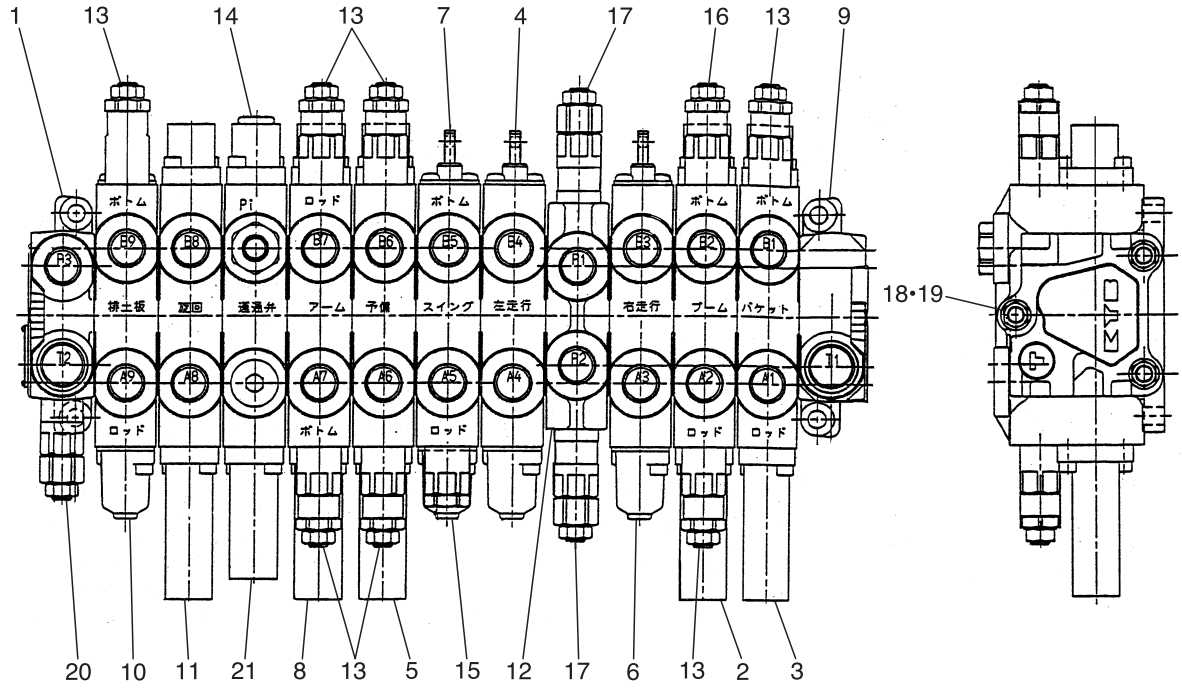
| Symptom | Probable Causes | Remedy |
|---|---|---|
| Load doesn't move. (Pressure rises.) | • Spool stroke is not the specified stroke. | • Check if there is something interfering with the link mechanism. Check if a pin or a pin hole in the link connection is worn or not. |

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## CONTROL VALVE (TB145)

### CONSTRUCTION



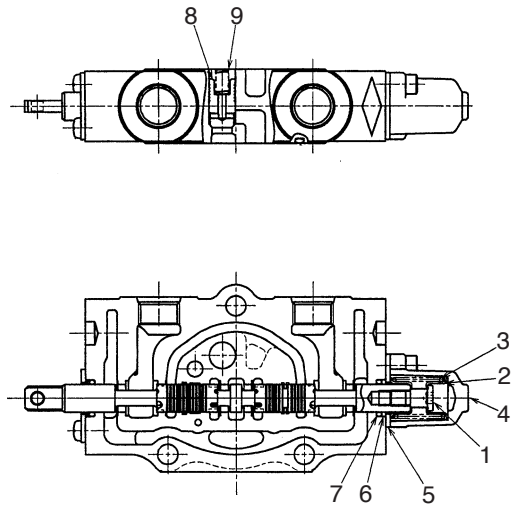

K3D200

1. Inlet Housing
2. Boom Block Assembly
3. Bucket Block Assembly
4. Left Travel Block Assembly
5. Auxiliary Block Assembly
6. Right Travel Block Assembly
7. Swing Block Assembly
8. Arm Block Assembly
9. Outlet Housing
10. Dozer Blade Block Assembly
11. Slew Block Assembly
12. Inlet Housing
13. Port Relief Valve
14. Plug Assembly
15. Anti Cavitation Valve
16. Port Relief Valve
17. Main Relief Valve
18. Tie Rod
19. Nut
20. Main Relief Valve
21. Switch Valve

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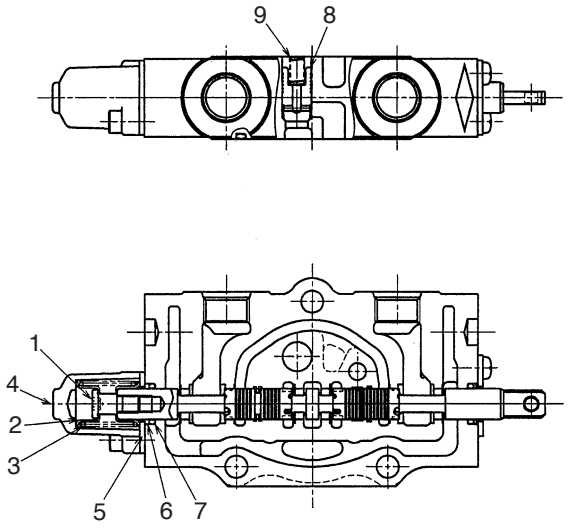
**Left Travel Block**




K3D201

1. Screw
2. Spring Holder
3. Spring
4. Cover
5. Seal Holder
6. Backup Ring
7. O-ring
8. Poppet
9. Spring

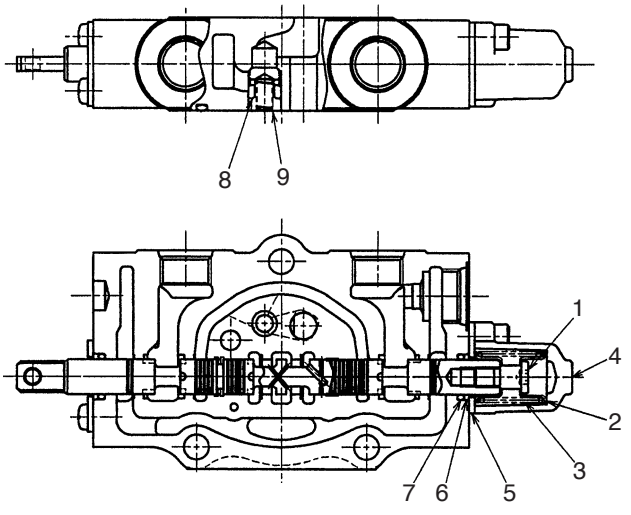
**Right Travel Block**




K3D202

1. Screw
2. Spring Holder
3. Spring
4. Cover
5. Seal Holder
6. Backup Ring
7. O-ring
8. Poppet
9. Spring

**Swing Block**



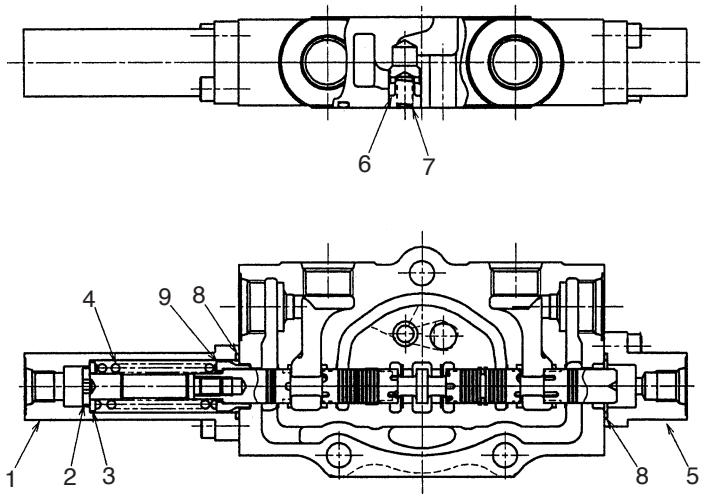

K3D203

1. Screw
2. Spring Holder
3. Spring
4. Cover
5. Seal Holder
6. Backup Ring
7. O-ring
8. Poppet
9. Spring

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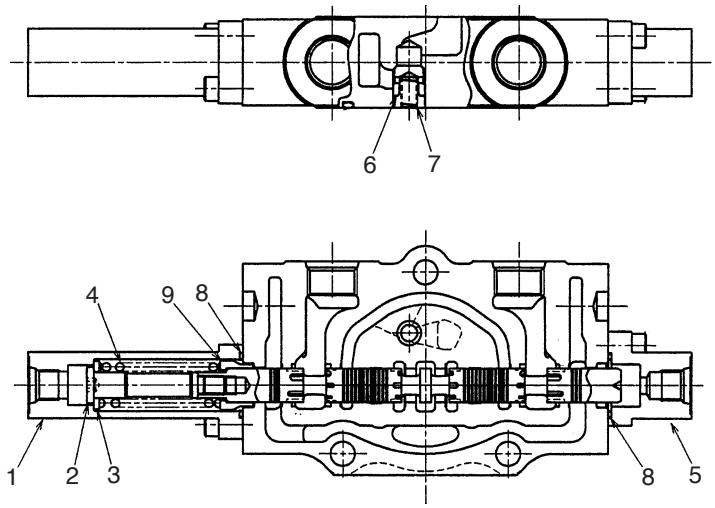
**Boom Block**




K3D204

1. Cover
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Poppet
7. Spring
8. O-ring
9. Spring Holder

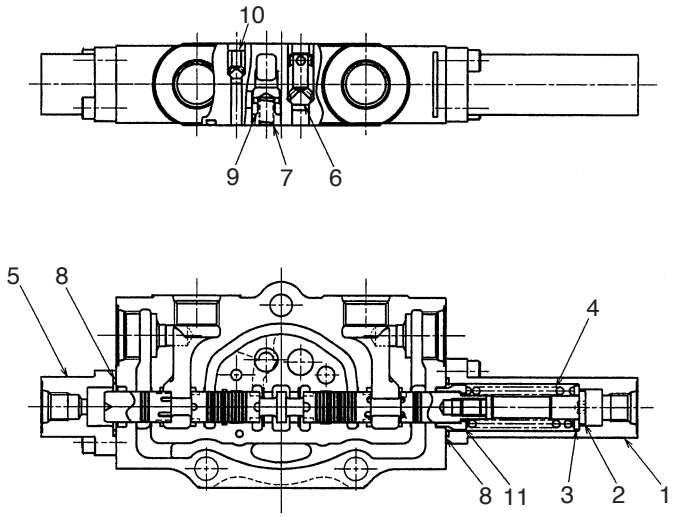
**Slew Block**




K3D205

1. Cover
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Poppet
7. Spring
8. O-ring
9. Spring Holder

**Arm Block**



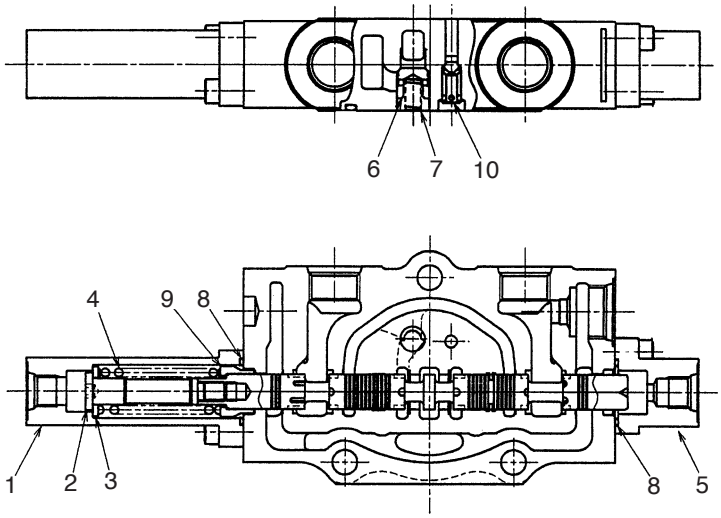

K3D206

1. Cover
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Poppet
7. Spring
8. O-ring
9. Poppet
10. Poppet
11. Spring Holder

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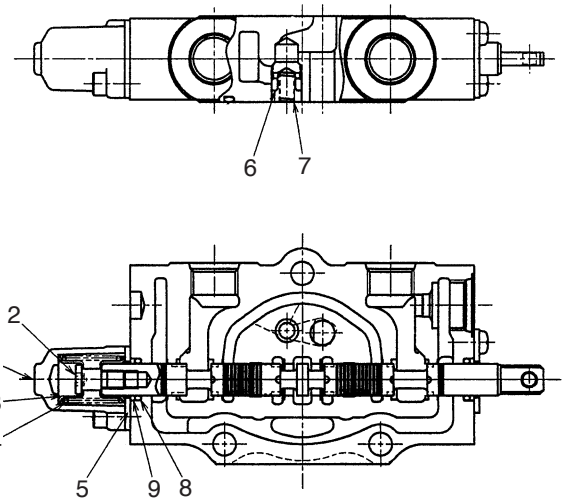
**Bucket Block**




K3D207

1. Cover
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Poppet
7. Spring
8. O-ring
9. Spring Holder
10. Poppet

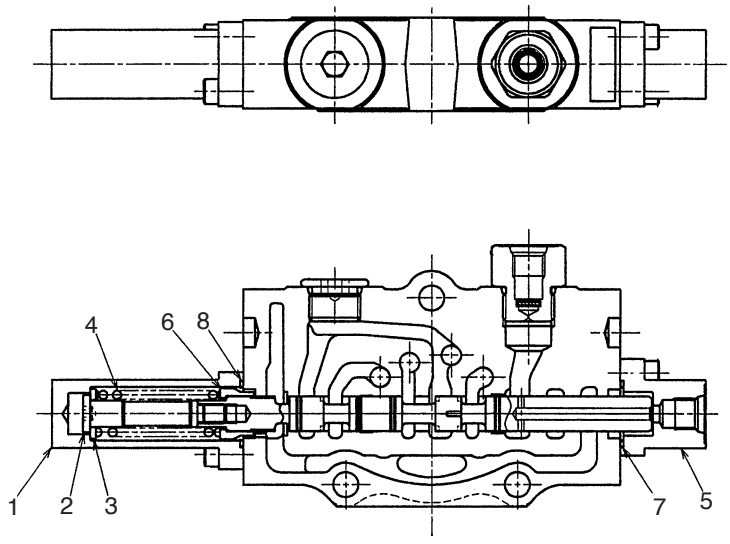
**Dozer Blade Block**




K3D208

1. Cover
2. Screw
3. Spring Holder
4. Spring
5. Seal Holder
6. Poppet
7. Spring
8. O-ring
9. Backup Ring

**Switch Valve**



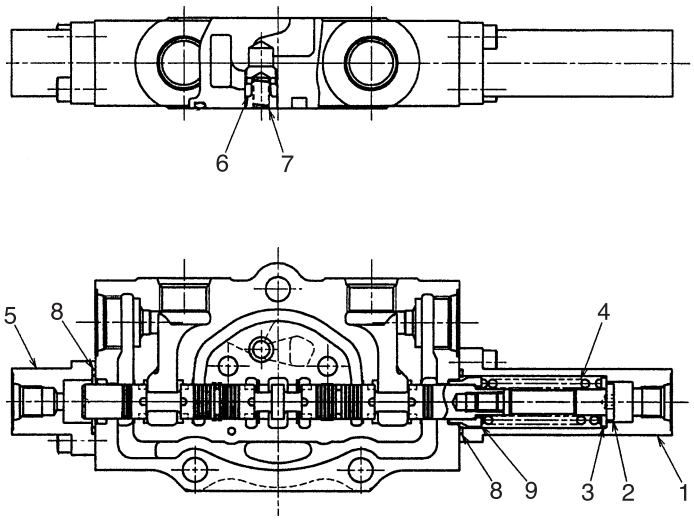

K3D209

1. Cover
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Spring Holder
7. O-ring
8. O-ring

https://truckmanualshub.com/

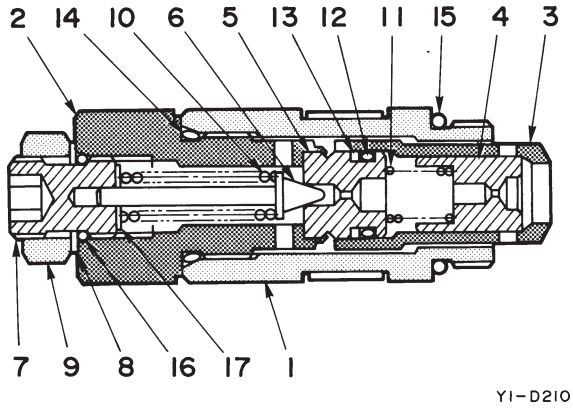


### Auxiliary Block



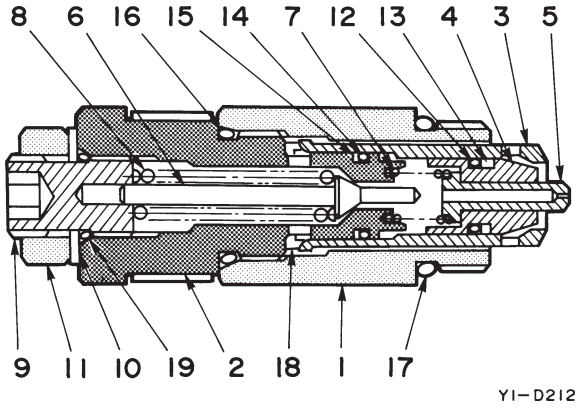

1. Cover
2. Screw
3. Spring Holder
4. Spring
5. Cover
6. Poppet
7. Spring
8. O-ring
9. Spring Holder

### Main Relief Valve




1. Housing
2. Plug
3. Sleeve
4. Main Poppet
5. Piston
6. Needle Valve
7. Set Screw
8. Washer
9. Lock Nut
10. Spring
11. Spring
12. O-ring
13. Backup Ring
14. O-ring
15. O-ring
16. O-ring
17. Washer

### Port Relief Valve

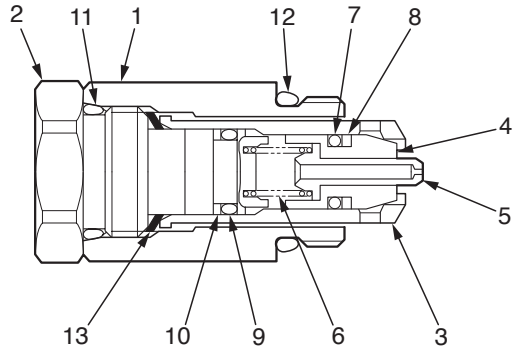



1. Housing
2. Plug
3. Sleeve
4. Main Poppet
5. Piston
6. Needle Valve
7. Spring
8. Spring
9. Set Screw
10. Washer
11. Lock Nut
12. O-ring
13. Backup Ring
14. O-ring
15. Backup Ring
16. O-ring
17. O-ring
18. Wave Washer
19. O-ring

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**Anti-Cavitation Valve**




K3D211

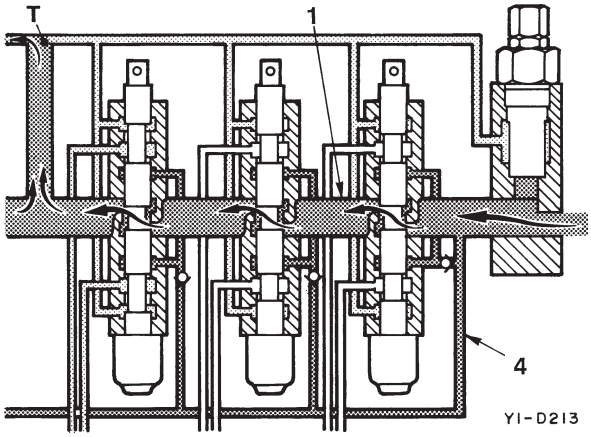
1. Housing
2. Plug
3. Poppet
4. Poppet
5. Piston
6. Spring
7. O-ring
8. Backup Ring
9. O-ring
10. Backup Ring
11. O-ring
12. O-ring
13. Wave Washer

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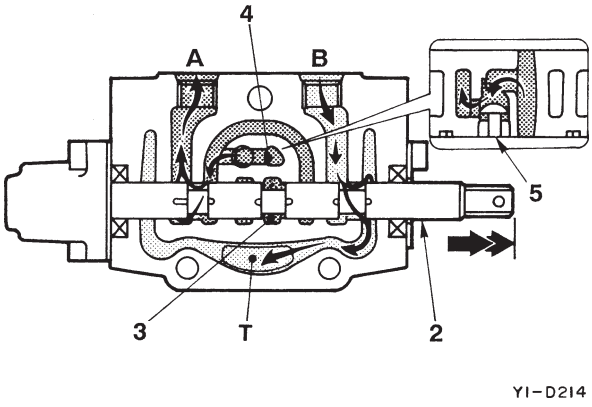


## OPERATION

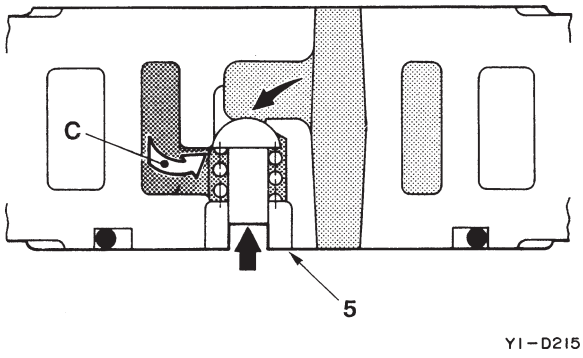
When the Spool is in the Neutral Position
When the control valve spool is not moving, hydraulic oil flows through the center bypass passage (1) and then through the tank passage (T) in the arrow direction, returning to the tank.




When the Spool is Actuated
Explanation is given for the case where the spool is moved to the right.
When the spool (2) is moved to the right, the center bypass passage (3) is closed and hydraulic oil entering from the pump passes through the load check valve (5) from the parallel passage (4), flowing from the A port to the actuator. On the other hand, oil returning from the B port flows through the tank circuit (T) and returns to the tank.




Load Check Valve
A load check valve (5) is included in each section except the travel (right, left) sections.
This valve prevents oil from flowing backward due to the load pressure (C) from the actuator port during switching of the spool.



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### Main Relief Valve

A main relief valve is mounted between the pump circuit and tank circuit of each inlet housing and serves to maintain the circuit pressure at the set value.

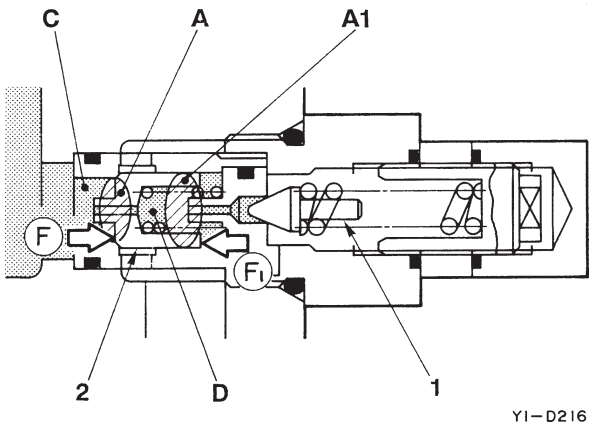
When the Relief Valve is NOT Operating

When the pressure in the circuit is low with respect to the set value, the relief valve maintains equilibrium. Hydraulic oil from the pump passes through the orifice from chamber (C) and arrives at the spring chamber (D) and the needle valve (1). On the other hand, forces F and F1 are acting in the respective arrow directions on both sides of the main poppet (2).

$F = P \times A$ $Fl = P \times A1$

P: Pressure A, A1: Cross Sectional Area

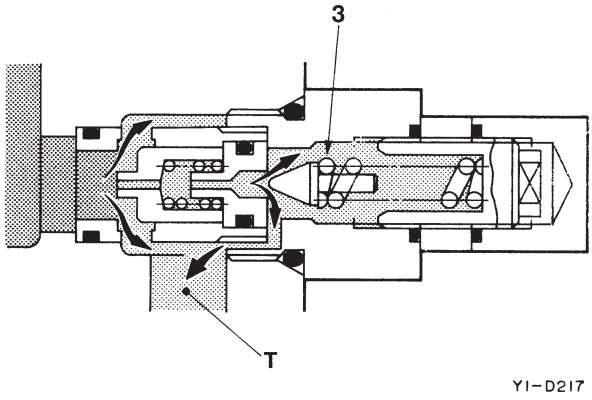
Since the cross sectional area of A is less than that of A1, the main poppet (2) is pushed by the force "F1 - F" to the seat surface on the left side.




When the Relief Valve is Operating

If the circuit's pressure becomes greater than the set value of the spring (3), the needle valve (1) is pushed to the right by hydraulic pressure and oil flows to the tank passage (T). When this happens, a pressure differential is generated between the two ends of orifice of the main poppet (2), and this hydraulic pressure pushes the main poppet toward the right. As a result, the pressurized oil in the circuit flows to the tank passage.

This operation maintains the pressure in the circuit at the set value.



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### Port Relief Valve

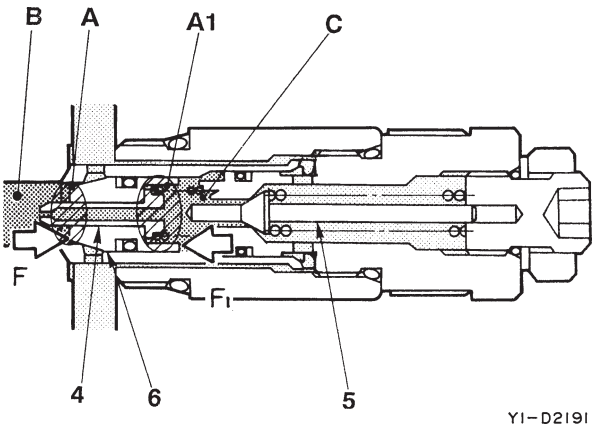
Relieving Operation

When the pressure in the circuit is low with respect to the set value, the relief valve is maintained at equilibrium. Pressure from the pump passes from chamber B to the orifice in piston (4), then reaches chamber C and the needle valve (5). On the other hand, forces F and F1 are acting in the arrow directions on both sides of the main poppet (6).

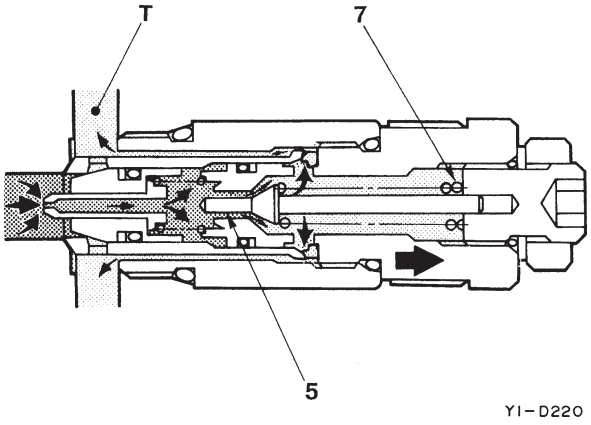
$F = P \times A$ $F1 = P \times A1$

P: Pressure A, A1: Sectional Area

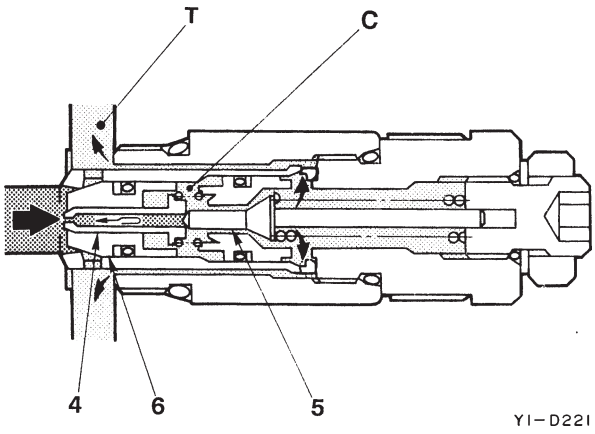
Since the sectional area of A is less than that of A1, the main poppet (6) is pushed by the force "F1-F" to the seat surface on the left side.



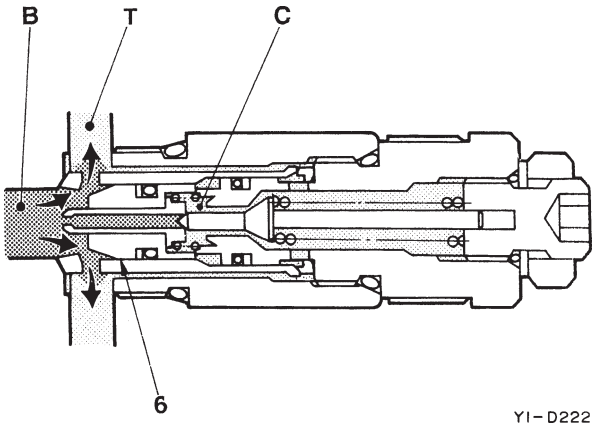

If the pressure in the circuit becomes higher than the force of the spring (7), the needle valve (5) is pushed to the right by hydraulic pressure, opening. Oil then flows around the circumference of the needle valve (5) and passes through the slits, flowing into the tank passage (T).




When the needle valve (5) opens, the pressure drops on the back side of the piston (4), pushing the piston (4) to be pushed to the right, seating with the needle valve (5). This shuts off the flow of hydraulic oil to the rear of the main poppet (6). As a result, the pressure in chamber C on the inside drops.




Compared to the chamber B side, the pressure in chamber C is low and there is no equilibrium in pressure. For this reason, the main poppet (6) opens and pressurized oil flows to the tank passage (T).



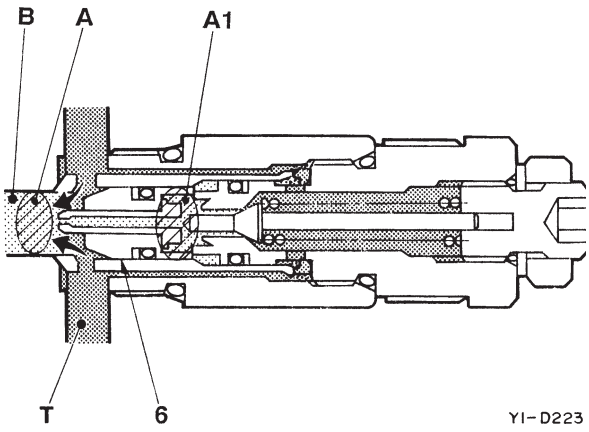
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Suction Operation

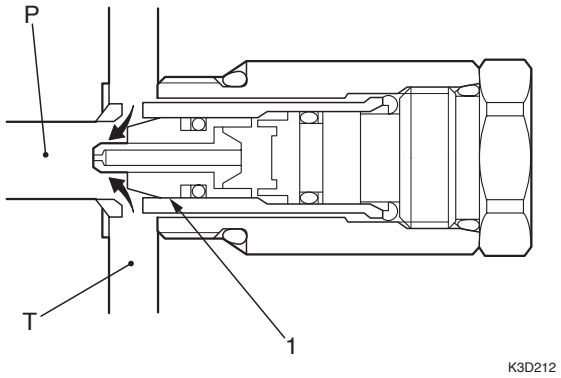
When the cylinder is operated at high speed, and the supply of oil cannot keep up with it, creating a vacuum in chamber B, oil is supplied from the tank side, preventing the occurrence of cavitation.

When the pressure in chamber B is lower than the pressure in the tank passage (T), the differences in the sectional areas A and A1 cause the main poppet (6) to open. Thus, sufficient oil from the tank passage (T) enters chamber B, filling the empty space.




### Anti-Cavitation Valve

The anti-cavitation valves are incorporated between the cylinder ports of the swing and bucket sections and the tank circuit. When a cylinder is operated at high speed and when the supply of hydraulic oil can't keep up with it, causing a vacuum to form at the cylinder port, this valve supplies oil from the tank, preventing cavitation from occurring. In the normal cylinder port, pressure is brought to bear, so the poppet (1) is closed. If a vacuum is generated at the cylinder port (P) and the pressure in the tank passage (T) drops as a result, it pushes on the poppet (1) and oil flows from the tank passage to the cylinder port.



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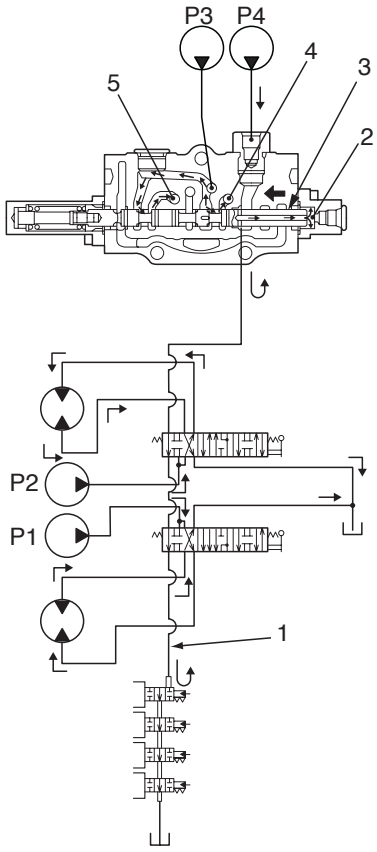
### Switch Valve

The switch valve is actuated only when the travel motor and hoe attachment are operated simultaneously.

When the Switch Valve is Actuated

When the spool of the hoe attachment is switched to block the pilot passage (1) connected to the tank passage, the pressure in the pilot chamber (2) is preserved.

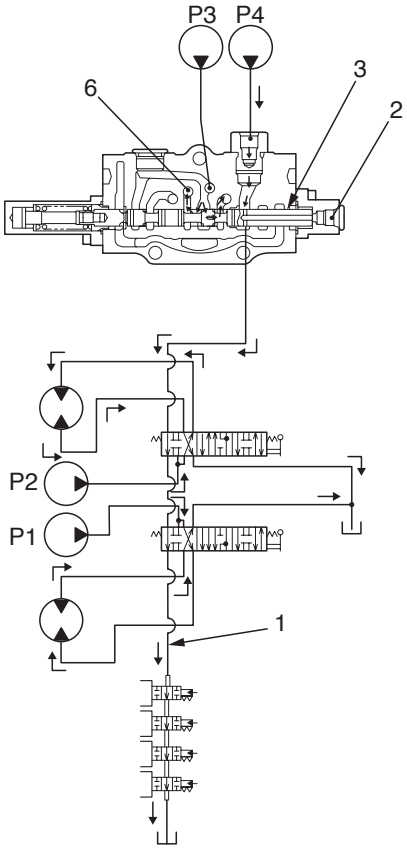
This switches the spool (3) to let the oil from the pump P3 flow into the passages (4) and (5) through the notch provided on the spool (3). As the passage (4) is connected to the boom and bucket block while the passage (5) is connected to the auxiliary block and swing block, the hoe attachment can be operated (except for arm operations) while the machine is traveling.




K3D213

When the Switch Valve is NOT Actuated

The pilot passage (1) is opened to the tank passage, making the pressure in the pilot chamber (2) equal to that in the tank, and the spool (3) is not switched. Therefore, the oil that has flowed into the switch valve from the pump P3 returns to the tank from the passage (6) through the center bypass passage of the arm block.




K3D214

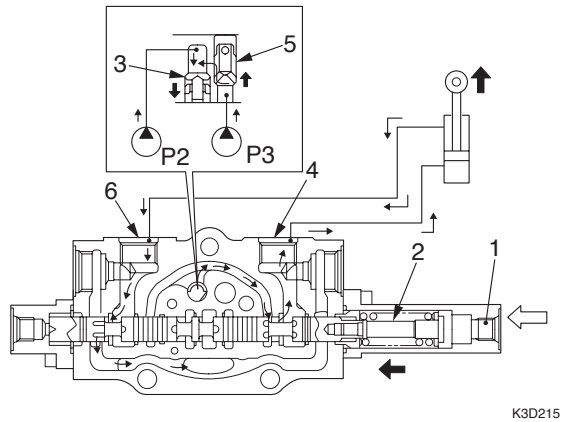
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**Arm Conflux Circuit**

When Moving the Arm In

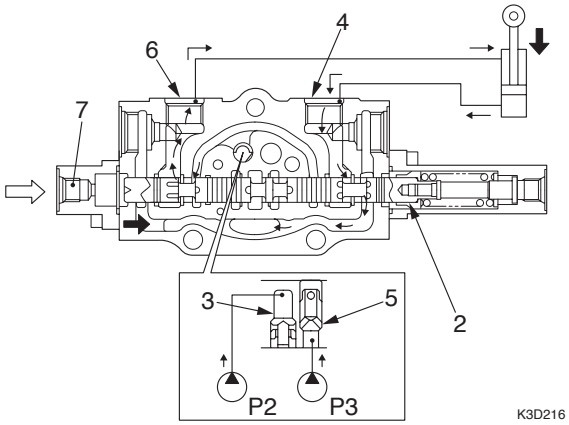
When the pilot port (1) is pressurized and the spool (2) is switched, the hydraulic oil from the pump P2 pushes up the load check valve (3) and flows into the cylinder port (4). The hydraulic oil from the pump P3 joins the oil from the pump P2 through the poppet (5), pushing up the load check valve (3) to let the oil flow into the cylinder port (4). The resulting oil flow equals the total oil flow from the pump P2 and pump P3. The returning oil from the cylinder port (6) flows into the tank passage and returns to the tank.



K3D215

When Moving the Arm Out

When the pilot port (7) is pressurized and the spool (2) is switched, the hydraulic oil from the pump P2 pushes up the load check valve (3) and flows into the cylinder port (6). The hydraulic oil from the pump P3 joins the oil from the pump P2 through the poppet (5), pushing up the load check valve (3) to let the oil flow into the cylinder port (6). The resulting oil flow equals the total oil flow from the pump P2 and pump P3. The returning oil from the cylinder port (4) flows into the tank passage and returns to the tank.



K3D216

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## DISASSEMBLY AND ASSEMBLY

### General Cautions

- Since all parts in control valves are precision machined, carry out disassembly and assembly operations in a clean place.
- Before disassembly, clean the outside surfaces around the valves.
- Clean each of the disassembled parts and apply clean hydraulic oil to them.
- Apply hydraulic oil to sliding surfaces and apply a thin coating of grease to seals when assembling them.
- Replace all seals with new ones each time the valves are disassembled.
- Spools and section bodies are specially selected for a precise fit. Therefore, if any damage is found in either of these parts, replace the section assembly as a unit.
- Be sure to number each section and spool to avoid mistakes during assembly.

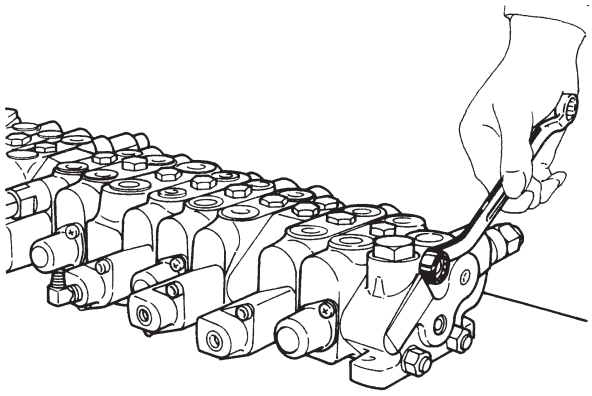
Following is an explanation of the control valve disassembly procedure.
Follow the procedure used to disassemble the control valve in reverse order when reassembling it.

- Before disassembly, number each section and spool.

### Disassembly

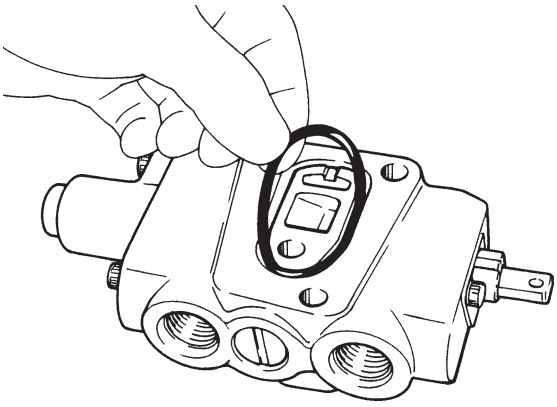
Valve Assembly

1. Loosen the nuts and remove the tie rods, then remove the sections.
   - Nut tightening torque:
     46.2 ±2 N·m (4.7 ±0.2 kgf·m)



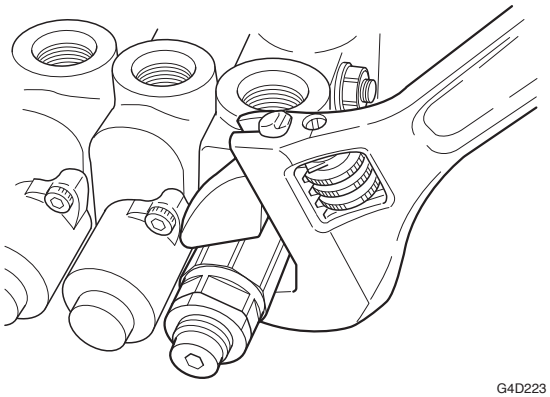
YI-D225

2. Remove the O-ring.
   - The mating surfaces are metal seals, so be careful not to scratch, bruise or otherwise damage them.



YI-D226

3. Remove the main relief valves and the port relief valves, then remove the O-rings from the relief valves.
   - Do not disassemble the relief valves unless it is necessary.
   - When using a spanner or adjustable wrench, be sure to attach it in the place shown in the figure at right.
   - Relief valve tightening torque:
     68.6~78.5 N·m (7~8 kgf·m)

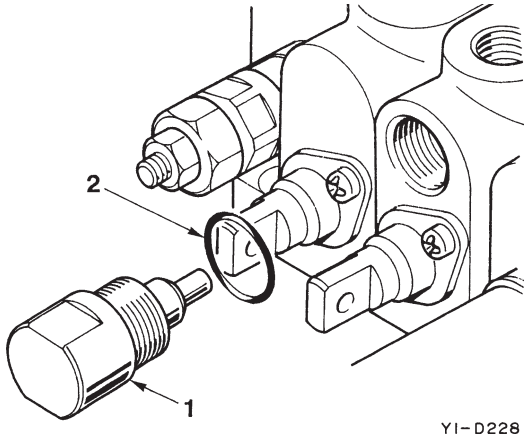


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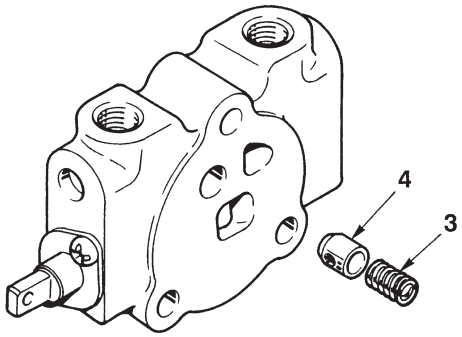


4. Remove the anti-cavitation valve (1) and remove the O-ring (2) from the valve.
   - Plug tightening torque:
     69~78 N·m (7~8 kgf·m)



YI-D228

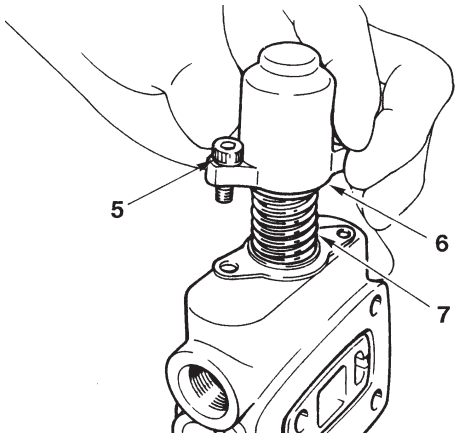
5. Remove the load check valve.
   - Remove the spring (3), then remove the poppet (4).



YI-D229

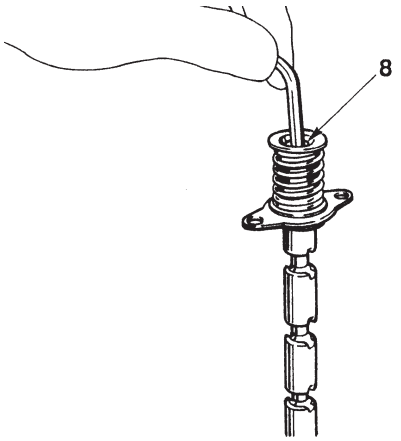
### Manually Operated Section

1. Remove the cap screws (5), the cover (6) and the spool assembly (7).
   - Cap screw tightening torque:
     8.8~10.8 N·m (0.9~1.1 kgf·m)



YI-D230

2. Loosen the screw (8) from the spool assembly (7).
   - Screw tightening torque:
     19~22 N·m (1.9~2.2 kgf·m)

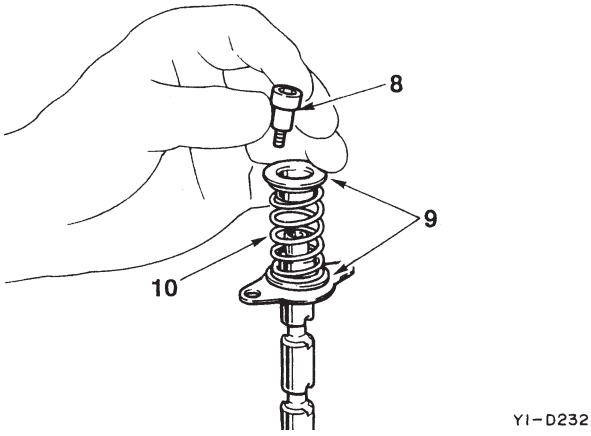


YI-D231

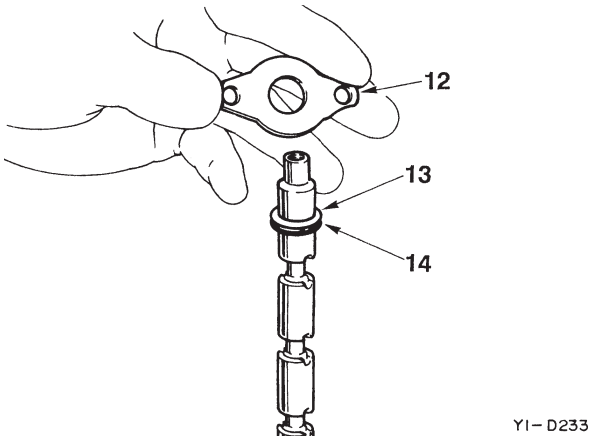
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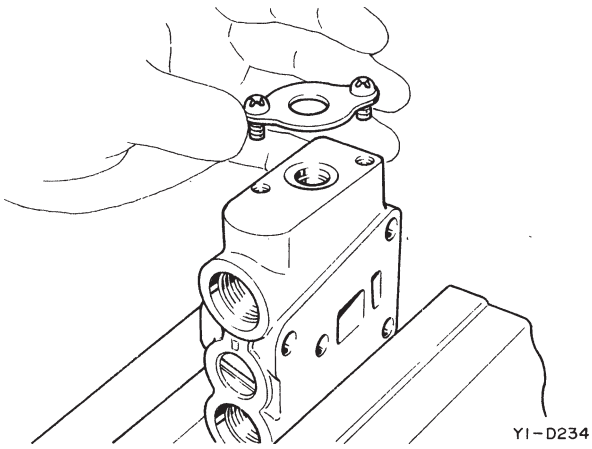
3. Remove the spring holder (9), spring (10), and spring holder (9).




4. Remove the seal holder (12), then remove the backup ring (13) and O-ring (14).

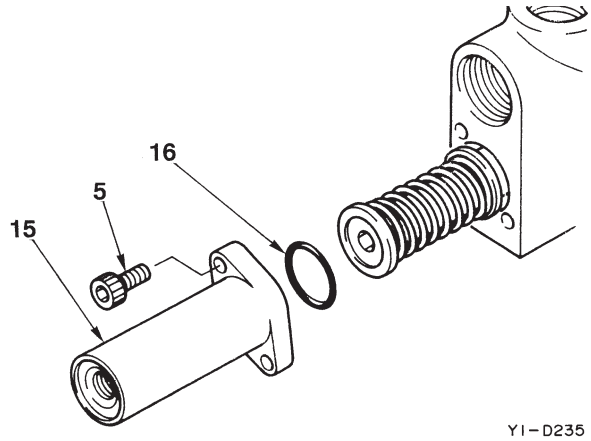



5. Remove the screws on the spool yoke end side of the section, then remove the seal holder, backup ring and O-ring.
   - Screw tightening torque:
     2.5~2.9 N·m (0.25~0.3 kgf·m)




### Pilot Operated Section

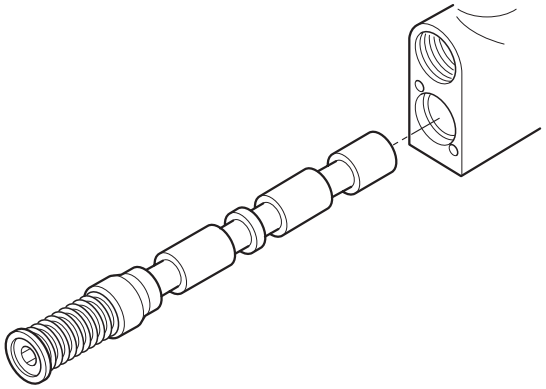
1. Take out the cap screw (5) and remove the cover (15), then remove the O-ring (16) from the cover (15).
   - Cap screw tightening torque:
     8.8~10.8 N·m (0.9~1.1 kgf·m)



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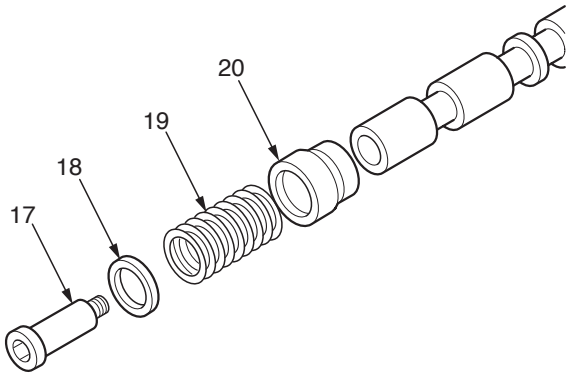


2. Remove the spool from the section.



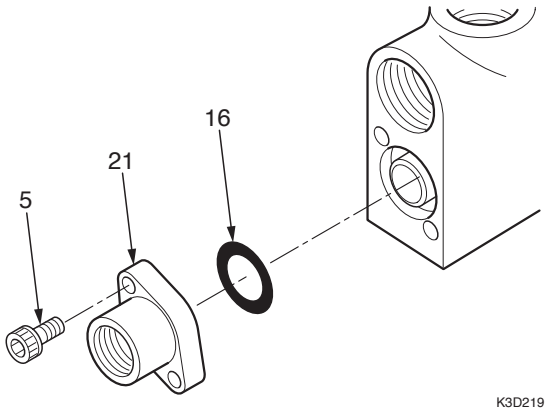
K3D217

3. Take out the screw (17) and remove the spring holder (18), spring (19) and spring holder (20).
   - Screw tightening torque:
     19~22 N·m (1.9~2.2 kgf·m)




K3D218

4. a. Take out the cap screws (5) and remove the cover (21).
   b. Remove the O-ring (16) from the cover (21).
   - Cap screw tightening torque:
     8.8~10.8 N·m (0.9~1.1 kgf·m)



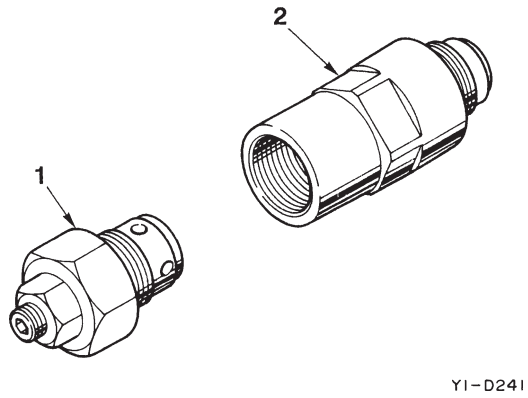

K3D219

https://truckmanualshub.com/

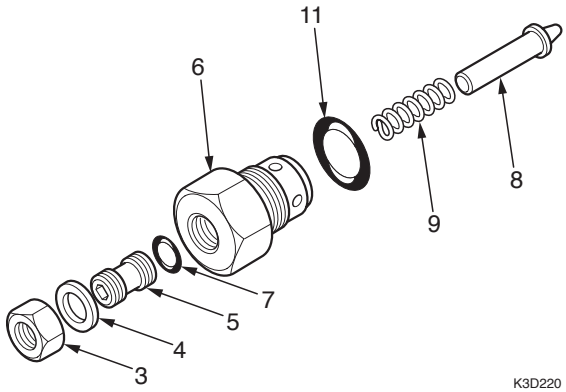


### Main Relief Valve

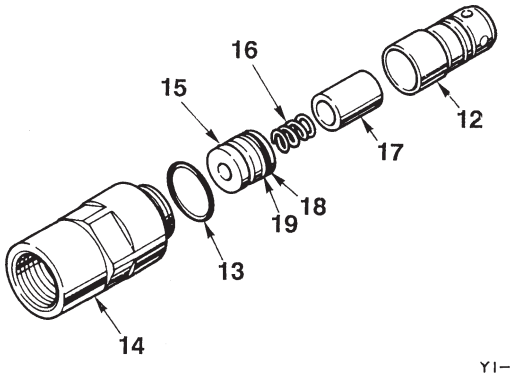
1. Separate the plug assembly (1) from the housing assembly (2).
   - Tightening torque:
     68.6~78.5 N·m (7~8 kgf·m)




2. Disassemble the plug assembly (1).
   a. Remove the lock nut (3), washer (4) and set screw (5) from the plug (6), then remove the O-ring (7) from the set screw (5).
      - During assembly, after installing the set screw (5), lock the lock nut (3) temporarily, then tighten it after adjusting the pressure.
      - Lock nut tightening torque:
        27.5~31.4 N·m (2.8~3.2 kgf·m)
   b. Remove the needle valve (8) and spring (9), then remove the O-ring (11) from the plug (6).




3. Disassemble the housing assembly (2).
   a. Remove the sleeve (12) and O-ring (13) from the housing (14).
   b. Remove the piston (15), spring (16) and main poppet (17) from the sleeve (12), then remove the O-ring (18) and backup ring (19) from the piston (15).



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## INSPECTION AND ADJUSTMENT

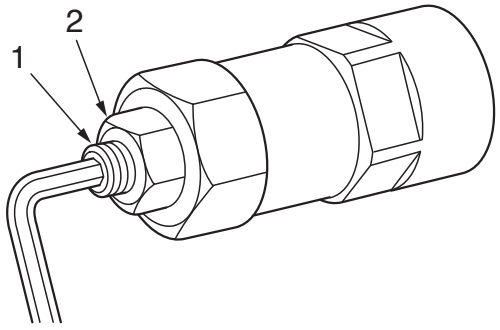
### Checking the Parts

| Parts | Judgment Criteria | Treatment |
|---|---|---|
| Housing, Section Body | • Scratches, rust, corrosion of the portion which slides against the spool. | • Replace |
| | • Scratches, rust, corrosion of the seal pocket portion of the part that enters the spool. | • Replace |
| | • Scratches, rust, corrosion of the port seal portion which is in contact with the O-ring. | • Replace |
| | • Scratches, rust, corrosion of the seal portion of the relief valve, etc. | • Replace |
| | • Other damage which could be a hindrance to correct function. | • Replace |
| Spool | • Scratch marks like being clawed around the outer circumference sliding portion. | • Replace |
| | • Scratches on the portion that slides against the seals on both ends. | • Replace |
| | • Spool not operating smoothly. | • Repair or replace. |
| Load Check Valve | • Imperfect sealing due to damage to the valve or spring. | • Repair or replace. |
| | • Does not catch, but operates lightly when inserted in the section body and operated. | • Normal |
| Around Springs | • Rust, corrosion, deformation, breakage or other marked damage to the spring, holder or cover. | • Replace |
| Around Spool Seal | • Oil leaking to the outside. | • Repair or replace. |
| | • Rust, corrosion or deformation of the seal holder. | • Repair or replace. |
| Main Relief Valve, Port Relief Valve, Anti-Cavitation Valve | • External rust, damage. | • Replace |
| | • Damage to valve seat contact surface. | • Replace |
| | • Damage to poppet contact surface. | • Replace |
| | • Abnormality in the spring. | • Replace |
| | • O-rings, backup rings, seals | • As a rule, all these should be replaced. |

### Adjusting the Main Relief Valve Pressure

1. Install a pressure gauge in the following pressure sensor port.
   - Control valve pressure sensor port.
     ☞ "II. Specifications, Standards for Judging Performance"
2. Run the pump at the rated speed.
3. Operate the control valve's cylinder spool over its full stroke and read the value indicated by the pressure gauge.
4. Turn the set screw (1) while watching the pressure gauge to adjust.
   Turning it to the right increases the set pressure.
   Turning it to the left decreases the set pressure.
5. After completing the pressure adjustment, tighten the lock nut (2) while holding the set screw (1) so it won't turn.
   Operate the relief valve again and check if the pressure is stabilized.

< TB145 >




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**TROUBLESHOOTING**

☞ “IV-62~64”

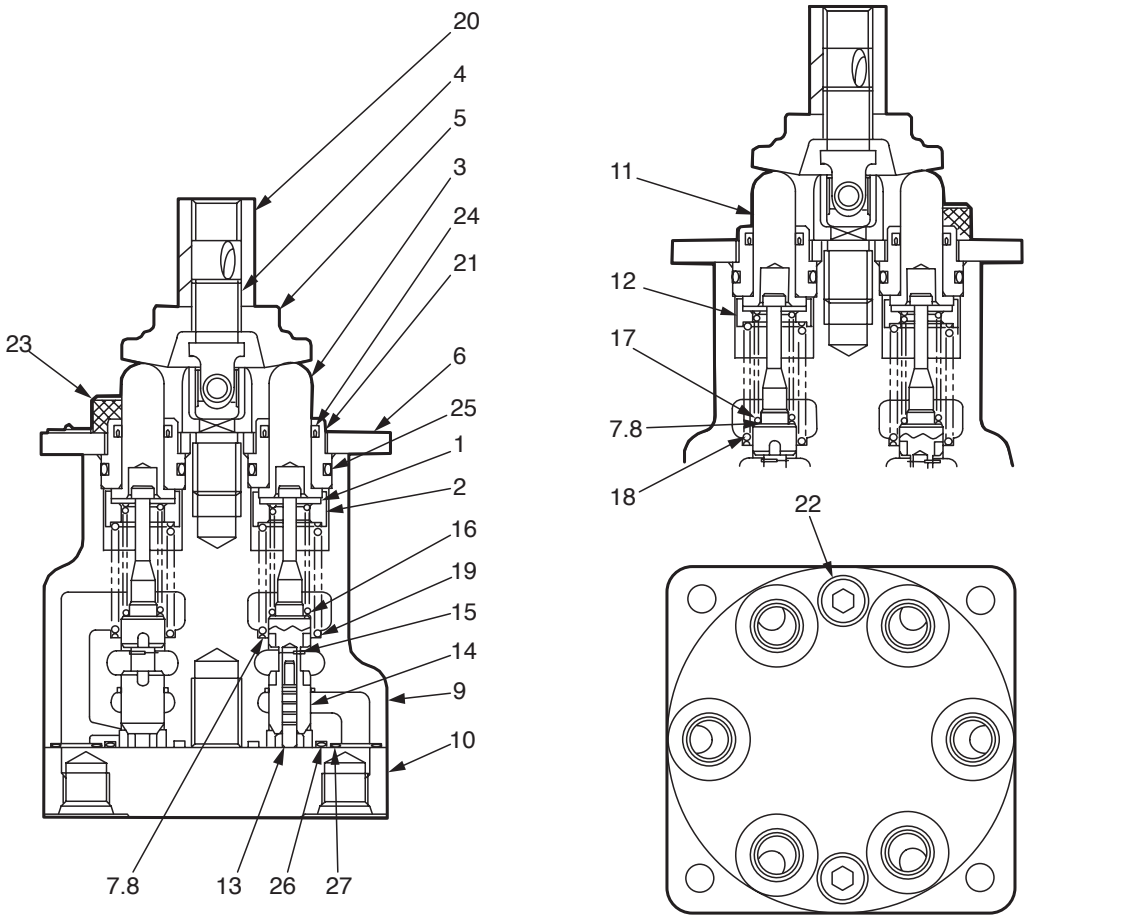
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# PILOT VALVE
## (TB125: S/N 12510003~12514525, TB135: S/N 13510004~13514050, TB145: S/N 14510004~14513260)

### CONSTRUCTION




1. Retainer
2. Spring Holder
3. Push Rod
4. Joint
5. Cam
6. Plate
7. Shim
8. Shim
9. Casing
10. Port Plate
11. Push Rod
12. Spring Holder
13. Piston
14. Spool
15. Wire Ring
16. Spring
17. Spring
18. Spring
19. Spring
20. Nut
21. Sleeve
22. Cap Screw
23. Cap Screw
24. U-Packing
25. O-ring
26. O-ring
27. O-ring

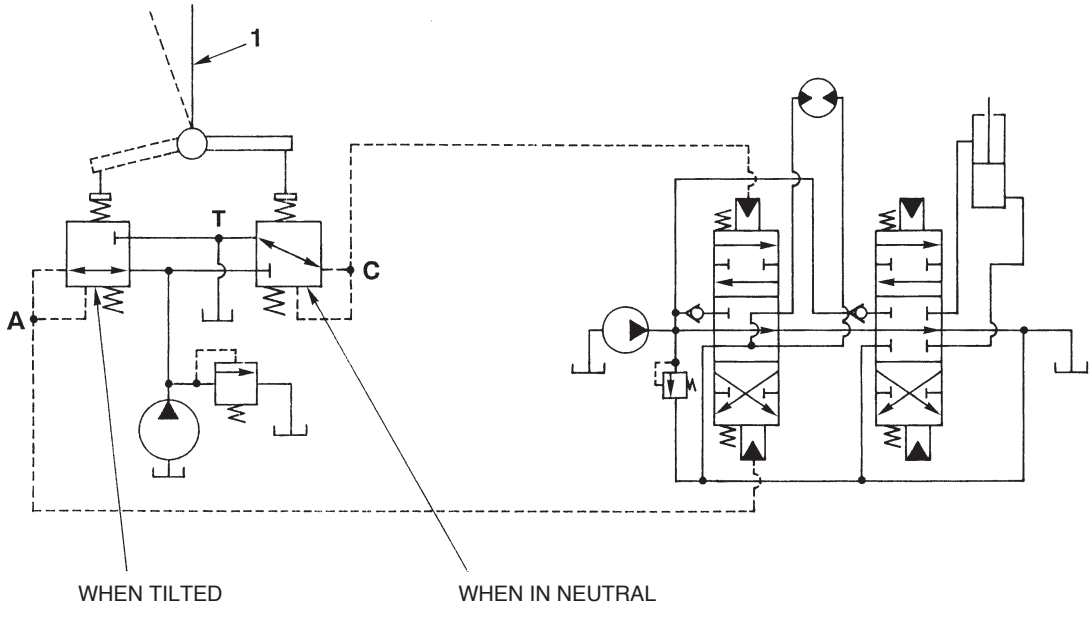
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## OPERATION

The pilot valve casing contains a vertical shaft hole with a reducing valve incorporated into it. When the handle is tilted, the push rod and spring seat are pushed down changing the secondary pressure spring's pressure.

The casing also contains an inlet port for hydraulic oil, port P (primary pressure), and an outlet port, port T (tank), and secondary pressure is taken from 4 ports, port 1, port 2, port 3 and port 4, on the bottom of the vertical shaft hole.




1. When the Handle is in Neutral
   In this case, the force of the secondary pressure setting spring, which determines the pilot valve's output pressure (secondary pressure), is not transmitted to the spool. Therefore, the spool is pushed up by the return spring and is in the output port C position shown above, with oil not flowing between port P and the output port C but flowing between the T port and output port C.

2. When the Handle is Tilted
   When the handle (1) is tilted and the push rod is pushed, the spool moves downward and port P and port A are joined. The oil in the pilot valve pump flows out to port A, generating pressure.
   When the pressure in port A is the same as the set force of the spring (set pressure), there is a balance between the hydraulic pressure and the spring force.
   When the pressure in port A is greater than the set pressure, port A and port P close and port A and port T open.
   When the pressure at port A is lower than the set pressure, port A and port P open and port A and port T close.
   In this way, the secondary pressure is kept constant.

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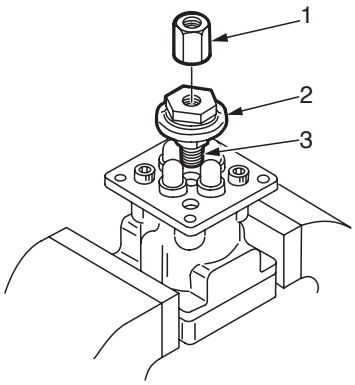
## DISASSEMBLY AND ASSEMBLY

### General Cautions

- Since all parts in the pilot valve are precision machined, carry out disassembly and reassembly operations in a clean place and take special care not to scratch the parts.
- Before disassembly, clean the outside surfaces of the pilot valve.
- Clean each of the disassembled parts and apply clean hydraulic oil to them.
- Replace all seals with new ones each time the pilot valve is disassembled.
- During assembly, remove all the foreign matter from each part and check them to make sure there are no burrs, bruises using or other marks on them. Remove all burrs and bruises using an oil stone.
- Apply thin coating of grease to seals when assembling them.

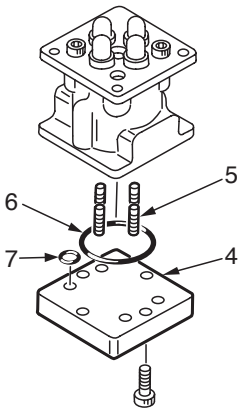
### Disassembly

1. Remove the nut (1) and separate the joint from the cam (2).
   - Fix the valve to the vise using a copper plate or lead plate.
2. Remove the joint (3).



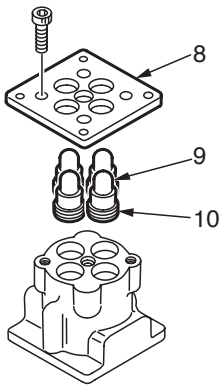
C4D301

3. Loosen the cap screws at the bottom and remove the port plate (4).
4. Remove the four pistons (5), one O-ring (6), and six O-rings (7).



C4D302

5. Loosen the cap screws and remove the plate (8).
6. Remove the push rods (9) together with the sleeves (10).
   - The push rods for port 1 and port 3 are different from those for port 2 and port 4. Store them carefully so that they can be restored at the same positions when assembling.

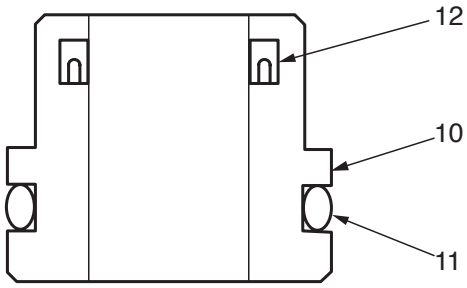


C4D303

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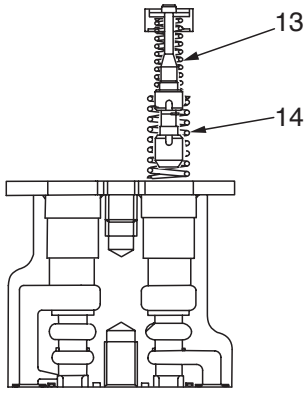


7. Remove the O-ring (11) and U-packing (12) from the sleeve (10).



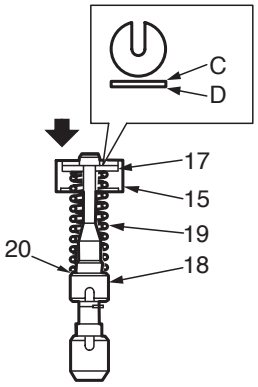

C4D304

8. Remove the spool assembly (13) and spring (14) from the casing.
   - The spool assemblies and springs for port 1 and port 3 are different from those for port 2 and port 4. Store them carefully so that they can be restored at the same positions when assembling.




C4D305

9. Disassemble the spool assembly.
   a. Push down the spring holder (15) and remove the retainer (17) from the spool (18).
   b. Remove the spring holder (15) and spring (19) from the spool (18).
      - Be careful not to lose the pressure adjusting shim (20) if assembled.



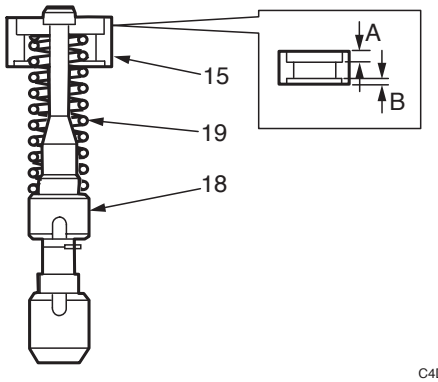

C4D306

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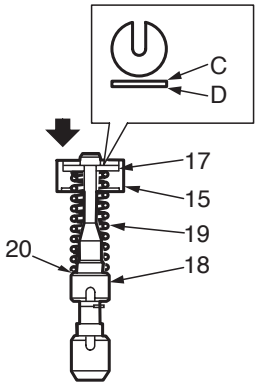
**Assembly**

1. Assemble the spring assembly.
   a. Fit the spring (19) to the spool (18) and install the spring holder (15).
      • Be careful of the direction of the spring holder.
        A: Make the side with the deeper hole up.
        B: Make the side with the shallow hole down.



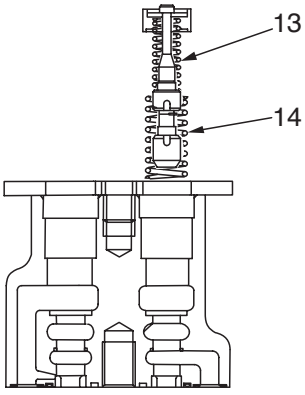
C4D307

   b. Push down the spring holder (15) and fit the retainer (17) to the spool (18).
      • Be careful of the direction of the retainer.
        C: Make the side with the sharp corner up.
        D: Make the side with the round corner down.



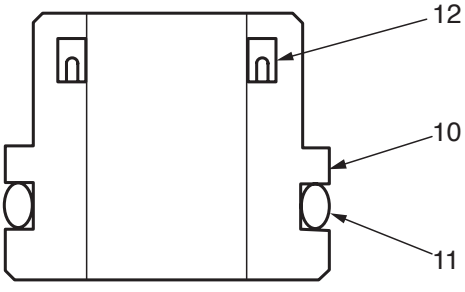
C4D306

2. Install the spring (14) and spool assembly (13) in the casing.
   • Install them at the same positions as previously assembled.
   • Be careful not to damage the spool hole.



C4D305

3. Install the O-ring (11) and U-packing (12) in the sleeve (10).
   • Be careful of the direction of the U-packing.

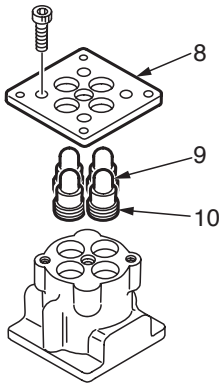


C4D304

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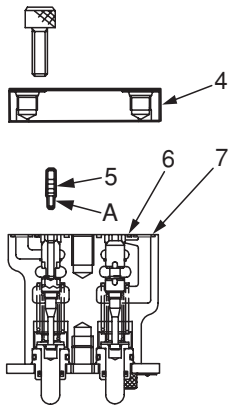
4. Assemble the push rods (9) and sleeves (10), and mount them on the spool assemblies in the casing.
   - Install them at the same positions as previously assembled.
   - Be careful not to damage the parts by pushing them too strongly.



C4D303

5. Mount the plate (8) and tighten the cap screws.
   - Cap screw tightening torque:
     23.5 ±2 N·m (2.4 ±0.2 kgf·m)

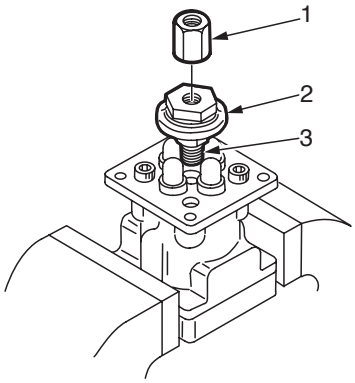
6. Turn the casing upside down to make the push rods the lower side and insert the four pistons (5) into the spool holes.
   - Let the side A with the smaller diameter (unpolished side) of the piston be positioned in the back of the holes.



C4D308

7. Install one O-ring (6), six O-rings (7) and the port plate (4) in the casing and tighten them with the cap screws.
   - Cap screw tightening torque:
     23.5 ±2 N·m (2.4 ±0.2 kgf·m)

8. Reverse the casing again to the original position and install the joint (3).
   - Joint tightening torque:
     49 ±4.9 N·m (5 ±0.5 kgf·m)
   - Apply Loctite #242 to the joint screws.

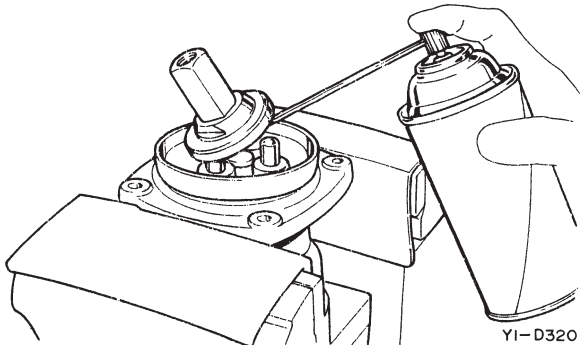


C4D301

9. Tighten the cam (2) with your fingers until it touches the push rod. Loosen the cam at an angle of around 45° before tightening the nut (1).
   - Nut tightening torque:
     49 ±4.9 N·m (5 ±0.5 kgf·m)

IMPORTANT: Never tighten the nut without loosening the cam, otherwise the cam will rotate with the nut, keeping the push rods pressed. This will generate secondary pressure in the neutral position that might cause erroneous operation.

10. Apply grease to the cam, push rods and joint rotating section.

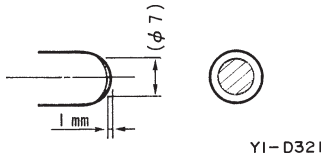

YI–D320

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## INSPECTION AND ADJUSTMENT

### Checking the Parts

| Parts | Judgment Criteria | Treatment |
|---|---|---|
| O-ring | —— | • Replace |
| Seal | —— | • Replace |
| Seal Washer | —— | • Replace |
| Spool | • Wear on sliding portions is 10 μm or greater compared to non-sliding portions<br>• Scratches on sliding portions<br>• Spool doesn't move smoothly | • Replace<br>• Replace<br>• Repair or replace |
| Push Rod | • Front end is worn 1 mm or more<br>  <br>• Scratches in the sliding portion | • Replace<br>• Replace |
| Plug | • Seal is imperfect due to damage | • Repair or replace |
| Operating Portion | • Tightening is loose at the pin, shaft or joint of the operating portion, with looseness of 2 mm or greater<br>• Due to wear, etc. tightening is loose at the pin, shaft or joint of the operating portion, with looseness of 2 mm or greater | • Tighten to the specified torque<br>• Replace |
| Casing,<br>Port Plate | • Scratches, rust or corrosion on the spool and sliding portion<br>• Scratches, rust or corrosion on seal portions which come in contact with the O-ring | • Replace<br>• Repair or replace |

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**TROUBLESHOOTING**

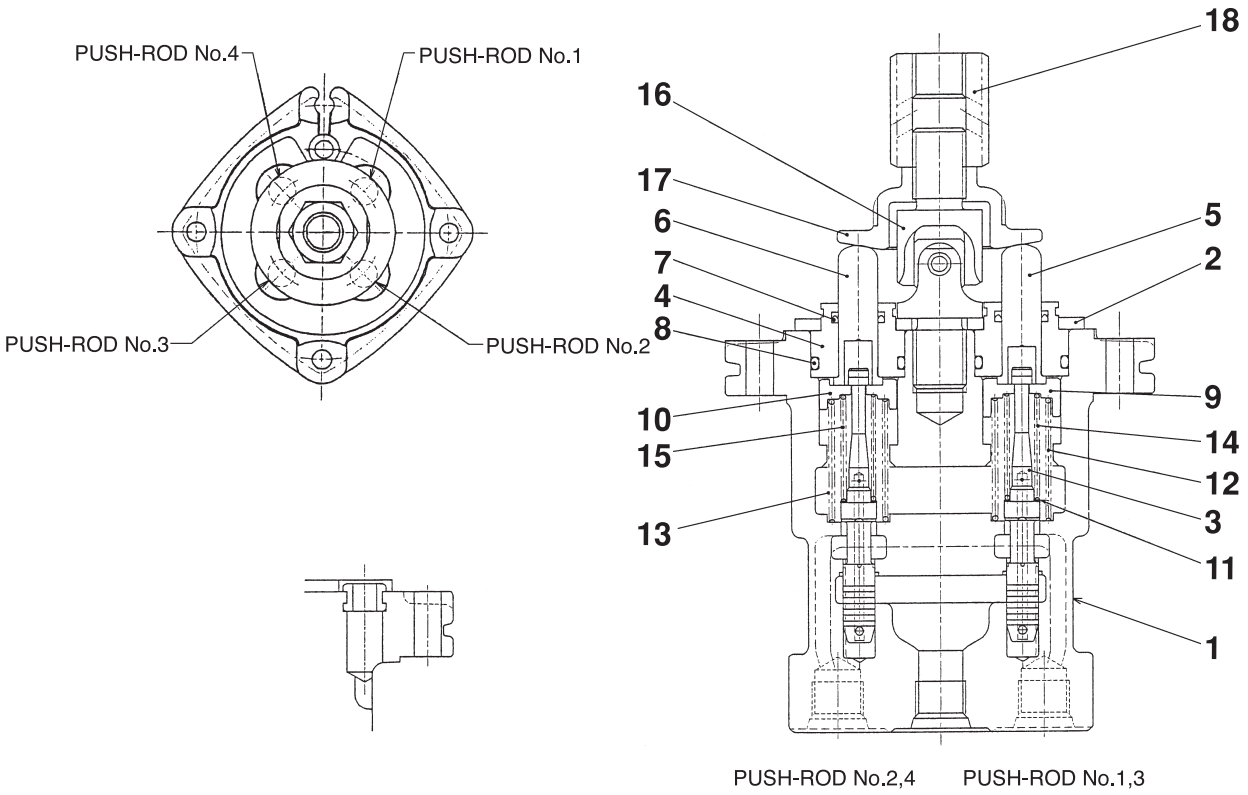
| Symptom | Probable Causes | Remedy |
|---|---|---|
| Secondary pressure doesn't rise | • Primary pressure is insufficient<br>• Spring is damaged or permanently deformed<br>• The clearance between the spool and casing is abnormally large<br>• There is looseness in the handle | • Keep the primary pressure<br>• Replace the spring<br>• Replace the spool and casing assembly<br>• Disassemble and reassemble, or replace the handle |
| Secondary pressure doesn't stabilize | • Sliding parts are catching<br>• Tank line pressure fluctuates<br>• Air gets mixed into the piping | • Repair or replace<br>• Remove the abnormal portions of the tank line<br>• Operate the machine several times and bleed out the air |
| Secondary pressure is high | • Tank line pressure is high<br>• Sliding parts are catching | • Remove the abnormal portions of the tank line<br>• Repair or replace |

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# PILOT VALVE
# (TB125 : S/N 12514526~, TB135: S/N 13514051~, TB145: S/N 14513261~)

## CONSTRUCTION




G4D300E

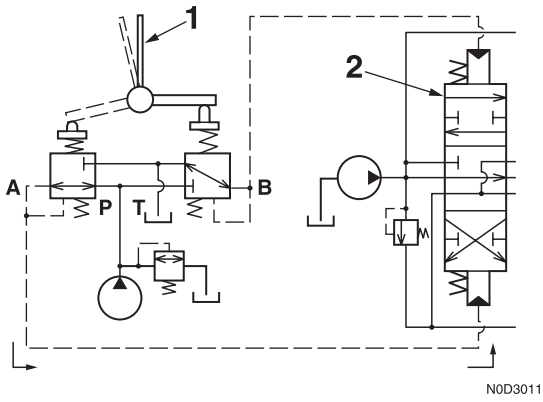
1. Casing
2. Plate
3. Spool
4. Plug
5. Push Rod
6. Push Rod
7. Seal
8. O-ring
9. Spring Seat
10. Spring Seat
11. Washer 2
12. Spring
13. Spring
14. Spring
15. Spring
16. Joint
17. Disc
18. Adjusting Nut

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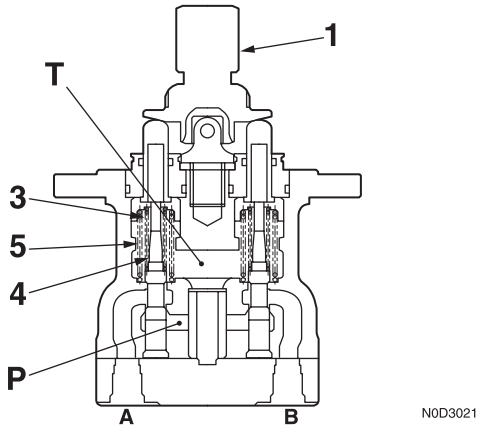
## OPERATION

The pilot valve casing contains a vertical shaft hole with a reducing valve incorporated into it. When the handle is tilted, the push rod and spring seat are pushed down changing the secondary pressure spring's pressure.

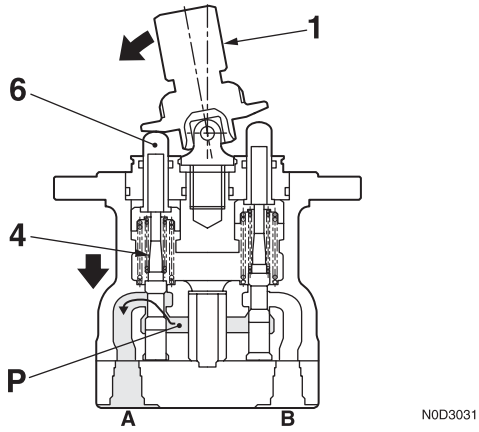



The casing provides the inlet port P (the primary pressure) and the tank port T. The secondary pressure commensurate with the variation of the operation angle of the handle (1) is taken out through the output ports A and B below the vertical shaft hole. The secondary pressure functions as the pilot pressure to actuate the spool of the control valve (2).

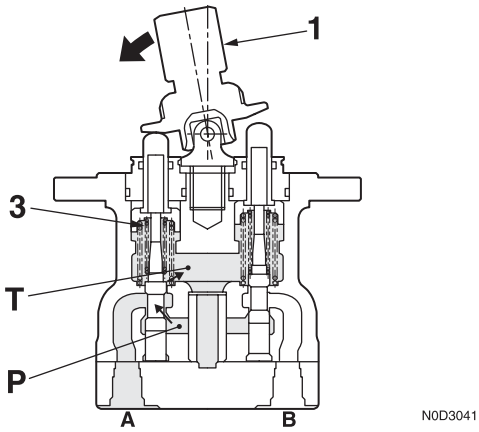
When the Handle (1) is at the Neutral Position:
The force of the spring (3) for setting the secondary pressure that determines the output pressure of the pilot valve is not conveyed to the spool (4). Therefore, the spool (4) is pushed up by the return spring (5), and the output ports A and B are connected with the tank port T, making the pressures in the ports A and B equal to the pressure in the tank port T.




When the Handle (1) is Tilted:
When the handle (1) is tilted and the push rod (6) is pushed, the spool (4) moves downward and the input port P is connected with the output port A. Then, the oil from the pilot pump flows into the output port A, generating a pressure.




When the Handle (1) is Kept at a Certain Position:
When the pressure in the output port A increases to the level equivalent to the force of the spring (3) set by inclination the handle (1), the hydraulic pressure balances with the spring force. When the pressure in the output port A becomes higher than the set spring force, the output port A and the input port P close while the output port B and the tank port T open. When the pressure in the output port A becomes lower than the set spring force, the output port A and the input port P open while the output port B and the tank port T close. Thus, the secondary pressure is always kept constant.

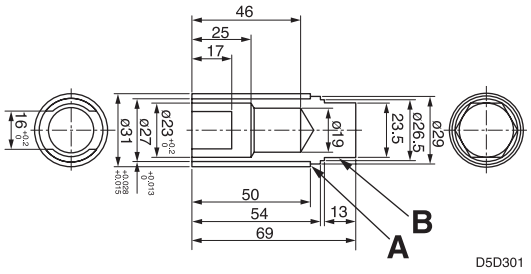


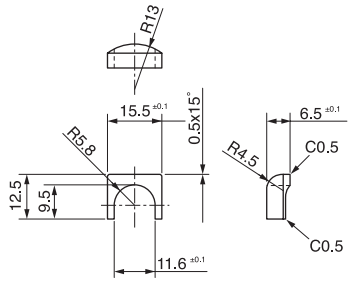
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## DISASSEMBLY AND ASSEMBLY

### Table of Special Tools

| NAME, DIMENSION | Q'ty |
|---|---|
| INSTALLATION JIG (A)<br>  <br><br>MATERIAL A; S45C<br>MATERIAL B; SCM415N WITH CEMENTATION HARDENING | 1 |

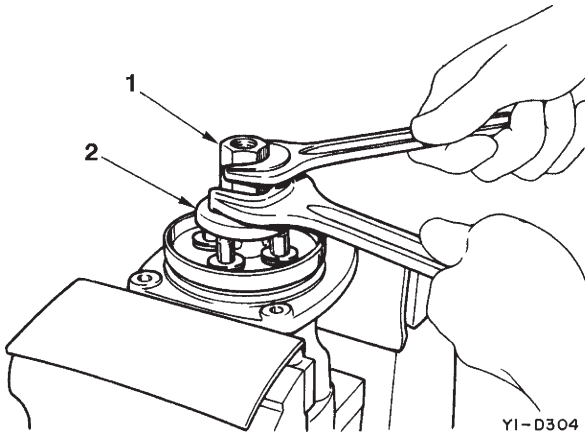
| NAME, DIMENSION | Q'ty |
|---|---|
| INSTALLATION JIG (B)<br>  <br><br>MATERIAL B; SCM415N WITH CEMENTATION HARDENING | 2 |

### General Cautions

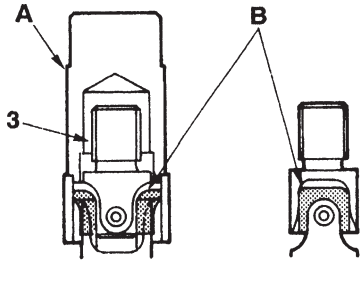
- Since all parts in the pilot valve are precision machined, carry out disassembly and reassembly operations in a clean place and take special care not to scratch the parts.
- Before disassembly, clean the outside surfaces of the pilot valve.
- Clean each of the disassembled parts and apply clean hydraulic oil to them.
- Replace all seals with new ones each time the pilot valve is disassembled.
- During assembly, remove all the foreign matter from each part and check them to make sure there are no burrs, bruises using or other marks on them. Remove all burrs and bruises using an oil stone.
- Apply thin coating of grease to seals when assembling them.

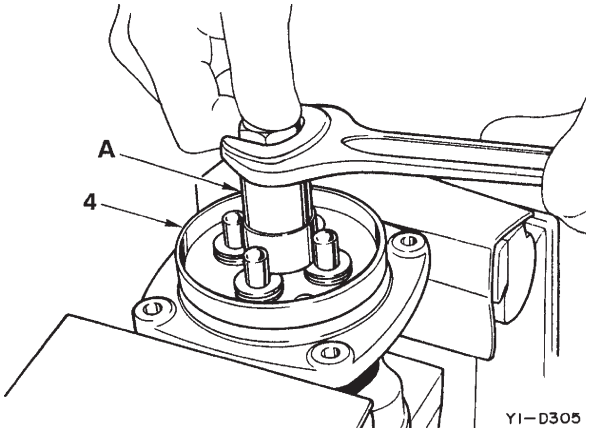
### Disassembly

1. Remove the lock nut and the adjust nut (1), then remove the disc (2).
   - Using copper or lead plates, fasten the valve in a vise.




2. Remove the joint (3), then remove the plate (4).
   - Use installation jigs (A) and (B).

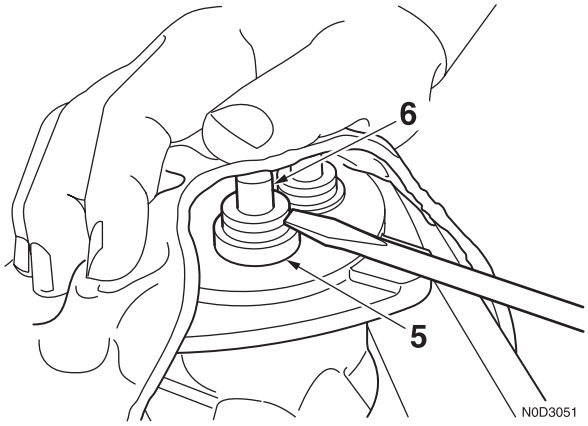


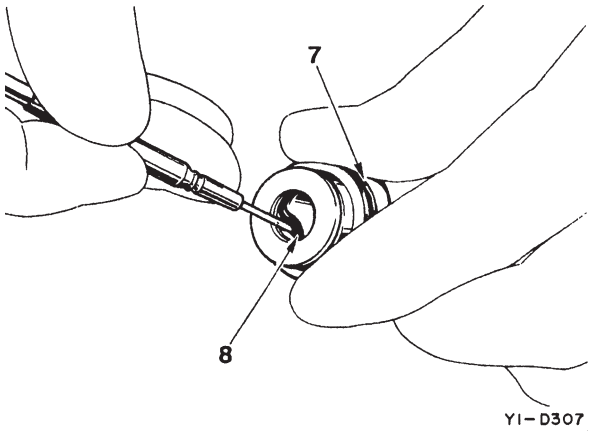
https://truckmanualshub.com/



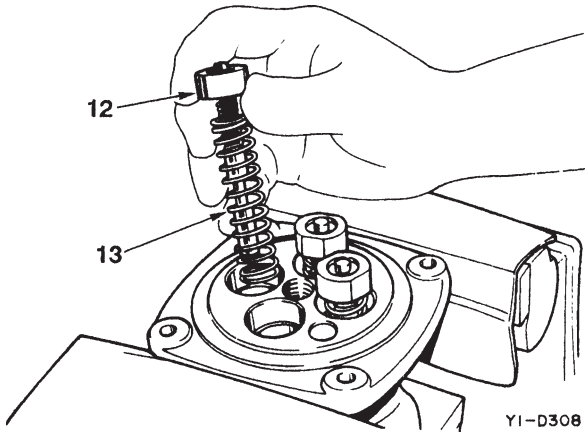
3. Take out the plug (5) then remove the push rod (6) from the plug (5).
   - If the plug is difficult to remove, use (–) screw driver to remove it.
   - Be careful not to let the plug fly out from the spring's force.



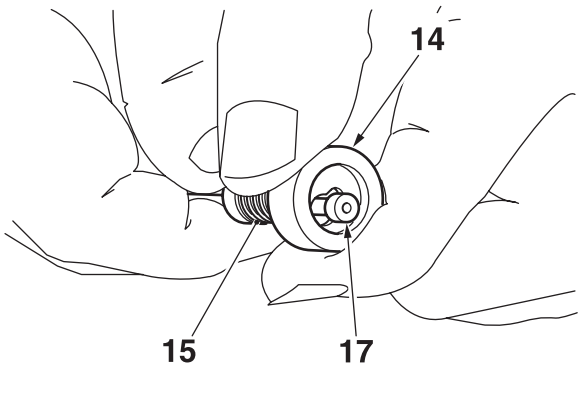

4. Remove the O-ring (7) and seal (8) from the plug.




5. Remove the reducing valve (12) and spring (13).
   - Make match marks on the reducing valve and casing hole so they can be placed in the same position when they are reassembled.



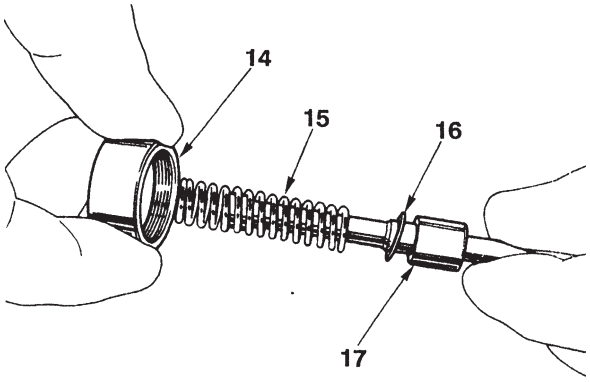

6. Disassemble the reducing valve.
   a. Push in the spring sheet (14) to contract the spring (15), and move the spool (17) from the small hole to the large hole of the spring sheet (14).
      - Do not push in the spring sheet too far (at most 6 mm).



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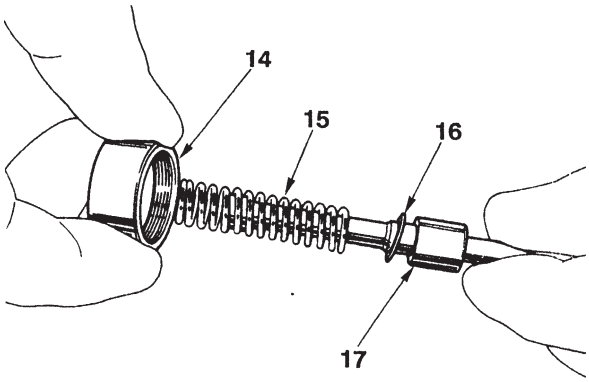
b. Remove the spring seat (14), spring (15) and washer 2 (16) from the spool (17).




YI–D310

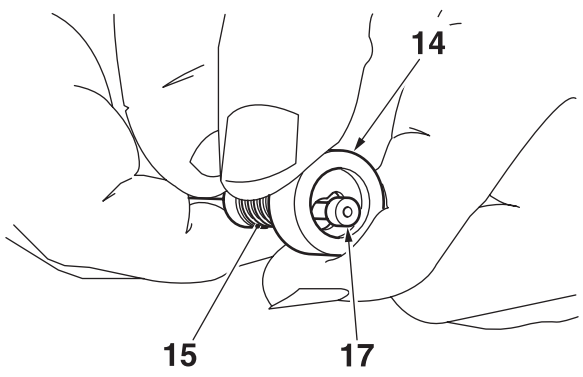
**Assembly**

1. Assemble the reducing valve (12).
   a. Install the washer 2 (16), spring (15) and spring seat (14) on the spool (17).




YI–D310

   b. Push in the spring sheet (14) to contract the spring (15), and move the spool (17) from the large hole to the small hole of the spring sheet (14).
      • Do not push in the spring sheet too far (at most 6 mm).

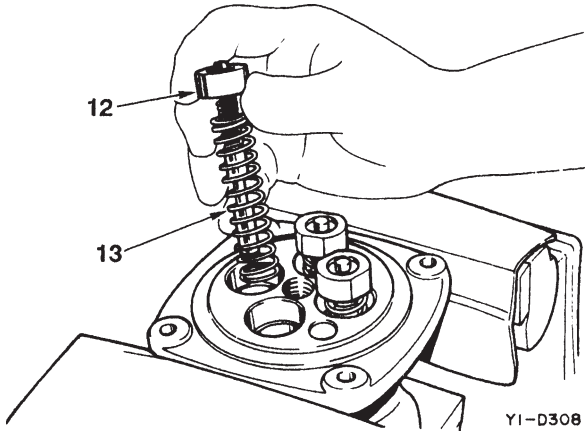



N0D3061

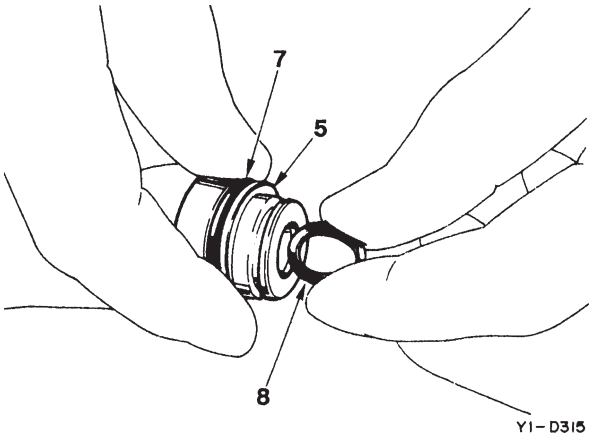
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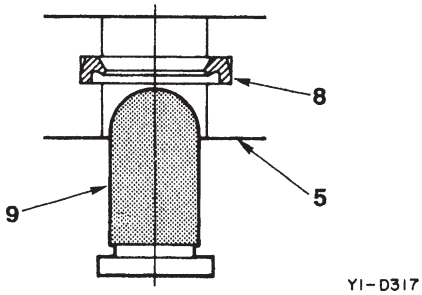
2. Install the spring (13) and reducing valve (12).
   - Install them in the positions they were in before disassembly.

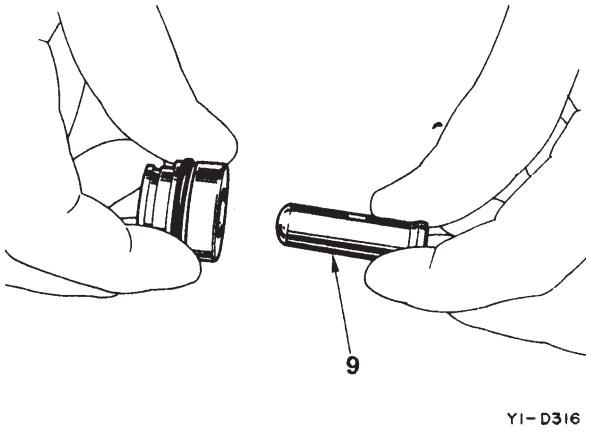



3. Install the O-ring (7) and seal (8) in the plug (5).



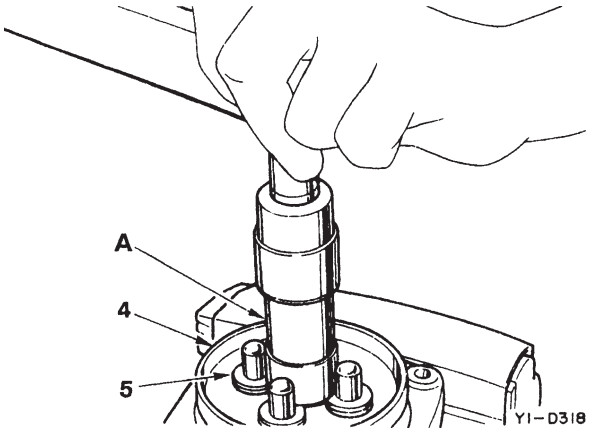

4. Install the push rod (9) in the plug (5).
   - Apply hydraulic oil to the push rod.




5. Install the plug (5) and plate (4), then install the joint.
   - Use installation jigs (A) and (B) to install the joint.

   Joint: 47.1 ±2.9 N·m

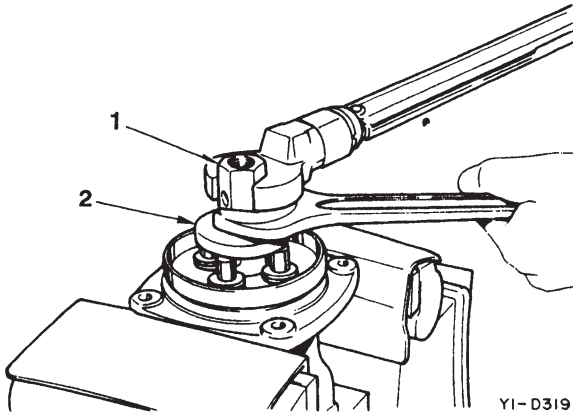


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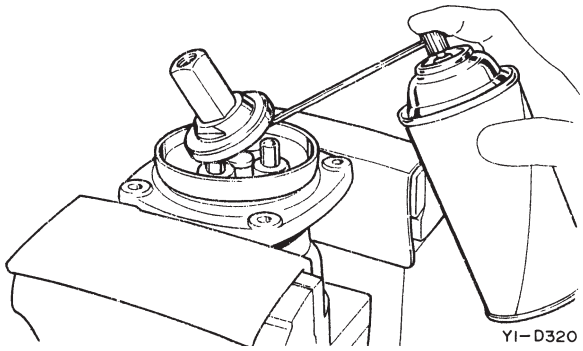


6. Install the disc (2), the adjust nut (1) and the lock nut.
   - Tighten the adjust nut to the point where all 4 push rods are uniformly making contact.
   - During tightening, the disc should not be moved.

   Adjust Nut: 68.6 ±4.9 N·m




7. Apply grease to the contact surfaces of the joint rotating portion, the disc and the push rod.

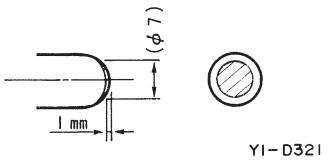


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## INSPECTION AND ADJUSTMENT

### Checking the Parts

| Parts | Judgment Criteria | Treatment |
|---|---|---|
| O-ring | —— | • Replace |
| Seal | —— | • Replace |
| Spool | • Wear on sliding portions is 10 μm or greater compared to non-sliding portions<br>• Scratches on sliding portions<br>• Spool doesn't move smoothly | • Replace<br>• Replace<br>• Repair or replace |
| Push Rod | • Front end is worn 1 mm or more<br>  <br>• Scratches in the sliding portion | • Replace<br>• Replace |
| Plug | • Seal is imperfect due to damage | • Repair or replace |
| Operating Portion | • Tightening is loose at the pin, shaft or joint of the operating portion, with looseness of 2 mm or greater<br>• Due to wear, etc. tightening is loose at the pin, shaft or joint of the operating portion, with looseness of 2 mm or greater | • Tighten to the specified torque<br>• Replace |
| Casing, Port Plate | • Scratches, rust or corrosion on the spool and sliding portion<br>• Scratches, rust or corrosion on seal portions which come in contact with the O-ring | • Replace<br>• Repair or replace |

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**TROUBLESHOOTING**

| Symptom | Probable Causes | Remedy |
|---|---|---|
| Secondary pressure doesn't rise | • Primary pressure is insufficient | • Keep the primary pressure |
| | • Spring is damaged or permanently deformed | • Replace the spring |
| | • The clearance between the spool and casing is abnormally large | • Replace the spool and casing assembly |
| | • There is looseness in the handle | • Disassemble and reassemble, or replace the handle |
| Secondary pressure doesn't stabilize | • Sliding parts are catching | • Repair or replace |
| | • Tank line pressure fluctuates | • Remove the abnormal portions of the tank line |
| | • Air gets mixed into the piping | • Operate the machine several times and bleed out the air |
| Secondary pressure is high | • Tank line pressure is high | • Remove the abnormal portions of the tank line |
| | • Sliding parts are catching | • Repair or replace |

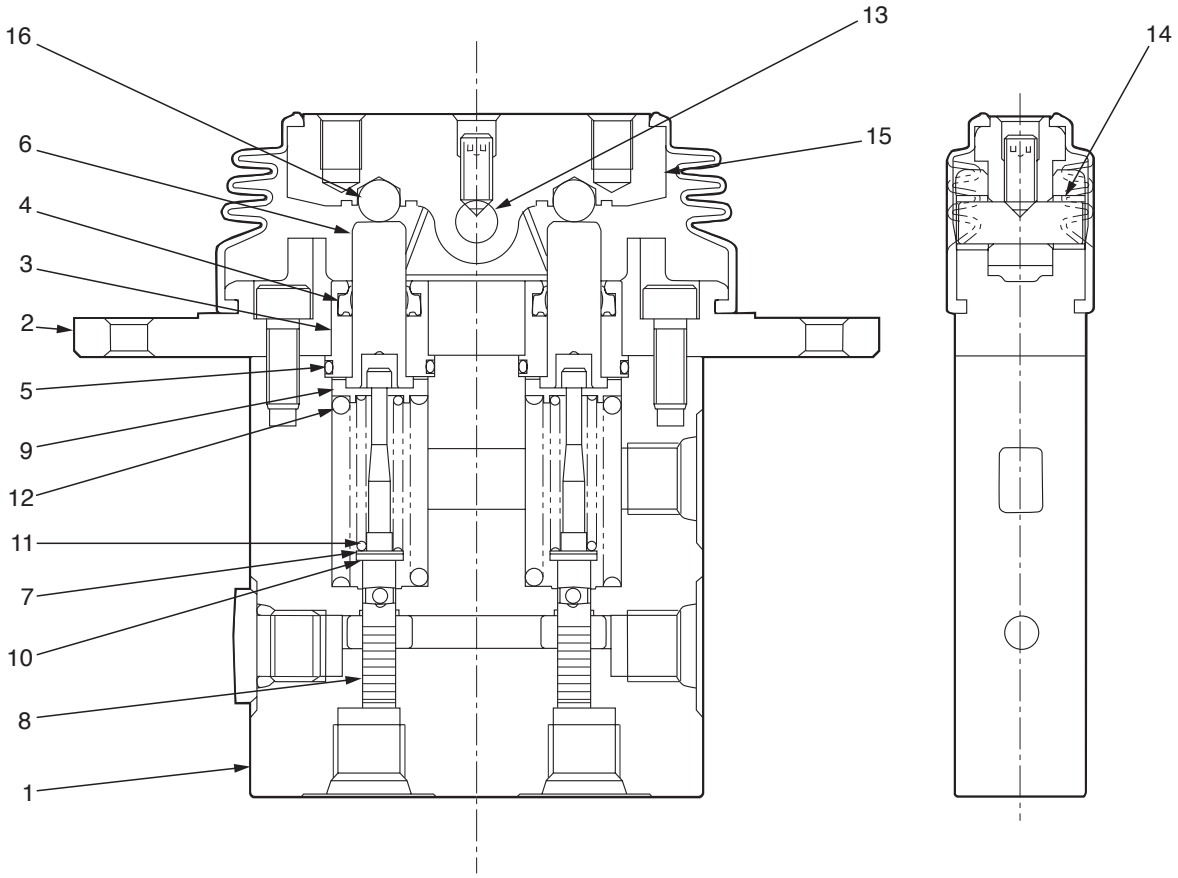
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## PILOT VALVE (SWING)

### CONSTRUCTION




L3D350

1. Casing
2. Cover
3. Plug
4. Seal
5. O-ring
6. Push Rod
7. Shim
8. Spool
9. Spring Seat
10. Washer
11. Spring
12. Spring
13. Shaft
14. Bushing
15. Cam
16. Ball

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## OPERATION

☞ "IV-92-2"

## DISASSEMBLY AND ASSEMBLY

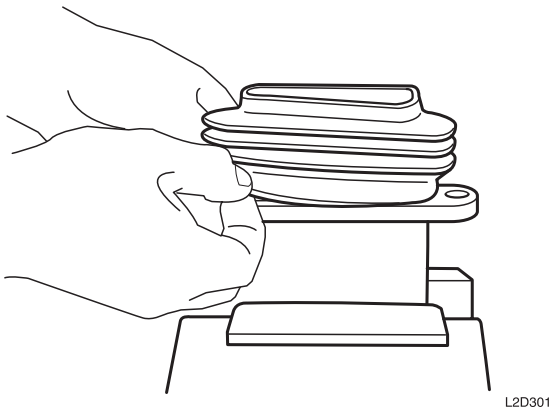
### General Cautions

☞ "IV-92-3"

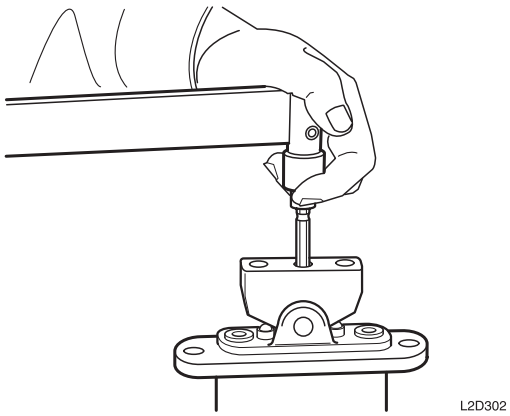
The following describes the disassembly procedure. For assembly, refer to the construction diagram and follow the disassembly procedure in the reverse order.

### Disassembly

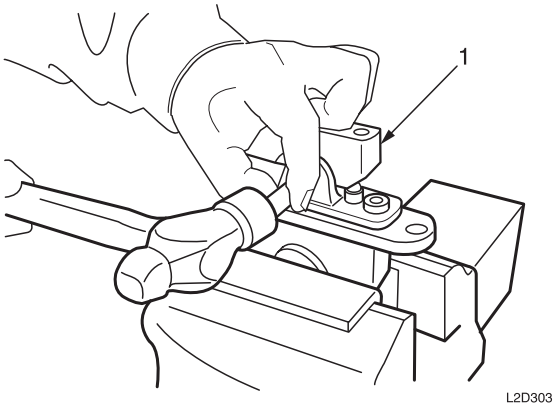
1. Remove the boot from the cover.
   - Use a copper or iron sheet to fasten the valve to the vice.
   - Apply grease to the cam and push rods.


L2D301

2. Remove the set screw.
   Set screw: 6.9 N·m
   - Apply Loctite #241 to the set screw.


L2D302

3. Remove the cam pin, then remove the cam (1).



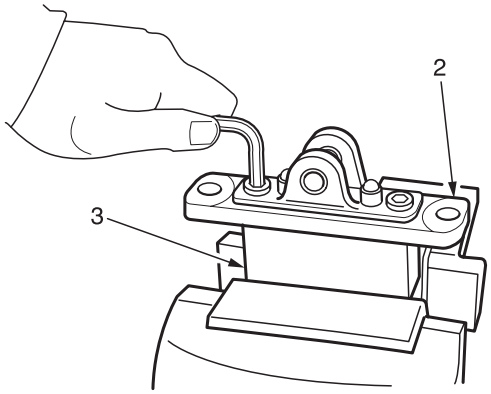
L2D303

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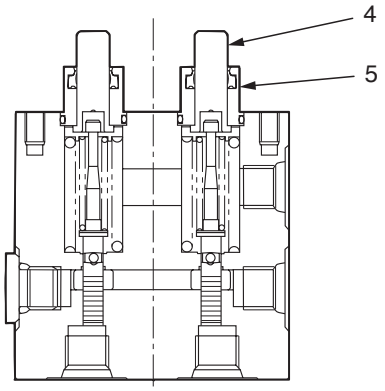
4. Loosen the cap screws and remove the cover (2).
   - The cover and plug will rise from the surface if the rebound spring is too strong, so loosen the cap screws alternately so that the cover is flat.
   - Mark the cover and casing so that they can be reassembled in the same positions.

   Cap screw: 8.8 N·m



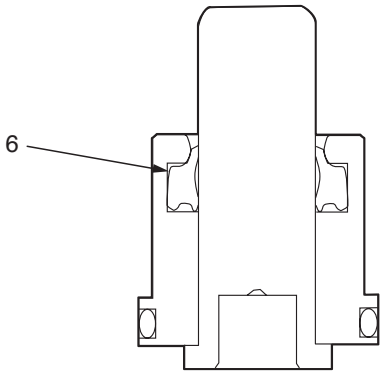
L2D304

5. Remove the push rods (4) together with the plug (5).



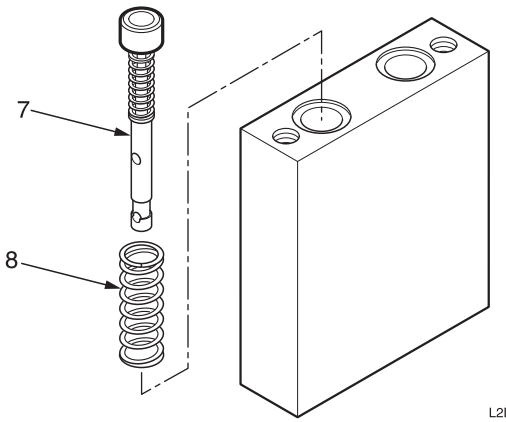
L3D351

6. Remove the O-rings and seal (6) from the plug.



L3D352

7. Remove the spool assembly (7) and spring (8) from the casing.
   - Never disassemble the spool assembly as the pressure has been adjusted by the shim.



L2D306

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## INSPECTION AND ADJUSTMENT

☞ “IV-91”

## TROUBLESHOOTING

☞ “IV-92”

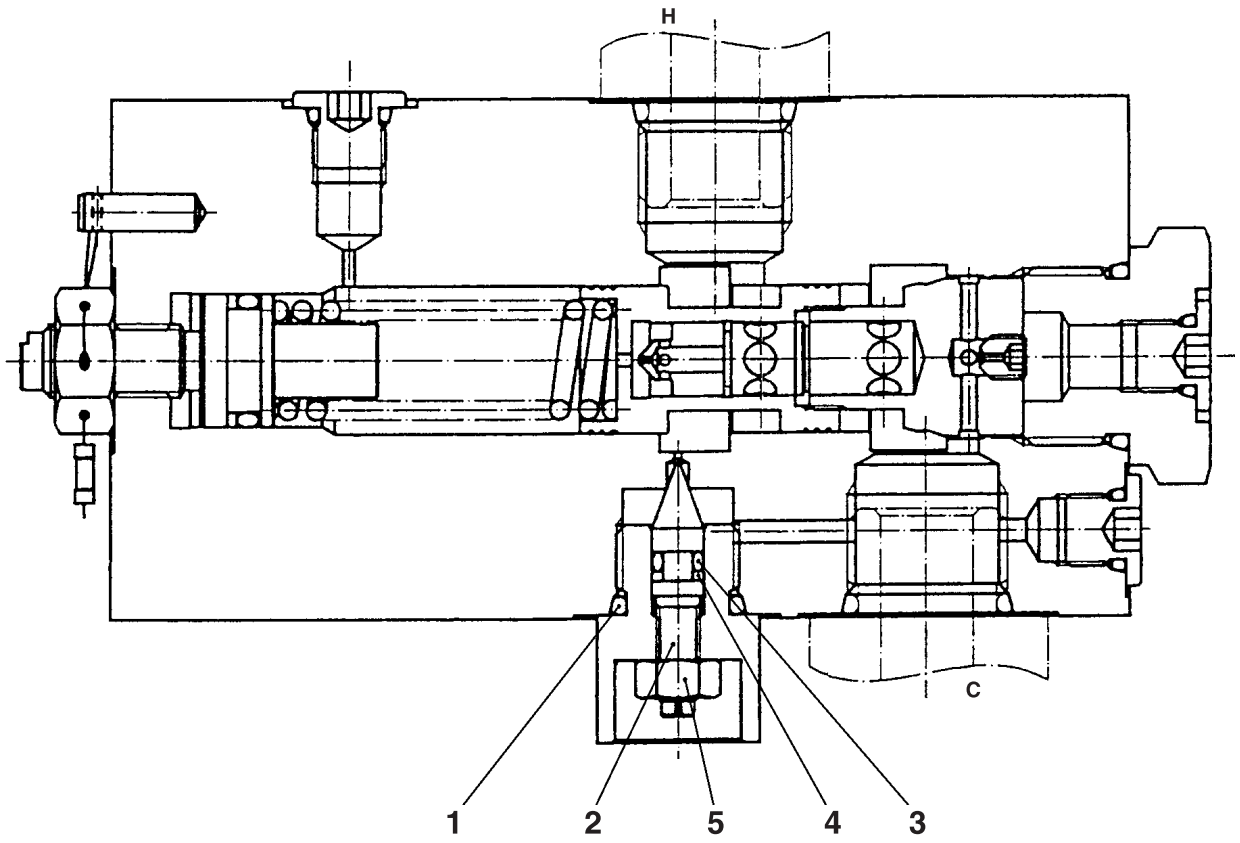
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# SHUT-OFF VALVES

## CONSTRUCTION

### Differential Pressure Detection (TB145: For Boom Cylinder Only)



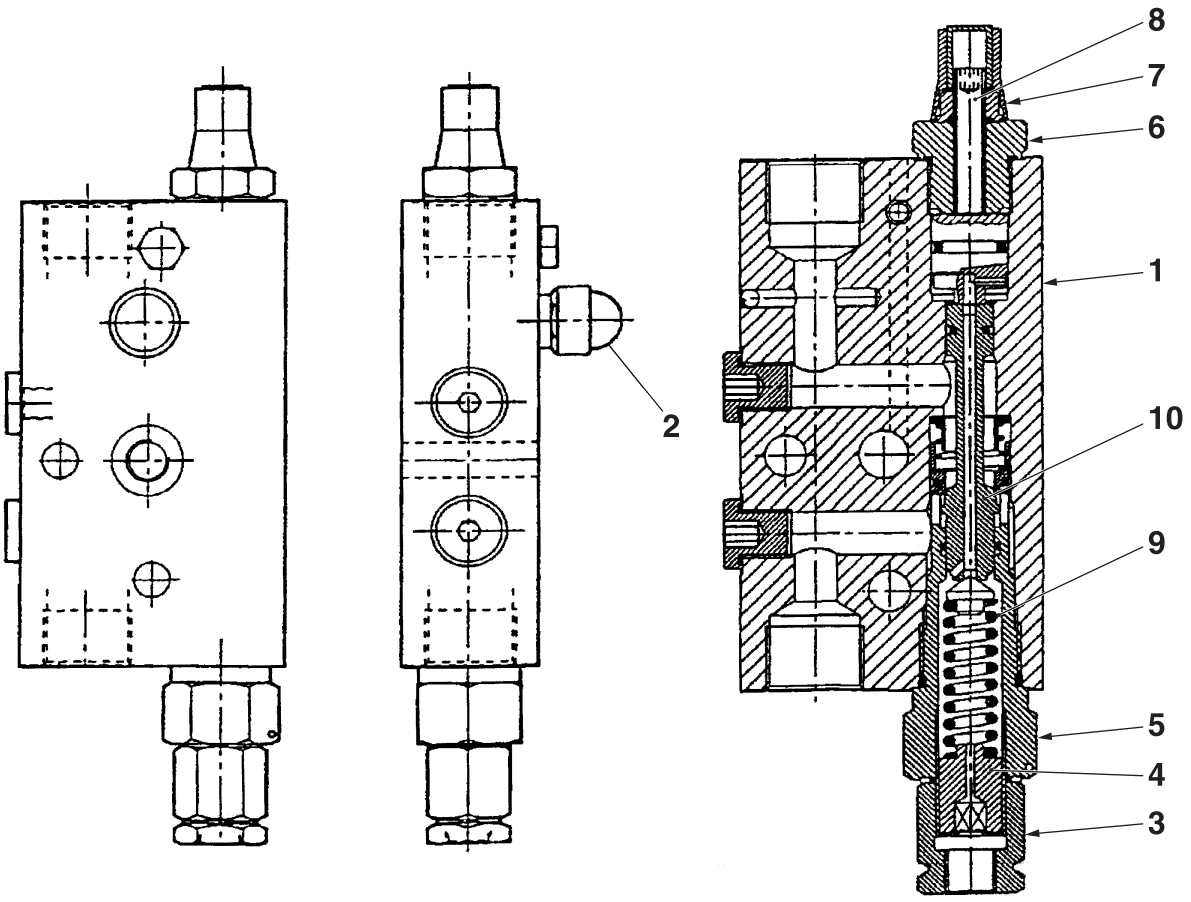

L3H600

1. O-ring
2. Stem
3. O-ring
4. Backup Ring
5. Lock Nut

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**Pilot Operated Hydraulic System (Boom and Arm Cylinder)**




W2H6001

1. Body
2. Relief Valve
3. Plug
4. Screw
5. Plug
6. Plug
7. Lock Nut
8. Adjusting Screw
9. Spring
10. Spool

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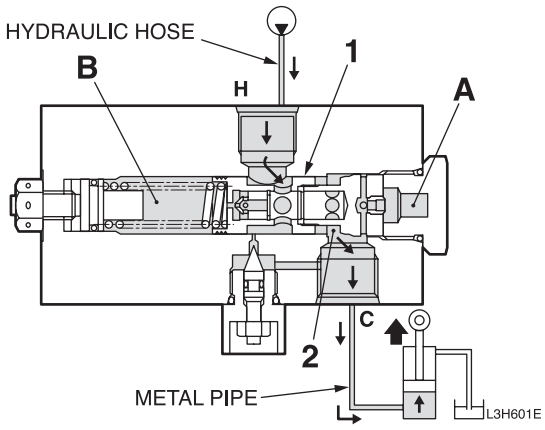


## OPERATION

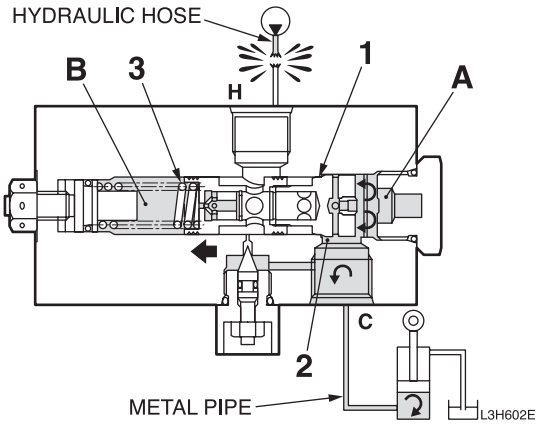
The isolation valve prevents the boom or arm being raised from falling. If the hydraulic hose breaks, the valve blocks and isolates the hydraulic oil flowing to the cylinder head.

### Differential Pressure Detection (TB145: For Boom Cylinder Only)

When the boom is raised, the oil from the hydraulic pump flows through the port H, the hole on the spool (1), the passage (2) and the port C into the boom cylinder. Meanwhile, the pressure from the ports C and H is led to the chambers A and B located on each side of the spool (1).

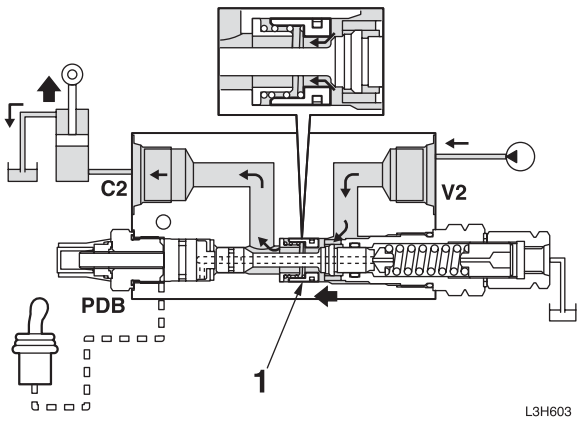



If the hydraulic hose breaks, the pressures between the chambers A and B on the sides of the spool (1) become different. The force caused by this differential pressure moves the spool (1) to the left when the force becomes larger than the force of the spring (3). Then the flow cross-section area of the passage (2) decreases and the pressure in the chamber (A) moves the spool (1) to be seated on the body, blocking the ports C and H. As a result, the oil flowing to the cylinder head is blocked, which prevents the boom from falling.

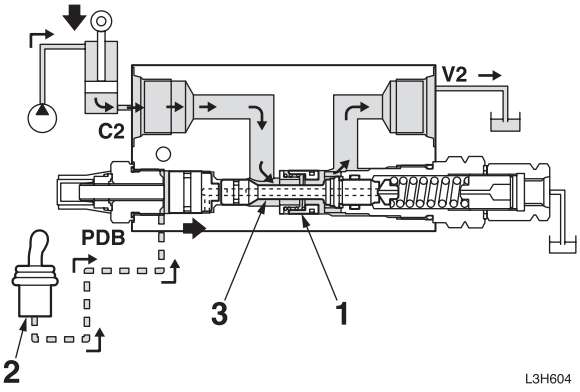



### Pilot Operated Hydraulic System (Boom and Arm Cylinder)

When the boom or arm is raised, the pressure oil from the hydraulic pump flows through the port V2 to push up the check valve (1) and then through the port C2 into the boom or arm cylinder.



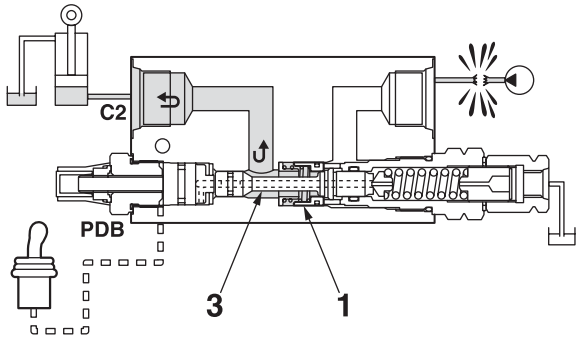

When the boom or arm is lowered, the pilot pressure from the pilot valve (2) is led to the port PDB. The pilot pressure in the port PDB moves the spool (3) to the left. The return oil from the cylinder flows from the port C2 to the passage through the spool (3) and the check valve (1), the port V2 and into the tank passage.



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The boom or arm does not fall in case of hydraulic hose breakage, because the oil flow leading to the boom or arm is blocked and isolated in the passage through the check valve (1) and the spool (3) if a hose breaks.




L3H605

## INSPECTION AND ADJUSTMENT

Never adjust the adjuster screws on the isolation valve. Otherwise, the valve may not work properly, or the boom or arm may fall.

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## TROUBLESHOOTING

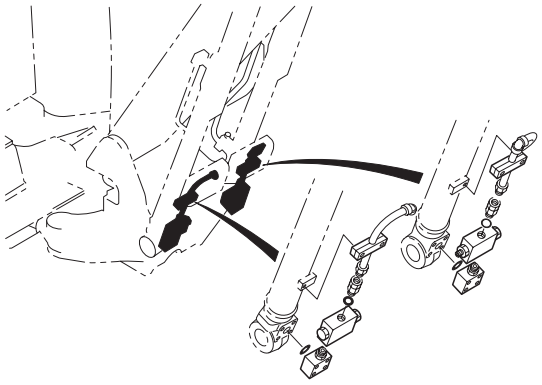
When the hose of the boom or arm cylinders are ruptured and the boom or arm falls, the emergency shut-off valve is activated and stops the boom or arm part way through the fall.

**⚠WARNING**

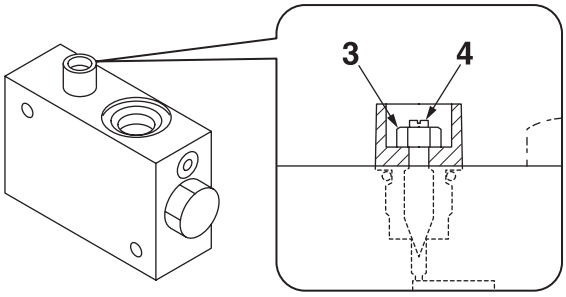
If the boom or arm drops and the emergency shut-off valves are activated, immediately move away from the suspended object.

### Differential Pressure Detection (TB145: For Boom Cylinder Only)

1. Check for safety in the working area and for stability of the machine and lifted load.
2. Loosen the emergency shut-off valve's lock nut (3) and stem (4) to lower the boom.
3. Check for stability of the hoe attachment and load.
4. Tighten the stem (4) secure it with the lock nut (3).
   Tightening torque:
   Stem (4): 1.0 ~ 1.5 N·m
   Lock nut (3): 3.2 N·m



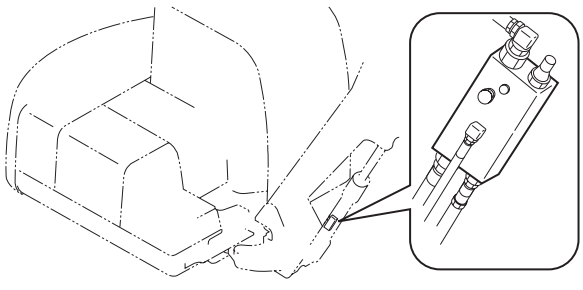
L3H606




L3H607

### Pilot Operated Hydraulic System (Boom and Arm Cylinder)

If the engine can be started, the boom or arm can be lowered with the operating lever. Check for safety, then slowly lower the boom or arm.
If the engine cannot be started, the boom or arm can be lowered using the procedure described below.



L3H608

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1. Check for safety in the working area and for stability of the machine and lifted load.

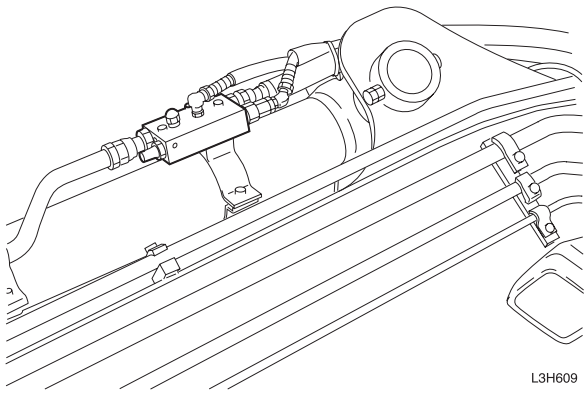
2. Remove the cap (2).

3. Loosen the lock nut (3).

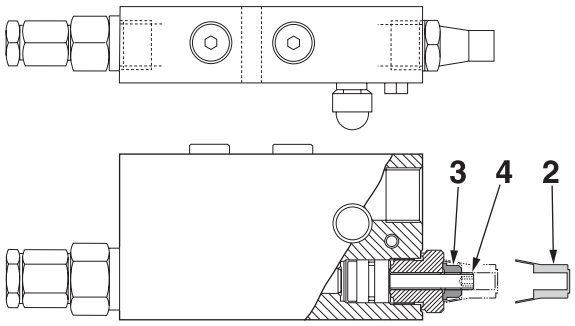
4. Tighten the stem (4) to lower the boom or arm.

5. Check for stability of the hoe attachment and load.

6. Loosen the stem (4) secure it with the lock nut (3).



L3H609



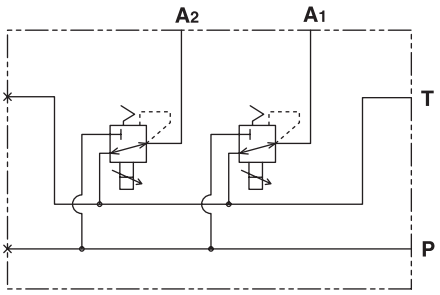

L3H610

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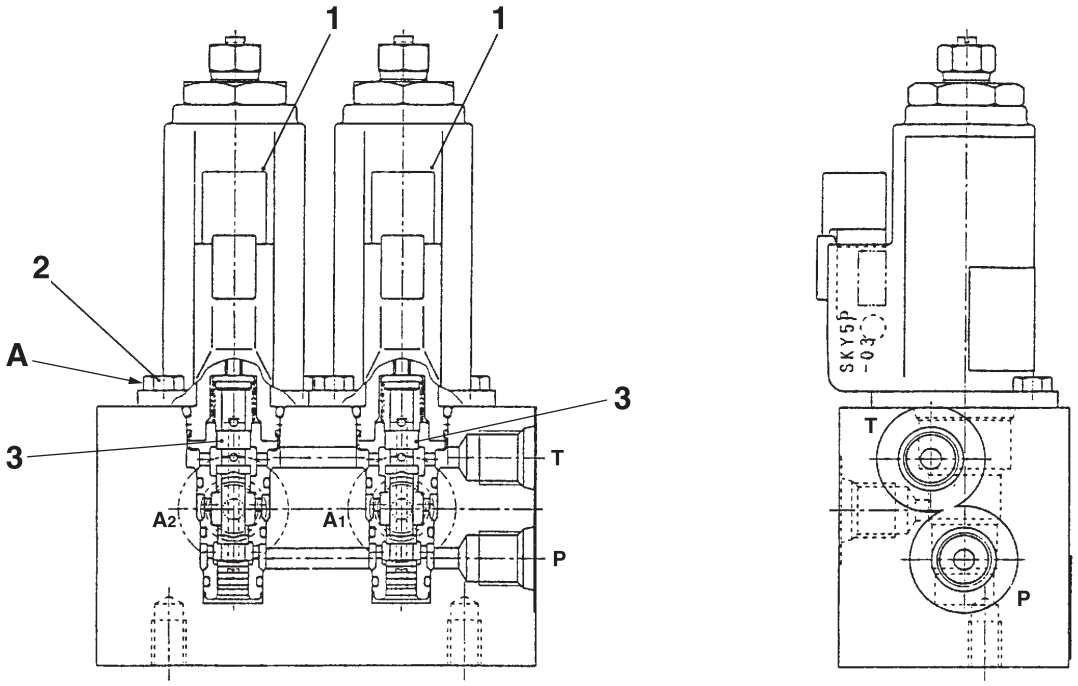


# PROPORTIONAL CONTROL SOLENOID VALVE (TB145)

## CONSTRUCTION




HYDRAULIC SYMBOL




T9H200E

A: 7 ±0.5 N·m

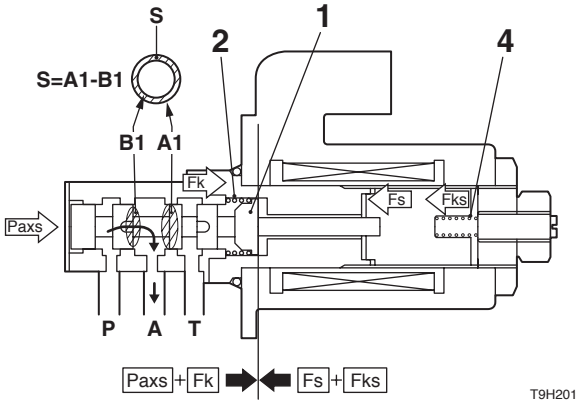
1. Proportional Control Solenoid
2. Bolt
3. Spool

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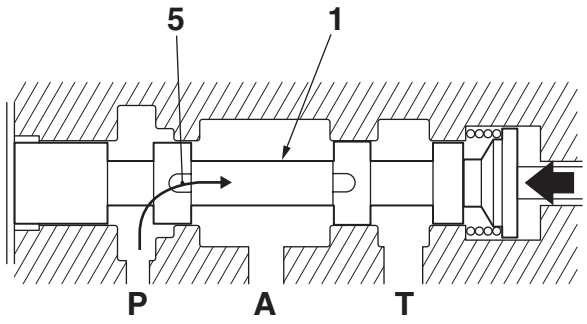


## OPERATION PRINCIPLE

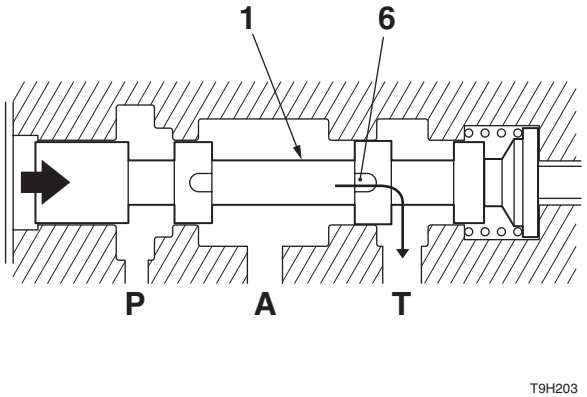
This valve controls the secondary pressure by using the built-in proportional pressure reducing valve. The secondary pressure of this valve is proportional to the magnitude of electric current flowing in the valve, because the force to generate the secondary pressure is applied by the solenoid based on the current passing through the coil.
When a current flows in the solenoid, a thrust force proportional to the current is generated and moves the spool (1) so that the oil supplied from Port P is led to the secondary pressure side Port A, thus increasing pressure Pa of Port A.
Pressure Pa is a function of the differential area S between the cross sections A1 and B1 of the spool (1), and the spool (1) is pushed to the solenoid side by the oil pressure Pa × S. The spool (1) stops at a position where the sum of the oil pressure Pa × S and the force Fk exerted by the springs (2) is balanced with the thrust force Fs generated by the solenoid. The weight Fks of the spring (4) for fine adjustment of the secondary pressure acts in the direction (left) to help the thrust force from the solenoid.




When the thrust force is larger than the set value, the spool (1) is moved to the left, connecting Port P (primary, supply side) and Port A (secondary, discharge side) through the notch (5).




When the thrust force is smaller than the set value, the spool (1) is moved to the right, connecting Port A (secondary, discharge side) and Port T (outlet to tank) through the notch (6).
Therefore, the opening areas of the supply side notch (5) and discharge side notch (6) are controlled by the movement of the spool (1), and secondary (pilot) pressure created by the thrust force generated by the solenoid can be provided.



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## DISASSEMBLY AND ASSEMBLY

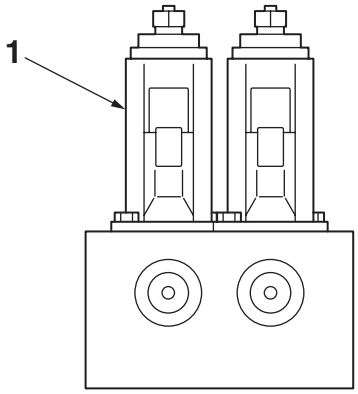
### General Cautions

- Carry out disassembly and assembly operations in a clean place and place disassembled parts in clean containers.
- Before disassembly, clean thoroughly around the ports and remove paint or thread lock, etc. from all joints with a wire brush.
- Clean disassembled parts with light oil or other cleaning oil.
- The spool and body are selectively fitted, so if one is found to be damaged, replace the valve assembly.
- Apply a thin coating of hydraulic oil to sliding surfaces and a thin coating of grease to seals when assembling them.
- Replace seals with new parts each time disassembly is done.

The following describes the disassembly procedure. For assembly, follow the disassembly procedure in the reverse order.

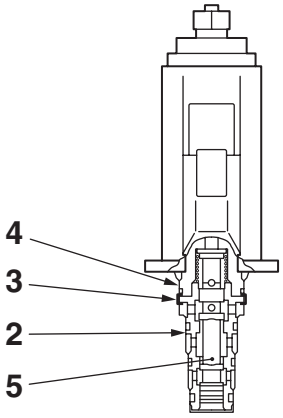
### Disassembly

1. Remove the bolts, and then remove the proportional control solenoid (1).
   Bolt: 6.9 ±1 N·m



T9H204

2. Remove the O-rings from the proportional control solenoid (1).
   - Do not disassemble the sleeve (2) that is swaged onto the solenoid (4) with the retaining ring (3).
   - Make sure that the spool (5) moves a little if pushed from the sleeve (2) end.



T9H205

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## INSPECTION AND ADJUSTMENT

### Checking the Parts

| Part | Judgment Criteria | Treatment |
|---|---|---|
| Coil assembly | • When the solenoid is burned, short-circuited, or has a wire break | • Replace |
| | • Wiring short-circuit or wire break | • Replace |
| Housing | • Scratches, rust, or corrosion at the sliding parts with the spool | • Replace |
| | • Scratches, rust, or corrosion of the seal part in contact with the O-ring | • Replace |
| | • Other damage considered to impair the normal functions | • Replace |
| Spool | • Damage on the outer circumference which catches a fingernail | • Replace |
| | • No smooth movement | • Adjust or replace |
| Spring | • Rust, corrosion, deformation, breakage, or other notable damage | • Replace |
| O-ring | —— | • Replace |

## TROUBLESHOOTING

| Symptom | Main Causes | Remedy |
|---|---|---|
| Solenoid valve does not operate | • Wiring short-circuit or wire break | • Replace |
| | • Coil assembly short-circuit or wire break | • Replace |
| | • Catching of foreign matter by the spool | • Overhaul and repair or replace |
| | • Damage on the outer circumference of the spool | • Overhaul and repair or replace |
| | • Defective the proportional controller | • Repair or replace |
| | • Primary pressure is insufficient | • Keep the primary pressure |
| Oil leakage from solenoid valve | • Damaged O-ring | • Replace |
| | • Damaged seal nut | • Replace |

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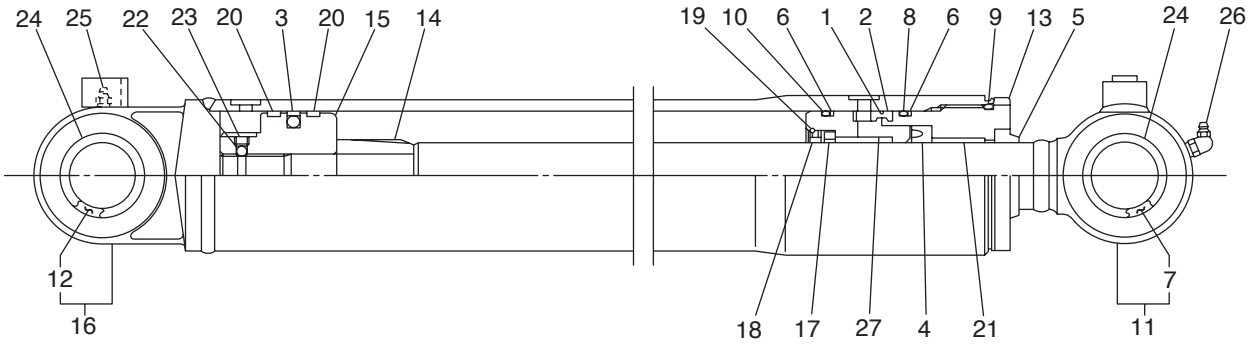


# CYLINDERS

## CONSTRUCTION

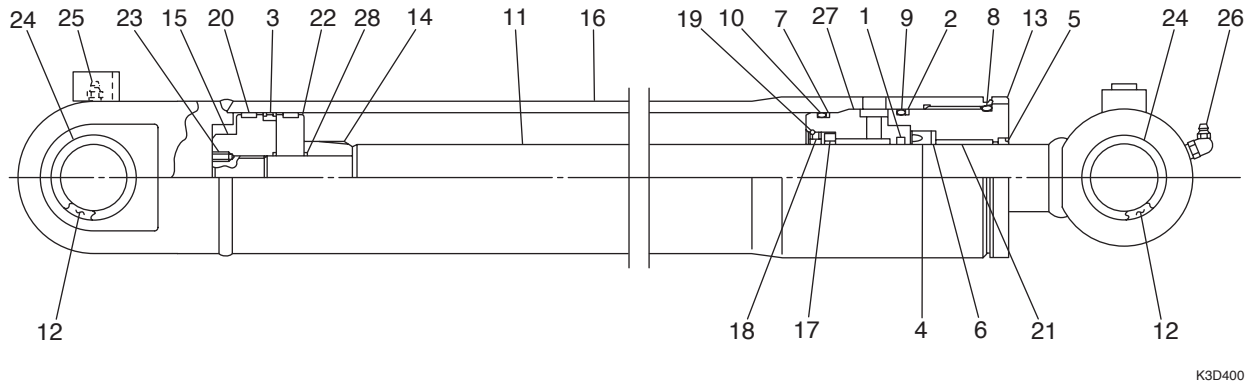
### Boom Cylinder

■ TB125, TB135




1. Stopper
2. Connector
3. Piston Packing
4. Rod Packing
5. Dust Seal
6. Backup Ring
7. Bushing
8. O-ring
9. O-ring
10. O-ring
11. Piston Rod
12. Bushing
13. Rod Cover
14. Cushion Bearing
15. Piston
16. Tube
17. Cushion Seal
18. Spacer
19. Stopper
20. Wear Ring
21. Bushing
22. Ball
23. Set Screw
24. Dust Seal
25. Grease Nipple
26. Grease Nipple
27. Retainer

■ TB145: S/N 14510004~14510788

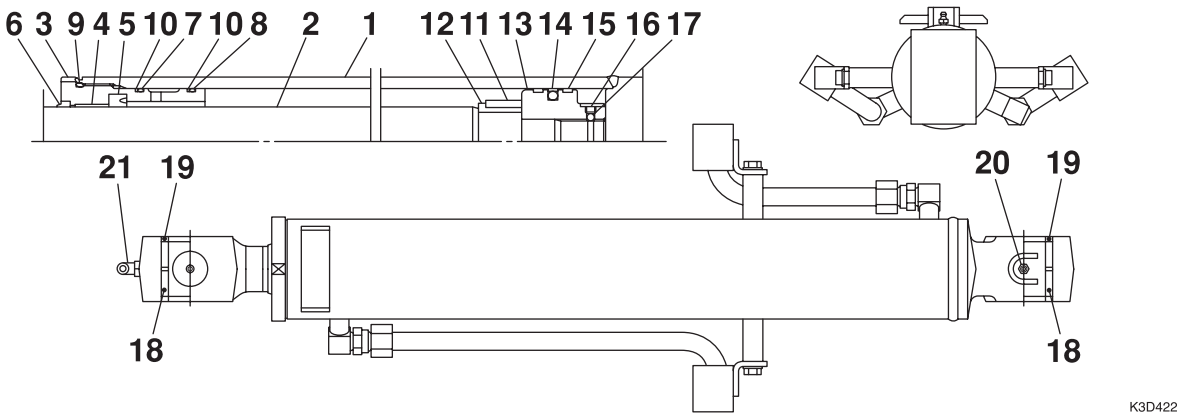



1. Ring
2. Backup Ring
3. Piston Packing
4. Rod Packing
5. Dust Seal
6. Backup Ring
7. Backup Ring
8. O-ring
9. O-ring
10. O-ring
11. Piston Rod
12. Bushing
13. Rod Cover
14. Cushion Bearing
15. Piston
16. Tube
17. Cushion Seal
18. Spacer
19. Stopper
20. Wear Ring
21. Bushing
22. Packing Holder
23. Set Screw
24. Dust Seal
25. Grease Nipple
26. Grease Nipple
27. Retainer
28. O-ring

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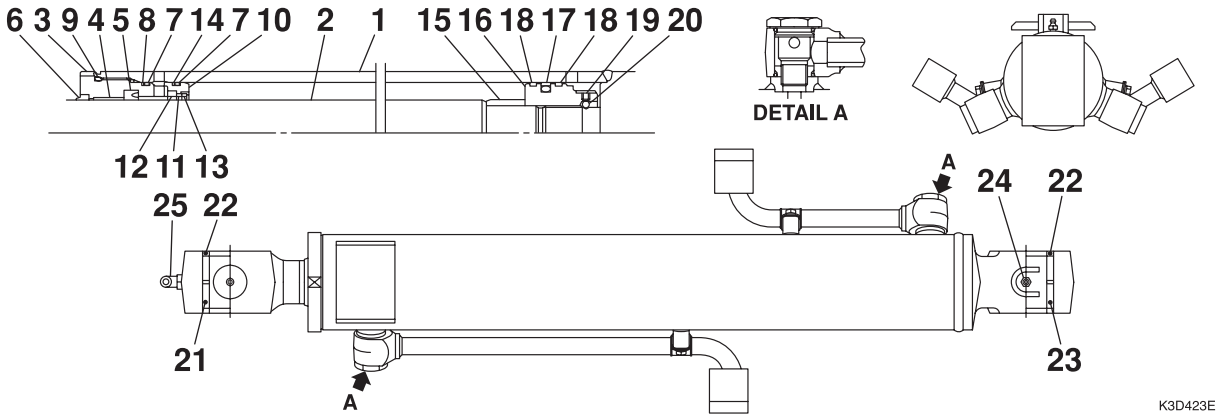


■ TB145: S/N 14510798~14511246




1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Dust Seal
7. O-ring
8. O-ring
9. O-ring
10. Backup Ring
11. Cushion Bearing
12. Spacer
13. Piston
14. Piston Packing
15. Wear Ring
16. Set Screw
17. Ball
18. Bushing
19. Dust Seal
20. Grease Nipple
21. Grease Nipple

■ TB145: S/N 14511247~



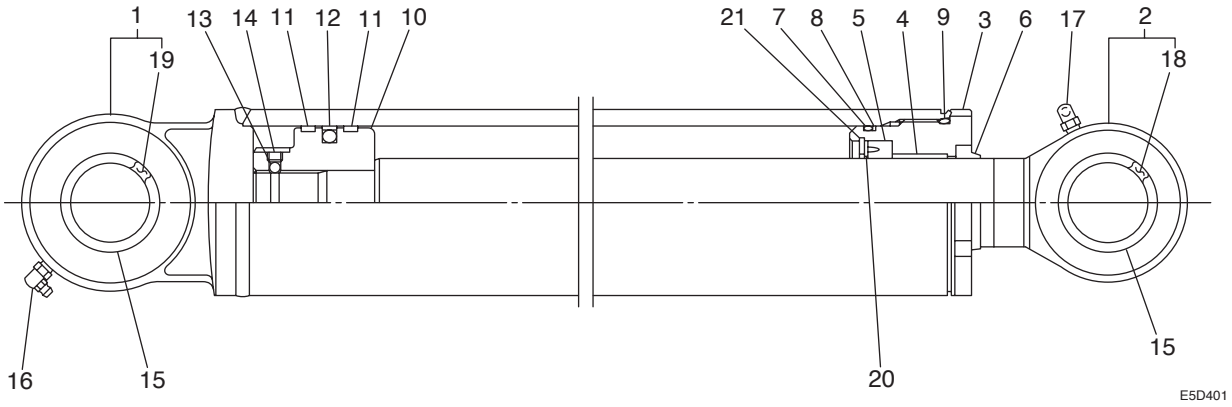

1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Dust Seal
7. O-ring
8. Backup Ring
9. O-ring
10. Holder
11. Cushion Ring
12. Collar
13. Spacer
14. Backup Ring
15. Cushion Bearing
16. Piston
17. Piston Packing
18. Wear Ring
19. Set Screw
20. Ball
21. Bushing
22. Dust Seal
23. Bushing
24. Grease Nipple
25. Grease Nipple

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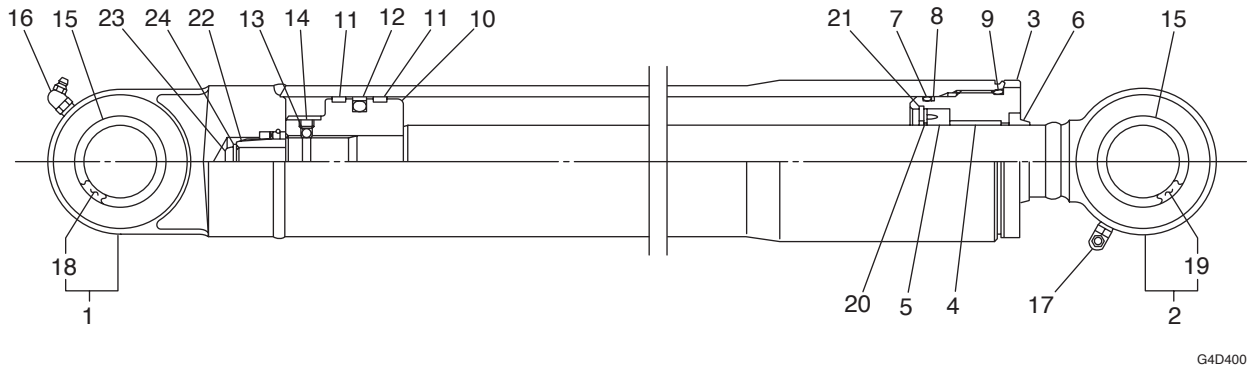
**Arm Cylinder**

■ TB125




1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Dust Seal
7. O-ring
8. Backup Ring
9. O-ring
10. Piston
11. Wear Ring
12. Piston Packing
13. Ball
14. Set Screw
15. Dust Seal
16. Grease Nipple
17. Grease Nipple
18. Bushing
19. Bushing
20. Packing Holder
21. Snap Ring

■ TB135

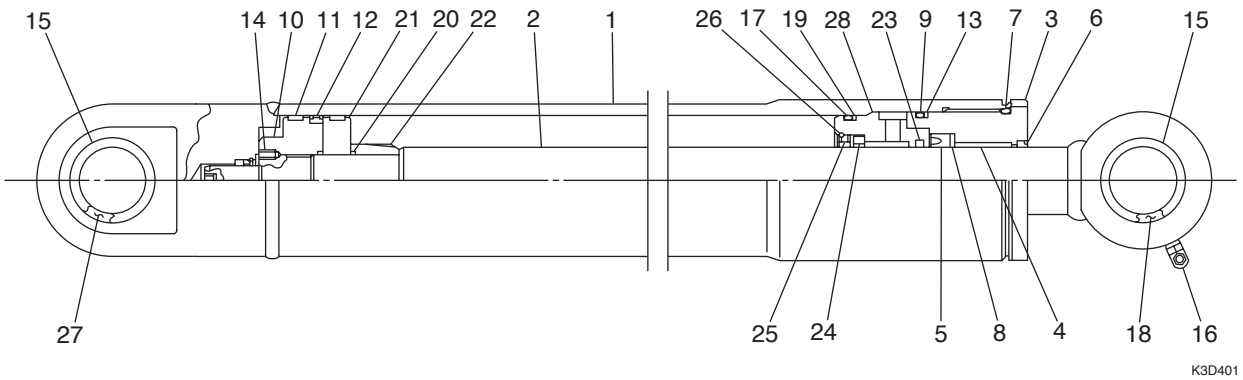



1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Dust Seal
7. O-ring
8. Backup Ring
9. O-ring
10. Piston
11. Wear Ring
12. Piston Packing
13. Ball
14. Set Screw
15. Dust Seal
16. Grease Nipple
17. Grease Nipple
18. Bushing
19. Bushing
20. Packing Holder
21. Snap Ring
22. Cushion Bearing
23. Bolt
24. Washer

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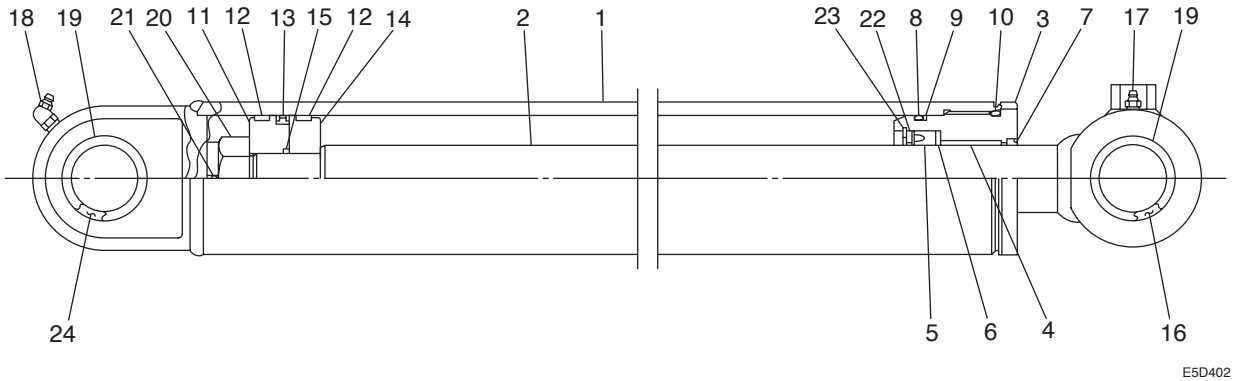
■ TB145




1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Dust Seal
7. O-ring
8. Backup Ring
9. O-ring
10. Piston
11. Wear Ring
12. Piston Packing
13. Backup Ring
14. Set Screw
15. Dust Seal
16. Grease Nipple
17. O-ring
18. Bushing
19. Backup Ring
20. O-ring
21. Packing Holder
22. Cushion Bearing
23. PG-ring
24. Cushion Seal
25. Spacer
26. Stopper
27. Bushing
28. Retainer

**Bucket Cylinder**

■ TB125

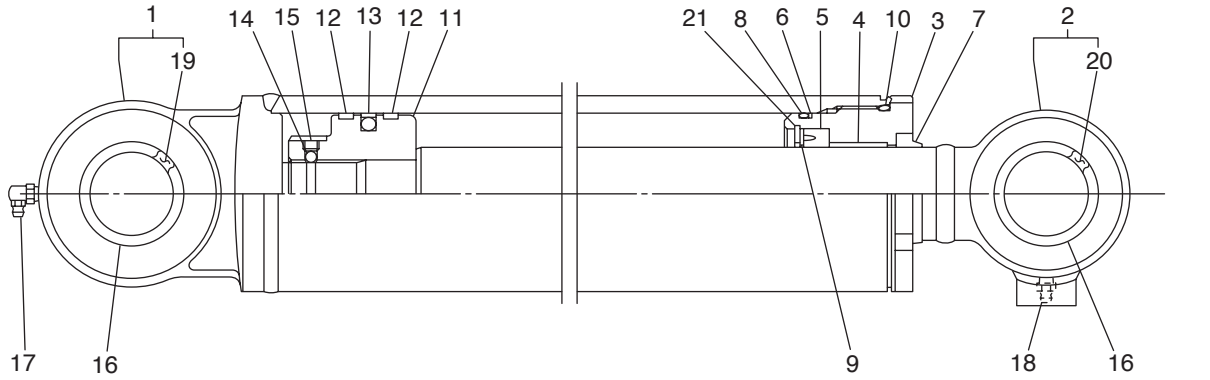



1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Backup Ring
7. Dust Seal
8. O-ring
9. Backup Ring
10. O-ring
11. Piston
12. Wear Ring
13. Piston Packing
14. Packing Holder
15. O-ring
16. Bushing
17. Grease Nipple
18. Grease Nipple
19. Dust Seal
20. Nut
21. Split Pin
22. Packing Holder
23. Snap Ring
24. Bushing

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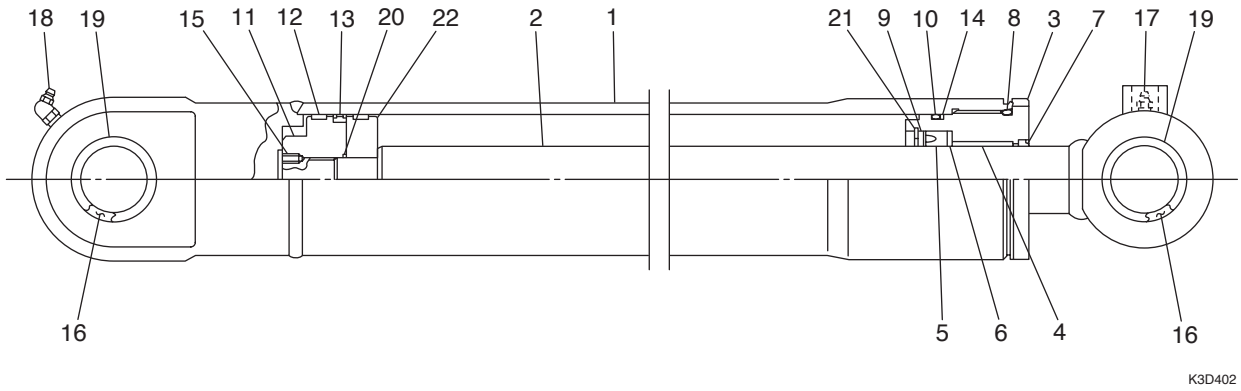


■ TB135




1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Backup Ring
7. Dust Seal
8. O-ring
9. Packing Holder
10. O-ring
11. Piston
12. Wear Ring
13. Piston Packing
14. Ball
15. Set Screw
16. Dust Seal
17. Grease Nipple
18. Grease Nipple
19. Bushing
20. Bushing
21. Snap Ring

■ TB145



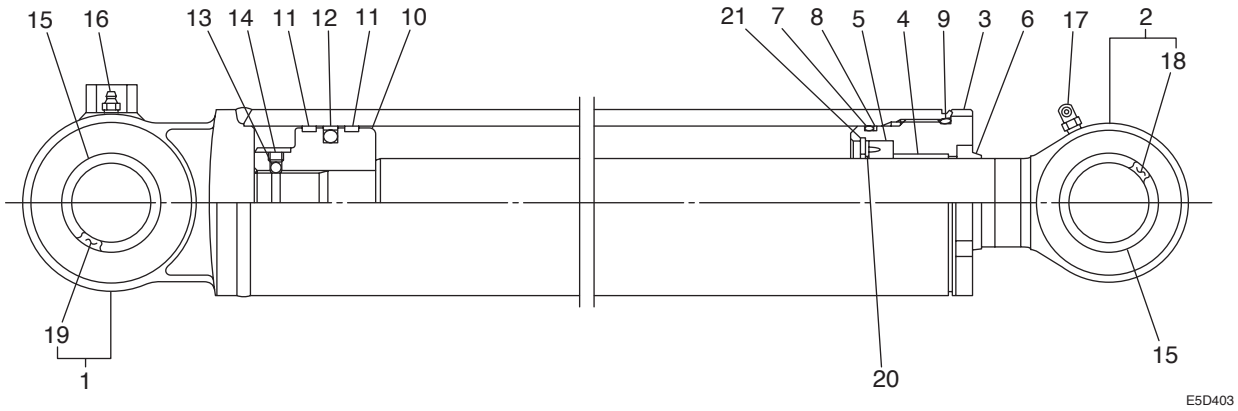

1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Backup Ring
7. Dust Seal
8. O-ring
9. Packing Holder
10. O-ring
11. Piston
12. Wear Ring
13. Piston Packing
14. Backup Ring
15. Set Screw
16. Bushing
17. Grease Nipple
18. Grease Nipple
19. Dust Seal
20. O-ring
21. Snap Ring
22. Packing Holder

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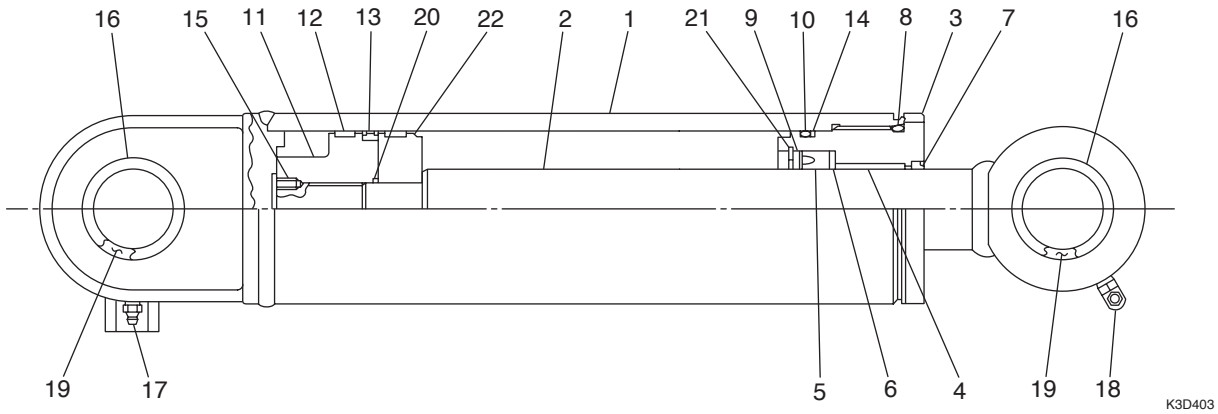
**Dozer Blade Cylinder**

■ TB125, TB135




1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Dust Seal
7. O-ring
8. Backup Ring
9. O-ring
10. Piston
11. Wear Ring
12. Piston Packing
13. Ball
14. Set Screw
15. Dust Seal
16. Grease Nipple
17. Grease Nipple
18. Bushing
19. Bushing
20. Packing Holder
21. Snap Ring

■ TB145



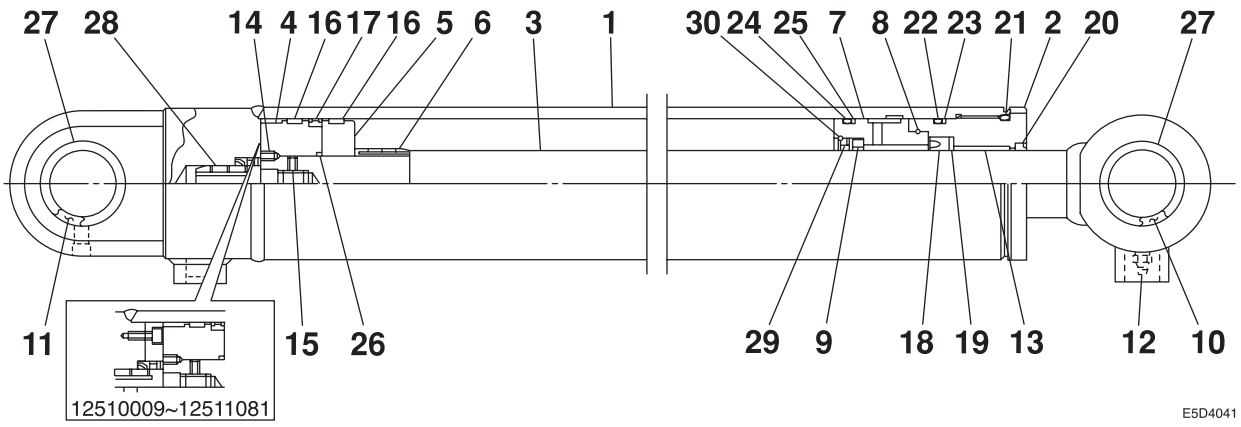

1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Backup Ring
7. Dust Seal
8. O-ring
9. Packing Holder
10. O-ring
11. Piston
12. Wear Ring
13. Piston Packing
14. Backup Ring
15. Set Screw
16. Dust Seal
17. Grease Nipple
18. Grease Nipple
19. Bushing
20. O-ring
21. Snap Ring
22. Packing Holder

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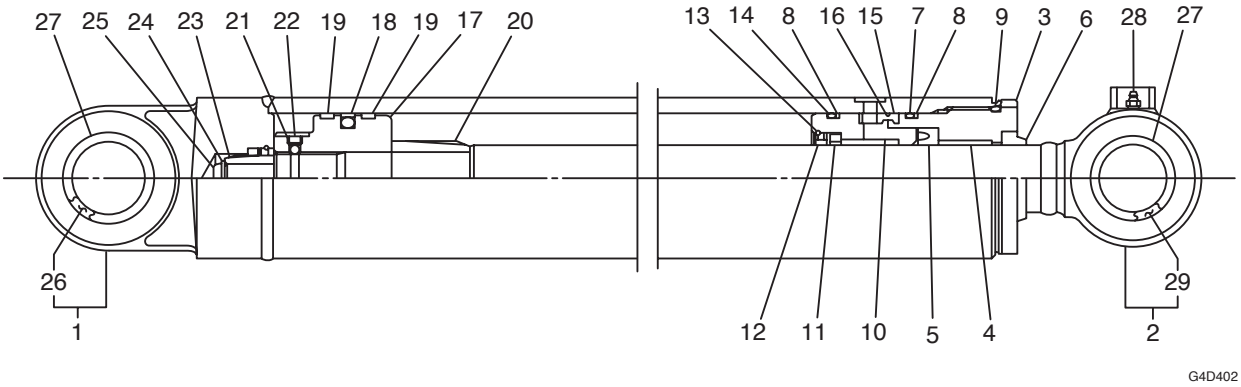
**Swing Cylinder**

■ TB125




1. Tube
2. Rod Cover
3. Piston Rod
4. Piston
5. Packing Holder
6. Cushion Bearing
7. Retainer
8. Ring
9. Cushion Seal
10. Bushing
11. Bushing
12. Grease Nipple
13. Bushing
14. Set Screw
15. Set Screw
16. Wear Ring
17. Piston Packing
18. Rod Packing
19. Backup Ring
20. Dust Seal
21. O-ring
22. O-ring
23. Backup Ring
24. O-ring
25. Backup Ring
26. O-ring
27. Dust Seal
28. Cushion Bearing
29. Cushion Seal
30. Stopper

■ TB135

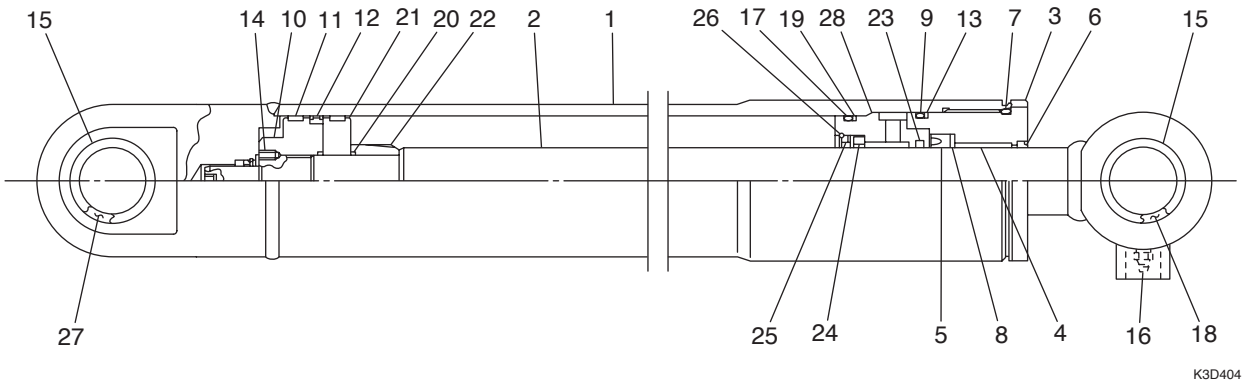



1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Dust Seal
7. O-ring
8. Backup Ring
9. O-ring
10. Retainer
11. Cushion Seal
12. Spacer
13. Stopper
14. O-ring
15. Connector
16. Stopper
17. Piston
18. Piston Packing
19. Wear Ring
20. Cushion Bearing
21. Ball
22. Set Screw
23. Cushion Bearing
24. Washer
25. Bolt
26. Bushing
27. Dust Seal
28. Grease Nipple
29. Bushing

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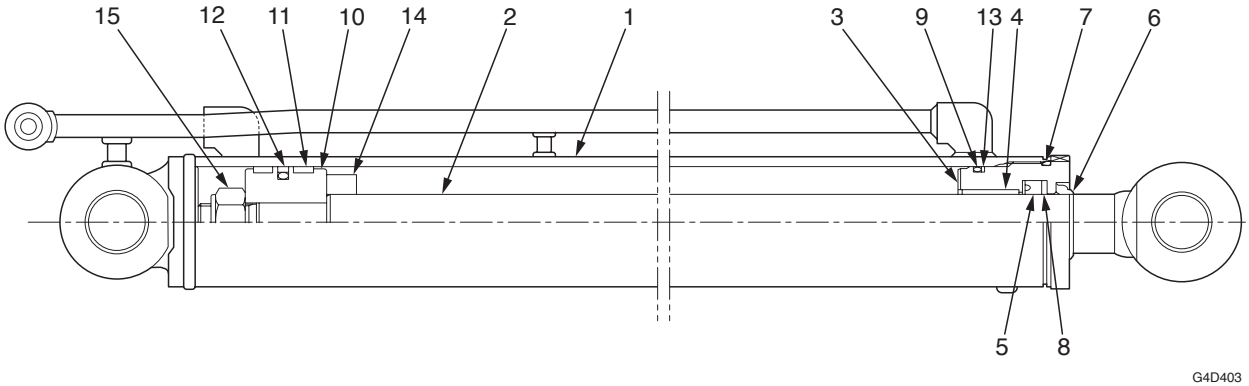
■ TB145




1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Dust Seal
7. O-ring
8. Backup Ring
9. O-ring
10. Piston
11. Wear Ring
12. Piston Packing
13. Backup Ring
14. Set Screw
15. Dust Seal
16. Grease Nipple
17. O-ring
18. Bushing
19. Backup Ring
20. O-ring
21. Packing Holder
22. Cushion Bearing
23. PG-ring
24. Cushion Seal
25. Spacer
26. Stopper
27. Bushing
28. Retainer

**Telescopic Arm Cylinder**

■ TB135

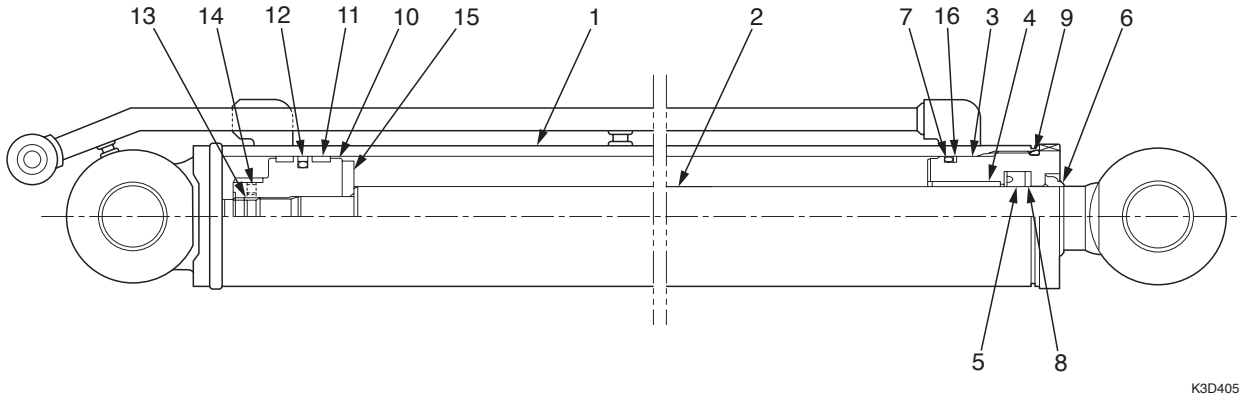



1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Dust Seal
7. O-ring
8. Backup Ring
9. O-ring
10. Piston
11. Wear Ring
12. Piston Packing
13. Backup Ring
14. Spacer
15. Nut

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■ TB145




1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Dust Seal
7. O-ring
8. Backup Ring
9. O-ring
10. Piston
11. Wear Ring
12. Piston Packing
13. Ball
14. Set Screw
15. Spacer
16. Backup Ring

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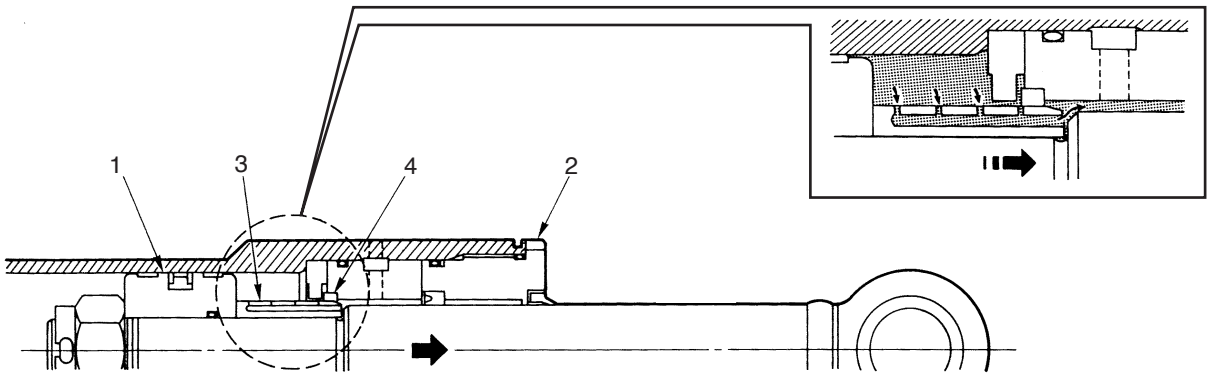
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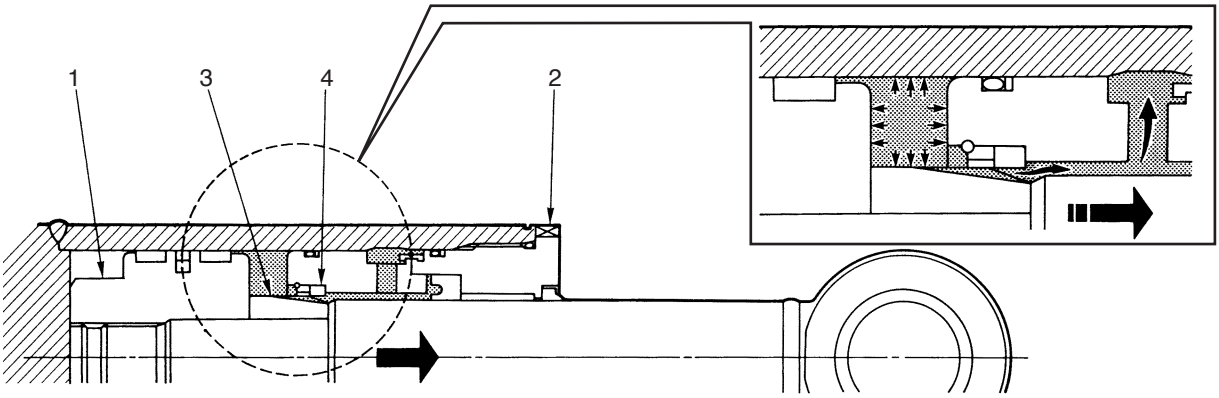
## OPERATION

Hydraulic oil flowing alternately in and out of the oil outlet and inlet on both sides (head and rod sides) of the piston acts on the piston and its force causes the piston to move back and forth.
In cylinders equipped with a cushion mechanism, the shock resulting from the piston colliding with the cover at the stroke end acts on that mechanism and is dampened by it.

### Cushion Mechanism




E5D405




E5D406

Before the piston (1) nears the stroke end and collides with the cover (2), the cushion bearing (3) which precedes it enters the cushion seal (4), shutting off the return passage for the hydraulic oil on the rear end of the piston and making it possible for oil to be expelled only along the groove provided in the cushion bearing (3). This causes the piston (1) back pressure to become high, slowing the speed of the piston.

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## DISASSEMBLY AND ASSEMBLY

### Special Tools
See the table of special tools at the back of this section for the jigs and tools used for disassembly and assembly.

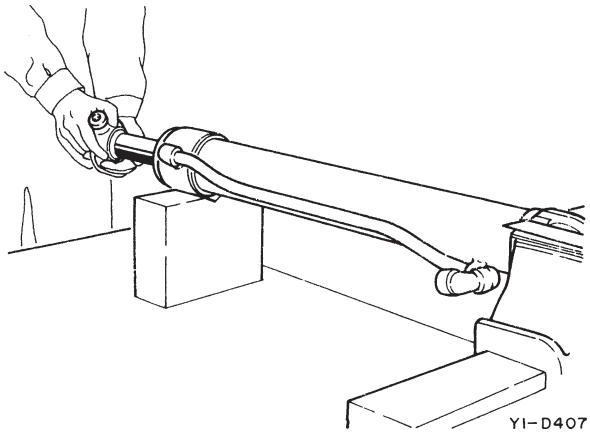
### General Cautions
- Carry out disassembly and assembly in a clean place and place the disassembled parts in a place where they will be kept clean at all times.
- Before disassembly, clean the outside surface of the cylinder thoroughly.
- In the disassembly and assembly operations, be careful not to scratch any part. Take particular caution with the sliding surfaces of parts.
- Clean all disassembled parts thoroughly with cleaning oil.
- Replace all seals with new parts.
- Apply a thin coating of hydraulic oil to seals before fitting them in place.
- After fitting, make sure the O-rings are not twisted.
- Apply clean hydraulic oil to each sliding portion before assembling them.

In this manual, the procedure for the boom cylinder is described. When necessary, the points which are different in other cylinders are mentioned.

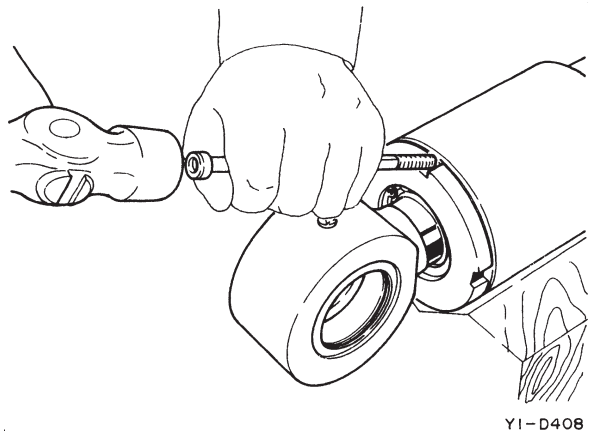
### Disassembly
Cylinder Assembly

1. Fasten the clevis of the tube in a vice and place the other end on a support black made of wood to fasten the cylinder in a horizontal condition.

2. Drain out hydraulic oil remaining in the cylinder.
   - Move the piston rod gently to prevent the hydraulic oil from spraying out and scattering all over.




3. Free the locked portion of the rod cover.
   - Since the lock is integrated with the cylinder tube, be careful not to bend it or to scratch it when the lock is being freed.

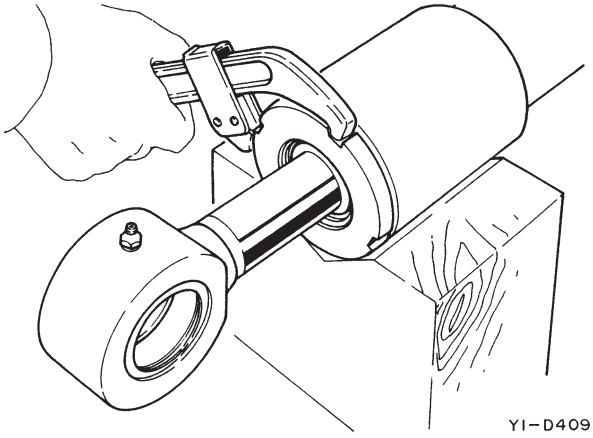


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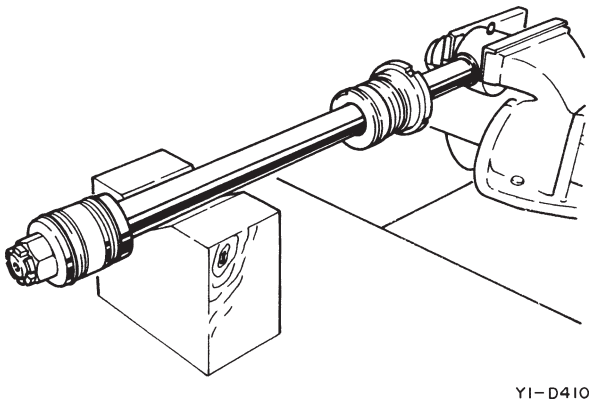
4. Loosen the rod cover.
   - The piston rod should be pulled out approximately 200 mm beforehand.
   - Measures should be taken to prevent the piston rod from being hit.

5. Take the piston rod assembly out of the tube.
   - Pull it out straight to prevent the sliding surface from being scratched.

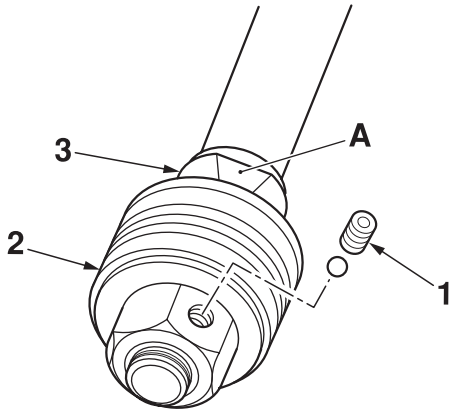


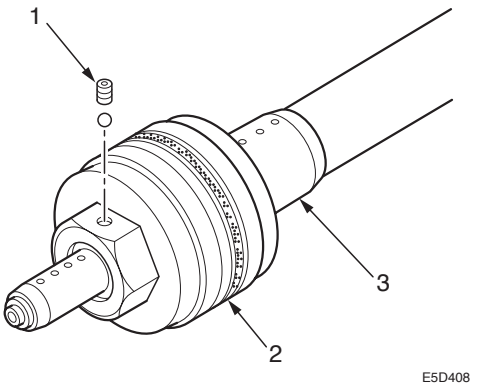

### Piston Rod Assembly

1. Fasten the piston rod assembly securely in a level position.




2. Remove the piston.
   a. Take out the set screw (1) and remove the ball.
      - The set screw is staked at 2 place with a punch, so grind off the staked portions using a hand drill.
   b. Remove the piston assembly (2).
   c. Remove the cushion bearing (3) and spacer.

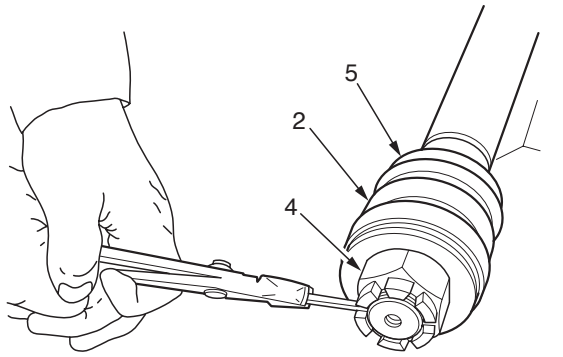


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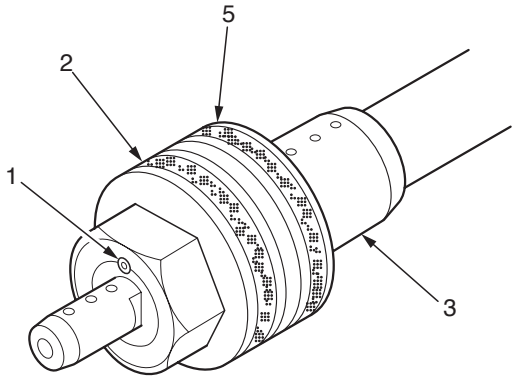


a. Take out the split pin and remove the nut (4).
b. Remove the piston assembly (2) and the packing holder (5), then remove the O-ring from the inner diameter of the piston assembly.

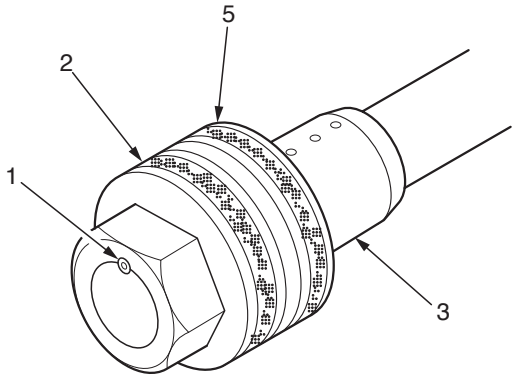



E5D409

a. Remove the set screw (1).
b. Remove the piston assembly (2) and the packing holder (5), then remove the O-ring from the inner diameter of the piston assembly.
c. Remove the cushion bearing (3). Furthermore, the head side cushion bearing should not be removed.

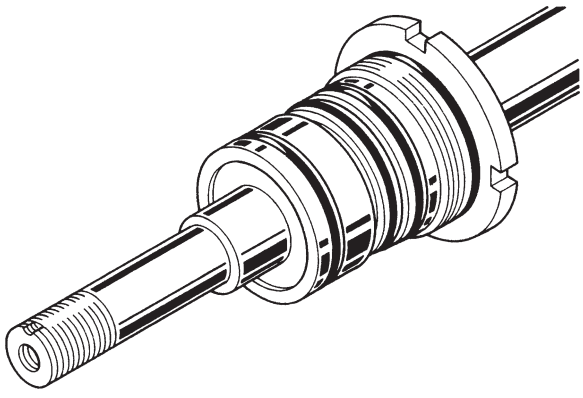



E5D410




E5D411

3. Remove the rod cover assembly.

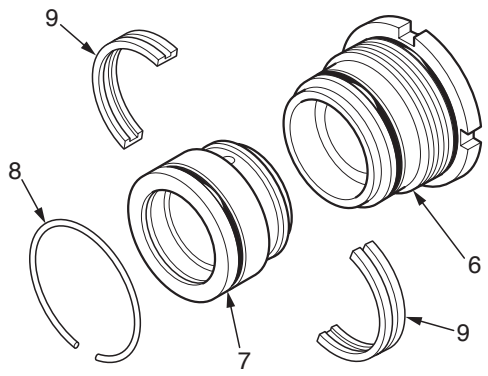


YI-D422

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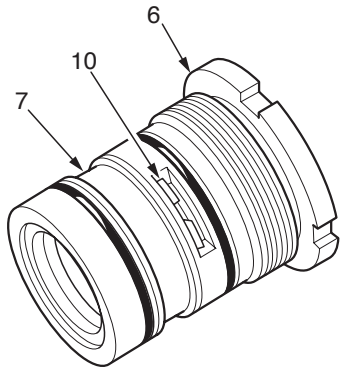


4. Separate the rod cover assembly (6) and retainer assembly (7).
   a. Remove the stopper (8) and separate the connector (9) into two to separate it from the rod cover assembly.



E5D412

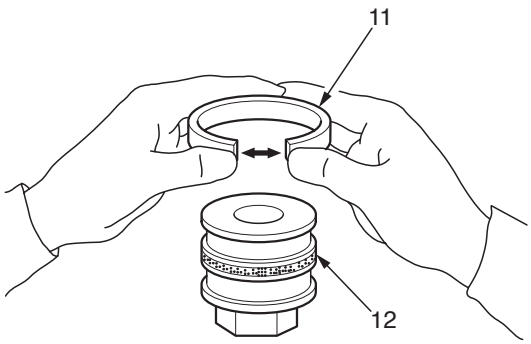
   a. Turn the retainer (7) until the bent part at the tip of the ring (10) can be seen in the notched part of the rod cover (6).
   b. Pull the tip of the ring (10) with pliers while turning the retainer (7) to pull the ring (10).



E5D413

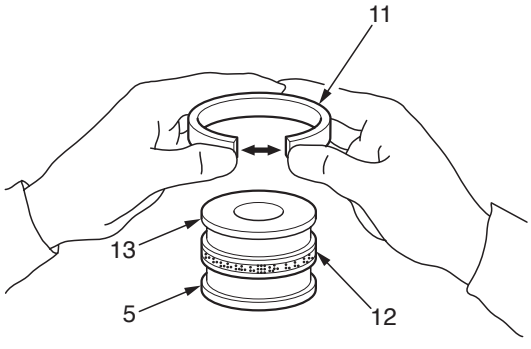
Piston

1. Remove the wear ring (11), then remove the piston packing (12).
   • Spread the wear ring at the cut portion the minimum amount necessary for it to be removed. Remove it in the direction of the shaft.
   • Either cut the piston packing off or use a flat bladed screwdriver, etc. to take it off.



E5D414

1. Remove the wear ring (11) from the piston (13) and the packing holder (5).
   • Spread the wear ring at the cut portion the minimum amount necessary for it to be removed, Remove it in the direction of the shaft.
2. Remove the piston packing (12).



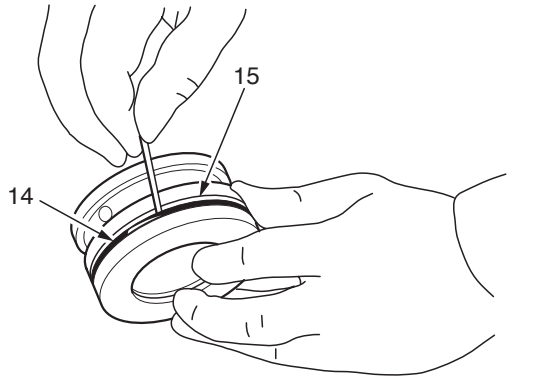
E5D415

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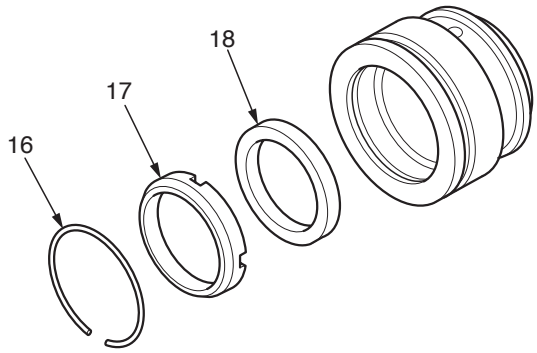
### Retainer Assembly

1. Remove the O-ring (14) and backup ring (15).



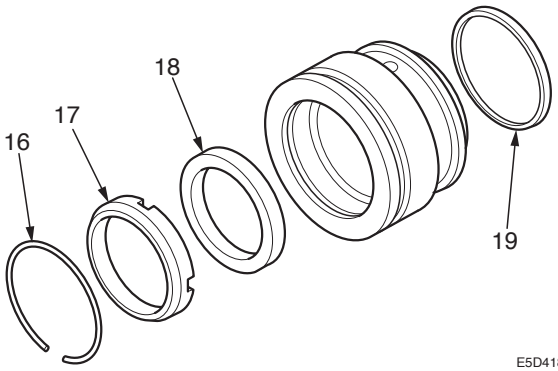

E5D416

2. Remove the stopper (16), spacer (17) and cushion seal (18).




E5D417

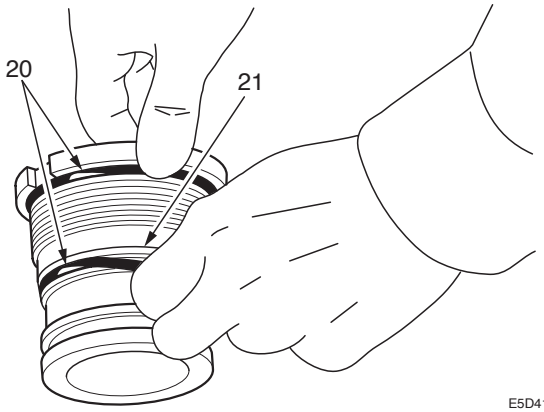
Remove the stopper (16), spacer (17), cushion seal (18) and ring (19).




E5D418

### Rod Cover

1. Remove the O-ring (20) from the outer diameter of the rod cover, then remove the backup ring (21).

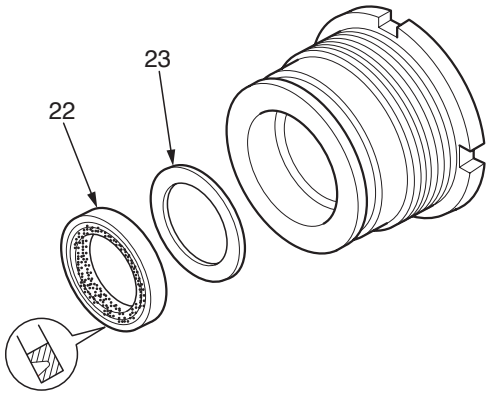



E5D419

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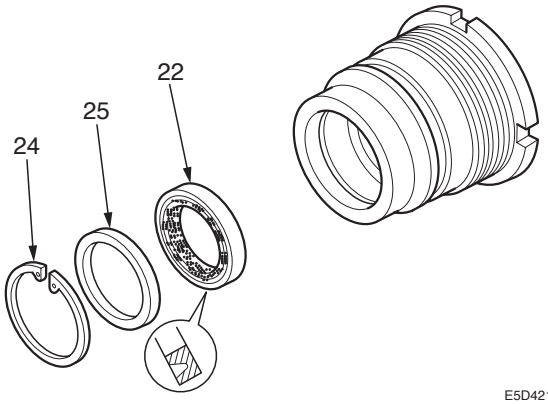


2. Remove the rod packing.
   a. Remove the rod packing (22).
   b. Remove the backup ring (23).



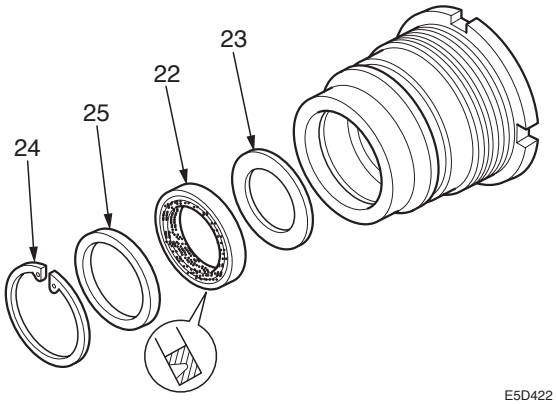
E5D420

   a. Remove the snap ring (24).
   b. Remove the packing holder (25).
   c. Remove the rod packing (22).



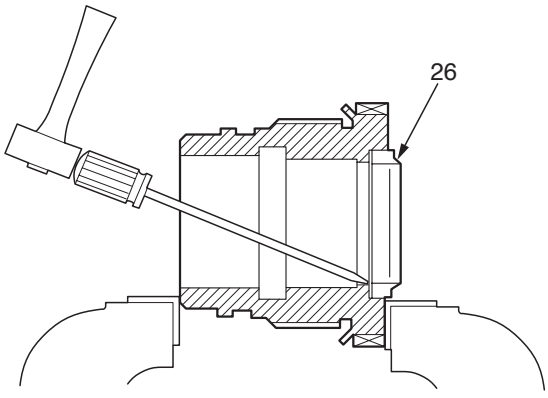
E5D421

   a. Remove the snap ring (24).
   b. Remove the packing holder (25).
   c. Remove the rod packing (22).
   d. Remove the backup ring (23).



E5D422

3. Remove the dust seal (26).
   • Tap alternately on several points around the circumference on the inside of the metal rig, pushing it out a little at a time to remove it.

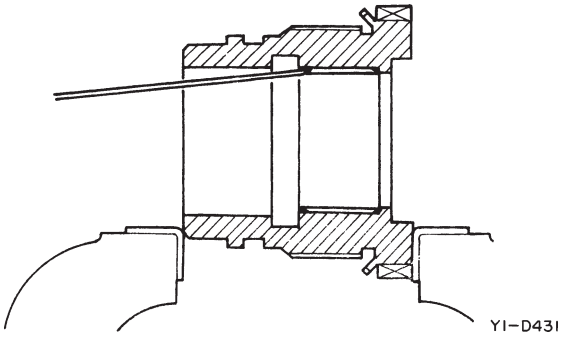


E5D423

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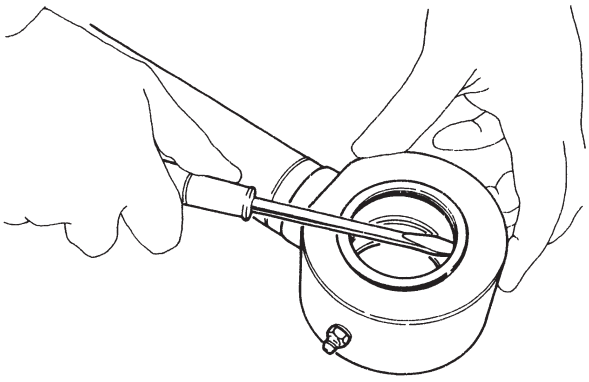


4. Remove the bushing.
   - Since the bushing has been pressure fitted tightly in the rod cover, it is impossible to take it out. First use a lathe to grind down the inside portion until only a thin piece remains, then insert a copper spatula strongly and pry it out to remove it.

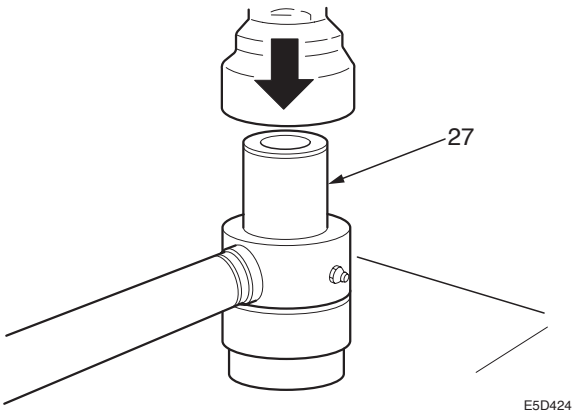



### Clevis

1. Remove the dust seals from the tube and piston rod.




2. Remove the bushings using a setting tool (27).



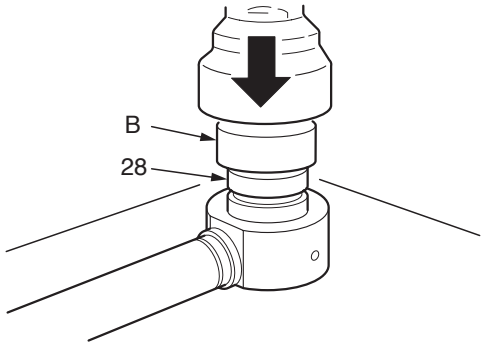
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**Assembly**

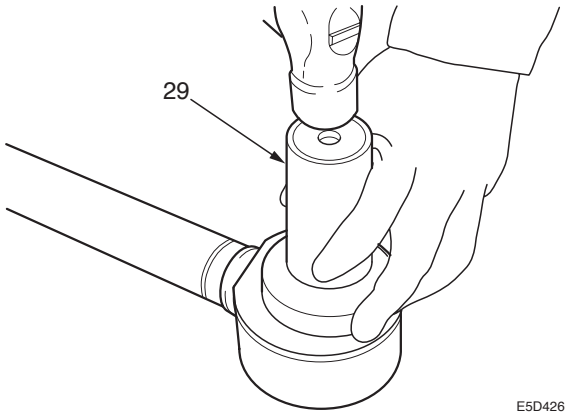
Clevis

1. Using installation jig (B), pressure fit the bushings (28) in the piston rod and tube.




E5D425

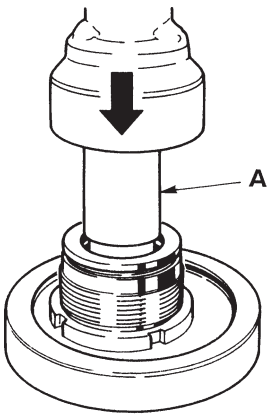
2. Using a setting tool (29), install the dust seals.




E5D426

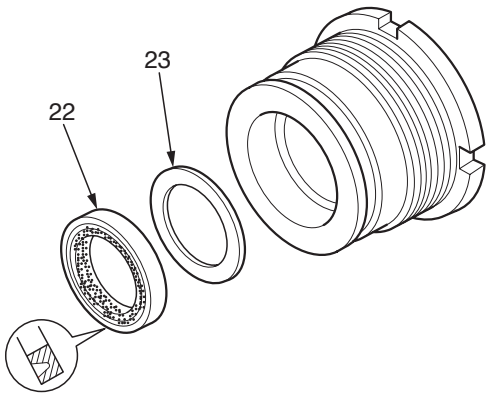
Rod Cover

1. Using an installation jig (A), pressure fit the bushing.
   - Hydraulic fluid should be applied to the inside surface of the rod cover before assembly.
   - After installation, make sure there are no level differences with the bushing.




YI-D436

2. Install the rod packing.
   a. Install the backup ring (23).
   b. Install the rod packing (22).
      - Pay attention to the installation direction.

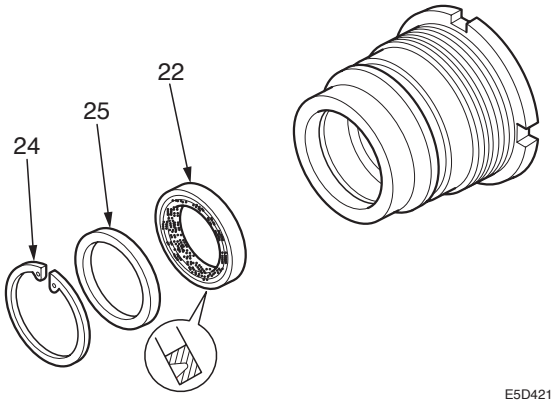



E5D420

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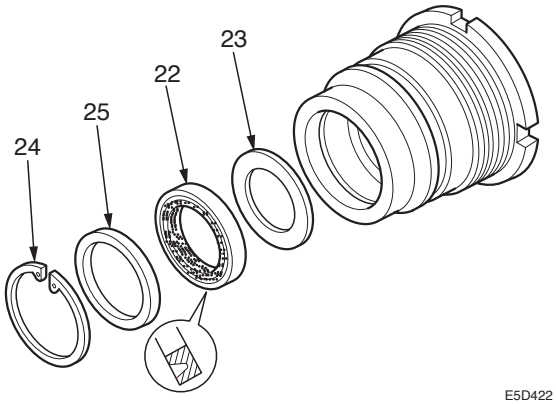


a. Install the rod packing (22), being careful of its installation direction.
b. Install the packing holder (25).
c. Install the snap ring (24).



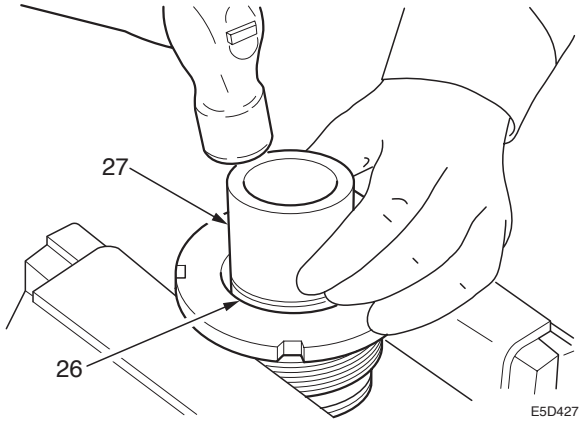
E5D421

a. Install the backup ring (23).
b. Install the rod packing (22), being careful of its installation direction.
c. Install the packing holder (25).
d. Install the snap ring (24).



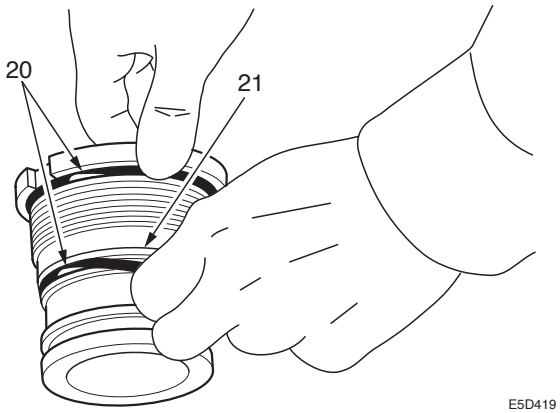
E5D422

3. Install the dust seal (26).
   • In the case of a dust seal with a metal ring around the outer circumference, use a setting tool (27) to install it.



E5D427

4. Install the backup ring (21) and fit the O-ring (20).
   • The cut portions of the backup ring should overlap correctly.



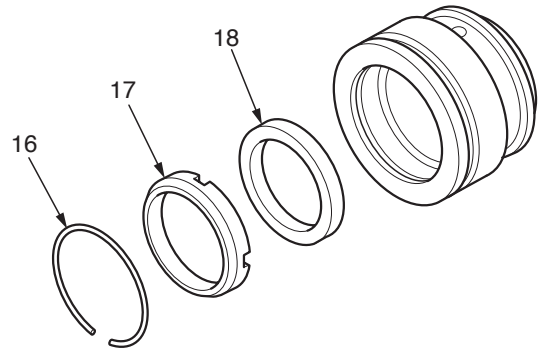
E5D419

https://truckmanualshub.com/



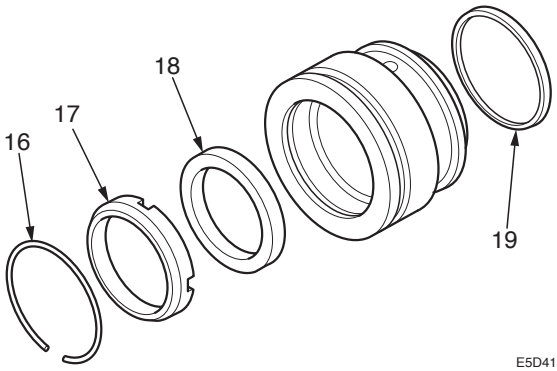
### Retainer

1. Install the cushion seal (18), the spacer (17), and the stopper (16) on the retainer.



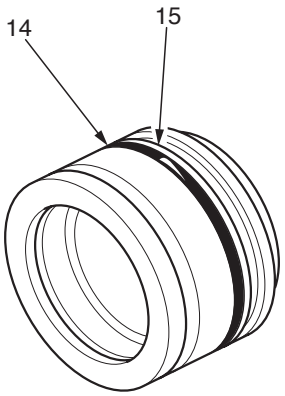

E5D417

Install the ring (19), the cushion seal (18), the spacer (17), and the stopper (16) on the retainer.




E5D418

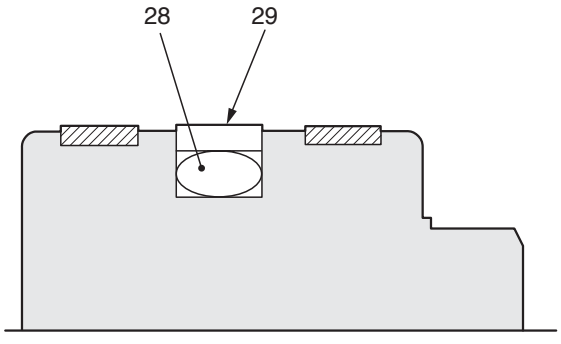
2. Install the O-ring (14) and the backup ring (15) on the outer circumference of the retainer.




E5D428

### Piston (in one piece)

1. Assemble the piston assembly.
   a. Fit the O-ring (28).
      • If the O-ring is twisted after it is fitted, correct it.

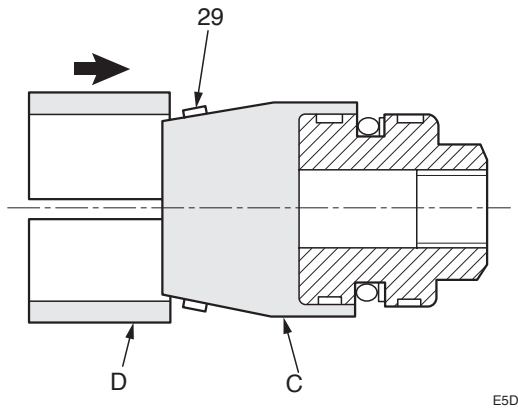



E5D429

https://truckmanualshub.com/

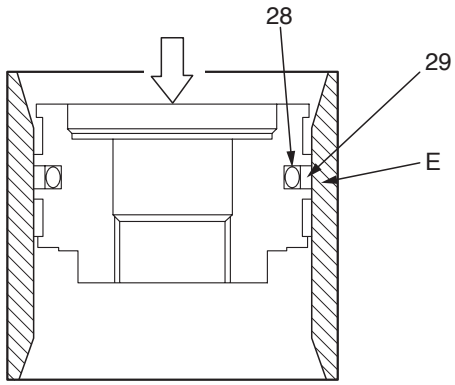


b. Cover the piston with the sliding jig (C), then using the fitting jig (D), insert the slipper ring (29) rapidly.



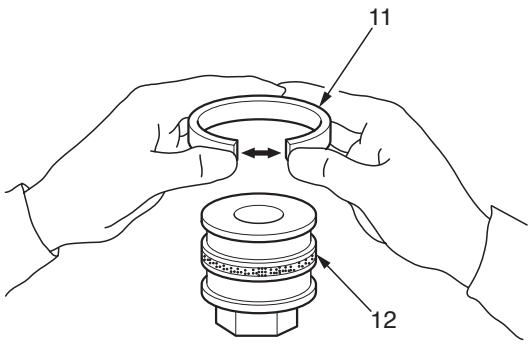
E5D430

c. Since the slipper ring (29) is extended when it is installed, correct it using the corrective jig (E).



E5D431

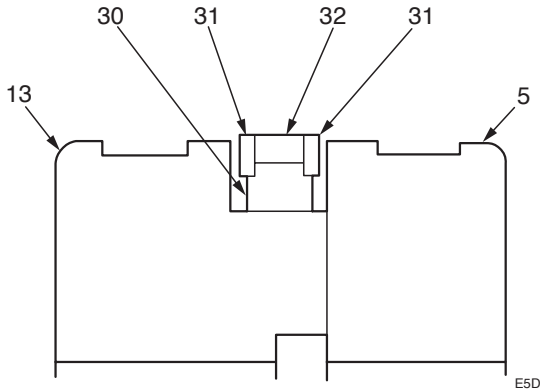
2. Install the wear ring (11).
   a. Spread the wear ring (11) at the cut portion the minimumu amount necessary, installing it on the piston from the shaft direction.



E5D414

Piston (in two pieces)

1. Install the back ring (30), the backup ring (31), and the slipper ring (32) on the piston (13).

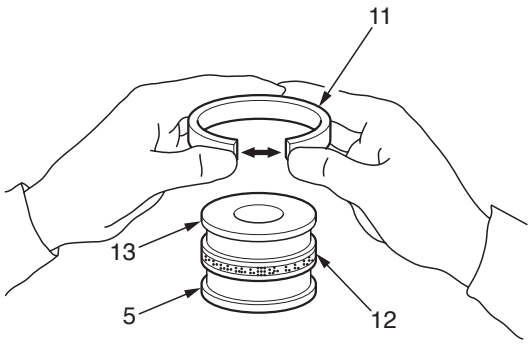


E5D432

https://truckmanualshub.com/



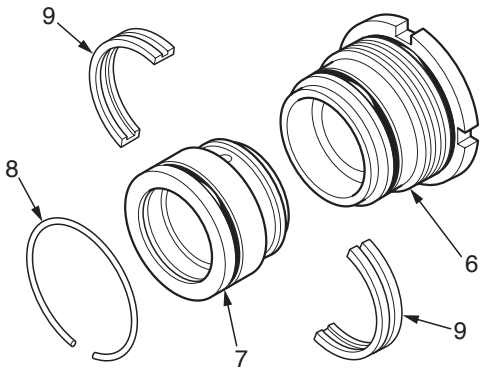
2. Install the wear ring (11) on the piston (13) and the packing holder (5).
   - Widen the cut part of the wear ring (11) only as far as required, and install it from the axial direction on the piston.




E5D415

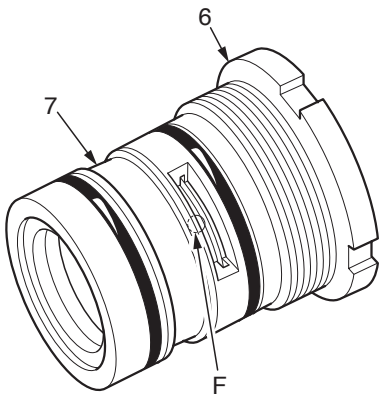
### Piston Rod Assembly

1. Assemble the rod cover assembly (6) and retainer assembly (7).
   a. Combine the retainer assembly (7) and rod cover (6), fit the divided connector (9) around both sides, then fasten it with the stopper (8).
   b. Assemble the retainer assembly (7) with reference to the item.
   ☞ "IV-111"



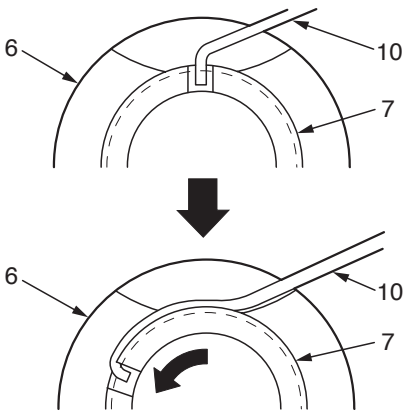

E5D412

   a. Insert the retainer (7) so into the rod cover (6) that the hole (F) of the retainer comes to the notched position of the rod cover (6).




E5D433

   b. Fix the rod cover (6), push the bending part of the ring (10) into the hole (F) of the retainer (7), and turn the retainer (7) to pull in the ring (10).
      - Take care that the bending part of the ring (10) does not come out of the catching hole of the retainer (7).

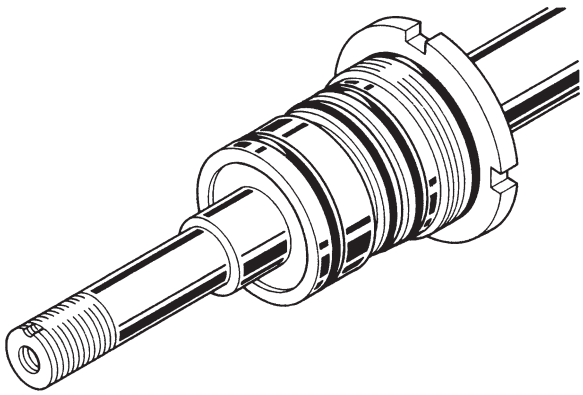



E5D434

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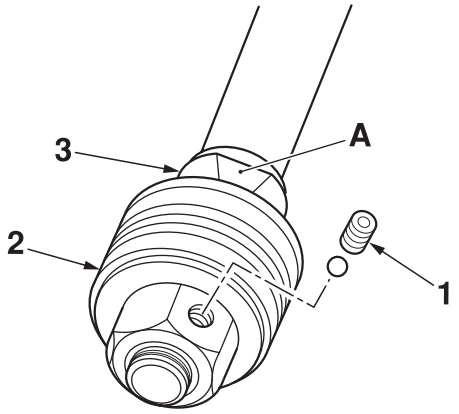


2. Install the rod cover assembly assembled in the above step (1) on the piston rod.

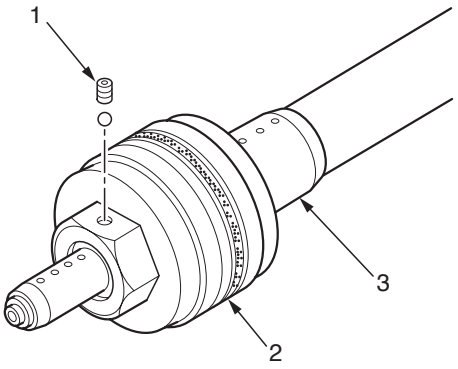


YI-D422

3. Install the piston unit.
   a. Install the spacer and cushion bearing (3).
      • Be sure to set with the flat side (A) of the cushion bearing in the proper direction.
      • Piston tightening torque: Refer to the table on the next page.
   b. Insert the ball, tighten the set screw (1) and stake at 2 points with a punch.
      • Set screw tightening torque: Refer to the table on the next page.

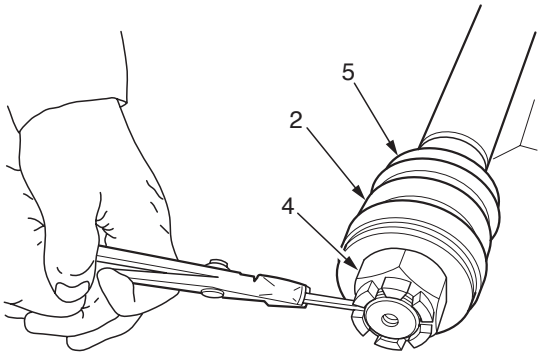



E5D4071




E5D408

   a. Install the packing holder (5) on the piston rod.
   b. Install the O-ring and the piston (2) on the piston rod.
   c. Tighten the nut (4) and fix it with the split pin.
      • Nut tightening torque: Refer to the table on the next page.

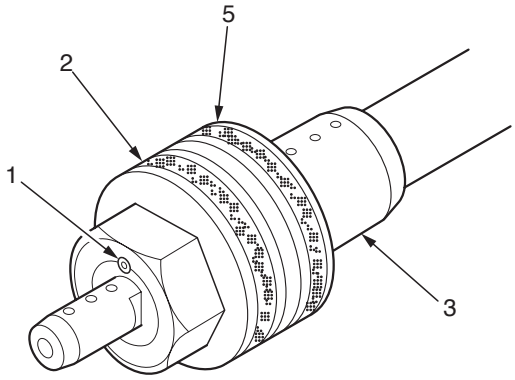



E5D409

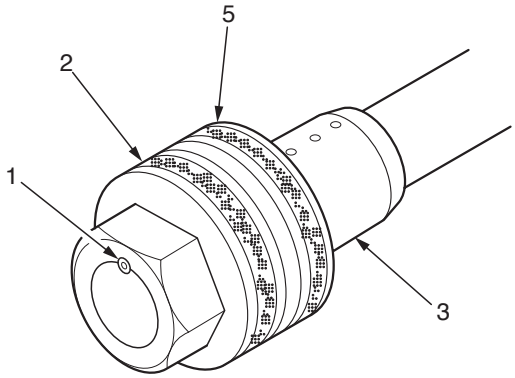
https://truckmanualshub.com/



a. Install the cushion bearing (3) and the packing holder (5) on the piston rod.
b. Install the O-ring and the piston (2) on the piston rod, and then tighten the piston (2).
   • Piston tightening torque: Refer to the table below.
c. Lock with the set screw (1).



E5D410



E5D411

• Tightening torques

| Model | TB125 | | TB135 | | TB145 | |
|---|---|---|---|---|---|---|
| Place Tightened | Piston | Set Screw | Piston | Set Screw | Piston | Set Screw |
| | N·m | N·m | N·m | N·m | N·m | N·m |
| Boom | 686 | 6.8 | 980 | 6.8 | 2020 (1363*, 1370**) | 31.5 (15.6*, 16.2**) |
| Arm | 686 | 6.8 | 882 | 6.8 | 1059 | 15.6 |
| Bucket | 235~265 | — | 588 | 6.8 | 824 | 15.6 |
| Dozer Blade | 954 (980***) | 16.2 (6.8***) | 1470 | 16.6 | 1638 | 15.6 |
| Swing | 314 | 6.8 | 882 | 6.8 | 1059 | 15.6 |
| Telescopic Arm | — | — | 558 | — | 686 | 9.8 |
| Bucket (for Telescopic Arm) | — | — | 539 | 6.8 | — | — |

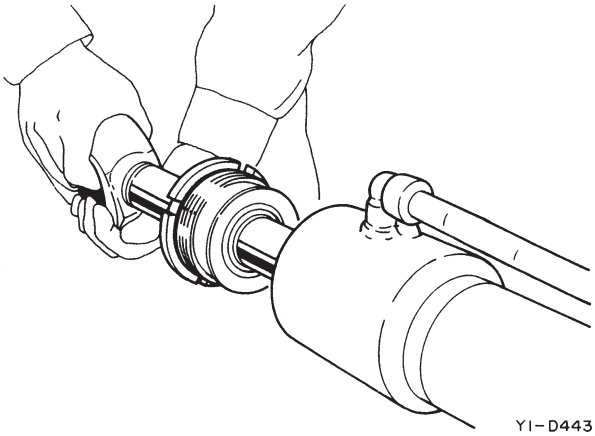
*: 14510004~14510788
**: 14510789~14511246
***: 12510009~12514525

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### Cylinder Assembly

1. Fasten the tube in a horizontal position, then insert the piston rod assembly in the tube.
   - During insertion, align the center of the piston rod with the center of the tube, inserting it straight so the seals will not be scratched.

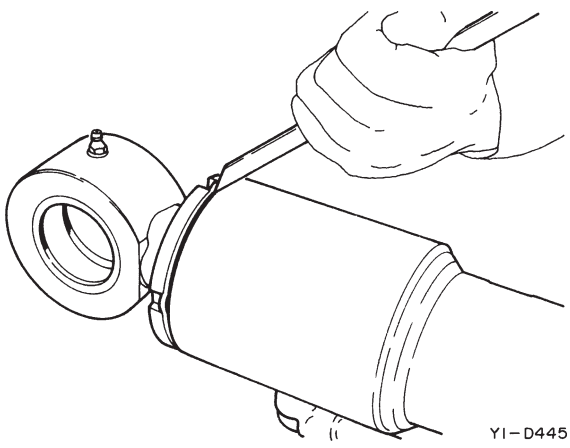



2. Tighten the rod cover.
   - Rod cover tightening torque

| Model | TB125 | TB135 | TB145 |
|---|---|---|---|
| Unit | N·m | N·m | N·m |
| Boom | 324 | 343 | 647 (735*) |
| Arm | 304 | 333 | 588 |
| Bucket | 402 | 304 | 539 |
| Dozer Blade | 490 (343**) | 392 | 853 |
| Swing | 235 | 333 | 588 |
| Telescopic Arm | — | 304 | 304 |
| Bucket (for Telescopic Arm) | — | 294 | — |

*: 14510004~14510788
**: 12510009~12514525

3. Bend the lock rib on the tube down in a notch of the rod cover to lock it.



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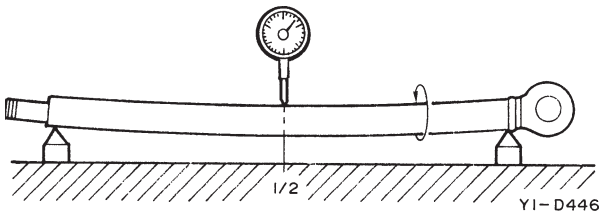
## INSPECTION AND ADJUSTMENT

### Inspection after Disassembly

Clean each part thoroughly with cleaning oil, then carry out the following checks. When a cylinder has been disassembled, replace all the seals with new ones.

1. Piston Rod
   - Replace the rod if there are cracks.
   - If the threads are damaged, repair them or replace it.
   - If the plating layer of the plated portion is broken, rusted or scratched, replace it.
   - If the rod is bent more than the limit of 1 mm in 1 m, replace it. (Measure by the method shown in the figure at right.
     If the bending of the rod is within the above limit, yet is bent a lot in a small distance so that it won't move smoothly, replace the rod if it makes a squeaking sound in the operation test after reassembly or if it catches during movement.
   - If the inner diameter of the clevis bushing is worn, replace the bushing.

Measuring the Bend




a. Support the portion of the rod with the same diameter at both ends on V-blocks.
b. Set a dial gauge at the center between the two blocks.
c. Rotate the rod and take a reading of the maximum and minimum runout indicated by the dial gauge.

2. Tube
   - If there are cracks in the welded portion, replace it.
   - Replace the tube if the inside surface is scratched or if it leaks hydraulic oil.
   - If the inner diameter of the clevis bushing is worn, replace the bushing.

3. Rod Cover
   - If the bushing inner diameter is worn and the clearance with the piston rod is greater than 0.25 mm, replace the bushing.
   - If the inside surface of the bushing is scratched, and the scratches are deeper than the depth of the coating layer, replace the bushing.

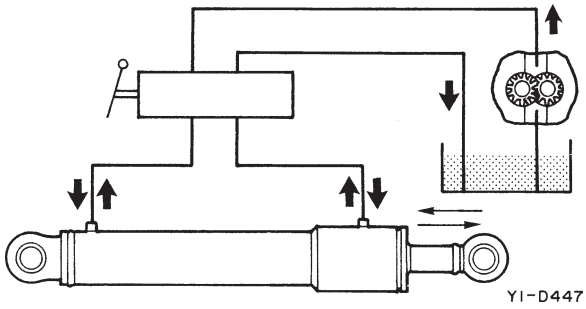
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### Inspection after Assembly

No Load Operation Test

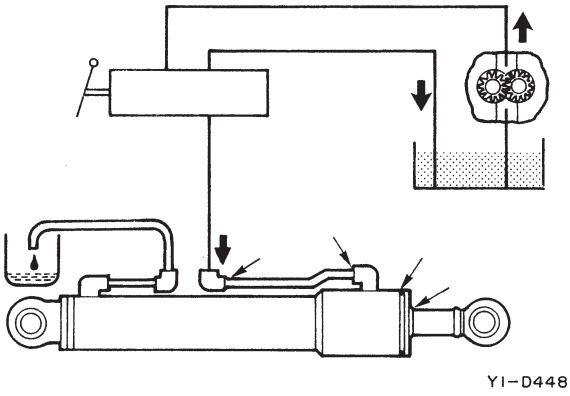
1. Place the cylinder in a horizontal position with no load.
2. Apply gentle pressure alternately to the ports at both ends, operating the piston rod 5 or 6 times.
3. Make sure there is no abnormality in the operating condition.




Leak Test

External Leakage

1. Apply test pressure for 3 minutes each to the retraction side and the extension side.
2. Make sure there are no abnormalities such as external leakage or permanent deformation, etc. in the rod seal, the rod cover mount, or in any welded portion.




Internal Leakage

1. Disconnect the extension side hose.
2. Apply test pressure to the retraction side for 3 minutes.
3. Measure the amount of oil that has leaked from the extension side.
   - The amount of leakage should be 1 $cm^3$ / 3min or less.

### Bleeding Air from the Hydraulic Cylinder

Bleed the air out of the cylinder when the cylinder is removed or when the hydraulic piping, etc. is disconnected.

1. Start the engine and let it idle for approximately 5 minutes.
2. With the engine running at slow speed, extend and retract the cylinder 4 or 5 times.
   - Move the piston rod to a position 100 mm before the end of the stroke, being careful not to apply any relief at all.
3. With the engine at top speed, repeat the operation in (2), then with the engine running at slow speed, move the piston rod to the stroke end and apply relief.

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## TROUBLESHOOTING

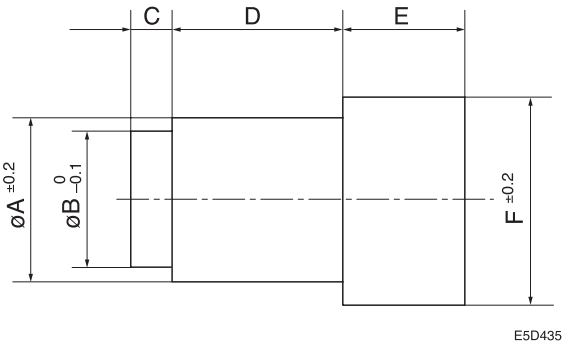
| Symptom | Probable Causes | Remedy |
|---|---|---|
| Oil leaks from piston rod sliding surface (an oil ring forms on the piston and this enlarges and drips off). | • Foreign matter is caught in the inner diameter portion of the rod packing, backup ring or dust seal.<br>• The inner diameter lip of the rod packing, backup ring or dust seal is damaged or abnormal. | • Remove the foreign matter.<br>• Replace the affected parts. |
| | • Piston rod sliding surface is scratched. | • Smooth the sliding surface with an oil stone (1.6 S or lower)<br>• If it leaks after the sliding surface has been smoothed, replace the rod packing and other seals.<br>• If it leaks after the seals have been replaced, replace the piston rod. |
| | • The hardened chrome plating is separating from the piston rod. | • Repair the hardened chrome plating. |
| Oil leaks from the outer circumference of the rod cover. | • O-ring is damaged.<br>• Backup ring is damaged. | • Replace the affected parts.<br>• Replace the affected parts. |
| Oil leaks from welded portion. | • The tube's welds are damaged. | • Replace the affected parts. |
| Cylinder natural drop (this is the maximum amount of movement of the piston in 10 minutes when a static weight corresponding to the maximum use pressure multiplied by the cylinder's surface area) is 0.5 mm or greater. | • Foreign matter is caught in the wear ring sliding surface.<br>• The sliding surface of the wear ring is scratched or abnormal.<br>• The piston packing sliding surface is scratched.<br>• The O-ring is damaged. | • Remove the foreign matter.<br>• Replace the affected parts.<br>• Replace the affected parts.<br>• Replace the affected parts. |

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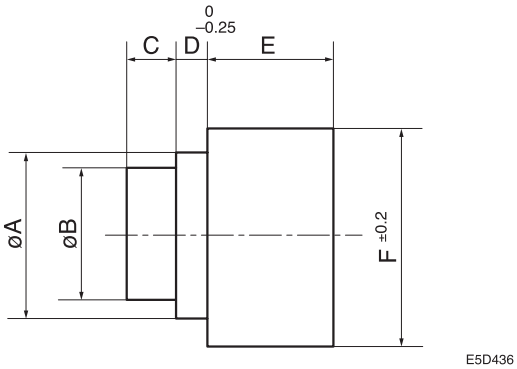
## TABLE OF SPECIAL TOOLS

Installation Jig (A)




MATERIAL: SS41

Installation Jig (B)




MATERIAL: SS41

Unit: mm

| Model | Installation Jig (A) | | | | | | Installation Jig (B) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TB125 | A | B | C | D | E | F | A | B | C | D | E | F |
| Boom | 43.5 | 40 | 30 | 21 | 30 | 50 | 49 (59*) | 40 (49.8*) | 15 | 5 | 30 | 55 (64*) |
| Arm | 43.5 | 40 | 30 | 21 | 30 | 50 | 49 | 40 | 15 | 5 | 30 | 55 |
| Bucket | 35.8 | 35 | 10 | 30 | 30 | 38 | 44 | 34.9 | 10 | 5 | 30 | 50 |
| Dozer Blade | 49.5 | 45 | 30 | 23 | 30 | 55 | 54 | 45 | 15 | 5 | 30 | 60 |
| Swing | 41.1 | 40 | 10 | 35 | 30 | 43 | 49 | 39.9 | 10 | 5 | 30 | 55 |

| Model | Installation Jig (A) | | | | | | Installation Jig (B) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TB135 | A | B | C | D | E | F | A | B | C | D | E | F |
| Boom | 49.5 | 45 | 30 | 21 | 30 | 55 | 54 | 45 | 15 | 5 | 30 | 60 |
| Arm | 49.5 | 45 | 30 | 21 | 30 | 55 | 54 | 45 | 15 | 5 | 30 | 60 |
| Bucket | 43.9 | 40 | 30 | 21 | 30 | 50 | 49 | 40 | 15 | 5 | 30 | 55 |
| Dozer Blade | 59.5 | 55 | 30 | 25 | 30 | 65 | 67 | 55 | 15 | 5 | 30 | 73 |
| Swing | 49.5 | 45 | 30 | 21 | 30 | 55 | 54 | 45 | 15 | 5 | 30 | 60 |
| Telescopic Arm | 43.9 | 40 | 30 | 21 | 30 | 50 | 49 | 40 | 15 | 5 | 30 | 55 |
| Bucket (for Telescopic Arm) | 43.9 | 40 | 30 | 21 | 30 | 50 | 49 | 40 | 15 | 5 | 30 | 55 |

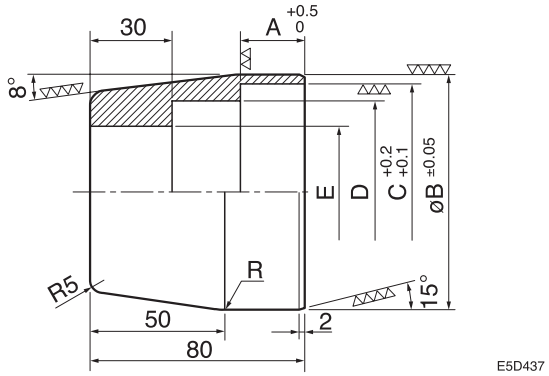
| Model | Installation Jig (A) | | | | | | Installation Jig (B) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TB145 | A | B | C | D | E | F | A | B | C | D | E | F |
| Boom | 56.2 | 55 | 10 | 35 | 30 | 58.5 | 59 | 49.8 | 10 | 5 | 30 | 64 |
| Arm | 51.2 | 50 | 10 | 35 | 30 | 53.5 | 59 | 49.8 | 10 | 5 | 30 | 64 |
| Bucket | 46.8 | 45 | 10 | 45 | 30 | 48.5 | 54 | 44.8 | 10 | 5 | 30 | 60 |
| Dozer Blade | 61.2 | 60 | 10 | 45 | 30 | 63.5 | 67 | 54.8 | 10 | 5 | 30 | 73 |
| Swing | 51.2 | 50 | 10 | 35 | 30 | 53.5 | 54 | 44.8 | 10 | 5 | 30 | 60 |
| Telescopic Arm | 49.5 | 45 | 30 | 21 | 30 | 55 | — | — | — | — | — | — |

*: Head Side, 12514526~

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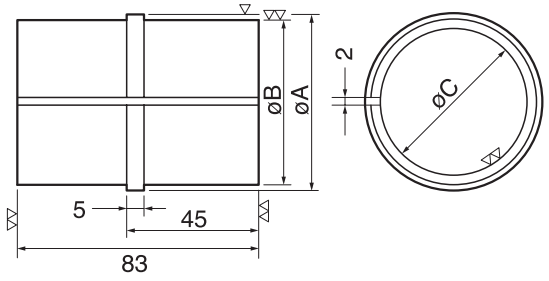
Sliding Jig (C)




E5D437

MATERIAL: STKM13C

Fitting Jig (D)




E5D438

MATERIAL: NYLON

Unit: mm

| Model | Sliding Jig (C) | | | | | Fitting Jig (D) | | |
|---|---|---|---|---|---|---|---|---|
| TB125 | A | B | C | D | E | A | B | C |
| Boom | 20 | 75.5 | 73 | 55 | 35 | 80 | 78 | 70 |
| Arm | 20 | 70.5 | 68 | 50 | 30 | 75 | 73 | 65 |
| Bucket | — | — | — | — | — | — | — | — |
| Dozer Blade | 25 | 85.5 | 83 | 65 | 45 | 90 | 88 | 80 |
| Swing | — | — | — | — | — | — | — | — |

| Model | Sliding Jig (C) | | | | | Fitting Jig (D) | | |
|---|---|---|---|---|---|---|---|---|
| TB135 | A | B | C | D | E | A | B | C |
| Boom | 25 | 85.5 | 83 | 65 | 45 | 90 | 88 | 80 |
| Arm | 20 | 80.5 | 78 | 60 | 40 | 85 | 83 | 75 |
| Bucket | 20 | 70.5 | 68 | 50 | 30 | 75 | 73 | 65 |
| Dozer Blade | 25 | 100.5 | 98 | 80 | 60 | 105 | 103 | 95 |
| Swing | 20 | 80.5 | 78 | 60 | 40 | 85 | 83 | 75 |
| Telescopic Arm | 15.7 | 65.5 | 63 | 45 | 25 | 70 | 68 | 60 |
| Bucket (for Telescopic Arm) | 20 | 70.5 | 68 | 50 | 30 | 75 | 73 | 65 |

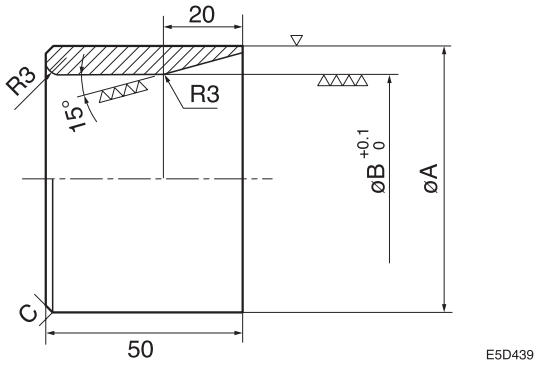
| Model | Sliding Jig (C) | | | | | Fitting Jig (D) | | |
|---|---|---|---|---|---|---|---|---|
| TB145 | A | B | C | D | E | A | B | C |
| Boom | 25 (—*) | 100.5 (—*) | 98 (—*) | 80 (—*) | 60 (—*) | 105 (—*) | 103 (—*) | 95 (—*) |
| Arm | — | — | — | — | — | — | — | — |
| Bucket | — | — | — | — | — | — | — | — |
| Dozer Blade | — | — | — | — | — | — | — | — |
| Swing | — | — | — | — | — | — | — | — |
| Telescopic Arm | 20 | 70.5 | 68 | 50 | 30 | 75 | 73 | 65 |

*: 14510004~14510788

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Corrective Jig (E)




MATERIAL: STKM13C

Unit: mm

| Model TB125 | A | B |
|---|---|---|
| Boom | 90 | 75 |
| Arm | 85 | 70 |
| Bucket | — | — |
| Dozer Blade | 100 | 85 |
| Swing | — | — |

| Model TB135 | A | B |
|---|---|---|
| Boom | 100 | 85 |
| Arm | 95 | 80 |
| Bucket | 85 | 70 |
| Dozer Blade | 115 | 100 |
| Swing | 95 | 80 |
| Telescopic Arm | 80 | 65 |
| Bucket (for Telescopic Arm) | 85 | 70 |

| Model TB145 | A | B |
|---|---|---|
| Boom | 115 (—*) | 100 (—*) |
| Arm | — | — |
| Bucket | — | — |
| Dozer Blade | — | — |
| Swing | — | — |
| Telescopic Arm | 85 | 70 |

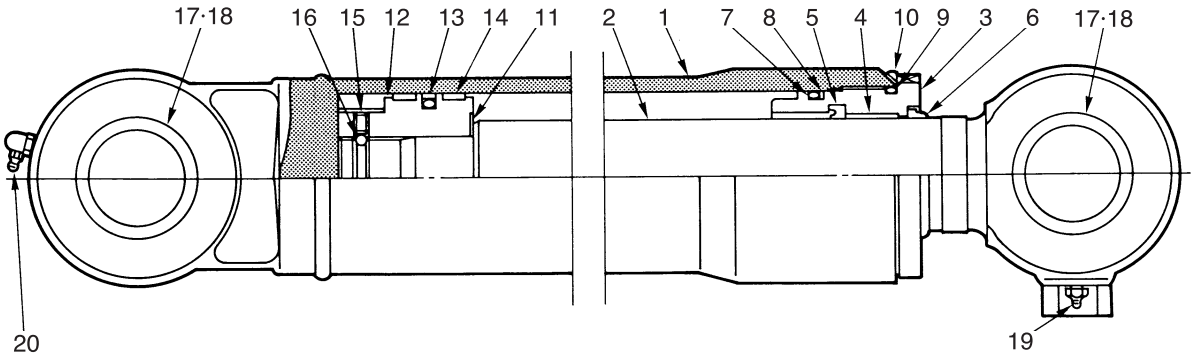
*: 14510004~14510788

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## BUCKET CYLINDER FOR TELESCOPIC ARM (TB145)

### CONSTRUCTION




1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Rod Packing
6. Dust Seal
7. O-ring
8. Backup Ring
9. O-ring
10. Lock Washer
11. Shim
12. Piston
13. Piston Packing
14. Wear Ring
15. Set Screw
16. Ball
17. Bushing
18. Dust Seal
19. Grease Nipple
20. Grease Nipple

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## DISASSEMBLY AND ASSEMBLY

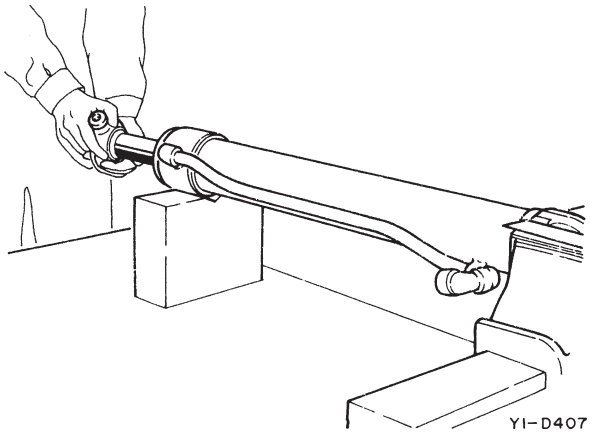
### Special Tools
See the table of special tools at the back of this section for the jigs and tools used for disassembly and assembly.

### General Cautions
- Carry out disassembly and assembly in a clean place and place the disassembled parts in a place where they will be kept clean at all times.
- Before disassembly, clean the outside surface of the cylinder thoroughly.
- In the disassembly and assembly operations, be careful not to scratch any part. Take particular caution with the sliding surfaces of parts.
- Clean all disassembled parts thoroughly with cleaning oil.
- Replace all seals with new parts.
- Apply a thin coating of hydraulic oil to seals before fitting them in place.
- After fitting, make sure the O-rings are not twisted.
- Apply clean hydraulic oil to each sliding portion before assembling them.

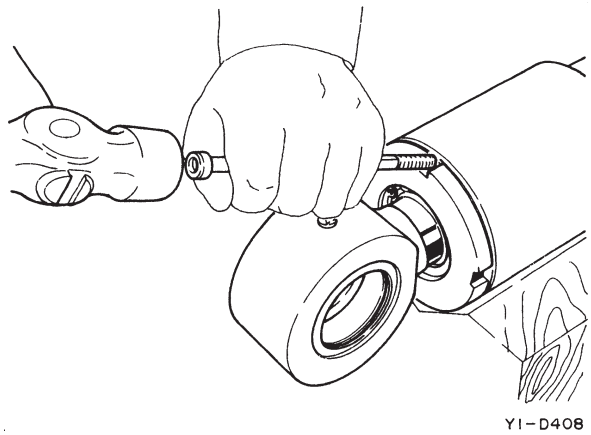
### Disassembly
Cylinder Assembly

1. Fasten the clevis of the tube in a vice and place the other end on a support black made of wood to fasten the cylinder in a horizontal condition.

2. Drain out hydraulic oil remaining in the cylinder.
   - Move the piston rod gently to prevent the hydraulic oil from spraying out and scattering all over.


YI-D407

3. Free the locked portion of the rod cover.
   - Since the lock is integrated with the cylinder tube, be careful not to bend it or to scratch it when the lock is being freed.

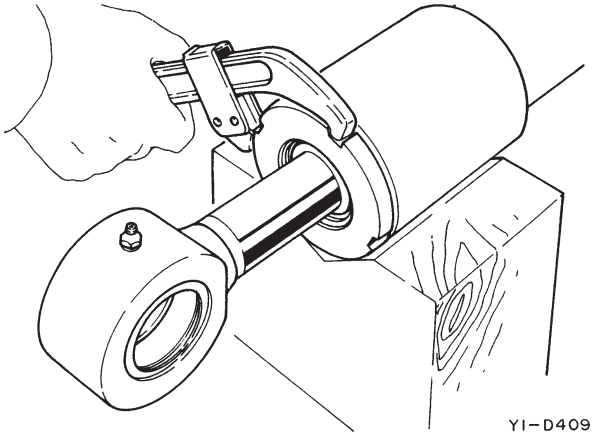

YI-D408

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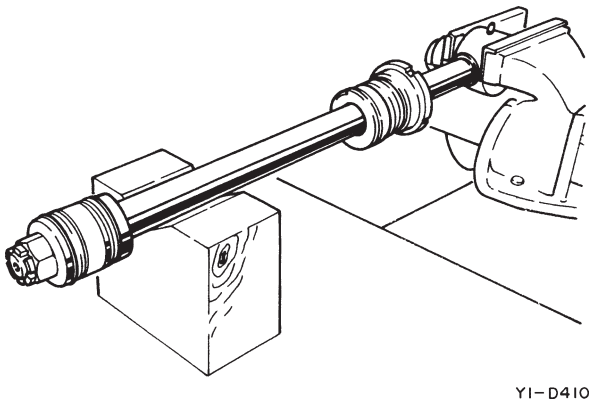
4. Loosen the rod cover.
   - The piston rod should be pulled out approximately 200 mm beforehand.
   - Measures should be taken to prevent the piston rod from being hit.

5. Take the piston rod assembly out of the tube.
   - Pull it out straight to prevent the sliding surface from being scratched.

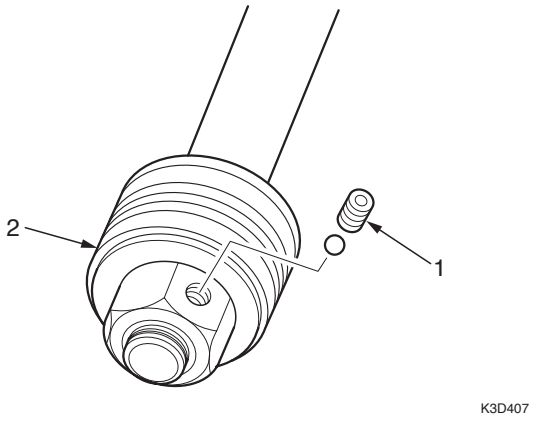



### Piston Rod Assembly

1. Fasten the piston rod assembly securely in a level position.

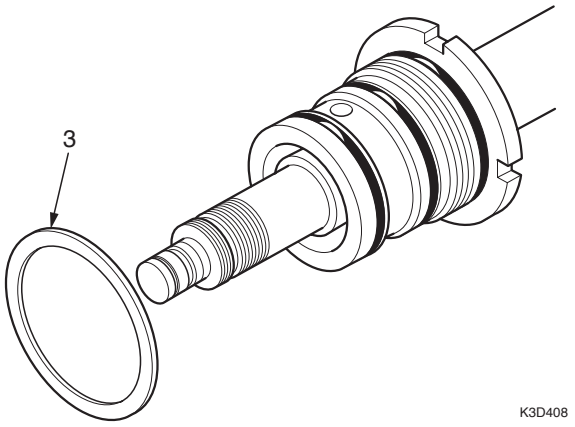



2. Remove the piston.
   a. Take out the set screw (1) and remove the ball.
      - The set screw is staked at 2 place with a punch, so grind off the staked portions using a hand drill.
   b. Remove the piston assembly (2) and shim.




3. Remove the lock washer (3).

4. Take the rod cover assembly out of the piston rod.

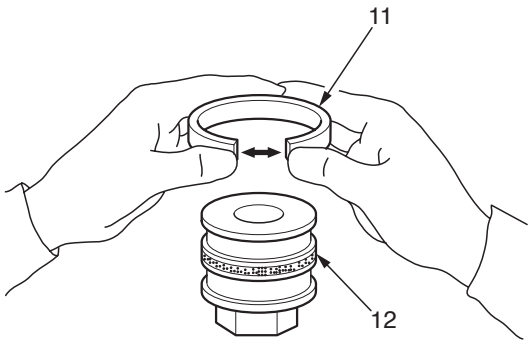


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### Piston

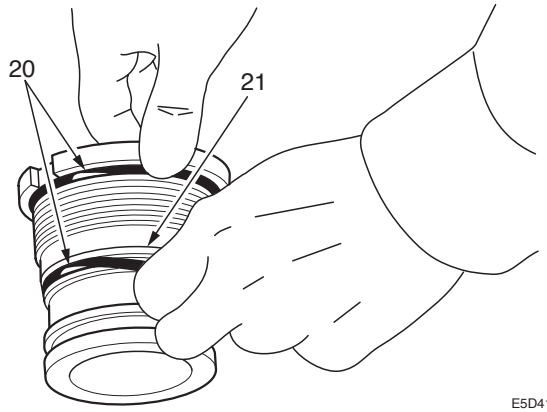
1. Remove the wear ring (11), then remove the piston packing (12).
   - Spread the wear ring at the cut portion the minimum amount necessary for it to be removed. Remove it in the direction of the shaft.
   - Either cut the piston packing off or use a flat bladed screwdriver, etc. to take it off.



E5D414

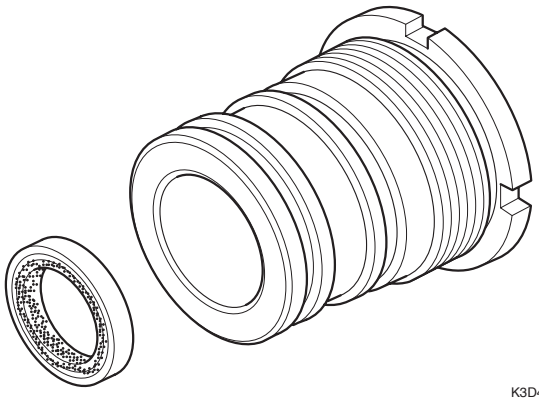
### Rod Cover

1. Remove the O-ring (20) from the outer diameter of the rod cover, then remove the backup ring (21).

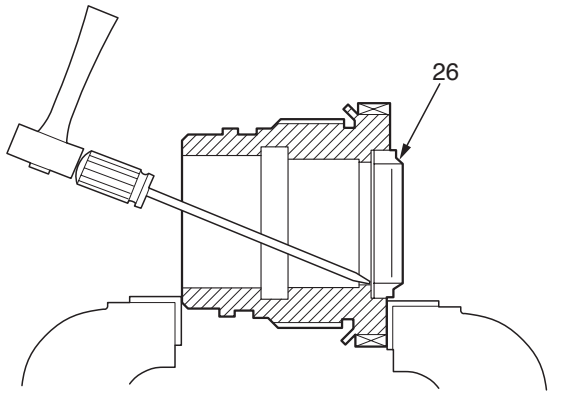


E5D419

2. Remove the rod packing.


K3D409

3. Remove the dust seal (26).
   - Tap alternately on several points around the circumference on the inside of the metal ring, pushing it out a little at a time to remove it.

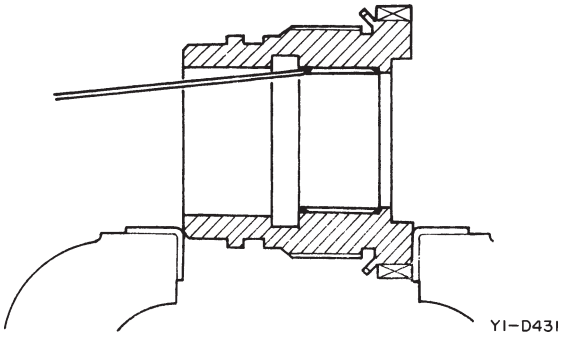


E5D423

https://truckmanualshub.com/

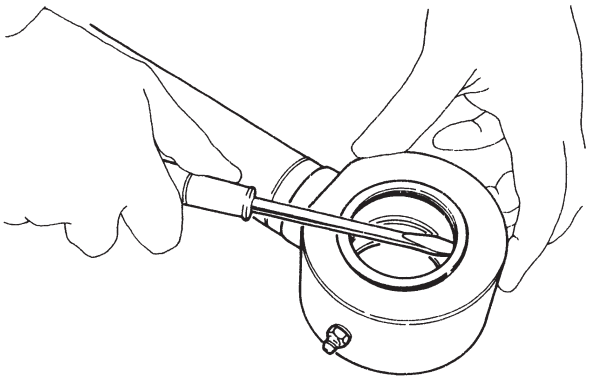


4. Remove the bushing.
   - Since the bushing has been pressure fitted tightly in the rod cover, it is impossible to take it out. First use a lathe to grind down the inside portion until only a thin piece remains, then insert a copper spatula strongly and pry it out to remove it.

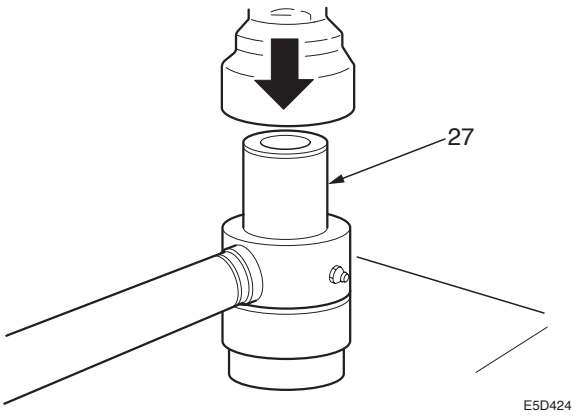



### Clevis

1. Remove the dust seals from the tube and piston rod.




2. Remove the bushings using a setting tool (27).



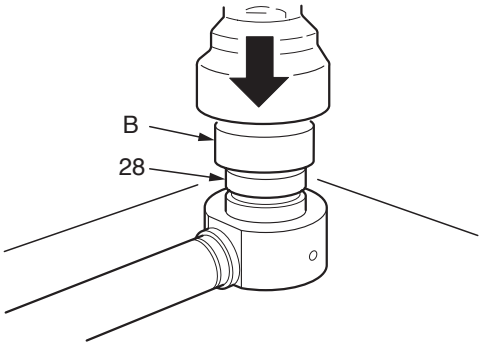
https://truckmanualshub.com/



**Assembly**

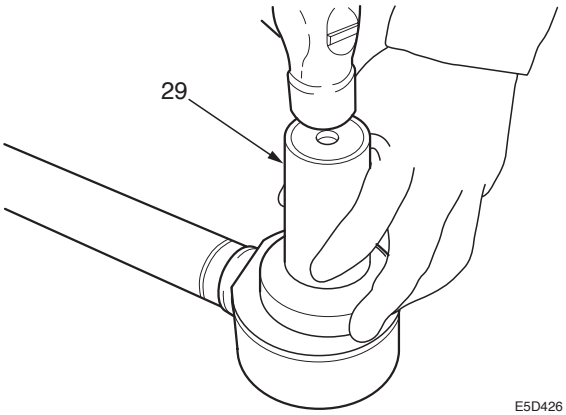
Clevis

1. Using installation jig (B), pressure fit the bushings (28) in the piston rod and tube.




E5D425

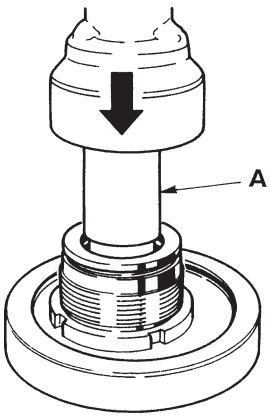
2. Using a setting tool (29), install the dust seals.




E5D426

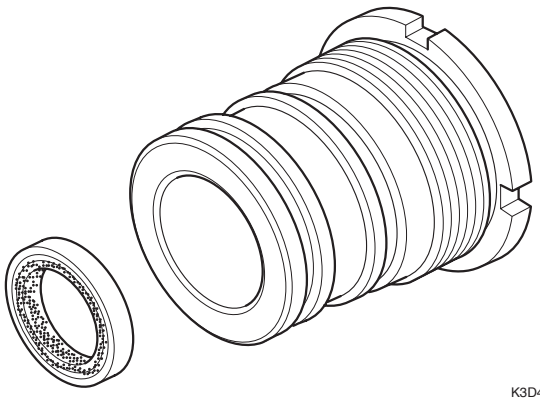
Rod Cover

1. Using an installation jig (A), pressure fit the bushing.
   - Hydraulic fluid should be applied to the inside surface of the rod cover before assembly.
   - After installation, make sure there are no level differences with the bushing.




YI-D436

2. Install the rod packing.
   - Pay attention to the installation direction.

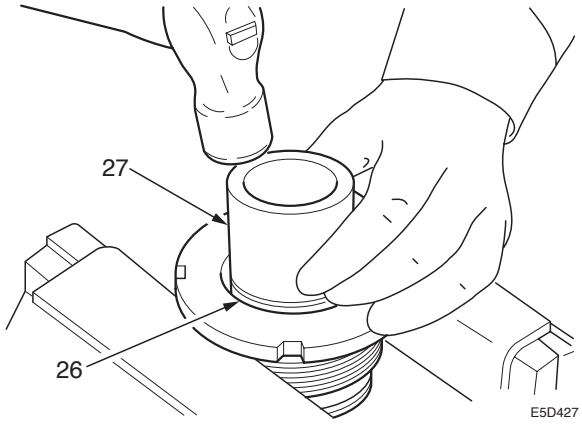


K3D409

https://truckmanualshub.com/

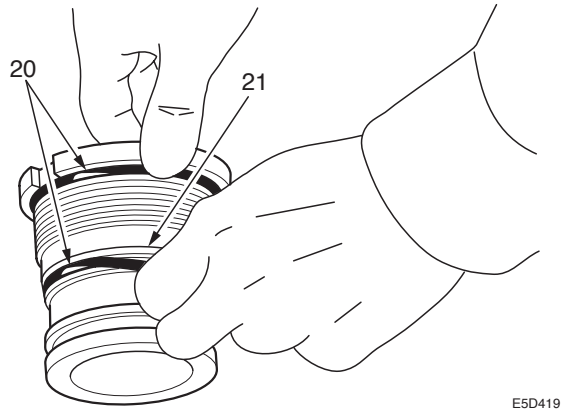


3. Install the dust seal (26).
   - In the case of a dust seal with a metal ring around the outer circumference, use a setting tool (27) to install it.



E5D427

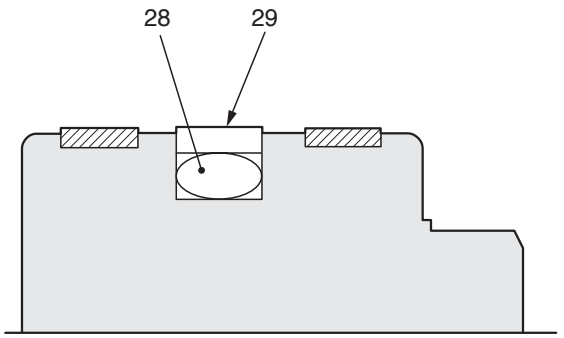
4. Install the backup ring (21) and fit the O-ring (20).
   - The cut portions of the backup ring should overlap correctly.



E5D419

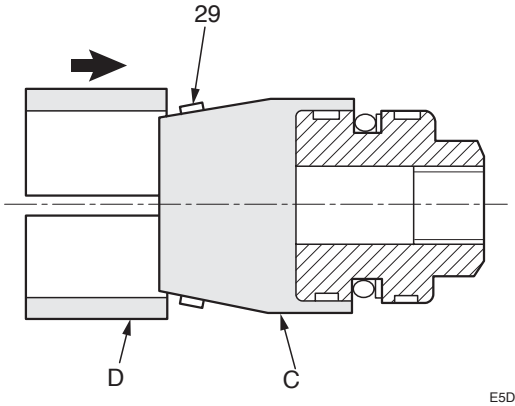
### Piston

1. Assemble the piston assembly.
   a. Fit the O-ring (28).
      - If the O-ring is twisted after it is fitted, correct it.



E5D429

   b. Cover the piston with the sliding jig (C), them using the fitting jig (D), insert the slipper ring (29) rapidly.

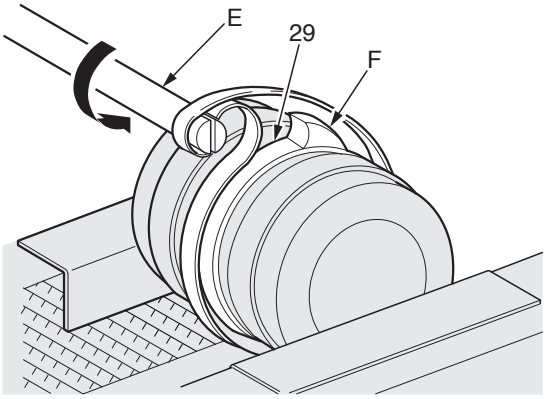


E5D430

https://truckmanualshub.com/

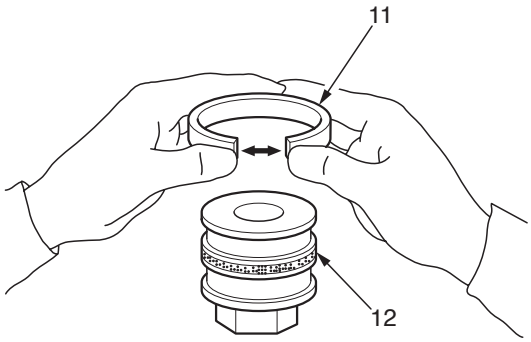


c. Since the slipper ring (29) is extended when it is installed, correct it by the following procedure.
   (1) Set correction jigs (E) and (F) as shown in the figure. The slipper ring should be positioned in the center of the band at this time.
   (2) Tighten for 10 seconds or longer.



K3D410

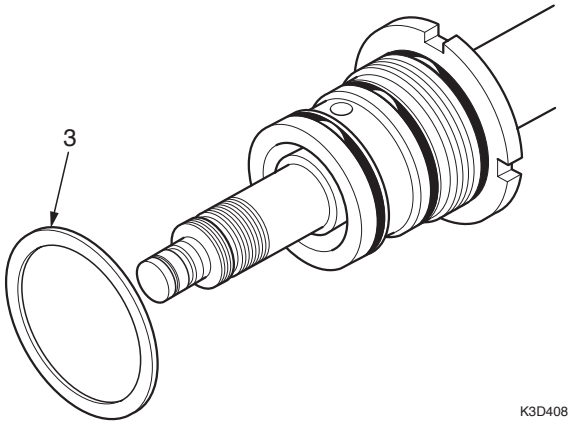
2. Install the wear ring (11).
   • Spread the wear ring at the cut portion the minimum amount necessary to install it in the shaft direction.



E5D414

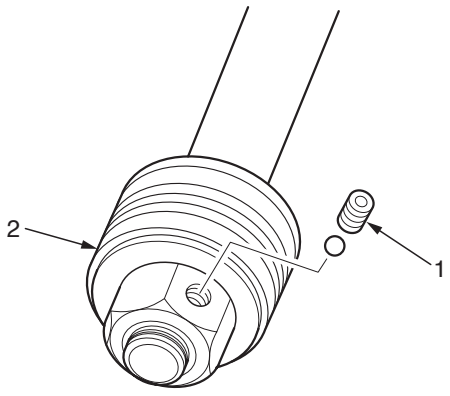
### Piston Rod Assembly

1. Fasten the piston rod in a horizontal position, then assemble the rod cover assembly and lock washer (3).



K3D408

2. Install the piston unit.
   a. Fit the shim and piston (2) and tighten them.
      • Piston tightening torque:
        980 N·m (100 kgf·m)
   b. Insert the ball, tighten the set screw (1) and stake at 2 points with a punch.
      • Setscrew tightening torque:
        16.2 N·m (1.65 kgf·m)



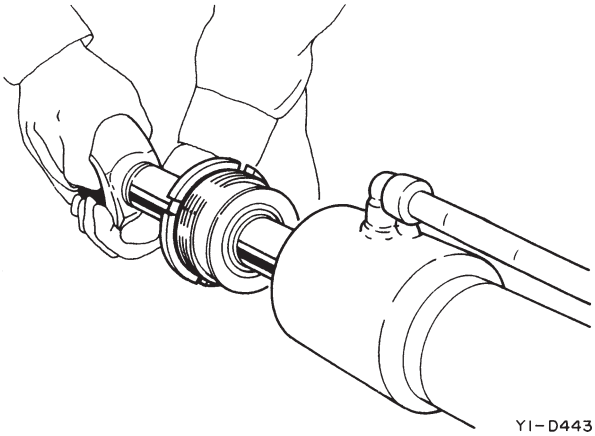
K3D407

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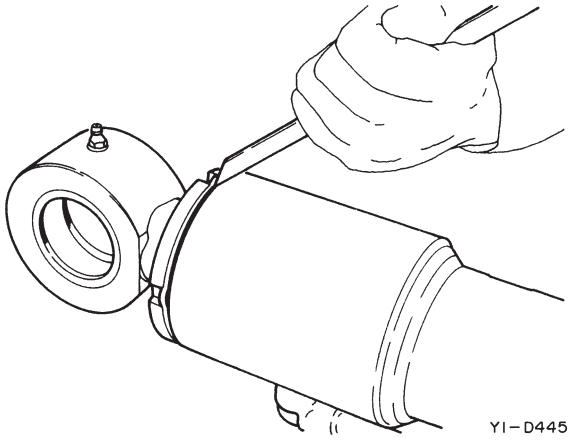


### Cylinder Assembly

1. Fasten the tube in a horizontal position, then insert the piston rod assembly in the tube.
   - During insertion, align the center of the piston rod with the center of the tube, inserting it straight so that the seals will not be scratched.




2. Tighten the rod cover, then bend the lock washer to prevent it from turning.
   - When installing the rod cover, apply Three Bond #1901 or a comparable product to the threads.
   - Rod cover tightening torque:
     451 ±104 N·m (46 ±10.6 kgf·m)




## INSPECTION AND ADJUSTMENT

☞ “IV-117~118”

## TROUBLESHOOTING

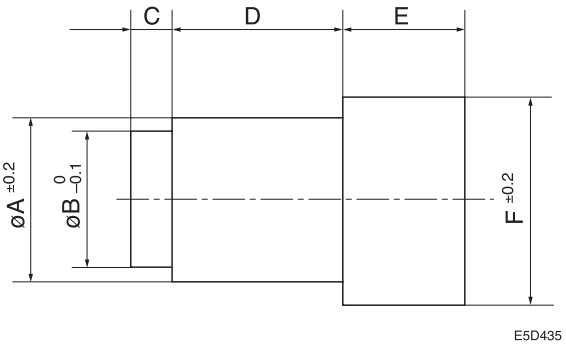
☞ “IV-119”

https://truckmanualshub.com/



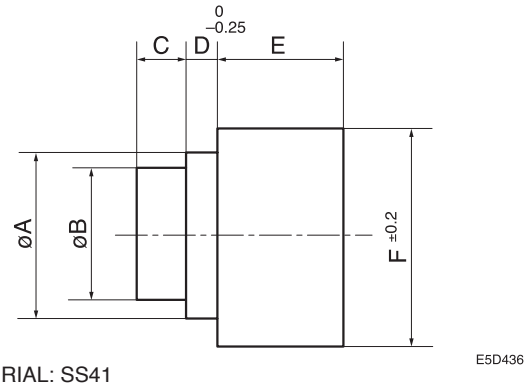
## TABLE OF SPECIAL TOOLS

Installation Jig (A)




MATERIAL: SS41

Installation Jig (B)

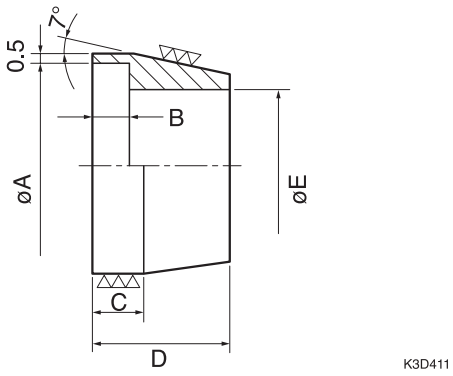



MATERIAL: SS41

Unit: mm

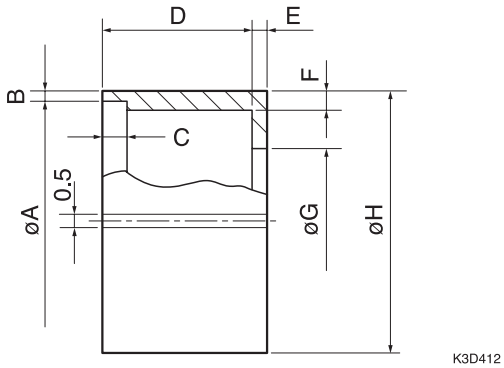
| Installation Jig (A) | | | | | | Installation Jig (B) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | A | B | C | D | E | F |
| 47.5 | 44.9 | 10.0 | 45.0 | 10.0 | 50.0 | 54.5 | 44.8 | 10.0 | 5.0 | 30.0 | 70.0 |

Sliding Jig (C)




MATERIAL: RESIN

Fitting Jig (D)




MATERIAL: RESIN

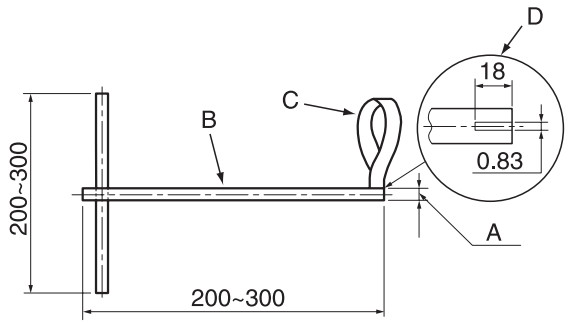
Unit: mm

| Sliding Jig (C) | | | | | Fitting Jig (D) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | B | C | D | E | A | B | C | D | E | F | G | H |
| 79.5 | 20.0 | 25.0 | 65.0 | 49.0 | 80.0 | 1.0 | 7.0 | 80.0 | 3.5 | 3.5 | 60.0 | 82.0 |

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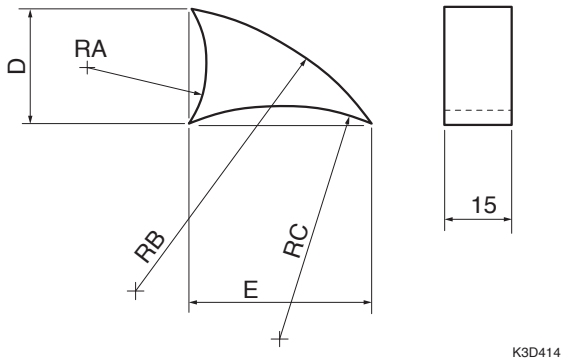
Corrective Jig (E)




K3D413

A: 15 mm
B: METAL BAR
C: POLYESTER BAND WITH CANVAS
D: BAND INSTALLATION SLOT

Corrective Jig (F)




K3D414

MATERIAL: ACRYL RESIN

Unit: mm

| Corrective Jig (F) | | | | |
|---|---|---|---|---|
| A | B | C | D | E |
| 20 | 45 | 40 | 15 | 30 |

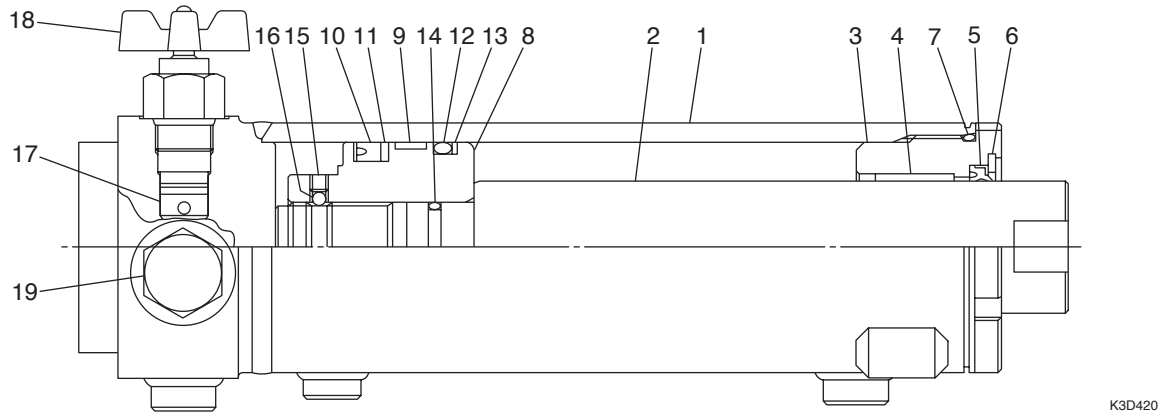
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## TENSIONING CYLINDER

### CONSTRUCTION




1. Tube
2. Piston Rod
3. Rod Cover
4. Bushing
5. Dust Seal
6. Snap ring
7. O-ring
8. Piston
9. Wear Ring
10. Rod Packing
11. Backup Ring
12. O-ring
13. Backup Ring
14. O-ring
15. Set Screw
16. Ball
17. Valve Set
18. Handle
19. Valve Set

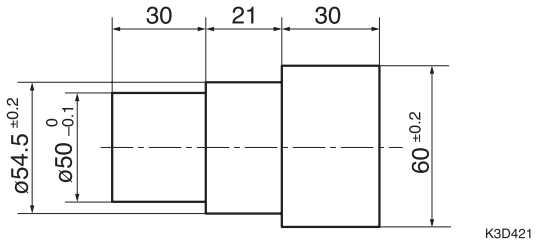
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## DISASSEMBLY AND ASSEMBLY

### Table of Special Tool

Unit: mm

| Names, Dimensions |
|---|
| Installation Jig (A)<br>  <br>MATERIAL: SS41 |

### General Cautions

☞ “IV-102”

Following is an explanation of the tensioning cylinder disassembly procedure. Follow the procedure used to disassemble the tensioning cylinder in reverse order when assembling it.

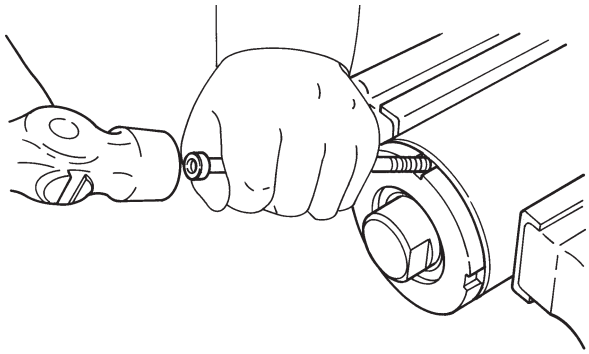
### Disassembly

Cylinder Assembly

1. Fasten the tube so that it is flat.

2. Drain out hydraulic oil remaining in the cylinder.
   - Move the piston rod gently to prevent the hydraulic oil from spraying out and scattering all over.

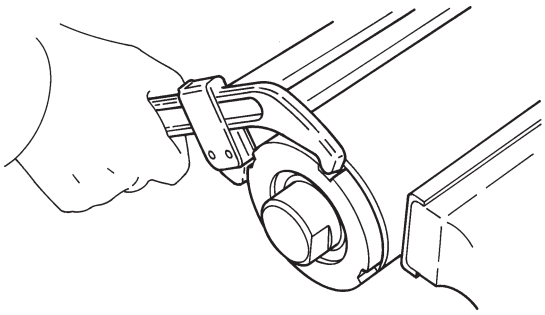
3. Free the locked portion of the rod cover.
   - Since the lock is integrated with the cylinder tube, be careful not to bend it or to scratch it when the lock is being freed.



L1−D431

4. Loosen the rod cover.
   - Measures should be taken to prevent the piston rod from being hit.
   - Rod cover tightening torque:
     333 N·m (34 kgf·m)

5. Take the piston rod assembly out or the tube.
   - Pull it out straight to prevent the sliding surfaces from being scratched.



L1−D432

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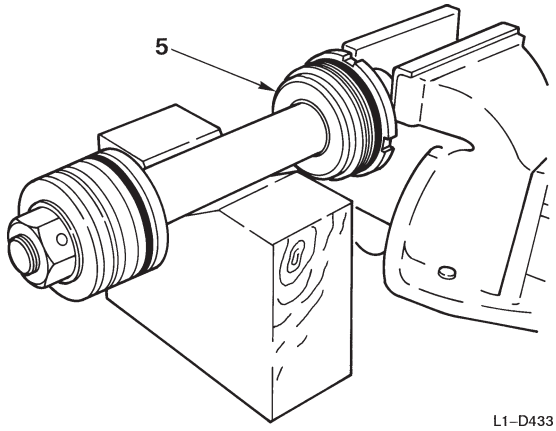


### Piston Rod Assembly

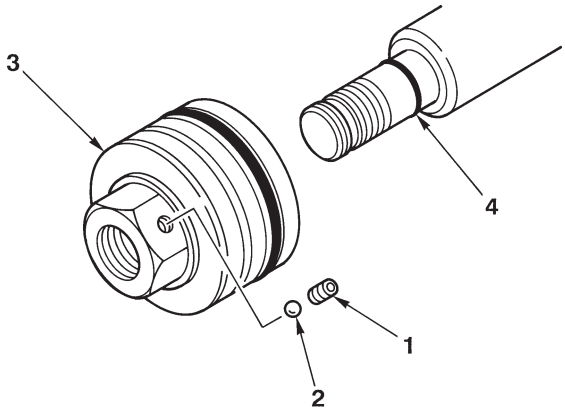
1. Fasten the piston rod assembly securely in a level position.

2. Remove the piston.
   a. Take out the set screw (1) and remove the ball (2).
      - The set screw is staked at 2 places with a punch, so grind off the staked portions using a hand drill.
      - When assembling, caulk the set screw at two places with a punch.
      - Set screw tightening torque:
        16.7 N·m (1.7 kgf·m)
   b. Loosen piston (3) and remove it.
      - Piston tightening torque:
        784 N·m (80 kgf·m)
   c. Remove the O-ring (4) from the piston rod.

3. Remove the rod cover (5).




L1–D433



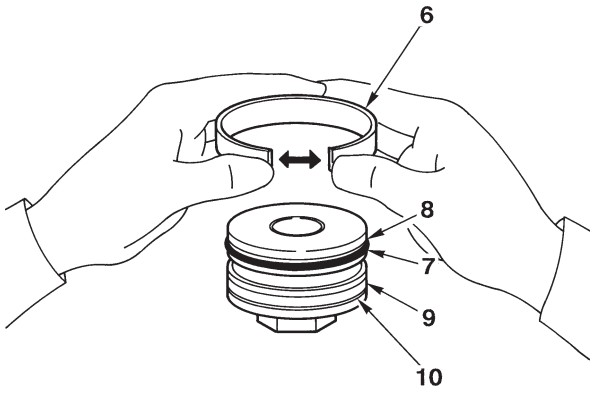

L1–D434

### Piston

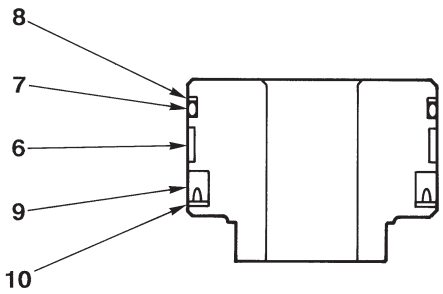
1. Remove the wear ring (6) from the piston.
   - Spread the wear ring the minimum amount necessary and remove it in the axial direction.

2. Remove the O-ring (7) and backup ring (8).
   - When assembling, be careful to install in the proper position.

3. Remove the rod packing (9) and backup ring (10).
   - When assembling, be careful to install the rod packing in the proper position.




L1–D435




L1–D436

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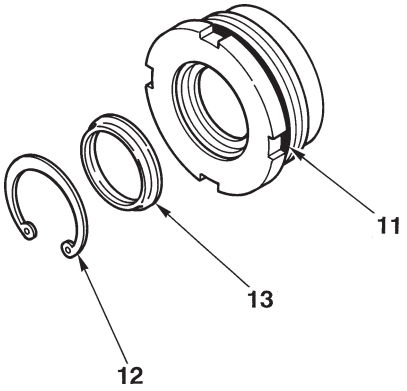


### Rod Cover

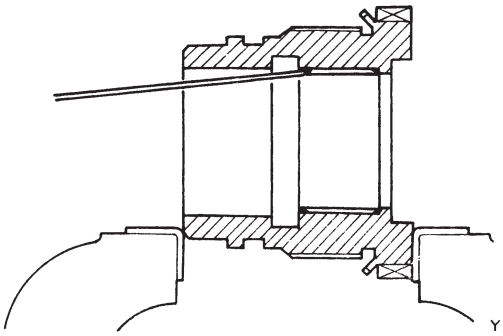
1. Remove the O-ring (11).

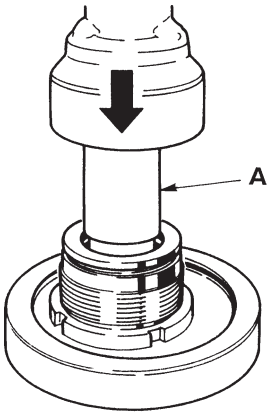
2. Remove the Snap ring (12) and the dust seal (13).

3. Remove the bushing.
   - Since the bushing has been pressure fitted tightly in the rod cover, it is impossible to take it out. First use a lathe to grind down the inside portion until only a thin piece remains, then insert a copper spatula strongly and pry it out to removed it.
   - When assembling, use installation jig (A) and pressure fit the bushing with a press.
   - When assembling, apply hydraulic oil to the inside surface of the rod cover before installing it.
   - After installation, make sure there are no level differences with the bushing.



L1-D437


YI-D431



YI-D436

## INSPECTION AND ADJUSTMENT

☞ “IV-117~118”

## TROUBLESHOOTING

☞ “IV-119”

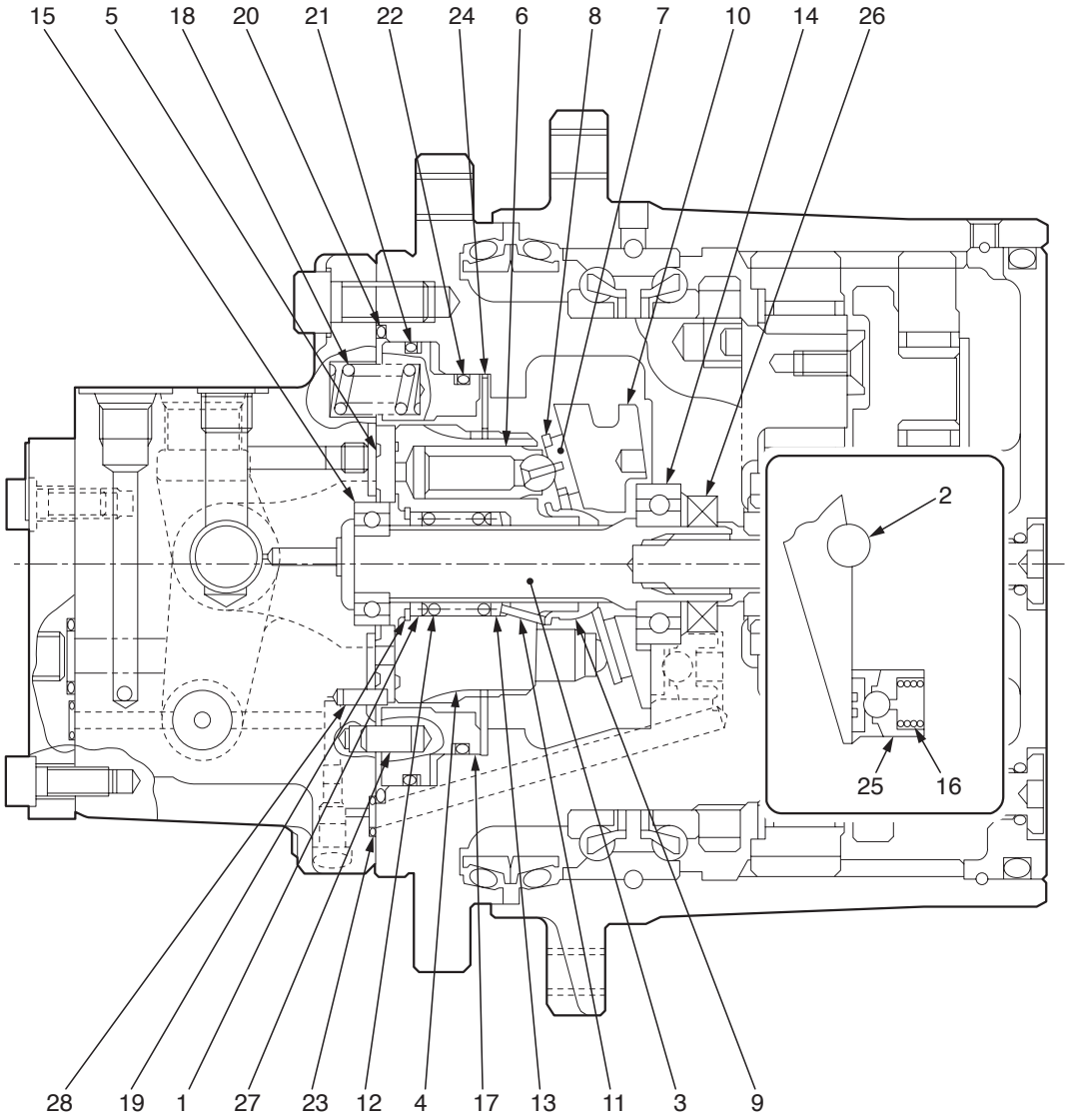
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# TRAVEL MOTOR (TB125: S/N 12510009~12514525)

## CONSTRUCTION

### Hydraulic Motor



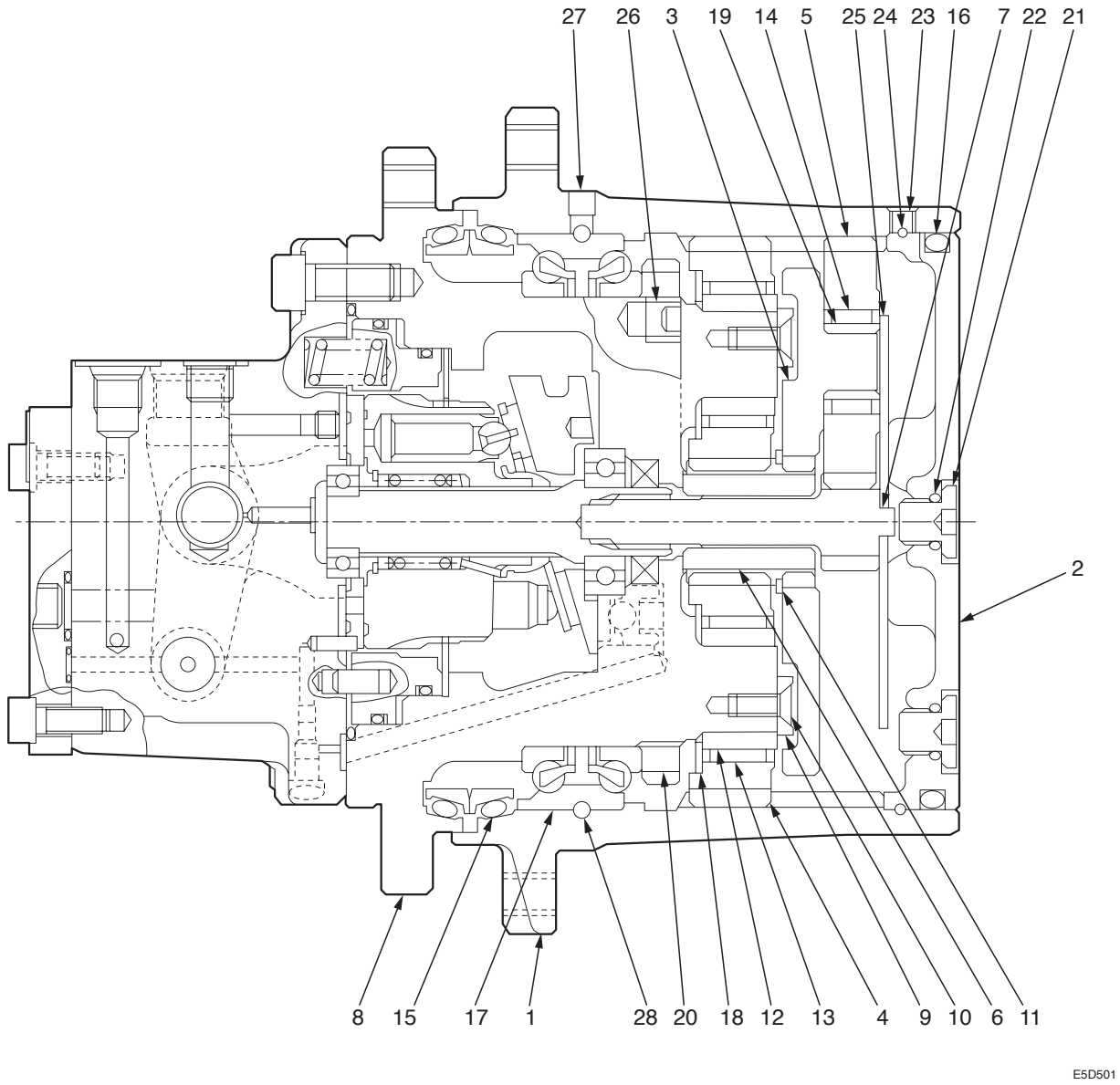

E5D500

1. Retainer
2. Ball
3. Shaft
4. Cylinder Block
5. Valve Plate
6. Piston
7. Shoe
8. Shoe Holder
9. Guide
10. Swash Plate
11. Pin
12. Spring
13. Retainer
14. Bearing
15. Bearing
16. Spring
17. Brake Piston
18. Spring
19. Snap Ring
20. O-ring
21. O-ring
22. O-ring
23. O-ring
24. Friction Disc
25. 2-Speed Piston
26. Oil Seal
27. Pin
28. Pin

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**Reduction Gears**

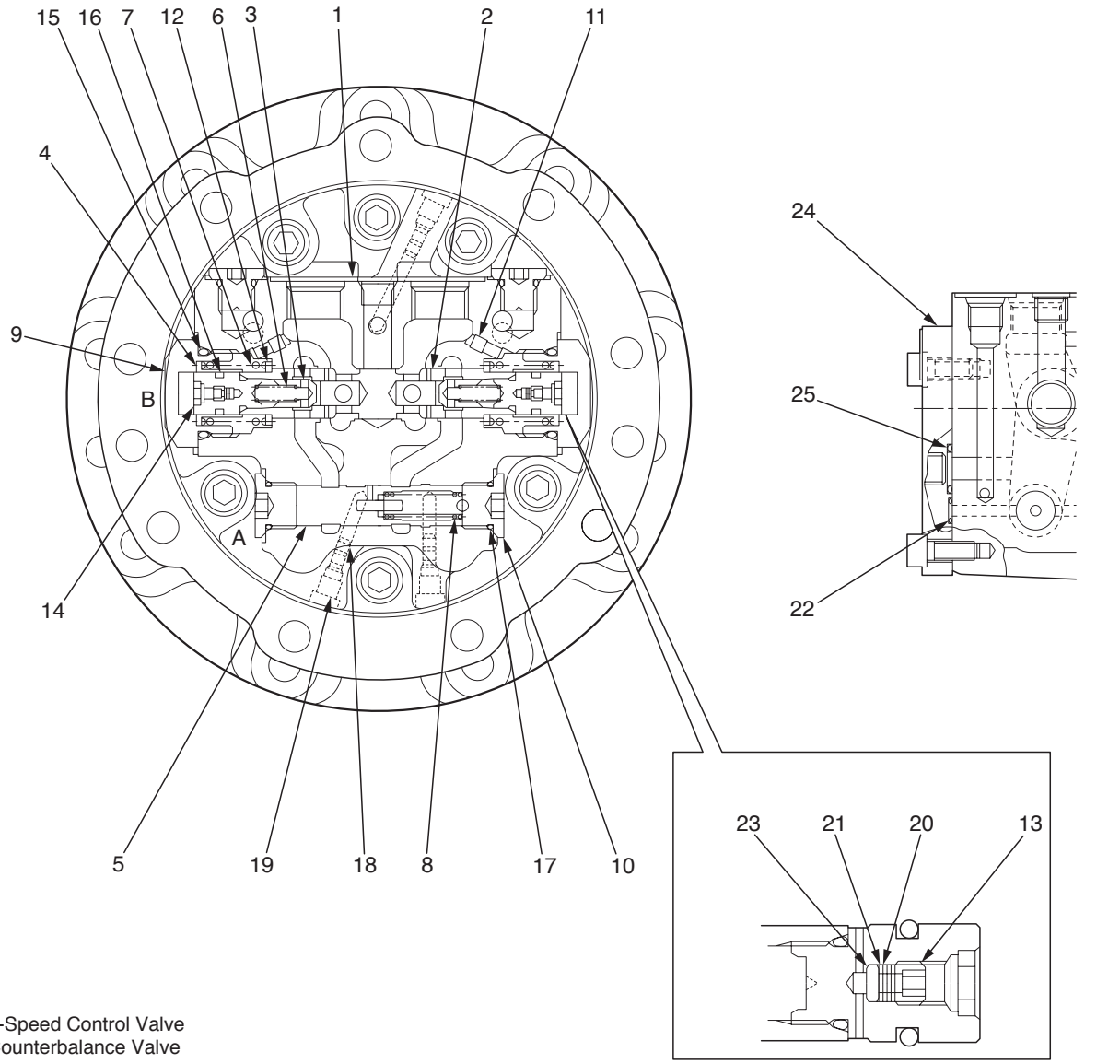



1. Housing
2. Cover
3. Carrier 2
4. Gear B1
5. Gear B2
6. Gear S1
7. Gear S2
8. Flange Holder
9. Thrust Plate
10. Screw
11. Snap Ring
12. Inner Race
13. Needle
14. Needle
15. Floating Seal
16. O-ring
17. Bearing
18. Thrust Washer
19. Inner Race
20. Ring Nut
21. Plug
22. O-ring
23. Plug
24. Wire
25. Thrust Plate
26. Plug
27. Plug
28. Ball

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**Counterbalance Valve, 2-speed Control Valve**




A: 2-Speed Control Valve
B: Counterbalance Valve

E5D502

1. Valve Body
2. Spool
3. Check Valve
4. Spring Seat
5. Spool
6. Spring
7. Spring
8. Spring
9. Plug
10. Plug
11. Orifice
12. Ring
13. Plug
14. Plug
15. O-ring
16. O-ring
17. O-ring
18. Orifice
19. Plug
20. Orifice
21. Washer
22. O-ring
23. Filter
24. Plate
25. O-ring

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## OPERATION

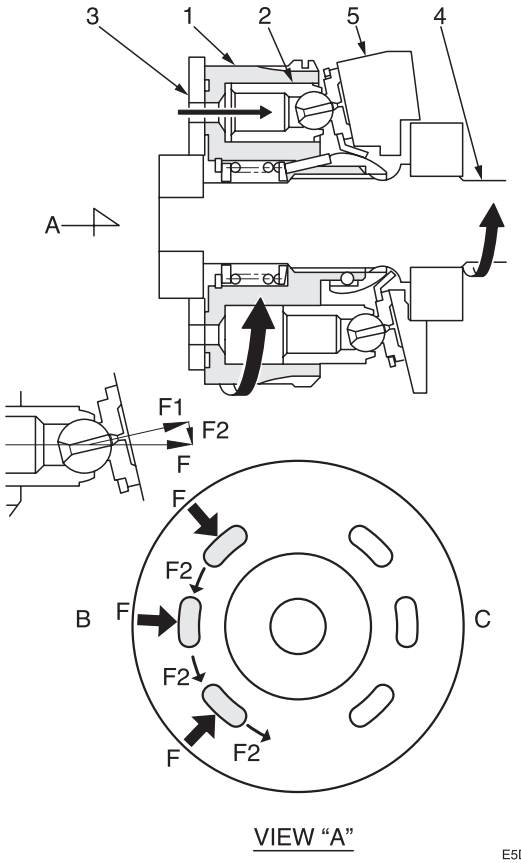
### Hydraulic Motor

9 pistons (2) are fitted in the cylinder block (1) and there is a valve plate (3) with two half moon ports, B and C in the end. Also, the cylinder block (1) rotates freely and is joined to the shaft (4) via the spline. On the other band, the swash plate (5) is fastened to the housing.

When high pressure oil is introduced into port B, one piston (2) makes contact and force F bears on the swash plate (5).

$F = P \times A$ P: Pressure A: Piston Sectional Area

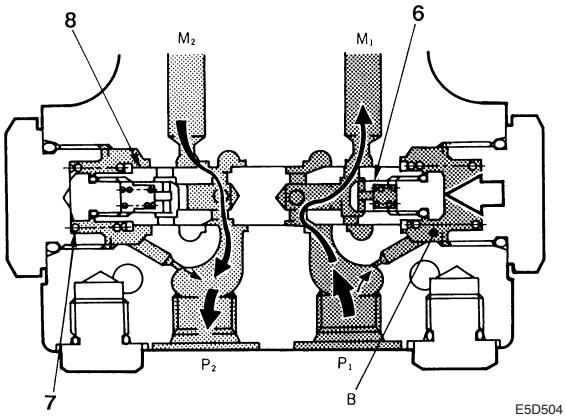
The force F which the piston (2) applies to the swash plate (5) is divided into force F1, which pushes the plate, and force F2, which rotates the cylinder block (1). The total sum of the components in the direction of rotation of the high pressure side piston generates a rotational force in the cylinder block (1) and via the spline, torque is transmitted to the shaft (4), turning it. Conversely, if high pressure oil is introduced to port C, rotation is the reverse of the above.




E5D503

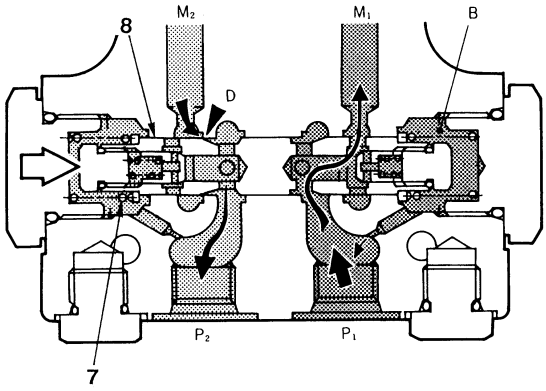
### Counterbalance Valve

If high pressure oil is introduced to port P1, the oil pushes the check valve (6) up. This causes oil to flow through the motor port M1 and to flow into chamber B of the pilot portion and fill it. When hydraulic oil flows the motor from port M1 and acts to turn the motor, even if oil returns from the motor and flows into port M2, since the flow is cut off by the check valve (6), the pressure at port P1 and in chamber B rises. If the pressure in chamber B becomes higher than the set valve of the spring (7), the spool (8) moves to the left side and ports M2 and P2 open up, causing the motor to turn.




E5D504

If the motor's turning becomes too fast, and the amount of oil flowing out of port M2 is greater than the amount of oil flowing into port M1, the pressure in port P1 and chamber B drops. When the pressure in chamber B drops below the set valve of the spring (7), the spool (8) attempts to return to the right side. As a result, since the resuming oil is constricted at portion D, back pressure is generated at port M2 and the motor's turning is slowed.



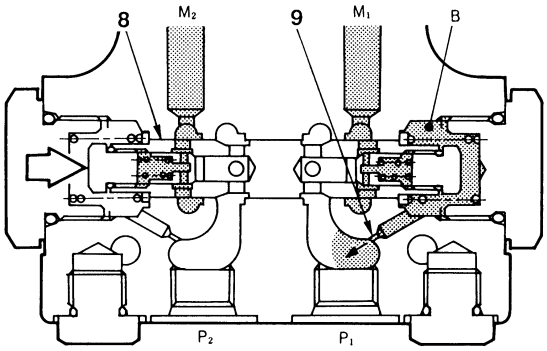

E5D505

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When the motor is slowed, the pressure in port P1 and chamber B rises again and the spool (8) moves to the left side, eliminating the back pressure generated at port M2. In this way, the motor is controlled so that it rotates at a speed appropriate for the amount of oil flowing into it.

If the high pressure hydraulic oil introduced into port P1 is cut off, the pressure at ports P1 and P2 becomes the same and the spool (8) returns to the neutral position by spring force. For this reason, the oil in chamber B is pushed out at port P1. At this time, the flow of oil is restricted by the orifice (9) as it is returning to port P1, so the spool (8) returns to the neutral position slowly. In this way, the motor is stopped while the shock during stopping is absorbed.

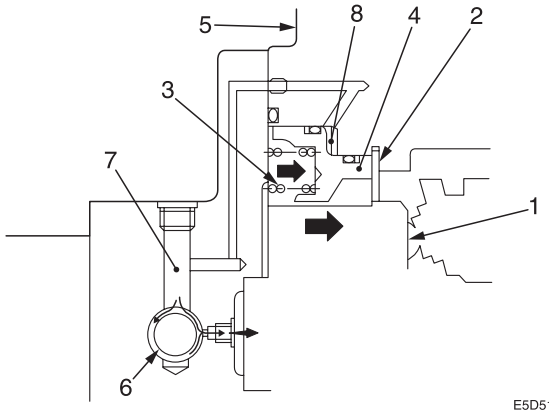


E5D506

**Parking Brake**

The cylinder block (1) and disc (2) are connected via a spline.

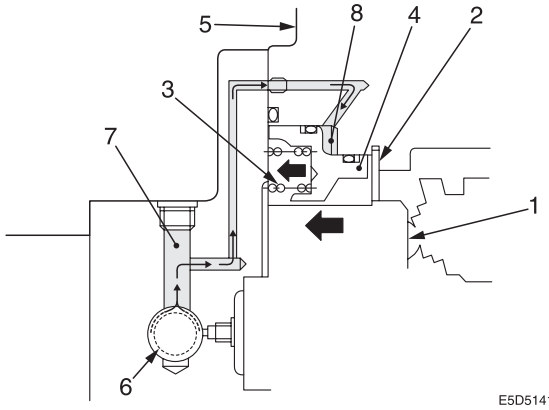
The disc (2) is pushed against the flange holder (5) by the force of the spring (3) via the brake piston (4) and brake force is generated by the friction force between the flange holder (5) and the brake piston (4) stopping the cylinder block (1) from turning.



E5D5131

When hydraulic oil is introduced into the motor, the spool (6) of the counterbalance valve moves out and the parking brake release port (7) opens. Hydraulic oil passes through this port and flows to the brake piston chamber (8), overpowers the spring and moves the brake piston (4) to the left. When this happens, the disc (2) rotates freely between the flange holder (5) and the brake piston (4), releasing the parking function.

Also, when the motor stops, the spool (6) returns to the neutral position and the parking release port (7) opens. Hydraulic oil in the brake piston chamber (8) is introduced into the motor case and parking brake force from the spring (3) acts.



E5D5141

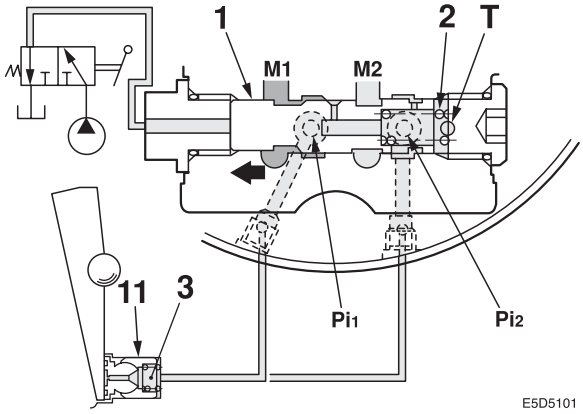
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## 2-Speed Mechanism

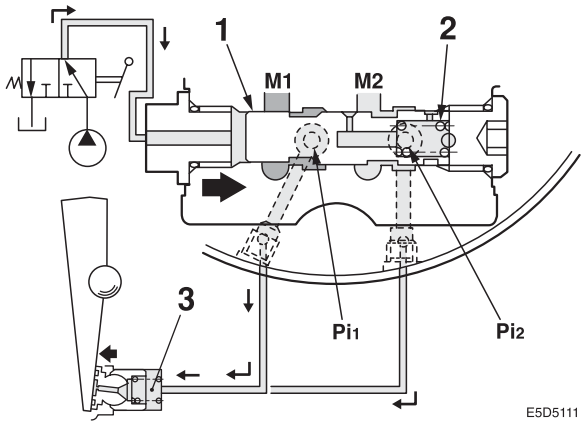
### 2-Speed Control Valve

If high pressure oil is introduced into port M1 and the control valve is in the 1st speed position, the spool (1) is moved to the left position by the spring (2) and the swash plate control piston chambers (3) connect with port T through the respective ports Pi1 and Pi2. For this reason, no force acts on the swash plate to push it up at the swash plate control position (11).

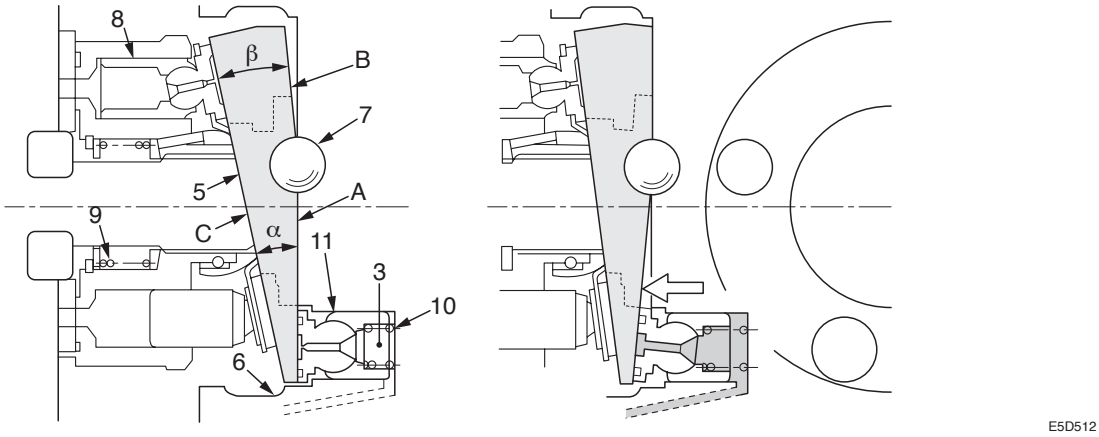



If the control valve is switched to the 2nd speed side position, hydraulic oil is introduced from the port to the spool (1) and the spool (1) switches to the right. As a result, some of the high pressure oil flows to the swash plate control piston chambers (3) through port M1, port Pi1, port M2 and port Pi2, respectively, moving the pistons.

When the engine stops, no hydraulic oil comes, so the spool (1) returns to the 1st speed by the spring (2).




### Swash Plate




The swash plate (5) has 3 planes, A, B and C, as shown in the figure, and it is assembled in such a way that its angle of inclination in the flange holder (6) can varied by two balls (7). When the 2-speed control valve is switched to the 1st speed side, the swash plate control piston chamber (3) is connected to tank port and the swash plate (5) is stabilized at plane A, forming swash plate angle $\alpha$, by the piston assembly (8) and the force of the springs (9), (10), achieving 1st speed (low speed) motor rotation.

When the 2-speed control valve is switched to 2nd speed, the swash plate control piston chamber (3) is connected to the motor drive pressure port and the swash plate (5) stabilizes at plane B due to the equilibrium between the force of the springs (9), (10) and the force of the control piston (11), thus, assuming swash plate angle $\beta$. In this way, 2nd speed (High speed) motor rotation is achieved.

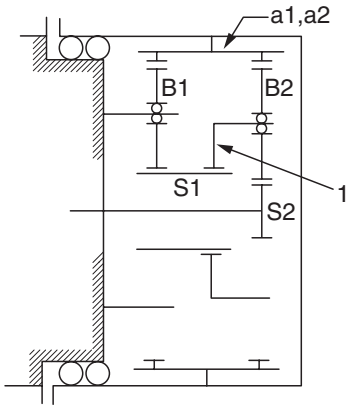
When the engine is stopped, the pilot pressure of the 2-speed control valve is cut off, so the swash plate (5) is stabilized at the swash plate a plane A by the force of the springs (9), (10), changing to the 1st speed side. For this reason, when starting, the motor also is in 1st speed.

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### Reduction Gears

The reduction gear has a simple planetary two-stage configuration. It decelerates the high speed rotary motions of the hydraulic motor, converts them into low speed high torque, and rotates the case. The output shaft of the hydraulic motor is connected to the gear S2 via the spline. The rotation of the gear S2 is decelerated by one stage among the gears S2, B2 and a2. This one-stage decelerated rotation is further decelerated by two stages among the gears S1, B1 and a1 that are connected to the carrier 2 (1) via the spline. This rotation is conveyed to the rotary main body via the inner gears a1 and a2 as the driving force of the motor.



C4D560

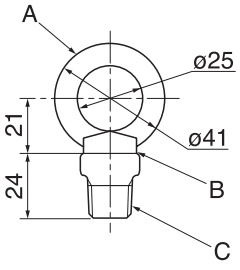
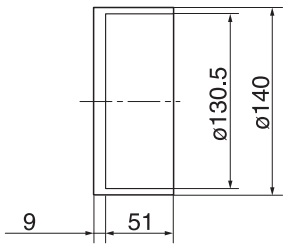
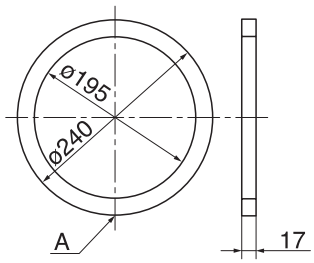
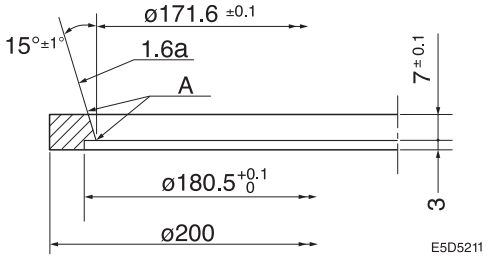
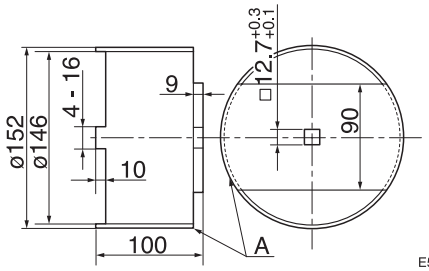
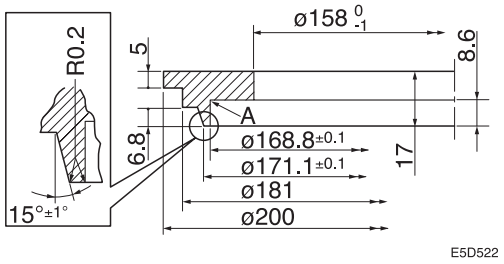
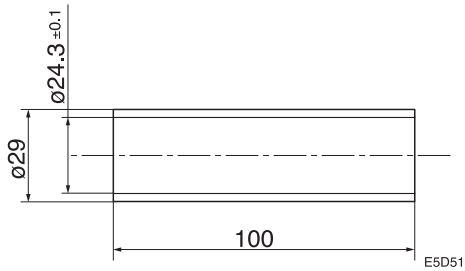
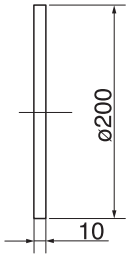
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## DISASSEMBLY AND ASSEMBLY

### Table of Special Tools

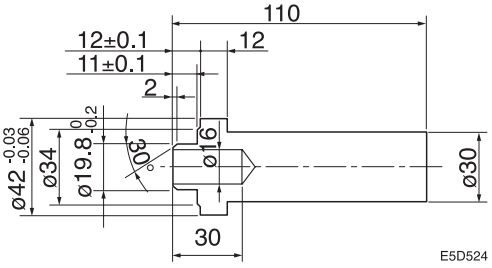
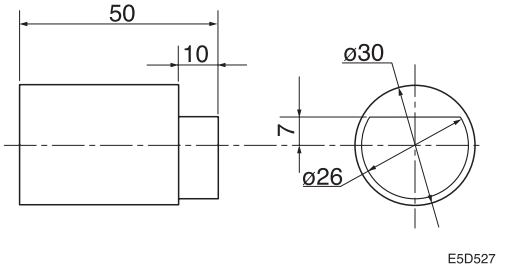
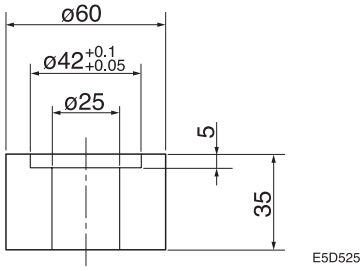
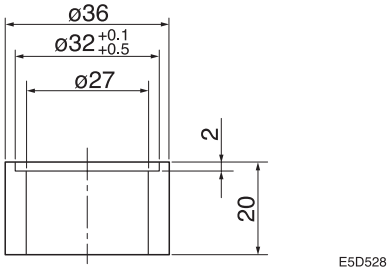
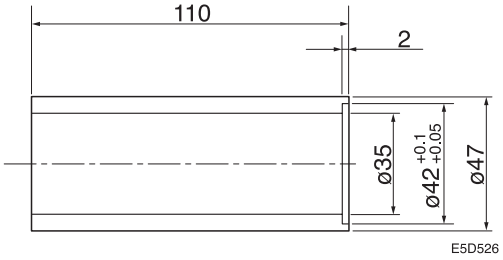
Unit: mm

| | NAME, DIMENSIONS | | NAME, DIMENSIONS |
|---|---|---|---|
| 1 | EYE BOLT<br>  <br>E5D516<br>A: EYE BOLT JIS B 1168 M10<br>B: WELD<br>C: BUSHING PT 3/8 × 1/4 | 5 | PRESSURE FITTING JIG (D)<br>  <br>E5D520 |
| 2 | REMOVING JIG (A)<br>  <br>E5D517<br>A: DIVIDED INTO 2 EQUAL PARTS | 6 | INSTALLATION JIG (E)<br>  <br>E5D5211<br>A: FINE CHAMFERING |
| 3 | TIGHTENING JIG (B)<br>  <br>E5D518<br>A: WELD | 7 | INSTALLATION JIG (F)<br>  <br>E5D522<br>A: R0.3 OR LESS |
| 4 | REMOVING JIG (C)<br>  <br>E5D519 | 8 | PRESSURE FITTING JIG (G)<br>  <br>E5D523 |

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Unit: mm

| | NAME, DIMENSIONS | | NAME, DIMENSIONS |
|---|---|---|---|
| 9 | PRESSURE FITTING JIG (H)<br>  | 12 | INSTALLATION JIG (K)<br>  |
| 10 | PRESSURE FITTING JIG ( I )<br>  | 13 | PRESSURE FITTING JIG (L)<br>  |
| 11 | PRESSURE FITTING JIG (J)<br>  | | |

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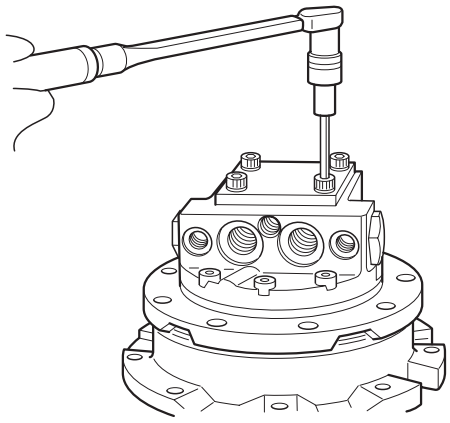


### General Cautions

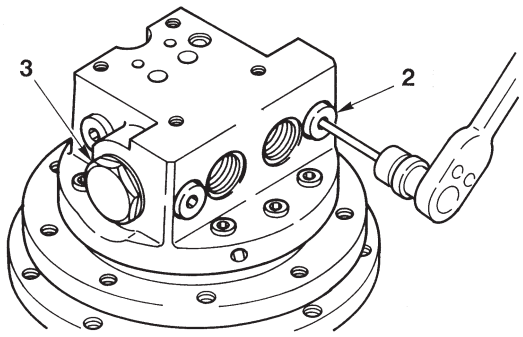
- Carry out disassembly and assembly operations in a clean place and provide clean containers to place the disassembled parts in.
- Before disassembly, clean around the ports and remove the paint from each joint using a wire brush.
- Wash the disassembled parts and dry them with compressed air. Do not use a rag, as this could cause clogging of dirt.
- Make match marks on each part so that they will be assembled in the same positions when reassembled.
- Replace all seals with new ones each time the unit is disassembled, coating them lightly with grease.
- Check each part to make sure there is no abnormal wear or seizing and use sandpaper, etc. to remove any burrs, sharp edges, etc.

### Disassembly

1. Take out the cap screws and remove the plate.

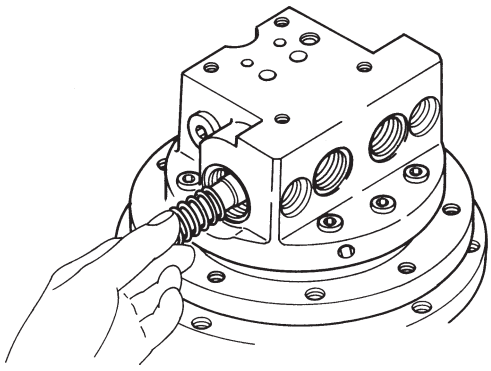

E5D529

2. Take out the plug (2) and remove the plug (3).



Y6–D517

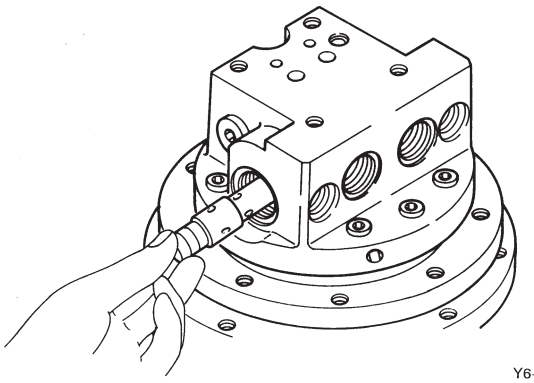
3. Remove the spring and spring seat.


Y6–D518

https://truckmanualshub.com/

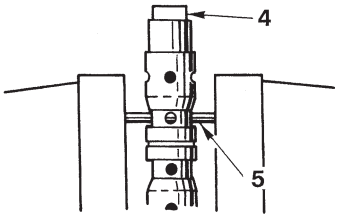


4. Remove the spool assembly.
   - Remove the spool assembly while turning it gently.
   - Be careful not to scratch or bruise the outside surface.



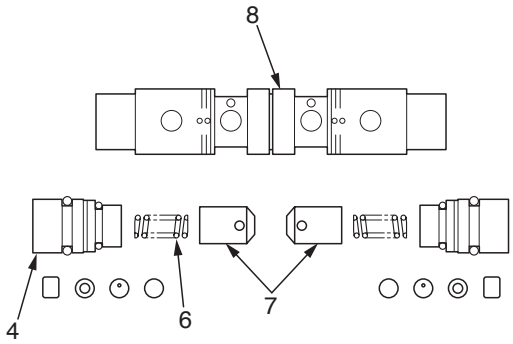
Y6–D519

5. Disassemble the spool assembly.
   - Do not disassemble the spool assembly unless it is absolutely necessary.
   a. Take out the plug (4).
      - Insert a ø5 × 30 mm pin (5) in the ø6 through hole in the spool, then fasten the pin (5) by both ends in a vise and fasten the spool assembly.



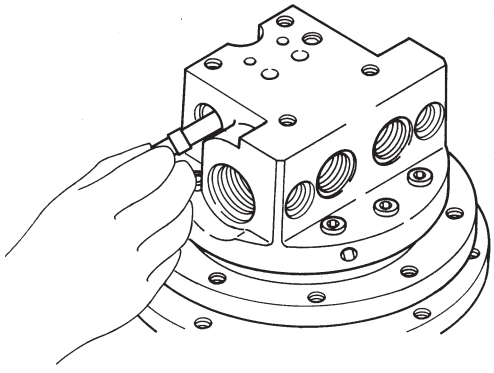

Y6–D520

   b. Remove the spring (6) and check valve (7).
      - Be sure to keep the parts of the spool (8) assembly so that the left-right combination of the check valve (7) with respect to the spool (8) is kept the same when they are assembled.




E5D530

6. Remove the plug, then remove the spring and spool.
   - Do not scratch or bruise the outside surface of the spool.

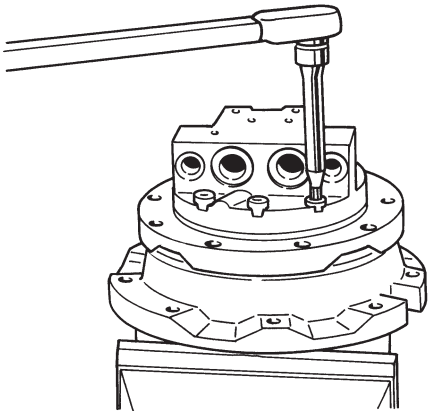


Y6–D522

https://truckmanualshub.com/

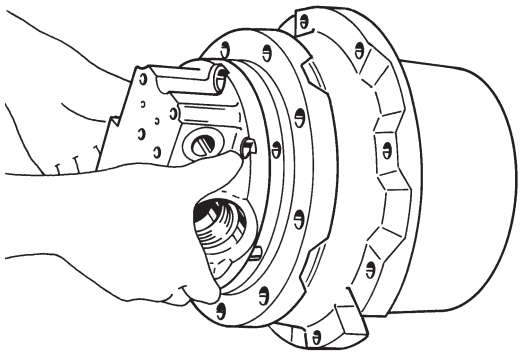


7. Take out the cap screws.



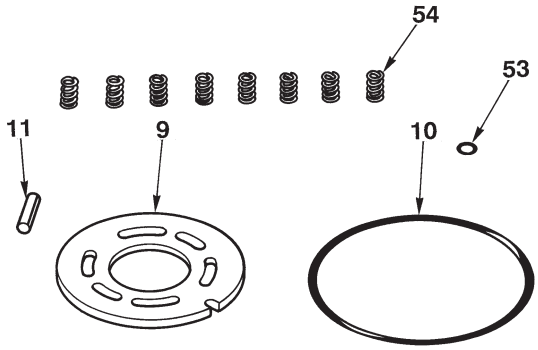
Y6–D523

8. Remove the valve body.
   - Be careful not to let cylinder block come out.
   - If it is difficult to remove, tap on it gently in the removal direction using a plastic hammer or pry it gently with a screw driver.



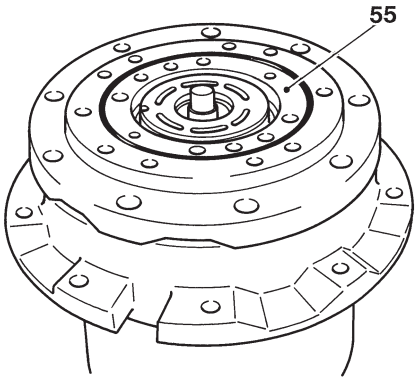
Y6–D524

9. Remove the pin (11), valve plate (9), O-ring (53) and spring (54).




Y6–D576

10. Remove the brake piston (55).
    - Blow compressed air into the parking brake release port of the flange holder and remove the brake piston.



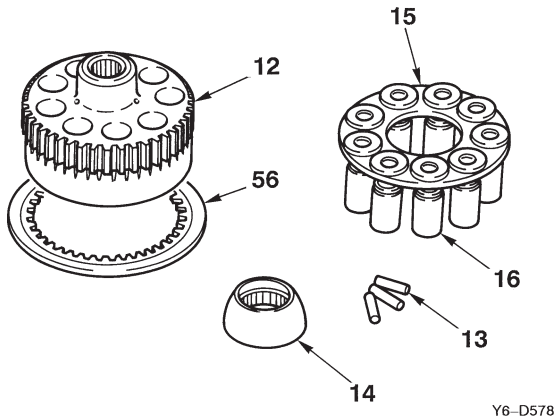

Y6–D577

https://truckmanualshub.com/



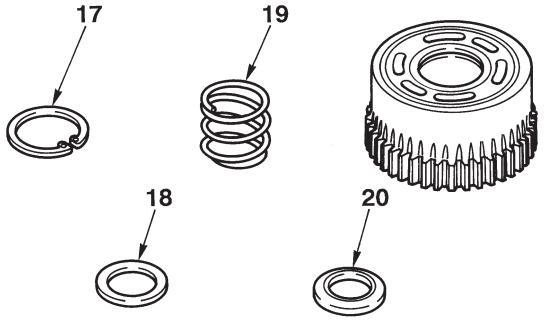
11. Remove the cylinder block assembly (12).

12. Disassemble the cylinder block assembly (12).
    a. Remove the pin (13), guide (14), shoe holder (15), piston assembly (16) and disc (56).
       • Be careful not to scratch the sliding surfaces of the cylinder block.



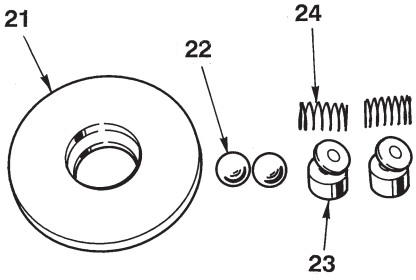
Y6–D578

    b. Remove the snap ring (17).
    c. Remove the retainer (18), spring (19) and retainer (20) from the cylinder block.
       • Do not scratch the sliding surfaces of the cylinder block.



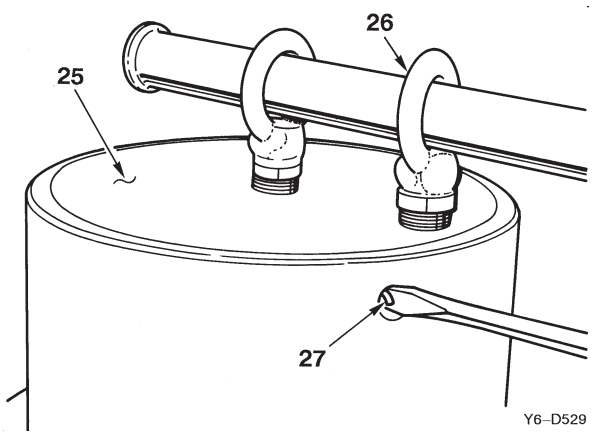
Y6–D579

13. Remove the swash plate (21), ball (22), piston assembly (23) and spring (24) from the flange holder.



Y6–D528

14. Remove the cover (25).
    a. Take out the plug, then set eye bolts (26) in the threaded holes, pass a round bar through the eye bolts and turn the cover (25) until the wire (27) can be seen.
    b. While pulling on the end of the wire (27) with pliers, turn the cover (25) and pull the wire (27) out.
    c. Remove the cover (25) by hooking a hook in the eye bolt (26) or using the round bar.



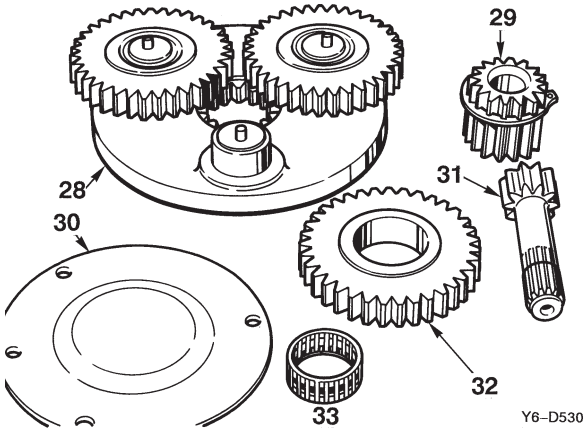
Y6–D529

https://truckmanualshub.com/

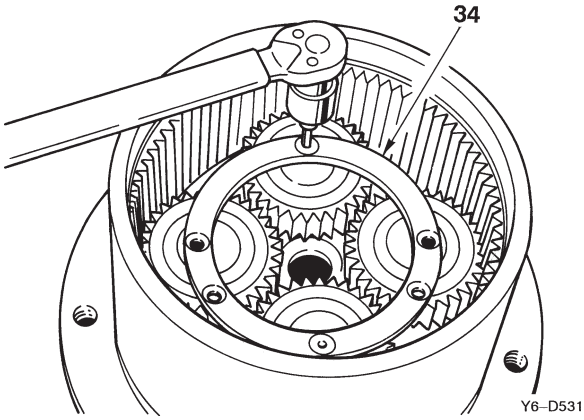


15. Remove the carrier assembly (28) and gear S1 (29).

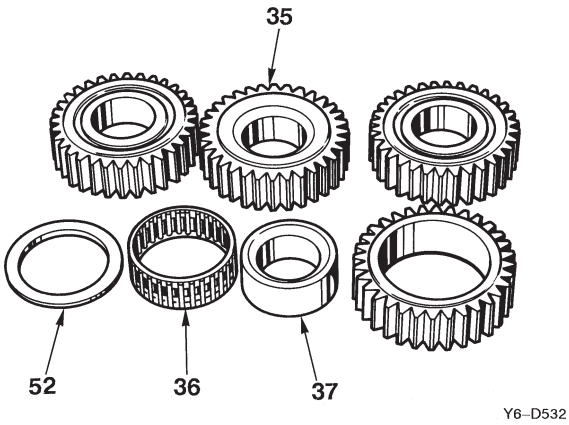
16. Disassemble the carrier assembly (28).
    a. Remove the thrust plate (30), then remove the gear S2 (31).
    b. Remove gear B2 (32) and inner race, needle (33).



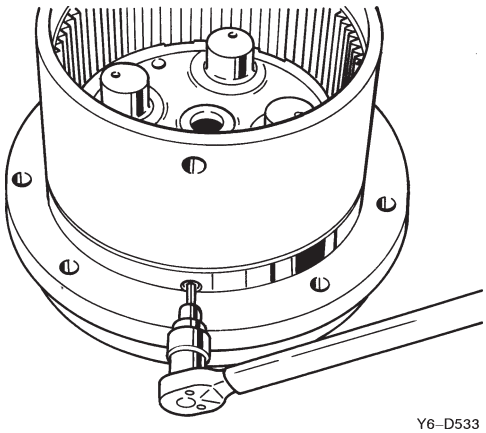

17. Remove the screw, then remove the thrust plate (34).




18. Remove gear B1 (35), the needle (36), inner race (37) and thrust washer (52).
    • Do not scratch the gear tooth surfaces or the rotating surface of the inner race (37).



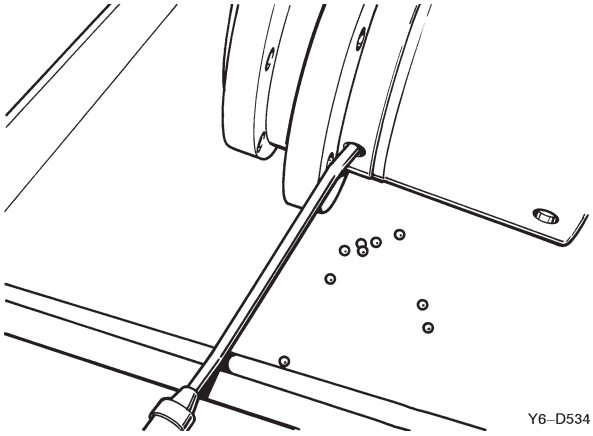

19. Remove the plug.



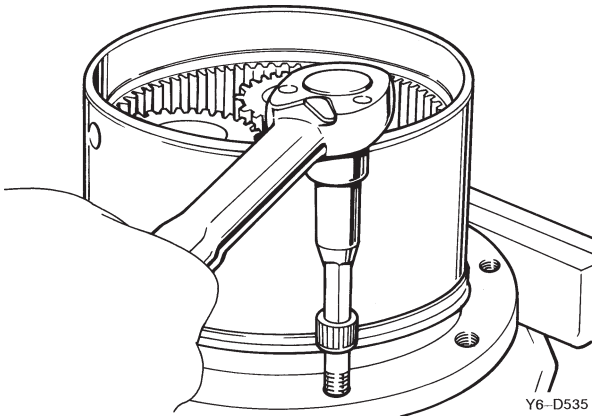
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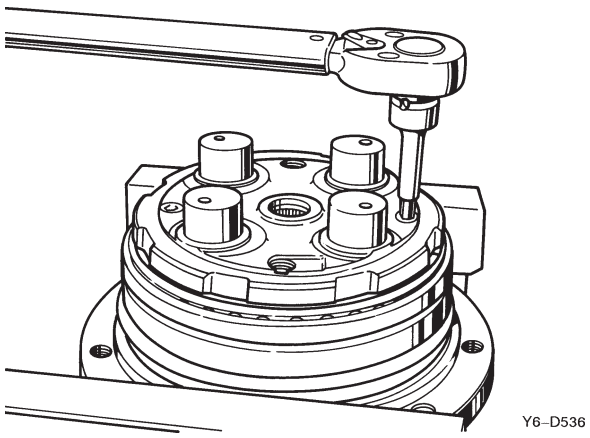
20. Take out the balls.
    a. After degreasing with paint thinner, white gasoline or similar cleaning oil, blow with air to remove the balls.
       • If the balls are difficult to remove, tap on the outside of the housing with a hammer.
    b. Insert a piece of piano wire through the bolt hole to make sure that all the balls have been removed.



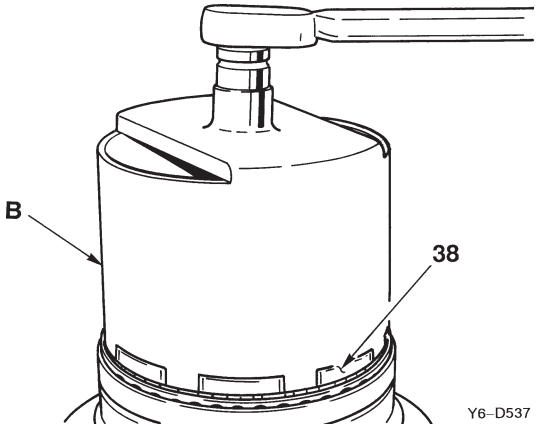

21. Disassemble the flange holder and housing.
    a. Insert a metal plate or removing jig (A) between the flange holder and housing.
    b. Tighten with 3 cap screws (M14 × 2.0) which are spaced equally apart.




22. Take out the plug.



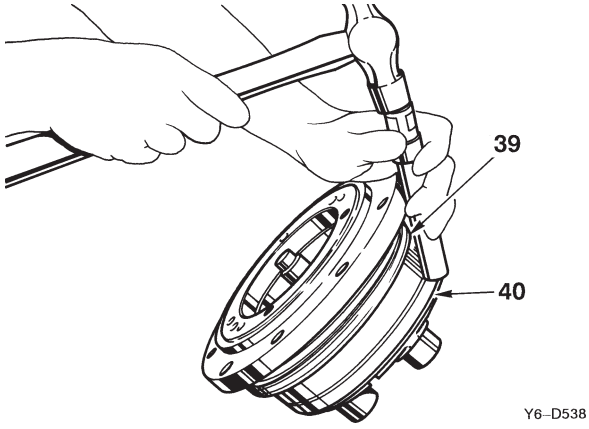

23. Remove the ring nut (38).
    • Use a tightening jig (B).



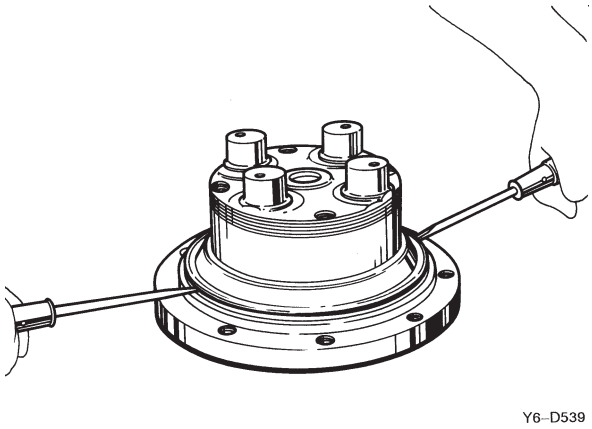
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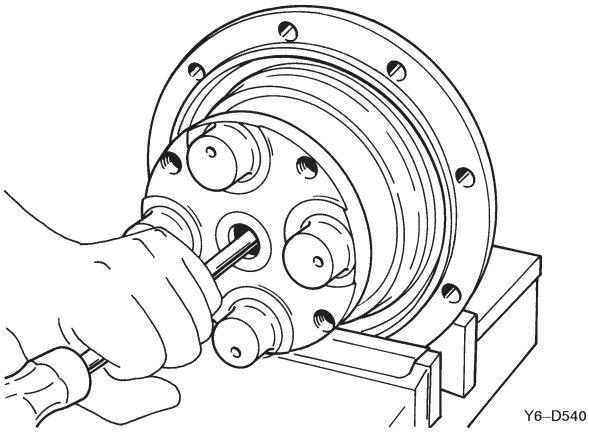
24. Remove the angular bearing (40) and remove the floating seal (39).
    - Place one end of a round bar against the steel groove and tap the other end of the bar with a hammer to remove the angular bearing (40).



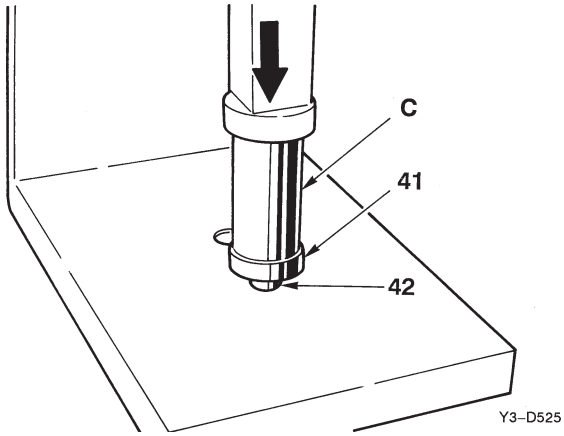

25. Remove the floating seal.




26. Remove the shaft, then remove the oil seal.
    - Bring a round bar in contact with the round hole of the shaft and tap lightly with a hammer.
    - Use a (–) screw driver to remove the oil seal.




27. Remove the bearing (41) from the shaft (42).
    - Use removing jig (C).

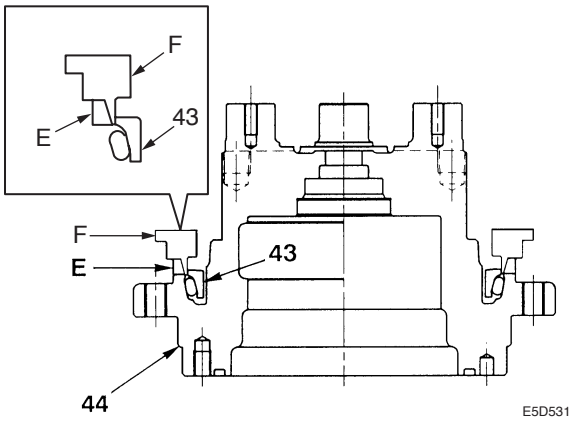


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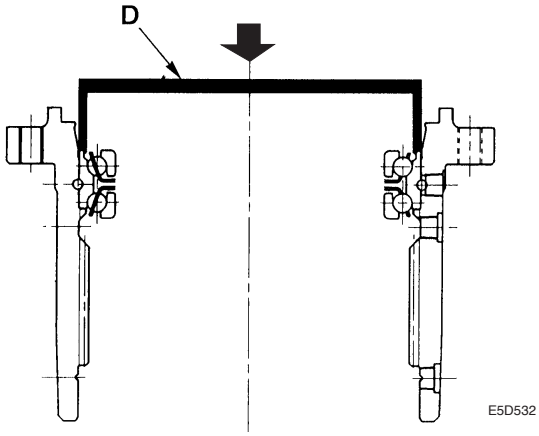


**Assembly**

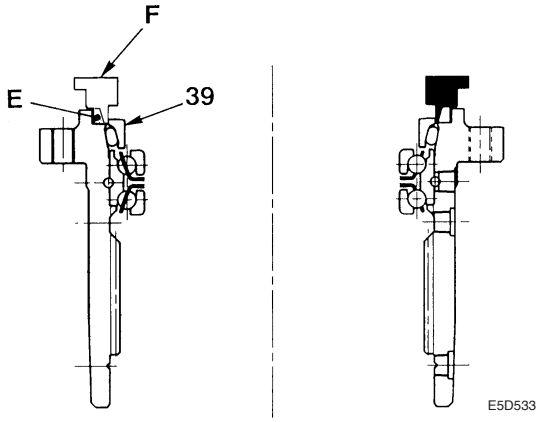
1. Install the floating seal (43) in the flange holder (44).
   a. Insert the floating seal (43) temporarily using installation jig (E).
   b. Install it using installation jig (F).



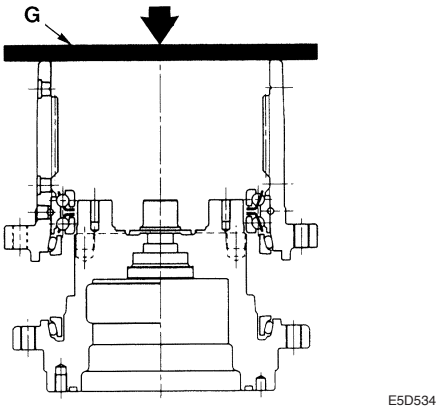

2. Install the angular bearing.
   • Use pressure fitting jig (D).




3. Install the other floating seal (39) on the housing.
   a. Insert the floating seal temporarily using installation jig (E).
   b. Install it using installation jig (F).



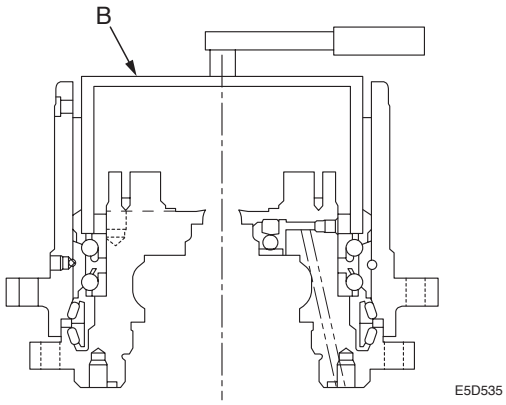

4. Install the flange holder.
   • Use pressure fitting jig (G).



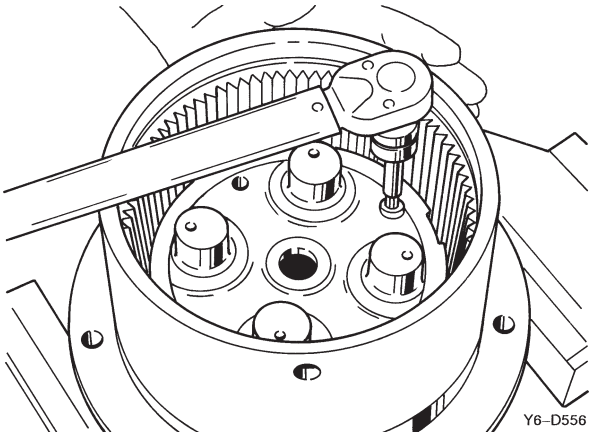
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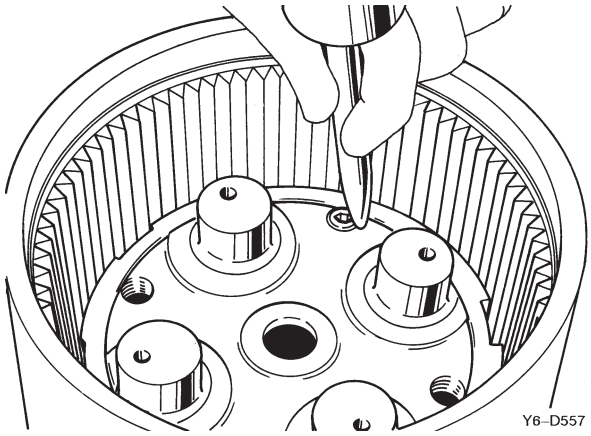
5. Tighten the ring nut to secure the angular bearing.
   - Use tightening jig (B).
   - Ring nut tightening torque:
     196 ±9.8 N·m (20 ±1 kgf·m)



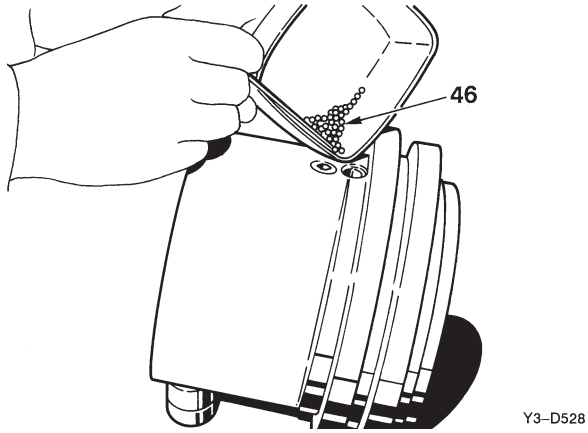

6. Install the plug.
   - The seal tape is unnecessary.
   - Plug tightening torque:
     14.7 ±4.9 N·m (1.5 ±0.5 kgf·m)




7. Stake the plug at 2 points with a punch.



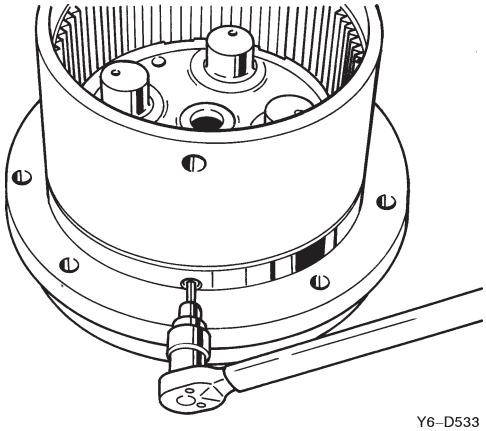

8. Put in the balls (46).



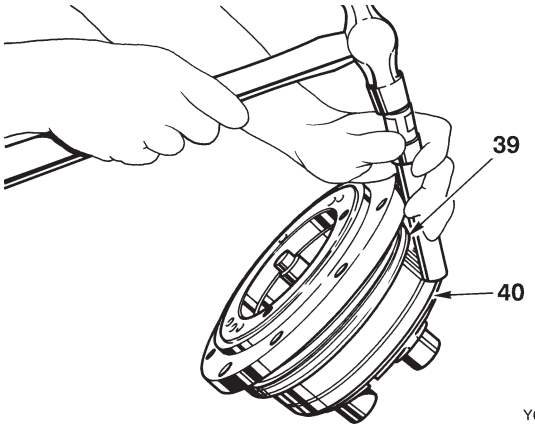
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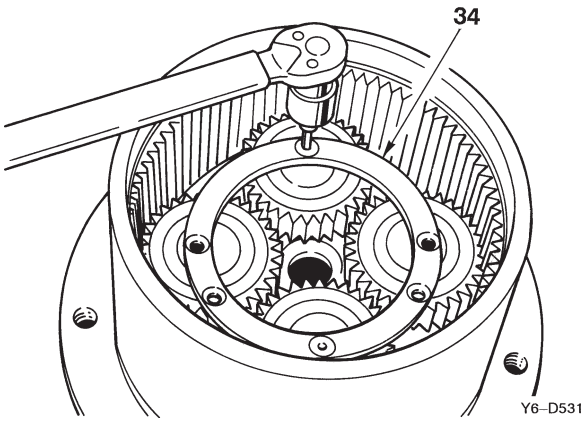
9. Install the plug.
   - Seal tape should be wound around the threads of the plug.
   - Plug tightening torque:
     7.9 ±1.0 N·m (0.8 ±0.1 kgf·m)




10. Install the thrust washer, gear B1, the inner race and the needle.

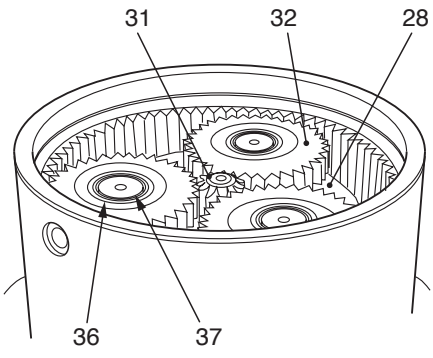



11. Install the thrust plate (34), then install the screw.
    - Apply Loctite #262 to the screw.
    - When applying Loctite, degrease all the surfaces thoroughly and use a hardening accelerator.
    - Screw tightening torque:
      6.1 ±2.0 N·m (0.62 ±0.20 kgf·m)




12. Install the snap ring on the gear S1, then install the gears S1.

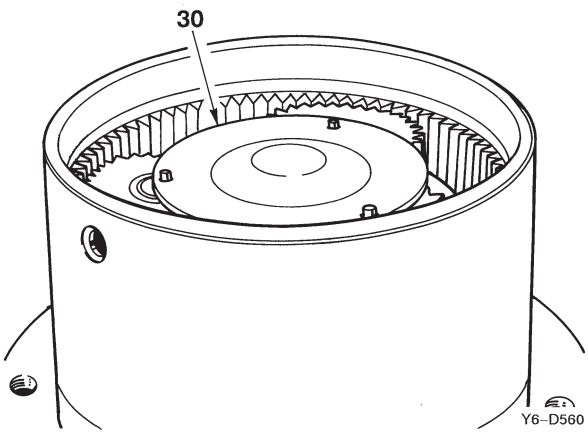
13. Install the carrier assembly.
    a. Install the inner race (37), the needle (36) and gear B2 (32) in the carrier (28).
    b. Install the carrier in the housing.
    c. Install the gear S2 (31).



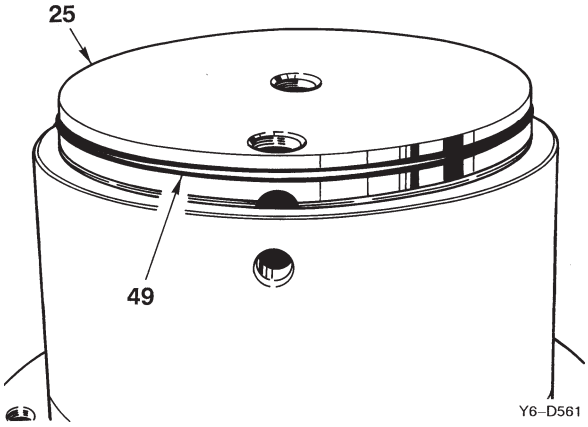
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d. Install the thrust plate (30).

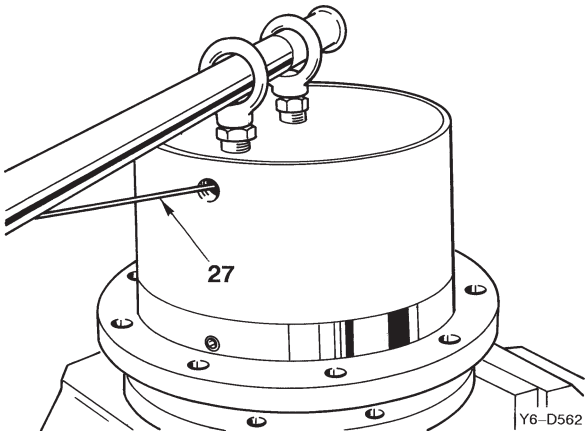



14. Fit the O-ring (49) on the cover (25) and install it on the housing.
    - Align the U-groove in the plug's hole position.

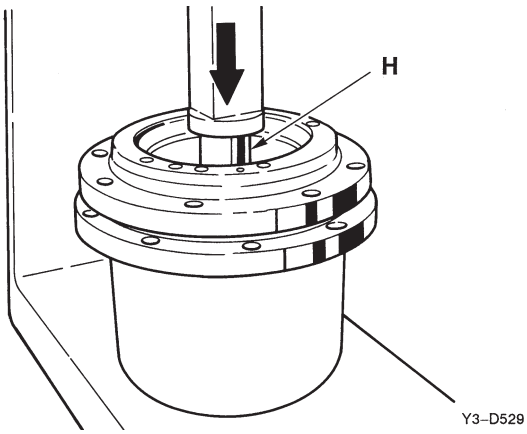



15. Install the wire (27).
    a. Bend the wire (27) at a point approximately 8 mm from the front end, then insert it in the bolt hole in the housing.
    b. Turn the cover and wind the wire (27) around it.
       - Use the eye bolts and a round bar.

16. Install the plug.
    - Wind seal tape around the threads of the plug.
    - Plug tightening torque:
      7.9 ±1.0 N·m (0.8 ±1.0 kgf·m)



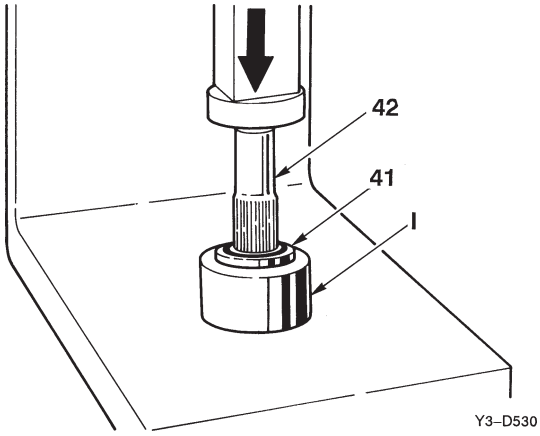

17. Install the oil seal in the flange holder.
    - Use pressure fitting jig (H).



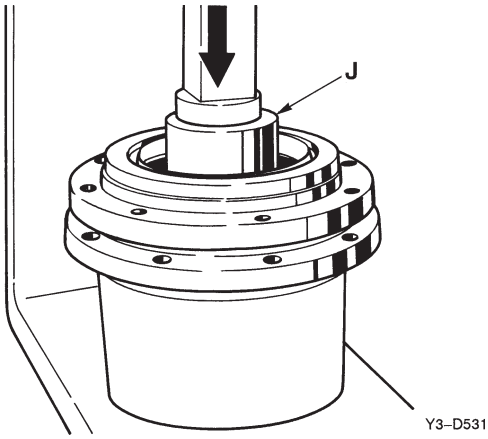
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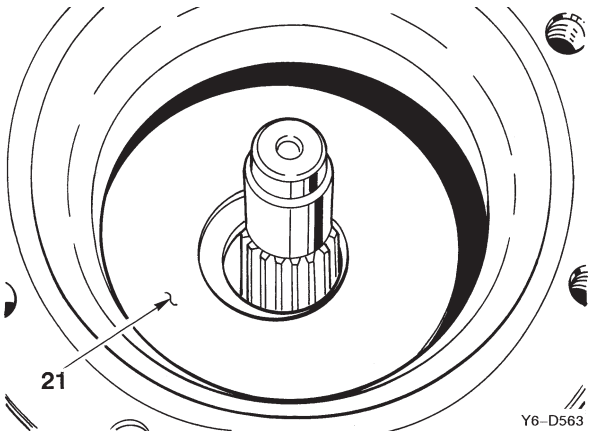
18. Install the ball bearing (41) on the shaft (42).
    - Use pressure fitting jig (I).



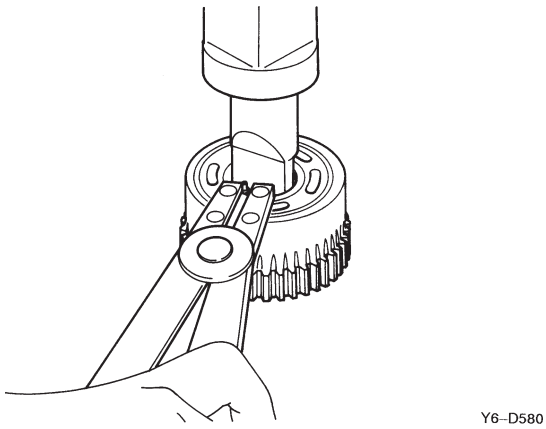

19. Install the shaft assembly in the flange.
    - Use pressure fitting jig (J).




20. Put in the balls and install the spring, piston assembly and swash plate (21).
    - Apply hydraulic oil to the sliding surfaces of the swash plate.



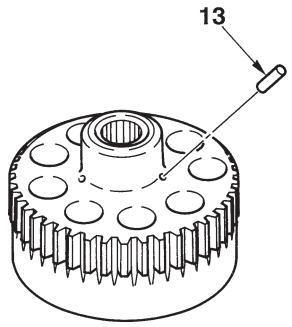

21. Assemble the cylinder block assembly.
    a. Install the collar, spring and washer in the cylinder block.
    b. Install the snap ring.
       - Use the installation jig (K).



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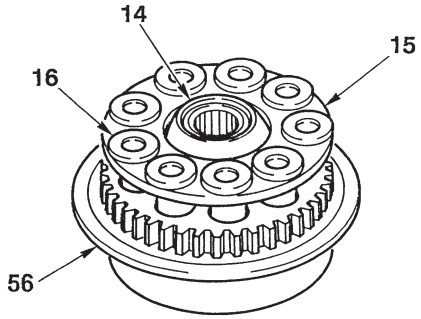


c. Install the pin (13) in the cylinder block.
   • Apply grease to the pin.



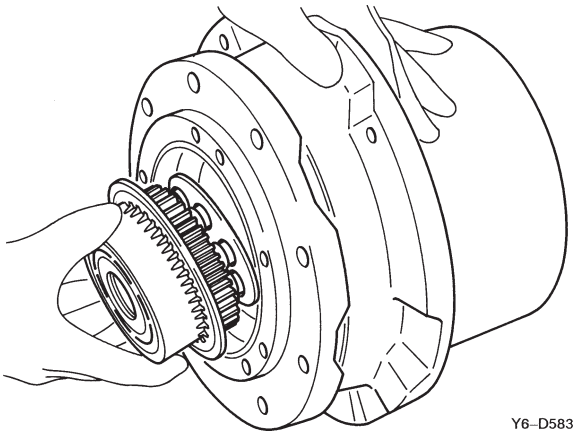

Y6–D581

d. Install the guide (14), shoe holder (15), piston assembly and disc (56).
   • Apply hydraulic oil to the hole in the cylinder block.



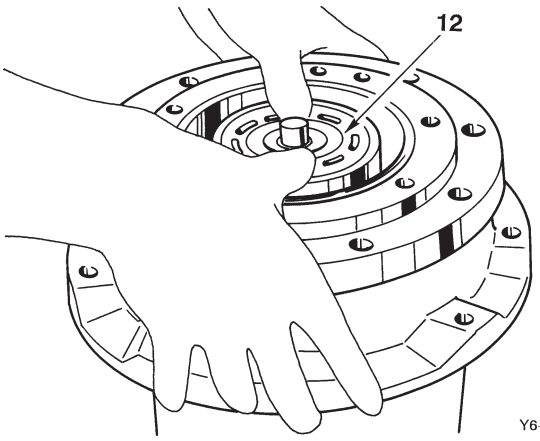

E3–5094

22. Install the cylinder block assembly.
    a. Install the shaft spline in the guide.



Y6–D583

b. Push the cylinder block (12) by hand, making sure the spring is working.
   • Apply hydraulic oil to the sliding surfaces of the cylinder block.

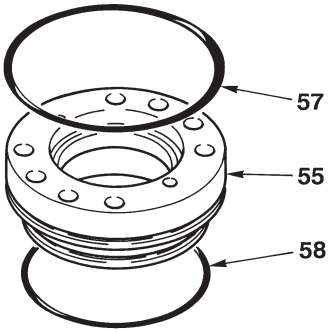



Y6–D568

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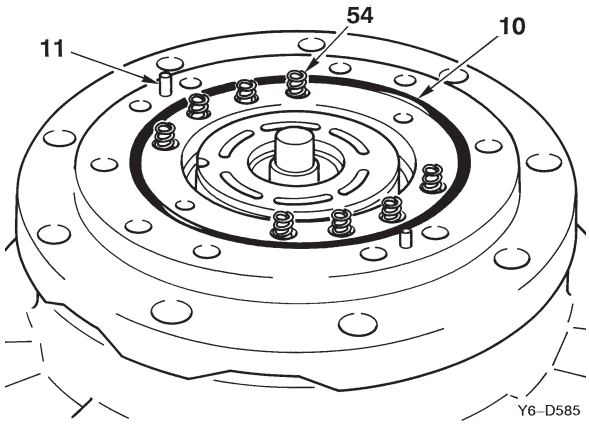
23. Fit the O-ring (57), (58) on the brake piston (55).




Y6–D584

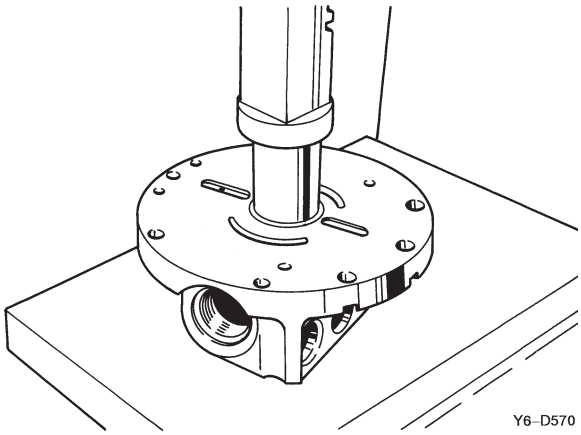
24. Install the brake piston on the flange holder.

25. Install the spring (54), O-ring (10) and pin (11) in the flange holder.



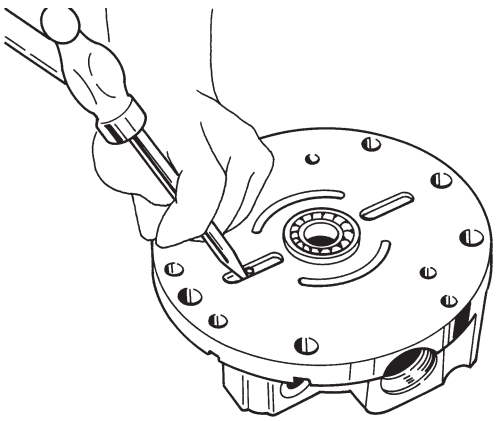

Y6–D585

26. Install the ball bearing in the valve body.
    - Use pressure fitting jig (L).



Y6–D570

27. Install the pin and stake it at 2 points.

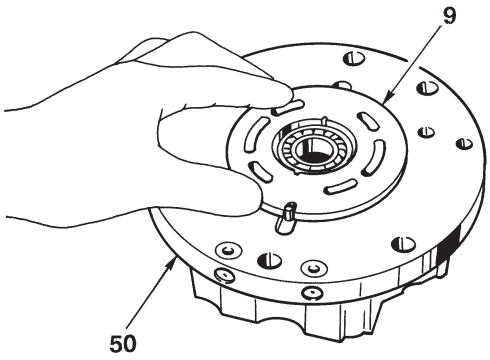


Y6–D571

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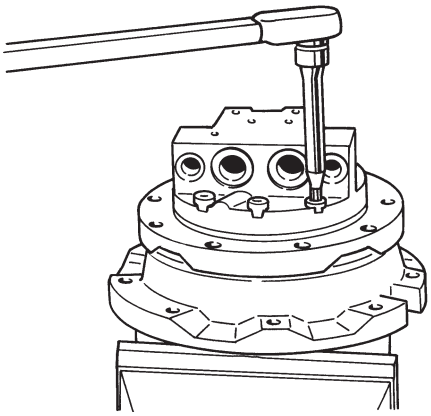


28. Install the valve plate (9) and O-ring on the valve body (50).
    - Apply grease to the bottom side of the valve plate (9).

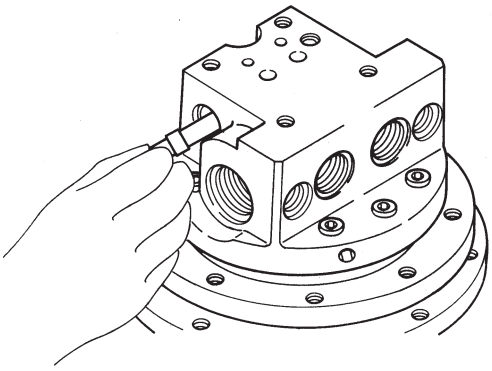


Y6–D572

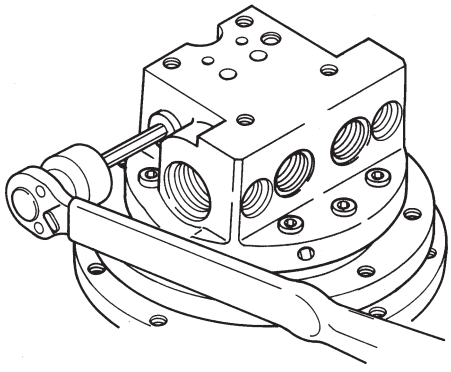
29. Set the valve body, then tighten the cap screw.
    - Cap screw tightening torque:
      63.7 ±4.9 N·m (6.5 ±0.5 kgf·m)


Y6–D523

30. Set the spring on the spool, then install it the valve body.
    - Install the spool while turning it, making sure it doesn't get caught.
    - Apply hydraulic oil to the spool.


Y6–D522

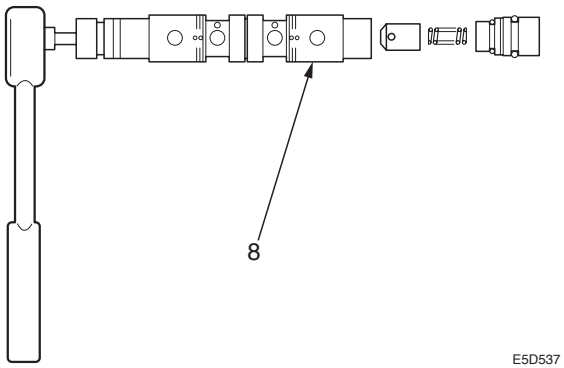
31. Fit an O-ring on the plug, then install it in the valve body.
    - Plug tightening torque:
      53.9 ±4.9 N·m (5.5 ±0.5 kgf·m)


Y6–D573

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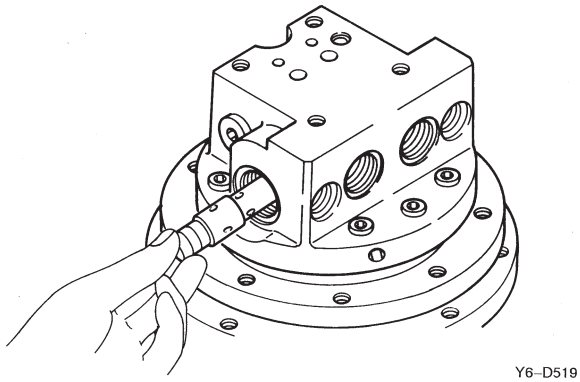


32. Assemble the spool assembly.
    a. Install the check valve and spring on the spool (8).
    b. Fit the O-ring on the plug, then install it in the spool.
       • Plug tightening torque:
         31.9 ±2.5 N·m (3.25 ±0.25 kgf·m)

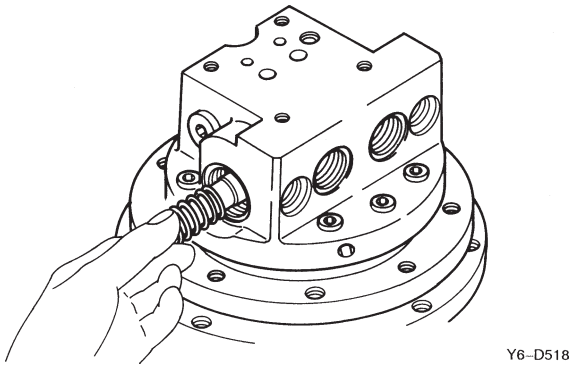


E5D537

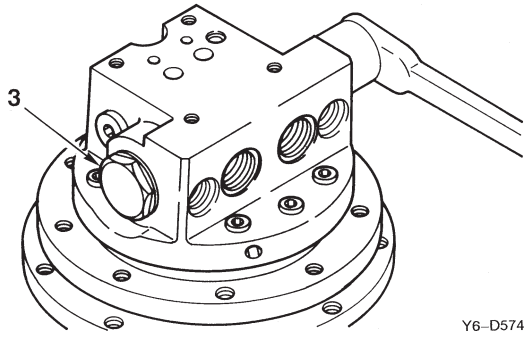
33. Install the spool assembly in the valve body.
    • Install the spool assembly while turning it, making sure it doesn't get caught.
    • Apply hydraulic oil to the spool assembly.


Y6–D519

34. Install the spring seat and spring.


Y6–D518

35. Fit the O-ring on the cap, then install the valve body.
    • Tightening torque:
      240 ±5 N·m (24.5 ±0.5 kgf·m)

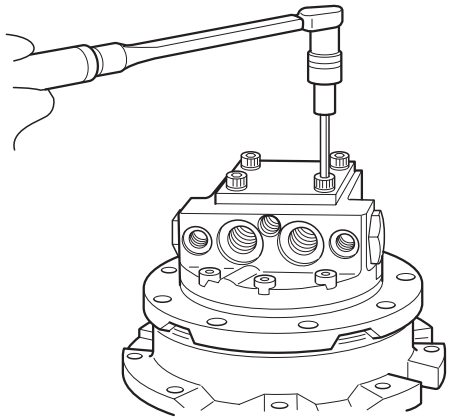


Y6–D574

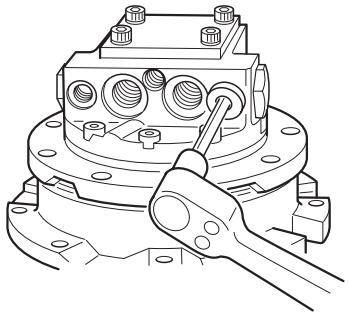
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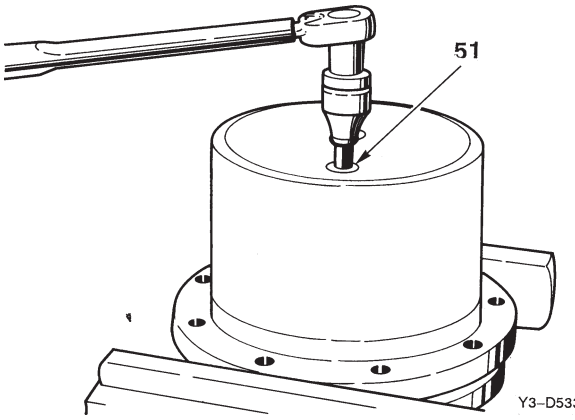
36. Install the O-ring in the plate, then install the plate on the valve body.
    - Cap screw tightening torque:
      29.4 ±2.0 N·m (3.0 ±0.2 kgf·m)


E5D529

37. Fit the O-ring on the plug (2), then install the plug in the valve body.
    - Plug tightening torque:
      34.3 ±4.9 N·m (3.5 ±0.5 kgf·m)


E5D538

38. Pour gear oil in through the plug hole, then install the plug (51).
    - Wind seal tape around the plug.
    - Quantity of oil: Approx. 0.5 L
    - Plug tightening torque:
      34.3 ±4.9 N·m (3.5 ±0.5 kgf·m)



Y3–D533

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## INSPECTION AND ADJUSTMENT

### Checking the Parts

| Parts | Area Checked | Judgement Criteria | Treatment |
|---|---|---|---|
| Floating Seal | Sliding Surface | There should be no abnormal scratches, wear or seizing. | Replace |
| Angular Bearing | Sliding Surface | There should be no abnormal scratches, wear, flaking, etc. in the ball or race. | Replace |
| Planetary Gears | Surface of Gear Teeth | There should be no abnormal scratches, wear or flaking of the tooth surfaces (if there has been pitting which covers 5% or more of the engagement portion of the tooth surface). | Replace |
| | Front of cage and roller rotating surface. | There should be no abnormal scratches, wear or flaking of the rotating surface. | |
| Inner Race | Surface condition of inner race rotating surface. | There should be no abnormal scratches, wear or flaking of the rotating surface. | Replace |
| Needle | Surface of needle. | There should be no abnormal scratches, wear or flaking. | Replace |
| Thrust Washer | Front of sliding surface | There should be no abnormal scratches, wear or seizing. | Replace |
| Housing, Sun Gear, Drive Gear | Front of Gear Tooth Surfaces | There should be no abnormal scratches, wear or flaking in the tooth surfaces (if there has been pitting which covers 5% or more of the engagement portion of the tooth surface). | Replace |
| Thrust Plate | Front of sliding surface. | There should be no abnormal scratches (0.02 mm or greater), wear or seizing, etc. | Replace |
| O-ring | — | — | Replace |
| Shaft | Surface of oil seal. | There should be no scratches or abnormal wear. | Replace |
| Ball Bearing | Front of sliding surface. | There should be no abnormal scratches, wear or flaking in the ball and race. | Replace |
| Oil Seal | — | — | Replace |
| Swash Plate | Front of the surface which slides with the sliding surface of the piston assembly. | There should be no abnormal scratches (0.02 mm or greater), wear or seizing. | Repair by lapping (#1000) or replace. |
| Cylinder Block | Clearance with the piston assembly. | 0.04 mm or greater | Repair with wrap (#1000) or replace the cylinder block and piston assembly at the same time. |
| | Front of the surface which slides with the valve plate. | There should be no abnormal scratches (0.02 mm or greater), wear or seizing. | |
| Piston Assembly | Clearance with cylinder block | 0.04 mm or greater | |
| | Front of the surface which slides with the swash plate. | There should be no abnormal scratches (0.02 mm or greater), wear or seizing. | |
| | Clearance between piston and shoe. | 0.4 mm or greater | Replace |

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| Parts | Area Checked | Judgement Criteria | Treatment |
|---|---|---|---|
| Valve Plate | Front of the surface which slides with the spool. | There should be no abnormal scratches (0.02 mm or greater), wear or seizing. | Repair by lapping (#1000) or replace. |
| Base Plate | Front of the surface which slides with the spool. | There should be no abnormal scratches, wear or seizing. | Replace the base plate and the spool at the same time. |
| Spool | Front of the surface which slides with the base plate. | There should be no abnormal scratches, wear or seizing. | |
| | Front of the surface which slides with the check valve. | There should be no abnormal scratches, wear or seizing. | Replace the spool and the check valve at the same time. |
| Check Valve | Front of the surface which slides with the spool. | There should be no abnormal scratches, wear or seizing. | |
| | Surface of spool and seat. | There should be contact with the seat around the entire circumference. | |

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## TROUBLESHOOTING

### Hydraulic Motor

| Symptom | Probable Causes | Remedy |
|---|---|---|
| Does not move. | • Equipment other than the motor, counterbalance valve or speed reducer is malfunctioning. | • Check if the proper pressure is reached on the motor inlet port side, then check each device and repair if necessary. |
| | • Hydraulic oil is escaping due to abnormal wear of motor sliding parts.<br>• Principal motor parts are malfunctioning due to damage. | • Replace the abnormally worn parts.<br>• Replace the damaged parts. |
| Motor won't speed up. | • The proper volume of hydraulic oil is not being supplied to the motor due to the hydraulic pump, control valve, etc. | • Check if the proper pressure is reached on the motor inlet port side, then check each device and repair if necessary. |
| | • The motor's volumetric efficiency is dropping. | • Check if the sliding parts are abnormally worn, then repair or replace the worn parts. |
| Changes in rotational speed are great. | • High pressure hydraulic oil is leaking and flowing out of the drain port due to wear of the motor's sliding parts.<br>• Bearings are worn. | • Replace the abnormally worn parts.<br>• Replace the bearings if they are abnormally worn. |
| Oil is leaking. | • Oil is leaking due damage to oil seals or O-rings. | • Replace the oil seals and O-rings. |

### Counterbalance Valve

| Symptom | Probable Causes | Remedy |
|---|---|---|
| Does not move or rotation is slow. | Spool does not switch.<br>• No hydraulic oil is arriving.<br>• Foreign matter is caught.<br>• The orifice is clogged up. | <br>• Repair or replace the damaged piping.<br>• Remove the foreign matter and repair or replace the damaged parts.<br>• Clean it. |
| Won't stop or stopping is slow. | The spool won't return.<br>• Foreign matter gets caught.<br>• A spring is missing.<br>• A spring is damaged.<br>• The orifice is clogged up. | <br>• Remove the foreign matter and repair or replace the damaged parts.<br>• Install the spring.<br>• Replace the spring.<br>• Clean it. |
| Shock is great when stopping. | Spool return is fast.<br>• The spring seat is missing. | <br>• Install the spring seat. |
| Valve makes an abnormal noise. | The spool does not return.<br>• Foreign matter gets caught.<br>• A spring is damaged.<br>• The orifice is clogged up. | <br>• Remove the foreign matter and repair or replace the damaged parts.<br>• Replace the spring.<br>• Clean it. |

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### 2-speed Control Function

| Symptom | Probable Causes | Remedy |
|---|---|---|
| Machine veers during travel. | Spool doesn't switch over.<br>• Foreign matter is caught.<br>• A spring is missing.<br>• A spring is damaged. | <br>• Remove the foreign matter and repair or replace the damaged parts.<br>• Install the spring.<br>• Replace the spring. |

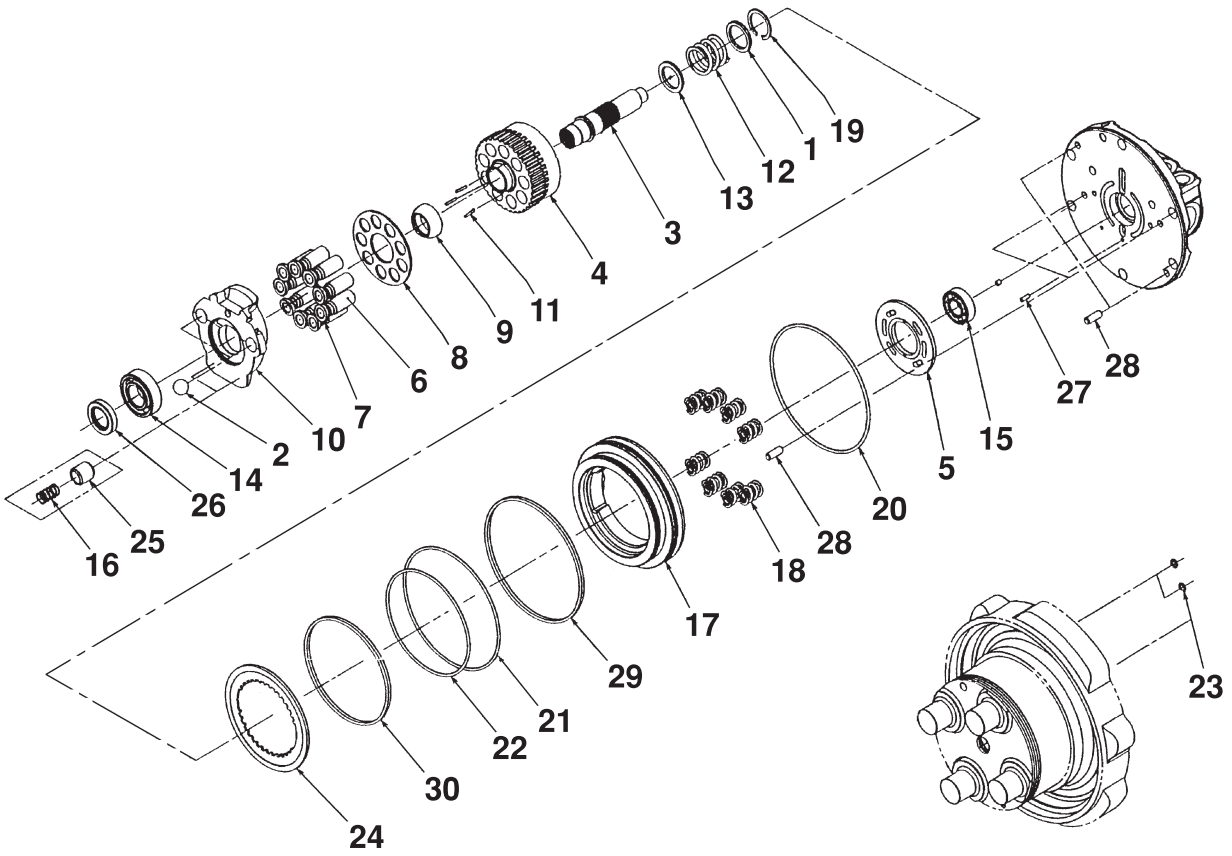
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# TRAVEL MOTOR (TB125: S/N 12514526~)

## CONSTRUCTION

### Hydraulic Motor



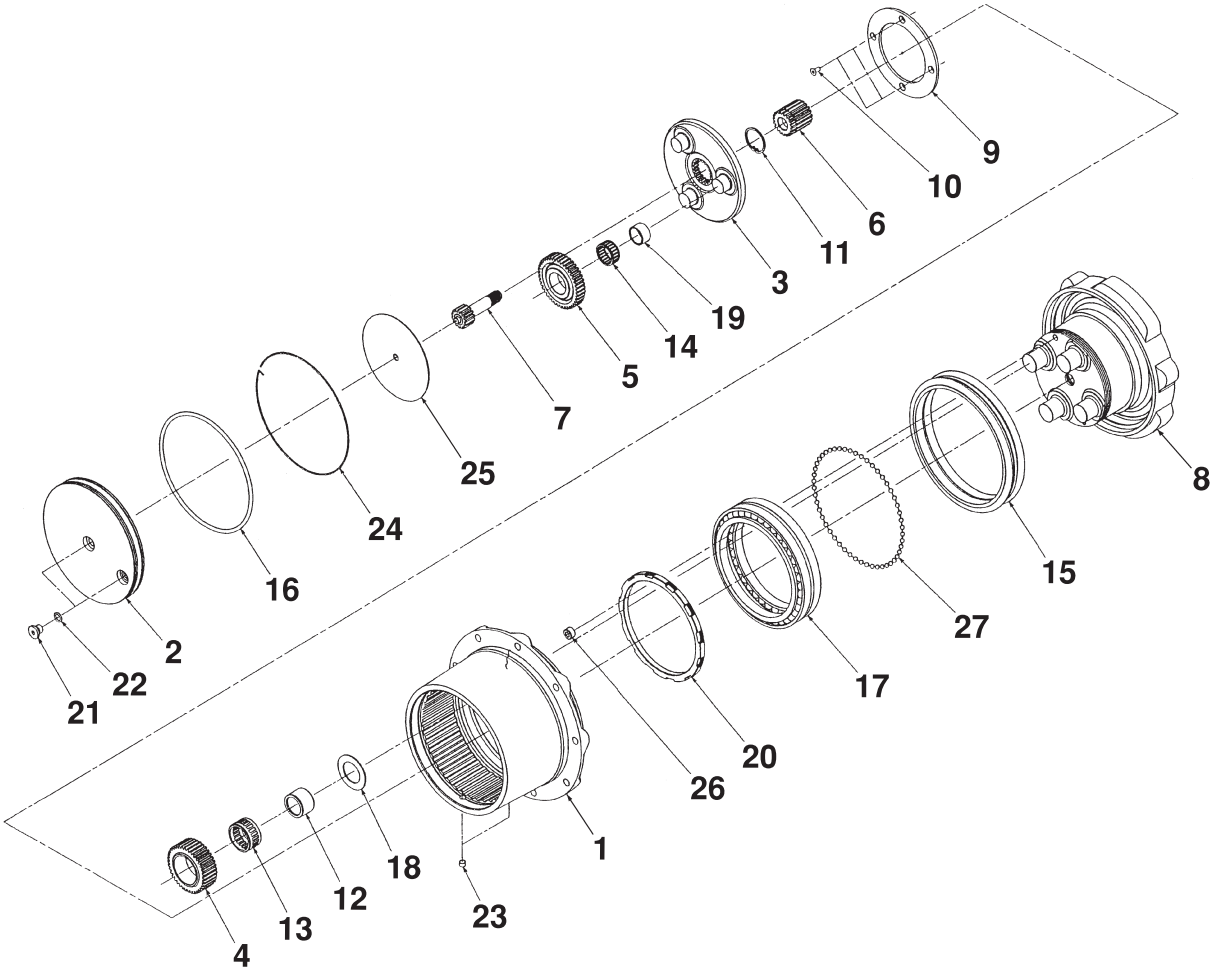

E5D540

1. Retainer
2. Ball
3. Shaft
4. Cylinder Block
5. Valve Plate
6. Piston
7. Shoe
8. Shoe Holder
9. Guide
10. Swash Plate
11. Pin
12. Spring
13. Retainer
14. Bearing
15. Bearing
16. Spring
17. Brake Piston
18. Spring
19. Snap Ring
20. O-ring
21. O-ring
22. O-ring
23. O-ring
24. Friction Disc
25. 2-Speed Piston
26. Oil Seal
27. Pin
28. Pin
29. Backup Ring
30. Backup Ring

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**Reduction Gears**



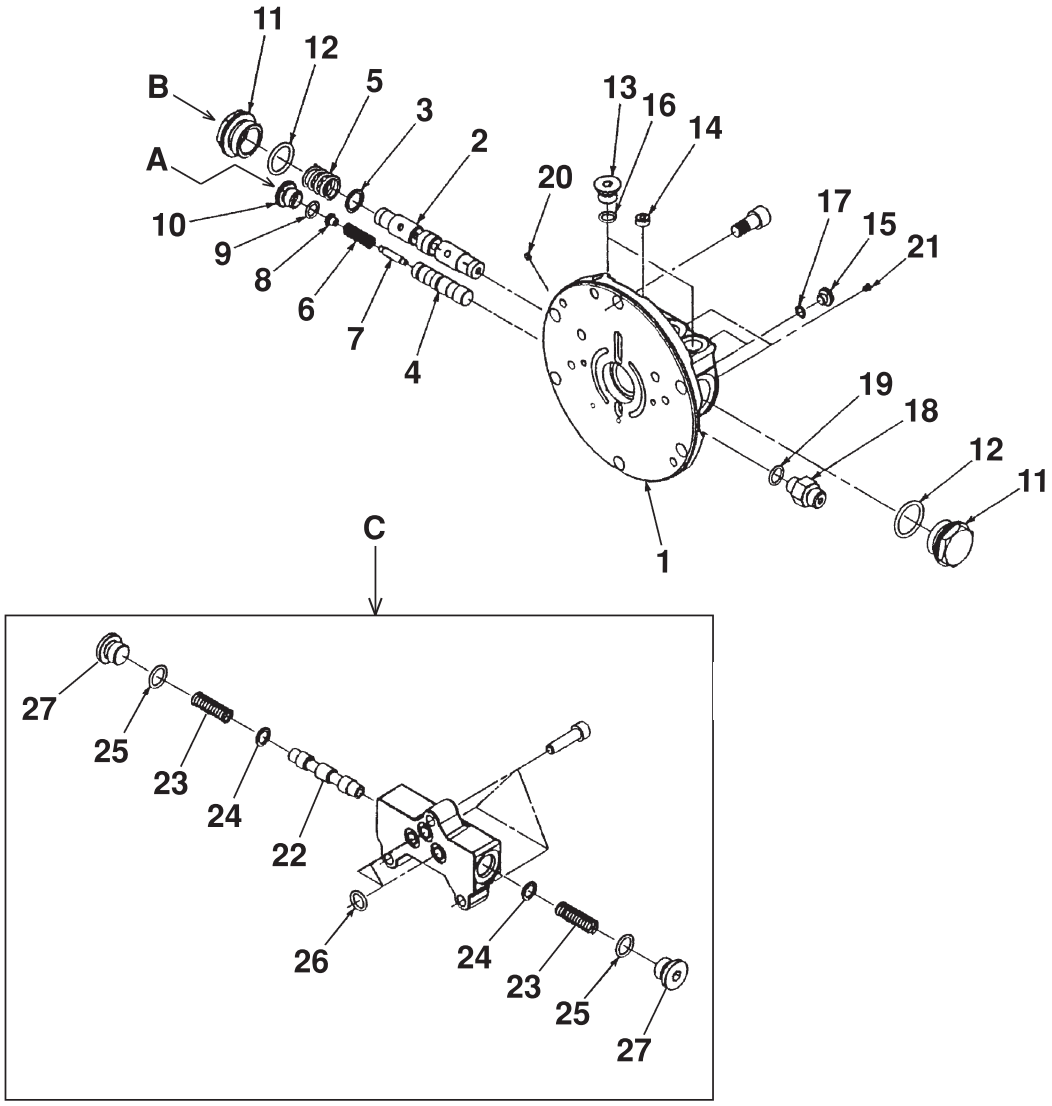

E5D541

1. Housing
2. Cover
3. Carrier 2
4. Gear B1
5. Gear B2
6. Gear S1
7. Gear S2
8. Flange Holder
9. Thrust Plate
10. Screw
11. Snap Ring
12. Inner Race
13. Needle
14. Needle
15. Floating Seal
16. O-ring
17. Bearing
18. Thrust Washer
19. Inner Race
20. Ring Nut
21. Plug
22. O-ring
23. Plug
24. Wire
25. Thrust Plate
26. Plug
27. Ball

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**Counterbalance Valve, 2-speed Control Valve**




E5D542

A: 2-Speed Control Valve
B: Counterbalance Valve
C: Anti-Cavitation Valve

| | | |
|---|---|---|
| 1. Valve Body | 10. Plug | 19. O-ring |
| 2. Spool | 11. Plug | 20. Orifice |
| 3. Spring Seat | 12. O-ring | 21. Plug |
| 4. Spool | 13. Plug | 22. Spool |
| 5. Spring | 14. Plug | 23. Spring |
| 6. Spring | 15. Plug | 24. Spring Seat |
| 7. Spool | 16. O-ring | 25. O-ring |
| 8. Spring Seat | 17. O-ring | 26. O-ring |
| 9. O-ring | 18. Plug | 27. Plug |

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## OPERATION

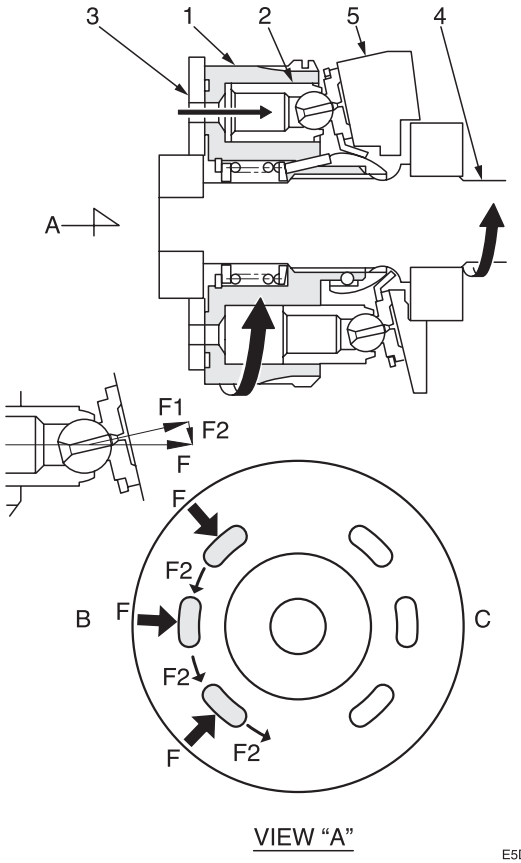
### Hydraulic Motor

9 pistons (2) are fitted in the cylinder block (1) and there is a valve plate (3) with two half moon ports, B and C in the end. Also, the cylinder block (1) rotates freely and is joined to the shaft (4) via the spline. On the other band, the swash plate (5) is fastened to the housing.

When high pressure oil is introduced into port B, one piston (2) makes contact and force F bears on the swash plate (5).

$F = P \times A$ P: Pressure A: Piston Sectional Area

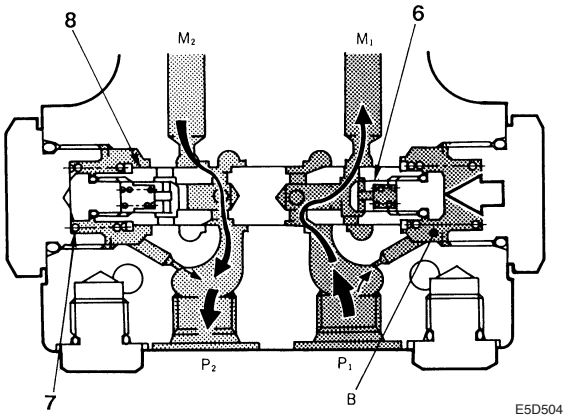
The force F which the piston (2) applies to the swash plate (5) is divided into force F1, which pushes the plate, and force F2, which rotates the cylinder block (1). The total sum of the components in the direction of rotation of the high pressure side piston generates a rotational force in the cylinder block (1) and via the spline, torque is transmitted to the shaft (4), turning it. Conversely, if high pressure oil is introduced to port C, rotation is the reverse of the above.




E5D503

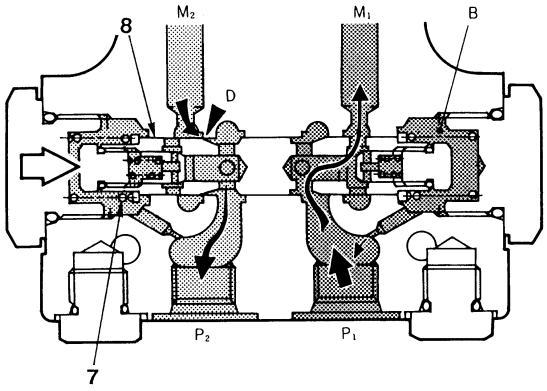
### Counterbalance Valve

If high pressure oil is introduced to port P1, the oil pushes the check valve (6) up. This causes oil to flow through the motor port M1 and to flow into chamber B of the pilot portion and fill it. When hydraulic oil flows the motor from port M1 and acts to turn the motor, even if oil returns from the motor and flows into port M2, since the flow is cut off by the check valve (6), the pressure at port P1 and in chamber B rises. If the pressure in chamber B becomes higher than the set valve of the spring (7), the spool (8) moves to the left side and ports M2 and P2 open up, causing the motor to turn.




E5D504

If the motor's turning becomes too fast, and the amount of oil flowing out of port M2 is greater than the amount of oil flowing into port M1, the pressure in port P1 and chamber B drops. When the pressure in chamber B drops below the set valve of the spring (7), the spool (8) attempts to return to the right side. As a result, since the resuming oil is constricted at portion D, back pressure is generated at port M2 and the motor's turning is slowed.



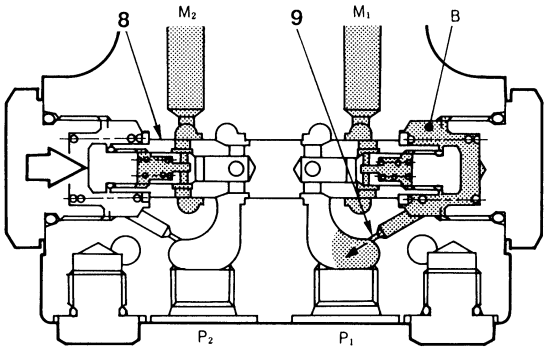

E5D505

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When the motor is slowed, the pressure in port P1 and chamber B rises again and the spool (8) moves to the left side, eliminating the back pressure generated at port M2. In this way, the motor is controlled so that it rotates at a speed appropriate for the amount of oil flowing into it.

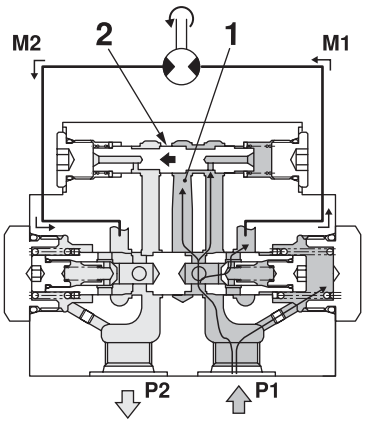
If the high pressure hydraulic oil introduced into port P1 is cut off, the pressure at ports P1 and P2 becomes the same and the spool (8) returns to the neutral position by spring force. For this reason, the oil in chamber B is pushed out at port P1. At this time, the flow of oil is restricted by the orifice (9) as it is returning to port P1, so the spool (8) returns to the neutral position slowly. In this way, the motor is stopped while the shock during stopping is absorbed.



E5D506

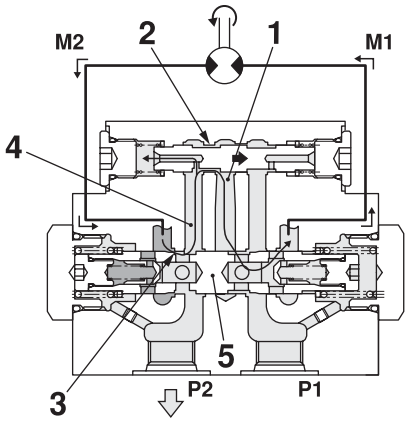
### Anti-Cavitation Valve

When decelerating, the oil supply from the P1 port to the M1 motor port is not sufficient, causing the M1 motor port to have negative pressure. When this happens, oil is directed from the M2 motor port to the M1 motor port, reducing possible cavitation.
Normally, the spool (2) is pushed to the left by the pressure of the passage (1).



E5D543

When a negative pressure is created in the M1 motor port during deceleration, the pressure in the passage (1) also decreases to move the spool (2) to the right. This causes the oil in the M2 motor port to flow from the orifice (3) of the counter valve through the passages (4) and (1) into the M1 motor port.
This supply of oil continues until the counterbalance valve spool (5) cuts the flow from the path (1) to the M1 motor port.



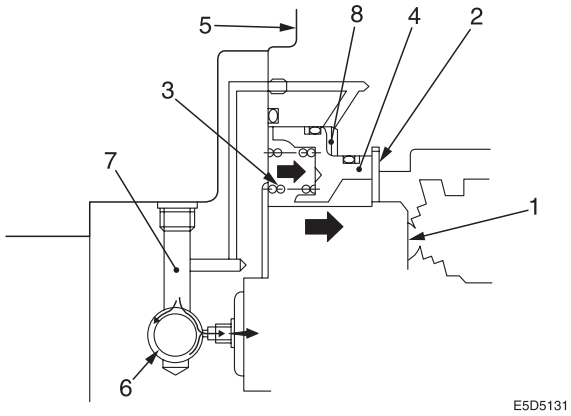
E5D544

https://truckmanualshub.com/

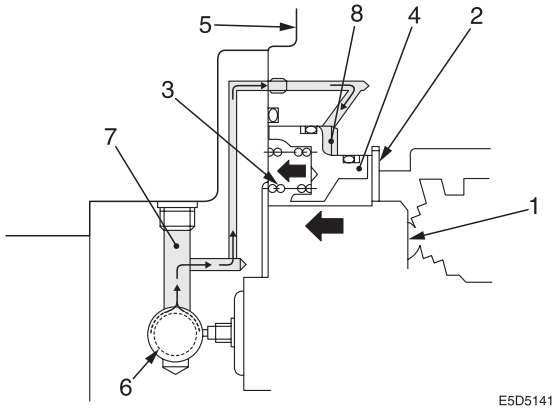


### Parking Brake

The cylinder block (1) and disc (2) are connected via a spline.
The disc (2) is pushed against the flange holder (5) by the force of the spring (3) via the brake piston (4) and brake force is generated by the friction force between the flange holder (5) and the brake piston (4) stopping the cylinder block (1) from turning.



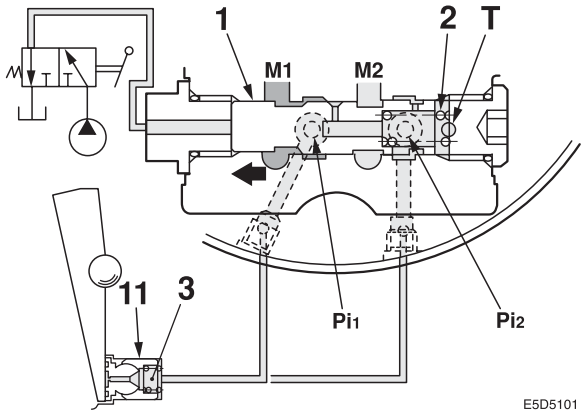

When hydraulic oil is introduced into the motor, the spool (6) of the counterbalance valve moves out and the parking brake release port (7) opens. Hydraulic oil passes through this port and flows to the brake piston chamber (8), overpowers the spring and moves the brake piston (4) to the left. When this happens, the disc (2) rotates freely between the flange holder (5) and the brake piston (4), releasing the parking function.
Also, when the motor stops, the spool (6) returns to the neutral position and the parking release port (7) opens. Hydraulic oil in the brake piston chamber (8) is introduced into the motor case and parking brake force from the spring (3) acts.



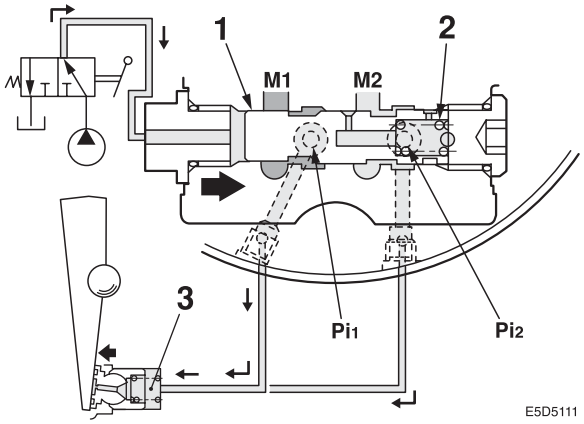

### 2-Speed Mechanism

#### 2-Speed Control Valve

If high pressure oil is introduced into port M1 and the control valve is in the 1st speed position, the spool (1) is moved to the left position by the spring (2) and the swash plate control piston chambers (3) connect with port T through the respective ports Pi1 and Pi2. For this reason, no force acts on the swash plate to push it up at the swash plate control position (11).



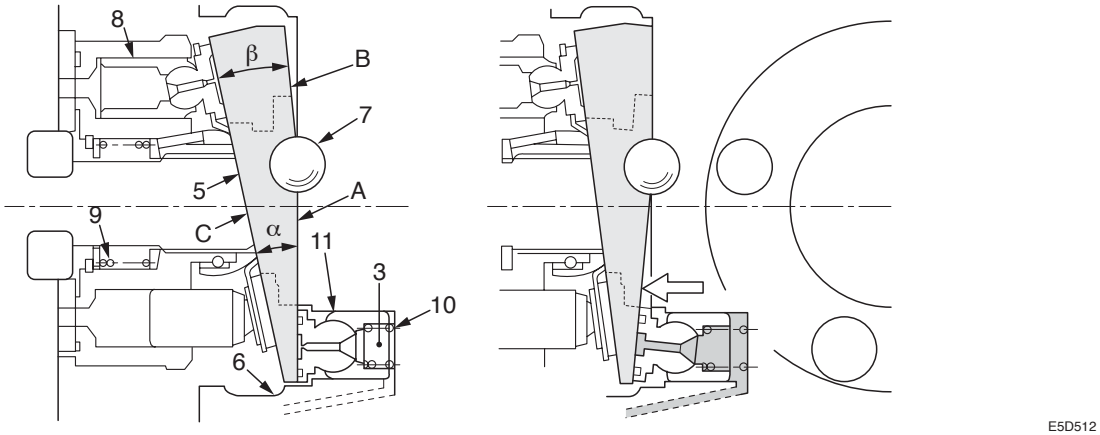

If the control valve is switched to the 2nd speed side position, hydraulic oil is introduced from the port to the spool (1) and the spool (1) switches to the right. As a result, some of the high pressure oil flows to the swash plate control piston chambers (3) through port M1, port Pi1, port M2 and port Pi2, respectively, moving the pistons.
When the engine stops, no hydraulic oil comes, so the spool (1) returns to the 1st speed by the spring (2).



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## Swash Plate




The swash plate (5) has 3 planes, A, B and C, as shown in the figure, and it is assembled in such a way that its angle of inclination in the flange holder (6) can varied by two balls (7). When the 2-speed control valve is switched to the 1st speed side, the swash plate control piston chamber (3) is connected to tank port and the swash plate (5) is stabilized at plane A, forming swash plate angle α, by the piston assembly (8) and the force of the springs (9), (10), achieving 1st speed (low speed) motor rotation.

When the 2-speed control valve is switched to 2nd speed, the swash plate control piston chamber (3) is connected to the motor drive pressure port and the swash plate (5) stabilizes at plane B due to the equilibrium between the force of the springs (9), (10) and the force of the control piston (11), thus, assuming swash plate angle β. In this way, 2nd speed (High speed) motor rotation is achieved.

When the engine is stopped, the pilot pressure of the 2-speed control valve is cut off, so the swash plate (5) is stabilized at the swash plate a plane A by the force of the springs (9), (10), changing to the 1st speed side. For this reason, when starting, the motor also is in 1st speed.

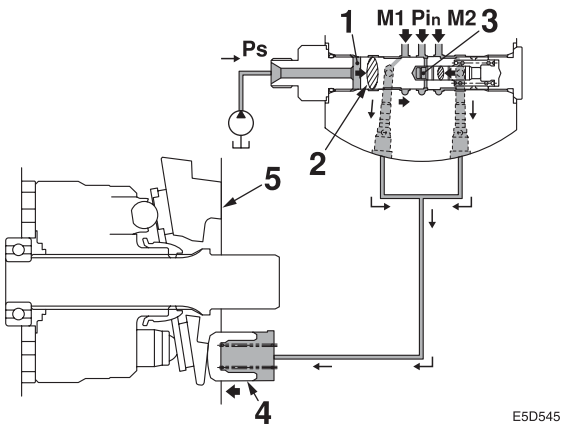
### Automatic Switching to 2nd Speed

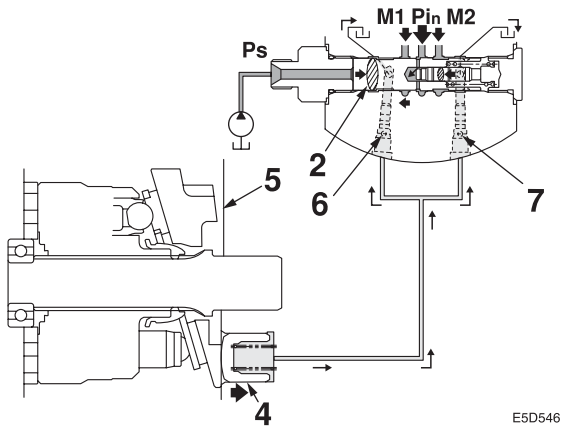
When the motor load is increased during the 2nd speed, the motor is automatically switched to the 1st speed position.

During the 2nd speed, the pilot pressure PS is led to the pilot chamber (1) to provide force for pushing the spool (2) to the right. The load pressure on the motor Pin is led to the chamber (3) to provide force for pushing the spool (2) to the left. When the motor is lightly loaded and the pressure Pin is low, the spool (2) is pushed to the right. The pressures M1 and M2 in the motor act on the swash plate control piston (4) to push up the swash plate (5).

When the motor becomes heavily loaded and the load pressure Pin is increased such that it exceeds the pilot pressure Ps, the spool (2) is moved to the left.

The pressurized oil that has been acting on the swash plate control piston (4) now flows through the orifices (6) and (7) into the tank passage. The return oil also flows through the orifices (6) and (7), which allows the swash plate control piston (4) to return slowly to change the motor to the 1st speed position.



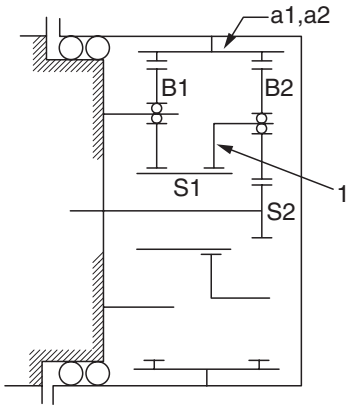



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### Reduction Gears

The reduction gear has a simple planetary two-stage configuration. It decelerates the high speed rotary motions of the hydraulic motor, converts them into low speed high torque, and rotates the case. The output shaft of the hydraulic motor is connected to the gear S2 via the spline. The rotation of the gear S2 is decelerated by one stage among the gears S2, B2 and a2. This one-stage decelerated rotation is further decelerated by two stages among the gears S1, B1 and a1 that are connected to the carrier 2 (1) via the spline. This rotation is conveyed to the rotary main body via the inner gears a1 and a2 as the driving force of the motor.



C4D560

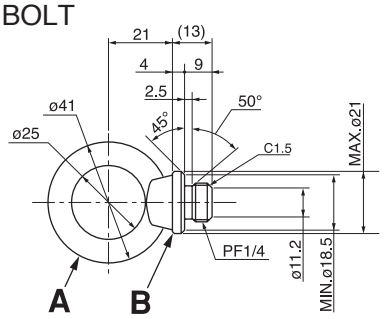
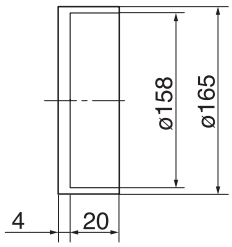
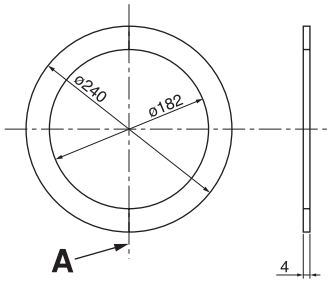
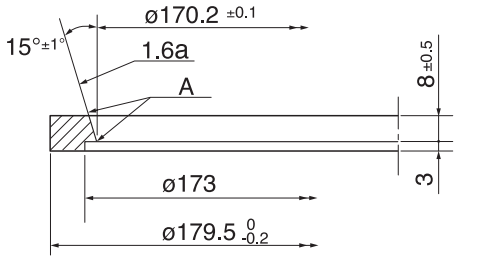
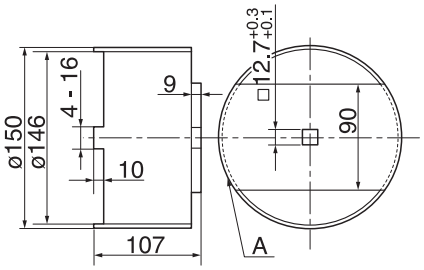
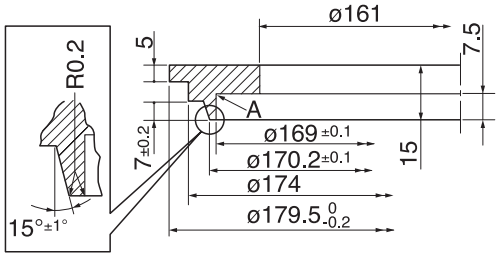
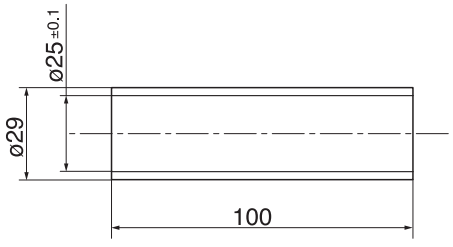
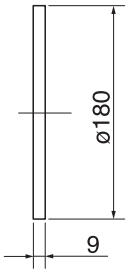
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## DISASSEMBLY AND ASSEMBLY

### Table of Special Tools

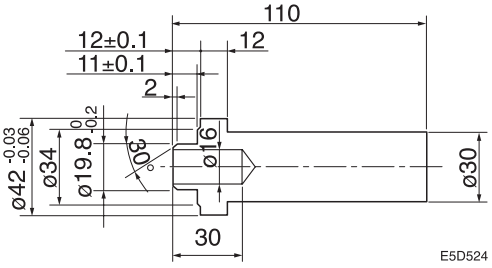
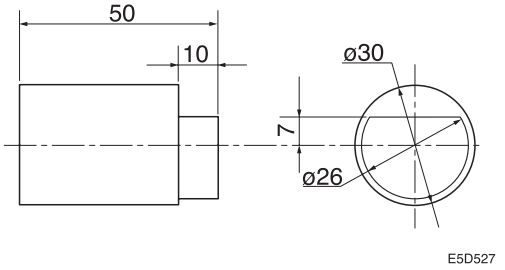
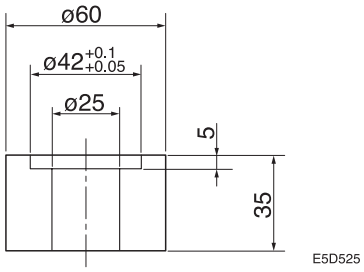
Unit: mm

| | NAME, DIMENSIONS | | NAME, DIMENSIONS |
|---|---|---|---|
| 1 | EYE BOLT<br>  <br>E5D547<br>A: EYE BOLT JIS B 1168 M10<br>B: WELD | 5 | PRESSURE FITTING JIG (D)<br>  <br>E5D551 |
| 2 | REMOVING JIG (A)<br>  <br>E5D548<br>A: DIVIDED INTO 2 EQUAL PARTS | 6 | INSTALLATION JIG (E)<br>  <br>E5D552<br>A: FINE CHAMFERING |
| 3 | TIGHTENING JIG (B)<br>  <br>E5D549<br>A: WELD | 7 | INSTALLATION JIG (F)<br>  <br>E5D553<br>A: R0.3 OR LESS |
| 4 | REMOVING JIG (C)<br>  <br>E5D550 | 8 | PRESSURE FITTING JIG (G)<br>  <br>E5D554 |

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Unit: mm

| | NAME, DIMENSIONS | | NAME, DIMENSIONS |
|---|---|---|---|
| 9 | PRESSURE FITTING JIG (H)<br>  <br> | 11 | INSTALLATION JIG (K)<br>  <br> |
| 10 | PRESSURE FITTING JIG ( I )<br>  <br> | | |

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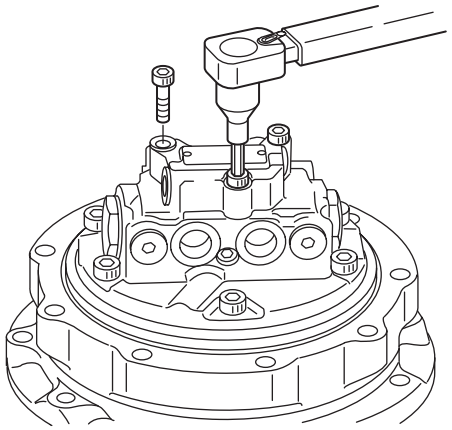
### General Cautions

- Carry out disassembly and assembly operations in a clean place and provide clean containers to place the disassembled parts in.
- Before disassembly, clean around the ports and remove the paint from each joint using a wire brush.
- Wash the disassembled parts and dry them with compressed air. Do not use a rag, as this could cause clogging of dirt.
- Make match marks on each part so that they will be assembled in the same positions when reassembled.
- Replace all seals with new ones each time the unit is disassembled, coating them lightly with grease.
- Check each part to make sure there is no abnormal wear or seizing and use sandpaper, etc. to remove any burrs, sharp edges, etc.

### Disassembly

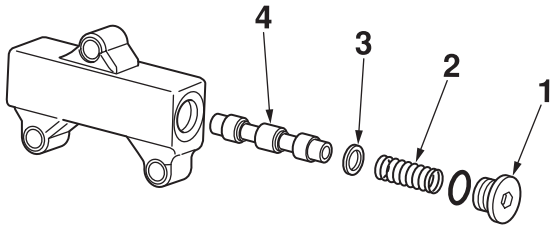
#### Anti-Cavitation Valve

1. Take out the cap screws and the anti-cavitation valve.



E5D555

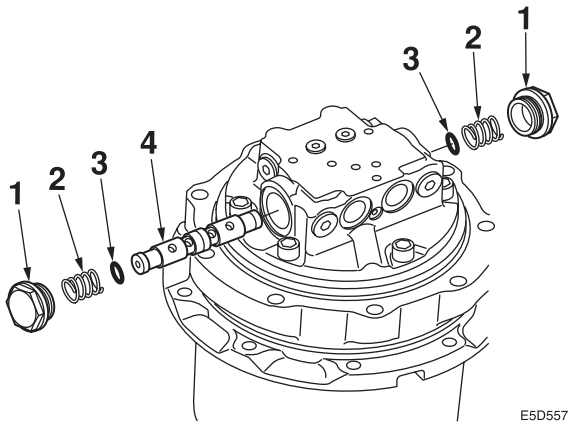
2. Take out the plug (1), then remove the spring (2), the spring seat (3) and the spool (4).




E5D556

#### Counterbalance Valve, 2-speed Control Valve

1. Take out the cap (1), then remove the spring (2), the spring seat (3) and the spool assembly (4).
   - Remove the spool assembly while turning it gently.
   - Be careful not to scratch or bruise the outside surface.

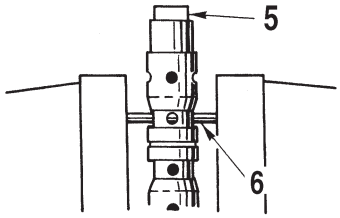



E5D557

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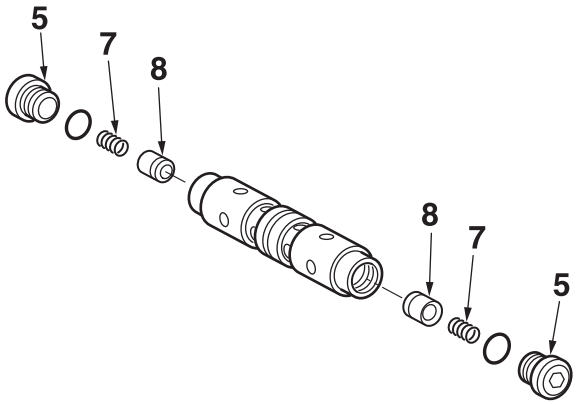


2. Disassemble the spool assembly (4).
   - Do not disassemble the spool assembly unless it is absolutely necessary.
   a. Take out the plug (5).
      - Insert a ø5 × 30 mm pin (6) in the ø6 through hole in the spool, then fasten the pin (6) by both ends in a vise and fasten the spool assembly.



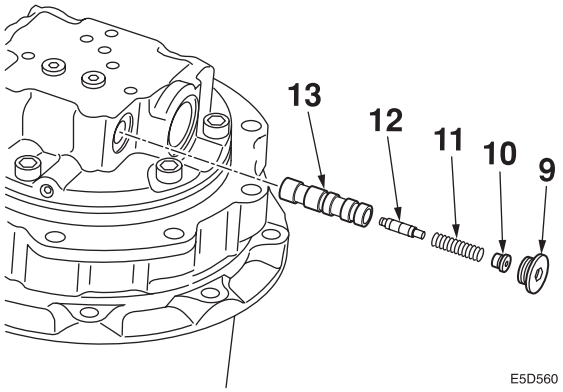

E5D558

   b. Remove the spring (7) and check valve (8).
      - Be sure to keep the parts of the spool assembly so that the left-right combination of the check valve (8) with respect to the spool is kept the same when they are assembled.



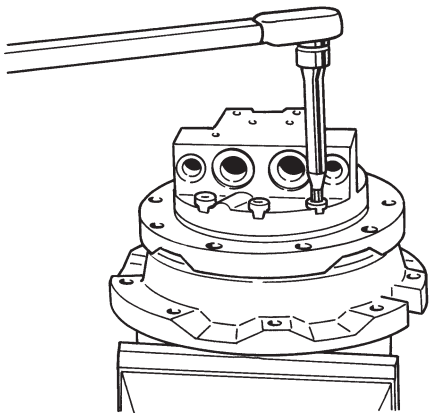

E5D559

3. Remove the plug (9), then remove the spring seat (10), the spring (11), the spool (12) and the spool (13).
   - Do not scratch or bruise the outside surface of the spool.




E5D560

4. Take out the cap screws.
   - Evenly loosen them, as the valve body may be lifted by the force exerted by the spring on the brake piston.

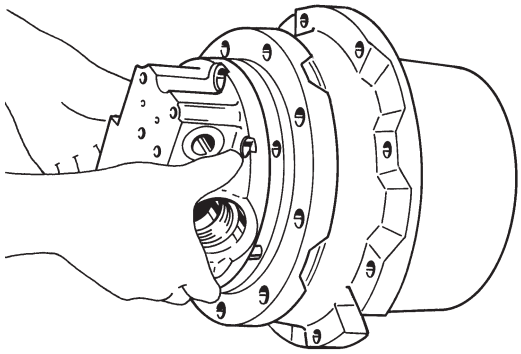


Y6–D523

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5. Remove the valve body.
   - Be careful not to let cylinder block come out.
   - If it is difficult to remove, tap on it gently in the removal direction using a plastic hammer or pry it gently with a screw driver.

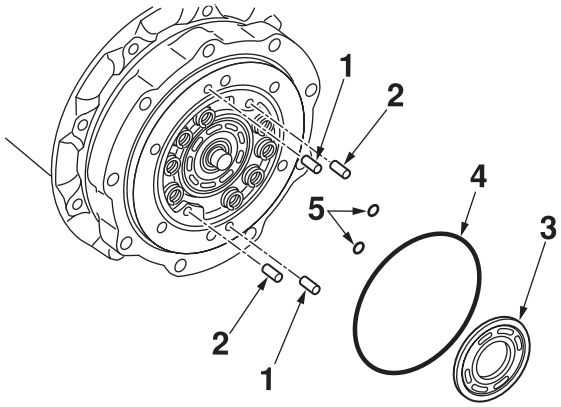


Y6–D524

### Hydraulic Motor, Reduction Gears

1. Remove the pins (1), (2) and the valve plate (3).

2. Remove the O-rings (4), (5).



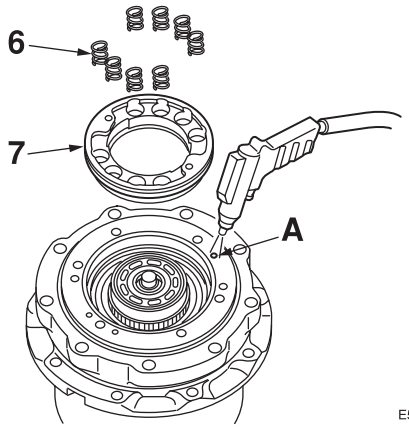

E5D561

3. Remove the springs (6) the brake piston (7).

**⚠WARNING**

Wear required appropriate equipment such as safety glasses and filter mask when using compressed air, as metal fragments or other objects can fly and cause serious personal injury.

- Blow compressed air into the parking brake release port (A) of the flange holder and remove the brake piston.



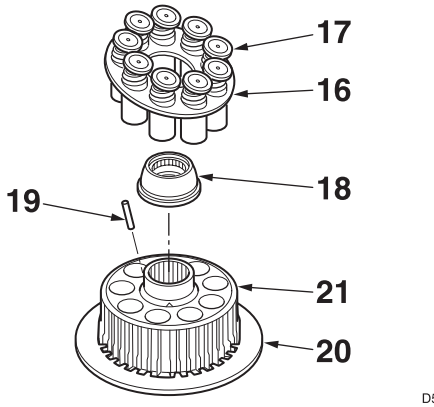

E5D562

4. Remove the cylinder block assembly, then disassemble the cylinder block assembly.

**⚠WARNING**

Watch for parts that may spring out. Wear protective gear such as goggles.

a. Remove the shoe holder (16), the piston assembly (17), guide (18), the pin (19) and the disc (20) from the cylinder block (21).
   - Be careful not to scratch the sliding surfaces of the cylinder block.

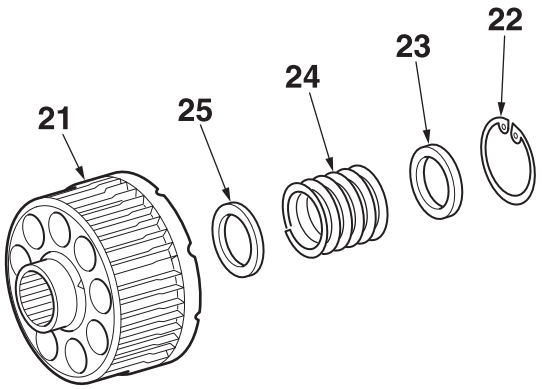



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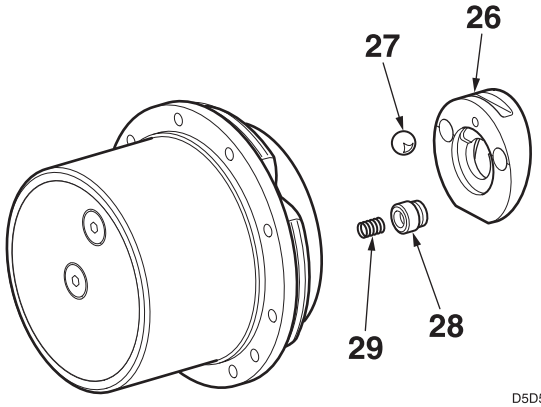


b. Remove the snap ring (22).
c. Remove the retainer (23), spring (24) and retainer (25) from the cylinder block (21).
   • Do not scratch the sliding surfaces of the cylinder block.



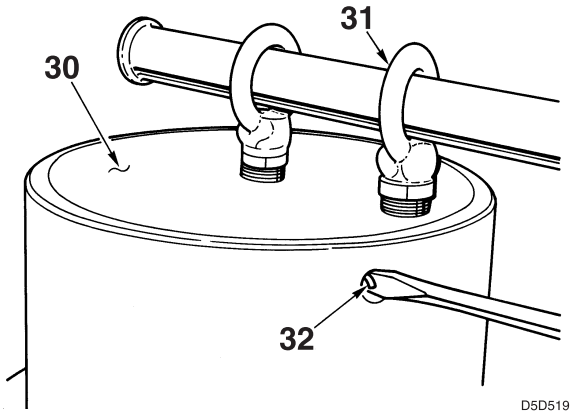
D5D517

5. Remove the swash plate (26), ball (27), piston assembly (28) and spring (29) from the flange holder.



D5D518

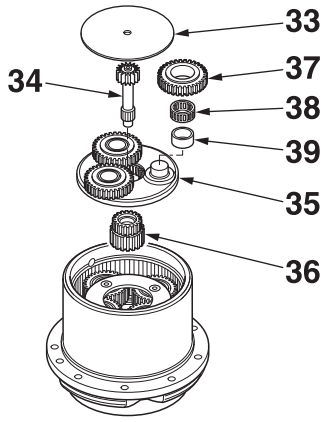
6. Remove the cover (30).
   a. Take out the plug, then set eye bolts (31) in the threaded holes, pass a round bar through the eye bolts and turn the cover (30) until the wire (32) can be seen.
   b. While pulling on the end of the wire (32) with pliers, turn the cover (30) and pull the wire (32) out.
   c. Remove the cover (30) by hooking a hook in the eye bolt (31) or using the round bar.



D5D519

7. Remove the thrust plate (33), the gear S2 (34), the carrier assembly (35) and the gear S1(36).

8. Remove the gear B2 (37), the needle (38) and the inner race (39) from the carrier.

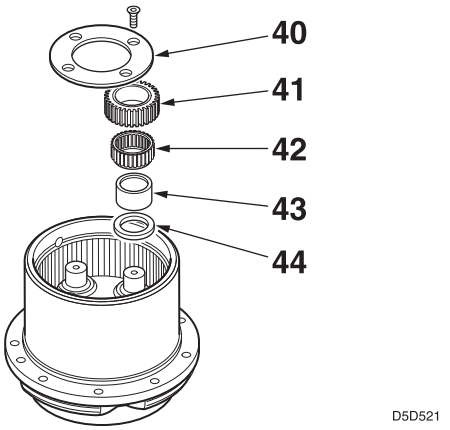


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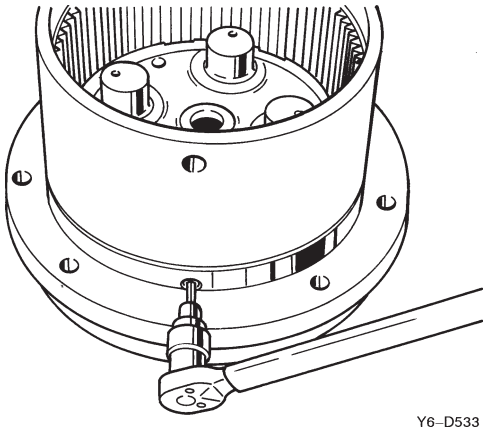


9. Remove the screw, then remove the thrust plate (40).
   - Heat the screws with a heat gun or the like to soften the Loctite applied on the screw.

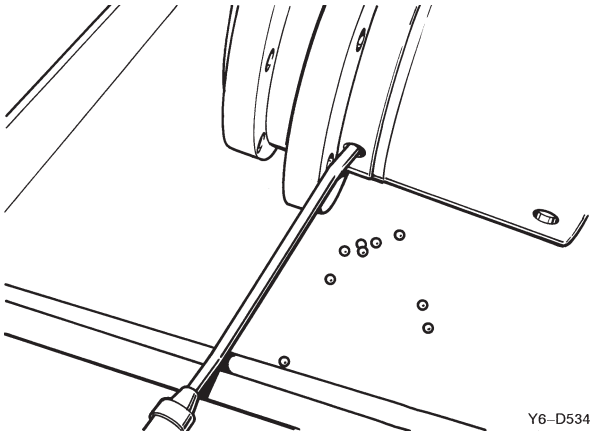



10. Remove gear B1 (41), the needle (42), inner race (43) and thrust washer (44).
    - Do not scratch the gear tooth surfaces or the rotating surface of the collar.

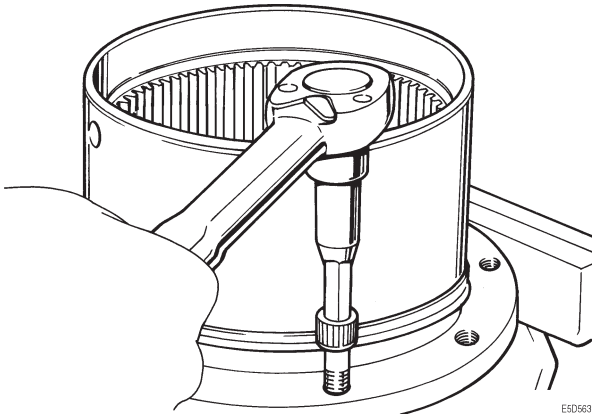
11. Remove the plug.




12. Take out the balls.
    a. After degreasing with paint thinner, white gasoline or similar cleaning oil, blow with air to remove the balls.
       - If the balls are difficult to remove, tap on the outside of the housing with a hammer.
    b. Insert a piece of piano wire through the bolt hole to make sure that all the balls have been removed.



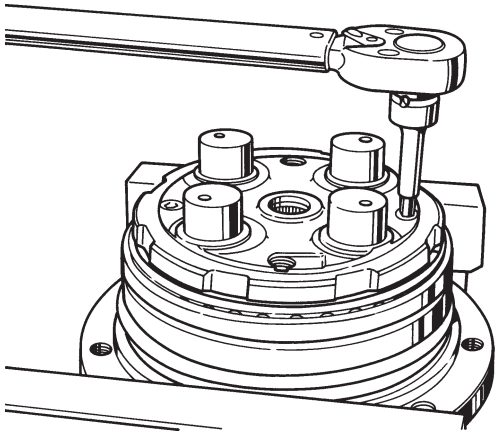

13. Disassemble the flange holder and housing.
    a. Insert a metal plate or removing jig (A) between the flange holder and housing.
    b. Tighten with 3 cap screws (M12 × 1.75) which are spaced equally apart.



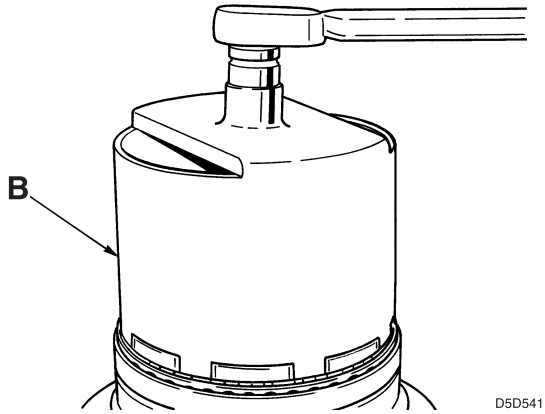
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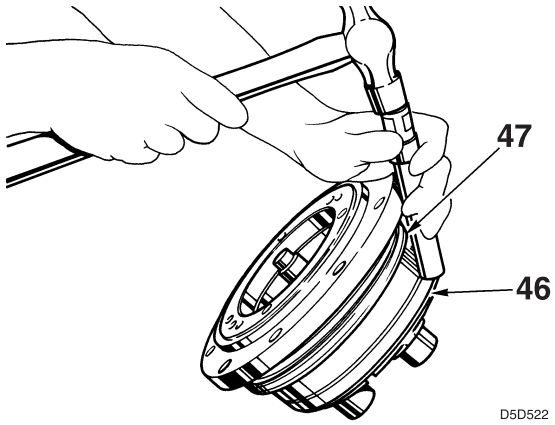
14. Take out the plug.



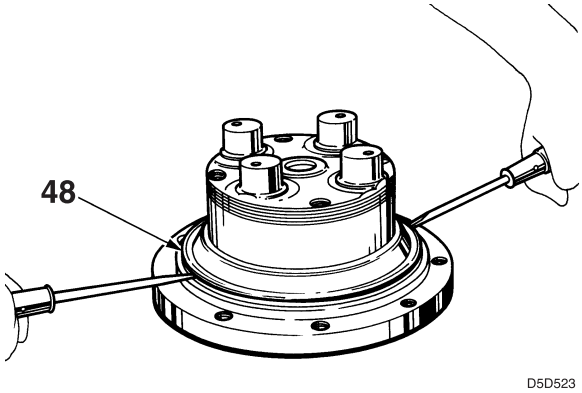

15. Remove the ring nut.
    - Use a tightening jig (B).




16. Remove the angular bearing (46) and remove the floating seal (47).
    - Place one end of a round bar against the steel groove and tap the other end of the bar with a hammer to remove the angular bearing (46).



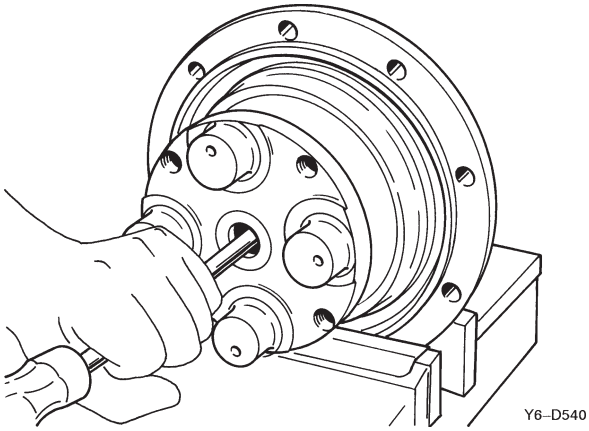

17. Remove the floating seal (48).



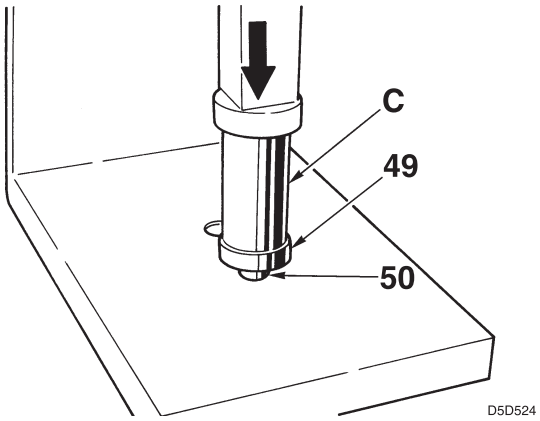
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18. Remove the shaft, then remove the oil seal.
    - Bring a round bar in contact with the round hole of the shaft and tap lightly with a hammer.
    - Use a (–) screw driver to remove the oil seal.




19. Remove the bearing (49) from the shaft (50).
    - Use removing jig (C).



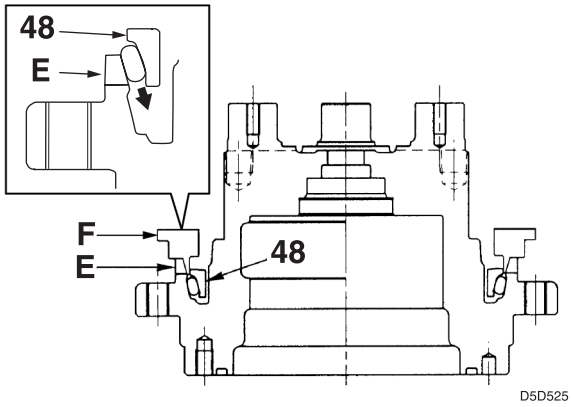
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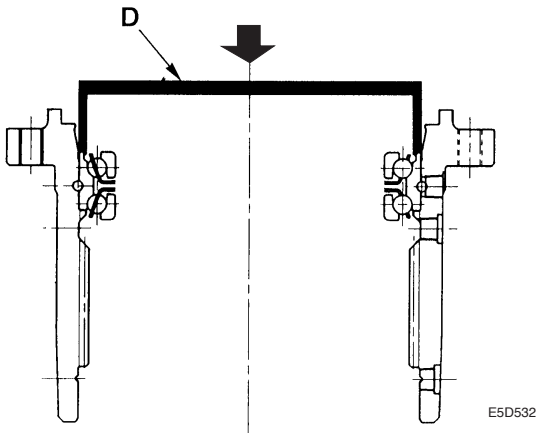
**Assembly**

Hydraulic Motor, Reduction Gears

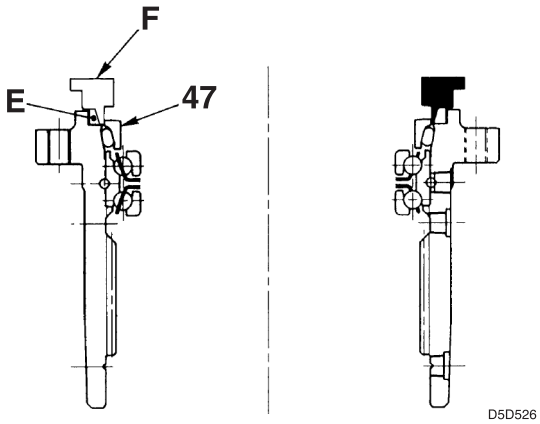
1. Install the floating seal (48) in the flange holder.
   a. Insert the floating seal (48) temporarily using installation jig (E).
      • Apply grease to the seal.
   b. Install it using installation jig (F).



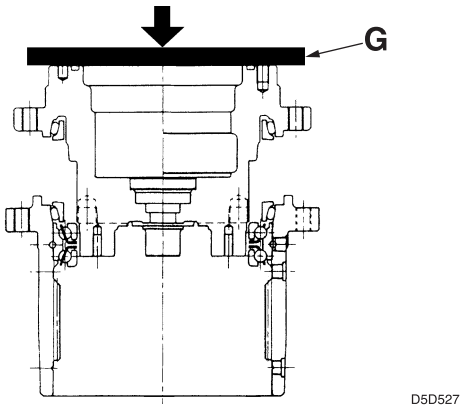

2. Install the angular bearing.
   • Use pressure fitting jig (D).




3. Install the other floating seal (47) on the housing.
   a. Insert the floating seal temporarily using installation jig (E).
      • Apply grease to the seal.
   b. Install it using installation jig (F).



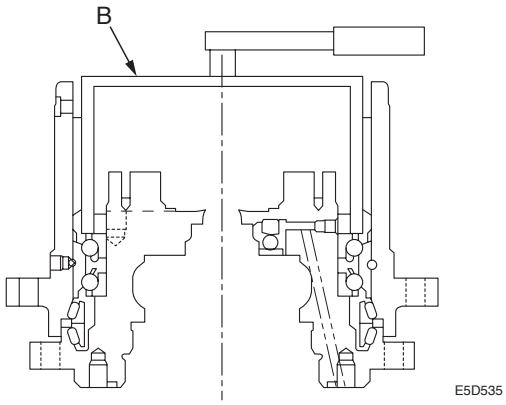

4. Install the flange holder.
   • Remove any foreign matter from the sliding surface of the floating seal and apply gear oil to it.
   • Use pressure fitting jig (G).



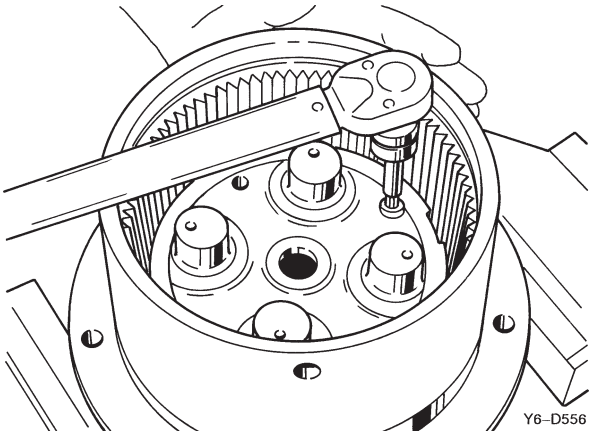
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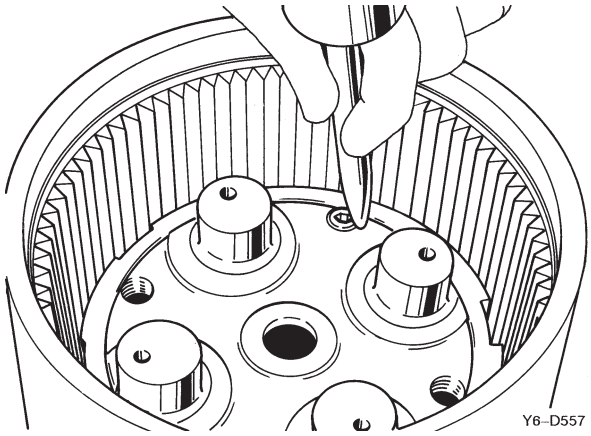
5. Tighten the ring nut to secure the angular bearing.
   - Use tightening jig (B).
   - Ring Nut: 196 ±9.8 N·m



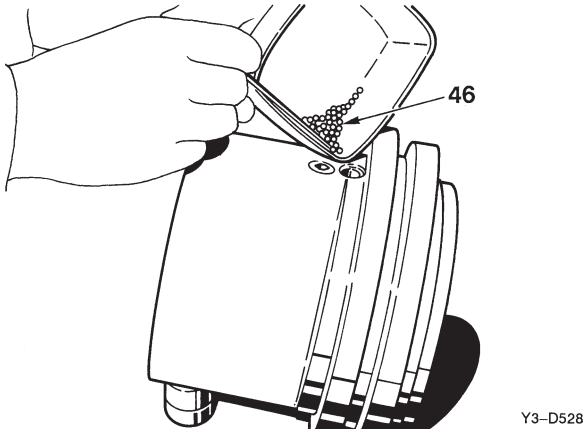

6. Install the plug.
   - The seal tape is unnecessary.
   - Plug: 14.7 ±4.9 N·m




7. Stake the plug at 2 points with a punch.




8. Put in the balls (46).

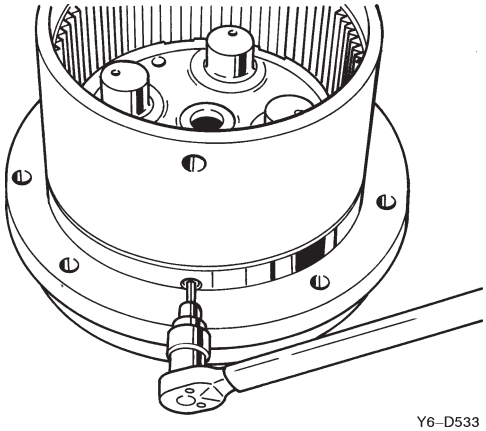


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9. Install the plug.
   - Seal tape should be wound around the threads of the plug.
   - Make sure the head of the plug is not sticking out of the housing.

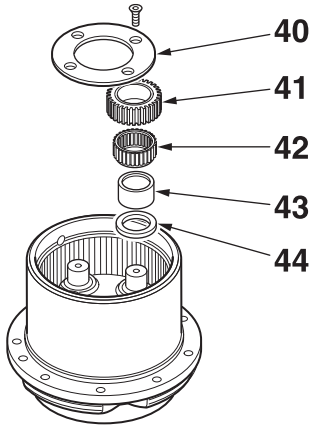
   Plug: 7.8 ±1.0 N·m




10. Install the thrust washer (44), gear B1 (41), the inner race (43) and the needle (42).

11. Install the thrust plate (40), then install the screw.
    - Apply Loctite #262 to the screw.
    - When applying Loctite, degrease all the surfaces thoroughly and use a hardening accelerator.

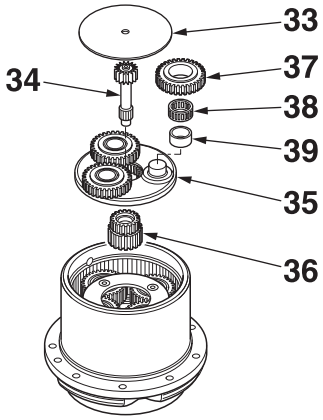
    Screw: 6.1 ±2.0 N·m



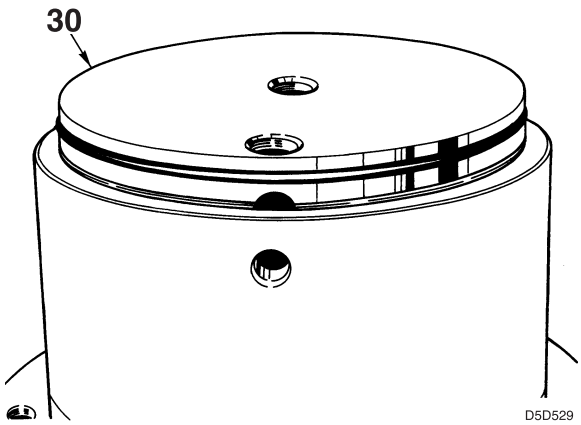

12. Install the snap ring on the gear S1 (36), then install the gears S1 (36).

13. Install the carrier assembly.
    a. Install the inner race (39), the needle (38) and gear B2 (37) in the carrier (35).
    b. Install the carrier (35) in the housing.
    c. Install the gear S2 (34).

14. Install the thrust plate (33).



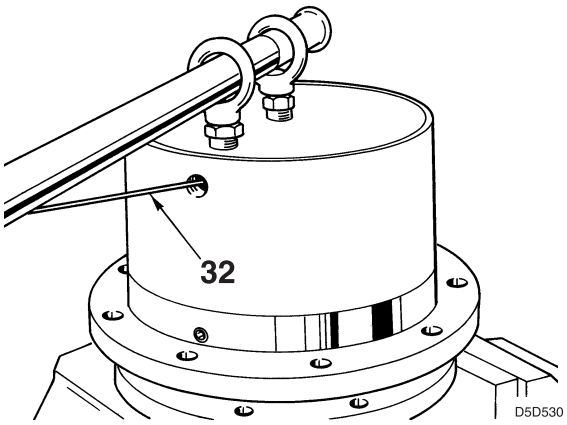

15. Fit the O-ring on the cover (30) and install it on the housing.
    - Align the U-groove in the plug's hole position.



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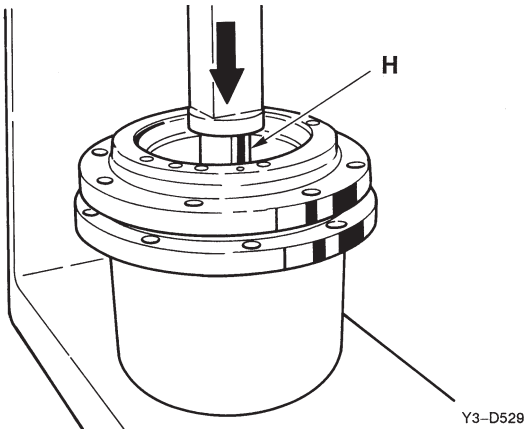


16. Install the wire (32).
    a. Bend the wire (32) at a point approximately 6 mm from the front end, then insert it in the bolt hole in the housing.
    b. Turn the cover and wind the wire (32) around it.
       • Use the eye bolts and a round bar.

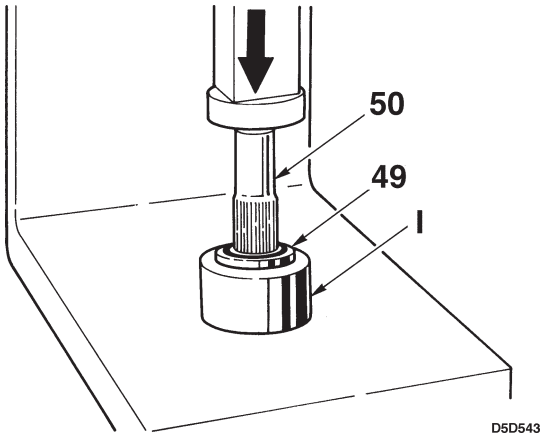



17. Install the plug.
    • Wind seal tape around the threads of the plug.
    Plug: 7.8 ±1.0 N·m

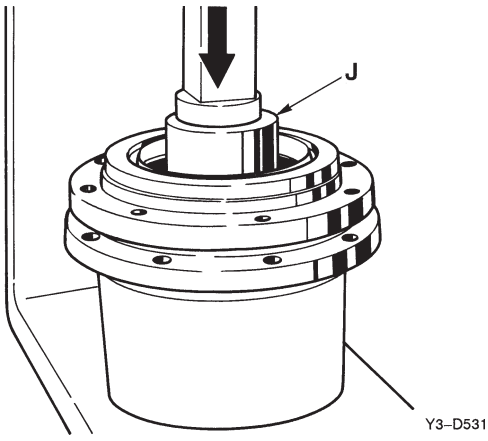
18. Install the oil seal in the flange holder.
    • Use pressure fitting jig (H).




19. Install the ball bearing (49) on the shaft (50).
    • Use pressure fitting jig ( I ).



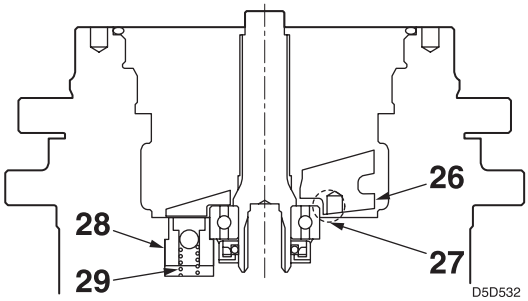

20. Install the shaft assembly in the flange.
    • Use pressure fitting jig (J).

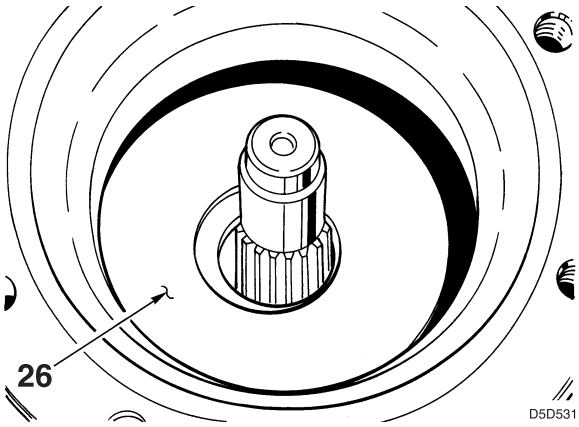


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21. Put in the balls (27) and install the spring (29), piston assembly (28) and swash plate (26).
    - Apply hydraulic oil to the sliding surfaces of the swash plate.



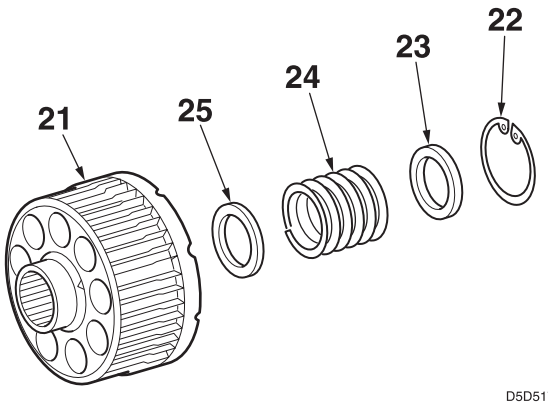



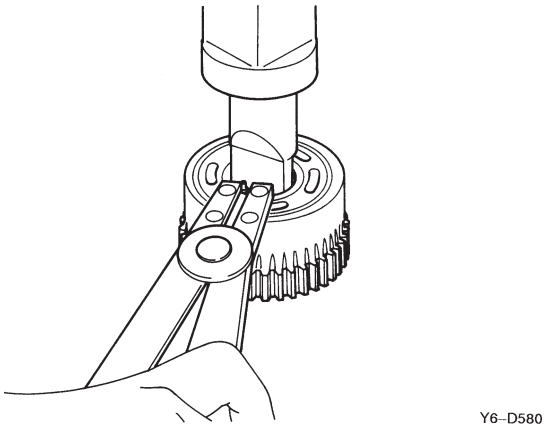

22. Assemble the cylinder block assembly.

**⚠WARNING**

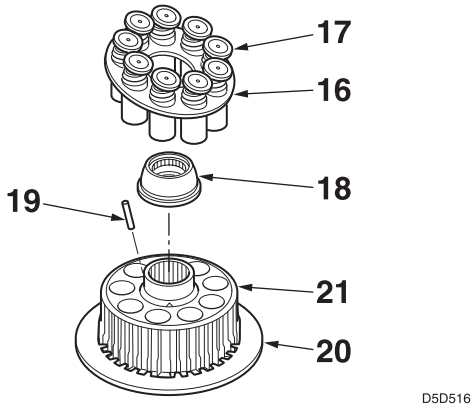
Watch for parts that may spring out. Wear protective gear such as goggles.

a. Install the retainer (25), spring (24) and retainer (23) in the cylinder block (21).
b. Install the snap ring (22).
    - Use the installation jig (K).



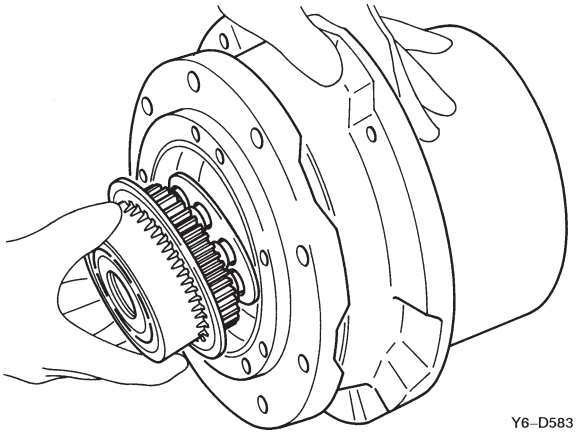

c. Install the pin (19) in the cylinder block (21).
    - Apply grease to the pin.
d. Install the guide (18), shoe holder (16), piston assembly (17) and disc (20).
    - Apply hydraulic oil to the hole in the cylinder block.



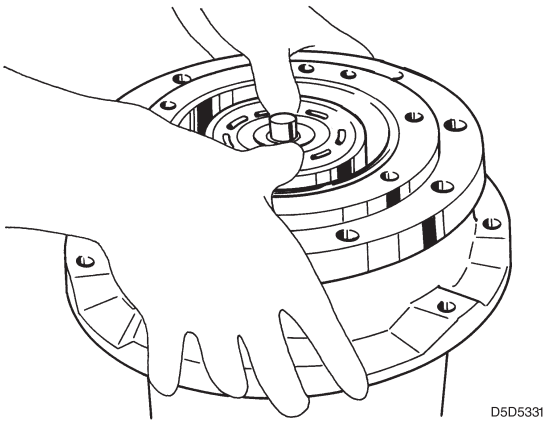
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23. Install the cylinder block assembly.
    a. Install the shaft spline in the guide.

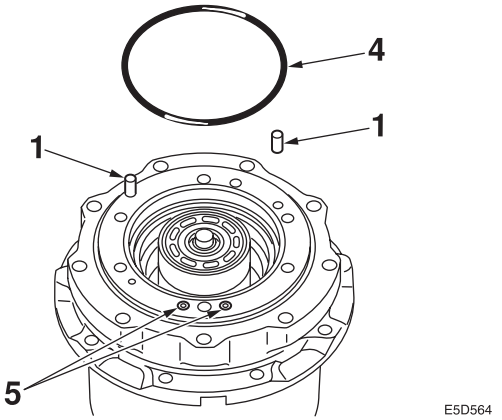



    b. Push the cylinder block by hand, making sure the spring is working.
       - Apply hydraulic oil to the sliding surfaces of the cylinder block.
       - Make sure the port area on the cylinder block is free from foreign matter.

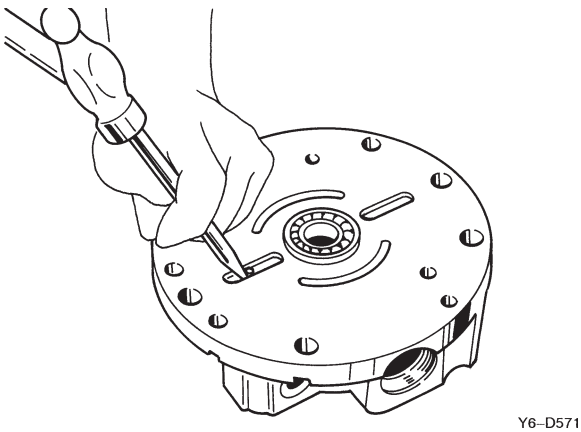



24. Install the pins (1) on the flange holder.

25. Install the O-ring (4) and the O-rings (5) on the flange holder.




26. Install the pin and stake it at 2 points.

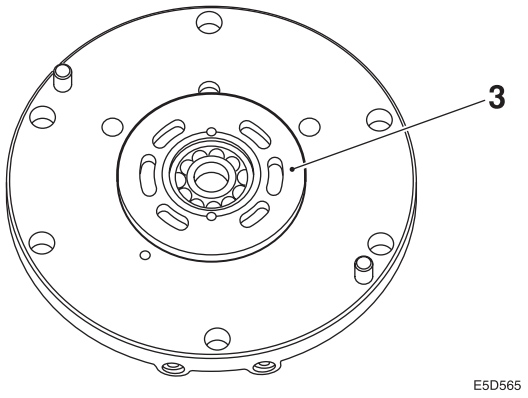


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27. Install the valve plate (3) on the valve body.
    - Apply grease to the bottom side of the valve plate.

28. Install the pin on the flange holder.

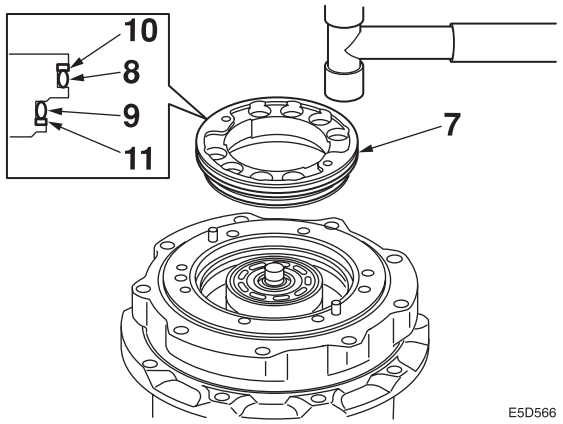


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29. Fit the O-rings (8), (9) on the brake piston (7).

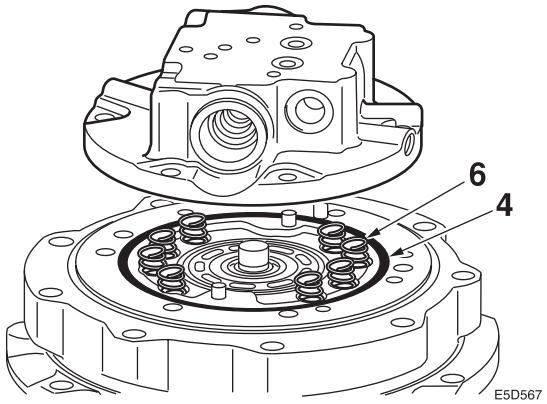
30. Fit the backup rings (10), (11) on the brake piston (7).

31. Install the brake piston (7) on the flange holder.
    - Align the flange holder pin with the flange holder pinhole.
    - Install the brake piston by tapping around the perimeter of it uniformly with a plastic hammer.



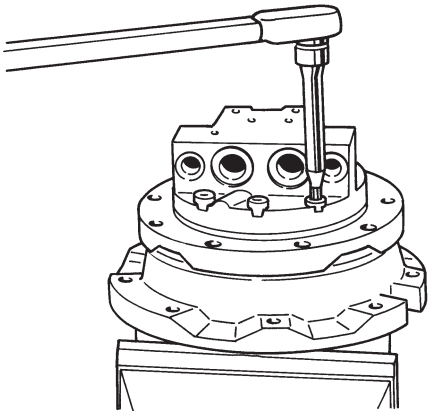
E5D566

32. Install the springs (6), the O-ring (4) and the valve body.



E5D567

33. Tighten the cap screws.
    Cap Screw: 63.7 ±4.9 N·m

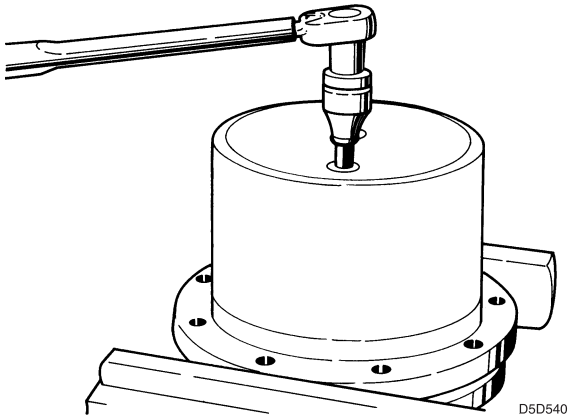

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34. Pour gear oil in through the plug hole, then install the plug.
    - Wind seal tape around the plug.
    - Quantity of oil: Approx. 0.5 L

    Plug: 39.2 ±2 N·m

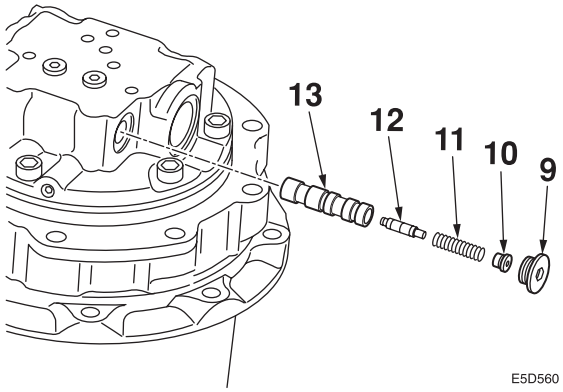



### Counterbalance Valve, 2-speed Control Valve

1. Install the spool (13), the spool (12), the spring (11) and the spring seat (10).
    - Install the spool while turning it, making sure it doesn't get caught.
    - Apply hydraulic oil to the spool.

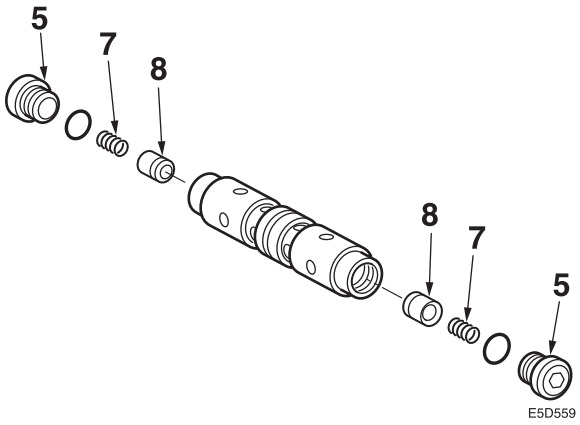
2. Fit an O-ring on the plug (9), then install it in the valve body.

    Plug: 53.9 ±4.9 N·m




3. Assemble the spool assembly.
    a. Install the check valve (8) and spring (7) on the spool.
    b. Fit the O-ring on the plug (5), then install it in the spool.

    Plug: 31.9 ±2.5 N·m

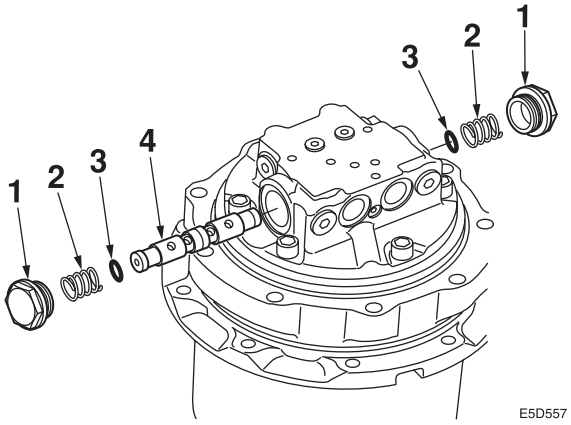



4. Install the spool assembly (4) in the valve body.
    - Install the spool assembly while turning it, making sure it doesn't get caught.
    - Apply hydraulic oil to the spool assembly.

5. Install the spring seat (3) and spring (2).

6. Fit the O-ring on the plug (1), then install the valve body.

    Plug: 240 ±5 N·m



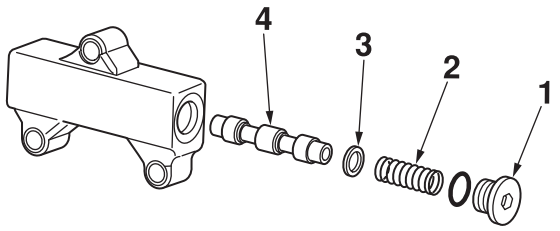
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### Anti-Cavitation Valve

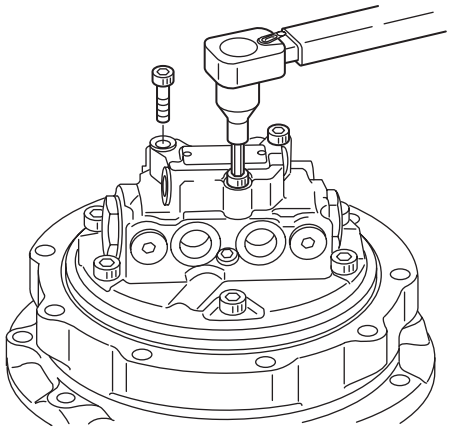
1. Install the spool (4), the spring seat (3) and the spring (2) in the valve vody.

2. Fit the O-ring on the plug (1), then install the valve body.
   Plug: 53.9 ±4.9 N·m




E5D556

3. Install the O-ring in the anti-cavitation valve, then install the anti-cavitatio on the valve body.
   Cap Screw: 36.9 ±1.9 N·m



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## INSPECTION AND ADJUSTMENT

### Checking the Parts

| Parts | Area Checked | Judgement Criteria | Treatment |
|---|---|---|---|
| Floating Seal | Sliding Surface | There should be no abnormal scratches, wear or seizing. | Replace |
| Angular Bearing | Sliding Surface | There should be no abnormal scratches, wear, flaking, etc. in the ball or race. | Replace |
| Planetary Gears | Surface of Gear Teeth | There should be no abnormal scratches, wear or flaking of the tooth surfaces (if there has been pitting which covers 5% or more of the engagement portion of the tooth surface). | Replace |
| | Front of cage and roller rotating surface. | There should be no abnormal scratches, wear or flaking of the rotating surface. | |
| Inner Race | Surface condition of inner race rotating surface. | There should be no abnormal scratches, wear or flaking of the rotating surface. | Replace |
| Needle | Surface of needle. | There should be no abnormal scratches, wear or flaking. | Replace |
| Thrust Washer | Front of sliding surface | There should be no abnormal scratches, wear or seizing. | Replace |
| Housing, Sun Gear, Drive Gear | Front of Gear Tooth Surfaces | There should be no abnormal scratches, wear or flaking in the tooth surfaces (if there has been pitting which covers 5% or more of the engagement portion of the tooth surface). | Replace |
| Thrust Plate | Front of sliding surface. | There should be no abnormal scratches (0.02 mm or greater), wear or seizing, etc. | Replace |
| O-ring | — | — | Replace |
| Shaft | Surface of oil seal. | There should be no scratches or abnormal wear. | Replace |
| Ball Bearing | Front of sliding surface. | There should be no abnormal scratches, wear or flaking in the ball and race. | Replace |
| Oil Seal | — | — | Replace |
| Swash Plate | Front of the surface which slides with the sliding surface of the piston assembly. | There should be no abnormal scratches (0.02 mm or greater), wear or seizing. | Repair by lapping (#1000) or replace. |
| Cylinder Block | Clearance with the piston assembly. | 0.04 mm or greater | Repair with wrap (#1000) or replace the cylinder block and piston assembly at the same time. |
| | Front of the surface which slides with the valve plate. | There should be no abnormal scratches (0.02 mm or greater), wear or seizing. | |
| Piston Assembly | Clearance with cylinder block | 0.04 mm or greater | |
| | Front of the surface which slides with the swash plate. | There should be no abnormal scratches (0.02 mm or greater), wear or seizing. | |
| | Clearance between piston and shoe. | 0.4 mm or greater | Replace |

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| Parts | Area Checked | Judgement Criteria | Treatment |
|---|---|---|---|
| Valve Plate | Front of the surface which slides with the spool. | There should be no abnormal scratches (0.02 mm or greater), wear or seizing. | Repair by lapping (#1000) or replace. |
| Base Plate | Front of the surface which slides with the spool. | There should be no abnormal scratches, wear or seizing. | Replace the base plate and the spool at the same time. |
| Spool | Front of the surface which slides with the base plate. | There should be no abnormal scratches, wear or seizing. | |
| | Front of the surface which slides with the check valve. | There should be no abnormal scratches, wear or seizing. | Replace the spool and the check valve at the same time. |
| Check Valve | Front of the surface which slides with the spool. | There should be no abnormal scratches, wear or seizing. | |
| | Surface of spool and seat. | There should be contact with the seat around the entire circumference. | |

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## TROUBLESHOOTING

### Hydraulic Motor

| Symptom | Probable Causes | Remedy |
|---|---|---|
| Does not move. | • Equipment other than the motor, counterbalance valve or speed reducer is malfunctioning. | • Check if the proper pressure is reached on the motor inlet port side, then check each device and repair if necessary. |
| | • Hydraulic oil is escaping due to abnormal wear of motor sliding parts.<br>• Principal motor parts are malfunctioning due to damage. | • Replace the abnormally worn parts.<br>• Replace the damaged parts. |
| Motor won't speed up. | • The proper volume of hydraulic oil is not being supplied to the motor due to the hydraulic pump, control valve, etc. | • Check if the proper pressure is reached on the motor inlet port side, then check each device and repair if necessary. |
| | • The motor's volumetric efficiency is dropping. | • Check if the sliding parts are abnormally worn, then repair or replace the worn parts. |
| Changes in rotational speed are great. | • High pressure hydraulic oil is leaking and flowing out of the drain port due to wear of the motor's sliding parts.<br>• Bearings are worn. | • Replace the abnormally worn parts.<br>• Replace the bearings if they are abnormally worn. |
| Oil is leaking. | • Oil is leaking due damage to oil seals or O-rings. | • Replace the oil seals and O-rings. |

### Counterbalance Valve

| Symptom | Probable Causes | Remedy |
|---|---|---|
| Does not move or rotation is slow. | Spool does not switch.<br>• No hydraulic oil is arriving.<br>• Foreign matter is caught.<br>• The orifice is clogged up. | <br>• Repair or replace the damaged piping.<br>• Remove the foreign matter and repair or replace the damaged parts.<br>• Clean it. |
| Won't stop or stopping is slow. | The spool won't return.<br>• Foreign matter gets caught.<br>• A spring is missing.<br>• A spring is damaged.<br>• The orifice is clogged up. | <br>• Remove the foreign matter and repair or replace the damaged parts.<br>• Install the spring.<br>• Replace the spring.<br>• Clean it. |
| Shock is great when stopping. | Spool return is fast.<br>• The spring seat is missing. | <br>• Install the spring seat. |
| Valve makes an abnormal noise. | The spool does not return.<br>• Foreign matter gets caught.<br>• A spring is damaged.<br>• The orifice is clogged up. | <br>• Remove the foreign matter and repair or replace the damaged parts.<br>• Replace the spring.<br>• Clean it. |

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### 2-speed Control Function

| Symptom | Probable Causes | Remedy |
|---|---|---|
| Machine veers during travel. | Spool doesn't switch over.<br>• Foreign matter is caught.<br>• A spring is missing.<br>• A spring is damaged. | • Remove the foreign matter and repair or replace the damaged parts.<br>• Install the spring.<br>• Replace the spring. |

### Anti-Cavitation Valve

| Symptom | Probable Causes | Remedy |
|---|---|---|
| Does not move or rotation is slow. | Spool seat is faulty.<br>• Foreign matter gets caught.<br>• A spring is damaged. | • Remove the foreign matter and repair or replace the damaged parts.<br>• Replace the spring. |
| Valve makes an abnormal noise. | Spool seat is faulty.<br>• Foreign matter gets caught. | • Remove the foreign matter and repair or replace the damaged parts. |

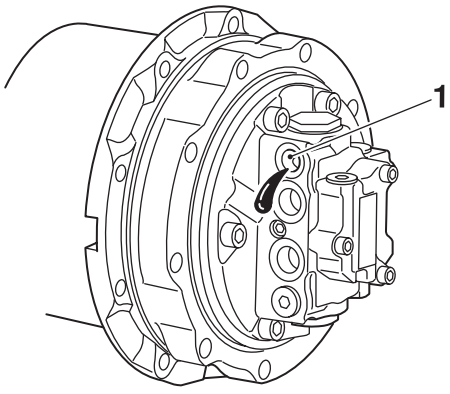
### Test Run

Upon completion of servicing and inspection, install the travel motor and perform the test run on the machine (no crawler should be installed).

1. Fill the piston motor case with hydraulic oil. Bleed air completely from each part of the piping.
   - Fill up the motor case until the oil comes out of the drain port (1) on the upper side.
   - When reassembling, make sure that the reduction gear case is filled with lubricating oil up to the specified level.

2. Run the travel motor at low RPMs.
   - Engine at low RPMs.
   - If there is any air left in the circuit, an unusual noise may be heard from the valve. Run the motor until no air is left.
   - Check for any oil leakage.

3. Run the travel motor at high RPMs.
   - Engine at the rated RPMs.
   - Make sure that the machine is running without any noise or vibration.



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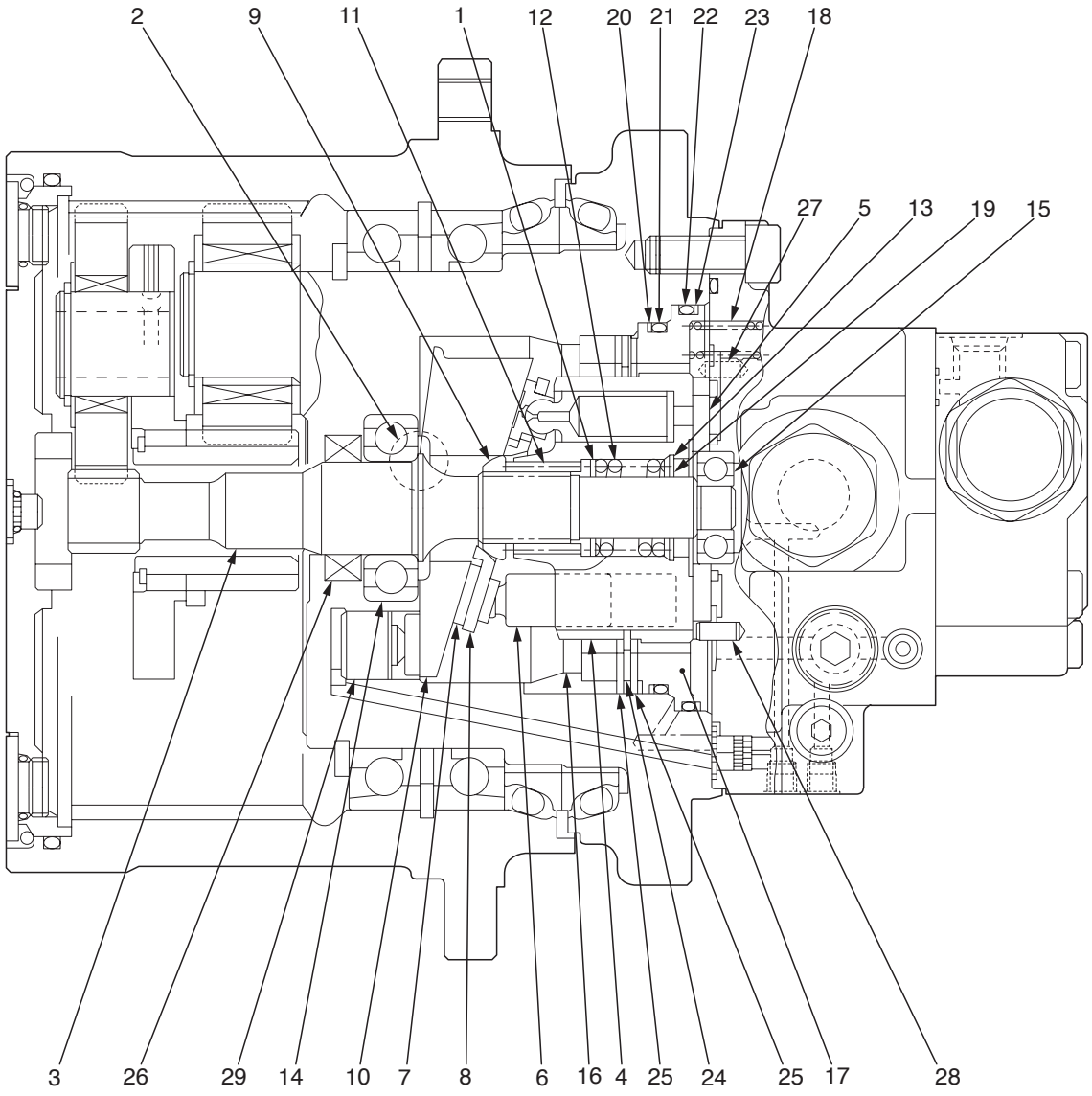
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# TRAVEL MOTOR (TB135)

## CONSTRUCTION

### Hydraulic Motor



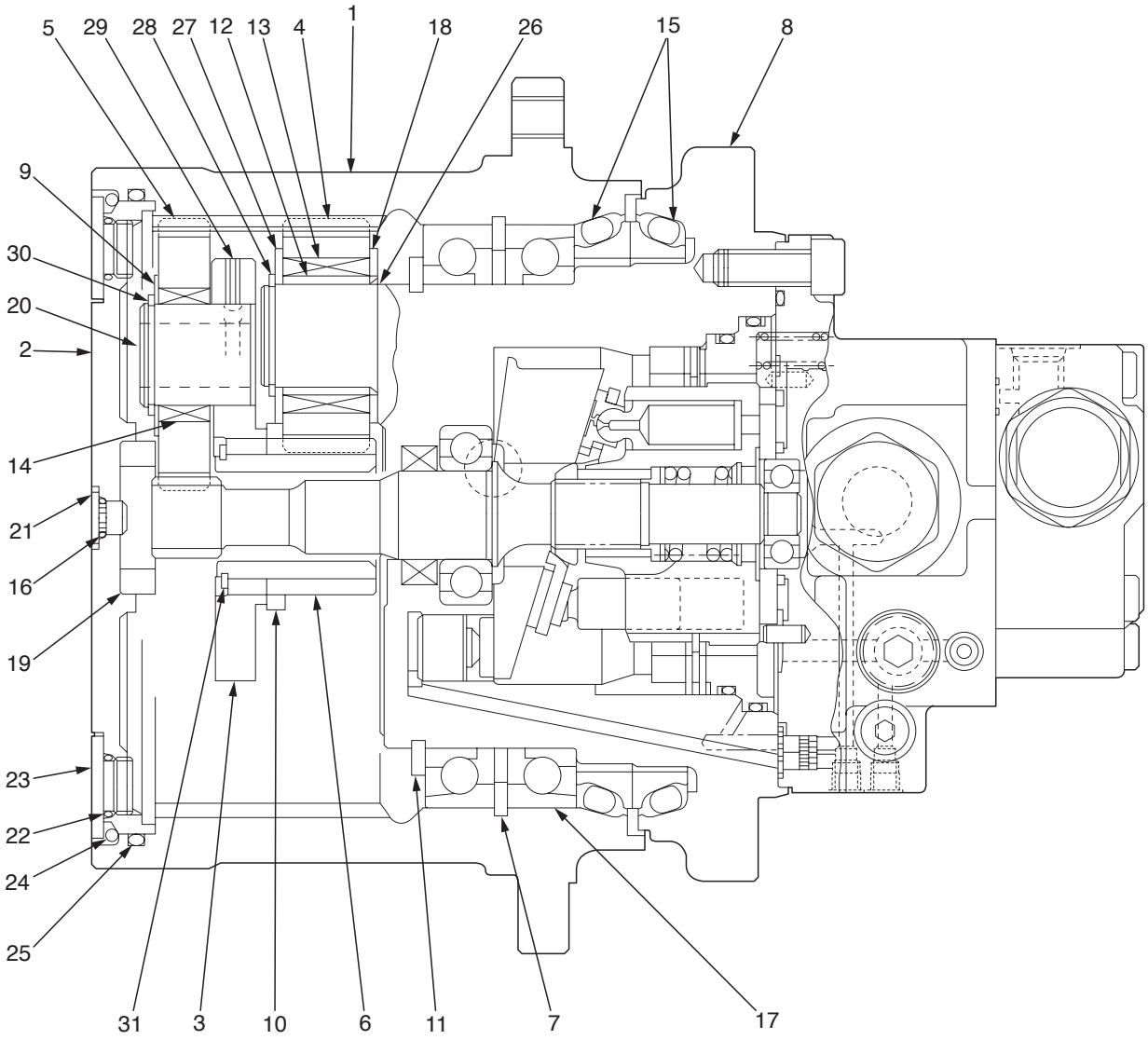

G4D500

1. Retainer
2. Ball
3. Shaft
4. Cylinder Block
5. Valve Plate
6. Piston
7. Shoe
8. Shoe Holder
9. Guide
10. Swash Plate
11. Pin
12. Spring
13. Retainer
14. Bearing
15. Bearing
16. Spacer
17. Brake Piston
18. Spring
19. Snap Ring
20. Backup Ring
21. O-ring
22. O-ring
23. Backup Ring
24. Friction Disc
25. Center Disc
26. Oil Seal
27. Pin
28. Pin
29. 2-Speed Piston

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**Reduction Gears**

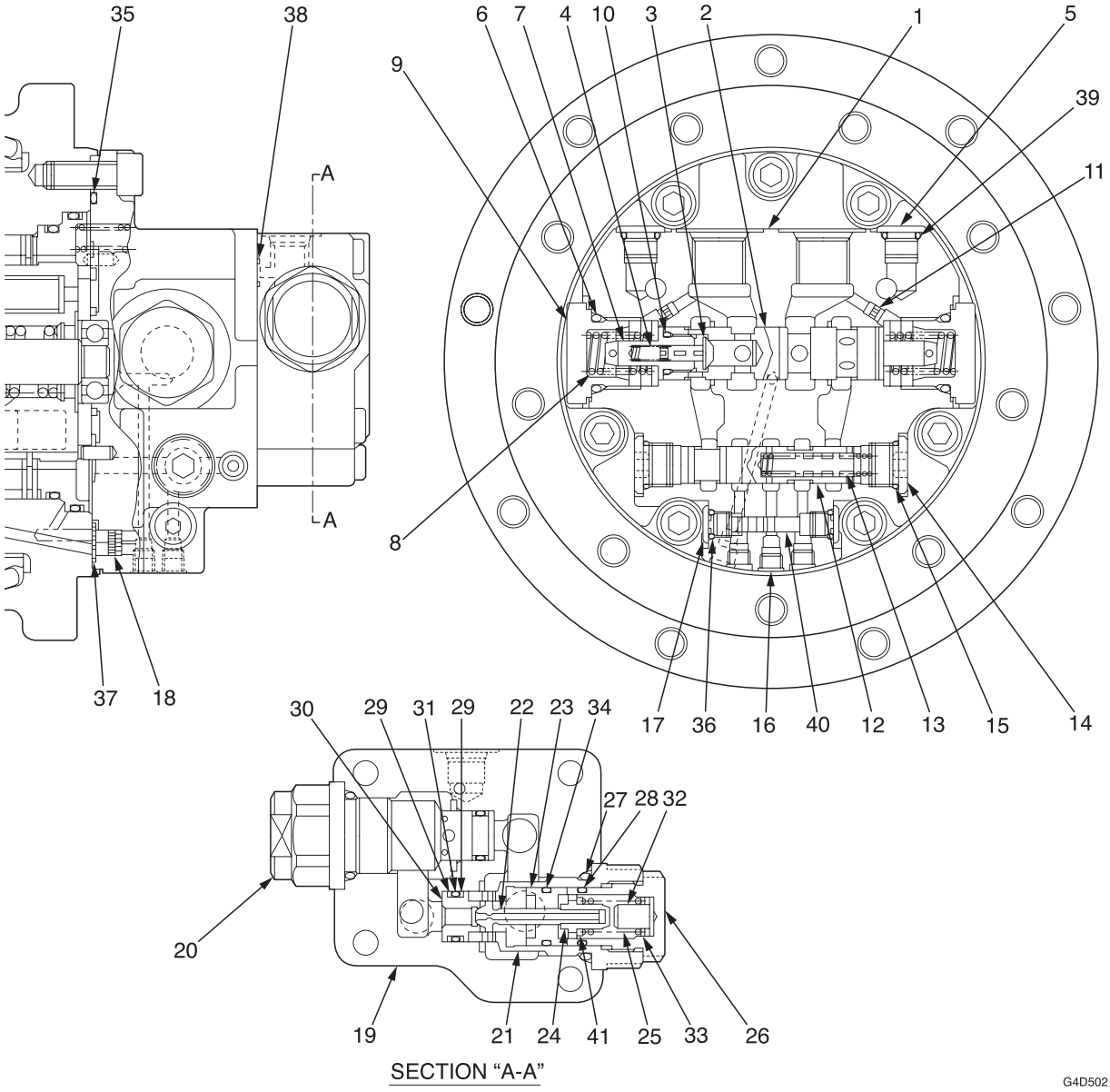



1. Housing
2. Cover
3. Carrier 2
4. Gear B1
5. Gear B2
6. Gear S1
7. Snap Ring
8. Flange Holder
9. Thrust Washer
10. Thrust Collar
11. Snap Ring
12. Collar
13. Needle
14. Needle
15. Floating Seal
16. O-ring
17. Bearing
18. Thrust Washer
19. Ring
20. Pin
21. Plug
22. O-ring
23. Plug
24. Snap Ring
25. O-ring
26. Pin
27. Thrust Washer
28. Snap Ring
29. Pin
30. Snap Ring
31. Snap Ring

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**Counterbalance Valve, 2-speed Control Valve, Relief Block Assembly**




1. Valve Body
2. Spool
3. Check Valve
4. Spring
5. Plug
6. O-ring
7. Spring Guide
8. Spring
9. Cap
10. O-ring
11. Orifice
12. Spool
13. Spring
14. Plug
15. O-ring
16. Plug
17. Plug
18. Orifice
19. Valve Body
20. Relief Valve Assembly
21. Relief Housing
22. Poppet
23. Seat
24. Spring Seat
25. Spring
26. Plug
27. O-ring
28. O-ring
29. Backup Ring
30. Piston
31. O-ring
32. Stopper
33. Spacer
34. O-ring
35. O-ring
36. O-ring
37. O-ring
38. O-ring
39. O-ring
40. Shuttle
41. Spacer

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## OPERATION

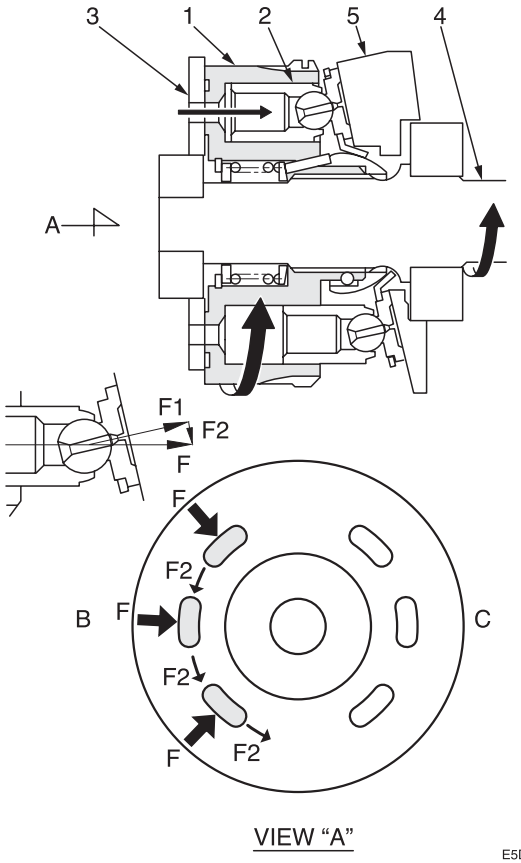
### Hydraulic Motor

9 pistons (2) are fitted in the cylinder block (1) and there is a valve plate (3) with two half moon ports, B and C in the end. Also, the cylinder block (1) rotates freely and is joined to the shaft (4) via the spline. On the other band, the swash plate (5) is fastened to the housing.

When high pressure oil is introduced into port B, one piston (2) makes contact and force F bears on the swash plate (5).

F = P × A P: Pressure A: Piston Sectional Area

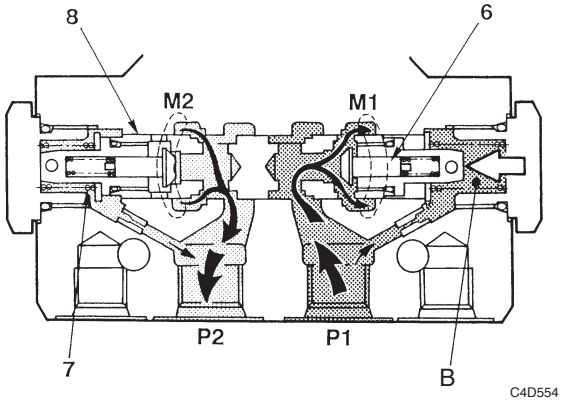
The force F which the piston (2) applies to the swash plate (5) is divided into force F1, which pushes the plate, and force F2, which rotates the cylinder block (1). The total sum of the components in the direction of rotation of the high pressure side piston generates a rotational force in the cylinder block (1) and via the spline, torque is transmitted to the shaft (4), turning it. Conversely, if high pressure oil is introduced to port C, rotation is the reverse of the above.




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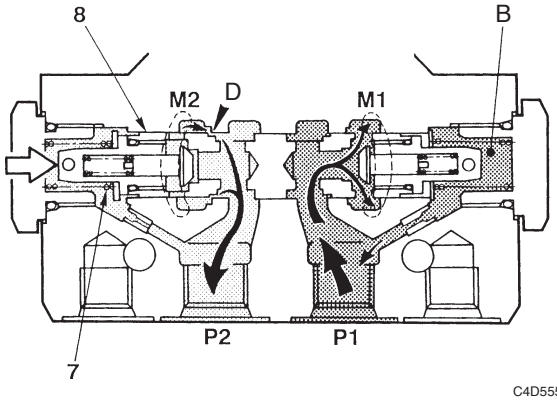
### Counterbalance Valve

If high pressure oil is introduced to port P1, the oil pushes the check valve (6) up. This causes oil to flow through the motor port M1 and to flow into chamber B of the pilot portion and fill it. When hydraulic oil flows the motor from port M1 and acts to turn the motor, even if oil returns from the motor and flows into port M2, since the flow is cut off by the check valve (6), the pressure at port P1 and in chamber B rises. If the pressure in chamber B becomes higher than the set valve of the spring (7), the spool (8) moves to the left side and ports M2 and P2 open up, causing the motor to turn.




C4D554

If the motor's turning becomes too fast, and the amount of oil flowing out of port M2 is greater than the amount of oil flowing into port M1, the pressure in port P1 and chamber B drops. When the pressure in chamber B drops below the set valve of the spring (7), the spool (8) attempts to return to the right side. As a result, since the resuming oil is constricted at portion D, back pressure is generated at port M2 and the motor's turning is slowed.



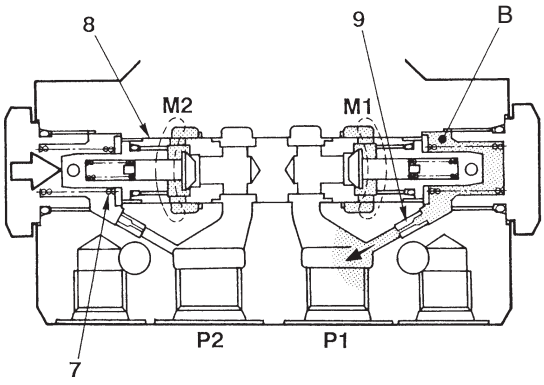

C4D555

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When the motor is slowed, the pressure in port P1 and chamber B rises again and the spool (8) moves to the left aide, eliminating the back pressure generated at port M2. In this way, the motor is controlled so that it rotates at a speed appropriate for the amount of oil flowing into it.

If the high pressure hydraulic oil introduced into port P1 is cut off, the pressure at ports P1 and P2 becomes the same and the spool (8) returns to the neutral position by spring force. For this reason, the oil in chamber B is pushed out at port P1. At this time, the flow of oil is restricted by the orifice (9) as it is returning to port P1, so the spool (8) returns to the neutral position slowly. In this way, the motor is stopped while the shock during stopping is absorbed.



C4D556

**Relief Valve**

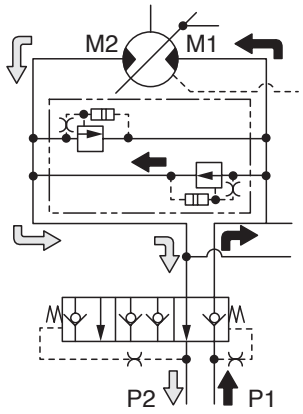
Operation 1

When the Motor is Started

When the motor is started, since the inertial load is great, the pressure of the oil required to accelerate it rises. If this pressure reaches the relief valve set pressure, the relief valve operates and oil returns to port M2.

In this way, the motor begins to turn as it relieves the relief valve, and as the rotational speed increases, the amount of relief decreases until it stops.

In this way, the shock during starting is absorbed.

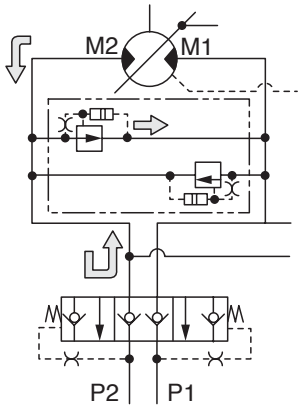


G4D503

When the Motor is Stopped

When the motor is stopped, the return circuit is closed off.

However, since the motor tends to want to continue rotating due to inertial energy, the pressure in port M2 rises. When this pressure reaches the relief valve's set pressure, the relief valve operates and oil flows to port M1. In this way, the flow of oil to port M1 prevents cavitation from occurring as it absorbs the shock during stopping.



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### Operation 2

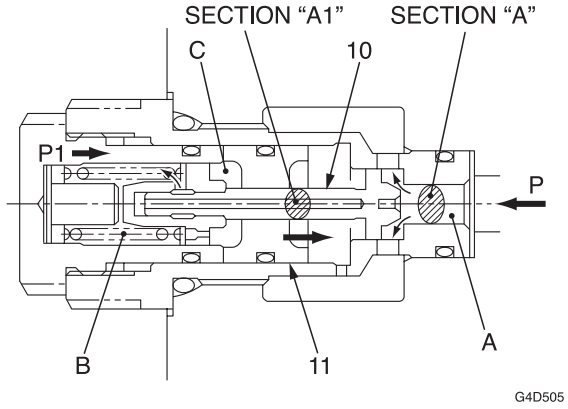
Since this relief valve has a shockless mechanism, it operates in 2 steps.

1st Step

When relief valve operation starts, the pressure in chamber B (P1) is kept at a pressure which is lower than that in chamber C while the pressure in chamber A (P) becomes higher than the pressure of the oil flowing in.

At this time, there are two forces acting on the poppet (10), force (F), which attempts to move the poppet (10) to the left and force (F1) which pushes against the seat on the right side. Since F = P 5 A, F1 = P1 5 A1, P > P1 and A > A1, the poppet (10) is moved to the left by this force "F – F1".

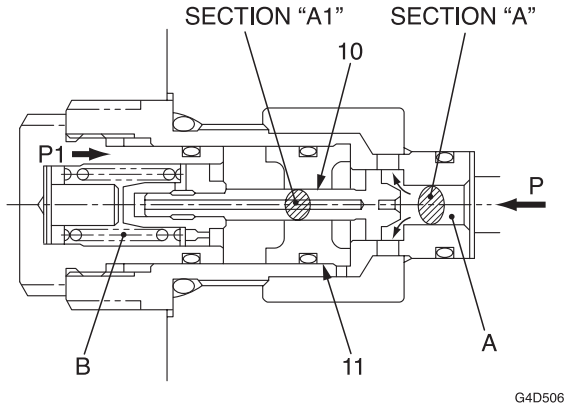
This opens a supply side circuit from chamber A and lets the pressure escape. That is, during the time piston (11) is moving to its stroke end, the relief valve operates at low pressure (about 1/3 the set pressure).




G4D505

2nd Step

When the piston (11) reaches the stroke end, the pressure in chamber B rises and the pressures in chamber A and chamber B equalize. At this time, the force moving the poppet (10) to the left side becomes "P = P1", so this becomes "A – A1" and the relief valve operates at the specified set pressure.

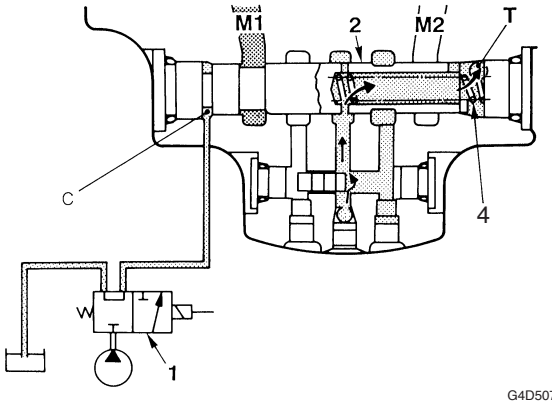



G4D506

### 2-Speed Mechanism

2-speed control valve

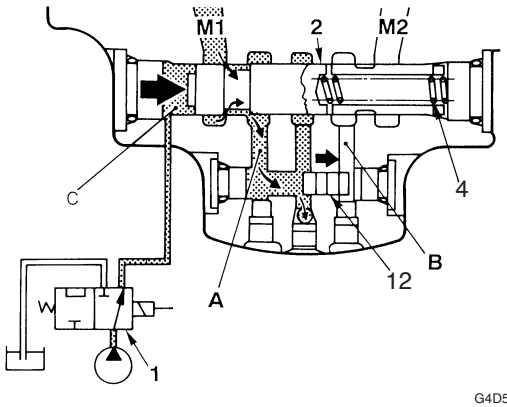
When high-pressure oil led to the port M1 and the travel 2-speed solenoid valve (1) is set to speed 1, the chamber C is connected to the tank via the travel 2-speed solenoid (1), so that a low pressure is obtained. For this reason, the spool (2) is pushed to the left by the spring (4), the swash plate control piston chamber (3) and the tank port (T) are connected, and there is no force pushing the swash plate (5) in upward direction.




G4D507

When the travel 2-speed solenoid valve (1) is switched to speed 2, the pressure oil from the travel 2-speed solenoid valve (1) flows to the chamber C, the spool (2) is moved to the right, and the port M1 is connected with the port A, while the port M2 is connected with the port B. Then the pressure oil from the port P1 moves the shuttle spool (12) to the right and flows to the swash plate control piston chamber (3). This causes operation of the control piston (11), and the swash plate (5) is pushed up.

At the time of engine stop, no pressure oil is supplied any longer, and the spring (4) returns the spool (2) to the speed 1 position.

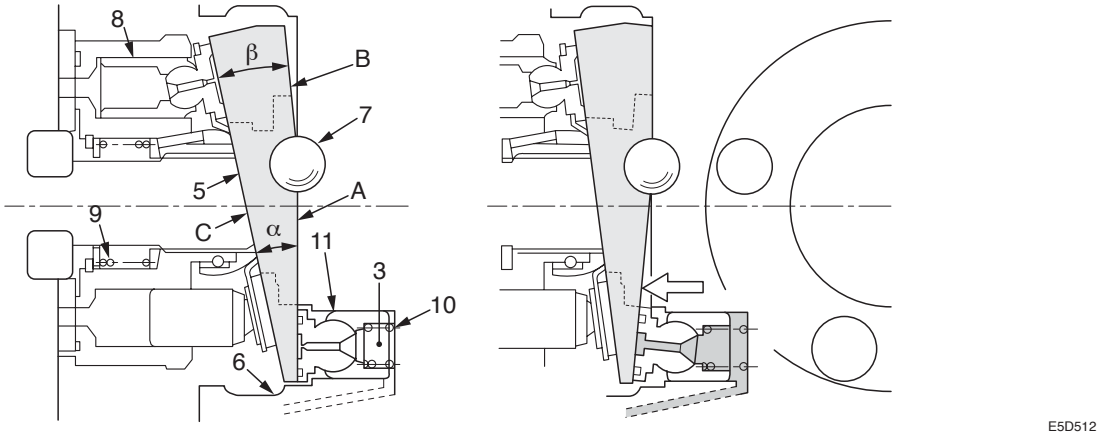



G4D508

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Swash Plate

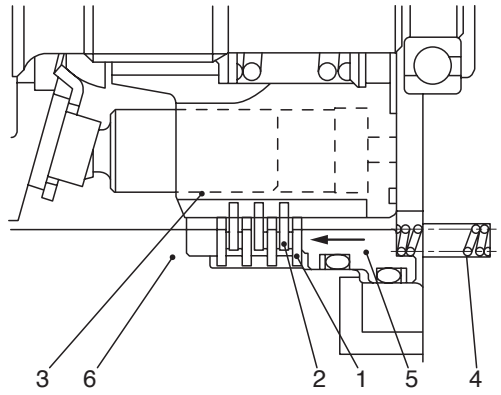


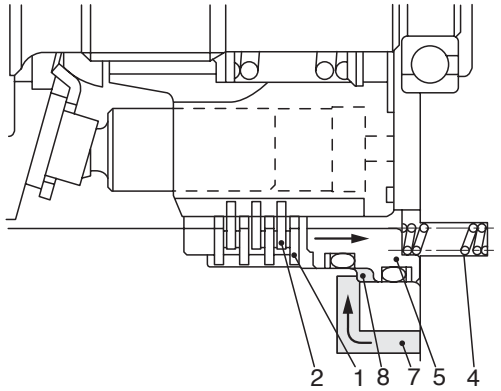

The swash plate (5) has 3 planes, A, B and C, as shown in the figure, and it is assembled in such a way that its angle of inclination in the flange holder (6) can varied by two balls (7). When the 2-speed control valve is switched to the 1st speed side, the swash plate control piston chamber is connected to tank port and the swash plate (5) is stabilized at plane A, forming swash plate angle α, by the piston assembly (8) and the force of the springs (9), (10), achieving 1st speed (low speed) motor rotation.
When the 2-speed control valve is switched to 2nd speed, the swash plate control piston chamber (3) is connected to the motor drive pressure port and the swash plate (5) stabilizes at plane B due to the equilibrium between the force of the springs (9), (10) and the force of the control piston (11), thus, assuming swash plate angle ß. In this way, 2nd speed (high speed) motor rotation is achieved.
When the engine is stopped, the pilot pressure of the 2-speed control valve is cut off, so the swash plate (5) is stabilized at the swash plate a plane A by the force of the springs (9), (10), changing to the 1st speed side. For this reason, when starting, the motor also is in 1st speed.

### Parking Brake

The center discs (1) are connected to the flange holder and the friction discs (2) are connected to the cylinder block (3) via the spline, respectively. The center discs (1) and friction discs (2) are pressed against the flange holder (6) by the springs (4) via the brake piston (5). The friction force between these discs generates the brake torque to prevent the cylinder block (3) from rotating.

When the pressure oil is introduced into the motor, the spool of the counterbalance valve moves and the oil flows from the parking brake release port (7) into the brake piston chamber (8). The oil pressure overpowers the spring force and moves the brake piston (5) to the right. This generates a clearance between the center discs (1) and friction discs (2) to release the parking brake. When the motor stops, the spool returns to the neutral position to close the parking brake release port (7). The pressure oil in the brake piston chamber (8) is introduced into the motor case and the spring (4) operates the parking brake.




### Reduction Gears

☞ “IV-145”

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## DISASSEMBLY AND ASSEMBLY

### General Cautions

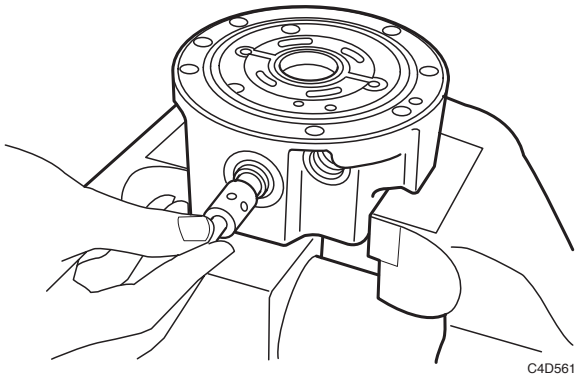
- Carry out disassembly and assembly operations in a clean place and provide clean containers to place the disassembled parts in.
- Before disassembly, clean around the ports and remove the paint from each joint using a wire brush.
- Wash the disassembled parts and dry them with compressed air. Do not use a rag, as this could cause clogging of dirt.
- Make match marks on each part so that they will be assembled in the same positions when reassembled.
- Replace all seals with new ones each time the unit is disassembled, coating them lightly with grease.
- Check each part to make sure there is no abnormal wear or seizing and use sandpaper, etc. to remove any burrs, sharp edges, etc.

The following describes the assembly procedure. For disassembly, follow the procedure in the reverse order referring to the construction diagram.

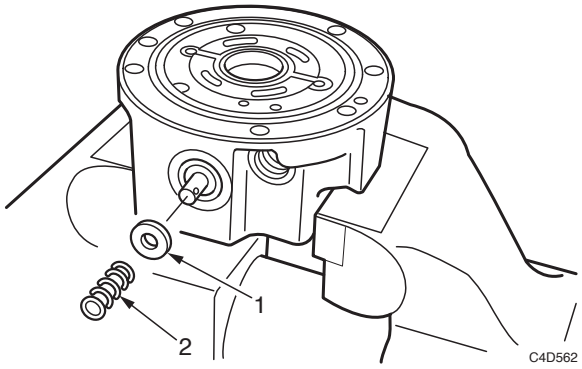
### Assembly

Counterbalance Valve and Hydraulic Motor

1. Fix the body with a vise and mount the spool on the valve body.
   - To prevent the outer surface of the valve body from being damaged, insert a protector such as an aluminum plate between the valve body and the vise.
   - Do not disassemble the spool assembly into parts.

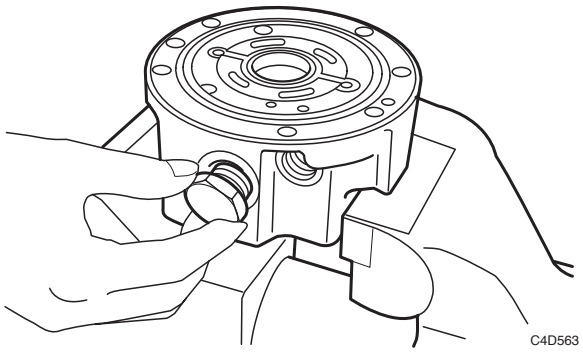

C4D561

2. Mount the rings (1) and springs (2) on both sides of the spool.



C4D562

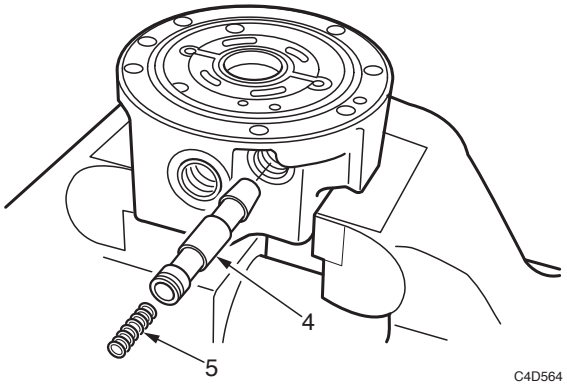
3. Fit the O-ring to the plug, and tighten the plug on both sides of the valve body.
   - Plug tightening torque:
     196~245 N·m (20~25 kgf·m)


C4D563

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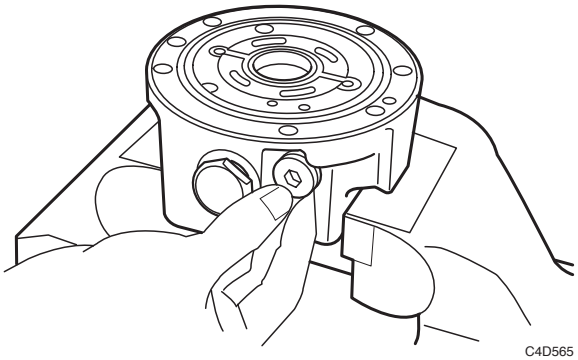


4. Mount the second speed spool (4) and spring (5) on the valve body.

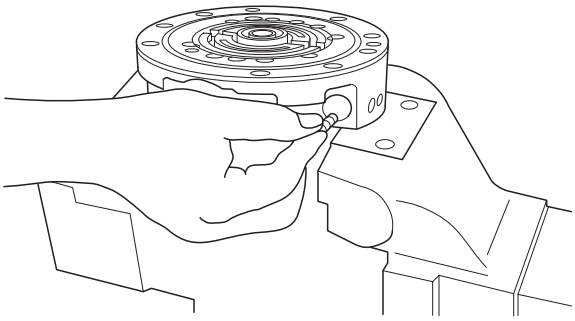


C4D564

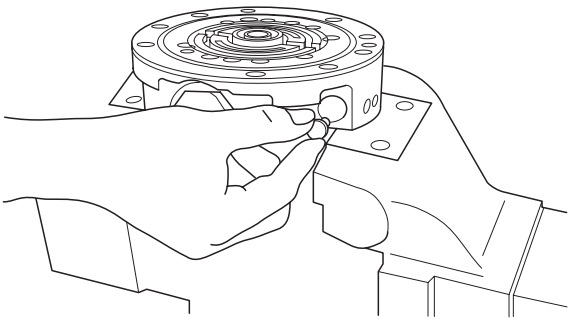
5. Fit the O-ring to the plug and tighten the plug to the valve body.
   - Plug tightening torque:
     46~51 N·m (4.7~5.3 kgf·m)


C4D565

6. Install the shuttle.


G4D511

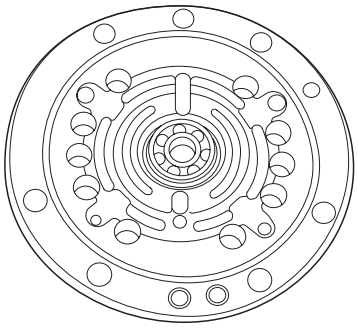
7. Fit the O-ring to the plug and tighten the plug to the valve body.
   - Plug tightening torque:
     12~23 N·m (1.2~2.3 kgf·m)


G4D512

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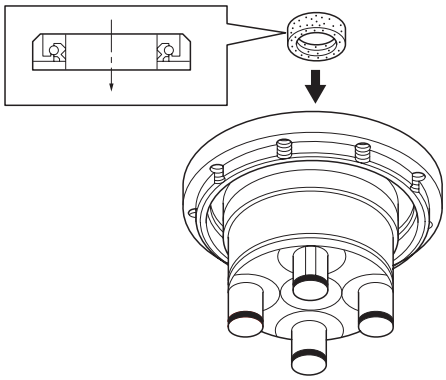


8. Mount the large and small O-rings on the valve body.



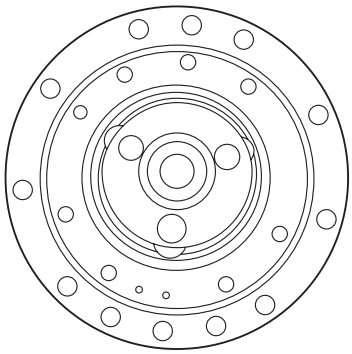
G4D513

9. Press fit the oil seal into the flange holder.
   - As the oil seal is be inserted, do not disassemble it unless necessary.
   - Fill between the lips of the oil seal with grease.



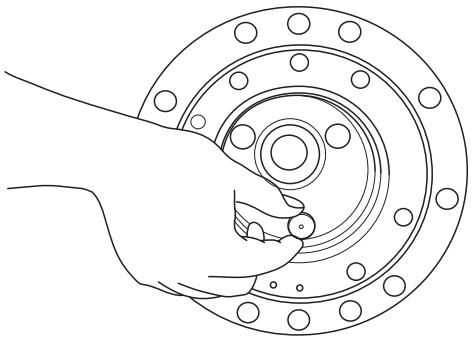
G4D514

10. Install the pin.



G4D515

11. Install the 2-speed piston.

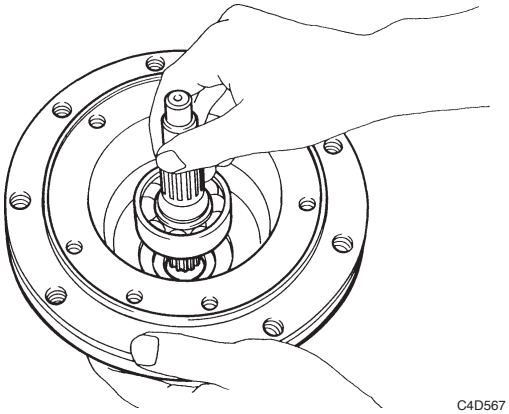


G4D516

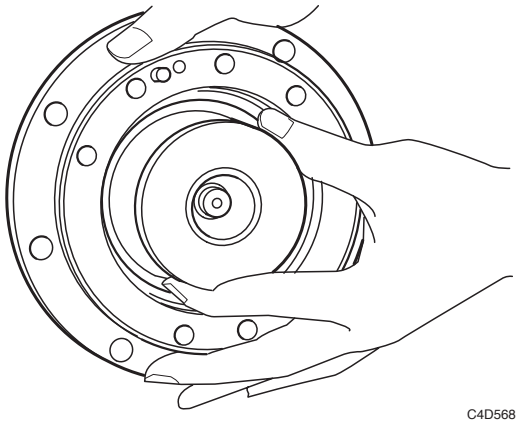
https://truckmanualshub.com/



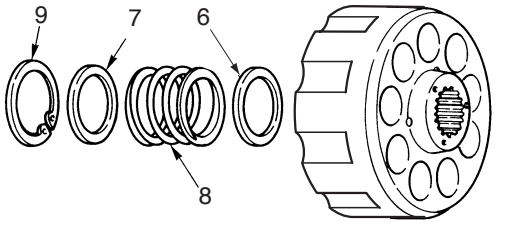
12. Mount the shaft on the flange holder.
    - The bearing has been inserted and cannot be disassembled.
    - Be careful not to damage the oil seal by the shaft.


C4D567

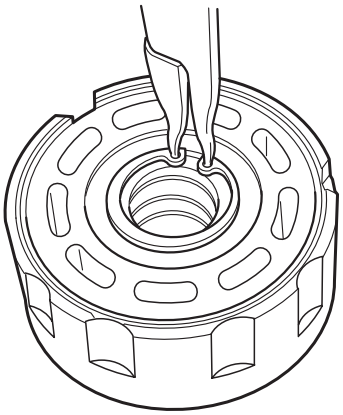
13. Install the balls and swash plate.
    - Apply hydraulic oil to the sliding surfaces of the swash plate.


C4D568

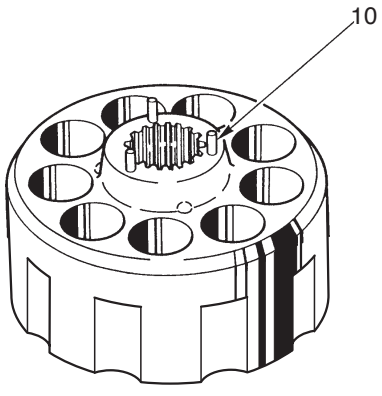
14. Mount the retainer (6), spring (8) and retainer (7) on the cylinder block and fix them with the snap ring (9).



C4D5701


C4D569

15. Fit the three pins (10) to the cylinder block.

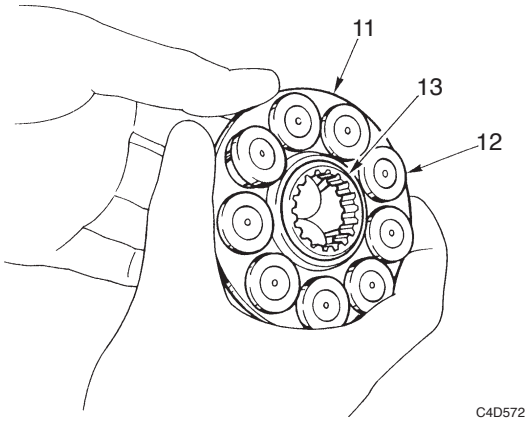


C4D571

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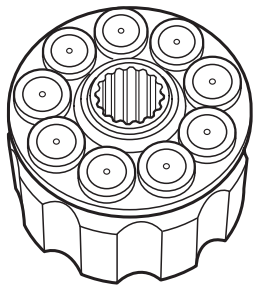


16. Mount the piston (12) and guide (13) on to the shoe holder (11) to assemble the shoe holder assembly.

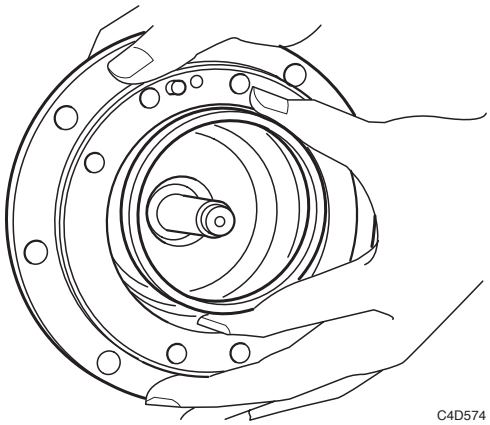


C4D572

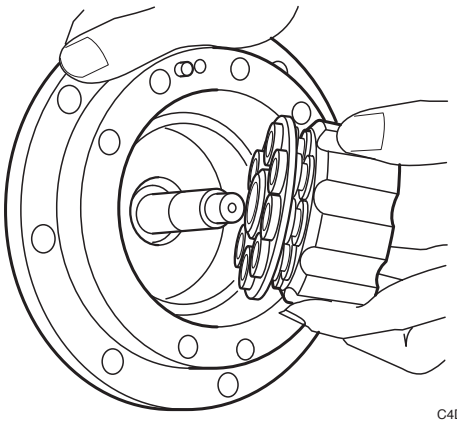
17. Mount the shoe holder assembly on the cylinder block to assemble the cylinder block assembly.


C4D573

18. Mount the brake spacer on the flange holder.


C4D574

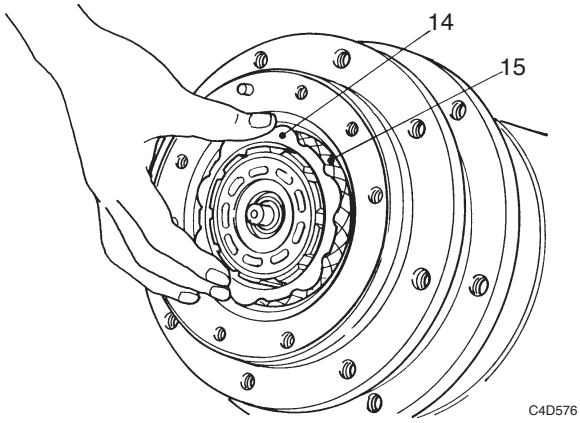
19. Mount the cylinder block assembly on the flange holder.
    - Mount the cylinder block assembly in such a manner that the shoe will touch the swash plate.


C4D575

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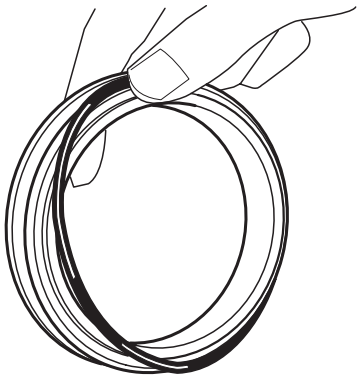


20. Install the center discs (14) in the groove of the flange holder and then install the friction discs (15) in the groove of the cylinder block, alternately one by one.
    - Total number of center discs: 2
    - Total number of friction disc: 1

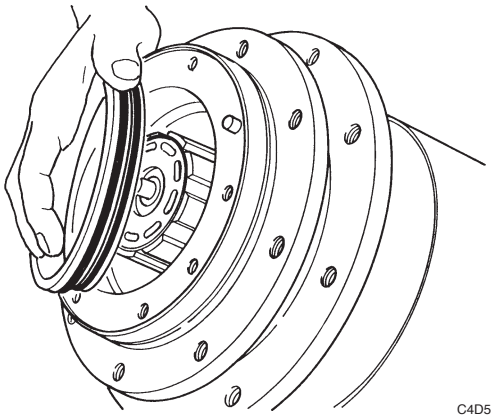


C4D576

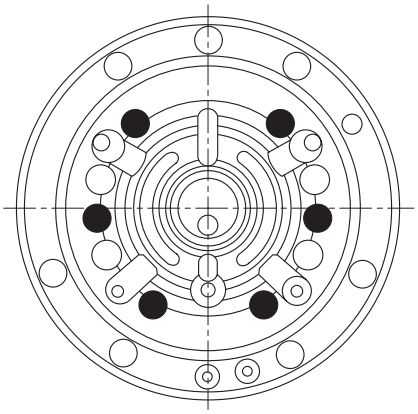
21. Mount two O-rings and two backup rings on the brake piston.
    - Be sure to position the backup rings on the outer side.


C4D577

22. Mount the brake piston assembly on the flange holder.
    - Apply grease to the O-ring and be careful not to let it bite the seal.


C4D578

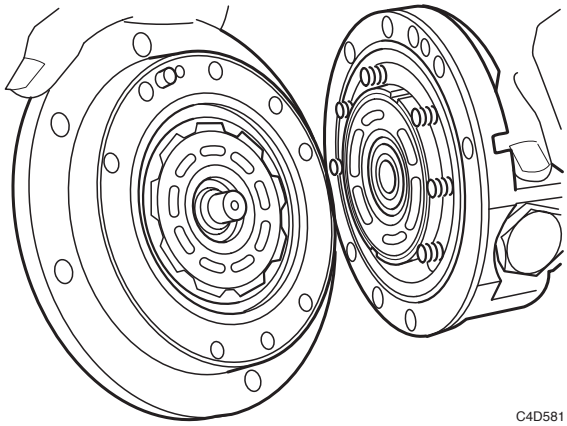
23. Mount the valve plate on the valve body and insert the springs into the spring holes.
    - The dot in the figure shows the spring installation positions.
    - Assemble the valve plate in such a manner that the copper surface is on the cylinder block side.
    - Apply grease to the valve plate and springs, and be careful not to drop them.


G4D529

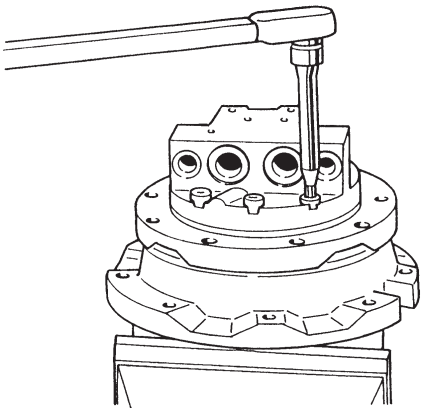
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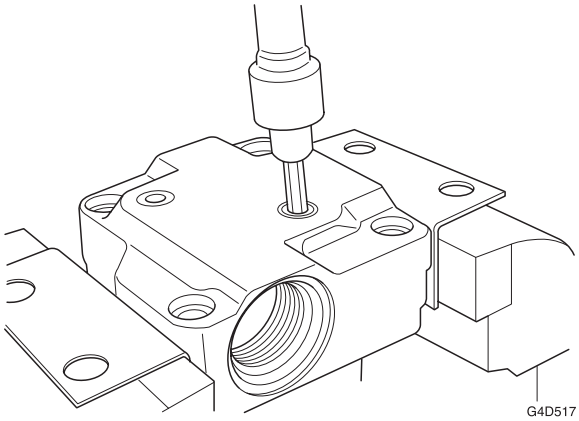
24. Supply 200 m*l* of hydraulic oil into the flange holder and mount the valve body on the flange holder.


C4D581

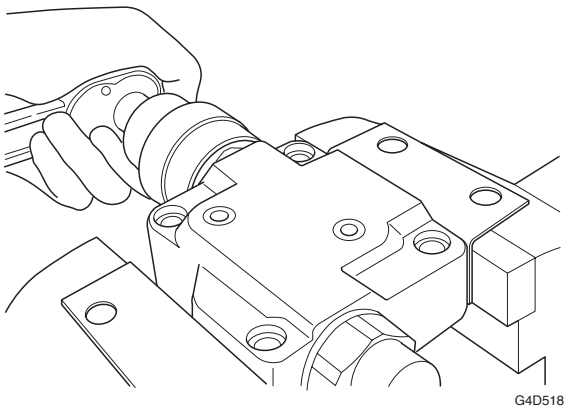
25. Fix the flange holder with a vise and tighten it with the screws.
    - Screw tightening torque:
      51~65 N·m (5.2~6.6 kgf·m)
    - Insert a protector such as an aluminum plate between the flange holder and the vise to prevent the outer surface of the body from being damaged.


C4D582

26. Install the plug.
    - Seal tape should be wound around the threads of the plug.
    - Plug tightening torque:
      26~31 N·m (2.7~3.2 kgf·m)


G4D517

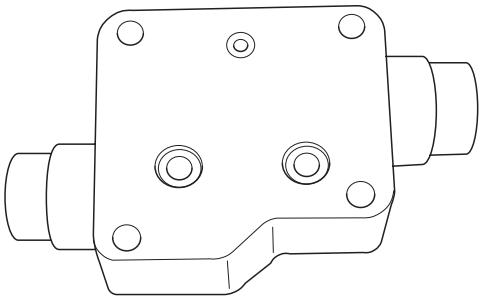
27. Mount the relief valve on the valve body.
    - Relief valve tightening torque:
      196~245 N·m (20~25 kgf·m)


G4D518

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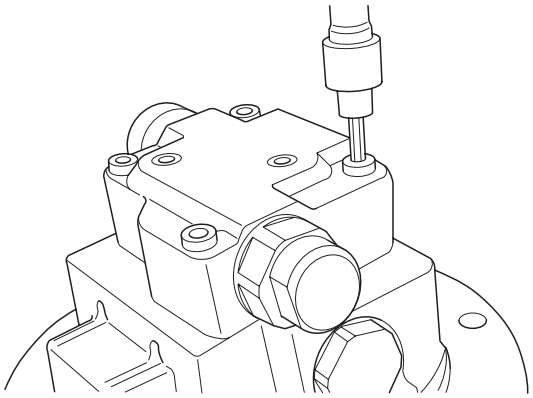


28. Mount the O-rings on the body.



G4D519

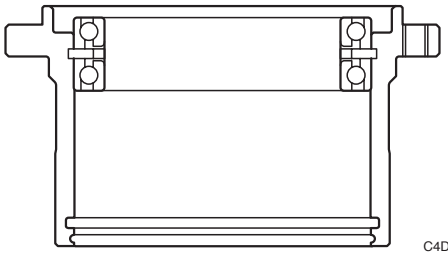
29. Mount the relief valve on the motor and tighten them with the cap screws.
    - Cap screw tightening torque:
      25~32 N·m (2.6~3.3 kgf·m)



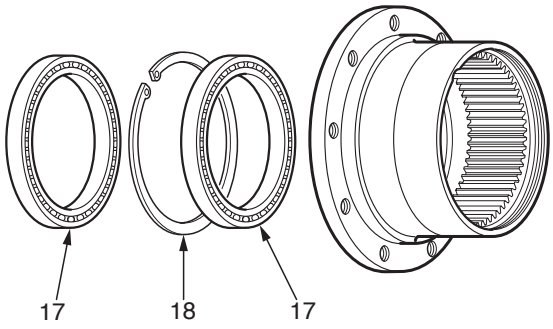
G4D520

### Reduction Gears

1. Install the bearing (17), snap ring (18) and bearing (17) in the housing.
    - Be careful of the installation direction of the bearings.

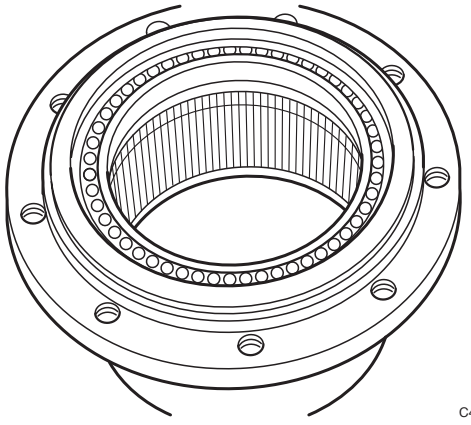


C4D584




C4D583

2. Fit the O-ring to the floating seal and install them in the housing.
    - Apply grease to the O-ring.

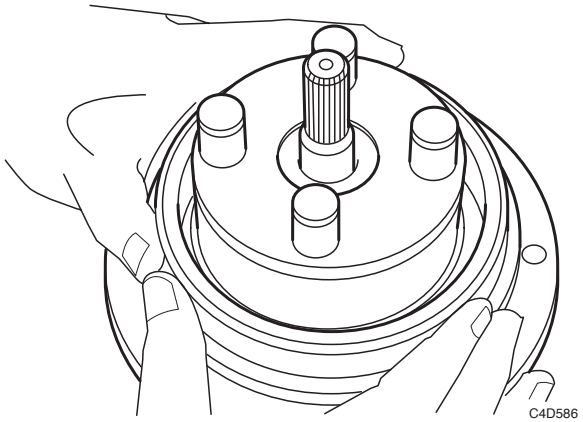


C4D585

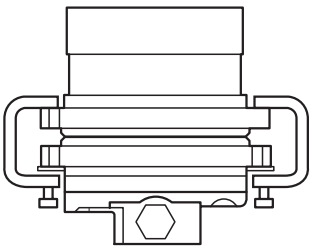
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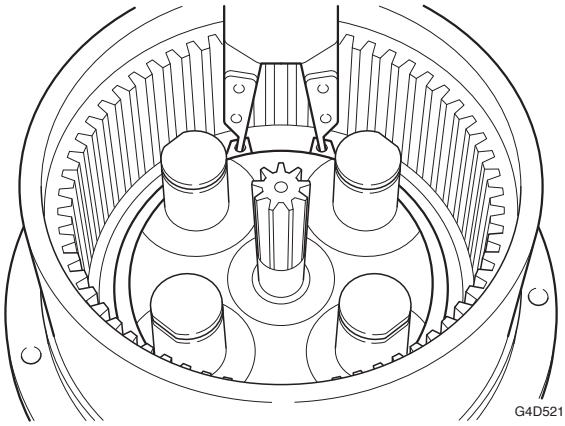


3. Mount the floating seal and O-ring on the flange holder.
   - Apply grease to the O-ring.

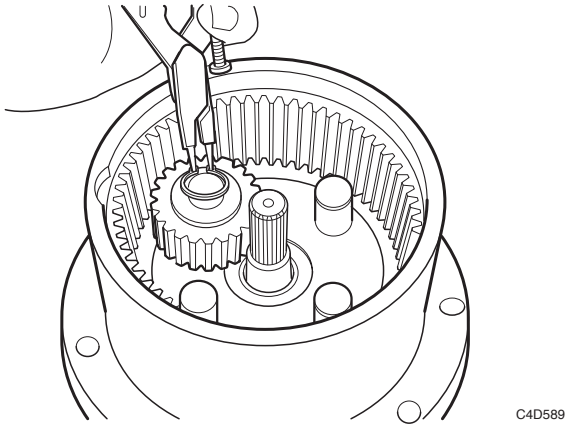

C4D586

4. Mount the housing on the flange holder and fix them with the snap ring.
   - Tighten the housing of the reduction gear and the flange of the hydraulic motor with a C-clamp or hydraulic press, and fix them with the snap ring.

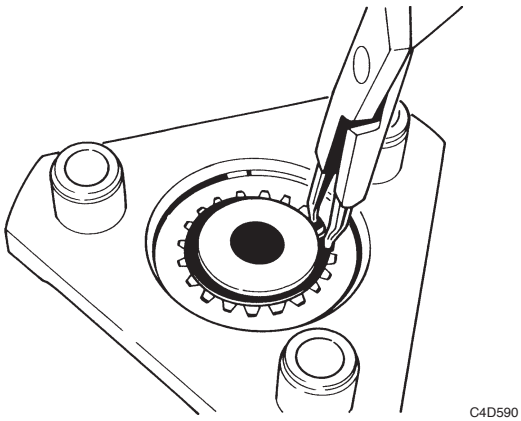

C4D588


G4D521

5. Mount the thrust washer, gear B1, needle, and thrust washer on the pin of the flange holder and fix them with the snap ring.
   - Be careful not to expand the snap ring more than necessary.
   - The thrust washer with a larger inner diameter should be fitted first.


C4D589

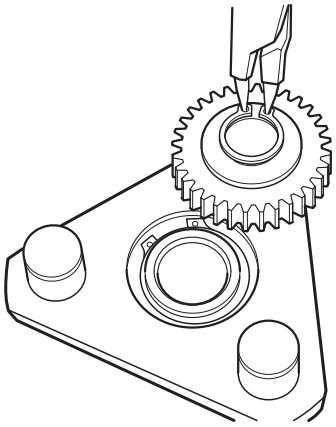
6. Mount the gear S1 on the carrier and fix them with the snap ring.


C4D590

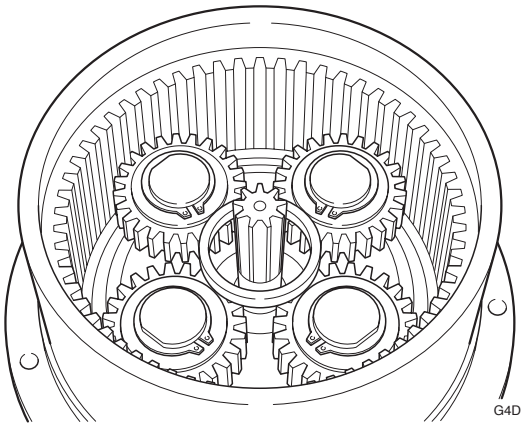
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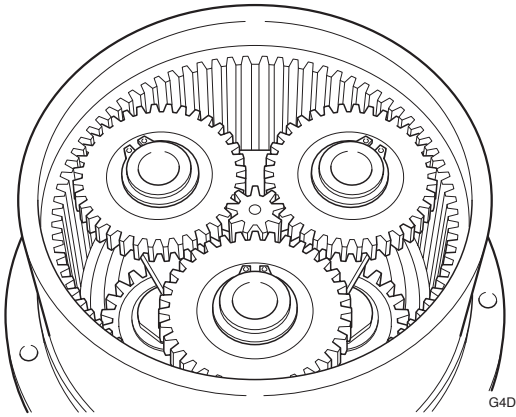
7. Mount the thrust washer, gear B2, needle and thrust washer on the carrier 2 and fix them with the snap ring.


C4D591

8. Mount the thrust collar on the housing.

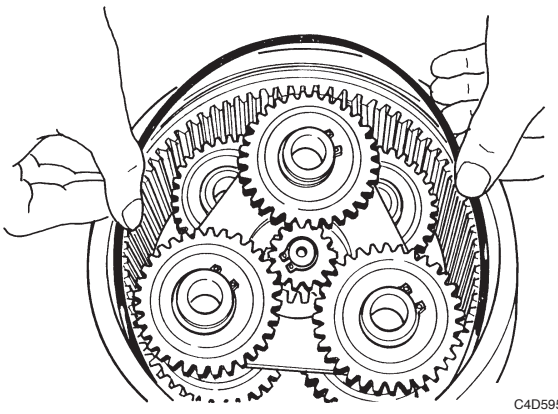

G4D522

9. Install the carrier 2 assembly in the housing.


G4D523

10. Fit the O-ring to the housing.

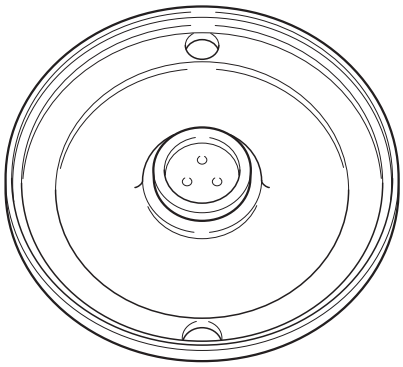
11. Supply 0.6 L of lubricant.


C4D595

https://truckmanualshub.com/

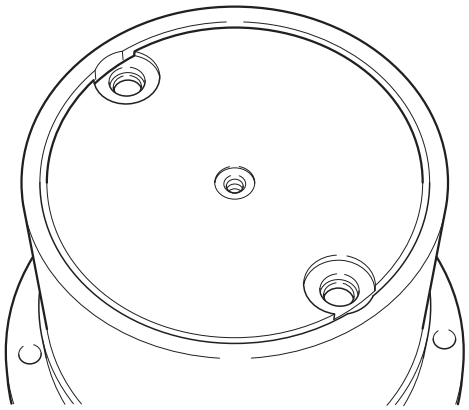


12. Install the ring on the cover.
    - Apply grease to secure.



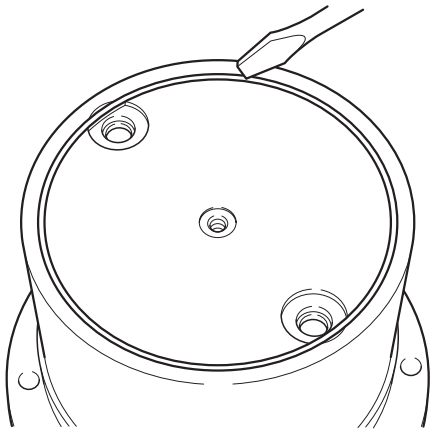
G4D524

13. Install the cover on the housing.
    - Line up the plug holes (G 3/8) with the cuts in the housing.



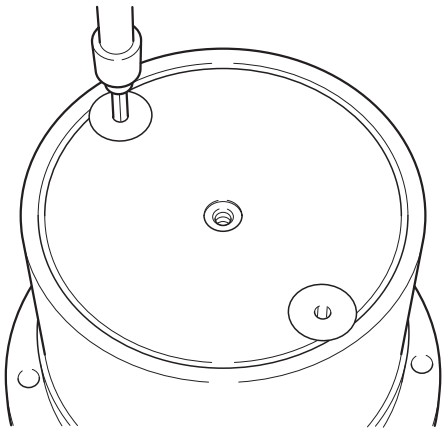
G4D525

14. Fit the snap ring to secure the cover.
    - Put the blade of a screwdriver on the snap ring end and push it into position.



G4D526

15. Fit the O-rings to the plugs and install the plugs on the cover.
    - Plug tightening torque:
      46~51 N·m (4.7~5.2 kgf·m)

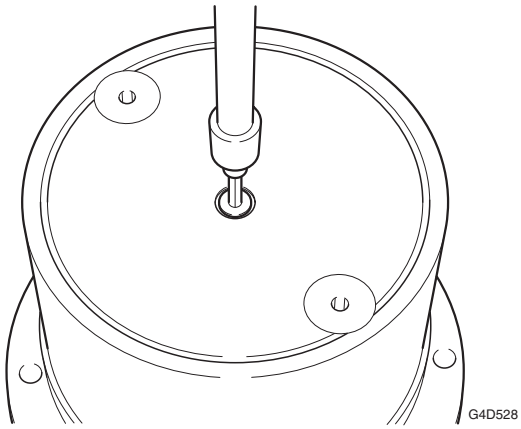


G4D527

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16. Fit the O-ring to the plug and install the plug on the cover.
    - Plug tightening torque:
      12~13 N·m (1.2~1.3 kgf·m)



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### INSPECTION AND ADJUSTMENT

☞ “IV-165~166”

### TROUBLESHOOTING

☞ “IV-167~168”

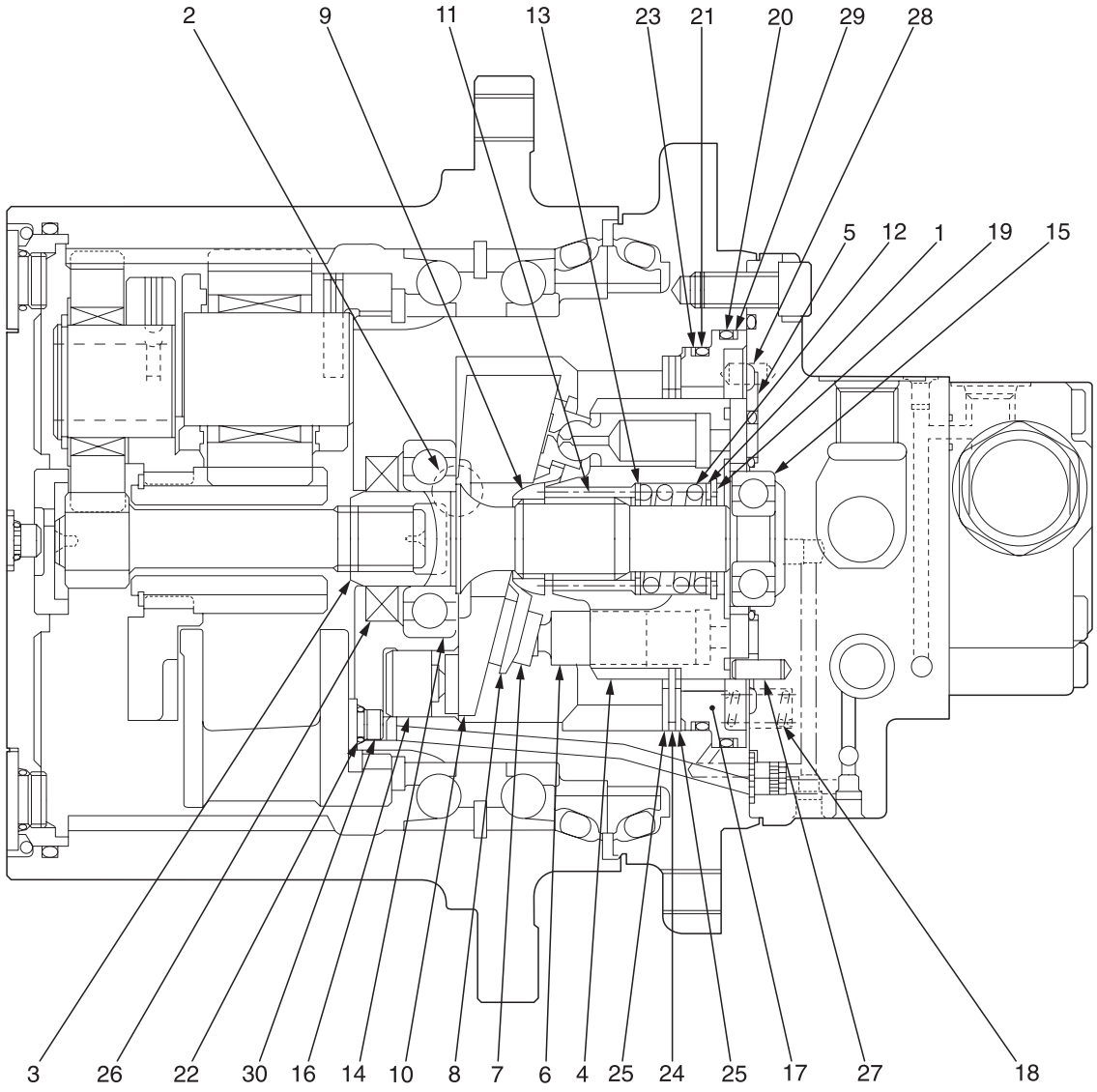
https://truckmanualshub.com/



# TRAVEL MOTOR (TB145)

## CONSTRUCTION

### Hydraulic Motor



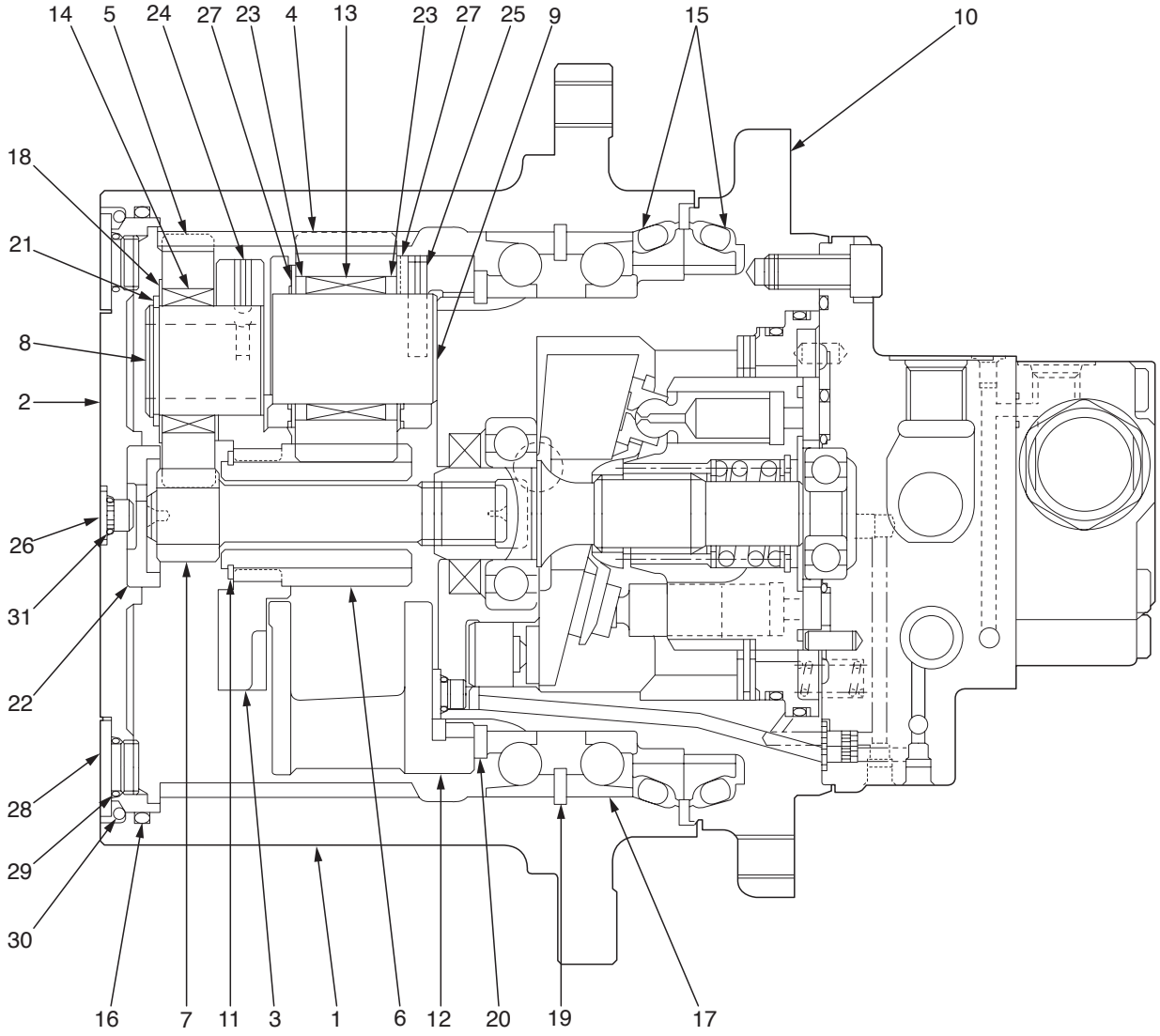

K3D500

1. Retainer
2. Ball
3. Shaft
4. Cylinder Block
5. Valve Plate
6. Piston
7. Shoe
8. Shoe Holder
9. Guide
10. Swash Plate
11. Pin
12. Spring
13. Retainer
14. Bearing
15. Bearing
16. 2-Speed Piston
17. Brake Piston
18. Spring
19. Snap Ring
20. O-ring
21. O-ring
22. O-ring
23. Backup Ring
24. Friction Disc
25. Center Disc
26. Oil Seal
27. Spring Pin
28. Pin
29. Backup Ring
30. Plug

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**Reduction Gears**

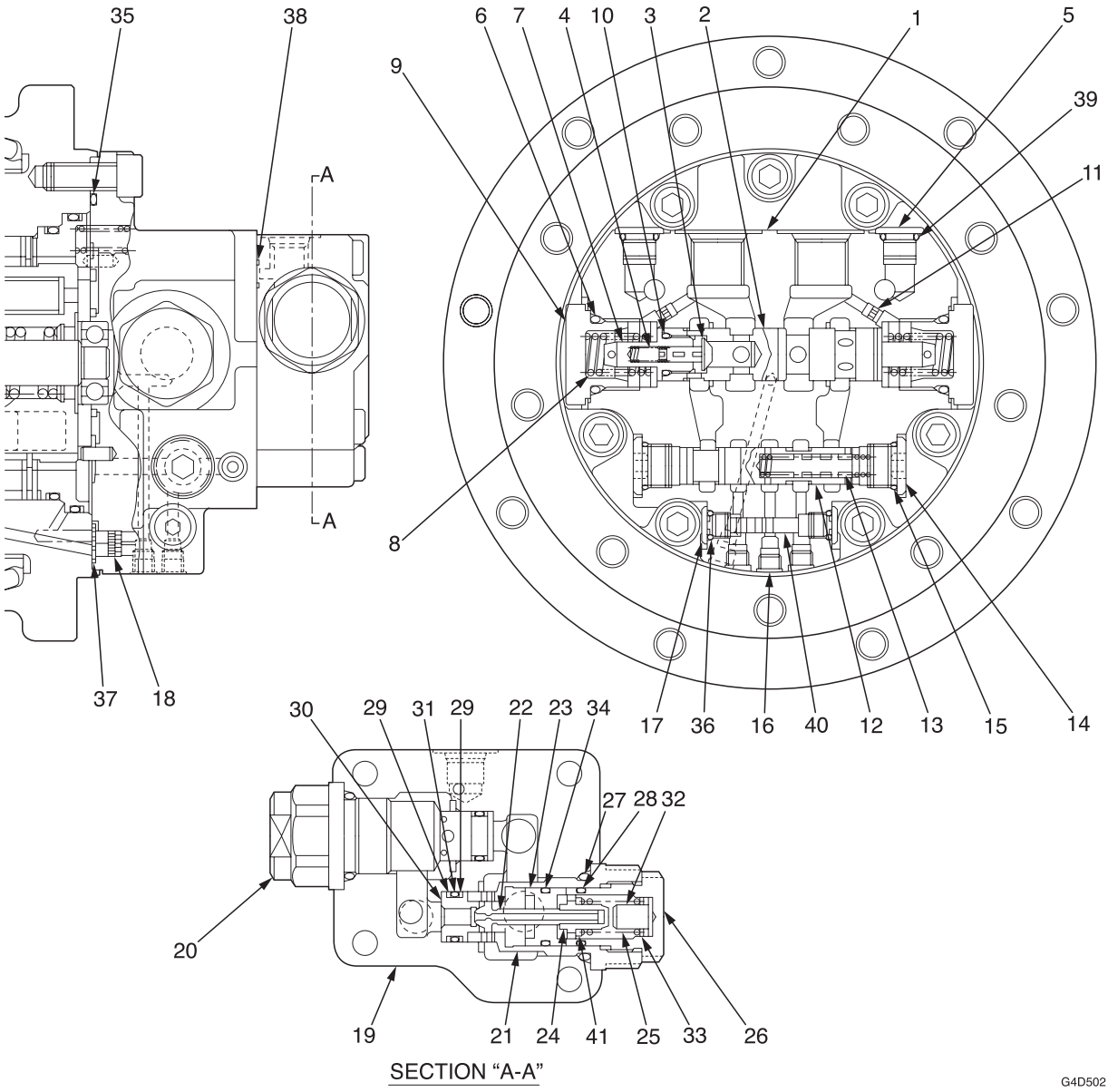



1. Housing
2. Cover
3. Carrier 2
4. Gear B1
5. Gear B2
6. Gear S1
7. Gear S2
8. Pin
9. Pin
10. Flange Holder
11. Snap Ring
12. Carrier 1
13. Needle
14. Needle
15. Floating Seal
16. O-ring
17. Bearing
18. Thrust Washer
19. Snap Ring
20. Snap Ring
21. Snap Ring
22. Ring
23. Ring
24. Pin
25. Pin
26. Plug
27. Thrust Washer
28. Plug
29. O-ring
30. Snap Ring
31. O-ring

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**Counterbalance Valve, 2-speed Control Valve, Relief Block Assembly**




1. Valve Body
2. Spool
3. Check Valve
4. Spring
5. Plug
6. O-ring
7. Spring Guide
8. Spring
9. Cap
10. O-ring
11. Orifice
12. Spool
13. Spring
14. Plug
15. O-ring
16. Plug
17. Plug
18. Orifice
19. Valve Body
20. Relief Valve Assembly
21. Relief Housing
22. Poppet
23. Seat
24. Spring Seat
25. Spring
26. Plug
27. O-ring
28. O-ring
29. Backup Ring
30. Piston
31. O-ring
32. Stopper
33. Spacer
34. O-ring
35. O-ring
36. O-ring
37. O-ring
38. O-ring
39. O-ring
40. Shuttle
41. Spacer

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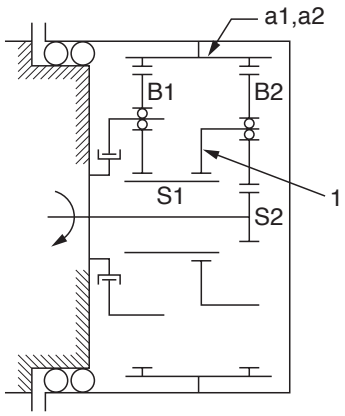


## OPERATION

☞ “IV-172~175”

### Reduction Gears

The reduction gear has a simple planetary two-stage configuration. It decelerates the high speed rotary motions of the hydraulic motor, converts them into low speed high torque, and rotates the case. The output shaft of the hydraulic motor is connected to the gear S2 via the spline. The rotation of the gear S2 is decelerated by one stage among the gears S2, B2 and a2. This one-stage decelerated rotation is further decelerated by two stages among the gears S1, B1 and a1 that are connected to the carrier 2 (1) via the spline. This rotation is conveyed to the rotary main body via the inner gears a1 and a2 as the driving force of the motor.



K3D502

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## DISASSEMBLY AND ASSEMBLY

### General Cautions

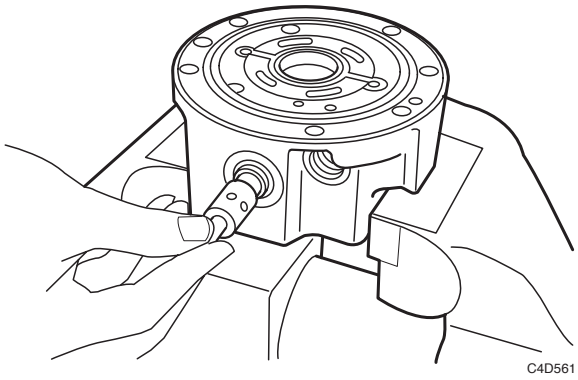
- Carry out disassembly and assembly operations in a clean place and provide clean containers to place the disassembled parts in.
- Before disassembly, clean around the ports and remove the paint from each joint using a wire brush.
- Wash the disassembled parts and dry them with compressed air. Do not use a rag, as this could cause clogging of dirt.
- Make match marks on each part so that they will be assembled in the same positions when reassembled.
- Replace all seals with new ones each time the unit is disassembled, coating them lightly with grease.
- Check each part to make sure there is no abnormal wear or seizing and use sandpaper, etc. to remove any burrs, sharp edges, etc.

The following describes the assembly procedure. For disassembly, follow the procedure in the reverse order referring to the construction diagram.

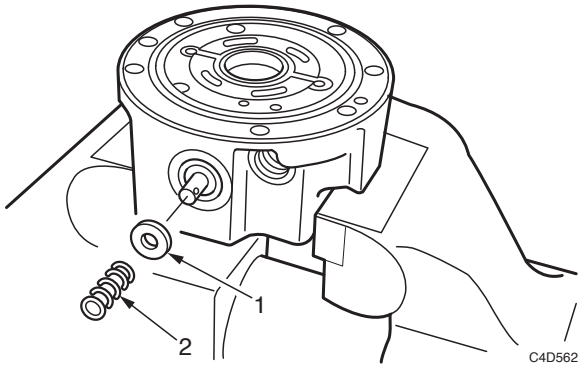
### Assembly

Counterbalance Valve and Hydraulic Motor

1. Fix the valve body with a vise and mount the spool on the valve body.
   - To prevent the outer surface of the valve body from being damaged, insert a protector such as an aluminum plate between the valve body and the vise.
   - Do not disassemble the spool assembly into parts.

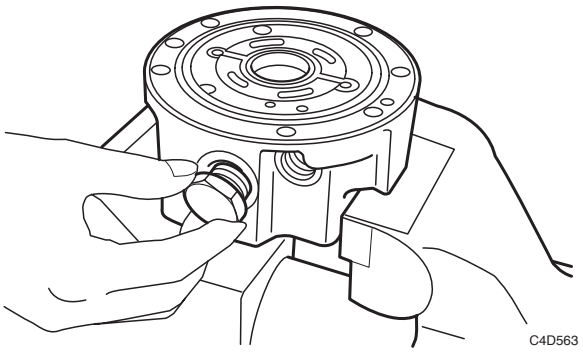

C4D561

2. Mount the rings (1) and springs (2) on both sides of the spool.



C4D562

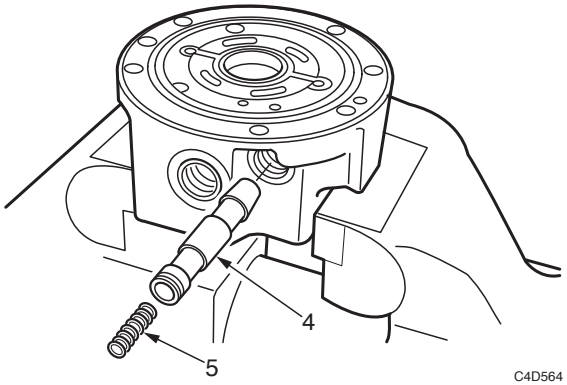
3. Fit the O-ring to the plug, and tighten the plug on both sides of the valve body.
   - Plug tightening torque:
     196~245 N·m (20~25 kgf·m)


C4D563

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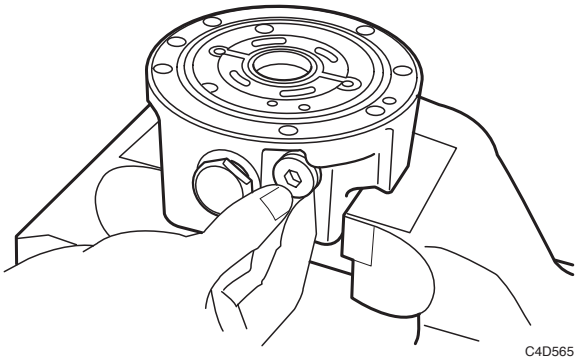


4. Mount the second speed spool (4) and spring (5) on the valve body.

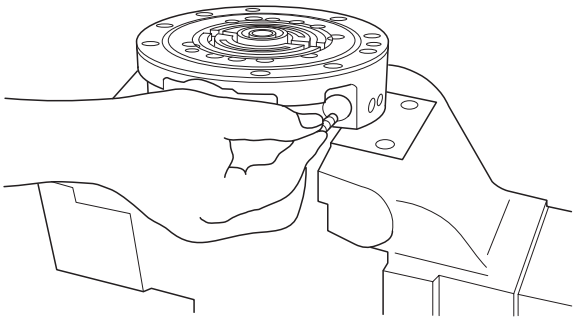


C4D564

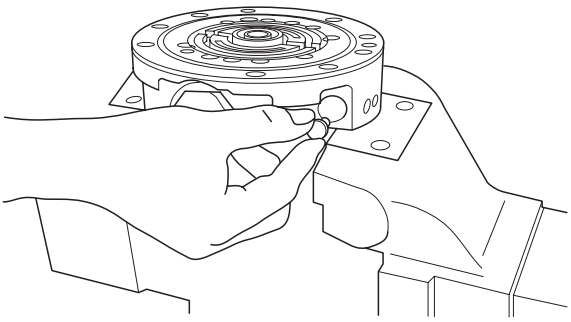
5. Fit the O-ring to the plug and tighten the plug to the valve body.
   - Plug tightening torque:
     46~51 N·m (4.7~5.3 kgf·m)


C4D565

6. Mount the shuttle on the valve body.


G4D511

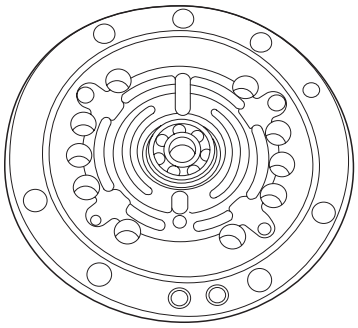
7. Fit the O-ring to the plug and tighten the plug to the valve body.
   - Plug tightening torque:
     12~23 N·m (1.2~2.3 kgf·m)


G4D512

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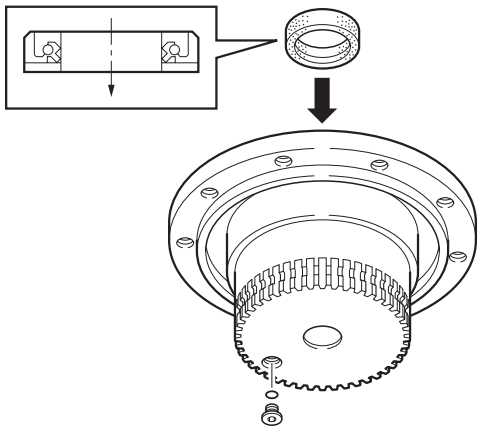
8. Mount the large and small O-rings on the valve body.



G4D513

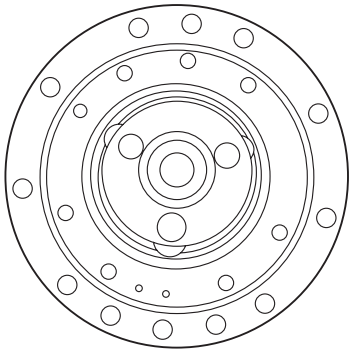
9. Press fit the oil seal into the flange holder.
   - As the oil seal is to be inserted, do not disassemble it unless necessary.
   - Fill between the lips of the oil seal with grease.

10. Fit the O-ring to the plug and install the plug on the flange holder.
    - Plug tightening torque:
      12~13 N·m (1.2~1.3 kgf·m)



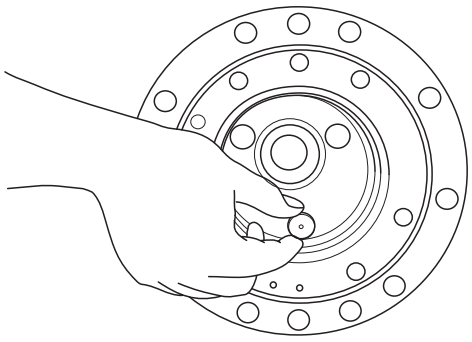
K3D503

11. Mount the pin.



G4D515

12. Mount the 2-speed piston.

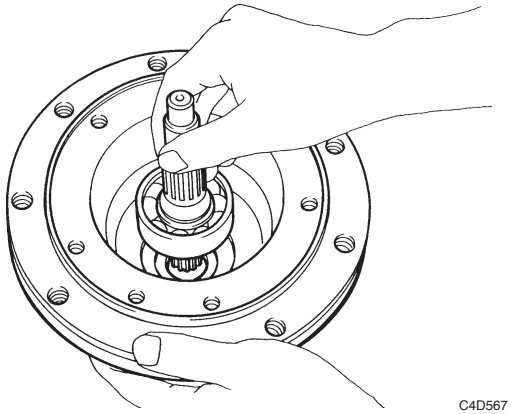


G4D516

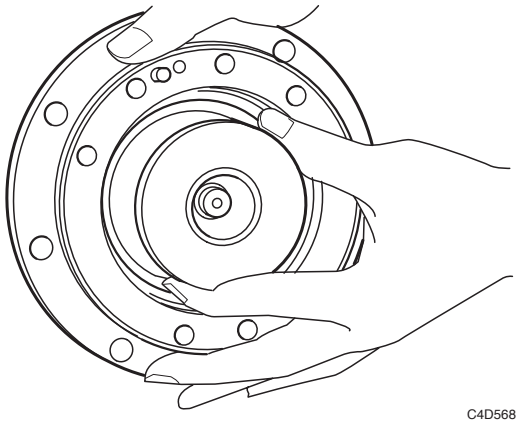
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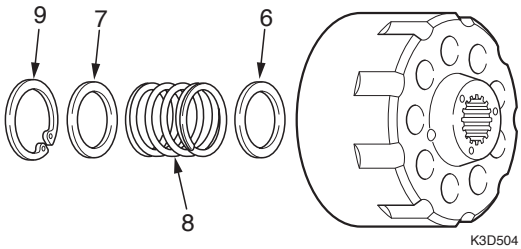
13. Mount the shaft on the flange holder.
    - The bearing has been inserted and cannot be disassembled.
    - Be careful not to damage the oil seal by the shaft.


C4D567

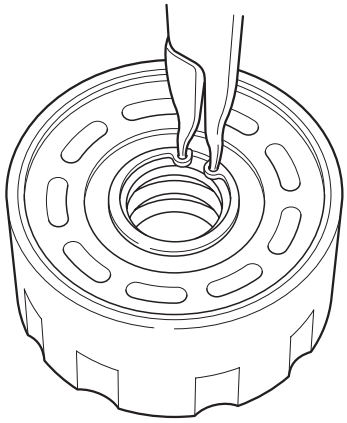
14. Mount the balls and swash plate.
    - Apply hydraulic oil to the sliding surfaces of the swash plate.


C4D568

15. Mount the retainer (6), spring (8) and retainer (7) on the cylinder block and fix them with the snap ring (9).

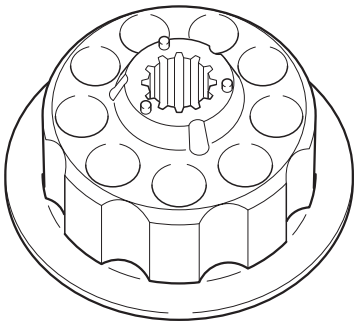


K3D504


K3D505

16. Fit the three pins to the cylinder block.

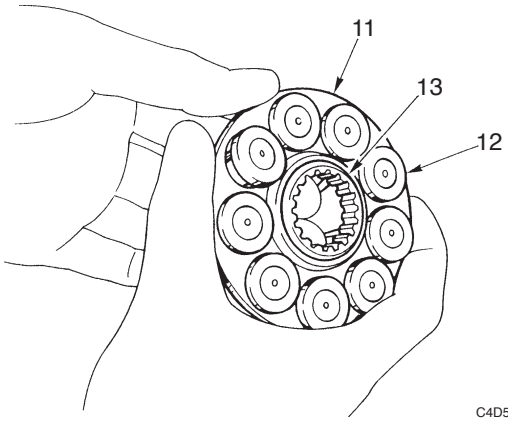
17. Install the friction disc.


K3D506

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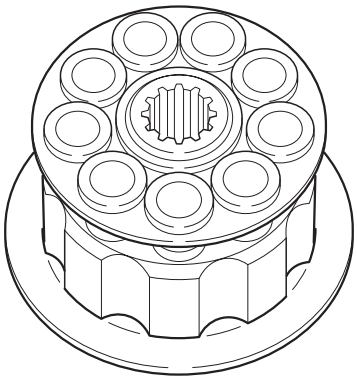


18. Mount the piston (12) and guide (13) on to the shoe holder (11) to assemble the shoe holder assembly.

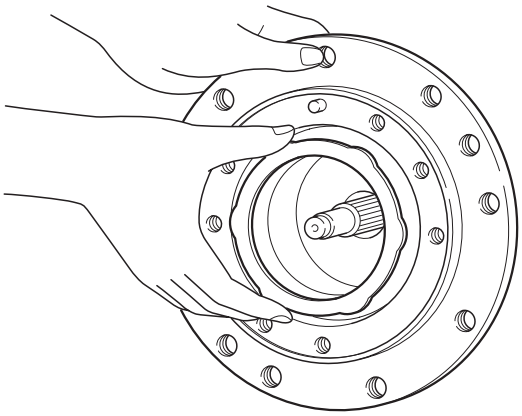


C4D572

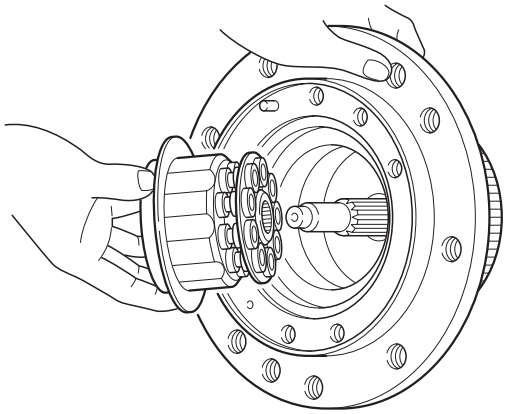
19. Mount the shoe holder assembly on the cylinder block to assemble the cylinder block assembly.


K3D507

20. Install the center disc in the groove of the flange holder.


K3D508

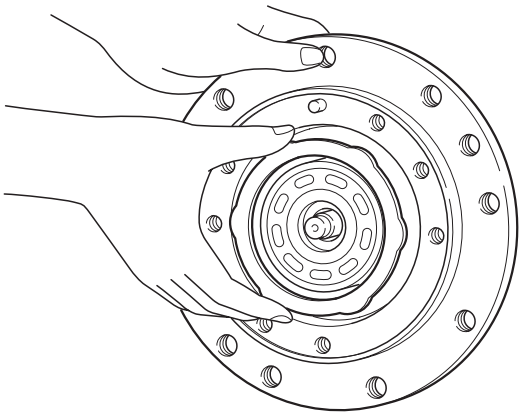
21. Install the cylinder block assembly.
    a. Install the shaft splinge in the guide.


K3D509

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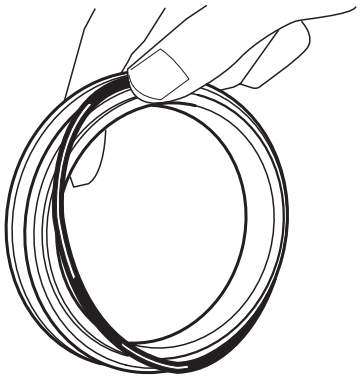


22. Install the center disc in the groove of the flange holder.



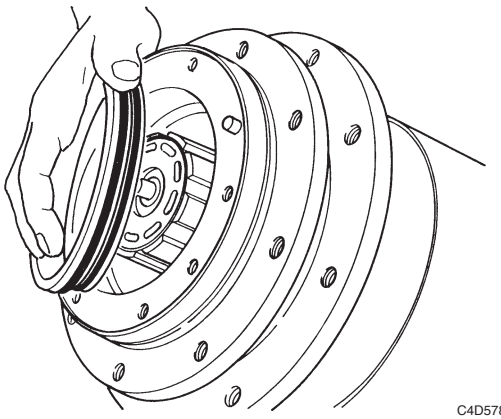
K3D510

23. Mount two O-rings and two backup rings on the brake piston.
    - Be sure to position the backup rings on the outer side.



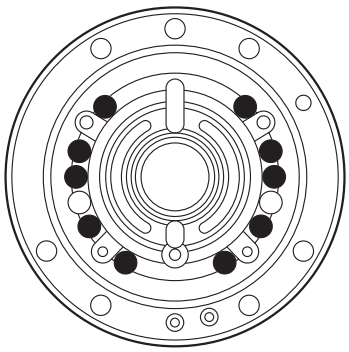
C4D577

24. Mount the brake piston assembly on the flange holder.
    - Apply grease to the O-ring and be careful not to let it bite the seal.



C4D578

25. Mount the valve plate on the valve body and insert the springs into the spring holes.
    - The dot in the figure shows the spring installation positions.
    - Assemble the valve plate in such a manner that the copper surface is on the cylinder block side.
    - Apply grease to the valve plate and springs, and be careful not to drop them.

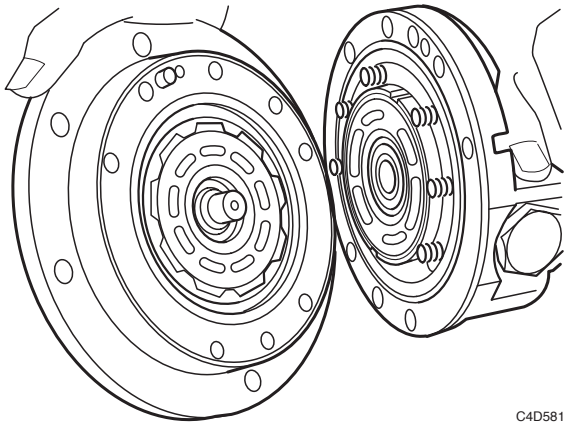


K3D511

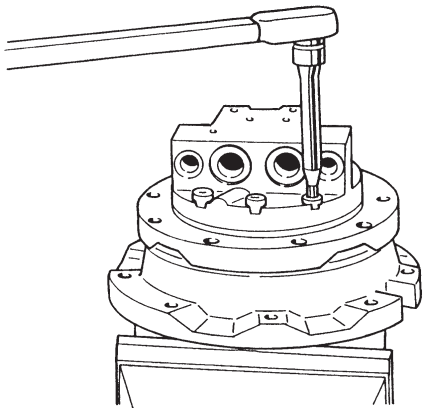
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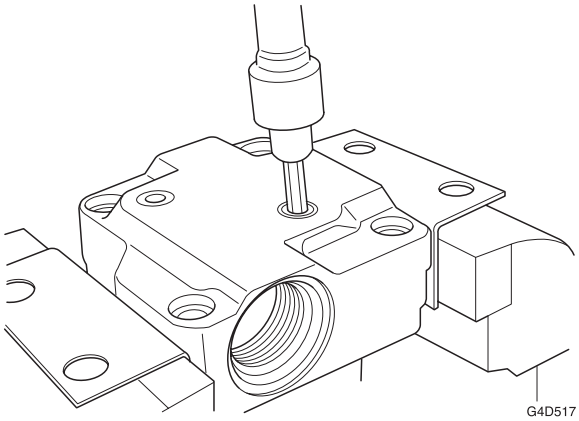
26. Supply 200 mL of hydraulic oil into the flange holder and mount the valve body on the flange holder.


C4D581

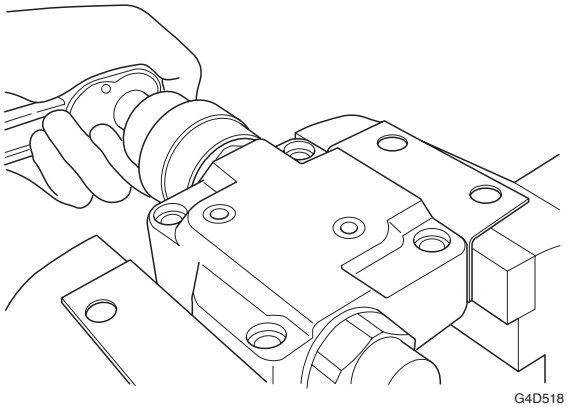
27. Fix the valve body with a vise and tighten it with the screws.
    - Screw tightening torque:
      51~65 N·m (5.2~6.6 kgf·m)
    - Insert a protector such as an aluminum plate between the flange holder and the vise to prevent the outer surface of the body from being damaged.


C4D582

28. Install the plug.
    - Seal tape should be wound around the threads of the plug.
    - Plug tightening torque:
      26~31 N·m (2.7~3.2 kgf·m)


G4D517

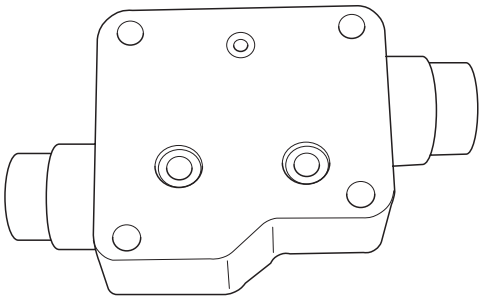
29. Mount the relief valve on the valve body.
    - Relief valve tightening torque:
      196~245 N·m (20~25 kgf·m)


G4D518

https://truckmanualshub.com/

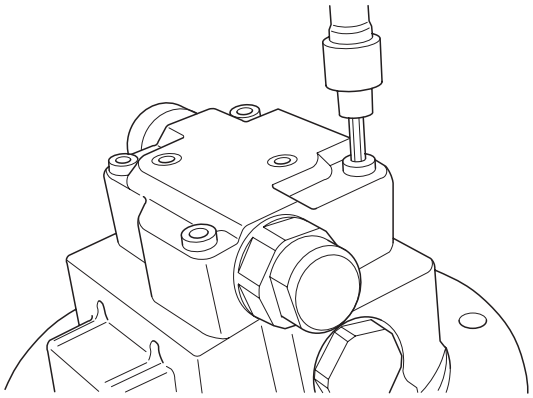


30. Mount the large and small O-ring on the body.



G4D519

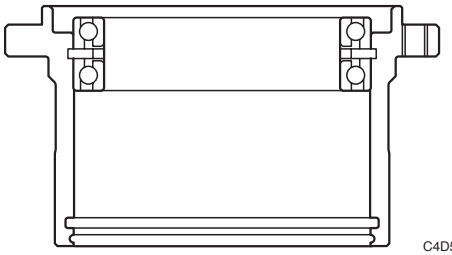
31. Mount the relief valve on the motor and tighten them with the cap screws.
    - Cap screw tightening torque:
      25~32 N·m (2.6~3.3 kgf·m)



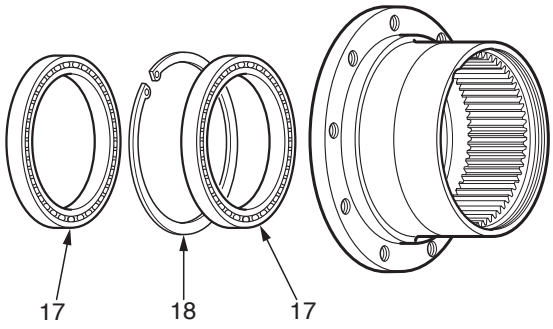
G4D520

### Reduction Gears

1. Install the bearing (17), snap ring (18) and bearing (17) in the housing.
    - Be careful of the installation direction of the bearings.

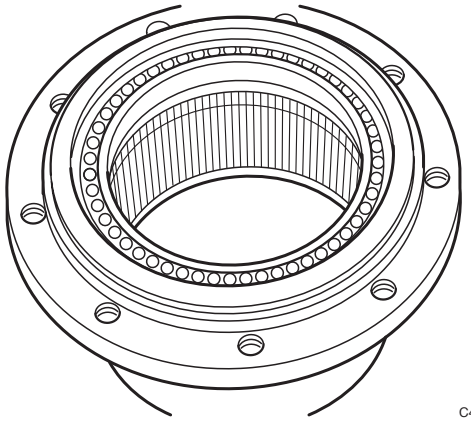


C4D584




C4D583

2. Fit the O-ring to the floating seal and install them in the housing.
    - Apply grease to the O-ring.

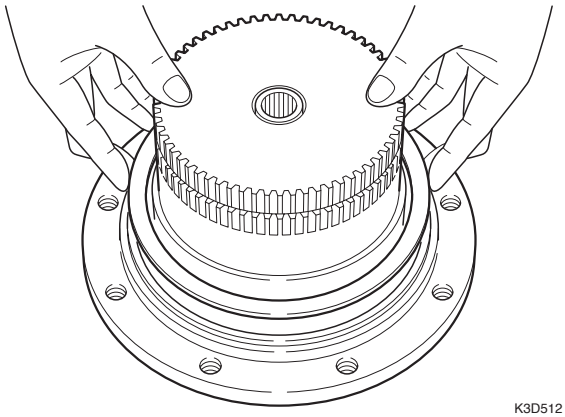


C4D585

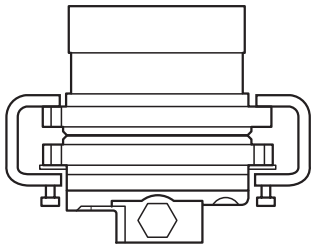
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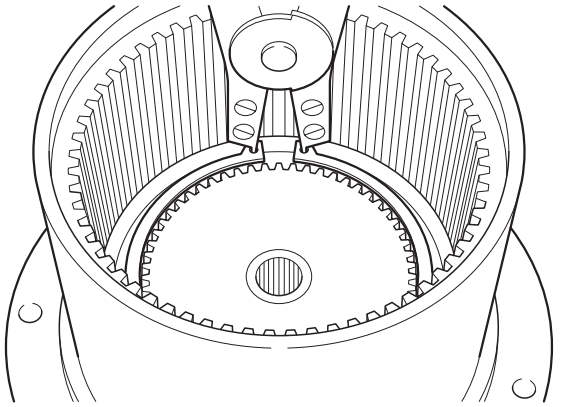


3. Fit the O-ring to the floating seal and install them in the flange holder.
   - Apply grease to the O-ring.


K3D512

4. Mount the housing on the flange holder and fix them with the snap ring.
   - Tighten the housing of the reduction gear and the flange of the hydraulic motor with a C-clamp or hydraulic press, and fix them with the snap ring.

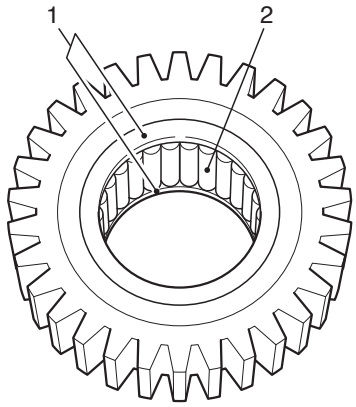

C4D588


K3D513

5. Press fit the ring (1) to the gear B.

6. Install the needles (2) in the gear B.
   - Apply grease to the needles to prevent from coming off.

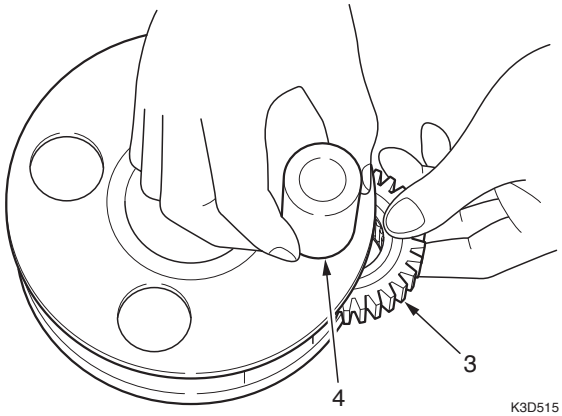
7. Press fit the ring (1) to the other end of the gear B.



K3D514

8. Install the thrust washer, the gear B assembly (3), the thrust washer and the pin (4).

9. Press fit the spring pins to secure the pins (4).

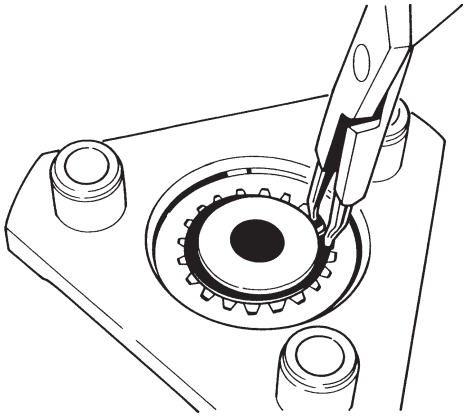


K3D515

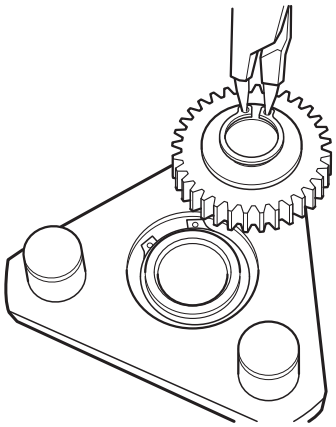
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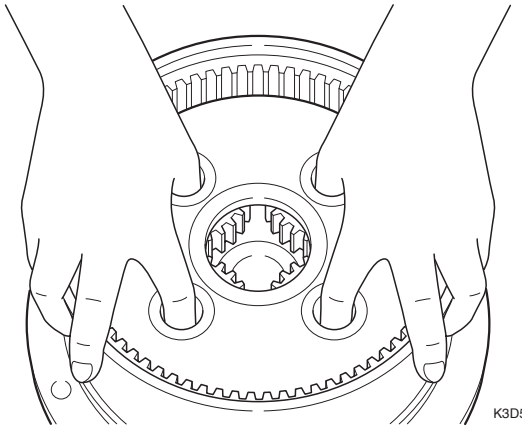
10. Mount the gear S1 on the carrier and fix them with the snap ring.


C4D590

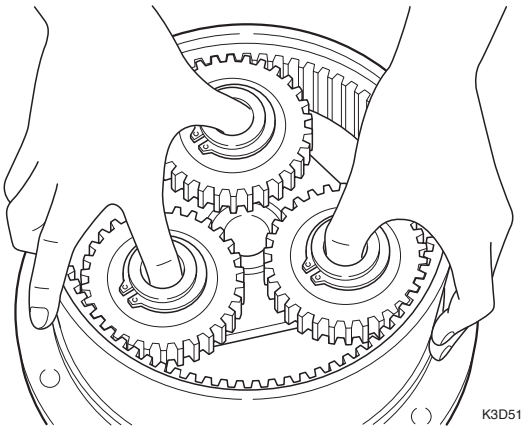
11. Mount the thrust washer, gear B2, needle and thrust washer on the carrier 2 and fix them with the snap ring.


C4D591

12. Install the carrier 1 assembly in the housing.


K3D516

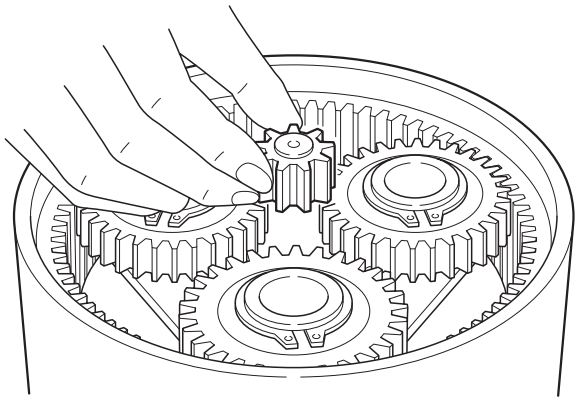
13. Install the thrust washer and the carrier 2 assembly in the housing.


K3D517

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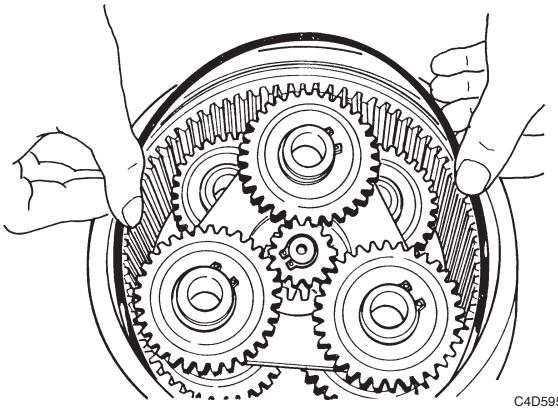


14. Install the gear S2.

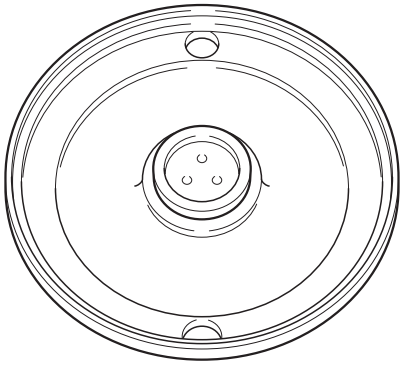

K3D518

15. Fit the O-ring to the housing.

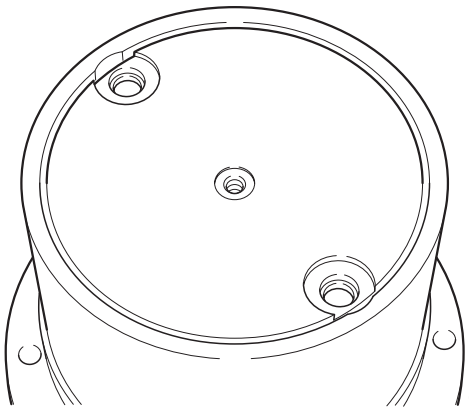
16. Supply 0.8 L of lubricant.


C4D595

17. Install the ring on the cover.
    - Apply grease to secure.


G4D524

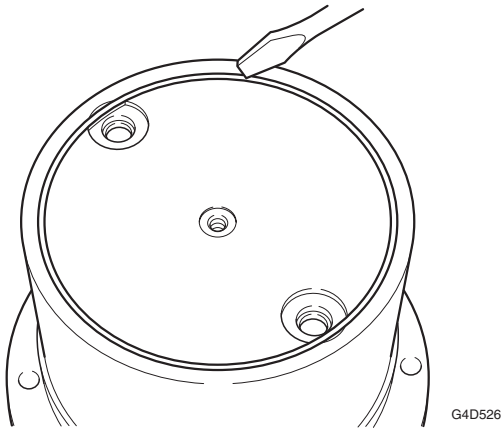
18. Install the cover on the housing.
    - Line up the plug holes (G 3/8) with the cuts in the housing.


G4D525

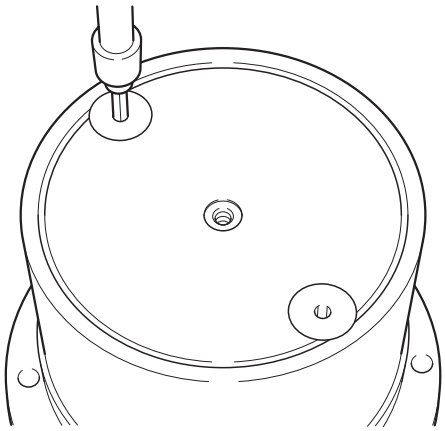
https://truckmanualshub.com/



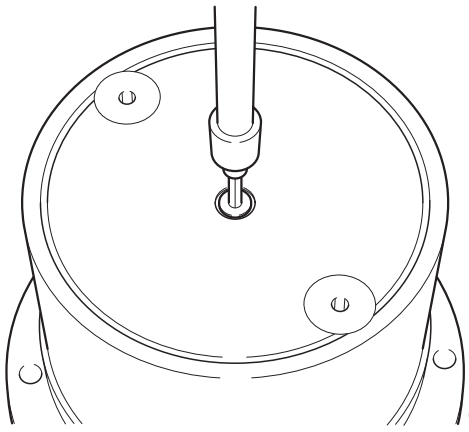
19. Fit the snap ring to secure the cover.
    - Put the blade of a screwdriver on the snap ring end and push it into position.


G4D526

20. Fit the O-rings to the plugs and install the plugs on the cover.
    - Plug tightening torque:
      46~51 N·m (4.7~5.2 kgf·m)


G4D527

21. Fit the O-ring to the plug and install the plug on the cover.
    - Plug tightening torque:
      12~13 N·m (1.2~1.3 kgf·m)


G4D528

**INSPECTION AND ADJUSTMENT**

☞ “IV-165~166”

**TROUBLESHOOTING**

☞ “IV-167~168”

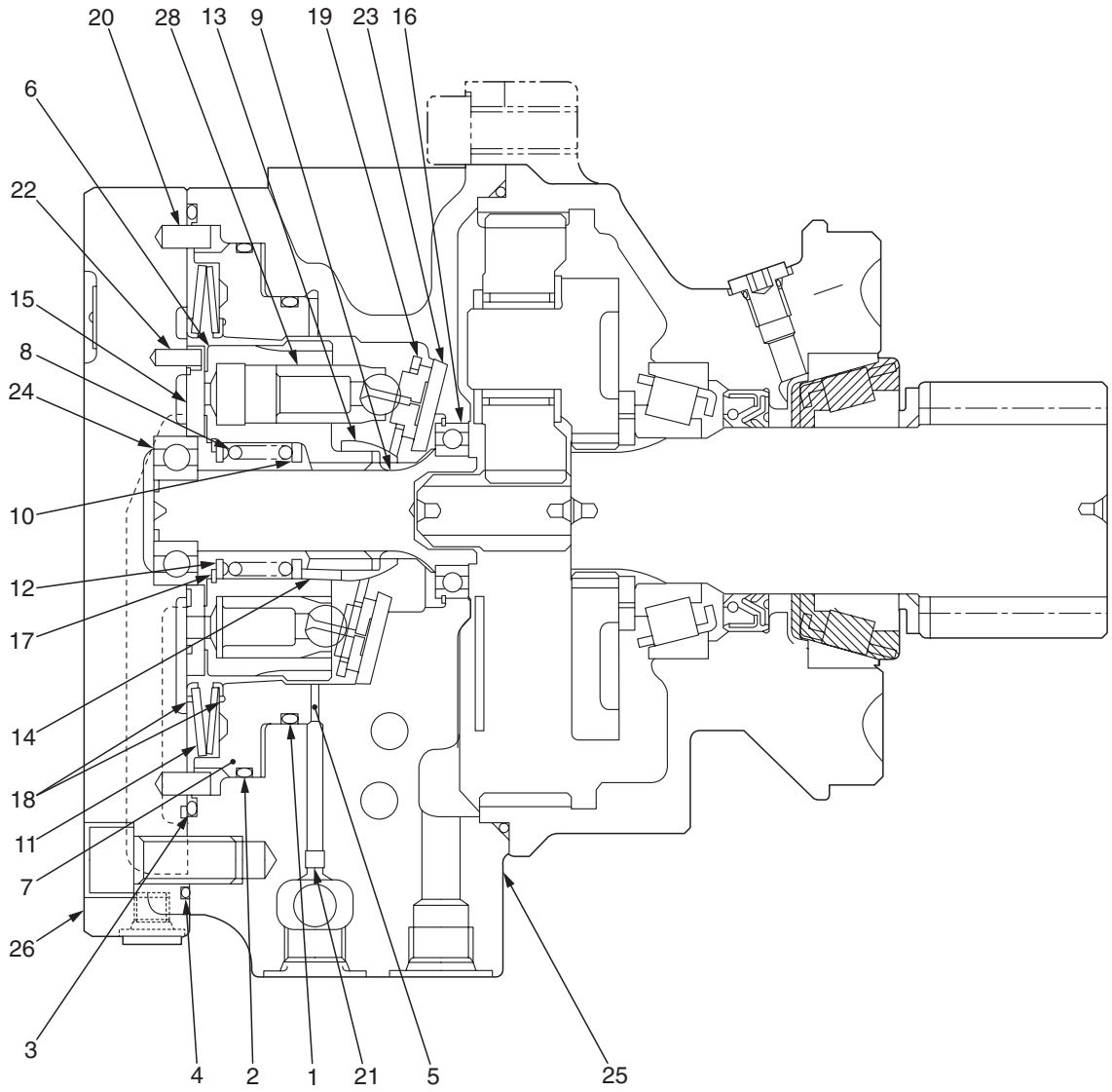
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# SLEW MOTOR (TB125)

## CONSTRUCTION

### Hydraulic Motor



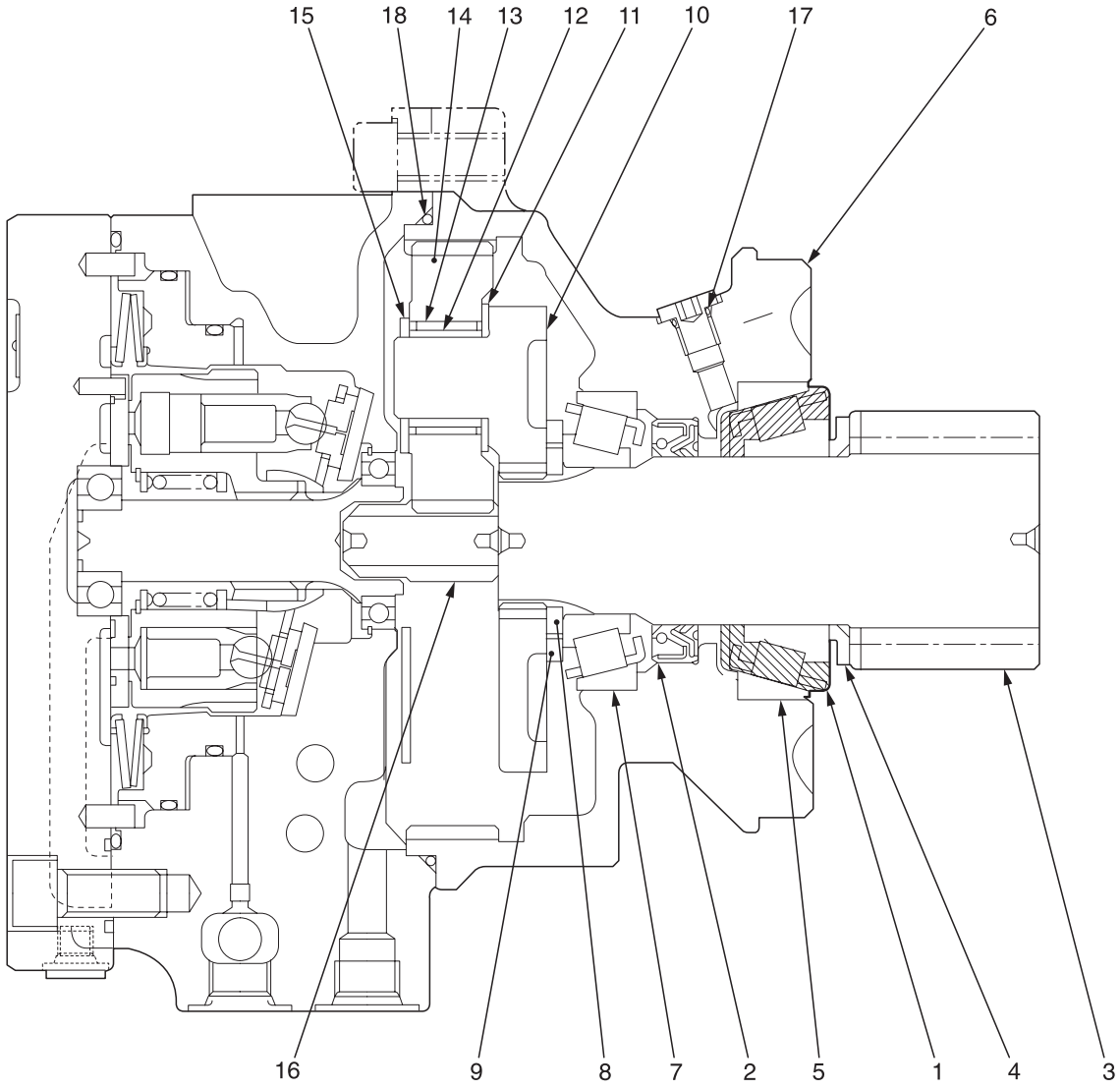

E5D600

1. O-ring
2. O-ring
3. O-ring
4. O-ring
5. Disc
6. Cylinder Block
7. Brake Piston
8. Spring
9. Shaft
10. Retainer
11. Disk Spring
12. Retainer
13. Guide
14. Pin
15. Valve Plate
16. Bearing
17. Snap Ring
18. Spring Seat
19. Shoe Holder
20. Pin
21. Orifice
22. Pin
23. Swash Plate
24. Bearing
25. Housing
26. Cover

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**Reduction Gears**



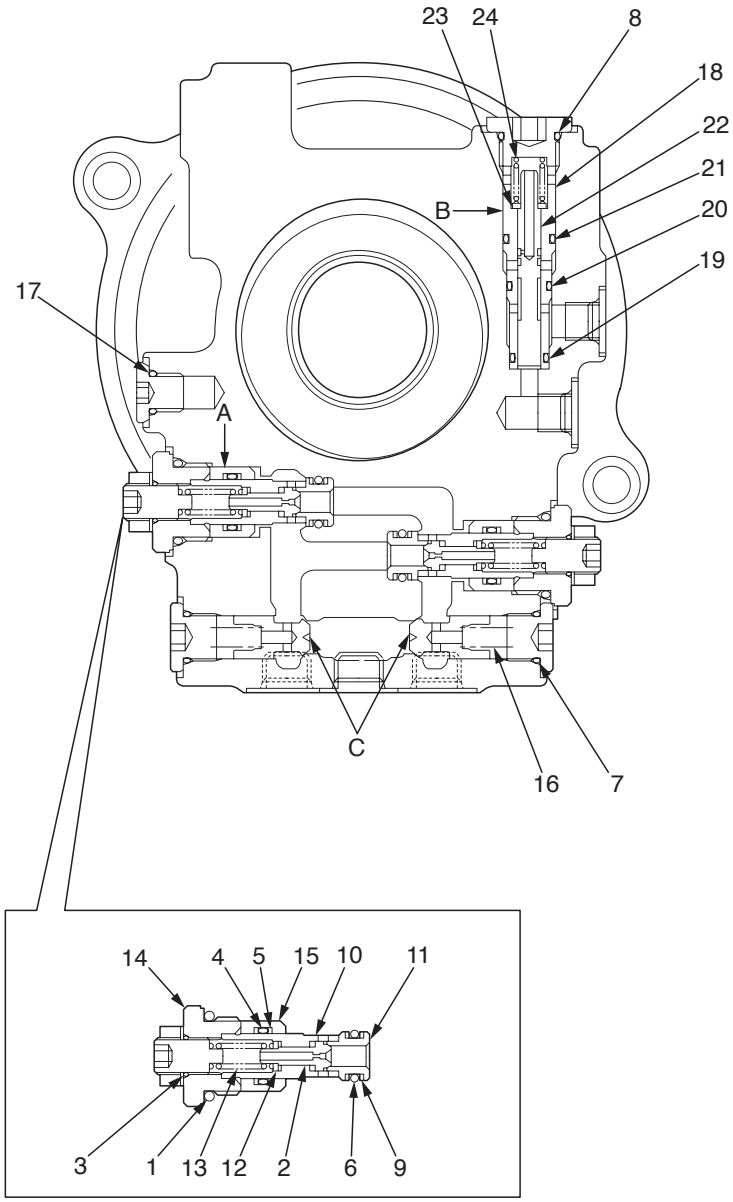

E5D601

1. Plate
2. Oil Seal
3. Shaft
4. Collar
5. Bearing
6. Housing
7. Bearing
8. Plate
9. Collar
10. Carrier
11. Thrust Washer
12. Race
13. Needle
14. Planetary Gear
15. Thrust Plate
16. Drive Gear
17. O-ring
18. O-ring

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**Brake Valve**




E5D602

A: Relief Valve
B: Timer Valve
C: Check Valve

1. O-ring
2. Poppet
3. O-ring
4. O-ring
5. Backup ring
6. O-ring
7. O-ring
8. O-ring
9. Backup ring
10. Sleeve
11. Seat
12. Seat
13. Spring
14. Plug
15. Piston
16. Spring
17. O-ring
18. Sleeve
19. O-ring
20. O-ring
21. O-ring
22. Spool
23. Washer
24. Spring

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## OPERATION

### Hydraulic Motor

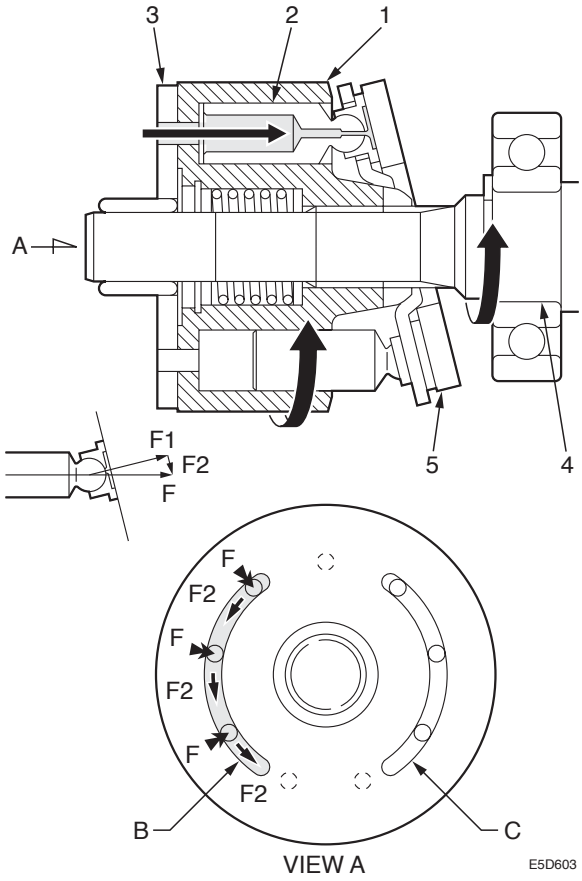
9 pistons (2) are fitted in the cylinder block (1) and there is a valve plate (3) with two half moon ports, B and C in the end. Also, the cylinder block (1) rotates freely and is joined to the shaft (4) via the spline. On the other band, the swash plate (5) is fastened to the housing.

When high pressure oil is introduced into port B, one piston (2) makes contact and force F bears on the swash plate (5).

F = P × A P: Pressure A: Piston Sectional Area

The force F which the piston (2) applies to the swash plate (5) is divided into force F1, which pushes the plate, and force F2, which rotates the cylinder block (1). The total sum of the components in the direction of rotation of the high pressure side piston generates a rotational force in the cylinder block (1) and via the spline, torque is transmitted to the shaft (4), turning it.

Conversely, if high pressure oil is introduced to port C, rotation is the reverse of the above.




### Relief Valve

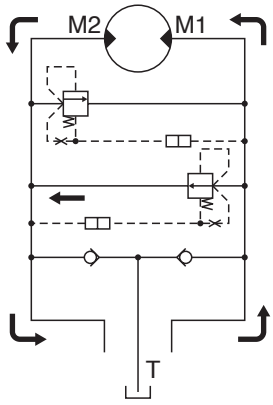
Operation 1

When the Motor is Started

When the motor is started, since the inertial load is great, the pressure of the oil required to accelerate it rises. If this pressure reaches the relief valve set pressure, the relief valve operates and oil returns to port M2.

In this way, the motor begins to turn as it relieves the relief valve, and as the rotational speed increases, the amount of relief decreases until it stops.

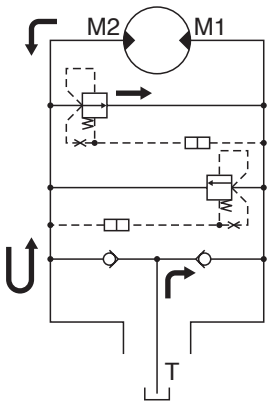
In this way, the shock during starting is absorbed.




When the Motor is Stopped

When the motor is stopped, the return circuit is closed off.

However, since the motor tends to want to continue rotating due to inertial energy, the pressure in port M2 rises. When this pressure reaches the relief valve's set pressure, the relief valve operates and oil flows to port M1. In this way, the flow of oil to port M1 prevents cavitation from occurring as it absorbs the shock during stopping.



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### Operation 2

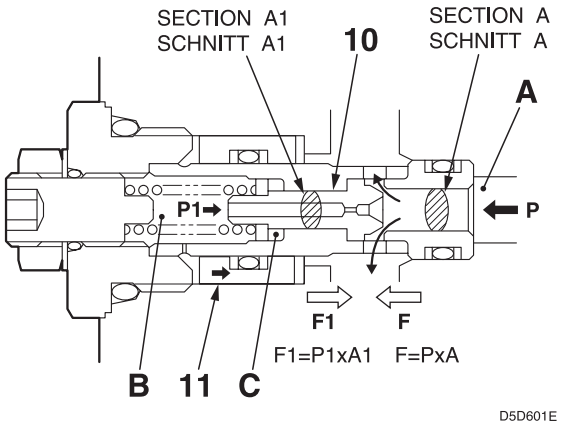
Since this relief valve has a shockless mechanism, it operates in 2 steps.

1st Step

When the relieving operation starts, the pressure P1 in the chamber B is kept low, while the pressure P in the chamber A becomes high due to the oil which flows into it.

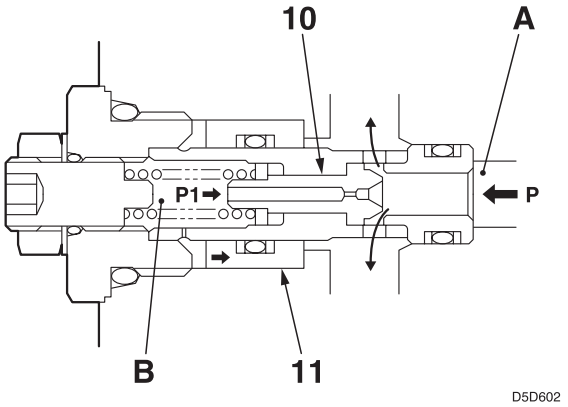
At this time, there are two forces acting on the poppet (10), force (F), which attempts to move the poppet (10) to the left and force (F1) which pushes against the seat on the right side. Since F = P × A, F1 = P1 × A1, P > P1 and A > A1, the poppet (10) is moved to the left by this force "F – F1".

This opens a supply side circuit from chamber A and lets the pressure escape. That is, during the time piston (11) is moving to its stroke end, the relief valve operates at low pressure.




2nd Step

When the piston (11) reaches the stroke end, the pressure in chamber B rises and the pressures in chamber A and chamber B equalize. At this time, the force moving the poppet (10) to the left side becomes "P = P1", so this becomes "A – A1" and the relief valve operates at the specified set pressure.

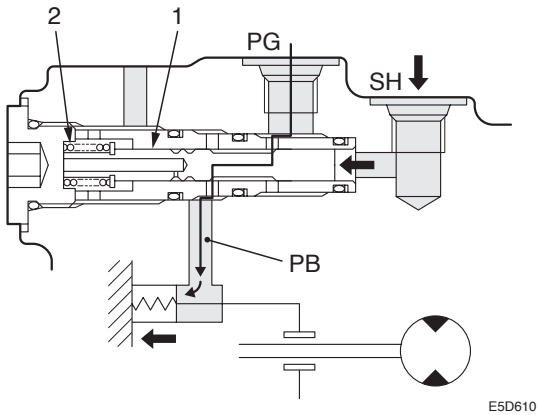



### Timer Valve

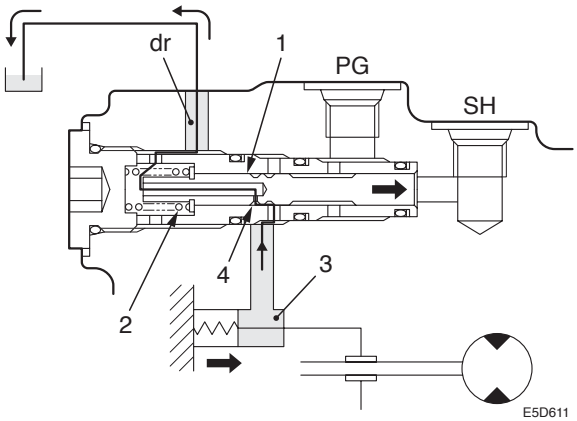
This function is used to prevent sudden operation of the parking brake when the motor is stopped.

At the time of parking brake operation, pressure oil from the port P4 is supplied at all times to the port PG, the valve spool (1) is pushed to the right by the force of the spring (2), and the port PG is closed.

When turning pilot pressure or arm pilot pressure is led to the port SH, the spool (1) is moved to the left against the force of the spring (2), and the port PG is opened. The pressure oil from the port PG passes through the hole at the center of the spool (1) and is led to the parking brake release port (PB), so that the parking brake is released.




When the pilot pressure at the port SH disappears, the spool (1) is moved by the force of the spring (2) to the right, the port PG is closed, and the oil in the brake piston chamber (3) is prevented from escaping. The oil in the chamber flows gradually through the orifice (4) at the outer circumference of the spool (1) to the drain port dr, so that the parking brake is not applied rapidly, but after a certain time, just as if a timer were used.

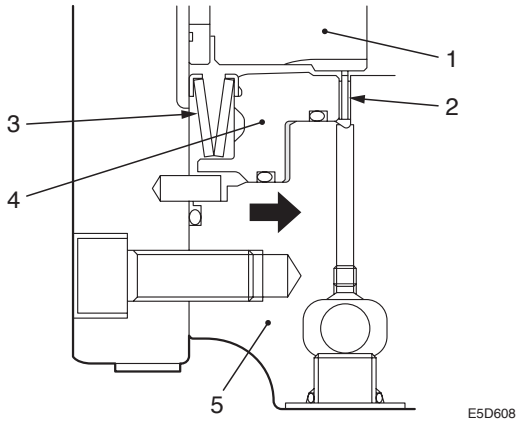


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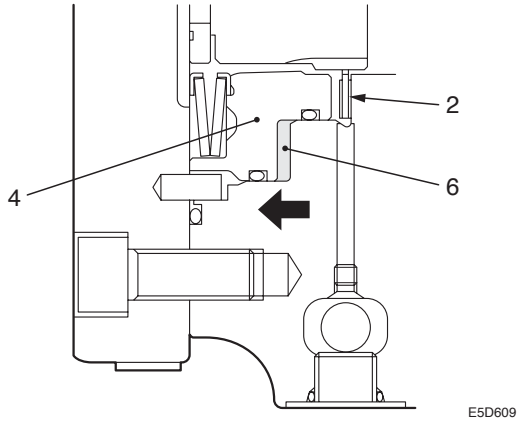


### Parking Brake

The cylinder block (1) and disc (2) are connected via a spline.
The disc (2) is pushed against the case (5) by the force of the spring (3) via the brake piston (4) and brake force is generated by the friction force between the case (5) and the brake piston (4) stopping the cylinder block (1) from turning.

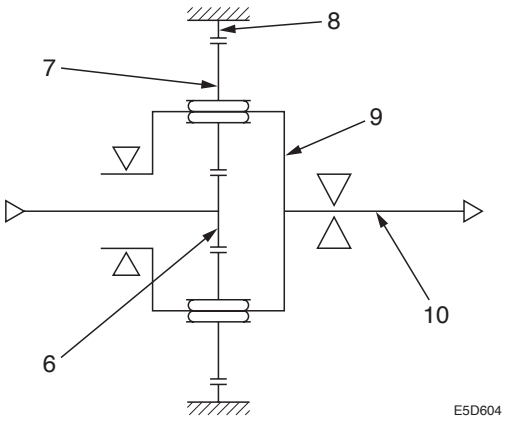



When the oil is introduced from the parking brake release port to the brake piston chamber (6), the oil pressure overpowers the spring force and moves the brake piston (4). This generates a clearance between the case and the disc (2) to release the parking brake.




### Reduction Gears

The drive gear (6) engages with the planetary gear (7) and the planetary gear (7) engages with the ring gear (8), which is integrated into the housing.
Driving force from the hydraulic motor is transmitted from the drive gear (6) to the planetary gear (7), then rotates the output shaft (10) via the planetary carrier (9).



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## DISASSEMBLY AND ASSEMBLY

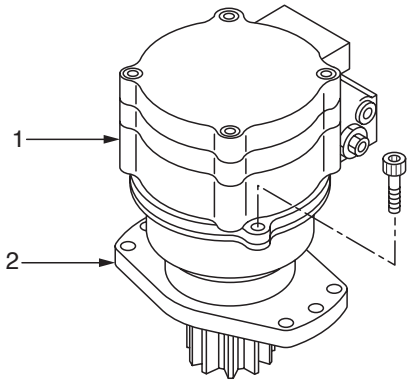
### General Cautions

- Carry out disassembly and assembly operations in a clean place and provide clean containers to place the disassembled parts in.
- Before disassembly, clean around the ports and remove the paint from each joint using a wire brush.
- Wash the disassembled parts and dry them with compressed air. Do not use a rag, as this could cause clogging of dirt.
- Make match marks on each part so that they will be assembled in the same positions when reassembled.
- Replace all seals with new ones each time the unit is disassembled, coating them lightly with grease.
- Check each part to make sure there is no abnormal wear or seizing and use sandpaper, etc. to remove any burrs, sharp edges, etc.

### Disassembly

Slew Motor

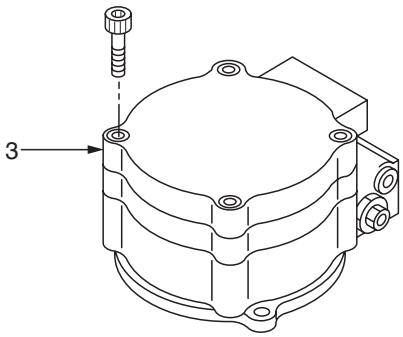
1. Remove the cap screws to disassemble the slew motor into the hydraulic motor (1) and the reduction gear (2).
   - Mark the mating position on both the hydraulic motor and the reduction gear so that they can be mated correctly when reassembling.
   - Fix the hydraulic motor with a vise.



E5D612

Brake Valve and Hydraulic Motor

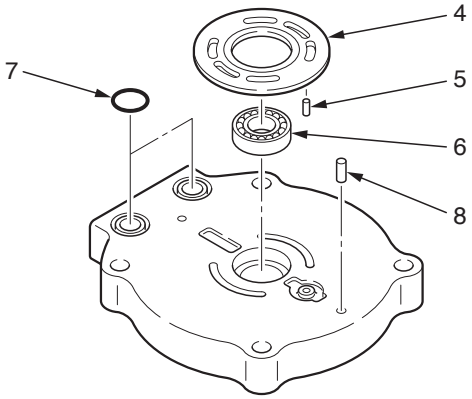
1. Remove the cap screws and then the cover (3).
   - Be careful not to drop the valve plate.



E5D613

2. Remove the valve plate (4) and pin (5) from the cover.

3. Remove the bearing (6), O-ring (7) and pin (8) from the cover.

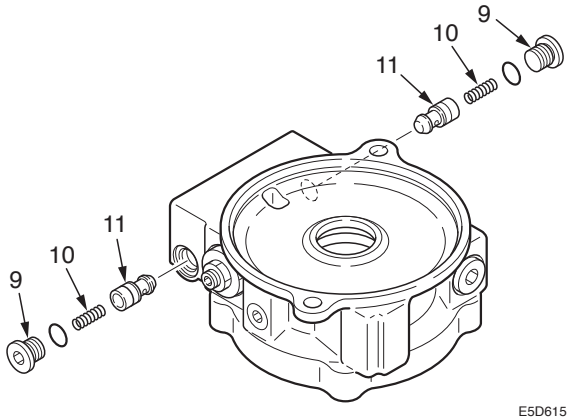


E5D614

https://truckmanualshub.com/

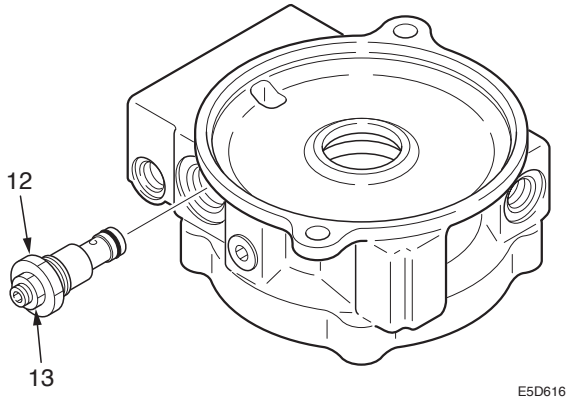


4. Remove the check valve.
   a. Remove the plug (9).
   b. Remove the spring (10) and check valve (11).



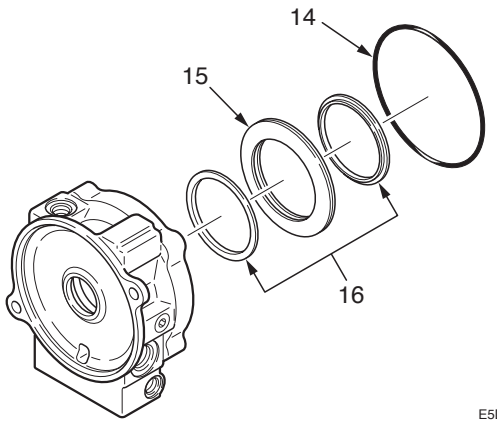
E5D615

5. Loosen the plug (12) and remove the relief valve.
   • Do not loosen the set screw nut (13).
   • Do not disassemble the relief valve.



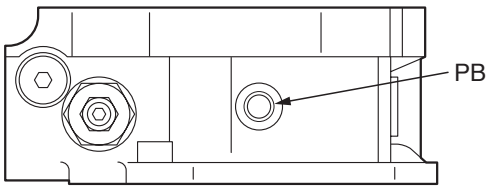
E5D616

6. Remove the O-ring (14), disc spring (15) and spring sheet (16).

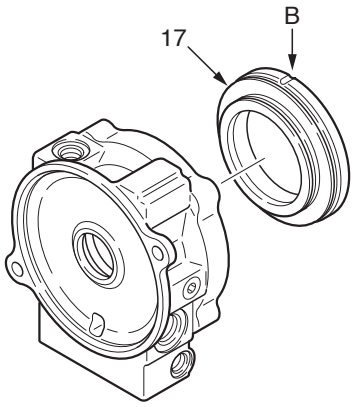


E5D617

7. Remove the brake piston (17).
   • Blow the air from the brake release port PB with care such that the brake piston does not protrude.



E5D619

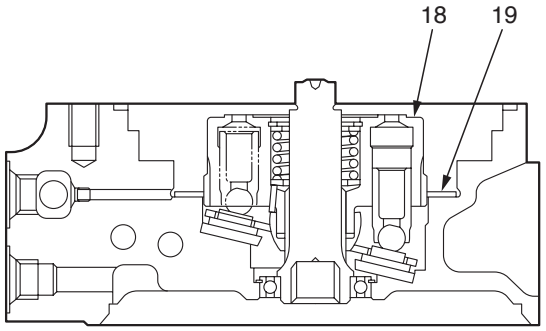


E5D618

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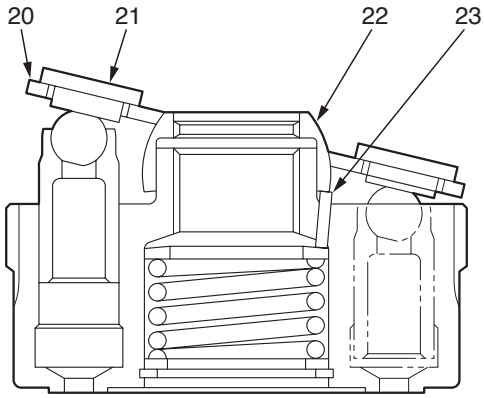
8. Remove the cylinder block (18) and the disc (19).




E5D620

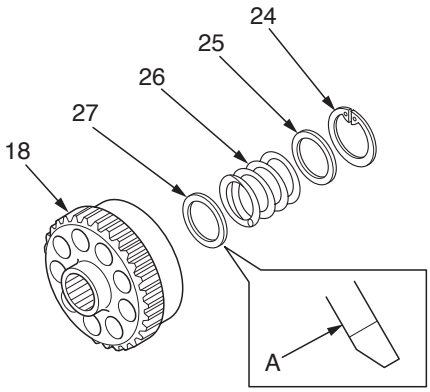
9. Remove the shoe holder (20) and the piston assembly (21) from the cylinder block.

10. Remove the guide (22) and pins (23) from the cylinder block.




E5D621

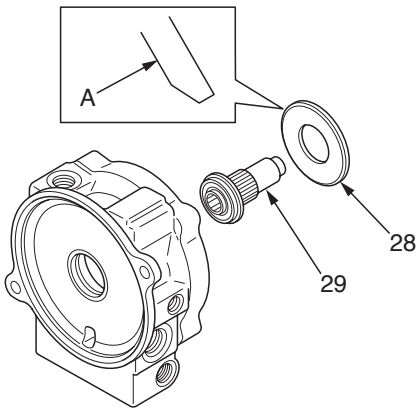
11. Remove the snap ring (24), retainer (25), spring (26) and retainer (27) from the cylinder block.
    - The snap ring should be removed while pushing the retainer (25).




E5D622

12. Remove the swash plate (28).

13. Remove the shaft (29).
    - Lightly tap the end face with a plastic hammer.

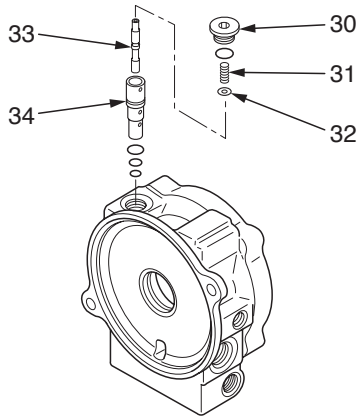



E5D623

https://truckmanualshub.com/



14. Disassemble the timer valve.
    a. Remove the plug (30).
    b. Remove the spring (31), washer (32) and spool (33).
    c. Remove the sleeve (34).



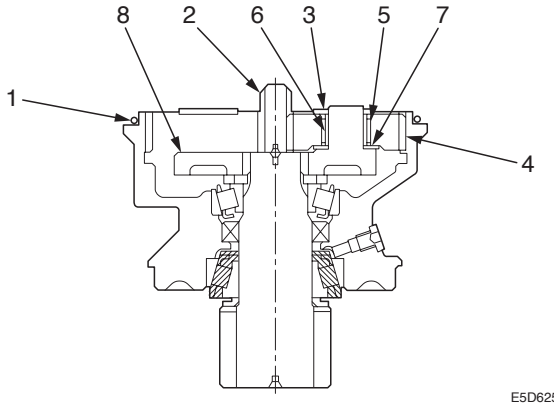
E5D624

### Reduction Gears

1. Remove the O-ring (1) and drive gear (2).

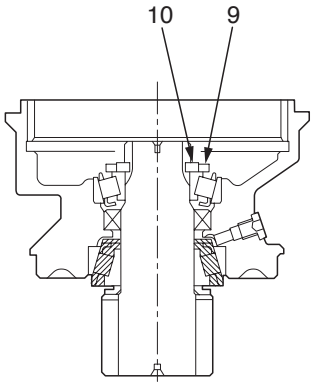
2. Remove the thrust plate (3), planetary gear (4), needles (5), inner race (6) and thrust washer (7) from the carrier (8).

3. Remove the carrier (8).



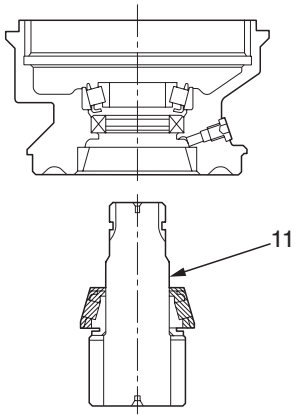
E5D625

4. Remove the collar (9) and plate (10).



E5D626

5. Remove the shaft (11).
    - Be careful not to miss the shaft.
    - If the shaft will not come out easily, lightly tap it with a plastic hammer.
    - To replace the taper roller bearing or collar, the case assembly should be replaced.



E5D627

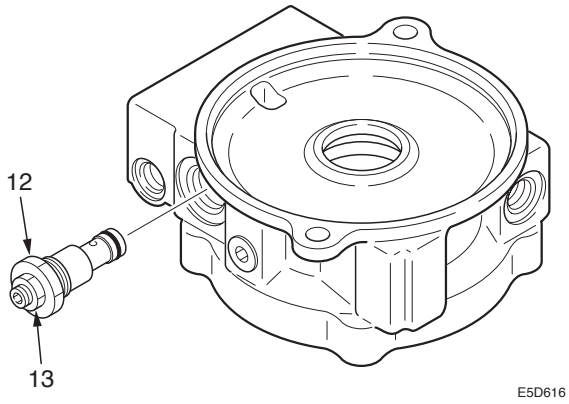
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**Assembly**

Brake Valve and Hydraulic Motor

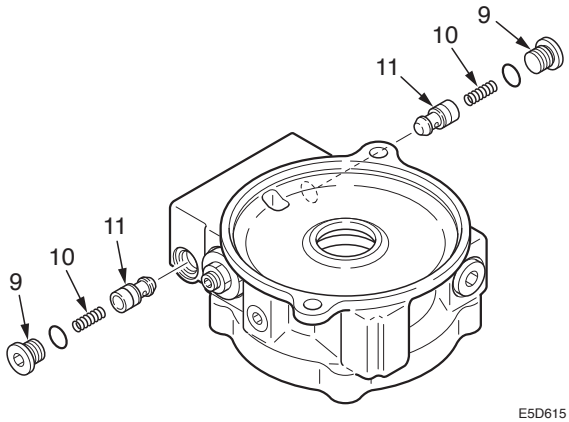
1. Mount the relief valve assembly.
   - Tighten the plug (12).
   - Plug tightening torque:
     157 ±10 N·m (16 ±1 kgf·m)



E5D616

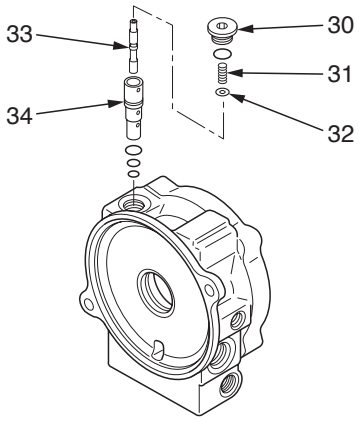
2. Install the check valve (11) and the spring (10) in the housing.

3. Fit the O-ring to the plug (9) and mount them on the cover.
   - Plug tightening torque:
     39.2 ±2 N·m (4.0 ±0.2 kgf·m)



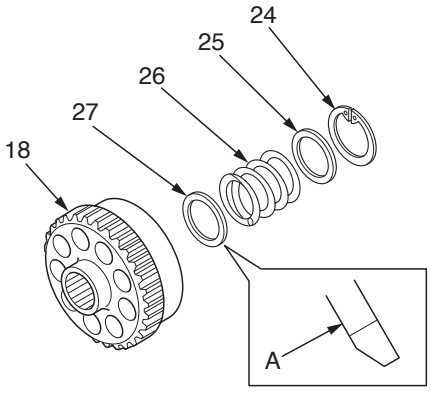
E5D615

4. Assemble the timer valve.
   a. Fit the O-rings to the sleeve (34) and install them in the housing.
   b. Fit the spool (33), washer (32) and spring (31) into the sleeve hole.
   c. Mount the plug (30).
      - Plug tightening torque:
        84 ±5 N·m (8.5 ±0.5 kgf·m)



E5D624

5. Mount the retainer (27), spring (26), retainer (25) and snap ring (24) on the cylinder block (18).
   - The snap ring should be mounted while pushing the retainer (25).
   - Position the retainer (27) so that the tapered (A) side faces the cylinder block.



E5D622

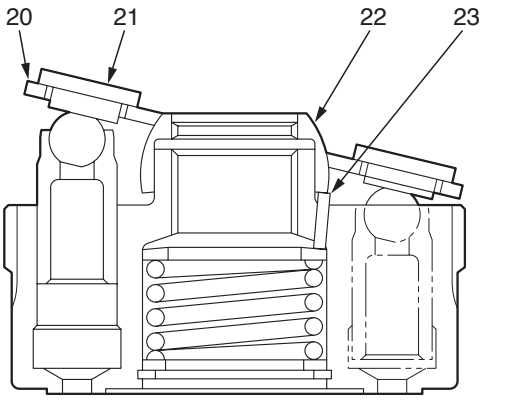
https://truckmanualshub.com/



6. Mount the pins (23) on the cylinder block.
   • Apply grease to the pins.

7. Mount the guide (22).

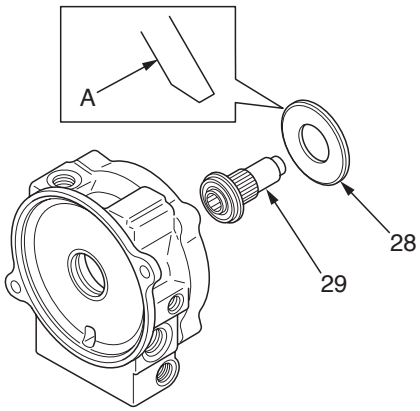
8. Fit the piston assembly (21) to the shoe holder (20) and mount them on the cylinder block.
   • Apply the hydraulic oil to the rotation section.



E5D621

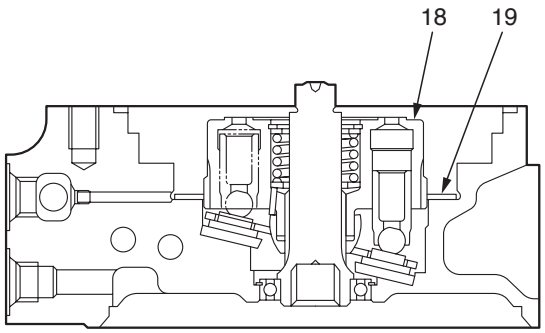
9. Press fit the shaft (29) in the housing.

10. Install the swash plate (28) in the housing.
    • Apply grease to side A of the swash plate.



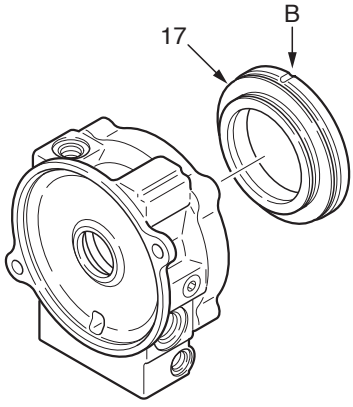
E5D623

11. Install the cylinder block (18) and disc (19) in the housing.
    • Be sure to position the pin (23) correctly.



E5D620

12. Fit the O-rings to the brake piston (17) and install them in the housing.
    • Position the pin hole (B) as shown in the figure.

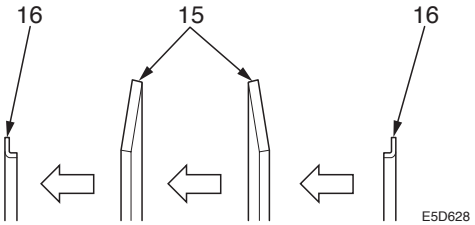


E5D618

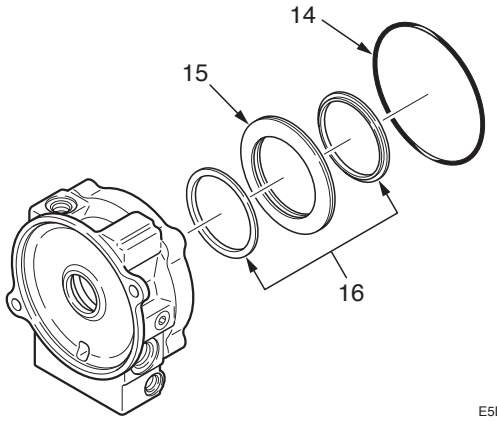
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13. Install the spring sheet (16) and disc spring (15) in the housing.

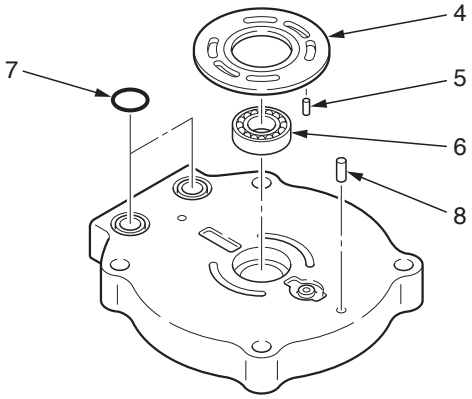



14. Fit the O-ring (14) to the housing.

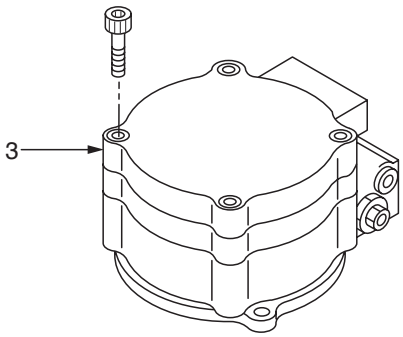



15. Fit the pins (8), bearing (6) and O-rings (7) to the cover.
    - Apply grease to the pins.

16. Fit the pin (5) and valve plate (4) to the cover.
    - Apply grease to the rear surface (cover side) of the valve plate to prevent the plate from dropping off.

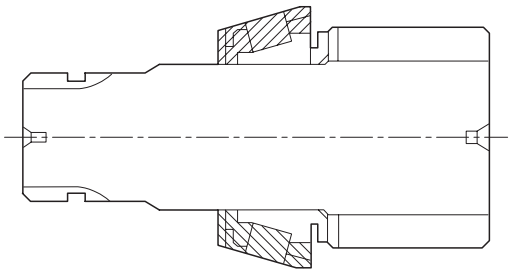



17. Mount the cover (3) on the housing and fix it with the cap screws.
    - Be careful not to miss the pin and valve plate.
    - Cap screw tightening torque:
      128 ±7 N·m (13.1 ±0.7 kgf·m)




### Reduction Gears

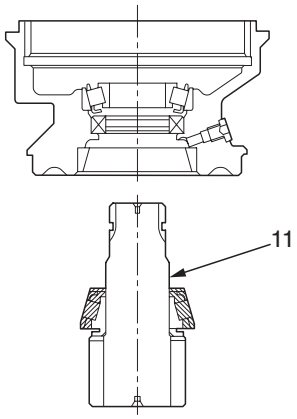
1. Put grease into the inner race of the taper roller bearing.
    - Grease type: Shell ALVANIA Grease
    - Grease volume: 17~20 mL



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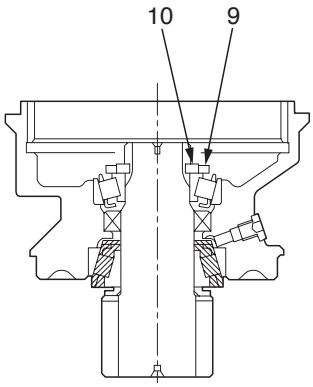


2. Install the shaft (11) in the housing.



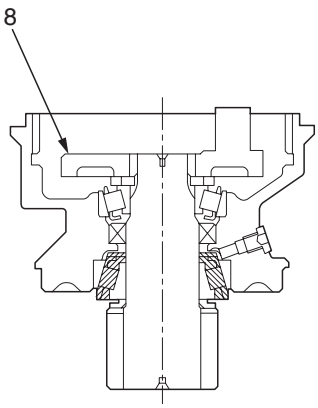
E5D627

3. Mount the collar (9) and plate (10).



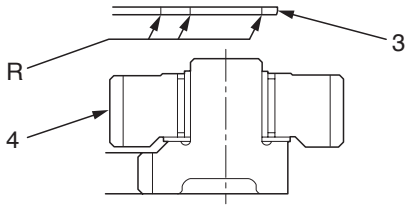
E5D626

4. Mount the carrier (8).

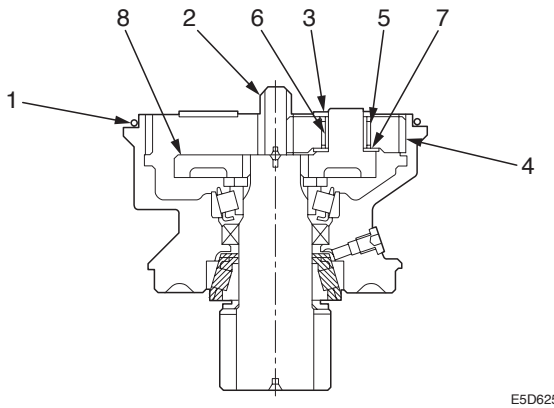


E5D630

5. Mount the thrust washer (7), inner race (6), needles (5), planetary gear (4), thrust plate (3) and drive gear (2) on the carrier (8).
   - The largely-rounded side of the thrust plate circumference should face the planetary gear.



E5D631



E5D625

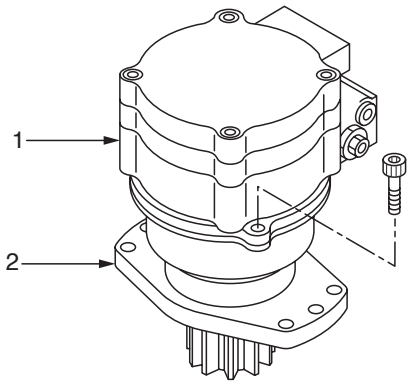
6. Fit the O-ring (1) to the case.

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## Slew Motor

1. Unite the hydraulic motor (1) and the reduction gear (2) and fix them with the cap screws.
   - Cap screw tightening torque:
     128 ±7 N·m (13.1 ±0.7 kgf·m)



E5D612

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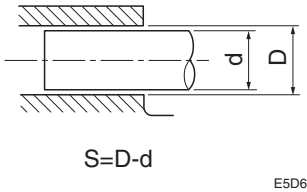
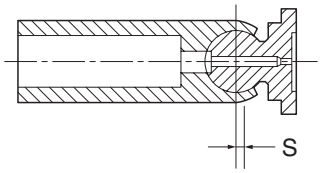
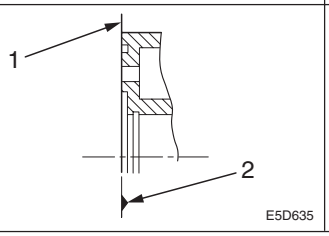
## INSPECTION AND ADJUSTMENT

### Checking the Parts

Brake Valve

| Parts | Judgement Criteria | Treatment |
|---|---|---|
| Check Valve, Piston | • Scratches in sliding portions are deep or roughness is severe.<br>• The clearance with the body is large.<br>• Scratches in sliding portions are deep or seating is uneven. | • Replace<br>• Replace<br>• Replace |
| Housing | • Scratches in sliding portions are deep or roughness is severe.<br>• There are scratches where oil leakage occurs. | • Replace<br>• Replace |
| Relief Valve Assembly | • The set pressure drops abnormally low.<br>• The set pressure is unstable and vibration occurs.<br>• There is a lot of leakage due to faulty seating, etc. | • Replace<br>• Replace<br>• Replace |
| Spring | • Damaged or severely deformed. | • Replace |

Hydraulic Motor

| Parts | | Standard Dimension | Recommended Replacement Value | Treatment |
|---|---|---|---|---|
| Clearance (S) between piston and cylinder bore |  | 0.02mm | 0.04mm | Replace cylinder block, swash plate assembly. |
| Clearance (S) between piston and shoe |  | 0.15mm | 0.4mm | Replace cylinder block, swash plate assembly. |
| Bearing | | | Flaking or pitting in the rolling surface. | Replace |
| Cylinder block sliding surface (1) |  | | Sliding surface is rough. | Carry out lap repairs (#1000 Powder) or replace. |
| Valve plate sliding surface (2) | | | | Replace |

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Reduction Gears

| Parts | Judgement Criteria | Treatment |
|---|---|---|
| Drive Gear | • Gear tooth surfaces are pitted or separating, etc.<br>• Clearance with motor joint is large due to spline wear. | • Replace<br>• Replace |
| Housing, Internal Gear | • Gear tooth surfaces are pitted or separating, etc. | • Replace |
| Planetary Gear | • Gear tooth surfaces are pitted or separating, etc.<br>• Needle rolling surfaces are pitted or separating, etc. | • Replace<br>• Replace |
| Needle Bearing, Planetary Shaft | • Needle and shaft rolling surfaces are pitted or separating, etc.<br>• Pressure marks, etc. on needle and shaft rolling surfaces.<br>• Bearing rotation is abnormal (abnormal noise, rotation not smooth, etc.). | • Replace<br>• Replace<br>• Replace |
| Carrier, Shaft | • Clearance with planetary shaft is large. | • Replace |
| Shaft | • Clearance with pinion is large due to spline wear. | • Replace |
| Thrust Wasyer | • Amount of wear is great. | • Replace |
| Ball Bearing, Roller Bearing | • Rotation is abnormal (abnormal noise, rotation not smooth, etc.).<br>• Flaking, separation, etc. on rolling surfaces.<br>• Pressure marks, etc. on rolling surfaces. | • Replace<br>• Replace<br>• Replace |
| Collar, Oil Seal, O-ring | • Scratches, etc. exist which cause leaks. | • Replace |

**Brake Valve**

Adjusting the Relief Valve Pressure

☞ "II, Specifications, Performance Judgment Standards"

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## TROUBLESHOOTING

If there is an abnormal increase in noise or heat, this is an indication that trouble has occurred. When this type of condition is manifested, stop the machine immediately and search out the source of the trouble.

The following table shows a number of causes of general breakdowns that can be seen in the hydraulic circuits and indicates coutermeasures to take in each case.

| Symptom | How/Where? | Probable Causes | Remedy |
|---|---|---|---|
| Motor does not start. | Pressure doesn't rise at the motor's inlet port. | • Relief valve's set pressure is low.<br>• Pump is broken down.<br>• Control valve is broken down. | • Set the pressure at the correct level.<br>• Repair or replace the pump.<br>• Repair or replace the control valve. |
| | Pressure rises at the motor's inlet port. | • The load is excessive.<br>• Hydraulic motor is broken down.<br>• Reduction gears are broken down. | • Lighten the load.<br>• Repair or replace the hydraulic motor.<br>• Repair or replace the reduction gears. |
| Motor's speed won't increase. | • Pump's discharge volume is insufficient.<br>• Depends on the motor's function. | • Pump's drain amount is large.<br>• The motor's volumetric capacity is dropping. | • Repair or replace the pump.<br>• Replace the motor. |
| Oil is leaking. | • Oil is leaking from oil seals. | • Lip is cut or damaged. | • Replace the oil seal. |
| | • Oil is leaking from mating surfaces. | • Bolts are loose.<br>• O-ring is cut or damaged.<br>• Mating surface is scratched. | • Tighten the bolts.<br>• Replace the O-ring.<br>• Repair the surface with a grind stone or sand paper. |
| Motor makes abnormal noise. | • Noise in piping. | • Piping support is faulty. | • Clamp the piping. |
| (The surface temperature of the reduction gears case becomes high.) | • Lubricating oil | • Oil level is low.<br>• Hydraulic oil is getting in. | • Replenish the oil.<br>• Replace the reduction gears. |
| | • Gear unit | • Bearings are damaged.<br>• Gear surfaces are damaged. | • Replace the reduction gears.<br>• Replace the reduction gears. |

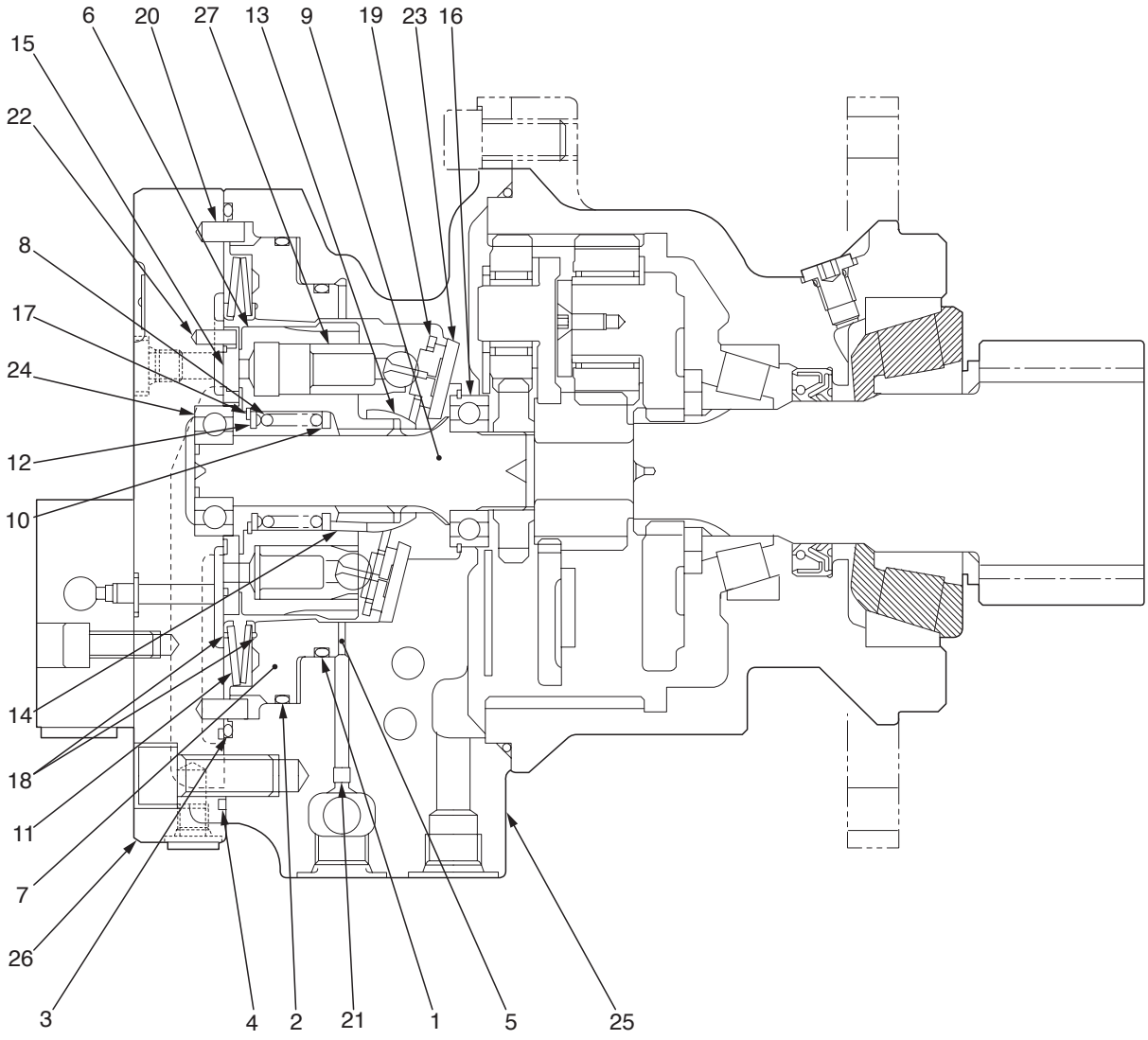
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# SLEW MOTOR (TB135)

## CONSTRUCTION

### Hydraulic Motor



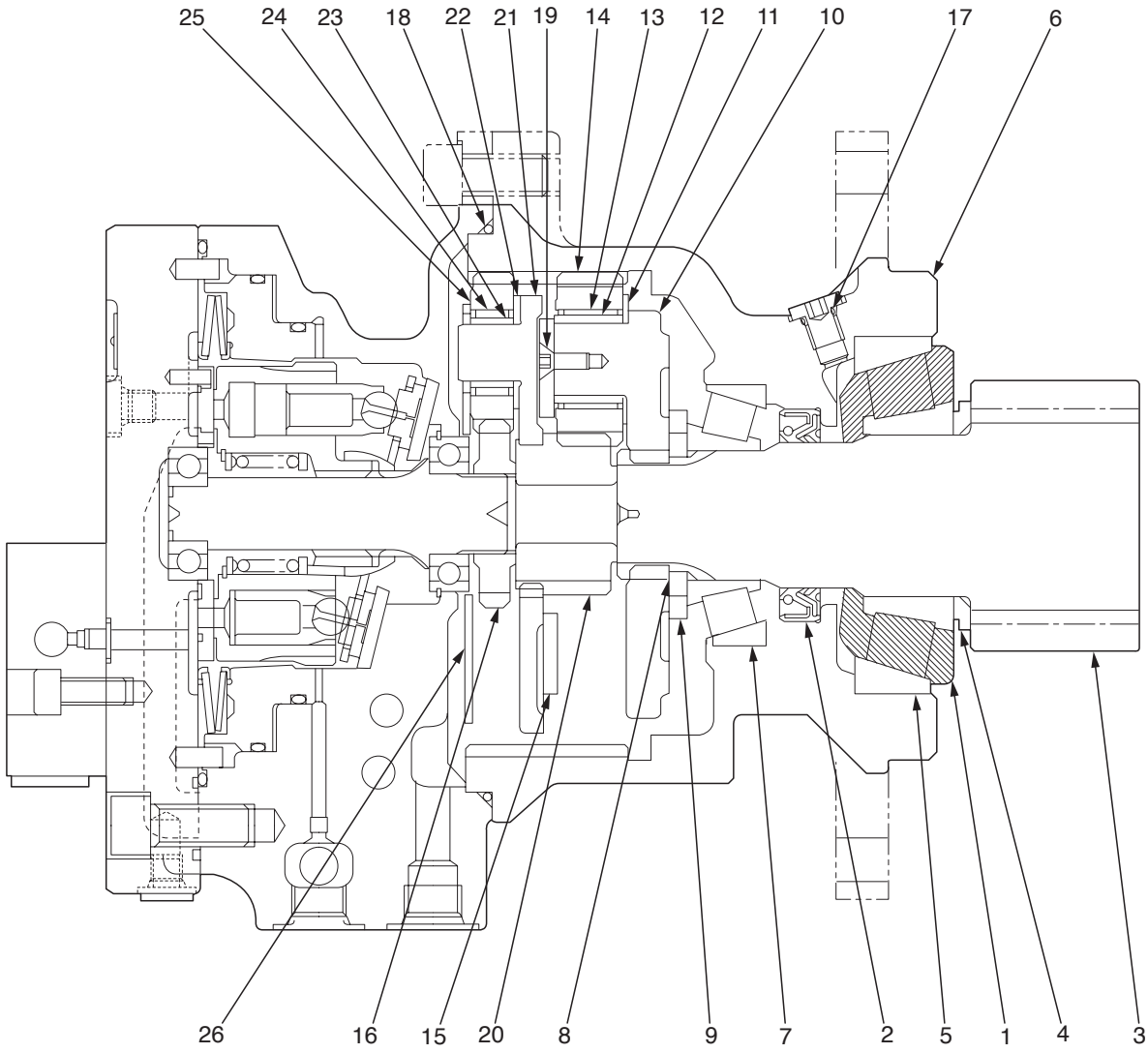

G4D600

1. O-ring
2. O-ring
3. O-ring
4. O-ring
5. Disc
6. Cylinder Block
7. Brake Piston
8. Spring
9. Shaft
10. Retainer
11. Disk Spring
12. Retainer
13. Guide
14. Pin
15. Valve Plate
16. Bearing
17. Snap Ring
18. Spring Seat
19. Shoe Holder
20. Pin
21. Orifice
22. Pin
23. Swash Plate
24. Bearing
25. Housing
26. Cover
27. Piston

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**Reduction Gears**



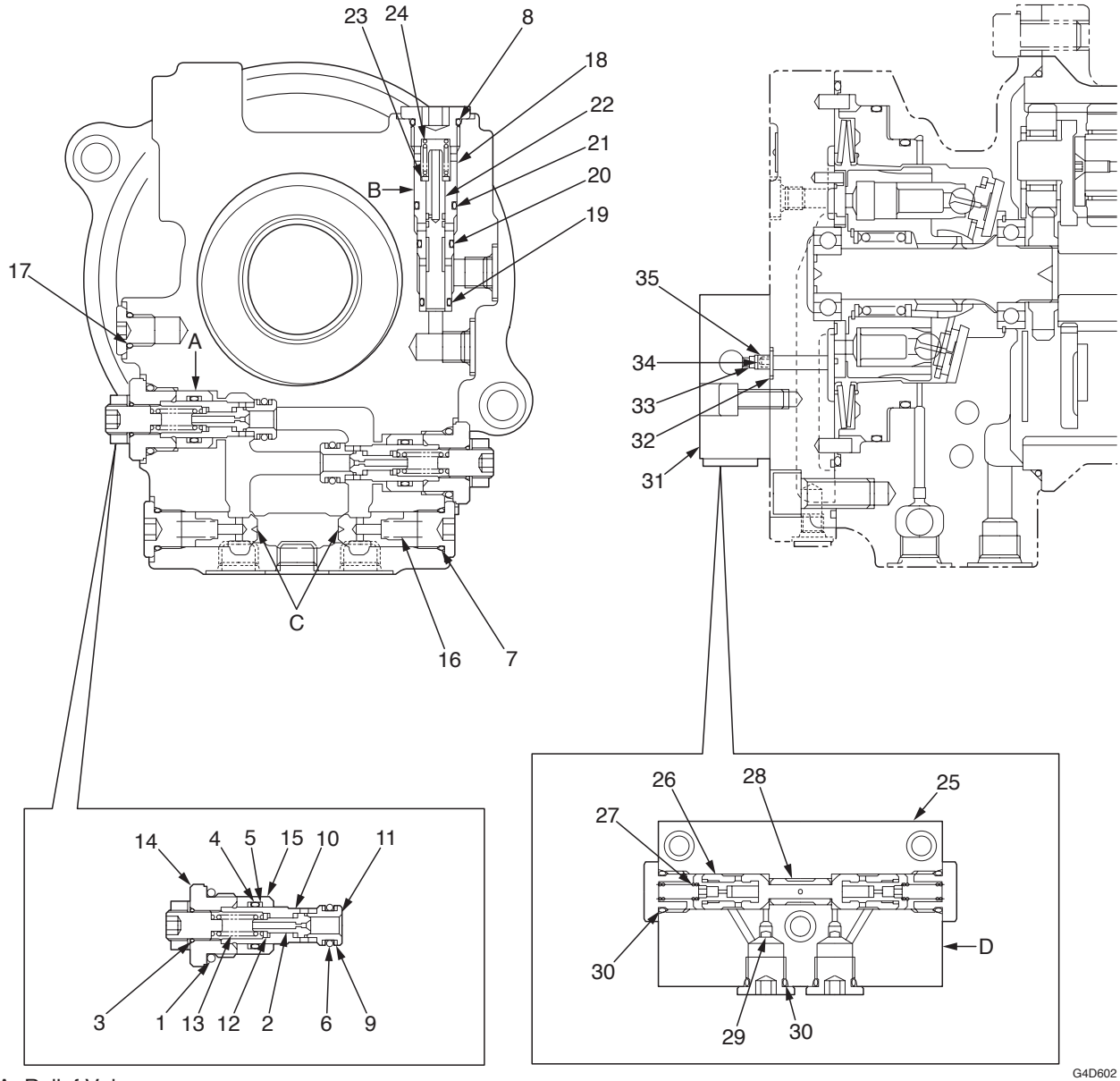

G4D601

1. Plate
2. Oil Seal
3. Shaft
4. Collar
5. Bearing
6. Housing
7. Bearing
8. Plate
9. Collar
10. Carrier
11. Thrust Washer
12. Race
13. Needle
14. Planetary Gear B
15. Plate
16. Drive Gear
17. O-ring
18. O-ring
19. Screw
20. Sun Gear
21. Carrier 1
22. Thrust Washer
23. Race
24. Needle
25. Planetary Gear A
26. Thrust Plate

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**Brake Valve**




A: Relief Valve
B: Timer Valve
C: Check Valve
D: Anti-rebound Valve

1. O-ring
2. Poppet
3. O-ring
4. O-ring
5. Backup Ring
6. O-ring
7. O-ring
8. O-ring
9. Backup Ring
10. Sleeve
11. Seat
12. Seat
13. Spring
14. Plug
15. Piston
16. Spring
17. O-ring
18. Sleeve
19. O-ring
20. O-ring
21. O-ring
22. Spool
23. Washer
24. Spring
25. Body
26. Check Valve Assembly
27. Spring
28. Sleeve
29. Orifice
30. O-ring
31. Body
32. O-ring
33. Filter
34. Washer
35. Orifice

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## OPERATION

### hydraulic motor

☞ "IV-208"

### Relief Valve

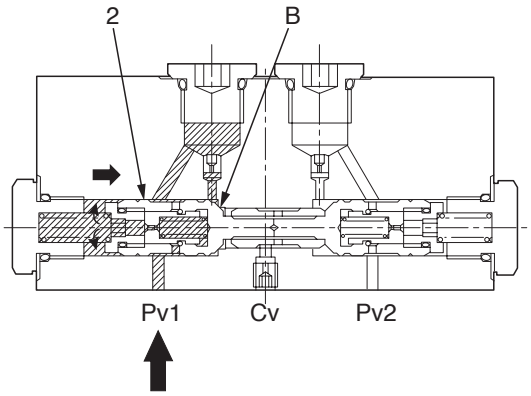
☞ "IV-208~209"

#### Anti-rebound Valve

When the motor stops, this valve will connect the motor main circuit to the makeup circuit for a prescribed time to prevent motor rebound due to the pressure in the main circuit.

When the Brake is Actuated

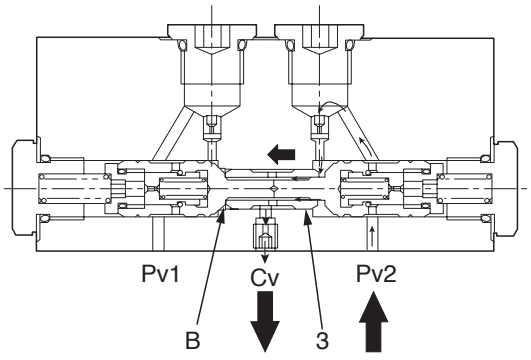
The braking pressure generated at the port Pv1 will move the check valve (2) to the right until it is seated at section B.




G4D604

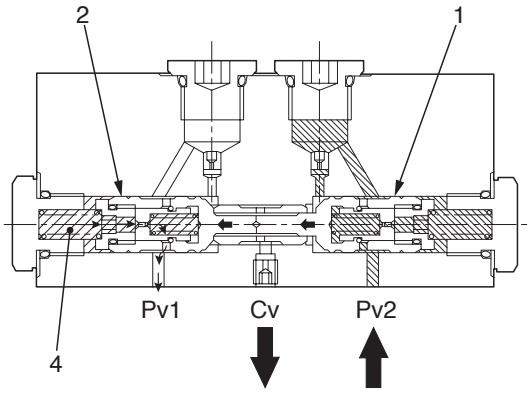
When the Motor Rebounds

When the motor is stopped by braking operation of the brake valve, it starts to rebound due to the pressure in the main circuit. This rebound pressure generated at the port Pv2 will move the sleeve (3) to the left to open the passage. This then releases the rebound pressure to the port Cv.




G4D605

The rebound pressure also pushes the check valve (1) to the left, which is the opposite direction of pushing at the time of braking. The flux control valve built in the check valve (2) (that is now on the lower pressure side) releases the oil in the damper chamber (4) at a constant flux. Therefore, the check valve (1) moves at a constant speed. When the check valve reaches its stroke end, the passage from the port Pv2 to the port Cv is closed.




G4D606

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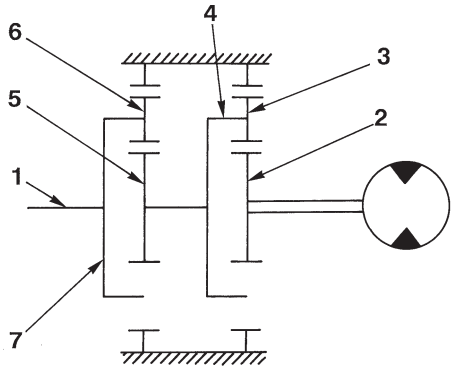
Timer Valve
☞ “IV-209”

Parking Brake
☞ “IV-210”

**Reduction Gears**

The reduction gear is composed of a 2-stage planetary gear mechanism, and it converts the high-speed operation of the motor to low speed torque for operation of the pinion shaft (1).

In the figure on the right, the drive force transmitted from the motor output shaft is transmitted to the second stage sun gear (5) via the first stage drive gear (2), the planetary gear (3) and the carrier 1 (4). Drive force is transmitted in the same way to the pinion shaft (1) via the second stage sun gear (5), the planetary gear (6), and the carrier 2 (7), and this becomes the slewing drive force.




Y3–D603

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## DISASSEMBLY AND ASSEMBLY

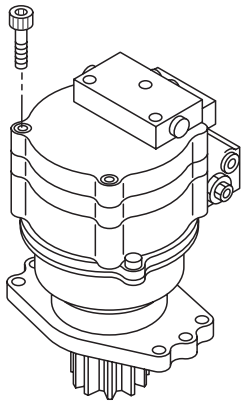
### General Cautions

- Carry out disassembly and assembly operations in a clean place and provide clean containers to place the disassembled parts in.
- Before disassembly, clean around the ports and remove the paint from each joint using a wire brush.
- Wash the disassembled parts and dry them with compressed air. Do not use a rag, as this could cause clogging of dirt.
- Make match marks on each part so that they will be assembled in the same positions when reassembled.
- Replace all seals with new ones each time the unit is disassembled, coating them lightly with grease.
- Check each part to make sure there is no abnormal wear or seizing and use sandpaper, etc. to remove any burrs, sharp edges, etc.

### Disassembly

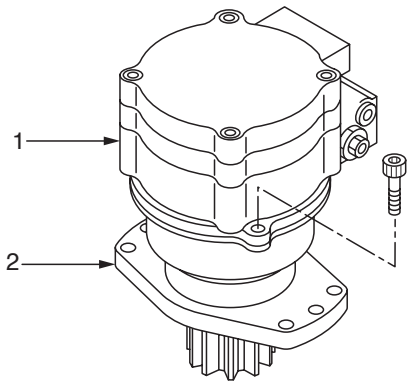
Slew Motor

1. Remove the cap screws and then the anti-rebound valve.



G4D607

2. Remove the cap screws to disassemble the motor into the hydraulic motor (1) and the reduction gear (2).
   - Mark the mating position on both the hydraulic motor and the reduction gear so that they can be mated correctly when reassembling.
   - Fix the hydraulic motor with a vise.



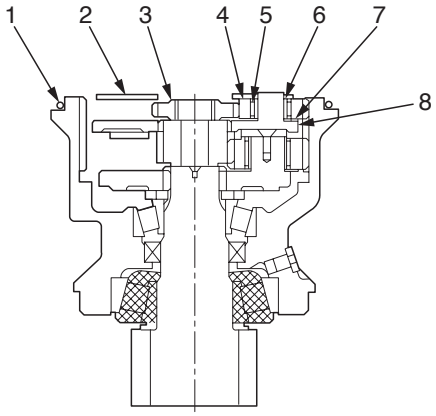

E5D612

Brake Valve and Hydraulic Motor

☞ “IV-211~214”

Reduction Gears

1. Remove the O-ring (1) and thrust plate (2).
2. Remove the drive gear (3).
3. Remove the planetary gear A (4), needles (5), inner race (6), and thrust washer (7) from the carrier 1 (8).
4. Remove the carrier 1 (8).

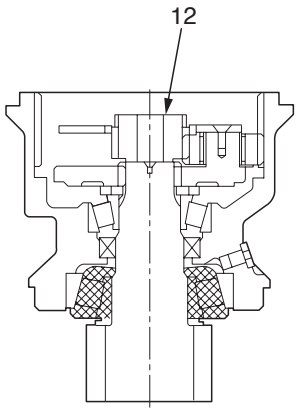



G4D608

https://truckmanualshub.com/

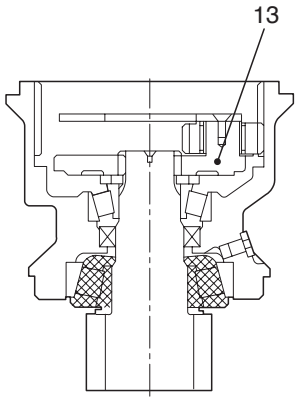


5. Remove the sun gear (12).



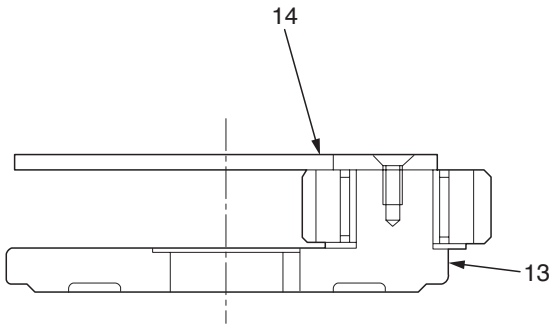

G4D609

6. Remove the carrier 2 (13).



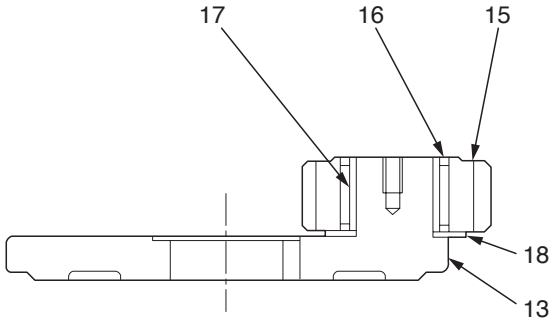

G4D610

7. Remove the cap screws and then the thrust plate (14) from the carrier 2 (13).
   - Fix the carrier 2 with a vise.
   - Loctite has been applied to the cap screws. Warming the screws (for example, using a portable drier) will make their removal much easier.




G4D611

8. Remove the planetary gear B (15), needles (16), inner race (17) and thrust washer (18) from the carrier 2 (13).

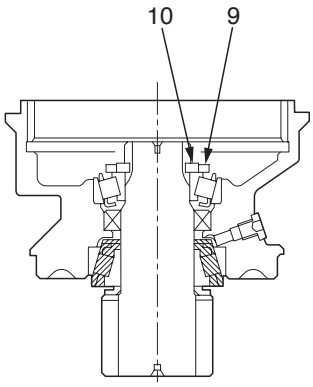



G4D612

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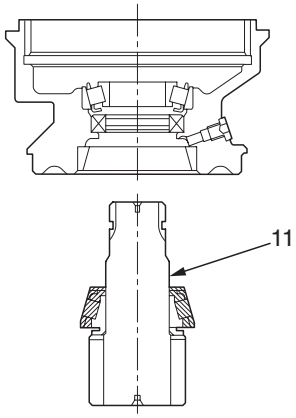


9. Remove the collar (9) and plate (10).




E5D626

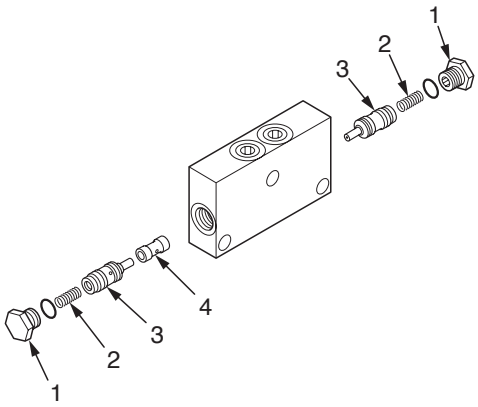
10. Remove the shaft (11) from the case.
    - Be careful not to miss the shaft.
    - If the shaft will not come out easily, lightly tap it with a plastic hammer.
    - To replacethe taper roller bearing or collar, the case assembly should be replaced.




E5D627

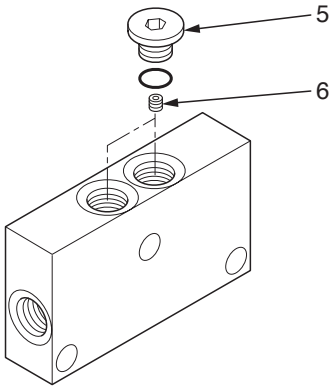
### Anti-rebound Valve

1. Remove the plug (1) and then the spring (2).
2. Remove the check valve assembly (3).
3. Remove the sleeve (4).




G4D613

4. Remove the plug (5) and then the orifice (6).

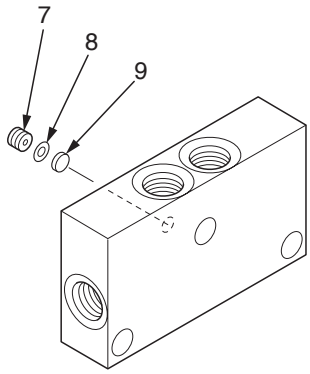



G4D614

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5. Remove the orifice (7), washer (8) and filter (9).
   - The filter should be replaced with a new one every time the anti-rebound valve is disassembled.

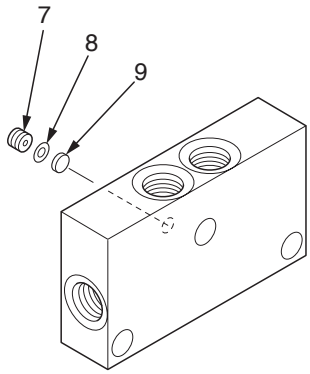



G4D615

**Assembly**

Anti-rebound Valve

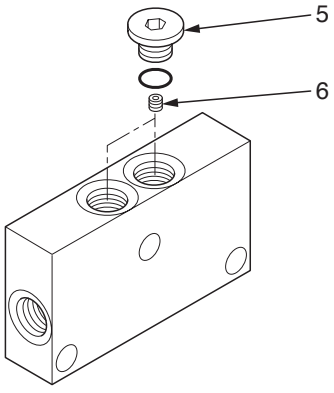
1. Mount the filter (9), washer (8) and orifice (7) on the body.
   - Use a new filter.
   - Orifice tightening torque: 4.9 N·m (0.5 kgf·m)




G4D615

2. Mount the orifice (6) on the body.
   - Orifice tightening torque: 2.45 N·m (0.25 kgf·m)

3. Fit the O-ring to the plug (5), and mount them on the body.
   - Plug tightening torque: 61.8 N·m (6.3 kgf·m)




G4D614

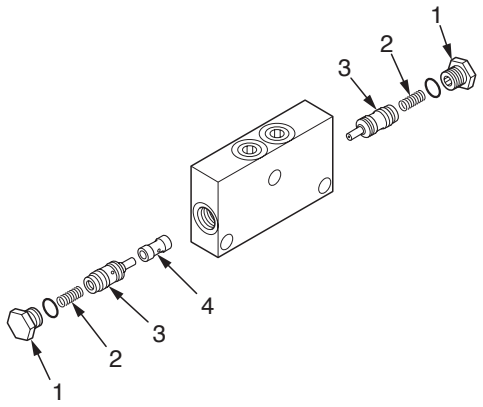
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4. Mount the sleeve (4) on the body.

5. Mount the check valve assembly (3) and the spring (2) on the body.

6. Fit the O-ring to the plug (1), and mount them on the body.
   - Plug tightening torque: 61.8 N·m (6.3 kgf·m)



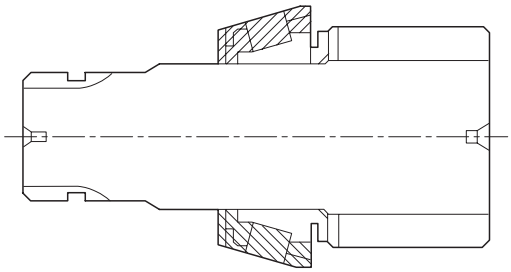

G4D613

### Brake Valve and Hydraulic Motor

☞ "IV-215~217"

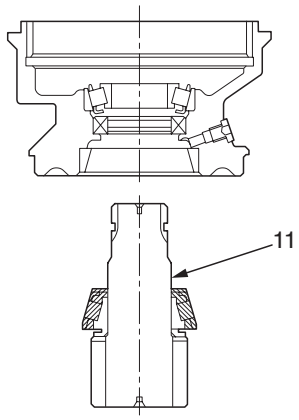
### Reduction Gears

1. Put grease into the inner race of the taper roller bearing.
   - Grease type: Shell ALVANIA Grease
   - Grease volume: 17~20 mL



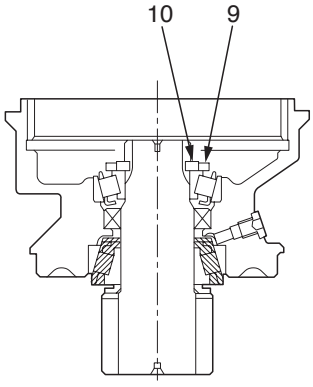
E5D629

2. Mount the shaft (11) on the case.




E5D627

3. Mount the plate (10) and collar (9).

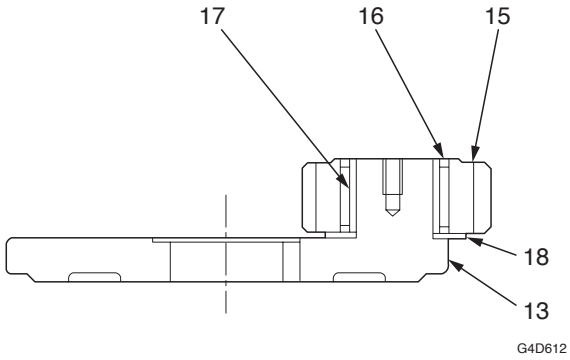



E5D626

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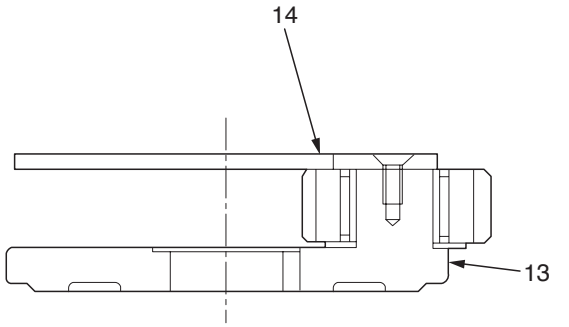


4. Mount the thrust washer (18), inner race (17), needles (16) and planetary gear B (15) on the carrier 2 (13).



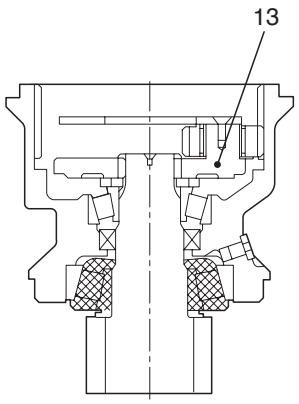
G4D612

5. Mount the thrust plate (14) on the carrier 2 (13) and fix them with the cap screws.
   - Apply Loctite #242 to the cap screws.
   - Cap screw tightening torque:
     3.92 ±0.49 N·m (0.4 ±0.05 kgf·m)



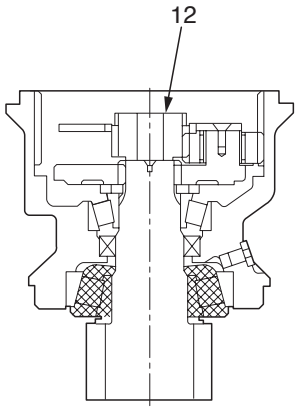
G4D611

6. Mount the carrier 2 (13) on the case.



G4D610

7. Mount the sun gear (12).



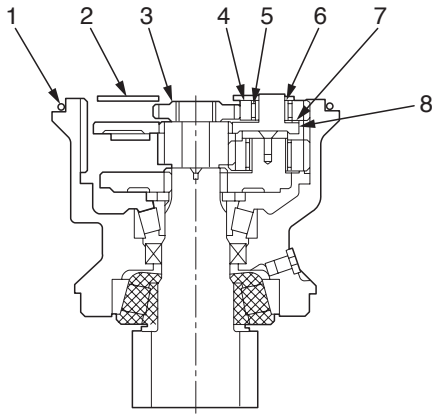
G4D609

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8. Mount the carrier 1 (8).

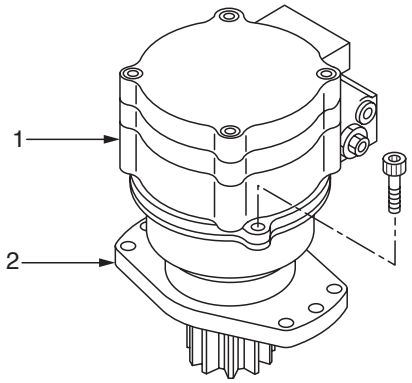
9. Mount the thrust washer (7), inner race (6), needles (5), planetary gear A (4), drive gear (3) and thrust plate (2) on the carrier 1 (8).



G4D608

### Slew Motor

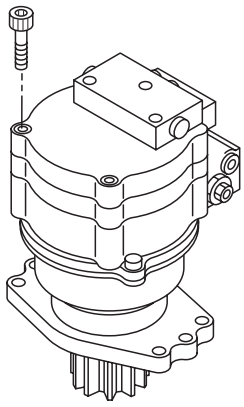
1. Unite the hydraulic motor (1) and the reduction gear (2) and fix them with the cap screws.
   - Cap screw tightening torque:
     128 ±7 N·m (13.1 ±0.7 kgf·m)



E5D612

2. Fit the O-ring to the cover.

3. Mount the anti-rebound valve on the cover and fix them with the cap screws.
   - Cap screw tightening torque:
     29.4 ±2 N·m (3.0 ±0.2 kgf·m)


G4D607

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## INSPECTION AND ADJUSTMENT

### Checking the Parts

☞ "IV-220~221"

Anti-rebound Valve

| Parts | Judgement Criteria | Treatment |
|---|---|---|
| Check Valve | • Scratches in sliding portions are deep or roughness is severe.<br>• The clearance with the body is large.<br>• Scratches in sliding portions are deep or seating is uneven. | • Replace<br>• Replace<br>• Replace |
| Body | • Scratches in sliding portions are deep or roughness is severe.<br>• There are scratches where oil leakage occurs. | • Replace<br>• Replace |
| Spring, Sleeve | • Damaged or severely deformed. | • Replace |

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## TROUBLESHOOTING

☞ "IV-222"

Anit-rebound Valve

| Symptom | Probable Causes | Remedy |
|---|---|---|
| The motor does not rotate or its rotation speed is slow. | Something other than the piston motor, valve unit or anti-rebound valve is malfunctioning. | Inspect the pressure at the entrance of the valve. Or, inspect individual units and service as necessary. |
| | The check valve assembly is not seated properly.<br>• Foreign matter is trapped.<br>• The tightening torque of the anti-rebound valve mounting bolt exceeds the prescribed value. | • Remove the foreign matter. Repair or replace the faulty parts.<br>• Use the prescribed tightening torque. |
| | The sleeve is malfunctioning.<br>• Foreign matter is trapped. | • Remove the foreign matter. Repair or replace the faulty parts. |
| The motor does not stop or its stopping speed is slow. | The check valve assembly is not seated properly.<br>• Foreign matter is trapped.<br>• The tightening torque of the anti-rebound valve mounting bolt exceeds the prescribed value. | • Remove the foreign matter. Repair or replace the faulty parts.<br>• Use the prescribed tightening torque. |
| | The valve within the check valve assembly is malfunctioning.<br>• Foreign matter is trapped.<br>• Foreign matter is in the orifice of the valve. | • Remove the foreign matter. Repair or replace the faulty parts.<br>• Remove the foreign matter. |
| | The sleeve is malfunctioning.<br>• Foreign matter is trapped. | • Remove the foreign matter. Repair or replace the faulty parts. |
| Slewing stops with a great shock. | The valve within the check valve assembly is malfunctioning.<br>• Foreign matter is trapped.<br>• Foreign matter is in the orifice of the valve. | • Remove the foreign matter. Repair or replace the faulty parts.<br>• Remove the foreign matter. |
| | The orifice is choked.<br>• Foreign matter is in the orifice of the anti-rebound valve body.<br>• Foreign matter is in the orifice of the valve unit. | • Remove the foreign matter.<br>• Remove the foreign matter. |

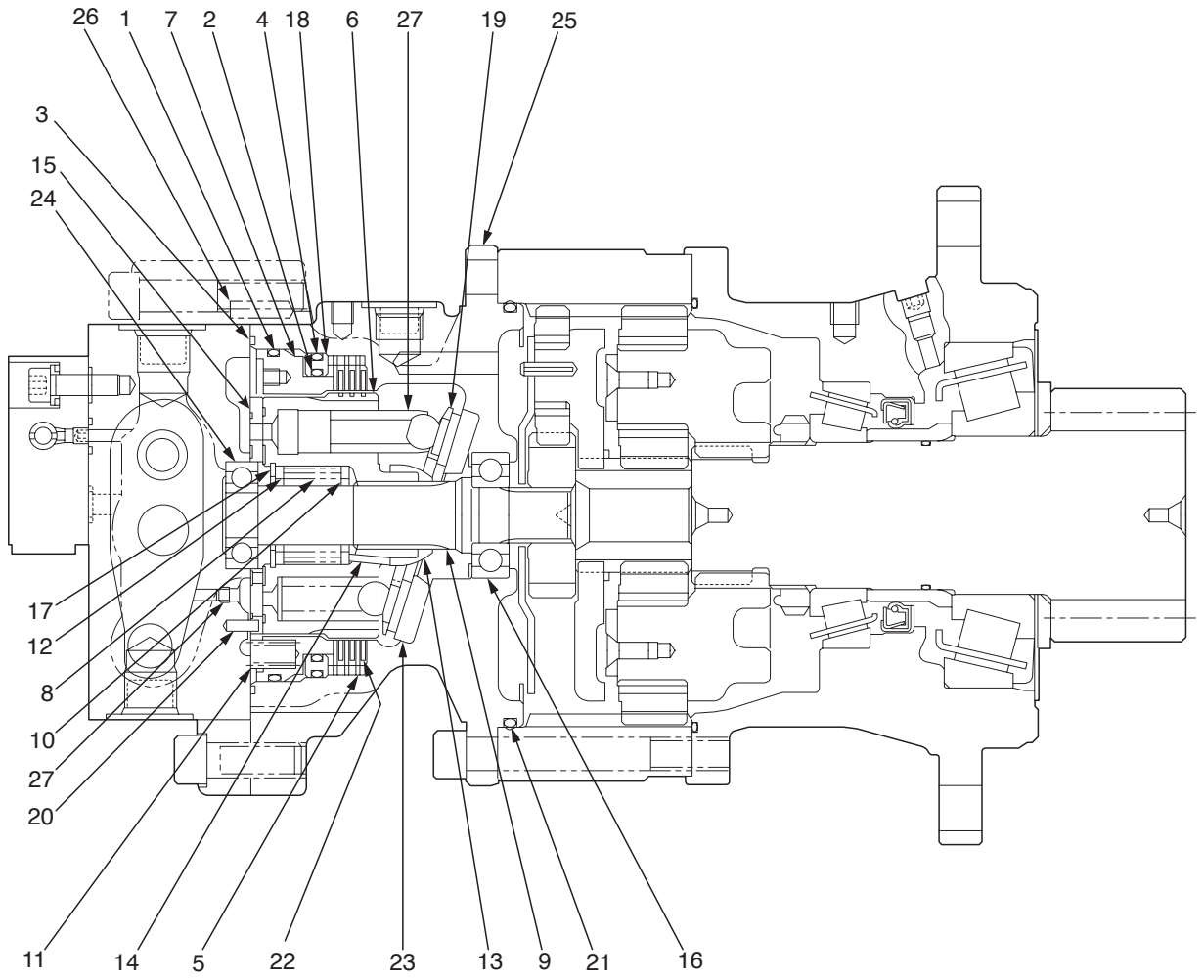
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# SLEW MOTOR (TB145)

## CONSTRUCTION

### Hydraulic Motor



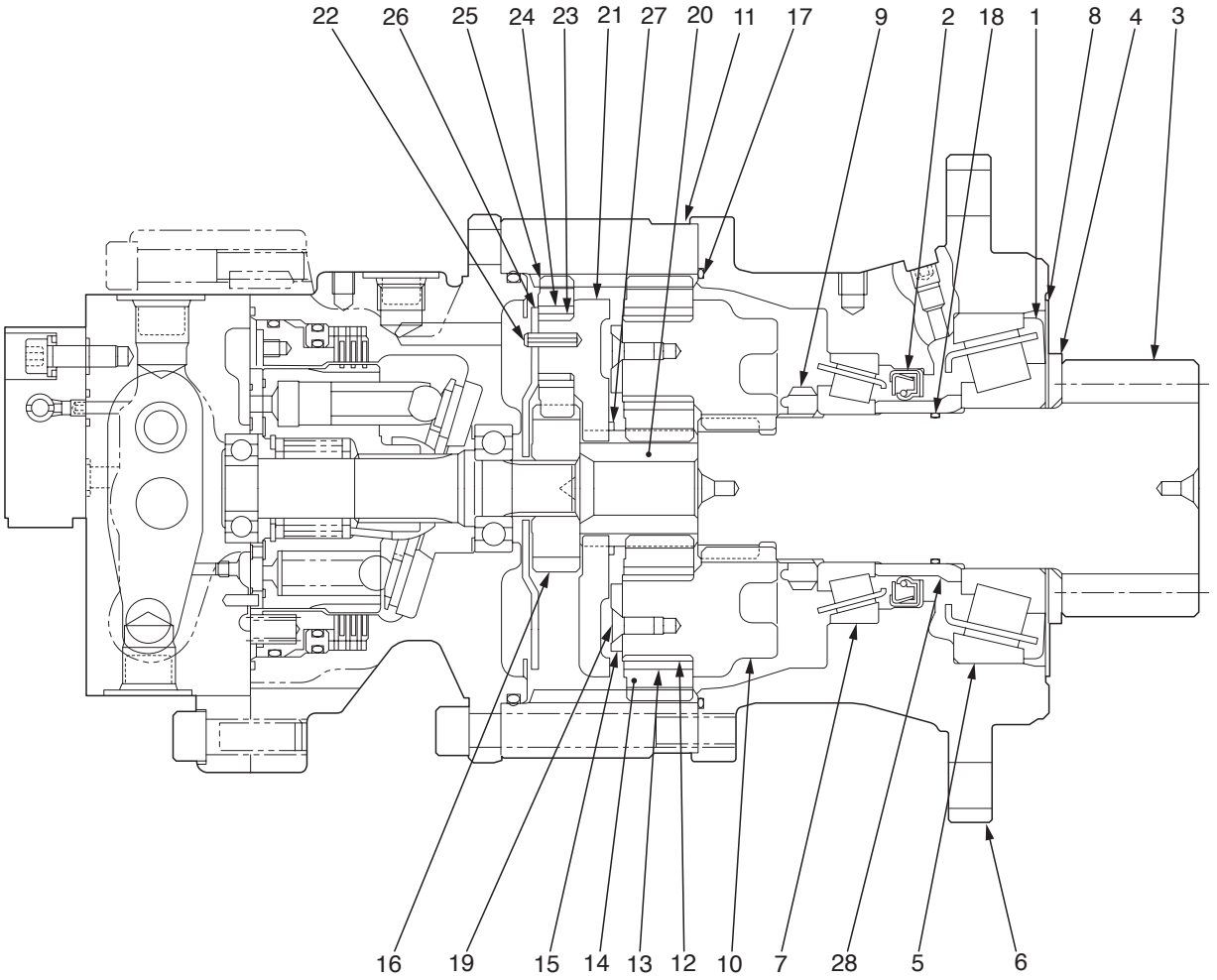

K3D6001

1. O-ring
2. O-ring
3. O-ring
4. O-ring
5. Friction Disc
6. Cylinder Block
7. Brake Piston
8. Spring
9. Shaft
10. Retainer
11. Spring
12. Retainer
13. Guide
14. Pin
15. Valve Plate
16. Bearing
17. Snap Ring
18. Collar
19. Shoe Holder
20. Pin
21. O-ring
22. Center Disc
23. Swash Plate
24. Bearing
25. Housing
26. Pin
27. Piston

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**Reduction Gears**

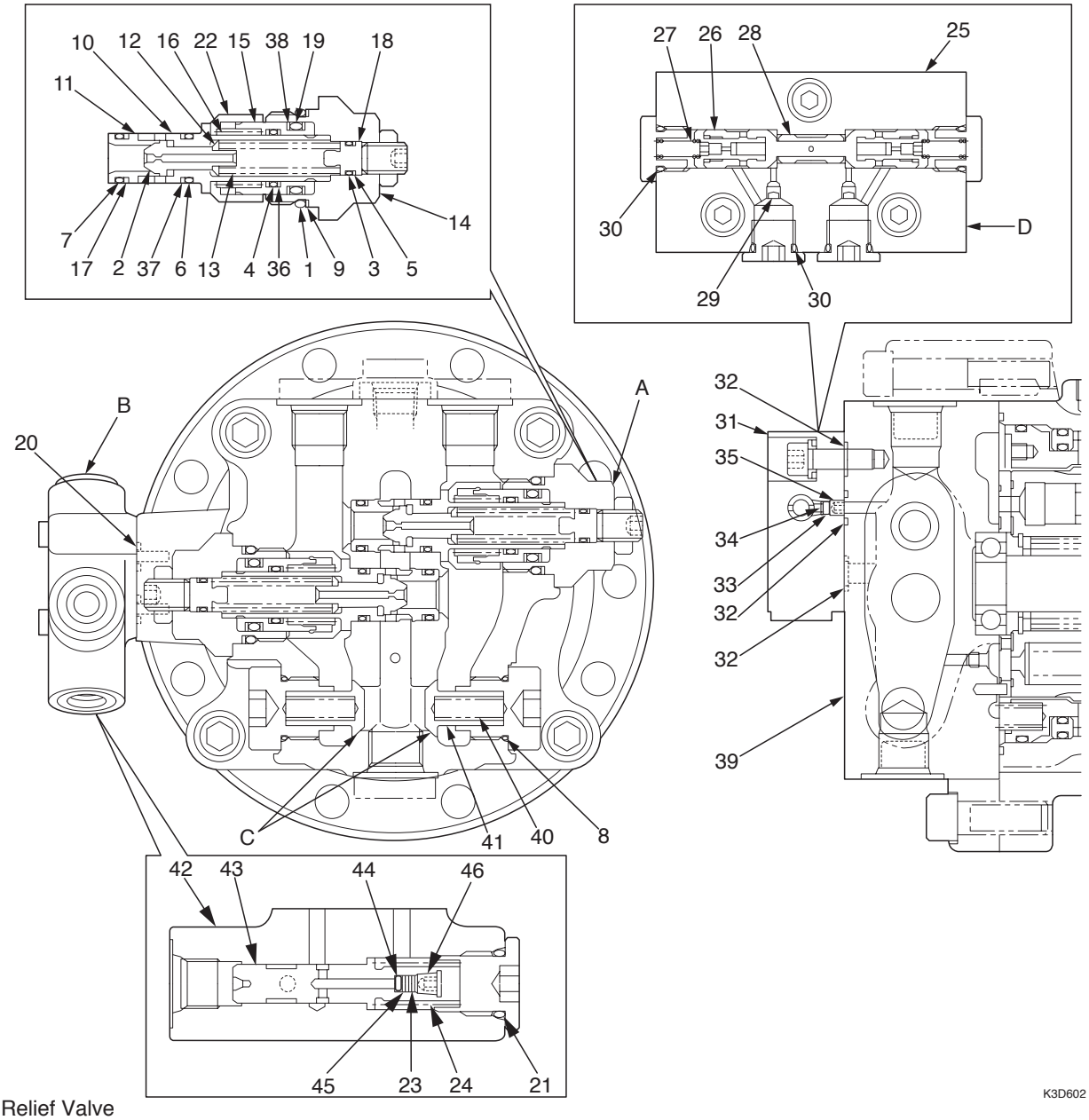



1. Plate
2. Oil Seal
3. Shaft
4. Collar
5. Bearing
6. Housing
7. Bearing
8. Plate
9. Nut
10. Carrier 2
11. Ring Gear
12. Race
13. Needle
14. Planetary Gear
15. Thrust Plate
16. Drive Gear
17. O-ring
18. O-ring
19. Screw
20. Sun Gear
21. Carrier 1
22. Pin
23. Race
24. Needle
25. Planetary Gear A
26. Thrust Plate
27. Snap Ring
28. Collar

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**Brake Valve**




A: Relief Valve
B: Timer Valve
C: Check Valve
D: Anti-rebound Valve

1. O-ring
2. Poppet
3. O-ring
4. O-ring
5. Backup ring
6. O-ring
7. O-ring
8. O-ring
9. Backup ring
10. Sleeve
11. Seat
12. Seat
13. Spring
14. Plug
15. Piston
16. Spring
17. O-ring
18. Guide
19. O-ring
20. O-ring
21. O-ring
22. Guide
23. Washer
24. Spring
25. Body
26. Check Valve Assembly
27. Spring
28. Sleeve
29. Orifice
30. O-ring
31. Body
32. O-ring
33. Filter
34. Washer
35. Orifice
36. Backup ring
37. Backup ring
38. Backup ring
39. Cover
40. Spring
41. Poppet
42. Body
43. Valve
44. Filter
45. Orifice
46. Orifice

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## OPERATION

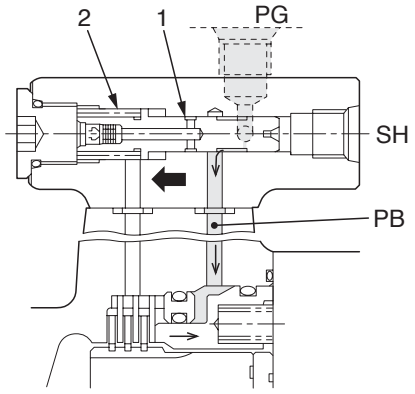
Hydraulic motor
☞ "IV-208"

Relief Valve
☞ "IV-208~209"

Anit-rebound Valve
☞ "IV-226"

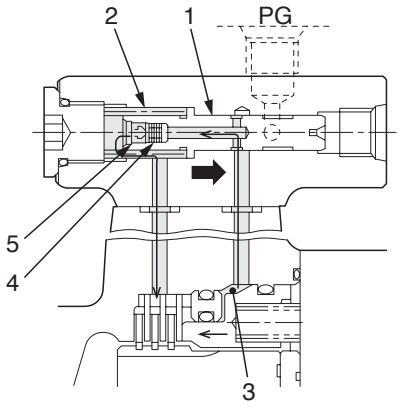
### Timer Valve

This function is used to prevent sudden operation of the parking brake when the motor is stopped.
At the time of parking brake operation, pressure oil from the port P4 is supplied at all times to the port PG, the valve spool (1) is pushed to the right by the force of the spring (2), and the port PG is closed.
When turning pilot pressure or arm pilot pressure is led to the port SH, the spool (1) is moved to the left against the force of the spring (2), and the port PG is opened. The pressure oil from the port PG passes through the hole at the center of the spool (1) and is led to the parking brake release port (PB), so that the parking brake is released.



K3D607

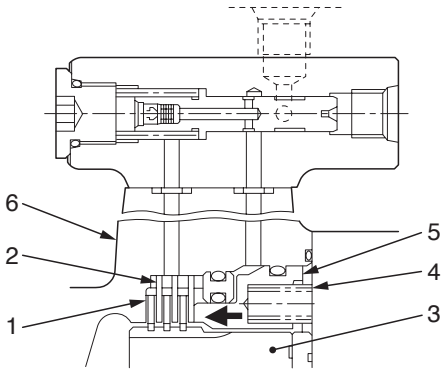
When the pilot pressure at the port SH disappears, the spool (1) is moved by the force of the spring (2) to the right, the port PG is closed, and the oil in the brake piston chamber (3) is prevented from escaping. The oil in the chamber flows gradually through the orifices (4), (5) in the spool (1) to the drain port dr, so that the parking brake is not applied rapidly, but after a certain time, just as if a timer were used.



K3D608

### Parking brake

The friction discs (2) are connected to the housing and the center discs (1) are connected to the cylinder block (3) via the spline, respectively. The center discs (1) and friction discs (2) are pressed against the housing (6) by the springs (4) via the brake piston (5). The friction force between these discs generates the brake torque to prevent the cylinder block (3) from rotating.



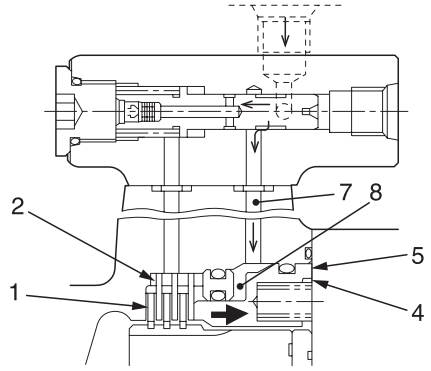
K3D605

When the pressure oil is introduced into the motor, the oil flows from the parking brake release port (7) into the brake piston chamber (8). The oil pressure overpowers the spring force and moves the brake piston

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(5) to the right. This generates a clearance between the center discs (1) and friction discs (2) to release the parking brake. When the motor stops, the spool returns to the neutral position to close the parking brake release port (7). The pressure oil in the brake piston chamber (8) is introduced into the motor case and the spring (4) operates the parking brake.




K3D6061

Reduction Gears

☞ “IV-227”

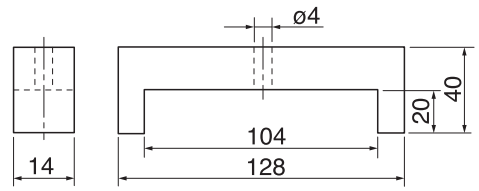
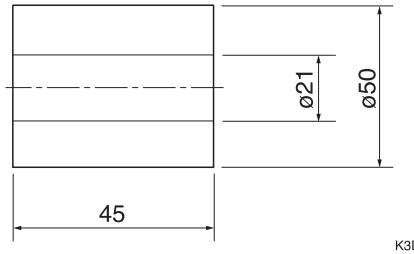
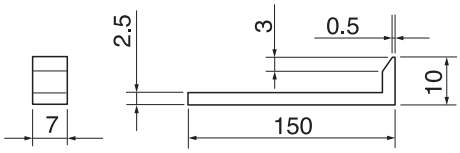
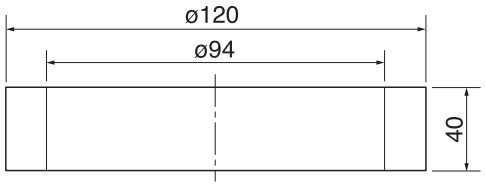
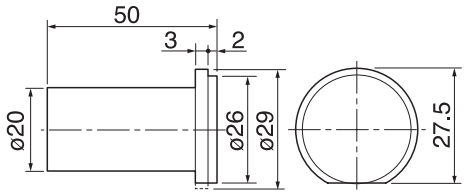
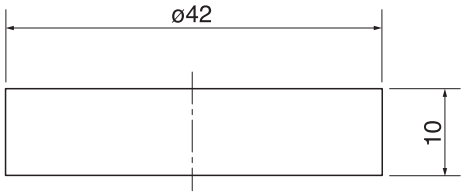
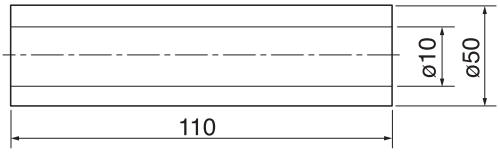
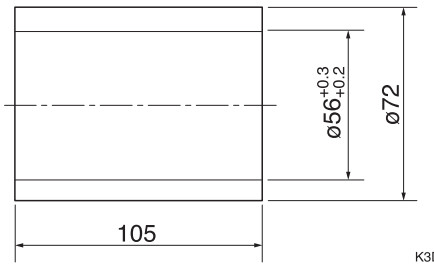
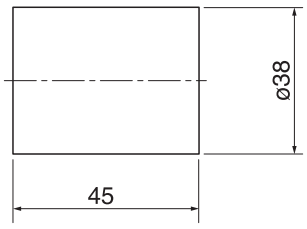
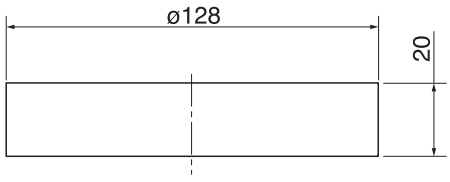
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## DISASSEMBLY AND ASSEMBLY

### Table of Special Tools

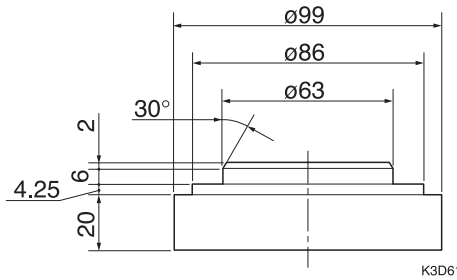
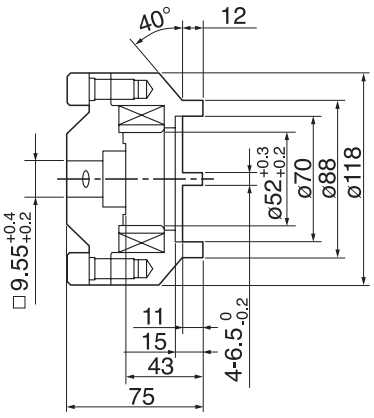
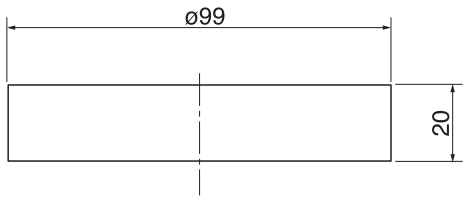
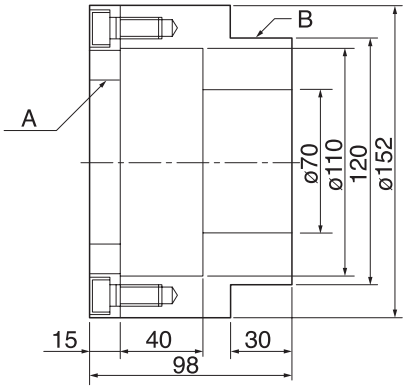
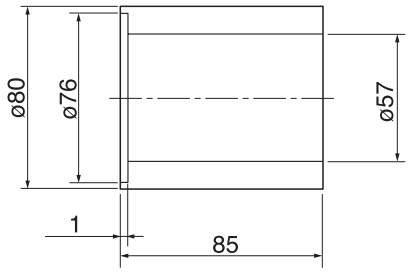
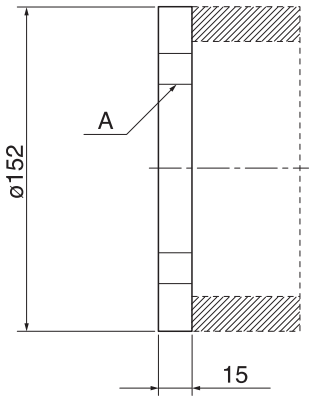
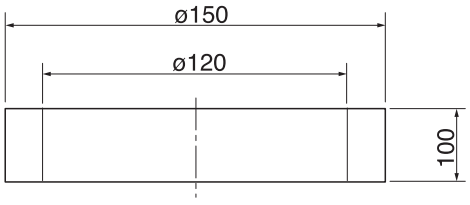
Unit: mm

| | NAME, DIMENSIONS | | NAME, DIMENSIONS |
|---|---|---|---|
| 1 | JIG (A)<br>  <br>K3D609 | 6 | JIG (F)<br>  <br>K3D614 |
| 2 | JIG (B)<br>  <br>K3D610 | 7 | JIG (G)<br>  <br>K3D615 |
| 3 | JIG (C)<br>  <br>K3D611 | 8 | JIG (H)<br>  <br>K3D616 |
| 4 | JIG (D)<br>  <br>K3D612 | 9 | JIG ( I )<br>  <br>K3D617 |
| 5 | JIG (E)<br>  <br>K3D613 | 10 | JIG (J)<br>  <br>K3D618 |

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Unit: mm

| | NAME, DIMENSIONS | | NAME, DIMENSIONS |
|---|---|---|---|
| 11 | JIG (K)<br>  | 15 | JIG (O)<br>  |
| 12 | JIG (L)<br>  | 16 | JIG (P)<br>  |
| 13 | JIG (M)<br>  | 17 | JIG (Q)<br>  |
| 14 | JIG (N)<br>  | | |

A: Adjust the internal gear so that a clearance of 0.3 to 0.5 mm is produced when the male gear (shown in the table) is inserted.
B: Width across flat

| | | | |
|---|---|---|---|
| Gear type | Profile shifted gear | Diameter of standard pitch circle | ø 91.000 |
| Tooth | Standard gear tooth | Amount of addendum modification | 1.95 |
| Module | 6.5 | Height of tooth | 14.625 |
| Pressure angle | 20° | Addendum circle diameter | ø 107.9 |
| No. of teeth | 14 | Dedendum circle diameter | ø 78.65 |

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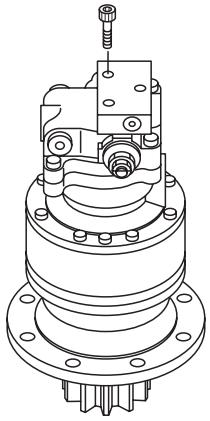
### General Cautions

- Carry out disassembly and assembly operations in a clean place and provide clean containers to place the disassembled parts in.
- Before disassembly, clean around the ports and remove the paint from each joint using a wire brush.
- Wash the disassembled parts and dry them with compressed air. Do not use a rag, as this could cause clogging of dirt.
- Make match marks on each part so that they will be assembled in the same positions when reassembled.
- Replace all seals with new ones each time the unit is disassembled, coating them lightly with grease.
- Check each part to make sure there is no abnormal wear or seizing and use sandpaper, etc. to remove any burrs, sharp edges, etc.

### Disassembly

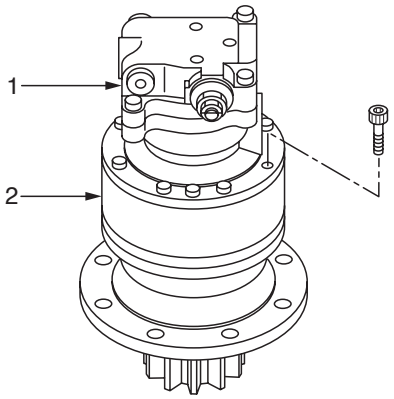
#### Slew Motor

1. Remove the cap screws and then the anti-rebound valve.



K3D626

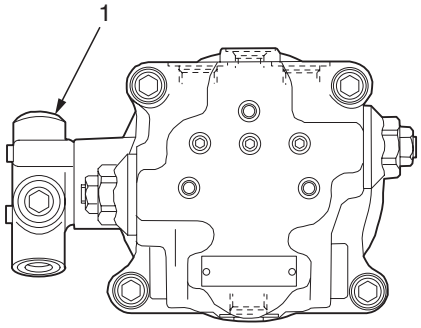
2. Remove the cap screws to disassemble the motor into the hydraulic motor (1) and the reduction gear (2).
   - Mark the mating position on both the hydraulic motor and the reduction gear so that they can be mated correctly when reassembling.
   - Fix the hydraulic motor with a vise.




K3D627

#### Brake Valve and Hydraulic Motor

1. Remove the cap screws and then the timer valve (1).
   - Be careful not to miss the O-ring.

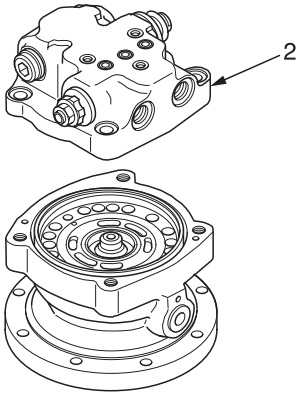



K3D628

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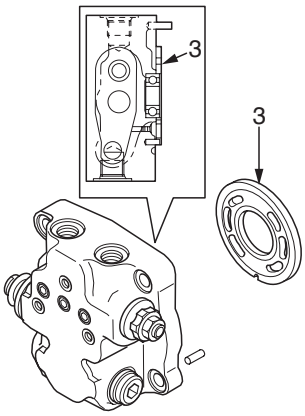


2. Remove the cap screws and then the cover (2).
   - Fix the hydraulic motor with a vise.
   - Be careful not to let the valve plate drop off.



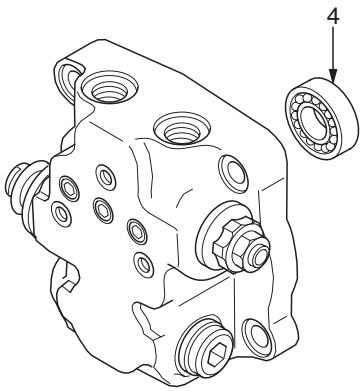

K3D629

3. Remove the valve plate (3) from the cover.



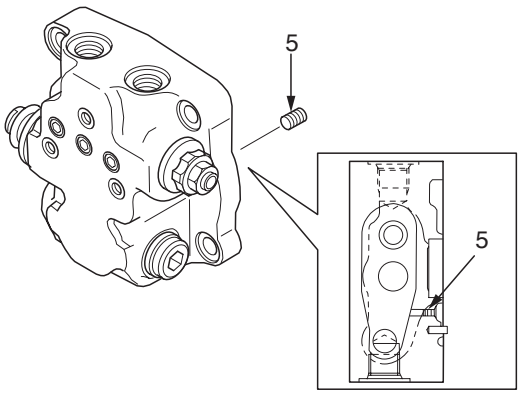

K3D630

4. Remove the bearing (4).




K3D631

5. Remove the orifice (5).
   - The orifice is caulked. Do not remove it unless necessary.

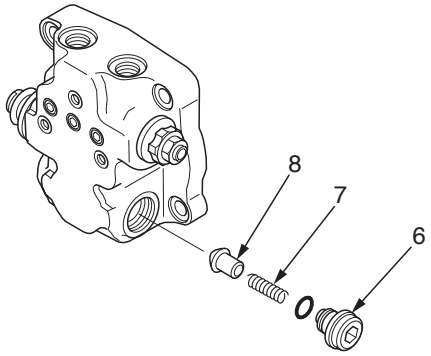



K3D632

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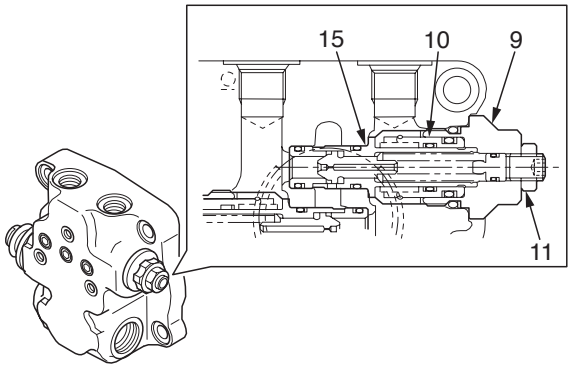


6. Remove the check valve.
   a. Remove the plug (6).
   b. Remove the spring (7) and check valve (8).



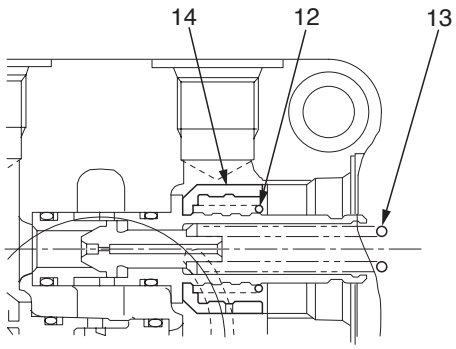
K3D633

7. Remove the relief valve.
   a. Remove the plug (9) and piston (10).
      • Do not loosen the set screw nut (11).



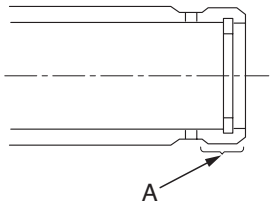
K3D634

   b. Remove the springs (12) and (13) and piston guide (14).
      • Use a pair of tweezers.
      • Be careful not to damage the piston guide.

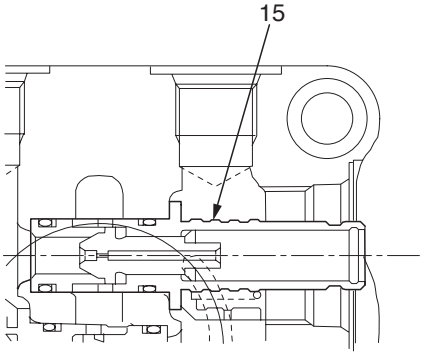


K3D635

   c. Remove the relief housing (15).
      • Pinch section A with a pair of pliers.
      • Be careful not to damage the pinched section.



K3D637

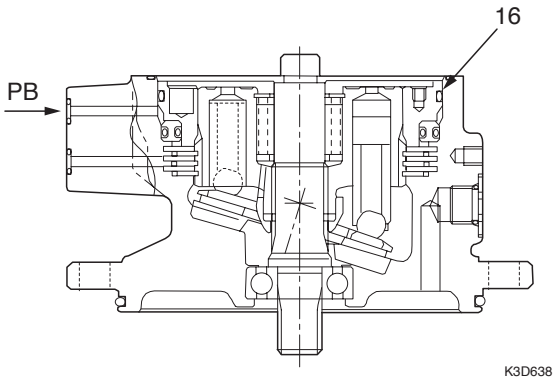


K3D636

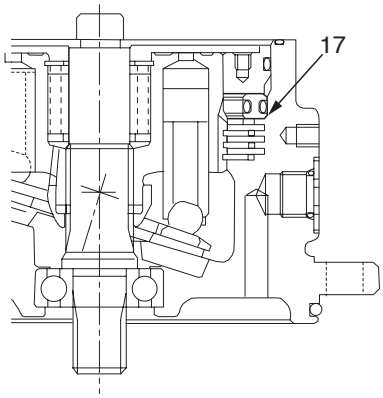
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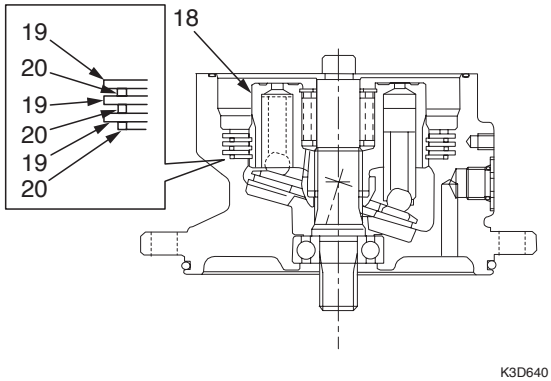
8. Remove the brake piston (16).
   - Blow the air from the brake release port PB with care such that the brake piston does not protrude.




9. Remove the collar (17).
   - Use the jig (B).

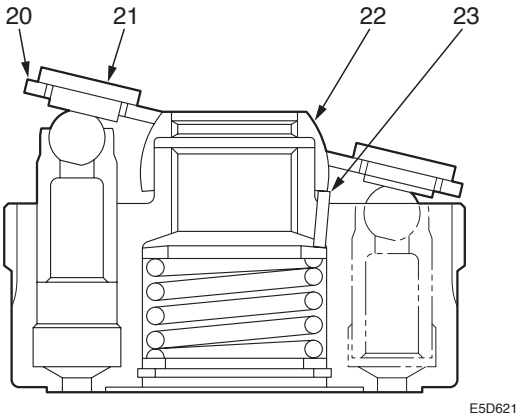



10. Remove the cylinder block (18), friction discs (19) and center discs (20).




11. Remove the shoe holder (20) and piston assembly (21) from the cylinder block.

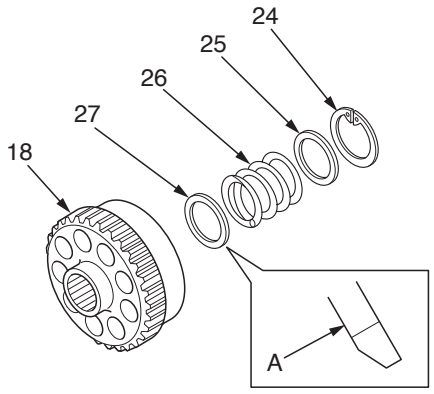
12. Remove the guide (22) and pins (23) from the cylinder block.



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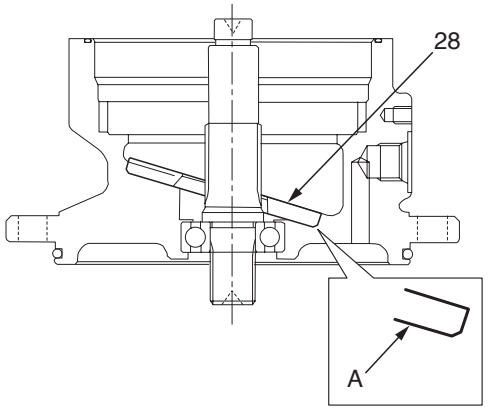


13. Remove the snap ring (24), retainer (25), spring (26) and retainer (27) from the cylinder block (18).
    - To remove the snap ring, push up the retainer (25) by using the press and jig (C).



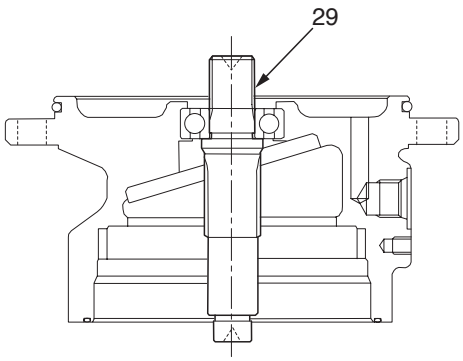
E5D622

14. Remove the swash plate (28).
    - Use the jig (B).



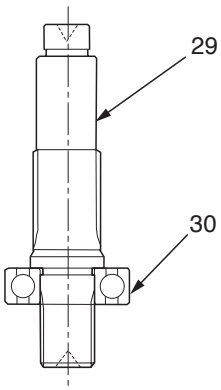
K3D641

15. Remove the shaft (29).
    - Lightly tap the end face with a plastic hammer.



K3D642

16. Remove the bearing (30) from the shaft (29).
    - Use the press and jig (D).

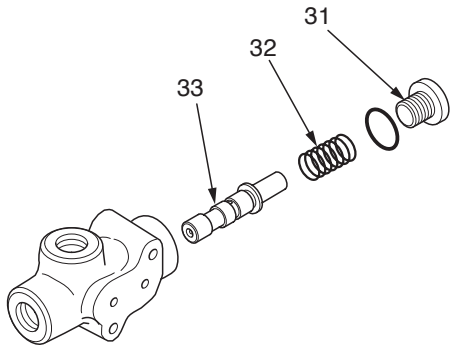


K3D643

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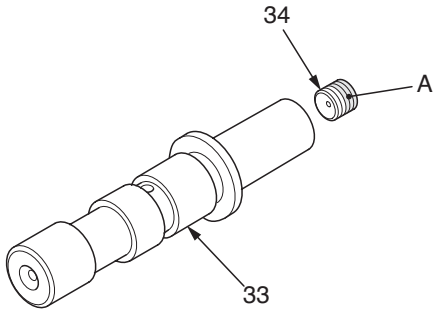


17. Disassemble the timer valve.
    - Be careful not to damage or deform the contact surface.
    a. Remove the plug (31).
    b. Remove the spring (32) and valve (33).
       - Use a pair of tweezers.



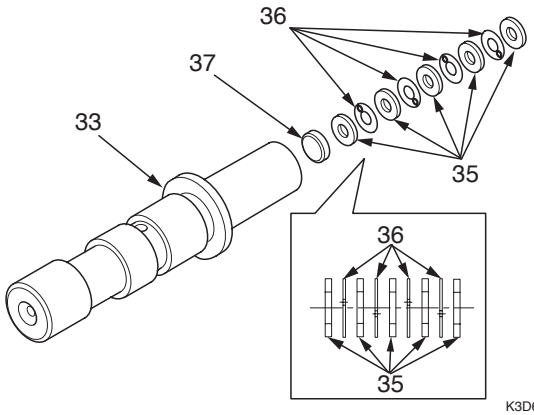

K3D644

    c. Remove the orifice (34) from the valve (33).
       - Adhesive has been applied to the orifice.




K3D645

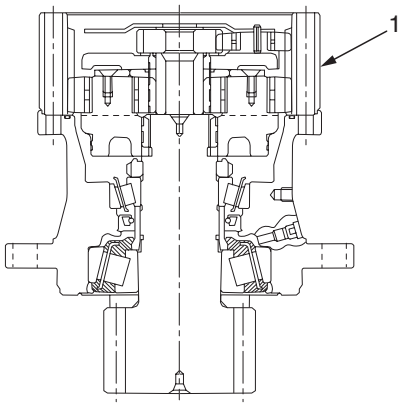
    d. Remove the washer (35), orifice (36) and filter (37) from the valve (33).




K3D646

### Reduction Gears

1. Remove the ring gear (1).

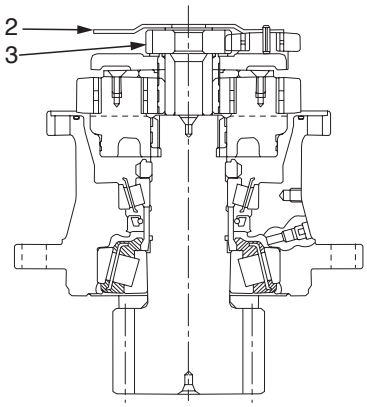



K3D647

https://truckmanualshub.com/

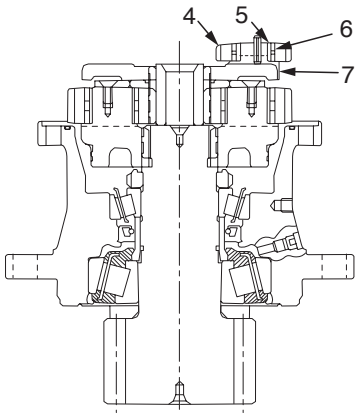


2. Remove the thrust plate (2).
3. Remove the drive gear (3).



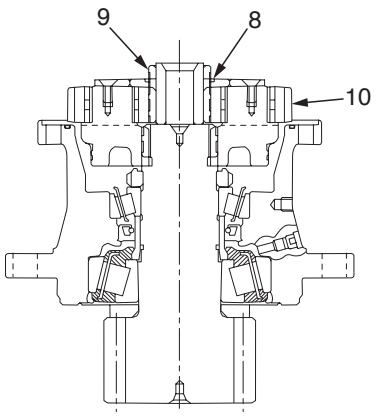
K3D648

4. Remove the planetary gear A (4), needles (5) and inner race (6).
5. Remove the carrier 1 (7).



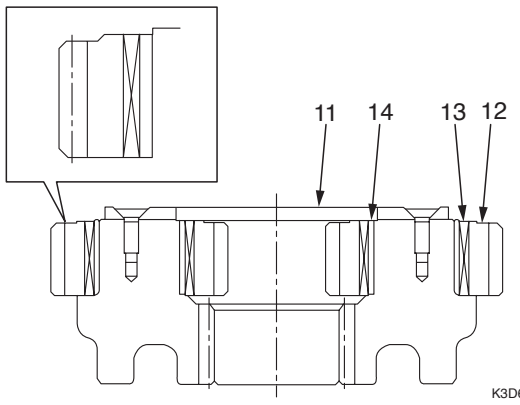
K3D649

6. Remove the snap ring (8) and then the sun gear (9).
7. Remove the carrier 2 assembly (10).



K3D650

8. Loosen the screw and remove the thrust plate (11).
   - Loctite has been applied to the screw. Warming the screw screws (for example, using a portable drier) will make its removal much easier.
9. Remove the planetary gear B (12), needle (13) and inner race (14).

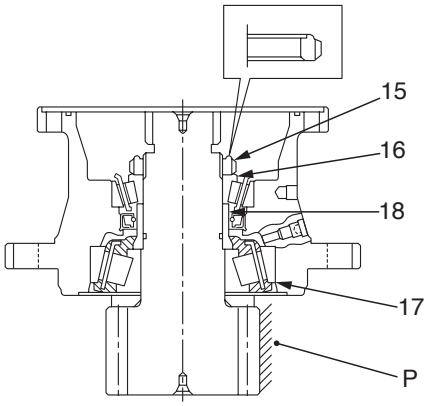


K3D651

https://truckmanualshub.com/



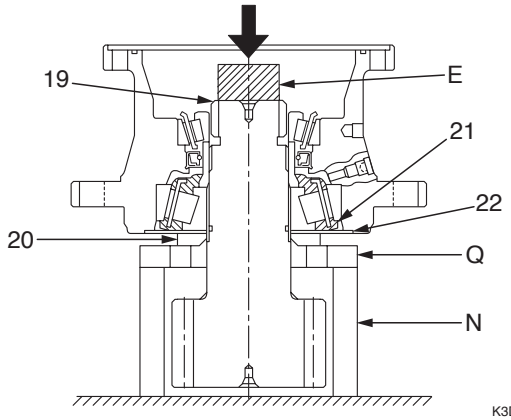
10. Remove the U nut (15).
    - Do not remove the U nut unless the taper roller bearing (16) or (17) and/or collar (18) is faulty. If one of them is faulty, the whole U nut should be replaced.
    - Use the jig (P) to fix the shaft.
    - The U nut should be replaced with a new one every time it is disassembled.



K3D652

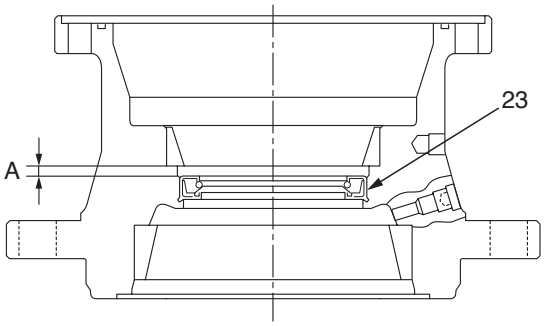
11. Insert the jigs (N) and (Q) in the pinion section of the shaft (19) to hold down the collar (20).
    - Do not remove the shaft unless necessary.

12. Put the jig (E) on the upper part of the shaft and pull out the shaft by using the press.
    - The plates (21) and (22) should be replaced with new ones every time they are disassembled.



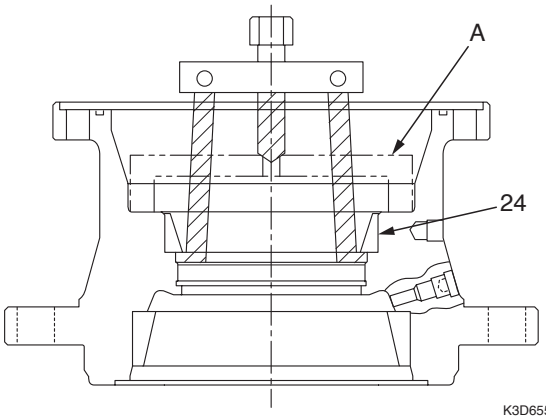
K3D653

13. Remove the oil seal (23).
    - Use a flat blade screwdriver.
    - The oil seal should be replaced with a new one every time it is disassembled.
    - Be careful not to damage the outer race of the taper roller bearing.



K3D654

14. Remove the outer race (24) of the taper roller bearing.
    - Use the pulley remover (for pulleys of ø85 mm in diameter) and jig (A).

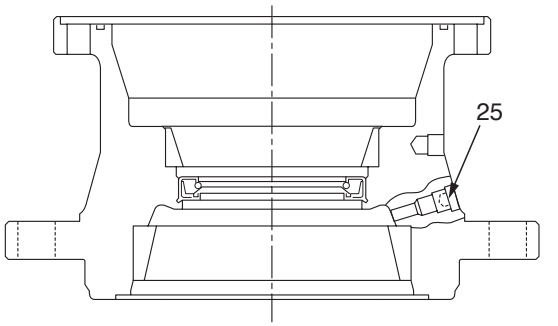


K3D655

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15. Remove the plug (25) from the case.



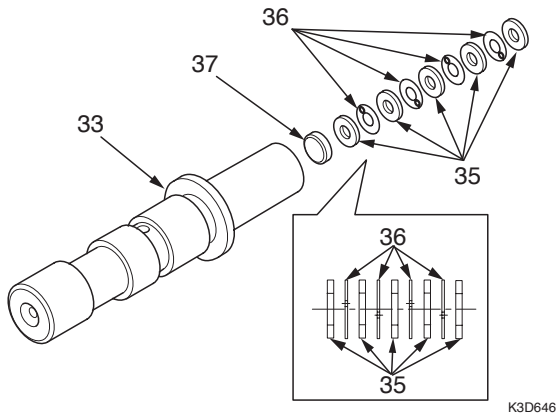

K3D656

**Assembly**

Brake Valve and Hydraulic Motor

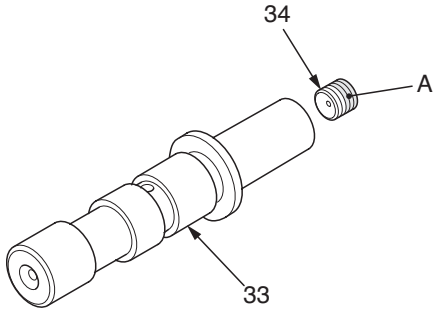
1. Assemble the timer valve.
   - Be careful not to damage the rotation section of the valve.

   a. Mount the filter (37), washer (36) and orifice (35) on the valve (33).
      - Position the hole of the orifice (35) as shown in the figure.




K3D646

   b. Mount the orifice (34) on the valve (33).
      - Apply adhesive to section A of the orifice in advance. Excessive application may clog the hole.
      - Orifice tightening torque:
        4.9 ±1.0 N·m (0.5 ±0.1 kgf·m)

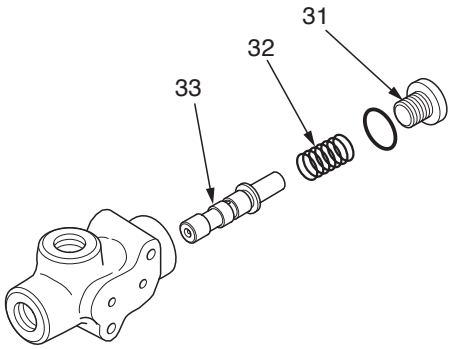



K3D645

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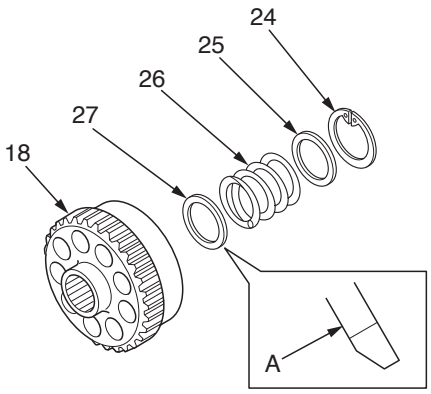


c. Mount the valve (33) and spring (32) on the body.
d. Fit the O-ring to the plug (31) and mount them on the body.
   • Plug tightening torque:
     39.2 ±2.0 N·m (4.0 ±0.2 kgf·m)



K3D644

2. Mount the retainer (27), spring (26), retainer (25) and snap ring (24) on the cylinder block (18).
   • To mount the snap ring, push the retainer (25) by using the press and jig (C).
   • Position the retainer (27) so that its tapered side (A) faces the cylinder block.

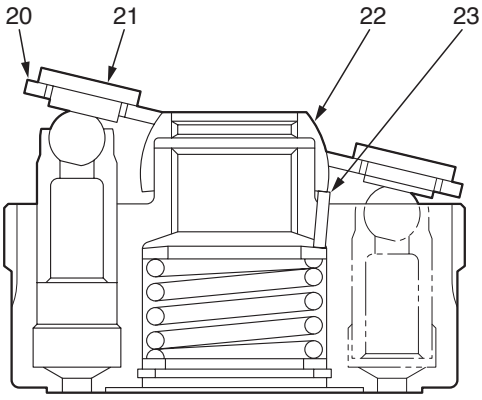


E5D622

3. Fit the pins (23) to the cylinder block.
   • Apply grease to the pins.

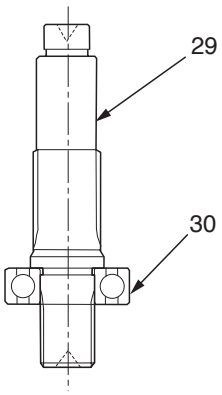
4. Mount the guide (22).

5. Fit the shoe holder (20) to the piston assembly (21) and mount them on the cylinder block.
   • Apply the hydraulic oil to the rotation section.



E5D621

6. Insert the bearing (30) into the shaft (29).
   • Insert the bearing by using the press and jig (F).

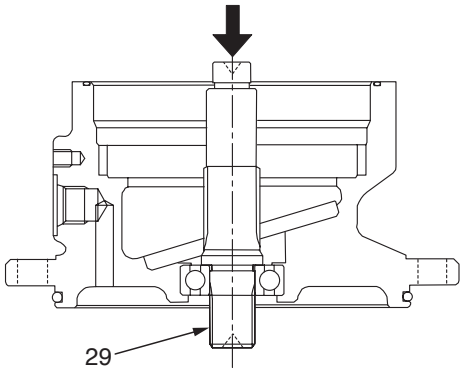


K3D643

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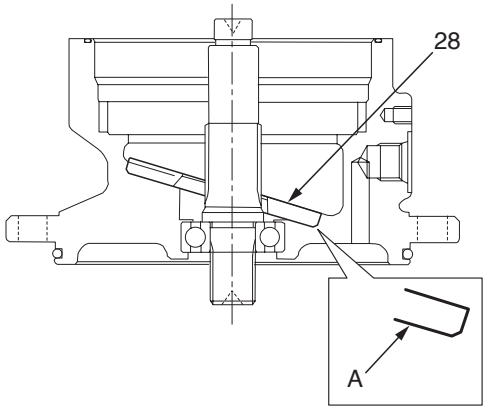


7. Install the shaft (29) in the housing.
   - Lightly tap with a plastic hammer to install.




K3D657

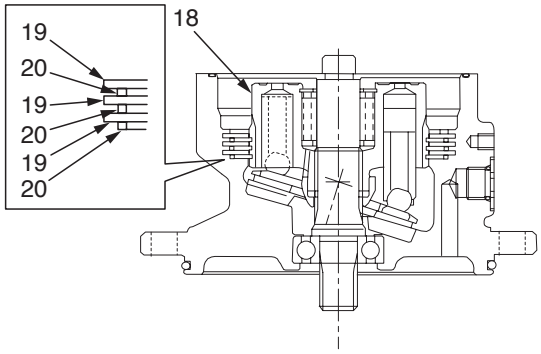
8. Install the switch plate (28) in the housing.
   - Apply grease to the side (A) of the swash plate.




K3D641

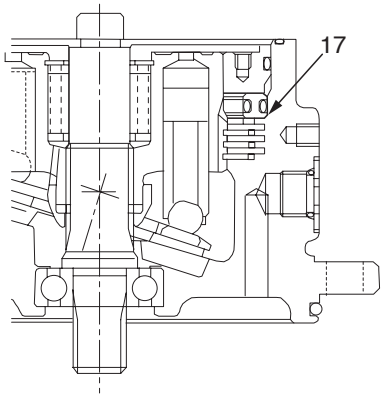
9. Install the cylinder block (18) in the housing.
   - Be careful not to let the shoe holder or other parts drop off.

10. Mount three center discs (20) and three friction discs (19).
    - Total number of friction discs: 3
    - Total number of center discs: 3
    - Be careful of the mounting order.




K3D640

11. Fit the O-ring to the collar (17) and insert them in the housing.
    - Use the jig (G) and the press to insert.

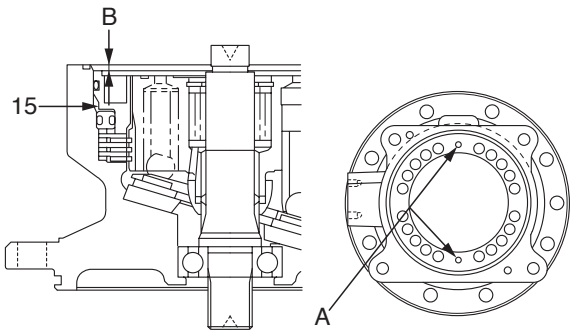



K3D639

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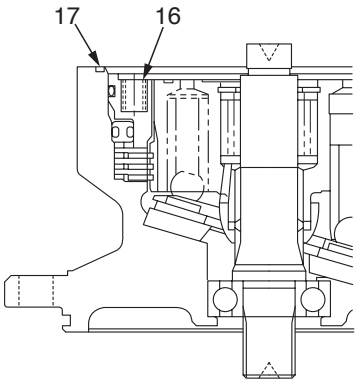


12. Fit the O-ring to the brake piston (15) and insert them in the housing.
    - Use the jig (G) and the press to insert.
    - The screw M6 position (A) should be as shown in the figure.
    - Insertion depth (B) should be 0 to 1 mm.



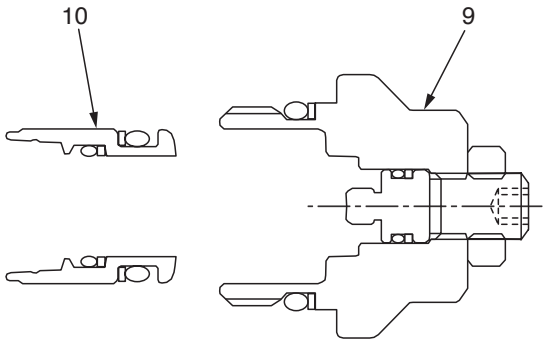

K3D658

13. Mount the springs (16) and O-ring (17).



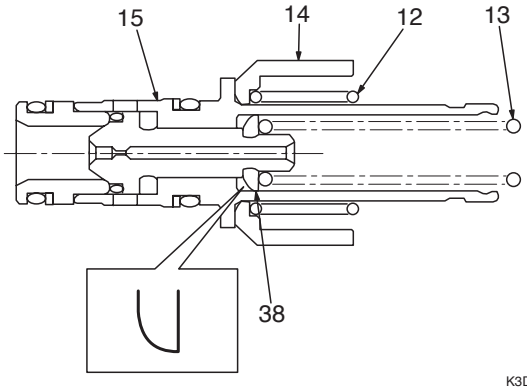

K3D659

14. Assemble the relief valve assembly.
    a. Fit the O-ring and backup ring to the piston (10).
    b. Fit the backup ring and O-ring to the plug (9).




K3D660

    c. Fit the backup ring and O-ring to the relief housing (15).
    d. Install the spring sheet (38) and spring (13) in the relief housing (15).
        - Be careful of the mounting direction of the spring sheet (38).
    e. Install the guide (14) in the relief housing (15).
    f. Mount the spring (12) on the guide(14).

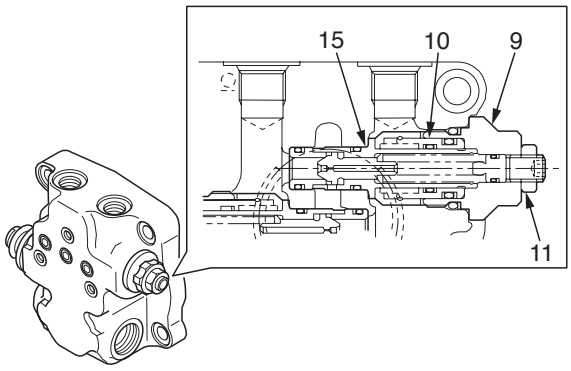



K3D661

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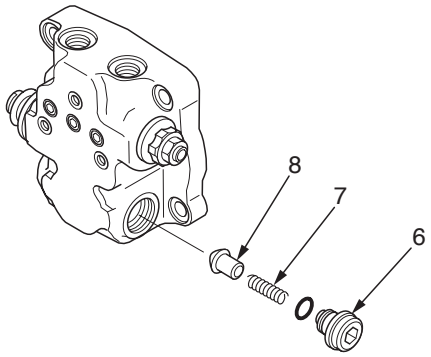


g. Unite the relief housing (15), plug (9) and piston (10).
h. Mount the relief valve assembly on the cover.
   • Be careful not to let the spring jump out.
   • Plug tightening torque:
     275 ±10 N·m (28 ±1 kgf·m)
   • Do not loosen the lock nut (11).



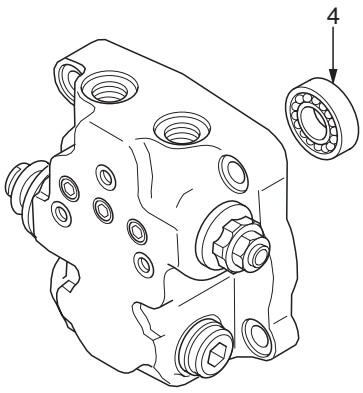

K3D634

15. Mount the check valve.
   a. Mount the spring (7) and poppet (8) on the cover.
   b. Fit the O-ring to the plug (6) and mount them on the cover.
      • Plug tightening torque:
        157 ±10 N·m (16 ±1 kgf·m)



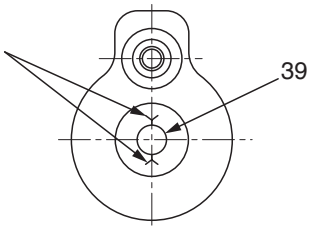

K3D633

16. Insert the bearing (4) into the cover.
   • Use the jig (H) and the press to insert.

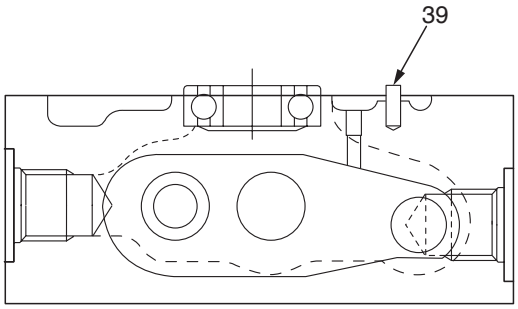



K3D631

17. Fit the pin (39) to the cover.
   • Caulk the pin at two positions by using a punch. Protrusion due to caulking should not be more than 1 mm.




K3D663

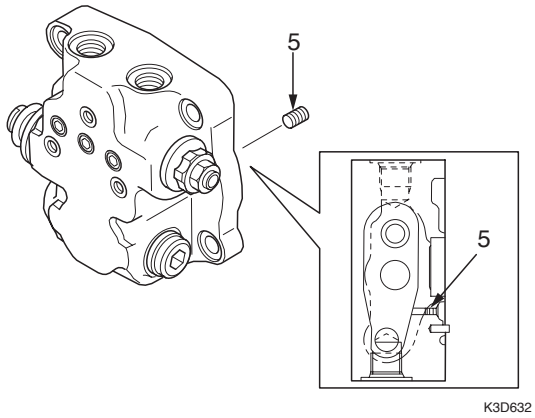



K3D662

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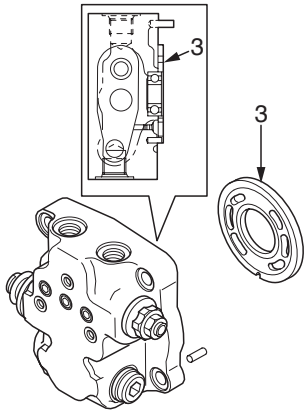


18. Mount the orifice (5) on the cover.
    - Caulk the circumference of the orifice female screw by using a punch.
    - Orifice tightening torque:
      2.45 ±0.49 N·m (0.25 ±0.05 kgf·m)



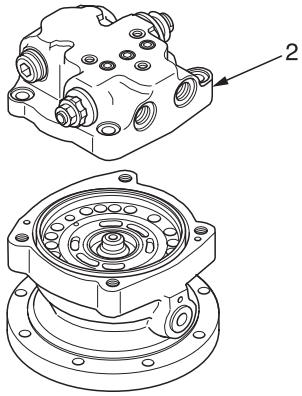
K3D632

19. Mount the pin and valve plate (3) on the cover.
    - Apply grease on the back of the valve plate (the side facing the cover) in advance to prevent the plate from dropping off.



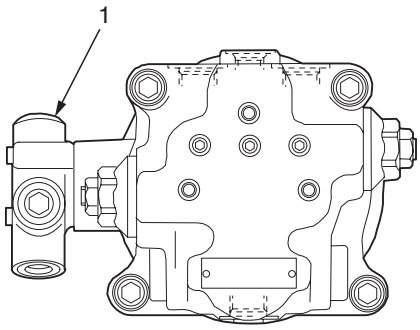
K3D630

20. Mount the cover (2) on the case and fix them with the cap screws.
    - Be careful not to let the valve plate drop off.
    - Cap screw tightening torque:
      128 ±7 N·m (13.1 ±0.7 kgf·m)



K3D629

21. Mount the timer valve (1).
    a. Fit the O-ring to the case.
    b. Mount the timer valve and fix it with the screw.
       - Screw tightening torque:
         10 ±1 N·m (1 ±0.1 kgf·m)



K3D628

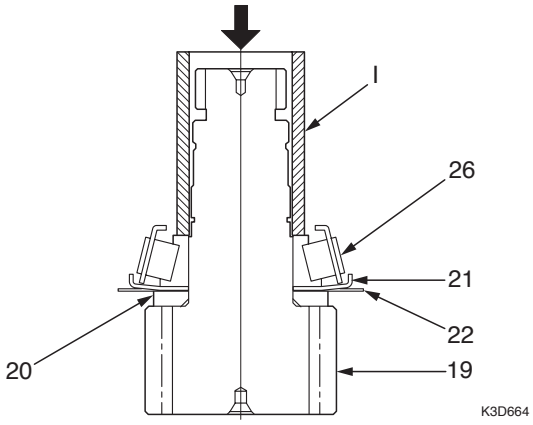
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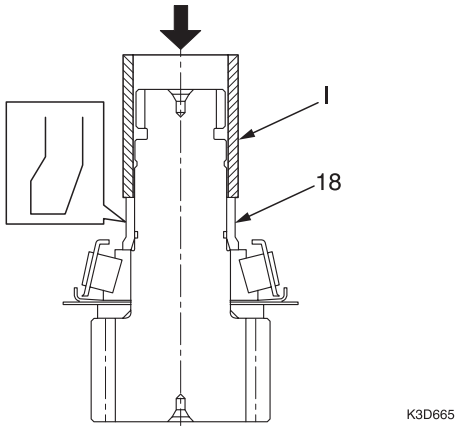
### Reduction Gears

1. Mount the collar (20) and plates (21) and (22) on the shaft (19).
   - Apply grease to the case side of the plate (22).
   - The plates (21) and (22) should be new ones.

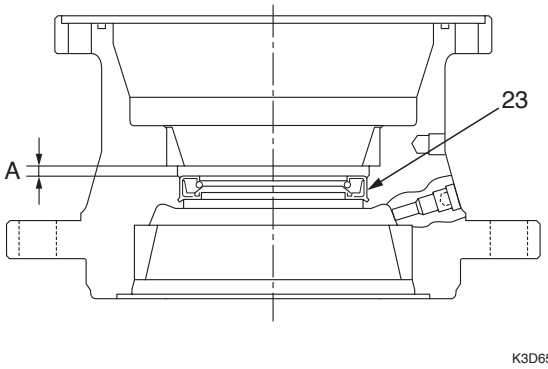
2. Insert the inner race (26) of the taper roller bearing into the shaft.
   - Use the jig (I) and the press to insert.



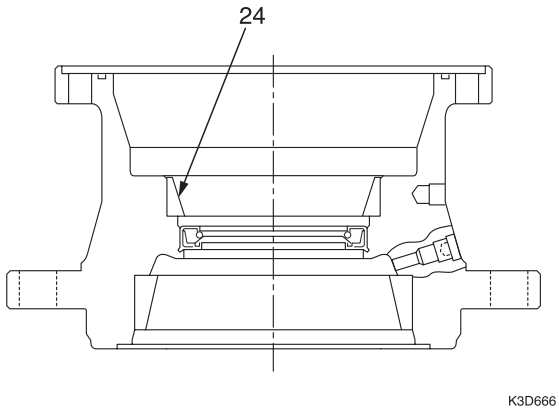

3. Fit the O-ring to the shaft and mount the collar (18).
   - Be careful of the mounting direction of the collar (18).
   - Use the jig (I) and the press to mount.




4. Insert the oil seal (23) into the case.
   - Use the jig (K) and the press to insert.
   - The installation dimension (A) after insertion should be 4.25 mm.



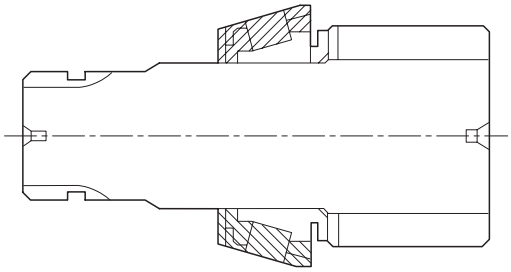

5. Insert the outer race (24) of the taper roller bearing into the case.
   - Use the jig (L) and the press to insert.



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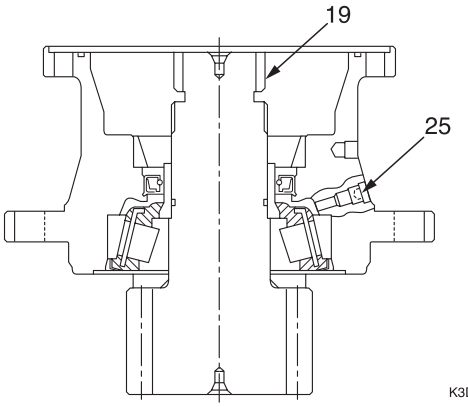


6. Put grease into the inner race of the taper roller bearing.
   - Grease type: Shell ALVANIA Grease
   - Grease volume: 62~72 mL



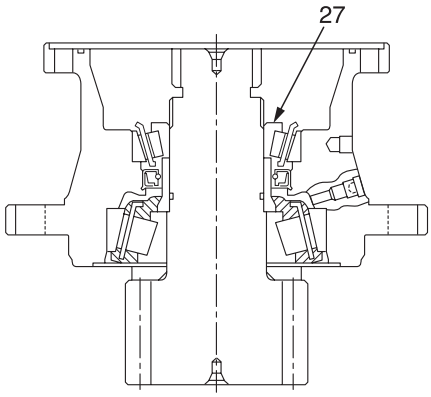
E5D629

7. Mount the shaft (19) and plug (25) on the case.
   - The shaft (19) should be mounted before mounting the plug (25).



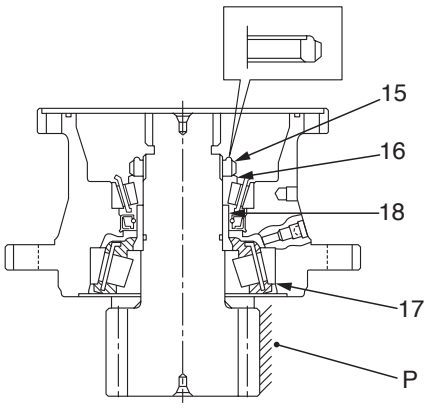

K3D667

8. Mount the inner race (27) of the taper roller bearing to the shaft.
   - Use the jig (M) and the press to mount.




K3D668

9. Mount the U nut (15).
   - Be careful of the mounting direction of the U nut.
   - Fix the shaft with the jig (P) and tighten it with the jig (O).
   - Be sure to use a new U nut.
   - U nut tightening torque:
     933 ±49 N·m (94 ±5 kgf·m)

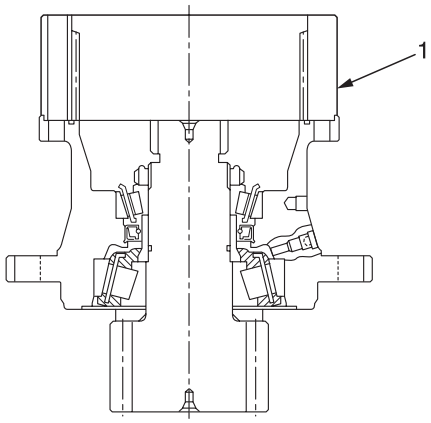



K3D652

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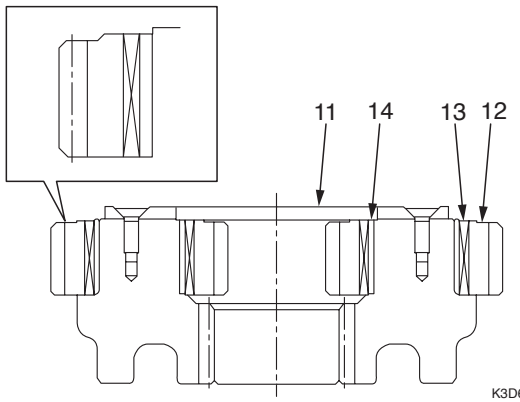
10. Fit the O-ring to the case and mount the ring gear (1).
    - Align the positions of the M12 hole of the case and the hole (ø13 mm in diameter) of the ring gear.



K3D669

11. Mount the inner race (14), needles (13) and planetary gear B (12) on the carrier 2.
    - Be careful of the mounting direction of the planetary gear B.

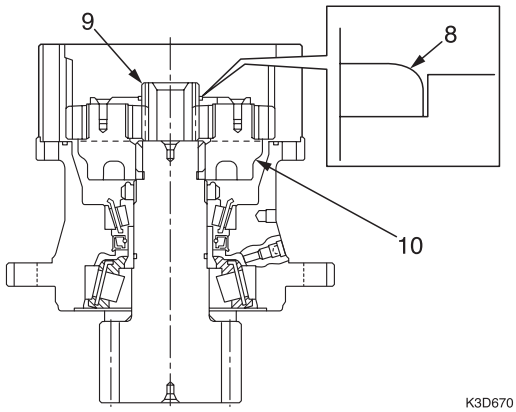
12. Mount the thrust plate (11) and fix it with the cap screws.
    - Apply Loctite #242 to the cap screws in advance.
    - Cap screw tightening torque:
      6.1 ±2.0 N·m (0.6 ±0.2 kgf·m)



K3D651

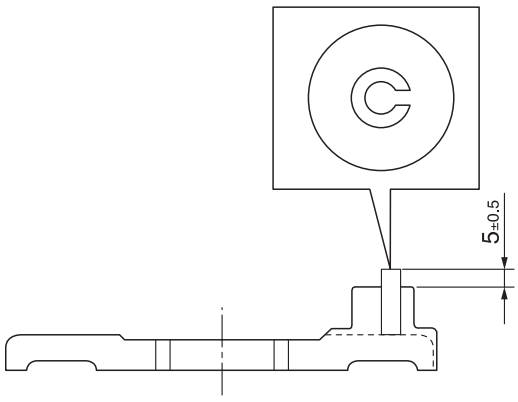
13. Mount the carrier 2 (10) on the case.

14. Fit the snap ring (8) to the sun gear (9) and mount them.



K3D670

15. Fit the spring pin to the carrier 1.
    - Let the slit section of the spring face outside as shown in the figure.



K3D671

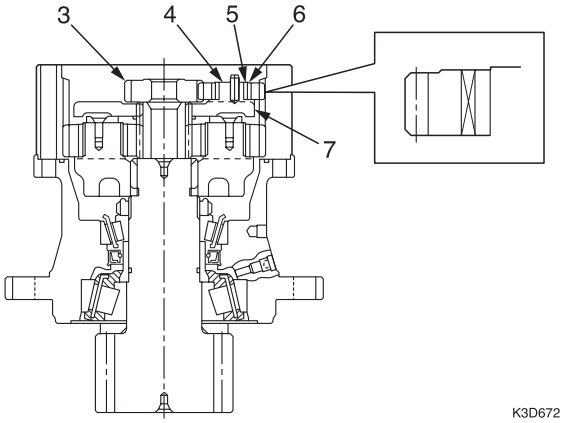
https://truckmanualshub.com/



16. Mount the carrier 1 (7).

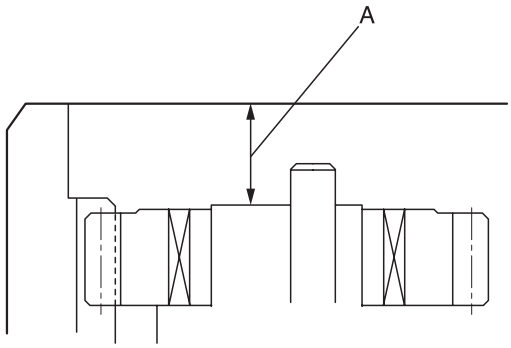
17. Mount the inner race (5), needles (6) and planetary gear A (4) on the carrier 1 (7).
    - Mount the planetary gear A as shown in the figure.

18. Mount the drive gear (3).



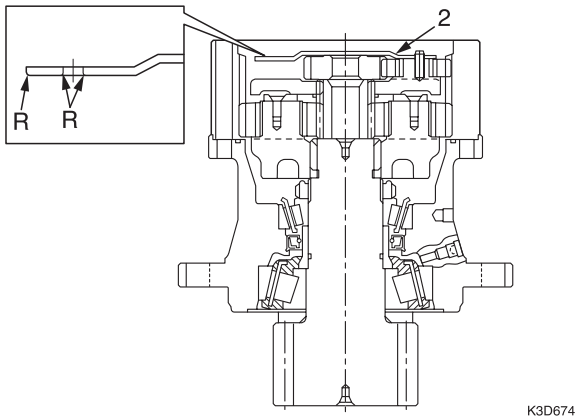
K3D672

19. Mount the thrust plate (2).
    - Measure the depth (A) from the case end to the carrier 1 and select a proper thickness for the thrust plate by referring to the table.
    - The largely-rounded side of the thrust plate circumference should face the planetary gear.



K3D673

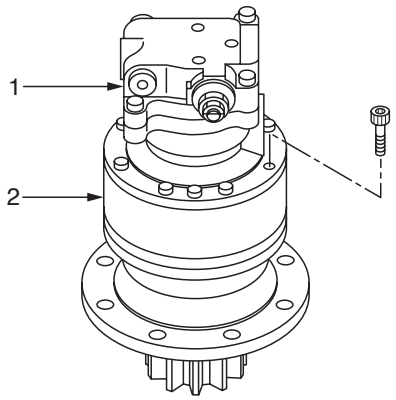
| Depth (A) | Less than 14.0 mm | From 14.0 to less than 14.5 mm | 14.5 mm or more |
|---|---|---|---|
| Thrust plate thickness | 1.8 mm | 2.3 mm | 2.8 mm |



K3D674

### Slew Motor

1. Unite the hydraulic motor (1) and the reduction gear (2) and fix them with the cap screws.
    - Cap screw tightening torque:
      128 ±7 N·m (13.1 ±0.7 kgf·m)



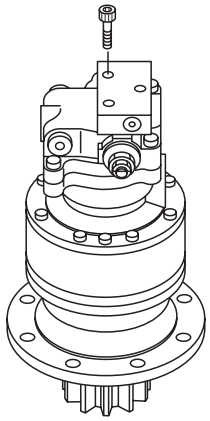
K3D627

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2. Fit the O-ring to the cover.

3. Fit the anti-rebound valve to the cover and mount the washer, seal and screws.
   - Screw tightening torque:
     29.4 ±2 N·m (3.0 ±0.2 kgf·m)



K3D626

## INSPECTION AND ADJUSTMENT

☞ “IV-235”

## TROUBLESHOOTING

☞ “IV-236”

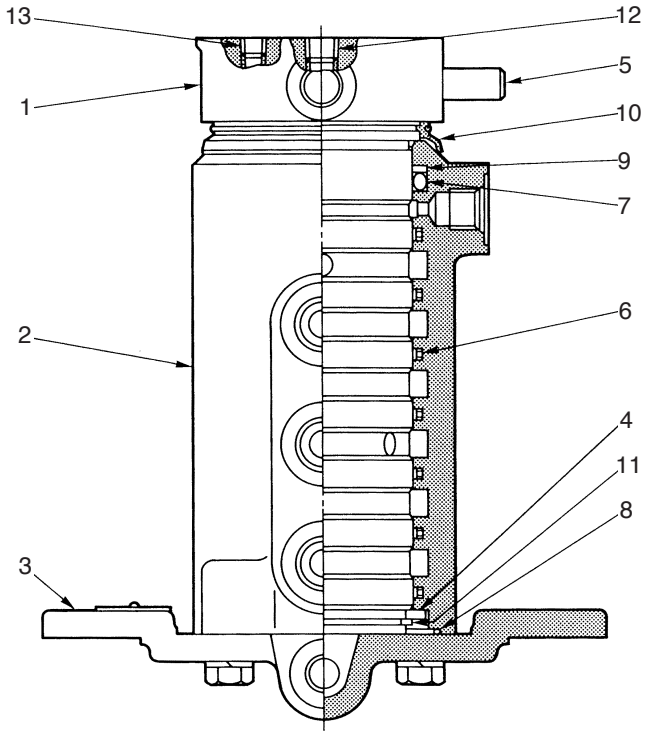
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# SWIVEL JOINT

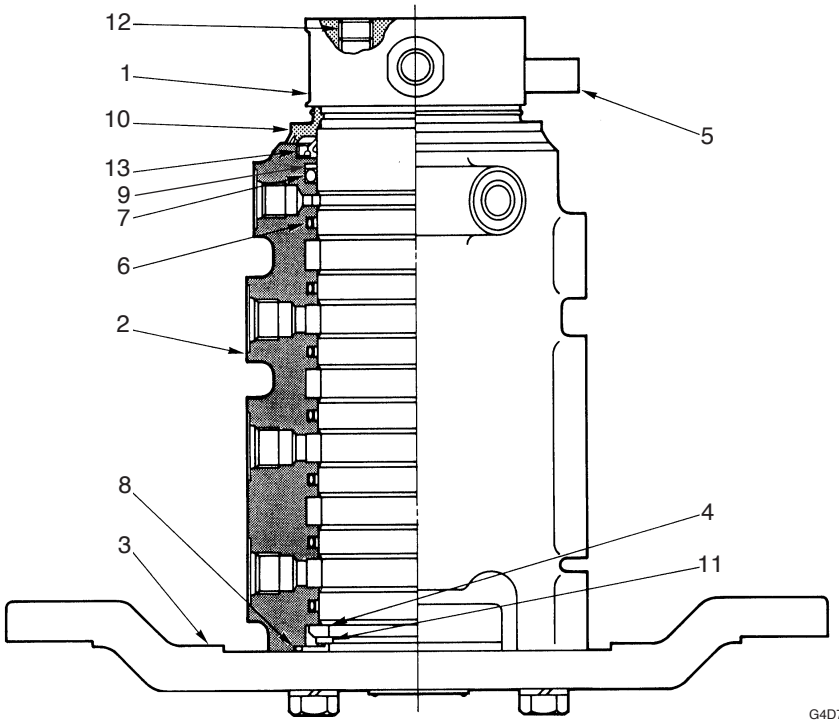
## CONSTRUCTION

■ TB125




1. Shaft
2. Hub
3. Flange
4. Thrust Ring
5. Pin
6. Slipper Seal
7. O-ring
8. O-ring
9. Backup Ring
10. Dust Seal
11. Snap Ring
12. Plug
13. Plug

■ TB135, TB145



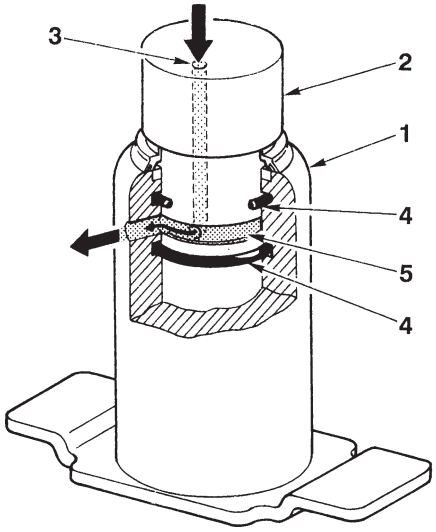

1. Shaft
2. Hub
3. Flange
4. Thrust Ring
5. Pin
6. Slipper Seal
7. O-ring
8. O-ring
9. Backup Ring
10. Dust Seal
11. Snap Ring
12. Dust Seal

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## OPERATION

The swivel joint is mounted in the center of the machine's slew axis. It serves the role of maintaining continuous connections in the hydraulic circuit regardless of the upper frame's slew angle.
Above the hub (1) and shaft (2), which are capable of rotating together, ports (3) are included for oil for the necessary number of circuits only. The inner circumference surface of the hub and the outer circumference surface of the shaft, grooves are cut which serve as passages for hydraulic oil. Seals (4) are placed above and below these circumferential grooves.
Oil flowing in from a port flows constantly through this hydraulic passage (5) between the hub and shaft and the circuits can be connected without a break when the upper frame is slewing.



YI-D701

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## DISASSEMBLY AND ASSEMBLY

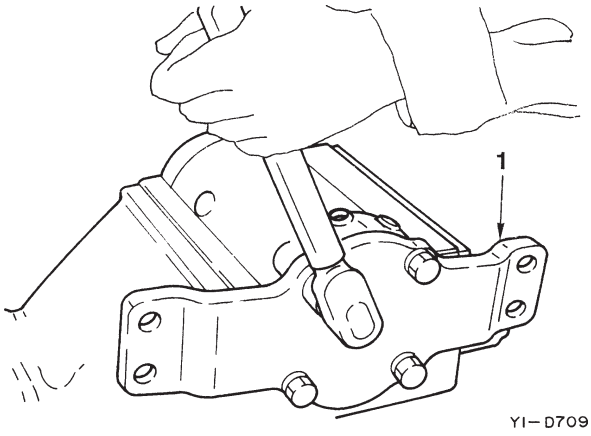
### General Cautions

- Carry out disassembly and assembly in a clean work area and provide clean containers to hold the disassembled parts.
- Clean thoroughly around the ports and remove the paint on the joints of each part with a wire brush.
- Clean the disassembled parts with a cleaning fluid such as diesel fuel.
- Replace the seals with new ones each time the swivel joint is disassembled, applying a thin coating of grease to them.
- Check each part for abnormal wear or seizing. Also remove any burrs or sharp edges, etc. with sandpaper or by a similar method.
- Check for foreign matter or dirt, etc. in the seal grooves.

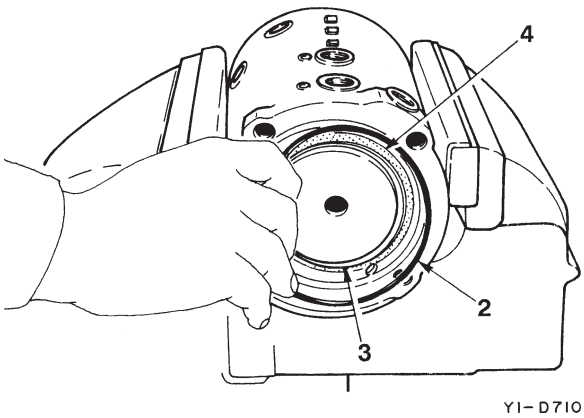
The following describes the disassembly procedure. For assembly, follow the disassembly procedure in the reverse order.

### Disassembly

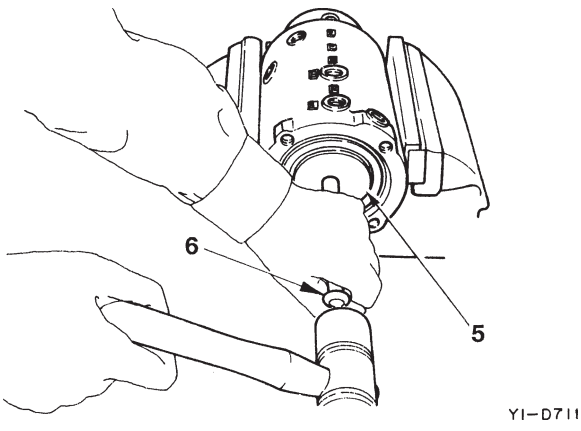
1. Take out the bolts and remove the spring washers, then remove the flange (1) from the hub.
   - Tightening torque:
     27.5 N·m (2.8 kgf·m) ..... TB125
     24.5~39.2 N·m (2.5~4.0 kgf·m) .... TB135,TB145
   - During assembly, place a pipe on the stopper pin of the shaft and check if the shaft rotates.




2. Remove the O-ring (2), snap ring (3) and thrust ring (4).
   - During assembly, make sure the snap ring fist securely in the groove.



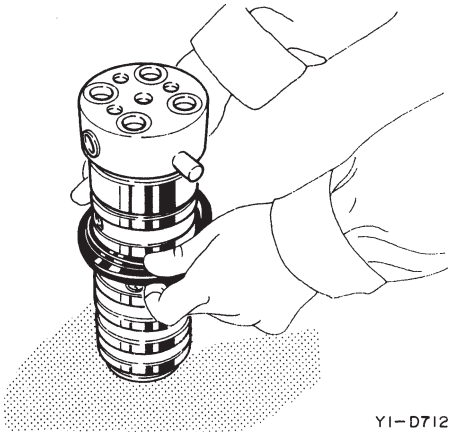

3. Remove the shaft (5) from the hub.
   - Place a knock pin (6) against the shaft end and tap with a hammer. Select a knock pin (6) made of copper or plastic, etc.
   - Apply a thin coating of hydraulic oil or grease to the outer circumference of the shaft.



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4. Remove the dust seal from the shaft.




5. Remove the seals from the inside diameter of the hub.
   - Check the positions of the seals in the structural drawing.
   - Use an O-ring tooth or eyeleteer with a sharp point on the end, etc.
   - Do not deform or bend the slipper seal strongly in any one place.
   - During assembly, O-rings should not be twisted when they are fitted in place.



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## INSPECTION AND ADJUSTMENT

### Inspection Procedure and Treatment

| Inspection Interval | Place Inspected | Inspection Procedure | Treatment |
|---|---|---|---|
| 2,000 hrs. | Seals which prevent external leakage of hydraulic oil | Check if oil is leaking out | Replace the O-rings if there is leakage |
| 4,000 hrs. Disassemble and check whether there is leakage or not | All seal parts | — | Replace all seal parts |
| | All sliding parts | Check for abnormal wear, scratches, corrosion, etc., due to seizing, biting of foreign matter, etc. | Treat in accordance with the use limit |
| When disassembling due to breakdown | All parts | Check for abnormal wear, scratches, corrosion, etc., due to seizing, biting of foreign matter, etc. | Treat in accordance with the use limit. However, replace the seal kit |

### Checking the Parts

Hub, Shaft

| Parts | Judgment Standard | Treatment |
|---|---|---|
| Seal parts and sliding parts | • Parts which wear away due to wearing of surfaces which have undergone ultrasonic tempering, and parts which come off due to seizing, biting in of foreign matter, etc. | Replace with new parts |
| Hub and shaft sliding parts other than seals | • Parts with abnormal wear or with scratches 0.1 mm deep or deeper due to seizing or biting in of foreign matter, etc. | Replace with new parts |
| | • Parts with scratches less than 0.1 mm deep | Repair with an oil stone |
| Portions which slide against the thrust ring | • Parts which are worn 0.5 mm or more, or abnormally worn parts | Replace with new parts |
| | • Parts with less than 0.5 mm of wear | Repair so that it is smooth |
| | • Parts with scratches due to seizing, biting in or foreign matter, etc., which are within the wear limit of 0.5 mm and which can be repaired | Repair so that it is smooth |

Flange

| Parts | Judgment Standard | Treatment |
|---|---|---|
| Portions which slide against the shaft end | • Parts which are worn 0.5 mm or more, or abnormally worn parts | Replace with new parts |
| | • Parts with less than 0.5 mm of wear | Repair so that it is smooth |
| | • Parts with scratches due to seizing, biting in or foreign matter, etc., which are within the wear limit of 0.5 mm and which can be repaired | Repair so that it is smooth |

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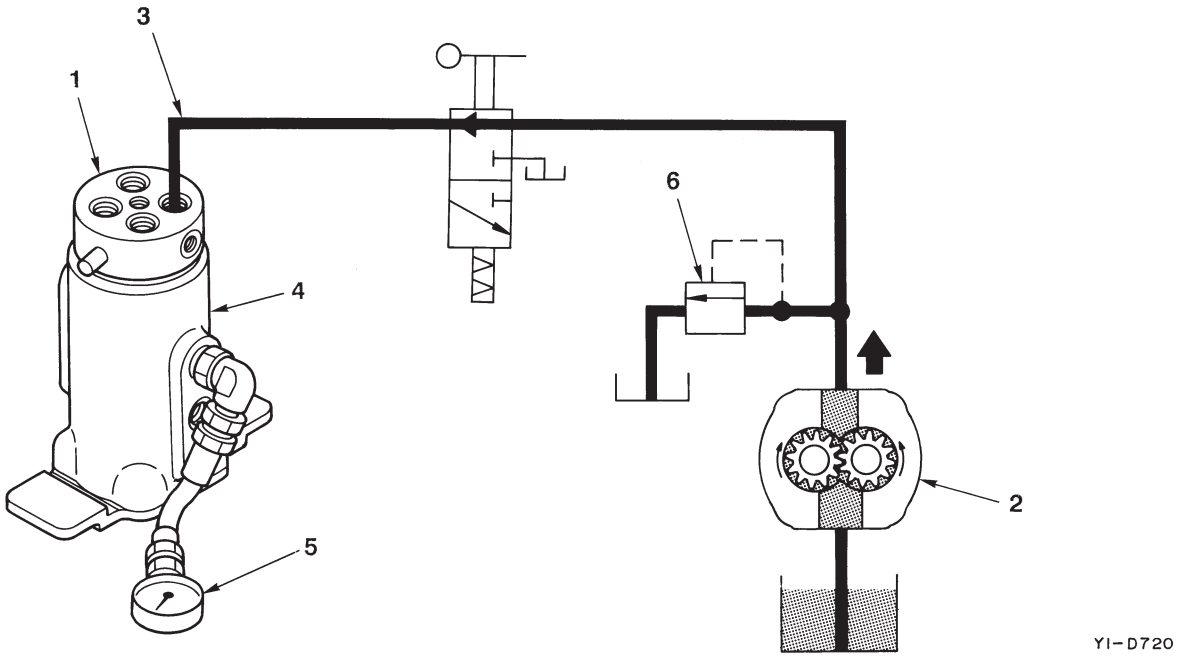


Thrust Ring

| Judgment Standard | Treatment |
|---|---|
| • Parts which are worn 0.5 mm or more, or abnormally worn parts | Replace with new parts |
| • Parts with less than 0.5 mm of wear | Repair so that it is smooth |
| • Parts with scratches due to seizing, biting in or foreign matter, etc., which are within the wear limit of 0.5 mm and which can be repaired | Repair so that it is smooth |

### Inspection after Assembly

After assembly is completed, carry out a leak check of each circuit using the apparatus shown in the figure.




1. Connect a pipe (3) from the hydraulic pump (2) to the shaft (1) side port.
2. Connect a pressure gauge (5) to the hub (4) side.
3. Increase the pressure gradually to 20.6 MPa while adjusting the relief valve (6), then perform a 1 minute leak test.
   - Release the neighboring ports on both sides and check visually for leakage from the ports.
   - Check for external leakage, etc., by a color check.

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**TROUBLESHOOTING**

| Symptom | Probable Causes | Remedy |
|---|---|---|
| External oil leakage | • O-ring is defective | • Replace all the seal parts |
| Internal oil leakage | • Thrust ring is defective<br>• Great wear on sliding surfaces | • Replace all the seal parts<br>• Replace the assembly |
| Shaft sticks | • Shaft and hub are stuck together | • Carry out polishing and honing. If looseness and oil leakage are great, replace the assembly |
| Flange looseness | • Socket bolt tightening is insufficient | • Retighten to the specified torque |

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# V. TROUBLESHOOTING

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## CAUTIONS IN TROUBLESHOOTING AND REPAIRS

(1) Do not begin disassembling the equipment immediately just because it has broken down. Conduct a thorough preliminary check before attempting disassembly.
   a. Ask the user the following questions.
      • What were the conditions when the machine broke down?
      • Did anything abnormal happen before breakdown occurred?
      • Are there any other places which were functioning poorly other than the part that broke down?
      • Are there any parts which have been repaired previous to the breakdown? What were they?
      • Has the same thing happened before?
   b. Run the machine yourself and confirm the breakdown conditions.
      • Judge whether the machine is really broken down or not following the judgment standards.
        The judgment on whether the machine has broken down may differ between individuals.

IMPORTANT: When running the machine, it is possible that moving the machine could make the breakdown worse than it already is, so do not forget to ask the user if there is anything to prevent your operating the machine.

   c. Based on the information that you have gathered from the user and the information obtained from running the machine yourself, judge the cause of the trouble. Also keep in mind that it is difficult to reproduce the conditions of the breakdown again once the machine has been disassembled, and early disassembly may make it impossible to determine the true cause of the trouble. Therefore be sure to find the true cause of the trouble before attempting disassembly.

(2) When it is thought that the trouble has more than one cause, begin investigating from the simplest cause.

(3) Think over why the trouble could have occurred and try to correct the root cause of that problem.

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AUXILIARY HYDRAULICS

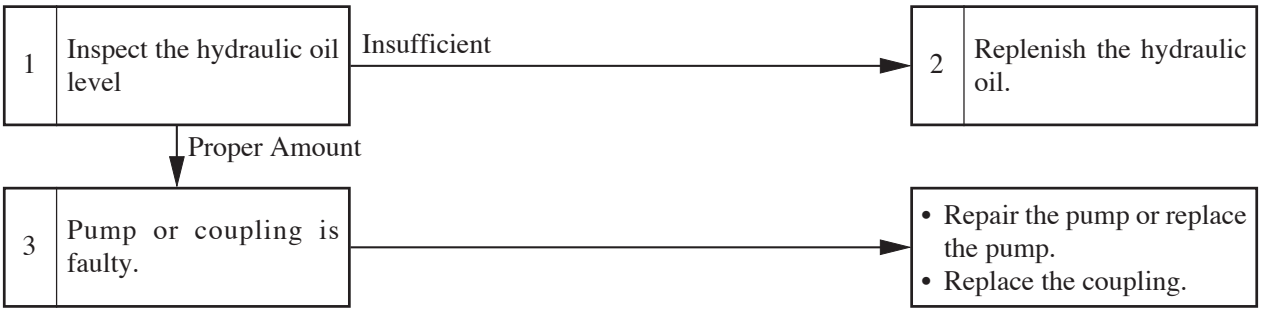
The proportional control is impossible (TB145). ..... 49

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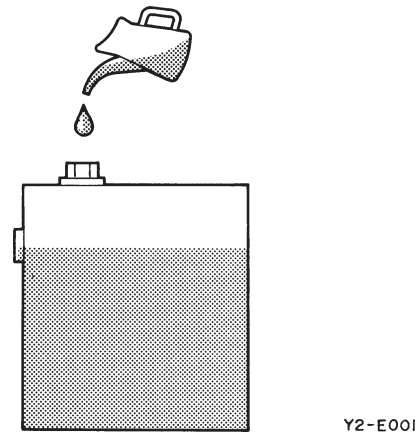


**NO OPERATIONS CAN BE DONE.**



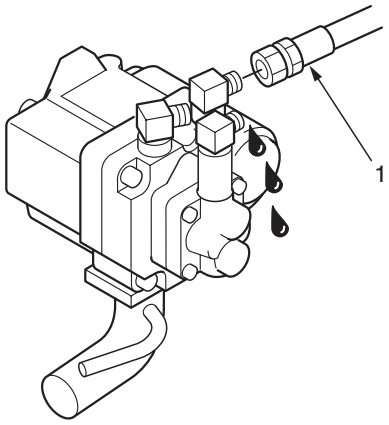

1. Inspect the hydraulic oil level.
   ☞ "III. Machine Configuration, Hydraulic Tank"

2. Replenish the hydraulic oil.
   Take out the plug and replenish the hydraulic oil.
   - The hydraulic oil supplied should be the same brand as the oil currently in the tank.
     "II. Specifications, Fluid Capacities"
   - After replenishing the hydraulic oil, be sure to pressurize the Hydraulic Tank.
     ☞ "I-12"

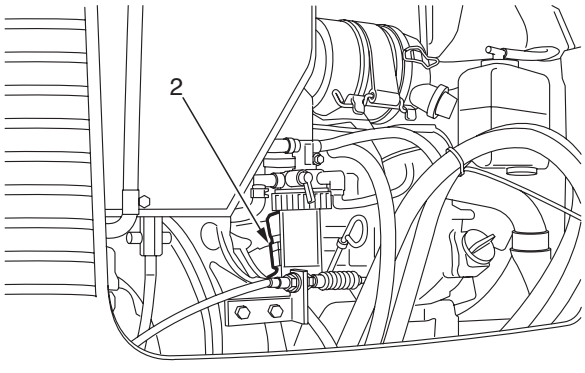

Y2-E001

3. Pump or coupling is faulty.
   a. Disconnect the discharge hose (1) from the pump side.
      Also fit a plug in the disconnected hose to keep the hydraulic oil from pouring out.
   b. Disconnect the electrical wiring (2) to the engine stop solenoid.
   c. Turn the engine over using the starting motor and inspect if hydraulic oil is discharged by the pump.
      - The throttle lever should be in the engine stop position.

   If the pump is normal, hydraulic oil will be discharged from it. If hydraulic oil is not discharged, the pump or the coupling is faulty.



C4E001

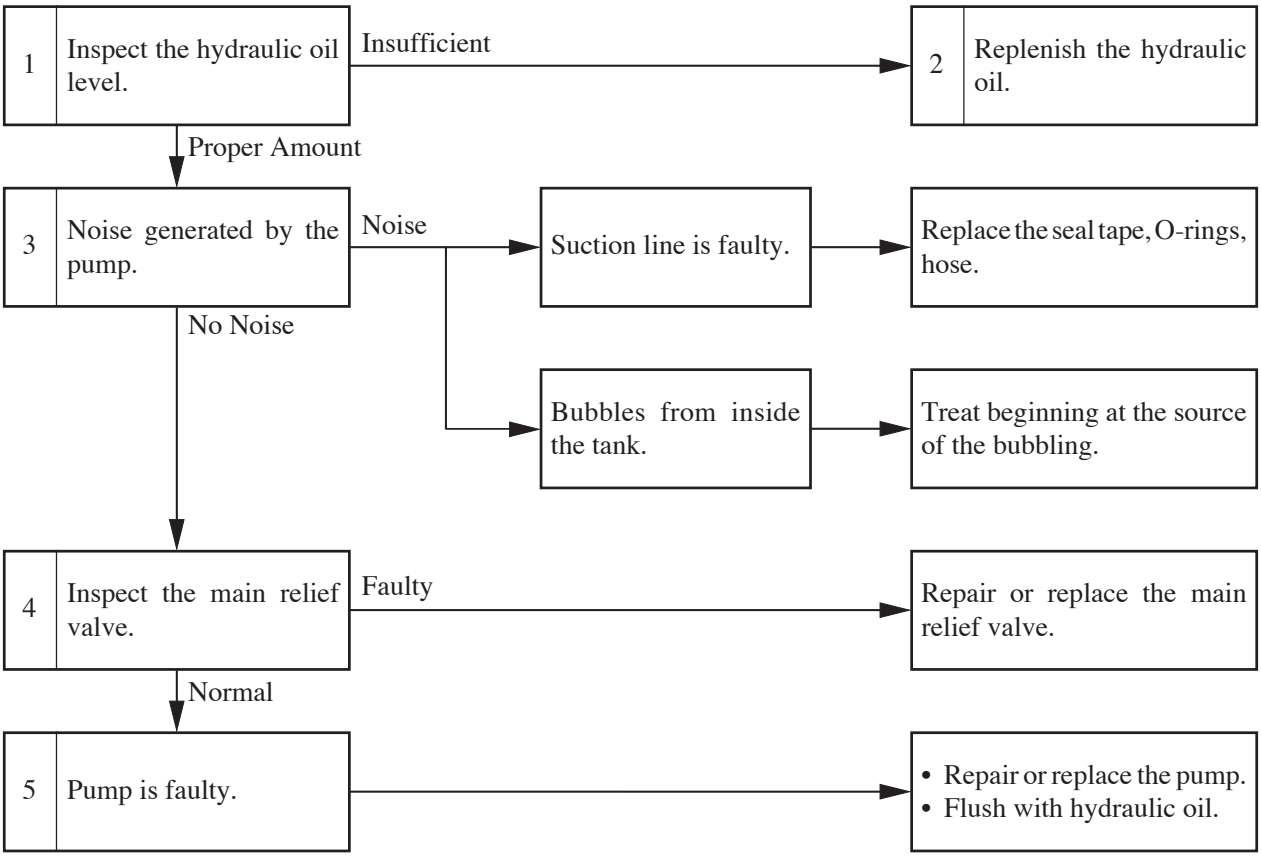


C4E002

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**ALL OPERATIONS CAN BE DONE, BUT THERE IS NO POWER.**




1. Inspect the hydraulic oil level.
   ☞ "III. Machine Configuration, Hydraulic Tank"

2. Replenish the hydraulic oil.
   ☞ "V-4"

3. Noise generated by the pump.
   A faulty suction line can make it easy for cavitation to occur in the pump and for noise to be generated. Carry out the following inspect.
   a. Inspect the piping used for suction of hydraulic oil.
      • Apply grease or oil to the part which appears to be making the noise and inspect if there is any change. (Inspect if it is sucking in air or not.)
   b. Inspect for clogging of the suction filter.
   c. Pressurize the Hydraulic Tank.
      ☞ "I-12"

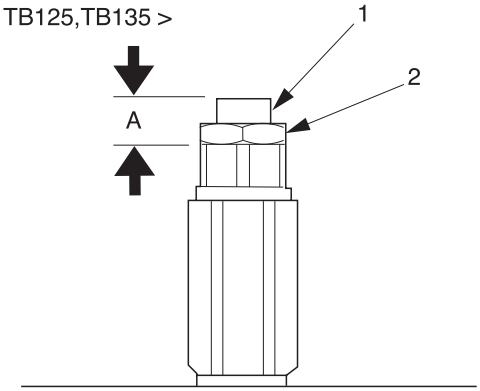
https://truckmanualshub.com/



4. Inspect the main relief valve.
   Measure the relief pressure of the main relief valve.
   - The valve is normal if the pressure gauge reading is the standard value.
     ☞ "II. Specifications, Standards for Judging Performance"

   If the main relief valve's set pressure is too low, adjust it by tightening the valve set screw gradually.
   - If the pressure doesn't rise after 1/4 turn of the screw, the main relief valve is faulty.

< TB125,TB135 >

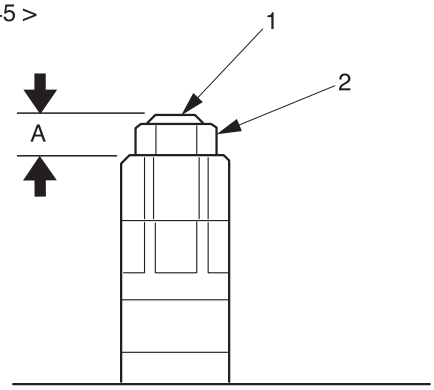



E5E001

Cautions During Disassembly and Assembly

- The dimension A of the set screw (1) should be measured and recorded when the cap nut (2) is removed.
- Inspect for biting of foreign matter and for scratches in the poppet seat surface.
- During assembly, the set screw should be set so that dimension A, measured before disassembly, is a little longer than previously. Then the screw should be tightened gradually to adjust the pressure.

< TB145 >




K3E001

5. Pump is faulty.
   If the pump is abnormally worn internally, or if it is damaged, it is possible that pieces of metal are mixed into the hydraulic oil. Therefore, carry out the following treatment.
   - Replace the spin filter cartridge.
   - Replace the hydraulic oil or flush out the hydraulic circuit.
     (Up to NAS Class 9)

   Caution : When replacing the hydraulic oil, be sure to clean the inside of the Hydraulic Tank and the suction strainer.
   ☞ "III. Machine Configuration, Hydraulic Tank"

   If the pump seal is damaged, replace the seal.
   ☞ "IV. Hydraulic Units, Hydraulic Pump"

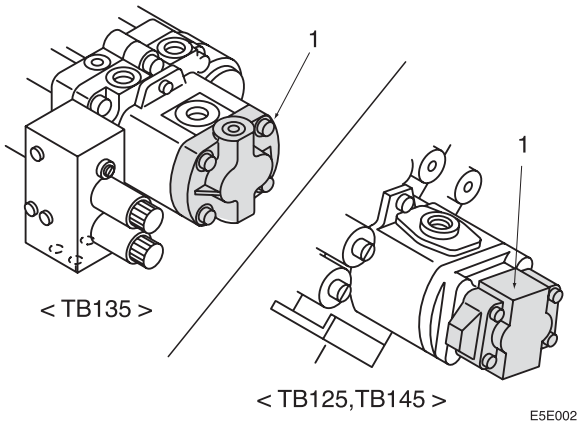
https://truckmanualshub.com/



**THE BOOM, BUCKET, SLEW AND ARM DO NOT MOVE AT ALL, OR THE SPEED IS LOW.**

| | | | |
|---|---|---|---|
| 1 | Inspect the hydraulic pump P4. | Faulty | Repair or replace the hydraulic pump P4. |
| | Normal | | |
| 2 | Inspect the fuse. | Faulty | Replace the fuse. |
| | Normal | | |
| 3 | Inspect the limit switch. | Faulty | Adjust or replace the limit switch. |
| | Normal | | |
| 4 | Inspect the lever lock solenoid valve. | Faulty | Repair or replace the lever lock solenoid valve. |
| | Normal | | |
| 5 | Inspect the pilot relief valve. | Faulty | Adjust, repair or replace the pilot relief valve. |
| | Normal | | |
| 6 | Inspect the pilot valve. | Faulty | Repair or replace the pilot valve. |

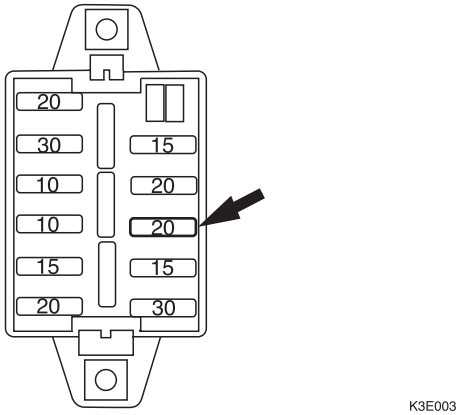
1. Inspect the hydraulic pump P4.
   Inspect the hydraulic pump P4 (1) which is the source of the hydraulic pressure for the pilot valve.
   ☞ "V-4"
   Since clogging of the line filter can also be considered, inspect and clean the filter.



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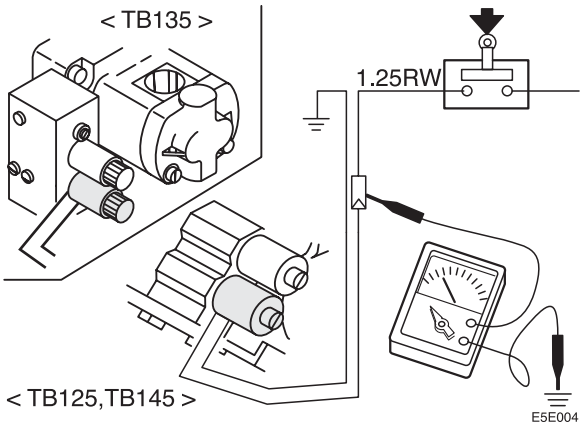
2. Inspect the fuse.
   Inspect the fuse for the electric power circuit that operates the pilot solenoid valve.



K3E003

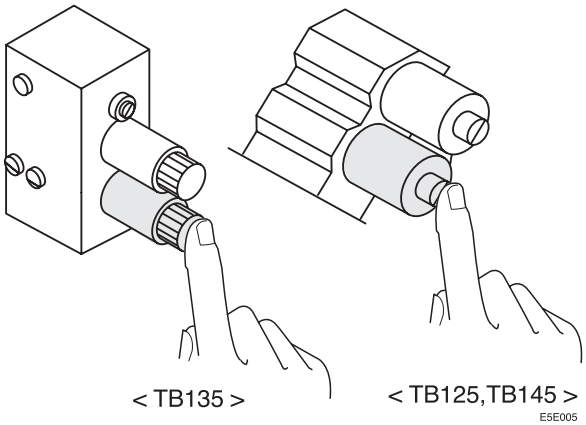
3. Inspect the limit switch.
   Set the lever stand to the operation position to turn on the limit switch. Check the voltage at the lever lock solenoid valve by using a tester.
   - The limit switch is normal if the voltage is being applied.

   Reference: If the limit switch is found to be faulty and the attachment must be moved, connect the lever lock release connectors A and B for emergency use. These connectors are taped on the main harness under the engine muffler.
   ☞ "III-113"



E5E004

4. Inspect the lever lock solenoid valve.
   Inspect by the following procedure.
   a. Turn the starter switch to the "ON" position.
   b. Push lightly on the projection on the front end of the solenoid valve.
   c. Move the lever stand and change the limit switch from "OFF" to "ON".
   d. If the spool moves and vibration can be felt with the fingertip when the circuit changes, then it is normal.



E5E005

5. Inspect the pilot relief valve.
   Measure the relief pressure of the pilot relief valve.
   - If the pressure is the standard value, the valve is normal.
     ☞ "II. Specifications, Standards for Judging Performance"

6. Inspect the pilot valve.
   ☞ "IV. Hydraulic Units, Pilot Valve"

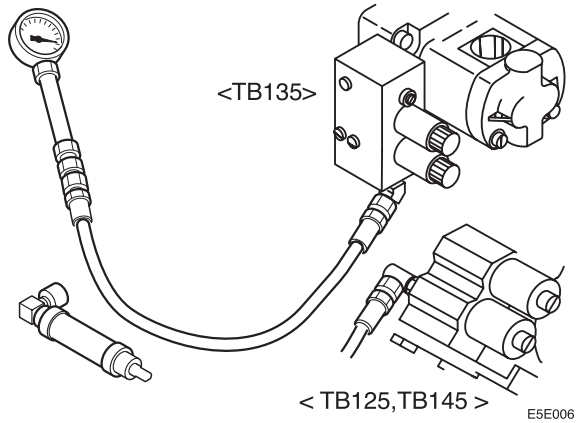
https://truckmanualshub.com/



**THE MACHINE WILL NOT TRAVEL AT ALL.**

| | | | |
|---|---|---|---|
| 1 | Inspect the pressure supplied to the travel lever lock cylinder. | | |
| | Normal | | |
| 2 | Inspect the linkage. | Faulty | Adjust, repair or replace the linkage. |
| | Normal | | |
| 3 | Inspect the travel lever lock cylinder. | Faulty | Replace the travel lever lock cylinder. |

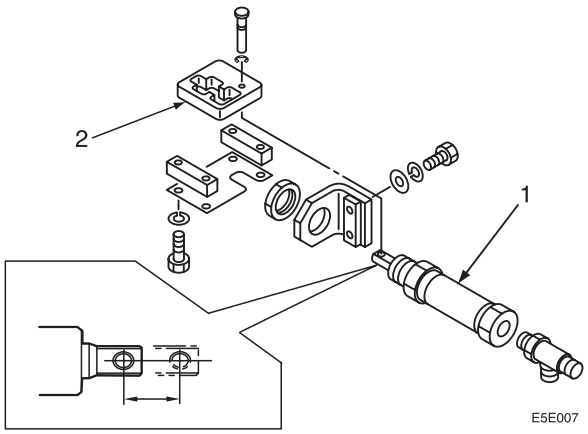
1. Inspect the pressure supplied to the travel lever lock cylinder.
   Disconnect the hose between the solenoid valve and the travel lever lock cylinder on the cylinder side. Connect a pressure gauge to the disconnected hose and measure the pilot pressure.
   - Keep the plug assembled on the port of the disconnected cylinder.
   - Standard value: Approx. 3.4 MPa (35 kgf/cm$^2$)



E5E006

2. Inspect the linkage.
   Inspect the operating status of the travel lever lock cylinder (1) and slide plate (2).
   - The cylinder stroke should be 10 mm.
   - Inspect the operating status of the lever lock cylinder and slide plate. Also, check whether the fixing bolt or nut is loose.

3. Inspect the travel lever lock cylinder.
   The travel lever lock cylinder cannot be disassembled. If it is faulty, replace it.

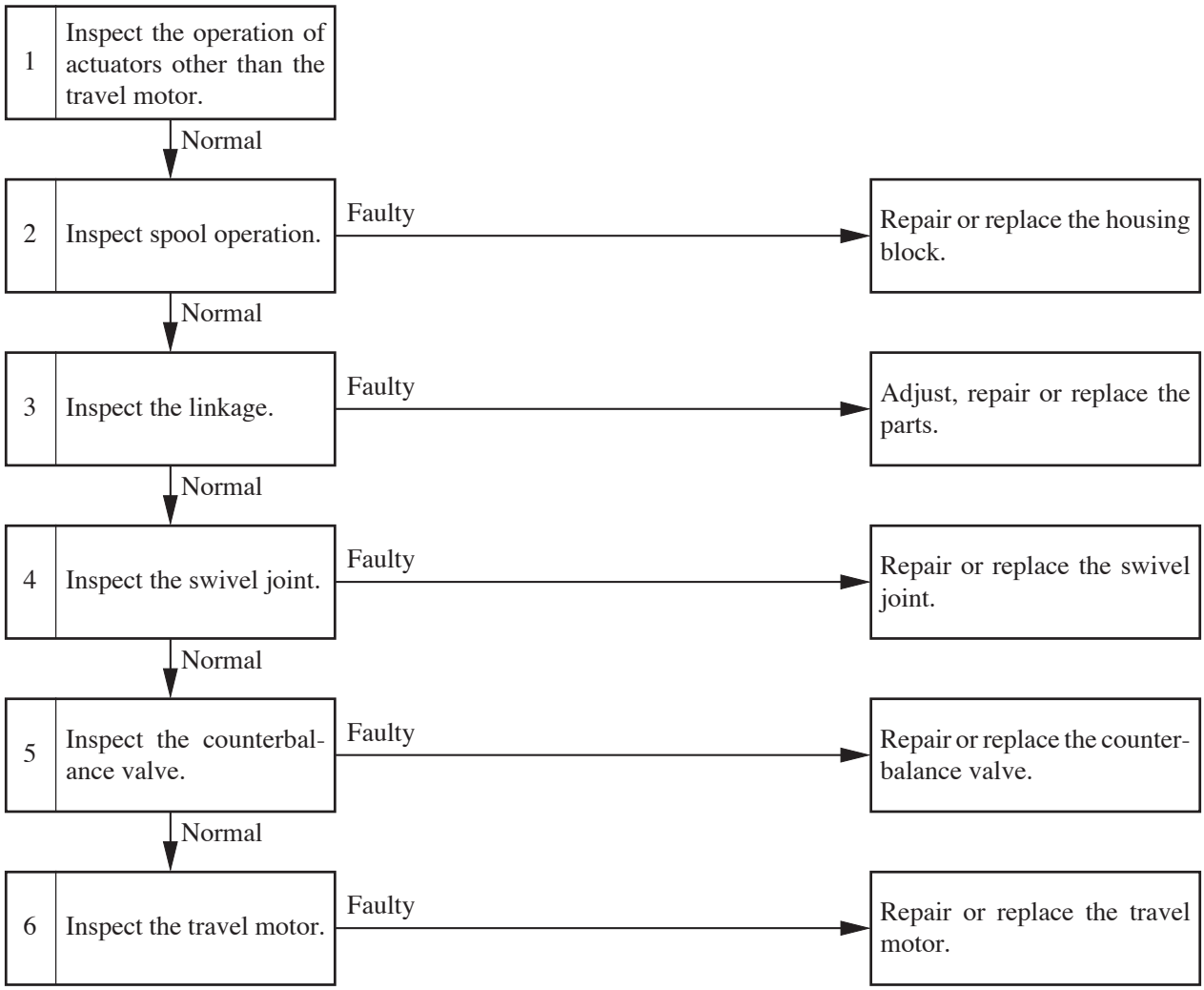


E5E007

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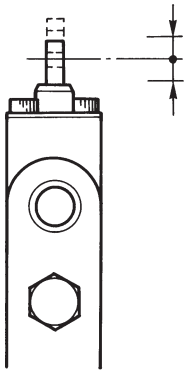
**RIGHT OR LEFT TRAVEL IS IMPOSSIBLE.**




1. Inspect the operation of actuators other than the travel motor.
   If operation of the right or left travel motor is impossible, operate each respective actuator in accordance with the table at right. If operation is faulty, inspect the main relief valve and pump.

| | Lever Operated | Place Inspected | |
|---|---|---|---|
| If right travel is impossible | Boom | Main Relief valve R1 | Pump P1 |
| If left travel is impossible | Arm | Main Relief valve R2 | Pump P2 |

2. Inspect spool operation.
   - Spool Stroke : 6.0 mm
   - If the spool is sticking, take it out and inspect it. If it can't be taken out, or if it is scratched, replace the housing block.
     Another cause of the spool not operating properly could be that the return spring installation bolt is loose.

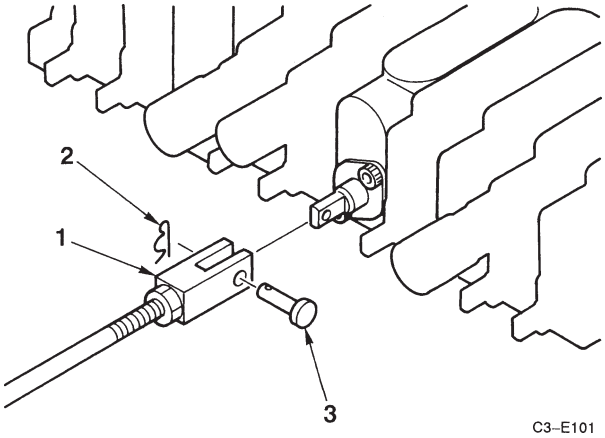


Y3-E101

https://truckmanualshub.com/

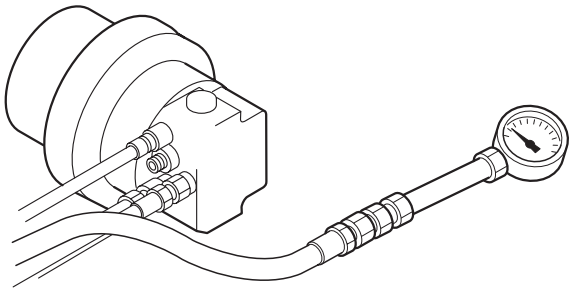


3. Inspect the linkage.
   The inspection of the linkage is done by inspecting the movement of the yoke (1) without the R pin (2) and the pin (3) which connect the yoke (1) and the spool.

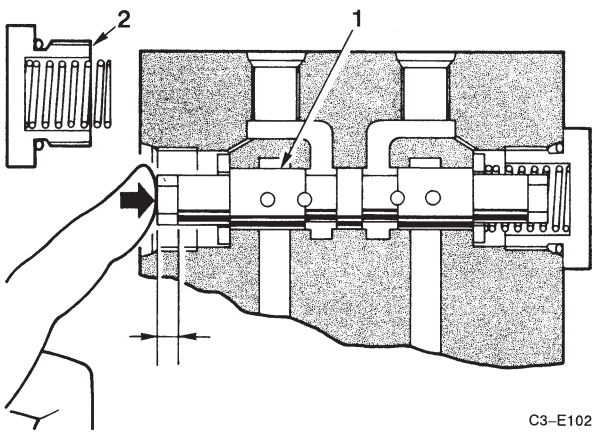


C3–E101

4. Inspect the swivel joint.
   - Disconnect the hose between the swivel joint and the counterbalance valve from the counterbalance valve side and set a pressure gauge in the hose.
   - Operate the travel lever and measure the pressure.
   - The swivel joint is normal if the pressure gauge reading indicates the standard value.
     Standard value:
     Approx. 20.6 MPa (210 kgf/cm$^2$)


E5E008

5. Inspect the counterbalance valve.
   - If neither forward nor reverse travel is possible, the spool (1) of the counterbalance valve could be sticking in the neutral position.
   - If either forward or reverse travel is possible, the spool (1) of the counterbalance valve could be sticking in a position other than the neutral position.
   - Disconnect the counterbalance valve plug (2) and try pushing the spool (1) with a finger. It is normal if it moves smoothly about 6 mm.



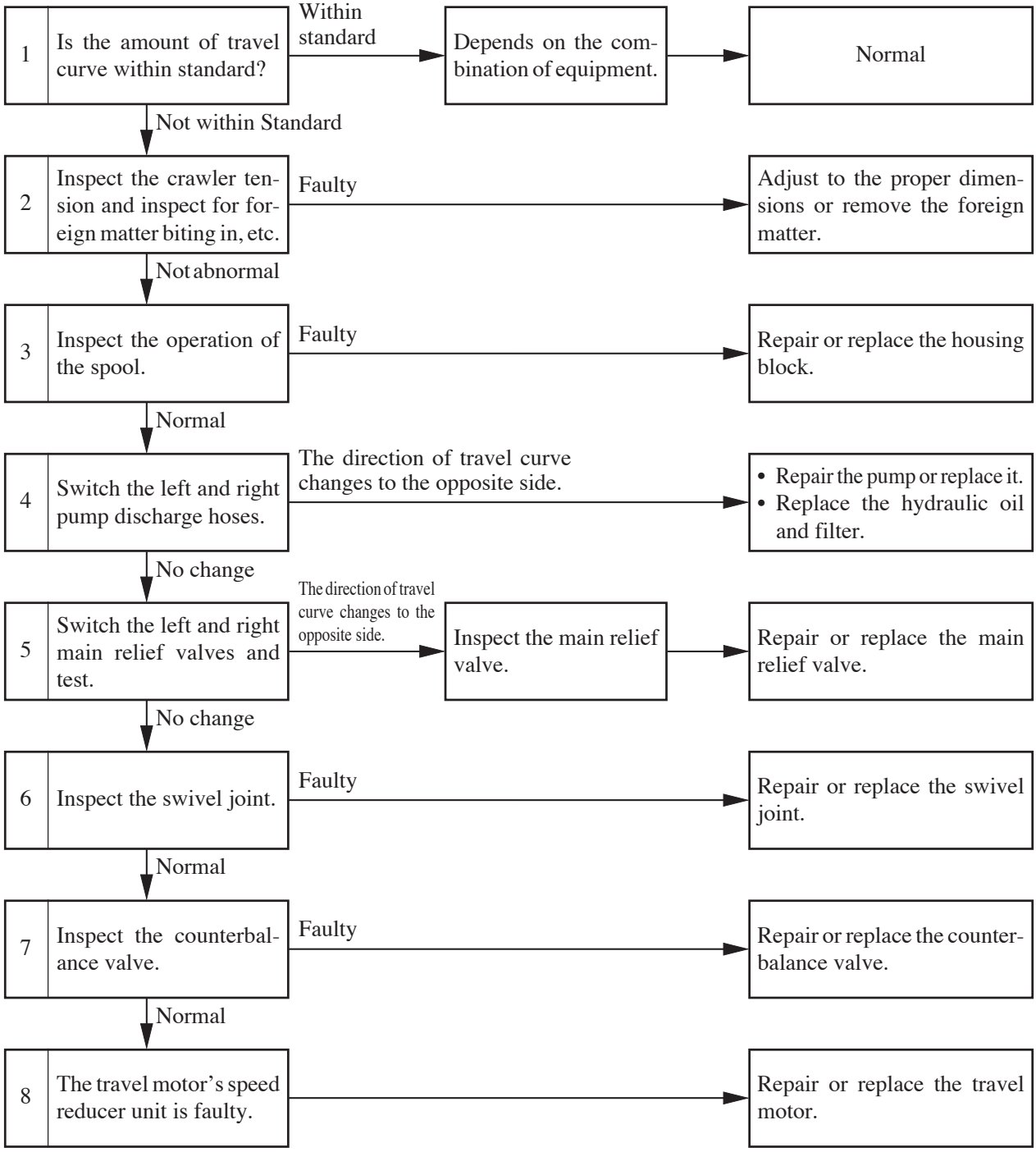
C3–E102

6. Inspect the travel motor.
   ☞ “IV. Hydraulic Units, Travel Motor”

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**SPEED DROPS IN THE LEFT OR RIGHT TRAVEL, CAUSING THE MACHINE TO TRAVEL IN A CURVE.**



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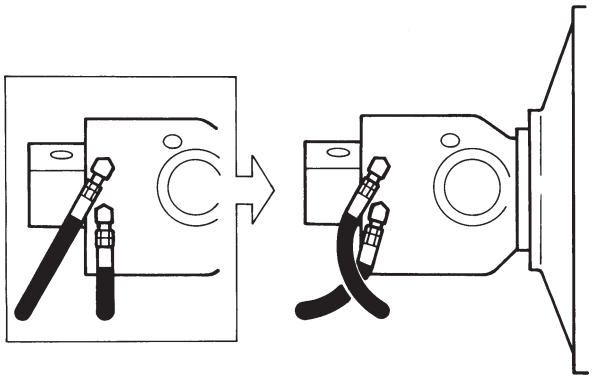


1. Is the amount of travel curve within standard?
   If the amount of travel curve is within standards, then operation is normal and the variation depends on the combination of equipment.
   ☞ "II. Specifications, Standards for Judging Performance"

2. Adjust the tension of the crawler belt.
   ☞ "II. Specifications, Standards for Judging Performance"

3. Inspect the operation of the spool.
   ☞ "V-10"

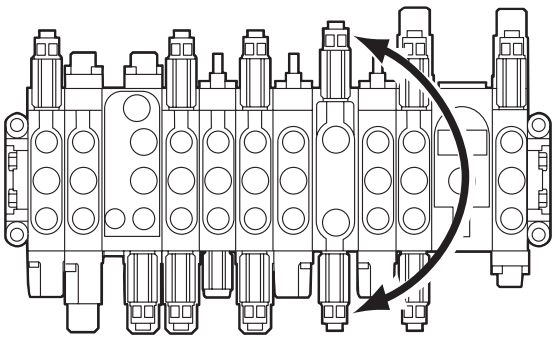
4. Switch the left and right pump discharge hoses.
   Switch the discharge hoses for Pump P1 and Pump P2. The pump is faulty if the direction in which the machine curves during travel is in the opposite direction.
   • Disassemble and inspect the pump.
     ☞ "IV. Hydraulic Units, Hydraulic Pump"



Y3-E104

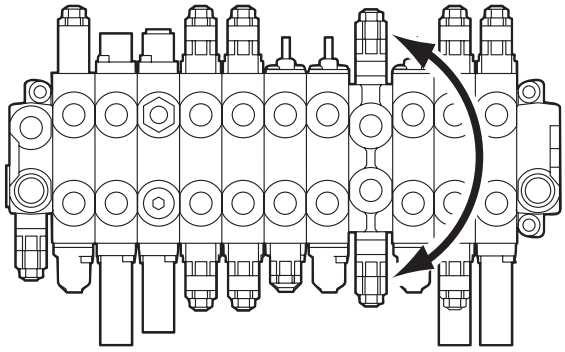
5. Switch the left and right main relief valves and test.
   Switch the left and right main relief valves and test. If the direction in which the machine curves during travel changes to the opposite direction, the main relief valve is faulty.
   • Inspect the main relief valve
     ☞ "V-6"

< TB125,TB135 >



E5E009

< TB145 >



E5E010

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6. Inspect the swivel joint.
   ☞ "V-11"

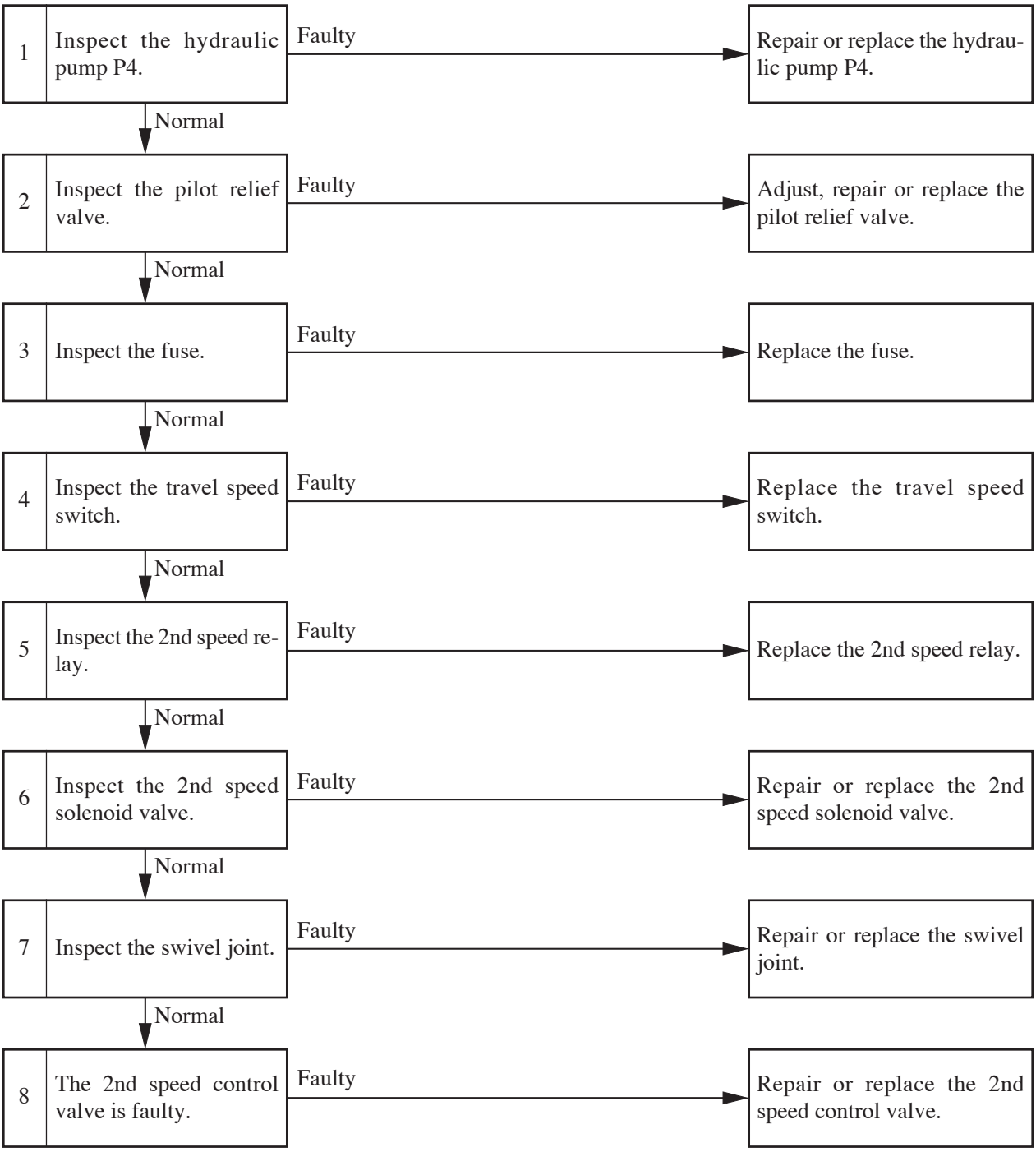
7. Inspect the counterbalance valve.
   Inspect if the counterbalance valve's plunger moves smoothly.
   ☞ "V-11"

8. The travel motor's speed reducer unit is faulty.
   ☞ "IV. Hydraulic Units, Hydraulic Pump"

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**MACHINE WON'T ACCELERATE DURING TRAVEL.**



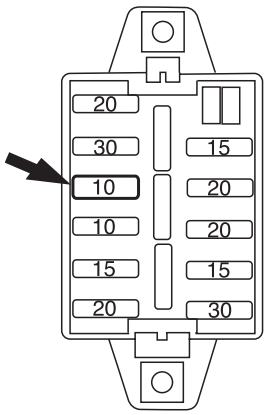

1. Inspect the hydraulic pump P4.
   Inspect the hydraulic pump P4 which is the source of the hydraulic pressure for switching to second gear.
   ☞ "V-6"
   Since clogging of the line filter can also be considered, inspect and clean the filter.

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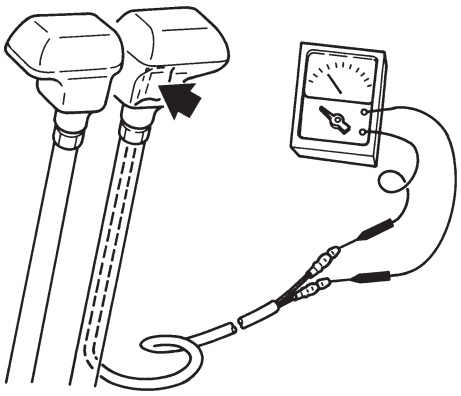
2. Inspect the pilot relief valve.
   Measure the relief pressure of the pilot relief valve.
   - If the pressure is the standard value, the valve is normal.
     ☞ "II. Specifications, Standards for Judging Performance"

3. Inspect the fuse.
   Operate the 2nd speed solenoid valve and check the fuse for the power supply circuit.

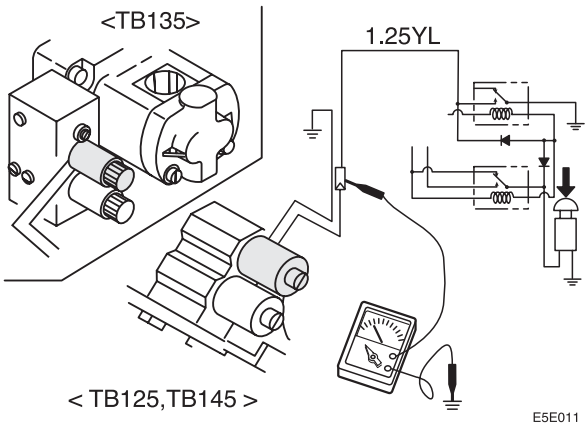


K3E004

4. Inspect the travel speed switch.
   Press the switch to turn it "ON". While it is in this condition, check if there is continuity with a tester.


Y2-E111

5. Inspect the 2nd speed relay.
   Press the travel speed switch to turn the second speed relay to "ON." Check whether the voltage is applied to the second speed solenoid valve by using a tester. Be sure to stop the engine before starting the inspection.

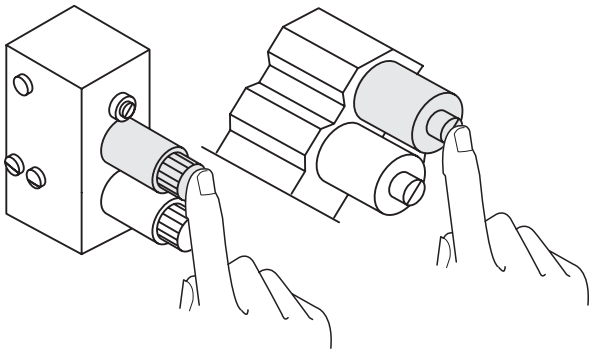


E5E011

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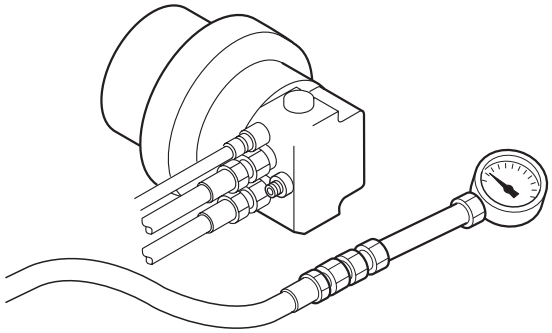


6. Inspect the 2nd speed solenoid valve.
   a. Turn the start switch “ON”.
   b. Press the protruding portion of the solenoid valve lightly.
   c. Turn the travel speed switch “ON”.
   d. If the spool moves and vibration can be felt with the fingertip when the circuit changes, then it is normal.




E5E012

7. Inspect the swivel joint.
   Disconnect the hose between the swivel joint and the 2nd speed control valve at the 2nd speed control valve side. Set a pressure gauge in the disconnected end of the hose and turn on the 2nd speed switch.
   • A pressure of 3.4 MPa (35 kgf/cm$^2$) is normal.



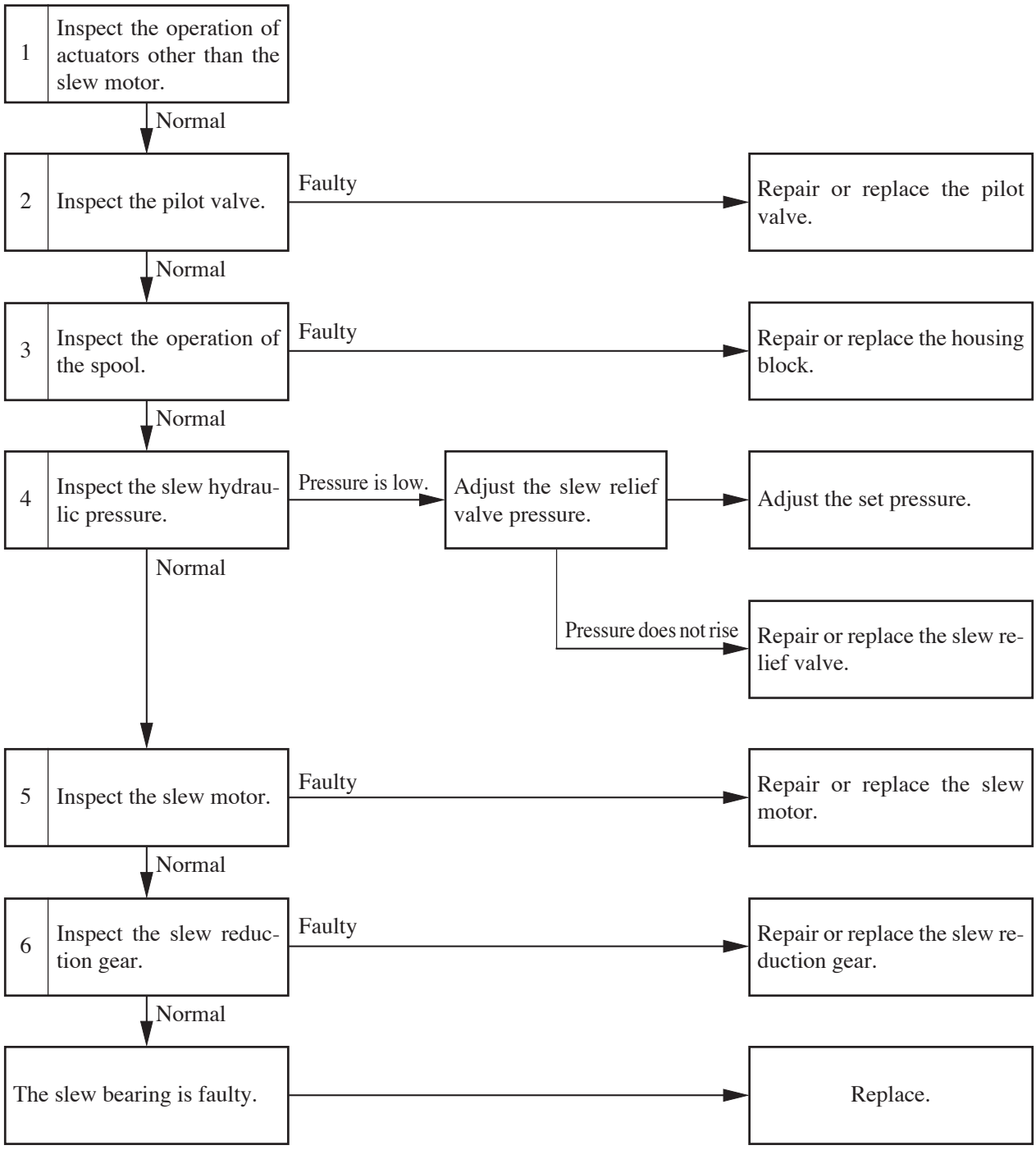
C4E013

8. The 2nd speed control valve is faulty.
   Check if the plunger of the 2nd speed control valve is sticking or if foreign matter is caught in it.
   ☞ “IV. Hydraulic Units, Travel Motor”

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**NO SLEWING CAN BE DONE.**



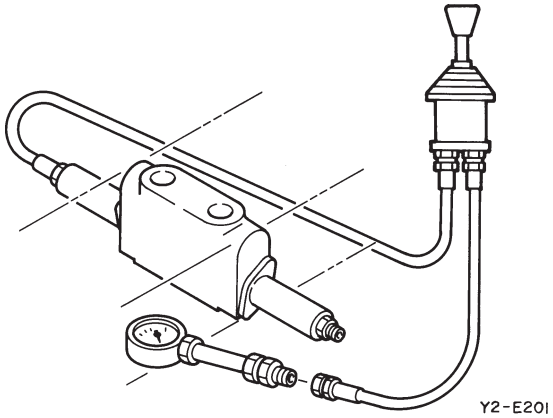

1. Inspect the operation of actuators other than the slew motor.
   Inspect if the operation of the slew motor only is faulty by the table at right. If its operation is faulty, inspect the main relief valve and the hydraulic pump.
   ☞ "V-6"

| Lever Operated | Places inspected | |
|---|---|---|
| Dozer Blade | Relief Valve R3 | Pump P3 |

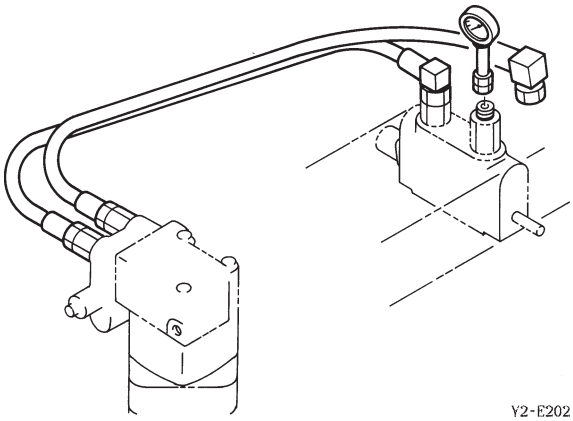
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2. Inspect the pilot valve.
Disconnect the hose between the pilot valve and control valve (slew section) at the control valve side, then set a pressure gauge in the disconnected hose.
- A plug should be inserted in the control valve port.
- Operate the lever (slew) and measure the pressure.
- Depending on the operating angle, a pressure in the 0~3.4 MPa (0~35 kgf/cm$^2$) range is normal.



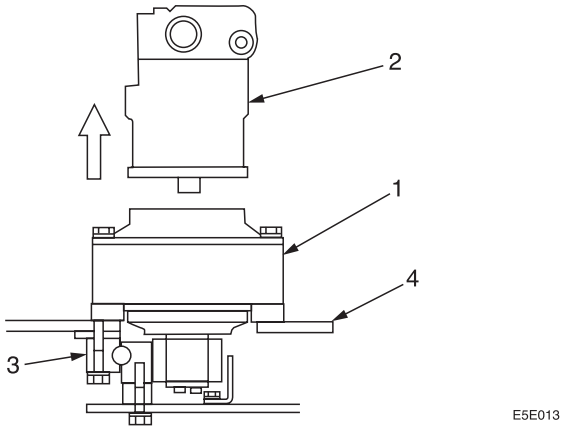

3. Inspect the operation of the spool.
Disconnect the hose that goes between the control valve (slew section) and the slew motor at the valve side and set a pressure gauge to the discharge port of the valve.
- Operate the lever (slew) and measure the pressure.
- The operation of the spool is normal if it agrees with the following value of supply pressure:
19.6 MPa (200 kgf/cm$^2$)




4. Inspect the slew hydraulic pressure.
Measure the pressure at the left and right slew relief valves.
- The pressure is normal if it is the standard value.
☞ "II. Specifications, Standards for Judging Performance"

If adjustment of the pressure is possible, the slew relief valve's adjustment is faulty. Also, if the pressure adjustment is impossible, the slew relief valve is faulty.

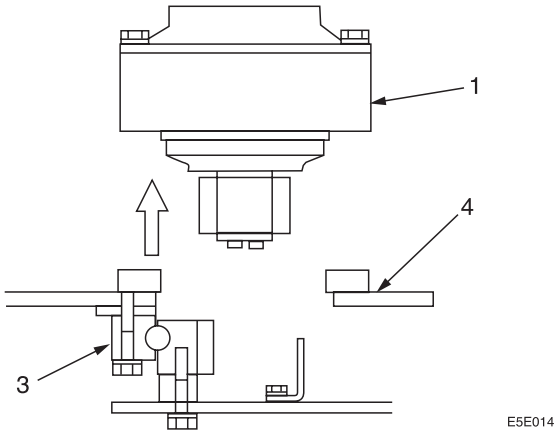
5. Inspect the slew motor.
Separate the slew motor and reduction gear (1) and turn the motor (2) only.
- If it turns, the reduction gear or the slew bearing (3) is faulty.
- If it doesn't turn, the slew motor is faulty.



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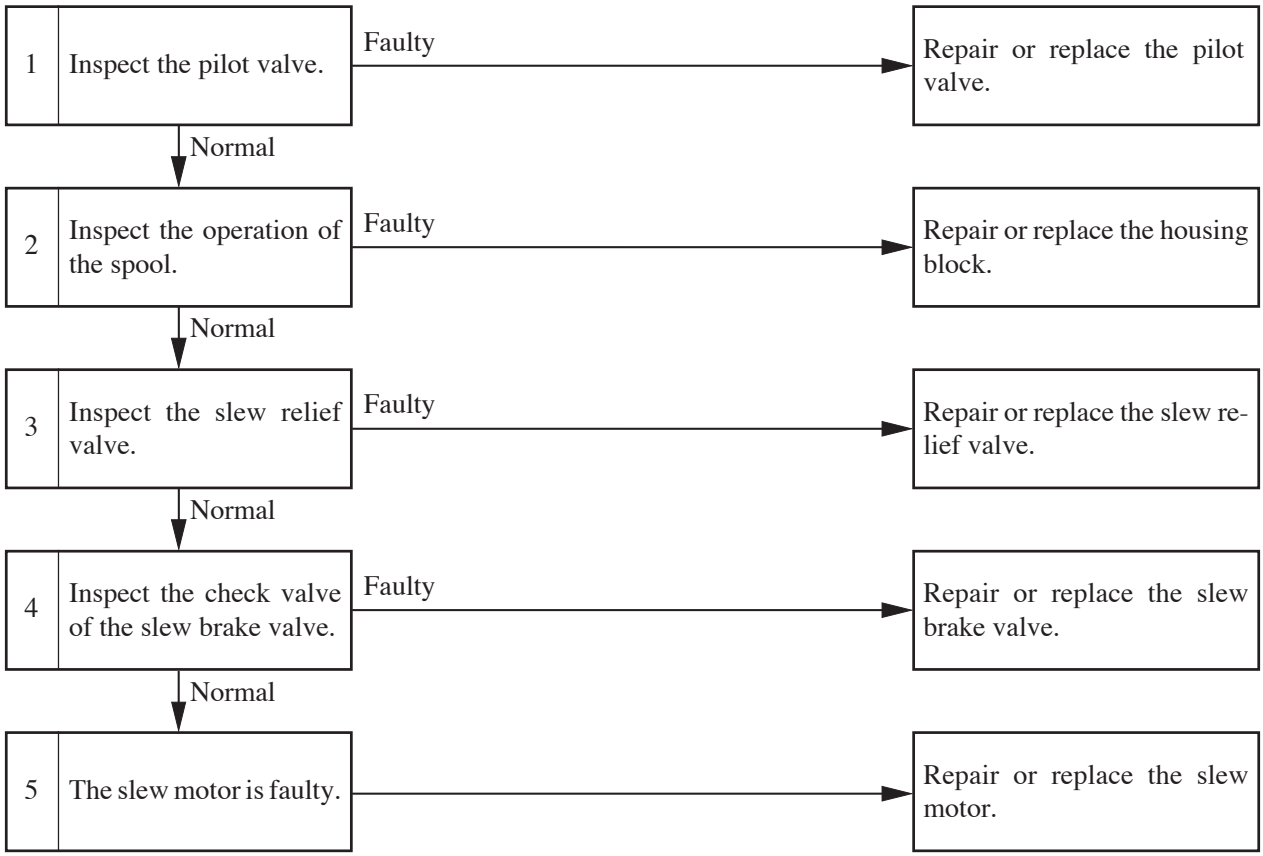
6. Inspect the slew reduction gear.
   Separate the reduction gear from the turntable (4) and turn the pinion manually.
   - If it turns, the slew bearing is faulty.
   - If it doesn't turn, the reduction gear is faulty.



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**RIGHT OR LEFT SLEWING CANNOT BE DONE.**



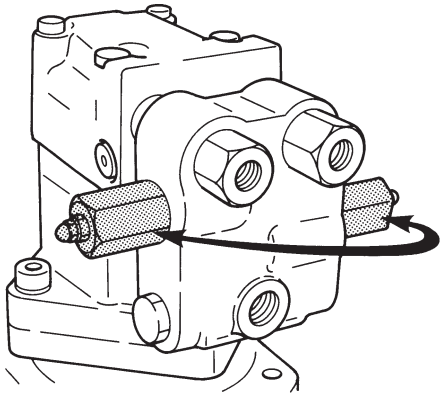

1. Inspect the pilot valve.
   It could be that the spool for only the side of the pilot valve for which slewing is impossible will not operate.
   ☞ "V-19"

2. Inspect the operation of the spool.
   It could be that the spool will not move only in the direction in which slewing is impossible.
   ☞ "V-19"

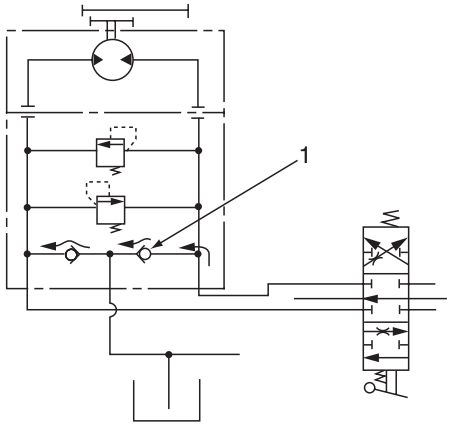
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3. Inspect the slew relief valve.
   Try switching the left and right slew relief valves. If slewing becomes possible, the relief valve is faulty.




4. Inspect the check valve of the slew brake valve.
   If foreign matter is caught in one end of the check valve (1), or if the valve is sticking, right or left slewing will be impossible.
   - If foreign matter is caught in one of the check valves, the hydraulic oil returns to the tank from the check valve.

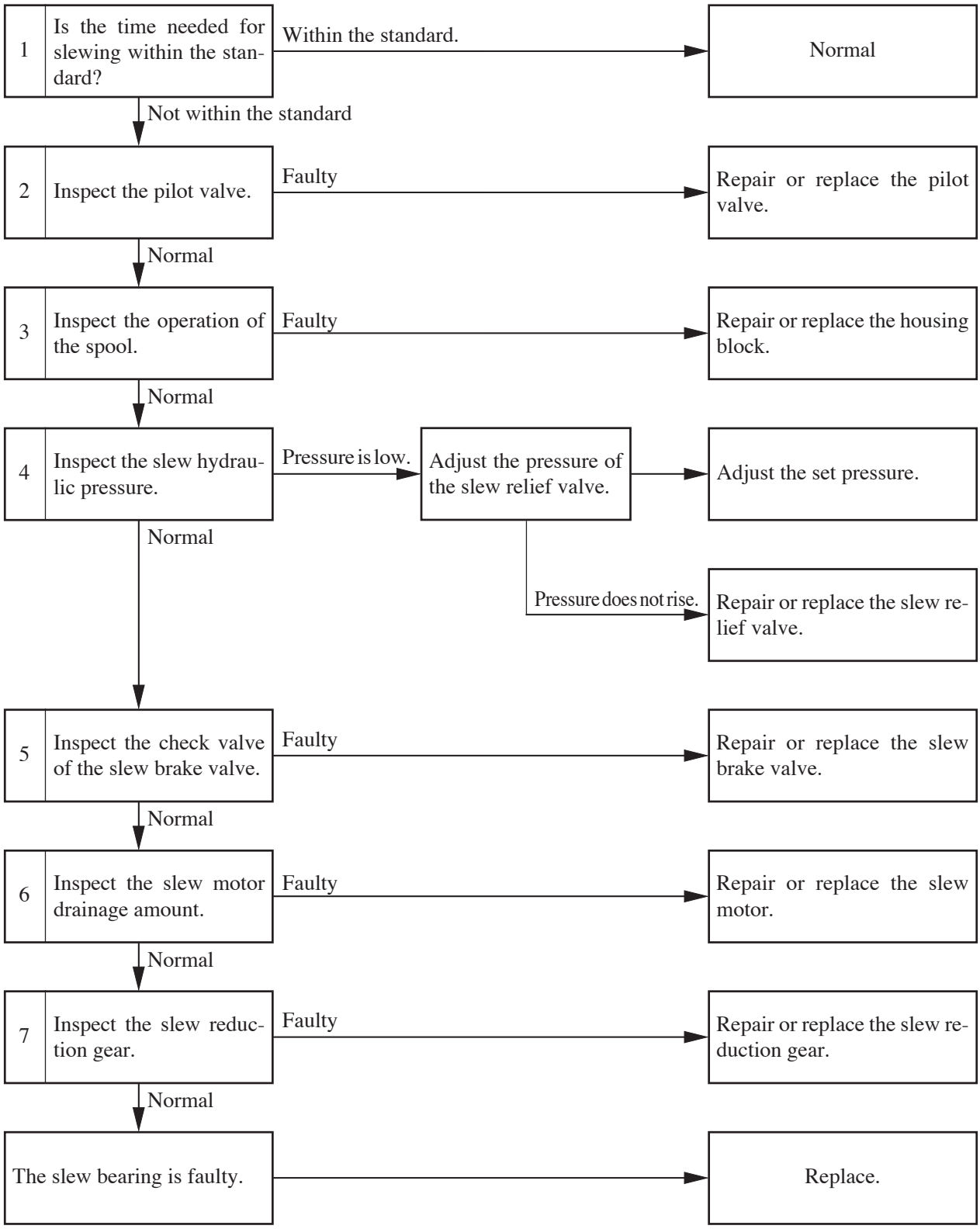



5. The slew motor is faulty.
   ☞ “IV. Hydraulic Units, Sew Motor”

https://truckmanualshub.com/



**SLEWING SPEED IS LOW, OR THERE IS NO POWER.**



https://truckmanualshub.com/



1. Is the time needed for slewing within the standard?
   ☞ "II. Specifications, Standards for Judging Performance"

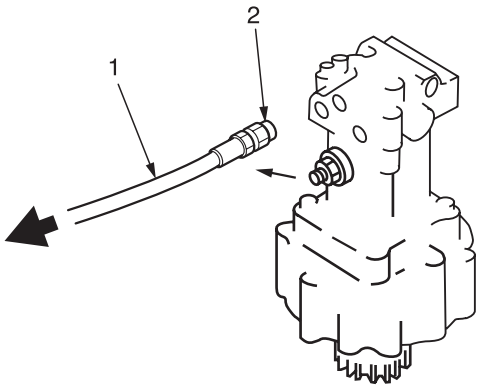
2. Inspect the pilot valve.
   ☞ "V-19"

3. Inspect the operation of the spool.
   ☞ "V-19"

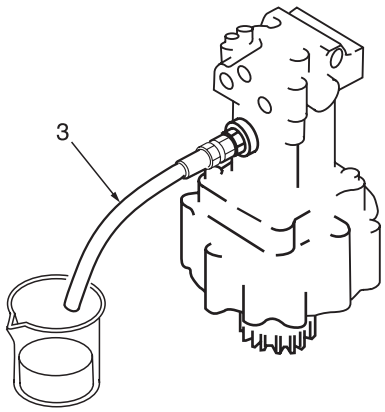
4. Inspect the slew hydraulic pressure.
   ☞ "V-19"

5. Inspect the check valve of the slew brake valve.
   ☞ "IV. Hydraulic Units, Slew Motor"

6. Inspect the slew motor drainage amount.
   Operate the slew motor under the following conditions and measure the amount of oil which drains out in 1 minute.
   a. Disconnect the drain hose (1) connected to the motor and insert a plug (2) in the end of the disconnected hose.
   b. Install a hose (3) for measuring the drainage amount in the motor's drain port.
   c. Operate the motor for 1 minute and measure the drainage amount. If it is as follows, the drainage amount is normal.
      Hydraulic Oil Temp.: 50~60°C
      Engine Speed: Rated Speed
      Drainage Amount: 0.5 L/min or less



E5E016



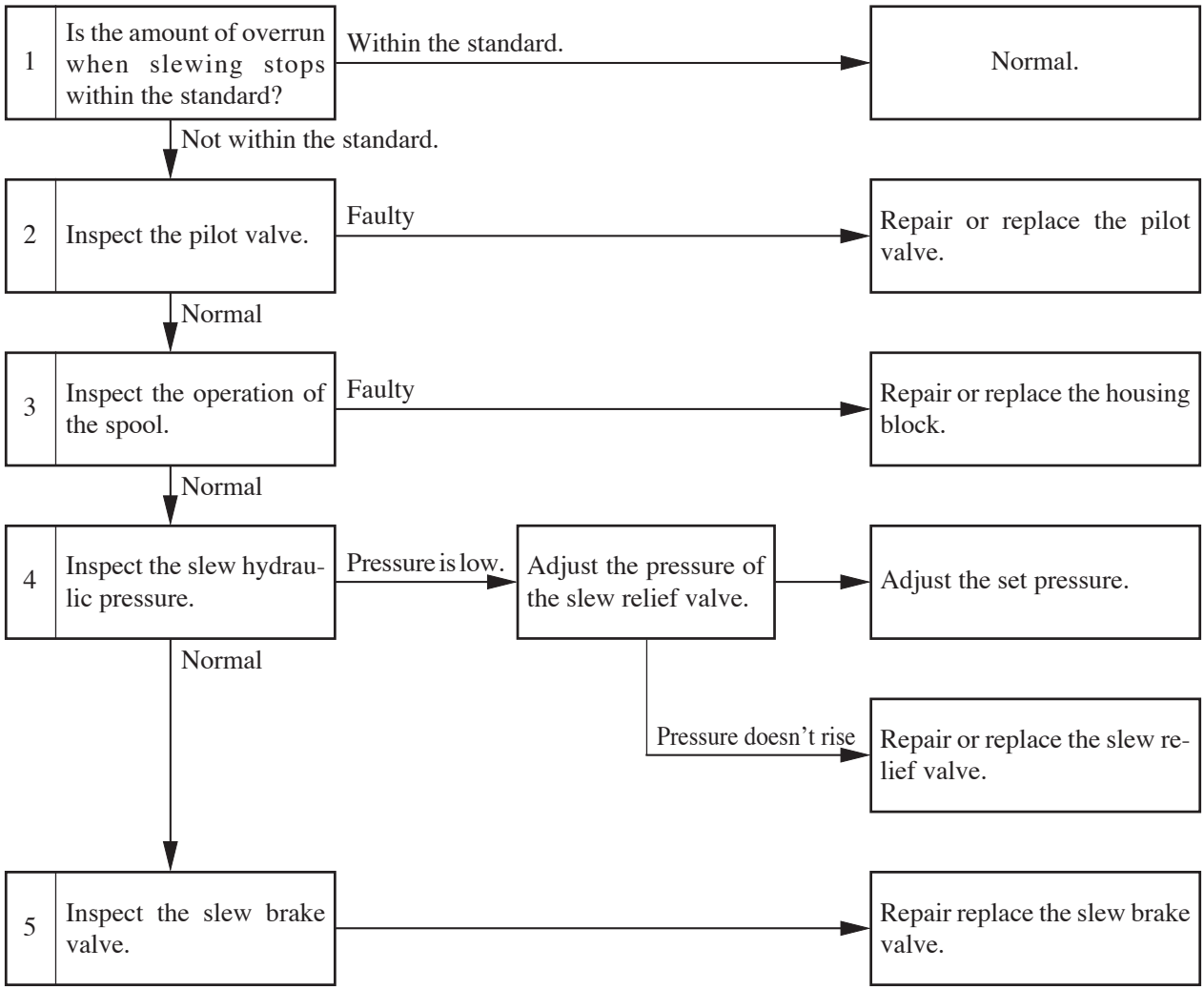
E5E017

7. Inspect the slew reduction gear.
   ☞ "IV. Hydraulic Units, Slew Motor"

https://truckmanualshub.com/

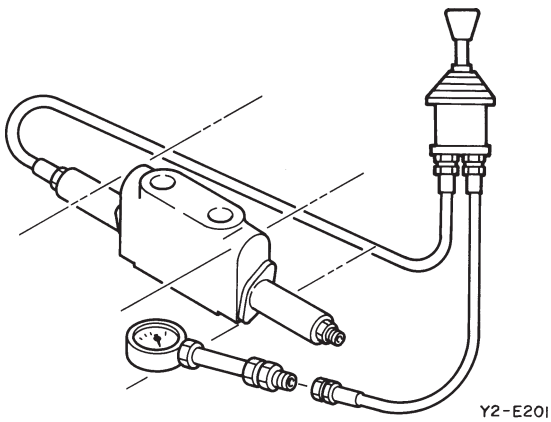


**THE MACHINE SLEWS, BUT OVERRUN WHEN SLEWING STOPS IS GREAT, OR IT CANNOT BE STOPPED.**




1. Is the amount of overrun when slewing stops within the standard?
   ☞ "II. Specifications, Standards for Judging Performance"

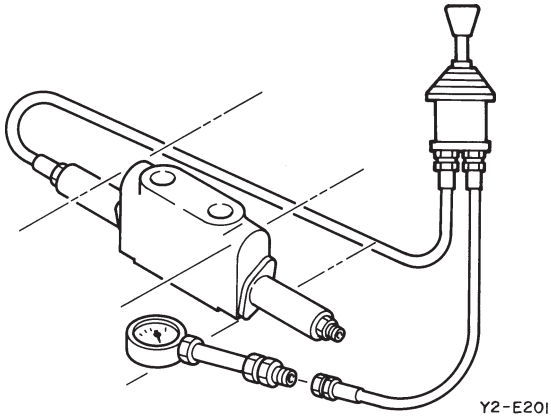
2. Inspect the pilot valve.
   Inspect if the spool of the pilot valve returns to the neutral position when the operation lever (slew) is released after operation. Disconnect the hose between the pilot valve and the control valve (slew section) on the control valve side, then set a pressure gauge in the disconnected hose.
   - Read the pressure gauge after operating the lever (slew), then releasing it.
   - If the pressure is zero, the pilot valve is normal.



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3. Inspect the operation of the spool.
   Inspect if the spool of the control valve (slew section) returns to the neutral position when the operation lever (slew) is released after operation. Disconnect the line from the slew section of the control valve, then set a pressure gauge in its supply port.
   - Read the pressure gauge after operating the lever (slew), then releasing it.
   - If the pressure is zero, the pilot valve is normal.



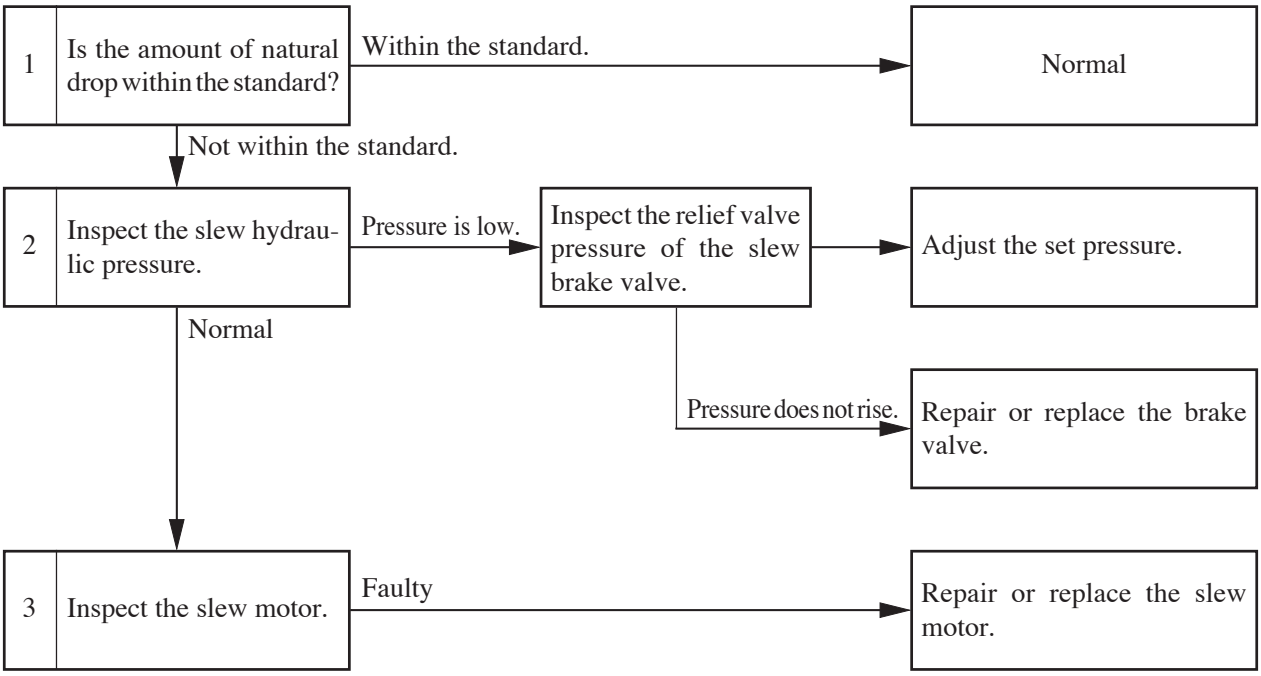

4. Inspect the slew hydraulic pressure.
   ☞ "V-19"

5. Inspect the slew brake valve.
   ☞ "IV. Hydraulic Units, Slew Motor"

https://truckmanualshub.com/



**WHEN STOPPED ON A SLOPE, THE SLEWING BODY CANNOT MAINTAIN ITS POSTURE AFTER STOPPING.**




1. Is the amount of natural drop within the standard?
   ☞ "II. Specifications, Standards for Judging Performance"

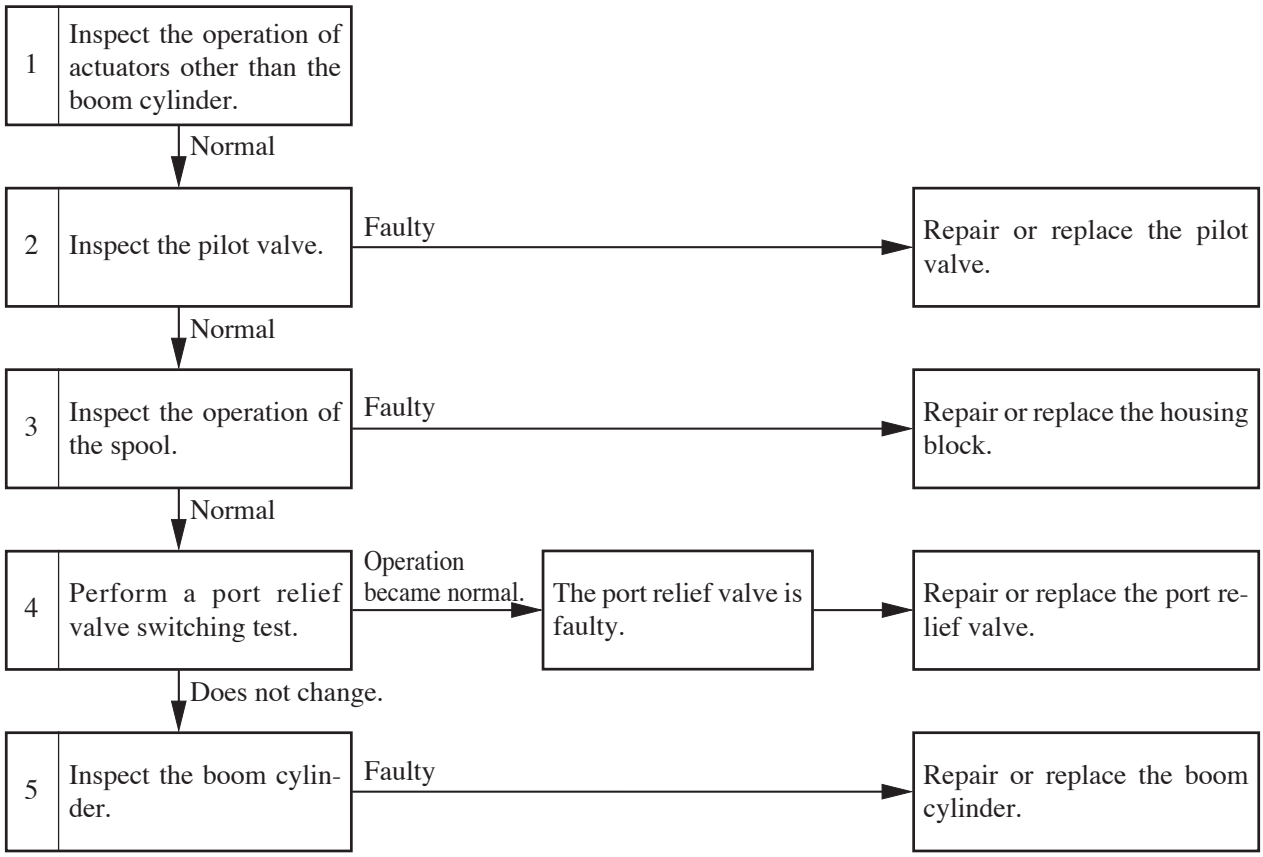
2. Inspect the slew hydraulic pressure.
   ☞ "V-19"

3. Inspect the slew motor.
   ☞ "IV. Hydraulic Units, Slew Motor"

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**THE BOOM CYLINDER DOESN'T MOVE.**



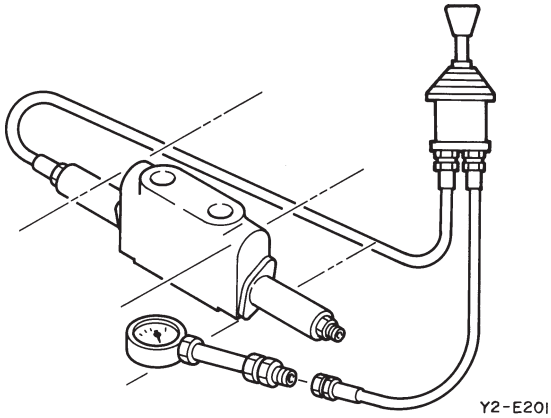

1. Inspect the operation of actuators other than the boom cylinder.
   Inspect if the operation of the boom cylinder only is faulty by the table at right. If its operation is faulty, inspect the main relief valve and the hydraulic pump.
   ☞ "V-6"

| Lever Operated | Places inspected | |
|---|---|---|
| Right Travel | Relief Valve R1 | Pump P1 |

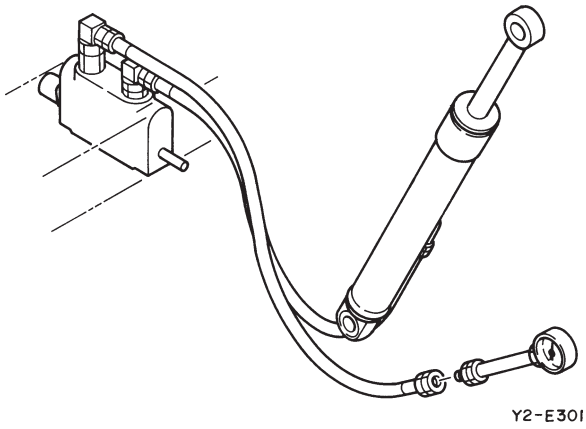
https://truckmanualshub.com/



2. Inspect the pilot valve.
   Disconnect the hose between the pilot valve and control valve (boom section) on the control valve side, then set a pressure gauge in the disconnected hose.
   - Operate the (boom) lever and measure the pressure.
   - Depending the operation angle, if the pressure is normal, it will range between 0~3.4 MPa (0~35 kgf/cm$^2$).

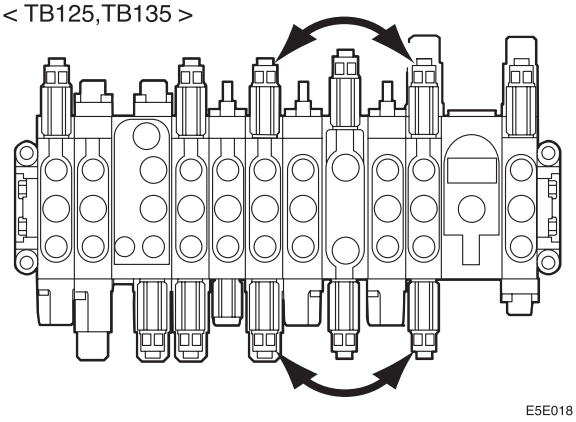



3. Inspect the operation of the spool.
   Disconnect the hose between the control valve (boom section) and the cylinder on the cylinder side, then set a pressure gauge in the disconnected hose.
   - Operate the (boom) lever and measure the pressure.
   - A pressure of 20.6 MPa (210 kgf/cm$^2$) is normal.

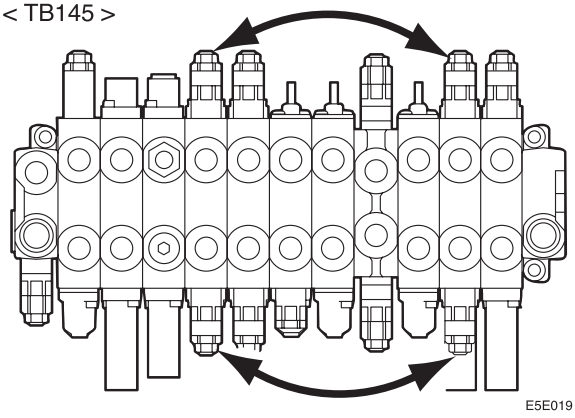



4. Perform a port relief valve switching test.
   Switch the port relief valve for the port relief valve of the normal arm. If the boom cylinder operates, the boom side port relief valve is faulty.

< TB125,TB135 >




< TB145 >

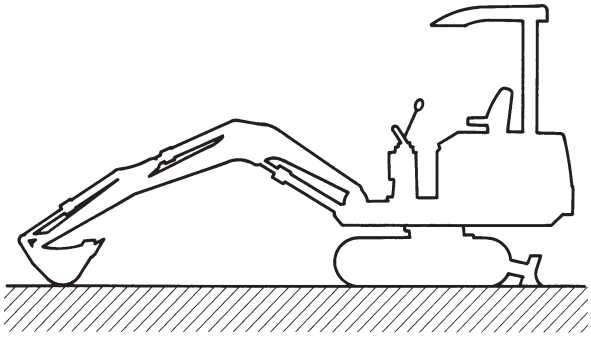


https://truckmanualshub.com/



5. Inspect the boom cylinder.
   a. Disconnect the hose between the control valve and the boom cylinder on the control valve side.
   b. Connect the disconnected hose to the arm section or the bucket section.
   c. Try operating the boom cylinder. If the cylinder doesn't operate, the cylinder is faulty.

   When performing the operation in "a~c" above, the bucket cylinder should be fully extended, the arm cylinder should be fully retracted and the bucket should be lowered to the ground.

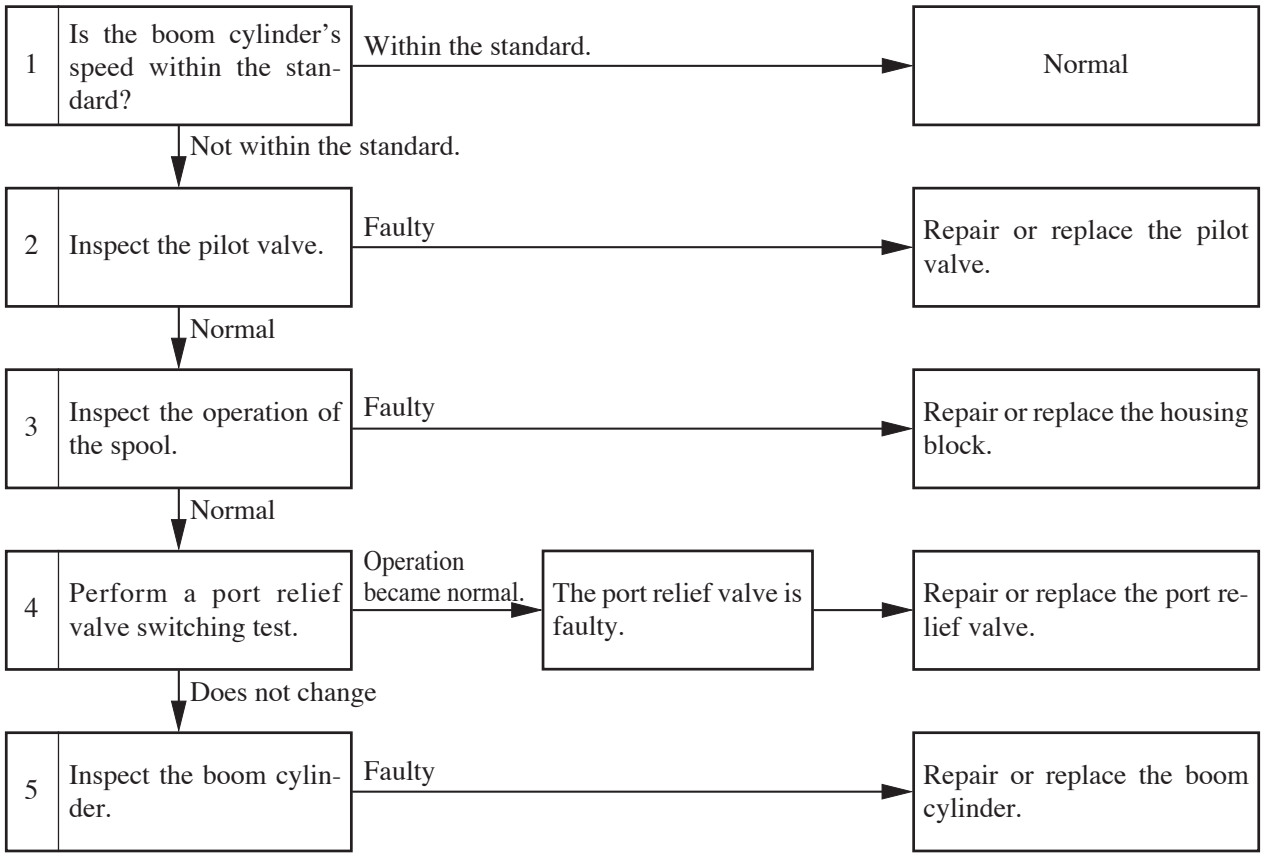


Y2-E303

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**BOOM CYLINDER OPERATION IS SLOW, OR THERE IS NO POWER.**




1. Is the boom cylinder's speed within the standard?
   ☞ "II. Specifications, Standards for Judging Performance"

2. Inspect the pilot valve.
   ☞ "V-29"

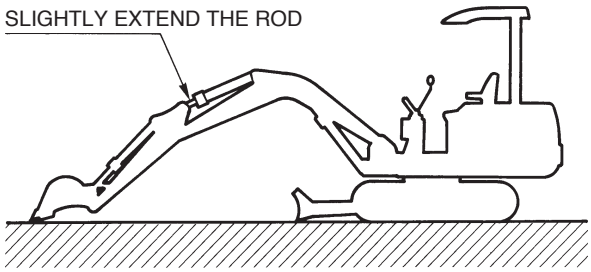
3. Inspect the operation of the spool.
   ☞ "V-29"

4. Perform a port relief valve switching test.
   ☞ "V-29"

https://truckmanualshub.com/

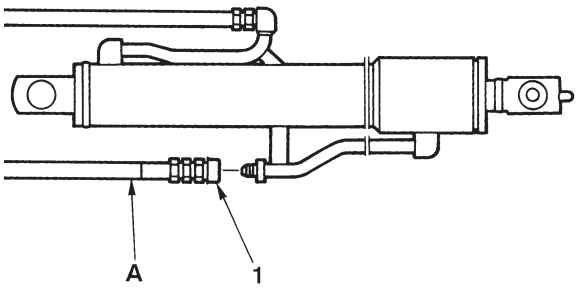


5. Inspect the boom cylinder.
   Boom Cylinder internal Leakage Inspect (1)
   a. With the bucket cylinder fully retracted and with the rod of the arm cylinder a little extended from the fully retracted position, lower the bucket front end to the ground.



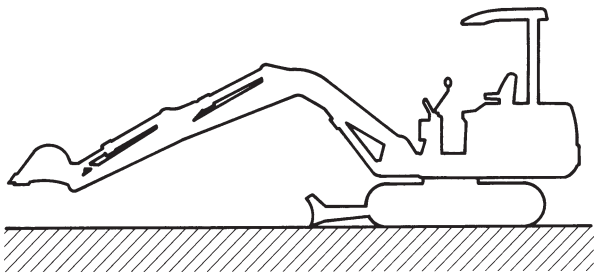

Y2-E304

   b. Disconnect the rod side hose (A) only and let the oil in the piping run out.
   Insert a plug (1) in the disconnected hose.



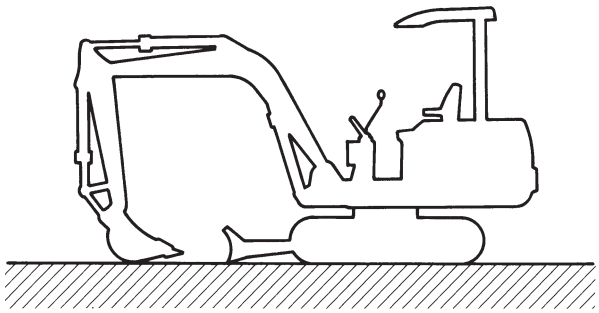

C3-E302

   c. Retract the arm cylinder and lift the bucket so it is floating above the ground.
   At this time, if there is oil leaking from the piping of the cylinder where the hose was disconnected, and if the boom cylinder's rod is retracted, the cylinder is leaking internally.
   Also, if there is no leakage of oil from the cylinder's piping, if the boom cylinder's rod is retracted, the control valve is leaking internally.



Y2-E306

   Boom Cylinder Internal Leakage Inspect (2)
   a. Place the machine in the posture shown in the figure.

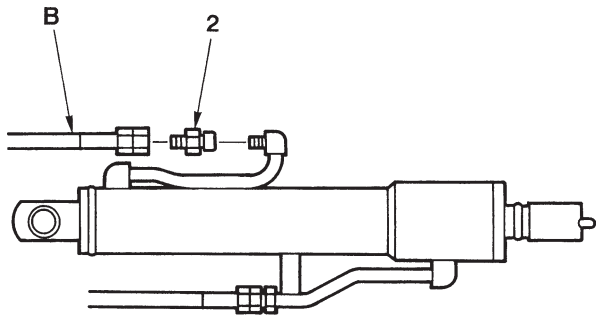


Y2-E307

https://truckmanualshub.com/

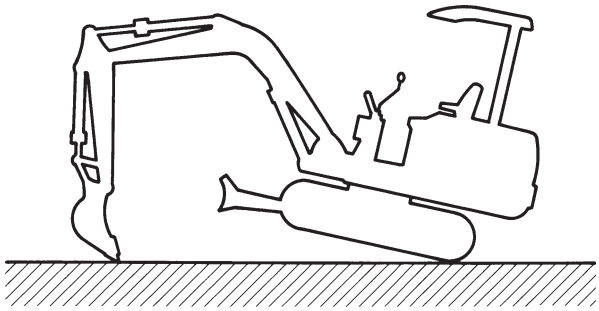


b. Disconnect the head side hose (B) and let the hydraulic oil out of the cylinder's piping. Insert a plug (2) in the disconnected hose.




C3–E303

c. Operate the bucket and raise the machine's body.
At this time, if there is oil leaking from the piping of the cylinder where the hose was disconnected, and if the boom cylinder's rod is extended, the cylinder is leaking internally.
Also, if there is no leakage of oil from the cylinder's piping, if the boom cylinder's rod is extended, the control valve is leaking internally.



Y2-E309

If the cylinder is damaged internally, the system should be flushed out to remove any broken pieces (NAS Class 9).

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**WHEN THE BOOM OPERATION LEVER IS PULLED GENTLY, THE BOOM DROPS TEMPORARILY.**

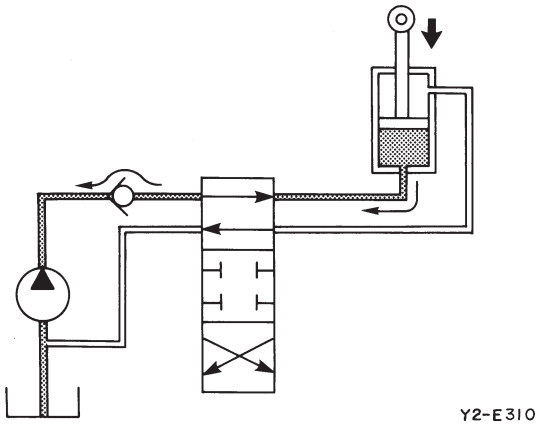
| | | | |
|---|---|---|---|
| 1 | Inspect the load check valve of the control valve. | Faulty → | Repair or replace the housing block. |
| | ↓ Normal | | |
| 2 | Inspect for internal leakage in the boom cylinder. | Faulty → | Repair or replace the boom cylinder. |

1. Inspect the load check valve of the control valve.
   a. Disconnect the hose between the control valve and boom cylinder at the control valve side.
   b. Connect the disconnected hose to the arm or bucket section.
   c. Try operating the boom cylinder.

   If operation is normal, the load check valve is faulty.

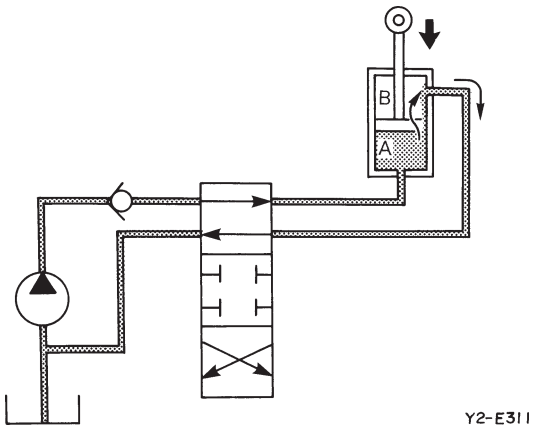
   Place the machine in the following posture when performing the operation in "a~c" above.
   - The bucket cylinder should be fully extended, the arm cylinder should be fully retracted and the bucket should be lowered to the ground.

   Reference: When the spool first starts to pull, the oil's pressure and flow are small, so if the load check valve is faulty, it causes a load to bear on the boom cylinder, which causes the oil to flow backwards for a time. For this reason, the boom will drop temporarily.


Y2-E310

2. Inspect for internal leakage in the boom cylinder.

   When the boom cylinder's piston or tube is faulty, if oil is leaking from the head side (A) to the rod side (B), since the oil's pressure and flow are low when the spool first starts pulling, the boom cylinder will drop temporarily. Also, the cylinder will have inadequate driving force. However, in this case as well, the amount of natural drop will be great.
   - Cylinder Inspect
     ☞ "V-32~33"

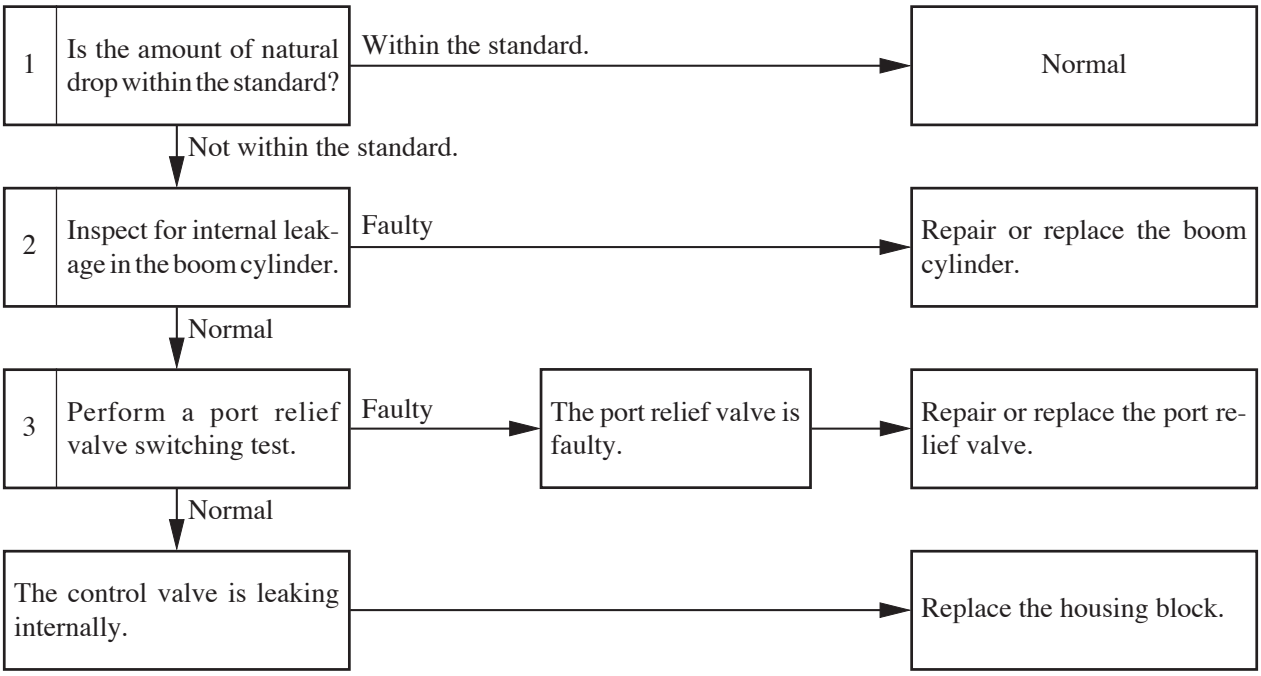


Y2-E311

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**THE AMOUNT OF BOOM NATURAL DROP IS GREAT.**




1. Is the amount of natural drop within the standard?
   ☞ "II. Specifications, Standards for Judging Performance"

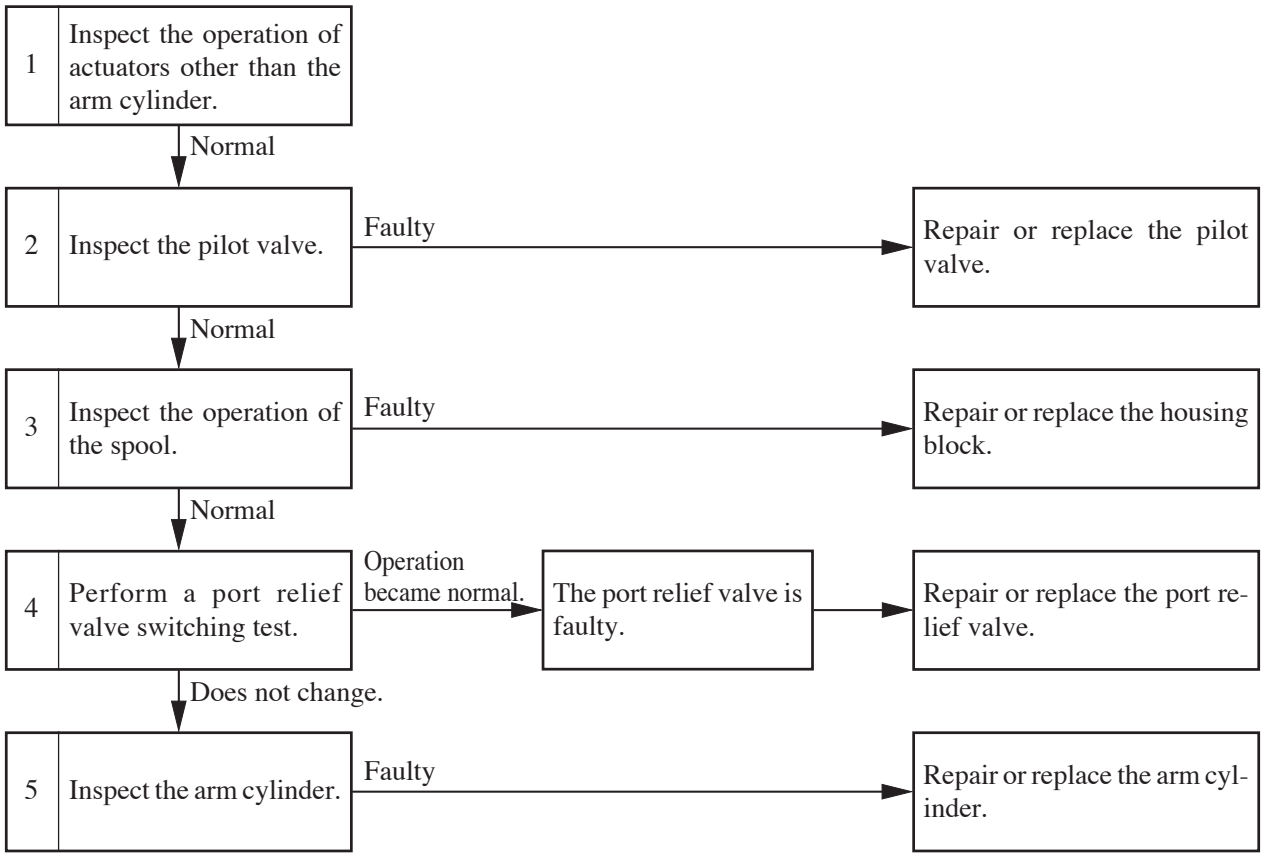
2. Inspect for internal leakage in the boom cylinder.
   ☞ "V-32~33"

3. Perform a port relief valve switching test.
   ☞ "V-29"

https://truckmanualshub.com/



**THE ARM CYLINDER DOESN'T MOVE.**




1. Inspect the operation of actuators other than the arm cylinder.
   Inspect if the operation of the arm only is faulty by the table at right. If operation is faulty, inspect the main relief valve and the hydraulic pump.
   ☞ "V-6"

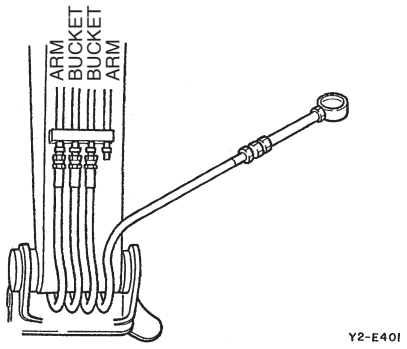
| Lever Operated | Places inspected | |
|---|---|---|
| Left Travel | Relief Valve R2 | Pump P2 |

2. Inspect the pilot valve.
   ☞ "V-29"

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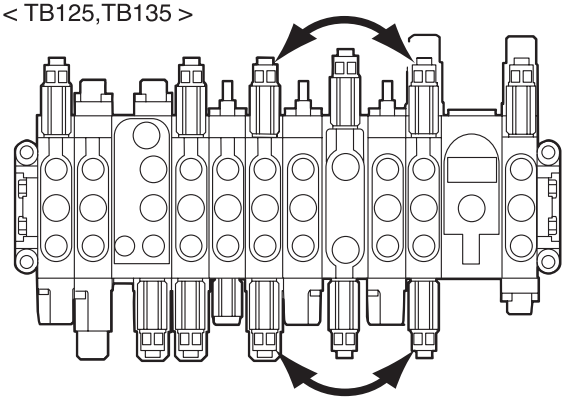


3. Inspect the operation of the spool.
   Disconnect the arm hose connected to the pipe at the boom foot, then set a pressure gauge in the disconnected hose.
   - Operate the (arm) lever and measure the pressure.
   - If the pressure is 20.6 MPa (210 kgf/cm$^2$), it is normal.

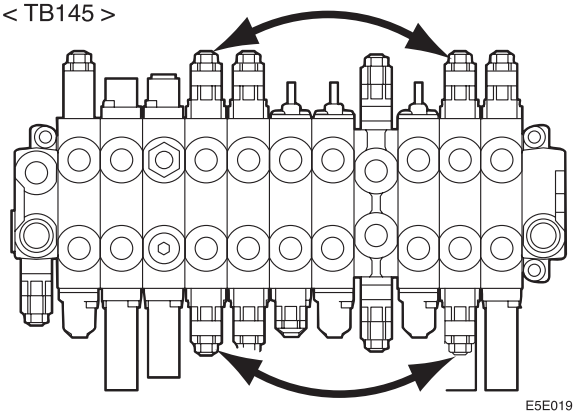



4. Perform a port relief valve switching test.
   Switch the port relief valve with that of the normal boom. If the arm cylinder then operates, the port relief valve is faulty.

< TB125,TB135 >

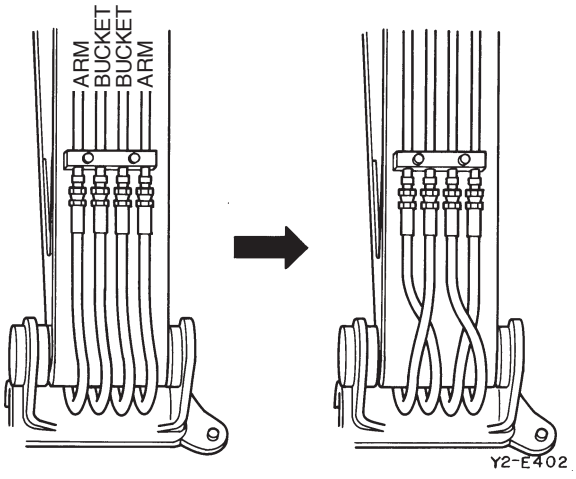



< TB145 >




5. Inspect the arm cylinder.
   Switch the arm hoses and bucket hoses connected to the pipes at the boom foot.
   - Try operating the (bucket) operation lever to operate the arm cylinder.
   - If the cylinder doesn't operate, the cylinder is faulty.

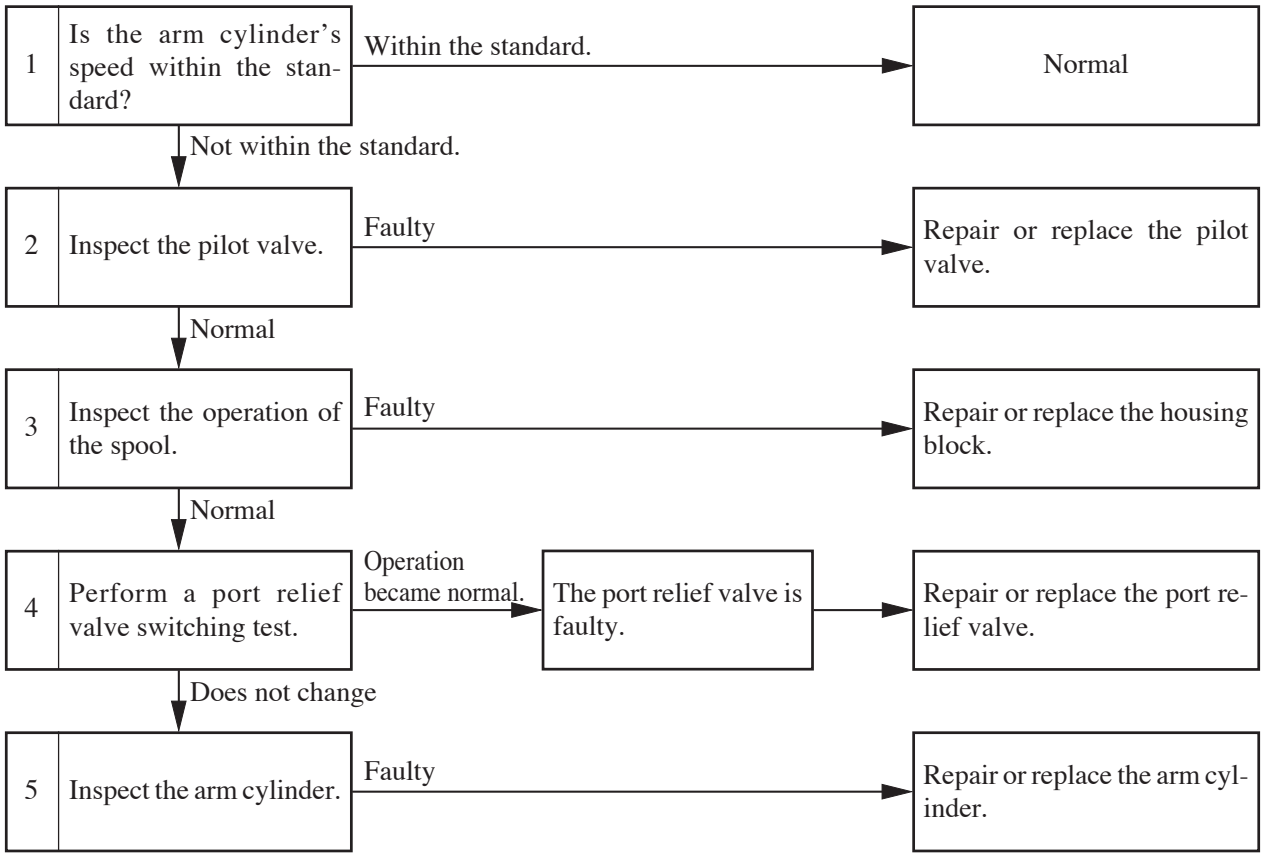
   When performing the operation above, the bucket cylinder should be fully extended, the arm cylinder should be fully retracted, and the bucket should be lowered to the ground.



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**ARM CYLINDER OPERATION IS SLOW, OR THERE IS NO POWER.**




1. Is the arm cylinder's speed within the standard?
   ☞ "II. Specifications, Standards for Judging Performance"

2. Inspect the pilot valve.
   ☞ "V-29"

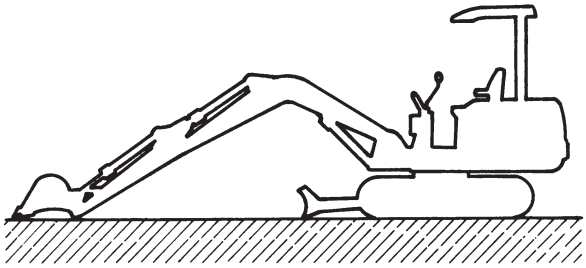
3. Inspect the operation of the spool.
   ☞ "V-37"

4. Perform a port relief valve switching test.
   ☞ "V-37"

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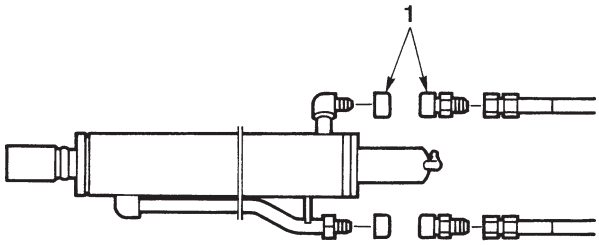


5. Inspect the arm cylinder.
   a. Fully retract the bucket cylinder, fully retract the arm cylinder and lower the bucket to the ground.



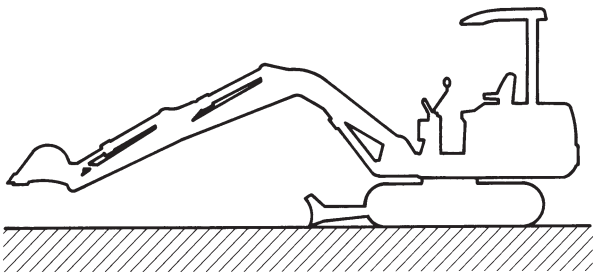
Y2-E403

   b. Disconnect the two hoses connected to the cylinder. Insert plugs (1) in the disconnected hoses and the cylinder piping.




C3-E401

   c. Raise the boom and raise the hoe attachment so it floats above the ground. If the arm dorps, the cylinder is faulty. If the arm does not drop, there is leakage inside the control valve.

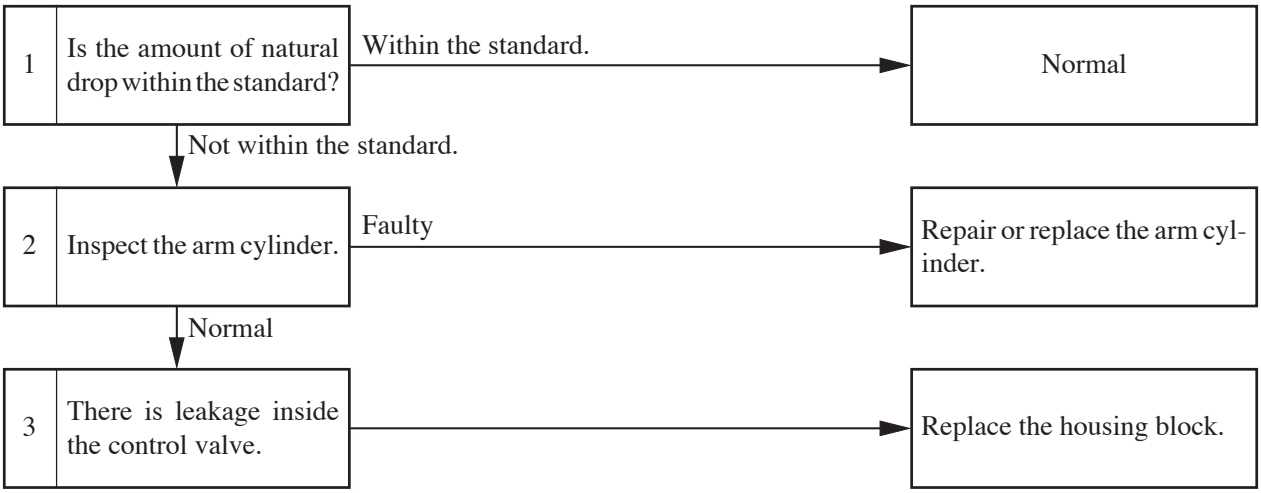


Y2-E306

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**THE AMOUNT OF ARM NATURAL DROP IS GREAT.**



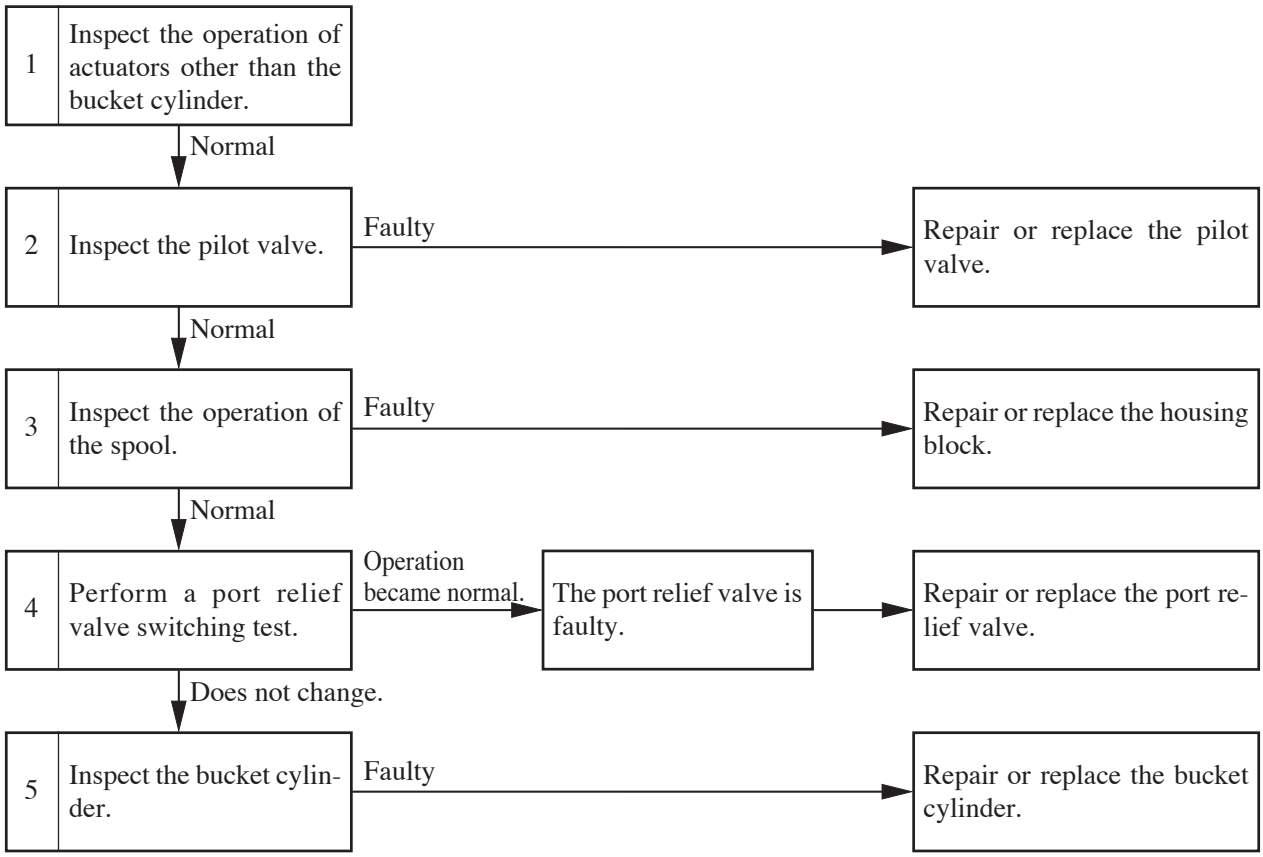

1. Is the amount of natural drop within the standard?
   ☞ "II. Specifications, Standards for Judging Performance"

2. Inspect the arm cylinder.
   ☞ "V-39"

https://truckmanualshub.com/



**THE BUCKET CYLINDER DOESN'T MOVE, OR THERE IS NO POWER.**




1. Inspect the operation of actuators other than the bucket cylinder.
   Inspect if the operation of the bucket only is faulty by the table at right. If operation is faulty, inspect the main relief valve and the hydraulic pump.
   ☞ "V-6"

| Lever Operated | Places inspected | |
|---|---|---|
| Right Travel | Relief Valve R1 | Pump P1 |

2. Inspect the pilot valve.
   ☞ "V-29"

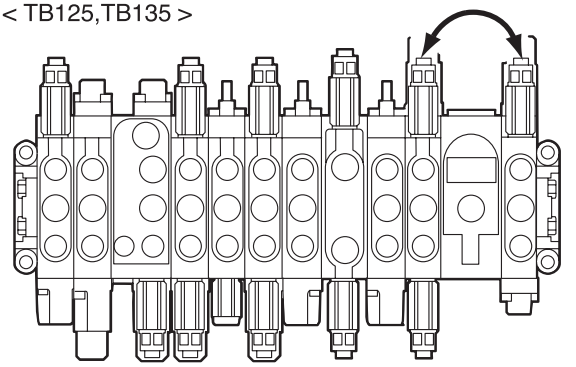
3. Inspect the operation of the spool.
   ☞ "V-37"

https://truckmanualshub.com/



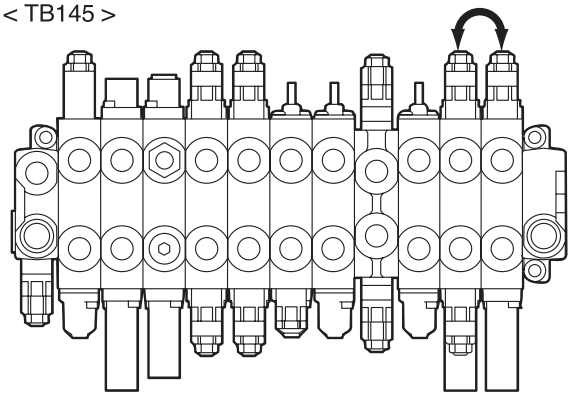
4. Perform a port relief valve switching test.
   When only “bucket load” side is inoperable:
   Replace the port relief valve with that of the normal boom, and test. If the bucket cylinder operates, the replaced old port relief valve was faulty.

< TB125,TB135 >



E5E020

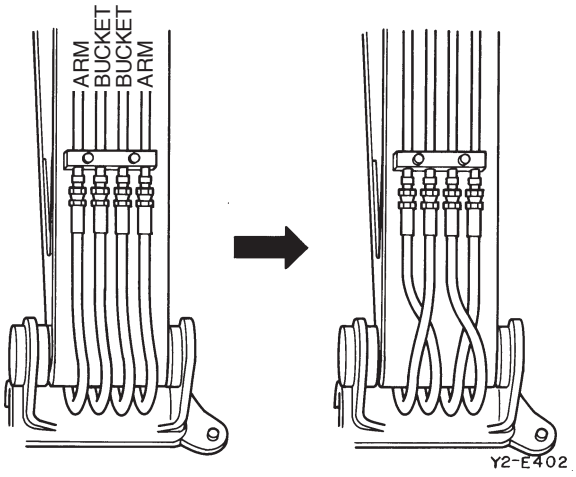
< TB145 >



E5E021

5. Inspect the bucket cylinder.
   At the boom foot, exchange the arm hose with the bucket hose that is connected to the pipe.
   - Move the lever (arm) and check whether the bucket cylinder operates.
   - If the bucket cylinder does not operate, the bucket cylinder is faulty.

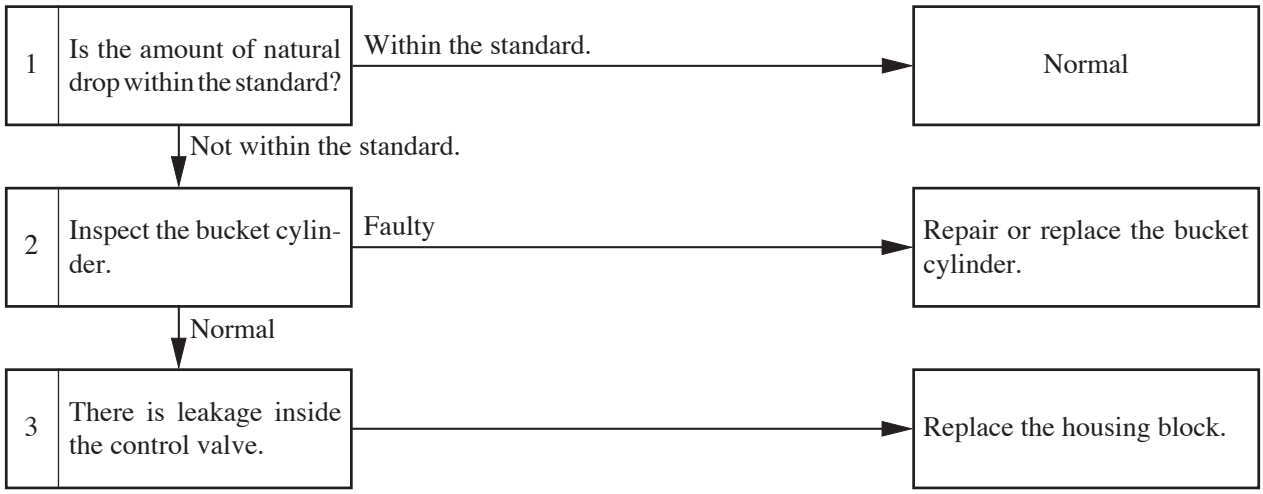
   This inspection should be done with the bucket cylinder fully extended and the arm cylinder fully retracted. Also, the bucket must be lowered to the ground.



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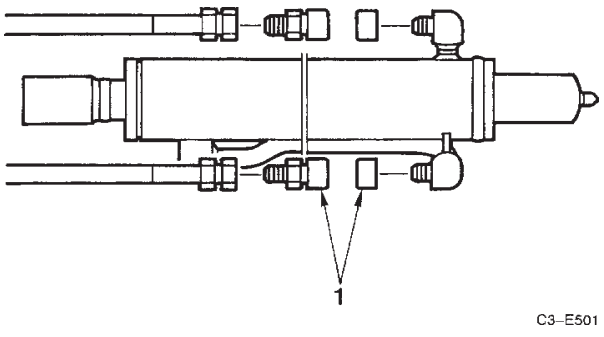


**THE AMOUNT OF BUCKET NATURAL DROP IS GREAT.**




1. Is the amount of natural drop within the standard?
   ☞ "II, Specifications, Standards for Judging Performance"

2. Inspect the bucket cylinder.
   a. Fully extend the bucket cylinder, fully retract the arm cylinder and lower the bucket to the ground,
   b. Disconnect the 2 hoses connected to the cylinder.
      Insert the plugs (1) in the disconnected hoses and the piping.



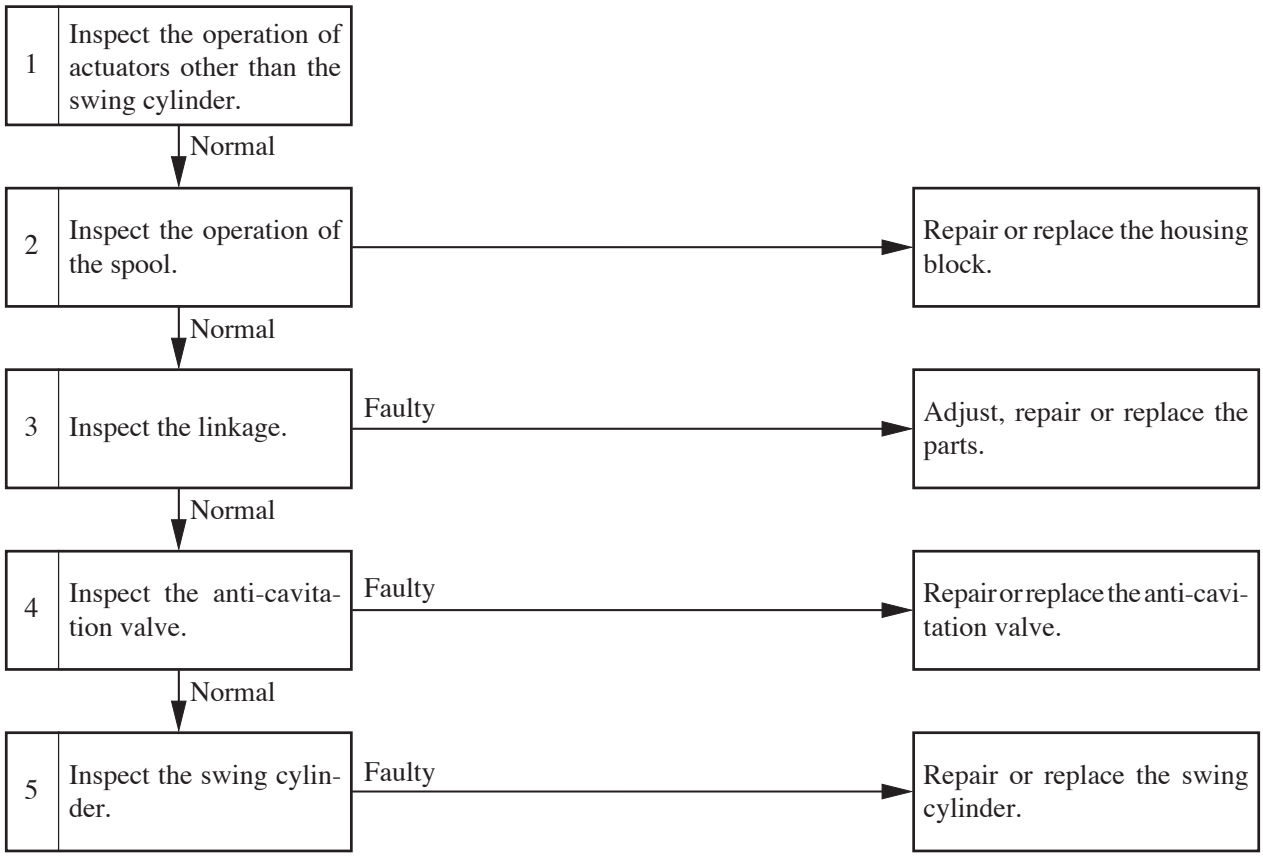
C3–E501

   c. Raise the boom and raise the hoe attachment so that it floats above the ground, If the bucket drops, the cylinder is faulty, If the bucket does not drop, there is leakage inside the control valve.

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**THE SWING CYLINDER DOESN'T MOVE.**




1. Inspect the operation of actuators other than the swing cylinder.
   Inspect if the operation of the boom swing only is faulty by the table at right. If operation is faulty, inspect the main relief valve and the hydraulic pump.
   ☞ "V-6"

| Lever Operated | Places inspected | |
|---|---|---|
| Left Travel | Relief Valve R2 | Pump P2 |

2. Inspect the operation of the spool.
   ☞ "V-10"

3. Inspect the linkage.
   ☞ "V-11"

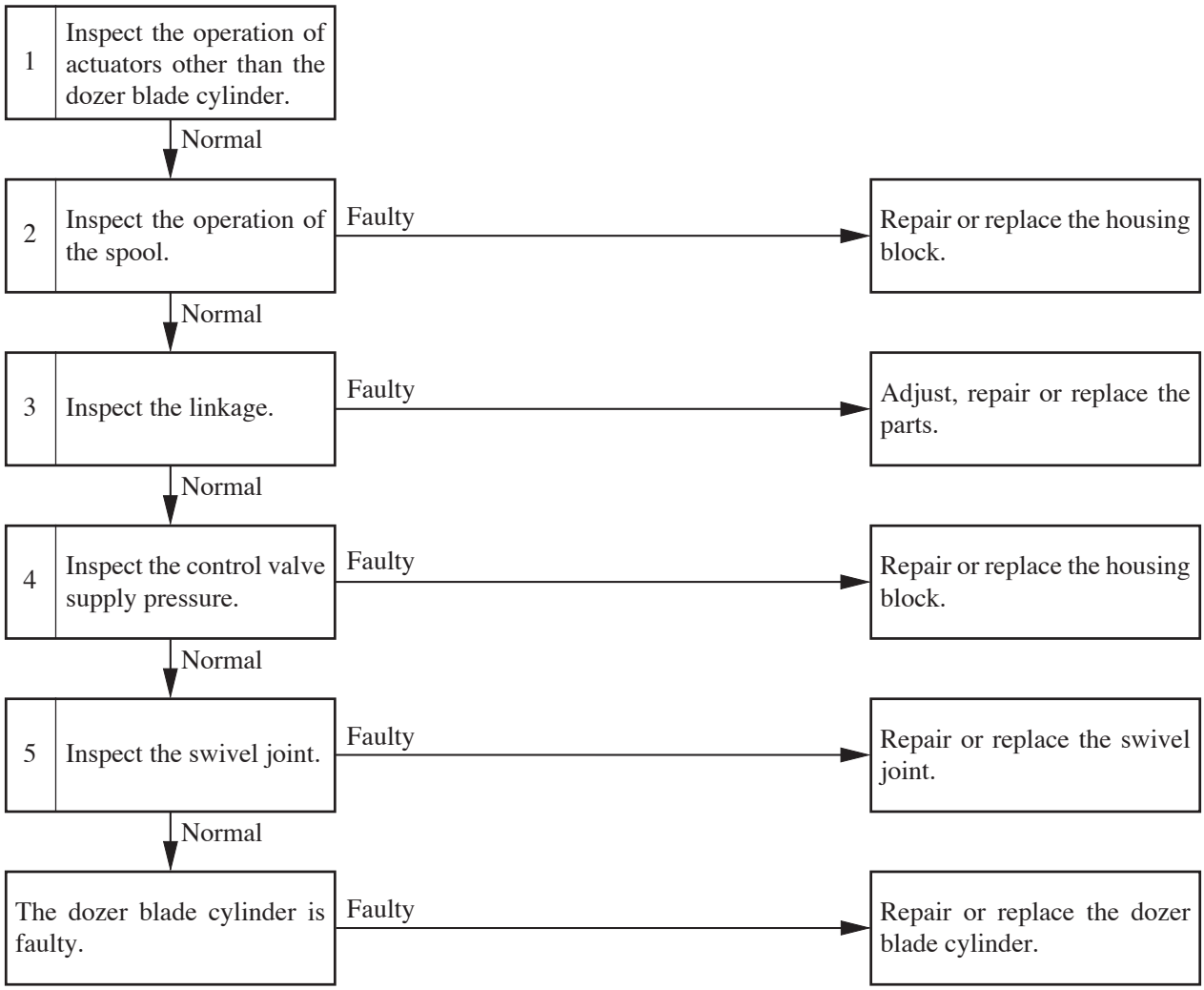
4. Inspect the anti-cavitation valve.
   If right swing cannot be done, then foreign matter is caught in the anti-cavitation valve or the valve is sticking.

5. Inspect the swing cylinder.
   Disconnect the hose between the swing cylinder and the control valve at the control valve side, then measure the pressure supplied from the valve. If the supply pressure is normal, the cylinder is faulty.
   - Supply Pressure: 20.6 MPa (210 kgf/cm$^2$)

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**THE DOZER BLADE CYLINDER DOESN'T MOVE, OR THERE IS NO POWER.**




1. Inspect the operation of actuators other than the dozer blade cylinder.
   Inspect if the operation of the dozer blade only is faulty by the table at right. If operation is faulty, inspect the main relief valve and the hydraulic pump.
   ☞ "V-6"

| Lever Operated | Places inspected | |
|---|---|---|
| Slew | Relief Valve R3 | Pump P3 |

2. Inspect the operation of the spool.
   ☞ "V-10"

3. Inspect the linkage.
   ☞ "V-11"

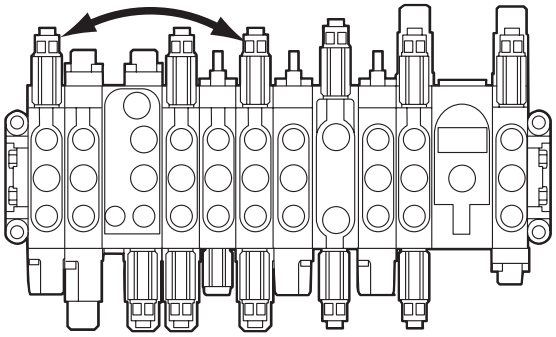
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4. Inspect the control valve supply pressure.
   Disconnect one of the hoses connected to the dozer blade section of the control valve. Set a pressure gauge in its section, operate the dozer blade operation lever and inspect the supply pressure.
   If the pressure indicated is not the value below, the housing block is faulty.
   - Supply Pressure: 19.6 MPa (200 kgf/cm$^2$)

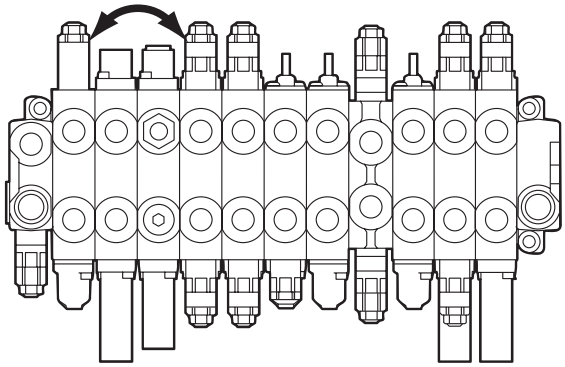
   When “dozer blade lower” side does not operate properly:
   - Replace the port relief valve with a new one having a normal arm, and test. If the dozer blade cylinder operates, the port relief valve on the dozer blade side is faulty.

< TB125,TB135 >



E5E022

< TB145 >



E5E023

5. Inspect the swivel joint.
   Disconnect the hose between the swivel joint and the dozer blade cylinder on the cylinder side. Connect a pressure gauge to the disconnected hose and operate the lever (blade).
   - If the measured pressure is not the following value, the swivel joint is faulty.
     Supply pressure: 19.6 MPa (200 kgf/cm$^2$)

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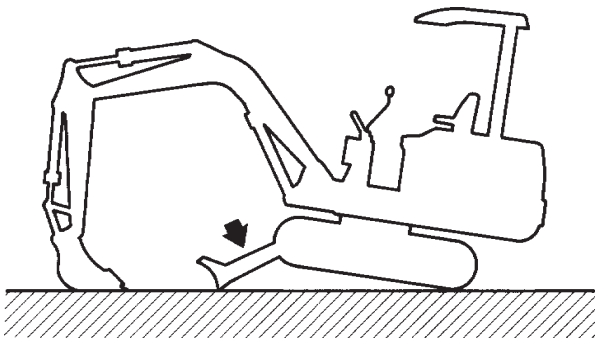


**THE AMOUNT OF DOZER BLADE NATURAL DROP IS GREAT OR THE DOZER BLADE WON'T HOLD THE MACHINE UP.**

| | | | |
|---|---|---|---|
| 1 | Is the amount of natural drop within the standard? | Within the standard. | Normal |
| | | Not within the standard. | |
| 2 | Inspect for internal leakage in the blade cylinder. | Faulty | Repair or replace the housing block. |
| | | Normal | |
| 3 | Inspect the swivel joint and control valve. | Faulty | Repair or replace the swivel joint, or replace the control valve. |

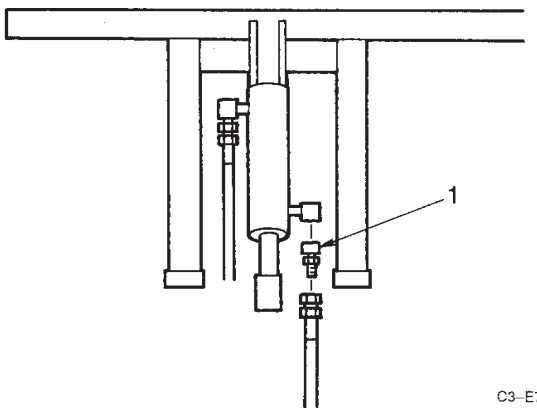
1. Is the dozer blade's natural drop within the standard?
   ☞ "II. Specifications, Standards for Judging Performance"

2. Inspect for internal leakage in the dozer blade cylinder.
   a. Using the hoe attachment, raise the machine's body, then lower the dozer blade fully.



Y2-E703

   b. Disconnect the dozer blade cylinder's rod side hose and drain out the oil in the piping. Insert a plug (1) in the disconnected hose.




C3-E702

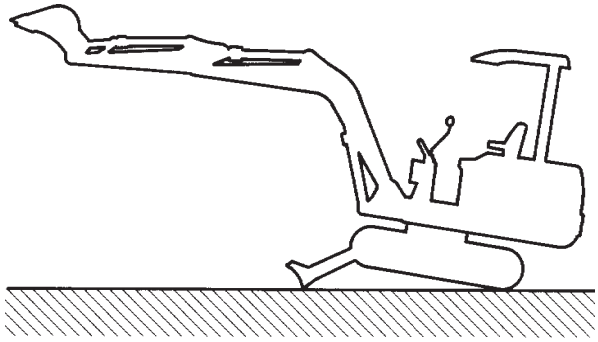
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c. Raise the boom and apply a load on the dozer blade.

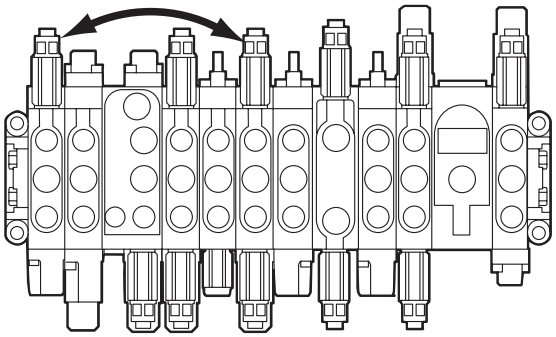
- If the machine's body drops while oil drains out of the cylinder's piping, the cylinder is faulty.
  If the body drops even though no oil drains out, the control valve or the swivel joint is faulty.

If the machine cannot be supported by the dozer blade, try replacing the port relief valve with a normal one.
If the dozer blade can support the machine's body after this, then the port relief valve is faulty.



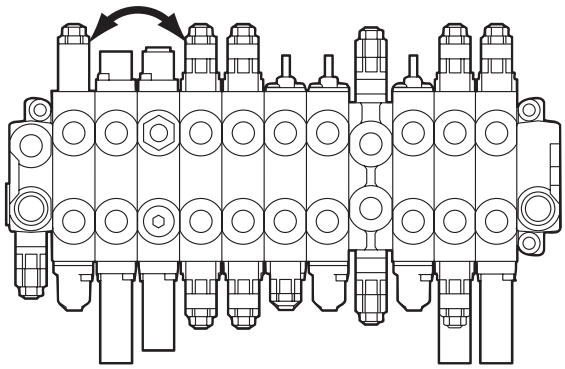
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E5E022

< TB145 >



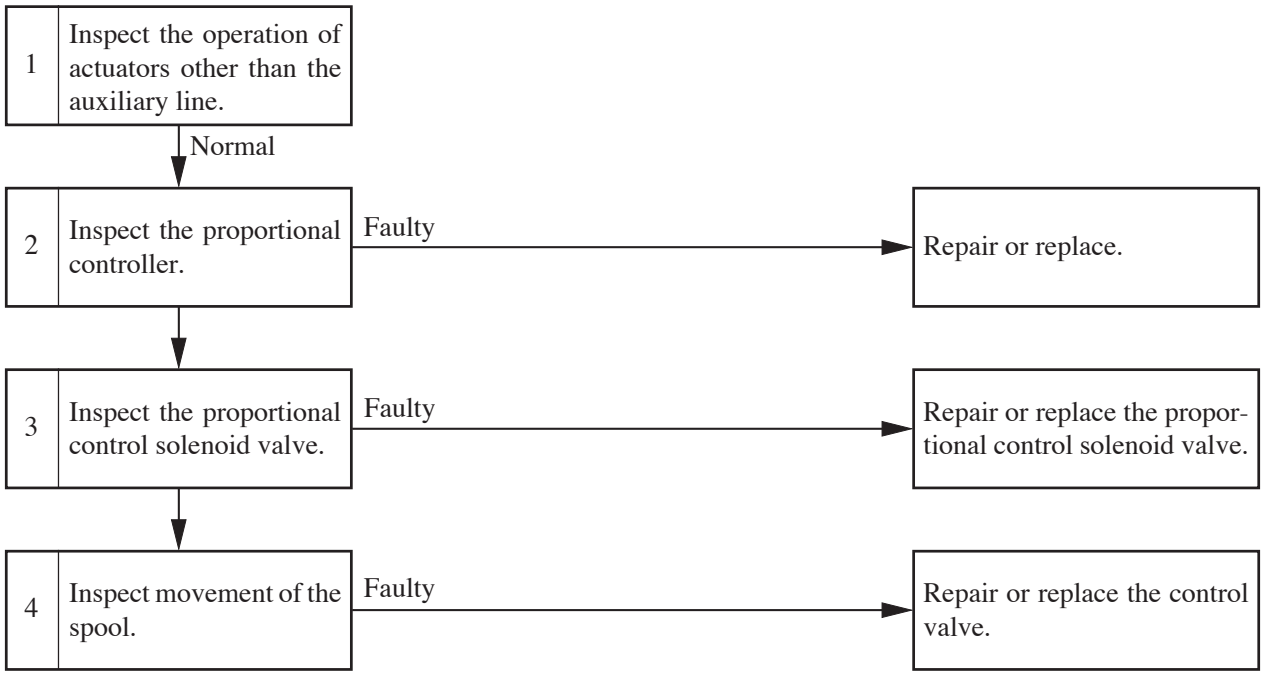
E5E023

3. Inspect the swivel joint and control valve.
   Disconnect the hose between the swivel joint and control valve at the control valve side, then insert a plug in the disconnected hose.
   Apply a load to the dozer blade by the procedure in the previous item 2, a~c.
   If the machine's body drops, the swivel joint is faulty.
   If the machine's body does not drop, there is internal leakage in the control valve.

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**THE PROPORTIONAL CONTROL IS IMPOSSIBLE (TB145).**




1. Inspect the operation of actuators other than the auxiliary line.
   Check the table at right to see if the problem lies with the auxiliary line alone. If the problem does lie with the auxiliary line, then check the main relief valve and the hydraulic pump (P2).
   ☞ "V-6"

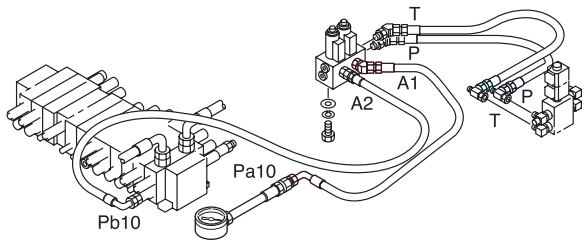
2. Inspect the proportional controller.
   ☞ "III-115~117"

| Lever operated | Places to be checked | |
|---|---|---|
| Left Travel | Relief valve R2 | Pump P2 |

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3. Inspect the proportional control solenoid valve.
   a. Disconnect the hose running from the proportional control solenoid valve to the control valve (auxiliary section) at the control valve.
   b. Fit a pressure gauge to the hose.
   c. Operate the proportional control lever on the left pilot valve to position it at various angles. If the pressure level falls between 0 and 3.4 MPa for each angle, it is normal.
      ☞ "IV. Hydraulic Units, Proportional Control Solenoid Valve"




K3E005

4. Inspect movement of the spool.
   ☞ "IV. Hydraulic Units, Control Valve"

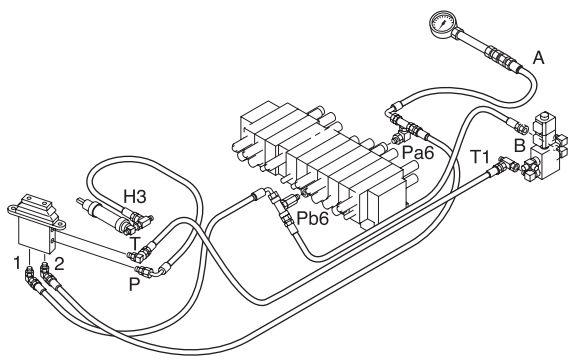
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**THE FLOW IN THE AUXILIARY HYDRAULIC CIRCUIT CANNOT BE CONTROLLED (TB145).**

| | | | |
|---|---|---|---|
| 1 | Inspect the supply pressure to the solenoid valve (auxiliary). | | |
| | Normal | | |
| 2 | Inspect the fuse. | Faulty | Replace the fuse. |
| | Normal | | |
| 3 | Inspect the auxiliary hydraulics switch. | Faulty | Replace the auxiliary hydraulics switch. |
| | Normal | | |
| 4 | Inspect the relay. | Faulty | Replace the relay. |
| | Normal | | |
| 5 | Inspect the solenoid valve (auxiliary). | Faulty | Repair or replace the solenoid valve (auxiliary). |
| | Normal | | |
| 6 | Inspect the operation of the spool. | Faulty | Repair or replace the housing block. |

1. Inspect the supply pressure to the solenoid valve (auxiliary).
   Disconnect the hose between the pilot valve (travel) and the solenoid valve (auxiliary) on the solenoid valve (auxiliary) side. Connect a pressure gauge to the disconnected hose and measure the pilot pressure.
   - Keep the plug assembles on the port of the disconnected solenoid valve.
   - Standard value: Approx. 3.4 MPa

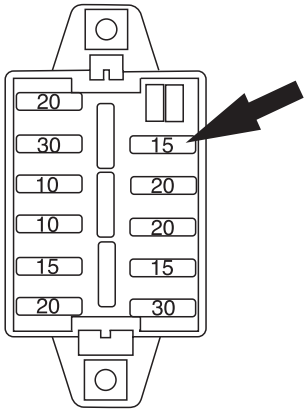



K3E006

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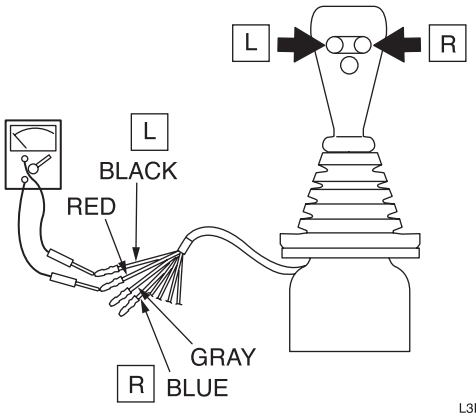


2. Inspect the fuse.
   Operate the solenoid valve and check the fuse for the power supply circuit.



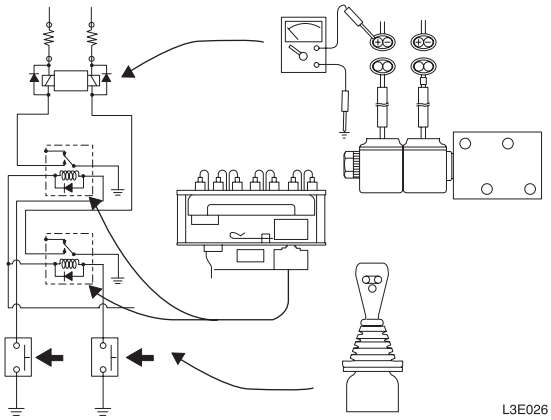

E5E003

3. Inspect the auxiliary hydraulics switch.
   Press the auxiliary hydraulics switch to turn it "ON". While it is this condition, check if there is continuity with a tester.




L3E025E

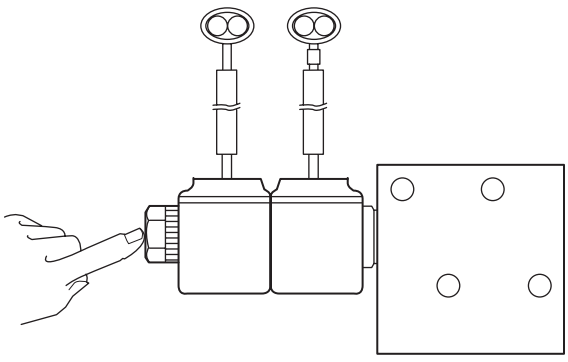
4. Inspect the relay.
   Press the auxiliary hydraulics switch to turn the relay to "ON". Check whether the voltage is applied to the solenoid valve by using a tester. Be sure to stop the engine before starting the inspection.



L3E026

5. Inspect the solenoid valve (auxiliary).
   a. Turn the start switch "ON".
   b. Press the protruding portion of the solenoid valve lightly.
   c. Turn the auxiliary hydraulics switch "ON".
   d. If the spool moves and vibration can be felt with the fingertip when the circuit changes, then it is normal.

6. Inspect the operation of the spool.
   ☞ "V-43"



L3E027

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# VI. ENGINE

| Machine Model | Machine Serial No. | Mounted Engine |
|---|---|---|
| TB125 | 12510003~12514525 | 3TNE82A |
| | 12514526~ | 3TNV82A* |
| TB135 | 13510004~13514050 | 3TNE88 |
| | 13514051~ | 3TNV88* |
| TB145 | 14510004~14513260 | 4TNE88 |
| | 14513261~ | 4TNV88* |

* Fuel Injection Equipment Model YPD-MP2/YPD-MP4

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T-NE

# YANMAR

# SERVICE MANUAL

## INDUSTRIAL DIESEL ENGINE

## MODEL TNE series




YANMAR DIESEL ENGINE CO.,LTD.

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# FOREWORD

*This Service Manual describes the procedure of maintenance and service of the Yanmar industrial TNE series engine (Special swirl precombustion chamber (hereinafter "Indirect injection system") and Direct injection systems).*

*Before starting service and maintenance of TNE engine, you are requested to read this Service Manual carefully to your full understanding and to take careful note that the standard TNE engine may differ in the structure and applicable specification from that loaded on each of individual driven machines (such as the generator, pump, compressor, and combine, etc.).*

*For further information, carefully read the Service Manual issued for each driven machine.*

*This Service Manual in subject to changes, with or without notice, with respect to the structure and the content of maintenance for the purpose of improving engine quality.*

## Setup before work

To perform work efficiently, the following setup (preparation) is necessary.

1. **Customer ledger check**
   (1) Previous date of service
   (2) Check on which month (and at what time) the last service was performed, what problem occurred, and what the history of the customer (engine) is.

2. **Stock control of parts**
   (1) Stock check for consumable parts, periodic replacement parts, etc., that are required for service.
   (2) Provision of check list, parts list and parts card.

3. **Provision of service record**
   (1) Work (process) time table
   (2) Check sheet (including used parts list)
   (3) Measurement data of parts
   (4) Operation data and quality
   } (for maintenance of performance and quality)

4. **Disassembly and reassembly tools**
   (1) Tools
   (2) Measuring devices
   (3) Other instruments and equipment necessary for service




This product has been developed, designed and produced in accordance with the Standards for Quality System of ISO 9001 (International Organization for Standardization) under the following authorized institutions: JMI (Japan Machinery and Metals Inspection Institute), BSI (British Standards Institution) Institution) and EQNET (The European Network for Quality System Assessment and Certification).

Certified under the following standards:
ISO 9001 - 1987 / BS 5750 : Part 1 : 1987 /
EN 29001 - 1987 / JIS Z9901 - 1991

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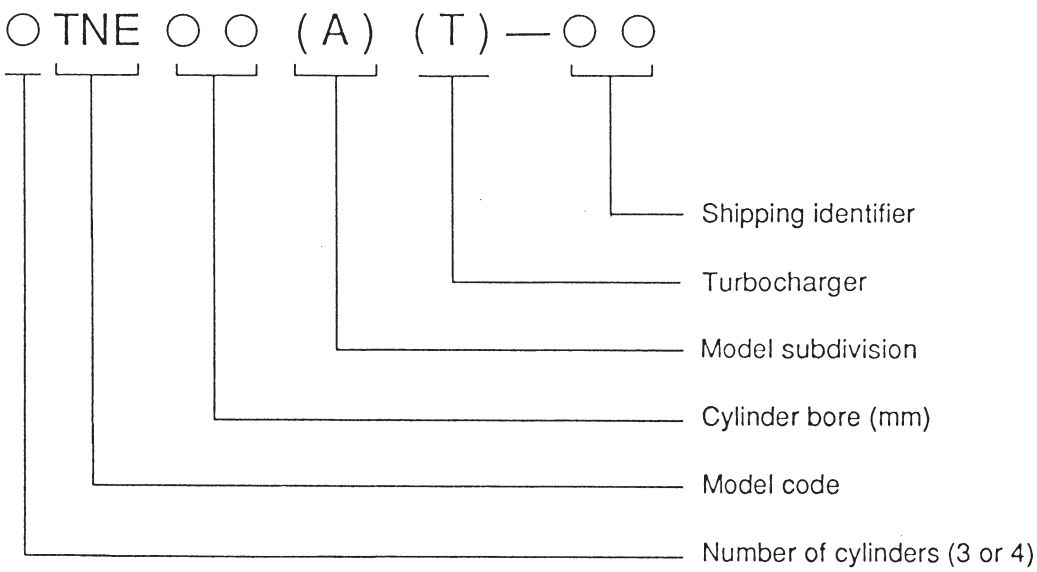
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## ○ Descriptive Breakdown of Model Name




## ○ Application Category

| Application code | Usage | Eng. Rev. type | Revolution speed (rpm) |
|---|---|---|---|
| CL | Generator drive | Constant | 1500 / 1800 |
| CH | | | 3000 / 3600 |
| VM | General use | Variable | 2000 ~ 3000 |
| VH | | | 3000 ~ 3600 |

✻ *For engine application category described in Chapter 1, Specifications and Performance.*

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# 1. Specifications and Performance

## 1-1 2TNE68

* **Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| Item | | | Model / Unit | 2TNE68 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | VM | | | | | | CH | | VH | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | | | | |
| | Combustion system | | — | Special swirl pre-combustion chamber | | | | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 2 – 68 × 72 | | | | | | | | | | |
| | Displacement | | ℓ | 0.523 | | | | | | | | | | |
| | Firing order | | — | 1 – 2 | | | | | | | | | | |
| | Revolution speed | | rpm | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3000 | 3600 | 3200 | 3400 | 3600 |
| | Output* | Continuous rating | kW(HP) | — | — | — | — | — | — | 7.72 (10.5) | 9.12 (12.4) | — | — | — |
| | | Max. rating | kW(HP) | 5.74 (7.8) | 6.25 (8.5) | 6.84 (9.3) | 7.43 (10.1) | 7.94 (10.8) | 8.46 (11.5) | 8.46 (11.5) | 10.0 (13.6) | 8.68 (11.8) | 9.19 (12.5) | 9.64 (13.1) |
| | Max. revolution speed at no load | | rpm | $2180^{+50}_{0}$ | $2375^{+50}_{0}$ | $2570^{+50}_{0}$ | $2780^{+50}_{0}$ | $2970^{+50}_{0}$ | $3180^{+50}_{0}$ | $3180^{+50}_{0}$ | $3780^{+50}_{0}$ | $3425^{+50}_{0}$ | $3640^{+50}_{0}$ | $3850^{+50}_{0}$ |
| | Min. revolution speed at no load | | | ≤800 | | | | | | ≤1500 | | ≤800 | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | | | | |
| | Compression ratio | | — | 23.0 | | | | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 14±1 | | | | | | 16±1 | | | | |
| | Compression pressure | | MPa (kgf/cm²) | 3.24±0.1 (33±1), at 250 rpm | | | | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $11.8^{+1.0}_{0}$ ($120^{+10}_{0}$) | | | | | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.) | | | | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 1.6/0.6 | | | | | | 2.3/1.0 | | | | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | | | | |
| | Cooling water capacity | | ℓ | 0.6 (for engine only) | | | | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Discharge type, 5 × ϕ290 | | | | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ95/ϕ85 | | | | | | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | | | | |
| | *1 Dimensions L × W × H | | mm | 373.5 × 417 × 498 / 383.5 × 417 × 498 | | | | | | 383.5 × 409 × 540 | | 373.5 × 417 × 540 / 383.5 × 417 × 540 | | |
| | *1 Dry weight | | kg | 55 / 65 | | | | | | 65 | | 55 / 65 | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤12 | | | | | | ≤10 | | ≤12 | | |
| | | Steady state speed band | % | ≤9 | ≤8 | | ≤7 | | ≤6 | ≤5 | | ≤7 | | |
| | | Recovery time | sec | ≤6 | | | | | | | | | | |
| | | Fluctuation of revolution | rpm | ≤30 | | | | | | ≤20 | | ≤30 | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.25±0.05 (2.5±0.5) | | 0.29±0.05 (3.0±0.5) | | | 0.34±0.05 (3.5±0.5) | | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | | | | |

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-2 3TNE68

* **Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| Item | | | Model / Unit | 3TNE68 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | VM | | | | | | CH | | VH | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | | | | |
| | Combustion system | | — | Special swirl pre-combustion chamber | | | | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 3 – 68 × 72 | | | | | | | | | | |
| | Displacement | | ℓ | 0.784 | | | | | | | | | | |
| | Firing order | | — | 1 – 3 – 2 – 1 | | | | | | | | | | |
| | Revolution speed | | rpm | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3000 | 3600 | 3200 | 3400 | 3600 |
| | Output* | Continuous rating | kW(HP) | — | — | — | — | — | — | 11.7 (15.7) | 13.7 (18.4) | — | — | — |
| | | Max. rating | kW(HP) | 8.6 (11.5) | 9.4 (12.6) | 10.3 (13.8) | 11.2 (15.0) | 12.0 (16.1) | 12.9 (17.3) | 12.9 (17.3) | 15.1 (20.2) | 13.1 (17.6) | 13.8 (18.5) | 14.5 (19.4) |
| | Max. revolution speed at no load | | rpm | $2180^{+50}_{0}$ | $2375^{+50}_{0}$ | $2570^{+50}_{0}$ | $2780^{+50}_{0}$ | $2970^{+50}_{0}$ | $3180^{+50}_{0}$ | $3180^{+50}_{0}$ | $3780^{+50}_{0}$ | $3455^{+50}_{0}$ | $3670^{+50}_{0}$ | $3890^{+50}_{0}$ |
| | Min. revolution speed at no load | | | ≤800 | | | | | | ≤1500 | | ≤800 | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | | | | |
| | Compression ratio | | — | 23.0 | | | | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 14±1 | | | | | | 16±1 | | | | |
| | Compression pressure | | MPa (kgf/cm²) | 3.24±0.1 (33±1), at 250 rpm | | | | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $11.8^{+1.0}_{0}$ ($120^{+10}_{0}$) | | | | | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.) | | | | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 2.4/1.0 | | | | | | 3.0/1.0 | | | | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | | | | |
| | Cooling water capacity | | ℓ | 0.9 (for engine only) | | | | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Pusher type, 5 × φ310 | | | | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | φ105/φ85 | | | | | | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | | | | |
| | *1 Dimensions L × W × H | | mm | 463.5 × 401 × 496 / 473.5 × 401 × 496 | | | | | | 473.5 × 401 × 496 | | 463.5 × 401 × 496/ 473.5 × 401 × 496 | | |
| | *1 Dry weight | | kg | 70 / 81 | | | | | | 81 | | 70 / 81 | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤12 | | | | | | ≤10 | | ≤12 | | |
| | | Steady state speed band | % | ≤9 | ≤8 | ≤7 | | ≤6 | | ≤5 | | ≤8 | | |
| | | Recovery time | sec | ≤6 | | | | | | | | | | |
| | | Fluctuation of revolution | rpm | ≤30 | | | | | | ≤20 | | ≤30 | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.25±0.05 (2.5±0.5) | | 0.29±0.05 (3.0±0.5) | | | 0.34±0.05 (3.5±0.5) | | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | | | | |

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-3 3TNE74

*Output conditions: Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| Item | | | Model / Unit | 3TNE74 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | VM | | | | | | CH | | VH | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | | | | |
| | Combustion system | | — | Special swirl pre-combustion chamber | | | | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 3 – 74 × 78 | | | | | | | | | | |
| | Displacement | | ℓ | 1.006 | | | | | | | | | | |
| | Firing order | | — | 1 – 3 – 2 – 1 | | | | | | | | | | |
| | Revolution speed | | rpm | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3000 | 3600 | 3200 | 3400 | 3600 |
| | Output* | Continuous rating | kW(HP) | — | — | — | — | — | — | 15.1 (20.2) | 17.4 (23.3) | — | — | — |
| | | Max. rating | kW(HP) | 11.0 (14.8) | 12.1 (16.2) | 13.2 (17.7) | 14.3 (19.2) | 15.5 (20.8) | 16.6 (22.3) | 16.6 (22.3) | 19.1 (25.6) | 16.6 (22.3) | 17.1 (22.9) | 17.7 (23.7) |
| | Max. revolution speed at no load | | rpm | $2180^{+50}_{0}$ | $2375^{+50}_{0}$ | $2570^{+50}_{0}$ | $2780^{+50}_{0}$ | $2970^{+50}_{0}$ | $3180^{+50}_{0}$ | $3180^{+50}_{0}$ | $3780^{+50}_{0}$ | $3455^{+50}_{0}$ | $3670^{+50}_{0}$ | $3890^{+50}_{0}$ |
| | Min. revolution speed at no load | | | ≤800 | | | | | | ≤1500 | | ≤800 | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | | | | |
| | Power take off | | — | Fly- heel | | | | | | | | | | |
| | Compression ratio | | — | 23.0 | | | | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 14±1 | | | | | | 16±1 | | | | |
| | Compression pressure | | MPa (kgf/cm²) | 3.43±0.1 (35±1), at 250 rpm | | | | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $11.8^{+1.0}_{0}$ ($120^{+10}_{0}$) | | | | | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.: 45 min.) | | | | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 2.4/1.0 | | | | | | 3.3/1.4 | | | | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | | | | |
| | Cooling water capacity | | ℓ | 0.9 (for engine only) | | | | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Pusher type, 5 × ϕ310 | | | | | | Pusher type, 6 × ϕ335 | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ110/ϕ85 | | | | | | ϕ110/ϕ97 | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | | | | |
| | *1 Dimensions L × W × H | | mm | 469.1 × 440 × 502 / 476.6 × 440 × 502 | | | | | | 476.6 × 440 × 502 | | 469.1 × 440 × 502/ 476.6× 440 × 502 | | |
| | *1 Dry weight | | kg | 85 /102 | | | | | | 100 | | 85 / 100 | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤12 | | | | | | ≤10 | | ≤12 | | |
| | | Steady state speed band | % | ≤9 | ≤8 | | ≤7 | | ≤6 | ≤5 | | ≤8 | | |
| | | Recovery time | sec | ≤6 | | | | | | | | | | |
| | | Fluctuation of revolution | rpm | ≤30 | | | | | | ≤20 | | ≤30 | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.25±0.05 (2.5±0.5) | | 0.29±0.05 (3.0±0.5) | | | 0.34±0.05 (3.5±0.5) | | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | | | | |

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-4 3TNE78A

***Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| Item | | | Model / Unit | 3TNE78A | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | CL | | VM | | | | | | CH | | VH | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | | | | | | |
| | Combustion system | | — | Direct injection system | | | | | | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 3 – 78 × 84 | | | | | | | | | | | | |
| | Displacement | | ℓ | 1.204 | | | | | | | | | | | | |
| | Firing order | | — | 1 – 3 – 2 – 1 | | | | | | | | | | | | |
| | Revolution speed | | rpm | 1500 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3000 | 3600 | 3200 | 3400 | 3600 |
| | Output* | Continuous rating | kW(HP) | 9.1 (12.2) | 10.8 (14.5) | — | — | — | — | — | — | 18.0 (24.1) | 21.0 (28.2) | — | — | — |
| | | Max. rating | kW(HP) | 9.9 (13.3) | 11.9 (16.0) | 13.2 (17.7) | 14.6 (19.6) | 15.9 (21.3) | 17.2 (23.1) | 18.5 (24.8) | 19.9 (26.7) | 19.9 (26.7) | 23.2 (31.1) | 20.5 (27.5) | 21.6 (29.0) | 23.2 (31.1) |
| | Max. revolution speed at no load | | rpm | $1575^{+50}_{0}$ | $1870^{+50}_{0}$ | $2180^{+50}_{0}$ | $2375^{+50}_{0}$ | $2570^{+50}_{0}$ | $2780^{+50}_{0}$ | $2970^{+50}_{0}$ | $3180^{+50}_{0}$ | $3150^{+50}_{0}$ | $3745^{+50}_{0}$ | $3455^{+50}_{0}$ | $3670^{+50}_{0}$ | $3890^{+50}_{0}$ |
| | Min. revolution speed at no load | | | ≤1200 | | ≤800 | | | | | | ≤1500 | | ≤800 | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | | | | | | |
| | Compression ratio | | — | 18.0 | | | | | | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 10±1 | | 12±1 | | 14±1 | | 16±1 | | 24±1 | | 18±1 | 20±1 | 24±1 |
| | Compression pressure | | MPa (kgf/cm²) | 3.14±0.1 (32±1), at 250 rpm | | | | | | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.: 45 min.) | | | | | | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 3.6/1.3 | | | | | | | | 5.0/1.7 | | | | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | | | | | | |
| | Cooling water capacity | | ℓ | 1.8 (for engine only) | | | | | | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Pusher type, 6 × ϕ335 | | | | | | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ120/ϕ90 | | ϕ110/ϕ110 | | | | | | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | | | | | | |
| | *1 Dimensions L × W × H | | mm | 553×489×565 | | 520.5 × 489 × 565 / 528 × 489 × 565 | | | | | | 528 × 489 × 565 | | 520.5 × 489 × 565/ 528 × 489 × 565 | | |
| | *1 Dry weight | | kg | 138 | | 112/128 | | | | | | 124 | | 112 / 124 | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤10 | ≤8 | ≤12 | | | | | | ≤10 | ≤8 | ≤12 | | |
| | | Steady state speed band | % | ≤5 | ≤4 | ≤9 | ≤8 | ≤7 | | ≤6 | | ≤5 | ≤4 | ≤8 | | |
| | | Recovery time | sec | ≤5 | | ≤6 | | | | | | ≤5 | | ≤6 | | |
| | | Fluctuation of revolution | rpm | ≤15 | | ≤25 | | | | | | ≤30 | | | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.29±0.05 (3.0±0.5) | | | | | | | | 0.34±0.05 (3.5±0.5) | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | | | | | | |

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-5 3TNE82A

*** Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| | Item | | Model / Unit | 3TNE82A | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | CL | | VM | | | | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | |
| | Combustion system | | — | Direct injection system | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 3 – 82 × 84 | | | | | | | |
| | Displacement | | ℓ | 1.330 | | | | | | | |
| | Firing order | | — | 1 – 3 – 2 – 1 | | | | | | | |
| | Revolution speed | | rpm | 1500 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 |
| | Output* | Continuous rating | kW(HP) | 9.9 (13.3) | 12.0 (16.1) | — | — | — | — | — | — |
| | | Max. rating | kW(HP) | 11.0 (14.8) | 13.2 (17.7) | 14.6 (19.6) | 16.0 (21.5) | 17.5 (23.5) | 19.0 (25.5) | 20.5 (27.5) | 21.9 (29.4) |
| | Max. revolution speed at no load | | rpm | $1575^{+50}_{0}$ | $1870^{+50}_{0}$ | $2180^{+50}_{0}$ | $2375^{+50}_{0}$ | $2570^{+50}_{0}$ | $2780^{+50}_{0}$ | $2970^{+50}_{0}$ | $3180^{+50}_{0}$ |
| | Min. revolution speed at no load | | | ≤1200 | | ≤800 | | | | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | |
| | Compression ratio | | — | 18.0 | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 10±1 | | 12±1 | | 14±1 | | 16±1 | |
| | Compression pressure | | MPa (kgf/cm²) | 3.04±0.1 (31±1), at 250 rpm | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.) | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 3.6/1.3 | | 5.0/1.7 | | | | | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | |
| | Cooling water capacity | | ℓ | 1.8 (for engine only) | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Pusher type, 6 × ϕ335 | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ120/ϕ90 | | ϕ110/ϕ110 | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | |
| | *1 Dimensions L × W × H | | mm | 553 × 489 × 565 | | 520.5 × 489 × 565 / 528 × 489 × 565 | | | | | |
| | *1 Dry weight | | kg | 138 | | 112/128 | | | | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤10 | ≤8 | ≤12 | | | | | |
| | | Steady state speed band | % | ≤5 | ≤4 | ≤9 | ≤8 | ≤7 | | ≤6 | |
| | | Recovery time | sec | ≤5 | | ≤6 | | | | | |
| | | Fluctuation of revolution | rpm | ≤15 | | ≤25 | | | | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.25 ± 0.05 (2.5 ± 0.5) | | 0.29±0.05 (3.0±0.5) | | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | |

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-6 3TNE82

*** Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| Item | | | Model / Unit | 3TNE82 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | CL | | VM | | | | | | CH | | VH | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | | | | | | |
| | Combustion system | | — | Direct injection system | | | | | | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 3 – 82 × 90 | | | | | | | | | | | | |
| | Displacement | | ℓ | 1.425 | | | | | | | | | | | | |
| | Firing order | | — | 1 – 3 – 2 – 1 | | | | | | | | | | | | |
| | Revolution speed | | rpm | 1500 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3000 | 3600 | 3200 | 3400 | 3600 |
| | Output* | Continuous rating | kW(HP) | 10.5 (14.1) | 12.7 (17.0) | — | — | — | — | — | — | 21.0 (28.2) | 24.4 (32.7) | — | — | — |
| | | Max. rating | kW(HP) | 11.6 (15.6) | 14.0 (18.8) | 15.5 (20.8) | 16.9 (22.7) | 18.4 (24.7) | 19.9 (26.7) | 21.3 (28.6) | 23.2 (31.1) | 23.2 (31.1) | 26.9 (36.1) | 24.4 (32.7) | 25.6 (34.3) | 26.9 (36.1) |
| | Max. revolution speed at no load | | rpm | $1570^{+50}_{0}$ | $1870^{+50}_{0}$ | $2160^{+50}_{0}$ | $2375^{+50}_{0}$ | $2570^{+50}_{0}$ | $2780^{+50}_{0}$ | $2970^{+50}_{0}$ | $3180^{+50}_{0}$ | $3150^{+50}_{0}$ | $3745^{+50}_{0}$ | $3455^{+50}_{0}$ | $3670^{+50}_{0}$ | $3890^{+50}_{0}$ |
| | Min. revolution speed at no load | | rpm | ≤1200 | | ≤800 | | | | | | ≤1500 | | ≤800 | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | | | | | | |
| | Compression ratio | | — | 18.0 | | | | | | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 10±1 | | 12±1 | | 14±1 | | 16±1 | | 24±1 | | 18±1 | 20±1 | 24±1 |
| | Compression pressure | | MPa (kgf/cm²) | 3.04 ± 0.1 (31 ± 1), at 250 rpm | | | | | | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.) | | | | | | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 4.7/1.8 | | | | | | | | 6.9/2.1 | | | | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | | | | | | |
| | Cooling water capacity | | ℓ | 2.0 (for engine only) | | | | | | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Pusher type, 6 × ϕ335 | | | | | | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ120/ϕ90 | | ϕ110/ϕ110 | | | | | | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | | | | | | |
| | *1 Dimensions L × W × H | | mm | 589×486×623 | | 556 × 486 × 623 / 564 × 486 × 623 | | | | | | 564 × 486 × 623 | | 556 × 486 × 623 / 564 × 486 × 623 | | |
| | *1 Dry weight | | kg | 161 | | 138/155 | | | | | | 149 | | 138/149 | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤10 | ≤8 | ≤12 | | | | | | ≤10 | ≤8 | ≤12 | | |
| | | Steady state speed band | % | ≤5 | ≤4 | ≤8 | | ≤7 | | ≤6 | | ≤5 | ≤4 | ≤8 | | |
| | | Recovery time | sec | ≤5 | | ≤6 | | | | | | ≤5 | | ≤6 | | |
| | | Fluctuation of revolution | rpm | ≤15 | | ≤25 | | | | | | ≤30 | | | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.29±0.05 (3.0±0.5) | | 0.34±0.05 (3.5±0.5) | | | | | | | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | | | | | | |

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-7 3TNE84

∗ **Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| Item | | | Model / Unit | 3TNE84 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | CL | | VM | | | | | | CH | | VH | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | | | | | | |
| | Combustion system | | — | Direct injection system | | | | | | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 3 – 84 × 90 | | | | | | | | | | | | |
| | Displacement | | ℓ | 1.496 | | | | | | | | | | | | |
| | Firing order | | — | 1 – 3 – 2 – 1 | | | | | | | | | | | | |
| | Revolution speed | | rpm | 1500 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3000 | 3600 | 3200 | 3400 | 3600 |
| | Output* | Continuous rating | kW(HP) | 11.3 (15.2) | 13.5 (18.1) | — | — | — | — | — | — | 22.4 (30.0) | 26.1 (35.0) | — | — | — |
| | | Max. rating | kW(HP) | 12.4 (16.6) | 14.8 (19.8) | 16.4 (22.0) | 18.1 (24.3) | 19.7 (26.4) | 21.3 (28.6) | 23.0 (30.8) | 24.6 (33.0) | 24.6 (33.0) | 28.7 (38.5) | 25.6 (34.3) | 27.0 (36.2) | 28.3 (38.0) |
| | Max. revolution speed at no load | | rpm | $1600^{+50}_{0}$ | $1900^{+50}_{0}$ | $2175^{+50}_{0}$ | $2375^{+50}_{0}$ | $2600^{+50}_{0}$ | $2800^{+50}_{0}$ | $3000^{+50}_{0}$ | $3225^{+50}_{0}$ | $3200^{+50}_{0}$ | $3800^{+50}_{0}$ | $3455^{+50}_{0}$ | $3670^{+50}_{0}$ | $3870^{+50}_{0}$ |
| | Min. revolution speed at no load | | | ≤1200 | | ≤800 | | | | | | ≤1500 | | ≤800 | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | | | | | | |
| | Compression ratio | | — | 18.0 | | | | | | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 10±1 | | 12±1 | | 14±1 | | 16±1 | | 24±1 | | 18±1 | 20±1 | 24±1 |
| | Compression pressure | | MPa (kgf/cm²) | 3.24 ± 0.1 (33 ± 1), at 250 rpm | | | | | | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.) | | | | | | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 4.7/1.8 | | | | | | | | 6.9/2.1 | | | | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | | | | | | |
| | Cooling water capacity | | ℓ | 2.0 (for engine only) | | | | | | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Pusher type, 6 × ϕ335 | | | | | | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ120/ϕ90 | | ϕ110/ϕ110 | | | | | | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | | | | | | |
| | ∗1 Dimensions L × W × H | | mm | 589×486×623 | | 556 × 486 × 623 / 564 × 486 × 623 | | | | | | 564 × 486 × 623 | | 556 × 486 × 623/ 564× 486 × 623 | | |
| | ∗1 Dry weight | | kg | 161 | | 138/155 | | | | | | 149 | | 138 / 149 | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤10 | ≤8 | ≤12 | | | | | | ≤10 | ≤8 | ≤12 | | |
| | | Steady state speed band | % | ≤5 | ≤4 | ≤9 | | ≤8 | | ≤7 | | ≤5 | ≤4 | ≤8 | | |
| | | Recovery time | sec | ≤5 | | ≤6 | | | | | | ≤5 | | ≤6 | | |
| | | Fluctuation of revolution | rpm | ≤15 | | ≤25 | | | | | | ≤30 | | | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.29±0.05 (3.0±0.5) | | 0.34±0.05 (3.5±0.5) | | | | | | 0.39±0.05 (4.0±0.5) | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | | | | | | |

∗1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-8 3TNE88

*** Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| Item | | | Model / Unit | 3TNE88 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | CL | | VM | | | | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | |
| | Combustion system | | — | Direct injection system | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 3 – 88 × 90 | | | | | | | |
| | Displacement | | ℓ | 1.642 | | | | | | | |
| | Firing order | | — | 1 – 3 – 2 – 1 | | | | | | | |
| | Revolution speed | | rpm | 1500 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 |
| | Output* | Continuous rating | kW(HP) | 12.3 (16.5) | 14.8 (19.8) | — | — | — | — | — | — |
| | | Max. rating | kW(HP) | 13.5 (18.1) | 16.3 (21.9) | 18.0 (24.1) | 19.9 (26.7) | 21.6 (29.0) | 23.5 (31.5) | 25.2 (33.8) | 27.1 (36.3) |
| | Max. revolution speed at no load | | rpm | $1600^{+50}_{0}$ | $1900^{+50}_{0}$ | $2175^{+50}_{0}$ | $2375^{+50}_{0}$ | $2600^{+50}_{0}$ | $2800^{+50}_{0}$ | $3000^{+50}_{0}$ | $3225^{+50}_{0}$ |
| | Min. revolution speed at no load | | rpm | ≤1200 | | ≤800 | | | | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | |
| | Compression ratio | | — | 18.0 | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 10±1 | | 12±1 | | 14±1 | | 16±1 | |
| | Compression pressure | | MPa (kgf/cm²) | 3.43 ± 0.1 (35 ± 1), at 250 rpm | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.) | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 4.7/1.8 | | | | | | 6.9/2.1 | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | |
| | Cooling water capacity | | ℓ | 2.0 (for engine only) | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Pusher type, 6 × ϕ335 | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ120/ϕ90 | | ϕ110/ϕ110 | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | |
| | *1 Dimensions L × W × H | | mm | 589 × 486 × 623 | | 556 × 486 × 623 / 564 × 486 × 623 | | | | | |
| | *1 Dry weight | | kg | 161 | | 138/155 | | | | | |
| PERFORMANCE | Governing performance (full speed range) | Transient speed difference | % | ≤10 | ≤8 | ≤12 | | | | | |
| | | Steady state speed band | % | ≤5 | ≤4 | ≤9 | | ≤8 | | ≤7 | |
| | | Recovery time | sec | ≤5 | | ≤6 | | | | | |
| | | Fluctuation of revolution | rpm | ≤15 | | ≤25 | | | | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.29 ± 0.05 (3.0 ± 0.5) | | 0.34±0.05 (3.5±0.5) | | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | |

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-9 4TNE82

* **Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| Item | | | Model / Unit | 4TNE82 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | CL | | VM | | | | | | CH | | VH | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | | | | | | |
| | Combustion system | | — | Direct injection system | | | | | | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 4 – 82 × 90 | | | | | | | | | | | | |
| | Displacement | | ℓ | 1.901 | | | | | | | | | | | | |
| | Firing order | | — | 1 – 3 – 4 – 2 – 1 | | | | | | | | | | | | |
| | Revolution speed | | rpm | 1500 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3000 | 3600 | 3200 | 3400 | 3600 |
| | Output* | Continuous rating | kW(HP) | 14.3 (19.2) | 17.1 (22.9) | — | — | — | — | — | — | 27.7 (37.1) | 32.7 (43.9) | — | — | — |
| | | Max. rating | kW(HP) | 15.7 (21.1) | 18.8 (25.2) | 20.6 (27.6) | 22.6 (30.3) | 24.5 (32.9) | 26.5 (35.5) | 28.5 (38.2) | 30.5 (40.9) | 30.5 (40.9) | 36.0 (48.3) | 32.4 (43.4) | 34.2 (45.9) | 36.0 (48.3) |
| | Max. revolution speed at no load | | rpm | $1575^{+50}_{0}$ | $1870^{+50}_{0}$ | $2160^{+50}_{0}$ | $2375^{+50}_{0}$ | $2570^{+50}_{0}$ | $2780^{+50}_{0}$ | $2970^{+50}_{0}$ | $3180^{+50}_{0}$ | $3150^{+50}_{0}$ | $3745^{+50}_{0}$ | $3455^{+50}_{0}$ | $3670^{+50}_{0}$ | $3890^{+50}_{0}$ |
| | Min. revolution speed at no load | | | ≤1200 | | ≤800 | | | | | | ≤1500 | | ≤800 | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | | | | | | |
| | Compression ratio | | — | 18.0 | | | | | | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 10±1 | | 12±1 | | 14±1 | | 16±1 | | 24±1 | | 18±1 | 20±1 | 24±1 |
| | Compression pressure | | MPa (kgf/cm²) | 3.04±0.1 (31±1), at 250 rpm | | | | | | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.) | | | | | | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 5.8/2.3 | | | | | | | | 7.9/2.5 | | | | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | | | | | | |
| | Cooling water capacity | | ℓ | 2.7 (for engine only) | | | | | | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Pusher type, 6 × ϕ370 | | | | | | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ120/ϕ90 | | ϕ110/ϕ110 | | | | | | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | | | | | | |
| | *1 Dimensions L × W × H | | mm | 683 × 498.5 × 618 | | 632 × 448.5 × 618 / 658 × 498.5 × 618 | | | | | | 658 × 498.5 × 618 | | 650 × 498.5 × 618 / 658 × 498 × 618 | | |
| | *1 Dry weight | | kg | 184 | | 160/170 | | | | | | 170 | | 160/170 | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤10 | ≤8 | ≤12 | | | | | | ≤10 | ≤8 | ≤12 | | |
| | | Steady state speed band | % | ≤5 | ≤4 | ≤8 | | ≤7 | | ≤6 | | ≤5 | ≤4 | ≤8 | | |
| | | Recovery time | sec | ≤5 | | ≤6 | | | | | | ≤5 | | ≤6 | | |
| | | Fluctuation of revolution | rpm | ≤15 | | ≤25 | | | | | | ≤30 | | | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.29±0.05 (3.0±0.5) | | 0.34±0.05 (3.5±0.5) | | | | | | | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | | | | | | |

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-10. 4TNE84

*** Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| Item | | | Model / Unit | 4TNE84 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | CL | | VM | | | | | | CH | | VH | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | | | | | | |
| | Combustion system | | — | Direct injection system | | | | | | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 4 – 84 × 90 | | | | | | | | | | | | |
| | Displacement | | ℓ | 1.995 | | | | | | | | | | | | |
| | Firing order | | — | 1 – 3 – 4 – 2 – 1 | | | | | | | | | | | | |
| | Revolution speed | | rpm | 1500 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3000 | 3600 | 3200 | 3400 | 3600 |
| | Output* | Continuous rating | kW(HP) | 14.9 (20.0) | 17.7 (23.7) | — | — | — | — | — | — | 29.9 (40.1) | 34.7 (46.5) | — | — | — |
| | | Max. rating | kW(HP) | 16.4 (22.0) | 19.5 (26.1) | 21.9 (29.4) | 24.1 (32.3) | 26.3 (35.3) | 28.5 (38.2) | 30.7 (41.2) | 32.9 (44.1) | 32.9 (44.1) | 38.2 (51.2) | 33.9 (45.5) | 35.8 (48.0) | 38.2 (51.2) |
| | Max. revolution speed at no load | | rpm | $1575^{+50}_{0}$ | $1870^{+50}_{0}$ | $2180^{+50}_{0}$ | $2400^{+50}_{0}$ | $2590^{+50}_{0}$ | $2810^{+50}_{0}$ | $2995^{+50}_{0}$ | $3210^{+50}_{0}$ | $3150^{+50}_{0}$ | $3745^{+50}_{0}$ | $3455^{+50}_{0}$ | $3670^{+50}_{0}$ | $3890^{+50}_{0}$ |
| | Min. revolution speed at no load | | | ≤1200 | | ≤800 | | | | | | ≤1500 | | ≤800 | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | | | | | | |
| | Compression ratio | | — | 18.0 | | | | | | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 10±1 | | 12±1 | | 14±1 | | 16±1 | | 24±1 | | 18±1 | 20±1 | 24±1 |
| | Compression pressure | | MPa (kgf/cm²) | 3.24±0.1 (33±1), at 250 rpm | | | | | | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.) | | | | | | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 5.8/2.3 | | | | | | | | 7.9/2.5 | | | | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | | | | | | |
| | Cooling water capacity | | ℓ | 2.7 (for engine only) | | | | | | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Pusher type, 6 × ϕ370 | | | | | | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ120/ϕ90 | | ϕ110/ϕ110 | | | | | | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | | | | | | |
| | *1 Dimensions L × W × H | | mm | 683 × 498.5 × 618 | | 632 × 498.5 × 618/658 × 498.5 × 618 | | | | | | 658 × 498.5 × 618 | | 650 × 498.5 × 618/ 658 × 498.5 × 618 | | |
| | *1 Dry weight | | kg | 184 | | 160/170 | | | | | | 170 | | 160 / 170 | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤10 | ≤8 | ≤12 | | | | | | ≤10 | ≤8 | ≤12 | | |
| | | Steady state speed band | % | ≤5 | ≤4 | ≤9 | | ≤8 | | ≤7 | | ≤5 | ≤4 | ≤8 | | |
| | | Recovery time | sec | ≤5 | | ≤6 | | | | | | ≤5 | | ≤6 | | |
| | | Fluctuation of revolution | rpm | ≤15 | | ≤25 | | | | | | ≤30 | | | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.29±0.05 (3.0±0.5) | | 0.34±0.05 (3.5±0.5) | | | | | | | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | | | | | | |

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-11. 4TNE88

∗ **Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| Item | | | Model / Unit | 4TNE88 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | CL | | VM | | | | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | |
| | Combustion system | | — | Direct injection system | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 4 – 88 × 90 | | | | | | | |
| | Displacement | | ℓ | 2.189 | | | | | | | |
| | Firing order | | — | 1 – 3 – 4 – 2 – 1 | | | | | | | |
| | Revolution speed | | rpm | 1500 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 |
| | Output* | Continuous rating | kW(HP) | 16.4 (22.0) | 19.6 (26.3) | — | — | — | — | — | — |
| | | Max. rating | kW(HP) | 18.0 (24.1) | 21.6 (29.0) | 24.1 (32.3) | 26.5 (35.5) | 28.8 (38.6) | 31.3 (42.0) | 33.7 (45.2) | 36.0 (48.3) |
| | Max. revolution speed at no load | | rpm | $1575^{+50}_{0}$ | $1870^{+50}_{0}$ | $2180^{+50}_{0}$ | $2400^{+50}_{0}$ | $2590^{+50}_{0}$ | $2810^{+50}_{0}$ | $2995^{+50}_{0}$ | $3210^{+50}_{0}$ |
| | Min. revolution speed at no load | | | ≤1200 | | ≤800 | | | | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | |
| | Compression ratio | | — | 18.0 | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 10±1 | | 12±1 | | 14±1 | | 16±1 | |
| | Compression pressure | | MPa (kgf/cm²) | 3.43±0.1 (35±1), at 250 rpm | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.) | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 5.8/2.3 | | | | | | 7.9/2.5 | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | |
| | Cooling water capacity | | ℓ | 2.7 (for engine only) | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Pusher type, 6 × ϕ370 | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ120/ϕ90 | | ϕ110/ϕ110 | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | |
| | ∗1 Dimensions L × W × H | | mm | 683 × 498.5 × 618 | | 632 × 498.5 × 618 / 658 × 498.5 × 618 | | | | | |
| | ∗1 Dry weight | | kg | 184 | | 160 /170 | | | | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤10 | ≤8 | ≤12 | | | | | |
| | | Steady state speed band | % | ≤5 | ≤4 | ≤9 | | ≤8 | | ≤7 | |
| | | Recovery time | sec | ≤5 | | ≤6 | | | | | |
| | | Fluctuation of revolution | rpm | ≤15 | | ≤25 | | | | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.29 ± 0.05 (3.0 ± 0.5) | | 0.34±0.05 (3.5±0.5) | | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | |

∗1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-12. 3TNE84T

*** Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

| Item | | | Model / Unit | 3TNE84T | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | CL | | VM | | | | | | CH | | VH | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | | | | | | |
| | Combustion system | | — | Direct injection system | | | | | | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 3 – 84 × 90 | | | | | | | | | | | | |
| | Displacement | | ℓ | 1.496 | | | | | | | | | | | | |
| | Firing order | | — | 1 – 3 – 2 – 1 | | | | | | | | | | | | |
| | Revolution speed | | rpm | 1500 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3000 | 3600 | 3200 | 3400 | 3600 |
| | Output* | Continuous rating | kW(HP) | 14.0 (18.8) | 16.6 (22.3) | — | — | — | — | — | — | 28.0 (37.5) | 30.5 (40.9) | — | — | — |
| | | Max. rating | kW(HP) | 15.8 (21.2) | 18.8 (25.2) | 21.0 (28.2) | 22.8 (30.6) | 25.0 (33.5) | 26.9 (36.1) | 29.1 (39.0) | 30.9 (41.4) | 30.9 (41.4) | 34.2 (45.9) | 32.0 (42.9) | 33.1 (44.4) | 34.2 (45.9) |
| | Max. revolution speed at no load | | rpm | $1600^{+50}_{0}$ | $1900^{+50}_{0}$ | $2175^{+50}_{0}$ | $2375^{+50}_{0}$ | $2600^{+50}_{0}$ | $2800^{+50}_{0}$ | $3020^{+50}_{0}$ | $3240^{+50}_{0}$ | — | — | — | — | — |
| | Min. revolution speed at no load | | | $1200^{+50}_{0}$ | | $\leq 800^{+50}_{0}$ | | | | | | — | | — | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | | | | | | |
| | Compression ratio | | — | 18.0 | | | | | | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 10±1 | | 12±1 | | 14±1 | | 16±1 | | — | | — | — | — |
| | Compression pressure | | MPa (kgf/cm²) | 2.94 ± 0.1 (30 ± 1), at 250 rpm | | | | | | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.) | | | | | | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 4.8 / 1.9 | | | | | | | | — | | | | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | | | | | | |
| | Cooling water capacity | | ℓ | 2.0 (for engine only) | | | | | | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Pusher type, 6 × ϕ335 | | | | | | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ110/ϕ90 | | ϕ110/ϕ110 | | | | | | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | | | | | | |
| | *1 Dimensions L × W × H | | mm | 589x54.0x629 | | 632 x 540 x 629 / 632 x 540 x 629 | | | | | | — | | — | | |
| | *1 Dry weight | | kg | 166 | | 147/160 | | | | | | — | | — | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤10 | ≤8 | ≤12 | | | | | | — | — | — | | |
| | | Steady state speed band | % | ≤5 | ≤4 | ≤9 | | ≤8 | | ≤8 | | — | — | — | | |
| | | Recovery time | sec | ≤5 | | ≤6 | | | | | | — | | — | | |
| | | Fluctuation of revolution | rpm | ≤15 | | ≤22 | | | | | | — | | | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.29±0.05 (3.0±0.5) | | 0.34±0.05(3.5±0.5) | | | | | | | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | | | | | | |

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

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# 1-13. 4TNE84T

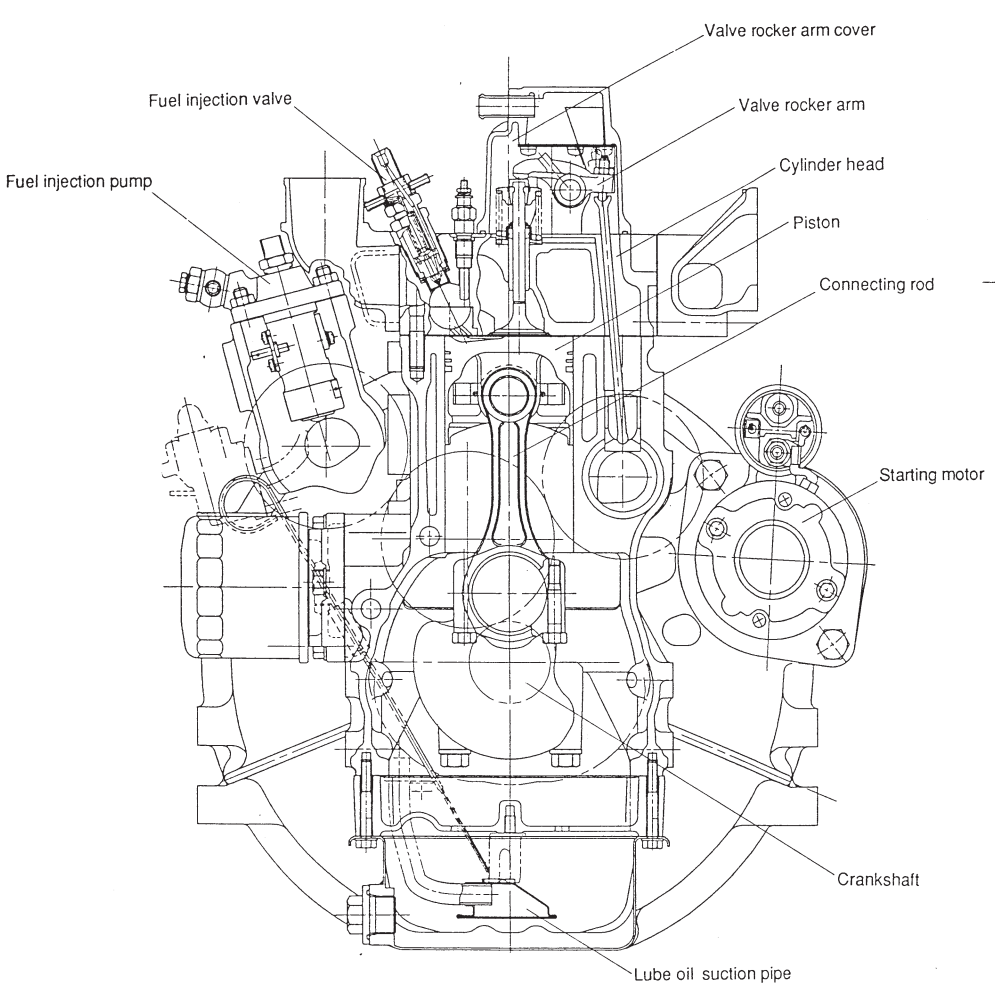
*** Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

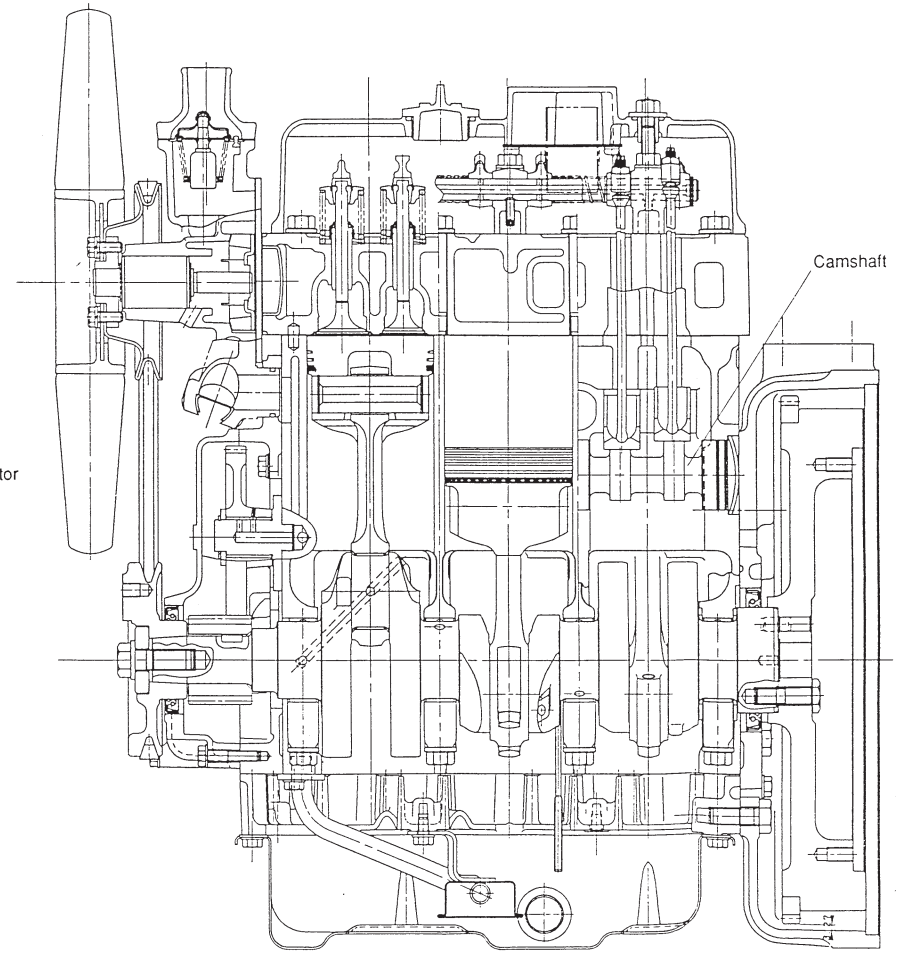
| Item | | | Model / Unit | 4TNE84T | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | Application | | — | CL | | VM | | | | | | CH | | VH | | |
| | Type | | — | Vertical, 4-cycle water-cooled diesel engine | | | | | | | | | | | | |
| | Combustion system | | — | Direct injection system | | | | | | | | | | | | |
| | No. of cylinders – Bore × Stroke | | mm | 4 – 84 × 90 | | | | | | | | | | | | |
| | Displacement | | ℓ | 1.995 | | | | | | | | | | | | |
| | Firing order | | — | 1 – 3 – 4 – 2 – 1 | | | | | | | | | | | | |
| | Revolution speed | | rpm | 1500 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3000 | 3600 | 3200 | 3400 | 3600 |
| | Output* | Continuous rating | kW(HP) | 19.1 (25.6) | 24.3 (32.6) | — | — | — | — | — | — | 37.1 (49.8) | 40.8 (54.7) | — | — | — |
| | | Max. rating | kW(HP) | 21.3 (28.6) | 26.9 (36.1) | 28.0 (37.5) | 30.5 (40.9) | 33.5 (44.9) | 35.7 (47.9) | 38.6 (51.8) | 41.2 (55.3) | 41..2 (55.3) | 45.6 (61.2) | 42.7 (57.3) | 44.1 (59.1) | 45.6 (61.2) |
| | Max. revolution speed at no load | | rpm | $1600^{+50}_{0}$ | $1900^{+50}_{0}$ | $2175^{+50}_{0}$ | $2375^{+50}_{0}$ | $2600^{+50}_{0}$ | $2800^{+50}_{0}$ | $3000^{+50}_{0}$ | $3225^{+50}_{0}$ | — | — | — | — | — |
| | Min. revolution speed at no load | | | $1200^{+50}_{0}$ | | $800^{+50}_{0}$ | | | | | | — | | —— | | |
| | Direction of rotation | | — | Counterclockwise (viewed from flywheel) | | | | | | | | | | | | |
| | Power take off | | — | Flywheel | | | | | | | | | | | | |
| | Compression ratio | | — | 18.0 | | | | | | | | | | | | |
| | Fuel injection timing (FID, b.T.D.C.) | | deg | 10±1 | | 12±1 | | 14±1 | | 16±1 | | — | | — | — | — |
| | Compression pressure | | MPa (kgf/cm²) | 2.94±0.1 (30±1), at 250 rpm | | | | | | | | | | | | |
| | Fuel injection pressure | | MPa (kgf/cm²) | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | $19.6^{+1.0}_{0}$ ($200^{+10}_{0}$) | | | | | | |
| | Recommended diesel gas oil | | — | ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.) | | | | | | | | | | | | |
| | Lubrication system | | — | Forced lubrication with trochoid pump | | | | | | | | | | | | |
| | Lubricating oil capacity Max/Effective | | ℓ | 5.8/2.3 | | | | | | | | —— | | | | |
| | Recommended lubricating oil | | — | API grade CC class or higher | | | | | | | | | | | | |
| | Cooling system | | — | Liquid cooling/Radiator | | | | | | | | | | | | |
| | Cooling water capacity | | ℓ | 2.7 (for engine only) | | | | | | | | | | | | |
| | Cooling fan No. of blade × dia. | | mm | Discharge type, 6 × ϕ370 | | | | | | | | | | | | |
| | Crank V-pulley dia./ Fan V-pulley dia. | | mm | ϕ110/ϕ90 | | ϕ110/ϕ110 | | | | | | | | | | |
| | Governor | | — | Mechanical centrifugal governor (All speed type) | | | | | | | | | | | | |
| | Starting system | | — | Electrical | | | | | | | | | | | | |
| | *1 Dimensions L × W × H | | mm | 674 × 498.5 × 713 | | 641 × 498.5 × 713 / 649 × 498.5 × 713 | | | | | | — | | — | | |
| | *1 Dry weight | | kg | 184 | | 165 / 175 | | | | | | — | | — | | |
| PERFORMANCE | Governing perform-ance (full speed range) | Transient speed difference | % | ≤10 | ≤8 | ≤12 | | | | | | — | — | — | | |
| | | Steady state speed band | % | ≤5 | ≤4 | ≤9 | | ≤8 | | ≤7 | | — | — | —— | | |
| | | Recovery time | sec | ≤5 | | ≤6 | | | | | | — | | — | | |
| | | Fluctuation of revolution | rpm | ≤15 | | ≤22 | | | | | | —— | | | | |
| | L.O. press. | Rated operation | MPa (kgf/cm²) | 0.29±0.05 (3.0±0.5) | | 0.34±0.05 (3.5±0.5) | | | | | | | | | | |
| | | Idling | | ≥0.06 (≥0.6) | | | | | | | | | | | | |

*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

# 2. Cross Sectional Views

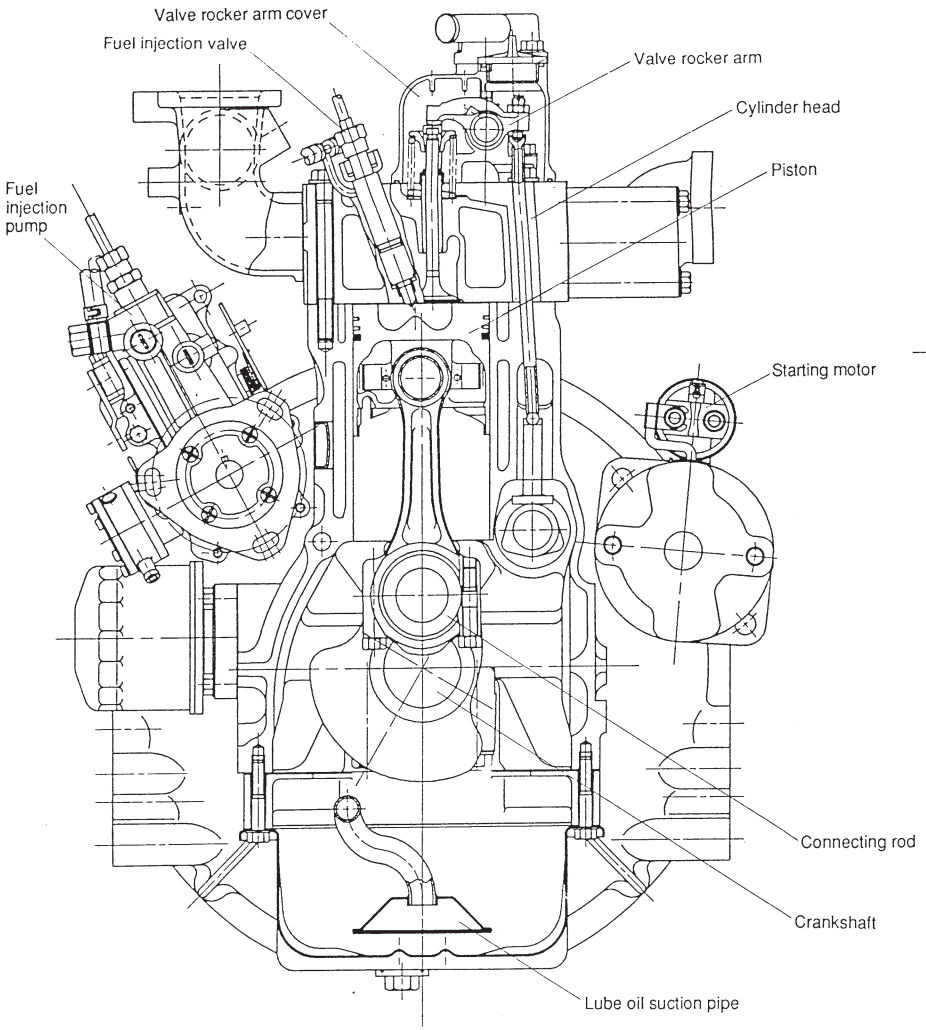
## 2-1. Special Swirl Pre-combustion Chamber System (Indirect Injection System)

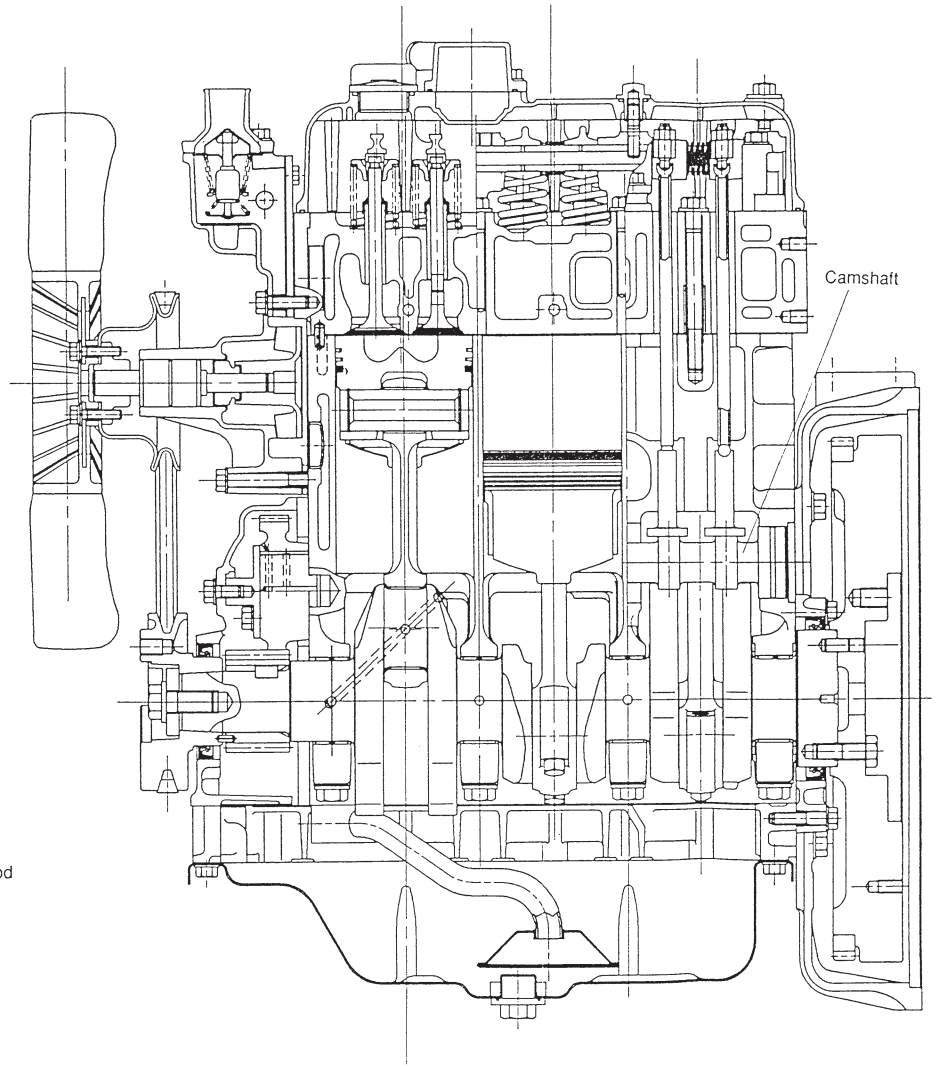



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## 2-2. Direct Injection System




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# 3. Cooling Water, Lubricating Oil and Fuel Oil

## 3-1. Cooling water

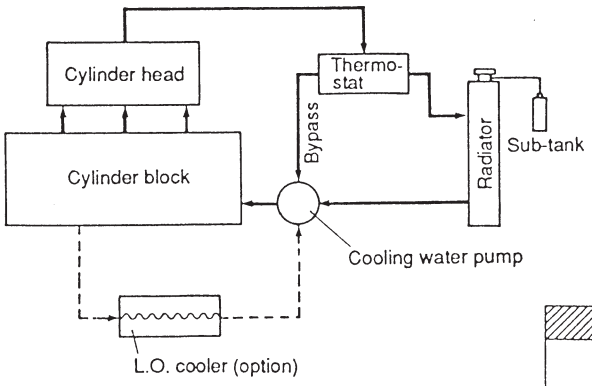
### 1. Proper use of cooling water

Impurities in cooling water are deposited in the engine and radiator in the form of scale and cause rusting. For this reason, heat conduction of the cooling system and cooling water flow are impaired, and cause cooling functions to reduce and the engine to overheat. Therefore, drain the cooling water at intervals of 400 hours or one year. Never use hard water as the cooling water.

In order to prevent the cooling water from freezing in cold weather, be sure to use an antifreeze agent. For further information on and proper usage and type of rust-preventive agents, antifreezes, and cleaning agents, contact your nearest dealer.

### 2. Cooling water system diagram

Indirect injection system and direct injection system




## 3-2. Lubricating oil

### 1. Proper use of lubricating oil

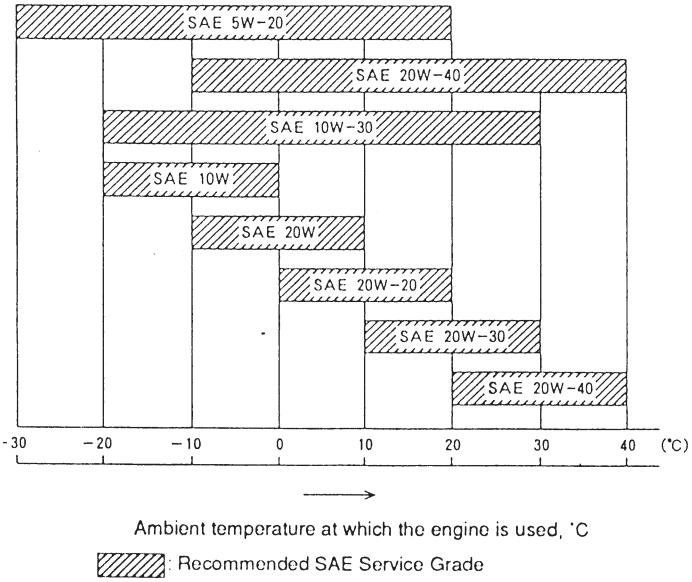
Use of proper lubricating oil brings about the following effects.

(1) The friction part of the engine is protected from friction and wear.
(2) The engine parts is protected from rusting and corrosion.
(3) The high temperature part of the engine is effectively cooled.
(4) The engine is protected from leakage of combustion gas.
(5) The engine parts are protected from sludge deposits.

For the above reasons, use lubricating oil API Service Classification Class CC or better.

**[Reference : Lubricating oil to be used at ambient temperature]**

Select the viscosity of lubricating oil depending on ambient temperature at which the engine is used, according to SAE Service Grade shown below.

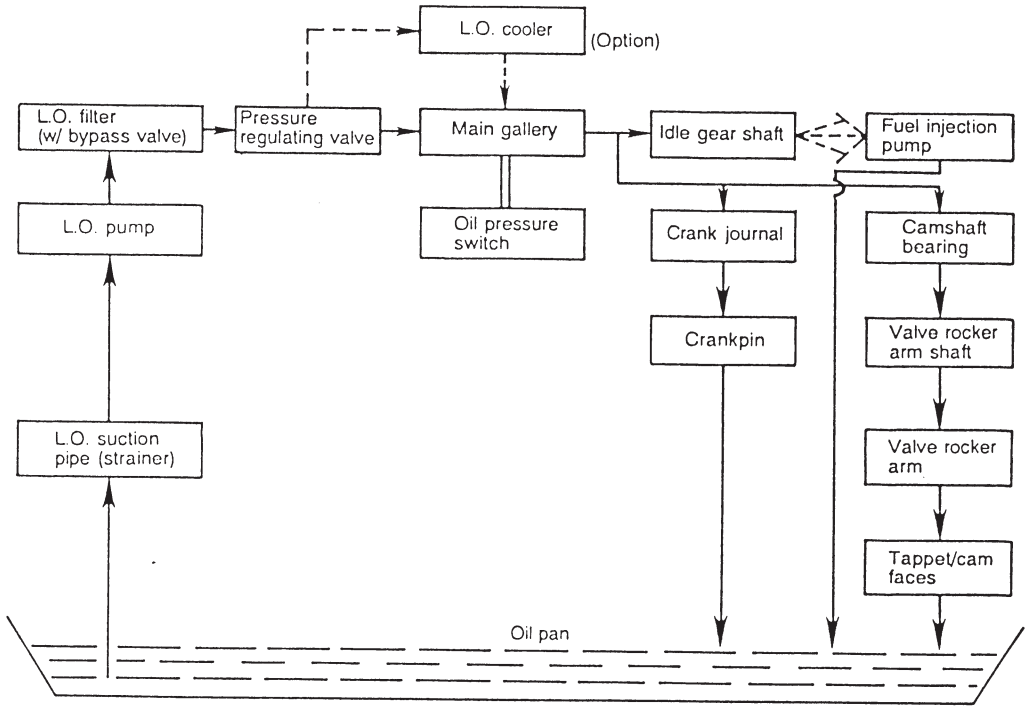


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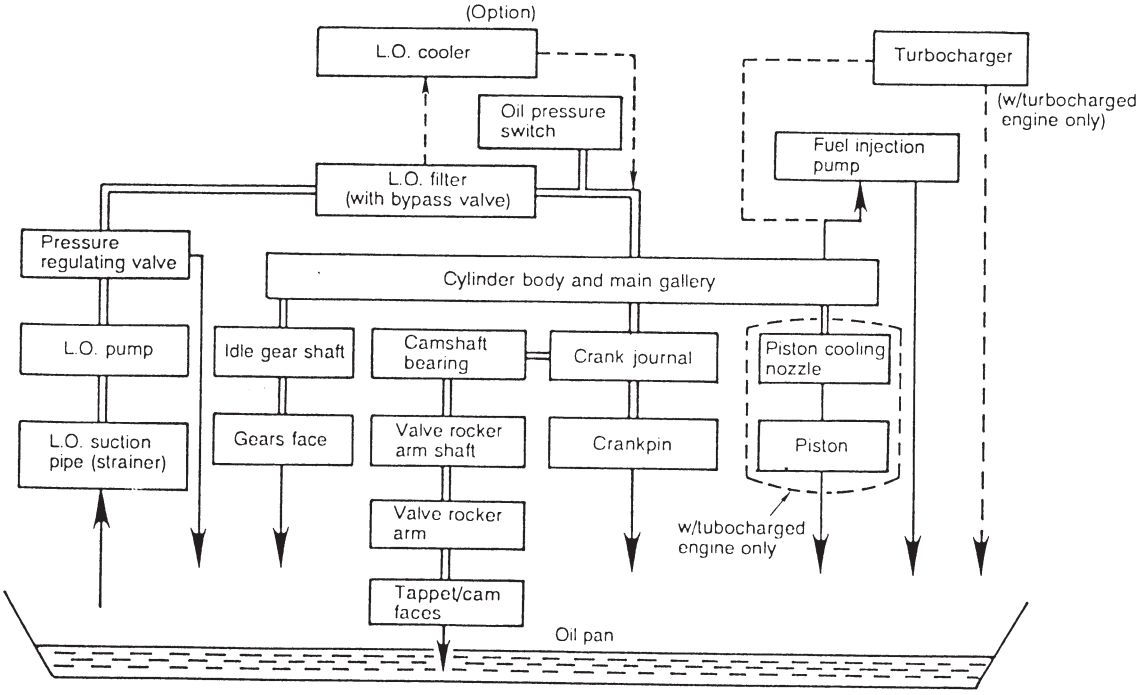


## 2. Lubrication system diagram

### (1) Indirect injection system




### (2) Direct injection system



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# 3-3. Fuel oil

## 1. Proper use of diesel gas oil

Use a diesel gas oil equivalent to or better than ISO 8217 DMA, BS 2869 Part 1 class A1 or Part 2 class A2. (Cetane Number: 45 min.) Give your customers instructions on proper use of fuel oil, or the customers may suffer from troubles stated below.

### (1) Deposits on the exhaust valve

Deposits on the exhaust valve cause unburnt oil mixture in exhaust gas and erosion of the exhaust valve seat, to occur in addition to poor compression, imperfect combustion, excessive fuel consumption, etc.

### (2) Deposits in the piston ring groove

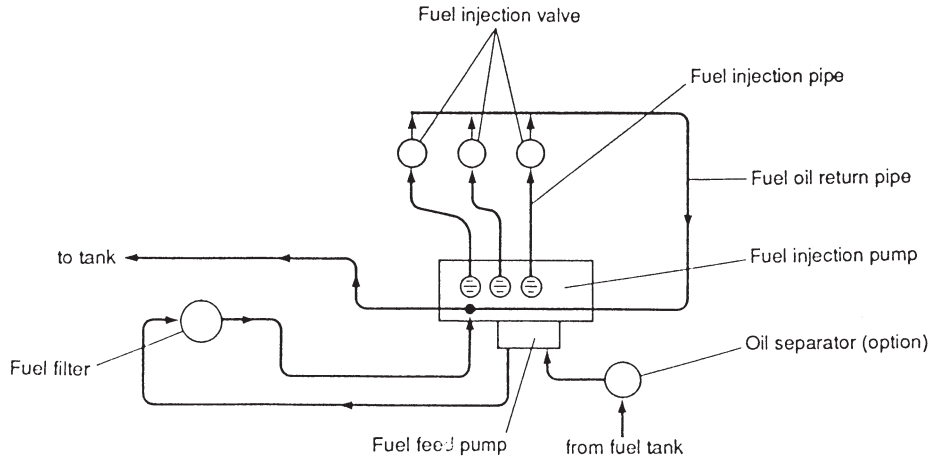
Deposits in the piston ring groove cause blow-by gas, poor lubrication, imperfect combustion, excessive fuel consumption, contamination of lubricating oil, premature wear, etc. of the cylinder liner and piston ring.

### (3) Clogging or corrosion of nozzle hole in fuel injection valve

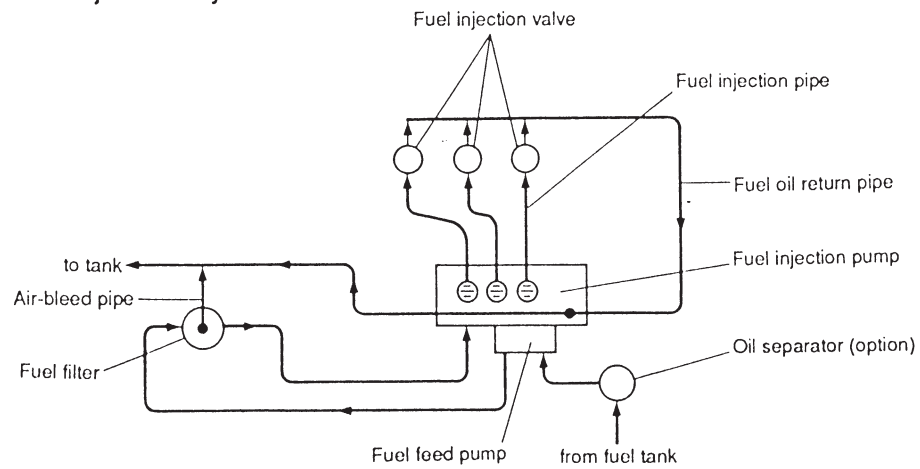
Imperfect combustion causes the fuel injection mechanism to wear and corrode and the nozzle to be clogged.

## 2. Fuel system diagram

### (1) Indirect injection system




### (2) Direct injection system



# 4. Troubleshooting

## 4-1. Trouble causes and remedies

The following table summarizes the symptoms and causes of general troubles. If any symptom of trouble is found, a corrective action shall be taken before the said symptom develops into a serious accident.

Carefully read Chapter 6, Measurement, Inspection and Adjustments, and Chapter 7, Measuring Procedures, Service Data and Countermeasures. Familiarize yourself with Chapter 6 and Chapter 7, which practice is extremely important for extending the service life of the engine.

| Cause \ Symptom of trouble | | Fails to start | | | | Insufficient engine output | | | Poor exhaust color | | High knocking sound during combustion | Abnormal engine noise | Uneven combustion sound | Hunting | | Large engine vibration | Poor return to low speed | Excessive fuel consumption | Lubricating oil | | | | Much blow-by gas | Cooling water | | Air intake | | Exhaust temperature rise | | | | Corrective action |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Engine will not start. | Engine starts but stops soon | | | Exhaust color | | | During work | | | | | During idling | During work | | | Excessive consumption | Excessive consumption | Diluted by fuel oil | Mixture with water | Low L.O. pressure | | Overheat | Low water temperature | Pressure drop | Pressure rise | | | | | |
| | | | Exhaust smoke | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Nil | Less | More | Regular | White | Black | White | Black | | | | | | | | | | | | | | | | | | | | | | |
| Engine System | Improper clearance of intake/exhaust valve | ○ | ○ | | | ○ | | | | | | ○ | | | | | | | | | | | | | | ○ | | | | | Adjust valve clearance (Refer to Chapter 6, 6-2.) |
| | Compression leakage from the valve seat | | | | | ○ | | ○ | | ○ | | ○ | | | | | | ○ | | | | | ○ | | | ○ | | | | | Rap valve seat (Refer to Chapter 7, 7-1-2. ) |
| | Seized intake/exhaust valve | ○ | | | ○ | ○ | | ○ | | ○ | | ○ | | | ○ | ○ | | | | ○ | | | ○ | | | ○ | | | | | Correct or replace. |
| | Blowout of cylinder head gasket | | | | | ○ | | | | | | | | | | | | | | | ○ | | | ○ | | | | | | | Replace the gasket. (Refer to Chapter 8, 8-2-(10) ) |
| | Seized or broken piston ring | ○ | | | ○ | | ○ | | ○ | | | ○ | | ○ | | ○ | | | ○ | ○ | | | ○ | ○ | | | | ○ | | | Replace the piston ring. (Refer to Chapter 7, 7-4-3, 4, (5) ) |
| | Worn piston ring, piston and cylinder | ○ | | | ○ | | ○ | | ○ | | | | | | | | | | ○ | ○ | | | ○ | | | | | | | | Make honing and use oversize parts. (Refer to Chapter 7, 7-2-3. & 7-4-(8) ) |
| | Seized crank pin metal and bearing | ○ | ○ | | | | | | | | | ○ | | ○ | ○ | ○ | | | | | | | ○ | | | | | | | | Repair or replace. |
| | Improper arrangement of piston ring joints | | ○ | | | | ○ | | | | | | | | | | | | ○ | | | | ○ | | | | | | | | Correct the ring joint positions. (Refer to Chapter 7, 7-4-(5) ) |
| | Reverse assembly of the piston ring | | | | | | ○ | | ○ | | | | | | | | | | ○ | | | | ○ | | | | | | | | Properly reassemble. (Refer to Chapter 7, 7-4-(5) ) |
| | Worn crank pin and journal metal | | | | | ○ | | | | | | ○ | | ○ | ○ | ○ | | | | | | ○ | | | | | | | | | Measure and replace . Refer to Chapter 7, 7-5-3. and 7-7-(5) ) |
| | Loosened connecting rod bolt | | | | | | | | | | | ○ | | | | ○ | | | | | | ○ | | | | | | | | | Tighten bolt to the specified torque. (Refer to Chapter 10, 10-1.) |
| | Foreign matter trapped in combustion chamber | ○ | | | | | | | | | | ○ | | | | | | | ○ | | | | ○ | | | | | | | | Disassemble and repair the combustion chamber. Eliminate foreign matter. |
| | Excessive gear backlash | | | | | | | | | | | ○ | | | | | | | | | | | | | | | | | | | Adjust meshing of gears. (Refer to Chapter 7, 7-8-(2) ) |
| | Worn valve guide of intake/exhaust valves | | | | | | ○ | | | | | | | | | | | | ○ | | | | ○ | | | | | | | | Measure and replace. (Refer to Chapter 7, 7-1-(3) ) |
| | Poor governor | | ○ | | | | | | | | | | | ○ | ○ | ○ | ○ | | | | | | | | | | | | | | Repair and adjust. (Refer to Chapter 13.) |
| | Improper open/close timing of intake/exhaust valves | ○ | | | | | ○ | ○ | ○ | ○ | | ○ | | | | | | | | | | | | | | | | | | | Adjust valve clearance (refer to Chapter 6, 6-2) and check intake/exhaust valve timing (Refer to Chapter 9, 9-1) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Turbocharger | Dirty blower | | | | | | | ○ | | ○ | | | | | | | | | | | | | | | | ○ | | | | | | Clean the blower. |
| | Waste gate malfunction | | | | | | | ○ | | ○ | | | | | | | | | | | | | | | | ○ | | | | | | Disassemble and inspect the waste gate. |
| | Worn journal bearing | | | | | | ○ | | ○ | | | | | | | | | | | | | | | | | | | | | | | Disassemble and inspect the journal bearing. |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cooling Water System | Cooling effect of radiator, excessive | | | | | | | | ○ | | | | | | | | | ○ | | | | | | ○ | | | | | | | | Malfunction of thermostat (kept closed). (Refer to Chapter 6, 6-9) |
| | Cooling effect of radiator, insufficient | | | | | | | ○ | | | | | | | | | | | | | | | | ○ | | | | ○ | | | | Malfunction of thermostat (kept opened). (Refer to Chapter 6, 6-9) Slipping fan belt (Refer to Chapter 6, 6-3) |
| | Insufficient cooling water level | | | | | | | ○ | | | | | | | | | | | | | | | | ○ | | | | ○ | | | | Check water leakage from Cooling water system (Refer to Chapter 6, 6-7) and clean cooling water system (Refer to chapter 3, 3-1) |
| | Cracked water jacket | | | | | | | | | | | | | | | | | | | | ○ | ○ | | ○ | | | | | | | | Repair and replace. |
| | Slackened fan belt tension | | | | | | | ○ | | | | | | | | | | | | | | | | ○ | | | | ○ | | | | Adjust fan belt tension. (Refer to Chapter 6, 6-3) |
| | Poor thermostat | | | | | | | ○ | | | | | | | | | | | | | | | | ○ | ○ | | | | | | | Check or replace. (Refer to Chapter 6, 6-9) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



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| Cause \ Symptom of trouble | | Fails to start | | | | Insufficient engine output | | | Poor exhaust calor | | High knocking sound during combustion | Trouble with the engine | Uneven combustion sound | Hunting | | Large engine vibration | Poor return to low speed | Excessive fuel consumption | Lubricating oil | | | | Much flow-by gas | Cooling water | | Air intake | | Exhaust temperature rise | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Engine will not start. | Engine starts but stops soon. Exhaust smoke: Nil | Exhaust smoke: Less | Exhaust smoke: More | Exhaust calor: Regular | Exhaust calor: White | Exhaust calor: Black | During work: White | During work: Black | | | | During idling | During work | | | | Excessive consumption | Diluted by fuel oil | Mixture with water | Low L.O. pressure | | Overheat | Low water temperature | Pressure drop | Pressure rise | | | | | | | |
| Lubricating Oil System | Improper properties of lubricating oil | ○ | ○ | | | ○ | | | | | | | | | | | | | ○ | | | ○ | ○ | | | | | | | | | | Use proper lube oil (Refer to Chapter 3, 3-2.) |
| | Leakage from lubricating oil piping system | | | | | | | | | | | | | | | | | | ○ | | | ○ | | | | | | | | | | | Repair |
| | Insufficient delivery capacity of trochoid pump | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Check and repair (Refer to Chapter 7, 7-9) |
| | Clogged lubricating oil filter | | | | | | | | | | | | | | | | | | | | | ○ | ○ | | | | | | | | | | Cleaning or replace |
| | Poor pressure control valve | | | | | | | | | | | | | | | | | | | | | ○ | | | | | | | | | | | Clean, Adjust or replace |
| | Insufficient lubricating oil capacity | | | | | | | | | | | | | | | | | | | | | ○ | | | | | | | | | | | Proper lube oil supply |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fuel System | Excessively early timing of fuel injection pump | | | | | | | | ○ | ○ | ○ | | | | | ○ | | | | | | | | | | | | | | | | | Check and adjust. (Refer to Chapter 6, 6-5.) |
| | Excessively late timing of fuel injection pump | | | | | | ○ | ○ | ○ | ○ | | | | | | | | ○ | | | | | | | | | | | | ○ | | | Check and adjust. (Refer to Chapter 6, 6-5.) |
| | Improper properties of diesel gas oil | | | | | ○ | ○ | ○ | ○ | ○ | | | ○ | | | | | | | | | | | | | | | | | | | | Use proper diesel gas oil. (Refer to Chapter 3, 3-3.) |
| | Water entering fuel system | ○ | | | ○ | | ○ | | ○ | | | | ○ | ○ | ○ | | | | | | | | | | | | | | | | | | Inspect and repair (Refer to Chapter 6, 6-7) |
| | Clogged fuel filter | ○ | ○ | | | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | Cleaning or replace. |
| | Air entering fuel system | ○ | ○ | | | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | Perform air bleed. |
| | Clogged or cracked fuel pipe | ○ | ○ | | | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | Cleaning or replace. |
| | Fuel insufficiently supplied to fuel injection pump | ○ | ○ | | | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | Inspect the fuel tank valve cock, fuel filter, fuel piping, and fuel feed pump. |
| | Uneven injection volume of fuel injection pump | | | | | | ○ | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | | | | | | | | | | | | | | ○ | | | Inspect and adjust (Refer to Chapter 11 and 12) |
| | Excessive fuel injection volume | | | | | | | | | ○ | | | | | | | | ○ | ○ | | | | ○ | ○ | | | | | | ○ | ○ | | | Inspect and adjust (Refer to Chapter 11 and 12) |
| | Poor spray pattern from fuel injection nozzle | | | | | | ○ | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | | ○ | | | | | | | | | | | | | | | Inspect and adjust (Refer to Chapter 6, 6-4-(2) ) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Air/exhaust-gas System | Clogged air filter | | | | ○ | | | ○ | | ○ | | | ○ | | | | | | | | | | | | | | ○ | | | | | | | Cleaning |
| | Engine used at high temperature or at high altitude | | | | | | | ○ | | ○ | | | | | | | | ○ | | | | | | ○ | | | ○ | | | | | | | Use more high-output engine |
| | Clogged exhaust pipe | | | | | | | ○ | | ○ | | | ○ | | | | | | | | | | | | | | | | | ○ | | | | Cleaning |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electric Wiring System | Malfunction starting motor | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Repair or replace |
| | Malfunction alternator | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Repair or replace |
| | Open-circuit of wires | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Repair |
| | Under voltage of battery | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Recharge of battery (Refer to Chapter 6, 6-8.) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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# 4-2. Trouble diagnosis through measurement of compression pressure

* : *For the compression pressure measuring procedure, refer to chapter 6, 6-1. Measurement of compression pressure.*

Reduction in compression pressure of the cylinder is one of major causes of an increase in blow-by gas (which causes contamination and increased consumption of lubricating oil, and other trouble) as well as the engine starting failure.
The compression pressure is influenced by the following factors:

1. Degree of clearance between the piston and cylinder.
2. Degree of clearance around intake/exhaust valve seats.
3. Gas leak through the nozzle gasket or cylinder head gasket.

In addition, the compression pressure decreases as the engine parts are worn and lose durability through use of the engine for a long period.
Scratches on the cylinder or piston caused by dust or foreign matter through the soiled air cleaner element, and wear or breakage of piston rings also decrease the compression pressure.
For this reason, diagnose the engine status by measuring the compression pressure.

## (1) Causes and countermeasures to be taken when the compression pressure is less than the limit value.

* *For the compression pressure limit values, refer to Chapter 6, 6-1 Measurement of compression pressure.*

| No. | Item | Cause | Countermeasures |
|---|---|---|---|
| 1 | · Filter element of air cleaner | · Clogged filter element<br>· Broken filter element<br>· Defective filter element seal | · Clean the filter element.<br>· Replace the filter element with a new one. |
| 2 | · Valve clearance | · Excessive valve clearance or no clearance | · Adjust the valve clearance (*Refer to Chapter 6, 6-2.*) |
| 3 | · Valve timing | · Improper valve timing<br>· Improper valve clearance | · Adjust the valve clearance (*Refer to Chapter 6, 6-2.*)<br>· Inspect and adjust of the valve rocker arm. (*Refer to Chapter 7, 7-3, 7-6 and 7-8.*) |
| 4 | · Cylinder head gasket<br>· Nozzle gasket | · Gas leak through the gasket | · Replace the gasket.<br>· Re-tighten the cylinder head and nozzle to the specified torque. (*Refer to Chapter 10, 10-1.*) |
| 5 | · Intake/exhaust valve<br>· Valve seat | · Gas leak caused by worn valve seats or trapped foreign matter<br>· Seizure of valves | · Rap valve seats. (*Refer to Chapter 7, 7-1. 2.*)<br>· Replace the intake/exhaust valves. |
| 6 | · Piston<br>· Piston ring<br>· Cylinder | · Gas leak caused by scratches and wear of piston, piston ring and cylinder | · Perform honing and use oversize parts. (*Refer to Chapter 7, 7-2. 3. and 7-4. 8.*) |

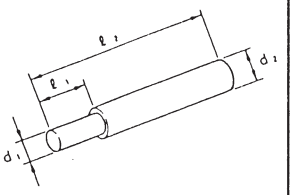
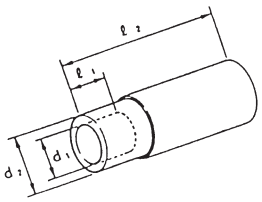
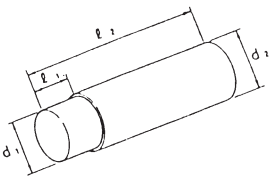
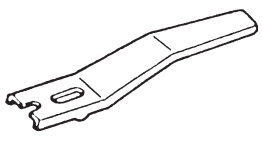
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# 5. Special Service Tools and Measuring Instruments

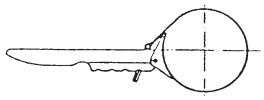
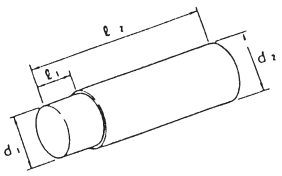
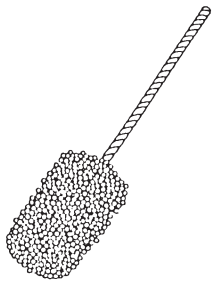
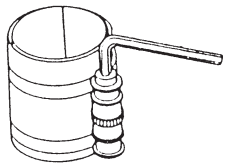
Although main engine parts can be disassembled and reassembled only with standard service tools, it is recommended to provide the following special service tools and measuring instruments for more efficient and accurate work, correct measurement, diagnosis, and troubleshooting.

## 5-1. Special service tools

<table>
<tr><th>No.</th><th>Tool name</th><th>Applicable model and tool dimension</th><th>Illustration</th></tr>
<tr><td>1</td><td>Valve guide extraction tool</td><td>(mm)<br><table><tr><th>Dimension / Model</th><th>$\ell_1$</th><th>$\ell_2$</th><th>$d_1$</th><th>$d_2$</th></tr><tr><td>2/3TNE68</td><td>20</td><td>55</td><td>5</td><td>8</td></tr><tr><td>3TNE74</td><td>20</td><td>75</td><td>6.5</td><td>10</td></tr><tr><td>3TNE78A/82A</td><td>20</td><td>75</td><td>6.5</td><td>10</td></tr><tr><td>3/4TNE82<br>3/4TNE84(T)<br>3/4TNE88</td><td>20</td><td>75</td><td>7.5</td><td>11</td></tr></table>* Locally manufactured</td><td>  </td></tr>
<tr><td>2</td><td>Valve guide insertion tool</td><td>(mm)<br><table><tr><th>Dimension / Model</th><th>$\ell_1$</th><th>$\ell_2$</th><th>$d_1$</th><th>$d_2$</th></tr><tr><td>2/3TNE68</td><td>7</td><td>60</td><td>11</td><td>17</td></tr><tr><td>3TNE74</td><td>9</td><td>60</td><td>13</td><td>19</td></tr><tr><td>3TNE78A/82A</td><td>12</td><td>60</td><td>13</td><td>19</td></tr><tr><td>3/4TNE82<br>3/4TNE84(T)<br>3/4TNE88</td><td>15</td><td>65</td><td>14</td><td>20</td></tr></table>* Locally manufactured</td><td>  </td></tr>
<tr><td>3</td><td>Connecting rod bushing replacer</td><td>(mm)<br><table><tr><th>Dimension / Model</th><th>$\ell_1$</th><th>$\ell_2$</th><th>$d_1$</th><th>$d_2$</th></tr><tr><td>2/3TNE68</td><td>22</td><td>62</td><td>$20^{-0.3}_{-0.6}$</td><td>$22^{-0.3}_{-0.6}$</td></tr><tr><td>3TNE74</td><td>20</td><td>80</td><td>$21^{-0.3}_{-0.6}$</td><td>$23^{-0.3}_{-0.6}$</td></tr><tr><td>3TNE78A/82A</td><td>25</td><td>85</td><td>$23^{-0.3}_{-0.6}$</td><td>$26^{-0.3}_{-0.6}$</td></tr><tr><td>3/4TNE82<br>3/4TNE84(T)<br>3/4TNE88</td><td>20</td><td>100</td><td>$26^{-0.3}_{-0.6}$</td><td>$29^{-0.3}_{-0.6}$</td></tr></table>* Locally manufactured</td><td>  </td></tr>
<tr><td>4</td><td>Valve spring compressor (Replacement of valve spring)</td><td><table><tr><th>Model</th><th>Yanmar Code No.</th></tr><tr><td>All model</td><td>129100–92630</td></tr></table></td><td>  </td></tr>
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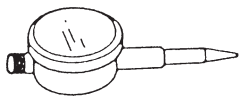
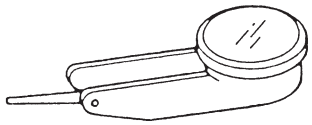
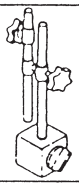
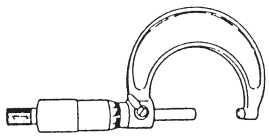
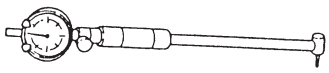
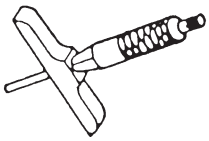
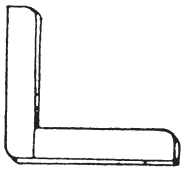
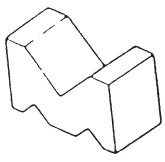


<table>
<tr><th>No.</th><th>Tool name</th><th>Applicable model and tool dimension</th><th>Illustration</th></tr>
<tr><td>5</td><td>Filter wrench<br>(Removal and installation of L.O. filter)</td><td>Sold on market</td><td>  </td></tr>
<tr><td>6</td><td>Camshaft bushing tool<br>(Extraction of camshaft bushing)</td><td>(mm)<br><table><tr><th>Dimension / Model</th><th>$\ell_1$</th><th>$\ell_2$</th><th>$d_1$</th><th>$d_2$</th></tr><tr><td>2/3TNE68</td><td>13</td><td>60</td><td>$36^{-0.3}_{-0.6}$</td><td>$39^{-0.3}_{-0.6}$</td></tr><tr><td>3TNE74</td><td>14</td><td>60</td><td>$40^{-0.3}_{-0.6}$</td><td>$43^{-0.3}_{-0.6}$</td></tr><tr><td>3TNE78A/82A</td><td>18</td><td>70</td><td>$45^{-0.3}_{-0.6}$</td><td>$48^{-0.3}_{-0.6}$</td></tr><tr><td>3/4TNE82<br>3/4TNE84(T)<br>3/4TNE88</td><td>18</td><td>70</td><td>$45^{-0.3}_{-0.6}$</td><td>$48^{-0.3}_{-0.6}$</td></tr></table>* Locally manufactured</td><td>  </td></tr>
<tr><td>7</td><td>Flex-Hone<br>(for honing cylinder liner)<br>* : For the usage procedure of the Flex-Hone, refer to Chapter 7, 7-2, 3.</td><td><table><tr><th>Model</th><th>Yanmar Code No.</th></tr><tr><td>2/3TNE68</td><td>129400–92400</td></tr><tr><td>3TNE74</td><td>129400–92410</td></tr><tr><td>3TNE78A/82A<br>3/4TNE82<br>3/4TNE84(T)</td><td>129400–92420</td></tr><tr><td>3/4TNE88</td><td>129400–92430</td></tr></table></td><td>  </td></tr>
<tr><td>8</td><td>Piston insertion tool<br>(Insertion of piston)</td><td><table><tr><th>Model</th><th>Yanmar Code No.</th></tr><tr><td>All model</td><td>95550–002476</td></tr></table>Note: The above piston insertion tool is applicable to pistons 60~125 mm in diameter.</td><td>  </td></tr>
<tr><td>9</td><td>Piston ring replacer</td><td>Sold on market</td><td>  </td></tr>
</table>

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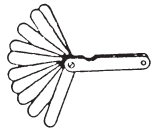
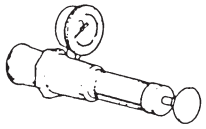
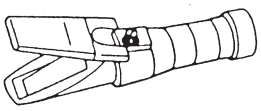
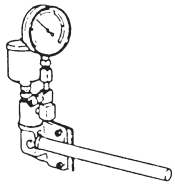
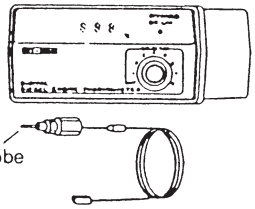
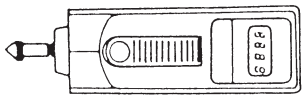
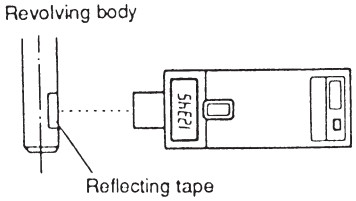


# 5-2. Measuring instruments

| No. | Instrument name | Purpose of use | Illustration |
|---|---|---|---|
| 1 | Dial gauge | Measures bent shafts, distorted flat surface, gaps, etc. |  |
| 2 | Test indicator | Measures the limited small portions and deep portions unmeasurable with dial gauge. |  |
| 3 | Magnetic stand | Used together with the dial gauge: holds the dial gauge at different angles. |  |
| 4 | Micrometer | Measures the outside diameter of the crankshaft, piston, and piston pin, etc. |  |
| 5 | Cylinder gauge | Measures the inside diameter of the cylinder liner, connecting rod metal, etc. |  |
| 6 | Vernier callipers | Measures the outside diameter, depth, thickness, width, etc. of various items. |  |
| 7 | Depth Micrometer | Measures the sinkage of the valve. |  |
| 8 | Square | Measures inclination of valve spring, squareness of engine parts, etc. |  |
| 9 | V-block | Measures bent shaft. |  |

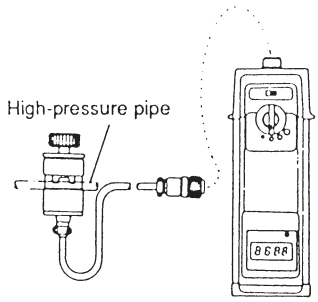
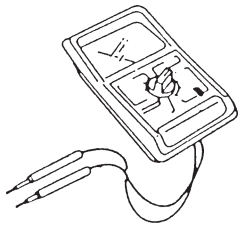
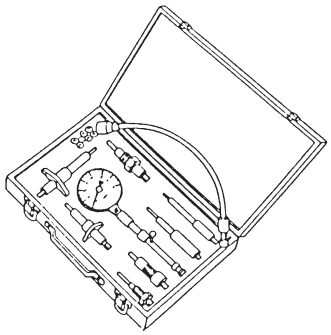
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| No. | Instrument name | Purpose of use | Illustration |
|---|---|---|---|
| 10 | Torque wrench | Used for tightening bolts and nuts to the specified torques. |   |
| 11 | Thickness gauge | Measures gaps between the rings and mating ring grooves and around shaft couplings during installation |  |
| 12 | Cap tester | Checks the fresh water system for leakage. |  |
| 13 | Battery coolant tester | Checks the antifreeze for concentration and the battery electrolyte for specific gravity, and charging state. |  |
| 14 | Nozzle tester | Checks the fuel injection valve for spray patterns and injection pressure. |  |
| 15 | Digital thermometer | Measures temperature of each part. |   |
| 16 | Tachometer — Contact type | Measures RPM of the rotary shaft by bringing the gage head into contact with the mortise. |  |
| | Tachometer — Photoelectric type | Applies a reflecting tape on the circumference of the rotating parts to measure RPM. |   |

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| No. | Instrument name | Purpose of use | Illustration |
|---|---|---|---|
| 16 | Tachometer: High pressure fuel pipe clamping type | Measures engine RPM's using pulse system, irrelevantly to the center of the rotary shaft and the circumference of the rotary object. |   |
| 17 | Circuit tester | Measures the resistance, voltage, and continuity of electric circuits. |  |
| 18 | Compression gauge kit | Measures compression pressure.<br>Yanmar Code No.: TOL-97190080 |  |

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# 6. Measurement, Inspection and Adjustment

## 6-1. Measuring the compression pressure

### 1. Measuring Procedure

(1) Warm up the engine. Remove the fuel injection pipe and fuel injection valve from the cylinder to be measured.

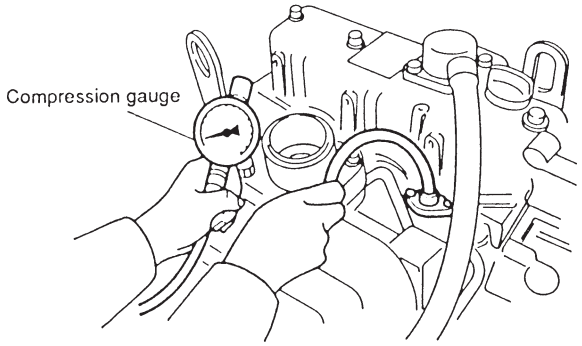
(2) Crank the engine before attaching the compression gauge adapter.

∗ : *1. Crank the engine when the regulator handle has been turned to "STOP" position (no injection state).*

*2. For the compression gauge and compression gauge adapter, refer to Chapter 5, 5-2.*

(3) Attach the compression gauge adapter and compression gauge to the cylinder to be measured.

∗ : *Never fail to attach the gasket to the tip of the adapter.*




**Measuring the compression pressure**

(4) Crank the engine by the starting moter until the reading of the compression gauge is stabilized, by taking steps shown in (2), ∗1.

**[Reference: List of Engine Compression Pressures]**

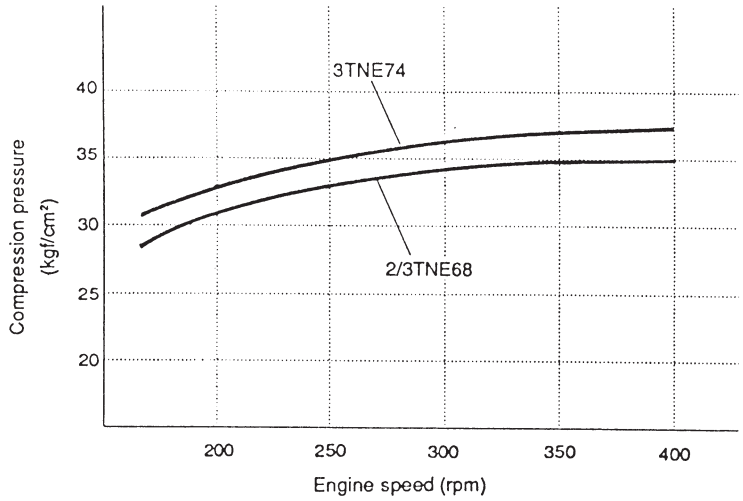
| Model | Compression pressure at 250 rpm (kgf/cm²) | | Dispersion of compression pressure among cylinders (kgf/cm²) |
|---|---|---|---|
| | Standard | Limit | |
| 2TNE68 | 33 ± 1 | 25 | 2 ~ 3 |
| 3TNE68 | 33 ± 1 | 25 | 2 ~ 3 |
| 3TNE74 | 35 ± 1 | 27 | 2 ~ 3 |
| 3TNE78A | 32 ± 1 | 25 | 2 ~ 3 |
| 3TNE82A | 31 ± 1 | 24 | 2 ~ 3 |
| 3TNE82 | 31 ± 1 | 24 | 2 ~ 3 |
| 3TNE84 | 33 ± 1 | 25 | 2 ~ 3 |
| 3TNE88 | 35 ± 1 | 27 | 2 ~ 3 |
| 4TNE82 | 31 ± 1 | 24 | 2 ~ 3 |
| 4TNE84 | 33 ± 1 | 25 | 2 ~ 3 |
| 4TNE88 | 35 ± 1 | 27 | 2 ~ 3 |
| 3TNE84T | 30 ± 1 | 24 | 2 ~3 |
| 4TNE84T | 30 ± 1 | 24 | 2 ~3 |

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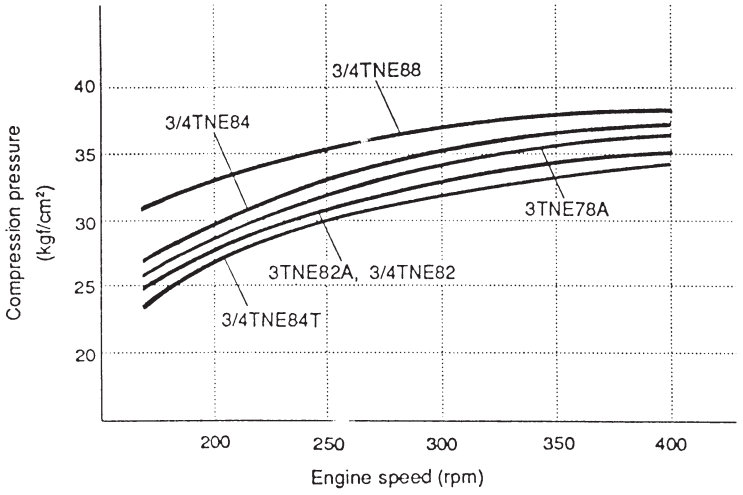


Reference: Variation of Compression Pressure with Engine Speed

(1) Indirect injection system




(2) Direct injection system




## 2. Action to be taken when the measured compression pressure is below the limit value.

Trouble occurs in a part of the engine. For troubleshooting, refer to Chapter 4, 4-2 trouble diagnosis through measurement of compression pressure.

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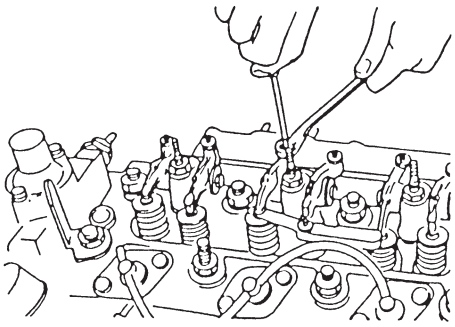


# 6-2. Adjusting the valve head clearance

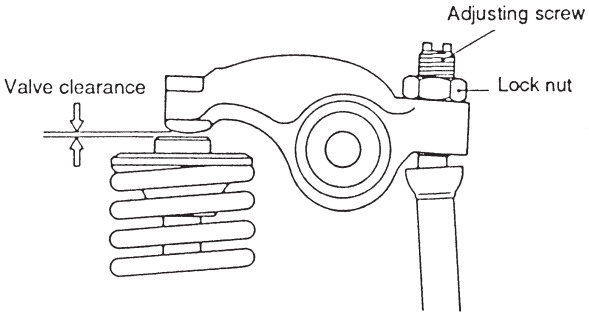
(1) Inspect and adjust a valve head clearance while the engine is in cold state.

(2) Raise the piston in the cylinder to be measured to the top dead center (TDC) of compression.

(3) Loosen the lock nut and adjusting screw. Make sure that the valve cap is free from inclination or trapped dirt.



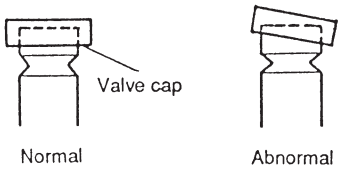
(4) Insert a thickness gauge in between the rocker arm and valve cap. Tighten the adjusting screw until the clearance listed below is attained.




**(Adjusting the valve head clearance)**

(mm)

| | All models |
|---|---|
| Intake/exhaust valve head cleaarance | 0.15 ~ 0.25 |




✻ : *1. If the valve cap is worn or otherwise damaged on the head, replace it with a new one.*

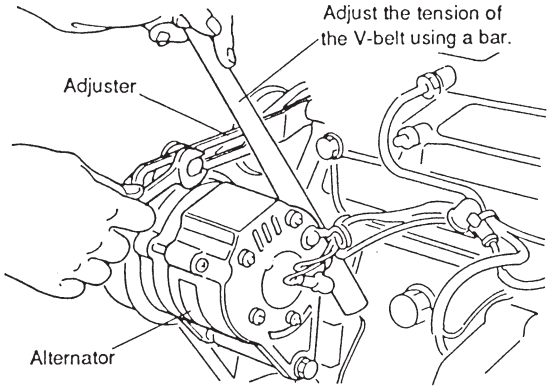
*2. Make sure that the valve cap is nested on the head of intake/exhaust valves.*

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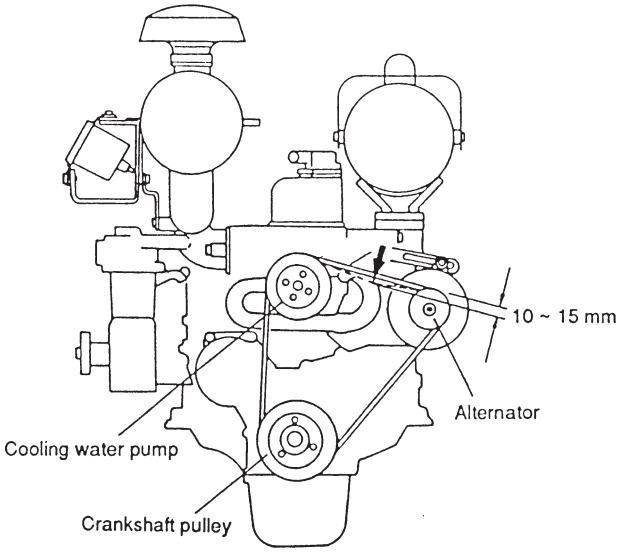


## 6-3. Checking the V-belt tension

Push the center of the V-belt between the alternator and cooling water pump with a finger. If the deflection is 10–15 mm, the V-belt tension is acceptable. If not, adjust the V-belt tension using the adjuster at the alternator.




(Adjustment of the V-belt tension)




## 6-4. Measuring and checking the injection pressure and spray patterns of the fuel injection valve

### 1. Measuring the injection pressure

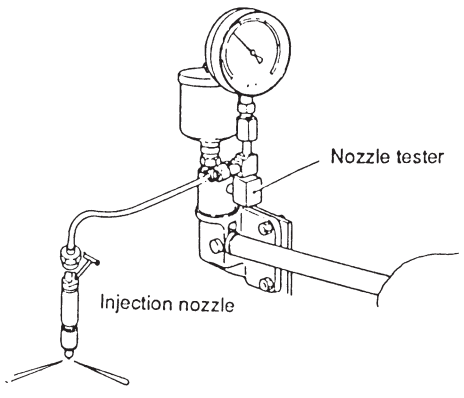
✻ : *Thoroughly remove carbon deposits from the injection nozzle before making measurement.*

(1) Connect the fuel injection valve to the high pressure pipe of the nozzle tester.

(2) While pumping the lever of the nozzle tester slowly, read the pressure gauge on the nozzle tester the moment the nozzle starts fuel injection.

✻ : *For injection pressure of each engine, refer to Chapter 1, "Specifications and Performance".*

(3) If the measured injection pressure is lower than the specified value, replace the pressure adjusting shim with a thicker one.




( Measuring the injection pressure with a nozzle tester )

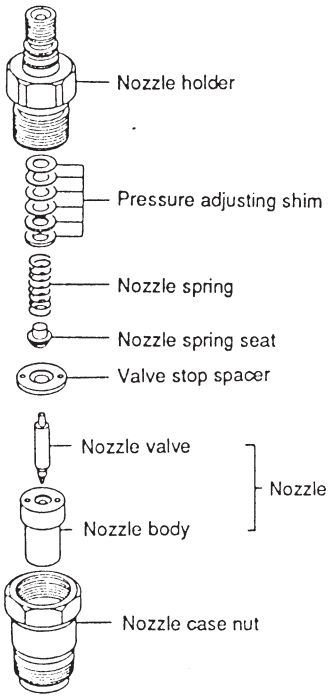
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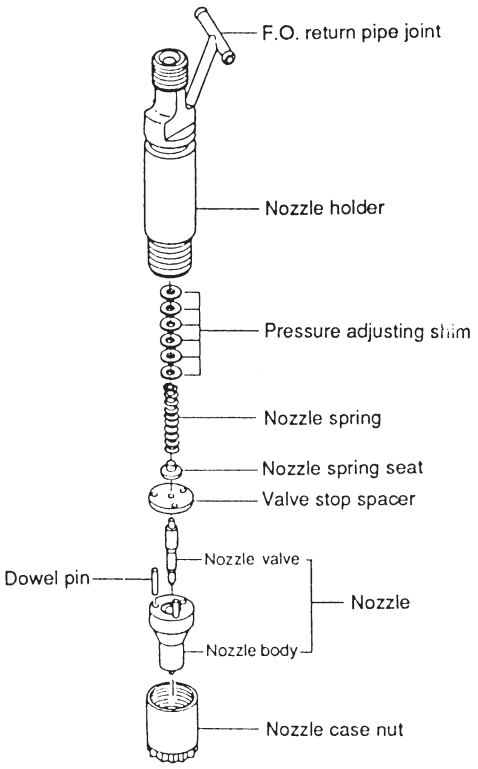
| | Type of pressure adjusting shim thickness (mm) | Injection pressure adjustment |
|---|---|---|
| Indirect injection system | 0.1, 0.2, 0.3, 0.4, 0.5 | Increase the pressure adjusting shim the thickness by 0.1 mm and the injection pressure is increased by 7-10 kgf/cm². |
| Direct injection system | 0.13, 0.15, 0.18, 0.4, 0.5, 0.8 | Increase the pressure adjusting shim thickness by 0.1 mm and the injection pressure is increased by about 19 kgf/cm². |

[Reference: Structure of fuel injection valve]

(Indirect injection system)




(Direct injection system)




## 2. Checking the spray patterns

While pumping the lever of the nozzle tester 4-6 times per second at the specified injection pressure (Refer to Chapter 1, specifications and performance), check the spray patterns. If the following trouble is found, clean or replace the nozzle.

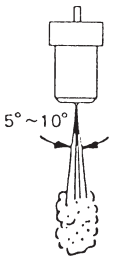
(1) Make sure that the pattern is neither stream nor sliver.

(2) Ensure that fuel is sprayed conically around the nozzle center line and that a fuel injection spreading angle is 5-10° in the indirect injection system or approx. 150° in the direct injection system.

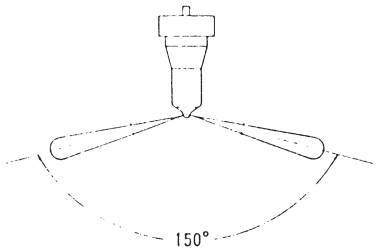
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[Normal spray pattern]

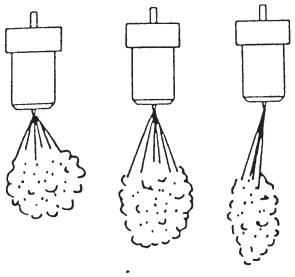



(Indirect injection system)

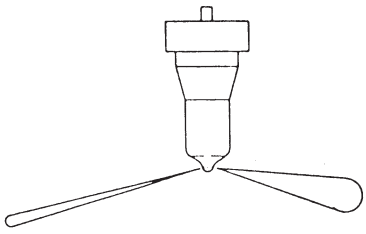



(Direct injection system)

[Abnormal spray patterns]



(Indirect injection system)



(Direct injection system)

(3) Place a sheet of white paper 30 cm below the nozzle. The injection spray should form a perfect circle.

(4) No oil should drip from the nozzle after injection.

(5) Oil should not ooze from the injection hole when the pressure is raised to a little less than the specified 20 kgf/cm$^2$.

(6) Test the injection with a nozzle tester; re-tighten and test again if there is excessive oil leak from the overflow coupling. Replace the nozzle as a set if the leaking oil is still excessive.

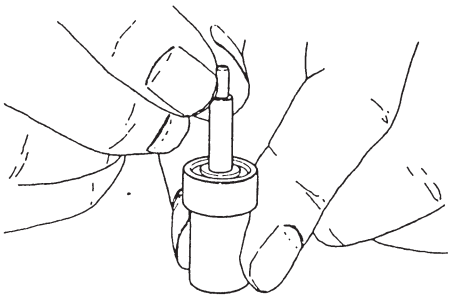
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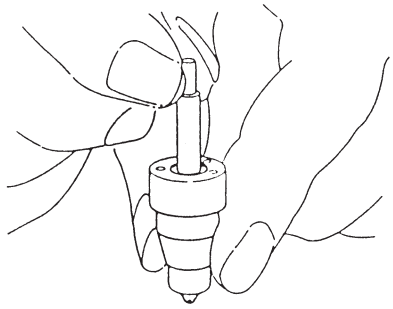
### 3. Nozzle valve sliding test

Thoroughly wash the nozzle valve using clean diesel oil. Hold the nozzle body vertically, and lift the nozzle valve approx. 1/3 of its length with one hand.

Check to see if the nozzle falls smoothly by itself gravity when released. If so, the nozzle valve is good. In case of a new nozzle, remove the seal peel, and immerse it in clean diesel oil or the like to clean the inner and outer surfaces and to thoroughly remove rust-preventive oil before using the nozzle. Note that a new nozzle is coated with rust-preventive oil and is pasted with the seal peel to shut off outer air.



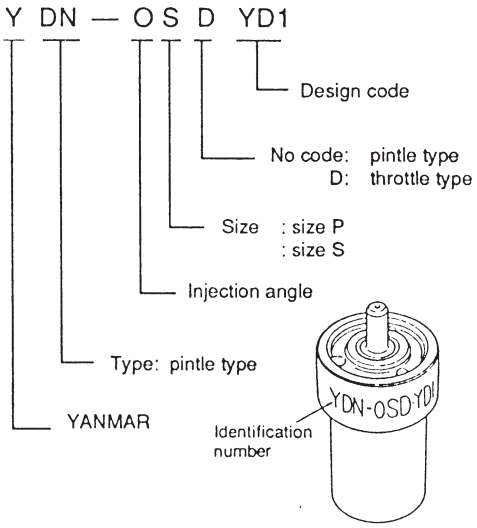
( Nozzle valve sliding check by gravity for indirect injection system )



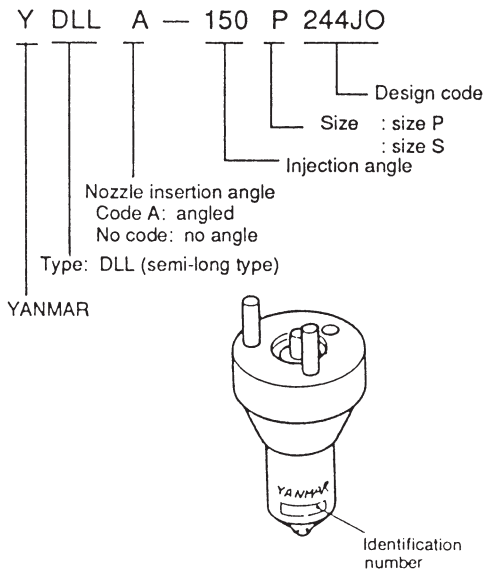
( Nozzle valve sliding check by gravity for direct injection system )

### 4. Nozzle body identification number

**(Indirect injection system)**




**(Direct injection system)**



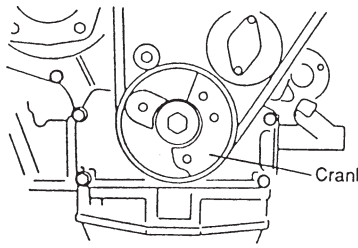
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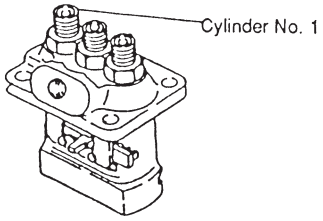


# 6-5. Checking and adjusting the fuel injection timing

## 1. Indirect Injection system

(1) Using the crankshaft pulley, turn the engine in the specified direction. Check the injection timing at the delivery valve of the fuel injection pump for cylinder No.1. (Cylinders are numbered sequentially from cylinder No. 1 from the flywheel side).

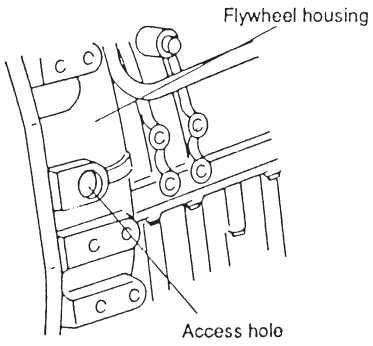


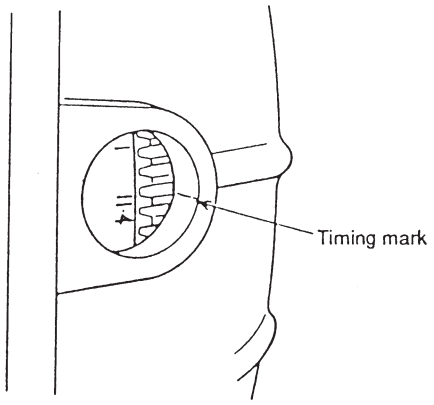




(2) When the crankshaft is turned in the specified direction, oil level rises at the tip of the delivery valve spring holder. At that time, stop the crankshaft.

(3) Identify the timing mark stamped on the flywheel through the access hole of the flywheel housing.

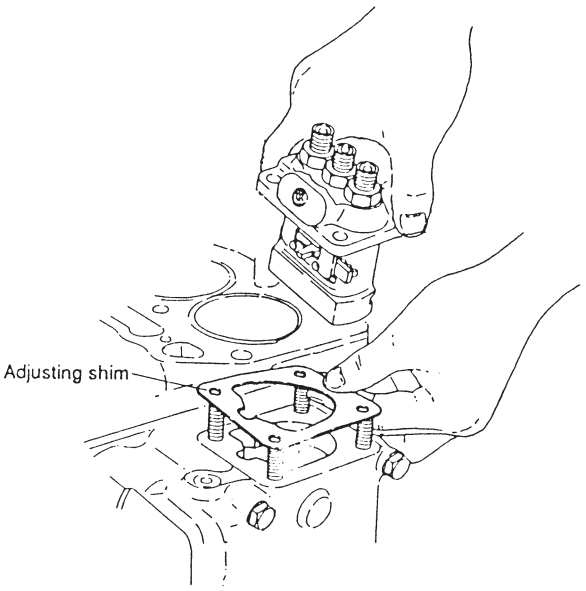
* : *For the fuel injection timing of each engine model, refer to Chapter 1, Specifications and Performance.*




(4) If the present injection timing differs from the specified timing, remove the fuel injection pump, and adjust the timing by increasing or decreasing the adjusting shim thickness between the fuel injection pump and gear case.

- Increase the shim thickness to delay the injection timing.
- Decrease the shim thickness to advance the injection timing.

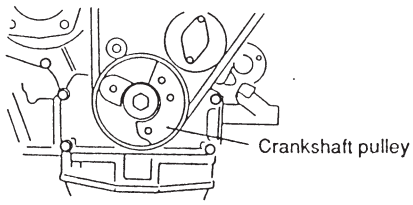


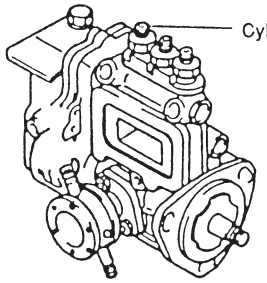
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## 2. Direct injection system

(1) Using the crankshaft pulley, turn the engine in the specified direction. Check the injection timing at the delivery valve of the fuel injection pump for cylinder No.1. (Cylinders are numbered se-quentially from cylinder No. 1 from the flywheel side).

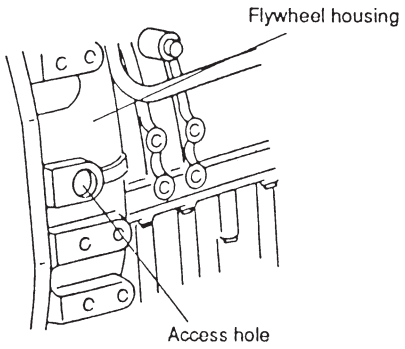


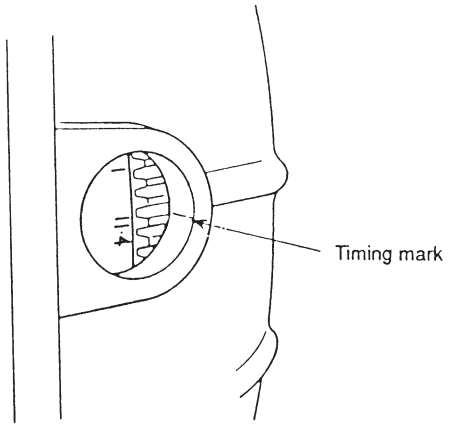




(2) When the crankshaft is turned in the specified direction, the oil level rises at the tip of the delivery valve spring holder. At that time, stop the crankshaft.

(3) Identify the timing mark stamped on the flywheel through the access hole of the flywheel housing.

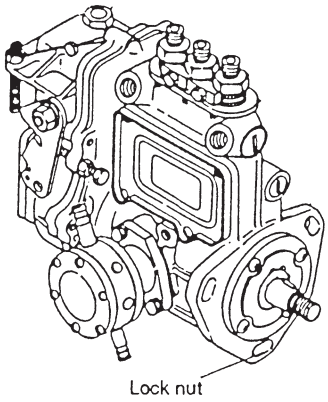
*: *For fuel injection timing for each engine model, refer to Chapter 1, Specifications and Performance.*




(4) If the measured injection timing differs from the specified timing, adjust the injection timing by turning down the fuel injection pump toward the engine or to the opposite side after loosening the lock nut of the fuel injection pump.

- If injection timing is late, turn down the fuel injection pump away from the engine.
- If the injection timing too early, turn the injection pump down toward the engine.



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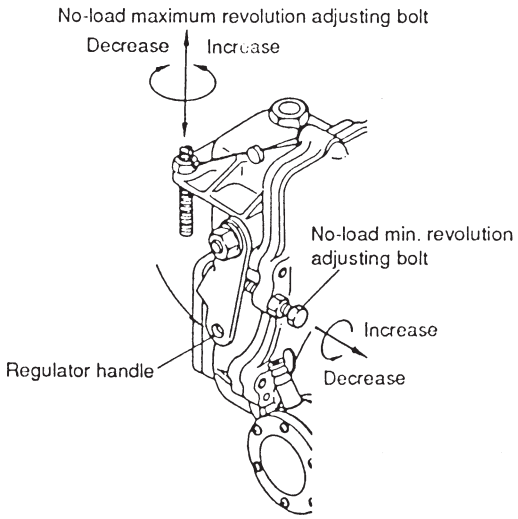


## 6-6. Adjusting the no-load maximum (or minimum) revolutions

(1) First warm up the engine. Then, gradually increase the engine speed up to the no-load max. revolution (Refer to Chapter 1, Specifications and Performance).

(2) If the present no-load max. revolution differ from the specified one, adjust the no-load max. revolution using the no-load max. revolution adjusting bolt.

(3) Set the engine to the idling revolution, (Refer to Chapter 1, Specifications and Performance) by turing the no-load min. revolution adjusting bolt.




∗ : *The illustration shows the partial perspective view of the governor for the direct injection system.*

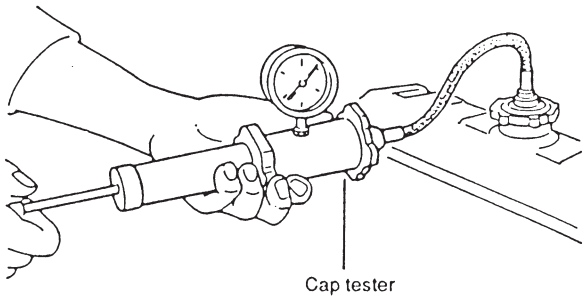
## 6-7. Checking the cooling water system and radiator for water leakage

### 1. Checking the cooling water system for water leakage

∗ : *The cooling water system can be checked effectively while the engine is warm.*

(1) Supply cooling water up to the normal water level in the radiator. Attach the cap tester body to the radiator.

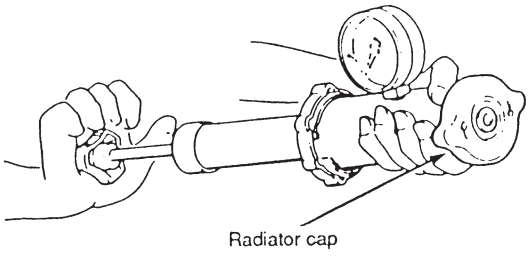
(2) Start the cooling water pump, and set it to a pressure of 0.9 ± 0.15 kgf/cm². Any lower reading of the pressure gauge on the cap tester indicates water leak from the cooling water system. Then, detect the portion where cooling water leaks from the cooling water system.




(Checking the cooling water system for water leakage)

### 2. Checking the radiator cap

Attach the radiator cap to a cap tester. Set the tester to a pressure of 0.9±0.15 kgf/cm². Check to see if the cap is opened at the set pressure. If not, replace the cap, because it is defective.



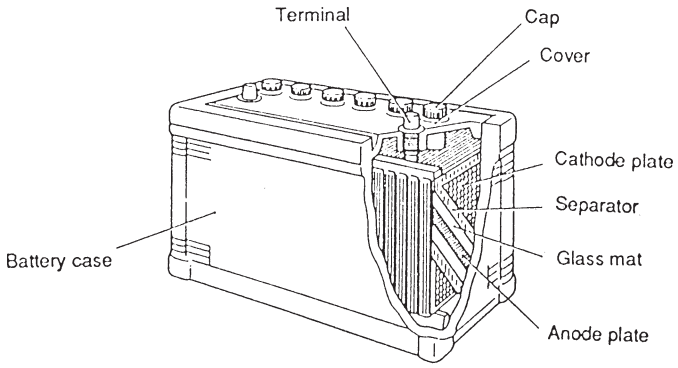

(Checking the radiator cap)

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# 6-8. Checking the battery

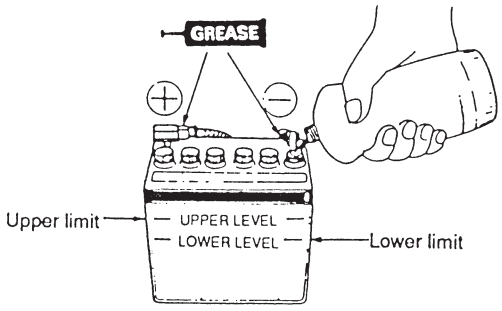
## 1. Structure of the battery

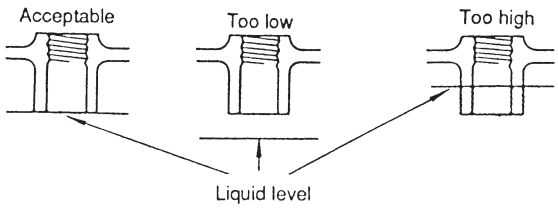



## 2. Checking the battery

### (1) Electrolyte level

Check the electrolyte level in each cell. If the level is low, add deionized water to bring the level to the UPPER level as illustrated below.



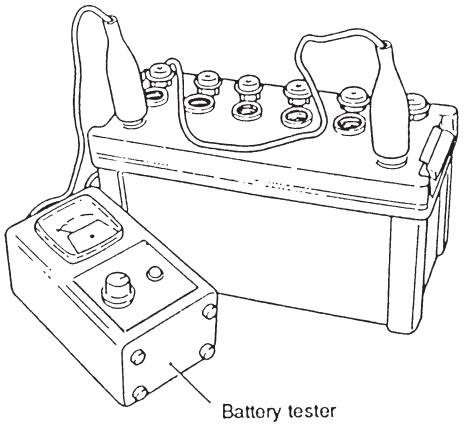

### (2) Battery charge

Using a battery tester or hydrometer, check the state of the battery. If the battery is discharged, recharge it.

○ **Measurement with a battery tester**

To check the battery with a battery tester, securely hold the ⊕ terminal of the battery with the red clip of the battery tester and the ⊖ terminal with the black clip. Judge battery charge level from the indicator position:

| | |
|---|---|
| Green zone: | normal |
| Yellow zone: | somewhat discharged |
| Red zone: | abnormal or much discharged |




( **Measuring the battery charge with battery tester** )

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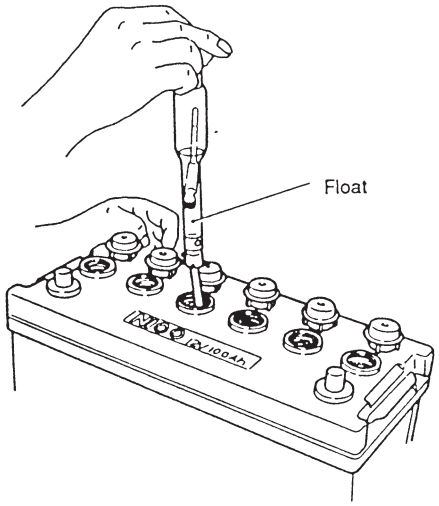


○ **Measurement with a hydrometer**

When using a hydrometer, correct the measured specific gravity according to the temperature. The specific gravity of the electrolyte of the battery is the standard when measured at 20°C. Correct the specific gravity according to the following equation, as it changes by 0.0007 per 1°C.

$$S_{20} = St + 0.0007\,(t-20)$$

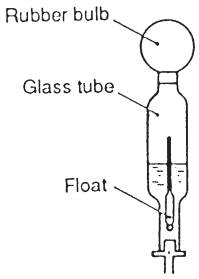
- $S_{20}$: Specific gravity converted to 20°C
- $St$: Measured specific gravity
- $t$: Measured electrolyte temperature



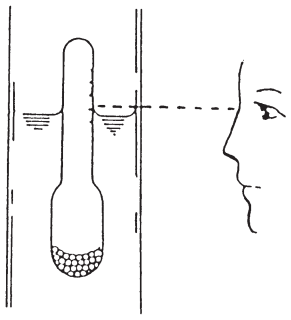

(Measuring the remaining battery charge with hydrometer)

**Hydrometer and remaining battery charge**

| Specific gravity (at 2°C) | Discharged level (%) | Remaining level (%) |
|---|---|---|
| 1.260 | 0 | 100 |
| 1.210 | 25 | 75 |
| 1.160 | 50 | 50 |
| 1.110 | 75 | 25 |
| 1.060 | 100 | 0 |




(Hydrometer)



(How to read a hydrometer)

(3) **Terminals**

Repair or clean the terminals if corroded or soiled.

(4) **Fittings**

Repair or replace the fittings if corroded. Re-tighten them if loosened.

(5) **Appearance of the battery**

Replace the battery if cracked or deformed. Clean it using fresh water if contaminated.

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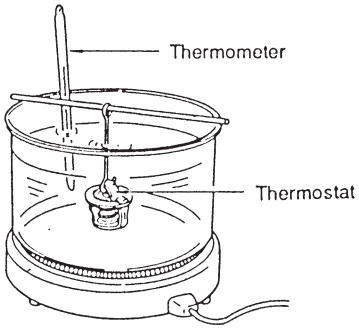


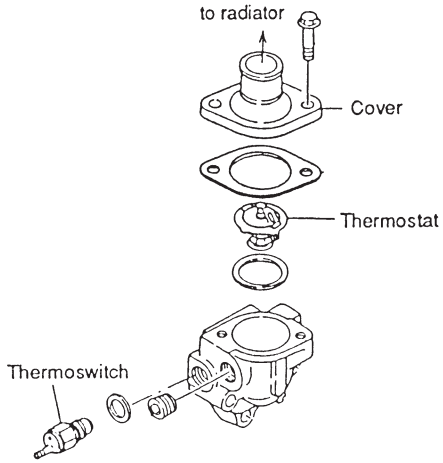
# 6-9. Checking the sensors

## 1. Checking the thermostat and thermoswitch

### (1) Thermostat

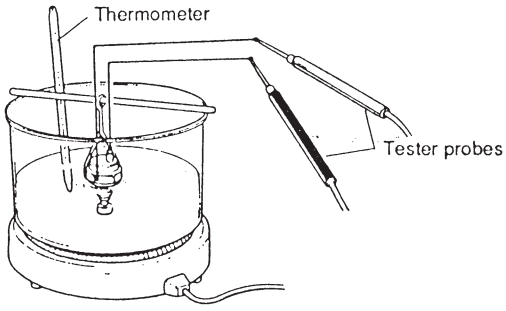
Put a thermostat into water in a container. While measuring water temperature, heat the water. Make sure that the thermostat functions at a temperature of 69.5-72.5°C. (80.5 ~ 83.5°C are used as option parts)




### (2) Thermoswitch

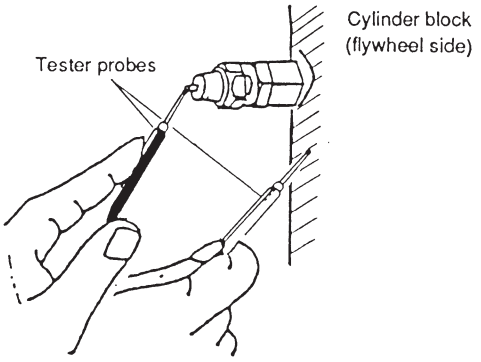
Put a thermoswitch into an antifreeze or oil in a container. While measuring liquid temperature, heat the liquid. If the tester shows continuity at a temperature of 107-113°C, the thermoswitch is acceptable.




## 2. LO pressure switch

Remove the connector from the LO pressure switch.

While running the engine, bring the tester probes into contact with the switch terminal and cylinder block. If the tester shows continuity, the LO pressure switch is defective.




(Continuity test)

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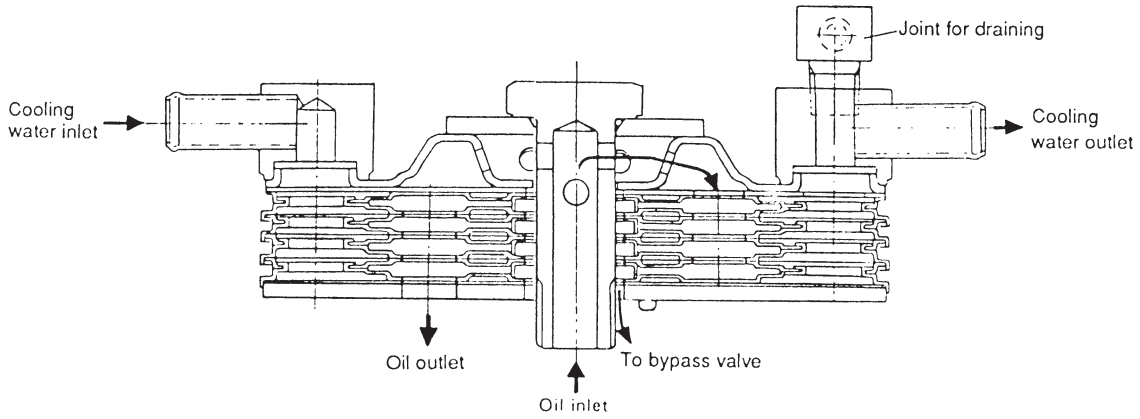
# 6-10. Checking the Oil Cooler

The oil cooler is of the core type and cooled by fresh water. It is installed as a standard component on turbocharged engines in the TNE series.

(1) Replace the packing at the joint and O-rings at the time of reassembly after disassembly.

(2) When the oil cooler is disassembled and cleaned for periodic inspection, remove the scale by using descaling agent "Unicon 146".

(3) Cooling tube leak check
Close either the inlet or outlet of the cooling tube. Apply an air pressure (5.0 kg/cm²) from the other end and check if air is leaking by immersing the tube in water. If leaking, repair or replace the cooling tube.



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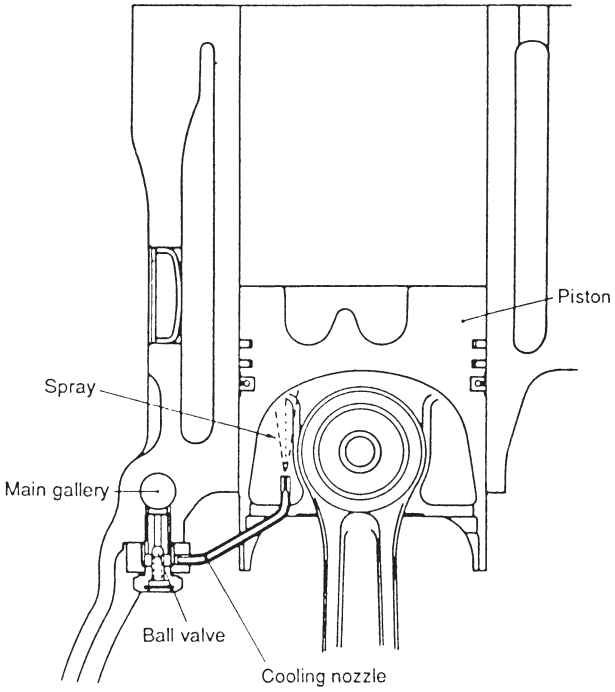


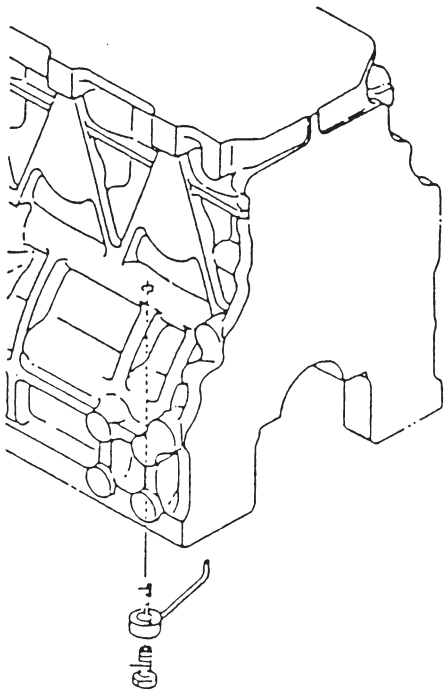
# 6-11. Checking the Piston Cooling Nozzle

The piston cooling nozzle is installed as a standard component on turbocharged engines in the TNE series.

(1) Piston cooling nozzle function
A nozzle made of a steel pipe is installed below the main gallery in the cylinder body. The lubricating oil from the main gallery is constricted at the nozzle hole (ϕ1.77 mm) at the tip end of the steel pipe to be jet-sprayed. This jet spray comes into contact with the rear face of the piston for cooling it.

| | |
|---|---|
| Jet flow rate | 1.3 ℓ/ min |
| Jetting pressure | 3.5 kg / cm² |



(2) Checking the piston cooling nozzle
1. Check the nozzle hole at the tip end for clogging with dirt or foreign matter, and clean it.

2. Check the brazed portion of the steel pipe for loosening or freeing by vibration. Replace with a new part if defective.

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# 7. Measuring Procedure, Service Data and Corrective Action

In maintaining various parts, make measurement according to the following measurement procedure. If any trouble is found and if any part deviates from the standard size, replace it with a new one. However, if any part within the limit is expected to deviate from the standard presumably because of the record of its use, be sure to replace such a part beforehand.

## 7-1. Cylinder head

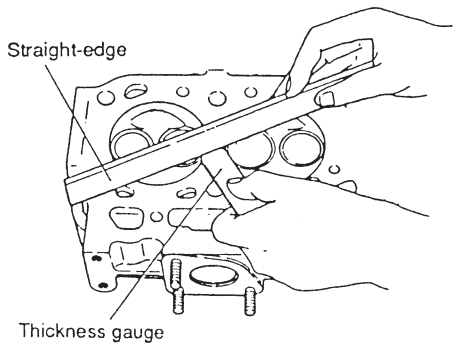
### 1. Distortion and inspection of the combustion surface

(1) Remove intake/exhaust valves and fuel injection valve from the engine. Clean the surface of the cylinder head.

(2) Place a straight-edge along each of the four sides and each diagonal of the cylinder head. Measure the clearance between the straight-edge and combustion surface with a thickness gauge.

(mm)

| Cylinder head combustion surface distortion | Standard | Wear limit |
|---|---|---|
| All models | 0.05 or less | 0.15 |




(Measuring the combustion surface distortion)

(3) Visually check to see if the combustion surface is free from discoloration, cracks, and crazing. In addition, use the color check kit for cracks and crazing.

### 2. Intake/exhaust valve seats

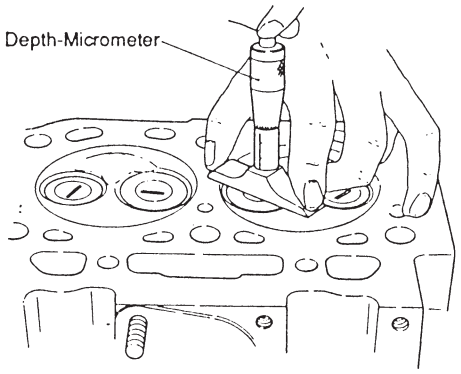
(1) Valve sinking

Over long periods of use and repeated lappings, combustion efficiency may drop. Measure the sinking depth and replace the valve and valve seat if the valve sinking depth exceeds the standard value.

(mm)

| | | 2/3TNE68 | | 3TNE74 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Valve sinking depth | Intake valve | 0.3~0.5 | 1.0 | 0.4~0.6 | 1.0 |
| | Exhaust valve | 0.75~0.95 | 1.0 | VM:0.75~0.95<br>CH:0.40~0.60<br>VH:0.40~0.60 | 1.0 |

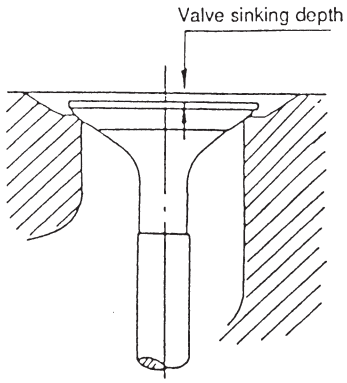
| | | 3TNE78A 3TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Valve sinking depth | Intake valve | 0.296 ~0.496 | 1.0 | 0.306 ~0.506 | 1.0 |
| | Exhaust valve | 0.3~0.5 | 1.0 | 0.3~0.5 | 1.0 |




(Measuring the valve sinkage)

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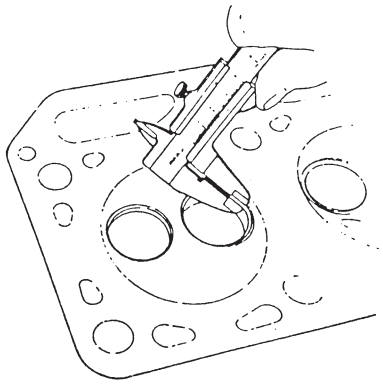

**(2) Width and angle of the valve seat**

Remove carbon deposits from the seat surface. Measure width and angle of the seat using vernier calipers and an angle gauge.

(mm)

| | | 2/3TNE68 | | 3TNE74 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Valve seat width | Intake | 1.15 | 1.65 | 1.44 | 1.98 |
| | Exhaust | 1.41 | 1.91 | 1.77 | 2.27 |
| Valve seat angle | Intake | 120° | — | 120° | — |
| | Exhaust | 90° | — | 90° | — |

| | | 3TNE78A 3TME82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Valve seat width | Intake | 1.36 ~1.53 | 1.93 | 1.07 ~1.24 | 1.74 |
| | Exhaust | 1.66 ~1.87 | 2.27 | 1.24 ~1.45 | 1.94 |
| Valve seat angle | Intake | 120° | — | 120° | — |
| | Exhaust | 90° | — | 90° | — |

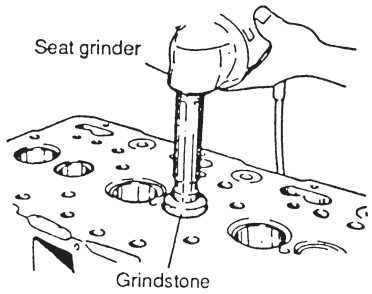


(Measuring the valve seat width)

**[Valve Seat Correction Procedure]**

(1) When the seat surface is worn or roughened slightly, lap the seat surface with a valve compound mixed with oil to a smooth state.

(2) When the seat surface is worn or roughened heavily, correct seat surface using a seat grinder or seat cutter, and finish it according to step (1).




**[Procedure for Using The Seat Grinder and Seat Cutter]**

(1) Correct the roughened seat surface with a seat grinder or seat cutter.

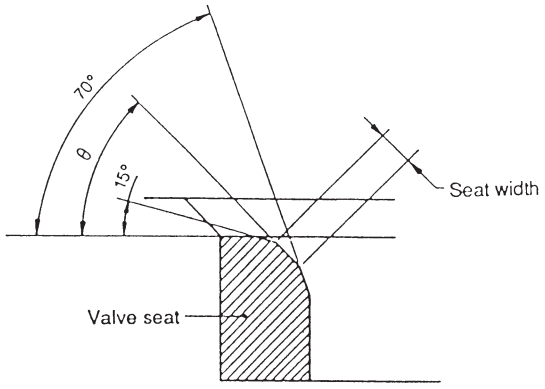
| Seat grinder | Angle (θ) |
|---|---|
| Intake valve | 30° |
| Exhaust valve | 45° |

(2) When the seat width is enlarged from the initial value, correct it by grinding the seat surface with a 70° seat grinder or seat cutter. Then, grind the seat to the standard width with a 15° grinder.

* *When using a seat cutter, evenly apply pressure taking care of avoiding uneven cutting.*

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(Valve seat correction angle)

(3) Knead valve compound with oil and finish the valve seat by lapping.

* *If any valve requires correction, be sure to measure the oil clearance between the valve stem outside dia. and valve guide inside dia. If the oil clearance exceeds the limit, replace the valve or valve guide before correcting the valve seat surface. (For oil clearance between the valve and valve guide, refer to section 3 in this chapter.)*

(4) Finally, lap the valve using only oil.

* *1. After the valve seat is corrected, thoroughly clean the valve and cylinder head using diesel oil or the like. Thoroughly remove the valve compound or grindstone powder.*

*2. For slightly poor contact, take steps (3) and (4).*

### [Extraction of Valve seat]

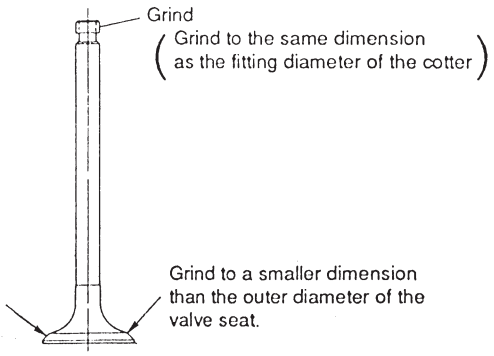
| | | |
|---|---|---|
| Without valve seat | 2/3TNE68:<br>3 TNE74:<br>Direct injection system: | All<br>VM<br>CL and VM |
| With valve seat | 3TNE74 (IDI):<br>Direct injection system:<br>Turbocharged engine: | CH and VH<br>CH and VH<br>All |

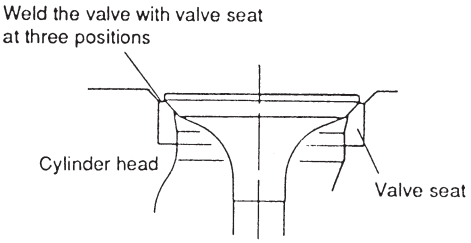
(1) Grind the circumference of the intake/exhaust valve head being or having been used to the dimension smaller than the valve seat outer diameter.

(2) Grind the circumference of the stem end of the valve to the same dimension as the fitting diameter of the cotter.

(3) Weld the intake/exhaust valve head with the valve seat at three positions.

(4) Hit the stem end of the intake/exhaust valve to extract the valve seat.



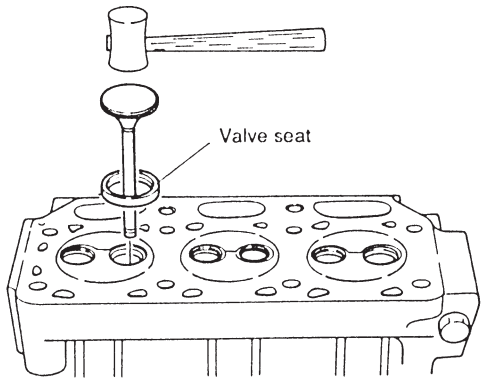

### [Insertion of valve seat]

(1) Put the valve seat in a container which contains liquefied nitrogen, or ether or alcohol with dry ice to cool it sufficiently.

(2) Heat the cylinder head around the portion for valve seat insertion to 80~100°C with a dryer.

(3) With the new intake/exhaust valve, securely insert the sufficiently cooled valve seat into the cylinder head by tapping the head of the intake/exhaust valve.

(4) Stand the cylinder head until the entire cylinder head is cooled to normal temperature.




(Insertion of valve seat)

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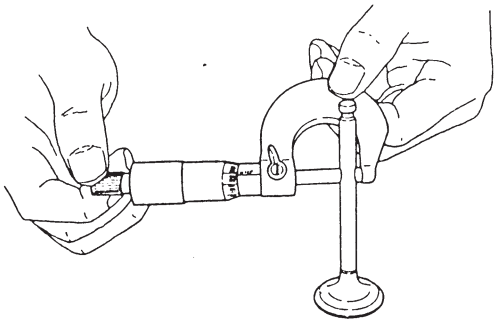
## 3. Intake/exhaust valve

### (1) Wear and bend of the valve stem

Replace a valve stem if bent or worn badly. In this case, replace the valve guide at the same time.

### (2) Valve stem and valve guide

Oil clearance is a difference between the valve guide inside diameter measured with a three-point micrometer (capable of measuring inside diameter between 4 mm and 8 mm) or a cylinder gauge (capable of measuring 6 mm or greater inside diameter) and the stem outside diameter measured with a micrometer. When oil clearance is near the limit, replace both the intake/exhaust valve and valve guide with new ones.



(Measuring the valve stem outside diameter)

(mm)

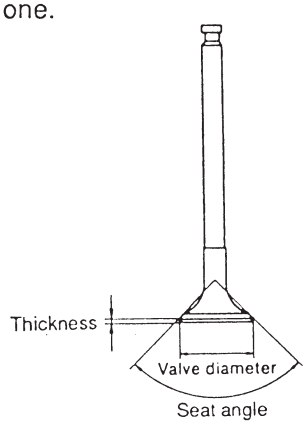
| | | 2/3TNE68 | | 3TNE74 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Intake valve | Stem O.D. | 5.460 ~5.475 | 5.4 | 6.960 ~6.975 | 6.9 |
| | Guide I.D. | 5.500 ~5.515 | 5.58 | 7.005 ~7.020 | 7.08 |
| | Oil clearance | 0.025 ~0.055 | 0.18 | 0.030 ~0.060 | 0.18 |
| Exhaust valve | Stem O.D. | 5.445 ~5.460 | 5.4 | 6.945 ~6.960 | 6.9 |
| | Guide I.D. | 5.500 ~5.515 | 5.58 | 7.005 ~7.020 | 7.08 |
| | Oil clearance | 0.040 ~0.070 | 0.18 | 0.045 ~0.075 | 0.18 |

| | | 3TNE78A 3TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Intake valve | Stem O.D. | 6.945 ~6.960 | 6.9 | 7.955 ~7.975 | 7.9 |
| | Guide I.D. | 7.000 ~7.015 | 7.08 | 8.010 ~8.025 | 8.1 |
| | Oil clearance | 0.040 ~0.070 | 0.18 | 0.035 ~0.070 | 0.2 |
| Exhaust valve | Stem O.D. | 6.940 ~6.955 | 6.9 | 7.955 ~7.970 | 7.9 |
| | Guide I.D. | 7.015 ~0.045 | 7.08 | 8.015 ~8.030 | 8.1 |
| | Oil clearance | 0.045 ~0.075 | 0.18 | 0.045 ~0.075 | 0.2 |

### (3) Thickness of valve head

Measure the thickness of the valve head with a micrometer.

When the measured value is near the wear limit, replace the valve with a new one.




(mm)

| | | 2/3TNE68 | | 3TNE74 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Thick-ness of valve head | Intake valve | 0.85 ~1.15 | 0.50 | 0.99 ~1.29 | 0.50 |
| | Exhaust Valve | 0.95 ~1.25 | | 0.95 ~1.25 | |

| | | 3TNE78A 3TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Thick-ness of valve head | Intake valve | 1.244 ~1.444 | 0.50 | 1.244 ~1.444 | 0.50 |
| | Exhaust Valve | 1.35 ~1.55 | | 1.35 ~1.55 | |

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[Replacing the Valve Guide]

(1) Extract the valve guide from the cylinder head using the valve guide extraction tool.

* *For the valve guide extraction tool, refer to Chapter 5, 5-1.*

(2) In a container containing liquefied nitrogen, ether or alcohol together with dry ice, put the valve guide to cool it. Then hit the sufficiently cooled valve guide to fit into the cylinder head using the valve guide insertion tool.

* *For the valve guide insertion tool, refer to Chapter 5, 5-1.*

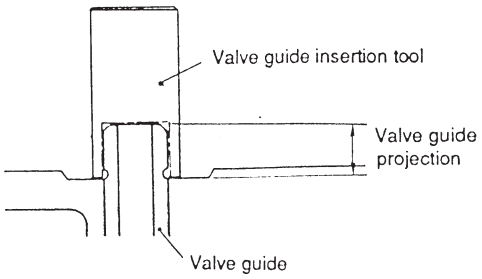
(3) After inserting the valve guide, finish the inside of the valve guide with a reamer.

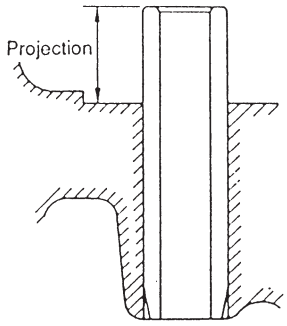
(4) Check the projection of the valve guide.

(mm)

| | 2/3TNE68 | | 3TNE74 | |
|---|---|---|---|---|
| | Standard | Wear limit | Standard | Wear limit |
| Valve guide projection | 7 | — | 9 | — |

| | 3TNE78A 3TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|
| | Standard | Wear limit | Standard | Wear limit |
| Valve guide projection | 12 | — | 15 | — |




(Valve guide projection)

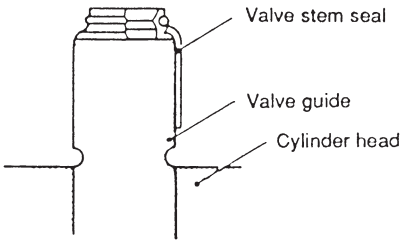
## 4. Valve stem seal

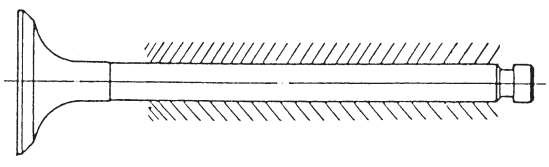
[Time of Replacement]

(1) When oil loss is found excessive
(2) When the valve stem seal is removed
(3) When intake/exhaust valves are removed

[Precautions on Installation]

Make sure that the entire surface of valve stem is smooth, and sufficiently apply lubricating oil to the valve stem before reassembling intake/exhaust valves.



(Hatched portion indicates where to apply lubricating oil.)

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## 5. Checking the valve spring

(1) Visually check to see if the valve spring is free from flaws and corrosion.

(2) Measure the free length (length of the spring) and inclination (squareness of the side of the coil).

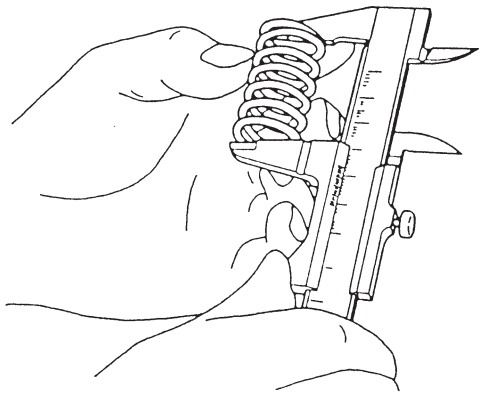
(mm)

| | | 2/3TNE68 | | 3TNE74 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Valve spring | Free length | 28 | — | 37.4 | — |
| | Inclination | — | 0.8 | — | 1.0 |
| | Tension (kg) (when compressed to by 1 mm) | 1.14 ~1.40 | — | *2.37/ 1.87 | — |

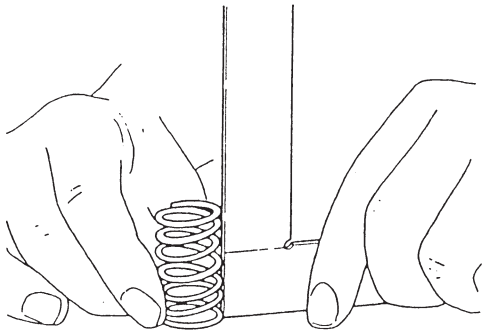
* Tension at variable pitch.

| | | 3TNE78A 3TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Valve spring | Free length | 44.4 | — | 42 | — |
| | Inclination | — | 1.1 | — | 1.1 |
| | Tension (kg) (when compressed to by 1 mm) | *3.61 /2.71 | — | *2.36 /3.101 | — |

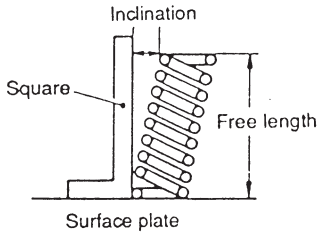
* Tension at variable pitch.



(Measuring the free length)



(Measuring the valve spring inclination)




(Measuring the inclination of valve spring)

## 6. Checking valve spring holder and cotter

Check contact of the inner surface of the valve spring holder with the circumference of the cotter as well as contact of the inner circumference of the cotter with the notch on the head of the valve stem. If such contact is uneven or if the cotter sinks, replace the cotter with a new one.

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# 7-2. Cylinder block

## 1. Checking the cylinder block

(1) Visually check to see if the cylinder block is free from water leak, oil leak and cracks. If any cylinder block is suspected to be cracked, check it by color check.

(2) Replace the cylinder block if badly damaged and incorrectable.

(3) Thoroughly clean each oil hole. Make sure that it is not clogged.

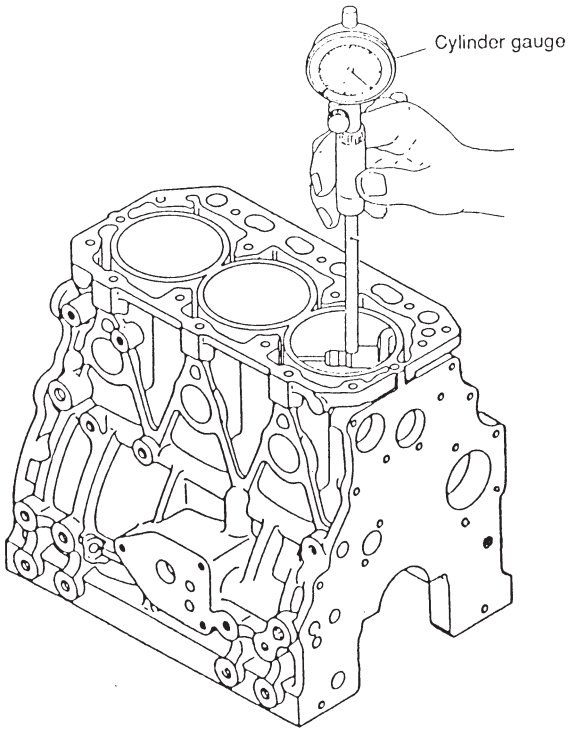
## 2. Measuring the bore and distortion of the cylinder

Measure the bore of each cylinder with a cylinder gauge. Measure the cylinder at point a, approx. 20 mm below the crest of the liner, and at points b and c at equal pitch (a–b = b–c).
Obtain distortion (roundness and cylindricity of each cylinder) from the measured values as follows:

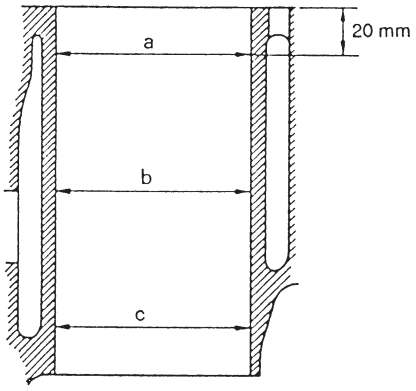
- ○ Roundness:
  Difference between max. and min. bore values on the same cross section of each liner.
- ○ Cylindricity:
  Difference between max. and min. bore values in the same direction of each liner.

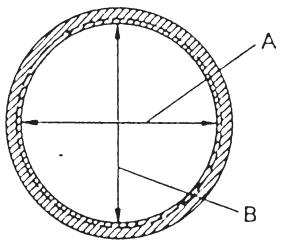
Honing (honing and boring) is required when the measured value exceeds the limit.

* *For oversized piston and piston ring, refer to this chapter, 7-4, 8.*




(Measuring the cylinder bore)




Note: Measurement should be made at a, b and c in the directions of A and B.

( Cylinder bore measuring positions )

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(mm)

| | 2/3TNE68 | | 3TNE74 | |
|---|---|---|---|---|
| | Standard | Wear limit | Standard | Wear limit |
| Cylinder bore | 68.000 ~68.030 | 68.20 | 74.000 ~74.030 | 74.20 |
| Cylinder roundness | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 |
| Cylindricity | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 |

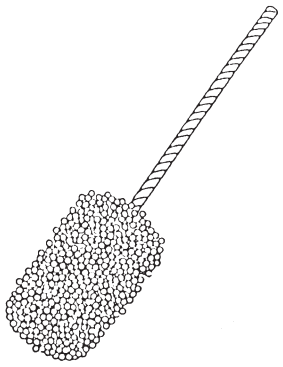
| | 3TNE78A | | 3TNE82A 3/4TNE82 | |
|---|---|---|---|---|
| | Standard | Wear limit | Standard | Wear limit |
| Cylinder bore | 78.000 ~78.030 | 78.20 | 82.000 ~82.030 | 82.20 |
| Cylinder roundness | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 |
| Cylindricity | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 |

| | 3/4TNE84(T) | | 3/4TNE88 | |
|---|---|---|---|---|
| | Standard | Wear limit | Standard | Wear limit |
| Cylinder bore | 84.000 ~84.030 | 84.20 | 88.000 ~88.030 | 88.20 |
| Cylinder roundness | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 |
| Cylinder cylindricity | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 |

## 3. Honing

### (1) Practice of honing

Honing or boring the cylinder if unevenly worn, flawed, or otherwise damaged. Slight uneven worn, flaws, etc. may well be only honing with a Flex-Hone. However, significant uneven wear should be first bored and then honed. It is important to take into careful consideration as to whether the cylinder can attain perfect roundness after honing, boring, or both, considering maximum wear. In addition, carefully study as to whether prepared oversized pistons and piston rings are applicable. (For the oversized piston and piston ring, refer to this chapter 7-4, 8.)



(Flex-Hone)

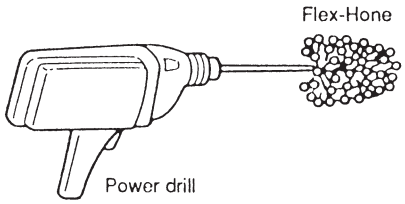
### (2) Procedure for using the Flex-Hone

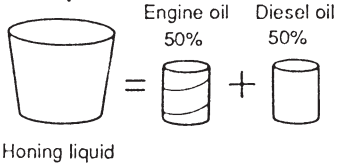
It is common practice to use the Flex-Hone for honing. The procedure for using it appears in the following table. Any material must allow for approx. 1/1000 mm when honed with the Flex-Hone.

### 1. Necessary items

Flex-Hone, power drill, and honing fluid

| Model | Flex-Hone Yanmar code No. | Applicable bore (mm) |
|---|---|---|
| 2/3TNE68 | 129400-92400 | 63~70 |
| 3TNE74 | 129400-92410 | 70~76 |
| 3TNE78A/82A 3/4TNE82 3/4TNE84(T) | 129400-92420 | 76~89 |
| 3/4TNE88 | 129400—92430 | 83~95 |



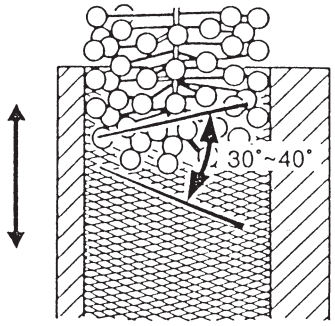
https://truckmanualshub.com/



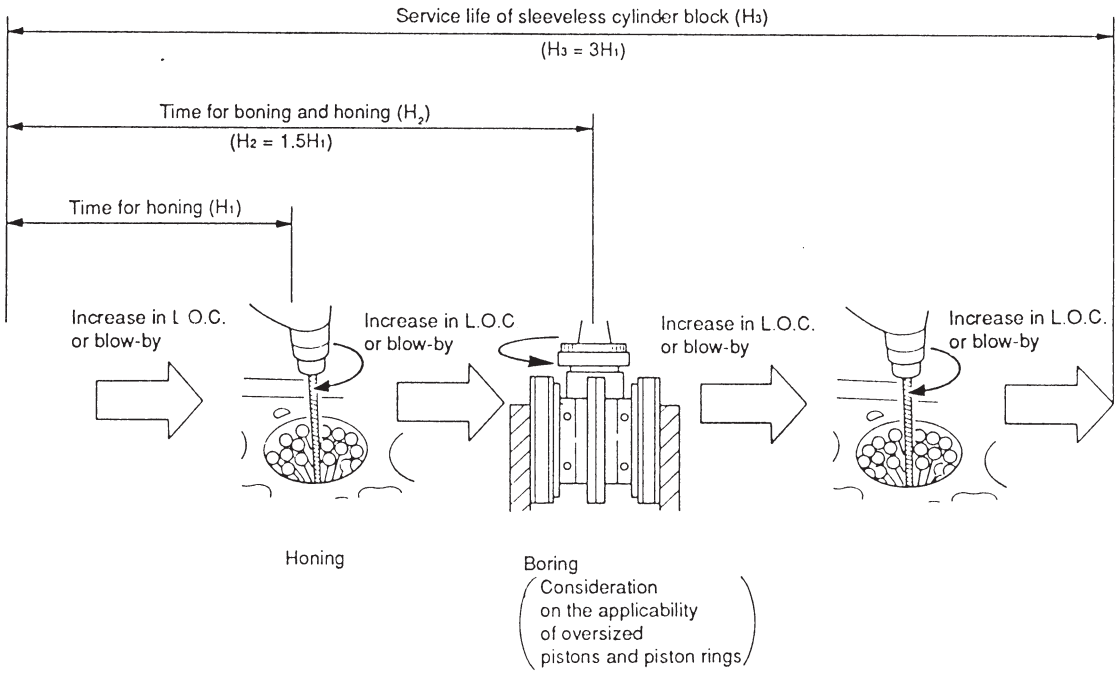
2. Handling procedure

Apply the honing fluid to the Flex-Hone. Insert the Flex-Hone into the cylinder while turning it, move it up and down for about 30 sec for a cross hatch angle of 30–40°. Extract the Flex-Hone while turning it.

* *Use the Flex-Hone at a speed of 300–1200 rpm. Use of the Flex-Hone at a higher speed may be hazardous.*
* *Never insert into or extract from the cylinder the Flex-Hone, with the power drill left stopped.*




4. Overhaul of cylinder (Reference)



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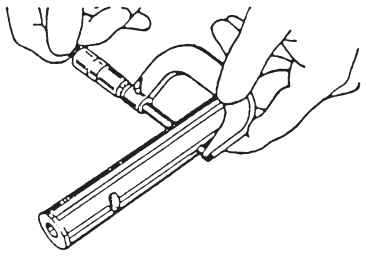
# 7-3. Valve rocker arm

## 1. Measuring the outside diameter of rocker arm shaft and inside diameter of rocker arm

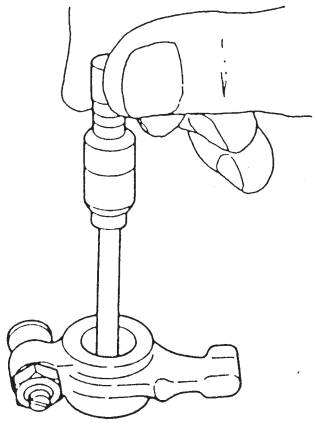
Oil clearance is the difference between the rocker arm inside diameter measured with a cylinder gauge and the rocker arm shaft outside diameter measured with a micrometer. When the oil clearance is near the limit, replace the rocker arm shaft and rocker arm with new ones.

(mm)

| | | 2/3TNE68 | | 3TNE74 | | 3TNE78A/82A 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Intake/exhaust rocker arm | Rocker arm shaft outside diameter | 9.972 ~9.987 | 9.95 | 11.966 ~11.984 | 11.95 | 15.966 ~15.984 | 15.95 |
| | Rocker arm bushing inside diameter | 10.000 ~10.020 | 10.09 | 12.000 ~12.020 | 12.09 | 16.000 ~16.020 | 16.09 |
| | Oil clearance | 0.013 ~0.048 | 0.14 | 0.016 ~0.054 | 0.14 | 0.016 ~0.054 | 0.14 |



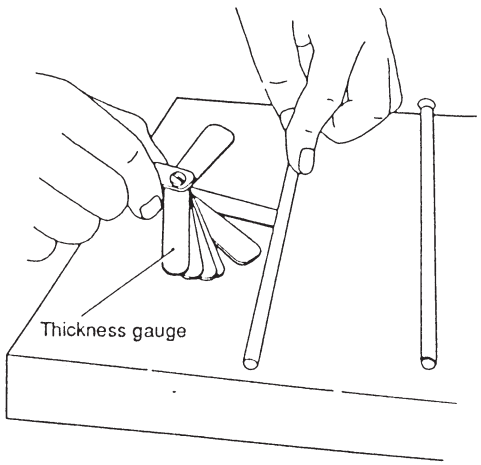
(Measuring the rocker arm shaft outside diameter)



(Measuring the rocker arm inside diameter)

## 2. Checking push rod bend, measuring tappet outside diameter and checking contact surface

Put the push rod on the stool, and measure the gap between the push rod and stool to make sure the push rod is in close contact with the stool. Also, measure the outside diameter of the tappet with a micrometer.




(Measuring the push rod bend)

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(mm)

| | | 2/3TNE68 | | 3TNE74 | | 3TNE78A/82A, 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Push rod bending | | 0.03 or less | — | 0.03 or less | — | 0.03 or less | — |
| Tappet | Tappet stem outside diameter | 17.950 ~17.968 | 17.93 | 20.927 ~20.960 | 20.90 | 11.975 ~11.990 | 11.93 |
| | Tappet guide hole inside diameter | 18.000 ~18.018 | 18.05 | 21.000 ~21.021 | 21.05 | 12.000 ~12.018 | 12.05 |
| | Oil clearance | 0.032 ~0.068 | 0.12 | 0.040 ~0.094 | 0.15 | 0.010 ~0.043 | 0.12 |

## 3. Other checks

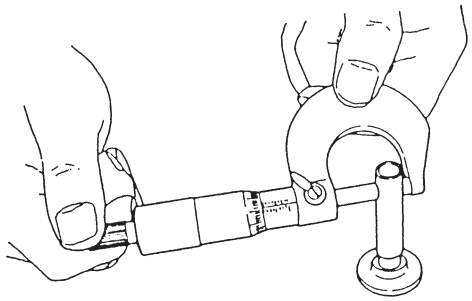
### (1) Valve rocker arm shaft spring

Check to see if the rocker arm shaft spring is free from corrosion and wear. If not, replace it with a new one.

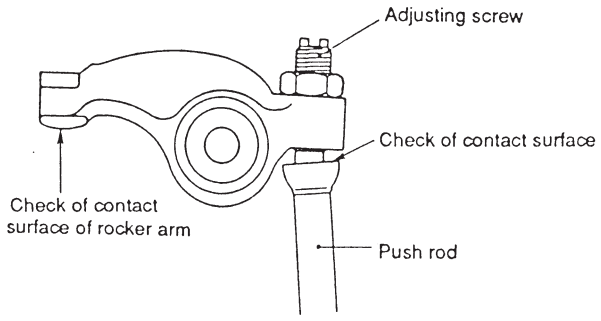
### (2) Wear of intake/exhaust valve rocker arm and valve cap

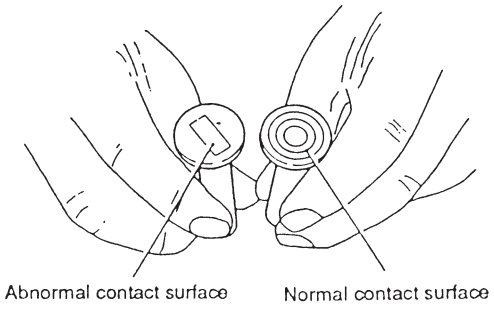
Check the intake/exhaust valve rocker arm for their contact surfaces with valve cap. If any of them is abnormally worn or partially flaked, replace it.

### (3) Check the portion where the valve clearance adjusting screw is in contact with the push rod. If the portion is worn and flaked, replace the pushrod or adjusting screw.



(Measuring the tappet outside diameter)




(Checking the tappet contact surface)

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# 7-4. Piston and piston ring

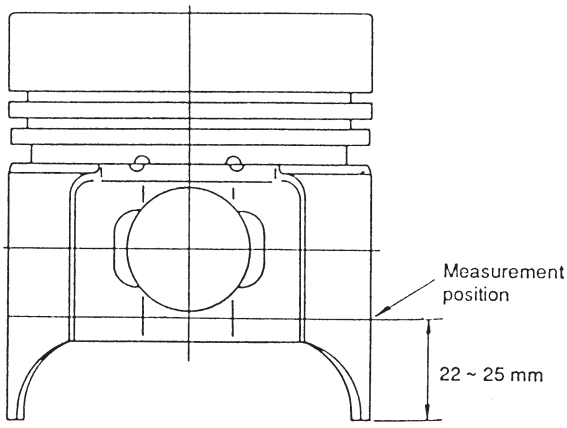
## 1. Checking the piston

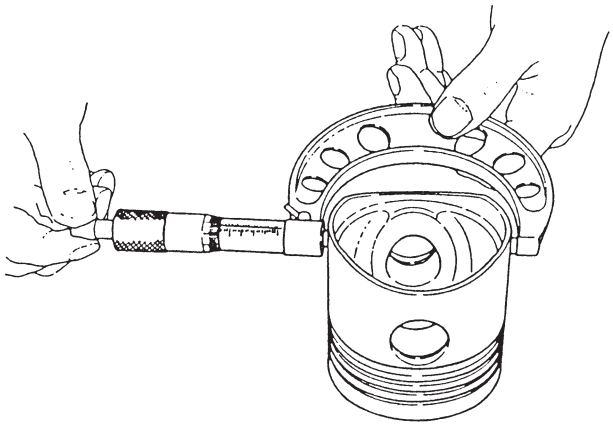
(1) Remove carbon deposits from the head and combustion surface of the piston so as not to impair the piston. Check to see if there is any crack or damage.

(2) Check the circumference and ring groove of the piston, and replace if worn or damaged.

## 2. Measuring the piston outside diameter

To measure the piston outside diameter, measure the long diameter of the oval hole in vertical direction to the pin hole and at a position 22–25 mm from the lower end of the piston.



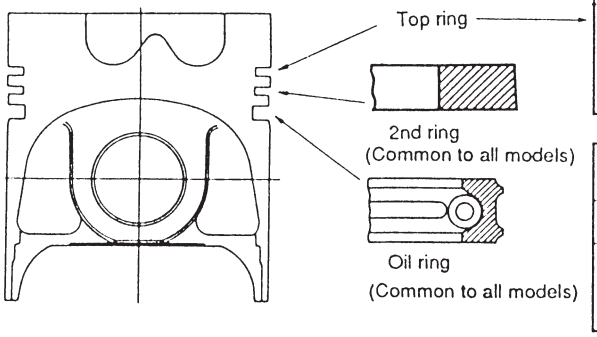



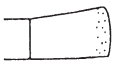
(Measuring the piston outside diameter)

(mm)

| | 2/3TNE68 | | | | 3TNE74 | | 3TNE78A | | 3TNE82A | | 3/4TNE82 | | 3/4TNE84(T) | | 3/4TNE88 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VM, VH | | CH | | | | | | | | | | | | | |
| | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit | Standard | wear limit |
| Piston outside diameter | 67.960 ~67.990 | 67.90 | 67.940 ~67.970 | 67.90 | 73.940 ~73.970 | 73.90 | 77.950 ~77.980 | 77.90 | 81.950 ~81.980 | 81.90 | 81.945 ~81.975 | 81.90 | 83.945 ~83.975 | 83.90 | 87.945 ~87.975 | 87.90 |
| Minimum clearance between piston and cylinder | 0.025 ~0.055 | — | 0.045 ~0.075 | — | 0.045 ~0.075 | — | 0.035 ~0.065 | — | 0.035 ~0.065 | — | 0.040 ~0.070 | — | 0.040 ~0.070 | — | 0.040 ~0.070 | — |

## 3. Shapes of piston rings




| Model | 2/3TNE68, 3TNE74 |
|---|---|
| Application | VM, CH, VH |
| Top ring |  |

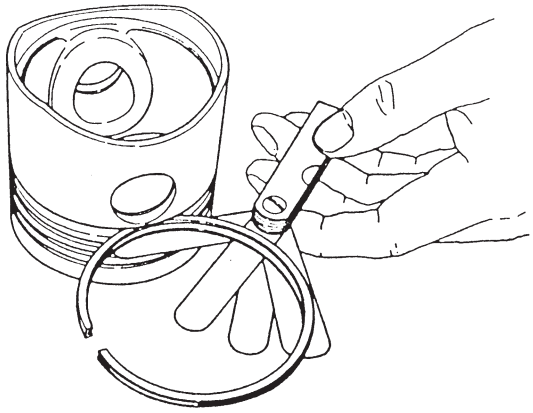
| Model | 3TNE78A/82A, 3/4TNE82, | 3/4TNE84(T) 3/4TNE88 |
|---|---|---|
| Application | CL, VM | CH, VH, w/turbocharged |
| Top ring |  |  |

https://truckmanualshub.com/

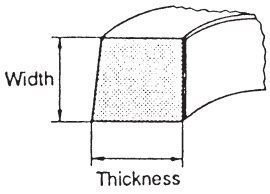


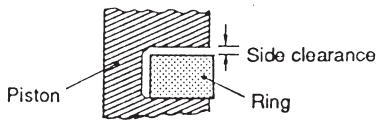
4. **Measuring the ring groove width, ring width, and end clearance**

To measure the piston ring groove width, first measure the width of the piston ring. Then, insert the piston ring into the ring groove that has been carefully cleaned. Insert a thickness gauge in between the piston ring and groove to measure the gap between them. Obtain the ring groove width by adding ring width to the measured side clearance.

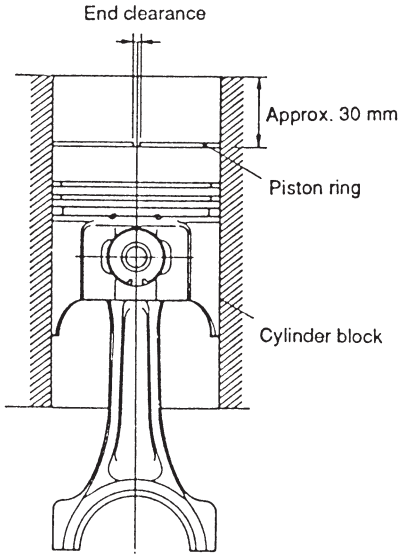


(Measuring the side clearance)




To measure the end clearance, push the piston ring into the sleeve using the piston head, insert a thickness gauge in end clearance to measure. If the sleeve is worn, measure the end clearance after pushing the piston ring to the portion of the sleeve which is less worn (approx. 30 mm from the lower end of the sleeve).




(Measuring the end clearance of piston ring)

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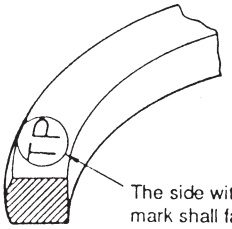


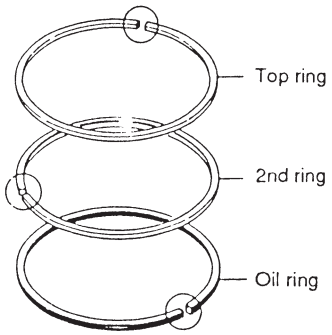
(mm)

| | | 2/3TNE68 | | 3TNE74 | | 3TNE78A | | 3TNE82A, 3/4TNE82, 3/4TNE84(T) | | 3/4TNE88 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Top ring | Ring groove width | 1.550 ~1.570 | — | 1.550 ~1.570 | — | 2.035 ~2.050 | — | 2.065 ~2.080 | — | 2.060 ~2.075 | — |
| | Ring width | 1.470 ~1.490 | — | 1.470 ~1.490 | — | 1.940 ~1.960 | — | 1.970 ~1.990 | — | 1.970 ~1.990 | — |
| | Min. side clearance | 0.060 ~0.100 | — | 0.060 ~0.100 | — | 0.075 ~0110 | — | 0.075 ~0.110 | — | 0.070 ~1.105 | — |
| | End clearance | 0.100 ~0.250 | 1.5 | 0.200 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 |
| 2nd ring | Ring groove width | 1.540 ~1.555 | — | 1.520 ~1.535 | — | 2.025 ~2.040 | — | 2.035 ~2.050 | — | 2.025 ~2.040 | — |
| | Ring width | 1.430 ~1.450 | — | 1.410 ~1.430 | — | 1.975 ~1.990 | — | 1.970 ~1.990 | — | 1.970 ~1.990 | — |
| | Min. side clearance | 0.090 ~0.125 | — | 0.090 ~0.125 | — | 0.035 ~0.065 | — | 0.045 ~0.080 | — | 0.035 ~0.070 | — |
| | End clearance | 0.150 ~0.350 | 1.5 | 0.200 ~0.400 | 1.5 | 0.250 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 |
| Oil ring | Ring groove width | 3.010 ~3.025 | — | 3.010 ~3.025 | — | 3.015 ~3.030 | — | 4.015 ~4.030 | — | 4.015 ~4.030 | — |
| | Ring width | 2.970 ~2.990 | — | 2.970 ~2.990 | — | 2.970 ~2.990 | — | 3.970 ~3.990 | — | 3.970 ~3.990 | — |
| | Min. side clearance | 0.020 ~0.055 | — | 0.020 ~0.055 | — | 0.025 ~0.060 | — | 0.025 ~0.060 | — | 0.025 ~0.060 | — |
| | End clearance | 0.150 ~0.350 | 1.5 | 0.150 ~0.350 | 1.5 | 0.200 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 |

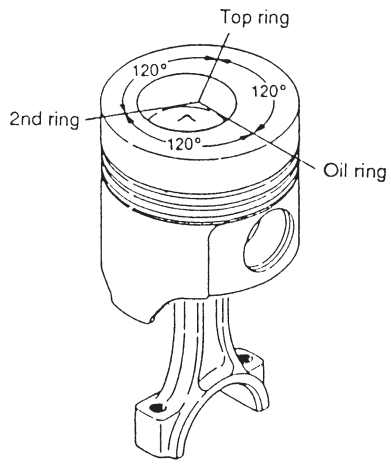
## 5. Reassembly of piston ring

(1) Using the piston ring replacer, insert the piston ring into the ring groove, with the manufacturer's mark near the joint of the piston ring facing up to the combustion chamber side. After fitting the piston ring, make sure that the piston ring moves freely.




(2) Stagger the piston rings joints at 120° intervals, making sure that they are not aligned along the piston. Apply lube oil to the circumference of the piston.

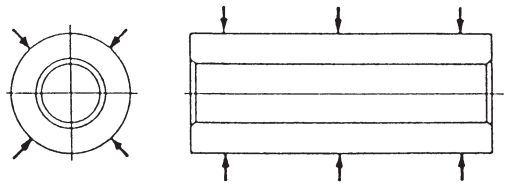


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## 6. Measuring the outside diameter of the piston pin and the pin hole diameter

Measure outside diameter of the piston pin and pin hole diameter. Replace the piston pin if the wear limit is exceeded.
Apply lubricating oil to the piston pin before inserting it into the piston.

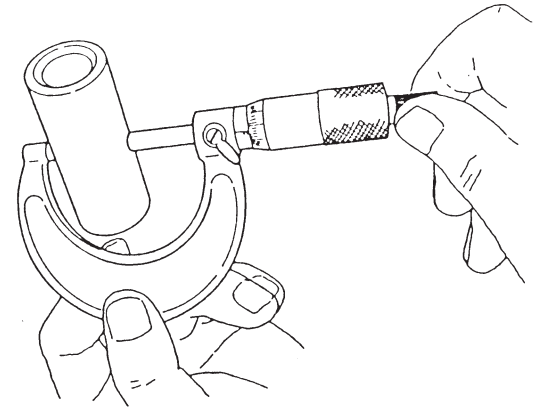


(Measuring point of the piston pin O. D.)

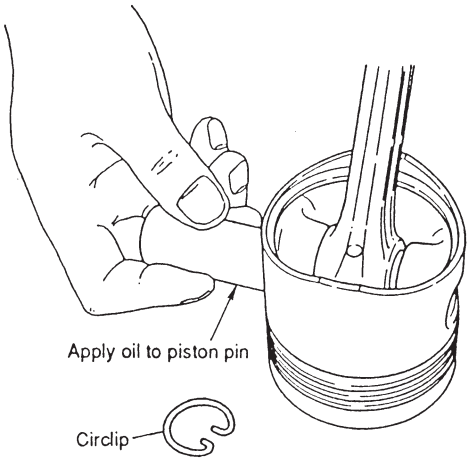
(mm)

| | | 2/3TNE68 | | 3TNE74 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Piston and piston pin | Piston pin outside diameter | 19.991 ~20.000 | 19.90 | 20.991 ~21.000 | 20.90 |
| | Piston pin hole dia. | 20.000 ~20.008 | 20.02 | 21.000 ~21.008 | 21.02 |
| | Oil clearance | 0.000 ~0.017 | 0.12 | 0.000 ~0.017 | 0.12 |

| | | 3TNE78A 3TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Piston and piston pin | Piston pin outside diameter | 22.991 ~23.000 | 22.90 | 25.987 ~26.000 | 25.90 |
| | Piston pin hole dia. | 23.000 ~23.008 | 23.02 | 26.000 ~26.009 | 26.02 |
| | Oil clearance | 0.000 ~0.017 | 0.12 | 0.000 ~0.022 | 0.12 |



(Measuring the piston pin outside diameter)




(Insertion of piston pin)

## 7. [Reference] Top clearance

(mm)

| | 2/3TNE68 | | 3TNE74 | |
|---|---|---|---|---|
| | Standard | Wear limit | Standard | Wear limit |
| Top clearance | 0.610 ~0.730 | — | 0.658 ~0.778 | — |

| | 3TNE78A 3TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|
| | Standard | Wear limit | Standard | Wear limit |
| Top clearance | 0.650 ~0.770 | — | 0.660 ~0.780 | — |

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## 8. List of the oversized piston and piston ring

(0.250S: Oversized by 0.25 mm)

| Model | | Size classification | Piston assy code (including piston ring assy) | Piston ring assy code |
|---|---|---|---|---|
| 2/3TNE68 | VM<br>VH | 0.250S | 119265—22930 | 119265—22950 |
| | CH | 0.250S | 119265—22900 | |
| 3TNE74 | VM<br>CH<br>VH | 0.250S | 119623—22900 | 119623—22950 |
| 3TNE78A | CL<br>VM<br>CH<br>VH | 0.250S | 119818—22910 | 119818—22950 |
| 3TNE82A | CL<br>VM | 0.250S | 119813—22900 | 129003—22950 |
| 3/4TNE82 | CL<br>VM | 0.250S | 129003—22900 | 129003—22950 |
| | CH<br>VH | 0.250S | 129003—22910 | 129003—22950 |
| 3/4TNE84(T) | CL<br>VM | 0.250S | 129002—22900 | 129002—22950 |
| | CH<br>VH | 0.250S | 129002—22910 | 129002—22950 |
| 3/4TNE88 | CL<br>VM | 0.250S | 129001—22900 | 129001—22950 |

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# 7-5. Connecting rod

## 1. Visual inspection

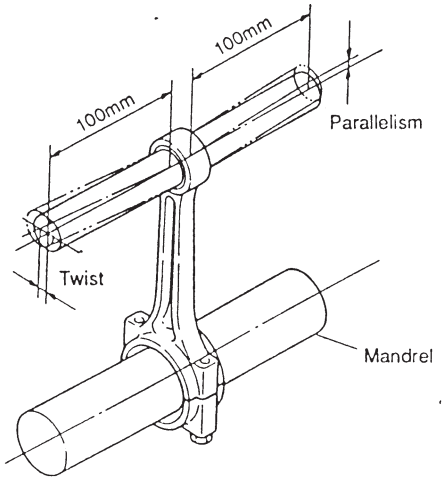
Inspect the portion near the boundary of the chamfered portion and I-beam section of the big and small ends of the connecting rod as well as the portion near the oil hole of the bushing at the small end for cracks, deformation, and discoloration.

## 2. Measuring the twist and parallelism

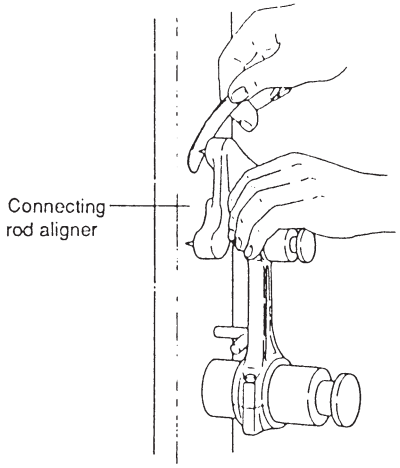
Measure the twist and parallelism by use of the connecting rod aligner.

(mm)

| | All models | |
|---|---|---|
| | Standard | Wear limit |
| Twist and parallelism | 0.03 or less per 100 mm | 0.08 |




(Measuring the twist and parallelism)



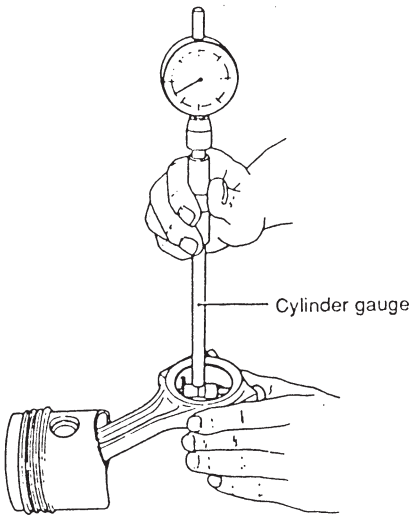

(Measuring the twist with connecting rod aligner)

## 3. Measuring the crankpin and bushing clearance

To measure the oil clearance of the crankpin and bushing, measure the inside diameter of the crankpin metal and outside diameter of the crankpin, and obtain the difference between them.

If the measured oil clearance exceeds or near the wear limit, replace the crankpin metal. If the crankpin is excessively or unevenly worn, grind the crankpin, and use an oversized crankpin metal.

* *To measure the inside diameter of the crankpin metal, reassemble the crankpin metal to the connecting rod and tighten the rod bolt to the specified torque, making sure each metal is fitted on the correct position.*




(Measuring the inside diameter of the crankpin metal)

(kgf-m)

| | 2/3TNE68 3TNE74 | 3TNE78A 3TNE82A | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 |
|---|---|---|---|
| | Specified torque | | |
| Rod bolt tightening torque (Apply lube oil to the rod bolt) | 2.3~2.8 | 3.8~4.2 | 4.5~5.5 |

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(mm)

| | | 2/3TNE68 | | 3TNE74 | | 3TNE78A 4TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Crankpin side | Crankpin bushing inside dia. | 39.000 ~39.016 | — | 43.000 ~43.016 | — | 46.000 ~46.016 | — | 51.000 ~51.010 | — |
| | Crankpin metal thickness | 1.487 ~1.500 | — | 1.487 ~1.500 | — | 1.487 ~1.500 | — | 1.492 ~1.500 | — |
| | Crankpin outside diameter | 35.970 ~35.980 | 35.91 | 39.970 ~39.980 | 39.91 | 42.952 ~42.962 | 42.91 | 47.952 ~47.962 | 47.91 |
| | Oil clearance | 0.033 ~0.059 | 0.15 | 0.033 ~0.059 | 0.15 | 0.038 ~0.0900 | 0.16 | 0.038 ~0.074 | 0.16 |

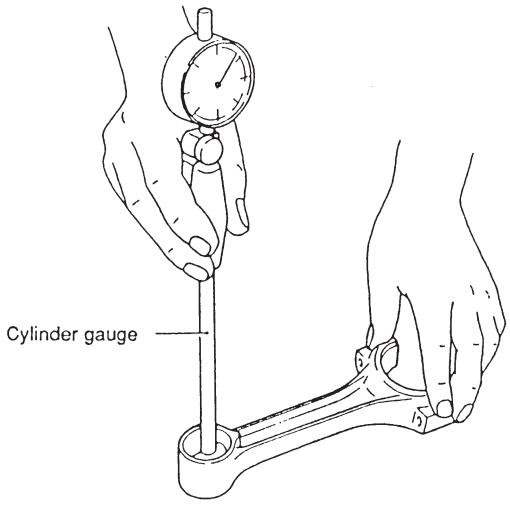
## 4. Measuring the oil clearance between the piston pin bushing and piston pin

To measure of oil clearance between the piston pin bushing and piston pin, measure the inside diameter of the piston pin bushing and outside diameter of the piston pin, and obtain the difference between them.

(mm)

| | | 2/3TNE68 | | 3TNE74 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Piston pin side | Piston pin bushing inside diameter | 20.025 ~20.038 | 20.10 | 21.025 ~21.038 | 21.10 |
| | Piston pin outside diameter | 19.991 ~20.000 | 19.90 | 20.991 ~21.000 | 20.90 |
| | Oil clearance | 0.025 ~0.047 | 0.2 | 0.025 ~0.047 | 0.2 |

| | | 3TNE78A 3TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Piston pin side | Piston pin bushing inside diameter | 23.025 ~23.038 | 23.10 | 26.025 ~26.038 | 26.10 |
| | Piston pin outside diameter | 22.991 ~23.000 | 22.90 | 25.987 ~26.000 | 25.90 |
| | Oil clearance | 0.025 ~0.047 | 0.2 | 0.025 ~0.051 | 0.2 |



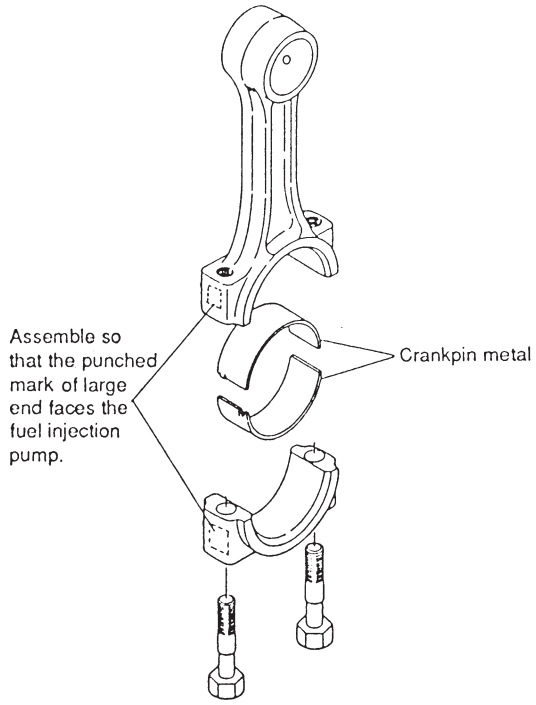

( Measuring the inside diameter of the piston pin bushing )

## 5. Checking the crankpin metal for contact

Apply a blue ink or a minium to the crankpin metal upper surface. Attach the crankpin metal to the connecting rod, and tighten the rod bolt to the crankshaft to the specified torque (Refer to this section 3) to check the metal for contact. If the contact surface occupies 75% or more of the total surface, the crankpin metal is acceptable in terms of contact.

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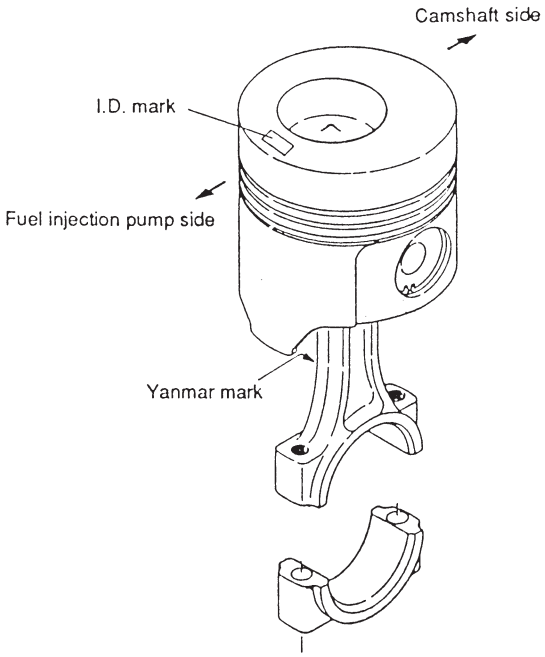




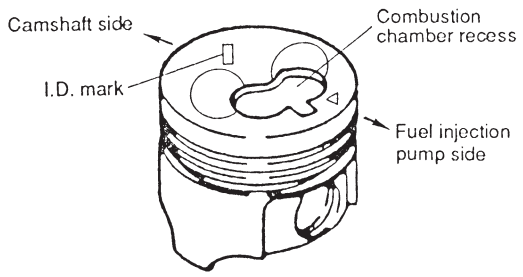

## 6. Assembling the piston and connecting rod

Assemble the piston with the connecting rod, with the mark at the big end of the connecting rod facing the fuel injection pump. Reassemble the piston so that the recess of the combustion chamber is on the side of the fuel injection pump as seen from the top.

(Direct injection system piston)




(Indirect injection system piston)

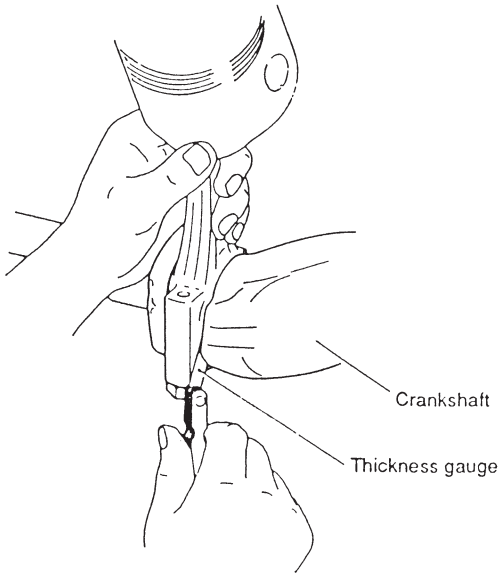



## 7. Side gap of the connecting rod

After attaching the connecting rod to the crankshaft, tighten the rod bolt to the specified torque (see this section 3). Measure the side gap by inserting a thickness gauge into the side gap. If the standard is exceeded, replace the crankpin metal or connecting rod.

(mm)

| | All models |
|---|---|
| Side gap | 0.2~0.4 |




(Measuring the connecting rod side gap)

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8. Oversized crankpin metal

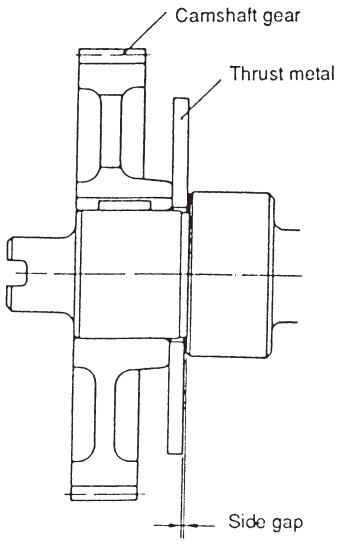
(0.25mm, oversized)

| | Crankpin metal | |
|---|---|---|
| | Part code No. | Metal thickness (mm) |
| | | Standard |
| 2/3TNE68 | 119260—23350 | 1.625 |
| 3TNE74 | 119620—23350 | 1.625 |
| 3TNE78A/82A | 119810—23350 | 1.625 |
| 3/4TNE82<br>3/4TNE84(T)<br>3/4TNE88 | 129150—23350 | 1.625 |

# 7-6. Camshaft

1. Camshaft side gap

Before extracting the camshaft, bring a dial gauge into contact with the camshaft gear and measure the side gap around the camshaft. If the measured value exceeds the limit, replace the thrust metal with a new one.




(mm)

| | All models |
|---|---|
| Side gap | 0.05~0.25 |

2. Checking the camshaft for appearance

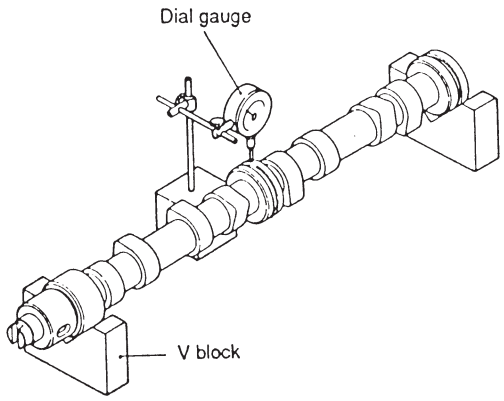
Check the camshaft for the contact surface of the tappet to the cam, seizure and wear of the bearing, and damage of the cam gear.

3. Measuring the bend of the camshaft

Support the camshaft with V blocks. Using a dial gauge, measure the runout of the journal at the center of the camshaft, while rotating the camshaft.
Take 50% of the measured runout as bend.

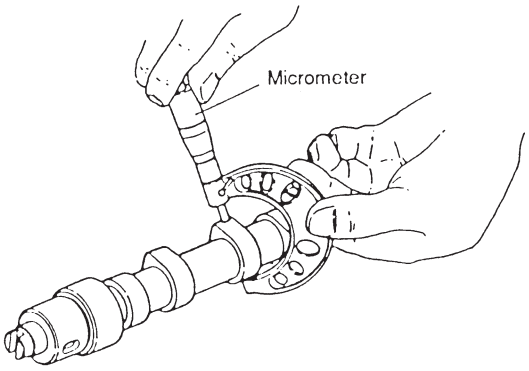
(mm)

| | All models | |
|---|---|---|
| | Standard | Wear limit |
| Camshaft bend | 0.02 or less | 0.05 |

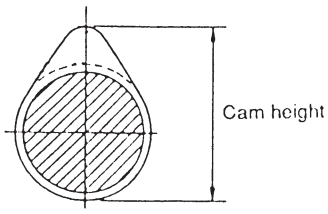



(Measuring the camshaft bend)

4. Measuring the intake/exhaust cam height




(Measuring the cam height)



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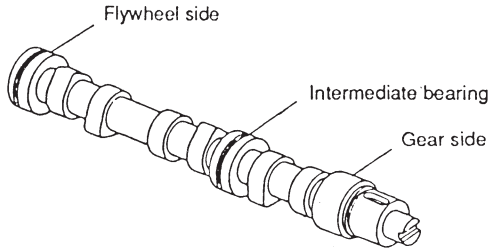


(mm)

| | | 2/3TNE68 | | 3TNE74 | | 3TNE78A/82A, 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Cam height | Intake cam | 29.970 ~30.030 | 29.75 | 33.950 ~34.050 | 33.75 | 38.635 ~38.765 | 38.40 |
| | Exhaust cam | 29.970 ~30.030 | 29.75 | 33.950 ~34.050 | 33.75 | 38.635 ~38.765 | 38.40 |

## 5. Measuring the outside diameter of the camshaft bearing

Measure the outside diameter of the camshaft with a micrometer. Calculate the oil clearance from measured camshaft outside diameter and the camshaft bushing inside diameter measured with a cylinder gauge after inserting the camshaft bushing into the cylinder block.




(mm)

| | | 2/3TNE68 | | 3TNE74 | | 3TNE78A/82A, 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Gear side | Camshaft journal outside diameter | 35.940 ~35.960 | 35.85 | 39.940 ~39.960 | 39.85 | 44.925 ~44.950 | 44.85 |
| | Oil clearance | 0.040 ~0.085 | — | 0.040 ~0.085 | — | 0.040 ~0.130 | — |
| Intermediate | Camshaft journal outside diameter | 35.910 ~35.935 | 35.85 | 39.910 ~39.935 | 39.85 | 44.910 ~44.935 | 44.85 |
| | Oil clearance | 0.065 ~0.115 | — | 0.065 ~0.115 | — | 0.065 ~0.115 | — |
| Flywheel side | Camshaft journal outside diameter | 35.940 ~35.960 | 35.85 | 39.940 ~39.960 | 39.85 | 44.925 ~44.950 | 44.85 |
| | Oil clearance | 0.040 ~0.125 | — | 0.040 ~0.125 | — | 0.040 ~0.100 | — |

## 6. Extracting the camshaft bushing

Extract the bushing with camshaft bushing tool (refer to Chapter 5, 5-1.)

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# 7-7. Crankshaft

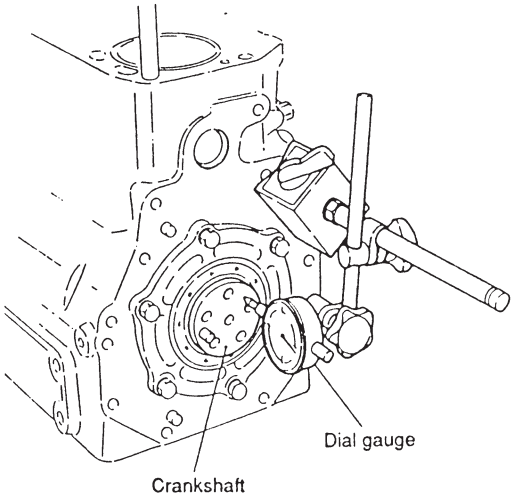
### 1. Side gap around the crankshaft

Before extracting the crankshaft and when reassembling it, bring a dial gauge into contact to the end of the crankshaft. Force the crankshaft to both sides in the axial direction to measure the thrust gap. Alternatively, insert a thickness gauge directly into a thrust gap between the thrust metal in the standard part and crankshaft to measure the side gap.

If the limit is exceeded, replace the thrust metal with a new one.

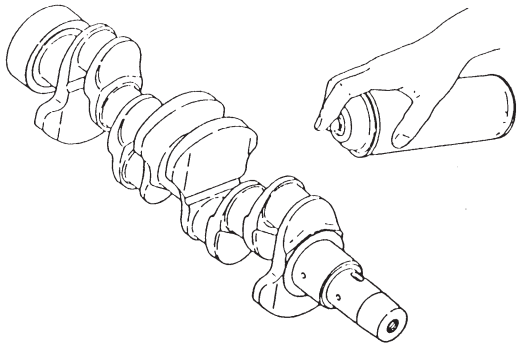
(mm)

| | All models |
|---|---|
| Thrust gap | 0.090~0.271 |




### 2. Color check of crankshaft

Clean the crankshaft and check it using a color check kit or a magnaflux inspector. Replace the crankshaft if cracked or badly damaged. If the crankshaft is slightly damaged, correct it by re-grinding.



(Color check Inspection)

### 3. Checking the metal

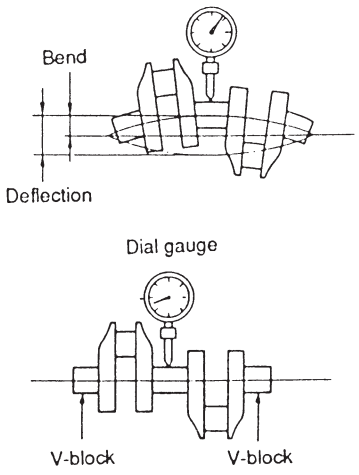
Check the metal for flaking, melting, seizure, and the state of the contact face. Replace the metal if found defective.

### 4. Bend of the crankshaft

Support the crankshaft with V-blocks at both ends of the journals; measure the runout at the center journal with a dial gauge while rotating the crankshaft to check the extent of crankshaft bend.

(mm)

| | All models |
|---|---|
| | Standard |
| Bend | 0.02 or less |




(Measuring the crankshaft bend)

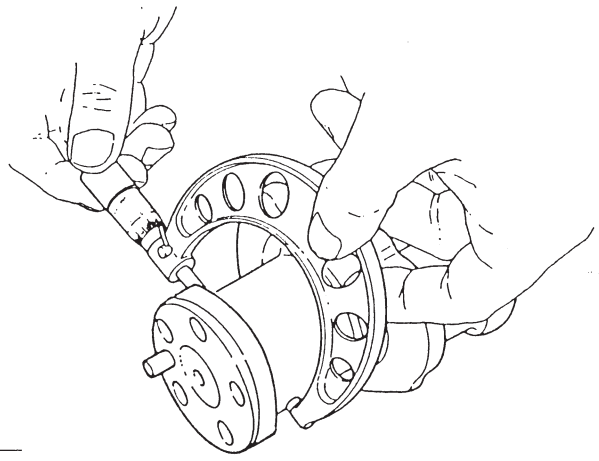
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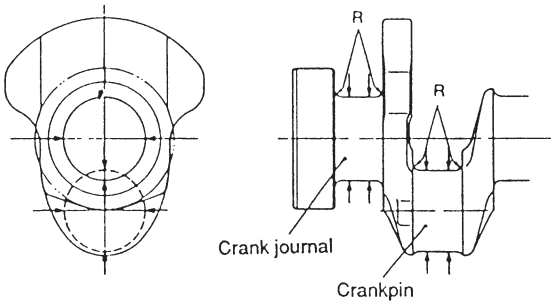


## 5. Measurement of crankpin and journal

Measure the outside diameter, roundness, taper angle of the crankpin and the journal. If uneven wear or roundness exceeds the wear limit but measured outside diameter is within the limit, use the crankpin and journal after correcting them by regrinding. Replace them with new ones, if any of the limit is exceeded.

An oversized crankpin metal by 0.25 mm is available. (See this Chapter 7-5, 8.)






( **Measuring position of the crankpin and crankjournal** )

(mm)

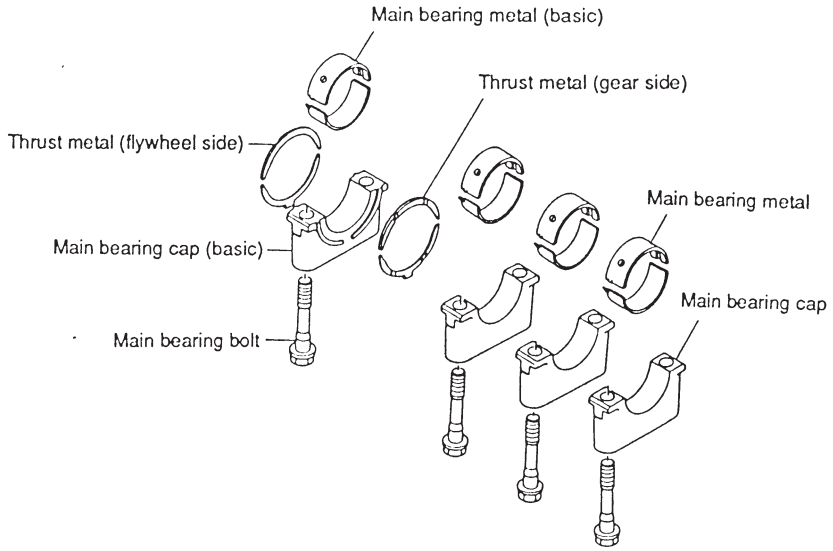
| | | 2/3TNE68 | | 3TNE74 | | 3TNE78A 4TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Crankpin | Crankpin outside diameter | 35.970 ~35.980 | 35.91 | 39.970 ~39.980 | 39.91 | 42.952 ~42.962 | 42.91 | 47.952 ~47.962 | 47.91 |
| Crank journal | Crankshaft journal outside diameter | 39.970 ~39.980 | 39.90 | 43.970 ~43.980 | 43.90 | 46.952 ~46.962 | 46.91 | 53.952 ~53.962 | 53.91 |
| | Bearing metal thickness | 1.487 ~1.500 | — | 1.987 ~2.000 | — | 1.987 ~2.000 | — | 1.995 ~2.010 | — |
| | Crank journal and bushing oil clearance | 0.033 ~0.059 | 0.15 | 0.033 ~0.059 | 0.15 | 0.038 ~0.093 | 0.25 | 0.038 ~0.068 | 0.15 |

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## 6. Precautions in mounting the metal cap

(1) The lower metal (cap side) has no oil groove.
(2) The upper metal (cylinder block side) has an oil groove.
(3) Check the cylinder block alignment No.
(4) Place the relief mark "FW" of the cap on the flywheel side.
(5) Place the main bearing metal on the flywheel side.




## 7. Undersized main metal by 0.25 mm and the oversized thrust metal by 0.25 mm

| | Main metal | | Thrust metal | |
|---|---|---|---|---|
| | Part code | Metal thickness (mm) | Part code | Metal thickness (mm) |
| | | Standard | | Standard |
| 2/3TNE68 | 719260—02870 | 1.625 | 119260—02940 | 2.125 |
| 3TNE74 | 719620—02870 | 2.125 | 119620—02940 | 2.125 |
| 3TNE78A/82A | 119810—02870 | 2.125 | 119810—02940 | 2.125 |
| 3/4TNE82<br>3/4TNE84(T)<br>3/4TNE88 | 129150—02870 | 2.125 | 129150—02940 | 2.125 |

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# 7-8. Gears

## 1. Checking gears

Inspect the gears and replace if the teeth are damaged, worn, or chipped.

## 2. Measuring the backlash

Apply a dial gauge onto the pitch circle of the gear, and measure the backlash.

(mm)

| | | 2/3TNE68, 3TNE74 | 3TNE78A/82A, 3/4TNE82, 3/4TNE84(T), 3/4TNE88 |
|---|---|---|---|
| Back-lash | Crankshaft gear, Camshaft gear, Idle gear and Fuel injection pump drive gear | 0.04~0.12 | 0.07~0.15 |
| | L.O. pump gear | 0.11~0.19 | |

## 3. Checking and measuring the idling gear shaft and idling gear

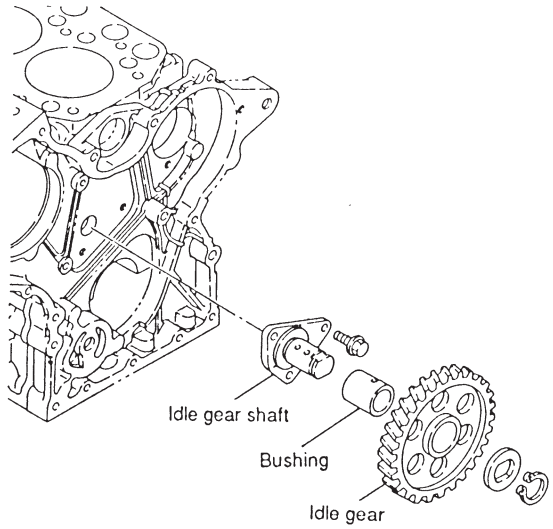
(1) Measure the bushing inside diameter and the idle gear shaft outside diameter, and replace the bushing or idling gear shaft if the oil clearance exceeds the wear limit.

(mm)

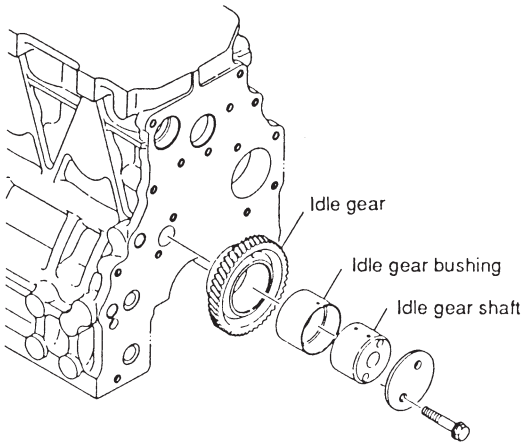
| | | 2/3TNE68, 3TNE74 | | 3TNE78A/82A, 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit |
| Idle gear | Shaft outside dia. | 19.959 ~19.980 | 19.93 | 45.950 ~45.975 | 45.93 |
| | Bushing inside dia. | 20.000 ~20.021 | — | 46.000 ~46.025 | 46.08 |
| | Oil clearance | 0.020 ~0.062 | 0.15 | 0.025 ~0.075 | 0.15 |

(2) Make sure that the oil hole of the idle gear shaft and bushing is a through hole.

(Indirect injection system)




(Direct injection system)



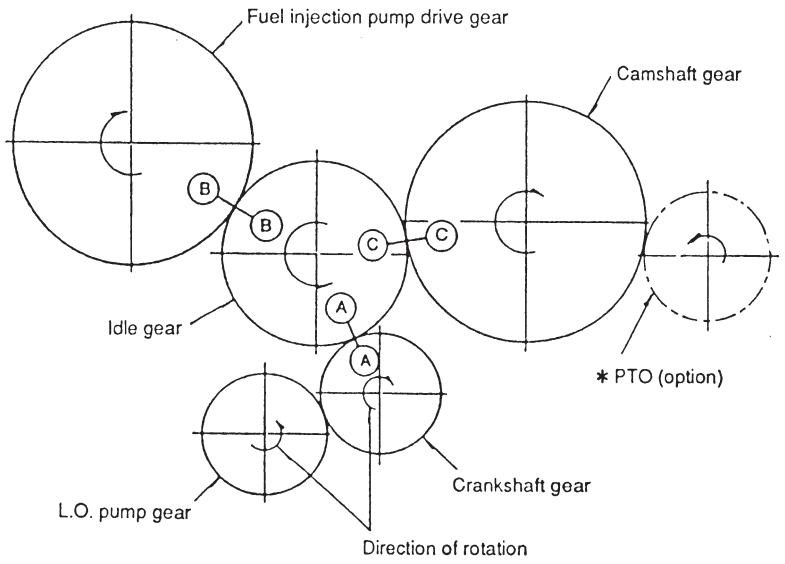
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4. Gear train

After installing each gear, make sure that aligning marks Ⓐ,Ⓑ and Ⓒ of the idle gear are aligned with those of the fuel injection pump gear, cam gear and crank gear.

**(View the gear case)**



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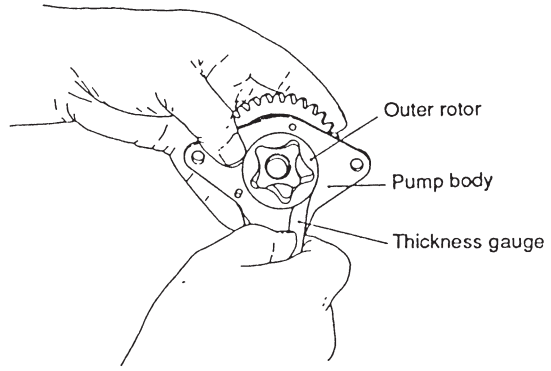
# 7-9. Trochoid pump

## 1. Clearance between outer rotor and pump body

Insert a thickness gauge between the outer rotor and pump body to measure the clearance.

(mm)

| | All models | |
|---|---|---|
| | Standard | Wear limit |
| Clearance between outer rotor and pump body | 0.10~0.16 | 0.25 |



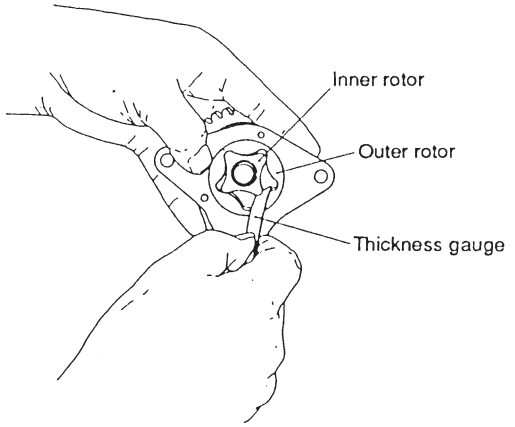

(Measuring the clearance between outer rotor and pump body)

## 2. Clearance between outer rotor and inner rotor

Insert a thickness gauge between the top of the inner rotor tooth and the top of the outer rotor tooth to measure the clearance.

(mm)

| | All models | |
|---|---|---|
| | Standard | Wear limit |
| Clearance between outer rotor and inner rotor | — | 0.15 |



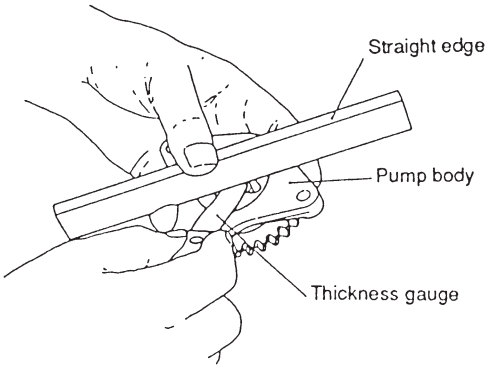

(Measuring the clearance between outer rotor and inner rotor)

## 3. Side clearance between pump body and inner rotor, outer rotor

Place a straight-edge against the end of the pump and insert a thickness gauge between the straight-edge and the rotors to measure the side clearance.

(mm)

| | 2/3TNE68 3TNE74 | | 3TNE78A 3TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|---|
| | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Pump body and inner-, outer-rotor side clearance | 0.03 ~0.09 | 0.13 | 0.05 ~0.10 | 0.15 | 0.03 ~0.09 | 0.15 |




(Measuring the clearance between the pump body and inner-, outer-rotor)

## 4. Clearance between rotor shaft and side cover hole

Measure the rotor shaft outside diameter and the side cover hole diameter, and calculate the difference between the hole diameter and the outside diameter.

(mm)

| | All models | |
|---|---|---|
| | Standard | Wear limit |
| Clearance between rotor shaft and side cover hole | 0.013 ~0.043 | 0.2 |

## 5. Others

(1) Check for looseness of drive gear/rotor shaft fitting, and replace the entire assembly if loose or wobbly.

(2) Push the oil pressure regulating valve piston from the oil hole side, and replace the entire assembly if the piston does not return due to spring breakage, etc. (Engine with oil cooler only)

(3) Make sure that the rotor shaft rotates smoothly and easily when the drive gear is rotated.

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# 8. Disassembly and Reassembly

Peripheral parts such as air cleaner, muffler and radiator differ in installation and types for each application. Therefore, description in this Chapter is started with the steps to be taken just after the peripheral parts have been removed.

Perform the procedure, with reference to the attached drawings, "Engine component Exploded View."

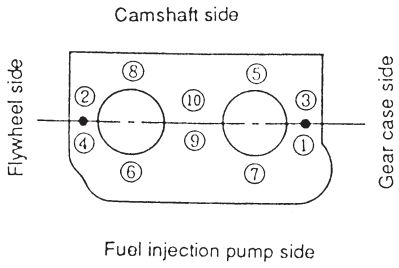
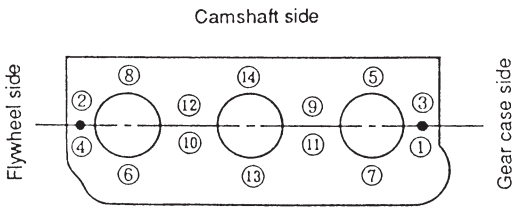
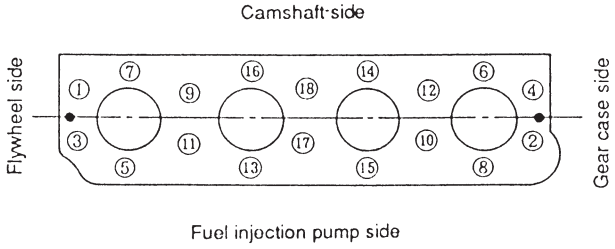
## 8-1. Disassembly

* *For the number following the part name, refer to attached drawing 1 and 2, "Exploded Views of Engine Components"*

| Step | Removal Parts | Remarks |
|---|---|---|
| 1 | 1. Thoroughly remove sand, dust, dirt and soil from the surface of the engine.<br>2. Drain cooling water and lubricating oil from the engine. | |
| 2 | 1. Remove turbocharger ⑭ and exhaust manifold ①.<br>2. Remove intake manifold ② and surge tank ⑮. | |
| 3 | 1. Close the fuel cock valve of the fuel tank.<br>2. Remove high-pressure fuel pipe ③.<br>3. Remove fuel return pipe ④.<br>4. Loosen the tightening nut on fuel injection nozzle retainer ⑤ and extract the retainer and fuel injection nozzle ⑥.<br>* *Fuel injection nozzle for Indirect injection system is screwed type.* | 1. If nozzle seat ⑦ is left on the cylinder head, remove the cylinder head before extracting nozzle seat ⑦.<br>2. To prevent dust from entering fuel injection nozzle ⑥, fuel injection pump ⑧ and high-pressure fuel pipe ③, seal their respective threads with a tape or the like.<br>3. Whenever extracting fuel injection nozzle ⑥, replace nozzle protector ⑨ with a new one. |
| 4 | 1. Remove bonnet assembly ⑩. | |
| 5 | 1. Remove valve rocker arm shaft assembly ⑪.<br>2. Remove push rod ⑫. | 1. Attach a tag to push rod ⑫ for each cylinder No. to put the push rod in order.<br>2. Remove valve cap ⑬ from the intake/exhaust valve head.<br>3. Note that tappet ⑲ of the indirect injection system can be removed at the same time when push rod ⑫ is extracted.<br>4. Attach a tag to tappet ⑲ for each cylinder No. to put the tappet in order. |

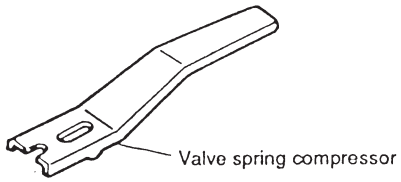
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| Step | Removal Parts | Remarks |
|---|---|---|
| 6 | 1. Remove fan mounting bolt ⑭, and then remove fan ⑮.<br>2. Loosen adjusting bolt ⑯ for the V-belt adjuster, and then remove V-belt ⑰.<br>3. Remove alternator ⑱.<br>4. Remove the spacer for cooling fan ⑲ and V-pulley ⑳. | 1. Never turn down alternator ⑱ vigorously toward the cylinder block. Otherwise, your finger may be nipped and alternator ⑱ broken. |
| 7 | 1. Remove lubricating oil filter assembly ㉑.<br>2. Extract dipstick ㉒ from the oil dipstick hole. | |
| 8 | 1. Disconnect fuel return pipes ㉓ to ㉖.<br>2. Remove fuel filter ㉗. | |
| 9 | 1. Disconnect cooling water pipe ㉘ from the cooling water pump.<br>2. Remove thermostat assembly ㉙.<br>3. Remove cooling water pump ㉚. | |
| 10 | 1. Remove cylinder head tightening bolt ㉛.<br>2. Remove cylinder head assembly ㉜.<br>3. Remove cylinder head gasket ㉝.<br>  | 1. Lay a cardboard or the like on the floor and place cylinder head assembly ㉜ on it so as not to damage the combustion surface.<br>2. Order of loosening the cylinder head tightening bolts<br>  <br>  |

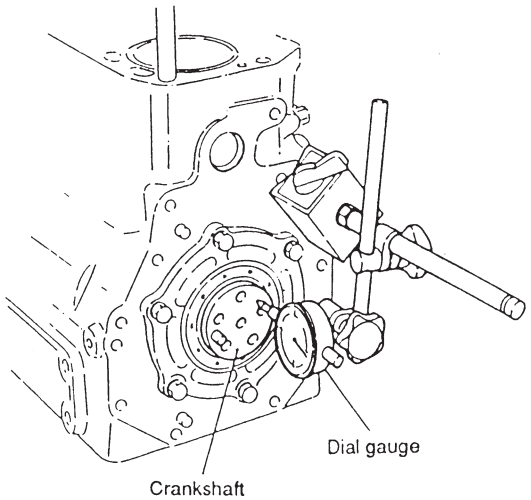
https://truckmanualshub.com/



| Step | Removal Parts | Remarks |
|---|---|---|
| | | 3. To remove the intake/exhaust valves from cylinder head assembly ㉜ , take the following steps.<br>(1) Using a valve spring compressor (see Chapter 5, 5-1), compress valve spring ㉞ and remove valve cotter ㉟ .<br>  <br><br>(2) Remove valve retainer ㊱ and valve spring ㉞ .<br>(3) Remove intake valve ㊲ and exhaust valve ㊳ . |
| 11 | 1. Remove crankshaft V-pulley clamping bolt ㊴ .<br>2. Using a puller, extract crankshaft V-pulley ㊵ . | 1. Extract crankshaft V-pulley ㊵ by hitting the bolt of the puller using a plastic hammer or the like. |
| 12 | 1. Remove oil pan mounting bolt ㊷ under gear case ㊶ .<br>2. Remove gear case mounting bolt ㊸ .<br>3. Remove gear case ㊶ . | 1. Never fail to remove stiffner bolt ㊹ at the center of the gear case.<br>2. When removing the gear case, carefully protect oil seal ㊺ from damage. |
| 13 | 1. Remove the nut from fuel injection pump drive gear ㊻ . Extract fuel injection pump drive gear ㊻ using a puller. | 1. Before removing fuel injection pump ⑧ , make sure of the position of the arrow of the pump body for adjusting fuel injection timing as well as the position of the scribed line of the gear case flange. (Applies only to direct injection system.) |
| 14 | 1. Remove lubricating oil pump ㊼ . | |
| 15 | 1. Remove starting motor ㊺ from flywheel housing ㊹ . | |
| 16 | 1. Remove flywheel mounting bolt ㊻ .<br>2. Remove flywheel ㊼ . | 1. Carefully protect the ring gear from damage. |
| 17 | 1. Remove flywheel housing ㊹ .<br>2. Remove oil seal case ㊽ with a screwdriver or the like by utilizing grooves on both sides of oil seal case ㊽ . | 1. Carefully protect the oil seal from damage. |

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| Step | Removal Parts | Remarks |
|---|---|---|
| 18 | 1. Remove oil pan ⑥⓪ and spacer ⑥① . | 1. Put the cylinder block with the attaching surface of the cylinder head facing down.<br>2. Carefully protect the combustion surface of the cylinder block from damage.<br>3. For indirect injection system, be careful to the possibility of the tappet to drop off when the cylinder block is turned upside down, because the tappet is cylindrical in shape. |
| 19 | 1. Remove idle gear shaft ④⑧ , and then remove idle gear ④⑨ .<br>2. Remove mounting bolt ⑤② of thrust bearing ⑤① through the hole of the camshaft gear ⑤⓪ . Remove camshaft assembly ⑤③ . | 1. Turn the cylinder block aside and carefully prevent tappet ⑤⑨ from jamming on the cam.<br>2. Preheat camshaft gear ⑤⓪ and camshaft assembly ⑤③ to 180°C ~ 200°C which are shrink fitted, before removing them. |
| 20 | 1. Remove gear case flange ⑥② . | |
| 21 | 1. Remove lubricating oil strainer ⑥③ . | |
| 22 | 1. Remove crankpin side cap ⑥④ of the connecting rod.<br>○ While turning crankshaft ⑥⑤ , place piston ⑥⑥ in the bottom dead center (BDC). | 1. Before extracting piston ⑥⑥ , remove carbon deposits from the upper wall of the cylinder using fine sandpaper, while taking care not to damage the inner surface of the cylinder.<br>2. Make sure that cap No. of connecting rod ⑥⑦ agrees with cylinder No.<br>3. Take care not to let crankpin metal ⑥⑧ fall when removing connecting rod crankpin side cap ⑥④ . |
| 23 | 1. Remove main bearing cap bolt ⑥⑨ . While shaking main bearing cap ⑦⓪ , remove main bearing cap ⑦⓪ together with lower main bearing metal ⑦① .<br>2. Extract crankshaft ⑥⑤ , taking care not to damage it.<br>3. Remove upper main bearing metal ⑦② . | 1. Before extracting crankshaft ⑥⑤ , measure the side gap around it.<br>  <br> |

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<table>
<tr><th>Step</th><th>Removal Parts</th><th>Remarks</th></tr>
<tr><td></td><td></td><td>Apply a dial gauge to the end of crankshaft ⑥⑤ . Force the crankshaft on both sides in the axial direction to measure the thrust gap. Alternatively, insert a thickness gauge directly between the base thrust metal and the thrust surface of the crankshaft to measure the gap. If the limit size is exceeded, replace the thrust metal with a new one.<br>(mm)<table><tr><th></th><th>All models</th></tr><tr><td>Thrust gap</td><td>0.090 ~ 0.271</td></tr></table>2. Notice on the removal of thrust metal ⑦③ .<br>(1) When removing thrust metal ⑦③ , ascertain the position and direction where thrust metal is installed in relation to the cap.<br>(2) Make sure that the thrust metal groove is outward in relation to the cap.</td></tr>
<tr><td>24</td><td>1. Remove piston ⑥⑥ and connecting rod ⑥⑦ assembly.</td><td>1. To selectively remove a desired piston and connecting rod assembly without extracting crankshaft ⑥⑤ , take the steps itemized below:<br>(1) Remove carbon deposits from the upper wall of the cylinder using fine sandpaper, taking care not to damage the inner surface of the cylinder.<br>(2) While turning the crankshaft, with the crankpin side cap ⑥④ removed, raise the piston up to the top dead center (TDC).<br>(3) Extract the piston/connecting rod assembly while tapping the connecting rod ⑥⑦ at the large end with the handle of a plastic hammer or the like.</td></tr>
<tr><td>25</td><td>1. Remove tappet ⑤⑨ .</td><td></td></tr>
</table>

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# 8-2. Precautions before and during reassembly

To reassemble engine components, reverse the procedure of diassembly. However, follow the precautions below particularly before and during reassembly.

**(1) Cleaning the component**

Use particular care to clean the cylinder block, cylinder head, crankshaft, and camshaft. Ensure that they are free from chips, dust, sand, and other foreign matter.

**(2) Parts to be replaced during reassembly**

Be sure to replace the following parts with new ones during assembly.

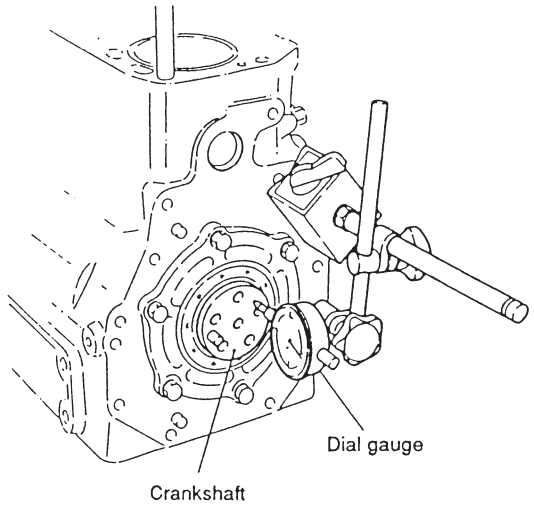
(1) Valve stem seal
(2) Head gasket packing
(3) Nozzle protector of the fuel injection valve
(4) Various copper packings, O-rings and gasket packings.

**(3) Measuring the side gap around crankshaft**

Apply a dial gauge to the end of the crankshaft. Force the crankshaft on both sides in the axial direction to measure the thrust gap. Alternatively, insert a thickness gauge directly between the base thrust metal and the thrust surface of the crankshaft to measure the gap. If the limit size is exceeded, replace the thrust metal with a new one.

(mm)

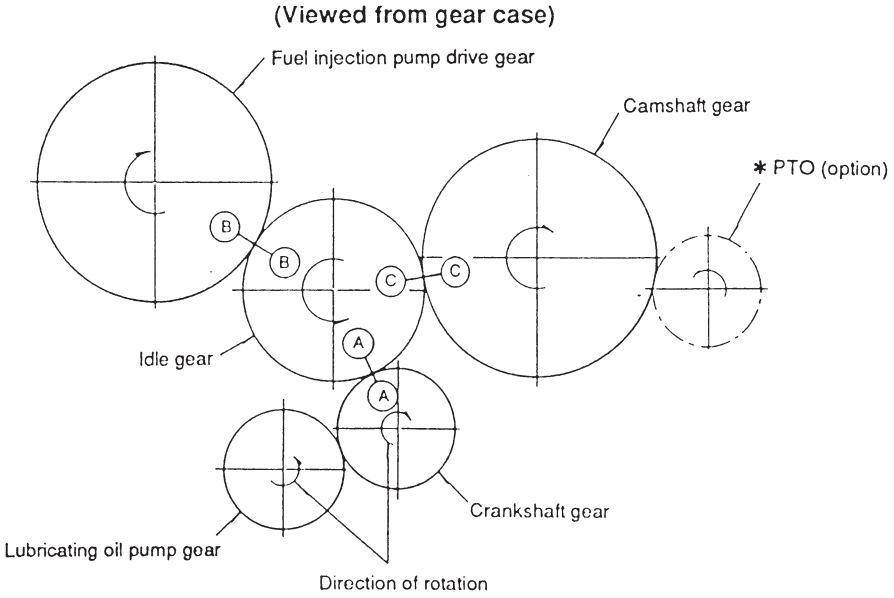
| | All models |
|---|---|
| Thrust gap | 0.090 ~ 0.271 |




( Measurement of side gap around crankshaft )

**(4) Gear train**

After having installed each gear, make sure that marks Ⓐ, Ⓑ and Ⓒ of the idle gear align with marks of the fuel injection pump drive gear, camshaft gear and crankshaft gear as shown below.



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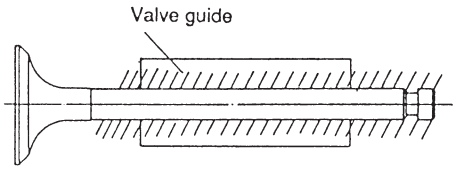
(5) Where to use liquid packings

1. Between the cylinder block and gear case flange
2. Between the gear case flange and gear case cover
3. Between the cylinder block and oil seal case (indirect injection system only)
4. Oil pan installation surface

** Use Three Bond No. 005 (Yanmar part code: 97777-001212) as the liquid packing.*

** Apply the liquid packing so as not to form any break on the midway. Otherwise, oil leakage, etc., may result.*

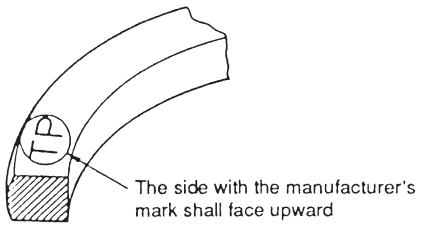
(6) Coating the lubricating oil on intake/ exhaust valve stem



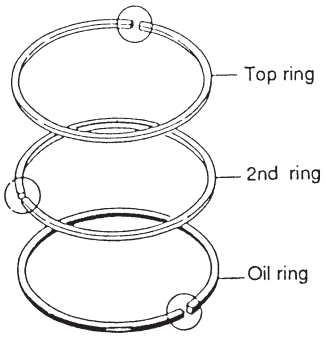

Apply lubricating oil down to the lower surface (hatched portion in the figure) of the valve guide before reassembling the valve stem.

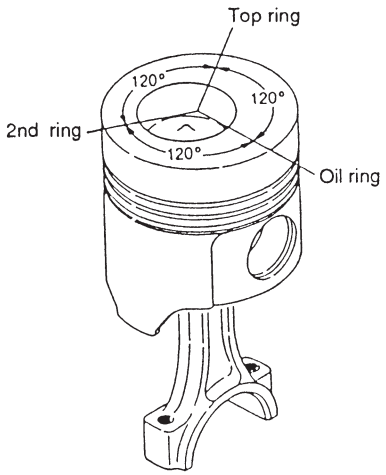
(7) Reassembly of the piston ring

1. Insert the piston ring into the ring groove, where the side with the manufacturer's mark on the matching ends facing up (to the combustion chamber side), using a piston ring replacer. After fitting the piston ring, make sure it moves easily and smoothly.




2. Assemble the piston rings to the cylinder, staggering the piston rings joints at 120° intervals, making sure that they are not aligned along the piston. Apply lube oil to the circumference of the piston.



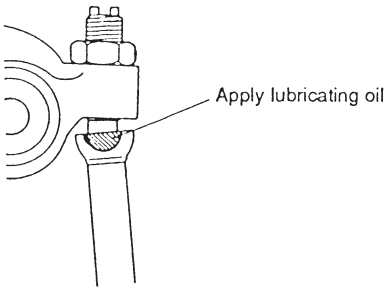



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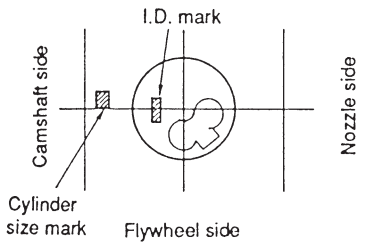
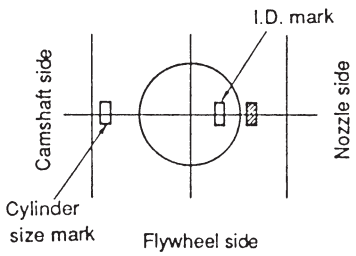
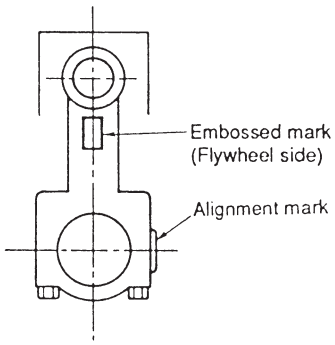
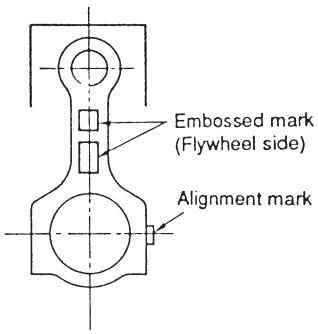


### (8) Coating the lubricating oil to pushrod adjusting screw contact

Apply lubricating oil to the hatched portion of the push rod as shown in the figure, before reassembly.




### (9) Assembly direction of piston and connecting rod

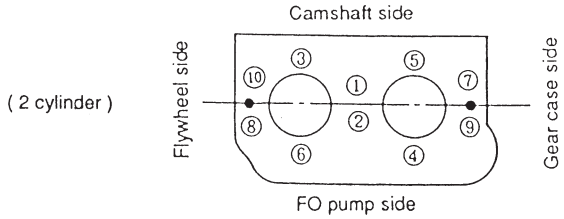
| | 2/3TNE68, 3TNE74 | 3TNE78A, 3TNE82A, 3/4TNE82<br>3/4TNE84(T), 3/4TNE88 |
|---|---|---|
| Piston |  |  |
| Connecting rod |  |  |

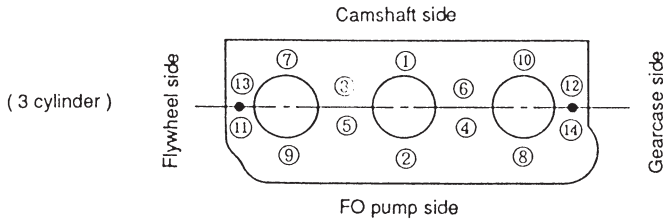
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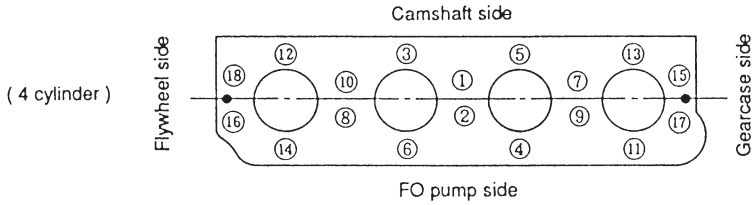


## (10) Order of tightening cylinder heads and tightening torque

Tighten cylinder heads in numerical order shown below to the specified torque.




(kgf-m)

| | 2/3TNE68 | 3TNE74 | 3TNE78A<br>3TNE82A | 3/4TNE82<br>3/4TNE84(T)<br>3/4TNE88 |
|---|---|---|---|---|
| Tightening torque | 3.8 ~4.2 | 6.0~6.5 | 6.8~7.2 | 8.7~9.3 |

## (11) After having reassembled the cylinder heads, carry out confirmation running to see if they are free from leakage of water and oil.

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# 9. Service Data

## 9-1 Cylinder Head

(Unit: mm)

| Item \ Model | | | 2/3TNE68 | | 3TNE74 | | 3TNE78A 3TNE82A | | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Cylinder head combustion surface distortion | | | 0.05 or less | 0.15 | 0.05 or less | 0.15 | 0.05 or less | 0.15 | 0.05 or less | 0.15 |
| Valve seat angle | Intake | | 120° | — | 120° | — | 120° | — | 120° | — |
| | Exhaust | | 90° | — | 90° | — | 90° | — | 90° | — |
| Valve seat width | Intake | | 1.15 | 1.65 | 1.44 | 1.98 | 1.36~1.53 | 1.98 | 1.07~1.24 | 1.74 |
| | Exhaust | | 1.41 | 1.91 | 1.77 | 2.27 | 1.66~1.87 | 2.27 | 1.24~1.45 | 1.94 |
| Intake valve | Valve stem outside dia. | | 5.460 ~5.475 | 5.4 | 6.960 ~6.975 | 6.9 | 6.945 ~6.960 | 6.9 | 7.955 ~8.025 | 7.9 |
| | Valve guide inside dia. | | 5.500 ~5.515 | 5.58 | 7.005 ~7.020 | 7.08 | 7.000 ~7.015 | 7.08 | 8.010 ~7.975 | 8.1 |
| | Oil clearance | | 0.025 ~0.055 | 0.18 | 0.030 ~0.060 | 0.18 | 0.040 ~0.070 | 0.18 | 0.035 ~0.070 | 0.2 |
| Exhaust valve | Valve stem outside dia. | | 5.445 ~5.460 | 5.4 | 6.945 ~6.960 | 6.9 | 6.940 ~6.955 | 6.9 | 7.955 ~8.030 | 7.9 |
| | Valve guide inside dia. | | 5.500 ~5.515 | 5.58 | 7.005 ~7.020 | 7.08 | 7.000 ~7.015 | 7.08 | 8.015 ~7.970 | 8.1 |
| | Oil clearance | | 0.040 ~0.070 | 0.18 | 0.045 ~0.075 | 0.18 | 0.045 ~0.075 | 0.18 | 0.045 ~0.075 | 0.2 |
| Valve guide projection | | | 7 | — | 9 | — | 12 | — | 15 | — |
| Valve sinking depth | Intake valve | | 0.3~0.5 | 1.0 | 0.4~0.6 | 1.0 | 0.296 ~0.496 | 1.0 | 0.306 ~0.506 | 1.0 |
| | Exhaust valve | | 0.75~0.95 | | VM: 0.75~0.95<br>CH: 0.40~0.60<br>VH: 0.40~0.60 | | 0.3~0.5 | | 0.3~0.5 | |
| Thickness of valve head | Intake valve | | 0.85~1.15 | 0.5 | 0.99~1.29 | 0.5 | 1.244 ~1.444 | 0.5 | 1.244 ~1.444 | 0.5 |
| | Exhaust valve | | 0.95~1.25 | | 0.95~1.25 | | 1.35~1.55 | | 1.35~1.55 | |
| Intake valve timing | Open | b.TDC | 5°~15° | — | 7°~17° | — | 10°~20° | — | 10°~20° | — |
| | Close | a.BDC | 37°~47° | | 35°~45° | | 40°~50° | | 40°~50° | |
| Exhaust valve timing | Open | b.BDC | 37°~47° | | 40°~50° | | 51°~60° | | 51°~61° | |
| | Close | a.TDC | 5°~15° | | 8°~18° | | 13°~23° | | 13°~23° | |
| Valve spring | Free length | | 28 | — | 37.4 | — | 44.4 | — | 42 | — |
| | Inclination | | — | 0.8 | — | 1.0 | — | 1.1 | — | 1.1 |
| | Tension (kg) (when compressed to 1mm length) | | 1.14 ~1.40 | — | 2.37 (variable pitch) /1.87 | — | 3.61 (variable pitch) /2.71 | — | 2.36 (variable pitch) /3.101 | — |
| Intake & exhaust valve clearance | | | 0.15~0.25 | — | 0.15~0.25 | — | 0.15~0.25 | — | 0.15~0.25 | — |

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# 9-2 Cylinder Block

(Unit: mm)

| Item \ Model | | 2/3TNE68 | | 3TNE74 | | 3TNE78A | |
|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Cylinder bore | | 68.000 ~68.030 | 68.20 | 74.000 ~74.030 | 74.20 | 78.000 ~78.030 | 78.20 |
| Cylinder bore | L mark | 68.020 ~68.030 | | 74.020 ~74.030 | | 78.020 ~78.030 | |
| | M mark | 68.010 ~68.020 | | 74.010 ~74.020 | | 78.010 ~78.020 | |
| | S mark | 68.000 ~68.010 | | 74.000 ~74.010 | | 78.000 ~78.010 | |
| Cylinder roundness | | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 |
| Cylindricity | | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 |

| Item \ Model | | 3TNE82A 3/4TNE82 | | 3/4TNE84(T) | | 3/4TNE88 | |
|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Cylinder bore | | 82.000 ~82.030 | 82.20 | 84.000 ~84.030 | 84.20 | 88.000 ~88.030 | 88.20 |
| Cylinder bore | L mark | 82.020 ~82.030 | | 84.020 ~84.030 | | 88.020 ~88.030 | |
| | M mark | 82.010 ~82.020 | | 84.010 ~84.020 | | 88.010 ~88.020 | |
| | S mark | 82.000 ~82.010 | | 84.000 ~84.010 | | 88.000 ~88.010 | |
| Cylinder roundness | | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 |
| Cylindricity | | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 | 0.00 ~0.01 | 0.03 |

# 9-3 Valve rocker arm

(Unit: mm)

| Item \ Model | | 2/3TNE68 | | 3TNE74 | | 3TNE78A/82A, 3/4TNE82, 3/4TNE84(T), 3/4TNE88 | |
|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Intake & Exhaust rocker arm | Rocker arm shaft outside dia. | 9.972~9.987 | 9.95 | 11.966~11.984 | 11.95 | 15.966~15.984 | 15.95 |
| | Rocker arm bushing inside dia. | 10.000~10.020 | 10.09 | 12.000~12.020 | 12.09 | 16.000~16.020 | 16.09 |
| | Oil clearance | 0.013~0.048 | 0.14 | 0.016~0.054 | 0.14 | 0.016~0.054 | 0.14 |
| Pushrod bending | | 0.03 or less | — | 0.03 or less | — | 0.03 or less | — |
| Tappet | Tappet stem outside dia. | 17.950~17.968 | 17.93 | 20.927~20.960 | 20.90 | 11.975~11.990 | 11.93 |
| | Tappet guide hole inside dia. | 18.000~18.018 | 18.05 | 21.000~21.021 | 21.05 | 12.000~12.018 | 12.05 |
| | Oil clearance | 0.032~0.068 | 0.12 | 0.040~0.094 | 0.15 | 0.010~0.043 | 0.12 |

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# 9-4 Piston

(Unit: mm)

| Item \ Model | | 2/3TNE68 VM, VH Standard | 2/3TNE68 VM, VH Wear limit | 2/3TNE68 CH Standard | 2/3TNE68 CH Wear limit | 3TNE74 Standard | 3TNE74 Wear limit | 3TNE78A Standard | 3TNE78A Wear limit | 3TNE82A Standard | 3TNE82A Wear limit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Piston outside dia. | | 67.960 ~67.990 | 67.90 | 67.940 ~67.970 | 67.90 | 73.940 ~73.970 | 73.90 | 77.950 ~77.980 | 77.90 | 81.950 ~81.980 | 81.90 |
| Piston outside dia. | L mark | 67.980 ~67.990 | | 67.960 ~67.970 | | 73.960 ~73.970 | | 77.970 ~77.980 | | 81.970 ~81.980 | |
| | ML mark | 67.975 ~67.980 | | 67.955 ~67.960 | | 73.955 ~73.960 | | 77.965 ~77.970 | | 81.965 ~81.970 | |
| | MS mark | 67.970 ~67.975 | | 67.950 ~67.955 | | 73.950 ~73.955 | | 77.960 ~77.965 | | 81.960 ~81.965 | |
| | S mark | 67.960 ~67.970 | | 67.940 ~67.950 | | 73.940 ~73.950 | | 77.950 ~77.960 | | 81.950 ~81.960 | |
| Min. clearance between piston and cylinder | | 0.025 ~0.055 | — | 0.045 ~0.075 | — | 0.045 ~0.075 | — | 0.035 ~0.065 | — | 0.035 ~0.065 | — |
| Top clearance | | 0.610 ~0.730 | | — | | 0.658 ~0.778 | — | 0.650 ~0.770 | — | 0.650 ~0.770 | — |
| Piston and piston pin | Piston pin outside dia. | 19.991 ~20.000 | | 19.90 | | 20.991 ~21.000 | 20.90 | 22.991 ~23.000 | 22.90 | 22.991 ~23.000 | 22.90 |
| | Piston pin hole dia. | 20.000 ~20.008 | | 20.02 | | 21.000 ~21.008 | 21.02 | 23.000 ~23.008 | 23.02 | 23.000 ~23.008 | 23.02 |
| | Oil clearance | 0.000 ~0.017 | | 0.12 | | 0.000 ~0.017 | 0.12 | 0.000 ~0.017 | 0.12 | 0.000 ~0.017 | 0.12 |

| Item \ Model | | 3/4TNE82 Standard | 3/4TNE82 Wear limit | 3/4TNE84(T) Standard | 3/4TNE84(T) Wear limit | 3/4TNE88 Standard | 3/4TNE88 Wear limit |
|---|---|---|---|---|---|---|---|
| Piston outside dia. | | 81.945 ~81.975 | 81.90 | 83.945 ~83.975 | 83.90 | 87.945 ~87.975 | 87.90 |
| Piston outside dia. | L mark | 81.965 ~81.975 | | 83.965 ~83.975 | | 87.965 ~87.975 | |
| | ML mark | 81.960 ~81.965 | | 83.960 ~83.965 | | 87.960 ~87.965 | |
| | MS mark | 81.955 ~81.960 | | 83.955 ~83.960 | | 87.955 ~87.960 | |
| | S mark | 81.945 ~81.955 | | 83.945 ~83.955 | | 87.945 ~87.955 | |
| Min. clearance between piston and cylinder | | 0.040 ~0.070 | — | 0.040 ~0.070 | — | 0.040 ~0.070 | — |
| Top clearance | | 0.660 ~0.780 | — | 0.660 ~0.780 | — | 0.660 ~0.780 | — |
| Piston and piston pin | Piston pin outside dia. | 25.987 ~26.000 | 25.90 | 25.987 ~26.000 | 25.90 | 25.987 ~26.000 | 25.90 |
| | Piston pin hole dia. | 26.000 ~26.009 | 26.02 | 26.000 ~26.009 | 26.02 | 26.000 ~26.009 | 26.02 |
| | Oil clearance | 0.000 ~0.022 | 0.12 | 0.000 ~0.022 | 0.12 | 0.000 ~0.022 | 0.12 |

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# 9-5 Piston Ring

(Unit: mm)

| Item \ Model | | 2/3TNE68 | | 3TNE74 | | 3TNE78A | |
|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Top ring | Ring groove width | 1.550 ~1.570 | — | 1.550 ~1.570 | — | 2.035 ~2.050 | — |
| | Ring width | 1.470 ~1.490 | — | 1.470 ~1.490 | — | 1.940 ~1.960 | — |
| | Min. side clearance | 0.060 ~0.100 | — | 0.060 ~0.100 | — | 0.075 ~0.110 | — |
| | End clearance | 0.100 ~0.250 | 1.5 | 0.200 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 |
| 2nd ring | Ring groove width | 1.540 ~1.555 | — | 1.520 ~1.535 | — | 2.025 ~2.040 | — |
| | Ring width | 1.430 ~1.450 | — | 1.410 ~1.430 | — | 1.975 ~1.990 | — |
| | Min. side clearance | 0.090 ~0.125 | — | 0.090 ~0.125 | — | 0.035 ~0.065 | — |
| | End clearance | 0.150 ~0.350 | 1.5 | 0.200 ~0.400 | 1.5 | 0.250 ~0.400 | 1.5 |
| Oil ring | Ring groove width | 3.010 ~3.025 | — | 3.010 ~3.025 | — | 3.015 ~3.030 | — |
| | Ring width | 2.970 ~2.990 | — | 2.970 ~2.990 | — | 2.970 ~2.990 | — |
| | Min. side clearance | 0.020 ~0.055 | — | 0.020 ~0.055 | — | 0.025 ~0.060 | — |
| | End clearance | 0.150 ~0.350 | 1.5 | 0.150 ~0.350 | 1.5 | 0.200 ~0.400 | 1.5 |

| Item \ Model | | 3TNE82A 3/4TNE82 | | 3/4TNE84(T) | | 3/4TNE88 | |
|---|---|---|---|---|---|---|---|
| | | Standard | Wear limit | Standard | Wear limit | Standard | Wear limit |
| Top ring | Ring groove width | 2.065 ~2.080 | — | 2.065 ~2.080 | — | 2.060 ~2.075 | — |
| | Ring width | 1.970 ~1.990 | — | 1.970 ~1.990 | — | 1.970 ~1.990 | — |
| | Min. side clearance | 0.075 ~0.110 | — | 0.075 ~0.1100 | — | 0.070 ~0.105 | — |
| | End clearance | 0.200 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 |
| 2nd ring | Ring groove width | 2.035 ~2.050 | — | 2.035 ~2.050 | — | 2.025 ~2.040 | — |
| | Ring width | 1.970 ~1.990 | — | 1.970 ~1.990 | — | 1.970 ~1.990 | — |
| | Min. side clearance | 0.045 ~0.080 | — | 0.045 ~0.080 | — | 0.035 ~0.0[illegible] | — |
| | End clearance | 0.200 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 | 0.200 ~0.400 | 1.5 |
| Oil ring | Ring groove width | 4.015 ~4.030 | — | 4.015 ~4.030 | — | 4.015 ~4.030 | — |
| | Ring width | 3.970 ~3.990 | — | 3.970 ~3.990 | — | 3.970 ~3.990 | — |
| | Min. side clearance | 0.025 ~0.060 | — | 0.025 ~0.060 | — | 0.025 ~0.060 | — |
| | End clearance | 0.200 ~0.400 | 1.5 | 0.200 ~0.450 | 1.5 | 0.200 ~0.400 | 1.5 |

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## 9-6 Connecting Rod

(Unit: mm)

| Item | | Model: 2/3TNE68 Standard | 2/3TNE68 Wear limit | 3TNE74 Standard | 3TNE74 Wear limit | 3TNE78A 3TNE82A Standard | 3TNE78A 3TNE82A Wear limit | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 Standard | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 Wear limit |
|---|---|---|---|---|---|---|---|---|---|
| Crankpin side | Crankpin bushing inside dia. | 39.000 ~39.016 | — | 43.000 ~43.016 | — | 46.000 ~46.016 | — | 51.000 ~51.010 | — |
| | Crankpin metal thickness | 1.487 ~1.500 | — | 1.487 ~1.500 | — | 1.487 ~1.500 | — | 1.492 ~1.500 | — |
| | Crankpin outside dia. | 35.970 ~35.980 | 35.91 | 39.970 ~39.980 | 39.91 | 42.952 ~42.962 | 42.91 | 47.952 ~47.962 | 47.91 |
| | Oil clearance | 0.033 ~0.059 | 0.15 | 0.033 ~0.059 | 0.15 | 0.038 ~0.090 | 0.16 | 0.038 ~0.074 | 0.16 |
| Piston pin side | Piston pin bushing inside dia. | 20.025 ~20.038 | 20.10 | 21.025 ~21.038 | 21.10 | 23.025 ~23.038 | 23.10 | 26.025 ~26.038 | 26.10 |
| | Piston pin outside dia. | 19.991 ~20.000 | 19.90 | 20.991 ~21.000 | 20.90 | 22.991 ~23.000 | 22.90 | 25.987 ~26.000 | 25.90 |
| | Oil clearance | 0.025 ~0.047 | 0.2 | 0.025 ~0.047 | 0.2 | 0.025 ~0.047 | 0.2 | 0.025 ~0.051 | 0.2 |
| Twist and parallelism | | Less than 0.03 per 100 mm | 0.08 | Less than 0.03 per 100 mm | 0.08 | Less than 0.03 per 100 mm | 0.08 | Less than 0.03 per 100 mm | 0.08 |

## 9-7 Camshaft

(Unit: mm)

| Item | | Model: 2/3TNE68 Standard | 2/3TNE68 Wear limit | 3TNE74 Standard | 3TNE74 Wear limit | 3TNE78A/82A, 3/4TNE82, 3/4TNE84(T), 3/4TNE88 Standard | 3TNE78A/82A, 3/4TNE82, 3/4TNE84(T), 3/4TNE88 Wear limit |
|---|---|---|---|---|---|---|---|
| Gear side | Camshaft journal outside dia. | 35.940 ~35.960 | 35.85 | 39.940 ~39.960 | 39.85 | 44.925 ~44.950 | 44.85 |
| | Oil clearance | 0.040 ~0.085 | — | 0.040 ~0.085 | — | 0.040 ~0.130 | — |
| Intermediate | Camshaft journal outside dia. | 35.910 ~35.935 | 35.85 | 39.910 ~39.935 | 39.85 | 44.910 ~44.935 | 44.85 |
| | Oil clearance | 0.065 ~0.115 | — | 0.065 ~0.115 | — | 0.065 ~0.115 | — |
| Flywheel side | Camshaft journal outside dia. | 35.940 ~35.960 | 35.85 | 39.940 ~39.960 | 39.85 | 44.925 ~44.950 | 44.85 |
| | Oil clearance | 0.040 ~0.125 | — | 0.040 ~0.125 | — | 0.050 ~0.100 | — |

## 9-8 Crankshaft

(Unit: mm)

| Item | | Model: 2/3TNE68 Standard | 2/3TNE68 Wear limit | 3TNE74 Standard | 3TNE74 Wear limit | 3TNE78A 3TNE82A Standard | 3TNE78A 3TNE82A Wear limit | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 Standard | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 Wear limit |
|---|---|---|---|---|---|---|---|---|---|
| Crank journal | Crankshaft journal outside dia. | 39.970 ~39.980 | 39.90 | 43.970 ~43.980 | 43.90 | 46.952 ~46.962 | 46.91 | 53.952 ~53.962 | 53.91 |
| | Bearing metal thickness | 1.487 ~1.500 | — | 1.987 ~2.000 | — | 1.987 ~2.000 | — | 1.995 ~2.000 | — |
| | Crank journal and bushing oil clearance | 0.033 ~0.059 | 0.15 | 0.033 ~0.059 | 0.15 | 0.038 ~0.093 | 0.25 | 0.038 ~0.068 | 0.15 |
| Bend | | 0.02 or less | — | 0.02 or less | — | 0.02 or less | — | 0.02 or less | — |

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# 9-9 Side Gap and Backlash

(Unit: mm)

| Item \ Model | | All models |
|---|---|---|
| | | Standard |
| Side gap | Crankshaft | 0.090~0.271 |
| | Camshaft | 0.05~0.25 |
| | Connecting rod | 0.2~0.4 |
| | Idle gear | 0.1~0.3 |

(Unit: mm)

| Item \ Model | | 2/3TNE68, 3TNE74 | 3TNE78A/82A, 3/4TNE82, 3/4TNE84(T), 3/4TNE88 |
|---|---|---|---|
| Backlash | Crankshaft gear, Camshaft gear, Idle gear and Fuel injection pump drive gear | 0.04 ~ 0.12 | 0.07 ~ 0.15 |
| | L.O. pump gear | 0.11 ~ 0.19 | |

# 9-10 Others

(Unit: mm)

| Item \ Model | | | 2/3TNE68 | 3TNE74 | 3TNE78A 3TNE82A | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 |
|---|---|---|---|---|---|---|
| Lubricating oil pump discharge volume | High speed operation | ℓ/min | 11.9 (at 3600rpm) | 15.8 (at 3600rpm) | 19.6 (at 3600rpm) | 25.0 (at 3000rpm) |
| | Low speed operation | | 2.5 (at 750rpm) | | 4.4 (at 800rpm) | 8.0 (at 800rpm) |
| Pressure control valve opening pressure | | kgf/cm² | 3.0~4.0 | 3.0~4.0 | 3.0~4.0 | 3.0~4.0 |
| L.O. pressure switch operating pressure | | kgf/cm² | 0.4~0.6 | 0.4~0.6 | 0.4~0.6 | 0.4~0.6 |
| Cooling water pump discharge volume | | ℓ/min | 45 (at 4320~4380 rpm) 32 (at 3320~3380 rpm) | 55 (at 4320~4380 rpm) 40 (at 3320~3380 rpm) | 35 (at 3220~3280 rpm) | 70 (at 3220~3280 rpm) |
| Thermostat valve opening temperature | Opening temperature | °C | 69.5~72.5 | 69.5~72.5 | 69.5~72.5 | 69.5~72.5 |
| | Lift height | mm | Min. 4.5 (at 85°C and above) | Min. 8.0 (at 85°C and above) | Min. 8.0 (at 85°C and above) | Min. 8.0 (at 85°C and above) |
| Thermoswitch operating temperature | ON | °C | 107~113 | 107~113 | 107~113 | 107~113 |
| | OFF | | 100 and above | 100 and above | 100 and above | 100 and above |

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# 10. Tightening Torque

## 10-1 Main bolt/nut

(Unit: kgf-m)

| No. | Item | Model / Torque | 2/3TNE68 | 3TNE74 | 3TNE78A 3TNE82A | 3/4TNE82, 3/4TNE84(T), 3/4TNE88 |
|---|---|---|---|---|---|---|
| 1 | Cylinder head bolt | Lubricating oil applied (Thread dia. × pitch) | 3.8~4.2 (M8 × 1.25) | 6.0~6.5 (M9 × 1.25) | 6.8~7.2 (M9 × 1.25) | 8.7~9.3 (M10 × 1.25) |
| 2 | Connecting rod bolt | Lubricating oil applied (Thread dia. × pitch) | 2.3~2.8 (M7 × 1.0) | 2.3~2.8 (M7 × 1.0) | 3.8~4.2 (M8 × 1.0) | 4.5~5.5 (M9 × 1.0) |
| 3 | Flywheel clamping bolt | Lubricating oil applied (Thread dia. × pitch) | 8.2~8.8 (M10 × 1.25) | 8.0~9.0 (M10 × 1.25) | 8.5~9.0 (M10 × 1.25) | 8.5~9.0 (M10 × 1.25) |
| 4 | Metal cap clamping bolt | Lubricating oil applied (Thread dia. × pitch) | 5.3~5.7 (M9 × 1.25) | 8.0~8.5 (M10 × 1.25) | 7.8~8.2 (M10 × 1.5) | 9.8~10.2 (M12 × 1.5) |
| 5 | Crankshaft V-pulley clamping bolt | Lubricating oil applied (Thread dia. × pitch) | S48C:11.5~12.5 FC25: 8.5~9.5 (M12 × 1.5) | S48C:11.5~12.5 FC25: 8.5~9.5 (M12 × 1.5) | 11.5~12.5 (M14 × 1.5) | 11.5~12.5 (M14 × 1.5) |
| 6 | Fuel injection nozzle nut | Lubricating oil not applied (Thread dia. × pitch) | 5.0~5.4 (M20 × 1.5) | 5.0~5.4 (M20 × 1.5) | 0.7~0.9 (M6 × 1.0) | 0.7~0.9 (M6 × 1.0) |
| 7 | Timer clamping nut | Lubricating oil not applied (Thread dia. × pitch) | — | — | 6.0~7.0 (M12 × 1.75) | 6.0~7.0 (M12 × 1.75) |
| 8 | Glow plug | Lubricating oil not applied (Thread dia. × pitch) | 1.5~2.0 (M10 × 1.25) | 1.5~2.0 (M10 × 1.25) | — | — |
| 9 | Stub shaft bolt | Lubricating oil not applied (Thread dia. × pitch) | 5.5~6.5 (M10 × 1.5) | 5.5~6.5 (M10 × 1.5) | — | — |
| 10 | Governor weight support nut | Lubricating oil not applied (Thread dia. × pitch) | 7.0~7.5 (M12 × 1.25) | 7.0~7.5 (M12 × 1.25) | 4.5~5.0 (M12 × 1.25) | 4.5~5.0 (M12 × 1.25) |
| 11 | High pressure pipe sleeve clamping nut | Lubricating oil not applied (Thread dia. × pitch) | 3.0~3.5 (M12 × 1.5) | 3.0~3.5 (M12 × 1.5) | 3.0~3.5 (M12 × 1.5) | 3.0~3.5 (M12 × 1.5) |

## 10-2 Standard bolt and nut

*** : Lubricating oil not applied**

(Unit: kgf-m)

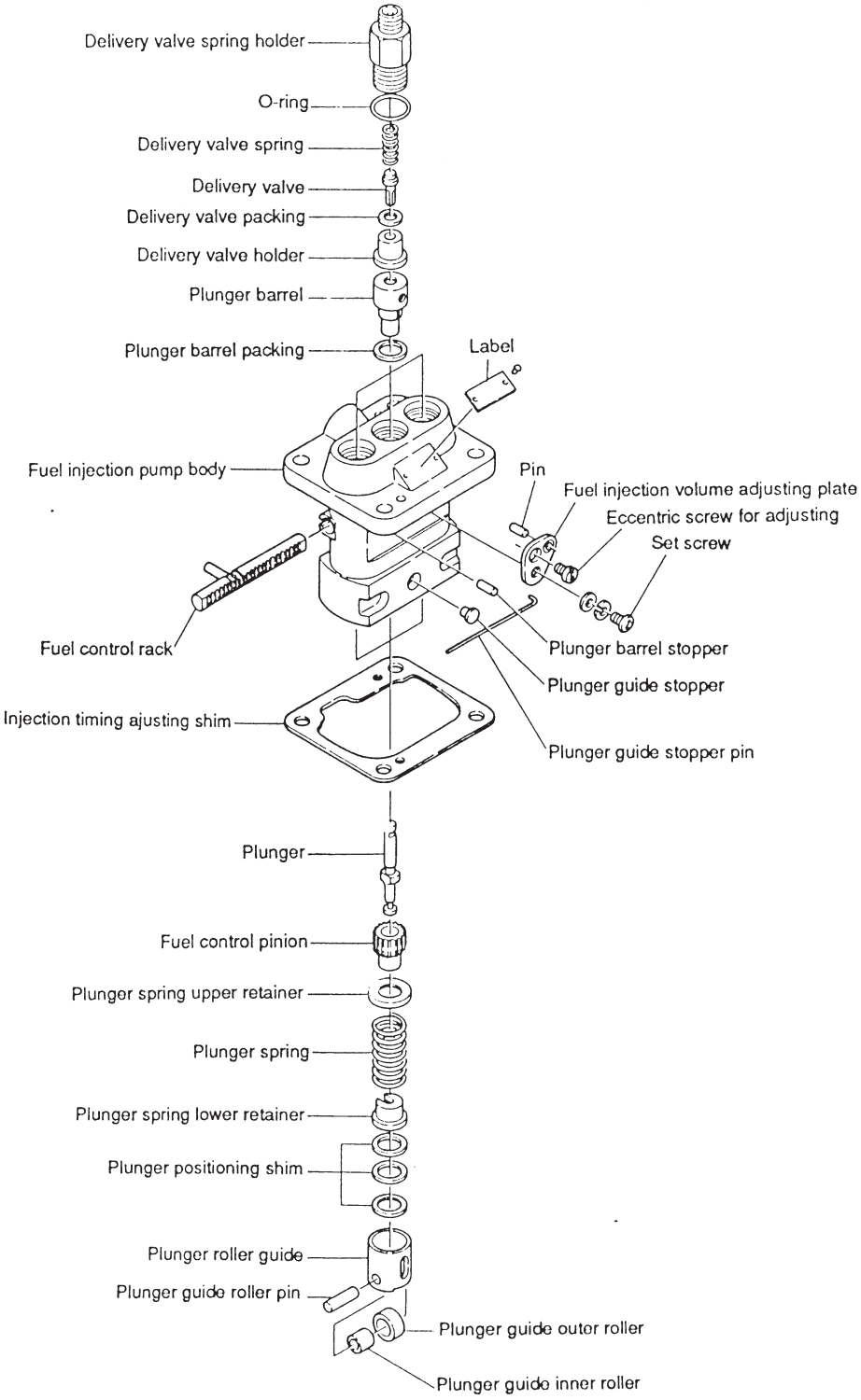
| Item | Thread dia. × pitch | Tightening torque | Remarks |
|---|---|---|---|
| Hexagon headed bolt (7T) and nut | M6 x 1 | 1.0~1.2 | 1) When bolting the aluminum parts, tighten the bolts with 80% of the tightening torque specified in the Table.<br>2) 4T bolt and lock nut should be tightened with 60% of the torque shown in the table. |
| | M8 x 1.25 | 2.3~2.9 | |
| | M10 x 1.5 | 4.5~5.5 | |
| | M12 x 1.75 | 8.0~10.0 | |
| PT plug | 1/8 | 1.0 | ——— |
| | 1/4 | 2.0 | |
| | 3/8 | 3.0 | |
| | 1/2 | 6.0 | |
| Pipe joint bolt | M8 | 1.3~1.7 | ——— |
| | M12 | 2.5~3.5 | |
| | M14 | 4.0~5.0 | |
| | M16 | 5.0~5.5 | |

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# 11. Fuel Injection Pump for Indirect Injection System

## 11-1. Exploded view (YPFR type)



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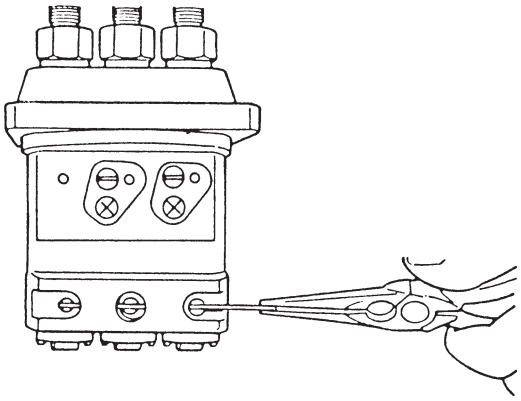


## 11-2. Disassembly

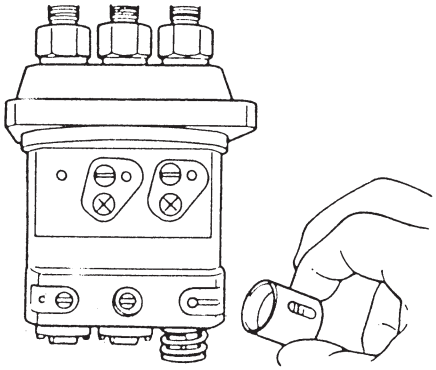
To disassemble the fuel injection pump, classify disassembled parts for each cylinder and carefully avoid allowing them to be mixed with one another. Identifiably classify paired parts supplied as assemblies, such as "plunger and plunger barrel" and "delivery valve and delivery valve holder" for each cylinder. Use particular care to prevent the assembly from going to pieces and being scattered.

(1) Remove the fuel injection pump.

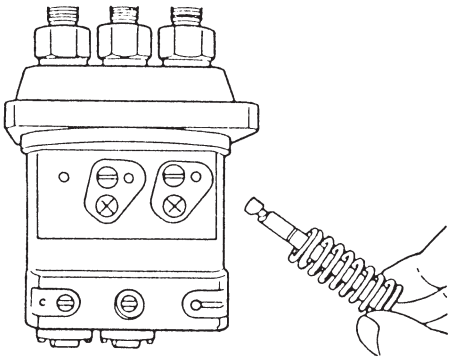
(2) Extract the plunger guide stopper pin and remove the plunger guide stopper and plunger barrel stopper.



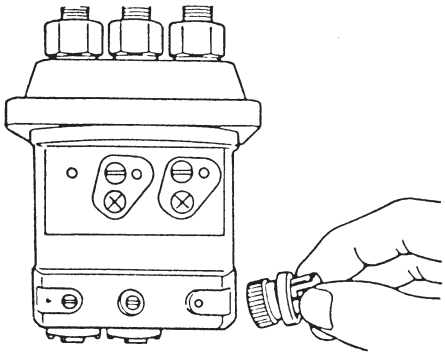
(3) Remove the right plunger roller guide assembly.



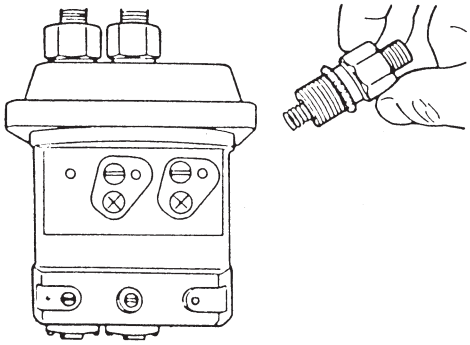
(4) Remove the plunger spring and plunger spring lower retainer.



(5) Remove the plunger spring upper retainer and the fuel control pinion.



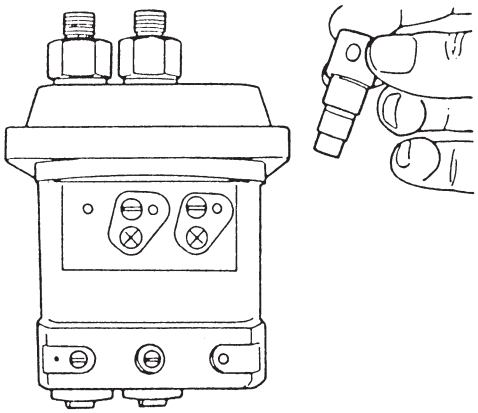
(6) Remove the delivery valve spring holder and then remove fuel control rack, delivery valve holder, delivery valve spring and delivery valve.



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(7) Remove the plunger barrel assembly.



(8) Remove the other plungers by repeating the above steps.

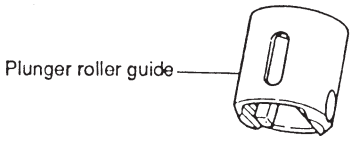
* *Never loosen the eccentric screw for adjusting and set screw for the fuel injection volume adjusting plate.*

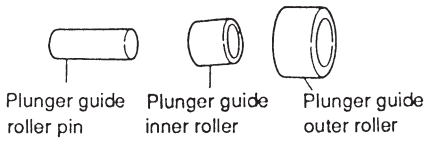
## 11-3. Inspection

Before inspection, thoroughly clean the parts, using new diesel oil. Be careful to avoid damage to the sliding surface of the plunger and delivery valve, etc.

**(1) Plunger guide outer roller, inner roller and plunger roller guide.**

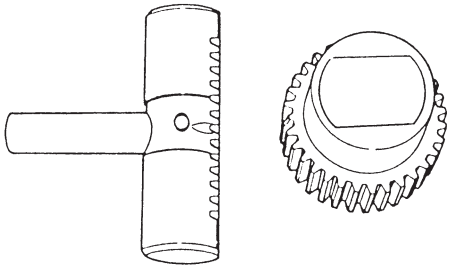
Inspect for wear and scratches with the plunger guide outer roller, inner roller and plunger roller guide. If a gap between the fuel injection pump camshaft and plunger guide outer roller exceeds 0.3 mm, replace the plunger roller guide assembly with a new one.




**(2) Fuel control rack and fuel control pinion**

1. Inspect for bending of fuel control rack and wear or deformation of engaged surface of fuel control pinion and fuel control rack.



**(Fuel control rack)** **(Fuel control pinion)**

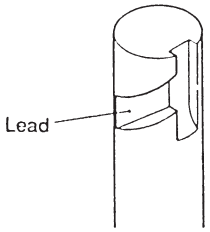
2. Check to see if the fuel control rack moves smoothly. If not, replace the fuel control rack with a new one.

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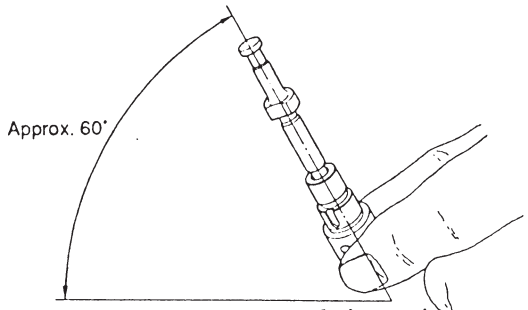
(3) Plunger

1. Thoroughly clean the plunger. If any plunger lead is scratched or discolored, replace the plunger assembly with a new one.




(Plunger)

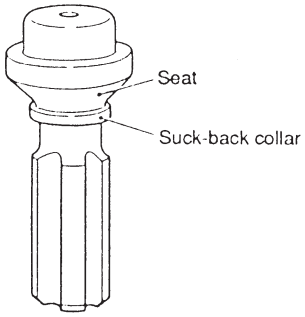
2. To test the plunger, hold the plunger barrel tilted approx. 60° and check to see if it slides down smoothly. If so, the plunger is acceptable. While turning the plunger, repeat the test several times. If any plunger slides down too quickly (slowly) or jams in the midway, correct it or replace the whole plunger assembly.



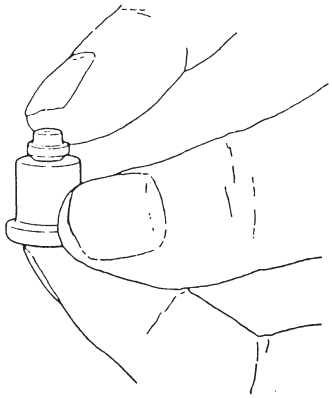

(Fall by gravity test of plunger)

(4) Delivery valve

1. If the suck-back collar or seat of the delivery valve is found scratched, dented, worn, or otherwise damaged, replace the whole delivery valve assembly.

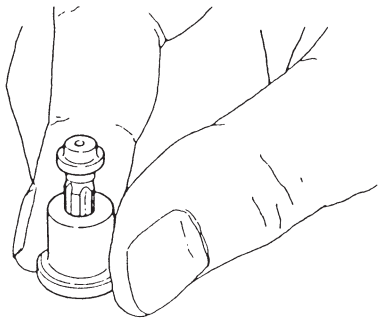



2. Stop up the hole in the bottom of the delivery valve holder and keep the seat as it is. Insert the delivery valve to the holder. While releasing your upper finger, check to see if the delivery valve springs back. If so, it is acceptable.



(Inspection of delivery valve)

3. Likewise as described in item 2, stop up the hole in the bottom of the delivery valve holder and check to see if the delivery valve perfectly falls by gravity, when the finger is released from the bottom hole.
If so, the delivery valve is acceptable. If not, replace it.



(Fall by gravity test of delivery valve)

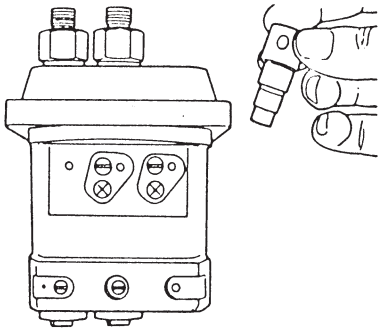
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# 11-4. Reassembly

(1) Insert the plunger barrel packing into the fuel injection pump body.

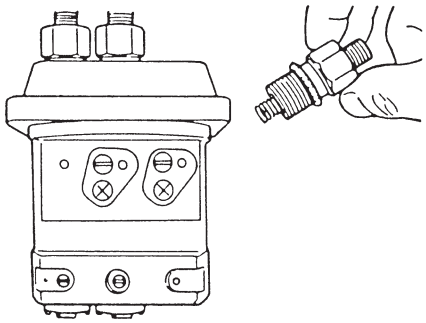
(2) Insert the plunger barrel assembly.



(3) Fit the delivery valve assembly, delivery valve spring and delivery valve spring holder.

(kgf-m)

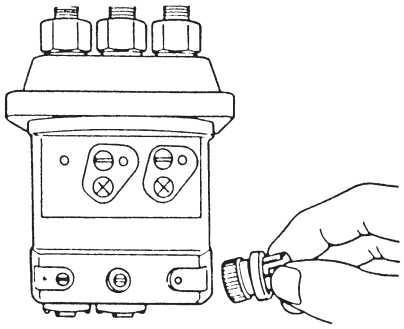
| | |
|---|---|
| Delivery valve spring holder tightening torque. | 4.0 ~4.5 |



(4) Reassemble the fuel control rack and fuel control pinion.

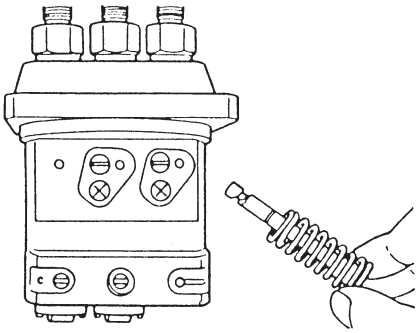
* 1. *Ensure that the match mark of the fuel control rack aligns with that of the fuel control pinion.*

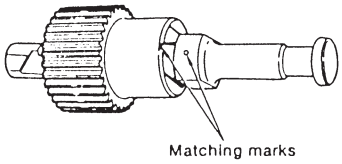
* 2. *Make sure that the fuel control rack moves smoothly over all the strokes.*



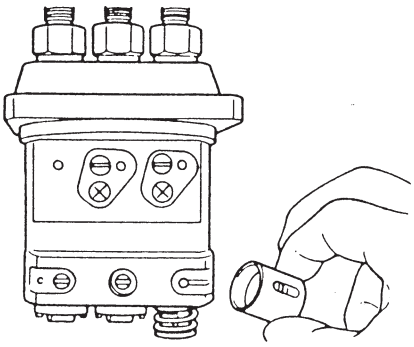
(5) Fit the plunger mounted with the plunger spring upper retainer, plunger spring and plunger spring lower retainer.

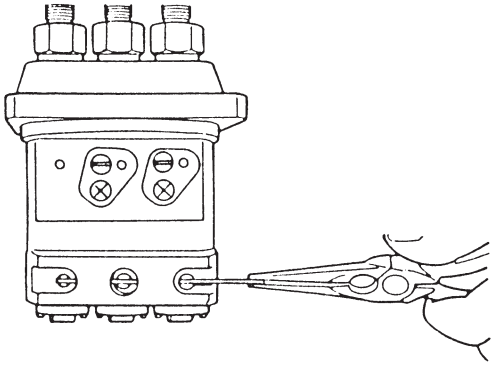
* *Ensure that the match mark of the plunger aligns with that of the fuel control pinion.*






(6) Insert the plunger adjusting shim. Press the plunger guide assembly by hand. While aligning the plunger guide stopper pin with the mating hole of the stopper pin of the fuel injection pump body, attach the plunger guide stopper pin.



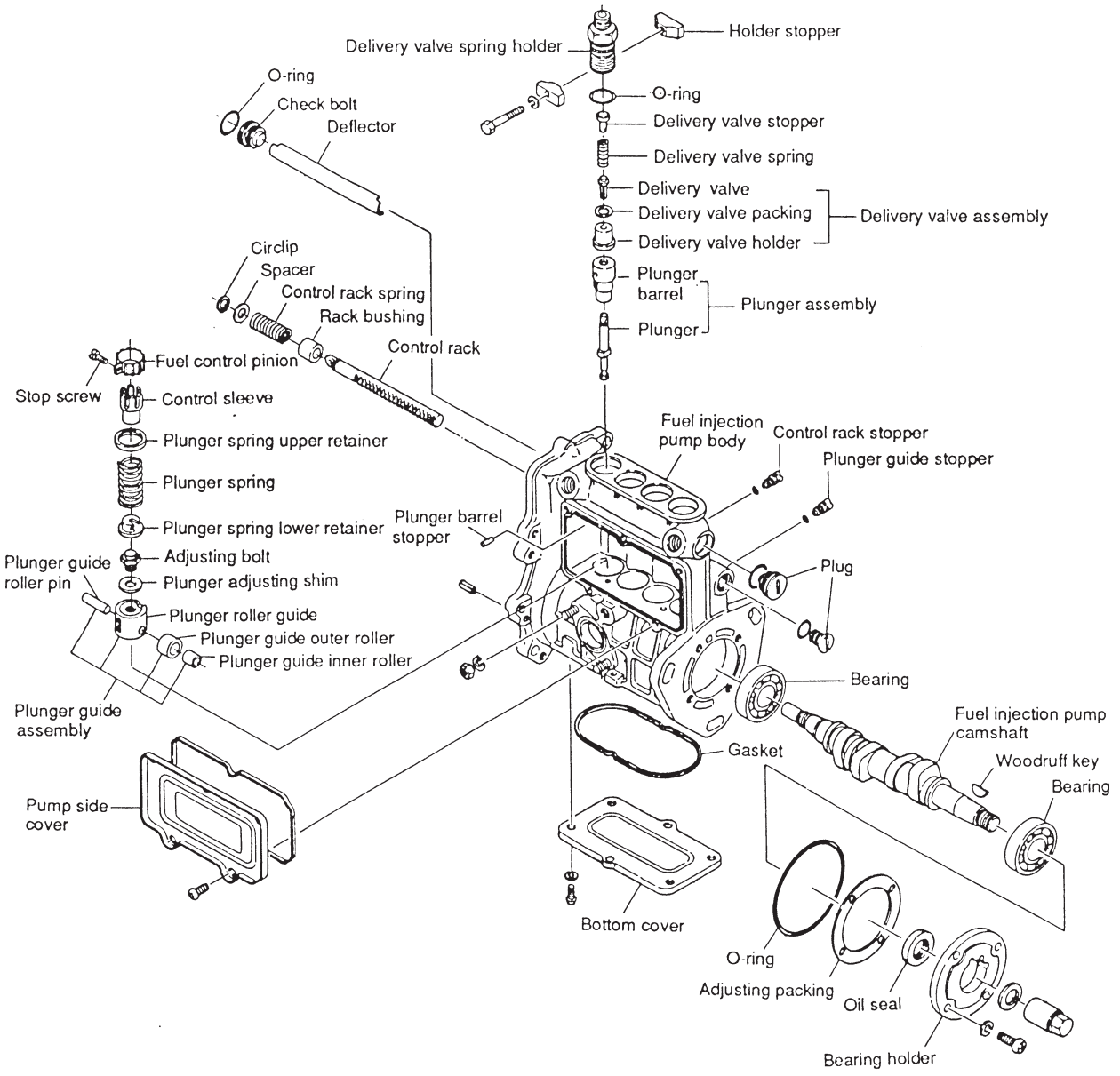


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# 12. Fuel Injection Pump for Direct Injection System

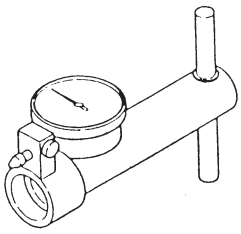
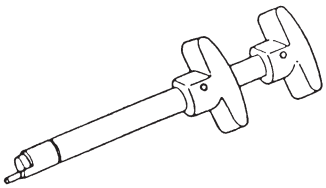
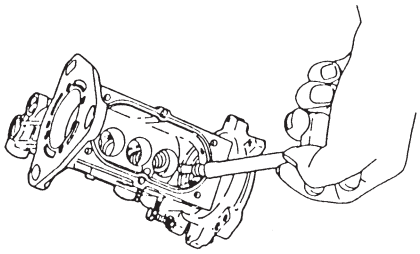
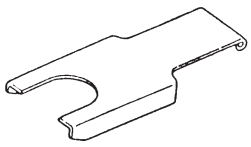
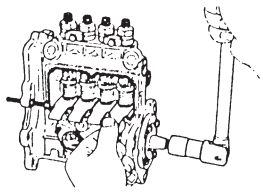
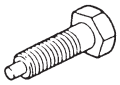
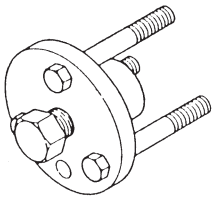
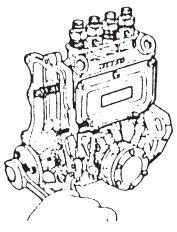
## 12-1. Exploded view (YPES type)



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# 12-2. Special service tools for disassembly and reassembly

| No. | Name of tool | Shape and size | Application |
|---|---|---|---|
| 1 | Side clearance measuring gauge<br>Yanmar code No. 158090-51050 |  | Measurement of camshaft side clearance |
| 2 | Plunger insertion tool<br>Yanmar code No. 158090-51100 |  |  |
| 3 | Tappet holder tool<br>Yanmar code No. 158090-51200 |  |  |
| 4 | Rack lock screw<br>Yanmar code No. 158090-51510 |  | |
| 5 | Governor weight extractor tool<br>Governor weight for 3 pcs. — Yanmar code No. 158090-51400<br>Governor weight for 4 pcs. — Yanmar code No. 158090-51450 |  |  |

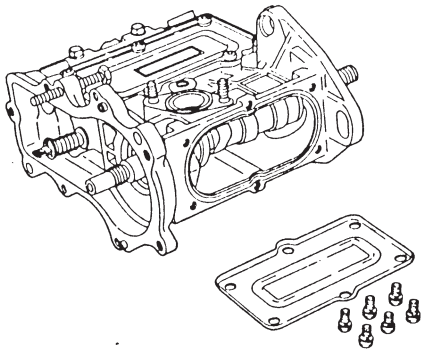
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# 12-3. Disassembly

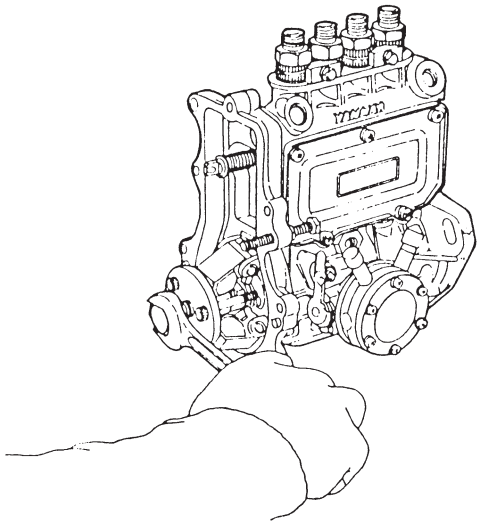
(1) Remove the bottom cover from the fuel injection pump to drain lubricating oil from the fuel injection pump.

(2) Turn the fuel injection pump upside down to drain fuel oil.



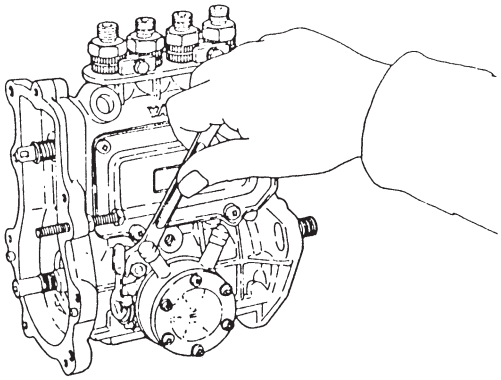
(3) Take out the governor weight assembly using the governor weight extractor tool (special service tool)

* *For separating the governor assembly from the fuel injection pump, refer to Chapter 13, 13-3.*

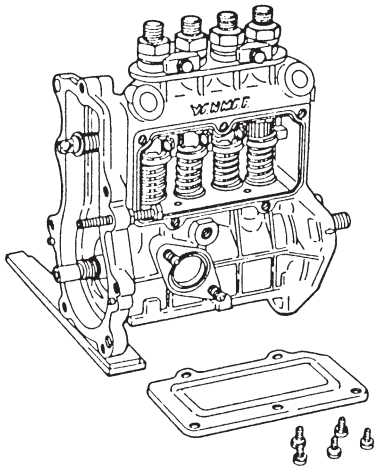


(4) Remove the fuel feed pump.

* *Do not disassemble the fuel feed pump.*



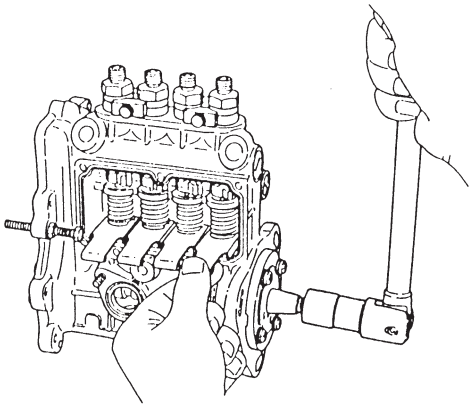
(5) Remove the fuel injection pump side cover.

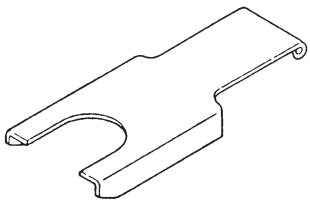


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(6) While turning the fuel injection pump camshaft, raise the plunger guide up to the max. stroke. Insert the tappet holders (special service tool) between the plunger spring lower retainer and fuel injection pump body.





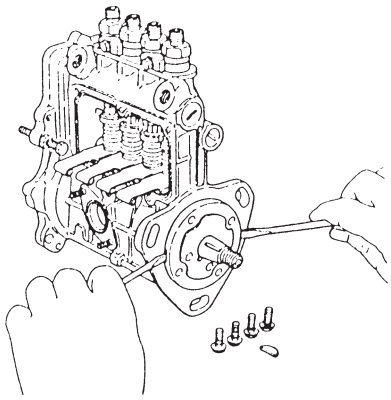
**(Special service tool: Tappet Holder)**

(7) Extract the woodruff key from the fuel injection pump camshaft.

(8) Extract the fuel injection pump camshaft bearing horizontally by inserting a screwdriver into the two grooves on the face where the bearing holder of the fuel injection pump camshaft is installed.

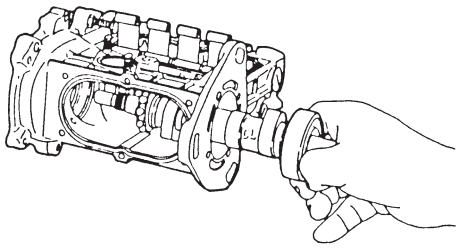
*1. *Carefully avoid allowing the thread of the fuel injection pump camshaft to damage the oil seal.*

*2. *Carefully avoid allowing the adjusting packings and oil seal between the pump body and bearing holder to be lost.*

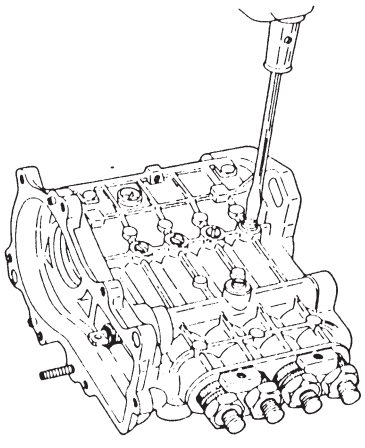


(9) Turn the fuel injection pump upside down. Move all plunger guides toward the plunger. Then, turn aside the fuel injection pump. While turning the fuel injection pump camshaft, find a position where the cams of each cylinder does not interfere with the plunger guide outer roller and place the camshaft in the position.

(10) Apply a plate against the governor end side of the camshaft. While tapping the plate, extract a set of the camshaft and drive bearing.



(11) Remove the plunger guide stopper.

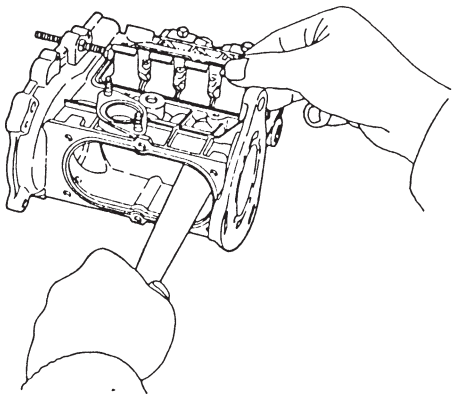


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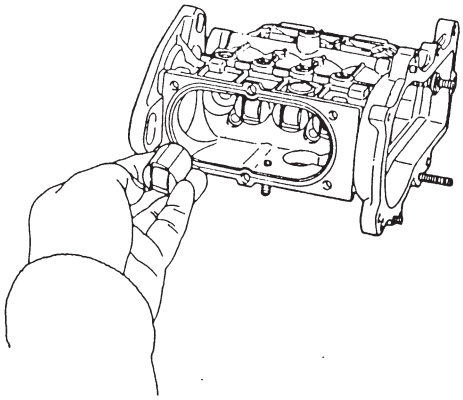
(12) By using the handle of a hammer, etc., push up the plunger guide from the bottom of the pump and take out the tappet holders (special service tool).

* *Use particular care to remove the tappet holder. Carefully prevent the plunger guide, plunger, etc., from jumping out. This is because the plunger spring is powerful enough to force them out.*



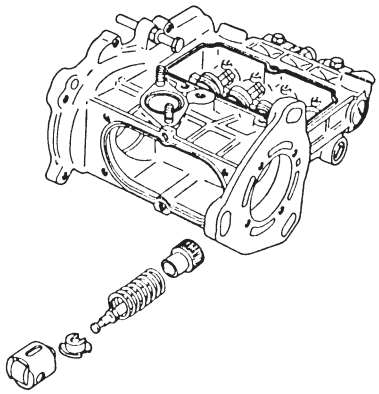
(13) Take out the plunger guide assembly.

* *Do not erect the fuel injection pump body, wherever possible. Otherwise, the plunger guide assembly falls off. Therfore, hold the fuel injection pump body tilted and remove the plunger guide assembly.*

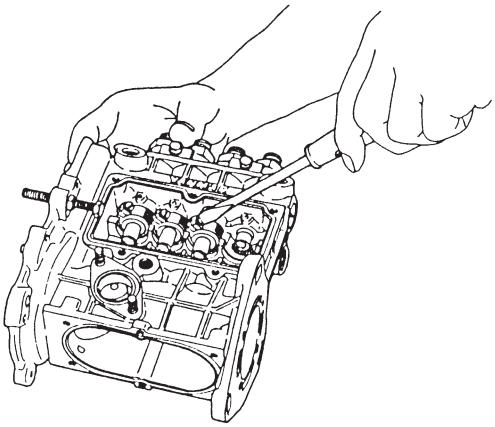


(14) Take out the plunger, plunger spring and plunger spring lower reteiner from the lower part of the fuel injection pump.

* *Separate these parts for each cylinder.*



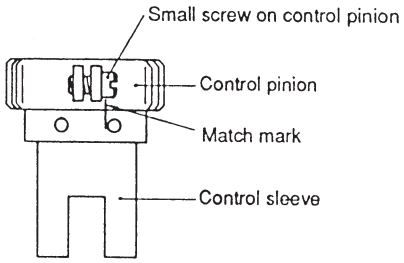
(15) Remove the stop screw from the fuel control pinion.



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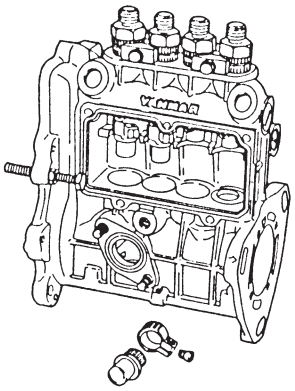
*1. *When the stop screw of the fuel control pinion is loosened, the fuel control pinion is separated from the control sleeve. Before loosening, therefore, make sure that the match mark of the fuel control pinion aligns with that of the control sleeve. If the match mark is difficult to identify or the match mark offsets, put new match marks. This practice helps adjusting injection volume later on.*



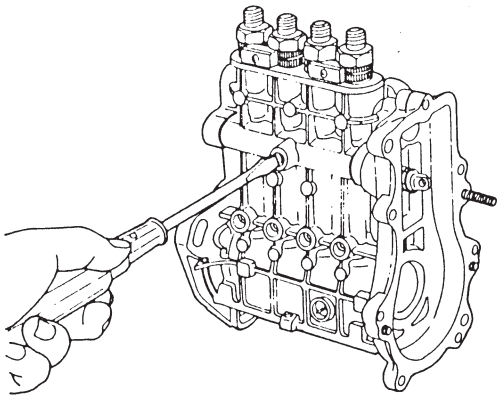

*2. *Separate all these parts for each cylinder.*

(16) Remove the fuel control pinion, control sleeve and plunger spring upper retainer.

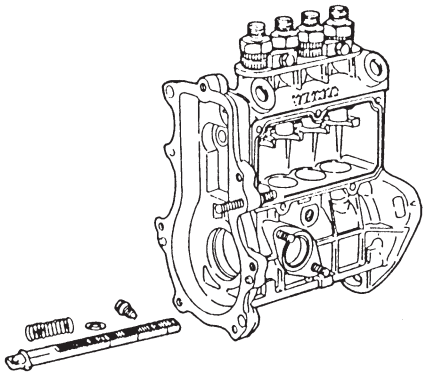
*: *Separate all these parts for each cylinder.*



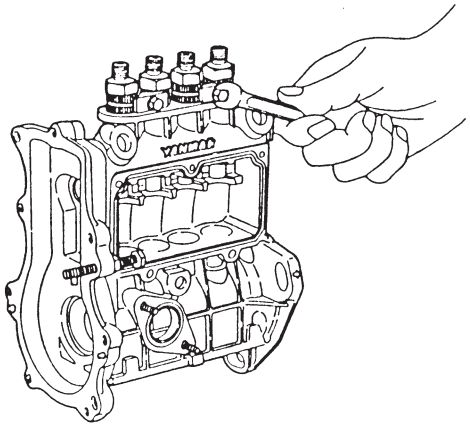
(17) Remove the control rack stopper. Extract the control rack.

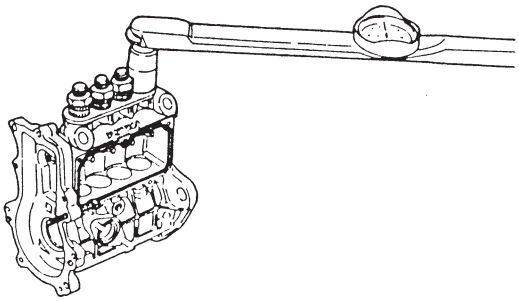


* *Carefully prevent the control rack spring and spacer on the control rack from being missing.*



(18) Loosen the bolt for the holder stopper. Remove the delivery valve sping holder.



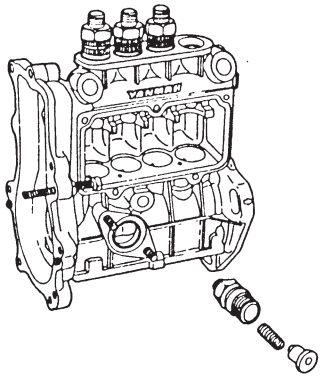


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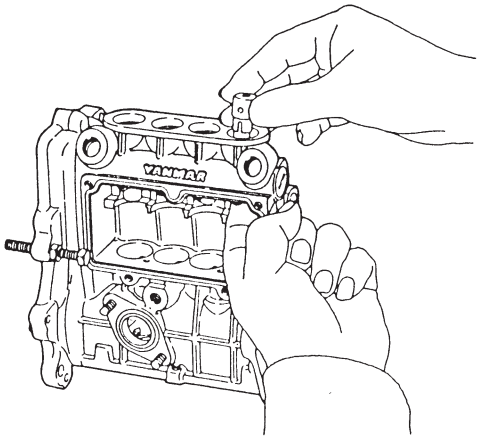
(19) Take out the delivery valve assembly.

* 1. *Carefully prevent small parts such as the delivery valve packing, delivery valve spring and delivery valve stopper from being missing.*
* 2. *Clearly separate the delivery valve assembly for each cylinder.*



(20) Take out the plunger barrel toward the upper part of the fuel injection pump.

* *Keep the plunger barrel just picked up together with the plunger which has been taken out.*



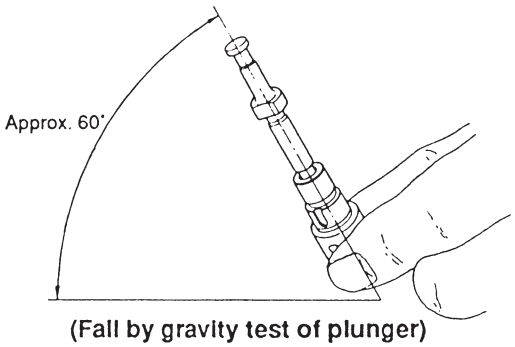
## 12-4. Inspection

Before inspection, thoroughly clean the parts, using new diesel oil. Be careful to avoid damage to the sliding surface of the plunger and delivery valve, etc.

**(1) Plunger**

1. Thoroughly clean the plunger. If any plunger lead is scratched or discolored, replace the plunger assembly with a new one.

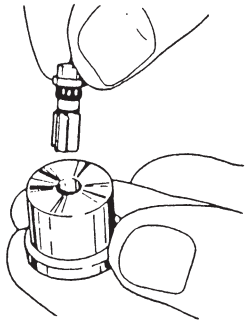
2. To test the plunger, hold the plunger barrel tilted approx. 60° and check to see if it slides down smoothly. If so, the plunger is acceptable. While turning the plunger, repeat the test several times. If any plunger slides down too quickly (slowly) or jams in the midway, correct it or replace the whole plunger assembly.




**(Fall by gravity test of plunger)**

**(2) Delivery valve**

1. If the suck-back collar or seat of the delivery valve is found scratched, dented, worn, or otherwise damaged, replace the whole delivery valve assembly.



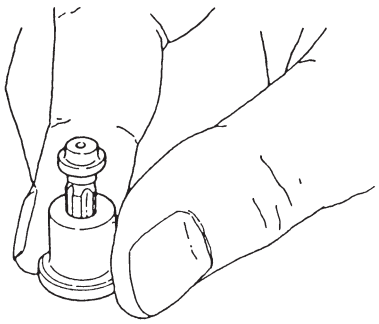
**(Check for delivery valve)**

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2. Stop up the hole in the bottom of the delivery valve holder and keep the seat as it is. Insert the delivery valve into the holder. While releasing your upper finger, check to see if the delivery valve springs back. If so, it is acceptable. If not, replace it.

3. Likewise as described in item 2, stop up the hole in the bottom of the delivery valve holder and check to see if the delivery valve falls by gravity perfectly, when the bottom hole's finger is released. If so, the delivery valve is acceptable. If not, replace it.



**(Fall by gravity test of delivery valve)**

### (3) Plunger guide, plunger barrel, etc.

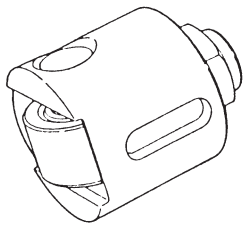
1. Check to see if the sliding surface of the plunger guide is free form excessive wear.

2. Check to see if the seat of the plunger barrel has uneven contact, burrs, the mark of blow-by gas or other defects etc. If so, correct or replace the plunger barrel. Otherwise, lubricating oil in use will be thinned.

3. If the surface of the plunger guide outer roller indicates wear, flaking, etc., replace the outer roller.

4. If the plunger guide has the circumference and roller pin hole worn or scratched, etc., replace it with a new one.

5. If the plunger guide assembly has a combination of the pin and roller that indicates chatters, replace the plunger guide assembly.



**(Plunger guide assembly)**

### (4) Fuel injection pump camshaft and bearing

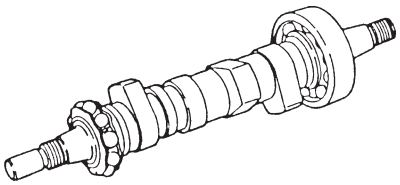
**1. Fuel injection pump camshaft**

Check for damage and wear of the camshaft surface, deformation of keyway and deformation of threads on both ends. If the camshaft proves to be defective, replace it.

**2. Bearing**

If the taper roller and outer race has flaking, wear, or any other damage on the surface, replace the bearing.

* *When replacing the fuel injection pump camshaft, replace the bearing at the same time.*



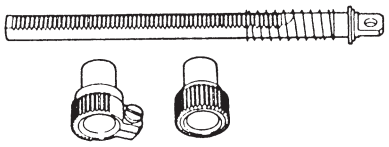
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(5) Control rack and fuel control pinion

1. Check the controll rack for bends and the wear and deformation of the portion where it is engaged with the fuel control pinion.
2. Check to see if the portion where the control rack is engaged with the fuel control pinion is free from wear and deformation.

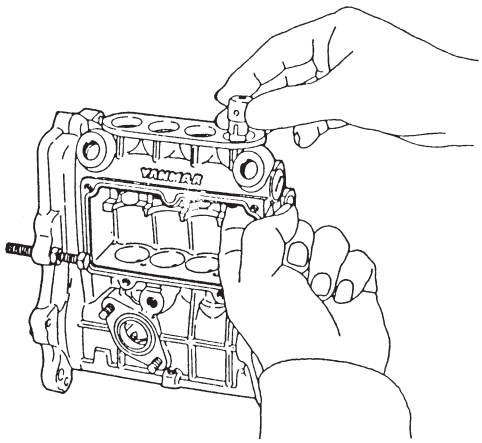
   * *If the control rack is in trouble with the teeth face and sliding part, it encounters increased resistance, causing the engine to be out of order (such as uneven revolutions and abrupt revolution changes).*



## 12-5. Reassembly

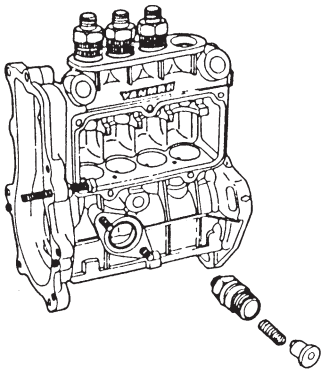
(1) Put the plunger barrel into the fuel injection pump from its top.

   * *Make sure that the plunger barrel stopper is snugly fitted with the key way.*



(2) Insert the delivery valve assembly, delivery valve spring and delivery valve stopper from the top of the fuel injection pump in that order.

   * *Replace the delivery valve packing and O-ring with new ones before reassembling the fuel injection pump.*



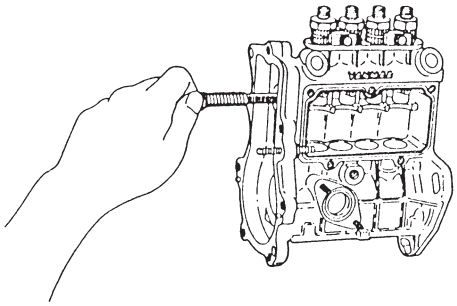
(3) Fit the control rack and tighten the control rack stopper.

   *1. *Never fail to install the control rack spring.*
   *2. *Make sure that the control rack moves smoothly over the full stroke.*

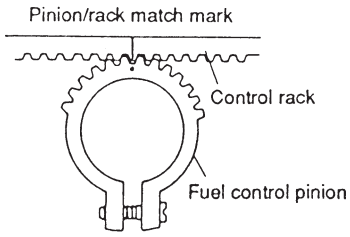
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(4) Insert a rack lock screw (special service tool) into the thread hole of the control rack stopper and fix the control rack.



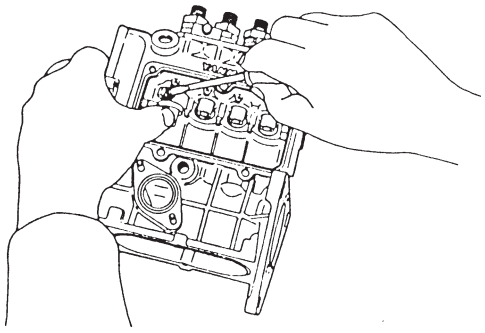
(5) Peep through the bottom of the fuel injection pump and align the match mark of the control rack with that of the fuel control pinion.

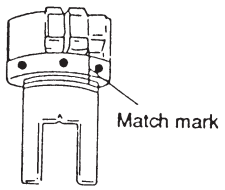



**( Matching mark on the control rack and fuel control pinion )**

(6) While holding the fuel control pinion by one hand so that its match mark may not be out of position, reassemble the control sleeve and lightly tighten the stop screw of the fuel control pinion.

* *Reassemble the control sleeve in the direction in which the holes around the control sleeve face the stop screw. At the same time, align the match mark with that of fuel control pinion.*

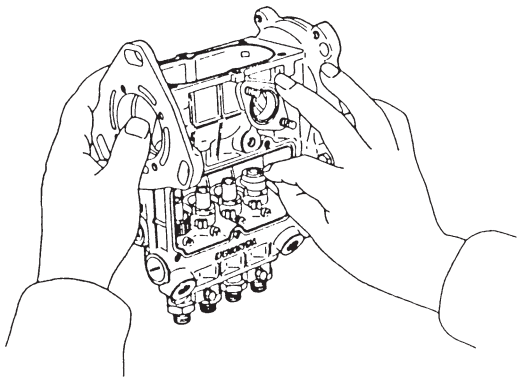





**(Fuel control pinion/control sleeve match mark)**

(7) Mount the plunger spring upper retainer

*1. *Mount the plunger spring upper retainer so that its recess faces downward.*
*2. *Once again, ascertain that the control rack moves smoothly.*

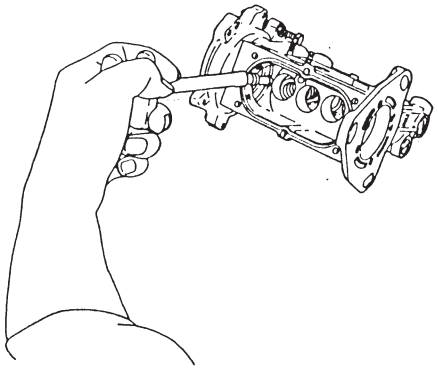


(8) Mount the plunger spring.

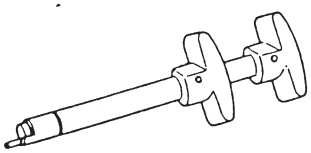
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(9) Mount the plunger spring lower retainer on the top of the plunger. While aligning the match mark of the plunger flange with that of the control sleeve, reassemble the plunger from the bottom of the fuel injection pump using a plunger insertion tool (special service tool).



**( Insertion of plunger with a special service tool: Plunger insertion tool )**

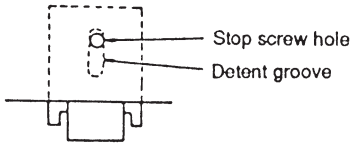


**( Special service tool: Plunger insertion tool )**

* *Never reassemble the plunger in reverse. Otherwise, fuel injection volume increases excessively to the point where fuel injection volume becomes uncontrollable.*

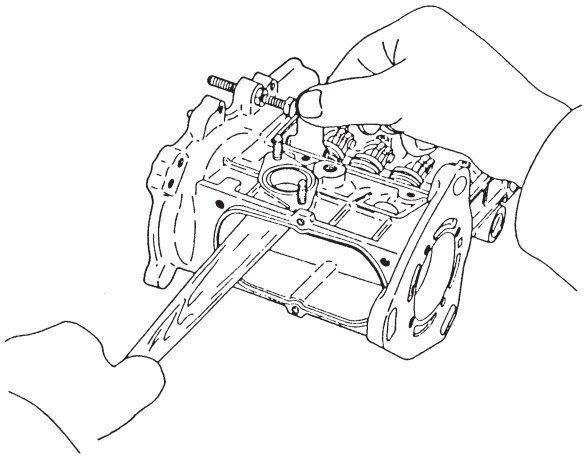
(10) Insert the plunger guide assembly into the fuel injection pump from its bottom. Push up the plunger guide using the handle of a hammer, etc., and put a tappet holder (special service tool) in between the lower spring retainer and fuel injection pump body.

*1. *While keeping the plunger guide detent groove facing upward, align with the mating screw hole of the plunger guide stopper on the fuel injection pump body.*

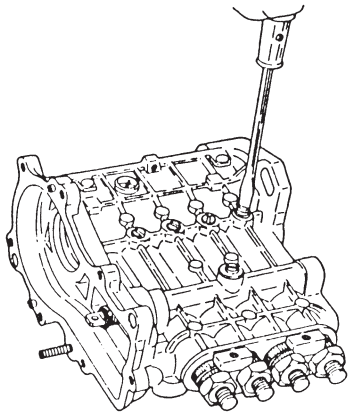



*2. *Check to see if the control rack moves freely. If not, the plunger spring interferes with something else. In this case, hold the plunger spring in position using a screwdriver.*

*3. *When replacing the plunger guide assembly with a new one, insert the standard shim, and temporarily tighten it.*



(11) Make sure that the plunger guide detent groove is in position. Tighten the plunger guide stopper.

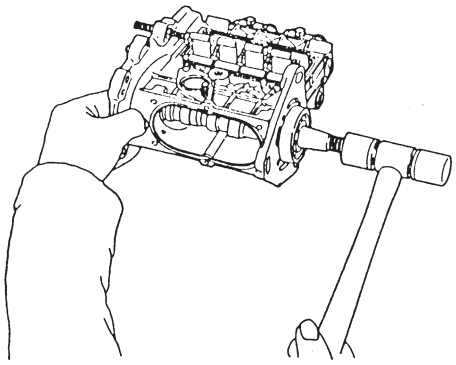


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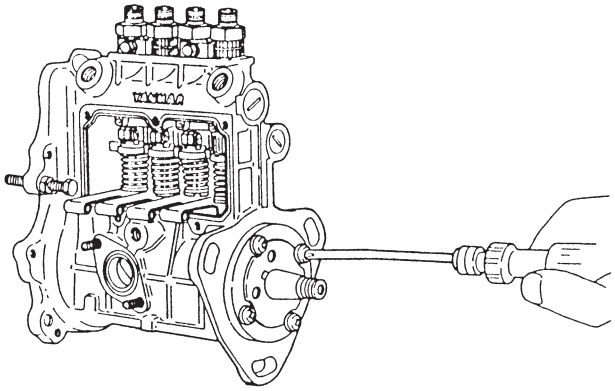
(12) Place the bearings on both ends of the fuel injection pump camshaft. Insert the bearings while tapping them from driving side.

* *Turn the fuel injection pump upside down. Move the plunger guide toward the plunger spring and drive in the fuel injection pump camshaft.*



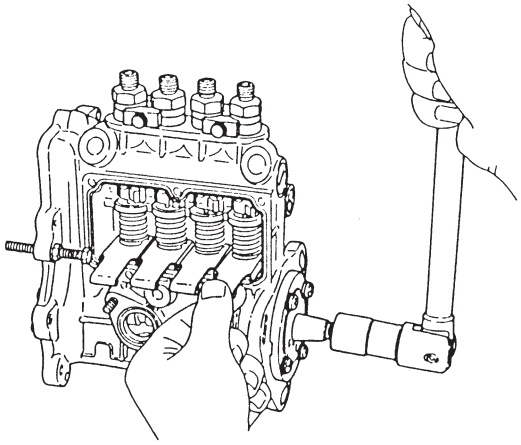
(13) Fit the oil seal to the inner side of the bearing holder. Mount the bearing holder.

* *Apply lubricating oil to the fuel injection pump camshaft and oil seal of the fuel injection pump camshaft in advance so as not to damage the oil seal.*



(14) Drive the woodruff key into the fuel injection pump camshaft.

(15) Turn the fuel injection pump camshaft, and extract the tappet holder (special service tool).



(16) Fix the fuel injection pump. Using a mallet, tap the end of the fuel injection pump camshaft to adjust the side clearance of the fuel injection pump camshaft using an adjusting packing and a side clearance gauge (special service tool).

(mm)

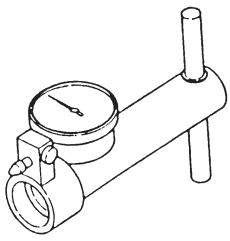
| | All models |
|---|---|
| Camshaft side clearance | 0.02 ~ 0.05 |

[Adjustment Procedure]

If a clearance is found small, remove the adjusting packing.

If a clearance is found large, add one or more adjusting packing.

Thickness of adjusting packing : 0.5, 0.4, 0.3, and 0.15 mm.

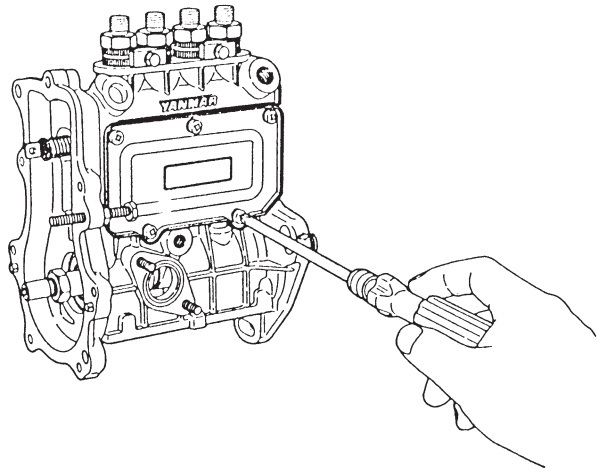


( **Special service tool:**
**Side clearance gauge** )

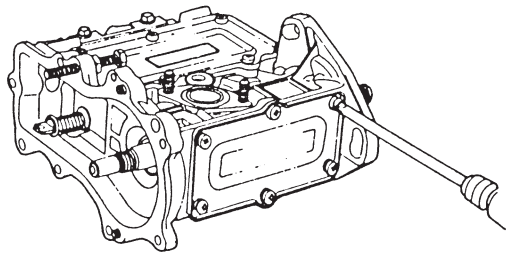
https://truckmanualshub.com/



(17) Mount the fuel injection pump side cover.



(18) Mount the fuel injection pump bottom cover.



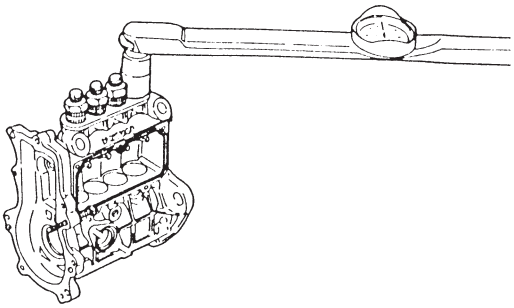
(19) Tighten the delivery valve spring holder to the specified torque.

(kgf-m)

| | All models |
|---|---|
| Tightening torque | 3.5 ~ 4.0 |

*1. *Tighten the delivery valve spring holder by hand as far as possible. If the bolt get hard to turn part way, the packing or delivery valve may be out of position. Remove, correct, and start tighten again.*

*2. *Never tighten the delivery valve holder excessively. Excessive tightening causes the control rack to malfunction.*

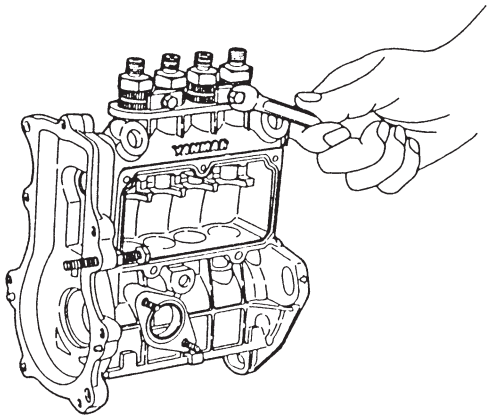


(20) Tighten the holder stopper to the specified torque.

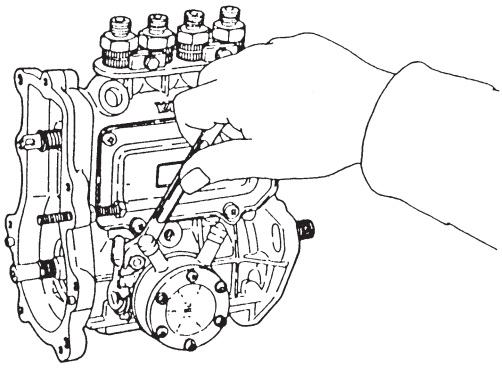
(kgf-m)

| | All models |
|---|---|
| Tightening torque | 0.3 |

* *Never tighten the delivery holder excessively. Otherwise, it upsets, causing oil to leak through it.*



(21) Mount the fuel feed pump.

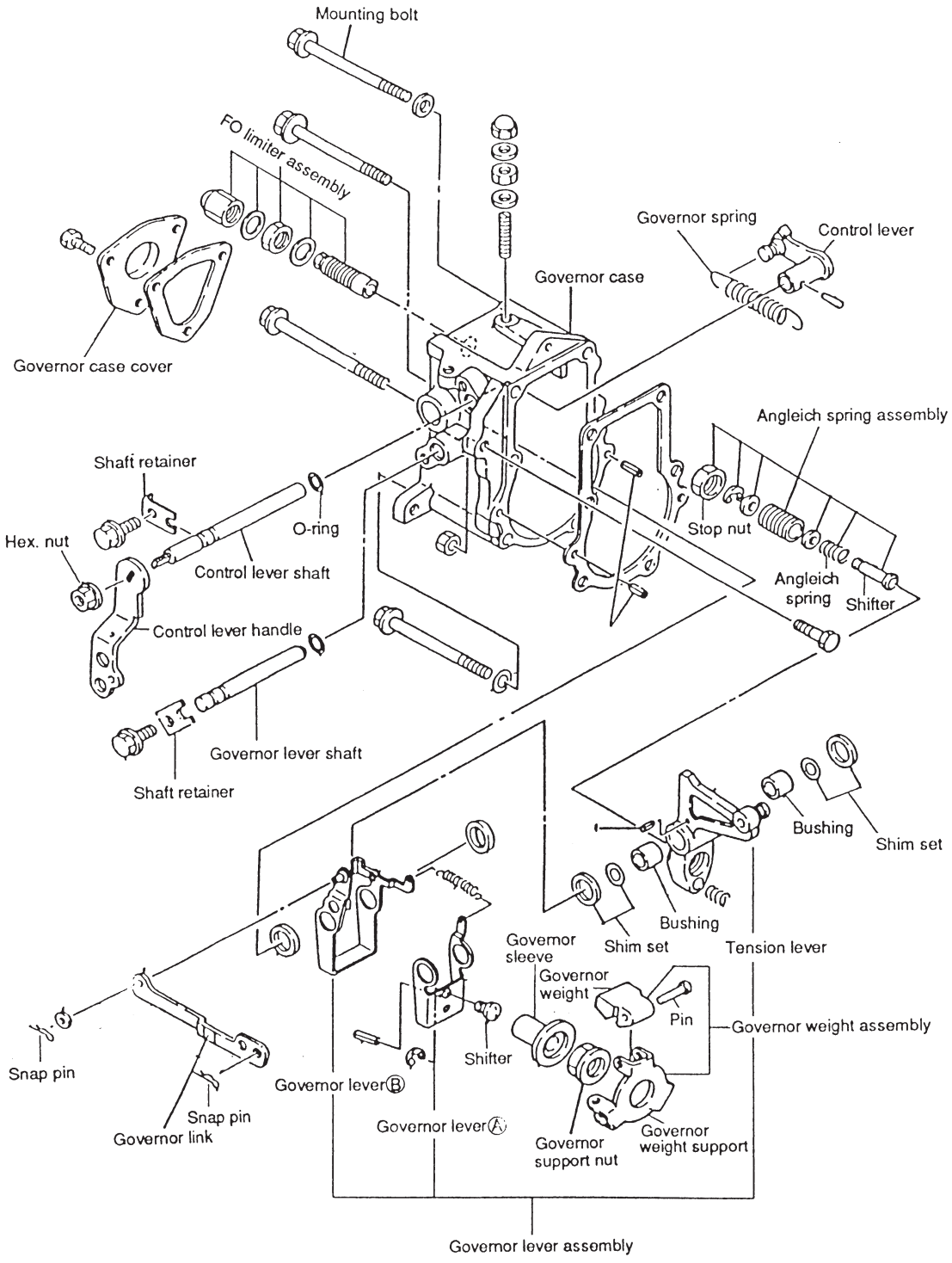


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# 13. Governor

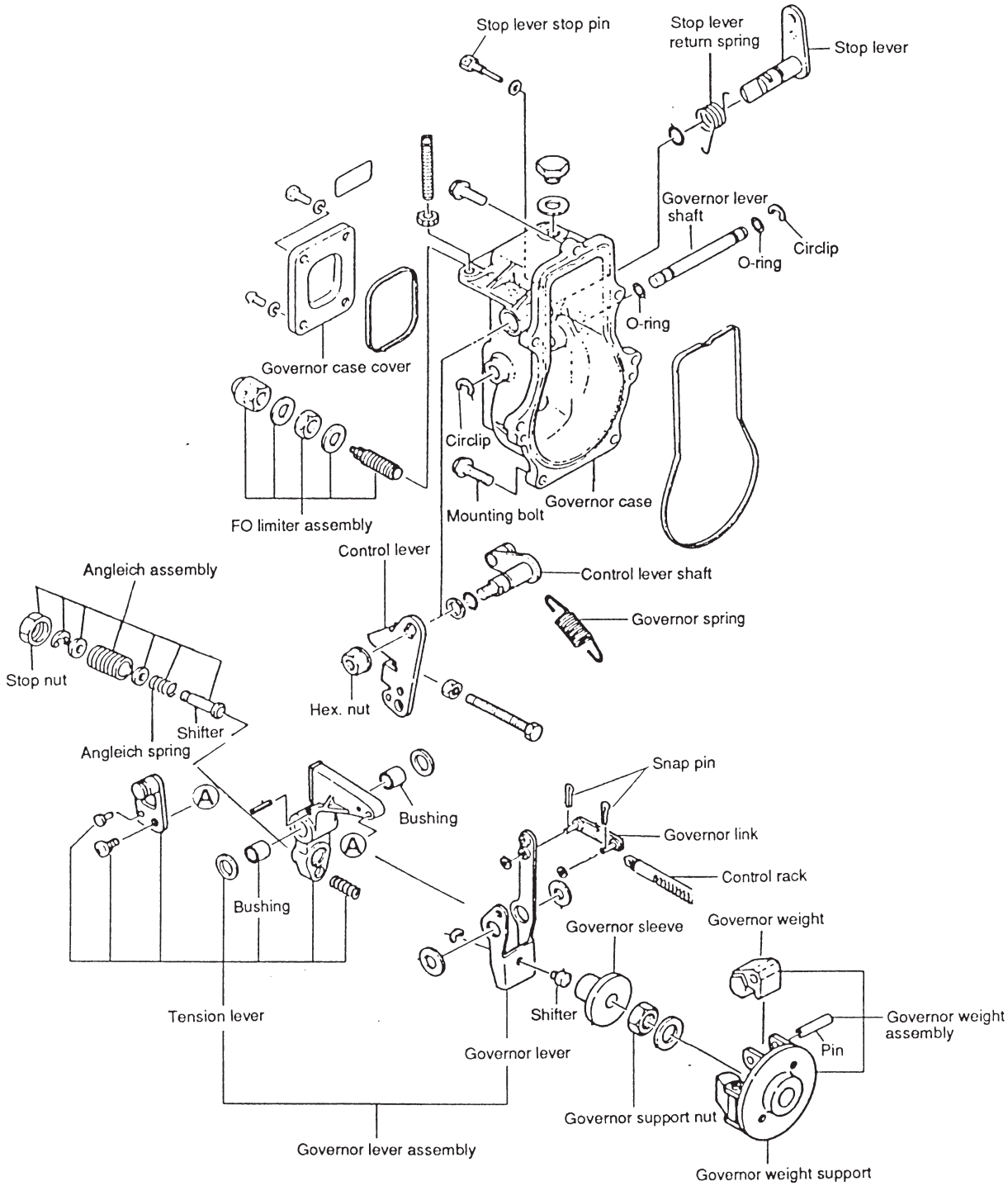
## 13-1. Exploded views of governor for indirect injection system



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# 13-2. Exploded views of governor for direct injection system



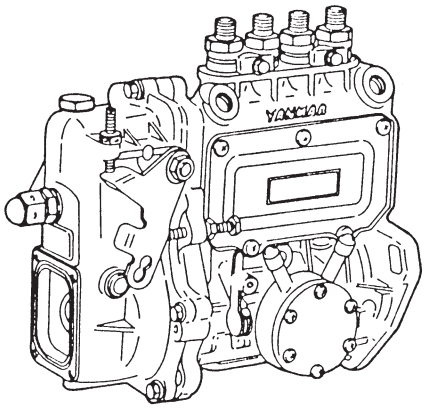
https://truckmanualshub.com/



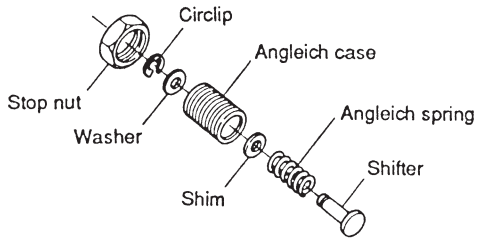
# 13-3. Disassembly

Disassembly and reassembly can be carried out similarly for Indirect injection system and Direct injection system.

(1) Remove the governor case.

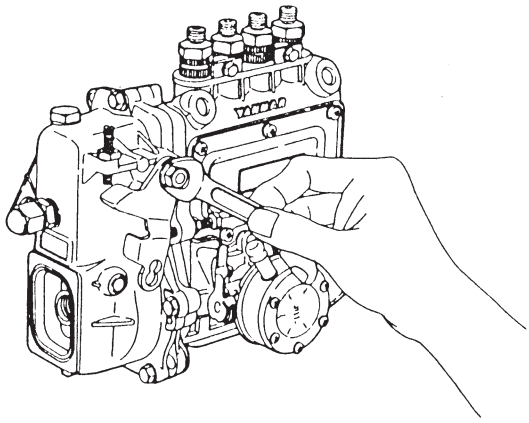


* *Loosen the stop nut on models with angleich assembly.*

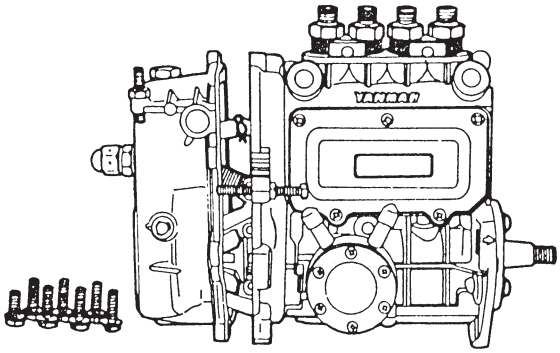



**(Angleich assembly)**

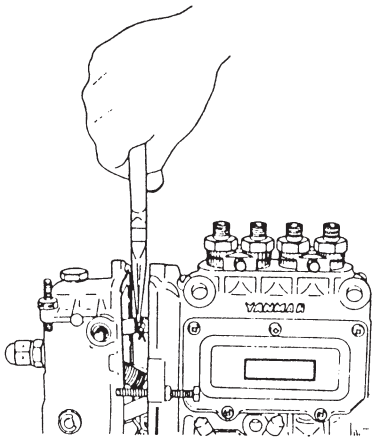
(2) Remove the control lever hex. nut and pull out the control lever from the control lever shaft.



(3) Remove the governor case mounting bolt. Remove the governor case from the fuel injection pump while gently tapping the governor case with a wooden hammer. Create a gap between the governor case and fuel injection pump by moving only the moving parts of the governor lever.



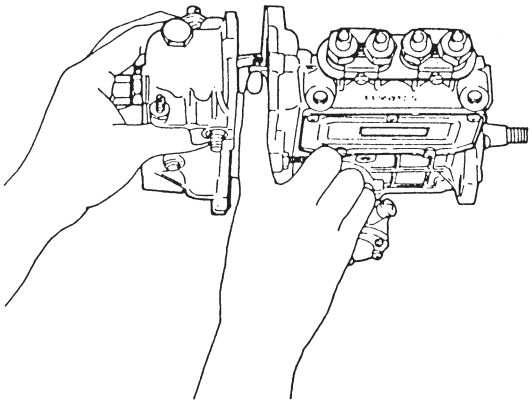
(4) Pull out the governor link snap pin by inserting long nosed pliers between the fuel injection pump and governor case.

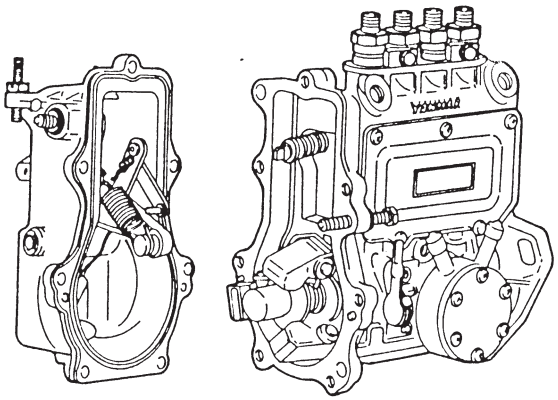


https://truckmanualshub.com/

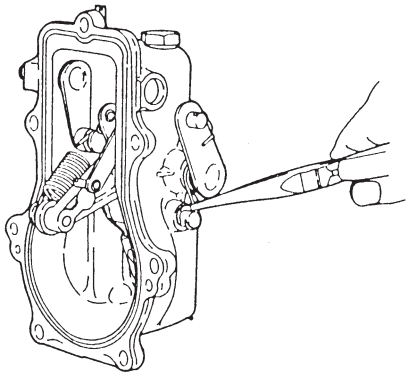


(5) Separate the governor and fuel injection pump by sliding the governor case and fuel injection pump apart and pulling out the snap pin of the governor link from the control rack.

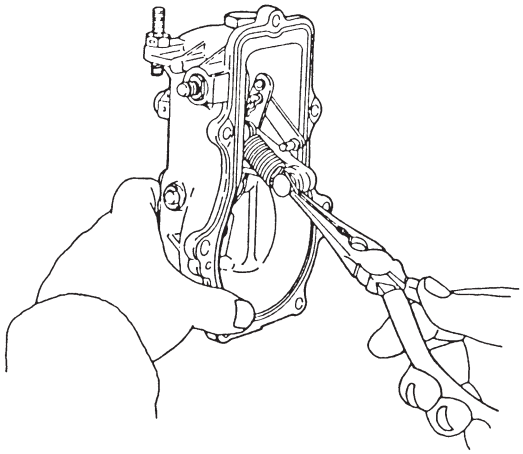




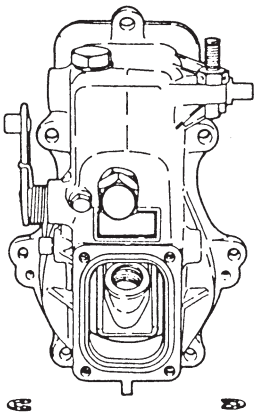
(6) Remove the stop lever return spring from the governor lever shaft. (DI only)



(7) Use long nosed pliers to unhook the governor spring from the tension lever and control lever shaft.



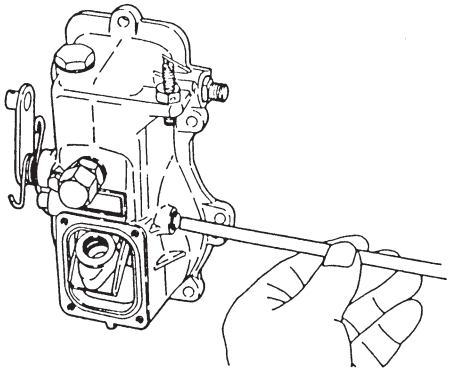
(8) Remove the shaft retainer on the governor lever shaft. (for IDI)
Remove the circlips on both ends of the governor lever shaft. (for DI)



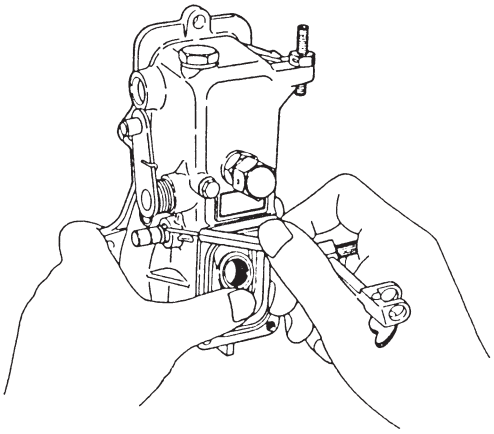
https://truckmanualshub.com/

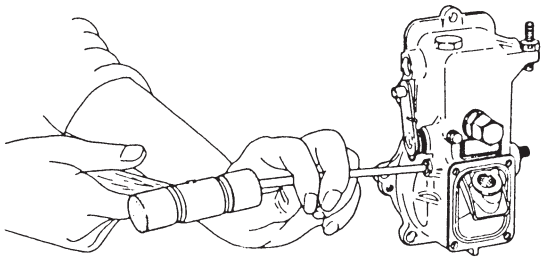


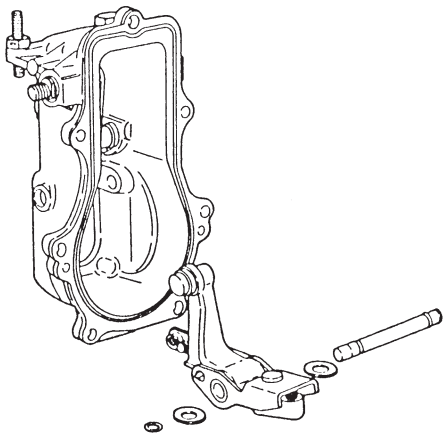
(9) Put a rod 8 mm in dia. or less in one end of the governor lever shaft and tap the governor lever shaft until the O-ring comes out the other side of the governor case.



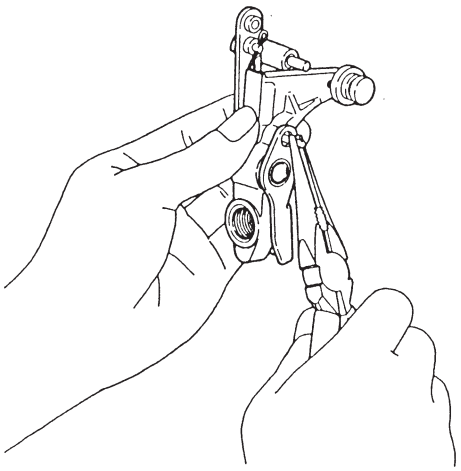
(10) After you remove the O-ring, lightly tap the end of the shaft that you removed the O-ring from, and extract the governor lever shaft.

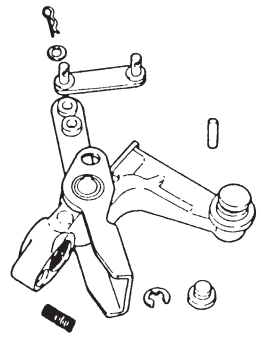






(11) Remove the governor link from the governor lever.



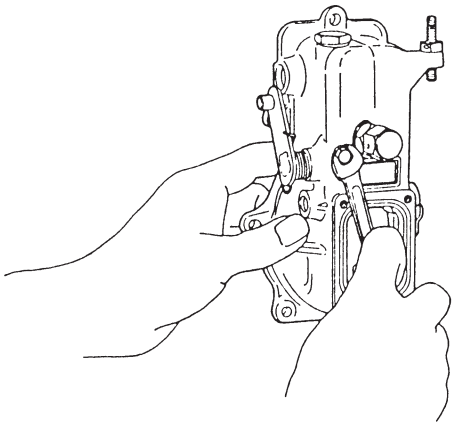


* *The governor assembly consists of the governor lever, tension lever and angleich, and is normally not disassembled.*

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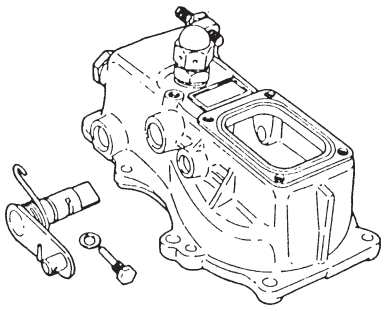
(12) When you need to pull out the stop lever, remove the stop lever shaft stop pin, and lightly tap the inside of the governor case. (DI only)



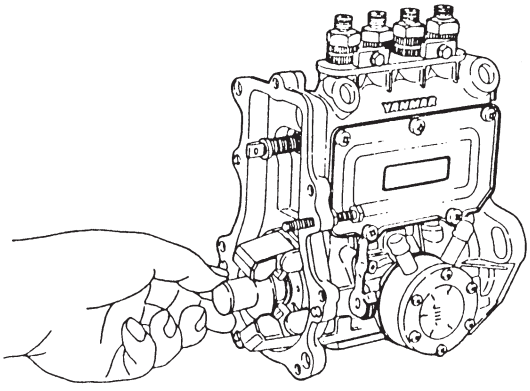
(13) When you need to pull out the control lever shaft, lightly tap the end of the shaft with a wooden hammer, and extract the control lever.

*1. *Do not remove the FO limiter assembly from the governor case unless necessary.*

*2. *On models with torque springs, first remove the box nut, stop nut, and then the torque spring assembly.*

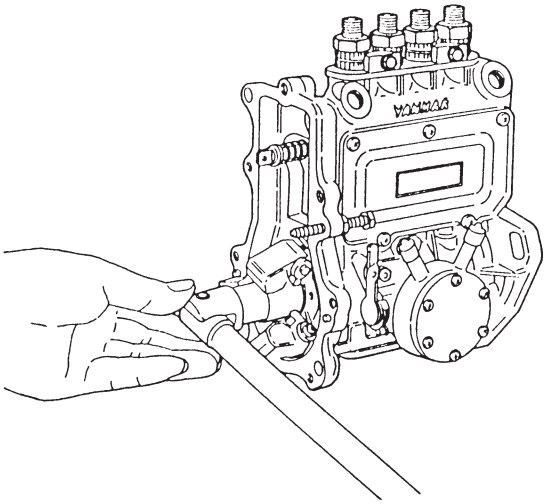


(14) Pull out the governor sleeve on the end of the fuel injection pump camshaft by hand.

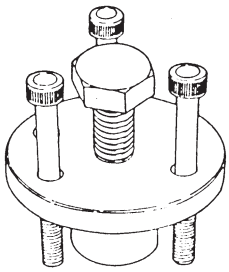


(15) Fix the bearing holder with a vise to hold the fuel injection pump camshaft. Loosen the governor support nut with a box spanner a few turns.

* *When the taper fit comes apart after you have removed the nut, the governor weight may fly out - Be careful.*



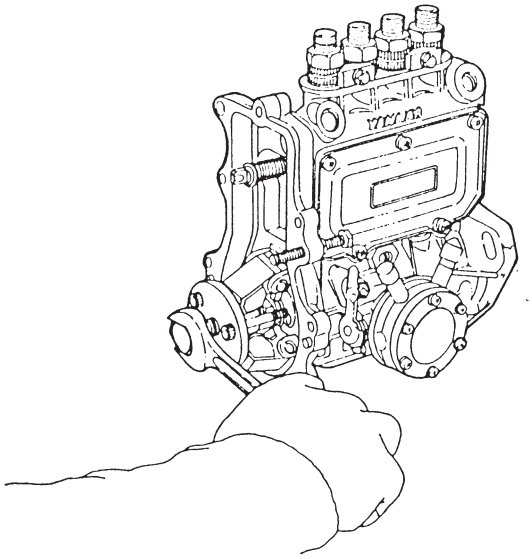
(16) Remove the governor weight assembly from the fuel injection pump camshaft using the governor weight extractor (special service tool).

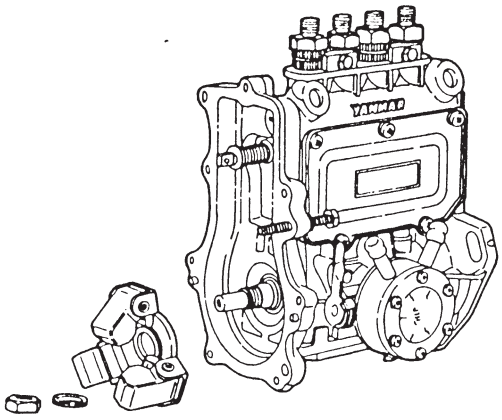


**(Governor weight extractor)**

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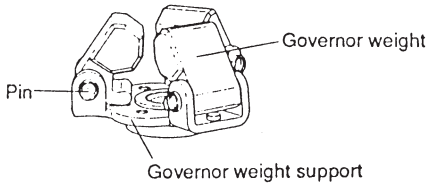




# 13-4. Inspection

## 1. Inspection of governor weight assembly

(1) Replace the governor weight if it does not open and close smoothly.




(2) Replace the governor weight assembly if the contact surface with governor sleeve is extremely worn.

(3) Replace if there is governor weight support and pin wear or the the caulking is loose.

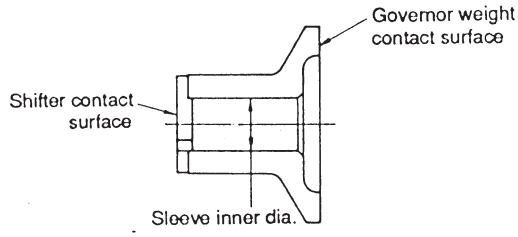
(4) Replace if the governor weight support stopper is excessively worn.

## 2. Inspection of governor sleeve

(1) Replace the governor sleeve if the contact surface with governor weight is worn or there is pitching.

(2) Replace the governor sleeve if the contact surface with shifter is excessively worn or there is pitching.

(3) If the governor sleeve does not move smoothly on the fuel injection pump camshaft due to governor sleeve inner dia. wear or other reasons, replace.



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### 3. Inspection of governor lever shaft assembly

(1) Measure the clearance between the governor lever shaft and bushing, and replace if it is near the wear limit.

(mm)

| | Standard dimension | Standard clearance | Limit |
|---|---|---|---|
| Governor lever shaft outer dia | $8^{-0.005}_{-0.014}$ | 0.065 ~0.124 | 0.5 |
| Bushing inner dia. | $8^{+0.11}_{+0.06}$ | | |

(2) Inspect the shifter contact surface, and if it is worn or scorched, remove the spring pin to disassemble and replace the shifter only.

(3) Check link parts for bends or kinks that will cause malfunctioning, and replace if it is faulty.

*1. *Side gap on top of governor lever shaft.*

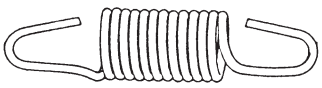
(mm)

| | |
|---|---|
| Standard side gap | 0.4 |

2. *Replace the governor lever, tension lever, bushing, shifter and angleich spring as an assembly.*

### 4. Inspection of springs

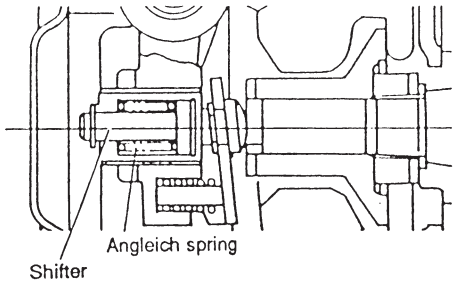
(1) Check the governor spring and other springs and replace if they are broken, settled or corroded.



### 5. Inspection of angleich spring assembly

(1) Inspect the sliding surface of shifter and replace if it is faulty.

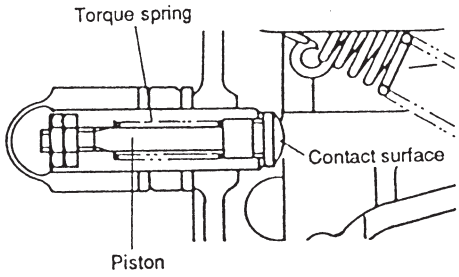
(2) Replace the angleich spring assembly if the angleich spring is broken.




### 6. Inspection of torque spring assembly

(1) Inspect the tip of the piston and contact surface for wear and replace if it is faulty.

(2) Replace the assembly if the torque spring is broken.



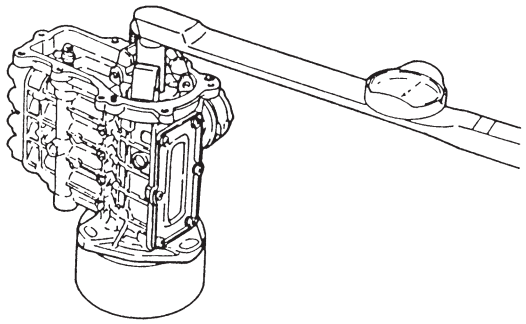
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# 13-5. Reassembly

Inspect all parts after disassembly and replace any parts as necessary. Before starting reassembly, clean all parts and put them in order.
Make sure to readjust the unit after reassembly to obtain the specified performance.

(1) Fix the bearing holder with a vise to hold the fuel injection pump camshaft. Insert the governor weight assembly in the taper portion at the end of the fuel injection pump camshaft. Mount the washer, and tighten the governor weight support nut with the specified torque.

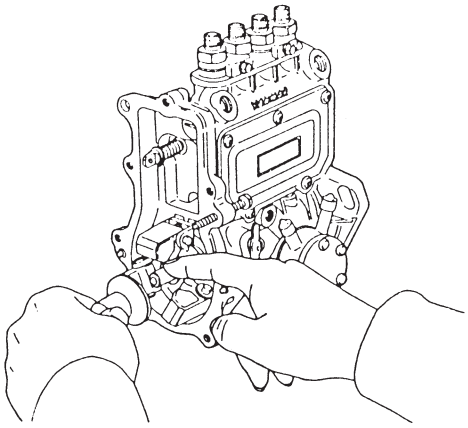


(kgf-m)

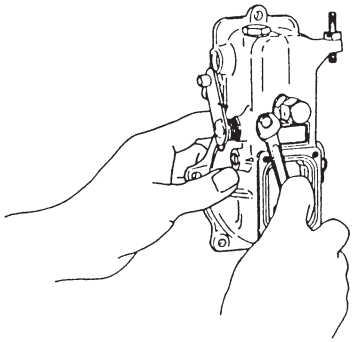
| | Governor weight support nut tightening torque |
|---|---|
| Indirect injection system | 7.0 ~ 7.5 |
| Direct injection system | 4.5 ~ 5.0 |

(2) Open the governor weight to the outside, and insert the sleeve in the end of the fuel injection pump camshaft.

* *Make sure that the sleeve moves smoothly after inserting it.*



(3) After the stop lever is disassembled, mount the stop lever return spring on the stop lever, tap the stop lever lightly with a wooden hammer to insert it, and tighten the stop lever stop pin. (DI only)

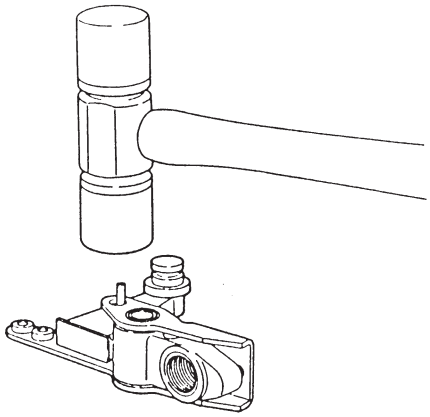


(4) After the control lever shaft is removed, lightly tap and insert the control lever shaft and washer from inside the governor case, using an appropriate plate.

(5) If the governor lever has been disassembled, tap in the spring pin.

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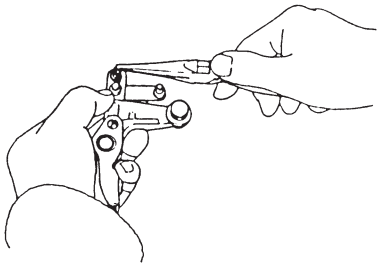




(6) Mount the governor lever assembly to the governor link.

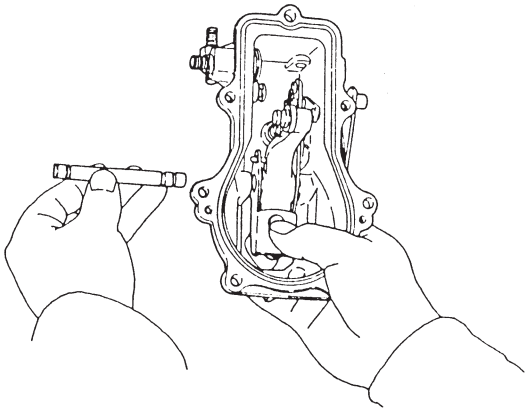
*1. *Make sure that the correct governor link mounting holes are used and that it is mounted in the correct direction.*

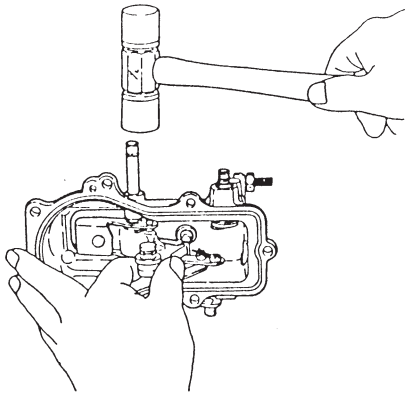
*2. *Make sure that the governor link moves smoothly.*



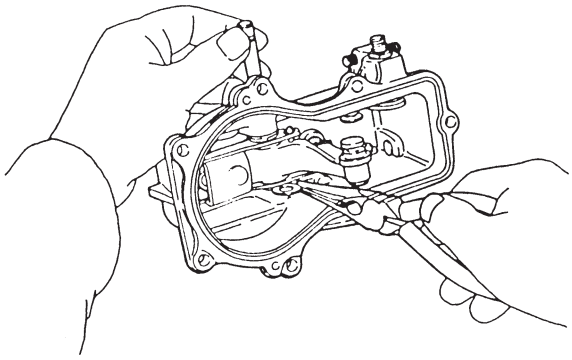
(7) Put the governor lever shaft assembly in the governor case, insert the governor lever shaft and tap it in until the O-ring groove comes out the opposite side of the governor case. (for DI)

*1. *Fit the O-ring beforehand to the side you tap in.*



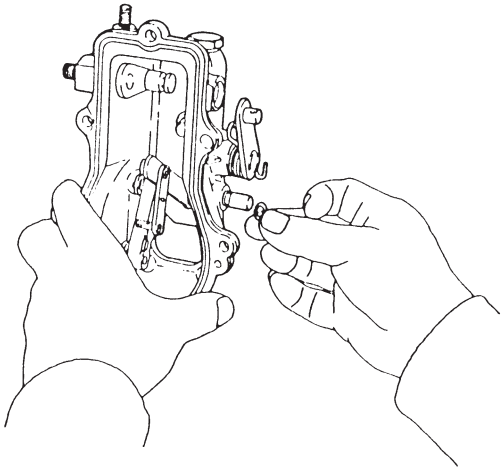


*2. *Make sure to insert the governor lever shaft in the correct direction.*



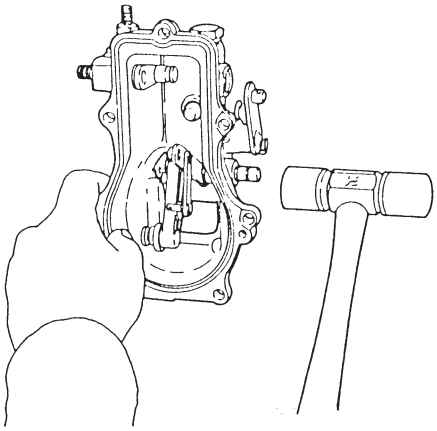
*3. *Don't forget to mount the washers on both sides of the governor lever.*

(8) After you have mounted the O-ring, tap the governor lever in the opposite direction, and mount the circlip on the grooves at both ends. (for DI)



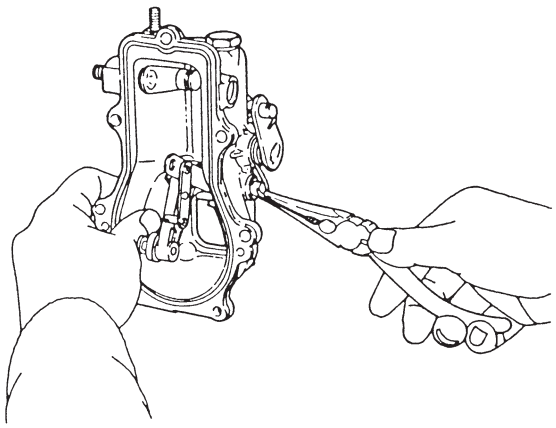
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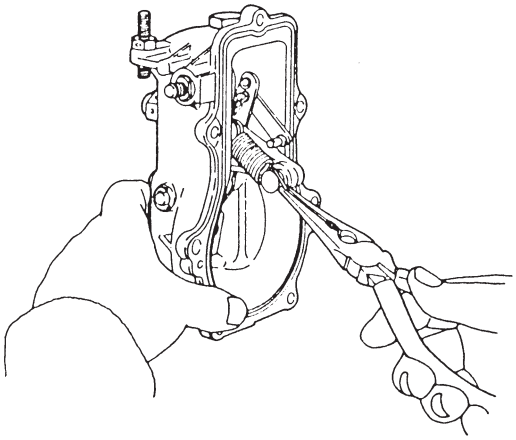


* *After mounting the governor lever assembly, make sure the governor lever assembly moves smoothly.*

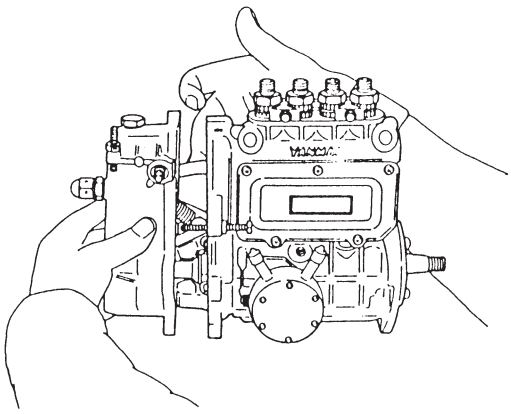
(9) Fit the stop lever return spring to the end of the governor lever shaft. (DI only)



(10) Hook the governor spring on the control lever shaft and tension lever hook with long nosed pliers.



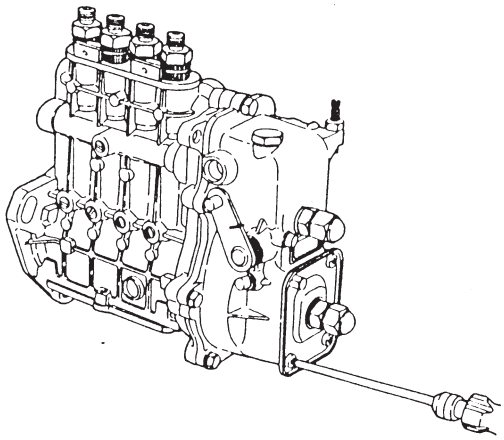
(11) Pull the governor link as far as possible towards the governor case mounting surface, insert the governor link pin in the fuel control rack pin hole and fit the snap pin on it.



(12) Mount the governor case to the fuel injection pump while lightly tapping it with a wooden hammer, and tighten the tightening bolt.

(13) Mount the governor case cover.
On models with idle subspring, insert the adjusting spring and adjusting rod on the governor case cover adjusting bolt.

* *If the angleich spring assembly has been removed, tighten the nut temporarily. The nut should be securely tightened after adjustment.*

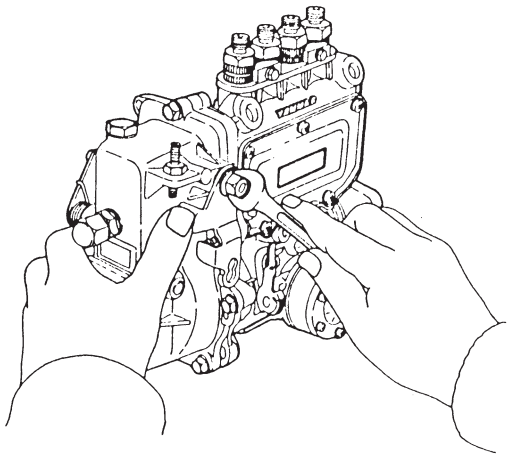


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(14) Insert the control lever in the control lever shaft and tighten the nut.

* *Move the control lever back and forth to make sure that the entire link moves smoothly.*



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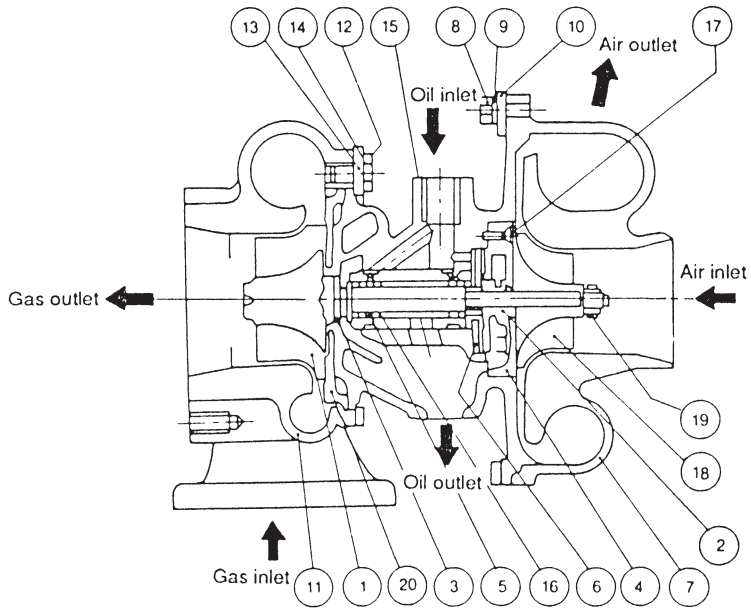
# 14. Turbocharger

## 14-1. Specifications

| | | |
|---|---|---|
| Applicable engine model (application) | 3TNE84T (CL, VM) | 3TNE84T (CH, VH) |
| | 4TNE84T (CL) | 4TNE84T (VM, CH, VH) |
| Turbocharger model | RHB31 | RHB51 |
| Turbocharger specification | Standard (w/waste gate) | |
| Turbine type | Radial flow | |
| Blower (compressor) type | Centrifugal | |
| Lubrication method | External lubrication | |
| Max. continuous allowable rpm | 250,000 | 180,000 |
| Max. continuous allowable gas inlet temperature | 750°C | |
| Dry weight | 2.4 kg | 4.2 kg |

Note) VM and VH applications are provided with the waste gate.

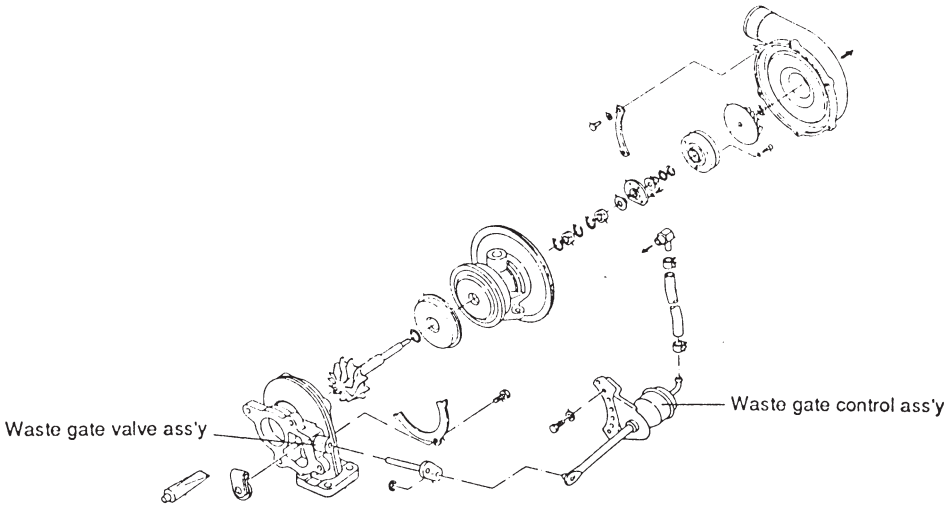
## 14-2. Construction




| No. | Part name |
|---|---|
| 1 | Turbine shaft |
| 2 | Oil thrower |
| 3 | Turbine side seal ring |
| 4 | Seal plate |
| 5 | Journal bearing |
| 6 | Thrust bearing |
| 7 | Compressor housing |
| 8 | M5 hexagon bolt |
| 9 | M5 spring washer |
| 10 | Compressor side clamp |
| 11 | Turbine housing |
| 12 | M6 hexagon bolt |
| 13 | Turbine side clamp |
| 14 | Lock washer |
| 15 | Bearing housing |
| 16 | Retaining ring |
| 17 | M3 countersunk flat head screw |
| 18 | Compressor wheel |
| 19 | Shaft end nut |
| 20 | Heat protector |

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**(Exploded view of turbocharger w/waste gate)**

*[Note]*

*A waste gate valve is adopted in the turbocharger for VM or VH (variable speed) application.*

* *The waste gate valve is a turbocharger speed control system to maintain the intake air pressure at a constant level by bypassing a part of the exhaust gas for driving the turbocharger by using the intake air pressure on the compressor side. It consists of a control ass'y separated from the turbocharger and a valve ass'y built in the turbine housing.*

(1) Turbine

The exhaust gas from the engine is accelerated at the nozzle portion in the turbine housing and blown onto the turbine impeller to rotate the turbine shaft. This is called the turbine. A seal ring and heat insulating plate are installed to prevent the bearing from being adversely influenced by the gas.

(2) Compressor

The compressor wheel installed on the turbine shaft is rotated with the shaft to suck and compress air for feeding into the intake manifold. This is called the blower or compressor.

(3) Bearing

1. Thrust bearing

As the turbine shaft is constantly applied with a thrust force, this bearing prevents the shaft from being moved by the thrust force.

2. Radial (journal bearing)

A floating journal bearing is adopted. Because the bearing moves with the turbine shaft as oil films are formed both inside and outside of the bearing, the bearing sliding speed is slower than the turbine shaft speed as compared with the ordinary fixed type bearing.

The dynamic stability is improved as a result.

3. Compressor side sealing mechanism

To prevent the intake air and oil from leaking, a seal ring and a seal plate is provided to form a double wall structure on the rear side of the compressor wheel.

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# 14-3. Waste Gate Valve Adjusting Method

Since turbochargers for VM and VH applications are provided the waste gate valve each, adjustment of the waste gate valve opening pressure and lift is indispensable at the time of overhaul or inner parts replacement. Omission of this adjustment will adversely affect the engine performance.

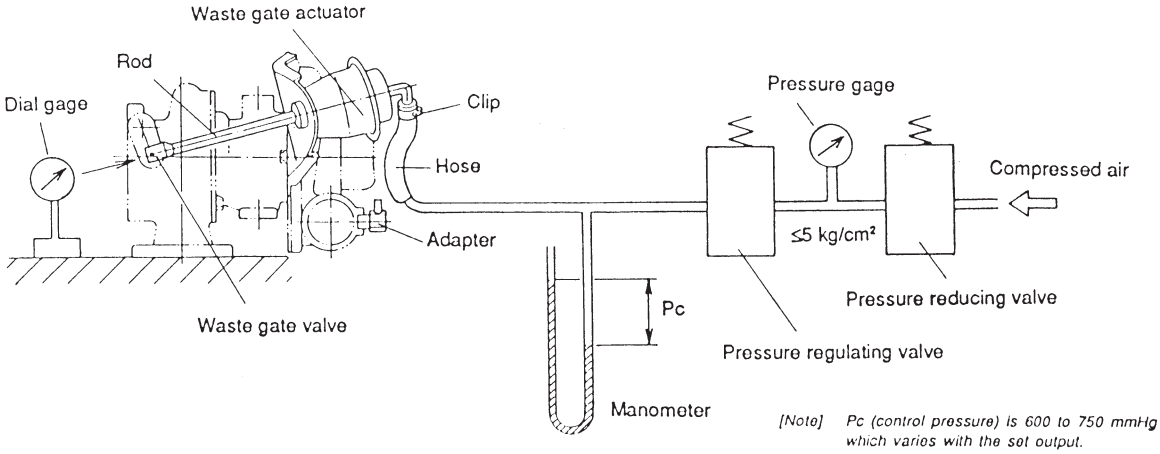
*[Note] If the adjustment is impossible, leave off inner parts replacement but replace the whole turbocharger ass'y.*

(1) Checking the waste gate valve pressure and lift characteristics

1. Equipment
   Prepare the equipment shown in the figure below.

2. Measuring instruments and devices

| | |
|---|---|
| Dial gage | Capable of measuring 0 to10 mm (A flat head type is desirable.) |
| Manometer | Either mercury column or electric type (capable of measuring 0 to 1500 mmHg) |
| Pressure regulating valve | Capable of gradually adjusting in a range between 0 and 2 kg/cm² (for controlling the pressure applied to the waste gate actuator) |
| Pressure reducing valve | Used for suppressing the air supply pressure at 5 kg/cm² or less |
| Pressure gage | Bourdon tube pressure gage (0 to 10 kg/cm²) |




*[Note] Pc (control pressure) is 600 to 750 mmHg which varies with the set output.*

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3. Check method
   ① Set the manometer control pressure (Pc) applied to the waste gate actuator to 0 and set the dial gage to the zero point.

   ② Gradually open the pressure regulating valve and measure the Pc value when the actuator rod is operated by 2 mm.

   ③ For the hysteresis, let the rod move to 3 mm first. Then gradually close the pressure regulating valve, measure the pressure when the rod is moved to 2 mm and obtain the difference from the pressure measured in ② above.

4. Precautions
   ① Set the dial gage on the extension line of the actuator rod.

   ② The piping and joints shall completely be free from leak.

   ③ Fix the turbocharger and dial gage securely.

   ④ An electric manometer, if used, shall have sufficient precision.

   ⑤ Even when an electric manometer is used, preparation of a mercury column type manometer is recommended for calibration and daily check.

   ⑥ The speed for increasing/decreasing Pc by means of the pressure regulating valve shall be very slow near the measuring point. If the 2 mm position is exceeded, restart from the beginning.

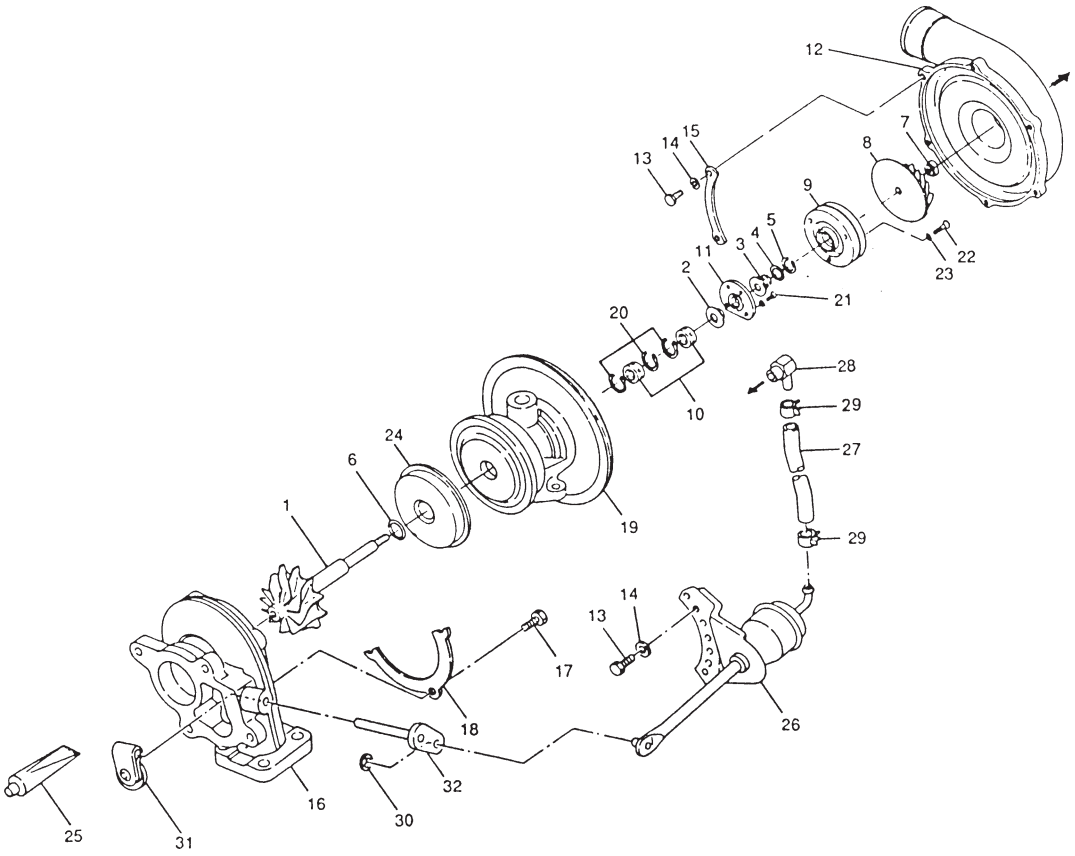
   ⑦ Do not apply over 5 kg/cm$^2$ to the actuator.

(2) Waste gate actuator leak test
Apply 1.2 kg/cm$^2$ to the actuator and hold the state for 1 minute. The actuator is good if the pressure then is 1.1 kg/cm$^2$ or more.

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# 14-4. Exploded View of Turbocharger (w/Waste Gate)




| No. | Part name | No. | Part name |
|---|---|---|---|
| 1 | Turbine shaft | 17 | Bolt |
| 2 | Thrust bushing | 18 | Lock plate |
| 3 | Oil thrower | 19 | Bearing housing |
| 4 | Seal ring | 20 | Retaining ring |
| 5 | Seal ring | 21 | Screw |
| 6 | Seal ring (turbine side) | 22 | Screw |
| 7 | Lock nut | 23 | Lock washer |
| 8 | Impeller | 24 | Heat protector |
| 9 | Seal plate | 25 | Liquid gasket |
| 10 | Journal bearing | 26 | Waste gate actuator |
| 11 | Thrust bearing | 27 | Hose |
| 12 | Compressor housing | 28 | Adapter |
| 13 | Flanged bolt | 29 | Clip |
| 14 | Spring washer | 30 | Retaining ring |
| 15 | Clamp | 31 | Waste gate valve |
| 16 | Turbine housing | 32 | Link plate |

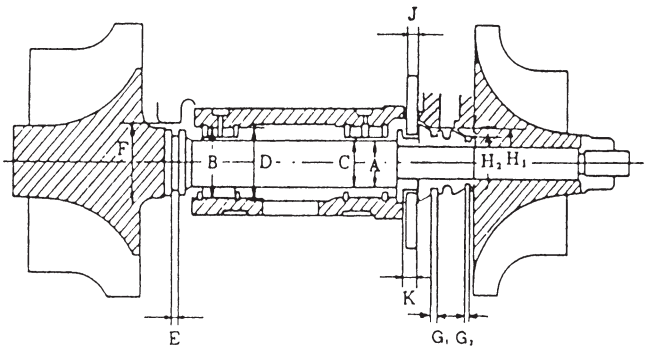
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## 14-5. Tightening Torque

| Part No. | Part name | Size | Tightening torque (kg-cm) | |
|---|---|---|---|---|
| | | | RHB31 | RHB51 |
| 7 | Lock nut | — | 9 ~ 11 | 18 ~ 22 |
| 13 | Flanged bolt | M5 | 40 ~ 50 | ← |
| 17 | Bolt | M6 | 120 ~ 130 | 120 ~130 |
| | | M8 | | 275 ~ 295 |
| 21 | Screw | M3 | 12 ~ 14 | ← |
| 22 | Screw | M3 | 12 ~ 14 | ← |

## 14-6. Service Standards




Unit: mm

| | | Standard dimension | | Wear limit | |
|---|---|---|---|---|---|
| | | RHB31 | RHB51 | RHB31 | RHB51 |
| Turbine shaft | Turbine shaft journal outside diameter (A) | 6.257 ~ 6.263 | 7.99 ~ 8.00 | 6.25 | 7.98 |
| | Turbine shaft seal ring groove width (E) | 1.038 ~ 1.062 | 1.25 ~ 1.28 | 1.07 | 1.29 |
| | Compressor side seal ring groove width ($G_1$) | 1.02 ~ 1.03 | 1.22 ~ 1.23 | 1.04 | 1.31 |
| | Compressor side seal ring groove width ($G_2$) | 0.82 ~ 0.83 | 1.02 ~ 1.03 | 0.84 | 1.11 |
| | Turbine shaft runout | 0.002 | 0.002 | 0.005 | 0.011 |
| Bearing | Journal bearing inside diameter (C) | 6.275 ~ 6.285 | 8.01 ~ 8.03 | 6.29 | 8.04 |
| | Journal bearing outside diameter (D) | 9.940 ~ 9.946 | 12.32 ~ 12.33 | 9.93 | 12.31 |
| | Bearing housing inside diameter (B) | 9.995 ~ 10.005 | 12.40 ~ 12.41 | 10.01 | 12.42 |
| Thrust bearing | Thrust bearing width (J) | 3.59 ~ 3.61 | 3.99 ~ 4.01 | 3.58 | 3.98 |
| | Thrust bushing groove dimension (K) | 3.632 ~3.642 | 4.04 ~ 4.05 | 3.65 | 4.07 |
| Seal ring fixing area | Turbine side (bearing housing) (F) | 11.00 ~ 11.018 | 15.00 ~ 15.02 | 11.03 | 15.05 |
| | Compressor side (seal ring) ($H_1$) | 9.987 ~ 10.025 | 12.40 ~ 12.42 | 10.04 | 12.45 |
| | Compressor side (seal ring) ($H_2$) | 7.968 ~ 8.00 | 10.00 ~ 10.02 | 8.01 | 10.05 |
| Rotor play in axial direction | | 0.022 ~ 0.053 | 0.03 ~ 0.06 | 0.07 | 0.09 |
| Rotor play in radial direction | | 0.061 ~ 0.093 | 0.08 ~0.13 | 0.12 | 0.17 |

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# 15. Service Information for CARB ULG regulation

## Introduction

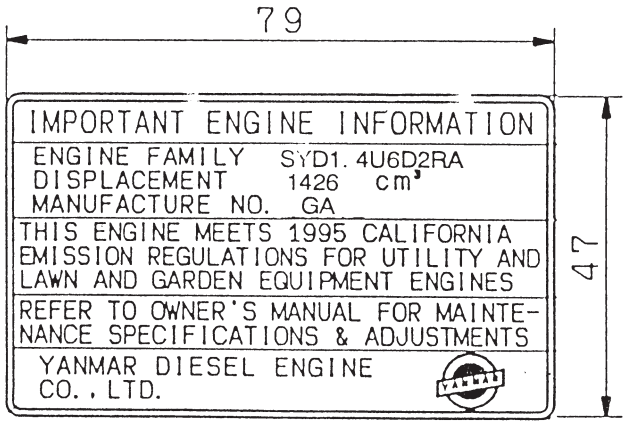
This chapter describes only the items designated as special specifications for servicing the TNE engine under 25 HP that complies with CARB ULG regulation (Regulation for small Utility engines and Lawn & Garden from California Air Resource Board, effects to the engines manufactured on Jan. 1st 1995 and later).

## 15-1. Emission control label

### 15-1-1. Content of the label

Size and contents of the label are as shown below.

**[ Example ]**



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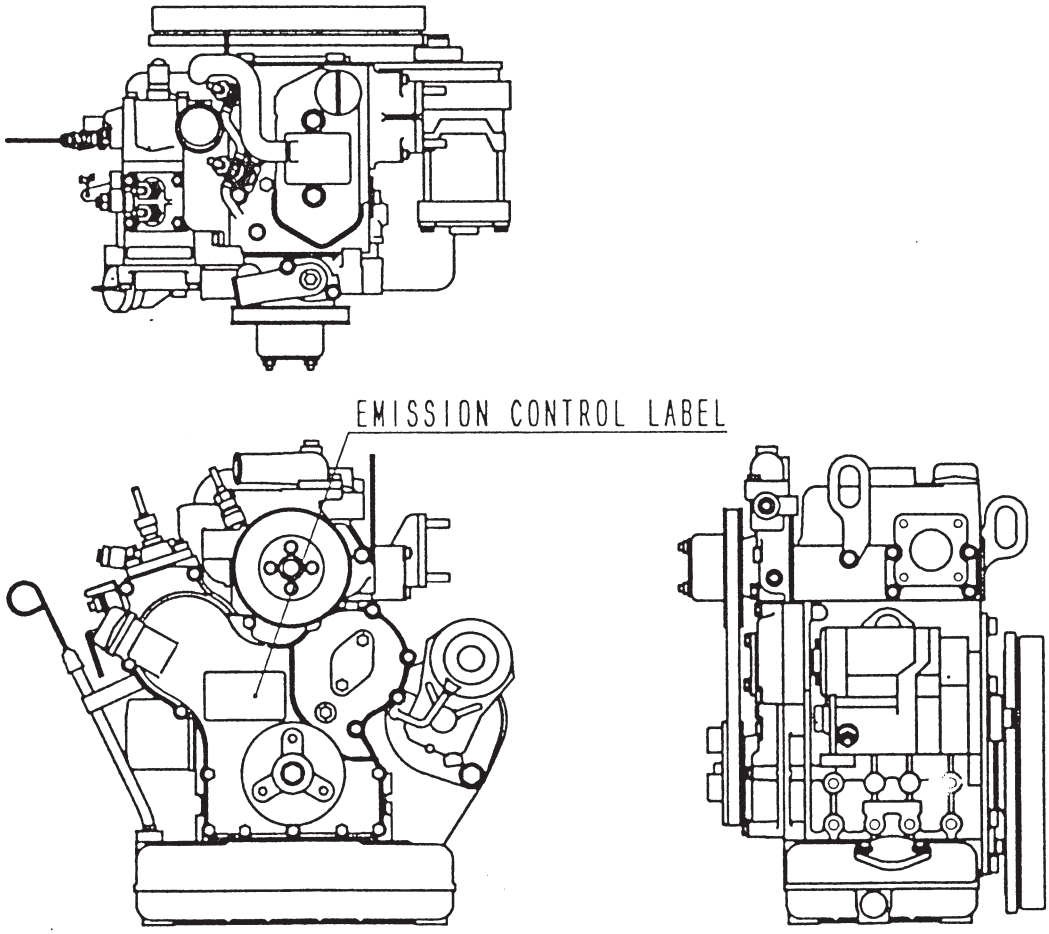
## 15-1-2. Location of the label

The locations of the label are three types A, B, and C, where the applicable engine families and engine models are as shown in the table below.

| Location of the labels | No. | Engine family name for certification | Engine model in Yanmar |
|---|---|---|---|
| A | 1 | SYD493U6D2RA | 2TN66C, 2TNE66KC |
| | 2 | SYD739U6D2RA | 3TN66C, 3TNE66KC |
| | 3 | SYD784U6D2RA | 3TNE68C |
| | 4 | SYD1.0U6D2RA | 3TNA72C/3TNE74C<br>3TNE72KC |
| B | 5 | SYD1.3U6D2RA | 3TNE78AC/3TNE82AC |
| | 6 | SYD1.4U6D2RA | 3TNE82C |
| | 7 | SYD1.6U6D2RA | 3TNE84C/3TNE88C |
| | 8 | SYD1.5U6D2RA | 3TNE84TC |
| C | 9 | SYD1.9U6D2RA | 4TNE82C |
| | 10 | SYD2.2U6D2RA | 4TNE84C/4TNE88C |

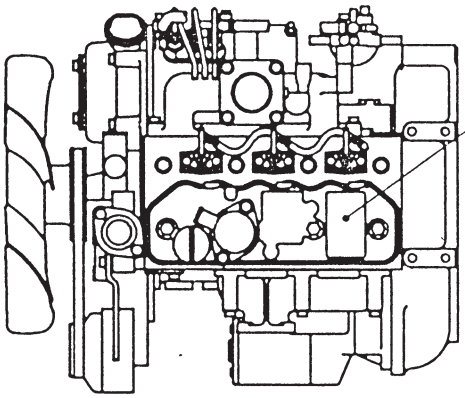
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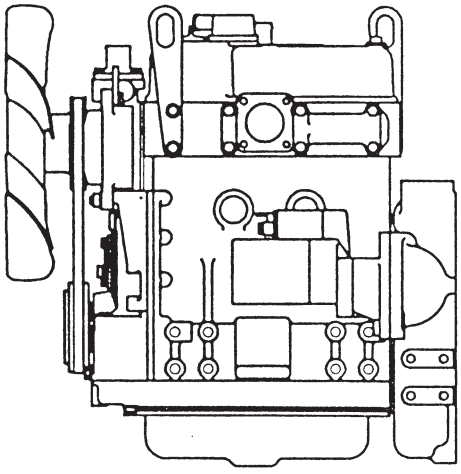
## Location: A

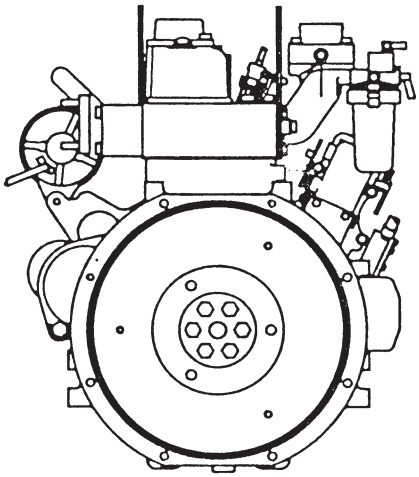


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## Location: B

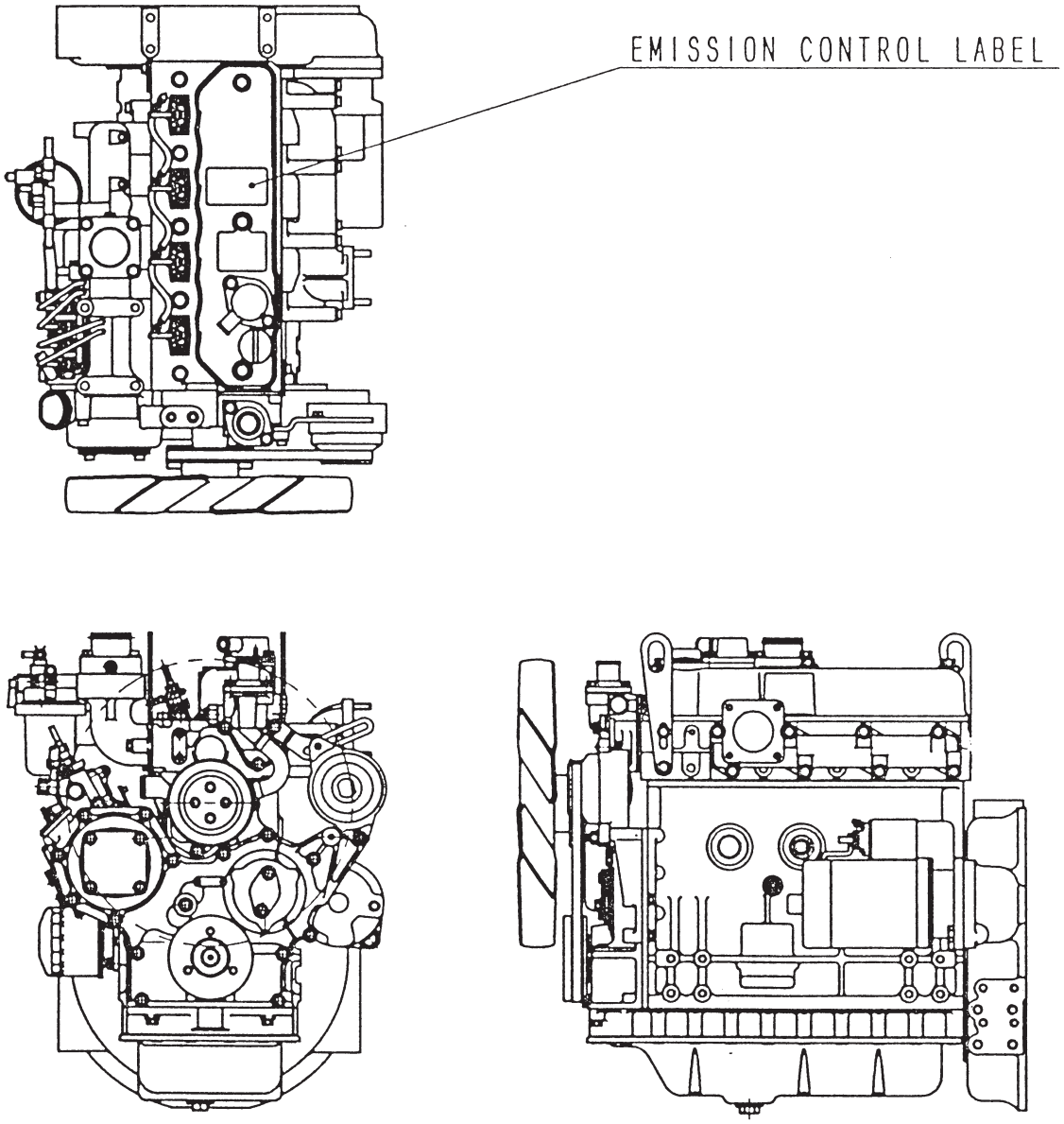




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## Location: C



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# 15-2 Limiting the high idle and low idle adjustment screw

## 15-2.1 High idle speed

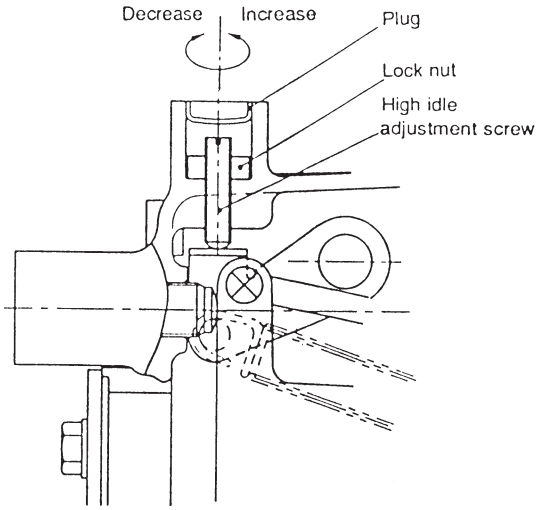
(1) First warm up the engine. Then, gradually increase the engine speed up to the high idle speed (Refer to Chapter 1, Specifications and Performance).

(2) If the present high idle speed differ from the specified one, adjust the high idle speed using the high idle adjustment screw.

(3) After locking the adjustment screw with the lock nut by using the special tool, insert the plug firmly to prevent re-adjustment and oil leakage.

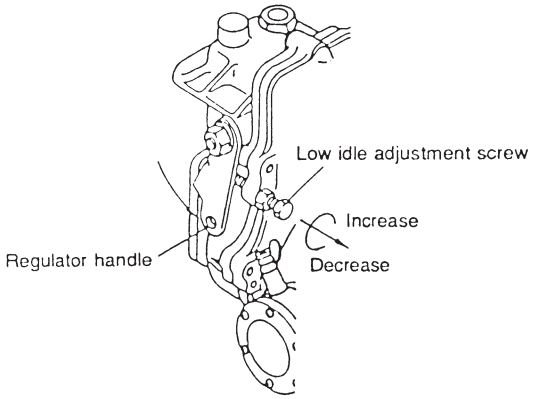
**1: Do not adjust the high idle adjustment screw unless necessary.*

**2: The illustration shows the partial perspective view of the governor for the direct injection system.*




## 15-2.2 Low idle speed

After warming up the engine, set the low idling speed (Refer to Chapter 1, Specifications and Performance) by turning the low idle adjustment screw.



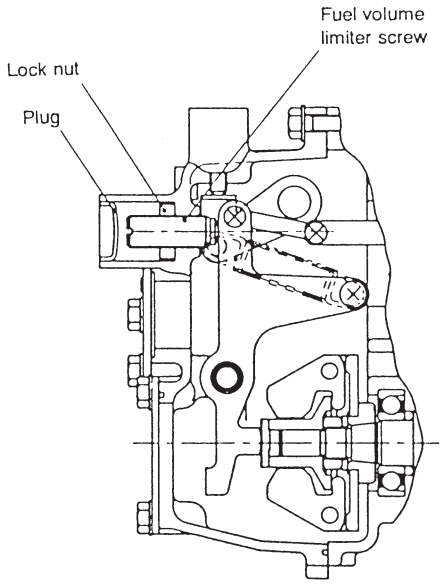
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## 15-3 Limiting the fuel volume limiter screw

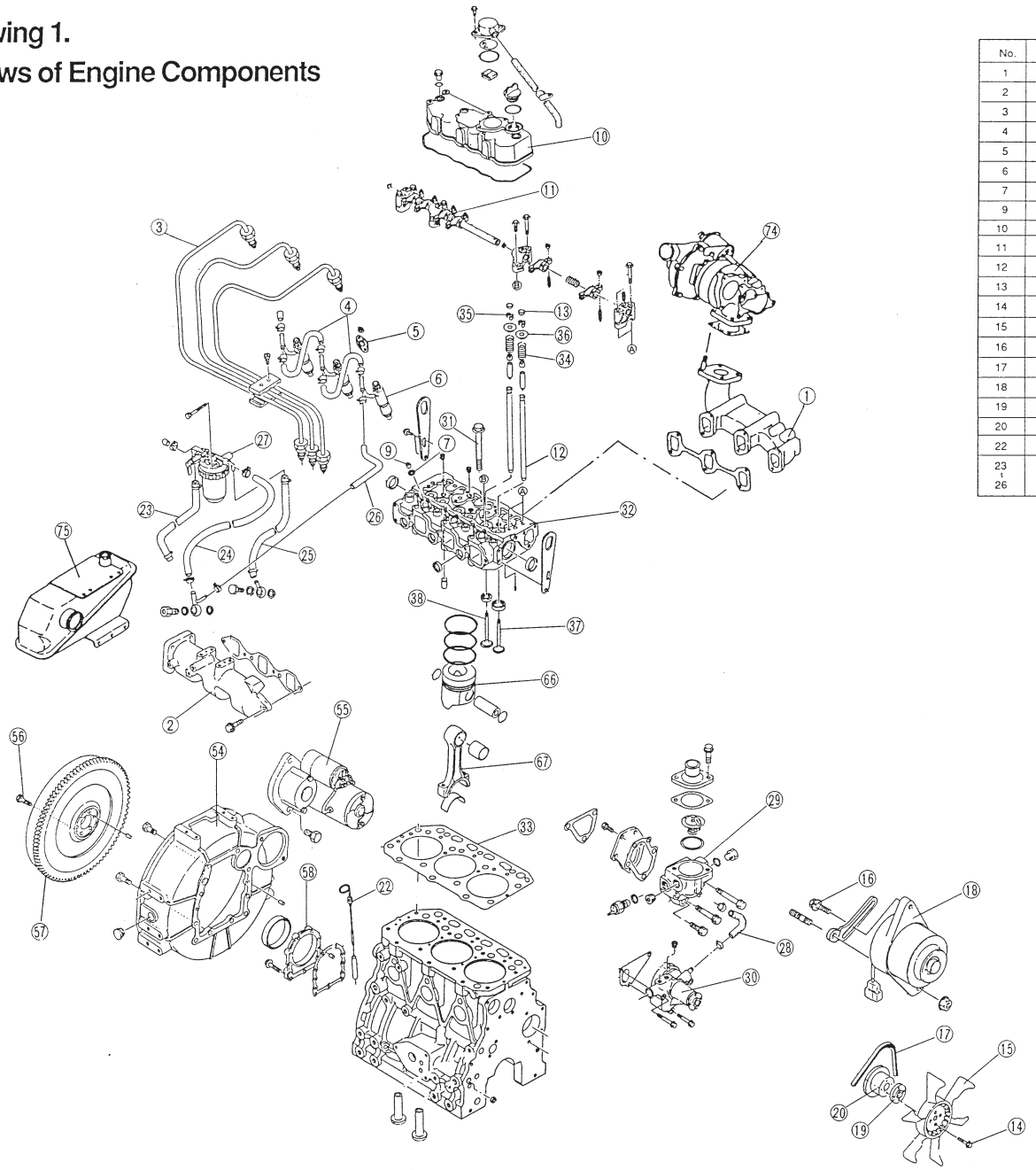
1) After limiting the fuel volume, lock the fuel volume limiter screw with the lock nut by using the special tool.

2) Then, insert the plug firmly to prevent re-adjustment and oil leakage.

***: Do not adjust the fuel volume limiter screw unless necessary.***



# Attached Drawing 1.
## Exploded Views of Engine Components

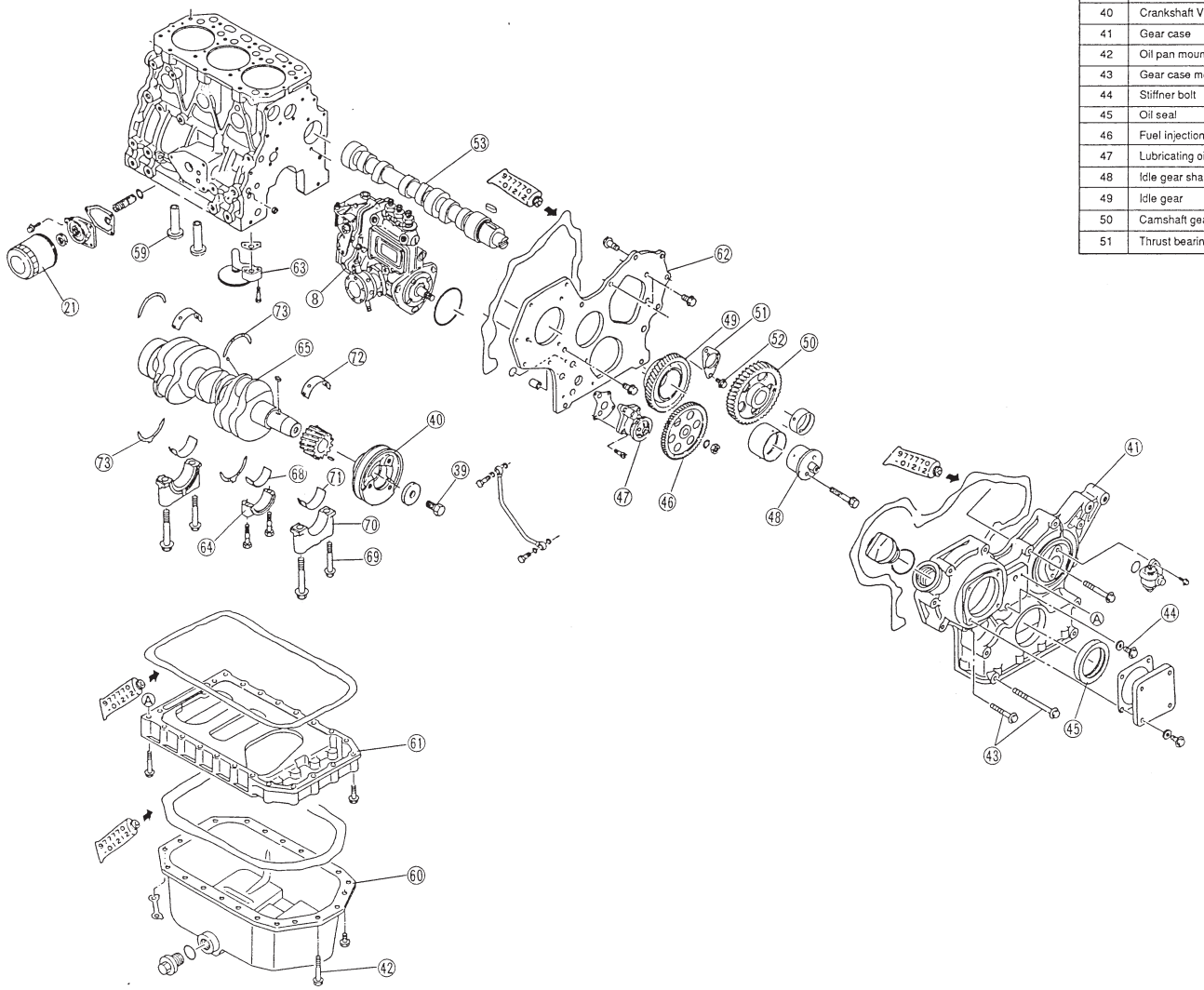


| No. | Engine Component | No. | Engine Component |
|---|---|---|---|
| 1 | Exhaust manifold | 27 | Fuel filter |
| 2 | Intake manifold | 28 | Cooling water pipe |
| 3 | High-pressure fuel pipe | 29 | Thermostat assembly |
| 4 | Fuel return pipe | 30 | Cooling water pump |
| 5 | Fuel injection nozzle retainer | 31 | Cylinder head tightening bolt |
| 6 | Fuel injection nozzle | 32 | Cylinder head assembly |
| 7 | Nozzle seat | 33 | Cylinder head gasket |
| 9 | Nozzle protector | 34 | Valve spring |
| 10 | Bonnet assembly | 35 | Valve cotter |
| 11 | Valve rocker arm shaft assembly | 36 | Valve retainer |
| 12 | Push rod | 37 | Intake valve |
| 13 | Valve cap | 38 | Exhaust valve |
| 14 | Fan mounting bolt | 54 | Flywheel housing |
| 15 | Fan | 55 | Starting motor |
| 16 | Adjusting bolt | 56 | Flywheel mounting bolt |
| 17 | V-belt | 57 | Flywheel |
| 18 | Alternator | 58 | Oil seal case |
| 19 | Spacer | 66 | Piston |
| 20 | V-pulley | 67 | Connecting rod |
| 22 | Dipstick | 74 | Turbocharger (3TNE84T, 4TNE84T) |
| 23 ~ 26 | Fuel return pipe | 75 | Surge tank (3TNE84T) |



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# Attached Drawing 2.
## Exploded Views of Engine Components



| No. | Engine Component | No. | Engine Component |
|---|---|---|---|
| 8 | Fuel injection pump | 52 | Mounting bolt |
| 21 | Oil filter assembly | 53 | Camshaft assembly |
| 39 | V-pulley clamping bolt | 59 | Tappet |
| 40 | Crankshaft V-pulley | 60 | Oil pan |
| 41 | Gear case | 61 | Spacer |
| 42 | Oil pan mounting bolt | 62 | Gear case flange |
| 43 | Gear case mounting bolt | 63 | Lubricating oil strainer |
| 44 | Stiffner bolt | 64 | Crank pin side cap |
| 45 | Oil seal | 65 | Crankshaft |
| 46 | Fuel injection pump drive gear | 68 | Crank pin metal |
| 47 | Lubricating oil pump | 69 | Main bearing cap bolt |
| 48 | Idle gear shaft | 70 | Main bearing cap |
| 49 | Idle gear | 71 | Lower main bearing metal |
| 50 | Camshaft gear | 72 | Upper main bearing metal |
| 51 | Thrust bearing | 73 | Thrust metal |

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TNV

M9961-02E050

# YANMAR

# SERVICE MANUAL

## INDUSTRIAL DIESEL ENGINE

## 3TNV·4TNV series

(Direct Injection System)

**MODEL** 3TNV82A
3TNV84(T)
4TNV84(T)
3TNV88
4TNV88
4TNV94L
4TNV98(T)
4TNV106(T)

YANMAR CO.,LTD.

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| | | | Publication No. | M9961-02E050 | |
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M9961-02E050

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# PREFACE

This manual describes the service procedures for the TNV series engines of indirect injection system that have been certified by the US EPA, California ARB and/or the 97/68/EC Directive for industrial use.

Please use this manual for accurate, quick and safe servicing of the said engine. Since the explanation in this manual assumes the standard type engine, the specifications and components may partially be different from the engine installed on individual work equipment (power generator, pump, compressor, etc.). Please also refer to the service manual for each work equipment for details.

The specifications and components may be subject to change for improvement of the engine quality without notice. If any modification of the contents described herein becomes necessary, it will be notified in the form of correction information each time.

## California Proposition 65 Warning

**Diesel engine exhaust and some of its constituents are known to the State of**

## California Proposition 65 Warning

**Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.**
**Wash hands, after handling.**

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# SAFETY LABELS

- Most accidents are caused by negligence of basic safety rules and precautions. For accident prevention, it is important to avoid such causes before development to accidents.
  Please read this manual carefully before starting repair or maintenance to fully understand safety precautions and appropriate inspection and maintenance procedures.
  Attempting at a repair or maintenance job without sufficient knowledge may cause an unexpected accident.

- It is impossible to cover every possible danger in repair or maintenance in the manual. Sufficient consideration for safety is required in addition to the matters marked ⚠ CAUTION. Especially for safety precautions in a repair or maintenance job not described in this manual, receive instructions from a knowledgeable leader.

- Safety marks used in this manual and their meanings are as follows:

**⚠ DANGER** — **DANGER**-indicates an imminently hazardous situation which, if not avoided, WILL result in death or serious injury.

**⚠ WARNING** — **WARNING**-indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

**⚠ CAUTION** — **CAUTION**-indicates a potentially hazardous situation which, if not avoided, MAY result in minor or moderate injury.

- **NOTICE**-indicates that if not observed, the product performance or quality may not be guaranteed.

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# Safety Precautions

## (1) SERVICE AREA

**⚠ WARNING**



### •Sufficient Ventilation

Inhalation of exhaust fumes and dust particles may be hazardous to ones health. Running engines welding, sanding, painting, and polishing tasks should be only done in well ventilated areas.

**⚠ CAUTION**

### •Safe / Adequate Work Area

The service area should be clean, spacious, level and free from holes in the floor, to prevent “slip” or “trip and fall” type accidents.

**⚠ CAUTION**



### •Bright, Safely Illuminated Area

The work area should be well lit or illuminated in a safe manner. For work in enclosed or dark areas, a “drop cord” should be utilized. The drop cord must have a wire cage to prevent bulb breakage and possible ignition of flammable substances.

**⚠ CAUTION**



### •Safety Equipment

Fire extinguisher(s), first aid kit and eye wash / shower station should be close at hand (or easily accessible) in case of an emergency.

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## (2) WORK – WEAR (GARMENTS

**⚠ CAUTION**




### •Safe Work Clothing

Appropriate safety wear (gloves, special shoes/boots, eye/ear protection, head gear, harness', clothing, etc.) should be used/worn to match the task at hand. Avoid wearing jewelry, unbuttoned cuffs, ties or loose fitting clothes around moving machinery. A serious accident may occur if caught in moving/ rotating machinery.

## (3) TOOLS

**⚠ WARNING**

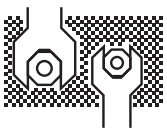
### •Appropriate Lifting / Holding

When lifting an engine, use only a lifting device (crane, jack, etc.) with sufficient lifting capacity. Do not overload the device. Use only a chain, cable, or lifting strap as an attaching device. Do not use rope, serious injury may result.

To hold or support an engine, secure the engine to a support stand, test bed or test cart designed to carry the weight of the engine. Do not overload this device, serious injury may result.

Never run an engine without being properly secured to an engine support stand, test bed or test cart, serious injury may result.

**⚠ CAUTION**

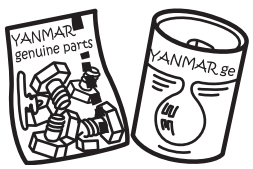


### •Appropriate Tools

Always use tools that are designed for the task at hand. Incorrect usage of tools may result in damage to the engine and or serious personal injury.

## (4) GENUINE PARTS and MATERIALS

**⚠ CAUTION**



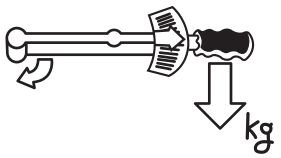

### •Genuine Parts

Always use genuine YANMAR parts or YANMAR recommended parts and goods. Damage to the engine, shortened engine life and or personal injury may result.

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## (5) FASTENER TORQUE

**⚠ WARNING**

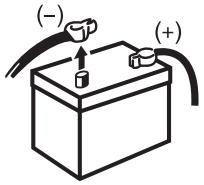



### •Torquing Fasteners

Always follow the torque values and procedures as designated in the service manual. Incorrect values, procedures and or tools may cause damage to the engine and or personal injury.

## (6) ELECTRICAL

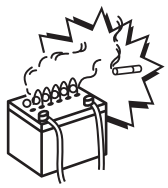
**⚠ WARNING**




### •Short Circuits

Always disconnect the (-) Negative battery cable before working on the electrical system. An accidental “short circuit” may cause damage, fire and or personal injury. Remember to connect the (-) Negative battery cable (back onto the battery) last.
Fasten the terminals tightly.

**⚠ WARNING**



### •Charging Batteries

Charging wet celled batteries produces hydrogen gas. Hydrogen gas is extremely explosive. Keep sparks, open flame and any other form of ignition away. Explosion may occur causing severe personal injury.

**⚠ WARNING**



### •Battery Electrolyte

Batteries contain sulfuric acid. Do NOT allow it to come in contact with clothing, skin and or eyes, severe burns will result.

## (7) WASTE MANAGEMENT

**⚠ CAUTION**

Observe the following instructions with regard to hazardous waste disposal. Negligence of these will have a serious impact on environmental pollution concerns.

1)Waste fluids such as lube oil, fuel and coolant shall be carefully put into separate sealed containers and disposed of properly.

2)Do NOT dispose of waste materials irresponsibly by dumping them into the sewer, overland or into natural waterways.

3)Waste materials such as oil, fuel, coolant, solvents, filter elements and batteries, must be disposed of properly according to local ordinances. Consult the local authorities or reclamation facility.

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## (8) FURTHER PRECAUTIONS

**⚠ WARNING**



### •Fueling / Refueling

Keep sparks, open flames or any other form of ignition (match, cigarette, etc.) away when fueling/refueling the unit. *Fire and or an explosion may result.*

**⚠ WARNING**



### •Hot Surfaces.

Do NOT touch the engine (or any of its components) during running or shortly after shutting it down. *Scalding / serious burns may result.* Allow the engine to cool down before attempting to approach the unit.

**⚠ WARNING**



### •Rotating Parts

Be careful around moving/rotating parts. Loose clothing, jewelry, ties or tools may become entangled causing damage to the engine and or severe personal injury.

**⚠ WARNING**



### •Preventing burns from scalding

1)Never open the radiator filler cap shortly after shutting the engine down.
Steam and hot water will spurt out and seriously burn you. Allow the engine to cool down before attempt to open the filler cap.

2)Securely tighten the filler cap after checking the radiator.
Steam can spurt out during engine running, if tightening loose.

# Precautions for Service Work

## (1) Precautions for Safety

Read the safety precautions given at the beginning of this manual carefully and always mind safety in work.

## (2) Preparation for Service Work

Preparation is necessary for accurate, efficient service work. Check the customer ledger file for the history of the engine.

- Preceding service date
- Period/operation hours after preceding service
- Problems and actions in preceding service
- Replacement parts expected to be required for service
- Recording form/check sheet required for service

## (3) Preparation before Disassembly

- Prepare general tools, special service tools, measuring instruments, oil, grease, nonreusable parts, and parts expected to be required for replacement.
- When disassembling complicated portions, put match-marks and other marks at places not adversely affecting the function for easy reassembly.

## (4) Precautions in Disassembly

- Each time a parts is removed, check the part installed state, deformation, damage, roughening, surface defect, etc.
- Arrange the removed parts orderly with clear distinction between those to be replaced and those to be used again.
- Parts to be used again shall be washed and cleaned sufficiently.
- Select especially clean locations and use clean tools for disassembly of hydraulic units such as the fuel injection pump.

## (5) Precautions for Inspection and Measurement

Inspect and measure parts to be used again as required to determine whether they are reusable or not.

## (6) Precautions for Reassembly

- Reassemble correct parts in correct order according to the specified standards (tightening torques, and adjustment standards). Apply oil important bolts and nuts before tightening when specified.
- Always use genuine parts for replacement.
- Always use new oil seals, O-rings, packing and cotter pins.
- Apply sealant to packing depending on the place where they are used. Apply of grease to sliding contact portions, and apply grease to oil seal lips.

## (7) Precautions for Adjustment and Check

Use measuring instruments for adjustment to the specified service standards.

# How to Read this Manual

## (1) Range of Operation Explanation

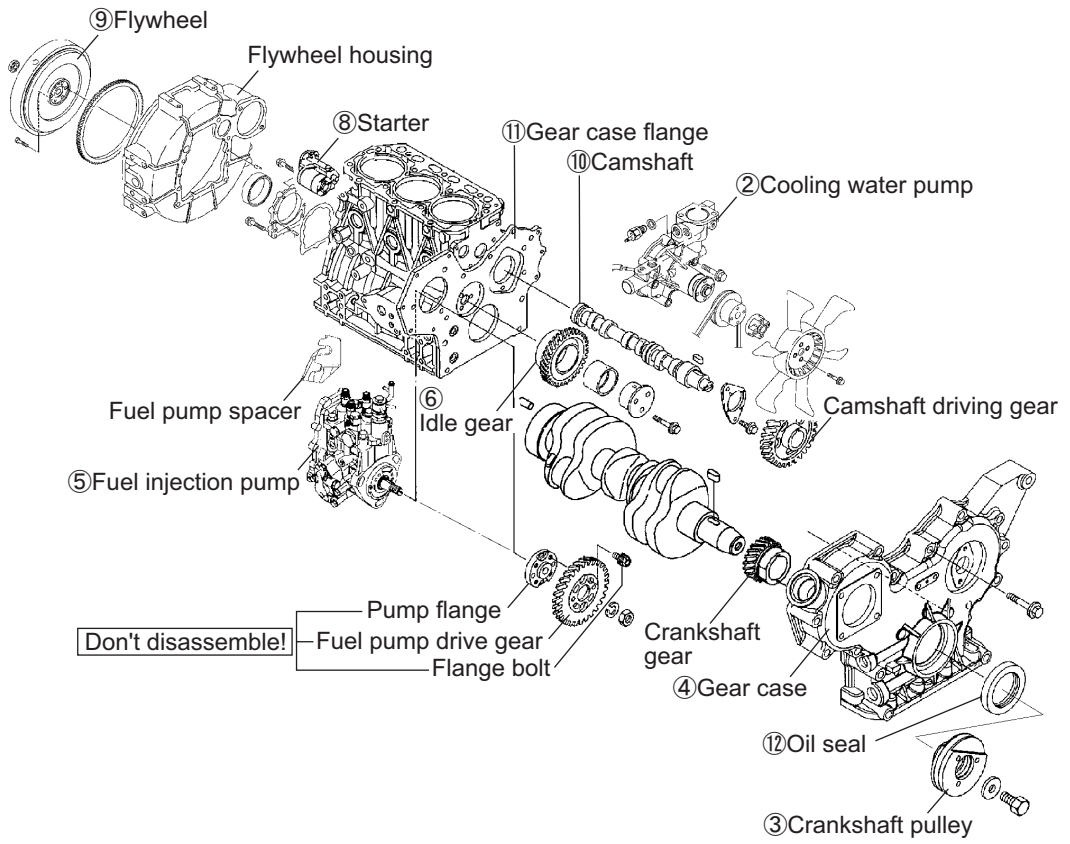
This manual explains the troubleshooting, installation/removal, replacement, disassemble/reassembly, inspection, adjustment and adjusting operation procedures for the TNV series engines with direct injection system.

Refer to the manufacturer’s manual for each of the fuel injection pump, governor, starting motor and alternator except for their installation.

## (2) How to Read the Explanations

- An exploded view, sectional views, a system diagram, etc. are shown at the beginning of each section as required for easy understanding of the mounted states of the components.
- For the removal/installation of each part, the procedure is shown with the procedural step No. in the illustration.
- Precautions and key points for disassembly and reassembly of parts are described as **points**. In the explanation for each point, detailed operation method, information, standard and precautions are described.

**Description Example**




Note) This figure shows the 3TNV84.

The job contents are described in the disassembly procedure for Nos. not shown in the illustration.

- Disassembly procedure

1)Follow steps (1) to (15) of the cylinder head disassembly procedure.
2)Remove the cooling water pump.
3)Remove the crankshaft pulley. (**Point 1**) ← Operation point to be explained on a later page.

- Operation points

Disassemble: Service point for removal
Reassemble: Service point for installation
Disassemble-Reassemble: Service point required in both removal and installation.

• Contents omitted in this manual

Though the following jobs are omitted in the explanation in this manual, they should be conducted in actual work:

3)Jacking up and lifting

4)Cleaning and washing of removed parts as required

5)Visual inspection

## (3) Definition of Terms

[NOTICE]: Instruction whose negligence is very likely to cause an accident. Always observe it.

Standard: Allowable range for inspection and adjustment.

Limit: The maximum or minimum value that must be satisfied during inspection or adjustment.

## (4) Abbreviations

| Abbreviation | Meaning | Abbreviation | Meaning |
|---|---|---|---|
| Assy | assembly | T.D.C. | top dead center |
| Sub-Assy | sub-assembly | B.D.C. | bottom dead center |
| a.T.D.C | after top dead center | OS | oversize |
| b.T.D.C | before top dead center | US | undersize |
| STD | Standard | $Min^{-1}$ | revolutions per minute |
| IN | Intake | PS | Output (metric horsepower) |
| EX | Exhaust | T | Bolt/nut tightening torque |

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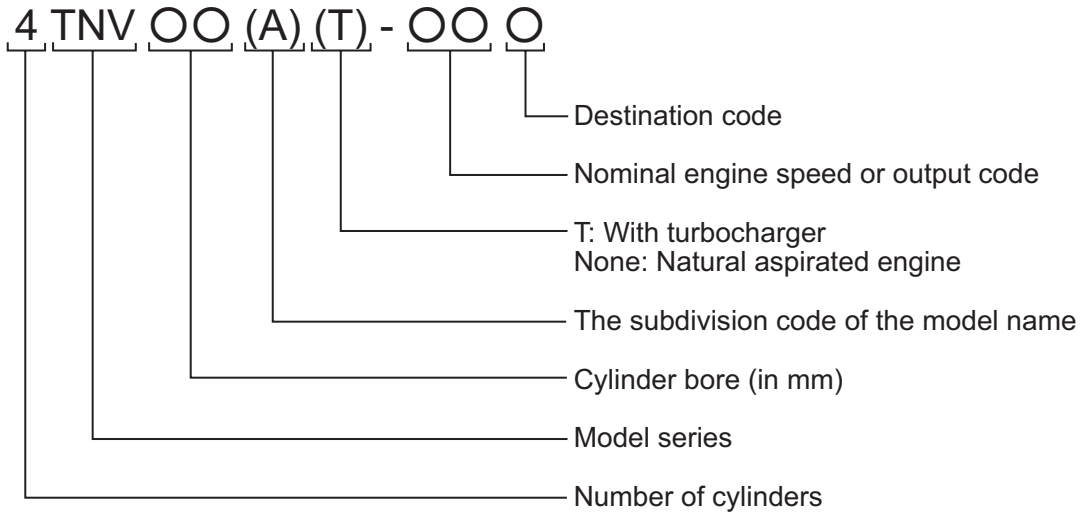
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# 1. General

## 1.1 Engine nomenclature




The engine specification class

| Classification | Load | Engine speed | Available engine speed ($min^{-1}$) |
|---|---|---|---|
| CL | Constant load | Constant speed | 1500/1800 |
| VM | Variable load | Variable speed | 2000-3000 |

※ The engine specification class (CL or VM) is described in the specifications table.

## 1.2 Specifications

NOTE:

1)The information described in the engine specifications tables (the next page and after) is for "standard" engine. To obtain the information for the engine installed in each machine unit, refer to the manual provided by the equipment manufacturer.

2)Engine rating conditions are as follows (SAE J1349, ISO 3046/1)

- Atmospheric condition: Room temp. 25 °C, Atmospheric press. 100 kPa (750 mm Hg), Relative humidity 30 %
- Fuel temp: 25 °C (Fuel injection pump inlet)
- With cooling fan, air cleaner, exhaust silencer (Yanmar standard parts)
- After running-in hours. Output allowable deviation: ± 3 %

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## (1) 3TNV82A

| Engine name | | Unit | 3TNV82A | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | | VM | | | | | | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | | | | | | |
| Combustion chamber | | - | Direct injection | | | | | | | | |
| Number of cylinders | | - | 3 | | | | | | | | |
| Cylinder bore × stroke | | mm × mm | 82 × 84 | | | | | | | | |
| Displacement | | L | 1.331 | | | | | | | | |
| Continuous rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | | | | | | |
| | Output | kW (ps) | 9.9 (13.5) | 12.0 (16.3) | - | | | | | | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 | 2400 | 2500 | 2600 | 2800 | 3000 |
| | Output | kW (ps) | 11.0 (14.9) | 13.2 (17.9) | 14.6 (19.9) | 16.0 (21.8) | 17.5 (23.8) | 18.2 (24.8) | 19.0 (25.8) | 20.4 (27.8) | 21.9 (29.8) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | 2180 | 2375 | 2570 | 2675 | 2780 | 2995 | 3180 |
| Ignition order | | - | 1-3-2-1 (No.1 cylinder on flywheel side) | | | | | | | | |
| Power take off | | - | Flywheel | | | | | | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | | | | | | |
| Cooling system | | - | Radiator | | | | | | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | | | | | | |
| Starting system | | - | Electric | | | | | | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.45 min.) | | | | | | | | |
| Applicable lubricant | | - | API grade class CD or CF | | | | | | | | |
| Lubricant capacity (oil pan) * | Total | L | 5.5 | | | | | | | | |
| | Effective | L | 1.9 | | | | | | | | |
| Cooling water capacity (engine only) | | L | 1.8 | | | | | | | | |
| Engine Dimensions ** (with flyw Crankshaft V pulley diameter & heel housing) * | Overall length | mm | 553 | | 528 | | | | | | |
| | Overall width | mm | 489 | | | | | | | | |
| | Overall height | mm | 565 | | | | | | | | |
| Engine mass (dry) *,** (with flywheel housing) | | kg | 138 | | 128 | | | | | | |
| Cooling fan (std.) * | | mm | 335 mm O/D, 6 blades pusher type F | | | | | | | | |
| Fun V pulley diameter (std.) * | | mm | 120 × 90 | | 110 × 110 | | | | | | |

* Items marked * may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

https://truckmanualshub.com/



## (2) 3TNV84

| Engine name | | Unit | 3TNV84 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | VM | | | | | | | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | | | | | | |
| Combustion chamber | | - | Direct injection | | | | | | | | |
| Number of cylinders | | - | 3 | | | | | | | | |
| Cylinder bore × stroke | | mm × mm | 84 × 90 | | | | | | | | |
| Displacement | | L | 1.496 | | | | | | | | |
| Continuous rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | | | | | | |
| | Output | kW (ps) | 11.3 (15.3) | 13.5 (18.3) | - | | | | | | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 | 2400 | 2500 | 2600 | 2800 | 3000 |
| | Output | kW (ps) | 12.4 (16.8) | 14.8 (20.1) | 16.4 (22.3) | 18.1 (24.6) | 19.7 (26.8) | 20.5 (27.9) | 21.3 (29.0) | 23.0 (31.3) | 24.6 (33.5) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | 2180 | 2400 | 2590 | 2690 | 2810 | 2995 | 3210 |
| Ignition order | | - | 1-3-2-1 (No.1 cylinder on flywheel side) | | | | | | | | |
| Power take off | | - | Flywheel | | | | | | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | | | | | | |
| Cooling system | | - | Radiator | | | | | | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | | | | | | |
| Starting system | | - | Electric | | | | | | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.45 min.) | | | | | | | | |
| Applicable lubricant | | - | API grade class CD | | | | | | | | |
| Lubricant capacity (oil pan) * | Total | L | 6.7 | | | | | | | | |
| | Effective | L | 2.8 | | | | | | | | |
| Cooling water capacity (engine only) | | L | 2.0 | | | | | | | | |
| Engine dimensions ** (with flywheel housing) * | Overall length | mm | 589 | 564 | | | | | | | |
| | Overall width | mm | 486 | | | | | | | | |
| | Overall height | mm | 622 | | | | | | | | |
| Engine mass (dry) *,** (with flywheel housing) | | kg | 161 | 155 | | | | | | | |
| Cooling fan (std.) * | | mm | 335 mm O/D, 6 blades pusher type F | | | | | | | | |
| Crankshaft V pulley diameter & Fun V pulley diameter (std.) * | | mm | 120 × 90 | 110 × 110 | | | | | | | |

* Items marked * may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

https://truckmanualshub.com/



## (3) 3TNV84T

| Engine name | | Unit | 3TNV84T | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | VM | | | | | | | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | | | | | | |
| Combustion chamber | | - | Direct injection | | | | | | | | |
| Number of cylinders | | - | 3 | | | | | | | | |
| Cylinder bore × stroke | | mm × mm | 84 × 90 | | | | | | | | |
| Displacement | | L | 1.496 | | | | | | | | |
| Continuous rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | | | | | | |
| | Output | kW (ps) | 14.0 (19.0) | 16.5 (22.5) | - | | | | | | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 | 2400 | 2500 | 2600 | 2800 | 3000 |
| | Output | kW (ps) | 15.8 (21.5) | 18.8 (25.5) | | | 25.0 (34.0) | 26.0 (35.3) | 26.8 (36.5) | 29.1 (39.5) | 30.9 (42.0) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | | | 2590 | 2700 | 2810 | 2995 | 3210 |
| Ignition order | | - | 1-3-2-1 (No.1 cylinder on flywheel side) | | | | | | | | |
| Power take off | | - | Flywheel | | | | | | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | | | | | | |
| Cooling system | | - | Radiator | | | | | | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | | | | | | |
| Starting system | | - | Electric | | | | | | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (cetane No.45 min.) | | | | | | | | |
| Applicable lubricant | | - | API grade class CD or CF | | | | | | | | |
| Lubricant capacity (oil pan) * | Total | L | 6.7 | | | | | | | | |
| | Effective | L | 2.8 | | | | | | | | |
| Cooling water capacity (engine only) | | L | 2.0 | | | | | | | | |
| Engine dimensions ** (with flywheel housing) * | Overall length | mm | 589 | 564 | | | | | | | |
| | Overall width | mm | 486 | | | | | | | | |
| | Overall height | mm | 622 | | | | | | | | |
| Engine mass (dry) *,** (with flywheel housing) | | kg | 161 | 155 | | | | | | | |
| Cooling fan (std.) * | | mm | 350 mm O/D, 6 blades pusher type F | | | | | | | | |
| Crankshaft V pulley diameter & Fun V pulley diameter (std.) * | | mm | 120 × 90 | 110 × 110 | | | | | | | |

* Items marked * may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

https://truckmanualshub.com/



## (4) 3TNV88

| Engine name | | Unit | 3TNV88 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | VM | | | | | | | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | | | | | | |
| Combustion chamber | | - | Direct injection | | | | | | | | |
| Number of cylinders | | - | 3 | | | | | | | | |
| Cylinder bore × stroke | | mm × mm | 88 × 90 | | | | | | | | |
| Displacement | | L | 1.642 | | | | | | | | |
| Continuous rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | | | | | | |
| | Output | kW (ps) | 12.3 (16.7) | 14.8 (20.1) | - | | | | | | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 | 2400 | 2500 | 2600 | 2800 | 3000 |
| | Output | kW (ps) | 13.5 (18.4) | 16.3 (22.1) | 18.0 24.5) | 19.9 (27.0) | 21.6 (29.4) | 22.6 (30.7) | 23.5 (31.9) | 25.2 (34.2) | 27.1 (36.8) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | 2180 | 2400 | 2590 | 2700 | 2810 | 2995 | 3210 |
| Ignition order | | - | 1-3-2-1 (No.1 cylinder on flywheel side) | | | | | | | | |
| Power take off | | - | Flywheel | | | | | | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | | | | | | |
| Cooling system | | - | Radiator | | | | | | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | | | | | | |
| Starting system | | - | Electric | | | | | | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.45 min.) | | | | | | | | |
| Applicable lubricant | | - | API grade class CD or CF | | | | | | | | |
| Lubricant capacity (oil pan) * | Total | L | 6.7 | | | | | | | | |
| | Effective | L | 2.8 | | | | | | | | |
| Cooling water capacity (engine only) | | L | 2.0 | | | | | | | | |
| Engine dimensions ** (with flywheel housing) * | Overall length | mm | 589 | 564 | | | | | | | |
| | Overall width | mm | 486 | | | | | | | | |
| | Overall height | mm | 622 | | | | | | | | |
| Engine mass (dry) *,** (with flywheel housing) | | kg | 155 | | | | | | | | |
| Cooling fan (std.) * | | Mm | 335 mm O/D, 6 blades pusher type F | | | | | | | | |
| Crankshaft V pulley diameter & Fun V pulley diameter (std.) * | | Mm | 120 × 90 | 110 × 110 | | | | | | | |

* Items marked * may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

(R.1)

https://truckmanualshub.com/



## (5) 4TNV84

| Engine name | | Unit | 4TNV84 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | VM | | | | | | | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | | | | | | |
| Combustion chamber | | - | Direct injection | | | | | | | | |
| Number of cylinders | | - | 4 | | | | | | | | |
| Cylinder bore × stroke | | mm × mm | 84 × 90 | | | | | | | | |
| Displacement | | L | 1.995 | | | | | | | | |
| Continuous Rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | | | | | | |
| | Output | kW (ps) | 14.9 (20.3) | 17.7 (24.1) | - | | | | | | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 | 2400 | 2500 | 2600 | 2800 | 3000 |
| | Output | kW (ps) | 16.4 (22.3) | 19.5 (26.5) | 21.9 (29.8) | 24.1 (32.8) | 26.3 (35.8) | 27.4 (37.3) | 28.5 (38.7) | 30.7 41.7) | 32.9 (44.7) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | 2180 | 2400 | 2590 | 2700 | 2810 | 2995 | 3210 |
| Ignition order | | - | 1-3-4-2-1 (No.1 cylinder on flywheel side) | | | | | | | | |
| Power take off | | - | Flywheel | | | | | | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | | | | | | |
| Cooling system | | - | Radiator | | | | | | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | | | | | | |
| Starting system | | - | Electric | | | | | | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (cetane No.45 min.) | | | | | | | | |
| Applicable lubricant | | - | API grade class CD or CF | | | | | | | | |
| Lubricant capacity (oil pan) * | Total | L | 7.4 | | | | | | | | |
| | Effective | L | 3.4 | | | | | | | | |
| Cooling water capacity (engine only) | | L | 2.7 | | | | | | | | |
| Engine dimensions ** (with flywheel housing) * | Overall length | mm | 683 | 658 | | | | | | | |
| | Overall width | mm | 498.5 | | | | | | | | |
| | Overall height | mm | 617 | | | | | | | | |
| Engine mass (dry) *,** (with flywheel housing) | | kg | 183 | 170 | | | | | | | |
| Cooling fan (std.) * | | mm | 370 mm O/D, 6 blades pusher type F | | | | | | | | |
| Crankshaft V pulley diameter & Fun V pulley diameter (std.) * | | mm | 120 × 90 | 110 × 110 | | | | | | | |

* Items marked * may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

https://truckmanualshub.com/



## (6) 4TNV84T

| Engine name | | Unit | 4TNV84T | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | | VM | | | | | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | | | | | |
| Combustion chamber | | - | Direct injection | | | | | | | |
| Number of cylinders | | - | 4 | | | | | | | |
| Cylinder bore × stroke | | mm × mm | 84 × 90 | | | | | | | |
| Displacement | | L | 1.995 | | | | | | | |
| Continuous rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | | | | | |
| | Output | KW (ps) | 19.1 (26.0) | 24.3 (33.0) | - | | | | | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 |
| | Output | KW (ps) | 21.3 (29.0) | 26.9 (36.5) | 27.9 (38.0) | 30.5 (41.5) | 33.5 (45.5) | 35.7 (48.5) | 38.6 (52.5) | 41.2 (56.0) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | 2180 | 2400 | 2590 | 2810 | 2995 | 3210 |
| Ignition order | | - | 1-3-4-2-1 (No.1 cylinder on flywheel side) | | | | | | | |
| Power take off | | - | Flywheel | | | | | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | | | | | |
| Cooling system | | - | Radiator | | | | | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | | | | | |
| Starting system | | - | Electric | | | | | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.45 min.) | | | | | | | |
| Applicable lubricant | | - | API grade class CD or CF | | | | | | | |
| Lubricant capacity (oil pan) * | Total | L | 7.4 | | | | | | | |
| | Effective | L | 3.4 | | | | | | | |
| Cooling water capacity (engine only) | | L | 3.2 | | | | | | | |
| Engine dimensions *,** | Overall length | mm | 683 | | 649 | | | | | |
| | Overall width | mm | 498.5 | | | | | | | |
| | Overall height | mm | 713 | | | | | | | |
| Engine mass (dry) *,** (with flywheel housing) | | kg | 183 | | 170 | | | | | |
| Cooling fan (std.) * | | mm | 370 mm O/D, 6 blades pusher type F | | | | | | | |
| Crankshaft V pulley diameter & Fun V pulley diameter (std.) * | | mm | 120 × 90 | | 110 × 110 | | | | | |

* Items marked * may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

https://truckmanualshub.com/



## (7) 4TNV88

| Engine name | | Unit | 4TNV88 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | VM | | | | | | | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | | | | | | |
| Combustion chamber | | - | Direct injection | | | | | | | | |
| Number of cylinders | | - | 4 | | | | | | | | |
| Cylinder bore × stroke | | mm × mm | 88 × 90 | | | | | | | | |
| Displacement | | L | 2.190 | | | | | | | | |
| Continuous rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | | | | | | |
| | Output | kW (ps) | 16.4 (22.3) | 19.6 (26.7) | - | | | | | | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 | 2400 | 2500 | 2600 | 2800 | 3000 |
| | Output | kW (ps) | 18.0 (24.5) | 21.6 (29.4) | 24.1 (32.7) | 26.5 (36.0) | 28.8 (39.2) | 30.1 (40.9) | 31.3 (42.5) | 33.7 (45.8) | 35.4 (48.1) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | 2180 | 2400 | 2590 | 2700 | 2810 | 2995 | 3210 |
| Ignition order | | - | 1-3-4-2-1 (No.1 cylinder on flywheel side) | | | | | | | | |
| Power take off | | - | Flywheel | | | | | | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | | | | | | |
| Cooling system | | - | Radiator | | | | | | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | | | | | | |
| Starting system | | - | Electric | | | | | | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (cetane No.45 min.) | | | | | | | | |
| Applicable lubricant | | - | API grade class CD or CF | | | | | | | | |
| Lubricant capacity (oil pan) * | Total | L | 7.4 | | | | | | | | |
| | Effective | L | 3.4 | | | | | | | | |
| Cooling water capacity (engine only) | | L | 2.7 | | | | | | | | |
| Engine dimensions ** (with wheel housing) * | Overall length | mm | 683 | 658 | | | | | | | |
| | Overall width | mm | 498.5 | | | | | | | | |
| | Overall height | mm | 618 | | | | | | | | |
| Engine mass (dry) *,** (with flywheel housing) | | kg | 183 | 170 | | | | | | | |
| Cooling fan (std.) * | | mm | 370 mm O/D, 6 blades pusher type F | | | | | | | | |
| Crankshaft V pulley diameter & Fun V pulley diameter (std.) * | | mm | 120 × 90 | 110 × 110 | | | | | | | |

* Items marked * may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

https://truckmanualshub.com/



## (8) 4TNV94L

| Engine name | | Unit | 4TNV94L | | | | | |
|---|---|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | | VM | | | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | | | |
| Combustion chamber | | - | Direct injection | | | | | |
| Number of cylinders | | - | 4 | | | | | |
| Cylinder bore × stroke | | mm × mm | 94 × 110 | | | | | |
| Displacement | | L | 3.054 | | | | | |
| Continuous rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | | | |
| | Output | kW (ps) | 26.1 (35.5) | 31.3 (42.5) | - | | | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 | 2400 | 2500 |
| | Output | kW (ps) | 29.1 (39.5) | 34.6 (47.0) | 35.3 (48.0) | 38.2 (52.0) | 41.6 (56.5) | 43.0 (58.5) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | 2180 | 2400 | 2590 | 2700 |
| Ignition order | | - | 1-3-4-2-1 (No.1 cylinder on flywheel side) | | | | | |
| Power take off | | - | Flywheel | | | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | | | |
| Cooling system | | - | Radiator | | | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | | | |
| Starting system | | - | Electric | | | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.45 min.) | | | | | |
| Applicable lubricant | | - | API grade class CD or CF | | | | | |
| Lubricant capacity (oil pan) * | Total | L | 10.5 | | | | | |
| | Effective | L | 4.5 | | | | | |
| Cooling water capacity (engine only) | | L | 4.2 | | | | | |
| Engine dimensions ** (with flywheel housing) * | Overall length | mm | 719 | | | | | |
| | Overall width | mm | 498 | | | | | |
| | Overall height | mm | 742 | | | | | |
| Engine mass (dry) *,** (with flywheel housing) | | kg | 245 (equivalent to SAE # 3) | | 235 (equivalent to SAE # 4) | | | |
| Cooling fan (std.) * | | mm | 410 mm O/D, 6 blades pusher type F | | | | | |
| Crankshaft V pulley diameter & Fun V pulley diameter (std.) * | | mm | 130 × 130 | | | | | |

* Items marked * may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

https://truckmanualshub.com/



## (9) 4TNV98

| Engine name | | Unit | 4TNV98 | | | | | |
|---|---|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | | VM | | | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | | | |
| Combustion chamber | | - | Direct injection | | | | | |
| Number of cylinders | | - | 4 | | | | | |
| Cylinder bore × stroke | | mm × mm | 98 × 110 | | | | | |
| Displacement | | L | 3.319 | | | | | |
| Continuous rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | | | |
| | Output | kW (ps) | 30.9 (42.0) | 36.8 (50.0) | - | | | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 | 2400 | 2500 |
| | Output | kW (ps) | 34.6 (47.0 | 41.2 (56.0) | 41.9 (57.0) | 45.6 (62.0) | 49.3 (67.0) | 51.1 (69.5) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | 2180 | 2400 | 2590 | 2700 |
| Ignition order | | - | 1-3-4-2-1 (No.1 cylinder on flywheel side) | | | | | |
| Power take off | | - | Flywheel | | | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | | | |
| Cooling system | | - | Radiator | | | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | | | |
| Starting system | | - | Electric | | | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.45 min.) | | | | | |
| Applicable lubricant | | - | API grade class CD or CF | | | | | |
| Lubricant capacity (oil pan) * | Total | L | 10.5 | | | | | |
| | Effective | L | 4.5 | | | | | |
| Cooling water capacity (engine only) | | L | 4.2 | | | | | |
| Engine dimensions ** (with flywheel housing) * | Overall length | mm | 719 | | | | | |
| | Overall width | mm | 498 | | | | | |
| | Overall height | mm | 742 | | | | | |
| Engine mass (dry) *,** (with flywheel housing) | | kg | 248 (equivalent to SAE # 3) | | 235 (equivalent to SAE # 4) | | | |
| Cooling fan (std.) * | | mm | 410 mm O/D, 6 blades pusher type F | | | | | |
| Crankshaft V pulley diameter & Fun V pulley diameter (std.) * | | mm | 130 × 130 | | | | | |

* Engine oil capacity may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

https://truckmanualshub.com/



## (10)4TNV98T

| Engine name | | Unit | 4TNV98T | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | | VM | | | | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | | | | |
| Combustion chamber | | - | Direct injection | | | | | | |
| Number of cylinders | | - | 4 | | | | | | |
| Cylinder bore × stroke | | mm × mm | 88 × 110 | | | | | | |
| Displacement | | L | 3.319 | | | | | | |
| Continuous rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | | | | |
| | Output | kW (ps) | 37.9 (51.5) | 45.6 (62.0) | - | | | | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 | 2400 | 2500 | 2600 |
| | Output | kW (ps) | 41.9 (57.0) | 50.4 (68.5) | 50.7 (69.0) | 55.5 (75.5) | 60.3 (82.0) | 62.5 (85.0) | 64.0 (87.0) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | 2180 | 2400 | 2590 | 2700 | 2810 |
| Ignition order | | - | 1-3-4-2-1 (No.1 cylinder on flywheel side) | | | | | | |
| Power take off | | - | Flywheel | | | | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | | | | |
| Cooling system | | - | Radiator | | | | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | | | | |
| Starting system | | - | Electric | | | | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (cetane No.45 min.) | | | | | | |
| Applicable lubricant | | - | API grade class CD or CF | | | | | | |
| Lubricant capacity (oil pan) * | Total | L | 10.5 | | | | | | |
| | Effective | L | 4.5 | | | | | | |
| Cooling water capacity (engine only) | | L | 4.2 | | | | | | |
| Engine dimensions ** (with flywheel housing) * | Overall length | mm | 715 | | | | | | |
| | Overall width | mm | 575 | | | | | | |
| | Overall height | mm | 804 | | | | | | |
| Engine mass (dry) *,** (with flywheel housing) | | kg | 258 (equivalent to SAE # 3) | | 245 (equivalent to SAE # 4) | | | | |
| Cooling fan (std.) | | mm | 430 mm O/D, 8 blades suction type | | | | | | |
| Crankshaft V pulley diameter & Fun V pulley diameter (std.) * | | mm | 130 × 130 | | | | | | |

* Items marked * may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

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## (11)4TNV106

| Engine name | | Unit | 4TNV106 | | | | | |
|---|---|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | | VM | | | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | | | |
| Combustion chamber | | - | Direct injection | | | | | |
| Number of cylinders | | - | 4 | | | | | |
| Cylinder bore × stroke | | mm × mm | 106 × 125 | | | | | |
| Displacement | | L | 4.412 | | | | | |
| Continuous rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | | | |
| | Output | kW (ps) | 41.2 (56.0) | 49.3 (67.0) | - | | | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 | 2400 | 2500 |
| | Output | kW (ps) | 45.6 (62.0 | 54.4 (74.0) | 56.6 (77.0) | 61.4 (83.5) | 65.5 (89.0) | 67.7 (92.0) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | 2180 | 2400 | 2590 | 2700 |
| Ignition order | | - | 1-3-4-2-1 (No.1 cylinder on flywheel side) | | | | | |
| Power take off | | - | Flywheel | | | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | | | |
| Cooling system | | - | Radiator | | | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | | | |
| Starting system | | - | Electric | | | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.45 min.) | | | | | |
| Applicable lubricant | | - | API grade class CD or CF | | | | | |
| Lubricant capacity (oil pan) * | Total | L | 14.0 | | | | | |
| | Effective | L | 9.0 | | 7.5 | | | |
| Cooling water capacity (engine only) | | L | 6.0 | | | | | |
| Engine dimensions ** (with flywheel housing) * | Overall length | mm | 808 | | 776 | | | |
| | Overall width | mm | 629 | | 629 | | | |
| | Overall height | mm | 803 | | 803 | | | |
| Engine mass (dry) *, ** (with flywheel housing) | | kg | 345 (equivalent to SAE # 3) | | 330 (equivalent to SAE # 3) | | | |
| Cooling fan (std.) * | | mm | 500 mm O/D, 7 blades pusher type | | 500 mm O/D, 7 blades suction type | | | |
| Crankshaft V pulley diameter & Fun V pulley diameter (std.) * | | mm | 150 × 150 | | | | | |

* Items marked * may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

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## (12)4TNV106T

| Engine name | | Unit | 4TNV106T | | | |
|---|---|---|---|---|---|---|
| Engine specification class | | - | CL | | VM | |
| Type | | - | Vertical, in-line, 4-cycle, water-cooled diesel engine | | | |
| Combustion chamber | | - | Direct injection | | | |
| Number of cylinders | | - | 4 | | | |
| Cylinder bore × stroke | | mm × mm | 106 × 125 | | | |
| Displacement | | L | 4.412 | | | |
| Continuous rating | Revolving speed | $Min^{-1}$ | 1500 | 1800 | - | |
| | Output | kW (ps) | 51.5 (70.0) | 61.8 (84.0) | - | |
| Rated output | Revolving speed | $Min^{-1}$ | 1500 | 1800 | 2000 | 2200 |
| | Output | kW (ps) | 56.8 (77.2 | 68.0 (92.5) | 69.9 (95.0) | 72.0 (97.9) |
| Max. no-load speed (± 25) | | $min^{-1}$ | 1600 | 1895 | 2180 | 2400 |
| Ignition order | | - | 1-3-4-2-1(No.1 cylinder on flywheel side) | | | |
| Power take off | | - | Flywheel | | | |
| Direction of rotation | | - | Counterclockwise (viewed from flywheel) | | | |
| Cooling system | | - | Radiator | | | |
| Lubrication system | | - | Forced lubrication with trochoid pump | | | |
| Starting system | | - | Electric | | | |
| Applicable fuel | | - | Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.45 min.) | | | |
| Applicable lubricant | | - | API grade class CD or CF | | | |
| Lubricant capacity (oil pan) * | Total | L | 14.0 | | | |
| | Effective | L | 9.0 | | 7.5 | |
| Cooling water capacity (engine only) | | L | 6.0 | | | |
| Engine dimensions ** (with flywheel housing) * | Overall length | mm | 808 | | 776 | |
| | Overall width | mm | 629 | | 629 | |
| | Overall height | mm | 866 | | 866 | |
| Engine mass (dry) *, ** (with flywheel housing) | | kg | 355 (equivalent to SAE # 3) | | 340 (equivalent to SAE # 3) | |
| Cooling fan (std.) * | | mm | 500 mm O/D, 7 blades pusher type | | 500 mm O/D, 7 blades suction type | |
| Crankshaft V pulley diameter & Fun V pulley diameter (std.) * | | mm | 150 × 150 | | | |

* Items marked * may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

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# 1.3 Fuel oil, lubricating oil and cooling water

## 1.3.1 Fuel oil

IMPORTANT:

Only use the recommended fuel to obtain the best engine performance and to keep the durability of the engine, also to comply with the emission regulations.

### (1) Selection of fuel oil

Diesel fuel oil should comply with the following specifications.

• The fuel specifications need to comply with each national standard or international standards.
  • ASTM D975 No.1-D, No.2-D ---------- for USA
  • EN590:96---------- for EU
  • ISO 8217 DMX ---------- International
  • BS 2869-A1 or A2 ---------- for UK
  • JIS K2204 ---------- for JAPAN

The following requirements also need to be fulfilled.

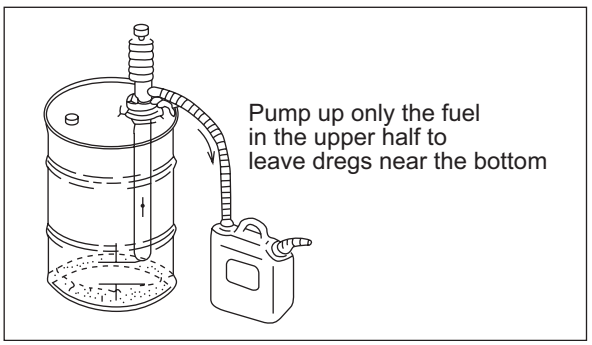
  • Cetane number should be equal to 45 or higher.
  • Sulphur content of the fuel
    It should not exceed 0.5%by volume. (Preferably it should be below 0.05 %)
  • For alternative fuel (Bio fuel such as FAME, JP-8), please contact YANMAR.
  • Water and sediment in the fuel oil should not exceed 0.05% by volume.
  • Ash should not exceed 0.01%by mass.
  • 10% Carbon residue content of the fuel
    It should not exceed 0.35%by volume. (Preferably it should be below 0.1 %)
  • Aromatics(total) content of the fuel
    It should not exceed 35% by volume. (Preferably it should be below 30% and aromatics(PAH*) content of the fuel preferably it should be below 10%)
    PAH*:polycyclic aromatic hydrocarbons
  • DO NOT use Biocide.
  • DO NOT use Kerosene, residual fuels.
  • DO NOT mix winter fuel and summer fuel.

***Note : Engine breakdown can be attributed to insufficient quality of fuel oil.***

### (2) Fuel handling

• Water and dust in the fuel oil can cause operation failure. Use containers which are clean inside to store fuel oil. Store the containers away from rain water and dust.

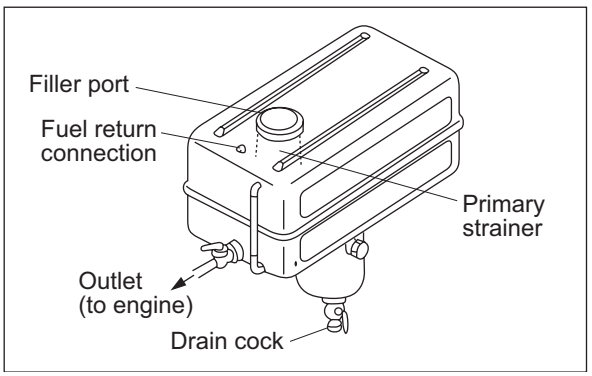
• Before supplying fuel, let the fuel container rest for several hours so that water and dust in the fuel are deposited on the bottom. Pump up only the clean fuel.




### (3) Fuel tank

Fuel tank inside should be always clean enough and dry it inside for the first use.

Drain the water according to the maintenance (section 5) with a drain valve.




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## 1.3.2 Lubricating oil

IMPORTANT:

Only use the recommended engine oil to keep the durability of the engine.

### (1) Selection of lube oil

Engine oil shoud comply with the following specifications.

1)Classification

- API classification ····· CD, CF, CF-4, CI-4
  TBN value : ≧9(CD), ≧9(CF), ≧7(CF-4), ≧7(CI-4)
- ACEA classification ····· E-3, E-4, E-5
  TBN value : ≧10(E-3), ≧10(E-4), ≧10(E-5)
- JASO classification ····· DH-1
  TBN value : ≧10(DH-1)

The oil must be changed when the Total Base Number (TBN) has been reduced to 2.0.

*TBN(mgKOH/g) test method; JIS K-2501-5.2-2(HCI), ASTM D4739(HCI)

DO NOT use The following engine oils.

- API : CG-4 , CH-4
- ACEA : E-1, E-2 , B grade
- JASO : DH-2 , DL-1

Reason

API CG-4, CH-4

In case CG-4, CH-4 is to be used for YANMAR TNV diesel engine series, there is a possibility that excessive wears occur on the valve train system due to the content of oil.

ACEA E-1,E-2, B

These fuels are developed for the different type of diesel engines.

JASO DH-2, DL-1

These fuels are developed for the different type of diesel engines.

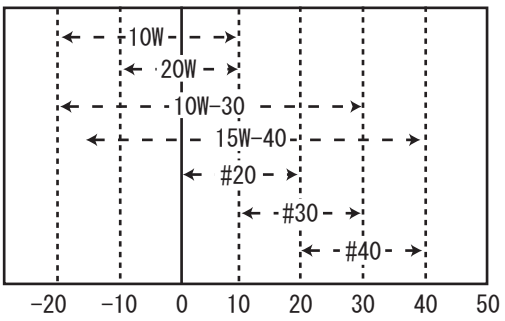
2)Viscosity

Selection of viscosity will be determined depending on the ambient temperature.
(Refer to the chart on the right.)

The following requirements are also need to be fulfilled.

- Standard engine oil service interval is 250 hrs or every 12 months.
- DO NOT add any additives to the engine oil.
- DO NOT mix the different types (brand) of engine oil.
- DO NOT use synthetic oil.

Selection of viscosity
(SAE Service grade)




Atmospheric temperature (˚C)

15W-40/10W-30 can be used almost throughout the year.

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(2) Handling of lube oil

- Keep the engine oil carefully in store in order to prevent any dust or dirt entrance.
- When filling the engine oil to the engine, avoid the spillage and pay attention to be clean around the filler port.

**⚠ CAUTION**

Contact with engine oil may result in the roughened skin. Care should be taken so as not to contact with engine oil wearing protective gloves and clothing.
If contact, wash with soap and water thoroughly.
When handling the engine oil, make sure to use the protective gloves at any time.
In case of contact, wash your hand or body with soap and water thoroughly.

## 1.3.3 Cooling water

Use clean soft water and always be sure to add LLC (Long Life Coolant) in order to prevent rust built up and freezing. (Do not use water only.)
The recommended LLC conform to the following specifications.

- JIS K-2234
- SAEbJ814C, J1941, J1034, J2036
- ASTM D4985

IMPORTANT:

- Always be sure to add LLC to soft water. In particular, in cold season, to add LLC is important.
- Without LLC,
- Cooling performance will decrease due to scale and rust in the cooling water system.
- Cooling water may freeze to form ice; it expands approx. 9% in volume.
- This causes serious damage in the cooling system.
- Be sure to use the proper amount of coolant concentrate specified by the LLC manufacturer depending on the ambient temperature.
- LLC concentration should be 30%as a minimum and 60%as a maximum.
- DO NOT mix the different types of brand of LLC, otherwise harmful sludge may yield.
- DO NOT use hard water.
- Water should be free from sludge and/or particles.
- Replace the coolant every once a year.

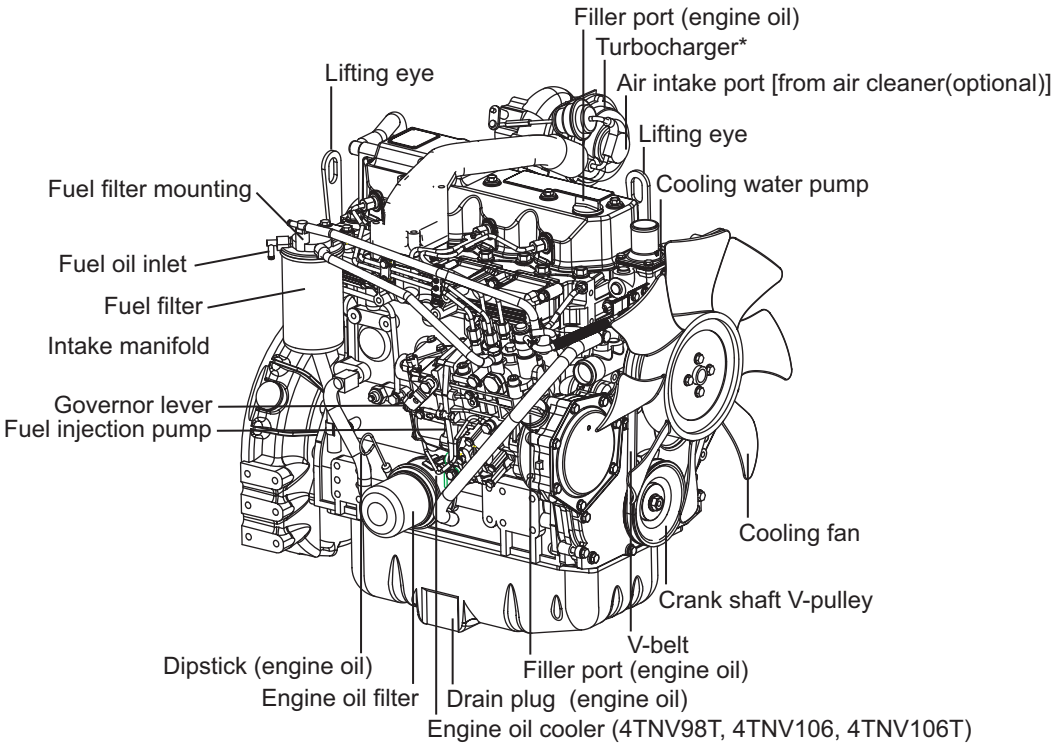
**⚠ CAUTION**

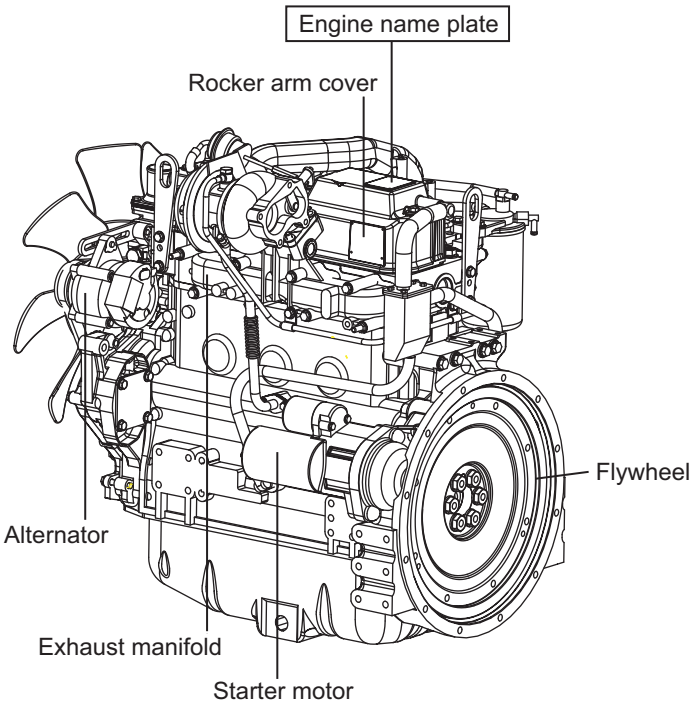
When handling LLC, use protective gloves to avoid skin contact.
In case you have a contact with your skin or eyes, wash out it with clean water.

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# 1.4 Engine external views



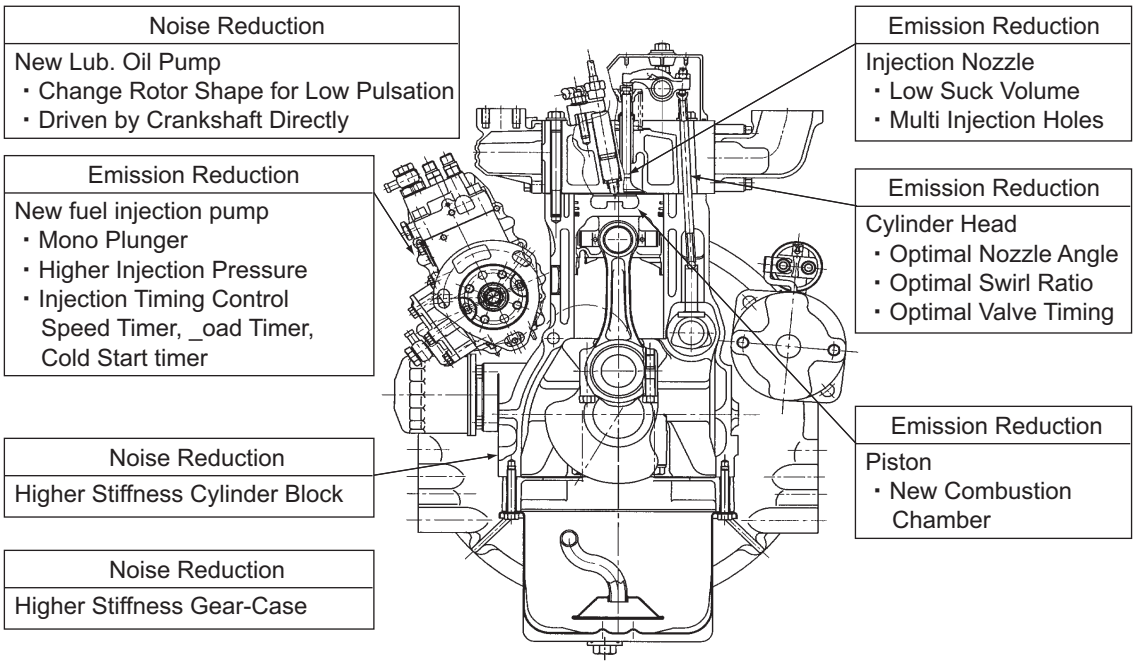

Note) ・This illustration shows the 4TNV98T engine (with turbocharger).
・The drain plug (engine oil) location depends on the engine installed on the machine unit to be on the fuel injection pump side (above illustration) or starter motor side.

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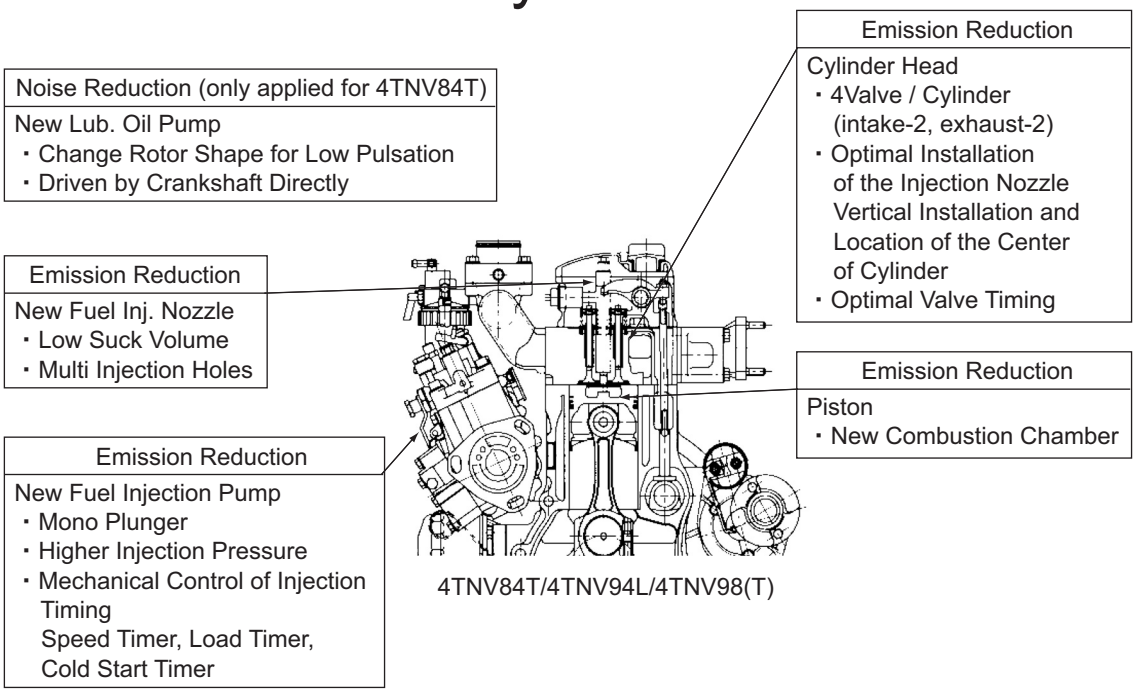


## 1.5 Structural description

# 2-valve cylinder head




# 4-valve cylinder head




4TNV84T/4TNV94L/4TNV98(T)

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# 1.6 Exhaust gas emission regulation

The engines in this manual have been certified by the US EPA, California ARB and/or the 97/68/EC Directive.

**California**

**Proposition 65 Warning**

Diesel engine exhaust and some of its constitutions are known to the State of California to cause cancer, birth defects, and other reproductive harm.

**California**

**Proposition 65 Warning**

Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.

## 1.6.1 The emission standard in USA

### (1) EPA Nonroad Diesel Engine Emission Standards

g/kW•hr (g/bhp•hr)

| Engine Power | Tier | Model Year | NOx | HC | NMHC + NOx | CO | PM |
|---|---|---|---|---|---|---|---|
| kW < 8 (hp < 11) | Tier 1 | 2000 | - | - | 10.5 (7.8) | 8.0 (6.0) | 1.0 (0.75) |
| | Tier 2 | 2005 | - | - | 7.5 (5.6) | 8.0 (6.0) | 0.80 (0.60) |
| 8 <= kW < 19 (11 <= hp < 25) | Tier 1 | 2000 | - | - | 9.5 (7.1) | 6.6 (4.9) | 0.80 (0.60) |
| | Tier 2 | 2005 | - | - | 7.5 (5.6) | 6.6 (4.9) | 0.80 (0.60) |
| 19<= kW < 37 (25 <= hp < 50) | Tier 1 | 1999 | - | - | 9.5 (7.1) | 5.5 (4.1) | 0.80 (0.60) |
| | Tier 2 | 2004 | - | - | 7.5 (5.6) | 5.5 (4.1) | 0.60 (0.45) |
| 37 <= kW < 75 (50 <= hp < 100) | Tier 1 | 1998 | 9.2 (6.9) | - | - | - | - |
| | Tier 2 | 2004 | - | - | 7.5 (5.6) | 5.0 (3.7) | 0.40 (0.30) |
| | Tier 3 | 2008 | - | - | 4.7 (3.5) | 5.0 (3.7) | |
| 75 <= kW < 130 (100 <= hp < 175) | Tier 1 | 1997 | 9.2 (6.9) | - | - | - | - |
| | Tier 2 | 2003 | - | - | 6.6 (4.9) | 5.0 (3.7) | 0.30 (0.22) |
| | Tier 3 | 2007 | - | - | 4.0 (3.0) | 5.0 (3.7) | |

Note1) The EPA emission regulation under 130 kW is mentioned below.

Note2) As for Model year, the year which a regulation is applicable to is shown.

| Engine classification | Transient smoke standards % opacity (acceleration/lug/peak modes) |
|---|---|
| Constant speed engine | Not regulated |
| Variable speed engine | 20/15/50 or less |

### (2) California ARB Emission Regulation

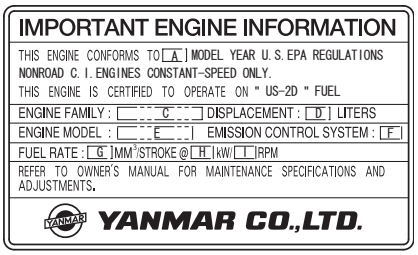
The ARB emission standard is based on that of the EPA.

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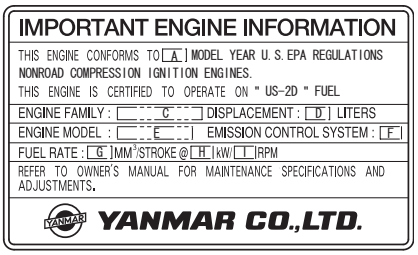


## 1.6.2 Engine identification

(1) Emission control labels of US EPA

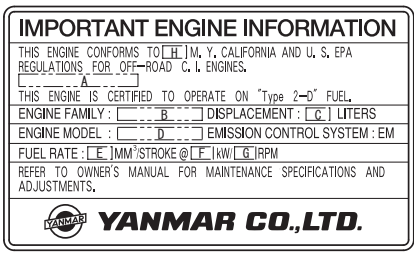



EPA label for constant speed engines

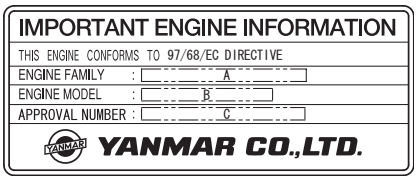



EPA label for variable speed engines

(2) Emission control label for both EPA and ARB




(3) 97/68EC Directive label



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## 1.6.3 Guarantee conditions for the EPA emission standard

The following guarantee conditions are set down in the operation manual. In addition to making sure that these conditions are met, check for any deterioration that may occur before the required periodic maintenance times.

(1) Requirement on engine installation condition

(a)Intake air depression

kPa (mmAq)

| Initial | Permissible |
|---|---|
| <= 2.94 (300) | <= 6.23 (635) |

(b)Exhaust gas back pressure

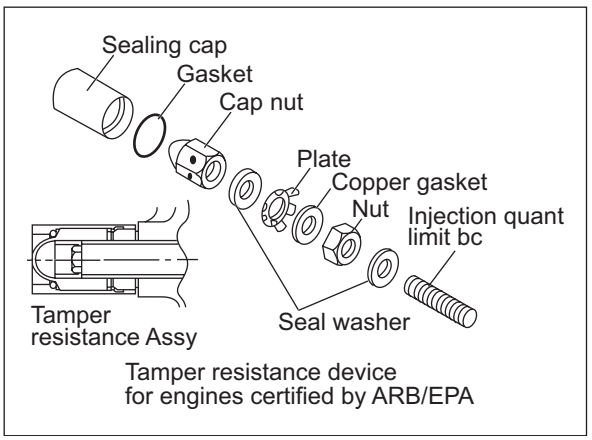
kPa (mmAq)

| Engine type | Initial | Permissible |
|---|---|---|
| Naturally aspirated engines | <= 12.75 (1300) | <= 15.30 (1560) |
| 4TNV98T, 4TNV106T | <= 9.81 (1000) | <= 11.77 (1200) |
| 3,4TNV84T | <= 4.90 (500) | <= 5.88 (600) |

(2) Fuel oil and lubricating oil

(a)Fuel: The diesel fuel oil US No.2 diesel fuel oil.
(b)Lube oil: API grade, class CD or CF

(3) Do not remove the seals restricting injection quantity and engine speed.



Tamper resistance device for engines certified by ARB/EPA

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## (4) Perform maintenance without fail.

Note: Inspections to be carried out by the user and by the maker are divided and set down in the "List of Periodic Inspections" and should be checked carefully.

## (5) Maintenance period and quality guarantee period for exhaust emission related parts

The maintenance of the parts related to the exhaust emission must be carried out in the maintenance period as shown in the below table.

A guarantee period is that either the operation hours or years shown in the table come first in the condition that the maintenance inspection was carried out based on the "List of Periodic Inspections".

| | Maintenance period | | Quality Guarantee Period |
|---|---|---|---|
| Parts / Power Rating | •Fuel nozzle cleaning | Adjustment, cleaning, repairs for fuel nozzle, fuel pump, turbocharger, electronic control unit etc. | For nozzle, fuel pump, turbocharger |
| 37 <= kW < 130 | Every 1500 hours (applied from Tier 2) | Every 3000 hours (applied from Tier 2) | 3000 hours / 5 years |
| 19 <= kW < 37 except constant speed engines >= 3000 $min^{-1}$ | Every 1500 hours | Every 3000 hours | 3000 hours / 5 years |
| KW < 19 And constant speed engines beyond 3000 $min^{-1}$ under 37 kW | Every 1500 hours | Every 3000 hours | 1500 hours / 2 years |

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# 2. Inspection and adjustment

## 2.1 Periodic maintenance schedule

The engine periodic inspection timing is hard to determine as it varies with the application, load status, qualities of the fuel and lubricating oils used and handling status. General rules are described here.

○: User-maintenance ◎: Parts replacement ●: Shop-inspection

| Classification | Item | Daily | Maintenance period | | | | |
|---|---|---|---|---|---|---|---|
| | | | Every 50 hours | Every 250 hours or 3 months | Every 500 hours or 6 months | Every 1000 hours or one year | Every 2000 hours or two years |
| Whole | Visual check around engine | ○ | | | | | |
| Fuel oil system | Fuel tank level check and fuel supply | ○ | | | | | |
| | Fuel tank draining | | ○ | | | | |
| | Water separator (Option) draining | | ○ | | | | |
| | Bleeding the fuel system | | ○ | | | | |
| | Water separator cleaning | | | | ○ | | |
| | Fuel filter element replacement | | | | ◎ | | |
| Lubricating oil system | Lube oil level check and replenishment | ○ | | | | | |
| | Lube oil replacement | | ◎ 1st time | ◎ 2nd time and thereafter | | | |
| | Lube oil filter replacement | | | | | | |
| Cooling water system | Coolant water level check and replenishment | ○ | | | | | |
| | Radiator fin cleaning | | | ○ | | | |
| | V-belt tension check | | ○ 1st time | ○ 2nd time and thereafter | | | |
| | Coolant water replacement | | | | | ◎ | |
| | Coolant water path flushing and maintenance | | | | | | |
| Rubber house | Fuel pipe and coolant water pipe inspection and maintenance | ○ | | | | | ● |
| Governor | Inspection and adjustment of governor lever and accelerator | ○ | | ○ | | | ● |
| Air intake system | Air cleaner cleaning and element replacement | | | ○ | ◎ | | |
| | Diaphragm assy inspection | | | | | ● (2 years) | |
| | Turbocharger blower cleaning* | | | | | ●* | |
| Electrical system | Warning lamp & instruments function check | ○ | | | | | |
| | Battery electrolyte level check and battery recharging | | ○ | | | | |
| Cylinder head | Intake/exhaust valve head clearance adjustment | | | | | ● | |
| | Intake/exhaust valve seat lapping | | | | | | ● |
| Fuel injection pump and nozzle | Fuel injection nozzle pressure inspection | | | | | ●* | |
| | Fuel injection timing adjustment<br>Fuel injection pump inspection and adjustment | | | | | | ●* |

*) EPA allows to maintain the emission related parts every 1,500 or 3,000 hours as shown in 1.6.3 of chapter1.

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# 2.2 Periodic inspection and maintenance procedure

## 2.2.1 Check before daily operation

Be sure to check the following points before starting an engine every day.

| No. | Inspection Item |
|---|---|
| (1) | Visual check around engine |
| (2) | Fuel tank level check and fuel supply |
| (3) | Lube oil level check and replenishment |
| (4) | Coolant water level check and replenishment |
| (5) | Fuel pipe and coolant water pipe inspection and maintenance |
| (6) | Inspection and adjustment of governor lever and accelerator |
| (7) | Warning lamp & instruments function check |

### (1) Visual check around engine

If any problem is found, do not use before the engine repairs have been completed.

- Oil leak from the lubrication system
- Fuel leak from the fuel system
- Coolant water leak from the cooling water system
- Damaged parts
- Loosened or lost bolts
- Fuel, radiator rubber hoses, V belt cracked, loosened clamp

### (2) Fuel tank level check and fuel supply

Check the remaining fuel oil level in the fuel tank and refuel the recommended fuel if necessary. (Refer to 1.3.(1))

### (3) Lube oil level check and replenishment

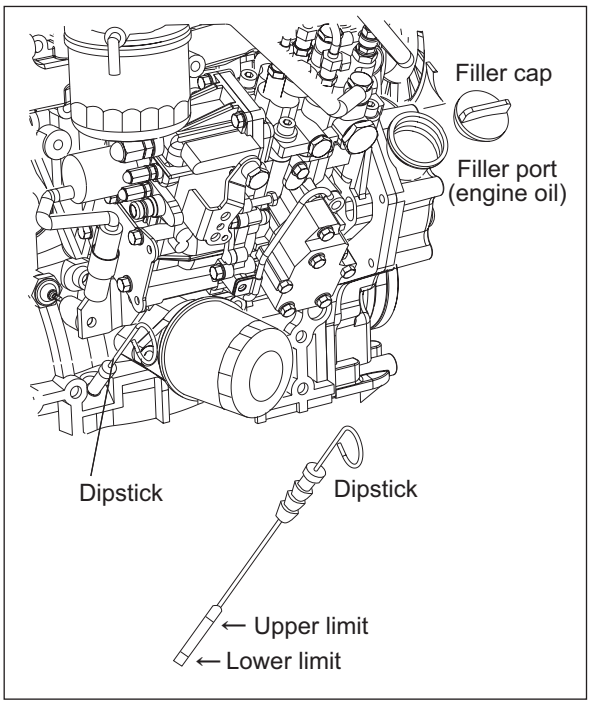
(a)Checking oil level

Check the lube oil level with the dipstick, after adjusting the posture of the machine unit so that an engine may become a horizontality. Insert the dipstick fully and check the oil level. The oil shall not be contaminated heavily and have appropriate viscosity. No coolant water or diesel fuel shall be mixed.

When lube oil is supplied after the engine running, check the lube oil level after about 10 minutes pass after the engine shutdown so that the lube oil inside may be retuned the oil pan.

**Standard**

The level shall be between the upper and lower limit lines on the dipstick.



https://truckmanualshub.com/



(Unit: liter)

| Model | Total volume (L) | Effective volume (L) |
|---|---|---|
| 3TNV82A | 5.5 | 1.9 |
| 3TNV84 (T)•88 | 6.7 | 2.8 |
| 4TNV84 (T)•88 | 7.4 | 3.4 |
| 4TNV94L98•(T) | 10.5 | 4.5 |
| 4TNV106 (T) (CL class) | 14.0 | 9.0 |
| 4TNV106 (T) (VM class) | 14.0 | 7.5 |

Lube oil capacity may differ from the above volume depending on an engine installed on a machine unit.

(b)Replenishing oil pan with lube oil

If the remaining engine oil level is low, fill the oil pan with the specified engine oil to the specified level through the filler port.

[NOTICE]

The oil should not be overfilled to exceed the upper limit line. Otherwise a naturally-aspirated engine may intake lube oil in the combustion chamber during the operation, then white smoke, oil hummer or urgent rotation may occur, because the blowby gas is reduced in the suction air flow.

In case of turbo-charged engine oil may jet out from the breather or the engine may become faulty.

## (4) Coolant water inspection

Daily inspection of coolant water should be done only by Coolant recovery tank.

**⚠ CAUTION**



- Never open the radiator filler cap while the engine and radiator are still hot. Steam and hot water will spurt out and seriously burn you. Wait until the radiator is cooled down after the engine has stopped, wrap the filler cap with a rag piece and turn the cap slowly to gently release the pressure inside the radiator.
- Securely tighten the filler cap after checking the radiator. Steam can spurt out during operation, if the cap is tightened loosely.

(a)Checking coolant water volume

Check the coolant water level in the Coolant recovery tank. If the water level is close to the LOW mark, open the Coolant recovery tank cap and replenish the Coolant recovery tank with clean soft water to the FULL mark.

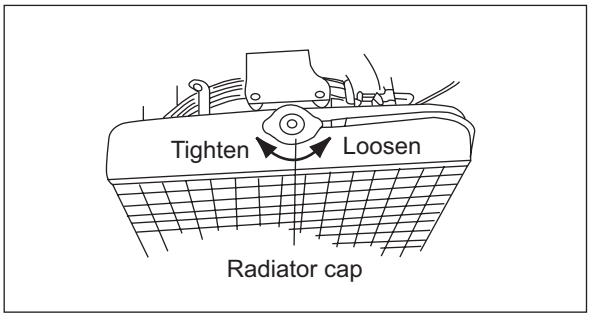
**Standard**

The water level of the Coolant recovery tank shall be between the upper and lower limit lines.

(b)Replenishing engine with water

If the Coolant recovery tank water level is lower than the LOW mark, open the radiator cap and check the coolant water level in the radiator. Replenish the radiator with the coolant water, if the level is low.

- Check the coolant water level while the engine is cool.
  Checking when the engine is hot is dangerous. And the water volume is expanded due to the heat.
- Daily coolant water level check and replenishing shall be done only at the Coolant recovery tank. Usually do not open the radiator cap to check or replenish.



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IMPORTANT:

If the coolant water runs short quickly or when the radiator runs short of water with the Coolant recovery tank level unchanged, water may be leaking or the air tightness may be lost. Increase in the Coolant recovery tank water level during operation is not abnormal.

The increased water in the Coolant recovery tank returns to the radiator when the engine is cooled down.

If the water level is normal in the Coolant recovery tank but low in the radiator, check loosened clamping of the rubber hose between the radiator and Coolant recovery tank or tear in the hose.

**Standard**

Engine: The radiator shall be filled up.

(Unit: liter)

| Model | Coolant water volume In an engine |
|---|---|
| 3TNV82A | 1.8 |
| 3TNV84 (T)<br>3TNV88 | 2.0 |
| 4TNV84 (T)<br>4TNV88 | 2.7 |
| 4TNV94L<br>4TNV98 (T) | 4.2 |
| 4TNV106 (T) | 6.0 |

Engine coolant water capacity may differ from the above volume depending on an engine installed on a machine unit.

### (5) Fuel pipe and coolant water pipe inspection and maintenance

Check the rubber hoses for fuel and coolant water pipes cracked. If the cracked hose is found, replace it with new one. Check the loosened clamp. If found, tighten it.

### (6) Inspection and adjustment of governor lever and accelerator

Make sure the accelerator of the machine unit can be operated smoothly before starting the engine. If it feels heavy to manipulate, lubricate the accelerator cable joints and pivots. Adjust the accelerator cable if there is a dislocation or excessive play between the accelerator and the governor lever. Refer to 3.2.3.

### (7) Warning lamp & instruments function check

Before and after starting the engine, check to see that the alarm function normally. Failure of alarm cannot warn the lack of the engine oil or the coolant water. Make it a rule to check the alarm operation before and after starting engine every day. Refer to each manual for machine units in details.

## 2.2.2 inspection after initial 50 hours operation

Be sure to check the following points after initial 50 hours operation, thereafter every 250 hours or 3 months operation.

| No. | Inspection Item |
|---|---|
| (1) | Lube oil and filter replacement |
| (2) | V-belt tension check |

### (1) Lube oil and filter replacement (1st time)

**⚠ CAUTION**

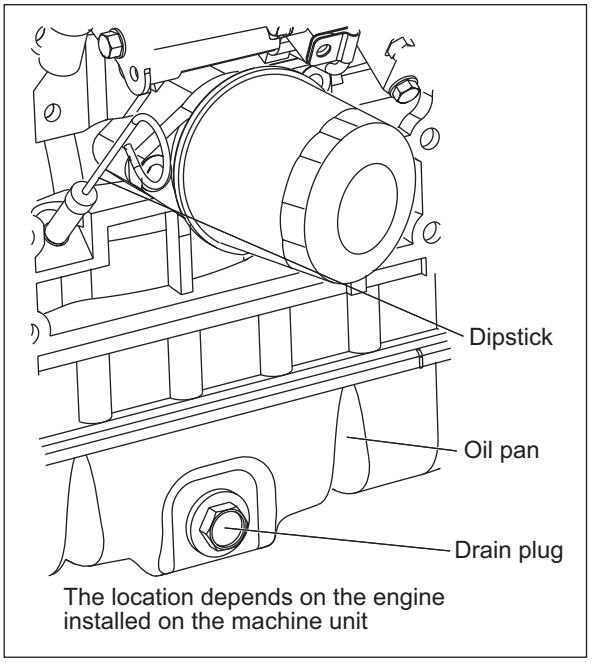


When an engine is still hot, be careful with a splash of engine oil which may cause burns. Replace engine oil after the engine oil becomes warm. It is most effective to drain the engine oil while the engine is still warm.

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In early period of use, the engine oil gets dirty rapidly because of the initial wear of internal parts. Replace the engine oil earlier.
Lube oil filter should also be replaced when the engine oil is replaced.
The procedure of lube oil and lube oil filter replacement is as follows.




(a)Drain engine oil

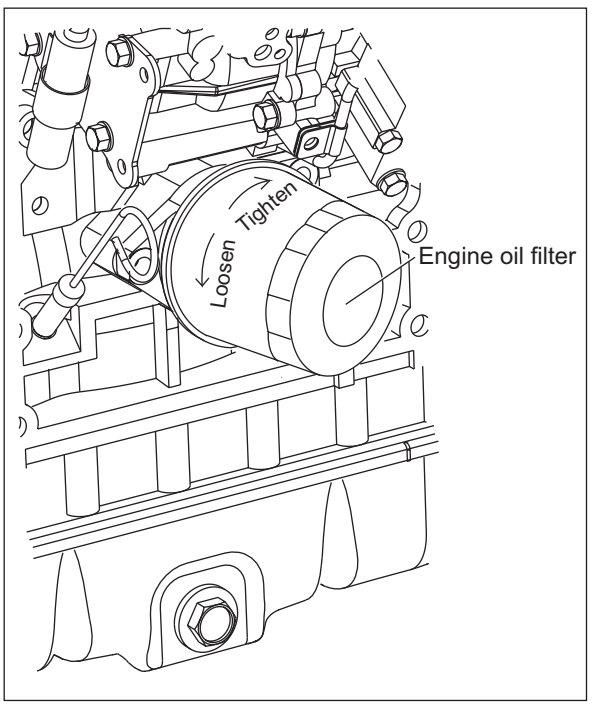
- Prepare a waste oil container collecting waste oil.
- Remove the oil filler cap to drain easily while draining the lube oil.
- Loosen the drain plug using a wrench (customer procured) to drain the lube oil.
- Securely tighten the drain plug after draining the lube oil.

[NOTICE]

Use a socket wrench or a closed wrench when removing or tightening a drain plug.

Don't use a spanner because it has the possibility that the spanner will slip and it will get hurt.

(b)Replacing oil filter




- Turn the lube oil filter counter-clockwise using a filter wrench (customer procured) to remove it.
- Clean the mounting face of the oil filter.
- Moisten the new oil filter gasket with the engine oil and install the new engine oil filter manually turning it clockwise until it comes into contact with the mounting surface, and tighten it further to 3/4 of a turn with the filter wrench.

Tightening torque: 20 to 24 N•m (2.0 to 2.4 kgf•m)

| Model | Applicable oil filter Part No. |
|---|---|
| 3TNV82A to 4TNV98 (T) | 129150-35151 |
| 4TNV106 (T) | 119005-35100 |

(c)Filling oil and inspection

- Fill with new engine oil until it reaches the specified level.

IMPORTANT:

Do not overfill the oil pan with engine oil.

Be sure to keep the specified level between upper and lower limit on the dipstick.

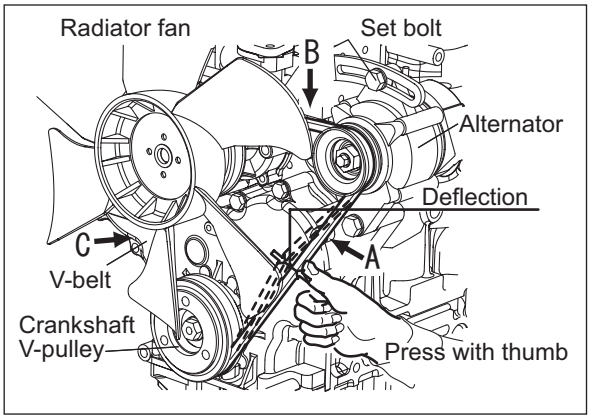
- Warm up the engine by running for 5 minutes while checking any oil leakage
- Stop the engine after warming up and leave it stopping for about 10 minute to recheck the engine oil level with dipstick and replenish the engine oil. If any oil is spilled, wipe it away with a clean cloth.

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## (2) V-belt tension check

When there is not enough tension in the V-belt, the V-belt will slip making it impossible for the alternator to generate power and cooling water pump and cooling fan will not work causing the engine to overheat.
Check and adjust the V-belt tension (deflection) in the following manner.




[NOTICE]

Be especially careful not to splash engine oil on the V-belt, because it will cause slipping, stretching and aging of the belt.

1)Press the V-belt with your thumb [approx. 98N (10 kgf)] at the middle of the V-belt span to check the tension (deflection).
Available positions to check and adjust the V-belt tension (deflection) are at the A, B or C direction as shown in the illustration right.
You may choose a position whichever you can easily carry out the check and adjustment on the machine unit.

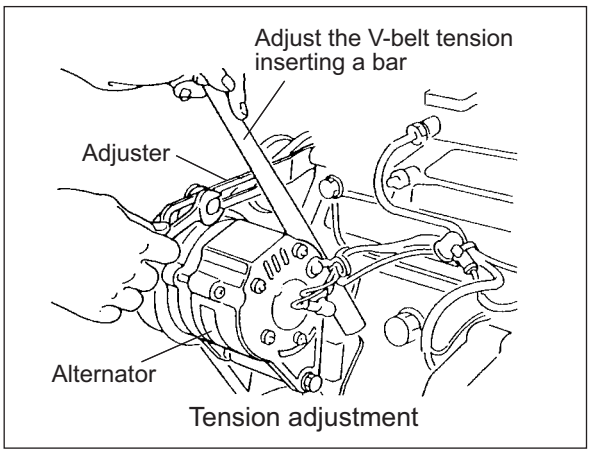
- "New V-belt" refers to a V-belt which has been used less than 5 minutes on a running engine.
- "Used V-belt" refers to a V-belt, which has been used on a running engine for 5 minutes or more.

The specified deflection to be measured at each position should be as follows.

(Unit: mm)

| Direction | A | B | C |
|---|---|---|---|
| For used V-belt | 10 to 14 | 7 to 10 | 9 to 13 |
| For new V-belt | 8 to 12 | 5 to 8 | 7 to 11 |

2)If necessary, adjust the V-belt tension (deflection).
To adjust the V-belt tension, loosen the set bolt and move the alternator to tighten the V-belt.
After replacing with a new V-belt and adjusting it, run the engine for 5 minutes and readjust the deflection to the value in the table above.



Tension adjustment

3)After replacing with a new V-belt and adjusting it, run the engine for 5 minutes and readjust the deflection to the value in the table above.

4)Visually check the V-belt for cracks, oiliness or wear. If any, replace the V-belt with new one.

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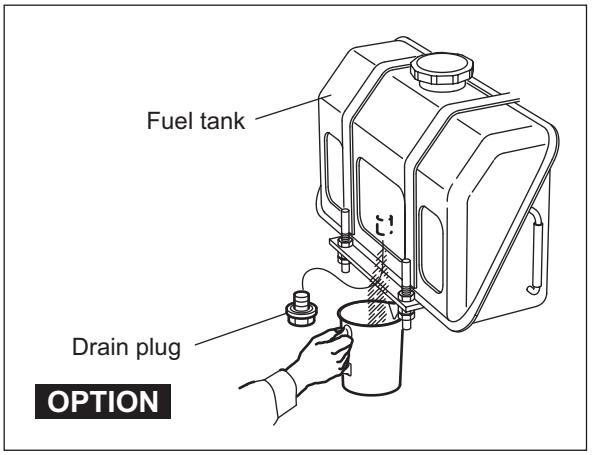
## 2.2.3 Inspection every 50 hours

Be sure to check the following points every 50 hours operation.

| No. | Inspection Item |
|---|---|
| (1) | Fuel tank draining |
| (2) | Water separator draining |
| (3) | Bleeding the fuel system |
| (4) | Battery electrolyte level check and battery recharging |

### (1) Fuel tank draining

1)Prepare a waste oil container.
2)Remove the drain plug of the fuel tank to drain (water, dust, etc.) from the fuel tank bottom.
3)Drain until fuel with no water and dust flow out. Then tighten the drain plug firmly.

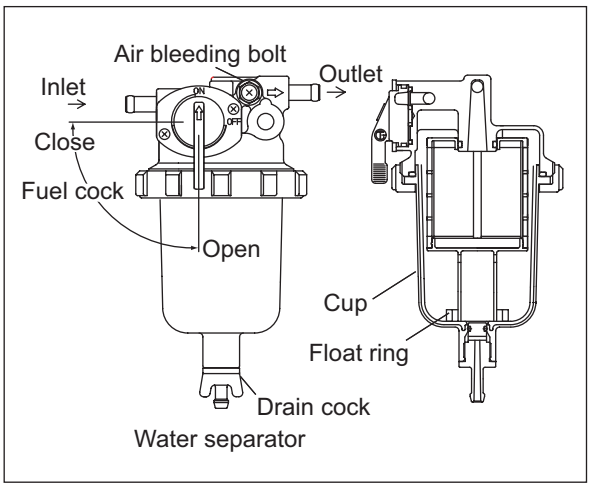



### (2) Water separator draining

Drain off the water separator whenever there is a lot of drain collected in the water separator at the bottom of the cup even if not the time for periodic inspection hour. The cup of the water separator is made from semi-transparency material and in the cup, the red colored float ring which rises on the surface of the drain is installed to visualize the amount of drain. Also, the water separator with sensor to detect the drain for warning device on a control panel is provided as the optional.

Drain off the water separator in the following manner.

1)Prepare a waste oil container.
2)Close the fuel cock.
3)Loosen the drain cock at the bottom of the water separator, and drain off any water collected inside.
4)Tighten the drain cock with hand.
5)Be sure to bleed air in the fuel system.




NOTE:

If no drain drips when the drain cock is opened, loosen the air bleeding bolt on the top of the water separator by turning counter-clockwise 2 to 3 times using screw driver.

(This may occur in case of the water separator position is higher than the fuel oil level in the fuel tank). After draining, be sure to tighten the air bleeding bolt.

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### (3) Bleeding the fuel system

Bleed the fuel system according to the following procedures. When there is air in the fuel system, the fuel injection pump will not be able to function.

1)Check the fuel oil level in the fuel tank. Refuel if insufficient.

2)Open the cock of the water separator.

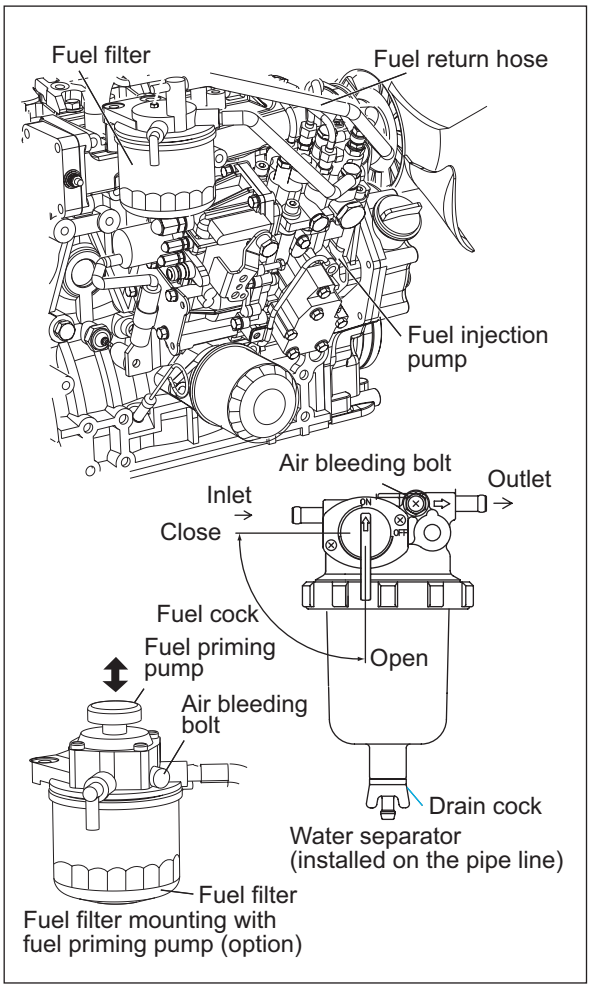
3)Loosen the air bleeding bolt on the water separator by turning 2 to 3 times to the counter-clockwise using screw driver or spanner.

4)When the fuel coming out is clear and not mixed with any bubble, tighten the air bleeding bolt.

5)Feed the fuel with the fuel priming pump or electro-magnetic fuel feed pump.

• In case of the engine using the electro-magnetic fuel feed pump.
Turn the starter switch to the ON position and hold it in the position for 10 to 5 seconds to operate the fuel feed pump.

• In case of the engine installed the fuel filter mounting with the fuel priming pump.
The priming pump is on the top of the fuel filter mounting. Move the priming pump up and down to feed fuel until feel your hand slightly heavy.



Fuel filter mounting with fuel priming pump (option)

### (4) Battery electrolyte level check and battery recharging

**⚠ WARNING**



## Fire due to electric short-circuit

•Make sure to turn off the battery switch or disconnect the negative cable (-) before inspecting the electrical system. Failure to do so could cause short-circuiting and fires.

•Always disconnect the (-) Negative battery cable first before disconnecting the battery cables from battery. An accidental "Short circuit" may cause damage, fire and or personal injury.
And remember to connect the (-) Negative battery cable (back onto the battery) LAST.



## Proper ventilation of the battery area

Keep the area around the battery well ventilated, paying attention to keep away any fire source. During operation or charging, hydrogen gas is generated from the battery and can be easily ignited.



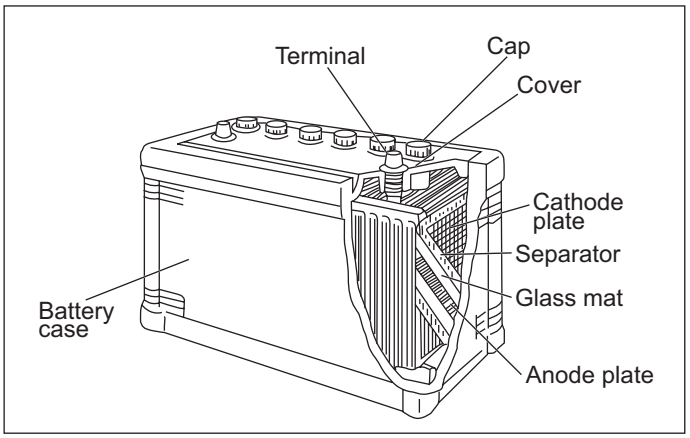
## Do not come in contact with battery electrolyte

Pay sufficient attention to avoid your eyes or skin from being in contact with the fluid. The battery electrolyte is dilute sulfuric acid and causes burns. Wash it off immediately with a large amount of fresh water if you get any on you.

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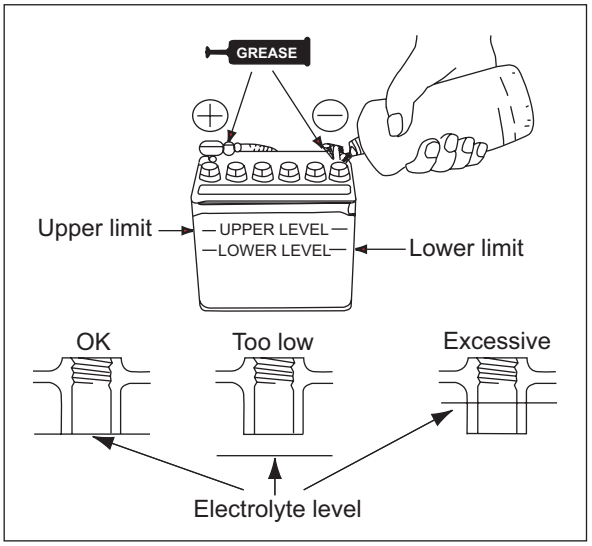


**Battery structure**




## (1) Electrolyte level

- Check the level of fluid in the battery.
  When the amount of fluid nears the lower limit, fill with battery fluid (available in the market) to the upper limit. If operation continues with insufficient battery fluid, the battery life is shortened, and the battery may overheat and explode.
- Battery fluid tends to evaporate more quickly in the summer, and the fluid level should be checked earlier than the specified times.
- If the engine cranking speed is so slow that the engine does not start up, recharge the battery.
- If the engine still will not start after charging, replace the battery.
- Remove the battery from the battery mounting of the machine unit after daily use if letting the machine unit leave in the place that the ambient temperature could drop at -15 °C or less. And store the battery in a warm place until the next use the unit to start the engine easily at low ambient temperature.



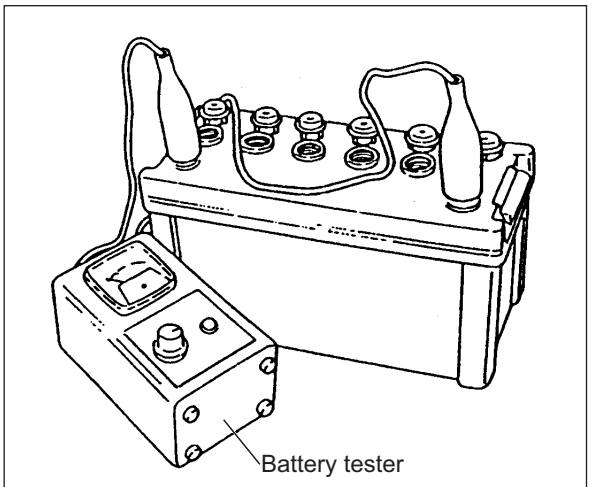

## (2) Battery charge

Use a battery tester or hydrometer and check the battery condition. If the battery is discharged, recharge it.

### (a)Measurement with a battery tester

When checking the battery with the batter tester, connect the red clip of the tester to the battery positive (+) terminal and black clip to the battery negative (-) terminal by pinching them securely, and judge the battery charge level from the indicator position.

Green zone: Normal
Yellow zone: Slightly discharged
Red zone: Defective or much discharged




Battery charge measurement with battery tester

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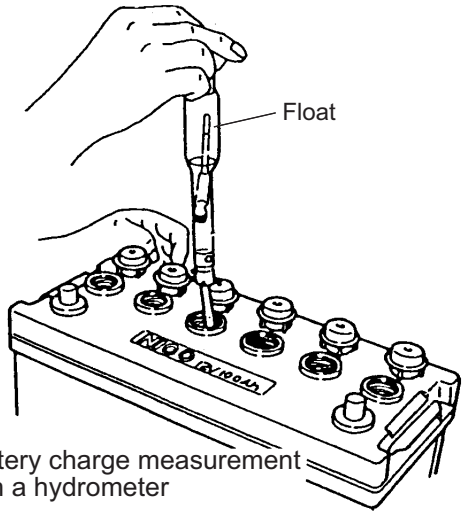


(b)Measurement with hydrometer

When using a hydrometer, the measured specific gravity must be corrected according to the temperature at the time of measurement. The specific gravity of battery electrolyte is defined with 20 °C as the standard. Since the specific gravity increases or decreases by 0.0007 when the temperature varies by 1 °C, correct the value according to the equation below.

$$S20 = St + 0.007(t-20)$$

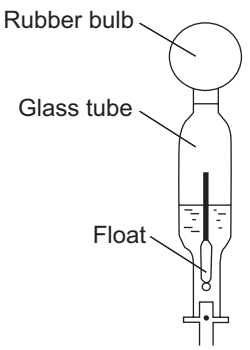
- t: Electrolyte temperature at measurement
- St: Specific gravity at measurement
- S20: Converted specific gravity at 20°C




Battery charge measurement with a hydrometer

(c)Specific gravity and remaining battery charge

| Specific gravity (20 °C) | Discharged quantity of electricity (%) | Remaining charge (%) |
|---|---|---|
| 1.28 | 0 | 100 |
| 1.26 | 10 | 90 |
| 1.24 | 20 | 80 |
| 1.23 | 25 | 75 |




Hydrometer structure

## (3) Terminals

Clean if corroded or soiled.

## (4) Mounting bracket

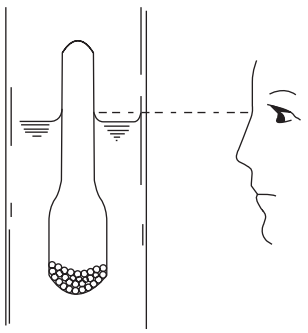
Repair or replace it if corroded.

Retighten if loosened.

## (5) Battery appearance

Replace the battery if cracked or deformed.

Clean with fresh water if contaminated.



How to read hydrometer

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## 2.2.4 Inspection every 250 hours or 3 months

Be sure to check the following points every 250 hours or 3 months operation, whichever comes first.

| No. | Inspection Item |
|---|---|
| (1) | Lube oil and filter replacement |
| (2) | Radiator fin cleaning |
| (3) | V-belt tension check |
| (4) | Inspection and adjustment of governor lever and accelerator |
| (5) | Air cleaner cleaning and element replacement |

### (1) Lube oil and filter replacement (The second replacement and after)

Replace the engine oil every 250 hours operation from 2nd time and on. Replace the engine oil filter at the same time. Refer to 2.2.1.(1).

### (2) Radiator fin cleaning

**⚠ CAUTION**



**Beware of dirt from air blowing**

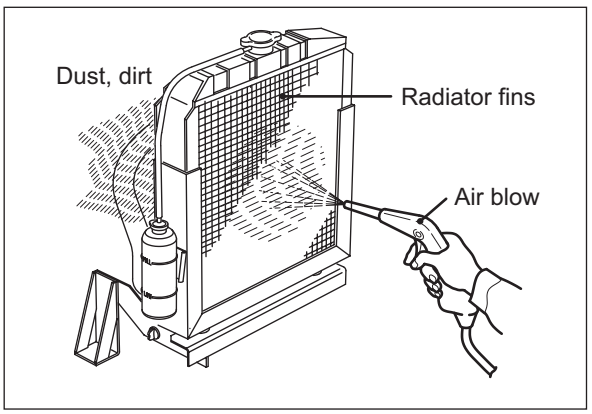
Wear protective equipment such as goggles to protect your eyes when blowing compressed air. Dust or flying debris can hurt eyes.

Dirt and dust adhering on the radiator fins reduce the cooling performance, causing overheating. Make it a rule to check the radiator fins daily and clean as needed.

- Blow off dirt and dust from fins and periphery with compressed air [0.19MPa (2 kgf/cm$^2$) or less] not to damage the fins with compressed air.
- If contaminated heavily, apply detergent, thoroughly clean and rinse with tap water shower.

IMPORTANT:

Never use high pressure water or air from close by fins or never attempt to clean using a wire brush. Radiator fins can be damaged.




### (3) V-belt tension check (The second time and after)

Check and adjust the V-belt tension. Refer to 2.2.2(2)

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### (4) Inspection and adjustment of governor lever and accelerator

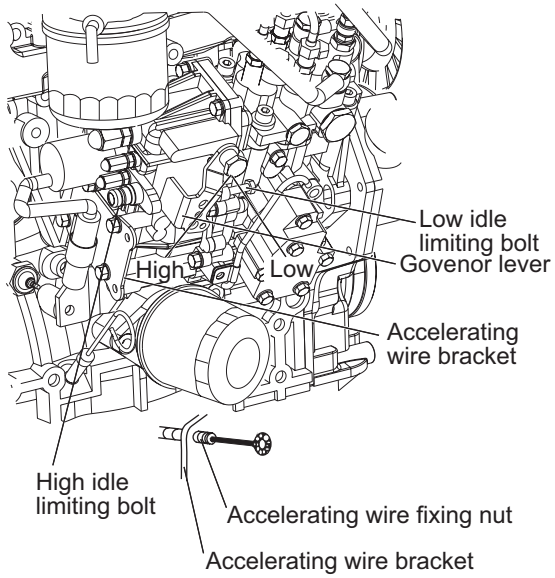
The governor lever and accelerating devices (accelerating lever, pedal, etc.) of the machine unit are connected by an accelerating wire or rod. If the wire becomes stretched or the connections loose, the deviation in the position may result and make operation unsafe. Check the wire periodically and adjust if necessary.

Do not strongly move the accelerating wire or accelerating pedal. It may deform the governor lever or stretch the wire to cause irregular engine speed control. Checking and adjusting procedure are as follows.

1)Check that the governor lever of the engine makes uniform contact with the high idling and low idling limiting bolt when the accelerating devices is in the high idling speed or low idling speed position.

2)If either the high or the low idling speed side does not make contact with the limiting bolt, adjust the accelerating wire.

Loosen the accelerating wire fixing nut and adjust the wire to contact with the limiting bolt.




**MP2 Fuel Injection pump**

**⚠ CAUTION**

Never release the limiting bolts. It will impair the safety and performance of the product and functions and result in shorter engine life.

### (5) Air cleaner cleaning and element replacement

**⚠ CAUTION**



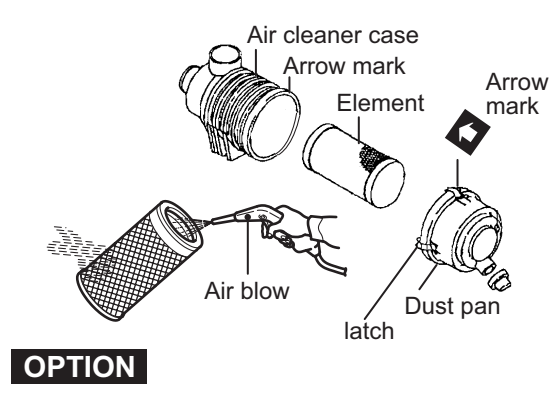
## Beware of dirt from air blowing

Wear protective equipment such as goggles to protect your eyes when blowing compressed air. Dust or flying debris can hurt eyes.

The engine performance is adversely affected when the air cleaner element is clogged by dust. So periodical cleaning after disassembly is needed.

1)Undo the clamps on the dust pan and remove the dust pan.

2)Loosen the wing bolt on the element and pull out the element.




**OPTION**

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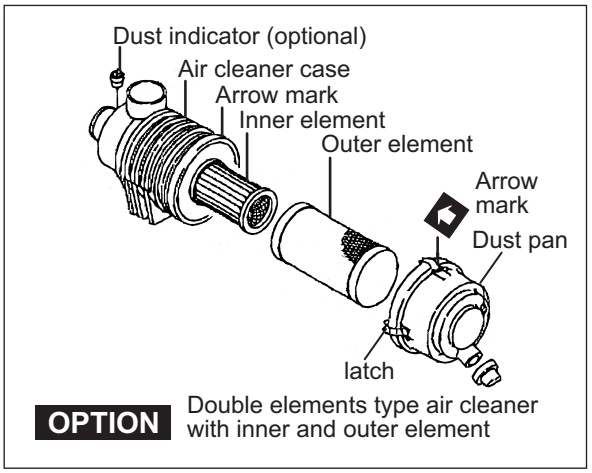


3)Blow air [0.29 to 0.49 MPa (3.0 to 5.0 kgf/cm$^2$)] from inside the element to blow dust off as shown in the illustration right.
Apply the air blowing pressure as low as possible so as not to damage the element.
If having the air cleaner with double elements, never remove and clean the inner element.
The aim of installing the inner element is for back up protecting from intaking dust during engine running when leaving the outer element to reinstall after removing it or when damaging the outer element unexpectedly during engine running.

4)Replace the element with new one, If the element is damaged, excessively dirty or oily.

5)Remove the inside dust cover of the dust pan, and clean inside of the dust pan.

6)Reinstall the element with the wing bolt. (do not leave the gasket.) Reattach the inside dust cover to the dust pan and install the dust pan to the air cleaner case placing the TOP mark upward.




IMPORTANT:

- When the engine is operated in dusty conditions, clean the element more frequently.
- Do not run the engine with removed air cleaner or element, as this may cause foreign material to enter and damage the engine.

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## 2.2.5 Inspection every 500 hours or 6 months

Be sure to check the following points every 500 hours or 6 months operation, whichever comes first.

| No. | Inspection Item |
|---|---|
| (1) | Water separator cleaning |
| (2) | Fuel filter element replacement |
| (3) | Air cleaner cleaning and element replacement |

### (1) Water separator cleaning

Periodically wash the water separator element and inside cup with clean fuel oil.

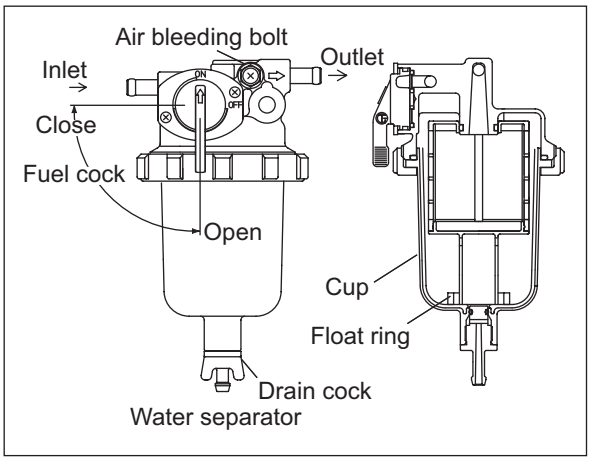
1)Prepare a waste oil container.

2)Close the fuel cock.

3)Loosen the drain cock and drain.
Refer to 2.2.3.(2)

4)Turn the retaining ring counter-clockwise and remove the cup.
(Disconnect the coupler of the lead wire for drain sensor before removing the cup if it is with drain sensor).

5)Wash the element and inside cup with clean fuel oil. Replace the element with new one if any damaged.




| Model | Applicable element Part No. |
|---|---|
| 3TNV82A to 4TNV106 (T) | 119802-55710 |

6)Insert the element to the bracket (O-ring) and after putting the float ring in the cup, install it to the bracket by tightening the retaining ring clockwise.
Tightening torque: 15 to 20 N•m (1.5 to 2.0 kgf•m)

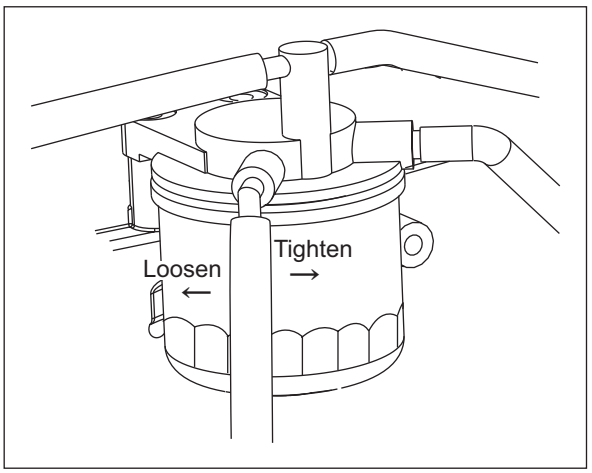
7)Close the drain cock (connect the coupler if with drain sensor).

8)Bleed the fuel system. Refer to 2.2.3.(3)

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## (2) Fuel filter element replacement




Replace the fuel filter at specified intervals, before it is clogged with dust to adversely affect the fuel flow. Also, replace the fuel filter after the engine has fully been cooled.

1)Close the fuel cock of the water separator.

2)Remove the fuel filter using a filter wrench (customer procured). When removing the fuel filter, hold the bottom of the fuel filter with a piece of rag to prevent the fuel oil from dropping. If you spill fuel, wipe such spillage carefully.

3)Clean the filter mounting surface and slightly apply fuel oil to the gasket of the new fuel filter.

4)Install the new fuel filter manually turning until it comes into contact with the mounting surface, and tighten it further to 1/2 of a turn using a filter wrench.
Tightening torque for 3TNV82A to 4TNV106 (T):
20 to 24 N•m (2.0 to 2.4 kgf•m)

| Model | Applicable fuel filter Part No. |
|---|---|
| 3TNV82A to 4TNV88 | 119802-55800 |
| 4TNV98 (T) to 4TNV106 (T) | 123907-55800 |

5)Bleed the fuel system. Refer to 2.2.3.(3)

IMPORTANT:

Be sure to use genuine Yanmar part (super fine mesh filter). Otherwise, it results in engine damage, uneven engine performance and shorten engine life.

## (3) Air cleaner cleaning and element replacement

Replace the air cleaner element periodically even if it is not damaged or dirty.

When replacing the element, clean inside of the dust pan at the time.

If having the air cleaner with double elements, do not remove the inner element. If the engine output is still not recover (or the dust indicator still actuates if having the air cleaner with a dust indicator) even though the outer element has replaced with new one, replace the inner element with new one.

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## 2.2.6 Inspection every 1,000 hours or one year

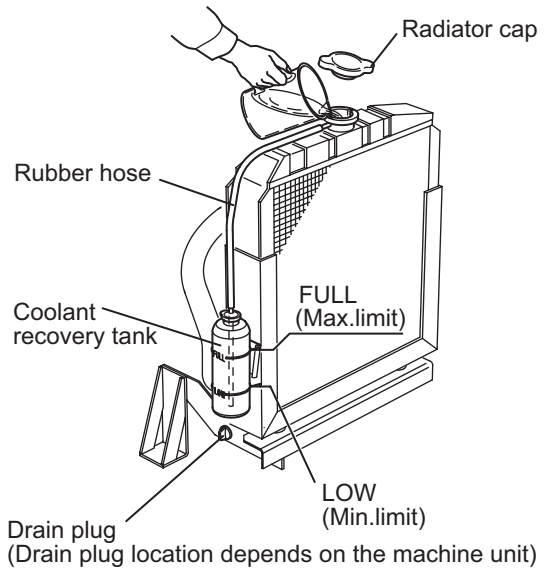
Be sure to check the following points every 1,000 hours or one year operation, whichever comes first.

| No. | Inspection Item |
|---|---|
| (1) | Cooling water replacement |
| (2) | Diaphragm assy inspection |
| (3) | Turbocharger blower cleaning* |
| (4) | Intake/exhaust valve clearance adjustment |
| (5) | Fuel injection nozzle pressure inspection |

### (1) Cooling water replacement

Cooling water contaminated with rust or water scale reduces the cooling effect. Even when antifreeze agent (LLC) is mixed, the cooling water gets contaminated due to deteriorated ingredients. Replace the cooling water at least once a year.

**OPTION**




(Drain plug location depends on the machine unit)

**⚠ CAUTION**



**Beware of scalding by hot water**

Wait until the temperature goes down before draining the coolant water. Otherwise, hot water may splash to cause scalding.

1)Remove the radiator cap.
2)Loosen the drain plug at the lower portion of the radiator and drain the cooling water.
3)After draining the cooling water, tighten the drain plug.
4)Fill radiator and engine with cooling water.
  a)Before filling, check to be sure the drain plug is closed.
  b)Remove the radiator cap of the radiator by turning the radiator cap counter-clockwise about 1/3 of a turn.
  c)Pour the cooling water slowly into the radiator up to the lip of the filler port so that air bubbles do not develop.
  d)After supplying the cooling water, surely tighten the radiator cap. To fasten the radiator cap, align the detents on the back face of the radiator cap with the slot of the filler port and turn clockwise pushing it downward approx. 1/3 of a turn until contact with each other.
  e)Remove the cap of the coolant recovery tank, supply the cooling water to the FULL mark and fasten the cap.
  f)Check the rubber hose connecting the coolant recovery tank to the radiator. Be sure the rubber is securely connected and there is no looseness or damage. When the rubber hose is not water tight, an excessive amount of cooling water will be consumed.

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g)When filling with the cooling water for the first time or replacing, the air contains in the cooling water system. So, as the air in the cooling water system is self-bleeded during engine operation, the cooling water level in the radiator and coolant recovery tank will be lowered. Replenish the cooling water into the radiator and coolant recovery tank until it reaches the FULL mark of the coolant recovery tank.

- Daily check of the cooling water level and refilling can be done by observing the coolant recovery tank.
- The cooling water capacity of the radiator depends on the machine unit. Refer to the operation manual provided by the equipment manufacturer.
- Check the cooling water level when the engine is cold. Cooling water flows to the coolant recovery tank when the radiator is still hot and makes accurate checks impossible.
- Check the radiator and hoses for leakage.

## (2) Diaphragm assy inspection

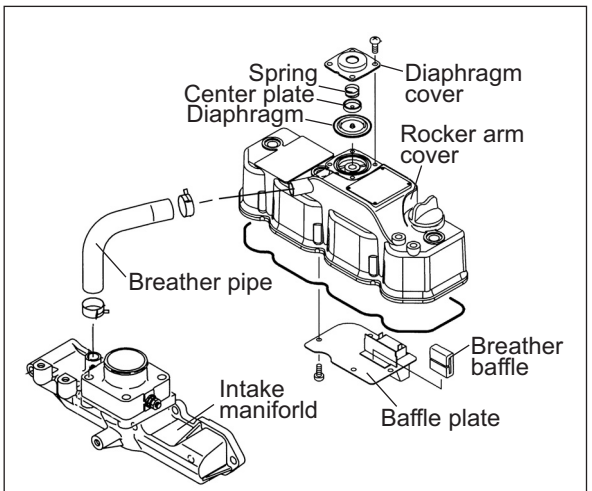
Inspect the diaphragm assy on the rocker arm cover every 1000 hours or **2 years**. Refer to 4.2.4 point 6 for the function of the diaphragm.

1)Loosen screws, and remove a diaphragm assy, and check whether oil and so on doesn't enter between the diaphragm and the cover. If oil and so on enters into the diaphragm assy, the diaphragm doesn't work well.

2)Check the damages of the diaphragm rubber and the spring. If necessary, replace with new ones.

[NOTICE]

- When a diaphragm is damaged, pressure control inside the crankcase becomes insufficient, and troubles such as combustion defect and so on occur.
- At lubricating oil replacement or lubricating oil supply, the amount of lubricating oil isn't to be beyond the standard upper limit. If the lubricating oil quantity is beyond the upper limit or an engine is operated beyond the allowable maximum angle of an engine, the amount of oil mist may be inducted in the combustion chamber and the oil hammer sometimes may occur.




**Breather system componert**

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## (3) Turbocharger blower cleaning*

When engine speed seems sluggish or the exhaust color looks poor, the blades of the turbocharger-blower may be dirty.

Wash the turbine blower in such a case.

### (a)General items

1)As for washing, use washing liquid and clear water.

2)Washing time is the time when about 10% of the boost pressure decreases more than that of usual operation state as a standard.

3)Disassemble and clean a turbocharger periodically because the whole of the turbocharger can't be cleaned in this method.

### (b)Washing point

1)A specified quantity of washing liquid/water is poured with a filler (ex. Oil sprayer) from the air inlet of the blower gradually (about ten seconds) at the normal load (3/4-4/4) of an engine.

And, perform this work at no-load after load running of the engine, if it is difficult to pour the liquid into the blower at load running.

Specified quantity of washing liquid/water

| Turbocharger model | RHB31, RHB51 |
|---|---|
| Injection amount, one time | 20 cc |

**⚠ CAUTION**

It causes an accident when large quantity of washing liquid is poured rapidly into a turbocharger.

2)Pour the same amount of clear water as washing liquid/water into the blower about 3-5 minutes later after the washing liquid/water injection and wash it.

**⚠ CAUTION**

It causes an accident when large quantity of water is poured rapidly into a turbocharger.

3)Repeat the washing after then minutes when there is no change with the boost pressure or the exhaust gas temperature after washing.

When there is no change at all even if it repeats 3-4 times, disassemble and maintain the turbocharger because of the cruel dirt of the blower or other causes.

4)Operate the engine at load for at least 15 minutes after washing, and dry.

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## (4) Intake/exhaust valve clearance adjustment

Make measurement and adjustment while the engine is cold.

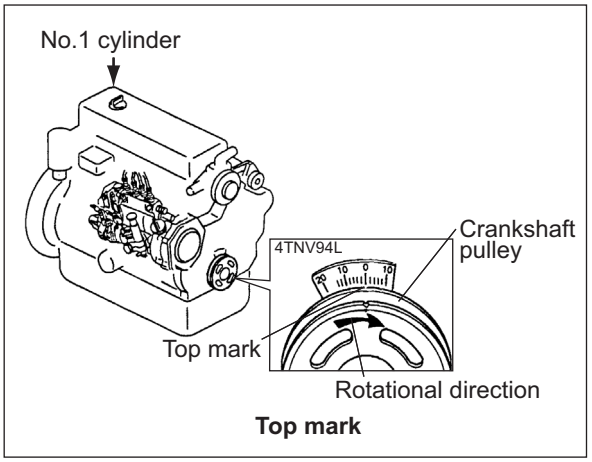
### (a)Valve clearance measurement

1)Remove the rocker arm cover above cylinder head.

2)Set the No.1 cylinder in the compression TDC

Turn the crankshaft to bring the piston of the No.1 cylinder to its compression top dead center while watching the rocker arm motion, timing scale and the top mark position of the crankshaft pulley.

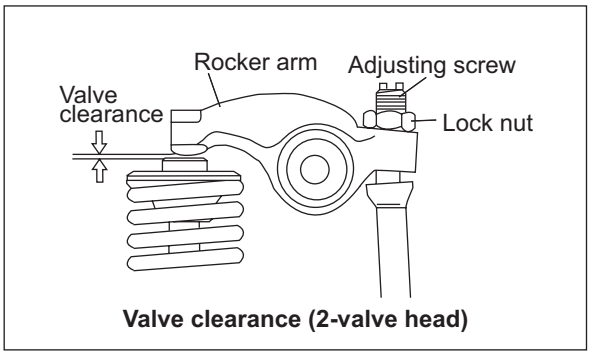
(Position where both the intake and exhaust valves are closed.)




**Top mark**

Notes:

- The crankshaft shall be turned clockwise as seen from the radiator side.
- The No.1 cylinder position is on the opposite side of the radiator and the ignition order shall be 1-3-4-2-1 at 180° intervals.
- Since the intake and exhaust valve rocker arms are operated the same and there is a clearance between the arm and valve generally at the top dead center, the position can be checked by means of the play when the arm head is held with a hand. Also see that the crankshaft pulley top mark is positioned at zero on the timing scale. If there is no valve clearance, inspection in the disassembled state is necessary since the valve seat may be worn abnormally.



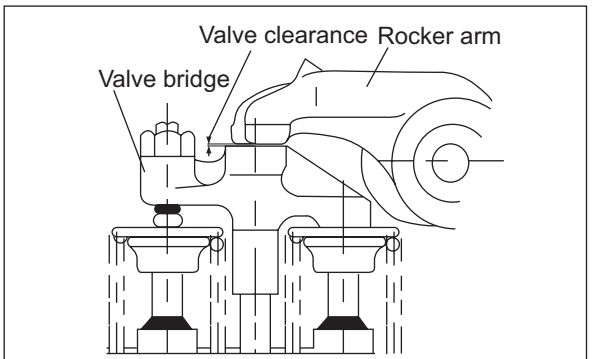

**Valve clearance (2-valve head)**

3)Valve clearance measurement

In case of 2-valve cylinder head insert a thickness gage between the rocker arm and valve cap, and record the measured valve clearance.

In case of 4-valve head insert a thickness gage between the rocker arm and the valve bridge, and record the measured valve clearance.

(Use it as the data for estimating the wear state.)




**Valve clearance (4-valve head)**

4)Adjusting other cylinders

In case of 4-cylinder engines, turn the crankshaft 180° and make adjustment for the No.3 cylinder. Then adjust the No.4 and No.2 cylinders in this order.

The cylinder to be adjusted first does not have to be the No.1 cylinder. Select and adjust the cylinder where the piston is the nearest to the top dead center after turning, and make adjustment for other cylinders in the order of ignition by turning the crankshaft 180° each time.

In case of 3-cylinder engines, turn the crankshaft 240° and make adjustment for the No.3 cylinder.

Then adjust the No.2 cylinder in this order.

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The cylinder to be adjusted first does not have to be the No.1 cylinder. Select and adjust the cylinder where the piston is the nearest to the top dead center after turning, and make adjustment for other cylinders in the order of ignition by turning the crankshaft 240° each time.

The adjustment method of reducing the flywheel turning numbers (for reference):

For 3 cylinder engines

Set No.1 cylinder to the compression T.D.C.and adjust the clearance of the ● mark of the below table. Next, turn the flywheel once (the suction / exhaust valve of No.1 cylinder is in the position of the overlap T.D.C. at this time), and adjust the clearance of the ○ mark.

Ignition order of 3 cylinder engines: 1→3→2

| Cylinder No. | 1 | | 2 | | 3 | | |
|---|---|---|---|---|---|---|---|
| Valve | Suction | Exhaust | Suction | Exhaust | Suction | Exhaust | |
| No.1 compression T.D.C | ● | ● | ● | | | ● | The first time |
| No.1 overlap T.D.C | | | | ○ | ○ | | The second time |

For 4 cylinder engines

Set No.1 cylinder to the compression T.D.C. and adjust the clearance of the ● mark of the bottom table. Next, turn the flywheel once, and adjust the clearance of the ○ mark.

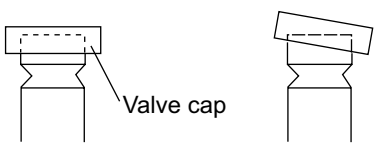
Ignition order of 4 cylinder engines: 1→3→4→2

| Cylinder No. | 1 | | 2 | | 3 | | 4 | | |
|---|---|---|---|---|---|---|---|---|---|
| Valve | Suction | Exhaust | Suction | Exhaust | Suction | Exhaust | Suction | Exhaust | |
| No.1 compression T.D.C | ● | ● | ● | | | ● | | | The first time |
| No.4 compression T.D.C | | | | ○ | ○ | | ○ | ○ | The second time |

(b)Valve clearance inspection and adjustment

1) Loosen adjusting bolts

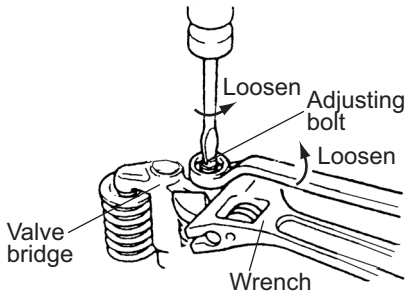
In case of 2-valve cylinder head loosen the lock nut and adjusting screw, and check the valve for any inclination of valve cap, entrance of dirt or wear.




In case of 4-valve cylinder head loosen the lock nut and adjusting screw of rocker arm. Be careful that excessive tension isn't applied to the valve bridge, and loosen a locknut of valve bridge.

[NOTICE]

When loosening a locknut of a valve bridge, loosen the locknut while fixing the valve bridge with a wrench so that the valve may not lean.



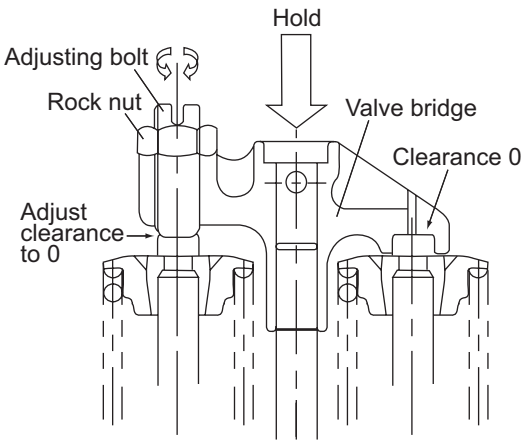

**4 Valve cylinder head**

(R.1)

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Push the bridge head so that a valve bridge and two valve stem heads may contact each other uniformly, and adjust an adjusting bolt so that a gap of the valve stem head may become 0. Tighten a locknut after a valve bridge is fixed with a wrench.



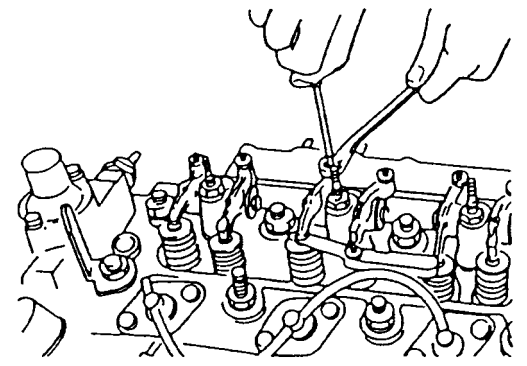

**4-Valve cylinder head**

2)Measuring valve clearance

Insert a 0.2 or 0.3 mm thickness gage between the rocker arm and valve cap / valve bridge, and adjust the valve clearance. Tighten the adjusting screw.

mm

| Model | Standard valve clearance |
|---|---|
| 3TNV82A to 98 | 0.15 to 0.25 |
| 4TNV106 (T) | 0.25 to 0.35 |



**Valve clearance adjustment**

[NOTICE]

When tightening a valve bridge locknut of 4-valve head, tighten a locknut after fixing a valve bridge with a wrench so that a bridge may not rotate and a valve may not lean.

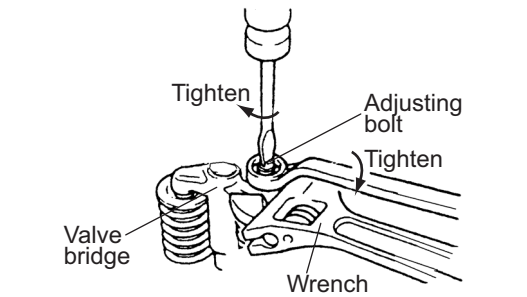
3)Apply oil to the contact surface between adjusting screw and push rod.

4)Adjusting other cylinders

In case of 4-cylinder engines turn the crankshaft 180° then and make adjustment for the No.3 cylinder. Then adjust the No.4 and No.2 cylinders in this order. The cylinder to be adjusted first does not have to be the No.1 cylinder. Select and adjust the cylinder where the piston is the nearest to the top dead center after turning, and make adjustment for other cylinders in the order of ignition by turning the crankshaft 180° each time.

In case of 3-cylinder engines turn the crankshaft 240° then and make adjustment for the No.3 cylinder. Then adjust the No.2 cylinder in this order.

The cylinder to be adjusted first does not have to be the No.1 cylinder. Select and adjust the cylinder where the piston is the nearest to the top dead center after turning, and make adjustment for other cylinders in the order of ignition by turning the crankshaft 240° each time.




**4 Valve cylinder head**

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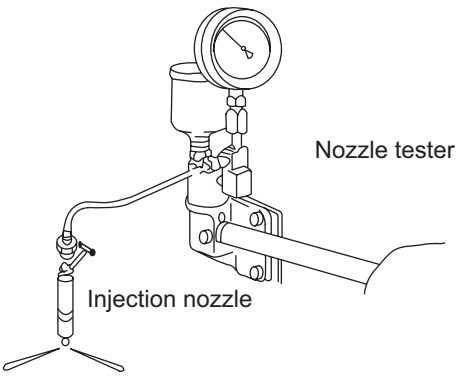
## (5) Fuel injection nozzle pressure inspection

**⚠ CAUTION**

Wear protective glasses when testing injection from the fuel injection valve. Never approach the injection nozzle portion with a hand. The oil jetting out from the nozzle is at a high pressure to cause loss of sight or injury if coming into careless contact with it.

### (a)Injection pressure measurement

| Model | Standard MPa (kgf/cm$^2$) |
|---|---|
| 3TNV82A to TNV88 (CL) | 19.6-20.6 (200-210) |
| 3TNV82A to TNV88 (VM) | 21.6-22.6 (220-230) |
| 4TNV94L4 to TNV106(T) | |




Injection pressure measurement with nozzle tester

[NOTICE]

As for the opening pressure of the brand-new fuel nozzle, about 0.5 Mpa (5 kgf/cm) declines by the engine operation for about 5 hours because of the initial wear-out of a spring etc. Therefore, adjust 0.5 MPa (5 kgf/cm) higher than the standard value of the above table when adjusting a new fuel nozzle of a spare part.

Remove carbon deposit at the nozzle hole thoroughly before measurement.

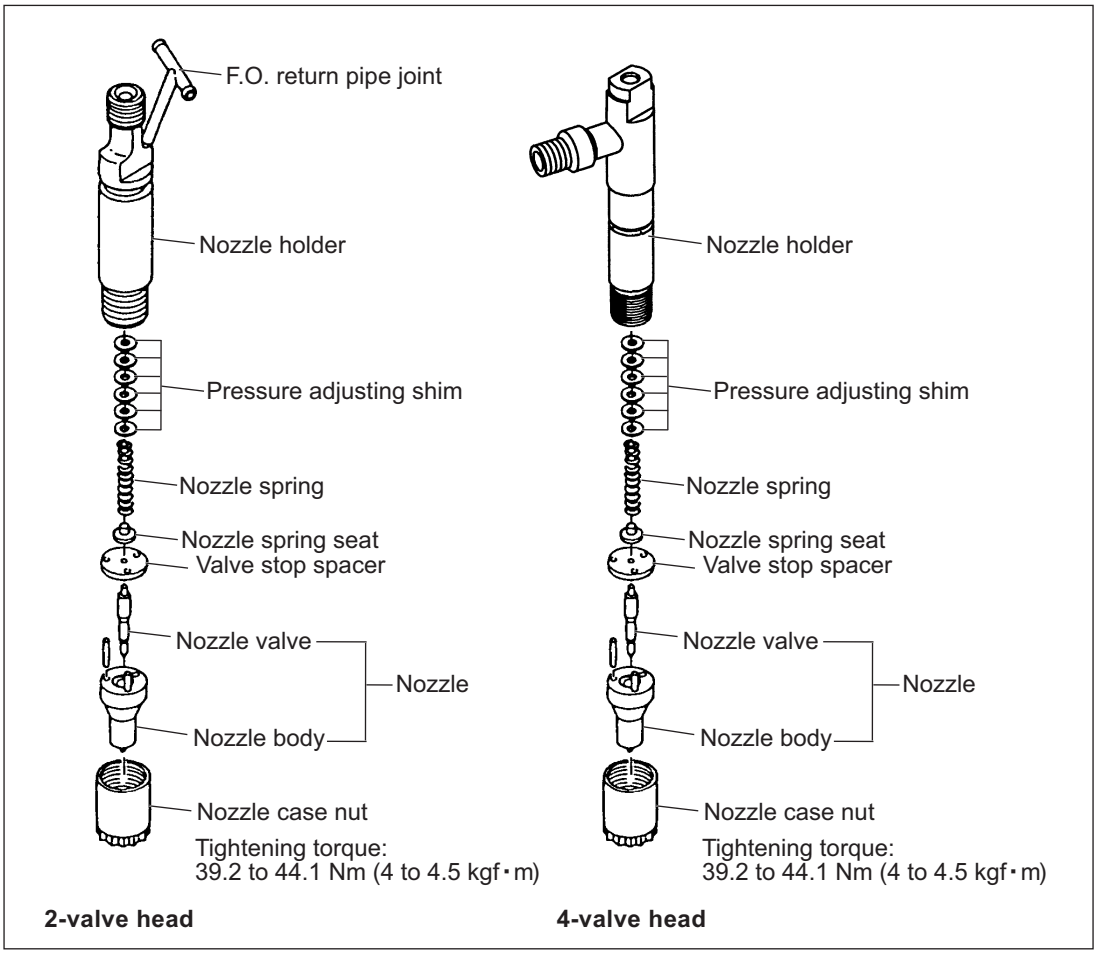
1)Connect the fuel injection valve to the high pressure pipe of the nozzle tester.
2)Operate the nozzle tester lever slowly and read the pressure at the moment when the fuel injection from the nozzle starts.
3)If the measured injection pressure is lower than the standard level, replace the pressure adjusting shim with a thicker one.

| Thickness of pressure adjusting shims mm | Injection pressure adjustment |
|---|---|
| 0.13, 0.15, 0.18, 0.4, 0.5, 0.8 | The injection pressure is increased by approx. l.9 MPa (l9 kgf/cm$^2$), when the adjusting shim thickness is increased by 0.l mm. |

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[Informative: Fuel injection valve structure]

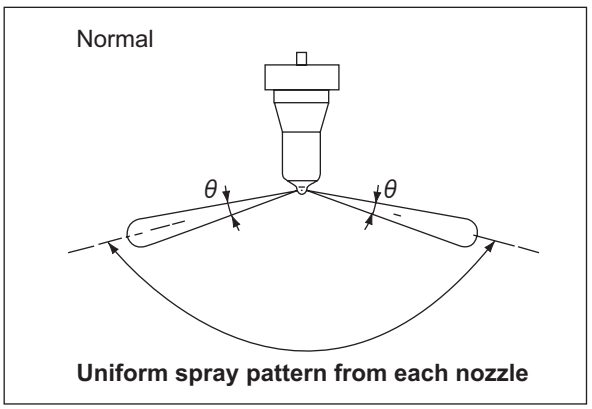



(b)Spray pattern inspection

After adjustment to the specified valve opening pressure, use a nozzle tester and check the spray pattern and seat oil-tightness.

**Seat oil tightness check**

- After injecting a few times, increase the pressure gradually. Hold the pressure for about 5 seconds at a little before the valve opening pressure of 1.96 MPa (20 kgf/cm$^2$), and check to see that oil does not drip from the tip end of the nozzle.
- If extreme oil leak from the overflow joint exists during injection by the nozzle tester, check after retightening. If much oil is leaking, replace the nozzle assembly.



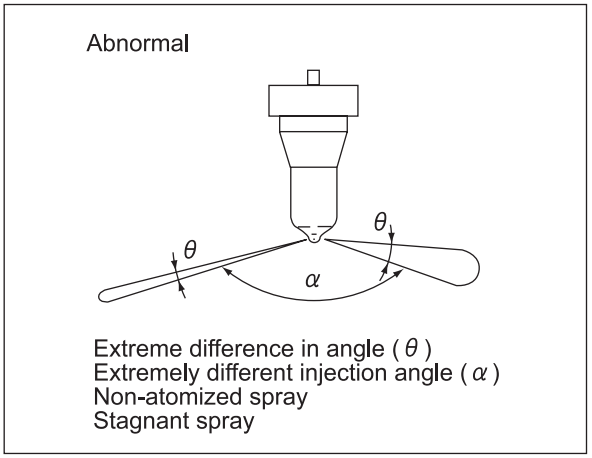

**Uniform spray pattern from each nozzle**

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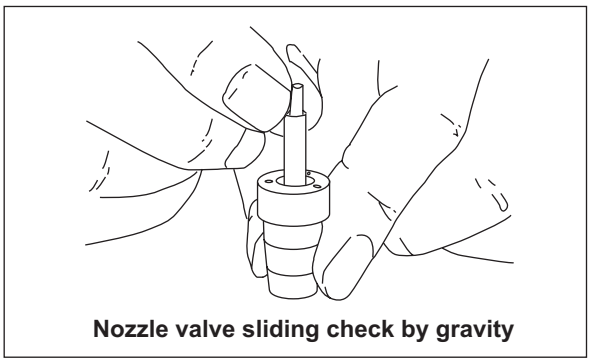
**Spray and injection states**

- Operate the nozzle tester lever at a rate of once or twice a second and check no abnormal injection.
- If normal injection as shown below cannot be obtained, replace the fuel injection valve.
- No extreme difference in angle (θ)
- No extreme injection angle difference (α)
- Finely atomized spray
- Excellent spray departure



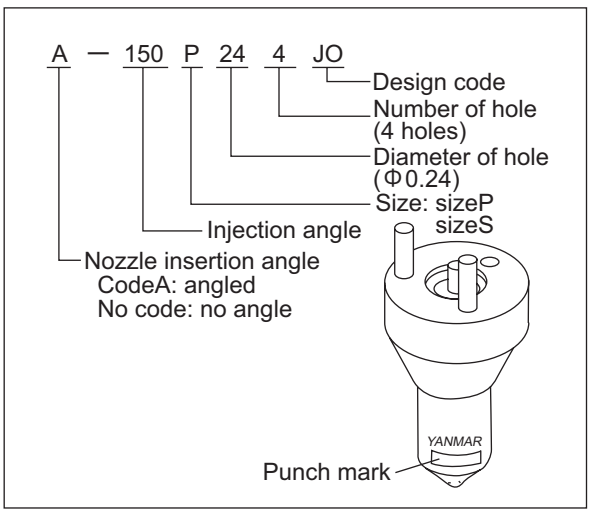

(c)Nozzle valve sliding test

Wash the nozzle valve in clean fuel oil. Place the nozzle body vertically and insert the nozzle into the body to about 1/3 of its length. The valve is normal if it smoothly falls by its own weight into the body. In case of a new nozzle, remove the seal peel, and immerse it in clean diesel oil or the like to clean the inner and outer surfaces and to thoroughly remove rust-preventive oil before using the nozzle. Note that a new nozzle is coated with rust-preventive oil and is pasted with the seal peel to shut off outer air.



**Nozzle valve sliding check by gravity**

(d)Nozzle punch mark



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## 2.2.7 Inspection every 2000 hours or 2 years

Be sure to check the following points every 2,000 hours or two years operation, whichever comes first.

| No. | Inspection Item |
|---|---|
| (1) | Coolant water path flushing and maintenance |
| (2) | Fuel pipe and coolant water pipe inspection and maintenance |
| (3) | Intake/exhaust valve seat lapping |
| (4) | Fuel injection timing adjustment<br>Fuel injection pump inspection and adjustment |

### (1) Coolant water path flushing and maintenance

Rust and water scale will accumulate in the cooling system through many hours of operation. This lowers the engine cooling effect. Oil coolers (attached to turbocharged engines and some of naturally aspirated engines) quickly deteriorate the lube oil. The cleaning and maintenance of the following parts are necessary in accordance with the coolant water replacement.

Cooling system parts: radiator, cooling water pump, thermostat, cylinder block, cylinder head, oil cooler.

### (2) Fuel pipe and coolant water pipe inspection and maintenance

Regularly check the rubber hoses of the fuel system and cooling water system. If cracked or degraded, replace them with new one. Replace the rubber hoses at least every 2 years even if 2,000 hours doesn't come.

### (3) Intake/exhaust valve seat lapping

The adjustment is necessary to maintain proper contact of the valves and seats. Refer to 4.2.6 in Chapter 4.

### (4) Fuel injection timing adjustment / Fuel injection pump inspection and adjustment

The fuel injection timing and the fuel injection pump are adjusted so that engine performance may become the best condition. As for the inspection and adjustment of the fuel pump, it is based on the service manual of the MP pump of the separate volume. The fuel injection timing is adjusted by the following procedure.

As for the engine, which adopts a MP type fuel injection pump, the fuel injection angle $\theta_i$ (note) is adjusted for the fuel injection timing adjustment.

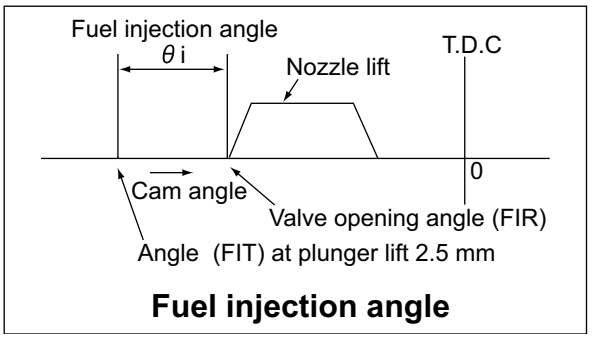
Note) The fuel injection angle $\theta_i$ (cam angle) is the difference from the injection valve opening angle(FIR) while the fuel injection pump being driven by a motor and the angle(FIR) at the plunger lift 2.5mm of the fuel pump.

And, as for the actual fuel injection angle $\theta_i$ , the measured value is recorded on the pump body by each every fuel pump as shown in the right figure.

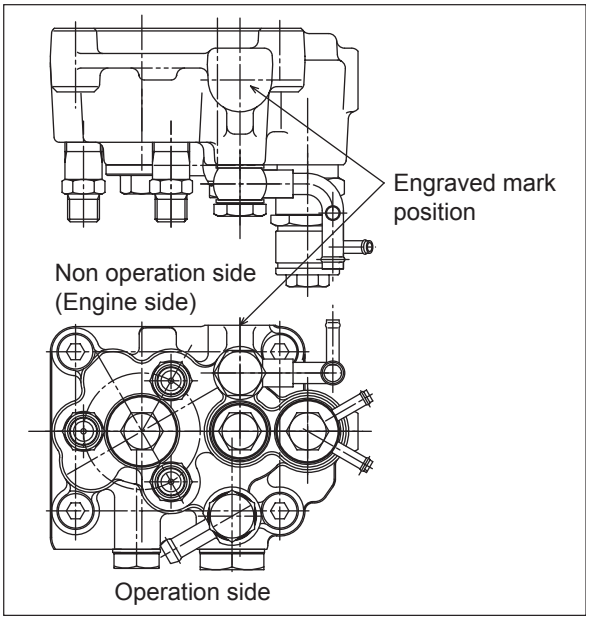
The engraved mark is shown by the value that 10 is mulitiplied by the injection angle $\theta_i$ as shown in the below table.

(Examle)

| Fuel injection angle $\theta_i$ (degree, cam angle) | Mark |
|---|---|
| 8.5 | 85 |
| 7.7 | 77 |




**Fuel injection angle**




(R.1)

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**The adjustment of fuel injection angle $\theta_i$**

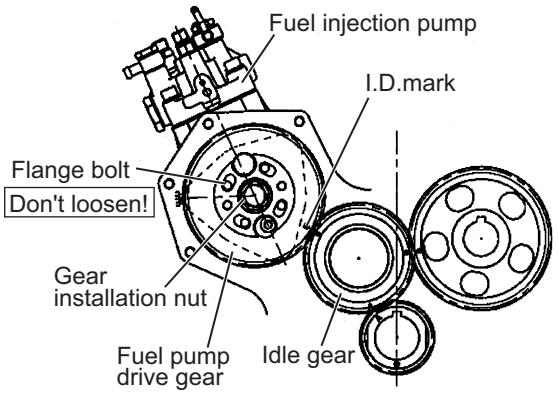
In case that the fuel pump are removed, and reassembled, the procedure of fuel injection angle adjustment is as follows. (As for the disassembly of a fuel injection pump, refer to 7.2.3 in chapter 7.)

[NOTICE]

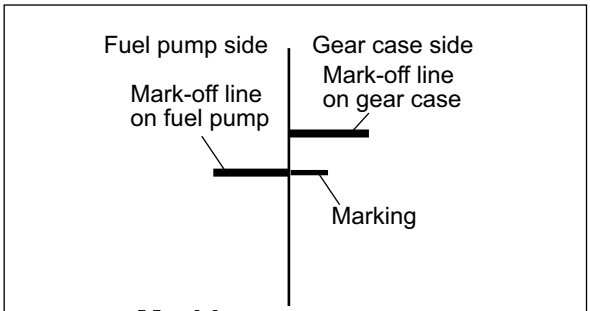
Never loosen four flange bolts, which fasten a pump flange and a fuel pump drive gear at the time of the removal of the fuel pump. When it is loosened, the adjustment of the fuel injection timing becomes very difficult.

1)Before removing a fuel pump drive gear, make ID marks on the gearing part of the pump drive gear and the idle gear with paint and so on.

2)Make the mark-off line to the gear case precisely in accordance with the position of mark-off line of the fuel pump.

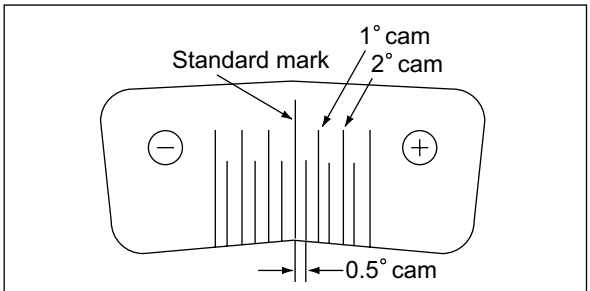



**Fuel pump installation angle**

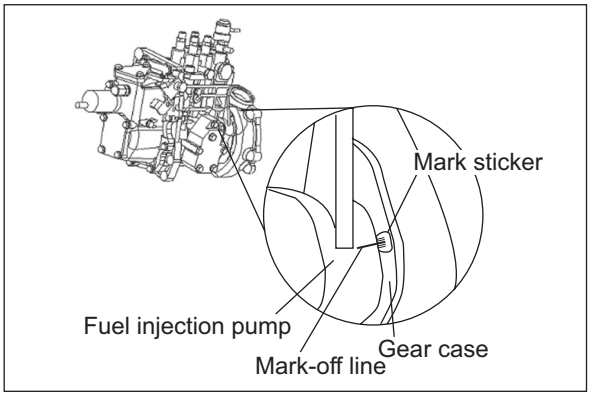



**Marking on gear case**

3)Before removing a fuel pump, put the standard mark of a sticker for fuel injection angle adjustment in accordance with the mark-off line of the fuel pump and paste it on the gear case.




**Sticker for adjusting injection angle**




(R.1)

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4)Remove a fuel pump, and read the fuel injection angle recorded in that fuel pump.

5)Read the injection angle recorded on a newly assembled fuel pump and calculate the difference from the injection angle of the disassembled fuel pump. (When re-installation does the same fuel pump, the angular difference is zero.)

Fuel injection angle difference $\Delta\ \theta_i$ (cam angle) = (the fuel injection angle $\theta_{i2}$ of a new fuel pump)
- (the fuel injection angle $\theta_{i1}$ of a disassembled previous fuel pump)

Calculation example

| Fuel injection angle difference<br><br>(degree, cam angle) | Fuel injection angle of a new fuel pump $\theta_{i2}$<br>(degree, cam angle) | Fuel injection angle of a disassembled fuel pump $\theta_{i1}$<br>(degree, cam angle) | Fuel pump installation method |
|---|---|---|---|
| +0.5 | 8.5 | 8.0 | Turn the fuel pump body in the outside directon of the cylinder block at 0.5 degree(cam angle).<br>[Advanced injection timing] |
| -0.3 | 7.7 | 8.0 | Turn the fuel pump body in the inside direction of the cylinder block at 0.3 degree(cam angle).<br>[Delayed injection timing] |

[NOTICE]

Tell the fuel pump number to Yanmar, and inquire the injection angle of the pump when it is hard to find out.

6)Put the fuel pump on the gear case temporarily and install the drive gear on the cam shaft with checking the ID marks, which were put on the fuel pump drive gear and the idle gear at the time of the disassembling.

Tighten the installation nut of a pump drive gear.

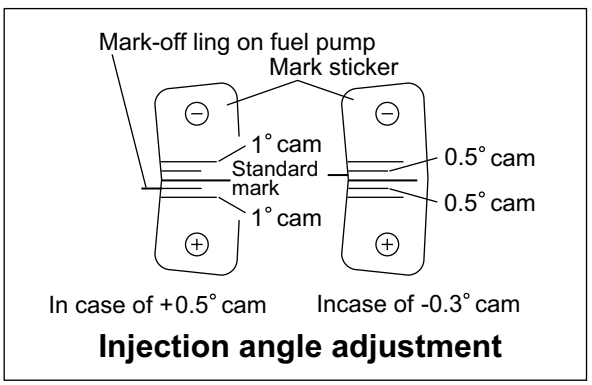
| Model | Fuel pump model | Tightening torque<br>N•m (kgf•m) | Lubricating oil application<br>(thread portion, and seat surface) |
|---|---|---|---|
| 3TNV82A to TNV88 | MP2 | 78 to 88 (8 to 9) | Not applied |
| 4TNV94L/98/106 (T) | MP4 | 113 to 123 (11.5 to 12.5) | |

7)Adjust the installation angle of the fuel pump while reading the injection angle difference, calculated in the above 5), withe the mark (minimum 0.5°, cam angle) of the adjustment mark sticker..

[NOTICE]

Push down the fuel pump in the outside direction of the cylinder block at +0.5 degree(cam) when a injection angle difference $\Delta\ \theta_i$ is +0.5 degree(cam).

And, push it down to the cylinder block side at 0.3 degree(cam) when a difference is -0.3 degree(cam).



**Injection angle adjustment**

8)Tighten the fuel pump installation nuts.

(R.1)

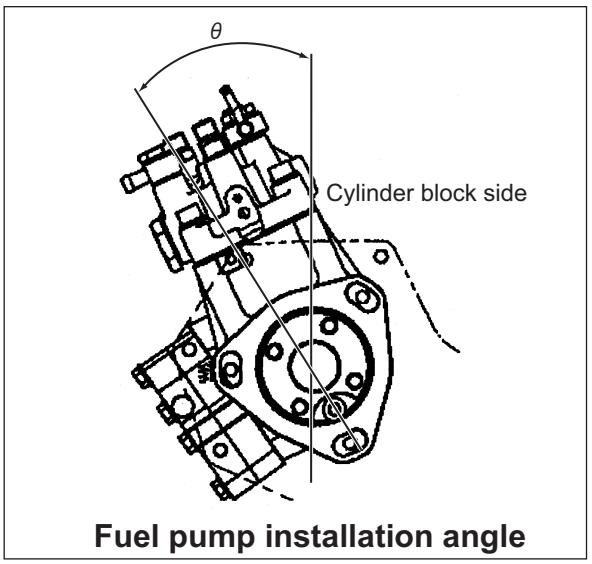
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**(Supplementary explanation 1)**

The installation angle of the fuel pump is as follows.

| Model | Installation angle θ (deg.) |
|---|---|
| 3TNV82A to TNV88 | 25 |
| 4TNV94L/98/106 (T) | 13 |
| 4TNV106 (T) | 11.5 |



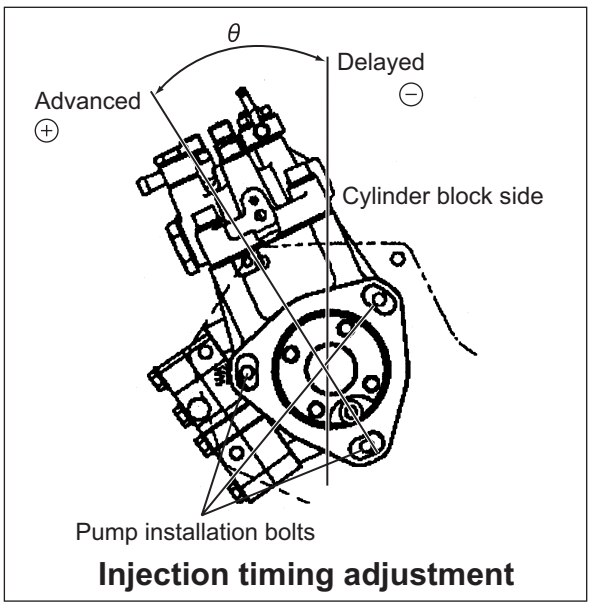

**Fuel pump installation angle**

**(Supplementary explanation 2)**

When fuel injection timing is advanced or delayed, the installation angle of the fuel pump is adjusted.

When fuel injection timing is advanced for example at 0.5 degrees(cam), loosen the nuts, which fix the fuel pump on the gear case, and turn the fuel pump body in the inside direction of the cylinder block at 0.5 degree(cam), and tighten the pump installation nuts.

And, when fuel injection timing is delayed, a pump is turned in that reverse direction.




**Injection timing adjustment**

(R.1)

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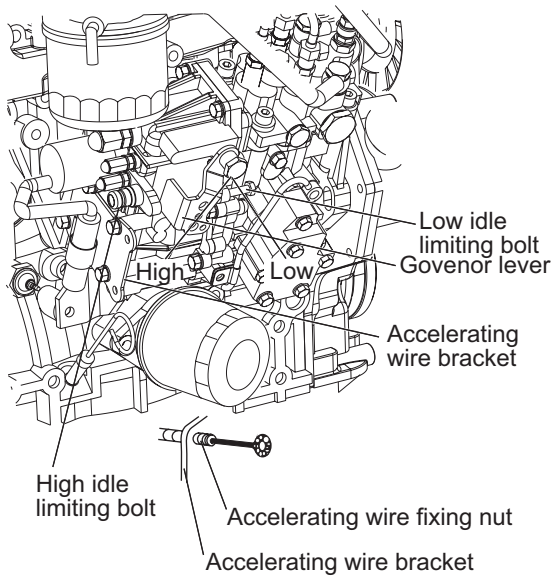


# 2.3 Adjusting the no-load maximum or minimum speed

1)After warming the engine up, gradually raise the speed and set it at the no-load maximum revolution.

2)If the no-load maximum speed is out of the standard, adjust it by turning the high idle limiting bolt.
The no-load maximum speed standard is shown in the specification tables in 1.2 of the chapter 1.

3)Then set the no-load minimum speed by adjusting the low idle limiting bolt.




**MP2 Fuel Injection pump**

No-load minimum speed standards (Unit: $min^{-1}$)

| Engine application class | No-load minimum speed (± 25) |
|---|---|
| CL | 1200 |
| VM | 800<br>(1100 for 4TNV106 (T)) |

Note) The engine speed may differ from the above standard depending on an engine installed on a machine unit.

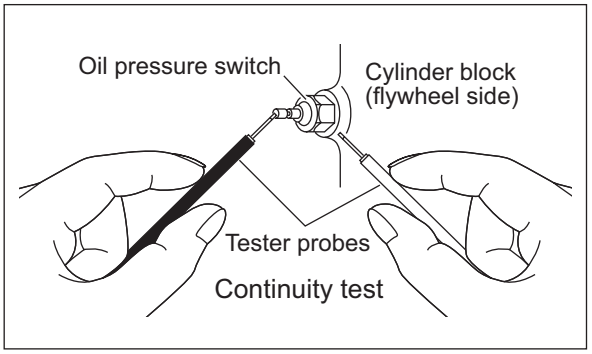
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# 2.4 Sensor inspection

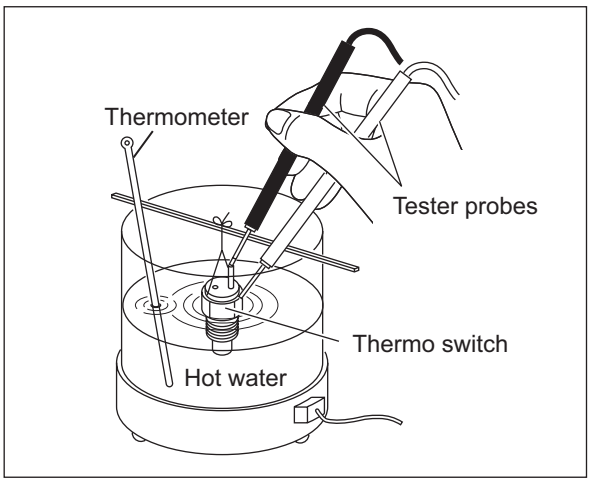
## 2.4.1 Oil pressure switch

Disconnect the connector from the oil pressure switch. Keep the voltameter probes in contact with the switch terminal and cylinder block while operating the engine. It is abnormal if circuit is closed.




## 2.4.2 Thermo switch

Place the thermo switch in a container filled with antifreeze or oil. Heat it while measuring the fluid temperature. The switch is normal if the voltameter shows continuity when the fluid temperature is
107 to 113 deg C.

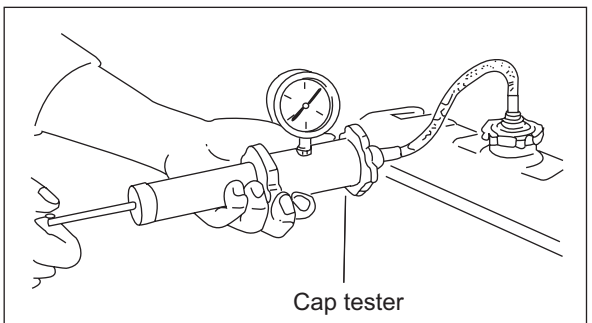



# 2.5 Water leak check in cooling water system

Check coolant water leakage from the cooling water system visually. If any problem is found, Inspect as follows.

1)Fill coolant water to the normal level in the radiator, and install the cap tester on the radiator.

2)Operate the manual pump to set the pressure to 0.09 ± 0.015 MPa (0.9 ± 0.15 kgf/cm$^2$). If the cap tester pressure gage reading drops then, water is leaking from the cooling water system. Check the water leaking point.



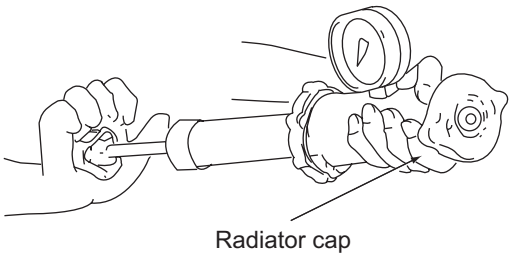

Water leak check in cooling water system

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## 2.6 Radiator cap inspection

Install the radiator cap on the cap tester. Set the tester pressure to 0.09 ± 0.015 MPa (0.9 ± 0.15 kgf/cm$^2$) and see that the cap is opened. If the cap does not open, replace the cap since it is abnormal.



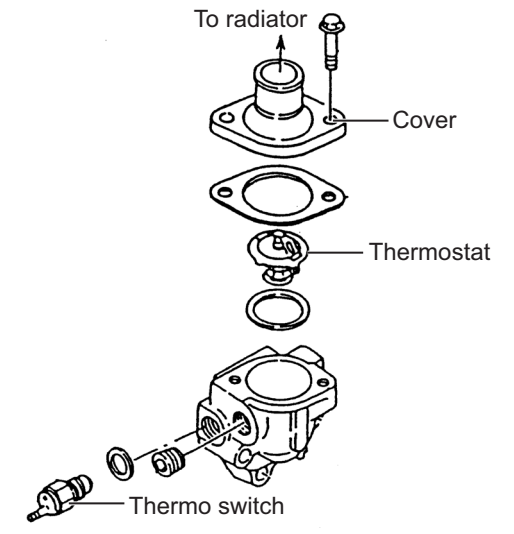

Radiator cap inspection

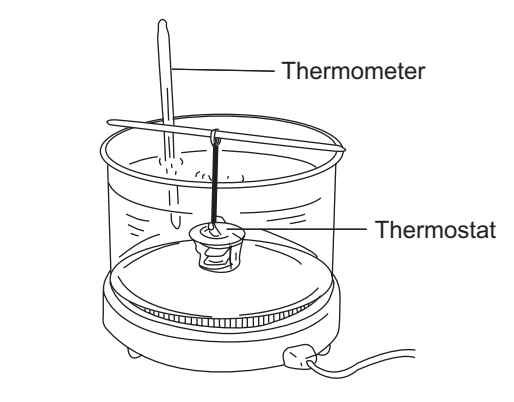
## 2.7 Thermostat Inspection

Place the thermostat in a container filled with water. Heat it while measuring the water temperature, and see that the thermostat is actuated at temperature of following table.

| Model | Valve opening Temperature (deg C)* | Full open lift (Temperature) (mm) |
|---|---|---|
| All models | 69.5 to 72.5 | 8 or more (85 deg C) |

* Valve opening temperature is carved on the flange.



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## 2.8 Adjusting operation

Perform the adjusting operation of a engine as follows after the maintenance job:

1)Supply the fuel oil, lubricating oil and coolant water.

Note:
Check the levels of the lubricating oil and coolant water again after test running (for about 5 minutes) and add as required.

2)Start the engine, and carry out idling at a low revolution (700 to 900 rpm) for a few minutes.

3)Run in the engine for about five minutes at the rated revolution (no-load). Check any water, fuel or oil leak and existence of abnormal vibration or noise. Also check the oil pressure, coolant water temperature and exhaust gas color.

4)Adjust the no-load minimum and maximum revolutions according to the specifications.

5)Perform loaded operation as required.

## 2.9 Long storage

Observe the following instructions when the engine is to be stored for a long period without operation:

1)Be sure to use clean soft water added Long Life Coolant Antifreeze (LLC) in the cooling water system and do not drain the coolant before long-term storage.
If drain the cooling water, it will cause to built up rust due to the residual water in the cooling water system.

2)Remove the mud, dust and oil deposit and clean the outside.

3)Perform the nearest periodic inspection before the storage.

4)Drain or fill the fuel oil fully to prevent condensation in the fuel tank.

5)Disconnect the battery cable from the battery negative (-) terminal.

6)Cover the silencer, air cleaner and electric parts with PVC (Poly Vinyl Chloride) cover to prevent water and dust from depositing or entrance.

7)Select a well-ventilated location without moisture and dust for storage.

8)Perform recharging once a month during storage to compensate for self-discharge.

9)When storing an engine for long time, run the engine or do motoring periodically according to the following procedure. Because the rust occurrence inside the engine, the rack agglutination of the fuel pump, and so on are likely to occur. (In case that the engine is equipped with a machine unit,)

a)Replace the lube oil and the filter before the engine running.

b)Supply fuel if the fuel in the fuel tank was removed, and bleed the fuel system.

c)Confirm that there is the coolant in the engine.

d)Operate the engine at the low idling speed for about five minutes. (If it can be done, one a month)

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# 3. Troubleshooting

## 3.1 Preparation before troubleshooting

If the signs of a trouble appear, it is important to lecture on the countermeasure and treatment before becoming a big accident not to shorten the engine life.

When the signs of a trouble appear in the engine or a trouble occurs, grasp the trouble conditions fully by the next point and find out the cause of sincerity according to the troubleshooting. Then repair the trouble, and prevent the recurrence of the trouble.

1)What's the occurrence phenomenon or the trouble situation? ····· (e.g. Poor exhaust color)

2)Investigation of the past records of the engine

Check a client control ledger, and examine the history of the engine.

- lInvestigate the engine model name and the engine number. (Mentioned in the engine label.)

Examine the machine unit name and its number in the same way.

- lWhen was the engine maintained last time?
- lHow much period and/or time has it been used after it was maintained last time?
- lWhat kind of problem was there on the engine last time, and what kind of maintenance was dane?

3)Hear the occurrence phenomenon from the operator of the engine in detail.

5W1H of the occurrence phenomenon : the investigation of when (when), where (where), who (who), what (what), why (why) and how (how)

- lWhen did the trouble happen at what kind of time?
- lWas there anything changed before the trouble?
- lDid the trouble occur suddenly, or was there what or a sign?
- lWas there any related phenomenon.

·····. (e.g. Poor exhaust color and starting failure at the same time)

4)After presuming a probable cause based on the above investigation, investigate a cause systematically by the next troubleshooting guide, and find out the cause of sincerity.

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## 3.2 Quick reference table for troubleshooting

The following table summarizes the general trouble symptoms and their causes. If any trouble symptom occurs, take corrective action before it becomes a serious problem so as not to shorten the engine service life.

| | Trouble symptom / Cause | Starting failure | | | | Insufficient engine output | Poor exhaust color | | High knocking sound during combustion | Abnormal engine sound | Uneven combustion sound | Hunting | | Large engine vibration | Difficulty in returning to low speed | Excessive fuel consumption | Lubricating oil | | | | Much blow-by gas | Cooling water | | Air intake | | Exhaust temperature rise | Corrective action |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Engine starts but stops soon. | | | Exhaust color | During work | | | | | | | | | | | | | | | | | | | | | |
| | | | Exhaust smoke | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Engine does not start. | None | Little | Much | Ordinary | White | Black | White | Black | | | | During idling | During work | | | | Excessive consumption | Dilution by fuel oil | Mixture with water | Low L.O. pressure | | Overheat | Low water temperature | Pressure drop | Pressure rise | | |
| Engine system | Improper clearance of intake/exhaust valve | ○ | ○ | | | ○ | | | | | | ○ | | | | | | | | | | | | | | ○ | | ○ | Adjust the valve clearance. (See 2.2.6 (4) in Chapter2.) |
| | Compression leakage from valve seat | | | | | ○ | | ○ | | ○ | | ○ | | | | | ○ | | | | | | ○ | | | ○ | | ○ | Lap the valve seat. (See 4.2.6 in Chapter4.) |
| | Seizure of intake/exhaust valve | ○ | | | ○ | ○ | | ○ | | ○ | | ○ | | | ○ | ○ | | | | ○ | | | ○ | | | ○ | | | Correct or replace. |
| | Blowout from cylinder head gasket | | | | | ○ | | | | | | | | | | | | | | | ○ | | | ○ | | | | | Replace the gasket. (See 4.2.2-12) in Chapter4.) |
| | Seized or broken piston ring | ○ | | | ○ | | ○ | | ○ | | | ○ | | ○ | | ○ | | | ○ | ○ | | | ○ | ○ | | | | ○ | Replace the piston ring. (See 4.4.2-5) & 10) in Chapter4.) |
| | Worn piston ring, piston or cylinder | ○ | | | ○ | | ○ | | ○ | | | | | | | | | | ○ | ○ | | | ○ | | | | | | Perform honing and use oversize parts. (See 4.4.5-1)4) and 4.4.6 in Chapter4.) |
| | Seized crankpin metal or bearing | ○ | ○ | | | | | | | | | ○ | | ○ | ○ | ○ | | | | | | | ○ | | | | | | Repair or replace. |
| | Improper arrangement of piston ring joints | | ○ | | | | ○ | | | | | | | | | | | | ○ | | | | ○ | | | | | | Correct the ring joint positions. (See 4.4.4-point 6 in Chapter4.) |
| | Reverse assembly of piston rings | | | | | | ○ | | ○ | | | | | | | | | | ○ | | | | ○ | | | | | | Reassemble correctly. (See 4.4.4-point 6 in Chapter4.) |
| | Worn crankpin and journal bearing | | | | | ○ | | | | | | ○ | | ○ | ○ | ○ | | | | | | ○ | | | | | | | Measure and replace. (See 4.4.5-(2) in Chapter4.) |
| | Loosened connecting rod bolt | | | | | | | | | | | ○ | | | | ○ | | | | | | ○ | | | | | | | Tighten to the specified torque. (See 4.4.4-point 2 in Chapter4.) |
| | Foreign matter trapped in combustion chamber | ○ | | | | | | | | | | ○ | | | | | | | ○ | | | | ○ | | | | | | Disassemble and repair. |
| | Excessive gear backlash | | | | | | | | | | | ○ | | | | | | | | | | | | | | | | | Adjust gear meshing. (See 4.3.4-point 2 in Chapter4.) |
| | Worn intake/exhaust valve guide | | | | | | ○ | | | | | | | | | | | | ○ | | | | ○ | | | | | | Measure and replace. (See 4.2.5-(2) and 4.2.7 in Chapter4.) |
| | Defective governor | | ○ | | | | | | | | | | | ○ | ○ | ○ | ○ | | | | | | | | | | | | Make adjustment. |
| | Improper open/close timing of intake/exhaust valves | ○ | | | | | ○ | ○ | ○ | ○ | | ○ | | | | | | | | | | | | | | | | | Adjust the valve clearance. (See 2.2.6-(4) in Chapter2.) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Turbocharger | Fouled blower | | | | | | | ○ | | ○ | | | | | | | | | | | | | | | | | | | Wash the blower. |
| | Waste gate malfunction | | | | | | | ○ | | ○ | | | | | | | | | | | | | | | | | | | Disassemble and inspect. |
| | Worn floating bearing | | | | | | ○ | | ○ | | | | | | | | | | | | | | | | | | | | Disassemble and inspect. |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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| Cause | Trouble symptom | Starting failure | | | | Insufficient engine output | | | Poor exhaust color | | High knocking sound during combustion | Abnormal engine sound | Uneven combustion sound | Hunting | | Large engine vibration | Difficulty in returning to low speed | Excessive fuel consumption | Lubricating oil | | | | Much blow-by gas | Cooling water | | Air intake | | Exhaust temperature rise | Corrective action |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Engine does not start. | Engine starts but stops soon. | | | Exhaust color | | | During work | | | | | During idling | During work | | | | Excessive consumption | Dilution by fuel oil | Mixture with water | Low L.O. pressure | | Overheat | Low water temperature | Pressure drop | Pressure rise | | |
| | | | Exhaust smoke | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | None | Little | Much | Ordinary | White | Black | White | Black | | | | | | | | | | | | | | | | | | | | |
| Cooling Water System | Excessive cooling effect of radiator | | | | | | | | ○ | | | | | | | | | ○ | | | | | | | | ○ | | | | Defective thermostat (kept closed) (See 2.2.7 in Chapter2.) |
| | Insufficient cooling effect of radiator | | | | | | | ○ | | | | | | | | | | | | | | | | ○ | | | | ○ | Defective thermostat (kept opened) (See 2.2.7 in Chapter2.) or slipping fan belt (See 2.2.2-2) in Chapter2.) |
| | Insufficient coolant water level | | | | | | | ○ | | | | | | | | | | | | | | | | ○ | | | | ○ | Check water leakage from cooling water system. (See 2.2.1-4) in Chapter2.) |
| | Cracked water jacket | | | | | | | | | | | | | | | | | | | | ○ | ○ | | ○ | | | | | Repair or replace. |
| | Slackened fan belt | | | | | | | ○ | | | | | | | | | | | | | | | | ○ | | | | ○ | Adjust the belt tension. (See 2.2.2-2) in Chapter2.) |
| | Defective thermostat | | | | | | | ○ | ○ | | | | | | | | | | | | | | | ○ | ○ | | | | Check or replace. (See 2.2.7 in Chapter2.) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lubricating System | Improper properties of lubricating oil | ○ | ○ | | | ○ | | | | | | | | | | | | | ○ | | | ○ | ○ | | | | | | Use proper lubricating oil. (See 1.3.2 in Chapter1.) |
| | Leakage from lubricating oil piping system | | | | | | | | | | | | | | | | | | ○ | | | ○ | | | | | | | Repair. |
| | Insufficient delivery capacity of trochoid pump | | | | | | | | | | | | | | | | | | | | | ○ | | | | | | | Check and repair. (See 5.5 in Chapter5.) |
| | Clogged lubricating oil filter | | | | | | | | | | | | | | | | | | | | | ○ | ○ | | | | | | Clean or replace. |
| | Defective pressure regulating valve | | | | | | | | | | | | | | | | | | | | | ○ | | | | | | | Clean, adjust or replace. |
| | Insufficient lubricating oil level | | ○ | | | | | | | | | | | | | | | | | | | ○ | | | | | | | Add proper lubricating oil. (See 2.2.1-3) in Chapter2.) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fuel system | Too early timing of fuel injection pump | | | | | | | | ○ | ○ | ○ | | | | | ○ | | | | | | | | | | | | | Check and adjust. (See 2.2.7-4) in Chapter2.) |
| | Too late timing of fuel injection pump | | | | | | ○ | ○ | ○ | ○ | | | | | | | | ○ | | | | | | | | | | ○ | Check and adjust. (See 2.2.7-4) in Chapter2.) |
| | Improper properties of fuel oil | | | | | ○ | ○ | ○ | ○ | ○ | | | ○ | | | | | | | | | | | | | | | | Use proper fuel oil. (See 1.3.1 in Chapter1.) |
| | Water entrance in fuel system | ○ | | | ○ | | ○ | | ○ | | | | ○ | ○ | ○ | | | | | | | | | | | | | | Perform draining from the fuel filter. (See 2.2.3 and 2.2.5 in Chapter2.) |
| | Clogged fuel filter | ○ | ○ | | | ○ | | | | | | | | | | | | | | | | | | | | | | | Clean or replace. (See 2.2.5 in Chapter2.) |
| | Air entrance in fuel system | ○ | ○ | | | ○ | | | | | | | | | | | | | | | | | | | | | | | Perform air bleeding. (See 2.2.3 in Chapter2.) |
| | Clogged or cracked fuel pipe | ○ | ○ | | | ○ | | | | | | | | | | | | | | | | | | | | | | | Clean or replace. |
| | Insufficient fuel supply to fuel injection pump | ○ | ○ | | | ○ | | | | | | | | | | | | | | | | | | | | | | | Check the fuel tank cock, fuel filter, fuel pipe, and fuel feed pump. |
| | Uneven injection volume of fuel injection pump | | | | | | ○ | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | | | | | | | | | | | | ○ | Check and adjust. |
| | Excessive fuel injection volume | | | | | | | | | ○ | | | | | | | | ○ | ○ | | | | ○ | ○ | | | ○ | ○ | Check and adjust. |
| | Poor spray pattern from fuel injection nozzle | | | | | | ○ | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | | ○ | | | | | | | | | | | Check and adjust. (See 2.2.6 in Chapter2.) |
| | Priming failure | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | Foreign matter trapped in the valve inside the priming pump. (Disassemble and clean.) |
| | Clogged strainer at feed pump inlet | | | | | ○ | | | | | | | | | | | | | | | | | | | | | | | Clean the strainer. |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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| Cause \ Trouble symptom | | Starting failure | | | | Insufficient engine output | | | Poor exhaust color | | High knocking sound during combustion | Abnormal engine sound | Uneven combustion sound | Hunting | | Large engine vibration | Difficulty in returning to low speed | Excessive fuel consumption | Lubricating oil | | | | Much blow-by gas | Cooling water | | Air intake | | Exhaust temperature rise | Corrective action |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Engine does not start. | Engine starts but stops soon. | | | Exhaust color | | | During work | | | | | During idling | During work | | | | Excessive consumption | Dilution by fuel oil | Mixture with water | Low L.O. pressure | | Overheat | Low water temperature | Pressure drop | Pressure rise | | |
| | | | Exhaust smoke | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | None | Little | Much | Ordinary | White | Black | White | Black | | | | | | | | | | | | | | | | | | | | |
| Air/Exhaust Gas System | Clogged air filter | | | | ○ | | | ○ | | ○ | | | ○ | | | | | | | | | | | | | ○ | | | Clean. (See 2.2.4 in Chapter2.) |
| | Engine used at high temperatures or at high altitude | | | | | | | ○ | | ○ | | | | | | | | ○ | | | | | | ○ | | ○ | | | Study output drop and load matching. |
| | Clogged exhaust pipe | | | | | | | ○ | | ○ | | | ○ | | | | | | | | | | | | | | | ○ | Clean. |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Electrical System | Starting motor defect | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | Repair or replace. (See Chapter8.) |
| | Alternator defect | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | Repair or replace. (See Chapter9.) |
| | Open-circuit in wiring | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | Repair. (See Chapter10.) |
| | Battery voltage drop | ○ | | | | | | | | | | | | | | | | | | | | | | | | | | | Inspect and change the battery. (See 2.2.3 in Chapter2.) |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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# 3.3 Troubleshooting by measuring compression pressure

Compression pressure drop is one of major causes of increasing blowby gas (lubricating oil contamination or increased lubricating oil consumption as a resultant phenomenon) or starting failure. The compression pressure is affected by the following factors:

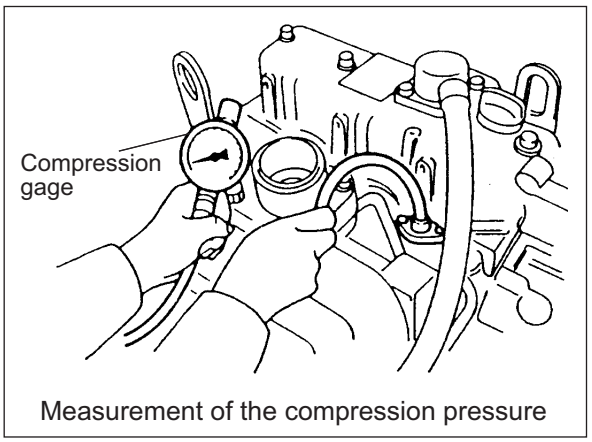
1)Degree of clearance between piston and cylinder
2)Degree of clearance at intake/exhaust valve seat
3)Gas leak from nozzle gasket or cylinder head gasket

In other words, the pressure drops due to increased parts wear and reduced durability resulting from long use of the engine.

A pressure drop may also be caused by scratched cylinder or piston by dust entrance from the dirty air cleaner element or worn or broken piston ring. Measure the compression pressure to diagnose presence of any abnormality in the engine.

## (1) Compression pressure measurement method

1)After warming up the engine, remove the fuel injection pipe and valves from the cylinder to be measured.
2)Crank the engine before installing the compression gage adapter.
*1) Perform cranking with the stop handle at the stop position (no injection state).
*2) See 12.2-18 in Chapter 12 for the compression gage and compression gage adapter.
3)Install the compression gage and compression gage adapter at the cylinder to be measured.
*1) Never forget to install a gasket at the tip end of the adapter.
4)With the engine set to the same state as in 2)*1), crank the engine by the starter motor until the compression gage reading is stabilized.



Measurement of the compression pressure

## (2) Standard compression pressure

Engine compression pressure list (reference value)

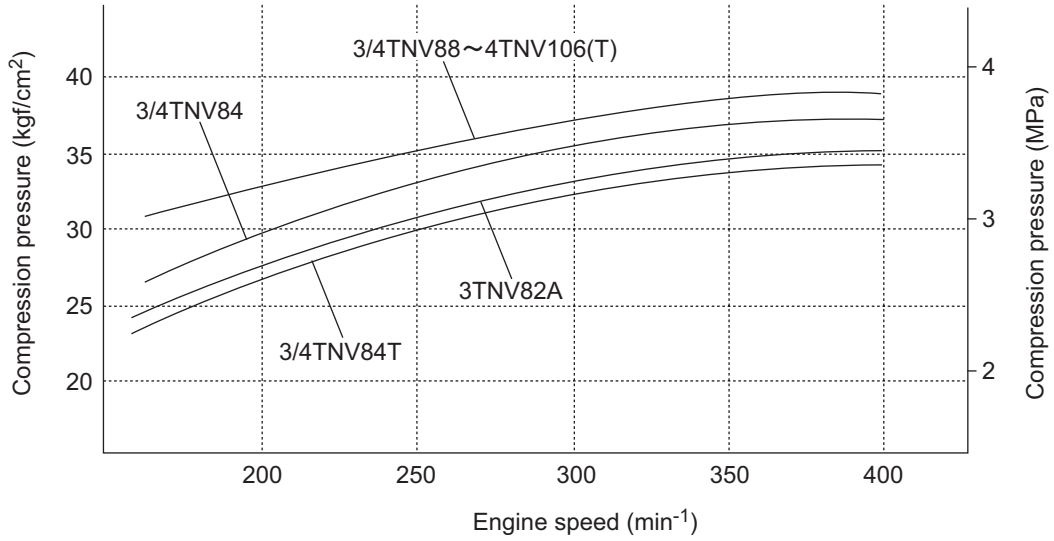
| Engine mode | Compression pressure at 250 $min^{-1}$ MPa ($kgf/cm^2$) | | Deviation among cylinders MPa ($kgf/cm^2$) |
|---|---|---|---|
| | Standard | Limit | |
| 3TNV82A | 3.04 ± 0.1 (31 ± 1) | 2.45 ± 0.1 (25 ± 1) | 0.2 to 0.3 (2 to 3) |
| 3/4TNV84 | 3.24 ± 0.1 (33 ± 1) | 2.55 ± 0.1 (26 ± 1) | |
| 3/4TNV84T | 2.94 ± 0.1 (30 ± 1) | 2.45 ± 0.1 (25 ± 1) | |
| TNV88 to 106 (T) | 3.43 ± 0.1 (35 ± 1) | 2.75 ± 0.1 (28 ± 1) | |

(R.1)

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## (3) Engine speed and compression pressure (for reference)




## (4) Measured value and troubleshooting

When the measured compression pressure is below the limit value, inspect each part by referring to the table below.

| No. | Item | Cause | Corrective action |
|---|---|---|---|
| 1 | • Air cleaner element | • Clogged element<br>• Broken element<br>• Defect at element seal portion | • Clean the element.<br>• Replace the element. |
| 2 | • Valve clearance | • Excessive or no clearance | • Adjust the valve clearance.<br>(See 3.5 in Chapter 3.) |
| 3 | • valve timing | • Incorrect valve clearance | • Adjust the valve clearance.<br>(See 3.5 in Chapter 3.) |
| 4 | • Cylinder head gasket | • Gas leak from gasket | • Replace the gasket.<br>• Retighten the cylinder head bolts to the specified torque.<br>(See 4.2 (2) 12) in Chapter 4.) |
| 5 | • Intake/exhaust vale<br>• Valve seat | • Gas leak due to worn valve seat or foreign matter trapping<br>• Sticking valve | • Lap the valve seat.<br>(See 4.2 (6) in Chapter 4.)<br>• Replace the intake/exhaust valve. |
| 6 | • Piston<br>• Piston ring<br>• Cylinder | • Gas leak due to scratching or wear | • Perform honing and use an oversized part.<br>(See 4.4 (5)-(5-1), (5-4) and (6) in Chapter 4.) |

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# 4. Disassembly, inspection and reassembly of engines

## 4.1 Complete disassembly and reassembly

### 4.1.1 Introduction

Make preparation as follows before starting engine inspection and service:

1)Fix the engine on a horizontal base.

**⚠ CAUTION**

Be sure to fix the engine securely to prevent injury or damage to parts due to falling during the work.

2)Remove the coolant water hose, fuel oil pipe, wire harness, control wires etc. connecting the driven machine and engine, and drain coolant water, lubricating oil and fuel.

3)Clean soil, oil, dust, etc. from the engine by washing with solvent, air, steam, etc. Carefully operate so as to prevent any foreign matter from entering the engine.

**⚠ CAUTION**

Always wear glasses or other protectors when using compressed air or steam to prevent any foreign matter from getting in the eyes.

[NOTICE]

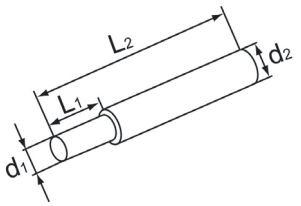
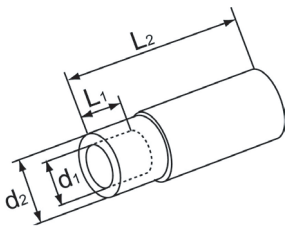
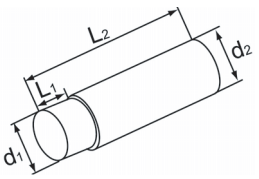
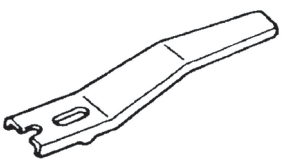
- Any part which is found defective as a result of inspection or any part whose measured value does not satisfy the standard or limit shall be replaced.
- Any part predicted to dissatisfy the standard or limit before the next service as estimated from the state of use should be replaced even when the measured value then satisfies the standard or limit.

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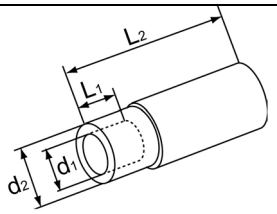
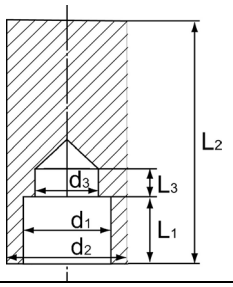
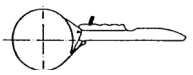
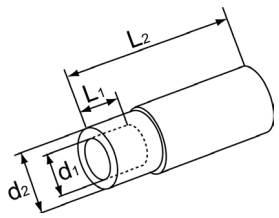
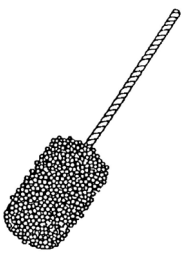
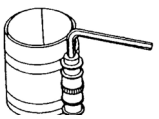
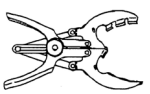
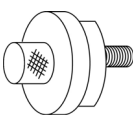
## 4.1.2 Special service tools

### (1) Special Tools

<table>
<tr><th>No.</th><th>Tool name</th><th>Applicable model and tool size</th><th>Illustration</th></tr>
<tr><td>1</td><td>Valve guide tool<br>(for extracting valve guide)</td><td>mm<br><table><tr><th>Model</th><th>L1</th><th>L2</th><th>d1</th><th>d2</th></tr><tr><td>3TNV82A<br>4TNV94L･98(T)<br>4TNV106(T)</td><td>20</td><td>75</td><td>6.5</td><td>10</td></tr><tr><td>4TNV84<br>3TNV84(T)<br>3/4TNV88</td><td>20</td><td>75</td><td>7.5</td><td>11</td></tr><tr><td>4TNV84T</td><td>20</td><td>75</td><td>5.5</td><td>9</td></tr></table>※Locally manufactured</td><td>  </td></tr>
<tr><td>2</td><td>Valve guide tool<br>(for inserting valve guide)</td><td>mm<br><table><tr><th>Model</th><th>L1</th><th>L2</th><th>d1</th><th>d2</th></tr><tr><td>3TNV82A</td><td>12</td><td>60</td><td>13</td><td>19</td></tr><tr><td>4TNV84<br>3TNV84(T)<br>3/4TNV88</td><td>15</td><td>65</td><td>14</td><td>20</td></tr><tr><td>4TNV84T</td><td>8.5</td><td>60</td><td>11</td><td>17</td></tr><tr><td>4TNV94L･98(T)</td><td>7</td><td>60</td><td>13</td><td>16</td></tr><tr><td>4TNV106(T)</td><td>13.6</td><td>65</td><td>13</td><td>16</td></tr></table>※Locally manufactured</td><td>  </td></tr>
<tr><td>3</td><td>Connecting rod bushing replacer<br>(for removal / installation of connecting rod bushing)</td><td>mm<br><table><tr><th>Model</th><th>L1</th><th>L2</th><th>d1</th><th>d2</th></tr><tr><td>3TNV82A</td><td>25</td><td>85</td><td>23</td><td>26</td></tr><tr><td>TNV84～88</td><td>20</td><td>100</td><td>26</td><td>29</td></tr><tr><td>4TNV94L･98</td><td>20</td><td>100</td><td>30</td><td>33</td></tr><tr><td>4TNV106(T)</td><td>20</td><td>100</td><td>37</td><td>40</td></tr></table>Allowance: $d1^{-0.3}_{-0.6}$ $d2^{-0.3}_{-0.6}$<br>※Locally manufactured</td><td>  </td></tr>
<tr><td>4</td><td>Valve spring compressor<br>(for removal / installation of valve spring)</td><td>yanmar code No.<br>129100-92630</td><td>  </td></tr>
</table>

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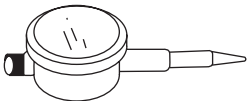
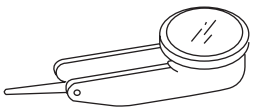
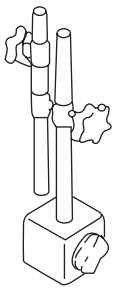
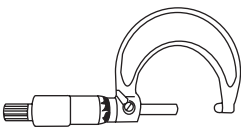
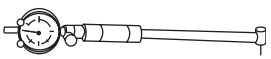
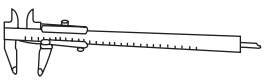
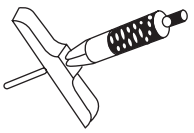
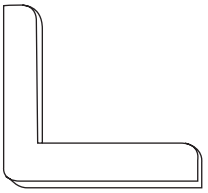
<table>
<tr><th>No.</th><th>Tool name</th><th>Applicable model and tool size</th><th>Illustration</th></tr>
<tr><td>5</td><td>Stem seal insertion<br>(for inserting stem seal)</td><td>mm<br><table><tr><th>Model</th><th>d1</th><th>d2</th><th>d3</th><th>L1</th><th>L2</th><th>L3</th></tr><tr><td>3TNV82A</td><td>15.2</td><td>21</td><td>12</td><td>15.8</td><td>65</td><td>4</td></tr><tr><td>4TNV84<br>3TNV84(T)<br>4TNV88</td><td>16.2</td><td>22</td><td>13.5</td><td>18.8</td><td>65</td><td>4</td></tr><tr><td>4TNV84T</td><td>12.9</td><td>19</td><td>11.5</td><td>10.0</td><td>65</td><td>4</td></tr><tr><td>4TNE94L･98</td><td>15.2</td><td>21</td><td>12</td><td>11.8</td><td>65</td><td>4</td></tr><tr><td>4TNE106(T)</td><td>15.2</td><td>21</td><td>12</td><td>15.5</td><td>65</td><td>4</td></tr></table>※ Locally manufactured</td><td>  <br>  </td></tr>
<tr><td>6</td><td>Filter wrench<br>(for removal / installation of L.O. filter)</td><td>Available on the market</td><td>  </td></tr>
<tr><td>7</td><td>Camshaft bushing tool<br>(for extracting camshaft bushing)</td><td>mm<br><table><tr><th>Model</th><th>L1</th><th>L2</th><th>d1</th><th>d2</th></tr><tr><td>TNV82A～88</td><td>18</td><td>70</td><td>45</td><td>48</td></tr><tr><td>4TNV94L･98</td><td>18</td><td>70</td><td>50</td><td>53</td></tr><tr><td>4TNV106(T)</td><td>18</td><td>70</td><td>58</td><td>61</td></tr></table>Allowance: $d1^{-0.3}_{-0.6}$ $d2^{-0.3}_{-0.6}$<br>※Locally manufactured</td><td>  </td></tr>
<tr><td>8</td><td>Flex-Hone<br>(For re-honing of cylinder liner)</td><td><table><tr><th>Model</th><th>Parts No.</th><th>Cylinder bore (mm)</th></tr><tr><td>TNV82A～</td><td>129400-92420</td><td>78～84</td></tr><tr><td>TNV88～4TNV94L</td><td>129400-92430</td><td>83～95</td></tr><tr><td>4TNV98</td><td>129400-92440</td><td>89～101</td></tr><tr><td>4TNV106(T)</td><td>129400-92450</td><td>95～108</td></tr></table></td><td>  </td></tr>
<tr><td>9</td><td>Piston insertion tool<br>(for inserting piston)</td><td>Yanmar code No. 95550-002476<br>※The above piston insertion tool is applicable to 60-125 mm diameter pistons.</td><td>  </td></tr>
<tr><td>10</td><td>Piston ring replacer<br>(for removal / installation of piston ring)</td><td>Available on the market</td><td>  </td></tr>
<tr><td>11</td><td>Crankshaft pulley installing tool</td><td>Locally manufactured<br>(for 4TNV94L)<br>(Refer to 4.3.6 in detail)</td><td>  </td></tr>
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(R.1)

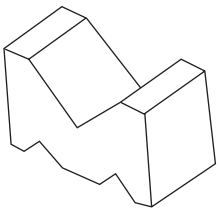
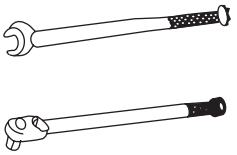
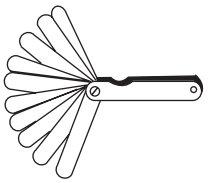
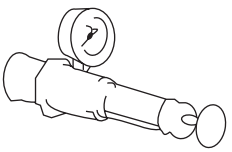
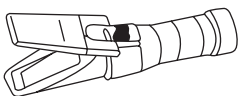
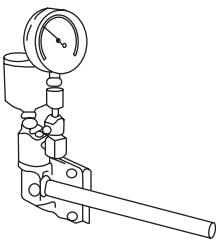
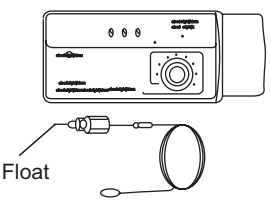
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## (2) Measuring instruments

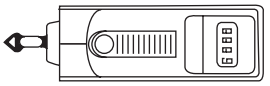
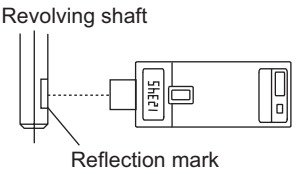
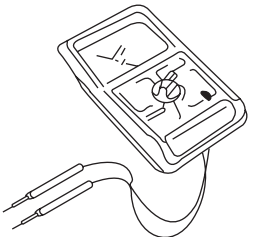
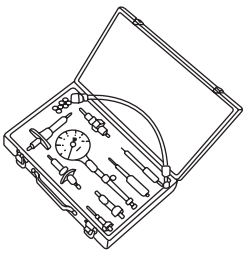
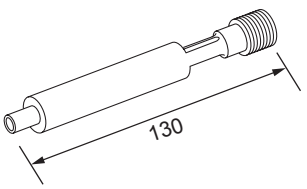
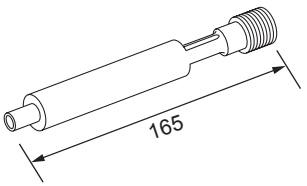
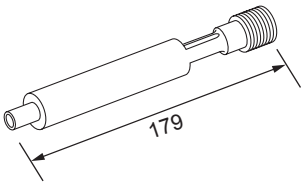
| No. | Instrument name | Application | Illustration |
|---|---|---|---|
| 1 | Dial gage | Measurements of shaft bending, and strain and gap of surfaces |  |
| 2 | Test indicator | Measurements of narrow or deep portions that cannot be measured by dial gage |  |
| 3 | Magnetic stand | For holding the dial gage when measuring using a dial gage, standing angles adjustable |  |
| 4 | Micrometer | For measuring the outside diameters of crankshaft, pistons, piston pins, etc. |  |
| 5 | Cylinder gage | For measuring the inside diameters of cylinder liners, rod metal, etc. |  |
| 6 | Calipers | For measuring outside diameters, depth, thickness and width |  |
| 7 | Depth micrometer | For measuring of valve sink |  |
| 8 | Square | For measuring valve spring inclination and straightness of parts |  |

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| No. | Instrument name | Application | Illustration |
|---|---|---|---|
| 9 | V-block | For measuring shaft bend |  |
| 10 | Torque wrench | For tightening nuts and bolts to the specified torque |  |
| 11 | Thickness gage | For measuring gaps between ring and ring groove, and shaft joints during assembly |  |
| 12 | Cap tester | For checking water leakage |  |
| 13 | Battery coolant tester | For checking concentration of antifreeze and the battery electrolyte charge status |  |
| 14 | Nozzle tester | For measuring injection spray pattern of fuel injection nozzle and injection pressure |  |
| 15 | Digital thermometer | For measuring temperatures |  |

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| No. | Instrument name | | Application | Illustration |
|---|---|---|---|---|
| 16 | Speedometer | Contact type | For measuring revolution by contacting the mortise in the revolving shaft |  |
| | | Photoelectric type | For measuring revolution by sensing the reflecting mark on the outer periphery of the revolving shaft |  |
| 17 | Circuit tester | | For measuring resistance, voltage and continuity of electrical circuits |  |
| 18 | Compression gage kit | | For measuring compression pressure<br><br>Gauge set code NO. TOL-97190080 |  |
| | | | Adapter for direct injection 2-valve head<br><br>Adapter code No. 119802-92950 |  |
| | | | Adapter for direct injection 4-valve head for 4TNV94L/98/98T<br><br>Adapter code No. 129906-92950 |  |
| | | | Adapter for direct injection 4-valve head for 4TNV106/106T<br><br>Adapter code No. 123907-92950 |  |

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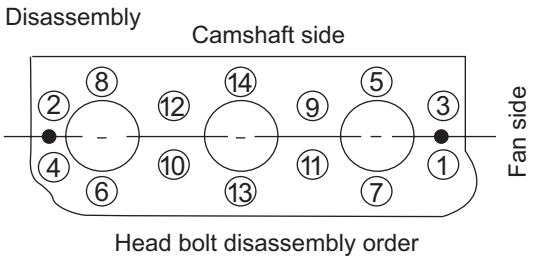
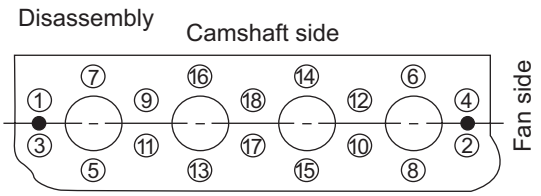

## 4.1.3 Complete disassembly

Peripheral parts such as air cleaner, muffler and radiator differ in installation and types for each application. Therefore, description in this Chapter is started with the steps to be taken just after the peripheral parts have been removed.

| Step | Removal Parts | Remarks |
|---|---|---|
| 1 | 1)Thoroughly remove sand, dust, dirt and soil from the surface of the engine.<br>2)Drain coolant water and lubricating oil from the engine. | |
| 2 | 1)Remove turbocharger and exhaust manifold.<br>2)Remove intake manifold and surge tank. | |
| 3 | 1)Close the fuel cock valve of the fuel tank.<br>2)Remove high-pressure fuel pipe.<br>3)Remove fuel return pipe.<br>4)Loosen the tightening nut on fuel injection nozzle retainer and extract the retainer and fuel injection nozzle.<br>*) Fuel injection nozzle for Indirect injection system is screwed type. | 1)If nozzle seat is left on the cylinder head, remove the cylinder head before extracting nozzle seat.<br>2)To prevent dust from entering fuel injection nozzle, fuel injection pump and high-pressure fuel pipe, seal their respective threads with a tape or the like.<br>3)Whenever extracting fuel injection nozzle, replace nozzle protector with a new one. |
| 4 | 1)Remove rocker arm cover assembly. | |
| 5 | 1)Remove valve rocker arm shaft assembly.<br>2)Remove push rod. | 1)Attach a tag to push rod for each cylinder No. to put the push rod in order.<br>2)Remove valve cap from the intake/exhaust valve head.<br>3)Note that tappet of the indirect injection system can be removed at the same time when push rod is extracted.<br>4)Attach a tag to tappet for each cylinder No. to put the tappet in order. |
| 6 | 1)Remove fan mounting bolt, and then remove fan.<br>2)Loosen adjusting bolt for the V-belt adjuster, and then remove V-belt.<br>3)Remove alternator.<br>4)Remove the spacer for cooling fan and V-pulley. | 1)Never turn down alternator vigorously toward the cylinder block. Otherwise, your finger may be nipped and alternator broken. |
| 7 | 1)Remove lubricating oil filter assembly.<br>2)Extract dipstick form the oil dip-stick hole. | |
| 8 | 1)Disconnect fuel return pipes to.<br>2)Remove fuel filter. | |

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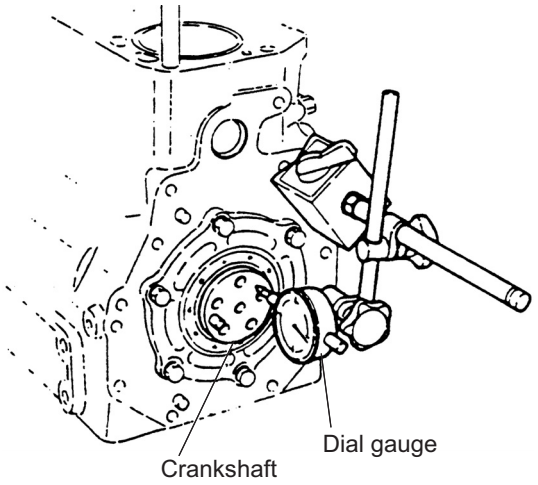
| Step | Removal Parts | Remarks |
|---|---|---|
| 9 | 1)Disconnect coolant water pipe from the cooling water pump.<br>2)Remove thermostat assembly.<br>3)Remove cooling water pump. | |
| 10 | 1)Remove cylinder head tightening bolt.<br>2)Remove cylinder head assembly.<br>3)Remove cylinder head gasket. | 1)Lay a cardboard or the like on the floor and place cylinder head assembly on it so as not to damage the combustion surface.<br>2)Order of loosening the cylinder head tightening bolts.<br>  <br>Head bolt disassembly order<br>3 cylinder head<br>  <br>Head bolt disassembly order<br>4 cylinder head<br>3)To remove the intake/exhaust valves from cylinder head assembly, take the following steps.<br>a)Using a valve spring compressor (see Chapter 5, 5-1), compress valve spring and remove valve cotter.<br>b)Remove valve retainer and valve spring.<br>c)Remove intake valve and exhaust valve. |
| 11 | 1)Remove crankshaft V-pulley clamping bolt.<br>2)Using a puller, extract crankshaft V-pulley. | 1)Extract crankshaft V-pulley by hitting the bolt of the puller using a plastic hammer or the like. |
| 12 | 1)Remove oil pan mounting bolt under gear case.<br>2)Remove gear case mounting bolt.<br>3)Remove gear case. | 1)Never fail to removes stiffener bolt at the center of the gear case.<br>2)When removing the gear case, carefully protect oil seal from damage. |
| 13 | 1)Remove the nut from fuel injection pump drive gear. Extract fuel injection pump drive gear using a puller. | 1)Before removing fuel injection pump, make sure of the position of the arrow of the pump body for adjusting fuel injection timing as well as the position of the scribed line of the gear case flange. (Applies only to direct injection system.) |

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| Step | Removal Parts | Remarks |
|---|---|---|
| 14 | 1)Remove lubricating oil pump. | |
| 15 | 1)Remove starting motor from flywheel housing sing. | |
| 16 | 1)Remove flywheel mounting bolt.<br>2)Remove flywheel. | 1)Carefully protect the ring gear from damage mage. |
| 17 | 1)Remove flywheel housing.<br>2)Remove oil seal case with a screwdriver or the like by utilizing grooves on both sides of oil seal case. | 1)Carefully protect the oil seal from damage. |
| 18 | 1)Remove oil pan and spacer. | 1)Put the cylinder block with the attaching surface of the cylinder head facing down.<br>2)Carefully protect the combustion surface of the cylinder block from damage.<br>3)For indirect injection system, be careful to the possibility of the tapped to drop off when the cylinder block is turned upside down, because the tappet is cylindrical in shape. |
| 19 | 1)Remove idle gear shaft, and then remove idle gear.<br>2)Remove mounting bolt of thrust bearing through the hole of the camshaft gear. Remove camshaft assembly. | 1)Turn the cylinder block aside and carefully prevent tappet from jamming on the cam.<br>2)Preheat camshaft gear and camshaft assembly to 180° to 200° which are shrink fitted, before removing them. |
| 20 | 1)Remove gear case flange. | |
| 21 | 1)Remove lubricating oil strainer. | |
| 22 | 1)Remove crankpin side cap of the connecting rod.<br>While turning crankshaft, place piston in the bottom dead center (BDC). | 1)Before extracting piston, remove carbon deposits from the upper wall of the cylinder using fine sandpaper, while taking care not to damage the inner surface of the cylinder.<br>2)Make sure than cap No. of connecting rod agrees with cylinder No.<br>3)Take care not to let crankpin metal fall when removing connecting rod crankpin side cap. |

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| Step | Removal Parts | Remarks |
|---|---|---|
| 23 | 1)Remove main bearing cap bolt. While shaking main bearing cap, remove main bearing cap together with lower main bearing metal.<br>2)Extract crankshaft, taking care not to damage it.<br>3)Remove upper main bearing metal. | 1)Before extracting crankshaft, measure the side gap around it.<br>  <br><br>Apply a dial gauge to the end of crankshaft. Force the crankshaft on both sides in the axial direction to measure the thrust gap. Alternatively, insert a thickness gauge directly between the base thrust metal and the thrust surface of the crankshaft to measure the gap. If the limit size is exceeded, replace the thrust metal with a new one.<br><br>Thrust gap (All models)<br>2)Notice on the removal of thrust metal.<br>a)When removing thrust metal, ascertain the position and direction where thrust metal is installed in relation to the cap.<br>b)Make sure that the thrust metal groove is outward in relation to the cap. |
| 24 | 1)Remove piston and connecting rod assembly. | 1)To selectively remove a desired piston and connecting rod assembly without extracting crankshaft, take the steps itemized below:<br>a)Remove carbon deposits from the upper wall of the cylinder using fine sandpaper, taking care not to damage the inner surface of the cylinder.<br>b)While turning the crankshaft, with the connecting rod cap removed, raise the piston up to the top dead center (TDC).<br>c)Extract the piston/connecting rod assembly while tapping the connecting rod at the large end with the handle of a plastic hammer or the like. |
| 25 | 2)Remove tappet. | |

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### 4.1.4 Precautions before and during reassembly

To reassemble engine components, reverse the procedure of disassembly. However, follow the precautions below and the precautions from in chapter 4 to in chapter 7 particularly before and during reassembly.

#### (1) Cleaning the component

Use particular care to clean the cylinder block, cylinder head, crankshaft, and camshaft. Ensure that they are free from chips, dust, sand, and other foreign matter.

#### (2) Parts to be replaced during reassembly

Be sure to replace the following parts with new ones during assembly.

- Valve stem seal
- Head gasket packing
- Nozzle protector and nozzle seat of the fuel injection valve
- Various copper packing, O-rings and gasket packing.

### 4.1.5 Adjusting operation

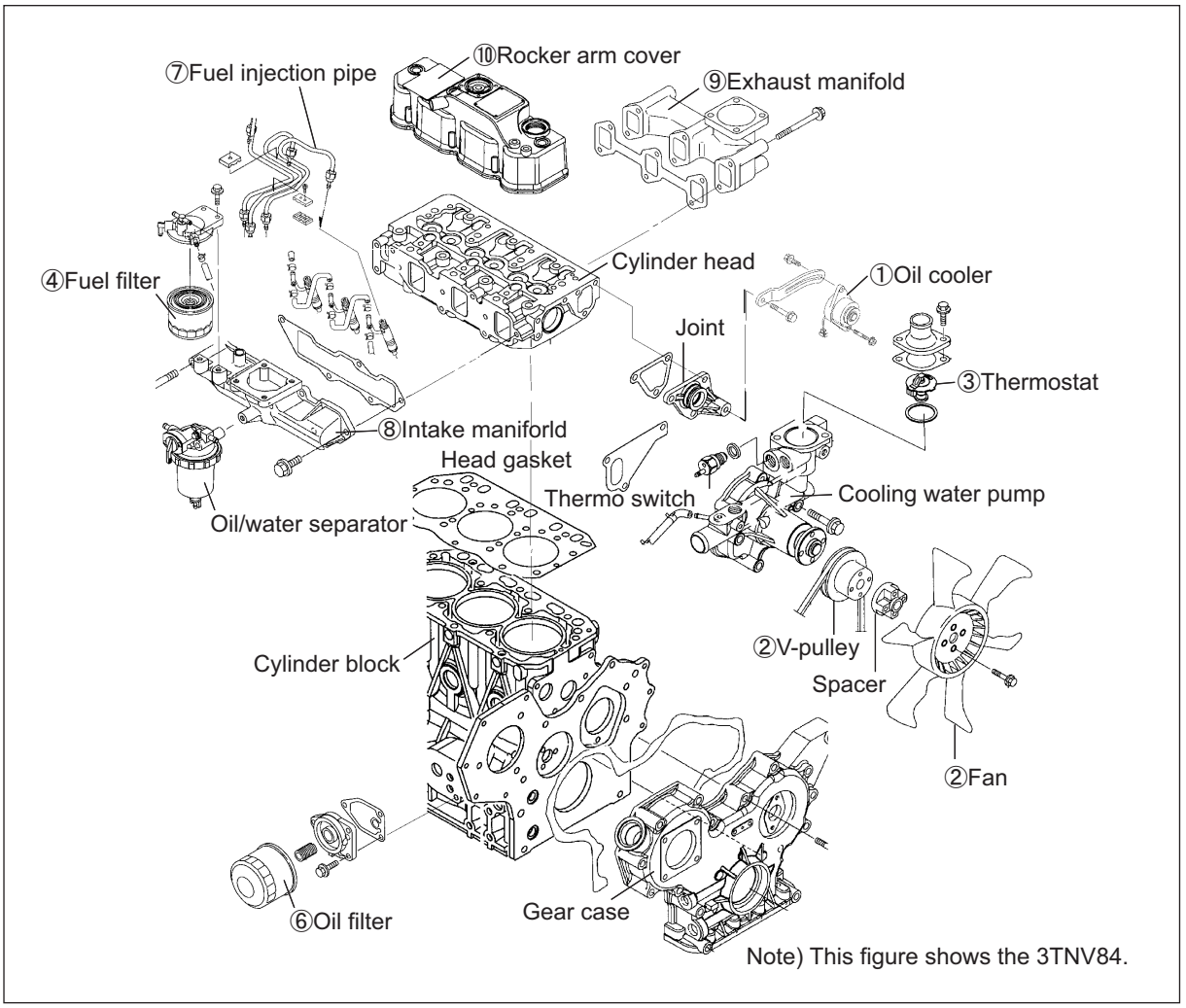
Make sure to perform adjusting operation after completing reassembly. Refer to section 2.5 in chapter 2 for the operation procedure.

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# 4.2 Cylinder head: Disassembly, inspection and reassembly

## 4.2.1 Components (2-valve cylinder head)

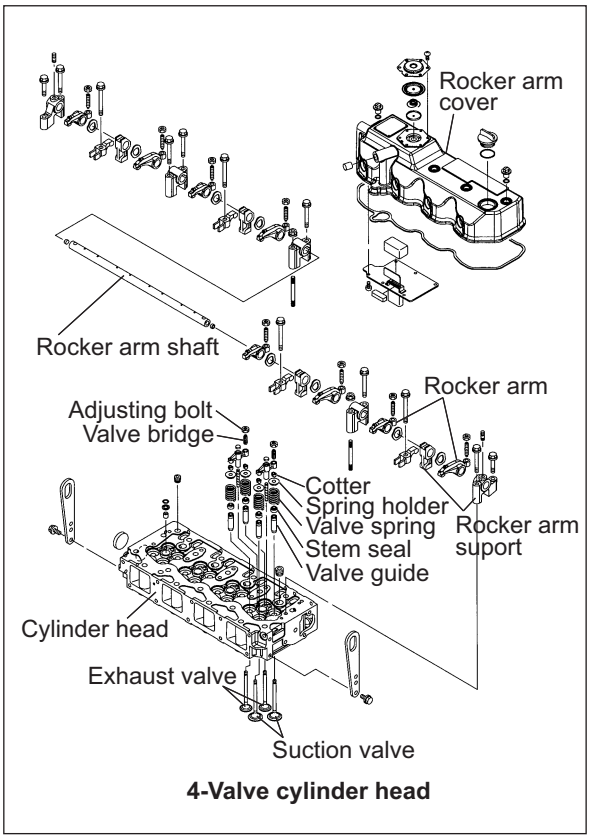



## 4.2.2 Disassembly procedure:

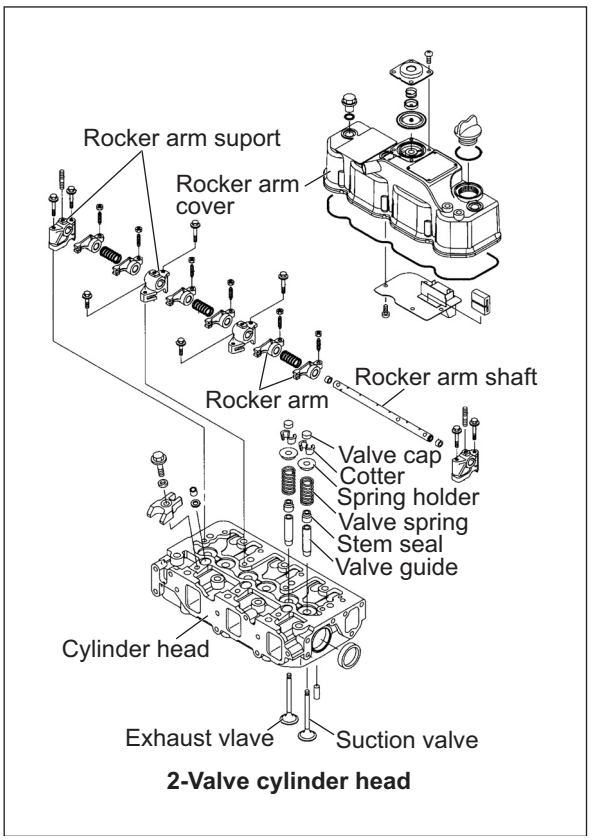
Disassemble in the order of the numbers shown in the illustration.

1)Remove the alternator assy. (Point1)
2)Remove the fan, pulley and V belt.
3)Remove the thermostat case. (Point2)
4)Remove the fuel filter and fuel oil piping. (Point3)
5)Remove the oil level gage assy.
6)Remove the oil filter. (Point4)
7)Remove the fuel injection pipes. (Point5)
8)Remove the intake manifold assy.
9)Remove the exhaust manifold assy.
10)Remove the rocker arm cover assy.
11)Remove the rocker shaft assy, push rods and valve caps. (Point6)
12)Remove the cylinder head assy and head gasket. (Point7)
13)Remove the fuel injection valves and fuel return pipe. (Point8)
14)Remove the intake/exhaust valves, stem seals and valve springs. (Point9)
15)Remove the rocker arms from the rocker shaft.

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**4-Valve cylinder head**




**2-Valve cylinder head**

## 4.2.3 Reassembly procedure:

Reverse order of the disassembly procedure.

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## 4.2.4 Servicing points

**Point1**

[Disassemble]

- Loosen the mounting bolt while supporting the alternator.

**⚠ CAUTION**

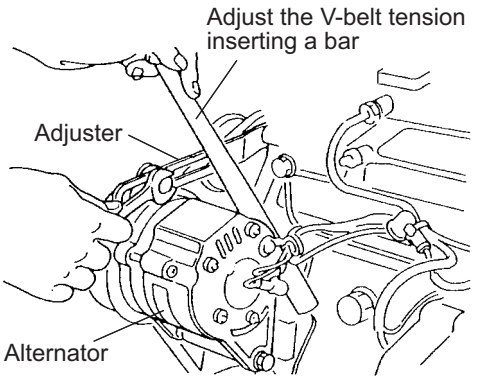
Do not tilt the alternator toward the cylinder block in haste since it may damage the alternator or pinch a finger.

[Reassemble]

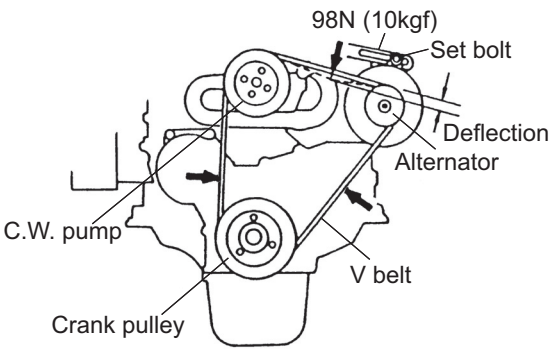
- The belt deflection shall be checked according to 2.2.2. in Chapter2.

[Reassemble]

- Replace the belt with a new one if cracked, worn or damaged.
- Carefully prevent the belt from being smeared with oil or grease.




**Tension adjustment**




**V-belt tention**

**Point2**

[Reassemble]

- Check the thermostat function. (See3.9 in Chapter 3 for the check procedure.)

**Pont3**

[Reassemble]

- Replace the fuel filter element with a new one.

[Disassemble]

- Cover the fuel pipe opening with tape to prevent intrusion of foreign matters.

**Point4**

[Reassemble]

- Replace the oil filter with a new one.
- After fully tightening the filter manually, retighten it with a filter wrench (see 11.1-6 in Chapter 11) by 3/4 turn.

**Point5**

[Disassemble]

- Cover the fuel injection pipe and pump inlets and outlets with tape or the like to prevent intrusion of foreign matters.

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**Point6**

1)Removing pipe seals of 4 valve head.

[Disassemble]

- Take off a rocker arm cover in case of 4 valve head after removing fuel injection pipes and pipe seals.

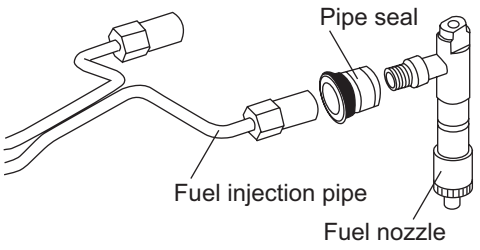
[NOTICE]

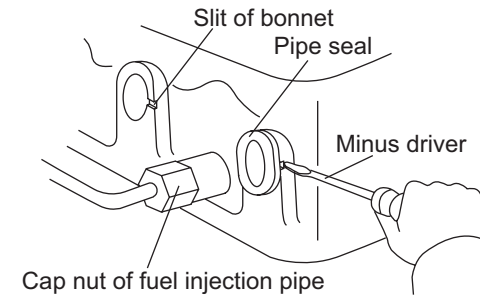
Attention is necessary because a fuel nozzle is caught in a pipe seal and the pipe seal is damaged when a rocker arm cover is lifted with a pipe seal sticking to the rocker arm cover.

- Insert a minus driver in the slit part of the rocker arm cover, and remove it when removing a pipe seal.

[Reassemble]

- Replace the used pipe seal with a new one when removing a pipe seal.




**Pipe seal replacement**

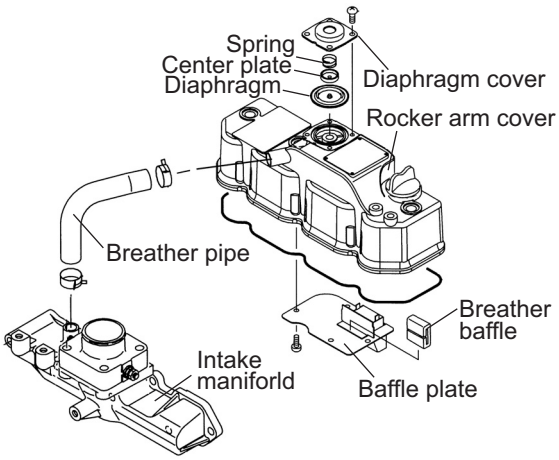
2)Breather system (A redactor to intake air system of blowby gas)

Emitting blowby gas is harmful to natural environment. Therefore blowby gas redactor is adopted to TNV series naturally- aspirated engines as breather system (Turbocharged engines emitblowby gas).

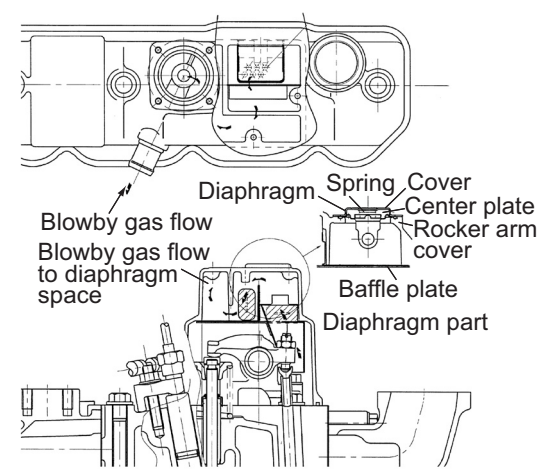
The system of model 3/4TNV84 is shown as a representative of that breather system in the right figure. Some of the combustion gas passes through the clearance between the cylinder and the piston, piston ring, and flows to the crankcase. This is said as blowby gas. While it passes into the cylinder head and the rocker arm cover, the blowby gas mixes with splash oil, and becomes oil mist-blowby gas mixes with splash oil, and becomes oil mist-blowby gas it passing through the baffle plate inside a rocker arm cover. And it passes through a diaphragm assy, and a intake manifold, and is reduced in the combustion chamber. Pressure inside a crankcase is controlled by the function of the diaphragm assy, and suitable amount of blowby gas is reduced in intake air system.

[Disassemble]

When a rocker arm cover is taken off, check whether oil or the like enter the diaphragm space from a small hole on the side of a diaphragm cover or not without disassembling the diaphragm.




**Breather system componert**




**Blowby gas flow**

https://truckmanualshub.com/



[NOTICE]

1)When a diaphragm is damaged, pressure control inside the crankcase becomes insufficient, and troubles occur. When the internal pressure of the crankcase decreases too much due to the damage of a spring, much blowby gas containing oil is reduced in intake air system, and it may cause the combustion defect by the early dirt of the intake valve or the urgent rotation of the engine by the oil burning.

When pressure progresses in the crank case too much due to the wrong operation of the diaphragm and so on, it is considered that oil leakage from the joint of a oil pan, a oil seal and so on will occur. When a diaphragm is damaged, blowby is discharged from the breathing hole on the side of diaphragm cover, and not reduced in the intake manifold. Therefore, be careful of the diaphragm trouble.

2)At lubricating oil replacement or lube oil supply

The amount of lubricating oil isn't to be beyond the standard upper limit (in the engine horizontally, the upper limit mark of the dip stick). Since the blowby gas redactor is adopted, be careful that the amount of oil mist may be inducted in the combustion chamber and the oil hammer sometimes may occur, when the lubricating oil quantity is beyond the upper limit or an engine is operated beyond the allowable maximum angle of an engine.

[Reassembly]

Replace the diaphragm with new one, when it is damaged.

**Point7**

[Disassemble]

- Keep the removed push rods by attaching tags showing corresponding cylinder Nos.

[Reassemble]

- Always apply oil to the contact portions of the push rods and clearance adjusting screws.

**Point8**

[Disassemble]

- Loosen the cylinder head bolts in two steps in the illustrated order.
- Place the cylinder head assy on a paper board to prevent the combustion face from any damage.

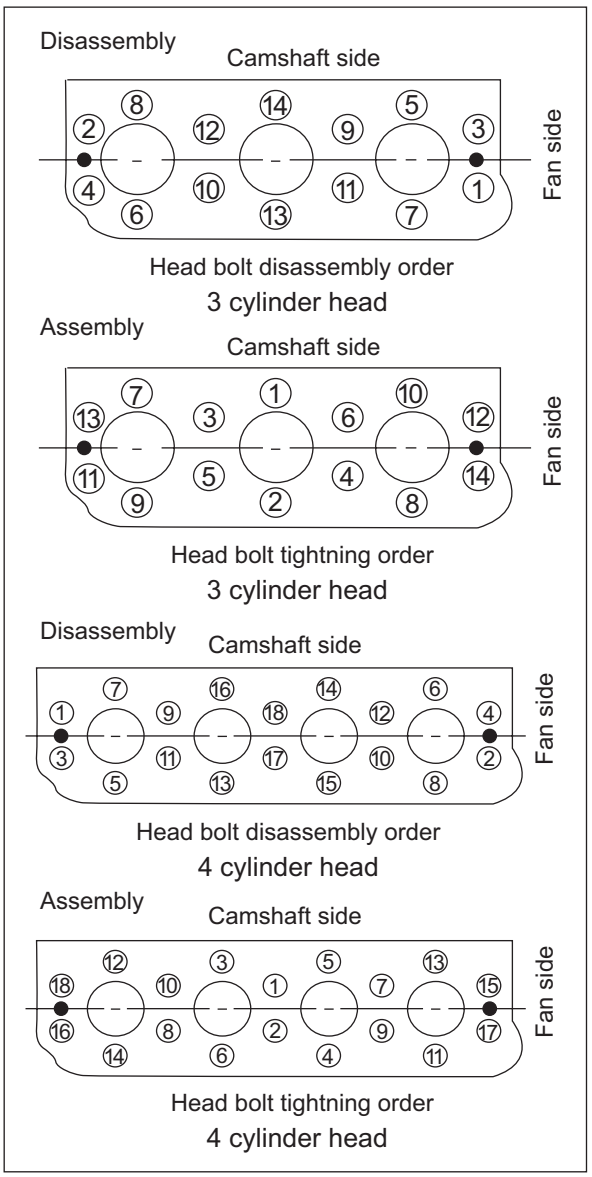
[Reassemble]

- Remove the head gasket with a new one.
- Uniformly install the head bolts manually after applying oil on the threaded and seat portions.
- They shall be tightened in two steps in the reverse of the order for disassembly.
- Tightening torque

N•m (kgf•m)

| | TNV82A | TNV84-88 |
|---|---|---|
| First step | 30.0 to 34.0<br>(3.1 to 3.5) | 41.1 to 46.9<br>(4.2 to 4.8) |
| Second step | 61.7 to 65.7<br>(6.3 to 6.7) | 85.3 to 91.1<br>(8.7 to 9.3) |

| | 4TNV94L/98 | 4TNV106 (T) |
|---|---|---|
| First step | 49.0 to 58.8<br>(5.0 to 6.0) | 88.3 to 98.1<br>(9.0 to 10.0) |
| Second step | 103.1 to 112.9<br>(10.5 to 11.5) | 188.0 to 197.8<br>(19.0 to 20.0) |



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**Point9**

[Disassemble]

- Carefully remove the fuel injection valve so as not to leave the top end protector from being left inside the cylinder.

[Reassemble]

- Replace the fuel injection valve protector with a new one.

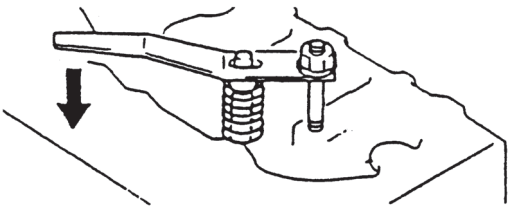
**Point10**

[Disassemble]

- When removing each intake/exhaust valve from the cylinder head, use a valve spring compressor (see 11.1-4 in Chapter 11) and compress the valve spring and remove the valve cotter.)
- Keep each removed intake/exhaust valve after attaching a tag showing the corresponding cylinder No.
- If cotter burr is seen at the shaft of each intake/ exhaust valve stem, remove it with an oilstone and extract the valve from the cylinder head.

[Reassemble]

- Replace the stem seal with a new one when an intake/exhaust valve is disassembled.
- Carefully install each valve after oil application so as not to damage the stem seal.
- Different stem seals are provided for the intake and exhaust valves. Do not confuse them since those for exhaust valves are marked with yellow paint.
- After assembling the intake/exhaust valve, stem seal, valve spring, seat, and cotter, tap the head of the valve stem lightly for settling.
- Do not forget to install the valve cap.



**Valve spring compressor**

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## 4.2.5 Parts Inspection and measurement

### (1) Cylinder head

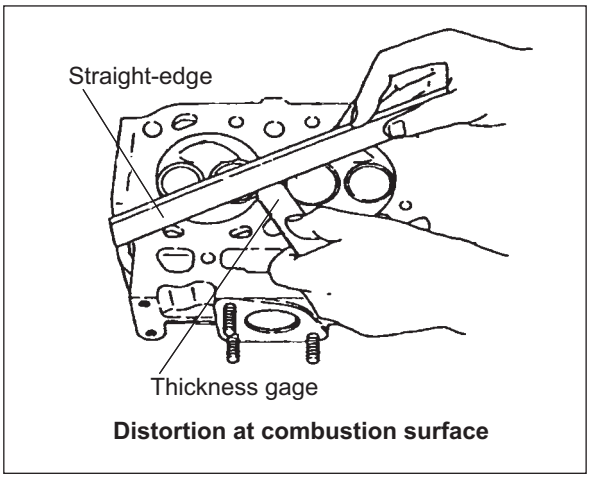
Clean the cylinder head, mainly the combustion surface, valve seats and intake/exhaust ports, remove carbon deposit and bonding agent, and check the surface state.

(a)Appearance check

Check mainly discoloration and crack. If crack is suspected, perform color check.

(b)Combustion surface distortion

Apply a strait-edge in two diagonal directions and on four sides of the cylinder head, and measure distortion with a thickness gage.



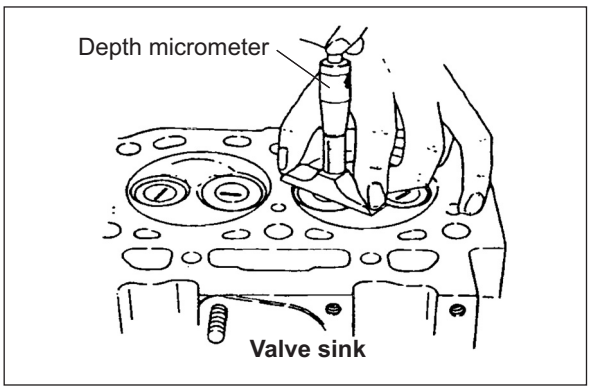
**Distortion at combustion surface**

mm

| | Standard | Limit |
|---|---|---|
| Distortion | 0.05 or less | 0.15 |

(c)Valve sink

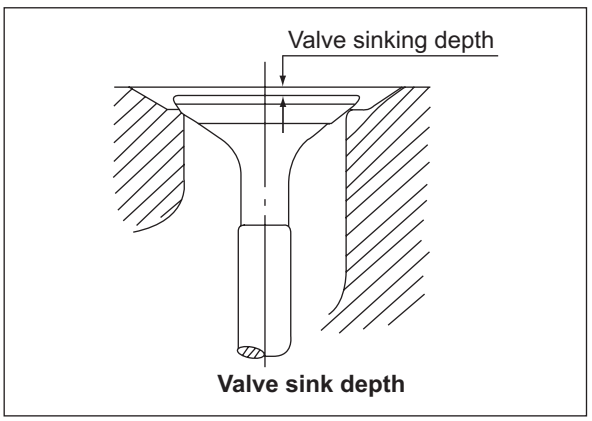
Measure with the valve inserted to the cylinder head.



**Valve sink**

mm

| | | Standard | Limit |
|---|---|---|---|
| 3TNV82A (2-valve head) | Intake | 0.35 to 0.55 | 0.8 |
| | Exhaust | 0.30 to 0.50 | 0.8 |
| 4TNV84 3TNV84 (T) 3/4TNV88 (2-valve head) | Intake | 0.30 to 0.50 | 0.8 |
| | Exhaust | 0.30 to 0.50 | 0.8 |
| 4TNV84T 4TNV94/98 (T) (4-valve head) | Intake | 0.36 to 0.56 | 0.8 |
| | Exhaust | 0.35 to 0.55 | 0.8 |
| 4TNV106 (T) (4-valve head) | Intake | 0.5 to 0.7 | 1.0 |
| | Exhaust | 0.7 to 0.9 | 1.2 |

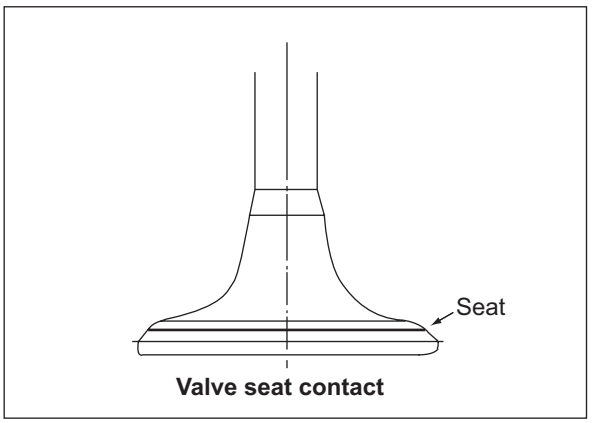


**Valve sink depth**

(d)Seat contact

Apply a thin coat of minimum on the valve seat. Insert the valve in the cylinder and push it against the seat to check seat contact.

Standard: Continuous contact all around

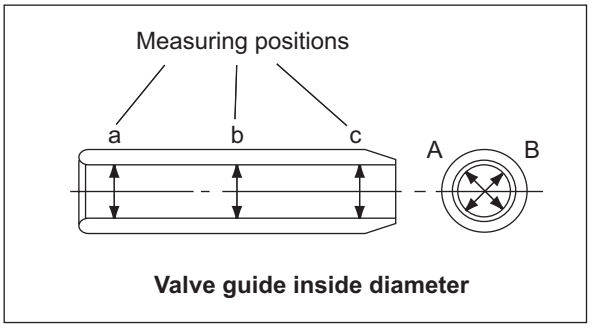


**Valve seat contact**

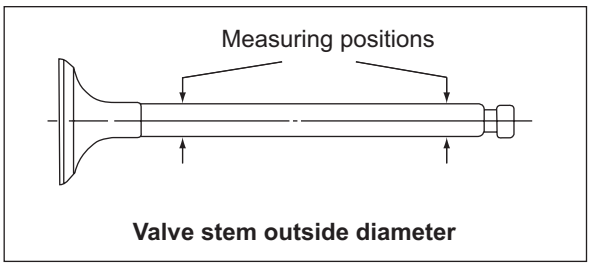
## (2) Valve guide

Mainly check damage and wear on the inside wall.
Apply the service part code when replacing a part.

| Model | | Service part code |
|---|---|---|
| 3TNV82A (2-valve) | Suction | 124060-11800 |
| | Exhaust | 119802-11810 |
| 4TNV84 3TNV84(T) 3/4TNV88 (2-valve) | Suction | 120130-11860 |
| | Exhaust | 129150-11810 |
| 4TNV84T (4-valve) | Suc./Exh. | 119717-11800 |
| 4TNV94L 4TNV98(T) (4-valve) | Suc./Exh. | 129907-11800 |
| 4TNV106(T) (4-valve) | Suction | 123907-11800 |
| | Exhaust | 123907-11810 |



**Valve guide inside diameter**



**Valve stem outside diameter**

**Valve stem clearance**

| Model | Part name | Place | Standard | Limit |
|---|---|---|---|---|
| 3TNV82A (2-valve head) | Intake value | Guide I.D. | 7.000 to 7.015 | 7.08 |
| | | Stem O.D. | 6.945 to 6.960 | 6.90 |
| | | Clearance | 0.040 to 0.070 | 0.18 |
| | Exhaust value | Guide I.D. | 7.000 to 7.015 | 7.08 |
| | | Stem O.D. | 6.940 to 6.955 | 6.90 |
| | | Clearance | 0.045 to 0.075 | 0.18 |
| 4TNV84 3TNV84 (T) 3/4TNV88 (2-valve head) | Intake value | Guide I.D. | 8.010 to 8.025 | 8.10 |
| | | Stem O.D. | 7.955 to 7.975 | 7.90 |
| | | Clearance | 0.035 to 0.070 | 0.18 |
| | Exhaust value | Guide I.D. | 8.015 to 8.030 | 8.10 |
| | | Stem O.D. | 7.955 to 7.970 | 7.90 |
| | | Clearance | 0.045 to 0.075 | 0.18 |
| 4TNV84T (4-valve head) | Intake value | Guide I.D. | 6.000 to 6.015 | 6.08 |
| | | Stem O.D. | 5.960 to 5.975 | 5.90 |
| | | Clearance | 0.025 to 0.055 | 0.15 |
| | Exhaust value | Guide I.D. | 6.000 to 6.015 | 6.08 |
| | | Stem O.D. | 5.945 to 5.960 | 5.90 |
| | | Clearance | 0.040 to 0.070 | 0.17 |
| 4TNV94L 4TNV98 (T) (4-valve head) | Intake value | Guide I.D. | 7.000 to 7.015 | 7.08 |
| | | Stem O.D. | 6.945 to 6.960 | 6.90 |
| | | Clearance | 0.040 to 0.070 | 0.17 |
| | Exhaust value | Guide I.D. | 7.000 to 7.015 | 7.08 |
| | | Stem O.D. | 6.940 to 6.955 | 6.90 |
| | | Clearance | 0.045 to 0.075 | 0.17 |
| 4TNV106(T) (4-valve head) | Intake value | Guide I.D. | 7.008 to 7.020 | 7.08 |
| | | Stem O.D. | 6.960 to 6.975 | 6.92 |
| | | Clearance | 0.033 to 0.060 | 0.16 |
| | Exhaust value | Guide I.D. | 7.008 to 7.020 | 7.08 |
| | | Stem O.D. | 6.945 to 6.960 | 6.90 |
| | | Clearance | 0.048 to 0.075 | 0.18 |

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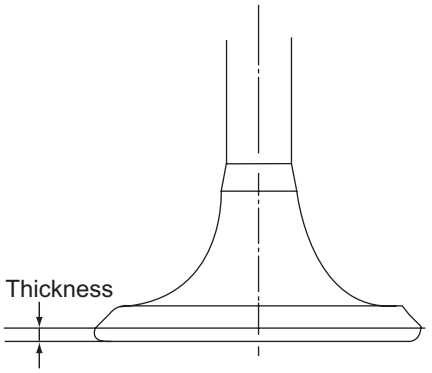
## (3) Intake/exhaust valve

Mainly clean and check damage and wear at the valve stem and seat.

(a)Seat contact: See (1)-(d) above.
(b)Stem outside diameter: See (2) above.
(c)Valve head thickness

mm

| Model | Part | Standard | Limit |
|---|---|---|---|
| 3TNV82A to 88 4TNV84 (2-valve head) | Intake | 1.24-1.44 | 0.8 |
| | Exhaust | 1.35-1.55 | 0.8 |
| 4TNV84T (4-valve head) | Intake | 1.00-1.20 | 0.6 |
| | Exhaust | 1.00-1.20 | 0.6 |
| 4TNV94L•98 (T) (4-valve head) | Intake | 1.44-1.84 | 1.0 |
| | Exhaust | 1.70-2.10 | 1.0 |
| 4TNV106(T) (4-valve head) | Intake | 1.60-2.00 | 1.2 |
| | Exhaust | 1.80-2.20 | 1.2 |

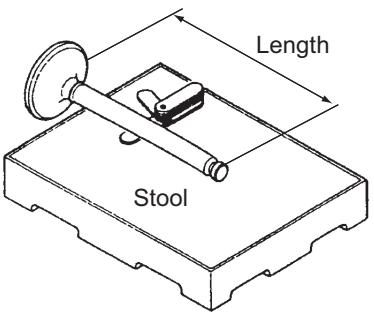



**Valve head thickness**

(d)Valve stem bend

mm

| | |
|---|---|
| Limit | 0.01 |

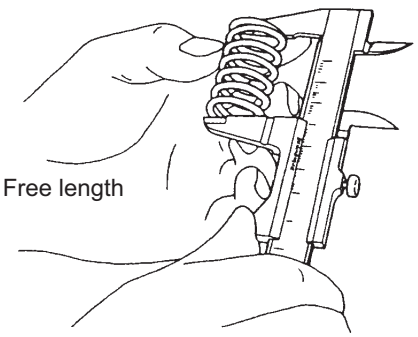



**Valve bend and length**

(e)Overall length

mm

| | | Standard | Limit |
|---|---|---|---|
| 3TNV82A | Intake/Exhaust | 97.2-97.8 | 97.0 |
| 3/4TNV84 to 88 | Intake/Exhaust | 108.7-109.3 | 108.5 |
| 4TNV84T | Intake/Exhaust | 100.0-100.6 | 99.8 |
| 4TNV94L 4TNV98(T) | Intake | 102.3-103.1 | 102.1 |
| | Exhaust | 102.4-103.2 | 102.2 |
| 4TNV106(T) | Intake | 117.3-118.1 | 117.1 |
| | Exhaust | 117.1-117.9 | 116.9 |



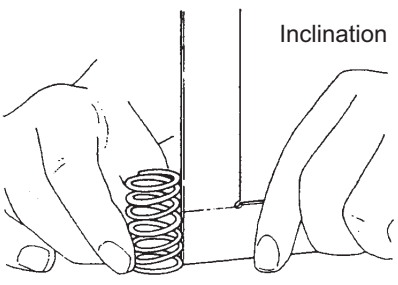

**Valve spring**

## (4) Valve spring

Mainly inspect damage and corrosion.

mm

| | Free length | | Inclination limit |
|---|---|---|---|
| | Standard | Limit | |
| 3TNV82A | 44.4 | 43.9 | 1.4 |
| 3/4TNV84 to 88 | 42.0 | 41.5 | |
| 4TNV84T | 37.4 | 36.9 | 1.3 |
| 4TNV94L•98(T) | 39.7 | 39.2 | 1.4 |
| 4TNV106(T) | 50.6 | 50.1 | 1.5 |

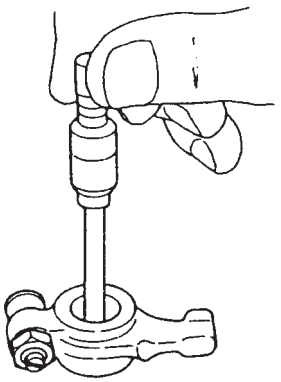



**Valve spring**

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## (5) Valve rocker arm

Mainly inspect valve head cap contact surface, inside surface defects and wear.
Slight surface defects shall be corrected with an oilstone.



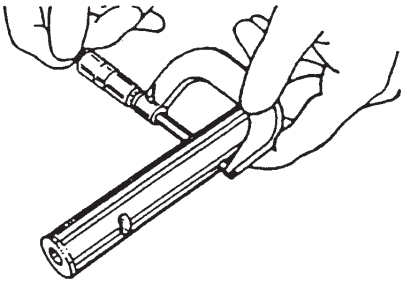
**Rocker arm hole diameter**

mm

| Model | Items | Standard | Limit |
|---|---|---|---|
| 3TNV82A<br>3/4TNV84(T)<br>3/4TNV88 | Arm hole diameter | 16.00 to 16.02 | 16.07 |
| | Shaft O.D. | 15.97 to 15.98 | 15.94 |
| | Clearance | 0.016 to 0.054 | 0.13 |
| 4TNV94L/98(T)<br>4TNV106(T) | Arm hole diameter | 18.50 to 18.52 | 18.57 |
| | Shaft O.D. | 18.47 to 18.49 | 18.44 |
| | Clearance | 0.01 to 0.05 | 0.13 |

## (6) Rocker arm shaft

Mainly inspect seizure and wear at the surface in sliding contact with the arm. The rocker shaft diameter shall be as specified in (5) above.

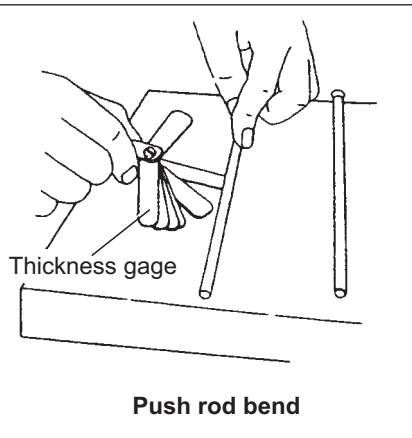


**Rocker shaft outside diameter**

## (7) Push rod

Mainly inspect the surface in contact with the tappet and adjusting screw. Slight defects shall be corrected with an oilstone.

| | |
|---|---|
| Bend limit | 0.03 mm |




**Push rod bend**

## (8) Valve clearance adjusting screw

Mainly inspect the surface in contact with the push rod. Slight defects shall be corrected with an oilstone.

## (9) Rocker arm spring

Mainly inspect surface defects and corrosion.

(R.1)

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## 4.2.6 Valve seat correction

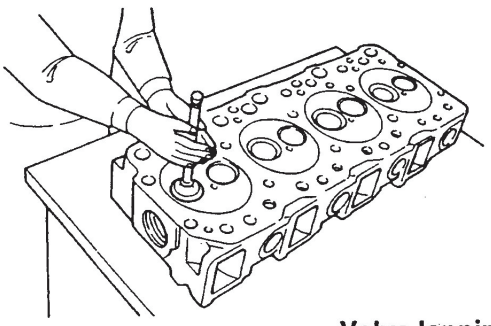
[NOTICE]

Always check the oil clearance between the valve and valve guide before correcting the valve seat. If it exceeds the limit, replace the valve or valve guide first to make the clearance satisfy the standard. After correction, wash the valve and the cylinder head sufficiently with diesel oil to remove all grinding powder or compound.

1)If the seat surface is slightly roughened: perform **[A]** and **[B]** below.

**[A]:** Lap the valve and seat with a mixture of valve compound and engine oil.

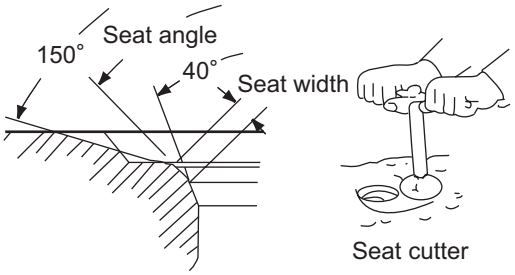
**[B]:** Lap with engine oil only.



**Valve lapping**

2)If the seat is heavily roughened but the width is almost normal, correct with a seat grinder or seat cutter first. Then perform lapping **[A]** and **[B]**.

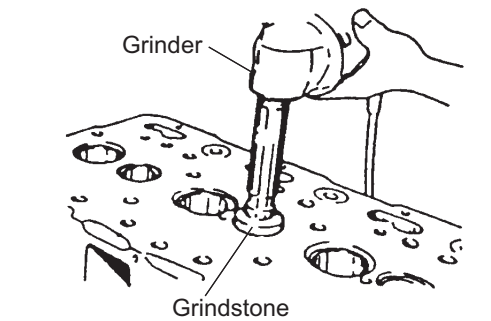
| | intake | Exhaust |
|---|---|---|
| Seat cutter angle | 120 | 90 |




**Cylinder head correction angle**

3)If the seat is heavily roughened and the width is much enlarged, grind the seat inner surface with a seat grinder whose center angle is 40°, then grind the seat outer surface with a grinder whose center angle is 150° to make the seat width match the standard. Then perform seat correction as described in 2), and then carry out lapping **[A]** and **[B]**.

| Grinding wheel angle | θ 1 | θ 2 |
|---|---|---|
| | 40 | 150 |




**Seat grinder**

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## 4.2.7 Valve guide replacement

1)Use a valve guide extraction tool (12.1-1 in Chapter 12) and extract the valve guide from the cylinder head.

2)Put liquid nitrogen or ether (or alcohol) with dry ice added in a container and put the valve guide for replacement in it for cooling. Then insert it in with a valve guide inserting tool (Refer to No.2 of 4.1.2 in Chapter 4).

**⚠ CAUTION**

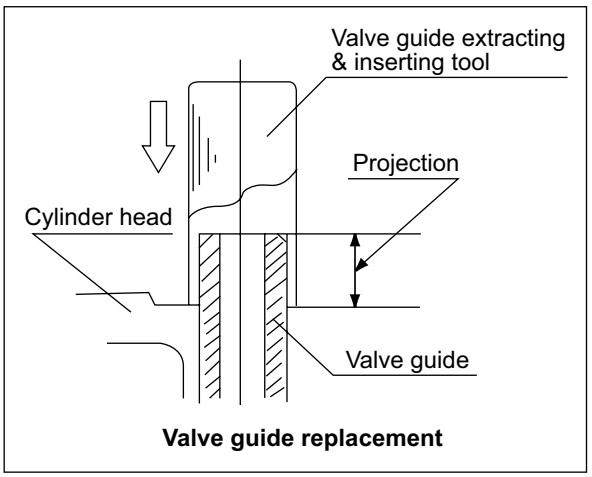
Do not touch the cooled valve guide with bare hands to avoid skin damage.

3)Check the inside diameter and finish to the standard inside diameter as required with a reamer.

4)Check the projection from the cylinder head.

mm

| Model | Number of valves | Projection |
|---|---|---|
| 3TNV82A | 2 valves | 11.7 to 12.0 |
| 4TNV84<br>3TNV84 (T)<br>4TNV88 | | 14.7 to 15.0 |
| 4TNV84T | 4 valves | 8.2 to 8.5 |
| 4TNV94L<br>4TNV98(T) | | 9.7 to 10. |
| 4TNE106(T) | | 13.4 to 13.6 |




**Valve guide replacement**

(R.1)

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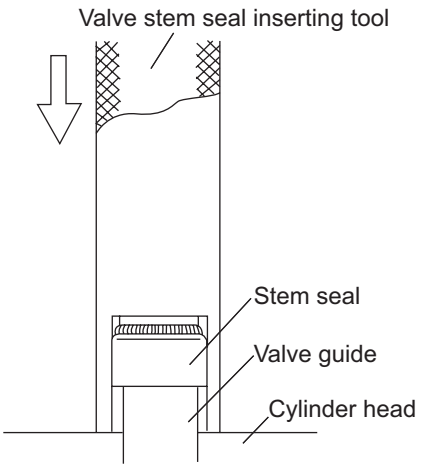


## 4.2.8 Valve stem seal replacement

Always use a new seal after the intake/exhaust valve is disassembled. Since the one for the exhaust valve is marked with yellow paint, do not confuse the intake and exhaust valves.

1)Apply engine oil to the lip.

2)Push with the inserting tool (Refer to No.5 of 4.1.2 in Chapter 4) for installation.

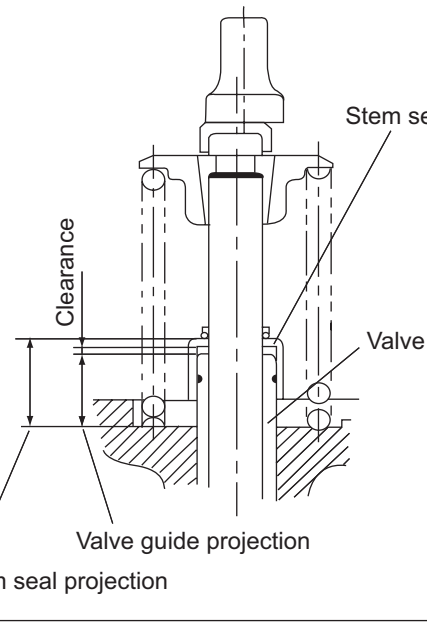



**Stem seal insertion**

3)Measure and check the projection of valve stem seal to keep proper clearance between valve guide and stem seal.

mm

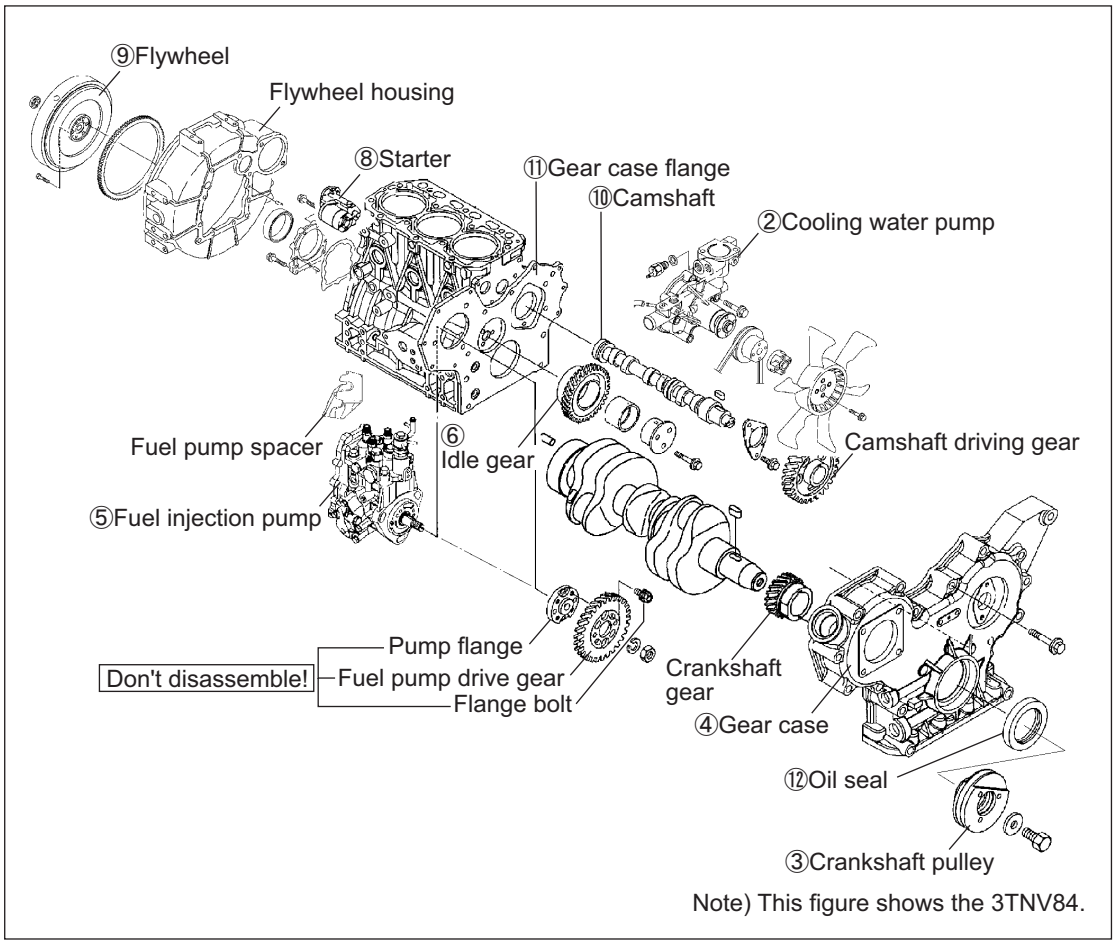
| Model | Number of valves | Projection |
|---|---|---|
| 3TNV82A | 2 valves | 15.7 to 16.0 |
| 4TNV84<br>3TNV84 (T)<br>4TNV88 | | 18.7 to 19.0 |
| 4TNV84T | 4 valves | 9.9 to 10.2 |
| 4TNV94L<br>4TNV98 (T) | | 11.7 to 12.0 |
| 4TNE106 (T) | | 15.4 to 15.6 |



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# 4.3 Gear train and camshaft

## 4.3.1 Components




Note) This figure shows the 3TNV84.

## 4.3.2 Disassembly procedure:

Disassemble in the order of the numbers in the illustration.

1)Perform steps 1) to 12) of the cylinder head disassembly procedure.
2)Remove the cooling water pump.
3)Remove the crankshaft pulley. (See **Point 1** of 4.3.4)
4)Remove the gear case cover. (See **Point 2** of 4.3.4)
5)Remove the fuel injection pump. (See **Point 3** of 4.3.4)
6)Remove the idle gear assy. (See **Point 4** of 4.3.4)
7)Remove the PTO drive gear. (See **Point 5** of 4.3.4)
8)Remove the starting motor.
9)Remove the flywheel. (See **Point 6** of 4.3.4)
10) Remove the camshaft assy. (See **Point 7** of 4.3.4)
11) Remove the gear case. (See **Point 8** of 4.3.4)
12) Remove the oil seal from the gear case cover. (See **4.3.6**)

## 4.3.3 Reassembly procedure:

Reverse of the disassembly procedure.

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## 4.3.4 Servicing points

**Point1**

[Disassemble]

- Remove the crankshaft pulley using a gear puller after removing the crankshaft pulley set bolt. When removing the pulley using the gear puller, use a pad and carefully operate so as not to damage the thread. Set the gear puller securely to prevent the pulley from being damaged.

[Reassemble]

- Apply lithium grease to the oil seal lips. For the oil seal with double lips dust seal, further slightly apply engine oil on the lips so as not to damage them.
- Clean by wiping off any oil on both taper surfaces using detergent.
- Be sure to use the crankshaft pulley installing tool so as not to damage the oil seal lips. (See 4.3(6) Oil seal replacement)
- When installing the crankshaft pulley, apply lube oil to the set bolt to tighten and carefully assemble so as not to damage the oil seal.

N•m (kgf•m)

| Model | Tightening torque |
|---|---|
| 3TNV82A to TNV88 | 112.7 to 122.7 (11.5 to 12.5) |
| 4TNV94L/98/106(T) | 107.9 to 127.5 (11.0 to 3.0) |

**Point2**

[Reassemble]

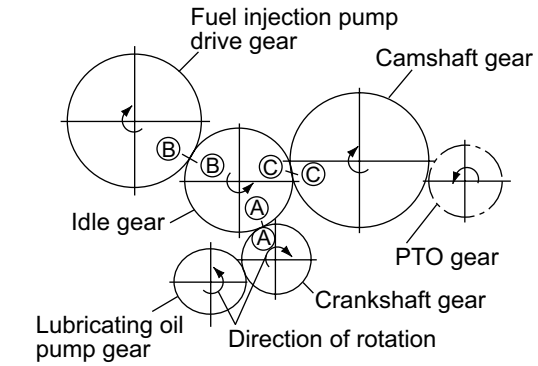
- When installing the gear case, do not forget to install the two reinforcing bolts at the center.
- Measure the backlash of each gear.

mm

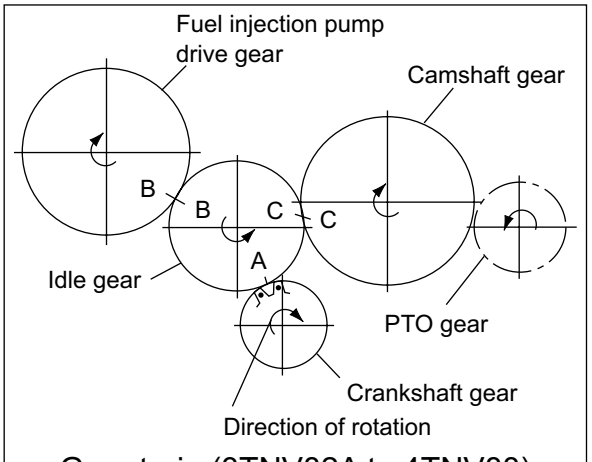
| 3TNV82A to 88 | Standard | Limit |
|---|---|---|
| Crankshaft gear,<br>Camshaft gear,<br>Fuel injection pump gear,<br>Idle gear, PTO gear, | 0.07 to 0.15 | 0.17 |

| 4TNV94L-106(T) | Standard | Limit |
|---|---|---|
| Crankshaft gear,<br>Camshaft gear,<br>Fuel injection pump gear,<br>Idle gear, PTO gear, | 0.08 to 0.14 | 0.16 |
| Balancer gear<br>(only 4TNV106(T)) | 0.12 to 0.18 | 0.20 |
| Lubricating oil pump gear | 0.09 to 0.15 | 0.17 |

- Apply sealant and install the gear case by correctly positioning the two dowel pins.




Gear train (4TNV94L to 106)




Gear train (3TNV82A to 4TNV88)

(R.1)

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**Point3: (Refer to 7.2.5 in chapter 7)**

[Disassemble]

- Remove the mounting nut of the fuel injection pump drive gear, remove the gear using the gear puller, and remove the fuel injection pump. Do not forget to remove the stay on the rear side. When extracting the gear using the gear puller, use a pad at the shaft and carefully operate so as not to damage the thread.

[Reassemble]

- Tightening torque for fuel pump drive gear nut (without lube. Oil)

N•m (kgf•m)

| Model | Tightening torque |
|---|---|
| TNV82A to 88 | 78 to 88 (8.0 to 9.0) |
| 4TNV94L/98/106 (T) | 113 to 123 (11.5 to 12.5) |

**Point4**

[Reassemble]

- Assemble crankshaft gear A, fuel injection pump drive gear B and camshaft gear C at the same time by aligning with idle gear A, B and C marks.
- Install the idle gear shaft with the oil hole facing upward.

**Point5**

[Reassemble]

- Install the PTO drive gear with its inner spline side facing the flywheel.

**Point6**

[Disassemble]

- Install a bolt as a handle in the hole at the end face of the flywheel and remove carefully so as not to damage the ring gear.

[Reassemble]

Flywheel mounting bolt : apply lube oil

N•m (kgf•m)

| Model | Tightening torque |
|---|---|
| 3TNV82A to 88 | 83.3 to 88.2 (8.5 to 9.0) |
| 4TNV94L/98/106 (T) | 186.2 to 205.8 (19.0 to 21.0) |

**Point7**

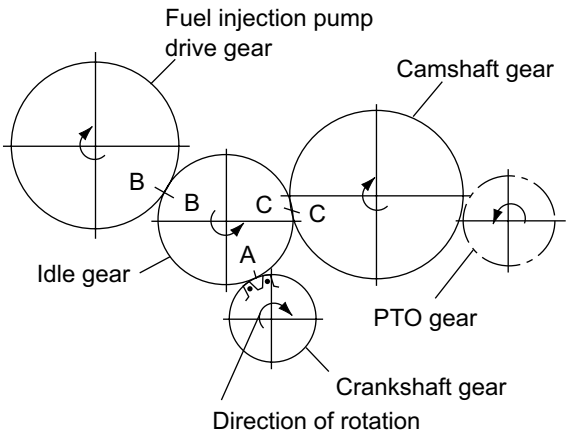
[Disassemble]

- Measure the camshaft side gap.

mm

| Item | Standard | Limit |
|---|---|---|
| Side gap | 0.05 to 0.20 | 0.30 |

- If the measured side gap exceeds the limit, replace the thrust metal.



Gear train (3TNV82A to 4TNV88)

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[Disassemble]

- Since the camshaft gear is shrink-fit, heat it to 180°C to 200°C for extraction.
- For camshaft removal, raise the engine with its mounting flange at the bottom. After removing the thrust metal mounting bolt from the camshaft gear hole, extract the camshaft carefully so as not to damage the bearing bushing.
- Rotate the camshaft a few turns before extracting it to prevent the tappet from being caught by the cam.
- After removing the camshaft, set the engine horizontal and fix it on the base.

**⚠ CAUTION**

Unforeseen injury may arise due to falling of slipping when raising the engine vertically or returning it to the horizontal position. Proceed carefully so as not to lose balance.

**Point8: Gear case**

[Reassemble]

- Do not forget to install the oil pan mounting bolts on the bottom side when installing the gear case.
- Apply sealant (code No.977770-01212) and install the gear case by matching the two dowel pints.

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## 4.3.5 Parts inspection and measurement

### (1) Camshaft

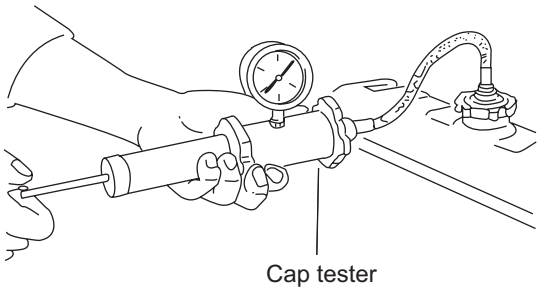
Mainly check the contact between the tappet and cam contact surface, bearing seizure and wear, and gear damage.

(a)Shaft bend measurement

Support the camshaft with V blocks. Rotate the camshaft and measure the runout at the center of the camshaft and at each journal with a dial gage. Half of the runout is the bend.

mm

| Item | Standard | Limit |
|---|---|---|
| Bend | 0 to 0.02 | 0.05 |

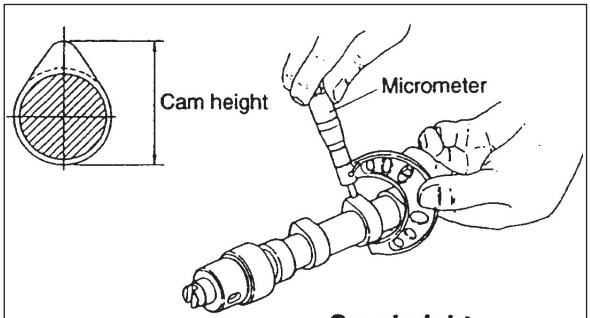



Water leak check in cooling water system

(b)Intake/exhaust cam height measurement

mm

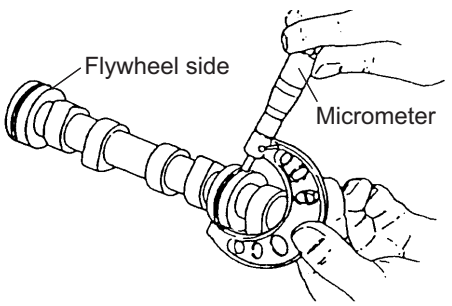
| Model | Standard | Limit |
|---|---|---|
| 3TNV82A to 88 | 38.600 to 38.800 | 38.350 |
| 4TNV94L•98 | 43.400 to 43.600 | 43.150 |
| 4TNV106 (T) | 50.900 to 51.100 | 50.650 |




**Cam height**

(c)Camshaft and bearing hole measurement

Measure the camshaft outside diameter with a micrometer. The oil clearance shall be calculated by subtracting the measured camshaft outside diameter from the inside diameter of the camshaft bearing or bushing. The camshaft bushing at gear case side is measured with a cylinder gage after insertion to the cylinder.




**Camshaft outside diameter**

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mm

| Model | Place | Item | Standard | Limit |
|---|---|---|---|---|
| 3TNV82A to TNV88 | Gear side | Bushing I.D. | 44.990 to 45.055 | 45.130 |
| | | Camshaft O.D. | 44.925 to 44.950 | 44.890 |
| | | Oil clearance | 0.040 to 0.130 | 0.240 |
| | Intermediate position | Bushing I.D. | 45.000 to 45.025 | 45.100 |
| | | Camshaft O.D. | 44.910 to 44.935 | 44.875 |
| | | Oil clearance | 0.065 to 0.115 | 0.225 |
| | Wheel side | Bushing I.D. | 45.000 to 45.025 | 45.100 |
| | | Camshaft O.D. | 44.925 to 44.950 | 44.890 |
| | | Oil clearance | 0.0500.100 | 0.210 |
| TNV94L/98 (T) | Gear side | Bushing I.D. | 49.990 to 50.055 | 50.130 |
| | | Camshaft O.D. | 49.925 to 49.950 | 49.890 |
| | | Oil clearance | 0.040 to 0.130 | 0.240 |
| | Intermediate position | Bushing I.D. | 50.000 to 50.025 | 50.100 |
| | | Camshaft O.D. | 49.910 to 49.935 | 49.875 |
| | | Oil clearance | 0.065 to 0.115 | 0.225 |
| | Wheel side | Bushing I.D. | 50.000 to 50.025 | 50.100 |
| | | Camshaft O.D. | 49.925 to 49.950 | 49.890 |
| | | Oil clearance | 0.05 to 0.100 | 0.210 |
| 4TNV106(T) | Gear side | Bushing I.D. | 57.980 to 58.050 | 58.105 |
| | | Camshaft O.D. | 57.910 to 57.940 | 57.875 |
| | | Oil clearance | 0.040 to 0.140 | 0.250 |
| | Intermediate position | Bushing I.D. | 58.000 to 58.030 | 58.105 |
| | | Camshaft O.D. | 57.895 to 57.925 | 57.860 |
| | | Oil clearance | 0.075 to 0.135 | 0.245 |
| | Wheel side | Bushing I.D. | 58.000 to 58.030 | 58.105 |
| | | Camshaft O.D. | 57.910 to 57.940 | 57.875 |
| | | Oil clearance | 0.050 to 0.120 | 0.230 |

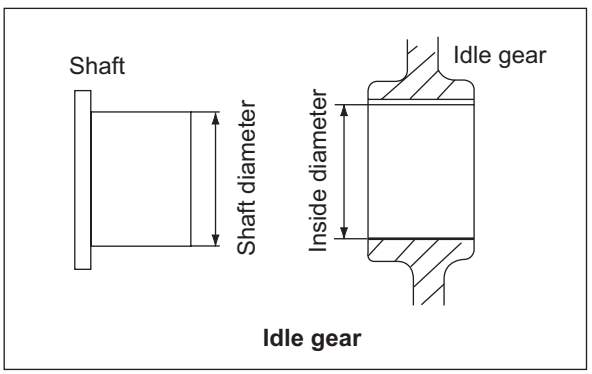
## (2) Idle gear

Mainly check the bushing seizure and wear, and gear damage.

Shaft outside diameter and bushing inside diameter measurement

mm

| Item | Standard | Limit |
|---|---|---|
| Shaft outside diameter | 45.950 to 49.975 | 45.900 |
| Bushing inside diameter | 46.000 to 46.025 | 46.075 |
| Clearance | 0.025 to 0.075 | 0.175 |




**Idle gear**

## (3) PTO drive gear

Mainly check sticking of bearings on both sides, gear damage and looseness, and gear shaft damage and wear.

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## 4.3.6 Oil seal replacement (Gear case side)

1)Replace the oil seal with a new one when the gear case is disassembled.
Extract the used oil seal.

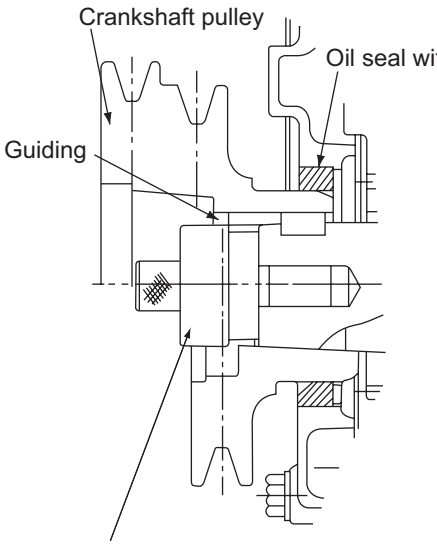
2)Insert a new oil seal. Fit the position of the oil seal insertion to the end face of the gear case. (Refer to the below figure.)

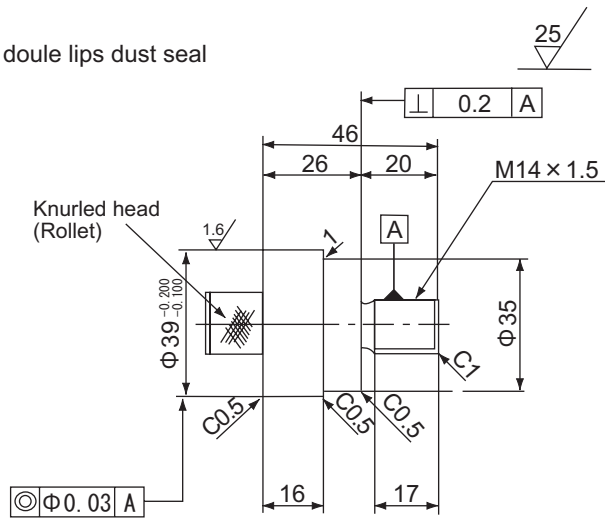
3)Apply lithium grease to the oil seal tips. For the oil seal with double lips dust seal, further, slightly apply engine oil on the oil seal lip so as not to damage them, when installing the pulley.

[NOTICE]

Pay attention not to drop any oil on the taper surface of the crankshaft. If dropped, clean by wiping off using detergent.

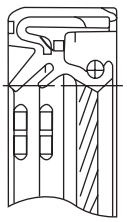
4)Carefully install the crankshaft pulley so as not to damage the oil seal lips. Especially for the engine installed the oil seal with double lips dust seal, be sure to use the crankshaft pulley-installing tool.




Detail of crankshaft pulley installing tool (Scale: free)
(Local supply)

**For 4TNV94L engine installed the oil seal with double lips dust seal**



Oil seal with double lips dust seal

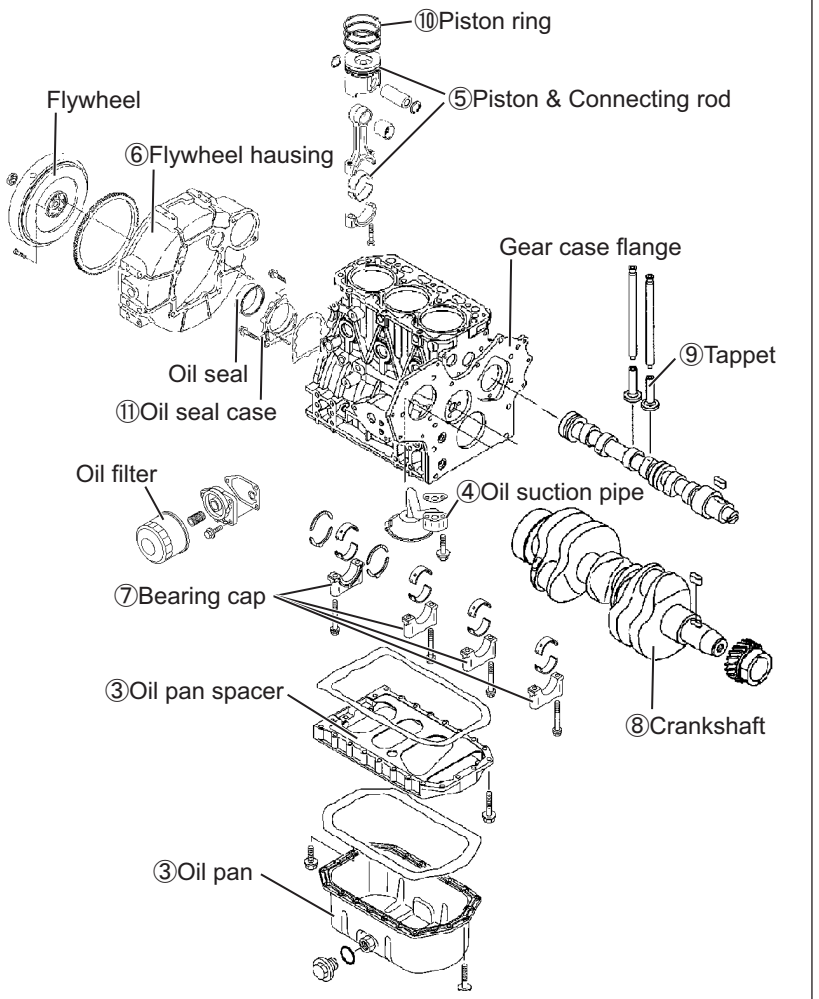
## 4.3.7 Camshaft bushing replacement

Replace the bushing using the special service tool (Refer to No.7 of 4.1.2 in Chapter 4).

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# 4.4 Cylinder block

## 4.4.1 Components




Note) This figure shows the 3TNV84.

## 4.4.2 Disassembly procedure:

Disassemble in the order of the numbers in the illustration.

1)Perform steps 1) to 12) in the cylinder head disassembly procedure.
2)Perform steps 1) to 12) in the gear train disassembly procedure.
3)Remove the oil pan. (See **Point 1** of 4.4.4)
4)Remove the lubricating oil suction pipe.
5)Remove the piston w/rod. (See **Point 2** of 4.4.4)
6)Remove the mounting flange. (See **Point 3** of 4.4.4)
7)Remove the bearing metal caps. (See **Point 4** of 4.4.4)
8)Remove the crankshaft. (See **Point 5** of 4.4.4)
9)Remove the tappets.
10)Remove the pistons and rings. (See **Point 6** of 4.4.4)
11)Remove the oil seal from the mounting flange. (See **4.4.8** of 4.4.4)

## 4.4.3 Reassembly procedure:

Reverse of the disassembly procedure.

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## 4.4.4 Servicing points

**Point1: Oil pan**

[Disassemble]

- Sealant is applied to the oil pan mounting surface on the block. Carefully operate soas not to damage or distort the bonding surface.

[Reassemble]

- Apply sealant (code No.977770-01212) before reassembly.

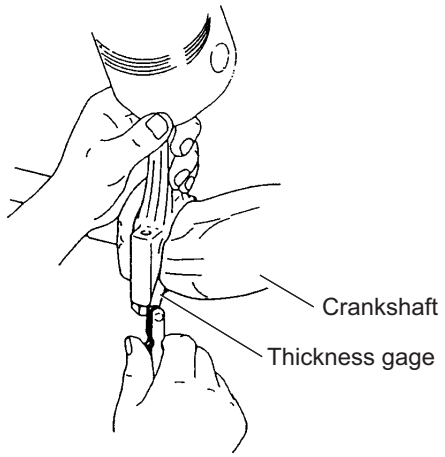
**Point2: Piston w/rod**

[Disassemble]

- Measure the connecting rod side gap.

mm

| | |
|---|---|
| Standard | 0.20 to 0.40 |




**Connecting rod side gap**

- Carefully remove the carbon deposit on top of the cylinder so as not to damage the inner side of the cylinder.
- Set the piston at the BDC position and remove the connecting rod cap. Then set the piston at the TDC position, and push the connecting rod big end with the wooden shaft of a hammer. Proceed carefully so as not to cause the cylinder block catch the rod big end. Set the rod caps and crankpin metals in their correct combinations.

[Reassemble]

- Apply oil especially carefully to the sliding contact surfaces of the pistons, rods and rings.
- Use the piston insertion tool (see 12.1-9 in Chapter 12) to insert each piston w/rod in the cylinder block and install the bearing metal cap.

Rod bolt tightening torque N•m (kgf•m)

| Model | Standard (apply lube oil) |
|---|---|
| 3TNV82A | 37.2 to 41.2 (3.8 to 4.2) |
| TNV84 to 88 | 44.1 to 49.0 (4.5 to 5.0) |
| 4TNV94L•98 | 53.9 to 58.8 (5.5 to 6.0) |
| 4TNV106(T) | 78.5 to 83.4 (8.0 to 8.5) |

**Point3: mounting flange**

[Disassemble]

Place the engine on a stable base with the cylinder block upper surface facing down, and remove the mounting flange carefully so as not to damage the combustion surface.

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[Reassemble]

Apply sealant (code No.977770-01212) and install the mounting flange by matching the two dowel pins. After assembly, raise the engine with its mounting flange on the bottom side.

**⚠ CAUTION**

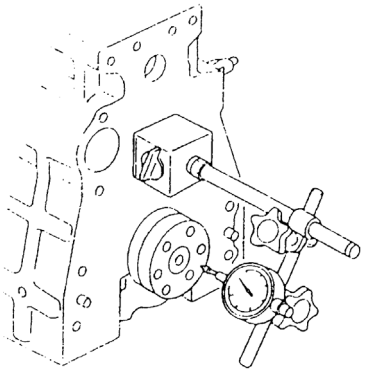
Unforeseen injury may arise due to falling of slipping when raising or reversing the engine. Carefully operate so as not to lose balance.

**Point4: Journal bearing cap**

[Disassemble]

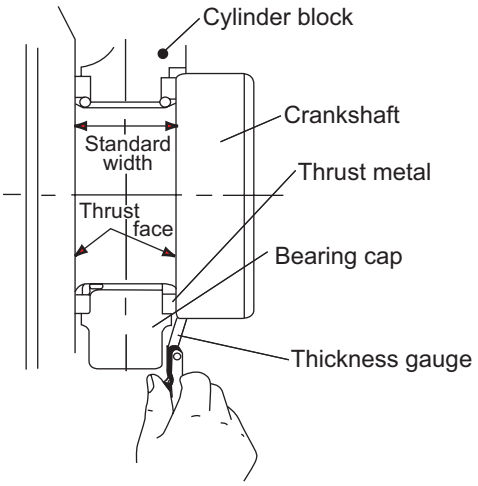
- Before removing the journal bearing, measure the crankshaft side gap. Measure it in either method because there are the next two methods.

1)Install a dial gage on the cylinder block, and move a crankshaft in front and back, and measure the side gap as shown in the right figure.



**Side gap measurement 1**

2)Put a thickness gauge in the clearance between thrust metal and crankshaft directly, and measure it.




**Side gap measurement 2**

Side gap standard

mm

| Model | Standard | Limit |
|---|---|---|
| 3TNV82A to 88 | 0.140 to 0.220 | 0.28 |
| 4TNV94L to 106 | 0.130 to 0.230 | 0.28 |

[Reassemble]

- If the side gap exceeds the standard, replace the thrust metal with an oversize one.

  Machine the standard width of the crankshaft thrust part into the dimension of the below table at the same time.

  Refer to a parts catalog when ordering the part.

  The surface finishing precision (refer to 4.4.5(2) in Chapter4): 1.6

0.25 mm Oversized thrust metal (0.25 DS) mm

| 0.25DS | Thrust metal assy code | Standard thickness |
|---|---|---|
| 3TNV82A | 119810-02940 | 2.055 to 2.105 |
| TNV84 to 88 | 129150-02940 | 2.055 to 2.105 |
| 4TNV94L•98 | 129900-02940 | 2.055 to 2.105 |
| 4TNV106(T) | 123900-02940 | 2.555 to 2.605 |

The standard width of the crankshaft thrust part

mm

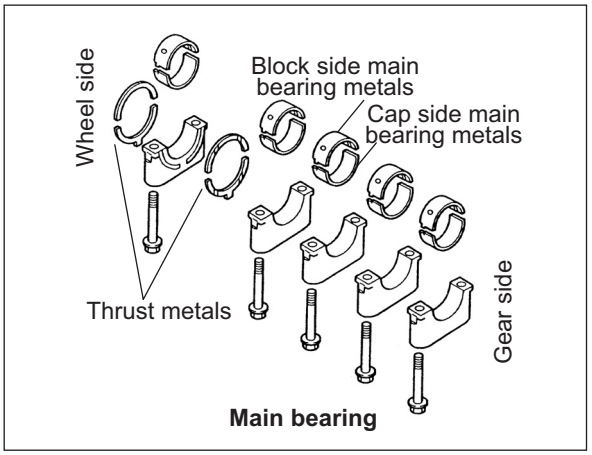
| Model | Standard thickness |
|---|---|
| 3TNV82A | 25.250 to 25.271 |
| TNV84 to 88 | 28.250 to 28.271 |
| 4TNV94L•98 | 32.250 to 32.275 |
| 4TNV106(T) | 36.250 to 36.275 |

(R.1)

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[Disassemble]

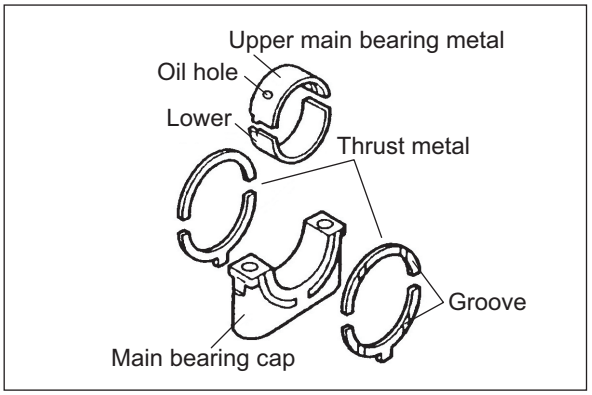
- Remove the bearing caps, cap side bearings, and thrust metals. Place each thrust metal with identification of the position and direction.
  The position number of reassembling is punched on a metal cap (except for both ends) and a cylinder block.



**Main bearing**

[Reassemble]

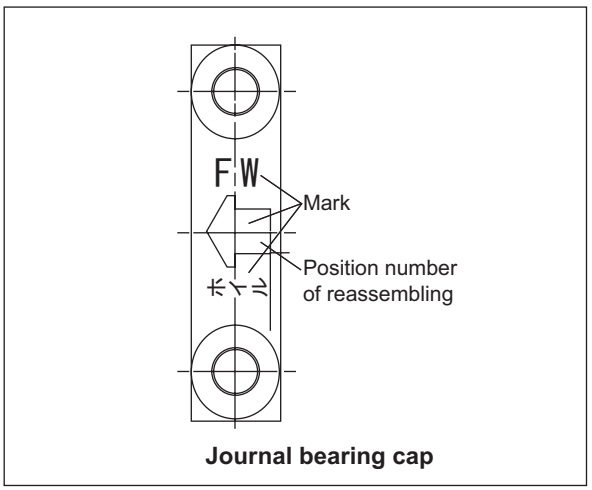
- Carefully install each thrust metal so that the grooved one is positioned away from the cap.
- Do not confuse the upper and lower main bearing metals. The upper main bearing metal (block side) has an oil hole, and the lower one does not. The “arrow” marks on the cap shall face the flywheel. Tighten main bearing cap bolts.




Main bearing cap bolt tightening torque
(apply lube oil)

N•m (kgf•m)

| Model | Standard |
|---|---|
| 3TNV82A | 76.4 to 80.4 (7.8 to 8.2) |
| TNV848 to 8 | 93.2 to 98.1 (9.5 to 10.5) |
| 4TNV94L•98 | 108.1 to 117.9 (11.0 to 12.0) |
| 4TNV106(T) | 186.2 to 205.8 (19.0 to 21.0) |



**Journal bearing cap**

**Point5: Crankshaft**

[Disassemble]

- Remove the crankshaft. Remove each main bearing metal upper (block side) and pair it with the metal cap side lower metal.

**⚠ CAUTION**

Carefully prevent damage to the bearing or finger injury when removing the crankshaft because it is heavy.

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**Point6: Piston pin and rings**

[Disassemble]

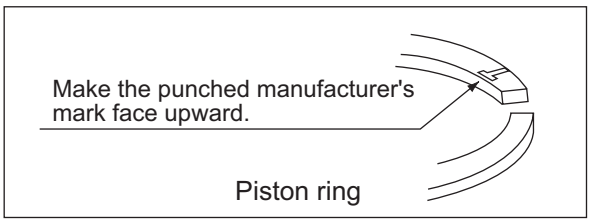
- Using the piston ring replacer (see 4.1.2 in Chapter 4), remove the piston rings.
- Remove the circlip and remove the piston pin by pushing it out.

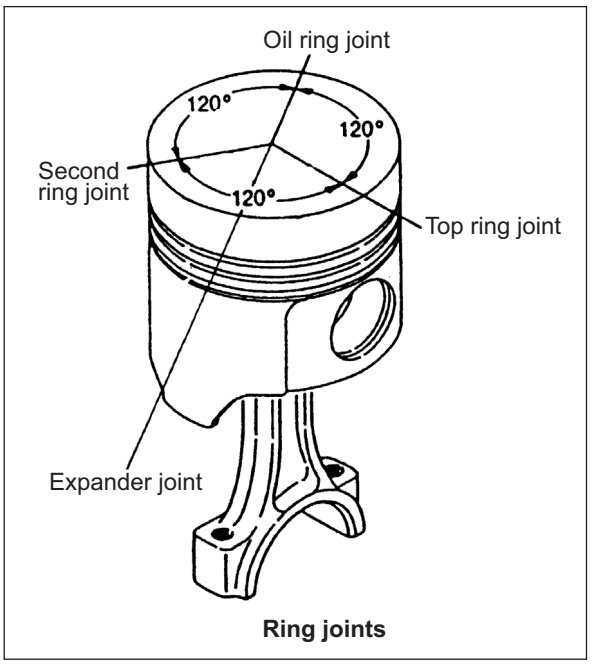
[Reassemble]

- Install each piston ring on the piston, with the punched manufacturer's mark facing upward.

[Reassemble]

- The piston ring joints shall be staggered at by 120° intervals. Do not position the top ring joint vertical to the piston pin. The coil expander joint shall be opposite to the oil ring joint.



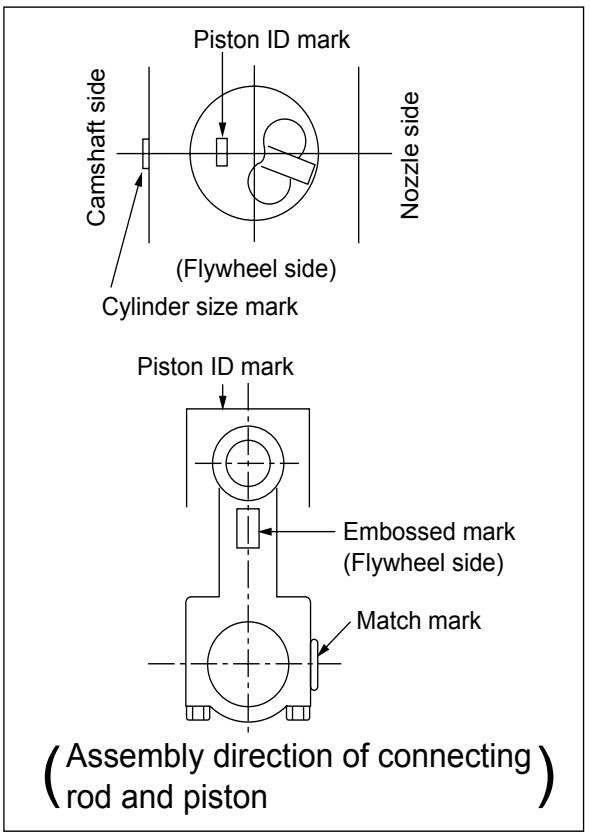

**Ring joints**

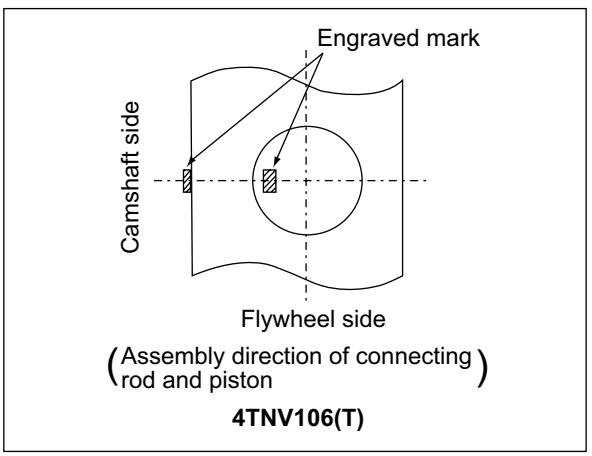
[Reassemble]

- When installing the piston pin to the rod and piston, the punched match mark on the big end of the connecting rod shall be opposite to the size mark on the piston top.

[Reassemble]

- Install the piston in the cylinder clock with the punched mark on the big end of the rod on the nozzle side. (The embossed mark at the connecting rod I-beam section shall be on the flywheel side.)




**4TNV106(T)**

(R.1)

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## 4.4.5 Parts inspection and measurement

### (1) Cylinder block

Especially clean head surface, cylinder bores and oil holes, and check after removing any carbon deposit and bonding agent.

(a)Appearance inspection

Check if there is any discoloration or crack. If crack is suspected, perform color check. Sufficiently clean the oil holes and check they are not clogged.

(b)Cylinder bore and distortion

Measure at 20 mm below the crest of the liner, at 20 mm from the bottom end and at the center.

**Roundness:**

Roundness is found as follows though it is the simple method. Measure cylinder diameters of the A direction and the B direction on each section of a, b and c.

Roundness is the maximum value among those difference values.

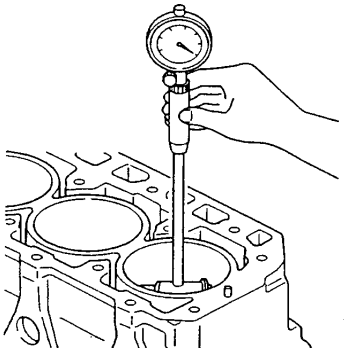
**Cylindricity:**

Cylindricity is found as follows though it is the simple method.

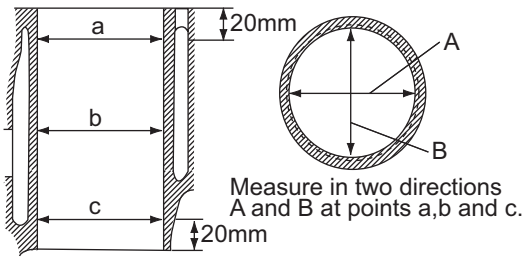
Measure cylinder diameters of a, b and c sections in the A direction, and calculate the difference in maximum value and minimum value of the measured diameters.

In the same way measure and calculate the difference in the B direction.

Cylindricity is the maximum value between those difference values.



**Cylinder bore**




**Cylinder bore measurement positions**

mm

| Item | | Model | Standard | Limit |
|---|---|---|---|---|
| Cylinder inside diameter | | 3TNV82A | 82.000 to 82.030 | 82.200 |
| | | TNV84 | 84.000 to 84.030 | 84.200 |
| | | TNV88 | 88.000 to 88.030 | 88.200 |
| | | 4TNV94L | 94.000 to 94.030 | 94.130 |
| | | 4TNV98 | 98.000 to 98.030 | 98.130 |
| | | 4TNV106(T) | 106.000 to 106.030 | 106.130 |
| Cylinder bore | Roundness | all TNV | 0.01 or less | 0.03 |
| | Cylindricity | | | |

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(c)If the limit is exceeded or any surface defect is found, repair by boring and honing. Use an oversized piston (and new piston rings) as required.

Oversized piston (0.25 mm, with piston rings)

| Model | Code No. | Standard (mm) |
|---|---|---|
| 3TNV82A | 719802-22900 | 82.250 |
| 3TNV84 (T)<br>4TNV84 | 129004-22900 | 84.250 |
| 4TNV84T | 129508-22900 | 84.250 |
| 3/4TNV88 | 129005-22900 | 88.250 |
| 4TNV94L | 729906-22900 | 94.250 |
| 4TNV98 | 129902-22700 | 98.250 |
| 4TNV106 | 729907-22900 | 106.250 |
| 4TNV106T | 723907-22910 | 106.250 |

Piston ring assy for oversized (0.25 mm)

| Model | Piston ring code No. |
|---|---|
| 3TNV82A | 719802-22950 |
| 3TNV84 (T)<br>4TNV84 | 129004-22950 |
| 4TNV84T | 129004-22950 |
| 3/4TNV88 | 129005-22950 |
| 4TNV94L | 729906-22950 |
| 4TNV98 | 729907-22950 |
| 4TNV106 (T) | 723907-22950 |

Cylinder dimension after boring and honing

| Model | Cylinder dimension (mm) | Honing angle (deg.) | Surface roughness | Roundness/Cylindricity (mm) |
|---|---|---|---|---|
| 3TNV82A | 82.250 to 82.280 | 30 to 40 deg. | $R_{max}$<br>1.0 to 3.5S | 0.01 or less |
| 3TNV84 (T)<br>4TNV84 | 84.250 to 84.280 | | | |
| 3/4TNV88 | 88.250 to 88.280 | | | |
| 4TNV94L | 94.250 to 94.280 | | | |
| 4TNV98 | 98.250 to 98.280 | | | |
| 4TNV106 (T) | 106.250 to 106.280 | | | |

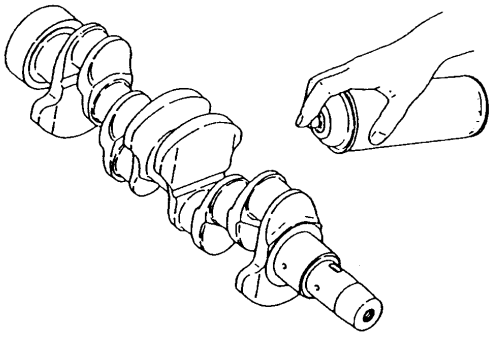
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## (2) Crankshaft

Mainly check seizure and wear of the crankpins and journals. Since the crankshaft gear is shrink-fitted, heat to 180 to 200°C when extraction is necessary.

### (a)Shaft portion color check

After washing the crankshaft, inspect it by means of color check or a magnaflux inspector. Replace it if cracked or heavily damaged. Slight defects shall be corrected by grinding.

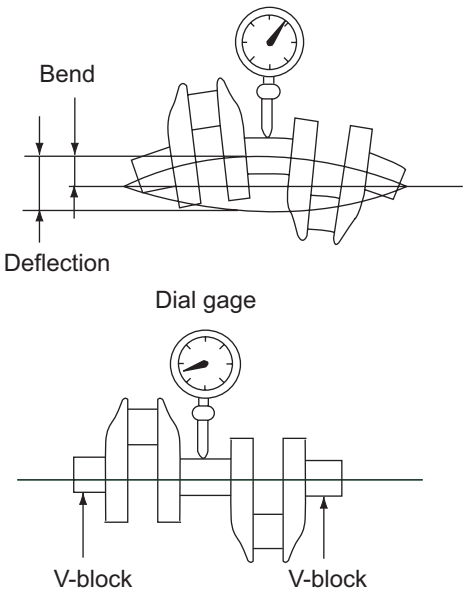


**Inspection by color check**

### (b)Crankshaft bend

Support the crankshaft journals at both ends with V-blocks. Use a dial gage and measure the runout at the center journal while rotating the shaft to inspect the bend.

| Limit | 0.02 mm or less |
|---|---|




**Crankshaft bend measurement**

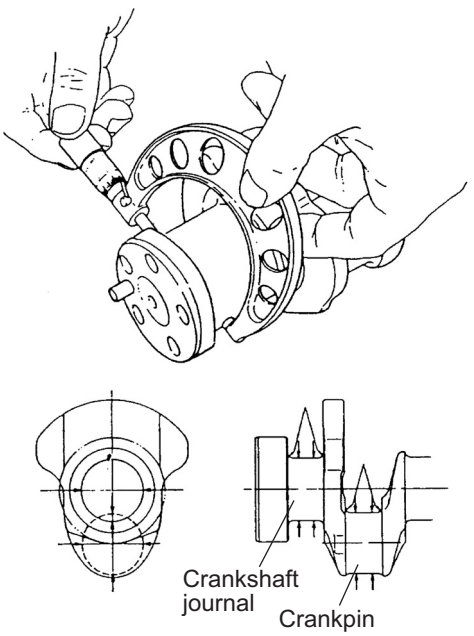
### (c)Crankpin and journal measurement

Measure the outside diameter, roundness and taper at each crankpin and journal.

Correct by grinding if unevenly wear, roundness exceeding the limit or insufficient outside diameter is found. Replace if the defect is excessive.

| Item | Limit (Diameter) (mm) |
|---|---|
| Roundness<br>Taper | 0.01 |

To look for the oil clearance of crank pin, measure the inside diameter of crank pin metal according to (5) (d) described later and calculate.




**Measuring position of the crankpin and crank journal**

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Crankpin mm

| Model & Item | | Standard | Limit |
|---|---|---|---|
| 3TNV82A | Pin outside diameter | 42.952 to 42.962 | 42.902 |
| | Metal thickness | 1.487 to 1.500 | - |
| | Oil clearance | 0.038 to 0.090 | 0.150 |
| TNV84 to 88 | Pin outside diameter | 47.952 to 47.962 | 47.902 |
| | Metal thickness | 1.492 to 1.500 | - |
| | Oil clearance | 0.038 to 0.074 | 0.150 |
| 4TNV94L•98 | Pin outside diameter | 57.952 to 57.962 | 57.902 |
| | Metal thickness | 1.492 to 1.500 | - |
| | Oil clearance | 0.038 to 0.074 | 0.150 |
| 4TNV106(T) | Pin outside diameter | 63.952 to 63.962 | 63.902 |
| | Metal thickness | 1.984 to 1.992 | - |
| | Oil clearance | 0.054 to 0.090 | 0.150 |

If the oil clearance exceeds the limit, use an undersized bearing.

Undersized crankpin bearing (0.25 mm)

| Model | Code No. | Standard thickness (mm) |
|---|---|---|
| 3TNV82A | 119810-23610 | 1.612 to 1.625 |
| TNV84 to 88 | 129150-23610 | 1.617 to 1.625 |
| 4TNV94L•98 | 129900-23610 | 1.617 to 1.625 |
| 4TNV106(T) | 123900-23610 | 2.109 to 2.117 |

Pin machining dimension

| Model | Pin machining dimension (mm) |
|---|---|
| 3TNV82A | ø 42.702 to 42.712 |
| TNV84 to 88 | ø 47.702 to 47.712 |
| 4TNV94L•98 | ø 57.702 to 57.712 |
| 4TNV106 (T) | ø 63.702 to 63.712 |

Crank journal mm

| Model | Item | Standard | Limit |
|---|---|---|---|
| 3TNV82A | Journal O.D. | 46.952 to 46.962 | 46.902 |
| | Metal thickness | 1.987 to 2.000 | - |
| | Oil clearance | 0.038 to 0.080 | 0.150 |
| TNV84 to 88 (Selective assembly) | Journal O.D. | 53.952 to 53.962 | 53.902 |
| | Metal thickness | 1.995 to 1.990 | - |
| | Oil clearance | 0.038 to 0.068 | 0.150 |
| 4TNV94•98 (Selective assembly) | Journal O.D. | 64.952 to 64.962 | 64.902 |
| | Metal thickness | 1.995 to 2.010 | - |
| | Oil clearance | 0.038 to 0.068 | 0.150 |
| 4TNV106(T) (Selective assembly) | Journal O.D. | 75.952 to 75.962 | 75.902 |
| | Metal thickness | 2.488 to 2.503 | - |
| | Oil clearance | 0.052 to 0.082 | 0.150 |

If the clearance limit is exceeded, use an undersized bearing.

Undersized bearing (0.25 mm)

| Model | Code No. | Standard thickness (mm) |
|---|---|---|
| 3TNV82A | 119810-02870 | 2.112 to 2.125 |
| TNV84 to 88 | 129150-02870 | 2.112 to 2.125 |
| 4TNV94L•98 | 129900-02340 | 2.112 to 2.125 |
| 4TNV106 (T) | 12900-02340 | 2.605 to 2.618 |

Crankshaft Journal machining dimension

| Model | Journal machining dimension (mm) |
|---|---|
| 3TNV82A | ø 46.702 to 46.712 |
| TNV84 to 88 | ø 53.702 to 53.712 |
| 4TNV94/98 | ø 64.702 to 64.712 |
| 4TNV106 (T) | ø 75.702 to 75.712 |

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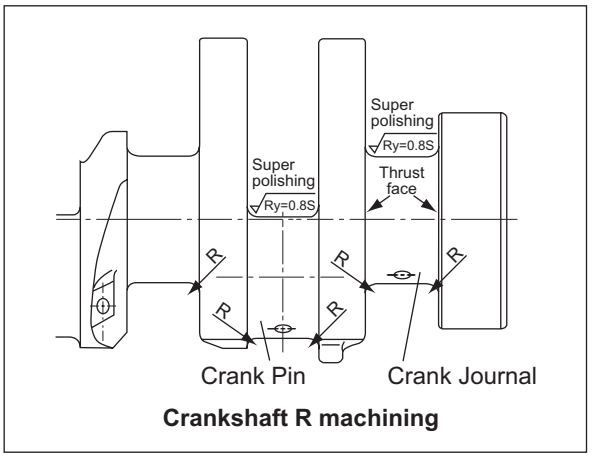
• Dimension R and finishing precision of crankshaft journal and pin

As for grinding processing of journal and pin, machine it by using the grinding wheel of the dimension R of below table.

Surface finishing precision standard on journal and pin:

Ry=0.8S super polishing

Surface finishing precision standard on the thrust side of crankshaft arm: 1.6




**Crankshaft R machining**

mm

| Model | Finishing precision standard of dimension R |
|---|---|
| 3TNV82A<br>3/4TNV84(T) to 88 | 3.5 +0.3/ 0 |
| 4TNV94L/98(T)<br>4TNV106(T) | 4.0 +0.3/ 0 |

[NOTICE]

1)If the oil clearance is excessive though the thicknesses of the journal and crankpin metals are normal or if partial uneven wear is observed, re-grind the crankshaft and use an oversized metals.

2)If rust or surface roughening exists on the rear side of the metals, coat it with blue or minimum. Then assemble the crankpin metal to the connecting rod, and tighten the rod bolt to the specified torque to check the metal for contact. If the contact surface occupies 75% or more, the metal is normal. If the contact surface is insufficient, the metal interference is insufficient. Replace the metal with a new one.

## (3) Thrust metal inspection

(a)Inspect any damage or wear.

(b)Measure side gap and thrust metal thickness

Side gap and thrust metal thickness mm

| Model | Side gap | | Thrust metal thickness | |
|---|---|---|---|---|
| | Standard | Limit | Standard | Limit |
| 3TNV82A<br>3/4TNV84 (T) to 88 | 0.14 to 0.22 | 0.28 | 1.930 to 1.980 | 1.850 |
| 4TNV94L•98 | 0.13 to 0.23 | | 1.930 to 1.980 | 1.850 |
| 4TNV106 (T) | 0.13 to 0.23 | | 2.430 to 2.480 | 2.35 |

If the side gap is exceeded, use an oversized thrust metal. (Refer to point 4 of 4.4.4.)

Oversized metal (0.25 mm)

| Model | Code No. (Up-down combination) |
|---|---|
| 3TNV82A | 119810-02940 |
| 3/4TNV84(T) to 88 | 129150-02940 |
| 4TNV94L to 4TNV106 (T) | 129900-02940 |

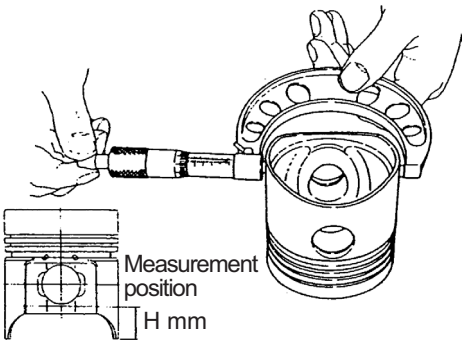
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## (4) Piston

Especially clean the combustion surface, circumference, ring grooves and piston pin bosses, and check after removing any carbon deposit. Any burr at a ring groove or snap ring groove shall be removed. If crack is suspected, inspect by color check.

### (a)Piston outside diameter measurement

Measure the long diameter at H mm from the bottom end of the piston of the oval hole in the vertical direction to the piston pin hole.




**Piston outside diameter**

Piston outside diameter

mm

| Model | Outside diameter Standard | Limit | Clearance between piston and cylinder | Measurement position (H) |
|---|---|---|---|---|
| 3TNV82A | 81.950 to 81.980 | 81.905 | 0.040 to 0.060 | 16 |
| 3,4TNV84(T) | 83.940 to 83.970 | 83.895 | 0.050 to 0.070 | 24 |
| 3,4TNV88 | 87.940 to 87.970 | 87.895 | | 24 |
| 4TNV94L | 93.935 to 93.965 | 93.900 | 0.055 to 0.075 | 22 |
| 4TNV98 (T) | 97.930 to 97.960 | 97.895 | 0.060 to 0.080 | 22 |
| 4TNV106 (T) | 105.930 to 105.960 | 105.880 | | 30 |

If the piston outside diameter exceed the limit, replace the piston with new one.

If the clearance between piston and cylinder exceeds the limit, use an oversized piston. (Refer to the tables of oversized pistons, oversized piston rings and cylinder boring dimension in (1) (c) above.)

Selective pairing of cylinder and piston

Piston must be paired with cylinder according to the below table. The size mark of a piston is shown on the top surface of the piston and the size mark of a cylinder block is shown on the non-operating side of the cylinder block. The service parts of pistons are provided.

| | | | Piston outside diameter. D2 | | | |
|---|---|---|---|---|---|---|
| | Tolerance | | +0.015 max. +0.005 min. | below +0.005 0 min. | below 0 -0.005 min. | below -0.005 -0.015 min. |
| | | Size mark | L | ML | MS | S |
| Cylinder inside diameter D1 | +0.030 max. +0.020 min. | L | ○ | ○ | × | × |
| | below +0.020 +0.010 min. | M | × | ○ | ○ | × |
| | below +0.010 0 min. | S | × | × | ○ | ○ |

| Model | Cylinder inside diameter D1 | Piston outside diameter. D2 |
|---|---|---|
| 3TNV82A | 82 | 81.965 |
| 3,4TNV84 (T) | 84 | 83.955 |
| 3,4TNV88 | 88 | 87.955 |
| 4TNV94L | 94 | 93.950 |
| 4TNV98 (T) | 98 | 97.945 |
| 4TNV106 (T) | 106 | 105.945 |

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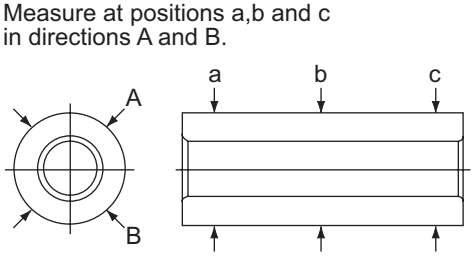


(b)Piston pin hole measurement

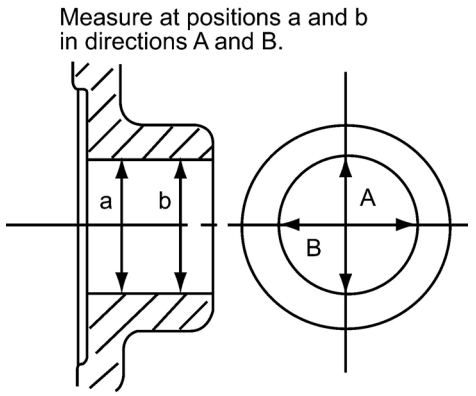
Measure the outside diameter of piston pin and the inside diameter of piston pin hole. Calculate the clearance between piston pin and piston pin hole. If any data exceeds the limit, replace the part with a new one.

mm

| Model | Item | Standard | Limit |
|---|---|---|---|
| 3TNV82A | Pin I.D. | 23.000 to 23.009 | 23.039 |
| | Pin O.D. | 22.995 to 23.000 | 22.965 |
| | Clearance | 0.000 to 0.014 | 0.074 |
| TNV84 to 88 | Pin I.D. | 26.000 to 26.009 | 26.039 |
| | Pin O.D. | 25.995 to 26.000 | 25.965 |
| | Clearance | 0.000 to 0.014 | 0.074 |
| 4TNV94L• 4TNV98 (T) | Pin I.D. | 30.000 to 30.009 | 30.039 |
| | Pin O.D. | 29.989 to 30.000 | 29.959 |
| | Clearance | 0.000 to 0.020 | 0.080 |
| 4TNV106 (T) | Pin I.D. | 37.000 to 37.011 | 37.039 |
| | Pin O.D. | 36.989 to 37.000 | 36.959 |
| | Clearance | 0.000 to 0.022 | 0.080 |



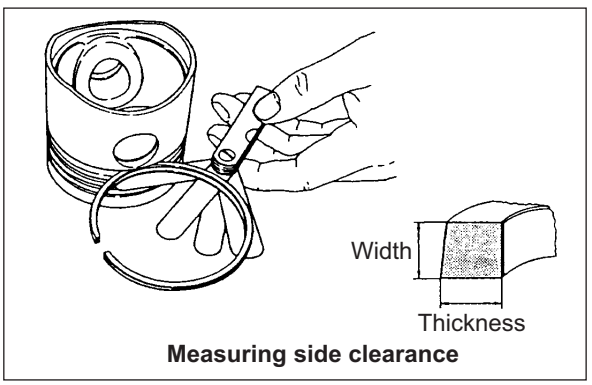

**Piston pin outside diameter**



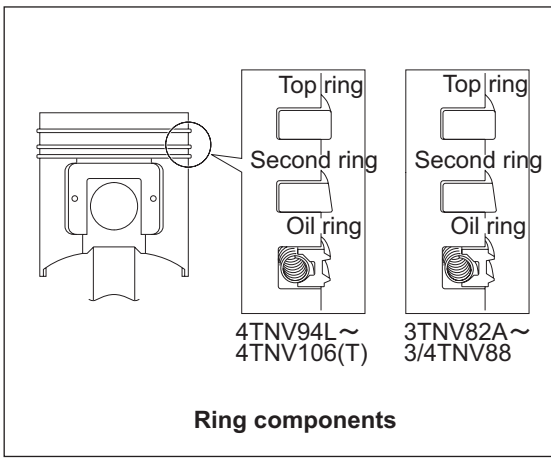

**Piston pin hole**

(c)Piston ring, ring groove and end clearance measurement

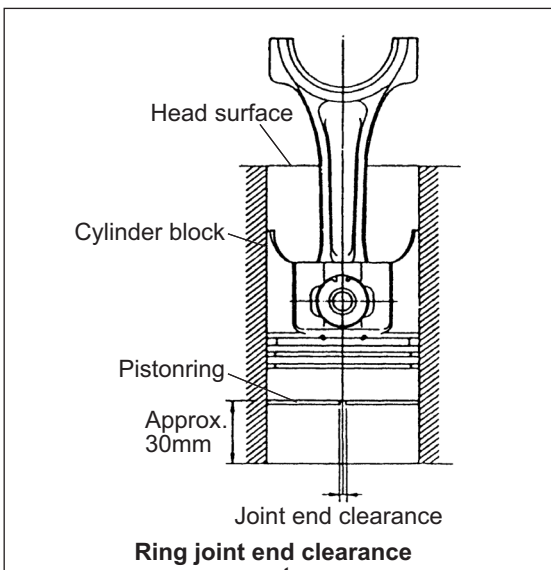
- Except for the top ring, to measure the piston ring groove width, first measure the width of the piston ring. Then insert the piston ring into the ring. Then insert the piston ring into the ring groove. Insert a thickness gage in between the piston ring and groove to measure the gap between them. Obtain the ring groove width by adding ring width to the measured side clearance.
- To measure the end clearance, push the piston ring into the sleeve using the piston head, insert a thickness gage in end clearance to measure. The ring shall be pushed in to approx. 30 mm above the bottom end of the cylinder. For the top ring, measure only the piston ring joint end clearance in normal state.




**Measuring side clearance**




**Ring components**




**Ring joint end clearance measurement**

(R.1)

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Piston ring dimension

mm

| Model | Part | Item | Standard | Limit |
|---|---|---|---|---|
| TNV82A/84 | Top ring | Ring groove width | 2.065 to 2.080 | 2.170 |
| | | Ring width | 1.970 to 1.990 | 1.950 |
| | | Side clearance | 0.075 to 0.110 | 0.200 |
| | | End clearance | 0.200 to 0.400 | 0.490 |
| | Second ring | Ring groove width | 2.035 to 2.050 | 2.150 |
| | | Ring width | 1.970 to 1.990 | 1.950 |
| | | Side clearance | 0.045 to 0.080 | 0.200 |
| | | End clearance | 0.200 to 0.400 | 0.490 |
| | Oil ring | Ring groove width | 4.015 to 4.030 | 4.130 |
| | | Ring width | 3.970 to 3.990 | 3.950 |
| | | Side clearance | 0.025 to 0.060 | 0.180 |
| | | End clearance | 0.200 to 0.400 | 0.490 |
| TNV88 | Top ring | Ring groove width | 2.060 to 2.075 | 2.170 |
| | | Ring width | 1.970 to 1.990 | 1.950 |
| | | Side clearance | 0.070 to 0.105 | 0.200 |
| | | End clearance | 0.200 to 0.400 | 0.490 |
| | Second ring | Ring groove width | 2.025 to 2.040 | 2.140 |
| | | Ring width | 1.970 to 1.990 | 1.950 |
| | | Side clearance | 0.035 to 0.070 | 0.190 |
| | | End clearance | 0.200 to 0.400 | 0.490 |
| | Oil ring | Ring groove width | 4.015 to 4.030 | 4.130 |
| | | Ring width | 3.970 to 3.990 | 3.950 |
| | | Side clearance | 0.025 to 0.060 | 0.180 |
| | | End clearance | 0.200 to 0.400 | 0.490 |
| 4TNV94L•98 | Top ring | Ring groove width | 2.040 to 2.060 | - |
| | | Ring width | 1.940 to 1.960 | 1.920 |
| | | Side clearance | 0.080 to 0.120 | - |
| | | End clearance | 0.250 to 0.450 | 0.540 |
| | Second ring | Ring groove width | 2.080 to 2.095 | 2.195 |
| | | Ring width | 1.970 to 1.990 | 1.950 |
| | | Side clearance | 0.090 to 0.125 | 0.245 |
| | | End clearance | 0.450 to 0.650 | 0.730 |
| | Oil ring | Ring groove width | 3.015 to 3.030 | 3.130 |
| | | Ring width | 2.970 to 2.990 | 2.950 |
| | | Side clearance | 0.025 to 0.060 | 0.180 |
| | | End clearance | 0.250 to 0.450 | 0.550 |
| 4TNV106 (T) | Top ring | Ring groove width | 2.520 to 2.540 | - |
| | | Ring width | 2.440 to 2.460 | 2.420 |
| | | Side clearance | 0.060 to 0.100 | - |
| | | End clearance | 0.300 to 0.450 | 0.540 |
| | Second ring | Ring groove width | 2.070 to 2.085 | 2.185 |
| | | Ring width | 1.970 to 1.990 | 1.950 |
| | | Side clearance | 0.080 to 0.115 | 0.235 |
| | | End clearance | 0.450 to 0.600 | 0.680 |
| | Oil ring | Ring groove width | 3.015 to 3.030 | 3.130 |
| | | Ring width | 2.970 to 2.990 | 2.950 |
| | | Side clearance | 0.025 to 0.060 | 0.180 |
| | | End clearance | 0.300 to 0.500 | 0.600 |

(R.1)

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## (5) Connecting rod

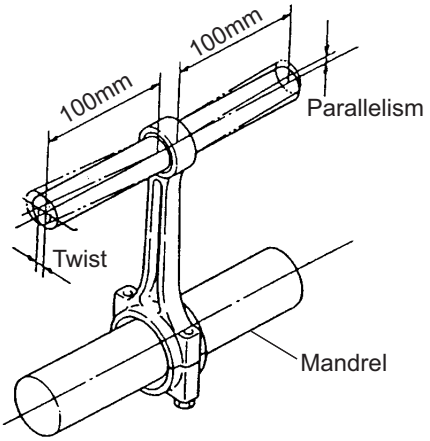
### (a)Appearance inspection

Inspect the portion near the boundary of the chamfered portion and I-beam section of the big and small ends of the connecting rod as well as the portion near the oil hole of the bushing at the small end for cracks, deformation, and discoloration.

### (b)Twist and parallelism measurement Use a connecting rod aligner and measure the twist and bend.

mm

| Item | Standard dimension | Limit dimension |
|---|---|---|
| Twist and parallelism | 0.03 or less per 100 mm | 0.08 |



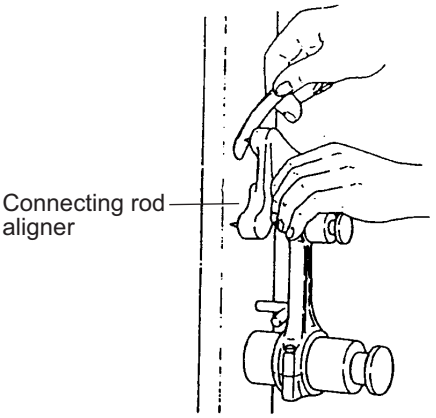

**Twist and parallelism measurement**

### (c)Rod small end measurement

Measure the pin outside diameter according to 4.4.5.(4) (a) described above.

mm

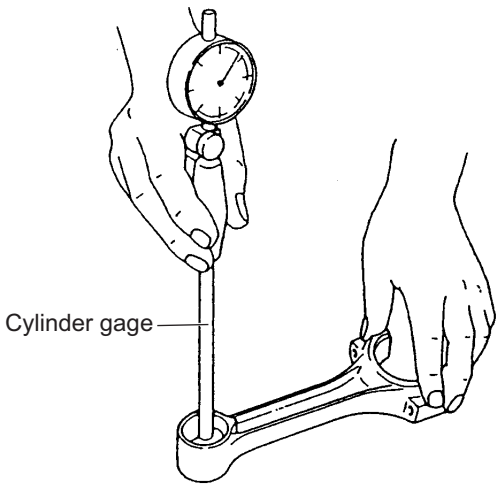
| Model | Item | Standard | Limit |
|---|---|---|---|
| 3TNV82A | Piston pin I.D. bushing | 23.025 to 23.038 | 23.068 |
| | Pin O.D. | 22.995 to 23.000 | 22.967 |
| | Clearance | 0.025 to 0.043 | 0.101 |
| TNV84 to 88 | Piston pin I.D. bushing | 26.025 to 26.038 | 26.068 |
| | Pin O.D. | 25.995 to 26.000 | 25.967 |
| | Clearance | 0.025 to 0.043 | 0.101 |
| 4TNV94L•98 | Piston pin I.D. bushing | 30.025 to 30.038 | 30.068 |
| | Pin O.D. | 29.987 to 30.000 | 29.959 |
| | Clearance | 0.025 to 0.051 | 0.109 |
| 4TNV106 (T) | Piston pin I.D. bushing | 37.025 to 37.038 | 37.068 |
| | Pin O.D. | 36.989 to 37.000 | 36.961 |
| | Clearance | 0.025 to 0.049 | 0.107 |




**Twist measurement using a connecting rod aligner**

If the bushing is to be replaced because the oil clearance exceeds the limit, use spare part.

| Model | Service part code |
|---|---|
| 3TNV82A | 119810-23910 |
| TNV84 to 88 | 129100-23910 |
| 4TNV94L•98 (T) | 129900-23910 |
| 4TNV106 (T) | 123900-23910 |




**Connecting rod small end**

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(d)Rod big end measurement

Measure the crankpin and bushing according to 4.4.5.(2) (c) described above.

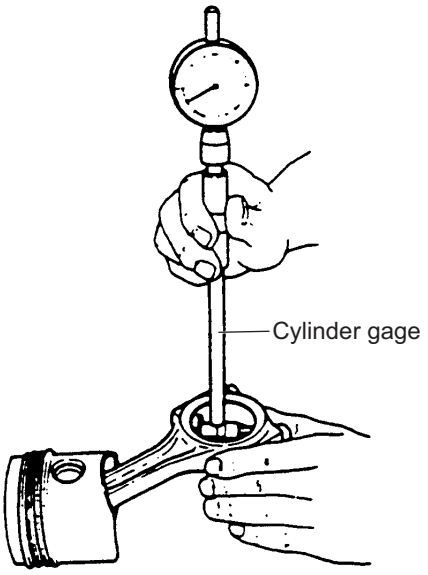
Calculate the oil clearance of a crank pin metal and a crank pin from the measured values of the crank pin metal inner diameter and the crank pin outside diameter.

Replace a crank pin metal if the oil clearance becomes about the limit dimension of the below table.

Correct by grinding if unevenly wear, roundness exceeding the limit or insufficient outside diameter is found. Also use an undersized metal. (Refer to the above (2) c.)

[NOTICE]

When measuring the inside diameter of the rod big end, install the crankpin metals in the rod big end not to mistake the top and bottom of the metals and tighten the rod bolts by the standard torque.




**Rod bushing I.D. measurement**

Tightening torque of rod bolt

| Model | Tightening torque N•m (kgf•m) | Lubricating oil application (threaded portion, and bearing seat surface) |
|---|---|---|
| 3TNV82A | 37.2 to 41.2 (3.8 to 4.2) | Lube. oil applied |
| TNV84/88 | 44.1 to 49.0 (4.5 to 5.0) | |
| 4TNV94L/98 | 53.9 to 58.8 (5.5 to 6.0) | |
| 4TNV106 (T) | 78.5 to 83.4 (8.0 to 8.5) | |

Standard of rod big end mm

| Model | Item | Standard | Limit |
|---|---|---|---|
| 3TNV82A | Rod I.D. bushing | 42.952 to 42.962 | 42.902 |
| | Crankpin O.D. | 43.000 to 43.042 | - |
| | Metal thickness | 1.487 to 1.500 | - |
| | Clearance | 0.038 to 0.090 | 0.150 |
| TNV84/88 | Rod I.D. bushing | 47.952 to 47.962 | 47.902 |
| | Crankpin O.D. | 48.000 to 48.026 | - |
| | Metal thickness | 1.492 to 1.500 | - |
| | Clearance | 0.038 to 0.074 | 0.150 |
| 4TNV94L/98 | Rod I.D. bushing | 57.952 to 57.962 | 57.902 |
| | Crankpin O.D. | 58.000 to 58.026 | - |
| | Metal thickness | 1.492 to 1.500 | - |
| | Clearance | 0.038 to 0.074 | 0.150 |
| 4TNV106 (T) | Rod I.D. bushing | 63.952 to 63.962 | 63.902 |
| | Crankpin O.D. | 64.016 to 64.042 | - |
| | Metal thickness | 1.984 to 1.992 | - |
| | Clearance | 0.054 to 0.090 | 0.150 |

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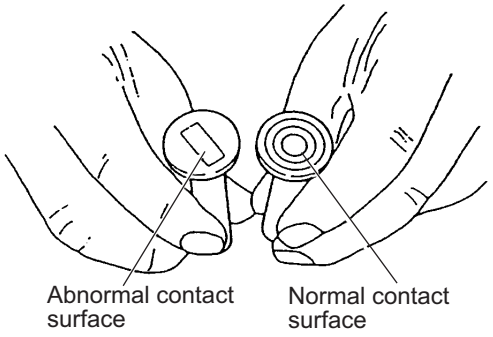
### (6) Tappet

Mainly check the tappet contact surface with the cam and push rod. Slight surface defects shall be corrected with an oilstone.

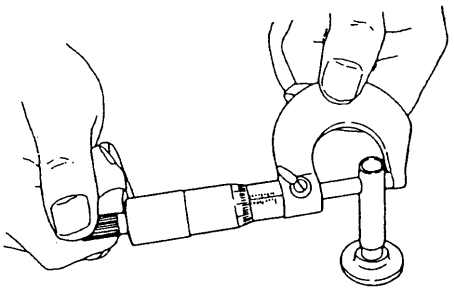
(a)Tappet stem outside diameter measurement

mm

| Model | Item | Standard | Limit |
|---|---|---|---|
| TNV82A to 88 | Tappet hole I.D. | 12.000 to 12.025 | 12.045 |
| | Stem O.D. | 11.975 to 11.990 | 11.955 |
| | Clearance | 0.010 to 0.050 | 0.090 |
| 4TNV94L•98 | Tappet hole I.D. | 12.000 to 12.018 | 12.038 |
| | Stem O.D. | 11.975 to 11.990 | 11.955 |
| | Clearance | 0.010 to 0.043 | 0.083 |
| 4TNV106 (T) | Tappet hole I.D. | 14.000 to 14.018 | 14.038 |
| | Stem O.D. | 13.966 to 13.984 | 13.946 |
| | Clearance | 0.015 to 0.052 | 0.092 |




**Tappet**



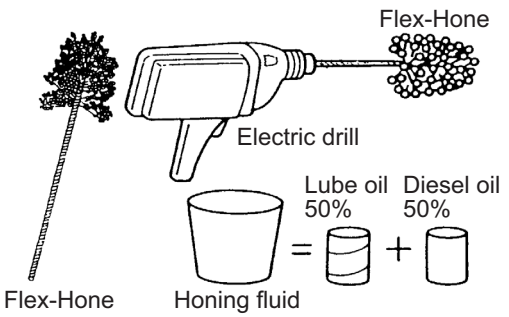
**Tappet stem outside diameter measuremen**

## 4.4.6 Cylinder bore correction

1)Slight uneven worn, flawed, etc. shall be corrected by honing only. If the cylinder is unevenly worn partially, flawed or otherwise damaged and cannot be repaired simply by honing, rebore the cylinder first and then hone. See 4.4.5.(1) (c) for the boring dimension.

2)Items to be prepared for honing

- Flex-Hone
  (see No.8 of 4.1.2 in Chapter 4)
- Electric drill
- Honing fluid
  (50:50 mixture of lube oil and diesel oil)



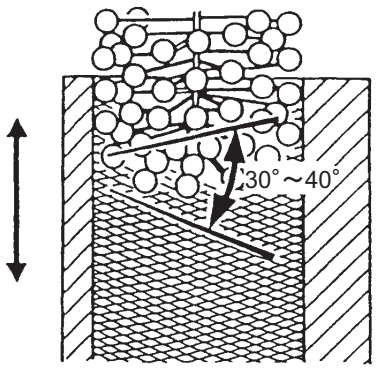

**Items to be prepared for honing**

3)Apply the honing fluid to the Flex-Hone and turn the electric drill at 300 to 1200 rpm. Then insert the Flex-Hone into the cylinder bore while turning it, and move it up and down for about 30 sec. to obtain a honing mark with a cross hatch angle of 30 to 40°.

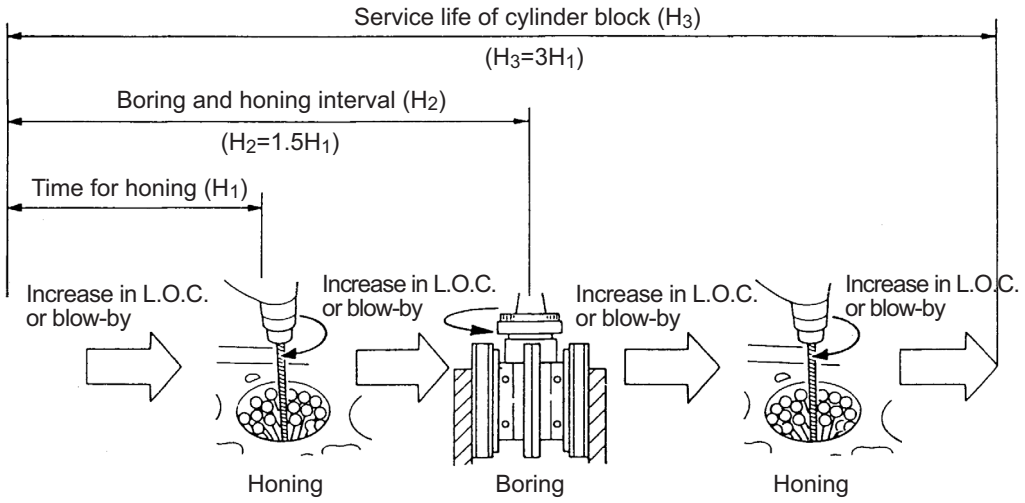
[NOTICE]

1)Avoid faster revolution than 1200 rpm since it may cause breakdown.

2)Do not insert or extract the Flex-Hone in stopped state because the cylinder will be damaged.




**Honing cross hatch**




**Study if an oversized piston or piston ring is usable**

## 4.4.7 Piston pin bushing replacement

Replace bushing by using the special service tool (see 4.1.2 No.3 in Chapter 4).

## 4.4.8 Oil seal replacement (Flywheel housing side)

1)Replace oil seal, when a flywheel housing is removed. Extract the used oil seal.

2)Insert a new oil seal with the oil seal insertion tool.

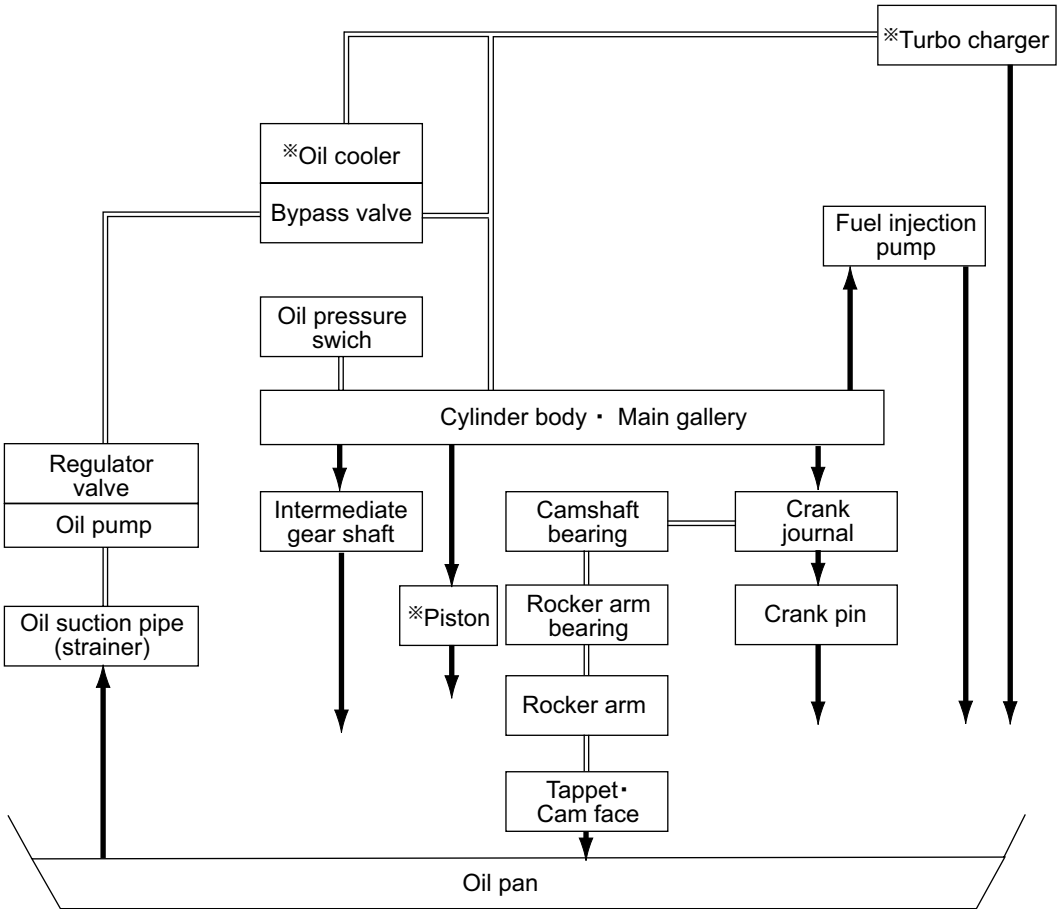
3)Apply lithium grease.

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# 5. Lubrication system

## 5.1 Lubrication system diagram



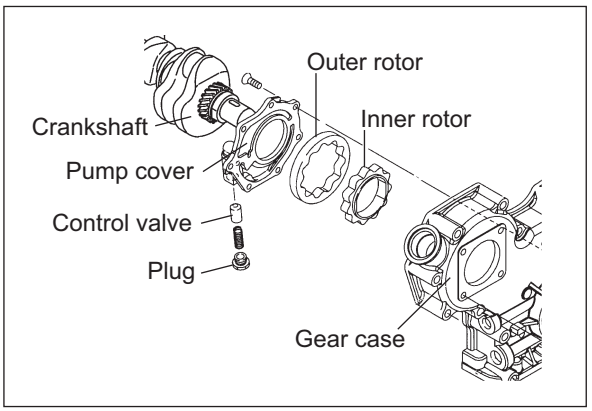

Note: It varies in the specifications of each model whether Oil cooler, Piston and Turbo charger of the * mark are attached.

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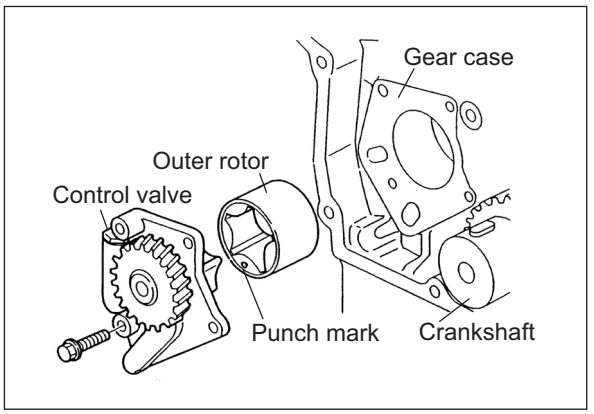


# 5.2 Trochoid pump components

Trochoid pump (3TNV82A to TNV88)




Trochoid pump (4TNV94L/98/106)




# 5.3 Disassembly (Reverse the procedure below for assembly)

1)Loosen the belt, and remove the radiator pulley, fan and V-belt. See 4.2.2. 2) in Chapter 4.
2)Remove the crankshaft pulley. See 4.3.2.3) in Chapter 4.
3)Remove the gear case cover. See 4.3.2. 4) in Chapter 4.
4)Remove the lubricating oil pump assy from the gear case for 4TNV94/98/106. (5.4 Point 1)
Remove the lube oil cover from gear case cover for 3TNV82A-88. (5.4 Point 1)
5)Remove the pressure regulating valve from the lubricating oil pump body. (5.4 Point 2)

# 5.4 Servicing points

**Point 1**

[Disassemble]

• Check if the pump rotates smoothly and see that there is no play between the shaft and gear, and inner rotor.

[Reassemble]

[NOTICE]

Always check if the pump rotates smoothly after installation on the gear case.

Running the engine when the pump rotation is heavy may cause the pump to be burnt.

1)3TNV82A-88

• Apply lube oil to rotor (outer/inner) insertion part.
• Assemble the outer rotor so that the mark of the end face may become a cover side when inserting it in the gear case.
• Fasten a lube oil pump cover by the standard torque.
• Tightening torque: 6.9 ± 1.5 N•m (0.7 ± 0.15 kgf•m)
• When replacing the lube oil pump, replace the whole assy.

2)4TNV94L/98/106

• Apply lube oil to lube oil pump insertion part of gear case.
• Install the outer rotor in the gear case so that the punch mark on the end face is seen.
• When replacing the lube oil pump, replace the whole assy.

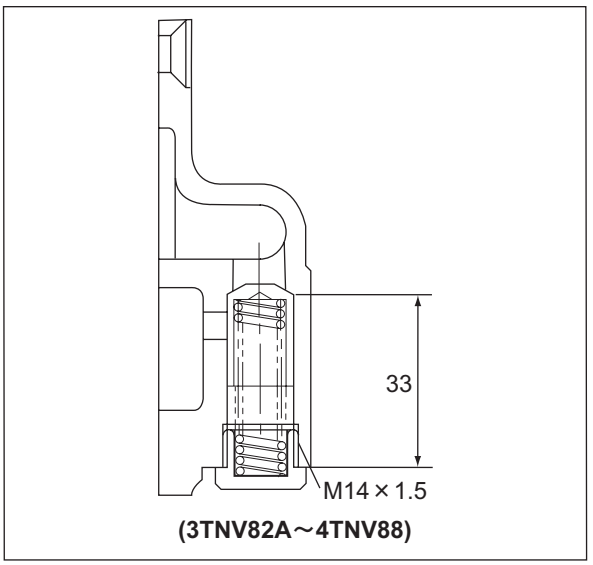
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**Point 2**

[Disassemble-Reassemble]

- Only wash the pressure regulating valve. Disassembly is unnecessary unless any abnormality in operation is detected.
- Lube oil pressure
  Refer to the table of 12.1 in chapter 12 for lube oil pressure.
- Structure of pressure regulating valve




**(3TNV82A～4TNV88)**

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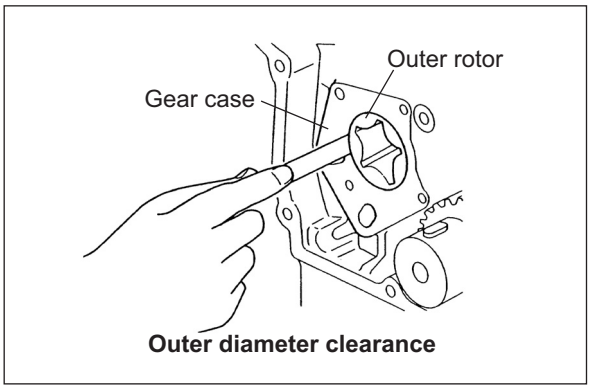


# 5.5 Parts Inspection and measurement

## 5.5.1 Trochoid pump inspection and measurement

(1) Outside clearance and side clearance of outer rotor

Insert a gap gage between a outer rotor and a pump body, and measure the clearance.



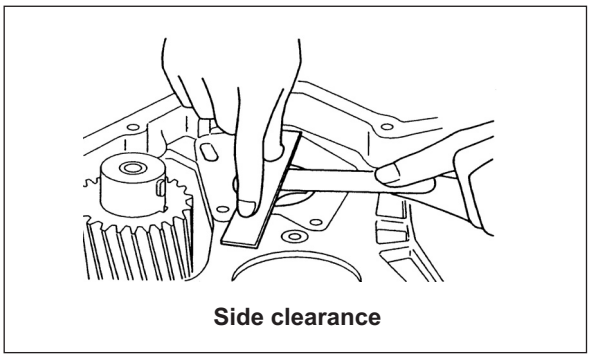
**Outer diameter clearance**

Outside clearance mm

| Model | Standard | Limit |
|---|---|---|
| 3TNV82A to 88 | 0.12 to 0.21 | 0.30 |
| 4TNV94L/98 | 0.100 to 0.155 | 0.25 |
| 4TNV106(T) | 0.100 to 0.165 | 0.25 |

(2) Tip clearance between outer rotor and inner rotor

Insert a gap gage between an outer rotor and an inner rotor, and measure the tip clearance.


**Side clearance**

Tip clearance mm

| Standard | Limit |
|---|---|
| - | 0.16 |

(3) Side clearance of outer rotor

When measuring a side clearance, put a right-angle gage to the pump body, insert a gap gage and measure the clearance.

Side clearance mm

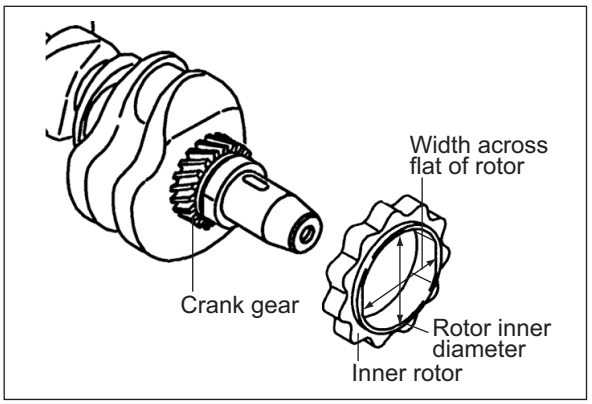
| Model | Standard | Limit |
|---|---|---|
| 3TNV82A to 88 | 0.02 to 0.07 | 0.12 |
| 4TNV94L/98 | 0.05 to 0.10 | 0.15 |
| 4TNV106(T) | 0.03 to 0.12 | 0.17 |

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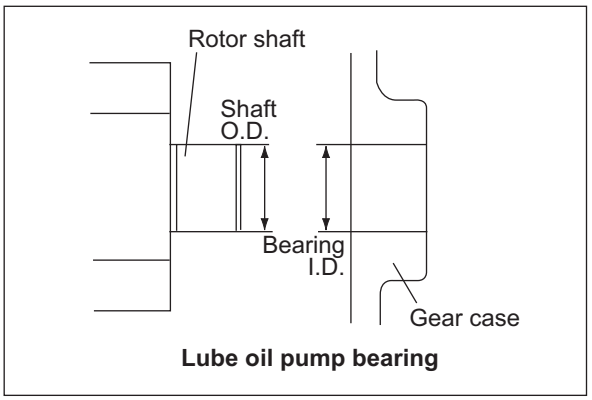
## (4) Inner rotor and gear boss clearance (3TNV82A-4TNV88)

| Item | Part | Standard dimension (mm) | Standard clearance (mm) | Standard clearance limit (mm) |
|---|---|---|---|---|
| Inside clearance of inner rotor | Gear boss diameter | 53.05 to 53.15 | 0.3 to 0.5 | 0.6 |
| | Rotor inner diameter | 53.45 to 53.55 | | |
| Width across flat clearance of inner rotor | Width across flat of gear boss | 49.45 to 49.75 | 0.2 to 0.6 | 0.7 |
| | Width across flat of rotor | 49.95 to 50.05 | | |




## (5) Rotor shaft clearance (4TNV94L/98/106)

Measure the outside diameter of rotor shaft and the shaft hole diameter of gear case. Calculate the clearance from that difference.




**Lube oil pump bearing**

mm

| Model | Inspection item | Standard | Limit |
|---|---|---|---|
| 4TNV94L/98 | Gear case bearing I.D. | 12.980 to 13.020 | 13.05 |
| | Rotor shaft O.D. | 12.955 to 12.970 | 12.945 |
| | Rotor clearance | 0.035 to 0.065 | 0.105 |
| 4TNV106(T) | Gear case bearing I.D. | 13.000 to 13.020 | 13.05 |
| | Rotor shaft O.D. | 12.955 to 12.965 | 12.945 |
| | Rotor clearance | 0.035 to 0.065 | 0.105 |

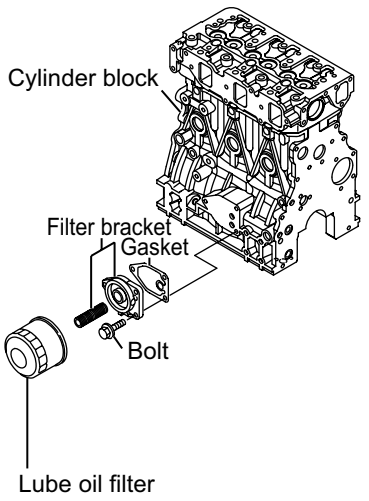
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# 5.6 Lube oil filter

## 5.6.1 Lube oil filter construction

The lube oil filter is a full-flow paper element type. mounted to the side of the cylinder body with the filter bracket. The cartridge type filter is easy to remove.
To prevent seizure in the event of the filter clogging up, a bypass circuit is provided in the oil filter. The bypass valve in the filter element opens when the difference in the pressure in front and behind the paper element reaches 0.8-1.2 kg/cm2.




**Lube oil filter**

| | Unit | |
|---|---|---|
| Part No. | - | 129150-35152 |
| Type | - | Full flow, paper element |
| Filtration area | $m^2$ | 0.12 |
| Discharge volume | l/min | 30 |
| Pressure loss | MPa ($kgf/cm^2$) | 0.02-0.04 (0.2-0.4) |
| By-pass valve regulating pressure | MPa ($kgf/cm^2$) | 0.08-0.12 (0.8-1.2) |

## 5.6.2 Lube oil filter replacement

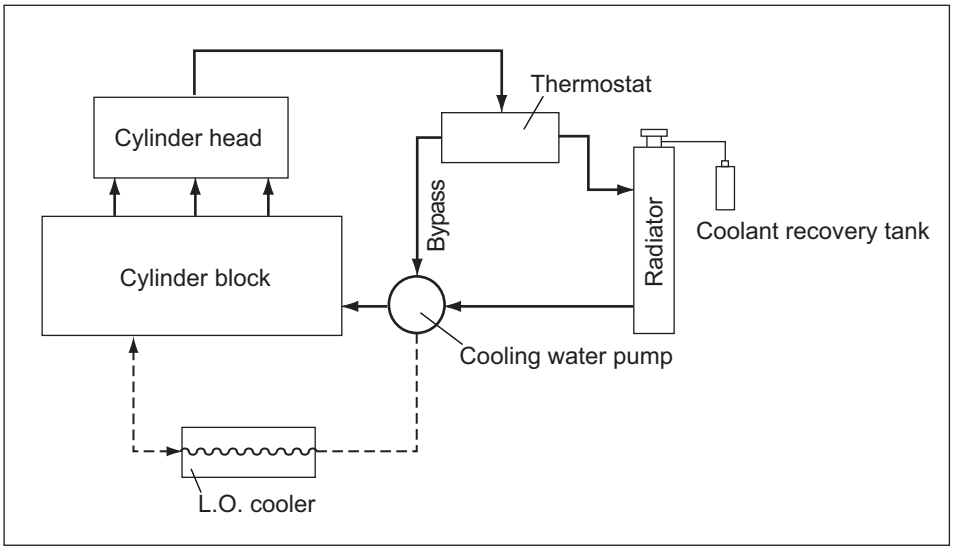
Refer to 2.2.2(1).

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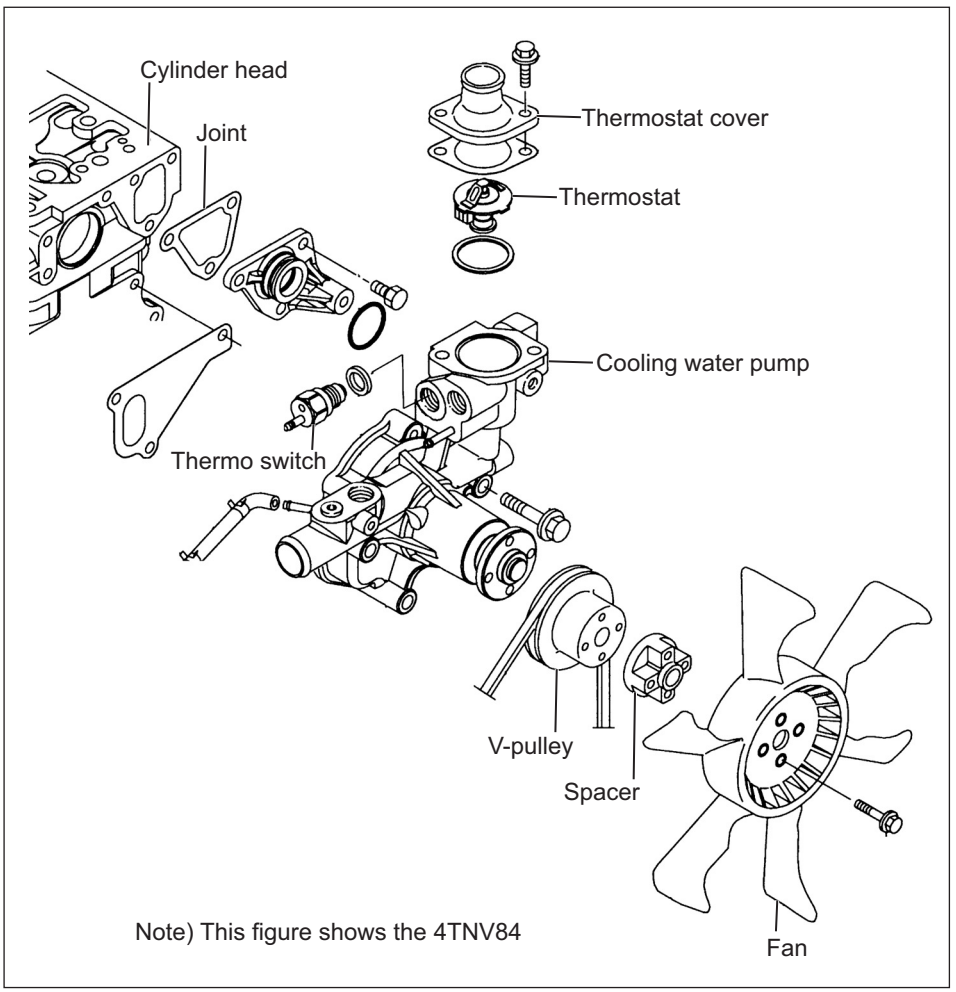


# 6. Cooling system

## 6.1 Cooling water system




## 6.2 Cooling water pump components



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# 6.3 Disassembly (Reverse the procedure below for assembly)

1)Remove the alternator. See 4.2.2. 1) in Chapter 4.
2)Remove the fan, V-belt and pulley. See 4.2.2. 2) in Chapter 4.
3)Remove the cooling water pump. (Point 1, in below 6.4)
4)Remove the thermostat. (Point 2 in below 6.4)

# 6.4 Servicing points

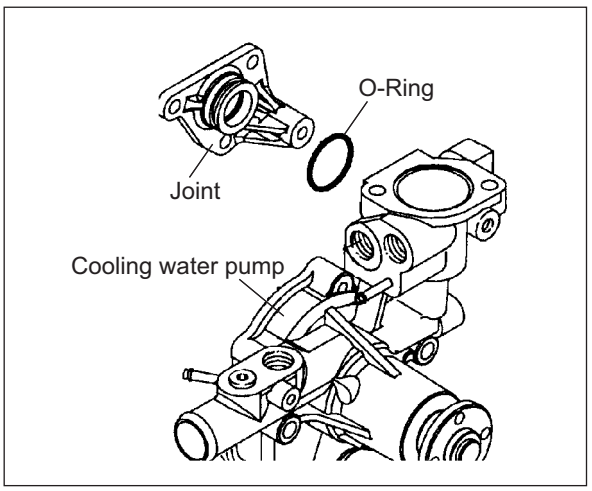
**Point 1**

Disassemble-Reassemble:

• Check to see that the cooling water pump bearing is free from abnormal noise, sticking or play and water leakage from the bearing. If replacement is necessary, replace the whole cooling water pump assy.

[NOTICE]

Replace the O-ring of the cooling water pump with new one when disassembling. And, be sure to use the special O-ring for each engine model, because the material is different, although the dimension is the same as a commercial part. (Refer to the right figure.)




**Point 2**

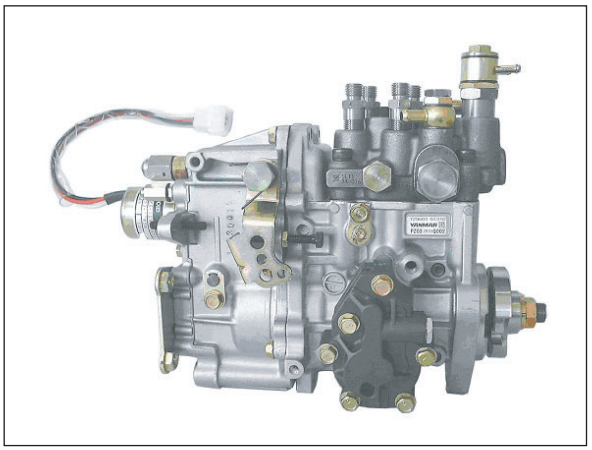
Disassemble:

• Check the thermostat function. See 2.7 in Chapter 2 for the inspection method.

# 7. Fuel injection pump / Governor

Only the outline of the MP fuel pump is explained in this chapter. Refer to the MP pump service manual of the separate volume for the disassembly and assembly.

## 7.1 Introduction



It is described about the features of the fuel injection pump, YDP-MP, manufactured by Yanmar, disassembly, assembly and adjustment procedure.

Fuel injection pump is the most important equipment, which is enable to make the sensitive adjustment according to the variable load of the engine.

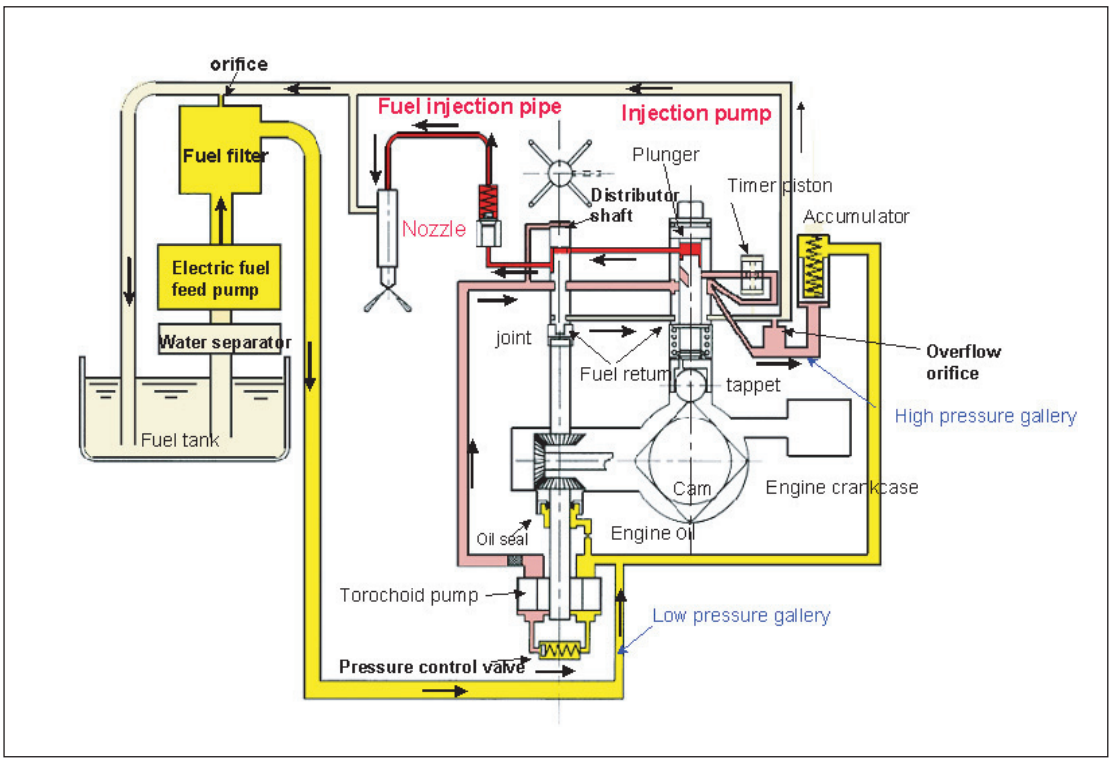
Therefore all of the parts are required not only very precise machining but also finest, assembling with top level.
The careful arrangement of keeping off the dust and the rust when disassemble, adjustment and reassemble of the fuel injection pump is made in the market.

Yanmar YDP-MP Pump is a distributor type pump which is unified of Mono-plunger, a distributing shaft, a hydraulic head which equipped the delivery valve for each cylinder, pump housing which has a cam shaft internally and governor.
The fuel, which is pressurized by the up and down movement of the plunger driven by the cam-rotation, is supplied through the distributor shaft, which is rotating accordingly.

There are a model YDP-MP2 and a model YDP-MP4, and plunger diameter and fuel cam speed are different.

## 7.2 Fuel injection pump

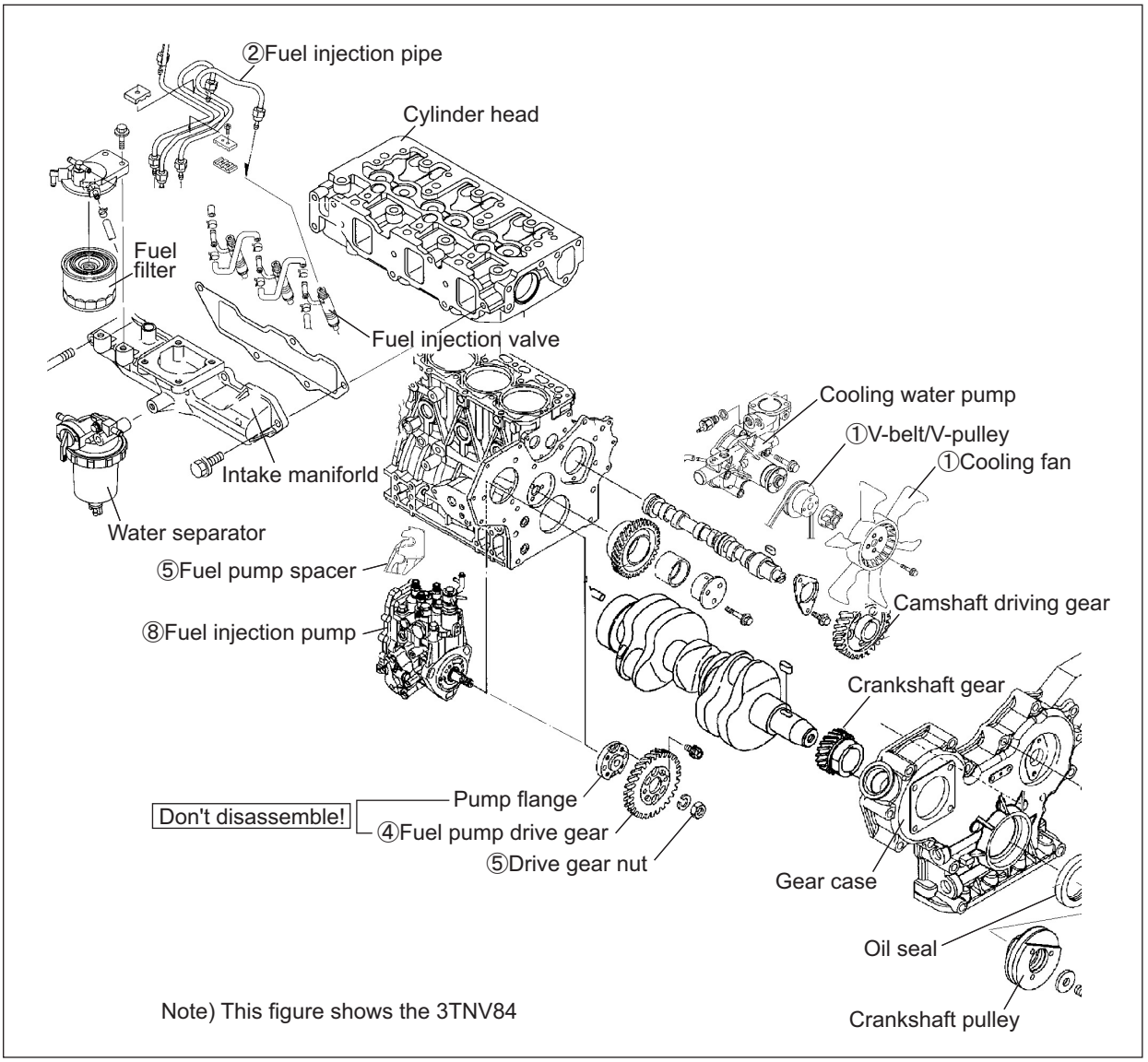
### 7.2.1 Fuel system diagram



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## 7.2.2 External view and components




## 7.2.3 Disassembly procedure:

Disassembly from the engine body

1)Remove the cooling fan, pulley and V-belt.

2)Remove the fuel injection pipe, fuel oil piping, fuel return pipe and rear stay. See point 1 of 7.2.5.

3)Remove the fuel injection pump cover (the cover of the drive gear).

4)Make ID marks on the gearing part of the pump drive gear and the idle gear with paint and so on. See Point 2 of 7.2.5.

5)Loosen a fuel pump drive gear nut, and remove a pump drive gear from the fuel pump by using a gear puller. See Point 3 of 4.3.4.

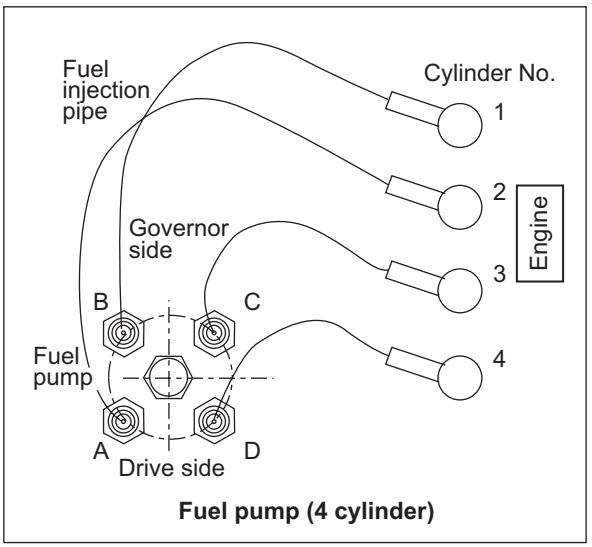
6)Remove a drive gear nut carefully not to drop it to the inside of the gear case.

7)Record the installation angle of the fuel pump precisely by using a mark-off line and a sticker. See (4) of 2.2.7.

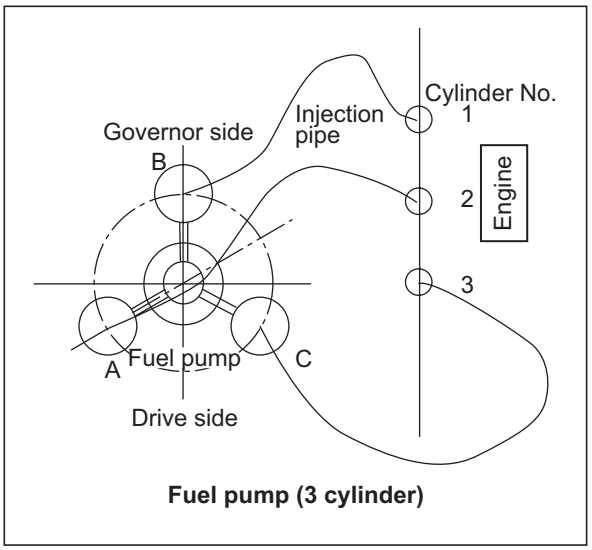
8)Remove the fuel injection pump. See Point 3 of 7.2.5.

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Fuel pump (4 cylinder)



Fuel pump (3 cylinder)

## 7.2.4 Assembly procedure

Reverse the disassembly procedure and adjust the fuel injection timing finally. See (4) of 2.2.7.

## 7.2.5 Servicing points

**Point 1**

[Disassemble]

- Block an entrance with the tape so that trash may not enter the fuel injection pipe and the fuel injection pump.

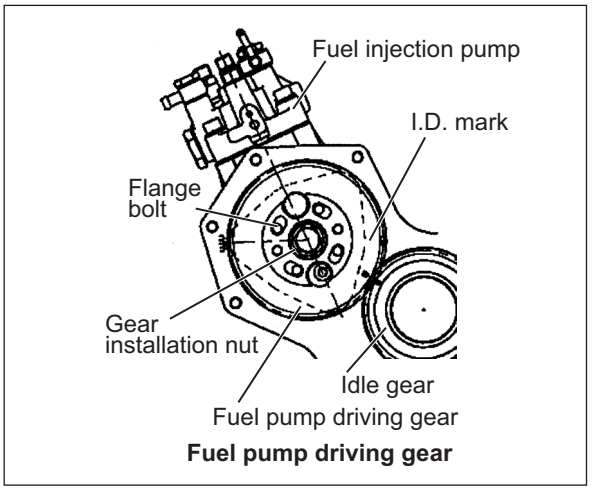
**Point 2**

[Disassemble]

- After putting the I.D. marks on the gearing part of the pump drive gear and the idle gear with paint and so on, remove the gear installation nut.

[NOTICE]

Don't remove four flange bolts.



Fuel pump driving gear

[Reassemble]

- Reassemble the pump driving gear while checking the I.D. marks on the driving gear and idle gear.

Tightening torque of the gear installation nut

| Model | N•m (kgf•m) | Lubricating oil application (thread portion, and seat surface) |
|---|---|---|
| TNV82A to 88 | 78 to 88 (8 to 9) | Not applied |
| 4TNV94 to 106 (T) | 113 to 123 (11.5 to 12.5) | |

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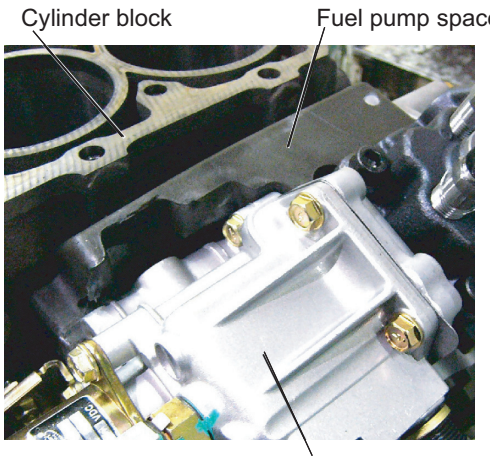
**Point 3**

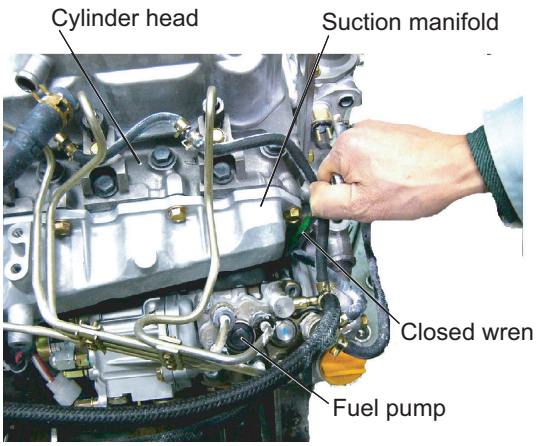
[Disassemble]

There is an acoustic material part to name as fuel pump spacer between the fuel pump and the cylinder block. Loosen fuel pump installation bolts with a closed wrench when disassembling a fuel pump.

[NOTICE]

An intake manifold may obstruct the disassembly of the fuel pump by the engine model. Remove the fuel pump after removing the intake manifold first.




**Disassembling a fuel pump**

[Reassemble]

When installing a fuel pump on the gear case, put a fuel pump spacer between the cylinder blocks, and install it.

## 7.2.6 C.S.D. (Cold Start Device)

In order to facilitate easy engine starting under cold temperature, the cold starting advancer senses the cooling water temperature and advances the fuel injection timing.

[NOTICE]

When engine starts under cold temperature, the minimum engine speed is automatically about 100-300 $min^{-1}$ higher than the normal low speed by the function of C.S.D.. A few minutes later the engine speed will reduce gradually to the normal minimum speed. Therefore it has the possibility that the machine unit begins to work because of the higher engine speed right after the engine start, and very dangerous.

Attention is especially necessary when the throttle lever of the governor is put in half-throttle position to hasten the warming up of the engine.

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# 8. Turbocharger: Disassembly, inspection and reassembly

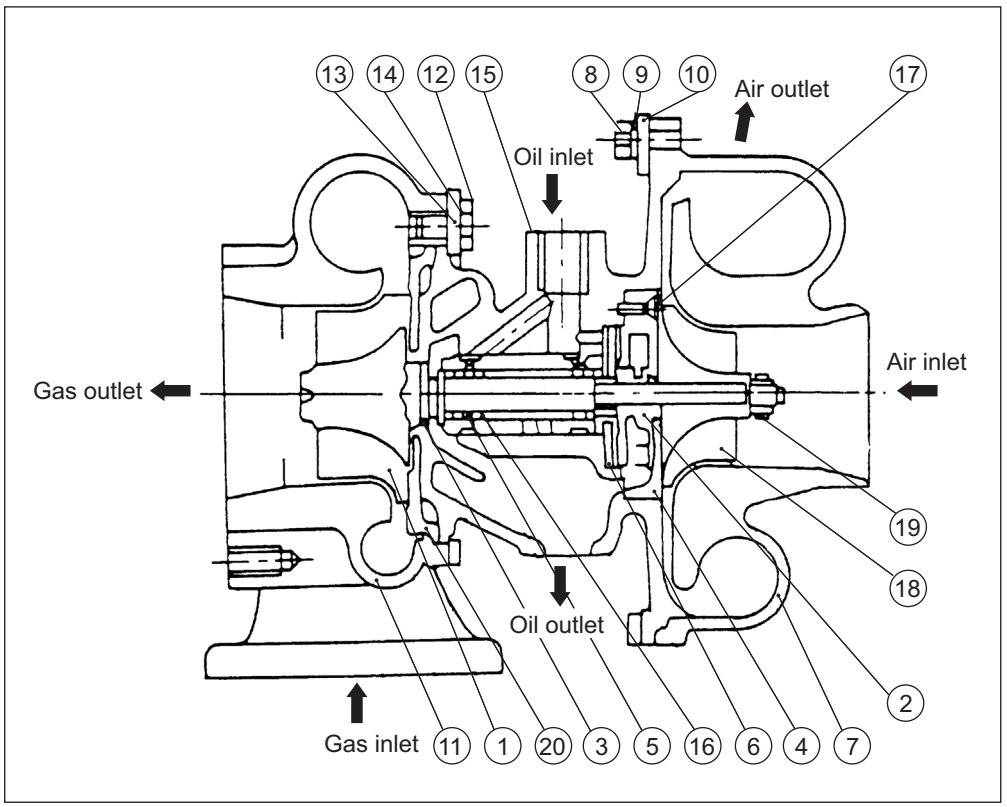
## 8.1 Structure and functions

### 8.1.1 Main specifications

| Applicable engine model (application) | 3TNV84T (CL, VM)<br>4TNV84T (CL) | 3TNV84T (VM) | 4TNV106T (CL, VM) |
|---|---|---|---|
| Turbocharger model | RHB31 | RHB51 | RHF5 |
| Turbocharger specification | Standard (w/waste gate) | | |
| Turbine type | Radial flow | | |
| Blower (compressor) type | Centrifugal | | |
| Lubrication method | External lubrication | | |
| Max. continuous allowable speed | 250,000 | 180,000 | |
| Max. continuous allowable gas inlet temperature | 750 | | |
| Dry weight<br>N (kgf) | 24 (2.4) | 41 (4.2) | 46 (4.7) |

Note) VM application is provided with the waste gate.

### 8.1.2 Construction



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## 8.1.3 Structural and functional outline

| No. | Part name |
|---|---|
| 1 | Turbine shaft |
| 2 | OiN thrower |
| 3 | Turbine side seal ring |
| 4 | Seal plate |
| 5 | Journal bearing |
| 6 | Thrust bearing |
| 7 | Compressor housing |
| 8 | M5 hexagon bolt |
| 9 | M5 spring washer |
| 10 | Compressor side clamp |
| 11 | Turbine housing |
| 12 | M6 hexagon bolt |
| 13 | Turbine side clamp |
| 14 | Lock washer |
| 15 | Bearing housing |
| 16 | Retaining ring |
| 17 | M3 countersunk flat head screw |
| 18 | Compressor wheel |
| 19 | Shaft end nut |
| 20 | Heat protector |

### (1) Turbine

The exhaust gas from the engine is accelerated at the nozzle portion in the turbine housing and blown onto the turbine impeller to rotate the turbine shaft.

This is called the turbine. A seal ring and heat insulating plate are installed to prevent the bearing from adverse influence of the gas.

### (2) Compressor

The compressor impeller installed on the turbine shaft rotates with the shaft to suck and compress air for feeding into the intake manifold.

This is called the blower or compressor.

### (3) Bearings

**Thrust bearing**

As the turbine shaft is constantly applied with a thrust force, this bearing prevents the shaft from being moved by the thrust force.

**Radial bearing**

A floating bearing is adopted. Since the bearing moves with the turbine shaft as the oil films are formed both inside and outside the bearing, the bearing sliding speed is slower than the turbine shaft speed, resulting in higher dynamic stability.

### (4) Compressor side sealing mechanism

To prevent the intake air and oil form leaking, a seal ring and a seal plate are provided to form a double wall structure on the rear side of the compressor impeller.

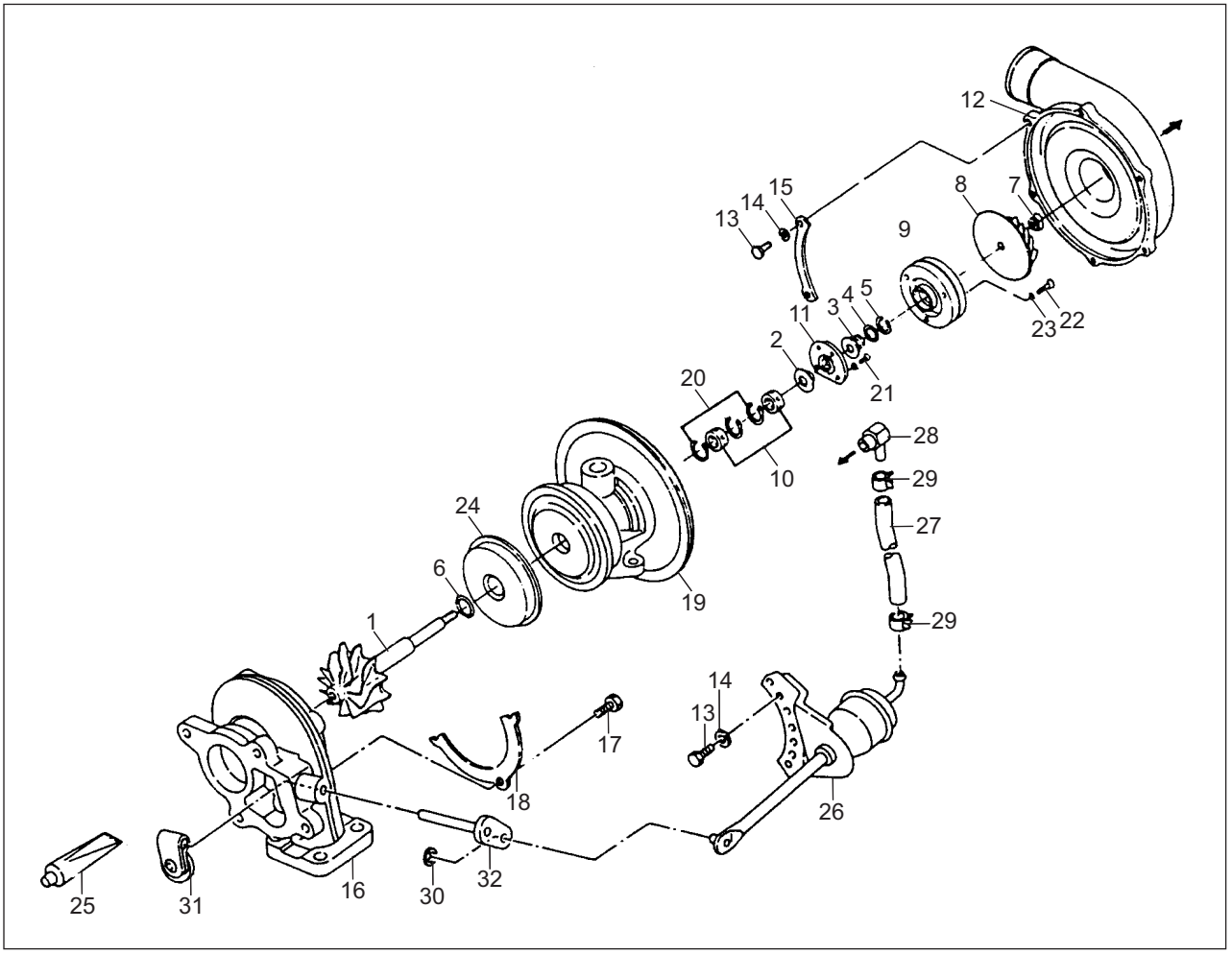
### (5) Waste gate

When the blower side pressure (intake air pressure) exceeds the specified level, the exhaust gas at the turbine inlet is partially bypassed to the exhaust discharge side to control the turbine rpm so as to maintain the intake pressure at the specified level for improving the response to load variation in the low to medium speed range and to minimize black smoke generation. It consists of a control assembly separated from the turbocharger and a valve assembly installed in the turbine impeller chamber.

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## 8.1.4 Components



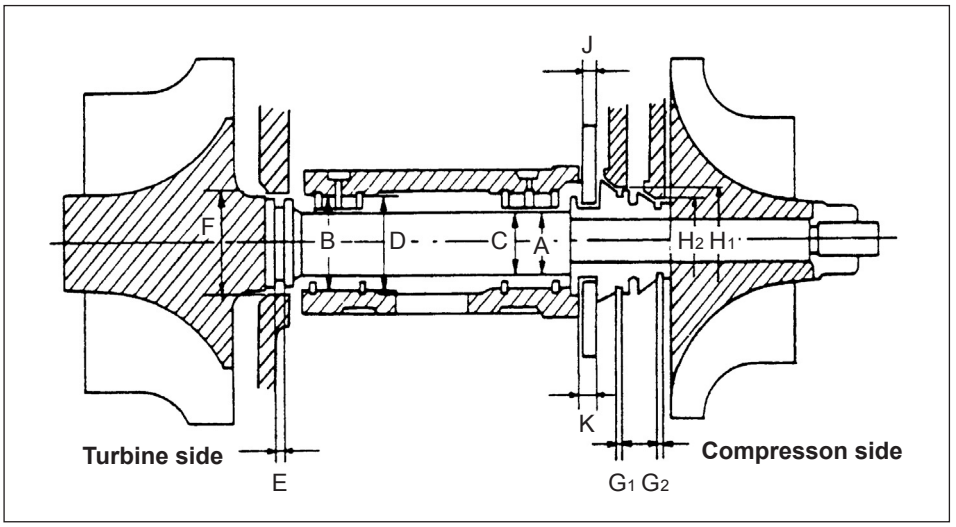

| No. | Part name | No. | Part name |
|---|---|---|---|
| 1 | Turbine shaft | 17 | Bolt |
| 2 | Thrust bushing | 18 | Lock plate |
| 3 | Oil thrower | 19 | Bearing housing |
| 4 | Seal ring | 20 | Retaining ring |
| 5 | Seal ring | 21 | Screw |
| 6 | Seal ring (turbine side) | 22 | Screw |
| 7 | Lock nut | 23 | Lock washer |
| 8 | Impeller | 24 | Heat protector |
| 9 | Seal plate | 25 | Liquid gasket |
| 10 | Journal bearing | 26 | Waste gate actuator |
| 11 | Thrust bearing | 27 | Hose |
| 12 | Compressor housing | 28 | Adapter |
| 13 | Flanged bolt | 29 | Clip |
| 14 | Spring washer | 30 | Retaining ring |
| 15 | Clamp | 31 | Waste gate valve |
| 16 | Turbine housing | 32 | Link plate |

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# 8.2 Service standards and tightening torque

## 8.2.1 Service standards




(1) RHF5 type

Unit: mm

| | | Standard dimension | Wear limit |
|---|---|---|---|
| Turbine shaft | Turbine shaft journal outside diameter (A) | 7.99 to 8.00 | 7.98 |
| | Turbine shaft seal ring groove width (E) | 1.25 to 1.28 | 1.29 |
| | Compressor side seal ring groove width (G1) | 1.22 to 1.23 | 1.31 |
| | Compressor side seal ring groove width (G2) | 1.02 to 1.03 | 1.11 |
| | Turbine shaft run-out | 0.002 | 0.011 |
| Bearing | Journal bearing inside diameter (C) | 8.01 to 8.03 | 8.04 |
| | Journal bearing outside diameter (D) | 12.32 to 12.33 | 12.31 |
| | Bearing housing inside diameter (B) | 12.40 to 12.41 | 12.42 |
| Thrust bearing | Thrust bearing width (J) | 3.99 to 4.01 | 3.98 |
| | Thrust bushing groove dimension (K) | 4.04 to 4.05 | 4.07 |
| Seal ring fixing area | Turbine side (bearing housing) (F) | 15.00 to 15.02 | 15.05 |
| | Compressor side (seal ring) (H1) | 12.40 to 12.42 | 12.45 |
| | Compressor side (seal ring) (H2) | 10.00 to 10.02 | 10.05 |
| Rotor play in axial direction | | 0.03 to 0.06 | 0.09 |
| Rotor play in radial direction | | 0.08 to 0.13 | 0.17 |

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(2) RHB31/RHB51 type

Unit: mm

| | | Standard dimension | | Wear limit | |
|---|---|---|---|---|---|
| | | RHB31 | RHB51 | RHB31 | RHB51 |
| Turbine shaft | Turbine shaft journal outside diameter (A) | 6.257 to 6.263 | 7.99 to 8.00 | 6.25 | 7.98 |
| | Turbine shaft seal ring groove width (E) | 1.038 to 1.062 | 1.25 to 1.28 | 1.07 | 1.29 |
| | Compressor side seal ring groove width (G1) | 1.02 to 1.03 | 1.22 to 1.23 | 1.04 | 1.31 |
| | Compressor side seal ring groove width (G2) | 0.82 to 0.83 | 1.02 to 1.03 | 0.84 | 1.11 |
| | Turbine shaft run-out | 0.002 | 0.002 | 0.005 | 0.011 |
| Bearing | Journal bearing inside diameter (C) | 6.275 to 6.285 | 8.01 to 8.03 | 6.29 | 8.04 |
| | Journal bearing outside diameter (D) | 9.940 to 9.946 | 12.32 to 12.33 | 9.93 | 12.31 |
| | Bearing housing inside diameter (B) | 9.995 to 10.005 | 12.40 to 12.41 | 10.01 | 12.42 |
| Thrust bearing | Thrust bearing width (J) | 3.59 to 3.61 | 3.99 to 4.01 | 3.58 | 3.98 |
| | Thrust bushing groove dimension (K) | 3.632 to 3.642 | 4.04 to 4.05 | 3.65 | 4.07 |
| Seal ring fixing area | Turbine side (bearing housing) (F) | 11.00 to 11.018 | 15.00 to 15.02 | 11.03 | 15.05 |
| | Compressor side (seal ring) (H1) | 9.987 to 10.025 | 12.40 to 12.42 | 10.04 | 12.45 |
| | Compressor side (seal ring) (H2) | 7.968 to 8.00 | 10.00 to 10.02 | 8.01 | 10.05 |
| Rotor play in axial direction | | 0.022 to 0.053 | 0.03 to 0.06 | 0.07 | 0.09 |
| Rotor play in radial direction | | 0.061 to 0.093 | 0.08 to 0.13 | 0.12 | 0.17 |

## 8.2.2 Tightening torque

(1) RHF5 type

N•m (kgf•cm)

| Part | Thread diameter | Tightening torque |
|---|---|---|
| Turbine housing set bolt | M8 | 27 to 29 (275 to 295) |
| Compressor housing set bolt | M5 | 4.2 to 5.2 (43 to 53) |
| Thrust bearing set screw | M3 | 1.2 to 1.4 (12 to 14) |
| Seal plate set screw | M3 | 1.2 to 1.4 (12 to 14) |
| Blower impeller set nut (left-handed screw) | M5 | 1.8 to 2.2 (18 to 22) |

(2) RHB31/ RHB51 type

N•m (kgf•cm)

| Part | Thread diameter | Tightening torque | |
|---|---|---|---|
| | | RHB31 | RHB51 |
| Waste gate actuator set bolt | M5 | 3.9 to 4.9 (40 to 50) | 3.9 to 4.9 (40 to 50) |
| Lock plate set bolt | M6 | 11.8 to 12.8 (120 to 130) | 11.8 to 12.8 (120 to 130) |
| | M8 | 11.8 to 12.8 (120 to 130) | 27.0 to 28.9 (275 to 295) |
| Thrust bearing set screw | M3 | 1.2 to 1.4 (12 to 14) | 1.2 to 1.4 (12 to 14) |
| Seal plate set screw | M3 | 1.2 to 1.4 (12 to 14) | 1.2 to 1.4 (12 to 14) |
| Blower impeller set nut (left-handed screw) | M5 | 0.9 to 1.1 (9 to 10) | 1.8 to 2.2 (18 to 22) |

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# 8.3 Periodic inspection procedure

## 8.3.1 Periodic inspection intervals

Periodically inspect the turbocharger for the overall conditions and fouling.
The inspection interval varies with the operating conditions, but refer to the table below for the guideline for each application.

| Application | Inspection interval | | |
|---|---|---|---|
| For vehicles (automobiles) | Every 6 months or 60,000km | Every 12 months or 150,000km | Every 24 months or 300,000km |
| For construction machinery | Every 6 months or 500hrs | Every 12 months or 1,000hrs | Every 24 months or 2,000hrs |
| For faming machinery | Every 6 months or 200hrs | Every 12 months or 400hrs | Every 24 months or 800hrs |
| For marine use | Every 6 months or 1,500hrs | Every 12 months or 3,000hrs | Every 24 months or 6,000hrs |
| Rotor rotation | ○ | | |
| Rotor play | | ○ | |
| Overhaul and overall inspection | | | ○ |
| Oil filter cleaning and inspection | Based on engine operation manual | | |
| Engine oil replacement | | | |

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## 8.3.2 Inspection procedure

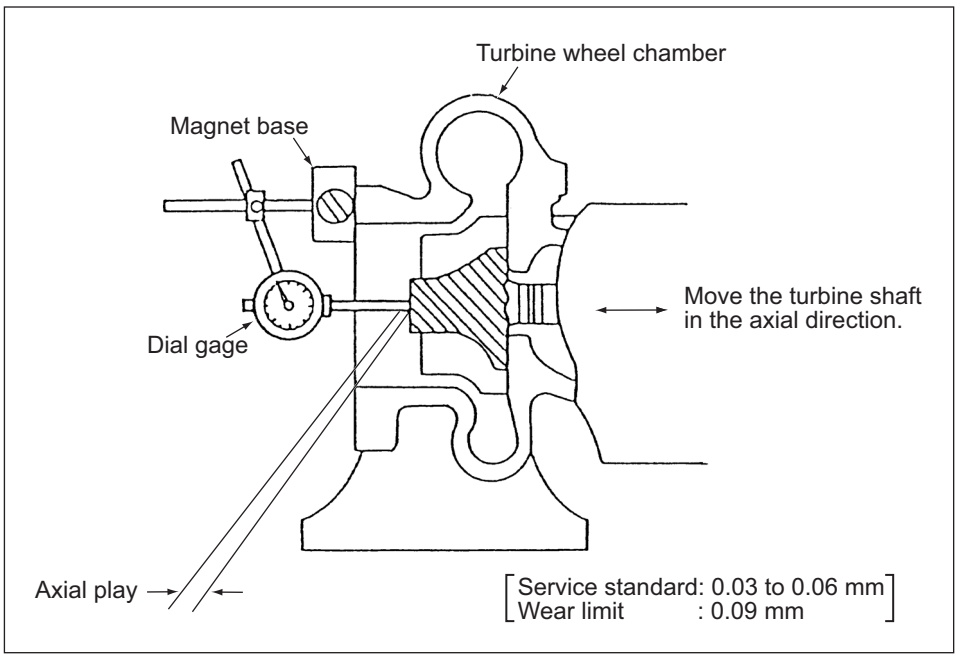
### (1) Rotor rotation inspection

Inspect the rotor rotation by listening to any abnormal sound generation during rotation.
For inspection with a sound detecting bar, bring the tip end of the bar into strong contact with the turbocharger case and raise the engine speed gradually.
If any high pitch sound is generated at intervals of 2 to 3 seconds, the rotation is abnormal. Since the bearing or rotor may be defective in this state, either replace or overhaul the turbocharger.

### (2) Rotor play inspection

Remove the turbocharger from the engine and inspect the rotor play in the axial and radial directions according to the procedure below.
After removing the turbocharger from the engine, always bind the oil inlet and outlet holes with adhesive tape.

Rotor play in axial direction

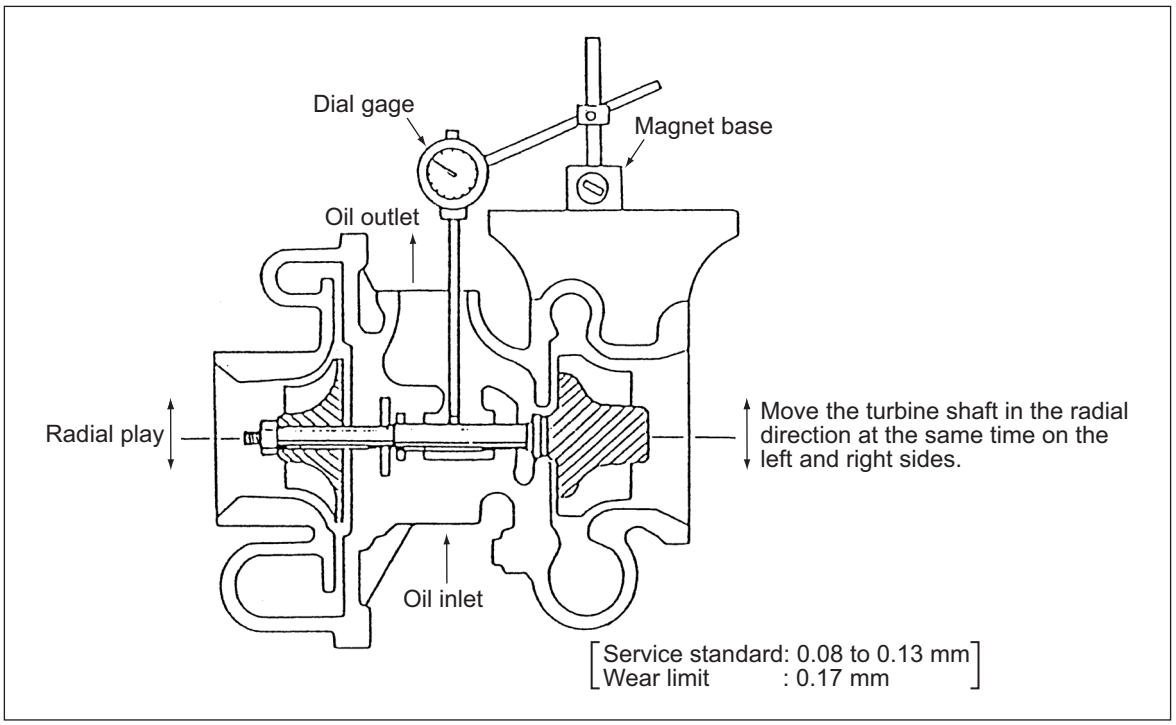


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## 8.3.3 Waste gate valve adjustment procedure

Rotor play in radial direction




It is indispensable to adjust the waste gate valve opening pressure and lift after its overhaul or inner parts replacement.

Negligence of this adjustment will adversely affect the engine performance.

[NOTICE]

If the adjustment is impossible, give up overhaul but replace the whole turbocharger assembly.

### (1) Method for checking the waste gate valve opening pressure and lift

#### (a)Equipment

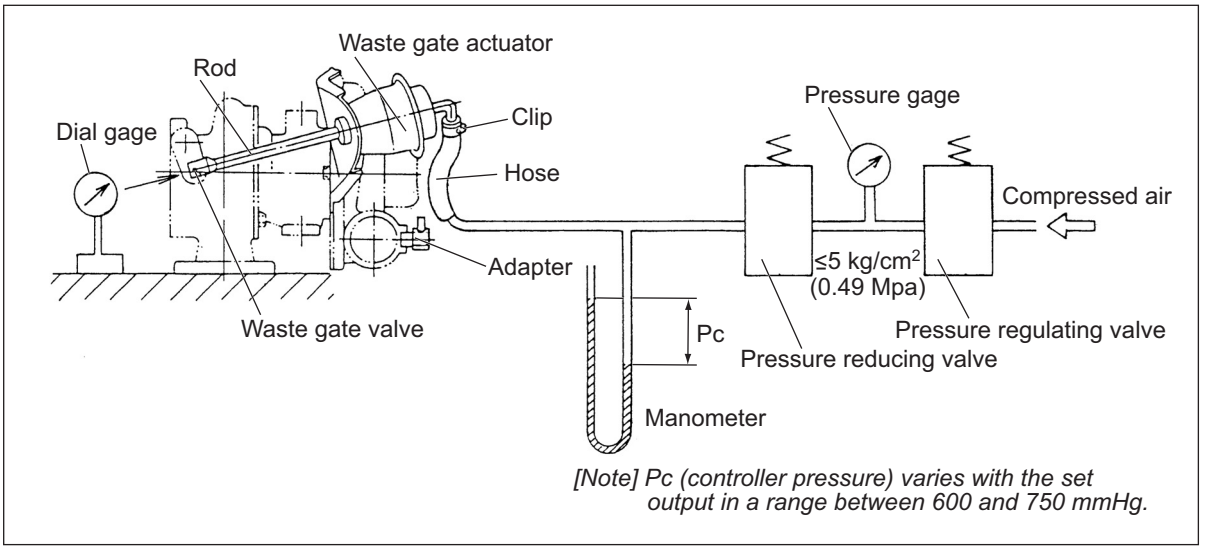
Prepare the equipment shown in the figure below.

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(b)Measuring instruments and devices

| Dial gage | Capable of measuring 0 to 10 mm (A flat head type is recommendable.) |
|---|---|
| Manometer | Mercury column or electrical type (capable of measuring 0 to 1500 mmHg) |
| Pressure regulating valve | Allowing gradual adjustment in a range between 0 and 2 kgf/cm$^2$ (0.196 Mpa) |
| Pressure reducing valve | Used for suppressing the air supply pressure at 5 kgf/cm$^2$ (0.49 Mpa) or less. |
| Pressure gage | Bourdon tube pressure gage (0 to 10 kgf/cm$^2$ (0.98 Mpa)) |




(c)Check method

1)Set the manometer control pressure (Pc) applied to the waste gate actuator to 0 and set the dial gage to the zero point.

2)Gradually open the pressure regulating valve and measure the Pc value when the actuator rod is operated by 2 mm.

3)For the hysteresis, let the rod move to 3 mm first. The gradually close the pressure regulating valve, measure the pressure when the rod is moved to 2mm and obtain the difference from the pressure measured in b. above.

4)Precautions

- Set the dial gage on the extension line of the actuator rod.
- The piping and joints shall completely be free from leak.
- Fix the turbocharger and dial gage securely.
- If an electric manometer is used, it shall have sufficient precision.
- Even when an electric manometer is used, use of a mercury column type manometer in combination is recommended for calibration and daily check.
- The speed for increasing/decreasing Pc by means of the pressure regulating valve shall be very slow near the measuring point. If the mm position is exceeded, restart from the beginning.
- Do not apply over 0.49 MPa (5 kgf/cm$^2$) to the actuator.

## (2) Waste gate actuator leak test

Apply 0.12 Mpa (1.2 kgf/cm$^2$) to the actuator and hold the state for minute. The actuator is good if the pressure then is 0.11 Mpa (1.1 kgf/cm$^2$) or above.

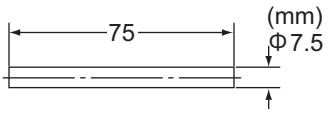
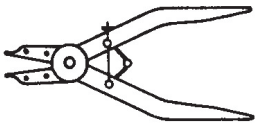
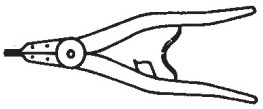
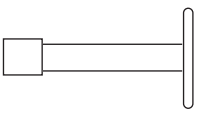
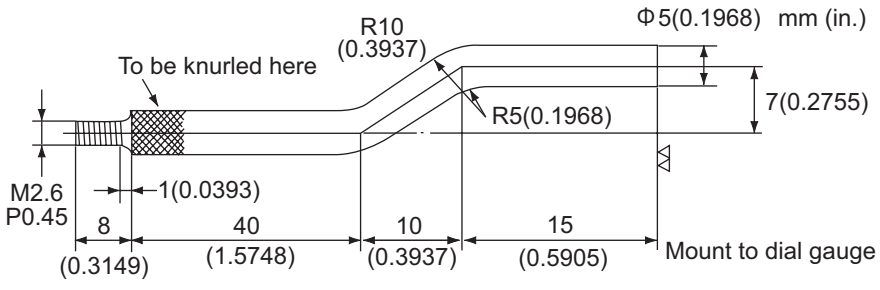
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# 8.4 Disassembly procedure

## 8.4.1 Preparation for disassembly

In addition to the general tools, the following special tools are required for turbocharger disassembly and reassembly:

| Tool name | Use | Illustration |
|---|---|---|
| Bar | For removing thrust bearing and thrust bushing |  Material: Copper or brass |
| Pliers | For removing floating bearing circlip |  |
| Pliers | For removing seal ring |  |
| Torque driver for TORX bolt (multifunctional type)<br>0.5 to 4.9 N•m (5 to 50 kgf•cm) | For thrust bearing installation (for M3) : 1.3 N•m (13 kgf•cm)<br><br>For seal plate installation (for M3) : 1.3 N•m (13 kgf•cm) | Item sold on market<br>  <br>(Type: TORX TT20 or equivalent) |
| Box wrench | For fixing turbine shaft (mm × dodecagonal) |  Box only may be used. |
| Torque wrench (single purpose) | For following bolts and nuts:<br>M8 : mm, kgf•cm (N•m)<br>M5 : mm, kgf•cm (N•m)<br>M5 : mm, kgf•cm (N•m) |  |
| Probe | For measuring play in axial and radial directions: To be installed on a dial gage |  |

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## 8.4.2 Inspection before disassembly

1)Inspect the turbine wheel and compressor impeller for any undesirable contact and the rotor for smooth rotation.

2)Measure the rotor play as described in section 8.3 (2.2).

• Rotor axial play Wear limit:  mm

• Rotor radial play Wear limit : mm

## 8.4.3 Disassembly

The mounting angles of the turbine housing, bearing housing and compressor housing are determined according to its mounting state on the engine. Put match marks before starting disassembly.

Note: The number after each part is the one described in the structural drawing in 8.1(2).

### (1) Compressor housing removal

1)Remove flanged hexagon bolt 8 and compressor side keep plate 10.

2)Remove compressor housing 7.

Note:

1)Liquid gasket is applied on the surface of compressor housing 7 where bearing housing 15 is mounted.

2)When disassembling compressor housing 7, carefully operate so as not to damage the compressor impeller.

### (2) Compressor impeller removal

1)Set a box spanner (10 mm) on the turbine side end of the turbine shaft, and remove shaft end clamp 18.

Note: Pay attention to the loosening direction since the shaft end nut has left-handed screw.

2)Remove compressor impeller 18.

### (3) Turbine housing removal

1)Remove hexagon nut 12 and turbine side keep plate 13.

2)Remove turbine housing 11.

### (4) Turbine shaft extraction

1)Hold heat insulating plate 20 lightly with a hand, and extract turbine shaft 1.

Note: If the turbine shaft is hard to be extracted, tap the compressor side end of the shaft lightly with a wooden hammer.

2)Remove heat insulating plate 20.

### (5) Seal plate removal

1)Use the Torx driver and loosen M3 Torx T-type machine screw 17 for seal plate mounting.

2)Remove seal plate 4.

Note: Liquid gasket has been applied to the seal plate and bearing housing mounting surface.

3)Remove oil thrower 2 from the seal plate.

### (6) Slide bearing and thrust bushing removal

1)Use the Torx driver and loosen the M3 Torx T-type machine screw for thrust bearing installation.

2)Use the bar (copper) and remove thrust bearing 6 and thrust bushing.

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### (7) Floating bearing removal

1)Use the stop ring pliers and remove circlip 16 from bearing housing 15.

2)Remove floating bearing 5 from bearing housing 15.

### (8) Seal ring removal

1)Remove turbine side seal ring 3 from turbine shaft 1.

2)Remove compressor side seal ring (small) and compressor side seal ring (large) from oil thrower 2.

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# 8.5 Washing and inspection procedure

## 8.5.1 Washing

### (1) Inspection before washing

Visually inspect each part before washing to check trace of seizure, wear, foreign matter or carbon adhesion. Carefully inspect for identifying the cause of trouble especially when a fault has occurred.

Major inspection items

| Check point | Checking position |
|---|---|
| Carbon adhesion state | 1)Turbine shaft 1, turbine side seal ring and rear side of turbine wheel<br>2)Heat insulating plate 20 mounting portion and inside of bearing housing 15 |
| Lubrication status<br>(wear, seizure, discoloration, etc.) | 1)Turbine shaft 1, journal portion and thrust bushing oil thrower 2<br>2)Floating bearing 5 and thrust bearing 6<br>3)Bearing housing 15 and inner wall of bearing fitting ring |
| Oil leak state | 1)Inner wall of turbine housing 11<br>2)Outer surface of bearing housing 11 and heat insulating plate 20 mounting portion<br>3)Turbine shaft 1 turbine side seal ring portion and rear side of turbine wheel<br>4)Inner wall of compressor housing 7<br>5)Rear side of compressor impeller 18<br>6)Surface and seal ring inserting portion of seal plate 4 |

### (2) Washing procedure

Keep the following in mind when washing the parts.

| Part | Tools and detergent | Procedure |
|---|---|---|
| a)Turbine s haft | •Tools<br>1)Bucket (500 × 500)<br>2)Heat source:<br>Steam or gas burner<br>3)Brush<br>•Detergent<br>Standard carbon removing agent | 1)Boil the turbine in the washing bucket.<br>Do not strike the blade to remove the carbon.<br>2)Immerse in the detergent until the carbon and other deposits are softened.<br>3)Use a plastic scraper or hand hair scrubber to remove the softened deposits.<br>4)Protect the bearing surface and seal ring groove on the turbine shaft so as not to be damaged.<br>5)Any deposit remaining on the turbine shaft due to improper washing may cause unbalancing. Be sure to remove thoroughly. Never use a wire brush. |
| b)Turbine wheel chamber | •Tools<br>Same as for turbine shaft<br>•Detergent<br>Same as for turbine shaft | 1)Boil the turbine in the washing bucket.<br>2)Immerse in the detergent until the carbon and other deposits are softened.<br>3)Use a plastic scraper or hard hair scrubber to remove the softened deposits. |
| c)Blower blade and chamber | •Tools<br>1)Bucket (500 × 500)<br>2)Brush<br>•Detergent | 1)Immerse in the washing bucket until the deposit is softened.<br>2)Use a plastic scraper or hard hair scrubber to remove the softened deposits.<br>Never use a wire brush. |
| d)Others | 1)Wash all other parts with diesel oil.<br>2)Clean the lubricating oil path by blowing with compressed air.<br>3)Be especially careful so as not to damage or corrode the parts. | |

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## 8.5.2 Inspection procedure

### (1) Compressor housing 7

Inspect the compressor housing for any contact trace with the compressor impeller, surface defect, dent or crack at joint surface, and replace it if defective.

### (2) Turbine housing 11

Inspect any trace of contact with the turbine wheel, exfoliation due to degradation by oxidation of the cast surface, thermal deformation or crack.
Replace with a new one of defective.

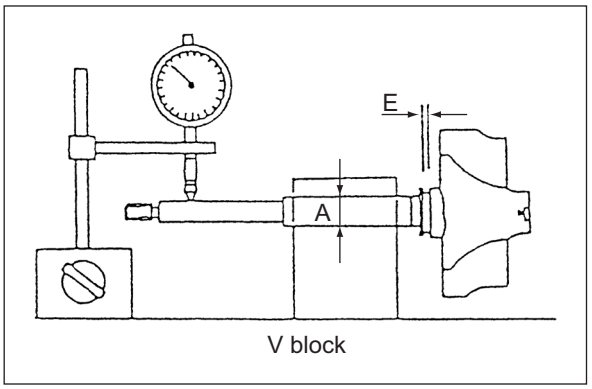
### (3) Compressor impeller 18

Inspect any contact trace, chipping, corrosion or deformation.
Replace with a new one if defective.

### (4) Turbine shaft 1

1)Inspect any contact trace, chipping, thermal discoloration or deformation at the turbine wheel. Check the shaft portion for bend, the journal portion for thermal discoloration or abnormal wear, and the seal ring groove for surface defect or wear. Replace with a new one if defective.

2)Measure the turbine shaft journal outside diameter (A) and seal ring groove width (E).
Replace with a new turbine shaft if beyond the wear limit.




**Wear limit of journal outside diameter (A)**

RHF5 ····· 7.98 mm
RHB51 ····· 7.98 mm
RHB31 ····· 6.25 mm

**Wear limit of ring groove width (E)**

RHF5 ····· 1.29 mm
RHB51 ····· 1.29 mm
RHB31 ····· 1.07 mm

3)Measure the turbine shaft run-out, and replace with a new turbine shaft if it exceeds 0.011 mm.

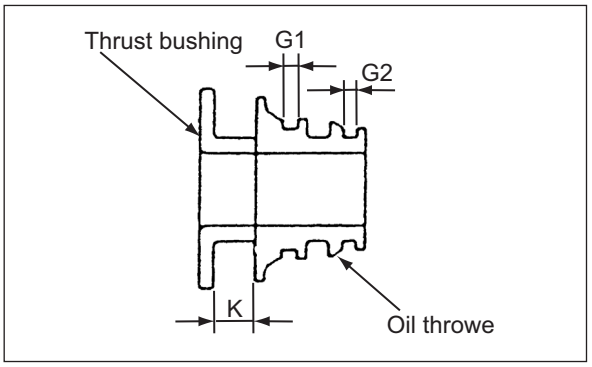
### (5) Heat insulating plate 20

Inspect the heat insulating plate for any contact trace, thermal deformation or corrosion Replace with a new one if defective.

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## (6) Thrust bushing, oil thrower 2 and thrust bearing 6 Inspect each part for wear, surface defect and discoloration.




Replace with a new one if defective even within the wear limit.

(a)Thrust bushing

Measure the distance between grooves (K) of the thrust bushing, and replace with a new one if the wear limit is exceeded.

**Wear limit**

RHF5 ····· 4.07 mm

RHB51 ····· 4.07 mm

RHB31 ····· 3.65 mm

(b)Oil thrower 2

Measure the seal ring groove widths (G1) and (G2), and replace with a new one if the wear limit is exceeded.

**Wear limits**

RHF5--- G1: 1.31 mm, G2: 1.11 mm

RHB51--- G1: 1.31 mm, G2: 1.11 mm

RHB31--- G1: 1.04 mm, G2: 0.84 mm

(c)Thrust bearing 6

Measure the thrust bearing width (J), and replace with a new one if the wear limit is exceeded.

**Wear limit**

RHF5 ····· 3.98 mm

RHB51 ····· 3.98 mm

RHB31 ····· 3.58 mm

## (7) Floating bearing 5

1)Inspect the floating bearing for abnormal wear, discoloration or surface defect.
Replace with a new one if defective.

2)Measure the inside diameter (C) and outside diameter (D).
Replace the bearing if either wear limit is exceeded.

**Wear limits**

RHF5 ····· Outside diameter (D): 12.31 mm,
Inside diameter (C): 8.04 mm

RHB51 ····· Outside diameter (D): 12.31 mm,
Inside diameter (C): 8.04 mm

RHB31 ····· Outside diameter (D): 9.93 mm,
Inside diameter (C): 6.29 mm

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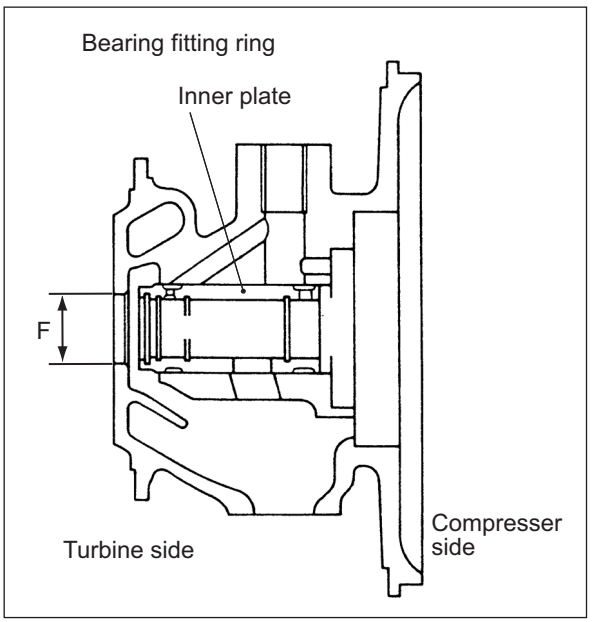
## (8) Bearing housing 15

1)Inspect the housing for cast surface exfoliation due to oxidation and degradation, dent or crack.

2)Inspect circlip 16 for chipping or crack, and replace with a new one if defective.

3)Measure the (B) and (F) portions of the bearing housing shown in the figure below.

Replace with a new one if either wear limit is exceeded.




**Wear limit of bearing housing inside diameter (B)**

RHF5 ····· 12.42 mm

RHB51 ····· 12.42 mm

RHB31 ····· 10.01 mm

**Wear limit of turbine side seal ring inserting portion (F)**

RHF5 ····· 15.05 mm

RHB51 ····· 15.05 mm

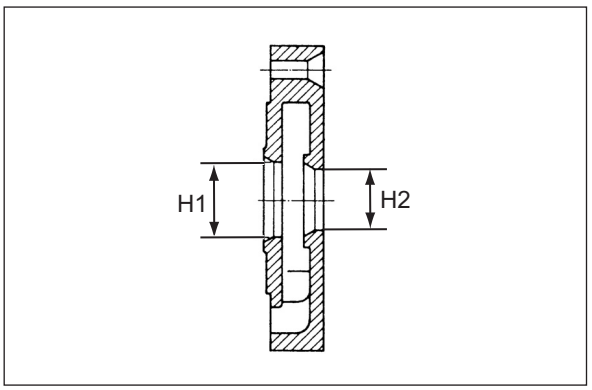
RHB31 ····· 11.03 mm

## (9) Seal plate 4

1)Inspect the seal plate for any contact trace, joint surface defect, dent or crack.

Replace it if defective.

2)Measure the seal ring inserting dimensions (H1 and H2) on the compressor side, and replace the seal ring with a new one if either wear limit is exceeded.




**Wear limits**

RHF5 ····· H1: 12.45 mm, H2: 10.05 mm

RHB51 ····· H1: 12.45 mm, H2: 10.05 mm

RHB31 ····· H1: 10.04 mm, H2: 8.01 mm

## (10)Seal rings

Replace seal rings with new ones.

## (11)Inspect keep plates 10, 13 and bolts for any deformation, and replace defective parts with new ones. Also replace M3 Torx machine screws with new ones.

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# 8.6 Reassembly procedure

## 8.6.1 Preparation for reassembly

1)Prepare general tools, special tools, liquid gasket (Three Bond No.1207) and Locktite No.242 before reassembling the turbocharger.

2)Always replace the following parts with new ones:

- Turbine side seal ring 1pc.
- Compressor side seal ring (large) 1pc.
- Compressor side seal ring (small) 1pc.
- M3 machine screws 3pcs.
- M3 machine screws 4pcs.

## 8.6.2 Reassembly

### (1) Floating bearing installation

1)Use the snap ring pliers and install inner circlip 16 on bearing housing 15.

2)Install floating bearing 5 in bearing housing 15.

3)Use the snap ring pliers and install outer circlip 16 on bearing housing 15.

Note:

1)The circlip joint shall be positioned as shown in the figure at right above.

**The rounded side of the circlip shall face the bearing.**

2)Apply lubricating oil on the floating bearing before reassembly.

### (2) Turbine shaft installation

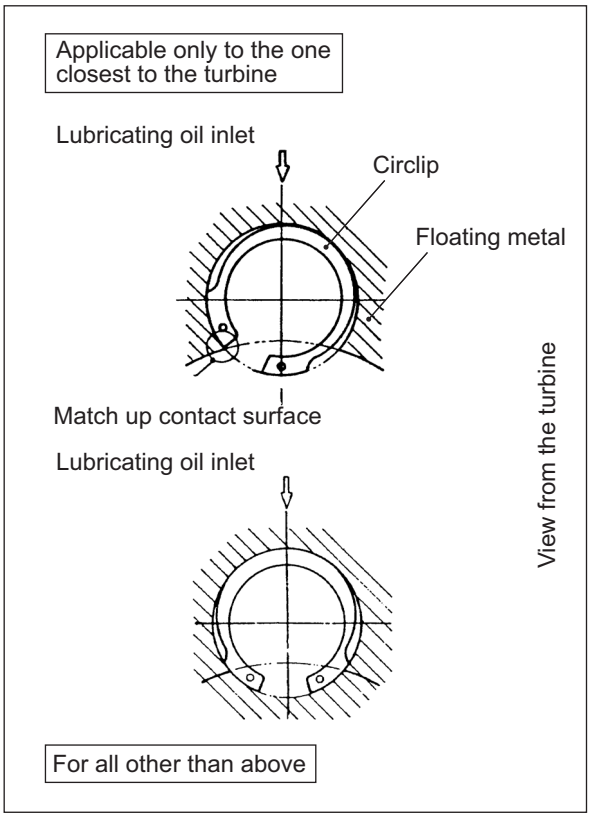
1)Fit the seal ring onto turbine shaft 1.

2)Install heat insulating plate 20 on the turbine side of bearing housing 15.

3)Apply lubricating oil on the journal portion of the turbine shaft and insert the shaft from the turbine side of bearing housing 15.

Note: Carefully operate so as not to damage the floating bearing by the turbine shaft.

The seal ring joint shall be positioned on the lubricating oil inlet side after centering with the turbine shaft.



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## (3) Thrust bearing installation

1)Fit thrust bushing on turbine shaft 1.

2)Apply lubricating oil on the bearing portion of thrust bearing 6 and install it in bearing housing 15.

3)Apply Locktite on the threaded portion of M3 Torx T machine screw 17 for thrust bearing installation, and use Torx torque driver for installation by tightening to the specified torque.

Tightening torque: 1.3 ± 0.1 N•m (13 ± 1 kgf•cm)

## (4) Seal plate installation

1)Fit the seal ring on oil thrower 2.

2)Insert oil thrower 2 into seal plate 4.

Note: The seal ring joint portion shall be positioned as illustrated at right.

3)Apply liquid gasket (Three Bond No.1207) on the seal plate mounting surface on the compressor side of bearing housing 15.

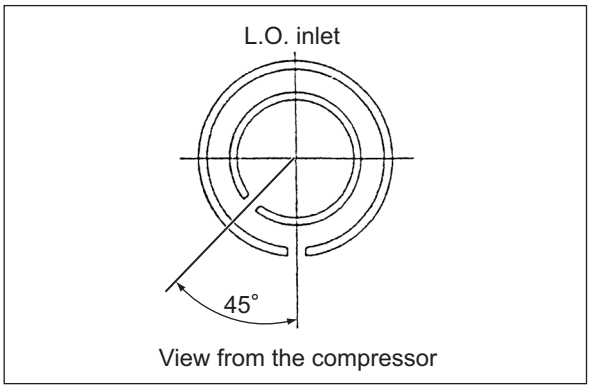
Note: See the illustration below for the applying position.

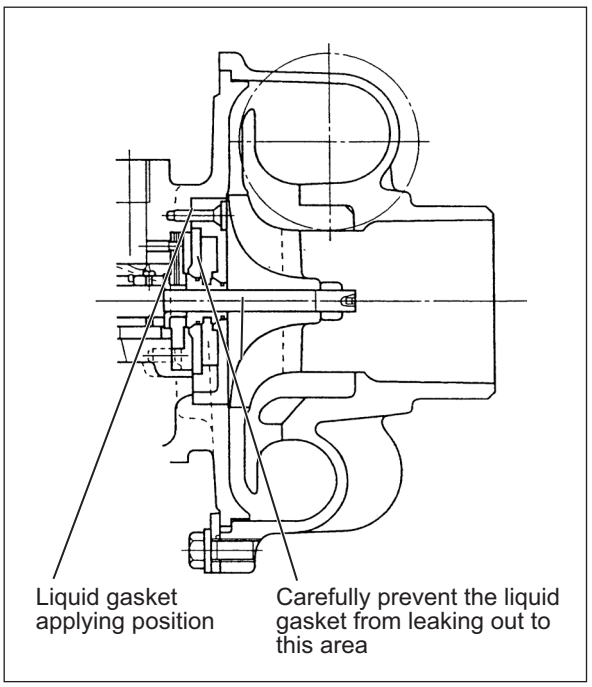
Applying thickness: 0.1 to 0.2 mm

4)Install seal plate 4 on bearing housing 15.

5)Apply Locktite on the threaded portion of M3 machine screw for seal plate mounting, and tighten it with a torque screwdriver.

Tightening torque: 1.3 ± 0.1 N•m (131 kgf•cm)



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### (5) Compressor impeller installation

1)Fit compressor impeller 18 onto turbine shaft 1.

2)Set a box spanner (10 mm) on the turbine side end of turbine shaft 1, and tighten shaft end nut 19.

Note: Since the shaft end nut has left-handed screw, pay attention to the tightening direction.

Tightening torque: 2.0 ± 0.2 N•m (20 ± 2 kgf•cm)

### (6) Turbine housing installation

1)Install bearing housing 15 on turbine housing 11 by aligning the match marks put before disassembly.

Note: In case of part replacement, check the oil inlet and outlet positions and the exhaust gas inlet position before reassembly.

2)Install the turbine side keep plate and tighten M8 hexagon bolt 12.

Tightening torque: 285 ± 10 N•m (28 ± 1 kgf•cm)

### (7) Compressor housing installation

1)Apply liquid gasket (Three Bond No.1207) on the compressor side flange of bearing housing 15.

Note: See section (4)3) for the portion to be applied.

Applying thickness: 0.1 to 0.2 mm

2)Check the mark and install the compressor housing 7 on the bearing housing 15.

Note: When a part is replaced, confirm a position of an oil entrance and a position of an air exit, and assemble it.

3)Install the keep plate 10 on compressor side, and tighten M8 hexagon bolt 8.

Tightening torque: 48 N•m (4.7 ± 0.5 kgf•cm)

### (8) Rotor play measurement

See the inspection procedure in section 8.3.2 for the measurement method.

If the rotor play does not satisfy the standard, reassembly is necessary since assembly error or use of a wrong part is conceivable.

**Service standard of rotor play in axial direction**

RHF5 ····· 0.03 to 0.06 mm

RHB51 ····· 0.03 to 0.06 mm

RHB31 ····· 0.022 to 0.053 mm

**Service standard of rotor play in radial direction**

RHF5 ····· 0.08 to 0.13 mm

RHB51 ····· 0.08 to 0.13mm

RHB31 ····· 0.061 to 0.093mm

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# 8.7 Handling after disassembly and reassembly

When installing the turbocharger on the engine or handling the turbocharger after installation, strictly observe the instructions given below.
Especially pay careful attention for preventing foreign matter entrance into the turbocharger.

## 8.7.1 Instructions for turbocharger installation

**Lubrication system**

1)Pour new lubricating oil through the oil filler port before installation on the engine, and manually turn the turbine shaft to lubricate the floating and thrust bearings.
2)Flush the oil inlet pipe from the engine and outlet pipe, and check no crushed pipe nor dirt or foreign matter remaining in the pipes.
3)Connect the pipes securely so as to ensure no oil leak from joints.

**Intake system**

1)Check no foreign matter or dirt in the intake line.
2)Connect securely to prevent any air leak from joints with the intake duct and air cleaner.

**Exhaust system**

1)Check no dirt or foreign matter in the exhaust system.
2)Since heat resistant steel is used for the bolts and nuts, do not use general bolts and nuts for installation. Always apply anti-seizure agent on fastening bolts and nuts to be tightened.
(Use heat-resistant hexagon bolts for the turbine housing.)
3)Connect exhaust pipes securely to prevent gas leak from each pipe joint.

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# 8.8 Troubleshooting

Sufficient turbocharger performance and required engine output cannot be obtained if there is any fault. In such a case, first check each engine part to see there is no engine fault. Then inspect the turbocharger for troubleshooting according to the procedure shown below.

## 8.8.1 Excessively exhaust smoke

(1) Insufficient intake air volume

| Cause | Corrective action |
|---|---|
| 1)Clogged air cleaner element<br>2)Blocked air intake port<br>3)Leak from a joint in intake line | •Replace or wash the element.<br>•Correct to the normal state.<br>•Inspect and repair. |

(2) Turbocharger revolution failure

| Cause | Corrective action |
|---|---|
| 1)Deposit of impurities in oil sticking on the turbine side seal portion to make turbine revolution heavy | •Turbocharger overhaul (disassembly and washing) with lubricating oil replacement |
| 2)Sticking bearing<br>•Insufficient lubrication or clogged lubrication piping<br>•Excessively high oil temperature<br>•Unbalanced rotating part<br>•Insufficient warming up or sudden stoop from loaded operation (no-load operation) | •Turbocharger overhaul (disassembly and repair)<br>•Lubricating oil line inspection, repair of defective portion and lubricating oil replacement<br>•Rotating part replacement or washing<br>•Strict observance of instructions in operation manual |
| 3)Contact or breakdown of turbine wheel or blower vane<br>•Excessive revolution<br>•Excessive exhaust temperature rise<br>•Foreign matter invasion<br>•worn bearing<br>•Assembly defect | •Inspection and repair of each engine part<br>•Perfect foreign matter elimination in disassembled state, followed by inspection and repair of individual air cleaner and engine components<br>•Turbocharger overhaul (disassembly and repair)<br>•Reassembly |

(3) Influence of exhaust resistance

| Cause | Corrective action |
|---|---|
| 1)Exhaust gas leak before the turbocharger to decrease its revolutions | •Joint inspection and correction |
| 2)Deformed or clogged exhaust pipe to decrease turbocharger revolutions | •Correct to the normal state. |

## 8.8.2 White smoke generation

| Cause | Corrective action |
|---|---|
| 1)Clogged or deformed oil return pipe causing oil flow to the blower or turbine side | •Repair or pipe replacement |
| 2)Excessive bearing wear causing abnormal wear or damage of seal ring | •Turbocharger disassembly and repair |

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### 8.8.3 Sudden oil decrease

| Cause | Corrective action |
|---|---|
| 1)Excessive bearing wear causing abnormal wear or damage of seal ring | •Turbocharger disassembly and repair |

### 8.8.4 Decrease in output

| Cause | Corrective action |
|---|---|
| 1) Gas leak from any part in exhaust piping | •Inspection and repair of defective portion |
| 2)Air leak from discharge side of blower | |
| 3)Clogged air cleaner element | •Element cleaning or replacement |
| 4)Fouled or damaged turbocharger | •Turbocharger disassembly and repair or replacement |

### 8.8.5 Poor (slow) response (starting) of turbocharger

| Cause | Corrective action |
|---|---|
| 1)Hard carbon deposit on the turbine side (wheel sealing portion) to make turbine shaft revolution heavy | •Turbocharger disassembly and washing with lubricating oil replacement |
| 2)Incomplete combustion | •Engine combustion state inspection, followed by improvement of combustion to normal state |

### 8.8.6 Abnormal sound or vibration

(1) Abnormal sound generation

| Cause | Corrective action |
|---|---|
| 1)Excessively narrowed gas path due to clogged nozzle in turbine wheel chamber or reverse flow of blower discharge in acceleration (generally called surging) | •Turbocharger disassembly and washing |
| 2)Contact rotating part | •Turbocharger disassembly and repair or replacement |

(2) Vibration

| Cause | Corrective action |
|---|---|
| 1)Loosened intake, exhaust or oil pipe connection with the turbocharger | •Turbocharger installation status check and repair of defective portion |
| 2) Damaged bearing, contact between rotating part and adjacent part, or chipping of turbine wheel or blower vane due to foreign matter in version | •Turbocharger disassembly with repair or replacement, or perfect removal of foreign matters in case of foreign matter invasion |
| 3) Unbalanced rotating part | •Repair or replacement of rotating part |

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# 9. Starting motror

As a representative example of starter, the one for 4TNV94L98 and 4TNV106 (T) is shown in this chapter.

## 9.1 For 4TNV94L/ 98

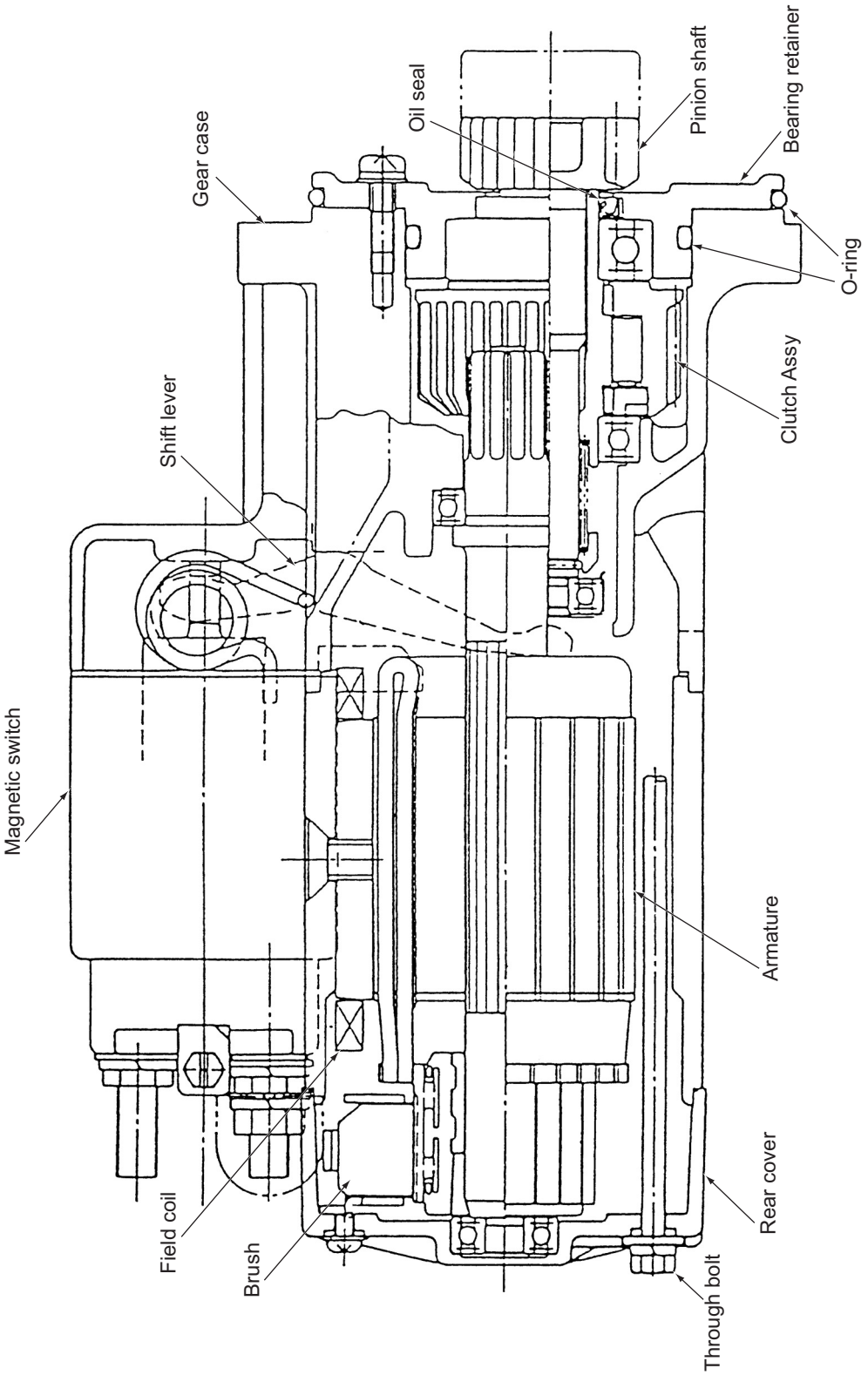
### 9.1.1 Specifications

| | | | | |
|---|---|---|---|---|
| Manufacturer's model (Hitachi) | | - | S13-204 | S13-205 |
| Yanmar code | | - | 129900-77010 | 129900-77020 |
| Nominal output | | kW | 2.3 | ← |
| Weight | | kg | 5.5 | ← |
| Revolution direction (as viewed from pinion) | | - | Clockwise | ← |
| Engagement system | | - | Magnetic shift | ← |
| No-load | Terminal voltage/current | V/A | 11/140 or less | ← |
| | Revolution | rpm | 4100 or above | ← |
| Loaded | Terminal voltage/current | V/A | 2.5/1050 or less | ← |
| | Torque | N•m (kgf•m) | 24.5 (2.5) or above | ← |
| Clutch system | | - | Overrunning | ← |
| Pinion projection voltage (at 100 °C) | | V | 8.6 or less | ← |
| Pinion DP or module/number of teeth | | - | M3/9 | ← |
| difference (O-ring, oil seal) | | - | Dry (none) | Wet (with) |
| Application | | - | Standard | Option |

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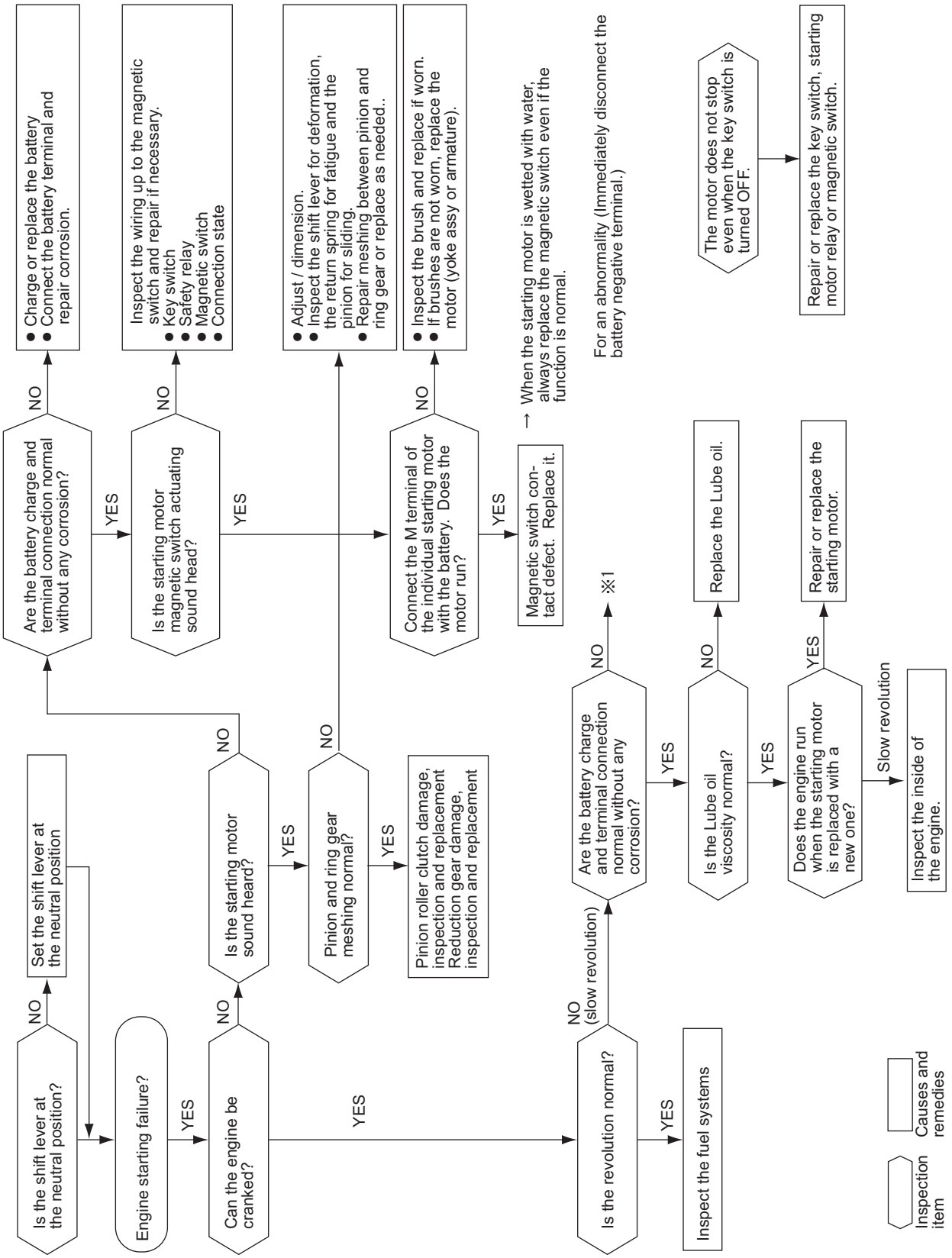
## 9.1.2 Components



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## 9.1.3 Troubleshooting



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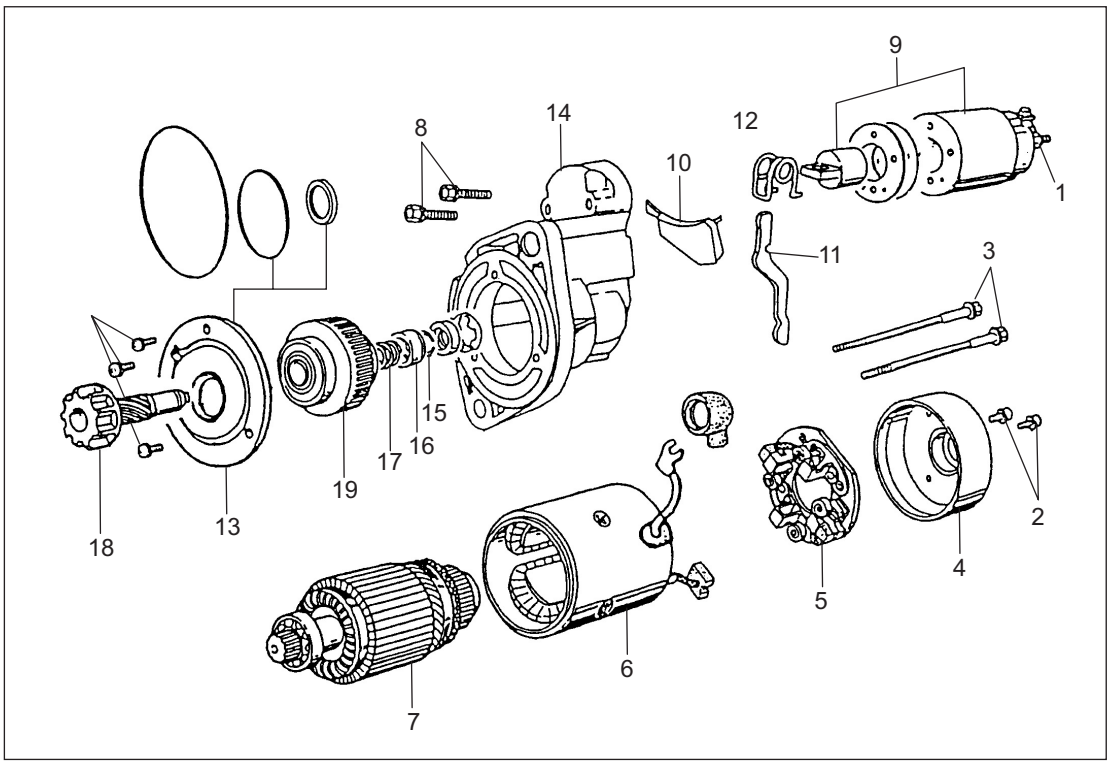


## 9.1.4 Names of parts and disassembly procedure

### (1) Disassembling order

1)Nut M8 (Disconnect the connecting wire.) ····· See the disassembly drawing.
2)Screw M4 (2)
3)Through bolt M5 (2)
4)Rear cover
5)Brush holder
6)Yoke assy.
7)Armature
8)Bolt M6 (2)
9)Magnetic switch
10)Dust cover
11)Shift lever
12)Screw M4 (3)
13)Bearing retainer
14)Gear case
15)Pinion stopper clip
16)Pinion stopper
17)Return spring
18)Pinion shaft
19)Clutch assy.

Disassembly drawing



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## (2) Disassembly procedure

1)Nut M8

Remove the magnetic switch nut M8 (12 mm), and disconnect the connecting wire.

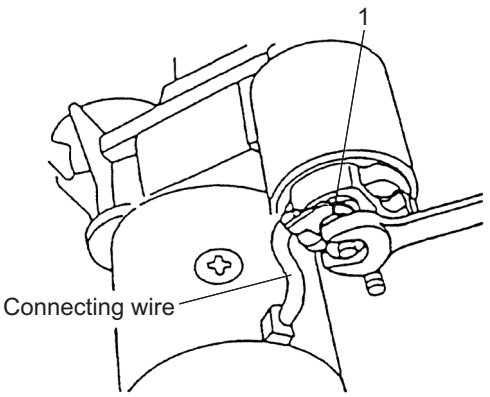



**Fig. 1**

2)Screw M4 (2)

3)Through bolt M5 (2)

4)Rear cover

Remove the M4 screw fastening the brush holder and remove through bolt M5 for rear cover removal.

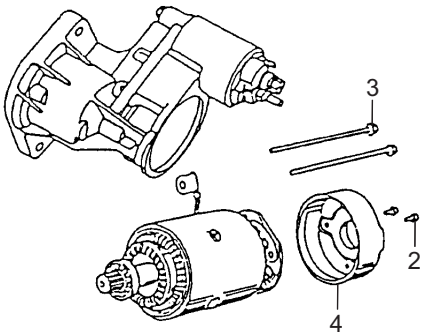



**Fig. 2**

5)Brush holder

Pull the brush spring up with the brush spring puller. On the negative (-) side, bring the brush spring into contact with the side of the brush for lifting from the commutator surface. On the positive (+) side, extract the brush from the brush holder.

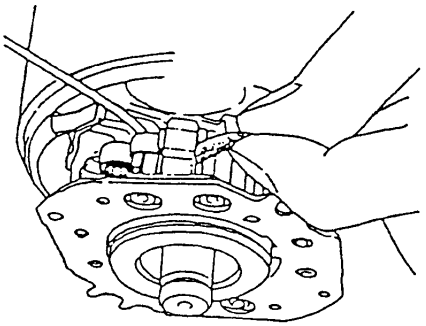


**Fig. 3**

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6)Yoke Assy.

7)Armature

Remove the brush holder. The armature and yoke assy can now be removed.

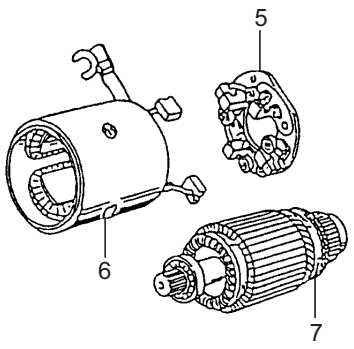



**Fig. 4**

8)Bolt M6 (2)

9)Magnetic switch

Remove bolt M6 (10 mm), and the magnetic switch can be removed.

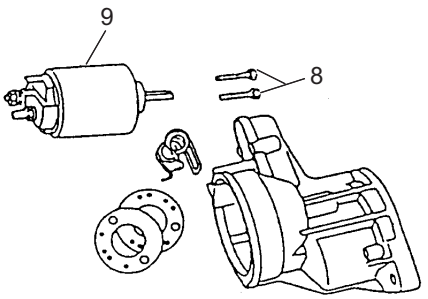



**Fig. 5**

10)Dust cover

11)Shift lever

Take the dust cover out from the gear case. The shift lever can be removed.

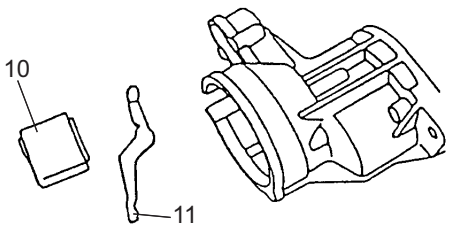



**Fig. 6**

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12)Screw M4 (3)

13)Bearing retainer

14)Gear case

Remove screw M4, and the bearing retainer and clutch assy can be removed.

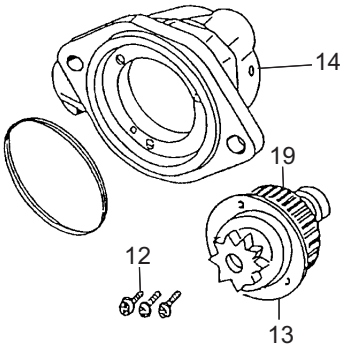



**Fig. 7**

15)Pinion stopper clip

Remove the bearing retainer at the edge and the bearing, and shift the pinion stopper toward the pinion. Use a plain screwdriver and pry to remove the pinion stopper clip.

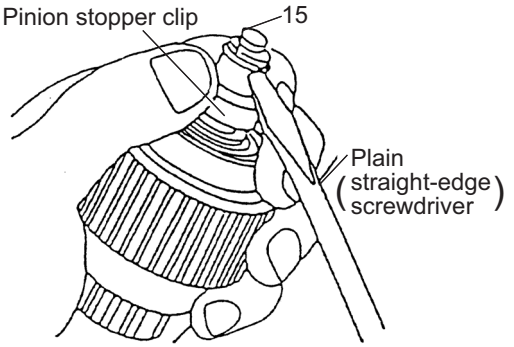



**Fig. 8**

16)Pinion stopper

17)Return spring

18)Pinion shaft

19)Clutch Assy

Remove the pinion stopper clip. The pinion stopper, return spring, pinion shaft and bearing retainer can be removed.

Disassembly is completed now.

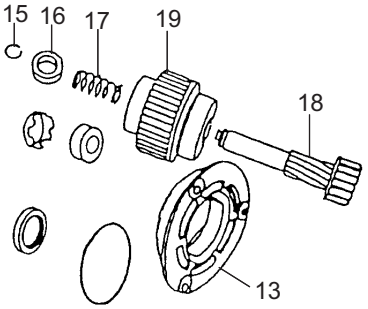



**Fig. 9**

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## 9.1.5 Inspection and maintenance

### (1) Armature

#### (a)Commutator outside diameter

Measure the commutator outside diameter and replace the commutator if the measured value is less than the limit.

mm

| Standard | Limit |
|---|---|
| 36.5 | 35.5 |

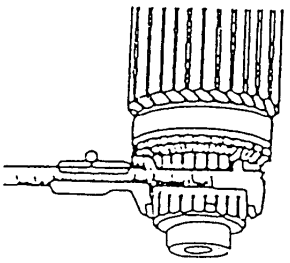


Fig. 10

#### (b)Armature coil continuity test

Check continuity between commutator segments with a multimeter. Good if continuity exists.

In case of no continuity (coil disconnection), replace the armature.

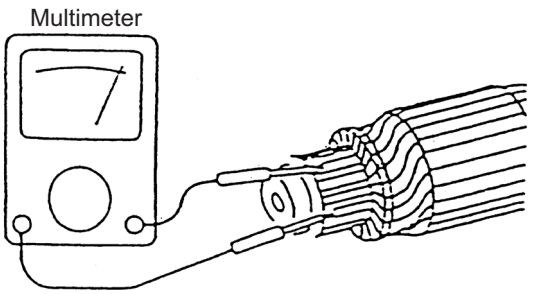



Fig. 11

#### (c)Armature coil insulation test

Inspect the continuity between a commutator segment and the shaft or core with a multimeter. Good if no continuity exists.

If continuity exists (coil short circuit), replace the armature.

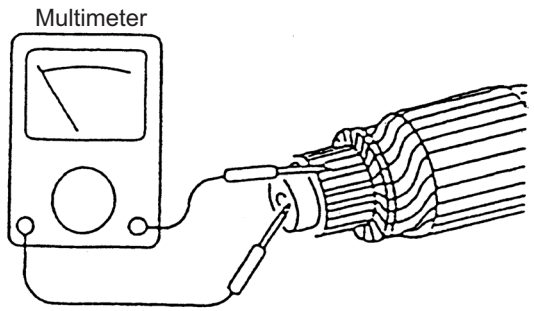



Fig. 12

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(d)Armature and commutator run-out

Use a dial gage and measure the armature core run-out and commutator run-out. Correct or replace if the limit is exceeded.

mm

| | Standard | Limit |
|---|---|---|
| Armature | 0.03 | 0.2 |
| Commutator | 0.03 | 0.2 |

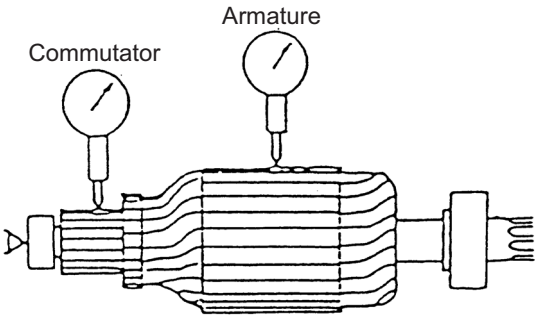



Fig. 13

(e)Commutator surface inspection

If the commutator surface is roughened, grind with #500 to #600 emery cloth.

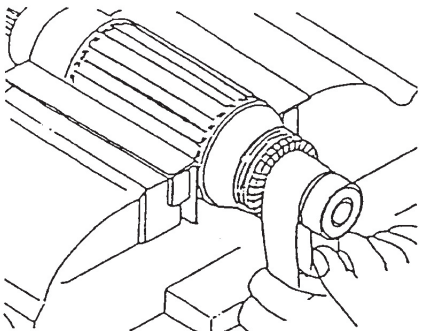


Fig. 14

(f)Commutator insulation depth

Measure the depth of the insulating material between commutator segments, and correct it if it is less than the limit.

mm

| Standard | Limit |
|---|---|
| 0.5 to 0.8 | 0.2 |

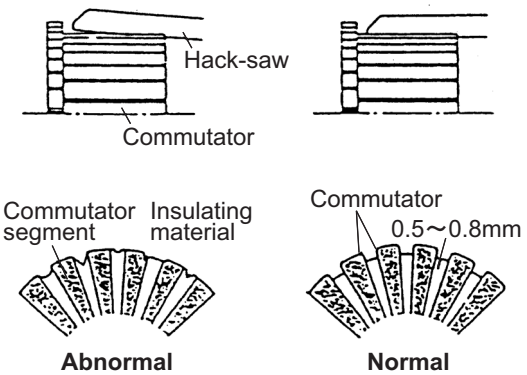



Fig. 15

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## (2) Field coil

### (a)Field coil continuity test

Check continuity between field coil terminals. Good if continuity exists.

If no continuity (coil disconnection), replace the field coil.

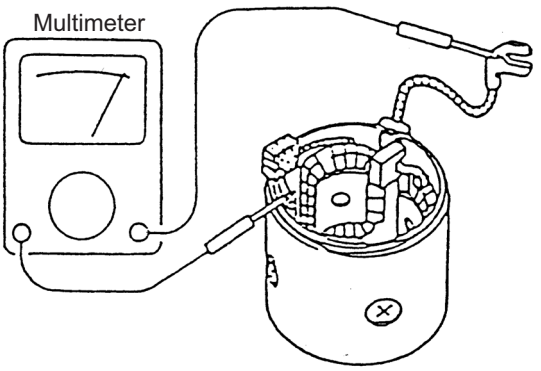



**Fig. 16**

### (b)Field coil insulation test

Check continuity between field coil terminal and yoke. Good if no continuity exists.

If continuity exists (coil short circuit), replace the armature.

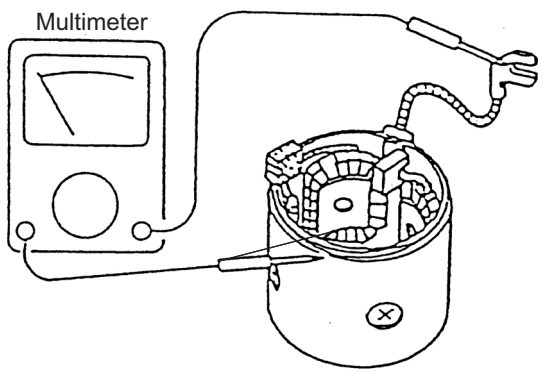



**Fig. 17**

## (3) Brush

Measure the length of the brush. Replace with a good one if the length is less than the limit.

mm

| Standard | Limit |
|---|---|
| 15 | 9 |

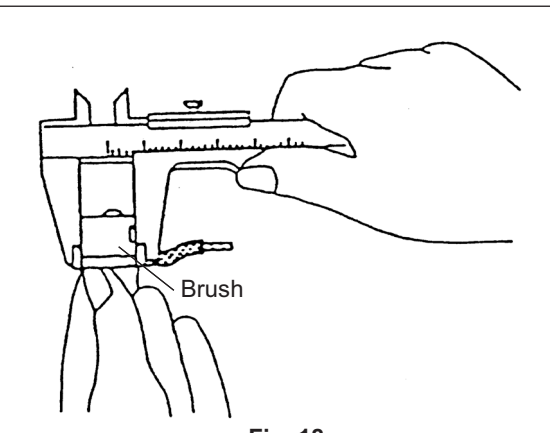



**Fig. 18**

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## (4) Brush holder

### (a)Brush holder insulation test

Check the continuity between the brush holder (+ side) and base (- side) with a multimeter. Good if no continuity exists.

If continuity exists (insulation defect), replace the brush holder.

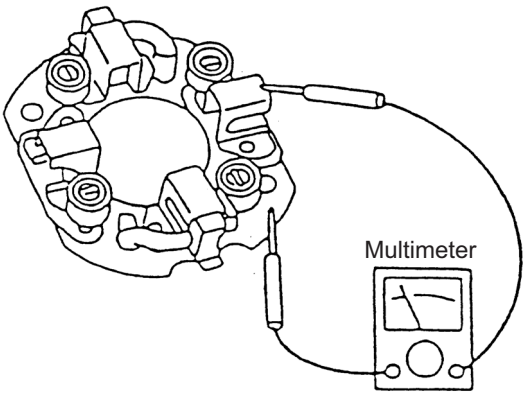



**Fig. 19**

### (b)Brush spring inspection

Inspect the brush spring pressure.

N (kgf)

| Standard spring force |
|---|
| 31 to 39 (3.1 to 3.9) |

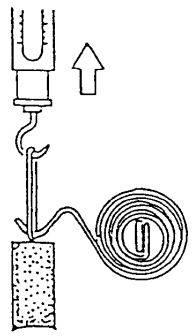


**Fig. 20**

## (5) Magnetic switch

When the starting motor is wetted with water, always replace the magnetic switch with a new even if the function is normal.

### (a)Shunt coil continuity test

Check the continuity between the S terminal and the switch body. Good if continuity exists.

If no continuity (coil disconnection), replace the magnetic switch.

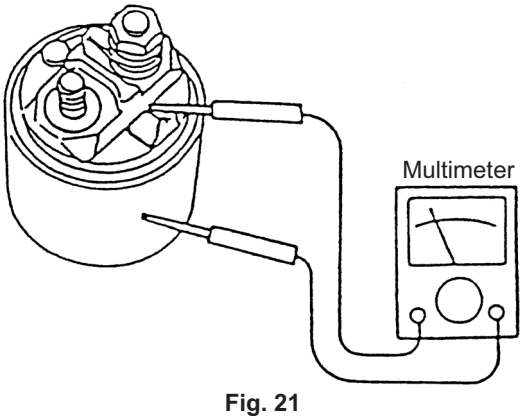



**Fig. 21**

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(b)Series coil continuity test

Check continuity between the S and M terminals. Good if continuity exists.

If no continuity (coil disconnection), replace the magnetic switch.

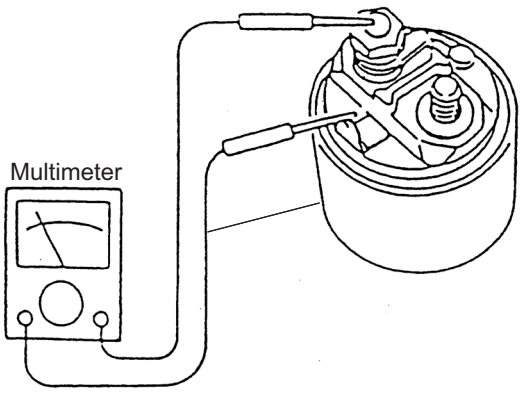



Fig. 22

(c)Contact continuity test

Depress the magnetic switch with the plunger at the bottom. Check continuity between the B and M terminals with a multimeter. Good if continuity exists.

If no continuity (coil continuity defect), replace the magnetic switch.

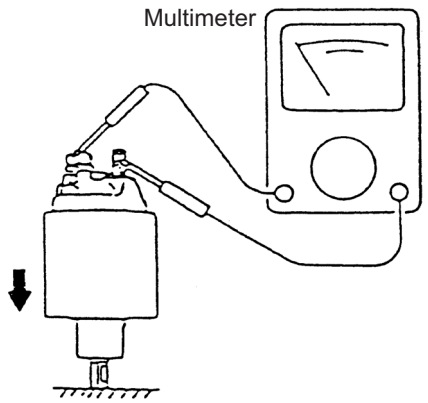



Fig. 23

## (6) Pinion clutch

(a)Pinion inspection

Manually rotate the pinion. Inspect if it is rotated smoothly in the driving direction, and is locked in the opposite direction. Replace the pinion clutch if abnormal.

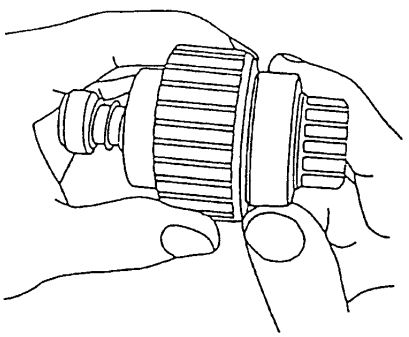


Fig. 24

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(b)Pinion sliding inspection

Check if the pinion slide smoothly in the axial direction.

If damaged, rusted or heavy in sliding, repair it.

If grease is applied too much on the pinion shaft, sliding becomes heavy.

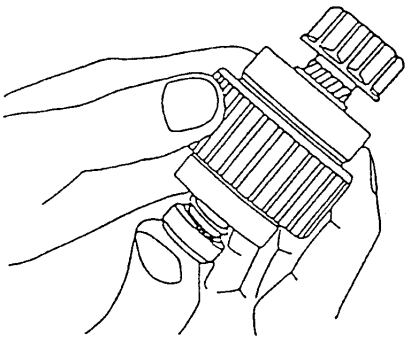


Fig. 25

(c)Ball bearing inspection

Rotate the ball bearing while holding the outer race with fingertips. Inspect if it is sticking or it there is play.

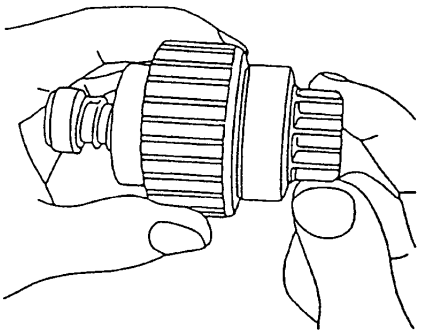


Fig. 26

## 9.1.6 Service standards

| | | | | |
|---|---|---|---|---|
| Brush | Spring force | | N (kgf) | 35 (3.6) |
| | Standard height/wear limit | | mm | 15/9 |
| Magnetic switch resistance, series coil/shunt coil (at 20°C) | | | Ω | 0.27/0.60 |
| Commutator | Standard diameter/limit diameter | | mm | 36.5/35.5 |
| | Difference between maximum and minimum diameter | Repair limit/repair accuracy | mm | 0.2/0.03 |
| | Mica undercut depth chips | Repair limit/repair accuracy | mm | 0.2/0.5 to 0.8 |
| Bearing type | Armature fount | Nominal number | - | 6903DDU |
| | Armature rear | | - | 608DDU |
| | Pinion front | | - | 60004DDU |
| | Pinion rear | | - | 6904DDU |
| L dimension (pinion projection length) | | | mm | 0.3-1.5 |

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## 9.1.7 Assembly

The assembly procedure is the reverse of the disassembly procedure, but pay attention to the following points:

### (1) Grease application points

- Gears in the gear case
- Shift lever operating portion
- Pinion sliding portion
- Magnetic switch plunger sliding portion

Use the specified grease as below table at all points.

| | |
|---|---|
| Pinion and magnetic switch plunger sliding portions | NPCFG-6A |
| Gears | MALTEMP SRL |
| Shift lever operating portion | ALBANIA No.1 |

### (2) Magnetic switch assembly

1)Install the shift lever on the magnetic switch with the torsion spring in-between.

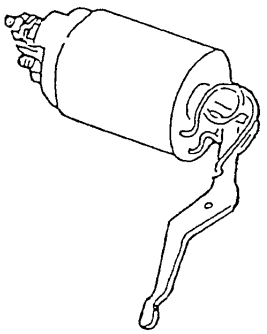


Fig. 27

2)For installation on the gear case, install the magnetic switch with the shift lever on the gear case after pulling the pinion out. Fix the magnetic switch by tightening a built-in bolt M6. Do not forget to install the dust cover (adjusting shim).

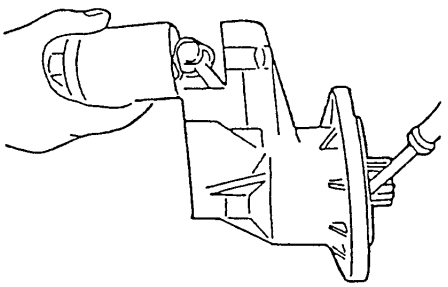


Fig. 28

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## (3) Pinion projection length

Connect the positive (+) lead from the battery to terminal S and negative (-) lead to terminal M. Turn the switch ON and measure the pinion moving distance L in the thrust direction.

Perform this test within 10 seconds.

mm

| | Standard |
|---|---|
| L | 0.31.5 |

**Note: Before measuring the dimension, pull the pinion out lightly in the direction of the arrow.**

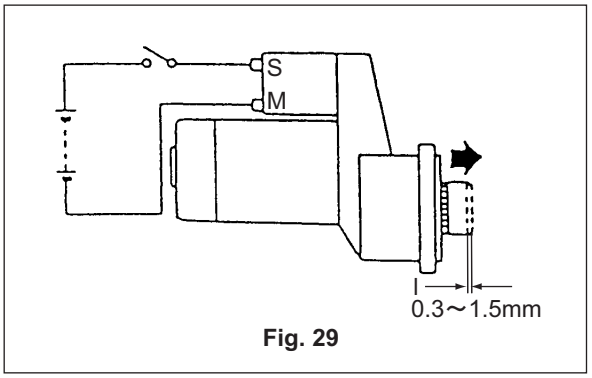



**Fig. 29**

If the measured L dimension is outside the standard range, either insert or remove the dust cover (adjusting shim 0.5 mm, 0.8 mm) for adjustment.

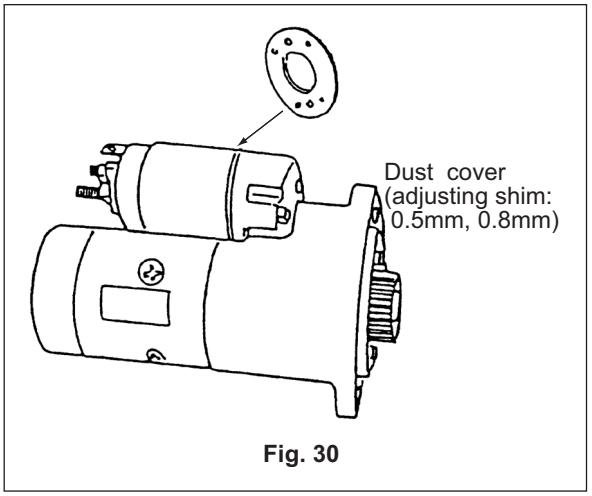



**Fig. 30**

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## 9.1.8 Characteristic test

Since the characteristics can be checked roughly by means of a simple no-load test as explained below.
NOTE: Complete the test quickly since the rating of the starting motor is 30 seconds.

### (1) No-load test

Fix the starting motor on a test bench and connect wiring as shown in Fig.31. When the switch is closed, a current flows in the starting motor, which is rotated at no-load. Measure the current, voltage and number of revolutions then and check if they satisfy the specified characteristics.

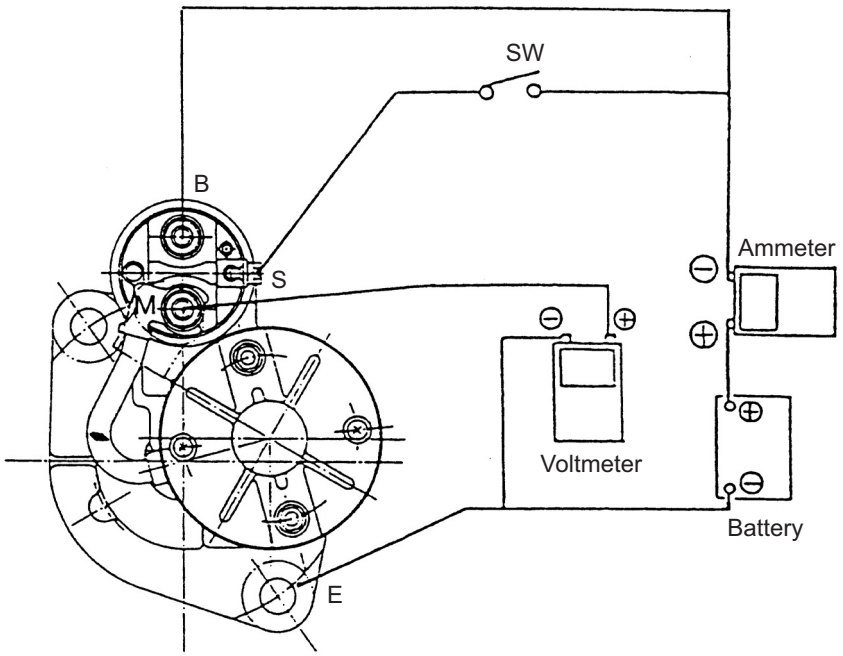



**Fig. 31**

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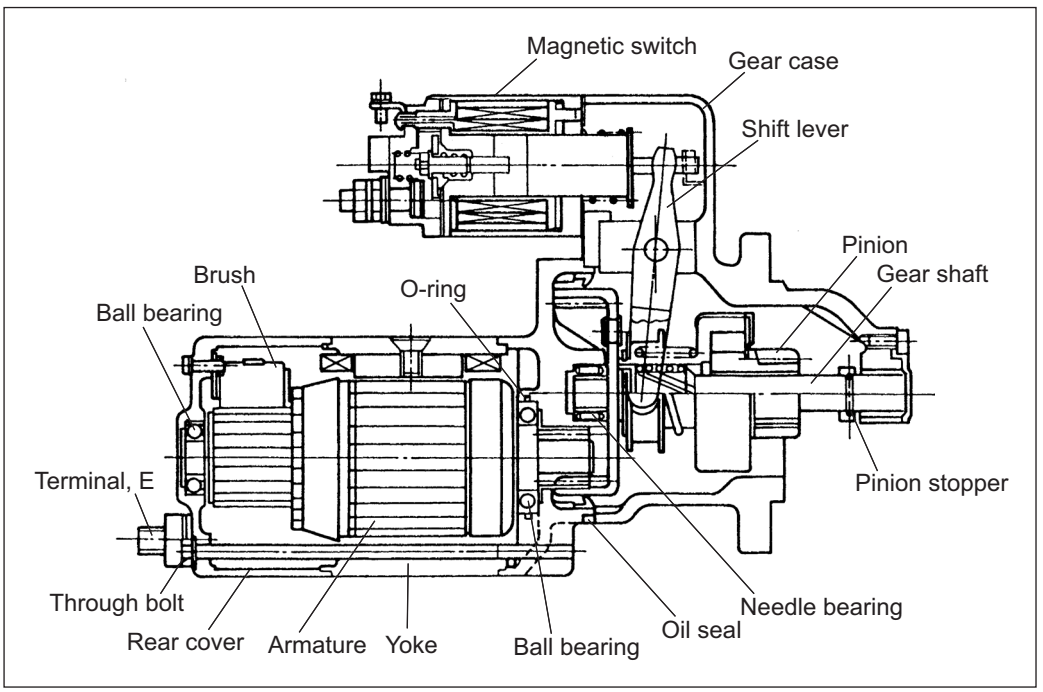


# 9.2 For 4TNV106 (T)

## 9.2.1 Specifications

| | | | |
|---|---|---|---|
| Manufacturer's model (Hitachi) | | - | S13-138 |
| Yanmar code | | - | 129953-77010 |
| Nominal voltage | | V | 12 |
| Nominal output | | kW | 3.0 |
| Rating | | Sec | 30 |
| Revolution direction (as viewed from pinion) | | - | Clockwise |
| Clutch system | | - | Roller clutch |
| Engagement system | | - | Magnetic shift |
| Pinion: Module/number of teeth | | - | M3/9 |
| Weight | | kg | 7.3 |
| Pinion projection voltage (at 100) | | V | 8 or less |
| No-load | Terminal voltage/current | V/A | 12/180 or less |
| | Revolution | rpm | 3000 or more |
| Loaded | Terminal voltage/current | V/A | 9/500 |
| | Torque | N•m (kgf•m) | 16.7 (1.7) or more |
| | Revolution | min-1 | 1270 or more |

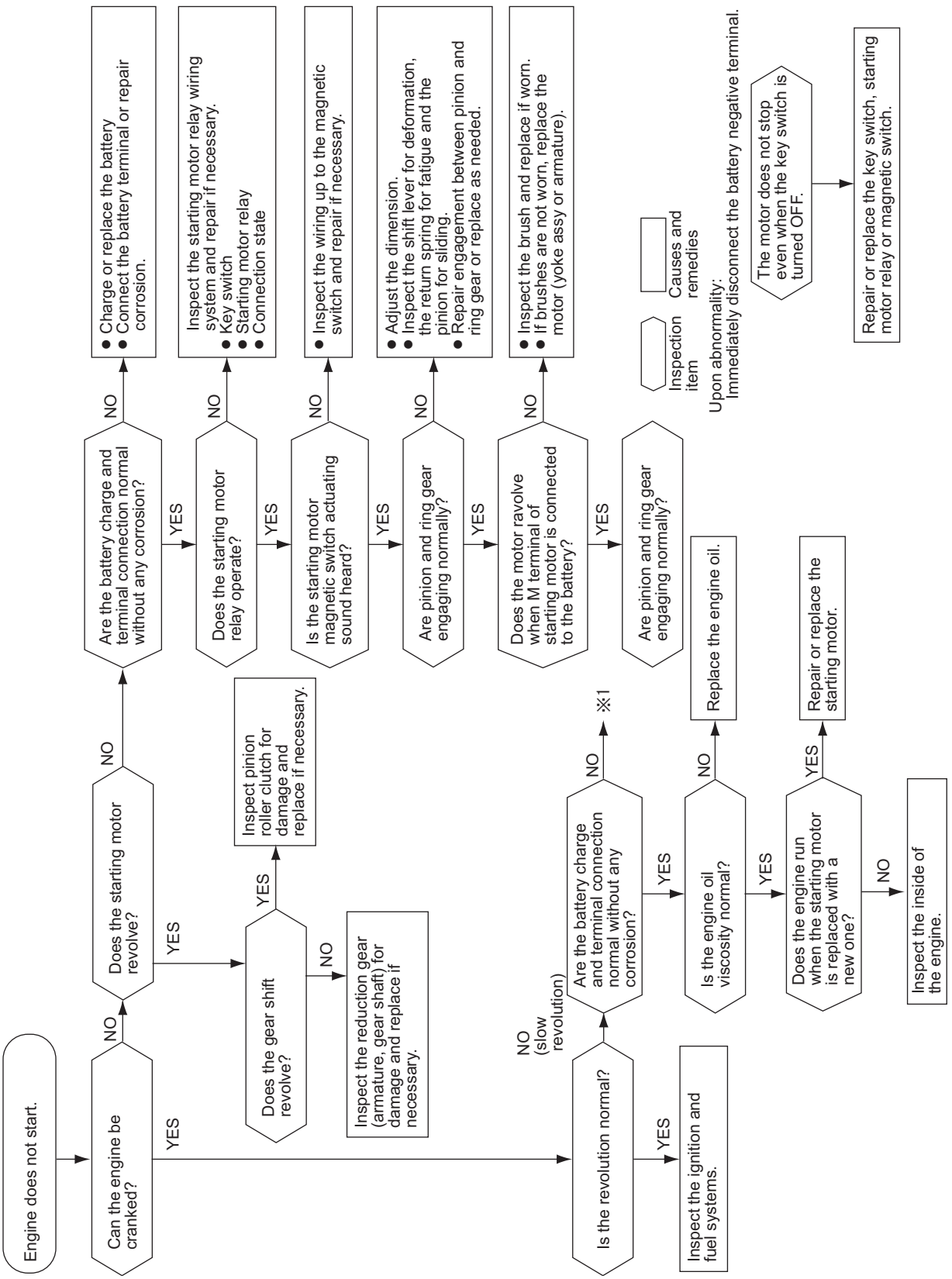
## 9.2.2 Congiguration drawing



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## 9.2.3 Troubleshooting



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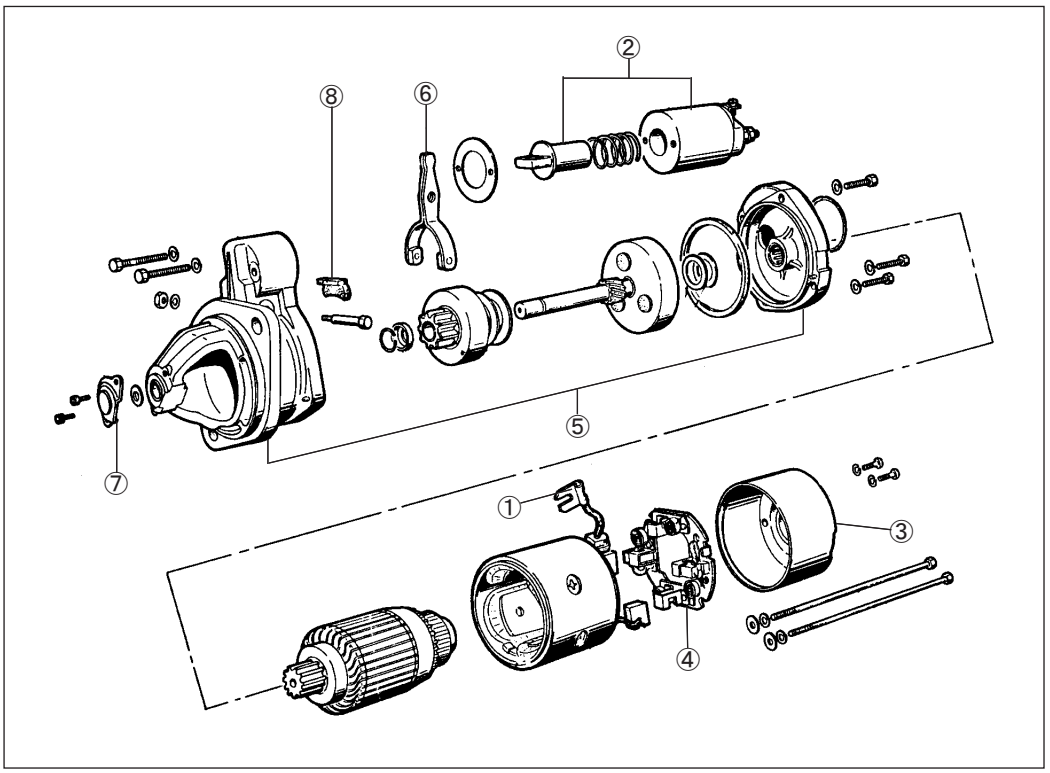


## 9.2.4 Component names and disassembly procedure

(1) Disassembly procedure

1)Disconnect the lead.
2)Remove the magnetic switch.
3)Remove the rear cover.
4)Remove the brush holder.
5)Disassemble the gear case and center bracket.
6)Remove the shift lever pin.
7)Remove the gear case dust cover.
8)Remove the pinion.

(2) Disassembly diagram



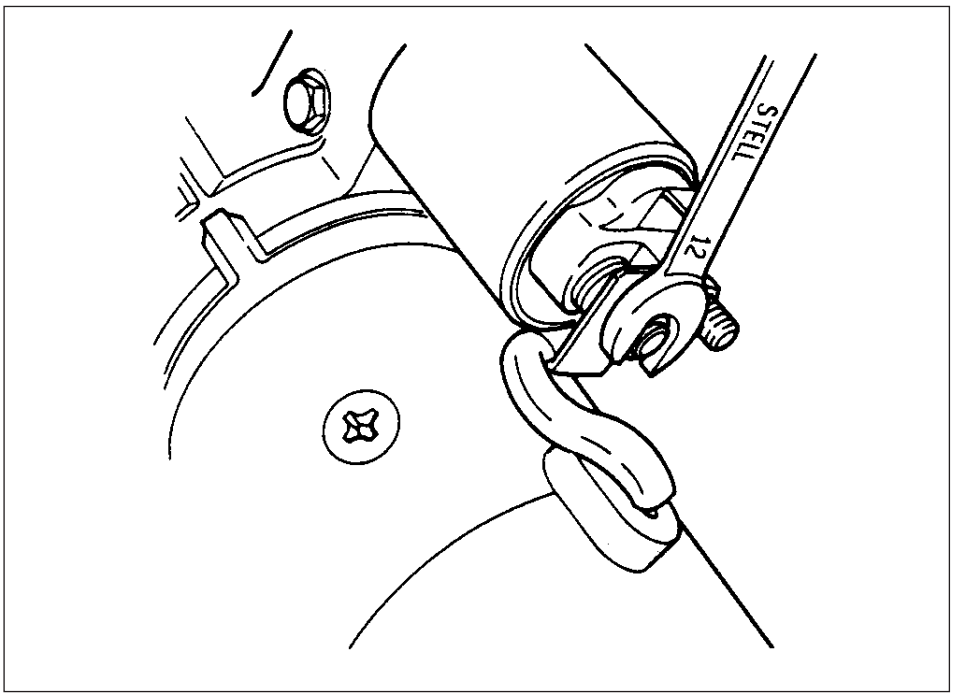
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### 9.2.5 Disassembly procedure

(1) Disconnecting the lead

Loosen the M8 nut (12 mm) of the magnetic switch and disconnect the lead.

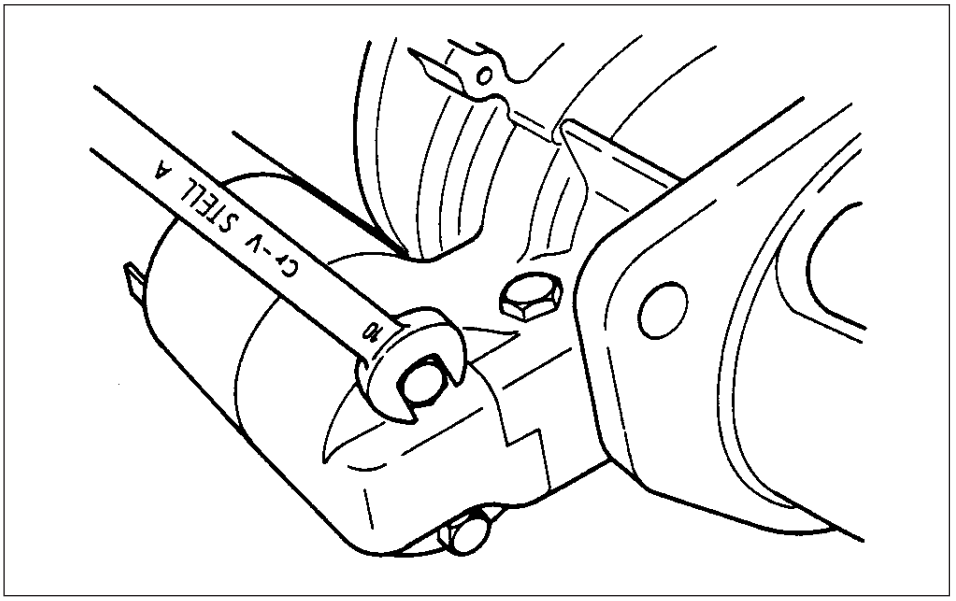


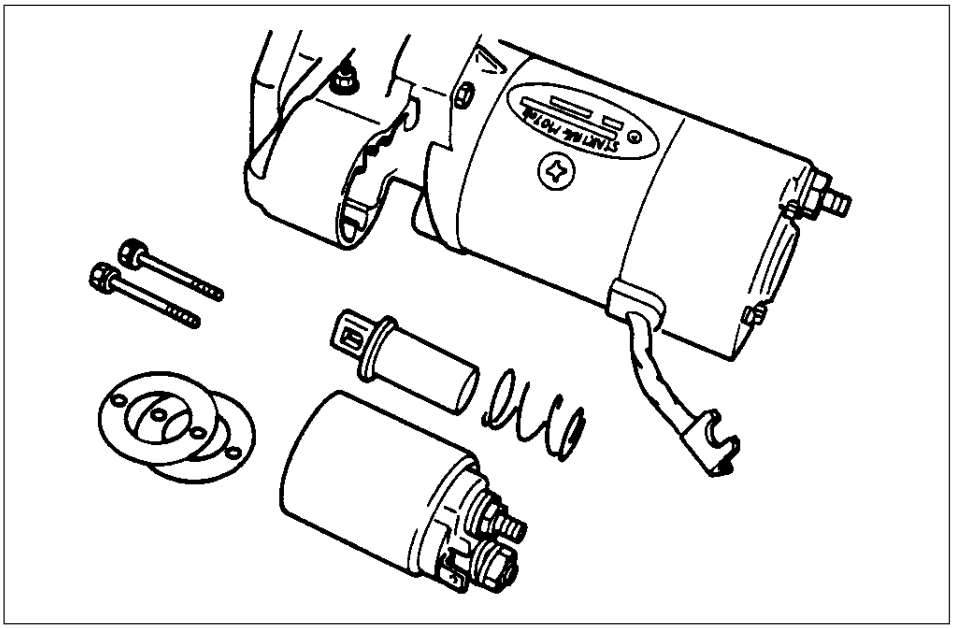
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## (2) Removal of magnetic switch

Remove the M6 bolts (10 mm × 2).



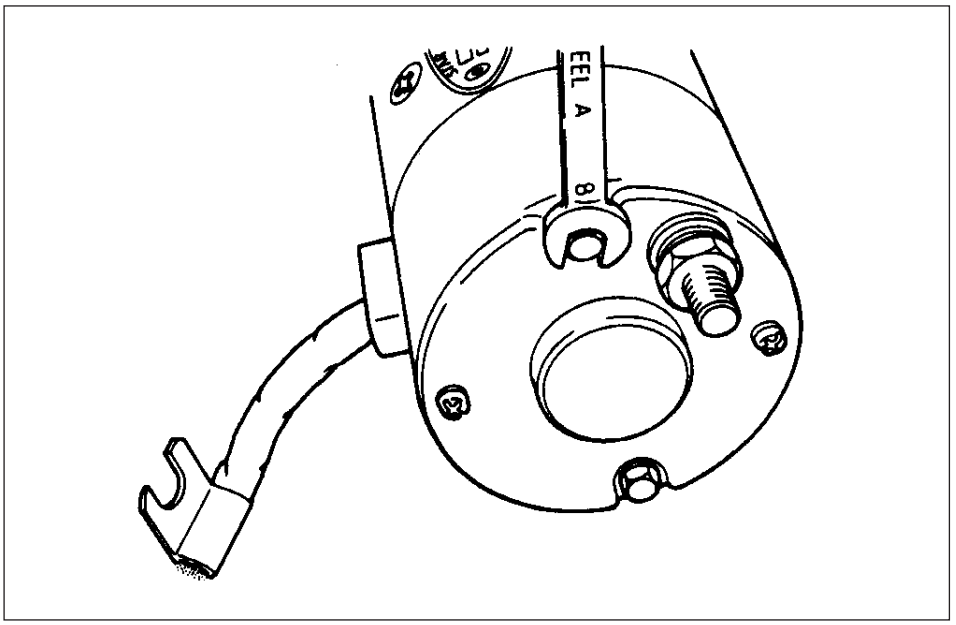


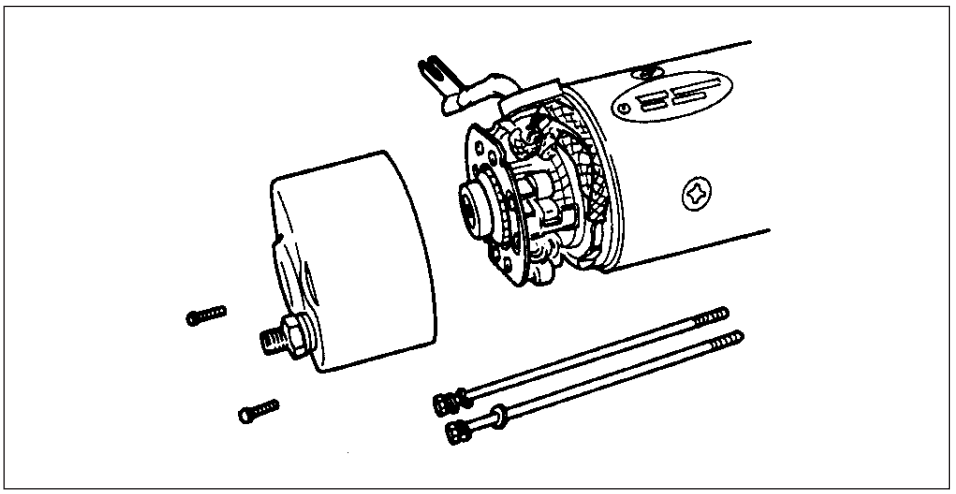
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## (3) Removal of rear cover

Remove the brush holder tightening screws (4 mmø × 2) and the M5 through bolts (× 2).
Next, disconnect the rear cover from the yoke using a – screwdriver.





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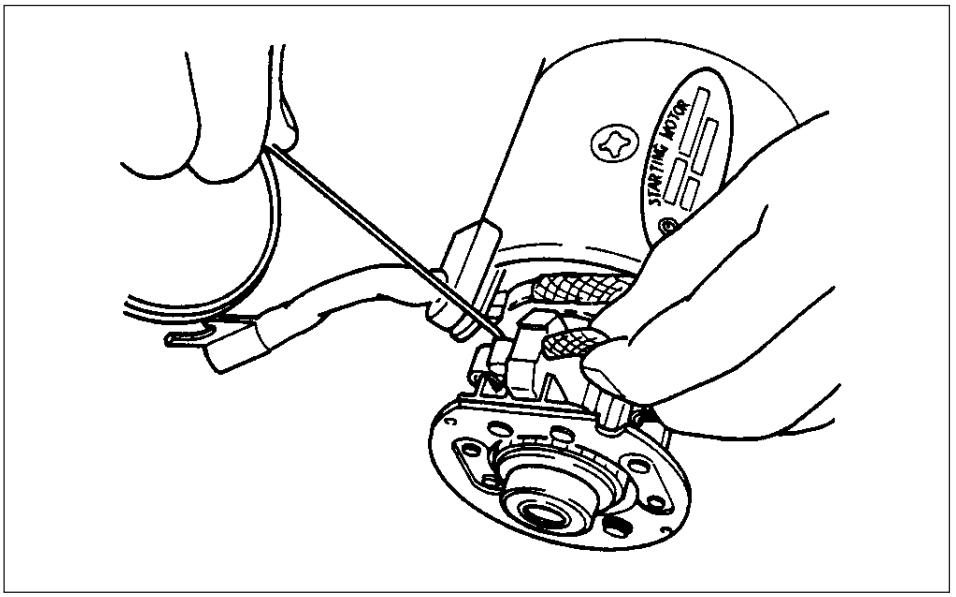


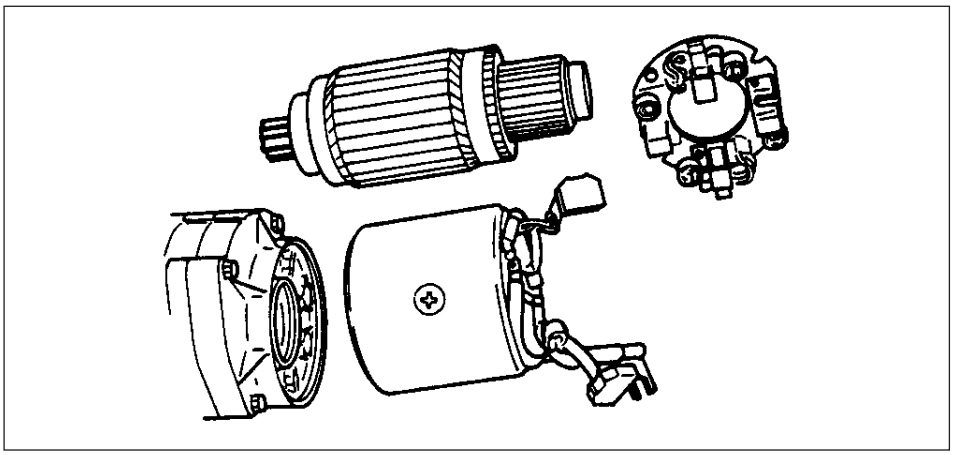
## (4) Removal of brush holder

For the negative (–) brush, bring the brush spring into contact with the side of the brush for lifting from the commutator surface.

For the positive (+) brush, extract the pull out the brush from the brush holder.

After the brush holder is removed, the armature and yoke can be disassembled.



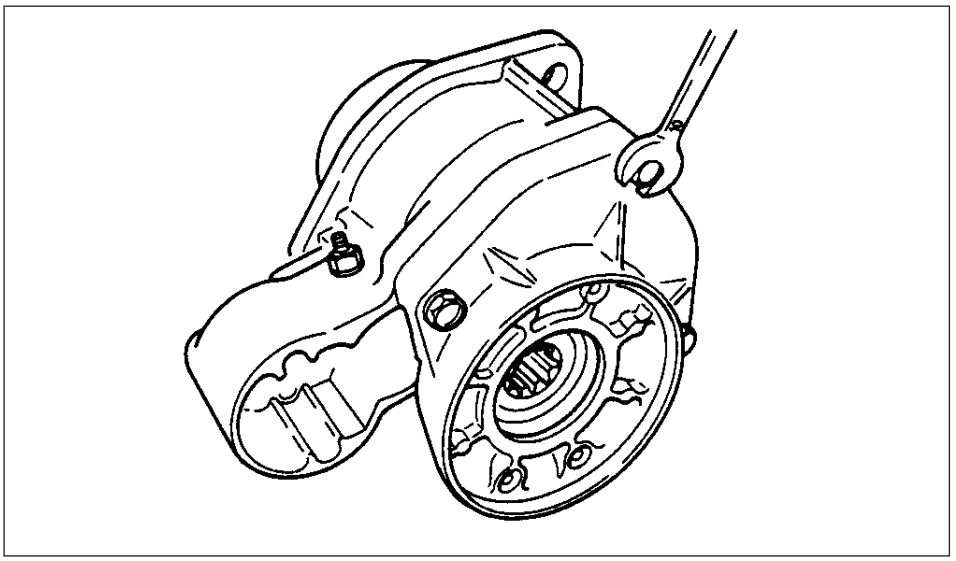



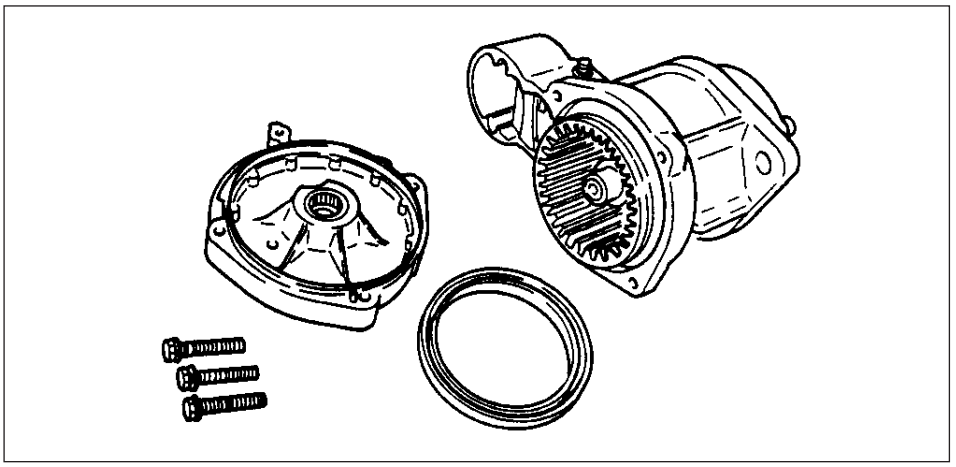
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## (5) Separating gear case from center bracket

Remove three M6 bolts (10 mm) fastening the gear case to the center bracket.
After removal of the M6 bolts, the center bracket and oil seal can be removed.





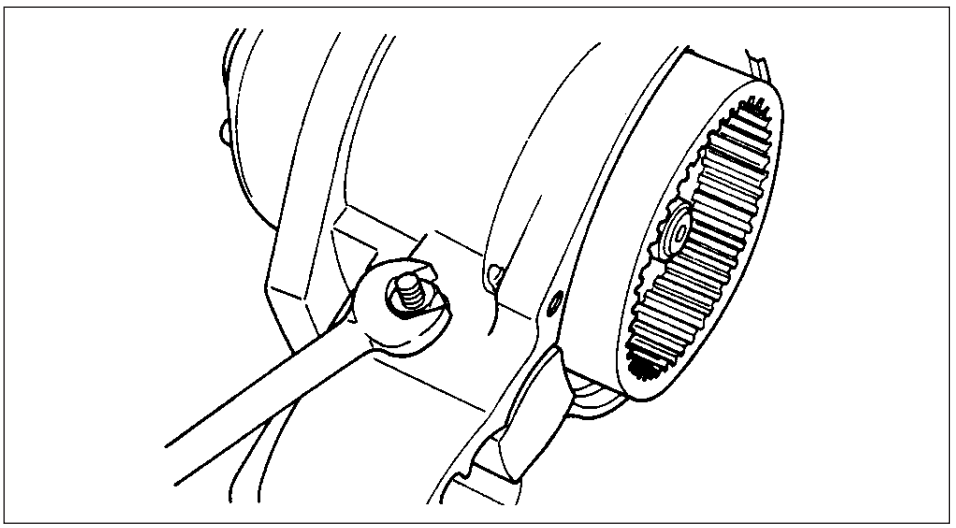
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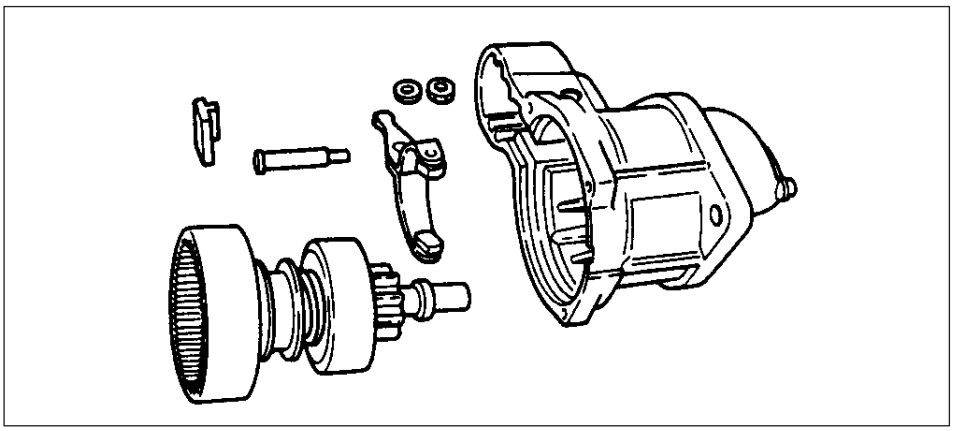


## (6) Removal of shift lever pin

Remove the M6 nut (10 mm) and pull out the shift lever pin.

Now. the dustcover, shift lever, gear case and gear shaft can be removed.



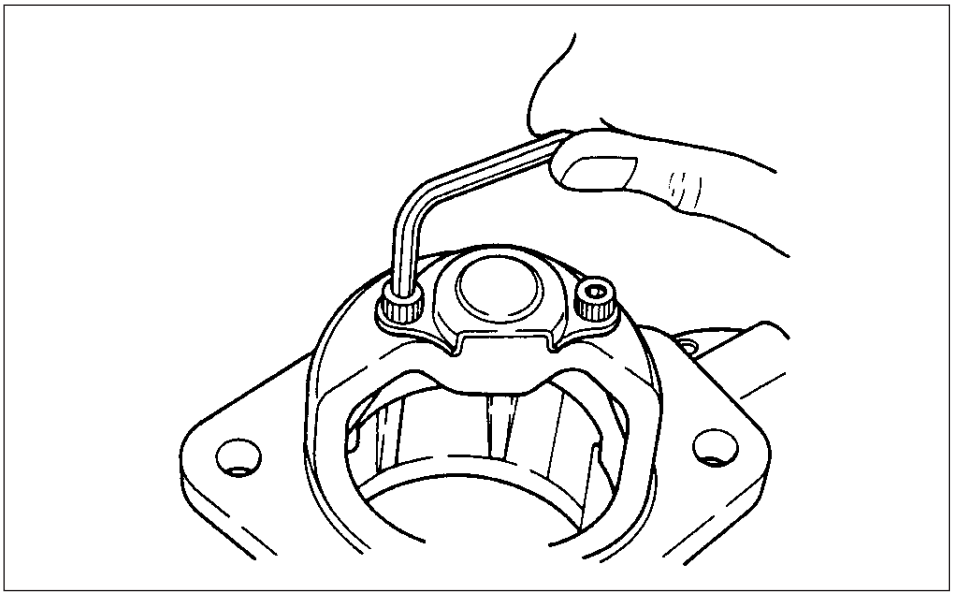


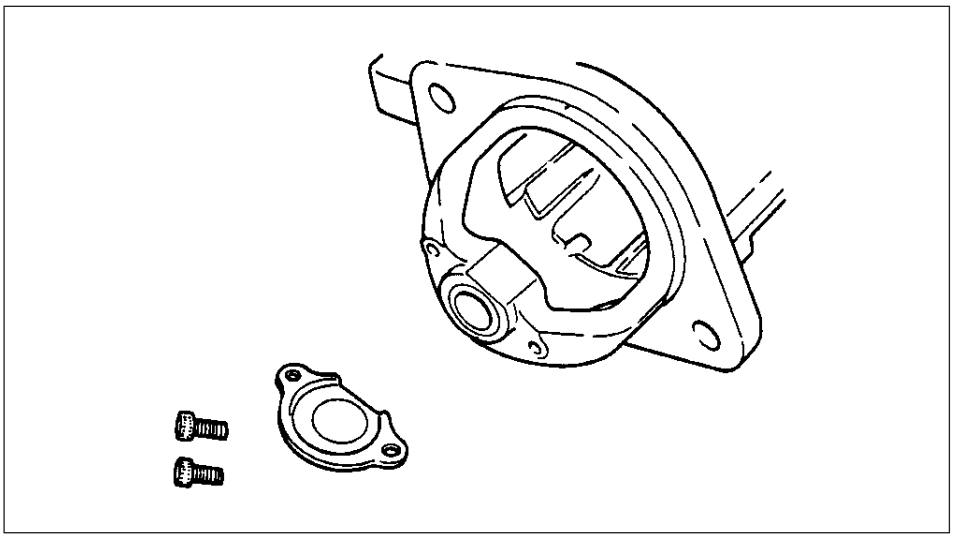
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## (7) Removal of gear case dust cover

Remove the two M5 bolts (using 4 mm hexagon wrench) to disassemble the dust cover from the gear case.



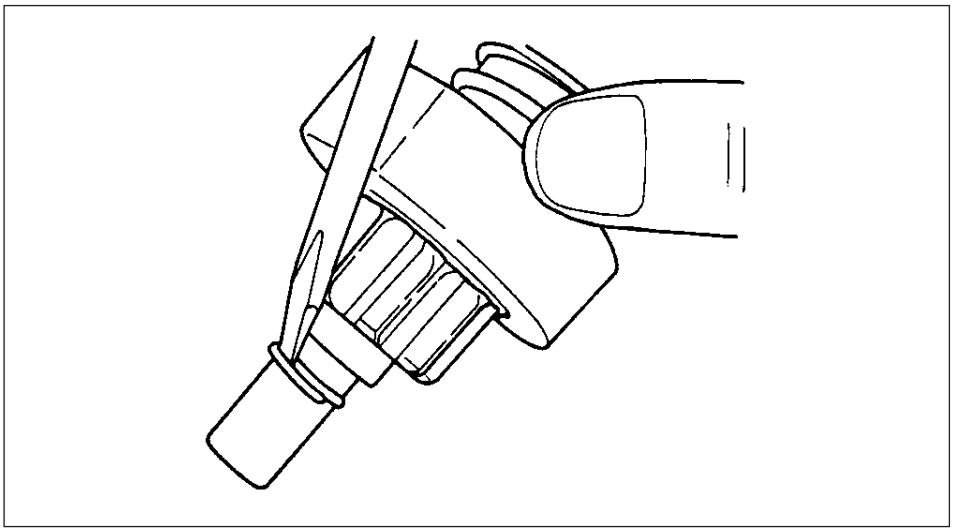


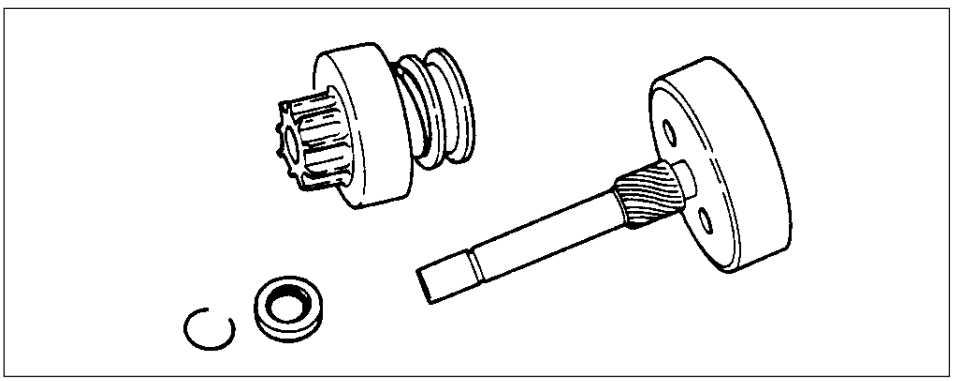
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## (8) Removal of pinion

Slide the pinion stopper towards the pinion and remove the pinion stopper clip using a – screwdriver.





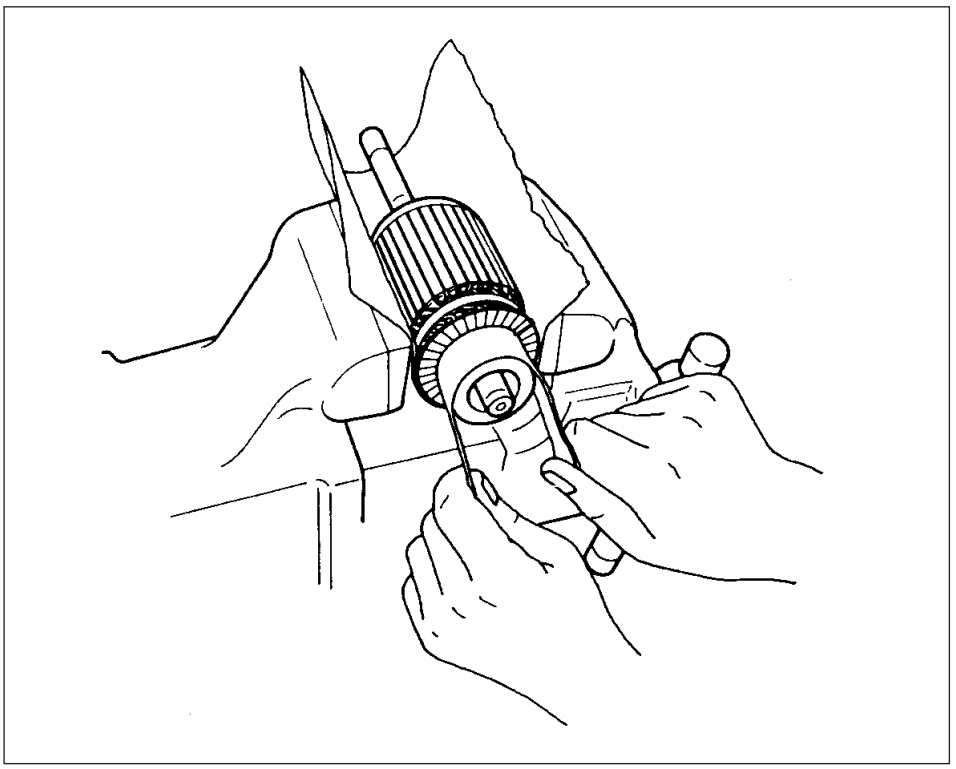
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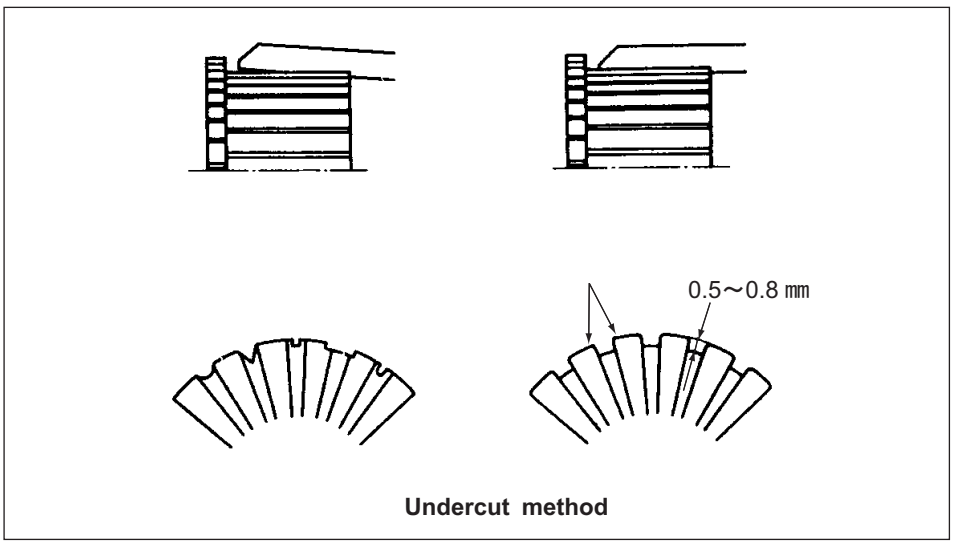
## 9.2.6 Inspection and maintenance

### (1) Armature

1)Check the commutator for rough surface. If so, smooth the surface using #500 to #600 emery cloth. If the outside periphery of the commutator has been deflected over 0.2 mm, repair by a lathe.



2)Measure the depth of the insulating material between commutator segments, and correct if it is less than 0.2 mm.




**Undercut method**

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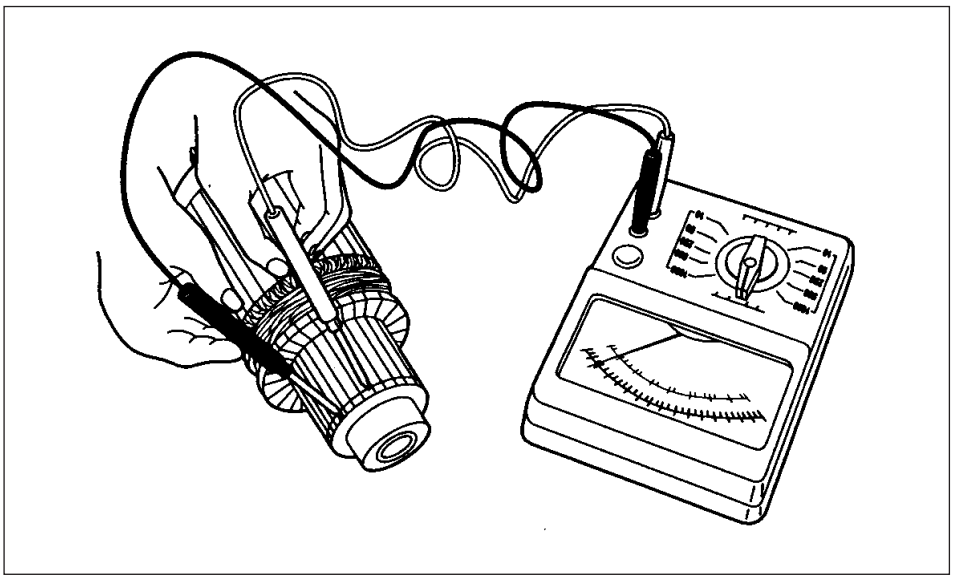


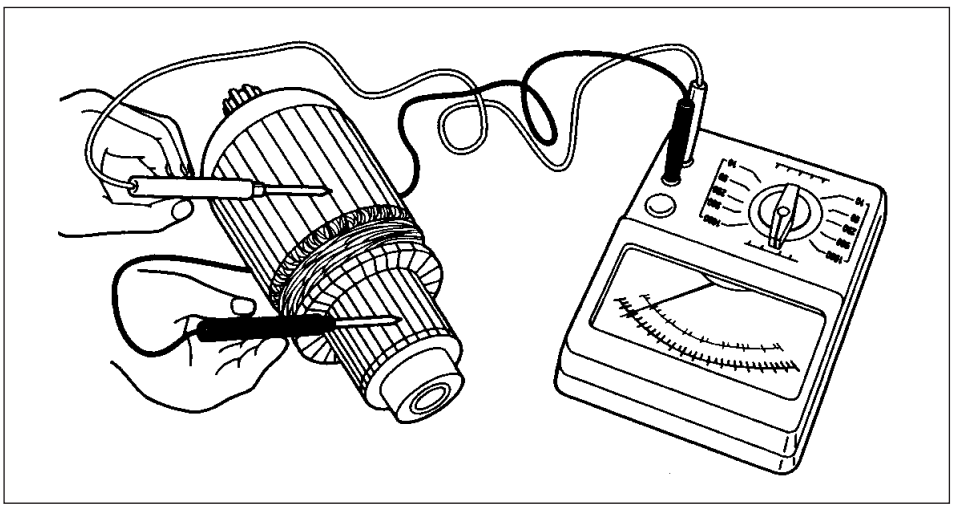
3)Armature coil continuity and earth tests

| Test type | Measurement point | Normal | Abnormal (cause) |
|---|---|---|---|
| Continuity test | Across commutator | Yes | None (open circuit) |
| Earth test | Between commutator and shaft or armature | None | Yes (short-circuiting) |

Replace if needed

.





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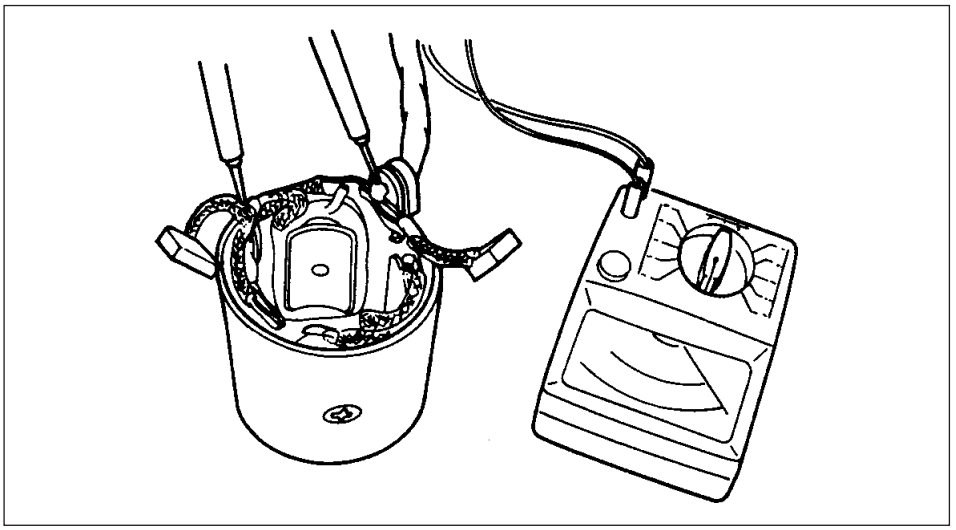
## (2) Field coil

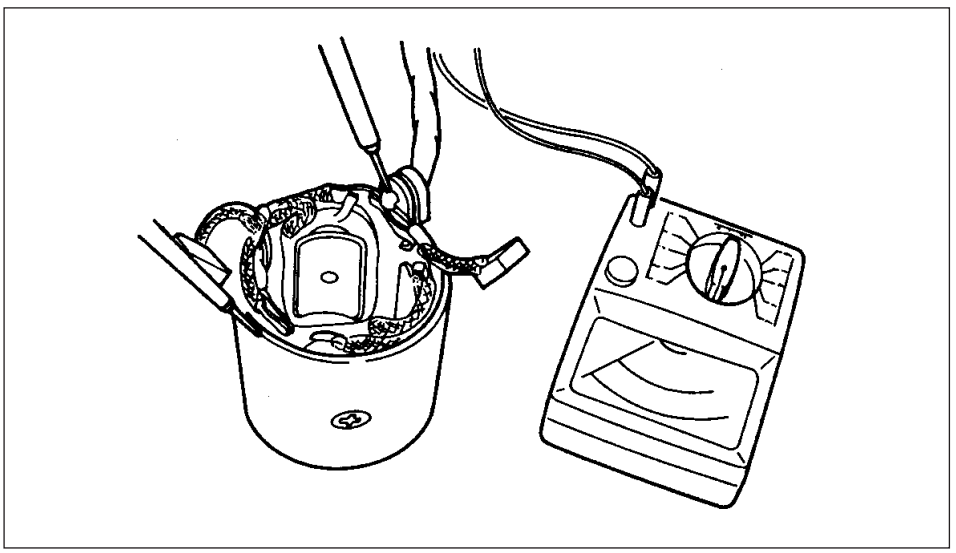
1)Field coil continuity and earth tests

| Test type | Measurement point | Normal | Abnormal (cause) |
|---|---|---|---|
| Continuity test | Across commutator | Yes | None (open circuit) |
| Earth test | Between commutator and shaft or armature | None | Yes (short-circuiting) |

Replace if needed

.



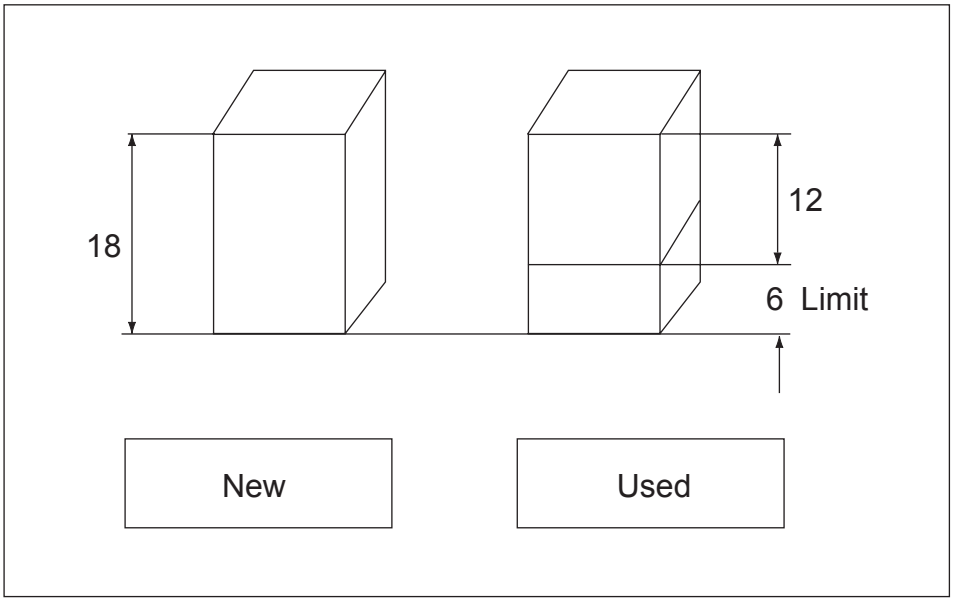


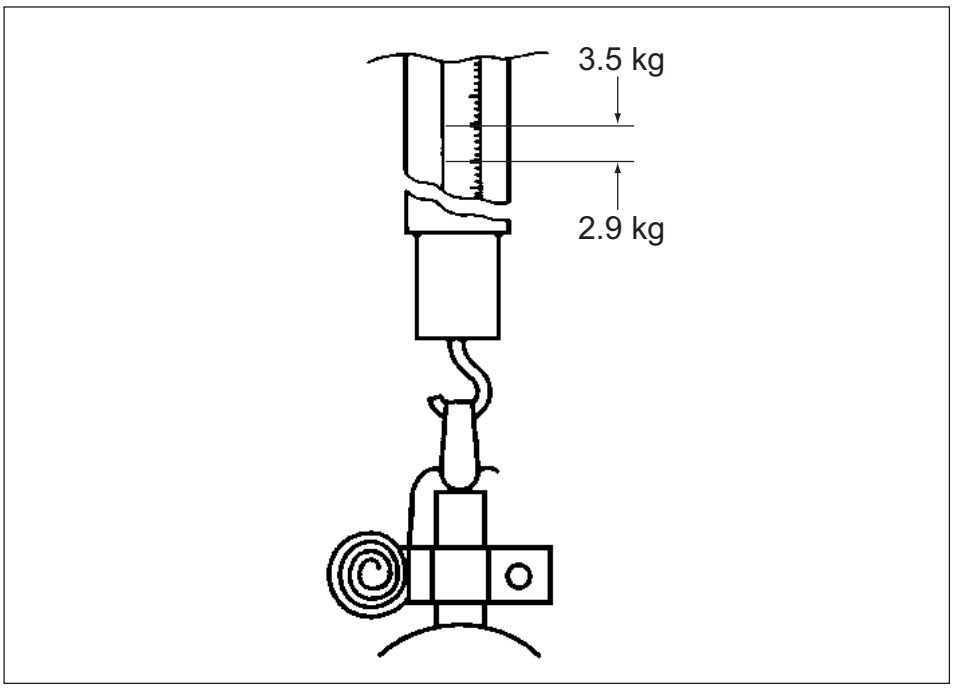
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## (3) Brush

1)Check wear of the brush and the brush spring force.



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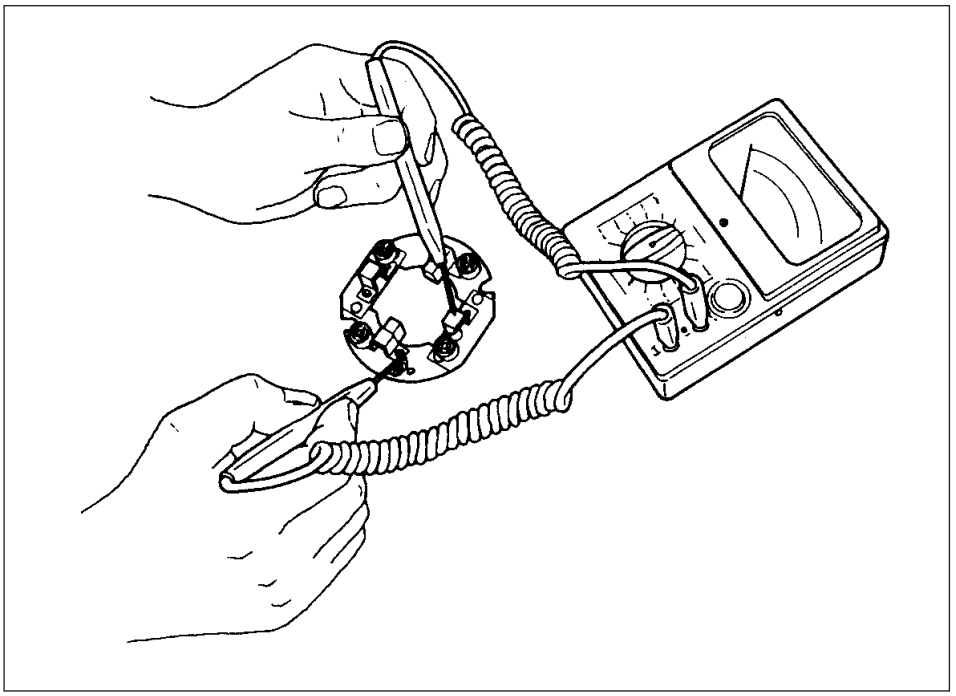


2)Check of brush movement

If the brush does not move smoothly, inspect the brush holder for bending and the brush holder sliding surface for dirt. Repair or clean as needed.

3)Check the continuity between the insulated brush holder (positive (+)) and the brush holder base (negative (-)).

If they are electrically continuous, replace since the holder is grounded.



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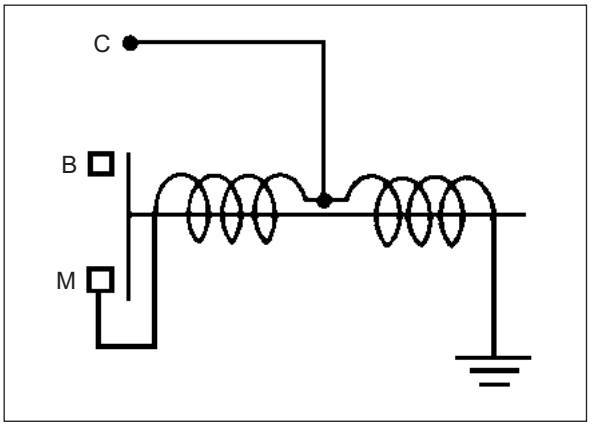


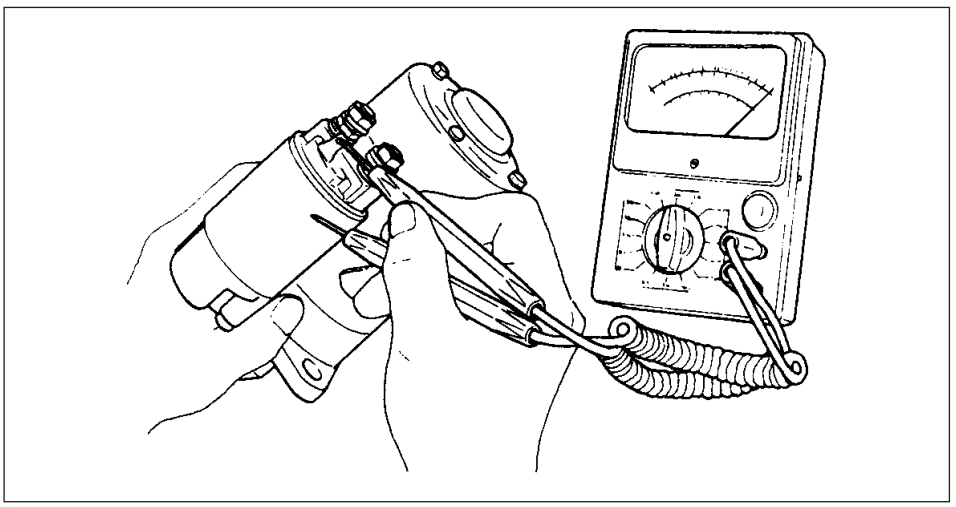
## (4) Magnetic switch continuity test

| Test type | Measurement point | Normal | Abnormal (cause) |
|---|---|---|---|
| Shunt coil | Between C and ground | Yes | None (open circuit) |
| Series coil | C and M | None | Yes (short-circuiting) |

Replace if needed.

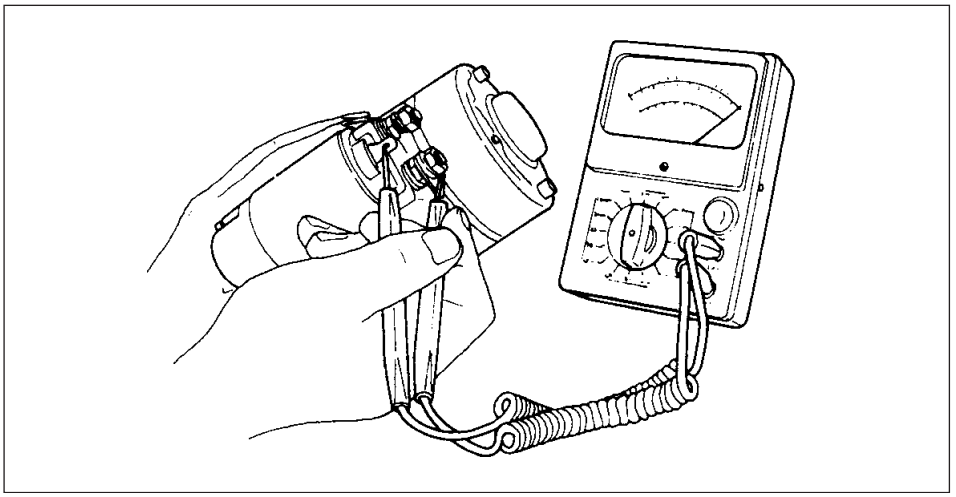
| | S13-138 |
|---|---|
| | Resistance (at 20°C) |
| Shunt coil | 0.6 |
| Series coil | 0.218 |



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(5) Pinion

1)Check the pinion teeth for wear and damage. Replace with a new one, if necessary.

2)Check if the pinion slides smoothly. If it is damaged or rusted or does not slide smoothly, repair.

3)Check springs for damage, and replace if necessary.

(6) Ball bearing

If abnormalities such as irregular noises are detected to the ball bearing, replace with a new one.

## 9.2.7 Assembly

The assembly procedure is reverse of the disassembly procedure, but pay attention to the following points.

(1) Apply grease as instructed below.

| Greasing point | Grease type |
|---|---|
| Sliding portions and head of plunger<br>Pinion metal and metal portions of gear case<br>Spline portions of pinion<br>Sliding portions of shift lever | NPC-FC6A Grease |
| Deceleration gear | MALTEMP SRL Grease |

(2) Armature thrust

No adjustments are needed for the thrust.

(3) Gear shaft thrust

Some thrust washers of 1.0 and 0.25 mm thickness are provided between the center bracket and gear shaft supporting surface. Make sure to check them at reassembly.

If washers are deformed or worn, replace them with new ones.

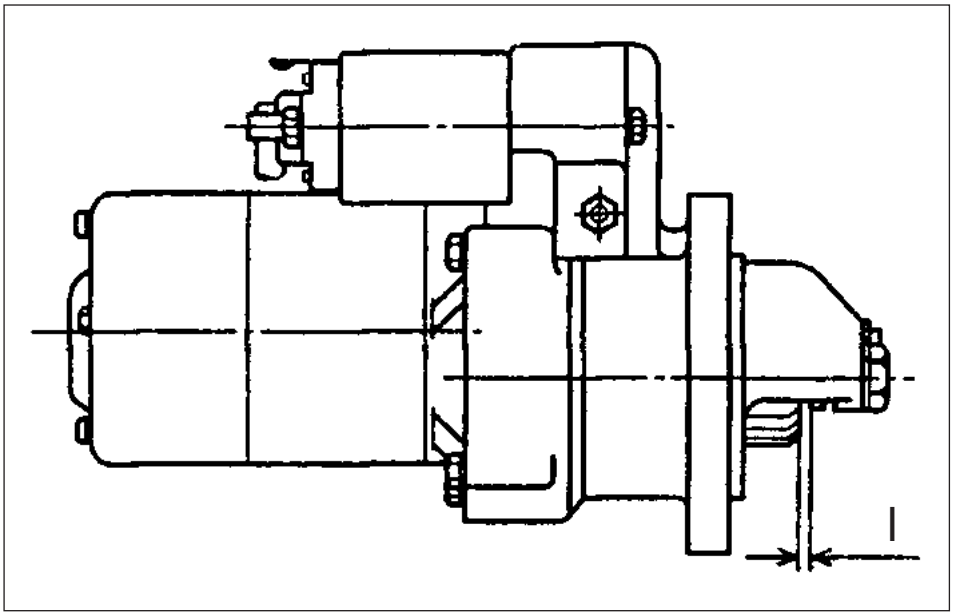
The appropriate thrust is from 0.05 to 0.3mm. If it is over 0.3mm, and the appropriate thrust washer, but pay attention so that the thrust is not 0.

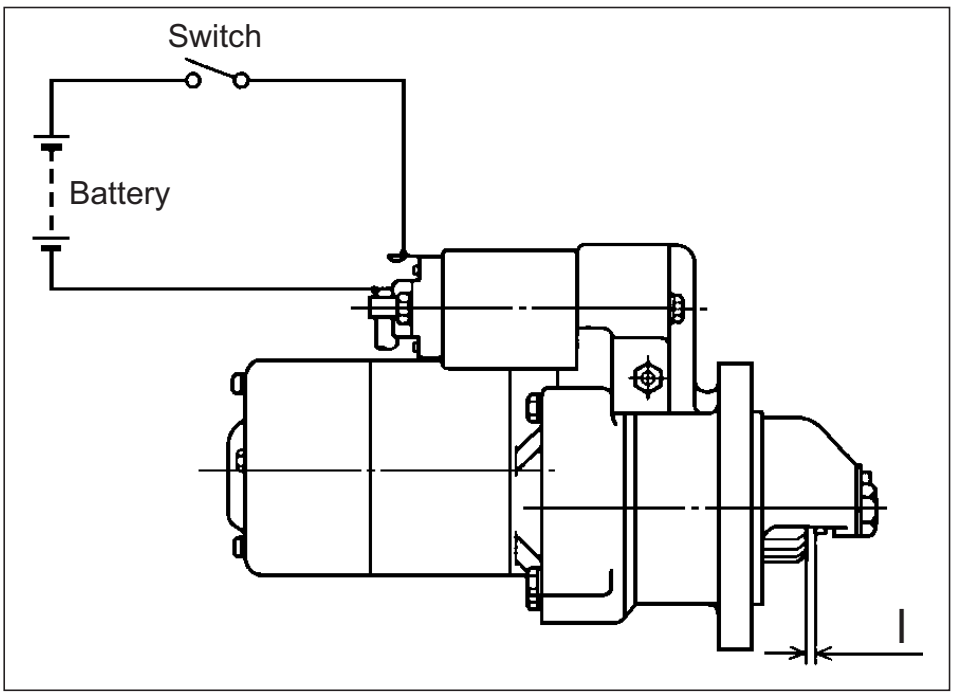
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## 9.2.8 Adjustment

(1) Pinion projection length L by magnetic switch

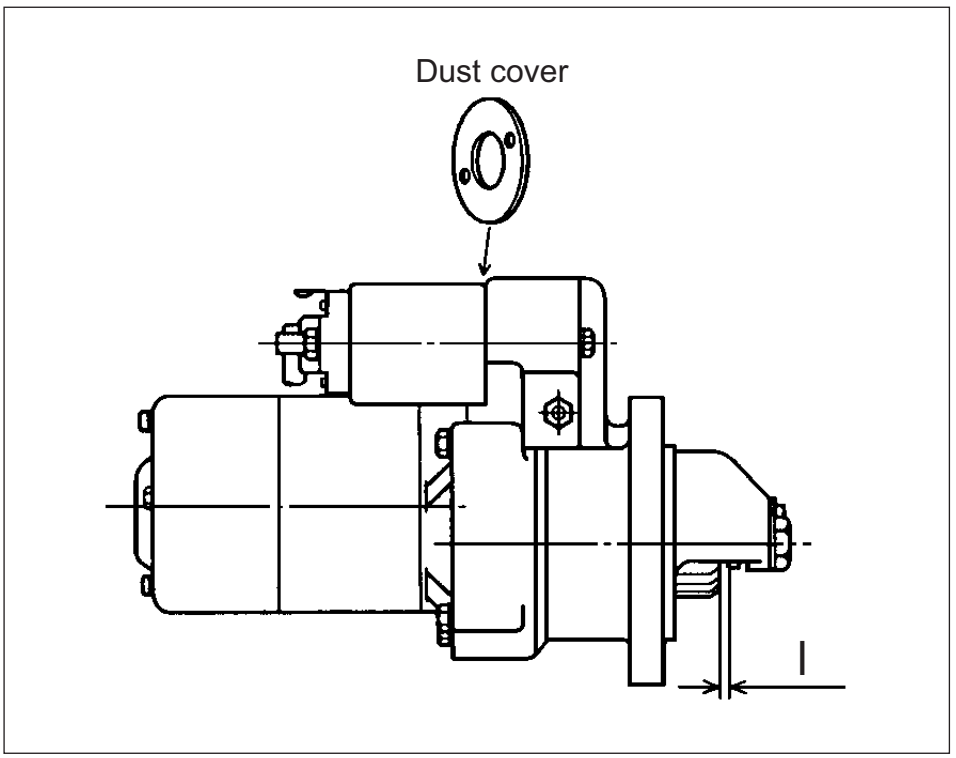



Measure the pinion moving distance L (0.3 to 1.5 mm) in the thrust direction when the pinion is protruded by the magnetic switch.
If the distance L is outside the standard range, adjust by the dust cover as shown below.

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## 9.2.9 Service standards

| | | | |
|---|---|---|---|
| Brush | Spring force N (kgf) | | 31.4 (3.2) |
| | Standard / Limit height | | 18/6 |
| Commutator | Outside diameter | Standard | 37 |
| | | Limit | 36 |
| | Deflection | Limit | 0.2 |
| | | Correction accuracy | 0.05 |
| | Depth of insulation mica | Limit | 0.2 |
| | | Correction accuracy | 0.5 to 0.8 |
| Standard dimensions | Armature shaft diameter | Front | 25 |
| | | Rear | 12 |
| | Bearing on gear case side | Gear shaft diameter | 13.95 to 13.968 |
| | | Hole diameter | 14.00 to 14.018 |
| | Sliding portion of pinion | Shaft diameter | 13.95 to 13.968 |
| | | Hole diameter | 14.03 to 14.05 |
| Ball bearing | Armature | Front | 6905DDU |
| | | Rear | 6001DDU |
| Length L (pinion projection length) | | | 0.3 to 1.5 |

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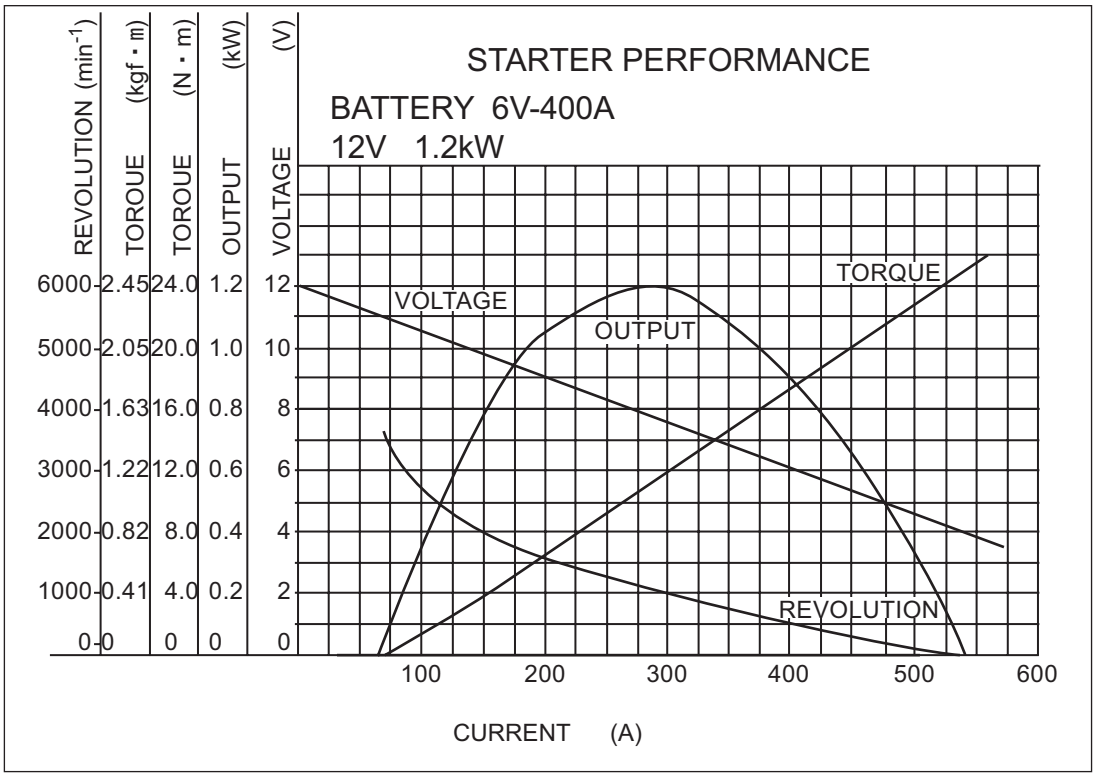


# 9.3 For 3TNV82A to 3/4TNV88

## 9.3.1 Specifications

| | | | |
|---|---|---|---|
| Manufacturer's code (Denso) | | - | 228000-0251 |
| Yanmar code | | - | 12912-77010 |
| Nominal voltage | | V | 12 |
| Nominal output | | kW | 1.2 |
| Rating | | Sec | 30 |
| Revolution direction (as viewed from pinion) | | - | Clockwise |
| Engagement system | | - | Magnetic shift |
| Pinion: Number | | - | 1.3 |
| Weight | | kg | 3.5 |
| Pinion projection voltage (at 100) | | V | 8 or less |
| No-load | Terminal voltage/current | V/A | 11.5/90 or less |
| | Revolution | $min^{-1}$ | 3000 or more |
| Loaded | Terminal voltage/current | V/A | 8/280 or less |
| | Torque | N•m (kgf•m) | 9.81(1.0) |
| | Revolution | $min^{-1}$ | 900 |

## 9.3.2 Characteristics

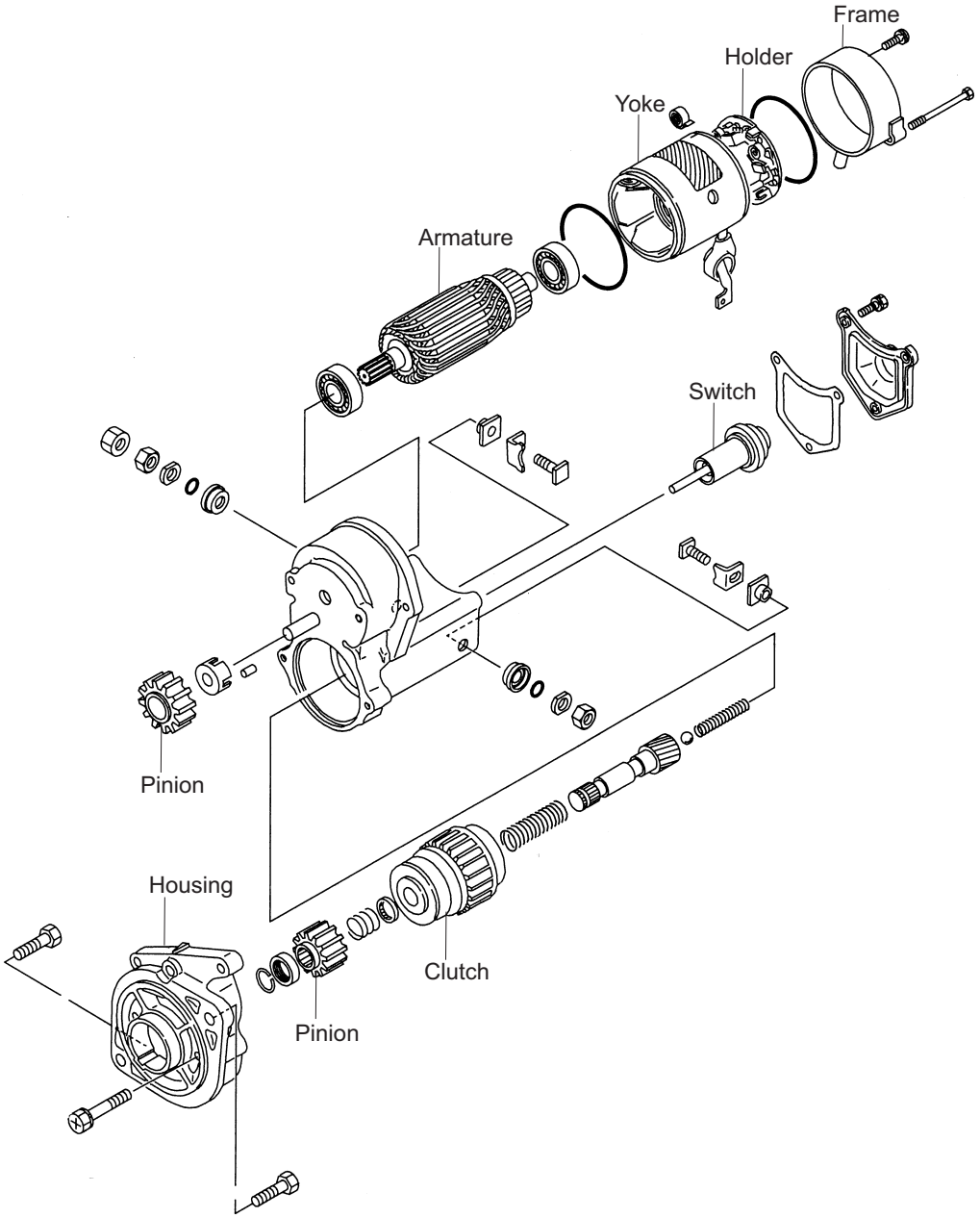



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## 9.3.3 Disassembly drawing

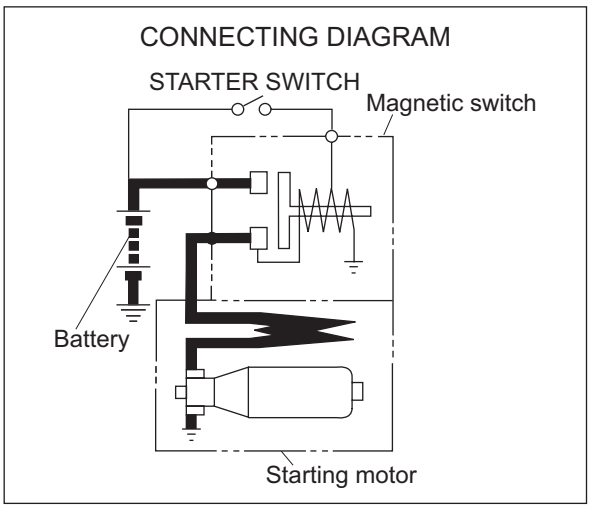



## 9.3.4 Connecting diagram of a starting motor

1)When a starter switch is turned on, a magnet switch is charged, and a moving core is absorbed, and a pinion clutch is moved forward through a lever, and the pinion engages with a ring gear.

2)When the pinion engages the ring gear, because a main contact point is closed and the main electric current flows and a pull coil is short-circuited by the main contact point and it stops being charged with electricity, the pinion is kept at the position by a holding coil during the start.

3)When the stater switch is turned off, the main contact point becomes open, and the pinion clutch is returned to the stop position by a return spring.




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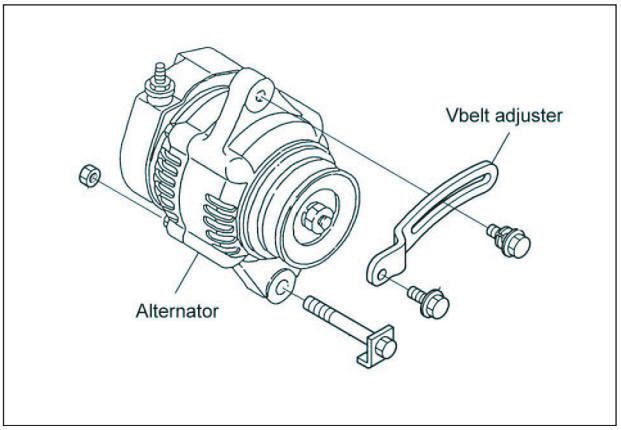
# 10. Alternator

As a representative example of alternator, the alternator of 40A is shown in this chapter.

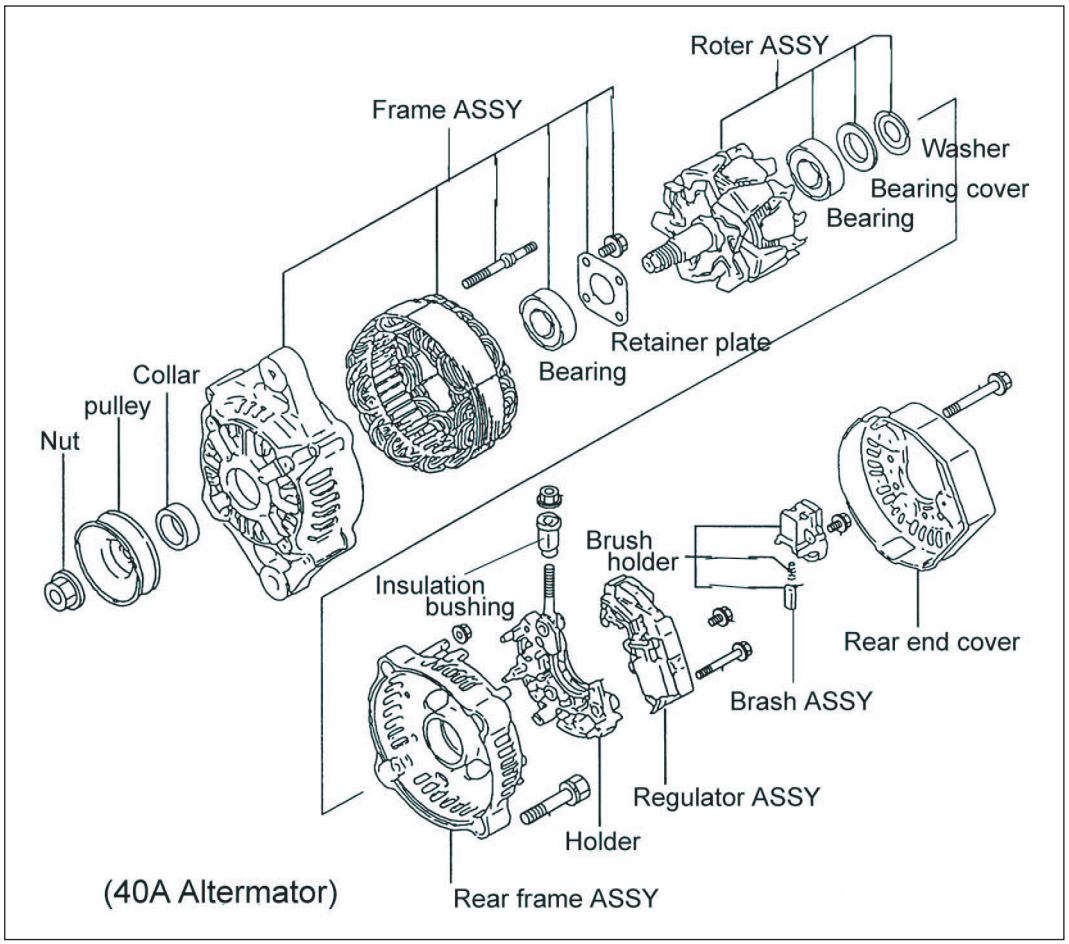
## 10.1 The 40A alternator for 3TNV84 and other models

### 10.1.1 Components

(1) Parts related to the alternator




(2) Alternator components of the disassembly and assembly



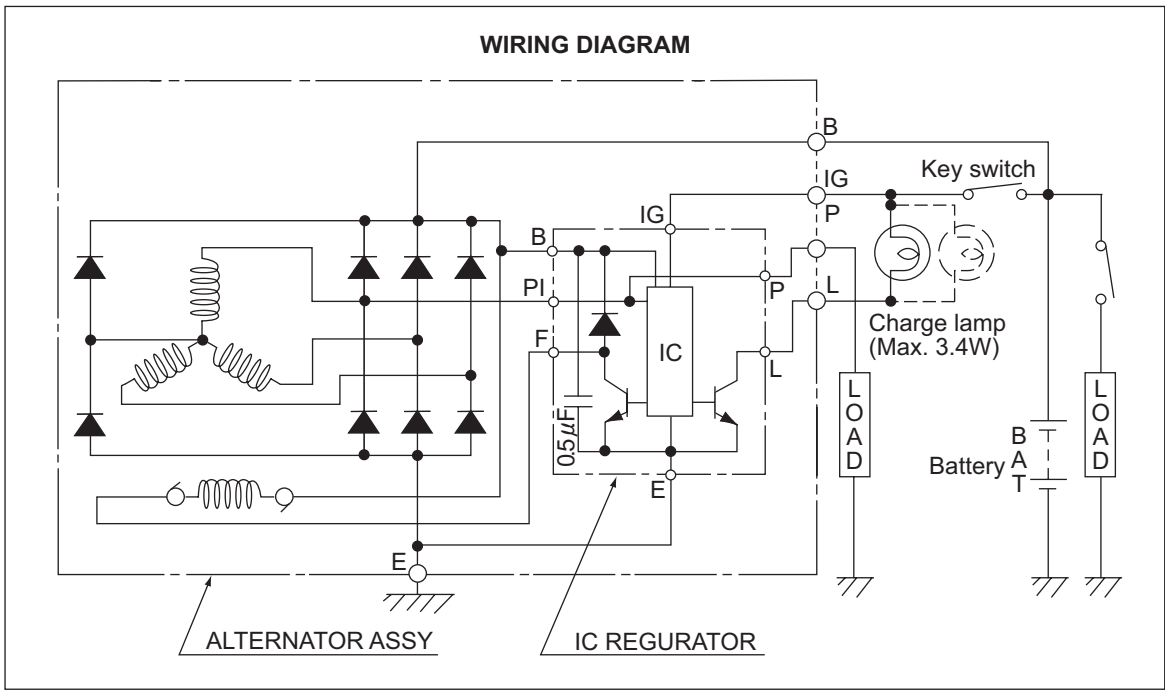
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## 10.1.2 Specifications

| | | |
|---|---|---|
| Manufacturer’s model (Hitachi) | - | ACFA68 |
| Yanmar code | - | 129423-77200 |
| Rating | - | Continuous |
| Battery voltage | V | 12 |
| Nominal output (13.5 V heat) | A | 40 |
| Rated revolution | $min^{-1}$ | 5,000 |
| Operating revolution | $min^{-1}$ | 1,350 to 18,000 |
| Grounding characteristics | - | Minus side grounding |
| Direction of revolution (viewed from pulley) | - | Clockwise |
| Integrated regulator | | IC regulator |
| Weight | kg | 2.8 |
| Pulley (outside diameter) | mm | 69.2 |
| Belt shape | - | Type A |

## 10.1.3 Wiring diagram




[NOTICE]

1)Don't do miss-wiring and short-circuit of each terminal.

2)Don’t short-circuit between IG and L. (Connect it through the charge lamp.)

3)Don’t connect a load between L and E.

4)Don't remove a battery terminal and a B terminal when rotating.

5)Shut out a battery switch during the alternator stop.

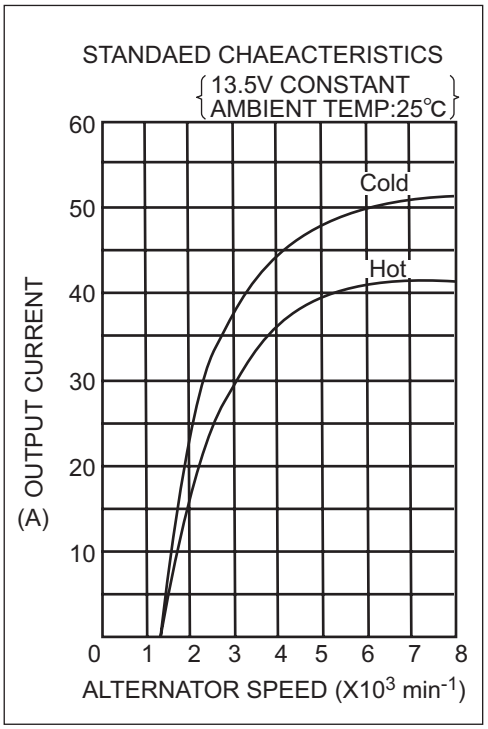
6)Tightening torque of each terminal: 1.7-2.3 N•m (17-23 kgf•cm)

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## 10.1.4 Standard output characteristics

The standard output characteristics of this alternator are shown as the right figure.

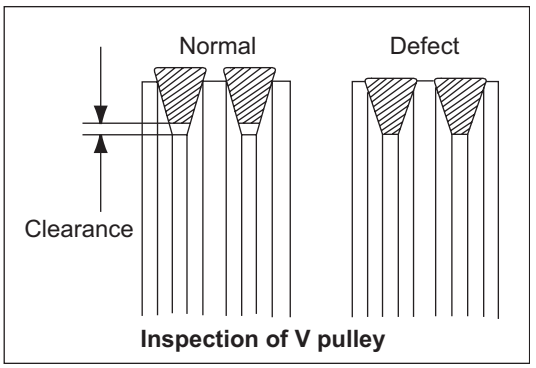



## 10.1.5 Inspection

### (1) V belt inspection

1)Inspect the matter whether there are not crack, stickiness and wear on the belt visually.
Check that a belt doesn't touch the bottom part of the pulley groove. If necessary, replace the V belt set.

2)V belt tension:
Push the center of the V belt and check the belt deflection. The V belt tension is normal if the deflection is within the standard. If not, adjust the V belt tension by the alternator adjuster.
(Refer to 2.2.2 in Chapter 2.)



**Inspection of V pulley**

### (2) Visual check of wiring and check of unusual sound

1)Confirm whether wiring is right or there is no looseness of the terminal part.

2)Confirm that there is no unusual sound from the alternator during the engine operation.

### (3) Inspection of charge lamp circuit

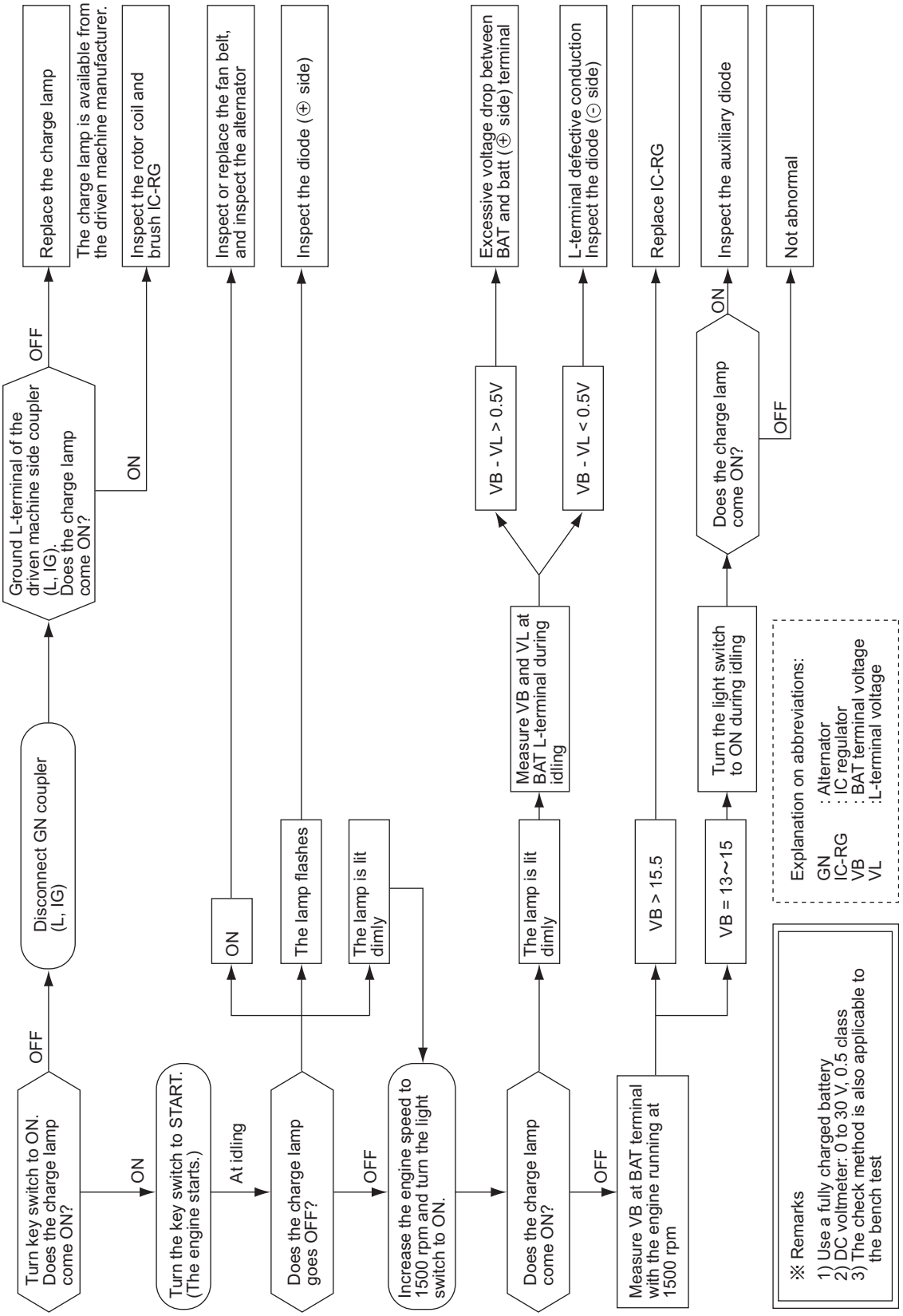
1)Move a start switch to the position of on. Confirm lighting of the charge lamp.

2)Start an engine, and confirm the lights-out of the lamp. Repair a charge lamp circuit when a lamp doesn't work.

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## 10.1.6 Troubleshooting

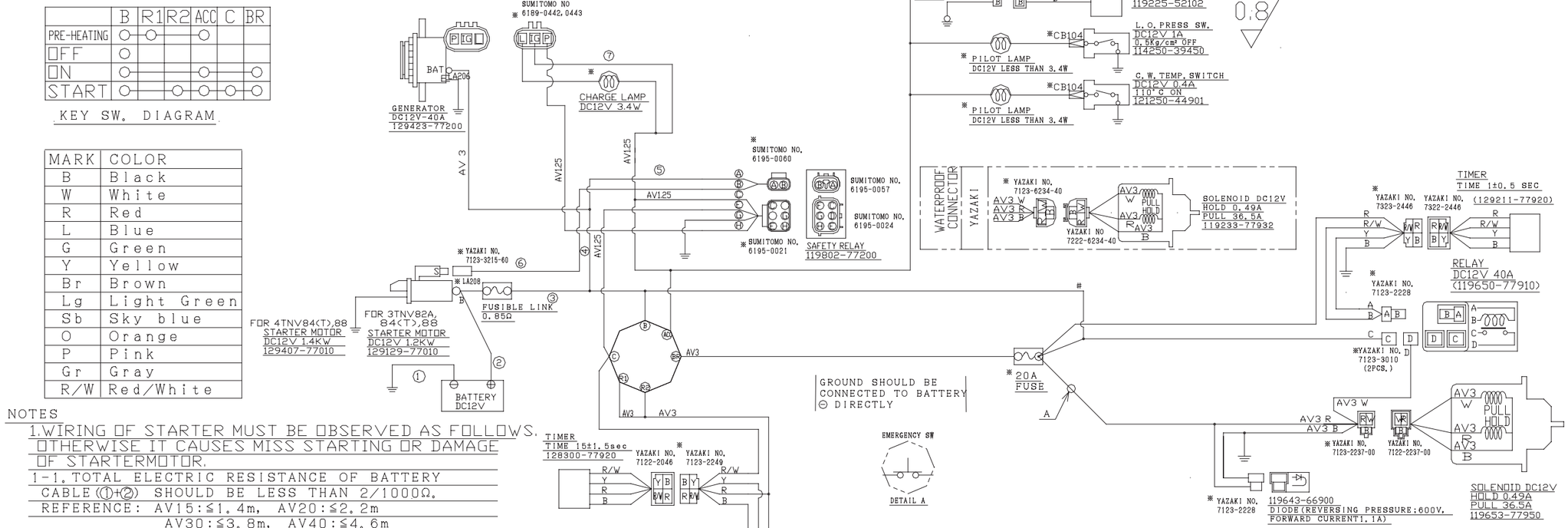


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# 11. Electric wiring

## 11.1 Electric wiring diagram




NOTES

1. WIRING OF STARTER MUST BE OBSERVED AS FOLLOWS, OTHERWISE IT CAUSES MISS STARTING OR DAMAGE OF STARTERMOTOR.
   1-1. TOTAL ELECTRIC RESISTANCE OF BATTERY CABLE (①+②) SHOULD BE LESS THAN 2/1000Ω.
   REFERENCE: AV15:≦1.4m, AV20:≦2.2m
   AV30:≦3.8m, AV40:≦4.6m
   1-2. TOTAL ELECTRIC RESISTANCE OF WIRING FOR STARTER (③~⑥) SHOULD BE LESS THAN 5/100Ω.
   REFERENCE OF TERMINAL RESISTANCE
   : 15/1000Ω PER COUPLER
   0Ω PER SCREW SETTIG
   1-3. BATTERY EARTH CABLE (①) CONNECTION SHALL BE ENSURED, PAINTED SURFACE MAY NOT BE USED (FOR EARTHING) AVOIDING THE MISS CONTACT.
2. BATTERY TREATMENT MUST BE OBSERVED AS FOLLOWS, OTHERWISE IT MAY CAUSE BURNING OF ELECTRIC EQUIPMENTS OR COMPONENTS. ALTERNATOR (DIODES) BURNING CAUSED BY BATTERY CABLE CONNECTION REVERSELY IS NOT WARRANTED.
   2-1. BATTERY SHOULD BE FIXED BY FITTING. (NOT TO MOVE)
   2-2. BATTERY CABLE LENGTH SHOULD BE ADJUSTED PROPERLY AND CLAMPED NOT TO BE CONNECTED REVERSELY.
   2-3. NOT LOOSE THE BATTERY CABLE TERMINAL, NOR TURN THE BATTERY SWITCH OFF DURING THE ENGINE RUNNING.
3. ONLY THE SPECIFIED LOAD SHOULD BE APPLIED ON THE ALTERNATOR "L" AND "P" LINE. IT IS NOT ALLOWED TO CONNECT ANY LOAD UNSPECIFIED WITHOUT YANMAR APPROVAL.
4. CHECK ANY SURGE CURRENT OR VOLTAGE OCCURED UNDER NORMAL OPERATIONS AND EXPECTIVE ERRONEOUS OPERATIONS, AND CONFIRM THE CIRCUIT NO SURGE OCCURS. ESPECIALLY PROVIDE THE FLYWHEEL DIODE FOR "C-LOAD" AND DIODE FOR "L-LOAD".

NOTES FOR ENGINE STOP SOLENOID

1. PERMISSIBLE RESISTANCE OF SOLENOID CIRCUIT SHOULD BE LESS THAN 0.07Ω TO GUARANTEE PERMISSIBLE LOWEST VOLTAGE 9V TO WORK SOLENOID(PULL COIL).
   (TERMINAL RESISTANCE :15/1000Ω PER COUPLER,
   0Ω PER SCREW SETTING.
   COUPLER RESISTANCE OF SOLENOID DOESN'T NEED TO BE COUNTED)
   REFERENCE :AV2(0.0088Ω/m):≦8.0m・・・WITHOUT TERMINAL RESISTANCE
   AV3(0.0056Ω/m):≦12.5m・・・SAME AS ABOVE
   WHEN YOU EXCEED PERMISSIBLE RESISTANCE, ADOPT THE CIRCUIT IMPRESSED FROM THE POWER SUPPLY TO THE SOLENOID DIRECTLY USING A RELAY ・・・REFER TO #
2. HIGH TEMPERATURE PARTS, SUCH AS AN EXHAUST PIPE, SHOULD NOT APPROACH FOR THE PULL POWER FALL OF SOLENOID, AND HEATING PREVENTION OF INNER COIL TEMPERATURE. (PERMISSIBLE AMBIENT TEMPERATURE:-30~100℃)
3. INSTALL FUSE TO PROTECT THE HARNESS AGAINST TROUBLES SUCH AS SHORT CIRCUIT OR CONTINUOUS DRIVE OF PULL-COIL.
4. THE POWER SUPPLY OF SOLENOID MAY NOT BE COMMON WITH THE LINE OF ALTERNATOR INITIAL EXCITATOR AS SHOWN IN THIS DRAWING. (OTHERWISE, SOLENOID MAY LOOSE STOP FUNCTION DUE TO THE POWER SUPPLY FROM ALTERNATOR "L" TERMINAL.)
5. IN CASE OF WATERPROOF CONNECT OR APPLICATION, CONNECTOR SHOULD BE FIXED BY FITTING TO PREVENT LEAD WIRE BREAK.
6. IN CASE OF EMARGENCY STOP OF MACHINE FOR SAFETY WILL BE APPLIED, SWITCH LOCATION SHOULD BE SHOWN AS A.
7. IN CASE OF THE SOLENOID CIRCUIT RESISTANCE WOULD BE LIMIT, # WIRING IS APPLICABLE.

REMARKS

1. ※ MARKED PARTS ARE NOT PROVIDED BY YANMAR.

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# 11.2 Precaution on electric wiring

## 11.2.1 Alternator

In the cases listed below the warranty shall not be deemed to apply. Please be sure to read these conditions carefully when planning to use it with other equipment. Also be certain to give appropriate guidance on usage to the user.

### (1) When the battery cable can be connected backwards

The alternator diode will be damaged and recharging made impossible if the plus and minus ends of the battery cable are confused. The stator coil will also be burned as a result. To prevent this, supply the user with a cable of such a length or structure that the plus and minus ends cannot be confused. Also warn the user not to connect the cable backwards.

### (2) When charging output voltage is used for control purposes

The engine speed at starting is not proportional to the output voltage of the alternator, so this output voltage must not be used for any control systems. It is especially wrong to use it for the control signal of the safety relay for cutting the starter motor because this will damage the starter motor and cause engine starting failure.

### (3) When the L line is used for control purposes

Consult with Yanmar first before connecting any load other than the charge lamp to the L line. Damage to the alternator and related equipment will not be warranted without such prior consultation.

### (4) Non-use of the Yanmar wiring diagram

Use without prior consultation of any wiring diagram other than that provided by Yanmar removes any breakdown of any electrical equipment from the warranty.

### (5) Regarding lamp control

Once the charge lamp goes out after the start of charging, it does not come on again even if the engine speed falls and charging is insufficient. The lamp will not light again if the charging circuit is normal. The lamp only comes on during operation if the alternator itself is broken or the drive V-belt breaks. However, when an LED is used for the charge lamp, the LED will shine faintly even during normal operation. This is due to the control system for the alternator lamp and is not an abnormality.

### (6) Use of a non-specified V-belt

Use of a non-specified V-belt will cause inadequate charging and shorten the life of the belt. Use a belt of the specified type.

### (7) Direct high pressure washing is prohibited

Water will enter the brush if the alternator is washed directly at high pressure, causing inadequate charging. Warn users not to use direct, high-pressure washing.

### (8) Use of agricultural or other chemicals (direct contact or airborne)

Adhesion of agricultural and other chemicals, especially those with high sulfur content, to the IC regulator corrodes the conductor on the substrate, leading to over-charging (battery boiling) and charging malfunctions. Consult with Yanmar prior to use in such an environment. Use without prior consultation removes any breakdown from the warranty.

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## 11.2.2 Starter

In the cases listed below the warranty shall not be deemed to apply. Please be sure to read these conditions carefully when planning to use it with other equipment. Also be certain to give appropriate guidance on usage to the user.

### (1) Starting performance in the case of using an untested battery

The starting performance of the engine is closely dependent on the battery capacity. This battery capacity is itself affected by the climate and the type of equipment installation. The details regarding ambient temperature and equipment installation vary depending on the OEM, so Yanmar cannot decide the battery capacity on its own. Confer with Yanmar in advance after checking these conditions and fix the battery capacity on the basis of confirmatory tests.

### (2) When the resistance of the battery cable exceeds the specified value

The combined total resistance of the battery cable in both directions between the starting motor and battery should be within the value indicated on the wiring diagram. The starting motor will malfunction or break down if the resistance is higher than the specified value.

### (3) When the resistance of the starter circuit exceeds the specified value

The combined total resistance of the wiring between the starting motor and key switch (or power relay or safety relay, depending on the application) should be within the value indicated on the wiring diagram. Engine starting will be difficult if the resistance is higher than the specified value. This can also cause welding of the magnet switch at the point of contact and resultant burning of the armature coil.

### (4) When there is no safety relay

Over-running (when the electric current flows for too long) is a major cause of starting failure. This burns the armature coil and causes clutch failure. Excessive work and failure of the key switch to return properly are the main causes of over-running. The user must be given sufficient warning about this.

Be sure to use the safety relay to prevent over-running. This safety relay is supplied as an option. Consult Yanmar first when planning to install a safety relay at your own company. In the case of failure to consult with Yanmar, our warranty will not be applied to all the electrical equipment.

### (5) When there is too much rust due to the entry of water

The water-proofing of the starting motor is equivalent to R2 of JIS D 0203. This guarantees that there will be no damage from the sort of exposure encountered in rain or when water is poured on from a bucket. You should, however, avoid the use of high-pressure washing and steeping in water.

### (6) Regarding the heat resistance of the starter motor

The starter motor has heat resistance for an ambient temperature of 80°C and surface temperature of 100°C. Insulators must be installed to prevent overheating when used near high temperature parts such as the exhaust system.

### (7) Corrosion of magnet switch contact point by corrosive gas.

When using equipment with a dry clutch, ammonium gas generated by friction is liable to corrode the contact of the magnet switch. Be sure to install a vent in the clutch case.

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### 11.2.3 Current limiter

In the cases listed below the warranty shall not be deemed to apply. Please be sure to read these conditions carefully when planning to use it with other equipment. Also be certain to give appropriate guidance on usage to the user.

#### (1) When an over-discharged battery is used

Use of booster starting with an over-discharged battery (when the voltage has dropped to 8 V or less) will destroy other electrical equipment by generating an abnormally high voltage. A specialized battery charger should be used to recharge such an over-discharged battery (when the voltage has dropped to 8 V or less).

#### (2) When checks for malfunctioning are not performed

When high voltage noise from other electrical equipment is impressed on the current limiter upon turning off the key switch, the current limiter can be damaged and cause loss of control over the output voltage. Other electrical equipment may also be damaged if this happens, so surge killers should be fitted to the electrical equipment whenever necessary. Be sure to check prior to mass production whether electrical noise might damage the current limiter by turning the key switch and other electrical equipment on and off while the engine is running, using both the vehicle and the wire harness that will be used in mass production.

#### (3) Removal of the battery cable during operation

The current limiter may malfunction if the battery cable and/or battery are removed during operation, depending on the kind of electrical equipment being used, causing loss of control over the output voltage. In such cases, the current limiter and other electrical equipment will be damaged by the generation of a continuous high voltage of 24-43 V (for 5,000 rpm dynamo). All electrical equipment falls outside the scope of the warranty under these circumstances. Be sure to warn the user not to remove the battery cable and/or battery during operation.

#### (4) If the battery cable can be attached in reverse

The current limiter’s SCR diode will be destroyed if the plus and minus ends of the battery cable are connected the wrong way around. This causes charging malfunctioning and burns the harness. Give the user a cable of such a length that it cannot be connected the wrong way and warn the user against connecting the cable backwards.

#### (5) Non-use of the Yanmar wiring diagram

Use without prior consultation of any wiring diagram other than that provided by Yanmar removes any breakdown of any electrical equipment from the warranty.

#### (6) Installation environment

Observe the following when installing the current limiter:

1)Do not install it on the engine.
2)Place it in a well-ventilated place with an ambient temperature of 65 °C or less.
3)Ensure that the cooling air flows in the right direction for the current limiter’s cooling fins.
4)Do not use the earth wire of the current limiter to earth any other electrical equipment.

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## 11.2.4 Section area and resistance of electric wire

(1) Allowable maximum cable length （Terminal resistance is not included.）

| Cable size $mm^2$ | Cable construction | | Resistance (Ω/m) | 2 mΩ Note1 (m) | 20 mΩ Ref. (m) | 50 mΩ Note2 (m) |
|---|---|---|---|---|---|---|
| | Element No. | Cable dia. | | | | |
| 3 | 41 | ø 0.32 | 0.005590 | 0.36 | 3.58 | 8.94 |
| 5 | 65 | ø 0.32 | 0.003520 | 0.57 | 5.68 | 14.20 |
| 8 | 50 | ø 0.45 | 0.002320 | 0.86 | 8.62 | 21.55 |
| 15 | 84 | ø 0.45 | 0.001380 | 1.45 | 14.49 | 36.23 |
| 20 | 41 | ø 0.80 | 0.000887 | 2.25 | 22.55 | 56.37 |
| 30 | 70 | ø 0.80 | 0.000520 | 3.85 | 38.46 | 96.15 |
| 40 | 85 | ø 0.80 | 0.000428 | 4.67 | 46.73 | 116.82 |
| 50 | 108 | ø 0.80 | 0.000337 | 5.93 | 59.35 | 148.37 |
| 60 | 127 | ø 0.80 | 0.000287 | 6.97 | 69.69 | 174.22 |
| 85 | 169 | ø 0.80 | 0.000215 | 9.30 | 93.02 | 232.56 |
| 100 | 217 | ø 0.80 | 0.000168 | 11.90 | 119.05 | 297.62 |

Note1) Allowable maximum resistance of Battery cable
Note2) Allowable maximum resistance of Starting motor circuit

(2) Terminal resistance

Generally, a terminal resistance is 15 mΩ per coupler and 0 Ω per screw setting. This resistance should be included in allowable maximum resistance when the cable length is planned.

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# 12. Service standards

## 12.1 Engine tuning

| No. | Inspection item | | | Standard | | Limit | Reference page |
|---|---|---|---|---|---|---|---|
| 1 | Gap at intake/exhaust valve heads mm | | TNV82 to A98 | 0.15 to 0.25 | | - | 2.2.6.(4) |
| | | | 4TNV106(T) | 0.25 to 0.35 | | - | |
| 2 | V-belt tension mm at 98N (10 kgf) | Between alternator and crank pulley | Used part | 10 to 14 | | - | 2.2.2.(2) |
| | | | New part | 8 to 12 | | - | |
| | | Between alternator and radiator fan | Used part | 7 to 10 | | | |
| | | | New part | 5 to 8 | | | |
| | | Between radiator fan and crank pulley | Used part | 9 to 13 | | | |
| | | | New part | 7 to 11 | | | |
| 3 | Fuel injection pressure MPa ($kgf/cm^2$) | 3TNV82A to TNV88(VM) 4TNV94L to 106(T) | | 21.57 to 22.55 (220 to 230) | | - | 2.2.6.(3) |
| | | 3TNV82A to TNV88(CL) | | 19.6 to 20.6 (200 to 210) | | | |
| 4 | Compression pressure (at 250 $min^{-1}$) MPa ($kgf/cm^2$) | TNV82A | | 3.16 (31) ± 0.1 (1) | | 2.45(25) ± 0.1(1) | 3.3 |
| | | TNV84 | | 3.24 (33) ± 0.1 (1) | | 2.55(26) ± 0.1(1) | |
| | | 3/4TNV84T | | 2.94 (30) ± 0.1 (1) | | 2.45(25) ± 0.1(1) | |
| | | TNV88-106 | | 3.43 (35) ± 0.1 (1) | | 2.75(28) ± 0.1(1) | |
| 5 | Coolant water Capacity (Only engine body) (Liter) | 3TNV82A, 84 | | 1.8 | | - | 2.2.1.(4) |
| | | 3TNV84T, 88 | | 2.0 | | - | |
| | | 4TNV84(T), 88 | | 2.7 | | - | |
| | | 4TNV94L•98(T) | | 4.2 | | - | |
| | | 4TNV106(T) | | 6.0 | | - | |
| 6 | Lubricating oil capacity (oil pan) (Liter) | - | | Full | Effective | - | 2.2.1.(3) |
| | | 3TNV82A | | 5.5 | 1.9 | - | |
| | | 3TNV84(T)/88 | | 6.7 | 2.8 | - | |
| | | 4TNV84(T)/88 | | 7.4 | 3.4 | - | |
| | | 4TNV94L/98(T) | | 10.5 | 4.5 | - | |
| | | 4TNV106(T)(CL class) | | 14.0 | 9.0 | - | |
| | | 4TNV106(T)(VM class) | | 14.0 | 7.5 | - | |

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| No. | Inspection item | | | Standard | Limit | Reference page |
|---|---|---|---|---|---|---|
| 7 | Lubricating oil pressure MPa ($kgf/cm^2$) at lube oil temperature 80 deg.C for 3TNV82A-4TNV98(T) 100 deg.C for 4TNV106(T) | - | Rated speed | at rated speed | at low idle speed | - |
| | | 3TNV82A | 1500~2700rpm | 0.392(+0.098/-0.049) (4.0(+1.0/-0.5)) | 0.06 (0.6) or above | 5.6 |
| | | | 2800~3000rpm | 0.441(+0.098/-0.049) (4.5(+1.0/-0.5)) | | |
| | | 3TNV84 | 1500~1800rpm | 0.392(+0.098/-0.049) (4.0(+1.0/0.5)) | | |
| | | | 2000~3000rpm | 0.441(+0.098/-0.049) (4.5(+1.0/-0.5)) | | |
| | | 3TNV88 | 1500~1800rpm | 0.392(+0.098/-0.049) (4.0(+1.0/0.5)) | | |
| | | | 2000~3000rpm | 0.441(+0.098/-0.049) (4.5(+1.0/-0.5)) | | |
| | | 3TNV84T | 1500~1800rpm | 0.343(+0.098/-0.049) (3.5(+1.0/0.5)) | | |
| | | | 2400~2700rpm | 0.392(+0.098/-0.049) (4.0(+1.0/0.5)) | | |
| | | | 2800~3000rpm | 0.441(+0.098/-0.049) (4.5(+1.0/-0.5)) | | |
| | | 3TNV84 | 1500~1800rpm | 0.392(+0.098/-0.049) (4.0(+1.0/0.5)) | | |
| | | | 2000~3000rpm | 0.441(+0.098/-0.049) (4.5(+1.0/-0.5)) | | |
| | | 4TNV88 | 1500~1800rpm | 0.392(+0.098/-0.049) (4.0(+1.0/0.5)) | | |
| | | | 2000~3000rpm | 0.441(+0.098/-0.049) (4.5(+1.0/-0.5)) | | |
| | | 4TNV84T | 1500~1800rpm | 0.343(+0.098/-0.049) (3.5(+1.0/0.5)) | | |
| | | | 2000~3000rpm | 0.412(+0.098/-0.049) (4.2(+1.0/0.5)) | | |
| | | 4TNV94L | 1500~2500rpm | 0.34(+/0.05) (3.5(+/0.5)) | | |
| | | 4TNV98 | 1500~2500rpm | 0.34(+/0.05) (3.5(+/0.5)) | | |
| | | 4TNV98T | 1500~2500rpm | 0.34(+/0.05) (3.5(+/0.5)) | | |
| | | 4TNV106 | 1500~1800rpm | 0.44(+0.05/0.10) (4.5(+0.5/-1.0)) | | |
| | | | 2000~2500rpm | 0.44(+/0.05) (4.5(+/0.5)) | | |
| | | 4TNV106T | 1500~1800rpm | 0.44(+0.05/-0.10) (4.5kgf/.$cm^2$(+0.5/-1.0)) | | |
| | | | 2000~2200rpm | 0.44(+/0.05) (4.5(+/0.5)) | | |
| 8 | Oil pressure switch operating pressure MPa ($kgf/cm^2$) | | | 0.05 ± 0.01 (0.5 ± 0.1) | - | - |
| 9 | Thermostat | | | valve opening temperature deg. C | Full opening lift (mm) (temperature) | 2.7 |
| | | All models | | 69.5 to 72.5 | 8 or above (85 deg.C) | |
| | | All models option | | 80 to 84 | 10 or above (95 deg.C) | |
| 10 | Thermo switch actuating temperature (deg.C) | | | 107 to 113 | - | 2.4.2 |

(R.1)

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# 12.2 Engine body

## 12.2.1 Cylinder head

(1) Cylinder head

| Inspection item | | | Standard | Limit | Reference page |
|---|---|---|---|---|---|
| Combustion surface distortion mm | | | 0.05 or less | 0.15 | 4.2.5.(1) |
| Valve sink mm | 3TNV82A (2-valve head) | Intake | 0.35 to 0.55 | 0.8 | |
| | | Exhaust | 0.30 to 0.50 | 0.8 | |
| | TNV84 to 88 (2-valve head) 4TNV84T(4-valve) | Intake | 0.30 to 0.50 | 0.8 | |
| | | Exhaust | 0.30 to 0.50 | 0.8 | |
| | 4TNV94L•98(T) (4-valve head) | Intake | 0.36 to 0.56 | 0.8 | |
| | | Exhaust | 0.35 to 0.55 | 0.8 | |
| | 4TNV106(T) (4-valve head) | Intake | 0.5 to 0.7 | 1.0 | |
| | | Exhaust | 0.7 to 0.9 | 1.2 | |
| Valve seat (2-valve, 4-valve) | Seat angle Deg. | Intake | 120 | - | 4.2.6. |
| | | Exhaust | 90 | - | |
| | Seat correction angle deg. | | 40, 150 | - | |

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## (2) Intake/exhaust valve and guide

mm

| Inspection item | | | Standard | Limit | Reference page |
|---|---|---|---|---|---|
| 3TNV82A (2-valve head) | Intake | Guide inside diameter | 7.000 to 7.015 | 7.08 | 4.2.5.(2) |
| | | Valve stem outside diameter | 6.945 to 6.960 | 6.90 | |
| | | Clearance | 0.040 to 0.070 | 0.18 | |
| | Exhaust | Guide inside diameter | 7.000 to 7.015 | 7.08 | |
| | | Valve stem outside diameter | 6.940 to 6.955 | 6.90 | |
| | | Clearance | 0.045 to 0.075 | 0.18 | |
| 4TNV84 3TNV84(T) 3/4TNV88 (2-valve head) | Intake | Guide inside diameter | 8.010 to 8.025 | 8.10 | |
| | | Valve stem outside diameter | 7.955 to 7.975 | 7.90 | |
| | | Clearance | 0.035 to 0.070 | 0.18 | |
| | Exhaust | Guide inside diameter | 8.015 to 8.030 | 8.10 | |
| | | Valve stem outside diameter | 7.955 to 7.960 | 7.90 | |
| | | Clearance | 0.045 to 0.075 | 0.18 | |
| 4TNV84T (4-valve head) | Intake | Guide inside diameter | 6.000 to 6.015 | 6.08 | |
| | | Valve stem outside diameter | 5.960 to 5.975 | 5.90 | |
| | | Clearance | 0.025 to 0.055 | 0.15 | |
| | Exhaust | Guide inside diameter | 6.000 to 6.015 | 6.08 | |
| | | Valve stem outside diameter | 5.945 to 5.960 | 5.90 | |
| | | Clearance | 0.040 to 0.070 | 0.17 | |
| 4TNV94L 4TNV98(T) (4-valve head) | Intake | Guide inside diameter | 7.000 to 7.015 | 7.08 | |
| | | Valve stem outside diameter | 6.945 to 6.960 | 6.90 | |
| | | Clearance | 0.040 to 0.070 | 0.17 | |
| | Exhaust | Guide inside diameter | 7.000 to 7.015 | 7.08 | |
| | | Valve stem outside diameter | 6.940 to 6.955 | 6.90 | |
| | | Clearance | 0.045 to 0.075 | 0.17 | |
| 4TNV106(T) (4-valve head) | Intake | Guide inside diameter | 7.008 to 7.020 | 7.08 | |
| | | Valve stem outside diameter | 6.945 to 6.960 | 6.92 | |
| | | Clearance | 0.048 to 0.075 | 0.16 | |
| | Exhaust | Guide inside diameter | 7.008 to 7.020 | 7.08 | |
| | | Valve stem outside diameter | 6.960 to 6.975 | 6.90 | |
| | | Clearance | 0.033 to 0.060 | 0.18 | |
| Valve guide projection from cylinder head | | 3TNV82A | 11.7 to 12.0 | - | 4.2.7. |
| | | 4TNV84, 3TNV84(T), 4TNV88 | 14.71 to 5.0 | - | |
| | | 4TNV84T | 8.2 to 8.5 | - | |
| | | 4TNV94L, 4TNV98(T) | 9.7 to 10.0 | - | |
| | | 4TNV106(T) | 13.4 to 13.6 | - | |
| Valve guide driving-in method | | | Cold-fitted | - | |

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## (3) Valve spring

mm

| Inspection item | | Standard | Limit | Reference page |
|---|---|---|---|---|
| Free length | 3TNV82A(2-valve) | 44.4 | 43.9 | 4.2.5.(4) |
| | 4TNV84,3TNV84(T), 4TNV88(2-valve) | 42.0 | 41.5 | |
| | 4TNV84T(4-valve) | 37.4 | 36.9 | |
| | 4TNV94L, 4TNV98(T),(4-valve) | 39.7 | 39.2 | |
| | 4TNV106(T)(4-valve) | 50.6 | 50.1 | |
| Inclination | 3TNV82A(2-valve) | - | 1.4 | |
| | 4TNV84, 3TNV84(T), 4TNV88(2-valve) | - | 1.4 | |
| | 4TNV84T(4-valve) | - | 1.3 | |
| | 4TNV94L, 4TNV98(T), (4-valve) | - | 1.4 | |
| | 4TNV106(T)(4-valve) | - | 1.5 | |

## (4) Rocker arm and shaft

mm

| Model | Inspection item | Standard | Limit | Reference page |
|---|---|---|---|---|
| TNV82A to 88 | Arm shaft hole diameter | 16.000 to 16.020 | 16.07 | 4.2.5.(5) |
| | Shaft outside diameter | 15.966 to 15.984 | 15.94 | |
| | Clearance | 0.016 to 0.054 | 0.13 | |
| 4TNV94L/98(T)/106(T) | Arm shaft hole diameter | 18.500 to 18.520 | 18.57 | |
| | Shaft outside diameter | 18.470 to 18.490 | 18.44 | |
| | Clearance | 0.010 to 0.050 | 0.13 | |

## (5) Push rod

mm

| Inspection item | Standard | Limit | Reference page |
|---|---|---|---|
| Bend | Less than 0.03 | 0.03 | 4.2.5.(7) |

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## 12.2.2 Gear train and camshaft

### (1) Camshaft

mm

| Inspection item | | | Standard | Limit | Reference page |
|---|---|---|---|---|---|
| Side gap | | | 0.05 to 0.20 | 0.30 | 4.3.4 |
| Bending (1/2 the dial gage reading) | | | 0 to 0.02 | 0.05 | 4.3.5.(1) |
| Cam height | | 3TNV82A-TNV88 | 38.600 to 38.800 | 38.350 | |
| | | 4TNV94L•98 | 43.400 to 43.600 | 43.150 | |
| | | 4TNV106(T) | 50.900 to 51.100 | 50.650 | |
| Shaft outside diameter / Metal inside diameter | | | | | |
| TNV82A to TNV88 | Gear side | Bushing inside diameter | 44.990 to 45.055 | 45.130 | 4.3.5.(1) |
| | | Camshaft outside diameter | 44.925 to 44.950 | 44.890 | |
| | | Clearance | 0.040 to 0.130 | 0.240 | |
| | Intermediate | Bushing inside diameter | 45.000 to 45.025 | 45.100 | |
| | | Camshaft outside diameter | 44.910 to 44.935 | 44.875 | |
| | | Clearance | 0.065 to 0.115 | 0.225 | |
| | Wheel side | Bushing inside diameter | 45.000 to 45.025 | 45.100 | |
| | | Camshaft outside diameter | 44.925 to 44.950 | 44.890 | |
| | | Clearance | 0.050 to 0.100 | 0.210 | |
| 4TNV94L/98(T) | Gear side | Bushing inside diameter | 49.990 to 50.055 | 50.130 | |
| | | Camshaft outside diameter | 49.925 to 49.950 | 49.890 | |
| | | Clearance | 0.040 to 0.130 | 0.240 | |
| | Intermediate | Bushing inside diameter | 50.000 to 50.025 | 50.100 | |
| | | Camshaft outside diameter | 49.910 to 49.935 | 49.875 | |
| | | Clearance | 0.065 to 0.115 | 0.225 | |
| | Wheel side | Bushing inside diameter | 50.000 to 50.025 | 50.100 | |
| | | Camshaft outside diameter | 49.925 to 49.950 | 49.890 | |
| | | Clearance | 0.05 to 0.100 | 0.210 | |
| 4TNV106(T) | Gear side | Bushing inside diameter | 57.980 to 58.050 | 58.105 | |
| | | Camshaft outside diameter | 57.910 to 57.940 | 57.875 | |
| | | Clearance | 0.040 to 0.140 | 0.250 | |
| | Intermediate | Bushing inside diameter | 58.000 to 58.030 | 58.105 | |
| | | Camshaft outside diameter | 57.895 to 57.925 | 57.860 | |
| | | Clearance | 0.075 to 0.135 | 0.245 | |
| | Wheel side | Bushing inside diameter | 58.000 to 58.030 | 58.105 | |
| | | Camshaft outside diameter | 57.910 to 57.940 | 57.875 | |
| | | Clearance | 0.050 to 0.120 | 0.230 | |

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(2) Idle gear shaft and bushing

mm

| Inspection item | Standard | Limit | Reference page |
|---|---|---|---|
| Shaft outside diameter | 45.950 to 45.975 | 45.900 | 4.3.5.(2) |
| Bushing inside diameter | 46.000 to 46.025 | 46.075 | |
| Clearance | 0.025 to 0.075 | 0.175 | |

(3) Backlash of each gear

mm

| Model | Inspection item | Standard | Limit | Reference page |
|---|---|---|---|---|
| 3TNV82A<br>3/4TNV84(T)<br>3/4TNV88 | Crank gear, cam gear, idle gear,<br>fuel injection pump gear and PTO gear | 0.07 to 0.15 | 0.17 | 4.3.4. |
| 4TNV94L<br>4TNV98(T)<br>4TNV106(T) | Crank gear, cam gear, idle gear,<br>fuel injection pump gear and PTO gear | 0.08 to 0.14 | 0.16 | |
| | Lubricating oil pump gear | 0.09 to 0.15 | 0.17 | |
| | Balancer drive gear<br>(only for 4TNV106(T)) | 0.12 to 0.18 | 0.20 | |

## 12.2.3 Cylinder block

(1) Cylinder block

mm

| Inspection item | | Standard | Limit | Reference page |
|---|---|---|---|---|
| Cylinder inside diameter | 3TNV82A | 82.000 to 82.030 | 82.200 | 4.4.5.(1) |
| | 3/4TNV84(T) | 84.000 to 84.030 | 84.200 | |
| | 3/4TNV88 | 88.000 to 88.030 | 88.200 | |
| | 4TNV94L | 94.000 to 94.030 | 94.130 | |
| | 4TNV98 | 98.000 to 98.030 | 98.130 | |
| | 4TNV106(T) | 106.000 to 106.030 | 106.130 | |
| Cylinder bore | Roundness | 0.01 or less | 0.03 | |
| | Inclination | | | |

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## (2) Crankshaft

mm

| Inspection item | | | Standard | Limit | Reference page |
|---|---|---|---|---|---|
| Bending (1/2 the dial gauge reading) | | | - | 0.02 | 4.4.5.(2) |
| Crank pin | 3TNV82A | Pin outside diameter | 42.952 to 42.962 | 42.902 | |
| | | Metal inside diameter | 43.000 to 43.042 | - | |
| | | Metal thickness | 1.487 to 1.500 | - | |
| | | Clearance | 0.038 to 0.090 | 0.150 | |
| | TNV84 to 88 | Pin outside diameter | 47.952 to 47.962 | 47.902 | |
| | | Metal inside diameter | 48.000 to 48.026 | - | |
| | | Metal thickness | 1.492 to 1.500 | - | |
| | | Clearance | 0.038 to 0.074 | 0.150 | |
| | 4TNV94L•98 | Pin outside diameter | 57.952 to 57.962 | 57.902 | |
| | | Metal inside diameter | 58.000 to 58.026 | - | |
| | | Metal thickness | 1.492 to 1.500 | - | |
| | | Clearance | 0.038 to 0.074 | 0.150 | |
| | 4TNV106(T) | Pin outside diameter | 63.952 to 63.962 | 63.902 | |
| | | Metal inside diameter | 64.016 to 64.042 | - | |
| | | Metal thickness | 1.984 to 1.992 | - | |
| | | Clearance | 0.054 to 0.090 | 0.150 | |
| Crank journal | 3TNV82A | Journal outside diameter | 46.952 to 46.962 | 46.902 | |
| | | Metal inside diameter | 47.000 to 47.032 | - | |
| | | Metal thickness | 1.987 to 2.000 | - | |
| | | Clearance | 0.038 to 0.080 | 0.150 | |
| | TNV84 to 88 Selective pairing | Journal outside diameter | 53.952 to 53.962 | 53.902 | |
| | | Metal inside diameter | 54.000 to 54.020 | - | |
| | | Metal thickness | 1.995 to 1.990 | - | |
| | | Clearance | 0.038 to 0.068 | 0.150 | |
| | 4TNV94L•98 Selective pairing | Journal outside diameter | 64.952 to 64.962 | 64.902 | |
| | | Metal inside diameter | 65.000 to 65.020 | - | |
| | | Metal thickness | 1.995 to 2.010 | - | |
| | | Clearance | 0.038 to 0.068 | 0.150 | |
| | 4TNV106(T) Selective pairing | Journal outside diameter | 75.952 to 75.962 | 75.902 | |
| | | Metal inside diameter | 76.014 to 76.034 | - | |
| | | Metal thickness | 2.488 to 2.503 | - | |
| | | Clearance | 0.052 to 0.082 | 0.150 | |

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## (3) Thrust bearing

mm

| Inspection item | | Standard | Limit | Reference page |
|---|---|---|---|---|
| Crankshaft side gap | All models | 0.13 to 0.23 | 0.28 | 4.4.4 |

## (4) Piston and ring

Piston

mm

| Inspection item | | | Standard | Limit | Reference page |
|---|---|---|---|---|---|
| Piston outside diameter (Measure in the direction vertical to the piston pin.) | | 3TNV82A | 81.950 to 81.980 | 81.905 | 4.4.5.(4) |
| | | 3,4TNV84(T) | 83.940 to 83.970 | 83.895 | |
| | | 3,4TNV88 | 87.940 to 87.970 | 87.895 | |
| | | 4TNV94L | 93.935 to 93.965 | 93.900 | |
| | | 4TNV98(T) | 97.930 to 97.960 | 97.895 | |
| | | 4TNV106(T) | 105.930 to 105.960 | 105.880 | |
| Piston diameter measure position (Upward from the bottom end of the piston) | | 3TNV82A | 16 | - | |
| | | 3,4TNV84(T) | 24 | - | |
| | | 3,4TNV88 | 24 | - | |
| | | 4TNV94L | 22 | - | |
| | | 4TNV98(T) | 22 | - | |
| | | 4TNV106(T) | 30 | - | |
| Piston pin | 3TNV82A | Hole inside diameter | 23.000 to 23.009 | 23.039 | |
| | | Pin outside diameter | 22.995 to 23.000 | 22.965 | |
| | | Clearance | 0.000 to 0.014 | 0.074 | |
| | 3,4TNV84(T) 3,4TNV88 | Hole inside diameter | 26.000 to 26.009 | 26.039 | |
| | | Pin outside diameter | 25.995 to 26.000 | 25.965 | |
| | | Clearance | 0.000 to 0.014 | 0.074 | |
| | 4TNV94L•98 | Hole inside diameter | 30.000 to 30.009 | 30.039 | |
| | | Pin outside diameter | 29.989 to 30.000 | 29.959 | |
| | | Clearance | 0.000 to 0.020 | 0.080 | |
| | 4TNV106(T) | Hole inside diameter | 37.000 to 37.011 | 37.039 | |
| | | Pin outside diameter | 36.989 to 37.000 | 36.959 | |
| | | Clearance | 0.000 to 0.022 | 0.080 | |

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Piston ring

mm

| Model | Inspection item | | Standard | limit | Reference page |
|---|---|---|---|---|---|
| 3TNV82A TNV84 | Top ring | Ring groove width | 2.065 to 2.080 | 2.170 | 4.4.5.(4) |
| | | Ring width | 1.970 to 1.990 | 1.950 | |
| | | Side clearance | 0.075 to 0.110 | 0.200 | |
| | | End clearance | 0.200 to 0.400 | 0.490 | |
| | Second ring | Ring groove width | 2.035 to 2.050 | 2.150 | |
| | | Ring width | 1.970 to 1.990 | 1.950 | |
| | | Side clearance | 0.045 to 0.080 | 0.200 | |
| | | End clearance | 0.200 to 0.400 | 0.490 | |
| | Oil ring | Ring groove width | 4.015 to 4.030 | 4.130 | |
| | | Ring width | 3.970 to 3.990 | 3.950 | |
| | | Side clearance | 0.025 to 0.060 | 0.180 | |
| | | End clearance | 0.200 to 0.400 | 0.490 | |
| TNV88 | Top ring | Ring groove width | 2.060 to 2.075 | 2.170 | |
| | | Ring width | 1.970 to 1.990 | 1.950 | |
| | | Side clearance | 0.070 to 0.105 | 0.200 | |
| | | End clearance | 0.200 to 0.400 | 0.490 | |
| | Second ring | Ring groove width | 2.025 to 2.040 | 2.140 | |
| | | Ring width | 1.970 to 1.990 | 1.950 | |
| | | Side clearance | 0.035 to 0.070 | 0.190 | |
| | | End clearance | 0.200 to 0.400 | 0.490 | |
| | Oil ring | Ring groove width | 4.015 to 4.030 | 4.130 | |
| | | Ring width | 3.970 to 3.990 | 3.950 | |
| | | Side clearance | 0.025 to 0.060 | 0.180 | |
| | | End clearance | 0.200 to 0.400 | 0.490 | |
| 4TNV94L/98 | Top ring | Ring groove width | 2.040 to 2.060 | - | |
| | | Ring width | 1.940 to 1.960 | 1.920 | |
| | | Side clearance | 0.080 to 0.120 | - | |
| | | End clearance | 0.250 to 0.450 | 0.540 | |
| | Second ring | Ring groove width | 2.080 to 2.095 | 2.195 | |
| | | Ring width | 1.970 to 1.990 | 1.950 | |
| | | Side clearance | 0.090 to 0.125 | 0.245 | |
| | | End clearance | 0.450 to 0.650 | 0.730 | |
| | Oil ring | Ring groove width | 3.015 to 3.030 | 3.130 | |
| | | Ring width | 2.970 to 2.990 | 2.950 | |
| | | Side clearance | 0.025 to 0.060 | 0.180 | |
| | | End clearance | 0.250 to 0.450 | 0.550 | |
| 4TNV106(T) | Top ring | Ring groove width | 2.520 to 2.540 | - | |
| | | Ring width | 2.440 to 2.460 | 2.420 | |
| | | Side clearance | 0.060 to 0.100 | - | |
| | | End clearance | 0.300 to 0.450 | 0.540 | |
| | Second ring | Ring groove width | 2.070 to 2.085 | 2.185 | |
| | | Ring width | 1.970 to 1.990 | 1.950 | |
| | | Side clearance | 0.080 to 0.115 | 0.235 | |
| | | End clearance | 0.450 to 0.600 | 0.680 | |
| | Oil ring | Ring groove width | 3.015 to 3.030 | 3.130 | |
| | | Ring width | 2.970 to 2.990 | 2.950 | |
| | | Side clearance | 0.025 to 0.060 | 0.180 | |
| | | End clearance | 0.300 to -0.500 | 0.600 | |

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## (5) Connecting rod

mm

| Inspection item | Standard | Limit | Reference page |
|---|---|---|---|
| Thrust clearance | 0.2 to 0.4 | - | 4.4.4 |

Rod small end

mm

| Model | Item | Standard | Limit | Reference page |
|---|---|---|---|---|
| 3TNV82A | Bushing inside diameter | 23.025 to 23.038 | 23.068 | 4.4.5.(5) |
| | Pin outside diameter | 22.995 to 23.000 | 22.967 | |
| | Clearance | 0.025 to 0.043 | 0.101 | |
| TNV84-88 | Bushing inside diameter | 26.025 to 26.038 | 26.068 | |
| | Pin outside diameter | 25.995 to 26.000 | 25.967 | |
| | Clearance | 0.025 to 0.043 | 0.101 | |
| 4TNV94L/98 | Bushing inside diameter | 30.025 to 30.038 | 30.068 | |
| | Pin outside diameter | 29.987 to 30.000 | 29.959 | |
| | Clearance | 0.025 to 0.051 | 0.109 | |
| 4TNV106(T) | Bushing inside diameter | 37.025 to 37.038 | 37.068 | |
| | Pin outside diameter | 36.989 to 37.000 | 36.961 | |
| | Clearance | 0.025 to 0.049 | 0.107 | |

## (6) Tappet

mm

| Inspection item | | Standard | Limit | Reference page |
|---|---|---|---|---|
| TNV82A-88 | Tappet hole (block) inside diameter | 12.000 to 12.025 | 12.045 | 4.4.5.(6) |
| | Tappet stem outside diameter | 11.975 to 11.990 | 11.955 | |
| | Clearance | 0.010 to 0.050 | 0.090 | |
| 4TNV94L•98 | Tappet hole (block) inside diameter | 12.000 to 12.018 | 12.038 | |
| | Tappet stem outside diameter | 11.975 to 11.990 | 11.955 | |
| | Clearance | 0.010 to 0.043 | 0.083 | |
| 4TNV106(T) | Tappet hole (block) inside diameter | 14.000 to 14.018 | 14.038 | |
| | Tappet stem outside diameter | 13.966 to 13.984 | 13.946 | |
| | Clearance | 0.015 to 0.052 | 0.092 | |

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# 12.3 Lubricating oil system (Trochoid pump)

## (1) Outside clearance of outer rotor

mm

| Model | Standard | Limit | Reference page |
|---|---|---|---|
| 3TNV82A to 88 | 0.12 to 0.21 | 0.30 | 5.5.1.(1) |
| 4TNV94L/98 | 0.100 to 0.155 | 0.25 | |
| 4TNV106(T) | 0.100 to 0.165 | 0.25 | |

## (2) Side clearance of outer rotor

mm

| Model | Standard | Limit | Reference page |
|---|---|---|---|
| 3TNV82A to 88 | 0.02 to 0.07 | 0.12 | 5.5.1.(1) |
| 4TNV94L/98 | 0.05 to 0.10 | 0.15 | |
| 4TNV106(T) | 0.03 to 0.12 | 0.17 | |

## (3) Tip clearance between outer rotor and inner rotor

Insert a gap gage between an outer rotor and an inner rotor, and measure the tip clearance.

Tip clearance mm

| Standard | Limit |
|---|---|
| - | 0.16 |

## (4) Inside clearance of inner rotor

mm

| Item | Parts | Standard | Standard | Limit | Reference page |
|---|---|---|---|---|---|
| Inside clearance of inner rotor | Gear boss diameter | 53.05 to 53.15 | 0.3 to 0.5 | 0.6 | 5.5.1.(2) |
| | Rotor diameter | 53.45 to 53.55 | | | |
| Width across flat clearance of inner rotor | Width across flat of Gear boss | 49.45 to 49.75 | 0.2 to 0.6 | 0.7 | |
| | Width across flat of rotor | 49.95 to 50.05 | | | |

## (5) Rotor shaft clearance

mm

| Model | Inspection item | Standard | Limit | Reference page |
|---|---|---|---|---|
| 4TNV94L/ 98 | Gear case bearing I.D. | 12.980 to 13.02 | 13.05 | 5.5.1.(3) |
| | Rotor shaft O.D. | 12.955 to 12.975 | 12.945 | |
| | Rotor clearance | 0.035 to 0.065 | 0.105 | |
| 4TNV106(T) | Gear case bearing I.D. | 13.00 to 13.02 | 13.05 | |
| | Rotor shaft O.D. | 12.955 to 12.965 | 12.945 | |
| | Rotor clearance | 0.035 to -0.065 | 0.105 | |

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# 13. Tightening torque for bolts and nuts

## 13.1 Tightening torques for main bolts and nuts

| Part and engine model | | Thread diameter × pitch mm | Tightening torque N•m (kgf•m) | Lubricating oil application (thread portion, and seat surface) | Reference page |
|---|---|---|---|---|---|
| Cylinder head bolt | 3TNV82A | M9 × 1.25 | 61.7 to 65.7 (6.3 to 6.7) | Applied | 4.2.4 |
| | TNV84 to 88 | M10 × 1.25 | 85.3 to 91.1 (8.7 to 9.3) | | |
| | 4TNV94L•98 | M11 × 1.25 | 103.1 to 112.9 (10.511.5) | | |
| | 4TNV106(T) | M13 × 1.5 | 188.0 to 197.8 (19.0 to 20.0) | | |
| Connecting rod bolt | 3TNV82A | M8 × 1.0 | 37.2 to 41.2 (3.8 to 4.2) | Applied | 4.4.4 |
| | TNV84 to 88 | M9 × 1.0 | 44.1 to 49.0 (4.5 to 5.0) | | |
| | 4TNV94L•98 | M10 × 1.0 | 53.9 to 58.8 (5.5 to 6.0) | | |
| | 4TNV106(T) | M11 × 1.0 | 78.5 to 83.4 (8.0 to 8.5) | | |
| Flywheel set bolt | TNV82A to 88 | M10 × 1.25 | 83.3 to 88.2 (8.5 to 9.0) | Applied | 4.3.4 |
| | 4TNV94L•98•106(T) | M14 × 1.5 | 186.2 to 205.8 (19 to 21) | | |
| Bearing cap set bolt | 3TNV82A | M10 × 1.25 | 76.4 to 80.4 (7.8 to 8.2) | Applied | 4.4.4 |
| | TNV84 to 88 | M12 × 1.5 | 93.2 to 98.1 (9.5 to 10.5) | | |
| | 4TNV94L•98 | M11 × 1.25 | 108.1 to 117.9 (11.0 to 12.0) | | |
| | 4TNV106(T) | M14 × 1.5 | 186.2 to 205.8 (19 to 21) | | |
| Crankshaft pulley set bolt | TNV82A to 88 | M14 × 1.5 | 112.7 to 122.7 (11.5 to 12.5) | Applied | 4.3.4 |
| | 4TNV94L•98•106(T) | M14 × 1.5 | 107.9 to 127.5 (11.0 to 13.0) | | |
| Fuel nozzle set bolt | TNV82A to 88 | M8 × 1.25 | 24.4 to 28.4 (2.5 to 2.9) | Not applied | - |
| | 4TNV94L•98•106(T) | M8 × 1.25 | 22.6 to 28.4 (2.3 to 2.9) | | |
| Fuel pump drive gear set nut | TNV82A to 88 | M14 × 1.5 | 78 to 88 (8 to 9) | Not applied | 4.3.4 |
| | 4TNV94L•98•106(T) | M18 × 1.5 | 113 to 123 (11.5 to 12.5) | | |
| Fuel injection pipe set bolt | TNV82A to 88 | M12 × 1.5 | 29.4 to 34.3 (3.0 to 3.5) | Not applied | - |
| | 4TNV94L•98•106(T) | M12 × 1.5 | 19.6 to 24.5 (2.0 to 2.5) | | |
| Fuel return pipe joint bolt | 4TNV94L98106(T) | M6 × 1.0 | 7.8 to 9.8 (0.8 to 1.0) | Not applied | - |
| Rocker arm cover set bolt | 4TNV106(T) | M8 × 1.25 | 16.7 to 22.5 (1.7 to 2.3) | Not applied | - |
| EPA flange set bolt | 4TNV106(T) | M18 × 1.5 | 113 to 123 (11.5 to 12.5) | Not applied | - |

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# 13.2 Tightening torques for standard bolts and nuts

| Item | Nominal thread diameter × pitch | Tightening torque N•m (kgf•m) | Remarks |
|---|---|---|---|
| Hexagon bolt (7T) and nut | M6 × 1 | 9.8 to 11.8 (1.0 to 1.2) | Use 80 % of the value at left when the tightening part is aluminum. Use 60 % of the value at left for 4T bolts and lock nuts. |
| | M8 × 1.25 | 22.6 to 28.4 (2.3 to 2.9) | |
| | M10 × 1.5 | 44.1 to 53.9 (4.5 to 5.5) | |
| | M12 × 1.75 | 78.4 to 98.0 (8.0 to 10) | |
| | M14 × 1.5 | 127.5 to 147.1 (13 to 15) | |
| | M16 × 1.5 | 215.7 to 235.4 (22 to 24) | |
| PT plug | 1/8 | 9.8 (1.0) | - |
| | 1/4 | 19.6 (2.0) | |
| | 3/8 | 29.4 (3.0) | |
| | 1/2 | 58.8 (6.0) | |
| Pipe joint bolt | M8 | 12.7 to 16.7 (1.3 to 1.7) | - |
| | M10 | 19.6 to 25.4 (2.0 to 2.6) | |
| | M12 | 24.5 to 34.3 (2.5 to 3.5) | |
| | M14 | 39.2 to 49.0 (4.0 to 5.0) | |
| | M16 | 49.0 to 58.8 (5.0 to 6.0) | |

Note) Lubricating oil is not applied to threaded portion and seat surface.

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# YANMAR

## SERVICE MANUAL

# FUEL INJECTION EQUIPMENT

## MODEL YPD-MP2/YPD-MP4 SERIES

YANMAR CO.,LTD.

# Introduction

This document describes the features, disassembly, reassembly and adjustment procedure of the fuel injection unit (Model YPD-MP2,MP4) for Yanmar Diesel Engine Model TNV.

Fuel injection unit is an essential mechanism of diesel engines, and thus, has to be designed to allow fine adjustment to the engine load.

Therefore, the components of the fuel injection pumps are required to be given high-precision. To meet this requirement, we process and assemble them very accurately.

Accordingly, when performing disassembly and adjustment works in the market, keep the workbenches and their environment clean to surely prevent dirt and dust from attaching to the components of the unit, and take special care that the components are not rusted.

Please note that the specifications of the components are revised to improve the quality of the product, and thus, the details of the changed specifications will be notified through the correction table every time the change occurs.

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# 1. For Safe Servicing

- Most accidents are caused by negligence of basic safety rules and precautions. For accident prevention, it is important to avoid such causes before development to accidents.
  Please read this manual carefully before starting repair or maintenance to fully understand safety precautions and appropriate inspection and maintenance procedures.
  Attempting at a repair or maintenance job without sufficient knowledge may cause an unexpected accident.
- It is impossible to cover every possible danger in repair or maintenance in the manual. Sufficient consideration for safety is required in addition to the matters marked CAUTION. Especially for safety precautions in a repair or maintenance job not described in this manual, receive instructions from a knowledgeable leader.

## 1.1. Warning Symbols

- Safety marks used in this manual and their meanings are as follows:




**DANGER** indicates an imminently hazardous situation, which if not avoided, WILL result in death or serious injury.




**WARNING** indicates a potentially hazardous situation, which if not avoided, COULD result in death or serious injury.




**CAUTION** indicates a potentially hazardous situation, which if not avoided, may result in minor or moderate injury.

- Any matter marked **[NOTICE]** in this manual is especially important in servicing.
  If not observed, the product performance and quality may not be guaranteed.

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# 1.2. Safety Precautions

**⚠ WARNING**



- Place allowing sufficient ventilation

  Jobs such as engine running part welding and polishing the paint with sandpaper should be done in a well-ventilated place.

Failure to Observe

Very dangerous for human body due to the possibility of inhaling poisonous gas or dust.

**⚠ CAUTION**

- Sufficient wide and flat place

  The floor space of the service shop for inspection and maintenance should be sufficiently wide and flat without any holes.

Failure to observe

An accident such as a violent fall may be caused.

**⚠ CAUTION**

- Clean, orderly arranged place

  No dust, mud, 0il or parts should be left on the floor surface.

Failure to Observe

An unexpected accident may be caused.

**⚠ CAUTION**



- Bright, safety illuminated place

  The working place should be illuminated sufficiently and safety. For a job in a dark place where it is difficult to see, use a portable safety lamp. The bulb should be covered with a wire cage for protection.

Failure to observe

The bulb may be broken accidentally causing ignition of leaking oil.

**⚠ CAUTION**



- Place equipped with a fire extinguisher

  Keep a first aid kit and fire extinguisher c1ose at hand in preparation for fire emergencies

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**⚠ CAUTION**



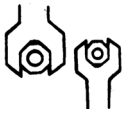
- Wears for safe operation

  Wear a helmet, working clothes , safety shoes and other safety protectors suited to the job. It is especially important to wear well-fiting work clothes.

Failure to observe

A serious accident such as trapping by a machine may occur.

**⚠ WARNING**



- Use of appropriate tools

  Use tools appropriate for the jobs to be done. Use a correctly sized tool for loosening or tightening a machine part.

Failure to observe

A serious injury or engine damage may occur.

**⚠ CAUTION**



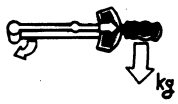
- Always use genuine parts

  Jobs such as engine running part welding and polishing the paint with sandpaper should be done in a well-ventilated place.

Failure to Observe

Shortening of MP pump unit life or an unexpected accident may arise.

**⚠ WARNING**




- Always tighten to the specified torque if designated in the manual.

Failure to Observe

Loosening or falling may cause parts damage or injury.

**⚠ CAUTION**

Observe the following instructions with regard to waste disposal.

Negligence of each instruction will cause environmental pollution.

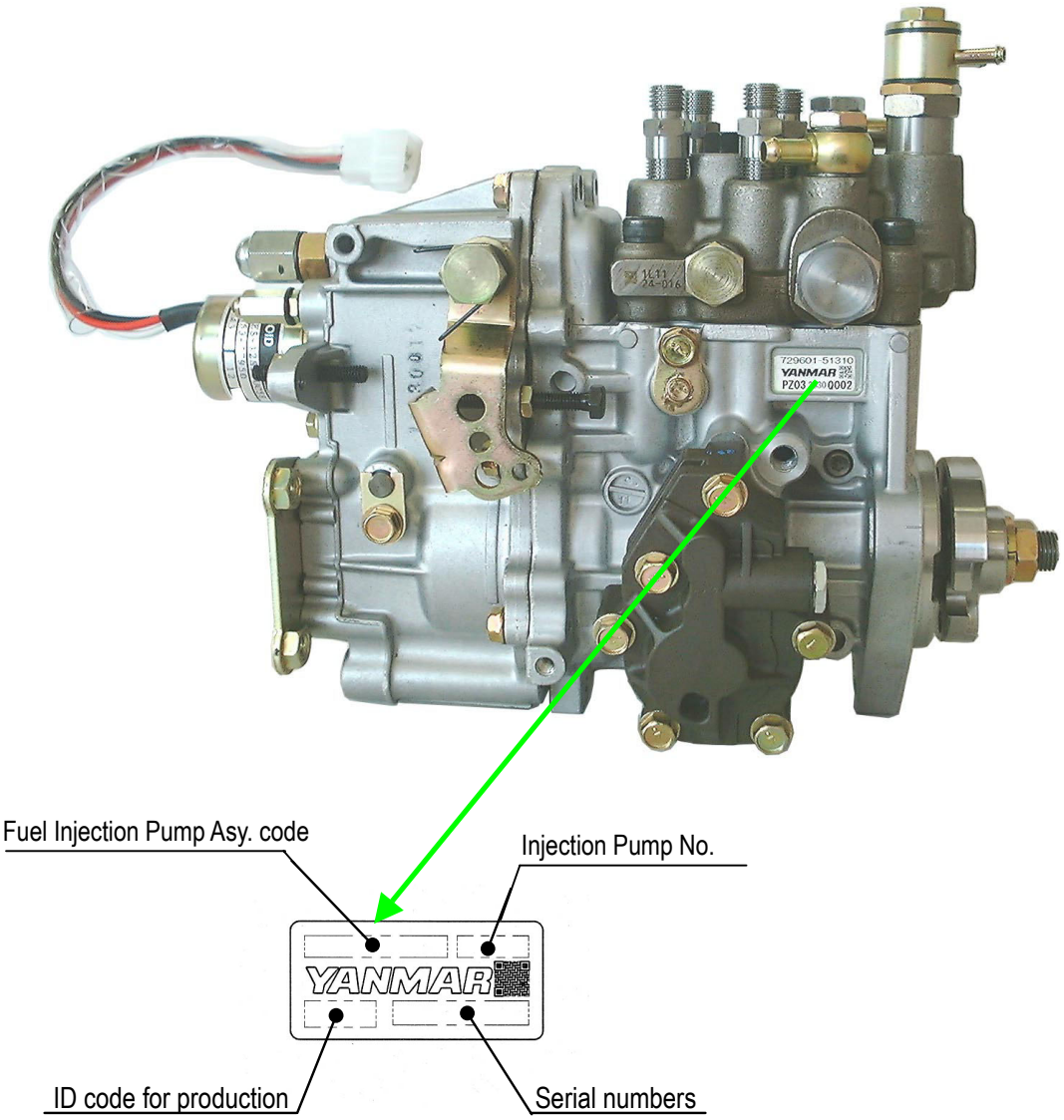
- Waste fluids such as engine oil and cooling water shall be discharged into a container without spillage onto the ground
- Do not let waste fluids be discharged into the sewerage, a river or the sea.
- Harmful wastes such as oil, fuel, solvents, filter elements and battery shall be treated according to the respective laws and regulations. Ask a qualified collecting company for example.

# 2. General information

## 2.1. Outline of MP pump

MP pump is a fuel injection pump that has been newly developed to be installed on Yanmar direct injection system diesel engines for the purpose of complying with the regulation for the exhaust gas emission that are becoming tighter in the future.
The fuel injection pump is a fuel distribution type pump that supplies fuel to each cylinder of the engine through a distribution shaft by using a single plunger unlike conventional rail system or distribution system pumps.

- Pump name plate



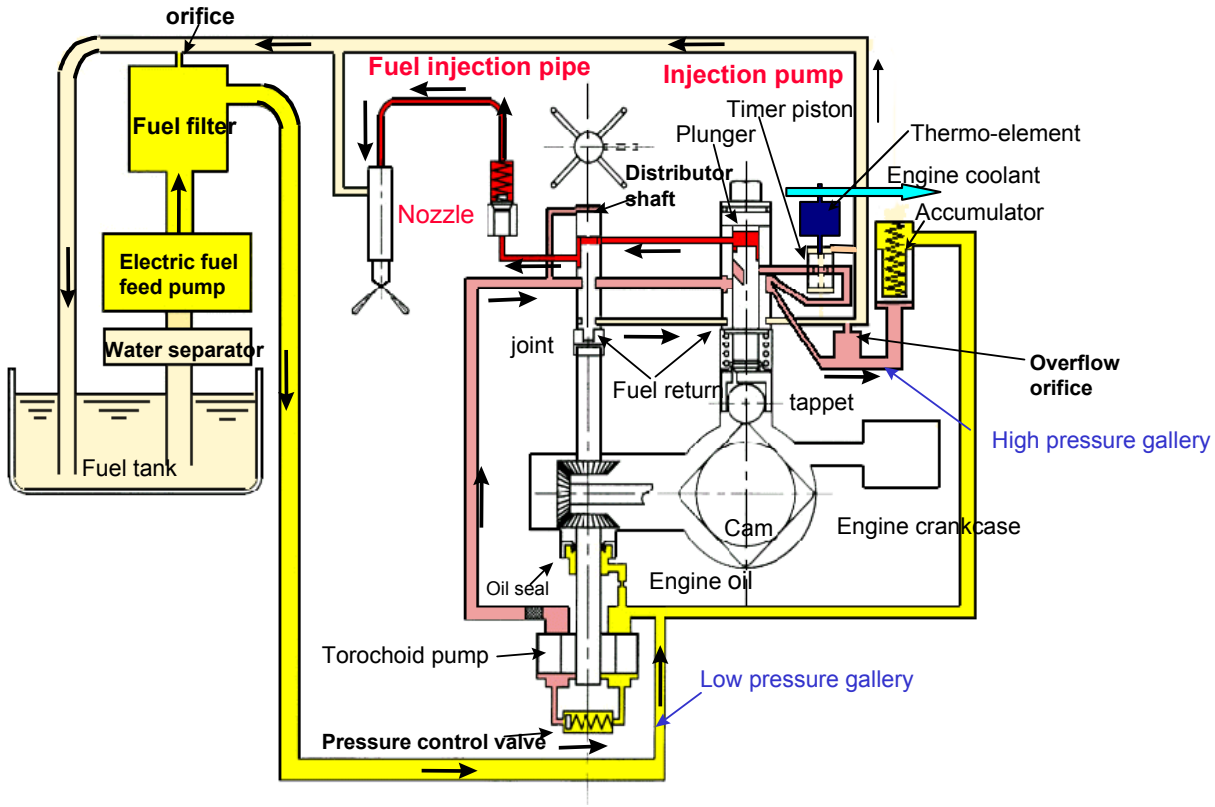
## 2.2. Specifications

| Model | YPD-3MP2 | YPD-4MP2 | YPD-4MP4 |
|---|---|---|---|
| Applicable Engine | 3TNV82A /84(T)/88 | 4TNV84(T) /88 | 4TNV94 /98(T)/106(T) |
| Plunger Diameter (mm) | 9mm | | 10mm |
| Max. Cam Lift (mm) | 8.1mm | | 10mm |
| Governor-System | Mechanical All Speed Governor | | |
| Fuel Injection Timing Control System | Built-in Hydraulic Control Timer | | |
| Fuel feed pump | Forced Lubrication System With Trochoid Pump | | |
| Lubrication system | Engine System Oil | | |
| Dry Weight (kg) | 8.4 | 8.6 | 11.5 |

# 2.3. Outline of fuel injection pump

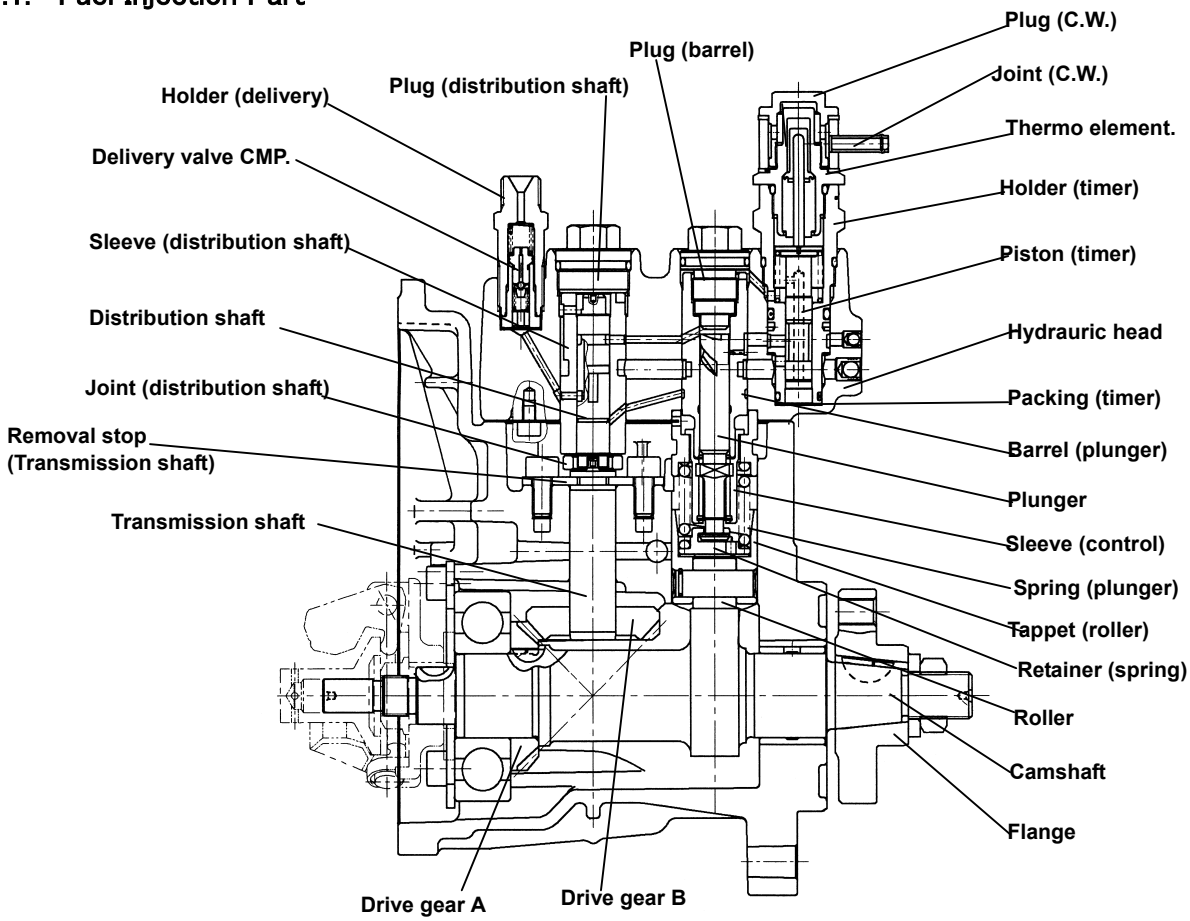
Yanmar distribution type fuel injection pump YPD-MP consists of a hydraulic head that is equipped with a single plunger, a single distribution shaft, and delivery valves for each individual cylinders, a pump housing that includes camshafts, and a governor, all of which are integrated into the main unit of the pump.
For the feed of the fuel, the plunger moves up / down and the distribution shaft rotates with the revolution of the camshaft to distribute the fuel among the cylinders individually.
Specifically, one revolution of camshaft completes three cycles (for three cylinder engine) of a process, including switching over to the high pressure flow path to each cylinder with the distribution shaft, opening delivery valve, high pressure pipe, fuel injection valve, and engine cylinders in this order. This process is repeated by the revolution of the camshaft.

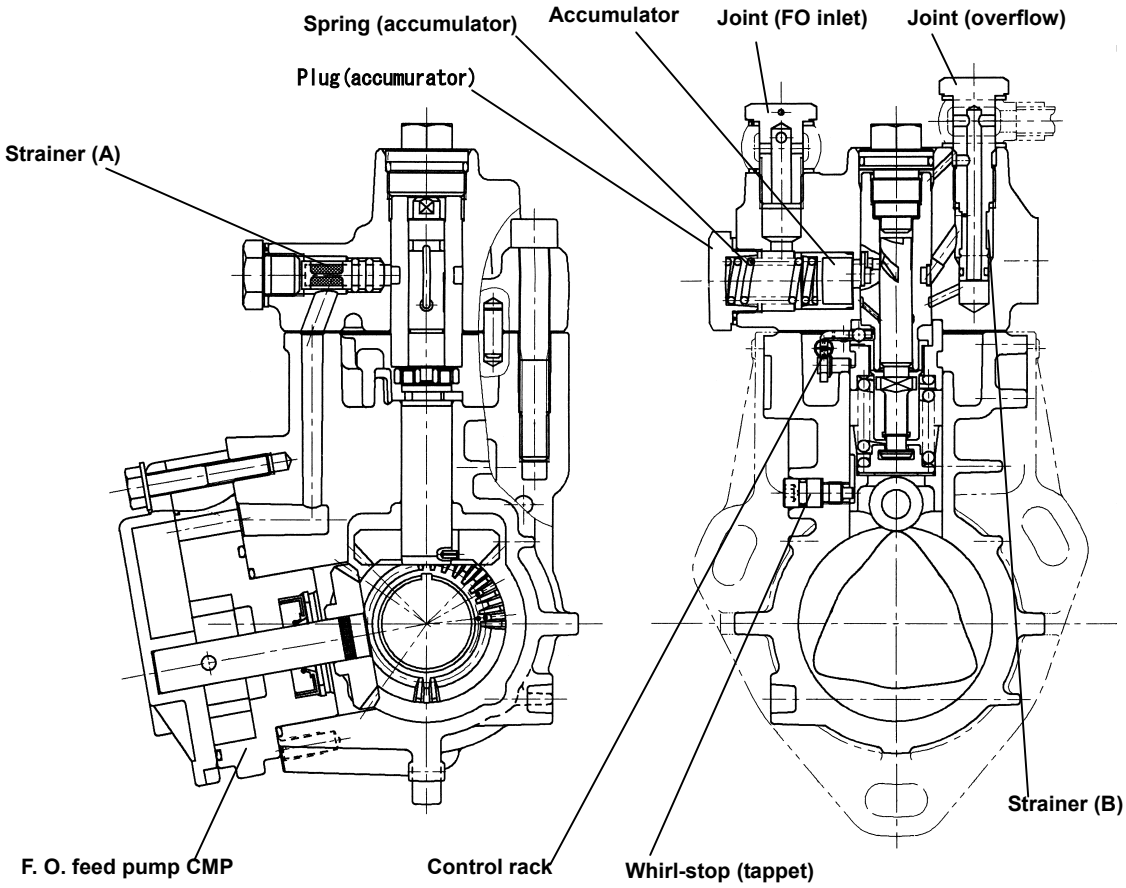
**< The Flow of the Fuel >**



# 2.4. Construction of MP-Pump

## 2.4.1. Fuel Injection Part



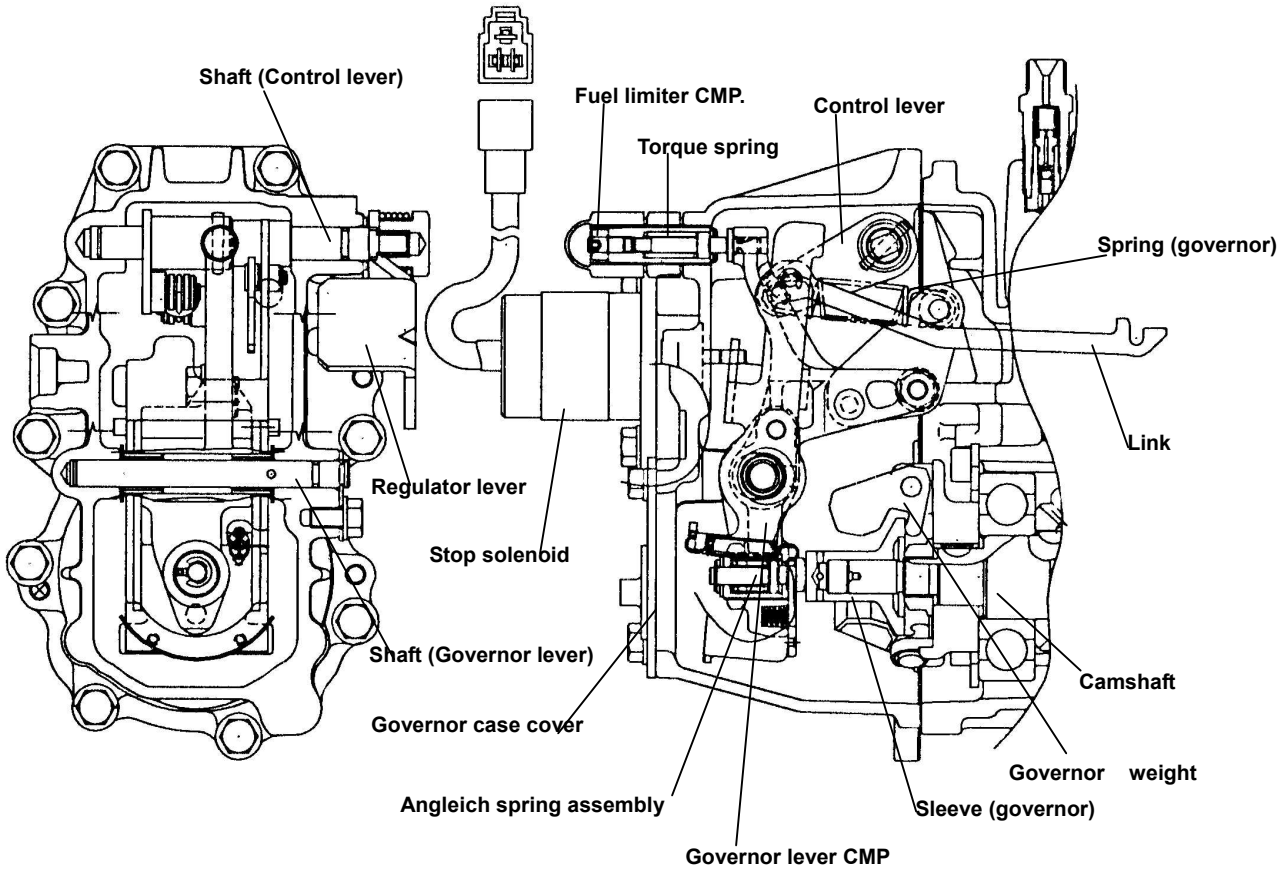



## 2.4.2. Governor Part

### 2.4.2.1. Construction of Governor

Usage condition of diesel engines are extremely varied, with a wide range of loads and speeds. The governor plays an important role in the operation of the engine by quickly adjusting the position of the control rack to control the amount of fuel injected, according to changes of engine speed.
It also automatically controls the engine to prevent engine speed from exceeding the maximum ,and keeps the engine from stopping.

- Mechanical governor




The governor weight mounted on the end of the fuel injection pump cam shaft rotates around the governor support pin, driven by the cam shaft, and is forced outwards by the centrifugal force acting on the weight.
The thrust force acting on the cam shaft due to this centrifugal force acts on the lower part of the tension lever through the sleeve A starting excess fuel spring is mounted on the bottom of the tension lever.
0ne end of the governor spring is hooked to the right upper end of the tension lever, and the other end to the spring lever of the control lever shaft.

As the spring lever and control lever are mounted on the same shaft, when the control lever is turned towards full, the governor spring is pulled and the load gradually increases.
Since the tension lever can move freely around the governor shaft on the player bearing, as speed increases and the shifter is pushed to the left, the tension lever rotates clockwise, and when speed decreases, the tension lever rotates counterclockwise.

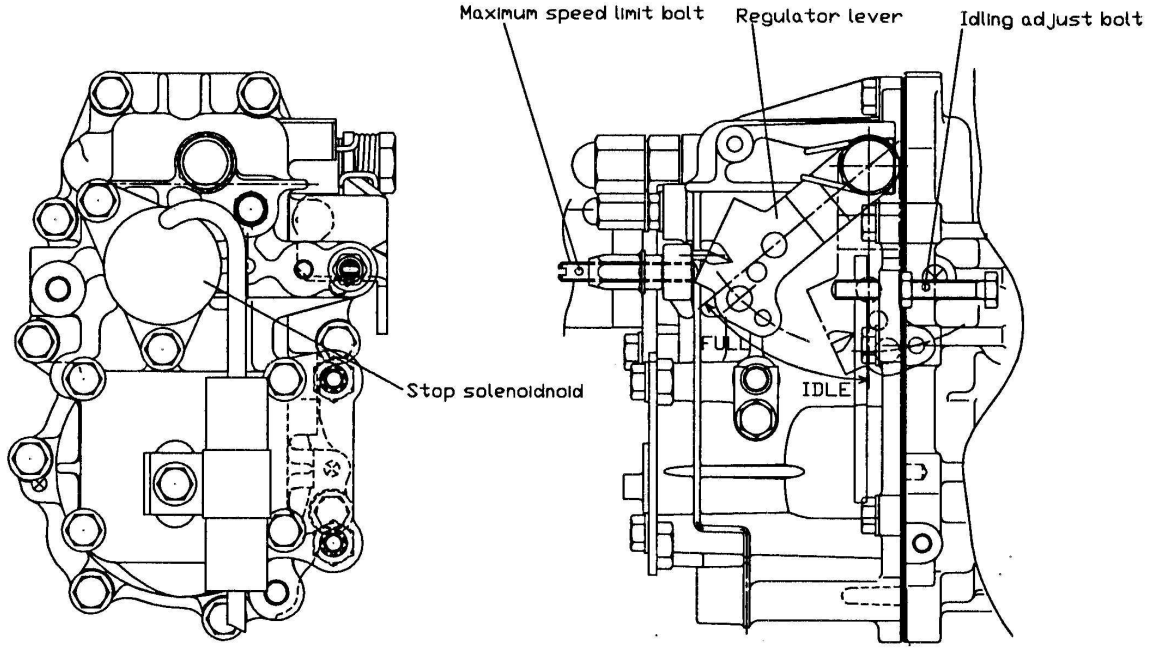
The governor lever rotates smoothly on the second shaft installed on the tension leveb. The bottom part of this lever is in contact with the sleeve through the shifter, which is in contact with the bottom of the tension lever through the excess fuel spring. It therefore moves with the tension lever according to increases／decreases in engine speed.

The top of the governor lever is connected to the fuel pump control rack through the governor link. The movement of the lever controls the volume of fuel injected by the pump. When speed increases the lever rotates clockwise to cause the control rack to reduce fuel and when speed decreases the lever rotates counterclockwise to cause the control rack to increase fuel, thus engine speed is controlled.

The top of the tension lever comes in contact with the stopper built into the top of the governor case to limit the maximum fuel injection volume.

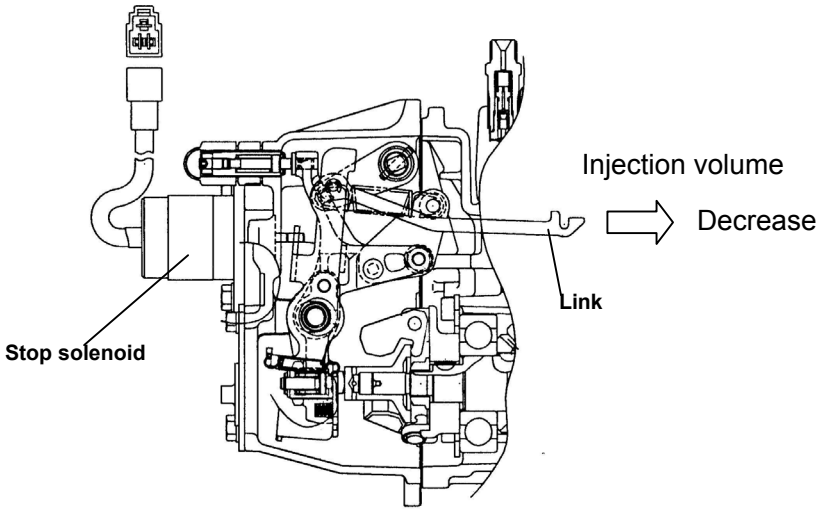
(1) Shape of control and stop levers

The control and stop levers that operate the governor have different shapes depending on engine design and method of attachment, as seen in the pictures below.
The motion of the control lever is regulated by the maximum speed adjustment bolt and the idling adjustment bolt. This maintains the necessary engine speed.



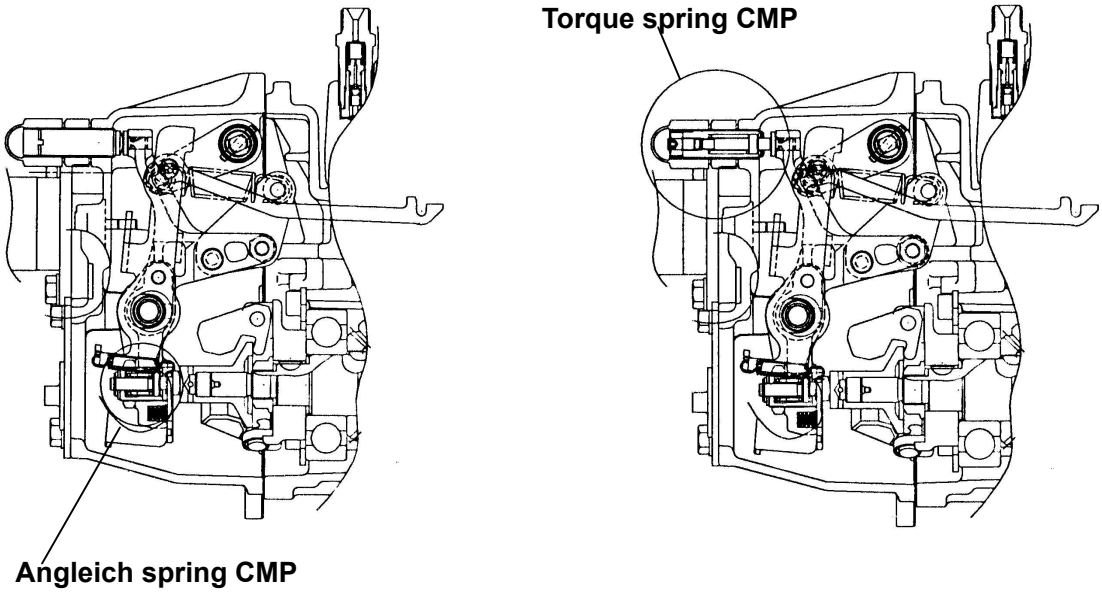
(2) Engine stop device

The magnetic solenoid is equipped to stop the engine.




(3)Torque rise equipment

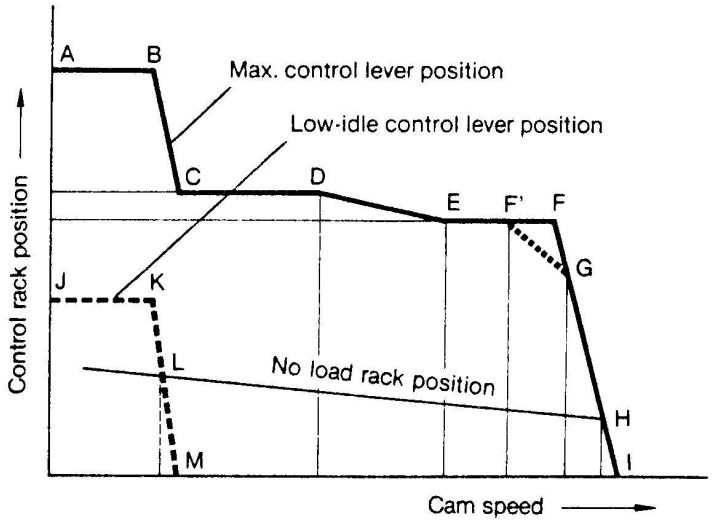
As mentioned before, this governor has a structure that allows you to equip it with an anglich and/or torque spring as torque rise equipment. In this way the requirements for different engines can full filled.



### 2.4.2.2. Function of Governor

(1) Function of governor

Following is a representation of the movement characteristics of the control rack at respective speeds, when the speed rise from 0,with the governor control lever at the maximum speed position:



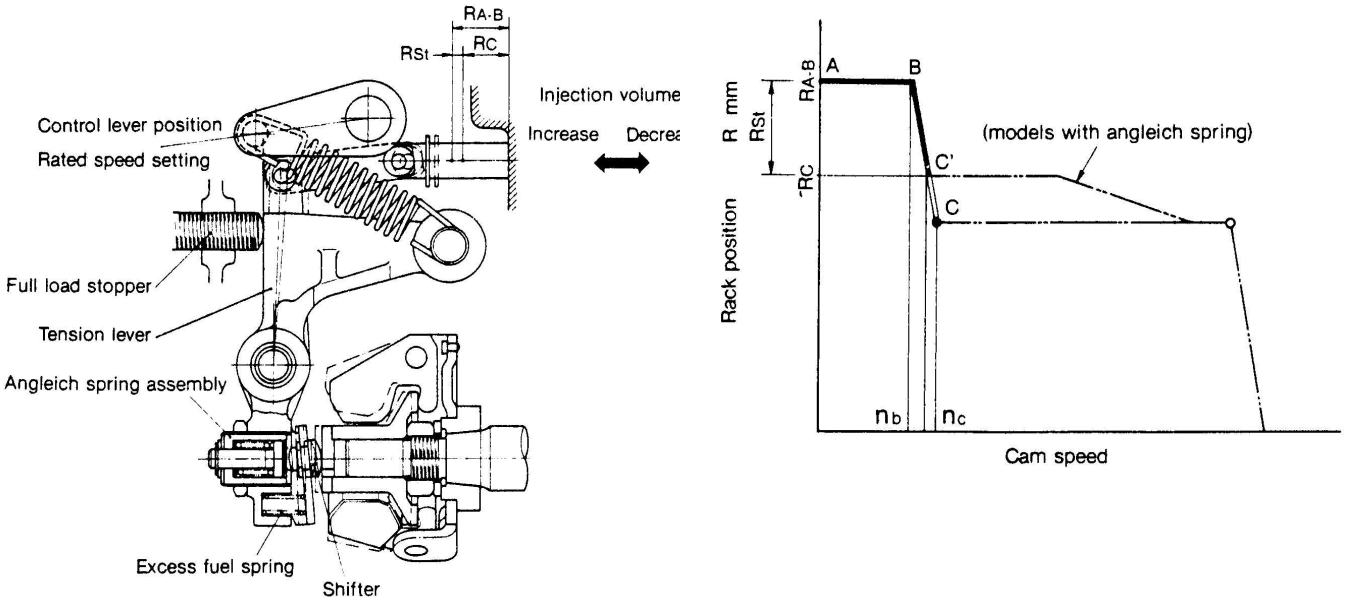

A-B : Fuel volume condition during starting. Volume is controlled by excess fuel spring.
B-C : The rack moves towards decrease after engine starts and speed increase as the load of the excess fuel spring is overcome by the centrifugal force of the governor weight.
C-D : High torque at low speed is developed by increasing fuel injection volume equivalent to the angleich stroke.
D-E : Condition when the thrust force exceeds that of the angleich spring force on the bottom of the tension lever and it gradually pushes the rack to decrease fuel when engine speed increases.
E-F : Condition when both right and left ends of the shifter come in contact with the sleeve and the bottom of the tension lever, and the control rack is kept at the normal position by the stopper.（max. injection volume position on models not equipped with an angleich spring)
F : Point when governor starts to take effect.
This is the rated output of the engine.
F' : Point when governor start to take effect on models with torque spring.
G : Continuous rating point（usually 85－90％ injection volume of F point).
H : No load max. speed
L : Low-idle position

(2) Starting control

Moving the control lever to the max. speed position pulls the governor spring, and moves the tension lever until it comes in contact with the control stopper.

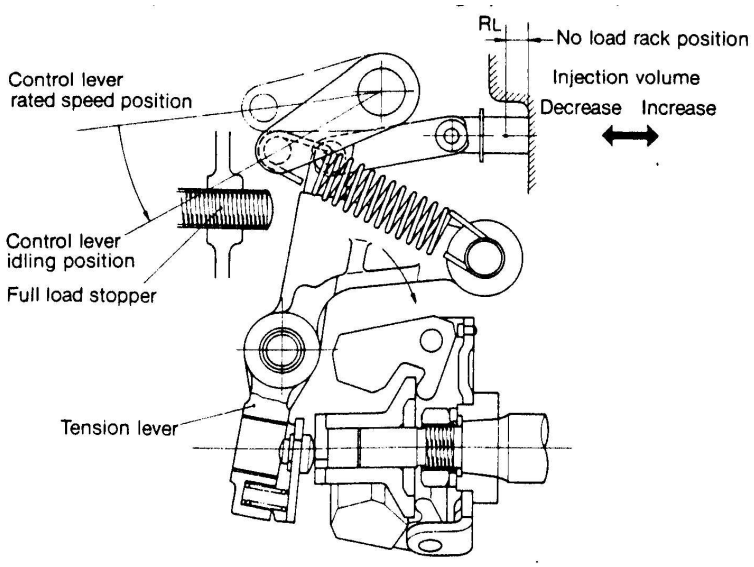
When this is done, the excess fuel spring provided in between the tension lever and governor lever holds the control rack at the maximum starting injection volume position $R_{A-B}$.

After the engine is started, the excess fuel spring is compressed when the centrifugal force of the governor weight overcomes the set of the excess fuel spring as speed exceeds $N_b$, speed goes from B to C' (on models with angleich spring ) or B to C(on models without angleich spring ). The rack reaches the position of $R_c$ where the governor lever and tension lever are interlocked.




(3) Idling

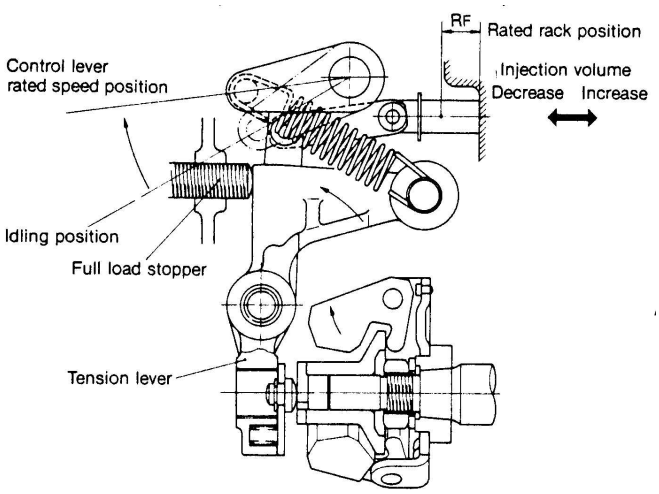
When the control lever is returned to the idling position after the engine is started. the governor spring tension decreases and the tension lever descends clockwise, and the governor weight load keeps the governor spring and the excess fuel spring load in equilibrium to maintain idling speed at ($R_L$).



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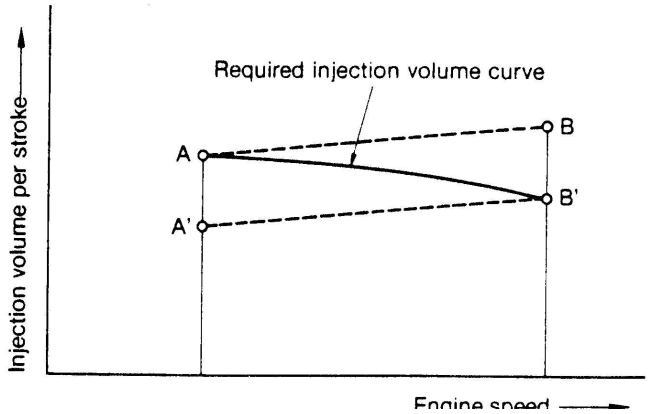
(4) Max speed

The angle of the control lever is set at determined engine speed. The governor keeps engine speed constant by adjusting sped when load changes.
For example, if the operator moves the control lever with the link from the idling position to max. Output, governor spring tension increases, the tension lever is pulled until it comes in contact with the full load stopper, the movement of the governor lever is transmitted
to the control rack via the link, maintaining the full load rack position, and engine sped increase until the governor weight thrust load and governor spring tension come into equilibrium at full load max. Speed.

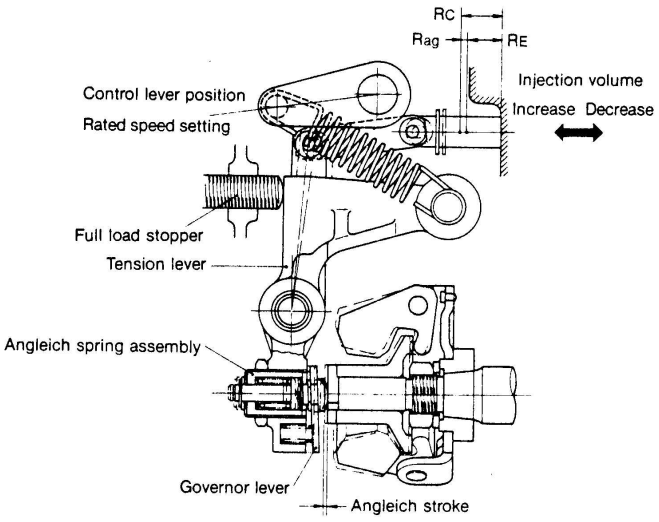


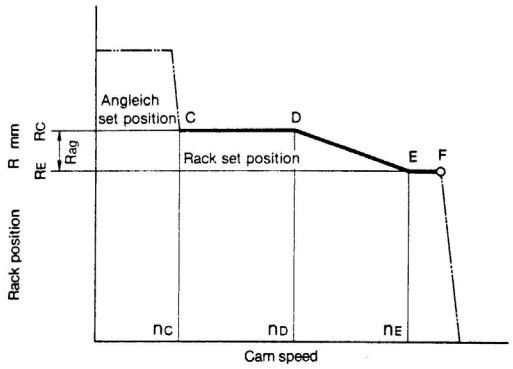

(5) Necessity and function of angleich

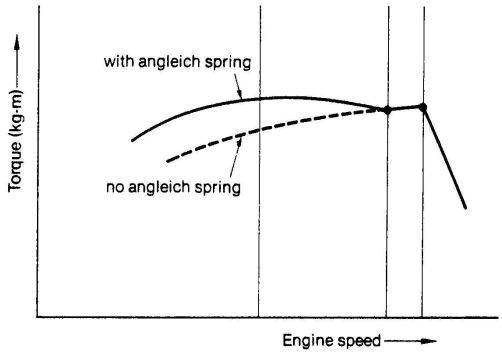
The governor must satisfy the required injection curves represented in the diagram below in order to obtain sufficient output at low speed, and not emit black smoke at high speed. the angleich spring was devised to provide for maximum torque at low sped by setting injection volume at point A, and shifting injection volume to point B' at high engine speed.



The angleich spring is mounted to the part of the tension lever (however some engine are not equipped with an angleich spring depending on usage and speed range utilized).
When engine speed is low, the governor weight cannot compress the angleich spring as the angleich spring load is lager than the governor weight, thrust load, and the control rack is held at a position ($R_C$) to increase injection volume.
Furthermore, as engine speed rise, the angleich spring is gradually compressed as governor weight thrust load increases and exceeds angleich load, before high speed control is effected. When the governor lever and the bottom of the tension lever come into contact (end of angleich stroke), injection volume is reduced by that amount, and the rack reaches the rated position ($R_E$).



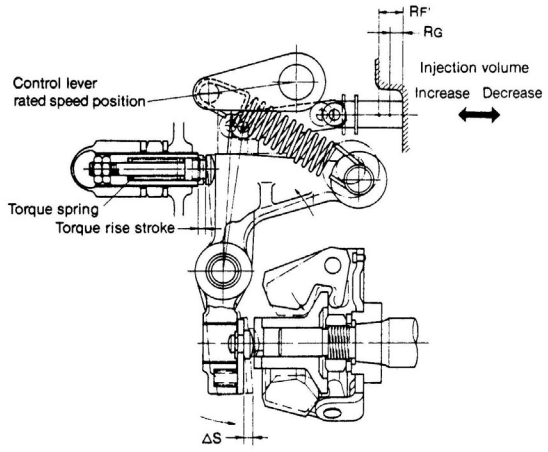
(6) Necessity of torque spring and function

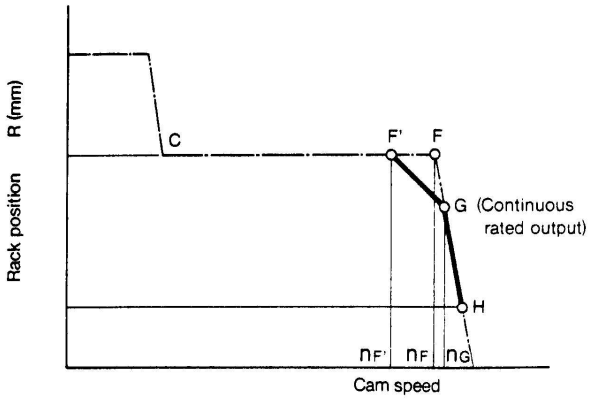
Engines used in construction machinery are subjected to sudden loads which cause a decrease in speed and sometimes results in stopping of the engine. A torque spring is provided to move the control rack towards injection volume increase when engine speed decrease, to increase torque to withstand overloads, and in turn prevent the engine from stopping.

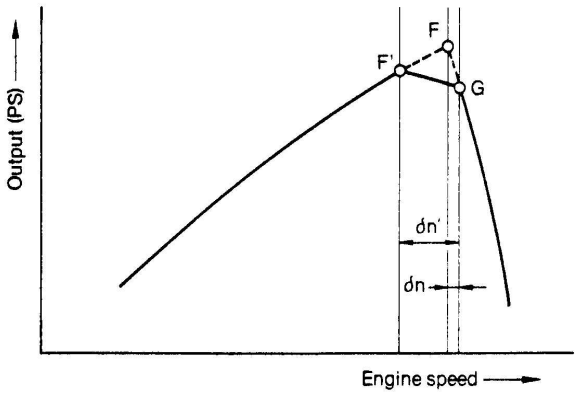
The governor control lever is fixed at point G in the diagram below, the continuous rated output position.

At this time, when engine is loaded, the tension lever encompasses the torque spring, the control rack comes away from full load stopper, and fluctuates between G and H according to engine load.

When the load on the engine exceeds the continuous rated output, speed decrease, governor spring tension exceeds the governor weight thrust load and overcomes the torque spring set load. The tension lever then gradually causes the control rack to move towards injection volume increase via the governor lever and link, and the torque rise stroke ends when the control rack reaches F'.



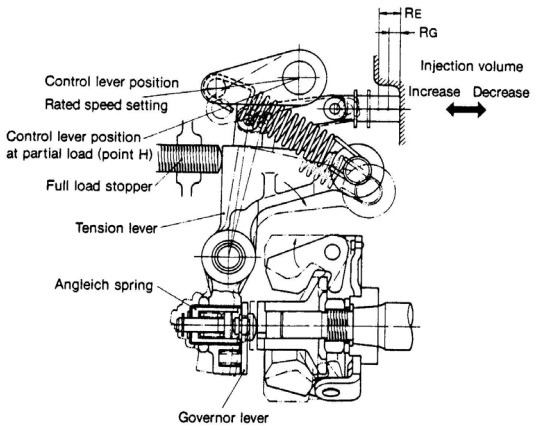



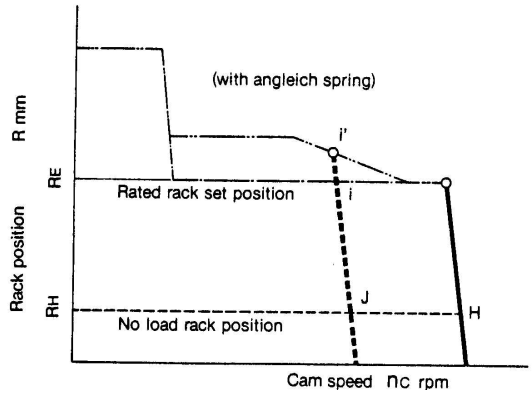

The torque spring thus provides for increasing of injection volume when speed decrease, to increase engine torque and in turn prevent engine stopping due to sudden increases in load, and also provide for strong engine output characteristics.

(7) No load max. speed

When the load decreases from full load max. speed and engine speed further increase, the increased thrust load of the governor weight acting on the governor spring through the tension lever exceeds the set load of the spring, the tension lever and governor lever descend clockwise, the control rack is pushed to the no load injection volume position (RH), and the engine is operated at no load max. Speed.

When the engine is being used at partial load, the governor spring functions in the same way at a lower speed (i, i'-j) as for full load max. Speed, as the governor spring set load is smaller.




(8) Stopping engine

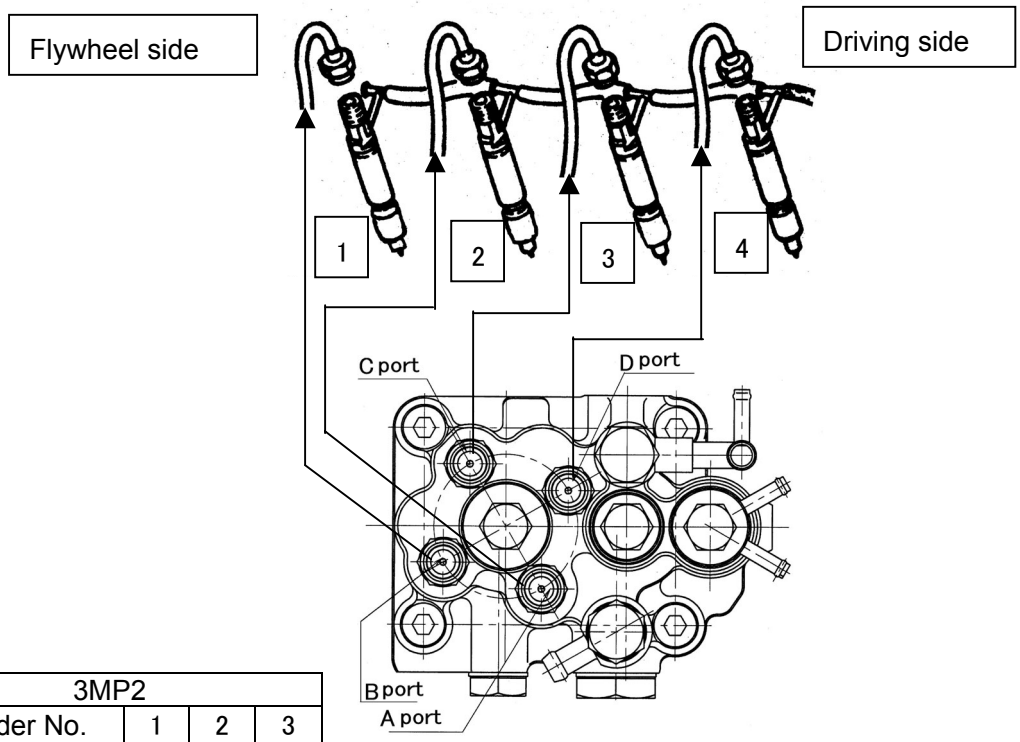
The engine stops when you turn the governor control lever all the way towards stop.

On engine equipped with a stop device, the engine can be stopped by moving the control rack to the stop position, regardless of the control lever position.

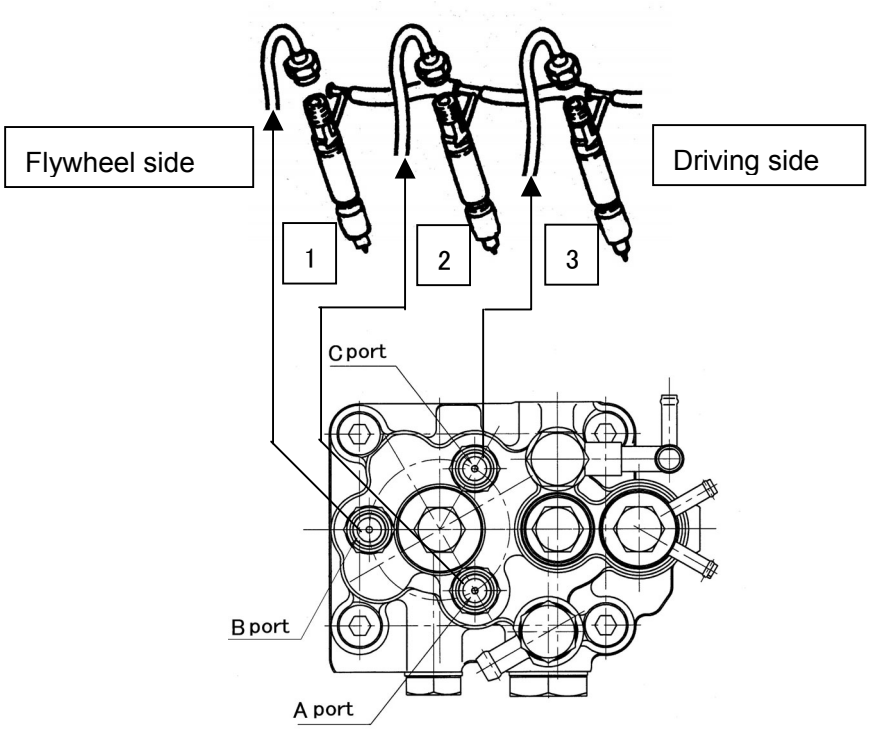
### 2.4.3. Delivery Part

**Delivery Ports and Cylinder Number**

| 4MP2, 4MP4 | | | | |
|---|---|---|---|---|
| Cylinder No. | 1 | 2 | 3 | 4 |
| Port No. | B | A | C | D |
| Injection Order | 2 | 1 | 3 | 4 |




| 3MP2 | | | |
|---|---|---|---|
| Cylinder No. | 1 | 2 | 3 |
| Port No. | B | A | C |
| Injection Order | 2 | 1 | 3 |

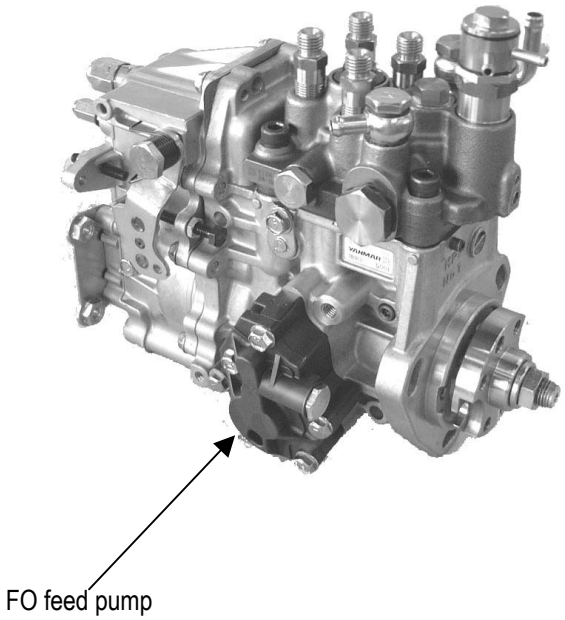


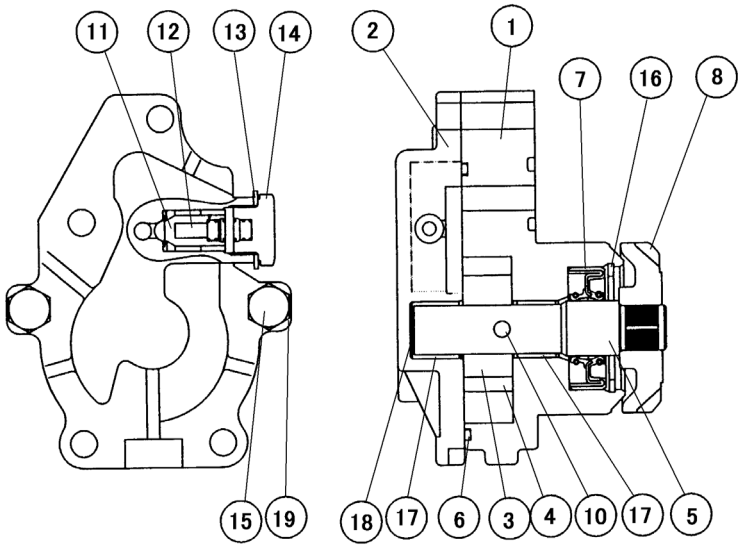
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# 2.5. Function of Component

## 2.5.1. F.O. Feed Pump

The FO feed pump feeds fuel oil from the fuel tank to the fuel injection pump via the water separator and fuel filter.
The trochoid FO feed pump, installed on the fuel injection pump side, is driven by the fuel camshaft via the bevel gear.
This feed pump can feed high pressure fuel oil into the FO injection pump, but while the fuel oil inside the piping is empty due to shortage of gases, etc., the pump's self-feeding performance is low. Accordingly, the manual priming pump with FO filter or solenoid pre-feed pump is used together. The feed pump failure causes the delivery pressure and volume to drop. This, in turn, shortens the service life of the fuel injection pump and causes the pump to become faulty.
Replace the feed pump assembly after 10,000 hours' use as a standard.




① Pump case
② Pump cover
③ Inner rotor
④ Outer rotor
⑤ Shaft
⑥ Molded ring
⑦ Oil seal
⑧ Bevel gear

⑩ Drive pin
⑪ Relief valve
⑫ Spring
⑬ Seal washer
⑭ Relief plug
⑮ Bolt
⑯ C-ring
⑰ Bush
⑱ Thrust washer
⑲ Washer

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### 2.5.1.1. Specifications of F.O. Feed Pump

| | YPD-MP2 | YPD-MP4 |
|---|---|---|
| Suction Head (kPa) | -10 | |
| Std. Delivery Pressure (MPa) | 0.4-0.5 | 0.6-0.7 |
| Std. Delivery Volume ($cm^3$/min) | 500 | 600 |

Pressure & delivery volume figures at conditions below:

Conditions:

Outlet orifice dia. : $\phi$ 0.7mm
F.O. grade : ISO 8217
Revolutions : 1000$min^{-1}$
F.O. temp. : 40 degC (104 degF)

### 2.5.1.2. Inspection of F.O. Feed Pump

(1) Check for the abnormal flaws and chipping on the bevel gear face. If found to be abnormal, replace the whole feed pump assembly.

(2) Check for the abnormal flaws or wear on the face contacting with the pump case, pump cover, inner rotor and outer rotor. If wear exceeds 0.1mm, replace the whole feed pump assembly.

(3) Check for the abnormal wear of the shaft and oil seal moving area. If wear exceeds 0.05mm in depth, replace the whole feed pump assembly.

(4) When no abnormality was found, just replace the molded ring and seal washer and re-assemble.

(5) After install the fuel injection pump, operate the fuel injection pump to check that no oil leaks from each part.

# 2.6. Timer Mechanism

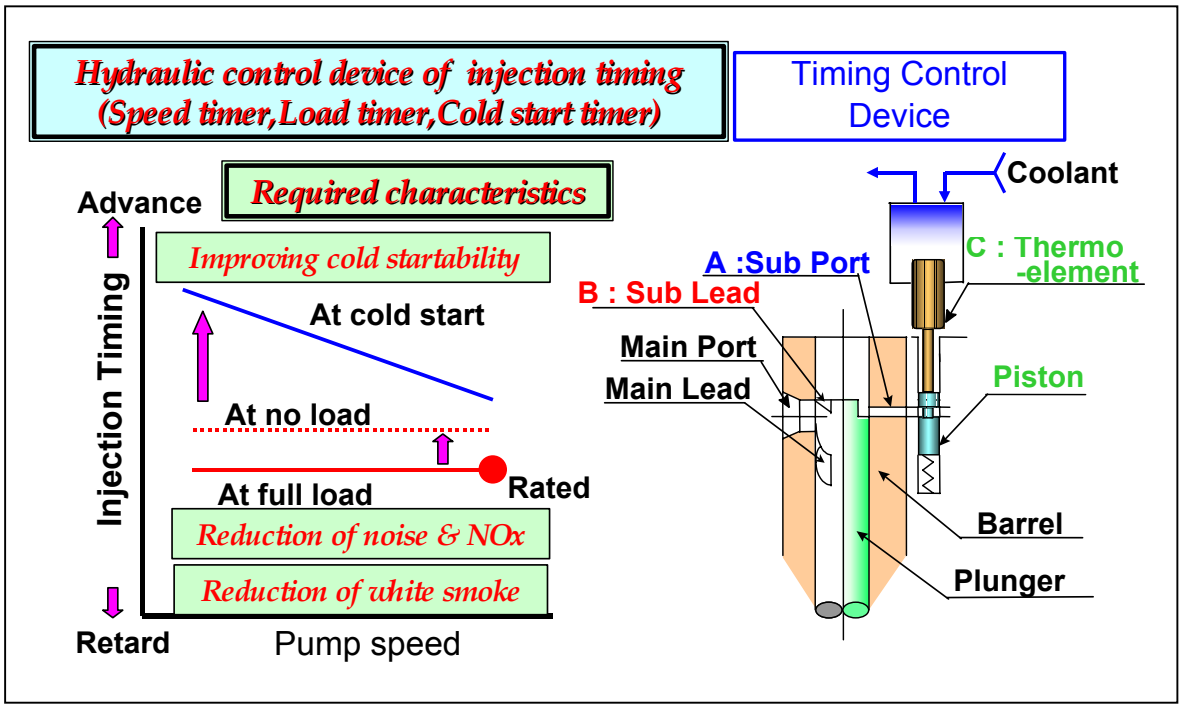
When the engine is used in a wide range from low to high speeds, it is necessary to change the fuel injection timing according to the engine speeds for always keeping the optimum firing timing. It is also necessary to optimize the injection timing for reducing noise and exhaust gas emissions.
This pump has the timer mechanism for revolutions, load and cold starting.

## 2.6.1. Structure and Functions

The engine speed timer is the mechanical timer which uses the oil leakage from the small diameter sub spill port installed slightly upper side of the main spill port of the jerk pump. When the engine speed is high, pressure rises before oil leaks from the small diameter port and injection is started. But when the engine speed is low, pressure does not rise until the port blocked by the plunger and the injection start is delays. Usually, the lower the engine speed, further the injection timing advances. But this engine speed timer prevents the injection timing from advancing during the low engine speed ranges and thus the noise and Nox. emissions can be controlled.

The fewer the injection amount, the earlier the load timer causes the main port to close by the plunger's upper lead for advancing the injection timing. This feature is instrumental in preventing misfire or emission of bluish white smoke during low load operation.

The cold start timer causes the sub port to be blocked only under cold temperatures for accelerating injection timing and facilitating in cold starting. The timer houses the thermo element and cooling water circulates around the temperature sensing section. The thermo-element senses the coolant temperature for adjusting the control piston. The sub-port is blocked when the temperature is lower than the set temperature and the pressure is raised earlier than in the normal temperature for advancing the injection timing. When the temperature exceeds the set temperature, the sub-port is opened and the regular injection characteristics are recovered.



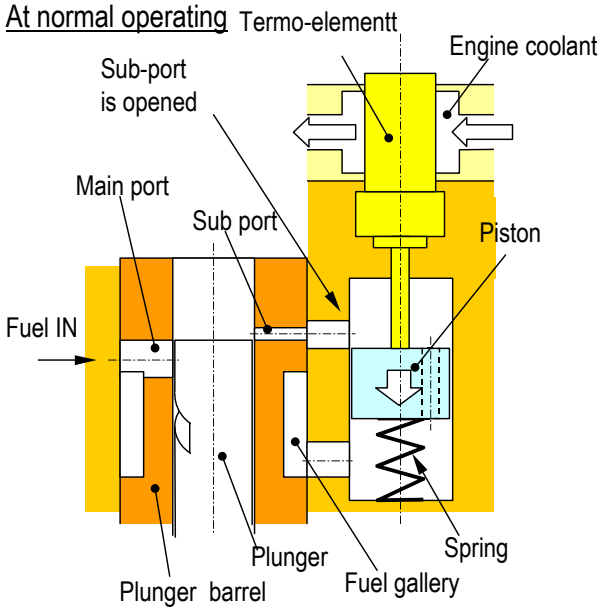
# 2.7. C.S.D.(Cold Start Device)

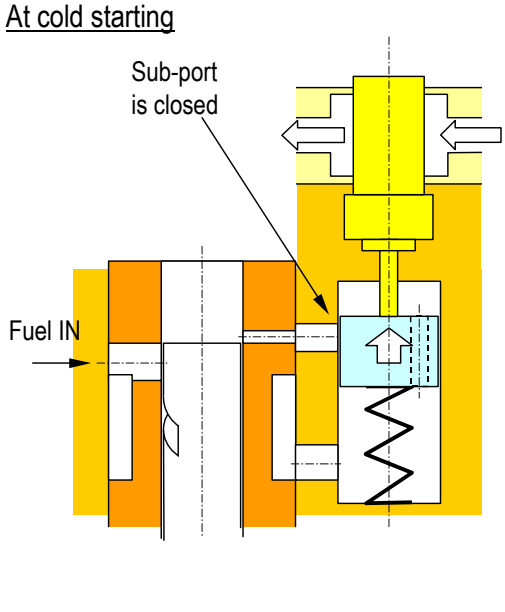
## 2.7.1. Cold Starting Advancer

Purpose

In order to facilitate easy engine starting under cold temperatures, the advancer senses the cooling water temperature for advancing the fuel injection timing.

### 2.7.1.1. Structure & Function



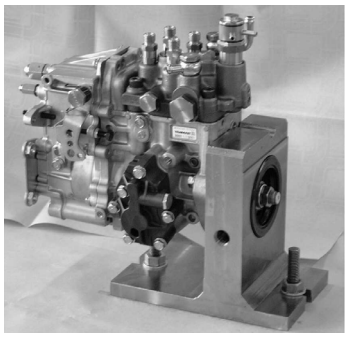

| | |
|---|---|
| When the coolant temperature is higher than specified value, the thermo-element keeps expanding and the sub-port is opened. | When the coolant temperature is lower than specified value, the thermo-element keeps shrinking and the sub-port is closed by piston. |

# 3. Disassembly ,Reassembly and Inspection

## 3.1. Disassembly

Disassembled parts must be put aside in order.
Wash them before reassembly.

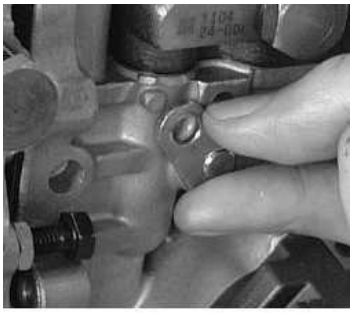
### 3.1.1. Separating the pump body from the governor body



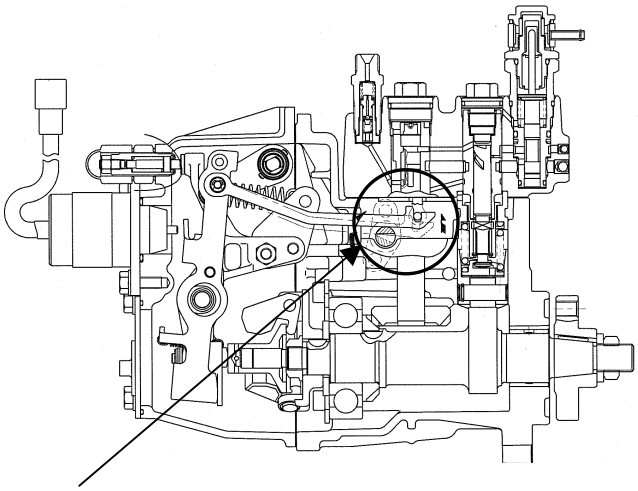
Install the pump body to the disassembly table.



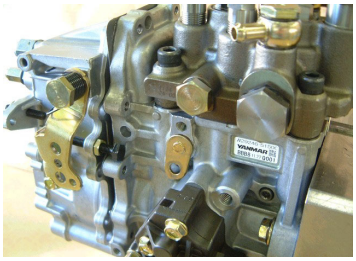
Remove the link lifter fix bolt.



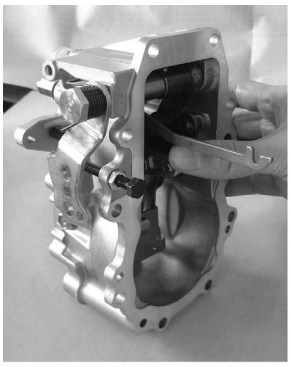
Turn the link lifter plate counterclockwise.



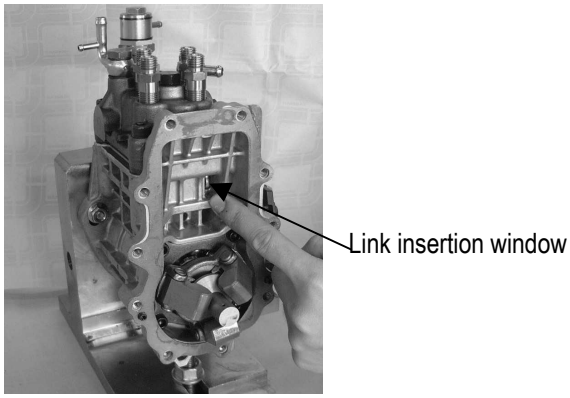
Rotating the link lifter will move the inside link upward/downward, so the control rack may be engaged/disengaged.



Remove the bolt fixing the pump and governor bodies.

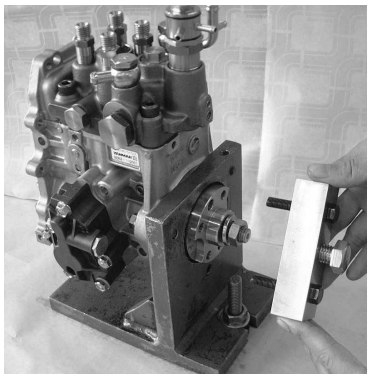


Separate the governor from the pump body.

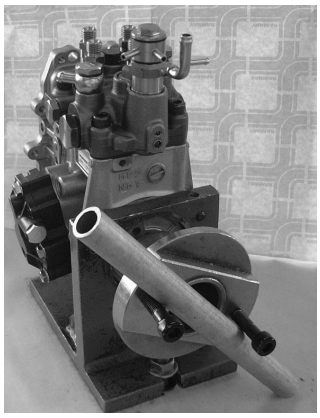



The pump body separated from t he governor body

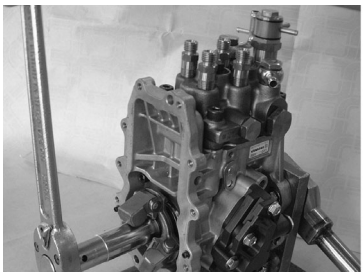
### 3.1.2. Separating the governor weight CMP



Providing whirl-stop to the camshatt



Example of whirl-stop



Remove the nut, (governor support).

### 3.1.3. Disassembling the hydraulic head

Disassembling the hydraulic head



Remove the joint, (FO inlet pipe).

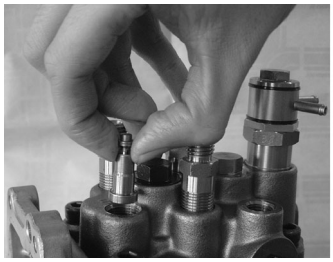
### Disassembling the delivery valve

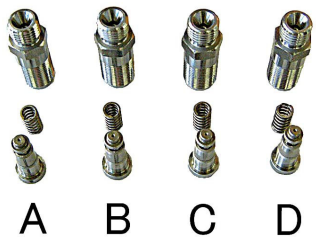


Remove the holder, (delivery).



Remove the delivery valve and gasket.



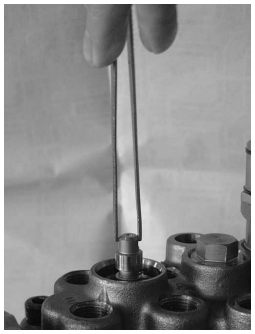



Delivery valve parts disassembled. (Take care not to mix these with other parts on reassembly. Reassemble these to the original port as a set.)



Remove the delivery valve and gasket.

Remove gasket



Remove the distribution shaft.

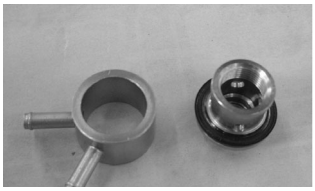
Removed parts must be stored in the cleaning oil sump.



Remove the plug and gasket, (barrel).



Remove the plug, (C.W.) and the joint, (C.W.)



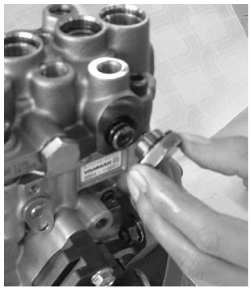
Parts disassembled.



Remove the thermo element.



Remove the holder and gasket, (timer)

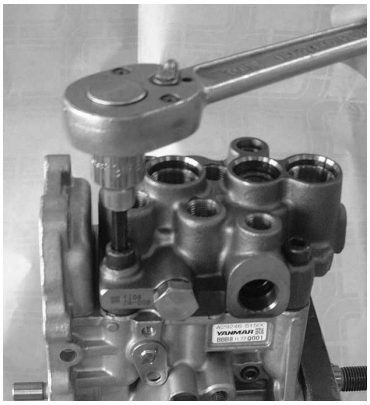


Remove the plug, (accumulator).

Make sure that the seal washer remains on the plug.



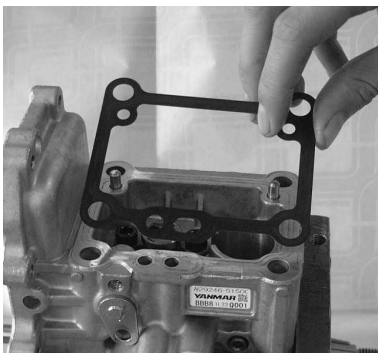
### 3.1.4. Separating hydraulic head CMP



Remove the hydraulic head CMP fixing bolt.



Remove the hydraulic head CMP.

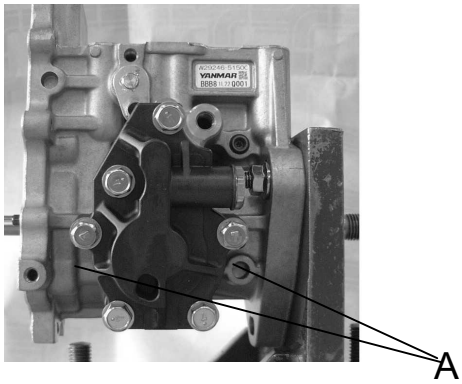


Remove the packing.

### 3.1.5. Separating the cam shaft

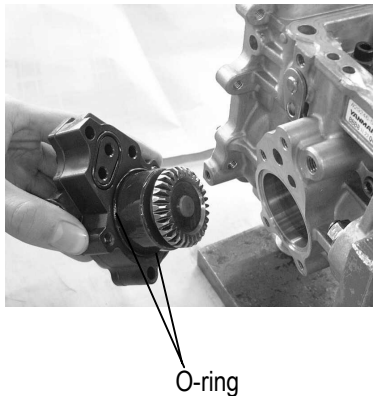


Remove the joint, (distribution shaft).




Remove the feed pump.

Do not loosen two bolts (A)




Make sure that two O-rings are free from damages.



Remove the removal stop, (transmission shaft) fastening bolt.





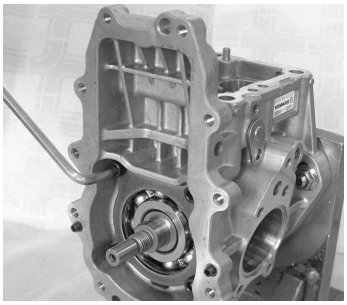
Remove the whirl-stop, (tappet).



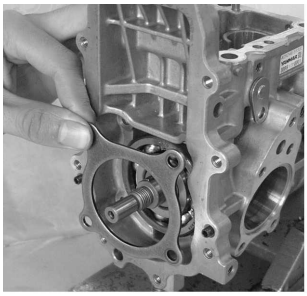
Take out the tappet.



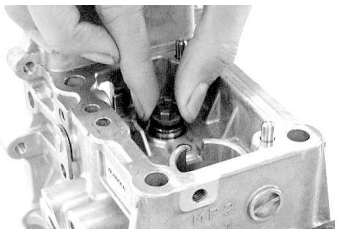
Tappet disassembled and FIC adjust shim.



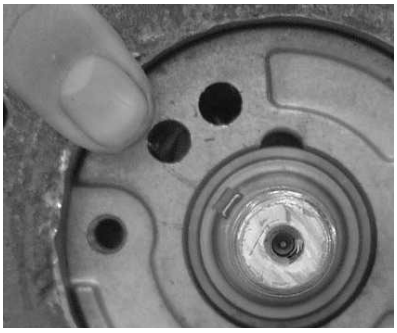
Remove the retainer, (bearing) fastening bolt.



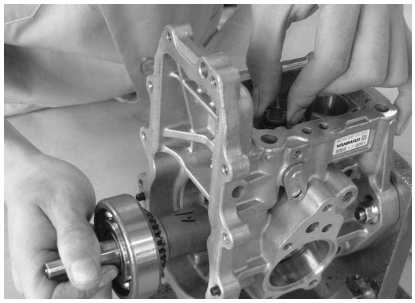
Remove the retainer, (bearing).



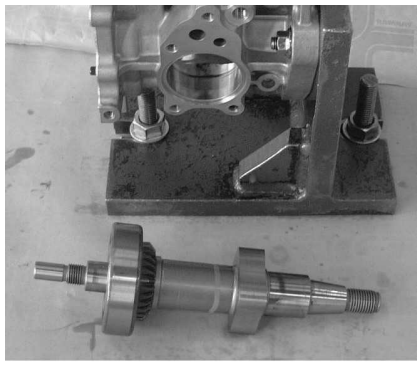
Lift the transmission shaft slightly by your hand.



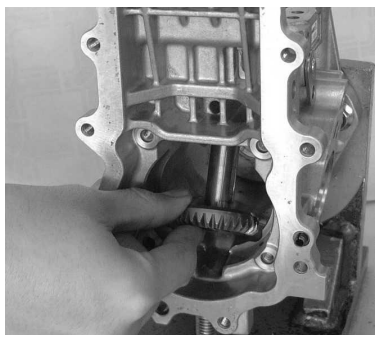
Align the camshaft's key groove with the embossed mark on the body.



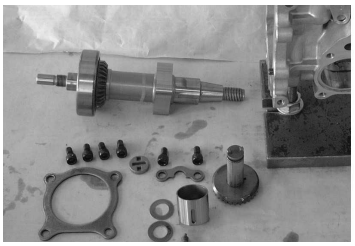
Lift the transmission shaft a little and pull out the camshaft.



Camshaft extracted



Remove the transmission shaft CMP.



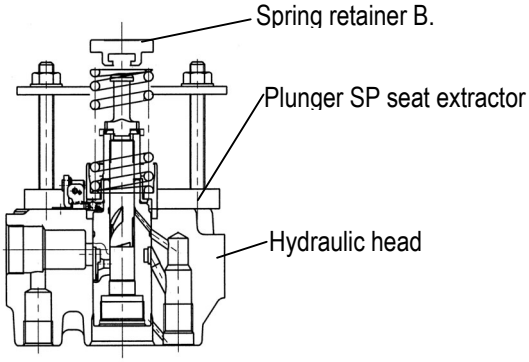
Remove the transmission shaft CMP.

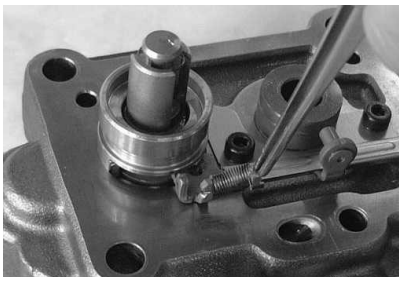
### 3.1.6. Disassembling the hydraulic head CMP



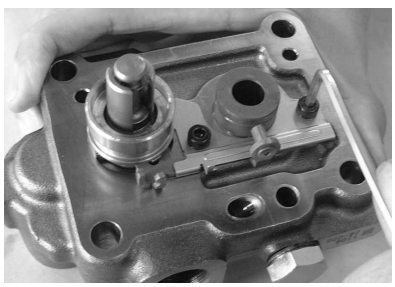
Compress the plunger spring and remove the spring retainer, (B).

While compressing the plunger spring using special service tool, remove spring retainer B.

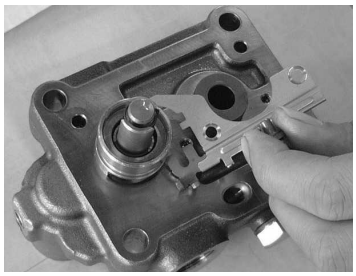


Remove the rack return spring.

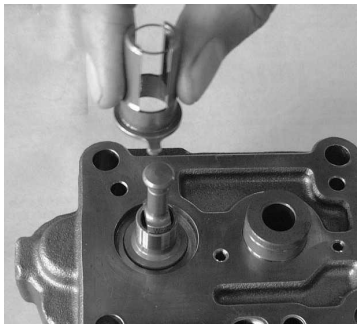


Remove the rack guide fastening bolt.





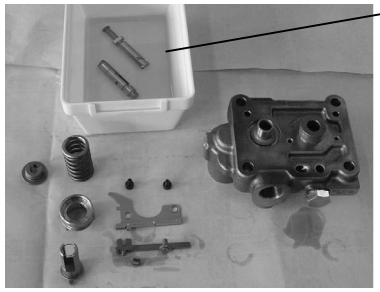
Remove the spring retainer.



Remove the control sleeve.



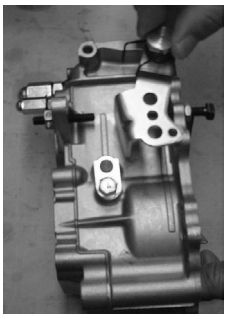

Remove the plunger.



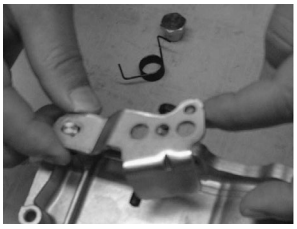

Parts removed from hydraulic head CMP

Disassembled parts must be separately stored in the cleaning oil sump.

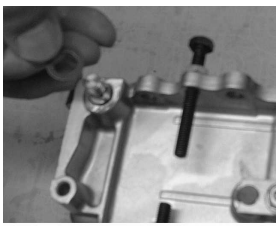
## 3.2. Disassembling the Governor



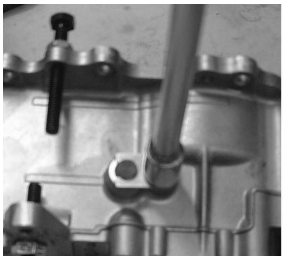
Remove the lock nut, (Control lever).



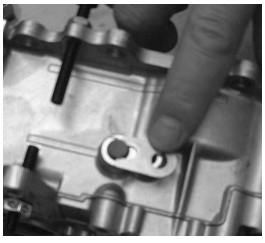
Remove the regulator lever.



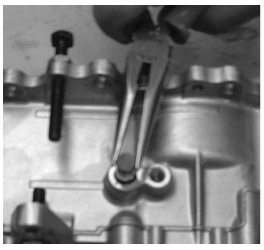
Remove the shim.



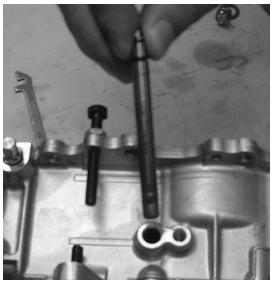
Remove the removal stop, (governor lever shaft) fixing bolt.



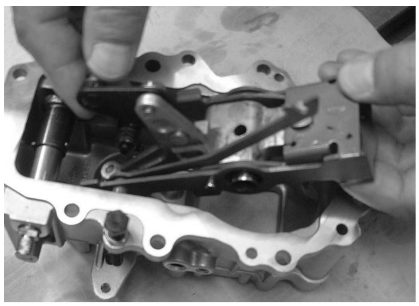
Remove the removal stop, (governor lever shaft).



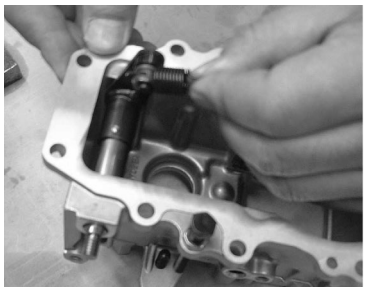
Pull out the governor lever shaft.



Removed governor lever shaft



Take out the governor lever CMP.



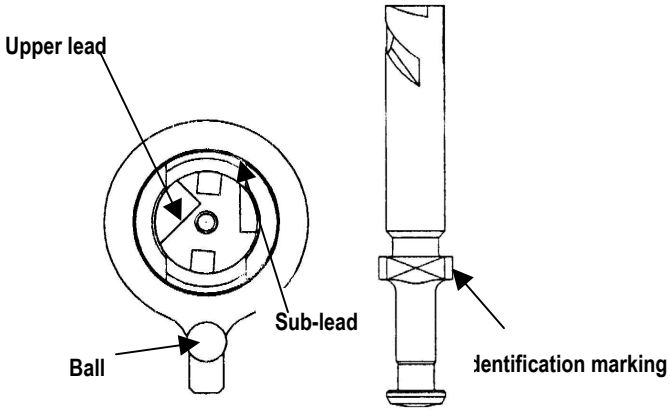
Remove the spring.

# 3.3. Reassembly

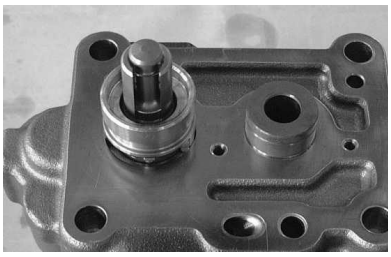
### 3.3.1. Re-assembling the hydraulic head



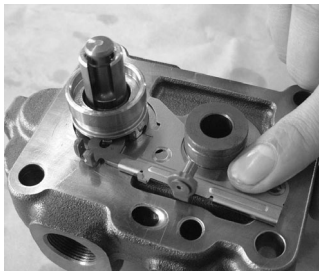
Install the plunger.



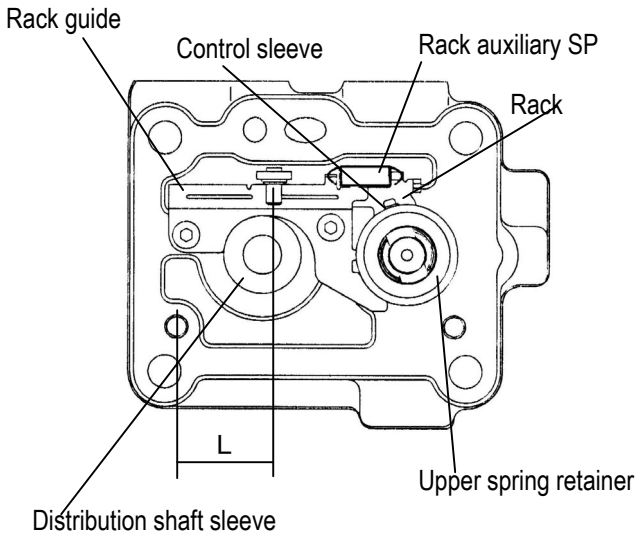

- Note that the positional relationship of the upper lead and sub-lead of the plunger and the ball of the control sleeve is as shown below. (Plunger identification marking (such as "W4") and the ball of the control sleeve are oriented in the same direction.)
- Be careful that the plunger is NOT inserted upside down.



Install the control sleeve and spring retainer.



Install the rack guide.



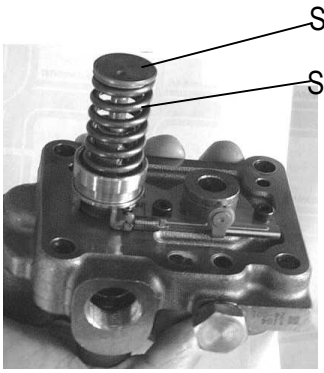

Attaching rack and rack guide

- When installing rack guide, push it against the distribution shaft sleeve and upper spring retainer so that the rack is in parallel with the direction of camshaft. (T = 3 to 4 N•m)
- Movable range of rack is to be equal to or larger than ±7 mm.
- Fix the rack at the position of L = 25, and measure the effective stroke and sub-step (overflow stroke) to check that they are within the standards (Refer to attached drawing 1.)
- The rack must not separate from the ball of the control sleeve within the movable range.
- Fix the plunger with a jig and measure the total backlash. (To be equal to or less than 0.2 mm)
- The load of rack auxiliary SP must be able to return the rack from the maximum decreased position to the maximum increased position).



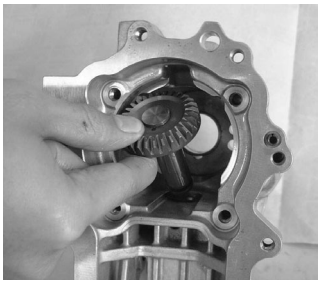
Install the rack guide fastening bolt.

| Tightening Torque : 3.9-4.9 N-m |
|---|

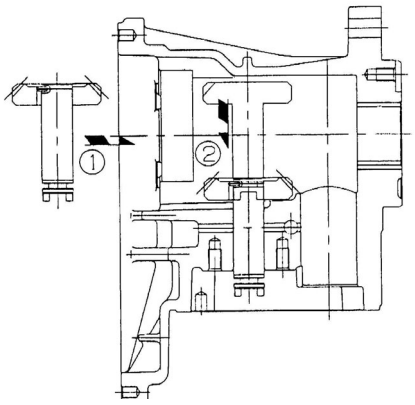



Install the plunger spring and spring retainer (B).

### 3.3.2. Re-assembling Cam Shaft

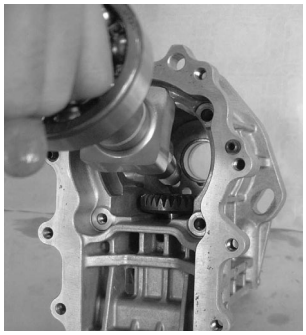


Install the transmission shaft CMP.

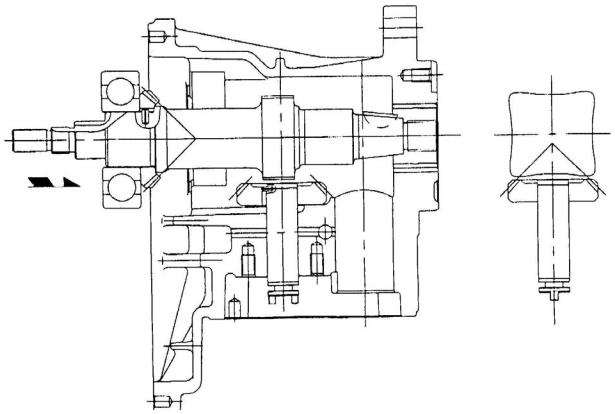



Attaching transmission shaft CMP

- Apply molybdenum disulfide to the shaft section.
- Check that the transmission shaft rotates



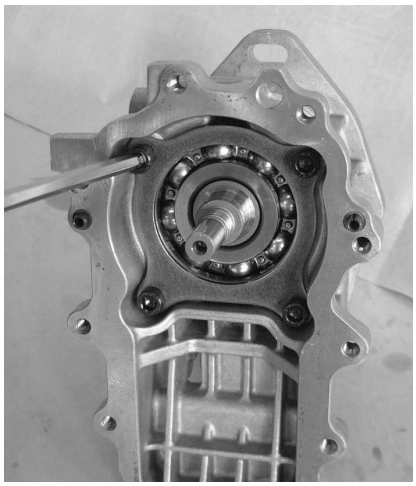
Install the camshaft.



Attaching camshaft

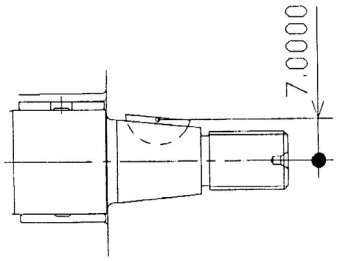
- Apply molybdenum disulfide to the bushing or the bearing.
- Insert the camshaft into the pump body with transmission shaft CMP at the lowered position (gear B touching the pump body).
- Be careful that the cam and gear B do not interfere with each other.
- (Especially for 4 cylinder engine, note that the phase in which the cam passes is limited.)
- The shaft can be inserted with the key of the driving side press-fitted to the camshaft.

  Be careful not to damage the camshaft bushing.



Install the camshaft.

| Tightening Torque : 8-10 N-m |
|---|

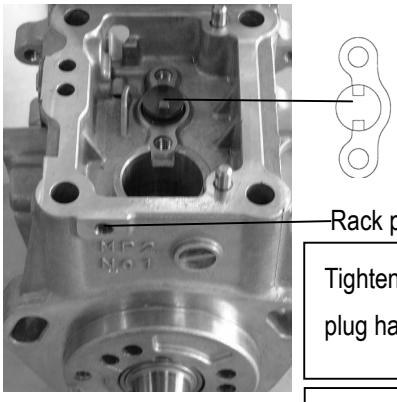



Checking backlash

- Rotate camshaft to check that transmission shaft rotates smoothly.
- Fix transmission shaft from upper surface of the housing, and turn the camshaft to check the backlash.

  Backlash must be in the range from 0.2 to 1.5 degree.

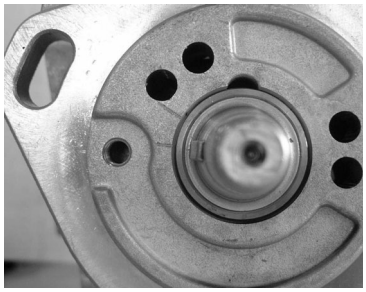
Note: When measuring at the position of camshaft driving side key (at the center of the key as shown below), the displacement must be in the range from 0.03 to 0.25.




| Tighten the rack plug. (If rack plug has been removed.) |
|---|

| Tightening Torque : 79-84 N-m |
|---|

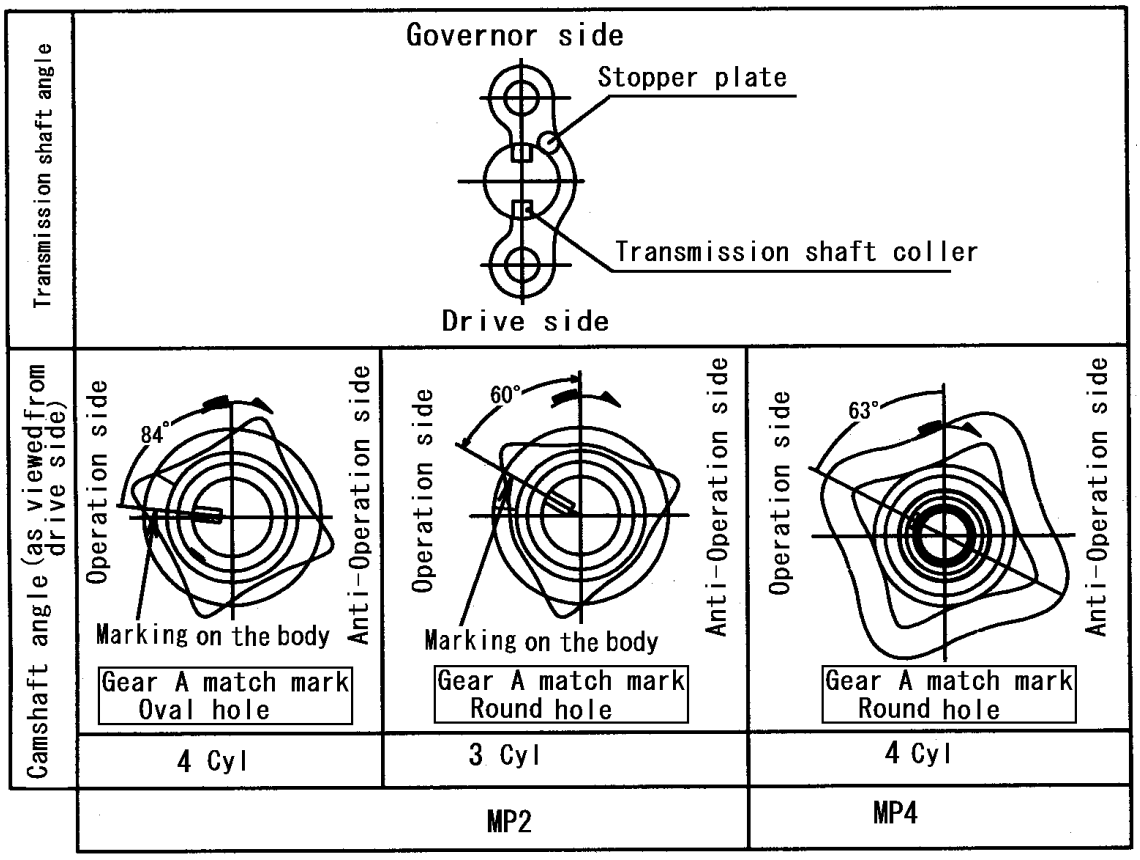
Position the transmission shoe of the transmission shaft CMP as shown in the illustration.



Position the camshaft key groove as shown in the illustration.

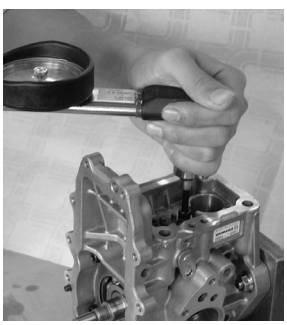
Engagement of gears

- With the phase of camshaft and collar of transmission shaft set in the direction as shown below, engage gears A and B with each other. (Check that the match mark of gear B and the mark of gear A shown below are aligned with each other by looking through the feed pump installation hole.)
- When inserting the stopper pin, do not raise the transmission shaft excessively, or the gears will be disengaged. (Check the engagement again after inserting the stopper pin.)
- The positions of the collars of transmission shaft are not limited only if either one is at the top or bottom as shown.



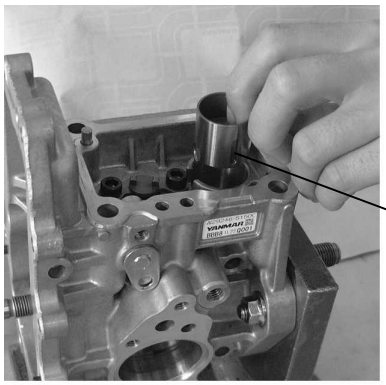



Install the removal stop, (transmission shaft).



Fasten the removal stop, (transmission shaft).

Tightening Torque : 8-10 N-m

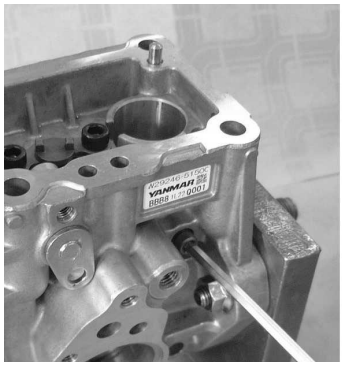



Install the tappet.

Direct the tappet's whirl-stop groove as shown in the illustration.

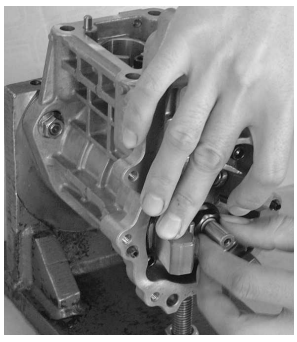
Assembling tappets

- Insert tappet into the pump body with the slit directed toward the lock side, and attach the tappet lock. (T = 4 to 5 N•m)
- Turn the camshaft to check that the tappet moves up and down smoothly.

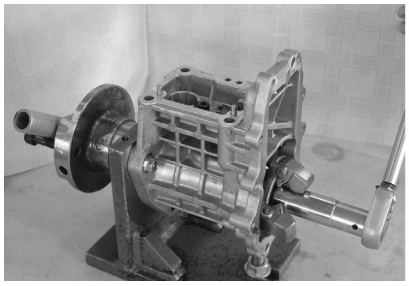


Install the whirl-stop, (tappet).

Tighten the tappet, while moving it upward and downward.



Install the governor weight CMP and nut, (governor support).

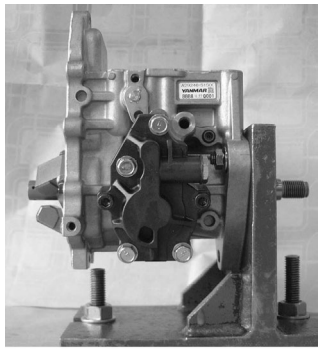


Fasten the nut, (governor support), (and provide the whirl-stop to the cam shaft.)

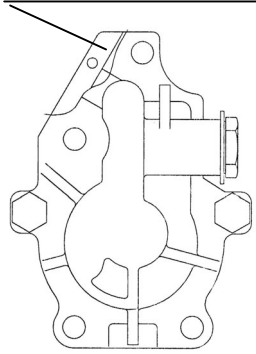
Tightening Torque : 79 - 84 N-m



Install the feed pump.



Identification hole ( $\phi$ 3, depth 2 mm)

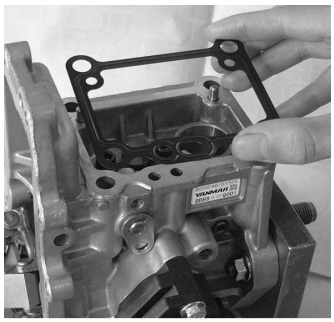


**Identification of feed pump**

| Spec. | $\phi$ 3 identification hole |
|---|---|
| General purpose | Not provided |
| TK | Provided |

Note that the identification hole can be seen only when looking from obliquely above because it is located on the pump case side.

### 3.3.3. Install the hydraulic head CMP.

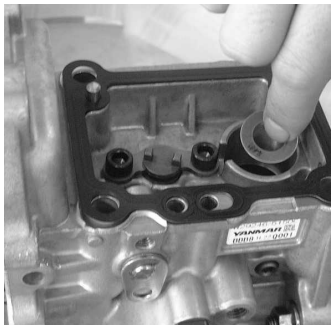


Install the hydraulic head CMP.

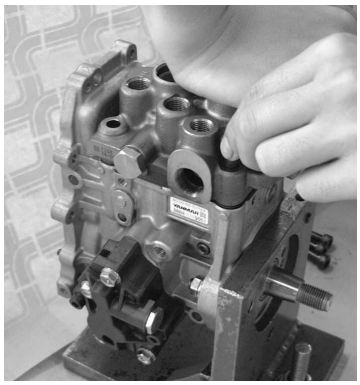
| |
|---|
| Insert the two positioning pins. Be sure not to confuse packing front with rear surface. (Align them with holes on the body.) |



Install the joint, (transmission shaft).

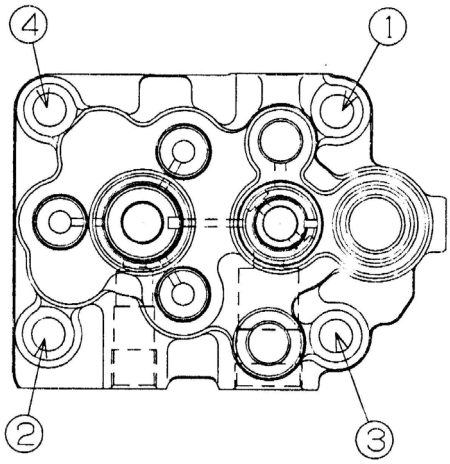


Assemble the FIC adjust shim inside the tappet.



Install the hydraulic head CMP.

| |
|---|
| While hand pressing the hydraulic head, temporarily tighten the tightening bolts. Then, tighten them with specified torque. |




Installing H head

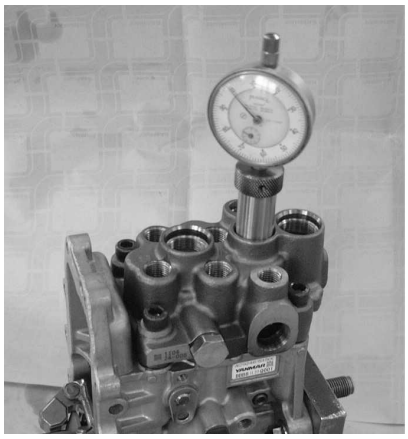
- Assemble shims with an appropriate thickness that corresponds to the measurement of the bottom clearance (refer to attached drawing 3).
- Temporarily tighten the hexagon socket head bolts evenly in the order as shown below until the surfaces of H head and pump body contact with each other, and subsequently tighten to the specified torque in the same order.
- After assembling H head, check the top clearance again.
- After assembling H head, push the rack from governor side to check that the rack is returned with the force of rack auxiliary SP.
- When reassembling H head, be sure to replace the head packing with new one.



Install the hydraulic head CMP fastening bolt.

| | |
|---|---|
| **Important** | Tightening Torque : 18-22 N-m |

| |
|---|
| Tighten the bolts in diagonal order, while checking the torque with torque meter. |



Measure the plunger top position.

Bottle clearance adjustment should refer to Page 59.

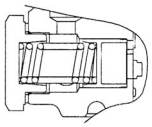
### 3.3.4. Assembling the Hydraulic Head

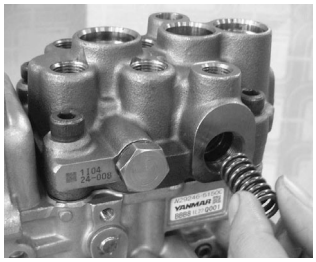


Install the accumulator.

Attaching accumulator

- Be sure to install the piston in the correct direction.
- Make sure that the piston can slide smoothly.





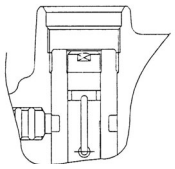
Install the spring, (accumulator).



Install the plug with new seal washer, (accumulator).



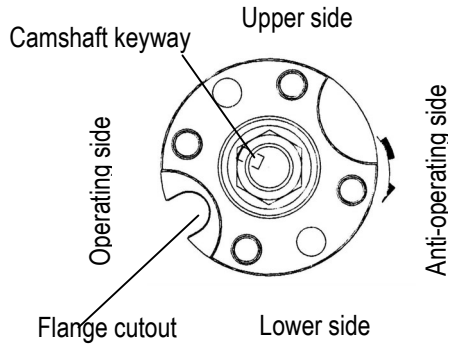
Install the distribution shaft.



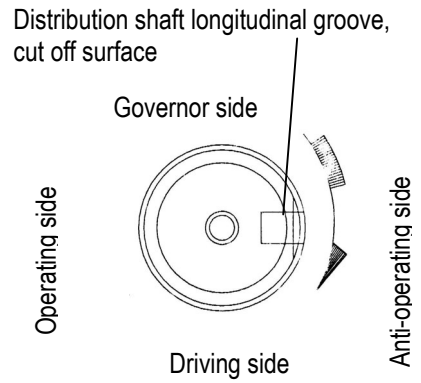
Inserting distribution shaft

- Insert distribution shaft so that the directional relationship between the shaft and camshaft is as shown below (Do not assemble upside down).
- Use the following drawing simply as a reference because the component can be inserted in either of two orientations.
- Insert the component securely into the distribution shaft joint until it is sunk below the end surface of the distribution shaft sleeve.

Direction of fixed flange (camshaft keyway)
(As viewed from driving side)




Direction of distribution shaft longitudinal groove
(As viewed from upper side





Install the plug, (distribution shaft).



Fasten the plug, (distribution shaft).

| Tightening Torque : 10-15 N-m |
|---|



Install the plug with new copper packing, (barrel).



Fasten the plug, (barrel).

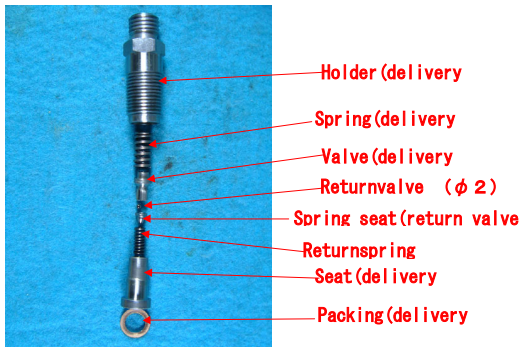
| Tightening Torque : 30-35 N-m |
|---|



Install the new packing, (delivery valve seat).



Install the delivery valve CMP.






Install the spring, (delivery).



Install the holder, (delivery).

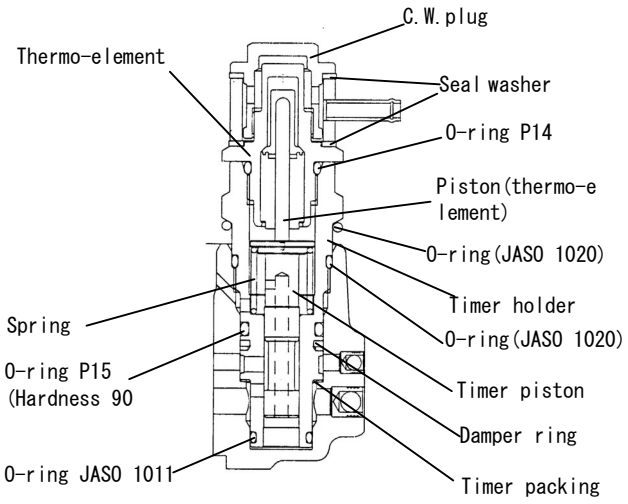
| Tightening Torque : 40-45 N-m |
|---|



Install the new packing, (timer).



Install the holder with new O-ring, (timer).




* JASO : Japanese Automobile Standard

- Do not forget to assemble the timer packing, (at holder bottom).
- Do not forget to assemble the damper ring.
- Take care not to use O-rings with inappropriate sizes.

Check that the timer piston moves smoothly in the timer holder hole (clearance: 4-8 micron m).



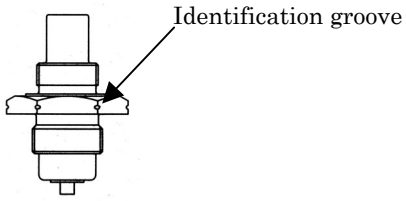
Fasten the holder, (timer).



Install the thermo-element with new O-ring.

- Before installing the thermo-element, press down the piston with the timer holder being installed to the head, (T=40-45N.m), and check that the piston returns up through the spring load.
- The standard thermo-element release temperature shall be 5-8 degC(41-46.4 degF). (Thermo-element released at 15-18 degC (59-64.4 degF) is available as option.

  Take care not to mistake the specifications: see diagram below.)



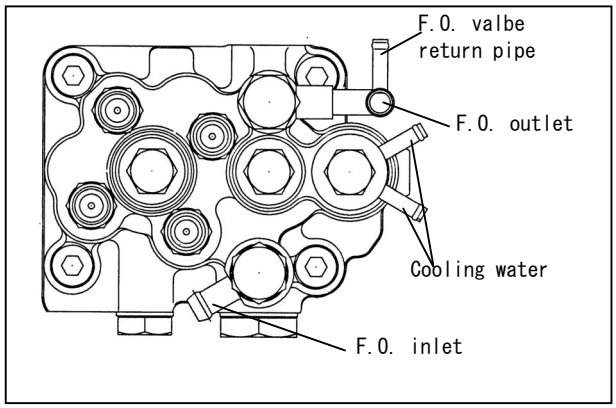

Thermo-element for 15～18 degC

- Do not pull out the piston housed in the thermo-element manually. If it is extracted manually, discard it since the re-use of the piston is no longer possible.
- Do not tighten the thermo-element with excessive tightening torque, (T=30-35N.m).
- Do not tighten t he cooling water plug with excessive tightening torque, (T=22-25N.m).
- Take care not to catch impurities in the seal washer.



Fasten the thermo-element.

Tightening Torque : 30-35 N-m






Install the joint, (C.W), and he plug, (C.W.)

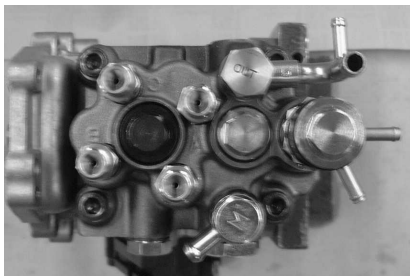
Assemble the seal washers, taking care not the washer stride over steps. (One seal washer is required for respective upper and lower portions.)



Install the joint, (FO inlet).



Fasten the plug, (C.W.)



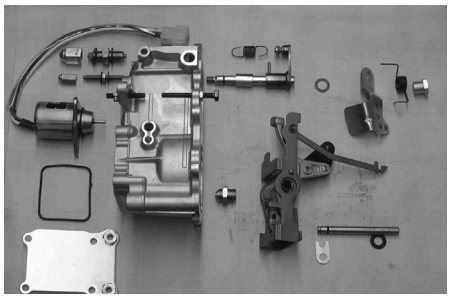
Installation position of Joints

Direction of pipe depends on respective specifications.



Install the joint, (overflow) and the joint, (overflow).

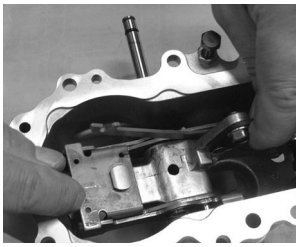
# 3.4. Re-assembling the Governor



Governor Body Parts

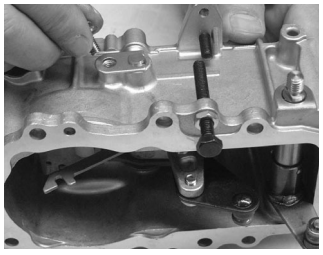


Governor Lever CMP End Float Adjust Shim

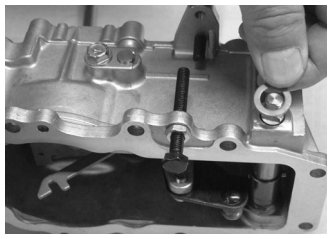


Pierce the governor lever CMP and shim through the governor lever shaft and assemble.

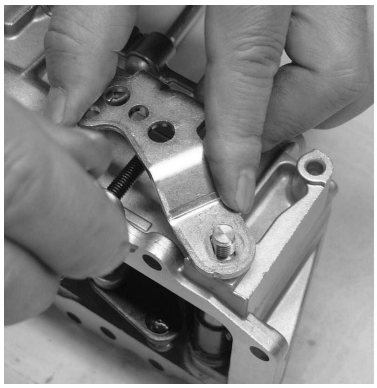
| |
|---|
| Measure the side clearance of the tension lever with thickness gauge.<br>Standard: 0.3 to 0.6 mm (adjusting with shim) |



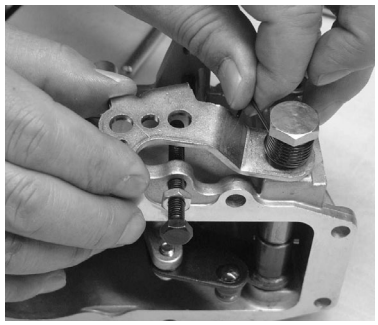
Fit the governor lever shaft with the removal stop, (governor lever shaft) and fasten the removal stop bolt.



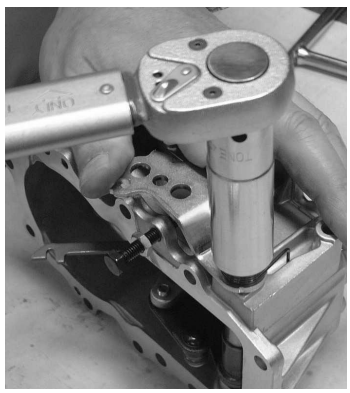
Install the shim to the shaft. (control lever).



Install the regulator lever.



Pierce the spring, (control lever) through the lock nut, (control lever) and fasten it to the thread of the shaft, (control lever).

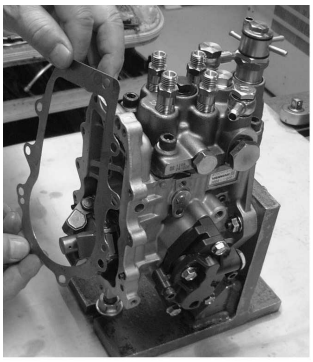


Fasten the nut, (control lever).

| |
|---|
| Tightening Torque : 19.6-24.5 N-m |

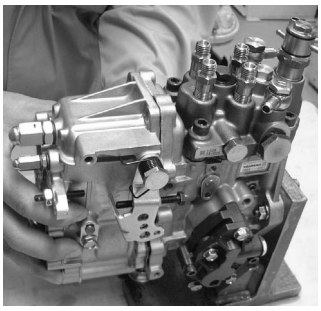
| |
|---|
| Measure the side clearance with thickness gauge.<br>Standard: 0.3 to 0.6 mm (adjusting with shim) |

# 3.5. Combining Governor and Pump Bodies

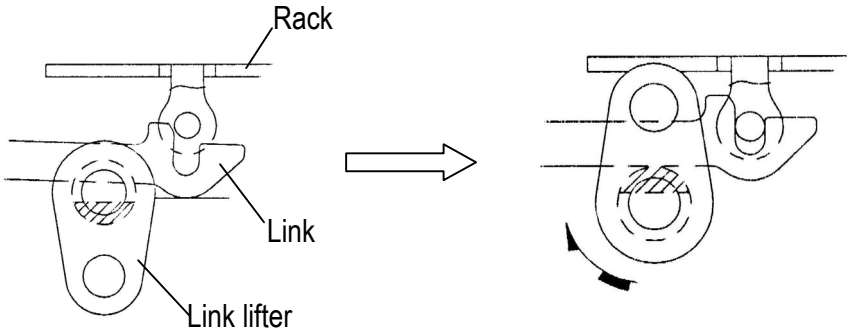


Install the new packing.

| |
|---|
| Do not confuse front with rear surface. Assemble it, while aligning bolt holes with those on the body. |



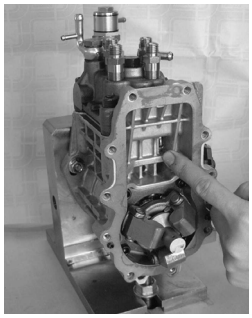
Turn the link lifter plate counterclockwise. and install the governor body to the pump bodies



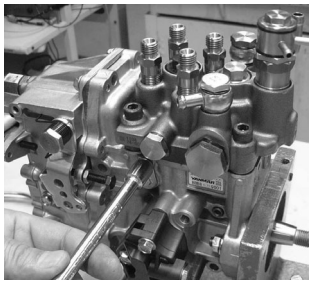

a) During assembly b) During operation

Attaching governor CMP

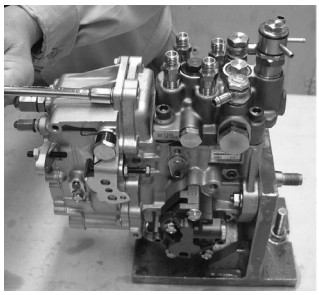
- Be careful not to bend or damage the governor case packing (GRC). (It is not reusable. If it sticks to the packing surface, remove it without giving damage to the surface of the packing.)
- Direct the link lifter as shown in Fig. a) shown below, where the semicircular section is positioned at the lower side, and bring governor CMP to the pump body until the link comes into contact with the rack.
  At this time, be careful that the link does not hit the pump body. (If the link hit the pump body severely, check that the link is not bent or deformed.)
- Direct the link lifter as shown in Fig. b) shown below, where the semicircular section is positioned at the upper side, and engage the rack and the link with each other.
  At this time, if it is difficult to engage the rack and the link with each other, assemble them while pushing the governor lever to the decreasing side (when mechanical governor is used).
- After putting the link lifter in the state shown in Fig. b), pull the governor CMP a little to check that the link and rack are engaged with each other. (Be sure not to pull governor CMP excessively).
  (If the barrel plug is not installed yet, the following method can be used to check the plunger rotation.
  Mechanical governor: Push the governor lever to the decreasing side through the solenoid attaching hole.
  New ECO governor: Push the rack to the increasing side through the rack inspection port.)
- Be sure to tighten the link lifter securing bolt. (T = 8 to 10 N - m)



Insert the governor link into the link hole of the pump body.

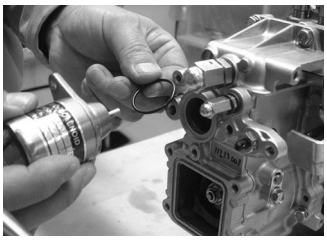


Fit the link lifter to the installation hole and fasten the bolt.



Pull the governor assembly slightly to check that the link is engaging securely.

Combine Governor and Pump Bodies

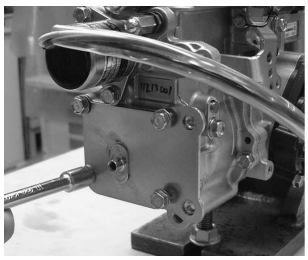


Install the new O-ring to the stop solenoid and assemble them to the governor case.

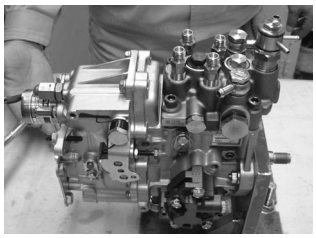
| Tightening Torque : 7.8-9.8 N-m |
|---|



nstall a new packing, (governor case cover) to the case.



Install the governor case cover to the case.



This completes reassembly of the pump.

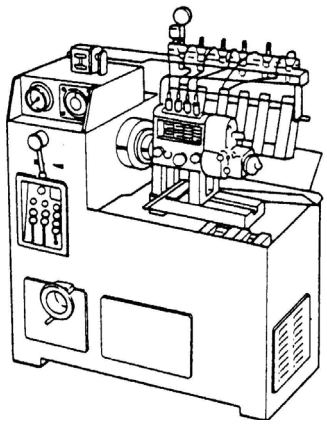
# 4. Adjustment of Fuel Injection Pump and Governor

Adjust the fuel injection pump after you have completed reassembly. The pump itself must be readjusted with a special pump tester when you have replaced major parts such as the plunger assembly, roller guide assembly, fuel camshaft, etc. Procure a pump tester like the one illustrated below.

## 4.1. Preparations

Prepare for adjustment of the fuel injection pump as follows:

(1) Adjusting nozzle assembly and inspection of injection starting pressure.



Mpa (kgf/cm$^{2)}$

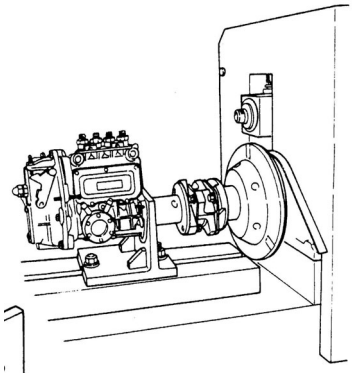
| | |
|---|---|
| Adjusting nozzle type | YDN-12SD12 |
| Injection starting pressure | 16.2 - 17.2(165 - 175) |

(2) Adjusting injection pipe.

mm

| | |
|---|---|
| Inner dia./outer dia. × length | Φ2.0/Φ6.0 × 600 |
| Minimum bending radius | 25 |

(3) Mount the fuel injection pump on the pump tester platform.

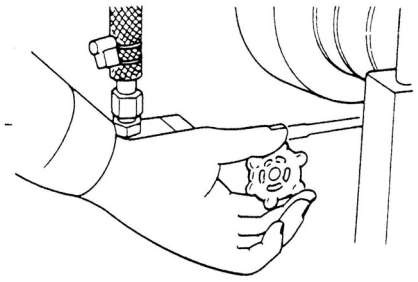


(4) Remove the plug in the oil fill hole on the top of the governor case, and fill the pump with about 200cc of pump oil or engine oil.



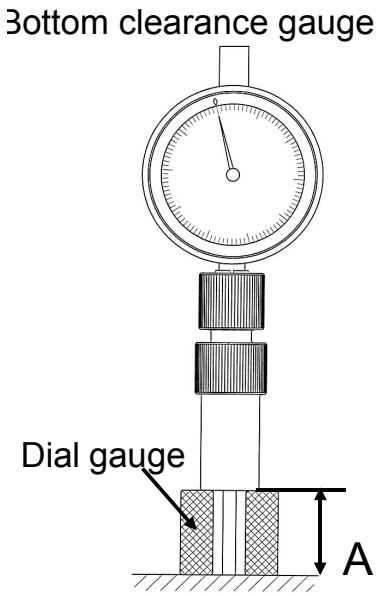

(5) Complete fuel oil piping and operate the pump tester to purge the line of air.

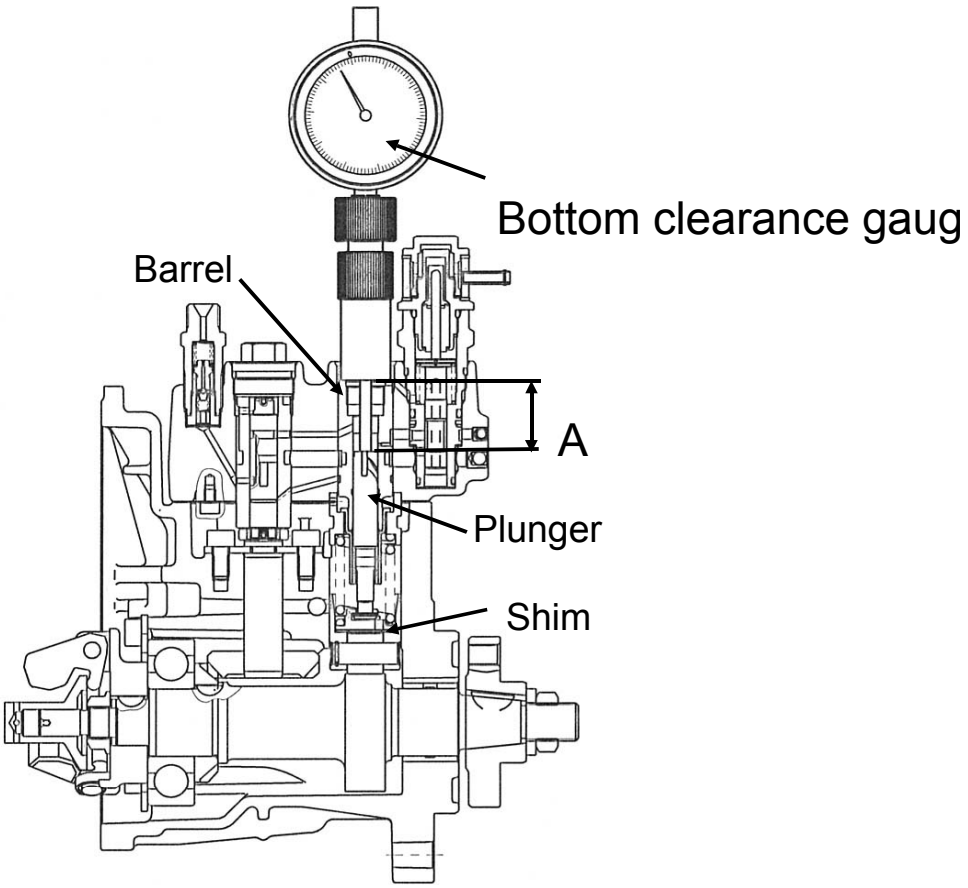
(6) Set the pressure of oil fed from pump tester to injection pump at 19.6-29.4kPa(0.2-0.3kgf/cm$^2$ ) ,temp. at 40±2 degC(104± 3.6 degF)



# 4.2. Bottom clearance adjustment(Fuel Injection Timing)

1. The Fuel Injection Timing of MP-pump is made by means of adjusting the bottom clearance of the Cam ie. adjustment of the Pre-stroke of the plunger , as follows.
2. The adjustment of the clearance shall be made at cam-top position in order to get the reliable and easier method. Therefore herein after we will mention that “The adjustment of the bottoms clearance (of the Cam)”.
3. First of all , put the JIG of the bottom clearance measurement on the standard gauge(W/”A”- measurement). Then set the O-point of the dial gauge.
4. Next adjust the clearance by shims into the standard after measuring the bottom clearance A* with JIG (Dial gauge)(Refer to the attached sheet)*Measurement between upper surface of the Barrel and upper surface of the plunger at Cam bottom position

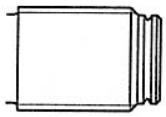
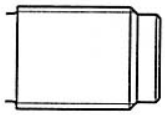
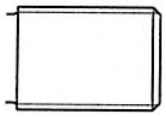


### 4.2.1. The bottom clearance adjusting value and the Cam classification

| Cam shaft | | | | Plunger bottom Clearance (dimension: A) (mm) | Standard shim thickness (mm) |
|---|---|---|---|---|---|
| | Cam speed | 3 cylinder | 4 cylinder | | |
| MP2 | 1.1 m/s | 158552-51020 | 158553-51020 | 25.5±0.05 | 1.3 |
| | 1.3 m/s | 158552-51030 | 158553-51030 | 25.9±0.05 | 0.9 |
| | 1.7 m/s | 158552-51040 | 158553-51040 | 26.3±0.05 | 0.8 |
| MP4 | 1.8 m/s | ———— | 123907-51040 | 25.55±0.05 | 1.05 |
| | 2.1 m/s | | 129906-51040 | | |
| | 2.3m/s | | 129907-51040 | | |

Shape of cam shaft end

| | Cam Speed | |
|---|---|---|
| | MP2 | MP4 |
|  | 1.1m/s | 2.3m/s |
|  | 1.3m/s | 2.1m/s |
|  | 1.7m/s | 1.8m/s |

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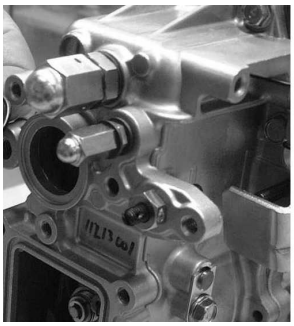
# 4.3. Adjustment of Governor

## 4.3.1. Adjustment of No Load Max. Engine Speed



Set the engine speed at the no load max. speed. Pull the regulator lever and adjust the max. speed limit bolt to obtain the specified injection amount. Fasten the nut after completing the adjustment.

## 4.3.2. Adjustment of Fuel Limit Bolt



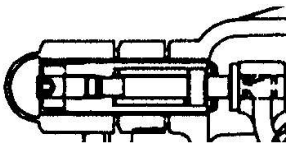
① The MP2 pump has the lift adjustment FO limiter as a standard equipment. Screw in the lift adjustment screw fully, then return the screw by 0.5 turns and fasten the screw with the lock nut. (In the specifications where no torque control spring is used, keep the lift adjustment screw completely free.)

② Set the pump speed at the rated speed and move the regulator lever until it contacts the maximum speed limit bolt.

③ Check that the amount being injected exceeds the rated injection amount, screw in the fuel limit bolt and adjust the injection amount.

## 4.3.3. Adjustment of Torque-Rise Point

The Torque-Rise adjustment comprises the FO limiter (torque spring) and the torque control spring.



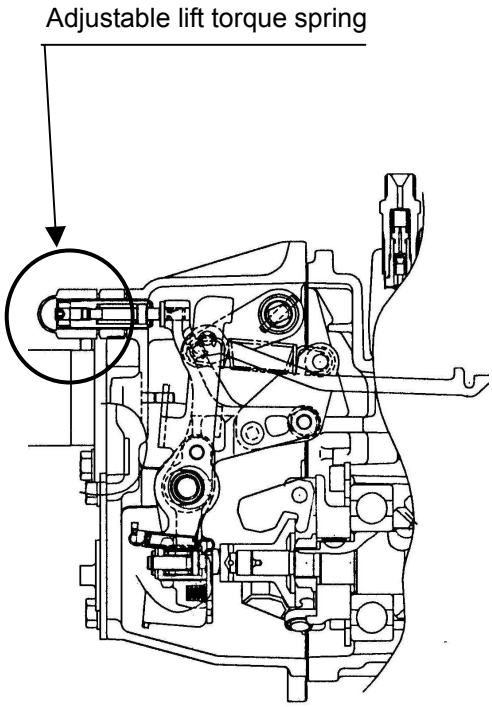
① Set the pump speed at the Torque-Rise speed and leave the regulator lever at the position in 2 above.

② When both of the FO limiter and torque control spring are used:

- Screw in the torque control assembly, adjust to obtain the specified injection amount and fasten the lock nut.

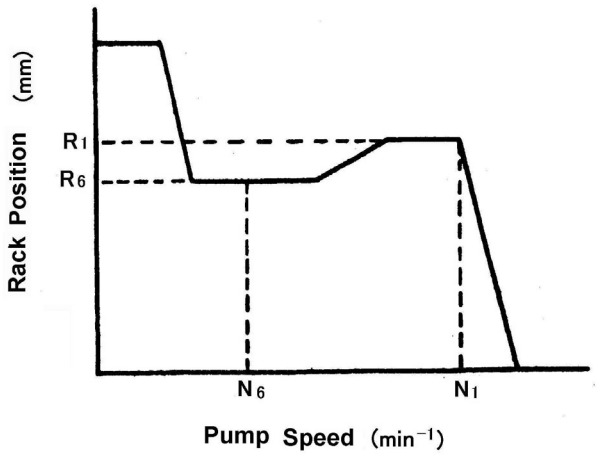
③ Specifications of Only the FO Limiter

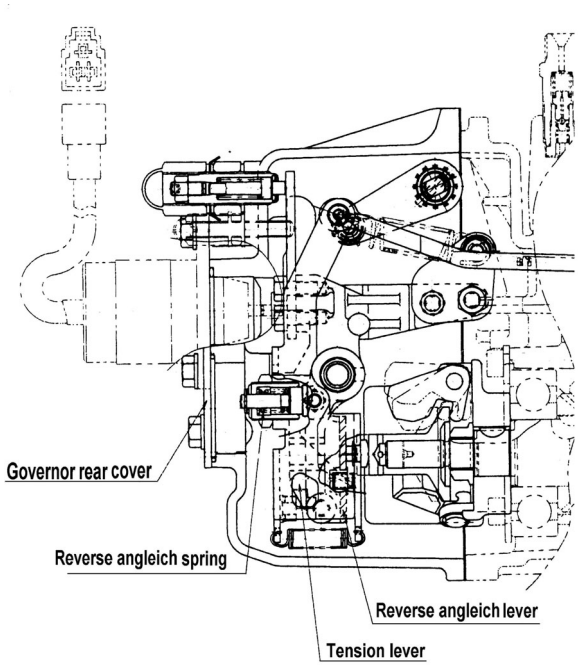
- Screw in lift limit bolt of the FO limiter, adjust to obtain the specified injection amount and fasten the lock nut.



## 4.3.4. Adjustment of Reverse Angleich

In the case of the governor with reverse angleich mechanism, use the reverse angleich spring in the assembled state.




Adjustment of Reverse Angleich

Make adjustment of reverse angleich after completing the following processes:

- Adjustment of fuel volume limiter bolt
- Adjustment of no-load max, and min. revolutions limiter bolt

① Shift the control lever to the full load position, and maintain the fuel injection pump revolution to the specified reverse angleich control revolution number ($N_6$).

② In this condition, remove the governor rear cover, and screw the reverse angleich assembly into the threaded portion of the tension lever until it hits the reverse angleich lever. If screwing it in additionally, the reverse angleich lever will shift in the direction of fuel reduction. Screw and set it to the position of the specified injection quantity ($R_6$).

③ Tighten the lock nut with specified tightening torque, and attach the governor rear cover.

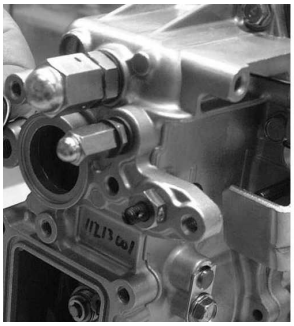
N-m (kgf-m)

| | |
|---|---|
| Lock Nut Tightening Torque | 24.5-29.4(2.5-3.0) |

④ Again, increase the revolution of the fuel injection pump to the rated revolution speed ($N_1$), check that the control rack will change the position of the reverse angleich stroke smoothly, and confirm that the rack position ($R_1$) and injection volume are within the specified limits.

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### 4.3.5. Adjustment of Staring Injection Amount



① Set the engine speed at the starting injection amount adjust speed and leave the regulator lever at the position in 2 above.

② Screw in the starting injection amount adjust bolt and adjust it to obtain the specified injection amount.

③ Set the pump speed at 50 $min^{-1}$ and check that the amount exceeding the specifications is being injected.

### 4.3.6. Checking the Injection Stop

Leave the regulator lever at the position as before.

① Checking the Injection Stop: Set the pump speed at the speed 50min-1 higher than the no load max. speed, and check that the injection amount reduces to zero.

② Checking the Stopping: Set the pump speed at the rated speed, turn off the stop solenoid and check that the injection amount reduces to zero.

# 5. Fuel injection Nozzle

When fuel 0il pumped by the fuel injection pump reaches the injection nozzle，it pushes up the nozzle valve（held down by spring），and is injected into the combustion chamber at high pressure.

The fuel is atomized by the nozzle to mix uniformly with the air in the combustion chamber. How well the fuel is mixed with high temperature air directly affects combustion efficiency，engine Performance and fuel economy.

Accordingly, the fuel injection nozzles must be kept in top condition to maintain performance and operating efficiency.

## 5.1. Functioning of fuel injection nozzle

Fuel from the fuel injection pump passes through the oil port in the nozzle holder and enters the nozzle body reservoir. When oil reaches the specified pressure，it pushes up the nozzle valve （held by the nozzle spring），and is injected through the small hole on the tip of the nozzle body.

The nozzle valve is automatically pushed down by the nozzle spring and closed after fuel is injected.

Oil that leaks from between the nozzle valve and nozzle body goes from the hole on top of the nozzle spring through the oil leakage fitting and back into the fuel tank.

Adjustment of injection starting pressure is effected with the adjusting shims.

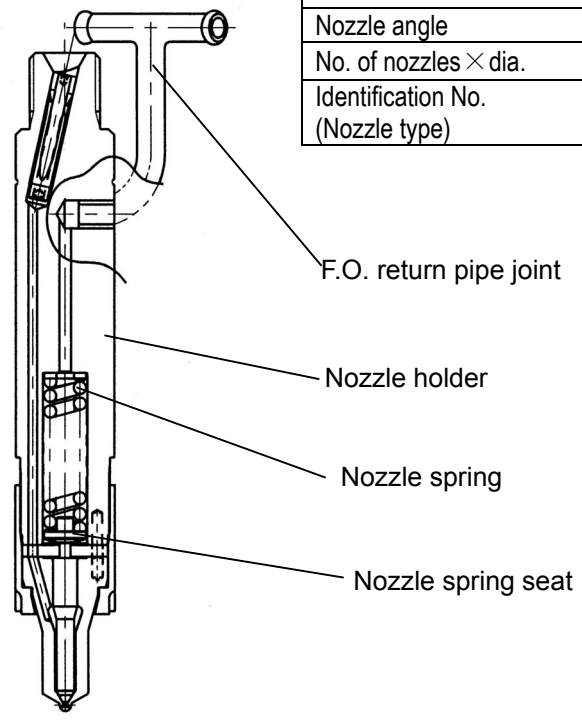
## 5.2. Type/construction of fuel injection nozzle

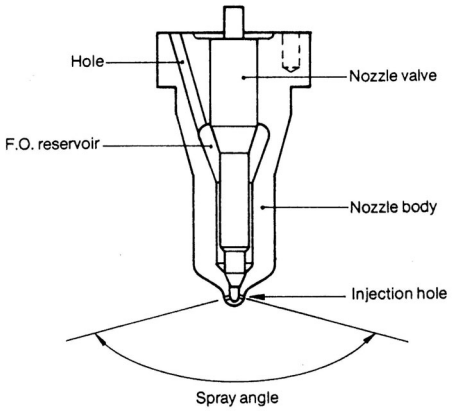
There are two types of fuel injection nozzles. Direct injection engines are equipped with the hole type, and indirect injection engines with the pintle type.

The YPD-MP fuel injection pump is designed for use with both direct and indirect injection engines. The hole type/pintle type of fuel injection nozzle are used according to the engine type.

Hole type fuel injection nozzle

| | | | | | |
|---|---|---|---|---|---|
| Nozzle opening pressure | MPa ($kgf/cm^2$) | 21.6 | +1.0<br>0 | (220) | (+10)<br>(0) |
| Nozzle angle | deg. | 162 | | 159 | |
| No. of nozzles × dia. | mm | 5×0.16 | | 5×0.17 | |
| Identification No. (Nozzle type) | —— | 162P165VAE1 | | 159P175VAD1 | |



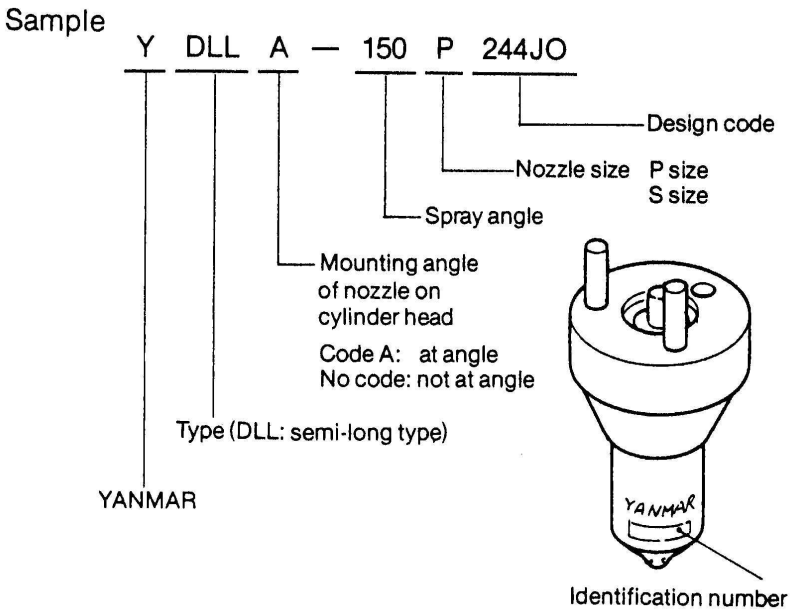



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Nozzle body identification number

The type of nozzle can be determined from the number inscribed on the outside of the nozzle body.

1） Hole type fuel injection nozzles



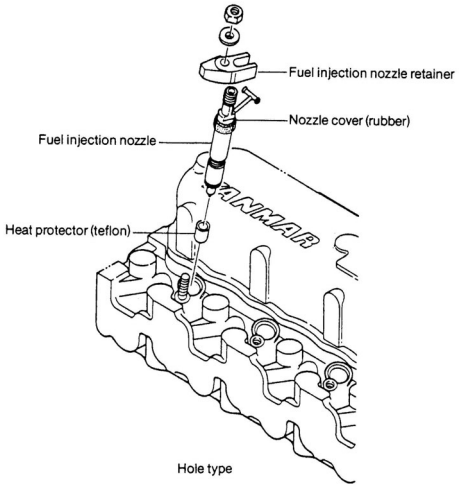

# 5.3. Fuel injection nozzle disassembly

Note:

1. Disassemble fuel injection nozzle in a clean area as for fuel injection pump.

2. When disassembling more than one fuel injection nozzle, keep the parts for each injection nozzle separate for each cylinder (i.e. the nozzle for cylinder 1 must be remounted in cylinder 1).

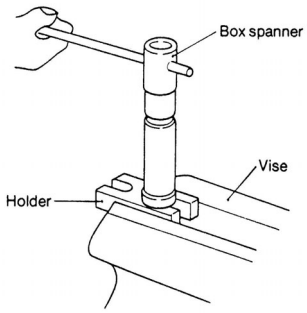
(1) When removing the injection nozzle from the cylinder head, remove the high pressure fuel pipe, fuel leakage pipe, etc., the injection nozzle retainer nut, and then the fuel injection nozzle.




(2) Put the nozzle in a vise

NOTE: Use the special nozzle holder for the hole type injection nozzle so that the high pressure mounting threads are not damaged.

（3） Remove the nozzle nut




NOTE: Use a special box spanner for the hole type (the thickness of the two nozzle nuts is 15mm(0.5906in.)).

(4) Remove the inner parts

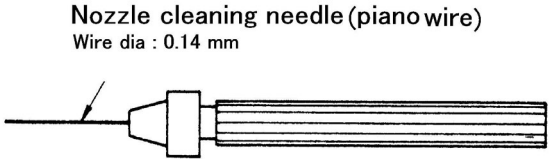
NOTE: Be careful not to loosen the spring seat, adjusting shims or other small parts.

# 5.4. Fuel injection nozzle inspection

## 5.4.1. Washing

（1） Make sure to use new diesel oil to wash the fuel injection nozzle parts.

（2） Wash the nozzle in clean diesel 0il with the nozzle cleaning kit.




(3) Clean off the carbon on the outside of the nozzle body with a brass brush.

(4) Clean the nozzle seat with cleaning spray.

(5)Clean off the carbon on the tip of nozzle with a piece of wood.

### 5.4.2. Nozzle inspection

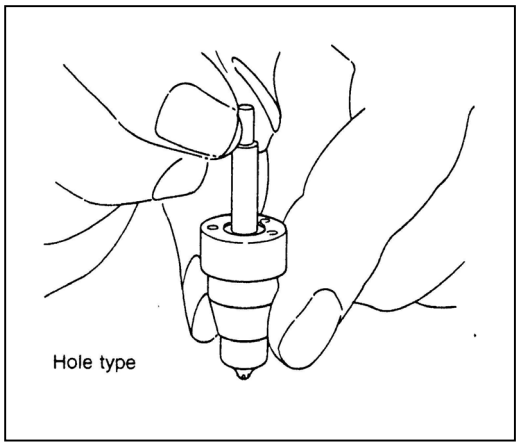
（1） Inspect for scratches/wear

Inspect oil seals for abnormal scratches or wear and replace nozzle if the nozzle sliding surface or seat are scratched or abnormally worn.

(2） Check nozzle sliding

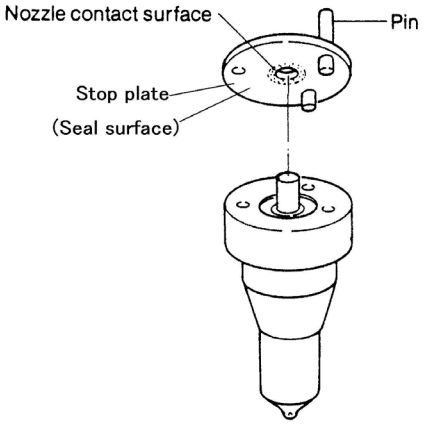
Wash the nozzle and nozzle body in clean diesel oil， and make sure that when the nozzle is pulled out about half way from the body， it slides down by itself when released.

Rotate the nozzle a little ; replace nozzle/nozzle body as a set if there are some places where it does not slide smoothly.



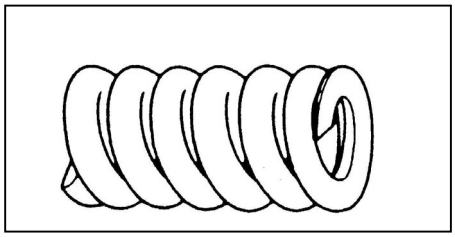

(3) Inspecting stop plate （inter-piece）

Check for scratches/wear in seals on both ends, check for abnormal wear on the surface where it comes in contact with the nozzle ; replace if stop plate is excessively worn.




（4） Inspecting nozzle spring

Replace the nozzle spring if it is extremely bent， or surface is scratched or rusted.



（5） Nozzle holder

Check oil seal surface for scratches/wear ; replace if wear is excessive.

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# 5.5. Fuel injection nozzle reassembly

The fuel injection nozzle is reassembled in the opposite order to disassembly.

(1) Insert the adjusting shims, nozzle spring and nozzle spring seat in the nozzle holder， mount the stop plate with the pin i nsert the nozzle body/nozzle set and tighten the nut.

(2) Use the special holder when tightening the nut for the hole type nozzle as in disassembly.

Nozzle nut tightening torque

N-m(kgf-m)

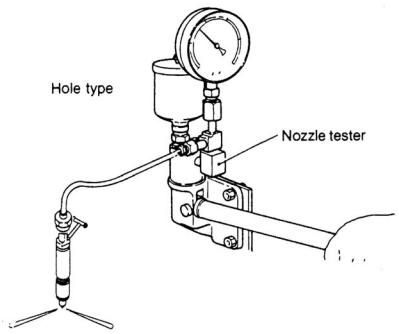
| | |
|---|---|
| Hole type nozzle | 39 – 44 ( 4 – 5 ) |

# 5.6. Adjusting fuel injection nozzle

## 5.6.1. Adjusting opening pressure

Mount the fuel injection nozzle on the nozzle tester and use the handle to measure injection starting pressure. If it is not at specified pressure, use the adjusting shims to increase/decrease pressure （both hole and pintle types).

| |
|---|
| Ajusting by 0.1 mm results in a change in the injection starting pressure of about 2 Mpa ( 20 kgf / $cm^2$ ) |




Injection starting pressure

MPa(kgf/$cm^2$)

| | |
|---|---|
| Injection starting pressure | 19.6 - 20.6 ( 200 – 210 ) |
| | 21.6 – 22.6 ( 220 – 230 ) |

Remark ) Injection starting pressure changes on enjine specifications.

### 5.6.2. Injection test

After adjusting the nozzle to the specified starting pressure, check the fuel spray condition and seat oil tightness.

(1) Check seat oil tightness

After two or three injections, gradually increase the pressure up to1.96MPa (20kg/cm²) before reading the starting pressure maintain the pressure for 5seconds, and make sure that no oil is dripping from the tip of the nozzle.

Test the injection with a nozzle tester ; retighten and test again if there is excessive oil leakage from the overflow coupling.

Replace the nozzle as set if oil leakage is still excessive.

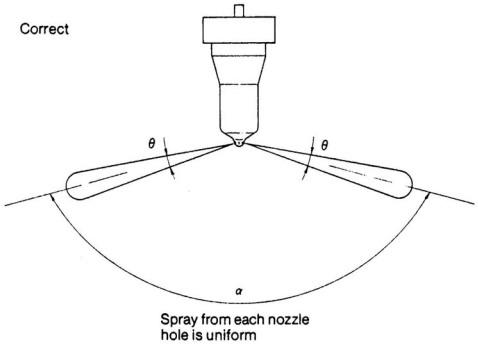
(2) injection spray condition

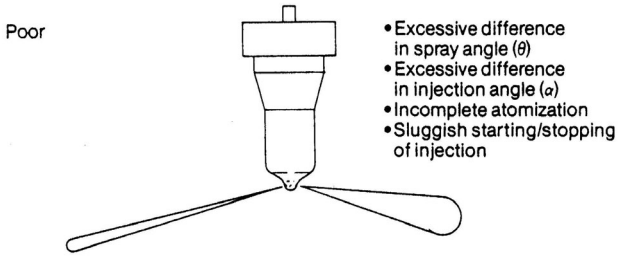
Operate the nozzle tester lever once to twice a second and check for abnormal injection.

#### 5.6.2.1. Hole type nozzles

Replace hole type nozzles that do not satisfy the following conditions :

- Proper spray ang1e (θ)
- Correct injection angle (α)
- Complete atomization of fuel
- Prompt starting /stopping of injection



# 6. Troubleshooting

## 6.1. Troubleshooting of fuel injection pump

Complete repair means not only replacing defective parts, but finding and eliminating the cause of the trouble as well. The cause of the trouble may not necessarily be in the pump itself, but may be in the engine or the fuel system. If the pump is removed prematurely, the true cause of the trouble may never be known. Before removing the pump from the engine, at least go through the basic check points given here.

Basic checkpoints

- Check for breaks or oil leaks throughout the fuel system, from the fuel tank to the nozzle.
- Check the injection timings for all cylinders. Are they correctly adjusted? Are they too fast or too slow?
- Check the nozzle spray.
- Check the fuel delivery. Is it in good condition? Loosen the fuel pipe connection at the injection pump inlet and test operate the fuel feed pump.

## 6.2. Major faults and troubleshooting

| Fault | | Cause | Remedy |
|---|---|---|---|
| 1. Engine won't start. | Fuel not delivered to injection pump. | (1) No fuel in the fuel tank. | Resupply |
| | | (2) Fuel tank cock is closed. | Open |
| | | (3) Fuel pipe system is clogged. | Clean |
| | | (4) Fuel filter element is clogged. | Disassemble and clean, or replace element |
| | | (5) Air is sucked into the fuel due to defective connections in the piping from the fuel tank to the fuel pump. | Repair |
| | | (6) Fuel feed pump is damaged. | Replace |
| | | (7) Fuel freeze. | Replace with a fuel for cold weather. |
| | Fuel delivered to injection pump. | (1) Defective connection of control lever and accel. rod of injection pump. | Repair or adjust |
| | | (2) Plunger is worn out or stuck. | Repair or replace |
| | | (3) Delivery valve is stuck. | Repair or replace |
| | | (4) Control rack doesn't move. | Repair or replace |
| | | (5) Injection pump coupling is damaged, or the key is broken. | Replace |
| | | (6) Air sucking. | Bleed air. |
| | | (7) Plunger/Distribution shaft is seized. | Replace pump. |
| | | (8) Tappet is seized. | Replace pump. |
| | | (9) Stop solenoid is damaged. | Replace |
| | | (10) Cold start device is damaged. | Replace |
| | | (11) Low cranking speed. | Replace battery. |
| | | (12) Governor is damaged. | Replace |
| | | (13) Barrel crack | Replace pump. |
| | | (14) Transmission shaft is seized. Gear slip. | Replace |

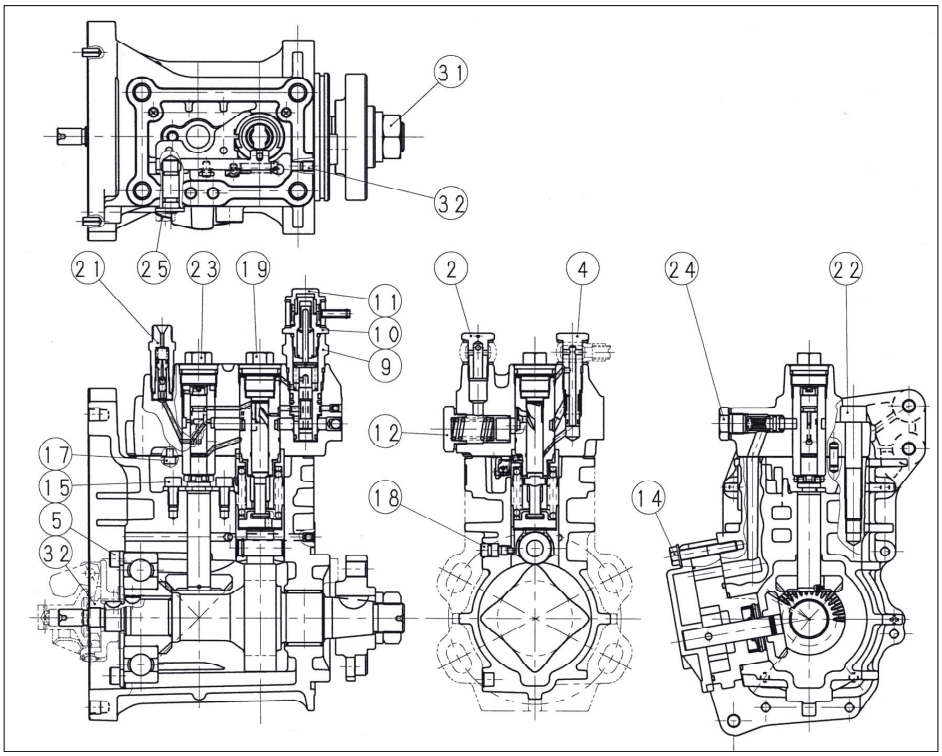
| | | | |
|---|---|---|---|
| | Nozzle doesn't work. | (1) Nozzle valve doesn't open or close normally. | Repair or replace |
| | | (2) Nozzle seat is defective. | Repair or replace |
| | | (3) Case nut is loose. | Inspect and tighten |
| | | (4) Injection nozzle starting pressure is too low. | Adjust |
| | | (5) Nozzle spring is broken. | Replace |
| | | (6) Fuel oil filter is clogged. | Repair or replace |
| | | (7) Excessive oil leaks from the nozzle sliding area. | Replace the nozzle assembly |
| | | (8) Deformation due to excessive tightening of nozzle retaining bolt. | Replace or adjust. |
| | | (9) Strainer is clogged. | Replace or clean |
| | Injection timing is defective. | (1) Injection timing is retarded due to failure of the coupling. | Adjust |
| | | (2) Camshaft is excessively worn. | Replace camshaft |
| | | (3) Roller tappet incorrectly adjusted or excessively worn. | Adjust or replace |
| | | (4) Plunger is excessively worn. | Replace plunger assembly |
| | | (5) Bad installation of injection pump. | Adjust. |
| | | (6) Air sucking. | Bleed air. |
| | | (7) Delivery valve is defective. | Replace. |
| 2. Engine starts, but immediately stops. | | (1) Fuel pipe is cogged. | Clean |
| | | (2) Fuel filter is clogged. | Disassemble and clean, or replace the element. |
| | | (3) Improper air-tightness of the fuel pipe connection, or pipe is broken and air is being sucked in. | Replace packing; repair pipe |
| | | (4) Insufficient fuel delivery from the feed pump. | Repair or replace. |
| | | (5) Trochoid pump is defective. | Replace. |
| | | (6) Air sucking. | Bleed air or hose check. |
| | | (7) Electromagnetic feed pump is clogged. | Replace. |
| | | (8) Out of fuel. | Fill the fuel. |
| | | (9) Stop solenoid is defective. | Replace. |
| | | (10) Accumulator is abnormal. | Replace. |
| 3.Engine's output is insufficient. | Defective injection timing, and other failures. | (1) Knocking sounds caused by improper (too fast) injection timing. | Inspect and adjust |
| | | (2) Engine overheats or emits large amount of smoke due to improper (too slow) injection timing. | Inspect and adjust |
| | | (3) Insufficient fuel delivery from feed pump. | Repair or replace |
| | | (4) Torochoid pump is defective. | Replace. |
| | | (5) Type of fuel is incorrect. | Check and refill proper fuel. |
| | | (6) Fuel tempererture is high. | Cool. |
| | Nozzle movements is defective | (1) Case nut loose. | Inspect and retighten |
| | | (2) Defective injection nozzle performance. | Repair or replace nozzle |
| | | (3) Nozzle spring is broken. | Replace |
| | | (4) Excessive oil leaks from nozzle. | Replace nozzle assembly |
| | Injection pump is defective. | (1) Max. delivery limit bolt is screwed in too far. | Adjust |
| | | (2) Plunger is worn. | Replace |
| | | (3) Injection amount is not uniform. | Adjust |
| | | (4) Injection timings are not even. | Adjust |
| | | (5) The 1st and 2nd levers of the governor and the control rack of the injection pump are improperly lined up. | Repair |
| | | (6) Delivery holderr is loose | Inspect and retighten |
| | | (7) Delivery packing is defective. | Replace packing |
| | | (8) Delivery valve seat is defective. | Repair or replace |
| | | (9) Delivery spring is broken. | Replace |
| | | (10) Carbon deposit is adhered. | Clean |
| | | (11) Spray pattern is abnormal. | Replace |
| | | (12) Nozzle crack. | Replace |
| | | (13) Plunger barrel crack. | Replace fuel injection pump. |

| | | | |
|---|---|---|---|
| 4. Idling is rough. | | (1) Movement of central rack is defective. | ———————— |
| | | 1) Stiff plunger movement or sticking. | Repair or replace |
| | | 2) Rack and pinion fitting is defective. | Repair |
| | | 3) Movement of governor is improper. | Repair |
| | | 4) Delivery holder is too tight. | Inspect and adjust |
| | | (2) Uneven injection volume. | Adjust |
| | | (3) Injection timing adjustment failure. | Adjust |
| | | (4) Plunger is worn and fuel injection adjustment is difficult. | Replace |
| | | (5) Governor spring is too weak. | Replace |
| | | (6) Feed pump can't feed oil at low speeds. | Repair or replace |
| | | (7) Fuel supply is insufficient at low speeds due to clogging of fuel filter. | Disassemble and clean, or replace element |
| | | (8) Weight abnormality. | Replace |
| | | (9) Shifter is worn. | Replace governor. |
| | | (10) Air sucking. | Check piping. |
| | | (11) Torochid pump is defective. | Replace |
| | | (12) Governor is worn. | Replace or adjust. |
| 5. Engine runs at high speeds, but cuts out at low Speeds. | | (1) The wire or rod of the accel is caught. | Inspect and repair |
| | | (2) Control rack is caught and can't be moved. | Inspect and repair |
| | | (3) Low idling stopper bolt is abnormal. | Replace or adjust. |
| 6. Engine doesn't reach max, rpm. | | (1) Governor spring is broken or excessively worn. | Replace |
| | | (2) Injection performance of nozzle is poor. | Repair or replace |
| | | (3) Trochiod pump is defective. | Replace |
| | | (4) Accumulator is abnormal. | Replace |
| | | (5) Filter and pipe are clogged. | Check piping. |
| | | (6) Governor is abnormal. | Replace |
| 7. Loud knocking. | | (1) Injection timing is too fast or too slow. | Adjust |
| | | (2) Injection from nozzle is improper fuel drips after each infection. | Adjust |
| | | (3) Injection nozzle starting pressure is too high. | Adjust |
| | | (4) Uneven injection. | Adjust |
| | | (5) Engine overheats, or insufficient compression. | Repair |
| 8.Engine exhausts too much smoke. | When exhaust smoke is black: | (1) Injection timing is too fast. | Adjust |
| | | (2) Air volume intake is insufficient. | Inspect and repair |
| | | (3) The amount of injection is uneven. | Adjust |
| | | (4) Injection from nozzle is improper. | Repair or replace |
| | When exhaust smoke is white: | (1) Injection timing is too slow. | Adjust |
| | | (2) Water is mixed in fuel. | Inspect fuel system, and clean |
| | | (3) Shortage of lube oil m the engine. | Repair |
| | | (4) Engine is over-cooled. | Inspect |

# 7. Tightening torques for main bolts and nuts

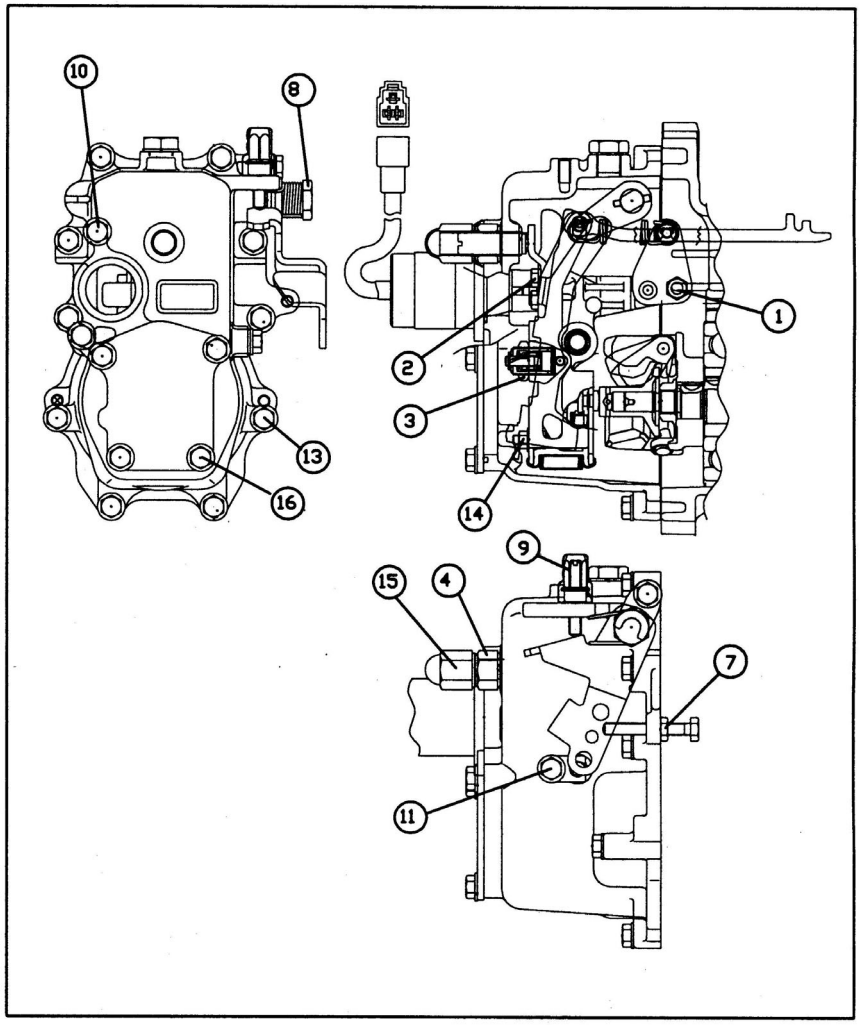
## 7.1. Pump part

| No. | Name of parts | Tightening torque ( N-m ) | | No. | Name of parts | Tightening torque ( N-m ) | |
|---|---|---|---|---|---|---|---|
| | | MP4 | MP2 | | | MP4 | MP2 |
| 2 | Pipe joint bolt, fuel inlet | 25 - 29 | | 18 | Tappet guide | 4 - 5 | |
| | | M12×1.25 | | | | M6×1 (hexagon socket head) | |
| 4 | Overflow joint, fuel outlet | 25 - 29 | | 19 | Plug, barrel | 50 - 55 | 30 - 35 |
| | | M12×1.25 | | | | M18×1 | M14×1 |
| 5 | Bearing retaining screw | 8 - 10 | | 21 | Delivery holder | 40 - 45 | |
| | | M6×1 (hexagon socket head) | | | | M14×1.25 | |
| 9 | Timer holder | 40 - 45 | | 22 | Head bolt | 28 - 32 | 18 - 22 |
| | | M22×1 | | | | M10×1.5 (hexagon socket head) | M8×1.25 (hexagon socket head) |
| 10 | Thermo element | 30 - 35 | | 23 | Plug, distribution shaft | 15 - 20 | |
| | | M16×1 | | | | M22×1 | |
| 11 | Plug, cooling water | 22 - 25 | | 24 | plug, strainer | 25 - 29 | |
| | | M14×1 | | | | M12×1.25 | |
| 12 | Accumulator | 50 - 55 | | 25 | Bolt, rink lifter | 8 - 10 | |
| | | M20×1 | | | | M6×1 | |
| 14 | Bolt, trochoid pump | 8 - 10 | | 31 | Nut, FIC fixing flange | 113 - 123 | 78 - 88 |
| | | M6×1 | | | | M18×1.5 | M14×1.5 |
| 15 | Bolt, driving shaft | 8 - 10 | | 32 | End nut | 79 - 84 | |
| | | M6×1 (hexagon socket head) | | | | M12×1.25 | |
| 17 | Retaining screw, rack guide | 3 - 4 | | 33 | plug, rack | 4 - 5 | |
| | | M4×0.7 (hexagon socket head) | | | | M6×1 | |



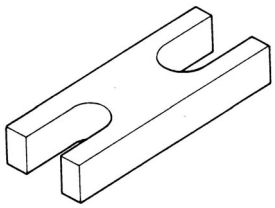
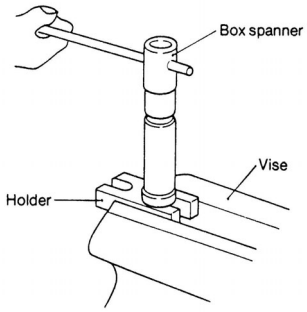
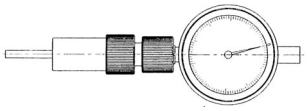
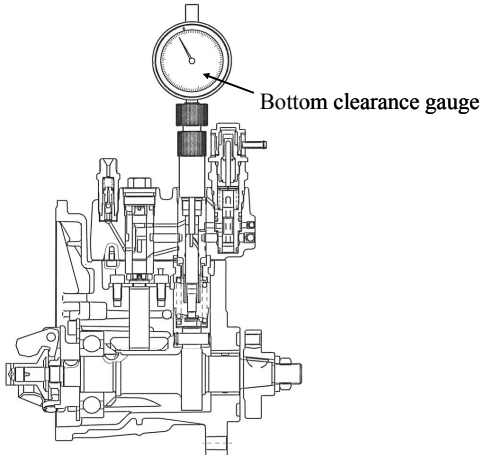
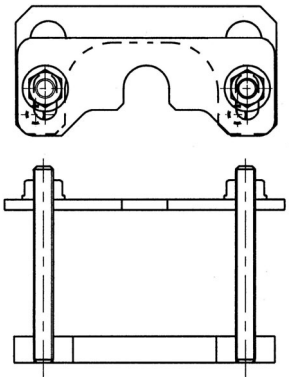
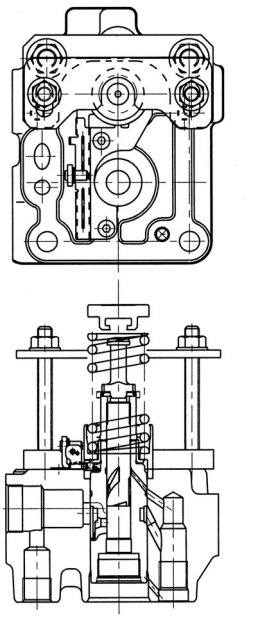
# 7.2. Mechanical governor part

| No. | Name of parts | Tightening torque ( N-m ) | | No. | Name of parts | Tightening torque ( N-m ) | |
|---|---|---|---|---|---|---|---|
| | | MP4 | MP2 | | | MP4 | MP2 |
| 1 | Fixing bolt, tension lever hook | 6 - 8<br>M6×1 | | 10 | Bolt, solenoid | 8 - 10<br>M6×1 | |
| 2 | Fixing bolt, patch | 5 - 7<br>M5×0.8 | — | 11 | Bolt, governor lever shaft | 8 - 10<br>M6×1 | |
| 3 | Angleich complete | 25 - 29<br>M14×1 | | 13 | Bolt, governor assy | 8 - 10<br>M6×1 | |
| 4 | Nut, fuel limiter | 19.6 - 21.6<br>M12×1.25 | | 14 | Starting fuel limiter | 6 - 8<br>M5×0.8 | 8 - 10<br>M6×1 |
| 7 | Setting bolt, min. idling speed | 8 - 10<br>M6×1 | | 15 | Cap nut | 20 - 22<br>M12×1.25 | |
| 8 | Nut, speed lever | 19.6 - 21.6<br>M8×1.25 | | 16 | Bolt, back cover | 8 - 10<br>M6×1 | |
| 9 | Setting nut, max. idling speed | 8 - 10<br>M6×1 | | | | | |



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# 8. Tools

| Name of tool | Shape and size | application |
|---|---|---|
| Nozzle plate<br>158090-51700 |  |  |
| Bottom clearance gauge<br><br>158090-51800 : MP2<br>158090-51810 : MP4 |  |  |
| Plunger SP seat extractor<br><br>158090-51900 |  |  |

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| | | | | Literature No. | M9961-03E070 |
|---|---|---|---|---|---|
| Revision history list | | | | Page No | 1 |
| Document name | SERVICE MANUAL FOR FUEL INJECTION EQUIPMENT | | | | |
| Product name | YDP-MP2 / YDP-MP4 | | | | |
| Revision No. | Revision date (A.D.) | Reason for revision | Revision outline | Revision item (page) | Revised by |
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