DX225LC

Shop Manual

K1015439E

Serial Number 5001 and Up

DOOSAN reserves the right to improve its products continuously, delivering the best possible product to the marketplace. These improvements can be implemented at any time with no obligation to change materials previously sold. It is recommended that consumers periodically contact their distributors for most recent documentation on purchased equipment.

This documentation may include attachments and optional equipment not available in your machine's package. Please call your distributor for additional items that you may require.

Illustrations used throughout this manual are used only as a representation of the actual piece of equipment, and may vary from the actual item.

K1015439E Shop Manual
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DX225LC
Serial Number 5001 and Up
Pub.No. K1015439E

Product Label

Instructions

Trim Out The Label Along The Lines And Insert Into Pocket On The Binder Spine

Pub. No. K1015439E

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PUBLICATION REQUEST FOR PROPOSED REVISION

In *DOOSAN's* continuing effort to provide the best customer satisfaction, we invite you to help us improve the manuals that you work with daily. This form is provided to give you a means of feedback to the publication department.

COMPANY NAME:	DATE:
STREET ADDRESS:	TELEPHONE:
CITY:	FAX:
STATE / PROVINCE:	
COUNTRY:	
NAME:	
MACHINE MODEL:	
SERIAL NUMBER:	
MANUAL NUMBER:	
SHOP MANUAL SECTION NUMBER:	

PROPOSED DESCRIPTION OF CORRECTION AND/OR SUGGESTION:

Use additional paper if needed. Please include copy of current manual pages for reference. Attach any photos or illustrations. If digital photos are available, E-mail them to Bill.Bernhardt@dhiac.com (If possible, use 1024 x 768 resolution.).

HAS THIS BEEN DISCUSSED WITH A *DOOSAN* SERVICE REPRESENTATIVE: YES NO

IF YES - WHO:

(It is advised to discuss this with a *DOOSAN* service representative to ensure the correction is appropriate and valid.)

Mail to:

DOOSAN Infracore America Corporation
2905 Shawnee Industrial Way
Suwanee, GA 30024
Attention: Publications

Safety

Track Excavator Safety

Edition 1

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MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX340LC	5001 and Up
DX420LC	5001 and Up
DX480LC	5001 and Up
DX520LC	5001 and Up

TO THE OPERATOR OF A *DOOSAN* EXCAVATOR

DANGER!

Unsafe use of the excavator could lead to serious injury or death. Operating procedures, maintenance and equipment practices or traveling or shipping methods that do not follow the safety guidelines on the following pages could cause serious, potentially fatal injuries or extensive damage to the machine or nearby property.

Please respect the importance of taking responsibility for your own safety, and that of other people who may be affected by your actions.

The safety information on the following pages is organized into the following sections:

1. “General Safety Essentials” on page 1-10
2. “Location of Safety Labels” on page 1-11
3. “Summary of Safety Precautions for Lifting in Digging Mode” on page 1-12
4. “Unauthorized Modifications” on page 1-13
5. “General Hazard Information” on page 1-13
6. “Before Starting Engine” on page 1-22
7. “Machine Operation” on page 1-26
8. “Maintenance” on page 1-33
9. “Battery” on page 1-42
10. “Towing” on page 1-44
11. “Shipping and Transportation” on page 1-45
12. “Lifting With Sling” on page 1-45

WARNING!

Improper operation and maintenance of this machine can be hazardous and could result in serious injury or death.

Operator and maintenance personnel should read this manual thoroughly before beginning operation or maintenance.

Keep this manual in the storage compartment to the rear of the operator's seat, and have all personnel involved in working on the machine read the manual periodically.

Some actions involved in operation and maintenance of the machine can cause a serious accident, if they are not done in a manner described in this manual.

The procedures and precautions given in this manual apply only to intended uses of the machine.

If you use your machine for any unintended uses that are not specifically prohibited, you must be sure that it is safe for others. In no event should you or others engage in prohibited uses or actions as described in this manual.

***DOOSAN* delivers machines that comply with all applicable regulations and standards of the country to which it has been sent. If this machine has been purchased in another country or purchased from someone in another country, it may lack certain safety devices and specifications that are necessary for use in your country. If there is any question about whether your product complies with the applicable standards and regulations of your country, consult *DOOSAN* or your *DOOSAN* distributor before operating the machine.**

SAFETY ALERT SYMBOL

Be Prepared - Get to Know All Operating and Safety Instructions

This is the Safety Alert Symbol. Wherever it appears in this manual or on safety signs on the machine you must be alert to the potential for personal injury or accidents. Always observe safety precautions and follow recommended procedures.

Learn Signal Words Used With Safety Alert Symbol

The words "**CAUTION**," "**WARNING**," and "**DANGER**" used throughout this manual and on decals on the machine indicate degree of risk of hazards or unsafe practices. All three degrees of risk indicate that safety is involved. Observe precautions indicated whenever you see the Safety Alert "Triangle," no matter which signal word appears next to the "Exclamation Point" symbol.

CAUTION!

This word is used on safety messages and safety labels and indicates potential threat of a hazardous situation that, if not avoided, could result in minor or moderate injury. It may also be used to alert against a generally unsafe practice.

WARNING!

This word is used on safety messages and safety labels and indicates potential threat of a hazardous situation that, if not avoided, could result in serious injury or death. It may also be used to alert against highly unsafe practice.

DANGER!

This word is used on safety messages and safety labels and indicates an imminent hazard of a situation that, if not avoided, is very likely to cause death or extremely serious injury. It may also be used to alert against equipment that may detonate or explode if handled or treated carelessly.

Safety precautions are described in SAFETY from page -11 on.

DOOSAN cannot predict every circumstance that might involve a potential hazard in operation and maintenance. Therefore the safety messages in this manual and on the machine may not include all possible safety precautions. If any procedures or actions not specifically recommended or allowed in this manual are used, you must be sure that you and others can do such procedures and actions safely and without damaging the machine. If you are unsure about the safety of any procedures, contact a *DOOSAN* distributor.

Accessory Applications

The excavator has been primarily designed for moving earth with a bucket. For use as a grapple or for other object handling, contact *DOOSAN* for proper installation and application. Lifting-work applications (unless restricted or prohibited by local regulations) are permitted in approved lift configuration, to rated capacity only, with no side-loading. DO NOT use the machine for activities for which it was not intended. DO NOT use the bucket for lifting work, unless lift slings are used in the approved configuration.

Use of an accessory hydraulic hammer (breaker), work in rough terrain, demolition applications or other hazardous operation may require installation of additional protective structures to safeguard the operator.

Lifting Capacity Rating Configuration

Lifting capacity ratings that are printed at the end of this safety section are based on the machine being level, on a firm supporting surface, with hooks and slings attached in approved configuration. Loads must be balanced and supported evenly. Use tag lines to keep the load steady if wind conditions and large surface area are a problem. Work crew hand signals, individual tasks and safe procedures should all be universally understood before the lift is made**.**

IMPORTANT

Before using the excavator to make lifts check municipal and regional regulations or statutes that could apply. Governing ordinances may require that all heavy lifting be done with single purpose equipment specifically designed for making lifts, or other local restrictions may apply. Making heavy lifts with a general purpose excavator that can be used for digging, loading, grading or other work may be expressly forbidden by a regional injunction or other legal prohibition. Always follow all the other instructions, guidelines and restrictions for Safe Lifting in the Operation and Maintenance Manuals.

LOCATION OF SAFETY LABELS

Location of safety labels (decals) can vary from unit to unit. Refer to appropriate Operation and Maintenance Manual, and parts manual for your unit.

Always replace damaged or faded decals.

SUMMARY OF SAFETY PRECAUTIONS FOR LIFTING IN DIGGING MODE

DANGER!

Unsafe use of the excavator while making rated lifts could cause serious, potentially fatal injuries or extensive damage to the machine or nearby property. Do not let anyone operate the machine unless they've been properly trained and understand the information in the Operation and Maintenance Manual.

To lift safely while in Digging Mode, the following items must be evaluated by the operator and the work site crew.

- Condition of ground support.
- Excavator configuration and attachments.
- Weight, lifting height and lifting radius.
- Safe rigging of the load.
- Proper handling of the suspended load.

Tag lines on opposite sides of the load can be very helpful in keeping a suspended load secure, if they are anchored safely to control points on the ground.

WARNING!

NEVER wrap a tag line around your hands or body.

NEVER rely on tag lines or make rated lifts when wind gusts are more than 48.3 km/h (30 MPH). Be prepared for any wind gust when working with loads that have a large surface area.

Always engage the "Digging Mode" control on the Instrument Panel before using the excavator for lifting work.

WARNING!

If you need more information or have any questions or concerns about safe operating procedures or working the excavator correctly in a particular application or in the specific conditions of your individual operating environment, please consult your local *DOOSAN* representative.

UNAUTHORIZED MODIFICATIONS

Any modification made without authorization or written approval from *DOOSAN* can create a safety hazard, for which the machine owner will be held responsible.

For safety's sake, replace all OEM parts with the correct authorized or genuine *DOOSAN* part. For example, not taking the time to replace fasteners, bolts or nuts with the correct replacement parts could lead to a condition where the safety of critical assemblies are dangerously compromised.

GENERAL HAZARD INFORMATION

Safety Rules

Only trained and authorized personnel can operate and maintain the machine.

Follow all safety rules, precautions and instructions when operating or performing maintenance on the machine.

Do not operate the machine if you are not feeling well, if you are taking medication that makes you feel sleepy, if you have been drinking, or if you are suffering from emotional problems. These problems will interfere with your sense of judgment in emergencies and may cause accidents.

When working with another operator or with a person on work site traffic duty, be sure that all personnel know the nature of the work and understand all hand signals that are to be used.

Always observe strictly any other rules related to safety.

Safety Features

Be sure that all guards and covers are installed in their proper position. Have guards and covers repaired immediately if damaged.

Be sure that you understand the method of use of safety features such as safety lock lever and the seat belt, and use them properly.

Never remove any safety features. Always keep them in good operating condition.

Failure to use safety features according to the instructions in the Operation and Maintenance Manual could result in serious bodily injury.

Inside Operator's Cabin

When entering the operator's cabin, always remove all mud and oil from the soles of your shoes. If you operate the travel pedal with mud or oil stuck to your shoes, your foot may slip and this may cause a serious accident.

After using the ashtray, make sure that any matches or cigarettes are properly extinguished, and be sure to close the ashtray. If the ashtray is left open, there is a danger of fire.

Do not stick suction pads to the window glass. Suction pads act as a lens and may cause fire.

Do not leave lighters laying around the operator's cabin. If the temperature inside the operator's cabin becomes high, there is a danger that the lighter may explode.

Do not use cellular telephones inside the operator's cabin when driving or operating the machine. There is a danger that this may lead to an unexpected accident.

Never bring any dangerous objects such as flammable or explosive items into the operator's cabin.

To ensure safety, do not use the radio or music headphones when operating the machine. There is a danger that this may lead to a serious accident.

When operating the machine, do not put your hands or head out of the window.

When standing up from the operator's seat, always place safety lock lever securely in the "LOCK" position. If you accidentally touch the work equipment levers when they are not locked, the machine may suddenly move and cause serious injury or damage.

When leaving the machine, lower the work equipment completely to the ground, set safety lock lever to the "LOCK" position and shut down engine. Use the key to lock all the equipment. Always remove key and take it with you.

Clothing and Personal Protective Items

Secure long hair, and avoid loose clothing and jewelry. These items have the tendency to catch on controls or protrude into parts and cause serious injury or death.

Do not wear oily clothes. They are flammable.

Full eye protection, a hard hat, safety shoes and gloves may be required at the work site.

While working on the machine, never use inadequate tools. They could break or slip, causing injury, or they may not adequately perform intended functions.



HAOA020L

Figure 1

Breathing Masks, Ear Protection May Be Required

Do not forget that some risks to your health may not be immediately apparent. Exhaust gases and noise pollution may not be visible, but these hazards can cause disabling or permanent injuries.

NOTE: *The equivalent continuous A-weighted sound pressure level at the workstation for this machine is given in the operation manual.*

Measurement is obtained on a dynamic machine following the procedures and cabin conditions as described in ISO 6396.

NOTE: *The guaranteed sound power level emitted by the machinery for this machine is given in the operation manual.*

Measurement is obtained on a dynamic machine with the procedures as described in 2000/14/EC.

Vibration Level Information

Hands/Arms: The weighted root mean square acceleration to which the hands/arms are subjected, is less than 2.5 m/s^2.

Whole body: The weighted root mean square acceleration to which the whole body is subjected, is less than 0.5 m/s^2.

Measurements are obtained on a representative machine, using measuring procedures as described in the following standard: ISO 2631/1. ISO 5349, and SAE J1166.

Recommendations for Limiting Vibrations

1. Select the right machine, equipment and attachments for a particular application.
2. Replace any damaged seat by a genuine *DOOSAN* part. Keep the seat maintained and adjusted.
   - Adjust the seat and suspension for the weight and size of the operator.
   - Inspect and maintain the suspension and adjustment mechanisms of the seat regularly.
3. Check that the machine is properly maintained.
   - Tire pressure, brakes, steering, linkages, etc.
4. Steer, brake, accelerate, shift gears, move the attachments and load the attachments smoothly.

5. Adjust the machine speed and travel path to reduce the vibration level.
    - Slow down if it is necessary when traveling through rough terrain.
    - When driving machine, avoid obstacles and excessive rough terrain.
6. Keep the machine on terrain where working and traveling conditions are good.
    - Remove any large rocks or obstacles.
    - Fill any ditches and holes.
    - Provide machines for and schedule time to maintain good terrain conditions.
7. Travel over longer distances (e.g. on public roads) at adjusted (medium) speed.
    - Always adjust the speed to prevent bouncing.

Mounting and Dismounting

Before getting on or off the machine, if there is any oil, grease, or mud on the handrails, steps, or track shoes, wipe it off immediately. Always keep these parts clean. Repair any damage and tighten any loose bolts.

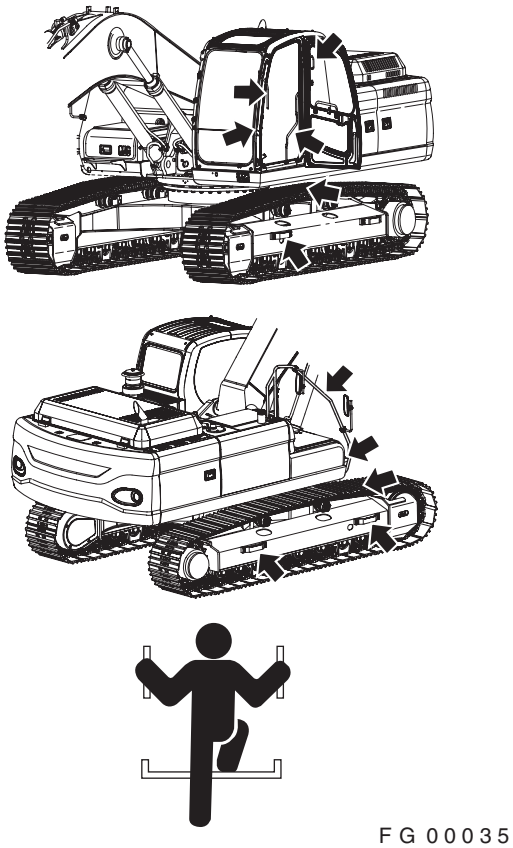
Never jump on or off the machine. In particular, never get on or off a moving machine. These actions may lead to serious injury.

When getting on or off the machine, always face the machine, and maintain three-point contact (both feet and one hand or one foot and both hands) with the handrails, steps, and track shoes to ensure that you support yourself securely.

Never hold any control levers when getting on or off the machine.

Apply the door lock securely. If you grip the handrail inside the door when moving on top of the track shoes, and the door lock is not applied securely, the door may move and cause you to fall.

Use the points marked by arrows in the diagram when getting on or off the machine.



FG 00035

Figure 2

Fuel, Oil and Hydraulic Fluid Fire Hazards

Fuel, oil and antifreeze will catch fire if it is brought close to a flame. Fuel is particularly flammable and can be hazardous.

Always strictly observe the following.

Add fuel, oil, antifreeze and hydraulic fluid to the machine only in a well ventilated area. The machine must be parked with controls, lights and switches turned "OFF." The engine must be "OFF" and any flames, glowing embers, auxiliary heating units or spark causing equipment must be extinguished, turned "OFF" and/or kept well clear of the machine.

Static electricity can produce dangerous sparks at the fuel filling nozzle. In very cold, dry weather or other conditions that could produce a static discharge, keep the tip of the fuel nozzle in constant contact with the neck of the fuel filling nozzle, to provide a ground.

Keep fuel and other fluid reservoir caps tight and do not start the engine until caps have been secured.



ARO1050S

Figure 3

Precautions When Handling Fluids at High Temperature

Immediately after operations are stopped, the coolant, engine oil, and hydraulic oil are at highest temperatures and the radiator and hydraulic tank are still under pressure. Attempting to remove cap, drain the oil or coolant, or replace the filters may lead to serious burns. Always wait for the temperature to go down, and follow the specified procedures when carrying out these operations.



HAOA050L

Figure 4

To prevent hot coolant from spurting out, shut down engine, wait for the coolant to cool, then loosen the cap slowly to relieve the pressure.

To prevent hot oil from spurting out, shut down engine, wait for the oil to cool, then loosen the cap slowly to relieve the pressure.



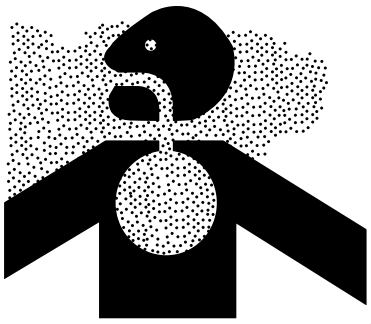
HAOA060L

Figure 5

Asbestos Dust Hazard Prevention

Asbestos dust can be HAZARDOUS to your health if it is inhaled. Materials containing asbestos fiber can be present on work site. Breathing air that contains asbestos fiber can ultimately cause serious or fatal lung damage. To prevent lung damage from asbestos fiber, observe following precautions:

- Use a respirator that is approved for use in an asbestos-laden atmosphere.
- Never use compressed air for cleaning.
- Use water for cleaning to keep down the dust.
- Work on the machine or component with the wind at your back whenever possible.
- Always observe any regulations related to the work site and working environment.



ARO1770L

Figure 6

Injury from Work Equipment

Do not enter or put your hand, arm or any other part of your body between movable parts, such as between the work equipment and cylinders, or between the machine and work equipment.

If the control levers are operated, the clearance between the machine and the work equipment will change and this may lead to serious damage or personal injury.

If going between movable parts is necessary, always position and secure the work equipment so it cannot move.



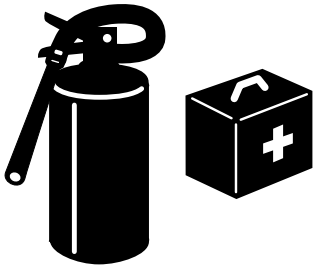
HDO1010L

Figure 7

Fire Extinguisher and First Aid Kit

As a precaution if any injury or fire should occur, always do the following.

- Be sure that fire extinguishers have been provided and read the labels to ensure that you know how to use them. It is recommended that an appropriately sized (2.27 kg [5 lb] or larger) multipurpose "A/B/C" fire extinguisher be mounted in the cabin. Check and service the fire extinguisher at regular intervals and make sure that all work site crew members are adequately trained in its use.
- Provide a first aid kit in the storage compartment and keep another at the work site. Check the kit periodically and make any additions if necessary.
- Know what to do in case of injury from fire.
- Keep emergency numbers for doctor, ambulance service, hospital and fire department near your telephone.



HDO1009L

Figure 8

If the machine catches fire, it may lead to serious personal injury or death. If a fire occurs during operation, escape from the machine as follows:

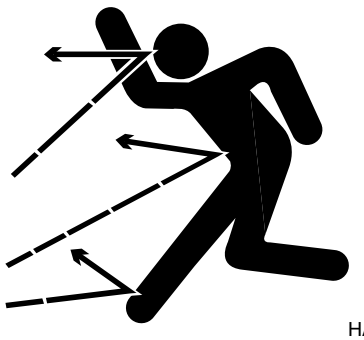
- Turn the starter switch to the "O" (OFF) position and shut down engine.
- If there is time, use the fire extinguisher to put out as much of the fire as possible.
- Use the handrails and steps to escape from the machine.

The above is the basic method for escaping from the machine, but changing the method may be necessary according to the conditions, so carry out practice drills at the work site.

Protection from Falling or Flying Objects

On work sites where there is a danger that falling objects or flying objects may hit the operator's cabin select a guard to match the operating conditions to protect the operator.

Working in mines, tunnels, deep pits or on loose or wet surfaces could produce danger of falling rock or hazardous flying objects. Additional protection for the operator's cabin could be required in the form of a Falling Object Protective Structure (FOPS) or window guards.



HAOA110L

Figure 9

Never attempt to alter or modify any protective structure reinforcement system, by drilling holes, welding, remounting or relocating fasteners. Any serious impact or damage to the system requires a complete integrity reevaluation. Reinstallation, recertification and/or replacement of the system may be necessary.

Contact your *DOOSAN* distributor for available safety guards and/or recommendations to prevent danger of getting hit by objects that could strike the operator's cabin. Make sure that all other work site crew members are kept well away from the excavator and safe from possible hazards.



HAOA100L

Figure 10

For breaker operation, install a front guard and apply a laminated coating sheet to the front glass. Contact your *DOOSAN* distributor for recommendations.

When carrying out demolition or cutting operation, install a front guard and top guard, and apply a laminated coating sheet to the front glass.

When working in mines or quarries where there is a danger of falling rock, install FOPS (Falling Objects Protective Structure) and apply a laminated coating sheet to the front glass.

If any glass on the machine is broken, replace it with new glass immediately.

Attachment Precautions

Option kits are available through your dealer. Contact *DOOSAN* for information on available one-way (single-acting) and two-way (double-acting) piping / valving / auxiliary control kits. Because *DOOSAN* cannot anticipate, identify or test all the attachments that owners may wish to install on their machines, please contact *DOOSAN* for authorization and approval of attachments, and their compatibility with optional kits.

Accumulator

The pilot control system is equipped with an accumulator. For a brief period of time after the engine has been shut down, the accumulator will store a pressure charge that may enable hydraulic controls to be activated. Activation of any controls may enable the selected function to operate under force of gravity.

When performing maintenance on the pilot control system, the hydraulic pressure in the system must be released as described in "Handling of Accumulator" in the Operation and Maintenance Manual.

The accumulator is charged with high-pressure nitrogen gas, so it is extremely dangerous if it is handled in the wrong way. Always observe the following precautions:

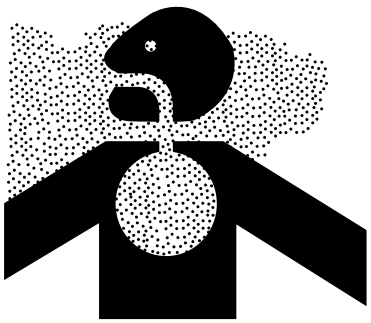
- Do not drill or make any holes in the accumulator or expose it to any flames, fire or heat source.
- Do not weld on the accumulator, or try attaching anything to it.
- When carrying out disassembly or maintenance of the accumulator, or when disposing of the accumulator, the charged gas must be properly released. Contact your *DOOSAN* distributor.
- Wear safety goggles and protective gloves when working on an accumulator. Hydraulic oil under pressure can penetrate the skin and cause serious injuries.

Indoor Ventilation

Engine exhaust gases can cause fatal accidents, and unconsciousness, loss of alertness, judgment and motor control and serious injury.

Make sure there is adequate ventilation before starting the engine in any enclosed area.

You should also be aware of open windows, doors or ductwork where exhaust may be carried, or blown by the wind, exposing others to danger.



ARO1770L

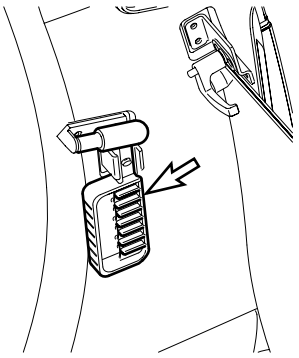
Figure 11

Emergency Exit

This machine is equipped with a glass breaking tool. It is behind the operator seat in the upper right corner of the cabin. This tool can be used in case of an emergency situation that requires the breaking of glass to exit from the operator's cabin. Grip the handle firmly and use the sharp point to break the glass.

WARNING!

Protect your eyes when breaking the glass.



FG000178

Figure 12

BEFORE STARTING ENGINE

Work Site Precautions

Before starting operations, thoroughly check the area for any unusual conditions that could be dangerous.

Check the terrain and condition of the ground at the work site, and determine the best and safest method of operation.

Make sure the ground surface is as hard and horizontal as possible before carrying out operations. If there is a lot of dust and sand on the work site, spray water before starting operations.

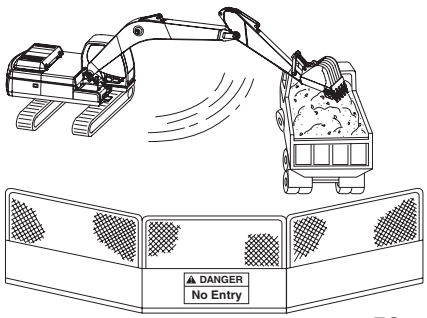
If you need to operate on a street, protect pedestrians and cars by designating a person for work site traffic duty or by erecting fences and posting "No Entry" signs around the work site.

Erect fences, post "No Entry" signs, and take other steps to prevent people from coming close to or entering the work site. If people come close to a moving machine, they may be hit or caught by the machine, and this may lead to serious personal injury or death.

Waterlines, gas lines, phone lines and high-voltage electrical lines may be buried under the work site. Contact each utility and identify their locations. Be careful not to damage or cut any of these lines.

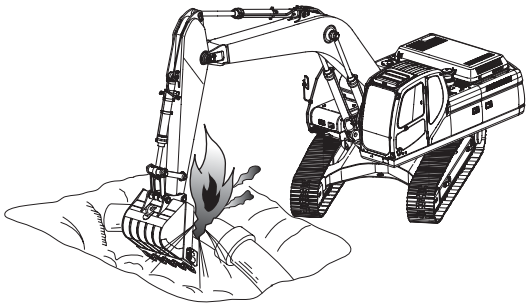
Check the condition of the riverbed, and the depth and flow of the water before operating in water or crossing a river. NEVER work in water that is more than the permissible water depth.

Any object in vicinity of boom could represent a potential hazard, or cause the operator to react suddenly and cause an accident. Use a spotter or signal person when working near bridges, phone lines, work site scaffolds, or other obstructions.



FG000400

Figure 13

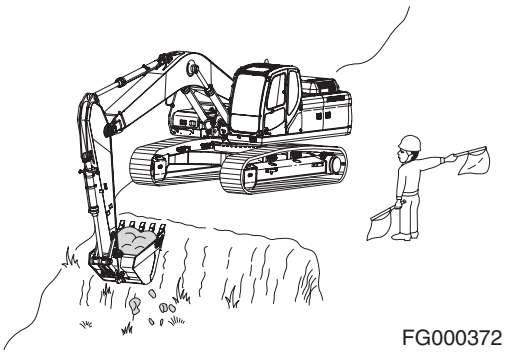


FG000363

Figure 14

Minimum levels of insurance coverage, work permits or certification, physical barriers around the work site or restricted hours of operation may be mandated by governing authorities. There may also be regulations, guidelines, standards or restrictions on equipment that may have to be followed for local requirements. There may also be regulations related to performing certain kinds of work. If there is any question about whether your machine and work site complies with the applicable standards and regulations contact your local authorities and agencies.

Avoid entering soft ground. It will be difficult for the machine to escape.



FG000372

Figure 15

Avoid operating your machine too close to the edge of cliffs, overhangs, and deep ditches. The ground may be weak in such areas. If the ground collapses, the machine could fall or tip over resulting in serious injury or death.

Remember that soil after heavy rain, blasting or after earthquakes, is weakened.

Newly laid earth and the soil near ditches is typically loose. It can collapse under the weight of vibration of your machine and cause your machine to tip over.

Install the head guard (FOPS) if working in areas where there is a danger of falling rocks.

Checks Before Starting Engine

Every day before starting the engine for the first time, carry out the following checks. If these checks are not carried out properly, there is a danger of serious injury.

Remove all wood chips, leaves, grass, paper and other flammable materials accumulated in the engine compartment and around the battery. They could cause a fire. Remove any dirt from the window glass, mirrors, handrails, and steps.

Do not leave tools or spare parts laying around in the operator's cabin. The vibration of the machine when traveling or during operations may cause them to fall and damage or break the control levers or switches. They may also get caught in the gap of the control levers and cause the work equipment to malfunction or move dangerously. This may lead to unexpected accidents.

Check the coolant level, fuel level, and hydraulic tank oil level, and check for clogged air cleaner and damage to the electrical wiring.

Adjust the operator's seat to a position where it is easy to operate the machine, and check the seat belt and mounts for damage and wear.

Check the operation of the gauges and the angle of the mirrors, and check that the safety lever is in "LOCKED" position.

If any abnormalities are found in the above checks, carry out repairs immediately.

Engine Starting

Walk around your machine before getting in the operator's cabin. Look for evidence of leaking fluid, loose fasteners, misaligned assemblies or any other indications of possible equipment hazard.

All equipment covers and machinery safety guards must be in place, to protect against injury while the machine is being operated.

Look around the work site area for potential hazards, people or property that could be at risk while operation is in progress.

NEVER start the engine if there is any indication that maintenance or service work is in progress, or if a warning tag is attached to controls in the cabin.

A machine that has not been used recently, or is being operated in extremely cold temperatures, could require a warm-up or maintenance service before start-up.

Check gauges and monitor displays for normal operation before starting the engine. Listen for unusual noises and remain alert for other potentially hazardous conditions at the start of the work cycle.

Do not short-circuit the starting motor to start the engine. This is not only dangerous, but may also damage the machine.

When starting the engine, sound the horn as an alert.

Start and operate the machine only while seated.

Before Operating Machine

If checks are not carried out properly after starting the engine, it may result in a delay in discovering abnormalities in the machine, and this may lead to personal injury or damage to the machine.

Carry out the checks in an open area where there are no obstructions. Do not let anyone near the machine when carrying out the checks.

- Check the operating condition of the equipment, and the movement of the bucket, arm, boom, travel, and swing systems.
- Check the machine for any abnormal noise, vibration, heat, smell, or abnormality with the gauges. Check also for leakage of air, oil, and fuel.
- If any abnormality is found, repair the problem immediately. If the machine is used without repairing the problems, it may lead to unexpected injury or failure.
- Clear all personnel from directly around machine and from the area.

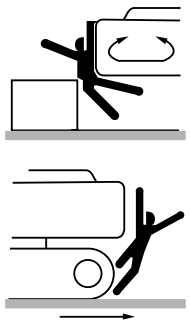
- Clear all obstacles from the machine's path. Beware of hazards.
- Be sure that all windows are clean. Secure the doors and the windows in the open position or in the shut position.
- Adjust the rearview mirrors for best visibility close to the machine. Make sure that the horn, the travel alarm (if equipped), and all other warning devices are working properly.
- Fasten the seat belt securely.
- Warm up the engine and hydraulic oil before operating machine.
- Before moving the machine, check undercarriage position. The normal travel position is with idler wheels to the front under the cabin and the drive sprockets to the rear. When the undercarriage is in the reversed position, the travel controls must be operated in opposite directions.

When Swinging or Changing Direction of Travel

Before operating the machine or the work equipment, always observe the following precautions to prevent serious injury or death.

- Start and operate the machine only while seated.
- When changing travel direction from forward to reverse or from reverse to forward, reduce speed early and stop the machine before changing travel direction.
- Sound the horn to warn people in the area.
- Check that there is no one in the area around the machine. There are blind spots behind the machine, so if necessary, swing the upper structure to check that there is no one behind the machine before traveling in reverse.
- When operating in areas that may be hazardous or have poor visibility, designate a person to direct work site traffic.
- Ensure that no unauthorized person can come within the turning radius or direction of travel.

Be sure to observe the above precautions even if a travel alarm or mirrors are installed.



HAOA190L

Figure 16

Travel Precautions

Never turn the starting switch to the "O" (OFF) position when traveling. It is dangerous if the engine stops while the machine is traveling. It will be impossible to operate the steering.

Attachment control levers should not be operated while traveling.

Do not change selected travel mode (FAST/SLOW) while traveling.

Fold in work equipment so the outer end of the boom is as close to the machine as possible, and is 40 - 50 cm (16 - 20 in) above ground.

Never travel over obstacles or slopes that will cause the machine to tilt severely. Travel around any slope or obstacle that causes the machine to tilt 10° or more to the right or left, or 30° or more from front to rear.

Do not operate the steering suddenly. The work equipment may hit the ground and cause the machine to lose its balance, and this may damage the machine or structures in the area.

When traveling on rough ground, travel at low speed, and avoid sudden changes in direction.

Always keep to the permissible water depth. Permissible water depth is to the centerline of the upper track rollers.

When traveling over bridges or structures on private land, check first that the bridge or structure can withstand the weight of the machine. When traveling on public roads, check with the local authorities and follow their instructions.

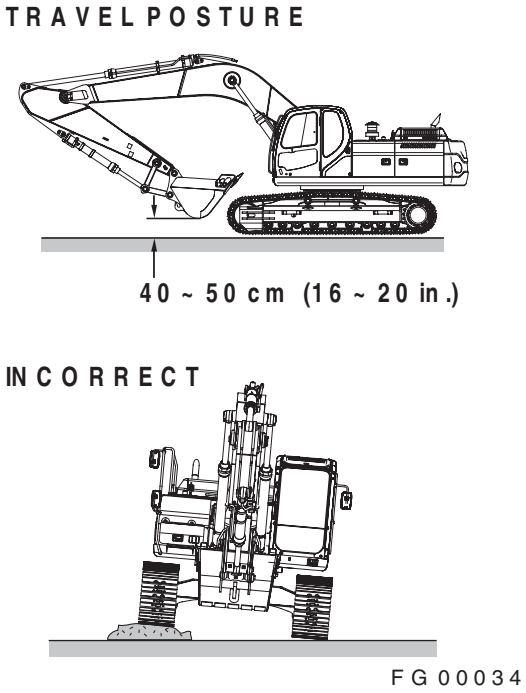


Figure 17

Traveling on Slopes

Never jump onto a machine that is running away to stop it. There is a danger of serious injury.

Traveling on slopes could result in the machine tipping over or slipping.

On hills, banks or slopes, carry the bucket approximately 20 - 30 cm (8 - 12 in) above the ground. In case of an emergency, quickly lower the bucket to the ground to help stop the machine.

Do not travel on grass, fallen leaves, or wet steel plates. Even slight slopes may cause the machine to slip to the side, so travel at low speed and make sure that the machine is always traveling directly up or down the slope.

Avoid changing travel direction on a slope. This could result in tipping or sideslipping of the machine.

When possible, operate the machine up slopes and downslopes. Avoid operating the machine across the slope, when possible.

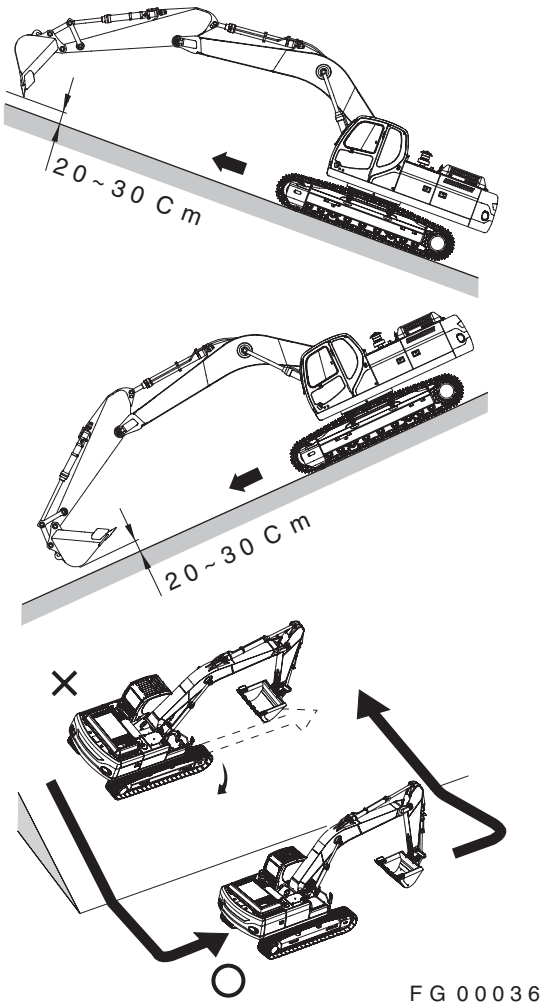


Figure 18

Prohibited Operations

Do not dig the work face under an overhang. This may cause the overhang to collapse and fall on top of the machine.

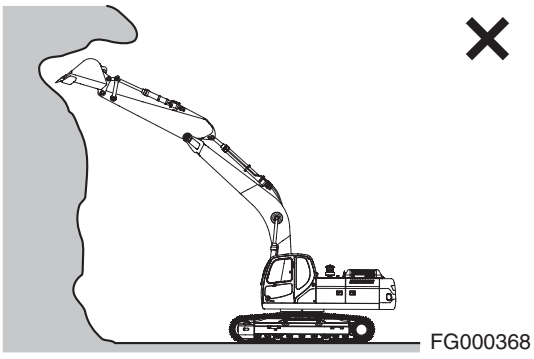


Figure 19

Do not carry out deep digging under the front of the machine. The ground under the machine may collapse and cause the machine to fall.

Working heavy loads over loose, soft ground or uneven, broken terrain can cause dangerous side load conditions and possible tipover and injury. Travel without a load or a balanced load may also be hazardous.

Never relay on lift jacks or other inadequate supports when work is being done. Block tracks fore and aft to prevent any movement.

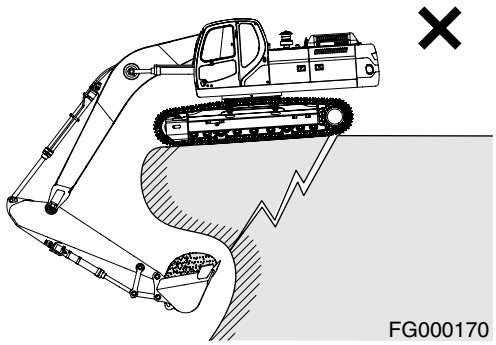


Figure 20

When using the machine, to prevent accidents caused by damage to the work equipment and overturning because of an excessive load, do not use the machine in excess of its ability (in terms of the maximum load and stability determined by the structure of the machine).

When working at the edge of an excavation or on a road shoulder, the machine could tip over, possibly resulting in serious injury or death. Investigate the configuration and ground conditions of the work site beforehand to prevent the machine from falling and to prevent the ground, stockpiles, or banks from collapsing.

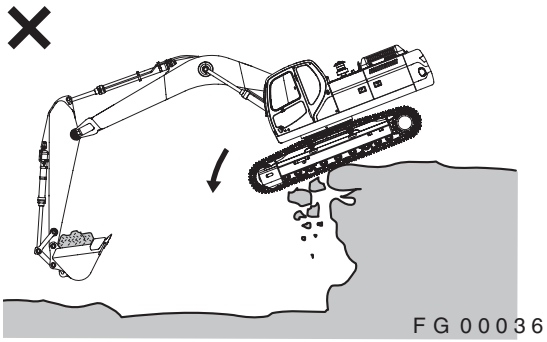


Figure 21

Precautions for Operation

Be careful not to mistakenly travel too close to the edge of a cliff.

Use the machine only for its main purpose. Using it for other purposes will cause failures.

To ensure a good view, always do the following:

- When working in dark areas, attach working lights and front lights to the machine. If necessary, set up lighting at the work site.
- Stop operations when the visibility is poor, such as in fog, mist, snow, and rain. Wait for the visibility to improve to a level which causes no problems for the operation.

To avoid hitting the work equipment, always do the following:

- When working in tunnels, on bridges, under electrical wires, or when parking the machine or carrying out other operations in places with limited height, be careful not to hit the bucket or other parts.
- To prevent collisions, operate the machine at a safe speed when working in confined spaces, indoors, or in crowded areas.
- Do not pass the bucket over the heads of workers or over the operator's cabin of dump truck.



Figure 22

Avoid High-voltage Cables

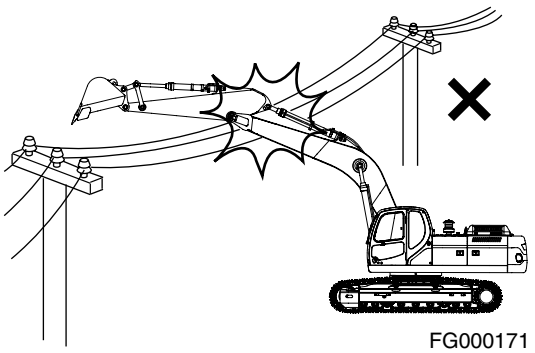
Serious injury or death can result from contact or proximity to high-voltage electrical lines. The bucket does not have to make physical contact with power lines for current to be transmitted.

Use a spotter and hand signals to stay away from power lines not clearly visible to the operator.

Voltage	Minimum Safe Distance
6.6 kV	3 m (9' 10")
33.0 kV	4 m (13' 1")
66.0 kV	5 m (16' 5")
154.0 kV	8 m (26' 3")
275.0 kV	10 m (32' 10")

Use these minimum distances as a guideline only. Depending upon the voltage in the line and atmospheric conditions, strong current shocks can occur with the boom or bucket as faraway as 4 - 6 m (13 - 20 ft.) from the power line. Very high voltage and rainy weather could further decrease that safety margin.

NOTE: *Before starting any operation near power lines (either above ground or buried cable type), you should always contact the power utility company directly and work out a safety plan with them.*



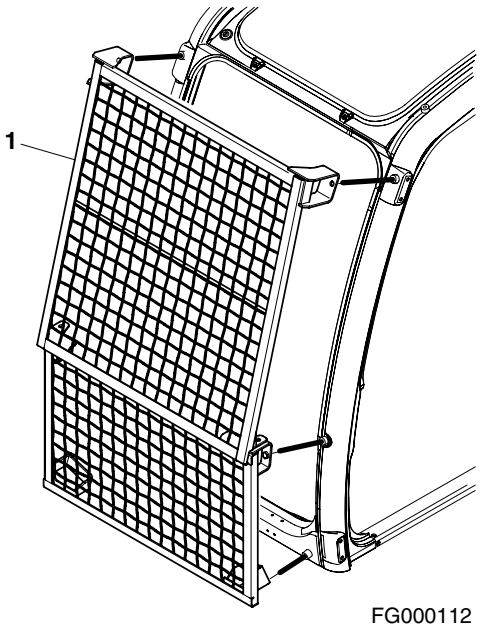
FG000171

Figure 23

Protecting Cabin from Falling Object (Optional)

In a work site where falling objects or flying objects are expected, be sure to install adequate protective devices for covering the cabin.

When using a breaker, be sure to install the front window protection guard (Figure 24).



FG000112

Figure 24

In a work site where falling rocks can cause damage and possibly crush personnel, or in a mining operation, be sure to install the falling object protective structure (Figure 25).

Be sure to install any other additional protective structures required for work site conditions.

When the falling object protective structure is installed, and the front window needs to be cleaned, loosen the bolts marked with an arrow. Be sure to tighten bolts when done.

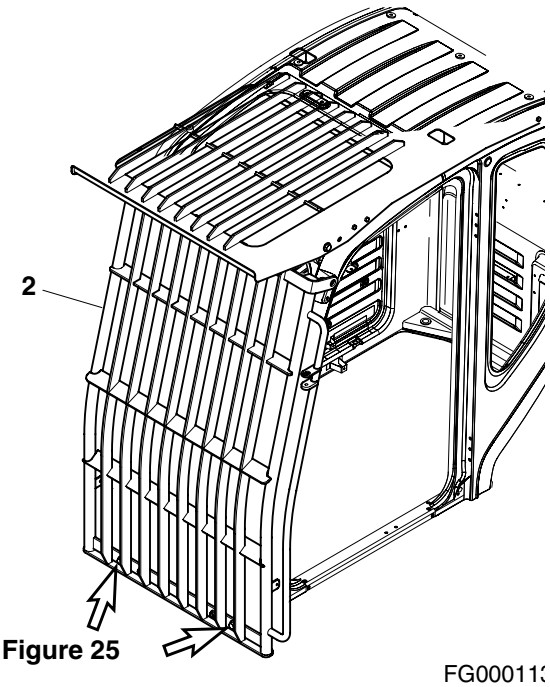


Figure 25

FG00011

Operate Carefully on Snow, Ice and in Very Cold Temperatures

In icy cold weather avoid sudden travel movements and stay away from even slight slopes. The machine could skid off to one side very easily.

Snow accumulation could hide or obscure potential hazards. Use care while operating or while using the machine to clear snow.

Warming up the engine for a short period may be necessary, to avoid operating with sluggish or reduced working capacity. The jolting shocks and impact loads caused by bumping or bottoming the boom or attachment are more likely to cause severe stress in very cold temperatures. Reducing work cycle rate and workload may be necessary.

When the temperature rises, frozen road surfaces become soft, and machine travel becomes unstable.

In cold weather, do not touch metal surfaces with your bare hands. If you touch a metal surface in extremely cold weather, your skin may freeze to the metal surface.

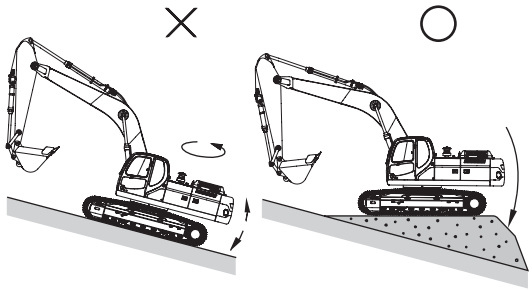
Operations on Slopes

When working on slopes. there is a danger that the machine may lose its balance and turn over, when swinging, or when work equipment is operated. Always carry out these operations carefully.

Do not swing the work equipment from the uphill side to the downhill side when the bucket is loaded. This operation is dangerous.

If the machine has to be used on a slope, pile the soil to make a platform that will keep the machine as horizontal as possible.

In addition, lower the bucket as far as possible, keep it pulled into the front, and keep the swing speed as low as possible.



FG000212

Figure 26

Parking Machine

Avoid making sudden stops, or parking the machine wherever it happens to be at the end of the workday. Plan so the excavator will be on firm, level ground away from traffic and away from high walls, cliff edges and any area of potential water accumulation or runoff. If parking on inclines is unavoidable, block the crawler tracks to prevent movement. Lower the bucket or other working attachment completely to the ground, or to an overnight support saddle. There must be no possibility of unintended or accidental movement.

When parking on public roads, provide fences, signs, flags, or lights, and put up any other necessary signs to ensure that passing traffic can see the machine clearly. Park the machine so the machine, flags, and fences do not obstruct traffic.

After the front attachment has been lowered to an overnight storage position and all switches and operating controls are in the "OFF" position, the safety lock lever must be set to the "LOCKED" position. This will disable all pilot circuit control functions.

Always close the door of the operator's cabin.

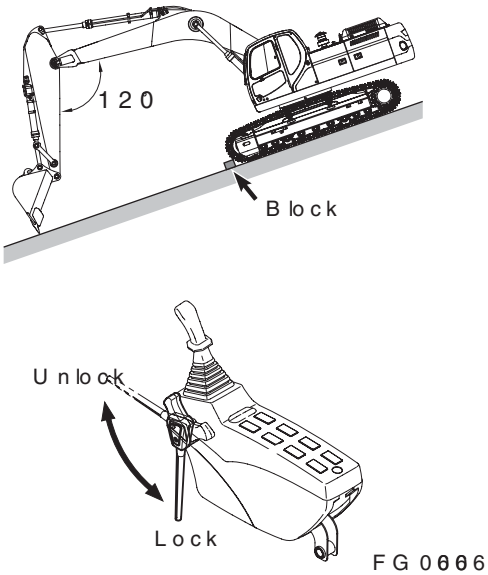


Figure 27

Never Let Anyone Ride on Attachment

Never let anyone ride on any work attachment, such as the bucket, crusher, grapple, or clamshell (grab bucket). There is a danger of the person falling and suffering serious injury.

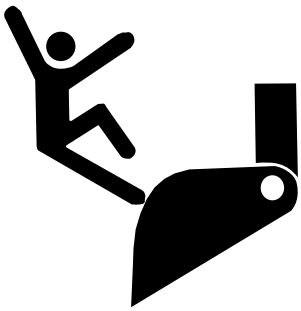


Figure 28

MAINTENANCE

Warning Tag

Alert others that service or maintenance is being performed and tag operator's cabin controls – and other machine areas if required – with a warning notice. OSHA mandated control lever lockout can be made with any OSHA certified lockout device and a length of chain or cable to keep the safety lever in the fully lowered, nonactive position.

Warning tags, for controls are available from *DOOSAN* distributors.



ARO1320L

Figure 29

Clean Before Inspection or Maintenance

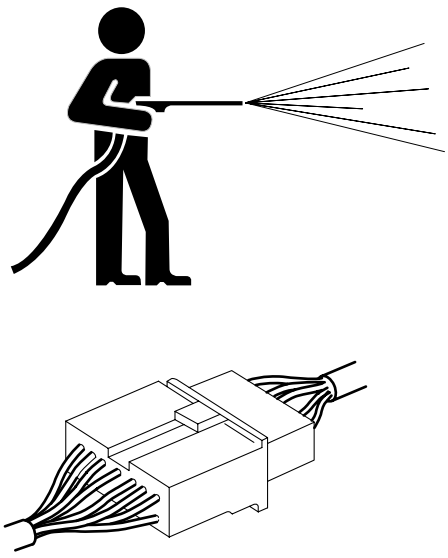
Clean the machine before carrying out inspection and maintenance. This prevents dirt from getting into the machine and ensures safety during maintenance.

If inspection and maintenance are carried out when the machine is dirty, it will become more difficult to locate the problems, and there is a danger that you may get dirt or mud in your eyes or that you may slip and injure yourself.

When washing the machine, do the following:

- Wear shoes with nonslip soles to prevent yourself from slipping and falling on wet places.
- Wear safety glasses and protective clothing when washing the machine with high-pressure steam.
- Take action to prevent touching high-pressure water and cutting your skin or having mud fly into your eyes.
- Do not spray water directly on electrical components (sensors, connector) (1, Figure 30). If water gets into the electrical system, there is a danger that it will cause defective operation and malfunction.

Pick up any tools or hammers that are laying in the workplace, wipe up any grease or oil or any other slippery substances, and clean the area to make it possible to carry out the operation in safety. If the workplace is left untidy, you may trip or slip and suffer injury.



ARO1330L

Figure 30

Proper Tools

Use only tools suited to the task. Using damaged, low quality, faulty, or makeshift tools could cause personal injury. There is potential danger of pieces from chisels with crushed heads, or hammers, may get into your eyes and cause blindness.



HDO1037L

Figure 31

Use of Lighting

When checking fuel, oil, battery electrolyte, or window washing fluid, always use lighting with antiexplosion specifications. Danger of an explosion is elevated when proper lighting equipment is not used.

If work is carried out in dark places without using lighting, it may lead to injury, so always use proper lighting.

Even if the place is dark, never use a lighter or flame instead of lighting. There is a danger of fire. There is also danger that the battery gas may catch fire and cause an explosion.



HDO1040L

Figure 32

Fire Prevention and Explosion Prevention

All fuels, most lubricants and some coolant mixtures are flammable. Leaking fuel or fuel that is spilled onto hot surfaces or onto electrical components can cause a fire.

Store all fuels and all lubricants in properly marked containers and away from all unauthorized persons.

Store oily rags and other flammable material in a protective container.

Do not smoke while you refuel the machine or while you are in a refueling area.

Do not smoke in battery charging areas or in areas the contain flammable material.

Clean all electrical connections and tighten all electrical connections. Check the electrical wires daily for wires that are loose of frayed. Tighten all lose electrical wires before you operate the machine. Repair all frayed electrical wires before you operate the machine.

Remove all flammable materials before they accumulate on the machine.

Do not weld on pipes or on tubes that contain flammable fluids. Do not flame cut on pipes or on tubes that contain flammable



HDO1015I

Figure 33

fluids. Before you weld on pipes or on tubes or before you flame cut on pipes or on tubes, clean the pipes or tubes thoroughly with a nonflammable solvent.

Burn Prevention

When checking the radiator coolant level, shut down engine, let the engine and radiator cool down, then check the coolant recovery tank. If the coolant level in the coolant recovery tank is near the upper limit, there is enough coolant in the radiator.

Loosen the radiator cap gradually to release the internal pressure before removing the radiator cap.

If the coolant level in the coolant recovery tank is below the lower limit, add coolant.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Allow cooling system components to cool before you drain the cooling system.

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Remove hydraulic tank filter plug only after the engine has been stopped. Make sure that the hydraulic tank filter plug is cool before you remove it with your bare hand. Remove hydraulic tank filter plug slowly to relieve pressure.

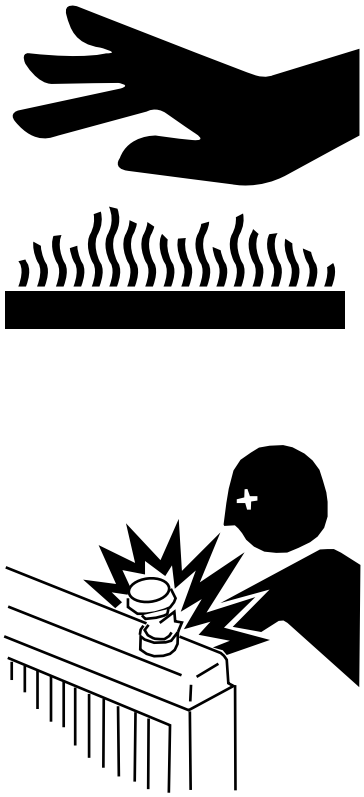
Relieve all pressure in the hydraulic oil system, in the fuel system, or in the cooling system before you disconnect any lines, fittings, or related items.

Batteries give off flammable fumes that can explode.

Do not smoke while you are checking the battery's electrolyte levels.

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact the skin or the eyes.

Always wear protective glasses when you work on batteries.



HAAE1980

Figure 34

Welding Repairs

CAUTION!

When you connect or disconnect connectors between ECU and Engine or connector between ECU and the machine, always disconnect the source power to protect damage of the ECU.

If you don't observe this procedure, the ECU would be damaged or the engine would operate abnormally.

When carrying out welding repairs, carry out the welding in a properly equipped place. The welding must be performed by a qualified worker. During welding operations, there is the danger of, generation of gas, fire, or electric shock, so never let an unqualified worker do welding.

The qualified welder must do the following:

- To prevent explosion of the battery, disconnect the battery terminals and remove batteries.
- To prevent generation of gas, remove paint from the location of the weld.
- If hydraulic equipment, piping or places close to them are heated, a flammable gas or mist will be generated and there is a danger of it catching fire. To avoid this, never subject these places to heat.
- Do not weld on pipes or on tubes that contain flammable fluids. Do not flame cut on pipes or on tubes that contain flammable fluids. Before you weld on pipes or on tubes or before you flame cut on pipes or on tubes, clean the pipes or tubes thoroughly with a nonflammable solvent.
- If heat is applied directly to rubber hoses or piping under pressure, they may suddenly break, so cover them with a fireproof covering.
- Wear protective clothing.
- Make sure there is good ventilation.
- Remove all flammable objects and provide a fire extinguisher.

Treatment for Electrical Welding to the Body Structure

To prevent damage to ECU by electrical welding, please observe the following procedures:

1. Open the door of the battery cover.
2. Detach the cover after loosening the bolts on the battery.
3. Detach the positive and negative terminal cables from the battery.
4. Detach the undercover, and after that detach the connector (1) from the ECU that are installed at the engine.
5. Proceed with welding.
6. After welding, carefully reassemble the connector.
7. Connect the battery terminal cables.
8. Reassemble the undercover under the engine.
9. Reassemble the cover over the battery.
10. Close the cover of the battery.

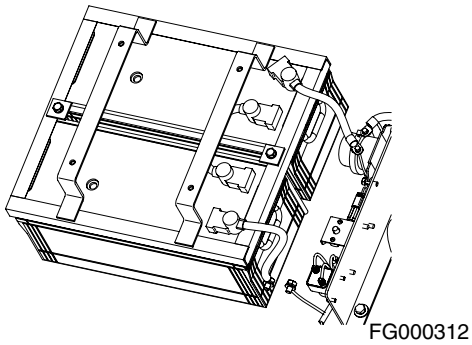
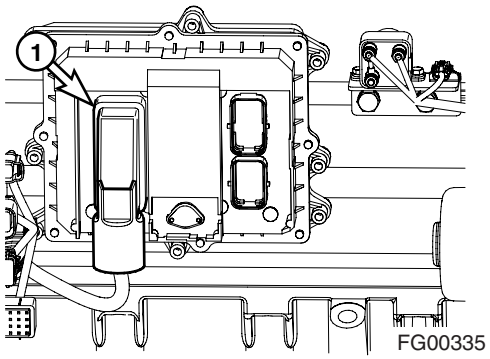

FG000312

Figure 35



FG00335

Figure 36

Warning for Counterweight and Front Attachment Removal

DANGER!

DOOSAN **warns any user, that the removal of the counterweight from the machine, front attachment or any other part, may affect the stability of the machine. This could cause unexpected movement, resulting in death or serious injuries.** ***DOOSAN*** **is not liable for any misuse.**

Never remove counterweight or front attachment unless the upper structure is in-line with the lower structure.

Never rotate the upper structure once the counterweight or front attachment has been removed.

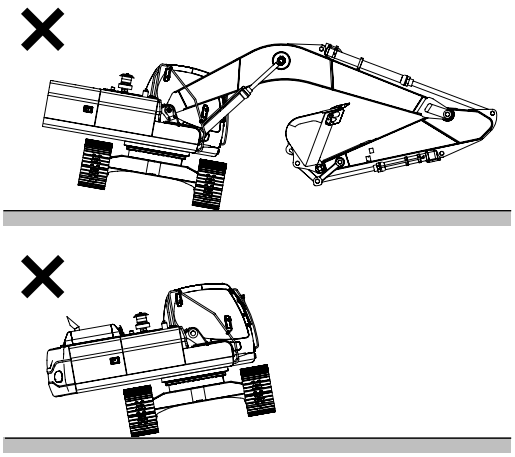

FG000371

Figure 37

Precautions for Removal, Installation and Storage of Attachments

Before starting removal and installation of attachments, decide on the team leader.

Do not allow anyone except the authorized workers close to the machine or attachment.

Place attachments that have been removed from the machine in a safe place so they do not fall. Put up a fence around the attachments and take other measures to prevent unauthorized persons from entering.



HDO1041L

Figure 38

Precautions When Working on Machine

When carrying out maintenance operations on the machine, keep area around your feet clean and tidy to prevent falls. Always do the following:

- Do not spill oil or grease.
- Do not leave tools laying about.
- Watch your step when walking.

Never jump down from the machine. When getting on or off the machine, use the steps and handrails, and maintain a three-point contact (both feet and one hand or both hands and one foot) to support yourself securely.

If the job requires it, wear protective clothing.

To prevent injury from slipping or falling, when working on the hood or covers, never use any area except the area equipped with nonslip pads.



ARO1380L

Figure 39

Lock Inspection Covers

When carrying out maintenance with the inspection cover open, lock the cover securely in position with the lock bar.

If maintenance work is carried out with the inspection cover open but not locked, there is a danger that it may suddenly close and cause injury if there is a gust of wind.

Prevention of Crushing and Cutting

You should always have at least two people working together if the engine must be run during service. One person needs to remain in the operator's seat, ready to work the controls or stop the machine and shut off the engine.

Unless you are instructed otherwise, never attempt adjustments while the machine is moving or while the engine is running.

Stay clear of all rotating parts and moving parts.

Keep objects away from moving fan blades. The fan blades will throw objects and the fan blades can cut objects.

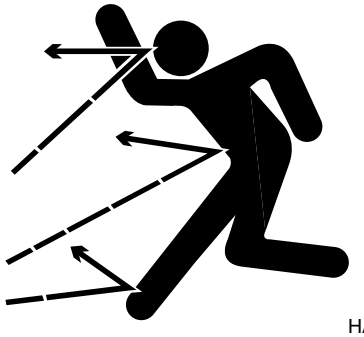
Do not use a wire rope cable that is kinked or flayed. Wear gloves when you handle a wire rope cable.

When you strike a retainer pin, the retainer pin might fly out. The loose retainer pin can injure personnel. Make sure that the area is clear of people when you strike a retainer pin. To avoid injury to your eyes, wear protective glasses when you strike a retainer pin.

Track Tension Adjustments Require Caution

Never turn out the track tension grease valve. To release pressure from the crawler frame track tension assembly, you should NEVER attempt to disassemble the track adjuster or attempt to remove track tension grease valve assembly.

Keep your face and body away from the valve. Refer to the track adjustment procedure in the Operator and Maintenance Manual or Shop Manual.



HAOA110L

Figure 40

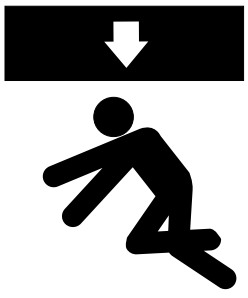
Supports and Blocking for Work Equipment

Do not allow weight or equipment loads to remain suspended.

Lower everything to the ground before leaving the operator's seat.

Do not use hollow, cracked or unsteady wobbling supports.

Do not work under any equipment supported only by a lifting jack.



HDO1042L

Figure 41

Action When Abnormality Is Found During Inspection

If any abnormality is found during inspection, always carry out repairs. In particular, if the machine is used when there are still problems with the brake or work equipment systems, it may lead to serious injury.

If necessary depending on the type of failure, please contact your *DOOSAN* distributor for repairs.

Precautions with High-pressure Lines, Tubes and Hoses

When inspecting or replacing high-pressure piping or hoses, check to verify that the pressure has been released from the circuit. Failure to release the pressure may lead to serious injury. Always do the following:

- Wear protective glasses and leather gloves.
- Fluid leaks from hydraulic hoses or pressurized components can be difficult to see but pressurized oil has enough force to pierce the skin and cause serious injury. Always use a piece of wood or cardboard to check for suspected hydraulic leaks. Never use your hands or expose your fingers.
- Do not bend high-pressure lines. Do not strike high-pressure lines. Do not install lines, tubes or hoses that are bent or damaged.
- Make sure that all clamps, guards and heat shields are installed correctly to prevent vibration, rubbing against other parts, and excessive heat during operation.
  - If any of the following conditions are found, replace the part:
  - Damage or leakage from hose end.
  - Wear, damage, cutting of covering, or exposure of strengthening wire layer.
  - Cover portion is swollen in places.
  - There is twisting or crushing at movable parts of hose.
  - Foreign material is embedded in the covering.
  - Hose end is deformed.

  NOTE: *Refer to "Hose In-service Lifetime Limit (European Standard ISO 8331 and EN982 CEN)" in the Operation and Maintenance Manual, for additional European regulations.*

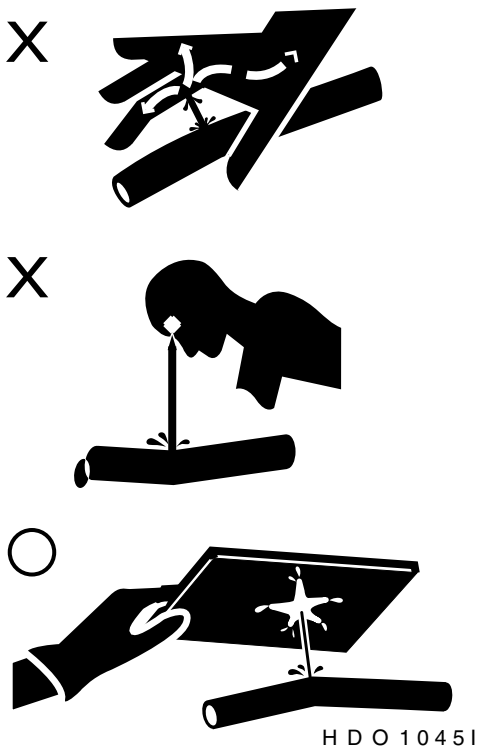


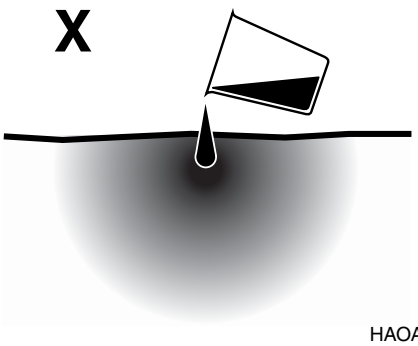
Figure 42

Waste Materials

Physical contact with used motor oil may pose a health risk. Wipe oil from your hands promptly and wash off any remaining residue.

Used motor oil is an environmental contaminant and may only be disposed of at approved collection facilities. To prevent pollution of the environment, always do the following:

- Never dump waste oil in a sewer system, rivers, etc.
- Always put oil drained from your machine in containers. Never drain oil directly onto the ground.
- Obey appropriate laws and regulations when disposing of harmful materials such as oil, fuel, solvent, filters, and batteries.



HAOA470L

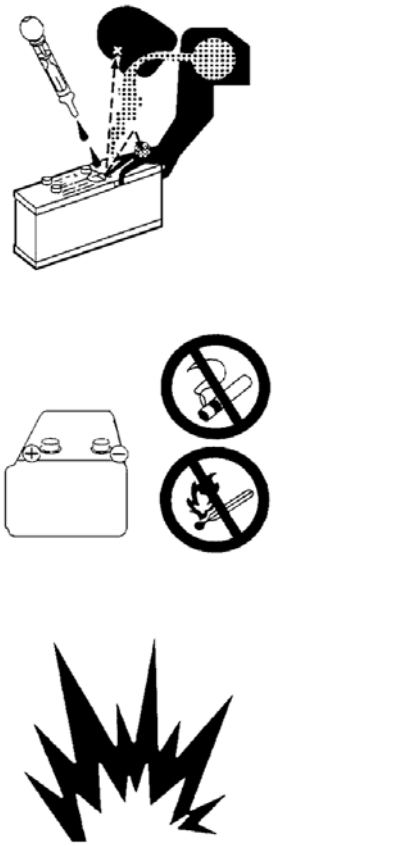
Figure 43

BATTERY

Battery Hazard Prevention

Battery electrolyte contains diluted sulfuric acid and batteries generate hydrogen gas. Hydrogen gas is highly explosive, and mistakes in handling them can cause serious injury or fire. To prevent problems, always do the following:

- Do not smoke or bring any flame near the battery.
- When working with batteries, ALWAYS wear safety glasses and rubber gloves.
- If you spill battery electrolyte on yourself or your clothes, immediately flush the area with water.
- If battery electrolyte gets into your eyes, flush them immediately with large quantities of water and see a doctor at once.
- If you accidentally drink battery electrolyte, drink a large quantity of water or milk, raw egg or vegetable oil. Call a doctor or poison prevention center immediately.
- When cleaning the top surface of the battery, wipe it with a clean, damp cloth. Never use gasoline, thinner, or any other organic solvent or detergent.
- Tighten the battery caps securely.
- If the battery electrolyte is frozen, do not charge the battery or start the engine with power from another source. There is a danger that the battery may catch fire.
- When charging the battery or starting with power from another source, let the battery electrolyte melt and check that there is no leakage of battery electrolyte before starting the operation.
- Always remove battery from the machine before charging.



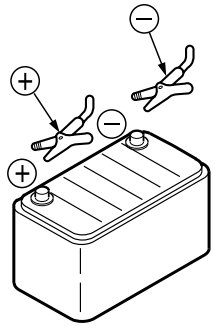
HAAE2100

Figure 44

Boost Starting or Charging Engine Batteries

If any mistake is made in the method of connecting the booster cables, it may cause an explosion or fire. Always do the following:

- Turn off all electrical equipment before connecting leads to the battery. This includes electrical switches on the battery charger or boost starting equipment.
- When boost starting from another machine or vehicle do not allow the two machines to touch. Wear safety glasses or goggles while required battery connections are made.
- 24 volt battery units consisting of two series connected twelve volt batteries have a cable connecting one positive terminal on one of the 12 volt batteries to a negative terminal on the other battery. Booster or charger cable connections must be made between the nonseries connected positive terminals and between the negative terminal of the booster battery and the metal frame of the machine being boosted or charged. Refer to the procedure and illustration in "Starting Engine With a Booster Cable" in the Operation and Maintenance Manual.
- Connect positive cable first when installing cables and disconnect the negative cable first when removing them. The final cable connection, at the metal frame of the machine being charged or boost started, must be as faraway from the batteries as possible.



HAOA310L

Figure 45

TOWING

Precautions When Towing

If any mistake is made in the method of selecting or inspecting the towing wire or in the method of towing, it may lead to serious personal injury. Always do the following:

- Always use the method of towing given in this Operation and Maintenance Manual. Do not use any other method.
- Use leather gloves when handling the wire rope.
- When carrying out the preparation work for towing with two or more workers, determine the signals to use and follow these signals correctly.
- Always fit the towing rope to the left and right hooks and secure in position.
- If the engine on the problem machine will not start or there is a failure in the brake system. always contact your *DOOSAN* distributor.
- Never go between the towing machine and the towed machine during the towing operation.
- It is dangerous to carry out towing on slopes, so select a place where the slope is gradual. If there is no place where the slope is gradual, carry out operations to reduce the angle of the slope before starting the towing operation.
- When towing a problem machine, always use a wire rope with a sufficient towing capacity.
- Do not use a frayed, kinked rope or a rope with any loss of diameter.
- Do not use the lightweight towing hook for towing another machine.

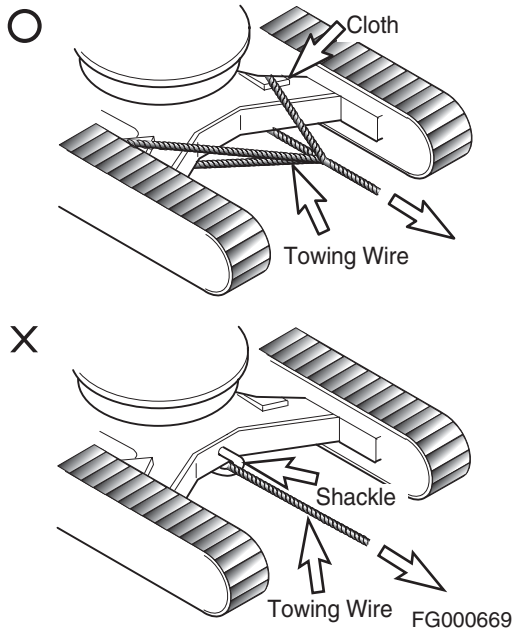


Figure 46

SHIPPING AND TRANSPORTATION

Obey State and Local Over-the-Road Regulations

Check state and local restrictions regarding weight, width and length of a load before making any other preparation for transport.

The hauling vehicle, trailer and load must all be in compliance with local regulations governing the intended shipping route.

Partial disassembly or teardown of the excavator may be necessary to meet travel restrictions or particular conditions at the work site. See the Shop Manual for information on partial disassembly.

Refer to the Transportation and Shipping section of this Operation and Maintenance Manual for information on loading, unloading and towing.

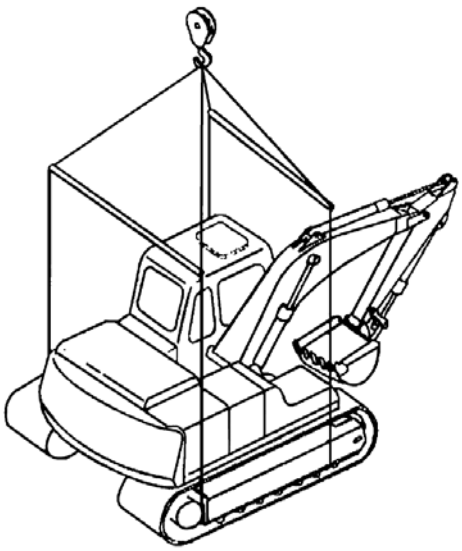
LIFTING WITH SLING

WARNING!

Improper lifting can allow load to shift and cause injury or damage.

1. Refer to Specification section of Operation and Maintenance Manual for information on weight and dimensions.
2. Use properly rated cables and slings for lifting.
3. Position machine for a level lift.
4. Lifting cables should have a long enough length to prevent contact with the machine. Spreader bars may be required.

If spreader bars are used, be sure that cables are properly secured to them and that the angle of the cables is factored into the lift strength.



HAOJ410L

Figure 47

Specifications

Specification for DX225LC

Edition 1

Table of Contents

Specification for DX225LC

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Excavator Performance Standards 21
- Test Conditions 21
- Travel Speed and Travel Motor Balance (Steering Deviation) Tests 21
- Swing Speed and Deceleration Force Test 23
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SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up

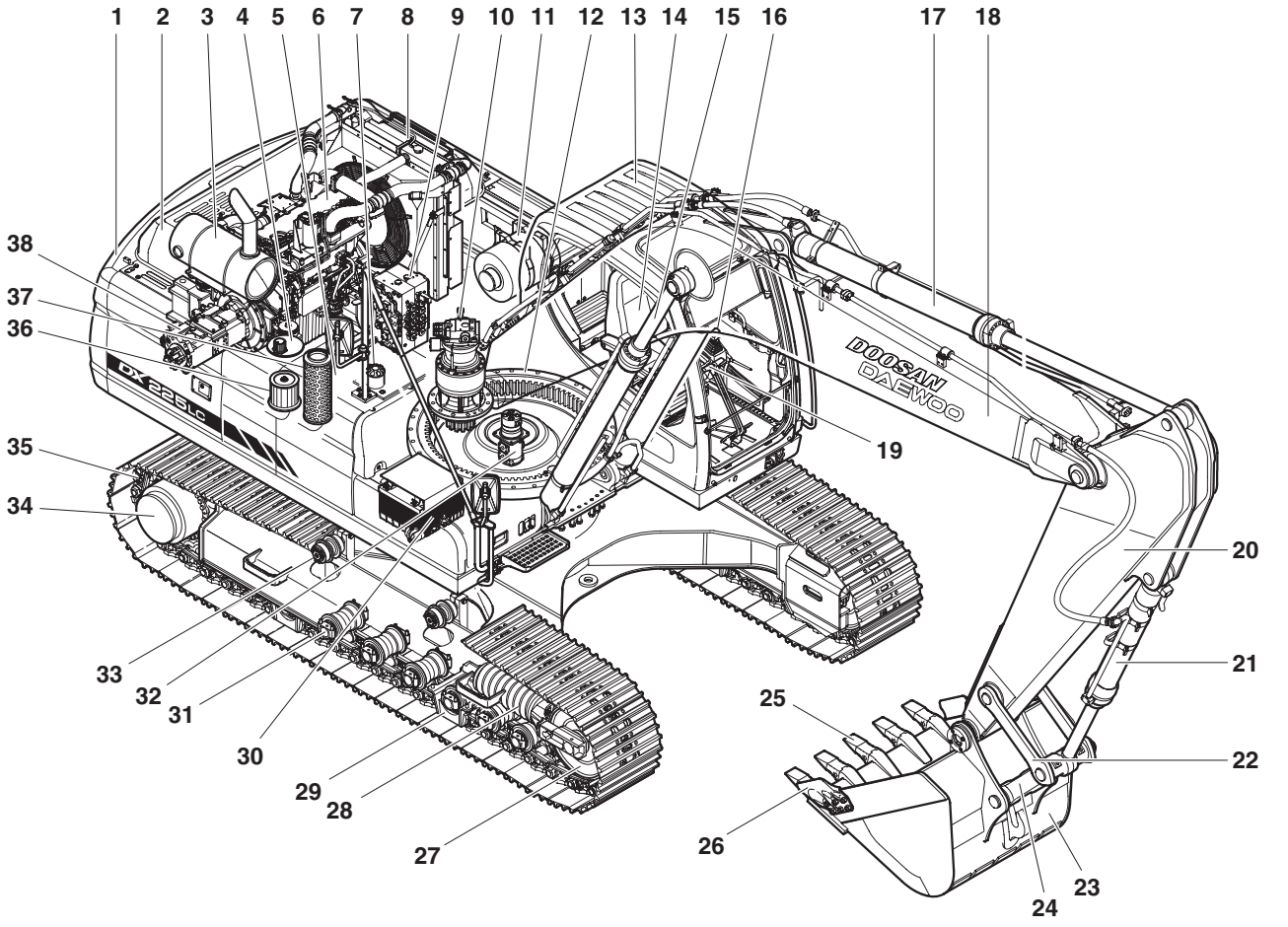
GENERAL DESCRIPTION

The excavator has three main component sections:

- The Upper Swing Body
- The Lower Undercarriage and Track Frames
- The Excavator Front-end Attachment

The following illustration identifies main components and their locations. (See Figure 1 on page 8.)

COMPONENT LOCATIONS



FG007028

Figure 1

Reference Number	Description
1	Counterweight
2	Hood
3	Muffler
4	Hydraulic Oil Tank
5	Fuel Tank
6	Engine
7	Fuel Tank Fill Cap
8	Radiator and Oil Cooler
9	Control Valves
10	Swing Motor
11	Air Cleaner
12	Swing Bearing
13	Cabin
14	Seat
15	Boom Cylinder
16	Work Lever (Joystick) Controls
17	Arm Cylinder
18	Boom
19	Travel Lever

Reference Number	Description
20	Arm
21	Bucket Cylinder
22	Guide Link
23	Bucket
24	Push Link
25	Tooth Point
26	Side Cutter
27	Idler
28	Track Adjuster
29	Track Guide
30	Battery
31	Lower Roller
32	Center Joint
33	Upper Roller
34	Travel Motor
35	Track Link and Shoe
36	Suction Filter
37	Return Filter
38	Pumps

GENERAL DIMENSIONS

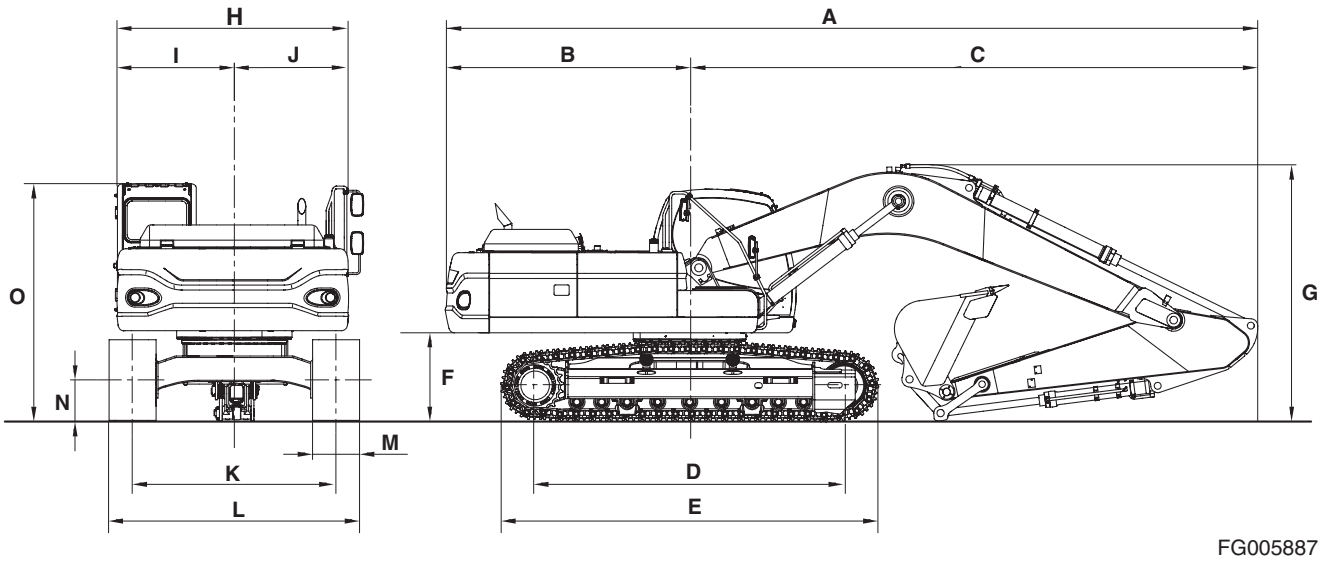


Figure 2

DIMENSION	5.2 M (17.1 ft) BOOM		5.7 M (18.7 ft) BOOM		
	2.0 M (6.6 ft) ARM	2.4 M (7.9 ft) ARM	2.4 M (7.9 ft) ARM	2.9 M (9.5 ft) ARM	3.5 M (11.5 ft) ARM
A	9,080 mm (29' 9")	8,990 mm (29' 6")	9,500 mm (31' 2")	9,485 mm (31' 1")	9,500 mm (31' 2")
B	2,750 mm (9' 0")				
C	6,330 mm (20' 9")	6,240 mm (20' 6")	6,750 mm (22' 2")	6,735 mm (22' 1")	6,750 mm (22' 2")
D	3,650 mm (11' 12")				
E	4,445 mm (14' 7")				
F	1,055 mm (3' 6")				
G	3,210 mm (10' 6")	3,050 mm (10' 0")	3,110 mm (10' 2")	3,005 mm (9' 10")	3,290 mm (10' 10")
H	2,710 mm (8' 11")				
I	1,400 mm (4' 7")				
J	1,310 mm (4' 4")				
K	2,390 mm (7' 10")				
L	2,990 mm (9' 10")				
M	600 mm (1' 12")				
N	480 mm (1' 7")				
O	2,975 mm (9' 9")				

WORKING RANGE

WARNING!

The actual value for dimension "L" Digging Reach, depends on the stability and support provided by ground conditions. Digging too far underneath the excavator if soil conditions are wet, loose or unstable can collapse ground support, which could cause injury and/or equipment damage.

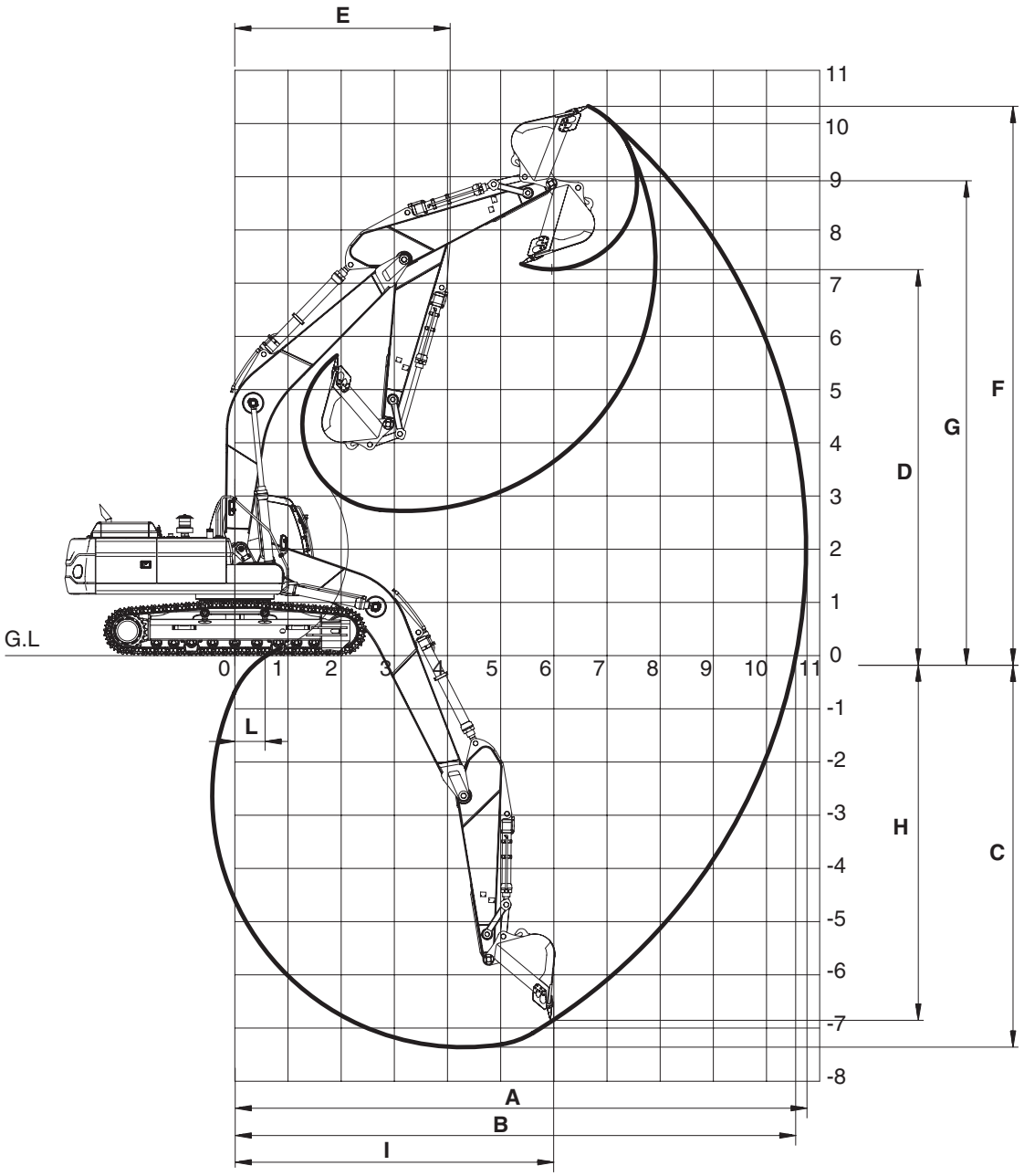


Figure 3

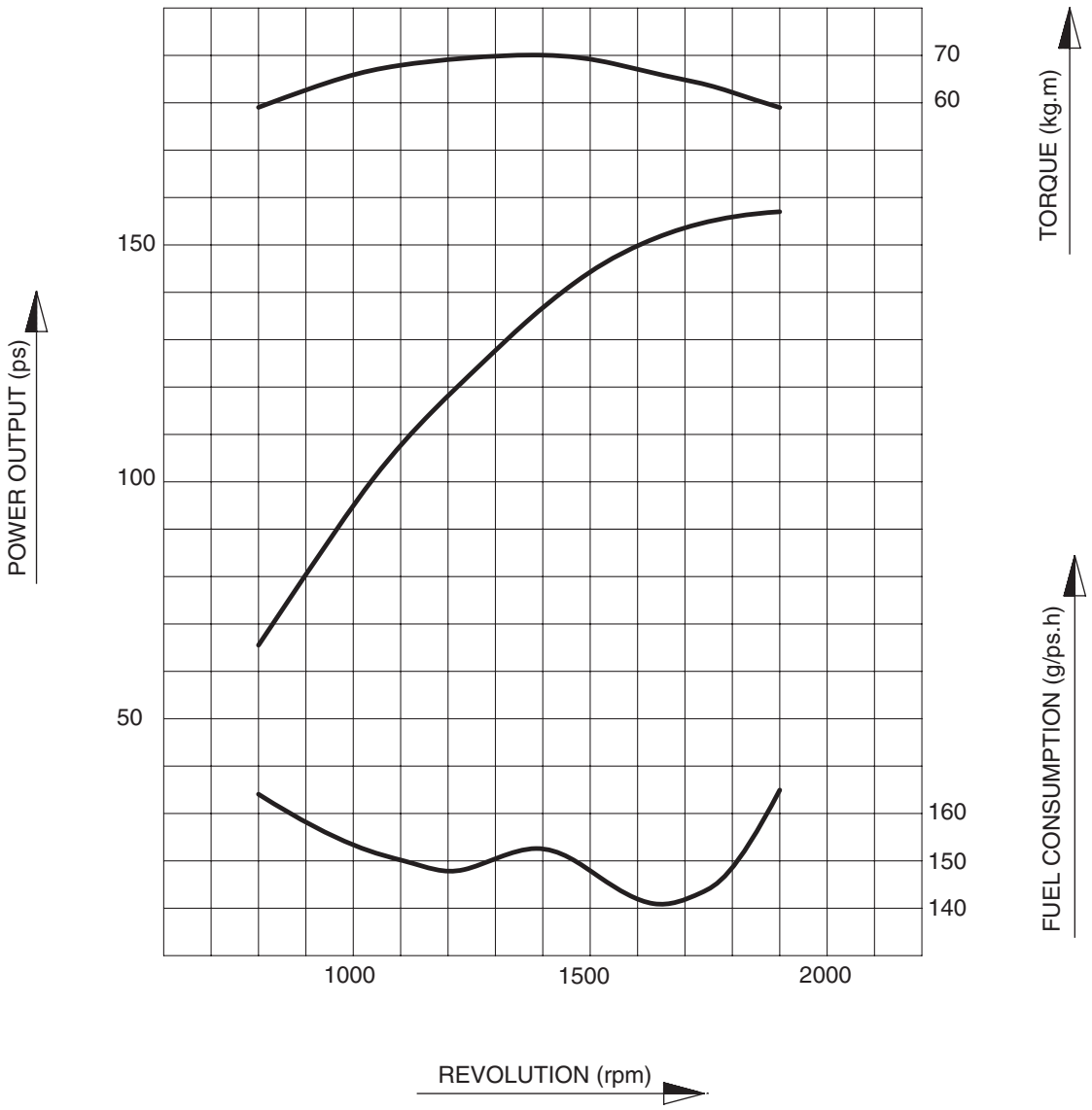
Dim.	Boom Type	One Piece 5.7 m (18.7 ft)				One Piece 5.2 m (18.1 ft)	
	Arm Type	**2.0 m (6.56 ft)**	**2.4 m (7.87 ft)**	**2.9 m (9.51 ft)**	**3.5 m (11.48 ft)**	**2.0 m (6.56 ft)**	**2.4 m (7.87 ft)**
	Bucket Type (PCSA)	**1.17 m^3 (1.43 yd^3)**	**1.05 m^3 (1.37 yd^3)**	**0.92 m^3 (1.20 yd^3)**	**0.81 m^3 (1.05 yd^3)**	**1.28 m^3 (1.66 yd^3)**	**1.17 m^3 (1.43 yd^3)**
A	Max. Digging Reach	9,110 mm (29' 11")	9,840 mm (32' 3")	9,900 mm (32' 6")	10,400 mm (34' 1")	8,580 mm (28' 2")	8,950 mm (29' 4")
B	Max. Digging Reach (Ground)	8,920 mm (29' 3")	9,330 mm (30' 7")	9,730 mm (31' 11")	10,235 mm (33' 7")	8,380 mm (27' 6")	8,760 mm (28' 9")
C	Max. Digging Depth	5,710 mm (18' 9")	6,110 mm (20' 1")	6,620 mm (21' 9")	7,220 mm (23' 8")	5,355 mm (17' 7")	5,755 mm (18' 11")
D	Max. Loading Height	6,610 mm (21' 8")	6,830 mm (22' 5")	6,990 mm (22' 11")	7,150 mm (23' 5")	6,085 mm (19' 12")	6,300 mm (20' 8")
E	Min. Swing Radius	3,675 mm (12' 1")	3,410 mm (11' 2")	3,410 mm (11' 2")	3,440 mm (11' 3")	3,370 mm (11' 1")	3,195 mm (10' 6")
F	Max. Digging Height	9,395 mm (30' 10")	9,630 mm (31' 7")	9,750 mm (31' 12")	9,870 mm (32' 5")	8,845 mm (29' 0")	9,065 mm (29' 9")
G	Max. Bucket Pin Height	8,080 mm (26' 6")	8,300 mm (27' 3")	8,455 mm (27' 9")	8,610 mm (28' 3")	7,555 mm (24' 9")	7,770 mm (25' 6")
H	Max. Vertical Wall	4,945 mm (16' 3")	5,385 mm (17' 8")	5,640 mm (18' 6")	6,005 mm (19' 8")	4,435 mm (14' 7")	4,880 mm (16' 0")
I	Max. Radius Vertical	6,010 mm (19' 9")	6,055 mm (19' 10")	6,410 mm (21' 0")	6,750 mm (22' 2")	5,790 mm (18' 12")	5,842 mm (19' 2")
J	Max. Depth to 8 ft Line	5,480 mm (17' 12")	5,910 mm (19' 5")	6,430 mm (21' 1")	7,050 mm (23' 2")	5,115 mm (16' 9")	5,545 mm (18' 2")
K	Max. Radius 8 ft Line	2,870 mm (9' 5")	2,880 mm (9' 5")	2,865 mm (9' 5")	2,630 mm (8' 8")	2,495 mm (8' 2")	2,510 mm (8' 3")
L	Min. Digging Reach	2,565 mm (8' 5")	1,698 mm (5' 7")	519 mm (1' 8")	- 224 mm (-0' 9")	1,819 mm (5' 12")	640 mm (2' 1")

GENERAL SPECIFICATIONS

Shipping Weight	21.5 metric tons (47,399 lb), includes fuel 10%, boom, 5,700 mm (18' 8"), arm 2,900 mm (9' 6"), standard bucket and standard shoes
Operating Weight	Add weight of full fuel tank and operator.
Shipping Weights with Optional Track Shoe	Add 285 kg (628 lb) for 700 mm (28") shoes
	Add 560 kg (1,235 lb) for 800 mm (32") shoes
	Add 850 kg (1,874 lb) for 900 mm (35") shoes
Major Component Weight	Standard Boom 5,700 mm (18' 8") 1,515 kg (3,340 lb)
	5,200 mm (17' 1") Boom 1,425 kg (3,141 lb)
	2,000 mm (6' 7") Arm 595 kg (1,311 lb)
	2,400 mm (7' 10") Arm 610 kg (1,345 lb)
	2,900 mm (9' 6") Arm 723 kg (1,594 lb)
	3,500 mm (11' 6") Arm 840 kg (1,852 lb)
	Boom Cylinders 174 kg (384 lb) each
	Arm Cylinder 239 kg (527 lb)
	Bucket Cylinder 151 kg (333 lb)
	Counterweight 4,100 kg (9,039 lb)
	Upper Turntable 6,500 kg (14,330 lb) (Excluding Counterweight and Front)
	Lower - 7,730 kg (17,041 lb) (Including Swing Bearing)
Digging Forces (At Power Boost):	
Bucket Cylinder	13,300 kg (29,321 lb) - (with either 3,500 mm [11' 6"] or 2,400 mm [7' 10"] arm)
Arm Cylinder	10,500 kg (23,149 lb) with 2,900 mm (9' 6") arm
Fuel Tank Capacity	400 liters (105.7 U.S. gal)
Hydraulic System Capacity	240 liters (63.4 U.S. gal)
Hydraulic Reservoir Capacity	140 liters (37 U.S. gal)
Bucket Heaped Capacity Range	PCSA 0.4 - 1.28 m^3 (0.5 - 1.67 yd^3)
	IMPORTANT: Refer to the Load Weight, Bucket and Arm Length Compatibility Table for information on which bucket sizes may be used safely with which arm length, for load material weights.
Shoe Type	Triple Grouser
Shoe Width and Optional Sizes	600 mm (24") - standard
	700 mm (28") - optional
	800 mm (32") - optional
	900 mm (35") - optional
Ground Pressure Ratings:	
Standard 600 mm (24") shoe	0.45 kg•cm^2 (6.4 psi)
Optional 700 mm (28") shoe	0.39 kg•cm^2 (5.55 psi)
Optional 800 mm (32") shoe	0.34 kg•cm^2 (4.84 psi)
Optional 900 mm (35") shoe	0.30 kg•cm^2 (4.27 psi)
Transport Dimensions	
Overall Shipping Length (standard boom and arm)	9,485 mm (31' 1")

Overall Shipping Width (standard shoes)	2,990 mm (9' 10")
Overall Shipping Height (to top of cylinder hose)	3,005 mm (9' 10")
Track Shipping Length	4,445 mm (14' 7")
Transport Trailer Capacity	30 metric tons (33 tons), minimum load capacity
Transport Loading Ramp Allowable Slope	15° angle **CAUTION:** Refer to Transport Maximum Procedure for Safe Shipping Instructions.

ENGINE PERFORMANCE CURVES (PER DIN 6270 STANDARD)



FG007031

Figure 4

Condition	Specification
Engine Model	DL06
Barometric Pressure	760 mmHg (20°C (68°F))
Cooling Fan	660.4 mm, SUCKER (26 in)
Alternator	24V x 50A
Air Cleaner	Installed
Muffler	Installed

Performance Standard	DIN 6270
Power	150 ps @ 1,900 rpm (148 hp @ 1,900 rpm)
Max. Torque	68 kg•m @ 1,400 rpm (492 lb•ft @ 1,400 rpm)
Fuel Consumption (Min. Rated)	165 g/ps•h (5.47 oz/hp•h)

APPROXIMATE WEIGHT OF WORKLOAD MATERIALS

IMPORTANT

Weights are approximations of estimated average volume and mass. Exposure to rain, snow or groundwater; settling or compaction because of overhead weight, chemical or industrial processing or changes because of thermal or chemical transformations could all increase the value of weights listed in the table.

Material	Low Weight or Density 1,100 kg•m^3 (1,850 lb/yd^3), or Less	Medium Weight or Density 1,600 kg•m^3 (2,700 lb/yd^3), or Less	High Weight or Density 2,000 kg•m^3 (3,370 lb/yd^3), or Less
Charcoal	401 kg•m^3 (695 lb/yd^3)	----------	----------
Coke, blast furnace size	433 kg•m^3 (729 lb/yd^3)	----------	----------
Coke, foundry size	449 kg•m^3 (756 lb/yd^3)	----------	----------
Coal, bituminous slack, piled	801 kg•m^3 (1,350 lb/yd^3)	----------	----------
Coal, bituminous r. of m., piled	881 kg•m^3 (1,485 lb/yd^3)	----------	----------
Coal, anthracite	897 kg•m^3 (1,512 lb/yd^3)	----------	----------
Clay, DRY, in broken lumps	1,009 kg•m^3 (1,701 lb/yd^3)	----------	----------
Clay, DAMP, natural bed	----------	1,746 kg•m^3 (2,943 lb/yd^3)	----------
Cement, Portland, DRY granular	----------	1,506 kg•m^3 (2,583 lb/yd^3)	----------
Cement, Portland, DRY clinkers	----------	1,362 kg•m^3 (2,295 lb/yd^3)	----------
Dolomite, crushed	----------	1,522 kg•m^3 (2,565 lb/yd^3)	----------
Earth, loamy, DRY, loose	----------	1,202 kg•m^3 (2,025 lb/yd^3)	----------
Earth, DRY, packed	----------	1,522 kg•m^3 (2,565 lb/yd^3)	----------

Material	Low Weight or Density 1,100 kg•m^3 (1,850 lb/yd^3), or Less	Medium Weight or Density 1,600 kg•m^3 (2,700 lb/yd^3), or Less	High Weight or Density 2,000 kg•m^3 (3,370 lb/yd^3), or Less
Earth, WET, muddy	----------	----------	1,762 kg•m^3 (2,970 lb/yd^3)
Gypsum, calcined, (heated, powder)	961 kg•m^3 (1,620 lb/yd^3)	----------	----------
Gypsum, crushed to 3 inch size	----------	1,522 kg•m^3 (2,565 lb/yd^3)	----------
Gravel, DRY, packed fragments	----------	----------	1,810 kg•m^3 (3,051 lb/yd^3)
Gravel, WET, packed fragments	----------	----------	1,922 kg•m^3 (3,240 lb/yd^3)
Limestone, graded above 2	----------	1,282 kg•m^3 (2,160 lb/yd^3)	----------
Limestone, graded 1-1/2 or 2	----------	1,362 kg•m^3 (2,295 lb/yd^3)	----------
Limestone, crushed	----------	1,522 kg•m^3 (2,565 lb/yd^3)	----------
Limestone, fine	----------	----------	1,602 kg•m^3 (2,705 lb/yd^3)
Phosphate, rock	----------	1,282 kg•m^3 (2,160 lb/yd^3)	----------
Salt	929 kg•m^3 (1,566 lb/yd^3)	----------	----------
Snow, light density	529 kg•m^3 (891 lb/yd^3)	----------	----------
Sand, DRY, loose	----------	1,522 kg•m^3 (2,565 lb/yd^3)	----------
Sand, WET, packed	----------	----------	1,922 kg•m^3 (3,240 lb/yd^3)
Shale, broken	----------	1,362 kg•m^3 (2,295 lb/yd^3)	----------
Sulfur, broken	529 kg•m^3 (1,620 lb/yd^3)	----------	----------

PERFORMANCE TESTS

1. Main Relief Pressure

   Normal Operation : 330 kg•cm^3 (4,689 psi)

   with "Pressure Up" : 350 kg•cm^3 (4,970 psi)

2. Actuator Speeds

Operation		Unit	Standard Mode	Power Mode
Boom	Up	sec	3.3 ± 0.4	2.9 ± 0.4
	Down	sec	2.6 ± 0.3	2.5 ± 0.3
Arm	Crowd	sec	4.1 ± 0.4	3.8 ± 0.4
	Dump	sec	2.6 ± 0.3	2.4 ± 0.3
Bucket	Crowd	sec	3.8 ± 0.4	3.5 ± 0.4
	Dump	sec	2.3 ± 0.3	2.2 ± 0.3
Swing	3 Revolutions	sec	17.5 ± 1.5	16.5 ± 1.5
Jack-up Speed (3 Turns)	Low	sec	34.5 ± 2.0	33.1 ± 2.0
	High	sec	18.9 ± 1.5	18.0 ± 1.5
Travel Speed 20 m (66 ft)	Low	sec	25 ± 1.5	24 ± 1.5
	High	sec	13.7 ± 1.0	13.1 ± 1.0
Travel Deviation 20 m (66 ft)	Low	mm (in)	150 (6)	150 (6)
	High	mm (in)	150 (6)	150 (6)

EXCAVATOR PERFORMANCE STANDARDS

Evaluation of equipment performance and operating condition can be made by running the excavator through a series of different tests, and recording results with a stopwatch and tape measure.

Compare results of performance tests against the specifications and standards that follow, which are for equipment in new or renewed condition.

Test Conditions

1. All tests should be performed on a flat, level, firm supporting ground surface.
2. All recommended, applicable maintenance and adjustment service should be completed before testing.
3. Hydraulic fluid and engine oil should be of appropriate viscosity for ambient weather. Warm up hydraulic oil to standard operating temperature, between 45° - 55°C (112° - 135°F).
4. Run all tests with the engine speed control set to maximum rpm.
5. Repeat tests with Power Mode engine control settings at both Standard Mode (standard work mode) and Power Mode (high-speed mode). Travel speed tests should also be repeated at both high and low speed.

Travel Speed and Travel Motor Balance (Steering Deviation) Tests

Speed Test

Prepare the excavator for travel speed tests by extending all hydraulic cylinders - boom, arm and bucket - to the fully extended position, shown in Figure 5.

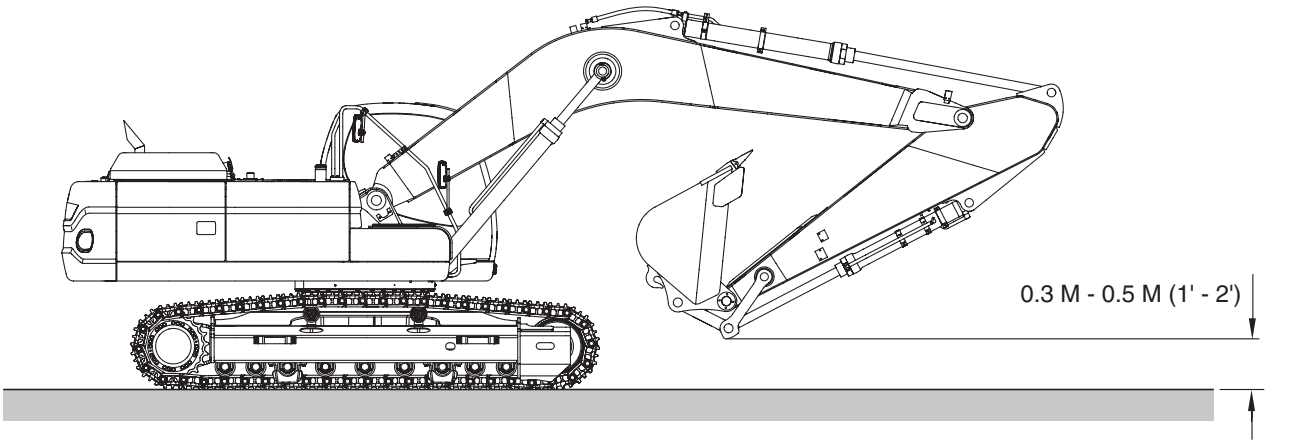


Figure 5

The lowest part of the bucket linkage should be 0.3 - 0.5 m (1' - 2') off the ground.

Mark off a 20 m (65' 7-1/2") test distance, with a 3 - 5 m (10' - 15') run-up area, and a 3 - 5 m (10' - 15', or longer) speed runoff distance.

Travel the excavator back and forth to be sure steering is centered and side frames are parallel with the test course.

Operate both travel levers at the fully engaged position and measure the time it takes to cross 20 m (65' 7-1/2"). Compare measured results against the standard for new machines:

Rate of Travel	Time	
	Standard Mode	Power Mode
High-speed	13.7 ± 1.0 sec	13.1 ± 1.0 sec
Low Speed	25 ± 1.5 sec	24 ± 1.5 sec

Rotate the turntable 180°. Both tests should be repeated three times. Average all results to obtain a final value.

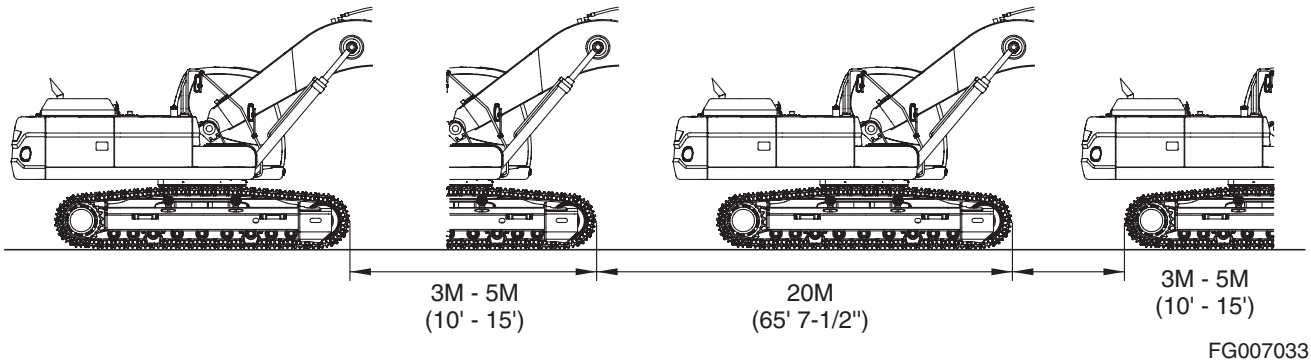


Figure 6

Travel Deviation

To check steering deviation (travel motor balance), use a long tape or rope, or the edge of an undeviating straight road curb or other marker to verify side to side travel motor uniformity.

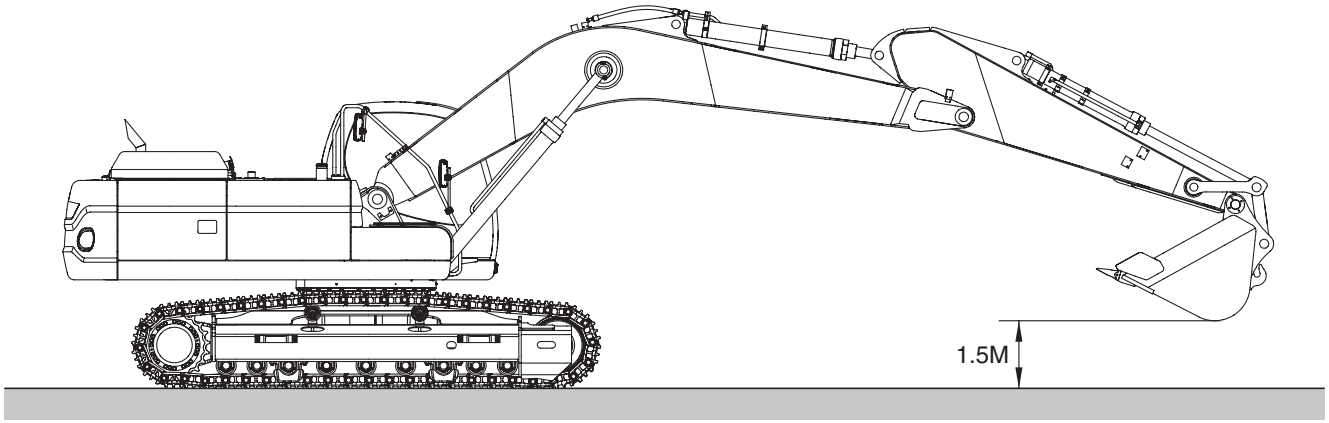
Deviation distance should always be measured at the 20 m (65' 7-1/2") "finish line." Repeat the test in reverse to measure in both directions, with starting point becoming the finish line, and vice versa. (Figure 6)

A greater amount of deviation is allowed with the travel control set for high-speed.

Rate of Travel	Max. Distance
High-speed	150 mm (6 in)
Low Speed	150 mm (6 in)

Swing Speed and Deceleration Force Test

Swing Speed Test



FG007034

Figure 7

Extend the bucket cylinder completely and retract the arm cylinder, as shown in Figure 7, to test swing speed. The lowest point of the bucket will be approximately 1.5 m (3') off the ground.

Use paint marks at the same point on the swing body and undercarriage, or select alternate measuring locations and use a stopwatch to time 3 full 360° rotations. The time required for 3 revolutions should be between 16 and 19 seconds in Standard Mode, 15 and 18 seconds in Power Mode.

Swing Deceleration Force Test

With the boom, arm and bucket in the same position as for the swing speed test, rotate the turntable so the boom is evenly centered between the side frames, pointing straight ahead. Locate the 90° reference point, perpendicular to the boom. Mark the turntable and undercarriage with paint at the 90° point.

Make several attempts to rotate the turntable exactly 90°, starting from the boom straight ahead position. Engage the swing lever and brake at the 90° point, shown as "swing stop" in Figure 8.

Record how far the turntable drifts past the stop point, measuring the distance between paint marks. Maximum distance should be less than 1200 mm (47-1/4"), in both Power Mode and Standard Mode.

Reference Number	Description
1	Start Swing
2	90° Swing
3	Swing Force
4	Swing Stop

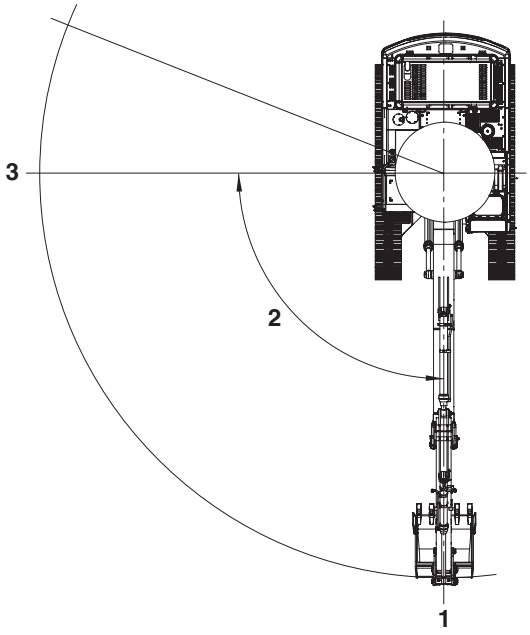


Figure 8

Cylinder Performance Tests

NOTE: *All tests are performed with standard boom, arm and bucket configuration. The bucket should be empty.*

Boom Cylinders Test

The starting points for the test are with the boom and arm extended away from the excavator, and the bucket curled inward. The arm cylinder should be fully retracted; boom and bucket cylinders must be extended. Test movement in both directions, several times, and average results for both Standard Mode and Power Mode.

Arm Cylinder Test

Start with the boom up and the arm cylinder fully retracted. Test movement in both directions several times, between the "crowd" and "dump" positions, and average the results of both tests, in both standard and extraduty power modes.

Bucket Cylinder Test

Start with the boom up and the teeth of the bucket hanging vertically, 500 mm (1-1/2' - 2') above the ground. Dump and crowd the bucket several times, and average results, for both standard and extraduty power modes.

Operation	Standard Mode	Power Mode
Boom Up	2.9 - 3.7 sec	2.5 - 3.3 sec
Boom Down	2.3 - 2.9 sec	2.2 - 2.8 sec
Arm Dump	2.3 - 2.9 sec	2.1 - 2.7 sec
Arm Crowd	3.7 - 4.5 sec	3.4 - 4.2 sec
Bucket Dump	2.0 - 2.6 sec	1.9 - 2.5 sec
Bucket Crowd	3.4 - 4.2 sec	3.1 - 3.9 sec

Hydraulic Cylinder Natural Drop Test

To check boom and arm cylinder tightness against the specified performance standard for new cylinders, put a full load of dirt in the bucket and move the attachment cylinders so the arm cylinder is extended 20 - 50 mm (1" - 2") and boom cylinders are retracted the same amount, 20 - 50 mm (1" - 2"). The top of the bucket should be approximately 2 m (6' - 7') off the ground.

Shut down engine and measure cylinder drop after 5 minutes. Bucket cylinder should not show more than 40 mm (1.57") change, while the arm and boom cylinders should not fall more than 10 mm (0.39").

Travel Motor Jack-up Test

Test travel motor operation on each side by painting or chalking a mark on one crawler shoe, with a corresponding mark on the travel frame. Use the attachment to jack up one side of the machine and operate the raised travel motor. Record the number of seconds it takes the crawler shoe to make 3 full rotations, during both high-speed and low speed operation.

Operation	Standard Mode	Power Mode
High-speed	17.4 - 20.4 sec	16.5 - 19.5 sec
Low Speed	32.5 - 36.5 sec	31.1 - 35.1 sec

General Maintenance

General Maintenance Procedures

Edition 1

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MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
ALL MODELS	ALL RANGES

WELDING PRECAUTIONS AND GUIDELINES

IMPORTANT

To avoid accidents, personal injury and the possibility of causing damage to the machine or to components, welding must only be performed by properly trained and qualified personnel, who possess the appropriate certification (when required) for the specific welding fabrication or specialized repair being performed.

⚠ WARNING!

Structural elements of the machine may be built from a variety of steels. These could contain unique alloys or may have been heat-treated to obtain particular strength characteristics. It is extremely important that welding repairs on these types of steel are performed with the proper procedures and equipment. If repairs are performed incorrectly, structural weakening or other damage to the machine (that is not always readily visible) could be caused. Always consult *DOOSAN* After Sales Service Distributor before welding on integral components (loader arm, frames, car body, track frames, turntable, attachment, etc.) of the machine. It is possible that some types of structurally critical repairs may require Magnetic Particle or Liquid Penetrant testing, to make sure there are no hidden cracks or damage, before the machine can be returned to service.

⚠ CAUTION!

Always perform welding procedures with the proper safety equipment. Adequate ventilation and a dry work area are absolutely essential. Keep a fire extinguisher nearby and always wear protective clothing and the recommended eye protection.

⚠ CAUTION!

Observe the following safety precautions:

1. **Use extra caution and adequate safety shielding when welding near fuel and oil tanks, batteries, hydraulic piping lines or other fire hazards.**
2. **Never weld when the engine is running. Battery cables must be disconnected before the welding procedure is started.**
3. **Never weld on a wet or damp surface. The presence of moisture causes hydrogen embrittlement and structural weakening of the weld.**
4. **If welding procedures are being performed near cylinder rods, operator's cabin window areas or any other assemblies that could be damaged by weld spatters, use adequate shielding protection in front of the assembly.**
5. **During equipment setup, always attach ground cables directly to the area or component being welded to prevent arcing through bearings, bushings, or spacers.**
6. **Always use correct welding rods for the type of weld being performed and observe recommended precautions and time constraints. AWS Class E7018 welding rods for low alloy to medium carbon steel must be used within two hours after removal from a freshly opened container. Class E11018G welding rods for T-1 and other higher strength steel must be used within 1/2 hour.**

HYDRAULIC SYSTEM - GENERAL PRECAUTIONS

Always maintain oil level in the system at recommended levels. Assemblies that operate under heavy loads, at high-speed, with extremely precise tolerances between moving parts - pistons and cylinders, or shoes and swash plates, for example - can be severely damaged if oil supply runs dry.

Assemblies can run dry and be damaged severely in a very short time when piping or hoses are disconnected to repair leaks and/or replacement of damaged components. Hoses that are inadvertently switched during disassembly (inlet for outlet and vice versa), air introduced into the system or assemblies that are low on oil because of neglect or careless maintenance, could all produce sufficient fluid loss to cause damage.

When starting the engine (after long shutdown or storage intervals), make sure that all hydraulic controls and operating

circuits are in neutral, or "OFF." This will prevent pumps or other components that may be temporarily being starved of oil from being run under a load.

Replacement of any hydraulic system component could require thorough cleaning, flushing, and some amount of prefilling with fresh, clean oil if the protective seal on replacement parts has obviously been broken or if seal integrity may have been compromised. When protective seals are removed before installation and reassembly, inspect all replacement parts carefully, before they are installed. If the replacement part is dry (with no trace of factory prelube) or has been contaminated by dirt or by questionable oils, flushing and prefilling with clean hydraulic fluid is recommended.

Vibration, irregular or difficult movement or unusual noise from any part of the hydraulic system could be an indication of air in the system (and many other types of problems). As a general precaution (and to help lessen the risk of potential long-term damage), allow the engine to run at no-load idle speed immediately after initial start-up. Hydraulic fluid will circulate, releasing any air that may have been trapped in the system before load demands are imposed.

A daily walk-around prestart equipment safety inspection, including a quick visual scan for any exterior evidence of leaking hydraulic fluid, can help extend the service life of system components.

IMPORTANT

Hydraulic system operating conditions (repetitive cycling, heavy workloads, fluid circulating under high-pressure) make it extremely critical that dust, grit or any other contamination be kept out of the system. Observe fluid and filter change maintenance interval recommendations and always preclean any exterior surface of the system before it is exposed to air. For example, the reservoir fill cap and neck area, hoses that have to be disassembled, and the covers and external surfaces of filter canisters should all be cleaned before disassembly.

MAINTENANCE SERVICE AND REPAIR PROCEDURE

General Precautions

Fluid level and condition should always be checked whenever any other maintenance service or repair is being performed.

NOTE: *If the unit is being used in an extreme temperature environment (in subfreezing climates or in high temperature, high humidity tropical conditions), frequent purging of moisture condensation from the hydraulic reservoir drain tap should be a regular and frequent part of the operating routine. In more moderate, temperate climates, draining reservoir sediment and moisture may not be required more than once or twice every few months.*

Inspect drained oil and used filters for signs of abnormal coloring or visible fluid contamination at every oil change. Abrasive grit or dust particles will cause discoloration and darkening of the fluid. Visible accumulations of dirt or grit could be an indication that filter elements are overloaded (and will require more frequent replacement) or that disintegrating bearings or other component failures in the hydraulic circuit may be imminent or have already occurred. Open the drain plugs on the main pump casings and check and compare drain oil in the pumps. Look for evidence of grit or metallic particles.

Vibration or unusual noise during operation could be an indication of air leaking into the circuit (Refer to the appropriate Troubleshooting section for component or unit for procedures.), or it may be evidence of a defective pump. The gear type pilot pump could be defective, causing low pilot pressure, or a main pump broken shoe or piston could be responsible.

NOTE: *If equipped, indicated operating pressure, as shown on the multidisplay digital gauge on the Instrument Panel ("F-Pump" and "R-Pump") will be reduced because of a mechanical problem inside the pump. However, pressure loss could also be because of cavitation or air leakage, or other faults in the hydraulic system.*

Check the exterior case drain oil in the main pumps. If no metallic particles are found, make sure there is no air in the system. Unbolt and remove tank return drain line from the top part of the swing motor, both travel motors and each main pump. If there is air in any one of the drain lines, carefully prefill the assembly before bolting together the drain line piping connections. Run the system at low rpm.

HYDRAULIC SYSTEM CLEANLINESS AND OIL LEAKS

Maintenance Precautions for Hydraulic System Service

Whenever maintenance, repairs or any other troubleshooting or service is being performed, it's important to remember that the hydraulic system - including both the interior and exterior surfaces of assemblies, and every drop of operating fluid - must be protected from contamination.

Dust and other foreign contaminants are major contributors to premature wear in hydraulic circuits. The narrow tolerances, rapidly moving parts and high operating pressures of the system require that fluid be kept as clean as possible. The performance and dependability of the machine (and the service lift of individual components) can be noticeably reduced if proper precautions are not observed:

- Use a safe, noncombustible, evaporative type, low residue solvent and thoroughly clean exterior surfaces of assemblies before any part of the circuit is opened or disassembled.

  NOTE: *It's just as important to clean the cap and reservoir top before routine fluid changes or quick checks as it is before major repairs. (Accumulated dirt attracts moisture, oil and other fluids - and more dirt.)*

- Keep dismantled parts covered during disassembly. Use clean caps, plugs or tape to protect the disconnected openings of flanges, manifolds and piping.
- Do not allow cleaning solvents or other fluids to mix with the oil in the system. Use clean oil to flush any traces of solvent or other residue before reassembly.
- If metal or rubber fragments are found in the system, flush and replace all fluid in the system and troubleshoot the circuit to identify the source of contamination.

IMPORTANT

Make sure that cleaning solvents will be compatible with rubber materials used in the hydraulic system. Many petroleum based compounds can cause swelling, softening, or other deterioration of system sealing elements, such as O-rings, caps and other seals.

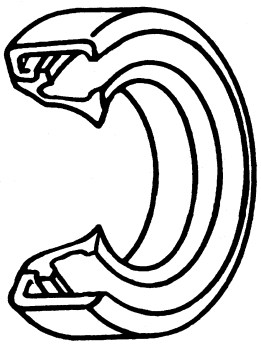
Oil Leakage Precautions

Oil that is visibly seeping from joints or seals should always serve as a "red flag" alarm.

Leaks must alert the machine operator and maintenance crew that air, water and dirt have an open, free passageway through which to enter the circuit. Harsh, corrosive salt air, freezing and thawing condensation cycles and working environments that are full of fine dust are especially hazardous. Clogging of valve spools or external piping (especially pilot circuit piping) can gradually diminish or suddenly put a stop to normal hydraulic function. You can prevent having to make these types of repairs by following recommended assembly procedures:

1. Use new O-rings and oil seals whenever hydraulic assemblies are rebuilt.
2. Prepare joint surfaces before assembly by checking alignment and flatness. Clean and repair corrosion or any other damage.
3. Follow bolt torque recommendations and all other assembly requirements.

NOTE: *Grease lip seals before assembly.*



0565A

Figure 1

CLEANING AND INSPECTION

General Guidelines

All parts must be clean to permit an effective inspection. During assembly, it is very important that no dirt or foreign material enters unit being assembled. Even minute particles can cause malfunction of close fitting parts such as thrust bearing, matched parts, etc.

⚠ WARNING!

Care should be exercised to avoid inhalation of vapors, exposure to skin and creating fire hazards when using solvent type cleaners.

1. Clean all metal parts thoroughly using a suitable cleaning fluid. It is recommended that parts be immersed in cleaning fluid and moved up and down slowly until all oils, lubricants, and/or foreign materials are dissolved and parts are thoroughly clean.
2. For bearings that can be removed, soak them in a suitable cleaning fluid for a minute or two, then remove bearings from cleaning fluid and strike flat against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning fluid to flush out particles. Repeat above operation until bearings are thoroughly clean. To dry bearings, use moisture-free compressed air. Be careful to direct airstream across bearing to avoid spinning bearings that are not lubricated. DO NOT SPIN BEARINGS WHEN DRYING; bearings may be rotated slowly by hand to facilitate drying process.
3. Carefully inspect all bearing rollers, cages and cups for wear, chipping or nicks to determine condition. Do not replace a bearing cone or cup individually without replacing mating cup or cone at the same time. After inspection, dip bearings in lightweight oil and wrap in clean lintless cloth or paper to protect them until installation.

   For those bearings that are to be inspected in place; inspect bearings for roughness of rotation, scoring, pitting, cracked or chipped races. If any of these defects are found, replace bearings. Also, inspect defective bearing housing and/or shaft for grooved, galled or burred conditions that indicate bearing has been turning in its housing or on its shaft.
4. It is more economical to replace oil seals, O-rings, sealing rings, gaskets and retaining rings when unit is disassembled than waiting for premature failures; refer to latest Micro Fiche and/or Parts Book for replacement items. Be careful when installing sealing members, to avoid cutting or scratching. Curling under of any seal lip will

seriously impair its efficiency. Apply a thin coat of Loctite #120 to outer diameter, of metal casing, on oil seals to assure an oil tight fit into retainer. Use extreme care not to get Loctite on lips of oil seals. If this happens, that portion of the seal will become brittle and allow leakage.

When replacing lip type seals, make sure spring loaded side is towards oil to be sealed.

5. If available, use magna-flux or similar process for checking for cracks that are not visible. Examine teeth on all gears carefully for wear, pitting, chipping, nicks, cracks or scores. Replace all gears showing cracks or spots where case-hardening has worn through. Small nicks may be removed with suitable hone. Inspect shafts and quills to make certain they have not been sprung, bent, or splines twisted, and that shafts are true.

   NOTE: *Spline wear is not considered detrimental except where it affects tightness of splined parts.*

   Inspect thrust washers for distortion, scores, burs, and wear. Replace thrust washer if defective or worn.

6. Inspect bores and bearing surfaces of cast parts and machined surfaces for scratches, wear, grooves and dirt. Remove any scratches and burrs with crocus cloth. Remove foreign material. Replace any parts that are deeply grooved or scratched which would affect their operation.

Bearing Inspection

The condition of the bearings are vital to the smooth and efficient operation of the machinery. When any component containing bearings is disassembled, always carefully examine the condition of the bearings and all of its components for wear and damage.

Once the bearing is removed, clean all parts thoroughly using a suitable cleaning solution. If the bearing is excessively dirty soak the bearing assembly in a light solution and move the bearing around until all lubricants and or foreign materials are dissolved and the parts are thoroughly clean.

When drying bearings, moisture free compressed air can be used. Be careful not to direct the air in a direction which will force the bearing to dry spin while not being properly lubricated.

After the bearings have been cleaned and dried, carefully inspect all bearing rollers, cages and cups for wear, chipping or nicks. If the bearing cannot be removed and is to be inspected in place, check for roughness of rotation, scoring, pitting, cracked or chipped races. If any of these defects are found replace the whole bearing assembly. NEVER replace the bearing alone without replacing the mating cup or the cone at the same time.

After inspection lightly coat the bearing and related parts with oil and wrap in a clean lintless cloth or paper and protect them from moisture and other foreign materials until installation.

It is also important to inspect the bearing housing and/or shaft for grooved, galled or burred conditions that indicate the bearing has been turning in its housing or on its shaft.

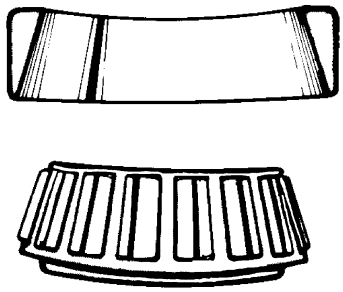
If available, use magna-flux or similar process for checking for cracks that are not visible.

The following illustrations will aid in identifying and diagnosing some of the bearing related problems.

NOTE: *The illustrations will only show tapered roller bearings, but the principles of identifying, diagnosing and remedying the defects are common to all styles and types of bearings.*

Normal Bearing

Smooth even surfaces with no discoloration or marks.

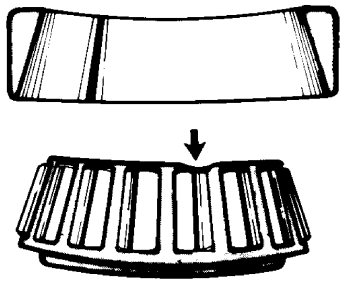


HASA620S

Figure 2

Bent Cage

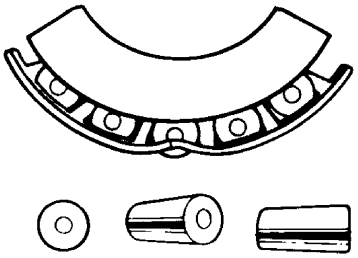
Cage damage because of improper handling or tool usage.



HASA460S

Figure 3

Replace bearing.



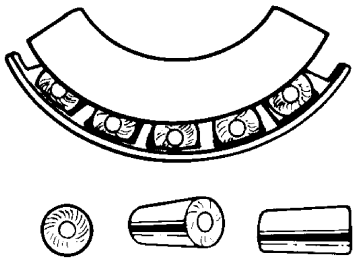
HASA470S

Figure 4

Galling

Metal smears on roller ends because of overheating, lubricant failure or overload.

Replace bearing - check seals and check for proper lubrication.



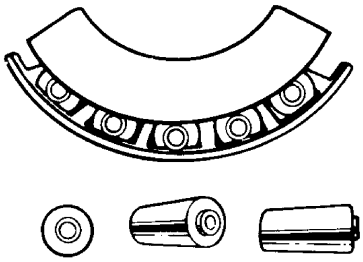
HASA480S

Figure 5

Abrasive Step Wear

Pattern on roller ends caused by fine abrasives.

Clean all parts and housings, check all parts and housings, check seals and bearings and replace if leaking, rough or noisy.



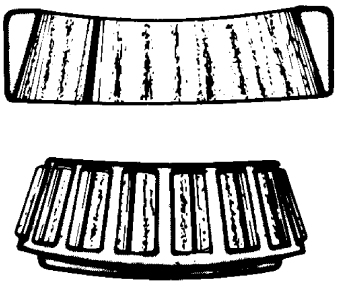
HASA490S

Figure 6

Etching

Bearing surfaces appear gray or grayish black in color with related etching away of material usually at roller spacing.

Replace bearings - check seals and check for proper lubrication.



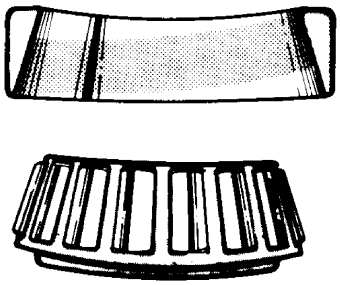
HASA500S

Figure 7

Misalignment

Outer race misalignment because of foreign object.

Clean related parts and replace bearing. Make sure races are properly seated.



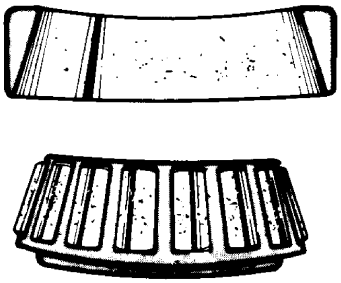
HASA510S

Figure 8

Indentations

Surface depressions on race and rollers caused by hard particles of foreign materials.

Clean all parts and housings, check seals and replace bearings if rough or noisy.



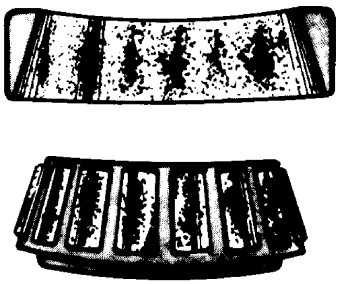
HASA520S

Figure 9

Fatigue Spalling

Flaking of surface metal resulting from fatigue.

Replace bearing - clean all related parts.



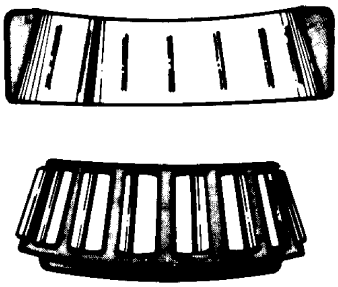
HASA530S

Figure 10

Brinelling

Surface indentations in raceway caused by rollers either under impact loading or vibration while the bearing is not rotating.

Replace bearing if rough or noisy.



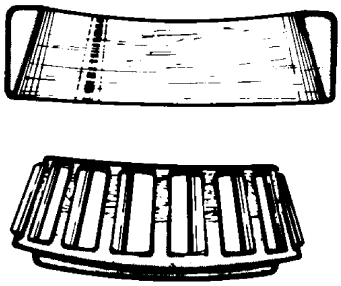
HASA540S

Figure 11

Cage Wear

Wear around outside diameter of cage and roller pockets caused by abrasive material and inefficient lubrication.

Replace bearings - check seals.



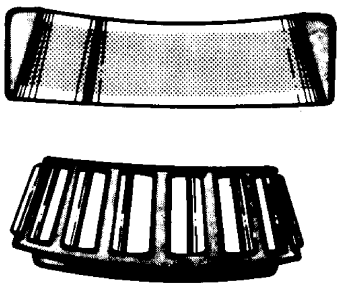
HASA550S

Figure 12

Abrasive Roller Wear

Pattern on races and rollers caused by fine abrasives.

Clean all parts and housings, check seals and bearings and replace if leaking, rough or noisy.



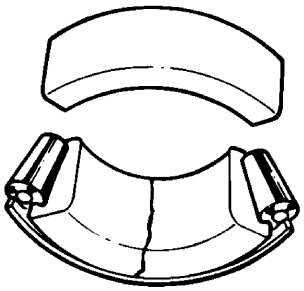
HASA560S

Figure 13

Cracked Inner Race

Race cracked because of improper fit, cocking or poor bearing seat.

Replace all parts and housings, check seals and bearings and replace if leaking.



HASA570S

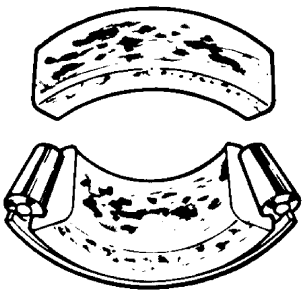
Figure 14

Smears

Smearing of metal because of slippage caused by poor fitting, lubrication, overheating, overloads or handling damage.

Replace bearings, clean related parts and check for proper fit and lubrication.

Replace shaft if damaged.



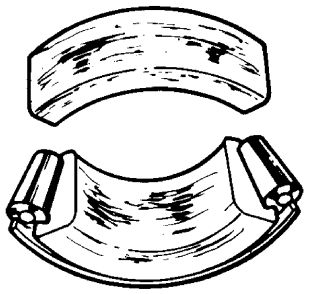
HASA580S

Figure 15

Frettage

Corrosion set up by small relative movement of parts with no lubrication.

Replace bearing. Clean all related parts. Check seals and check for proper lubrication.



HASA590S

Figure 16

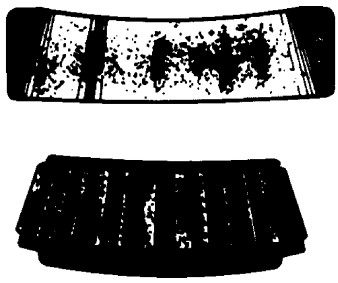
Heat Discoloration

Heat discoloration can range from faint yellow to dark blue resulting from overload or incorrect lubrication.

Excessive heat can cause softening of races or rollers.

To check for loss of temper on races or rollers, a simple file test may be made. A file drawn over a tempered part will grab and cut metal, whereas a file drawn over a hard part will glide readily with no metal cutting.

Replace bearing if overheating damage is indicated. Check seals and other related parts for damage.



HASA600S

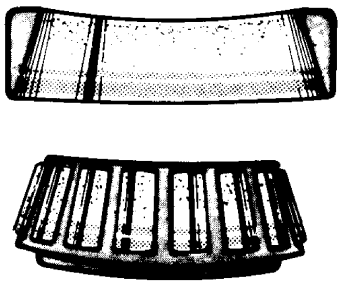
Figure 17

Stain Discoloration

Discoloration can range from light brown to black caused by incorrect lubrication or moisture.

If the stain can be removed by light polishing or if no evidence of overheating is visible, the bearing can be reused.

Check seals and other related parts for damage.



HASA610S

Figure 18

Standard Torques

Edition 1

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Standard Torques

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SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
ALL MODELS	ALL RANGES

TORQUE VALUES FOR STANDARD METRIC FASTENERS

NOTE: *The units for the torque values are kg•m (ft lb).*

Dia. x Pitch (mm)	Grade										
	3.6 (4A)	4.6 (4D)	4.8 (4S)	5.6 (5D)	5.8 (5S)	6.6 (6D)	6.8 (6S)	6.9 (6G)	8.8 (8G)	10.9 (10K)	12.9 (12K)
M5 x Std.	0.15 (1.08)	0.16 (1.15)	0.25 (1.80)	0.22 (1.59)	0.31 (2.24)	0.28 (2.02)	0.43 (3.11)	0.48 (3.47)	0.50 (3.61)	0.75 (5.42)	0.90 (6.50)
M6 x Std.	0.28 (2.02)	0.30 (2.16)	0.45 (3.25)	0.40 (2.89)	0.55 (3.97)	0.47 (3.39)	0.77 (5.56)	0.85 (6.14)	0.90 (6.50)	1.25 (9.04)	1.50 (10.84)
M7 x Std.	0.43 (3.11)	0.46 (3.32)	0.70 (5.06)	0.63 (4.55)	0.83 (6.00)	0.78 (5.64)	1.20 (8.67)	1.30 (9.40)	1.40 (10.12)	1.95 (14.10)	2.35 (16.99)
M8 x Std.	0.70 (5.06)	0.75 (5.42)	1.10 (7.95)	1.00 (7.23)	1.40 (10.12)	1.25 (9.04)	1.90 (13.74)	2.10 (15.18)	2.20 (15.91)	3.10 (22.42)	3.80 (27.48)
M8 x 1	0.73 (5.28)	0.80 (5.78)	1.20 (8.67)	1.00 (7.23)	1.50 (10.84)	1.35 (9.76)	2.10 (15.18)	2.30 (16.63)	2.40 (17.35)	3.35 (24.23)	4.10 (29.65)
M10 x Std.	1.35 (9.76)	1.40 (10.12)	2.20 (15.91)	1.90 (13.74)	2.70 (19.52)	2.35 (19.99)	3.70 (26.76)	4.20 (30.37)	4.40 (31.18)	6.20 (44.84)	7.20 (52.07)
M10 x 1.25	1.50 (10.84)	1.60 (11.57)	2.50 (18.08)	2.10 (15.18)	3.10 (22.42)	2.80 (20.25)	4.30 (31.10)	4.90 (35.44)	5.00 (36.16)	7.00 (50.63)	8.40 (60.75)
M12 x Std.	2.40 (17.35)	2.50 (18.08)	3.70 (26.76)	3.30 (23.86)	4.70 (33.99)	4.20 (30.37)	6.30 (45.56)	7.20 (52.07)	7.50 (54.24)	10.50 (75.94)	12.50 (90.41)
M12 x 1.25	2.55 (18.44)	2.70 (19.52)	4.00 (28.93)	3.50 (25.31)	5.00 (36.16)	4.50 (32.54)	6.80 (49.18)	7.70 (55.69)	8.00 (57.86)	11.20 (81.00)	13.40 (96.92)
M14 x Std.	3.70 (26.76)	3.90 (28.20)	6.00 (13.23)	5.20 (37.61)	7.50 (54.24)	7.00 (50.63)	10.00 (72.33)	11.50 (83.17)	12.00 (86.79)	17.00 (122.96)	20.00 (144.66)
M14 x 1.5	4.10 (29.65)	4.30 (31.10)	6.60 (47.73)	5.70 (41.22)	8.30 (60.03)	7.50 (54.24)	11.10 (80.28)	12.50 (90.41)	13.00 (94.02)	18.50 (133.81)	22.00 (159.12)
M16 x Std.	5.60 (40.50)	6.00 (43.39)	9.00 (65.09)	8.00 (57.86)	11.50 (83.17)	10.50 (75.94)	15.50 (112.11)	17.90 (129.47)	18.50 (133.81)	26.00 (188.05)	31.00 (224.22)
M16 x 1.5	6.20 (44.84)	6.50 (47.01)	9.70 (70.16)	8.60 (62.20)	12.50 (90.41)	11.30 (81.73)	17.00 (122.96)	19.50 (141.04)	20.00 (144.66)	28.00 (202.52)	35.50 (256.77)
M18 x Std.	7.80 (56.41)	8.30 (60.03)	12.50 (90.41)	11.00 (79.56)	16.00 (115.72)	14.50 (104.87)	21.00 (151.89)	27.50 (198.90)	28.50 (206.14)	41.00 (296.55)	43.00 (311.01)
M18 x 1.5	9.10 (65.82)	9.50 (68.71)	14.40 (104.15)	12.50 (90.41)	18.50 (133.81)	16.70 (120.79)	24.50 (177.20)	27.50 (198.90)	28.50 (206.14)	41.00 (296.55)	49.00 (354.41)
M20 x Std.	11.50 (83.17)	12.00 (86.79)	18.00 (130.19)	16.00 (115.72)	22.00 (159.12)	19.00 (137.42)	31.50 (227.83)	35.00 (253.15)	36.00 (260.38)	51.00 (368.88)	60.00 (433.98)
M20 x 1.5	12.80 (92.58)	13.50 (97.64)	20.50 (148.27)	18.00 (130.19)	25.00 (180.82)	22.50 (162.74)	35.00 (253.15)	39.50 (285.70)	41.00 (296.55)	58.00 (419.51)	68.00 (491.84)
M22 x Std.	15.50 (112.11)	16.00 (115.72)	24.50 (177.20)	21.00 (151.89)	30.00 (216.99)	26.00 (188.05)	42.00 (303.78)	46.00 (332.71)	49.00 (354.41)	67.00 (484.61)	75.00 (542.47)
M22 x 1.5	17.00 (122.96)	18.50 (133.81)	28.00 (202.52)	24.00 (173.59)	34.00 (245.92)	29.00 (209.75)	47.00 (339.95)	52.00 (44.76)	56.00 (405.04)	75.00 (542.47)	85.00 (614.80)
M24 x Std.	20.50 (148.27)	21.50 (155.50)	33.00 (238.68)	27.00 (195.29)	40.00 (289.32)	34.00 (245.92)	55.00 (397.81)	58.00 (419.51)	63.00 (455.67)	82.00 (593.10)	92.00 (655.43)
M24 x 2.0	23.00 (166.35)	35.00 (253.15)	37.00 (267.62)	31.00 (224.22)	45.00 (325.48)	38.00 (202.52)	61.00 (441.21)	67.00 (484.61)	74.00 (535.24)	93.00 (672.66)	103.00 (744.99)

TORQUE VALUES FOR STANDARD U.S. FASTENERS

Type	S.A.E. Grade	Description	Bolt Head Marking
1	1 OR 2	WILL HAVE NO MARKINGS IN THE CENTER OF THE HEAD. Low or Medium Carbon Steel Not Heat-treated.	
5	5	WILL HAVE THREE RADIAL LINES. Quenched and Tempered Medium Carbon Steel.	
8	8	WILL HAVE 6 RADIAL LINES. Quenched and Tempered Special Carbon or Alloy Steel.	

Recommended torque, in foot-pounds, for all Standard Application Nuts and Bolts, provided:

1. All thread surfaces are clean and lubricated with SAE-30 engine oil. (See Note.)
2. Joints are rigid, that is, no gaskets or compressible materials are used.
3. When reusing nuts or bolts, use minimum torque values.

NOTE: *Multiply the standard torque by:*

- 0.65 When finished jam nuts are used.
- 0.70 When Molykote, white lead or similar mixtures are used as lubricants.
- 0.75 When Parkerized bolts or nuts are used.
- 0.85 When cadmium plated bolts or nuts and zinc bolts w/waxed zinc nuts are used.
- 0.90 When hardened surfaces are used under the nut or bolt head.

NOTE: *When reusing bolts and nuts in service, use minimum torque values.*

The following General Torque Values must be used where **SPECIAL TORQUE VALUES** are not given.

NOTE: *Torque values listed throughout this manual are lubricated (wet) threads; values should be increased 1/3 for nonlubricated (dry) threads.*

Thread Size	Heat-treated Material Grade 5 and Grade 8			
	Grade 5 (3 Radial Dashes On Head)		Grade 8 (6 Radial Dashes On Head)	
	Foot-pounds (ft lb)	Newton Meter (Nm)	Foot-pounds (ft lb)	Newton Meter (Nm)
1/4" - 20	6	8	9	12
1/4" - 28	7	9	11	15
5/16" - 18	13	18	18	24
5/16" - 24	15	20	21	28
3/8" - 16	24	33	34	46
3/8" - 24	27	37	38	52
7/16" - 14	38	52	54	73
7/16" - 20	42	57	60	81
1/2" - 13	58	79	82	111
1/2" - 20	65	88	90	122
9/16" - 12	84	114	120	163
9/16" - 18	93	126	132	179
5/8" - 11	115	156	165	224
5/8" - 18	130	176	185	251
3/4" - 10	205	278	290	393
3/4" - 16	240	312	320	434
7/8" - 9	305	414	455	617
7/8" - 14	334	454	515	698
1" - 8	455	617	695	942
1" - 14	510	691	785	1064
1 1/8" - 7	610	827	990	1342
1 1/8" - 12	685	929	1110	1505
1 1/4" - 7	860	1166	1400	1898
1 1/4" - 12	955	1295	1550	2102
1 3/8" - 6	1130	1532	1830	2481
1 3/8" - 12	1290	1749	2085	2827
1 1/2" - 6	1400	2034	2430	3295
1 1/2" - 12	1690	2291	2730	3701
1 3/4" - 5	2370	3213	3810	5166
2" - 4 1/2	3550	4813	5760	7810

NOTE: *If any bolts and nuts are found loose or at values less than the chart states, it is recommended that the loose bolt and/or nut be replaced with a new one.*

TYPE 8 PHOSPHATE COATED HARDWARE

This chart provides tightening torque for general purpose applications using original equipment standard hardware as listed in the Parts Manual for the machine involved. **DO NOT SUBSTITUTE**. In most cases, original equipment standard hardware is defined as Type 8, coarse thread bolts and nuts and thru hardened flat washers (Rockwell "C" 38 - 45), all phosphate coated and assembled without supplemental lubrication (as received) condition.

The torques shown below also apply to the following:

1. Phosphate coated bolts used in tapped holes in steel or gray iron.
2. Phosphate coated bolts used with phosphate coated prevailing torque nuts (nuts with distorted threads or plastic inserts).
3. Phosphate coated bolts used with copper plated weld nuts.

Markings on bolt heads or nuts indicate material grade ONLY and are NOT to be used to determine required torque.

Nominal Thread Diameter	Standard Torque ±10%	
	Kilogram-meter (kg•m)	Foot-pounds (ft lb)
1/4"	1.1	8
5/16"	2.2	16
3/8"	3.9	28
7/16"	6.2	45
1/2"	9.7	70
9/16"	13.8	100
5/8"	19.4	140
3/4"	33.2	240
7/8"	53.9	390
1"	80.2	580
1 - 1/8"	113.4	820
1 - 1/4"	160.4	1160
1 - 3/8"	210.2	1520
1 - 1/2"	279.4	2020
1 - 3/4"	347.1	2510
2	522.8	3780

TORQUE VALUES FOR HOSE CLAMPS

The following chart provides the tightening torques for hose clamps used in all rubber applications (radiator, air cleaner, operating lever boots, hydraulic system, etc.).

Clamp Type And Size	Torque			
	Radiator, Air Cleaner, Boots, Etc.		Hydraulic System	
	Kilogram-meter (kg•m)	Inch Pounds (in lb)	Kilogram-meter (kg•m)	Inch Pounds (in lb)
"T" Bolt (Any Diameter)	0.68 - 0.72	59 - 63	-------	------
Worm Drive - Under 44 mm (1-3/4 in) Open Diameter	0.2 - 0.3	20 - 30	0.5 - 0.6	40 - 50
Worm Drive - Over 44 mm (1-3/4 in) Open Diameter	0.5 - 0.6	40 - 50	-------	------
Worm Drive - All "Ultra-Tite"	0.6 - 0.7	50 - 60	0.5 - 0.6	40 - 50

TORQUE VALUES FOR SPLIT FLANGES

The following chart provides the tightening torques for split flange connections used in hydraulic systems. Split flanges and fitting shoulders should fit squarely. Install all bolts, finger tight and then torque evenly.

NOTE: *Over torquing bolts will damage the flanges and/or bolts, which may cause leakage.*

Flange Size (*)	Bolt Size	Bolt Torque	
		Kilogram-meter (kg•m)	Foot-pounds (ft lb)
1/2"	5/16"	2.1 - 2.5	15 - 18
3/4"	3/8"	3.0 - 3.7	22 - 27
1"	3/8"	3.7 - 4.8	27 - 35
1 - 1/4"	7/16"	4.8 - 6.2	35 - 45
1 - 1/2"	1/2"	6.4 - 8.0	46 - 58
2"	1/2"	7.6 - 9.0	55 - 65
2 - 1/2"	1/2"	10.9 - 12.6	79 - 91
3"	5/8"	19.1 - 20.7	138 - 150
3 - 1/2"	5/8"	16.2 - 18.4	117 - 133

(*) - Inside diameter of flange on end of hydraulic tube or hose fitting.

NOTE: *Values stated in chart are for Standard Pressure Series (Code 61) Split Flanges.*

TORQUE WRENCH EXTENSION TOOLS

Very large diameter, high-grade fasteners (nuts, bolts, cap screws, etc.) require a great deal of turning force to achieve recommended tightening torque values.

Common problems that could occur as a result are:

- Recommended torque exceeds the measuring capacity of the torque wrench.
- Specialized sockets do not fit the adapter on the front end (nose) of the torque wrench.
- Generating adequate force on the back end (handle) of the wrench is difficult or impossible.
- Restricted access or an obstruction may make use of the torque wrench impossible.
- A unique application requires fabrication of an adapter or other special extension.

Most standard torque wrenches can be adapted to suit any one of the proceeding needs or situations, if the right extension tool is used or fabricated.

Torque Multiplication

A wrench extension tool can be used to increase the tightening force on a high capacity nut or bolt.

For example, doubling the distance between the bolt and the back (handle) end of the torque wrench doubles the tightening force on the bolt. It also halves the indicated reading on the scale or dial of the torque wrench. To accurately adjust or convert indicated scale or dial readings, use the following formula:

I = A x T / A + B where:

I = Indicated force shown on the torque wrench scale or dial.

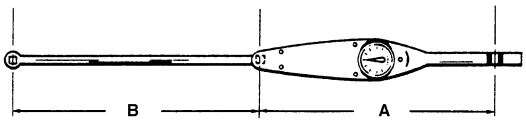
T = Tightening force applied to the nut or bolt (actual Torque).

A = Length of the torque wrench (between the center of the nut or bolt and the center of the handle).

B = Length of the extension.

As an example, if a 12" extension is added to a 12" torque wrench, and the indicated torque on the dial reads "150 ft lb," the real force applied to the bolt is 300 ft lb:

$$I = \frac{A \times T}{A + B} = \frac{12 \times 300}{12 + 12} = \frac{3600}{24} = 150$$



0552A

Figure 1

NOTE: *The formula assumes that there is no added deflection or "give" in the joint between the extension and torque wrench. Readings may also be inaccurate:*

- If the extension itself absorbs some of the tightening force and starts to bend or bow out.
- If an extension has to be fabricated that is not straight (for example, an extension made to go around an obstruction, to allow access to a difficult to tighten fastener), the materials and methods used must be solid enough to transmit full tightening torque.

Other Uses for Torque Wrench Extension Tools

Torque wrench extensions are sometimes made up for reasons other than increasing leverage on a fastener.

For example, a torque wrench and extension can be used to measure adjustment "tightness" of a linkage or assembly. Specially fabricated extensions can be used to make very precise checks of the force required to engage or disengage a clutch mechanism, release a spring-applied brake assembly, or "take up" free play in most any movable linkage.

Once the value of the adjustment force is established, repeated checks at regular intervals can help to monitor and maintain peak operating efficiency. These types of adjustment checks are especially useful if physical measurements of linkage travel are difficult to make or will not provide the needed degree of precision and accuracy.

To allow the assembly or mechanism to accept a torque wrench, welding a nut or other adapter on the end of a linkage shaft or other leverage point will allow turning the shaft or assembly manually.

Tightening Torque Specifications (Metric)

(For coated threads, prelubricated assemblies.)

CAUTION!

Disassembly, overhaul and replacement of components on the machine, installation of new or replacement parts and/or other service related maintenance may require the use of thread or flange sealing assembly compound.

Use the information on this page as a general guide in selecting specific formulas that will meet the particular requirements of individual assembly installations. *DOOSAN* does not specifically endorse a specific manufacturer or brand name but the following table of "Loctite" applications is included for which cross-references to other makers' products should also be widely available.

IMPORTANT

Use primer "T" or "N" for all cold weather assembly of fastener adhesives, with Thread locker sealers 222, 242/243, 262, 271, 272, or 277.

I. "Loctite" Fastener Adhesives

Product	Application	Color	Removal	Breakaway Cure Strength (in lb) of Sealer Alone
222	Low strength for 6 mm (1/4") or smaller fasteners.	Purple	Hand tools	45
242 or 243	Medium strength for 6 mm (1/4") and larger fasteners.	Blue	Hand tools	80
262	High strength for high-grade fasteners subject to shock, stress and vibration.	Red	Heat/260°C (500°F) Remove HOT (NO solvent)	160
271	Extra high strength for fine thread fasteners up to 25 mm (1") diameter.	Red	Heat/260°C (500°F) Remove HOT	160
272	High temperature/high strength for hostile environments to 232°C (450°F).	Red	Heat/316°C (600°F) Remove HOT	180
277	Extra high strength for coarse thread fasteners 25 mm (1") diameter and larger.	Red	Heat/260°C (500°F) Remove HOT	210

II. "Loctite" Pipe Thread Sealant

Product	Application	Color	Removal	Required Setup
545	"No-filler/nonclog" formula for high-pressure hydraulic systems. Over application will not restrict or foul system components.	Purple	Hand tools	4 Hours (or 1/2 hour with Locquic "T" Primer)
656	Solvent resistant, higher viscosity tapered thread sealer.	White	Hand tools	4 Hours (or 1/2 hour with Locquic "T" Primer)

III. "Loctite" gasket/flange sealer

Product	Application	Color	Notes
518	Gasket eliminator specifically made for aluminum flanges/surfaces. For hydraulic systems to 34,475 kPa (5,000 psi).	Red	Use Locquic "N" primer for fast (1/2 - 4 hours) setup. Unprimed setup 4 - 24 hours.
504	Low-pressure/wide-gap gasket eliminator compound. Fills gaps to 0.0012 mm (0.030"), cures to rigid seal.	Orange	Use Locquic "N" primer for faster (1/2 - 4 hours) setup. Unprimed setup 4 - 24 hours.
515	General purpose, fast setup, flexible-cure gasket eliminator. For nonrigid assemblies subject to shock, vibration or deflection.	Purple	Use Locquic "N" primer for faster (1/4 - 2 hours) setup. Unprimed setup 1 - 12 hours.

IV. "Loctite" retaining compounds

Product	Application	Color	Notes
609	For bushings, sleeves, press fit bearings, splines and collars. For gaps to 0.0002 mm (0.005"), temperatures to 121°C (250°F).	Green	Use Locquic "N" primer for increased bond strength and all cold temperature applications.
620	For high temperatures to 232°C (450°F).	Green	Same as 609, above.
680	For high strength bonds and tight clearance gaps, to 0.00008 mm (0.002").	Green	Same as 609, above.

V. "Loctite" Adhesives

Product	Application	Color	Notes
380	Black Max instant adhesive for shock and vibration-resistant bonds.	Black	May take 120 hours to reach full cure strength.
454	Adhesive for porous surfaces.	Clear	Full strength in 24 hours.
480	Increased strength (+50%), shock and vibration-resistant.	Black	Full strength in 24 hours.

Upper Structure

Cabin

Edition 1

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SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX300LL	5001 and Up
DX340LC	5001 and Up
DX420LC	5001 and Up
DX480LC	5001 and Up
DX520LC	5001 and Up

REMOVAL

CAUTION!

Avoid disassembling cabin if there are strong wind gusts, which could catch large surface area of cabin shell and push it sideways during lift.

1. Park on firm and level ground.
2. Lower front attachment (bucket) to ground.
3. Shut down engine.
4. Set safety lever on "RELEASED" position.
5. Turn starter switch to "I" (ON) position.

WARNING!

If engine must be run while performing maintenance, use extreme care. Always have one person in the cabin at all times. Never leave the cabin with the engine running.

6. Fully stroke work levers (joysticks) in all directions to relieve pressure from accumulators.
7. Set safety lever on "LOCK" position.
8. Turn key to "O" (OFF) position and remove from starter switch.
9. Hang maintenance warning tag on controls.
10. Disconnect the battery cable from the negative (-) battery terminal.
11. Prepare cabin shell for removal by disconnecting wiring connectors for:
    A. Cabin interior lighting.
    B. External light wiring.
    C. Radio antenna and connections.
    D. Wiper/washer connections.

    NOTE: *Control console wiring harnesses and hydraulic piping lines that pass through the floor of the cabin do not need to be disassembled.*

    NOTE: *If unit is equipped with a cabin protective structure (for forestry, or hazardous working conditions), it must be removed.*

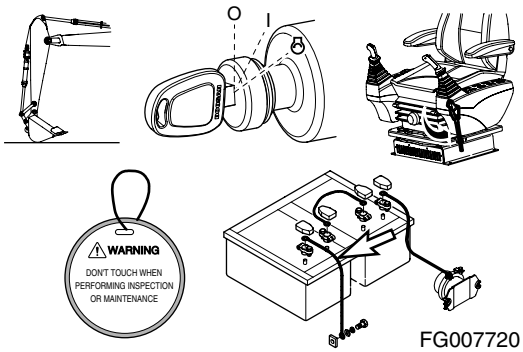


Figure 1

12. Remove floor mat (1, Figure 2).
13. Remove seat (2, Figure 2).

    NOTE: *Be careful not to damage seat covering.*

14. Remove cup holder (3, Figure 2).

    Remove front cover (4, Figure 2) and side covers (5 and 6). When removing cover (4), disconnect hour meter connector.

    NOTE: *Don't remove monitor panel (7, Figure 2) and switch panel (8).*

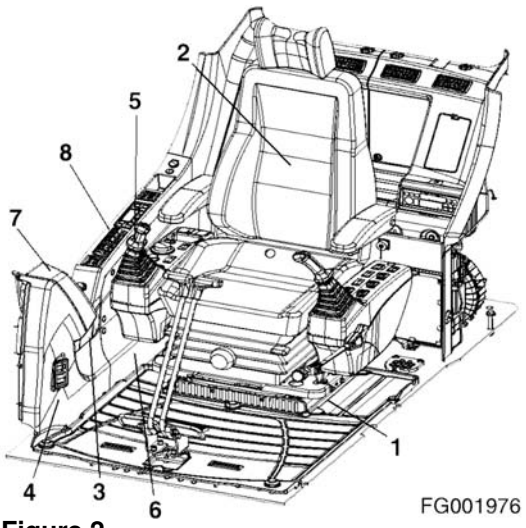


Figure 2

15. After removing rear mat (1, Figure 3), remove rear center cover (2), cassette cover (3) and rear side covers (4 and 5).

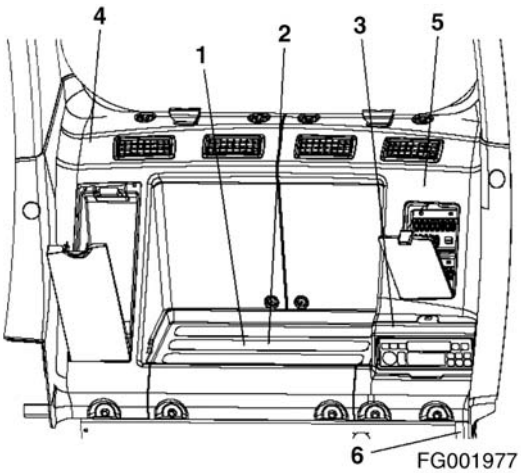


Figure 3

16. Remove fuse box bracket (1, Figure 4) from left sidewall without disassembly harness connector.
17. Disconnect cabin ground cable located near fuse box bracket.
18. Remove cassette bracket (2, Figure 4) and disconnect antenna and speaker wire.
19. Remove electrical box (4, Figure 4) without disassembly harness connectors.

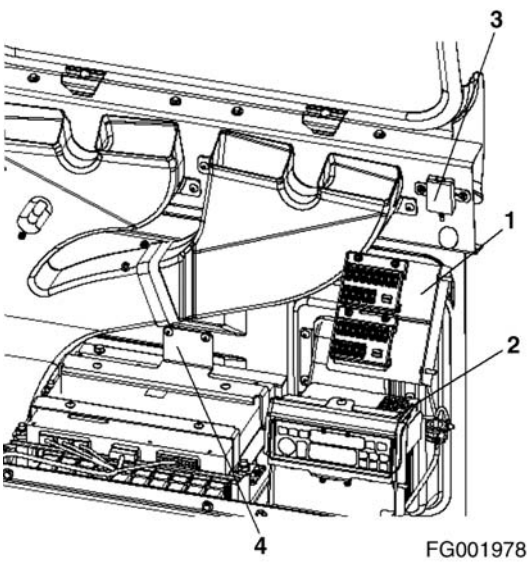


Figure 4

20. Remove air ducts (1, 2, 3 and 4, Figure 5) from cabin rear panel.
21. Remove across bar (5, Figure 5) between left and right side of cabin.

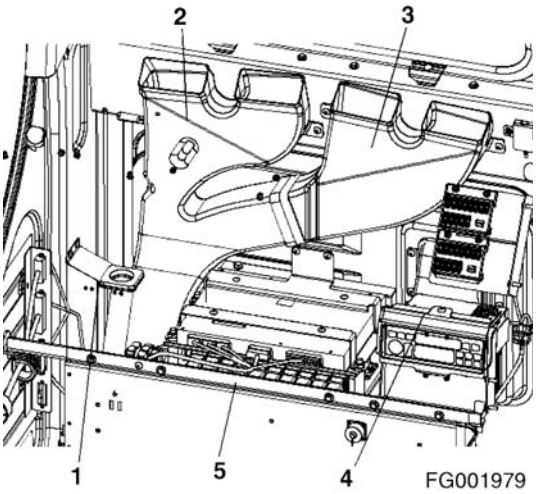


Figure 5

22. Remove air ducts (1, 2, 3, 4 and 5, Figure 6) right side of cabin step by step from the front duct.
23. Disconnect washer hose located at floor plate bottom.
24. Disconnect cabin wiring connectors from main harness.

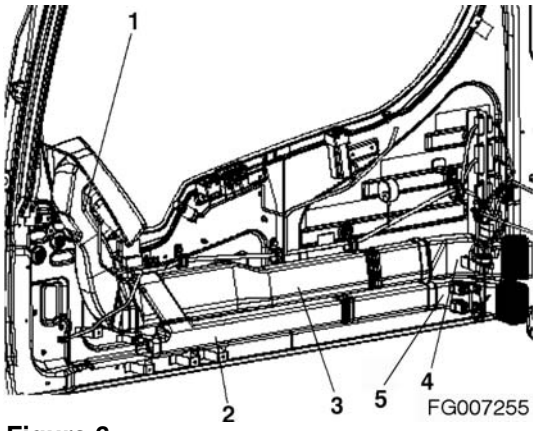


Figure 6

25. Remove four mounting nuts from four corners of cabin floor (1, Figure 7).
26. Remove four M12 hex bolts (2, Figure 7) and two M10 hex bolts (3).

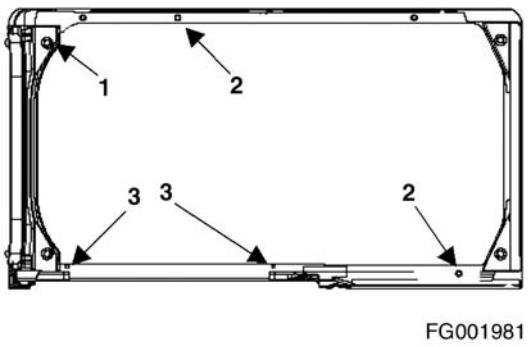


Figure 7

27. Using a suitable lifting device, attach slings to four lift points on top of cabin (Figure 8).

    NOTE: *Cabin weights approximately 315 kg (700 lb).*

28. Lift cabin from 25 - 50 mm (1" - 2") above deck height. Check that all electrical connections have been disconnected and all other items unbolted.

29. Continue lifting with the assist crane to remove cabin shell. Lower the shell to a prepared safe blocking support.

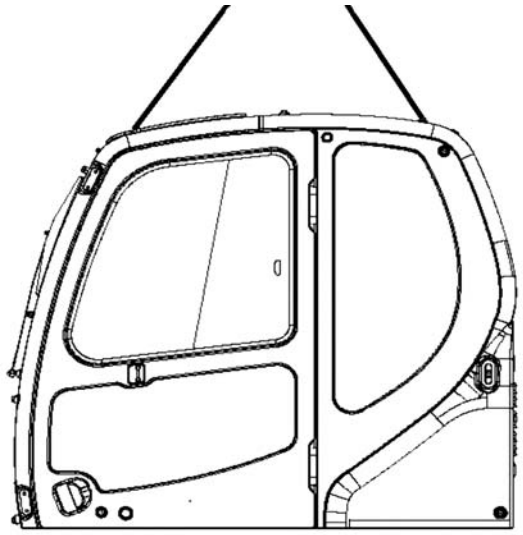


Figure 8

INSTALLATION

1. Using a suitable lifting device, attach slings to four lift points on top of cabin (Figure 9).

   NOTE: *Cabin weights approximately 315 kg (700 lb).*

2. Lower cabin into position on cabin floor.

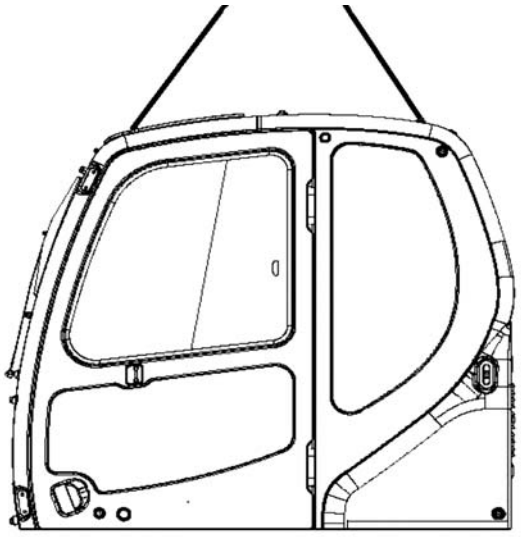


Figure 9

3. Install four mounting nuts from four corners of cabin floor (1, Figure 10).

   NOTE: *Mounting nut torque 21 kg•m (205 Nm, 150 lbf ft).*

4. Install four M12 hex bolts (2, Figure 10) and two M10 hex bolts (3).

   NOTE: *Mounting nut torque*
   M12 - 11 kg•m (108 Nm, 80 lbf ft).
   M10 - 6.5 kg•m (64 Nm, 47 lbf ft).

5. Once cabin is mounted to floor, unhook lifting device.

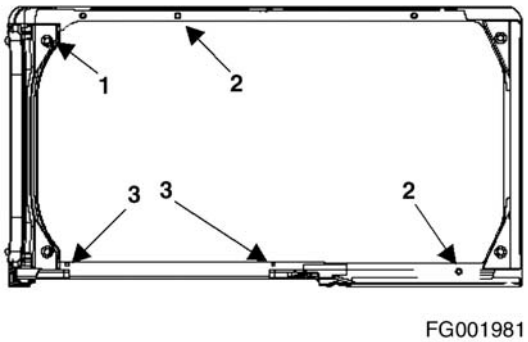


Figure 10

6. Connect cabin wiring connectors to main harness.
7. Connect washer hose located at floor plate bottom.
8. Install air ducts (1, 2, 3, 4 and 5, Figure 11) right side of cabin step by step from the rear duct.

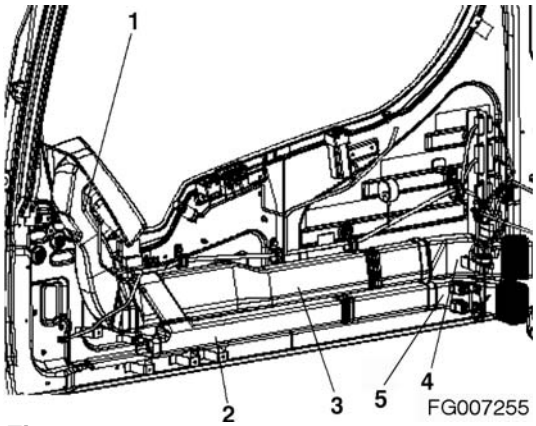


Figure 11

9. Install across bar (5, Figure 12) between left and right side of cabin.
10. Install air ducts (1, 2, 3 and 4, Figure 12) from cabin rear panel.

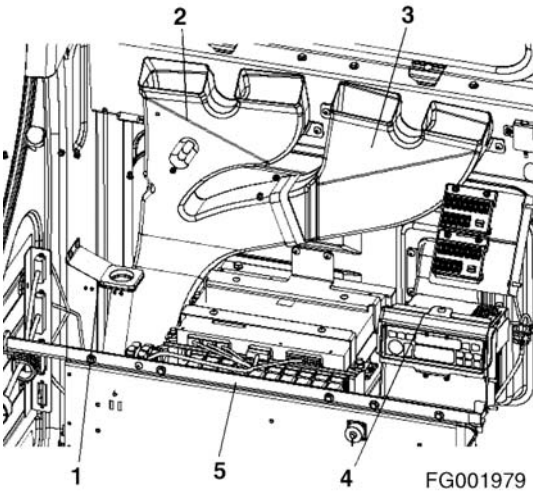


Figure 12

11. Install electrical box (4, Figure 13).
12. Install cassette bracket (2, Figure 13) and connect antenna and speaker wire.
13. Connect cabin ground cable located near fuse box bracket.
14. Install fuse box bracket (1, Figure 13) to left sidewall of the cabin.

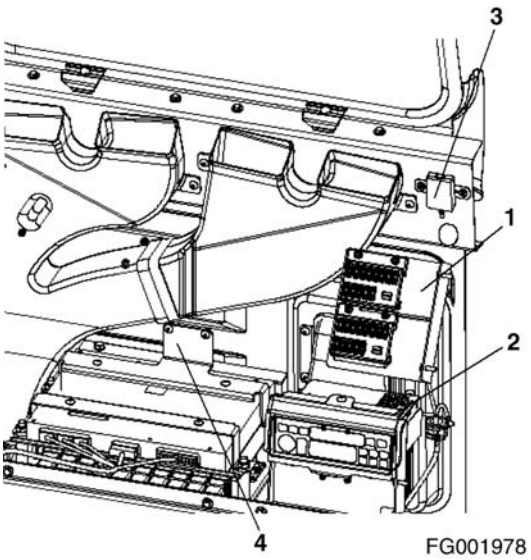


Figure 13

15. Install rear side covers (4 and 5, Figure 14), cassette cover (3) and rear center cover (2), last install rear mat (1).

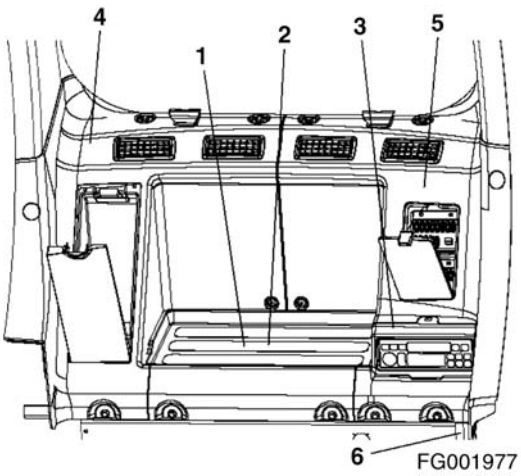


Figure 14

16. Install front cover (4, Figure 15), and side covers (5 and 6), when install cover (4) connect hour meter connector.
17. Install seat (2, Figure 15).

    NOTE: *Be careful not to damage seat covering.*
18. Install floor mat (1, Figure 15).
19. Connect negative (-) battery cable leading to frame from battery.

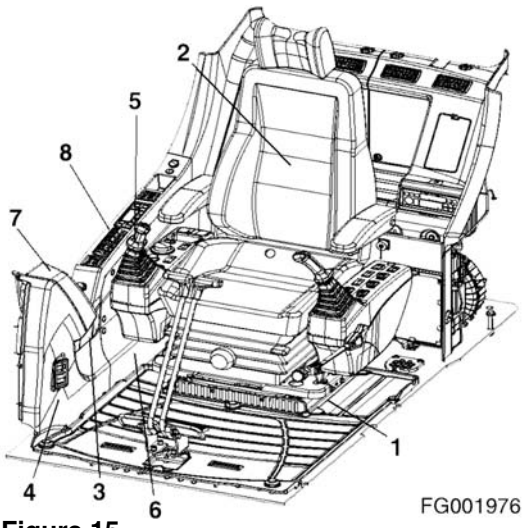


Figure 15

Counterweight

Edition 1

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Counterweight

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SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

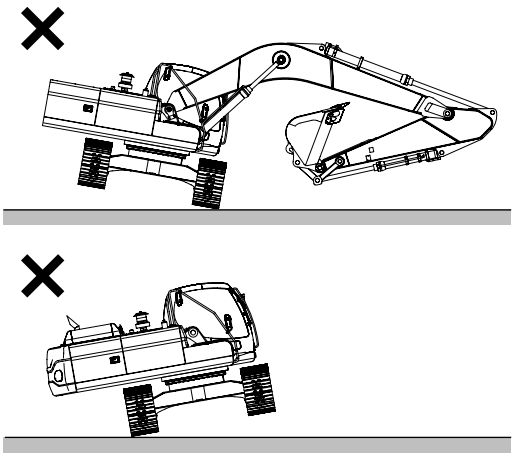
Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX340LC	5001 and Up

Warning for Counterweight and Front Attachment Removal



FG000371

Figure 1

DANGER!

DOOSAN **warns any user, that the removal of the counterweight from the machine, front attachment or any other part, may affect the stability of the machine. This could cause unexpected movement, resulting in death or serious injuries.** ***DOOSAN*** **is not liable for any misuse.**

Never remove counterweight or front attachment unless the upper structure is in-line with the lower structure.

Never rotate the upper structure once the counterweight or front attachment has been removed.

Before any attempt is made to begin removal or installation of the counterweight, the excavator must be parked on a firm and level supporting surface, with no sloping surfaces or soft or muddy ground in the area where the assist lift crane will be working. Position all accessories in the overnight storage position.

WARNING!

The weight of counterweight is given in the following table. Use only rated and approved slings and hardware when removal or installation lifts are being made. Lifting slings, shackles and all other hardware must be rigged safely. An assist crane that is rated above weight capacity is required.

Model	Weight of Counterweight
DX180LC	3,000 kg (6,614 lb)
DX225LC	4,100 kg (9,039 lb)
	5,300 kg (11,685 lb) (Optional)
DX225NLC	4,100 kg (9,039 lb)
	4,700 kg (10,361 lb) (Optional)
DX255LC	4,700 kg (10,361 lb)
DX300LC	5,300 kg (11,685 lb)
	5,900 kg (13,007 lb) (Optional)
DX340LC	6,800 kg (14,991 lb)

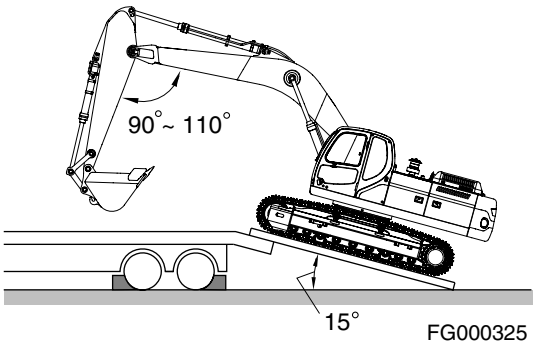
Responsibility should be assigned to one person to be in charge of the lifting crew, and to verify that required safe lifting precautions have been taken before each part of this procedure has been started.

All members of the working crew should know and understand the signals that will be used between the lifting leader, the assist crane operator and the remainder of the work crew.

⚠ WARNING!

If the turntable deck has been unbalanced by removal of weight from one end only, traveling the excavator, swinging the turntable, movement over bumps or sloping and uneven surfaces could cause loss of control and possible accidents or injuries.

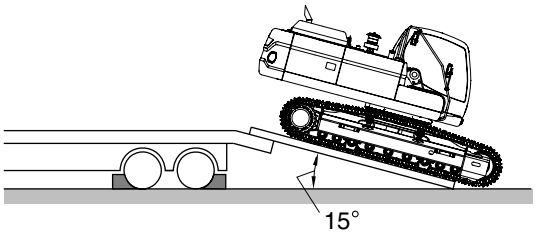
To maintain stability the counterweight should be removed whenever the front attachment is taken off the machine.



FG000325

Figure 1

When loading an excavator (either track or wheeled type) on a trailer for transport after the front attachment has been removed, always go backwards up the loading ramp. The counterweight end of the deck has to get on the trailer first, while the cabin is still going up the ramp (Figure 1).



FG000326

Figure 2

REMOVAL

1. Park on firm and level ground.
2. Lower front attachment (bucket) to the ground.
3. Shut down engine.
4. Set safety lever on "RELEASED" position.
5. Turn starter switch to "I" (ON) position.

WARNING!

If engine must be run while performing maintenance, use extreme care. Always have one person in the cabin at all times. Never leave the cabin with the engine running.

6. Fully stroke work levers (joysticks) in all directions to relieve any pressure from accumulators.
7. Set safety lever on "LOCK" position.
8. Turn key to "O" (OFF) position and remove from starter switch.
9. Hang maintenance warning tag on controls.
10. Disconnect the battery cable from the negative (-) battery terminal.
11. Remove engine compartment cover.

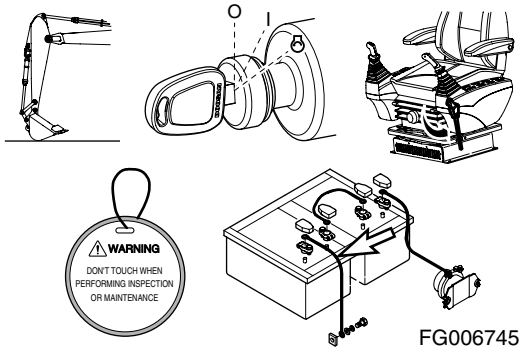


Figure 3

12. Remove two caps (1, Figure 4) from counterweight (2).
13. Install two lifting eyes in lifting holes (3, Figure 4).

Model	Lifting Eye Size
DX180LC	M48x5.0
DX225LC	
DX225NLC	
DX255LC	
DX300LC	
DX340LC	

14. Using a suitable lifting device capable of handling a heavy load, partially support counterweight (2, Figure 4) before loosening four bolts (4). Stop lifting with assist crane as soon as lifting slings are taut.
15. Remove four bolts (4, Figure 4) and washers (5) from counterweight (2).

    NOTE: *Heat bolts if necessary, to free them.*
16. When bolts (4, Figure 4) and washers (5) have been removed, lift counterweight (2) a very short distance above support frame (6) and stop. Check slings and make sure counterweight is being supported evenly.

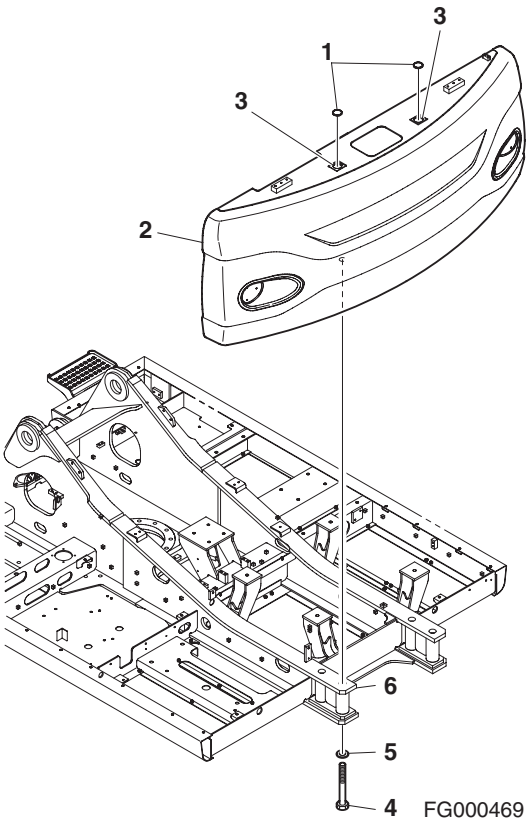


Figure 4

INSTALLATION

1. Using suitable lifting device capable of handling a heavy load, raise counterweight (2, Figure 5) into position just above support frame (6) leaving counterweight suspended. Verify that counterweight is level and even.

   NOTE: *Leave counterweight (2, Figure 5) suspended 3 mm (0.125") above support frame (6) until all four mounting bolts (4) are started in counterweight mounting holes.*

2. Slide washers (5, Figure 5) onto bolts (4). Apply Loctite #242 to mounting bolt threads.

3. Install four bolts (4, Figure 5) with washers (5) into counterweight until washers contact support frame. Fully lower counterweight onto support frame and finish tightening bolts.

   NOTE: *Torque bolts (4, Figure 5) to values shown in following table.*

Model	Bolt Torque
DX180LC	150 kg•m (1,085 ft lb)
DX225LC	
DX225NLC	
DX255LC	
DX300LC	250 kg•m (1,807 ft lb)
DX340LC	

4. Remove lifting device and lifting eyes from counterweight lifting holes (3, Figure 5).

5. Install two caps (1, Figure 5) in lifting holes (3).

6. Install engine compartment cover.

7. Connect negative (-) battery cable to battery.

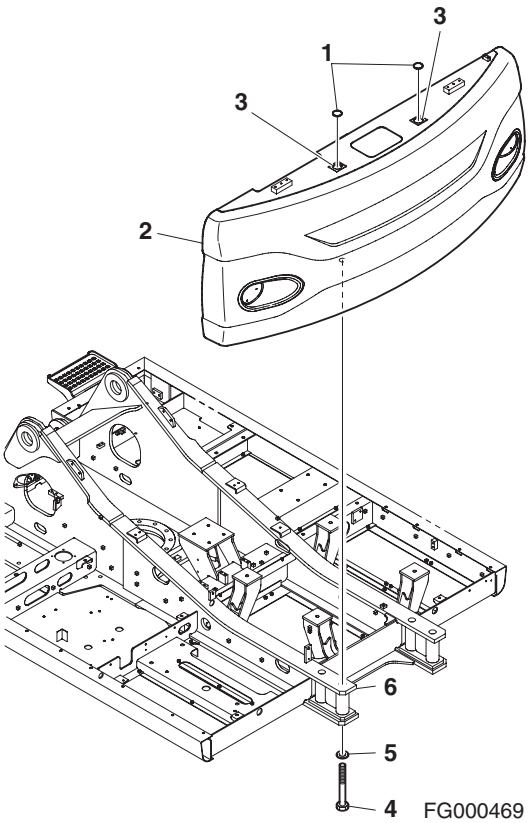


Figure 5

Fuel Tank

Edition 1

MEMO

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Fuel Tank

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MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up

GENERAL DESCRIPTION

⚠ WARNING!

Engine fuel is highly flammable and potentially explosive. To prevent possible injury and/or damage to equipment, extinguish or move to a safe distance all potential fire hazards.

Parts List

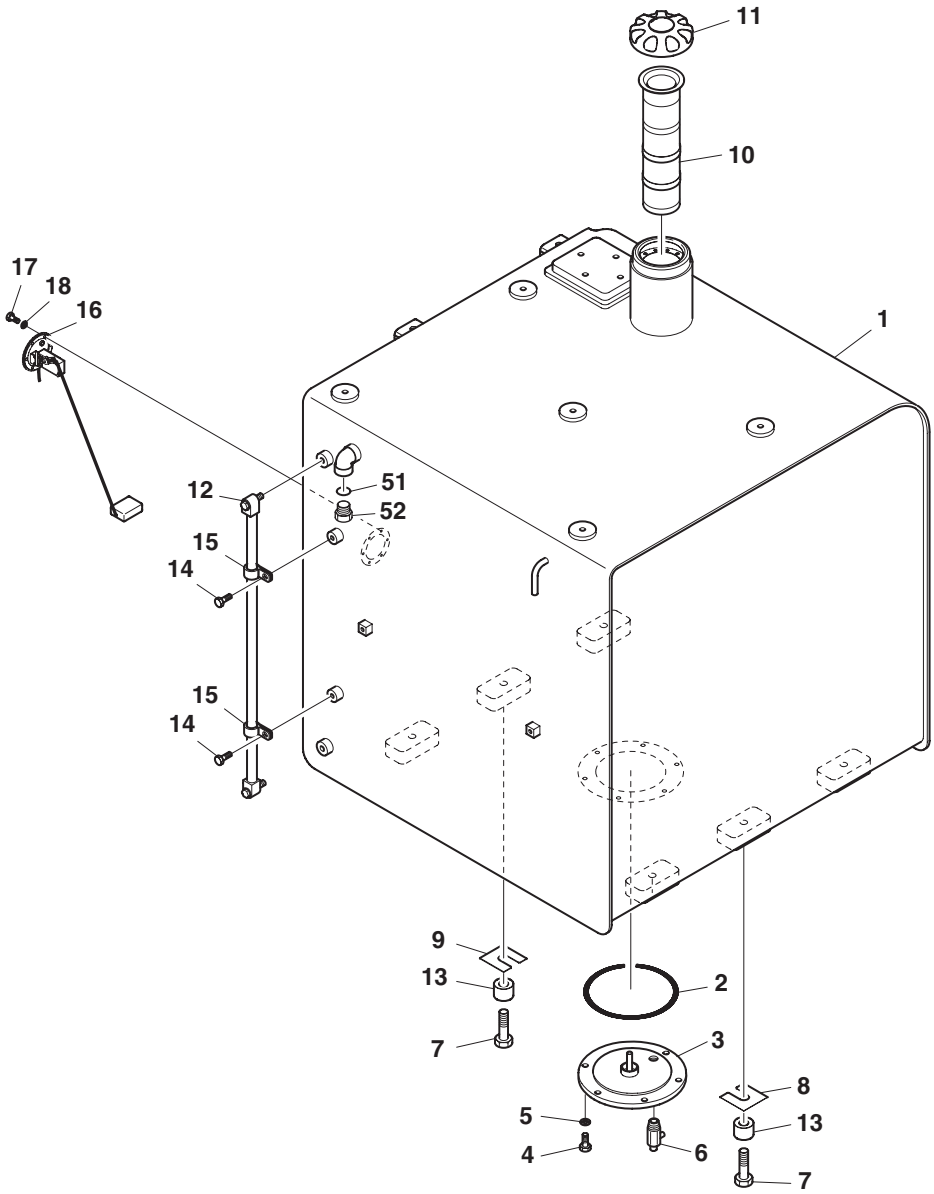


Figure 1

Reference Number	Description
1	Fuel Tank
2	O-ring
3	Cover
4	Bolt
5	Spring Washer
6	Drain Valve
7	Bolt
8	Shim
9	Shim

Reference Number	Description
10	Fuel Strainer
11	Cap
12	Level Gauge
13	Spacer
14	Bolt
15	Clip
16	Fuel Sender
17	Bolt
18	Spring Washer

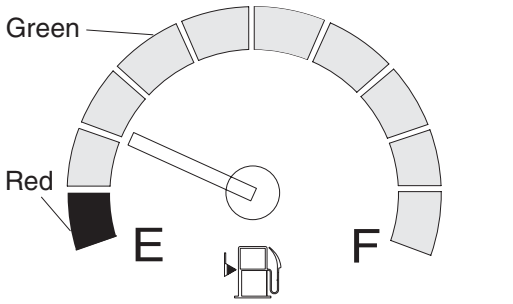
Specifications

Fuel tank capacity is 400 liters (105 U.S. gal).

REMOVAL

1. Look at fuel level display (Figure 2) on instrument panel in operator's cabin to see what it displays. The display is divided into ten separated segments, each representing 10 percent of total fuel supply. Also, look at level gauge on side of tank to estimate volume of fuel left in tank.

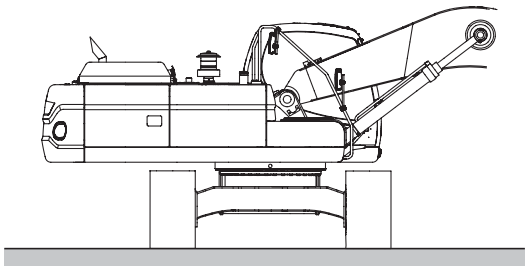
   NOTE: *If possible, work excavator until available fuel supply in tank has been run down as far as possible.*



FG000608

Figure 2

2. Park on firm and level ground and swing turntable to approximately a 90° with respect to tracks. See Figure 3.



FG000471

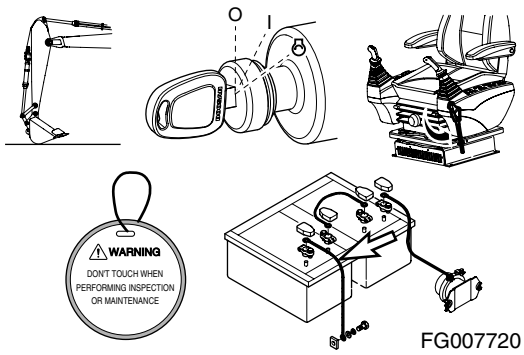
Figure 3

3. Lower front attachment (bucket) to ground.
4. Shut down engine.
5. Set safety lever on "RELEASED" position.
6. Turn starter switch to "I" (ON) position.

⚠ WARNING!

If engine must be run while performing maintenance, use extreme care. Always have one person in the cabin at all times. Never leave the cabin with the engine running.

7. Fully stroke work levers (joysticks) in all directions to relieve any pressure from accumulators.
8. Set safety lever on "LOCK" position.
9. Turn key to "O" (OFF) position and remove from starter switch.
10. Hang maintenance warning tag on controls.
11. Disconnect negative (-) battery cable leading to frame from battery.



FG007720

Figure 4

12. Clean area around fuel tank fill cap (11, Figure 5). Open fuel cap.

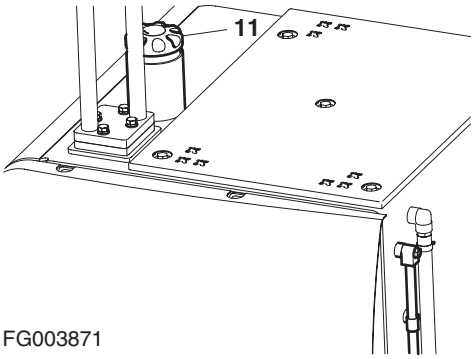


Figure 5

13. Place a large enough container under fuel tank to collect remaining fuel. Open drain valve (6, Figure 6) at bottom of tank and drain.

    NOTE: *Fuel tank capacity is 400 liters (105 U.S. gal).*

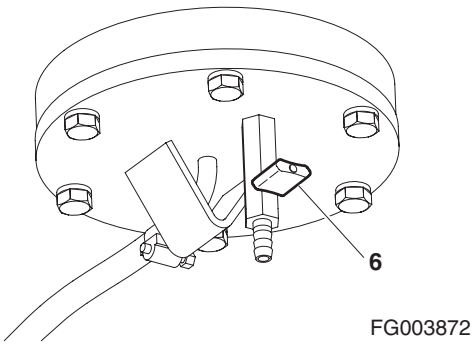


Figure 6

14. Tag and disconnect fuel supply line (21, Figure 7) and fuel return line (19) from fuel tank (1) and carefully drain remaining fuel from lines.
15. Remove clamp (20, Figure 7) holding fuel return line (19) to tank (1).

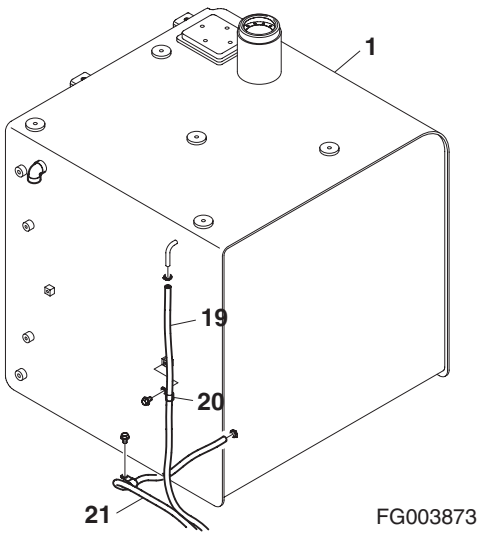


Figure 7

16. If equipped, remove components from fuel filler pump port (22, Figure 8) on side of fuel tank (1).

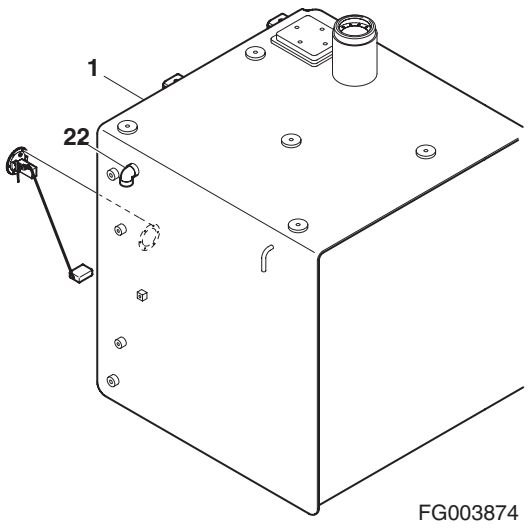


Figure 8

17. Remove five bolts (23, Figure 9) and cover (24) from fuel tank.

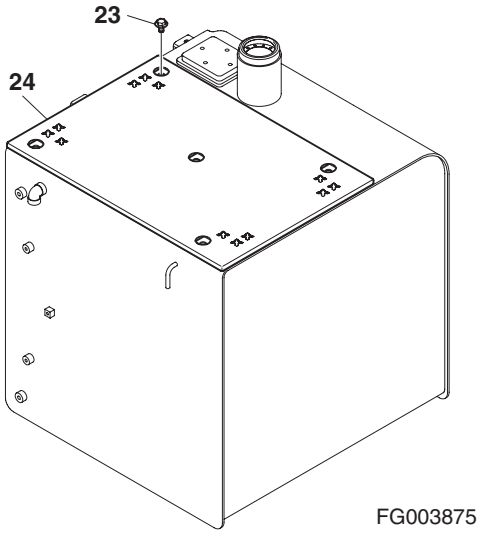


Figure 9

18. Remove eight bolts (25 and 26, Figure 10) and stay (27) from fuel tank and frame.

    Remove four bolts (28 and 29) and fuel tank cover (30) from fuel tank.

    Remove two bolts (31) and bracket (32) from tank.

    Remove four bolts (33) and battery cover (34) from frame.

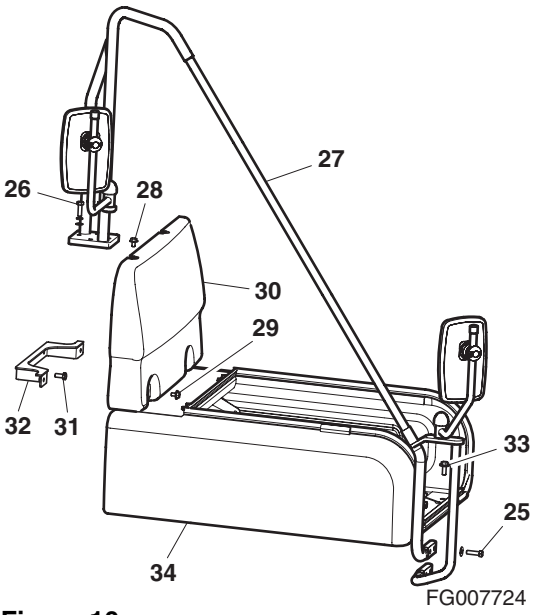


Figure 10

19. Tag and disconnect wires leading to fuel sender (16, Figure 11) on side of fuel tank (1).

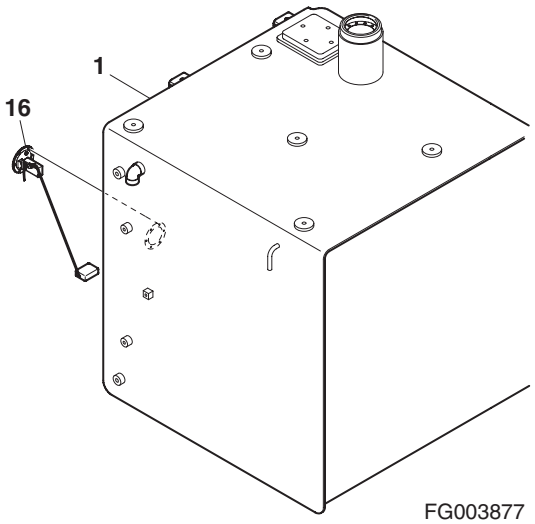


Figure 11

20. Remove four bolts (35 and 36, Figure 12) and cover (37) from fuel tank and support.

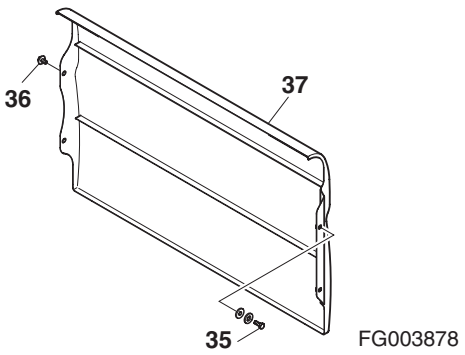


Figure 12

21. Install two 12 mm eyebolts in threaded holes (38 and 39, Figure 13). Using a suitable lifting device, sling eyebolts.

22. Remove six bolts (7) and spacers (13, Figure 13) holding tank (1) to frame. Lift tank 25 mm (1") and make sure it is balanced. Make sure there are no other electrical wires or hoses connected to tank. Remove tank after inspection.

    NOTE: *The clear level gauge on the side of the tank is easily damaged. Be careful of obstacles and wind gusts.*

23. Remove shims (9, Figure 13).

    NOTE: *If tank is to be reused note position and amount of shims used for each mounting bolt location.*

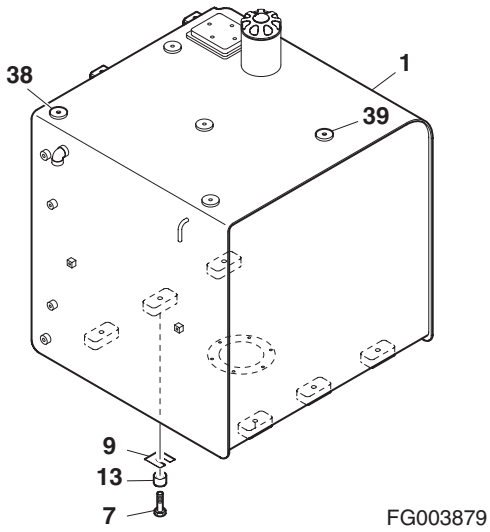


Figure 13

INSTALLATION

1. Install two 12 mm eyebolts in threaded holes (38 and 39, Figure 14). Using a suitable lifting device, sling eyebolts.
2. Set fuel tank (1, Figure 14) into position. Install six bolts (7) and spacers (13) finger tight, to secure tank to frame.

   NOTE: *The clear level gauge on the side of the tank is easily damaged. Be careful of obstacles and wind gusts.*
3. Install shims (9, Figure 14) as needed to prevent tank (1) from rocking or stress from mounting bolts (7).
4. Tighten mounting bolts (7, Figure 14) after shims are installed.

   NOTE: *Bolt torque is 27 kg•m (200 ft lb).*

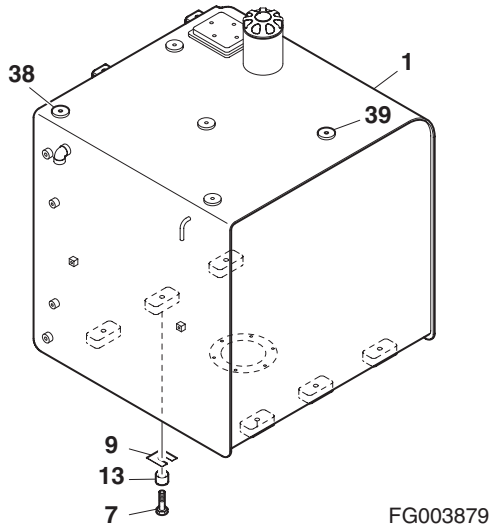


Figure 14

5. Install four bolts (35 and 36, Figure 15) and cover (37) on fuel tank and support.

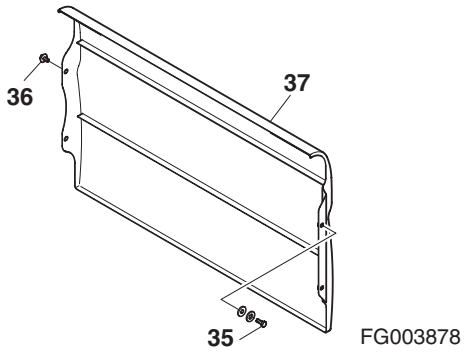


Figure 15

6. Connect wires as tagged to fuel sender (16, Figure 16) on side of fuel tank (1).

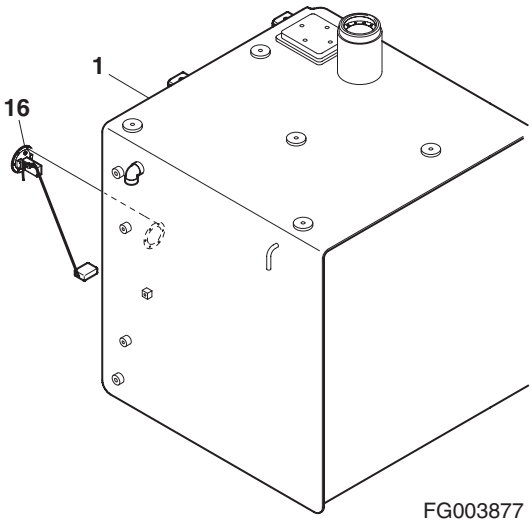


Figure 16

7. Install four bolts (33, Figure 17) and battery cover (34) on frame.

   Install two bolts (31) and bracket (32) on fuel tank.

   Install four bolts (28 and 29) and fuel tank cover (30) on fuel tank.

   Install eight bolts (25 and 26) and stay (27) on fuel tank and frame.

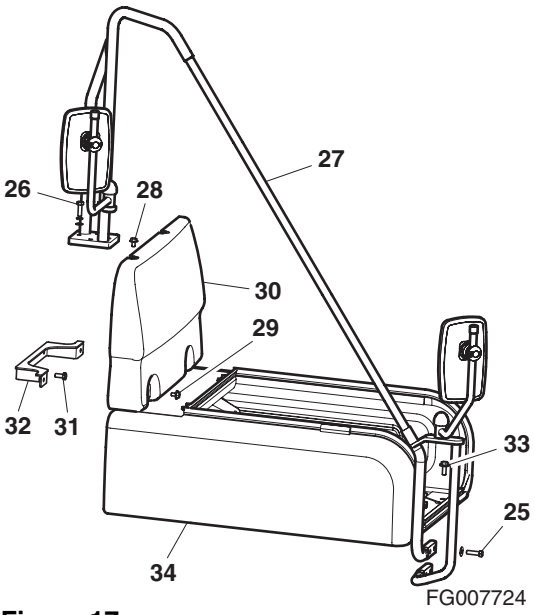


Figure 17

8. Install five bolts (23, Figure 18) and cover (24) on fuel tank.

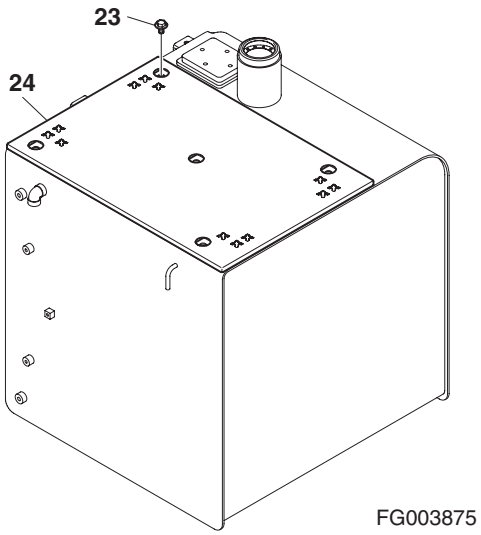


Figure 18

9. If equipped, connect components to fuel filler pump port (22, Figure 19) on side of fuel tank (1).

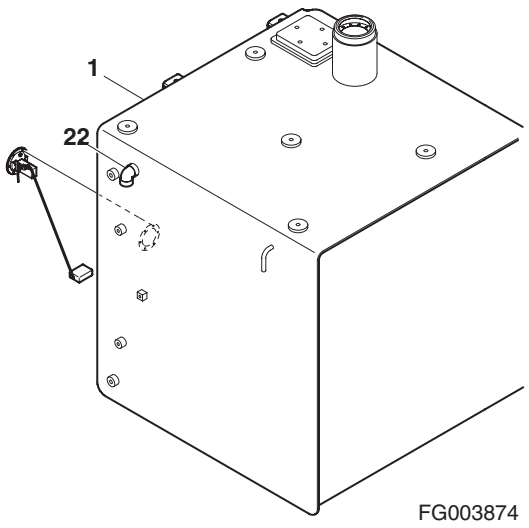


Figure 19

10. Connect as tagged, fuel supply line (21, Figure 20) and fuel return line (19) to fuel tank (1).
11. Install clamp (20, Figure 20) to hold fuel return line (19) to tank (1).

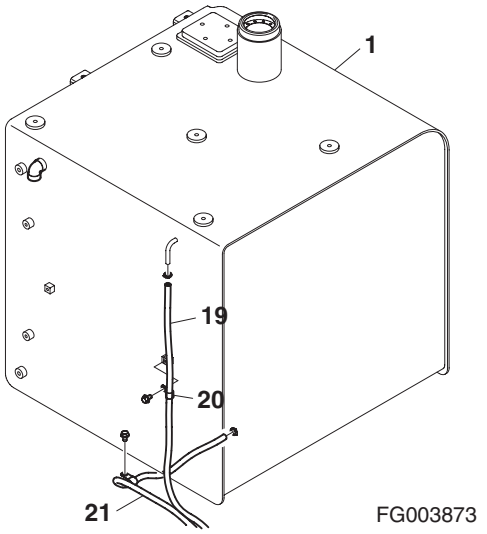


Figure 20

12. Make sure fuel tank drain valve (6, Figure 21) on bottom of tank is closed.
13. Fill fuel tank and check for signs of leaks. Correct any problems found.
14. Connect negative (-) battery cable to battery.

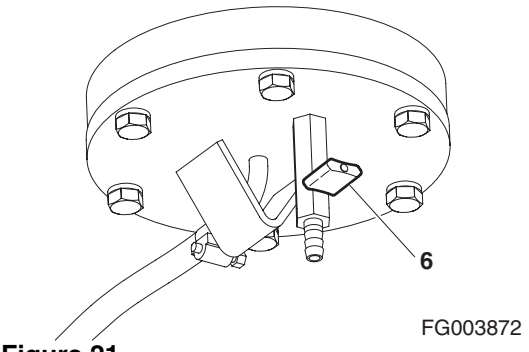


Figure 21

START-UP PROCEDURES

If engine does not start, the fuel system may need priming. Prime the fuel system using the following procedure:

1. Stop Engine.
2. Open left side door and then there is fuel filter.

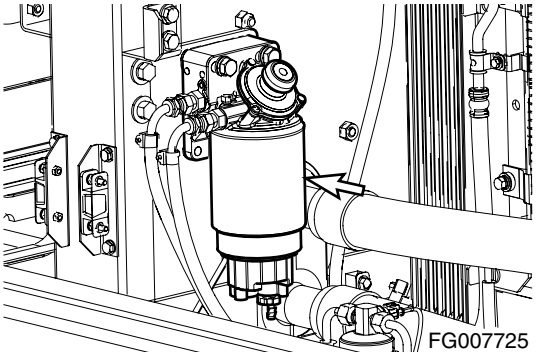


Figure 22

3. Loosen plug (1, Figure 23) on top of fuel filter head.
4. Pump hand-operated primer pump (2, Figure 23) by the fuel injection pump. Pump primer until fuel is present at plug hole in fuel filter head.
5. Tighten plug in fuel filter head.
6. Continue to pump primer pump until a strong resistance is felt.
7. Start engine and look for signs of leaks.

Repeat procedure if necessary.

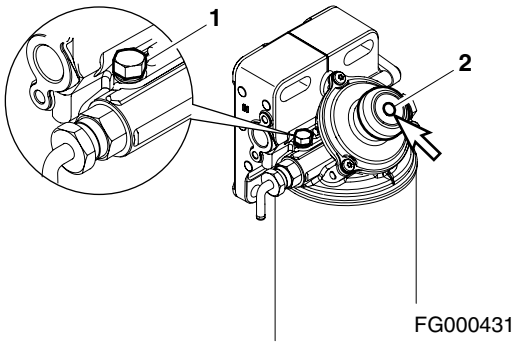


Figure 23

Fuel Transfer Pump

Edition 1

MEMO

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Fuel Transfer Pump

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Replacement of Rear Cover 8
Replacement of Armature 8

MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX300LL	5001 and Up

GENERAL DESCRIPTION

Theory of Operation

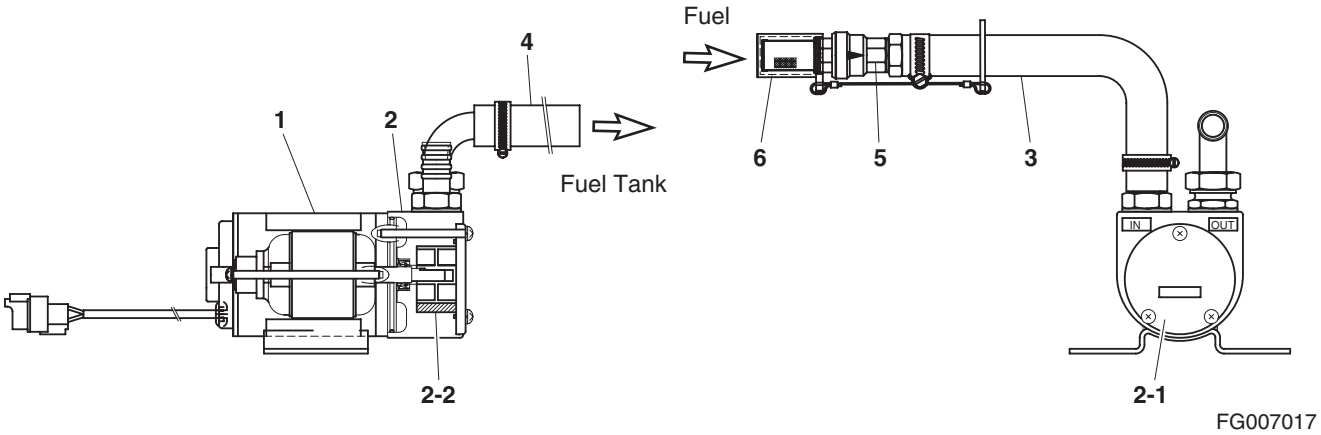


Figure 1

Reference Number	Description
1	Motor
2	Pump
2-1	Pump Cover
2-2	Rotor and Vane

Reference Number	Description
3	Inlet Hose
4	Outlet Hose
5	Check Valve
6	Strainer Cap

The fuel pump consists of a motor, pump, switch, and hose assembly.

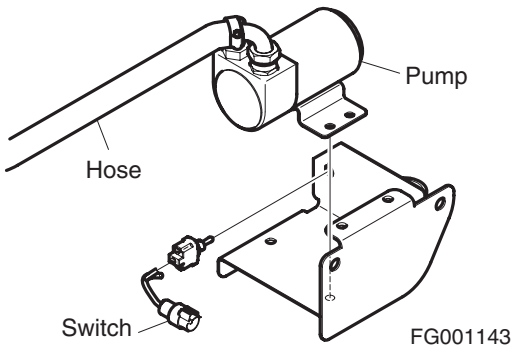


Figure 2

TROUBLESHOOTING

On some pumps the ON-OFF switch is installed separately at a remote location.

A thermal limiter, built into the motor, will automatically shut off power if motor is overheating to protect it from being damaged.

NOTE: *OPEN TEMP: 150 ±5°C (302 ±41°F). After circuit is automatically shut off because of overheating the pump will stop running. When temperature drops below 143°C (289°F) the circuit will reactivate allowing the pump to restart.*

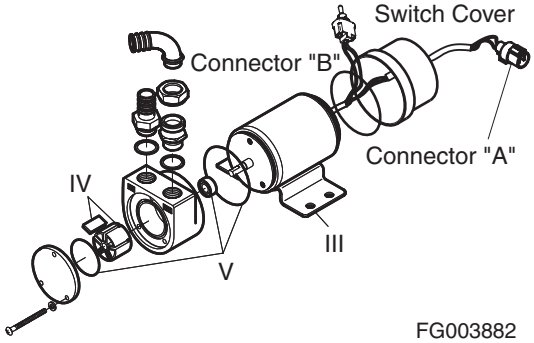


Figure 3 WITH TOGGLE SWITCH

Check resistance at connectors "A." If reading is zero, or very close to zero, the motor is bad and must be replaced.

On units equipped with a toggle switch, check the resistance through the toggle switch, while the switch is in the "ON" position. If continuity is not present, the switch is bad. Be sure to check resistance through the motor.

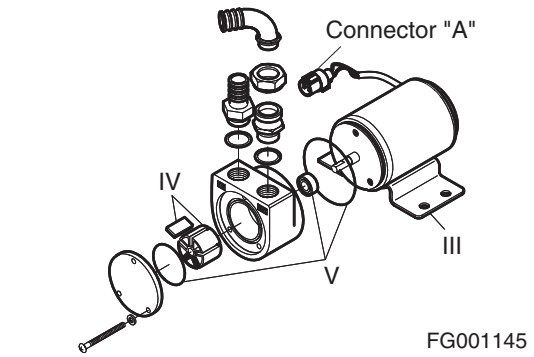


Figure 4 WITHOUT TOGGLE SWITCH

REPLACEMENT OF ROTOR AND VANE

If dirt or other foreign materials enter the pump during operation, it can become lodged between the rotor and/or vanes and generate heat which can cause the pump damage.

Remove pump cover and check the rotor and vane. If any pump parts or components become lost, damaged or inoperable, immediately replace them with new ones.

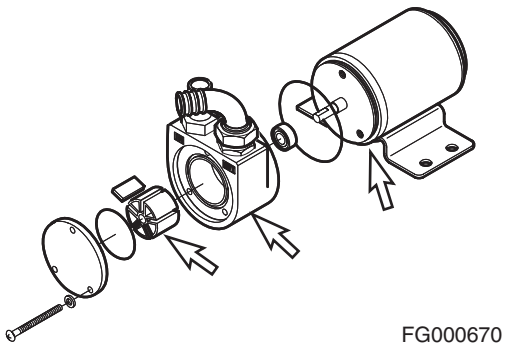
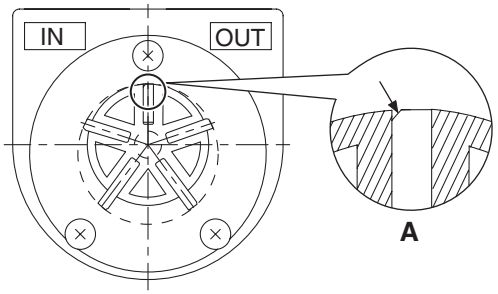


Figure 5 WITHOUT TOGGLE SWITCH

Insert vane, with the circled edge of vane facing in the counterclockwise direction. (Detail A)

Insert a new O-ring during reassembly of pump cover.



FG003883

Figure 6

REPLACEMENT OF REAR COVER

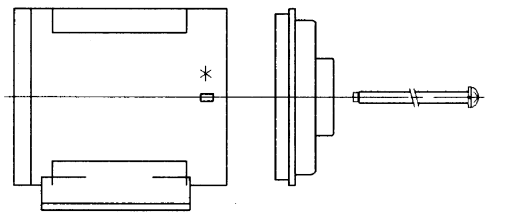
Brush assembly and a thermal limiter are installed in the rear cover. If you find any damage, replace them with new ones.

Remove switch cover and screw (M5 x L95) from the rear cover.

Remove cover.

At reassembly of rear cover, widen the space of the brush and insert it to the armature. Then fit the hole of screw in the housing.

Be careful when installing the screw. The cover screw may be attracted by the motor magnet.



HAAG0330

Figure 7

REPLACEMENT OF ARMATURE

You can replace only the armature in case motor was damaged by a short circuit.

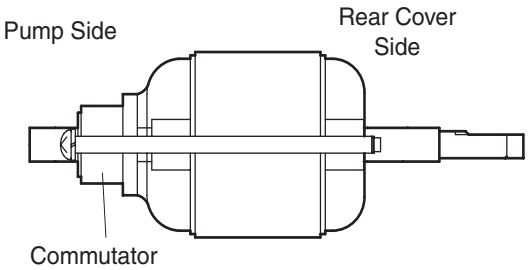
Remove switch cover and rear cover, than remove armature from the housing.

Remove pump cover and remove rotor and vane.

Insert a new armature into the housing.

Refer to “Replacement of Rear Cover” on page 1-8, for installation of the rear cover.

Fit the rotor into the shaft flute of the armature. Insert vane to the rotor being careful of the direction. Refer to “Replacement of Rotor and Vane” on page 1-7.



FG001146

Figure 8

Swing Bearing

Edition 1

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- Measuring Bearing Lateral Play 7
- Swing Bearing Basic Operation..... 8
- Rebuilding Swing Bearing 8

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX300LC	5001 and Up
DX300LL	5001 and Up
DX340LC	5001 and Up

SWING BEARING MAINTENANCE

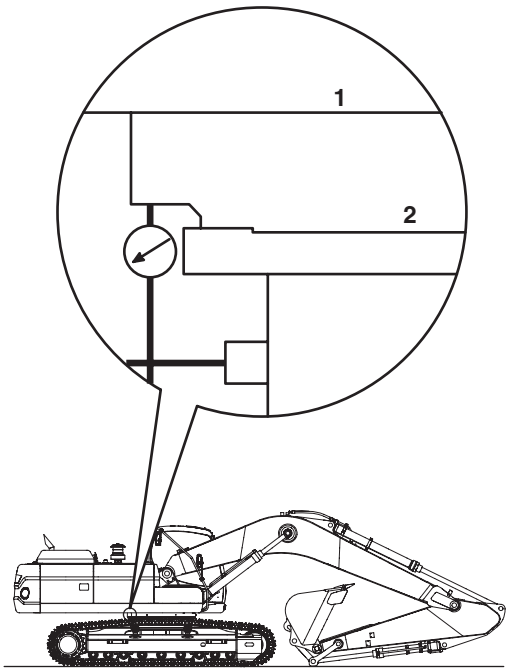
Operating Recommendation

The service life of the swing bearing may be extended if a conscientious, daily routine is created to even out usage of both ends of the excavator. If the excavator is used in the same operating configuration daily (for example, with the travel motors always under the counterweight, or with the attachment over one side of the machine more than the other), without variation, the bearing's service life could be reduced. Take a few minutes in the middle of each work shift to reposition the excavator. Working the opposite end of the bearing, will provide a payoff in terms of a more even, gradual rate of wear and extended service life.

Measuring Swing Bearing Axial Play

Periodic, regular checks of bearing displacement should be made at least twice a year. Use a dial indicator. Push the attachment against the ground to lift the excavator off the ground and take measurements at 4 points, 90° apart, around the circumference of the bearing (Figure 1).

Record and keep all measurements. Play in the bearing should increase minimally from one inspection to the next. Eventually, however, as the bearing begins to approach the limit of its service life, clearance increases becoming much more pronounced, with actual measured play in the bearing exceeding twice the value of measurements recorded when the machine was new.



FG000533

Figure 1

Measuring Bearing Lateral Play

When vertical checks are made, the side to side play in the bearing can be checked by fully retracting the arm and bucket cylinders and extending the tip of the bucket as far forward as it will go. With the excavator parked on a flat, level surface and the bucket tip just off the ground, push against the bucket sideways to take up all the lateral clearance in the bearing. (Less than 100 lb of force should be required to move the bucket over all the way.) Check lateral play in both directions and record the values. When the bearing is beginning to approach the end of its service life, measured lateral clearance should start to show larger and larger increases.

Swing Bearing Basic Operation

The swing bearing, which connects the upper structure with the lower structure, consists of an inner ring, outer ring and ball bearings. During swing movement, power from the swing motor is transferred to the pinion by planetary gears connected to gears on the inner ring, which is fixed in the undercarriage. Ball bearings turn the outer ring.

Reference Number	Description
1	Outer Ring
2	Inner Ring
3	Tapered Pin
4	Plug
5	Ball
6	Retainer
7	Seal A

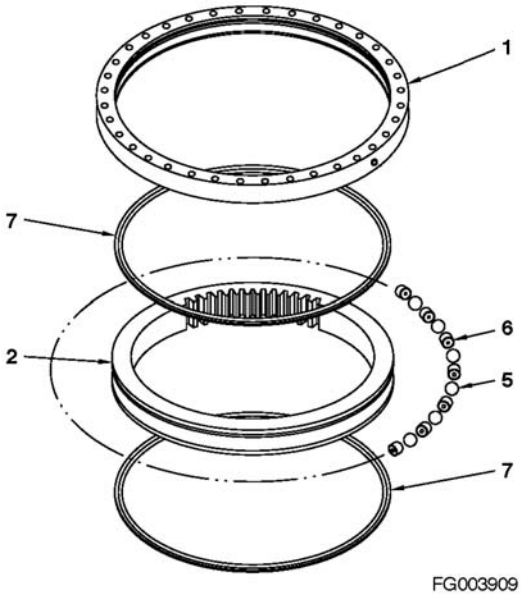


Figure 2

Rebuilding Swing Bearing

1. Remove tip of tapered pin (3, Figure 3) using grinder and tap lightly to remove debris.

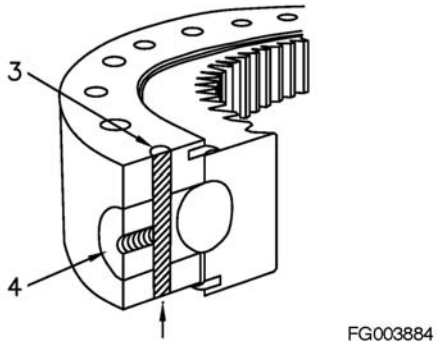


Figure 3

2. Remove plug (4, Figure 4) using a M10 x 1.25 bolt.

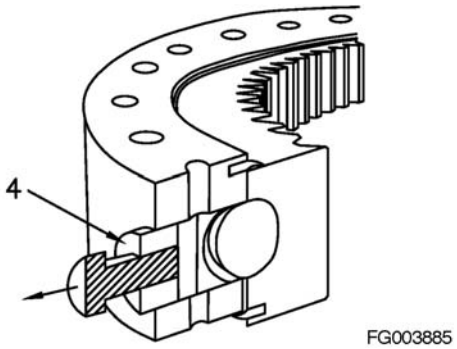
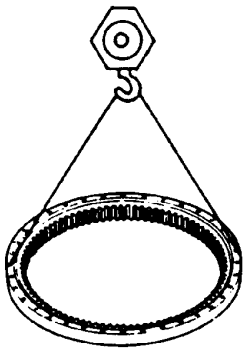


Figure 4

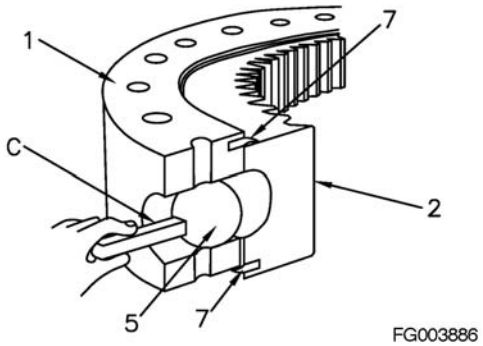
3. Lift outer ring and check that inner ring can move freely. See Figure 5, if not, replace seal (7, Figure 6).



1588A

Figure 5

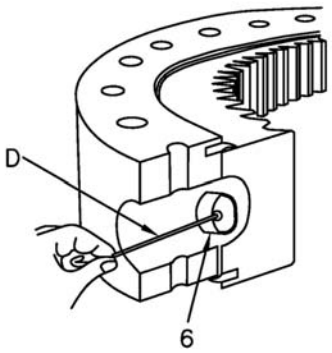
4. Turn inner ring and use magnet bar (C, Figure 6) to remove steel balls (5).



FG003886

Figure 6

5. Turn inner ring and use wire (D, Figure 7) to remove retainers (6).



FG003908

Figure 7

Swing Reduction Gear

Edition 1

MEMO

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SAFETY PRECAUTIONS

CAUTION!

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Use lifting and hoisting equipment capable of safely handling the load.

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APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up

GENERAL DESCRIPTION

Theory of Operation

The swing motor final drive is a two-stage planetary gearbox with two planet gears, two sun gears and two-stage output reduction. The planetary gear engages the ring gear. The pinion gear is connected to the output shaft and spline.

The final drive reduces swing motor rpm to increase swing motor output torque. The available maximum swing speed provides a fast turning rate for efficient, rapid work cycling with more than adequate power for good acceleration.

Parts List

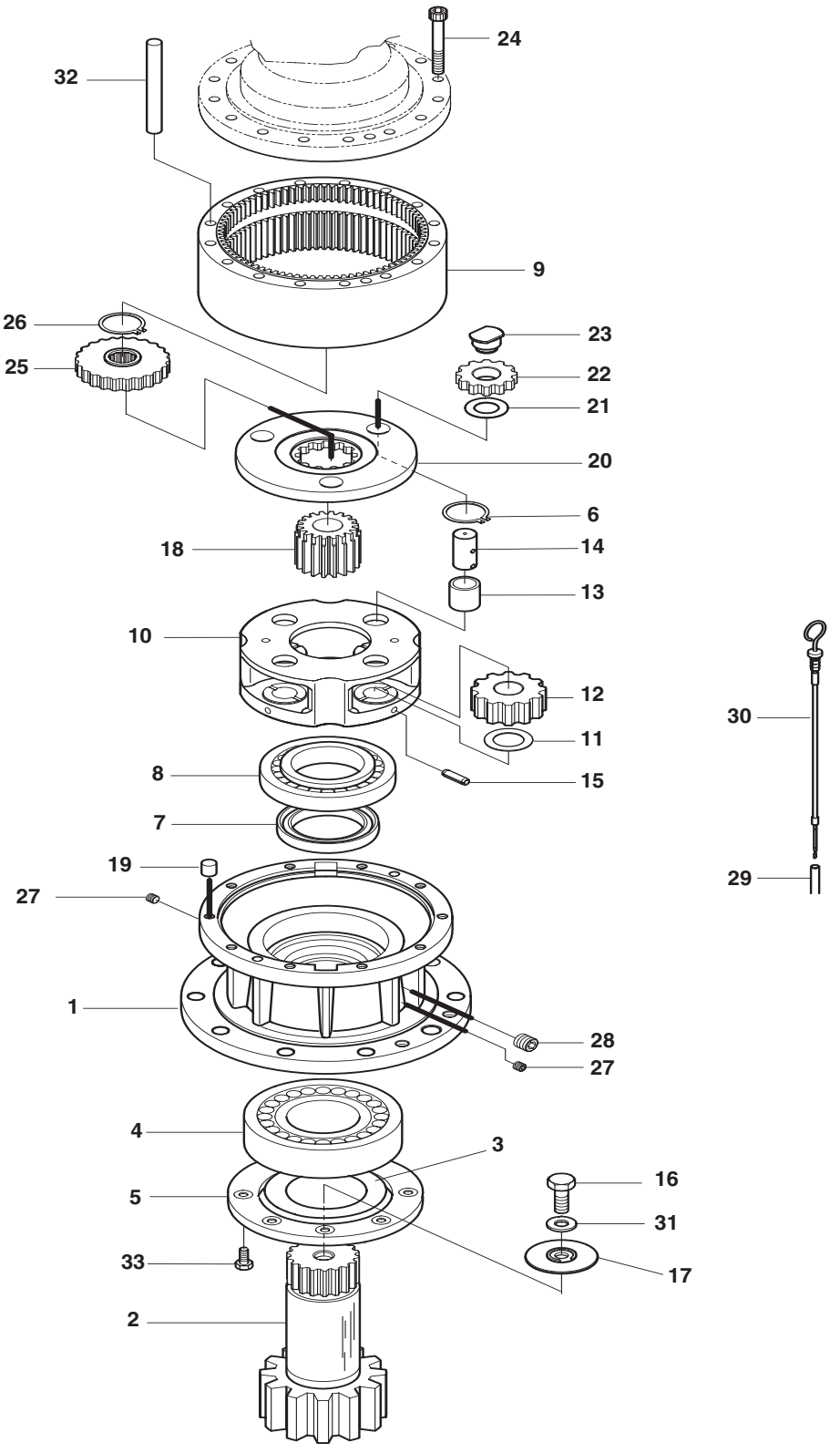


Figure 1

Reference Number	Description
1	Casing
2	Driveshaft
3	Plate
4	Spherical Roller Bearing
5	Cover Plate
6	Retaining Ring
7	Oil Seal
8	Spherical Roller Bearing
9	Ring Gear
10	No. 2 Carrier
11	No. 2 Thrust Washer
12	No. 2 Planet Gear
13	No. 2 Bushing
14	No. 2 Pin
15	Spring Pin
16	Hex Head Bolt
17	No. 3 Thrust Washer

Reference Number	Description
18	No. 2 Sun Gear
19	Lock Pin
20	No. 1 Carrier
21	No. 1 Thrust Washer
22	No. 1 Planet Gear
23	No. 1 Pin Assembly
24	Socket Head Bolt
25	No. 1 Sun Gear
26	Retaining Ring
27	Plug
28	Plug
29	Level Gauge Pipe
30	Level Gauge
31	Double Tap Washer
32	Pipe
33	Hex Head Bolt

Specifications

Swing Reduction Gearbox	Specification
Drive Type	Two-stage Planetary Gear
Reduction Ratio	19.636
Maximum Output Speed	83.6 rpm
Maximum Output Torque	1,120 kg•m (8,100 lb ft)
Weight	120 kg (265 lb)

Pinion Gear	Specification
Type	Spur Gear
Gear P.C.D	156 mm (6.14 in)
No. of Teeth	13
Module	12

Symptoms	Possible Causes	Remedies
1. No rotation and –		
a. Pressure at swing motor inlet *increases*	Swing brake not releasing	Check brake engagement and disengagement, check release pressure
	Internal damage to gearbox drive train	Replace broken gears, drive train assemblies
	Overload	Reduce load weight
b. Pressure at swing motor inlet shows *no increase,* **and** the swing motor is making irregular noises	Swing motor drive shaft damage	Replace swing motor
	Internal damage to gearbox drive train	Repair/replace broken or faulty assemblies
c. Pressure at swing motor inlet shows *no increase,* but **without** irregular *noises* from the swing motor	Hydraulic pump or valve broken	Troubleshoot hydraulic system
2. Oil leakage		
a. From drive shaft	Oil seal damaged	Replace oil seal
b. From bolted connections or other assembled surfaces	Assembly compound (joint sealer) old and not sealing, bolt not tight or flange warped	Disassemble and check mating surfaces. Reapply Loctite, torque bolts to specifications
3. Excess heat		
Gearbox casing becomes excessively hot, with or without irregular noise(s) during operation	Low oil level	Replace oil, refill to specified level
	Bearings or gear worn but not completely inoperative	Repair or replace gearbox

HAOE960L

REMOVAL

1. Park on firm and level ground.
2. Lower front attachment (bucket) to ground.
3. Shut down engine.
4. Set safety lever on "RELEASED" position.
5. Turn starter switch to "I" (ON) position.

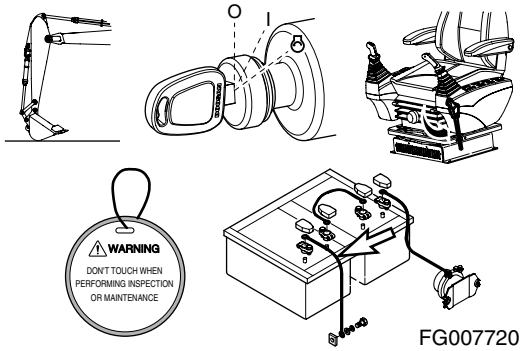


Figure 2

⚠ WARNING!

If engine must be running while performing maintenance, always use extreme caution. Always have one person in cabin at all times. Never leave cabin with engine running.

6. Fully stroke work levers (joysticks) in all directions to relieve any pressure from accumulators.
7. Set safety lever on "LOCK" position.
8. Turn key to "O" (OFF) position and remove from starter switch.
9. Hang a maintenance warning tag on controls.
10. Disconnect negative (-) battery cable leading to frame from battery.
11. Tag and disconnect hoses from swing motor (1, Figure 3). Plug and cap hoses and ports to prevent contamination from entering hydraulic system or component.
12. Assemble drain hose (3, Figure 3) to drain valve (8) and drain oil from reduction gearbox (5, Figure 3).
13. Remove drain hose (3, Figure 3) from drain valve (8) and disconnect hose (2, Figure 3) from reduction gearbox (5).
14. Disconnect grease lubrication line (7, Figure 3) from reduction gearbox (5).
15. Remove eleven bolts and washers (4, Figure 3) holding swing reduction gearbox (5) to frame.
16. Using a suitable lifting device, sling swing motor (1, Figure 3) and remove swing motor and reduction gearbox (5) as an assembly from unit.

NOTE: *There is an alignment pin (6*, Figure 3*), on reduction gearbox flange.*

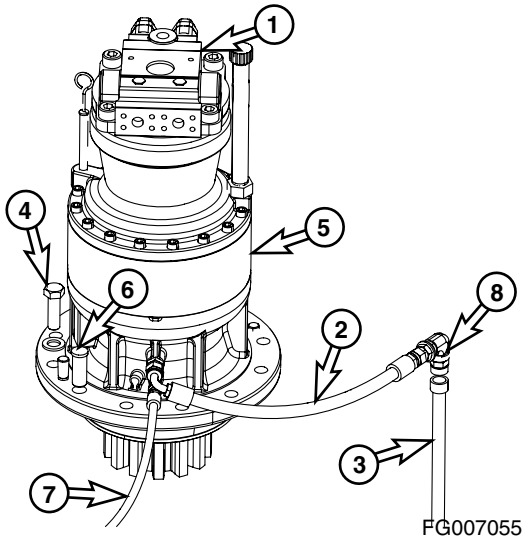


Figure 3

DISASSEMBLY

IMPORTANT

Select a clean place.

Spread a rubber mat or cloth on top of the overhaul workbench to prevent parts from being damaged.

1. Remove bolts and motor from swing reduction case.



Figure 4

CAUTION!

The motor should be separated without damage or any foreign substance.

CAUTION!

Care should be taken not to damage mounting surface of motor. Carefully remove all gasket material from mounting surfaces.

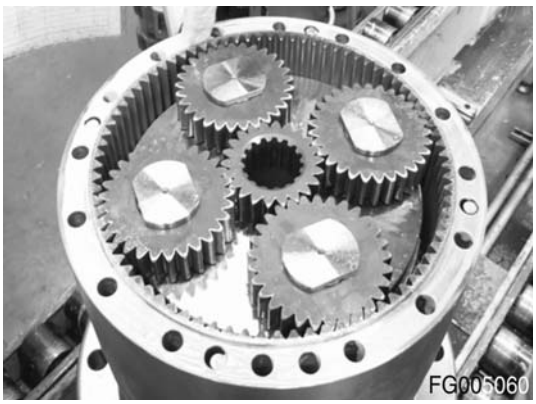


Figure 5

2. Remove No. 1 sun gear from No. 1 carrier.

CAUTION!

Care should be taken not to damage teeth of No. 1 sun gear.

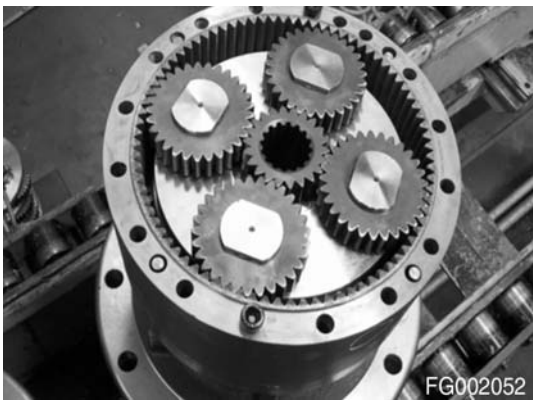


Figure 6

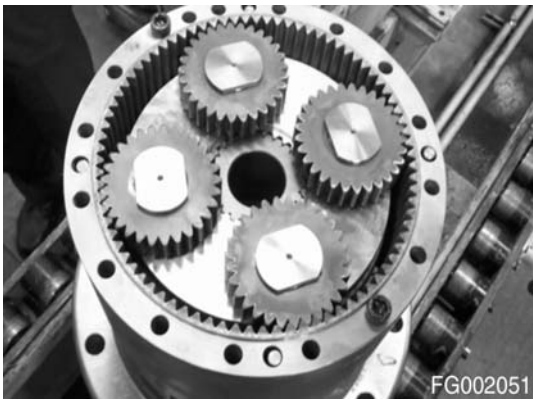


Figure 7

3. Remove No. 1 carrier.

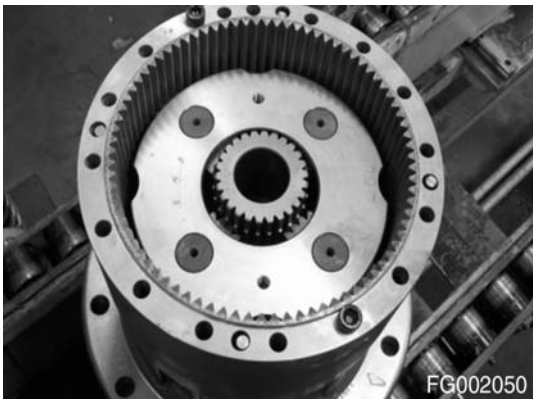


Figure 8

4. Remove washer and No. 2 sun gear.

CAUTION!

Care should be taken not to damage teeth of No. 2 sun gear.



Figure 9

5. Remove bolt in No. 2 carrier.

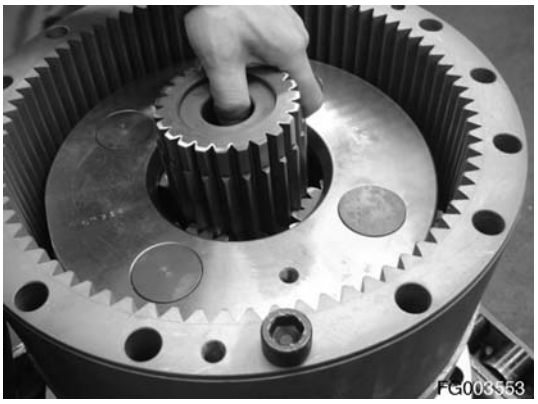


Figure 10

6. Install eyebolts in No. 2 carrier and remove it from ring gear.

CAUTION!

Care should be taken not to damage teeth of No. 2 carrier and ring gear.



Figure 11



Figure 12

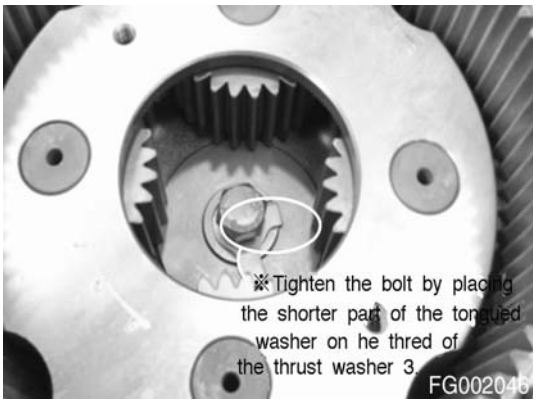


Figure 13

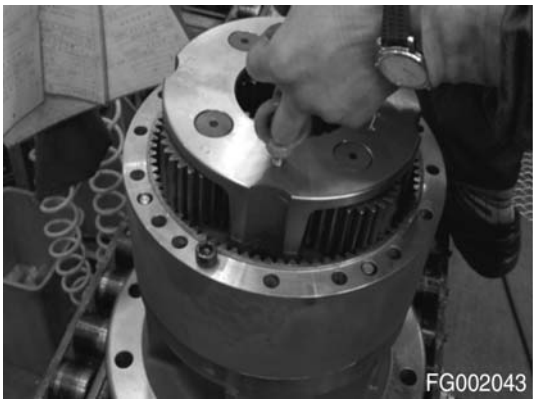


Figure 14

7. Install eyebolts in ring gear and remove it.

CAUTION!

Care should be taken not to damage mounting surfaces of ring gear and case. Carefully remove all gasket material from mounting surfaces.

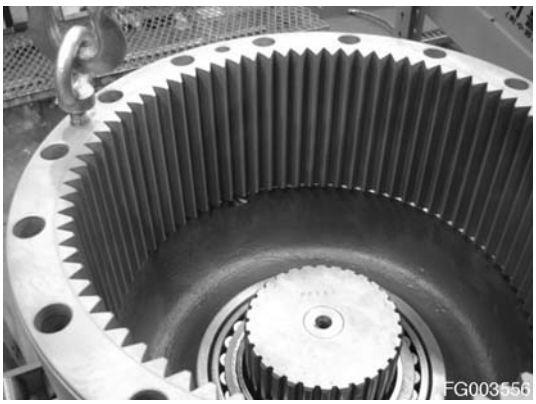


Figure 15

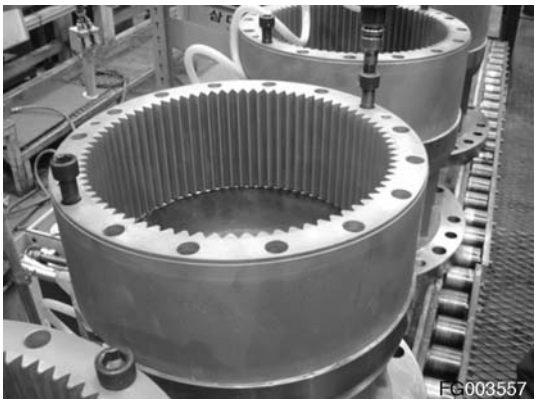


Figure 16

8. Use a rollover machine to turn assembly over.
9. Remove cover plate.

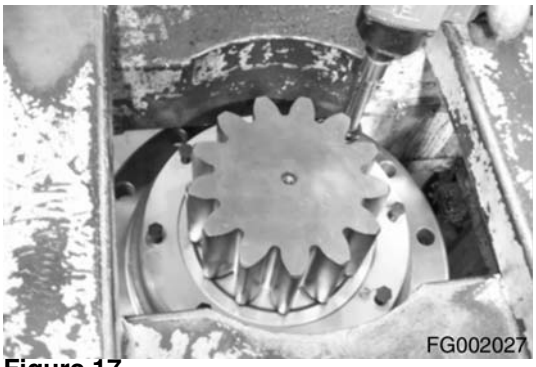


Figure 17

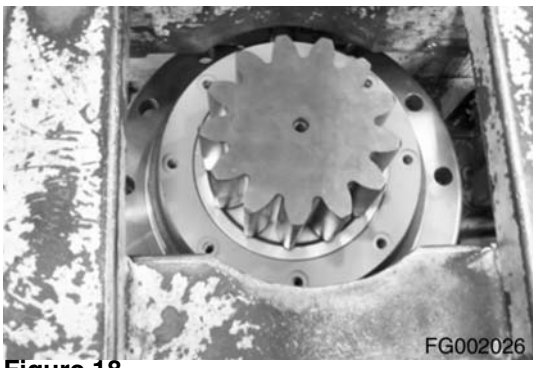


Figure 18

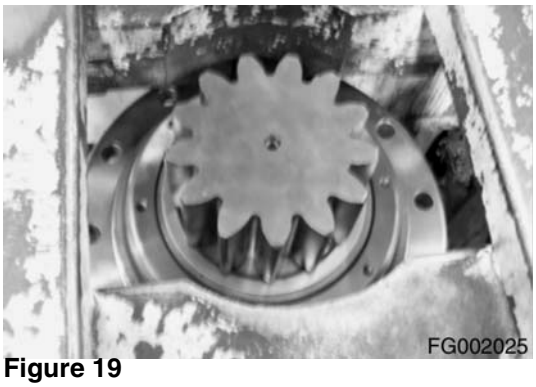


Figure 19

10. Use a rollover machine to turn case over and place a jig on driveshaft. Use a press to remove driveshaft from case.

CAUTION!

Care should be taken not to have driveshaft drop to floor when it is pressed out of case.



Figure 20



Figure 21

11. Remove bearing from case.



Figure 22

12. Put driveshaft in press, and remove bearing and spacer.



Figure 23



Figure 24

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

For general cleaning and inspection procedures, refer to "General Maintenance Procedures" section.

REASSEMBLY

Shaft and S/R Bearing Heat-fit

1. To cleaning shaft, remove any remnants of anticorrosion liquid applied on shaft and remove all of foreign substances using an air gun.
2. Insert spacer on cleaned shaft as shown in figure below and heat bearing on a special heater.



Figure 25



Figure 26

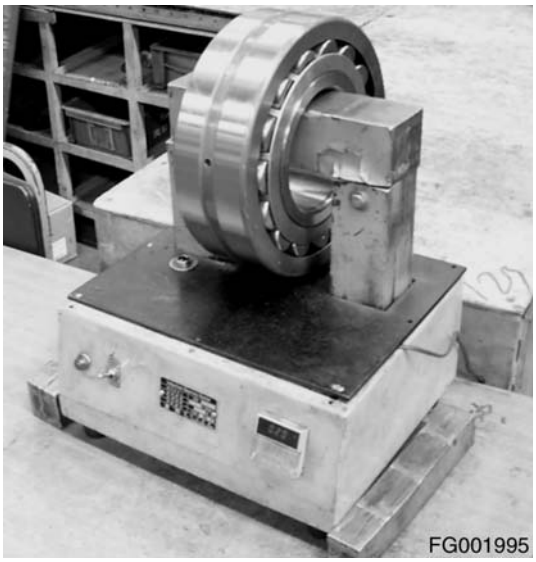


Figure 27

3. Stop heating when bearing temperature is between 90° - 100°C (194° - 212°F) and insert it on shaft, holding it with both hands to keep it level. Insert it slowly first by 4 - 5 mm (0.16 - 0.29 in) for bearing to seat itself and then push it hard that it contacts to spacer assembled in shaft completely.
4. After bearing assembly is completed, leave it air cool for 1 - 2 hours.



Figure 28

Assembly of Carrier Subassemblies

Cleaning Carrier

Put carrier, to whose corners grinding was made to remove all foreign substances like burr, on steam washer if there remain any foreign substance and put it on assembly die.

Cleaning Planet Gear

Check if planet gears are washed cleanly and got imprinted and put it on assembly die.

Assembly of No. 1 Carrier

1. Put No. 1 carrier on assembly jig as shown in Figure 29.

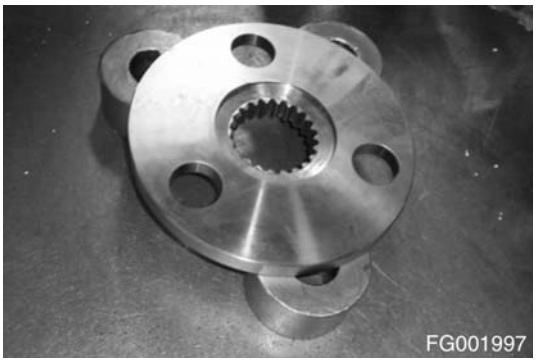


Figure 29

2. Assemble the pin assembly 1 and the washer into planet gear 1 and arrange it on the pinhole of the carrier 1.

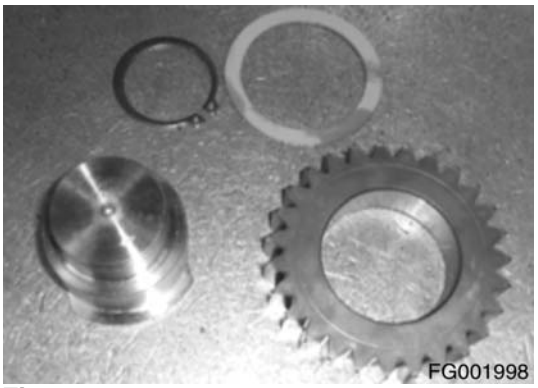


Figure 30

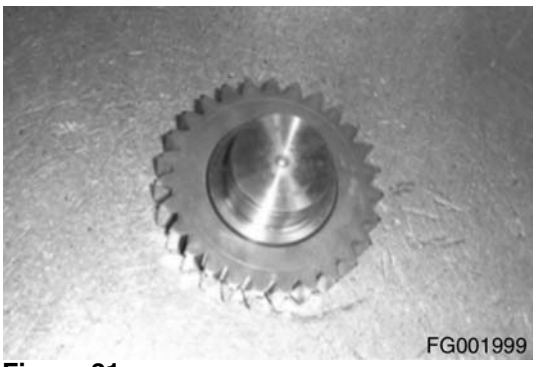


Figure 31



Figure 32

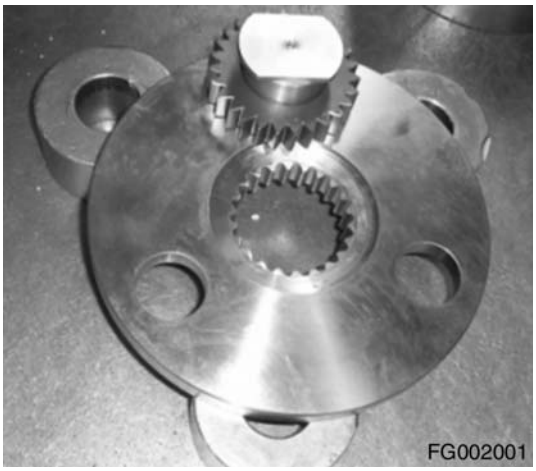


Figure 33

3. Put the jig, while keeping the pin assembly 1 perpendicular, and push it with a press.
4. After its pressure insert, check the state of the pressure insert visually.



Figure 34

5. Insert the 2 remaining parts with pressure in the same way.

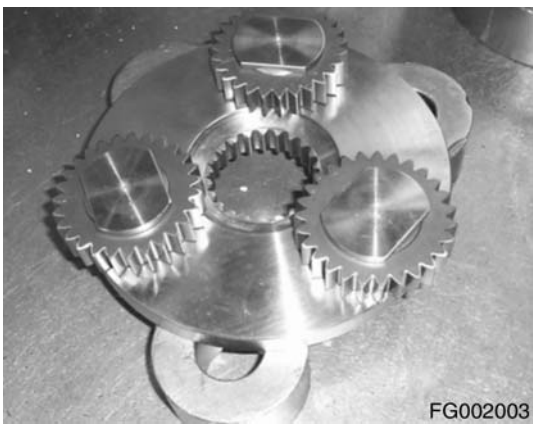


Figure 35

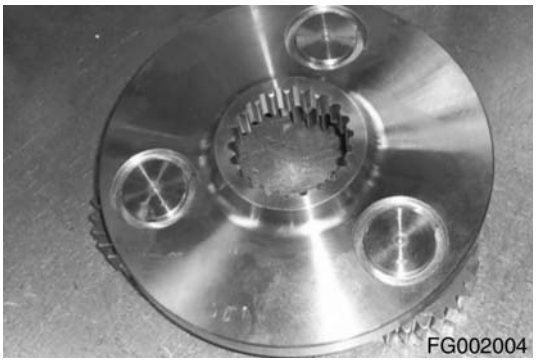


Figure 36

6. Engage the retaining ring (for ϕ 38 axis) to each thread of the pin 1 and check if gear turns smooth by turning it.

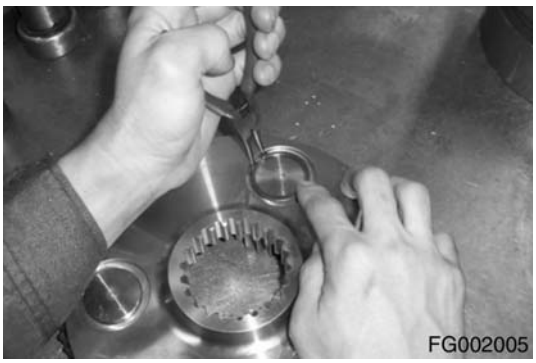


Figure 37

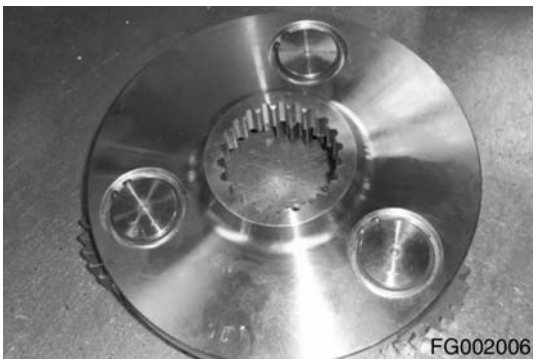


Figure 38

Assembly of No. 2 Carrier

1. Put No. 2 carrier on assembly jig as shown in Figure 39.

   NOTE: *Lifting eyehole should be facing up.*

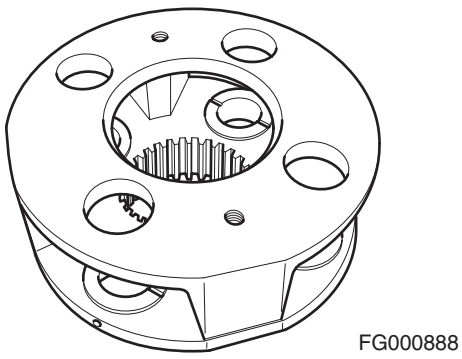
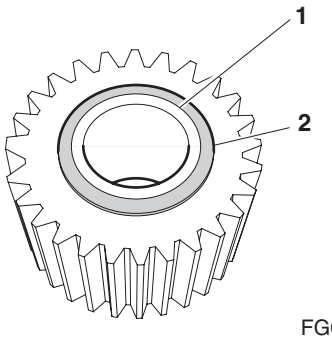


Figure 39

2. Insert No. 2 bushing into No. 2 planetary gear, and position a No. 2 thrust washer on it.

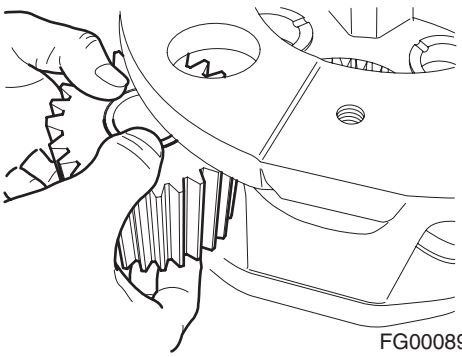


FG000889

Figure 40

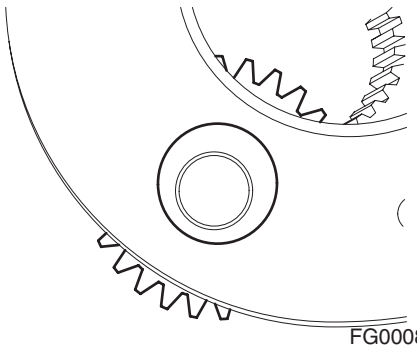
3. Turn over gear assembly and insert it into No. 2 carrier. Align bushing hole with carrier holes.

   NOTE: *Thrust washer must be on bottom side of gear.*



FG000890

Figure 41

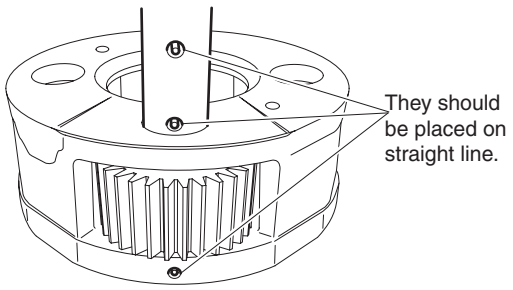


FG000891

Figure 42

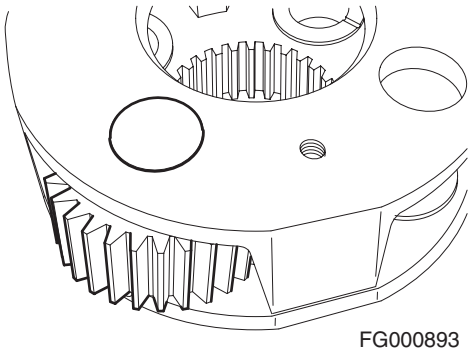
4. Align spring pinhole in No. 2 shaft with spring pinhole of No. 2 carrier. Insert shaft into carrier and No. 2 bushing.

   NOTE: *Shaft may need to be gently tapped with a soft faced hammer.*



FG001354

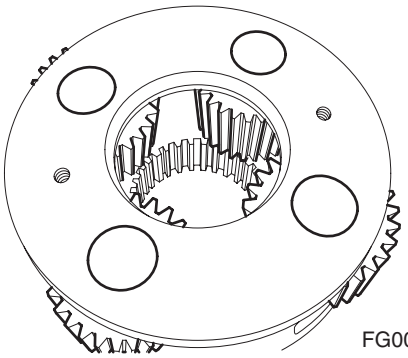
Figure 43



FG000893

Figure 44

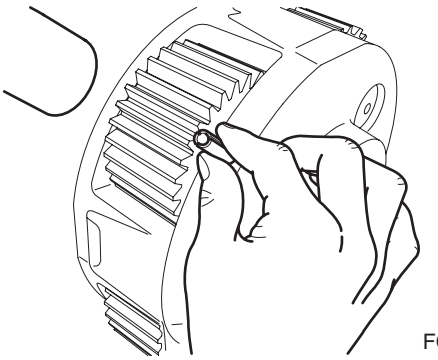
5. Install three remaining No. 2 gears in same manner.



FG000894

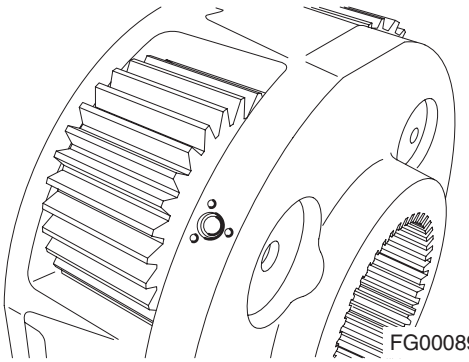
Figure 45

6. After all four shafts are installed, align spring pin (ϕ 10x25L) with carrier hole and drive it into position using a hammer. Using a hammer and punch, calking spring pin into position.



FG000895

Figure 46



FG000898

Figure 47

7. Repeat procedure for other three spring pins. Make sure that gears properly rotate.

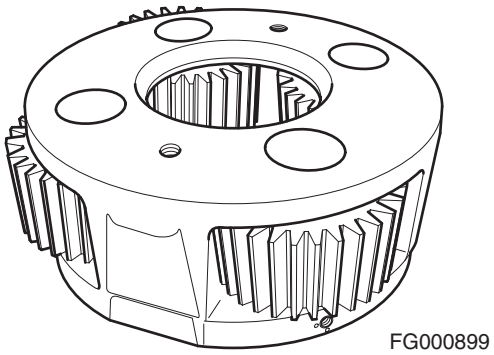


Figure 48

Assembly of Main Case

Cleaning Casing and Other Parts

Steam clean case and other parts, to remove any foreign substances.

- Cleaning fluid: PK6540 (alkali)
- Liquid density: 3 - 5%
- Liquid temperature: 60° - 70°C (140° - 158°F)

Assembly of Shaft and Pinion

1. Insertion of shaft subassembly:
   A. Set gear case as shown in Figure 49.
   B. Using a suitable lifting device, lower shaft subassembly into case.
   C. Using special jig, keep bearing level and press it into case.



Figure 49



Figure 50

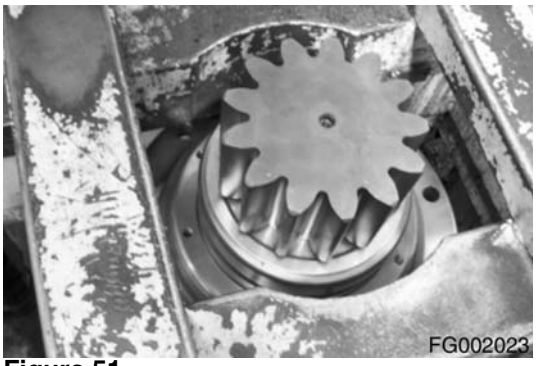


Figure 51

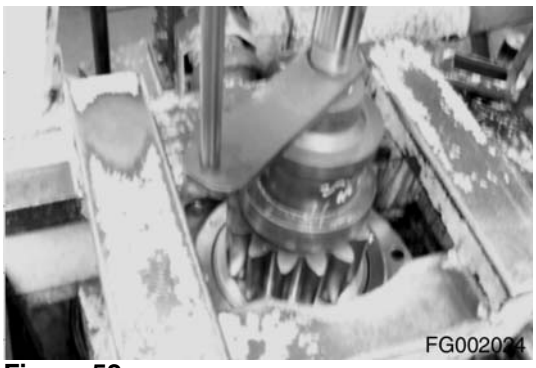


Figure 52

2. Remove bearing press fitting jig, place the cover plate as shown in the figure, and tighten 8 Loctite (#262) applied bolts (M10x25L) (with torque of 700 kg•cm).

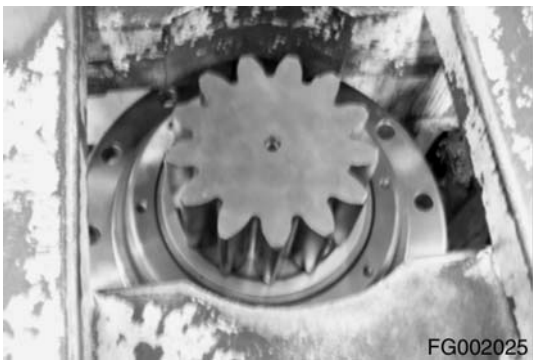


Figure 53

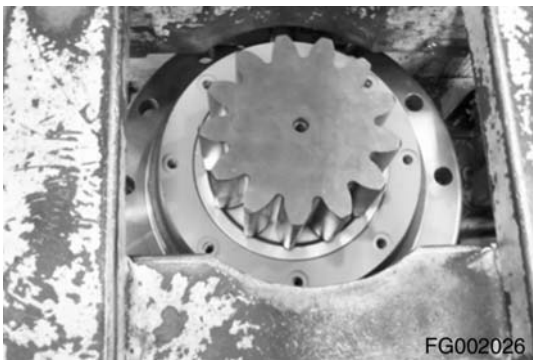


Figure 54

Assembly of Seal and Bearing

1. Position case so pinion gear is pointing down.

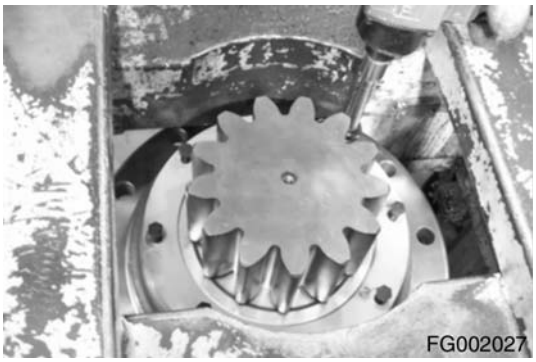


Figure 55

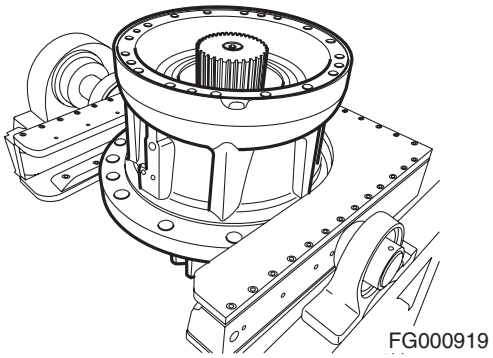


Figure 56

2. Make sure there is no foreign substance left on seal assembly, apply grease to and around lip of oil seal (TC5001300) as in Figure 57 and Loctite #609 to its external part.
3. Using seal installation jig, press seal into case, keeping it level during installation. Make sure that seal is fully seated.

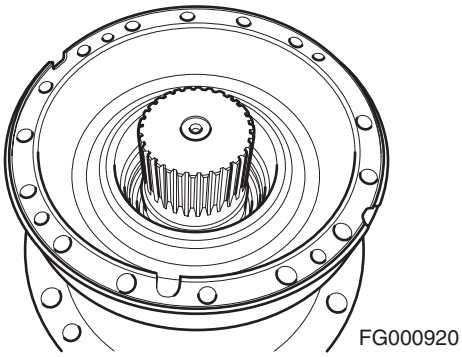


Figure 57

⚠ CAUTION!

Make sure there is no foreign substances on lip area. Use care not to damage seal when inserting it. Check for proper installation after pressing seal into position.

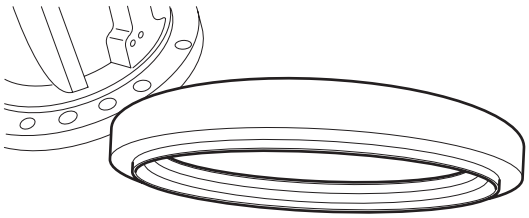


Figure 58

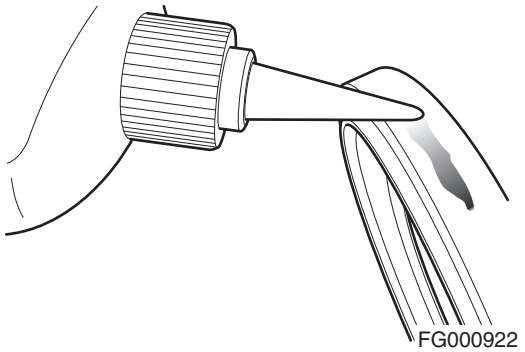


Figure 59

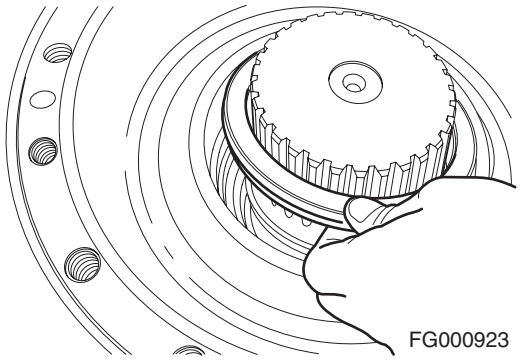


Figure 60

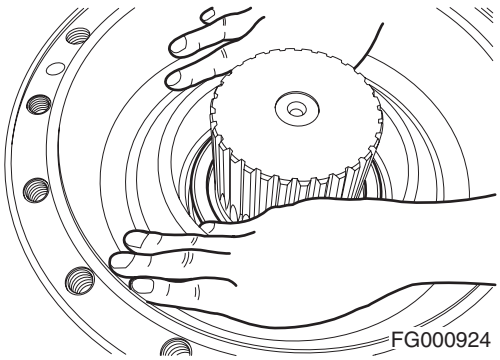


Figure 61

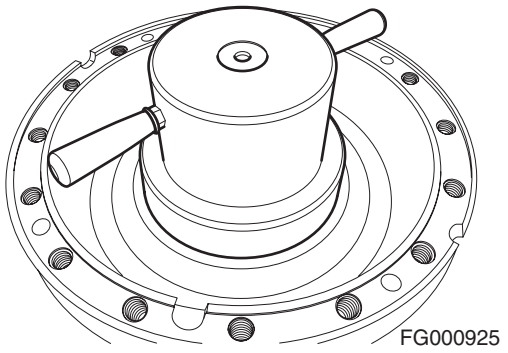


Figure 62

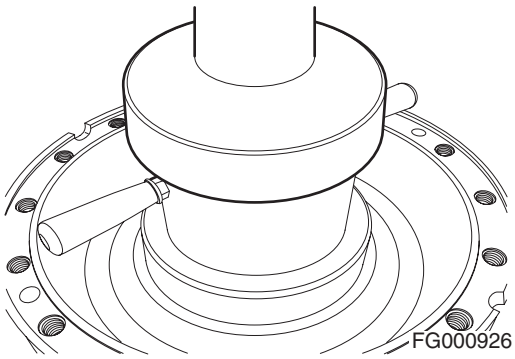


Figure 63

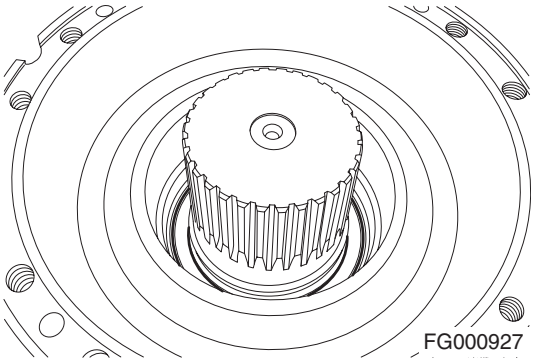


Figure 64

4. Using seal installation jig, position bearing on end of shaft, with bearing trademark on inner race facing up. Press bearing firmly into place, making sure it is properly seated.

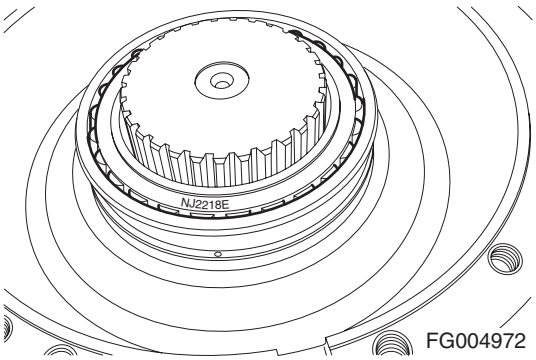


Figure 65

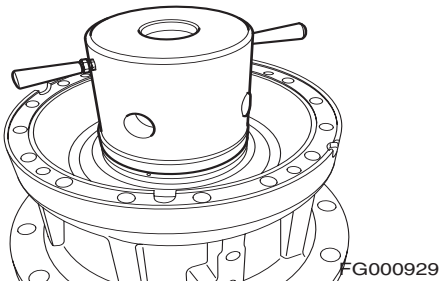


Figure 66

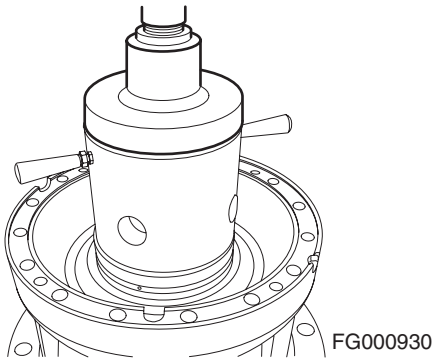


Figure 67

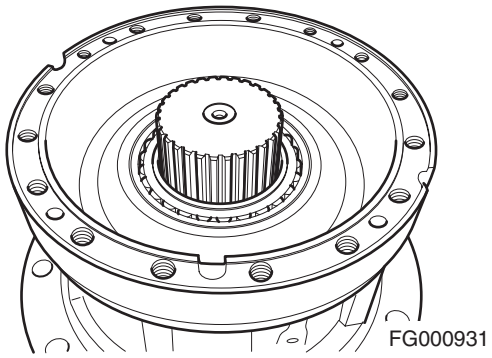


Figure 68

5. Rotate pinion by hand and check if it turns properly.

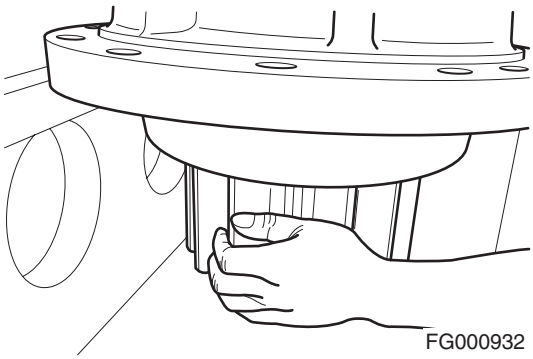


Figure 69

6. Install plugs into PT1/2 and PT1/4 drain ports.

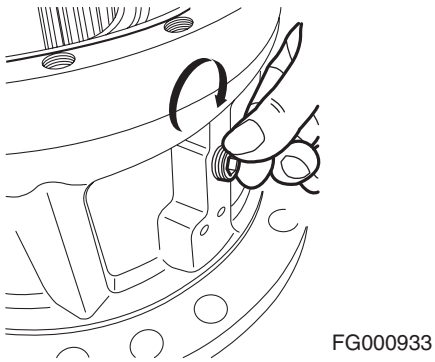


Figure 70

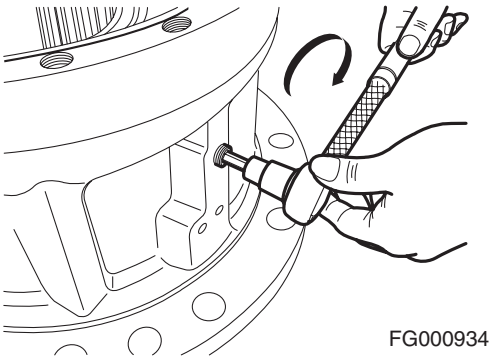


Figure 71

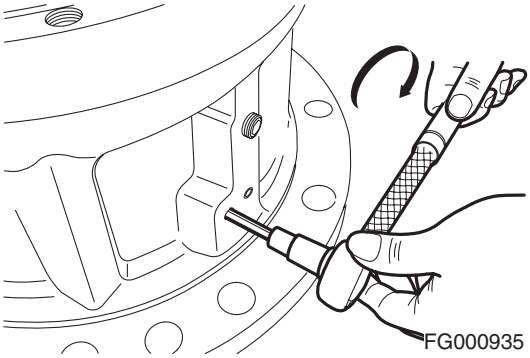


Figure 72

Assembly of Ring Gear

1. Insertion of lock pin.

   Insert four lock pins in four reamed holes of case flange. Tap them into place, by gently hitting them with a soft-face hammer.

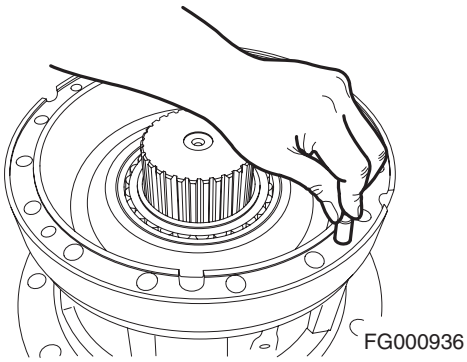


Figure 73

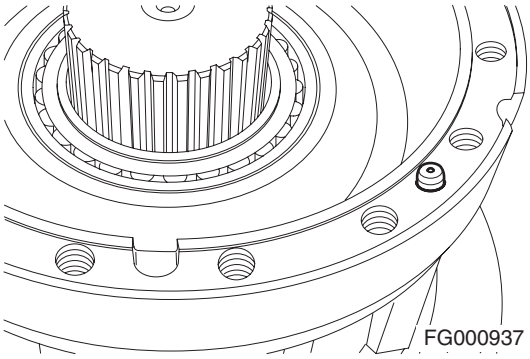


Figure 74

2. Apply liquid gasket (Three Bond #1104) evenly to ring gear assembly of casing.

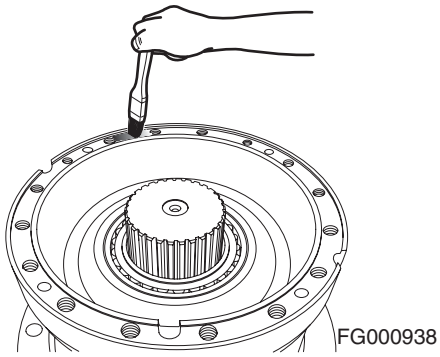


Figure 75

3. Lift ring gear with hoist, wipe its mating surface clean with cloth, match and align holes after checking its assembling direction, and press assembled parts firmly by tightening special bolts (M12x150) on which no Loctite has been applied.

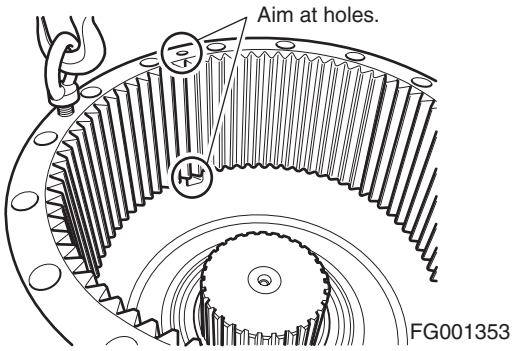


Figure 76

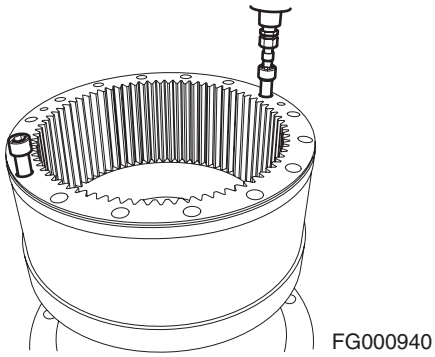


Figure 77

Assembly of Carrier.

1. Using a suitable lifting device, lower No. 2 carrier assembly into ring gear, making sure that planetary gears are engaged. Continue to lower carrier and engaging it onto splines of pinion shaft. Make sure that carrier is resting on bearing.

   NOTE: *Make sure that carrier and driveshaft can rotate.*

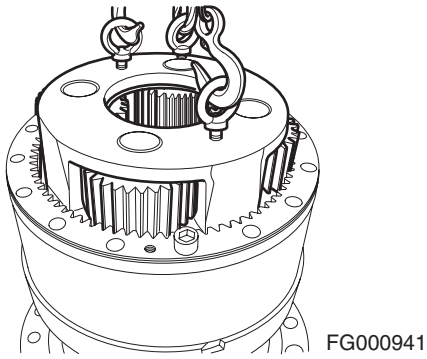


Figure 78

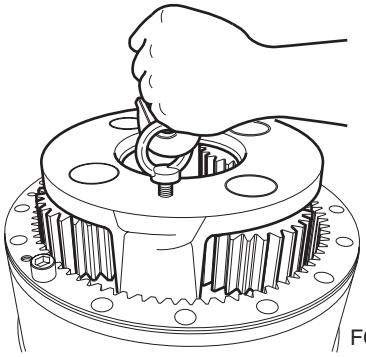


Figure 79

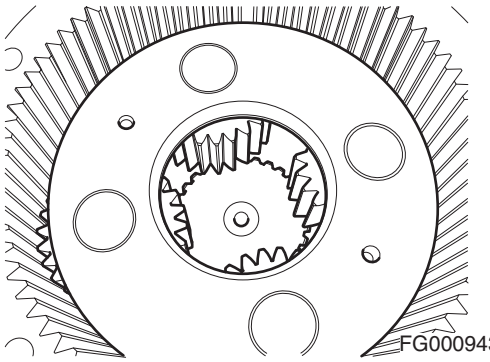


Figure 80

2. Place a tongued washer on the thrust washer 3 of the carrier assembly 2 and engage a hexagon bolt (M16x25L, torque: 3,000 kg•cm) applied Loctite (#262) with it.

⚠ CAUTION!

The shorter part of the tongued washer should be placed on the thread of the thrust washer 3 and then bolt tightened. To prevent the washer from moving, use a proper device like one shown in the figure below to press a part of the washer and tighten the bolt.



Figure 81

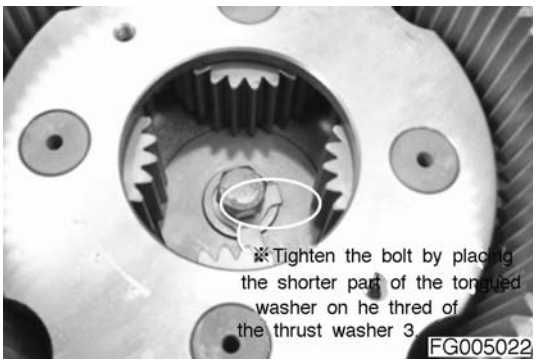


Figure 82

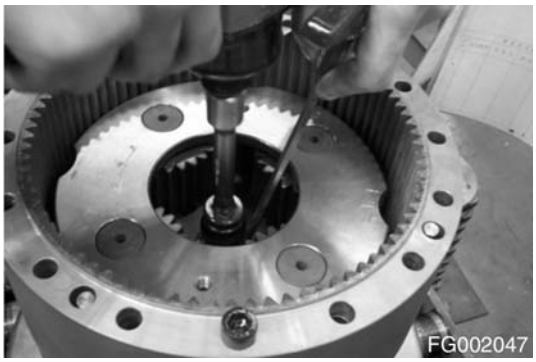


Figure 83

3. After tightening the bolt, fix the carrier assembly 2 and use a torque wrench to tighten it up to the standard torque. After checking the torque, bend the longer part of the tongued washer until it sticks to the head of the hexagon bolt.



Figure 84



Figure 85

4. Install No. 2 sun gear in No. 2 carrier.

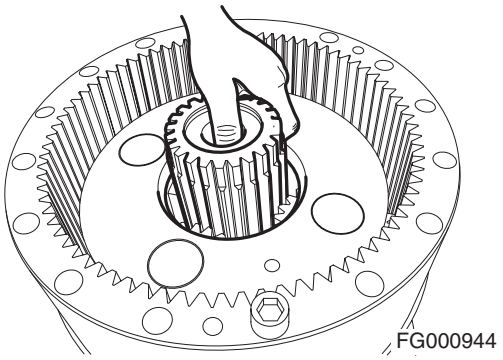


Figure 86

5. Lift the carrier assembly 1, and turn it clockwise or counterclockwise gently for it to engage with the spline of the sun gear 2 and the ring gear.



Figure 87

6. Assemble the sun gear 1.

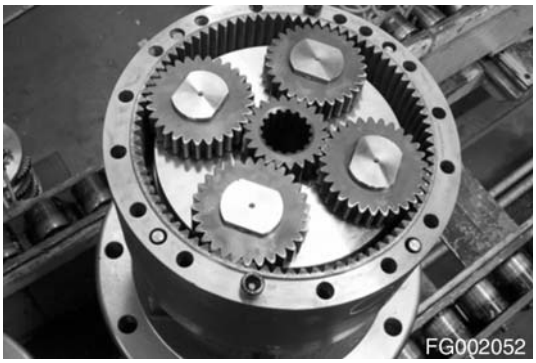


Figure 88

Assembly of the Motor

Assembly of the motor

1. Remove compression bolts of the ring gear, wipe out the motor assembly with clean cloth, and apply liquid (#1104) gasket evenly.

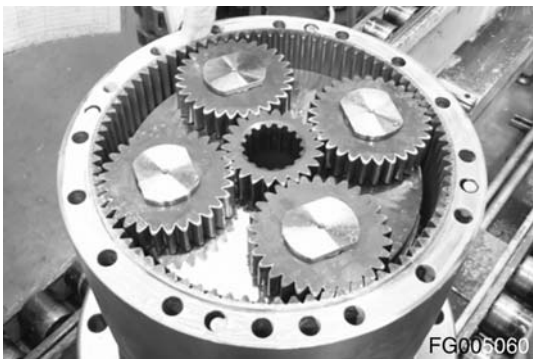


Figure 89

2. Use a hoist to lift the prepared motor, wipe out the assembly, and engage the retaining ring on the shaft.



Figure 90

3. Put the motor on the reduction gear carefully with the adjustment of its direction as shown in the figure below (care should be taken not to have its flange touch the surface of the ring gear to which liquid gasket was applied). Assembly the motor by turning it clockwise or counterclockwise gently that the spline of the shaft shall be engaged with the sun gear 1.



Figure 91

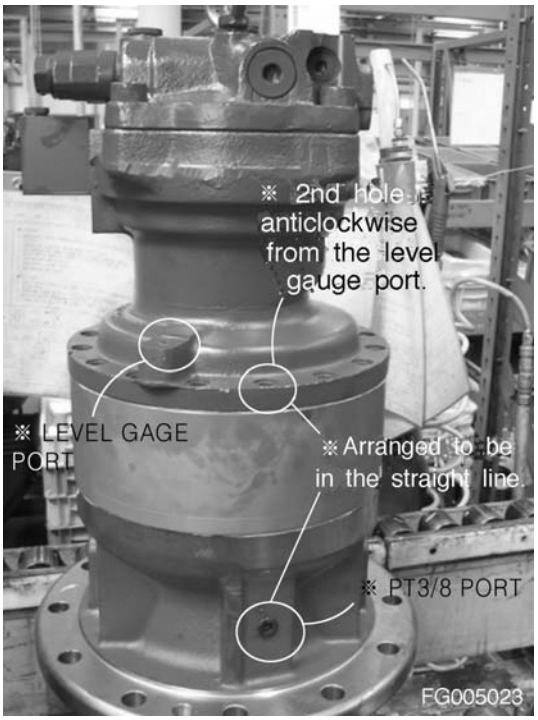


Figure 92

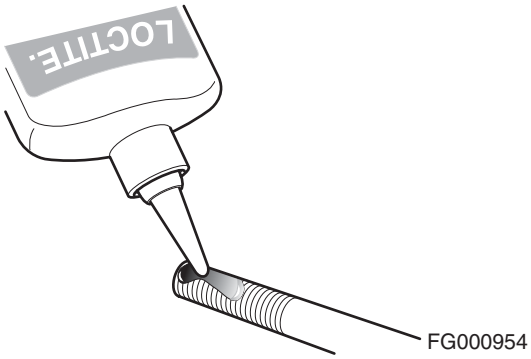


Figure 93

4. Apply Loctite (#2652) to 16 socket bolts (M12x150L, torque: 1,440 kg•cm), insert into holes, and tighten with an impact wrench.



Figure 94

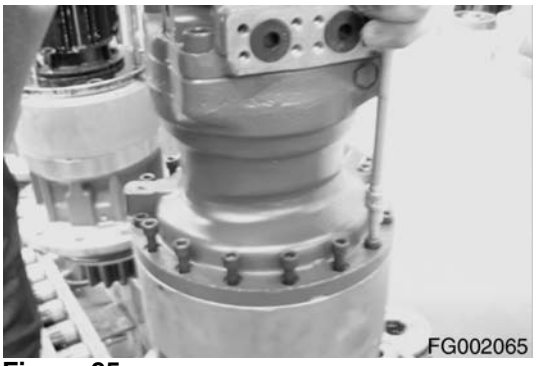


Figure 95



Figure 96



Figure 97

5. Engage the level gauge pipe sealed with Teflon tape to the level gauge port of the port with a pipe wrench.

WARNING!

Do not insert the level gauge bar before supplying gear oil.

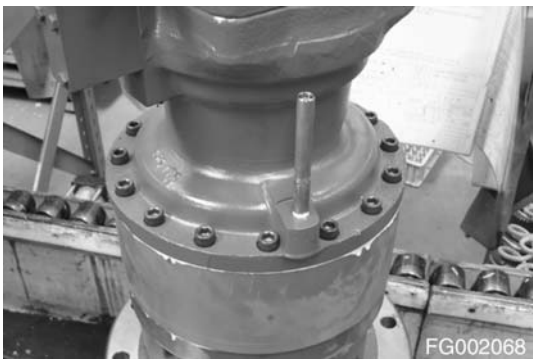


Figure 98

Supply of Gear Oil and Grease

1. Open the oil inlet lid and supply gear oil (EP80W/90) of 3.8 liter.



Figure 99

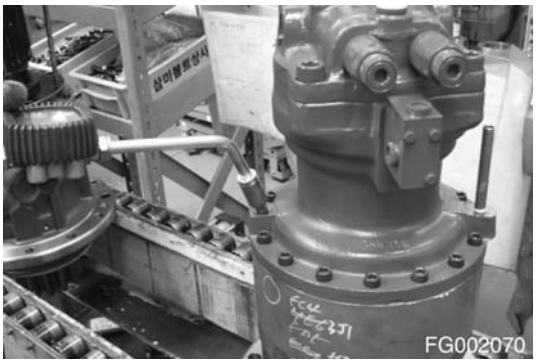


Figure 100



Figure 101

2. After the supply of oil, stick the level gauge into tank and check the oil level.

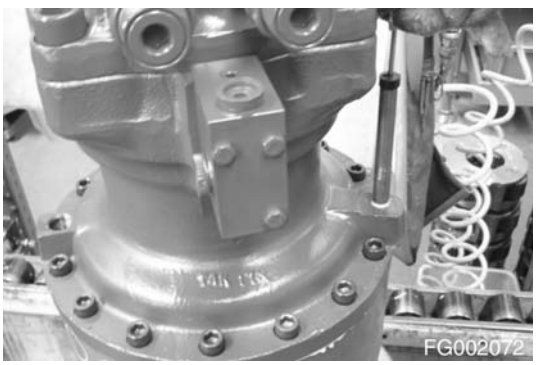


Figure 102

3. Put the nipple to supply grease in the PT1/4 tap hole and start to supply grease until it flows out of the opposite PT1/4 hole.

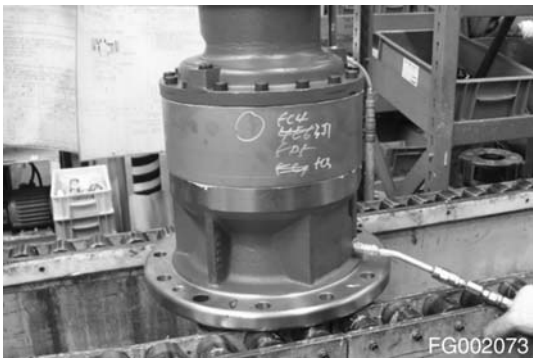


Figure 103

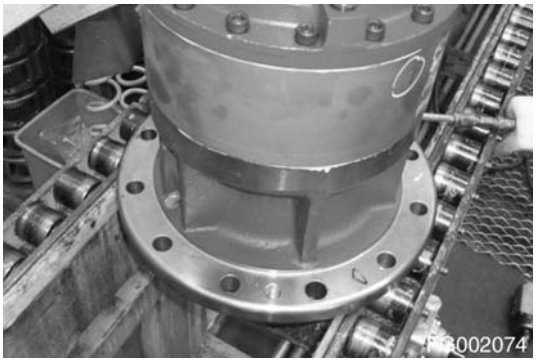


Figure 104

4. After the completion of supplying grease, release and remove cokes, assemble the PT1/4 plug sealed with Teflon tape (torque: 220 kg•cm), tighten it with a torque wrench, wipe out grease and other foreign substance remaining on the surface, and check the assembled position of the motor again.

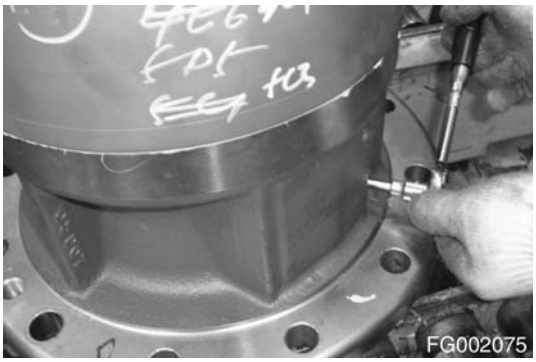


Figure 105

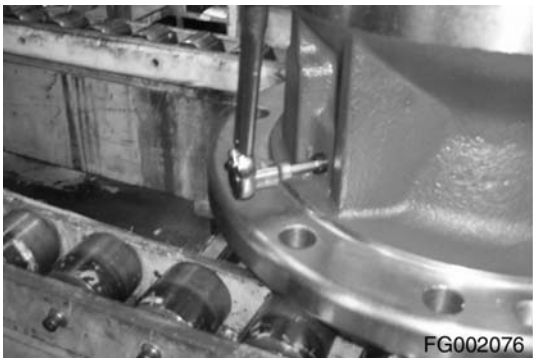


Figure 106

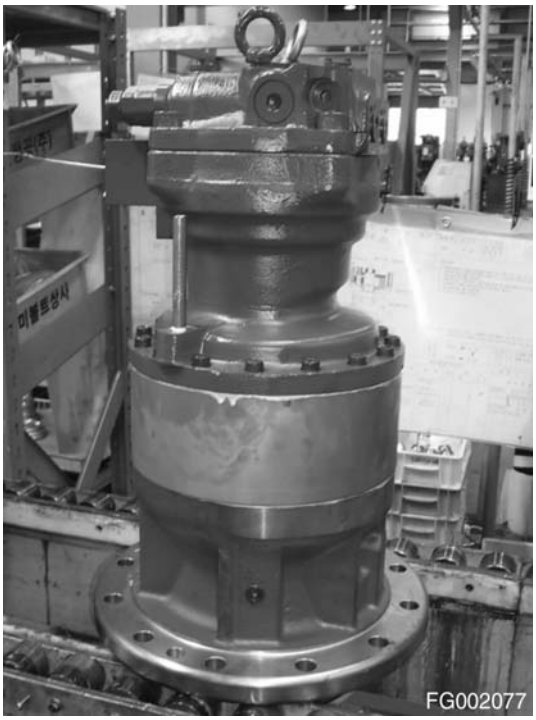


Figure 107



Figure 108

INSTALLATION

1. Coat pinion gear with grease. Refer to operation manual for specifications.
2. Make sure a alignment pin (6, Figure 109) is installed in flange of swing reduction gearbox (5).
3. Using a suitable lifting device, sling swing motor (1, Figure 109) and position swing motor and reduction gearbox (5) as an assembly on unit.
4. Install eleven bolts and washers (4, Figure 109) to secure swing reduction gearbox (5) to frame.

   NOTE: *Apply Loctite #262 to bolt threads.*

   NOTE: *Tighten bolt to 55 kg•m (398 ft lb).*
5. Connect hose (2, Figure 109) to reduction gearbox (5).
6. Connect grease lubrication line (7, Figure 109) to reduction gearbox (5).
7. Connect hoses as tagged during removal to swing motor (1, Figure 109).
8. Fill swing reduction gearbox with oil. Refer to operation manual for specifications.

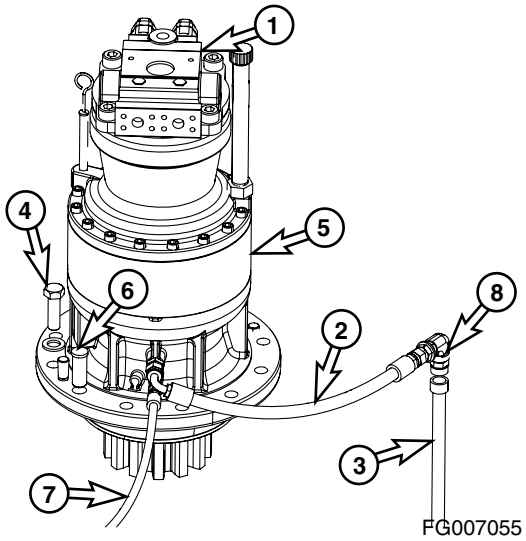


Figure 109

START-UP PROCEDURES

IMPORTANT

If air is not vented from system, it will cause damage to swing motor and bearings.

1. Disconnect drain hose and fill swing motor case with hydraulic oil.
2. Connect drain hose.
3. Start engine and set throttle at "LOW IDLE" and swing upper structure slowly two full revolutions to left and right.
4. Shut engine down and check hydraulic oil level. Fill hydraulic oil tank to "H" mark on sight gauge.
5. Check for oil leaks and clean all fill and venting locations.

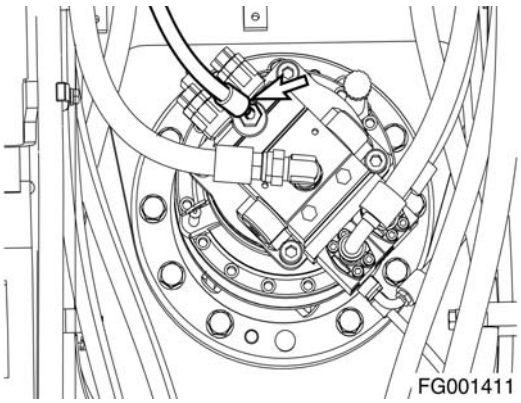


Figure 110

Lower Structure and Chassis

Track Assembly

Edition 1

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SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up
DX225NLC	5001 and Up

GENERAL DESCRIPTION

The track assembly is composed of the following major components:

1. Track
2. Front Idler Roller
3. Upper Roller
4. Lower Roller
5. Track Spring and Track Adjustment Cylinder

TRACK TENSION

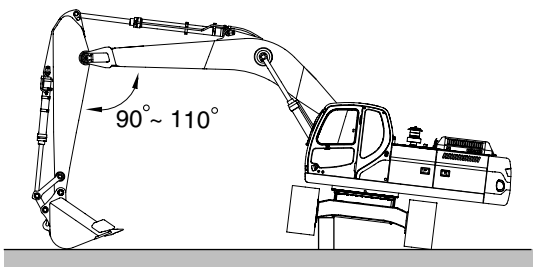
⚠ WARNING!

Safely measuring track tension requires two people. One person must be in the operator's seat, running the controls to keep one side frame in the air, while the other person makes dimensional checks. Take all necessary precautions to make sure the machine won't move or shift position during service. Warm up the engine to prevent stalls, travel the excavator to an area that provides level, uniform ground support and/or use support blocks when necessary.

The track adjusting mechanism is under very high-pressure. NEVER release pressure too suddenly. The track tension grease valve should never be backed off more than 1 complete turn from the fully tightened down position. Bleed off pressure slowly and keep your body away from the valve at all times.

Track shoe link pins and bushings wear with normal usage, reducing track tension. Periodic adjustment is necessary to compensate for wear and it may also be required by working conditions.

1. Track tension is checked by jacking up one side of the excavator. See Figure 1. Place blocking under frame while taking measurement.



FG000345

Figure 1

2. Measuring the distance (A, Figure 2) between the bottom of the side frame and the top of the lowest crawler shoe. Recommended tension for operation over most types of terrain is distance "B" on below table.

   NOTE: *This measurement can be thrown off if there is too much mud or dirt or other material in the track assembly. Clean off the tracks before checking clearance.*

3. Too little sag in the crawler track (less than clearance distance "C" on below table) can cause excessive component wear. The recommended adjustment can also be too tight causing accelerated stress and wear if ground conditions are wet, marshy or muddy, or if the ground is hard and full of rocks or gravel.

4. The increased clearance recommended for muddy ground conditions is between distance "D" on below table. The clearance should be approximately distance "E" on below table for operation over gravel, rocky terrain, or over sand or snow.

Terrain Type	Distance "A"
	DX225LC
Normal "B"	320 - 340 mm (12.60 - 13.39 in)
Minimum "C"	320 mm (12.60 in)
Muddy "D"	340 - 370 mm (13.39 - 14.57 in)
Gravel, Rocky, Sand or Snow "E"	370 mm (14.57 in)

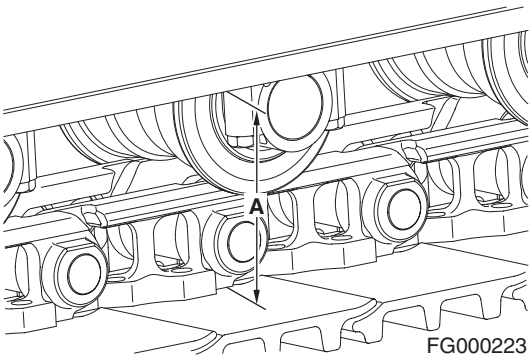


Figure 2

WARNING!

The track adjusting mechanism is under very high-pressure. NEVER release pressure too suddenly. The track tension grease valve should never be backed off more than 1 complete turn from the fully tightened down position. Bleed off pressure slowly and keep your body away from the valve at all times.

5. Track tension adjustments are made through the grease fitting (1, Figure 3) in the middle of each side frame. Adding grease increases the length of an adjustment cylinder (2). The longer the adjustment cylinder, the greater the pressure on the tension spring pushing the track idler wheel outward.

6. If there is not enough slack or clearance in the tracks and the adjustment is too tight, the idler wheel and adjusting cylinder can be retracted by bleeding off grease through hole in valve (3, Figure 3) by loosening valve slowly.

   NOTE: *After track tension is adjusted by loosening valve, be sure to tighten valve (3, Figure 3) to 14 kg•m (137 Nm, 101 ft lb).*

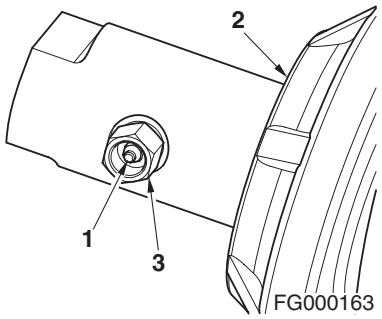


Figure 3

⚠ WARNING!

Do not loosen or remove grease fitting (1, Figure 3) until the pressure is entirely bled off by loosening valve (3, Figure 3) slowly.

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

CAUTION!

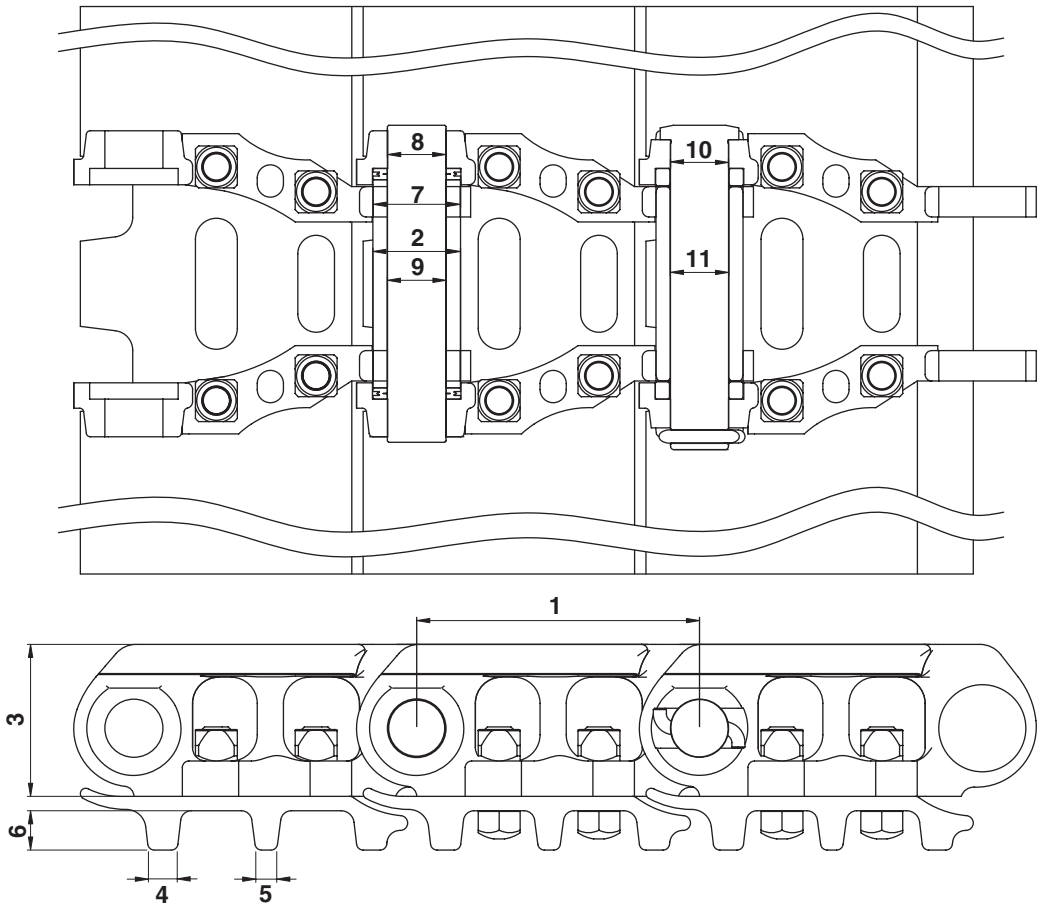
Refer to the "Welding Precautions and Guidelines" information in "General Maintenance Procedures" section for general recommendations and specific safety precautions, before starting any lower travel frame component rebuilding procedure.

The tables that follow provide factory specified dimensional limits (as new condition, recommended service and replacement limit) for lower travel frame components.

Recommended maintenance to renew most listed components requires welding on additional material and grinding off excess. Some components must be replaced before the service limit is exceeded. No maintenance or renewal is possible.

Compare the values in the tables with dimensions and profiles shown in the adjacent figures.

Track Shoe



FG003910

Figure 4

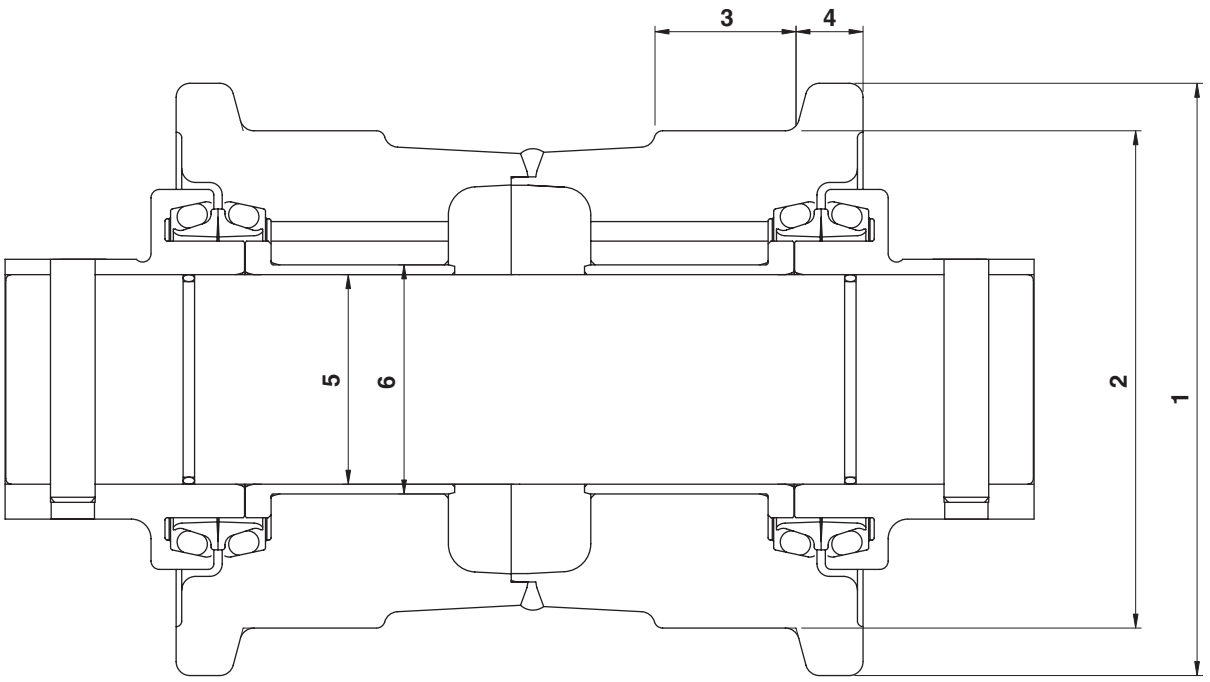
No.	Check Item	Standard Dimension	Recommended Limit for Maintenance	Limit for Use (Repair - P or Replace - R)
1	Link Pitch	190 mm (7.48")	193 mm (7.598")	194.5 mm [R] (3.72")
2	Bushing Outside Diameter	59 mm (2.323")	57 mm (2.244")	54.0 mm [R] (2.126")
3	Link Height	105 mm (4.134")	100 mm (3.937")	96 mm [P] (3.78")
4	Length at Tip	21 mm (0.827")		
5	Length at Tip	14 mm (0.551")		
6	Height	25 mm (0.984")	20 mm (0.787")	20 mm (0.787")

No.	Check Item	Standard Dimension	Tolerance		Standard Interference	Repair Limit
			Shaft	Hole		
7	Interference between Bushing and Link	59 mm (2.323")	+0.434 +0.394	+0.074 0.0	0.32 - 0.434	
8	Interference between Regular Pin and Link	38 mm (1.496")	+0.222 +0.162	-0.138 -0.20	0.3 - 0.422	
9	Clearance between Regular Pin and Bushing	38 mm (1.496")	+0.222 +0.162	+0.902 +0.402	0.18 - 0.74	
10	Interference between Master Pin and Bushing	37.83 mm (1.489")	+0.015 -0.015	-0.032 -0.03	0.045 - 0.047	
11	Clearance between Master Pin and Bushing	37.83 mm (1.489")	+0.015 -0.015	+1.072 +0.572	0.557 - 1.087	

No.	Check Item	Standard Dimension	Recommended Limit for Maintenance	Limit for Use (Repair - P or Replace - R)
1	Link Pitch	190 mm (7.48")	193 mm (7.598")	194.5 mm [R] (3.72")
2	Bushing Outside Diameter	59 mm (2.323")	57 mm (2.244")	54.0 mm [R] (2.126")
3	Link Height	105 mm (4.134")	100 mm (3.937")	96 mm [P] (3.78")
4	Length at Tip	20 mm (0.787")		
5	Length at Tip	14 mm (0.551")		
6	Height	26 mm (1.024")	20 mm (0.787")	20 mm (0.787")

No.	Check Item	Standard Dimension	Tolerance		Standard Interference	Repair Limit
			Shaft	Hole		
7	Interference between Bushing and Link	59 mm (2.323")	+0.434 +0.394	+0.074 0.0	0.32 - 0.434	
8	Interference between Regular Pin and Link	38 mm (1.496")	+0.222 +0.162	-0.138 -0.20	0.3 - 0.422	
9	Clearance between Regular Pin and Bushing	38 mm (1.496")	+0.222 +0.162	+0.902 +0.402	0.18 - 0.74	
10	Interference between Master Pin and Bushing	37.83 mm (1.489")	+0.015 -0.015	-0.032 -0.03	0.045 - 0.047	
11	Clearance between Master Pin and Bushing	37.83 mm (1.489")	+0.015 -0.015	+1.072 +0.572	0.557 - 1.087	

Lower Roller



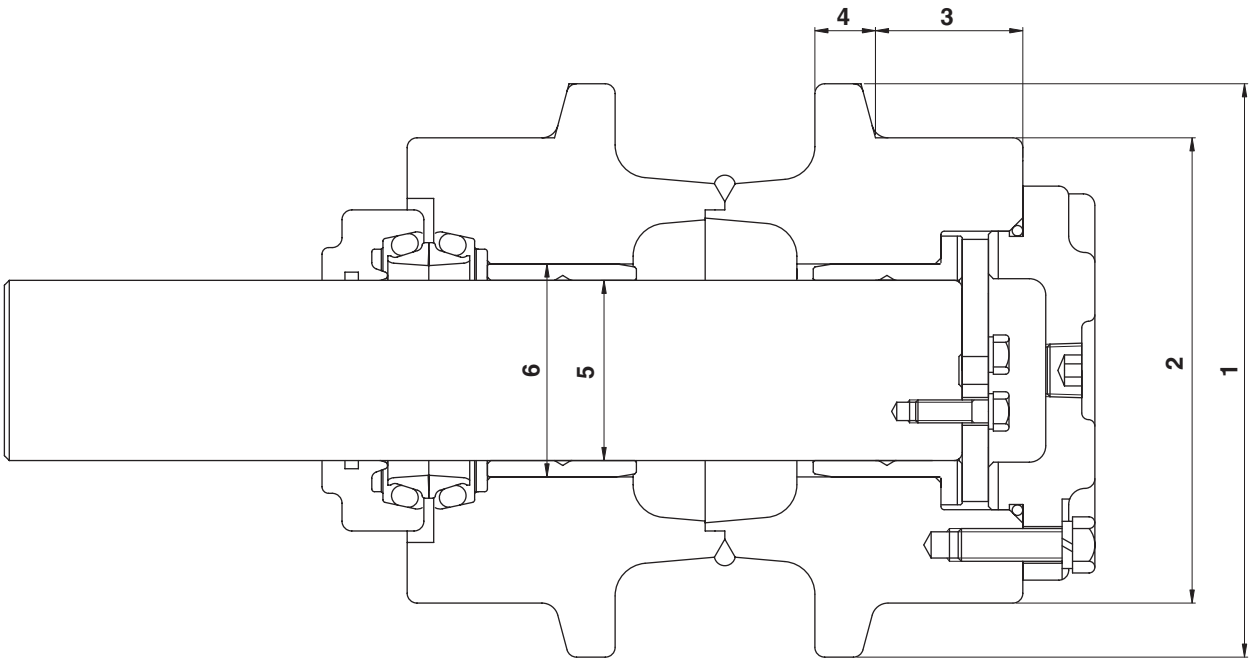
FG000508

Figure 5

No.	Check Item	Standard Dimension	Recommended Limit for Maintenance	Limit for Use (Repair - P or Replace - R)
1	Outside Diameter of Flange	195 mm (7.677")	190 mm (7.48")	185 mm [P] (7.283")
2	Outside Diameter of Tread	160 mm (6.299")	154 mm (6.063")	150 mm [P] (5.906")
3	Width of Tread	49 mm (1.929")	55 mm (2.165")	
4	Width of Flange	22.5 mm (0.886")		

No.	Check Item	Standard Dimension	Tolerance		Standard Interference	Repair Limit
			Shaft	Hole		
5	Clearance between Shaft and Bushing	70 mm (2.756")	-0.06 -0.09	+0.32 +0.17	+0.41 +0.21	68.30 mm [R] (1.181")
6	Interference between Roller and Bushing	77 mm (3.031")	+0.14 +0.09	+0.03 -0.02	+0.16 +0.06	

Upper Roller

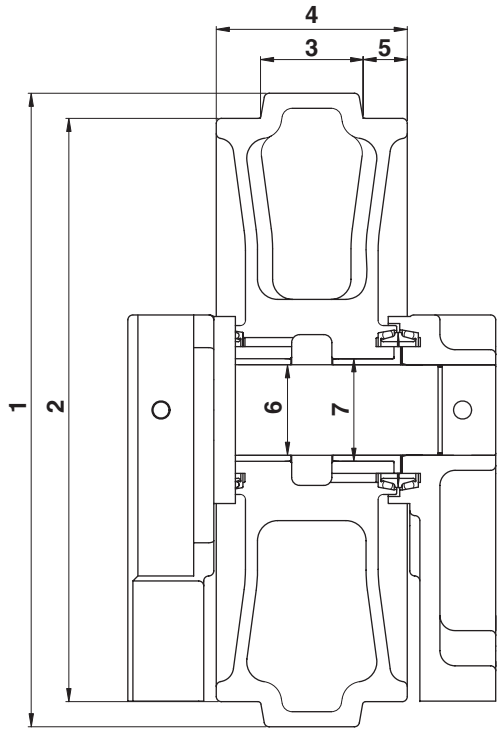


FG000509

Figure 6

No.	Check Item	Standard Dimension			Recommended Limit for Maintenance	Limit for Use (Repair - P or Replace - R)
1	Outside Diameter of Flange	169 mm (6.653")				
2	Outside Diameter of Tread	142 mm (5.591")			136 mm (5.354")	130 mm [P] (5.118")
3	Width of Tread	51.5 mm (2.028")			56.5 mm (2.224")	
4	Width of Flange	15 mm (0.591")				
5	Clearance between Shaft and Bushing	Standard Dimension	Tolerance		Standard Interference	Repair Limit
			Shaft	Hole		
		47 mm (1.850")	+0.070 +0.054	+0.29 +0.18	+0.236 +0.110	
6	Interference between Roller and Bushing	Standard Dimension	Tolerance		Standard Interference	Repair Limit
			Shaft	Hole		
		57 mm (2.244")	+0.14 +0.10	+0.03 0	+0.14 +0.07	

Front Idler



FG000510

Figure 7

No.	Check Item	Standard Dimension	Recommended Limit for Maintenance	Limit for Use (Repair - P or Replace - R)
1	Outside Diameter of Flange	541.5 mm (21.319")		
2	Outside Diameter of Tread	500 mm (19.685")	488 mm (19.213")	
3	Width of Protrusion	85 mm (3.346")	75 mm (2.953")	65 mm (2.559")
4	Total Width	160 mm (6.299")	150 mm (5.906")	140 mm (5.512")
5	Width of Tread	37.5 mm (1.476")	43 mm (1.693")	

No.	Check Item	Standard Dimension	Tolerance		Standard Interference	Repair Limit
			Shaft	Hole		
6	Clearance between Shaft and Bushing	75 mm (2.953")	-0.06 -0.09	+0.36 +0.25	+0.45 +0.31	76 mm [R] (2.992")
7	Interference between Roller and Bushing	85 mm (3.346")	+0.12 +0.09	+0.035 0	+0.12 +0.07	

TRACK SHOES AND LINKS

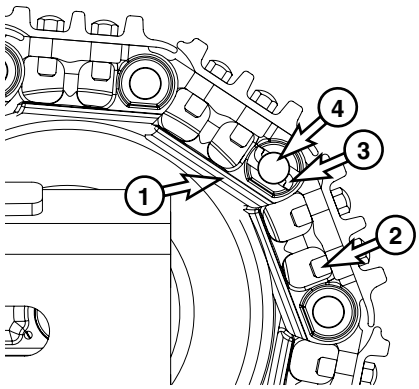
Track Removal

1. Position machine on a smooth level surface with adequate room for forward and reverse travel.
2. Relieve track tension. Refer to "Track Tension" in this section for procedure.
3. Move machine until master link (1, Figure 8) is positioned at approximately 10 o'clock from top position on front idle roller.
4. Remove four nuts and bolts (2, Figure 8) holding shoe to link. Remove enough shoes to make access to lock pin easier.

   NOTE: *Support track shoes with blocking so when master pin (4*, Figure 8*) is removed track will not fall.*

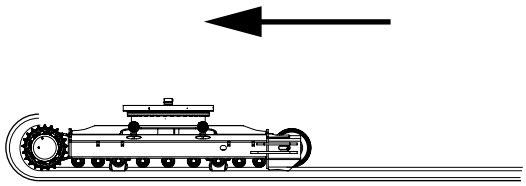
5. Straighten lock pin (3, Figure 8) and remove it from master pin (4). Discard lock pin.
6. Remove master pin from master links.
7. Move unit backward until entire track is laying on ground.

   NOTE: *Do not drive unit off track.*



FG00398

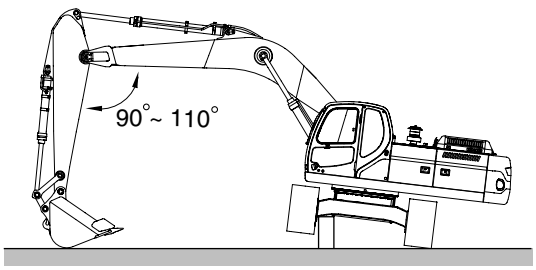
Figure 8



FG003911

Figure 9

8. Rotate upper structure to 90° from track. Use bucket and boom to raise track frame off track.
9. Position blocking under frame.

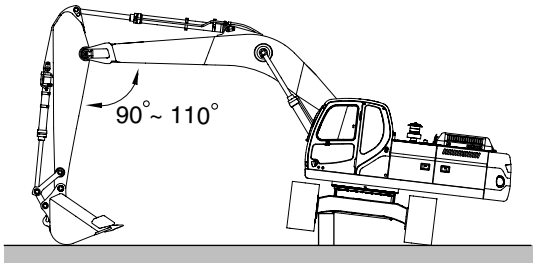


FG000345

Figure 10

Track Installation

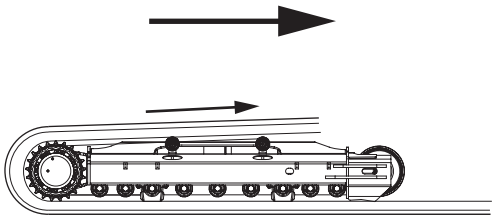
1. Lay rebuilt or new track into position under track frame. End of track should be positioned under drive sprocket.
2. With upper structure at 90° to track frame. Use bucket and boom to raise track frame off blocking.
3. With blocking removed, lower track frame onto track. Make sure all rollers are properly positioned on track.



FG000345

Figure 11

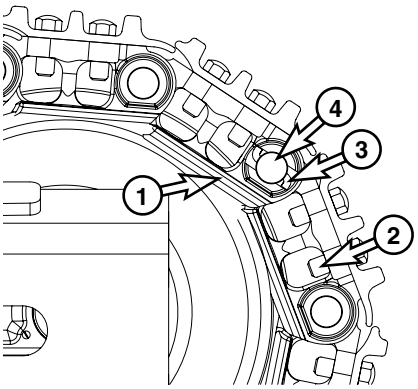
4. Move unit forward while feeding track up over drive sprocket. Continue to pull track back until it engages front idle roller.



FG003912

Figure 12

5. Align master links and install master pin.
6. Insert new lock pin in master pin. Bend end of pin over so it is pointing in opposite direction of other end as shown.
7. Apply track tension. Refer to "Track Tension" in this section for procedure.



FG00398

Figure 13

FRONT IDLER ROLLER

Parts List

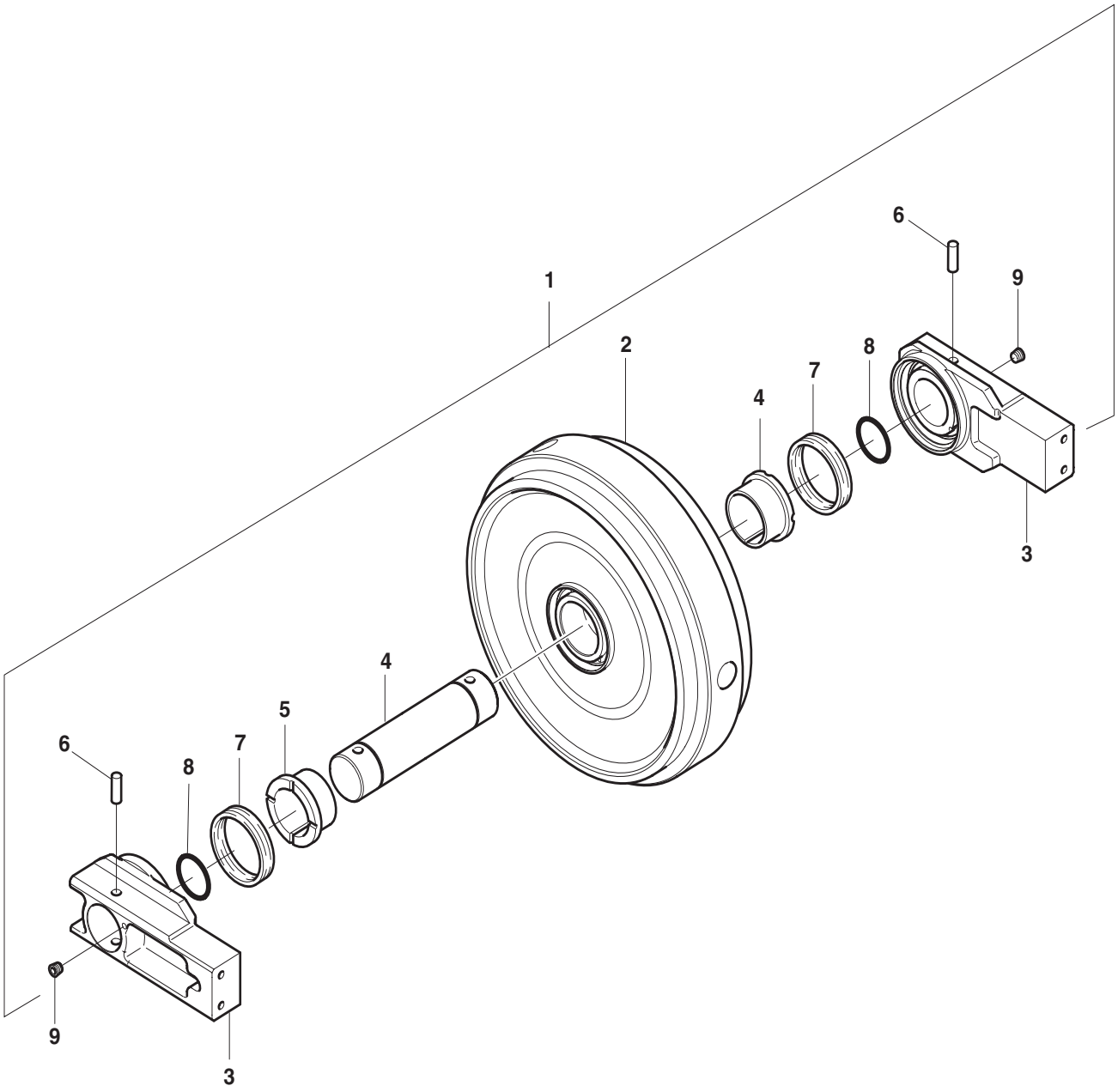


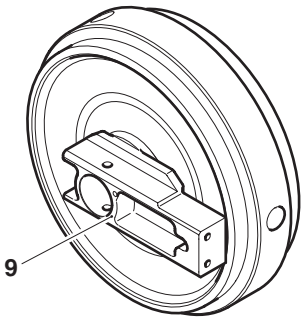
Figure 14

Reference Number	Description
1	Idler Assembly
2	Idler
3	Bearing
4	Shaft
5	Bushing

Reference Number	Description
6	Pin
7	Floating Seal
8	O-ring
9	Plug

Front Idler Roller Disassembly

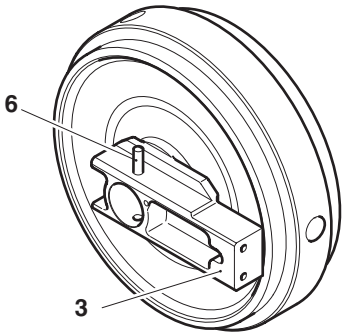
1. Remove plug (9, Figure 15) from idler assembly (1), and drain into a suitable container.



FG003914

Figure 15

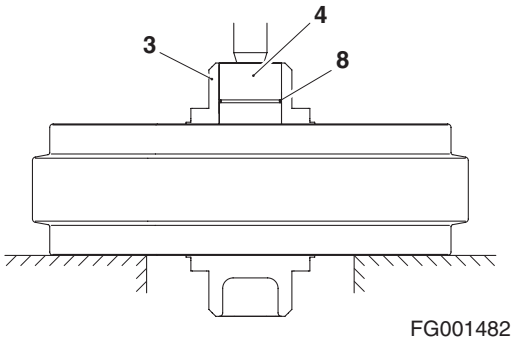
2. Separate the pin (6, Figure 16) from the bearing (3).



FG003915

Figure 16

3. Use a press to remove bearing from the axle (4). Separate the O-ring (8, Figure 17) from the axle.



FG001482

Figure 17

4. Detach the floating seal (7, Figure 18) from the idler (2) and bearing (3).

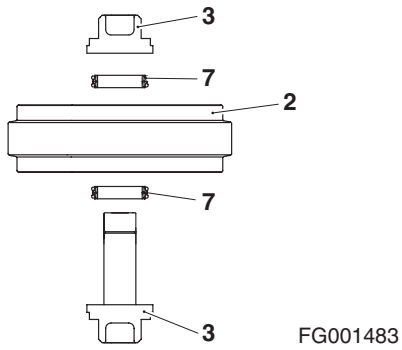


Figure 18

5. Use a press to separate the axle (4, Figure 19), O-ring (8) and bearing (3).

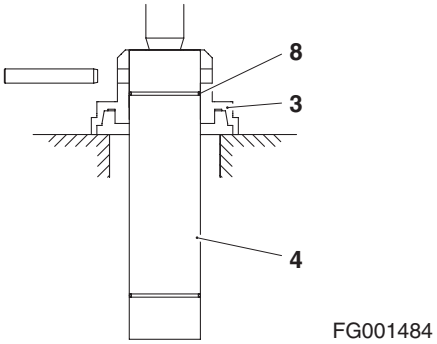


Figure 19

6. Remove bushing (5, Figure 20) with the press and special tool (10, ST-1909).

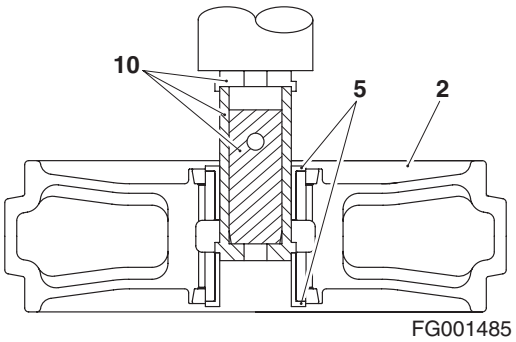


Figure 20

Front Idler Roller Reassembly

1. Degrease, clean and dry all parts before reassembly. Insert bushing (5, Figure 20) into the idler (2).
2. Grease O-ring (8, Figure 21) and insert it into the axle.
3. Align the bearing (3, Figure 21) and axle (4) holes and pin (6) them together.

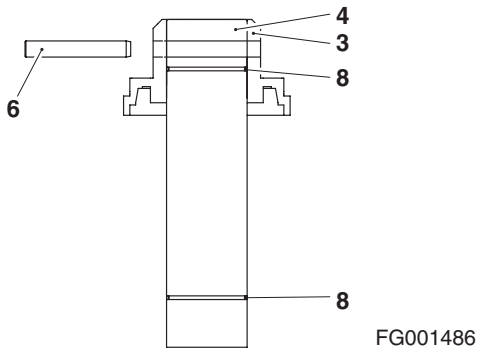


Figure 21

4. Install floating seal (7, Figure 22) inside the idler (2) and bearing (3).

   NOTE: *Apply clean engine oil to the joint side of the floating seal. Apply grease to the floating seal O-ring.*

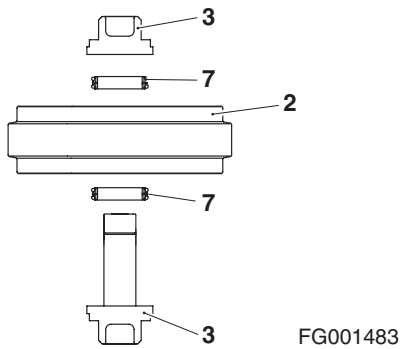


Figure 22

5. Install idler (2, Figure 23) on the axle.
6. Install bearing (3, Figure 23) and pin (6) to the axle.

   NOTE: *Fill the idler assembly with new engine oil with approximately 320 cc (10.8 oz).*

7. Install plug (9, Figure 28) on the bearing.

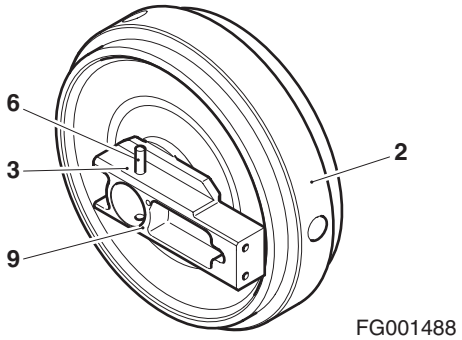
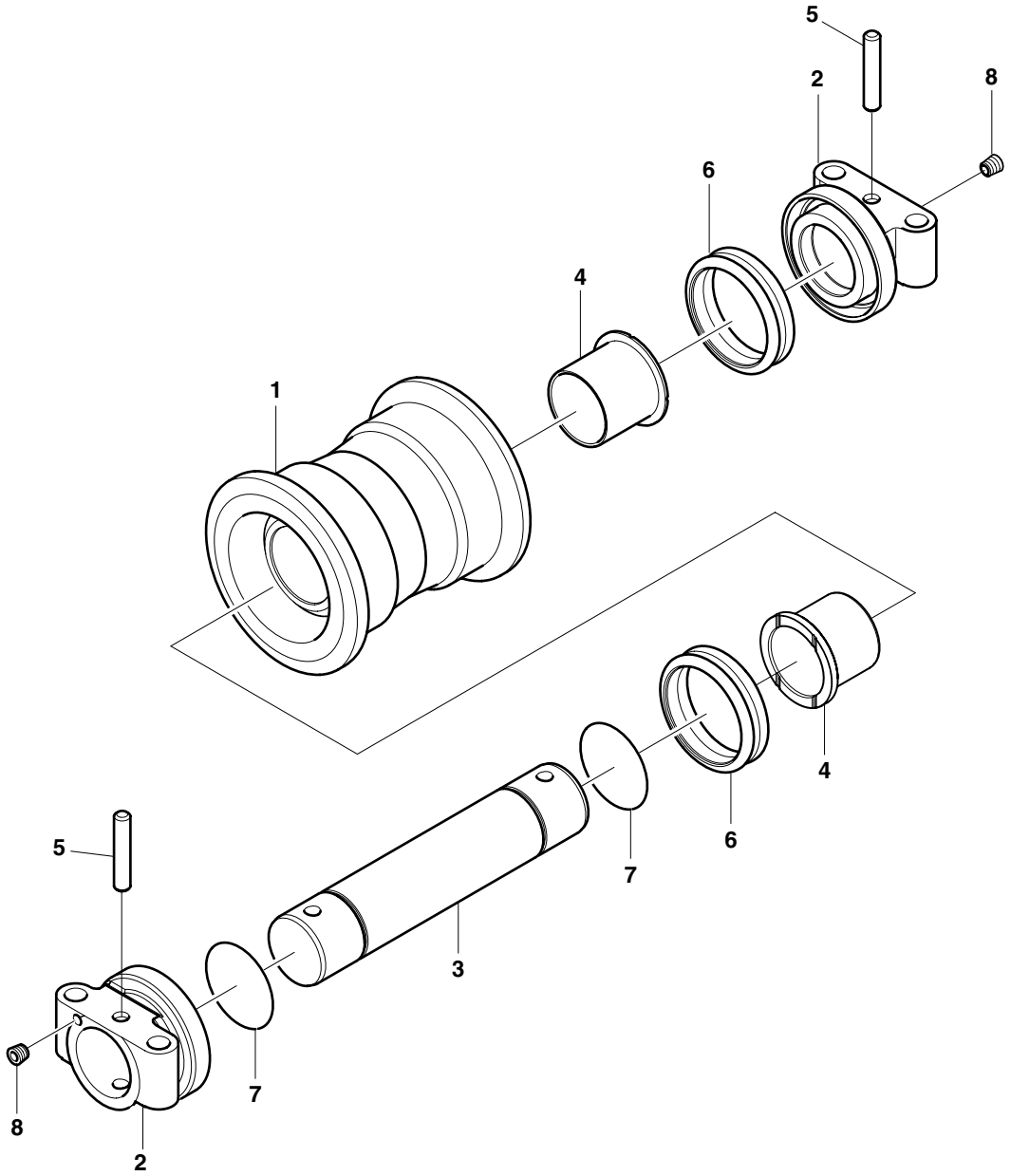


Figure 23

LOWER ROLLER

Parts List



FG000483

Figure 24

Reference Number	Description
1	Roller
2	Collar
3	Shaft
4	Bushing

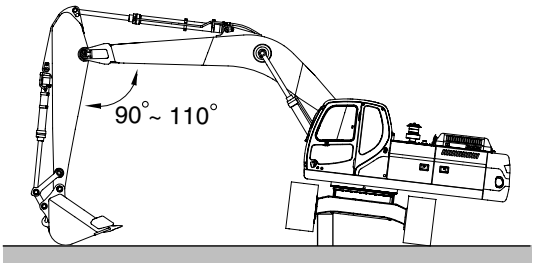
Reference Number	Description
5	Pin
6	Floating Seal
7	O-ring
8	Plug

Lower Roller Removal

1. Relieve track tension. Refer to "Track Tension" in this section for procedure.
2. Swing upper structure at 90° to frame.
3. Using bucket raise track off ground and place blocking under frame.
4. Remove four bolts and lower roller assembly from track frame. There is an alignment pin on each end of lower roller assembly.

   NOTE: *To gain access to some rollers the link guard may have to be removed. Remove four spring washers and bolts to remove guard.*

   NOTE: *If additional track clearance is required, remove upper rollers before raising track.*

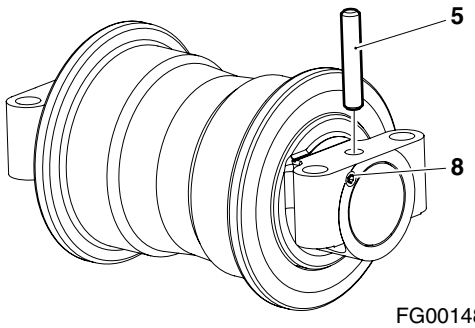


FG000345

Figure 25

Lower Roller Disassembly

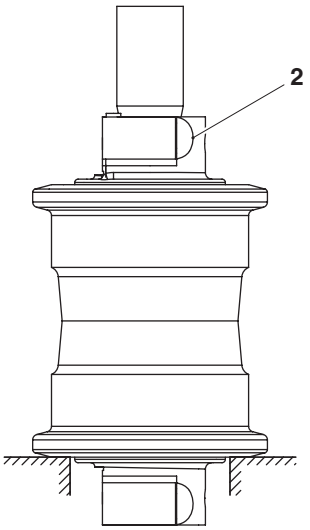
1. Remove plug (8, Figure 26) from the collar and drain oil.
2. Pull the pin (5, Figure 26) from the collar.



FG001489

Figure 26

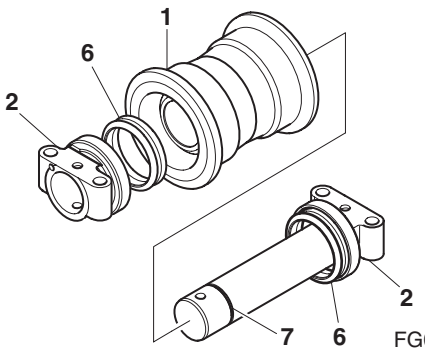
3. Separate the collar (2, Figure 27) from the axle, using press.



FG001490

Figure 27

4. Detach O-rings (7, Figure 28) from the axle.
5. Separate floating seals (6, Figure 28) from the collar and roller (1).
6. Detach collar (2, Figure 28) and O-rings (7) from the axle, using press.

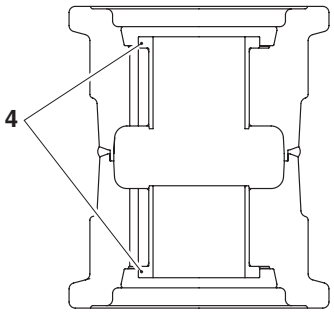


FG001493

Figure 28

Lower Roller Reassembly

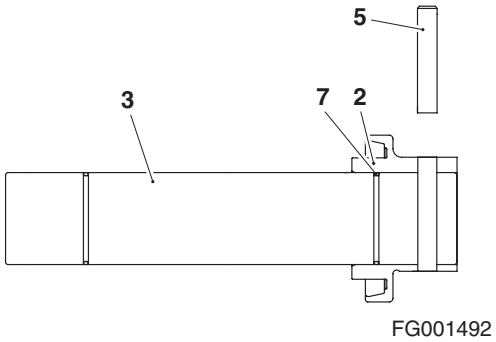
1. Degrease, clean and dry all parts before reassembly. Insert bushing (4, Figure 29) into roller.



FG001491

Figure 29

2. Apply grease to the O-rings (7, Figure 29) and insert into axle.
3. Align collar (2, Figure 30) and axle (3) pinholes and pin (5) the collar.



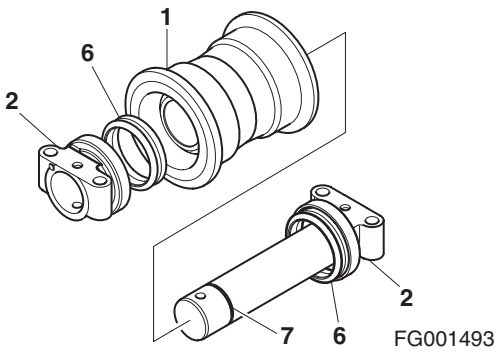
FG001492

Figure 30

4. Insert floating seals (6, Figure 31) into the roller (1) and collar (2).

   NOTE: *Apply clean engine oil to the joint side of the floating seal. Apply grease to the floating seal O-ring.*

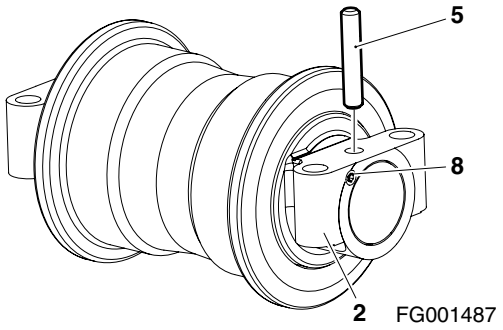
5. Slide the axle inside the roller.



FG001493

Figure 31

6. Install the collar (2, Figure 32), O-ring (7), and pin (5) on the remaining side.
7. Fill with clean engine oil with approximately 330 cc (11.2 oz).
8. Install plug (8, Figure 32) on the collar.



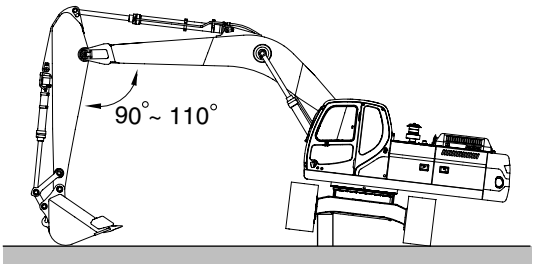
FG001487

Figure 32

Lower Roller Installation

1. Install four bolts to hold lower roller assembly to track frame.

   NOTE: *To gain access to some rollers a link guard may have to be removed. Remove four spring washers and bolts to remove guard.*



FG000345

Figure 33

UPPER ROLLER

Parts List

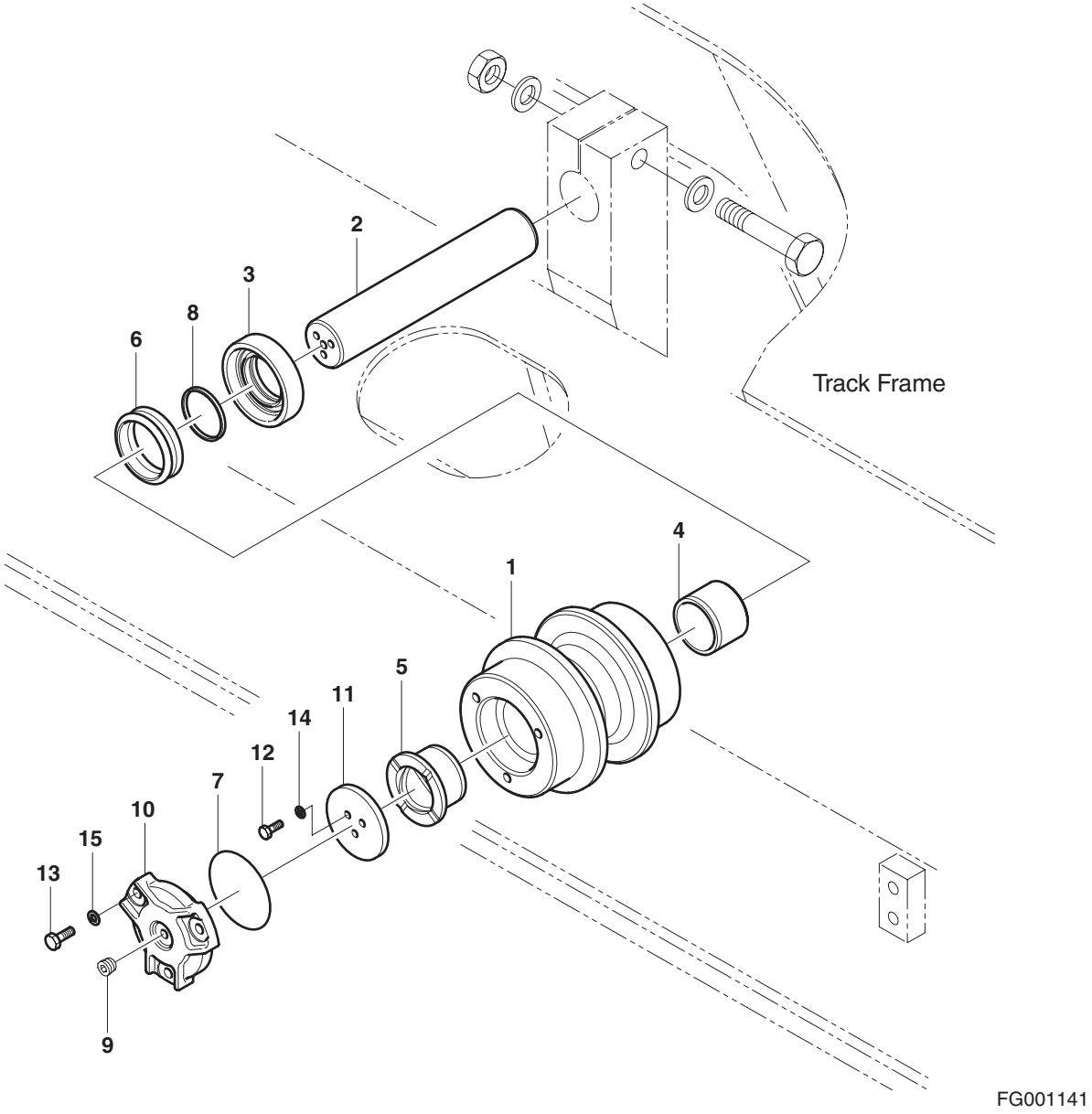


Figure 34

Reference Number	Description
1	Roller
2	Shaft
3	Thrust Ring
4	Bushing
5	Bushing
6	Floating Seal
7	O-ring
8	O-ring

Reference Number	Description
9	Plug
10	Cover
11	Washer
12	Bolt
13	Blot
14	Spring Washer
15	Spring Washer

Upper Roller Removal

1. Relieve track tension. This will allow track to be raised so links clear top of roller.
2. Position a bottle jack on top of track frame and apply pressure to track shoe.
3. Remove mounting hardware holding upper roller assembly to track frame.

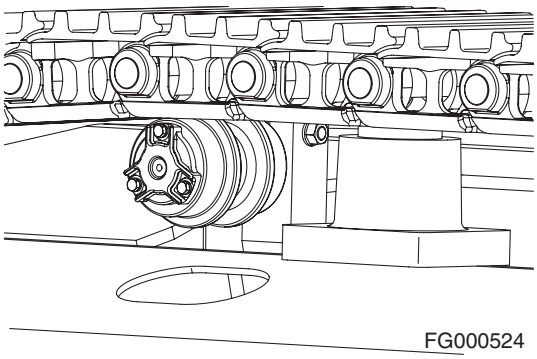


Figure 35

Upper Roller Disassembly

1. Remove plug (9, Figure 36) from the cover and drain oil.

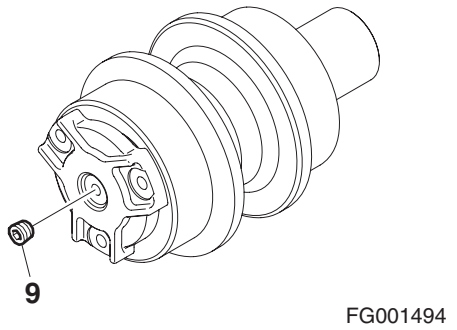
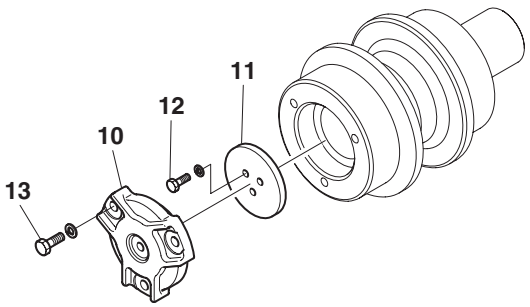


Figure 36

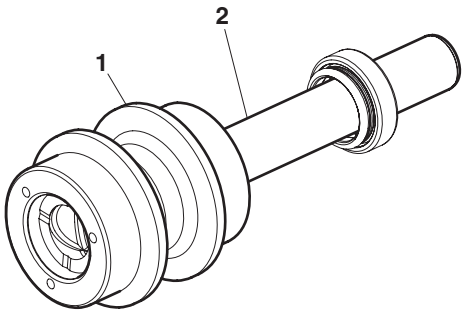
2. Remove bolts (13, Figure 37) and cover (10). Detach bolts (12) and washer (11).



FG001495

Figure 37

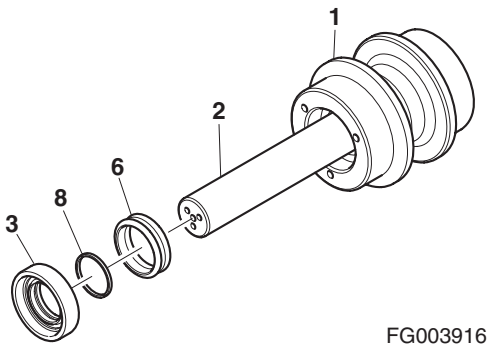
3. Separate the roller (1, Figure 38) from the axle (2).



FG001497

Figure 38

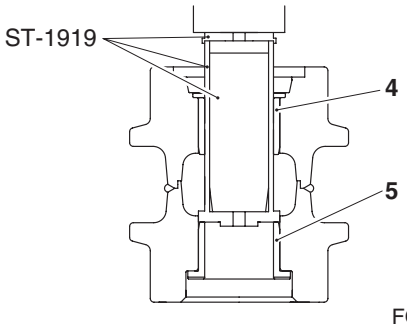
4. Separate the floating seal (6, Figure 39) from the roller.
5. Separate the O-ring (8) and thrust ring (3) from the axle.



FG003916

Figure 39

6. Separate the bushing (4 and 5, Figure 40) from the roller with a press and special tool (ST-1919).



FG001502

Figure 40

Upper Roller Reassembly

1. Degrease, clean and dry all parts before reassembly. Insert bushing (4 and 5, Figure 41) into the roller (1).

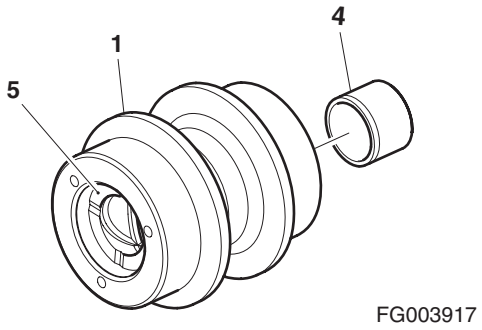


Figure 41

2. Insert floating seal (6, Figure 42) into the roller (1) and bushing.

   NOTE: *Apply clean engine oil to the joint side of the floating seal. Apply grease to the floating seal O-ring.*

3. Install the axle (2), O-ring (8) and thrust ring (3).

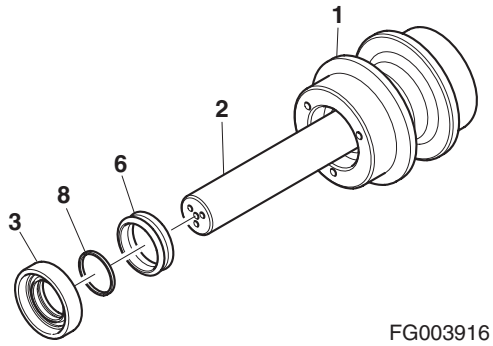


Figure 42

4. Install washer (11, Figure 43) and bolt (12).
5. Insert the O-ring (7, Figure 43) to the cover (10). Attach cover (10) and bolt (13) to the roller.
6. Fill with engine oil with 200cc.
7. Tighten plug (9, Figure 43).

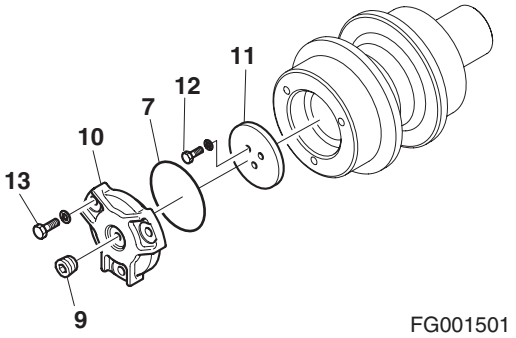
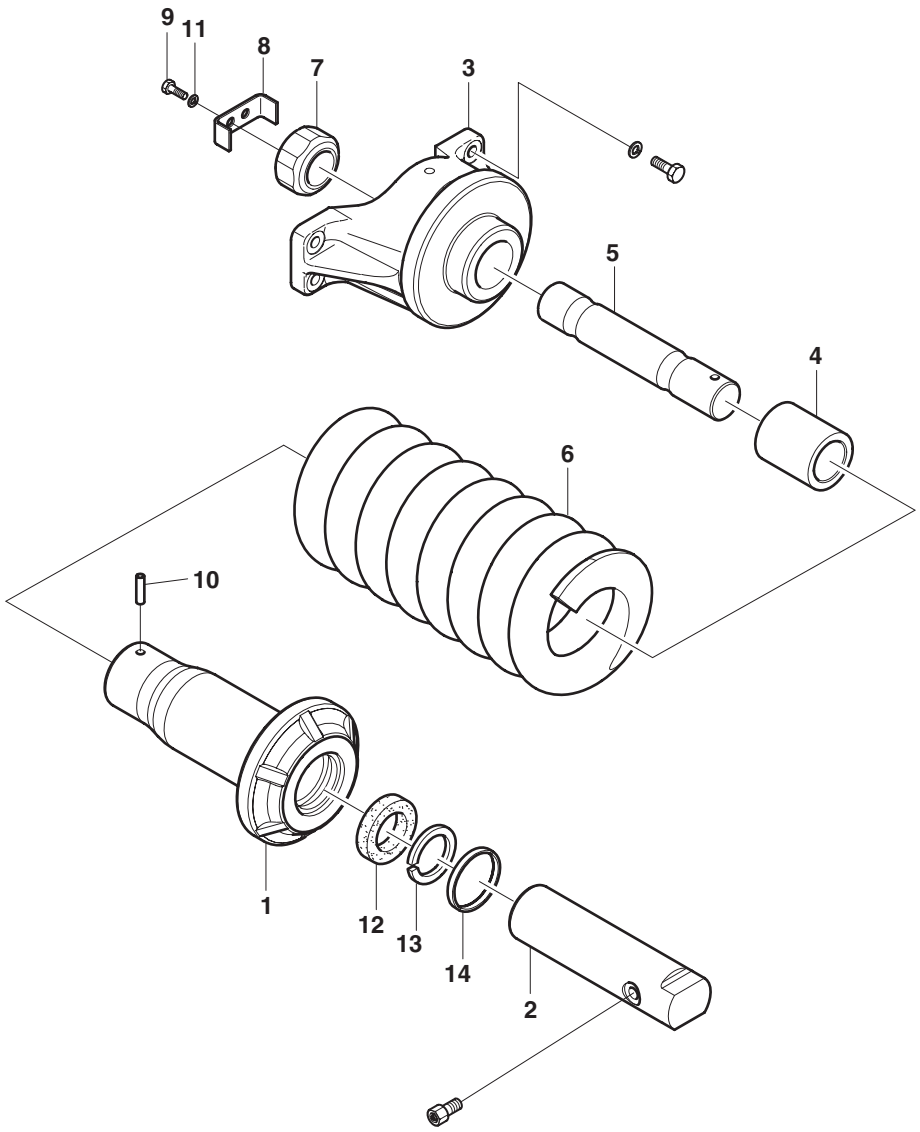


Figure 43

TRACK SPRING AND TRACK ADJUSTING CYLINDER

Parts List



FG003918

Figure 44

Reference Number	Description
1	Cylinder
2	Piston Rod
3	Yoke
4	Spacer
5	Shaft
6	Spring
7	Locknut

Reference Number	Description
8	Lock Plate
9	Bolt
10	Spring Pin
11	Spring Washer
12	Packing
13	Backup Ring
14	Dust Seal

Engine and Drivetrain

Air Conditioner

Edition 1

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MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

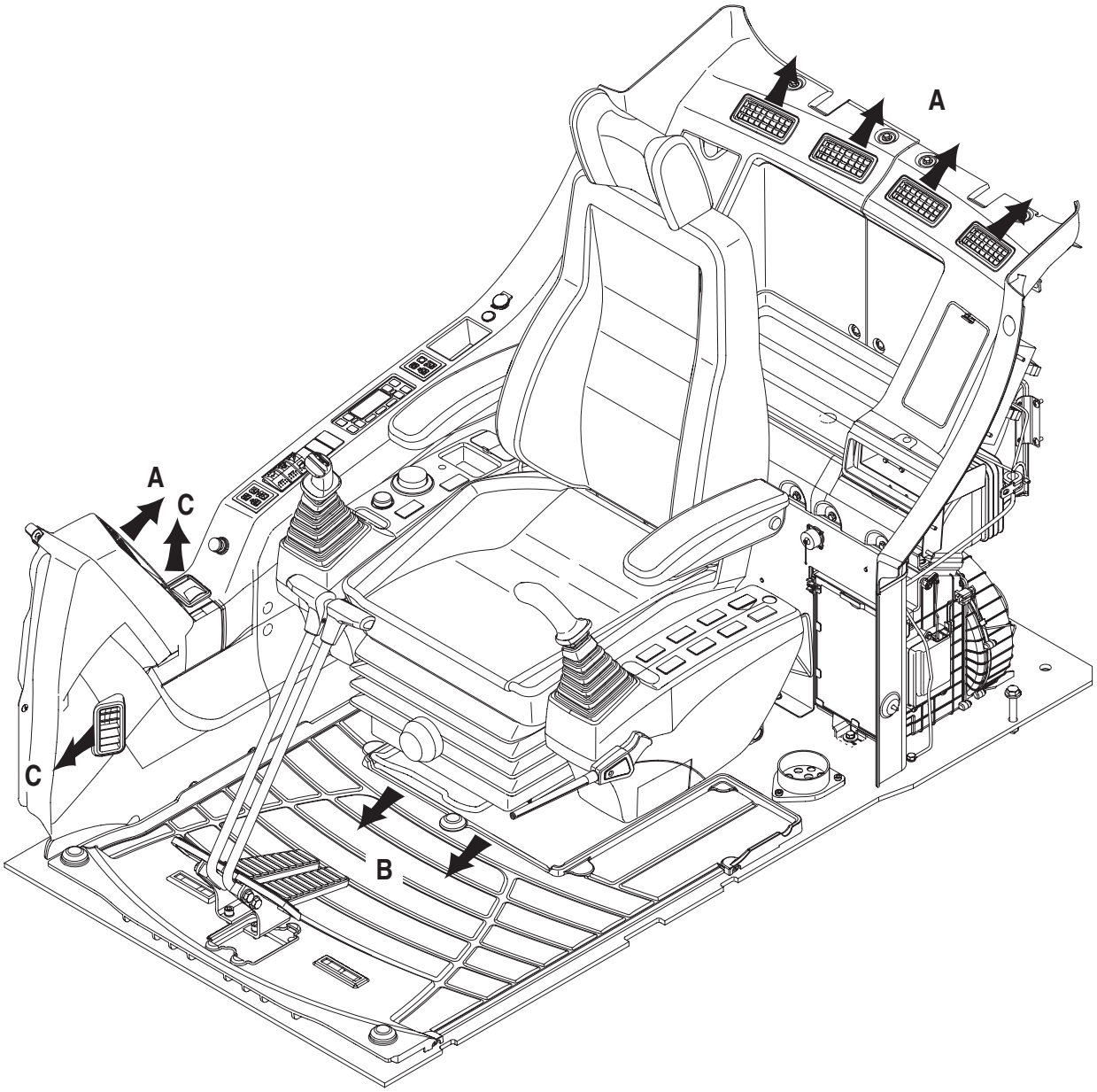
APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX300LC	5001 and Up

AIR CONDITIONER SYSTEM

Outline



FG000784

Figure 1

Solid type heater and air conditioner are installed in the cover behind the driver's seat.

Temperature of the driver's room is adjusted automatically to the temperature set by operator.

(Please refer to the Operation Manual for detailed whole automatic control.

Vent mode selects the direction of discharged air.

Outlets by vent modes

Modes					
Outlets	A	A+B	B	B+C	C

Internal and external filters

Internal and external air purification filters are installed for the driver's room.

Filters must be cleaned every 500 hours.

If machine operates in an excessively contaminated environment, filters must be cleaned more frequently and if necessary, replaced with new ones.

How to check Indoor air filter

1. Press both levers on the left and right side at the top of the filter installed behind the driver's seat.

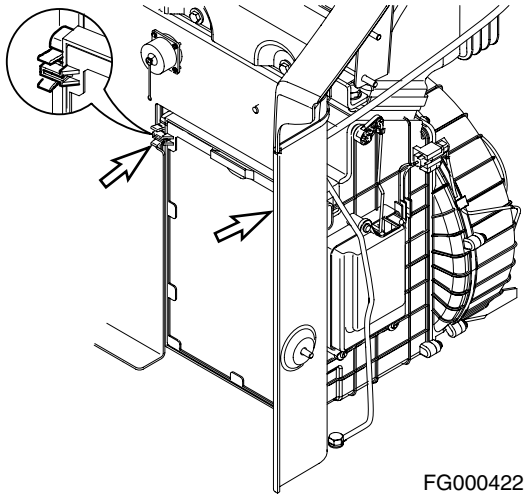


Figure 2

How to check outdoor air filter

1. Open the front door at the left side of machine and loosen four marked bolts to remove cover (1, Figure 3).

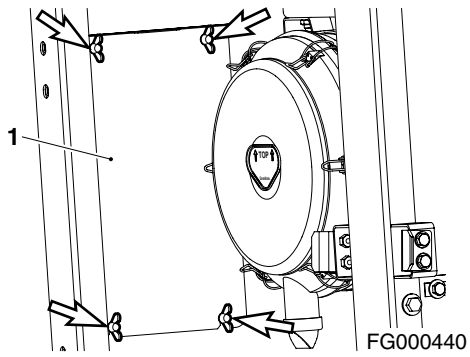


Figure 3

2. Turn marked knobs (1, Figure 4) at the rear side of the cabin to open the cover.

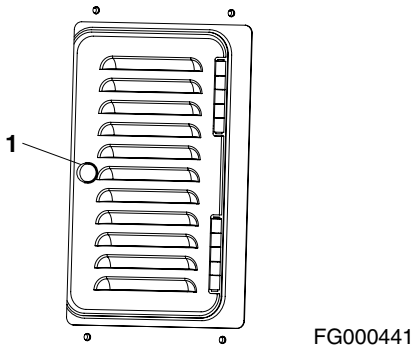


Figure 4

3. Remove filter attached to the cover and clean the contaminated filter using compressed air.
4. Close the cover, replace the knobs, and secure the cover to the support with butterfly bolts.

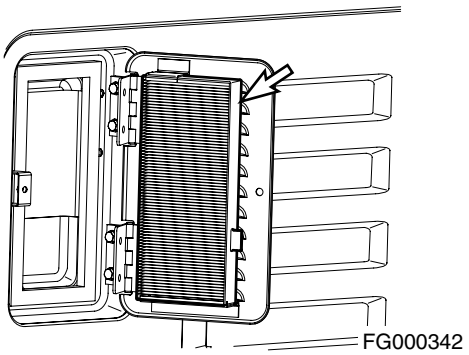


Figure 5

Air-Conditioning System Layout

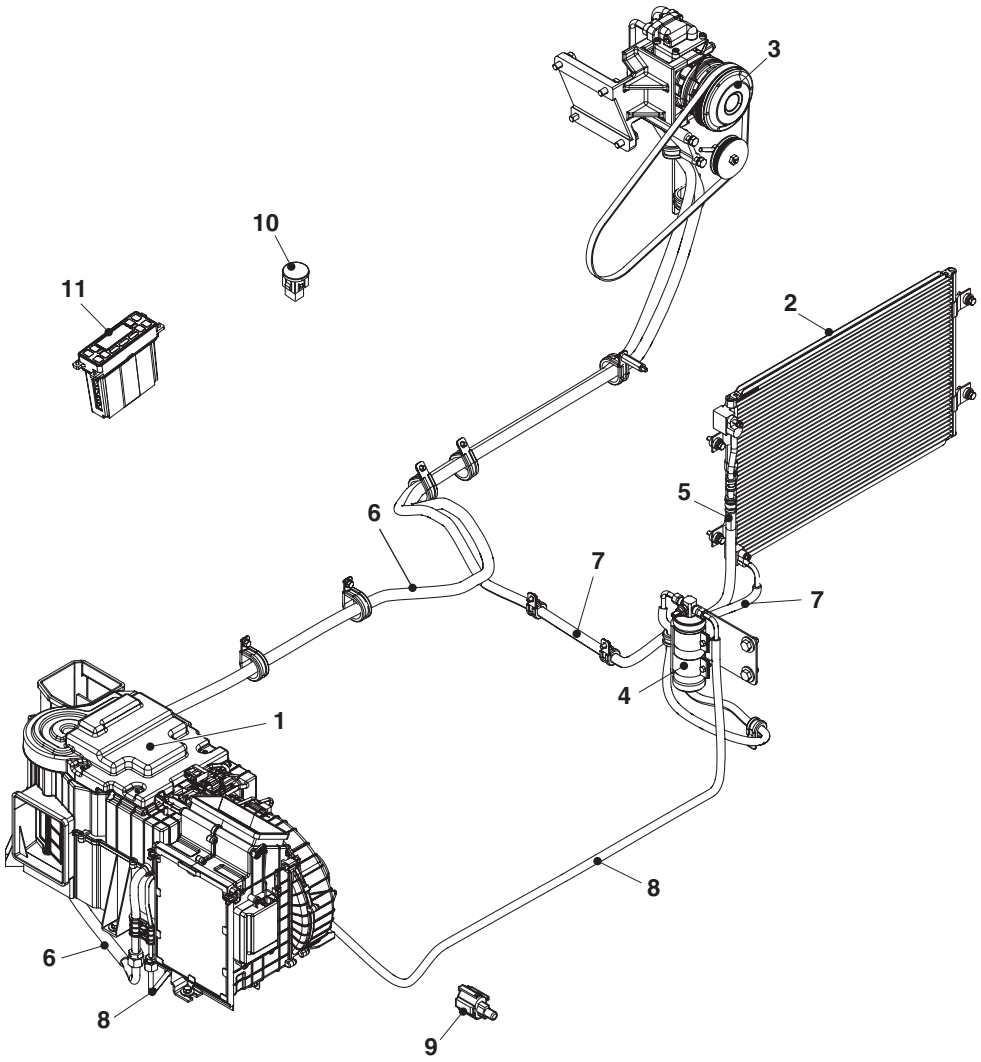
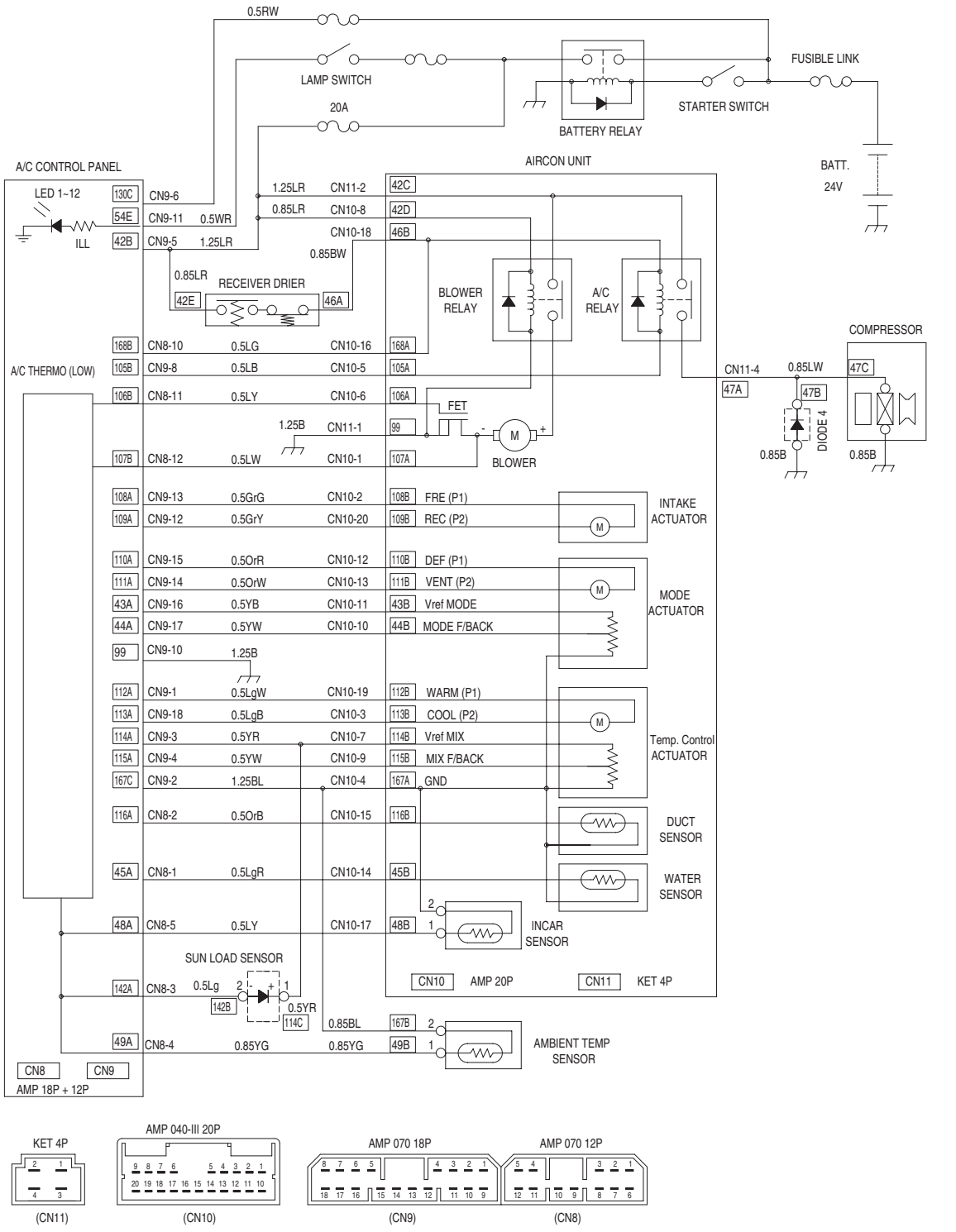


Figure 6

Reference Number	Description
1	Air Conditioner/heater Unit
2	Condenser
3	Compressor
4	Receiver Dryer
5	High-pressure Hose
6	Low-pressure Hose

Reference Number	Description
7	Liquid Hose (1)
8	Liquid Hose (2)
9	Ambient Temperature Sensor
10	Sun Sensor
11	Control Panel

Air Conditioner/heater Circuit Diagram



FG000781

Figure 7

Air Conditioner/heater Unit

Airflow Diagram

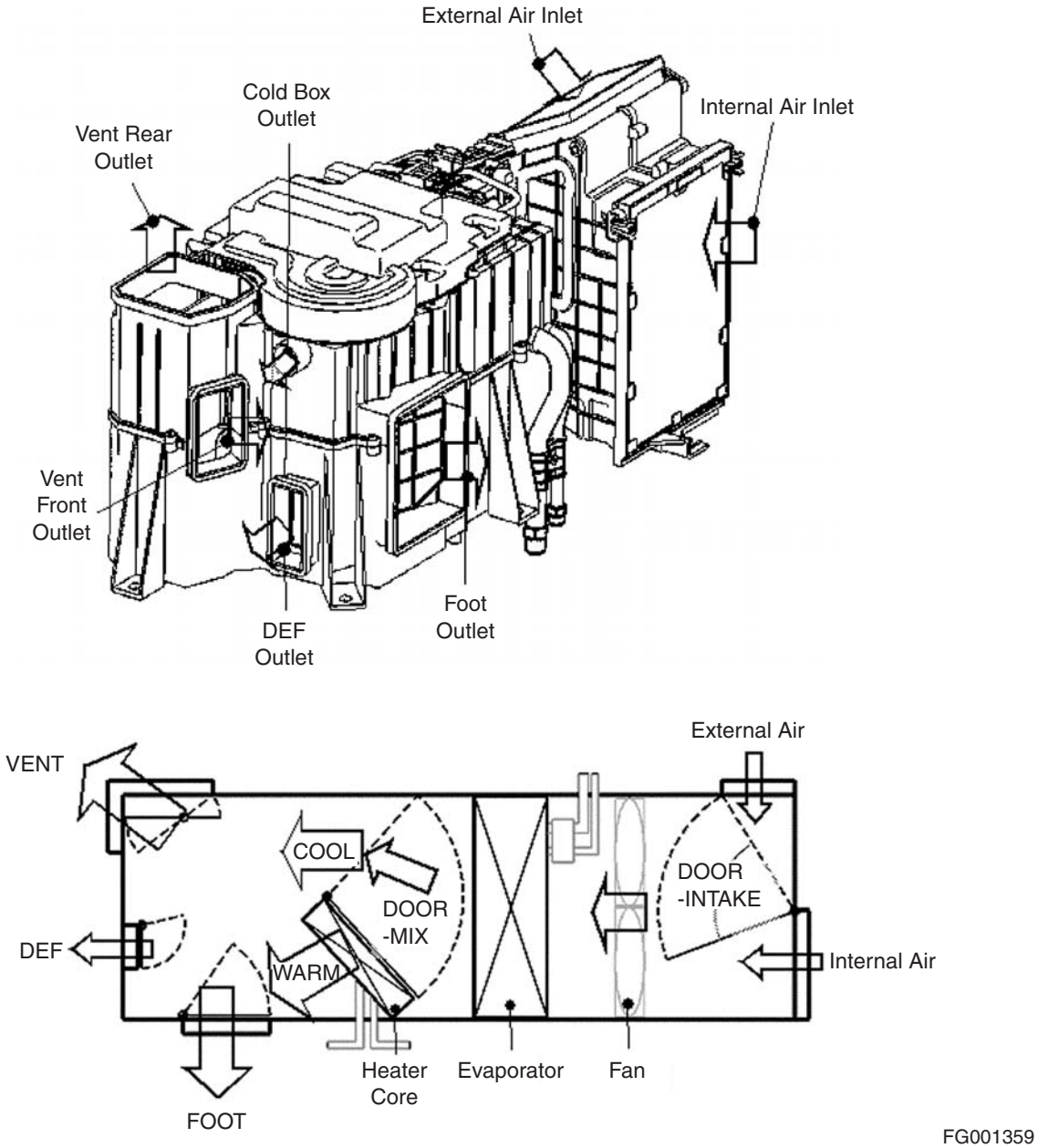


Figure 8

Door Open by Vent Modes

Door	Mode				
	Vent	Bi-level	Foot	Def/foot	Def
Vent	100	60	0	0	0
Foot	0	40	100	80	60
Def	0	0	0	20	40

Main Components

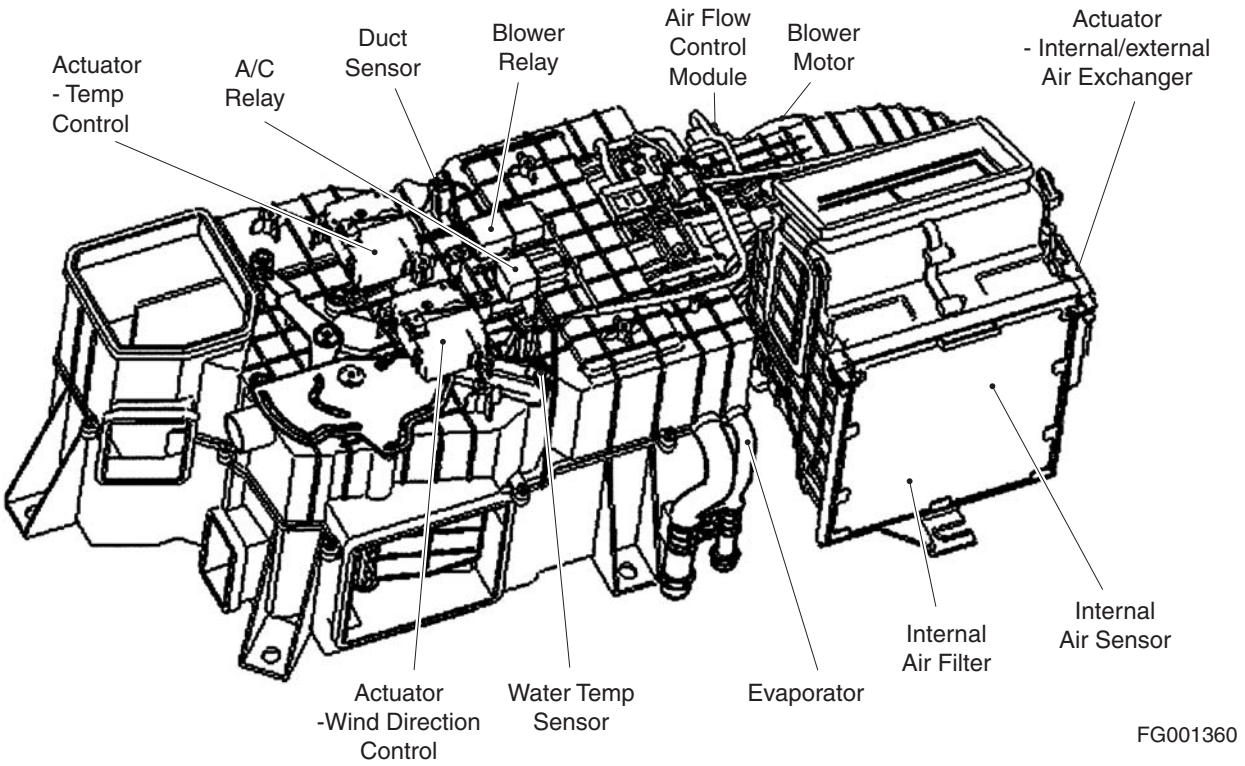
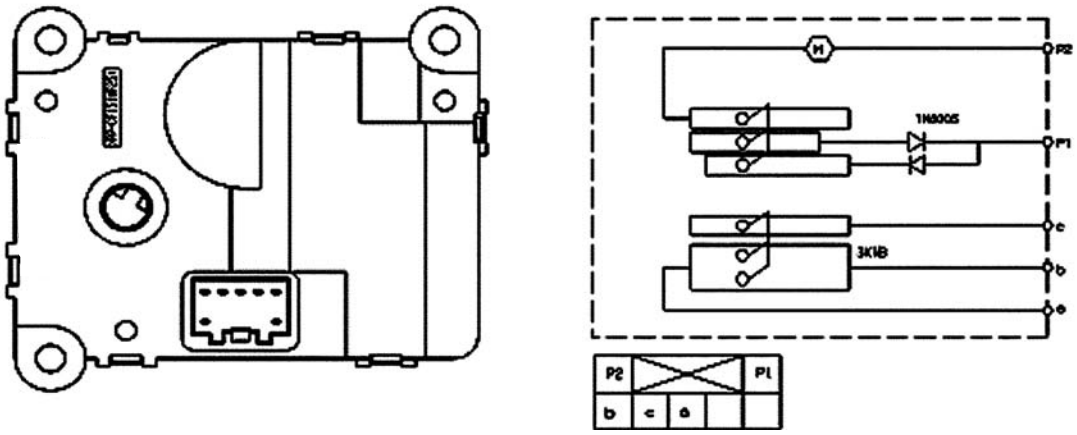


Figure 9

Actuator - Wind direction control: change of discharged airflow according to selected wind direction mode - Change of wind direction: Direction changes in the order of VENT→ BI-LEVEL → FOOT → FOOT/DEF → VENT.

Actuator - Temp control: Change of discharged air temperature by controlling the position of temp control door.



FG001361

Figure 10

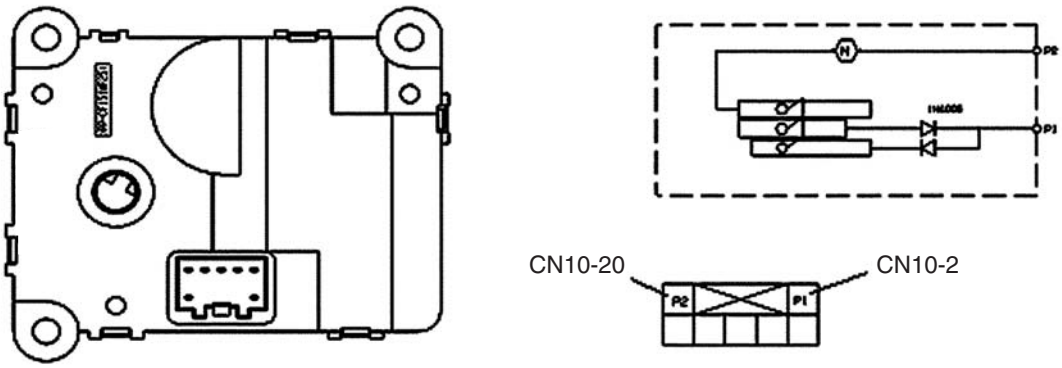
Actuator - Wind direction control

Wind Direction Mode	Output Terminal	Voltage
Vent	c (+): CN10-10 b (-): CN10-4	0.5 ±0.2V
Bi-level		1.3 ±0.2V
Foot		2.45 ±0.2V
Foot/def		3.5 ±0.2V
Def		4.5 ±0.2V

Actuator - Temp control

Set Temp	Output Terminal	Voltage
Maximum cooling	c (+): CN10-9 b (-): CN10-4	Below 0.4V
Maximum heating		Above 4.5V

Actuator - Internal/external air exchange



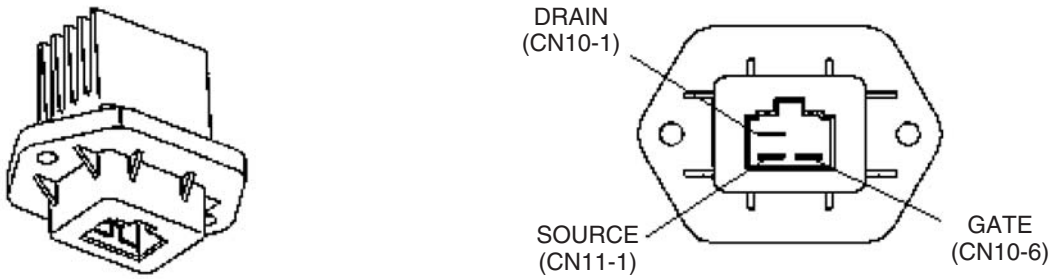
FG001055

Figure 11

Sel mode	Output Terminal	Output
Internal Air	P1 (+), P2 (-)	Moving of exchange door by selecting external air
External Air	P1 (-), P2 (+)	Moving of exchange door by selecting internal air

Airflow Control Module

Airflow is controlled through the control of voltage between GATE and SOURCE.



FG001056

Figure 12

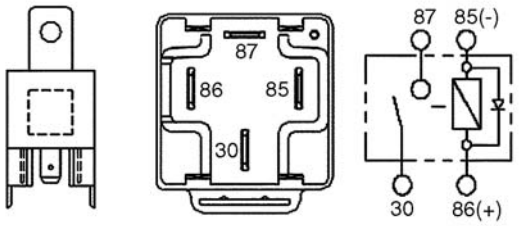
Airflow	Output Terminal		Output
1st	CN11-2	CN10-1	10 ±0.5V
2nd			12.5 ±0.5V
3rd			15 ±0.5V
4th			17.5 ±0.5V
5th			20.0 ±0.5V
6th			22.0 ±0.5V
7th			More than 25V

Applied voltage: Standard voltage is 27.5V.

Basically, airflow is set manually.

Relay - Blower: Power is supplied to the blower motor when the system is turned on.

Specifications	
Rated voltage	24V
Rated current	20A

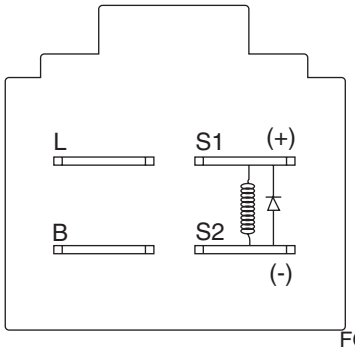


FG001057

Figure 13

Relay - A/C: Power is supplied to the magnetic clutch of the compressor.

Specifications	
Rated voltage	24V
Rated current	10A



FG001058

Figure 14

Duct sensor: It is inserted in the core of the evaporator to prevent freezing of the evaporator.

The sensor consist of negative characteristic thermistor that resistant value increases and decreases when the temperature rises and falls, respectively.

Temp (°C)	Resistance (KßŸ)
0	11.36 ±0.1
2	10.39 ±0.2
2.5	10.17 ±0.2
3	9.95 ±0.2
3.5	9.73 ±0.2
4	9.52 ±0.2
5	9.12 ±0.2
10	7.36 ±0.15
25	4.02 ±0.08
30	3.33 ±0.07

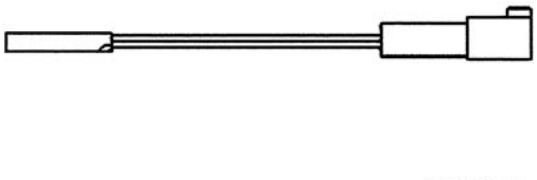


FG001059

Figure 15

Water temp sensor: It senses the temperature of coolant water in the heater core.

Temp (°C)	Resistance (KßŸ)
-10	55.8 ±1.7
0	32.9 ±0.9
15	15.76 ±0.5
25	10.0 ±0.3
35	6.5 ±0.2

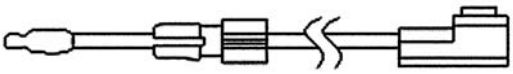


FG001060

Figure 16

Internal air temp sensor: Built in the internal air filter, it senses the internal temperature.

Temp (°C)	Resistance (KßŸ)
-15	218.2 ±7.5
0	97.83 ±0.9
15	47.12 ±0.7
25	30.0 ±0.36
35	19.60 ±0.3



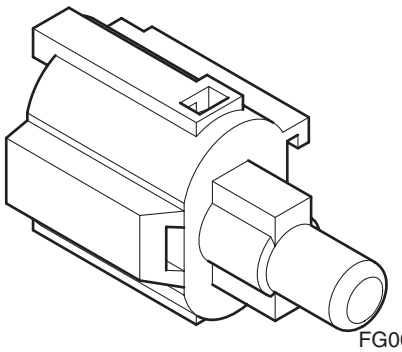
FG001061

Figure 17

Ambient Temperature Sensor

Built at the bottom of the cockpit, it senses the temperature of external air.

Temp (°C)	Resistance (KßŸ)
-10	163 ±4.9
0	96.9 ±2.9
10	59.4 ±1.8
20	37.4 ±1.1
25	30 ±0.9
30	24.2 ±0.7

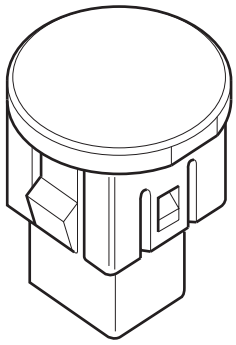


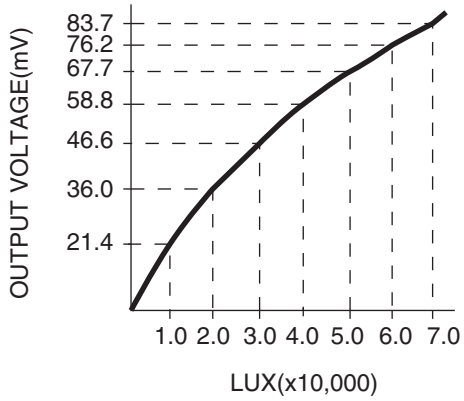
FG001064

Figure 18

Sun Sensor

Built beside the socket of standby power supply, it senses the quantity of the sun radiation to regulate discharge temperature and airflow as set by driver.



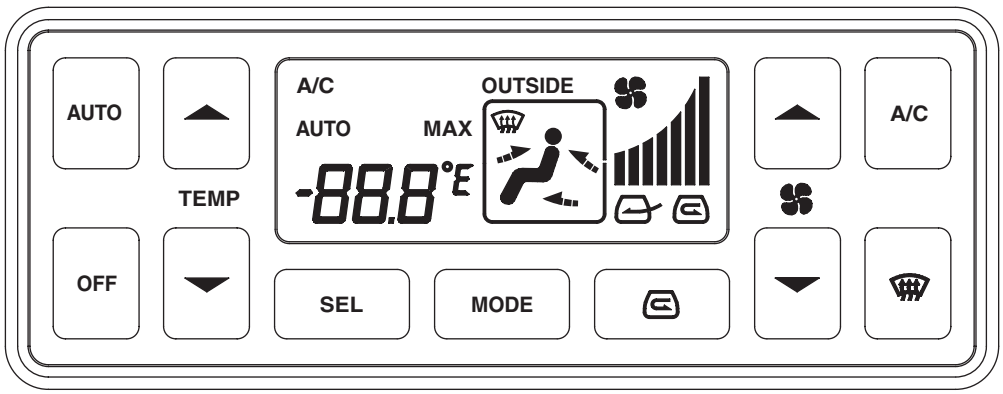


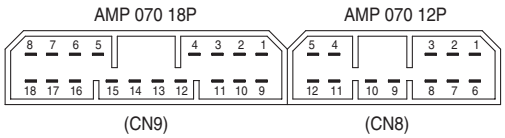
FG001062

Figure 19

Control Panel

Appearance and Terminal Arrangement





FG001063

Figure 20

Refer to Air Conditioner and Heater for functions of each switch.

Terminal Terms

CN	Term No.	Terms
CN9	1	Temp control (warm)
	2	Sensor earth
	3	Temp control Power (5V)
	4	Mix feedback
	5	Power (KEY ON)
	6	Backup
	7	-
	8	A/C output (LOW)
	9	-
	10	Earth
	11	Light
	12	External/internal air (Ex.)
	13	External/internal air (In.)
	14	Wind direction control (VENT)
	15	Wind direction control (DEF.)
	16	Wind direction control Power (5V)
	17	Wind direction control (feedback)
	18	Temp control (cool)

CN	Term No.	Terms
CN8	1	Water temp sensor
	2	Duct sensor
	3	Sun sensor
	4	Ambient air temp sensor
	5	Internal air temp sensor
	6	-
	7	-
	8	-
	9	-
	10	D.P.S CHECK
	11	Airflow module (gate)
	12	Blower motor (feedback)

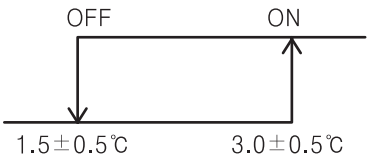
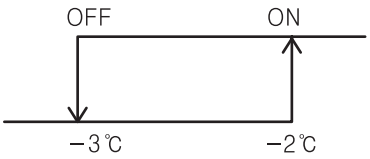
Control Logic

Categories	Inputs	System Operation
AUTO	Set Temp Internal air temp sensor External air temp sensor Water temp sensor Sun sensor	1. Automatically adjust room temp as set and then next items. Temp/wind direction/internal, external air/airflow/ compressor. 2. Auto mode is released when manually setting any switch except. Temp Control switch in Auto mode. 3. Upon the releasing of Auto mode, all of functions except selected S/W are controlled automatically.

<table>
<tr><th>Categories</th><th>Inputs</th><th>System Operation</th></tr>
<tr><td>Sensor compensation</td><td>Set Temp
Internal air temp sensor
Ambient temp sensor
Water temp sensor</td><td>1. In case of sensor failure, following defaults are applied:
Internal air temp sensor: 25°C Ambient temperature sensor: 25°C, Duct sensor: -2°C.
Temp setting actuator:
- Set Temp 17 - 24.5°C: Maximum cooling, Set Temp 25 - 32°C: Maximum heating.
Wind direction mode actuator
- VENT: VENT fix, modes other than VENT: Fixed to DEF
* Sun sensor is not compensated.</td></tr>
<tr><td>Maximum cooling/ heating control</td><td>Set Temp
Auto Setting</td><td>1. Set Temp 32°C: Maximum heating
2. Set Temp 17°C: Maximum cooling
<table><tr><th></th><th>Max Cooling (17 ˚C)</th><th>Max Heating (32 ˚C)</th></tr><tr><td>Temp Control Actuator</td><td>FULL COOL</td><td>FULL HOT</td></tr><tr><td>Air Flow</td><td>MAX HI</td><td>AUTO HI</td></tr><tr><td>Compressor</td><td>Forced ON</td><td>OFF</td></tr><tr><td>Intake/Recircle</td><td>Recircle</td><td>Intake</td></tr><tr><td>Wind Direction Mode</td><td>VENT</td><td>FOOT</td></tr></table>* Maximum cooling/heating control is possible only in Auto mode.</td></tr>
</table>

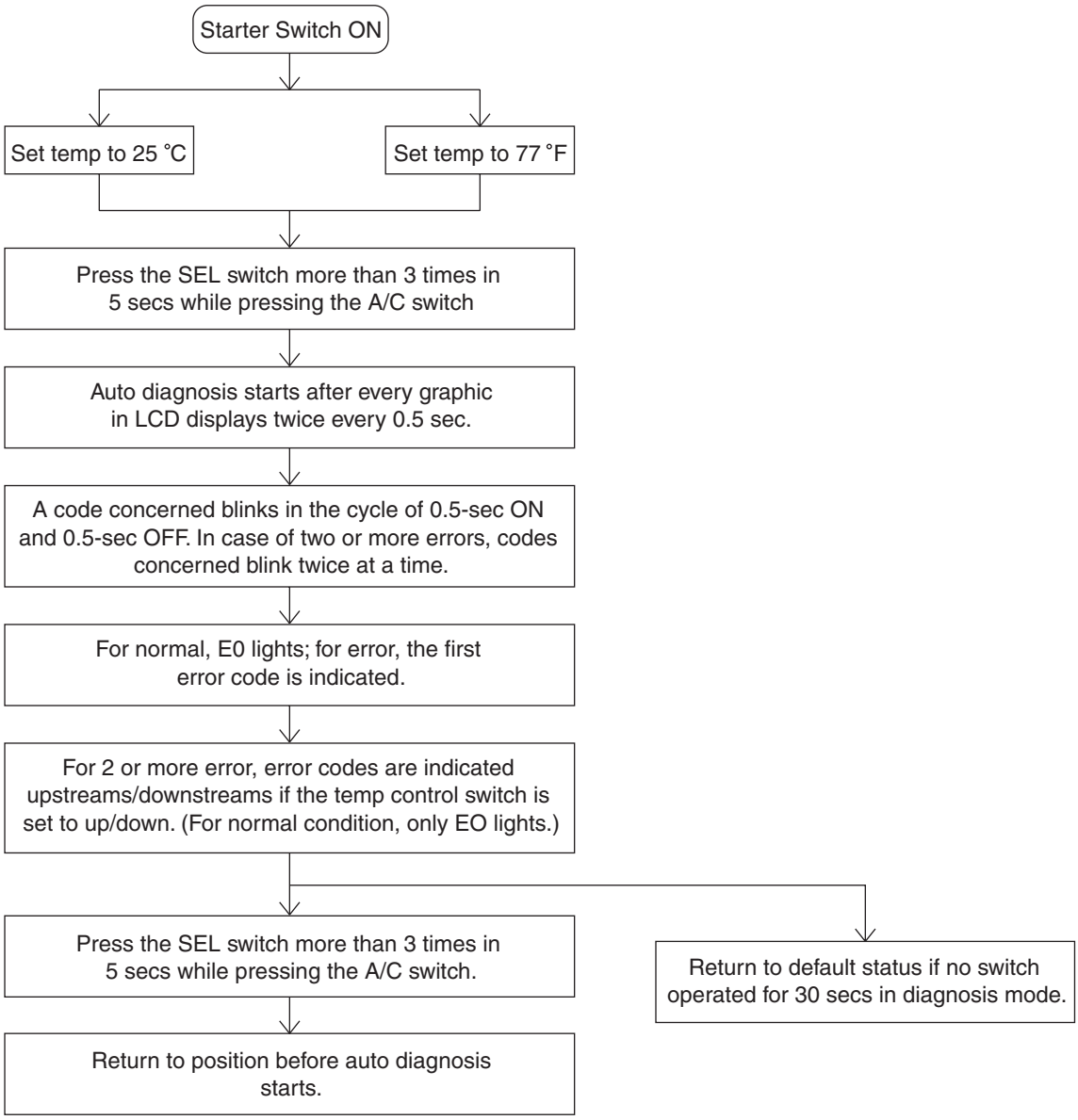
Categories	Inputs	System Operation
Starting Control of Cooling	Auto mode Duct sensor	1. Prevention of discharge of hot air before discharge temp drops enough in hot summer weather. 2. Start conditions (AND condition) (1) A/C ON (AUTO or manual) (2) Temperature sensed by the duct sensor is above 30°C (3) Airflow: Auto mode 3. One time control in the cycle of engine OFF → engine run 4. Initial cooling control is executed when the Auto S/W is On in the manual status. (A/C Off and manual control of airflow) in 5 seconds after engine run. 5. Initial cooling control must be before maximum cooling. 6. Release condition (OR condition) (1) A/C OFF (2) Airflow: Manual control (3) Release is possible with the OFF switch but not allowed within 12 seconds (after Start On) while the system is off using the OFF switch and during the time of initial cooling control.

Categories	Inputs	System Operation
Starting control of heater (1)	Water temp sensor Internal air temp sensor Auto mode Set Temp	1. Start condition (AND condition) (1) When wind direction mode is one of the following modes in the Auto or manual control mode - BI-LEVEL, FOOT or FOOT/DEF (2) The Water temp sensor is stable and the water temp < 73°C (3) Airflow: Auto mode (4) Set temp > Internal air temp + 3°C * Airflow falls gradually up to 12 seconds when operation released.
		2. One time control in the cycle of engine OFF → engine start 3. Initial heating control must be before maximum heating. 4. Airflow is controlled only when the wind direction is in the manual mode and BI-LEVEL, FOOT, or FOOT/DEF is set. 5. Control through the water temp sensor for start 6. Heater starting control (2) starts in case of fault of the water temp sensor during controlling. 7. Operation release (OR condition) (1) Only airflow is released if it is selected manually. (2) When handling the wind direction mode switch, only wind direction is released but the airflow control is performed only for the remaining period of the starting control of heater. (3) When Maximum Cooling (17°C) is selected. (4) Water temp sensor > 73°C

Categories	Inputs	System Operation
Initial heating control (2)	Water temp sensor External temperature sensor Internal air temp sensor Auto mode	1. Entry condition (AND condition) (1) Auto Mode (2) External air temp < 5°C and difference between external and internal air temp ??5°C (3) Failure of water temp sensor 2. Only one time of engine OFF → engine run 3. Starting control of heater is before maximum heating. 4. Operation release (OR condition) (1) Airflow: Manual selection (2) When handling the wind direction mode switch, only wind direction is released but the airflow control is performed only for the remaining period of the starting control of heater. (3) Difference between internal and external air temp>15°C (4) When Maximum Cooling (17°C) is selected. 5. Exceptional case Starting control of heater is performed only once during the remaining period if the entry condition is satisfied within the starting control period that is the accumulation of initial start times. (Inclusive of Auto mode ON case within the period of starting control of heater.) * Airflow must be reduced slowly for up to 12 seconds in case of exceptional entry case.
Compressor control	Duct sensor	1. Function: Magnetic clutch of compressor is turned ON/OFF depending on temp of the duct sensor to prevent the freezing of the evaporator with A/C being ON. 2. Control pattern 
	External temperature sensor	1. Function: Prevention of compressor in winter. 2. Control pattern  *Only for Auto mode.

Self-diagnostics

How to start self-diagnostics



FG001367

Figure 21

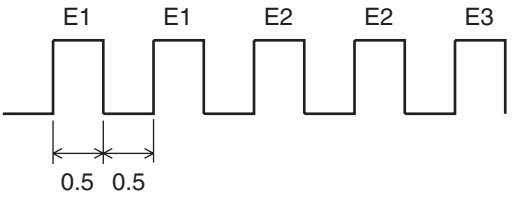
Error codes

Code	Description
E0	Normal
E1	Internal Air Sensor Short
E2	Internal Air Sensor Open
E3	Ambient Sensor Short
E4	Ambient Sensor Open
E5	Duct Sensor Short
E6	Duct Sensor Open
E7	Sun Sensor Short
E8	Sun Sensor Open
E9	Water Temp Sensor Short
E10	Water Temp Sensor Open
E11	D.P.S OPEN
E12	Actuator Place Error in Wind Direction Mode
E13	Temp. Control Actuator Place Error

NOTE: *Actuator place error means that it fails to move to designated place in 40 seconds.*

Sun sensor displays E8 in case of no sunlight.

2 and more fails: Codes concerned blinks twice at a time.



FG001067

Figure 22

Ambient Temp Display

Selection of both the SEL and MODE switch for more than 3 seconds indicates the ambient temp in the set temp display.

- Range of temp display: -40 - +60°C

NOTE: *Display of ambient temp may be released in the same way for its entry way.*

It returns automatically to default mode 5 seconds after entering the ambient air temp display mode.

Compressor

Categories	Specifications
Output	155.3 cc/rev (9.48 in3)
Oil Level	120 cc (ND-OIL8) (7.32 in3 (ND-OIL8))
Refrigerant	R134a
Rated Voltage	24V
Relief Valve	Open: 35 - 42.2 kg•cm^{2}G (500 - 600 psi) Close: 28.1 kg•cm^{2}G (400 psi)

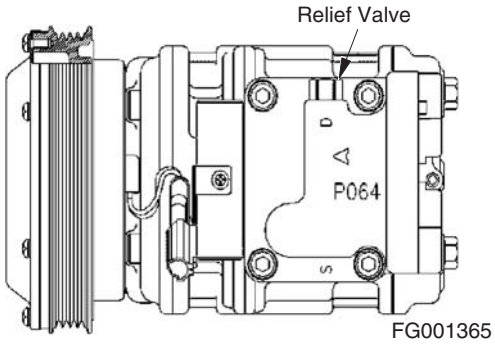


Figure 23

Compressor sucks in refrigerant which evaporates completely in the evaporator and discharges it to the condenser.

Refrigerant undergoes repeated changes of states, in the order of liquid, gas, and liquid in the freezing cycle, and the compressor makes evaporated refrigerant a high temperatures and high-pressured gas to freeze it in the condenser.

Receiver Driver

The receiver driver reserves refrigerant enough to ensure smooth freezing cycle responding immediately to the change of level in the freezing cycle.

As liquid refrigerant from the condenser may contain refrigerant gas with bubbles whose presence in the expansion valve decreases the freezing power excessively, it separates liquid and gas and sends liquid only to the expansion valve.

Water in refrigerant shall be eliminated with dryer and through filter.

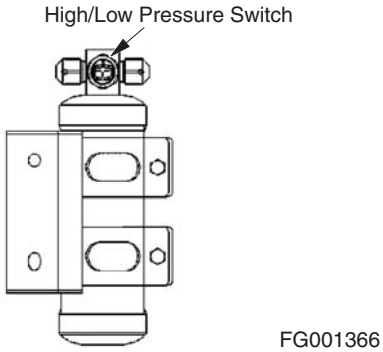


Figure 24

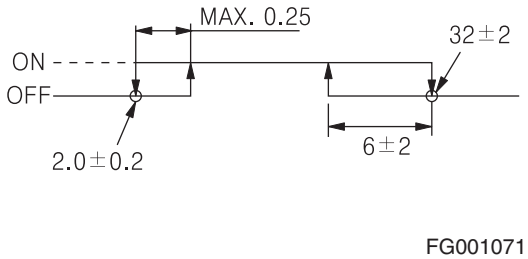
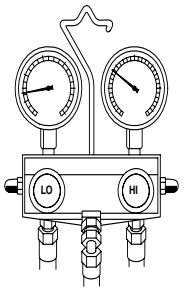


Figure 25

TROUBLESHOOTING

Refrigerant Pressure Check

1. Open all doors and windows.
2. Install manifold gauge set.
3. Start engine and maintain engine speed at 1,800 - 2,000 rpm.



HDA6074L

Figure 26

4. Check high / low-pressure of refrigerant.

1	**High-pressure: 8.0 - 10.0 kg•cm^2 (114 - 142 psi)** **Low-pressure: Approximately 1.0 kg•cm^2 (14 psi)**		
Possible Cause: Low Refrigerant Level			
Step	**Inspection Item**		**Remedy**
1	Check for traces of refrigerant oil.	Yes	Reassemble using correct tightening torque.
		No	Go to next step.
2	Using a leak detection device or soapy water check for refrigerant leakage at all major components and joints.	Yes	Repair leaking component.
		No	Recharge system to correct pressure.

2	**High-pressure: Over 23 kg•cm^2 (327 psi)** **Low-pressure: Approximately 2.5 - 3.0 kg•cm^2 (36 - 43 psi)**		
Possible Cause: Overcharge, Frost on condenser			
Step	**Inspection Item**		**Remedy**
1	Check for condenser pin damage or contamination.	Yes	Clean, repair or replace condenser.
		No	Refrigerant overcharge.

3	**High-pressure: Approximately 20 - 25 kg•cm^2 (285 - 356 psi)** **Low-pressure: Approximately 2.5 - 3.5 kg•cm^2 (36 - 50 psi)**
Possible Cause: Air in system.	
1. Recover any remaining refrigerant. 2. Vacuum out system. 3. Recharge system. **NOTE:** *If the system has been exposed to the air for a long time, replace the receiver dryer.*	

4	**High-pressure: Over 6 kg•cm^2 (85 psi)** **Low-pressure: Approximately 760 mmHg (Negative Pressure)**		
Possible Cause: Refrigerant does not circulate			
Step	**Inspection Item**		**Remedy**
1	1. Connect manifold gauge and start engine. 2. Turn on air conditioner. 3. Set blower switch to HIGH position. 4. Turn air conditioner OFF and wait 10 minutes. 5. Recheck high / low-pressure readings. High-pressure: 13.0 - 19.0 kg•cm^2 (185 - 270 psi) Low-pressure: 1.5 - 3.3 kg•cm^2 (21.3 - 46.9 psi)	Yes	Moisture in system, replace receiver dryer.
		No	Contaminated system, replace expansion valve. (Replace evaporator core assembly.)

5	**High-pressure: Over 6 - 18 kg•cm^2 (85 - 256 psi)** **Low-pressure: 500 mmHg (Negative Pressure) - Dial indicator needle unstable.**
Possible Cause: Moisture in system has iced up the expansion valve.	
NOTE:	*When the absorbed moisture freezes the pressure readings may look normal. Careful readings must be made to determine whether pressure is in normal range.*
1. Recover any remaining refrigerant. 2. Vacuum out system. 3. Recharge system. **NOTE:** *If the system has been exposed to the air for a long time, replace the receiver dryer.*	

6	**High-pressure: Over 22.0 - 23 kg•cm^2 (313 - 327 psi)** **Low-pressure: 2.5 kg•cm^2 (36 psi)**		
Possible Cause: Refrigerant pressure problem because of defective expansion valve or temperature sensor.			
Step	**Inspection Item**		**Remedy**
1	Inspect whether the temperature sensor is installed properly.	Yes	Replace expansion valve.
		No	Exchange duct sensor.

7	**High-pressure: Over 7.0 - 11.0 kg•cm^2 (100 - 156 psi)** **Low-pressure: 4.0 - 6.0 kg•cm^2 (57 - 85 psi)**
Possible Cause: Low refrigerant pressure because of poor compressor compression.	
Inspect and replace compressor if necessary.	

WEIGHT OF R134a GAS USED IN MACHINES

Model	Weight of Gas
DL300	850 ±20 grams (30 ±0.7 oz)
DL400	850 ±20 grams (30 ±0.7 oz)
DL500	850 ±20 grams (30 ±0.7 oz)
DX140W	800 ±20 grams (28 ±0.7 oz)
DX180LC	800 ±20 grams (28 ±0.7 oz)
DX225LC	800 ±20 grams (28 ±0.7 oz)
DX225NLC	800 ±20 grams (28 ±0.7 oz)
DX300LC	800 ±20 grams (28 ±0.7 oz)
DX300LL	800 ±20 grams (28 ±0.7 oz)
DX340LC	800 ±20 grams (28 ±0.7 oz)
DX35Z	450 ±20 grams (16 ±0.7 oz)
DX420LC	800 ±20 grams (28 ±0.7 oz)
DX480LC	800 ±20 grams (28 ±0.7 oz)
DX520LC	800 ±20 grams (28 ±0.7 oz)

REFRIGERANT SYSTEM REPAIRS

⚠ WARNING!

Always wear protective glasses and gloves when handling refrigerant. If refrigerant comes in contact with the skin or eyes, immediately flush with clean, running water and consult a physician.

Select a clean and well ventilated area to work.

The refrigerant container is under high-pressure and must be stored below 40°C (104°F). Be careful not to drop the container from a high location.

The contents are under high-pressure and should not be used with compressed air or near an open flame.

Refrigerant Safe Handling Procedures

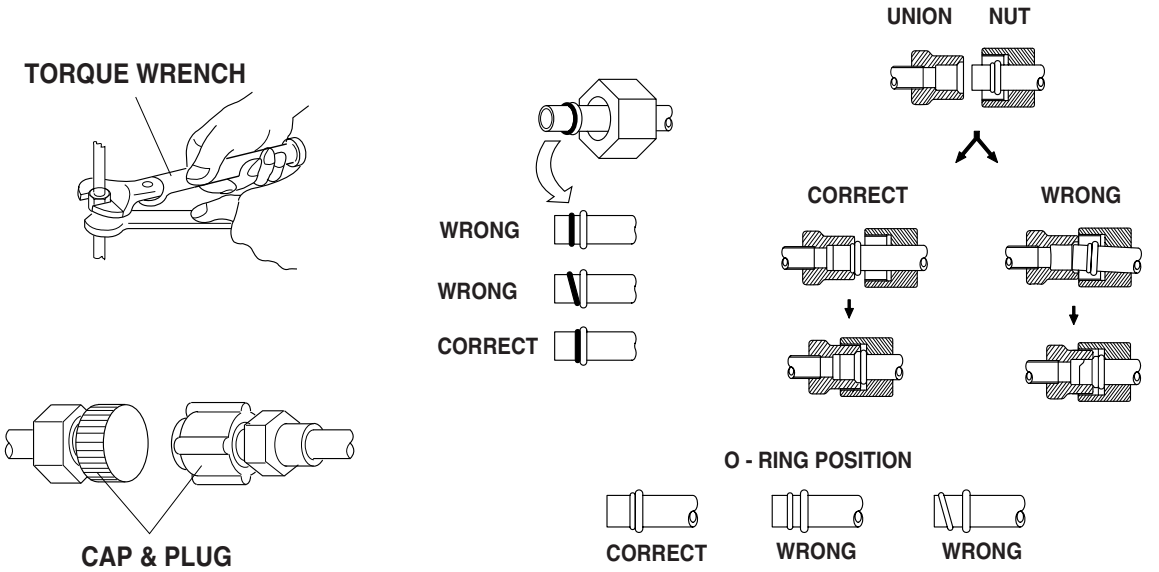


Figure 27

The following procedures must be observed for safe handling of refrigerant during vacuum and charging process.

1. Use an approved recovery / charging device which can safely perform vacuum and charge work simultaneously.
2. The new refrigerant has improved cooling characteristics than the old type and care must be used not to overcharge the system.

3. Do not over tighten connections when working on refrigerant system.
4. The new refrigerant system standards require new tools, equipment and parts. DO NOT attempt to use parts from old refrigerant system.
5. The new refrigerant oil (PAG type) has a high moisture absorption characteristic. When the refrigerant system vacuum seal has been broken, immediately plug up all openings to prevent moisture from entering the system.
6. When joining unions which use O-ring seals, lightly coat O-rings with refrigerant oil. Be careful not to drip oil on the threads of the nut.
7. Be certain the O-rings are seated properly on the refrigerant line lip. Always use new O-rings when reassembling parts. Do not reuse old O-rings.
8. Use a vacuum pump to evacuate refrigerant system of air.
9. When charging the refrigerant system with the engine running, do not open the high-pressure valve on the manifold gauge as the reverse flow of high-pressure refrigerant will rupture the hose.
10. When releasing the high-pressure hose after completing the charging process, quickly disconnect the hose to minimize refrigerant released to the air.

Repair and Replacement Procedure

1. Work Procedure
   A. Before repairing or replacing any refrigerant components first, return all refrigerant oil to the compressor and perform recovery procedures.
2. Operating Condition
   A. Run engine at maximum engine speed.
   B. Select 'HI' blower fan speed and select A/C switch to 'ON'.
   C. Set the temperature control switch for maximum cooling and leave running for approximately 20 minutes.

      NOTE: *The manifold gauge dial pointer can vary depending on the outdoor temperatures.*

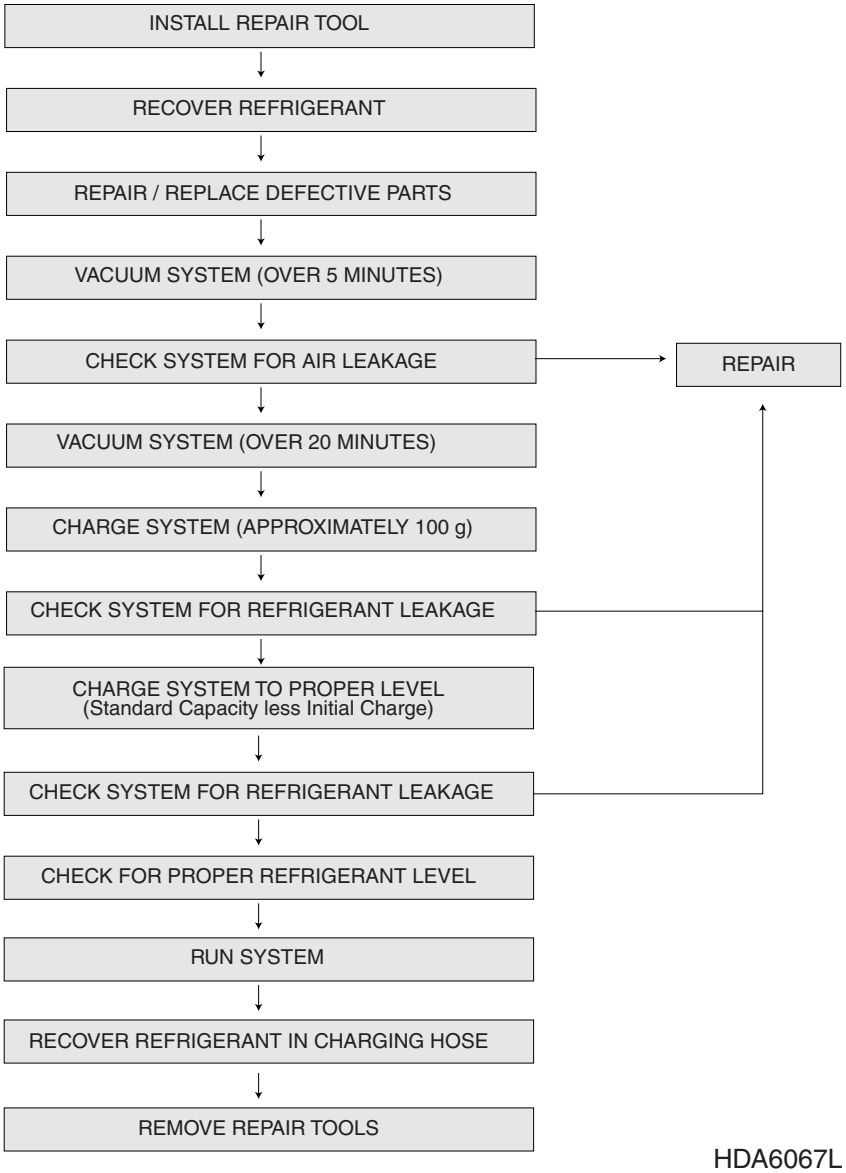

INSTALL REPAIR TOOL
RECOVER REFRIGERANT
REPAIR / REPLACE DEFECTIVE PARTS
VACUUM SYSTEM (OVER 5 MINUTES)
CHECK SYSTEM FOR AIR LEAKAGE
REPAIR
VACUUM SYSTEM (OVER 20 MINUTES)
CHARGE SYSTEM (APPROXIMATELY 100 g)
CHECK SYSTEM FOR REFRIGERANT LEAKAGE
CHARGE SYSTEM TO PROPER LEVEL
(Standard Capacity less Initial Charge)
CHECK SYSTEM FOR REFRIGERANT LEAKAGE
CHECK FOR PROPER REFRIGERANT LEVEL
RUN SYSTEM
RECOVER REFRIGERANT IN CHARGING HOSE
REMOVE REPAIR TOOLS
HDA6067L

Figure 28

Refrigerant Recovery

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	From Receiver
5	Refrigerant Recovery Tank

1. Attach the manifold gauges and the refrigerant recovery unit to the refrigerant lines as shown.

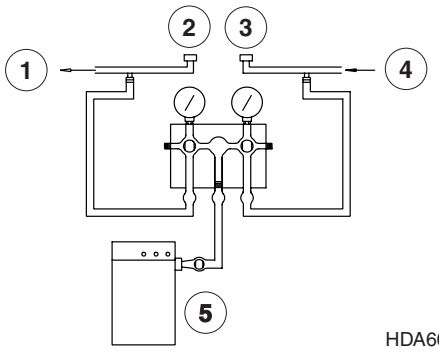
   NOTE: *Be careful not to switch the connections for the low and high-pressure valves.*

2. Open the high-pressure valve slowly to release the refrigerant to the recovery unit.

   NOTE: *Open the valve slowly, while checking to see that refrigerant is not leaking out.*

3. When the manifold gauge dial falls below 3.5 kg•cm^2 (50 psi), slowly open the low-pressure valve.

4. Open both the high and low-pressure valves slowly until the manifold gauge dials indicates 0 kg•cm^2 (0 psi).



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Figure 29

Vacuuming Refrigerant System

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	From Receiver
5	Vacuum Pump

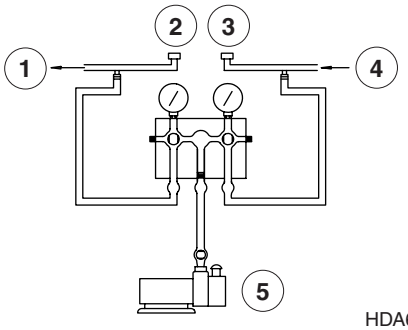
1. Vacuuming Procedure

   NOTE: *When the A/C system has been exposed to the air, it must be vacuumed out. Perform vacuum process for 30 minutes for complete moisture and air evacuation.*

   A. Attach the manifold gauges and vacuum pump to the refrigerant system as shown.

   B. Turn on the vacuum pump and open both valves.

   C. When the low-pressure gauge shows approximately 710 mmHg, close both valves and turn off vacuum pump.



HDA6068L

Figure 30

2. Check system for vacuum leak.

   Allow system to sit for 10 minutes and check whether the system is holding the pressure. If the pressure has dropped, it must be repaired before proceeding to the next step.

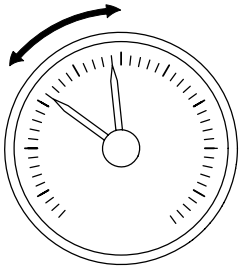
3. Vacuuming Procedure

   If the system is holding the pressure and it has not changed for 10 minutes, vacuum out the system for an additional 20 minutes.

   A. Turn on the vacuum pump and slowly open both valves.

   B. Allow vacuum pump to run for additional 20 minutes until the low-pressure gauge dial reads approximately 750 mmHg.

   C. Close both valves and stop the vacuum pump.

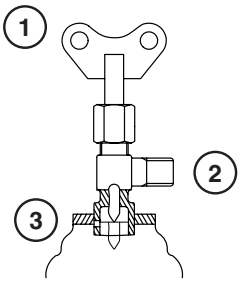


HDA6069L

Figure 31

4. Installation of Refrigerant Container

Reference Number	Description
1	Handle
2	Hose Connection
3	Mounting Disk



HDA6070L

Figure 32

   A. Before mounting valve on the container, make sure the handle is in the counterclockwise most position, with the puncture pin retracted and the mounting disk is in the raised position.

   B. Attach the manifold gauge center hose to the valve assembly.

   C. Turn the disk in the clockwise direction and securely mount valve onto refrigerant container.

   D. Turn the valve handle in the clockwise direction and puncture the container seal with the pin.

   E. Once the can has been punctured, turn the handle in the counterclockwise direction so the refrigerant can flow into the manifold gauge center hose. At this time, do not open the low and high-pressure valves of the manifold gauge.

   F. Press the manifold gauge low side valve to eliminate the trapped air in the hose.

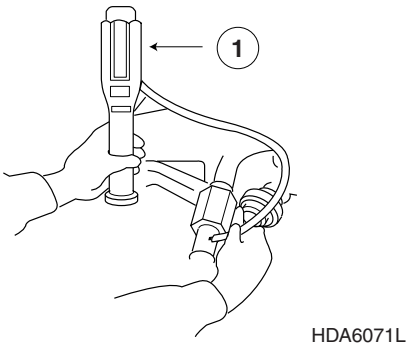
Leakage Check

NOTE: *Perform the leakage check after completing vacuuming process.*

1. After attaching the manifold gauge, open the high side valve.
2. Charge system until the low side gauge dial indicates a pressure of 1 kg•cm^2 (14 psi) and close the high side valve.
3. Using a refrigerant leak detector or soapy water check each joint for leakage.

Reference Number	Description
1	Refrigerant Leak Detection Device

4. If a leak is detected, check for O-ring damage or correct tightening torque and replace or repair as necessary.
5. If no leaks are detected, proceed with the charging process.



HDA6071L

Figure 33

⚠ WARNING!

For accurate refrigerant leak detection, perform leak detection procedure in a well ventilated area.

Refrigerant Charging

1. Perform the vacuuming procedure, vacuum holding and leaking tests as described in the preceding headings.

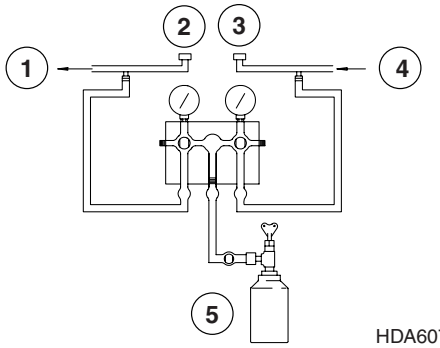
   NOTE: *First charge the refrigerant system with 100g (3.5 ounces) of refrigerant with the engine off. Then using the manifold gauges as a guide fully charge the system with the engine running.*

   When exchanging refrigerant containers, press the manifold gauge low side valve to eliminate air from the charging hose.

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	From Receiver
5	Refrigerant Supply Container

2. Charge the system by opening the manifold gauge low side valve.

   Initial charge amount: 100 g (3.5 ounces).



HDA6072L

Figure 34

3. If refrigerant does not flow freely into system, try starting engine first before operating air conditioner.

   - Temperature control switch setting: Maximum Cooling

     Blower Speed Setting: Hi (3 step)

     Engine Speed: 1,300 - 1,500 rpm

⚠ WARNING!

When charging refrigerant system with the engine running:

- **Always keep refrigerant supply container in the upright position.**
- **Never open the high side pressure valve.**

4. Open the manifold gauge low side valve and charge system to standard capacity.

Gauge Dial	Standard Reading
High Side Gauge	13 - 20 kg•cm^2 (185 - 285 psi)
Low Side Gauge	1.5 - 3.5 kg•cm^2 (22 - 50 psi)

NOTE: *These standards are for outside temperatures between 30° - 35°C (86° - 95°F). The gauge readings may vary for extreme temperature conditions.*

⚠ WARNING!

- **When outside temperature is low, warm the refrigerant supply container with warm water not exceeding 40°C (104°F). Do not allow water to come in contact with the charging adapter valve handle.**
- **When outside temperature is high, cool off refrigerant supply container and condenser to aid the refrigerant charging process.**

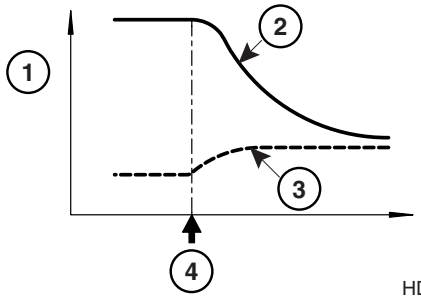
5. Close low-pressure side valve.
6. Shut off engine and close refrigerant supply container adapter valve. Disconnect manifold gauge hoses from vehicle.

Inspecting System For Leakage

After completing charging procedures, clean all joints and connections with a clean dry cloth. Using a refrigerant leak detecting device or soapy water, inspect system for leaks starting from the high-pressure side.

NOTE: *When the refrigerant circulation has been stopped the high-pressure will start to decrease and the low-pressure will start to increase until they are equalized. Starting the inspection from the high side will result in an accurate test.*

Reference Number	Description
1	Pressure
2	High-pressure
3	Low-pressure
4	Compressor Stop



HDA6073L

Figure 35

Inspection Procedure

1. High-pressure Side

   Compressor outlet → condenser inlet → receiver dryer inlet → air conditioner unit inlet.

2. Low-pressure side

   Compressor inlet → air conditioner unit outlet.

3. Compressor

   Compressor shaft area, bolt hole area and magnetic clutch area.

4. Receiver dryer

   Pressure switch and plug area.

5. Connection valve area

   Inspect all valve areas.

   Verify all valves are capped to prevent leaking.

   Check for foreign material inside of valve cap.

6. Interior of air-conditioning unit.

   After stopping engine, insert detector probe into drain hose. (Leave inserted for 10 seconds minimum.)

   NOTE: *When inspecting leakage from the air-conditioning unit, perform the inspection in a well ventilated area.*

Drive Coupling (Main Pump)

Edition 1

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Drive Coupling (Main Pump)

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MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

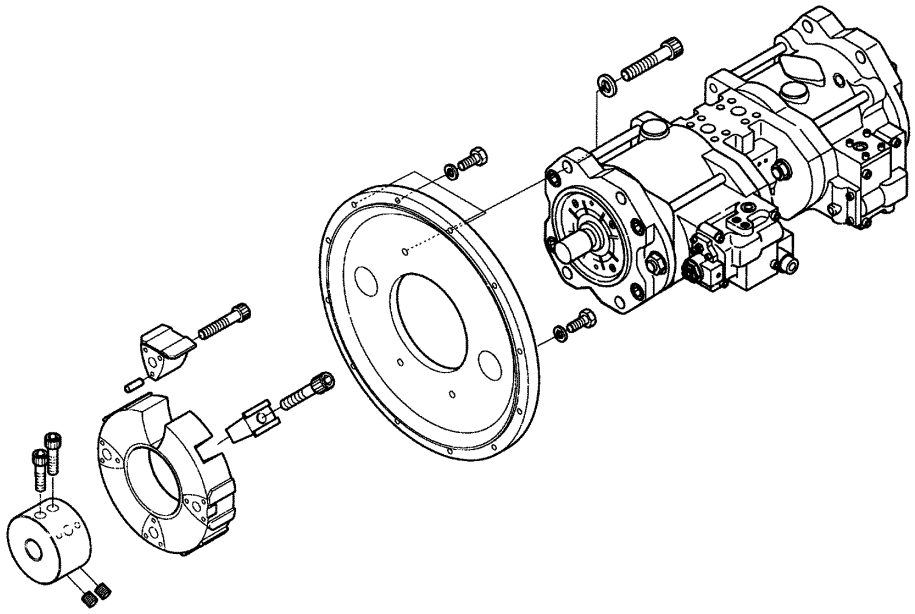
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up

DRIVE COUPLING

It is very important to set specified clearance between the end of the pump driveshaft (the "Dimension H" described below) and the coupling hub surface when installing the main pump in the engine.

The Figure 1 shows installation of a typical drive coupling.



HAAA8380

Figure 1

SPECIAL TOOLS

This tool is used to adjust the clearance, referred to as "Measure H" in the installation instructions below, between the pump driveshaft and the front side of the drive coupling hub (4, Figure 2).

NOTE: *Dimensions A and B are the same as Measure H in* Figure 3*. Two tools in the figure below are designed for various models, while only their one end may be used in some special models.*



Figure 2

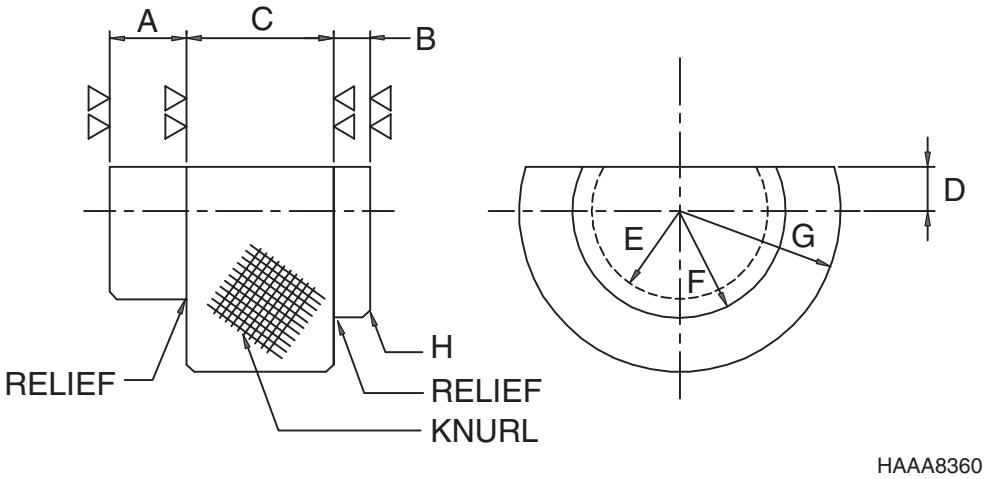


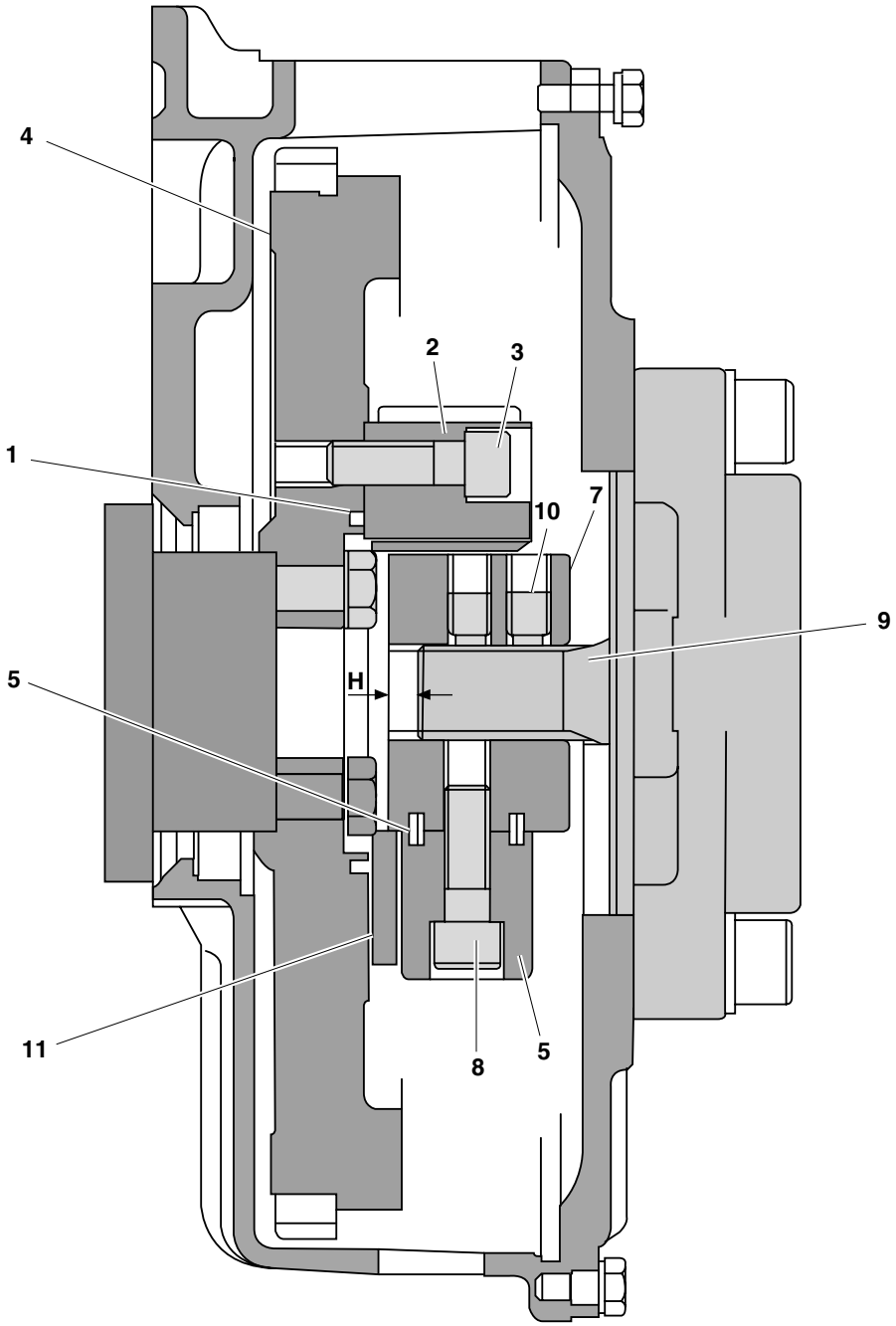
Figure 3

MODEL	A	B	C	D	E	F	G	H
DX225LC	10.5 ± 0.1 mm	5.0 ± 0.1 mm	20.0 mm	7.0 mm	Radius, 12.0 mm	Radius, 14.0 mm	Radius, 25.0 mm	1.0 mm X 45°

INSTALLATION OF DRIVE COUPLING

Follow the installation dimensions and procedures whenever installing the drive coupling in the main pump.

NOTE: *Failure to follow the procedures results in noise and the shortage of the service life of the drive coupling or the main pump.*



HAAA8040

Figure 4 INSTALLATION OF DRIVE COUPLING

Parts and Torques			
References	**Parts**	**Qty**	**Torque**
1	Spring Pin	4	
2	Insert	4	
3	Bolt	4	Ta
4	Flywheel	1	
5	Spring Pin	8	
6	Insert	4	
7	Hub	1	
8	Bolt	4	Ta
9	Pump Shaft	1	
10	Fixing Nut	2	Tb
11	Element	1	

Ensure to follow the specification of Measure H from the front hub surface to the pump shaft and tightening torques of bolts and screws.

MODEL	Coupling Part Reference	Measure H	Torque of Ta	Torque of Tb
DX225LC	K1013825	10.0 - 11.0 mm	21 - 23 kg•m	10 - 12 kg•m

Installation Procedure

NOTE: *Refer to Figure 5 for the installation procedure.*

1. Install spring pin (1) and then insert (2) with bolt (3) into engine flywheel (4).

   NOTE: *Tighten the bolt using the torque Ta value specified in the table.*

2. Install two spring pins (5) and then insert (6) in bolt (8) of hub (7).

   NOTE: *Tighten the bolt using the torque Ta value specified in the table.*

3. Install the flywheel cover in the main pump with bolts.

4. Connect hum (7) with pump shaft (9) as referred to as Measure H in Table 1 and fix its position with screws (10).

   NOTE: *Tighten the screws using the torque Tb value specified in the table.*

   NOTE: *Apply Loctite #262 to fixing screws (10).*

5. Install element (11) between the engine flywheel (4) and the insert.

6. Install the main pump and hub (7) by gently pushing them with element (11).

7. Bolt down the flywheel cover and the pump housing on the flywheel housing.

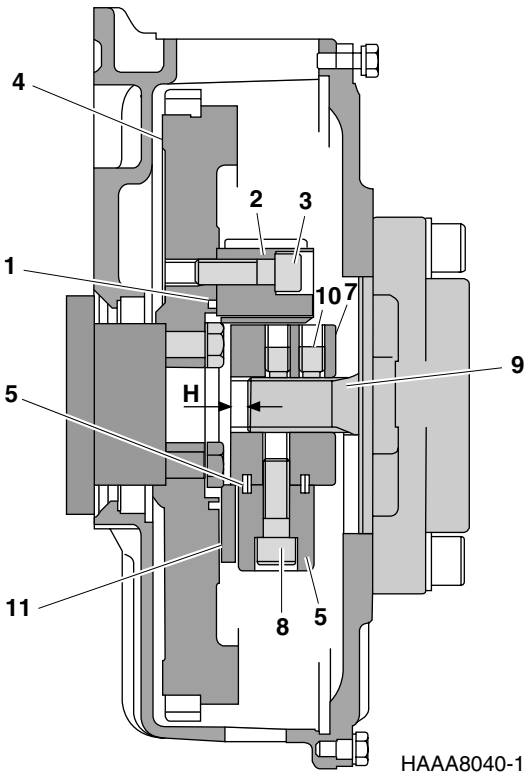


Figure 5

CAUTION!

Apply the adhesive to bolts (3 and 8) to prevent the loosening of seals. Do not use additional adhesive nor any oil or cleaning solvent. As element (11) cannot resist adhesive, oil, and grease, take care not have it exposed to such materials.

Remove oil and dust on the flywheel cover and the pump shaft before assembly.

Adjust the arrangement allowance between the pump and the engine at below 0.6 mm (0.023 in).

Hydraulics

Hydraulic System Troubleshooting, Testing and Adjustment

Edition 1

MEMO

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Hydraulic System Troubleshooting, Testing and Adjustment

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SAFETY PRECAUTIONS

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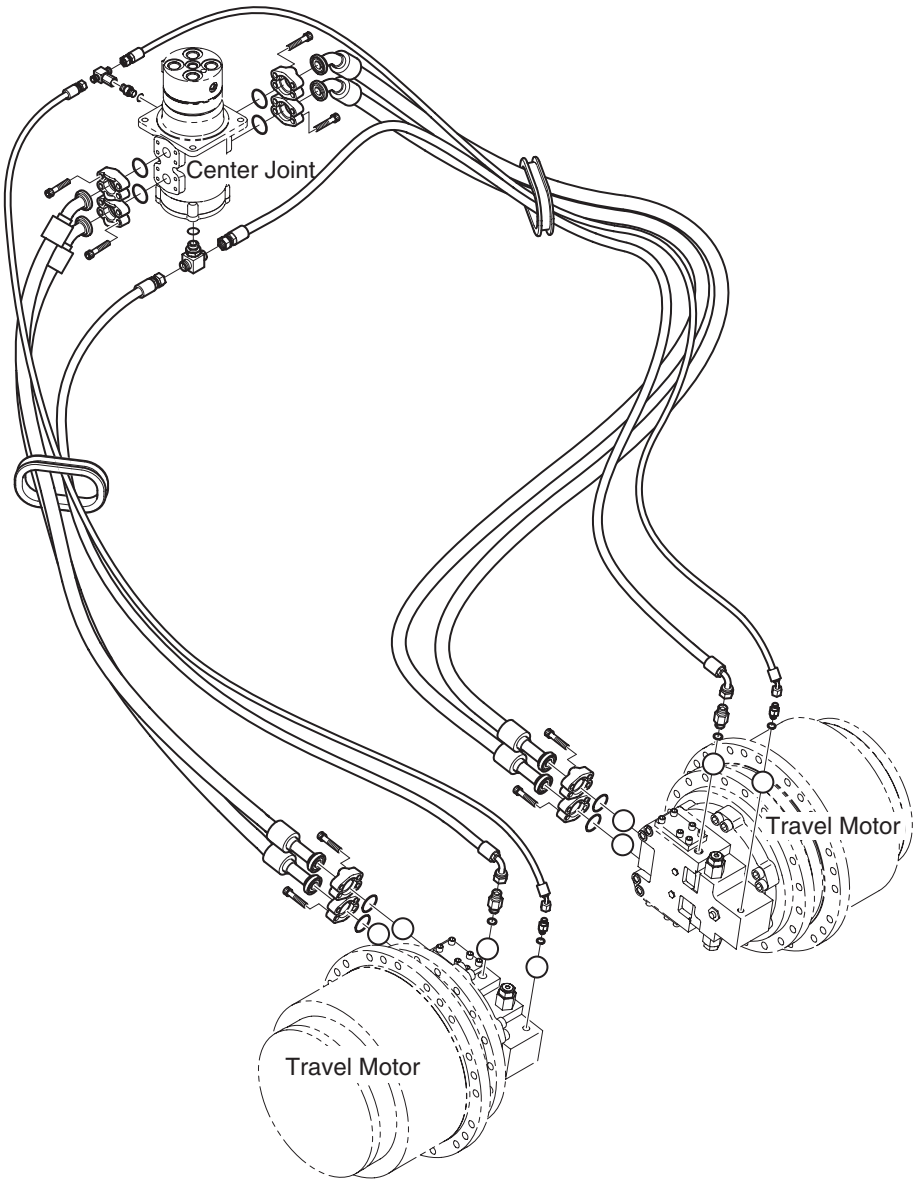
Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up
DX225NLC	5001 and Up

HYDRAULIC SYSTEM - GENERAL NOTES



FG001322

Figure 1

The hydraulic system has several improvements over conventional hydraulic systems - including cross sensing total horsepower control - to maximize output efficiency.

The system features an electronically controlled output optimization system, which allows the operator to choose between two, distinctly different power modes: high output/rapid cycling maximum speed power mode, and a standard power mode for most types of general operation.

Electronic management of hydraulic control valves assists in optimizing the application speed and overall operator control of hydraulic actuators and functions.

HYDRAULIC SCHEMATIC

The hydraulic schematic (s) is available in the "Hydraulic and Electrical Schematic Shop Manual." This manual is a collection of diagrams and schematics for several models.

General Notes

When referring to the schematic, refer to the following items:

- As shown in the schematic, the main pump assembly is driven by the engine. Mechanical energy is converted to hydraulic power, generating the required hydraulic flow which drives the system. Two main pumps (a right side pump and a left side pump) make up the main pump assembly.
- Hydraulic output from the right side pump is transmitted to the right side of the control valve. Output from the left side pump is transmitted to the valve spools on the left side of the control valve. Hydraulic output from the pilot pump is used to control the pump and to operate pilot and solenoid valves.
- The right half of the hydraulic control valve, supplied by the right pump in the pump assembly, operates valve spools for right travel, bucket, boom and arm functions. The amount of oil flow to the actuators at the output end of each of those circuits is regulated through the movement of each individual valve spool.
- The left half of the hydraulic control valve, fed by the left pump in the pump assembly, has control spools for left travel, swing, boom up and arm operation.
- Two-stage operation is a feature of boom and arm function. All of these circuits can be operated using the output of only one half of the hydraulic pump assembly (one pump or the other), or – since both halves of the control valve have a spool and available circuit for these functions – the output of both pumps can be combined, allowing higher speed operation. Boom up, arm crowd and dumping functions can operate in any one of the two available power modes – the standard or general duty mode, the high-speed/ rapid cycling mode.
- Whenever the right travel or left travel control spools are shifted, output from the main pump assembly flows through the center joint to one or both of the axial piston motors driving the side frame crawler tracks. A pilot valve connected to the swash plate of each travel motor changes motor capacity (and output) in direct proportion to the position of the travel switch selected by the operator.

- The hydraulic reservoir return line and the pilot circuit both have 10 micron full flow filters. The disposable elements in these two canister type filters trap and remove impurities from the oil in the system. An 80 mesh, 177 micron reservoir intake strainer also helps maintain system cleanliness and should be cleaned each time hydraulic fluid is drained and replaced. An oil cooler in the hydraulic system helps maintain the operating temperature of the system at approximately 50°C (122°F).
- The arm cylinder operating circuit includes anticavitation valves which protect the hydraulic system from vacuum that could result from external shocks or other unusual conditions. Boom, Arm, and Bucket cylinder circuit are also protected by overload relief valves. Whenever high-pressure is generated because of a shock or overload, excess pressure is dumped to the reservoir return circuit through the relief valve.

A selection valve in the travel circuit can be used to provide constant high torque/low speed travel, or variable speed/variable torque output for travel. To prevent sliding during simultaneous travel and boom/arm/bucket operation, select the high torque/ low speed travel position.

OPERATION OF WORKING COMPONENTS

Boom Operating Circuit

The boom operating circuit includes the right and left main hydraulic pumps (both halves of the main pump assembly), both sides of the control valve and the boom cylinder. The circuit operates in boom down mode through the first shift position and through the second shift position in boom up mode. Overload relief valves set at 360 kg•cm^2 (5,112 psi) protect the hydraulic system from being damaged because of overloads or shocks to the boom.

Boom Up Circuit

When you pull the boom control lever backward, the right side pilot valve generates secondary boom up pilot pressure that is transmitted to the BOOM1 and BOOM2 spools of the control valve simultaneously. When secondary pilot pressure reaches 7 - 9 kg•cm^2 (100 - 130 psi), boom control valve spools open and oil from both pumps goes to the boom cylinder.

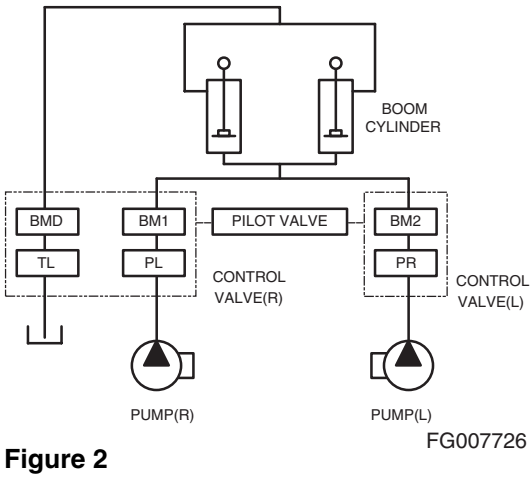


Figure 2

Boom Down Circuit

When the boom control lever is pushed forward, the right side pilot valve generates secondary boom down pilot pressure that is transmitted only to the BOOM1 spool of the control valve. When secondary pilot pressure reaches 7 - 9 kg•cm^2 (100 - 130 psi), the BOOM1 spool on the right side of the control valve opens so oil from only one pump (PUMP (R)) assembly goes to the boom cylinder for boom lowering.

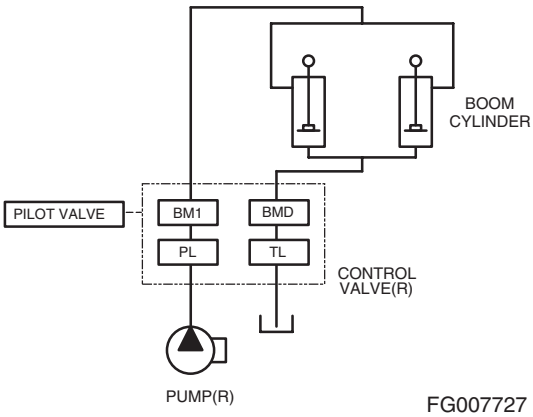


Figure 3

Arm Operating Circuit

The arm operating circuit includes both the right and left hydraulic main pumps, the right and left halves of the control valve, a slow return orifice, and the arm cylinder. The circuit can be operated in the two-stage speed control mode which works through both halves of the control valve and doubles the volume of oil flowing to the cylinder.

Overload relief valves set at 360 kg•cm^2 (5,112 psi) have been installed at the AM 1 and AMD 1 ports on the left side of the control valve to protect the circuit and system components from possible damage caused by shocks and/or overload pressure. Additional protection - to prevent cavitation of the cylinder - is provided by a makeup valve and reservoir return circuit, which ensures that the volume of oil going to the cylinder will not exceed the volume of oil coming out.

Arm Crowd Circuit

When the arm control lever is put in the crowd mode, the left side pilot valve generates secondary pressure that is transmitted to the AM1 and AM2 spools of the control valve simultaneously.

When secondary pilot pressure reaches 7 - 9 kg•cm^2 (100 - 130 psi), the arm control valve spools AM1 and AM2 open. Output flow from both halves of the pump assembly is directed to the arm cylinder.

When working in the arm crowd mode, under certain conditions, oil in the arm cylinder could suddenly be forced out by the weight of the arm and bucket. Insufficient oil flow to the cylinder could lead to cavitation in the cylinder and/or surging or irregular movement. This is prevented by a regeneration valve attached to the control valve which maintains the balance between oil flowing into the cylinder and oil flowing out.

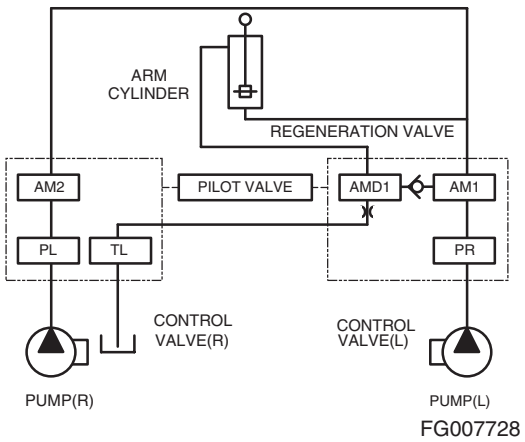


Figure 4

Arm Dump Circuit

When the arm control lever is put in "dump" mode, the left side pilot valve generates secondary pilot pressure that goes to both spools AM1 and AM2 of the control valve simultaneously.

When pilot pressure reaches 7 - 9 kg•cm^2 (100 - 130 psi), the control spools open, allowing oil from PUMP (L) and PUMP (R) to flow to the arm cylinder.

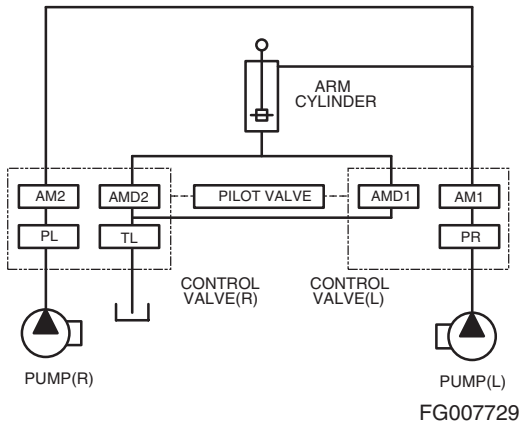


Figure 5

Bucket Operating Circuit

The bucket operating circuit includes the right main pump, the right half of the control valve and the bucket cylinder. 360 kg•cm^2 (5,112 psi) overload relief valves at BKT and BKTD 1 ports of the control valve protect the circuit and its components from being damaged.

Bucket Crowd Circuit

When the bucket control lever is placed in the crowd position, the bucket control valve spool on the right side of the control valve opens and oil from right main pump flows to the bucket cylinder.

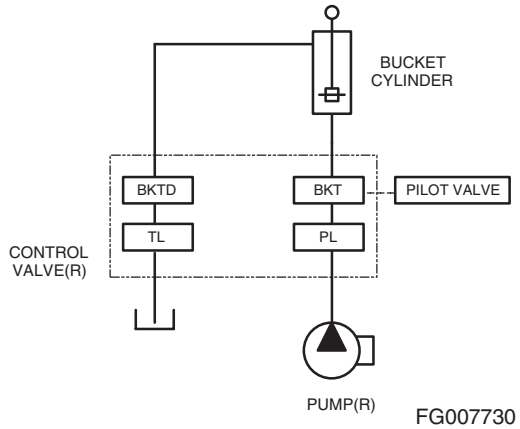


Figure 6

Bucket Dump Circuit

When the bucket control lever is put in the dump mode, the bucket control valve spool in the right half of the control valve opens to supply oil from the right main pump to the cylinder.

Swing Operating Circuit

The swing operating circuit consists of the left main pump in the pump assembly, the left half of the control valve and the swing motor. To keep the upper works from coasting when the swing control is in neutral, an electrical sensor in the control circuit activates a valve to automatically engage a mechanical brake.

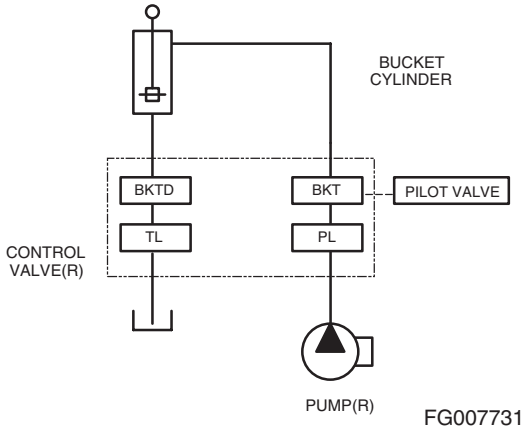


Figure 7

Right Swing Operating Circuit

When the swing control lever is pushed to the right swing position, pilot pressure from the left side pilot valve is directed to the left side pump regulator and left half of the control valve. Output flow from the left pump is then directed through the PR and SWR ports of the control valve to the swing motor.

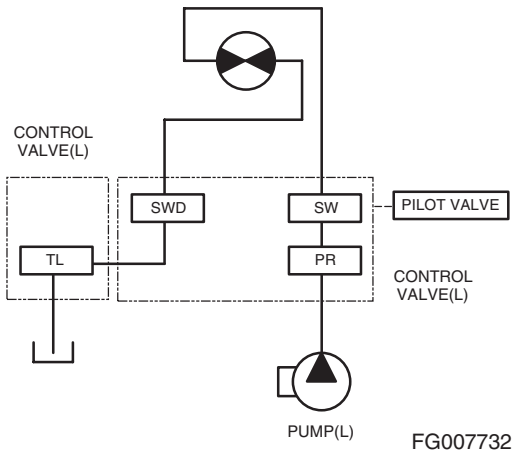


Figure 8

Left Swing Operating Circuit

When the swing control lever is pushed to the left swing position, the control valve spool at the left side of the control valve moves in the opposite direction and output flow from the left pump is directed through the PR and SWL ports of the control valve to the swing motor.

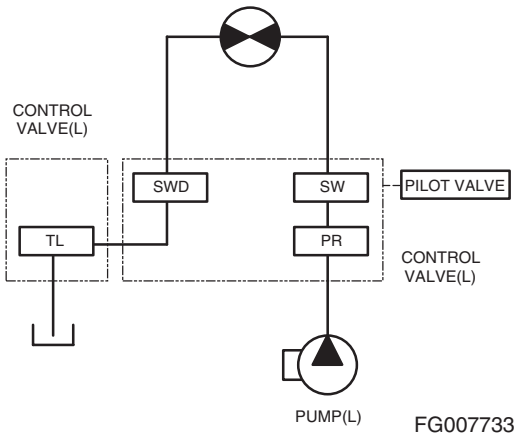


Figure 9

Swing Relief Valve and Makeup Valve

Whenever the spool is shifted to the neutral mode during swing operation, the possibility exists that surge pressure in the circuit - caused by inertial momentum of the upper works and correspondingly reduced pressure at the opposite motor port - could produce cavitation in the circuit. To keep that from happening, a 270 kg•cm^2 (3,840 psi) relief valve is installed in the swing motor and a large capacity makeup valve is connected to the entrance port of the hydraulic reservoir, helping maintain acceptable pressures on both sides of the circuit.

Travel Operating Circuit

Output flow from both halves of the pump assembly is directed to the right and left travel motors through the right and left sides of the control valve, and the upper works center joint.

Forward Travel Circuit

When the right and left travel control levers are pushed forward, output from both of the main pumps is directed through the PR, PL, TRRF, and TRLF ports on the control valve, through the upper works center joint, to the travel motors on each side of the machine.

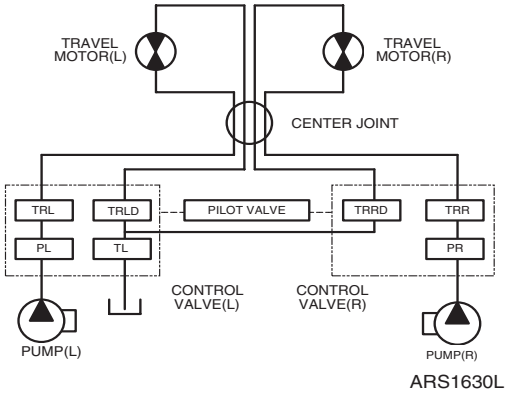


Figure 10

Reverse Travel Circuit

When the right and left travel control levers are pushed backward, output from both main pumps is directed through the PR, PL, TRRR, and TRLR ports on the control valve, through the upper works center joint, to the travel motors.

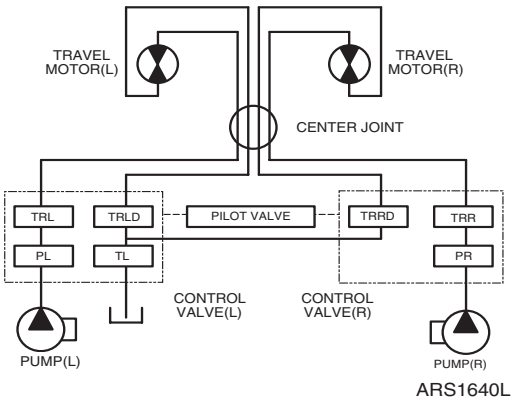


Figure 11

PROCEDURAL TROUBLESHOOTING BASELINE RECOMMENDATIONS

Initial Checks and Tests to Establish Operating Condition of the Excavator

Triage Summary

An excavator that fails to deliver designed performance should be checked for the following:

- Hydraulic flow, first, and.
- Hydraulic pressure, afterwards, in a specified order of priority through different points of the system.

To verify adequate available hydraulic flow, before any other tests are performed through the circuit:

Check engine operation -

- at 1,900 rpm with no load.
- at 1,900 rpm stall load.

If engine rpm drops excessively with a load or fails to surpass rated speed (1,900 rpm), performance problems may be because of inadequate hydraulic flow caused by lagging rotational speed.

NOTE: *Verify actual flow on the excavator against rated performance, with a flow meter.*

If engine tests meet specifications and adequate torque and horsepower are available at the pump drive flex coupling, pull out the electrical tray under the operator's seat to inspect the self-diagnostic display.

If the EPOS trouble code display is clear, check hydraulic functions in the following sequence:

- Pilot pressure.
- Negacon, negative control pressure.
- Main relief pressure (front and rear pump)
- Swing pressure.
- Port relief pressure (individual control functions; boom, arm, bucket, swing, and travel)
- Power boost circuit.
- Standard performance tests; cylinder speed, hydraulic motor (travel and swing) speed, cylinder oil tightness "permissible drift" test.

NOTE: *System specification performance tests of individual activator function are determined by flow rate through the component or circuit, not the control pressure or system pressure available to the actuator. Poor flow through the individual circuit may indicate that the component is worn beyond tolerance limits, while all other hydraulic functions are adequate.*

IMPORTANT

It is suggested that the troubleshooter maintain the testing sequence of the preceding list. Checks and adjustments nearer the middle or the end of the list may depend on adequate functioning of systems tested nearer the top of the list.

PILOT PRESSURE

Adjustment and Testing

⚠ WARNING!

This procedure should be done with two people. To reduce the chance of accident or unintended start-up, one person should remain at the operator's control stand while checks and adjustments are made.

Vent hydraulic pressure from the reservoir before breaking the seal on fittings to install two in-line "T-style" adapters and test gauges (60 bar/1,000 psi) at the gear pump outlet port, and at the joystick control valve pilot line.

Start the engine and turn the engine speed control dial to the maximum setting. After the excavator has been operated long enough to reach normal operating temperature, back off the engine control dial to minimum rated rpm speed. With all controls in neutral, make sure the left console control stand is locked in the down (operating) position and check pressure at the gear pump outlet port and at the joystick.

If gear pump pressure is outside the tolerance specified in the table, adjust gear pump relief pressure by loosening the locknut and turning the set screw in (clockwise) to increase pressure, or turning it out to decrease it.

NOTE: *Be aware that serial number changes and variation in the joystick assemblies used on different excavators could produce slight change in actual performance characteristics. Comparison of part numbers to serial numbers stamped on your assembly may be required, if questions or doubt exists.*

IMPORTANT

Top off the hydraulic fluid reservoir if there is any measurable loss of hydraulic oil during test gauge and adapter fitting installation.

Engine rpm	Pilot Pressure @ Pump	Pilot Pressure - Joystick
Minimum Speed Setting (full left) on Speed Control Dial	40 ± 5 bar (580 ± 73 psi)	23.5 ± 1.5 bar (341 ± 22 psi)

POWER MODE VALVE

Current Signal and Hydraulic Pressure Adjustments

WARNING!

This procedure should be done with two people. To reduce the chance of accident or unintended start-up, one person should remain at the operator's control stand while checks and adjustments are made.

The electromagnetic pressure proportioning control (EPPR) "power mode" valve is on the underside of the pumps (not visible in the harness connections drawing, because it is underneath the assembly), near the engine/pump flexible coupling, adjacent to the pump return line. To test and adjust power shift current and pressure through the power mode valve a multilead jumper harness is required. The jumper harness (which is available through *DOOSAN* After Sales Service, or could be spliced together from commonly available, purchased parts) has extra leads so a VOM meter can be connected to the circuit.

To set up the testing equipment, shut down engine and disconnect the single electrical lead from the power mode valve. Attach the jumper harness to the terminal on the valve, connect the test leads of the multimeter to the extra leads on the harness and reconnect the valve electrical lead.

Vent the lever on top of the hydraulic tank to relieve pressure and connect an in-line "T-style" adapter to the valve pressure port. Install a 60 bar (1,000 psi) test gauge in the adapter.

Restart the engine and increase engine rpm by turning the speed control to the maximum speed setting. Warm up the engine and hydraulic system until hydraulic oil temperature is at least 45°C (113°F). Select Power Mode on the Instrument Panel. Check current readings (in milliamps) on the VOM meter and hydraulic pressure gauge readings and make sure both conform to the values in the table below.

NOTE: *If recorded values do not conform to the specified current or pressure in the table, back off the locknut on the end of the valve, turn the adjusting screw 1/4 turn and recheck current and pressure. Repeat adjustment as required to obtain specified performance and retighten the valve locknut.*

SWING PRIORITY VALVE

Mode	Engine rpm	Current	Pressure
Power Mode	High Idle: 1,980 rpm	0 mA Midrange value corresponding to engine rpm for both current and hydraulic pressure readings.	0 bar (0 psi)
Standard Mode	High Idle: 1,900 rpm	300 mA	8 bar (116 psi)

Control Valve Pressure and Current Adjustments

⚠ WARNING!

This procedure should be done with two people. To reduce the chance of accident or unintended start-up, one person should remain at the operator's control stand while checks and adjustments are made.

The swing priority control valve is inside the compartment behind the cabin.

The same jumper harness used for testing the power mode (EPOS) control valve is used to test this valve. Shut down engine, disconnect either of the electrical leads and connect the test equipment to that side of the valve. An in-line "T-style" gauge adapter can be used to connect a 60 bar/870 psi (1,000 psi) test gauge to the outlet (pressure) side of the valve. Set the engine control speed dial to maximum and warm up the engine to at least 45°C (113°F) before making any tests.

NOTE: *Vent air from the hydraulic system before installing test equipment. Use the lever on the reservoir, while the engine is running. Pour clean replacement fluid into the system if excessive fluid was lost.*

To verify operation of the swing priority solenoid valve, connect test equipment and begin testing with the work mode switch set to "digging" (the state turning off the "trenching" light) and the engine speed control dial at the maximum rpm position.

Operate the swing motor in both directions. Measure signal current and hydraulic pressure through the valve and record the highest and lowest values as the swing motor rotate clockwise and counterclockwise several times. Reset the work mode control to "trenching" mode and repeat the same tests.

Valve Function / Work Mode	Signal Voltage	Hydraulic Pressure
Swing Priority / Digging	0 V	0 bar (0 psi)
Swing Priority / Trenching	20 - 30 V	20 - 40 bar (290 - 580 psi)

NOTE: *If recorded values do not conform to the specified current or pressure in the table, readjust as required.*

PRESSURE UP VALVE

Checks and Adjustments

⚠ WARNING!

This procedure should be done with two people. To reduce the chance of accident or unintended start-up, one person should remain at the operator's control stand while checks and adjustments are made.

Vent hydraulic pressure from the reservoir to install an in-line "T-style" adapter and test gauge (60 bar/1,000 psi) at the pilot pump signal port relief valve outlet.

Start the engine and turn the engine speed dial to maximum. When normal operating temperature is reached:

- Check pilot pressure and readjust it, if required:
- Select the Instrument Panel rear pump "pressure display."
- Select Power Mode.
- Stall the boom cylinder (towards the extend side).
- Read rear pump pressure on the Instrument Panel display.

Repeat all tests with and without "pressure up" selected through the console rocker switch and joystick button.

If the two-stage main relief valve was not set correctly and main relief high stage pressure ("pressure up") is outside the tolerance range, begin valve adjustment by loosening the outside (widest diameter) locknut on the relief valve. Turn the adjusting screw clockwise to increase pressure, or counterclockwise to decrease it. Pressure must be 350 bars (5075 psi), or up to 10 bars (145 psi) higher.

Because one adjustment can affect the other, check low stage main relief pressure by repeating the cylinder stall test without "pressure up." Readjust standard relief pressure by turning the innermost (smallest diameter) screw clockwise to increase the setting, or counterclockwise to decrease it. Pressure should be at least 330 bars (4,785 psi), but less than 335 bars (4,858 psi).

IMPORTANT

Pressure adjustments and checks cannot be made if pilot pressure is outside the specified range. Refer to the pilot pump adjustment procedure if required, then proceed with any necessary adjustments to main relief pressure settings.

Power Mode	Operation	Main Pressure and Tolerance	Pilot Pressure and Tolerance
Power Mode	Neutral, No Operation	20 - 40 bar (290 - 580 psi)	30 bar +10 bar (435 psi +145 psi)
Power Mode	Cylinder Stall	330 bar +5 bar (4,785 psi +75 psi)	30 bar +10 bar (435 psi +145 psi)
Power Mode W/ Pressure Up	Cylinder Stall	350 bar +10 bar 5,075 psi +145 psi	30 bar +10 bar (435 psi +145 psi)

NOTE: *The electrical pressure up (power boost) solenoid valve alongside the swing priority solenoid and arm speed control solenoid, in compartment rear of the operator's cabin, must be operating correctly, or pressure tests and further adjustments cannot be made.*

PUMP INPUT POWER CONTROL

Pump Regulator Adjustment

⚠ WARNING!

This procedure should be done with two people. To reduce the chance of accident or unintended start-up, one person should remain at the operator's control stand while checks and adjustments are made.

To perform these adjustments accurately the use of a flow meter is strongly recommended, as is consulting the factory (before starting work) to validate the need for making regulator adjustments. Vent hydraulic pressure from the reservoir before breaking the seal on fittings to install the flow meter kit. (Refer to the "Flow meter Installation and Testing" procedure.)

IMPORTANT

Before starting this procedure or going onto make any changes of adjustment settings:

- **Verify engine output to the rated speed – 1,980 ±50 rpm.**
- **Permanently mark setscrew positions at the current regulator control setting.**

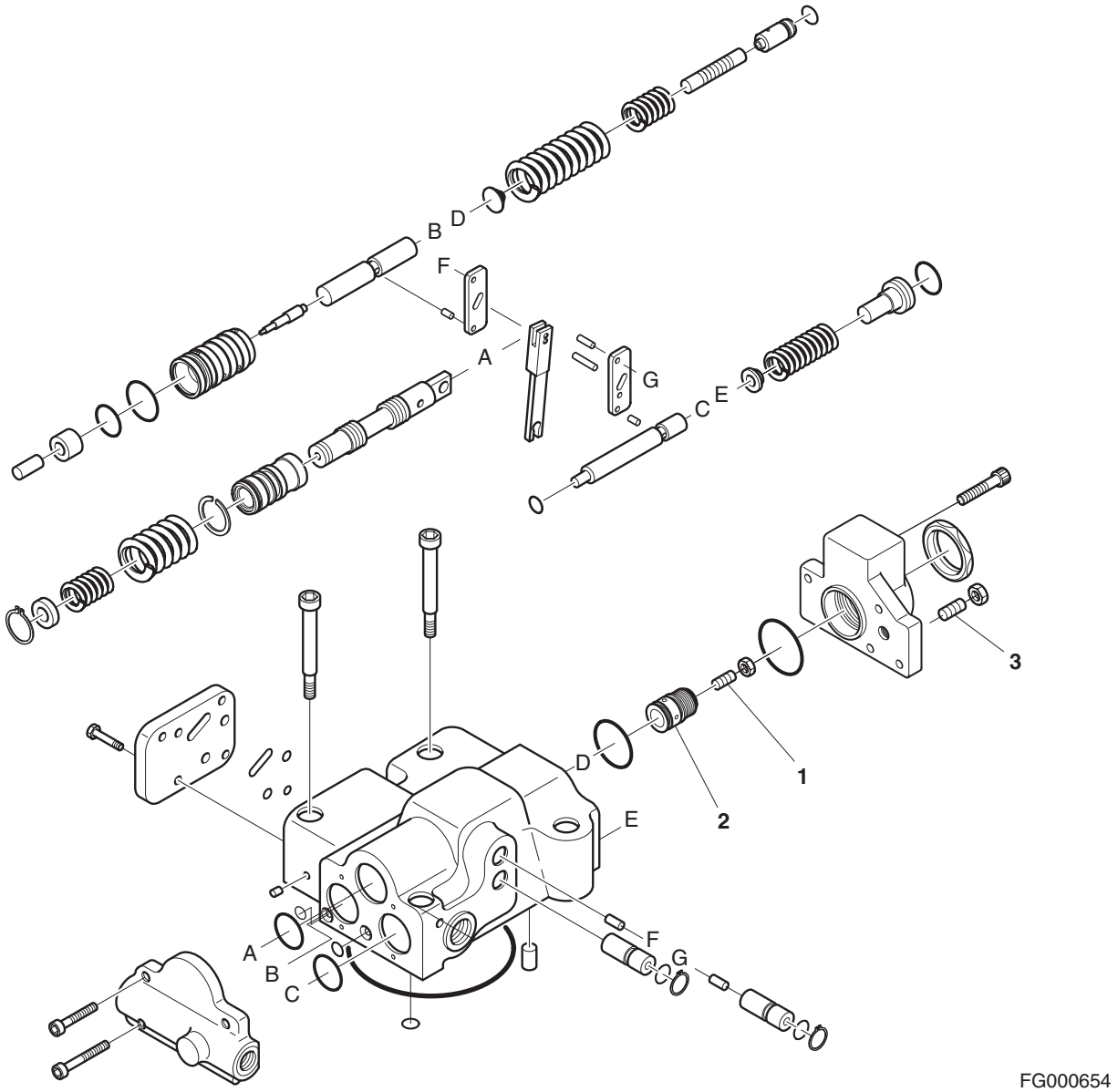
Use a scribe or other permanent marker to identify a reference point on adjusting screws with a corresponding reference on the body of the valve. The adjustment process affects a complex balance and could require some time to complete. If adjustment has to be interrupted or postponed, reference marks at the adjustment point allow immediate restoration of original performance.

This adjustment procedure is normally performed:

- If the engine is being consistently overloaded (and engine troubleshooting shows engine performance to be at or above rated output).
- If reduced cylinder speed and diminished work performance provide an indication that rated, maximum pump flow may not be available (and all other troubleshooting gives no indication of other flaws or hydraulic system defects).
- If pump output is out of balance and one pump is failing to keep up with the output flow of the other.

To check pump imbalance without a flow meter, travel the excavator forward on flat, level terrain. If the machine veers off despite neutral control input and even, balanced track

adjustment, the pump which supplies output to the track frame toward which the excavator is veering is weak.



FG000654

Figure 12

Refer to the illustration of the pump regulator control valve (Figure 12) for the location of adjustment screws (1, 2 and 3). There are two different adjustments, along with the Negacon, negative control, adjustment screw (3, directly below 1 and 2). Each one of the adjustment procedures could affect the setting of the others.

Check and record the arm dump speed performance test before and after input power adjustment, whether or not a flow meter is used.

NOTE: *Regulator adjustments affect total cumulative horsepower, since each regulator compensates for*

the output of the other. It is not necessary to adjust both regulators at the same time, but after checking or adjusting one of them, the remaining unit should also be checked.

Start the engine and turn the engine speed dial to maximum. When normal operating temperature is reached, loosen the largest diameter locknut around the adjustment screw (2) for the outer regulator spring. Tightening the screw shifts the P/Q (Pressure/Flow) control curve to the right, and increases compensating control pressure.

On the other hand, if the persistent cause of performance problems is engine overloading, decreasing the adjustment by turning the larger diameter adjusting screw (2) out will decrease pump input horsepower. 1/4 turn on the adjusting screw is equal to approximately 17 horsepower.

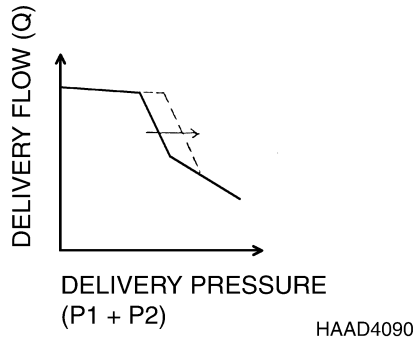


Figure 13

IMPORTANT

Because changing the position of adjusting screw (2) also affects the setting of the adjustment for the inner spring, the smaller diameter adjusting screw (1), turn in the inner screw 198° (slightly more than 1/2 turn, 180°) before screw (2) is backed out 1/4 turn (90°).

NOTE: *For each full turn of adjustment on the larger diameter screw (2), the square-tipped adjusting screw should be turned in the opposite direction 2.2 turns to avoid changing inner spring adjustment.*

Pump input power adjustments are normally made in small increments, 1/4 turn (90°) or less, each time.

Turning the square-tipped, smaller diameter screw (1) clockwise moves the flow curve up, increasing flow and then input horsepower.

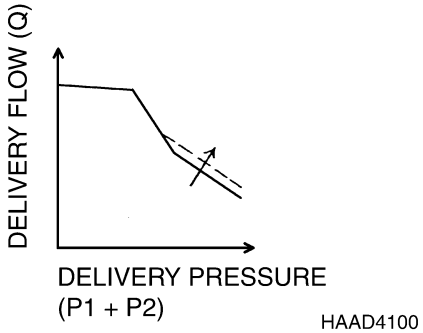


Figure 14

The adjusting screw (1, Figure 12) affects the delivery rate (Q) of the pump. Tightening the adjusting screw decreases the maximum cut flow (as shown in Figure 15) while backing out the screw increases cut flow delivery rate.

Balance both pumps for equal output.

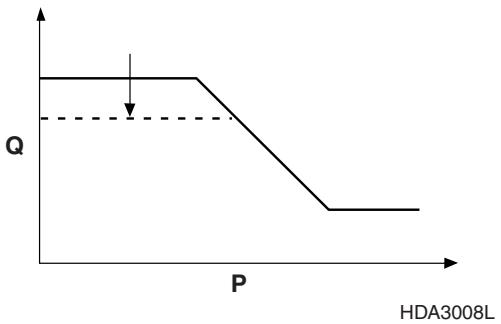


Figure 15

FLOW METER AND FLOW METER KIT INSTALLATION AND TESTING

Checking regulator and pump output, to assess the output balance between the front and rear pumps and to verify operating adjustment of each regulator, will require installation of a flow meter.

The After Sales Service department of the nearest local *DOOSAN* dealer can assist you with these tests or, if you prefer carrying out your own testing, they should be able to help in putting together a hose and fitting kit (or the required dimensions and specifications for hoses and fittings) to allow you to install a flow meter downstream from the main pump assembly.

Installation and Testing Procedure

- Shut down engine and operate controls to release hydraulic pressure from the accumulator.
- Vent the reservoir to release all pressure from the hydraulic system.
- Remove guard panels from around the main pump assembly.
- Disconnect the main pump discharge output line. Install the input flange of the flow meter on the pump end of the output line.
- Cap off the unused (input) end of the pump discharge line with a blocking flange.
- Connect a premeasured length of hydraulic hose, between the output end of the flow meter assembly and the top of the reservoir. Use appropriate fittings and adapter flanges to guarantee a pressure tight seal.

  NOTE: *Be sure to maintain even tightening torque on all flange fittings. Use Loctite brand "PST 545" (or an alternate manufacturer's hydraulic system joint seal) if required, to give an airtight seal.*

- An assistant – who must remain at the operator's control station at all times – should restart the engine and run it long enough (at minimum rpm) to deaerate the system and warm up the engine and hydraulic system to operating temperature.

Record the values of all test results in three columns, comparing 1) pump pressure (from the instrument panel display) with 2) measured flow, in gallons or liters per minute, from the installed flow meter. The third column of test results should provide a record of engine rpm measured during each of the following tests – with the engine speed control dial set at maximum, the

power mode selector at Power Mode and the work mode selector at digging mode:

- Unloaded maximum engine speed baseline test (all controls in neutral).
- Front pump test – operate "travel right" lever. Record values at all specified pressures.
- Rear pump test – operate "travel left" lever. Record values at all specified pressures.

Record the values for each of the three tests (neutral, travel right and travel left) at the following pump pressure levels, with travel speed control set at "high-speed."

Engine rpm	Pressure	Flow
	100 kg•cm^2 (1,422 psi)	
	135 kg•cm^2 (1,930 psi)	
	180 kg•cm^2 (2,560 psi)	
	240 kg•cm^2 (3,413 psi)	
	320 kg•cm^2 (4,550 psi)*	
	*See below note.	

Compare recorded values with output shown in the P-Q curve in the specifications section of this book.

If test results do not meet specified values, pump output tests can be repeated using different control levers. Recheck front pump operation while stroking the bucket cylinder out lever, and the rear pump by actuating the swing control lever.

NOTE: *When testing bucket and swing functions, read maximum flow tests at 330 kg•cm^2 (4,785 psi), not 350 kg•cm^2 (5075 psi).*

SWING SYSTEM TROUBLESHOOTING

Precautions/Initial Checks

1. Stop work. Release all weight or any load safely before proceeding. Avoid risking injury or adding to damage.
2. Shut down engine and disengage control functions until initial tests are ready to be made.

WARNING

Prevent possible injury and/or loss of operating control. Stop work and park the excavator at the first indication of:

1. **Equipment breakdown.**
2. **Inadequate control response.**
3. **Erratic performance.**

Stop the machine, put the boom and arm in the inoperative (overnight park) position and begin by making the fastest, simplest checks first:

- Check oil level.
- Check for overheating, oil leaks, external oil cooler clogging or broken fan belt. Consult service record for prior repair/service work.
- Drain some tank oil into a clean, clear container. Look for metal shavings/grit, cloudiness/water or foam/air bubbles in the oil.

  NOTE: *Dispose of drained fluids according to local regulations.*

- Check for wobble through the engine/pump flex coupling. Run engine with the pump input hydraulic power control nut turned to the lowest power to check the engine.
- Investigate unusual operating noises or vibration. Check for loose bolts, connections.

Swing Relief Valve Checking and Adjustment

Make a check of operating pressures through the swing relief valve if:

- The swing motor fails to turn.
- Swings in one direction only.
- Swings but continues to coast.
- There is drifting on a slope.

1. Check operation by connecting:

   A. Two 600 bar (8,700 psi) pressure gauges to the inlet and outlet measuring ports on top of the swing motor.

      Pressure should be between 265 and 275 bar (3,844 psi and 3,989 psi), with both swing locks engaged. With swing locks released, during full acceleration and deceleration, pressure should approach 250 bar (3,625 psi) in each direction.

   B. Connect a 60 bar (870 psi) pressure gauge at the "SH" port of the hydraulic brake.

      Pressure should always stay at or above 13 bar (190 psi) when operating swing, boom or arm.

   C. Connect a 10 bar (145 psi) gauge at the motor makeup valve.

      Pressure should stay consistently above 2.5 bar (36 psi). If pressure drops below the recommended minimum level, forceful acceleration of the swing motor could lead to cavitation of the circuit and stalling, slowed rotation, noise and possible damage.

2. If main inlet and outlet pressures were off in the preceding tests in Step 1, adjust swing relief valve pressure.

   Following adjustment, repeat the operating pressure tests (with gauges connected to the inlet and outlet test ports on top of the swing motor) and check pressures with the swing locks engaged and released.

   If pressure adjustment fails to restore adequate performance, proceed to the Troubleshooting – Swing table.

3. If pressure tests were at recommended levels through the main inlet and outlet ports, and through the "SH" port of the swing brake, the causes of poor swing performance could include a faulty swing motor, drivetrain overloading or gearbox defect, or a problem in the brake assembly or swing control valve. Proceed to the troubleshooting information in the next procedure.

   If pressure through the "SH" port was tested below the minimum 13 bar (190 psi) level, check the shuttle valve in the rear compartment behind cabin. When pressure through the port is at the recommended level, the brake

release valve should disengage the swing brake, allowing the swing motor to rotate the excavator. If pressure adjustment to the valve has been restored but the brake still fails to release, the brake piston or friction plate may be frozen, requiring disassembly of the motor and parts repair/replacement.

4. If pressure tested at the motor makeup valve drops below recommended minimum level, and consequent problems with cavitation, stalling and surging are observed, check the restriction valve. If pressure adjustment to the valve has been restored but if problems with cavitation continues, disassemble the upper swing motor housing and clean or replace assembly components as required.

   NOTE: *If all tested pressures are at or above recommended levels, and there are no mechanical problems in the drivetrain or in the motor/brake assembly, the problem will require further hydraulic troubleshooting. It's also possible that a defective joystick, an intermittent short in an electrical control circuit or a problem in the e-EPOS circuit is causing diminished swing performance. Pull out the e-EPOS indicator panel from underneath the operator's seat and perform the self-diagnostic test. If the display panel reads code "0.2," it is reporting that the swing priority proportional valve is not functioning, except in the minimum "fail-safe" mode. Refer to the Electrical section of this book for more information.*

TROUBLESHOOTING – SWING GEARBOX

Problem	Possible Cause	Remedy
Swing motor fails to operate and:		
Three pressure tests at motor, brake or makeup valve show low reading (s).	Swing relief valve defective Brake release valve defective Motor makeup valve defective.	Adjust pressure to recommended range in affected valve. OR Disassemble and clean valve assembly. Replace all valve components that show damage.
All three pressure checks are OK but left travel also fails to run.	Exchange front and rear pump inlet and outlet hoses to test pump function.	If swing and left travel are restored but right travel stops working, replace or repair P1 pump.
All three pressure tests are OK, but machine fails to swing at all.	Brake assembly or motor friction plate failing to release.	Check for binding. Disassemble and repair.
	Pilot (control) pressure low or swing control valve stuck.	Disassemble / Repair pilot pressure swing spool (305) and/or swing control valve.
	Swing motor defective.	Test motor drain rate. Replace / Repair motor.
	Gear train defective.	Refer to "Swing Gear Troubleshooting" procedure.
Swing functions but only at reduced rpm.	Causes listed above could also produce dragging swing, OR hot or wrong oil OR worn-out parts.	Check above list; then replace oil, test motor drain rate and check for "03" reading (e-EPOS self-test).
Left travel speed is also reduced.	Low output at P1 pump or external pilot piping leaks/is clogged.	Clean and repair piping or repair or replace pump P1.
Swing control movement is reversed.	Inlet / outlet piping reversed.	Reset controls or reverse piping.
Machine swings but continues coasting on past stopping point.	Swing control valve spool not centered.	Replace return spring; clean/ repair valve piston and spool.
	Pilot pressure may be outside range.	Disassemble, clean or replace pilot relief valve or pilot valve.
	Swing relief valve may be faulty.	Repair/Replace swing relief valve.
Swing movement is in one direction only.	Check to see that pilot pressure is the same right and left.	If pilot pressure is unequal, clean or repair piping or repair/replace valve.
	Swing control valve spool may be stuck.	Repair/Replace the swing control valve.
	Swing relief valve may be faulty.	Repair/Replace the swing relief valve.
No rotation and:		
Pressure at swing motor inlet increases.	Swing brake not releasing.	Check brake engagement and disengagement; check release pressure.
	Internal damage to gearbox drivetrain.	Replace broken gears and drivetrain assemblies.
	Overload.	Reduce load weight.

Problem	Possible Cause	Remedy
Pressure at swing motor inlet shows no increase, and the swing motor is making irregular noises.	Swing motor driveshaft damage.	Replace swing motor.
	Internal damage to gearbox drivetrain.	Repair/Replace broken or faulty assemblies.
Pressure at swing motor inlet shown no increase, but without irregular noises from the swing motor.	Hydraulic pump or valve problem.	Troubleshoot hydraulic system.
Oil Leakage:		
From driveshaft From bolted connections or other assembled surfaces.	Oil seal damaged Assembly compound (joint sealer) old and not sealing, bolt not tight or flange warped.	Replace oil seal Disassemble and check mating surfaces. Reapply Loctite; torque bolts to specifications.
Excess heat:		
Gearbox casing becomes excessively hot, with or without irregular noise (s), during operation.	Low oil level.	Replace oil; refill to specified level.
	Bearings or gears worn but not completely inoperative.	Repair or replace gearbox.

TROUBLESHOOTING – HYDRAULIC PROBLEMS

Problem	Possible Cause	Remedy
Attachment cylinders, swing and travel motors are all inoperable. Loud noises are heard from main pump assembly.	Main pump (s) malfunction.	Repair or replace.
	Low oil level in hydraulic system.	Refill.
	Main pump inlet (oil supply) piping or hose damaged.	Repair or replace.
Attachment cylinders, swing and travel motors are all inoperable. No usual or loud noises can be heard.	Pilot pump malfunction.	Repair or replace.
	Pilot cutoff solenoid stuck.	Repair or replace.
	Pilot cutoff switch faulty.	Repair or replace.
	Engine/pump flex coupling damaged.	Replace flex coupling.
Sluggish performance of all hydraulic functions – attachment, swing and travel.	Main pump (s) damaged or worn.	Repair or replace.
	Main relief valve pressure off.	Readjust pressure.
	Low oil level in hydraulic system.	Refill.
	Hydraulic reservoir intake strainer clogged.	Clean.
	Pump inlet (supply side) piping or hose allowing air into hydraulic system.	Tighten connection.

Problem	Possible Cause	Remedy
Oil temperature abnormally high.	Oil cooler clogged or air circulation to cooler blocked.	Clean.
	Cooling fan belt tension too loose.	Readjust belt tension.
	Relief valve set too low.	Readjust valve.
	Relief valve in constant use.	Reduce or slow workload or cycling rate.
	Hydraulic oil severely neglected or incorrect for application.	Replace oil.
One circuit in hydraulic system inoperable.	Overload relief valve malfunction.	Readjust or replace.
	Oil leak at makeup valve.	Clean, repair.
	Control valve spool damaged.	Repair or replace.
	Dirt in control valve spool.	Clean or replace.
	Actuator (joystick, foot pedal) damaged or worn.	Repair or replace.
	Internal seal leak in cylinder.	Repair or replace.
	Cylinder rod damaged.	Repair or replace.
	Pilot valve or piping malfunction.	Repair or replace.
	Mechanical linkage frozen, loose or damaged.	Repair or replace.
Travel motors inoperable.	Center joint damaged.	Repair or replace.
	Parking brake not releasing.	Repair or replace.
	Travel motor worn or damaged.	Repair or replace.
	Travel motor pilot piping damaged.	Repair or replace.
Travel motors operate very slowly.	Track tension poorly adjusted Low oil in idlers or rollers.	Readjust tension Refill.
	Travel brake dragging.	Repair.
	Track frame out of alignment, deformed or twisted.	Repair.
Swing motor inoperable.	Swing brake not releasing.	Repair or replace.
	Relief valve malfunction.	Repair or replace.
	Pilot piping damaged.	Repair or replace.
Swing motor operates unevenly.	Swing gear, bearing or mounting loose or worn.	Repair or replace.
	Lubricant worn away, inadequate.	Grease.
	Swing relief valve may be faulty.	Repair/Replace the swing relief valve.

TROUBLESHOOTING – CONTROL VALVE

Check control valve problems only after other hydraulic circuit operational tests have been made. Refer to the "Troubleshooting Baseline Recommendations" procedure. Pump flow, pilot pressure, Negacon pressure, main relief pressure, and port relief pressure should all be checked before starting to work on the control valve. Make sure the hydraulic system is topped up to the required level and free of oil leaks or air in the system that could cause cavitation problems.

Problem	Possible Cause	Remedy
Main relief valve.	Particulate contamination.	Disassemble, clean main poppet.
	Broken or damaged spring.	Replace.
	Adjusting screw loose.	Readjust.
	Main poppet sticking.	Repair/replace.
	Clogged orifice in pilot passage to control valve.	Clean/replace.
Cylinder goes down in spool neutral.	Excessive clearance between casing and spool.	Replace spool or casing.
	Spool does not return to neutral/ sticking spool.	Check secondary pilot pressure.
	Spool does not return to neutral because of dirt or other contaminants.	Clean.
	Broken or damaged spring.	Replace.
	Main relief or port relief not operating properly.	See above.
	Impurities in pilot circuit.	Clean.
Cylinder drops before start at boom up operation.	Rod check valve damaged or clogged.	Clean/replace.
	Poppet sticking.	Clean/replace.
	Broken or damaged spring.	Replace.
Slow operation or response.	Excessive clearance between spool or casing.	Check pilot pressure and/or replace spool or casing.
	Sticking spool.	Clean/replace.
	Broken or damaged spring.	Replace.
	Main or port relief valve damaged.	Check pressure/replace.
Swing priority not operating correctly.	Sticking spool.	Clean/replace.
	Solenoid valve faulty.	Replace.
Boom and arm cylinders do not perform normally in combined operation.	Priority valve faulty or spool sticking.	Check pilot pressure.
	Broken or deformed spring.	Replace.
	Excess clearance between right and left casing and valve spool.	Clean/replace.
	Clogged spool passage.	Clean/replace, replace filter.
Relief valve malfunctions:		

Problem	Possible Cause	Remedy
Pressure does not increase at all.	Main poppet or pilot poppet stuck open.	Clean/replace.
Irregular or uneven pressure.	Poppet seat damaged or pilot piston sticking to main poppet.	Clean/replace.
	Loose locknut and adjusting screw.	Readjust.
	Components worn out, past wear limits.	Replace.

TROUBLESHOOTING – TRAVEL CONTROL VALVE

Problem	Possible Cause	Remedy
Secondary pressure does not increase.	Low primary pressure.	Check primary pressure.
	Broken spring.	Replace spring.
	Spool sticking.	Clean, repair or replace.
	Excess spool to casing clearance.	Replace spool casing.
	Worn or loose universal joint (handle) subassembly.	Repair or replace U-joint subassembly.
Secondary pressure too high.	Dirt, other interference between valve parts.	Clean, repair or replace.
	Return line pressure too high.	Redirect return line.
Secondary pressure does not hold steady.	Dirt, other interference between valve parts, or worn spool sticking intermittently.	Clean, repair or replace.
	Interference or binding on spool return spring.	Clean, repair or replace.
	Interference, restriction or unsteady pressure in tank return line.	Repair or reroute tank return line.
	Air bubbles in piping (temporary) or air leak.	Vent air, or repair leak.
NOTE: *Look for evidence of leaking oil.*		

TROUBLESHOOTING – JOYSTICK CONTROL VALVE

Problem	Possible Cause	Remedy
Secondary pressure does not increase.	Low primary pressure.	Check primary pressure.
	Broken spring.	Replace spring.
	Spool sticking.	Clean, repair or replace.
	Excess spool to casing clearance.	Replace spool casing.
	Worn or loose handle subassembly.	Repair or replace handle subassembly.
Secondary pressure too high.	Dirt, other interference between valve parts.	Clean, repair or replace.
	Return line pressure too high.	Redirect return line.
Secondary pressure does not hold steady.	Dirt, other interference between valve parts, or worn spool sticking intermittently.	Clean, repair or replace.
	Interference or binding on spool return spring.	Clean, repair or replace.
	Unsteady pressure in tank return line.	Redirect return line.
	Air bubbles in piping (temporary) or air leak.	Vent air, or repair leak.
NOTE: *Look for evidence of leaking oil to help find damaged seals or gaskets that could be the cause of air leaks.*		

Accumulator

Edition 1

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Accumulator

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SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, safety is ultimately remember, safety is your personal responsibility your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX300LL	5001 and Up
DX340LC	5001 and Up
DX35Z	5001 and Up
DX420LC	5001 and Up
DX480LC	5001 and Up
DX520LC	5001 and Up

GENERAL DESCRIPTION

The accumulator is a gas-charged storage device designed to hold a reserve quantity of hydraulic fluid under pressure. Accumulators are used in hydraulic circuits in much the same way that condensers (or capacitors) are used to collect, store and maintain electrical charge in a circuit.

In a hydraulic circuit, minor variations or lags in pump output that might otherwise cause unsteady or irregular operation are made up from the supply of pressurized oil in the accumulator.

Reference Number	Description
1	Screw Plug
2	Steel Pressure Vessel
3	Diaphragm
4	Fluid Valve

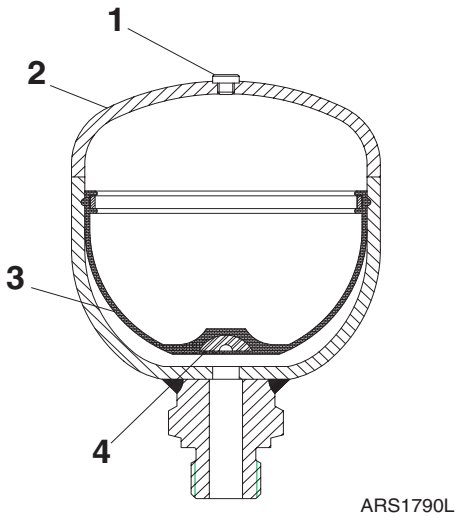


Figure 1

Accumulators are solidly constructed to resist the high operating pressures of the fluids they contain. There are only three main moving parts: a plug at the top allows precharging or expelling gas from the compressible, precharged upper chamber; a valve assembly at the bottom of the accumulator for passing hydraulic fluid in and out, and an elastic diaphragm to separate the two chambers. The flexible diaphragm changes shape to conform to the changing pressures and volumes of the two fluids in the upper and lower chambers.

The drawings in Figure 2 display the six possible states the diaphragm can be in, they are as follows:

1. With no gas charge in the upper chamber 0 bar (0 psi, empty) and no oil in the bottom 0 bar (0 psi, dry) the elastic diaphragm hangs loosely.
2. When the prepressure charge of gas (usually nitrogen) is introduced through the port at the top of the accumulator, the diaphragm expands to maximum size. The valve button in the center of the diaphragm pushes into the fluid opening in the bottom chamber, sealing off the lower valve. If the pressure of the gas charge exceeds system oil pressure, no fluid enters the accumulator. The button also keeps the diaphragm from protruding into the lower valve opening.

   NOTE: *Precharge pressure is referred to as the "P1" pressure. The accumulator manufacturer's "P1" rated pressure should be stamped or marked on the accumulator's rating plate. Annual checks of actual precharge pressure should be made by tapping a hydraulic pressure gauge (and 3-way adapter coupling) into the valve on the bottom of the accumulator. When hydraulic fluid is pushed out the lower valve opening by the pressure of the gas charge on the other side of the diaphragm - and there is no counterpressure from system oil - the valve*

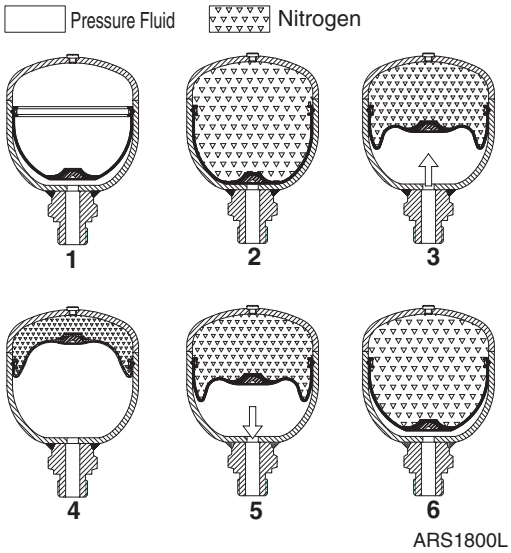


Figure 2

button on the bottom of the diaphragm eventually seals off the lower oil passage. Just after the needle on the gauge reaches its highest point (when there is 0 bar (0 psi) resistance from hydraulic system pressure) pressure on the gauge will drop sharply to zero, as the accumulator is completely emptied of oil and the diaphragm button closes.

Record the highest gauge reading and compare to the "P1" rated precharge pressure on the accumulator manufacturer's data label. Repeat this test at least once a year to verify proper functioning of the accumulator.

3. As hydraulic system pressure overcomes accumulator precharge pressure, the flexible diaphragm begins to retract upward.

4. When system oil is at highest working pressure and the accumulator fills to maximum reserve capacity, the flexible diaphragm is pushed up into the top of the upper chamber.

   The highest working pressure is sometimes referred to as the "P3" pressure and can also be referenced on the manufacturer's data label on the exterior of the accumulator.

5. If system oil pressure begins to fall off or is momentarily checked or interrupted, the energy stored on the other side of the diaphragm, in the form of compressed gas, pushes oil back out of the lower chamber, maintaining oil pressure of the circuit.

6. With minimal system pressure, an equilibrium point may be reached in which accumulator precharge pressure and hydraulic system oil pressure achieve a rough balance. In this state a minimal amount of oil is stored in the accumulator.

Specifications

Model	Serial Number	System	Charge Pressure	Volume
DX35Z	S/N 5001 and Up	Pilot	10 kg•cm^2 (140 psi)	320 cc (19.53 in^3)
DX180LC	S/N 5001 and Up	Pilot	10 kg•cm^2 (140 psi)	320 cc (19.53 in^3)
DX225LC	S/N 5001 and Up	Pilot	10 kg•cm^2 (140 psi)	320 cc (19.53 in^3)
DX225NLC	S/N 5001 and Up	Pilot	10 kg•cm^2 (140 psi)	320 cc (19.53 in^3)
DX255LC	S/N 5001 and Up	Pilot	10 kg•cm^2 (140 psi)	320 cc (19.53 in^3)
DX300LC	S/N 5001 and Up	Pilot	10 kg•cm^2 (140 psi)	320 cc (19.53 in^3)
DX340LC	S/N 5001 and Up	Pilot	10 kg•cm^2 (140 psi)	320 cc (19.53 in^3)
DX420LC	S/N 5001 and Up	Pilot	10 kg•cm^2 (140 psi)	320 cc (19.53 in^3)
DX480LC	S/N 5001 and Up	Pilot	10 kg•cm^2 (140 psi)	320 cc (19.53 in^3)
DX520LC	S/N 5001 and Up	Pilot	10 kg•cm^2 (140 psi)	320 cc (19.53 in^3)

Center Joint (Swivel)

Edition 1

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Center Joint (Swivel)

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SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX300LL	5001 and Up

GENERAL DESCRIPTION

The center joint (swivel) is designed to allow hydraulic oil from the upper structure to flow to components in the lower structure.

It is capable of allowing continuous 360° rotation of the upper structure in relationship to the lower structure.

Parts List

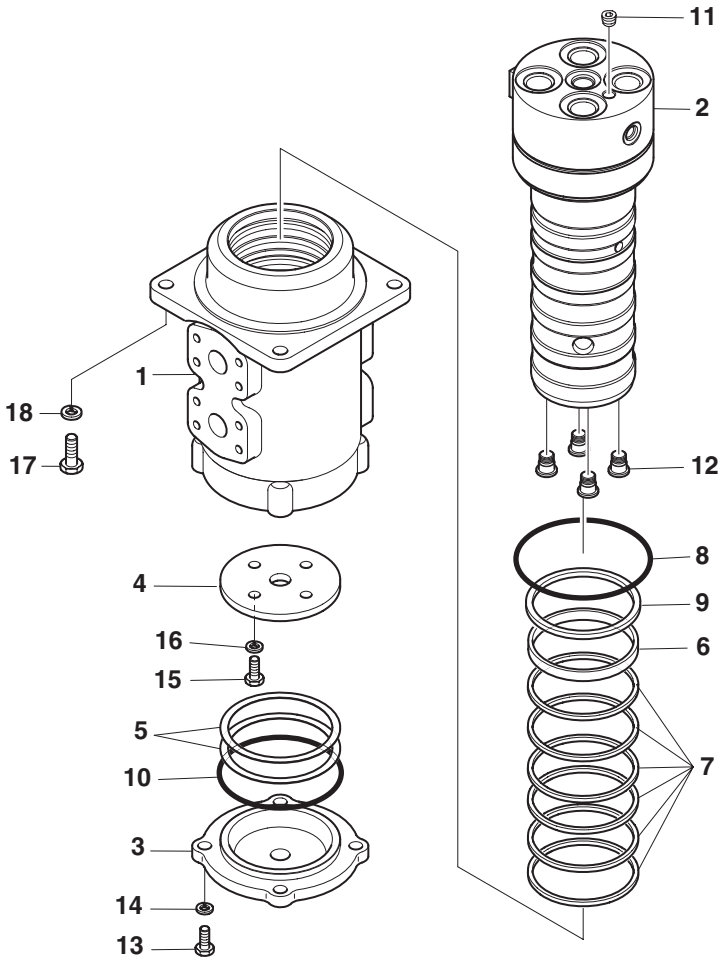


Figure 1

Reference Number	Description
1	Body
2	Spindle
3	Cover
4	Spacer
5	Shim
6	Wear Ring
7	Slipper Ring
8	O-ring
9	O-ring

Reference Number	Description
10	O-ring
11	Plug
12	Plug
13	Bolt
14	Spring Washer
15	Bolt
16	Spring Washer
17	Bolt
18	Spring Washer

TROUBLESHOOTING, TESTING AND ADJUSTMENT

Inspection

The center joint should be checked for evidence of external oil leakage every 2,000 operating hours. Leaking or defective O-rings are an indication that dirt and other contaminants could be getting inside the assembly, which will promote accelerated, abnormal wear and may cause early failure of the assembly.

If internal seals or other sliding surface components are worn and there is internal fluid leakage, complete overhaul and repair or replacement of the center joint may be required.

Testing

To check pressure through the center joint, make up a test kit from the following equipment list:

- 700 bar (10,000 psi) pressure gauge.
- Adapters, connectors, piping and flange block off plates conforming to those used in high-pressure piping connections of the excavator.
- A high-pressure relief valve with a setting pressure 1.5 times maximum system pressure.
- A stop valve.
- A manually operated, in-line changeover valve.

Install the changeover valve upstream from one of the stem high-pressure ports. Connect the pressure gauge downstream from one of the body ports. Install the stop valve between the changeover valve and the stem of the center joint. Other components should be installed according to the layout in the block diagram. The test kit is used to pressurize the center swivel above normal working pressure and lock in the higher pressure (as the stop valve is closed manually) for a leak down test.

NOTE: *The same type of kit can also be made up for the drain port (return line) side of the center joint. Use appropriate piping, connectors, test gauges, etc., and follow the same block diagram general layout (Figure 2).*

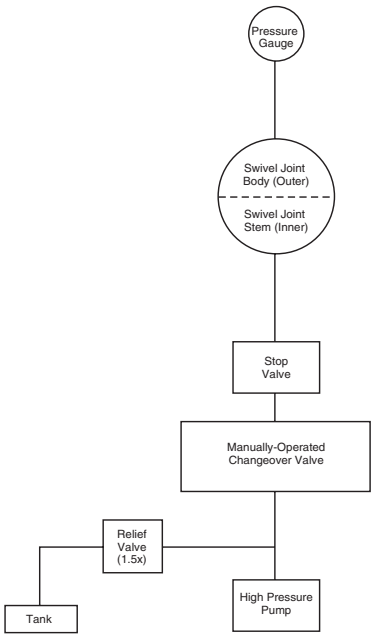


Figure 2

DISASSEMBLY

Refer to the assembly drawing of the swivel joint for component references (Figure 1).

IMPORTANT

Do not unbolt the center joint from the lower car body until an adequate number of piping block off plates are available, for disconnected piping lines. Be sure that system pressure has been vented - including the hydraulic accumulator and tank reserve pressure - before disassembly is started.

1. Clean off the exterior of the swivel joint after it has been removed.
2. Scribe or otherwise mark a line across the cover and the body of the center joint, to allow reassembly in the same configuration.
3. Unbolt the four 12 mm fasteners holding the cover. Use a vise or V-block to hold the assembly in place.
4. Remove cover, withdraw the O-ring and remove retaining ring holding the thrust plate, taking care to support the spindle assembly, so it will not separate and fall out when retaining ring is removed.
5. If the spindle assembly doesn't separate easily when the thrust plate and retaining ring are removed, use a wooden block and hammer to drive it out of the housing.
6. O-rings and seals should be replaced whenever the assembly is being overhauled or rebuilt. For repair procedures or emergency tear down, use a thin but rounded tip, smoothedge scraper or spatula to remove O-rings or seals, to avoid causing damage to those that must be reused.

   NOTE: *The "backup ring" shown in the assembly drawing (above the swivel joint spindle lower seals) should not be overlooked. It is tucked behind the top slip ring, doubled up inside the same groove in the body of the spindle.*

7. Before reassembling the center swivel, visually inspect ball bearing surfaces for visible signs of wear, damage or discoloration and replace any worn component.

   Check clearance between the spindle and thrust plate. Replace any component that shows more than 0.5 mm (0.020") of visible wear.

   Clearance between the spindle and body of the center swivel must be tight. Replace or repair either component if there is more than 0.1 mm (0.0039") of measurable wear.

REASSEMBLY

1. Prelubricate O-rings with hydraulic oil, white grease or petroleum jelly.

⚠ CAUTION!

Apply a very light film of white grease or petroleum jelly to the lower rim of the stem and inner surface of the center swivel body. Apply slow, evenhanded pressure, using both hands, to slowly push the stem into the body. Seals may be damaged if the stem is pushed in too quickly.

2. Thoroughly clean all other component surfaces of dirt or grease before reassembly.
3. Reverse disassembly steps for reassembly.
4. Clean threads of fasteners before preapplying Loctite #243 to the threads, and before torquing the thrust plate and cover bolts.
5. Prefill the center swivel with clean hydraulic fluid before reassembly of high-pressure and drain line piping. Clean and prefill piping line ends to reduce the amount of air in the system. Bleed air from the hydraulic system and verify hydraulic tank fluid level before returning the excavator to service.

Cylinders

Edition 1

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Cylinders

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SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX300LC	5001 and Up
DX340LC	5001 and Up
DX420LC	5001 and Up

GENERAL DESCRIPTION

Two essentially similar types of hydraulic cylinders are used on the excavator. The cylinder that is used to operate the excavator boom or bucket is equipped with a rod stopper, which acts as a cushion only when the cylinder rod is fully retracted (and the bucket is pulled close to the arm). This type of cylinder is shown in the lower drawing.

Arm cylinders have a cushion or stopper for operation in both directions. This type of cylinder is shown in the upper drawing.

Theory of Operation

1	**Piston**
2	**Oil Path A**
3	**Oil Path B**

Cylinder piston rods are extended or retracted by oil flow to the back side of the cylinder (shown as ("oil path A") or to the front of the cylinder ("oil path B").

The cylinder rod is extended as oil flow is pumped through the circuit to the back side of the piston. The force (F1) of the piston stroke can be expressed by the formula below, where P = circuit oil pressure and the inside diameter of the cylinder is expressed by D (Figure 1).

$$F_1 = P \times \frac{\pi D^2}{4}$$

(P: Pressure, π = 3.14, D: Cylinder Inside Diameter)

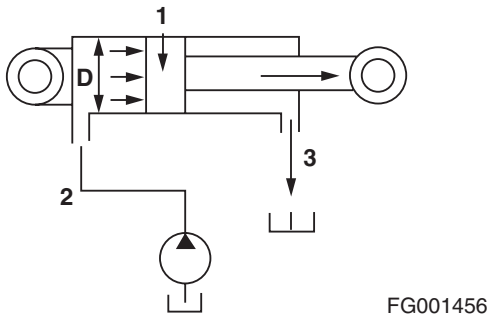


Figure 1

1	**Cylinder Inside Diameter - D**
2	**Oil Path A**
3	**Oil Path B**
4	**Rod Diameter - R**

When the cylinder rod is retracted, oil flow through the circuit from the pump to the front side of the cylinder generates a force (F2) that can be expressed by the formula in which the diameter of the piston rod is expressed by R, and the other two terms are the same as in the preceding expression.

$$F_2 = P \times \frac{\pi(D^2-R^2)}{4}$$

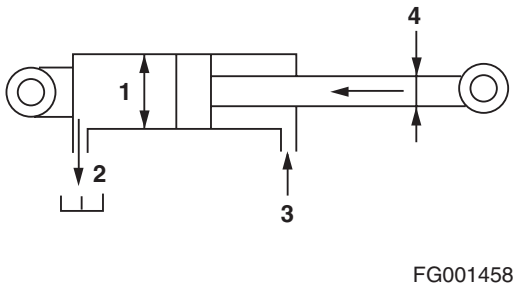


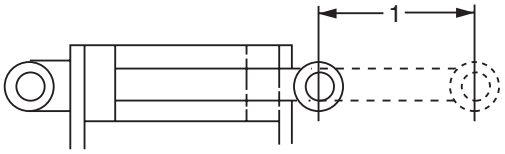
Figure 2

Because the volume of oil needed to lengthen the cylinder rod (Q1) is greater than the volume of oil required to retract the cylinder rod, it takes more time to extend a cylinder than it does to retract it.

$$Q_1 = S \times \frac{\pi(D^2)}{4}$$

$$Q_2 = S \times \frac{\pi(D^2-R^2)}{4}$$

$Q_1 > Q_2$



FG001459

Figure 3

Parts List

The following parts list is a partial listing only; for complete parts list information, refer to the Hydraulic Equipment Component Parts List.

Cross-section in Figure 4 shows an arm cylinder.

Cross-section in Figure 5 shows a boom cylinder.

The bucket and boom cylinders are identical and differ only in the attached pipes.

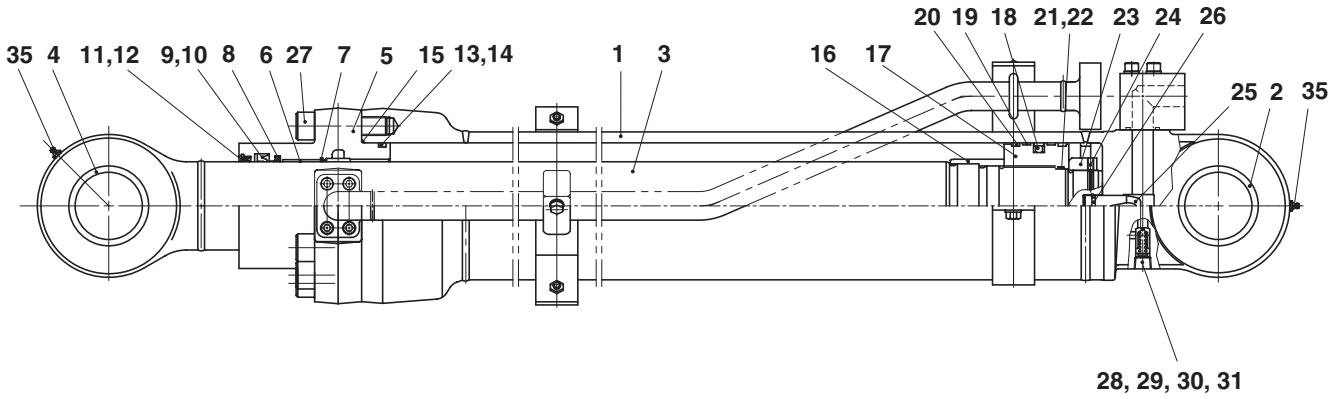


Figure 4

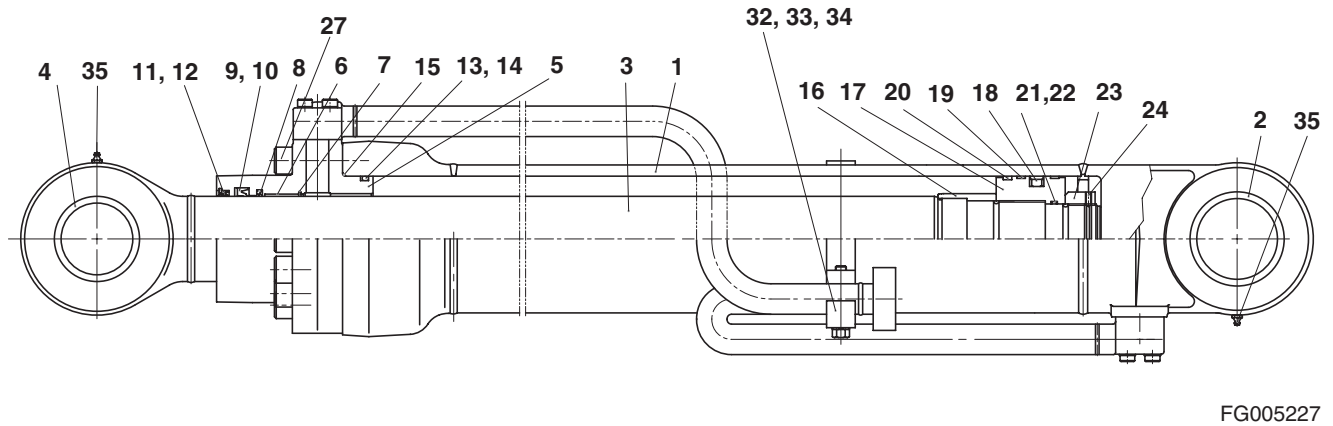


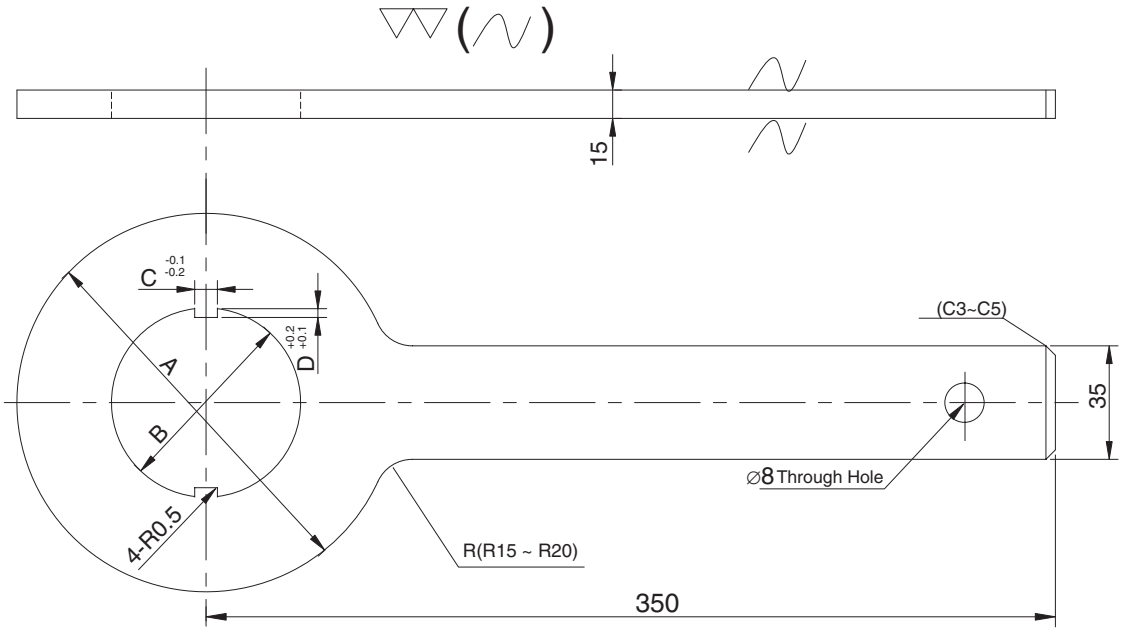
Figure 5

Reference Number	Description
1	Tube Assembly
2	Bushing
3	Rod Assembly
4	Bushing
5	Rod Cover
6	DD-Bushing
7	Retaining Ring
8	Buffer Seal
9	U-Packing
10	Backup Ring
11	Dust Wiper
12	Retaining Ring
13	O-ring
14	Backup Ring
15	O-ring
16	Cushion Ring
17	Piston
18	Slipper Seal

Reference Number	Description
19	Wear Ring
20	Ring
21	O-ring
22	Backup Ring
23	Piston Nut
24	Set Screw
25	Socket Head Bolt
26	Pipe Band Assembly
27	Hex Socket Bolt
28	Check Valve
29	Spring
30	Spring Support
31	Hex Socket Plug
32	Spring Washer
33	Hex Bolt
34	Pipe Assembly
35	Grease Fitting

SPECIAL TOOLS AND MATERIALS

Piston Nut



ARS4730L

Figure 6

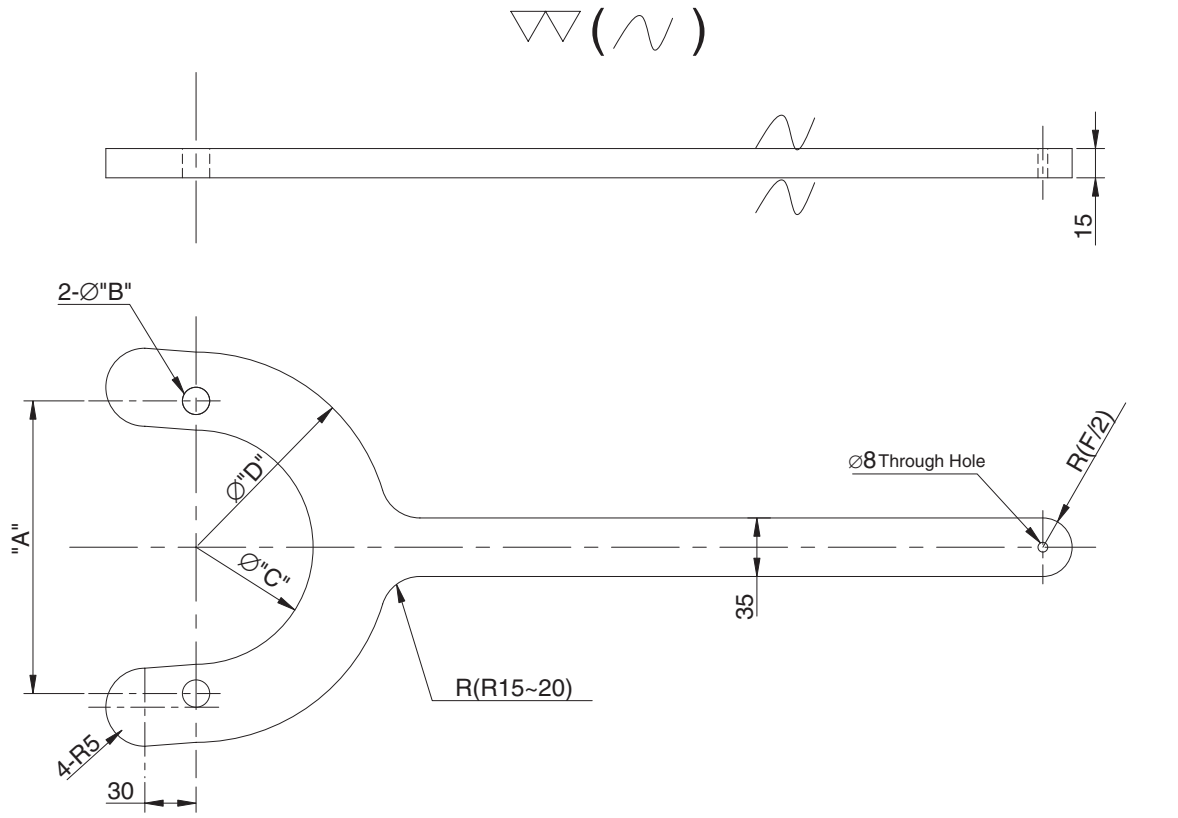
Material SM45C (AISI 1045)

Rockwell Harden from 22 - 27

Oil Quench

MODEL	CYLINDER	øA	øB	C	D	MODEL (CYLINDER)
DX225LC	BOOM	145.0 mm (5.71 in)	105.0 mm (4.13 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
	ARM	145.0 mm (5.71 in)	105.0 mm (4.13 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
	BUCKET	130.0 mm (5.11 in)	89.0 mm (3.50 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
DX225NLC	BOOM	145.0 mm (5.71 in)	105.0 mm (4.13 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
	ARM	145.0 mm (5.71 in)	105.0 mm (4.13 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
	BUCKET	130.0 mm (5.11 in)	89.0 mm (3.50 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
DX300LC	BOOM	142.0 mm (5.59 in)	102.0 mm (4.02 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
	ARM	147.0 mm (5.79 in)	107.0 mm (4.21 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	S/ARM
	BUCKET	140.0 mm (5.52 in)	98.0 mm (3.86 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	S/BUCKET
DX340LC	BOOM	145.0 mm (5.71 in)	105.0 mm (4.13 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	OPT BOOM
	ARM	147.0 mm (5.79 in)	107.0 mm (4.21 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	OPT ARM
	BUCKET	145.0 mm (5.71 in)	105.0 mm (4.13 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	OPT BUCKET
DX420LC	BOOM	147.0 mm (5.79 in)	107.0 mm (4.21 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
	ARM	147.0 mm (5.79 in)	107.0 mm (4.21 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
	BUCKET	155.0 mm (6.10 in)	115.0 mm (4.53 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	

Piston Jig



ARS4740L

Figure 7

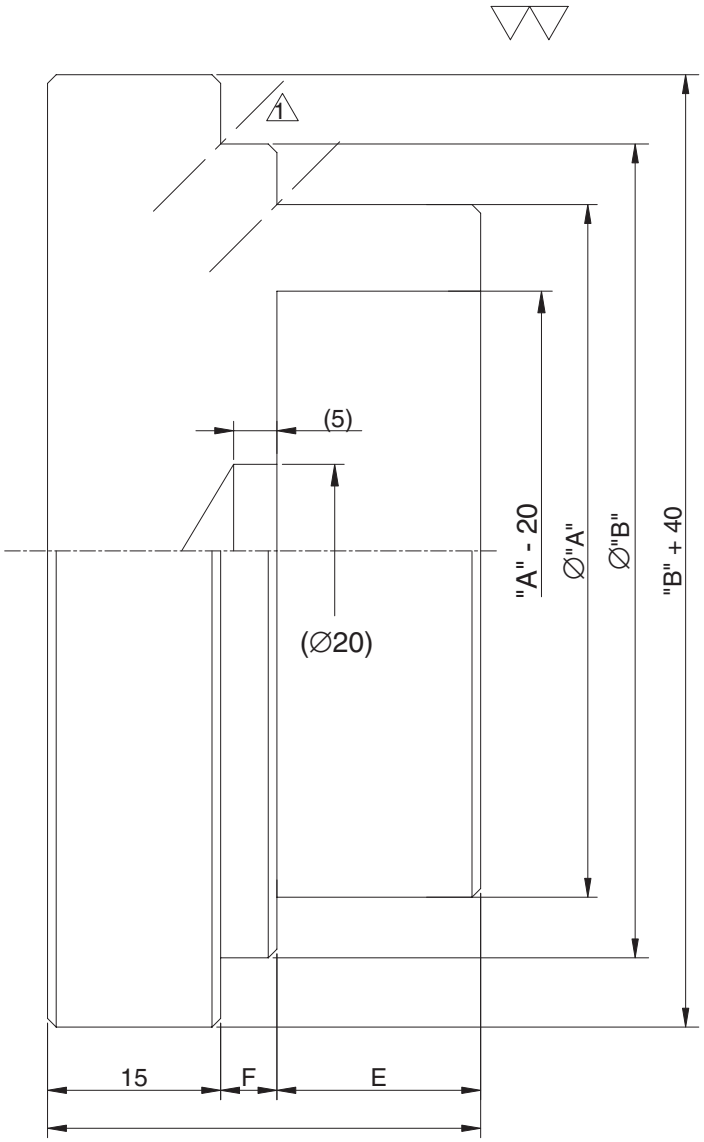
Material SM45C (AISI 1045)

Rockwell Harden from 22 - 27

Oil Quench

MODEL	CYLINDER	A (±0.1)	øB	øC	øD	MODEL (CYLINDER)
DX225LC	BOOM	90.0 mm (3.54 in)	11.0 mm (0.43 in)	63.0 mm (2.48 in)	115.0 mm (4.53 in)	
	ARM	110.0 mm (4.33 in)	13.0 mm (0.51 in)	75.0 mm (2.95 in)	140.0 mm (5.51 in)	
	BUCKET	90.0 mm (3.54 in)	11.0 mm (0.43 in)	63.0 mm (2.48 in)	115.0 mm (4.54 in)	
DX225NLC	BOOM	90.0 mm (3.54 in)	11.0 mm (0.43 in)	63.0 mm (2.48 in)	115.0 mm (4.53 in)	
	ARM	110.0 mm (4.33 in)	13.0 mm (0.51 in)	75.0 mm (2.95 in)	140.0 mm (5.51 in)	
	BUCKET	90.0 mm (3.54 in)	11.0 mm (0.43 in)	63.0 mm (2.48 in)	115.0 mm (4.54 in)	
DX300LC	BOOM	110.0 mm (4.33 in)	13.0 mm (0.51 in)	76.0 mm (2.99 in)	140.0 mm (5.51 in)	
	ARM	120.0 mm (4.72 in)	13.0 mm (0.513 in)	85.0 mm (3.35 in)	150.0 mm (5.91 in)	S/ARM
	BUCKET	110.0 mm (4.33 in)	13.0 mm (0.51 in)	76.0 mm (2.99 in)	140.0 mm (5.51 in)	S/BUCKET
DX340LC	BOOM	120.0 mm (4.72 in)	13.0 mm (0.51 in)	85.0 mm (3.35 in)	150.0 mm (5.91 in)	OPT BOOM
	ARM	130.0 mm (5.12 in)	13.0 mm (0.513 in)	93.0 mm (3.66 in)	165.0 mm (6.50 in)	OPT ARM
	BUCKET	120.0 mm (4.72 in)	13.0 mm (0.51 in)	85.0 mm (3.35 in)	150.0 mm (5.91 in)	OPT BUCKET
DX420LC	BOOM	130.0 mm (5.12 in)	13.0 mm (0.51 in)	93.0 mm (3.66 in)	165.0 mm (6.50 in)	
	ARM	130.0 mm (5.12 in)	13.0 mm (0.513 in)	93.0 mm (3.66 in)	165.0 mm (6.50 in)	
	BUCKET	130.0 mm (5.12 in)	13.0 mm (0.51 in)	93.0 mm (3.66 in)	165.0 mm (6.50 in)	

Steel Bushing Jig



ARS4750L

Figure 8

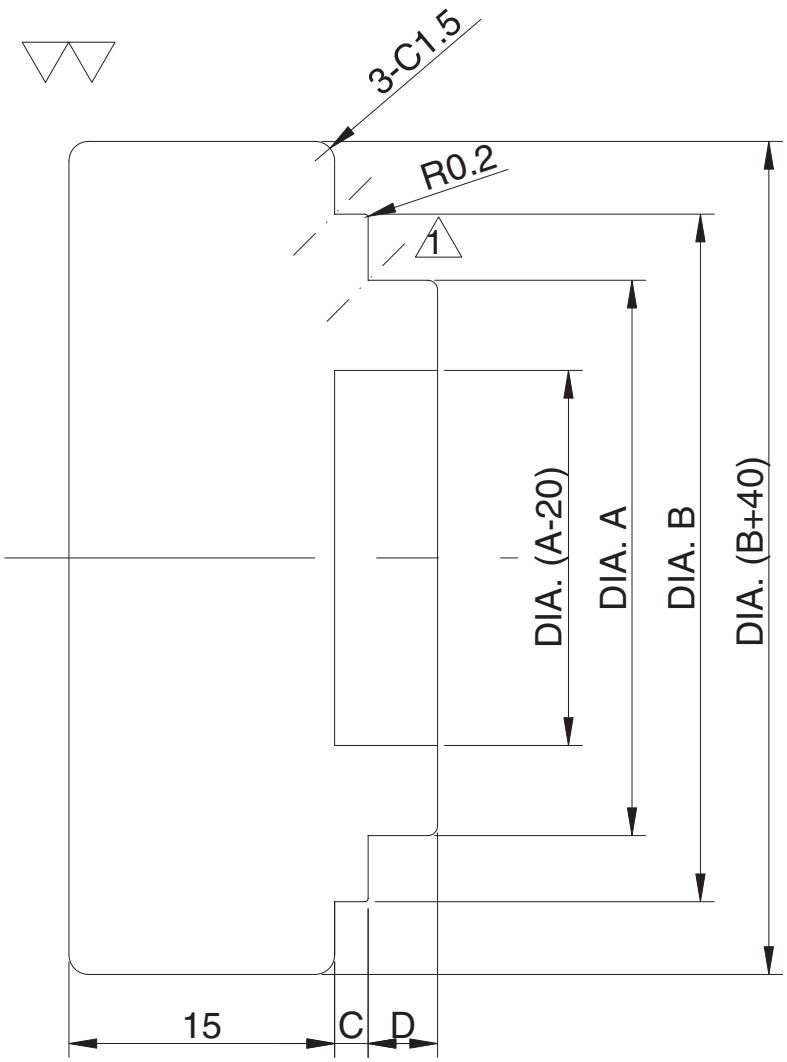
Material: SM45C which is done thermal refining <QT> Hrc 22 - 28

Undefined Chamfer C/R = 0.5 Max.

1 Place: Finally work to used DNMG Tip <Nose R0.4>

MODEL	CYLINDER	øA $^{-0.05}_{-0.15}$	øB (±0.1)	E	F $^{+0.05}_{0}$	Part	MODEL (CYLINDER)
DX225LC	BOOM	80.0 mm (3.15 in)	95.0 mm (3.74 in)	40.0 mm (1.58 in)	6.5 mm (0.26 in)		
	ARM	80.0 mm (3.15 in)	95.0 mm (3.74 in)	40.0 mm (1.58 in)	6.5 mm (0.26 in)		
	BUCKET	80.0 mm (3.15 in)	95.0 mm (3.74 in)	40.0 mm (1.58 in)	6.5 mm (0.26 in)		
DX225NLC	BOOM	80.0 mm (3.15 in)	95.0 mm (3.74 in)	40.0 mm (1.58 in)	6.5 mm (0.26 in)		
	ARM	80.0 mm (3.15 in)	95.0 mm (3.74 in)	40.0 mm (1.58 in)	6.5 mm (0.26 in)		
	BUCKET	80.0 mm (3.15 in)	95.0 mm (3.74 in)	40.0 mm (1.58 in)	6.5 mm (0.26 in)		
DX300LC	BOOM	90.0 mm (3.54 in)	105.0 mm (4.13 in)	40.0 mm (1.58 in)	7.0 mm (0.28 in)		
	ARM	90.0 mm (3.54 in)	105.0 mm (4.13 in)	40.0 mm (1.58 in)	6.5 mm (0.26 in)		S/ARM
	BUCKET	90.0 mm (3.54 in)	105.0 mm (4.13 in)	40.0 mm (1.58 in)	7.0 mm (0.28 in)		S/BUCKET
DX340LC	BOOM	100.0 mm (3.94 in)	115.0 mm (4.53 in)	45.0 mm (1.77 in)	7.5 mm (0.30 in)		OPT BOOM
	ARM	100.0 mm (3.94 in)	115.0 mm (4.53 in)	45.0 mm (1.77 in)	7.5 mm (0.30 in)		OPT ARM
	BUCKET	100.0 mm (3.94 in)	115.0 mm (4.53 in)	45.0 mm (1.77 in)	7.5 mm (0.30 in)		OPT BUCKET
DX420LC	BOOM	110.0 mm (4.33 in)	130.0 mm (5.12 in)	70.0 mm (2.76 in)	11.0 mm (0.43 in)		
	ARM	110.0 mm (4.33 in)	130.0 mm (5.12 in)	70.0 mm (2.76 in)	11.0 mm (0.43 in)		
	BUCKET	110.0 mm (4.33 in)	130.0 mm (5.12 in)	70.0 mm (2.76 in)	11.0 mm (0.43 in)		

Dust Wiper Jig



ARS4760L

Figure 9

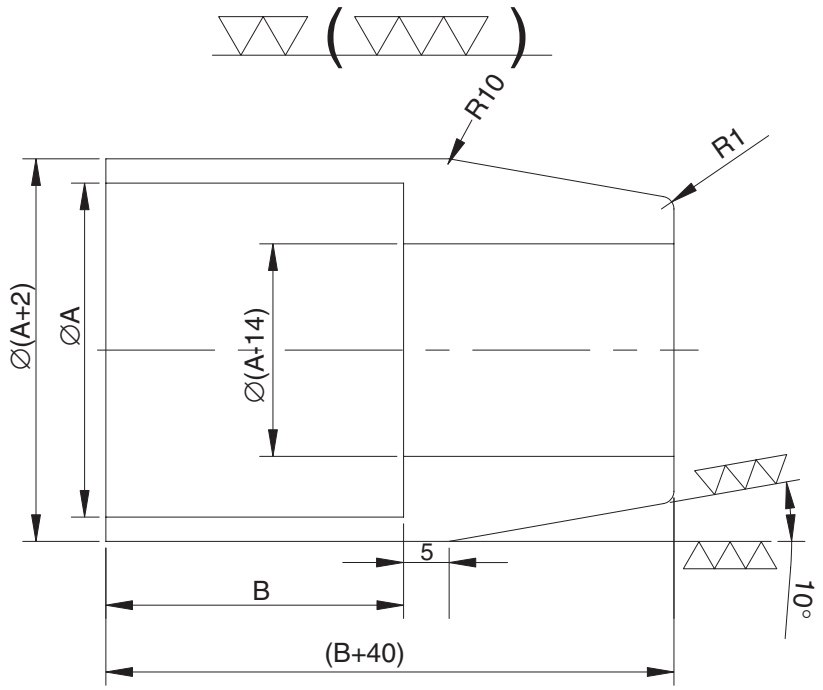
Material: SM45C which is done thermal refining <QT> Hrc 22 - 28

Undefined Chamfer C/R = 0.5 Max.

1 Place: Finally work to used DNMG Tip <Nose R0.4>

MODEL	CYLINDER	øA$^{-0.2}_{-0.3}$	øB$^{-0.2}_{-0.3}$	C$^{0}_{-0.1}$	D	MODEL (CYLINDER)
DX225LC	BOOM	100.0 mm (3.94 in)	114.0 mm (4.49 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	ARM	100.0 mm (3.94 in)	114.0 mm (4.49 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	BUCKET	80.0 mm (3.15 in)	94.0 mm (3.70 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
DX225NLC	BOOM	100.0 mm (3.94 in)	114.0 mm (4.49 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	ARM	100.0 mm (3.94 in)	114.0 mm (4.49 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	BUCKET	80.0 mm (3.15 in)	94.0 mm (3.70 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
DX300LC	BOOM	95.0 mm (3.74 in)	109.0 mm (4.29 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	ARM	105.0 mm (4.13 in)	121.0 mm (4.76 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	S/ARM
	BUCKET	90.0 mm (3.54 in)	104.0 mm (4.10 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	S/BUCKET
DX340LC	BOOM	100.0 mm (3.94 in)	114.0 mm (4.49 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	OPT BOOM
	ARM	115.0 mm (4.53 in)	131.0 mm (5.16 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	OPT ARM
	BUCKET	100.0 mm (3.94 in)	114.0 mm (4.49 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	OPT BUCKET
DX420LC	BOOM	115.0 mm (4.53 in)	131.0 mm (5.16 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	ARM	120.0 mm (4.72 in)	136.0 mm (5.35 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	BUCKET	110.0 mm (4.33 in)	126.0 mm (4.96 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	

Slipper Seal Jig

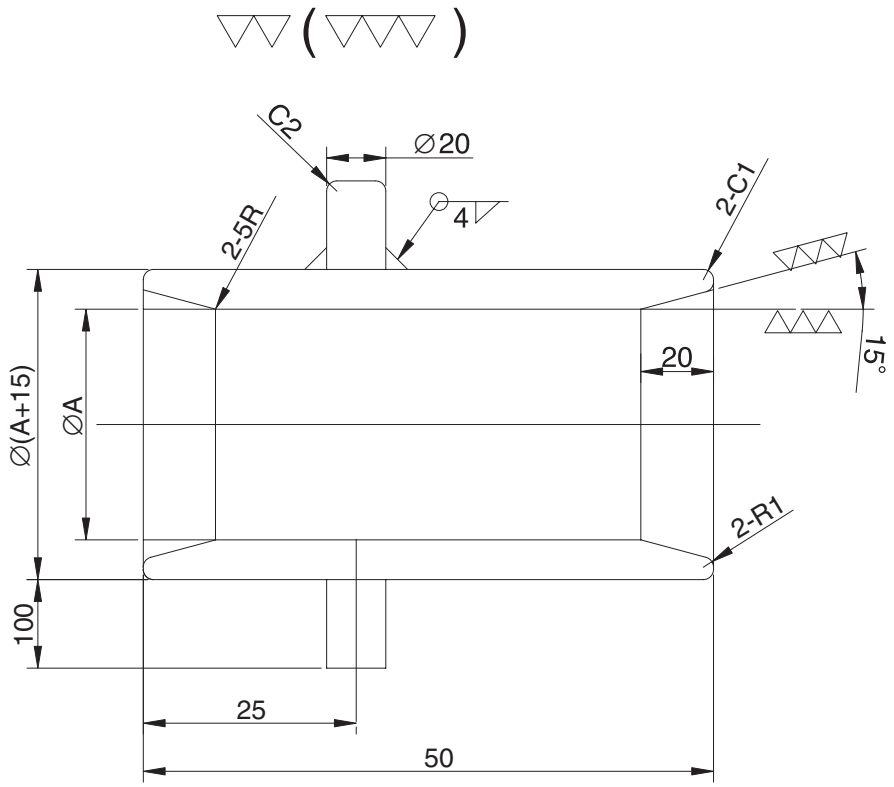


ARS4770L

Figure 10

MODEL	CYLINDER	$\text{øA}^{+0.2}_{+0.1}$	$\text{B}^{+0.2}_{+0.1}$	MODEL (CYLINDER)
DX225LC	BOOM	140.0 mm (5.51 in)	28.5 mm (1.12 in)	
	ARM	150.0 mm (5.91 in)	28.5 mm (1.12 in)	
	BUCKET	120.0 mm (4.72 in)	28.5 mm (1.12 in)	
DX225NLC	BOOM	140.0 mm (5.51 in)	28.5 mm (1.12 in)	
	ARM	150.0 mm (5.91 in)	28.5 mm (1.12 in)	
	BUCKET	120.0 mm (4.72 in)	28.5 mm (1.12 in)	
DX300LC	BOOM	140.0 mm (5.51 in)	28.5 mm (1.12 in)	
	ARM	150.0 mm (5.91 in)	28.5 mm (1.12 in)	S/ARM
	BUCKET	140.0 mm (5.51 in)	28.5 mm (1.12 in)	S/BUCKET
DX340LC	BOOM	150.0 mm (5.91 in)	28.5 mm (1.12 in)	OPT BOOM
	ARM	170.0 mm (6.69 in)	34.5 mm (1.36 in)	OPT ARM
	BUCKET	150.0 mm (5.91 in)	28.5 mm (1.12 in)	OPT BUCKET
DX420LC	BOOM	165.0 mm (6.50 in)	34.5 mm (1.36 in)	OPT BOOM
	ARM	180.0 mm (7.09 in)	41.5 mm (1.63 in)	OPT ARM
	BUCKET	160.0 mm (6.30 in)	34.5 mm (1.36 in)	OPT BUCKET

Slipper Seal Straightening Jig



ARS4780L

Figure 11

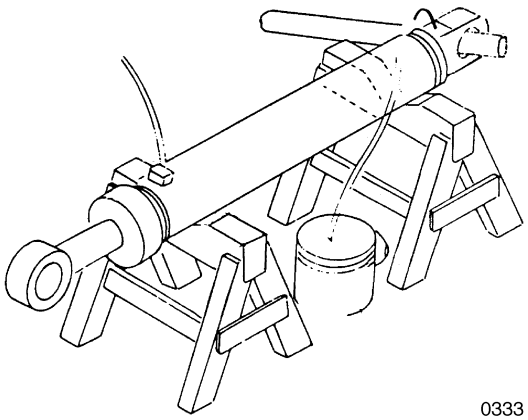
MODEL	CYLINDER	$øA^{+0.2}_{+0.1}$	MODEL (CYLINDER)
DX225LC	BOOM	140.0 mm (5.51 in)	
	ARM	150.0 mm (5.91 in)	
	BUCKET	120.0 mm (4.72 in)	
DX225NLC	BOOM	140.0 mm (5.51 in)	
	ARM	150.0 mm (5.91 in)	
	BUCKET	120.0 mm (4.72 in)	
DX300LC	BOOM	140.0 mm (5.51 in)	
	ARM	150.0 mm (5.91 in)	S/ARM
	BUCKET	140.0 mm (5.51 in)	S/BUCKET
DX340LC	BOOM	150.0 mm (5.91 in)	OPT BOOM
	ARM	170.0 mm (6.69 in)	OPT ARM
	BUCKET	150.0 mm (5.91 in)	OPT BUCKET
DX420LC	BOOM	165.0 mm (6.50 in)	OPT BOOM
	ARM	180.0 mm (7.09 in)	OPT ARM
	BUCKET	160.0 mm (6.30 in)	OPT BUCKET

DISASSEMBLY

⚠ CAUTION!

Vent air from the hydraulic system before disconnecting cylinder piping connections. Use the lever on the reservoir, while the engine is running. Discharge the hydraulic accumulator and vent residual tank pressure after the engine is shut off. Pour clean replacement fluid into the system if excessive fluid is lost.

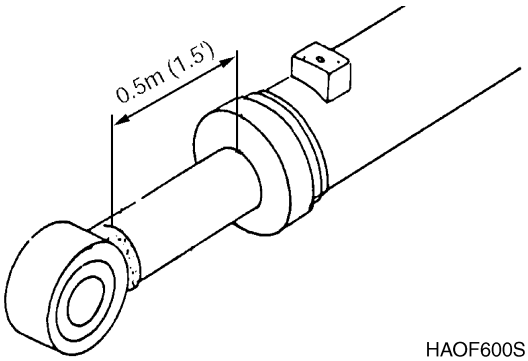
1. Following removal of cylinder from excavator attachment, support cylinder on some type of sturdy work platform and drain all oil. Rotate cylinder so piping ports are on top, to allow trapped air to vent.



0333

Figure 12

2. Position piston rod so it is extended approximately one half meter (20").

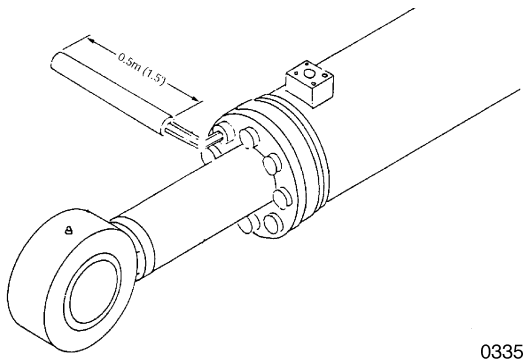


HAOF600S

Figure 13

3. Remove bolts (27) on the end of cylinder.

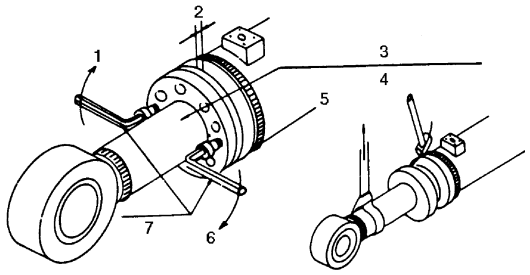
   NOTE: *Wrap a cloth or other protective material around piston rod, to avoid possibility of accidentally scratching or scoring rod surface while fasteners are being loosened and removed. Component parts (numbered in parentheses) are keyed to Figure 4.*



0335

Figure 14

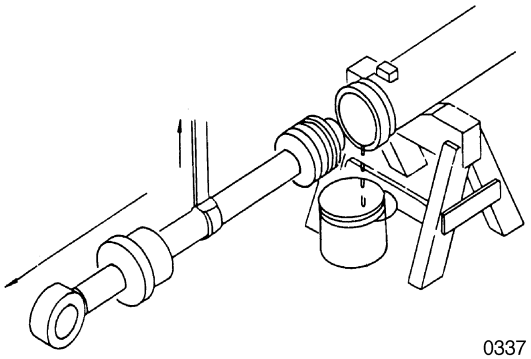
4. Tap two bolts into cover of cylinder head, 180° apart. Tighten them in a staggered, even sequence, to back off piston rod end cover from edge of cylinder wall. Look for adequate clearance between cover and end of cylinder wall before using a plastic or other soft faced hammer for final disassembly.



HAOF610S

Figure 15

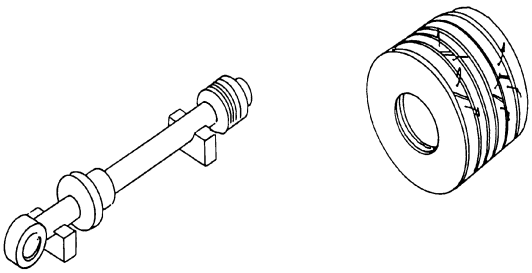
5. Begin withdrawing piston rod assembly, away from cylinder. Attach a lifting support when final 1/3 of rod is still inside barrel of cylinder. Prepare support blocks for piston rod before it has been completely withdrawn.



0337

Figure 16

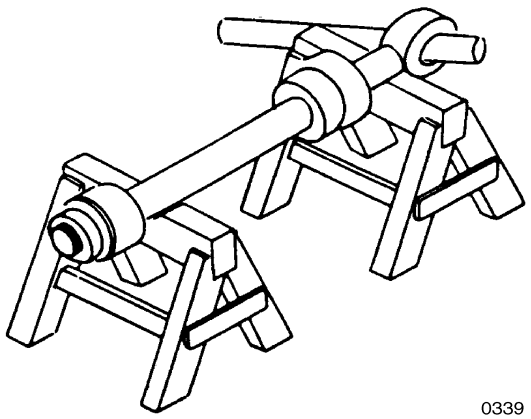
6. Lower piston rod to support blocks and detach wear ring (outer surface) (19) from end of rod.



HAOF620S

Figure 17

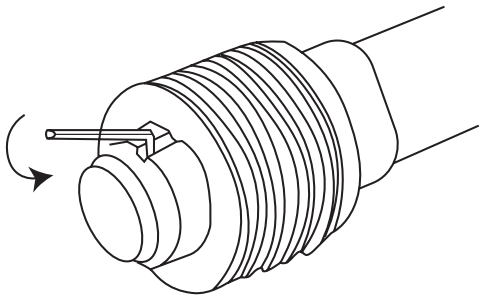
7. Immobilize piston rod by inserting a wooden or other nonscoring, nonmetallic support through end of rod.



0339

Figure 18

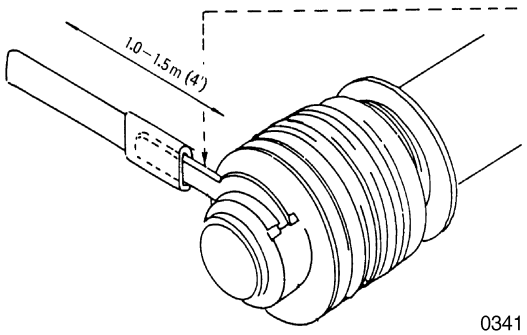
8. Remove set screw using socket wrench.



HAOF340L

Figure 19

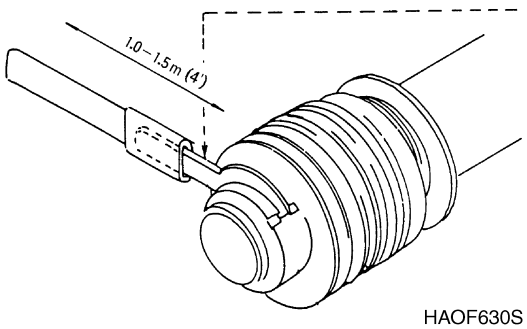
9. Fabricate or purchase a piston nut removal wrench. (Dimensions are called off at beginning of this procedure. This tool may also be ordered through your local *DOOSAN* Parts distributor). Remove nut from end of piston.



0341

Figure 20

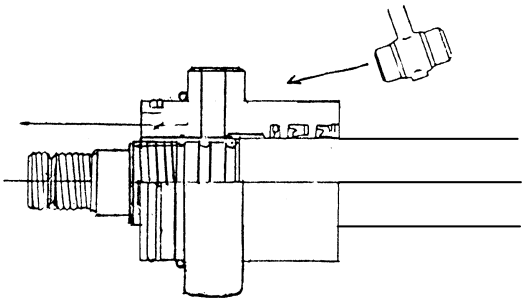
10. Use second piston tool described at beginning of this procedure to separate piston. Detach cushion ring (16), taking care not to damage cushion ring.



HAOF630S

Figure 21

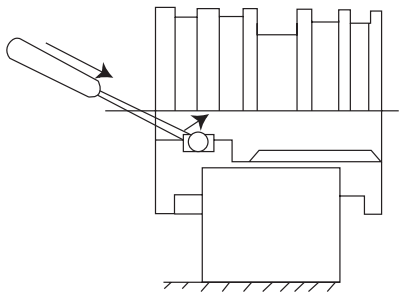
11. Use a plastic hammer to evenly pull off rod cover (5) from end of piston rod. Be careful not to damage rod bushing (6) and dust wiper, U-packing and other seals.



HAOF350S

Figure 22

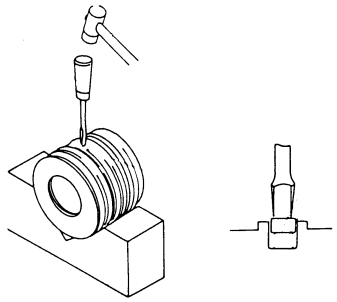
12. Use a dull, rounded tip tool to pry off O-ring (13) and backup ring (14).



HAOF37OL

Figure 23

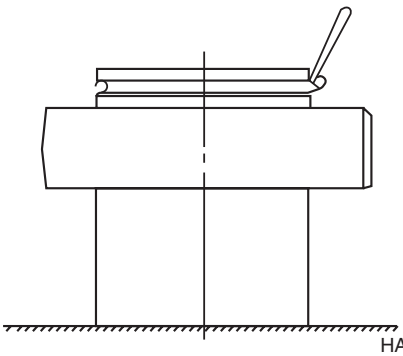
13. Find a screwdriver with an appropriate width tip to facilitate removal of slipper seal (18), wear ring (19) and slide ring (20) from piston (17).



0345

Figure 24

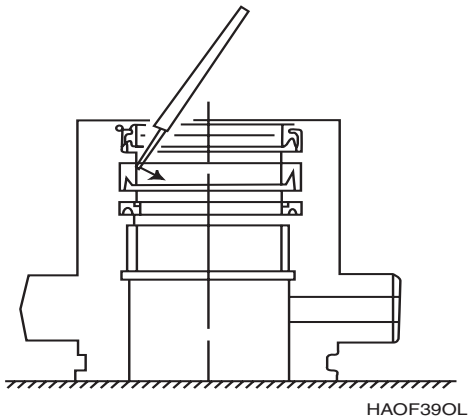
14. Remove O-ring (21) and backup ring (22) from cylinder head.



HAOF38OS

Figure 25

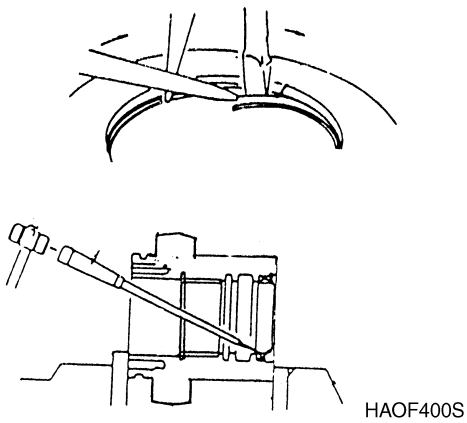
15. During disassembly of cylinder head, be careful not to damage buffer seal (8) and U-packing (9).



HAOF39OL

Figure 26

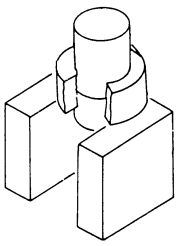
16. Disassemble retaining ring (12) and dust wiper (11). Separate retaining ring (7) and rod bushing (6).



HAOF400S

Figure 27

17. Force out pin bushing (2 and 4) from body of cylinder.



0349

Figure 28

REASSEMBLY

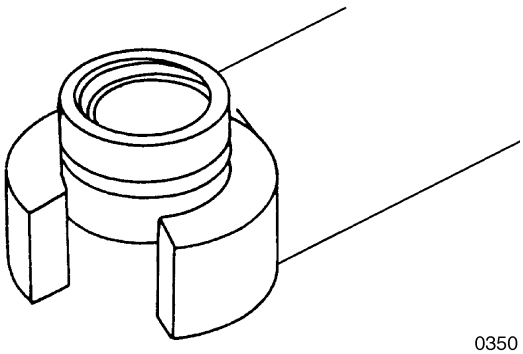
IMPORTANT

Replace any part that shows evidence of damage or excessive wear. Replacement of all O-rings and flexible seals is strongly recommended. Before starting the cylinder reassembly procedure, all parts should be thoroughly cleaned and dried, and/or prelubricated with clean hydraulic fluid. Prepare the work area beforehand to maintain cleanliness during the reassembly procedure.

NOTE: *Reassemble the subassemblies of the cylinder in the following order:*

1. *Body of the cylinder.*
2. *Piston rod.*
3. *Piston assembly.*
4. *Cylinder head assembly.*

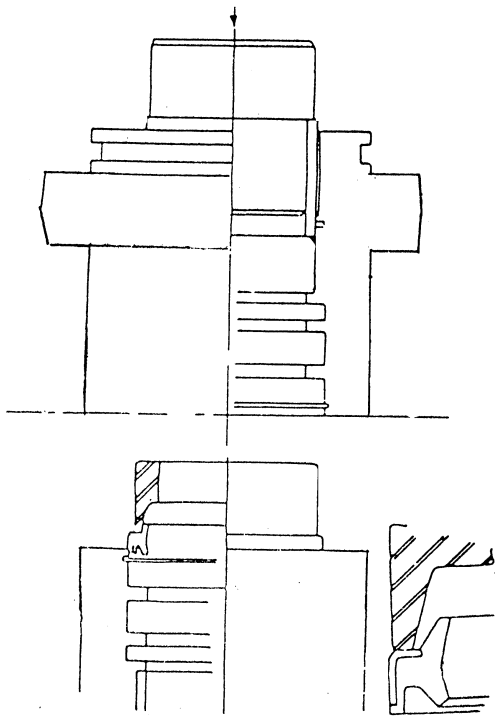
1. Reassemble pin bushing (2 and 4) to piston rod and body of cylinder.



0350

Figure 29

2. Following reassembly of rod cover components, install the dust wiper (11) and rod bushing (6) to the rod cover (5). Insert retaining rings (7 and 12).



HAOF440S

Figure 30

3. Prelubricate O-rings and seals before reassembly (Figure 31).

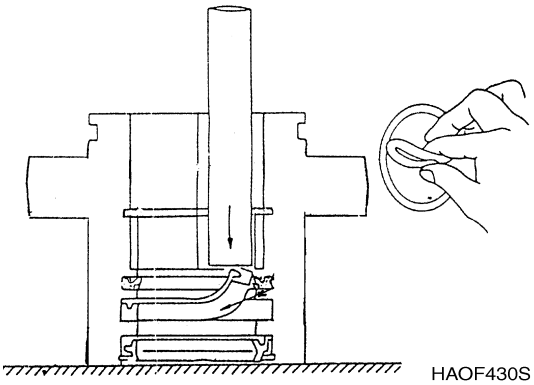


Figure 31

4. Before starting to rebuild piston assembly, heat slipper seal for 5 minutes in an oil bath warmed to 150° - 180°C (302° - 356°F). Use special slipper seal jig (third item in list of specialized tools at the beginning of this procedure) to attach seal. Cool seal by pushing a retracting jig against seal for several minutes. Apply a strip of clean, see-through sealing tape around slipper seal to keep it free of dust.

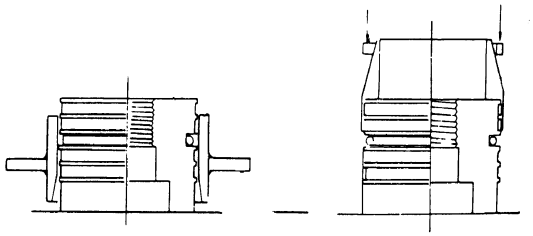


Figure 32

5. Immobilize piston rod on solid support blocks. Assemble O-ring (21) and backup ring (22). Prepare to attach rod cover assembly to piston rod. Push rod cover by tightening piston nut (23).

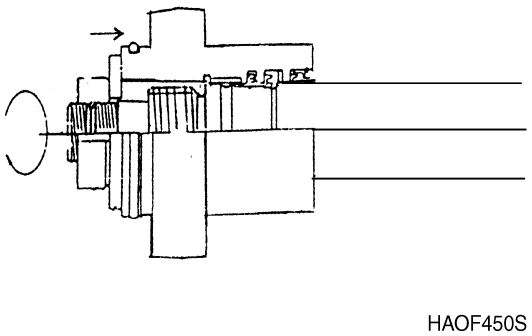


Figure 33

6. Assemble cushion ring (16) and attach piston assembly to piston rod.

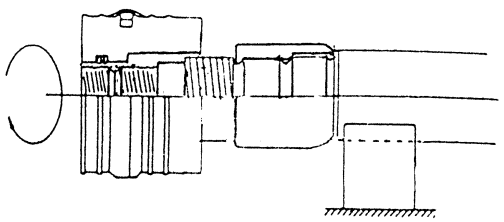
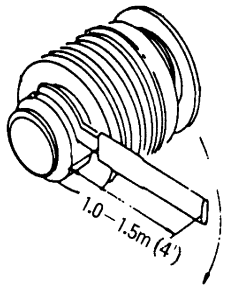


Figure 34

7. Use specially fabricate or factory sourced tool to tighten piston nut (23).

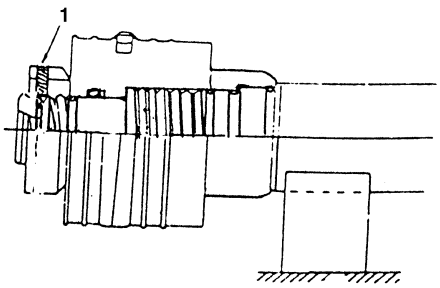


0356

Figure 35

8. Assemble wear ring (19), slide ring (20) and set screw (24) to piston assembly.

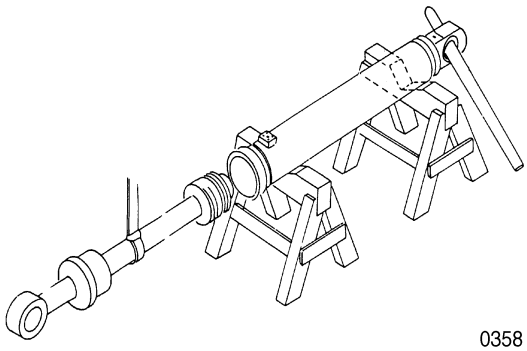
Reference Number	Description
1	Set Screw



HAOF470S

Figure 36

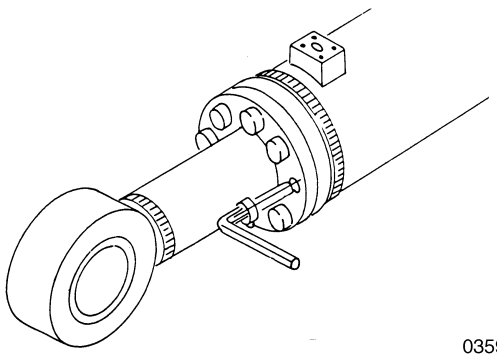
9. Immobilize body of cylinder before reassembly.



0358

Figure 37

Preapply fastener locking compound (Loctite #242 or #243 or an alternate manufacturer's equivalent product) to all end cover retaining bolts. Wrap a protective cushion around end of rod while tightening fasteners, to prevent possible damage to polished surface of rod, should a wrench slip during retightening.



0359

Figure 38

Swing Motor

Edition 1

Table of Contents

Swing Motor

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Applicable Models..... 5

Operation Manual 6

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- Specifications 7
- Structure and Operational Principles..... 8
- Cautions 15

Maintenance Instructions..... 22

- Disassembly and Assembly..... 22
- Maintenance..... 34

MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

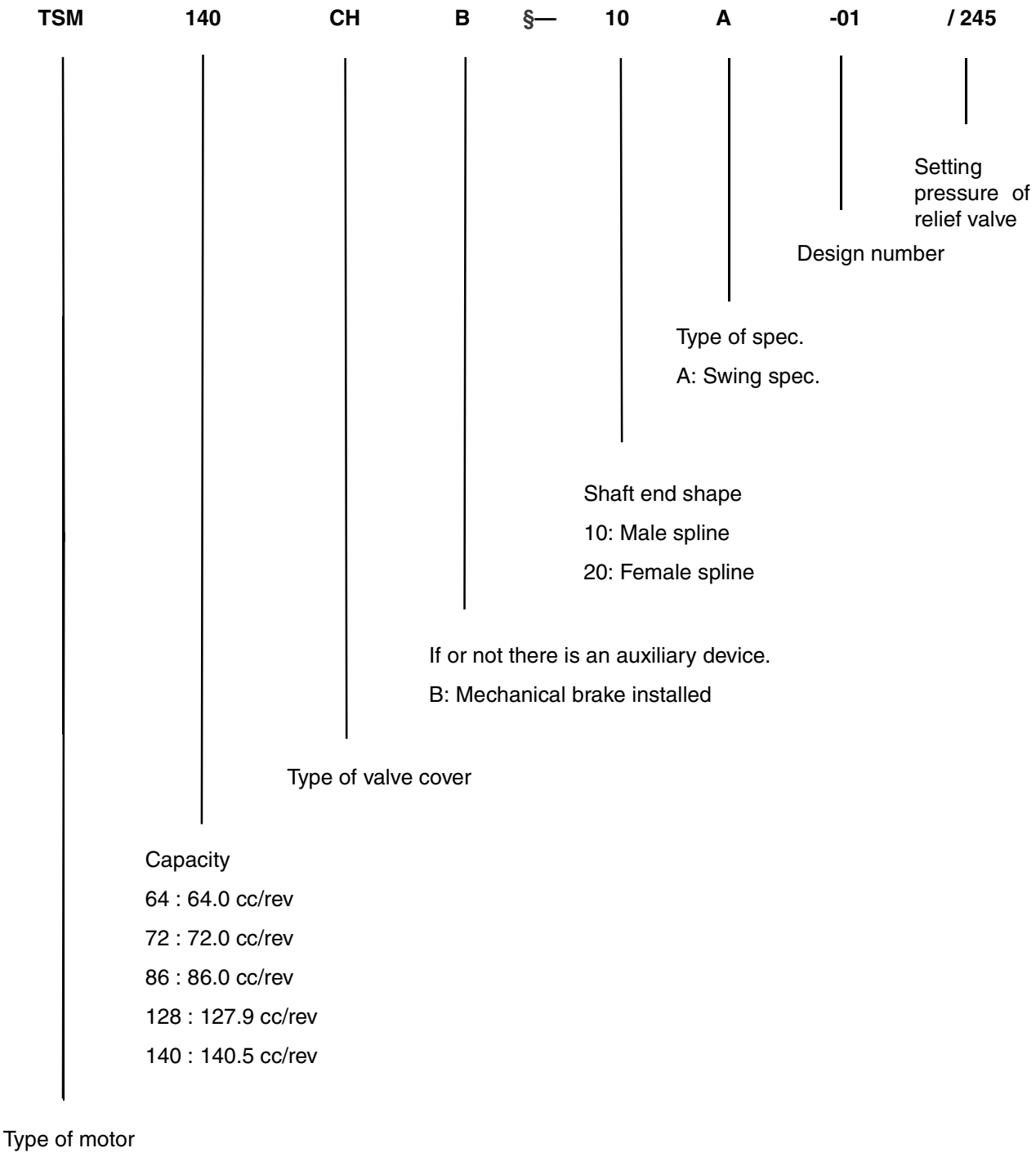
Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX480LC	5001 and Up
DX520LC	5001 and Up

Information on Marking



Specifications

Types		TSM64	TSM72	TSM86	TSM128	TSM140
Theoretical Capacity		64	72	86	127.9	140.5
Pressure ($kg•cm^2$)	Nominal	330	330	330	330	330
	Maximum	400	400	400	400	400
Maximum number of revolution (minimum)		2500	2200	1900	2000	1800
Theoretical output torque (kg•m)		33.6	37.8	45.1	67.1	73.7
Theoretical output (KW)		75.8	85.2	86.0	134.2	134.5
Brake torque (kg•m)		36.8	36.8	36.8	70	70
Brake release pressure ($kg•cm^2$)		24	24	24	26	26
Weight (kg)		42.3	42.3	42.3	62	62

NOTE: *1 means theoretical values for nominal pressure.*
2 means theoretical values for nominal pressure and maximum revolution.

NOTE: *TSM140 series may handle up to 140.5 cc/rev using the change of the area of the swash plate.*

Structure

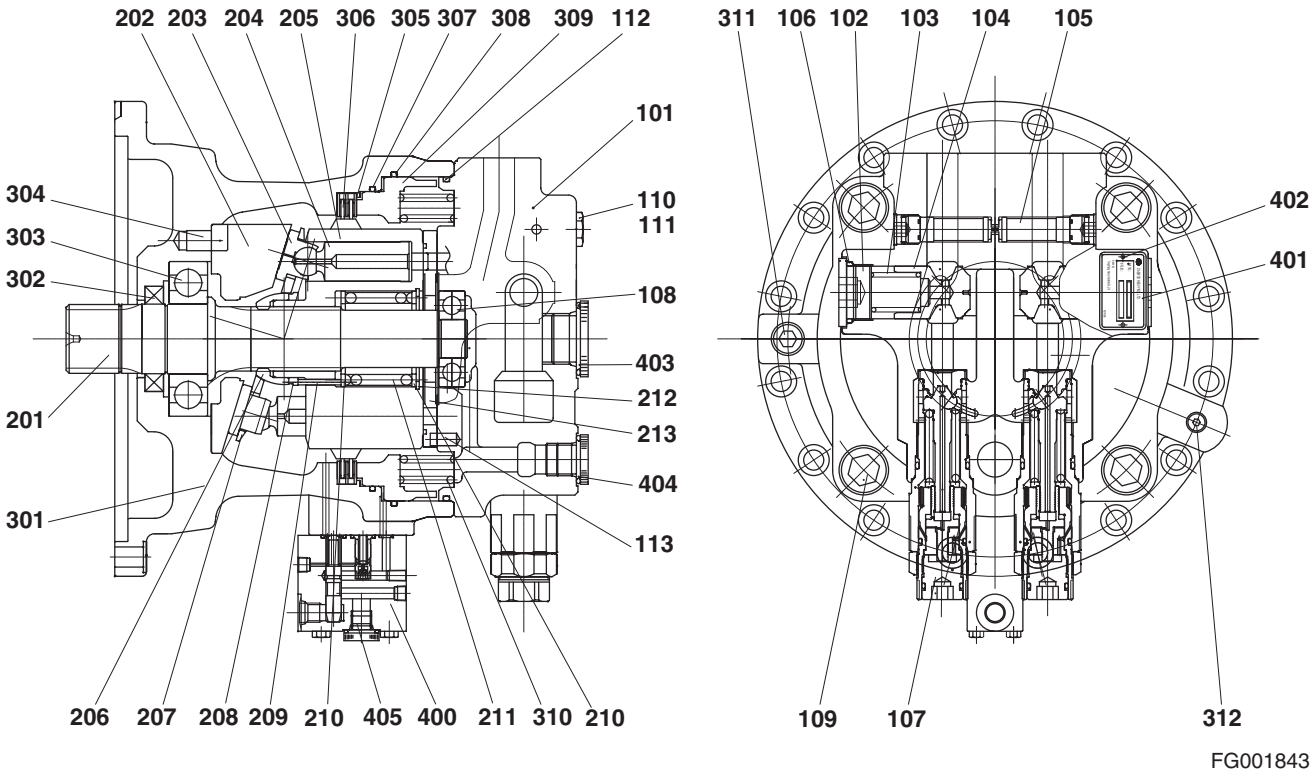


Figure 1

Reference Number	Description
101	V/V Casing
102	Plug
103	Spring
104	Plunger
105	S/R Valve Assembly
106	O-ring
107	Relief valve
108	Ball Bearing
109	Socket Bolt
110	VP Plug
111	O-ring
112	O-ring
113	Pin Spring
201	Driveshaft
202	Swash Plate
203	Shoe
204	Piston
205	Cylinder Block
206	Thrust Ball
207	Retainer Plate
208	Collar

Reference Number	Description
209	Roller
210	Washer
211	Spring
212	Ring Snap
213	Valve Plate
301	Casing
302	Oil Seal
303	Ball Bearing
304	Parallel Pin
305	Separation Plate
306	Friction Plate
307	O-ring
308	O-ring
309	Brake Piston
310	Brake Spring
311	PT Plug
312	PT Plug
400	Hex Bolt
401	Nameplate
402	Rivet Screw

Operational Principles

1. Hydraulic Motor

   Hydraulic pressure acting on the piston generates a force F along the direction of the shaft when high-pressure oil flows into the cylinder block through the port of the valve plate (1) inlet as shown in the figure below. The force F is vector divided through the shoe (2) into a force, F1, perpendicular to the swash plate and a force F2 perpendicular to the axis. The force F2 is transferred to the cylinder block (4) by way of the piston, generating a revolution torque for the revolution of the output shaft.

   The cylinder block has nine pistons which are arranged at the same interval, and the revolution torque is transferred to output shaft through several pistons connected to the port at the inlet of the high-pressure oil.

   Reversing the direction of the flow of oil also reverses the direction of the revolution of the output shaft.

$$T = \frac{P \times q}{2 \times \pi}$$

P: Effective differential pressure ($kg \cdot cm^2$)
q: Capacity per revolution (cc/rev)

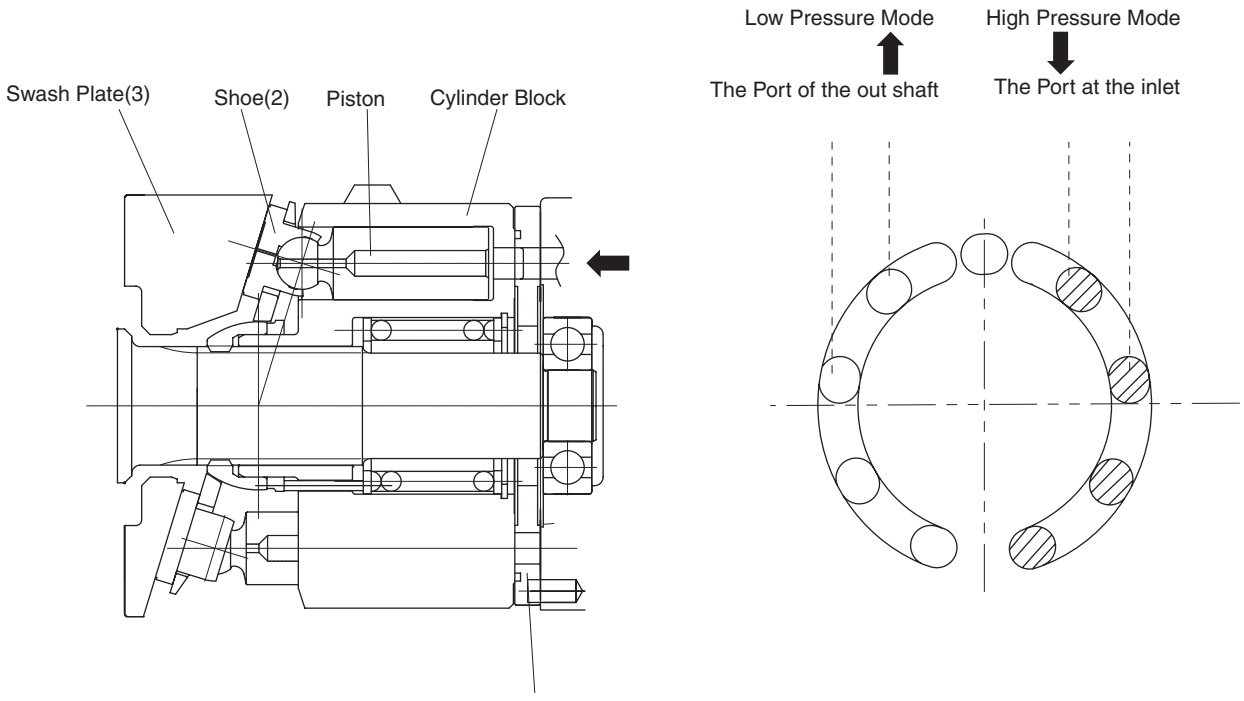


Figure 2

2. The Valve Casing

A. Anticavitation check valve subassembly

The revolution of the motor often is often more than that allowed by oil flow because the system with a motor like this one has no valve with a counterbalance function.

To avoid cavitation because of the lack of oil, it compensates for the lack using the check valve.

B. Relief valve subassembly: KRD22EK10C (See Fig 4, page 12.)

Here, let's consider that port (P) is pressurized by the tank pressure.

Ports (P and R) are in such a state as shown in Fig. 3-(1), by the tank pressure. The relief valve starts to run when the force determined by the hydraulic pressure area (A1) of the plunger (301) times the pressure P1 equals to the sum of the spring (321) force (Fsp) and the force determined by the plunger (301) times the hydraulic pressure area (A2) of the pressure Pg of the chamber (g).

Here, Pg is the pressure of the chamber (g) under the pressure of oil which has passed the orifice m, which starts to move to the left side of the piston when it reaches the pressure determined by the spring (321) pressing the piston (302).

$$P_1 x\ A1 = Fsp' + F_g x\ A2$$

$$P_1 = \frac{Fsp' + P_g \times A2}{A1}$$

As the piston (302) starts to move to the left, the chamber h acts as a damping chamber by the orifice (n) installed at the side of the adjustment plug (401) and the piston (302).

Thus, the pressure in the chamber h increases smooth until the piston (302) reaches the end part of the adjustment plug (401). [Fig. 3-(2)]

When the piston (302) reaches the end part of the adjustment plug (401), it does not move further that the pressure in the chamber h will be Ps and the force of the spring (321) Fsp. [Fig. 3-(3)]. So, the pressure P changes as shown in Fig 3-(4). The resulting pressure (Ps) can be obtained with the following formula:

$$P_s \times A1 = Fsp' + P_s \times A2$$

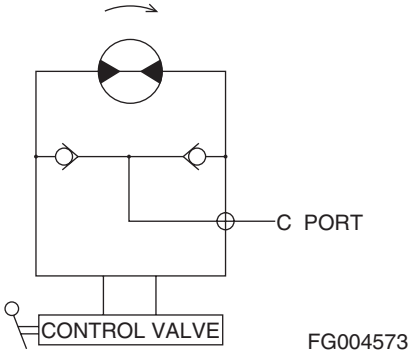
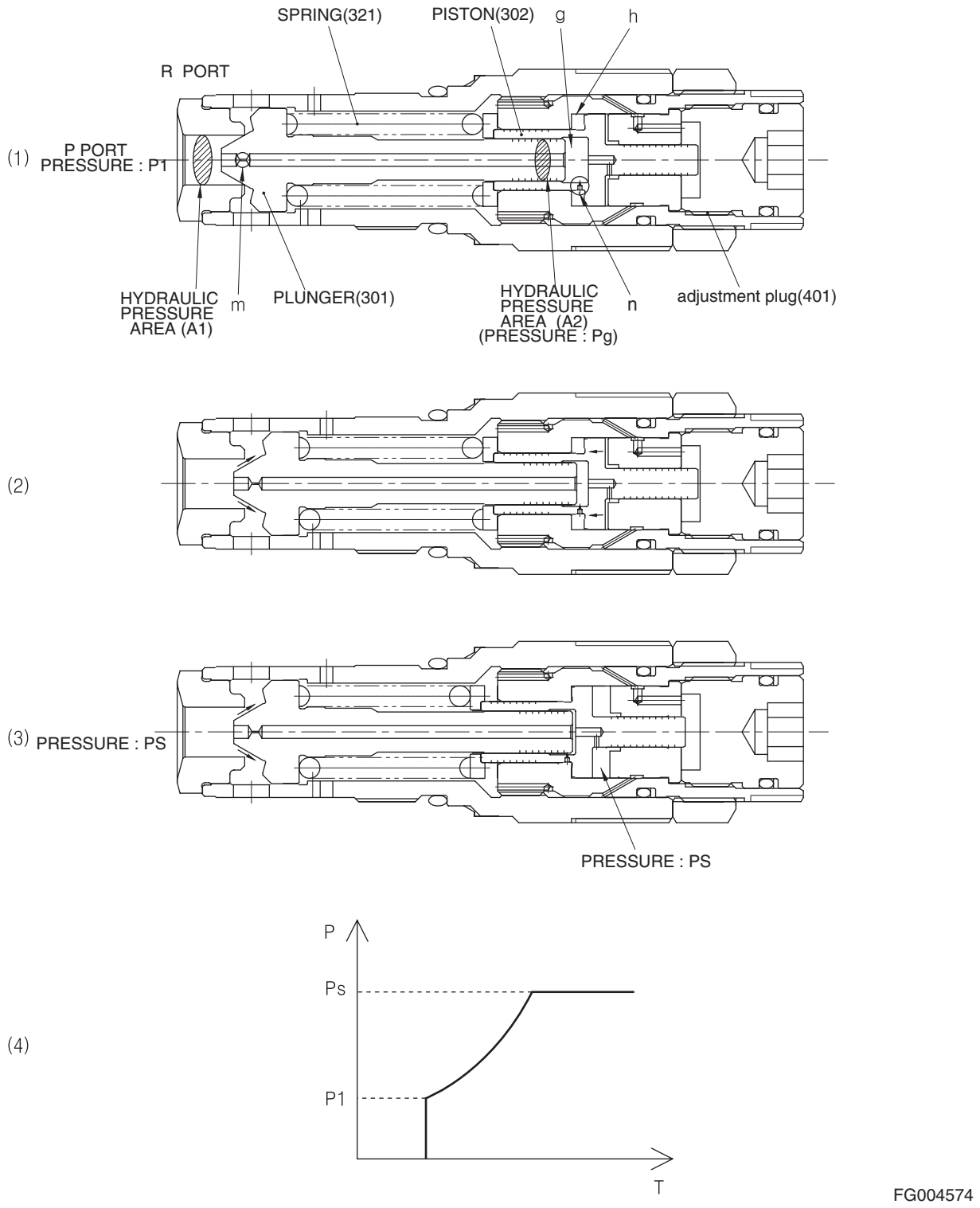


Figure 3

$$P_s = \frac{Fsp'}{A1 - A2}$$



FG004574

Figure 4

3. Reactionless Valve Subassembly

Pressure oil starts to flow to the port A (or B) of the pressure oil motor as the direction switching valve of the swing motor switches and the poppet of the reactionless valve moves to the right side to stop the bypass channel and to drive the swing body.

Then, the direction switching valve returns to the middle position, both ports of the hydraulic motor are blocked but the swing body stops its revolving movement soon because of its inertia whose force is transferred to the hydraulic motor by way of the reducer, that the port (B) (or A) generates the brake pressure to stop the swing body and then to try to revolve it in the reverse direction.

That brake pressure stops the swing motor and then makes it revolve in the reverse direction and the pressure at the port (B) would make the poppet switched to the left, which will be delayed by the orifice of the port A. In this case a bypass channel is generated between ports A and B, and pressure oil of the port (B) flows to port A through the bypass channel.

And, the poppet at the port (B) moves to the left until it stops the bypass channel. [Fig. 5-(3)]. As such, the reaction is prevented and the swing motor stops immediately by bypassing pressure oil to port A when reverse pressure is generated at the port B.

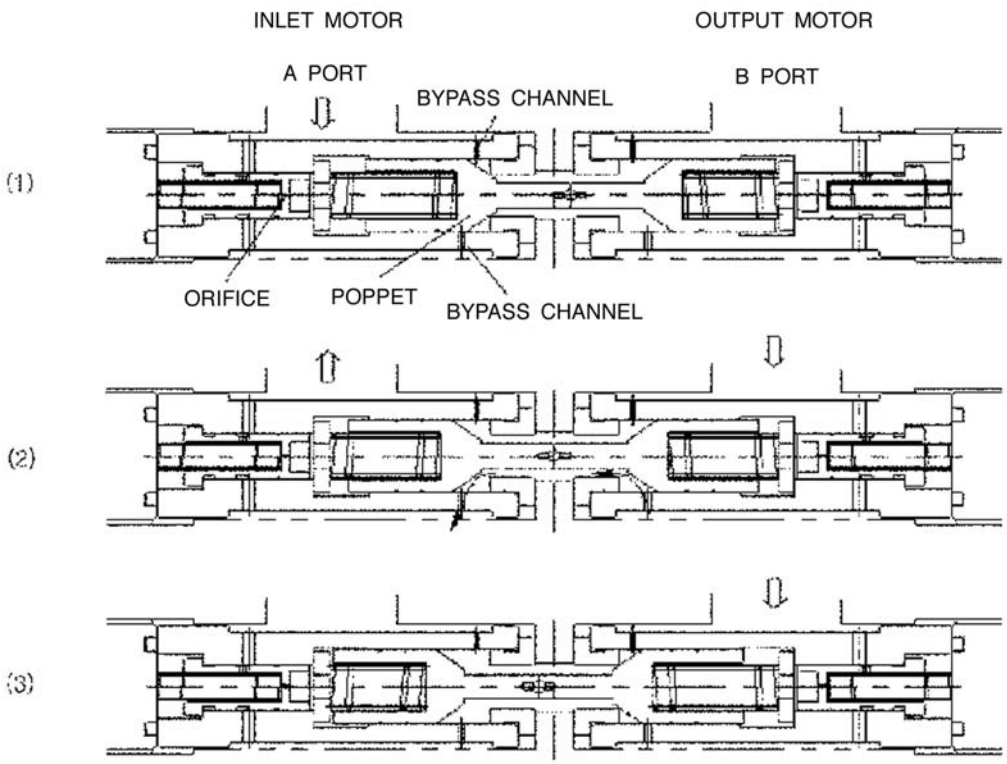


Figure 5

Brake Subassembly

The cylinder block (205) consists of the driving shaft (201) and the spline.

The separation plate (305) is kept from the revolution in the cylindrical direction by the arc opening processed at the casing.

A friction force occurs among the friction plate (300) in the tooth combination at the circumference of the cylinder and the casing (301), the separation plate (305), and the brake piston (309) when the friction plate is pressed against the casing through the separation plate, and the brake piston.

This friction force constraints the driving shaft, engaging the brake.

Meanwhile, the brake piston moves and the friction plate is separated from the casing to release the brake, as oil pressure force overcomes the spring force by applying a releasing force to the oil chamber formed between the brake piston and the casing.

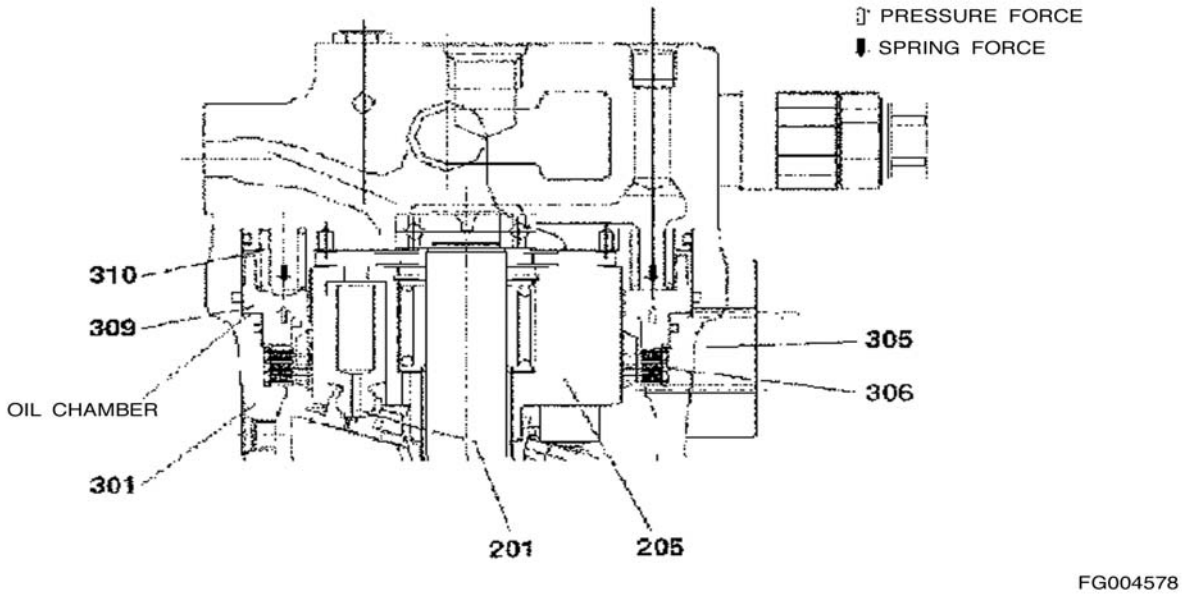


Figure 6

Cautions

Check Points

Before Installing a new Motor, Check if;

- It is damaged or lacks part (s) during the transfer.
- Each joint is tightened firmly.
- Flange and cover of the drain port are secured firmly and there is no dirt or dust in it.

Rotation Direction

Fig.7 and Table 3 (page 16) shows the relation between the direction of oil flow and rotation of the shaft. The rotation direction depends on the incline direction of the casing. Be careful for the swing direction because it depends on the casing shape and the flange direction.

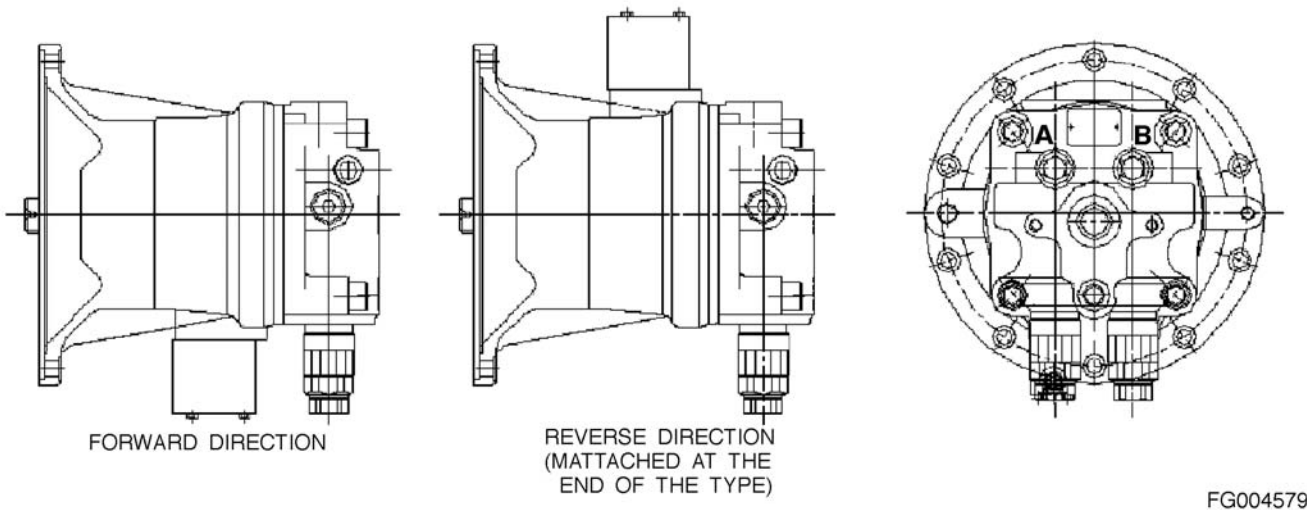


Figure 7

Directions	Inlets	Outlets	Rotation direction of shaft viewed from the shaft end
Forward direction	A	B	Clockwise
Reverse direction (M attached at the end of the type)	B	A	Counterclockwise

External Load on Shaft End

In principle, the shaft end of the motor should not be applied external radial and thrust loads.

Active Oil and Temperature Range

1. Type of Oil

   Generally used mineral hydraulic active oil is recommended, but with additives of extreme pressure, foaming preventive prevention, oxidation prevention, and damp proofing and high coefficient of viscosity.

2. Optimum Viscosity and Temperature of Active Oil

   The allowable viscosity range is between 10 and 1000 cSt, but 10 - 200 cSt is recommended for the optimum efficiency.

   The temperature range is limited to -25° - 100°C for the sake of the oil seal and the O-ring.

   For the operation temperature, at most 60°C is recommended taking into consideration the degradation of active oil and seals.

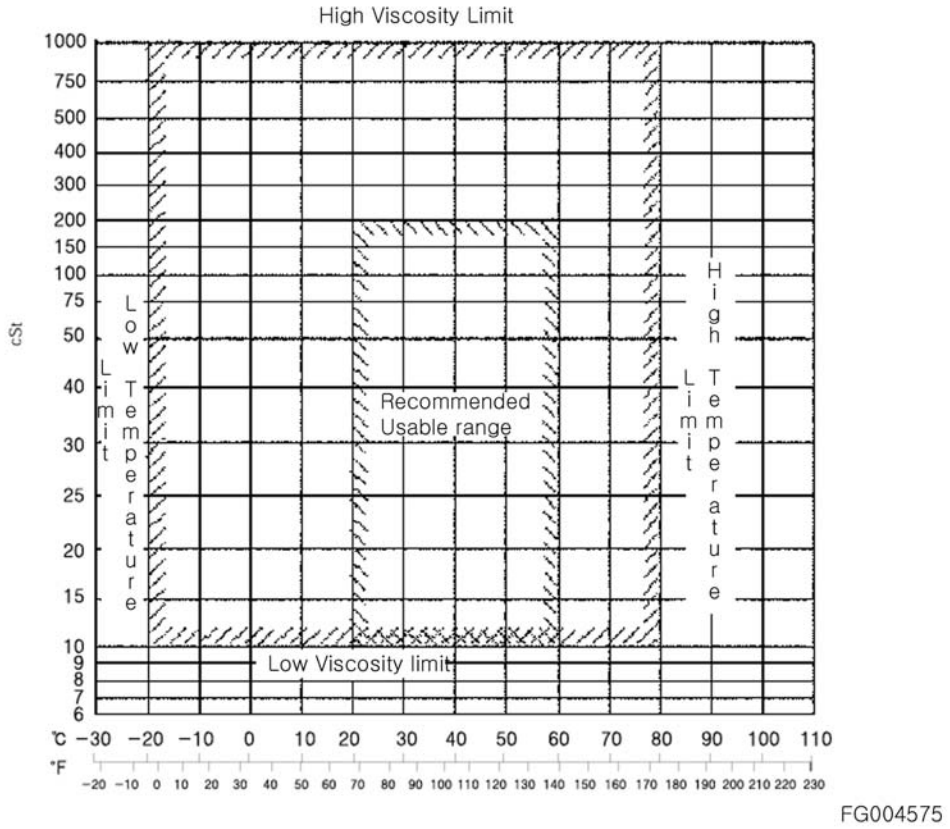


Figure 8

3. Active Oil Other than Mineral Oil

   If you are going to use phosphoric acid-, water-glycol-, or fatty acid-based active oil, please contact us in advance.

Filter

To prevent the presence of earth, dirt, metal particles in active oil which facilitates the wear of sliding parts, or sometimes makes them stuck or melted, filters should be installed in the circuit of 10m.

Recommended contamination level is below the 8th grade of NAS or 2-4 mg/100c by the Millipore Filter Contamination.

Installation and Piping

1. Basically, the motor should be installed that its axis directs downward.
2. Offset center from driven parts should be equal to or less than 0.05 mm.
3. Torque to be used to bolt the motor to brackets should be decided taking consideration into external measures.
4. The casing should always be full of oil. The drain of the motor should be positioned in such a place as shown in Fig 9 that the casing can be full of oil.
5. The pressure in the casing is allowed up to 3 kg•cm^2, but we recommend 2 kg•cm^2.
6. Pipes should be washed enough, but flushing is not allowed.
7. Piping should be installed that no overload is applied.
8. For the drain piping, use pipes bigger than the port of the motor but as short as possible.

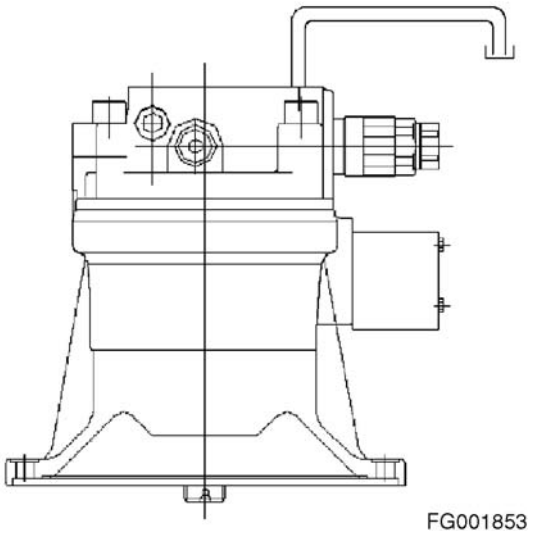


Figure 9

Fill Up and Air Discharge

1. Fill up the casing with oil through the drain port before operation. The motor has fast sliding components such as bearings, pistons, shoes, and round bushes in it. Without sufficient oil, these components may be burned or damaged. The PF 1/4 port of the casing is used as air discharge port.
2. Air in the circuit and the motor should be discharged completely without fail, or it may cause malfunction or damage to them.

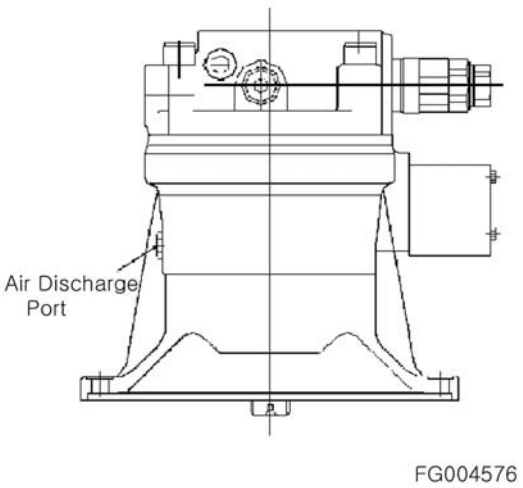


Figure 10

Cautions During Start

1. Make sure that every piping is made correctly.
2. Make sure that the revolution direction is correct.
3. There should be no leakage in the motor.
4. There should be no abnormal vibration when operating a direction switching valve or during the revolution.
5. Oil temperature should not be increased abnormally during the short operation.
6. Pressure should not be too higher or lower than its set point.

General Cautions.

When observing abnormality during the operation of the hydraulic motor, follow the directions:

1. Before Treatment

   Determine the nature of the observed abnormality and check if the same was happened before. And, give a second thought to its cause.

2. For Dirt

   Be careful not let dirt in during disassembly, which is one of the most frequent causes of friction.

3. Handling of Components

   Every component is machined precisely that it should be handled very carefully not to damage it.

4. For any work, O-ring oil and gasket faces without any defect should be used. And, O-ring is recommended to be replaced with new one after disassembly.

How to Check Defects of Motor

It is very important to find out causes of problems for the hydraulic circuit. Check the following items and determine if its causes lie in the motor itself.

1. Check of Oil in the Casing

   Separate the drain plug and check active oil in the casing.

2. Abnormal Sound

   Check if there is an abnormal sound in the motor.

3. Pressure Measurement in Each Part

   Measure pressure in each part and check its abnormality before starting disassembly or maintenance procedure.

4. Measurement of Drain Level of the Motor

   A. If the drain level is below 25 lpm, it is normal when applying oil pressure after locking the swing.

   B. If the drain level is below 2 lpm, it is normal during the normal swing.

Problem, Possible Cause and Remedy

Hydraulic Motor Does not Revolve

Problem	Possible Cause	Remedy
Pressure does not increase	The relief valve of the circuit is not set up correctly.	Set the relief valve according to a correct value.
	Malfunction of the relief valve. • Plunger stuck, or • Throttling hole of the plunger blocked.	• Repair or replace the stuck part. • Disassemble and wash.
	Defect in the seat of the plunger.	Check the seat and, if necessary, replace it.
Pressure increases	Overload.	Release the overload.
	Moving part stuck.	Check and repair piston/shoe, cylinder block, valve plate, etc.
	Relief pressure is not applied to the brake.	• Check and repair circuits. • Check the brake switching valve.
	Brake piston is stuck.	Disassemble and check.
	Friction plate is stuck.	Disassemble and check. Replace any stuck part.

Reverse Revolving

Problem	Possible Cause	Remedy
Reverse revolving	Reverse revolving direction is set to the motor.	Refer to Fig 5 and set the direction correctly.
	Inlet and outlet of the piping are changed each other.	Fix the piping

Revolution Less than Set Point

Problem	Possible Cause	Remedy
Revolution less than set point	Insufficient inflow of oil.	Check pumps, amount of discharge, and circuits up to the motor.
	High temperature and abnormally excessive leakage.	Decrease the oil temperature.
	Wear or damage of sliding parts.	Replace.

Insufficient Brake Torque

Problem	Possible Cause	Remedy
Insufficient brake torque	The friction plate is worn.	Disassemble and check. If excessively worn, replace.
	The brake piston is stuck.	Disassemble and check.
	Relief pressure of the brake is not discharged.	Check and repair circuits. Check the switching valve for the brake.
	The spline of the friction plate is damaged.	Disassemble and check. Replace a damaged part.

Excessive slip of the hydraulic motor

Check the amount of drain of the hydraulic motor.

The motor may be considered normal, if it is about 500 cc/ minute
(1 pint)

Problem	Possible Cause	Remedy
The hydraulic motor undergoes excessive slip when it is applied external torque	Abnormal operation of the relief valve. Same as 1) above.	Same as 1) above.
	Defect in the seat of the plunger.	Replace

Leakage

Leakage from Oil Seal

Problem	Possible Cause	Remedy
Leakage from oil seal	Damage because of dust in the lip.Same as 1) above.	Replace the oil seal.
	Shaft is damaged or worn.	Exchange the positions of the lip and the shaft or replace them.
	Lip of oil seal is turned over because of excessively high-pressure in the casing.	Repair the blocked drain piping.
	Shaft is in rust.	Disassemble and fix.

Leakage from Combined Sliding Parts

Problem	Possible Cause	Remedy
Leakage from combined sliding parts	The O-ring is not inserted.	Insert and fix the O-ring.
	The O-ring is damaged.	Replace.
	Seal surface is damaged.	Disassemble and fix.
	Bolt is loose or broken.	Tighten up to reference torque or replace.

MAINTENANCE INSTRUCTIONS

Disassembly and Assembly

Bolt Tightening Torque

Bolt Sizes	Names	Torques (kg•cm)	Ref. Nos. of Parts
M6	Hex bolt	120 ±20	400
M20	Hex Socket bolt	4400 ±660	109
M22	Ro Plug	1100 ±100	105
M36	Ro Plug	2450 ±250	105
PGF 1/4	Plug	370 ±20	111
M33	Relief Valve	1800 ±100	105

Tools Used for Disassembly and Assembly

Names	Sizes	2-face Width	Applied Parts	Tools
Hex bolt	M6	10	Switching valve for brake	Hex wrench socket wrench
Hex Socket bolt	M20	17		Hex bar wrench
Plug	M22	10	Ro Plug	Hex bar wrench
Plug	M36	17	Ro Plug	Hex bar wrench
Plug	PGF 1/4	19	VP Plug	Hex wrench socket wrench
	M33	36	Relief Valve	Hex wrench socket wrench

Tools	Units
Pliers	065 bore
Driver	2, flat
Steel bar	1, about 10x8x200
Hammer	1 plastic and metal each
Torque wrench	Range of torque: °ÿ100 - 450 kg•cm °ÿ400 - 1800 kg•cm °ÿ1200 - 4800 kg•cm
Slide hammer bearing puller	
Brake piston drawing tool	See Page 25.

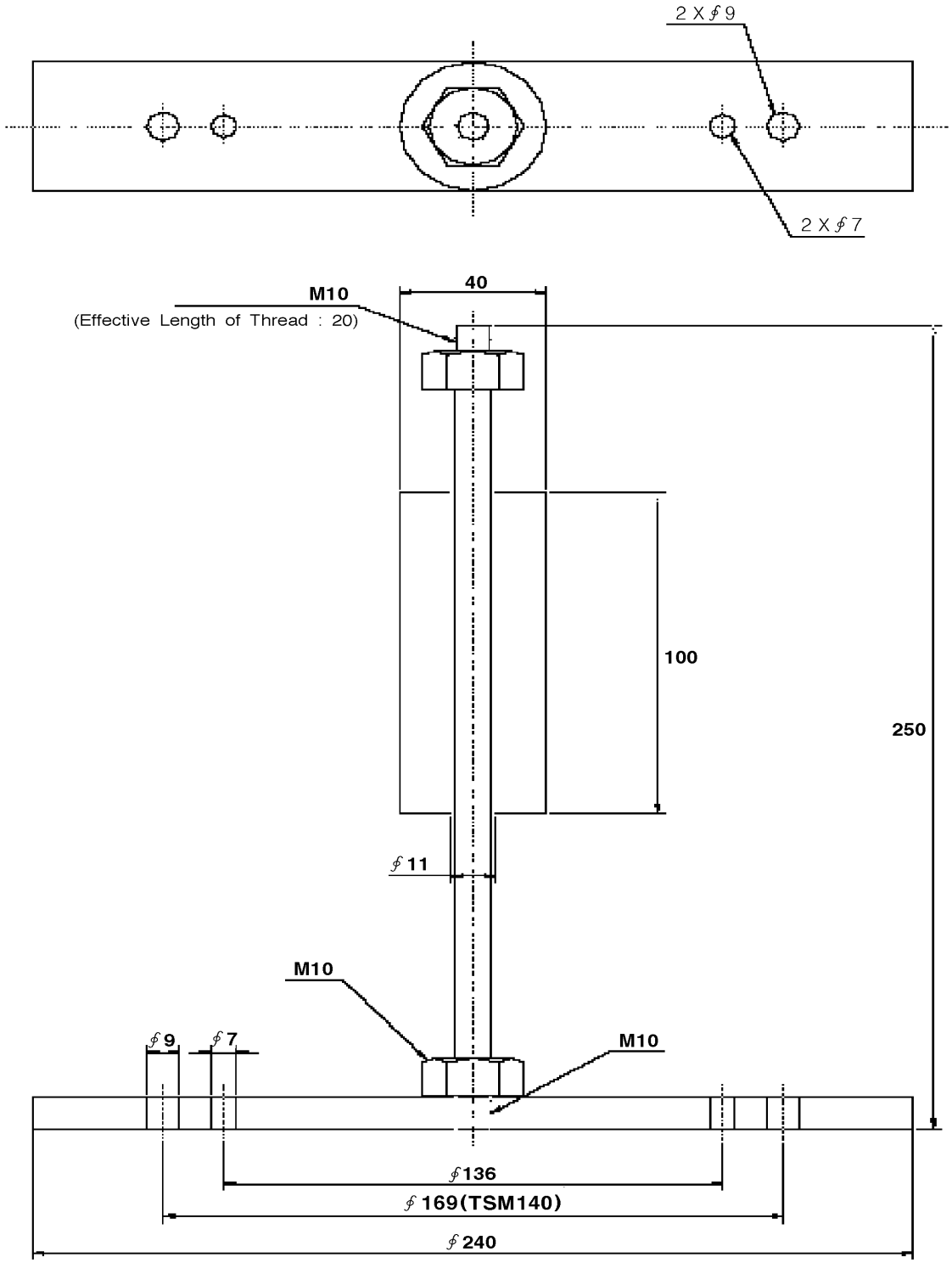


Figure 11 (Brake piston disassemble tool)

Disassembly

The motor should be disassembled in the following order. Numbers in the parenthesis indicate those as shown in the Assembly Diagram.

1. Wrap wire around the motor, use a crane to lift it, wash it with cleaning oil, and then dry it with compressed air.
2. Discharge oil in the casing (301) through the drain port.
3. Put the motor with the driving shaft (201) facing downward for easy disassembly.
    - Mark parts of the casing (301) and the valve casing (101) to be engaged.



Figure 12

4. Separate the brake valve (400).

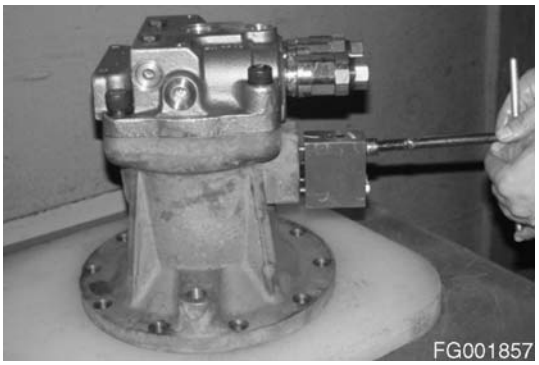


Figure 13

5. Undo and remove relief valve (107) from the casing (101).



Figure 14

6. Separate the plug (102) from the valve casing (101) and disassemble the spring (103) and the plunger (104).

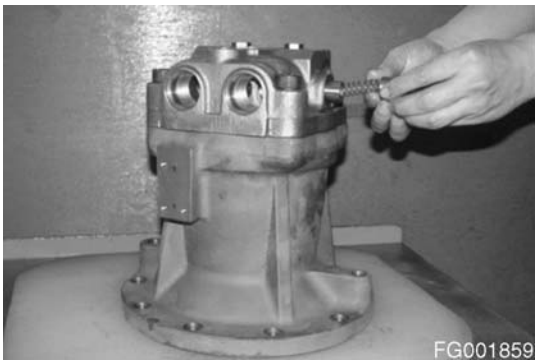


Figure 15

7. Disassemble the S/R V/V assembly (105) from the valve casing (101).

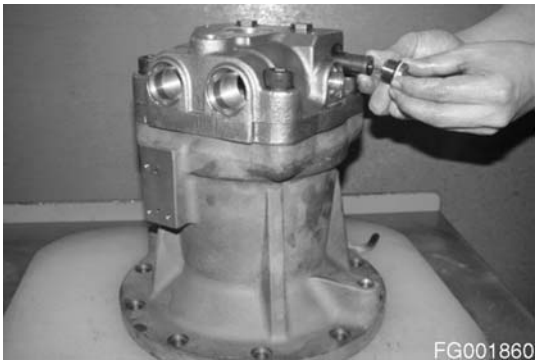


Figure 16

8. Loosen and remove hexagon socket head cap bolts (109, 110) from the valve casing (101). (Upon removing the bolts with the force of the brake spring (310), the valve casing is separated from the casing automatically.)

   Separate the valve plate (213) from the valve casing (101).

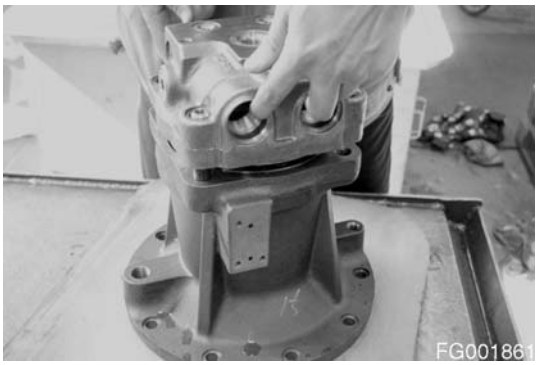


Figure 17

9. Remove brake spring (310) from the brake piston (309).

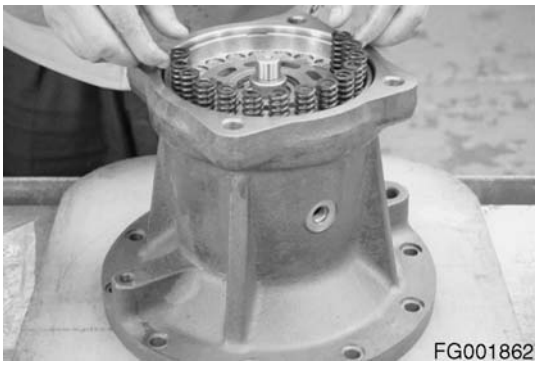


Figure 18

10. Use a tool to remove brake piston (309) from the casing.

    To use a hole of bolt, pull it upward straight.



Figure 19

11. Put the motor horizontally and separate the cylinder block (205) from the driving shaft (201). Then, remove piston assemblies (203, 204), the retainer (207), the thrust ball (206), and the collar roller (209). Care should be taken when taking out the cylinder block (205), as it may fall off. Also sliding parts of the cylinder block, the thrust ball, shoes, etc. should not be damaged. [Do not remove 2 washers (210), the spring (211), and the retaining ring (212).]



Figure 20

12. Separate 2 friction plates (306) and 3 separation plates (305) from the casing (301).

    (For TSM72: 4 separation plates and 3 friction plates)

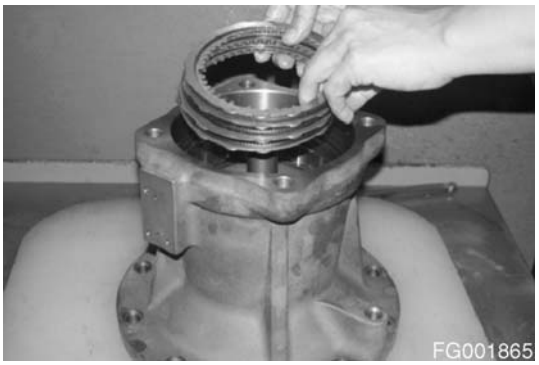


Figure 21

13. Use a plastic hammer to tap the face of the casing shaft to disassemble the driving shaft (201) consisting of the swash plate (202) and the ball bearing (303). Care should be taken not to damage sliding parts of the oil seal when separating the driving shaft from the casing.

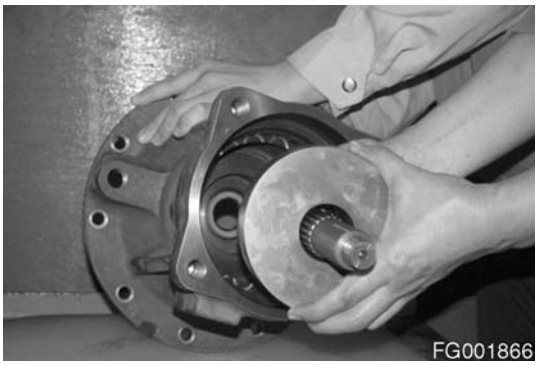


Figure 22

14. Carry out the following procedures as necessary.

A. Remove parallel pin (304) from the casing.

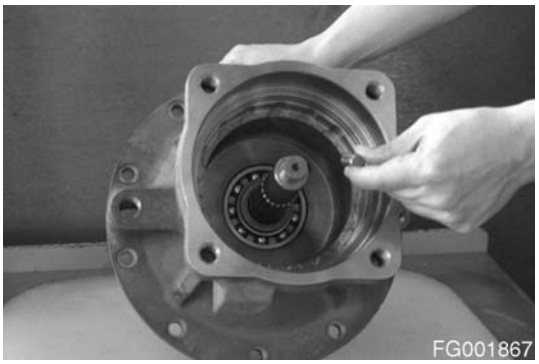


Figure 23

B. Remove ball bearing (303) from the driving shaft (201). Do not reuse the removed bearing.

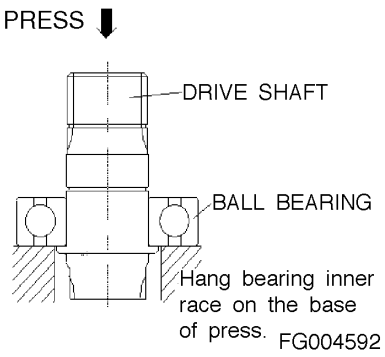


Figure 24

C. Use a tool to separate from the casing (301) the oil seal (302), which should not be reused.

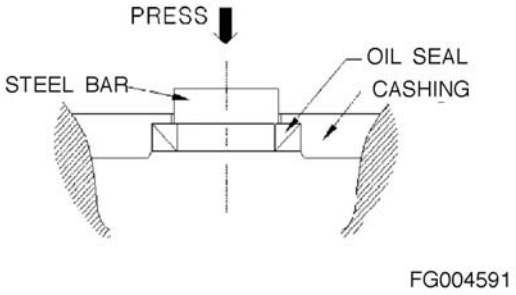


Figure 25

D. Remove ball bearing (303) from the valve casing.

E. Now, disassembly is done. Check every component carefully to see if there is any defect.

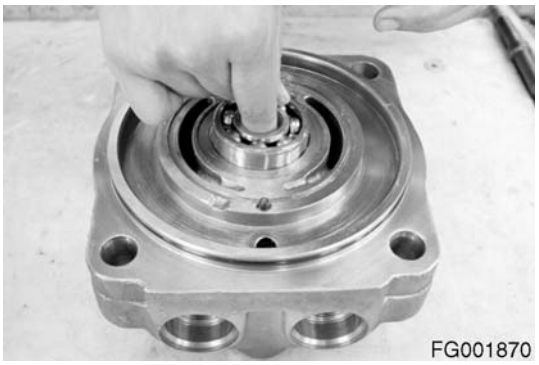


Figure 26

Assembly

Assembly shall be done in the reverse order of disassembly described above, taking into consideration the following points:

1. Parts damaged during disassembly should be repaired without fail and spare parts should be prepared in advance.
2. Every part should be cleaned enough with cleaning oil and dried with compressed air before starting assembly.
3. Sliding parts and bearings should be applied clean active oil before their assembly.
4. Seal parts of the O-ring and the oil seal should be replaced according to the standards.
5. Use a torque wrench to tighten or engage bolts and plugs in accordance with reference torques as shown in Table 1.

The Following is the Order of Assembly:

1. Put the casing (301) on a proper place.



Figure 27

2. (This procedure is necessary when the oil seal is separated from the casing.)

   Use a tool to insert the oil seal (302) in the casing (301).

   (Give heed to the direction of the oil seal and insert it until it reaches the end completely.)

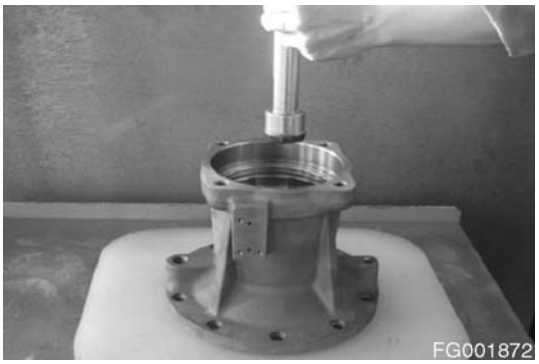


Figure 28

3. (This procedure is necessary when the ball bearing was separated from the driving shaft.)

   Install the ball bearing (303) in the driving shaft (201) by shrinkage fitting.



Figure 29

4. Insert the driving shaft (101) with the ball bearing (303) in the casing (301) with its output shaft facing upward and use a hammer to tap the surface of the ball bearing into the casing. At this point, apply grease to the lip of the oil seal light and then insert it carefully that it may not be damaged.

   (Wrap a tape around the spline of the driving shaft to prevent the damage of the spline because of the lip. Tap the surface of the external circumference evenly until it reaches the end completely.)



Figure 30

5. (This procedure is necessary when the parallel pin was removed from the casing.)

   Insert the parallel pin (304) in the casing (301).

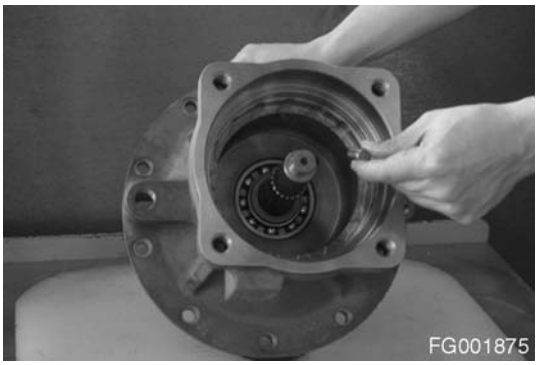


Figure 31

6. Assemble the swash plate (202) in the casing (301). (It is easy to assembly when the casing is put horizontally.)

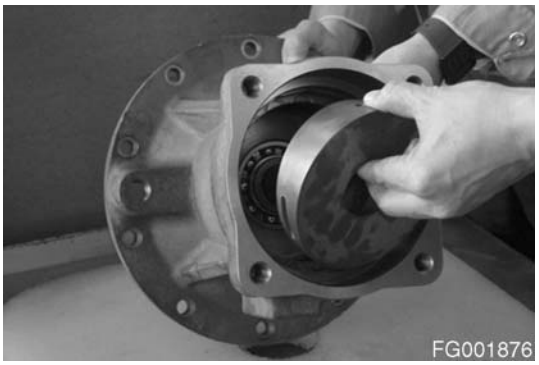


Figure 32

7. Insert the roller (209) in the cylinder block (205). [Check if the cylinder block has the washer (210), the spring (211), and the ring snap (212). Sliding parts of the cylinder block should not be damaged. Put a roller into a hole.]

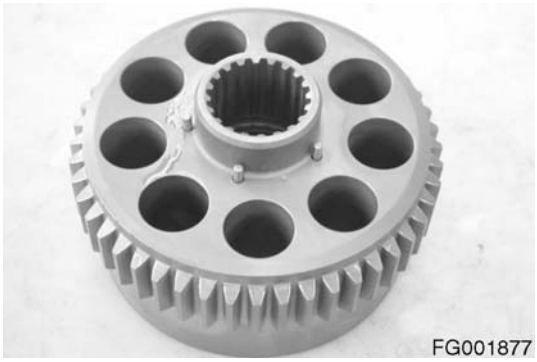


Figure 33

8. Assemble the collar (208) and the thrust ball (206) in cylinder block (205).



Figure 34

9. Assemble the piston assembly (203, 204) assembled in the retainer (207) in the cylinder block (205).

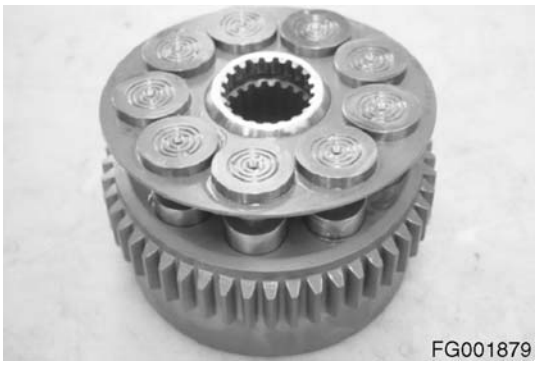


Figure 35

10. Assemble the cylinder block (205) in the driving shaft (201).

    At this point, arrange phases of the thrust ball and the cylinder block that it may be inserted in the driving shaft more easily.



Figure 36

11. Insert the separation plate (305) and then the friction plate (306) in the casing (301). 3 separation plates and 2 friction plates shall be assembled. (To assemble them, the friction should have the same phase for its parts where 4 gears are cut face up and down, and do does the separation plate for its parts where 4 jaws are cut.)

    (For TSM72: 4 separation plates and 3 friction plates)

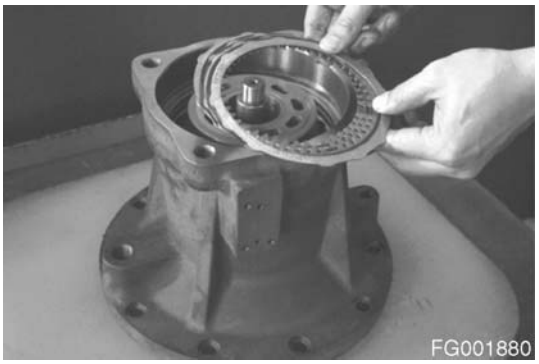


Figure 37

12. Insert the O-rings (307, 308) in the casing (301). (Apply grease to the O-rings light to prevent their breakage when inserting them in the brake piston.)

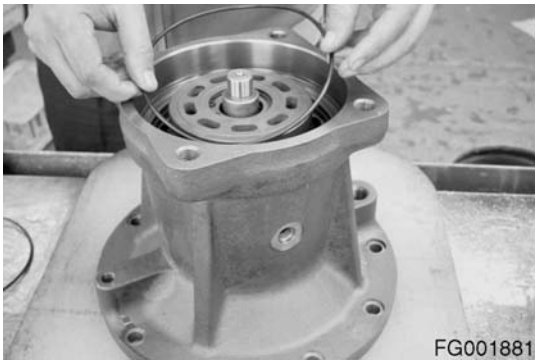


Figure 38

13. Assemble the brake piston in the casing (301). If it is not inserted well because of the resistance of the O-ring, engage a hex M8 bolt to the brake piston and use a plastic hammer to tap its surface evenly.



Figure 39

14. Assemble the brake spring (310) in the brake piston (309). Make sure that the spring should take the seat of the brake piston firmly.

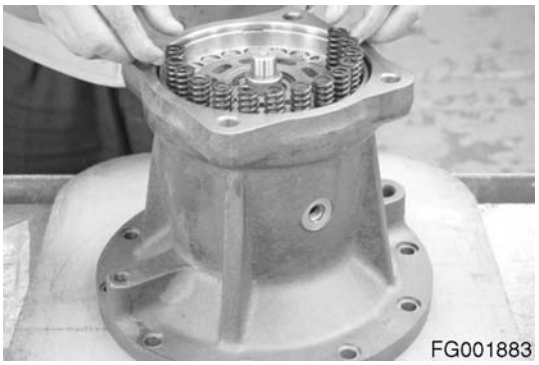


Figure 40

15. [This procedure is necessary when the ball bearing (108) was disassembled.] Use a hammer tied to a steel bar to tap the surface of the ball bearing into the valve casing (101).

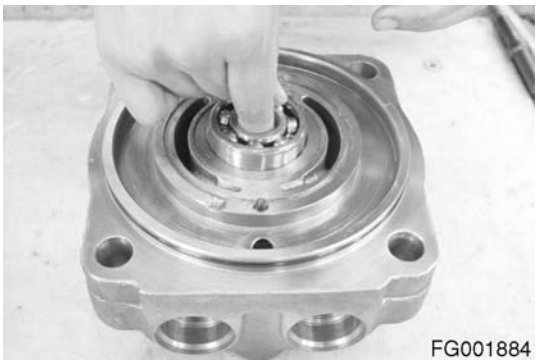


Figure 41

16. Assemble the valve plate (213) in the valve casing (101) and insert the O-ring (112). Apply grease to the engaging part of the valve plate light (to prevent its falling off).



Figure 42

17. Mount the valve casing (101) on the casing (301) and connect them with hex socket head cap bolts (109, 110). Give heed to the mounting direction of the valve casing (and its external measures).

    Care should be taken not to have the valve plate fall off and the brake spring fall down. Tighten hex socket head cap bolts uniformly.



Figure 43

18. Insert the plunger (104) and the spring (103) in the valve casing (101) and engage the plug (102) with the O-ring (106) to the valve casing (101). Make sure that the plunger moves smooth.

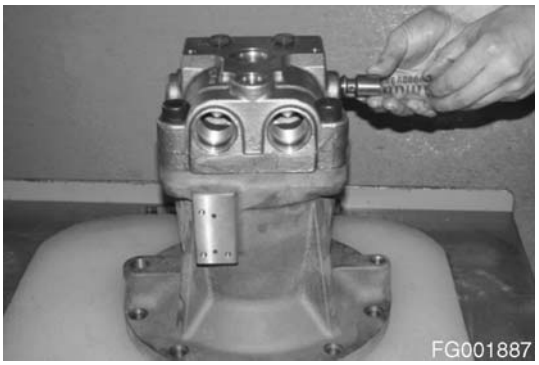


Figure 44

19. Assemble the S/R V/V assembly (105) in the valve casing (101). Check the spring in the S/R V/V assembly.



Figure 45

20. Apply grease to O-ring on the relief valve (107) and insert it in the valve casing (101).



Figure 46

21. Use hex socket head cap bolts to connect the brake valve (400) and the casing (301).

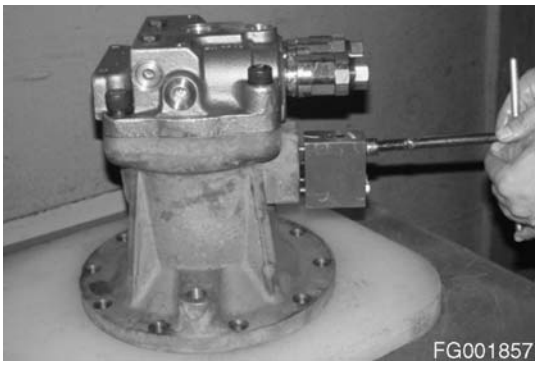
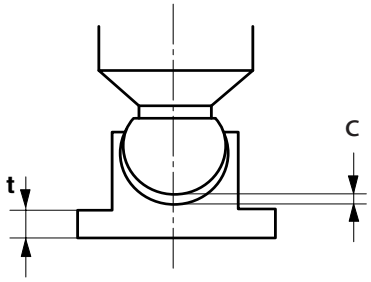


Figure 47

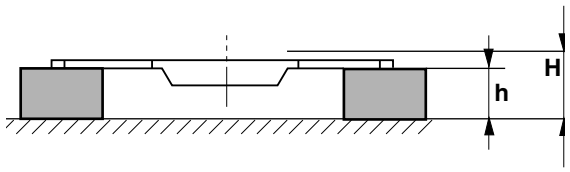
References for Replacement of Worn Parts

Replace or readjust parts which are worn more than references as shown in the table below. Note that the table does not show references for defects that are clearly visible.

For	Standards	Estimated Measures for Replacement	Solutions
Clearance between the piston and the cylinder block bore	0.025 (0.036)	0.055 (0.066)	Replace the piston and/or the cylinder block.
Distance between the piston and the shoe compression part (c)	0.05	0.2	Replace the piston and/or the shoe assembly.
Thickness of the shoe (t)	4.5 (6.5)	4.3 (6.2)	Replace the piston and/or the shoe assembly.
Height (H-h) of the assembled retainer plate and the thrust ball	10.8 (13.0)	10.3 (12.5)	Replace the set of the retainer plate and the thrust ball.
Thickness of the friction plate	3.5	3.1	Replace.



Clearance between the piston and the shoe (•‰)



Height of the assembled retainer plate and the thrust ball: H-h

Fixing References for Sliding Parts

Replace or readjust sliding parts whose roughness is higher than references as shown in the table below.

For	Surface Roughness Standards	Measures for Replacement
Shoe	0.8 - Z (Ra=0.2) (Lapping)	3 - Z (Ra=0.8)
Swash Plate	0.4 - Z (Ra=0.1) (Lapping)	3 - Z (Ra=0.8)
Cylinder	1.6 - Z (Ra=0.4) (Lapping)	12.5 - Z (Ra=3.2)
Valve Plate	0.8 - Z (Ra=0.2) (Lapping)	6.3 - Z (Ra=1.6)

NOTE: *Keep the surface roughness of each sliding part below the roughness standards.*

NOTE: *When the sliding part of the retainer or a round bushing is too rough, it should be replaced in the set.*

Travel Motor

Edition 1

MEMO

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MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up
DX225NLC	5001 and Up

TM40VC MANUAL

This manual contains information needed for the use of TM40VC.

Read it carefully before using the product.

TM40VC, a reduction gear attached hydraulic motor, is characterized by

1. Traveling motor for excavator consisting of planetary differential reduction gear, axle piston motor, and brake valve.
2. Small and light with high performance and good durability.
3. Directly engaged with the sprocket and seated fully in the crawler.
4. Stand against big external load because of a heavy-duty bearing in it.
5. Two speed, high and low, switching available for high-speed low-torque and low-speed high-torque rotations.

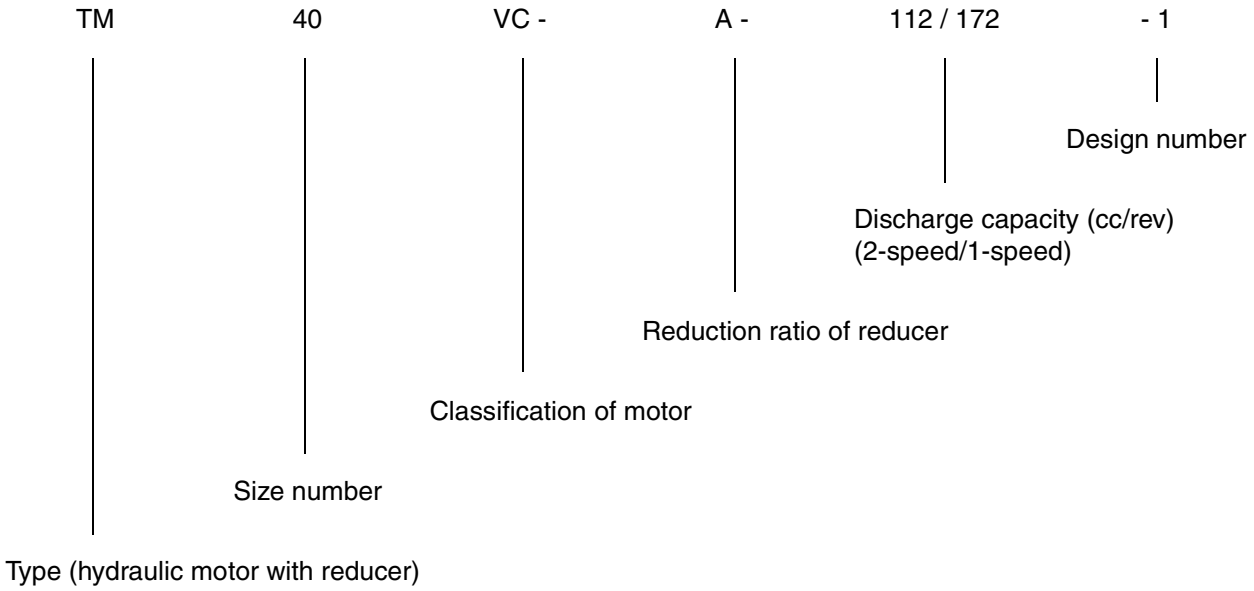
General Specifications

ITEM		UNITS	TM40VC
Nominal Output Torque		kg•m	max. 4000
Max. Number of Rotation Available		rpm	50
Reduction Ratio			48
Hydraulic Motor	Max. Stroke Capacity	cc/rev	183.9
	Max. Number of Rotation	rpm	2400
	Max. Pressure Available	$kg•cm^2$	350
	2-speed Switching Pressure	$kg•cm^2$	20 - 70
Parking Brake	Brake Torque (min)	kg•m	49.3
	Release Pressure	$kg•cm^2$	11
Total Weight		kg	310

– Specifications above are for typical performance.

– Performance of parts are illustrated in the External Specifications Diagrams.

Legend


TM
40
VC -
A -
112 / 172
- 1
Design number
Discharge capacity (cc/rev)
(2-speed/1-speed)
Reduction ratio of reducer
Classification of motor
Size number
Type (hydraulic motor with reducer)

Basic Structure and Diagram

Basic Structure of TM Motor

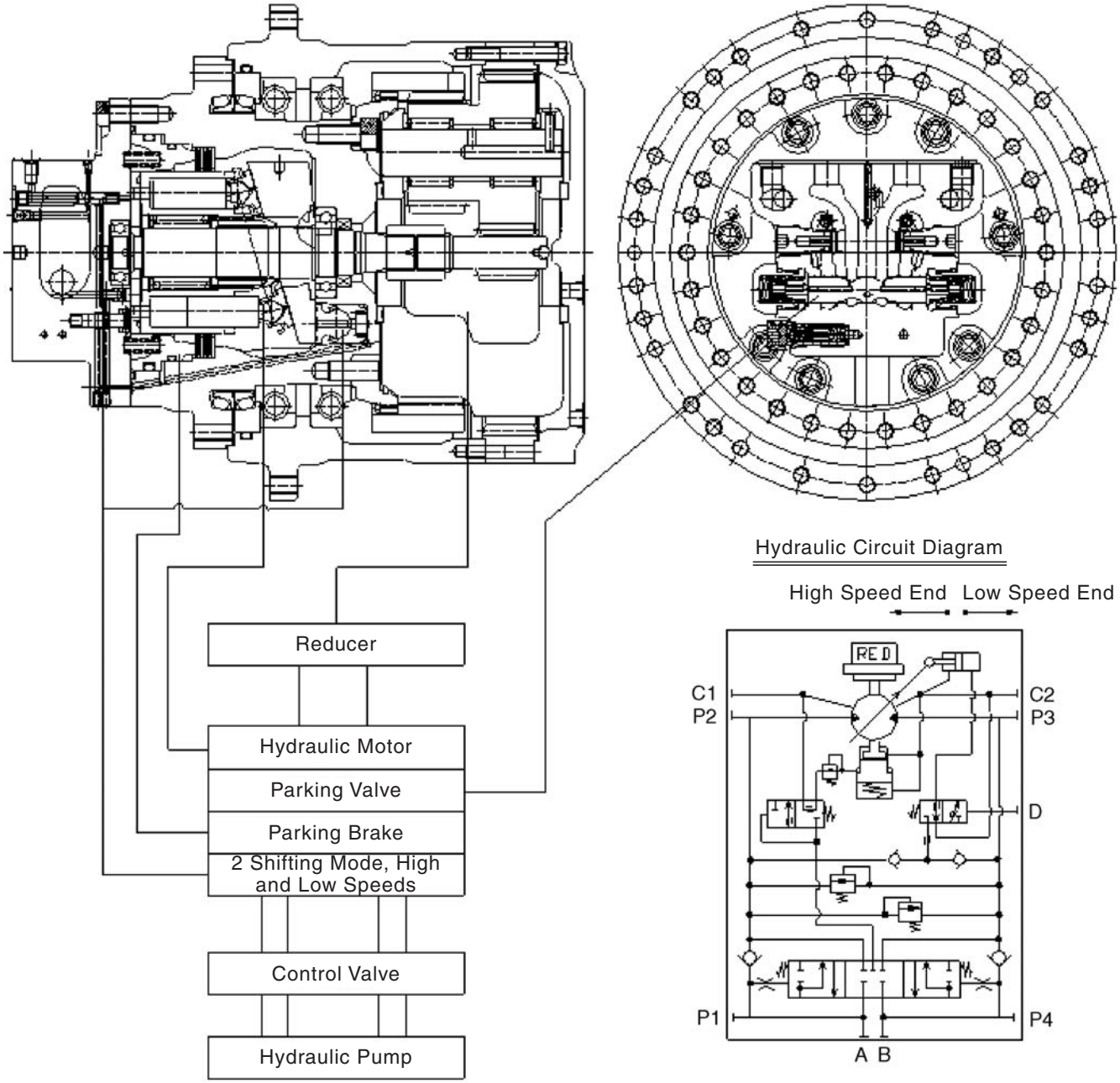


Figure 1

Operation Principles

Reducer

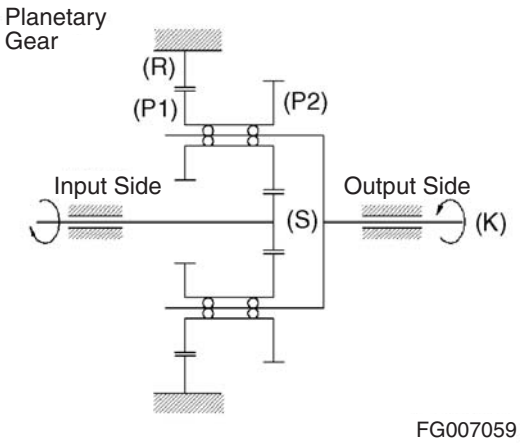
1. Function

   The reducer consists of the planetary automatic combination including the planetary gear and the differential gear, maintaining the high-speed rotation of the hydraulic motor, changing it to torque, and creating the hub (case) rotation.

2. Operation (Principle)

   The rotation of the sun gear (S) at the input side rotates the planetary gear (P) on its on axis to be engaged and revolve with the fixed ring (R). This revolution is transferred to the carrier (K) to create torque.

$$i1 = 1 + \frac{R \bullet P2}{S \bullet P1}$$

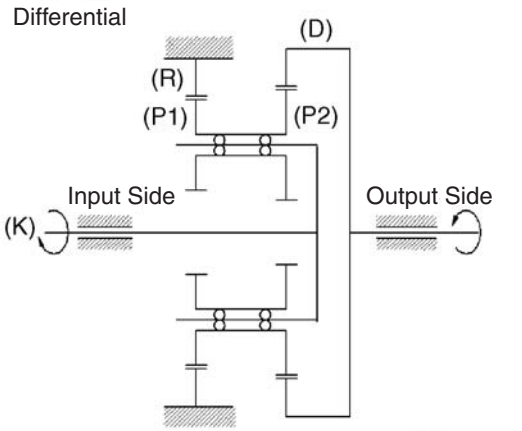


FG007059

Figure 2

   The rotation of the carrier (K) will have planetary gears (P1, P2) revolved. At this time, setting of a proper difference between teeth of (P1 and R) and (P1 and P2) creates the rotation difference at the gear D, for gears (P1 and P2) are coaxial, to generate torque.

$$i2 = \frac{1}{1 - \frac{R \bullet P2}{D \bullet P1}}$$



FG007060

Figure 3

The rotation of the sun gear (S) will create planetary movement between gears (S, P1, and R) that the revolution of gear (P1) rotates carrier (K). Its rotation starts automatic movements among gears (R, P1, P2, and D) and rotates ring gear (D). As the ring gear is connected to the hub (case) of the TM motor, TM starts to rotate.

$$i = i1 \times i2 = \frac{1 + \frac{R \bullet P2}{S \bullet P1}}{1 - \frac{R \bullet P2}{D \bullet P1}}$$

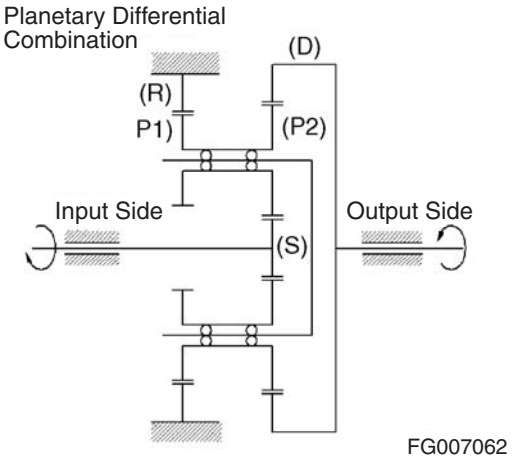


Figure 4

Hydraulic Motor (Brake Valve, Parking Brake, High and Low 2-Speed Shifting)

1. Functions

   A. Function of Hydraulic Motor

      The hydraulic motor called a swash plate axial piston motor, changes force of pressure oil from the pump into rotation force.

   B. Function of Brake Valve

      1) It ensures smooth stop of motor by controlling inertia rotation of the TM motor because of the inertia of its body when shutting down the motor.

      2) It acts like a check valve preventing the cavitation of the hydraulic valve.

      3) It acts like a surge cut valve controlling the brake pressure of the hydraulic valve and a anticavitation valve preventing the cavitation.

   C. Function of High and Low Speed Shifting

      It switches the tilting degree of the swash plate between the high-speed low-torque and low-speed high-torque rotations using the operation of the switching valve and the control valve.

   D. Function of Parking Brake

      Assembled in the hydraulic motor, it uses a friction plated brake to prevent the slip of excavator when it is parked or stopped on a slope.

2. Description and Principles of Operation

A. Hydraulic Motor

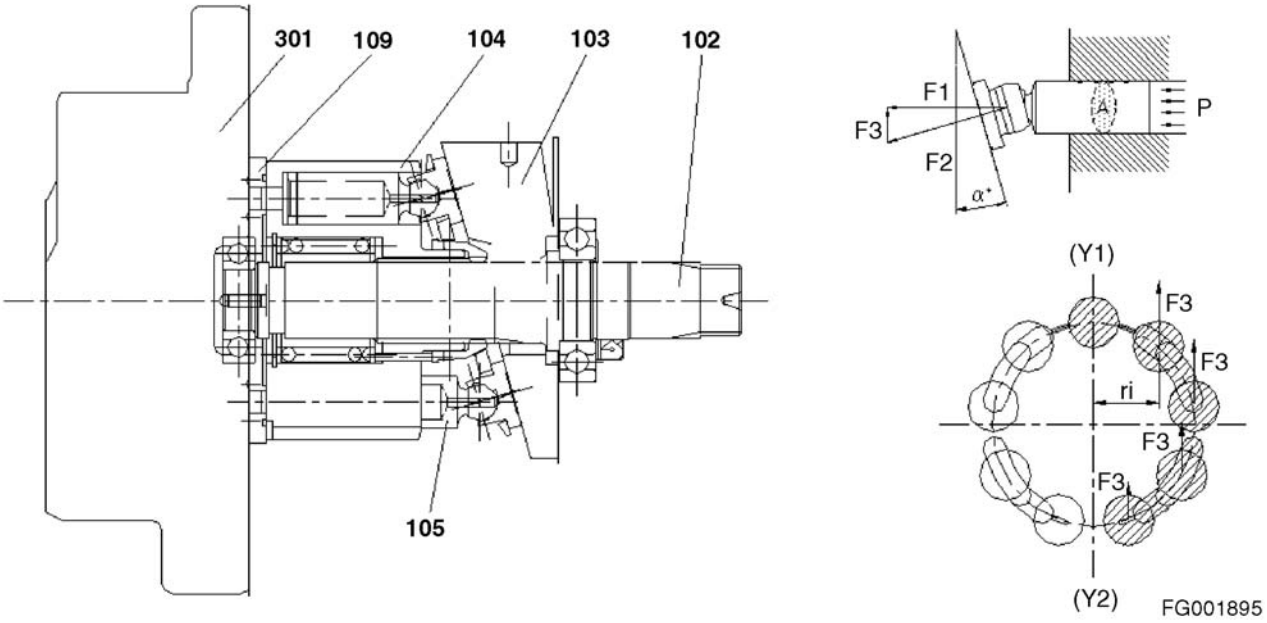


Figure 5

Pressure oil from the hydraulic pump flows into the rear flange of TM motor (101) and through timing plate (109) in the brake valve into the cylinder block (104). This pressure oil is designed to dictate the top and bottom dead centers and to be induced only to the lateral side of (Y1)-(Y2).

Pressure oil in the lateral side of cylinder block (104) press down piston (105) (4 or 5 ea.), generating the force [F (kgf) = P (kg•cm^2) x A (cm^2)]. This force acts to swash plate (103) and then is divided into F1 and F3, as the plate is fixed to the axis of driveshaft (102) at the degree of a°. F3, the vertical force of such divided ones. generates torques (T = F3 x ri) for (Y1)-(Y2) each, the sum of which is the rotation power (T = Σ (F3 x ri) and rotates cylinder block (104) through piston (105). As cylinder block (104) is connected to driveshaft (102) and the spline, driveshaft (102) rotates and torque is transmitted.

B. Brake Valve

Here, let's consider that port (P) is pressurized by the tank pressure.

(When Traveling) - Brake Released -

Oil from port (A) opens valve (227) to flow into port c at the suction side of the motor to enable the rotation of the hydraulic motor.

At the same time, the oil flows into chamber (b) through channel a by way of a small hole of spool (223) and acts to the surface of spool (223), opening port (D) of bypass line of the hydraulic motor and port (B) at tank which was closed by the force of spring (228) and having the return oil to flow into the tank, which rotates the hydraulic motor.

And, oil flows into port (P) according to the movement of spool (223). Oil in port (P) runs piston (112) of the parking brake to release its force.

(Refer to the Parking Brake for details.)

If oil is supplied from port (B) of the suction and return sides of the hydraulic motor, right and left actions of spool (223) and valve (227) reverse to generate reverse rotation.

(When Stopping) - Brake Applies -

If oil supply from port (A) stops during travel, the hydraulic force is released and spool (223) that was moved to the left side tries to move to the right side (neutral position) trough stopper (225) by the force of spring (228).

This hydraulic oil in chamber (b) that would flow into port (A) through line (a) in spool (223) controls the returning speed of spool (223) by the back pressure of throttling of line (a) and spool (295). At the same time, the return oil tries to return to B port through a line in the gap between rear flange (101) and hole of spool (223) in port (D).

When spool (223) returns to the neutral position, the line generated in the gap closes completely and the hydraulic motor stops running. In this way hydraulic fluid from the hydraulic motor is slowly controlled according to the return speed and the spool shape of spool (223) to smooth brake and stop the hydraulic motor.

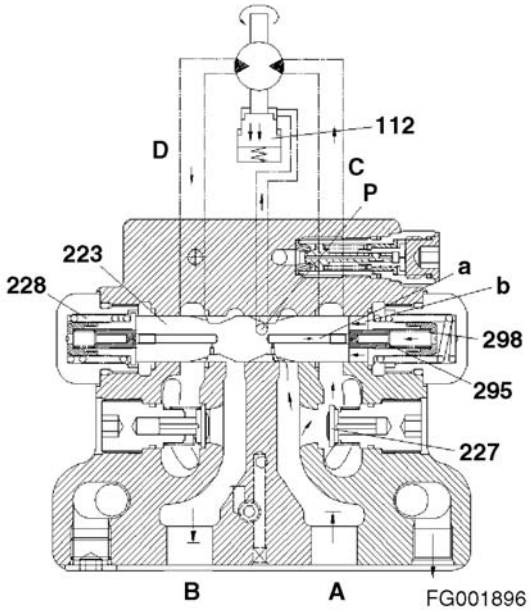


Figure 6

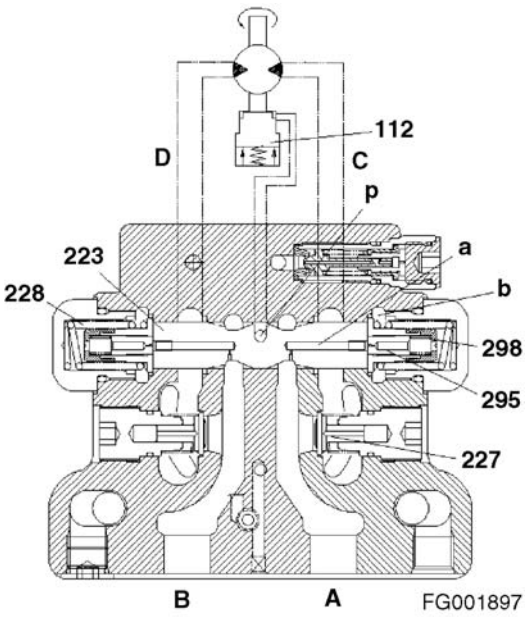


Figure 7

C. Parking Brake

(When Traveling)

Oil is supplied to the brake valve to run the spool in the brake valve of the hydraulic motor and open the line to the parking brake and oil flows into cylinder chamber (a) consisting of spindle and piston (112) of the reducer.

If hydraulic oil is above 11 kg•cm^2, oil surpasses the force of spring (113) to move piston (112). As piston (112) moves, its force pressing plate (116) and friction plate (115) vanishes that friction plate (115) inserted in the cylinder block of the hydraulic motor can move free and the brake force of the motor is released. If oil is above 45 kg•cm^2, it is reduced by the reducing valve to set the pressure of cylinder chamber (a) at 45 kg•cm^2.

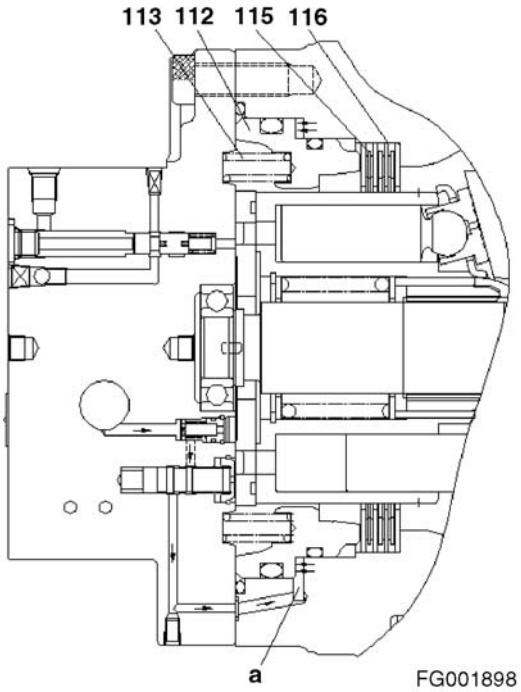


Figure 8

(When Stopping)

If the pressure in cylinder chamber (a) is below 11 kg•cm^2 after oil supply from the brake valve stops, piston (112) tries to return by the force of spring (113)

This force of spring (113) presses down piston (112) to cause mating plate (116) and friction plate (115) that have been free to be pressed against the spindle of the reducer, generating friction that stops rotation of the cylinder block and supplies the hydraulic motor shaft with a braking torque (49.3 kg•m), and, the smooth operation is ensured because of the control of hydraulic fluid according to its supply line properly.

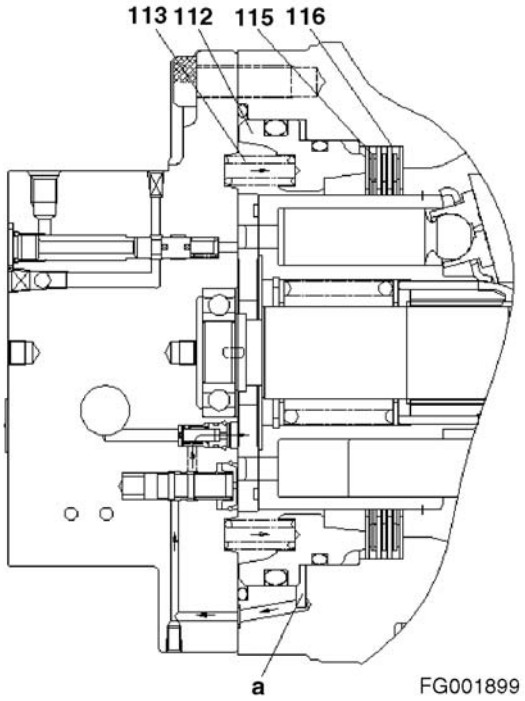


Figure 9

D. High and Low 2-Speed Shifting

(At Low Speed) - Pilot Pressure is Below 15 kg•cm^2

Without pilot pressure from port (A) (pressure is below 15 kg•cm^2), valve (263) is moved to the left side by the force of spring (266) to stop hydraulic fluid of supply port (B) but to release hydraulic fluid of chamber (C) into the motor case. So, the Max. tilting angle of swash plate (103) becomes $\theta 1$ and the piston stroke capacity of the hydraulic motor becomes minimum to enable low-speed rotation.

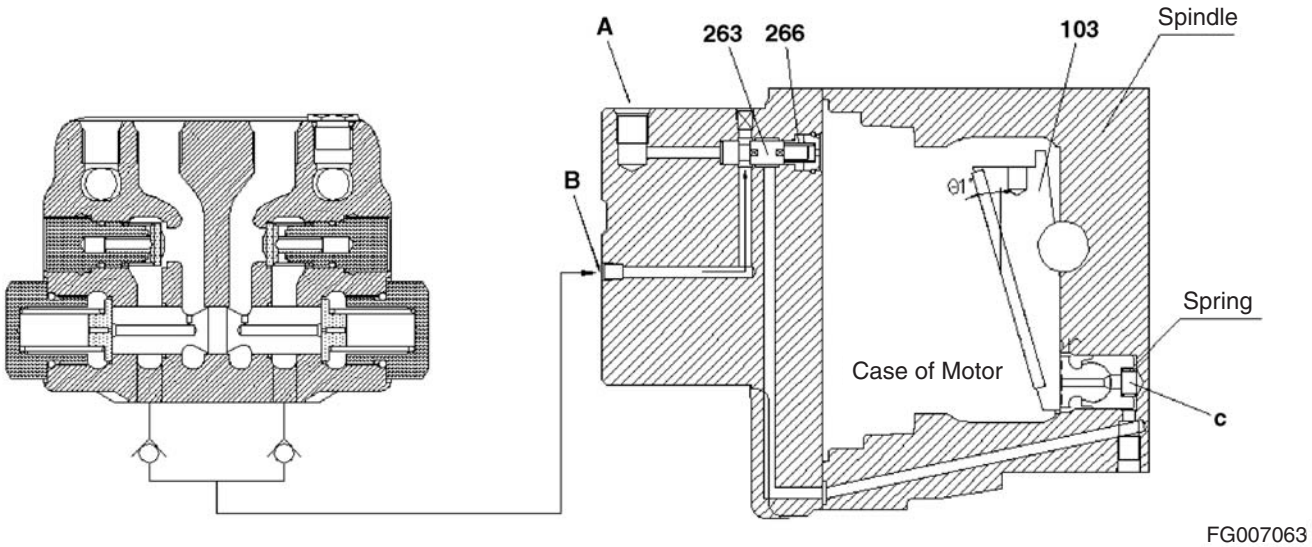


Figure 10

(At High-speed) - Pilot Pressure is Above 15 kg•cm^2

Without pilot pressure from port (A) (pressure is above 15 kg•cm^2), pilot pressure overcomes the force of spring (266) to move valve (263) to the right side and pressure oil of supply port (B) flows into chamber (C) through valve (263). Oil in chamber (C) presses piston (161) that swash plate (103) touches side (b) of the holder flange and keeps the status. At this time, the minimum tilting degree of swash plate (103) becomes $\theta 2$ and the piston stroke capacity of the hydraulic motor becomes minimum to enable high-speed rotation.

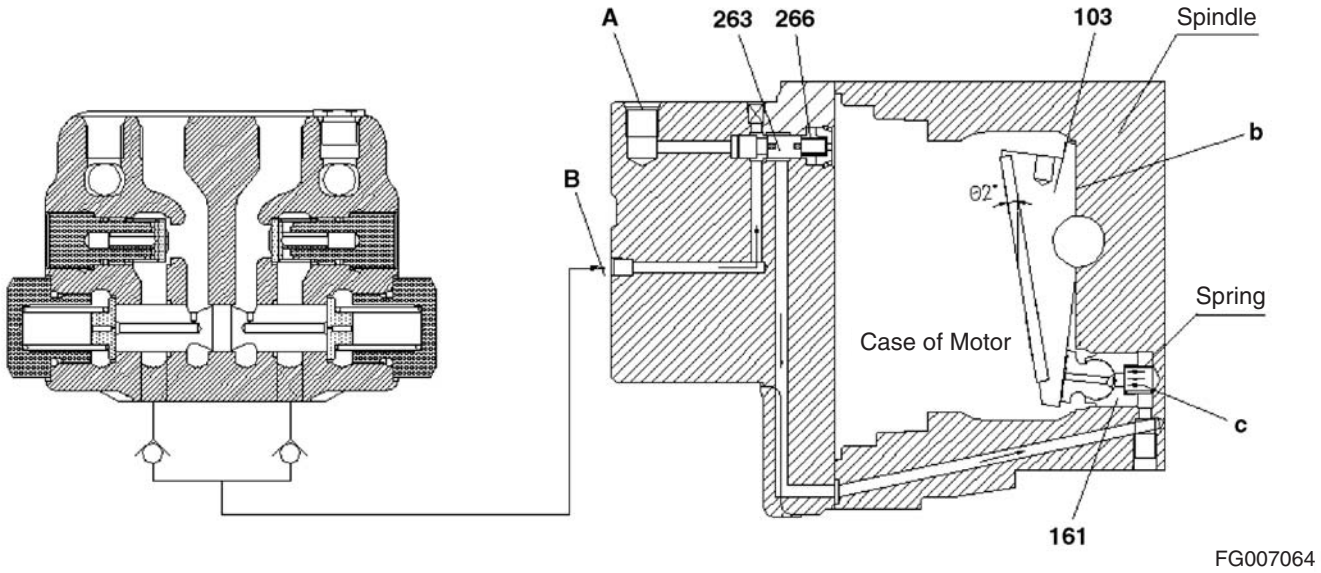
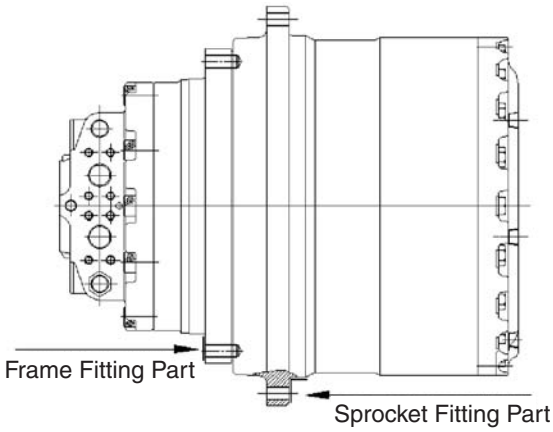


Figure 11

Fitting (Refer to the External Specifications Diagrams.)



FG007065

Figure 12

Tightening Torques of Fitting Parts

Categories	Qty	Bolt Sizes	Tightening Torques
Body Fitting Bolt	30	M16 (P2.0)	25.7 ±4.0 kg•m
Sprocket Fitting Bolt	22	M16 (P2.0)	25.7 ±4.0 kg•m
(Sprocket Fitting Bolt)	(30)	M16 (P2.0)	25.7 ±4.0 kg•m

NOTE: *Use bolts whose JIS strength is above 10.9. Do not strike the TM motor with hammer or similar item but use a bolt hole to fix it.*

Piping

1. Connect piping considering the rotation direction of the motor (refer to the External Specifications Diagrams.)
2. The product is delivered with its piping ports (of brake valve and motor drain) covered with plug.
3. Do not remove cover or plug from ports before connecting piping, as they are intended to prevent dust or weld scale from entering them).
4. Fill motor case with oil before starting the motor.

   NOTE: *Recommended quantity of oil for the case: 1.2 liter*

5. Select piping that the back pressure of the motor drain port may be same as or below 2 kg•cm^2 (or 7 kg•cm^2 at the peak).

Hydraulic Oil

As the products are shipped with hydraulic oil in the hydraulic motor case being drained, be sure to fill the case with hydraulic oil before operation.

1. Selection of Hydraulic Oil

   Be careful the following matters when selecting hydraulic oil for TM motor.

   A. Use hydraulic oil equal to VG32-VG56.

   B. Hydraulic oil should be of wear resistance.

   C. Contact us when selecting other hydraulic oil than those in the table below.

Grade	Viscosity (40°C)	32 CST	46 CST
	ISO VG	VG 32	VG 46
Manufacturers	HOUGHTON	HYDRO DRIVE HP32	HYDRO DRIVE HP46
	GULF	HARMONY 32AW	HARMONY 46AW
	CALTEX	RANDO HD32, AZ	RANDO HD46
	MOBLIL	DTE 24	DTE 25
	SHELL	TELUS 32	TELUS 46

2. Check and Change of Hydraulic Oil

   Change oil according to the following intervals, though its frequency depends on operation conditions.

   The following is the recommended interval of changing hydraulic oil.

   A. Interval - 1,000 hours or 1 year

   B. Change criteria

Checking Points	**Change Standards**
Change of Viscosity (40°C)	±10%
Oxidation (mgKQH/g)	*
Water (%)	0.1%
Impurities	10mg / 100m liter
Insolubility (%)	0.05%
Color	Excessively changed.

NOTE: *Contact us for the type of hydraulic oil, for it is different depending on its maker.*

Lubricating Oil

Products are shipped with lubricating oil (gear oil) for reducer filled, but check it before operation.

1. Selection of Gear Oil

   Use gear oil equal to SAE #90 containing an extreme pressure additive (above the 4th GL grade, API classification).

2. Interval of Gear Oil Change

   A. 1st oil change after 500 operating hours.

   B. Further oil change every 1000 operating hours or 1 year.

      NOTE: *If gear oil reduces, check its cause, fix the problem, and fill it.*

Location of Lubricating Oil Filling and Drain Ports

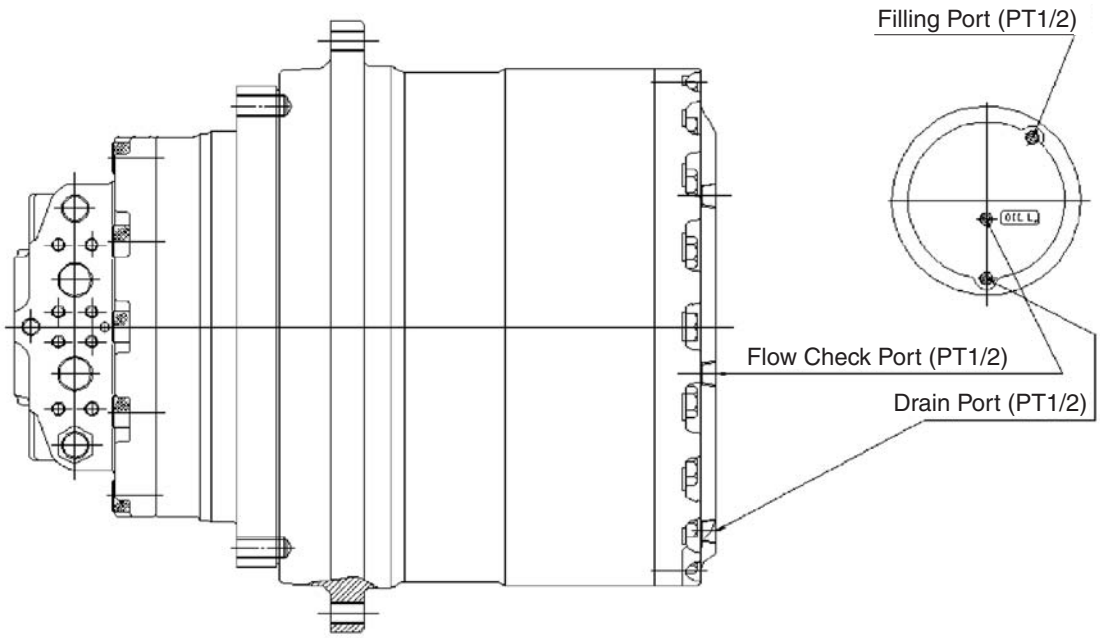


Figure 13

3. Quantity of Lubricating Oil to be Changed - 3.3 liter§

4. Order of Lubricating Oil Change

   Gear oil to be changed or refilled should be same as the used oil and do not mix with different oil.

   A. Make sure that the filling and the drain ports should be at right angles with the level surface.

   B. To drain oil, remove both plugs at two ports and drain it.

   C. Fill gear oil above the flow check port.

D. To install plugs at ports, be sure to wrap them with seal tape.

Maintenance

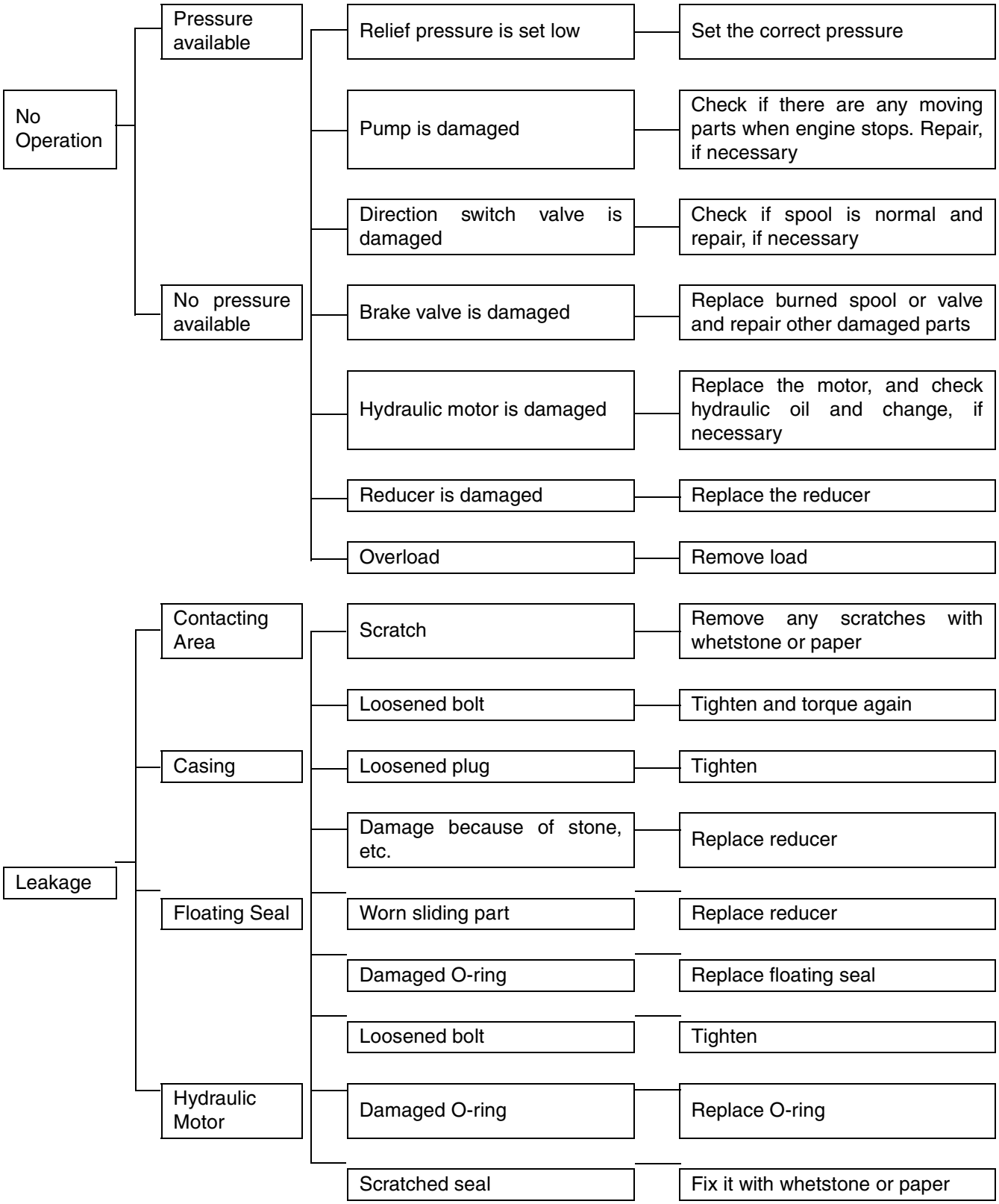
Make sure to check the following lists before operating the TM motor.

1. If there is any leakage (hydraulic or gear oil).
2. If bolts are loosen.
3. If there is any noise
4. If temperature in the case increases abnormally.

   (External standard temperature of the case during continuous operation = Max. 80°C)
5. If gear oil is changed at proper intervals. (See “Lubricating Oil” on page -19.)
6. Allowed quantity of drain for the hydraulic motor.

   Idle - Number of rotation: 25 rpm

   - Pressure: 50 kg•cm^2 -> 4 lpm


No Operation
Pressure available
Relief pressure is set low
Set the correct pressure
Pump is damaged
Check if there are any moving parts when engine stops. Repair, if necessary
Direction switch valve is damaged
Check if spool is normal and repair, if necessary
No pressure available
Brake valve is damaged
Replace burned spool or valve and repair other damaged parts
Hydraulic motor is damaged
Replace the motor, and check hydraulic oil and change, if necessary
Reducer is damaged
Replace the reducer
Overload
Remove load
Leakage
Contacting Area
Scratch
Remove any scratches with whetstone or paper
Loosened bolt
Tighten and torque again
Casing
Loosened plug
Tighten
Damage because of stone, etc.
Replace reducer
Floating Seal
Worn sliding part
Replace reducer
Damaged O-ring
Replace floating seal
Hydraulic Motor
Loosened bolt
Tighten
Damaged O-ring
Replace O-ring
Scratched seal
Fix it with whetstone or paper

Siding on the slope	Bad volumetric efficiency of motor	Replace the hydraulic motor
	Increased internal leakage of brake valve	Replace the brake valve (rear flange)
	No operation of parking brake	
	Damaged spring	Replace the spring
	Worn friction plate	Replace the friction plate and mating plate
High temperature of the surface of the reducer case	Lack of gear oil	Fill up to proper volume
	Shaken bearing	Replace the reducer
	Entering of hydraulic oil into the gear case	Replace the oil seal
Tilted operation	Happens at low-pressure	
	Difference between the right and the left discharges	Repair the pump
	Difference between the right and the left motor drains	Replace the hydraulic motor
	Happens at high-pressure	
	Difference between the right and the left discharges	Replace the pump and the regulator
	Difference between the right and the left motor drains	Replace the motor
	Different movement between the right and the left brake valves	Replace the brake valves (rear flanges)
	Reduction of either the right or the left control valve	Set the correct pressure Replace the relief valve
Poor speed	Low discharge of the pump	
	Incorrect operation of the pump regulator	Repair the regulator
	Too much external drain of the pump	Repair or replace the pump
	Too much external leakage of the pump	Repair or replace the motor
Noise	Damaged motor or reducer	Repair or replace the motor or the reducer
	Vibration of piping	Raise claim

External Specifications Diagrams

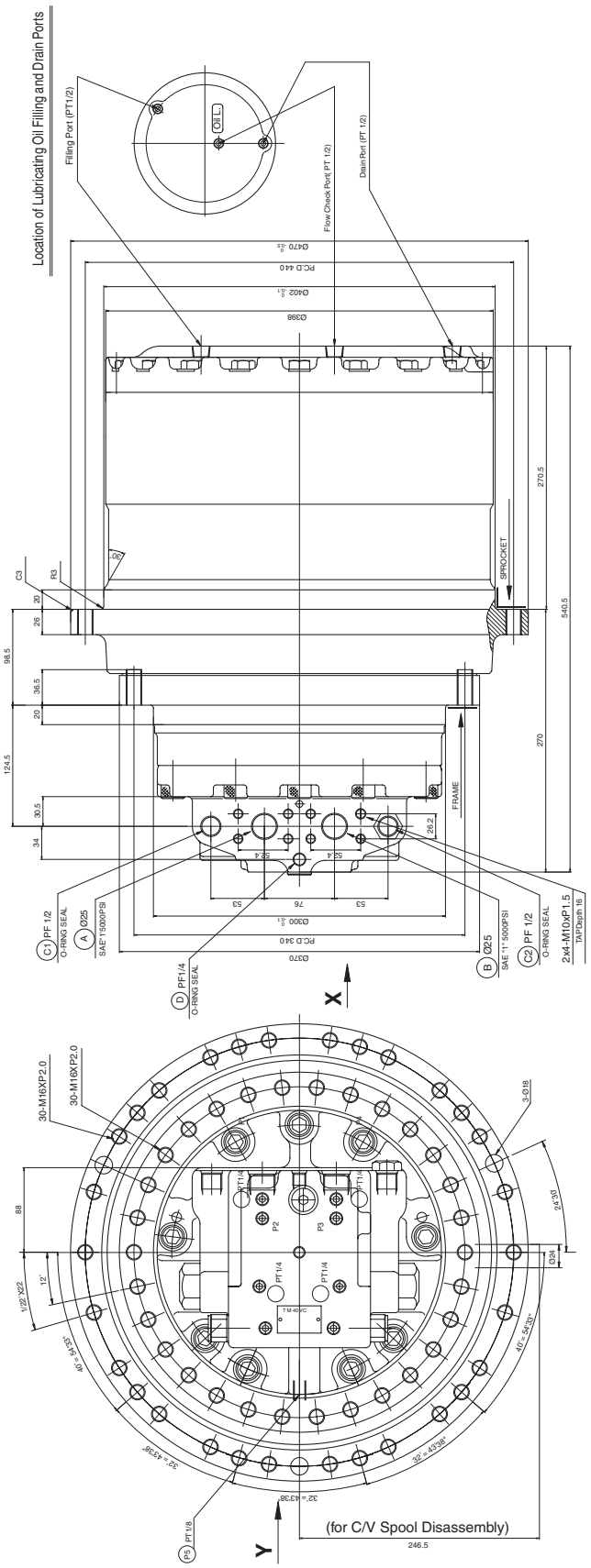


Figure 14

FG007068

Assembly Cross-section

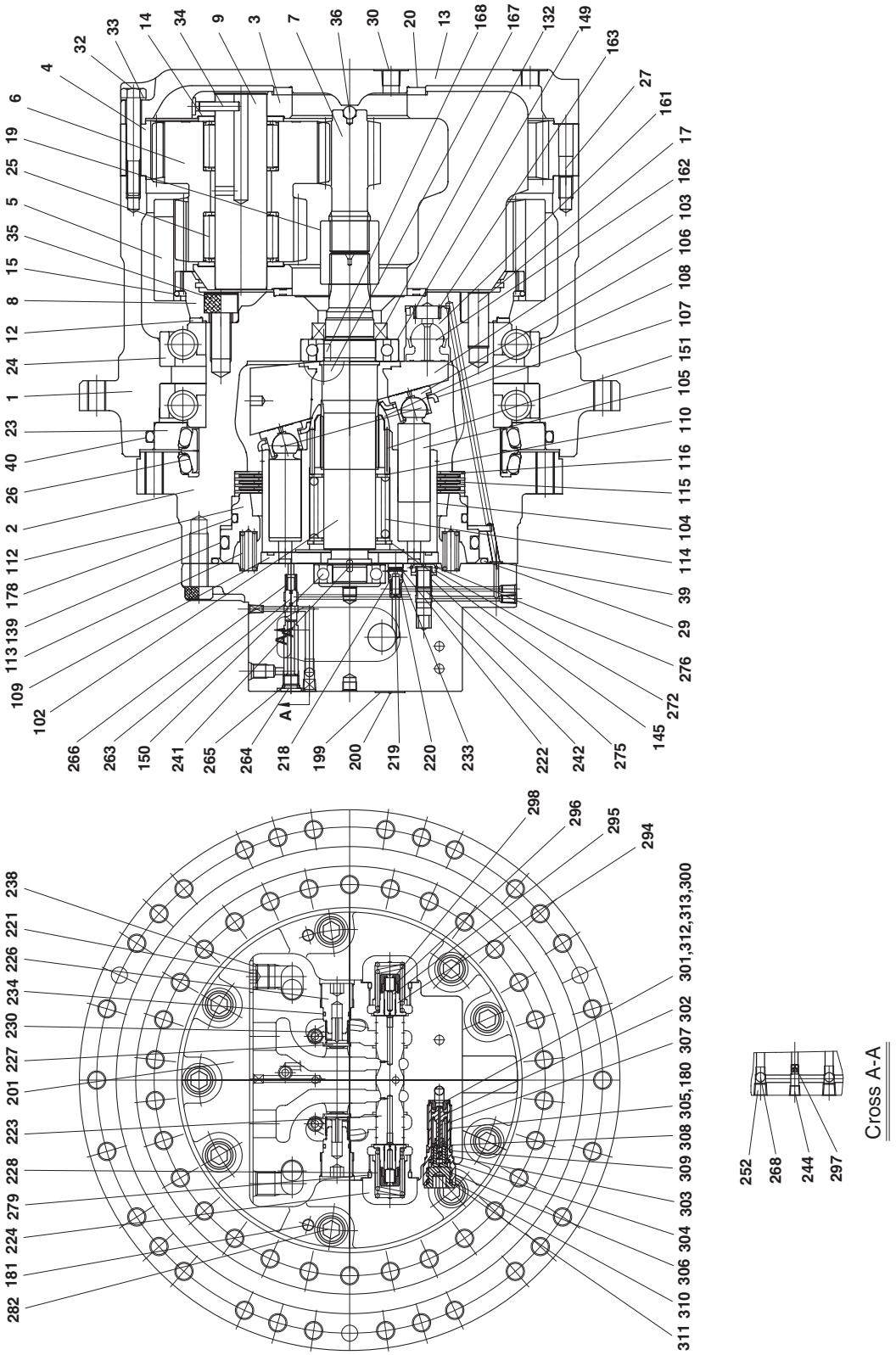


Figure 15

Parts List

Reference Number	Description
RG	Reducer Assembly
RG1	Hub Assembly
1	Hub
4	Ring Gear A
27	Parallel Pin
RG2	Spindle Assembly
2	Spindle
8	Gear
35	Socket Bolt
17	Pin
RG3	Carrier Assembly
3	Carrier
6	Gear
9	Shaft
14	Thrust Collar
25	Needle Bearing
5	Ring Gear B
7	Sung Gear
12	Distance Piece
13	Cover
15	Ring
19	Coupling
20	Thrust Plate
23	Seal Ring
24	Bearing
26	Floating Seal
29	O-ring
30	Plug
32	Hex Bolt
33	Spring Washer
34	Parallel Pin
36	Steel Ball
39	O-ring
40	O-ring
RL	Rear Flange Assembly
RL1	Rear Flange Kit
201	Rear Flange
223	Main Spool
RL2	Stopper Assembly
294	Stopper
295	Main Spool

Reference Number	Description
296	Spring
297	Washer
298	Retaining Ring
224	Plug
228	Spring
279	O-ring
226	Check Plug
227	Check Valve
230	Check Spring
234	O-ring
221	Plug
238	O-ring
252	Plug
244	Plug
268	Steel Ball
242	Reducing Valve
272	Valve Reducing Seat
276	Reducing Ring
275	Spring
218	Valve
219	Valve
220	Spring
222	Ring
233	O-ring
263	Valve
264	Plug
265	O-ring
266	Spring
241	Parallel Pin
282	Socket Bolt
297	Orifice
M	Motor Part
M1	Cylinder Block and Piston Kit
104	Cylinder Block
110	Washer
114	Spring
145	Retaining Ring
M11	Piston Assembly
105	Piston
106	Shoe
108	Thrust Ball

Reference Number	Description
151	Roller
107	Retainer Plate
M2	Piston Assembly
161	Piston
162	Shoe
163	Spring
102	Shaft
103	Swash Plate
109	Timing Plate
115	Friction Plate
116	Mating Plate
112	Parking Piston
113	Spring
132	Oil Seal
149	Ball Bearing
150	Ball Bearing
139	O-ring

Reference Number	Description
178	O-ring
181	Pin
167	Pivot
R-1	Relief Valve Assembly
301	Seat
302	Plunger
303	Rod
304	Piston
305	Body
306	Plug
307	Spring
308	Shim
309	O-ring
310	O-ring
311	Backup Ring
900	Seal Kit

TM40VC MAINTENANCE INSTRUCTIONS

CAUTION!

Please read these instructions carefully before the disassembly and reassembly.

Precautions

1. The overhaul of this machine should be performed in accordance with instructions stated in this manual.
2. Use tools stated in these instructions for the disassembly and reassembly of the machine.
3. Use parts we produce or recommend for expendables and parts to be replaced.
4. Types and Meanings of Warning Words

   Four types of warnings are used in these instructions to indicate the severity (degrees of fault).

   Be aware of those warnings and follow their instructions.

Warnings	Descriptions
Emergency	Very danger. Failure of following order or instructions may cause serious injury or even death.
Alert	Subject to danger. Failure of following order or instructions may cause serious injury or even death.
Caution	Subject to danger. Failure of following order or instructions may cause injury or damage to machine or device.
	Indicates information requiring special attention or to be eMPHasized.

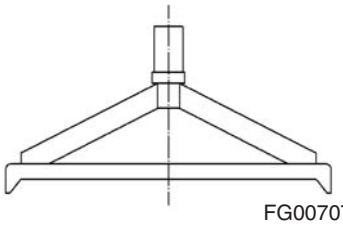
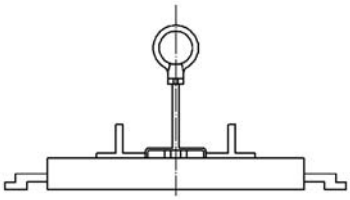
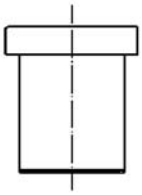
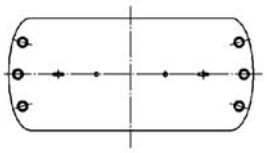
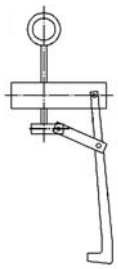
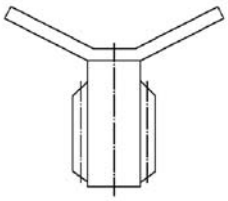
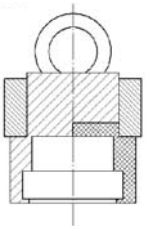
There are no Emergency or Alert items in these instructions, however.

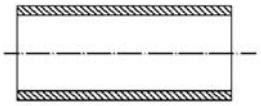
Tools List for Disassembly and Reassembly

General Tools

No.	Tools	Types / Sizes	Qty
1	Hex Wrench (JIS B 4648)	14 (for M16)	1 1
2	Socket Wrench (Ratchet handle)		
3	Torque Wrench	About 280N, dial About 560N, dial	1 1
4	Torque Wrench Adapter (12.9 mm drive, each) (19.0 mm drive, each)	Nominal 19.41 socket Nominal 6, 10, 14 rod	EA 1 EA 1
5	Extension Bar (JISB 4637)	150 mm	1
6	Hammer	Nominal 12	1
7	Plastic Hammer	Equal to L = 300	1
8	θ Driver	About 150 mm	1
9	Flyer for Retaining Ring	For shaft and hole	1
10	Hanger	Weight: Above 400 kgf Eyebolt (for M12)	1 set
11	Press Die	Press Capacity: Above 200 kgf	1 set
12	Compressed Air	3 - 5 kg•cm^2, nozzle	1 set
13	Container	General container: W450 x D300 x H120	2
14	Heater Set	Temp increase: Above 100°C Volume: Above 500 x 500 x 500	1 set
15	Seal Tape		1
16	Dipstick Micro Meter	Measure range: 30 mm Minimum scale: 0.01 mm	1
17	Thickness Measure Gauge	Measure range: 0.04 - 0.3 mm	1

Machined Tools

No.	Names and Typical Sizes	Qty	No.	Names and Typical Sizes	Qty
1	Main Bearing Press Fitting Tool  FG007070	1	6	Coupling Gear Hanger  FG007071	1
2	Aluminum Rod  FG007072	1	7	Pressing Tool (1)  FG007073	1
3	Thrust Plate (R) Adjustment Tool  FG007074	1	8	Gap Measuring Tool  FG007075	1
4	Hanger (1)  FG007076	1	9	Sun Gear Positioning Tool  FG007077	1
5	Hanger (2)  FG007078	1	10	Tapered Steel Rod  FG007079	1

No.	Names and Typical Sizes	Qty	No.	Names and Typical Sizes	Qty
11	Steel Rod FG007080	1	13	Cocking Tool  FG007081	1
12	Insert Tool  FG007082	1	14	Shaft Insertion Guiding Tool  FG007083	1

Disassembly Instructions

General Cautions

1. Before starting disassembly, check faulty parts properly and treat them according to the disassembly order.
2. Select a clean place as described in see “Disassembly” on page -31, for disassembly.
3. Put a rubber sheet or clothing on the working surface.
4. Mark each connecting part during disassembly.
5. Put disassembled parts in order during disassembly to prevent their damage or loss.
6. Make it a rule to replace any removed seal, though it is not damaged.

Disassembly

1. TM motor should be overhauled in the following order.
2. Numbers in parentheses next to each part name indicates those in the manual.
3. Fit the TM motor on the turn over working die to start its disassembly.

Disassembly of Hydraulic Motor

1. Remove relief valve (300) from rear flange (201).
   - Tool - wrench 27



Figure 16

2. Remove socket bolt (282).
   - Tool - Socket wrench, extension bar, and wrench adapter #14

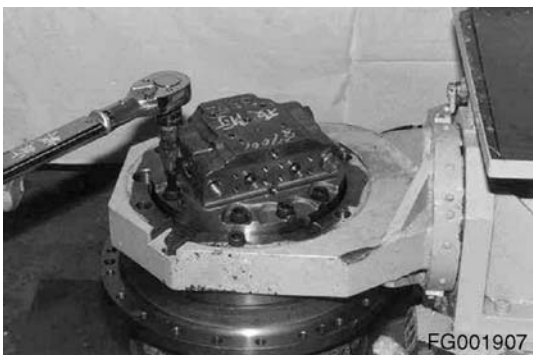


Figure 17

3. Remove rear flange (201) from spindle (2).

   NOTE: *Be careful not to remove rear flange (201) with shaft (102), as they are sometimes removed together.*

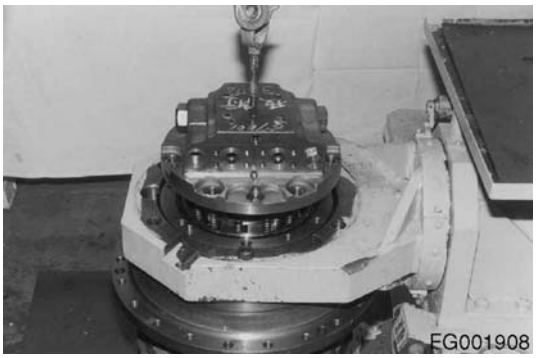


Figure 18

4. Remove timing plate (109), one parallel pin (241), 12 springs (113), and ball bearing (150) from rear flange (201) and the hydraulic motor.
5. Remove 2 O-rings (29 and 39) from spindle (2).

   NOTE: *Do not reuse removed O-rings (29 and 39).*



Figure 19

Disassembly of Brake Valve Parts

Spool

1. Remove plug (224) from rear flange (201).

   NOTE: *Disassembly would be easier if it is already removed on the turn over working die.*

   - Insert wrench and wrench adapter #41

2. Remove O-ring (279) from plug (224).

   NOTE: *Do not reuse removed O-ring (279).*



Figure 20

3. Remove 2 springs (228), 2 stoppers (225), and spool (223) from rear flange (201).

   NOTE: *Be careful not to damage the outer surface of spool (223) and the sliding part of rear flange (201). Remove spool (223) with the a plug port of rear flange (201) being tilted.*

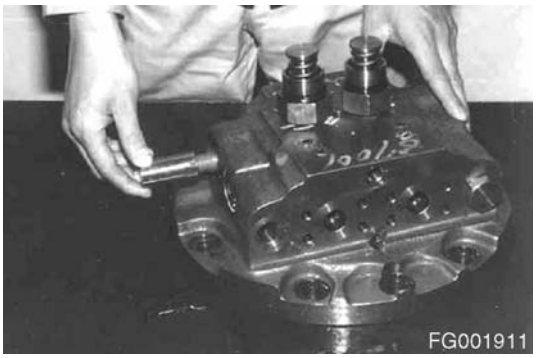


Figure 21

Check Valve

1. Remove 2 plugs (226) from rear flange (201).

   NOTE: *Disassembly would be easier if it is already removed on the turn over working die.*

   - Insert wrench and wrench adapter #14

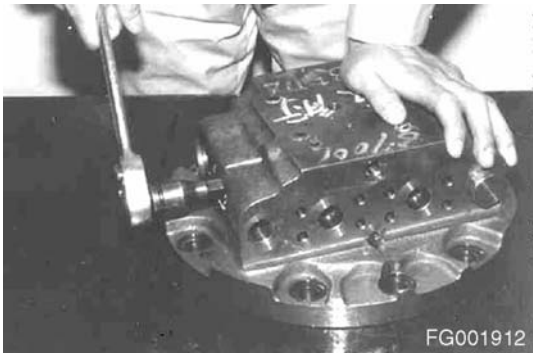


Figure 22

2. Remove 2 springs (230) and 2 valves (227) from rear flange (201).

   NOTE: *Be careful not to damage the seats of valve (227) and rear flange (201).*

3. Remove O-ring (234) from plug (226).

   NOTE: *Do not reuse removed O-ring (234).*

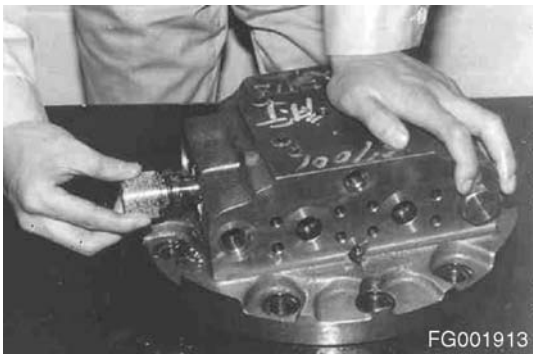


Figure 23

2-Speed Valve

1. Disassemble plug (264), 2-speed valve (263), and spring (266) in order.

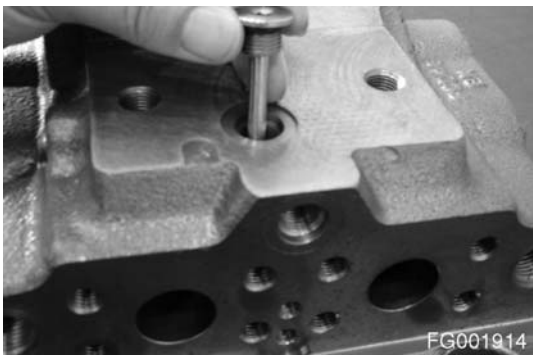
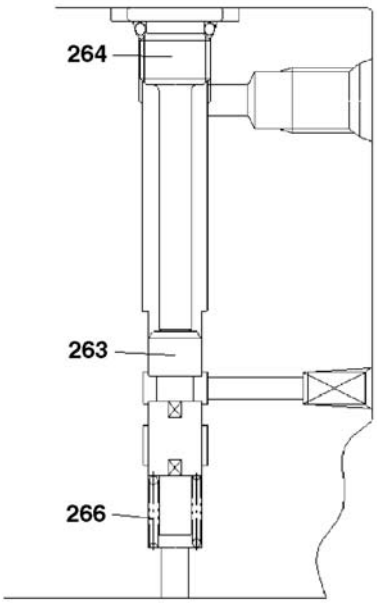


Figure 24



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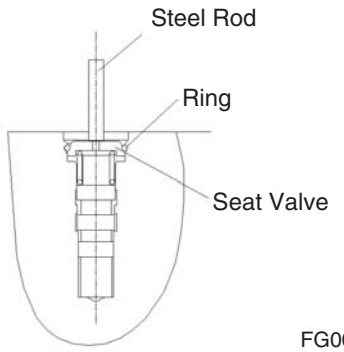
Figure 25

Reduction Valve

1. Use a tapered steel rod to press the connecting part of ring (276) with valve seat (272) being pressed with a steel rod. Then, ring (276) is flexed to be removed from rear flange (201).

   NOTE: *Do not disassemble valve and steel rod seat (272) except when it should be, as the inner part of rear flange (201) may be damaged to cause leakage when ring (276) is disassembled.*
   Do not reuse removed ring (276) and valve seat (272). Repair the thread of ring (276) cleanly, because the thread of the removed ring may be damaged.

   - Tapered steel rod and steel rod.



FG007087

Figure 26

Disassembly of the Parking Brake

1. Remove piston (112) by applying compressed air into the line to the parking brake of spindle (12).

   NOTE: *Set a protection cover on piston (112), because you may be injured by piston (112) burst out because of sudden applying of compressed air into it.*

   - Compressed air: 3 - 5 kg•cm^2, nozzle.

2. Remove O-rings (139, 178) from piston (112).

   NOTE: *Do not reuse removed O-rings (139, 178).*



Figure 27



Figure 28

Parts in Motor

1. Turn the body of the TM motor horizontally (900).
2. Drain oil in the TM motor.

   NOTE: *Put a container under horizontally turned TM motor to receive hydraulic oil drained from it.*

3. Remove cylinder block (104) and spindle (2) by holding them with both hands.

   NOTE: *To do so, shake cylinder block (104) two or three times that shoe (106) parts from swash plate (103). Be careful to prevent assembled parts [e.g., piston (105)] from falling down inside spindle (2), as it may be difficult to take shoe (106) away from swash plate (103).*

4. Remove friction plate (115) (3 EA) and mating plate (116) (4 EA) from the outer area of cylinder block (104).

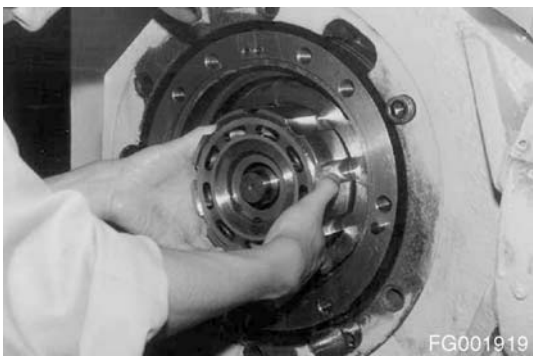


Figure 29

5. Remove the piston assembly [e.g., piston (105), shoe (106), retainer plate (107), thrust ball (108), collar (111), and roller] from cylinder block (104).

   NOTE: *The cylinder block (104) and piston assembly [consisting of piston (105), shoe (106), retainer plate (107), etc.] is the minimum part unit of the cylinder block and the piston kit that it should be replaced as a whole when one of its parts is damaged. (Refer to Parts List.)*

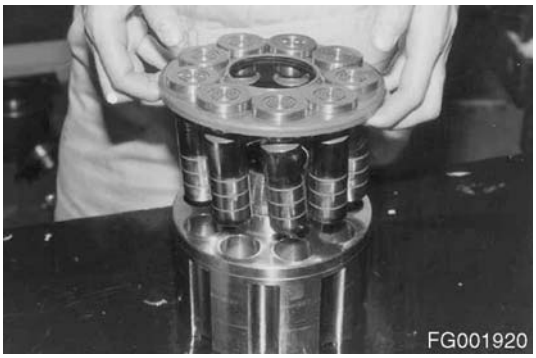


Figure 30

6. Remove swash plate (103) from spindle (2).



Figure 31

7. Remove shaft (102).

   NOTE: *Do not remove oil seal (132). Be careful not to damage oil seal (132).*

8. Remove 2 pivots (167) and 2 parallel pins (168) from spindle (2).

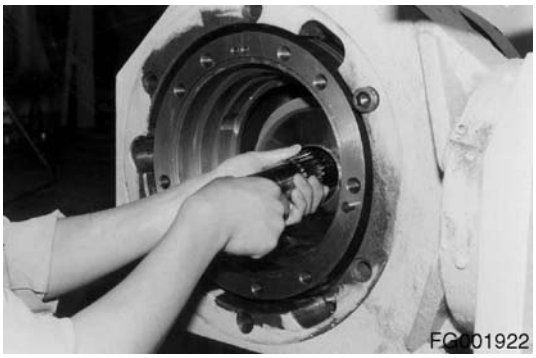


Figure 32

9. Disassemble 2-speed shifting piston assembly [piston (161) and shoe (162)] and spring (163) by applying compressed air into the line of spindle (2).

   NOTE: *If either piston (161) or shoe (162) has to be replaced, the piston KT should be replaced because they are consolidated.*
   Be careful when applying compressed air, because the air may burst forth the piston assembly to cause personal injury.
   Compressed air pressure: 3 - 5 kg•cm^2

   - Compressed air: 3 - 5 kg•cm^2, nozzle.

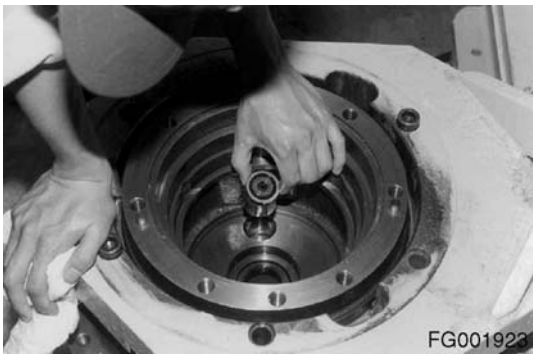


Figure 33

Disassembly of Parts in the Cylinder Block

1. Put cylinder block (104) on the press die, use a pressing tool (1) to press washer (110) and use a retaining ring flyer to remove retaining ring (145).

   NOTE: *Load of press: Wrap a vinyl cover around the sliding part of cylinder block (104) to protect against load of more than 200 kgf. Remove it only when spring (114) should be replaced.*

   - Press die, pressing tool (1), and retaining ring flyer

2. Slowly operate the press until the force of spring vanishes.

   NOTE: *Be careful not to operate the press suddenly, as spring may burst out to cause personal injury because of its compressive force.*

3. Remove retaining ring (145), washer (110), spring (114), and washer (110) from cylinder block (104) in order.



Figure 34



Figure 35

Disassembly of Reducer

1. Ring Gear (A) (4)

   A. Mark connecting positions on ring gear (A) (4) and hub (1) before disassembly.

   B. Engage a barrel with ring gear (A) (4) and twist its surface evenly to remove it.

      NOTE: *After removing ring gear (A) (4), remove adhesive on the surface contacting ring gear (A) (4) and hub (1).*

      – Barrel and paint marker

   C. Remove parallel pin (27) from hub (1).

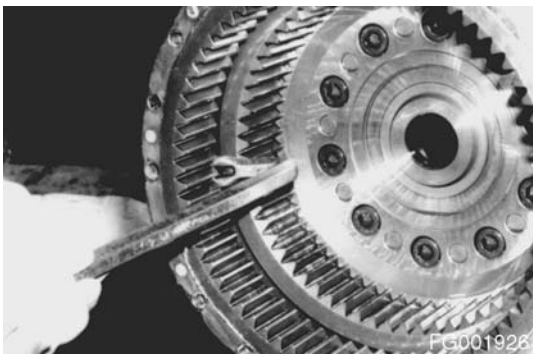


Figure 36

2. Hub (1), Ring Gear (B) (5), Coupling Gear (8)

   A. Remove 10 socket bolts (35).

      NOTE: *Use torque more than recommend tightening torque because adhesive is applied to screws of socket bolts (35).*
      Tightening torque: 35.5 ±5.5 kg•m
      Take sufficient care not to have screws of socket bolts (35) baked.

      – Hex wrench

   B. Mark connecting positions on coupling gear (8) and spindle (2) and remove the former from the latter.

      – Paint marker

   C. Engage the eyebolt in the tap hole of M12 of hub (1) and use hanger (1) to raise it and disassemble hub (1) and spindle (2). At this time, disassemble ball bearing (24), sealing (23), O-ring (40), coupling gear (8), ring gear (B)(5), ring (15), and distance piece (12) simultaneously.

      – Aluminum rod, hammer, and rubber sheet

   • If it is impossible to disassemble in this way said above, try the following way again.

      1) Turn the TM motor until it is at an 180 degree and the spindle shaft faces upward.

      2) Use an aluminium rod and a hammer to strike the surface of hub (1) evenly (see photos below) to remove spindle (2) from hub (1). At this time remove the following items too.

         NOTE: *Put a rubber sheet on the working die to prevent any damage of hub (1) or the following items that fall on the surface.*

         Ball bearing (24), sealing (23), O-ring (40), coupling gear (8), O-ring gear (5), ring (15), and distance piece (12)



Figure 37

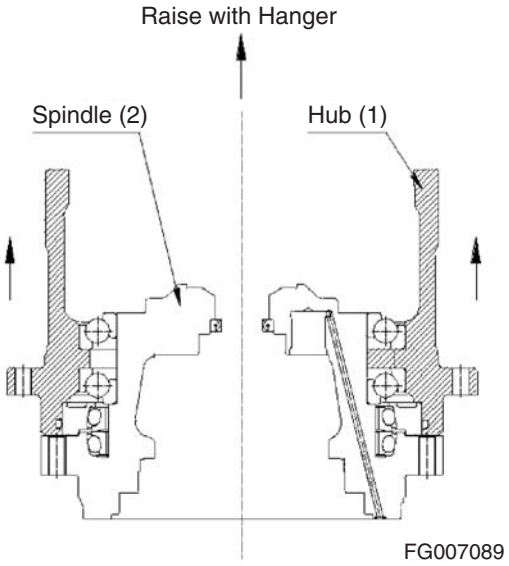


Figure 38

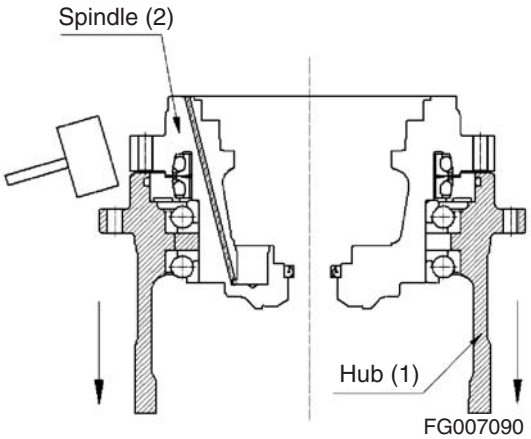


Figure 39

3. Parts in Spindle (2)

   A. Turn spindle (2) until it is at an 180 degree.

   B. Remove oil seal (132) from spindle (2). (To do so, use hammer to strike driver against the circumference of oil seal.)

      NOTE: *Remove oil seal (132) only when it has to be replaced. Do not reuse removed oil seal.*

      – θ driver and hammer

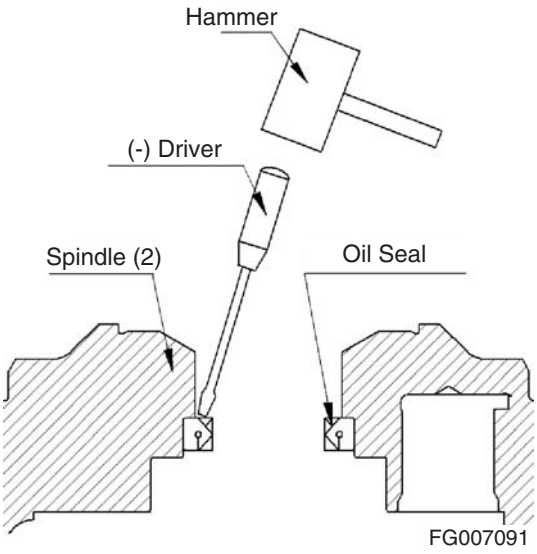


Figure 40

   C. Remove floating seal (26) from spindle (2).

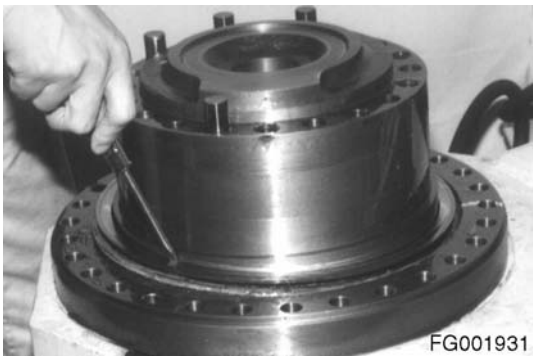


Figure 41

4. Disassembly of Parts in Hub (1)

   A. Remove floating seal (26) from hub (1).

   B. Remove ball bearing (24) from hub (1) as shown in the figure below. Remove sealing (23) too.

      NOTE: *Basically, do not remove ball bearing (24) from hub (1) because the bearing is thermal driven into hub (1). Do not reuse removed ball bearing (24).*

   C. Put hub (1) on the working die with its spindle facing upward.

      – Steel rod and hammer

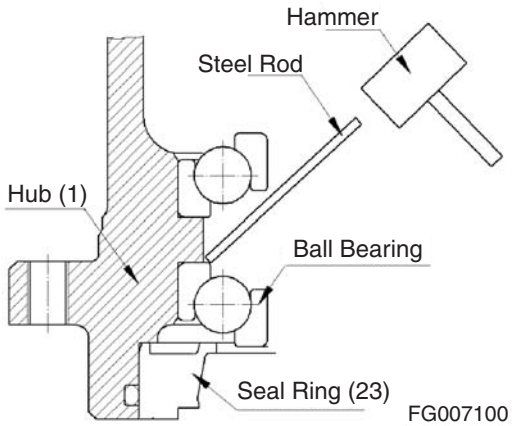


Figure 42

D. Remove another remaining ball bearing (24) from hub (1).

E. Remove O-ring (40) from hub (1).

NOTE: *Do not reuse removed O-ring (40).*

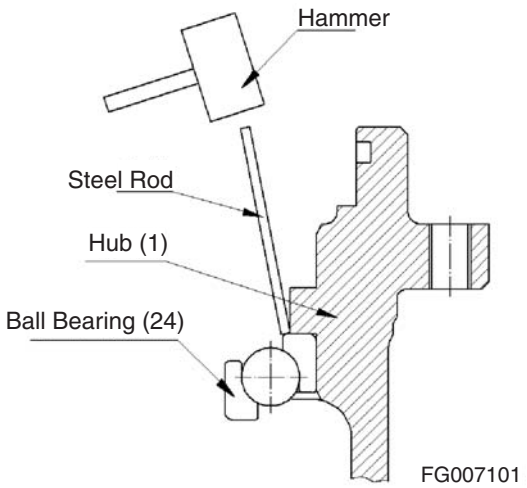


Figure 43

5. Disassembly of Coupling Gear (8)

A. Remove ring (15) from ring gear (B)(5).

NOTE: *Do not reuse removed ring (15).*

– Tapered steel rod

B. Remove coupling gear (8) from ring gear (B)(5).

NOTE: *Do not disassemble coupling gear (8) and ring gear (B)(5) except when its part has to be replaced.*

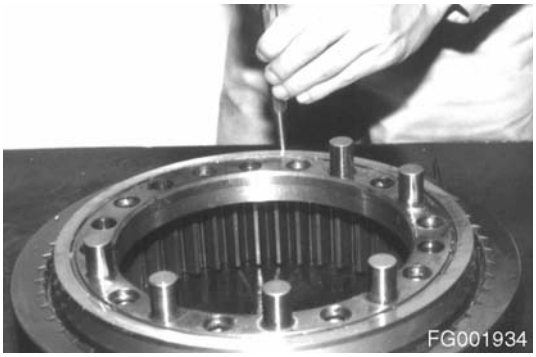


Figure 44

6. Disassembly of Carrier Assembly

A. Do not disassemble the carrier assembly. If it has to be replaced because of damage to its part, replace it with a carrier assembly set.

NOTE: *The carrier assembly consists of carrier (3), cluster gear (6), shaft (9), thrust collar (14), needle bearing (25), and parallel pin (34).*



Figure 45

Maintenance Standards

The overhaul of the TM motor should be done in accordance with the following standards. And, special care should be taken in treating each part, especially sliding and moving parts.

1. Seals

   Removed seals (for O-ring, oil, floating) should be replaced with new ones, though they have not been damaged.

2. Standards of Treating Worn Parts

   A. A part with clearly visible damage should be replaced with a new one immediately.

   B. Any part showing one of such symptoms as described below should be replaced.

Reference Nos.	Parts	Symptoms	References (Standard)	Allowances (for Decision)
(2) (8) (17)	Spindle Kit Spindle Assembly Spindle Coupling Gear Pin	• Visibly clear damage. • Abnormal wear like nibbling		
(3) (6) (9) (14) (25) (34)	Carrier Assembly Carrier Cluster Gear Shaft Thrust Collar Needle Bearing Parallel Pin	• A section of cluster gear is worn or damaged. • Cluster gear does not rotate smooth.		
(4)	Ring Gear (A)	• Tooth is worn on one side or damage.		
(5)	Ring Gear (B)	• Tooth is worn on one side or damage.		
(7)	Sun Gear	• Tooth is worn on one side or damage. • Spool line is worn.		
(8)	Coupling Gear	• Tooth is worn abnormally.		
(19)	Coupling	• Spool line is worn		
(20)	Thrust Plate (R)	• Worn.	Axial gap of 0.3-0.6 between coupling gear (8) and cover (13)	Gap of 0.8
(22)	Distance Piece	• Sliding part is damaged. • Sliding part is worn abnormally.		
(24)	Ball Bearing	• Dark mark • Flaking • One side worn		

Reference Nos.	Parts	Symptoms	References (Standard)	Allowances (for Decision)
201	Rear Flange Kit Rear Flange	• A moving part with spool (123) is damaged. • Gap with spool	Diameter gap: 10 - 20 μ	Diameter gap: 25 μ
(223)	Spool	• Damage at outer surface. • One-side wear at outer surface.		
102	Shaft	• Contacting part with oil seal is damaged. • Spool line is worn.		
103	Swash Plate	• Burning adhesion		
104	Cylinder Block	• Spool line is worn. • The inside of bore is worn. • Sliding part against timing plate (109) is damaged and/or worn.		
 (105) (106)	Piston Assembly Piston Shoe	• Gap in the axial direction of piston (105) and shoe (106). • Shoe is worn abnormally. • Shoe is worn on one side.	Gap: 0.05 m	Gap: 0.15 m
107	Retainer Plate	• An external section is worn on one side.		
108 109	Thrust Ball Timing Plate	• One-side wear at round sliding area along with retainer plate (107). • Burning adhesion or one-side wear at sliding part.		
115 116	Friction Plate Mating Plate	• One-side wear at both sections. • Below specified torque • Burning adhesion	Braking torque: Above 49.3 kg•m	Braking torque: Below 49.3 kg•m
149 150	Ball Bearing Ball Bearing	• Pressed mark • Flaking • One-side wear		

Reassembly

General Cautions

1. Select a clean place for reassembly.
2. Do not wear cotton gloves for reassembly (to prevent fiber from entering the machine).
3. Repair damaged parts and replace O-ring and oil seals with new ones during disassembly.
4. Wash every part and dry it with compressed air. Do not use wax.
   A. Wash hub, spindle, cover, and rear flange.

      NOTE: *Remove any earth on the surface of every part. Be careful when using flushing oil as it is flammable and may cause fire.*

   B. Wash other parts by dipping them in a flushing oil container with care not to damage washing parts.
5. Apply clean hydraulic oil (equal to NAS9 class) to moving and sliding parts of the hydraulic motor valves.
6. Tighten bolts and plugs with torque wrench with specified torque.

Tightening Torque

Ref. Nos	Parts	Screw Sizes	Qty	Torque
30	PT plus	PT 1/2	3	10 ±2 kg•m
32	Socket bolt	M12	20	10.4 ±1.6 kg•m
35	Socket bolt	M18	10	35.5 ±5.5 kg•m
221	Plug	PF 1/2	2	10 ±2 kg•m
224	Plug	M45 (P1.5)	2	51 ±7.5 kg•m
226	Plug	M36 (P1.5)	2	26 ±4 kg•m
265	Plug	PF (1/4)	1	3 ±0.5 kg•m
282	Socket bolt	M16 (P2.0)	9	25.7 ±4 kg•m
282	Socket bolt	M8 (P1.25)	4	3.0 ±0.5 kg•m
154.169	Plug	NPTF1/16	9	1.0 ±0.25 kg•m

Reassembly of Brake Valve

1. Check Valve

   A. Install O-ring (234) on plug (226).

      NOTE: *Apply grease to O-ring (234).*

   B. Put spring (230) and valve (277) in plug (226), apply grease and install them in plug (226) that they contact it.

      NOTE: *Apply sealant to screws of plug (226).*

   C. Install plug assembly (226) on rear flange (201) with specified torque.

      NOTE: *Use a torque wrench to install plug (226).*

      Tightening torque: 26 ±4 kg•m

      – Torque wrench and wrench adapter #14

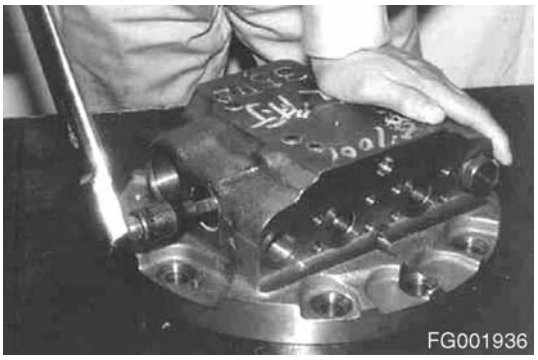


Figure 46

2. Spool

   A. Install spool (223) in rear flange (201).

      NOTE: *Apply hydraulic oil to spool (223) before installing it in rear flange (201).*
      Be careful not to damage outer surface of spool (223) or internal surface of hole of rear flange (201), which may cause internal leakage after the reassembly to decrease the motor performance.

   B. Install O-ring (279) on plug (224).

      NOTE: *Apply grease to O-ring (279).*

   C. Install stopper (225) and spring (228) in plug (224) and tighten two plugs (224) with specified torque.

      NOTE: *Tightening torque: 51 ±7.5 kg•m*
      When rear flange (201) or spool (223) should be replaced, it should be replaced with rear flange kit for they are contained in the kit.

      – Torque wrench and wrench adapter socket

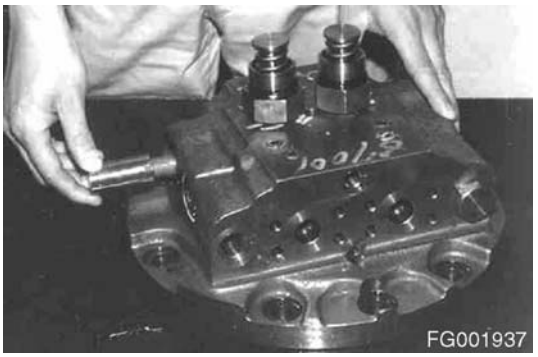


Figure 47

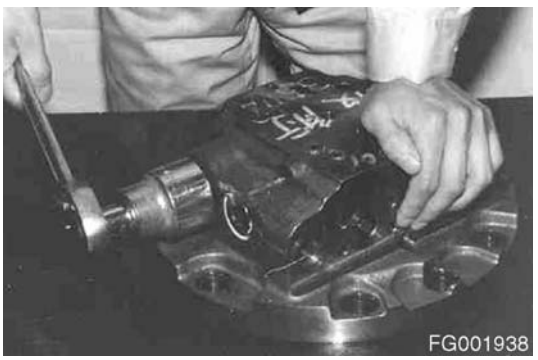


Figure 48

3. 2-Speed Valve

   A. Assemble spring (266), 2-speed valve (263), and plug (264) in order.

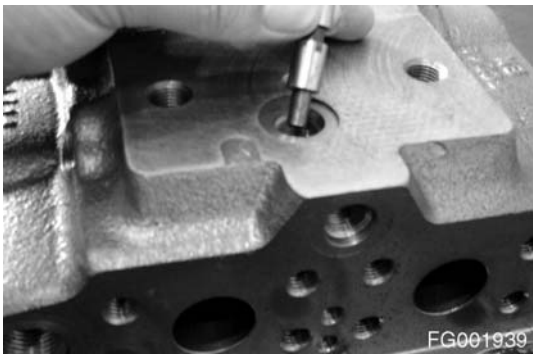


Figure 49

NOTE: *Tightening torque: 3 ±0.5 kg•m*

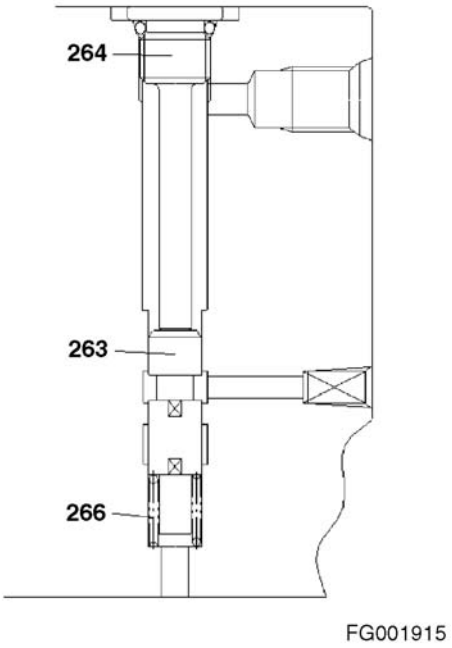


Figure 50

4. Reducing Valve

   A. Install the valve assembly [valve (242), spring (243), and valve seat (241)] in rear flange (201).

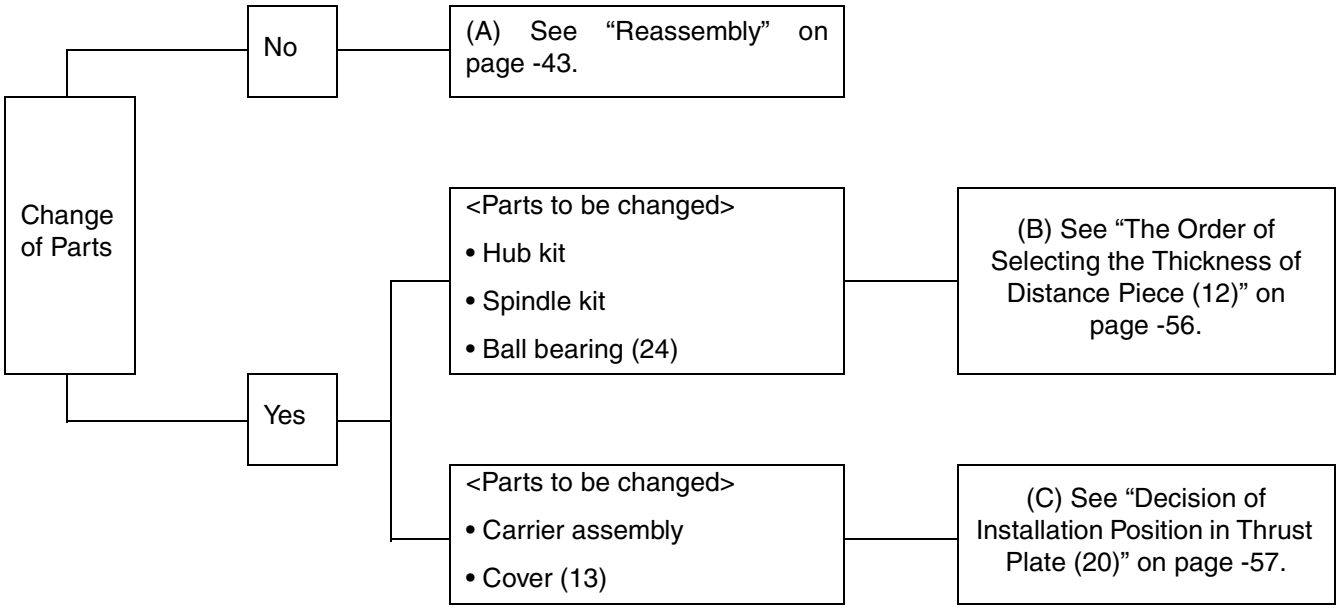
   B. Bend new ring (145) a little and install it in rear flange (201).

      NOTE: *Always use a new ring (145).*

Reassembly of Reducer and Hydraulic Motor

If the following parts are replaced for reassembly,

1. Use distance piece (12) with proper thickness.
2. Use thrust plate (20) with proper thickness. It may be necessary to reassemble it by adjusting the gap said above. Make sure if the following parts should be replaced or not before starting the reassembly.



NOTE: *If the parts above are replaced for reassembly, each part should be adjusted properly. A part which is installed without proper adjustment causes malfunction and earlier breakdown of the TM motor.*

1. Hub (1) Part

   A. Fix hub (1) on the working die with its cover (13) assembly facing upward.

      NOTE: *Heat hub (1) up to 90 ±5°C.*

   B. Use a press tool to install ball bearing (24) in hub (1).

      NOTE: *Install ball bearing (24) with Shrinkage Fitting. If a press tool is not available, install ball bearing (24) in hub (1) and strike it gently with hammer.*

      – Heater, bearing press-in tool, hammer, leather glove, and plastic hammer

   C. Turn hub (1) upside down until it is at a 180 degree with the mounting part of spindle (2) facing upward.

   D. Use a press tool to press ball bearing (24) in hub (1).

      NOTE: *Install ball bearing (24) with Shrinkage Fitting.*

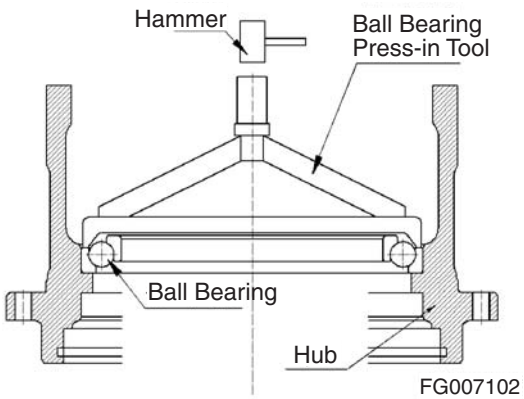


Figure 51

E. Install O-ring (40) in hub (1).

NOTE: *Apply a thin coat of grease to O-ring (40).*

F. Install sealing (23) on hub (1) by gently and evenly knocking the surface of the sealing with plastic hammer.

NOTE: *Be careful not to damage O-ring (40) when installing it in hub (1).*

2. Spindle (2) Part

A. Install floating seal (31) in spindle (2).

NOTE: *Apply a thin coating of grease to O-ring of floating seal (31). Remove any dust on the surface of seal.*

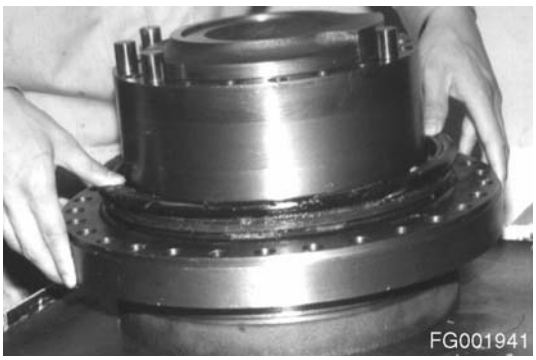


Figure 52

3. Assembly of Hub (1) and Spindle (2)

A. Fix spindle (2) on the working die with its cover (13) assembly facing upward.

B. Install eyebolts in hub (1) and use a hanger to install it in spindle (2).

NOTE: *Install hub (1) and spindle (2) in ball bearing (24) by gently and evenly knocking the surface of hub (1) with plastic hammer.*

– 1 set of hanger and plastic hammer



Figure 53

4. Assembly of Coupling Gear (8) and Ring Gear (B)(5)

A. Install coupling gear (8) on ring gear (B)(5).

B. Insert ring (15) into the ring thread of ring gear (B)(5).

NOTE: *Do not use removed ring (15). Use a new ring only for replacement.*

5. Assembly of Coupling Gear (8)

A. Install distance piece (12) in coupling gear (8).

If replacement of part is required Hub kit Spindle kit ball bearing (24)	(B) Distance piece (12) width selection See “The Order of Selecting the Thickness of Distance Piece (12)” on page -56.
If replacement of part is not required	Connect in the following order.

NOTE: *Apply a thin coating of grease to the connection part of coupling gear (8) and fix distance piece (12) to prevent the piece from falling (dropping).*

B. Use a hanger to lift coupling gear (8) [with ring gear (B)(5) attached] to install in spindle.

– Coupling gear and hanger

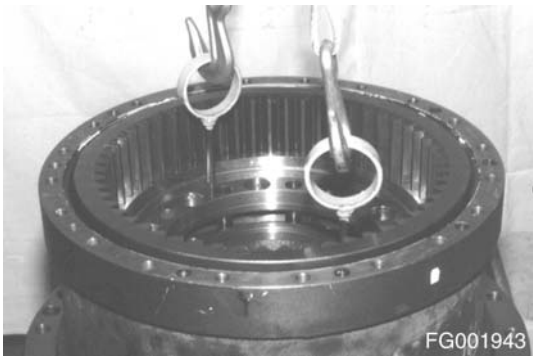


Figure 54

C. Coat the surface of pinhole of coupling gear (8) when installing pin (17).

D. Check marks made on coupling gear (8) and spindle (2) when assembling them.

E. Use a torque wrench to tighten socket bolt (35) with specified torque.

NOTE: *Do not reuse removed pin (17) and use a new one only for replacement.*
Tightening torque: 35.5 ±5.5 kg•m
Degrease threads and pinholes of spindle (2) completely and apply adhesive.
Degrease socket bolt (35) completely and apply grease to its head.

– Punch, hammer, torque wrench, wrench adapter, and extension bar



Figure 55

F. Turn the TM motor upside down until it is at a 180 degree with the shaft of spindle (2) facing upward.

6. Assembly of Shaft (102)

   A. Install ball bearing (149) in shaft (102) with Shrinkage Fitting.

      NOTE: *Be careful to prevent a burn. (Use leather gloves.)*
      If ball bearing (149) is removed, use a new one for Shrinkage Fitting.
      Temperature of Shrinkage Fitting: 100 ±10°C

      – Heater and leather gloves

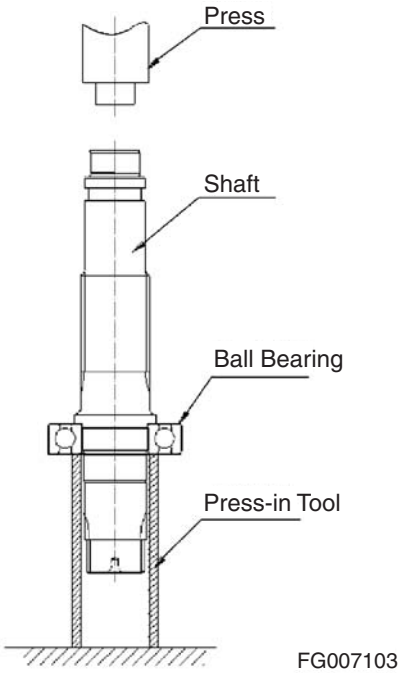


Figure 56

7. Assembly of Piston Assembly (161, 162)

   A. Apply grease to spring (163) and assemble piston parts.

   B. Apply hydraulic oil to sliding area of piston parts to be installed and install them in the piston hole of spindle (2).



Figure 57

8. Assembly of Steel Balls (167)

   A. Install 2 steel balls (167) in spindle (2).

9. Assembly of Cylinder Block

   A. Put cylinder block (104) on the press die.

   B. Assemble washer (110), spring (114), and washer (110) in the cylinder block (104).

      NOTE: *Refer to the next figure for the installation of washer (110).*



Figure 58

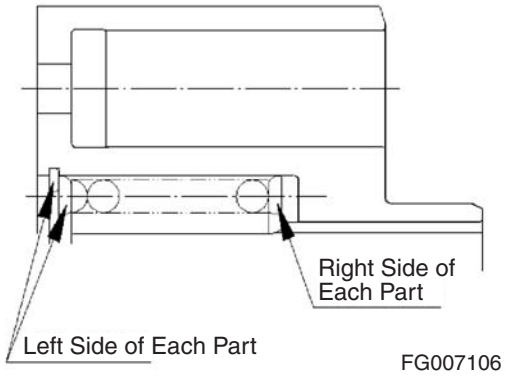


Figure 59

C. Put 4 cylinder blocks stated above on the press die and use a press tool (1) to press spring (114) in washer (110) to install retaining ring (145).

NOTE: *Wrap a vinyl cover around sliding part of the cylinder block to protect it against damage. Spring pressing pressure: Above 200 kg•m Fast hold retaining ring (145) with flyer during reassembly as it may burst out to cause an injure.*

– Press die, press-in tool (1), and retaining ring flyer



Figure 60

10. Assembly of Motor Parts

A. Install roller (151) in cylinder block (104) and then thrust ball (108).

B. Install piston parts (105, 106) in retainer plate (107).



Figure 61

C. Apply hydraulic oil to piston parts and assemble cylinder block (104)

D. Apply hydraulic oil to sliding part of shoe (106) and round part of thrust ball (108).

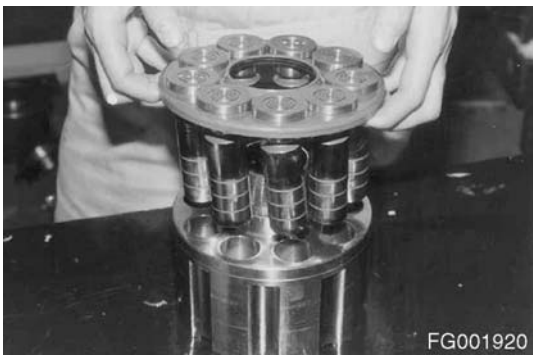


Figure 62

E. Use a hanger to install swash plate (103), thrust ball (108), retainer plate (107), roller (151), cylinder block (104), and piston assembly (105, 106) in shaft (102).

– Hanger (2)

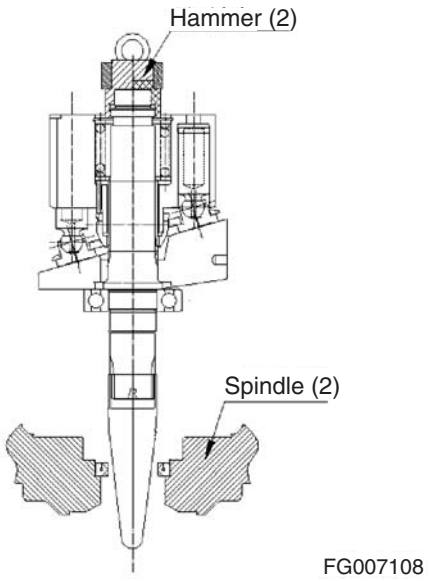


Figure 63

11. Assembly of Motor Assembly

A. Use hanger (2) to lift the motor assembly and install the insertion guide tool in the section spool line of shaft (102).

B. Lift motor shaft (102) slowly and install it in spindle (2).

C. Remove hanger (2) and the insertion guide tool after the assembly.

NOTE: *Be careful not to contact spindle (2) and other parts when arranging the pivot hole of swash plate (103) and steel ball (167), which may cause damage.*
After the assembly of motor assembly, rotate the cylinder block to check if it is loose. If necessary, adjust its fitting.

– Insertion guide tool

12. Assembly of Hydraulic Motor

A. Install two friction plates (115) and mating plate (116) in the outer space of cylinder block (104), alternately.

NOTE: *Apply hydraulic oil to friction plates (115) before assembly.*
Be careful to install friction plates (115) and mating plate (116) in correct order. It they are installed in wrong order, braking torque may decrease.

B. Install O-rings (139, 178) on piston (112).

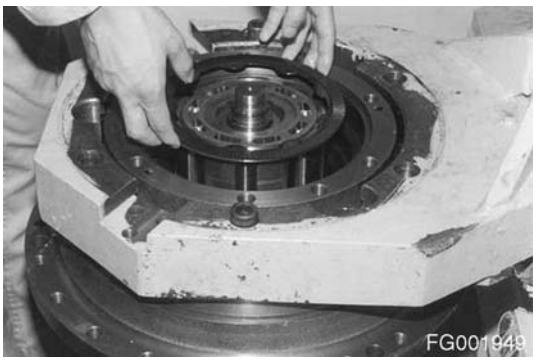


Figure 64

C. Install piston (112) carefully in spindle (2) by knocking its surface with plastic hammer.

NOTE: *Apply grease to O-rings (139, 178).*

– Plastic hammer



Figure 65

D. Install ball bearing (150), timing plate (109), one parallel pin (341), 12 springs (113) in rear flange (201).

NOTE: *Sufficiently apply grease to springs (113) and timing plate (109) that they do not fall off from rear flange (201). Apply hydraulic oil to ball bearing (150).*

– Grease and hydraulic oil

E. Fill hydraulic oil.

– Hydraulic oil: 1.7 liter



Figure 66

F. Install O-rings (29, 39), 2 parallel pins (181), and rear flange (201) in spindle (2).

NOTE: *Install rear flange (201) by arranging pinhole to parallel pin (181) of spindle (2).*

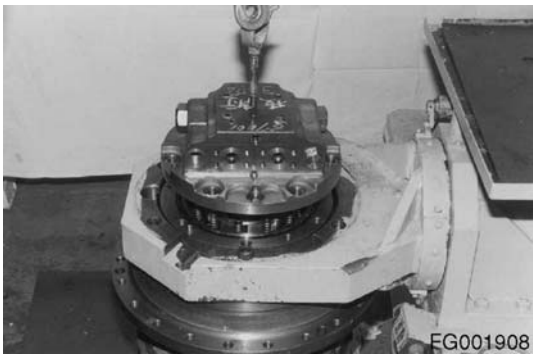


Figure 67

G. Install 12 socket bolts (282) in spindle (2) with specified torque.

NOTE: *Tightening torque: 25.7 ±4 kg•m*

– Torque wrench and wrench adapter

H. Install O-ring (238) to plug (221) and connect it to a port without piping.

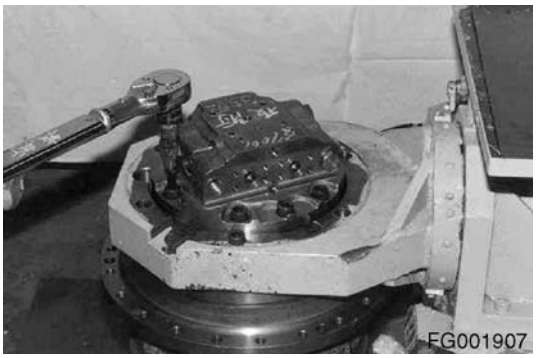


Figure 68

I. Install relief valve (300) on rear flange (201) and tight it with specified torque.

NOTE: *Tightening torque: 12 ±1 kg•m*



Figure 69

13. Assembly of Carrier Assembly

A. Install one thrust plate (20) in coupling gear (8).

If replacement of part is required Hub kit, cover (13) Spindle kit carrier assembly (24)	Distance piece (12) width selection See “The Order of Selecting the Thickness of Distance Piece (12)” on page -56.
If replacement of part is not required	Connect in the following order.

NOTE: *Apply a thin coating of molybdenum bisulfide grease to the surface of thrust plate (20).*

B. Install coupling (19) in shaft (102).

NOTE: *Apply a thin coating of grease to the spool line of coupling (19).*

C. Install steel ball (36) on sun gear (A)(7) and install it on coupling (19).



Figure 70

D. Insert the carrier assembly in hub (1) and correctly arrange teeth of ring gear (B)(5) and teeth B of cluster gear (6) to assemble them. See “Decision of Installation Position in the Carrier Assembly” on page -54.

– One set of hanger and hanger (1)

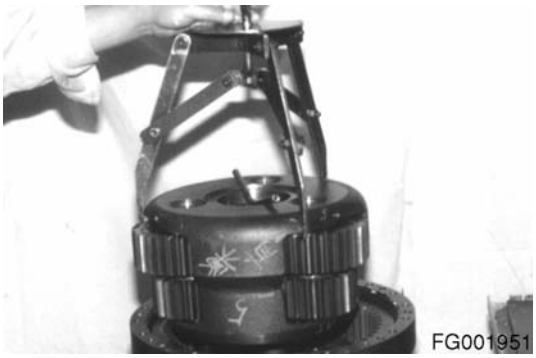


Figure 71

Decision of Installation Position in the Carrier Assembly

Insert the carrier assembly in hub (1) and correctly arrange the teeth of gears of cluster gear (6)B and ring gear (B)(5) in the following way.

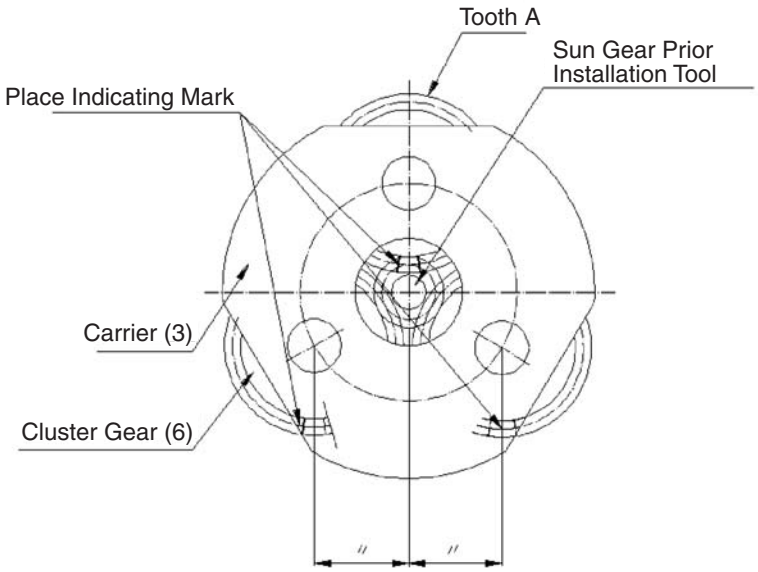


Figure 72

- Arrange place indication marks of 3 cluster gears (6) to the place shown in the figure above.
- At that place fix the sun gear (A) prior installation tool that it can be arranged with cluster gear (6).
- Install the carrier assembly in (hub) in this state. Then, the sun gear (A) prior installation tool will fall out.

14. Assembly of Ring Gear (A)(4)

A. Install ring gear (A)(4) in hub (1). Make sure that teeth of ring gear (A) and cluster gear A teeth are correctly arranged.

B. Hold hub (1) and arrange it to the simultaneous machining mark of ring gear (A) and the hub.

NOTE: *Degrease the connection areas of hub (1) and ring gear (A)(4)completely and apply a thin coating of herme seal (NO.SS60F).*

C. Insert parallel pin (27) in hub (1).

D. Fill lubricating oil in the reducer. Amount of lubricating oil: About 3.3 liter

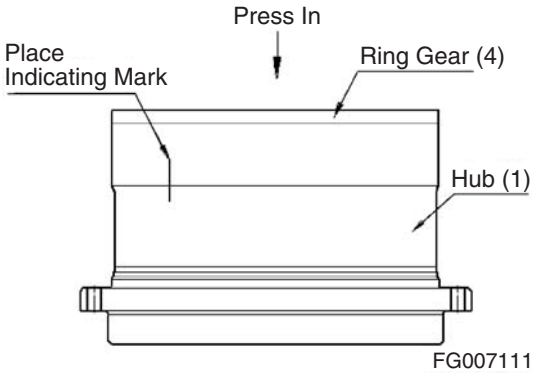


Figure 73

15. Assembly of Cover (13)

A. Install thrust plate (20) on carrier (3).

NOTE: *Apply a thin coating of molybdenum bisulfide grease to the surface of thrust plate (20).*

B. Install cover (13) on hub (1).

NOTE: *Apply a thin coating of herme seal (NO.SS60F) to the hub connection area of cover (13).*

– Hanger and eyebolt PT 1/2



Figure 74

C. Install cover (13) in hub (1) with socket bolt (32) and retaining ring washer (33) with specified torque.

NOTE: *Tightening torque: 10.4 ±1.6 kg•m*
Apply a thin coating of Loctite #242 to socket bolt (32) before installing it.

– Torque wrench

D. Install plug (30) on cover (13) with specified torque.

NOTE: *Tightening torque: 10 ±2 kg•m*
When installing plug (30) on cover, wrap seal tape around it and the teeth should be within ±1 tooth than the end of counter boring of cover (13).

– Torque wrench and seal tape

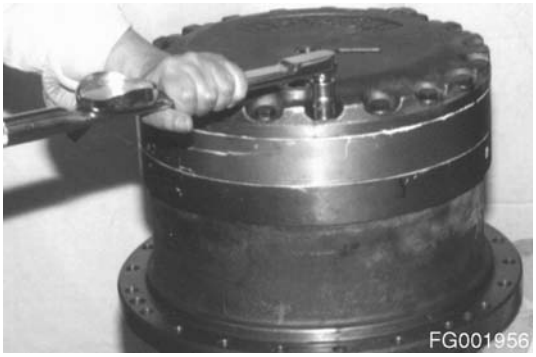


Figure 75

The Order of Selecting the Thickness of Distance Piece (12)

If the following parts are replaced, they should be installed no.5 of page -48 after the thickness of distance piece (12) is selected in the following way.

	Hub Kit
Changing Parts	Spindle Kit
	Ball Bearing (24)

Installation from no.1 to no.4 may be done in ordinary ways.

1. Fix the distance piece gap adjustment tool on the spindle with distance piece (12) not being inserted.
2. Set socket bolt (35) gently.
3. Measure distance A shown in the picture on the right side using a depth micro meter.
4. Measure distance C of coupling gear (8) to be installed next (refer to the picture on the right side).



Figure 76

5. Select the distance piece with proper thickness depending on the measurements from above procedures according to the following formulas.
   A. Measure the gap between both ends of spindle (2) and ball bearing (24).

      Where, X is the gap.

      "X" = "A" - "B"

   B. Use the following formula to calculate the proper thickness of the distance piece.

      "T" = ("C" + "X") 0.1

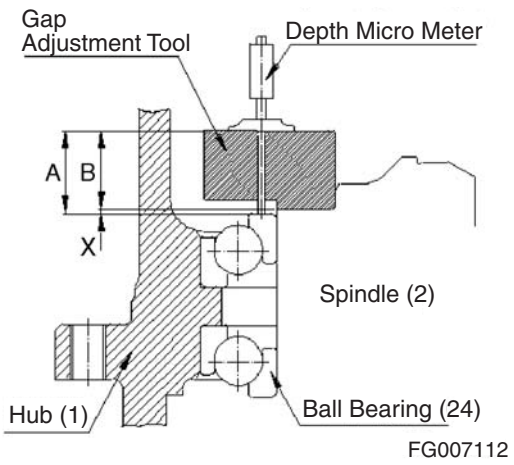


Figure 77

6. Select one from 9 sizes of the distance piece for the final installation depending on the result of procedures 1) to 5).

   NOTE: *Set about 3 socket bolts and tighten them evenly.*

   - Distance piece, gap measuring tool, and depth micro meter

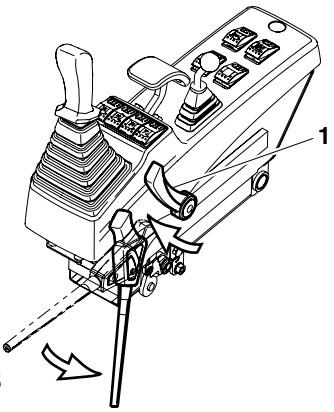


Figure 78

Decision of Installation Position in Thrust Plate (20)

If the following parts are replaced, they should be installed no.15 of page -55 after the thickness of thrust plate (20) is selected in the following way.

Changing Parts
- Hub Kit
- Spindle Kit
- Carrier Assembly
- Cover (13)

Installation from no. 1 to no.4 may be done in ordinary ways.

1. Fix one of two thrust plates (20) on coupling gear (8). Use thrust plate #1.
2. Install coupling (19) on shaft (102).
3. Install sun gear (A)(1) on coupling (19).
4. Insert carrier assembly in hub (1) and set them by correctly arranging teeth Bs of ring gear (B)(5) and cluster gear (6). Here, you have to decide the installation position in the carrier assembly.
   See “Decision of Installation Position in the Carrier Assembly” on page -54.

   NOTE: *Do not apply molybdenum bisulfide grease to the surface of thrust plate (20).*

   - One set of hanger and hanger (1)



Figure 79

5. Arrange ring gear (A)(4) to the simultaneous machining mark and install it in hub (1). Make sure that teeth A of cluster gear (6)A and teeth of ring gear (A)(4) should be arranged correctly.

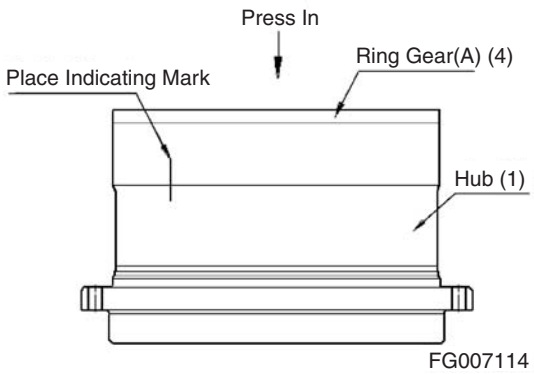


Figure 80

6. Set the adjustment tool of thrust plate (R) in hub (1) and retain them gently with 2 socket bolts (M12).

7. Measure distance A shown in the picture on the right side using a depth micro meter.

   NOTE: *Here, do not install thrust plate (20).*

   – Adjustment tool of thrust plate

8. Measure distance C of hub (13) to be installed next (refer to the picture on the right side).

9. Select the thrust plate with proper thickness depending on the measurements from above procedures according to the following formulas.

   A. Measure the gap between both ends of carrier (3) and ring gear (A)(4).

      Where, X is the proper value.

      "X" = "B" - "A"

      "A": Measured value.

      "B": Value of the tool.

   B. Calculate the proper thickness of the thrust plate.

      Where, T is the proper value.

      "T" = ("C" - "X") - (0.3 - 0.6)

10. Select the thrust plate with proper thickness among 3 sizes according to the results of numbers 7 to 9 above. (See “Gap Adjustment Tools Size Table” on page -61.)



Figure 81

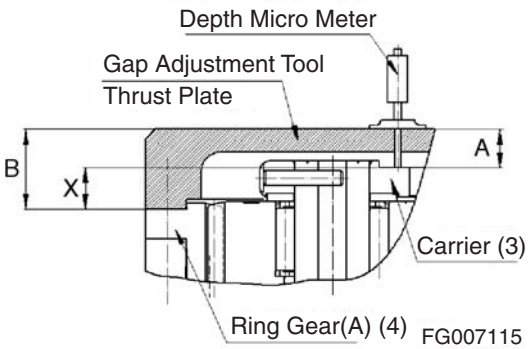


Figure 82

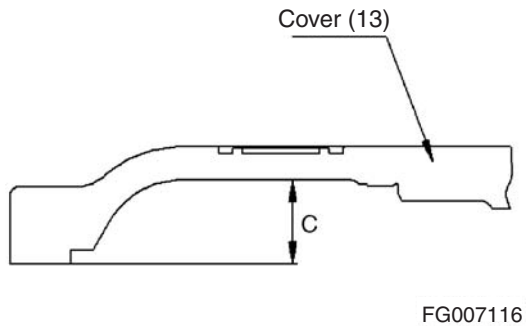


Figure 83

Performance Check Test

Fill hydraulic oil fully in the motor casing before the performance check test.

The following test is necessary after the maintenance of the TM motor.

1. When Test Devices are Available

   If some internal parts have been replaced, start test with the following prior operation status.

   A. Prior Operation Conditions

      Right and left operations for one minute without idle at 20 rpm
      Below 200 kg•cm^2 at 10 rpm
      Right and left operations for one minute without idle at 25 rpm

      1) Efficiency Test (at 1st speed)

      2) Volumetric Efficiency Check Test at 2-speed

At 2-speed shifting	Volumetric Efficiency	Drain from Hydraulic Motor
Pressure difference: 100 kg•cm^2 Number of rotation: 15 rpm	Above 96%	Below 2.0 lpm

      3) Check of 2-speed Operation

      Check if speed is changed from low to high when applying pressure oil of 25 kg•cm^2 to 2-speed shift pilot port (D port) under the no load test with the prior operation conditions above (A and B).
      Also check if speed is changed from high to low with the pressure below 120 kg•cm^2.

TM Type	Volumetric Efficiency	Mechanic Efficiency	External Drain (Reference Value)	Remark
TM40VC	Above 90%	Above 83%	Below 4.0 lpm	
	Pressure difference: 250 kg•cm^2 Number of rotation: 10 rpm			

B. When Test Devices are not Available

Set the TM motor in the car and drain it with shoe not attached and start the prior operation in the following way before the test.

– Prior Operation Conditions

a) Right and left operations for one minute without load at 10 rpm

b) Right and left operations for one minute without load at 20 rpm

– Test Conditions

Temperature: Hydraulic oil - 50 ±5°C

Case: - 40 ±80°C

No Load Drive Pressure (Pressure Difference)

1st speed	At 10 rpm	Below 20 kg•cm^2
2nd speed	At 20 rpm	Below 30 kg•cm^2

Measured Drain of Motor

Common at 1st and 2nd speed	At 10 rpm	Below 2.0 lpm

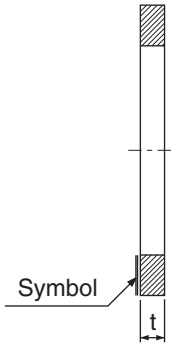
Summary of Seal Information

No.	Parts	Size	Qty	Remarks
1	O-ring	1BP8	2	39
2	O-ring	1AG230	1	29
3	Floating seal	JS2500S	2	26
4	O-ring	P340	1	40
5	O-ring	1BP9	1	233
6	O-ring	1BP22A	2	234
7	O-ring	1BP18	1	238
8	O-ring	1BP210	1	139
9	O-ring	1BP195	4	178
10	O-ring	TCN42 x 65 x 12	1	132
11	O-ring	1BP32	3	279
12	O-ring	1BP11	1	265
13	Oil seal	1BP8	2	39
14	O-ring	1AG230	1	29
15	O-ring	JS2500S	2	26

Gap Adjustment Tools Size Table

1. Distance Piece (12)

Symbols	t	
A	Above 4.10	Below 4.15
B	4.15	4.20
C	4.20	4.25
D	4.25	4.30
E	4.30	4.35
F	4.35	4.40
G	4.40	4.45
H	4.45	4.50
I	4.50	4.55
J	4.55	4.60
K	4.60	4.65
L	4.65	4.70
M	4.70	4.75
N	4.75	4.80

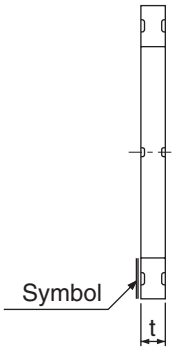


FG007119

Figure 84

2. Thrust Plate (R)

Symbol	t ±0.05
1	5.7
2	6.0
3	6.3



FG007120

Figure 85

Gear Pump

Edition 1

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SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

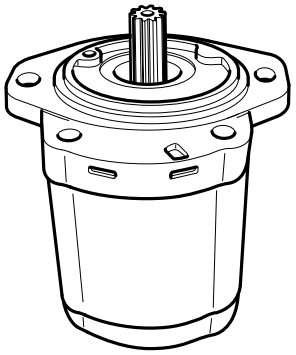
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up

SINGLE GEAR PUMP

Disassembly

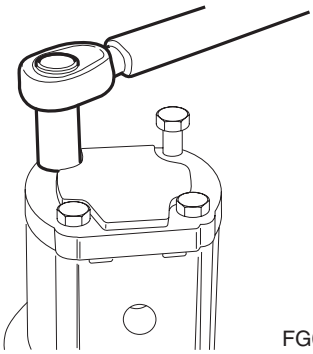
1. Clean exterior of pump.



FG001072

Figure 1

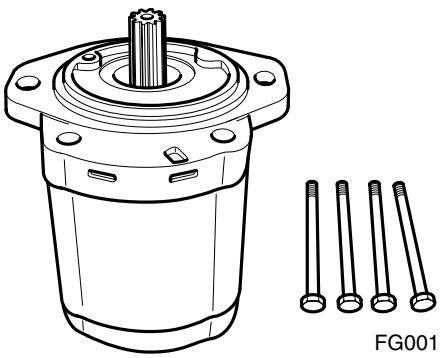
2. Remove clamp bolts.



FG001074

Figure 2

3. Cover sharp edges of driveshaft with adhesive tape and coat shaft end extension with clean grease, to avoid any damage to lip of shaft seal when removing mounting flange.



FG001073

Figure 3

4. Remove mounting flange taking care to keep flange as straight as possible during removal.

   If mounting flange is stuck, tap around edge with rubber mallet to break it away from body.

   NOTE: *Make sure that while removing mounting flange, shaft and other components remain in position.*

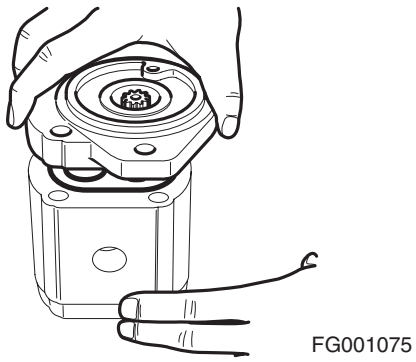


Figure 4

5. Remove retaining ring, if replacement is necessary.

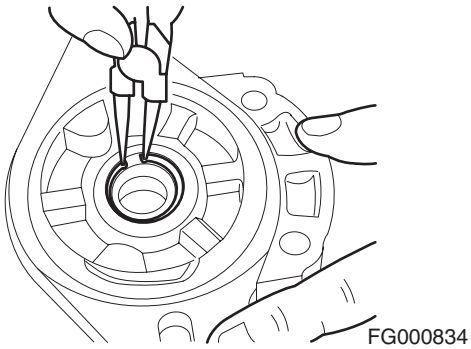


Figure 5

6. Remove shaft seal taking care not to damage surface of shaft hole, if replacement is necessary.

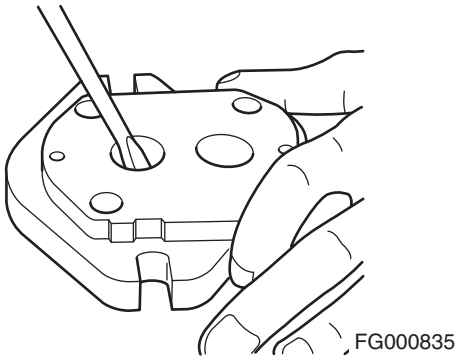


Figure 6

7. Pull drive gear up to facilitate removal of front plate.

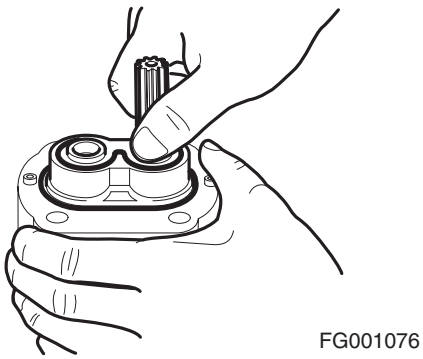


Figure 7

8. Remove driving gear and driven gear, keeping gears as straight as possible.

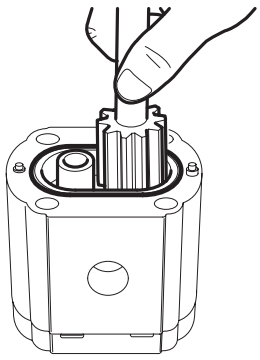


Figure 8

9. Remove rear plate and end cover.

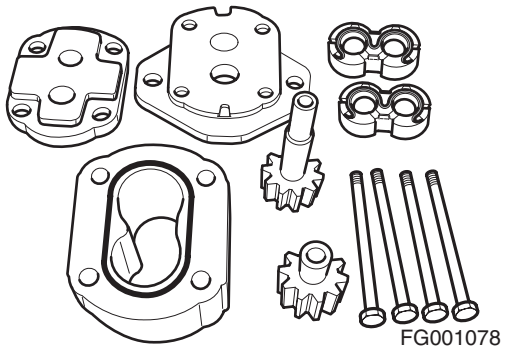


Figure 9

Reassembly

1. Clean all components with care.

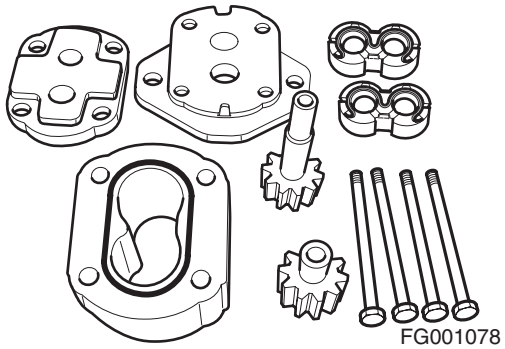


Figure 10

2. Using a suitable driver, install shaft seal in mounting flange.

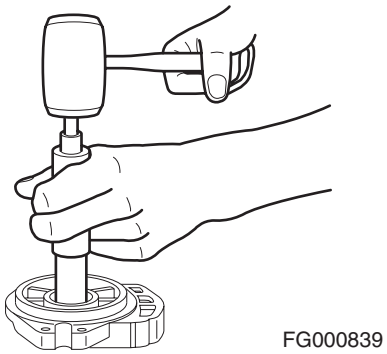


Figure 11

3. Install retaining ring in groove.

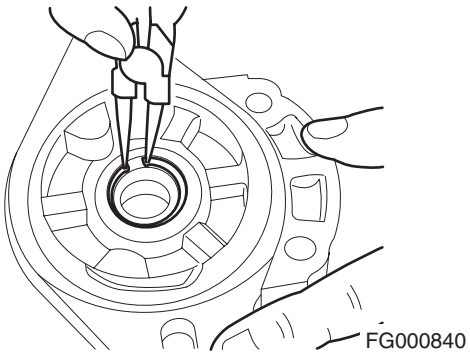


Figure 12

4. Install O-ring on both sides of rear section of body.

   NOTE: *Coat O-rings with grease to hold O-rings in body.*

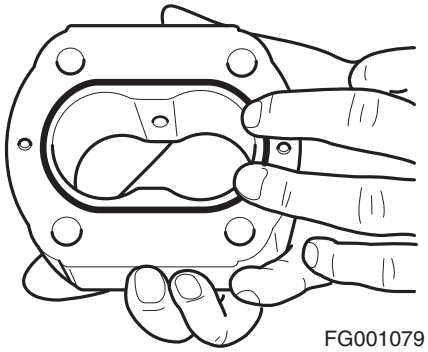


Figure 13

5. Install rear section body on rear cover.

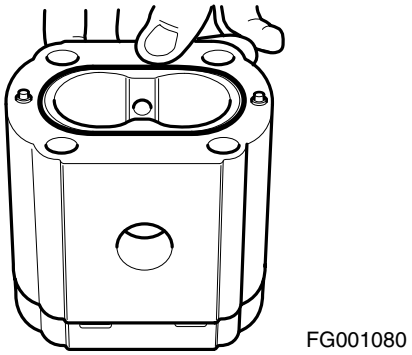


Figure 14

6. Install seals in pressure plate (s) groove. Then install backup ring in groove with seals. Coat seals with grease.

   NOTE: *The front and rear pressure plates and seals and backup rings are the same.*

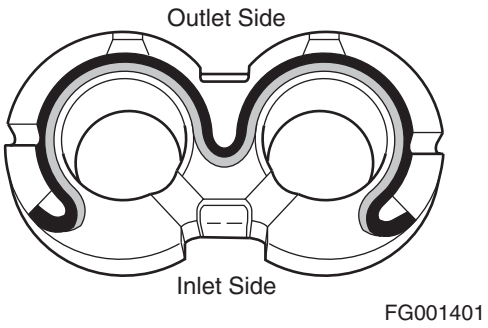


Figure 15

7. Insert pressure plate assembly into body while keeping it straight.

   NOTE: *Seal side should face to rear cover, opposite side of gears.*

   NOTE: *Pay attention to installation direction of seal.*

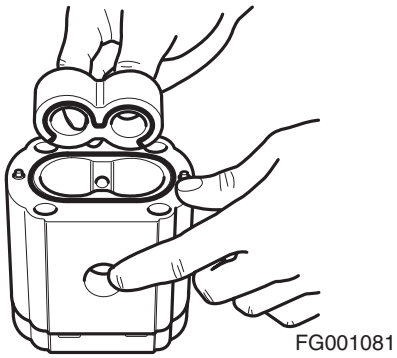


Figure 16

8. Install drive gear and driven gear.

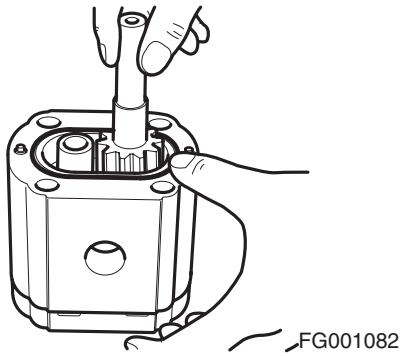


Figure 17

9. Insert pressure plate into body in proper direction.

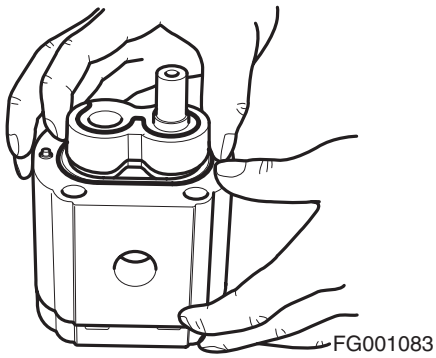


Figure 18

10. Locate mounting flange in right position.

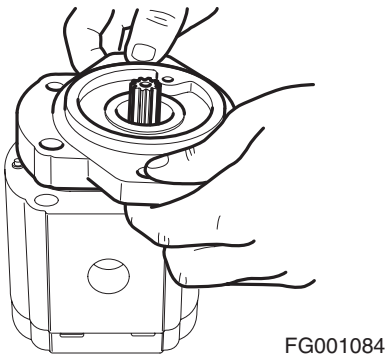
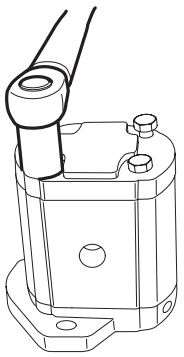


Figure 19

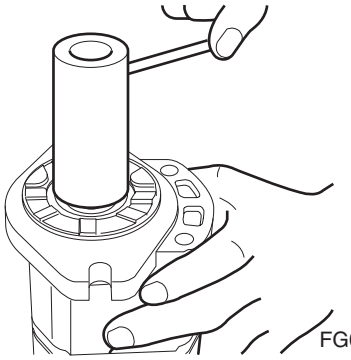
11. Tighten bolts with washer in a crisscross pattern to a torque value of 45 Nm.



FG001085

Figure 20

12. Check that pump rotates freely when driveshaft is turned by hand. If not a pressure plate seal may be pinched.



FG000851

Figure 21

Main Control Valve

Edition 1

MEMO

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MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX300LC	5001 and Up
DX340LC	5001 and Up

GENERAL DESCRIPTION

Theory of Operation

When All Spools are in Neutral

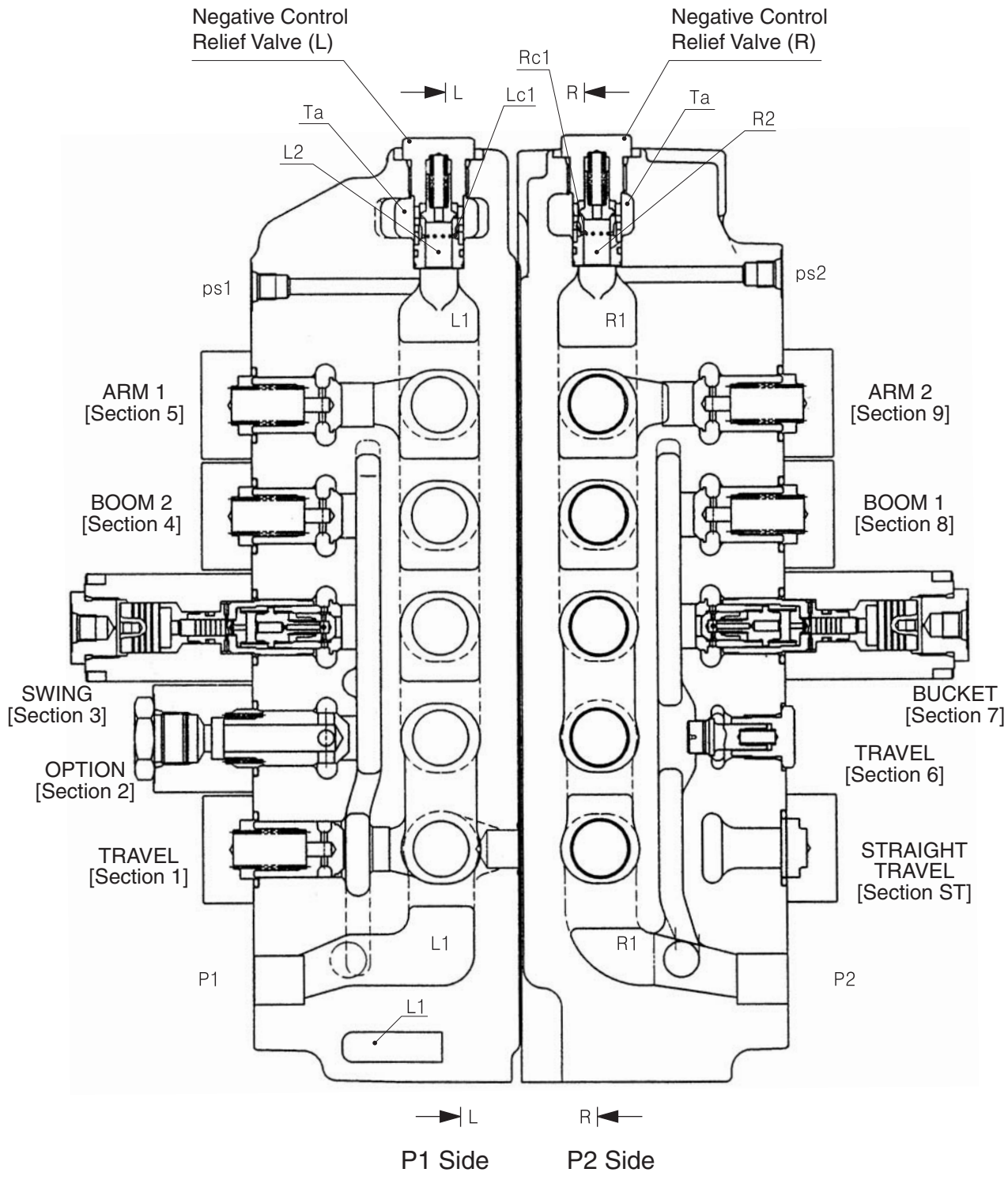
Neutral Passage

The oil supplied from the port (P1) enters into the tank passage (Ta) through the orifice (Lc 1) of negative relief from the neutral passage (L1) and returns to ports (T1, T2 and T3).

The oil supplied from the port (P2) passes the tank passage (Ta) through orifice (Rc 1) of negative relief from the neutral passage (R1) and returns to port (T1, T2 and T3).

The pressure of chambers (L2 and R2) flowing over the negative relief, flows into pump from ports (ps1 and ps2), to control the volume of pump P1 and P2.

In addition, when excessive oil flows excessive into the neutral passage, the negative relief operates to prevent the abnormally high-pressure on ports (ps1 and ps2).



FG001295

Figure 1

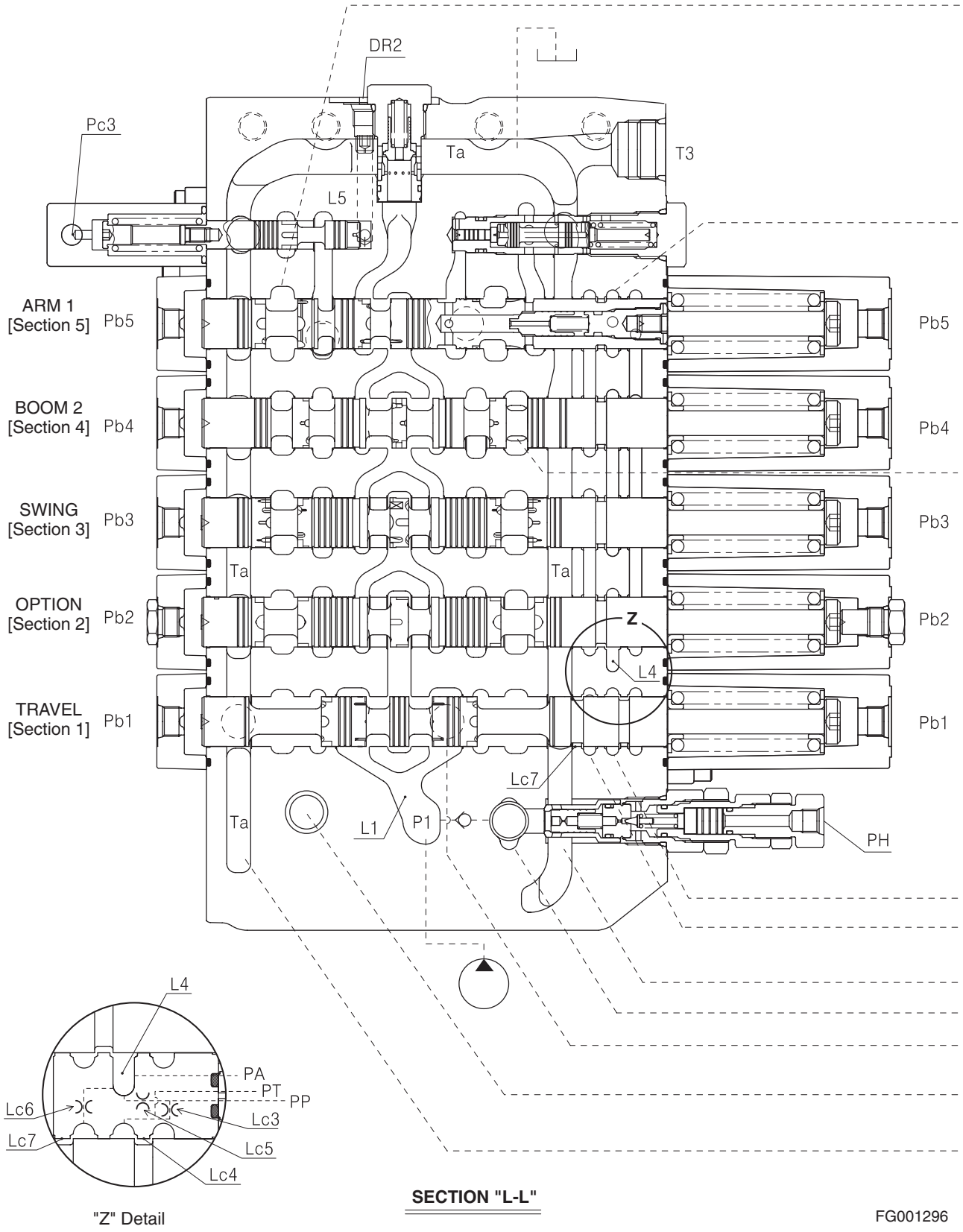

DR2
Pc3
Ta
T3
L5
ARM 1
[Section 5]
Pb5
BOOM 2
[Section 4]
Pb4
SWING
[Section 3]
Pb3
OPTION
[Section 2]
Pb2
TRAVEL
[Section 1]
Pb1
Ta
Ta
Z
L4
Lc7
Ta
L1
P1
PH
L4
PA
PT
PP
Lc6
Lc3
Lc7
Lc5
Lc4
"Z" Detail
SECTION "L-L"
FG001296

Figure 2

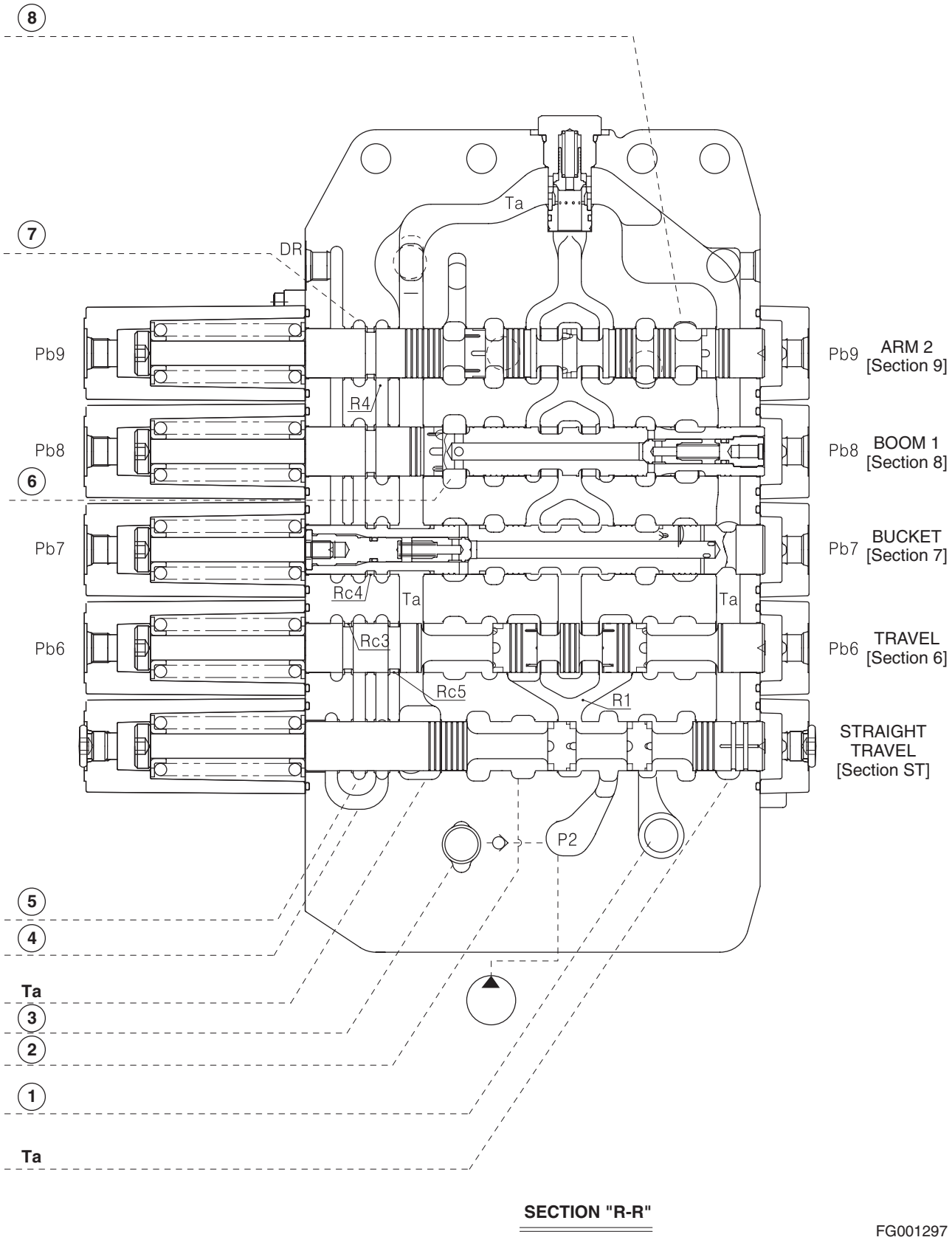

8
7
6
5
4
Ta
3
2
1
Ta
DR
Ta
Pb9
Pb8
Pb7
Pb6
R4
Rc4
Ta
Ta
Rc3
Rc5
R1
P2
Pb9 ARM 2 [Section 9]
Pb8 BOOM 1 [Section 8]
Pb7 BUCKET [Section 7]
Pb6 TRAVEL [Section 6]
STRAIGHT TRAVEL [Section ST]
SECTION "R-R"
FG001297

Figure 3

Signal Passage

Oil supplied to port (PP) flows through orifice (Lc3) to port (PT) and simultaneously flows through land (Lc4), passage (5), and land (Rc3) into tank passage (Ta).

The same oil supplied to port (PP), then flows through orifice (Lc5) into port (PA), and it also flows through passages (L4, 7 and R4) to bucket spool land (Rc4) and then flows into drain passage (DR).

The oil passing through orifice (Lc6) flows through land (Lc7) to tank passage (Ta) or flows through passage (4) to travel spool land (Rc5) and then flows into tank passage (Ta).

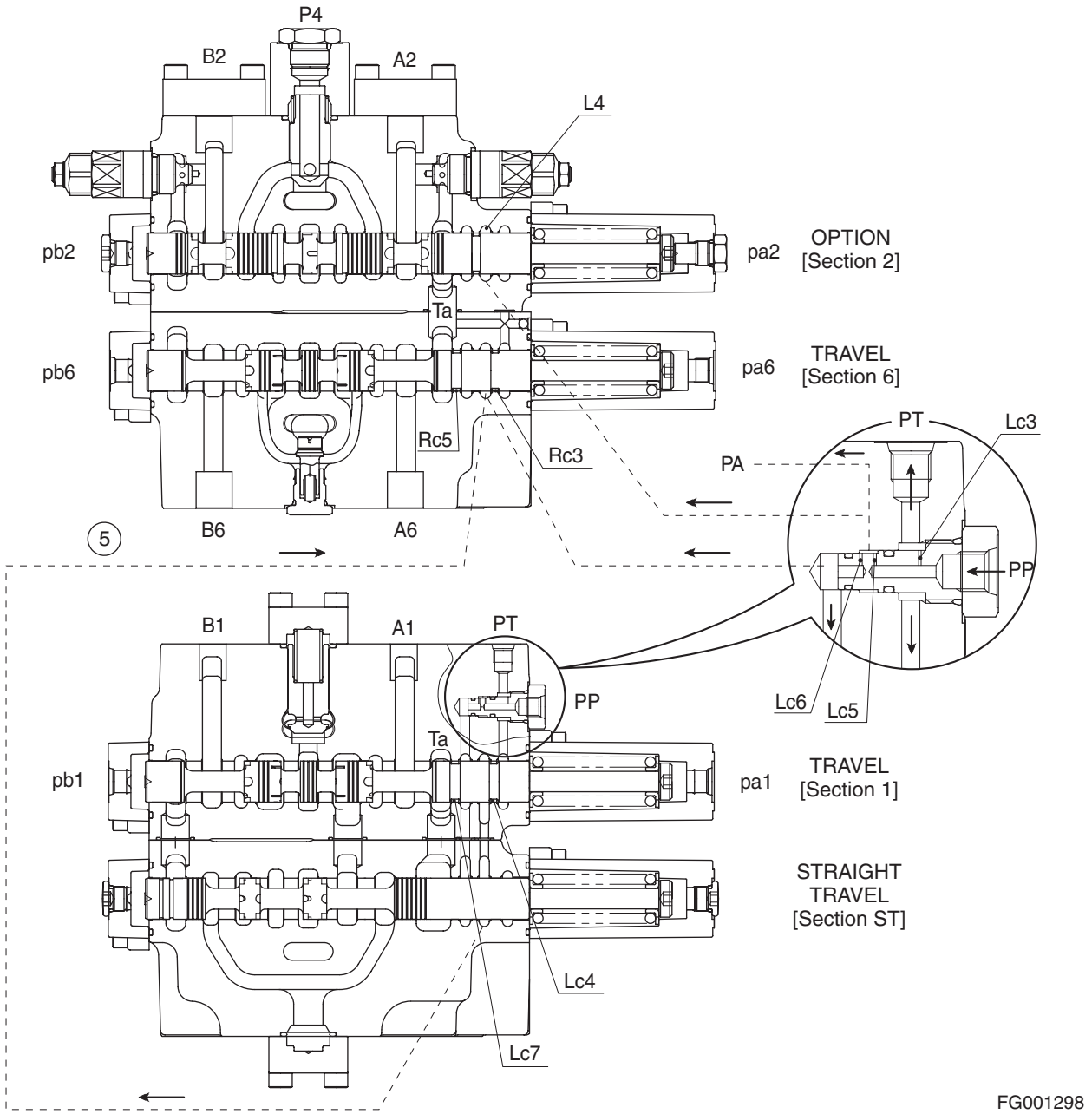


Figure 4

Travel Spool Shift

When shifting travel spool by increasing pressure of travel (Section 1) pilot port (Pb1 (Pa1)), oil supplied to port (P1) flows through neutral passage (L1) to spool and flows to port (B1 (A1)). Return oil flows through port (A1 (B1)), to spool and returns to tank passage (Ta).

When shifting travel spool by increasing pressure of travel (Section 6) pilot port (Pb6 (Pa6)), oil supplied to port (P2) flows through neutral passage (R1) to spool or passage (S6-1) and flows to port (B6 (A6)). At this time, pressure of parallel passage (R3) and passage (S6-1) are equal, so poppet (S6-2) does not open. Return oil flows through port (A6 (B6)) to spool and returns to tank passage (Ta).

When shifting either spool (Section 1 or 6), land (Lc4) or (Rc3) is closed. Oil supplied from port (PP) does not flow into tank passage, so pressure at port (PT) rises.

Option Spool Shift

When shifting option spool by increasing pressure of option (Section 2) pilot port (Pb2 (Pa2)), neutral passage (L1) is closed. Oil supplied to port (P1) flows through parallel passage (L3), load check valve (S2-2), passage (S2-1), and spool, it then flows to port (B2 (A2)).

Return oil flows through port (A2 (B2)) to spool and returns to tank passage (Ta).

When oil is also supplied from port (P4), it flows through load check valve (S2-2) and is combined at passage (S-1).

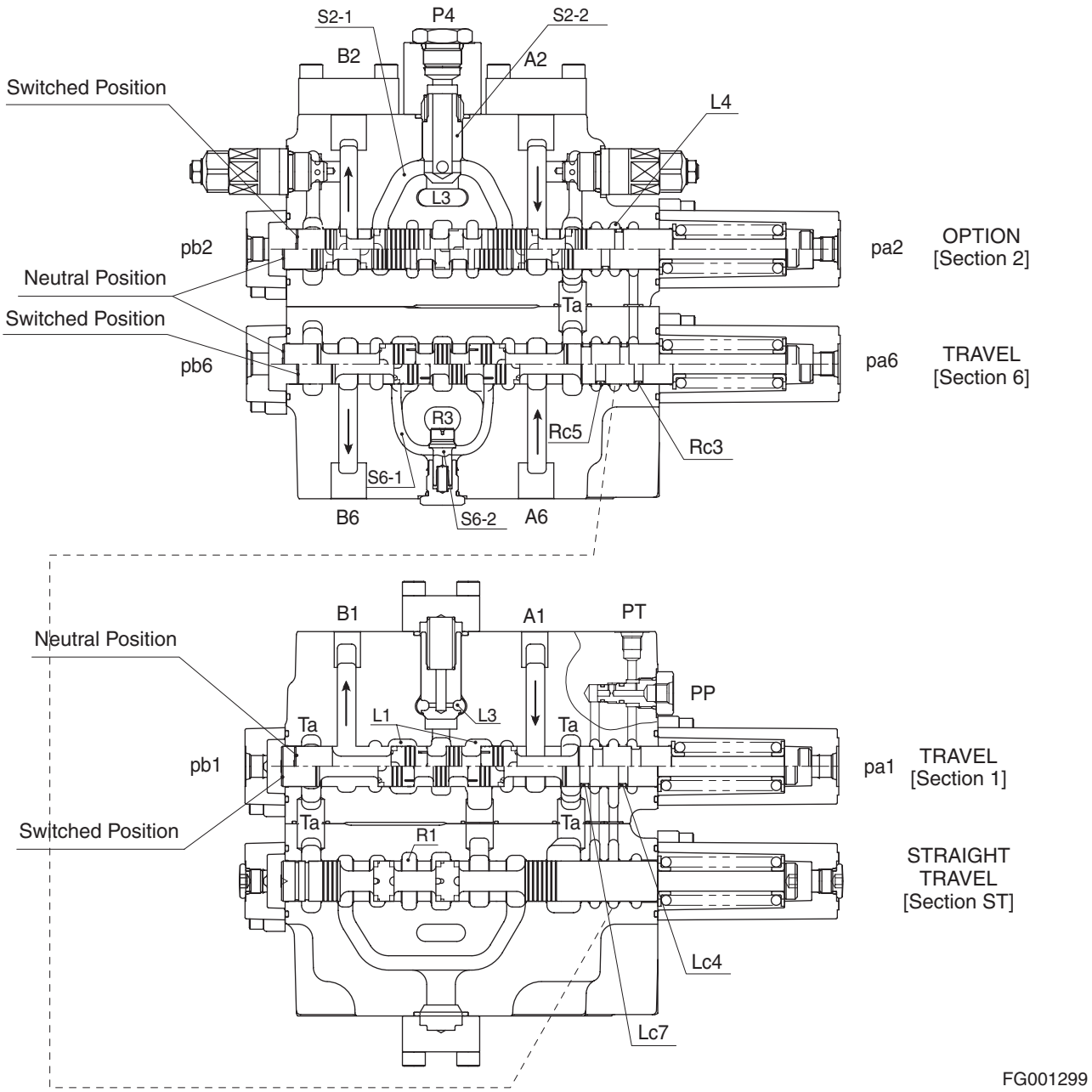

S2-1
P4
S2-2
B2
A2
Switched Position
L4
L3
pb2
pa2
OPTION
[Section 2]
Neutral Position
Ta
Switched Position
pb6
pa6
TRAVEL
[Section 6]
R3
Rc5
Rc3
S6-1
B6
S6-2
A6
B1
A1
PT
Neutral Position
PP
L1
L3
Ta
Ta
pb1
pa1
TRAVEL
[Section 1]
Ta
Ta
Switched Position
R1
STRAIGHT
TRAVEL
[Section ST]
Lc4
Lc7
FG001299

Figure 5

Swing Spool Shift

When shifting swing spool by increasing pressure of swing (Section 3) pilot port (Pb3 (Pa3)), neutral port (L1) is closed. Oil supplied to port (P1) flows through parallel passage (L3), load check valve (S3-2), passage (S3-1) and spool, it then flows to port (B3 (A3)).

Return oil flows through port (A3 (B3)) to spool and is returned to tank passage (Ta).

Bucket Spool Shift

Oil flow control in bucket section portion of valve is different from other sections because it has a regeneration function that works against pilot port pressure.

1. Dump

   When bucket spool is shifted by increasing pressure of bucket (Section 7) pilot port (Pa7), neutral passage (R1) is closed. Oil supplied to port (P2) flows through parallel passage (R3), load check valve (S7-2), passage (S7-1), spool and into port (B7).

   Oil returns through port (A7) and spool to tank passage (Ta).

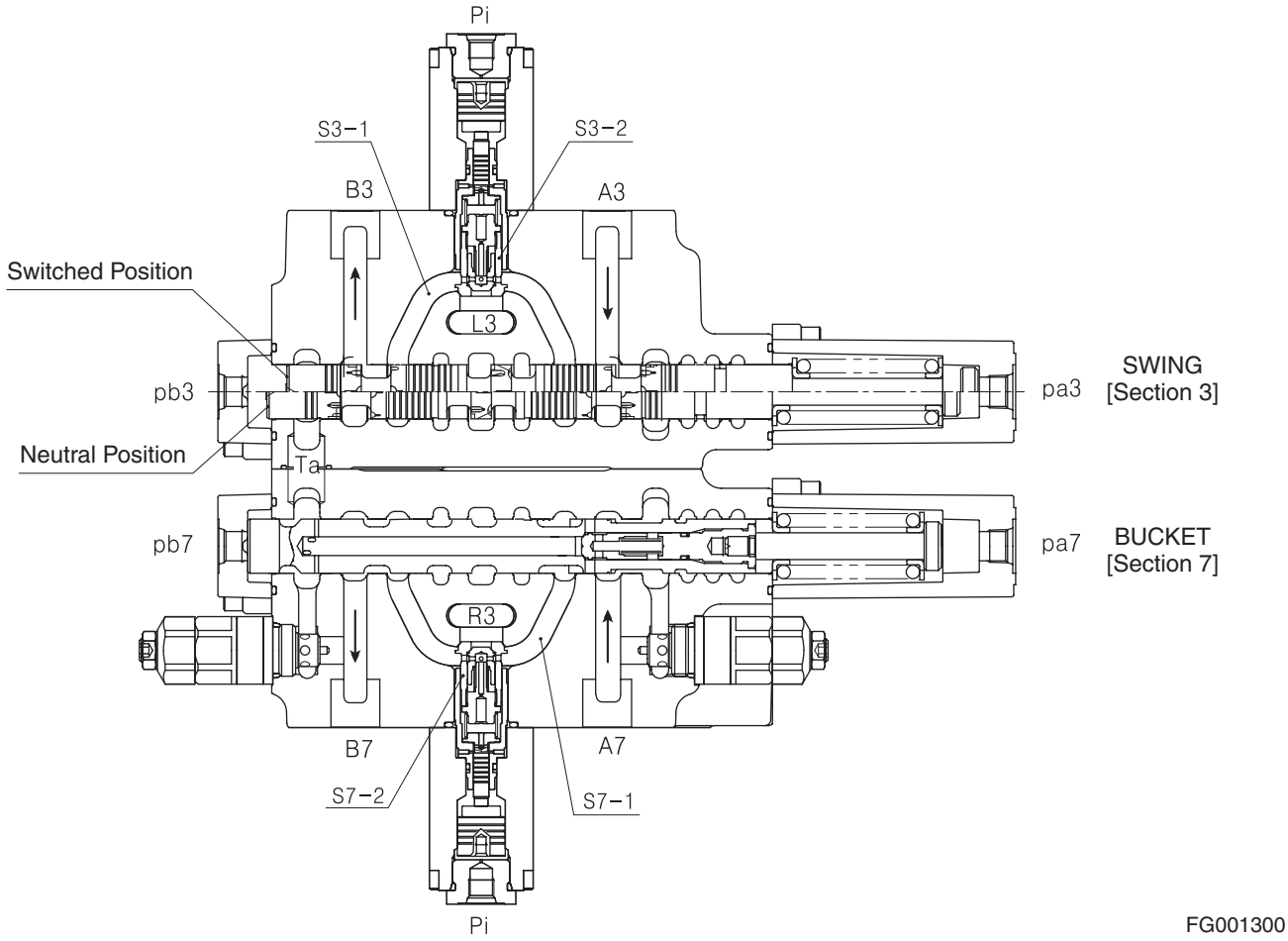

Pi
S3-1
S3-2
B3
A3
Switched Position
L3
pb3
pa3
SWING
[Section 3]
Neutral Position
Ta
pb7
pa7
BUCKET
[Section 7]
R3
B7
A7
S7-2
S7-1
Pi
FG001300

Figure 6

2. Regeneration

When bucket spool is shifted by increasing pressure of bucket (Section 7) pilot port (Pb7), neutral passage (R1) is closed. Oil supplied to port (P2) flows through parallel passage (R3), load check valve (S7-2), passage (S7-1), spool and into port (A7).

Oil flows through port (B7) and one portion of the oil returns through spool to tank passage (Ta), and the other portion of oil flows through inside of spool, and pushes up load check, and then is combined at port (A7).

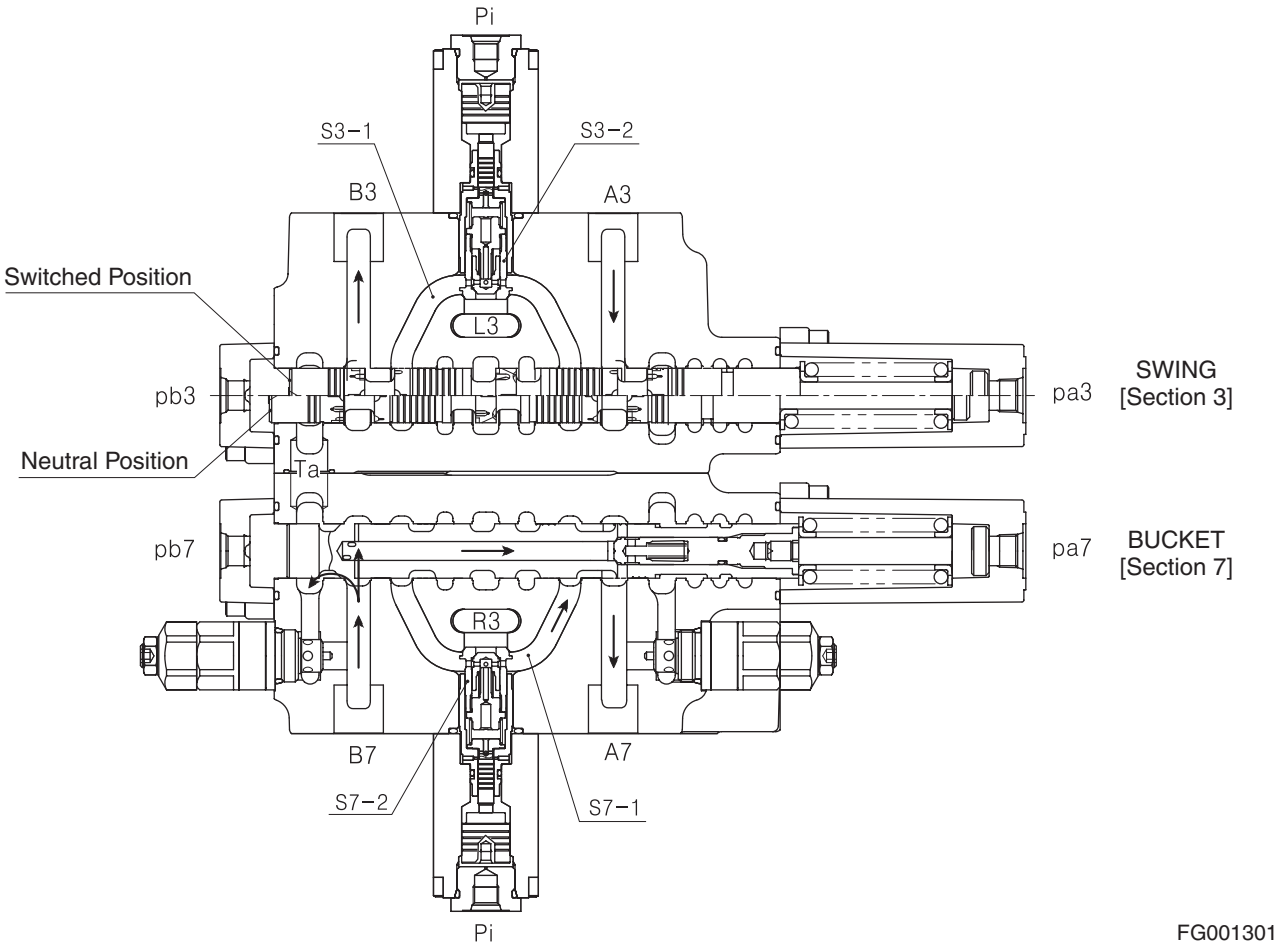


Figure 7

Boom Spool Shift

1. Neutral

   This valve also works with antidrift valves that are installed on the bottom side of each boom cylinder.

   When in neutral, poppet (AD1) is closed by port (A8) pressure that is sent through passage (AD2), spool (AD3) to spring chamber (AD4).

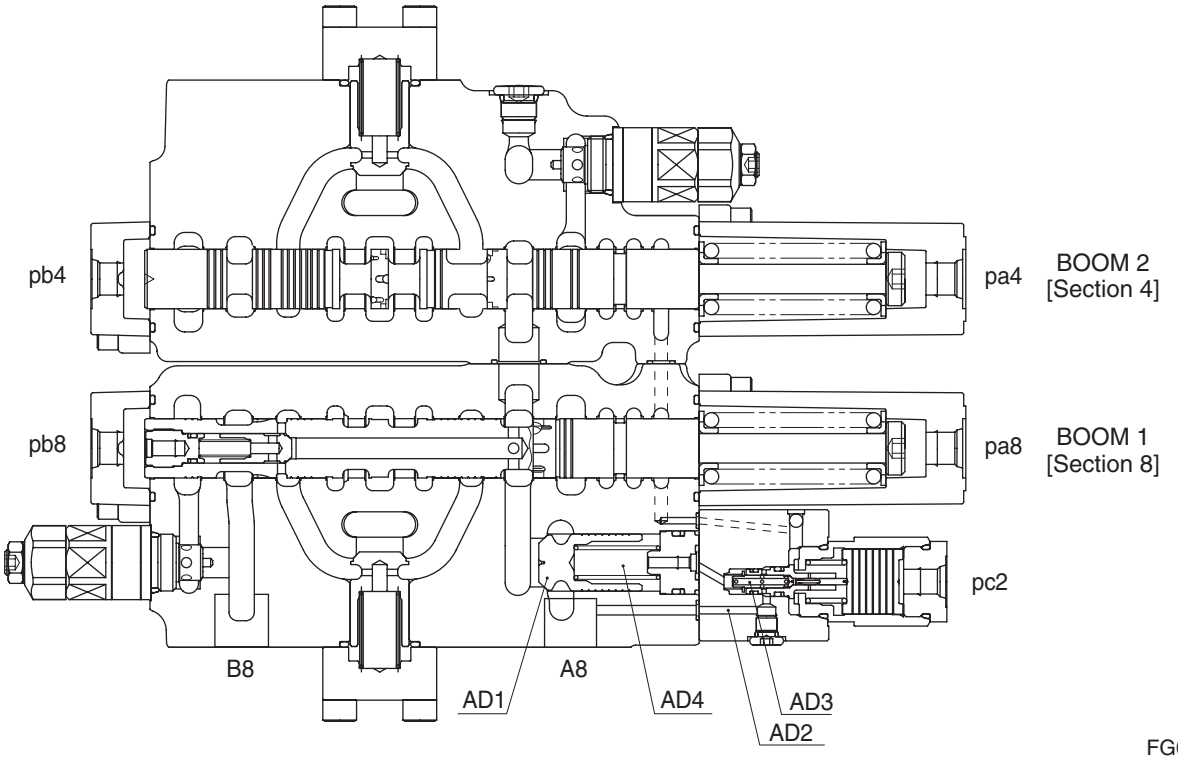


Figure 8

2. Boom up (2-pump confluence)

When boom 1 spool is shifted by increasing pressure of boom 1 (Section 8) pilot port (Pa8), neutral passage (R1) is closed. Oil supplied to port (P2) flows through parallel passage (R3) and load check valve (S8-2) to spool and flows into port (A8).

When boom 2 spool is shifted by increasing pressure of boom 2 (Section 4) pilot port (Pb4), neutral passage (L1) is closed. Oil supplied to port (P1) flows through parallel passage (L3), load check valve (S4-2), spool, and to passage (6) and joins at port (A8). Return oil flows from port (B8) to spool and returns to tank passage (Ta).

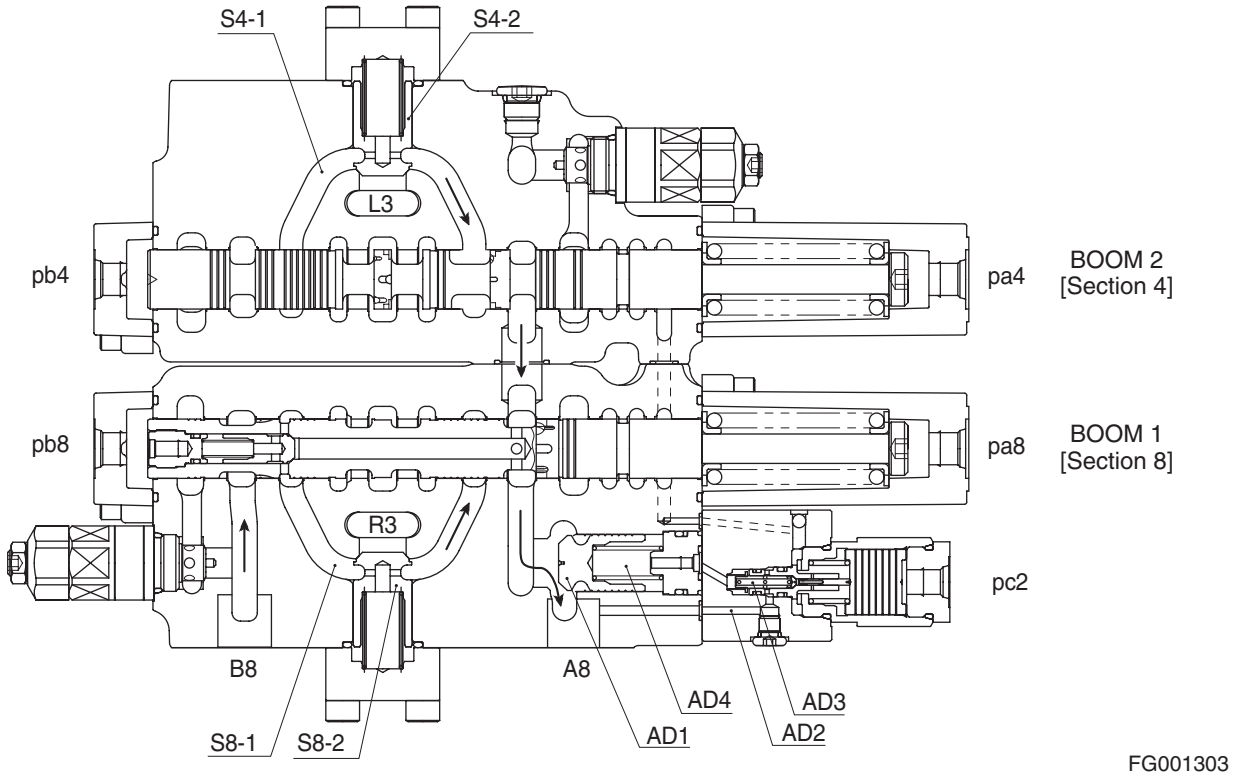


Figure 9

3. (Boom down (regeneration)

When boom 1 (Section 8) spool is shifted by increasing pressure of boom 1 pilot port (Pb8), neutral passage (R1) is closed. Oil supplied to port (P2) flows through parallel passage (R3) and load check valve (S8-2) to spool and flows into port (B8).

When spool (AD3) of antidrift valve is shifted by increasing pressure of port (P2), poppet (AD1) is opened by decreasing of pressure of spring chamber (AD4), and return oil from port (A8) flows to tank passage. Some return oil opens poppet (S8-3) in boom 1 spool, flows through passage (S8-2), joins at port (B7), and then prevents cavitation of cylinder rod side.

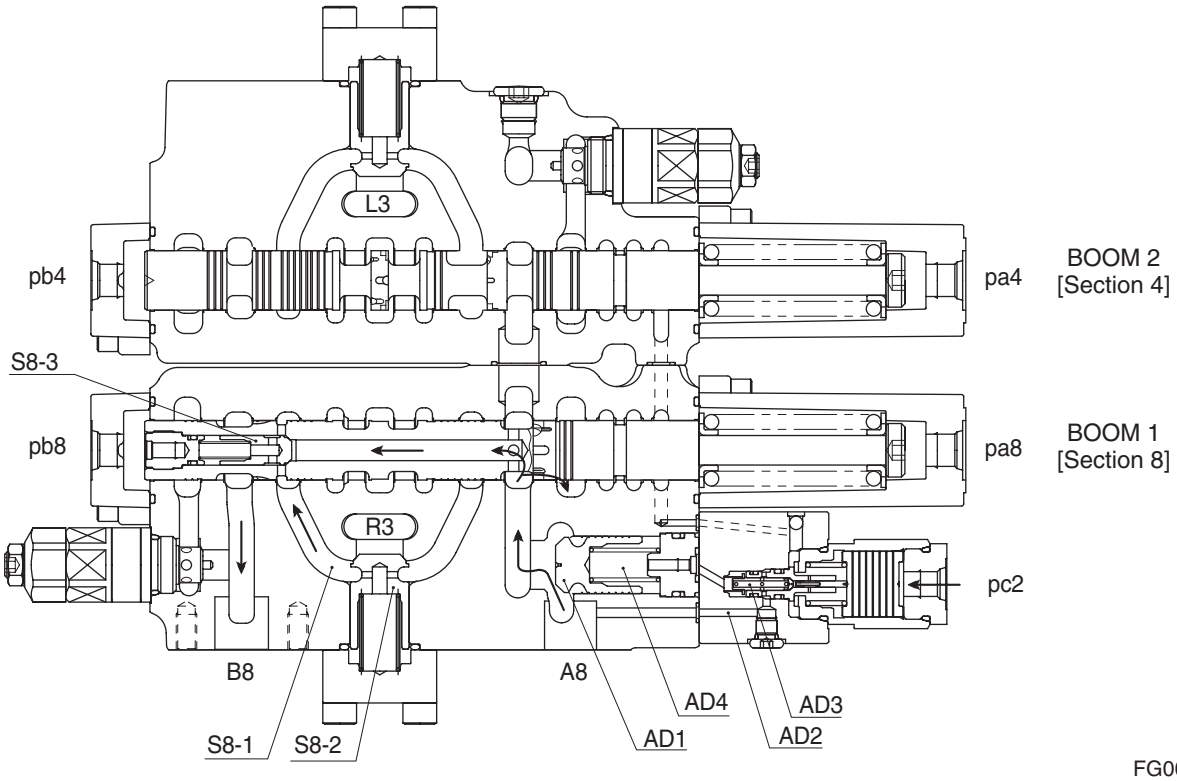


Figure 10

Arm Spool Shift

1. Neutral

   This valve also works with an antidrift valve that is installed on rod side of the arm cylinder.

   When in neutral, poppet (AD1) is closed by port (A5) pressure that is sent through passage (AD2), spool (AD3) and to spring chamber (AD4).

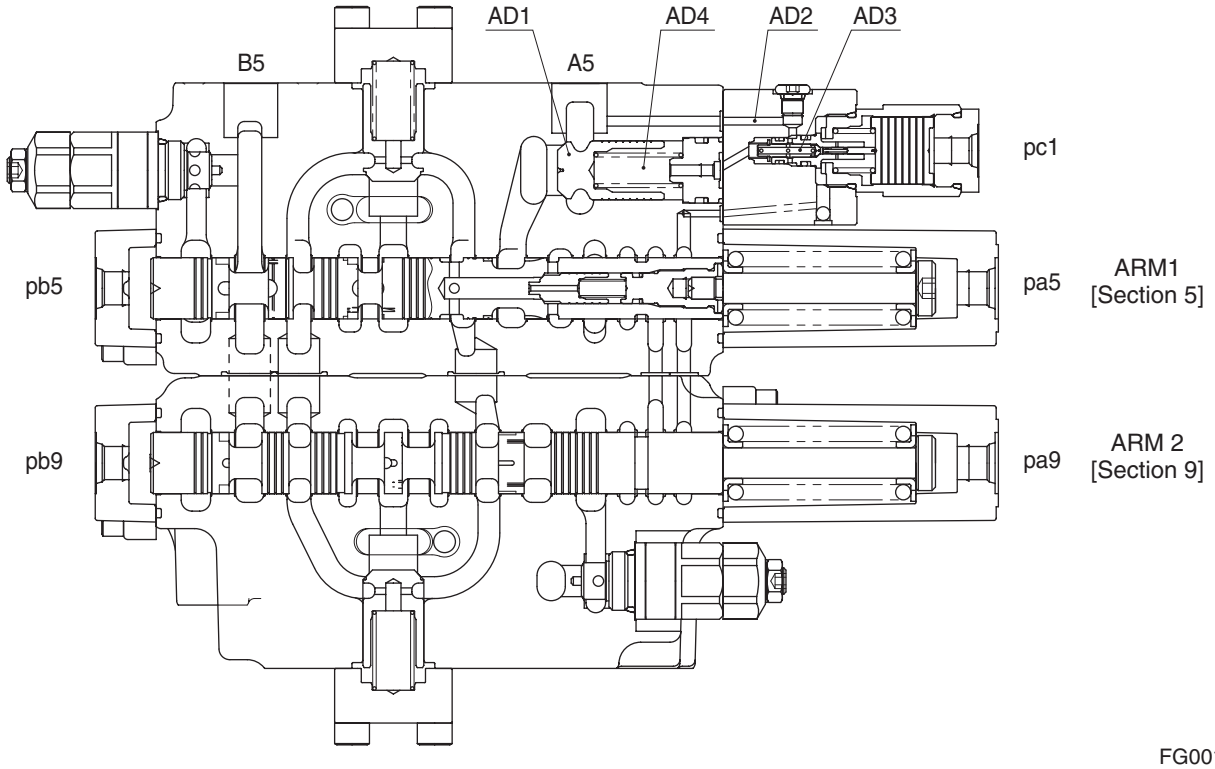


Figure 11

2. Arm in

A. 2-pump confluence

When arm 1 spool is shifted by increasing pressure of arm 1 (Section 5) pilot port (Pb5), oil supplied to port (P1) flows through neutral passage (L1), load check valve (S5-2), passage (S5-1) and spool into port (B5).

When arm 2 spool is shifted by increasing pressure of arm 2 (Section 9) pilot port (pb9), oil supplied to port (P2) flows through neutral passage (R1), load check valve (S9-1), passage (S9-2), and spool to passage (8) and joins at port (B5).

The return oil from port (B5) flows through regeneration check valve in spool, and then flows to port (B) to regenerate, and some oil returns through variable regeneration release valve to tank (Ta). (Refer to section 2-2)

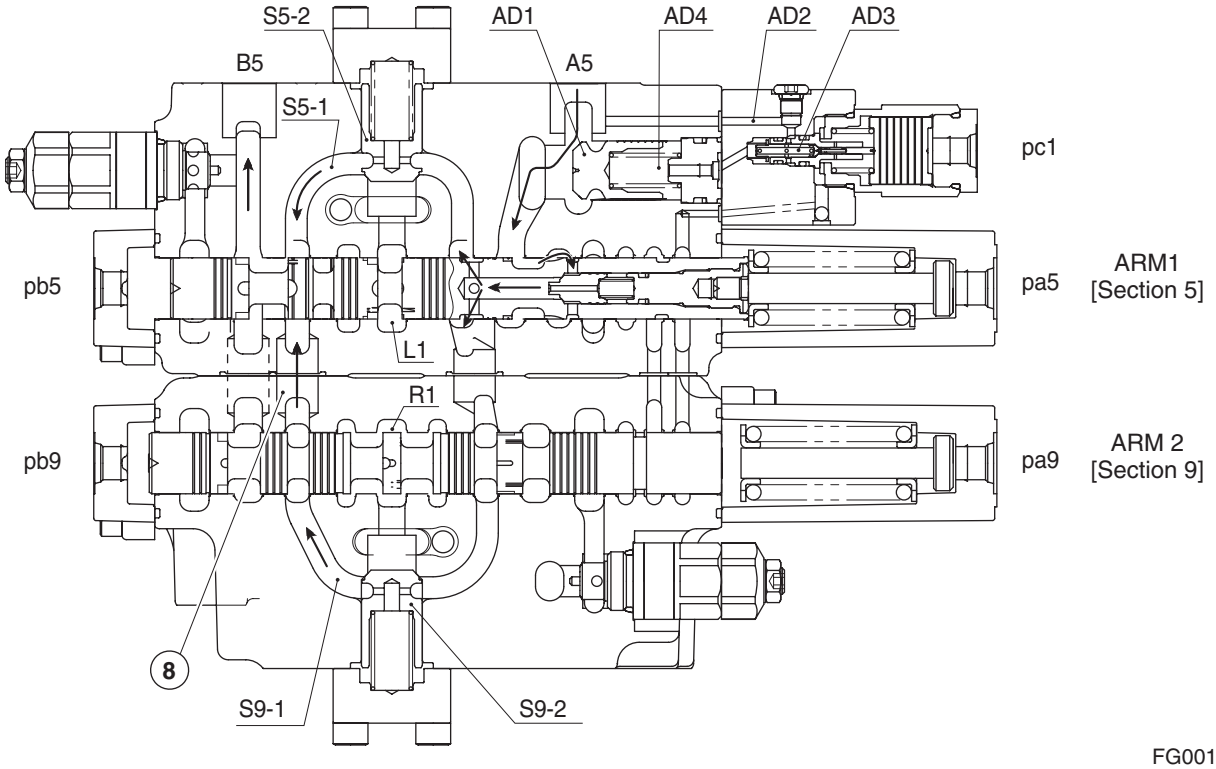


Figure 12

B. Variable regeneration

When crowding arm, after return oil from port (A5) flows through notch (a), one portion of the oil returns through fixed orifice (d), passage (e) and variable orifice (f) and to tank passage (Ta). The other portion of the oil flows through fixed orifice (b), regeneration check (c), and fixed orifice (i) in arm 1 spool, and joins in bridge passage (S5-1).

From there, if load pressure of port (B) is increased, it flows through regeneration release valve piston (g) and pushes regeneration release spool (h), as a result area of variable orifice (f) is increased, and oil returning to tank (Ta) is increased, and some oil to regenerate in port (B5) is decreased.

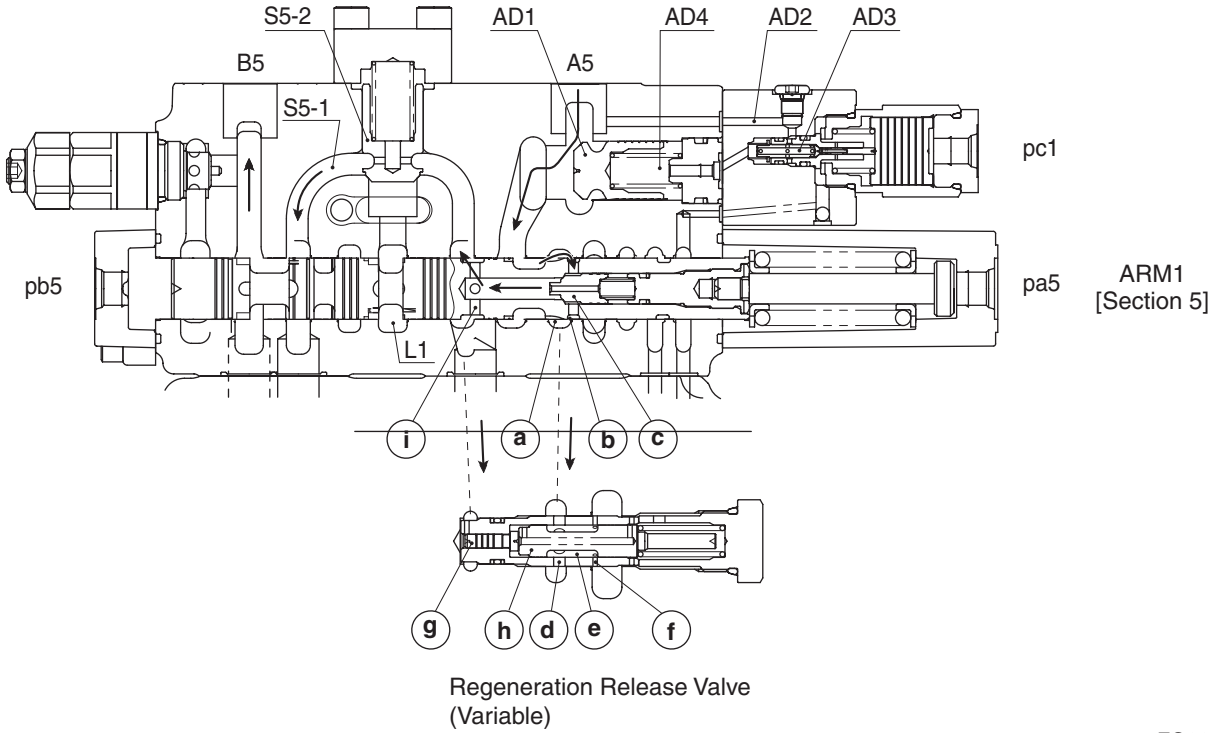


Figure 13

3. Arm out (2-pump confluence)

When arm 1 spool is shifted by increasing pressure of arm 1 (Section 5) pilot port (Pa5), oil supplied to port (P1) flows through neutral passage (L1), load check valve (S5-2), passage (S5-1) and spool and into port (A5).

Oil supplied to port (P2) flows through neutral passage (R1), load check valve (S9-2), passage (S9-1), spool and passage (8) and joins at port (A5). Return oil from port (B5) returns through spool to tank passage (Ta).

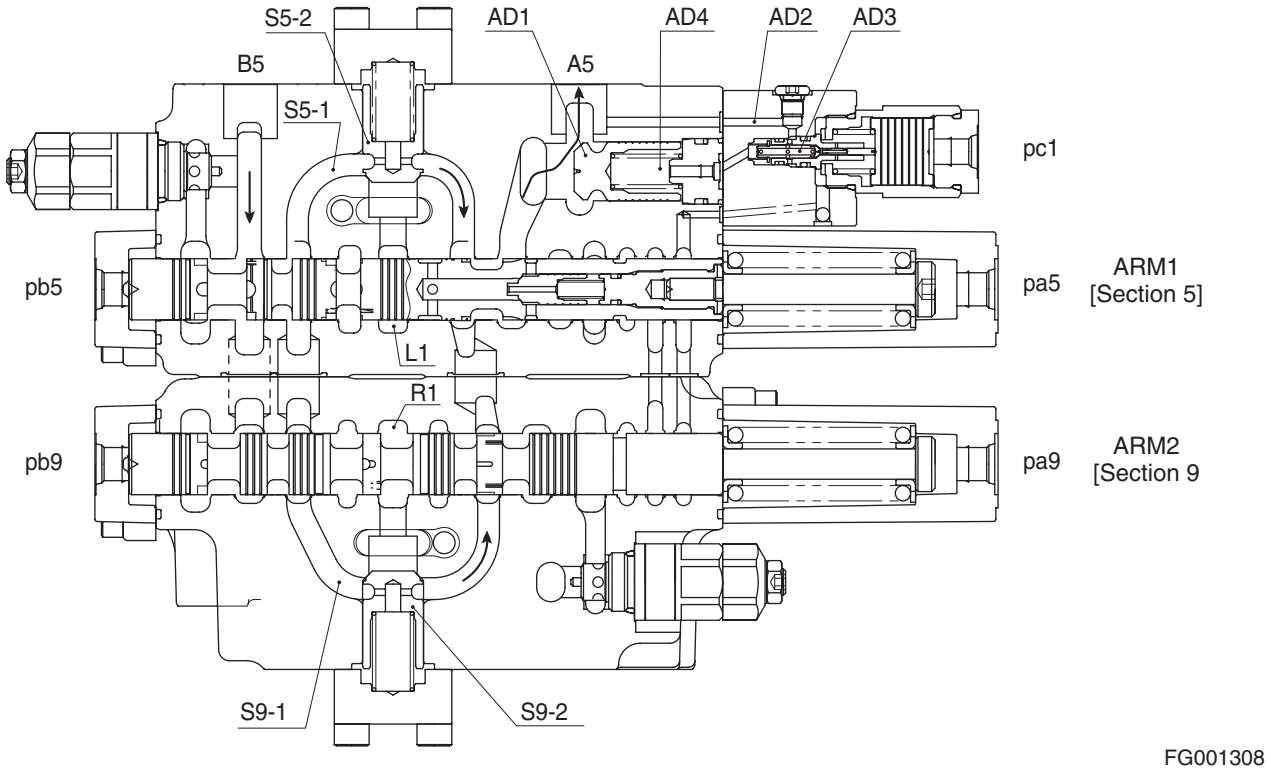
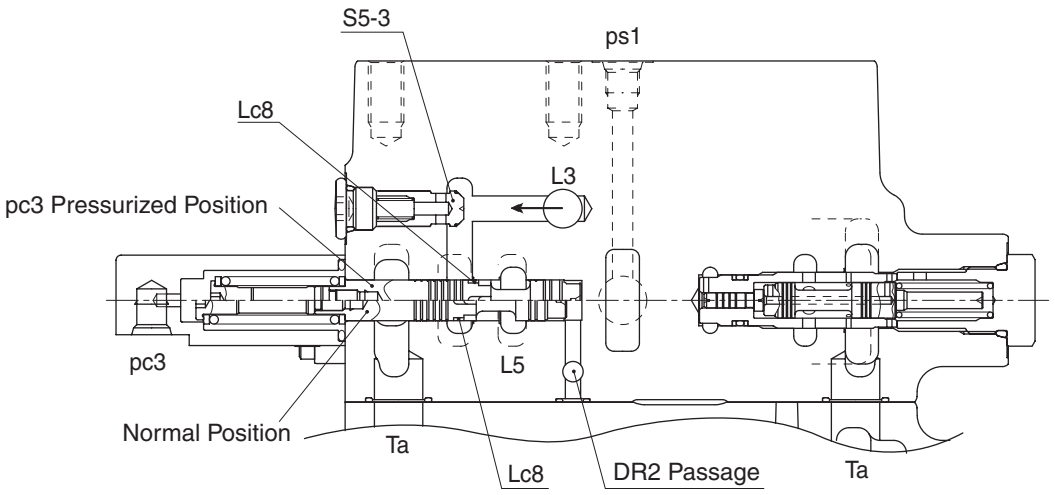


Figure 14

Parallel Orifice for Arm

The orifice, that is installed in parallel passage for arm 1, controls arm speed when operating in a combined operation. Oil supplied from parallel passage (L3) of arm 1 (Section 5) pushes open poppet (S5-3). It then flows through orifice (Lc8) of variable orifice spool, and then is connected to passage (L5). From here, flow of orifice (Lc8) can be varied by increasing or decreasing pressure against pilot poppet (Pc3).



FG001309

Figure 15

Relief Valve

1. Main relief valve

   Oil supplied to port (P1) flows through poppet (LP). Oil supplied to port (P2) flows through poppet (RP) and passage (3). They join at the main relief valve. The highest pressure of pump (P1 and P2) is controlled by reaction of main relief valve.

2. Overload relief valve

   The overload relief valve, that is installed in each cylinder port of boom 1, arm 1 and bucket, prevents pressure of actuator from increasing extremely high from outside forces. This relief valve, when pressure of cylinder port is negative, has a function to prevent cavitation by drawing oil from tank.

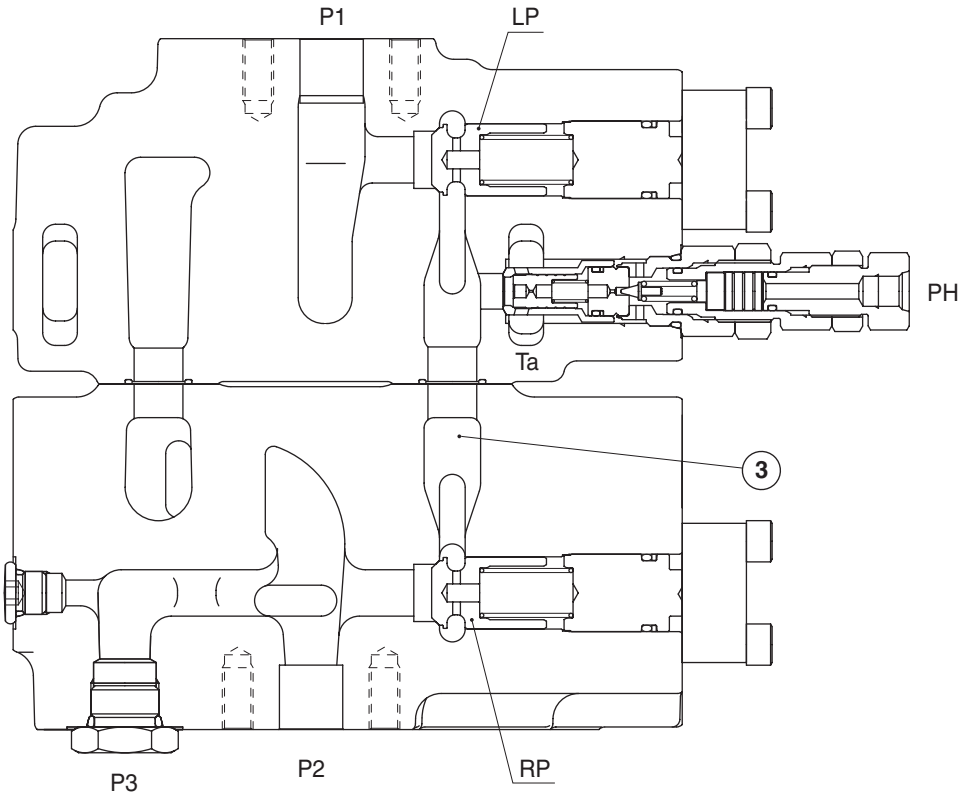


Figure 16

Travel Compound Operation

In the event of operating another function when the traveling left or right (when advancing, backing, or pivot turning) or operating for travel operation during the operation other than traveling, the oil supplied from the port (PP) is cut off from the tank passage (Ta) in the signal land part of the section other than the travel shifted from the land (Lc4, Lc7, Rc3 and Rc5), and the pressure of the signal passage is increased to the relief set pressure of the oil origin for signal.

Due to the increase of the signal pressure, the spool before traveling is shifted to cause an increase of pressure in ports (PT and PA).

When the straight travel spool is shifted, the oil supplied from port (P1) flows to travel (section1) from neutral passage (L1) while oil supplied to port (P2) flows into travel (section 6) after passing through passage (2), straight travel spool head, and neutral passage (R1) flowing into the parallel passage (L3) after passing the straight travel spool head, and passage (1).

In the event that load pressure of section other than traveling is higher than the travel (Section 6) load pressure, some of the oil supplied from port (P2) pushes and opens poppet (S6-2), and it merged into the passage (S6-1) after passing the orifice of the poppet.

The operation is made by oil supplied from travel (Section 1 and 6) port (P1), and work device other than traveling is operated by the oil supplied from the port (P2), and projection is prevented when operating with travel operation and other work device.

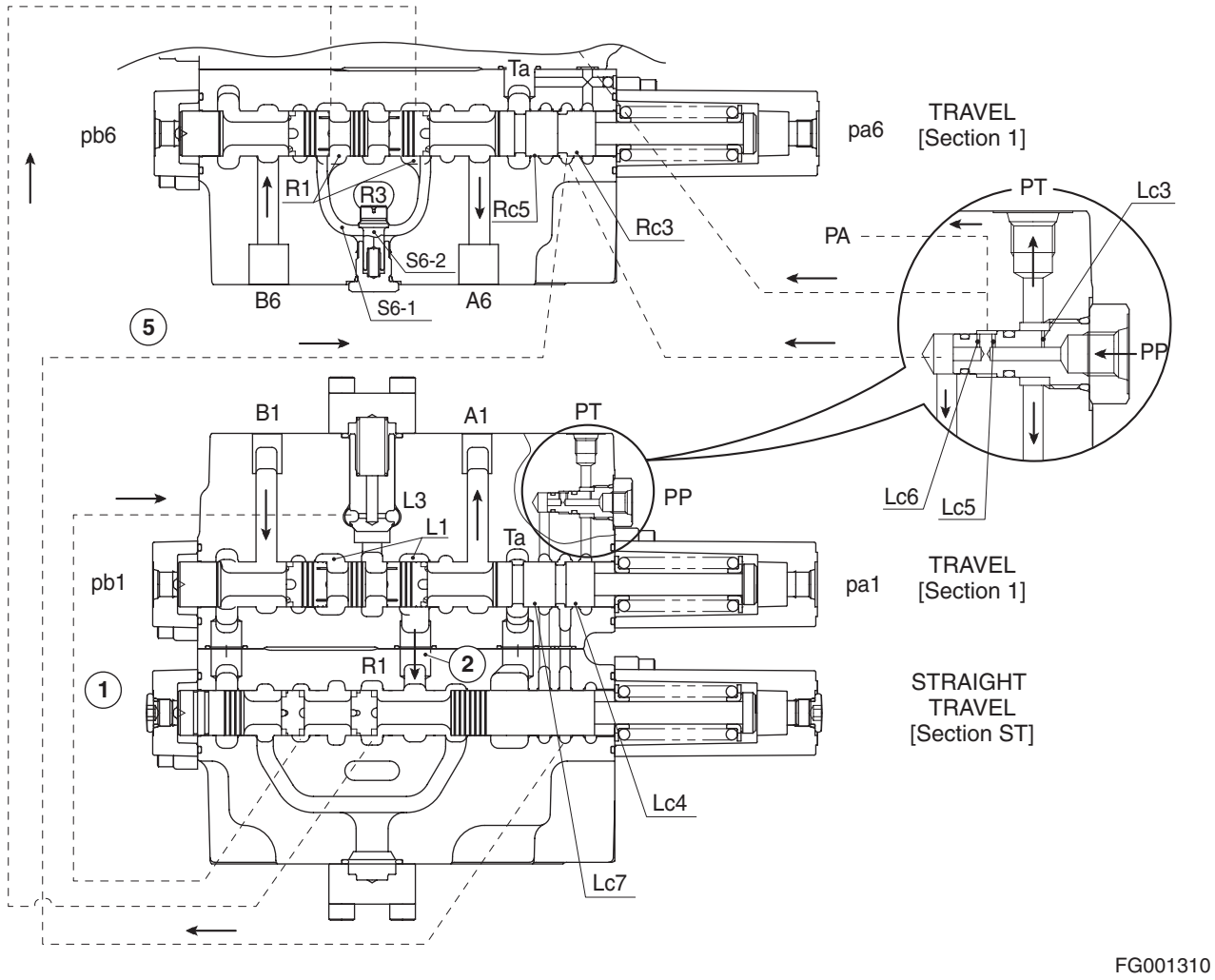

Ta
pb6
pa6
TRAVEL
[Section 1]
R1
R3
Rc5
Rc3
PT
Lc3
PA
S6-2
B6
S6-1
A6
5
PP
B1
A1
PT
L3
L1
Ta
PP
Lc6
Lc5
pb1
pa1
TRAVEL
[Section 1]
R1
2
1
STRAIGHT
TRAVEL
[Section ST]
Lc4
Lc7
FG001310

Figure 17

Bucket Compound Operation

A priority control valve is installed in bucket (Section 7). This valve controls oil flow entering bucket when operating during a combined operation with travel, boom 1, and arm 2 sections, on P2 side.

If pressure at port (Pi) is increased when operating bucket, piston (S7-6), piston (S7-5) and plug (S7-4) are pressed, and poppet assembly (S7-2) is seated on valve housing. This causes oil flowing from parallel passage (R3) to open poppet (S7-3) in poppet assembly and flow into passage (S7-1).

As a result, passage diameter is smaller during combined operation, than passage diameter during a single operation. This smaller passage reduces flow of oil to port (A7, B7). Remaining oil flows through parallel passage (R3) and primarily flows to section being operated at P2 side during a combine operating procedure.

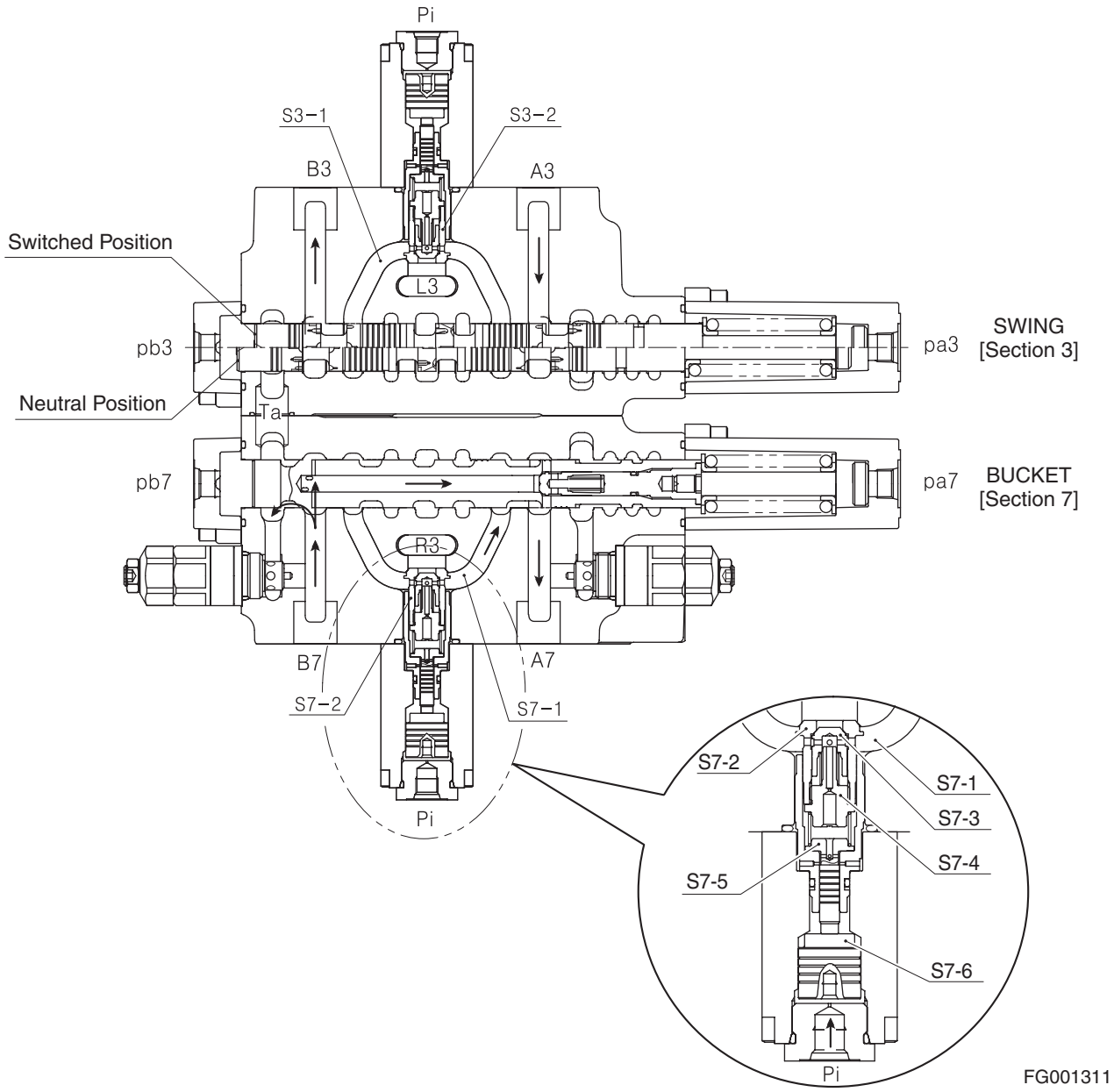

Pi
S3-1
S3-2
B3
A3
Switched Position
L3
pb3
pa3
SWING
[Section 3]
Neutral Position
Ta
pb7
pa7
BUCKET
[Section 7]
R3
B7
A7
S7-2
S7-1
Pi
S7-2
S7-1
S7-3
S7-4
S7-5
S7-6
Pi
FG001311

Figure 18

Swing Compound Operation

The valve's swing Section (Section 3) is equipped with the control valve that adjusts the flux that flows into the swing when combined operating with the Section (travel, boom 2, arm 1) of P1.

If port (Pi) is pressurized when operating swing function, piston (S3-6) is pushed to have the poppet assembly (S3-2) to be pressed under the seat part of the valve housing through the piston (S3-5) and plug (S3-4). In this way, the oil in the parallel passage (L3) is flowing into the passage (S3-1) by pushing up the poppet (S3-3) inside the poppet assembly.

As a result, the passage at the time of compound operation is tightened more than when single operation that the flux flowing into A3 (B3) is reduced, and the surplus flux is advanced to the section that P1 is simultaneously operated through the parallel passage (L3).

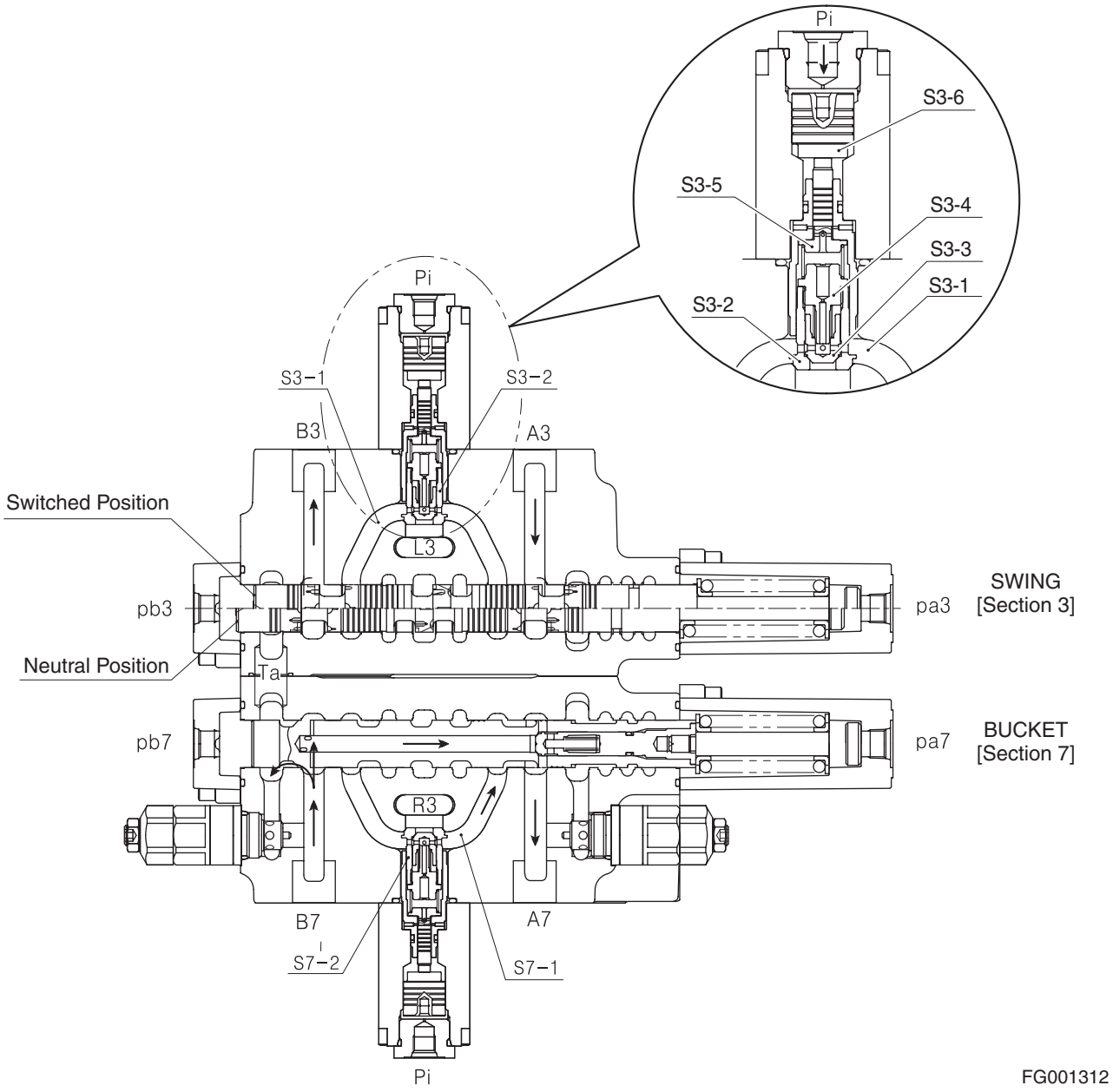

Pi
S3-6
S3-5
S3-4
S3-3
S3-1
S3-2
Pi
S3−1
S3−2
B3
A3
Switched Position
L3
pb3
pa3
SWING
[Section 3]
Neutral Position
Ta
pb7
pa7
BUCKET
[Section 7]
R3
B7
A7
S7−2
S7−1
Pi
FG001312

Figure 19

Antidrift Valve

The antidrift valve is installed on the cylinder port on the arm load (boom bore) for the natural antidrift of the arm (boom) cylinder. (For typical example, arm (A5) is shown.)

1. Neutral condition (maintaining port (A5))

   A. The holding pressure of port (A5) is sent through passages (a, b, and c), and into spring chamber (d) of poppet (1). At this time pressurized oil flow, from port (A5) is cut off by seats (S1 and S2).

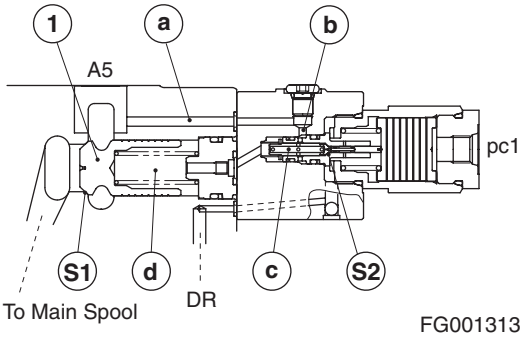


Figure 20

2. Oil passage cut off condition of the port (A5) and the spring chamber.

   A. If port pc1 is pressurized, piston (2) is moved and spool (3) reacts.

   B. Spool (3) activates poppet (4).

   C. Then by moving poppet (4), port (A5) and spring chamber (d) is cut off by part (T1).

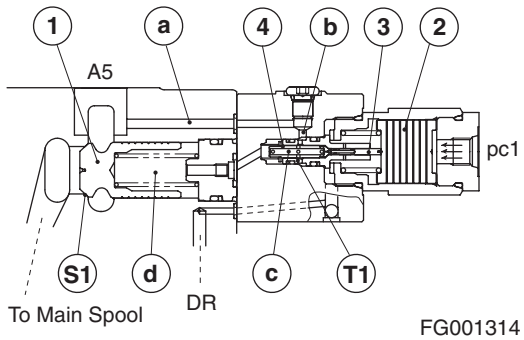


Figure 21

3. Main poppet operation condition.

   A. When the piston (2) starts, the spring chamber (d) passes from the passage (c) to the passage (e) and connect the oil passage by the part (T2) to the drain chamber (DR).

   B. The spring chamber (d) drains pressure and the main poppet (1) starts to unseat.

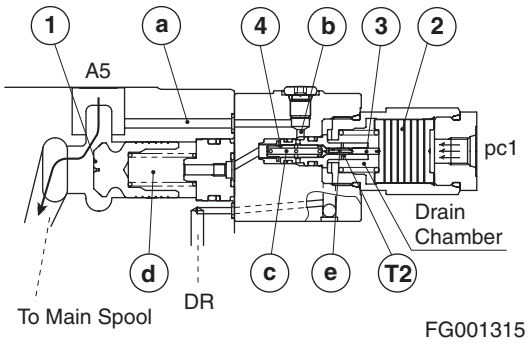


Figure 22

Main Relief Valve

1. The main relief valve is between neutral oil passage (HP, Figure 23) and low-pressure oil passage (LP). Pressurized oil flows into neutral oil passage (HP) through orifice in the main poppet (C) to fill internal cavity (D). Due to the difference in areas between (A and B), on which hydraulic pressure acts, main poppet (C) seats on sleeve (E).

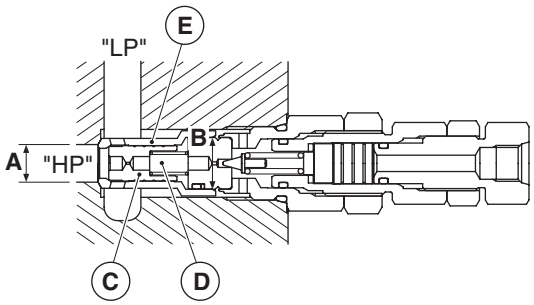


Figure 23

2. When pressure in neutral oil passage (HP) rises and exceeds relief valve setting, pilot poppet (F) opens. Pressurized oil flows through pilot poppet (F) into low-pressure oil passage (LP), passing through hole (G).

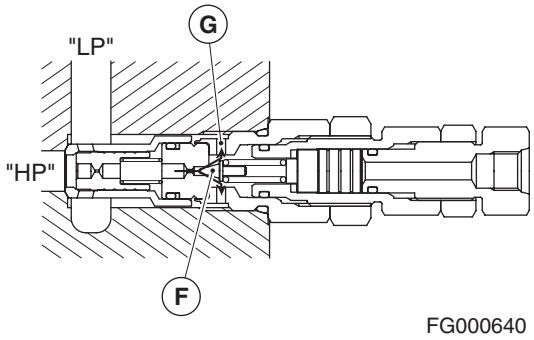


Figure 24

3. As pilot poppet (F) opens, pressure in internal cavity (D) lowers to move main poppet (C) so pressurized oil flows into neutral oil passage (HP) and directly into low-pressure oil passage (LP).

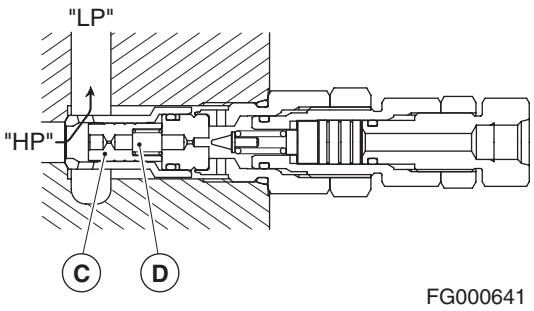


Figure 25

4. Pressure up operation

   If pressure is applied to pilot port "PH," piston (H) moves to the pressure setting position of plug (I) so the force of spring increases, thus increasing pressure in the neutral oil passage (HP).

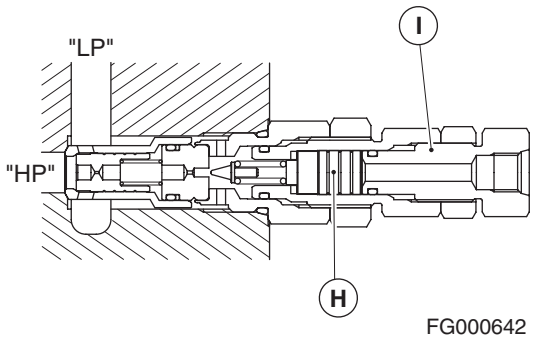


Figure 26

Overload Relief Valve

Operation

1. The overload relief valve is between cylinder port (HP) and low-pressure oil passage (LP). Pressurized oil at cylinder port (HP), flows through an orifice in piston (C), to fill internal cavity (G). Due to the difference in area between (A and B) on which the hydraulic pressure acts, main poppet (D) seats on sleeve (K).

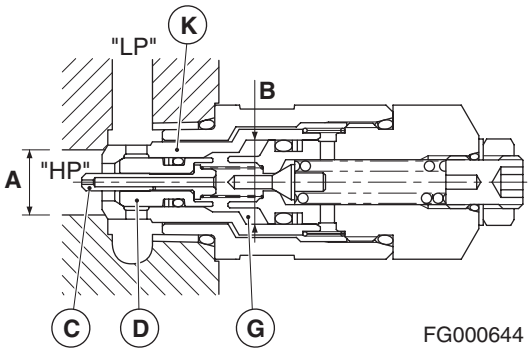


Figure 27

2. When pressure in cylinder port (HP) rises and exceeds the relief valve setting, pilot poppet (E) opens. Pressurized oil then flows through pilot poppet (E) into low-pressure oil passage (LP), passing through hole (H).

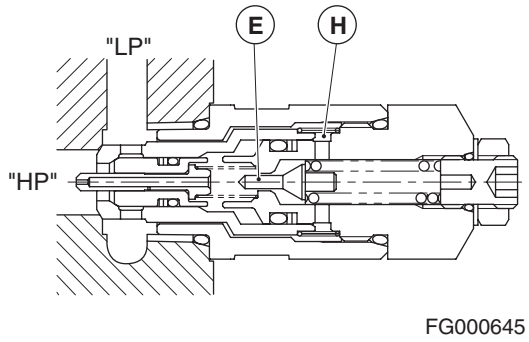


Figure 28

3. As pilot poppet (E) opens, pressurized oil flows through orifice (I) so pressure on back of piston (C) lowers to move piston (C). As a result, piston (C) seats on pilot poppet (E).

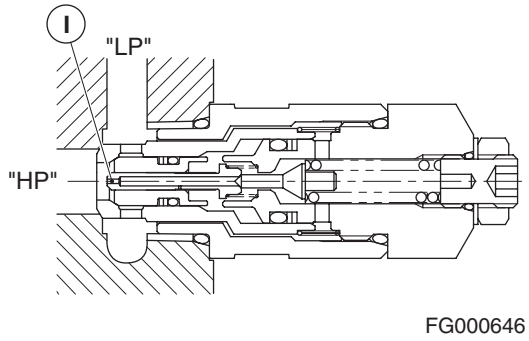


Figure 29

4. Pressurized oil in passage (HP) flows through orifice (F) in piston (C) so pressure on back of main poppet (D) moves main poppet (D). Pressurized oil then flows into passage (HP) and directly into passage (LP).

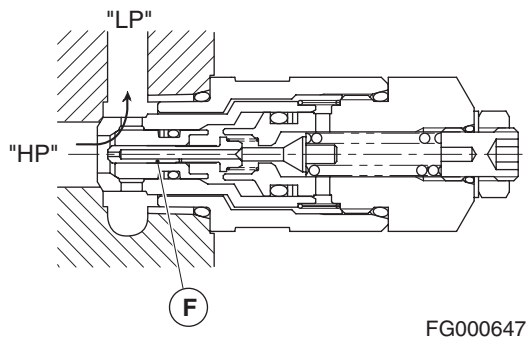
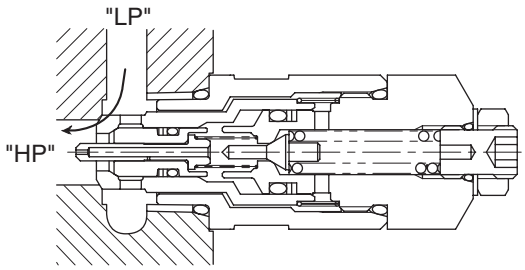


Figure 30

Absorption Operation

An anticavitation unit is installed in cylinder port (HP) to prevent the development of cavitation. If pressure at cylinder port (HP) becomes lower than that of oil passage (LP), sleeve (K) moves so oil is supplied from the low-pressure oil passage (LP) to cylinder port (HP) to eliminate cavitation.



FG000648

Figure 31

Low-pressure Relief Valve

1. Signal pressure

   Oil supplied from pump port (P1 (P2)) flows through neutral passage (L1 (R1)), low-pressure relief valve passage (L2 (R2)), and orifice (Lc1 (Rc1)) to tank passage (Ta).

   Now, pressure generated at passage (L2 (R2)) by orifice (Lc1 (Rc1)) moves to low-pressure relief signal port (Ps1 (Ps2)).

   If main spool of upper reaches of L2 (R2)) operates, signal pressure of Ps1 (Ps2) decreases because oil flowing to L2 (R2) decreases.

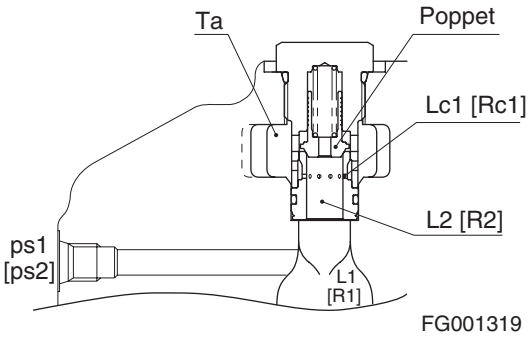


Figure 32

2. Operation of relief

   If excessive oil flows into passage (L2 (R2)), pressure generated at passage (L2 (R2)) by orifice (Lc1 (Rc1)) goes to back chamber of poppet, and poppet operates by the difference of pressurized area between passage and back chamber.

   By operation of this poppet, oil flows from passage through plug and drill hole to tank passage (Ta). By this action, generation of excessive pressure in low-pressure relief signal port is prevented.

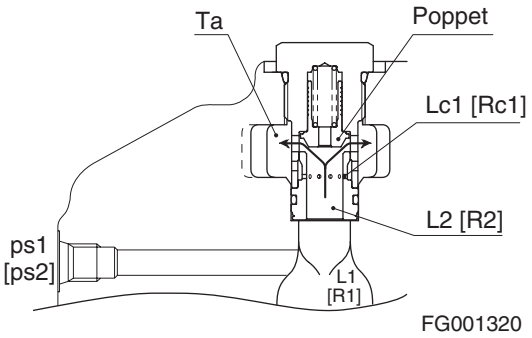


Figure 33

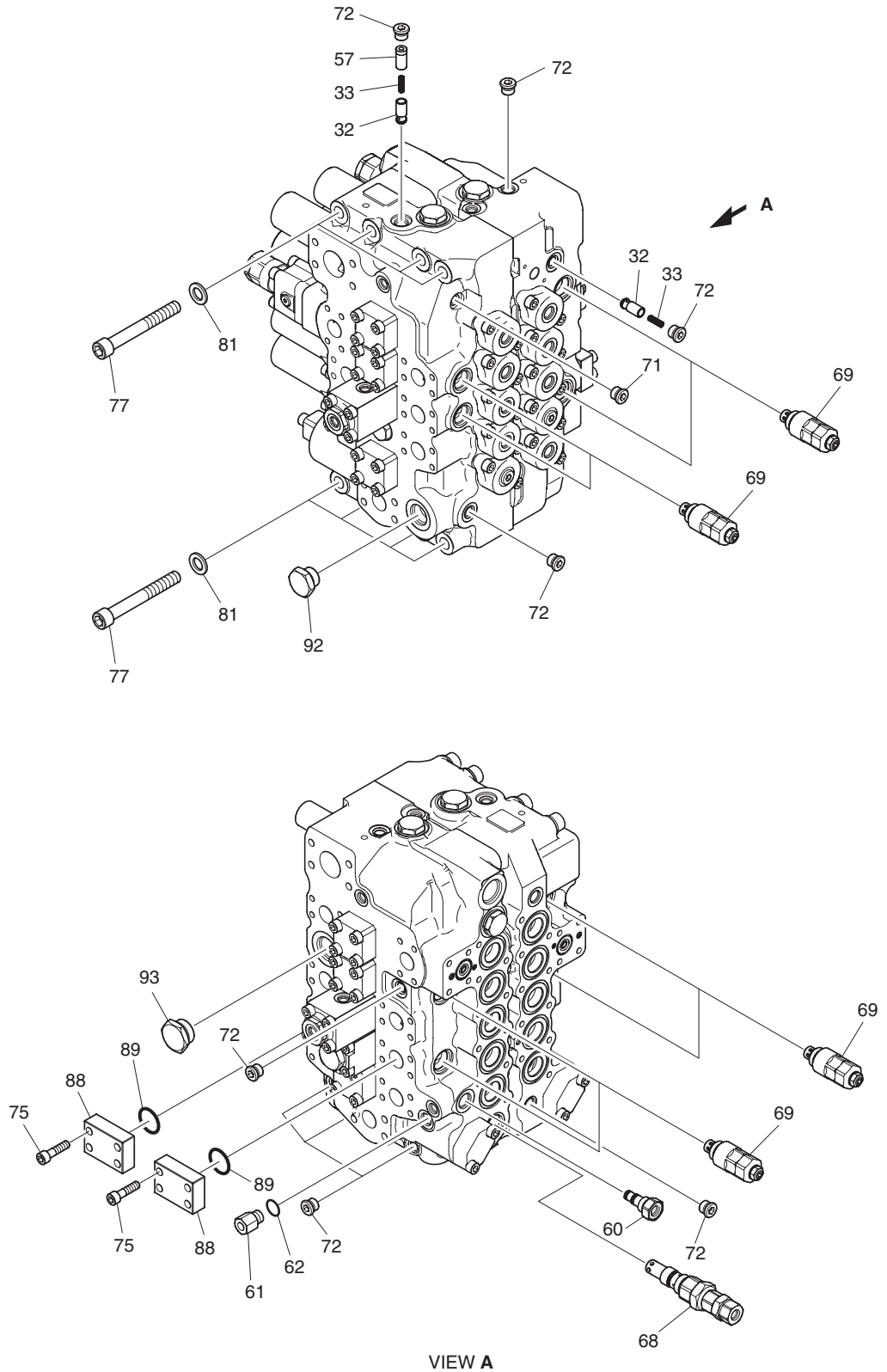

72
57
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A
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68
VIEW A
FG003962

Figure 34

Reference Number	Description
32	Poppet
33	Spring
57	Spacer
60	Plug Assembly
61	Plug
62	O-ring
68	Main Relief Valve
69	Overload Relief Valve
71	Plug Assembly

Reference Number	Description
72	Plug Assembly
75	Socket Bolt (M10 x40L)
77	Socket Bolt (M16 x130L)
81	Washer
88	Cap
89	O-ring
92	Plug Assembly
93	Plug Assembly

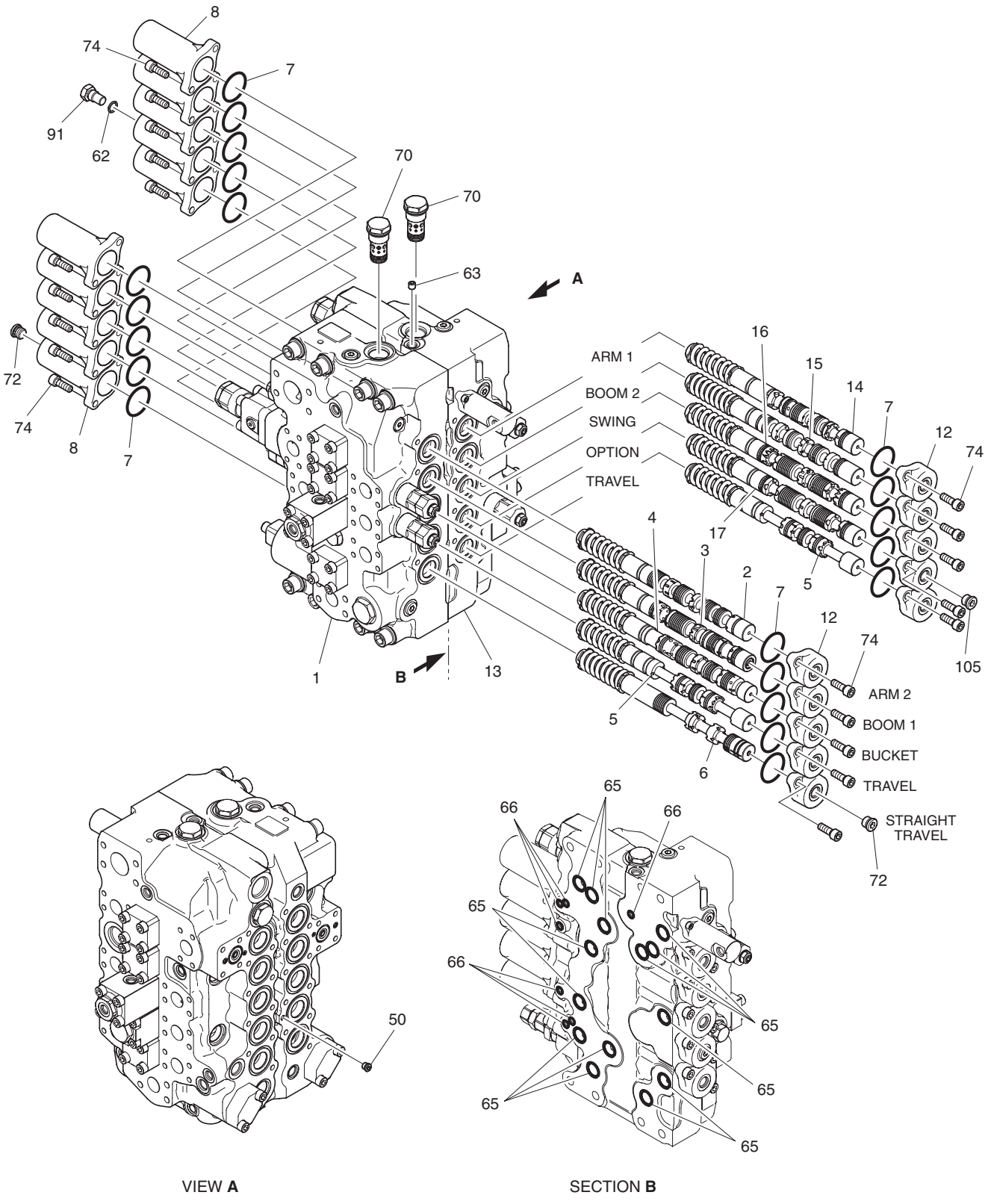

8
74
7
91
62
70
70
63
A
72
74
8
7
ARM 1
BOOM 2
SWING
OPTION
TRAVEL
16
15
14
7
12
74
17
4
3
2
7
5
12
74
105
1
B
13
5
ARM 2
BOOM 1
BUCKET
TRAVEL
STRAIGHT TRAVEL
6
72
65
66
66
65
66
65
65
65
65
65
50
VIEW A
SECTION B
FG003963

Figure 35

Reference Number	Description
1	Housing Valve
2	Arm Spool Assembly 2
3	Boom Spool Assembly 1
4	Bucket Spool Assembly
5	Travel Spool Assembly
6	T/S Spool Assembly
7	O-ring
8	Cap
12	Cap
13	Housing Valve
14	Arm Spool Assembly 1
15	Boom Spool Assembly 2

Reference Number	Description
16	Swing Spool Assembly
17	Option Spool Assembly
50	Plug
62	O-ring
63	Orifice Plug
65	O-ring
66	O-ring
70	Foot Relief Valve
72	Plug Assembly
74	Socket Bolt (M10x28L)
91	Plug
105	Plug Assembly

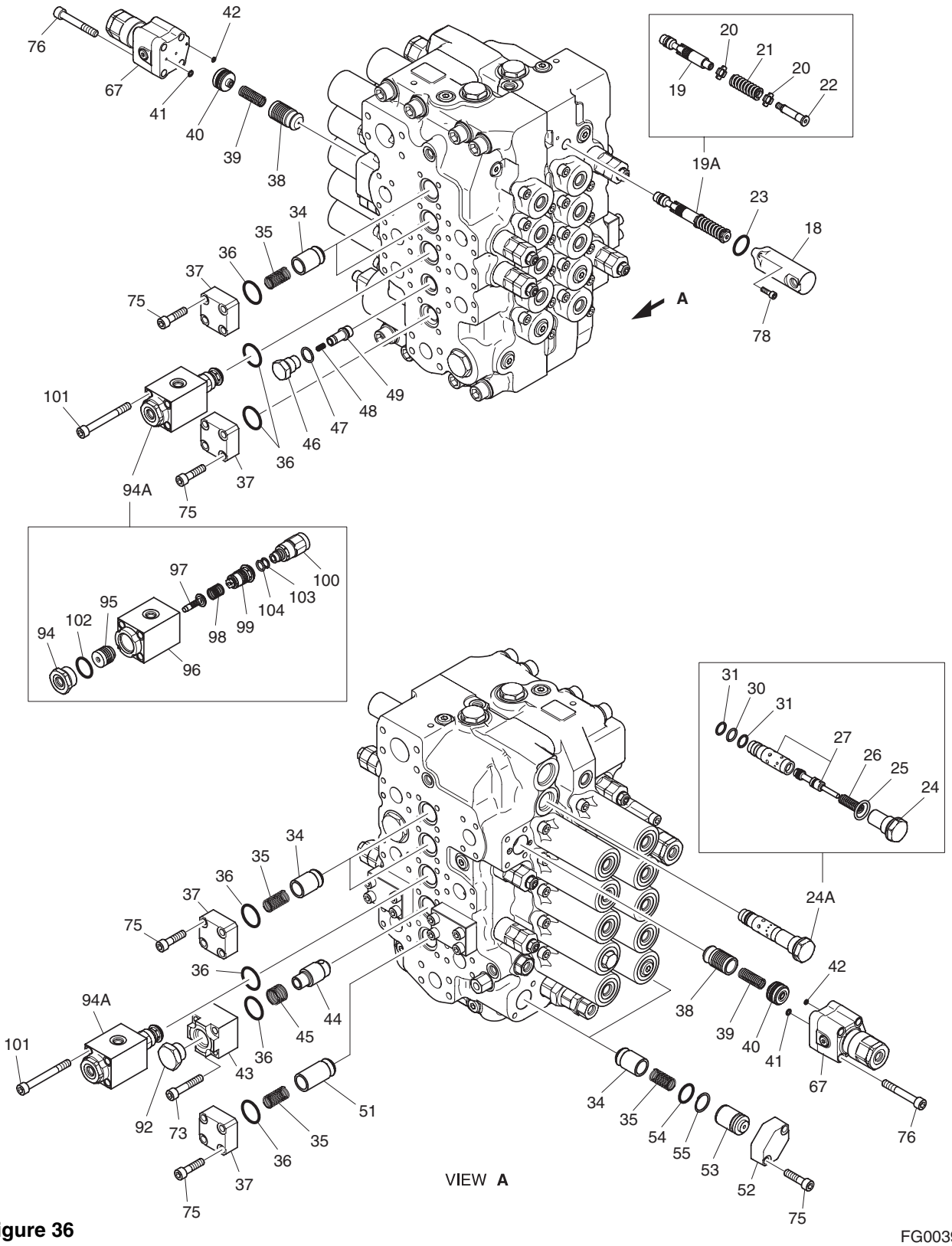


Figure 36

FG003964

Reference Number	Description
18	Cap
19A	SP Valve
19	Spool
20	Spring Seat
21	Spring
22	End Spool
23	O-ring
24A	Arm Regeneration Assembly
24	Plug
25	O-ring
26	Spring
27	Spool
30	O-ring
31	Backup Ring
34	Poppet
35	Spring
36	O-ring
37	Flange
38	Poppet
39	Spring
40	Spacer Assembly
41	O-ring
42	O-ring
43	Flange
44	Poppet
45	Spring
46	Plug

Reference Number	Description
47	O-ring
48	Spring
49	Poppet
51	Poppet
52	Flange
53	Spacer
54	O-ring
55	Backup Ring
67	Antidrift Valve Assembly
73	Socket Bolt (M10x55L)
75	Socket Bolt (M10x40L)
76	Socket Bolt (M10x70L)
78	Socket Bolt (M6x20L)
92	Plug Assembly
94A	Boom Priority Valve
94	Plug
95	Piston
96	Body
97	Piston
98	Spring
99	Sleeve
100	Poppet Assembly
102	O-ring
103	Backup Ring
104	O-ring
101	Socket Bolt (M10x90L)

Specifications

Rated flux: 270 lpm

However, 50lpm in neutral

Rated pressure: 34.3MPa

Permitted pressure: Max. pressure of 1.5MPa or less

Used pressure of 0.5MPa or less

Permitted use of oil temperature: Normally -20 - 80°C

Highest 100°C

(Use of the rubber for thread.)

TROUBLESHOOTING, TESTING AND ADJUSTMENT

Troubleshooting

Overall Control Valve

Problem	Possible Cause	Remedy
Spool does not move.	Oil temperature is abnormally increased.	Remove part with resistance of oil leakage within pipeline.
	Pollution of operation oil.	Replace operation oil and wash circuit at same time.
	Overly tighten pipe port joint.	Check Torque.
	Valve housing is skewed in loading.	Loosen and confirm loading bolt.
	Pressure is too high.	Check pressure of pump and cylinder port.
	Spool is bent.	Replace valve assembly.
	Return spring is damaged.	Replace damaged part.
	Spring or cap is not in line.	Loosen cap to release load.
	The temperature distribution in valve is inconsistent.	Warm up entire circuit.
	The valve is clogged by dust.	Remove (flushing) dust.
	The pilot pressure is insufficient.	Check pilot valve and pilot relief pressure.
Load is not maintained.	Oil is leaking from cylinder.	Check chamber part of cylinder.
	Oil is bypassed from spool.	Check groove of spool.
	Oil is leaking from overload relief valve.	Wash valve housing seat part and relief valve seat part.
	Oil is leaking from antidrift valve.	Disintegrate antidrift valve and wash seat part of each part. In event that there is grooves on seat part, replace poppet or wrap poppet and seat part. In event of having malfunction in antidrift valve spool, spool and sleeve make pair that both shall be replaced.
When spool is shifted to up position from neutral, load is dropped.	The load check valve has dust.	Disintegrate check valve and wash.
	The poppet or seat part of check value has groove.	Replace poppet or wrap poppet and seat part.

Relief Valve

Problem	Possible Cause	Remedy
Press does not increase.	Main poppet, sleeve or pilot poppet are stuck open and valve seat part has dust.	Replace relief valve.
Unstable relief pressure.	The seat part of pilot poppet has groove.	
	Piston or main poppet gets stuck.	
Abnormal relief pressure.	Abrasion of seat part by dust.	
	Locking screw and adjustment equipment are loosened.	Reset pressure and tighten locking screw with regular Torque.
Oil leakage.	Damage to relief valve seat part.	Replace relief valve.
	Each part is stuck with dust.	
	The O-ring is worn out.	Replace adjustment equipment or O-ring of loading part.

Overall Oil Pressure

Problem	Possible Cause	Remedy
Oil pressure condition is bad or not operate at all.	Breakdown of pump.	Check pressure or replace pump.
	Breakdown of relief valve.	Replace relief valve.
	Breakdown of cylinders.	Repair or replace.
	Pump load pressure is significant.	Check circuit pressure.
	Valve has crevice.	Replace valve assembly.
	Spool does not make full stroke.	Check operation of spool.
	Tank surface is too low.	Add operation oil.
	Filter in circuit is clogged.	Wash or replace filter.
	Circuit pipeline is tightened.	Check pipeline.

Adjustment of Valves

Main Relief Valve

1. Connect an accurate pressure gauge to inlet port.
2. Start engine and maintain rated pump speed.
3. Shift control valve spool and read pressure gauge from stroke end of cylinder.

   NOTE: *Shift a spool that the actuator pressure setting of the overload relief valve is higher than the pressure of the main relief valve.*

4. High-pressure adjustment (1st stage) (Refer to Figure 38 on page 54.)

   A. Loosen locknut (7) and tighten plug (8) until piston contacts step (* mark) of plug (6). Plug (8) should be torque below 2.0 kg•m (15 ft lb). While plug (8) is tightened, plug (6) should not be turned. Distance A (Figure 38 on page 54) must be more than 4.0 mm (0.16 in). Tighten locknut (7).

   B. Loosen locknut (4) and turn adjusting plug (6) clockwise to raise relief pressure of preceding step. Turn adjusting plug (6) counterclockwise to lower relief pressure. One turn varies pressure by approximately 28.4 MPa [9,290 kg•cm^2 (4,120 psi)]. Tighten locknut (4) after pressure has been adjusted.

5. Low-pressure adjustment (second stage)

   A. Loosen locknut (7) and turn adjusting plug (8) counterclockwise to lower relief pressure at state of 4. One turn varies pressure by approximately 21.3 MPa [217 kg•cm^2 (3,090 psi)]. Tighten locknut (7) after pressure has been adjusted.

6. Recheck pressure setting by raising pressure once more.

Overload Relief Valve

CAUTION!

If pressure of main relief valve is higher than the specified pressure for it, change main relief valve assembly setting without adjusting overload relief valve.

1. Shift control valve spool and read pressure gauge from stroke end of cylinder.
2. Loosen locknut (3) and turn adjusting plug clockwise to raise pressure. Item number (69: six places). One turn varies pressure by approximately 21.2 MPa [216 kg•cm^2 (3,075 psi)].
3. Tighten locknut (3) after pressure has been adjusted. Locknut (3) should be torque to 2.8 - 3.2 kg•m (20 - 23 ft lb).
4. Recheck pressure setting by raising pressure once more.

DISASSEMBLY

Caution in Disassembly

1. Shut down engine when pressure of actuator is not indicated.

   It is dangerous to disassemble control valve while it is under pressure. High-pressure oil can squirt out or components can spring out. When partially disassembling control valve that is on machine, be careful to follow the following caution.

CAUTION!

When disassembling assembly, when pressure is not fully released, or bucket is not lowered to ground, is very dangerous. A poppet in an antidrift valve may spring out and drop the bucket at the same time. Always lower bucket to ground and fully release pressure before disassembling.

2. Vent pressurized air from hydraulic oil tank.
3. Clean all exterior surfaces of valve before to disassembly and protect it from dirt and foreign materials.
4. Match mark the disassembled parts to make sure of proper reassembling position.
5. Replace all sealing parts such as O-rings and backup rings with a new ones.
6. Do not replace spools, they are matched with valve housing and sleeve.

   NOTE: *The further part numbers of an assembly part are shown as (assembly part number - further part number).*

Disassembly of Main Spool Part

1. Remove socket head bolt (74, two places on each section, width across flats: 8 mm) and cap (8, ten places).
2. Remove plug assembly (72, width across flats: 8 mm) and plug (91, width across flats: 22 mm) according to necessity.
3. Remove O-ring (7, one place on each section) from valve housing (1 and 13).
4. Remove all spool subassemblies from valve housing

CAUTION!

When removing spool, be careful not to damage it.

Attach label to each spool to install it in the correct position when reassembling.

5. Remove socket head bolt (74, two places on each section, width across flats: 8 mm) and cap (12, ten places).
6. Remove O-ring (7, one place on each section) from valve housing (1 and 13).
7. Disassembly of spool.

CAUTION!

Work with spool gripped in vise with wood (see Figure 37) so as not to scratch outside diameter of spool.

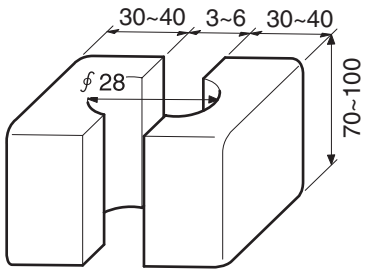
Because Loctite is applied to threaded portion of spool end, heat outside surface of spool with industrial drier to release Loctite.

Heat spool until spool end is easily loosened, and remove immediately after heating it to 200° - 250°C (392° - 482°F).°

If it is overheated, change spring to new one.

A. Remove spool end (width across flats: 8 mm), spring seat and spring from spool assembly (2-6 and 14-17).

NOTE: *There is a poppet, spring and plug in spool assembly. Do not disassemble unless absolutely necessary. If disassembly is necessary, heat spool outside surface to release Loctite in screw portion and remove plug. When reassembling, replace O-ring and backup ring to new ones.*



FG001316

Figure 37

Disassembly of Arm 1 Para-turn Spool Part

1. Remove socket head bolt (78, width across flats: 5 mm) and cap (18).
2. Remove O-ring (23) from cap (18).
3. Remove spool (19) from valve housing under subassembly conditions.
4. Disassembly of spool.

CAUTION!

Work with spool gripped in vise with wood (see Figure 37), so as not to scratch outside diameter of spool.

Because Loctite is applied to threaded portion of spool end, heat outside surface of spool with industrial drier to release Loctite.

Heat spool until spool end is easily loosened, and remove immediately after heating it to 200° - 250°C (392° - 482°F).

If it is overheated, replace spring with a new one.

A. Remove spool end (22, width across flats: 5 mm), spring seat (20) and spring (21) from spool (19).

Disassembly of Arm Regeneration Release Valve Part

NOTE: *The part including assembly is shown (assembly number -part number).*

CAUTION!

When removing a plug, when pressure is not fully released, or bucket is not lowered to ground, is very dangerous. A part in the valve may spring out and drop the bucket at the same time. Always lower bucket to ground and fully release pressure before disassembling.

1. Remove plug (24, width across flats: 32 mm) and O-ring (25).
2. Remove spring (26) and spool (27-1) from sleeve (27-2).
3. Remove sleeve (27-2) from valve housing.
4. Remove piston (27-3), O-ring (30) and backup ring (31) from sleeve (27-2).

CAUTION!

Removing a plug, when pressure is not fully released, or bucket is not lowered to ground, is very dangerous. A part in the valve may spring out and drop the bucket at the same time. Always lower bucket to ground and fully release pressure before disassembling.

1. Remove socket head bolt (75, four places on each section, width across flats: 8 mm) and flange (37, seven places).
2. Remove spring (35), poppet (34) (poppet (51)) and O-ring (36) from valve housing.

CAUTION!

Be careful, there is not a poppet and spring in travel straight valve section (Section H-H).

3. Remove socket head bolt (75, width across flats: 8 mm) and flange (52, two places).
4. Remove spacer (53) from valve housing. Remove O-ring (54) and backup ring (55) from spacer (53).
5. Remove spring (35) and poppet (34) from valve housing.
6. Remove plug (72, width across flats: 8 mm) (Section C-C).
7. Remove spring (33) and poppet (32) from valve housing.
8. Remove plug (72, width across flats: 8 mm) (Section L-L).
9. Remove spacer (57), spring (33) and poppet (32) from valve housing.
10. Remove plug (92, width across flats: 36 mm) (Section G-G).
11. Remove socket head bolt (73, four places, width across flats: 8 mm) and flange (43).
12. Remove spring (45), poppet (44) and O-ring (36) from valve housing.
13. Remove plug (46, width across flats: 27 mm) and O-ring (47).
14. Remove spring (48) and poppet (49) from valve housing.
15. Remove socket head bolt (101, four places, width across flats: 8 mm) from body (96, one places).
16. Remove body (96) from valve housing. Remove sleeve (99), piston (97), spring (98), poppet assembly (100), backup ring (103), and O-ring (104).
17. Remove O-ring (36).

18. Grip body (96) in vise. Remove plug (94), piston (95) and O-ring (102).

Disassembly of Antidrift Valve Part

NOTE: *The part including the assembly is shown (assembly number-part number).*

CAUTION!

Removing antidrift valve seat, when pressure is not fully released, or bucket is not lowered to ground, is very dangerous. A part in the valve may spring out and drop the bucket at the same time. Always lower bucket to ground and fully release pressure before disassembling.

1. Remove socket head bolt assembly (76, four places per section, width across flats: 8 mm) and antidrift valve assembly (67, two places).
2. Remove O-ring (41 and 42) from valve housing. Remove O-ring (40-4) from spacer assembly.
3. Screw socket head bolt (78, M6*1) into spacer, and remove spacer assembly (40) from valve housing.
4. Remove O-ring (40-2) and backup ring (40-3).
5. Remove spring (39) and poppet (38) from valve housing.
6. Disassembly of antidrift valve assembly

CAUTION!

Removing inner parts of antidrift valve, when pressure is not fully released, or bucket is not lowered to ground, is very dangerous. A part in the valve may spring out and drop the bucket at the same time. Always lower bucket to ground and fully release pressure before disassembling.

Slowly loosen plug assembly (67-14) and plug (67-3), check if there is a resistance by remaining pressure and remove.

A. Remove plug assembly (67-14, width across flats: 38 mm) and O-ring.

B. Remove piston (67-4), spool (67-5), and spring (67-7).

C. Remove plug (67-3, width across flats: 38 mm) and O-ring (67-13).

D. Remove sleeve (67-6) and poppet (67-2) from body. Remove O-ring (67-9 and 10) and backup ring (67-11 and 12) from outside diameter of sleeve.

E. Pull spring seat (67-16) and spring (67-8) out of inside hole.

F. Remove plug assembly (67-15) if necessary.

NOTE: *Do not remove steel ball (67-14) because it is pressed in body.*

Disassembly of Relief Valve

⚠ CAUTION!

Removing relief valve, when pressure is not fully released, or bucket is not lowered to ground, is very dangerous. A part in the valve may spring out and drop the bucket at the same time. Always lower bucket to ground and fully release pressure before disassembling.

Do not loosen adjusting plug for pressure setting or locknut.

Adjusting plug for pressure setting is dangerous because pressure setting will be changed which may result in a dangerous situation.

1. Remove overload relief valve (69, six places, width across flats: 32 mm).
2. Remove main relief valve (68, width across flats: 32 mm).
3. Remove relief valve assembly (70, two places, width across flats: 32 mm) and O-ring (70- 5 and 70-6).

Disassembly of Option Section Part

1. Remove socket head bolt (75, width across flats: 8 mm), cap (88, two places) and O-ring (89).

Disassembly of Other Plugs

1. Remove plug assembly (60, width across flats: 27 mm) and O-ring (Section J-J).
2. Remove plug (61, width across flats: 22 mm) and O-ring (62) (Section K-K).
3. Remove orifice plug (63, width across flats: 5 mm) (Section A1-A1).
4. Remove plug assembly (92, width across flats: 36 mm) and O-ring.
5. Remove plug assembly (71, width across flats: 6 mm) and O-ring.
6. Remove plug assembly (72, width across flats: 8 mm) and O-ring.

CAUTION!

Do not disassemble combined bolt (77) if it is unnecessary.

If it is necessary to disassemble it, work by placing it horizontally on a workbench.

Prepare spare O-ring (65 and 66).

1. Remove socket head bolt (77, eight places, width across flats: 14 mm) and washer (81, eight places).
2. Remove O-ring (65 and 66) from valve housing mating surface.

Disassembly of Main Relief Valve

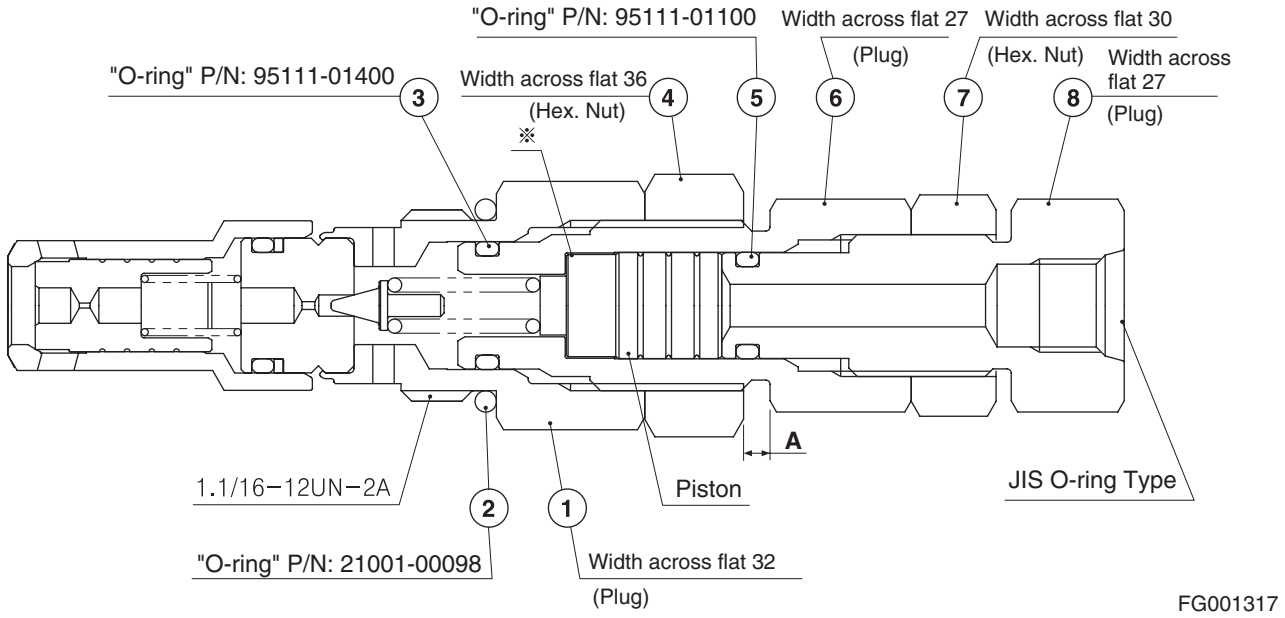


Figure 38

1. This relief valve should be replaced as an assembly. When replacing it, remove plug (1, width across flats: 32 mm), and O-ring (2). If oil is leaking from nut (4), remove nut (4) and plug (1), and replace O-ring (3). If oil is leaking from nut (7), remove nut (7) and plug (8), and replace O-ring (3).

Disassembly of Overload Relief Valve

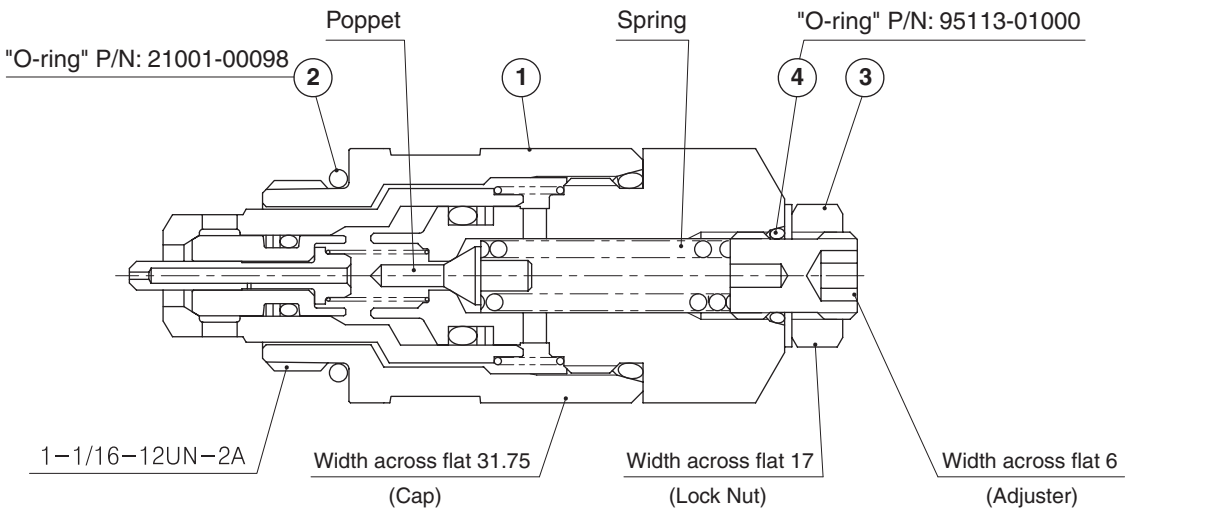


Figure 39

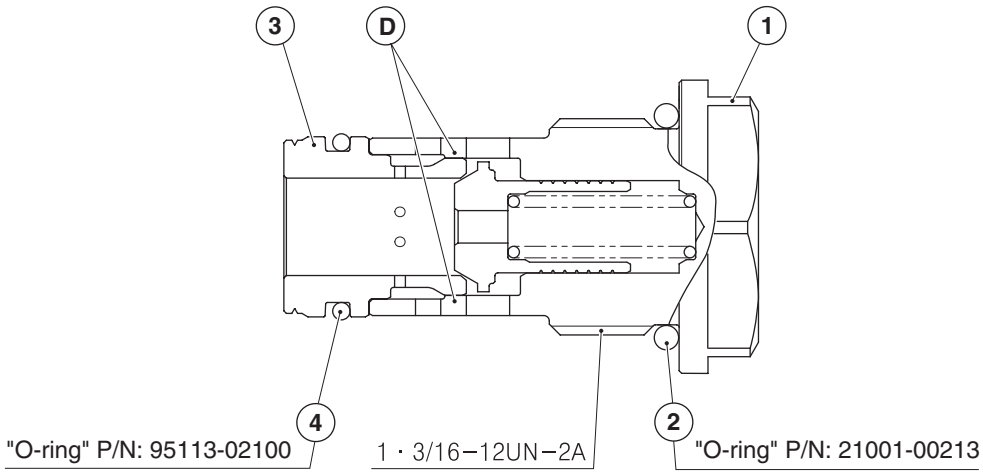
1. This relief valve should be replaced as an assembly. When replacing it, remove cap (1, width across flats: 32 mm) and O-ring (2). If oil is leaking from nut (4), remove nut (4) and plug (1), and replace O-ring (3). If oil is leaking from nut (7), remove nut (7) and plug (8), and replace O-ring (3).

   NOTE: *This relief valve should be replaced as an assembly. When replacing it, Remove cap (1, width across flats: 32 mm) and O-ring (2). If oil is leaking from adjusting kit (3), remove adjusting kit (3), and replace O-ring (4).*

CAUTION!

When disassembling adjuster kit, be careful not to let parts spring out or lose poppet because of spring force.

Instruction of Disassembly and Assembly of Low-pressure Relief Valve



FG007736

Figure 40

1. This unit has press fit portion (D) and it should be replaced as a complete assembly.

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

For general cleaning and inspection procedures, refer to "General Maintenance Procedures" section.

Cleaning

Clean all parts thoroughly using a suitable cleaning fluid and dry them with moisture free compressed air. Put them on a clean paper or a vinyl for inspection.

Inspection

Inspect all parts for scratches, notches and other defects.

1. Inspect load check seat surface of valve housing for scratches, scores, dirt, notches and corrosion. Remove small scratches with oilstone.
2. Inspect exterior surface of spool for scratches and notches. Remove small scratches with oilstone.
3. Sliding parts should be moved lightly and foreign materials should be removed in all grooves and passages.
4. Replace any springs that are damaged, heavy deformed or worn.
5. If relief valve malfunction, inspect it using relief valve maintenance procedure.
6. Replace all O-rings and backup rings with new.
7. After disassembling cap or plug, check whether there are paint chips around body hole or plug. If paint chips penetrate into valve, they can cause malfunction or valve to leak.

REASSEMBLY

Caution on Assembly

Caution on Handling O-ring

1. Do not use O-ring which has any defect or scratches from handling.
2. Apply grease or hydraulic oil to installation portion of O-ring grooves and O-ring to ease installation.
3. Do not stretch O-ring beyond permanent set.
4. When installing O-ring, be careful not to twist it. (A twisted O-ring, is very difficult to return to its original shape after installing it. This could also cause a leak.)

Caution on Handling Spool

1. Rated torque should be kept because over torque of screw portion, can cause a malfunction of spool.
2. Be careful that each spool, spring and spool end should be reassembled like before disassembling.

Method of Painting the Adhesives (screw part and arm screw part of parts requiring the adhesiveness)

NOTE: *Male and female screw threads of parts which need to adhere.*

CAUTION!

When working with Loctite, work in a place that is well ventilated.

1. Cleaning (removal of grease)

   Remove grease with steam, acetate, etc. or clean with an alkali cleanser.

2. Dry

   Dry Loctite surface with moisture free air or naturally. If it is not completely dried, the effect of Loctite is weakened.

3. Primer painting

   Slightly spray Loctite primer T effect promoter to Loctite surface and leave it for three or five minutes to dry.

4. Loctite application

   Lightly apply Loctite #274 or equivalent to two or three threads of spool female inlet. At this time, be careful not to touch coated part to spring seat.

Sequence of Subassembly

CAUTION!

Check number of each part, installation position and tools needed before reassembling.

Spool Assembly (Main Spool)

1. Apply Loctite to threaded portion of spool (2-6 and 14-17) and install spring seat, spring and spool end.
2. After gripping spool in vise with wood (that is used when disassembling it), tighten spool end. Tightening torque: 2.04 - 2.24 kg•m (15 - 16 ft lb).

CAUTION!

Be careful not to get Loctite into spool by over applying it.

Be careful that spool operation does become deteriorated by over torquing spool end.

When reassembling it and A56, be careful because there are two different types of springs.

Arm 1 Para-turn Spool Assembly

1. Apply Loctite to threaded portion of spool (19) and install spring seat (20), spring (21) and spool end (22).
2. After gripping spool in vise with wood (that is used when disassembling it), tighten spool end. Tightening torque: 1.94 - 2.24 kg•m (14 - 16 ft lb).

CAUTION!

Be careful not to get Loctite into spool by over applying it.

Be careful that spool operation does become deteriorated by over torquing spool end.

Antidrift Valve Assembly

1. Install O-ring (67-9 and 67-10) and backup ring (67-11 and 67-12) in groove of sleeve (67-6).

CAUTION!

Be careful of installation position of O-ring and backup ring.

If they are reversed, the O-ring will be damaged and drift speed of actuator can be increased.

2. Insert poppet (67-2) and spool (67-5) in sleeve hole.
3. Install spring seat (67-16) on small diameter of poppet end. Insert spring (67-8) and poppet assembly with sleeve into body (67-1).

CAUTION!

It Is better to apply grease to seat surface when installing spring and spring seat onto seat of poppet.

4. Install spring (67-7) and piston (67-4) in plug (67-3).
5. Tighten plug assembly (67-14) with O-ring installed on plug (67-3). Tightening torque: 15 - 16 kg•m (108 - 116 ft lb).
6. Install O-ring (67-13) on plug (67-3). Install it in body (67-1). Tightening torque: 15 - 16 kg•m (108 - 116 ft lb).
7. Tighten plug assembly (67-15) with O-ring in body (67-1). Tightening torque: 1.4 - 1.8 kg•m (10 - 13 ft lb).

Assembly Sequence of Main Body of the Control Valve

CAUTION!

When reassembling safety valve, securely tighten plug that is installed in body.

Do not loosen adjusting plug for pressure setting or locknut.

Adjusting plug for pressure setting is dangerous because pressure setting will be changed which may result in a dangerous situation.

Assembly of Relief Valve

1. Install main relief valve (68). Tightening torque: Tightening torque: 7.95 - 8.97 kg•m (58 - 65 ft lb).
2. Install overload relief valve (69, six places) in each section. Tightening torque: 7.95 - 8.97 kg•m (58 - 65 ft lb).
3. Install spring seat (67-16) on small diameter of poppet. Then insert spring (67-8) and them with sleeve to body (67-1). Tightening torque: 11 - 12 kg•m (76 - 83 ft lb).

Assembly of Load Check Valve

1. Install O-ring (36) on arm (1 and 2, section D-D), boom (1 and 2, section E-E) and swing section (Section F-F). Install poppet (34) and spring (35). Mount flange (37) and install socket head bolt (75). Tightening torque: 5.91 - 6.53 kg•m (43 - 47 ft lb).
2. Install O-ring (36) on travel section (Section H-H). Install poppet (51) and spring (35). Mount flange (37) and install socket head bolt (75). Tightening torque: 6 - 6.5 kg•m (43 - 47 ft lb).
3. Install O-ring (36) on travel straight section (Section H-H). Mount flange (37) and install socket head bolt (75). Tightening torque: 5.91 - 6.53 kg•m (43 - 47 ft lb).
4. Install poppet (51) and spring (35) in common (Section I-I). Insert spacer (53) with O-ring (54) and backup ring (55). Tightening torque: 3.98 - 4.49 kg•m (29 - 32 ft lb).

CAUTION!

Be careful of installation position of O-ring and backup ring.

If they are reversed, the O-ring will be damaged and an oil leak can occur.

5. Install O-ring (36) on option section (Section G-G). Install poppet (44) and spring (45). Mount flange (43) and install socket head bolt (96). Tightening torque: 6 - 6.5 kg•m (43 - 47 ft lb).
6. Tighten flange assembly (92) with O-ring. Tightening torque: 21 - 23 kg•m (151 - 167 ft lb).
7. Insert poppet (49) and spring (48) in travel section (Section G-G). Install plug (46) with O-ring (47). Tightening torque: 10.91 - 11.93 kg•m (79 - 86 ft lb).
8. Bucket section (Section F-F)
   A. Insert piston (95) and O-ring (102) on plug (94) and install in body (96). Tightening torque: 11 - 12 kg•m (76 - 83 ft lb).

B. Insert backup ring (103), O-ring (104), spring (98) and poppet assembly (100) in sleeve (99), and install it to body (96).

C. Install O-ring (36) in valve housing and fasten body using socket head bolt (101). Tightening torque: 5.91 - 6.53 kg•m (43 - 47 ft lb)

9. Insert poppet (32) and spring (33) in arm 1 para turn part (Section C-C). Install plug assembly (72) with O-ring. Tightening torque: 7.44 - 8.06 kg•m (54 - 58 ft lb).

10. Insert poppet (32), spring (33), and spacer (57) in arm 2 para turn part (Section L-L). Install plug assembly (72) with O-ring. Tightening torque: 7.44 - 8.06 kg•m (54 - 58 ft lb).

Assembly of Antidrift Valve

1. Install O-rings (41 and 42) on surfaces of antidrift valve assembly of arm 1 section (Section D-D) and boom 1 section (Section E-E).

2. Insert poppet (38) and spring (39). Install spacer assembly (40) with O-ring and backup ring.

CAUTION!

Be careful of installation position of O-ring and backup ring.

If they are reversed, the O-ring will be damaged and an oil leak can occur.

Check installing of O-ring (40-4) on spacer assembly and be careful of installation direction.

3. Install antidrift valve assembly (67, two places) and socket head bolt. Tightening torque: 3.98 - 4.49 kg•m (29 - 32 ft lb).

Assembly of Option Section Part

1. Install O-ring (89) on cap (88, two places) and fasten it in place with socket head bolt (75). Tightening torque: 5.91 - 6.53 kg•m (43 - 47 ft lb).

Assembly of Arm Regeneration Release Valve

1. Install O-ring (30) and backup ring (31, two places) on spool assembly (27).

2. Install piston (29) and spool (27) in sleeve. Insert sleeve in valve housing.

3. Install O-ring (25) on plug (27), insert spring (26) and install it in valve housing. Tightening torque: 11 - 12 kg•m (76 - 83 ft lb).

Assembly of Arm 1 Para-turn Spool

1. Install spool subassembly (19) into valve housing.

CAUTION!

After inserting spool, check to see if it slides easily.

2. Install O-ring (23) on cap (18) and fasten it in place with socket head bolt (78). Tightening torque: 0.90 - 1.10 kg•m (6.49 - 7.97 ft lb).

Assembly of Main Spool

1. Install O-ring (7, twenty places) on mating surface of valve housing cap.
2. Install spool of subassembly condition (2-6 and 14-17) in same positions that they were remove from during disassembly

CAUTION!

Align spool with hole and insert it slowly.

After inserting spool, check to see if it slides easily.

If spool is inserted when it is in a poor operating condition with a scratch, it can cause a malfunction of the spool.

3. Install cap (12, ten places) and fasten it in place with socket head bolt (74). Tightening torque: 3.98 - 4.49 kg•m (29 - 32 ft lb).
4. Install cap (8, ten places) and fasten it in place with socket head bolt (74). Tightening torque: 3.98 - 4.49 kg•m (29 - 32 ft lb).
5. Install O-ring on plug assembly (72) and tighten it to two sides of cap of travel straight section (Section H-H). Tightening torque: 3.98 - 4.49 kg•m (29 - 32 ft lb).
6. Install O-ring (62) on plug assembly (91) and install it on long cap of spare section (Section G-G). Install O-ring (62) on plug assembly (105). Install plug assembly on short cap of spare section (Section G-G). Tightening torque: 3.98 - 4.49 kg•m (29 - 32 ft lb).

CAUTION!

When tightening plug to cap, be careful not to over tighten. If it is over tighten, threads of cap can be damaged.

Assembly of Other Plugs

1. Install O-ring on plug assembly (60) and install. Tightening torque: 11 - 12 kg•m (76 - 83 ft lb)
2. Install O-ring (62) on plug assembly (61) and install. Tightening torque: 4 - 4.5 kg•m (29 - 32 ft lb)
3. Tighten orifice plug (63). Tightening torque: 1.4 - 1.8 kg•m (10 - 13 ft lb).
4. Install O-ring on plug assembly (92) and install. Tightening torque: 21 - 23 kg•m (151 - 167 ft lb).
5. Install O-ring on plug assembly (71) and install. Tightening torque: 1.4 - 1.8 kg•m (10 - 13 ft lb).
6. Install O-ring on plug assembly (72) and install. Tightening torque: 7.5 - 8 kg•m (54 - 58 ft lb)

Reassembly of Main Relief Valve

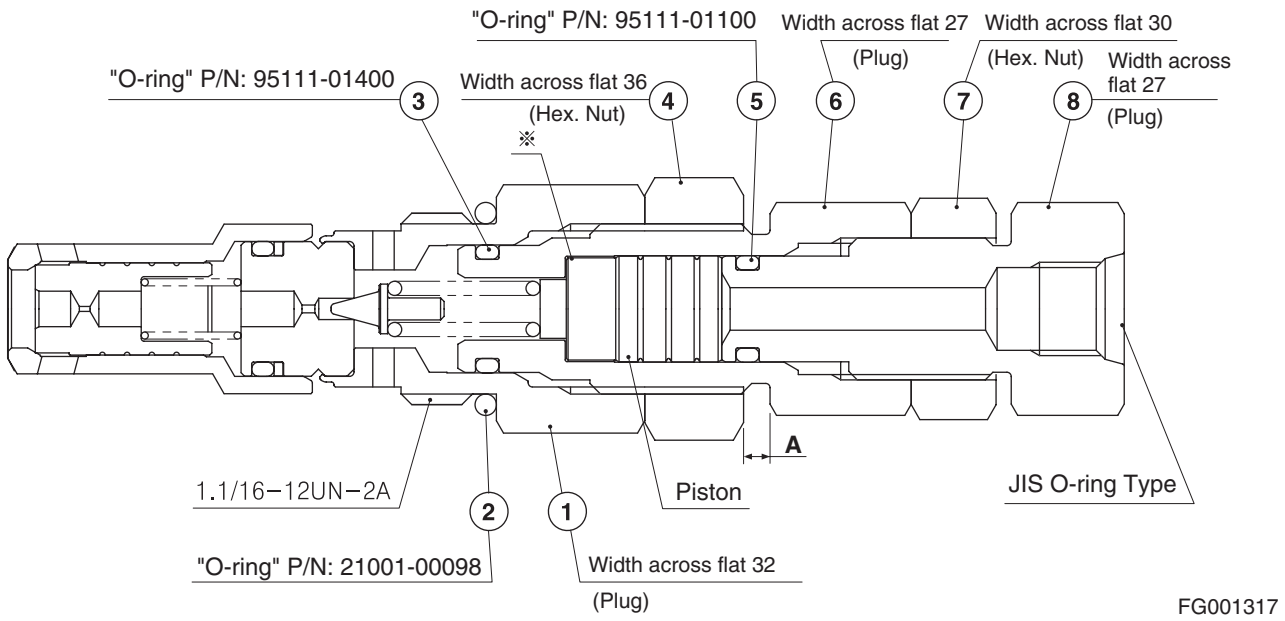


Figure 41

1. Check if there is dirt and paint chips around threads of plug (1, 6 and 8) and nut (4 and 7). Replace O-ring with new one. Clean installation portion of relief valve and valve housing. Install valve, and then tighten plug (1, width across flats: 32 mm). Tightening torque: 7.95 - 8.97 kg•m (58 - 65 ft lb).

   NOTE: *The torque values are based on use of lubricated threads.*

   NOTE: *If relief valve was disassembled, adjust pressure by referring to "Main Relief Valve" on page 1-45.*

Reassembly of Overload Relief Valve (69, Total of 6 Places)

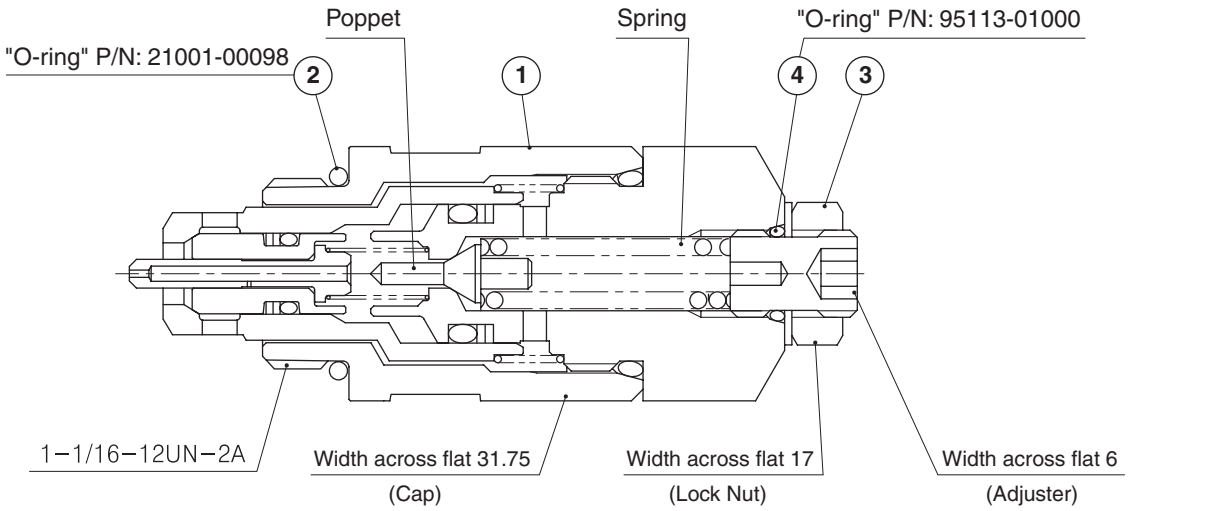


Figure 42

1. Check if there is dirt and paint chips around cap (1). Replace O-ring with new one. Clean installation portion of relief valve and valve housing. Install relief valve and tighten cap (1). Torque: 7.95 - 8.97 kg•m (58 - 65 ft lb).

   NOTE: *The torque values are based on use of lubricated threads.*

   NOTE: *If relief valve was disassembled, adjust pressure by referring to "Overload Relief Valve" on page 1-46.*

CAUTION!

In the event of disassembling the adjustment kit, be careful for popping out of parts by the spring or the loss of the poppet.

Reassembly of Low-pressure Relief Valve (70, Total of 2 Places)

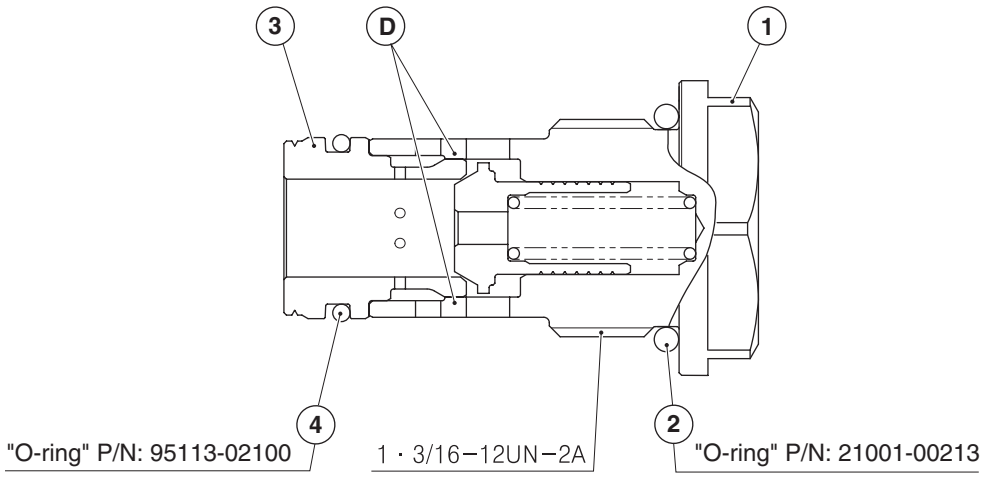


Figure 43

1. Check if there is dirt and paint chips around plug (1). Replace O-ring (3) with new one. Install new O-ring (4) on sleeve (2). Clean installation portion of relief valve and valve housing. Tighten plug (1, width across flats: 32 mm) of relief valve. Torque: 11 - 12 kg•m (76 - 83 ft lb).

   NOTE: *The torque values are based on use of lubricated threads.*

⚠ CAUTION!

The sources of all tightening torque is coating with the operation oil.

INSTALLATION

1. Be careful not to apply stress on control valve when attaching piping and hoses. Unnecessary stress may cause spools to bind and the control valve from functioning properly.
2. Tighten the assembling bolts alternately and evenly to the specified torque.
3. If welding procedures are being performed near the control valve, the valve could damaged by weld spatter and heat. Use adequate shielding to protect valve.
4. Valve ports should be covered with caps, plugs or tape to protect them from dust and other foreign materials, until pipe laying work is started.

START-UP PROCEDURES

1. Before operating machine, make sure that oil passages and hydraulic oil are clean.
2. Hydraulic oil of which annealing point is 82° - 113°C (180° - 235°F) should be used in the hydraulic system.
3. Relief valve pressure should not be raised above specified pressure setting.
4. The difference between main relief valve setting pressure and overload relief valve setting pressure should not be over 2.0 MPa [20.39 kg•cm^2 (290 psi)].
5. Before operating machine, the hydraulic system should be fully warmed up. If machine is operated with cold hydraulic oil and valve, be careful of the following, to prevent spool sticking because of heat shock.

   NOTE: *Do not operate main relief valve or overload relief valve suddenly and continuously. Cycle oil through all actuators and warmed up cold hydraulic oil in the lines and components uniformly.*

   NOTE: *Slight or compound work should not be suddenly operated at cold weather because heat is developed partly at all the orifices.*

Axle Piston Pump

Edition 1

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Axle Piston Pump

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MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up

PUMP MAINTENANCE

Component Locations

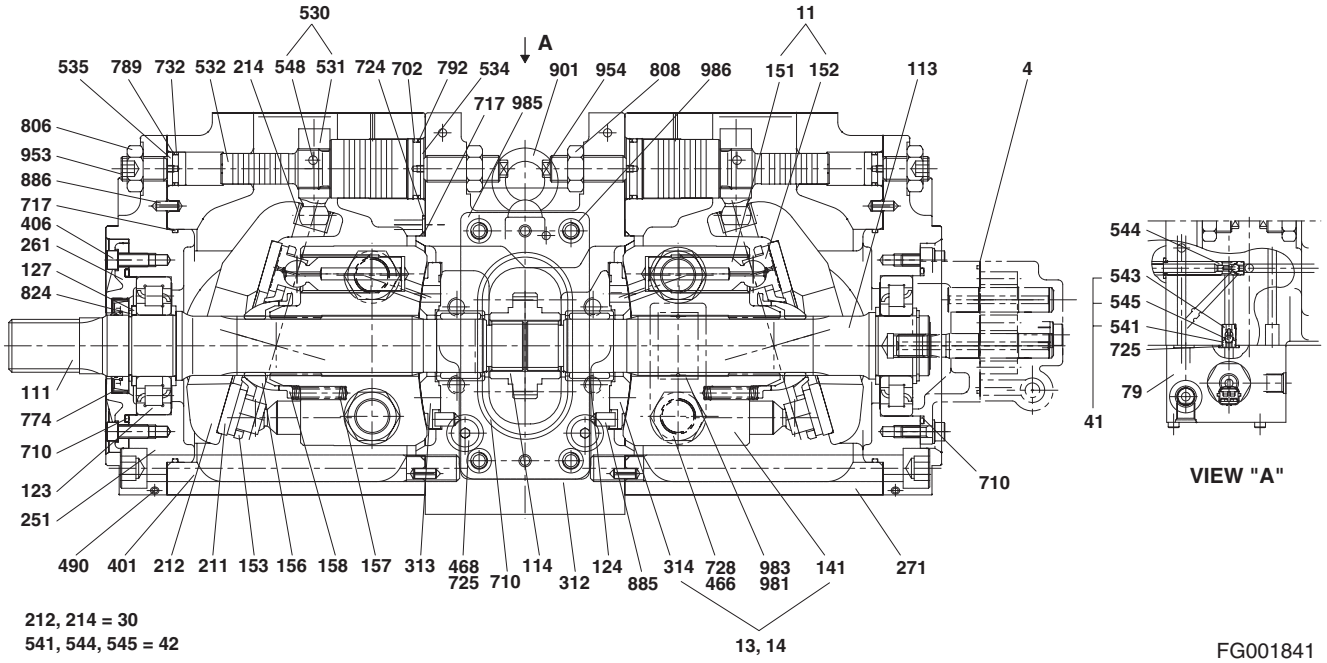


Figure 1

No.	Parts
11	Piston and Shoe Assembly
13	Cylinder Block and Valve (R)
14	Cylinder Block and Valve (L)
30	Swash Plate Assembly
41	Check 1 Assembly
42	Check 2 Assembly
79	Professional Valve
111	Driveshaft
113	Driveshaft
114	Gear
123	Roller Bearing
124	Spacer Bearing
127	Bearing Spacer
153	Push Plate
156	Flexible Bushing
157	Cylinder Spring
158	Spacer
211	Shoe Plate
250	Support Kit
251	Support
261	Seal Cover
271	Pump Casing
312	Valve Block
401	Socket Bolt
406	Socket Bolt
466	Plug

No.	Parts
468	Plug
490	Expander
530	Tilted Pin Assembly
532	Piston
534	Stopper
535	Stopper
702	O-ring
710	O-ring
717	O-ring
724	O-ring
725	O-ring
723	O-ring
732	O-ring
774	Oil Seal
789	Backup Ring
792	Backup Ring
806	Nut
808	Nut
824	Retaining Ring
885	Pin
886	Spring Pin
901	Eyebolt
953	Set Screw
954	Adjustment Screw
985	Cover
986	Socket Bolt

Parts List

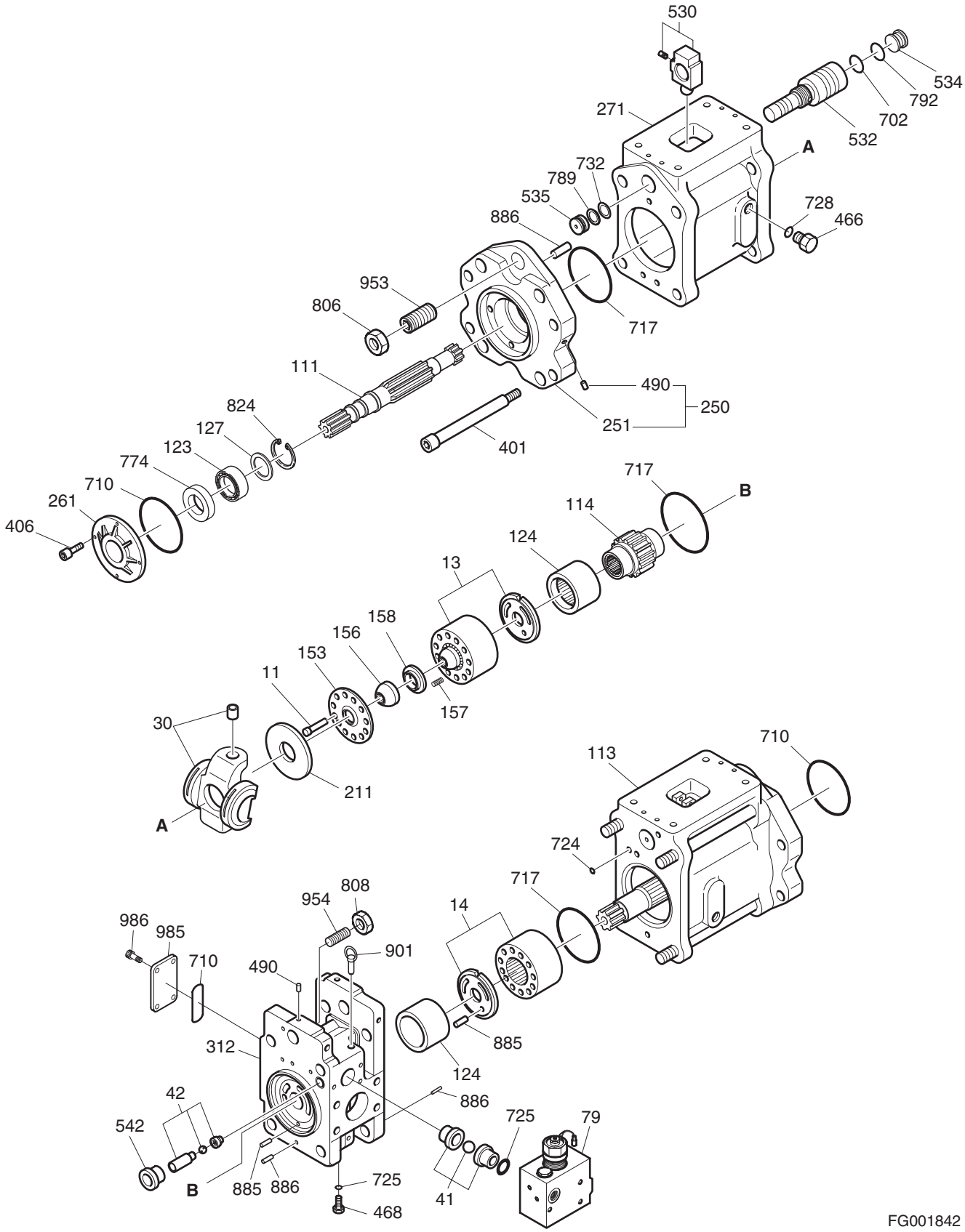


Figure 2

Tools

The following table contains tools required for the disassembly and reassembly of the T5V pump.

Each type of pump uses different bolts and plugs.

Tools and Sizes		Necessary tools marked 0		Parts			
		Pump Types					
Tools	**B**	**T5V 80**	**T5V 112**	**Socket Bolts**	**PT Plugs (NPTF Screws)**	**PF Plugs**	**Adjustment Screws**
Hex Wrench	4	O	O	M5	BP-1/16		M8
	5	O	O	M6	BP-1/8		M10
	6	O	O	M8	BP-1/4	PF-1/4	M12, M14
	8	O	O	M10	BP-3/8	PF-3/8	M16, M18
	10			M12	BP-1/2	PF-1/2	M20
	14	O		M16,M18	BP-3/4	PF-3/4	
	17		O	M20,M22	BP-1	PF-1,1 1/4,1 1/2	
Socket Wrench	19	O	O	M12		VP-1/4	
	22	O				VP-3/8	
	24	O	O	M16			
	27	O		M18		VP-1/2	
	30		O	M20			
	36		O	M5		VP-3/4	
Monkey Wrench		O	O	1, mid-size			
Driver		O	O	2, - type, mid-size			
Hammer		O	O	1, plastic			
Flyer		O	O	TSR-160 for stop ring			
Steel Rod		O	O	Key grade steel rod, about 10 x 8 x 200			
Torque Wrench		O	O	Suitable for specified torques			

Tightening Torque

Parts	Sizes	Tightening Torque (kg•m)	Tools	
			Size (mm)	Names
Socket Bolts (Quality: SCL435)	M5	0.7	B=4	 Hex Wrench
	M6	1.2	5	
	M8	3	6	
	M10	5.8	8	
	M12	10	10	
	M14	16	12	
	M16	24	14	
	M18	34	14	
	M20	44	17	
PT Plugs (Quality: S45C). Wrap thread tape 1.5-2 times.	PT 1/16	0.9	4	Hex Wrench
	PT 1/8	1.05	5	
	PT 1/4	1.75	6	
	PT 3/8	3.5	8	
	PT 1/2	5.0	10	
PF Plugs (Quality: S45C)	PF 1/4	3.0	6	Hex Wrench
	PF 1/2	10	10	
	PF 3/4	15	14	
	PF 1	19	17	
	PF 1 1/4•	27	17	
	PF 1 1/2	28	17	

DISASSEMBLY

Read this Disassembly instructions thoroughly before starting to disassemble the pump, and follow the procedures below.

Numbers in the parentheses following the parts indicate the reference numbers in the next pump figures.

1. Select a place to disassemble the pump.

CAUTION!

1. The place should be clean.

2. Put a rubber sheet of cloth on the floor to prevent any damage to parts

2. Remove dust or rust on the surface of the pump using lubricating oil.

3. Remove drain plug (468) to drain hydraulic oil in the pump casing.

CAUTION!

Drain the oil from both the front and the rear pumps.

4. Remove socket bolts (412, 413) to disassemble the regulator and PTO.

CAUTION!

1. Refer to the regulator manual for its disassembly.

2. Refer to the PTO manual for its disassembly.

5. Loosen socket bolts (401) retaining swash plate support (251), pump casing (271), and valve block (312).

CAUTION!

Gear pump and other parts, if attached to the rear side of the pump, should be removed before continuing this procedure.

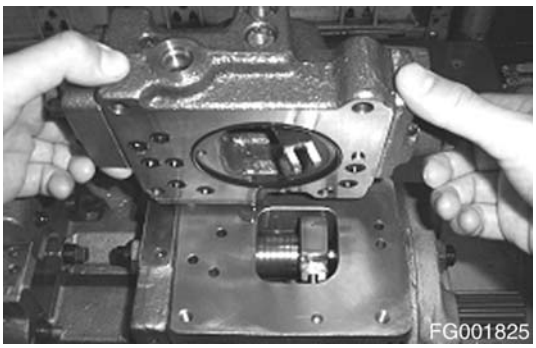


Figure 3

6. Put the pump flat on the working die with its regulator connection part facing downward and remove pump casing (271) and valve block (312).

CAUTION!

1. Always put a rubber sheet or similar item on the working die to prevent any damage to the regulator connection part facing downward.

2. When removing pump casing and valve block, remove the gear #1 too.



Figure 4

7. Take out cylinder block (141) from pump casing (271) while keeping it perpendicular to driveshaft (111) along with piston (151), push plate (153), flexible bushing (156), and cylinder spring (157).

CAUTION!

Be careful not to damage sliding parts of cylinder block, flexible bushing, shoe, and swash plate.

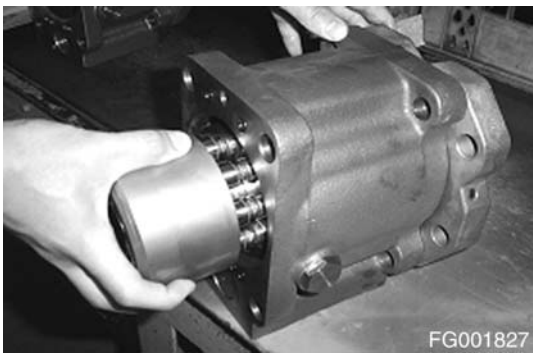


Figure 5

8. Unscrew socket bolt (406) to remove seal cover (F)(261).

CAUTION!

1. You can remove seal cover (F)(261) easily by inserting a bolt in its hole (M6 screw) and taking it out.

2. Be careful not to damage oil seal installed in seal cover (F) when removing it.

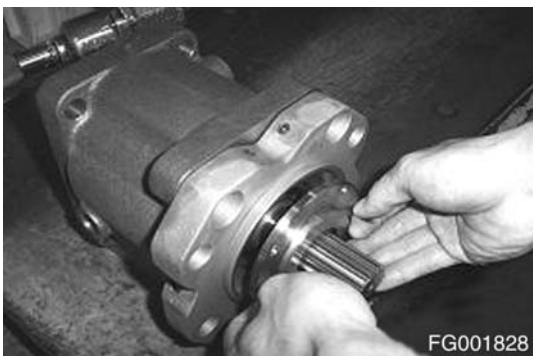


Figure 6

9. Unscrew hex bolt (408) and remove rear cover (263).

10. Disengage swash plate (251) from pump casing (271) by gently knocking the connecting flange part of swash plate at the shaft of pump casing with plastic hammer.

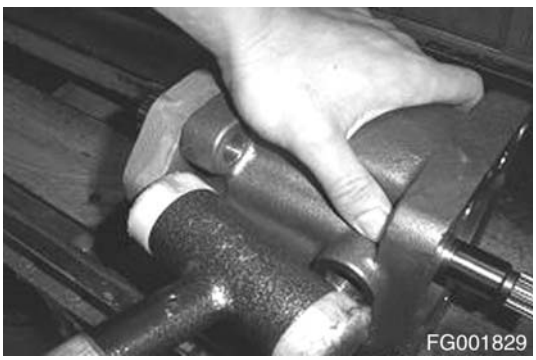


Figure 7

11. Remove shoe plate (211) and swash plate (212) from pump casing (271).

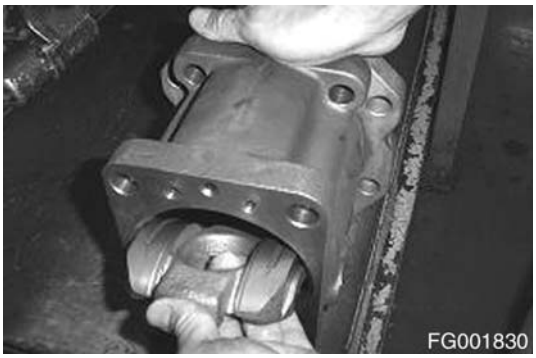


Figure 8

12. Remove driveshaft from the swash plate support by gently knocking the end of driveshafts (111, 113) with plastic hammer.

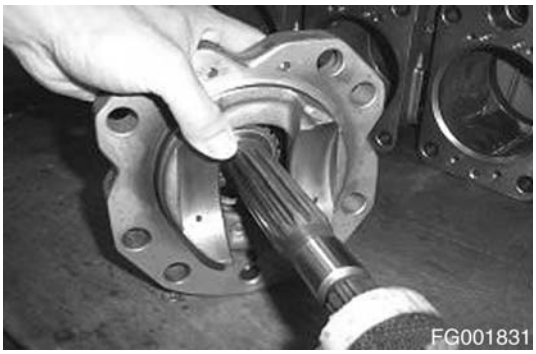


Figure 9

13. Remove valve block (312) from valve plates (313, 314).

⚠ CAUTION!

Sometimes this procedure may not be necessary.

14. If necessary, remove stopper (L)(534), stopper (S)(535), servo piston (532), and tilting pin (531) from pump casing (271) and needle bearing (124) and spool line coupling (114) from valve block (312).

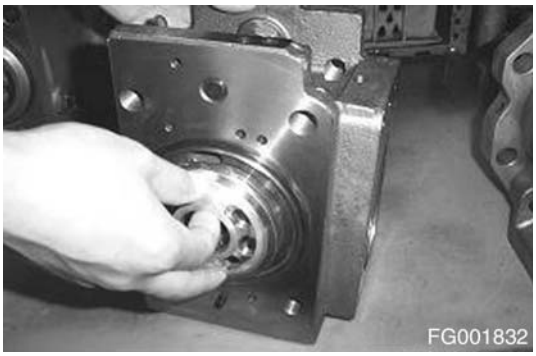


Figure 10

⚠ CAUTION!

1. **Use a proper tool when removing tilting pin to prevent any damage to its head.**
2. **Be careful not to damage servo piston, for the inserting area of tilting pin and servo piston is applied Loctite.**
3. **Do not remove needle bearing up to its life, if possible practically.**
4. **Do not unscrew hex nut (808) of the swash plate support, valve bloc, or setting value of oil volume may change.**

REASSEMBLY

Reassembly shall be done in the reverse order of disassembly, but with cautions for:

1. Repair any parts damaged during disassembly and have spare parts at hand.
2. Wash each part sufficiently with lubricating oil and dry them with compressed air before their reassembly.
3. Always apply clean lubricating oil to sliding parts and bearing before their reassembly.
4. Make it a rule to replace O-rings and oil seals.
5. Tighten fixing bolts and plugs with proper torque wrenches and with torques specified in the Maintenance Standards.
6. For the tandem pump, take care not to mix parts of the front and the rear pumps.
7. Install swash plate support (251) in pump casing (271) by gently knocking it with plastic hammer.

⚠ CAUTION!

1. Insert removed servo piston, tilting pin, stopper (L), and stopper (S) in pump casing first.

2. Use a proper tool to connect servo piston and tilting pin to prevent any damage to the head of tilting pin or feedback pin. Apply Loctite (of middle grade) to screws.



Figure 11

8. Put the pump casing with its regulator connection part facing downward, insert the tilting bushing of swash plate in tilting pin (531), and set swash plate (212) on its support (251) properly.

⚠ CAUTION!

1. Use tips of both fingers to check if swash plate moves smooth.

2. Apply grease to moving parts of swash plate and its support to facilitate the connection of the driveshaft.

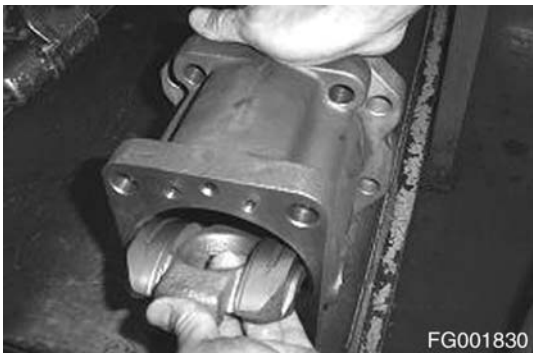


Figure 12

9. Install driveshaft (111) containing bearing (123), bearing spacer (127), and stop ring (824) in swash plate support (251).

CAUTION!

1. Do not strike driveshaft with hammer or similar item.

2. Use a plastic hammer to gently knock the rim of bearing to insert it and use a steel rod to insert it up to the end firmly.



Figure 13

10. Insert seal cover (F)(261) in pump casing (271) and fix it with socket bolts (406).

CAUTION!

1. Apply a thin grease coating to the oil seal of seal cover (F).

2. Be careful not to damage the oil seal during reassembly.

3. For the tandem pump, assemble parts up to rear cover (263) in the same way as for seal cover (262).

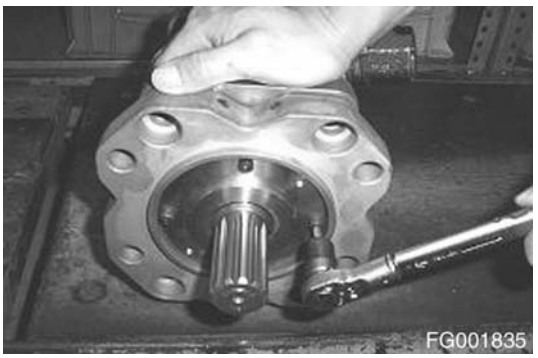


Figure 14

11. Assemble the piston cylinder subassembly [cylinder block (141), piston subassembly (151, 152), push plate (153), flexible bushing (156), spacer (158), and cylinder spring (157)] and install it in pump casing by arranging it to the spool line of cylinder block and flexible bushing.

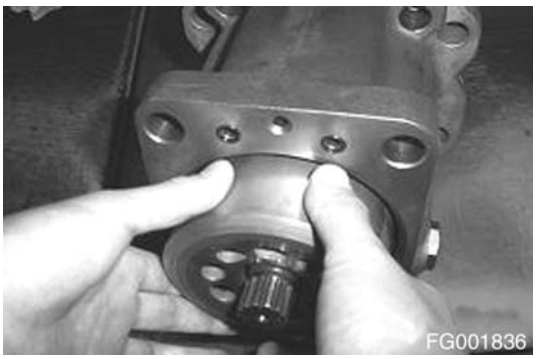


Figure 15

12. Install valve plate (313) in valve block (312) by arranging pin (885).

CAUTION!

Be careful to set correct directions of suction and discharge of the valve plate.

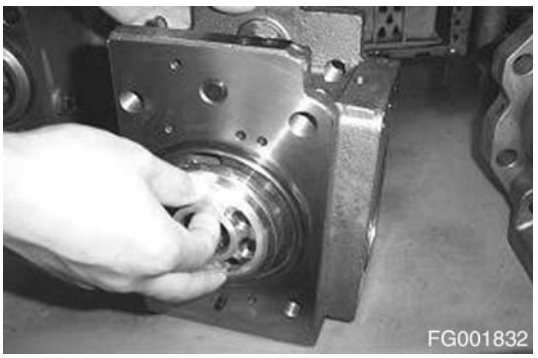


Figure 16

13. Install valve block (312) in pump casing (271) and tighten socket bolts (401).

⚠ CAUTION!

1. Start to reassemble from the rear pump, which facilitates the reassembly.

2. Be careful not to set valve block at wrong direction (the ball regulator should be at the top and the suction flange at the right side when observed from the front side).

3. Insert gear #1 in valve block and connect it to spool line of the driveshaft.

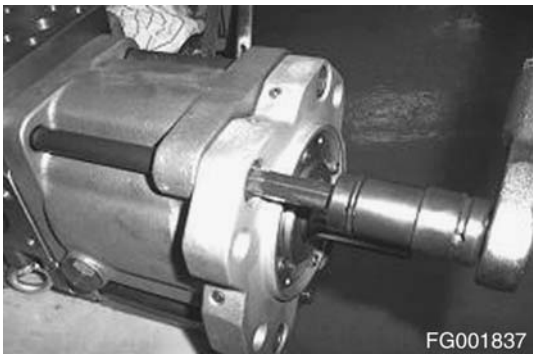


Figure 17

14. Insert feedback pin (548) of tilting pin (531) in the feedback lever of the regulator, connect the regulator and the PTO sub, and tighten socket bolts (412, 413).

⚠ CAUTION!

Do not confuse the front and rear regulators with each other.

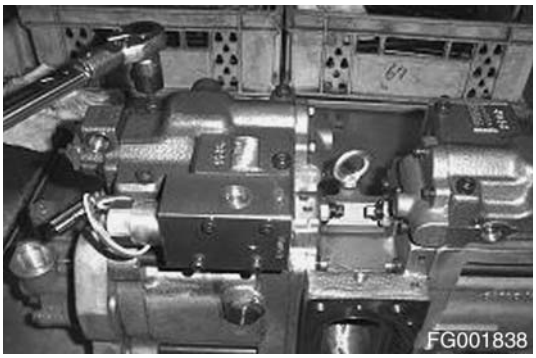


Figure 18

15. Install drain plug (468) to complete the reassembly procedure.

PUMP BODY MAINTENANCE STANDARDS

Change Standards of Worn Parts

Change or readjust parts which are worn more than references below. Always change, however, any parts which have clearly visible damage.

Parts and Checks	Standard References/Change References		Remarks
	Pump Types		
	T5V80	T5V112	
Gap between Piston and Cylinder Bore (ØD- Ød) (See Figure 1)	0.028 / 0.056	0.039 / 0.067	Change piston or cylinder block.
Gap between Piston and Shoe Pressing Part (and) (See Figure 2)	0-0.1 / 0.3	0-0.1 / 0.3	Change piston or use sub.
Thickness of Shoe (t) (See Figure 2)	3.9 / 3.7	4.9 / 4.7	Change piston or use sub.
Free Field of Cylinder Spring (L) (See Figure 3)	31.3 / 30.2	41.1 / 40.3	Change cylinder spring.
Height of Push Plate and Flexible Bushing Assembly (See Figure 4)	10.5 / 9.8	12.0 / 11.0	Change push plate or flexible bushing

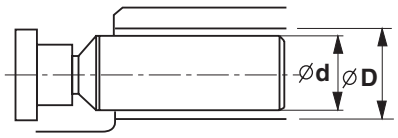


Fig. 1 Gap between Piston and Cylinder Bore

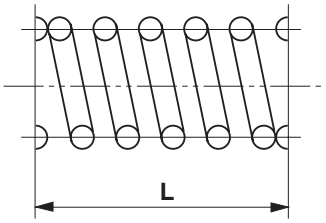


Fig. 3 Free Field of Cylinder Spring : L

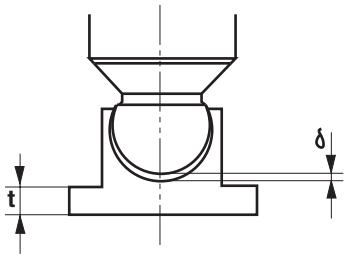


Fig. 2 Gap between Piston and Shoe Pressing Part : δ
Thickness of Shoe : T

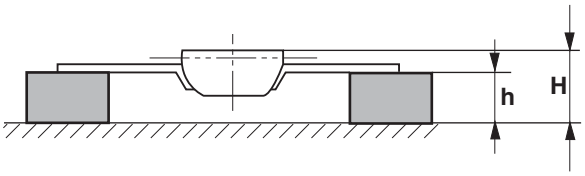


Fig. 4 Height of Push Plate and
Spherical Bush Assembly : H-h

FG007123

Figure 19

Fix Standards of Cylinder Block, Valve Plate, and Swash Plate (Shoe Plate)

Valve Plate (Sliding Part) Swash Plate (Shoe Plate Part)	Adjustment Needed Surface Intensity of Illumination	0.8a (3.2z)
Intensity of Illumination Each Face of Cylinder Block (Sliding Part)	Standard Surface Intensity of Illumination (Adjusted Value)	Below 0.1a (0.4z) (Lopping)

PTO Server

Edition 1

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PTO Server

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SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up

PUMP MAINTENANCE

1. Tools

   The following tools are needed for the disassembly and reassembly of the T5V PTO server:

Tools	B	Parts List
Hex Wrench	10	Hex Bolt (M10) Flange Socket Bolt (10)
Flyer TRR150 TRR200	/	Retaining Ring RR-20 Retaining Ring RR-72

2. Tightening Torque

Parts	Size	Torque Values (kg•m)
Socket Bolt (Material: SOM435)	M10	5.8
Flange socket Bolt	M10	3.4

DISASSEMBLY

Read the disassembly instructions thoroughly before starting to disassemble the PTO server, and follow the procedures below.

Numbers in the parentheses following the parts indicate the reference numbers in the next pump figures.

1. Select a place to disassemble the pump.

   NOTE: *The place should be clean.*
   Put a rubber sheet of cloth on the floor to prevent any damage to parts.

2. Remove dust or rust on the surface of the pump using lubricating oil.

3. Remove oil plug (468) to drain hydraulic oil in the pump casing.

   NOTE: *Drain the oil from both the front and the rear pumps.*

4. Remove flange socket bolts and then the gear pump.

5. Remove hex socket bolt (414) and then the PTO server.

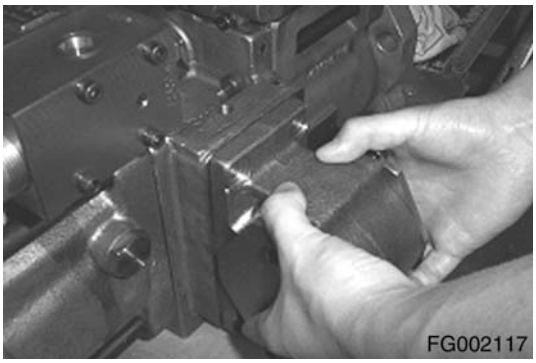


Figure 1

6. Remove retaining ring (827) and disassemble idle shaft (115), and remove gear 2 (117), roller bearing (126), and bearing space (128).

   NOTE: *Do not remove roller bearing (126) from the gear 2 (117).*

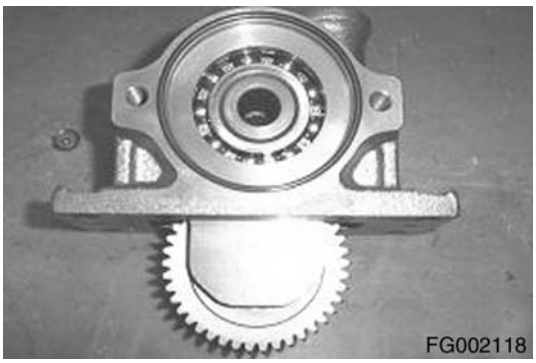


Figure 2

7. Remove retaining ring (825) and disassemble the gear 3 (118) and the ball bearing.

   NOTE: *Do not remove ball bearing (125) from the gear 3 (118).*

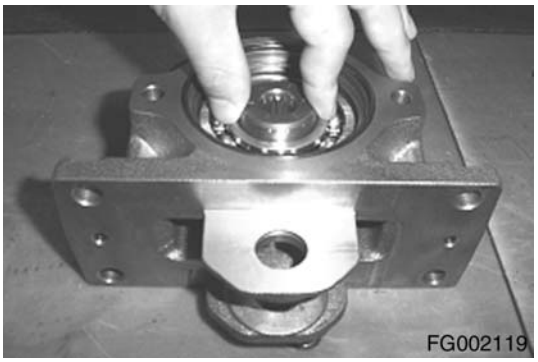


Figure 3

REASSEMBLY

Reassembly shall be made in the reverse order of the Disassemble with cautions for:

1. Repair damaged parts during the disassembly and have spare parts prepared by hand.
2. Wash each part sufficiently with lubricating oil and dry them with compressed air before their reassembly.
3. Always apply clean lubricating oil to sliding parts and bearing before their reassembly.
4. Make it a rule to replace O-rings and oil seals.
5. Tighten fixing bolts and plugs with proper torque wrenches and with torques specified in the Maintenance Standards.

MAINTENANCE STANDARDS OF PUMP BODY

1. Standards to Replace Worn Parts

   Replace gears 2 (117) and 3 (118) whose teeth have pitting (the size of 1 ft is the same and below 1 mm or is more than 5% of the area). Any parts whose appearance is severely damaged should be replaced also.

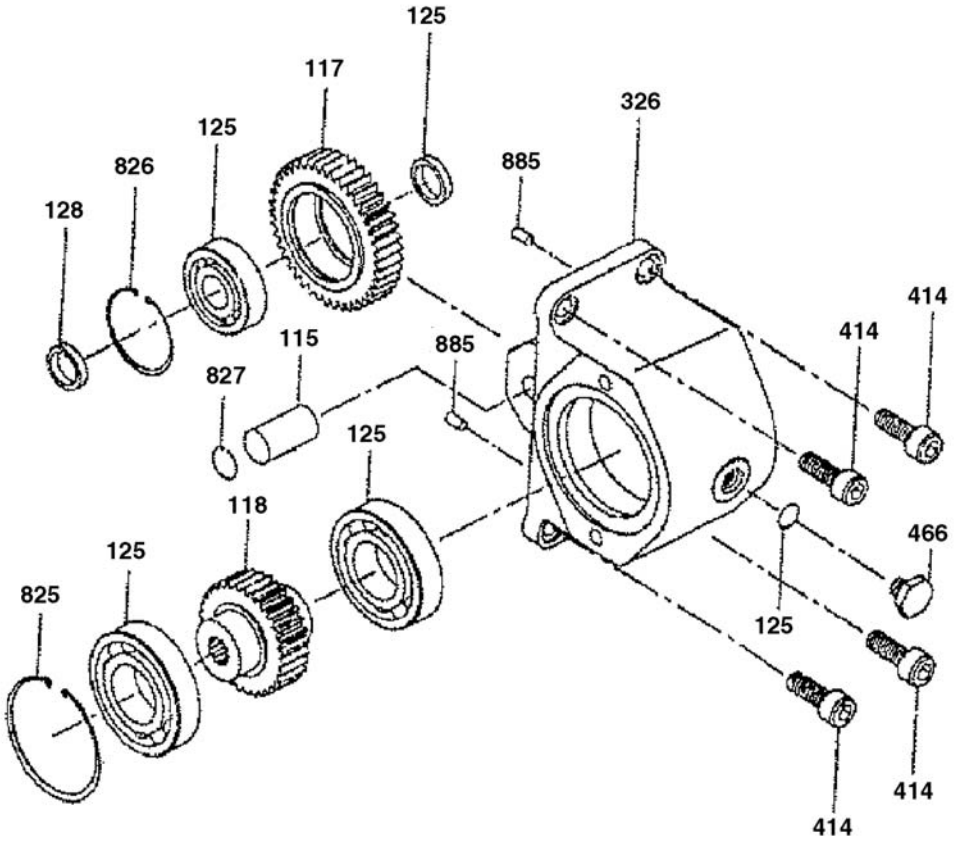


Figure 4

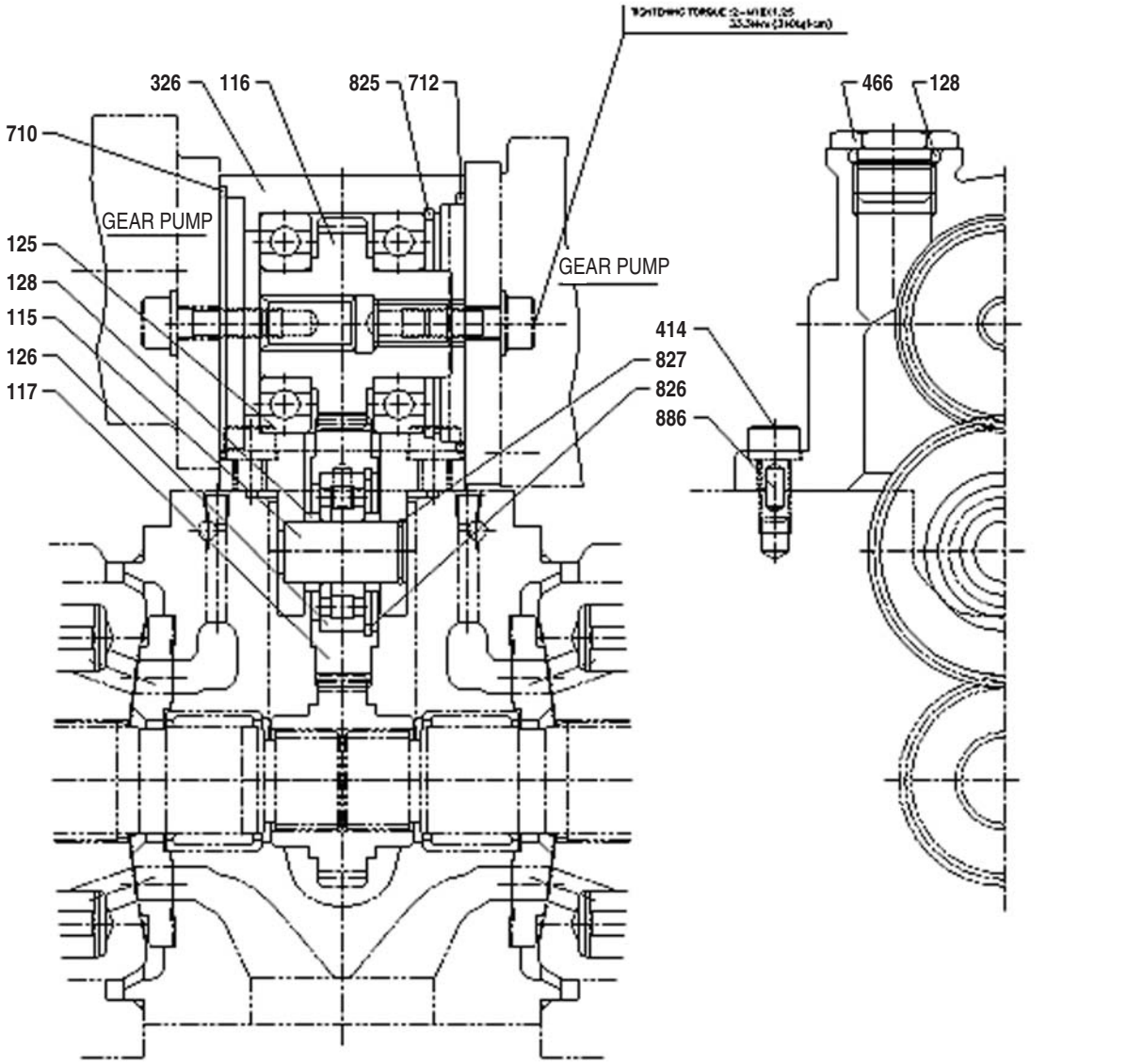


Figure 5

Reference	Parts
886	Pin
827	Retaining Ring
826	Retaining Ring
825	Retaining Ring
728	O-ring
712	O-ring
710	O-ring
466	VP Plug

Reference	Parts
414	Socket Bolt
326	Gear Case
128	Bearing Spacer
126	Roller Bearing
125	Ball Bearing
118	Gear 3
117	Gear 2
115	Idle Shaft

Remote Control Valve (Work Lever / Joystick)

Edition 1

MEMO

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MEMO

SAFETY PRECAUTIONS

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APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX180LC	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX300LL	5001 and Up
DX340LC	5001 and Up

GENERAL DESCRIPTION

Theory of Operation

Structure

The remote control valve contains four push rods, spring holders, spools and return springs, which are in the valve casing. The valve works as a pressure reduction valve.

The housing has six ports, which include input port P, tank port T, and four secondary pressure ports.

The electric horn button is installed in the valve handle.

Gear pump pressure is used for operating control spools.

Function

1. Neutral Position

   When the lever is in neutral mode, the spool is pushed upward by return spring. The force of balancing spring, which determines the secondary discharge pressure, is not transmitted to the spool. The input port is closed and the pressure of the output port is the same as the pressure of the tank port T.

2. Control Switch

   Pressing of the push rod starts to press the balance spring, whose force is transferred to the spool to connect the P and T ports, transferring the pilot pressure. Output pressure acts on the bottom of the spool and press the spool upwards until it is balanced with the force of the balance spring.

   In short, the second pressure (output pressure) changes in proportion to the pressing force of the balance spring.

Parts List

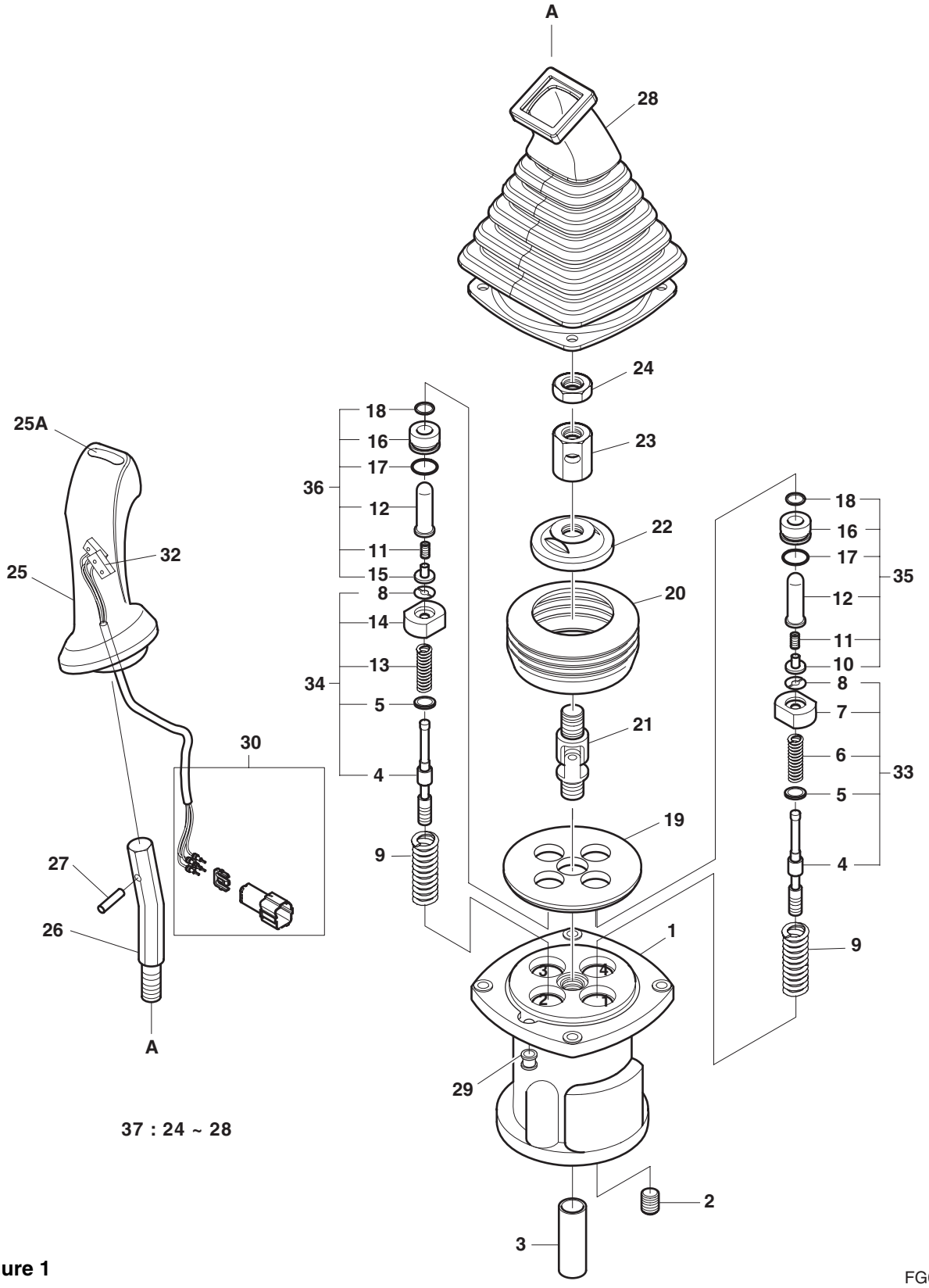


Figure 1

FG003938

Reference Number	Description
1	Case
2	Plug
3	Bushing
4	Spool
5	Shim
6	Spring
7	Spring Seat
8	Stopper
9	Spring
10	Stopper
11	Spring
12	Push Rod
13	Spring
14	Spring Seat
15	Stopper
16	Plug
17	O-ring
18	Rod Seal
19	Plate
20	Boot

Reference Number	Description
21	Joint Assembly
22	Swash Plate
23	Nut
24	Nut
25	Handle Assembly (L) Handle Assembly (R)
25A	Cap
26	Handle Bar
27	Spring Pin
28	Bellows
29	Bushing
30	Connector Assembly
32	Switch Assembly
33	Spool Kit 1, 3
34	Spool Kit 2, 4
35	Plug Kit 1, 3
36	Plug Kit 2, 4
37	Handle Kit (Left) Handle Kit (Right)

Specifications

Performance

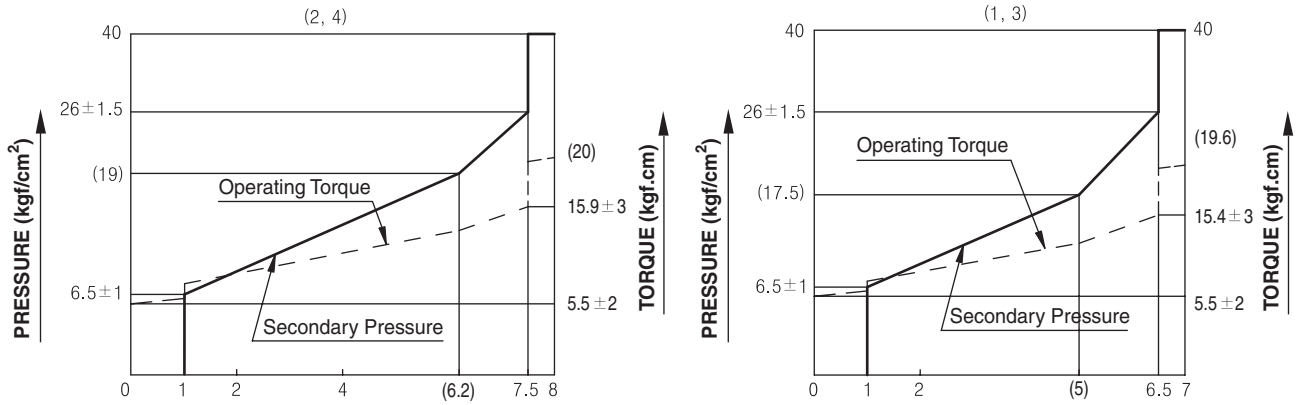


Figure 2

Torques

No.	Tool	Standard	Remark
3	Plug	PF 3/8	500 kg•cm (36 ft lb)
19	Swash Plate	27 mm	1,660 kg•cm (120 ft lb)
20	Hex Nut	22 mm	1,660 kg•cm (120 ft lb)
22	Nut	22 mm	1,660 kg•cm (120 ft lb)

TOOLS AND MATERIALS

No.	Tool	Standard	Remark
3	L Wrench	8 mm	
19	Wrench	27 mm	
20	Wrench	22 mm	
22	Wrench	22 mm	

DISASSEMBLY

1. Remove lead wire from bushing (29).

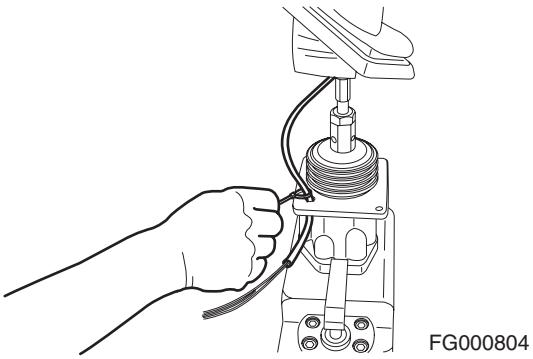


Figure 3

2. Remove lever assembly from case (1).

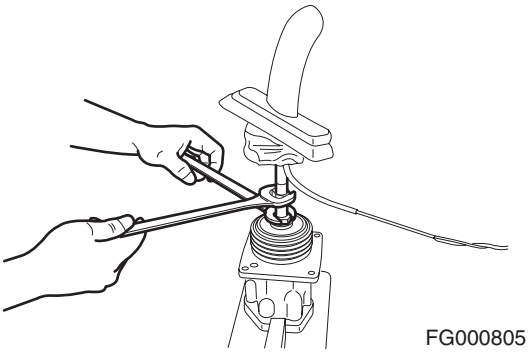


Figure 4

3. Remove hex nut (23) and swash plate (22) from case.

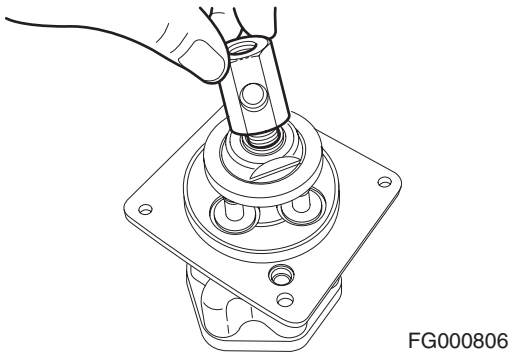


Figure 5

4. Remove joint assembly (21) from case.

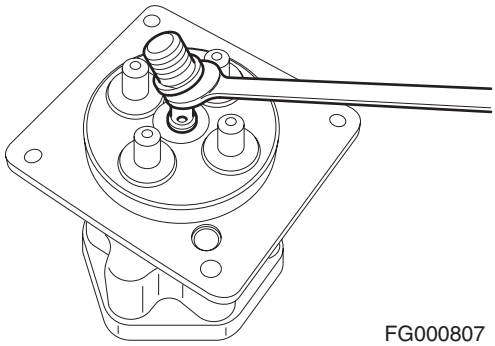
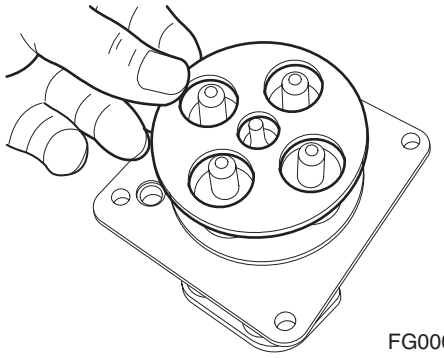


Figure 6

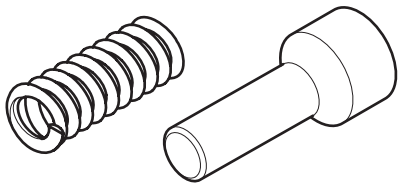
5. Remove plate (19) from case (1).



FG000808

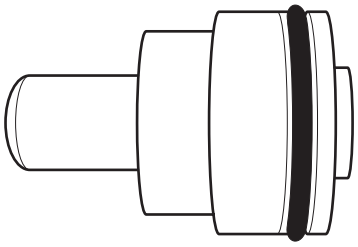
Figure 7

6. Remove plug kit assembly, stopper (10), and spring (11) from case (1).



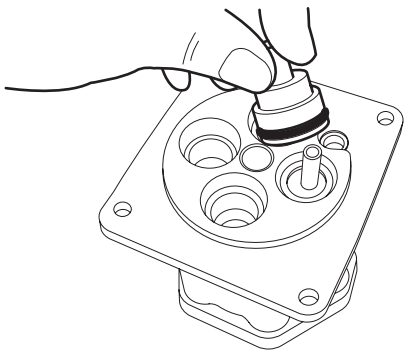
FG000809

Figure 8



FG000810

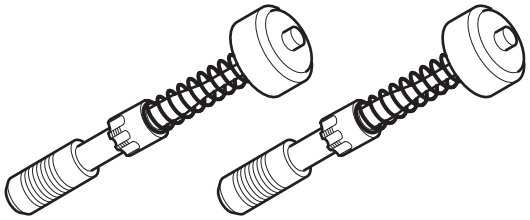
Figure 9



FG000811

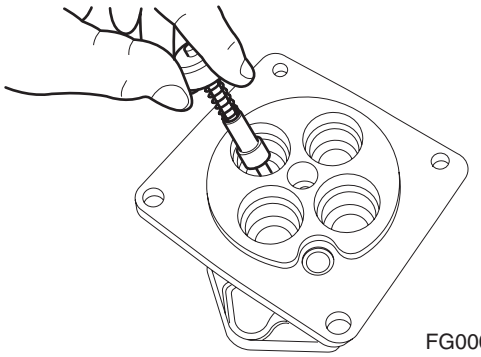
Figure 10

7. Remove four spool kit assemblies from case (1).



FG000812

Figure 11



FG000813

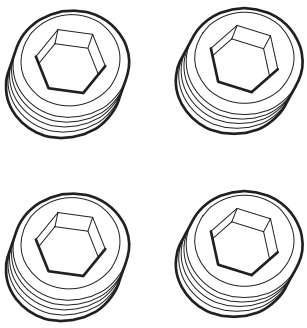
Figure 12

8. The bushing (3) and plug cannot be removed from case (1).



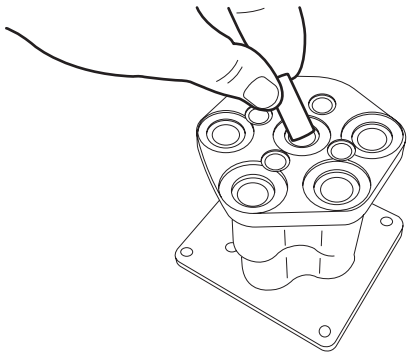
FG000814

Figure 13



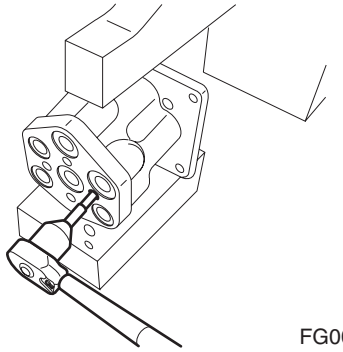
FG000815

Figure 14



FG000816

Figure 15



FG000817

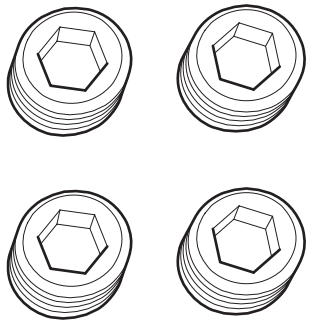
Figure 16

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

For general cleaning and inspection procedures, refer to "General Maintenance Procedures" section.

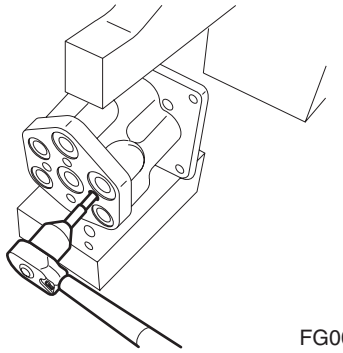
REASSEMBLY

1. Install four plugs (2) into case (1).



FG000815

Figure 17



FG000817

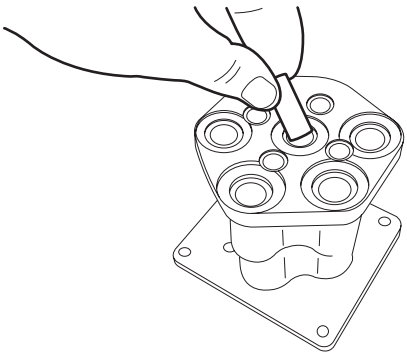
Figure 18

2. Install bushing (3) into case (1) using jig.



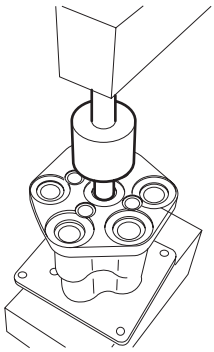
FG000814

Figure 19



FG000816

Figure 20

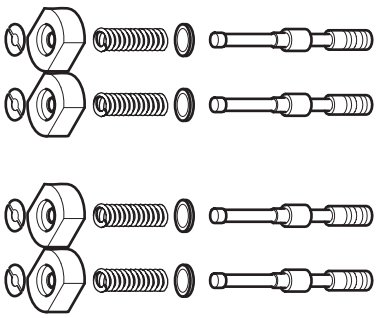


FG000818

Figure 21

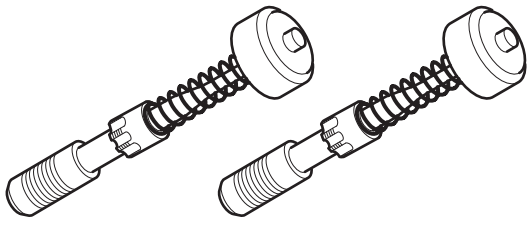
3. Be careful when assembling spool kit assemblies (1 and 3, 2 and 4). They should be assembled in same way).

   The assembly order is; spool (4), shim (5), spring (6), spring seat (7), and stopper (8).



FG000819

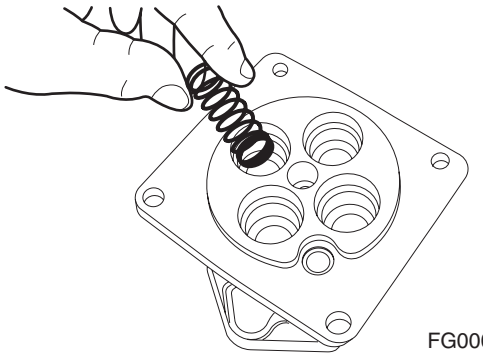
Figure 22



FG000812

Figure 23

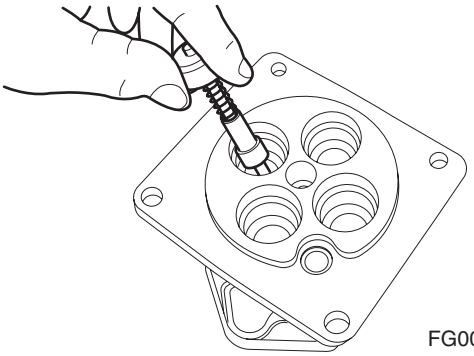
4. Install spring (9) into case (1).



FG000820

Figure 24

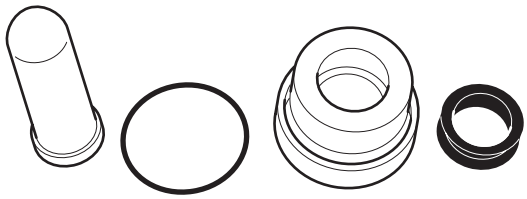
5. Install spool kit assembly into case (1). (The same way is used for four parts.)



FG000821

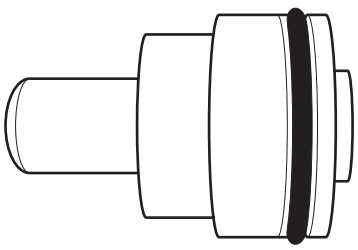
Figure 25

6. Assemble plug kit insert rod seal (18), O-ring (17), and push rod (2) into plug (16) in proper order.



FG000822

Figure 26

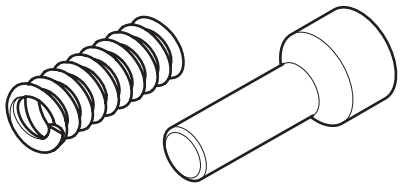


FG000810

Figure 27

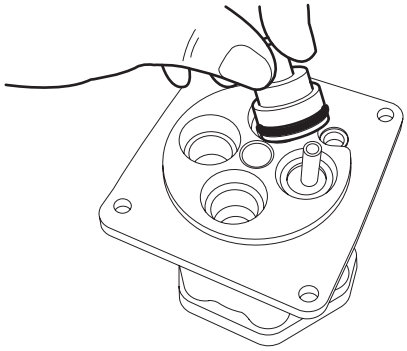
7. Assemble four springs (11) and stoppers (10) and insert assembled set in case (1) to form a plug kit assembly.

   NOTE: *Pay attention to measurement specifications of stoppers (1 and 3, 2 and 4).*



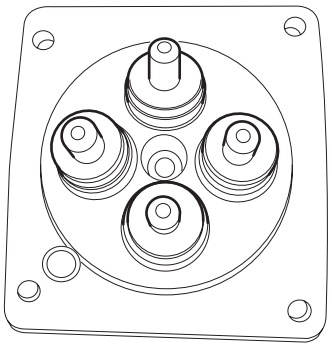
FG000809

Figure 28



FG000811

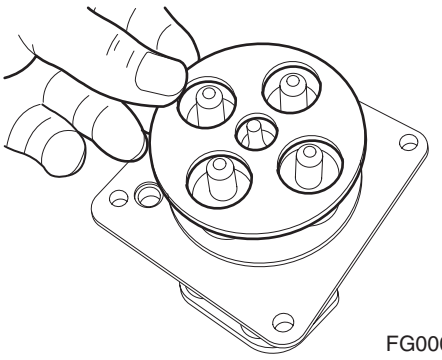
Figure 29



FG000823

Figure 30

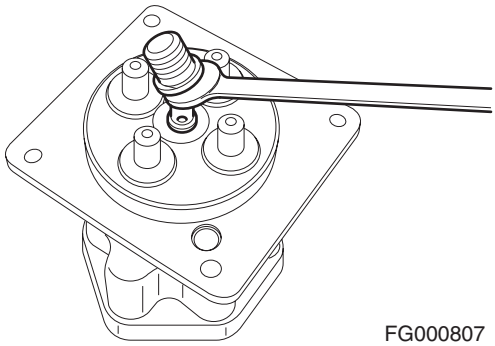
8. Install plate (19) into case (1).



FG000808

Figure 31

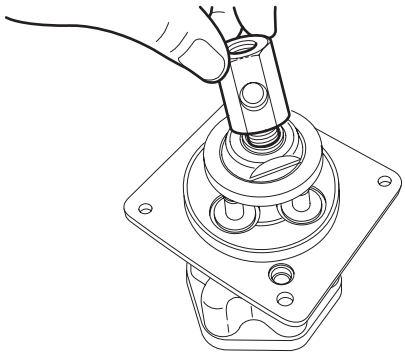
9. Install joint assembly (21) into case (1).



FG000807

Figure 32

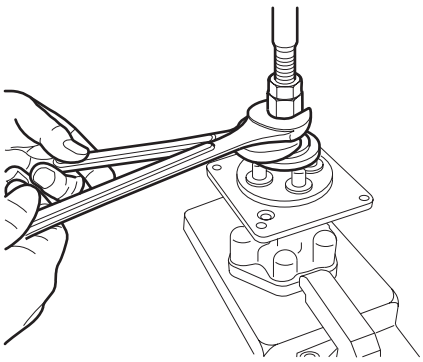
10. Install wash plate (22) and hex nut (23) into case (1).



FG000806

Figure 33

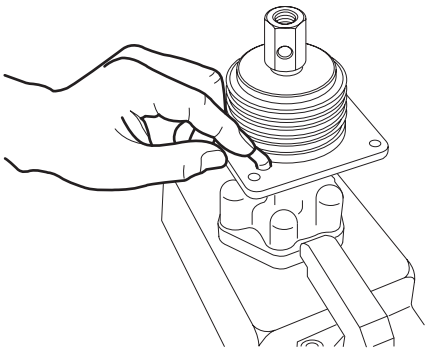
11. Insert bar and tighten it with a wrench to check balance of joint assembly.



FG000824

Figure 34

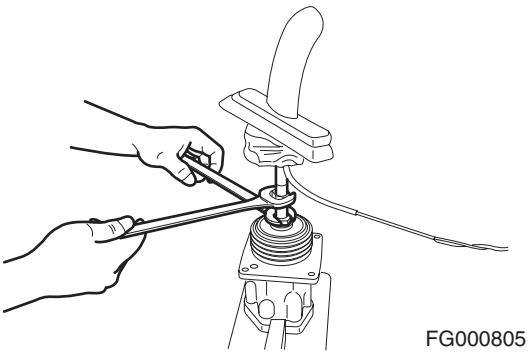
12. Install boot (20) and bushing (29) into case (1).



FG000825

Figure 35

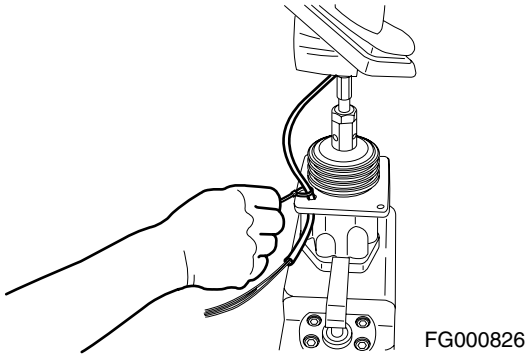
13. Install lever assembly into case (1).



FG000805

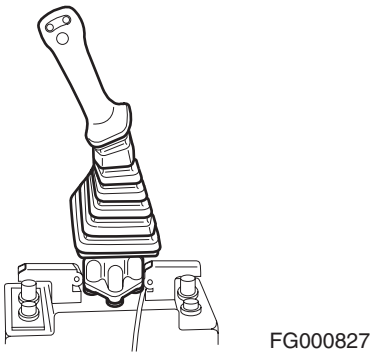
Figure 36

14. Put lead wire in bushing (29), tie it, and arrange boot.



FG000826

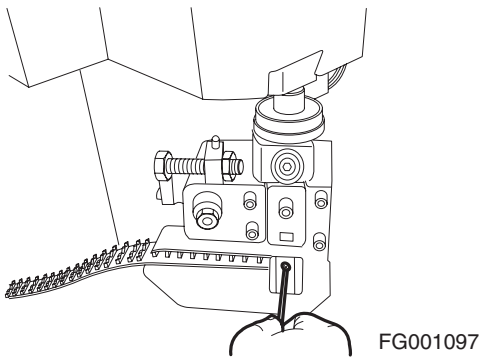
Figure 37



FG000827

Figure 38

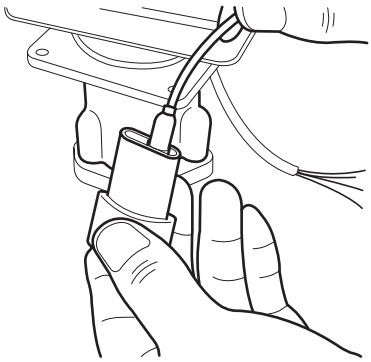
15. Install lead wire terminal into connector terminal pressing them together.



FG001097

Figure 39

16. Assemble connector assembly (30), and connect it to lead wire terminal, and properly route wiring.



FG000828

Figure 40

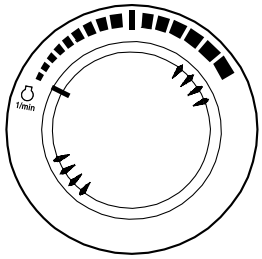


FG000829

Figure 41

START-UP PROCEDURES

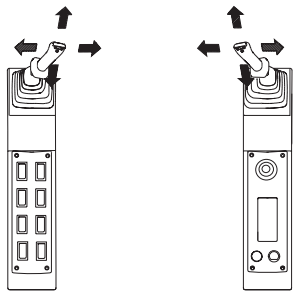
1. Start engine and set throttle at "LOW IDLE."
2. Set safety lever on "UNLOCK" position.



HAOB290L

Figure 42

3. Slowly cycle boom, arm, bucket cylinders and swing motor about five times without a load to vent air from pilot lines. Do this for five minutes.



ARO0470L

Figure 43

Travel Control Valve (with Damper)

Edition 1

MEMO

Table of Contents

Travel Control Valve (with Damper)

Safety Precautions 5
Applicable Models 5
General Description 7
- Theory of Operation 7
- Deceleration Valve 8
- Dampening Parts of the Control Section 9

Causes of Faults and Measures 11
- Parts List 12
- Specifications 13
- Torques 13

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Disassembly 15
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Assembly 19
Installation 25
Start-up Procedures 26

MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

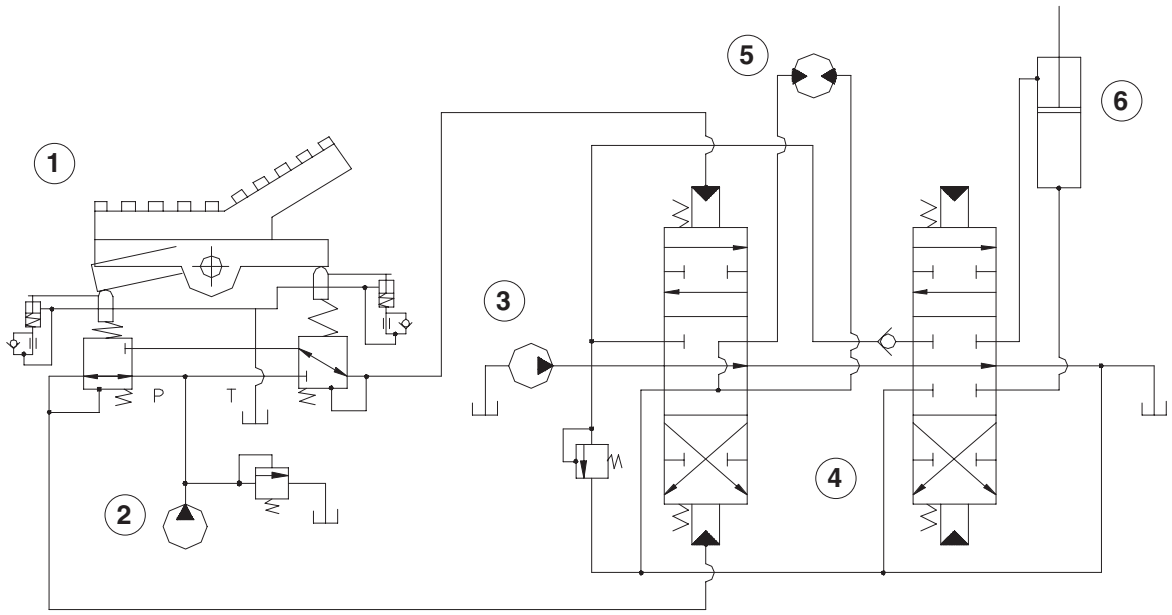
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX300LL	5001 and Up
DX340LC	5001 and Up
DX420LC	5001 and Up
DX480LC	5001 and Up
DX520LC	5001 and Up

GENERAL DESCRIPTION

Theory of Operation

The damper valve is divided into two areas of operation. There is the pressure reducing valve (a) and the damper mechanism (b). The following hydraulic circuit is an example of a remotely located control valve.



ARS1810L

Figure 1

Reference Number	Description
1	Remote Control Valve
2	Pilot Pump
3	Main Pump

Reference Number	Description
4	Control Valve
5	Hydraulic Motor
6	Hydraulic Cylinder

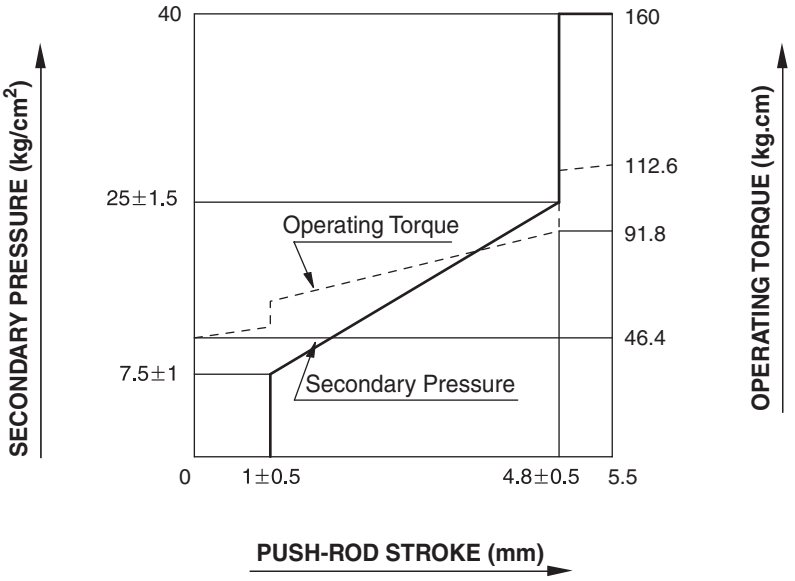
Deceleration Valve

1. In neutral position, the damper spool is pushed to the neutral position by return spring which is seated on the spring seat (and washer. Because of the damper spool's switching function, the output port is connected to port T and the pressure at the output port and port T is the same.

2. When the cam of the remote control valve is operated and moved from the neutral position to the clockwise direction, the push rod and damper spool of port 1 is moved down within the constraints of washer 1, spring seat, secondary pressure select spring, washer 2 and washer 3. As a result port P and port 1 are connected and oil pressure from the pilot pump flows through port 1, generating pressure.

   When the pressure of port 1 reaches the selected pressure of the secondary pressure select spring, the oil pressure and the spring set pressure will equalize and the output pressure of port 1 is maintained at a constant rate.

   The damper spool in port 2 is in the neutral position, oil returning from the control valve is discharged through port T. In cases where the controls are operated to the maximum position, the push rod makes direct contact with the damper spool forcing port P to make a direct path with the discharge port, permitting the pressure to equalize at these ports.



FG003924

Figure 2

Dampening Parts of the Control Section

1. In the neutral position, the push rod is pushed up to its neutral position by the return spring and damper spring.
2. When the cam is moved in the clockwise direction from the neutral position, the push rod and damper spool of port 1 are moved in a downward direction. At this time, the pressurized oil in the damper spool is discharged through the orifice and the dampening pressure is generated. Meanwhile, the push rod in port 2 moves up with the damper spring and the damper spool between them. At the same time, the oil from the oil tank passes through the check ball (3 positions) consisting of a spring and steel ball, and flows out through port T in the upper portion of the casing to tank.
3. When the operating levers are moved to the extreme opposite position: When the cam is moved to the counterclockwise position from the clockwise most position, the push rod and piston in port 2 is moved in the downward direction. As in the case described above, the oil in the damping piston chamber is discharged through the orifice and the dampening pressure is generated in this chamber, providing dampening force. In port 1, the push rod is moved up by the action of the return spring and damper spring. At the same time, the oil from the oil tank passes through the check ball (3 positions) consisting of a spring and steel ball, and flows out through port T in the upper portion of the casing to tank

The damping operation is effective in both operations, when the levers are moved from the neutral position to the maximum travel position and when the levers are moved from the maximum travel position to the neutral position as well.

A. When moving lever from the neutral position

Moving the lever from the neutral position to the right forces oil in the right damper spool to discharged through the orifice, generating pressure that creates a dampening force.

Moving the lever in the opposite direction, causes the left damper spool to assume the function of the right spool.

Thus, a dampening force is generated at both ways.

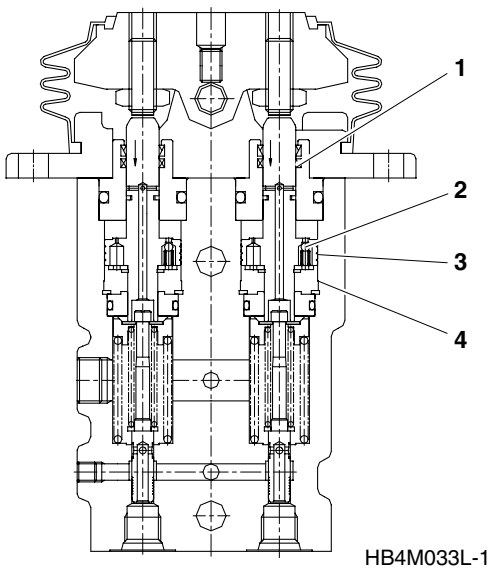


Figure 3

B. Operation of forward and reverse lever control

Oil outside the damper spool runs out through the channel from the top of the casing to the port (T), and oil in the damper spool is discharged through orifice, generating pressure that creates a dampening force.

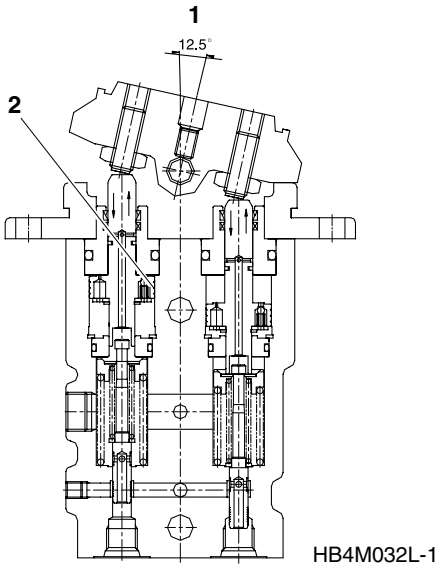


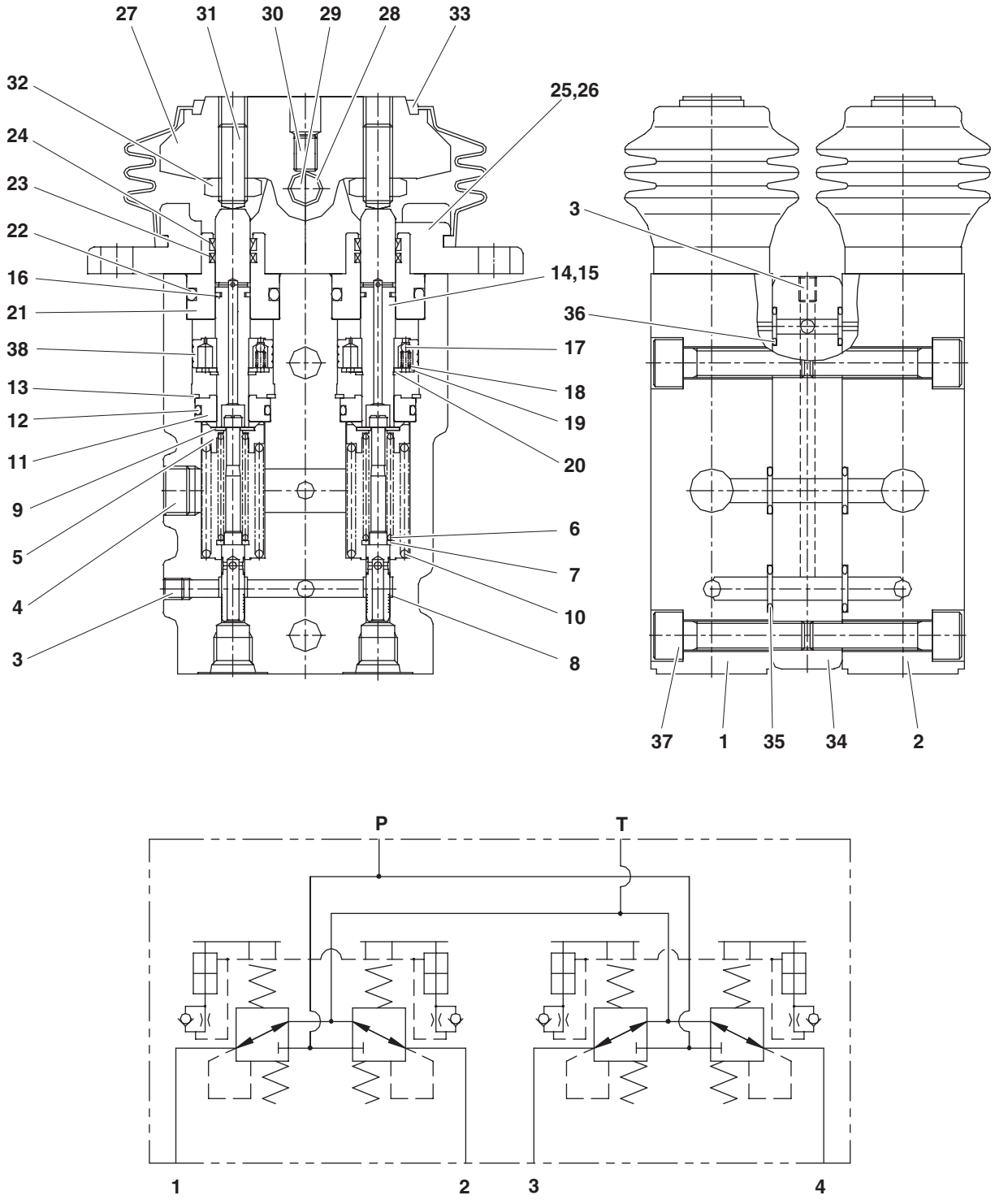
Figure 4

CAUSES OF FAULTS AND MEASURES

At times it may be difficult to pinpoint the source of the problem. The following table lists some of the possible problems, possible causes and remedies. Refer to this table for possible causes and remedies to assist in correcting the sometimes difficult problems.

The table only lists some general problems, possible causes and their remedies. Often the problem is not caused by the failure of a single part but, may be the result of a combination of problems from related parts and their components. Possible problems other than the ones list are not being specified but that is not to say that these are the only possible problems that can occur. The technician must diagnose the problem, considering all possible causes and repair the source of the malfunction.

Problem	Possible Cause	Remedy
Secondary pressure will not increase.	Low primary pressure.	Adjust primary pressure.
	Defective secondary pressure select spring.	Replace with new spring.
	Gap between damper spool and casing is abnormally large.	Replace damper spool casing assembly.
	Defective operating parts and components.	Disassemble/reassemble and replace defective parts.
Unstable secondary pressure.	Jamming of interconnected parts.	Repair/replace cause of jamming.
	Unstable tank line pressure.	Install direct line to hydraulic tank.
	Air in hydraulic lines.	Vent air from system.
Abnormally high secondary pressure.	High tank line pressure.	Install direct line to hydraulic tank.
	Jamming of interconnected parts.	Repair/replace cause of jamming.
No dampening.	Air in piston chamber.	Vent air from system.
	Jamming of interconnected parts.	Repair/replace cause of jamming.
	Worn damper springs.	Replace with new parts.
	Worn damper spool and housing.	Replace damper spool and housing assembly.
	Defective/damaged check valve.	Disassemble and examine check valve.
	Worn damper spool orifice.	Replace damper spool.
Damper spool feels heavy.	Defective interconnected components.	Repair/replace defective parts.
	Restricted movement of damper spool.	Repair/replace damaged piston.



FG003925

Figure 5

Reference Number	Description
1	Body (1)
2	Body (2)
3	Plug
4	Plug
5	Spring Seat
6	Damper Spring
7	Spring Seat
8	Damper Spool
9	Stopper
10	Return Spring
11	Rod Guide
12	O-ring
13	Retaining Ring
14	Push Rod
15	Spring Pin
16	Seal
17	Steel Ball
18	Damper Spring
19	Cam Plate

Reference Number	Description
20	Retaining Ring
21	Plug
22	O-ring
23	Rod Seal
24	Dust Seal
25	Cover
26	Hex Socket Head Bolt
27	Cam
28	Bushing
29	Camshaft
30	Set Screw
31	Set Screw
32	Hex Nut
33	Bellows
34	Spacer
35	O-ring
36	O-ring
37	Hex Socket Head Bolt
38	Piston

Specifications

Travel Control Valve	Specification
Type	Pilot Control (With Damper)
Pressure / Stroke	25 kg•cm^2 @ 4.8 mm Stroke (356 psi @ 0.1890 in Stroke)
Weight	7.8 kg (17 lb)

Torques

Part Reference Number	Bolt Size	Tool	Tightening Torque
26	M6	5 mm L-Wrench	88 kg•cm (6 ft lb)
30	M8	4 mm L-Wrench	100 kg•cm (7 ft lb)
32	M10	17 mm Wrench	440 kg•cm (32 ft lb)
37	M10	8 mm L-Wrench	440 kg•cm (32 ft lb)

REMOVAL

1. Park on firm and level ground.
2. Lower front attachment (bucket) to ground.
3. Shut down engine.
4. Set safety lever on "RELEASED" position.
5. Turn starter switch to "I" (ON) position.

WARNING!

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

6. Fully stroke work levers (joysticks) in all directions to relieve any pressure from accumulators.
7. Set safety lever on "LOCK" position.
8. Turn key to "O" (OFF) position and remove from starter switch.
9. Hang a maintenance warning tag on controls.
10. Disconnect negative (-) battery cable leading to frame from battery.
11. Remove cabin under cover by loosening bolts.
12. Tag and disconnect hoses from pedal valve (1, Figure 7). Plug and cap hoses and ports to prevent contamination from entering hydraulic system or component.

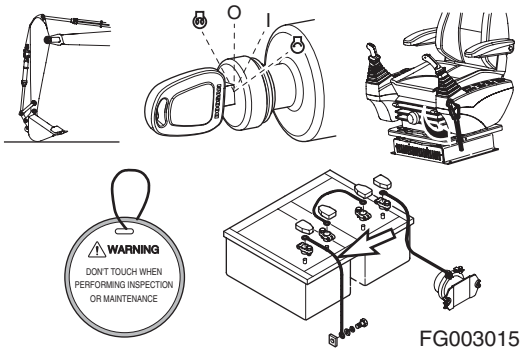


Figure 6

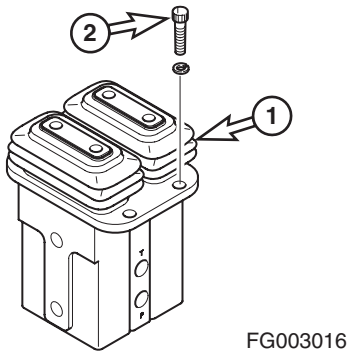
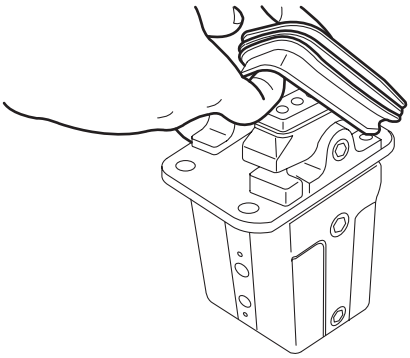


Figure 7

DISASSEMBLY

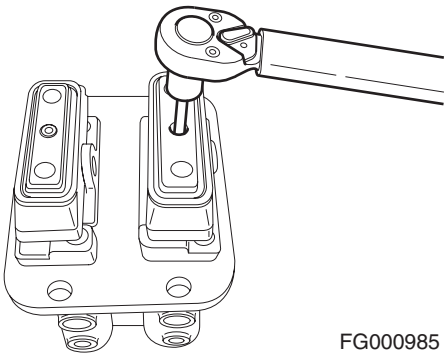
1. Remove bellows (33).



ARS1870P

Figure 8

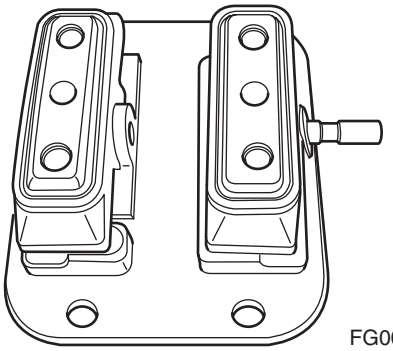
2. Remove set screw (30) from cam (27).



FG000985

Figure 9

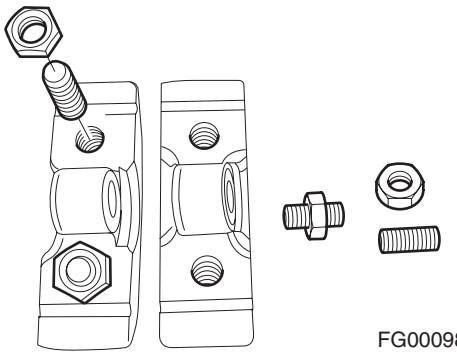
3. Remove camshaft (29) and cover (25) from cam (27).



FG000986

Figure 10

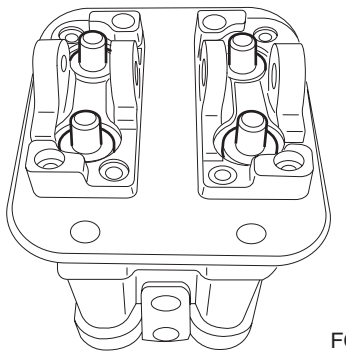
4. Remove hex nut (32) and swash plate (31) from cam.



FG000987

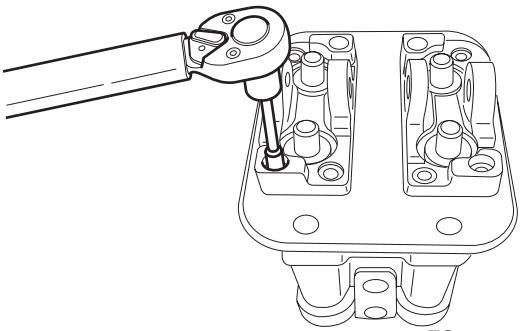
Figure 11

5. Remove hex socket head bolt (26) and cover (25) from each body (1 and 2).



FG000988

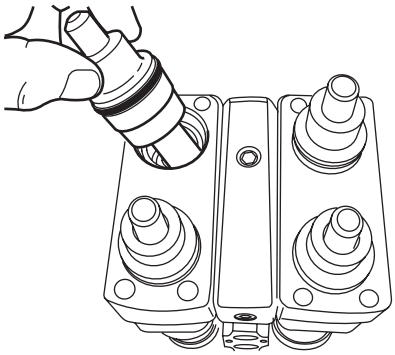
Figure 12



FG000989

Figure 13

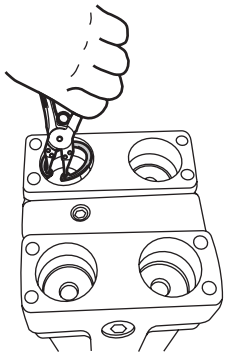
6. Remove push rod assembly from each body (1 and 2).



FG000990

Figure 14

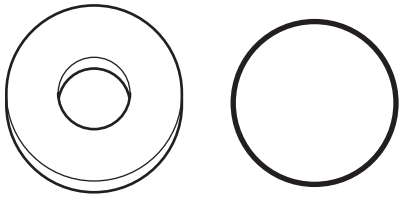
7. Remove retaining ring (13).



FG000991

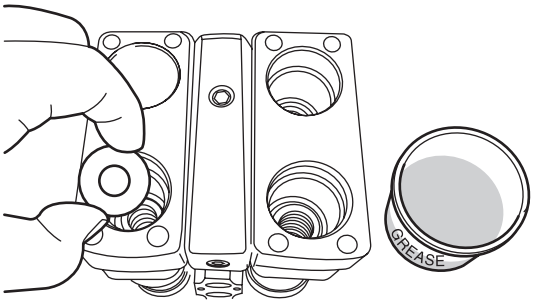
Figure 15

8. Remove rod guide (11) from each body (1 and 2).



FG000992

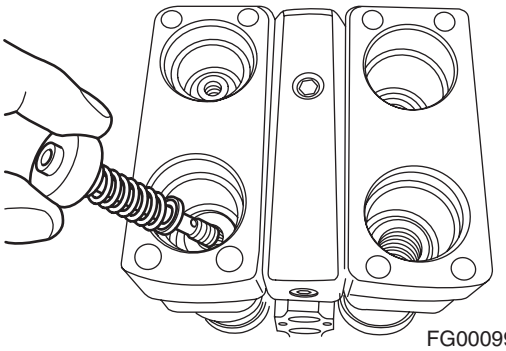
Figure 16



FG000993

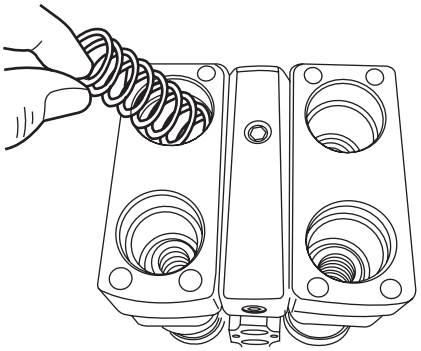
Figure 17

9. Remove damper spool assembly and spring (10) from each body (1 and 2).



FG000994

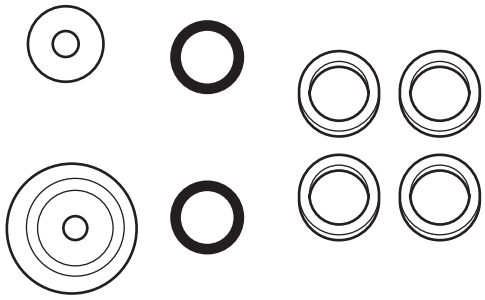
Figure 18



FG000995

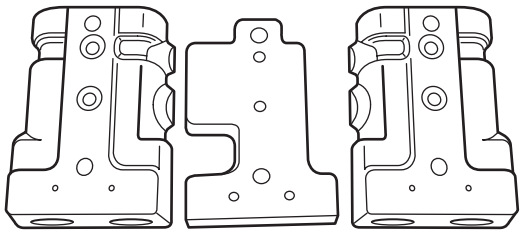
Figure 19

10. Remove hex socket head bolt (37) from each body (1 and 2). Disassemble each body (1 and 2) and spacer (34). Remove plugs (3 and 4) and O-rings (35 and 36).



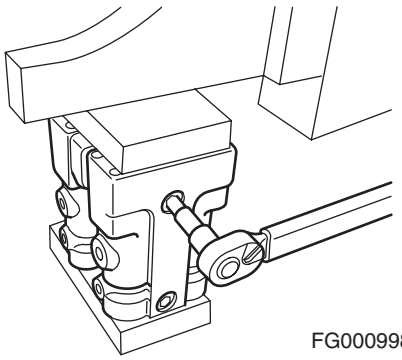
FG000996

Figure 20



FG000997

Figure 21



FG000998

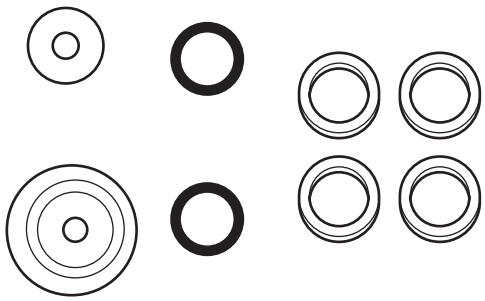
Figure 22

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

For general cleaning and inspection procedures, refer to "General Maintenance Procedures" section.

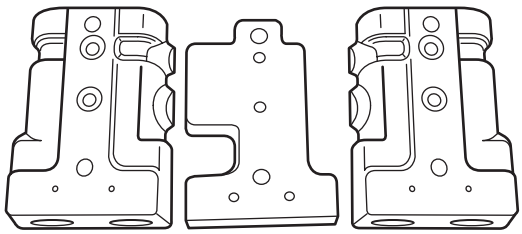
ASSEMBLY

1. Assemble plugs (3 and 4) and O-rings (35 and 36) into each body (1 and 2) and spacer (34). Install hex socket head bolt (37) using torque wrench.



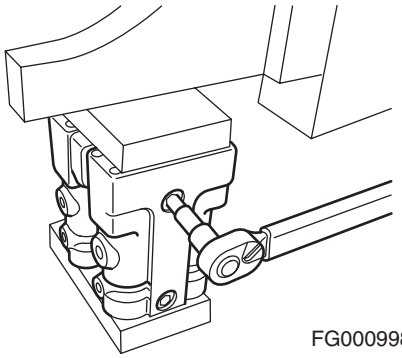
FG000996

Figure 23



FG000997

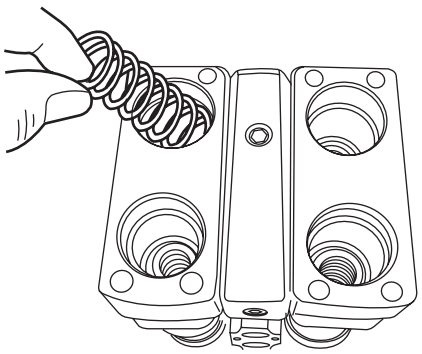
Figure 24



FG000998

Figure 25

2. Insert spring (10) into each body (1 and 2).



FG000995

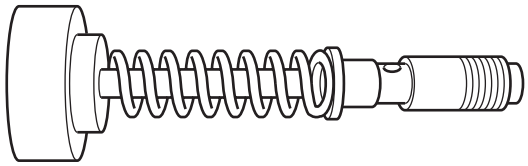
Figure 26

3. Assemble in proper order, damper spool (8), shim (7), spring (6), spring seat (5), and stopper (9).



FG000999

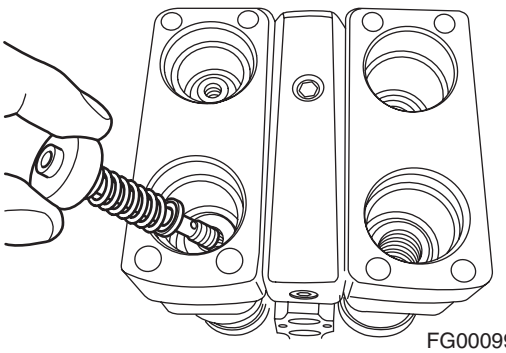
Figure 27



FG001000

Figure 28

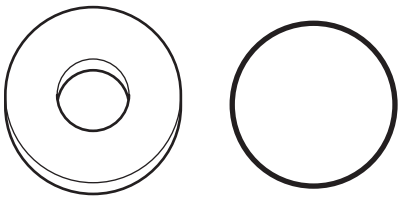
4. Install damper spool assembly into each body (1 and 2).



FG000994

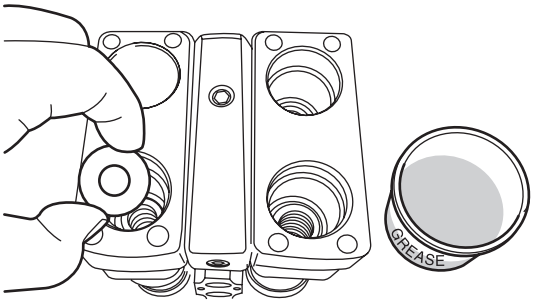
Figure 29

5. Install O-ring (12) on rod guide (11). Coat guide assembly with grease, and slide it into each body (1 and 2).



FG000992

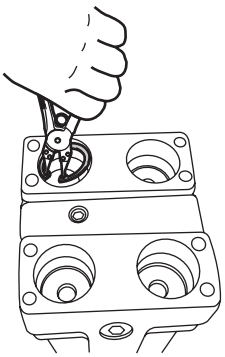
Figure 30



FG000993

Figure 31

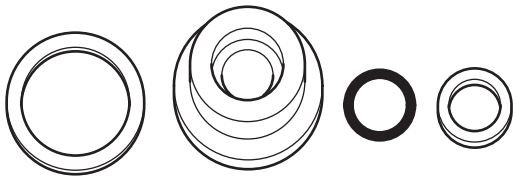
6. Install retaining ring (13). Make sure that it is properly seated.



FG000991

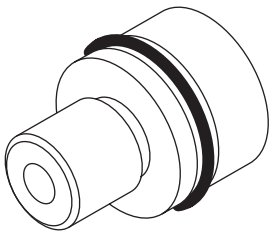
Figure 32

7. Assemble rod seal (23), dust seal (24), and O-ring (22) into plug (21).



FG001001

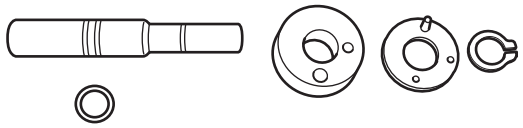
Figure 33



FG001002

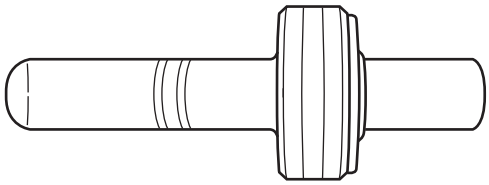
Figure 34

8. Assemble seal (16), piston (38), steel ball (17), plate (19), spring (18), and retaining ring (20) into push rod (14).



FG001003

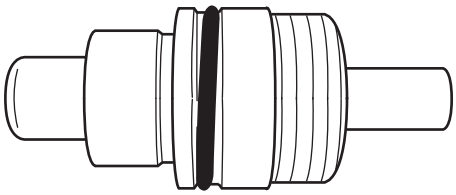
Figure 35



FG001004

Figure 36

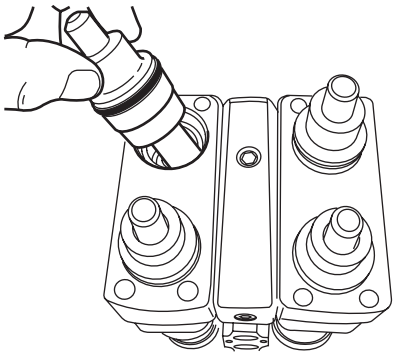
9. Assemble push rod and plug.



FG001005

Figure 37

10. Install push rod assembly into each body (1 and 2).



FG000990

Figure 38

11. Install bushing (28) in cover (25) using jig.

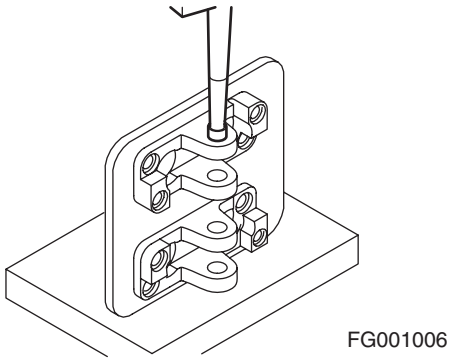


Figure 39

12. Assemble cover (28) onto each body (1 and 2) and install hex socket head bolt (26) using torque wrench.

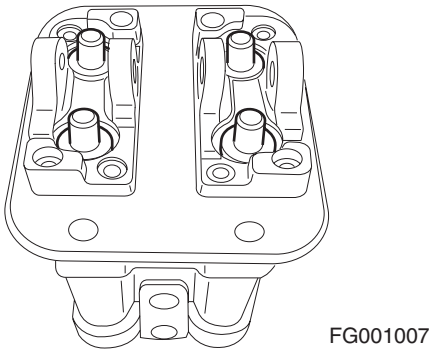


Figure 40

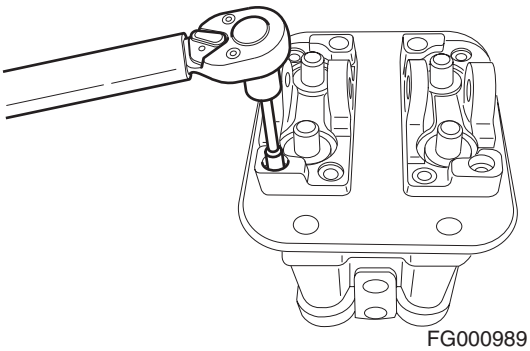


Figure 41

13. Install set screws (31) and hex nut (32) into cam (27) and tighten it.

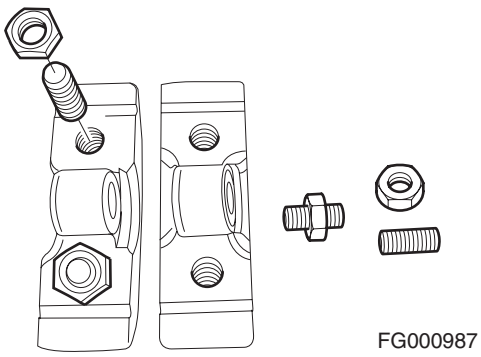
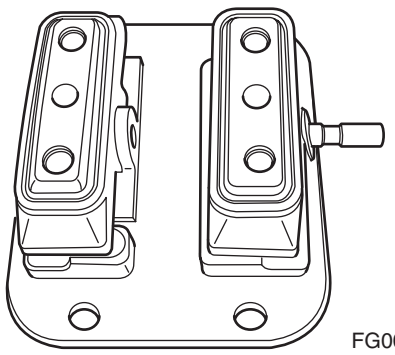


Figure 42

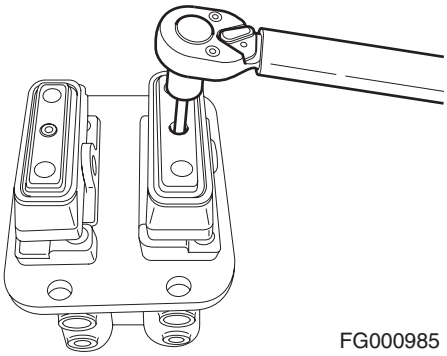
14. Position cam (27) on cover (25), and insert camshaft (29) using hammer.



FG000986

Figure 43

15. Install set screw (30) in cam (27) and tighten it using torque wrench.



FG000985

Figure 44

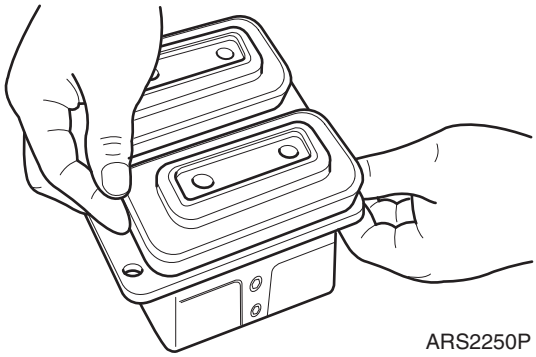
16. Check cam balance.



FG001009

Figure 45

17. Install bellows.



ARS2250P

Figure 46

INSTALLATION

1. Position pedal valve (1, Figure 47) on cabin floor plate and install four bolts and washers (2).

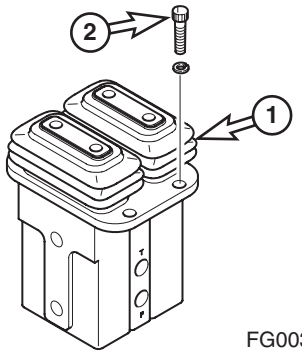


Figure 47

2. Install pedal brackets (3) and levers (4, Figure 48) on pedal valve and install four bolts and washers (2).
3. Install rubber boots (1, Figure 48).

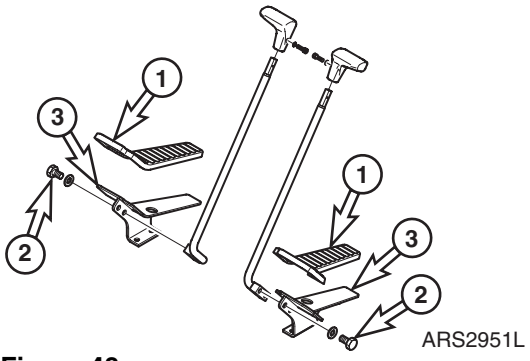


Figure 48

4. Connect hoses as tagged during removal to pedal valve (1, Figure 49).
5. Install cabin under cover by tightening bolts.

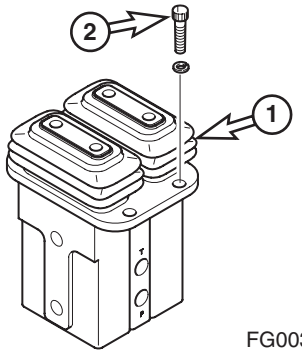
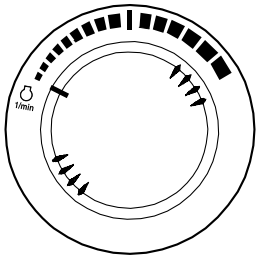


Figure 49

START-UP PROCEDURES

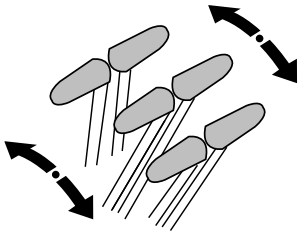
1. Start engine and set throttle at "LOW IDLE."
2. Set safety lever on "UNLOCK" position.



HAOB290L

Figure 50

3. Slowly push and pull both travel lever about five times without a load to vent air from pilot lines.



HAOB903L

Figure 51

Solenoid Valve Assembly

Edition 1

MEMO

Table of Contents

Solenoid Valve Assembly

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Applicable Models..... 5

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Functions of 5-Solenoid Valve Assembly Package..... 8

- Functions of Solenoid Valve Assembly Package..... 8
- Assembly Diagram and Tools Required 10
- Solenoid Valve Diagram 12
- Check Points and Solutions for Problems 13

MEMO

SAFETY PRECAUTIONS

CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

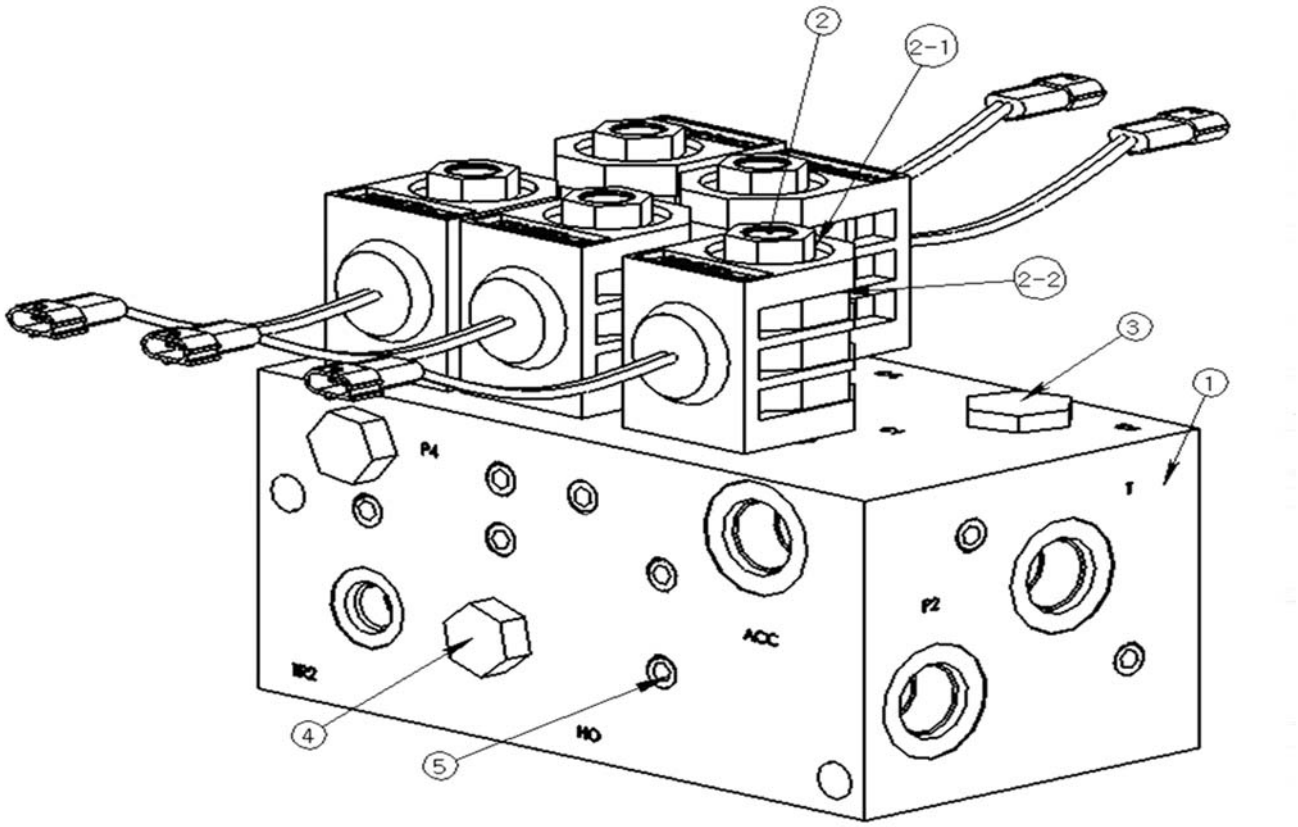
APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX300LL	5001 and Up
DX340LC	5001 and Up
DX380LC	5001 and Up

PARTS LIST

Components used for the solenoid valve package are the same as in the parts list below.



FG005305

Figure 1

Reference Number	Description	Sizes	Quantity	Remarks
1	Block Body	95x110x200	1	1-A1073-05-0
2	Solenoid valve	TF-S3A-00	5	C1, C2, C3, C4, C5
3	Check Valve	FD-DCP-0-A	1	C6
4	Plug	PF 1/4"	3	P4, P5, H0
5	Plug	PT 1/8"	9	

FUNCTIONS OF 5-SOLENOID VALVE ASSEMBLY PACKAGE

Functions of Solenoid Valve Assembly Package

This solenoid valve assembly package have the following functions.

1. Pilot cutoff
2. Breaker pressure supply
3. High travel speed
4. Main pressure increase
5. Work modes control - Swing Priority

Functions and operations of solenoid valves

Reference Number	Function	Operations	Remarks
C1	Pilot Cutoff	Provides pressure and oil from the pilot pump for the pilot pressure supply solenoid valve to drive each work system.	
C2	Breaker Operation	Supplies pilot pressure for the breaker valve assembly and the breaker pressure supply solenoid valve.	
C3	High Travel Speed	Sets low travel speed and high travel speed, of shifts speed between both depending on the state of the solenoid valve operation or a signal detected in the e-EPOS controller.	
C4	Main Pressure Increase	Increases the pressure set for the main relief valve temporally to increase the excavation power.	
C5	Work Modes Control	Operating the C5 solenoid valve starts the Swing Priority valve of the main control valve to improve swing operation.	

Detailed Functions and Operations of Solenoid Valves

1. Pilot Cutoff

   It provides pressure and oil from the pilot pump for breaker solenoid valve (C2), high travel speed solenoid valve (C3), main pressure increase solenoid valve (C4), and the work modes control solenoid valve (C5). Push down the Cutoff lever located on the left side of the driver's seat, and the electrical signal of the limit switch starts the pilot cutoff valve to supply pressure and oil to each pilot pressure supply solenoid valve.

2. Breaker pressure supply

   Pressing the breaker switch on the joystick operates the breaker solenoid valve (C2) to supply pilot pressure to the option valve of the main control valve. The pressure switches the spool of the option valve, which transfers pressure and oil from the main pump to the breaker system.

3. High travel speed control

   When the automatic travel switch is "OFF," the travel speed switches to "0" (low speed); when the switch is turned to the 1st position, the travel speed switches to "I" (high-speed); when the switch is turned to the 2nd position, the travel speed switches to "II," automatically. In this case, the high travel speed control shows "OFF" when the automatic travel switch is "OFF," "ON" when it is in the 1st position, and "ON/OFF" when it is in the 2nd position. Turning the automatic travel switch to the 2nd position, the e-EPOS controller detects the discharge pressure from the main pump, and automatically turns the high travel speed control "ON" or "OFF" depending on if the travel load is high or low to switch the travel speed to speed 1 or 2. The travel load is detected by 2 pressure sensors located on the discharge line of the front and rear pumps. If the load is high (pressure about 300 kg•cm^2), the solenoid valve turns "OFF" for ~~the~~ travel at low; If the load is low (pressure about 160 kg•cm^2), the solenoid valve turns "ON" for the travel at high. If the engine control dial is set equal and below 1400 rpm, however, the solenoid valve always turns "ON" for the travel at low, though automatic travel switch is set to the automatic travel (2nd position).

4. Boost main pressure

   It increases the pressure of the main relief valve temporarily to increase excavation power. Pressing the power boost switch on the work lever; also sends the signal of the e-EPOS controller to start the pressure increase solenoid valve. Then, as it turns "ON," the pressure of the main relief valve increases about 330 - 350 kg•cm^2, which in turn increases the excavation power.

5. Work modes control

   A work mode can be chosen as either Excavation or Trenching mode using a Trenching mode switch on the operation panel.

   Turning on the starter switch, Excavation is automatically accepted as the work mode and the Swing Priority solenoid valve turns "OFF."

   This Excavation mode is used for ordinary excavation work, loading, and fast levelling work.

   Choosing the Trenching mode on the operation panel the Swing Priority solenoid valve for the control valve turns "ON" and starts to work, reducing the oil lines to booms and arms to increase the swing capacity.

Assembly Diagram and Tools Required

Table 1 shows assembly torques recommended for components of the solenoid valve package. Designated tools and torques should be followed.

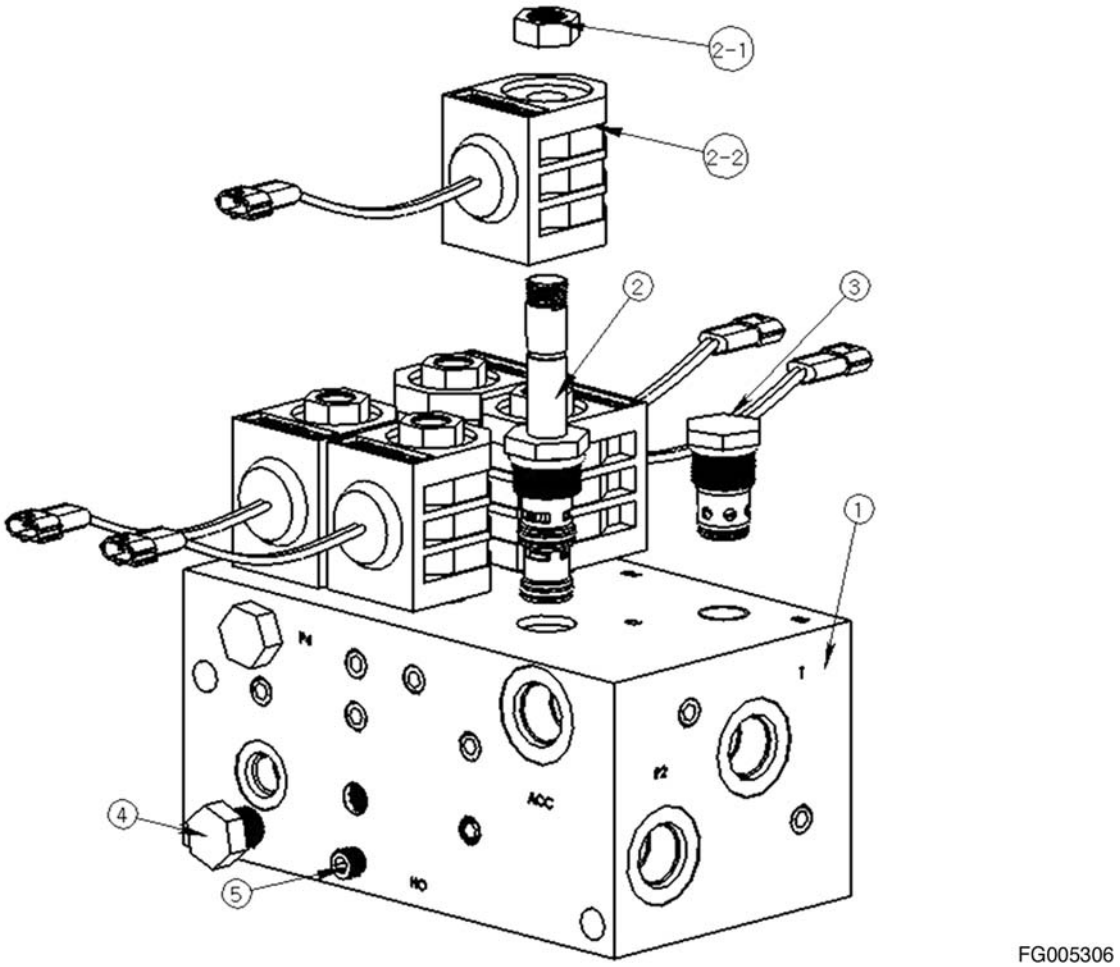


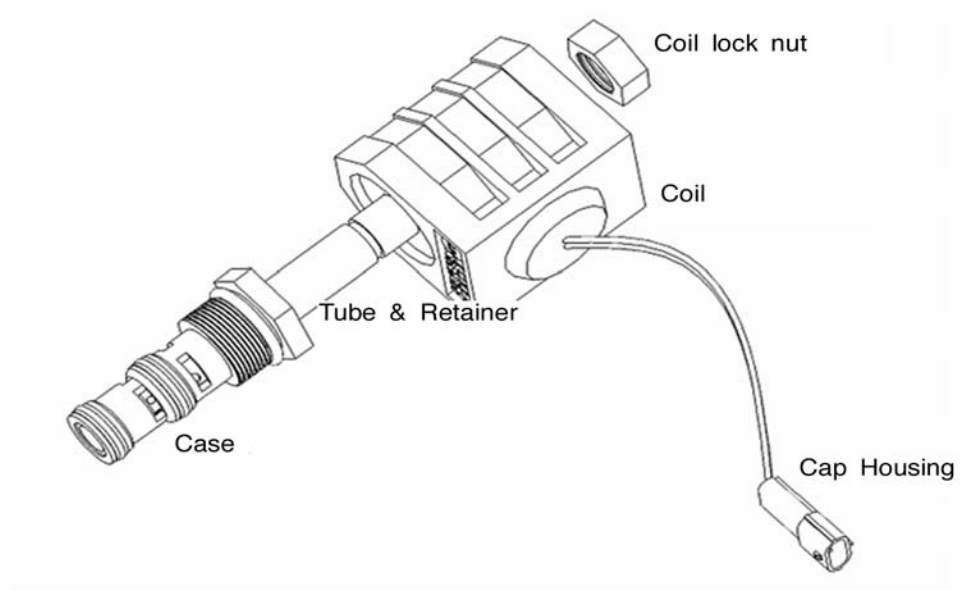
Figure 2

Reference Number	Components	Screw Sizes	Torques (kg•cm)	Tools
2	Solenoid Valve	UNF7/8 - 14"	200 ±25	Hex torque wrench/1," socket
2-1	Coil Locknut	UNF1/2 -20"	60 ±2	Hex torque wrench/ 19 mm, socket
3	Check Valve	UNF7/8 - 14"	400 ±2	Hex torque wrench/1," socket
4	PT 1/4" Plug	PF 1/4 19"	250 ±25	Torque wrench/ 19 mm, socket
5	PT 1/8" Plug Bolt	PT 1/8 28"	280	Torque wrench/ 5 mm, wrench socket

Cautions During Disassembly and Reassembly

1. Wipe dust and dirt in the area where disassembly and reassembly will be performed.
2. For disassembly and reassembly, standard torques and tools stated in Table in should be used.
3. The directions of disassembly and reassembly are same as the "Disassembly Direction" and "Reassembly Direction" as shown in Figure 2.
4. Disassembly and reassembly of the solenoid valve
   A. Remove coil locknut (2-1) by turning it in the Disassembly Direction.
      – Be careful not to damage the valve tube and the retainer when disassembling the coil locknut.
      – If the valve tube or the retainer is damaged (bent or deformed), the solenoid valve may not operate.
   B. Grip the coil (2-2) with a hand and pull it out.
   C. Remove solenoid valve (2) by turning it in the Disassembly Direction.
   D. Check disassembled components, and reassemble them in the reverse order of the disassembly.
   E. Torque should not be excessive when assembling he solenoid valve and coil.
      – Excessive torque may damage the solenoid valve.
5. Be careful not allow any contaminants to flow into the package valve during reassembly after disassembly and check procedures.
6. Every component should be washed out before reassembly.

Solenoid Valve Diagram



FG004537

Figure 3

Check Points and Solutions for Problems

Symptoms	Causes	How to Check	Solutions
Malfunction of solenoid valve	Foreign substance, dirt, dust in solenoid valve	Disassemble the solenoid valve concerned and check if there are any contaminant such as foreign substance and sludge between the case and the spool.	Remove contaminant, wash, and assemble compartments.
	Tube or retainer of solenoid valve damaged	Disassemble the solenoid valve concerned and check if there is any deformation (bending or reduction) in the tube or the retainer.	Replace the solenoid valve.
	Coil broken, short, or burned	Disassemble the solenoid valve concerned and check the resistance of the coil. Spec: 26.7Ω @ 20°C Disconnection: ∞ Short: Low or excessive resistance Disassemble the solenoid valve concerned and check the outside of the coil to see if its molding is burned and melted.	Replace the coil.
	Connector terminal earth defect	Check if the cap housing (where coil lead is attached) and the housing (across its length) are earthed properly.	Replace housing or terminal concerned.
Pilot pressure fails to generate	Pilot pressure	Remove plug of the "P5" port, set up a pressure gauge, and check the pilot pressure discharged from the pilot pump when operating the cutoff (C1) valve.	Refer to Causes and How to Check of the solenoid valve above.
	Pilot relief valve	Check if the relief valve installed in the pilot line operates properly. • Check if pressure is bypassed because of the presence of foreign substance.	Remove foreign substance, reassemble, and replace the relief valve.
	Pilot pump	Check if the pilot pump works properly.	Replace the pilot pump.
	Pilot filter	Check if the mesh screen of the pilot filter is contaminated by foreign substance.	Wash, reassemble, and replace the filter
Poor Actuator Performance	Pilot system	Check any defect of the pilot system considering findings from "Pilot pressure fails to generate" category.	Treat defect (s) accordingly.
	Solenoid valve	Set up a pressure gauge at each outlet port of the solenoid valve concerned (HO, TR2, PH, and SP ports) and check the pressure value discharged from the pilot pump when operating the solenoid valve.	Refer to causes and how to check of the solenoid valve above.
	Main control valve	Check if main control valve of each component works properly.	Treat according to findings.
	Other components	Check if each component works properly.	Treat according to findings.

Checking of Pilot Pressure for Defects

Port where pressure gauge set up	Screw size	Remark
P1, P3, P4, P5, P6, TR2, PH, HO, SP	PF1/4" O-ring BOSS	Operate the solenoid valve concerned (ON).

Breaker EPPR Valve (Opt)

Edition 1

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Breaker EPPR Valve (Opt)

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SAFETY PRECAUTIONS

⚠ CAUTION!

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling the load.

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX180LC	5001 and Up
DX210W	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX340LC	5001 and Up
DX420LC	5001 and Up
DX480LC	5001 and Up
DX520LC	5001 and Up

STRUCTURE

Numbers and Names of Parts

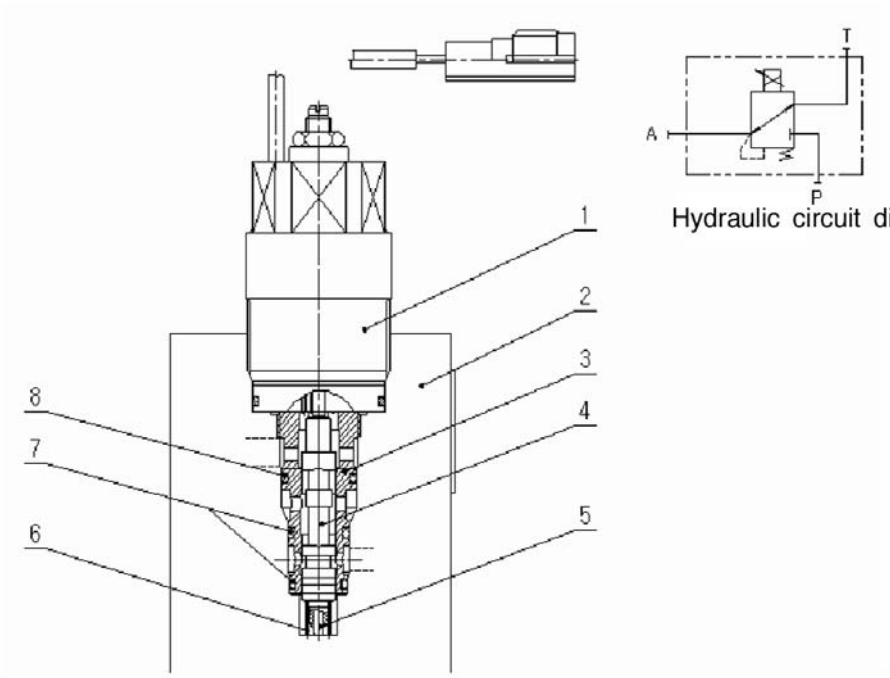


Figure 4

Reference Number	Description
1	Solenoid
2	Valve casing
3	Sleeve
4	Spool

Reference Number	Description
5	Pin
6	Spring
7	O-ring
8	O-ring

FUNCTIONS AND OPERATION

The proportional reducing valve should be adjusted so its reduced pressure is proportional to the current of the solenoid.

The proportional solenoid should conform to a pressure proportionate to the electrical input signal. Flow increases corresponding to the force of the solenoid. As the solenoid (1) receives pressure, the spool (4) opens and oil flows from P to A. Pressure of the port A influences the top surface of the pin (5). When it reaches the valve setting of the solenoid, the spool starts to move and oil flow from P to A decreases.

CAUTIONS FOR OPERATION

1. Wiring of the solenoid
    - The solenoid has no polarity.
2. Input electricity
    - Do not supply electric current more than 0.7A to the solenoid coil.
3. Adjustment screw
    - It was adjusted to the standard.
    - The pressure of the port A increases when turning the adjustment screw clockwise.
4. Symptoms and Solutions of Problems

Problem	Possible Cause	Remedy
Pressure does not increase nor change	Poor wiring	Fix wiring
	Solenoid damaged	Replace the solenoid
	Piston or spool stuck	Fix, or clean and grind
	Amplifier damaged	Repair or replace the amplifier
Unnatural pressure change	Poor opening space Too wide Too narrow	Readjust
	Piston or spool stuck	Fix, or clean and grind
Unnatural pressure	Poor opening space Too wide Too narrow	Readjust
Slow reaction	Low-pressure supplied	Readjust

MAINTENANCE INSTRUCTIONS

Maintenance

Bolt Tightening Torque

Table 1 shows torques used to tighten bolts of the motor.

Make sure that assembly work should be done according to Table 1.

Bolt Sizes	Names	Used Torques (kg•cm)
M 35	Hex bolt	450 ±50
M 10	Hex bolt	200 ±20
NPTF 1/16	Plug	90

Tools Used for Disassembly and Assembly

Table 2 shows tools necessary for disassembly and assembly.

For	Sizes	Used Torques	Used Tools
Solenoid	M 35	450 ±50	Wrench
Sleeve	M 10	200 ±20	Hex bar wrench
NPTF plug	1/16	90	Hex bar wrench

Disassembly

1. Determine a place for disassembly.
   - It should be clean.
   - Lay a rubber board or a cloth on the table and take care not to damage parts.
2. Remove dust and rust from proportional pressure reducing valve with cleansing oil.
3. Disassemble the solenoid
   - Be careful not to damage O-rings of the solenoid.



Figure 5

4. Disassemble the spool, the spring, and the pin.



Figure 6

5. Disassemble the sleeve.
   - Be careful not to damage O-rings of the sleeve.



Figure 7

Assembly

Assembly shall be done in the reverse order of disassembly described above, taking into consideration the following points.

- Parts damaged during disassembly should be repaired without fail and spare parts should be prepared in advance.
- Every part should be cleaned thoroughly with cleaning oil and dried with compressed air before starting assembly.
- Sliding parts and bearings should be cleaned and coated with hydraulic oil before their assembly.
- Always replace O-rings and the oil seals.
- Use a torque wrench to tighten or engage bolts and plugs in accordance with reference torques as listed.

1. Assemble the sleeve.



Figure 8

- Be careful not to damage O-rings of the sleeve.



Figure 9

2. Assemble the spool, the spring, and the pin.



Figure 10

- The spring and the pin should not fall off and must remain in place during installation.



Figure 11

3. Assemble the solenoid correctly.



Figure 12

- Be careful not to damage solenoid O-rings.



Figure 13

Hydraulic Schematic (DX225LC)

Edition 1

MEMO

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Hydraulic Schematic (DX225LC)

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MEMO

SAFETY PRECAUTIONS

CAUTION!

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APPLICABLE MODELS

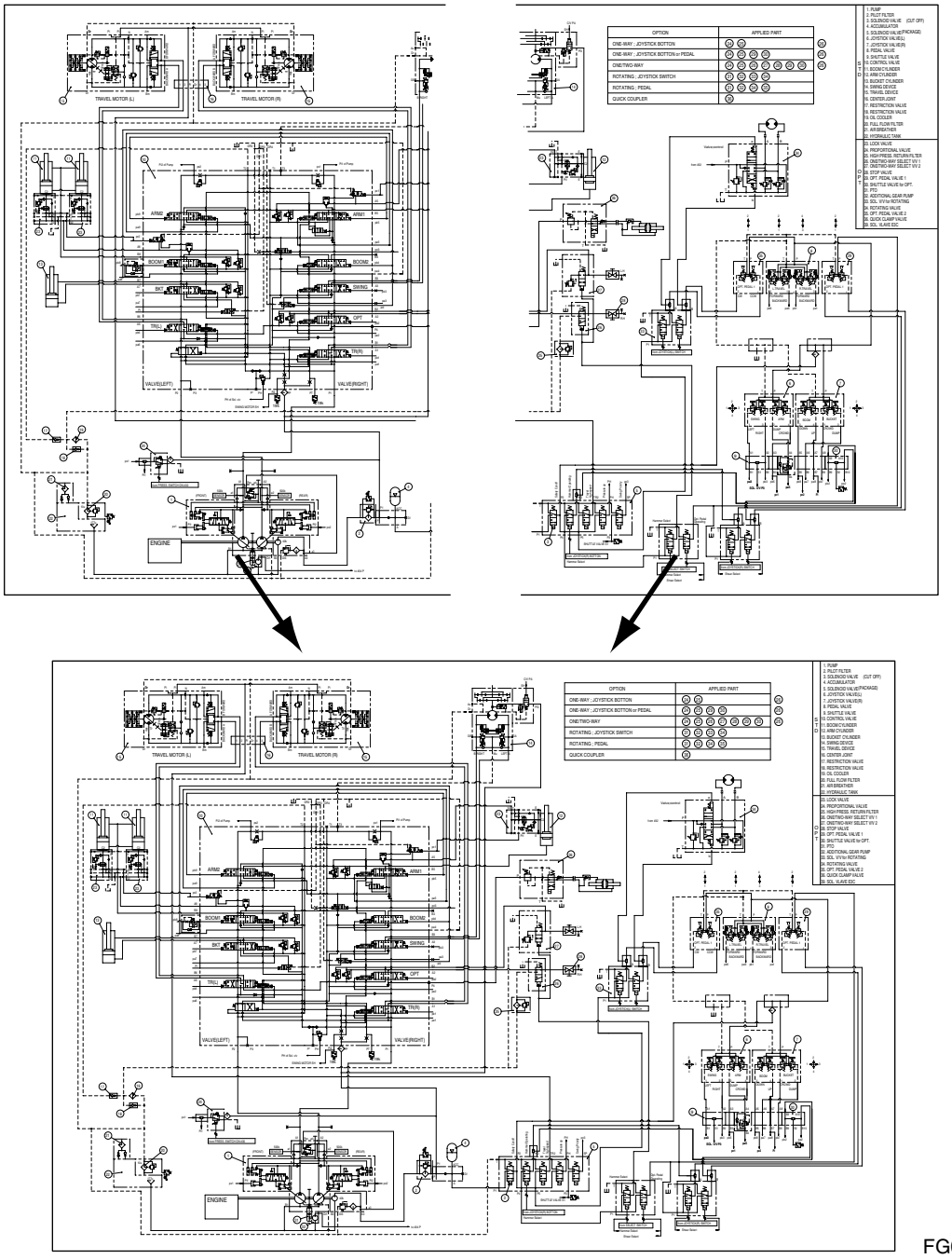
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up

GENERAL DESCRIPTION

Schematic (s) presented in this section are laid out on facing pages.

An overlapping edge has been taken into consideration so a photocopy can be made and pasted together to make a complete schematic.



FG001424

Figure 1

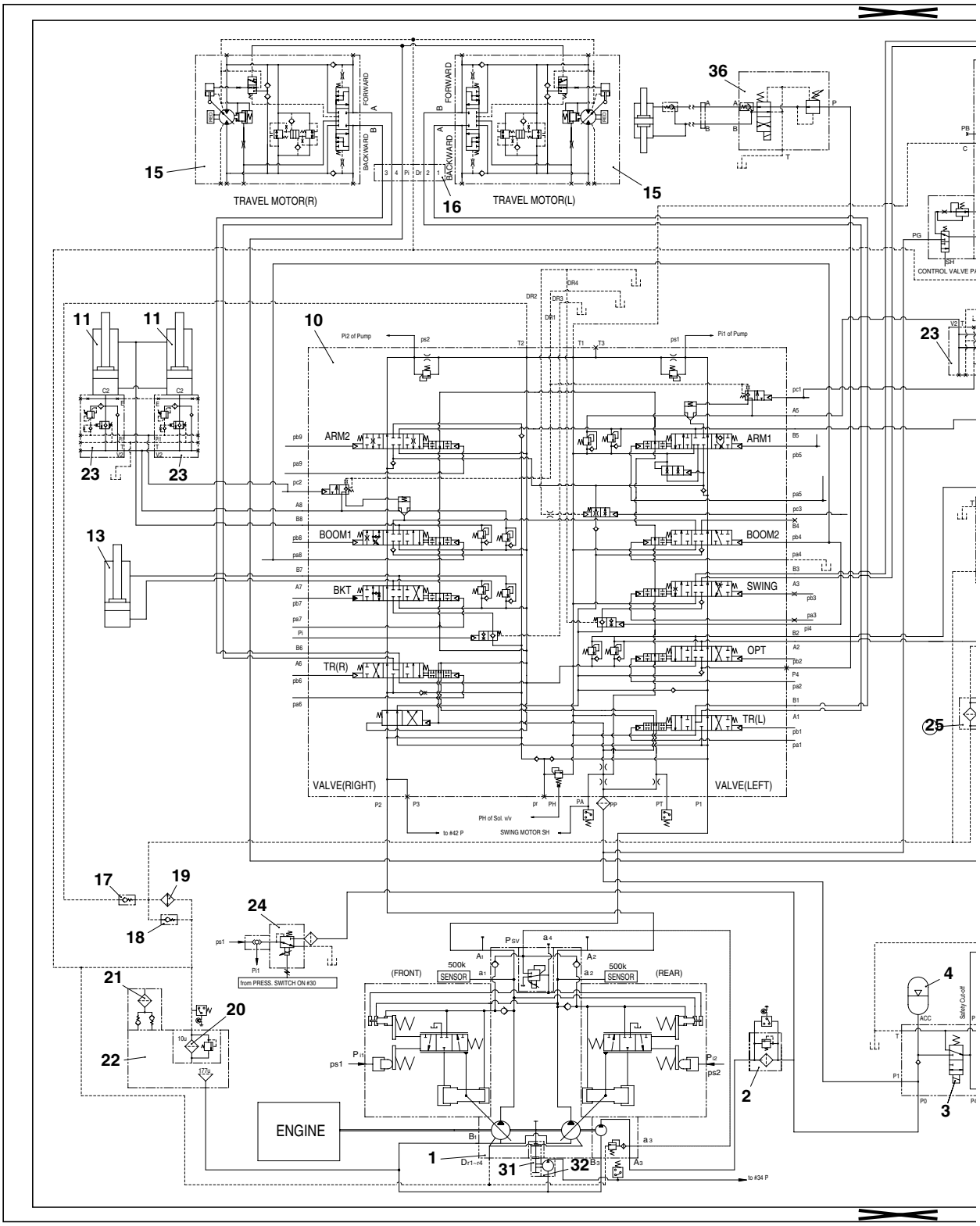
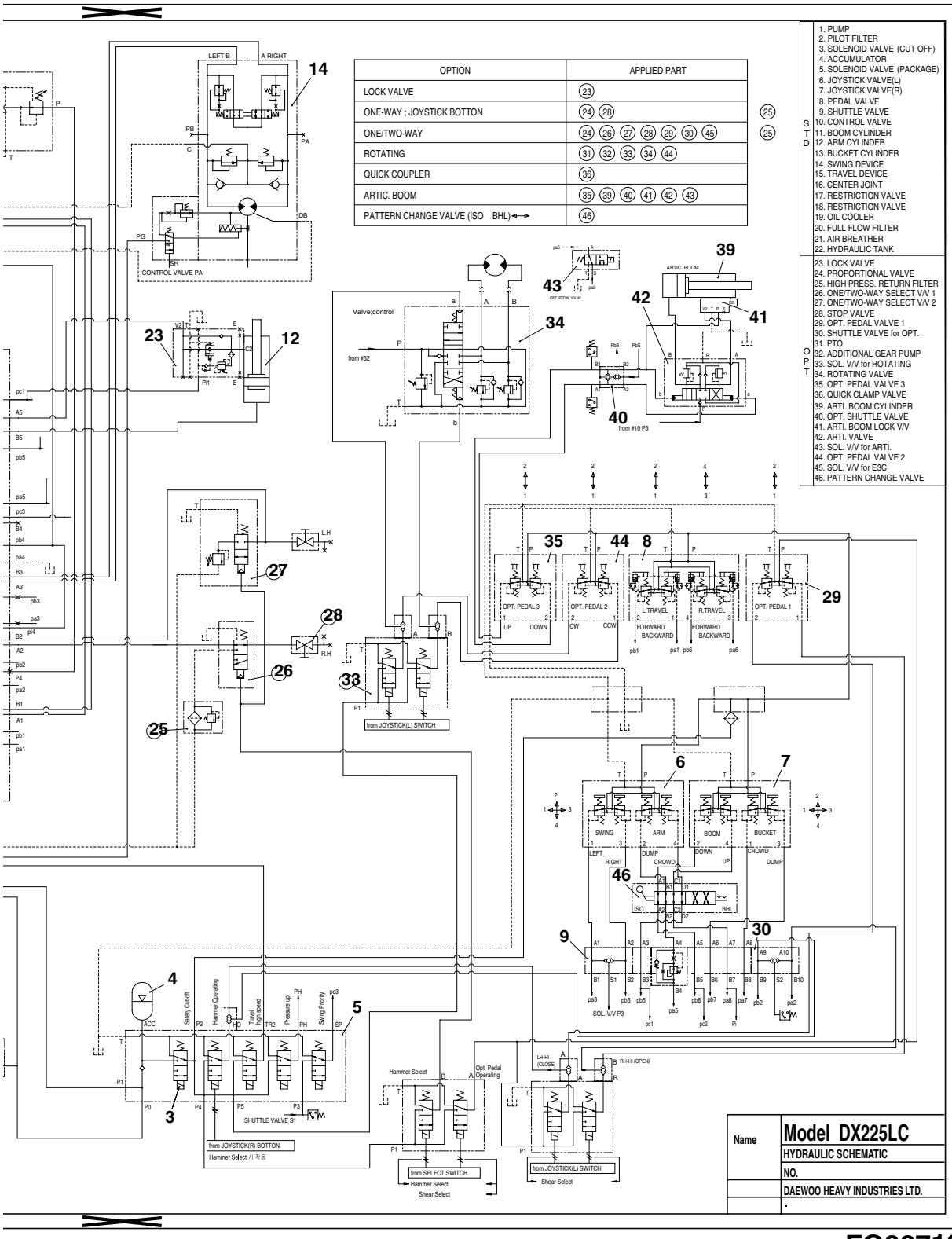

TRAVEL MOTOR(R)
TRAVEL MOTOR(L)
FORWARD
BACKWARD
CONTROL VALVE P/
ARM2
ARM1
BOOM1
BOOM2
BKT
SWING
OPT
TR(R)
TR(L)
VALVE(RIGHT)
VALVE(LEFT)
PI2 of Pump
PI1 of Pump
PH of Sol. v/v
SWING MOTOR SH
to #42 P
to #34 P
from PRESS. SWITCH ON #30
(FRONT)
(REAR)
500k
SENSOR
ENGINE
ACC
Safety Cut-off
10u
177u
15
16
36
11
10
23
13
25
17
19
18
24
21
20
22
4
2
3
1
31
32

Figure 2


OPTION
APPLIED PART
LOCK VALVE
ONE-WAY ; JOYSTICK BOTTON
ONE/TWO-WAY
ROTATING
QUICK COUPLER
ARTIC. BOOM
PATTERN CHANGE VALVE (ISO BHL)
STD
1. PUMP
2. PILOT FILTER
3. SOLENOID VALVE (CUT OFF)
4. ACCUMULATOR
5. SOLENOID VALVE (PACKAGE)
6. JOYSTICK VALVE(L)
7. JOYSTICK VALVE(R)
8. PEDAL VALVE
9. SHUTTLE VALVE
10. CONTROL VALVE
11. BOOM CYLINDER
12. ARM CYLINDER
13. BUCKET CYLINDER
14. SWING DEVICE
15. TRAVEL DEVICE
16. CENTER JOINT
17. RESTRICTION VALVE
18. RESTRICTION VALVE
19. OIL COOLER
20. FULL FLOW FILTER
21. AIR BREATHER
22. HYDRAULIC TANK
OPT
23. LOCK VALVE
24. PROPORTIONAL VALVE
25. HIGH PRESS. RETURN FILTER
26. ONE/TWO-WAY SELECT V/V 1
27. ONE/TWO-WAY SELECT V/V 2
28. STOP VALVE
29. OPT. PEDAL VALVE 1
30. SHUTTLE VALVE for OPT.
31. PTO
32. ADDITIONAL GEAR PUMP
33. SOL. V/V for ROTATING
34. ROTATING VALVE
35. OPT. PEDAL VALVE 3
36. QUICK CLAMP VALVE
39. ARTI. BOOM CYLINDER
40. OPT. SHUTTLE VALVE
41. ARTI. BOOM LOCK V/V
42. ARTI. VALVE
43. SOL. V/V for ARTI.
44. OPT. PEDAL VALVE 2
45. SOL. V/V for E3C
46. PATTERN CHANGE VALVE
CONTROL VALVE PA
LEFT B
A RIGHT
PB
PA
DB
PG
SH
Valve;control
from #32
ARTIC. BOOM
from #10 P3
OPT. PEDAL 3
OPT. PEDAL 2
L.TRAVEL
R.TRAVEL
OPT. PEDAL 1
UP
DOWN
CW
CCW
FORWARD
BACKWARD
SWING
ARM
BOOM
BUCKET
LEFT
RIGHT
DUMP
CROWD
ISO
BHL
SOL. V/V P3
ACC
Safety Cut-off
Hammer Operating
Travel high speed
Preasure up
Swing Priority
SHUTTLE VALVE S1
from JOYSTICK(R) BOTTON
Hammer Select 시 작동
from JOYSTICK(L) SWITCH
Hammer Select
Opt. Pedal Operating
LH-HI (CLOSE)
RH-HI (OPEN)
from SELECT SWITCH
Hammer Select
Shear Select
from JOYSTICK(L) SWITCH
Shear Select
Name
Model DX225LC
HYDRAULIC SCHEMATIC
NO.
DAEWOO HEAVY INDUSTRIES LTD.

FG007134

Electrical System

Electrical System

Edition 1

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Audio Controller Circuit Diagram 125

SAFETY PRECAUTIONS

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APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up
DX225NLC	5001 and Up

INTRODUCTION

The electrical system for this equipment is DC 24 volts. The rated voltage for all electrical components is 24 volts with the exception of the stereo and the air-conditioning control actuator. The system contains two 12 volt batteries connected in series and a three phase AC generator with a rectifier. The electrical wiring used in the system is easily identifiable by the insulator color. The color symbols used in the electrical system are listed in the following chart.

Electrical Wire Color

Symbol	Color
W	White
G	Green
Or	Orange
B	Black
L	Blue
Lg	Light green
R	Red
Gr	Gray
P	Pink
Y	Yellow
Br	Brown
V	Violet

NOTE: *RW: Red wire with White stripe*

R - Base Color, W - Stripe Color

NOTE: *0.85G: Nominal sectional area of wire core less insulator = 0.85 mm^2*

ELECTRICAL SUPPLY SYSTEM

The electric power circuit supplies electric current to each electric component. It consists of a battery, battery relay, starter switch, circuit breaker, fusible link and fuse box.

The negative terminal of the battery is grounded to the vehicle body.

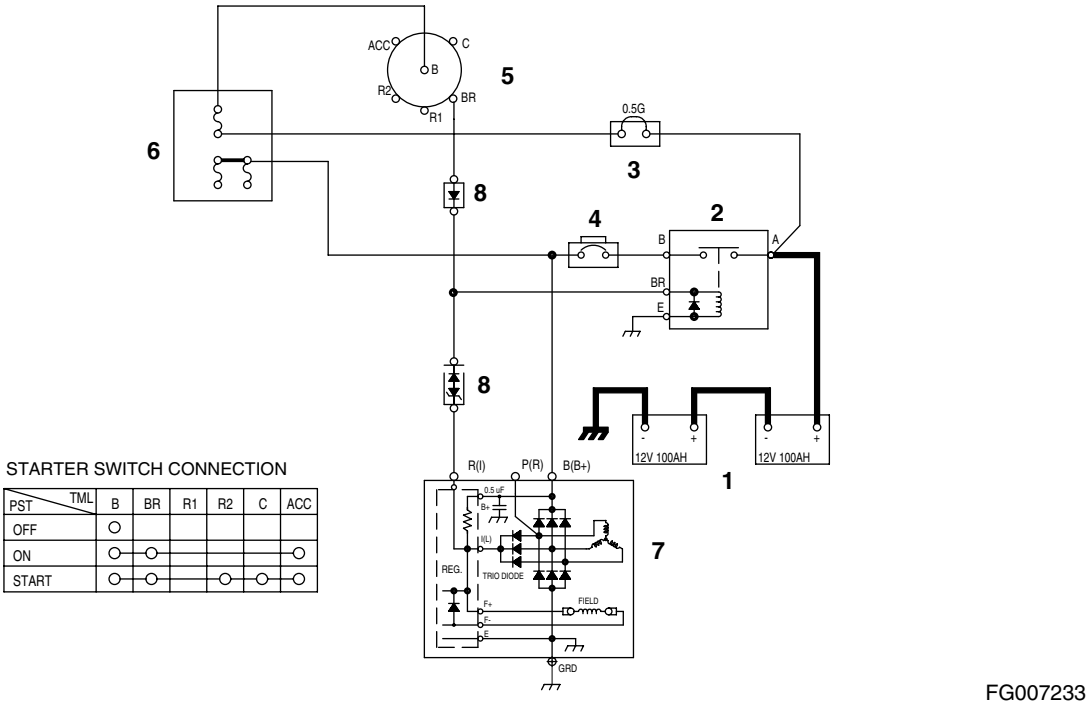
Even when the starter switch (5) is in the "OFF" position, electric current is supplied to the following components through battery (1) → fusible link (3) → fuse box (6).

1. Terminal "1" of DC-DC converter (for memory backup of stereo)
2. Terminal "B" of starter switch
3. Hour meter
4. Engine controller
5. Fuel feeder pump switch
6. Terminal "6" of wiper motor
7. Terminal "13" of wiper controller
8. Terminal "CN6-11" of instrument panel
9. Terminal "CN9-6" of air conditioner panel
10. Cabin light

When the starter switch (5) is in the "ON or START" positions, the current flows from the battery (1) → fusible link (3) → fuse box (6) → "B" terminal of starter switch (5) → "BR" terminal of starter switch (5) → "BR" terminal of battery relay (2) which activates the coil of the battery relay and the electric supply system is energized.

When the battery relay's contacts are connected, all electric devices can be operated.

While the engine is not running, the electric power for all electric devices are supplied by the battery. Once the engine is started the power is supplied from the alternator (7).



FG007233

Figure 1 ELECTRIC POWER CIRCUIT DIAGRAM

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker

Reference Number	Description
5	Starter Switch
6	Fuse Box
7	Alternator
8	Diode

ENGINE STARTING CIRCUIT

Start Operation

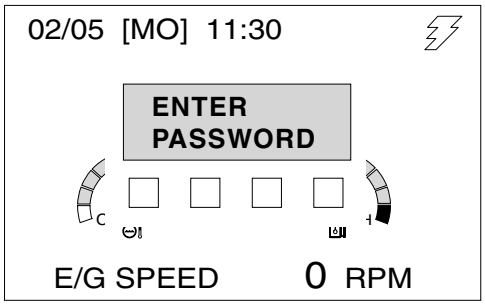
When the starter switch is turned to the "START" position, the "S" and "E" terminals of the starter controller (7) are connected. At this time the contacts in the starter relay (8) are closed by the current flow from the battery (1) → fusible link (3) → fuse box (6) → "B" terminal of starter switch (5) → "C" terminal of starter switch (5) → "30" terminal of starter relay (12) - "87a" terminal → "C" terminal of starter relay (8) - "D" terminal → "S" terminal of starter controller (7) - "E" terminal → ground.

When the contact point "B" and "PP" of starter relay (8) are connected, the pinion gear of the starter (9) is pushed forward and makes contact with the ring gear of the flywheel and the internal contacts of the starter are connected. The current flows from the battery (1) → "A" terminal of the battery relay (2) → "B" terminal of the battery relay (2, Figure 3) → "B" terminal of the starter (9). The starter motor is rotated and the engine is started.

If the instrument panel has the password function activated, input number should match the set number, otherwise the start circuit closes and the engine does not start.

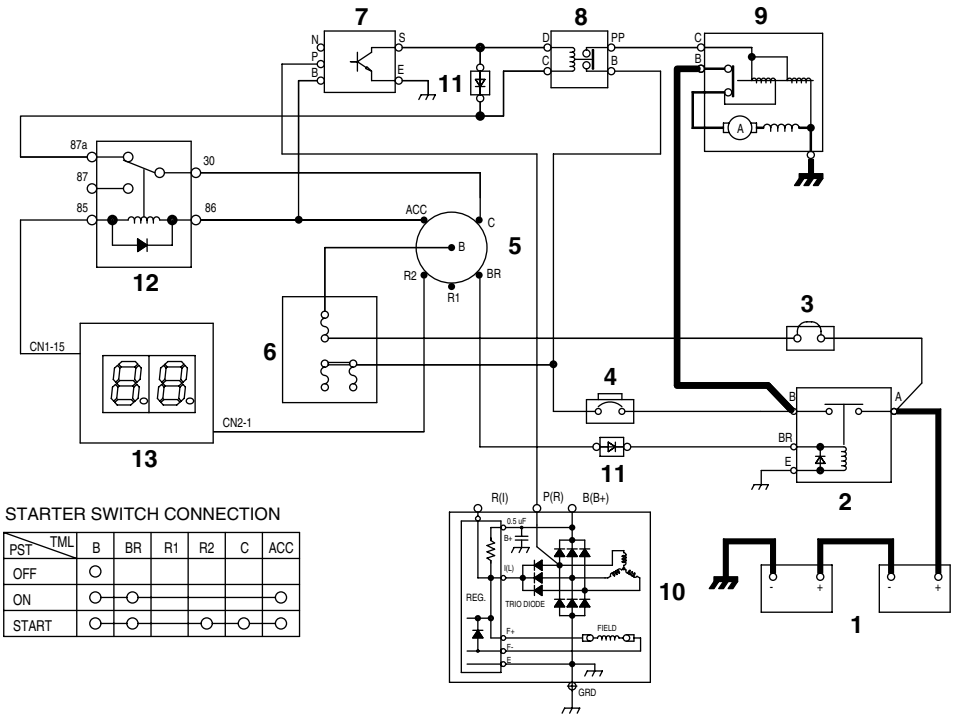
NOTE: *If the security system is "LOCKED," a four-digit password will be required to start the engine. If the system is "UNLOCKED," no password will be required and this display screen will not appear.*

In the event the security system is locked, current flows from battery (1) → fusible link (3) → fuse box (6) → "B" terminal of starter switch (5) → "ACC" terminal of starter switch (5) → "86" terminal of starter relay (12) → "85" terminal of starter relay (12) → "CN1-15" terminal of e-EPOS (13) → ground. This current flow causes the coil in starter relay (12) to be activated, opening contacts at "87a" terminal. This prevents starter relay (8) from functioning.



FG001445

Figure 2



FG007234

Figure 3 STARTER CIRCUIT (1) - WHILE STARTING

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch
6	Fuse Box
7	Starter Controller

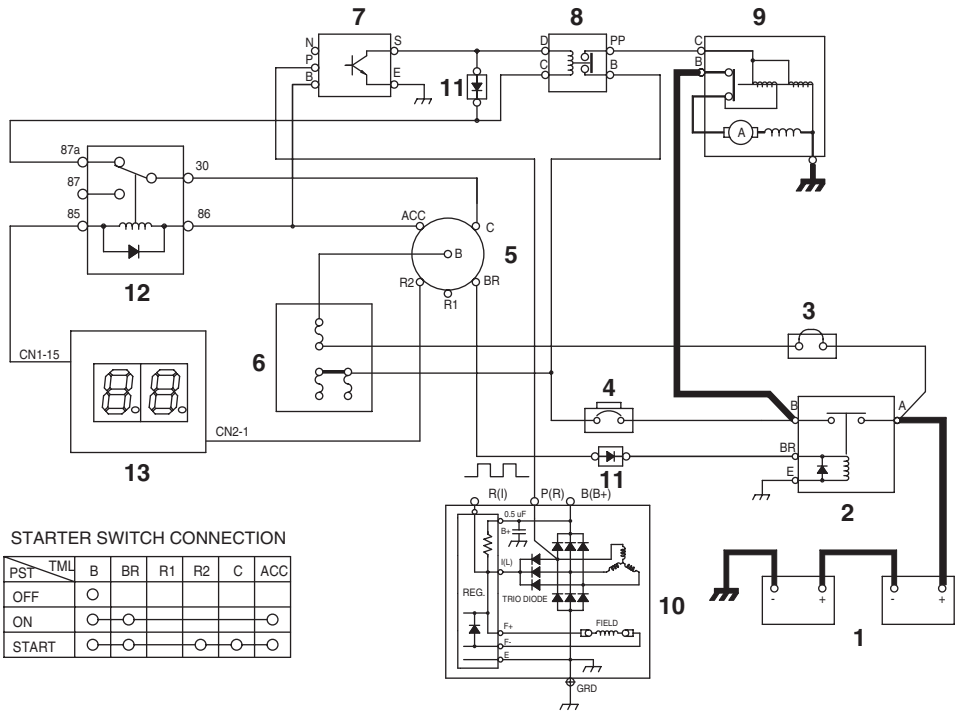
Reference Number	Description
8	Starter Relay
9	Starter
10	Alternator
11	Diode
12	Starter Relay 2
13	e-EPOS Controller

After Start

Once the engine has been started, the belt driven alternator (10) generates a current.

The output generated by the alternator (10) is a square wave pulse voltage through the "P" terminal and the frequency of the pulse voltage is proportional to the rotation of the alternator.

The starter controller (7) monitors the frequency of the output current. Once the frequency is equivalent to 500 rpm, it is sensed and the connection between "S" and "E" terminals and the connection between "B" and "PP" terminals are opened. As a result the rotation of the starter (9) is stopped. Once the engine is running, the starter (9) will not operate even if the starter switch (5) is moved to the start position, preventing possible damage to the starter.



FG007237

Figure 4 OPERATION OF START CIRCUIT (2) - IMMEDIATELY AFTER START

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch
6	Fuse Box
7	Starter Controller

Reference Number	Description
8	Starter Relay
9	Starter
10	Alternator
11	Diode
12	Starter Relay 2
13	e-EPOS Controller

ENGINE PREHEATING SYSTEM

An air heater (8) is installed in the intake manifold of the engine. When the starter switch (5) is turned "ON," the current flows from the battery (1) → fusible link (3) → fuse box (6) → "B" terminal of starter switch (5) → "BR" terminal of starter switch (5) → "1-39" terminal of engine controller (12), causing current to flow though "1-16" terminal of engine controller (12) → "C and D" terminals of preheat relay (7) → "1-04" terminals of engine controller (12) → ground.

This current flow causes the coil in preheat relay (7) to be activated, closing contacts.

When the contacts of the preheat relay (7) are closed, the heating coils of the air heating device (8) are heated by current flowing from the battery (1) → battery relay (2) → preheat relay (7) → air heater (8) → ground.

The duration of the heating cycle depends on the temperature of engine coolant. The preheat indicator light in the instrument panel (9) will turn "ON" during preheating cycle.

The preheat relay (7) is controlled by the engine controller (12) and operates only at temperatures of 10°C (50°F) and below.

The longer the preheating period, the lower the temperature of coolant is.

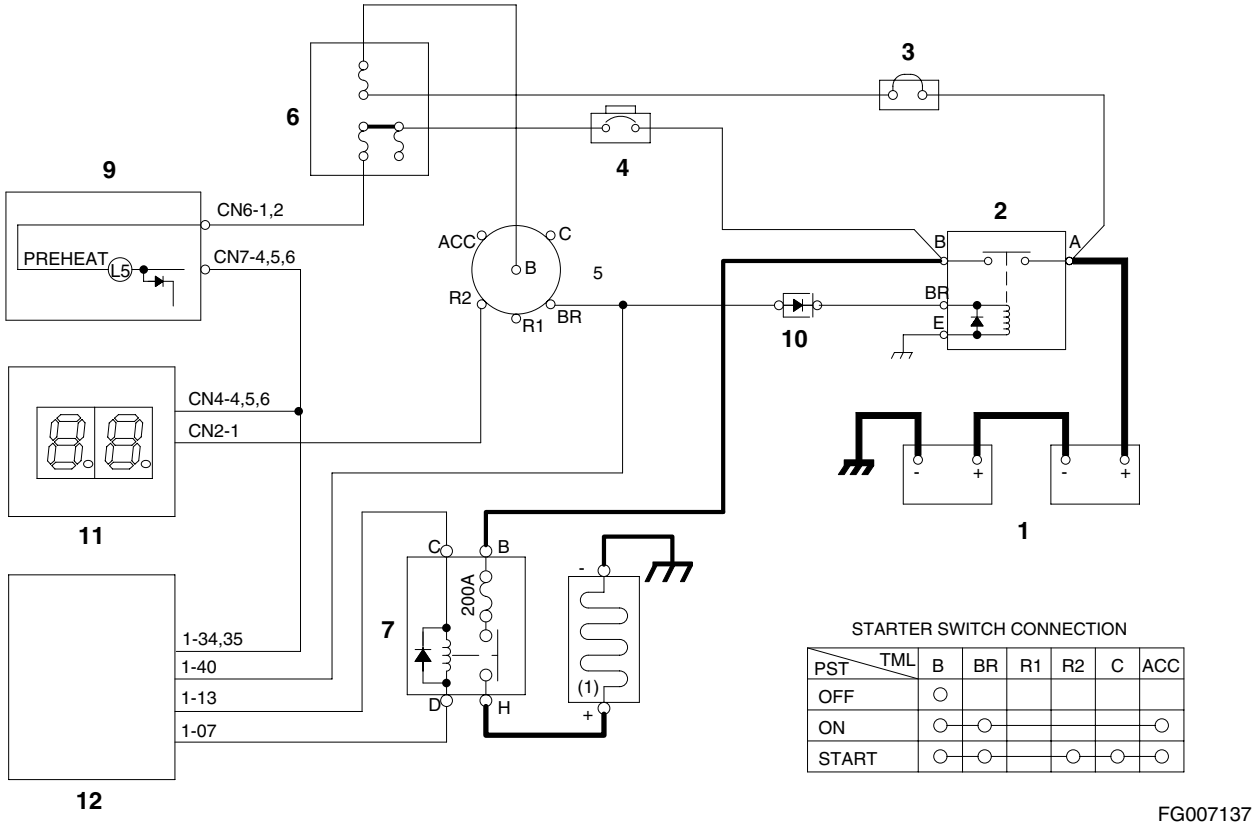


Figure 5 ENGINE PREHEAT CIRCUIT

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch
6	Fuse Box

Reference Number	Description
7	Preheat Relay
8	Air Heater
9	Preheat Indicator Light
10	Diode
11	e-EPOS Controller
12	Engine Controller

ENGINE STOP

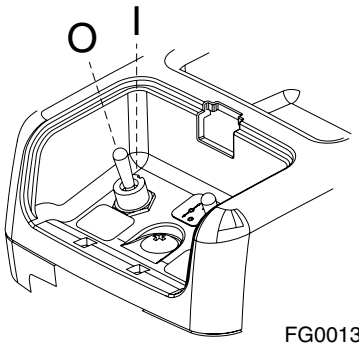
When starter switch (5) is turned "ON" the engine controller (8) is activated. The engine controller monitors and controls the engine including the injector solenoid (9). It controls the fuel deliver rate and the injection timing for each cylinder.

NOTE: *There is an individual injector solenoid (9) for each of the six cylinders. Only one solenoid is shown in Figure 7.*

When starter switch (5) is turned "OFF," the engine controller stops suppling power to the injector solenoid (9). This stops fuel from being injected into the engine cylinder, thus stopping the engine.

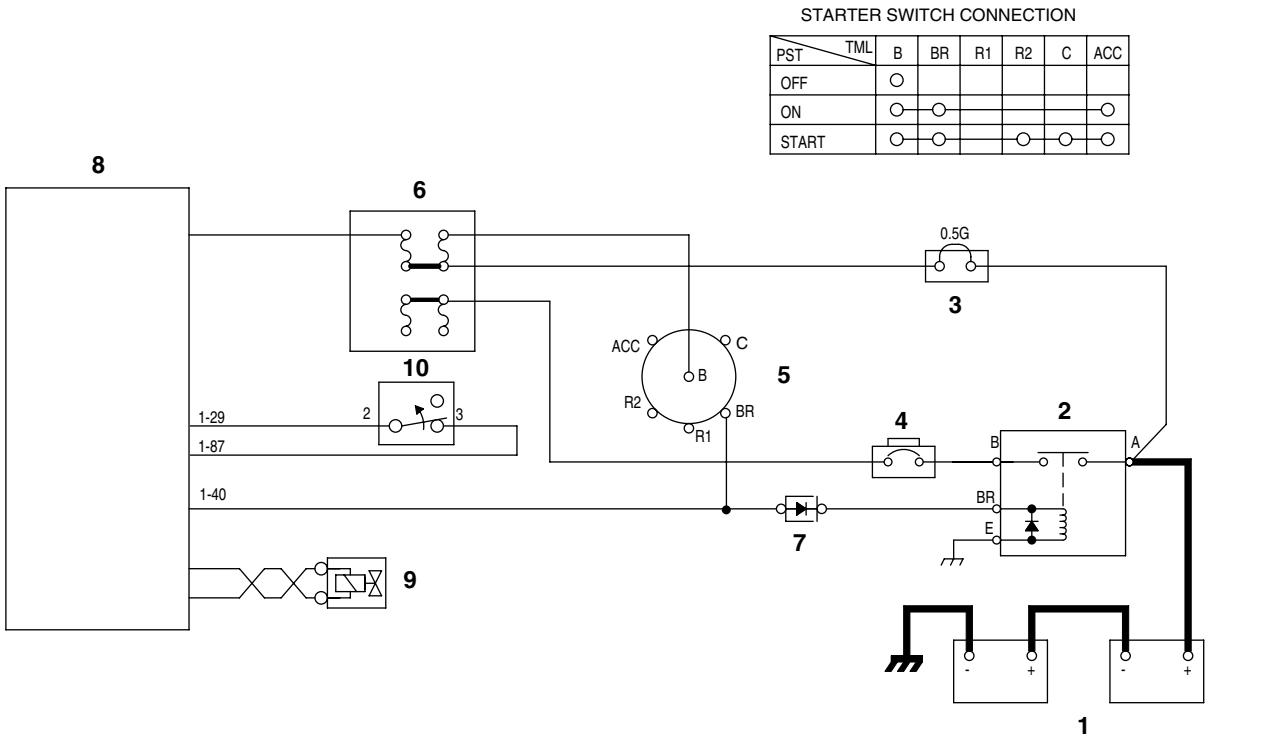
In the event that the engine can be shut down using the starter switch (5), an emergency stop switch (10) is provided to shut down engine. To activate the emergency stop switch, move it to the "I" (EMERGENCY STOP) position.

The emergency stop switch (10) is in its "O" (OFF) position during normal operation. The switch must be moved and held in the "I" (EMERGENCY STOP) position until the engine stops. When released it will automatically move back to the "O" (OFF) position.



FG001344

Figure 6 ENGINE EMERGENCY STOP SWITCH



FG007138

Figure 7 ENGINE STOP CIRCUIT

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch

Reference Number	Description
6	Fuse Box
7	Diode
8	Engine Controller
9	Injector Solenoid
10	Emergency Stop Switch

CHARGING SYSTEM

When the starter switch (5) is turned to the "ON" position, an initial excited current flows to the field coil of the alternator (7) through the battery relay (2) and circuit breaker (4). When the engine is started from this condition the alternator (7) starts charging. The current flows from the "B (B+)" terminal of alternator (7) → circuit breaker (4) → battery relay (2) → battery (1).

The alternator also supplies electric current to other electrical components. When the alternator (7) starts to operate, a current flows from the "R (I)" terminal of alternator → diode (8) → battery relay (2) coil securing a path for the charging current to the battery (1). Thus preventing the possibility of a high voltage build up and possible damage to the electrical system.

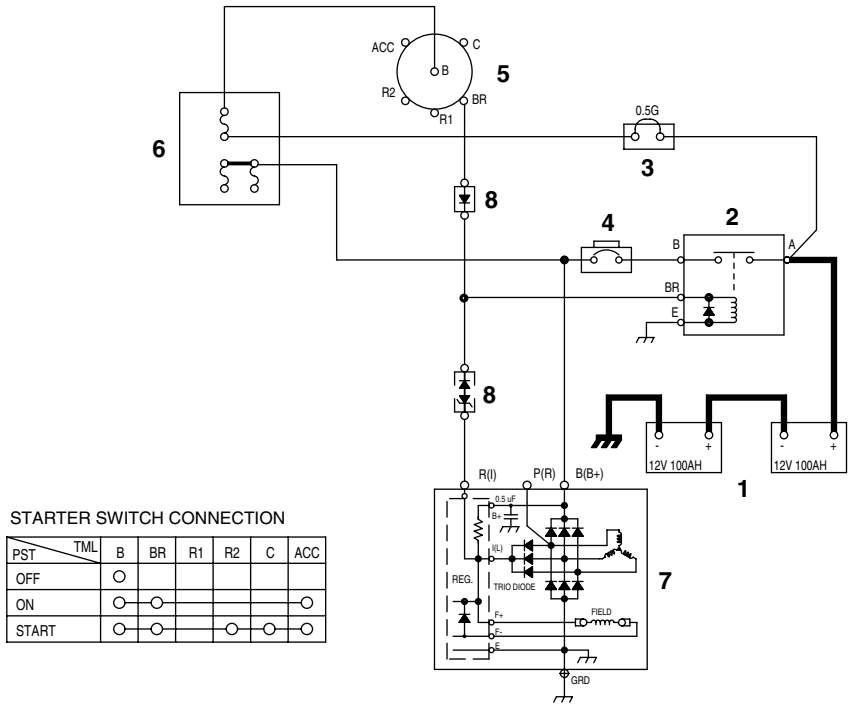


Figure 8 CHARGING CIRCUIT

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker

Reference Number	Description
5	Starter Switch
6	Fuse Box
7	Alternator
8	Diode

MONITORING SYSTEM

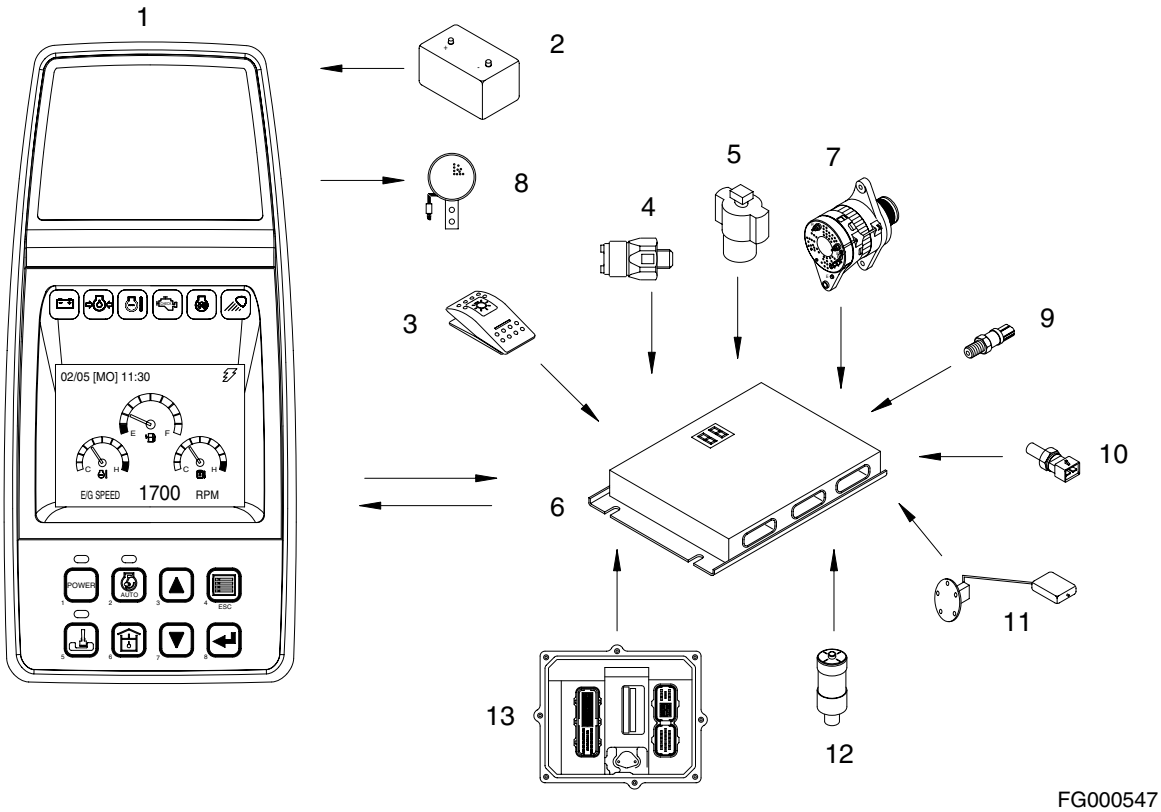


Figure 9

Reference Number	Description
1	Instrument Panel
2	Battery
3	Light Switch
4	Return Filter Switch
5	Pilot Filter Switch
6	e-EPOS Controller
7	Alternator

Reference Number	Description
8	Warning Buzzer
9	Pump Discharge Pressure Sensor
10	Hydraulic Oil Temperature Sensor
11	Fuel Sensor
12	Air Cleaner Indicator
13	Engine Controller

The monitoring system displays the various data and warning signals onto the instrument panel by processing the information gathered from the e-EPOS controller. It displays information selected by the operator.

Instrument Panel

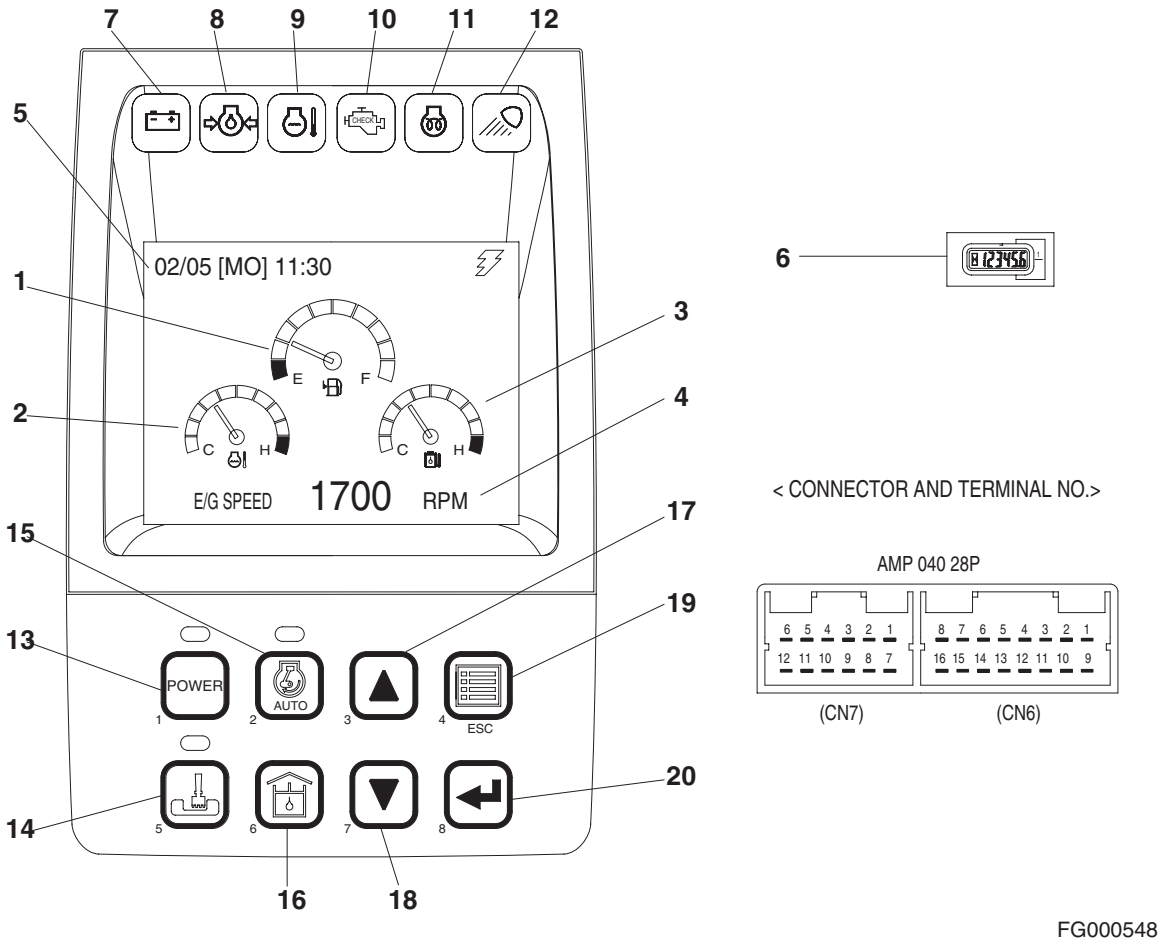


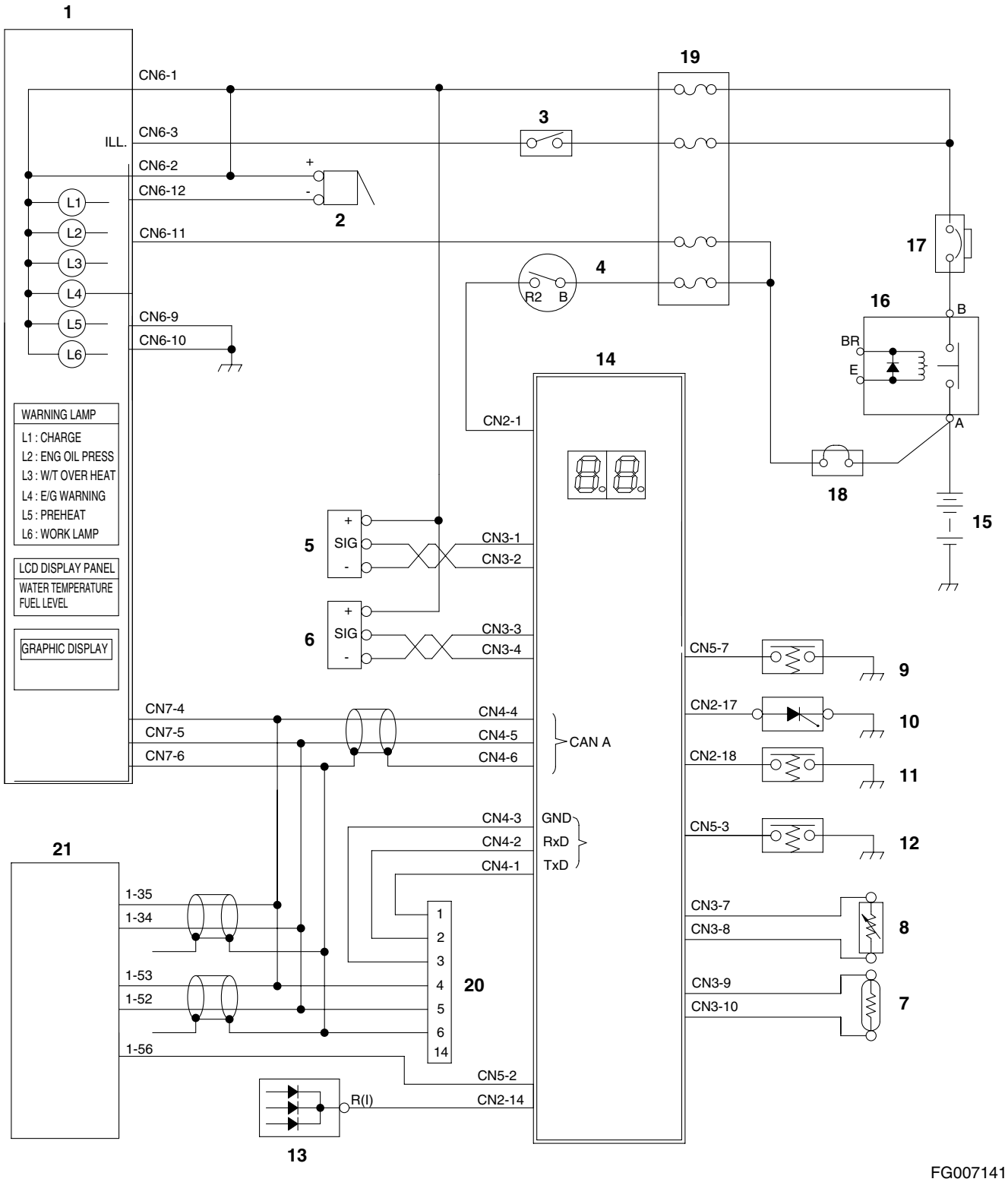
Figure 10

Gauges	Warning Lights	Mode Selector Switches
1. Fuel Gauge	7. Charge Warning Light	13. Power Mode Selector Switch and Indicator
2. Engine Coolant Temperature Gauge	8. Engine Oil Pressure Warning Light	14. Work Mode Selector Switch and Indicator
3. Hydraulic Oil Temperature Gauge	9. Coolant Temperature Warning Light	15. Auto Idle Switch and Indicator
4. Multifunction Gauge and Letter Information Area	10. Engine Check Warning Light	16. Flow Adjusting Switch
5. Digital Clock	11. Preheat Indicator Light	17. Up Button Switch
6. Hour Meter	12. Work Light Indicator Light	18. Down Button Switch
		19. Display Selector Switch
		20. Selector Button Switch

When the engine starter switch is turned to the "I" (ON) position, all gauge bands, switch/button indicator lights and indicator/ warning lights will turn "ON" and the alarm buzzer will sound about two seconds.

During this functional check, a LOGO will appear on the multifunction gauge in the graphic information area

Monitoring System Schematic



FG007141

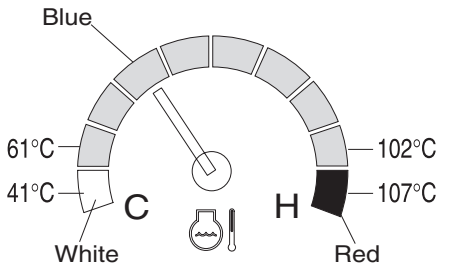
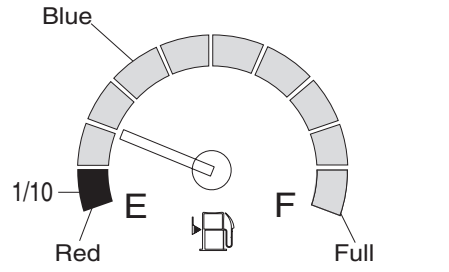
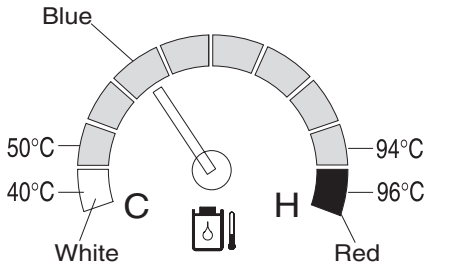
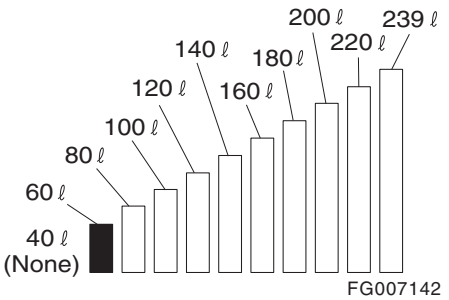
Figure 11

Reference Number	Description
1	Instrument Panel
2	Pilot Buzzer
3	Light Switch
4	Starter Switch
5	Front Pump Pressure Sensor
6	Rear Pump Pressure Sensor
7	Hydraulic Oil Temperature Sensor
8	Fuel Sensor
9	Pedal Pressure Switch (Optional)
10	Air Cleaner Indicator

Reference Number	Description
11	Pilot Filter Switch
12	Return Filter Switch
13	Alternator
14	e-EPOS Controller
15	Battery
16	Battery Relay
17	Circuit Breaker
18	Fusible Link
19	Fuse Box
20	Check Connector
21	Engine Controller

OPERATION

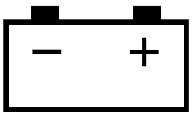
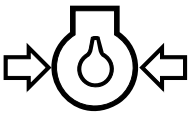
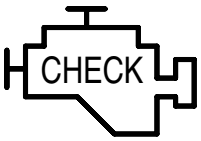
Instruments

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Coolant Temperature		ECU-CAN Communication	
Fuel Level		CN3-7 CN3-8	1/10 LCD (Red Zone) Blinking → over 5K ohms FULL → under 525 ohms
Hydraulic Oil Temperature		CN3-9 CN3-10	40°C (104°F) → 1,397 ohms 50°C (122°F) → 1,139 ohms 60°C (140°F) → 881 ohms 94°C (201°F) → 190 ohms 96°C (205°F) → 177 ohms (When reading increase)
Flow Adjusting		(Output Terminal) CN1-19 CN1-20	40 lpm → 615 mA 60 lpm → 583 mA 80 lpm → 555 mA 120 lpm → 495 mA (Default Set) 200 lpm → 376 mA 239 lpm → 260 mA

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Tachometer	**E/G SPEED 1700 RPM** FG000049	ECU-CAN Communication	N = 162 f / 60 N = Engine speed (rpm) f = Frequency of engine speed sensor (Hz)
Voltmeter	**BATTERY 28.0 VOLT** FG000050	CN2-14	0 - 32 VDC
Main pump discharge pressure (front pump)	**FRONT PUMP 320 BAR** FG000051	CN3-1 CN3-2	V = 0.00816 x P + 1.0 V: Sensor output voltage (V) P: Displayed pressure (Bar)
Main pump discharge pressure (rear pump)	**REAR PUMP 313 BAR** FG000052	CN3-3 CN3-4	

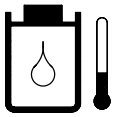
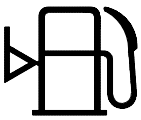
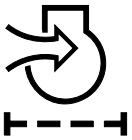
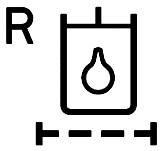
WARNING AND INDICATOR LIGHTS

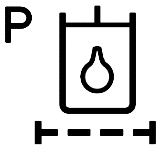
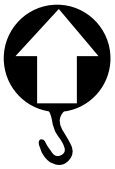
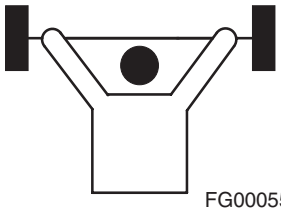
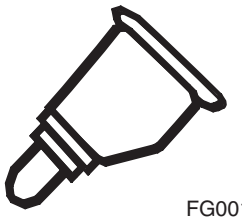
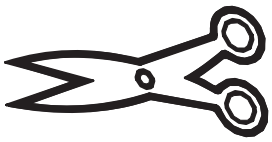
Indication of Warning Lights

Description	Symbol	Input Terminal	Operation	Remarks
Charge	 HAOA610L	CN2 - 14	It lights in case of no charge [voltage of "R (I)" terminal is below 12 ±1V] or overcharge [voltage of "R (I)" terminal is above 33 (V)].	Normally, it lights when starting engine and is out after engine starts.
Engine Oil Pressure	 HAOA620L	ECU-CAN Communication	It lights when engine oil pressure is below the reference.	After starting engine, if engine oil pressure is insufficient after 8 seconds, a warning buzzer will sound.
Engine Check	 FG000045	ECU-CAN Communication	It lights in case of failure in engine system.	
Coolant Temperature	 HAOD350L	ECU-CAN Communication	It lights when engine coolant temperature sensor resistant is below about 128 ohms.	
Preheating	 HAOA639L	CN5-2	It lights during preheating ("CN5-2" terminal voltage is below 2V) and turns "OFF" after completion of preheating.	Preheating period depends on coolant temperature. No preheating at above 10°C 10 sec preheating at 5°C 20 sec preheating at below 0°C

Description	Symbol	Input Terminal	Operation	Remarks
Work Light	 HB4O2003	CN2 - 6	It lights when work light turns "ON" (24V applied).	

Indication of Multifunction Gauge and Letter Information Area

Description	Symbol	Input Terminal	Operation	Remarks
Hydraulic Oil Temperature	 FG000056	CN3-9 CN3-10	When hydraulic oil temperature is above about 96°C.	
Fuel Exhausted	 FG000057	CN3-7 CN3-8	When fuel is almost exhausted.	
Air Cleaner	 FG000053	CN2-17	When air cleaner is clogged.	
Return Filter	 FG000054	CN5-3	When return filter pressure is above about 1.50 kg•cm2 (21 psi)	

Description	Symbol	Input Terminal	Operation	Remarks
Pilot Filter	 FG000055	CN2-18	When pilot filter pressure is above about 1 kg•cm2 (14 psi)	
Overload Warning	 FG000253	CN3-5 CN3-6	Warning buzzer also starts when boom pressure sensor output voltage is about 2.7V while overload warning switch is "ON."	It flickers in case of 2.71V and above and lights continuously in case of 2.8V and above (and warning buzzer also starts).
Boost	 FG000554	CN2-2	It lights when boost is selected.	
Breaker	 FG001470	CN2-10	It lights when breaker is selected.	
Shear	 FG001471	CN2-9	It lights when shear is selected.	

INITIAL OPERATION

Item	Input (Terminal)	Output (Operation and initial setting mode)
Initial Operation	When "CN6-1,2" is applied battery voltage (starter switch shifts from "OFF" to "ON"	• LCD, all of LED and warning lights are turned "ON" and turned "OFF" after about 2 seconds. • Warning buzzer is activated and turned "OFF" after about 2 seconds. • Power mode: Standard mode. • Work Mode: Digging mode. • Auto Idle: High Output (Activation). • Display: Indicating coolant temperature, Fuel level, Hydraulic oil temperature, Engine speed. • Clock: Current time display.

NOTE: *Refer to method for setting clock in operation manual for setting time.*

MODE SELECTOR SWITCH

Power Mode / Trenching Mode Switch

Operation Mode		Output Check (Operation mode display LED)	e-EPOS Output		
			Electromagnetic Proportional Pressure Reducing Valve (E.P.P.R Valve) Current (mA)	Swing Priority Solenoid Valve	7-Segment Display
Power Mode	Power Mode	ON	No-load: 150 ±20mA Load: Variable output (Max. current: 400 ±20mA)	-	9 x
	Standard Mode	OFF	No-load: 400 ±20mA Load: Variable output (Max. current: 600 ±60mA)	-	7 x
Work Mode	Trenching Mode	OFF	-	ON	x 2
	Digging Mode	ON	-	OFF	x 0

NOTE: *When the engine speed is below 1,000 rpm, the output current of E.P.P.R valve is fixed to be 600 ±60mA.*

Auto Idle Switch

Operation Mode		Output Check (Operation mode display LED)
Auto Idle	Activation	ON
	Cancellation	OFF

GRAPHIC INFORMATION AREA DISPLAY

Overview

Many kinds of condition of machine are displayed on the letter information display department. The information display department is divided into two menus. One is main menu for user and the other is special menu for specialist. These menus can be moved from normal display mode by the combination of selector buttons.

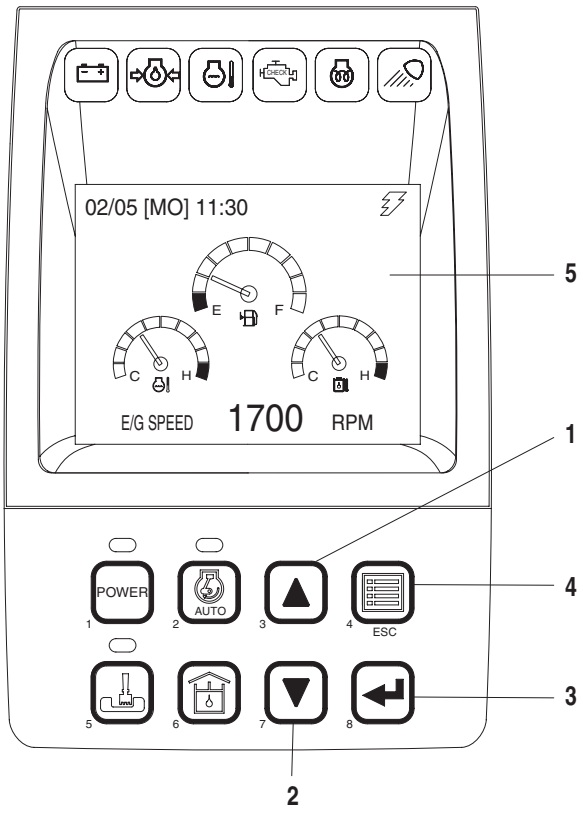


Figure 12

Selector Buttons	Graphic Display Area
1. Up Arrow Button	5. Letter Information Display Department
2. Down Arrow Button	
3. Enter Button	
4. Escape Button	

Main Menus for the Graphic Display Area

1. Main menu: Language setting, Time setting, Filter/Oil information, Brightness adjustment, Password
2. Special menu: Information of machine status, failure information, Information of machine operation.

Menu Selector Buttons

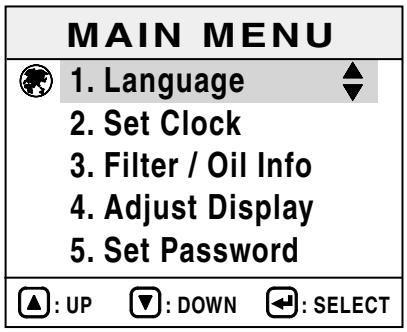
1. Up Arrow Button (▲, 1 on Figure 12): Move the cursor to up, left and previous screen.
2. Down Arrow Button (▼, 2 on Figure 12): Move the cursor to down, right and next screen.
3. Enter Button (↵, 3 on Figure 12): Move the menu to selected mode. When setting the menu, this button is used to function as the selector button.
4. Escape Button (ESC, 4 on Figure 12): Move a screen to previous menu or main menu.

MAIN MENU

When the "ESC" button is pressed for more than 3 seconds, the main menu screen is displayed.

Main menu offers submenus (language setting, time setting, or filter/oil information, brightness adjustment, password) to the operator.

Refer to the "Operation and Maintenance Manual" for details.



FG000072

Figure 13

Language

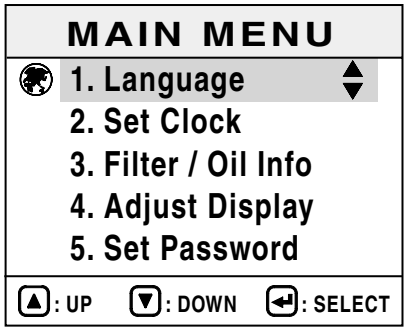
Put the cursor on Language in the main menu and put the Enter Button (↵, 3 on Figure 12) and the language select view appears.

The default language is Korean, but it will memorize and use the newly set language.

Use the Up Arrow Button (▲, 1 on Figure 12) or Down Arrow Button (▼, 2 on Figure 12) to move cursor to a language to be selected on the Language Select display and press the Enter Button (↵, 3 on Figure 12) and the selected language is indicated in the right bottom of the screen.

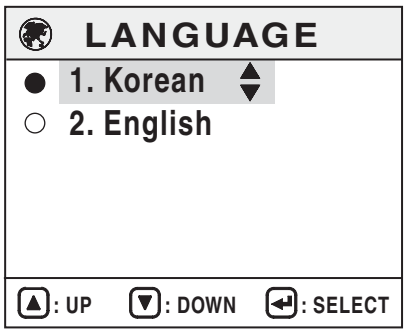
At this point pressing the Enter Button (↵, 3 on Figure 12) or the Escape Button (ESC, 4 on Figure 12) more than 1 second brings the main menu with changed language and then pressing the ESC button again shows the default view.

Without pressing a button more than 20 seconds, the default view appears.



FG000072

Figure 14



FG000783

Figure 15

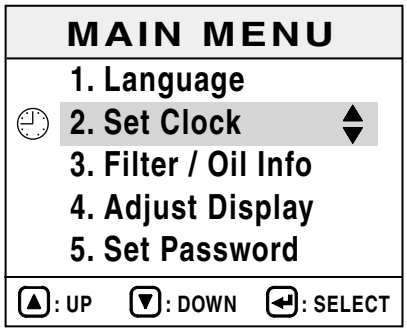
Set Clock

It is used to adjust time of the digital clock.

Pressing the Enter Button (, 3 on Figure 12) in the Main Menu after putting cursor on Set Clock brings Set Clock display.

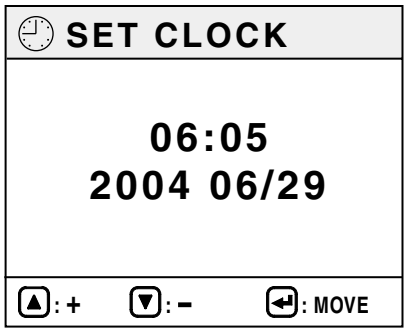
Without pressing a button more than 20 seconds, the default view appears.

Please refer to the Operation Manual for details on Time Setting.



FG000075

Figure 16



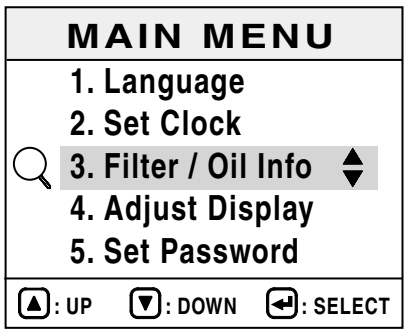
FG000076

Figure 17

Filter/Oil Info

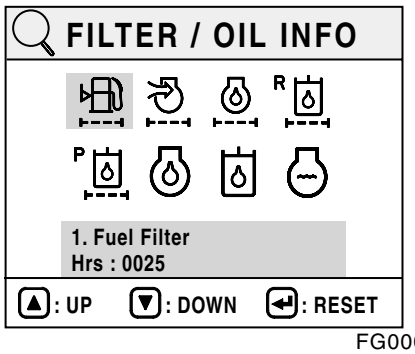
This mode displays total operating hours of filters and oils.

After changing the filter and oil, reset the operating hour and then the operating hours until the next service interval can be easily checked.



FG000077

Figure 18



FG000078

Figure 19

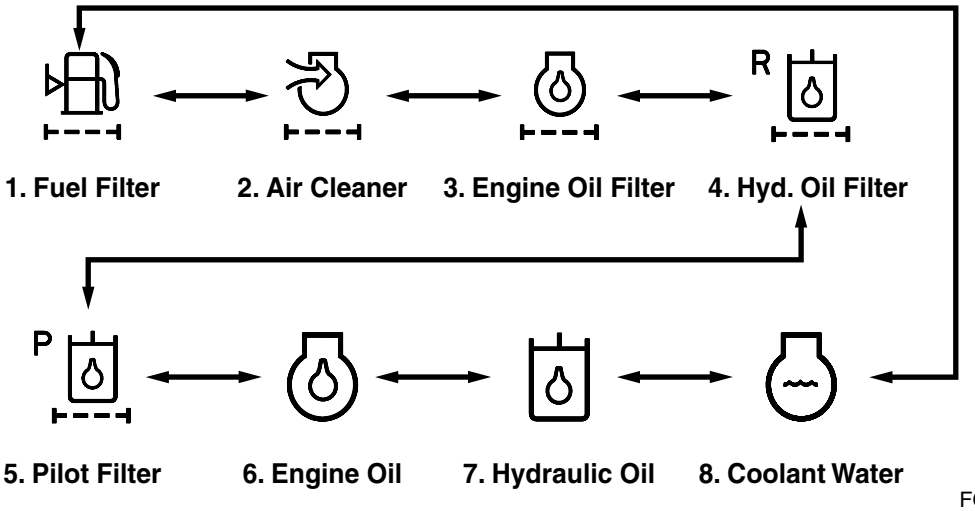


Figure 20

Adjust Display

Pressing the Enter Button (↵, 3 on Figure 12) in the main menu after putting cursor on Adjust Display brings Adjust Display.

Screen brightness can be adjusted using the Up Arrow Button (▲, 1 on Figure 12) or the Down Arrow Button (▼, 2 on Figure 12).

The default brightness is set to 50%.

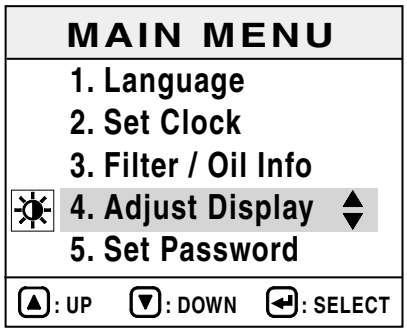


Figure 21

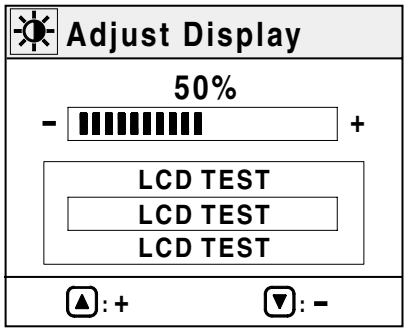
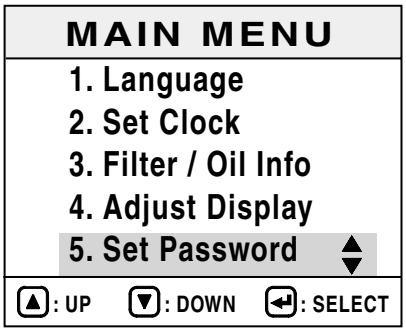


Figure 22

Set Password

This menu is used to apply (lock), release, or change password.

Please refer to the Operation Manual for details on Password Setting.



FG000227

Figure 23

SPECIAL MENU

In this menu, many types of operating conditions and functions can be accessed and displayed, including the e-EPOS controller. This menu is mainly used for machine testing and failure diagnostics.

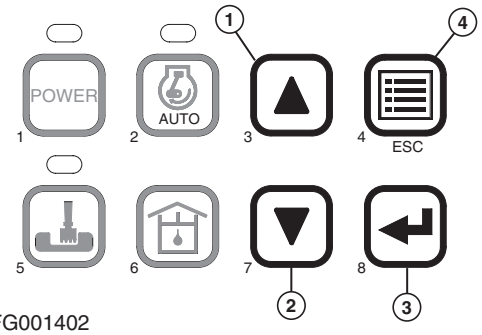
The special menu offers three submenus:

1. Machine status.
2. Failure information.
3. Information on machine operation.

Entering/Accessing and Exiting/Escaping Menus

Entering/Accessing Menus

When normal mode screen is displayed, if the enter button (↵, 3) and escape button (ESC, 4) are pressed simultaneously for more than 3 seconds, normal mode screen (Figure 25) will be changed to special menu screen (Figure 26).

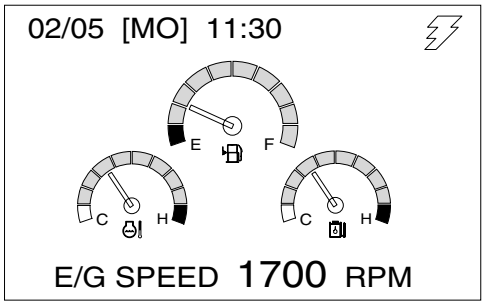


FG001402

Figure 24

Normal Mode Screen

NOTE: *Normal mode screen can display many kinds of display mode by selecting, for example, engine speed (rpm), battery voltage (VOLT), front pump pressure (BAR), rear pump pressure (BAR) and so on by selecting.*



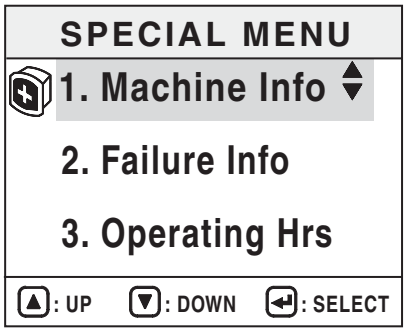
FG000043

Figure 25

Special Menu Screen

NOTE: *Displayed language on the special menu screen consists of Korean and English.*

If any language except for Korean is selected during language selection mode of main menu, only English will be displayed on special menu screen.



FG000558

Figure 26

Exiting/Escaping Menus

1. If escape button (ESC, 4 on Figure 24) is pressed for more than 1 second, the special menu screen will be returned to the normal mode screen.
2. If this special menu is "ON" without any activity, for more than 20 seconds, it will turn to the normal mode screen.
3. After the turning starter switch to the "OFF" position, turn it back to the "ON" position, and the normal mode screen displayed once again.

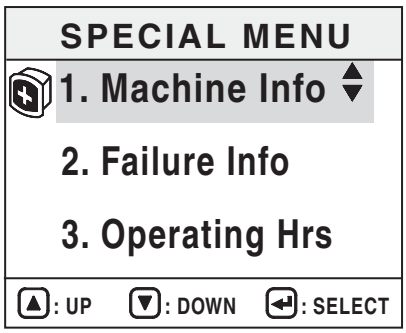
Special Menu Selections

Submenu Selection Method

Various submenus can be selected by pressing "Up (▲, 1 on Figure 24)" and "Down (▼, 2 on Figure 24)" button.

Move the cursor to desired menu and a selected menu will be inverse displayed.

When the selected menu is inverse displayed, press the "Enter (↵, 3 on Figure 24)" button for menu selection.

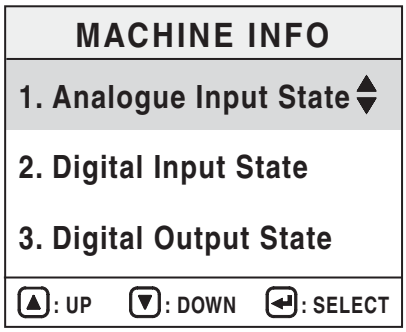


FG000558

Figure 27

Information of Machine Status

1. Entering Submenus: When cursor is located on "Machine Info" of special menu screen, press "Enter (↵, 3 on Figure 24)" button and the "Machine Info" will be displayed.
2. Exiting Submenus: If escape button (ESC, 4 on Figure 24) is pressed for more than 1 second, display will be turned to previous screen.



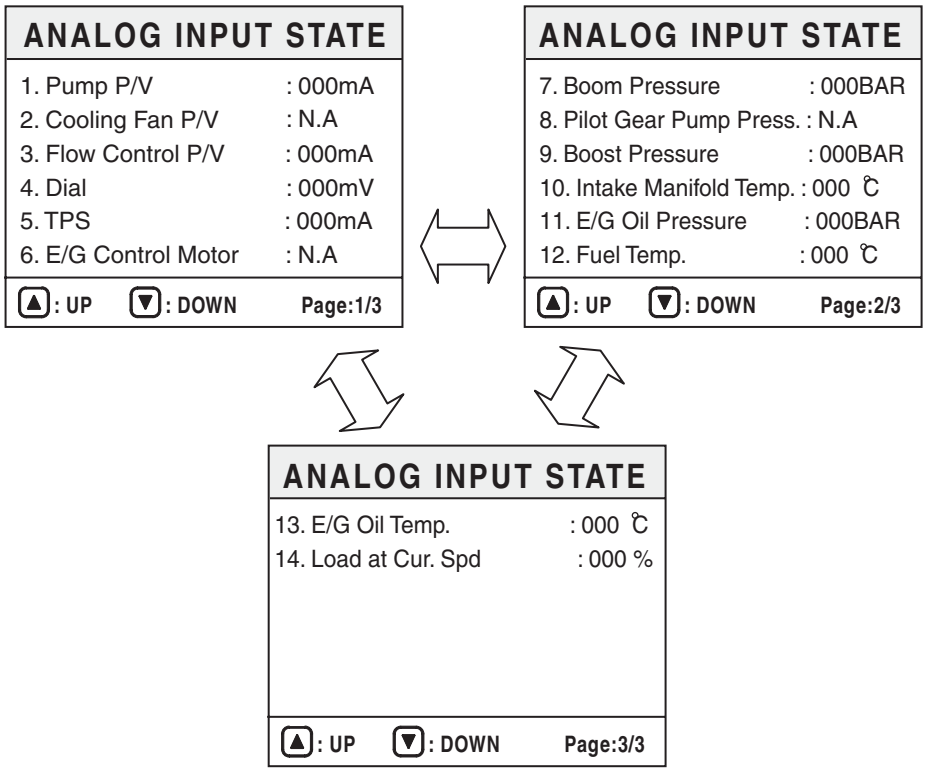
FG000559

Figure 28

Analog Inputs Description

Analog Input Items	Display	Remark
1. Pump P/V	mA	Current in pump proportional valve.
2. Cooling Fan P/V	mA	N.A.
3. Flow Control P/V	mA	Current in flow control proportional valve.
4. Dial	mV	Indicating dial voltage.
5. TPS	mV	N.A.
6. E/G Control Motor	mV	N.A.
7. Boom Pressure	BAR	Boom cylinder head pressure.
8. Pilot Gear Pump Press	BAR	N.A.
9. Boost Pressure	BAR	Pump pressure for boost.
10. Intake Manifold Temperature	°C	Temperature of air incoming to intake manifold.
11. E/G Oil Pressure	BAR	Engine oil pressure.
12. Fuel Temperature	°C	Fuel temperature.
13. E/G Oil Temperature	°C	Engine oil temperature.
14. Load At Cur. Speed	%	Current load ratio of equipment.

Submenu Selections

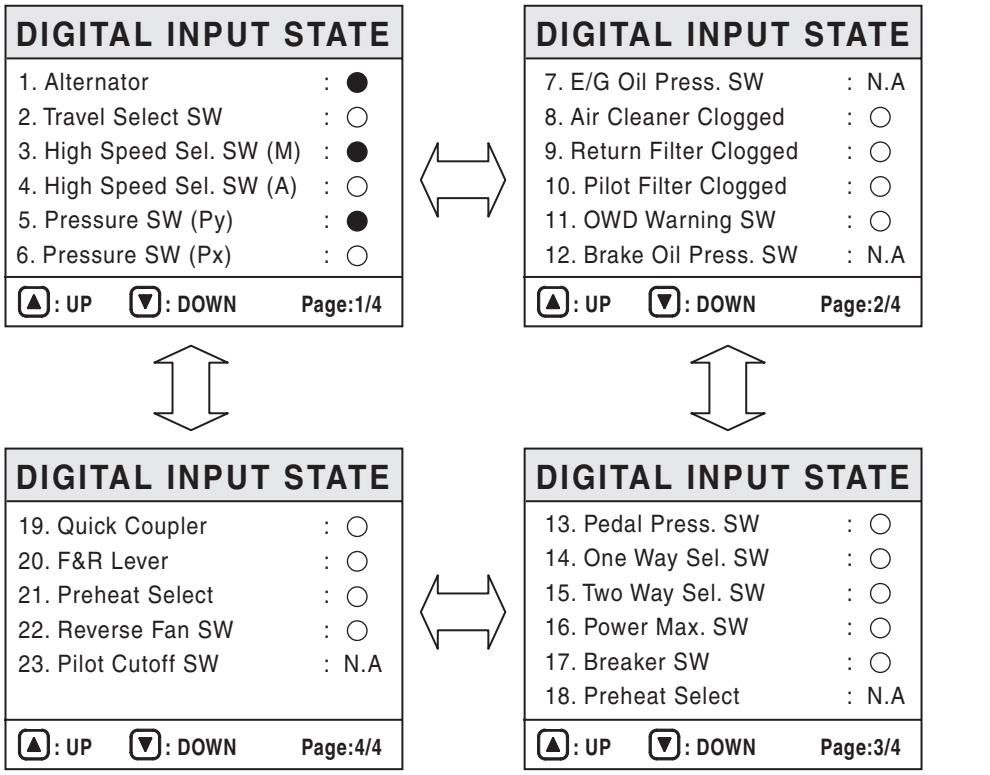


FG008126

Figure 29

Digital Inputs Descriptions

Digital Inputs Items	Mark	Remark
1. Alternator	ON / OFF	Lights up when output at alternator "R (I)" terminal is above 12 ±1V.
2. Travel Select SW		N.A. (only for wheel type equipment)
3. High-speed Sel. SW (M)		Lights up when the travel speed selector switch is set to the "I" position.
4. High-speed Sel. SW (A)		Lights up when the travel speed selector switch is set to the "II" position.
5. Pressure SW (Py)		Lights up when the pressure switch (Py) is "ON."
6. Pressure SW (Px)		Lights up when the pressure switch (Px) is "ON."
7. E/G Oil Press. SW		N.A. (only for mechanical engine)
8. Air Cleaner Clogged		Lights up when the air cleaner indicator contact is "ON."
9. Return Filter Clogged		Lights up when the return filter pressure switch is "ON."
10. Pilot Filter Clogged		Lights up when the pilot filter pressure switch is "ON."
11. OWD Warning SW		Lights up when the overload warning selector switch is "ON."
12. Brake Oil Press. SW		N.A. (only for wheel type equipment)
13. Pedal Press. SW		Lights up when the pedal pressure switch is ON.
14. One Way Sel. SW		Lights up when the selector switch is turned to breaker.
15. Two-way Sel. SW		Lights up when the Selector Switch is turned to "SHEAR."
16. Power Max. SW		Lights up when the boost button is "ON" with the Select switch turned to "BOOST."
17. Breaker SW		Lights up when the boost button is "ON" with the selector switch turned to "BREAKER."
18. Preheat Select		N.A.
19. Quick Coupler		Lights up when the Quick Coupler switch is "ON."
20. F and R Lever		N.A. (only for wheel type equipment)
21. Preheat Select		Lights up during preheating (CN5-2) terminal voltage is below 2V.
22. Reverse Fan SW		N.A.
23. Pilot Cutoff SW		N.A.



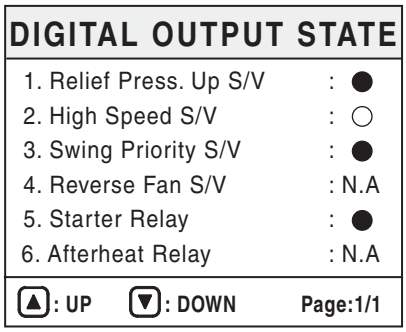
FG008136

Figure 30

Digital Outputs Descriptions

Digital Outputs Items	Mark	Remark
1. Relief Press. Up S/V	ON / OFF	Lights up when the relief press up solenoid valve is "ON."
2. High-speed S/V		Lights up when the high-speed solenoid valve is "ON."
3. Swing Priority S/V		Lights up when the swing priority solenoid valve is "ON."
4. Reverse Fan S/V		N.A.
5. Starter Relay		When the starter relay is "ON."
6. After Heat Relay		N.A.

Menu Select

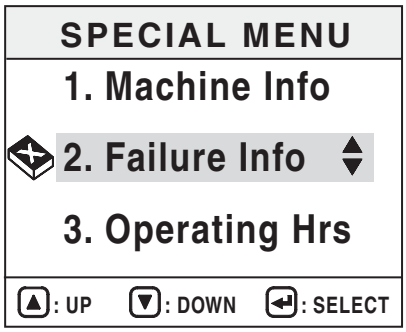


FG003930

Figure 31

Failure Information

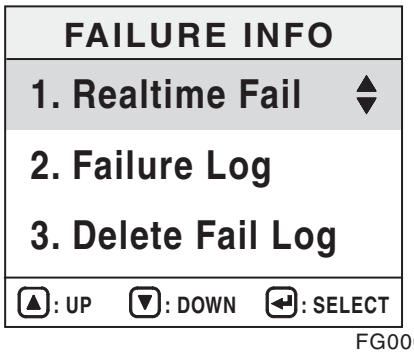
1. Entering Submenus: When a cursor is located in "Failure Info" of special menu screen press enter button (↵, 3 on Figure 24) and "Failure Info" screen is displayed.
2. Exiting Submenus: If escape button (ESC, 4 on Figure 24) is pressed for more than 1 second, this information screen will be returned to previous screen.



FG000563

Figure 32

* Real-time Failure:
  Current status of failure is displayed.
* Failure Log:
  Memorized record of past failure is displayed.
* Delete Fail Log:
  This mode is used to delete all the memorized record of past failure.



FG000564

Figure 33

A. Current failure information

Current status of failure is displayed (Failure code, failure contents).

When several failures are produced, failure information can be checked using "UP" (▲, 1 on Figure 24) or "DOWN" (▼, 2 on Figure 24) button.

* 1/2: A serial number of current failure/ total quantity of failure.

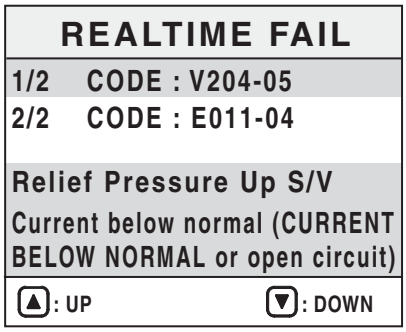
* Vxxx-xx: Vxxx is a unique code and xx is a FMI (Failure Mode Identifier) number.

  - V: Machine related failure code

  - E: Engine related failure code

Refer to the failure information code for unique codes and FMI numbers.

This example shows one of two failures.



FG000565

Figure 34

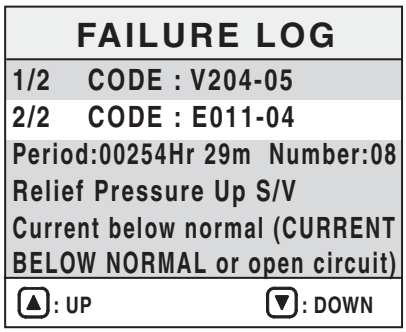
B. Past failure information

Memorized record of past failure is displayed (Failure code, failure contents).

When several failures are produced, failure information can be checked using "UP" (▲, 1 on Figure 24) or "DOWN" (▼, 2 on Figure 24) button.

NOTE: *" Number: xxx ": "xxx" means that the totally counted number of the same failure.*

" Period:xxxxxHrxxm ": It indicates the period for which machine has operated until a failure takes place. (For more than two occurrences of the same failure, until the first occurrence time.)



FG000566

Figure 35

C. Failure record deletion

This mode is used to delete the memorized record of past failure. If this mode is selected, all records will be deleted.

When "YES" (↵, 3 on Figure 24) button is pressed, the memorized record will be deleted.
At this time, deletion signal will be displayed and the screen will move to previous menu after deletion.

This screen will be displayed during 3 seconds.

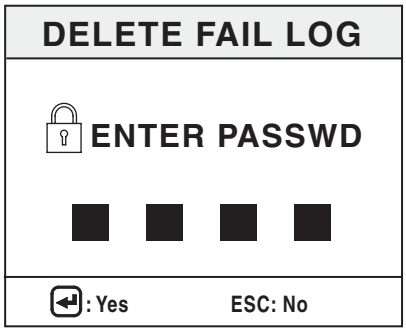


FG000567

Figure 36

Input your password with one of No. 1 - 8 switches.

When "NO" (ESC, 4 on Figure 24) button is pressed, the screen will recover to previous menu without deletion.

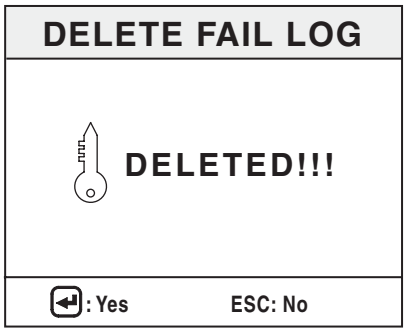


FG000568

Figure 37

Delete Completed screen will appear 3 seconds and the screen will move to Failure Info screen.

It has been shown 3 seconds upon deleting Fail Log.



FG000569

Figure 38

The screen shown on the left will appear 3 seconds in case of wrong password input and then Enter Password screen appears again.

It has been shown 3 seconds in case of password failure.



FG000570

Figure 39

Failure Information Code at Machine Side

Code	Failure Component	Measuring Points	Correct Value		Remarks
			Active	Passive	
V201	Gauge Panel Communication Error	CN7-4 CN7-5	-	R = 60 ± 5 Ω	It is a composite resistance of CAN line. This value has to be measured by connected condition of CAN line.
V202	ECU Communication Error	CN4-4 CN4-5	-	R = 60 ± 5 Ω	
V210	Pump P/V	CN1-10 CN1-21	-	R = 18 ± 2 Ω (25°C (77°F))	Pump proportional pressure reducing valve.
V211	Cooling Fan P/V		-	-	N.A.
V212	Flow Control P/V	CN1-19 CN1-20	-	R = 14 ± 2 Ω (25°C (77°F))	Flow control proportional pressure reducing valve.
V213	Relief Pressure Up S/V	CN1-1 CN1-11	V = V_volt (Note 4.)	R = 26.2 ± 2 Ω (25°C (77°F))	Breaker/boost/ shear selector switch has to be selected as a boost function and the boost switch on the right-hand joystick is "ON" status.
V214	High-speed S/V	CN1-1 CN1-12	V = V_volt	R = 26.2 ± 2 Ω (25°C (77°F))	Voltage is only measured when the pressure switch (Py) is turned "ON."
V215	Swing Priority S/V	CN1-1 CN1-13	V = V_volt	R = 26.2 ± 2 Ω (25°C (77°F))	Work mode has to be selected as a trenching mode.
V216	Reverse Fan Speed S/V		-	-	N.A.
V217	Starter Relay	CN1-1 CN1-15	V = V_volt	-	It has to be measured in engine start up state.
V218	After Heat Relay	1-16 1-04	-	-	N.A.

Code	Failure Component	Measuring Points	Correct Value		Remarks
			Active	Passive	
V220	Front Pump Press. Sensor	CN3-1 CN3-2	V = 1V	-	It has to be measured in engine stop state.
V221	Rear Pump Press. Sensor	CN3-3 CN3-4	V = 1V	-	
V222	Hydraulic Oil Temperature Sensor	CN3-9 CN3-10	-	R = 2.45 ± 0.25 kΩ (25°C (77°F)) R = 320 ±32 Ω (80°C (176°F))	
V223	Water Temperature Sensor		-	-	N.A.
V224	Engine Speed Sensor		-	-	N.A.
V225	Fuel Level Sensor	CN3-7 CN3-8	-	Empty: 5 ±0.25 kΩ Full: 320 ±32 Ω	
V226	Alternator Potential	CN2-14 CN1-8	V = 2 ±1V	-	It has to be measured in engine stop state.
V227	Dial	CN3-16 CN3-17	-	R = 1.0 ±0.3 kΩ R = 4.0 ±1.5 kΩ	
V228	Tps (Wheel)		-	-	N.A.
V229	Parking Brake Press. Sensor		-	-	N.A.
V230	E/g Control Motor Sensor		-	-	N.A.

NOTE: *1. Active value: Starter switch has to be turned "ON"*

Measuring points between component and wire harness have to be connected.

2. Passive value: Starter switch has to be turned "OFF"

Measuring points between component and wire harness have to be disconnected.

3. Measuring points are engine controller's points and passive value is each component's value.

4. V_batt: Source power of equipment.

Failure Information Code at Engine Side

Code	Failure Component	Measuring Points	Current Valve		Remarks
			Active	Passive	
E011	Coolant temperature sensor	2-15 2-26	-	R=186 ±5 Ω (100°C (212°F))	
E012	Fuel temperature sensor	2-35 2-26	-	R=186 ±5 Ω (100°C (212°F))	
E013	Boost air temperature sensor	2-36 2-25	-	R=186 ±5 Ω (100°C (212°F))	
E014	Boost air pressure sensor	2-34 2-33	V = 1,071 ±58mV (at 23°C (73°F) and absolute pressure 1bar)	-	It has to be measured in engine running state.
E017	E/G oil temperature sensor	2-28 2-24	-	R=186 ±5 Ω (100°C (212°F))	
E018	E/G oil pressure sensor	2-27 2-32	V = 2,318 ±80mV (at 23°C (73°F) and absolute pressure 3bar)	-	It has to be measured in engine running state.
E021	Battery voltage	1-03 1-06	V = V_volt (Note 4.)	-	
E022	Fuel pressure sensor	2-14 2-12	V = 1,833 ±28mV (at 23°C (73°F) and absolute pressure 300bar)	-	It has to be measured in engine running state.
E032	Fuel pressure monitoring MPROP	3-09 3-10	-	R=2.60 ±3.15 Ω (20°C (68°F))	
E037	CAN - B Line	1-35 1-34	-	R=60 ±5 Ω (20°C (68°F))	It is a composite resistance of CAN line. This value has to be measured by connected condition of CAN line.
E038	Engine overspeed		-	-	
E039	Main relay SCG (ECU)		-	-	Engine ECU fail.
E041	Redundant shutoff path		-	-	Abnormal engine stop.
E042	E/G speed (Crankshaft)	2-23 2-19	-	R=860 ±6 Ω (20°C (68°F))	

Code	Failure Component	Measuring Points	Current Valve		Remarks
			Active	Passive	
E043	E/G speed (Camshaft)	2-09 2-10	-	-	
E044	Engine speed sensor		-	-	Synchronizing error between crankshaft speed sensor and camshaft speed sensor.
E045	EEPROM		-	-	Data storing error when engine stop.
E046	Recovery		-	-	
E047	Monitoring of PRV		-	-	When the pressure sensor of common rail or high-pressure pump has a defect.
E048	Power supply	1-03 1-06	V = V_volt	-	
E049	Main Relay SCB (ECU)		-	-	Engine ECU fail.
E051	Main Relay (ECU)		-	-	Engine ECU fail.
E058	Solenoid power stage 1	3-04 3-13	-	R=0.31 ±0.42 Ω (20°C (68°F))	
E059	Solenoid power stage 2	3-11 3-06	-	-	
E061	Solenoid power stage 3	3-05 3-12	-	-	
E062	Solenoid power stage 4	3-03 3-14	-	-	
E063	Solenoid power stage 5	3-01 3-16	-	-	
E064	Solenoid power stage 6	3-02 3-15	-	-	
E065	Fuel HI pressure pump (E/G: Current controlled High Side power stage 1)	-	-	-	Fuel metering unit error of high-pressure pump.

Code	Failure Component	Measuring Points	Current Valve		Remarks
			Active	Passive	
E068	Preheat relay (E/G: High Side Power stage 1)	1-13 1-07	V = V_volt	R=40 ±5 Ω (25°C (77°F))	Voltage is only measured when after heat function is operating status.
E083	Preheat light (E/G: Low Side Power stage 2)	1-13 1-56	-	-	
E091	CAN - A Line	1-53 1-52	-	R=60 ±5 Ω (20°C (68°F))	It is a composite resistance of CAN line. This value has to be measured by connected condition of CAN line.
E097	Monitoring of misfire cylinder 1	-	-	-	Injector error Speed signal error of camshaft speed sensor or crankshaft speed sensor.
E098	Monitoring of misfire cylinder 2	-	-	-	
E099	Monitoring of misfire cylinder 3	-	-	-	
E101	Monitoring of misfire cylinder 4	-	-	-	
E102	Monitoring of misfire cylinder 5	-	-	-	
E103	Monitoring of misfire cylinder 6	-	-	-	
E104	Monitoring of misfire multiple cylinder	-	-	-	
E105	Monitoring of overrun	-	-	-	
E106	Engine speed redundant	-	-	-	

NOTE: *1. Active value: Starter switch has to be turned "ON"*

Measuring points between component and wire harness have to be connected.

2. Passive value: Starter switch has to be turned "OFF"

Measuring points between component and wire harness have to be disconnected.

3. Measuring points are engine controller's points and passive value is each component's value.

4. V_batt: Source power of equipment.

FMIs (Failure Mode Identifier)

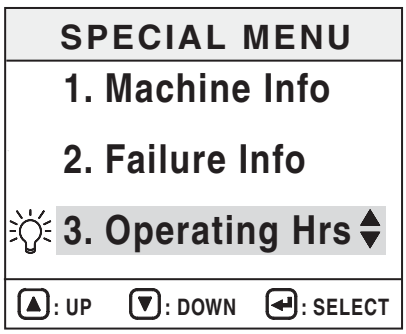
FMI 0	Above normal range (DATA VALID but ABOVE NORMAL OPERATIONAL RANGE)
FMI 1	Below normal range (DATA VALID but BELOW NORMAL OPERATIONAL RANGE)
FMI 2	Incorrect signal (DATA ERRATIC, INTERMITTENT OR INCORRECT)
FMI 3	Voltage above normal (VOLTAGE ABOVE NORMAL OR SHORTED TO HIGH SOURCE)
FMI 4	Voltage below normal (VOLTAGE BELOW NORMAL OR SHORTED TO LOW SOURCE)
FMI 5	Current below normal (CURRENT BELOW NORMAL OR OPEN CIRCUIT)
FMI 6	Current above normal (CURRENT ABOVE NORMAL OR GROUNDED CIRCUIT)
FMI 8	Abnormal signal (ABNORMAL FREQUENCY OR PULSE WIDTH OR PERIOD)
FMI 11	Failure mode not identifiable (ROOT CAUSE NOT KNOWN - Malfunction)
FMI 31	NOT AVAILABLE OR CONDITION EXISTS

Information of Machine Operation

Accumulated operation hour of each mode and status is displayed.

1. Operating Hour Information

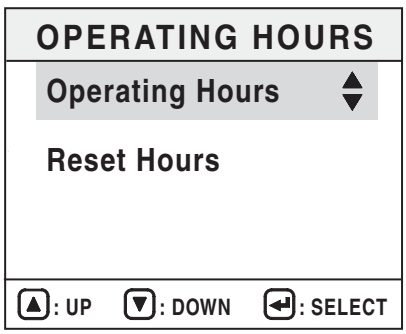
   A. Entering Submenus: When a cursor is located in "Operating Hrs" of special menu screen (Figure 40) press enter button (↵, 3 on Figure 24) and "Operating Hrs" screen will be displayed (Figure 41).



FG000571

Figure 40

   B. Information screen of machine operation (Figure 41).

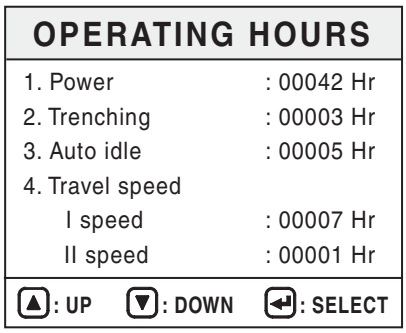


FG000572

Figure 41

C. Operating Hours Screen

D. Exiting Submenus: If escape button (ESC, 4 on Figure 24) is pressed for more than 1 second, this information screen will be returned to previous screen.



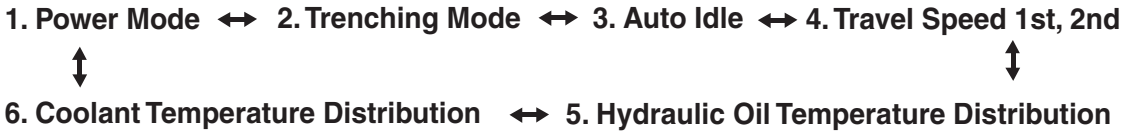
FG000573

Figure 42

Information contents of operation hour

Item	Information Contents	Detection Method
Power Mode	Operation hours used power mode are displayed.	Power mode switch (Instrument panel) - "ON" status and Alternator signal (CN2-14) is "HI"
Trenching Mode	Operation hours used trenching mode are displayed.	Trenching mode switch (Instrument panel) - "ON" status and Alternator signal (CN2-14) is "HI"
Auto Idle	Operation hours used auto idle status are displayed.	Auto idle switch (Instrument panel) - "ON" status and Alternator signal (CN2-14) is "HI"
Travel Speed: -1st - 2nd	Operation hours used low speed and high-speed are displayed.	1st: High-speed s/v "OFF" status 2nd: High-speed s/v and travel pressure switch "Py" (control valve) - "ON" status.
Hydraulic Oil Temperature Distribution (°C (°F))	Temperature of hydraulic oil is classified 6 steps, and operation hours of each step are displayed Under 30°C (87°F) 31 - 50°C (88 - 123°F) 51 - 75°C (124 - 168°F) 76 - 85°C (169 - 186°F) 86 - 95°C (187 - 203°F) Over 96°C (204°F)	The resistance delivered from temperature sensor of hydraulic oil is classified 6 steps, and operation hours of each step are displayed. (Alternator output HI status)
Coolant Temperature Distribution (°C (°F))	Temperature of coolant is classified 6 steps, and operation hours of each step are displayed. Under 40°C (105°F) 41 - 60°C (106 - 141°F) 61 - 85°C (142 - 186°F) 86 - 95°C (187 - 204°F) 96 - 105°C (205 - 222°F) Over 106°C (223°F)	The resistance delivered from coolant sensor is classified 6 steps, and operation hours of each step are displayed. (Alternator output HI status)

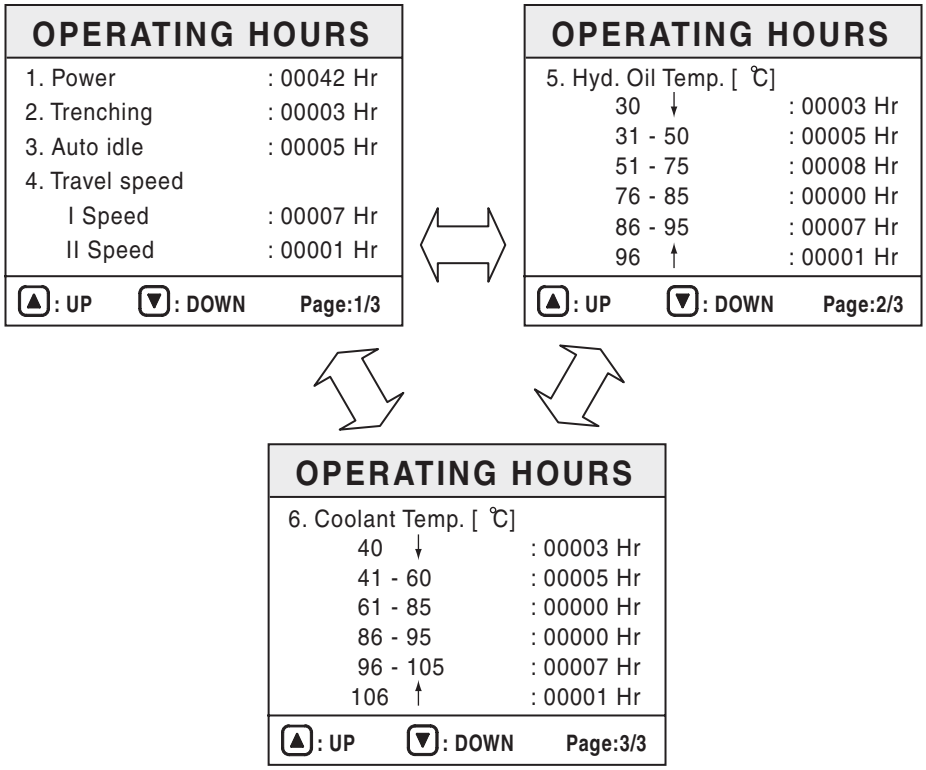
Menu Selection of Operation Hour Information



FG000574

Figure 43

Example of Machine Operation Info Screen

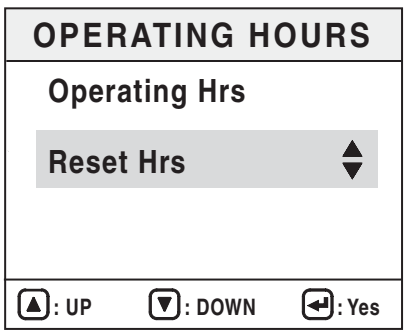


FG000575

Figure 44

2. Operation hour reset

   A. Entering Submenus: When cursor is located in "Reset Hrs" of information screen of operating hours press enter button (↵, 3 on Figure 24) and "Machine Operation Info" screen will be displayed.



FG000578

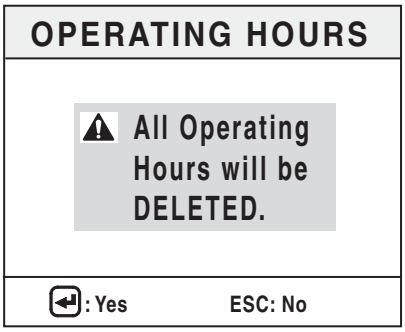
Figure 45

B. Reset screen of operation hour

C. Exiting Submenus: If escape button (ESC, 4 on Figure 24) is pressed for more than 1 second, this information screen will be returned to previous screen.

NOTE: *When "YES" (↵, 3 on Figure 24) button is pressed, operation hours will reset. At this time, resetting signal will be displayed and the screen will move to previous menu after resetting.*

NOTE: *When "NO" (ESC, 4) button is pressed, the screen will recover to previous menu without resetting.*

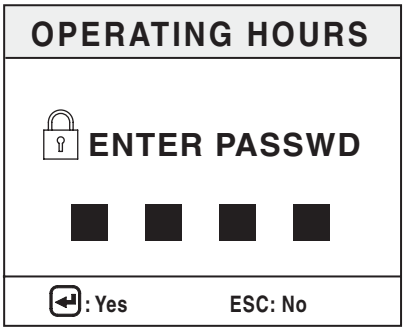


FG000579

Figure 46

Machine Operation Info Screen

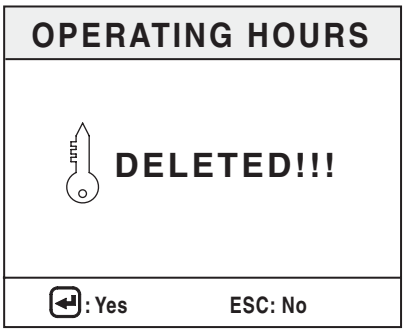
1. If you press the YES" (↵, 3 on Figure 24) button, password entrance screen appears.



FG000576

Figure 47

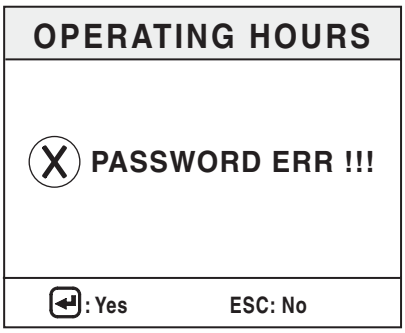
2. When right password is input, machine operation periods will be deleted and Reset Completed screen will appear 3 seconds.



FG000577

Figure 48

3. If you press the "NO" (ESC, 4) button, the previous screen appears without resetting operation periods.

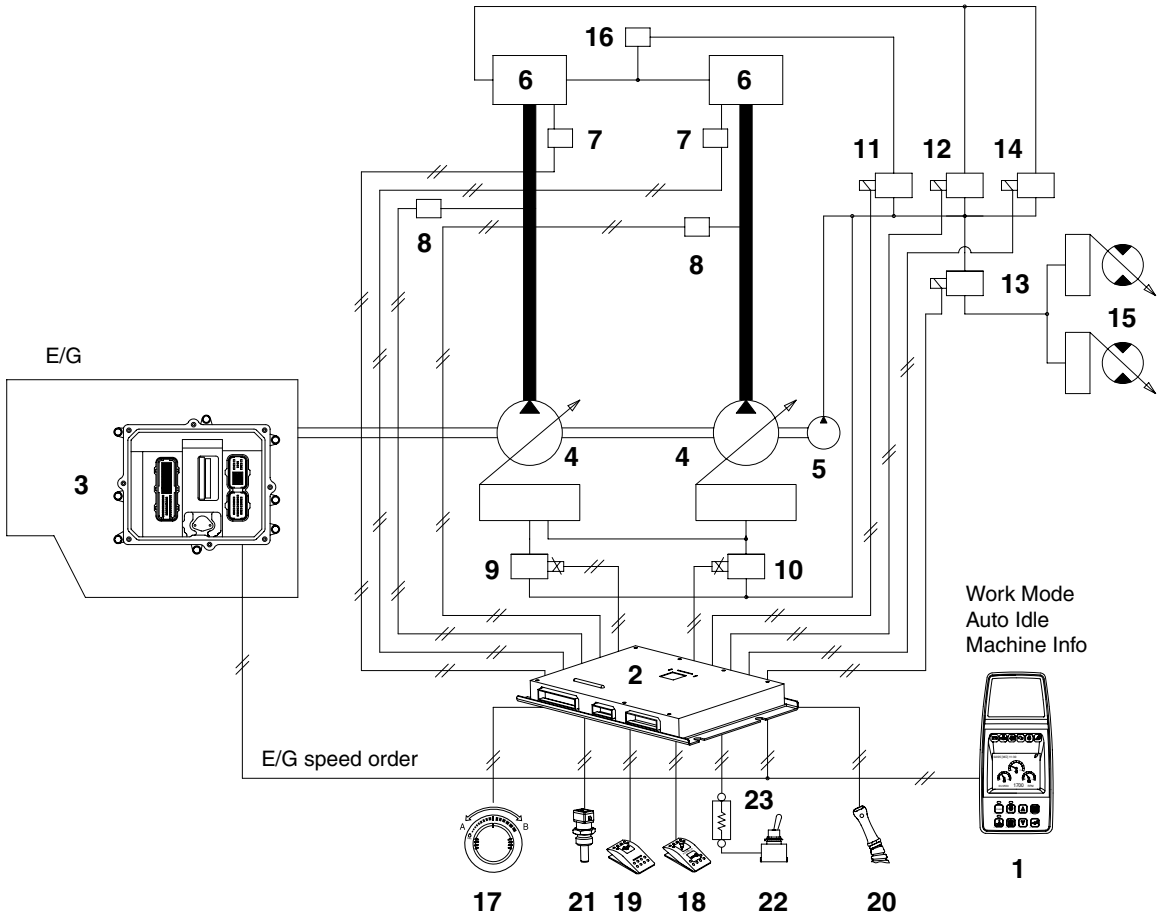


FG001086

Figure 49

ELECTRONIC HYDRAULIC CONTROL SYSTEM (e-EPOS)

Control System Schematic



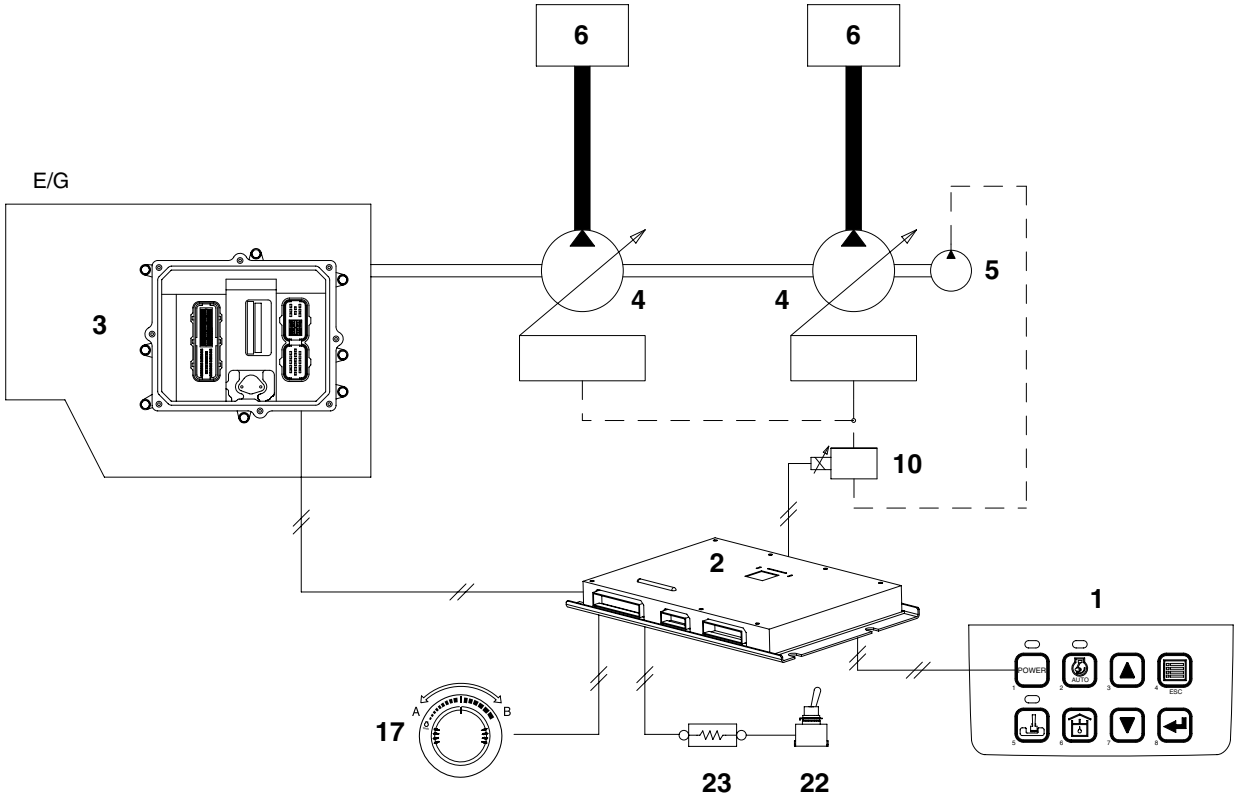
FG000795

Figure 50

Reference Number	Description
1	Instrument Panel
2	e-EPOS Controller
3	Engine Controller (ECU)
4	Main Pump
5	Aux Pump
6	Control Valve
7	Pressure Switch
8	Pump Pressure Sensor
9	Electromagnetic Proportional Pressure Reducing Valve (Attachment)
10	Electromagnetic Proportional Pressure Reducing Valve (Mode Control)

Reference Number	Description
11	Solenoid Valve (Boost)
12	Solenoid Valve (Swing Priority)
13	Solenoid Valve (High-speed)
14	Solenoid Valve (Breaker)
15	Travel Motor
16	Main Relief Valve
17	Engine Control Dial
18	Breaker/Boost/Shear Selector Switch
19	Auto Travel Selector Switch
20	Boost Switch (Right Work Lever)
21	Sensor
22	Aux Mode Switch
23	Aux Mode Resistor

POWER MODE CONTROL



FG000796

Figure 51

Reference Number	Description
1	Instrument Panel (Power Mode Selector Switch)
2	e-EPOS Controller
3	Engine Controller (ECU)
4	Main Pump
5	Aux Pump
6	Control Valve

Reference Number	Description
10	Electromagnetic Proportional Pressure Reducing Valve (Mode Control)
17	Engine Control Dial
22	Aux Mode Switch
23	Aux Mode Resistor

The power mode switch permits the selection of the appropriate engine power depending on the working condition. One of the two, Power Mode or Standard Mode, setting can be selected. When the engine starter switch is turned "ON," the power mode is automatically defaulted to standard mode. The desired mode can be selected by pressing the selector button on the instrument panel. When the power mode is selected, the indicator light will turn "ON" to display the selected mode.

The quantity of oil discharged by the pump and the engine speed are determined by the mode selected by the operator. The pump output in each mode is determined by the mode selection and is listed in the following table

Mode	Standard Mode	Power Mode
Output (%)	Approximately 85%	100%

1. Power Mode

This mode should be selected for high-speed work. In this mode the engine output is most efficiently utilized because of the discharged oil volume being controlled based on the equivalent horsepower curve at various loaded pressures. The e-EPOS controller compares the target engine speed with the actual engine speed and controls the signal to the E.P.P.R. (Electromagnetic Proportional Pressure Reducing) valve which in turn varies the pump output quantity.

If the load increases, the engine speed will fall below the rated speed. When this occurs, the controller senses this decrease and immediately reduces the pump discharge volume to maintain the engine speed at the rated level.

On the other hand, if the load is decreased the controller increases the discharge volume of the pump to maintain the engine speed at the rated level.

By repeating these control operations, the engine speed is maintained at the rated speed so maximum power can be generated.

In Power Mode, the e-EPOS controller receives engine speed signals from the engine control dial and the engine controller (ECU) and converts it to an operating signal current and is then transferred to the pump's E.P.P.R valve. At this time the E.P.P.R. valve converts the electric signal to the corresponding control pressure and sends it to the two pumps, adjusting the pump discharge volume to the desired level.



ARO0260L

Figure 52

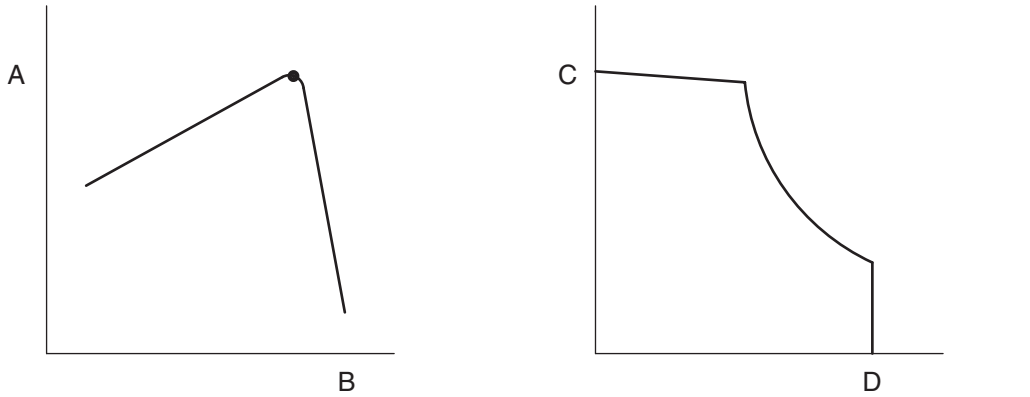


Figure 53

Reference Number	Description
A	Engine Horsepower (hp)
B	Engine Speed (rpm)
C	Pump Discharge Volume (lpm)

Reference Number	Description
D	Pump Discharge Pressure ($kg \bullet cm^2$)

2. Standard Mode

Standard Mode is used for general work. When this mode is selected it will reduce noise and fuel consumption in comparison with Power Mode. The current to the E.P.P.R. valve is shut off and pump discharge volume is controlled by pump regulator.

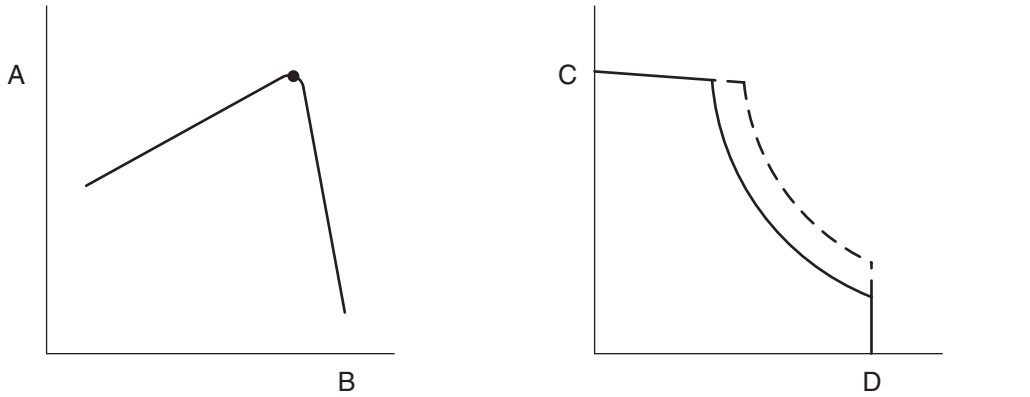


Figure 54

Reference Number	Description
A	Engine Horsepower (hp)
B	Engine Speed (rpm)

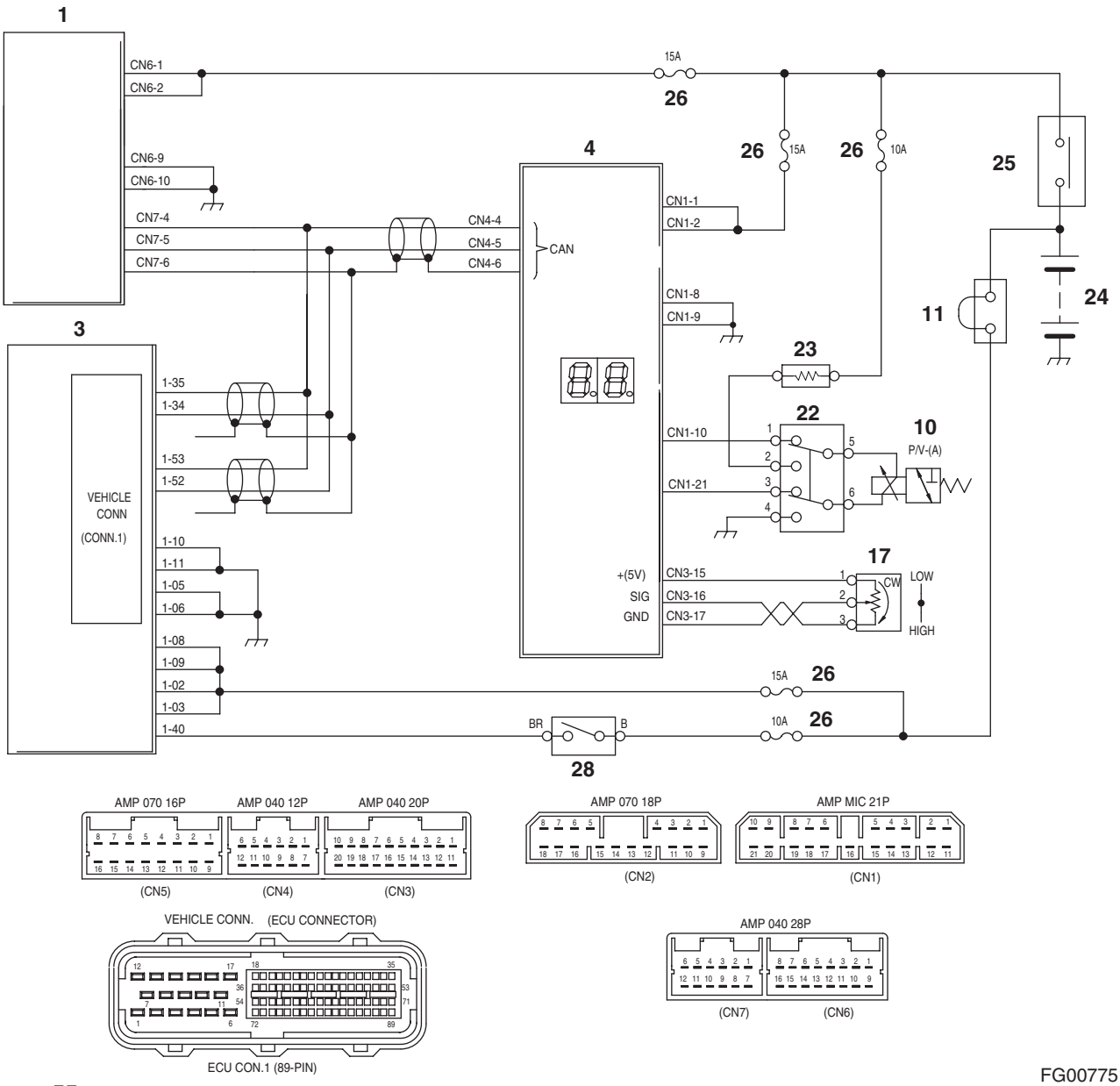
Reference Number	Description
C	Pump Discharge Volume (lpm)
D	Pump Discharge Pressure ($kg \bullet cm^2$)

3) Operation in case of failure in the control system (Aux mode operation

Though it is impossible to control current of the E.P.P.R (Electromagnetic Proportional Pressure Reducing) Valve controlling the discharge volume of pump because of fault in control system, the machine can be operated in the aux mode.

Upon turning "ON" the aux mode switch, the E.P.P.R Valve controlling the discharge volume of pump comes into contact with the aux mode resistor to let current of a certain value flow. At this time, the discharge volume of pump follow the control by the pump regulator, nearly at quantity roughly similar to that in the standard mode.

POWER MODE CONTROL - CIRCUIT DIAGRAM



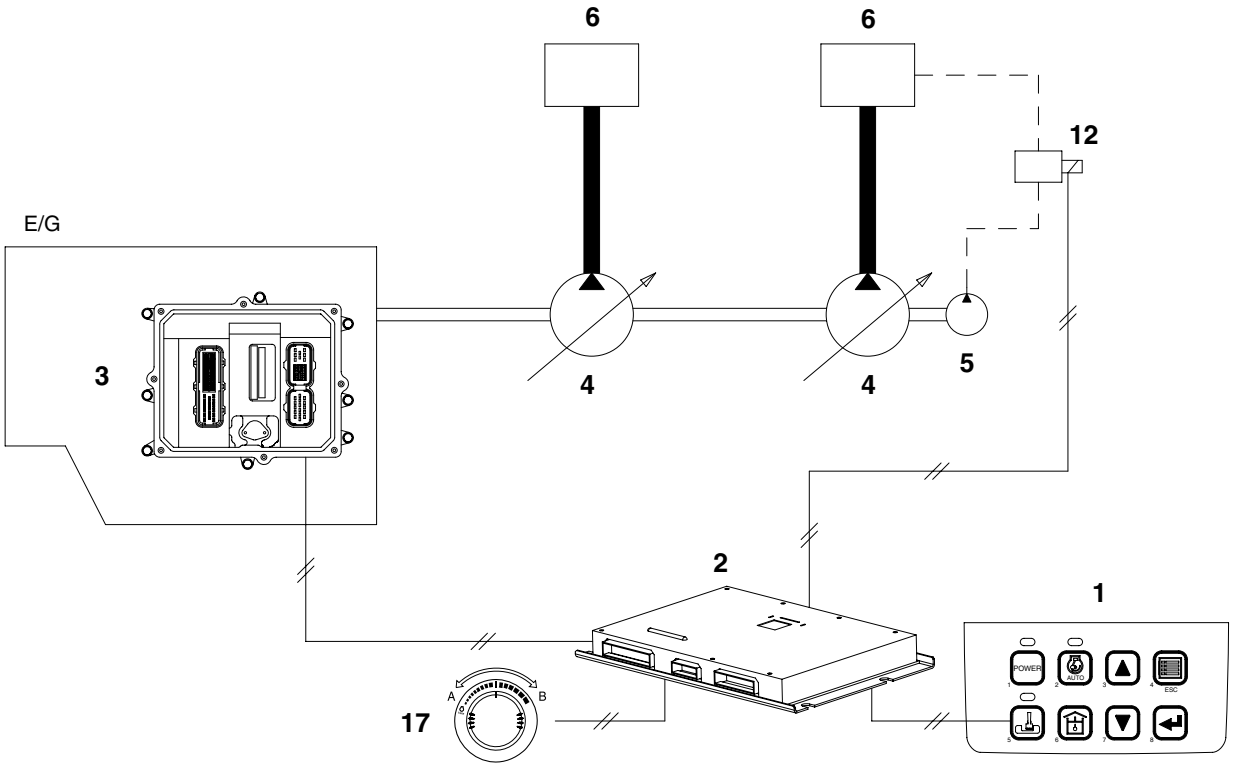
FG007751

Figure 55

Reference Number	Description
1	Instrument Panel
3	Engine Controller
4	e-EPOS Controller
10	E.P.P.R. Valve (Electromagnetic Proportional Pressure Reducing)
17	Engine Control Dial
22	Aux Mode Switch

Reference Number	Description
23	Aux Mode Resistor
24	Battery
25	Battery Relay
26	Fuse
27	Fusible Link
28	Starter Switch

WORK MODE CONTROL



FG000797

Figure 56

Reference Number	Description
1	Instrument Panel (Trenching Mode Selector Switch)
2	e-EPOS Controller
3	Engine Controller
4	Main Pump

Reference Number	Description
5	Aux Pump
6	Control Valve
12	Solenoid Valve
17	Engine Control Dial

Depending on the working condition, one of two work modes, "DIGGING" or "TRENCHING" can be selected from the instrument panel.

When the engine starter switch is turned "ON," the work mode is automatically defaulted to digging mode.

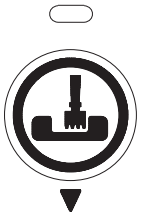
Depending on the trenching mode selected, the control valve solenoid adjusts the assignment of hydraulic oil flow to each device on the equipment.

1. Digging Mode

This mode is used for general digging work, loading work and ground leveling work requiring quick stops. The current to the solenoid valve for swing priority is shut off.

2. Trenching Mode

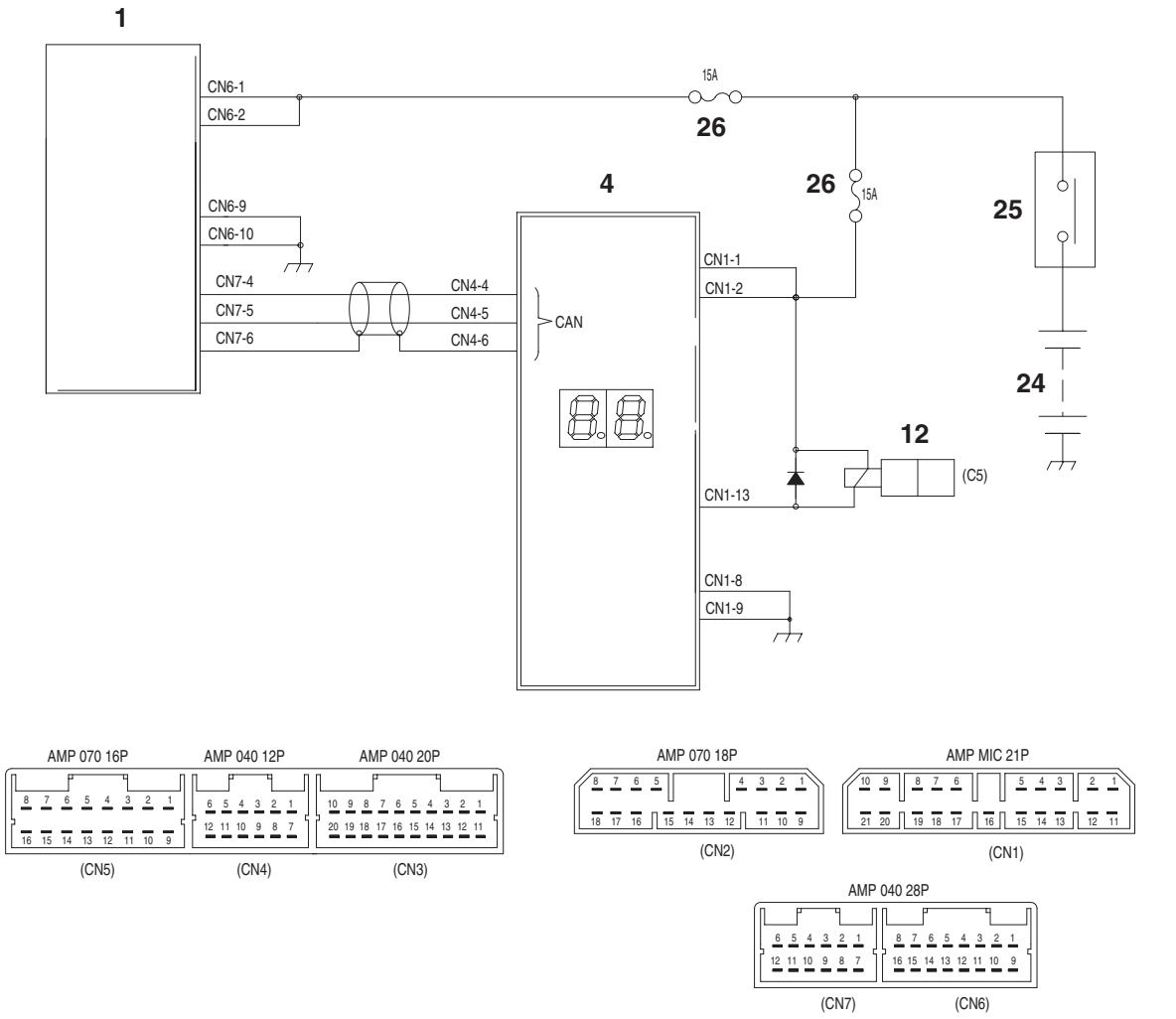
This mode is used for heavy duty ditch digging work or for loading work requiring big swing angles. The voltage is assigned to the swing priority control valve activating the swing control valve restricting the flow of oil to the boom and the arm.



ARO0270L

Figure 57

WORK MODE CONTROL - CIRCUIT DIAGRAM

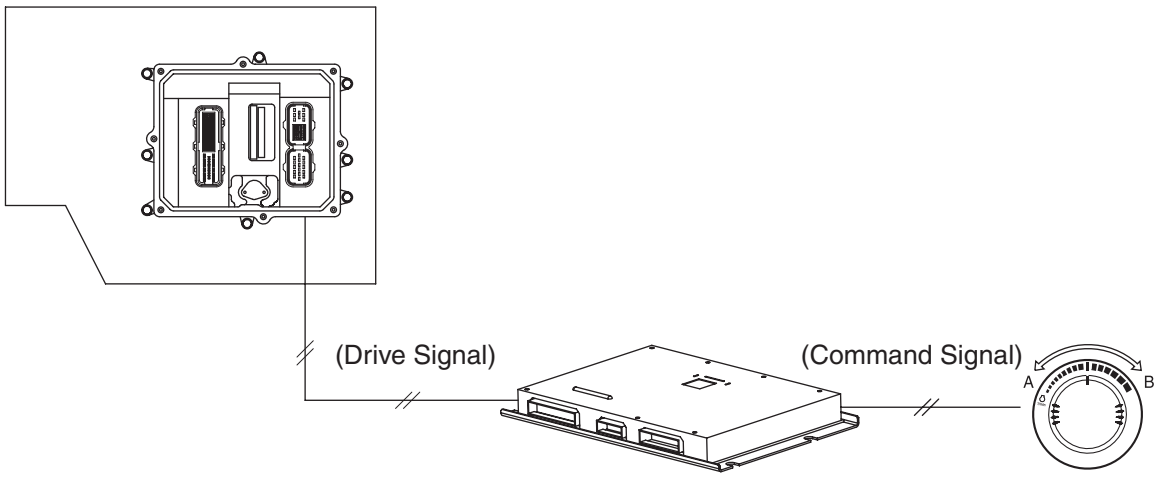


FG000583

Figure 58

Reference Number	Description
1	Instrument Panel
2	e-EPOS Controller
12	Solenoid Valve (Swing Priority)

Reference Number	Description
24	Battery
25	Battery Relay
26	Fuse



FG000584

Figure 59

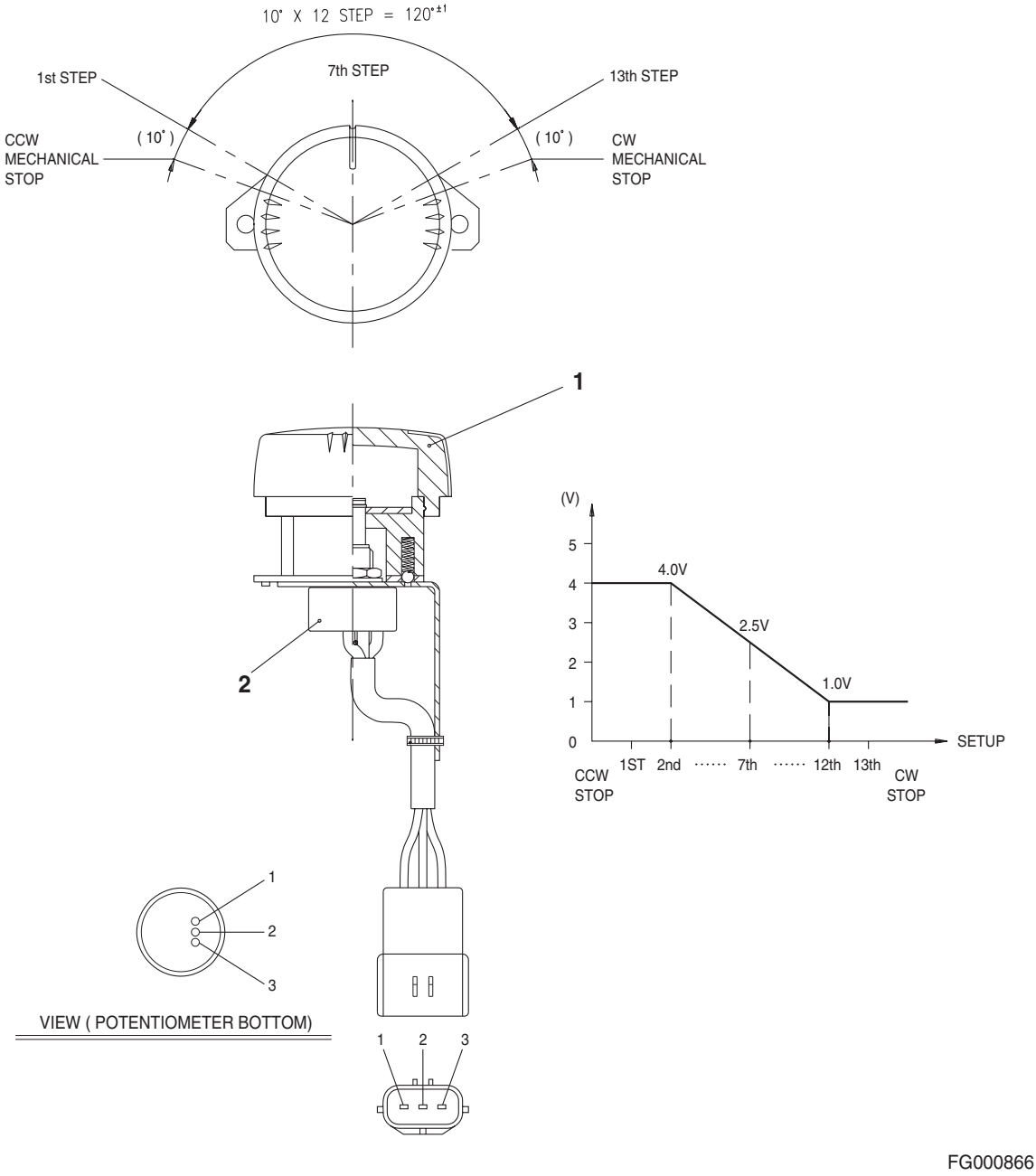
Reference Number	Description
3	Engine Controller
4	e-EPOS Controller

Reference Number	Description
17	Engine Control Dial

When the engine control dial is moved the output voltage changes according to the dial position.

The e-EPOS controller converts this output voltage of dial to digital signal and sends it to the engine controller by CAN line. According to the dial command, the quantity of fuel injection is adjusted.

ENGINE CONTROL DIAL



FG000866

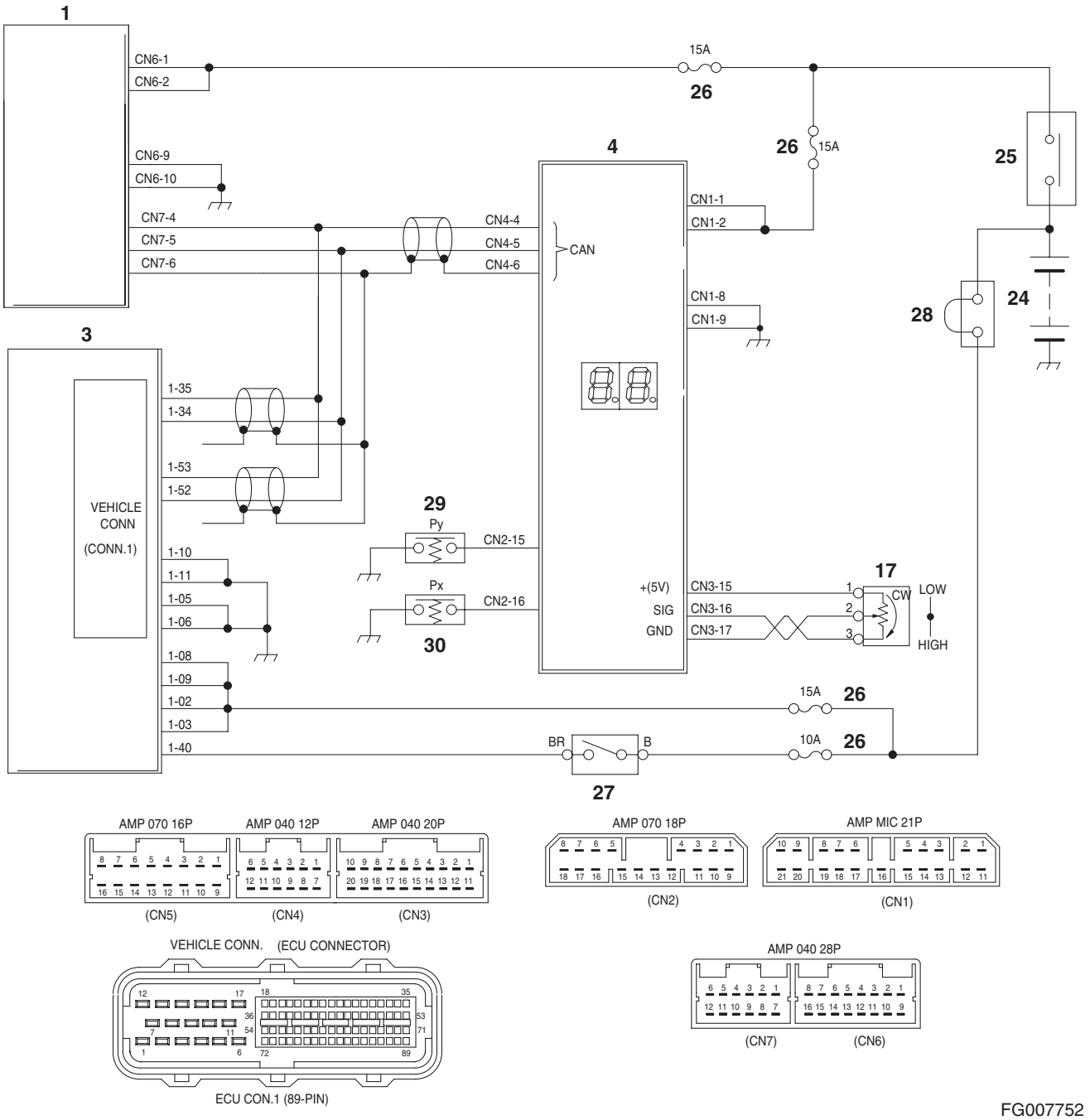
Figure 60

Reference Number	Description
1	Knob

Reference Number	Description
2	Potentiometer (Variable Resistor)

The engine control dial has a built in potentiometer. When the control knob is moved the output voltage (through "2 and 3" terminals) will vary from the 5 V supplied from the e-EPOS controller as shown in the graph.

ENGINE CONTROL CIRCUIT DIAGRAM



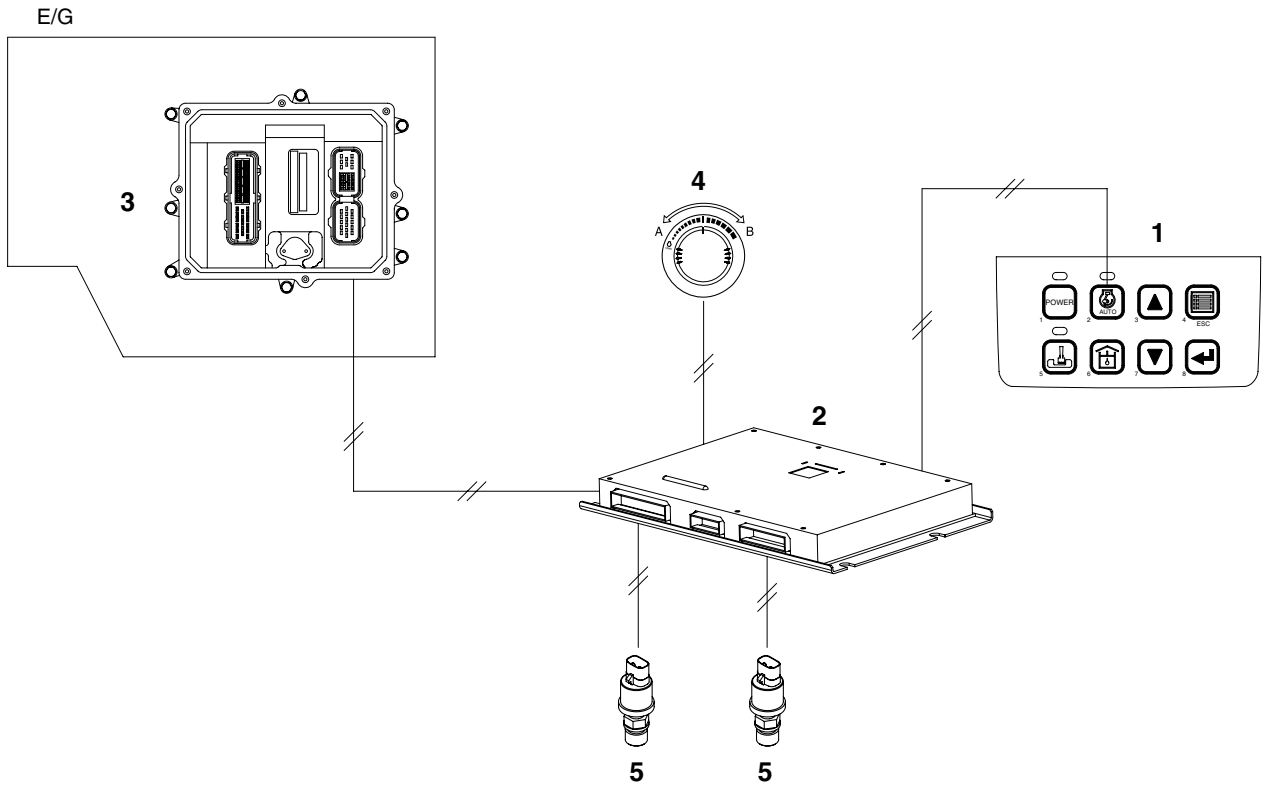
FG007752

Figure 61

Reference Number	Description
1	Instrument Panel
3	Engine Controller
4	e-EPOS Controller
17	Engine Control Dial
24	Battery
25	Battery Relay

Reference Number	Description
26	Fuse
27	Starter Switch
28	Fusible Link
29	Pressure Switch (Py)
30	Pressure Switch (Px)

AUTOMATIC DECELERATION CONTROL (AUTO IDLE CONTROL)



FG000798

Figure 62

Reference Number	Description
1	Instrument Panel (Auto Idle Switch)
2	e-EPOS Controller
3	Engine Controller

Reference Number	Description
4	Engine Control Dial
5	Pressure Switch

If the machine is idling without the controls being operated or is waiting for a dump truck the engine speed is automatically lowered. Once the controls are operated and work is being started the machine will be restored to the previous settings. As a result, noise and fuel consumption will be reduced. This function can be selected or canceled through the Auto Idle Selector Switch on the instrument panel.

The initial setting at start-up is with this switch in the select position. Approximately 4 seconds after this function is selected, if all work levers are in the neutral position, the e-EPOS controller compares the automatic reduction signal with the signal set by engine control dial. The lower of the two signals is selected, the e-EPOS controller sends a signal to the engine controller to control the engine speed.

The neutral status of the machine is detected by the two pressure switches in the control valve. When the work levers are in the neutral position, the switch is in the "OFF" position.

ENGINE OVERHEAT PROTECTION SYSTEM

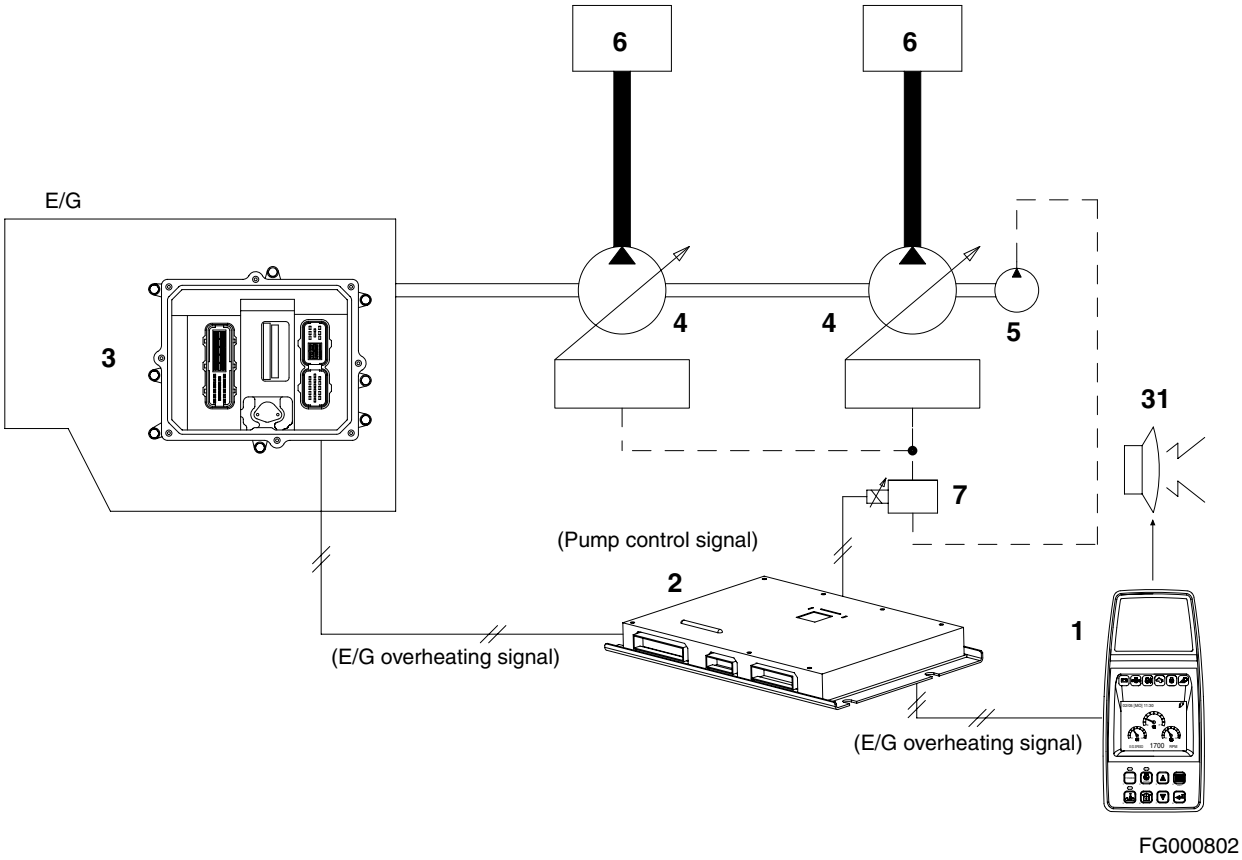


Figure 63

Reference Number	Description
1	Instrument Panel
2	e-EPOS Controller
3	Engine Controller
4	Main Pump
5	Aux Pump

Reference Number	Description
6	Control Valve
10	E.P.P.R. Valve (Electromagnetic Proportional Pressure Reducing Valve)
31	Warning Buzzer

When the engine coolant temperature increases to over 107°C (225°F), the engine controller detects it from the sensor mounted in the coolant line and will send a signal to the e-EPOS controller. The e-EPOS controller sends a overheat signal to the instrument panel turning "ON" the warning light and buzzer simultaneously.

Also, the e-EPOS controller returns an overheat signal to the engine controller and changes power mode to standard mode. The engine speed is then set to a low speed by the engine controller.

When coolant temperature falls below 95°C (203°F), normal operation will resume.

POWER BOOST MODE

Operation

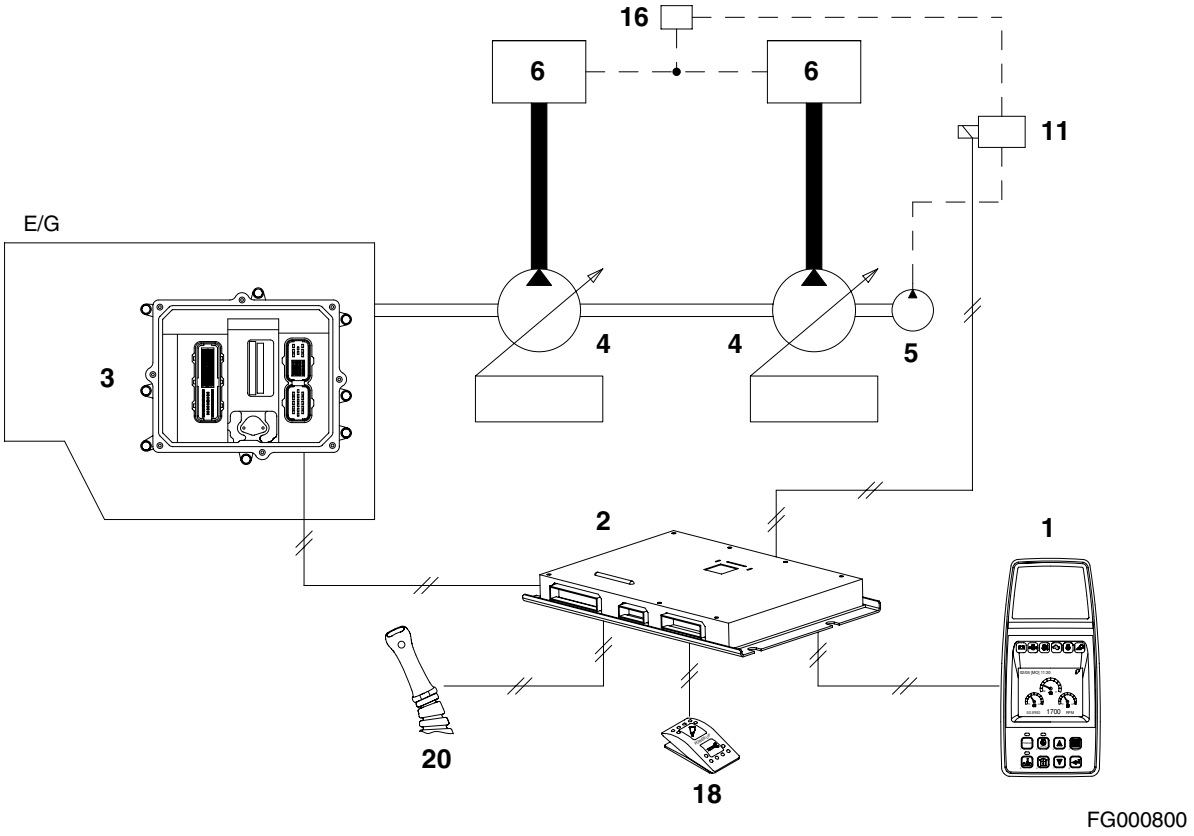


Figure 64

Reference Number	Description
1	Instrument Panel
2	e-EPOS Controller
3	Engine Controller
4	Main Pump
5	Aux Pump
6	Control Valve

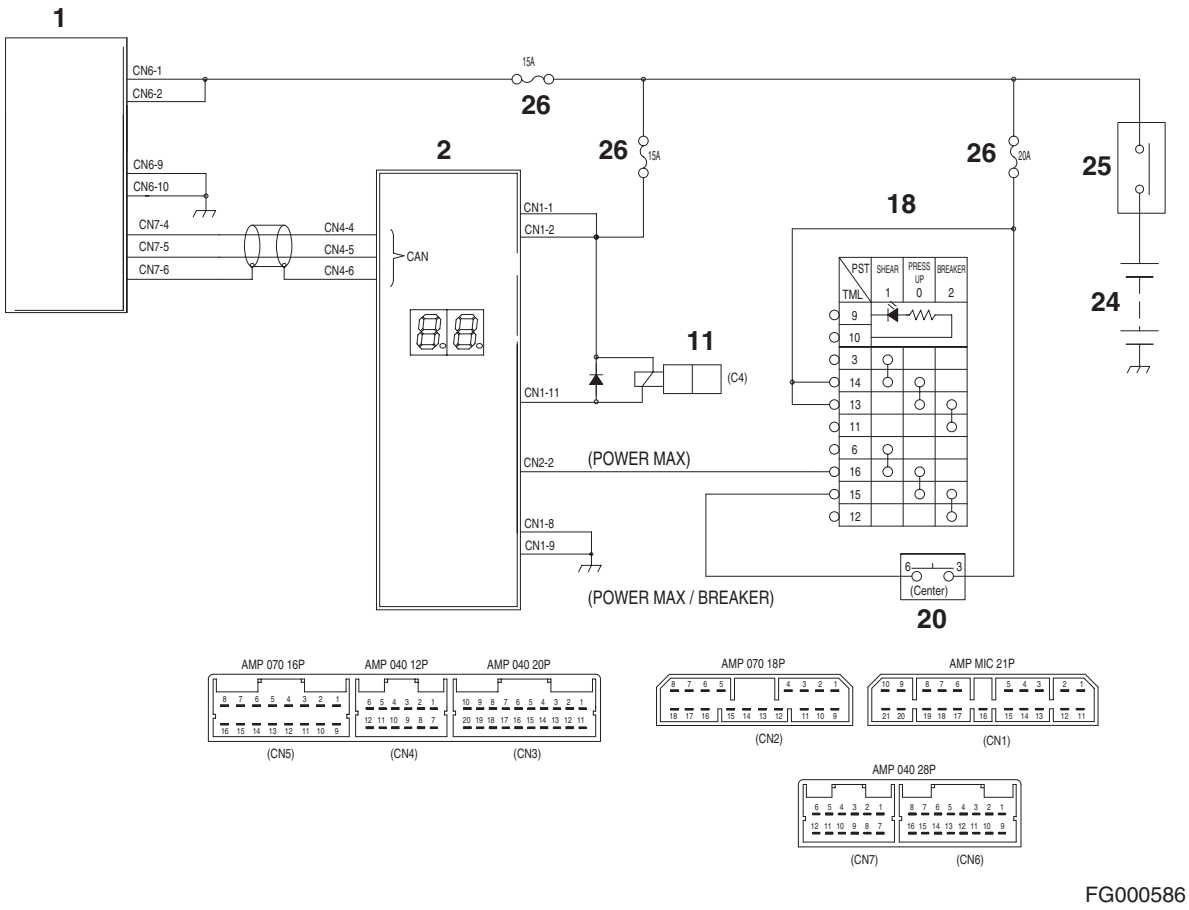
Reference Number	Description
11	Solenoid Valve (Boost)
16	Main Relief Valve
18	Breaker/Boost/Shear Selector Switch
20	Power Boost Switch (Top of Right Work Lever)

The Power Boost function is used to temporarily increase the main relief pressure to enhance excavation ability. When the breaker/boost/shear selector switch is set to "BOOST" and the power boost button on the center of the right-hand work lever (joystick) is pressed during work, the e-EPOS controller will activate the power boost solenoid valve and increase the relief valve pressure from 330 - 350 kg•cm^2 (4,700 - 5,000 psi). The excavation ability is increased by approximately 6%.

When the power boost function is in activated, a power boost symbol appears on the information display department of instrument panel.

NOTE: *Do not use this switch for more than 10 seconds.*

Power Boost Control - Circuit Diagram



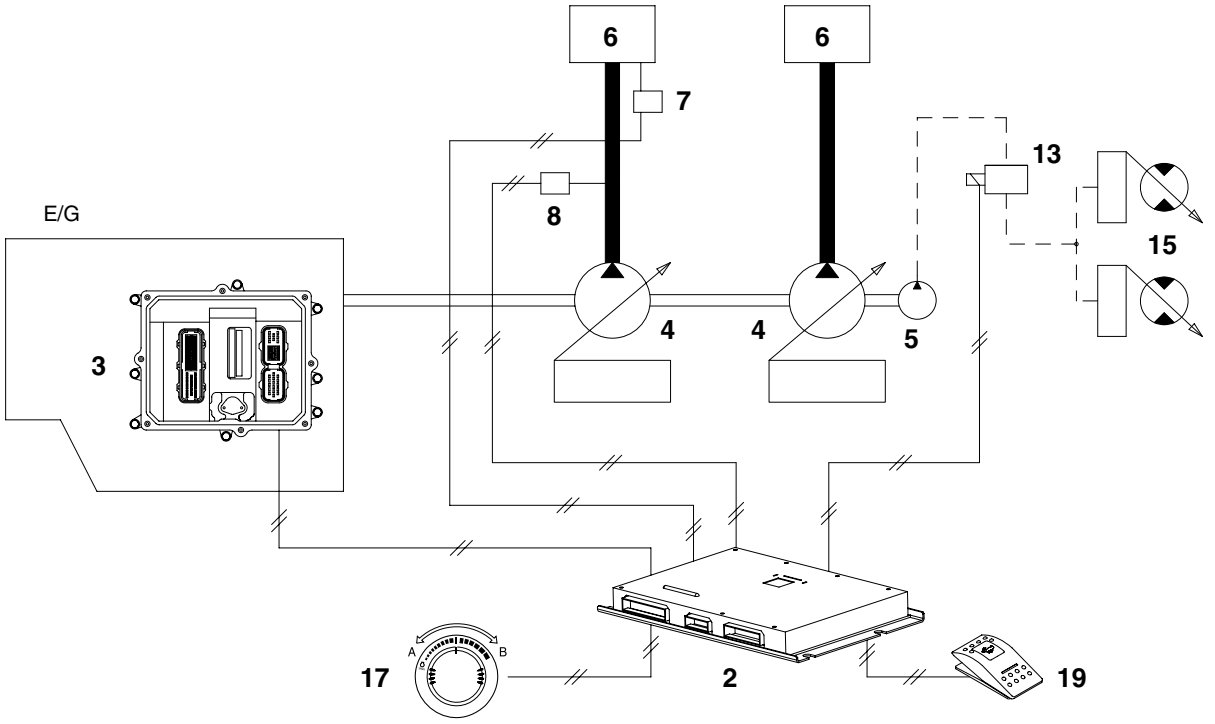
FG000586

Figure 65

Reference Number	Description
1	Instrument Panel
2	e-EPOS Controller
11	Solenoid Valve (Pressure Up)
18	Breaker/Boost/Shear Selector Switch

Reference Number	Description
20	Power Boost Switch (Top of Right Work Lever)
24	Battery
25	Battery Relay
26	Fuse

AUTOMATIC TRAVEL SPEED CONTROL



FG000799

Figure 66

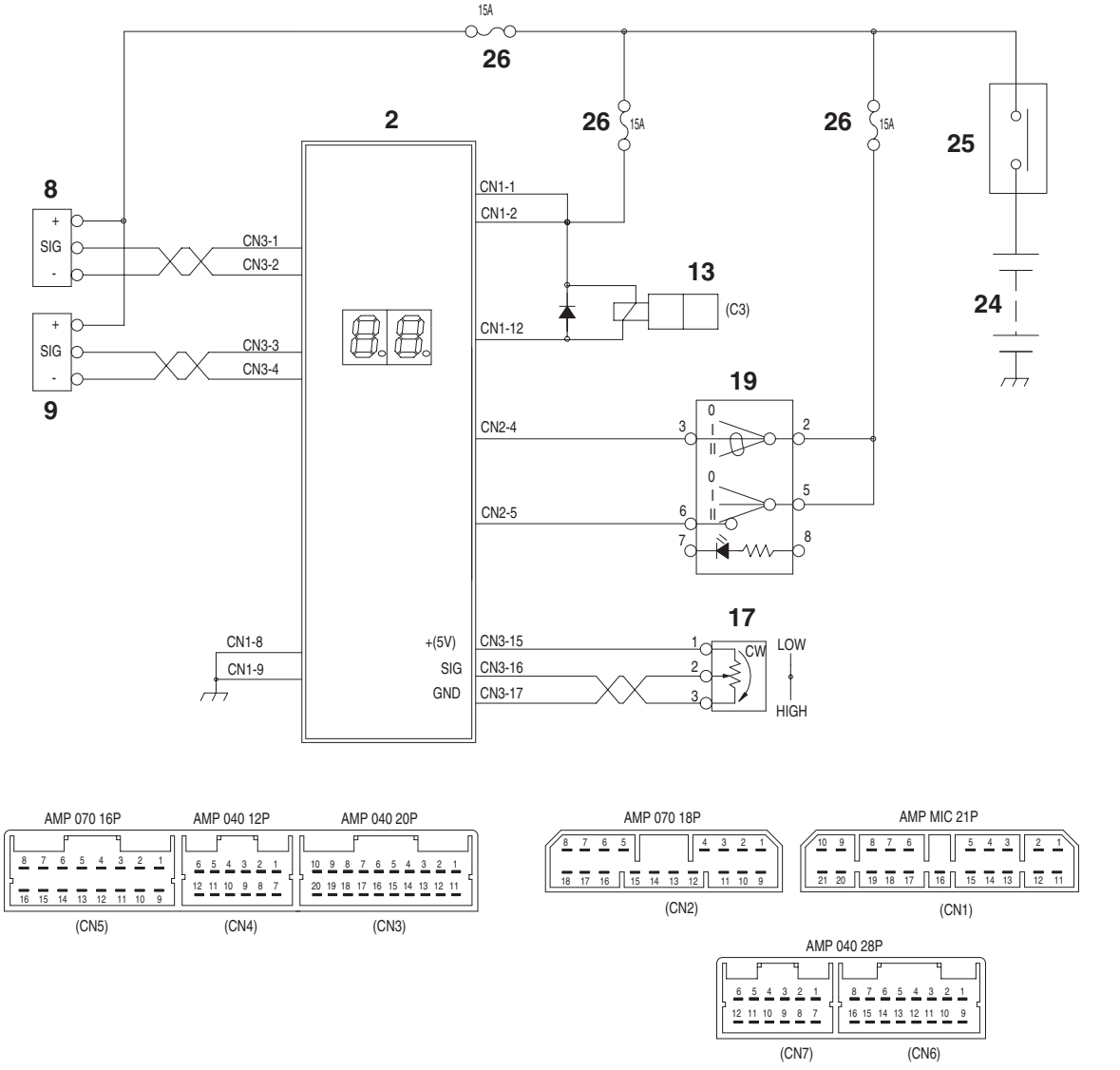
Reference Number	Description
2	e-EPOS Controller
3	Engine Controller
4	Main Pump
5	Aux Pump
6	Control Valve
7	Pressure Switch (Py Port)

Reference Number	Description
8	Pump Pressure Sensor
13	Solenoid Valve (High-speed)
15	Travel Motor
17	Engine Control Dial
19	Selector Switch For Automatic Travel

If the automatic travel speed control switch is set to the "OFF" position, the travel motor will run in the I-speed (low speed) range. If the selector switch is set to the "I" position, the travel motor will run in the II-speed (high-speed) range. If the selector switch is set to the "II" position, the e-EPOS controller will monitor the main pump discharge pressure and automatically select the "ON" - "OFF" status of the II-speed travel solenoid valve based on the travel load. The travel speed is changed between the I-speed and the II-speed mode.

The travel load is monitored by the two pressure sensors in the discharge lines of the front (upper) and rear (lower) pumps. When the travel load is high (pressure over 300 kg•cm^2 (4,300 psi) the solenoid valve is turned "OFF" and I-speed (low) is selected. In the case when the travel load is low (pressure under 160 kg•cm^2 (2,280 psi), the solenoid valve will be turned "ON" and the II-speed will be selected. But, if the engine speed control switch dial is set below approximately 1400 rpm, the travel speed will be set to I-speed mode.

Automatic Travel Speed Control - Circuit Diagram



FG000587

Figure 67

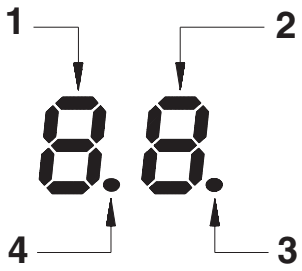
Reference Number	Description
2	e-EPOS Controller
8	Pressure Sensor (Front Pump)
9	Pressure Sensor (Rear Pump)
13	Solenoid Valve (High-speed)
17	Engine Control Dial

Reference Number	Description
19	Selector Switch For Automatic Travel
24	Battery
25	Battery Relay
26	Fuse

SELF-DIAGNOSTIC FUNCTION

e-EPOS Controller

The system operation status and malfunction codes can be checked through the display on top of the e-EPOS controller box the rear cover behind the operator's seat.



FG000588

Figure 68

Reference Number	Description
1	Upper Digit
2	Lower Digit
3	Engine Speed Monitor LED (Flash Interval Increases With Engine Speed.)

Reference Number	Description
4	Power Monitor (Stays "ON" While Power Is In Normal Range,)

1. Power Monitor

This LED is turned "OFF" when the input voltage to the e-EPOS controller is below 18.5 ± 1 V or above 32.5 ± 1 V. Stays "ON" while in normal range.

2. Engine Speed Monitor

This LED light flashes according to the engine speed. The flashing interval is proportional to the engine speed.

3. Normal Operation Display Readout

Mode Selection		Display Readout		Operation Status
		Upper Digit	Lower Digit	
Power Mode	Power Mode	 HAOH340L		Normal Operation Power Mode
	Standard Mode	 HAOH350L		Normal Operation Standard Mode
Work Mode	Digging		 HAOH370L	Normal Operation Digging Mode
	Trenching		 HAOH380L	Normal Operation Trenching Mode

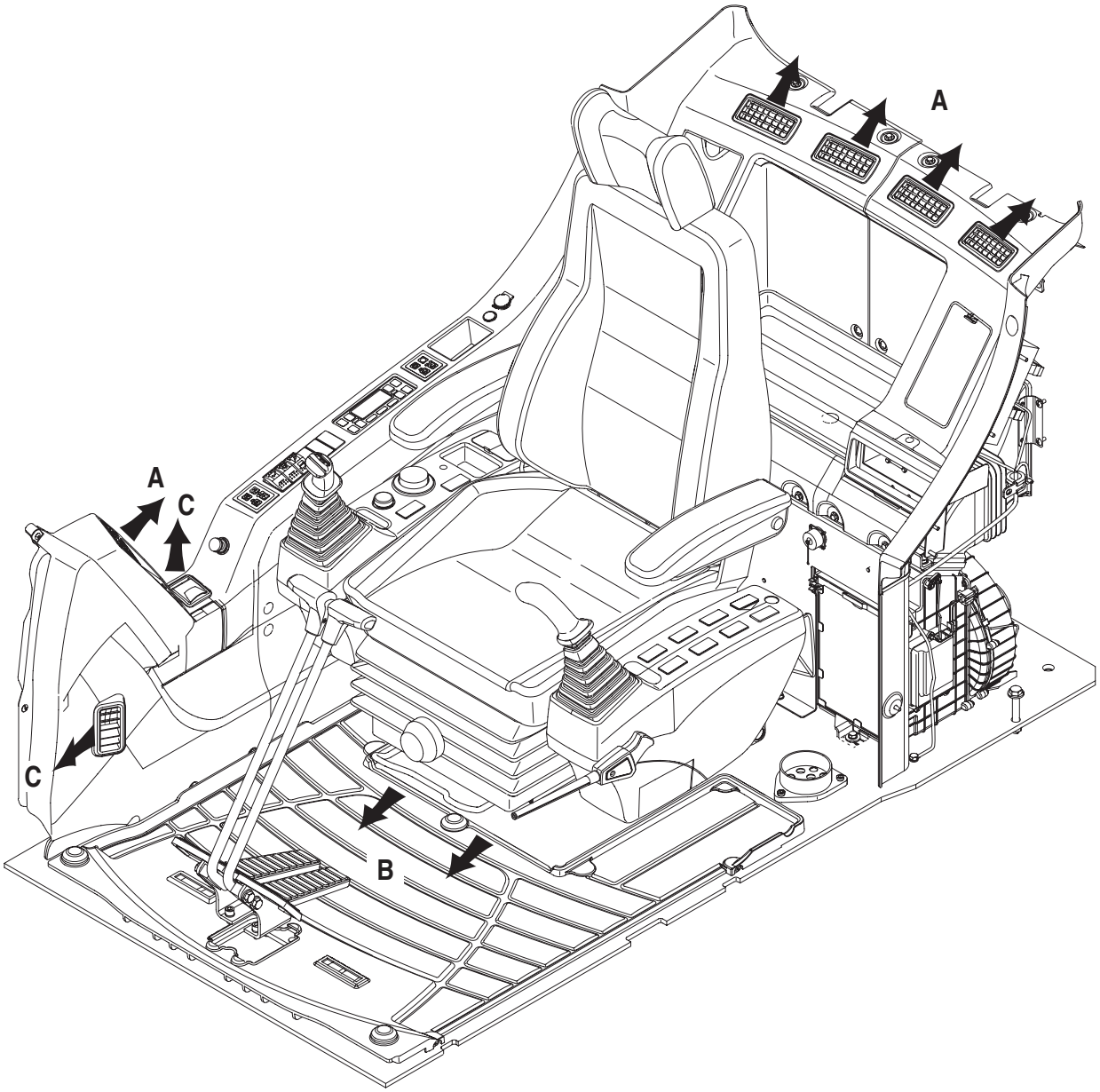
4. Communication Monitor

What are shown in the 7-SEGMENT LED are same as those in the Error Codes.

Error Code	Indication Code	Fault Location
V201	01	Communication error in instrument panel.
V202	02	Communication error in engine controller.

AIR CONDITIONER SYSTEM

Outline



FG000784

Figure 69

Solid type heater and air conditioner are installed in the cover behind the operator's seat.

Temperature of the operator's room is adjusted automatically to the temperature set by operator.

(Please refer to the Operation Manual for detailed full automatic control.

Vent mode selects the direction of discharged air.

Outlets by vent modes

Modes					
Outlets	A	A+B	B	B+C	C

Internal and External Filters

Internal and external air purification filters are installed for the operator's room.

Filters should be cleaned every 500 hours.

If machine operates in an excessively contaminated environment, filters should be cleaned more frequently and if necessary, replaced with new ones.

How to Check Internal Air Filter

1. Press both levers on the left and right side at the top of the filter installed behind the operator's seat.

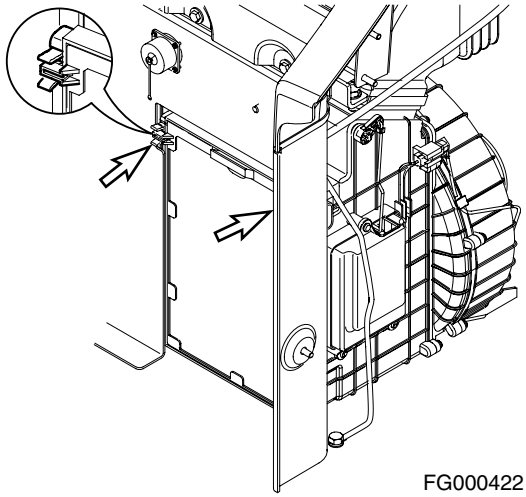


Figure 70

How to Check External Air Filter

1. Open the door at the left side of machine and loosen four marked bolts to remove cover (1, Figure 71).

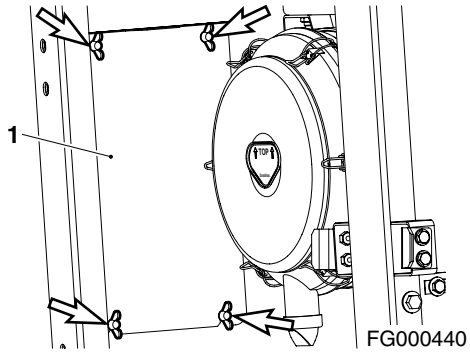


Figure 71

2. Turn marked knobs (1, Figure 72) at the rear side of the cabin to open the cover.

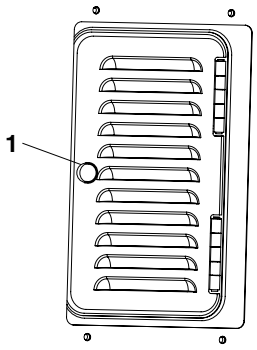


Figure 72

3. Remove filter attached to the cover and clean the contaminated filter using compressed air.
4. Close the cover, replace the knobs, and secure the cover to the support with butterfly bolts.

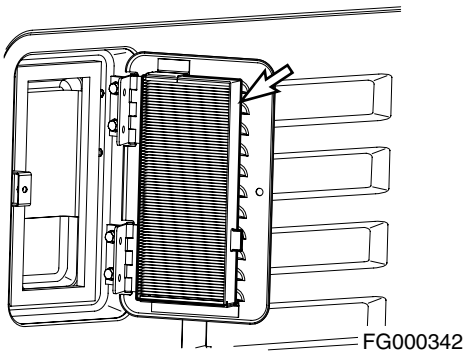
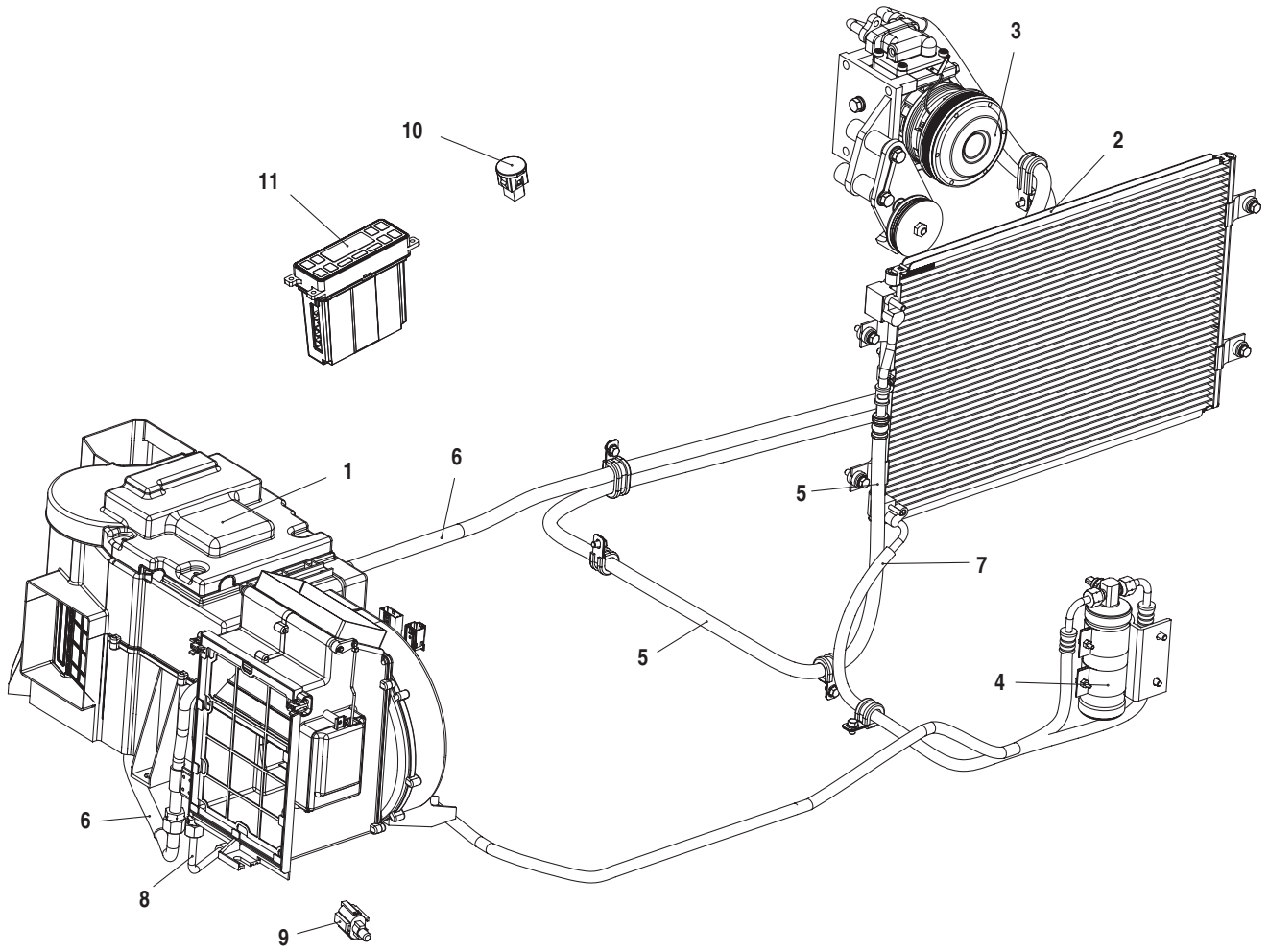


Figure 73

Air-Conditioning System Layout



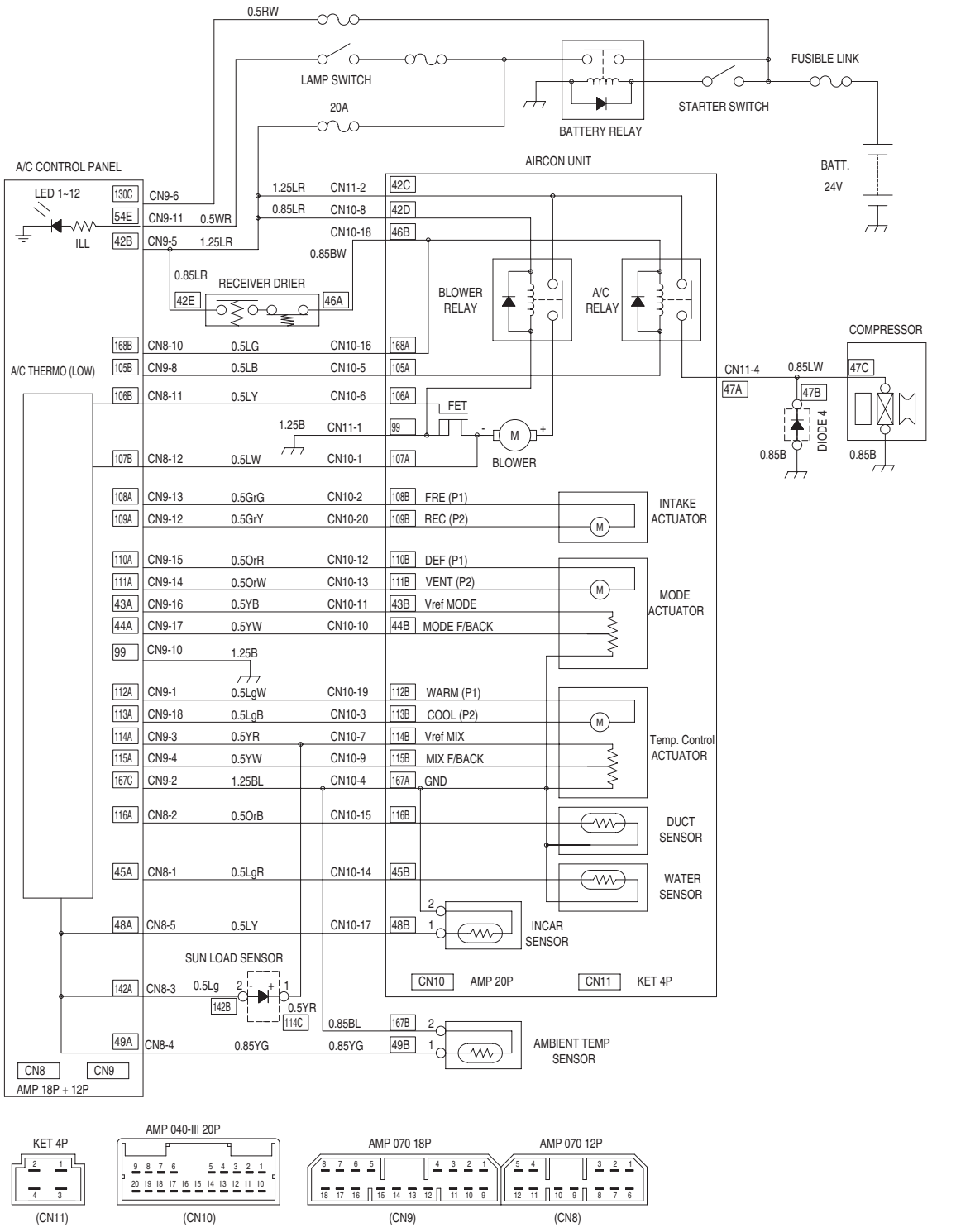
FG007144

Figure 74

Reference Number	Description
1	Air Conditioner/heater Unit
2	Condenser
3	Compressor
4	Receiver Dryer
5	Discharge Hose
6	Suction Hose

Reference Number	Description
7	Liquid Hose (1)
8	Liquid Hose (2)
9	Ambient Temperature Sensor
10	Sun Sensor
11	Control Panel

Air Conditioner/heater Circuit Diagram



FG001463

Figure 75

Air Conditioner/heater Unit

Airflow Diagram

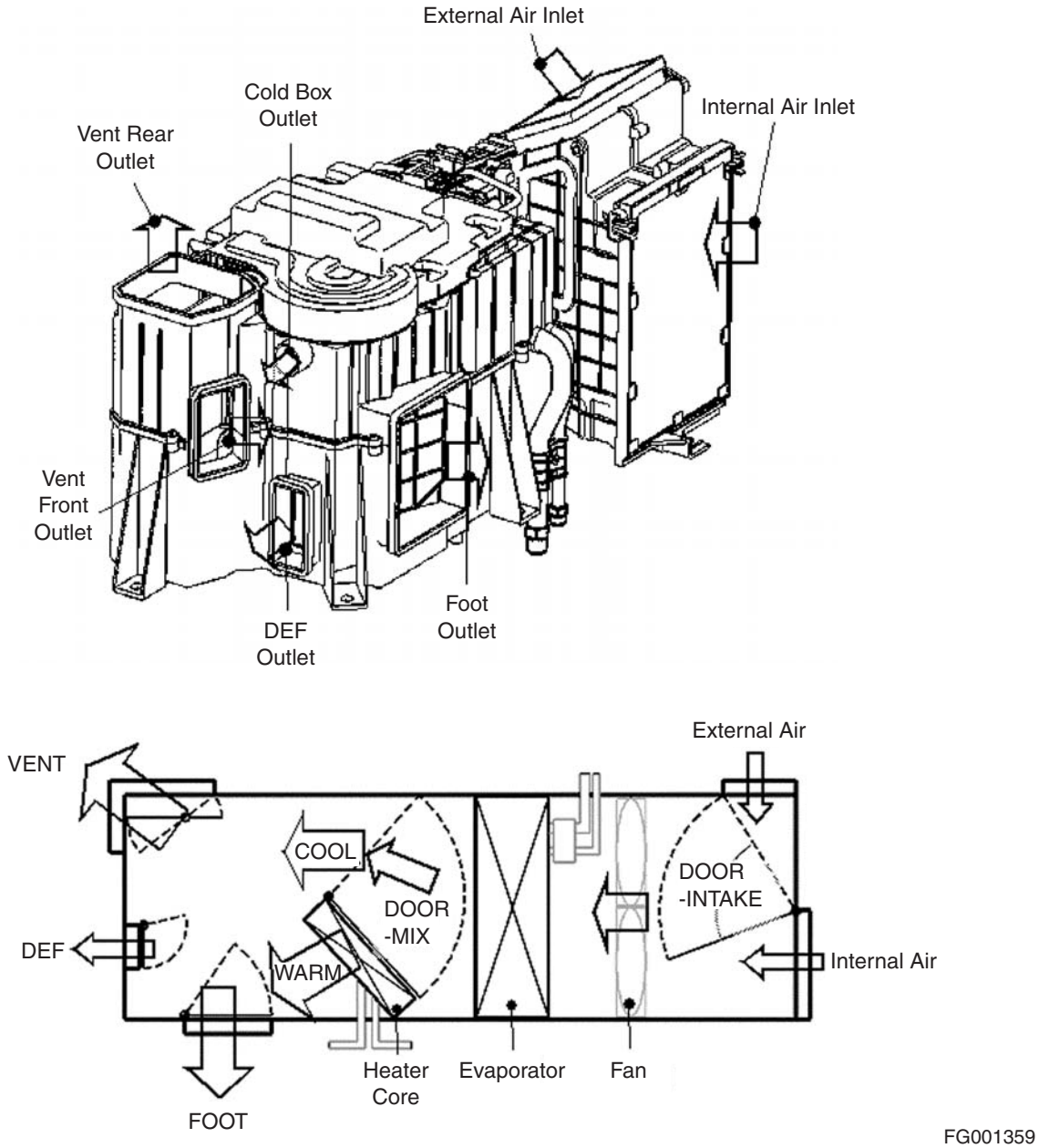


Figure 76

Door Open by Vent Modes

Door	Mode				
	Vent	Bi-level	Foot	Def/foot	Def
Vent	100	60	0	0	0
Foot	0	40	100	80	60
Def	0	0	0	20	40

Main Components

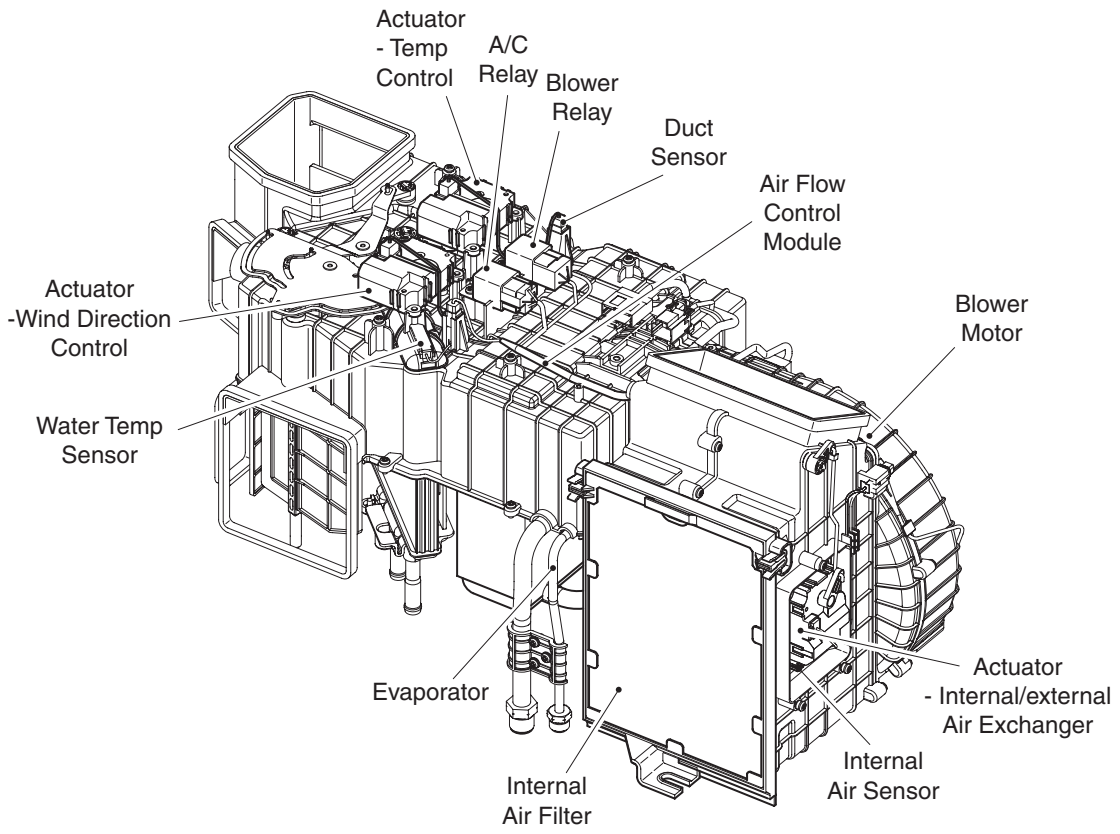


Figure 77

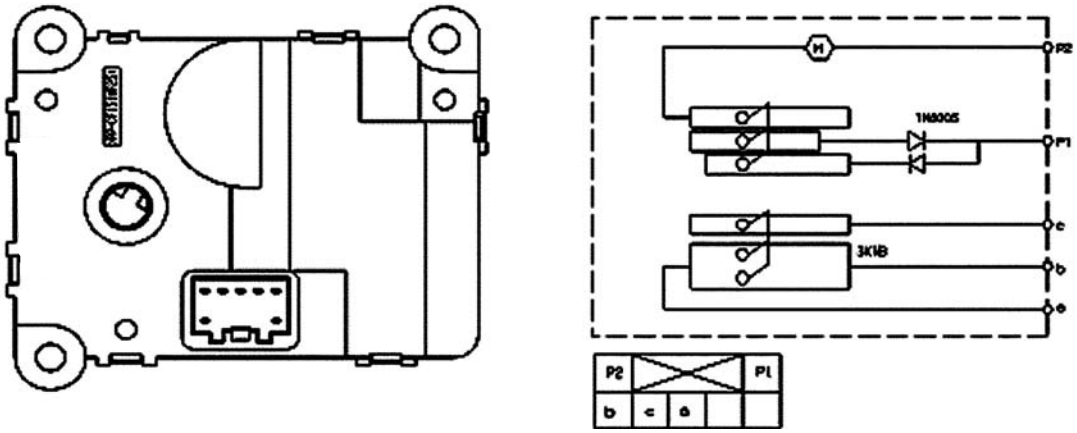
Actuator - Wind Direction Control

Change of discharged airflow according to selected wind direction mode

Change of wind direction: Direction changes in the order of VENT→ BI-LEVEL → FOOT → FOOT/DEF → VENT.

Actuator - Temperature Control

Change of discharged air temperature by controlling the position of temperature control door.



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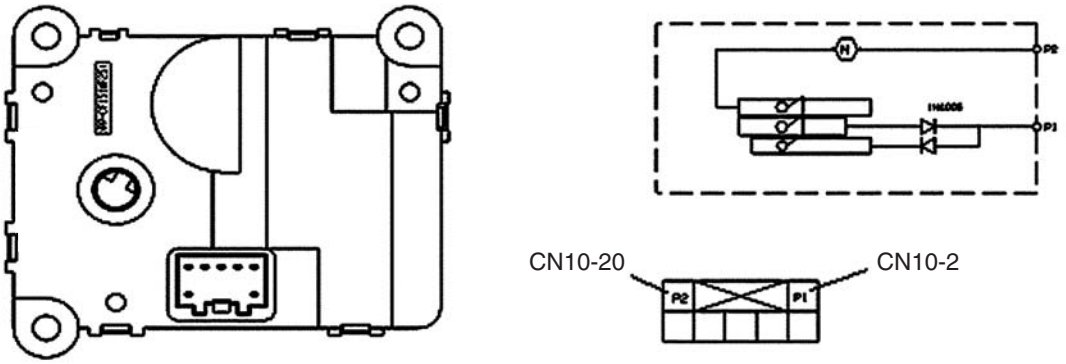
Figure 78

Actuator - Wind Direction Control

Wind Direction Mode	Output Terminal	Voltage
Vent	c (+): CN10-10 b (-): CN10-4	0.5 ± 0.2V
Bi-level		1.3 ± 0.2V
Foot		2.45 ± 0.2V
Foot/def		3.5 ± 0.2V
Def		4.5 ± 0.2V

Actuator - Temperature Control

Set Temperature	Output Terminal	Voltage
Max cooling	c (+): CN10-9	Below 0.4V
Max heating	b (-): CN10-4	Above 4.5V



FG001055

Figure 79

Mode	Output Terminal	Output
Intake	P1 (+), P2 (-)	Moving of exchange door by selecting intake.
Recirculate	P1 (-), P2 (+)	Moving of exchange door by selecting recirculate.

Airflow Control Module

Airflow is controlled through the control of voltage between GATE and SOURCE.

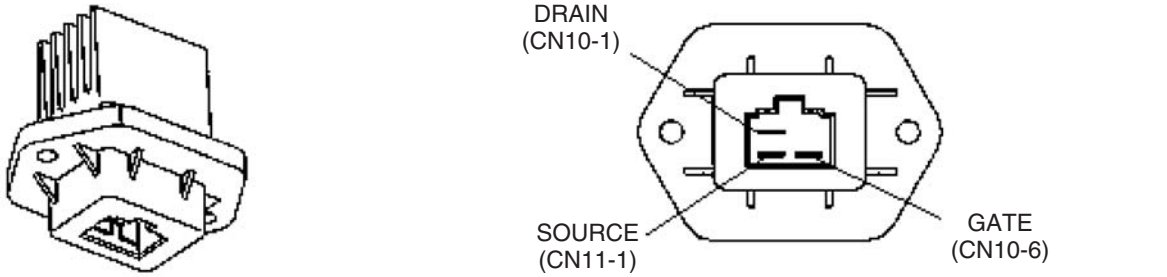


Figure 80

Airflow	Output Terminal		Output
1st	CN11-2	CN10-1	10 ± 0.5V
2nd			12.5 ± 0.5V
3rd			15 ± 0.5V
4th			17.5 ± 0.5V
5th			20.0 ± 0.5V
6th			22.0 ± 0.5V
7th			More than 25V

Input voltage is 27.5V.

The airflow is based on manual set.

Relay - Blower: Power is supplied to the blower motor when the system is turned "ON."

Specifications	
Rated voltage	24V
Rated current	20A

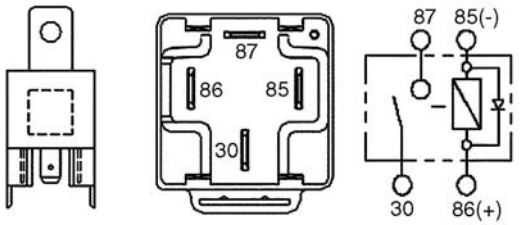


Figure 81

Relay - A/C: Power is supplied to the magnetic clutch of the compressor.

Specifications	
Rated voltage	24V
Rated current	10A

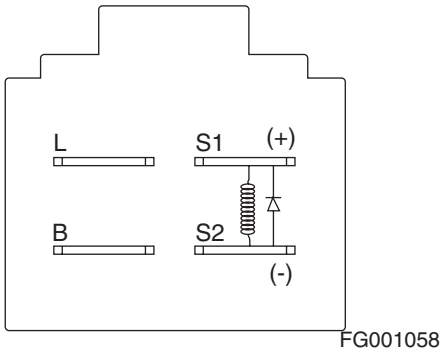


Figure 82

Duct Sensor: It is inserted in the core of the evaporator to prevent freezing of the evaporator.

The sensor consist of negative characteristic thermistor that resistant value increases and decreases when the temperature rises and falls, respectively.

Temperature (°C)	Resistance (KΩ)
0	11.36 ± 0.1
2	10.39 ± 0.2
2.5	10.17 ± 0.2
3	9.95 ± 0.2
3.5	9.73 ± 0.2
4	9.52 ± 0.2
5	9.12 ± 0.2
10	7.36 ± 0.15
25	4.02 ± 0.08
30	3.33 ± 0.07

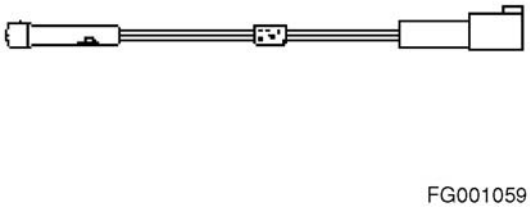


Figure 83

Water Temperature Sensor: It senses the temperature of coolant water in the heater core.

Temperature (°C)	Resistance (KΩ)
-10	55.8 ± 1.7
0	32.9 ± 0.9
15	15.76 ± 0.5
25	10.0 ± 0.3
35	6.5 ± 0.2

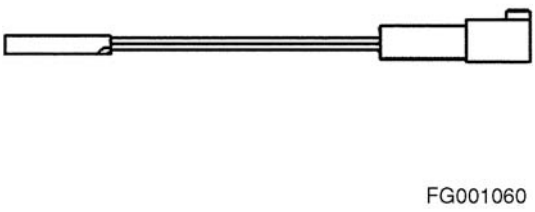
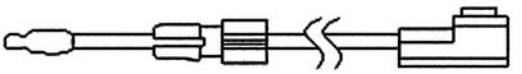


Figure 84

Internal Air Temperature Sensor: Built in the internal air filter, it senses the internal temperature.

Temperature (°C)	Resistance (KΩ)
-15	218.2 ± 7.5
0	97.83 ± 0.9
15	47.12 ± 0.7
25	30.0 ± 0.36
35	19.60 ± 0.3



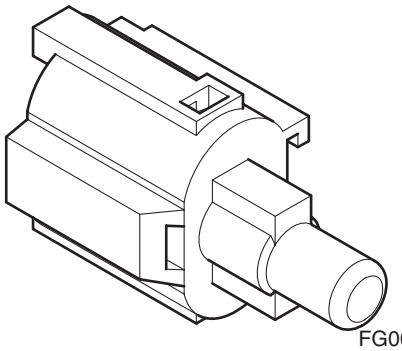
FG001061

Figure 85

Ambient Air Temperature Sensor

Built at the bottom of the cockpit, it senses the temperature of external air.

Temperature (°C)	Resistance (KΩ)
-10	163 ± 4.9
0	96.9 ± 2.9
10	59.4 ± 1.8
20	37.4 ± 1.1
25	30 ± 0.9
30	24.2 ± 0.7

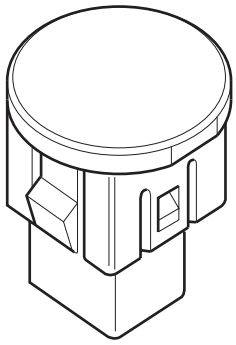


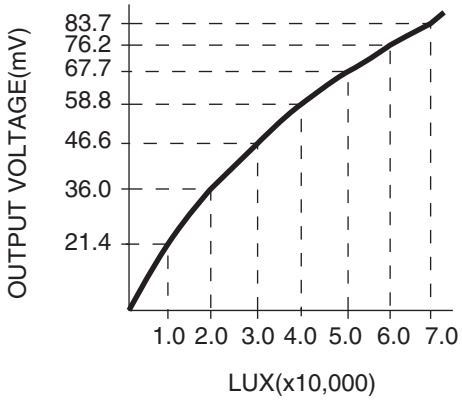
FG001064

Figure 86

Sun Sensor

Built beside the socket of spare power, it senses the quantity of the sun radiation to regulate discharge temperature and airflow as set by operator.



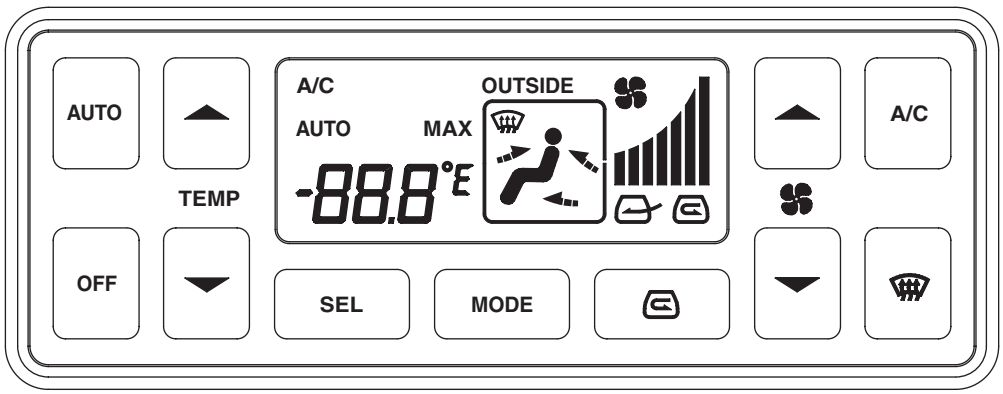


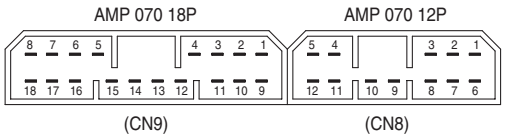
FG001062

Figure 87

Control Panel

Appearance and Terminal Arrangement





FG001063

Figure 88

Refer to "Air Conditioner and Heater" of operation manual.

Terminal Terms

CN	Term No.	Terms
CN9	1	Temperature control (warm)
	2	Sensor ground
	3	Temperature control Power (5V)
	4	Mix feedback
	5	Power (KEY "ON")
	6	Backup
	7	-
	8	A/C output (LOW)
	9	-
	10	Ground
	11	Illumination
	12	Intake/Recirculate (Recirculate)
	13	Intake/Recirculate (Intake)
	14	Wind direction control (VENT)
	15	Wind direction control (DEF.)
	16	Wind direction control Power (5V)
	17	Wind direction control (feedback)
	18	Temperature control (cool)

CN	Term No.	Terms
CN8	1	Water temperature sensor
	2	Duct sensor
	3	Sun sensor
	4	Ambient air temperature sensor
	5	Internal air temperature sensor
	6	-
	7	-
	8	-
	9	-
	10	D.P.S CHECK
	11	Airflow module (gate)
	12	Blower motor (feedback)

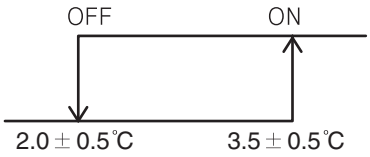
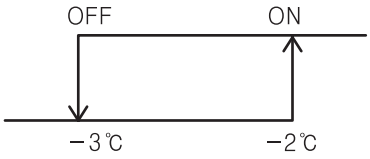
Control Logic

Categories	Inputs	System Operation
AUTO	Set temperature Internal air temperature sensor Ambient air temperature sensor Water temperature sensor Sun sensor	1. Automatically adjust room temperature as set and then next items. Temperature, Wind direction, Recirculate/Intake, Airflow, Compressor 2. Auto mode is released when manually setting any switch except, Temperature Control switch in Auto mode. 3. Upon the releasing of Auto mode, all of functions except selected switch are controlled automatically.

<table>
<tr><th>Categories</th><th>Inputs</th><th>System Operation</th></tr>
<tr><td>Sensor compensation</td><td>Set temperature
Internal air temperature sensor
Ambient air temperature sensor
Water temperature sensor</td><td>1. In case of sensor failure, following defaults are applied:
Internal air temperature sensor: 25°C, Ambient air temperature sensor: 25°C, Duct sensor: -2°C
Temperature control actuator:
- Set Temperature 17 - 24.5°C: Max cooling, Set Temperature 25 - 32°C: Max heating
Wind direction mode actuator
- VENT: VENT fix, modes other than VENT: Fixed to DEF
* Sun sensor is not compensated.</td></tr>
<tr><td>Max cooling/ heating control</td><td>Auto Setting</td><td>1. Set Temperature 32°C: Max heating
2. Set Temperature 17°C: Max cooling
<table><tr><th></th><th>Max Cooling (17 ˚C)</th><th>Max Heating (32 ˚C)</th></tr><tr><td>Temp Control Actuator</td><td>FULL COOL</td><td>FULL HOT</td></tr><tr><td>Air Flow</td><td>MAX HI</td><td>AUTO HI</td></tr><tr><td>Compressor</td><td>Forced ON</td><td>OFF</td></tr><tr><td>Intake/Recircle</td><td>Recircle</td><td>Intake</td></tr><tr><td>Wind Direction Mode</td><td>VENT</td><td>FOOT</td></tr></table>* Max cooling/heating control is possible only in Auto mode.</td></tr>
<tr><td>Starting Control of Cooling</td><td>Auto mode
Duct sensor</td><td>1. Prevention of discharge of hot air before discharge temperature drops enough in hot summer weather
2. Start conditions (AND condition)
(1) A/C on (AUTO or manual)
(2) Temperature sensed by the duct sensor is above 30°C
(3) Airflow: Auto mode
3. One time control in the cycle of engine OFF → engine run
4. Initial cooling control is executed when the Auto switch is "ON" in the manual status (A/C "OFF" and manual control of airflow) in 5 seconds after engine run.
5. Initial cooling control should be before max cooling.
6. Release condition (OR condition)
(1) A/C "OFF"
(2) Airflow: Manual control
(3) Release is possible with the "OFF" switch but not allowed within 12 seconds (after Start "ON") while the system is off using the "OFF" switch and during the time of initial cooling control.</td></tr>
</table>

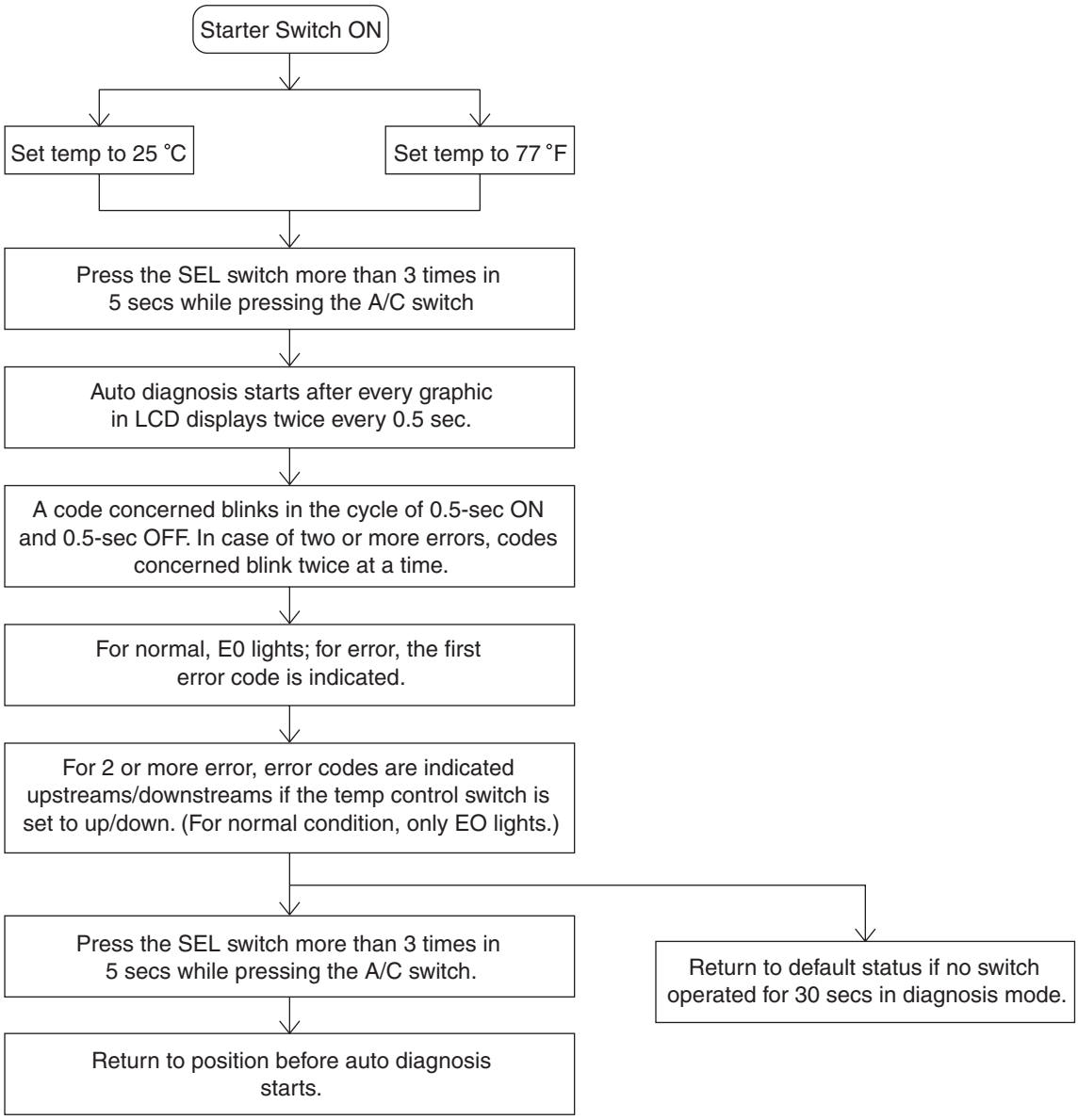
Categories	Inputs	System Operation
Starting control of heating (1)	Water temperature sensor Internal air temperature sensor Auto mode Set Temperature	1. Start condition (AND condition) (1) When wind direction mode is one of the following modes in the Auto or manual control mode - BI-LEVEL, FOOT or FOOT/DEF (2) The Water temperature sensor is stable and the water temperature < 73°C (3) Airflow: Auto mode (4) Set temperature > Internal air temperature + 3°C * Airflow falls gradually up to 12 seconds when operation released.
		2. One time control in the cycle of engine OFF → engine run 3. Initial heating control should be before max heating. 4. Airflow is controlled only when the wind direction is in the manual mode and BI-LEVEL, FOOT, or FOOT/DEF is set. 5. Control through the water temperature sensor for start. 6. Starting control of heating (2) starts in case of fault of the water temperature sensor during controlling. 7. Operation release (OR condition) (1) Only airflow is released if it is selected manually. (2) When handling the wind direction mode switch, only wind direction is released but the airflow control is performed only for the remaining period of the starting control of heater. (3) When Max Cooling (17°C) is selected. (4) Water temperature sensor > 73°C.

Categories	Inputs	System Operation
Starting control of heating (2)	Water temperature sensor Ambient air temperature sensor Internal air temperature sensor Auto mode	1. Entry condition (AND condition) (1) Auto Mode (2) Ambient air temperature < 5°C and difference between ambient and internal air temperature ??5°C (3) Failure of water temperature sensor 2. Only one time of engine OFF → engine run 3. Starting control of heating is before max heating. 4. Operation release (OR condition) (1) Airflow: Manual selection (2) When handling the wind direction mode switch, only wind direction is released but the airflow control is performed only for the remaining period of the starting control of heater. (3) Difference between internal and ambient air temperature>15°C (4) When Max Cooling (17°C) is selected. 5. Exceptional case Starting control of heating is performed only once during the remaining period if the entry condition is satisfied within the starting control period that is the accumulation of initial start times. (Inclusive of Auto mode "ON" case within the period of starting control of heater.) * Airflow should be reduced slowly for up to 12 seconds in case of exceptional entry case.

Categories	Inputs	System Operation
Compressor control	Duct sensor	1. Function: Magnetic clutch of compressor is turned "ON/ OFF" depending on temperature of the duct sensor to prevent the freezing of the evaporator with A/C being "ON." 2. Control pattern. 
	External temperature sensor	1. Function: Prevention of compressor in winter. 2. Control pattern.  *Only for Auto mode.

Self-diagnostics

How to start self-diagnostics



FG001367

Figure 89

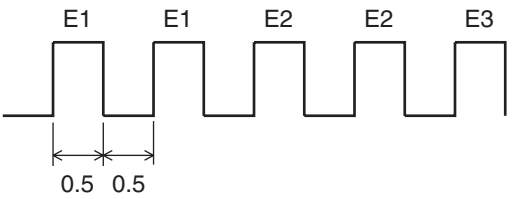
Error codes

Code	Description
E0	Normal
E1	Internal air temperature sensor short
E2	Internal air temperature sensor open
E3	Ambient air temperature sensor short
E4	Ambient air temperature sensor open
E5	Duct sensor short
E6	Duct sensor open
E7	Sun sensor short
E8	Sun sensor open
E9	Water temperature sensor short
E10	Water temperature sensor open
E11	D.P.S open
E12	Position error of wind direction actuator
E13	Position error of temperature control actuator

NOTE: *The position error means that it fails to move to designated place in 40 seconds.*

Sun sensor displays E8 in case of no sunlight.

2 and more fails: Codes concerned blinks twice at a time.



FG001067

Figure 90

Ambient Temperature Display

Selection of both the SEL and MODE switch for more than 3 seconds indicates the ambient temperature in the set temperature display department.

- Range of temperature display: -40 - +60°C

NOTE: *Display of ambient temperature may be released in the same way for its entry way.*

It returns automatically to default mode 5 seconds after entering the ambient air temperature display mode.

Compressor

Categories	Specifications
Output	155.3 cc/rev
Oil Level	120 cc (ND-OIL8)
Refrigerant	R134a
Rated Voltage	24V
Relief Valve	Open: 35 - 42.2 kg•cm^{2}G Close: 28.1 kg•cm^{2}G

Compressor sucks in refrigerant which evaporates completely in the evaporator and discharges it to the condenser.

Refrigerant undergoes repeated changes of states, in the order of liquid, gas, and liquid in the freezing cycle, and the compressor makes evaporated refrigerant a high temperature and high-pressured gas to freeze it in the condenser.

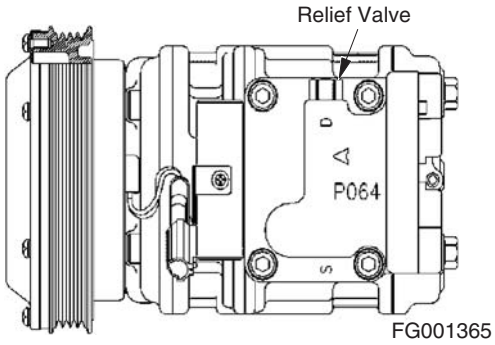


Figure 91

Receiver Dryer

The receiver dryer reserves refrigerant enough to ensure smooth freezing cycle responding immediately to the change of level in the freezing cycle.

As liquid refrigerant from the condenser may contain refrigerant gas with bubbles whose presence in the expansion valve decreases the freezing power excessively, it separates liquid and gas and sends liquid only to the expansion valve.

Water in refrigerant shall be eliminated with dryer and through filter.

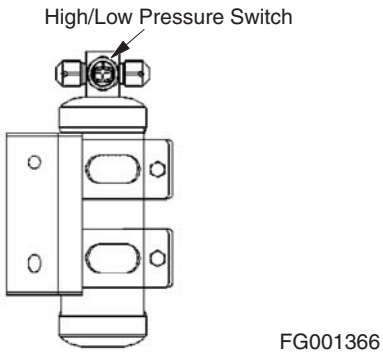


Figure 92

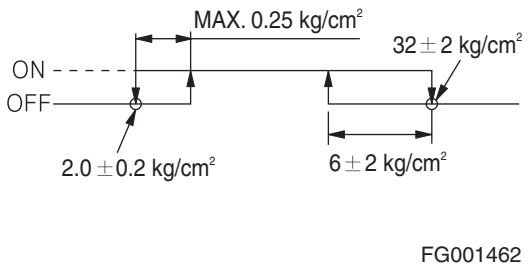


Figure 93

TROUBLESHOOTING

Refrigerant Pressure Check

1. Open all doors and windows.
2. Install manifold gauge set.
3. Start engine and maintain engine speed at 1,800 - 2,000 rpm.

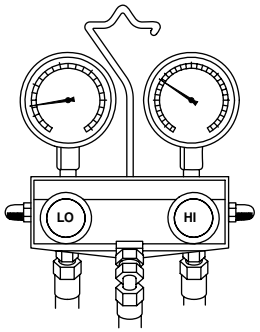


Figure 94

4. Check high / low-pressure of refrigerant.

1	**High-pressure: 8.0 - 10.0 kg•cm^2 (114 - 142 psi)** **Low-pressure: Approximately 1.0 kg•cm^2 (14 psi)**		
Possible Cause: Low Refrigerant Level			
Step	**Inspection Item**		**Remedy**
1	Check for traces of refrigerant oil.	Yes	Reassemble using correct tightening torque.
		No	Go to next step.
2	Using a leak detection device or soapy water check for refrigerant leakage at all major components and joints.	Yes	Repair leaking component.
		No	Recharge system to correct pressure.

2	**High-pressure: Over 23 kg•cm^2 (327 psi)** **Low-pressure: Approximately 2.5 - 3.0 kg•cm^2 (36 - 43 psi)**		
Possible Cause: Overcharge, Frost on condenser			
Step	**Inspection Item**		**Remedy**
1	Check for condenser pin damage or contamination.	Yes	Clean, repair or replace condenser.
		No	Refrigerant overcharge.

3	**High-pressure: Approximately 20 - 25 kg•cm^2 (285 - 356 psi)** **Low-pressure: Approximately 2.5 - 3.5 kg•cm^2 (36 - 50 psi)**
Possible Cause: Air in system.	
1. Recover any remaining refrigerant. 2. Vacuum out system. 3. Recharge system. **NOTE:** *If the system has been exposed to the air for a long time, replace the receiver dryer.*	

4	**High-pressure: Over 6 kg•cm^2 (85 psi)** **Low-pressure: Approximately 760 mmHg (Negative Pressure)**		
Possible Cause: Refrigerant does not circulate			
Step	**Inspection Item**		**Remedy**
1	1. Connect manifold gauge and start engine. 2. Turn on air conditioner. 3. Set blower switch to HIGH position. 4. Turn air conditioner OFF and wait 10 minutes. 5. Recheck high / low-pressure readings. High-pressure: 13.0 - 19.0 kg•cm^2 (185 - 270 psi) Low-pressure: 1.5 - 3.3 kg•cm^2 (21.3 - 46.9 psi)	Yes	Moisture in system, replace receiver dryer.
		No	Contaminated system, replace expansion valve. (Replace evaporator core assembly.)

5	**High-pressure: Over 6 - 18 kg•cm^2 (85 - 256 psi)** **Low-pressure: 500 mmHg (Negative Pressure) - Dial indicator needle unstable.**
Possible Cause: Moisture in system has iced up the expansion valve.	
NOTE:	*When the absorbed moisture freezes the pressure readings may look normal. Careful readings should be made to determine whether pressure is in normal range.*
1. Recover any remaining refrigerant. 2. Vacuum out system. 3. Recharge system. **NOTE:** *If the system has been exposed to the air for a long time, replace the receiver dryer.*	

6	**High-pressure: Over 22.0 - 23 kg•cm^2 (313 - 327 psi)** **Low-pressure: 2.5 kg•cm^2 (36 psi)**		
Possible Cause: Refrigerant pressure problem because of defective expansion valve or temperature sensor.			
Step	**Inspection Item**		**Remedy**
1	Inspect whether the temperature sensor is installed properly.	Yes	Replace expansion valve.
		No	Exchange duct sensor.

7	**High-pressure: Over 7.0 - 11.0 kg•cm^2 (100 - 156 psi)** **Low-pressure: 4.0 - 6.0 kg•cm^2 (57 - 85 psi)**
Possible Cause: Low refrigerant pressure because of poor compressor compression.	
Inspect and replace compressor if necessary.	

WEIGHT OF R134a GAS USED IN MACHINES

Model	Weight of Gas
DL300	850 ±20 grams (30 ±0.7 oz)
DL400	850 ±20 grams (30 ±0.7 oz)
DL500	850 ±20 grams (30 ±0.7 oz)
DX140W	800 ±20 grams (28 ±0.7 oz)
DX180LC	800 ±20 grams (28 ±0.7 oz)
DX225LC	800 ±20 grams (28 ±0.7 oz)
DX225NLC	800 ±20 grams (28 ±0.7 oz)
DX300LC	800 ±20 grams (28 ±0.7 oz)
DX300LL	800 ±20 grams (28 ±0.7 oz)
DX340LC	800 ±20 grams (28 ±0.7 oz)
DX35Z	450 ±20 grams (16 ±0.7 oz)
DX420LC	800 ±20 grams (28 ±0.7 oz)
DX480LC	800 ±20 grams (28 ±0.7 oz)
DX520LC	800 ±20 grams (28 ±0.7 oz)

REFRIGERANT SYSTEM REPAIRS

WARNING!

Always wear protective glasses and gloves when handling refrigerant. If refrigerant comes in contact with the skin or eyes, immediately flush with clean, running water and consult a physician.

Select a clean and well ventilated area to work.

The refrigerant container is under high-pressure and should be stored below 40°C (104°F). Be careful not to drop the container from a high location.

The contents are under high-pressure and should not be used with compressed air or near an open flame.

Refrigerant Safe Handling Procedures

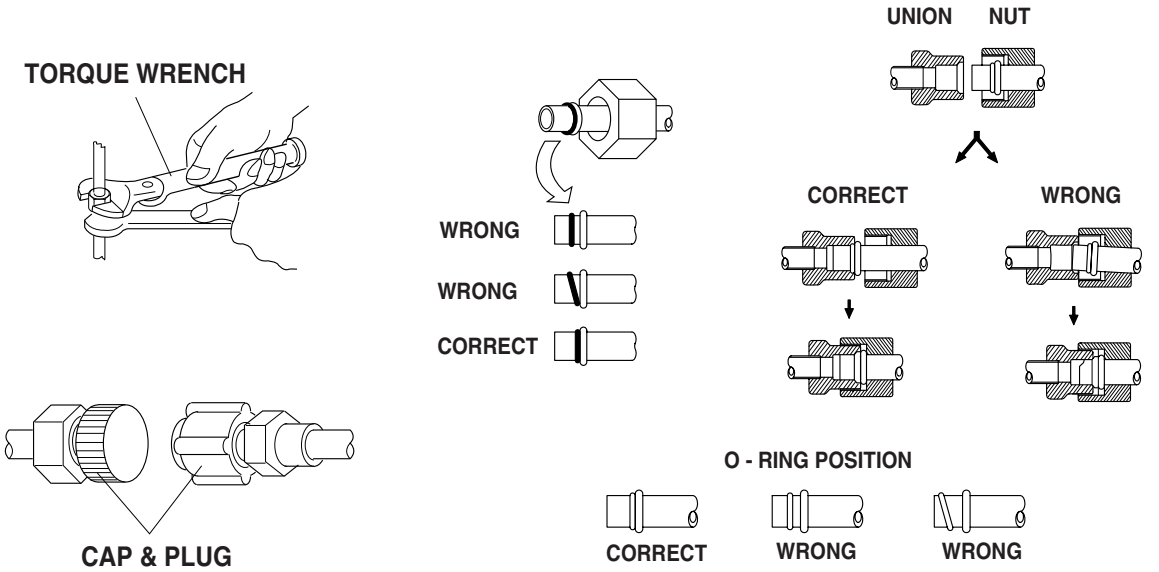


Figure 95

The following procedures should be observed for safe handling of refrigerant during vacuum and charging process.

1. Use an approved recovery / charging device which can safely perform vacuum and charge work simultaneously.
2. The new refrigerant has improved cooling characteristics than the old type and care should be used not to overcharge the system.

3. Do not over tighten connections when working on refrigerant system.
4. The new refrigerant system standards require new tools, equipment and parts. DO NOT attempt to use equipment use in servicing the old refrigerant system.
5. The new refrigerant oil (PAG type) has a high moisture absorption characteristic. When the refrigerant system vacuum seal has been broken, immediately plug up all openings to prevent moisture from entering the system.
6. When joining unions which use O-ring seals, lightly coat O-rings with refrigerant oil. Be careful not to drip oil on the threads of the nut.
7. Be certain the O-rings are seated properly on the refrigerant line lip. Always use new O-rings when reassembling parts. Do not reuse old O-rings.
8. Use a vacuum pump to evacuate refrigerant system of air.
9. When charging the refrigerant system with the engine running, do not open the high-pressure valve on the manifold gauge as the reverse flow of high-pressure refrigerant will rupture the hose.
10. When releasing the high-pressure hose after completing the charging process, quickly disconnect the hose to minimize refrigerant released to the air.

Repair and Replacement Procedure

1. Work Procedure
   A. Before repairing or replacing any refrigerant components first, return all refrigerant oil to the compressor and perform recovery procedures.
2. Operating Condition
   A. Run engine at maximum engine speed.
   B. Select 'HI' blower fan speed and select A/C switch to 'ON'.
   C. Set the temperature control switch for maximum cooling and leave running for approximately 20 minutes.

      NOTE: *The manifold gauge dial pointer can vary depending on the outdoor temperatures.*

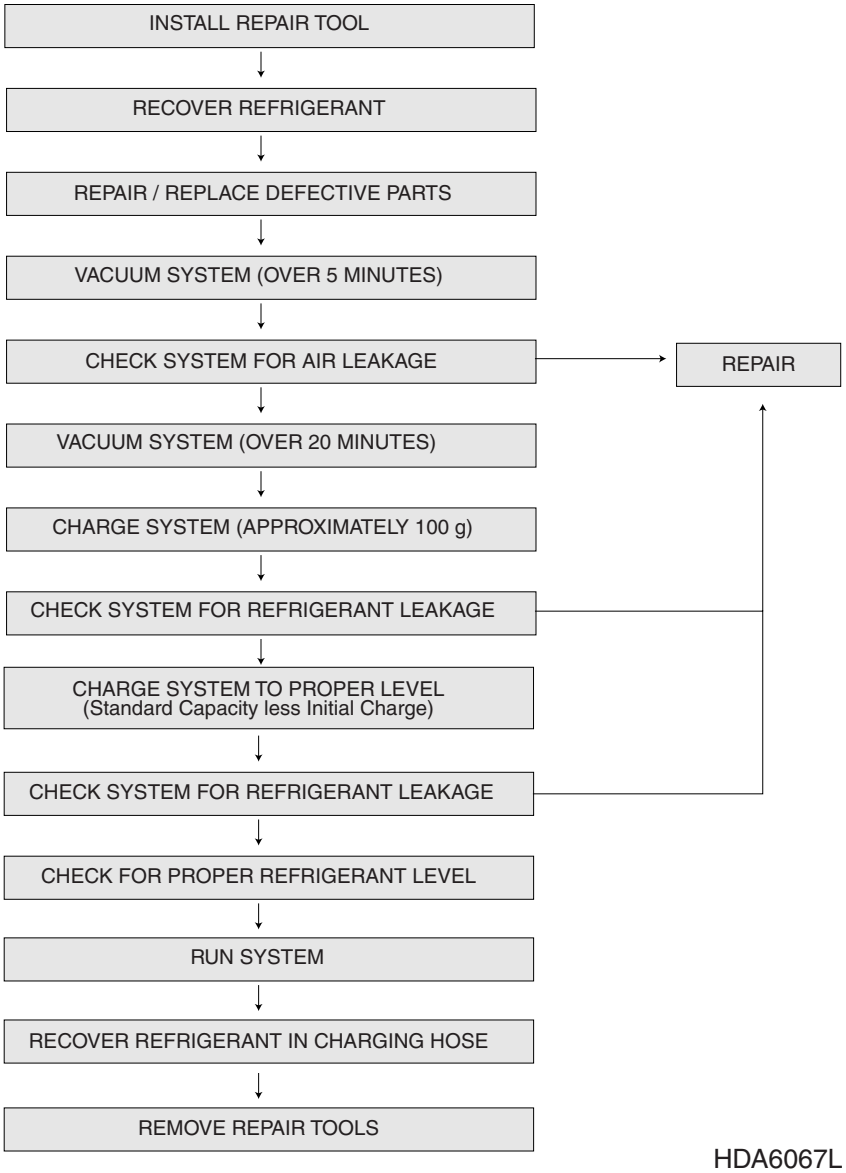
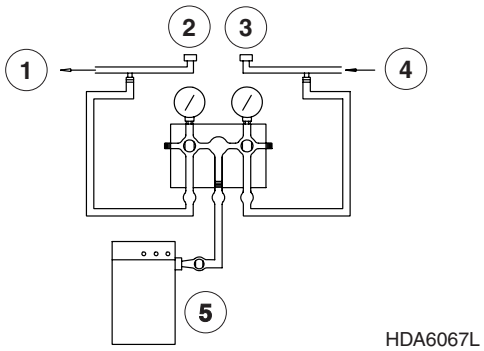

INSTALL REPAIR TOOL
RECOVER REFRIGERANT
REPAIR / REPLACE DEFECTIVE PARTS
VACUUM SYSTEM (OVER 5 MINUTES)
CHECK SYSTEM FOR AIR LEAKAGE
REPAIR
VACUUM SYSTEM (OVER 20 MINUTES)
CHARGE SYSTEM (APPROXIMATELY 100 g)
CHECK SYSTEM FOR REFRIGERANT LEAKAGE
CHARGE SYSTEM TO PROPER LEVEL
(Standard Capacity less Initial Charge)
CHECK SYSTEM FOR REFRIGERANT LEAKAGE
CHECK FOR PROPER REFRIGERANT LEVEL
RUN SYSTEM
RECOVER REFRIGERANT IN CHARGING HOSE
REMOVE REPAIR TOOLS
HDA6067L

Figure 96

Refrigerant Recovery

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	From Receiver
5	Refrigerant Recovery Tank



HDA6067L

Figure 97

1. Attach the manifold gauges and the refrigerant recovery unit to the refrigerant lines as shown.

   NOTE: *Be careful not to switch the connections for the low and high-pressure valves.*

2. Open the high-pressure valve slowly to release the refrigerant to the recovery unit.

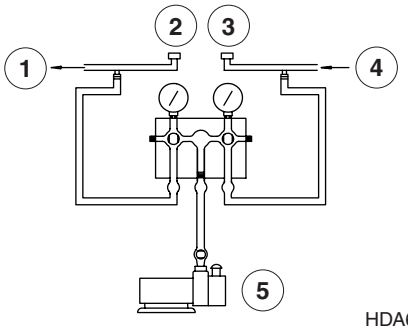
   NOTE: *Open the valve slowly, while checking to see that refrigerant is not leaking out.*

3. When the manifold gauge dial falls below 3.5 kg•cm^2 (50 psi), slowly open the low-pressure valve.

4. Open both the high and low-pressure valves slowly until the manifold gauge dials indicates 0 kg•cm^2 (0 psi).

Vacuuming Refrigerant System

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	From Receiver
5	Vacuum Pump



HDA6068L

Figure 98

1. Vacuuming Procedure

   NOTE: *When the A/C system has been exposed to the air, it must be vacuumed out. Perform vacuum process for 30 minutes for complete moisture and air evacuation.*

   A. Attach the manifold gauges and vacuum pump to the refrigerant system as shown.

   B. Turn on the vacuum pump and open both valves.

   C. When the low-pressure gauge shows approximately 710 mmHg, close both valves and turn off vacuum pump.

2. Check system for vacuum leak.

   Allow system to sit for 10 minutes and check whether the system is holding the pressure. If the pressure has dropped, it must be repaired before proceeding to the next step.

3. Vacuuming Procedure

   If the system is holding the pressure and it has not changed for 10 minutes, vacuum out the system for an additional 20 minutes.

   A. Turn on the vacuum pump and slowly open both valves.

   B. Allow vacuum pump to run for additional 20 minutes until the low-pressure gauge dial reads approximately 750 mmHg.

   C. Close both valves and stop the vacuum pump.

4. Installation of Refrigerant Container

Reference Number	Description
1	Handle
2	Hose Connection
3	Mounting Disk

   A. Before mounting valve on the container, make sure the handle is in the counterclockwise most position, with the puncture pin retracted and the mounting disk is in the raised position.

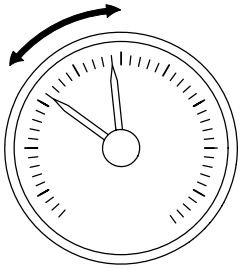
   B. Attach the manifold gauge center hose to the valve assembly.

   C. Turn the disk in the clockwise direction and securely mount valve onto refrigerant container.

   D. Turn the valve handle in the clockwise direction and puncture the container seal with the pin.

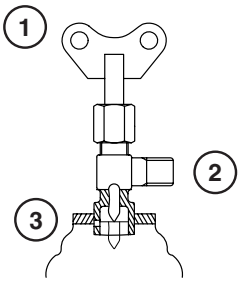
   E. Once the can has been punctured, turn the handle in the counterclockwise direction so the refrigerant can flow into the manifold gauge center hose. At this time, do not open the low and high-pressure valves of the manifold gauge.

   F. Press the manifold gauge low side valve to eliminate the trapped air in the hose.



HDA6069L

Figure 99



HDA6070L

Figure 100

Leakage Check

NOTE: *Perform the leakage check after completing vacuuming process.*

1. After attaching the manifold gauge, open the high side valve.
2. Charge system until the low side gauge dial indicates a pressure of 1 kg•cm^2 (14 psi) and close the high side valve.
3. Using a refrigerant leak detector or soapy water check each joint for leakage.

Reference Number	Description
1	Refrigerant Leak Detection Device

4. If a leak is detected, check for O-ring damage or correct tightening torque and replace or repair as necessary.
5. If no leaks are detected, proceed with the charging process.

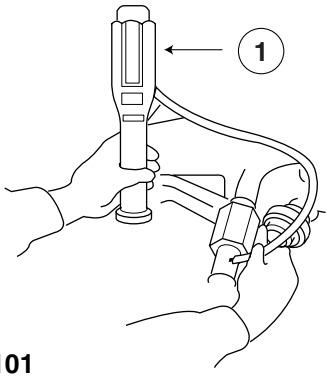


Figure 101 HDA6071L

WARNING!

For accurate refrigerant leak detection, perform leak detection procedure in a well ventilated area.

Refrigerant Charging

1. Perform the vacuuming procedure, vacuum holding and leaking tests as described in the proceeding headings.

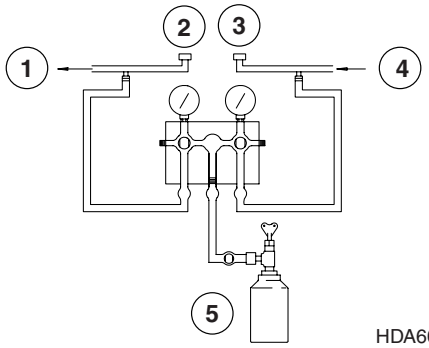
   NOTE: *First charge the refrigerant system with 100g (3.5 ounces) of refrigerant with the engine off. Then using the manifold gauges as a guide fully charge the system with the engine running.*

   When exchanging refrigerant containers, press the manifold gauge low side valve to eliminate air from the charging hose.

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	From Receiver
5	Refrigerant Supply Container

2. Charge the system by opening the manifold gauge low side valve.

   Initial charge amount: 100 g (3.5 ounces).



HDA6072L

Figure 102

3. If refrigerant does not flow freely into system, try starting engine first before operating air conditioner.

   - Temperature control switch setting: Maximum Cooling

     Blower Speed Setting: Hi (3 step)

     Engine Speed: 1,300 - 1,500 rpm

WARNING!

When charging refrigerant system with the engine running:

- **Always keep refrigerant supply container in the upright position.**
- **Never open the high side pressure valve.**

4. Open the manifold gauge low side valve and charge system to standard capacity.

Gauge Dial	Standard Reading
High Side Gauge	13 - 20 kg•cm^2 (185 - 285 psi)
Low Side Gauge	1.5 - 3.5 kg•cm^2 (22 - 50 psi)

NOTE: *These standards are for outside temperatures between 30° - 35°C (86° - 95°F). The gauge readings may vary for extreme temperature conditions.*

WARNING!

- **When outside temperature is low, warm the refrigerant supply container with warm water not exceeding 40°C (104°F). Do not allow water to come in contact with the charging adapter valve handle.**
- **When outside temperature is high, cool off refrigerant supply container and condenser to aid the refrigerant charging process.**

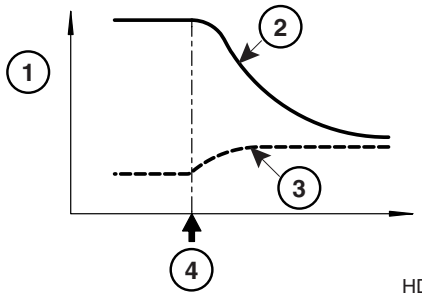
5. Close low-pressure side valve.
6. Shut off engine and close refrigerant supply container adapter valve. Disconnect manifold gauge hoses from vehicle.

Inspecting System For Leakage

After completing charging procedures, clean all joints and connections with a clean dry cloth. Using a refrigerant leak detecting device or soapy water, inspect system for leaks starting from the high-pressure side.

NOTE: *When the refrigerant circulation has been stopped the high-pressure will start to decrease and the low-pressure will start to increase until they are equalized. Starting the inspection from the high side will result in an accurate test.*

Reference Number	Description
1	Pressure
2	High-pressure
3	Low-pressure
4	Compressor Stop



HDA6073L

Figure 103

Inspection Procedure

1. High-pressure Side

   Compressor outlet → condenser inlet → receiver dryer inlet → air conditioner unit inlet.

2. Low-pressure side

   Compressor inlet → air conditioner unit outlet.

3. Compressor

   Compressor shaft area, bolt hole area and magnetic clutch area.

4. Receiver dryer

   Pressure switch and plug area.

5. Connection valve area

   Inspect all valve areas.

   Verify all valves are capped to prevent leaking.

   Check for foreign material inside of valve cap.

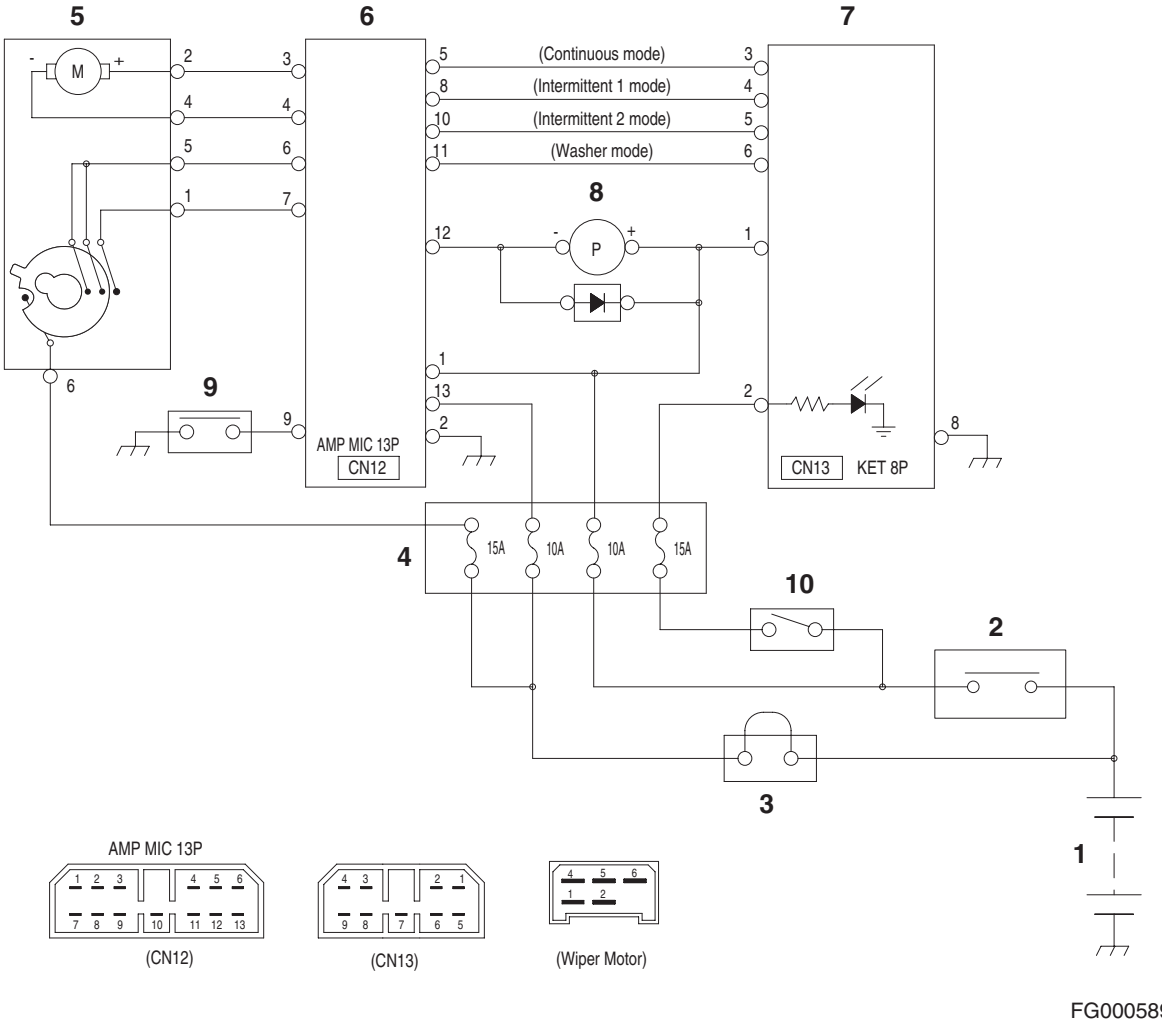
6. Interior of air-conditioning unit.

   After stopping engine, insert detector probe into drain hose. (Leave inserted for 10 seconds minimum.)

   NOTE: *When inspecting leakage from the air-conditioning unit, perform the inspection in a well ventilated area.*

WIPER SYSTEM

Wiper Circuit



FG000589

Figure 104

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Fuse Box
5	Wiper Motor

Reference Number	Description
6	Wiper Controller
7	Wiper Switch Panel
8	Window Washer
9	Wiper Cutoff Switch
10	Light Switch

Wiper operation

Continuous operation

Operation of wiper motor

Pressing the successive operation switch on the wiper switch panel (7) changes the voltage of the "5" terminal of the wiper controller (6) from HIGH (about 5.5 ± 0.5V) to LOW (0+0.5V) and current flows by way of the "3" terminal of the wiper controller (6) → the "2" and "4" terminals of the wiper motor (5) → the "4" terminal of the wiper controller (6) to run the wiper motor (5) continuously.

Stop of wiper motor

Pressing again the successive operation switch on the wiper switch panel (7) changes the voltage of the "5" terminal of the wiper controller (6) from LOW (0+0.5V) to HIGH (about 5.5 ±0.5V). As the "5" and "6" terminals of the wiper motor are connected still that power is supplied to the "6" terminal of the wiper controller (6),

However, the controller (6) runs the wiper motor continuously and then rotates the motor reversely by " letting current flow by way of the "4" terminal of the wiper controller (6) → the "2" and "4" terminals of the wiper motor (5) → the "3" terminal of he wiper controller (6) when the "1" and "6" terminals of he wiper motor (5) are connected and thus power voltage is supplied to the "7" terminal of the wiper controller (6).

The Wiper motor (5) stops reverse revolution when the contact of a cam switch connected to the "6" terminal of the wiper motor (5) moves to an insulation area of the cam plate to disconnect the "5" and "6" terminals of the wiper motor (5).

When the wiper motor (5) stops, arm and blade connected to it move to the stop positions of the right pole in the cabin.

Intermittent operation

Intermittent 1st (3-second)

Pressing once the Intermittent switch in the switch panel (7) changes voltage of the "8" terminal in the wiper controller (6) from HIGH (about 5.5 ±0.5V) to LOW (0+0.5V) and current flows through the "3" terminal in the wiper controller (6) → the "2" and "4" terminals in the wiper motor (5) → the "4" terminal in the wiper controller (6) to start the cycle that wiper stops 3 seconds after every operation.

Intermittent 2nd (6-second)

Pressing twice the Intermittent switch in the switch panel (7) changes voltage of the "10" terminal in the wiper controller (6) from HIGH (about 5.5 ±0.5V) to LOW (0+0.5V) and current flows through the "3" terminal in the wiper controller (6) → the "2" and "4" terminals in the wiper motor (5) → the "4" terminal in the wiper controller (6) to start the cycle that wiper stops 6 seconds after every operation.

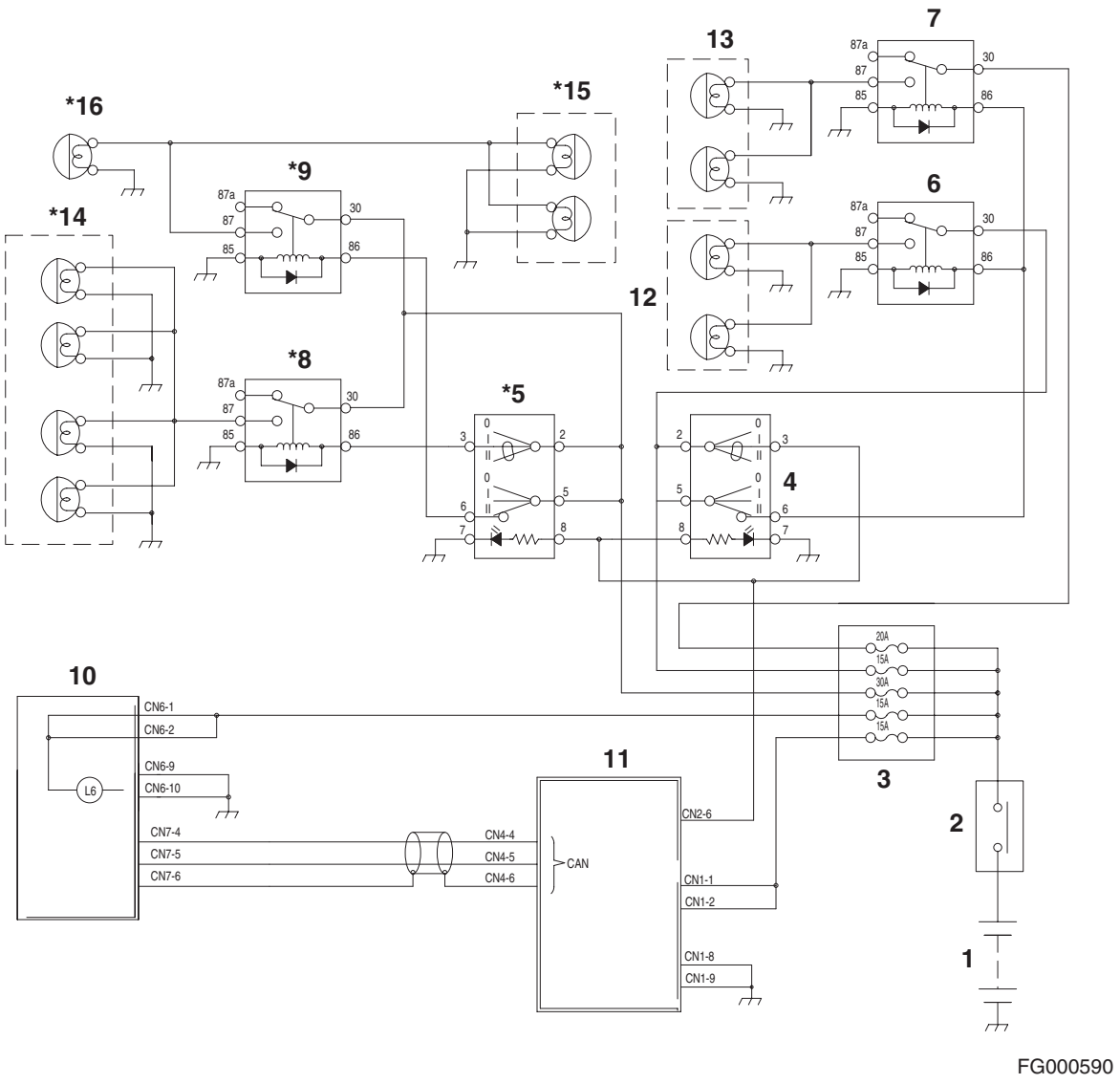
Stopping the intermittent action

Pressing three times the Intermittent switch in the switch panel (7) while the wiper is operating stops the action of the wiper motor.

NOTE: *The wiper system does not work when the wiper cutoff switch (9) is "ON."*

LIGHTING SYSTEM

Lighting System Circuit Diagram



FG000590

Figure 105

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse Box
4	Light Switch
5	Cabin Light Switch
6	Headlight Relay (Work Light Indicate Light)
7	Work Light Relay
8	Front Cabin Light Relay

Reference Number	Description
9	Front Cabin Light / Rear Work Light Relay
10	Instrument Panel
11	e-EPOS Controller
12	Headlight (2 ea.)
13	Work Light (2 ea.)
14	Front Cabin Light (4 ea.)
15	Rear Cabin Light (2 ea.)
16	Rear Work Light (1 ea.)

NOTE: *The "*" mark are optional parts.*

Kind of Light

The lighting system is consists of headlights, work lights, cabin lights (optional), relays and switches.

Operation

Switch	Position	Connected Terminal of switch	Activated Relay	Lit Light
Light Switch	1	"2-3" Terminal	-	Illumination Light of Switch
	2	"2-3" Terminal	-	Illumination Light of Switch
		"5-6" Terminal	Headlight Relay	Headlight (2 Ea.)
			Work Relay	Work Light (2 Ea.) Indicator Light of Work Light (L6)
Cabin Light Switch	1	"2-3" Terminal	Front Cabin Light Relay	Front Cabin Light (2 Ea.) or Front Cabin Light (4 Ea.)
	2	"2-3" Terminal	Front Cabin Light Relay	Front Cabin Light (2 Ea.) or Front Cabin Light (4 Ea.)
		"5-6" Terminal	Rear Cabin Light Relay / Rear Work Light Relay	Rear Cabin Light (2 Ea.) and Rear Work Light (1 Ea.)

OVERLOAD WARNING DEVICE

Overload Warning Device Circuit Diagram

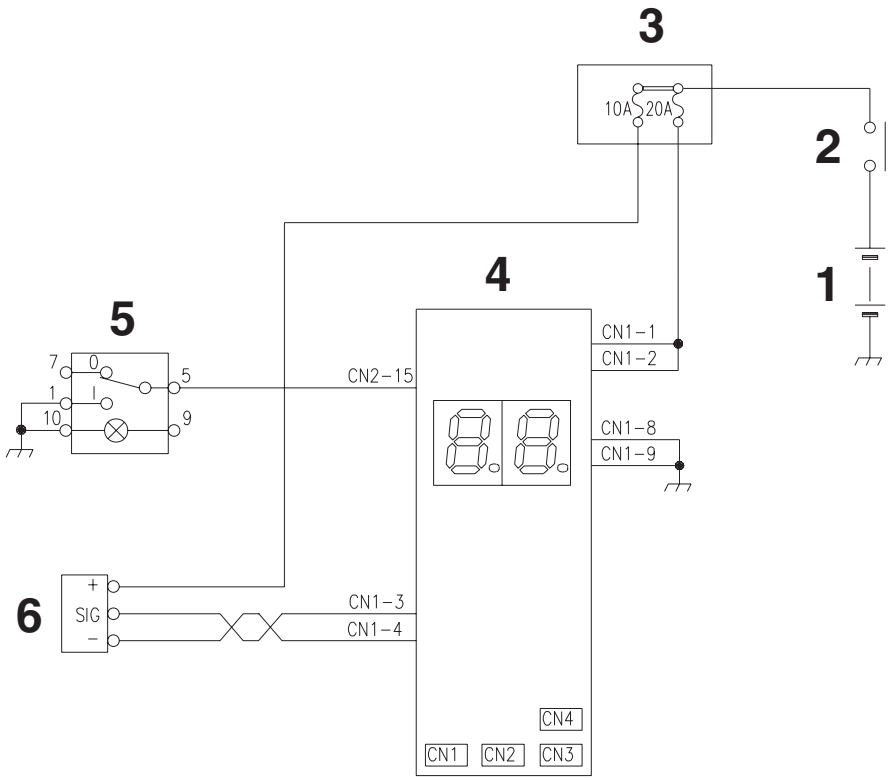


Figure 106

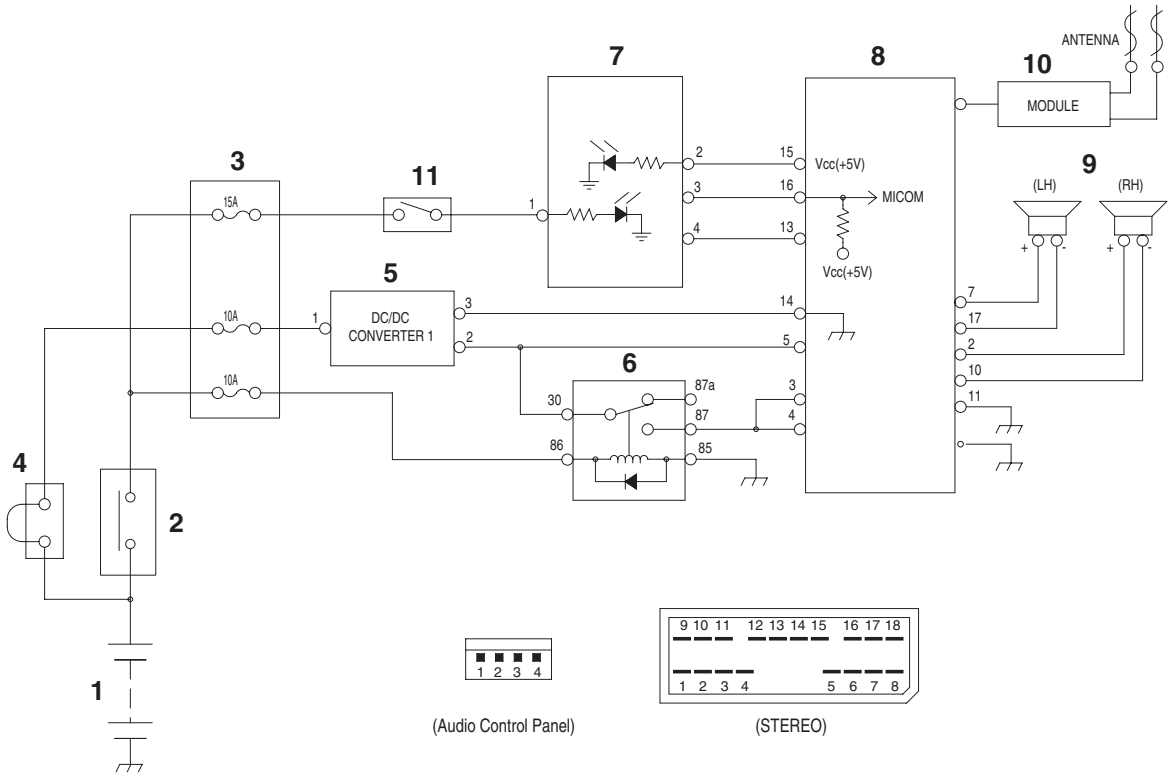
ARS1260L

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse Box

Reference Number	Description
4	e-EPOS Controller
5	OWD Selector Switch
6	Pressure Sensor

AUDIO CONTROLLER

Audio Controller Circuit Diagram



FG000591

Figure 107

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse Box
4	Fusible Link
5	Converter
6	Stereo Relay

Reference Number	Description
7	Audio Control Panel
8	Stereo
9	Speaker
10	Antenna Module
11	Light Switch

Operations Via Audio Control Panel

Switch	Connected Terminal of switch	Measured values	Operations
PWR	"3-4"	4.36 ± 0.2V	Stereo ON, OFF
▲		1.24 ± 0.2V	Volume up
▼		0 + 0.2V	Volume down
SCAN		2.49 ± 0.2V	Frequency selection

Electrical Schematic (DX180LC/DX225LC/ DX225NLC/DX255LC)

Edition 1

MEMO

Table of Contents

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MEMO

SAFETY PRECAUTIONS

CAUTION!

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APPLICABLE MODELS

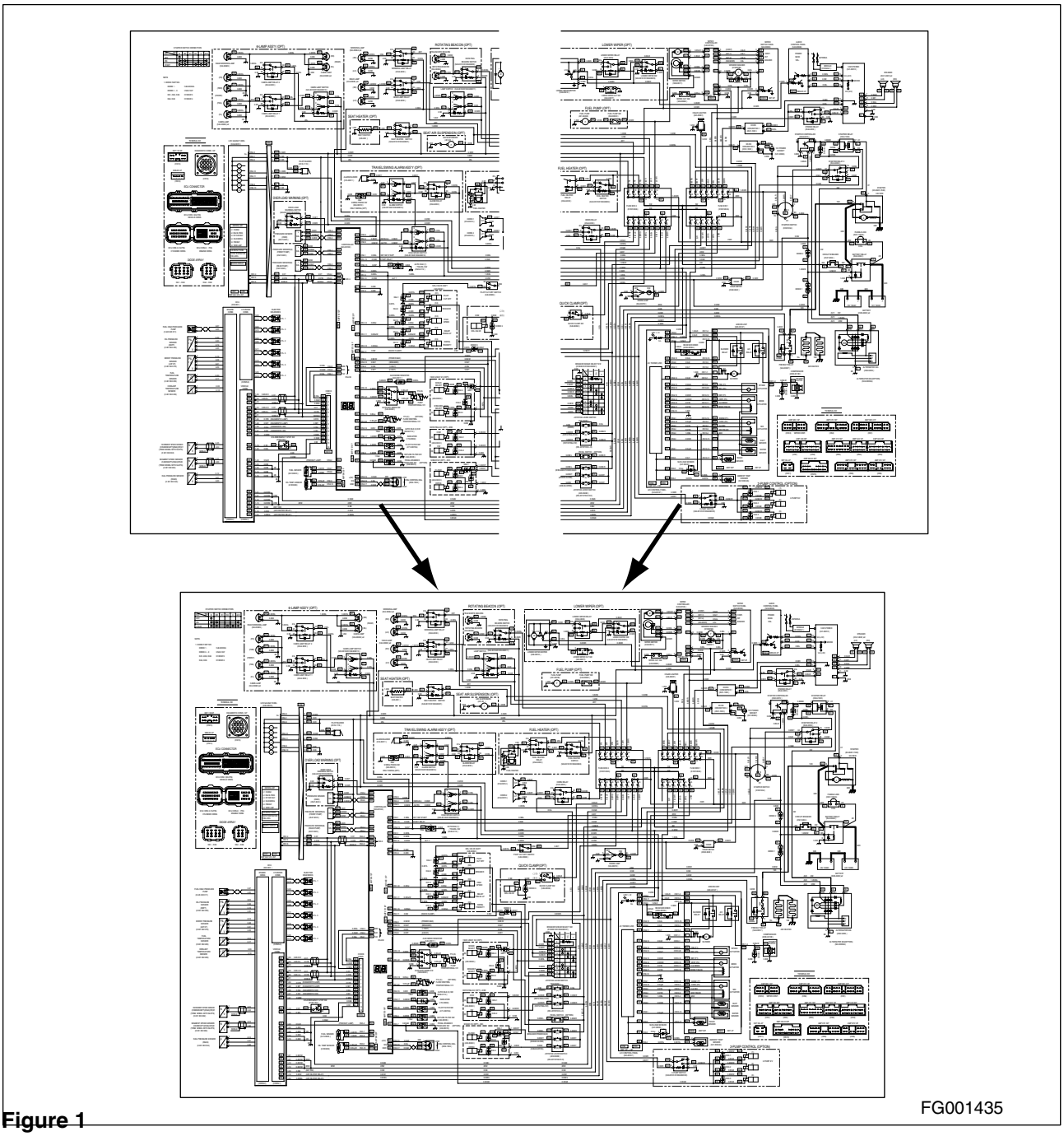
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX225LC	5001 and UP
DX225NLC	5001 and Up
DX255LC	5001 and Up

GENERAL DESCRIPTION

Schematic (s) presented in this section are laid out on facing pages.

An overlapping edge has been taken into consideration so a photocopy can be made and pasted together to make a complete schematic.



FG001435

Figure 1

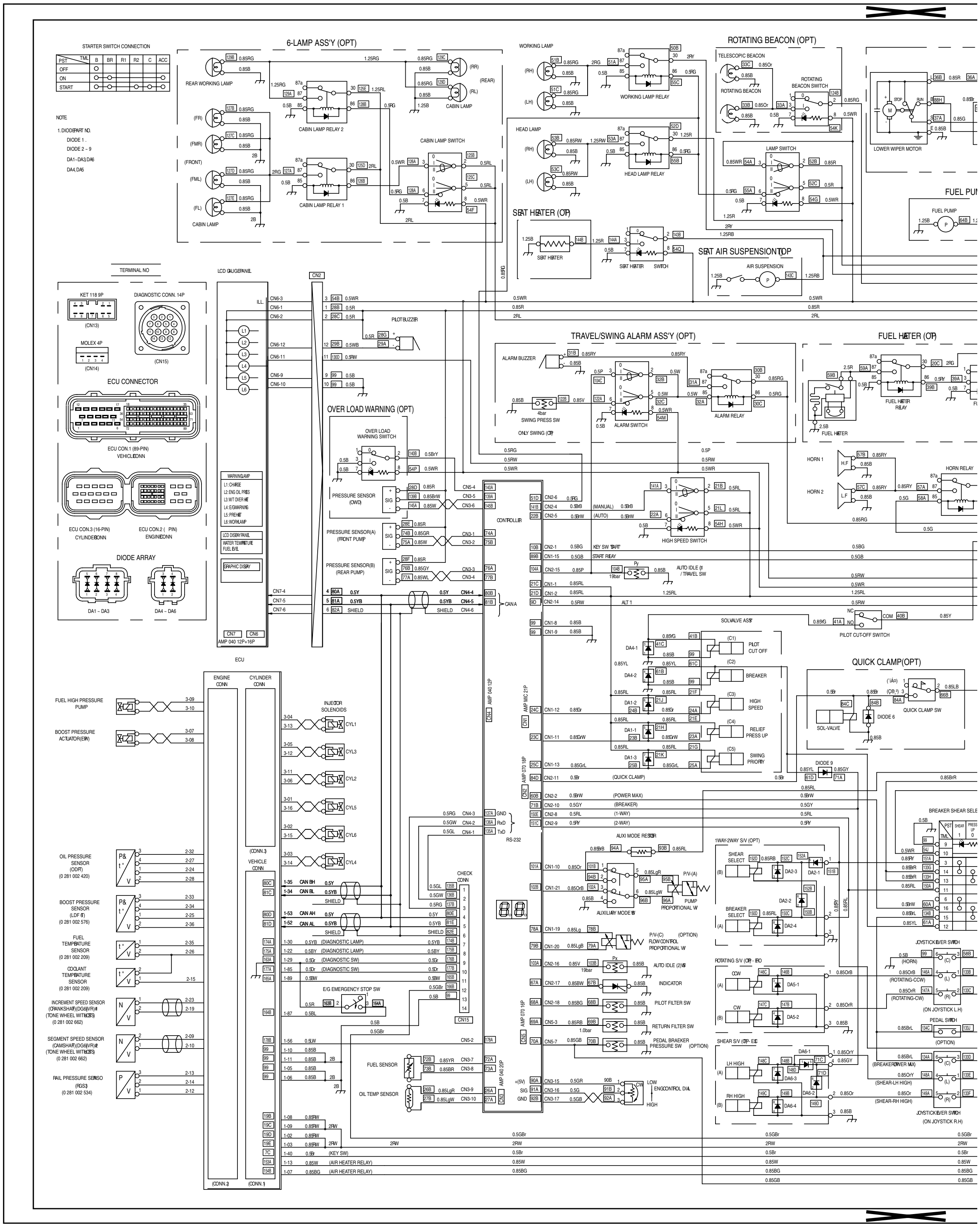
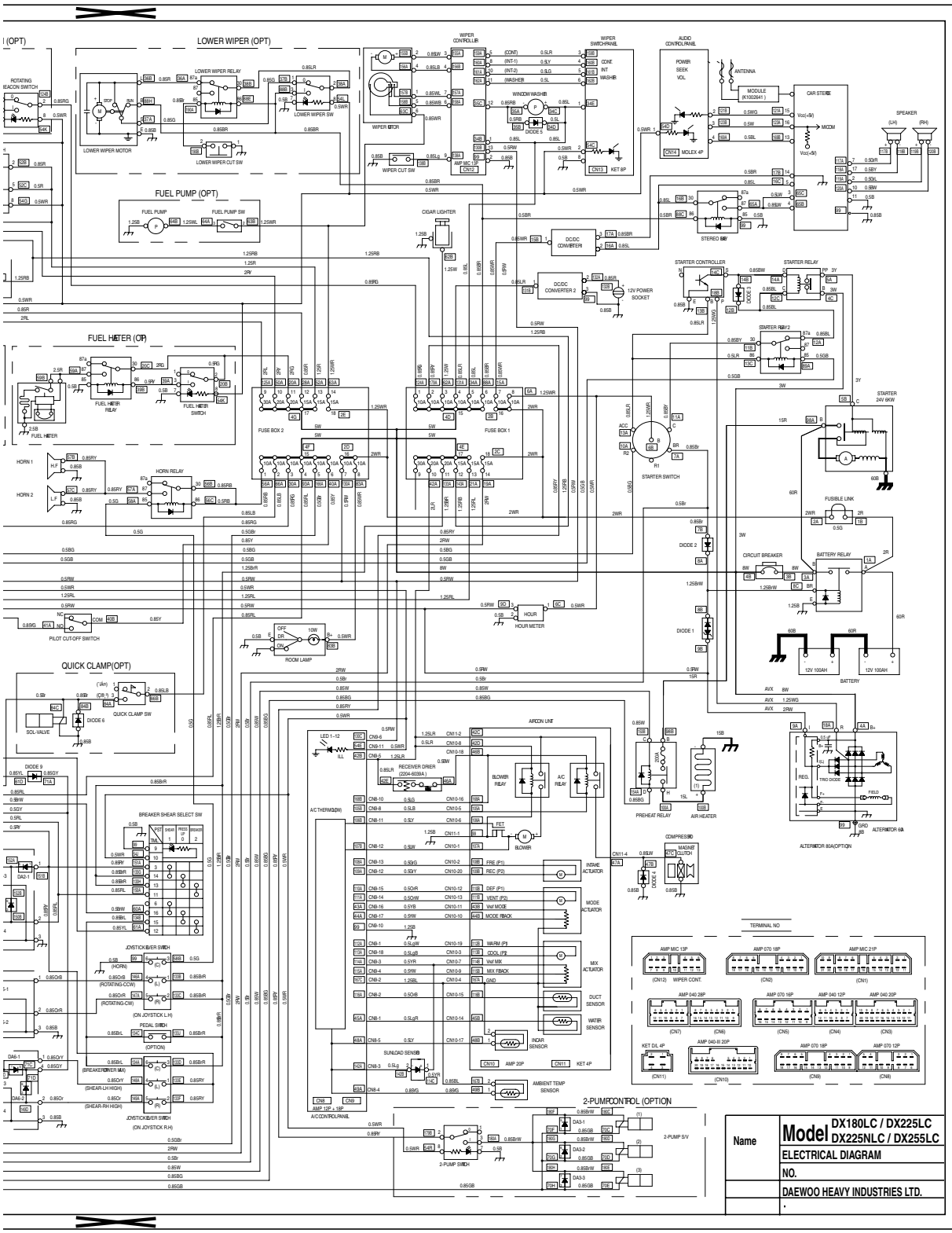


Figure 2


LOWER WIPER (OPT)
FUEL PUMP (OPT)
FUEL HEATER (OPT)
QUICK CLAMP(OPT)
WIPER CONTROLLER
WIPER SWITCH PANEL
AUDIO CONTROL PANEL
ANTENNA
CAR STEREO
SPEAKER
STARTER CONTROLLER
STARTER RELAY
STARTER
FUSIBLE LINK
CIRCUIT BREAKER
BATTERY RELAY
BATTERY
ALTERNATOR 80A(OPTION)
ALTERNATOR 60A
FUSE BOX 1
FUSE BOX 2
HORN RELAY
HOUR METER
ROOM LAMP
PILOT CUT-OFF SWITCH
FUEL HEATER RELAY
FUEL HEATER SWITCH
FUEL HEATER
FUEL PUMP
FUEL PUMP SW
LOWER WIPER MOTOR
LOWER WIPER RELAY
LOWER WIPER SW
LOWER WIPER CUT SW
WIPER MOTOR
WIPER CUT SW
WINDOW WASHER
CIGAR LIGHTER
DC/DC CONVERTER
DC/DC CONVERTER 2
12V POWER SOCKET
STARTER SWITCH
ACC
DIODE 1
DIODE 2
DIODE 3
DIODE 4
DIODE 5
DIODE 6
PREHEAT RELAY
AIR HEATER
COMPRESSOR
MAGNET CLUTCH
AIRCON UNIT
BLOWER RELAY
A/C RELAY
BLOWER
FET
RECEIVER DRIER (2004-6039A)
LED 1-12
A/C THERM(93W)
A/C CONTROL PANEL
INTAKE ACTUATOR
MODE ACTUATOR
MIX ACTUATOR
DUCT SENSOR
WATER SENSOR
INCAR SENSOR
AMBIENT TEMP SENSOR
SUNLOAD SENSOR
2-PUMP CONTROL (OPTION)
2-PUMP S/V
2-PUMP SWITCH
BREAKER SHEAR SELECT SW
JOYSTICK/LEVER SWITCH
(ON JOYSTICK L.H)
(ON JOYSTICK R.H)
PEDAL SWITCH
(OPTION)
(BREAKER/LEVER MIX)
(SHEAR-LH HIGH)
(SHEAR-RH HIGH)
(HORN)
(ROTATING-CCW)
(ROTATING-CW)
TERMINAL NO
AMP MIC 15P
AMP 070 16P
AMP MIC 21P
AMP 040 28P
AMP 070 16P
AMP 040 12P
AMP 040 20P
KET 04 4P
AMP 040-III 20P
AMP 070 18P
AMP 070 12P
WIPER CONT.
MOLEX 4P
KET 6P
AMP 20P
AMP 12P x 18P
Name
Model
DX180LC / DX225LC
DX225NLC / DX255LC
ELECTRICAL DIAGRAM
NO.
DAEWOO HEAVY INDUSTRIES LTD.

FG007145

Attachments

Boom and Arm

Edition 1

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Boom and Arm

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SAFETY PRECAUTIONS

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APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX225LC	5001 and Up
DX225NLC	5001 and Up

FRONT ATTACHMENT PIN SPECIFICATIONS

The table below has a complete listing of dimensional specifications for all mounting pins used on the front attachment.

NOTE: *Some mounting pins must be drilled and tapped for lubrication fittings and piping, or may have other required specifications. Consult DOOSAN After Sales Service for information on wear tolerances and replacement limits for mounting pins.*

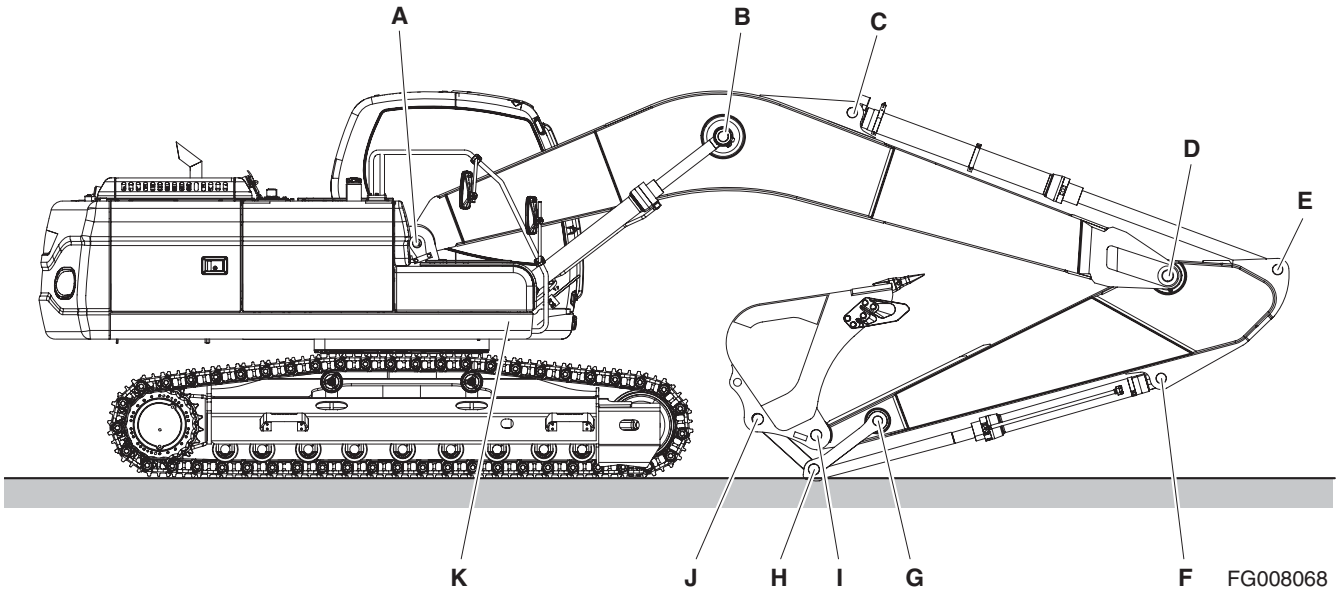


Figure 1

(Unit: mm)

Mark	Measuring Part	Criteria					Remedy
		Standard Size	Tolerance		Standard Clearance	Clearance Limit	
			Pin	Hole			
A	Boom Foot	90 mm (3.543")	-0.10 -0.15	+0.18 +0.03	0.13 to 0.33	1.5	Replace
B	Boom Cylinder Head	80 mm (3.150")	-0.06 -0.11	+0.18 +0.03	0.09 to 0.29	1.5	
C	Boom Center	80 mm (3.150")	-0.06 -0.11	+0.18 +0.03	0.09 to 0.29	1.5	
D	Boom End	90 mm (3.543")	-0.10 -0.15	+0.18 +0.03	0.13 to 0.33	1.5	
E	Arm Cylinder Head	80 mm (3.150")	-0.06 -0.11	+0.18 +0.03	0.09 to 0.29	1.5	
F	Arm Cylinder Rod	80 mm (3.150")	-0.06 -0.11	+0.18 +0.03	0.09 to 0.29	1.5	
G	Bucket Cylinder Head	80 mm (3.150")	-0.06 -0.11	+0.18 +0.03	0.09 to 0.29	1.5	
H	Arm Link	71 mm (2.795")	-0.06 -0.11	+0.18 +0.03	0.09 to 0.29	2.0	
I	Arm End	80 mm (3.150")	-0.06 -0.11	+0.18 +0.03	0.09 to 0.29	2.0	
J	Bucket Cylinder Rod	80 mm (3.150")	-0.06 -0.11	+0.18 +0.03	0.09 to 0.29	2.0	
K	Push Link to Bucket	80 mm (3.150")	-0.06 -0.11	+0.18 +0.03	0.09 to 0.29	2.0	

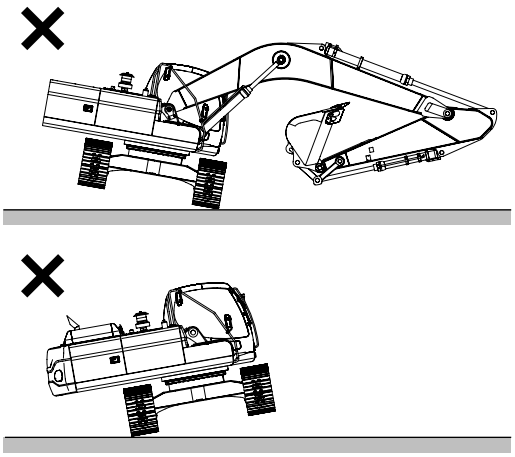
FRONT ATTACHMENT - REMOVAL AND INSTALLATION

DANGER!

DOOSAN **warns any user, that the removal of the counterweight from the machine, front attachment or any other part, may affect the stability of the machine. This could cause unexpected movement, resulting in death or serious injuries.** ***DOOSAN*** **is not liable for any misuse.**

Never remove the counterweight or front attachment unless the upper structure is in-line with the lower structure.

Never rotate the upper structure once the counterweight or front attachment has been removed.



FG000371

Figure 2

IMPORTANT

Always break down the front attachment by removing outermost sections first - the bucket before the arm, the arm before the boom. Reinstallation of the attachment should begin with the boom and end with the bucket.

Refer to the appropriate Bucket section for its removal and installation procedure before going onto the initial step of the front attachment removal or installation procedure.

Arm Removal Procedure

WARNING!

This procedure is only intended for routine removal or replacement of the attachment, while working under normal, safe operating conditions. In the event of a major structural collapse of some part of the attachment, an accident or complete loss of attachment hydraulic function, DO NOT proceed with attachment disassembly unless you are completely sure of what you are doing. Please call your local ***DOOSAN*** **distributor or** ***DOOSAN*** **After Sales Service for assistance. DO NOT allow personnel to stand underneath a weakened or only partially supported attachment section. Keep clear of hydraulic lines that may have fluid escaping at high-pressure - it can cause severe or even fatal injuries.**

Complete the bucket end removal procedure by pulling out the two bucket linkage pins and the bucket cylinder mounting pin, on the arm. Use an assist crane or hoist to lift the cylinder and relieve weight on mounting pins.

Park the excavator away from obstructions and all traffic on clear, flat, level ground. Extend the arm cylinder and crowd the arm into the boom. Partially retract the boom cylinder so the boom is stretched out in front of the excavator, as low to the ground as possible, with the arm crowded under the boom.

The tip of the arm point should be lowered to secure blocking that will safely support the weight of the arm. Place the blocking directly in front of the excavator and make sure that it will not be unbalanced with an initial weight load that is all to one end, under the arm point.

Shut off the engine and release hydraulic system pressure - move any of the control levers with the engine off to release pressure built up in the accumulator. Manually vent residual hydraulic pressure in the tank by moving the lever near the cap, on top of the reservoir.

⚠ WARNING!

Secure the swing lock and tag and lock out controls in the operator's cabin to keep anyone from moving or inadvertently starting the engine. Restrict access to the work site while sections of the attachment are in the air, or while they are being supported by the assist crane. The safe lifting capacity of the assist crane or hoist that is used must exceed the weight of the heaviest section of the attachment, the boom (approximately 1,500 kg [3,307 lb], not including the weight of accessories or fixtures).

Before beginning the disassembly of attachment mounting pins, disconnect the arm cylinder hydraulic hose couplings and put a clean plug in the end of each one. Use any reasonable precautions necessary to avoid introducing dirt or other contaminants into the hydraulic system. Wipe down coupling points before disconnecting hydraulic lines and use evaporative type solvent spray cleaner. Tag and mark hoses for reassembly, if necessary.

Place a sling under the arm cylinder (the cylinder used to extend and retract the attachment arm, pinned to the top of the boom). Lift the sling so the weight load on the rod end of the arm cylinder (pinned to the ears on the inner end of the arm) is released. Prepare blocking under the arm that will securely support the weight of the arm and arm cylinder.

⚠ CAUTION!

To make sure that the polished surfaces of cylinder rod ends will not suffer accidental damage during disassembly or removal procedures, wrap exposed rod surfaces (especially those of boom cylinders) with a protective covering material. Immediately following disassembly and removal, cylinder rods should always be fully retracted. This eases handling problems and avoids possible damage.

Remove retainers on the end of the mounting pin for the arm cylinder rod end. Use the assist crane to relieve the weight load and withdraw the pin. Lower the arm down to the blocking support for any continued disassembly procedures.

Boom Removal Procedure

NOTE: *Boom removal may be simplified if the shell of the operator's cabin is taken off the turntable deck first. Refer to the Operator's Cabin Removal procedure before continuing, if both components are to be removed from the excavator.*

After the bucket, arm and arm cylinder have been removed, lower the end of the boom to a stable, secure blocking support.

Attach the assist crane sling to the body of either boom cylinder, break the mounting pin connection to the boom by tapping through the pin from the same side of the boom and repeat for the opposite cylinder.

Release hydraulic pressure and disconnect line couplings as previously outlined in the Arm Removal Procedure, observing the same precautions.

Disconnect wiring for work light assemblies and any other accessory lines or connections. Locate the sling of the assist crane near the center of gravity, optimum lift point for the boom, and use the crane to take pressure off the boom foot pin. Drive out the pin after disassembling retainers and carefully lift away the boom.

⚠ WARNING!

Traveling the excavator, swinging the turntable or movement over bumps or sloping, uneven surfaces could all produce loss of control and possible accidents or injuries, if the turntable deck has been unbalanced by removal of weight from one end only.

To maintain stability, the counterweight should be removed whenever the front attachment is taken off the machine.

INSTALLATION

Arm Installation Procedure

Reattach the base of the arm cylinder to the mounting point on top of the boom.

⚠ WARNING!

Before assembling the front attachment, make sure that the individual boom, arm and bucket sections are all compatible and can be used safely for work intended. Refer to the General Safety Pages, Lift Ratings, Working Range Diagrams and Weights of Materials sections in the Operation and Maintenance Manual. Consult your dealer or *DOOSAN* After Sales Service for more information if you have any questions or require more information.

Begin with the arm securely supported on blocking in front of the excavator. Pregrease the mounting pin for the rod end of the arm cylinder and push it through the ears on the end of the arm. Attach a sling around that mounting pin and lift the arm with an assist crane until it is in position for the boom-arm pin connection to be made.

Relieve hydraulic pressure from all points of the system before any hydraulic lines are opened, then carefully assemble hydraulic connections to the arm cylinder.

Remove sling from around the rod end arm cylinder pin, withdraw the pin and lift the body of the arm cylinder to repin the mounting connection.

Boom Installation Procedure

Before reassembling the attachment, make sure to inspect all bushings and pivot points of each section. To avoid damaging the seats, bushings should never be hammered or chiseled out of their seats.

Installation is otherwise a reversal of the removal procedures.

START-UP PROCEDURES

Once the boom has been serviced, it should be lubricated as outlined in the initial start-up procedures of the operation manual. Refer to the appropriate operation and maintenance manual for unit.

Bucket

Edition 1

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Bucket

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BUCKET TOOTH INSPECTION AND REPLACEMENT

There are several different types of attachment methods for replaceable bucket teeth. Some of the most common types are shown in the following drawings.

Bucket teeth are usually replaced in sets but it may sometimes be necessary to replace individual teeth.

Look for the following indications of wear or damage:

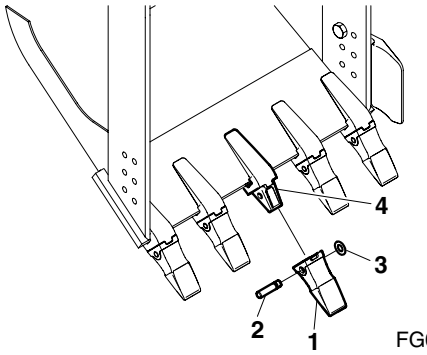
- Lock pins protrude unevenly on one side.
- Lock pins have been worn down so far that they no longer make full contact through the length of the pinhole.
- Lock washers or pins show obvious damage or weakness.
- Wear points on the working surfaces of tooth points - pits, cracks, chips or craters - are larger than 8 mm to 10 mm (1/3" to 1/2") across.



HAOC680L

Figure 1

1. On a routine basis, inspect the bucket teeth to make sure that tooth wear or breakage has not developed. Do not allow the replaceable bucket teeth to wear down to the point that the bucket adapter is exposed. See Figure 1.
2. To replace a tooth (1, Figure 2), use a hammer and punch to drive the locking pin (2) and lock washer (3) out of the tooth adapter (4).
3. Once the worn tooth has been removed, use a putty knife to scrape the adapter as clean as possible.
4. Slide the new tooth into position and insert the lock washer.
5. Insert the locking pin into the tooth and with a hammer, drive the pin in until the lock washer seats in the locking groove.



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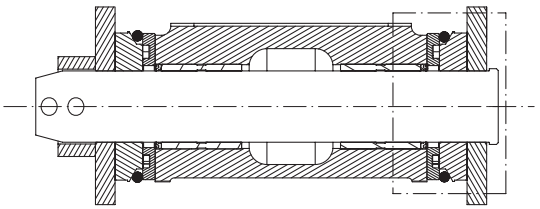
Figure 2

BUCKET O-RING REPLACEMENT

WARNING!

Due to possibility of flying metal objects, always wear safety helmet, protective gloves and eye protection when changing pins.

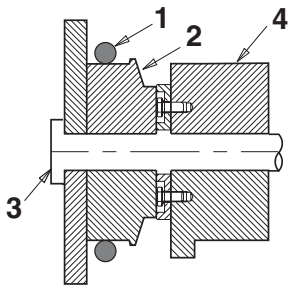
1. Inspect the bucket O-rings on a routine basis. If worn or damaged, replacement is necessary.



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Figure 3

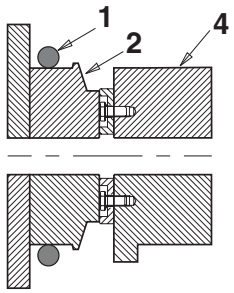
2. Roll the old O-ring (1, Figure 4) onto the boss (2) around the bucket pin (3). Remove bucket pin and move the arm or bucket link (4) out of the way.



ARO1390L

Figure 4

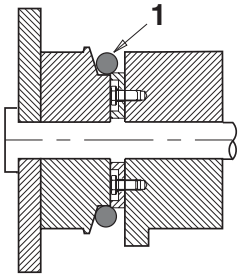
3. Remove old O-ring and temporarily install the new O-ring (1, Figure 5) onto the bucket boss (2). Make sure that the O-ring groove on both the bucket link (4) and boss have been cleaned.
4. Realign the arm or link with the bucket pinhole and insert the bucket pin (3, Figure 4).



ARO1391L

Figure 5

5. Roll the new O-ring (1, Figure 6) into the O-ring groove.



ARO1392L

Figure 6

BUCKET ATTACHMENT, REMOVAL AND REVERSAL

Detaching the Bucket

Park the excavator away from obstructions on clear, flat, level ground. Lower the bucket carefully to preassembled blocking on the ground. Brace the bucket so there is no load weight on the pin connecting the bucket and arm. Disassemble the fasteners on the end of the bucket pin and pull out the pin.

If the pin sticks and resists normal withdrawal, there may be a load on it. Raise and lower the arm slightly until an unstressed pin position is located.

CAUTION!

Use care pulling out the pin to avoid damaging the dust seals on either end of the arm.

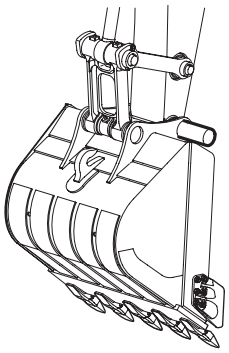
When the pin has been withdrawn, move the operating joystick slightly to take weight off the remaining link pin. Disassemble the link pin end retainers and pull out the pin.

Lift the arm away from the bucket so the bucket can be carried away or another end attachment can be put on the excavator.

Attaching the Bucket

Carefully inspect all parts before reassembling the bucket linkage. Look for cracks or any other evidence of physical damage and replace any seal or O-ring that is not in like-new condition. Prelube linkage pins before reassembly.

Use an old cylinder rod, a long breaker bar or a similar, relatively thin diameter support bar for making the first (temporary) pin connection, between the bucket and arm. If the support bar is straight, the arm can be raised and the bucket will hang level, allowing direct insertion of the bucket ear-attachment linkage pin.



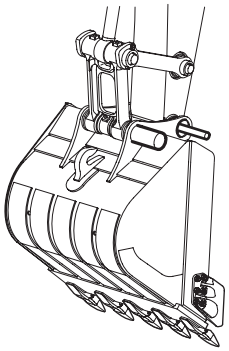
FG000606

Figure 7

When the link pin has been installed, withdraw the temporary support rod from the bucket pinholes, lower and raise the arm and boom and install the bucket pin.

⚠ WARNING!

When making linkage alignments, never insert fingers into pinholes. The attachment or bucket could shift position and cause a severe injury. Match holes by visually lining them up. Use the sharp-tipped, soft point of a pencil or a similar tool to check for high spots or irregularities.



FG000607

Figure 8

Reversing the Bucket

Follow instructions for "Detaching the Bucket" and remove both the bucket and link pins. Rotate the bucket 180° to change bucket configuration. This procedure is greatly simplified if some type of rotating or swiveling support can be used, on the ground underneath the bucket. Follow instructions for "Bucket Attachment" to replace pins.

⚠ WARNING!

Bucket curl and dump levers must be used in opposite directions, after the bucket has been reversed.