Solar 470LC-V

Shop Manual

023-00047E

Serial Number 1001 and Up

May 2002

Daewoo reserves the right to improve our products in a continuing process to provide the best possible product to the market place. These improvements can be implemented at any time with no obligation to change materials on previously sold products. It is recommended that consumers periodically contact their distributors for recent documentation on purchased equipment.

This documentation may include attachments and optional equipment that is 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.

Product Label 

Instructions

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

Solar 470LC-V

Serial Number 1001 and Up

Pub.No. 023-00047E

DAEWOO

Pub. No. 023-00047E

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SAFETY

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

TRACK EXCAVATOR SAFETY

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 130LC-V	0001 and Up
Solar 170LC-V	1001 and Up
Solar 220LC-V	0001 and Up
Solar 220N-V	1001 and Up
Solar 250LC-V	1001 and Up
Solar 290LC-V	0001 and Up
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 330LC-V	1001 and Up
Solar 340LC-V	1001 and Up
Solar 400LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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May 2002

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TO THE OPERATOR OF A DAEWOO 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 6
2. “Location of Safety Labels” on page 6
3. “Summary of Safety Precautions for Lifting in Digging Mode” on page 7
4. “Unauthorized Modifications” on page 8
5. “General Hazard Information” on page 8
6. “Before Starting Engine” on page 16
7. “Machine Operation” on page 19
8. “Maintenance” on page 26
9. “Battery” on page 34
10. “Towing” on page 36
11. “Shipping and Transportation” on page 37
12. “Lifting With Sling” on page 37

⚠ 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 periodically read the manual.

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 any others. In no event should you or others engage in prohibited uses or actions as described in this manual.

Daewoo delivers machines that comply with all applicable regulations and standards of the country to which it has been shipped. 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 Daewoo or your Daewoo 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 should be alert to the potential for personal injury or accidents. Always observe safety precautions and follow recommended procedures.

LEARN THE SIGNAL WORDS USED WITH THE 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 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 of a hazardous situation that, if not avoided, could result in serious injury or death. It may also be used to alert against a 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 explode or detonate if handled or treated carelessly.

Safety precautions are described in SAFETY from page -6 on.

Daewoo 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 some procedures, contact a DAEWOO distributor.

GENERAL SAFETY ESSENTIALS

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 Daewoo 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 taglines 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 of 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.

Taglines 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 tagline around your hands or body.

NEVER rely on taglines or make rated lifts when wind gusts are more than 48.3 km/hr (30 mi/h). Be prepared for any type of 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 Daewoo representative.

UNAUTHORIZED MODIFICATIONS

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

For safety's sake, replace all OEM parts with the correct authorized or genuine Daewoo part. For example, not taking the time to replace fasteners, bolts or nuts with the correct replacement parts could lead to a condition in which the safety of critical assemblies is 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 judgement 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 COMPARTMENT

When entering the operator's compartment, 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 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 compartment. If the temperature inside the operator's compartment becomes high, there is danger that the lighter may explode.

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

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

To ensure safety, do not use the radio or music headphones when operating the machine. There is 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 serous 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 the key and take it with you.

CLOTHING AND PERSONAL PROTECTIVE ITEMS

Contain long hair, and avoid loose clothing and jewelry. They can catch on controls or in protruding parts and cause serious injury or death.

Do not wear oily clothes. They are highly 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.

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.



Figure 1

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.

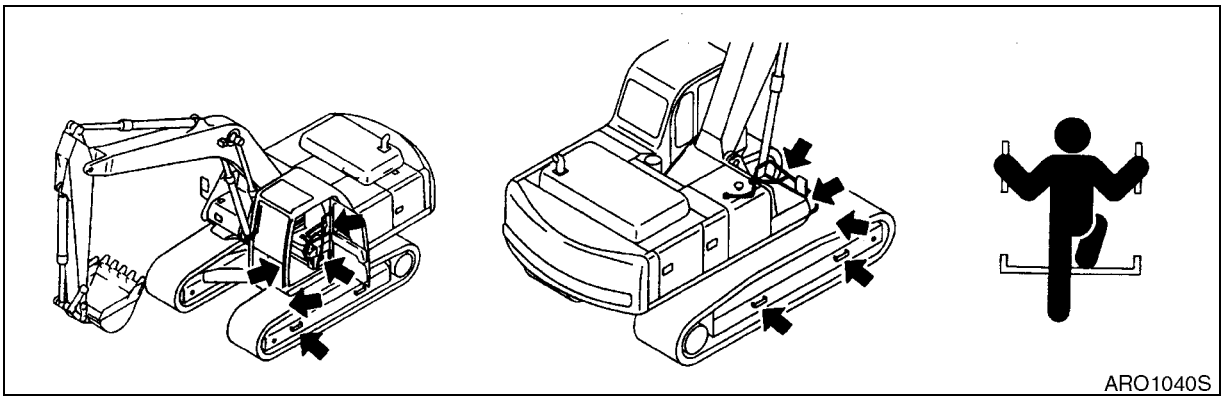


Figure 2

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 doused, 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.



Figure 3

PRECAUTIONS WHEN HANDLING FLUIDS AT HIGH TEMPERATURE

Immediately after operations are stopped, the coolant, engine oil, and hydraulic oil are at high temperature and the radiator and hydraulic tank are still under pressure. Attempting to remove the 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.

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

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

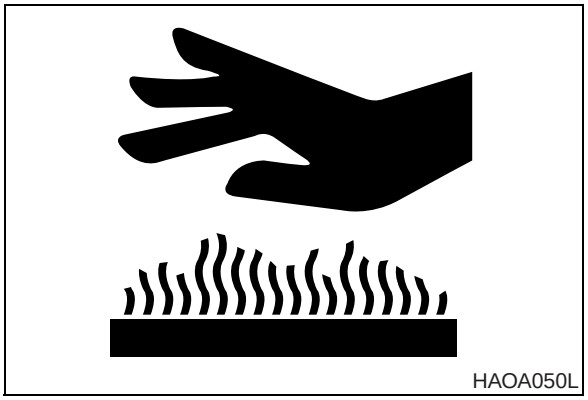


Figure 4

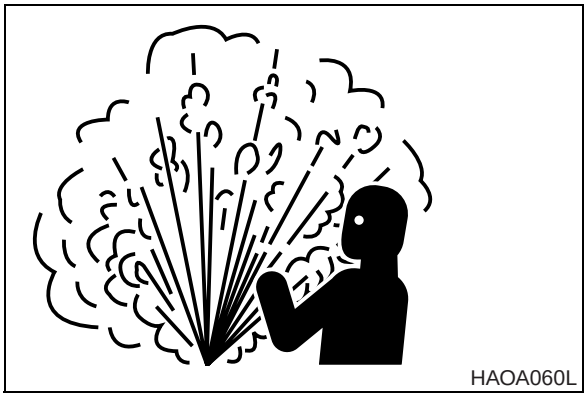


Figure 5

ASBESTOS DUST HAZARD PREVENTION

Asbestos dust can be HAZARDOUS to your health if it is inhaled.

If you handle materials containing asbestos fibers, follow these guidelines as given below:

- Use an approved respirator.
- 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 rules and regulations related to the work site and working environment.

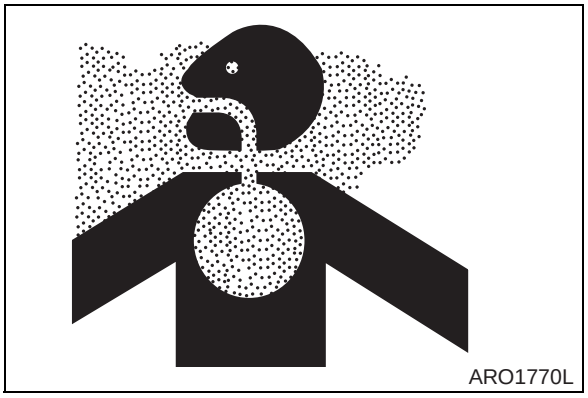


Figure 6

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 that it cannot move.

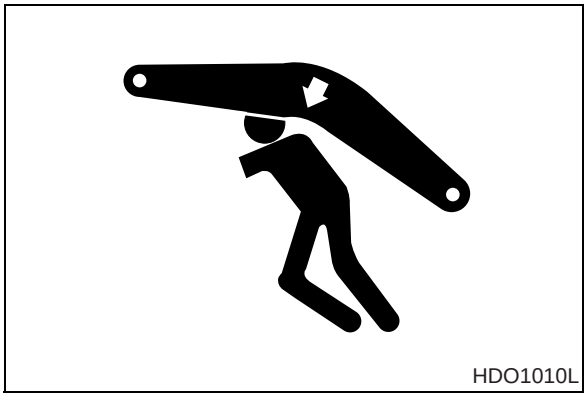


Figure 7

FIRE EXTINGUISHER AND FIRST AID KIT

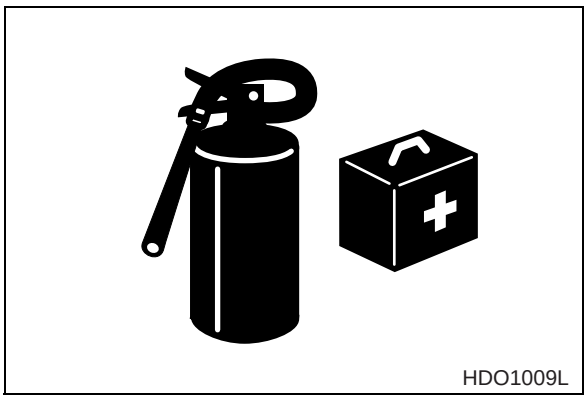


Figure 8

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 now 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 cab. 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.

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 "OFF" and stop the engine.
- If there is time, use the fire extinguisher to extinguish 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 danger that falling objects or flying objects may hit the operator's cab 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 cab could be required in the form of a FOPS (Falling Object Protective Structure) or window guards.

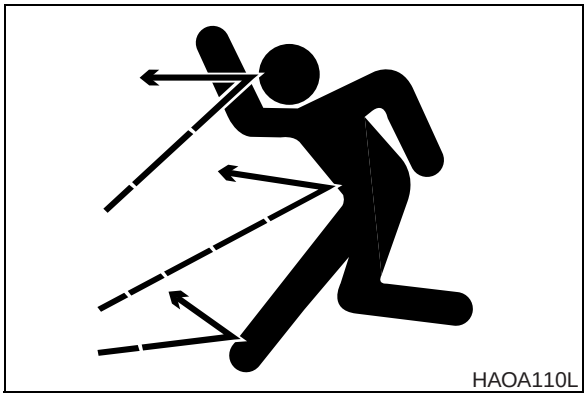


Figure 9

Never attempt to alter or modify any type of 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 Daewoo distributor for available safety guards and/or recommendations if there is any danger of getting hit by objects that could strike the operator's cab. Make sure that all other work site crew members are kept well away from the excavator and safe from possible hazards.



Figure 10

For breaker operation, install a front guard and apply a laminated coating sheet to the front glass. Contact your DAEWOO 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 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 Daewoo for information on available one-way (single-acting) and two-way (double-acting) piping / valving / auxiliary control kits. Because Daewoo cannot anticipate, identify or test all of the attachments that owners may wish to install on their machines, please contact Daewoo for authorization and approval of attachments, and their compatibility with options 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 describe 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 any flame, 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 Daewoo 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, judgement 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 into which exhaust may be carried, or blown by the wind, exposing others to danger.

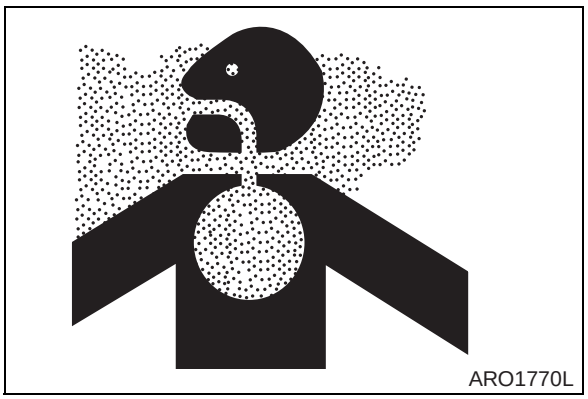


Figure 11

EMERGENCY EXIT

This machine is equipped with a glass breaking tool. It is behind the operator seat in the upper right corner of the cab. 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.



Figure 12

WARNING!

Protect your eyes when breaking the glass.

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 the ground surface 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.

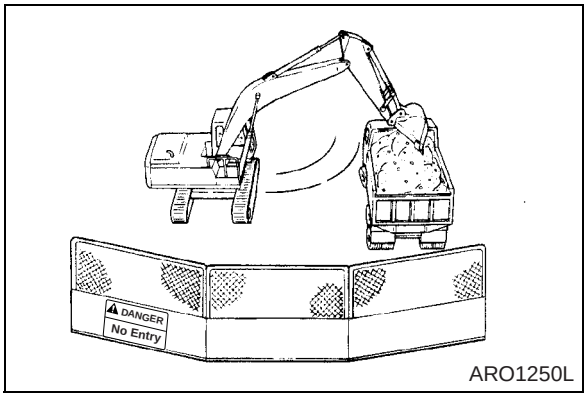


Figure 13

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.

Water lines, 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 river bed, and the depth and flow of the water before operating in water or crossing a river. NEVER be in water that is in excess of the permissible water depth.

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

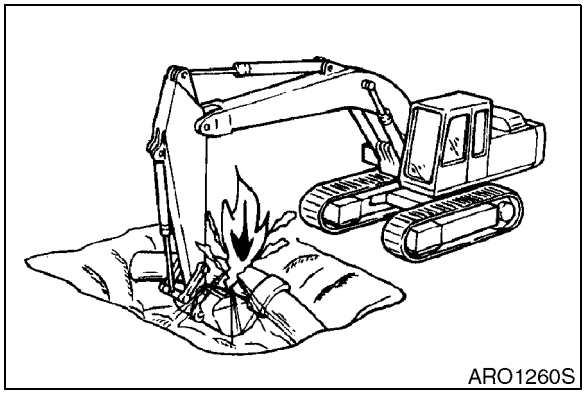


Figure 14

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.

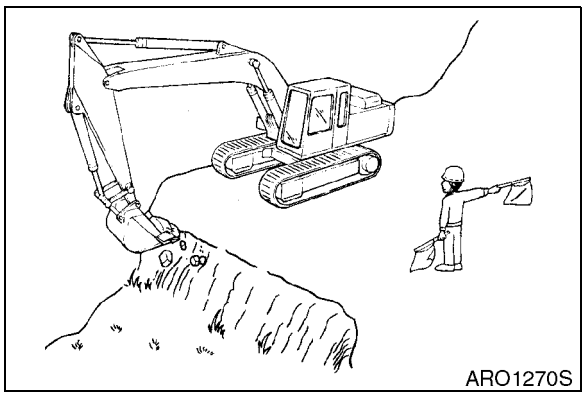


Figure 15

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

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

Remember that the soil after heavy rain, blasting or after earthquakes, is weakened in these areas.

Earth laid on the ground and the soil near ditches is 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 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 danger of serious injury.

Completely 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 compartment. 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 cab. 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 properly 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 cab.

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 actuation 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 rear view 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 the position of undercarriage. The normal travel position is with idler wheels to the front under the cab and the drive sprockets to the rear. When the undercarriage is in the reversed position, the travel controls must be operated in opposite directions.

MACHINE OPERATION

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.

- When changing the direction of travel from forward to reverse or from reverse to forward, reduce speed early and stop the machine before changing the direction of travel.
- 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.

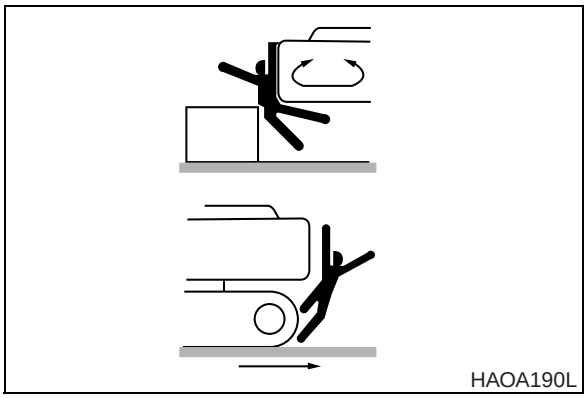


Figure 16

TRAVEL PRECAUTIONS

Never turn the starting switch to the "O" (OFF) position when traveling. It is dangerous if the engine stops when 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 that 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 degrees or more to the right or left, or 30 degrees 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.

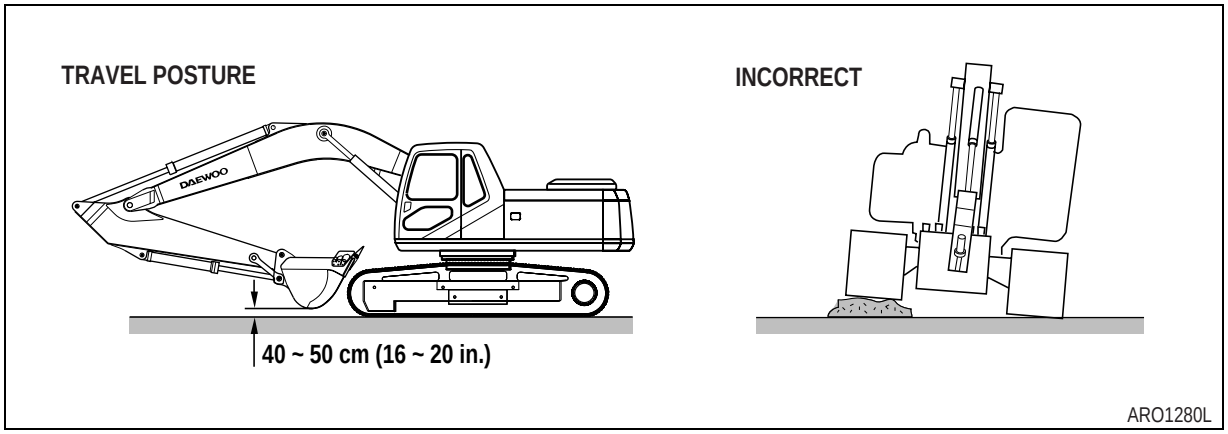


Figure 17

TRAVELING ON SLOPES

Never jump onto a machine that is running away to stop it. There is 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.

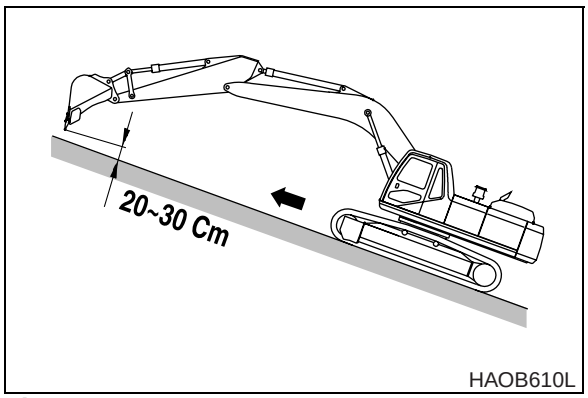


Figure 18

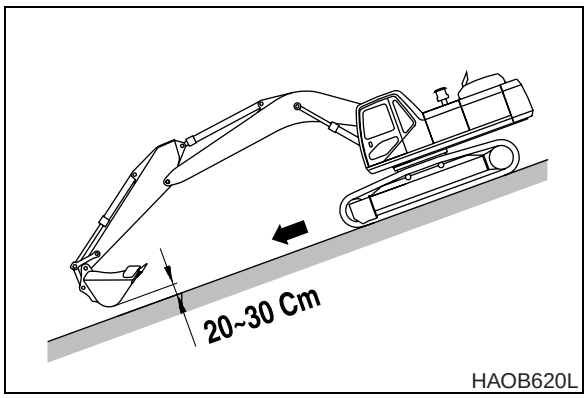


Figure 19

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 the direction of travel on a slope. This could result in tipping or side slipping of the machine.

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

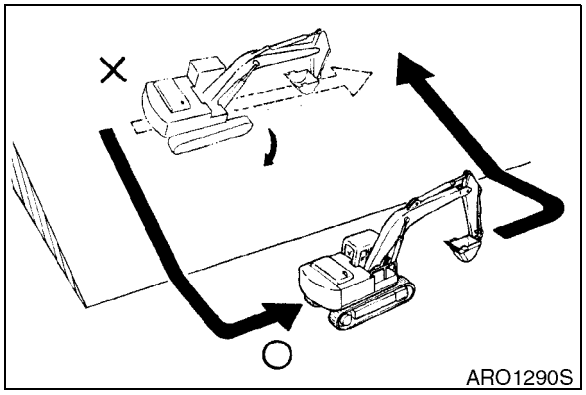


Figure 20

PROHIBITED OPERATIONS

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

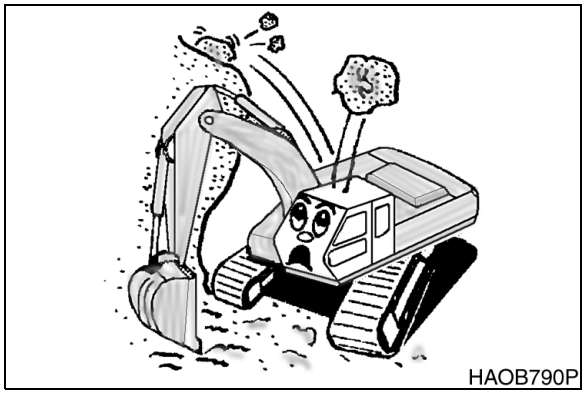


Figure 21

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.

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).

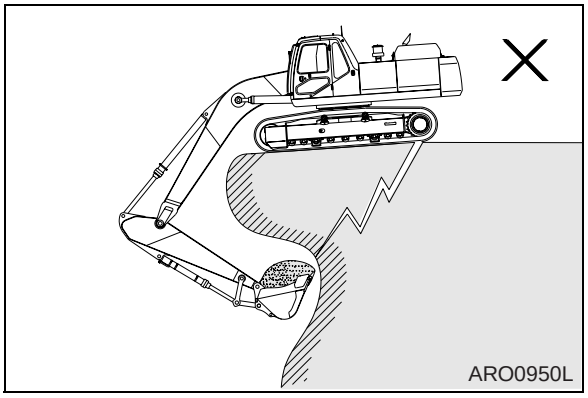


Figure 22

PRECAUTIONS FOR OPERATION

Be careful not to go close to the edge of a cliff by mistake.

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

To ensure an ample view, do as follows:

- 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 electric wires, or when parking the machine or carrying out other operations in places with limited height, be extremely 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 compartment of dump truck.

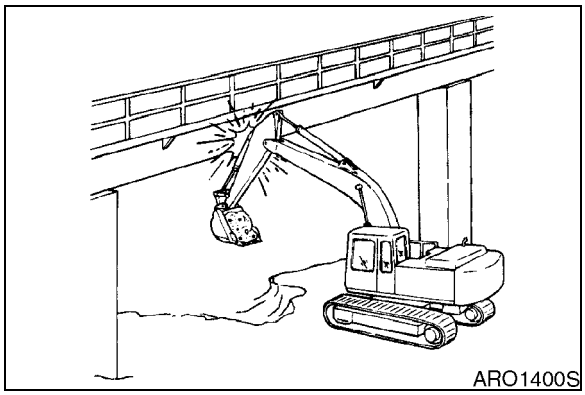


Figure 23

AVOID HIGH-VOLTAGE CABLES

Serious injury or death can result from contact or proximity to high-voltage electric 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")

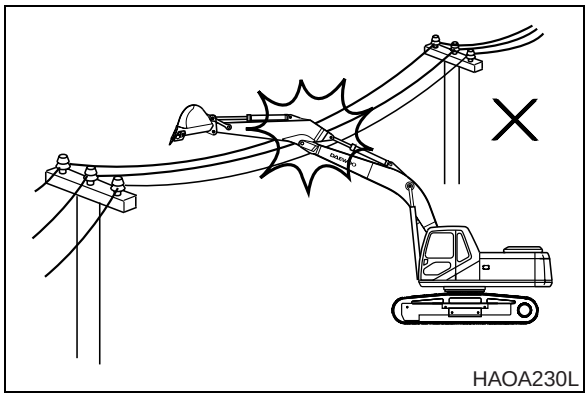


Figure 24

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 far away 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 type of operation near power lines (either above ground or buried cable-type), you should always contact the power utility directly and work out a safety plan with them.*

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 work load may be necessary.

When the temperature rises, frozen road surfaces become soft, so the 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 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.

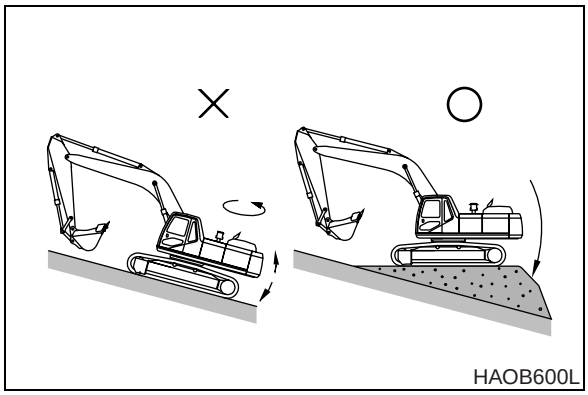


Figure 25

PARKING MACHINE

Avoid making sudden stops, or parking the machine wherever it happens to be at the end of the work day. Plan ahead so that 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 should 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, and park the machine so that 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 compartment.

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.

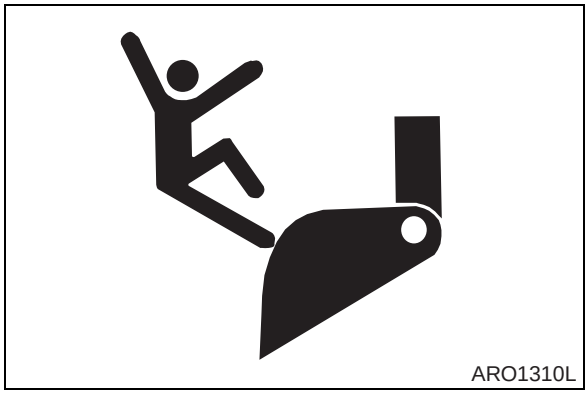


Figure 26

MAINTENANCE

WARNING TAG

Alert others that service or maintenance is being performed and tag operator's cab 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 left-hand control console in the fully raised, non-active position.

Warning tags, for controls are available from Daewoo distributors.



Figure 27

CLEAN BEFORE INSPECTION OR MAINTENANCE

Clean the machine before carrying out inspection and maintenance. This prevents dirt from getting into the machine and also 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 also there is 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 non-slip 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 28). If water gets into the electrical system, there is danger that it will cause defective operation and malfunction.

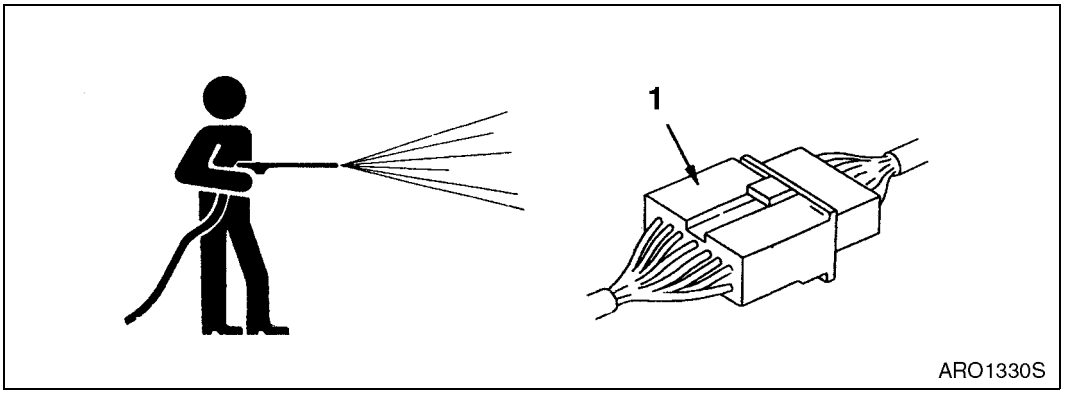


Figure 28

Pick up any tools or hammers that are laying in the work place, 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 work place is left untidy, you may trip or slip and suffer injury.

PROPER TOOLS

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

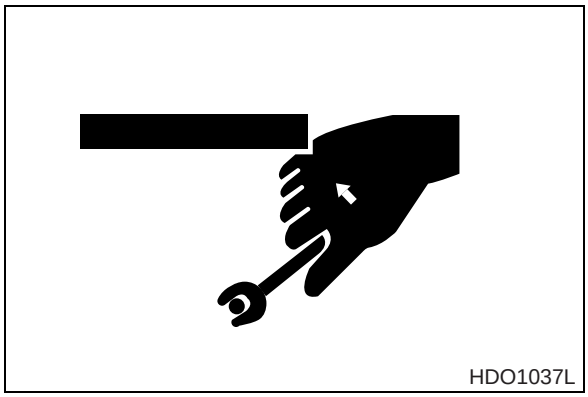


Figure 29

USE OF LIGHTING

When checking fuel, oil, battery electrolyte, or window washing fluid, always use lighting with anti-explosion specifications. If such lighting equipment is not used, there is danger of explosion.

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 danger of fire. There is also danger that the battery gas may catch fire and cause and explosion.

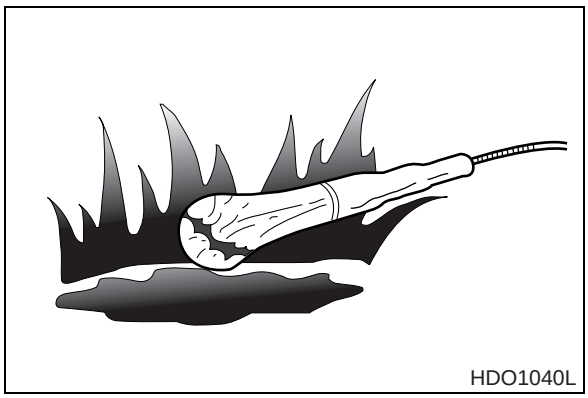


Figure 30

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 the flammable materials 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 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, stop the 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.

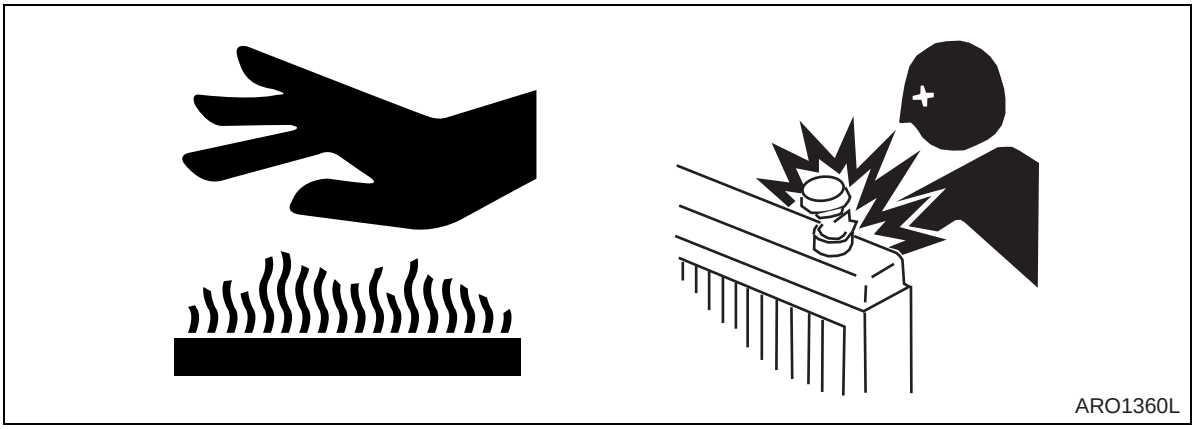


Figure 31

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 the 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 the 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 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.

WELDING REPAIRS

When carrying out welding repairs, carry out the welding in a properly equipped place. The welding should 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 the 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 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.

WARNING FOR COUNTERWEIGHT AND FRONT ATTACHMENT REMOVAL

DANGER!

Daewoo 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. Daewoo 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.

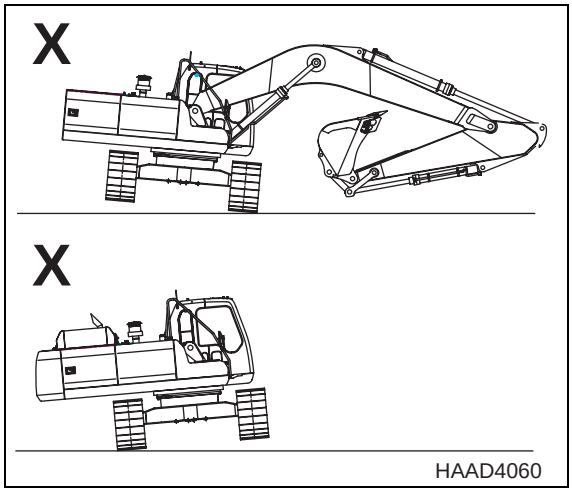


Figure 32

PRECAUTIONS FOR REMOVAL, INSTALLATION, AND STORAGE OF ATTACHMENTS

Before starting removal and installation of attachments, decide 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 that they do not fall. Put up a fence around the attachments and take other measures to prevent unauthorized persons from entering.

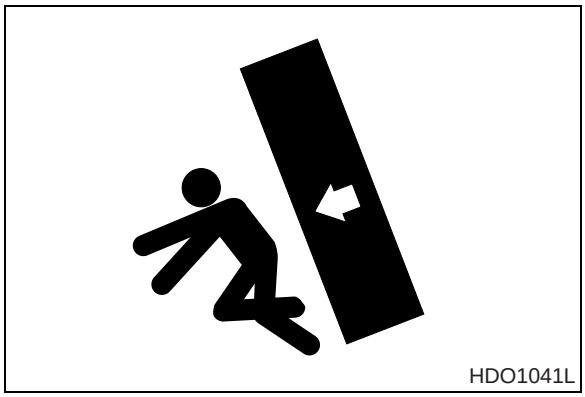


Figure 33

PRECAUTIONS WHEN WORKING ON MACHINE

When carrying out maintenance operations on the machine, keep the area around your feet clean and tidy to prevent you from falling. 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 part except the inspection passage fitted with non-slip pads.



Figure 34

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 danger that it may suddenly close and cause injury if there is a gust of wind.

CRUSHING PREVENTION AND CUTTING PREVENTION

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 fitting nut. To release pressure from the crawler frame track tension assembly, you should NEVER attempt to disassemble the track adjuster or attempt to remove the grease fitting or 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.

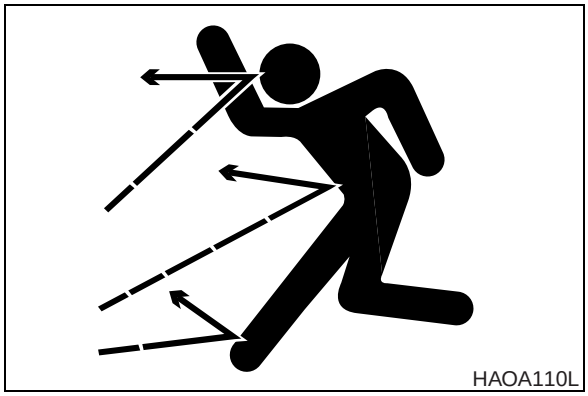


Figure 35

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 weight supports. Do not work under any equipment supported solely by a lift jack.

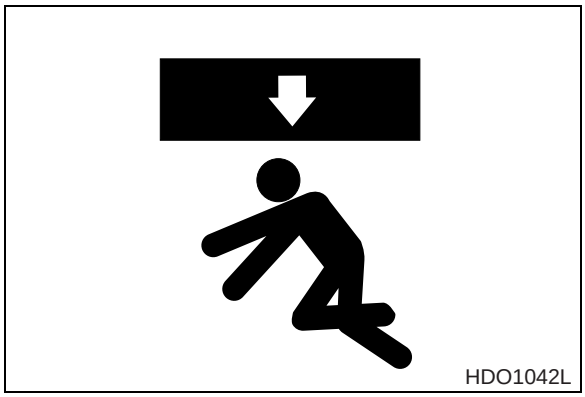


Figure 36

ACTION WHEN ABNORMALLY 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 Daewoo distributor for repairs.

PRECAUTIONS WITH HIGH PRESSURE LINE, TUBES AND HOSES

When inspecting or replacing high-pressure piping or hoses, check that the pressure has been released form 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.

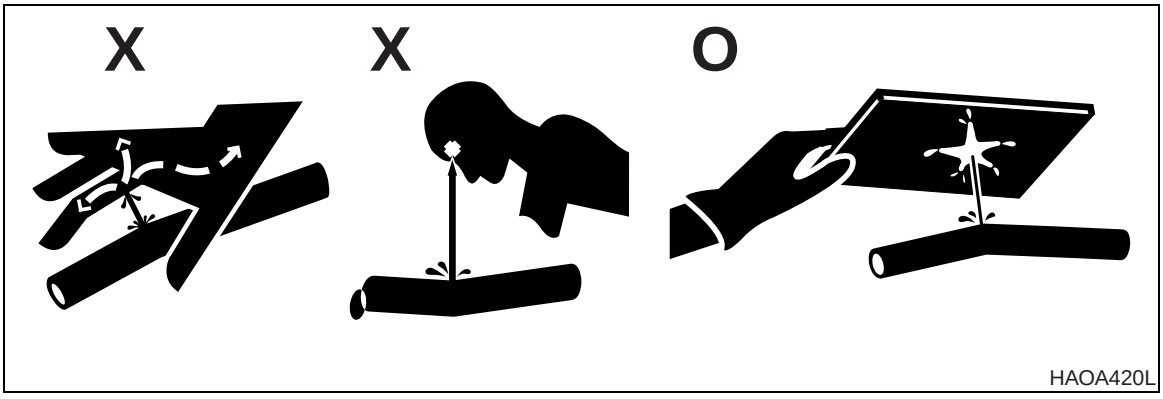


Figure 37

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.

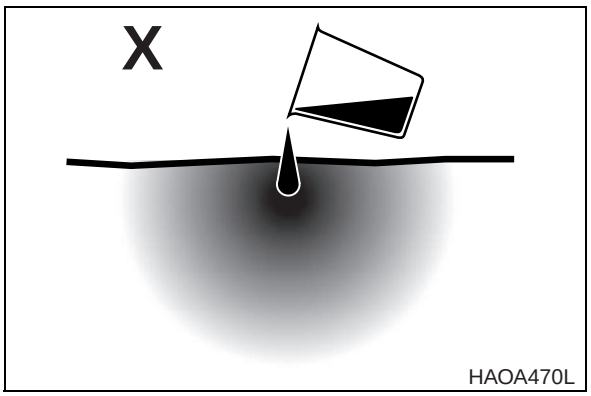


Figure 38

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 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 the battery from the machine before charging.

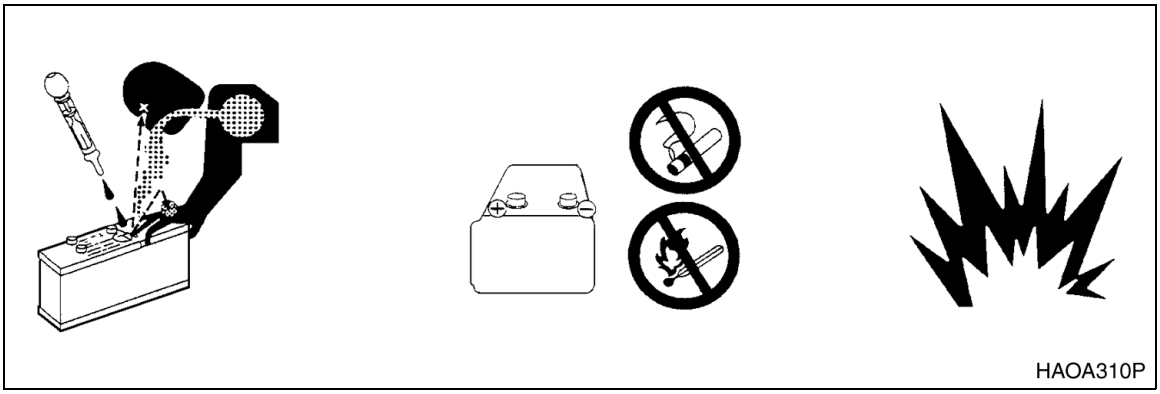


Figure 39

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.

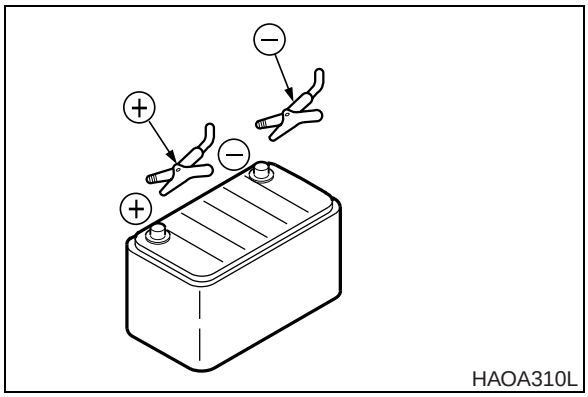


Figure 40

- 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 non-series-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, should be as far away from the batteries as possible.

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 Daewoo 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 light-weight towing hook for towing another machine.

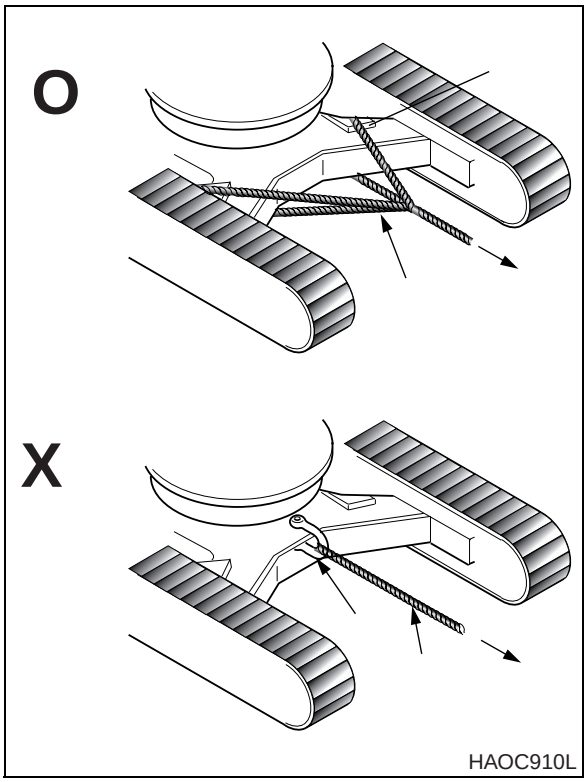


Figure 41

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 tear-down 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.

   NOTE: *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.*

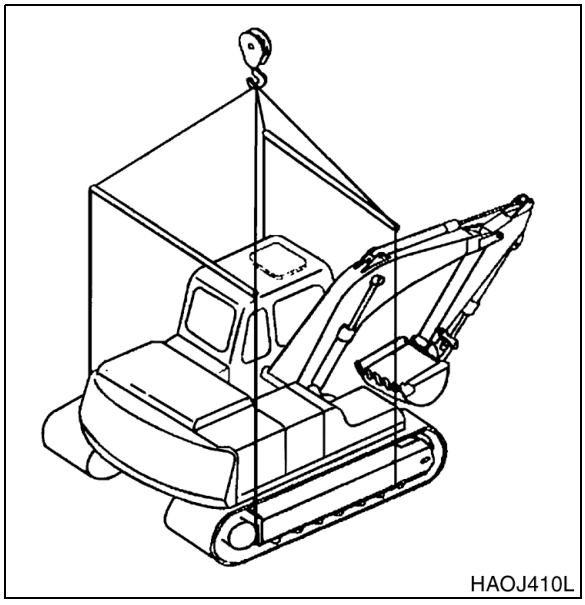


Figure 42

SPECIFICATIONS

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

SPECIFICATIONS FOR SOLAR 470LC-V

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 470LC-V	1001 and UP

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May 2002

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GENERAL DESCRIPTION

The excavator has three main component sections:

- The Upper Turntable
- 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 -4.)

COMPONENT LOCATIONS

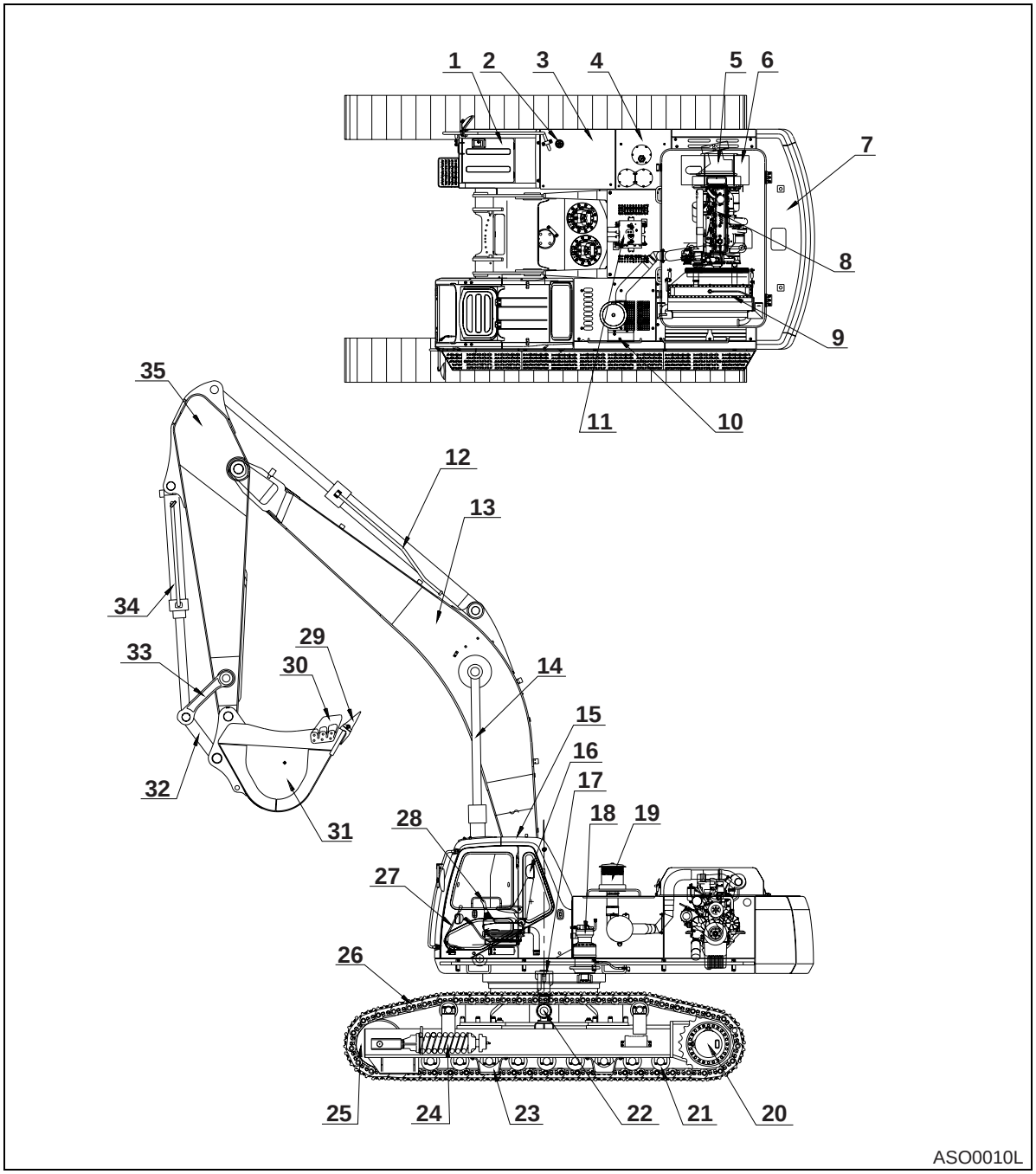


Figure 1

1. BATTERY
2. FUEL TANK FILL CAP
3. FUEL TANK
4. HYDRAULIC OIL TANK
5. PUMPS
6. MUFFLER
7. COUNTERWEIGHT
8. ENGINE
9. RADIATOR AND OIL COOLER
10. AIR CLEANER
11. CONTROL VALVES
12. ARM CYLINDER
13. BOOM
14. BOOM CYLINDER
15. CAB
16. SEAT
17. CENTER JOINT
18. SWING MOTOR
19. PRECLEANER
20. TRAVEL MOTOR
21. LOWER ROLLER
22. UPPER ROLLER
23. TRACK GUIDE
24. TRACK ADJUSTER
25. IDLER
26. TRACK LINK AND SHOE
27. TRAVEL LEVER
28. WORK LEVER (JOYSTICK) CONTROLS
29. TOOTH POINT
30. SIDE CUTTER
31. BUCKET
32. PUSH LINK
33. GUIDE LINK
34. BUCKET CYLINDER
35. ARM

GENERAL DIMENSIONS

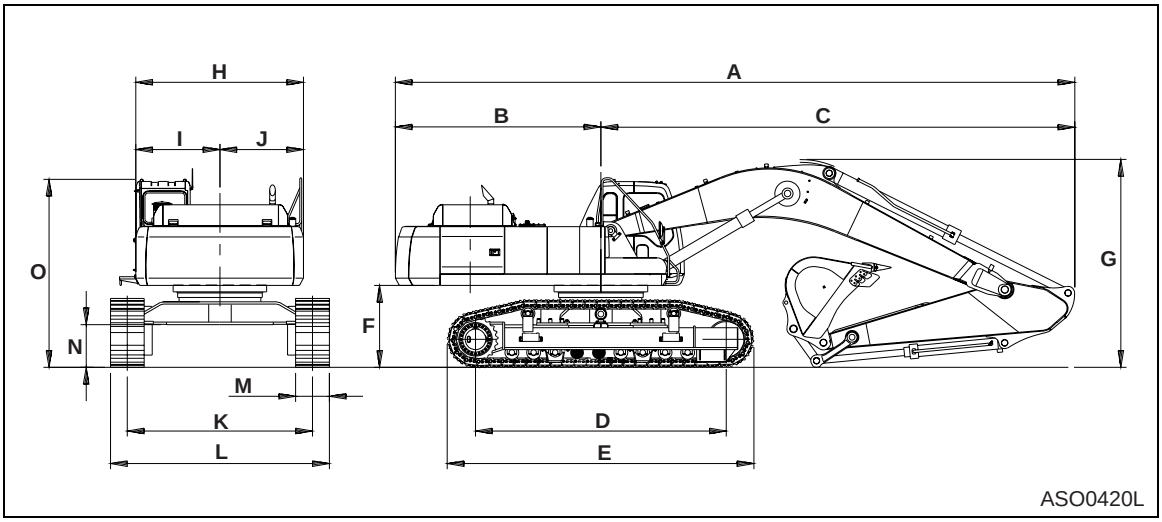


Figure 2

DIMENSION	7.1 m (23.3 ft) BOOM		
	2.9 m (9.5 ft) ARM	**3.35 m (11.0 ft) ARM**	**4.0 m (13.1 ft) ARM**
A	12,200 mm (40' 0")	12,110 mm (39' 9")	12,180 mm (40' 0")
B	3,665 mm (12' 0")		
C	8,535 mm (28' - 0")	8,445 mm (27' 8")	8,515 mm (27' 11")
D	4,470 mm (14' 8")		
E	5,465 mm (17' 11")		
F	1,460 mm (4' 9")		
G	3,905 mm (12' - 10")	3,705 mm (12' 1")	3,940 mm (12' 11")
H	2,990 mm (9' 10") CAT Walk 3,278 mm (10' 9")		
I	1,500 mm (4' 11") CAT Walk 1,788 mm (5' 10")		
J	1,490 mm (4' 10")		
K	3,300 mm (10' 10") Extended (Working) / 2,740 mm (8' 12") Retracted (Transport)		
L	3,900 mm (12' 10") Extended (Working) / 3,340 mm (10' 11") Retracted (Transport)		
M	600 mm (2' 0")		
N	761 mm (2' 6")		
O	3,350 mm (10' 11")		

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.

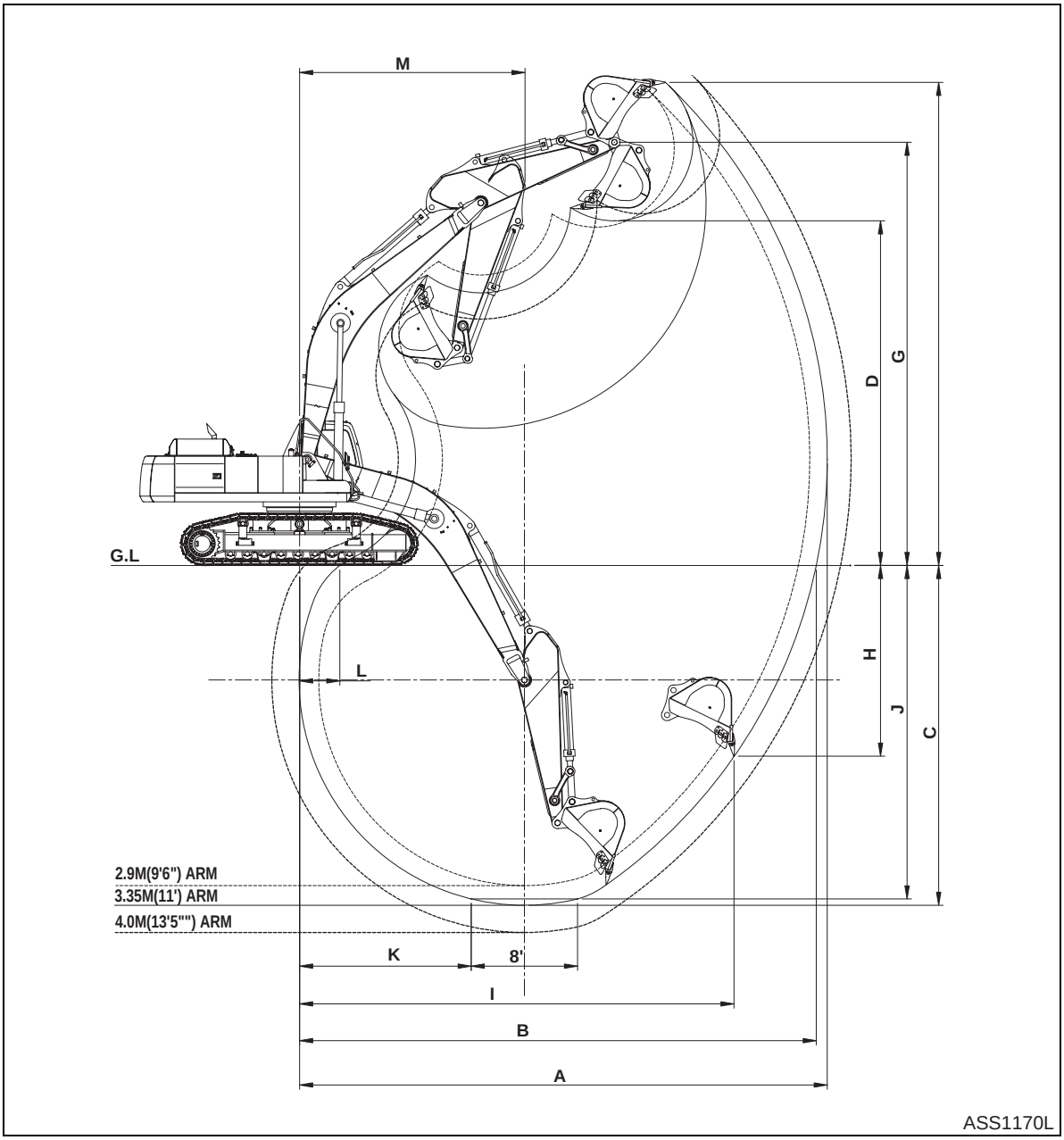


Figure 3

Dim.	Boom Type	One Piece 7.1 m (23.3 ft)		
	Arm Type	**2.9 m (10.17 ft)**	**3.35 m (8.2 ft)**	**4.0 m (12.3 ft)**
	Bucket Type (PCSA)	**2.39 m^3 (3.12 yd^3)**	**2.15 m^3 (2.80 yd^3)**	**1.8 m^3 (2.35 yd^3)**
A	Max. Digging Reach	11,700 mm (38' 5")	12,100 mm (39' 8")	12,650 mm (41' 6")
B	Max. Digging Reach (Ground)	11,440 mm (37' 6")	11,850 mm (38' 11")	12,410 mm (40' 9")
C	Max. Digging Depth	7,340 mm (24' 1")	7,790 mm (25' 7")	8,420 mm (27' 8")
D	Max. Loading Height	7,760 mm (25' 6")	7,900 mm (25' 11")	8,070 mm (26' 6")
F	Max. Digging Height	10,940 mm (35' 11")	11,810 mm (36' 4")	11,230 mm (36' 10")
G	Max. Bucket Pin Height	9,560 mm (31' 4")	9,705 mm (31' 10")	9,865 mm (32' 4")
H	Max. Vertical Wall	4,050 mm (13' 3")	4,370 mm (14' 4")	4,930 mm (16' 2")
I	Max. Radius Vertical	9,960 mm (32' 8")	10,230 mm (33' 7")	9,700 mm (31' 10")
J	Max. Depth to 8 ft Line	7,180 mm (23' 7")	7,660 mm (25' 2")	8,290 mm (27' 2")
K	Min. Radius 8 ft Line	3,935 mm (12' 11")	3,935 mm (12' 11")	3,935 mm (12' 11")
L	Min. Digging Reach	2,095 mm (6' 11")	925 mm (3' 0")	120 mm (0' 5")
M	Min. Swing Radius	5,195 mm (17' 1")	5,170 mm (16' 12")	5,135 mm (16' 10")

GENERAL SPECIFICATIONS

Shipping Weight	46.9 metric tons (103,400 lb), includes 10% fuel, boom, 3,350 mm (11’ 0") arm, 1,681 mm (5’ 6") backhoe bucket and standard shoes
Operating Weight	Add weight of full fuel tank and operator.
Shipping Weights With Optional Track Shoes	Add 700 kg (1,540 lb) for 750 mm (30") shoes
	Add 1,000 kg (2,204 lb) for 800 mm (32") shoes
	Add 1,500 kg (3,310 lb) for 900 mm (35") shoes
Major Component Weights	Standard Boom 3,700 kg (8,160 lb)
	2,900 mm (9’ 6") Arm 1,440 kg (3,170 lb)
	3,350 mm (11’ 0") Arm 1,560 kg (3,440 lb)
	4,000 mm (13’ 5") Arm 1,780 kg (3,260 lb)
	Boom Cylinders 430 kg (948 lb) each
	Arm Cylinder 660 kg (1,460 lb)
	Bucket Cylinder 380 kg (838 lb)
	Counterweight 8,500 kg (18,700 lb)
	Upper Turntable 9,995 kg (22,000 lb)
	Lower - below Swing Bearing 18,195 kg (40,100 lb)
Digging Forces:	
Bucket Cylinder	267 KN or 27,200 kg (59,970 lb) with 3,350 mm (11’ 0") standard arm
Arm Cylinder	216 KN or 22,100 kg (48,720 lb) with 3,350 mm (11’ 0") standard arm
Fuel Tank Capacity	620 liters (164 U.S. gal)
Hydraulic System Capacity	500 liters (132 U.S. gal)
Hydraulic Reservoir Capacity	265 liters (70 U.S. gal)
Bucket Heaped Capacity Range	PCSA 1.27 - 2.86 m^3 (1.66 - 3.73 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
	750 mm (30") - optional
	800 mm (32") - optional
	900 mm (35") - optional
Ground Pressure Ratings:	
Standard 600 mm (24") shoe -	0.81 kg/cm^2 (11.5 psi)
Optional 750 mm (30") shoe -	0.66 kg/cm^2 (9.4 psi)
Optional 800 mm (32") shoe -	0.62 kg/cm^2 (8.8 psi)
Optional 900 mm (35") shoe -	0.56 kg/cm^2 (7.9 psi)

Transport Dimensions	
Overall Shipping Length (standard boom and arm)	12,110 mm (39’ 9")
Overall Shipping Width (standard shoes)	3,900 mm (12’ 9") Extended (Working) / 3,340 mm (10' 11") Retracted (Transport)
Overall Shipping Height (to top of cylinder hose)	3,705 mm (12’ 1")
Track Shipping Length	5,465 mm (17’ 11")
Transport Trailer Capacity	47 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)

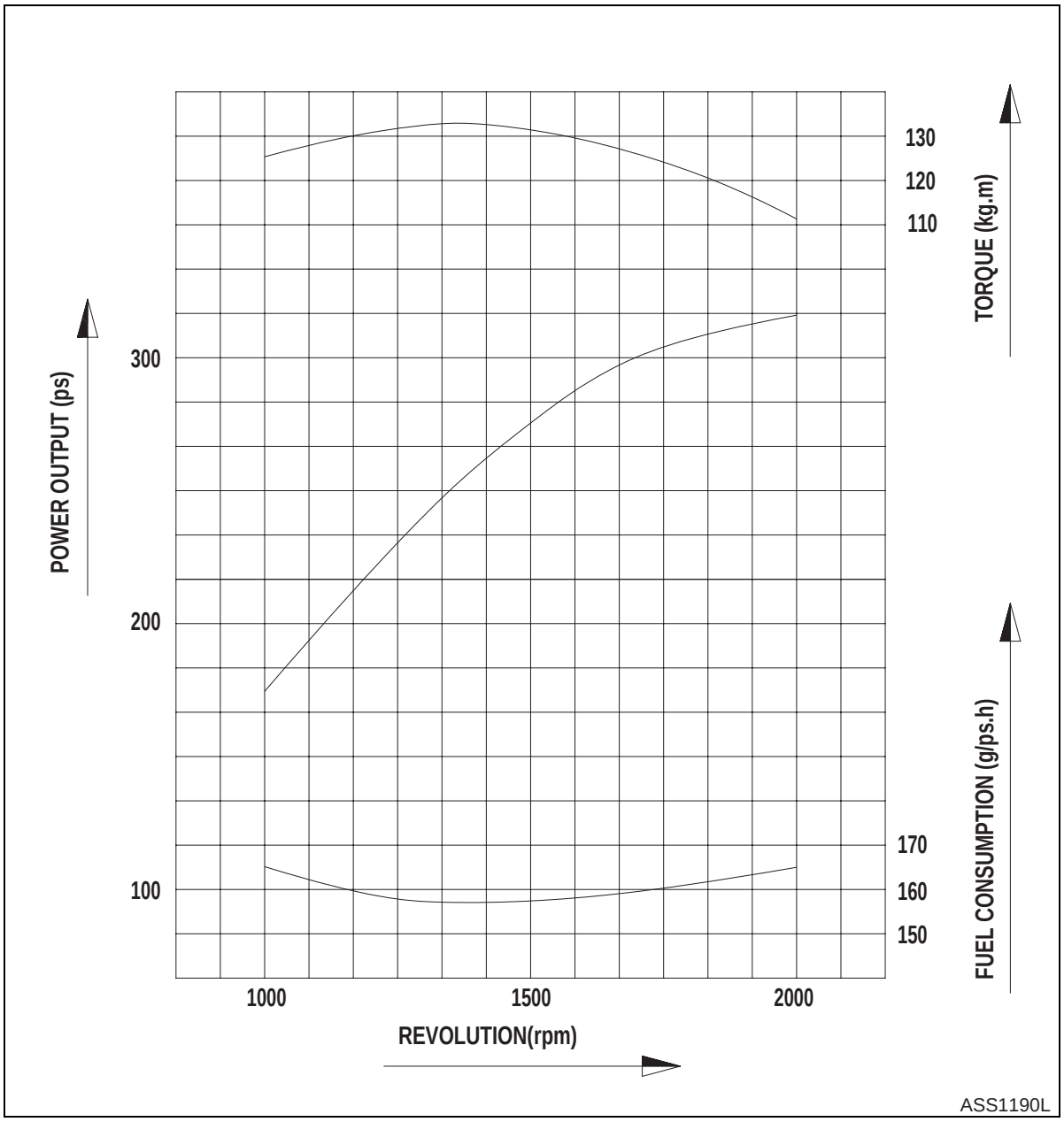


Figure 4

Condition	Specification
Engine Model	DE12TIS
Barometric Pressure	760 mmHg (20°C (68°F))
Cooling Fan	813 mm, SUCKER (32 in)
Alternator	24V x 50A
Air Cleaner	Installed
Muffler	Installed

Performance Standard	DIN 6270
Power	316 ps @ 2,000 rpm (312 hp @ 2,000 rpm)
Max. Torque	133 kg•m @ 1,400 rpm (962 ft lb @ 1,400 rpm)
Fuel Consumption (Min. Rated)	165 g/ps•h (5.82 oz/hp•h)

APPROXIMATE WEIGHT OF WORKLOAD MATERIALS

IMPORTANT

Weights are approximations of estimated average volume and mass. Exposure to rain, snow or ground water; settling or compaction due to overhead weight, chemical or industrial processing or changes due to 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)	----------

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, DRY, packed	----------	1,522 kg/m^3 (2,565 lb/yd^3)	----------
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)

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
Shale, broken	----------	1,362 kg/m^3 (2,295 lb/yd^3)	----------
Sulphur, broken	529 kg/m^3 (1,620 lb/yd^3)	----------	----------

PERFORMANCE TESTS

1. Main Relief Pressure

   normal operation: 320 kg/cm^3 (4,641 psi)

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

2. Actuator Speeds

Operation		Unit	Standard Mode	Power Mode
Boom	Up	sec.	4.3 ±0.4	3.9 ±0.4
	Down	sec.	3.0 ±0.3	3.0 ±0.3
Arm	Dump	sec.	3.4 ±0.4	3.1 ±0.3
	Crowd	sec.	5.1 ±0.4	4.6 ±0.4
Bucket	Dump	sec.	3.1 ±0.3	3.0 ±0.3
	Crowd	sec.	3.3 ±0.3	2.9 ±0.4
Swing (3 Revolutions)		sec.	18.8 ±1.5	17.5 ±1.5
Jack-Up Speed (3 Turns)	High	sec.	24.9 ±1.5	23.5 ±1.5
	Low	sec.	40.7 ±2.0	38.0 ±2.0
Travel Speed 20 m (65.62 ft)	High	sec.	15.7 ±1.0	14.5 ±1.0
	Low	sec.	24.2 ±1.5	23.5 ±1.5
Travel Deviation 20 m (65.62 ft)	High	mm (in)	150 (5.91)	150 (5.91)
	Low	mm (in)	150 (5.91)	150 (5.91)

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 stop watch 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, firmly supporting ground surface.
2. All recommended, applicable maintenance and adjustment service should be completed prior to testing.
3. Hydraulic fluid and engine oil should be of appropriate viscosity for ambient weather conditions. 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.

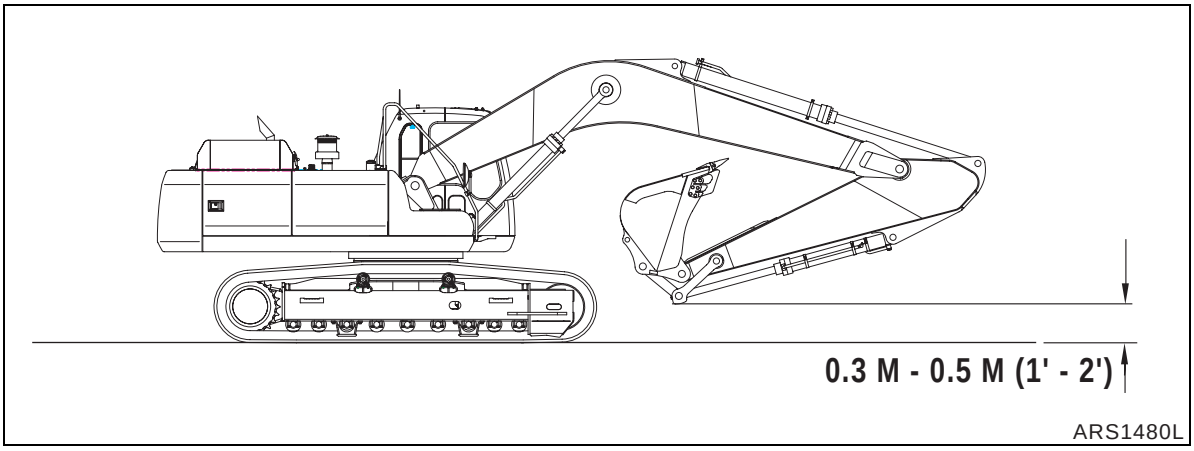


Figure 5

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 run-off distance.

Travel the excavator back and forth to be sure steering is centered and side frames are perfectly 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	15.7 ±1.0 seconds	14.5 ±1.0 seconds
Low Speed	24.2 ±1.5 seconds	23.5 ±1.5 seconds

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

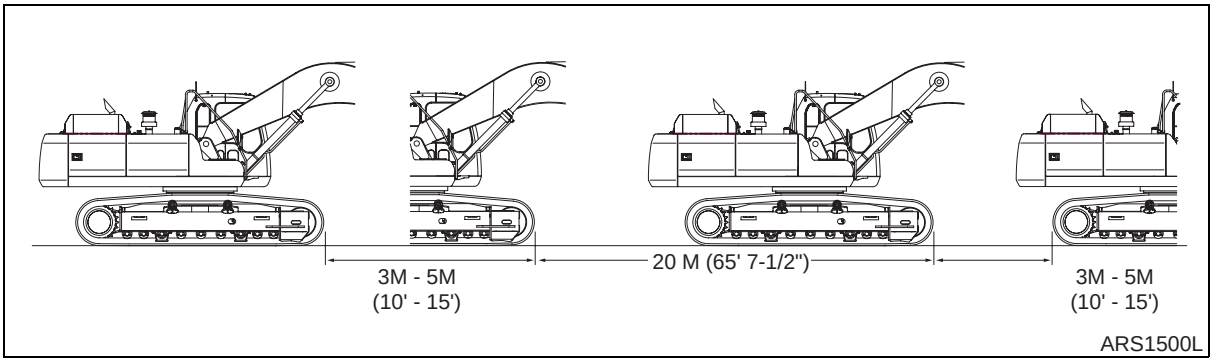


Figure 6

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

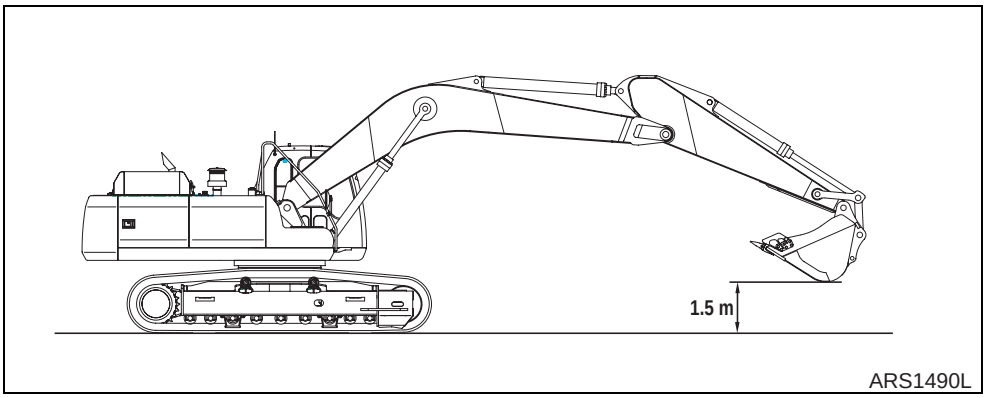


Figure 7

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 turntable 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 16.5 and 19.5 seconds in Standard Mode, 16.0 and 19.0 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 that 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.

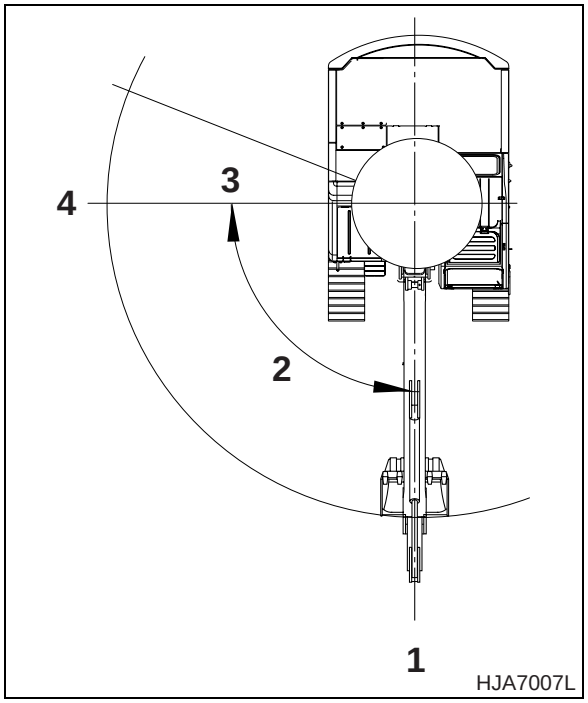


Figure 8

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

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 extra-duty 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 extra-duty power modes.

OPERATION	STANDARD MODE	POWER MODE
Boom Up	3.9 - 4.7 seconds	3.5 - 4.3 seconds
Boom Down	2.7 - 3.3 seconds	2.7 - 3.3 seconds
Arm Dump	3.0 - 3.8 seconds	2.8 - 3.4 seconds
Arm Crowd	4.7 - 5.5 seconds	4.2 - 5.0 seconds
Bucket Dump	2.8 - 3.4 seconds	2.7 - 3.3 seconds
Bucket Crowd	3.0 - 3.6 seconds	2.5 - 3.3 seconds

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 that 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.

Turn off the 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	23.4 - 26.4 seconds	22.0 - 25.0 seconds
Low Speed	38.7 - 42.7 seconds	36.0 - 40.0 seconds

GENERAL MAINTENANCE

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GENERAL MAINTENANCE PROCEDURES

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
ALL MODELS	ALL RANGES

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May 2002

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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 correct 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 Daewoo After Sales Service 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 on hand. Adequate ventilation and a dry work area are absolutely essential. Keep a fire extinguisher nearby and always wear protective clothing and the recommended type of 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 cab 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 dimensional 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 be run dry and damaged severely in a very short time when piping or hoses are disconnected to repair leaks and/or replace 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 due to neglect or careless maintenance, could all produce sufficient fluid loss to cause damage.

When starting the engine (particularly after long layoff or storage intervals), make sure that all hydraulic controls and operating circuits are in neutral, or "OFF." That will prevent pumps or other components that may be temporarily oil-starved from being run under a load.

Replacement of any hydraulic system component could require thorough cleaning, flushing, and some amount of pre-filling 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 bone dry (with no trace of factory pre-lube) or has been contaminated by dirt or by questionable oils, flushing and pre-filling 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 minimize 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 pre-start 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 work loads, fluid circulating under high pressure) make it extremely critical that dust, grit or any other type of contamination be kept out of the system. Observe fluid and filter change maintenance interval recommendations and always pre-clean any exterior surface of the system before it is exposed to air. For example, the reservoir filler 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 type of maintenance service or repair is being performed.

NOTE: *If the unit is being used in an extreme temperature environment (in sub-freezing 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 as a result of a mechanical problem inside the pump. However, pressure loss could also be due to 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 the 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 pre-fill 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 type of 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, non-combustible, evaporative-type, low-residue solvent and thoroughly clean exterior surfaces of assemblies before any part of the circuit is opened up 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 very suddenly put a complete 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.*

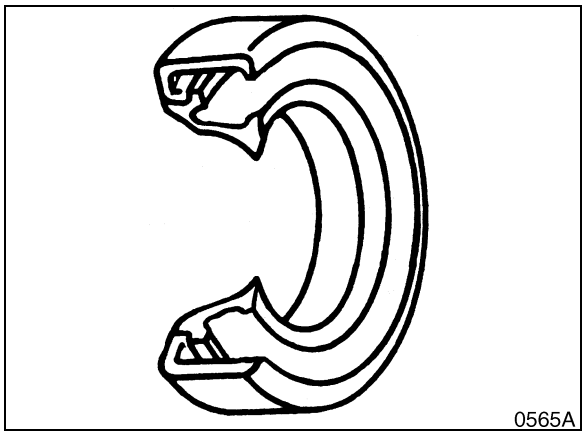


Figure 1

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 air stream 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 light weight 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 snap rings when unit is disassembled than waiting for premature failures; refer to latest Micro Fiche and/or Parts Book for replacement items. Be extremely 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 to the eye. 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 conditions of the bearing 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 foe 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 that 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 to the naked eye.

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.

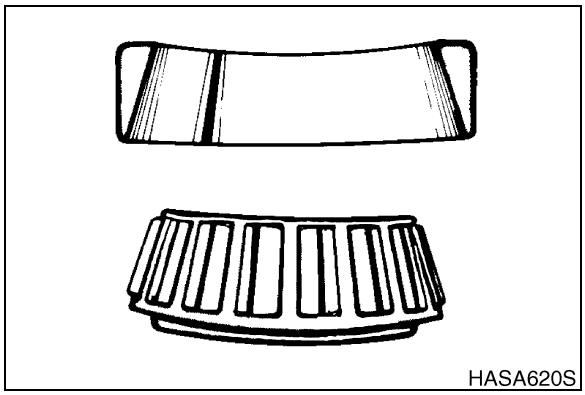


Figure 2

Bent Cage

Cage damage due to improper handling or tool usage.

Replace bearing.

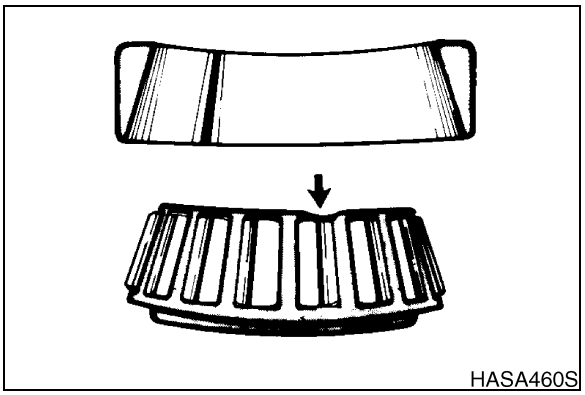


Figure 3

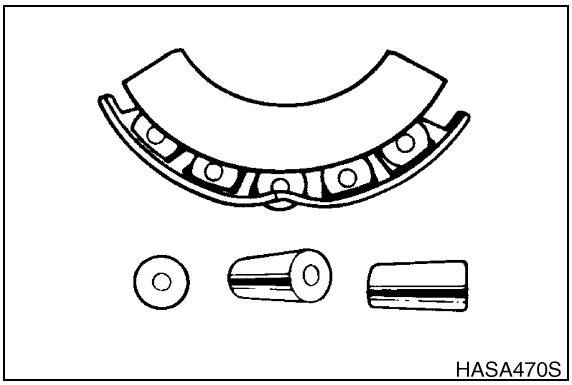


Figure 4

Galling

Metal smears on roller ends due to overheat, lubricant failure or overload.

Replace bearing - check seals and check for proper lubrication.

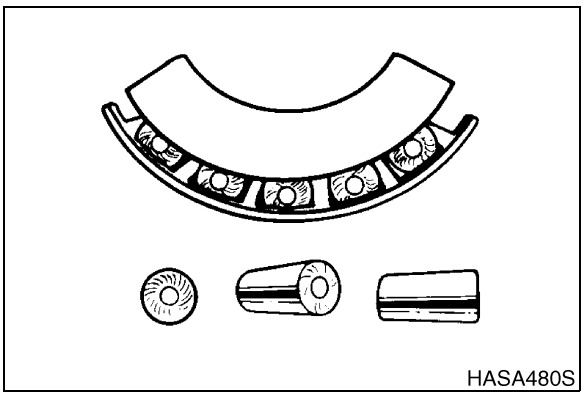


Figure 5

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.

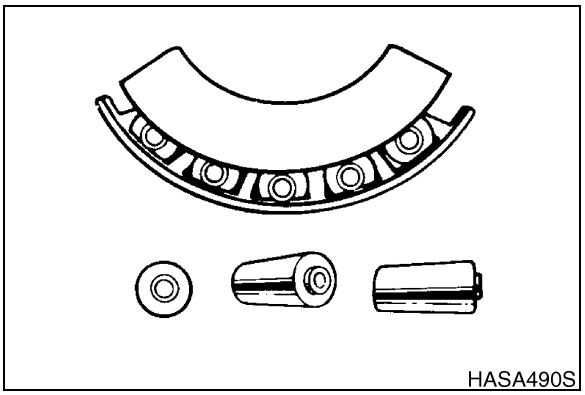


Figure 6

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.

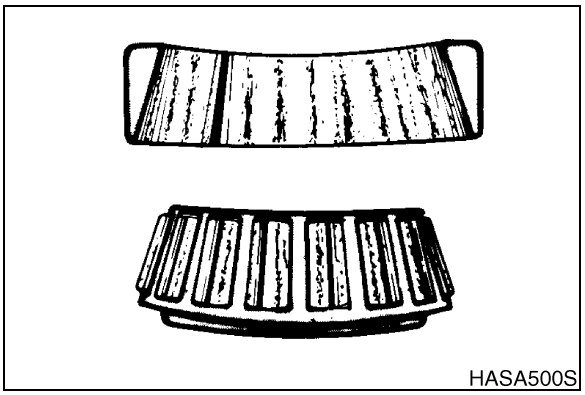


Figure 7

Misalignment

Outer race misalignment due to foreign object.

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

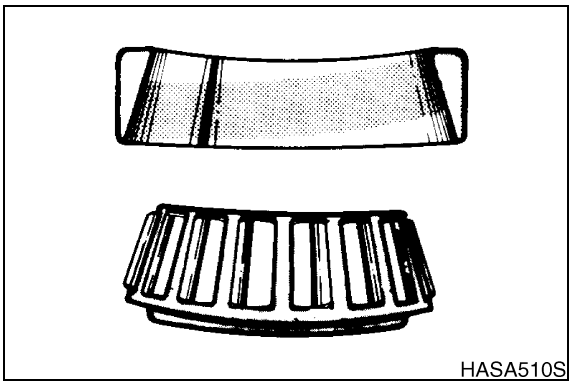


Figure 8

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.

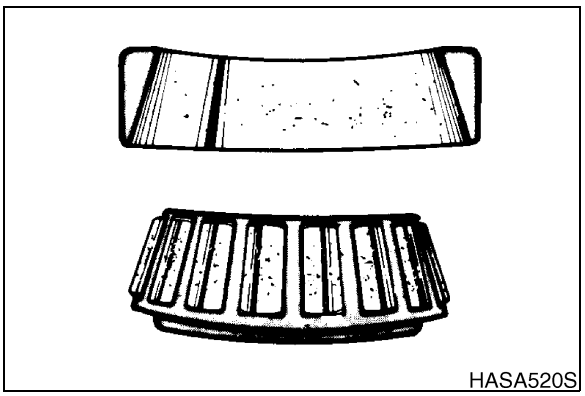


Figure 9

Fatigue Spalling

Flaking of surface metal resulting from fatigue.

Replace bearing - clean all related parts.

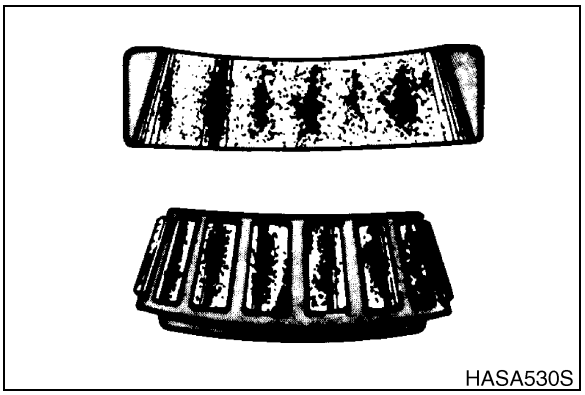


Figure 10

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.

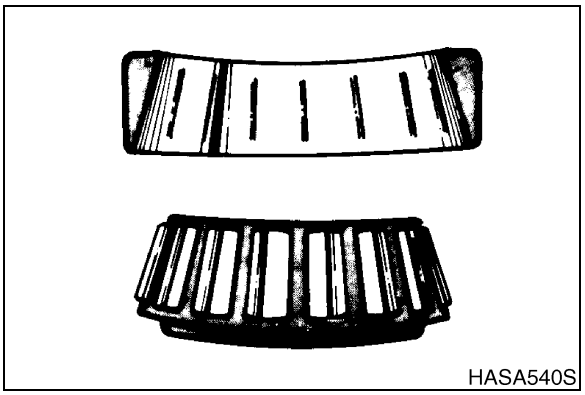


Figure 11

Cage Wear

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

Replace bearings - check seals.

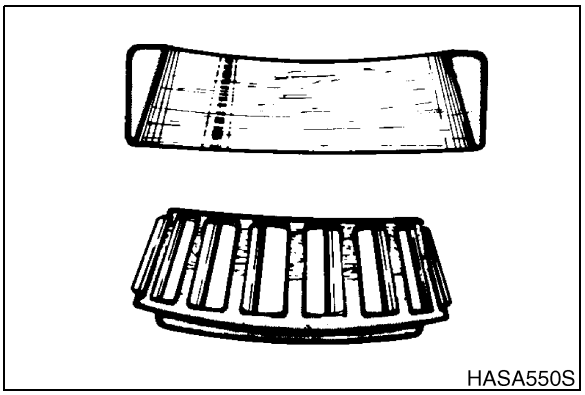


Figure 12

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.

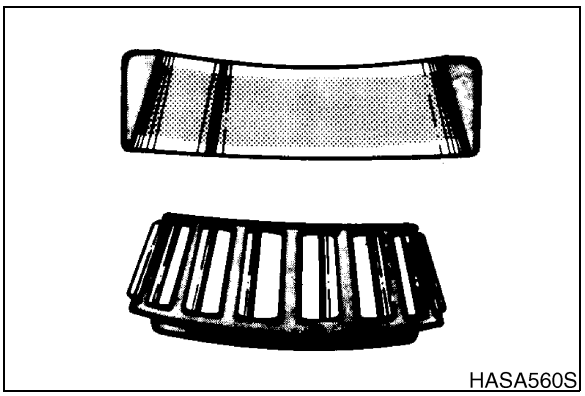


Figure 13

Cracked Inner Race

Race cracked due to improper fit, cocking or poor bearing seat.

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

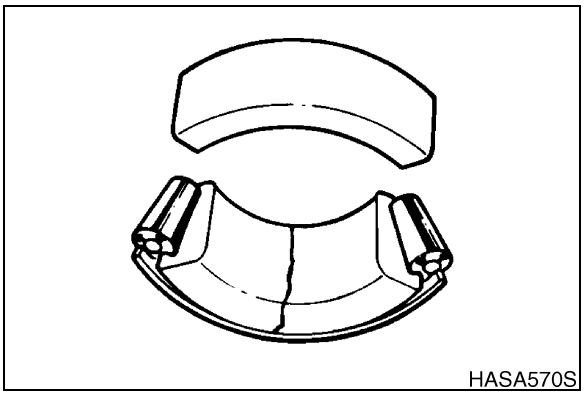


Figure 14

Smears

Smearing of metal due to 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.

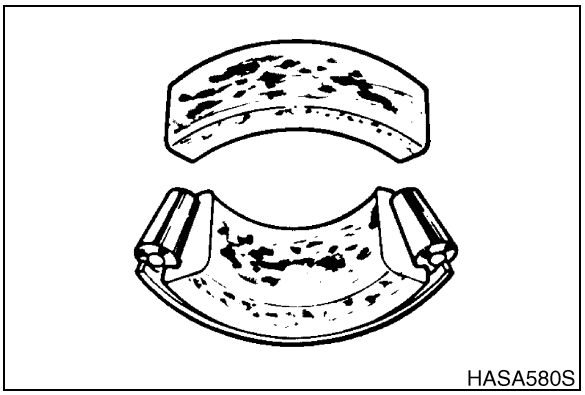


Figure 15

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.

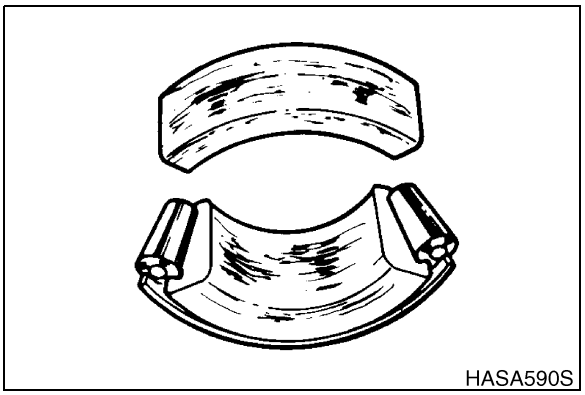


Figure 16

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 over heating damage is indicated. Check seals and other related parts for damage.

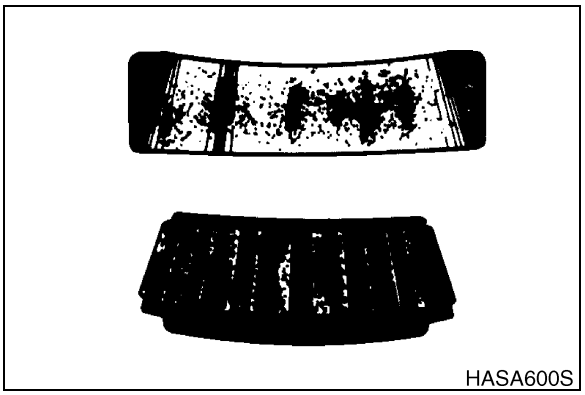


Figure 17

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.

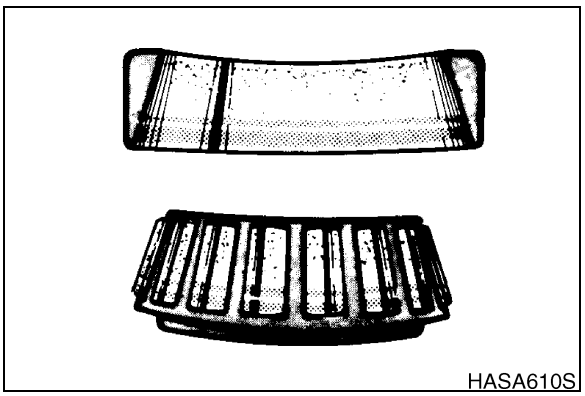


Figure 18

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STANDARD TORQUES

⚠ CAUTION!

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

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Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
ALL MODELS	ALL RANGES

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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	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 1.5	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 (11.26)	22.00 (158.12)
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 1.5	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 in all cases 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 NON-LUBRICATED (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 what 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:

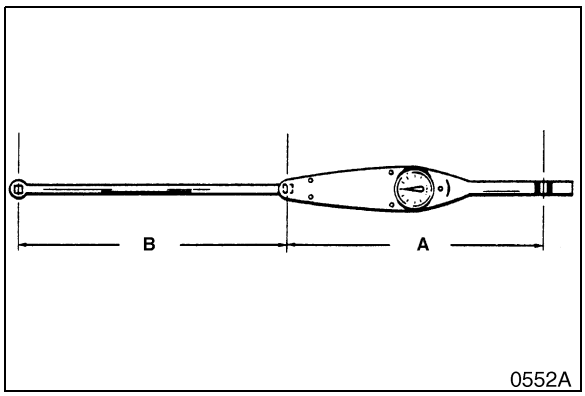


Figure 1

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:

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

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 perfectly 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. Daewoo 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	Break-away 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/non-clog" 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 non-rigid 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

CAB

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 340LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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REMOVAL

CAUTION!

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

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

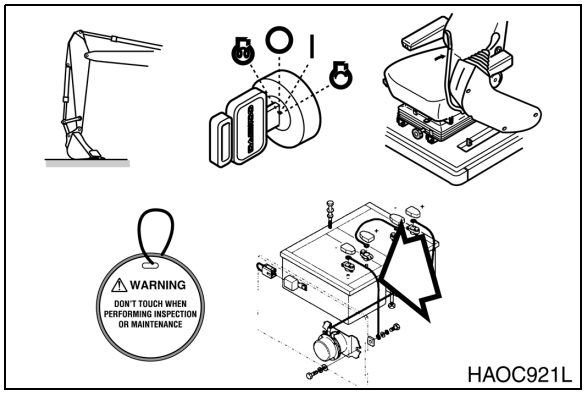


Figure 1

WARNING!

If engine must be run while performing maintenance, use extreme care. Always have one person in the cab at all times. Never leave the cab 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 "OFF" position and remove from starter switch.
9. Hang maintenance warning tag on controls.
10. Disconnect negative (-) battery cable leading to frame from battery.
11. Prepare cab shell for removal by disconnecting wiring connectors for:
    - A. Cab 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 cab do not need to be disassembled.*

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

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

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

14. Remove duct covers (2, 3 and 4, Figure 2). When removing cover (2) disconnect hour meter connector and cigar lighter connector. Disconnect main harness connector before removing cover (4).
15. Remove pocket (5, Figure 2) before removing side panel (6, Figure 2).

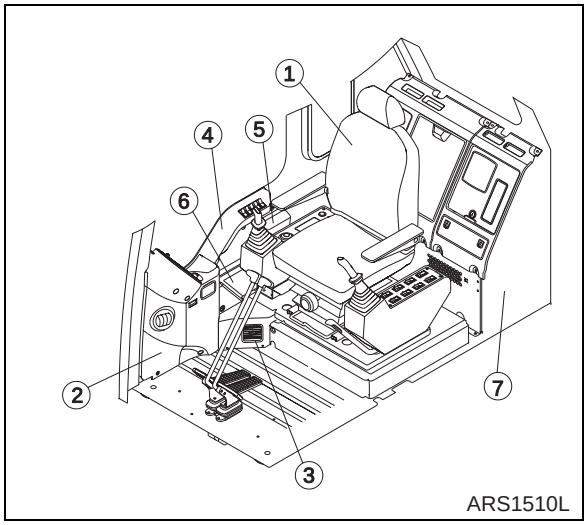


Figure 2

16. Remove air duct (1, 2 and 3, Figure 3) located at right side of cab. Disconnect duct wiring connector before removing duct (2).
17. Disconnect washer hose located at floor plate bottom.

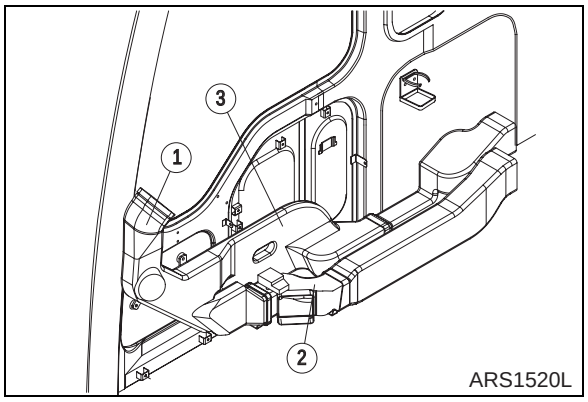


Figure 3

18. Remove cover (5, Figure 4) on left side dash cover (3) and bolts (1, Figure 5).

    NOTE: *When removing cover disconnect speaker wire.*

19. Remove two rubber stops (2, Figure 4) used in storing the front lower glass. Remove bolts (1) from the rear left and right dash covers. Remove left side cover (3).
20. Lift right side dash cover (4, Figure 4) and disconnect speaker wire. Remove cover.

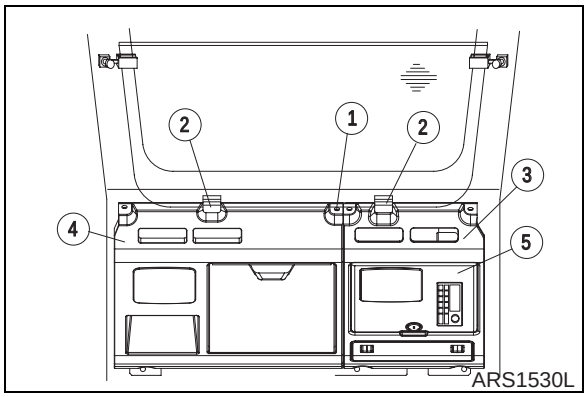


Figure 4

21. Remove three bolts (2, Figure 5) after disconnect speaker wire and antenna wire. Remove stereo assembly.
22. Disconnect cab lamp wiring connector.
23. Disconnect cabin ground cable (7, Figure 2).

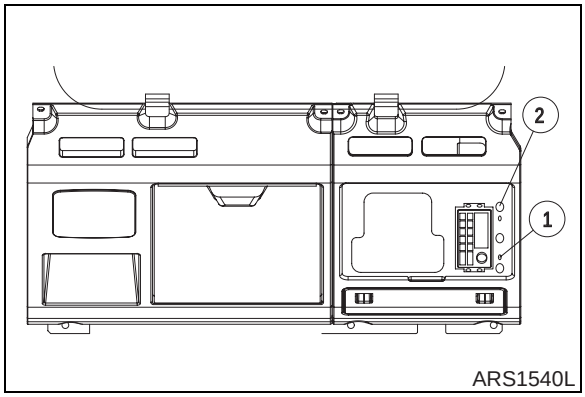


Figure 5

24. Remove four mounting nuts from four corners of cabin floor (2, Figure 6).
25. Remove four hex bolts (3, Figure 6) from door side of cabin floor.
26. Remove two hex bolts (1, Figure 6) from right side of cabin floor and one bolt (4) from front of cab floor.

Quantity	Description
4	16 mm hex nuts at each corner of the cab
4	10 mm x 1.5 hex bolts at the door side of the cab
3	10 mm x 1.5 mm hex head bolts, 2 on the right side of the cab and 1 under the front window.

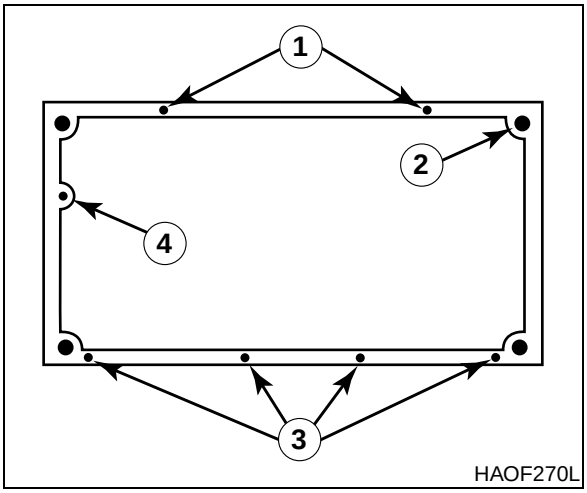


Figure 6

27. Using a suitable lifting device, attach slings to four lift points on top of cab (Figure 7).

    NOTE: *Cab weighs approximately 290 kg (639 lb).*

28. Lift cab 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 the cab shell. Lower the shell to a pre-prepared safe blocking support.

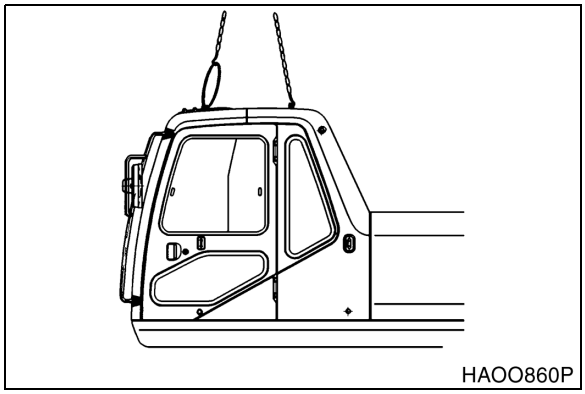


Figure 7

INSTALLATION

1. Using a suitable lifting device, attach slings to four lift points on top of cab (Figure 7).

   NOTE: *Cab weighs approximately 290 kg (639 lb).*

2. Lower cab into position on cab floor

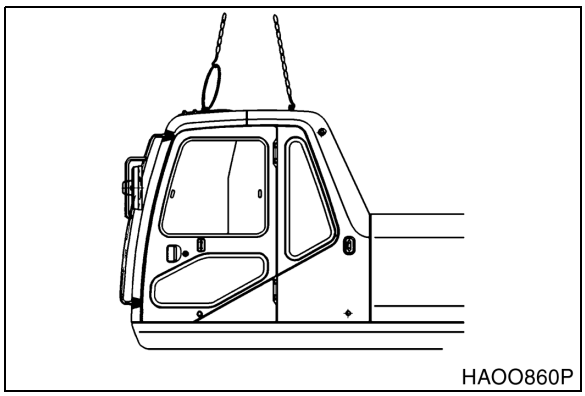


Figure 8

3. Install four mounting nuts on four corners of cabin floor (2, Figure 9).

   NOTE: *Mounting nut torque 20.2 kg•m* (146 ft lb)

4. Install four hex bolts (3, Figure 9) in door side of cabin floor.

5. Install two hex bolts (1, Figure 9) in right side of cabin floor and one bolt (4) in front of cab floor.

Quantity	Description
4	16 mm hex nuts at each corner of the cab
4	10 mm x 1.5 hex bolts at the door side of the cab
3	10 mm x 1.5 mm hex head bolts, 2 on the right side of the cab and 1 under the front window.

6. Once cab is mounted to floor, unhook lifting device

7. Connect cabin ground cable (7, Figure 2).

8. Connect cab light wiring connector.

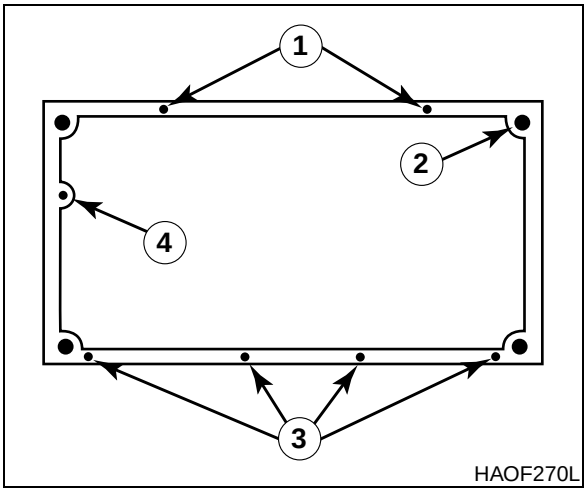


Figure 9

9. Install stereo assembly with bolts (2, Figure 10) after connect speaker wire and antenna wire.

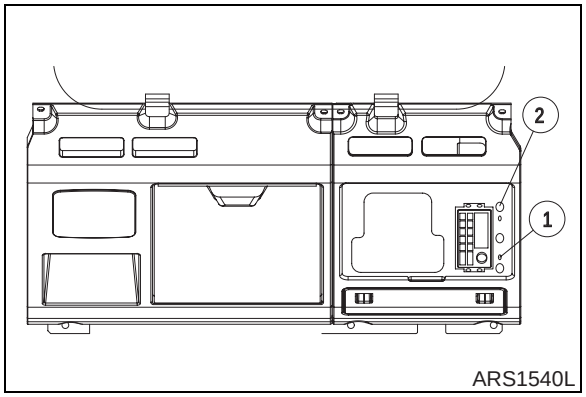


Figure 10

10. Install right side dash cover (4, Figure 11) with bolts (1, Figure 10).
11. Install left side dash cover (3, Figure 11) with bolts (1, Figure 10). Install two rubbers (2, Figure 11).
12. Install cover (5, Figure 11) on left side dash cover (3).

    NOTE: *Connect speaker wire before installing cover.*

13. Connect washer hose located at floor plate bottom.
14. Install air duct (3, 2 and 1, Figure 12) located at right side of cab.

    NOTE: *Connect wire connector of duct (2*, Figure 12*).*

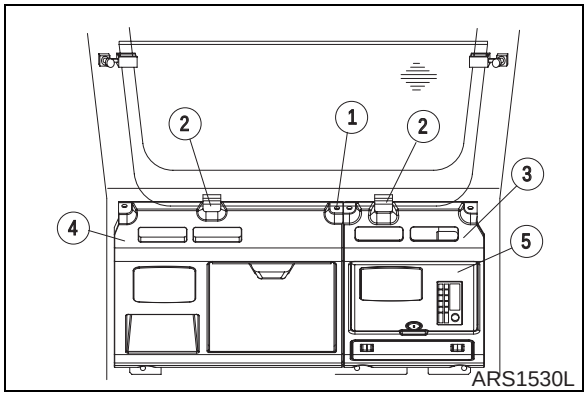


Figure 11

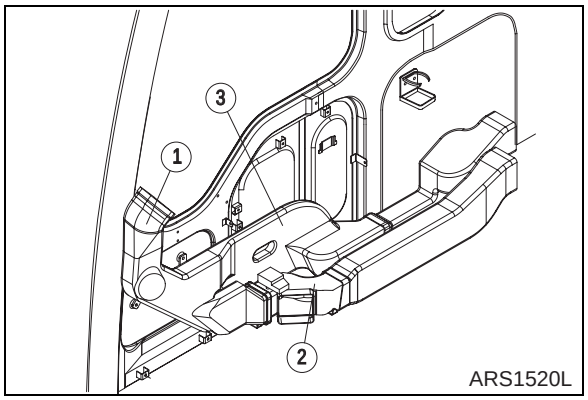


Figure 12

15. Install side panel (6, Figure 13) and pocket (5).
16. Install cover (4, Figure 13) and connect main harness. Install cover (3). Connect hour meter connector and cigar lighter connect of cover (2).
17. Install cover (2, Figure 13).
18. Install operator's seat (1, Figure 13).

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

19. Install floor mat.
20. Connect negative (-) battery cable leading to frame from battery.

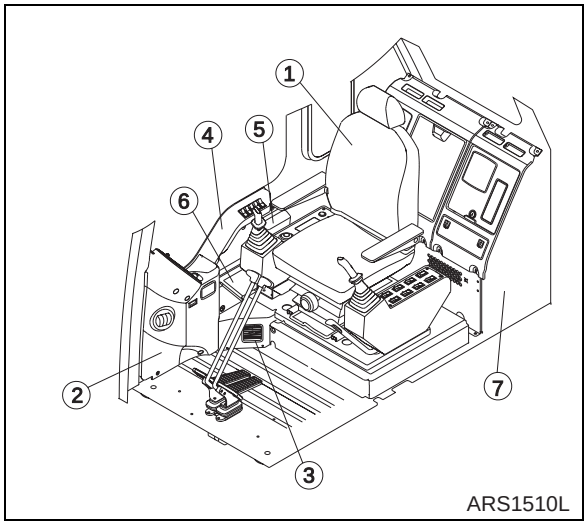


Figure 13

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COUNTERWEIGHT

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 340LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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GENERAL

DANGER!

Daewoo 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. Daewoo 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.

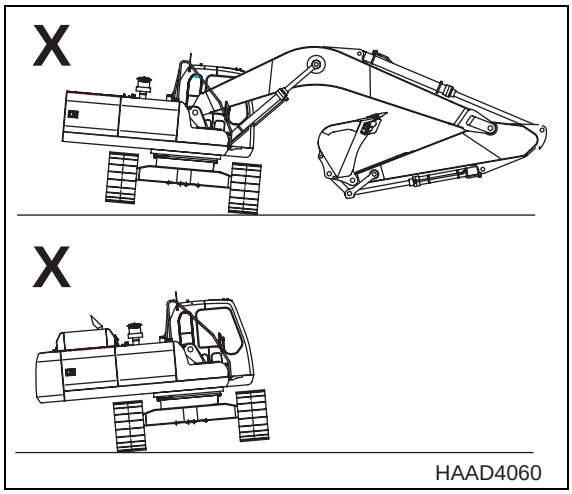


Figure 1

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
Solar 300LC-V	4,900 kg (10,803 lb)
Solar 300LL	6,300 kg (13,890 lb)
Solar 340LC-V	6,400 kg (14,110 lb)
Solar 420LC-V	8,200 kg (18,078 lb)
Solar 470LC-V	8,500 kg (18,740 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 the 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.

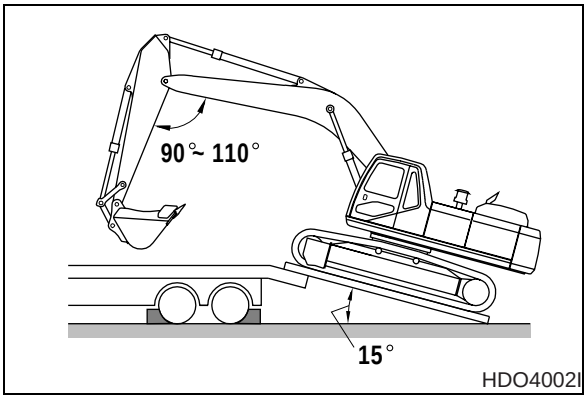


Figure 1

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

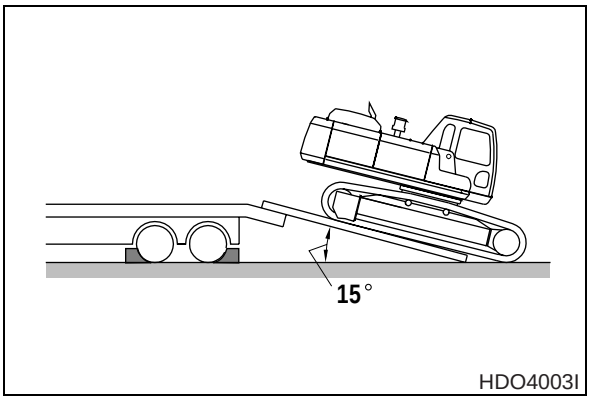


Figure 2

REMOVAL

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

> **WARNING!**
>
> **If engine must be run while performing maintenance, use extreme care. Always have one person in the cab at all times. Never leave the cab 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 "OFF" position and remove from starter switch.
9. Hang maintenance warning tag on controls.
10. Disconnect negative (-) battery cable leading to frame from battery.
11. Raise engine compartment cover.

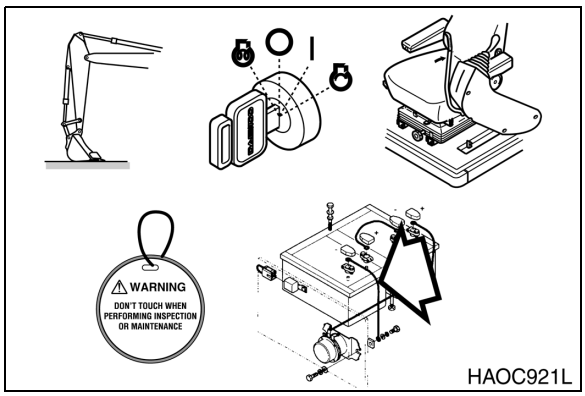


Figure 3

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
Solar 300LC-V Solar 300LL Solar 340LC-V Solar 420LC-V Solar 470LC-V	M48x5.0

14. Using a suitable lifting device capable of handling load, partially support counterweight (2, Figure 4) before beginning to loosen 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.

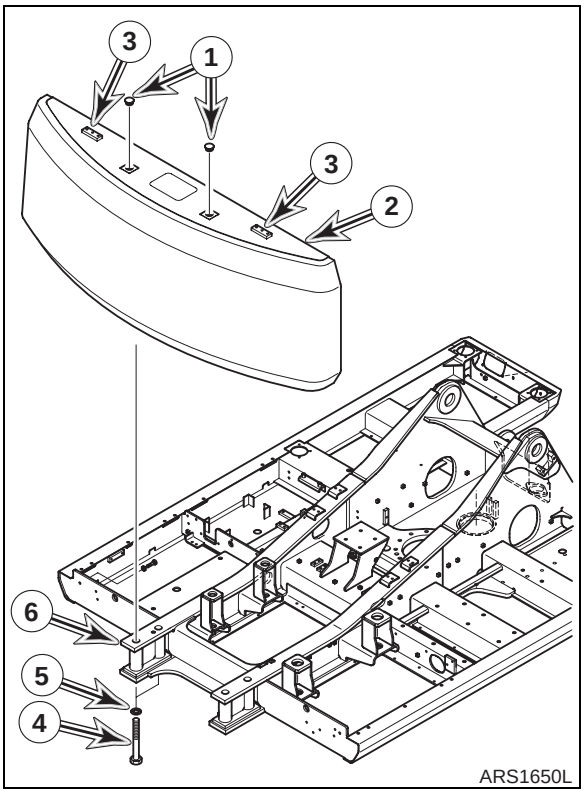


Figure 4

INSTALLATION

1. Raise engine compartment cover.
2. Using suitable lifting device capable of handling 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.*
3. Slide washers (5, Figure 5) onto bolts (4). Apply Loctite #242 to mounting bolt threads.
4. 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: *Tighten bolts (4, Figure 5) to values shown in following table.*

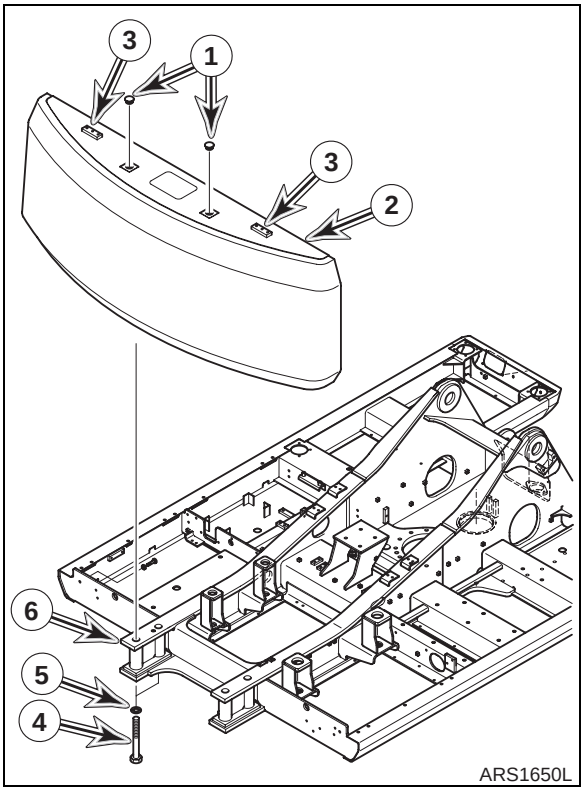


Figure 5

Model	Bolt Torque
Solar 300LC-V Solar 300LL Solar 340LC-V Solar 420LC-V Solar 470LC-V	250 kg•m (1,807 ft lb)

5. Remove lifting device and lifting eyes from counterweight lifting holes (3, Figure 5).
6. Install two caps (1, Figure 5) in lifting holes (3).
7. Connect negative (-) battery cable to battery.

FUEL TANK

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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 470LC-V	1001 and Up

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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.

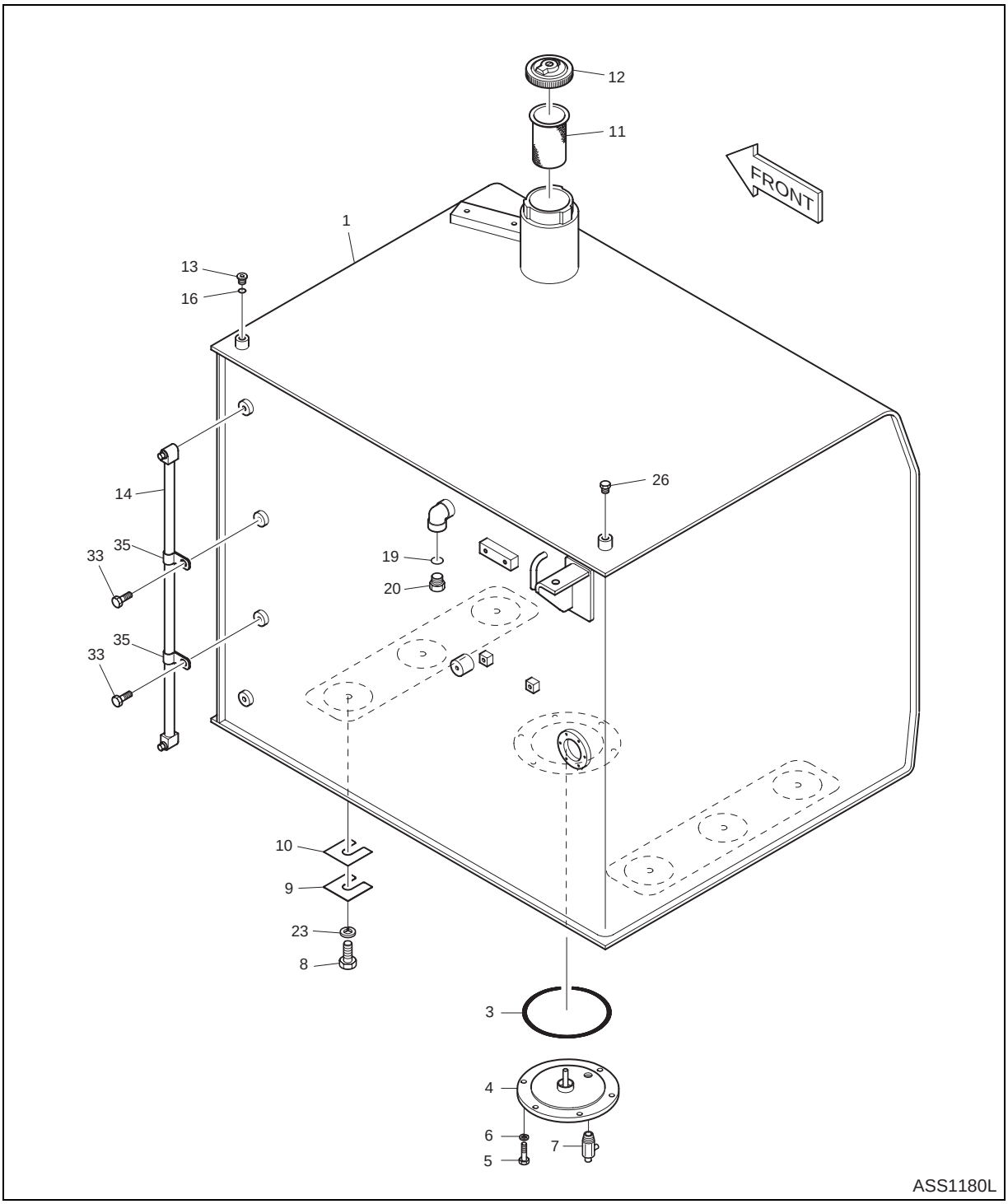


Figure 1

Reference Number	Description
1	Fuel Tank
3	O-ring
4	Cover
5	Bolt (M10x1.5x25)
6	Spring Washer
7	Drain Cock
8	Bolt (M16x2.6x60)
9	Shim
10	Shim
11	Fuel Filter

Reference Number	Description
12	Cap
13	Plug
14	Level Gauge
16	O-ring
19	O-ring
20	Plug
23	Spacer
26	Bolt (M12x1.75x16)
33	Bolt (M8x1.25x12)
35	Clip

SPECIFICATIONS

Fuel tank capacity is 620 liters (164 U.S. gal).

REMOVAL

1. Look at fuel level display (Figure 2) on instrument panel in operator's cab 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.*

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

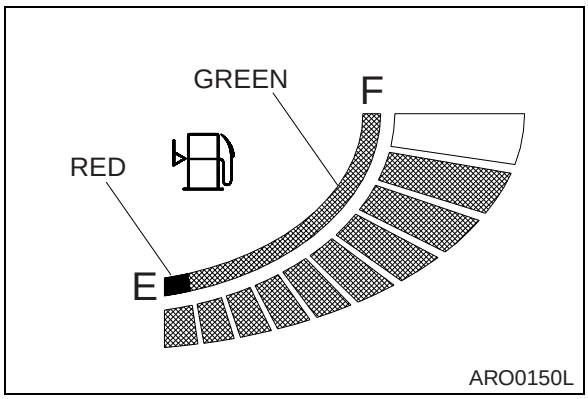


Figure 2

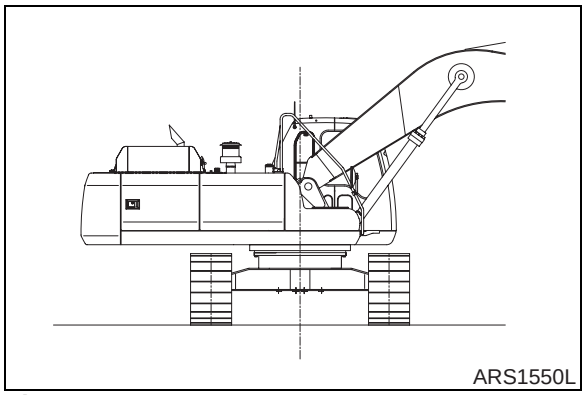


Figure 3

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

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

7. Fully stroke work levers (joysticks) in all directions to relieve pressure from accumulators.
8. Set safety lever on "LOCK" position.
9. Turn key to "OFF" position and remove from starter switch.
10. Hang maintenance warning tag on controls.
11. Disconnect negative (-) battery cable leading to frame from battery.
12. Clean area around fuel tank fill cap (1, Figure 5). Open fuel cap.

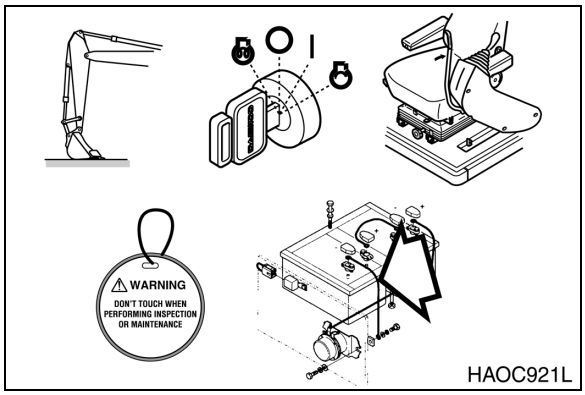


Figure 4

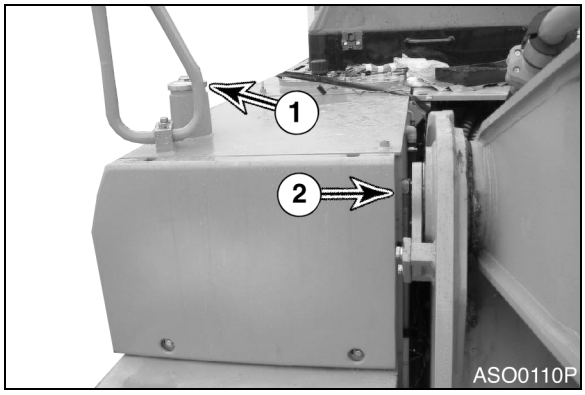


Figure 5

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

    NOTE: *Fuel tank capacity is 620 liters (164 U.S. gal).*

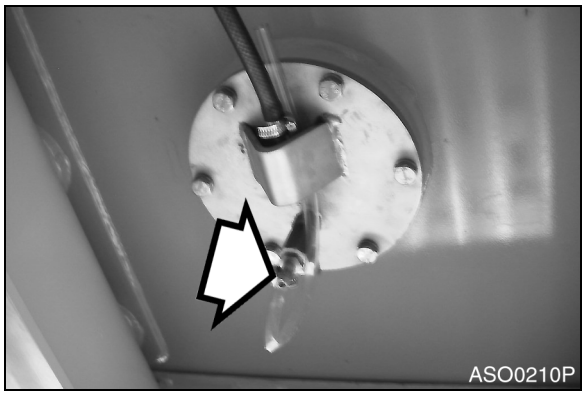


Figure 6

14. Tag and disconnect fuel supply line (1, Figure 7) and fuel return line (2) from Fuel tank (3) and carefully drain remaining fuel from lines.

15. Remove clamp (4, Figure 7) holding fuel return line (2) to tank (3).

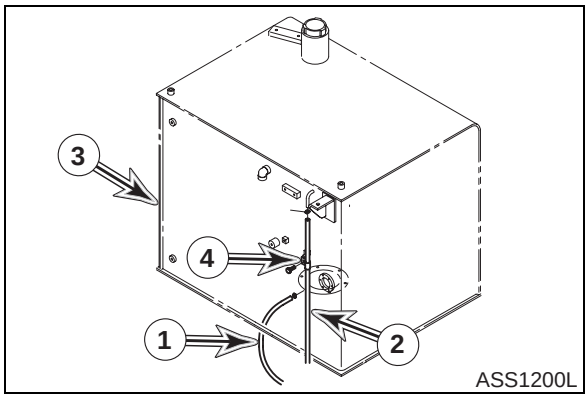


Figure 7

16. Tag and disconnect wires leading to fuel sensor (1, Figure 8) on side of fuel tank (2).

17. If equipped, remove components from fuel filler pump port (3, Figure 8) on side of fuel tank (2).

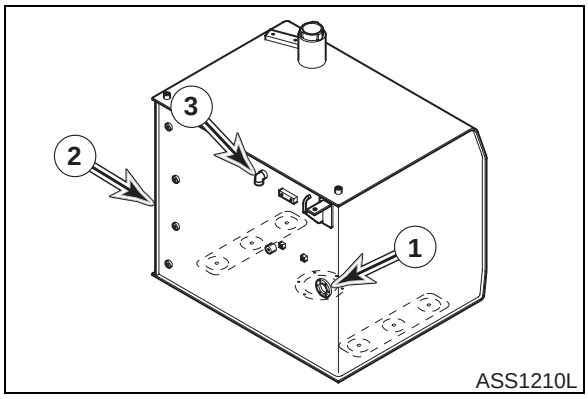


Figure 8

18. Remove four bolts (1 and 2, Figure 9), clamp (6) and stay (3) from fuel tank and frame.

    Remove four bolts (4) and cover (5) from fuel tank.

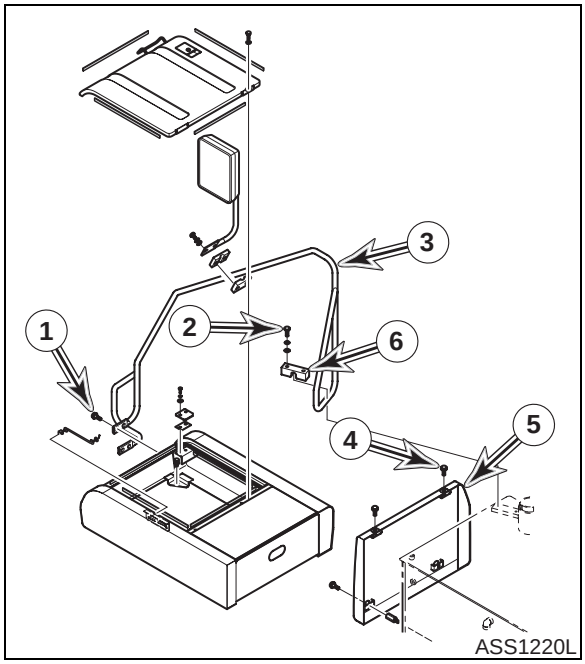


Figure 9

19. Install two 12 mm eye bolts in threaded holes (1 and 2, Figure 10). Using a suitable lifting device, sling eye bolts.

20. Remove six bolts and washers (4, Figure 10) holding tank (3) to frame. Lift tank 25 mm (1 in) and make sure it is balanced. Make sure that there are no other electrical wires or hoses connected to tank. Completely 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.*

21. Remove shims (5, Figure 10).

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

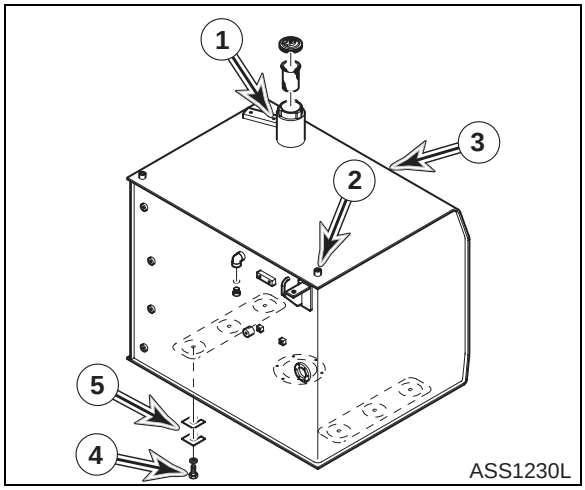


Figure 10

INSTALLATION

1. Install two 12 mm eye bolts in threaded holes (1 and 2, Figure 11). Using a suitable lifting device, sling eye bolts.
2. Set fuel tank (3, Figure 11) into position. Install six bolts and washers (4) 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 (5, Figure 11) as needed to prevent tank (3) from rocking or stress from mounting bolts (4).
4. Tighten mounting bolts (4, Figure 11) after shims are installed.

   NOTE: *Bolt torque is 27 kg•m*
5. Install four bolts (4, Figure 12) and cover (5) on fuel tank.

   Install four bolts (1 and 2), clamp (6) and stay (3) on fuel tank and frame.

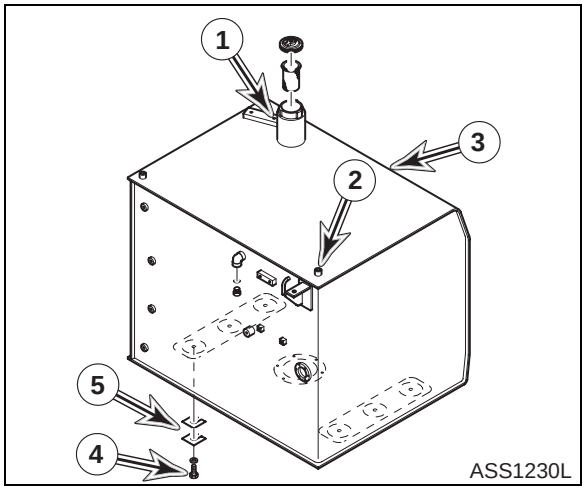


Figure 11

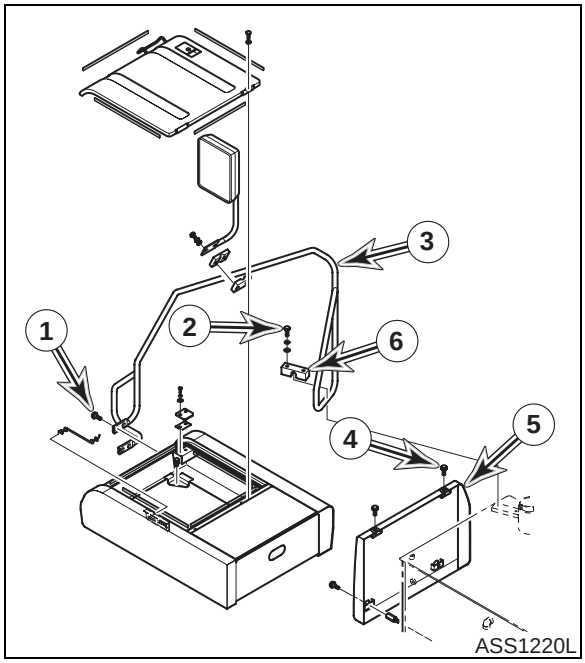


Figure 12

6. Connect wires as tagged to fuel sensor (1, Figure 13) on side of fuel tank (2).
7. If equipped, connect components to the fuel filter pump port (3, Figure 13) on side of fuel tank (2).

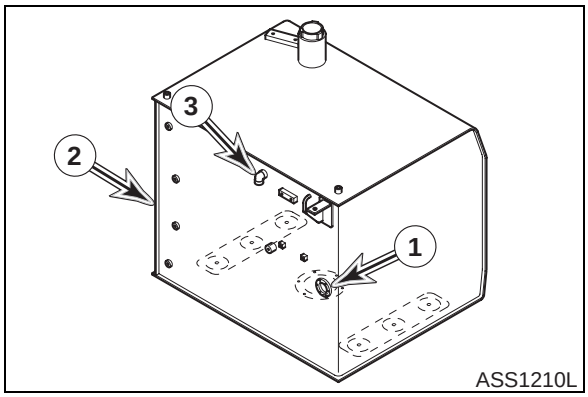


Figure 13

8. Connect as tagged, fuel supply line (1, Figure 14) and fuel return line (2) to fuel tank (3).
9. Install clamp (4, Figure 14) to hold fuel return line (2) to tank (3).

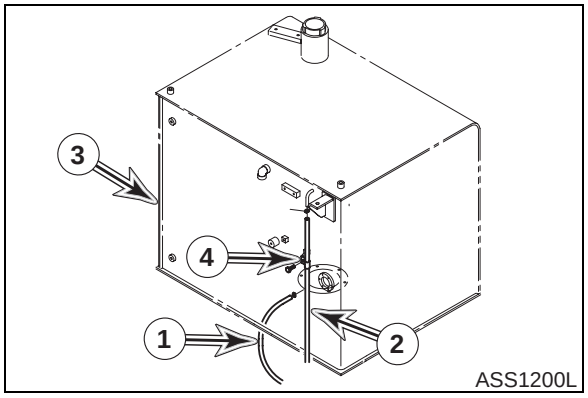


Figure 14

10. Make sure fuel tank drain valve (Figure 15) on bottom of tank is closed.
11. Fill fuel tank and check for signs of leaks. Correct any problems found.
12. Connect negative (-) battery cable to battery.

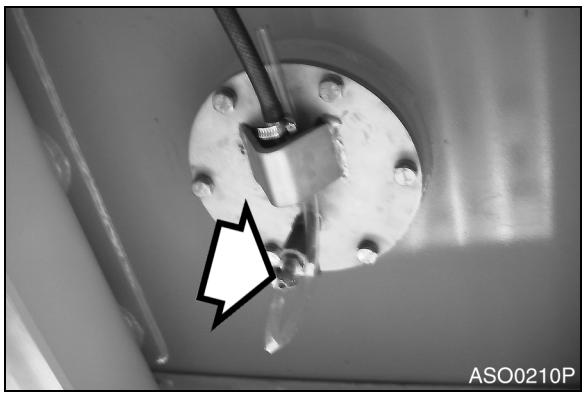


Figure 15

START-UP PROCEDURES

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

1. Loosen plug (Figure 16) on top of fuel filter head.

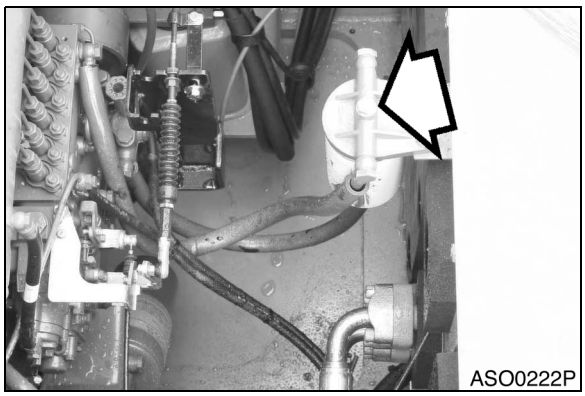


Figure 16

2. Unscrew and pump hand operated primer pump (Figure 17) by fuel injection pump. Pump primer until fuel is present at plug hole in fuel filter head.
3. Tighten plug in fuel filter head.
4. Continue to pump primer pump until a strong resistance is felt. Screw primer pump knob back into housing.
5. Start engine and look for signs of leaks.
6. Repeat procedure if necessary.

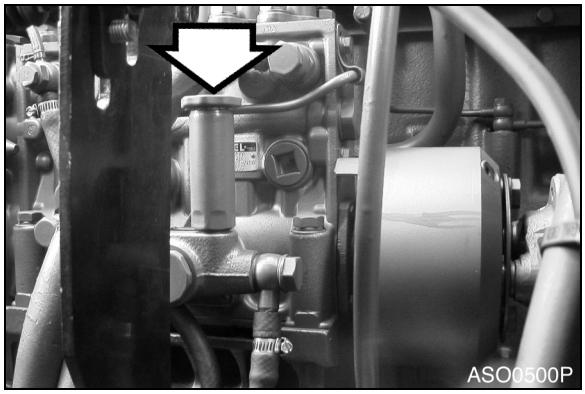


Figure 17

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FUEL TRANSFER PUMP

⚠ CAUTION!

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Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Mega 130	0001 and Up
Mega 160	0001 and Up
Mega 200-III	1001 and Up
Mega 200-V	1001 and Up
Mega 250-III	1001 and Up
Mega 250-V	1001 and Up
Mega 300-V	1001 and Up
Mega 400-III PLUS	1001 and Up
Mega 400-V	1001 and Up
Mega 500-V	1001 thru 2000
Mega 500-V (Tier II)	2001 and Up
Solar 130LC-V	0001 and Up
Solar 130W-V	0001 and Up
Solar 170LC-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 220LC-V	0001 and Up
Solar 220LL	1001 and Up
Solar 220N-V	1001 and Up

Models continued on back of cover.

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MODEL	SERIAL NUMBER RANGE
Solar 250LC-V	1001 and Up
Solar 290LC-V	0001 and Up
Solar 290LL	1001 and Up
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 330LC-V	1001 and Up
Solar 340LC-V	1001 and Up
Solar 400LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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GENERAL DESCRIPTION

THEORY OF OPERATION

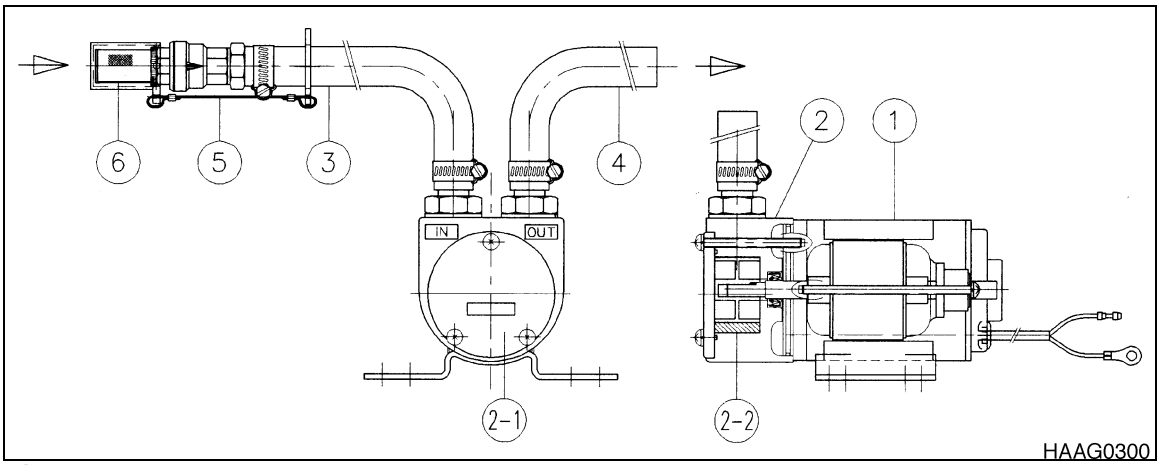


Figure 1

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

Fuel pump consists of 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 damage.

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

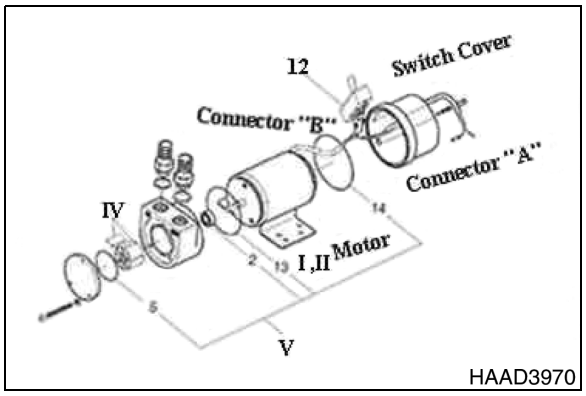


Figure 3 WITH TOGGLE SWITCH

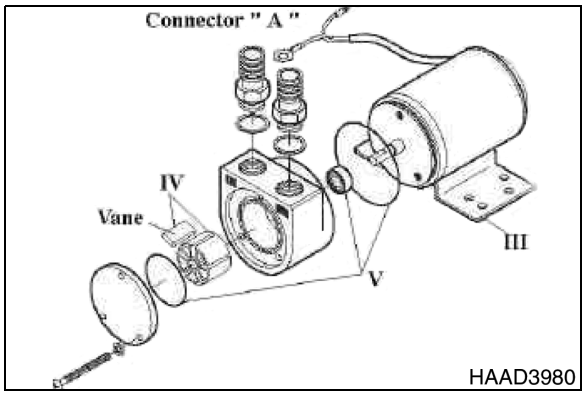


Figure 4 WITHOUT TOGGLE SWITCH

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.

REPLACEMENT OF ROTOR AND VANE

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

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

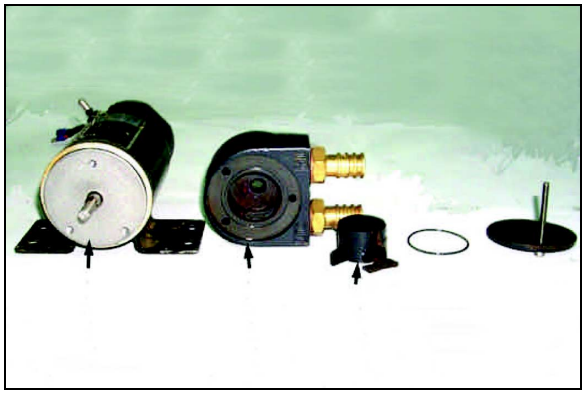


Figure 5 WITHOUT TOGGLE SWITCH

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

Insert O-ring again at reassembly of pump cover.

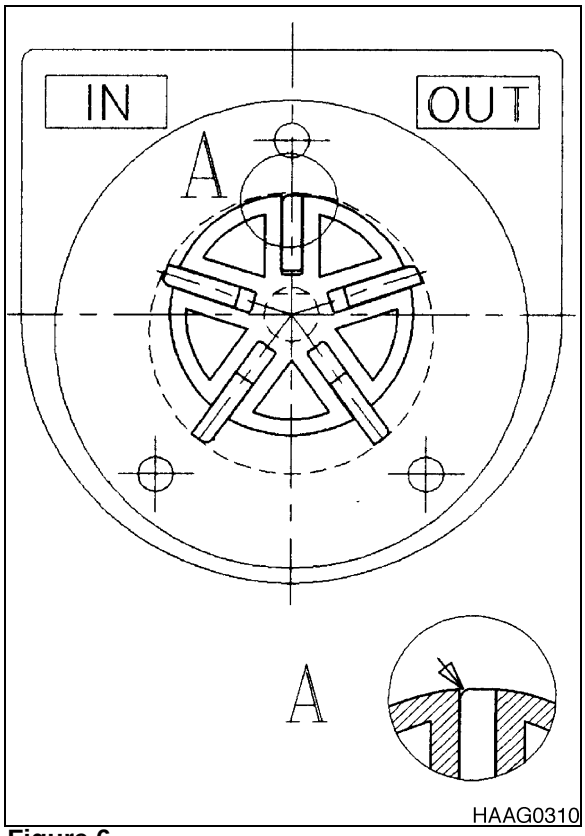


Figure 6

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

Remove cover.

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

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

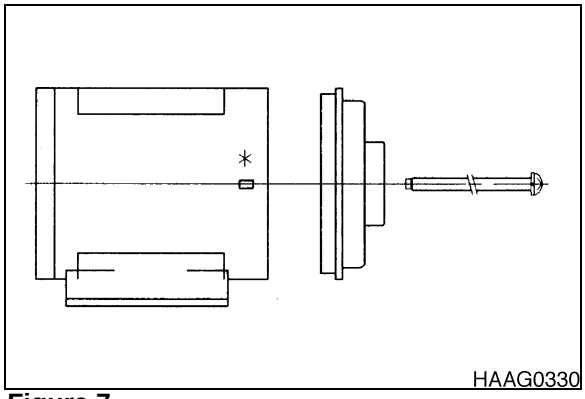


Figure 7

REPLACEMENT OF ARMATURE

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

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

Remove the pump cover and remove the rotor and vane.

Insert a new armature into the housing.

Refer to “Replacement of Rear Cover” on page 5, for installation of rear cover.

Fit the rotor in the shaft flute of armature. Insert vane to the rotor being careful for the direction. Refer to “Replacement of Rotor and Vane” on page 4.

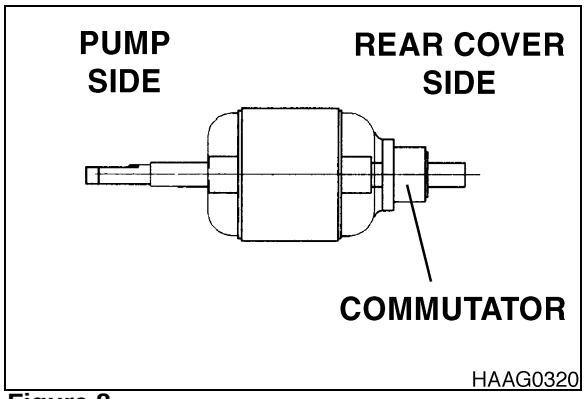


Figure 8

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SWING BEARING

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 130LC-V	0001 and Up
Solar 170LC-V	1001 and Up
Solar 220LC-V	0001 and Up
Solar 220LL	1001 and Up
Solar 250LC-V	1001 and Up
Solar 290LC-V	0001 and Up
Solar 290LL	1001 and Up
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 330LC-V	1001 and Up
Solar 340LC-V	1001 and Up
Solar 400LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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Measuring Swing Bearing Axial Play 3
Measuring Bearing Lateral Play 3
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Rebuilding Swing Bearing 4

SWING BEARING MAINTENANCE

OPERATING RECOMMENDATION

The service life of the swing bearing may be extended if a conscious, daily effort is made to equalize usage over both ends of the excavator. If the excavator is used in the same operating configuration day in and day out (for example, with the travel motors always under the counterweight, or with the attachment over one side of the machine more than the other), the bearing's service life could be reduced. Taking a few minutes in the middle of each work shift to reposition the excavator, to work the opposite end of the bearing, will provide a payoff in terms of 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 become much more pronounced and the actual measured play in the bearing could exceed twice the value that was measured when the machine was new.

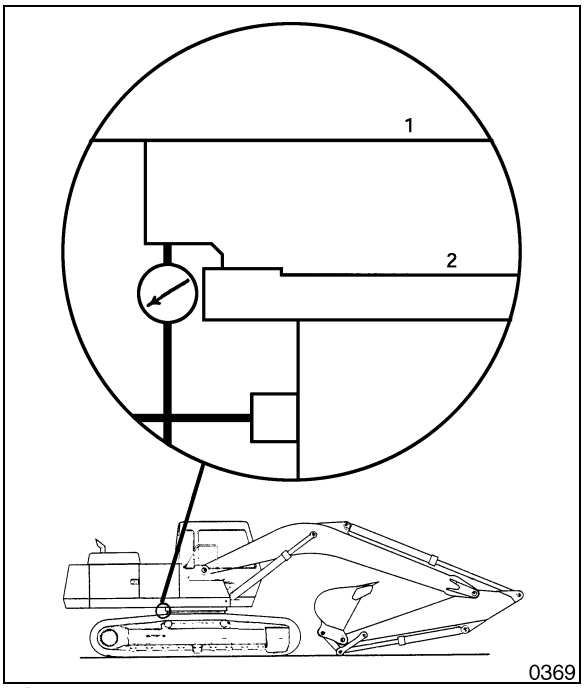


Figure 1

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 of 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 a 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	Ball
2	Seal A
3	Seal B
4	Retainer
5	Retainer
6	Outer Ring
7	Inner Ring
8	Tapered Pin
9	Plug

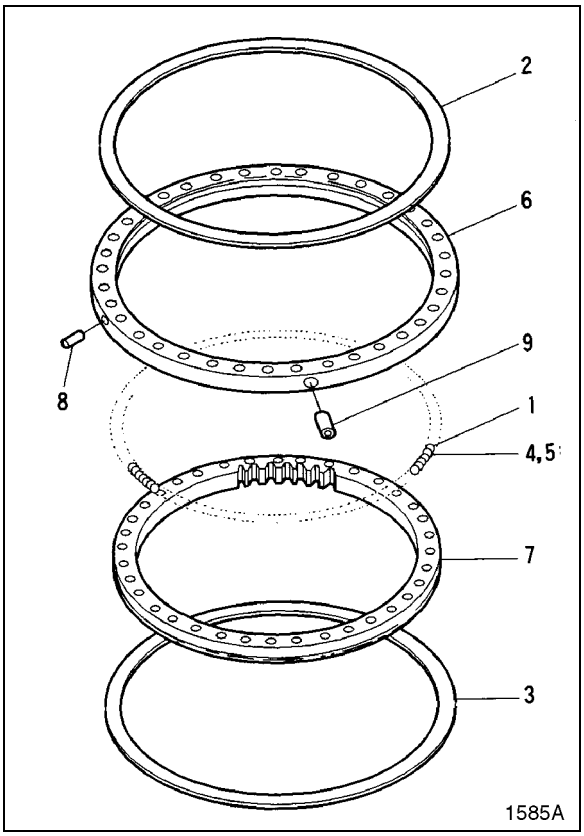


Figure 2

REBUILDING SWING BEARING

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

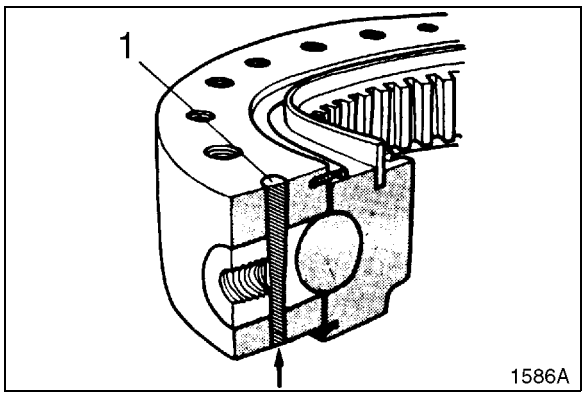


Figure 3

2. Remove plug (1, Figure 4) using a M10 x 1.25 bolt (2).

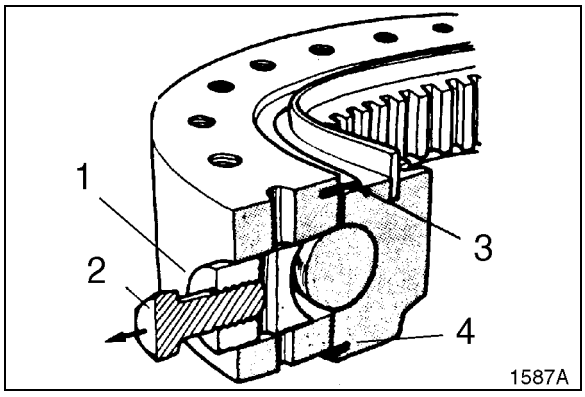


Figure 4

3. Lift outer ring and check that inner ring can move freely. See Figure 5, if not, replace seal (3, Figure 4) and/or seal (4, Figure 4).

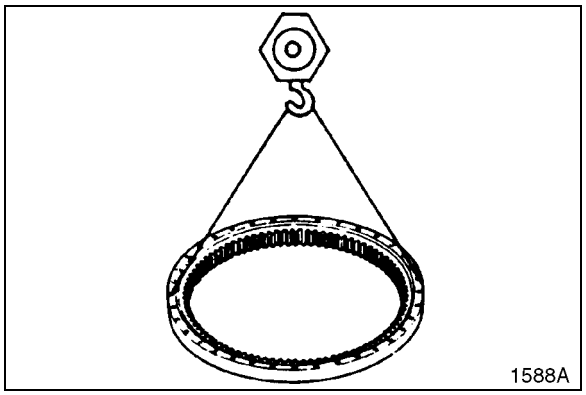


Figure 5

4. Turn inner ring and use magnet bar (1, Figure 6) to remove steel balls (2).

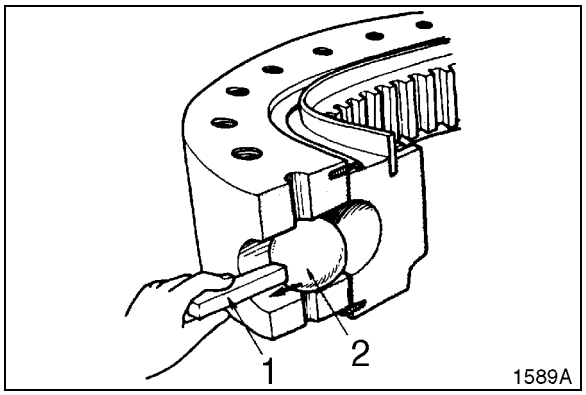


Figure 6

5. Turn inner ring and use wire (1, Figure 7) to remove retainers (2).

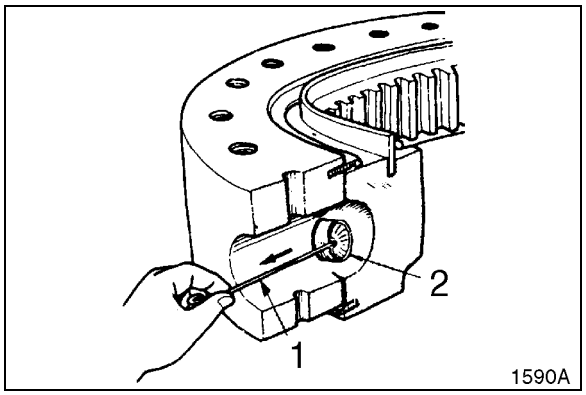


Figure 7

6. Assemble in reverse order of disassembly and then adjust the gap between the steel balls and retainers using the following guidelines: Assemble steel ball, retainer (A) and retainer (B) to bearing; if gap is too wide, adjust by moving steel balls or by replacing one of the retainers.

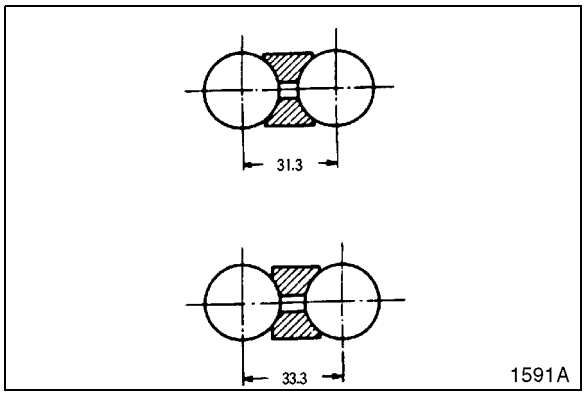


Figure 8

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SWING REDUCTION GEARBOX

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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GENERAL DESCRIPTION

THEORY OF OPERATION

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

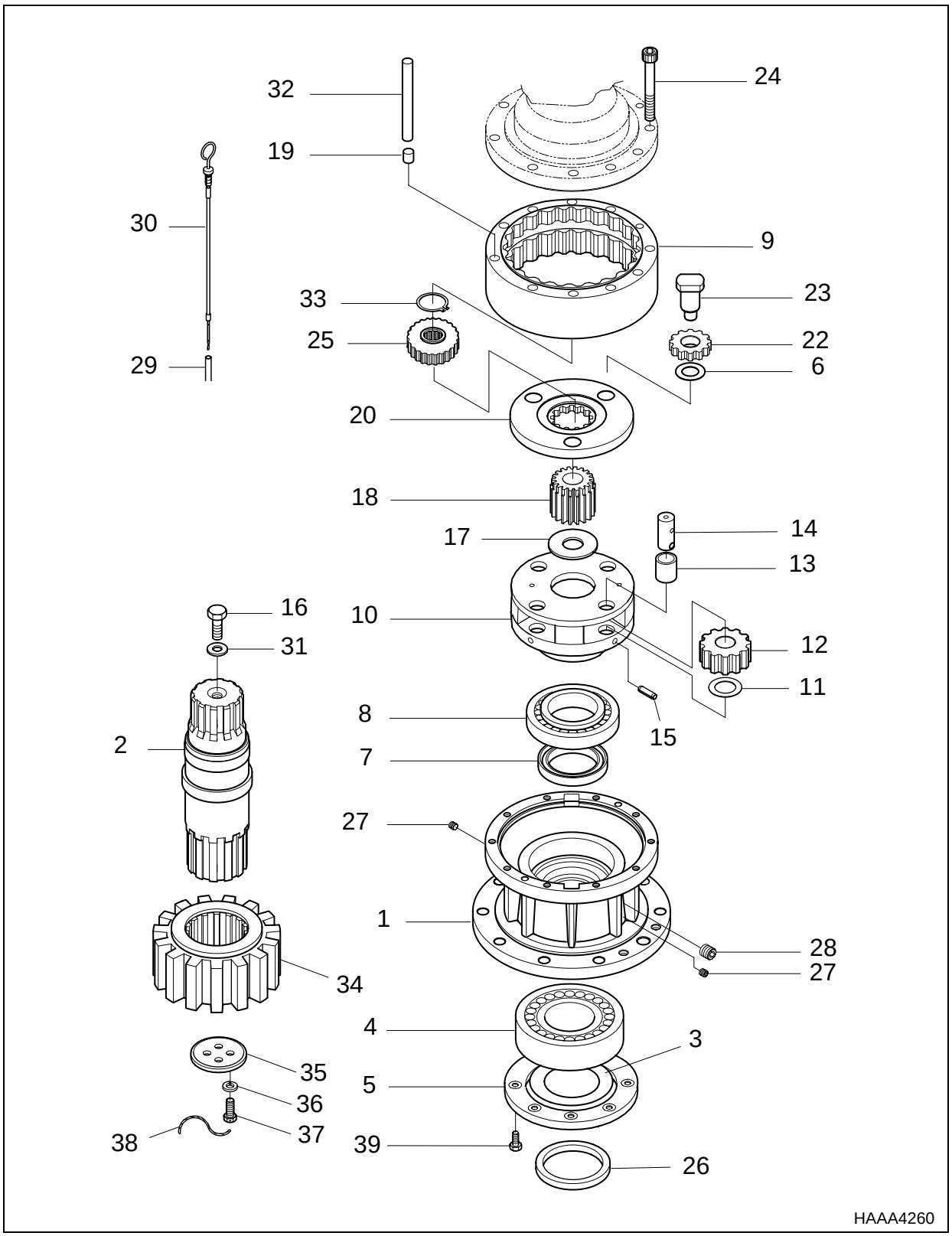

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Figure 1

Reference Number	Description
1	Casing
2	Drive Shaft
3	Plate
4	Roller Bearing
5	Cover Plate
6	Thrust Washer No. 1
7	Oil Seal
8	Roller Bearing
9	No. 1 Ring Gear
10	No. 2 Carrier
11	Thrust Washer No. 2
12	Planet Gear No. 2
13	No. 2 Bushing
14	No. 2 Pin
15	Spring Pin
16	Bolt
17	No. 3 Thrust Washer
18	No. 2 Sun Gear
19	Knock Pin
20	No. 1 Carrier

Reference Number	Description
21	----------
22	No. 1 Planet Gear
23	No. 1 Pin Assembly
24	Socket Bolt
25	No. 1 Sun Gear
26	Spacer
27	Plug
28	Plug
29	Level Gauge Pipe
30	Level Gauge
31	Double Tab Washer
32	Pipe
33	Snap Ring
34	Pinion
35	Cover
36	Spring Washer
37	Bolt
38	Wire
39	Bolt

SPECIFICATIONS

Swing Reduction Gearbox	Specification
Drive Type	Two Stage Planetary Gear
Reduction Ratio	19.64
Maximum Output Speed	74.3 rpm
Maximum Output Torque	1,176.8 kg•m (8,512 ft lb)
Weight	170 kg (375 lb)

Pinion Gear	Specification
Type	Stub Gear
Gear P.C.D.	180 mm (7.09 in)
No. of Teeth	15
Module	12

SPECIAL TOOLS AND MATERIALS

SPECIAL TOOLS

Drive Shaft Front Bearing Jig

Dimension	Measurement
A	130.0 mm (5.1181 in) Dia.
B	100.0 mm (3.9370 in) Dia,
C	83.0 mm (3.2677 in)

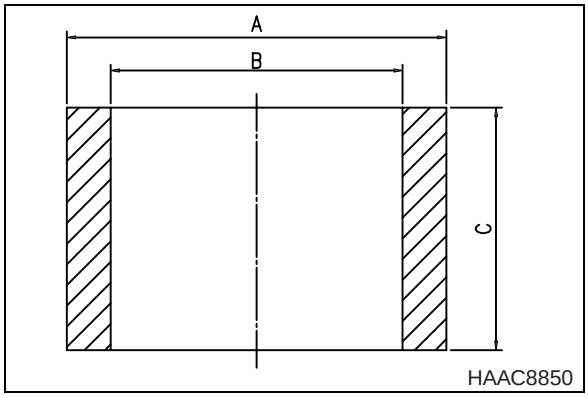


Figure 2

Oil Seal Insert Jig

Dimension	Measurement
A	10.0 mm (0.3937 in)
B	20.0 mm (0.7874 in)
C	99.0 mm (3.8976 in) Dia.
D	123.0 mm (4.8425 in) Dia.
E	40.0 mm (1.5748 in) Dia.
F	100.0 mm (3.9370 in)

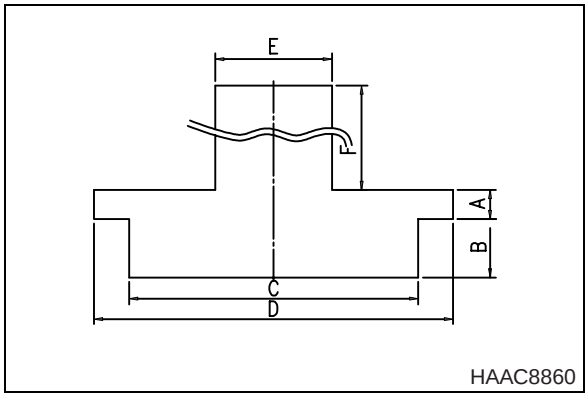


Figure 3

Spring Pin Insert Jig

Dimension	Measurement
A	9.50 mm (0.3740 in) Dia.
B	15.0 mm (0.5906 in)
C	5.50 mm (0.2165 in) Dia.

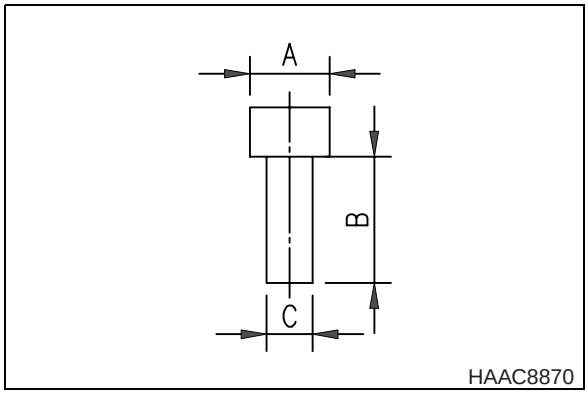


Figure 4

Swage Jig

Dimension	Measurement
A	18.0 mm (0.7087 in) Dia.
B	26.0 mm (1.0236 in) Dia.
C	40.0 mm (1.5748 in) Dia.
D	10.0 mm (0.3937 in)
E	1.0 mm (0.0394 in) Radius
F	2.0 mm (0.0787 in) Radius

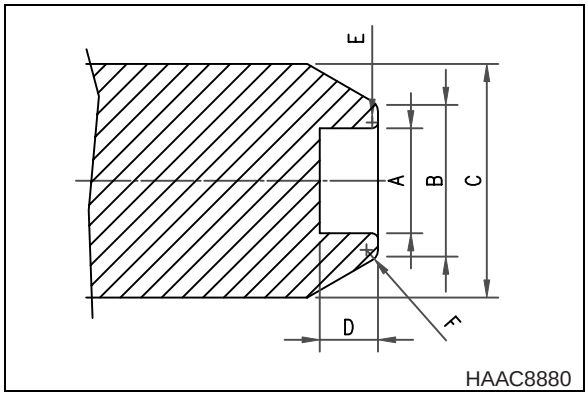


Figure 5

Roller Bearing insert Jig

Dimension	Measurement
A	90.10 - 90.20 mm (3.5472 - 3.5512 in) Dia.
B	159.70 - 159.8 mm (6.2874 - 6.2913 in) Dia.
C	50.0 mm (1.9685 in)

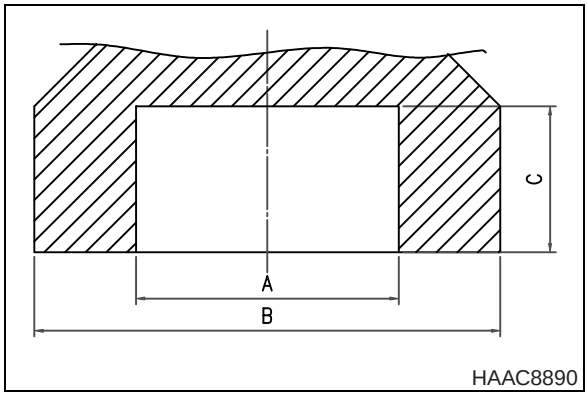


Figure 6

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 the ground.
3. Stop the engine.
4. Set safety lever on "RELEASED" position.
5. Turn starter switch "ON."

> **WARNING!**
>
> **If engine must be run while performing maintenance, use extreme care. Always have one person in the cab at all times. Never leave the cab 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 "OFF" position and remove from starter switch.
9. Hang maintenance warning tag on controls.
10. Disconnect negative (-) battery cable leading to frame from battery.

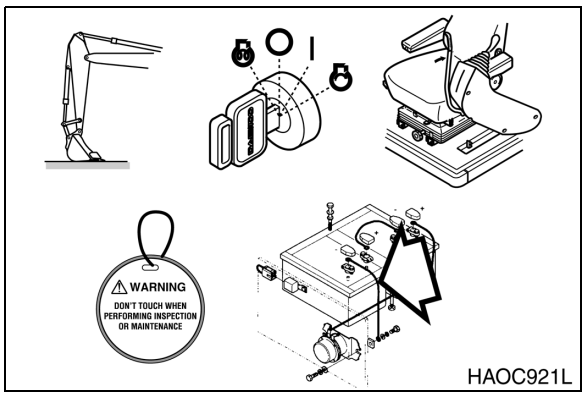


Figure 7

11. Tag and disconnect hoses from swing motor (1, Figure 8). Plug and cap hoses and ports to prevent contamination from entering hydraulic system or component.

12. Disconnect tube (2, Figure 8) from reduction gear box (5). (Solar 470LC-V)

    -or-

    Disconnect tube from drain cock (not shown). (Solar 450LC-V)

13. Disconnect grease lubrication line (3, Figure 8) from reduction gearbox (5).

14. Remove twenty-two bolts and washers (4, Figure 8) holding swing reduction gearbox (5) to frame.

15. Using a suitable lifting device, sling swing motor (1, Figure 8) and remove swing motor and reduction gearbox (5) as an assembly from unit.

    NOTE: *A drain cock and tube (not shown) are on side of gearbox. Be careful not to damage valve or tube.(Solar 450LC-V)*

    NOTE: *There are two alignment pins (6*, Figure 8*), on reduction gearbox flange.*

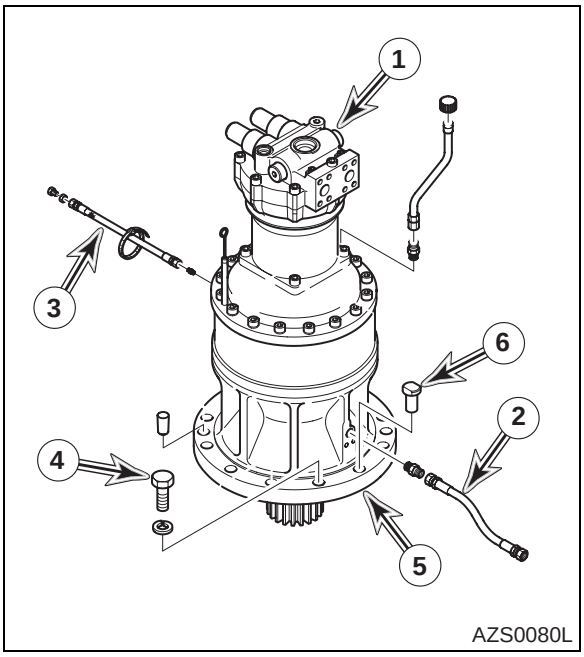


Figure 8 SOLAR 470LC-V

DISASSEMBLY

NOTE: *Prior to disassembly match mark swing motor (2, Figure 9), No. 1 ring gear (9, Figure 10) and casing (1, Figure 10).*

1. Remove oil level dipstick, dipstick tube and adaptor (1, Figure 9) from swing motor (2).
2. Remove breather pipe (3, Figure 9) and adaptor (4) from swing motor (2).
3. Remove breather (5, Figure 9) from breather pipe (3) if replacement is necessary.
4. Remove adapters (6 and 7, Figure 9) from gearbox (8). (Solar 470LC-V)

   -or-

   Remove drain cock and reducer (not shown) to drain gear oil from gearbox (8). (Solar 450LC-V)

IMPORTANT

Use a clean, dry container (with at least 11 liters, or 2.9 gallons capacity) to catch gear oil. A clean container allows an evaluation to be made of the used oil. The presence or relative lack of metal wear shavings in the used oil or obvious deterioration or contamination of the oil can provide a useful indicator of the motor's general condition.

5. Cut lock wire (9, Figure 9) and remove it from drilled head bolts (10).
6. Remove four drilled head bolts and lock washers (10, Figure 9), lock plate (11), pinion gear (12) and spacer ring (13) from drive shaft (14).

   NOTE: *Loctite is spread on the spacer ring (13*, Figure 9*) when it is originally installed at factory. Heat may be required for disassembly.*

7. Unbolt the sixteen socket head bolts (15, Figure 9) and separate swing motor (2) from gearbox (8).

   NOTE: *Ring gear (9, Figure 10) may come loose with swing motor (2, Figure 9).*

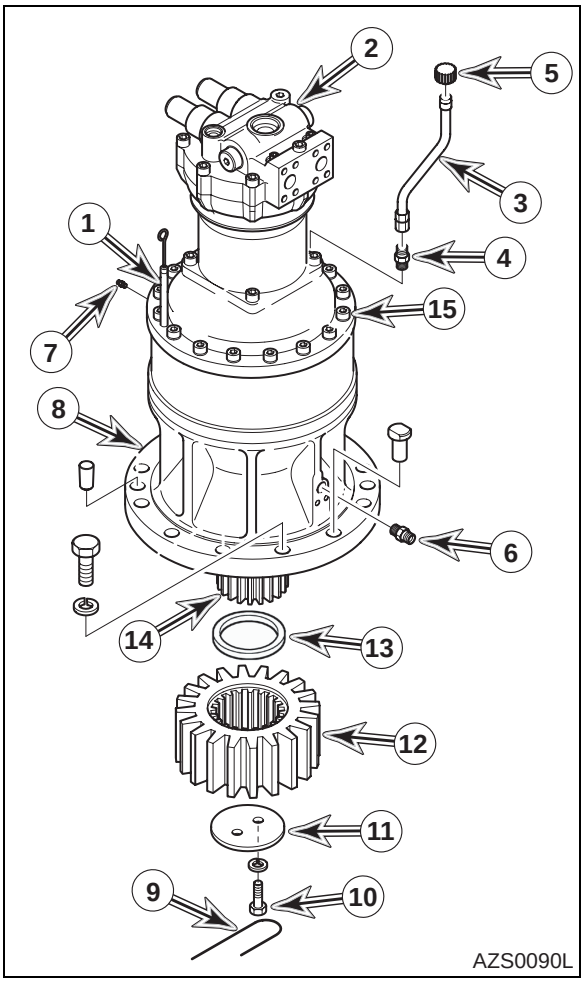


Figure 9 SOLAR 470LC-V

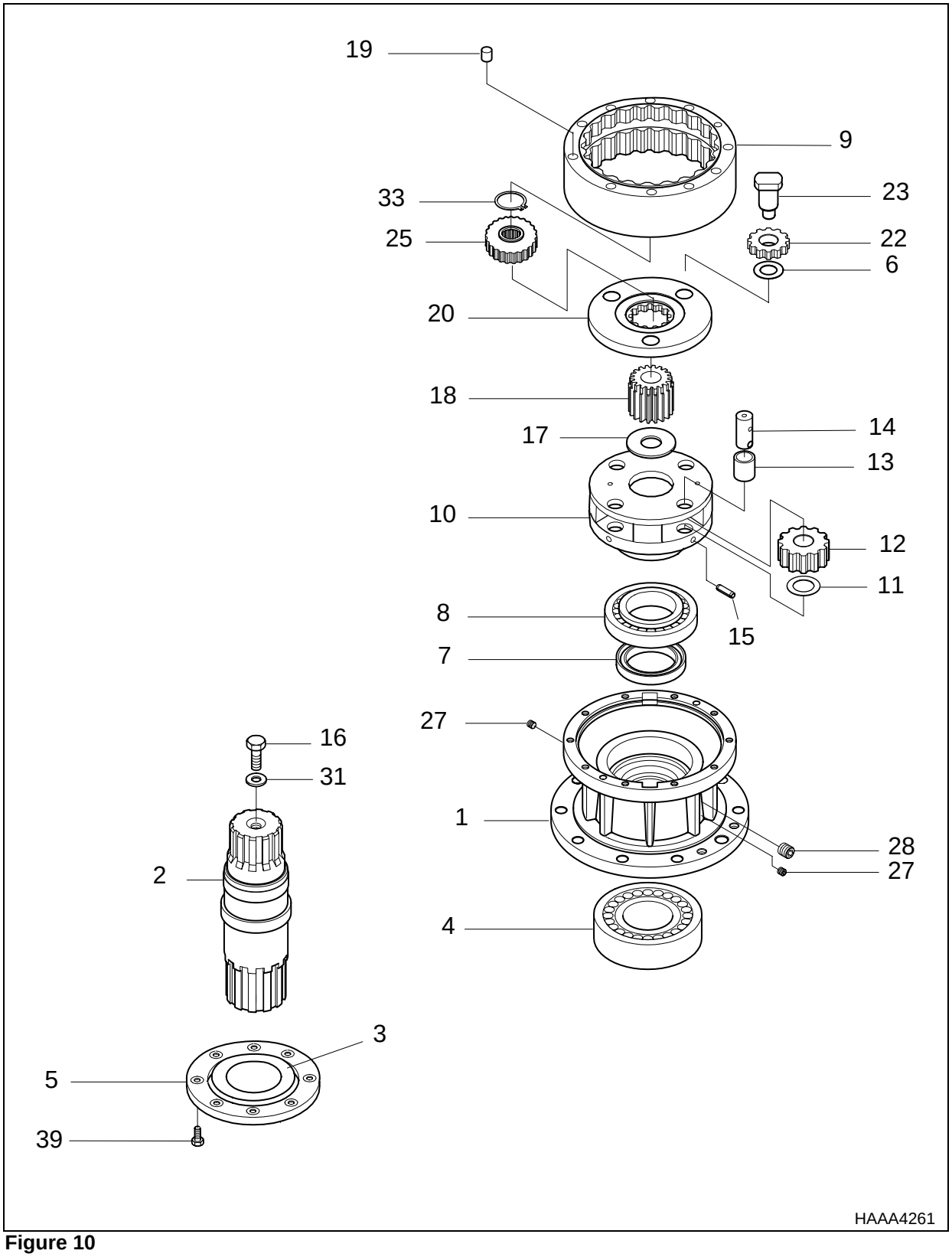

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Figure 10

8. Snap ring (1, Figure 10) will remain on swing motor shaft. Remove snap ring only if replacement is necessary.

9. Remove No. 1 sun gear (25, Figure 10) from No. 1 carrier (20) and from end of No. 2 sun gear (18).

10. Remove No. 1 carrier (20, Figure 10) with three No. 1 planetary gears (22) still installed.

    NOTE: *When removing carrier (20*, Figure 10*), No. 2 sun gear (18) may come out with it.*

11. Remove pin (23, Figure 10), No. 1 planet gear (22) and No. 1 thrust washer (6) from No. 1 carrier (20). Repeat procedure for remaining planetary gear assemblies.

    NOTE: *Discard pin (23*, Figure 10*) and use a new one at reassembly.*

    NOTE: *Keep all components together in proper orientation so that wear patterns match during assembly. Do not mix previously used parts.*

12. Remove No. 1 ring gear (9, Figure 10) from casing (1).

    NOTE: *Remove knock pin (19*, Figure 10*) from No. 1 ring gear (9) if replacement is necessary.*

13. Remove No. 2 sun gear (18, Figure 10) from on top of No. 3 thrust washer (17).

14. Bend tabs on double tab washer (31, Figure 10) away from head of bolt (16). Remove bolt (16), double tab washer (31) and No. 3 thrust washer (17) securing No. 2 carrier (10) to drive shaft (2).

    NOTE: *Discard double tab washer (23*, Figure 10*) and use a new one at reassembly.*

15. Remove No. 2 carrier (10, Figure 10) from drive shaft (2).

16. Disassemble No. 2 carrier (10, Figure 10).

    A. Remove spring pin (15, Figure 10) from No. 2 carrier (10) and No. 2 pin (14).

    B. Remove No. 2 pin (14, Figure 10), No. 2 thrust washer (11), No. 2 planet gear (12) and No. 2 bushing (13).

    C. Repeat procedure for remaining planetary gear assemblies.

    NOTE: *Keep all components together in proper orientation so that wear patterns match during assembly. Do not mix previously used parts.*

17. Remove eight bolts (39, Figure 10) and cover plate (5) from casing (1).

18. Remove plate (3, Figure 10) from cover plate (5).

19. Press drive shaft (2, Figure 10) and roller bearing (4) from casing (1).

    NOTE: *Press on carrier end of drive shaft (2*, Figure 10*). Be careful not to damaged threaded hole.*

20. Press drive shaft (2, Figure 10) out of roller bearing (4).

21. Using a suitable puller, remove roller bearing (8, Figure 10) from casing (1).

22. Remove oil seal (7, Figure 10) from casing (1).

23. Remove two plugs (27, Figure 10) and plug (28) from front casing (1), if replacement is necessary.

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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

Inspect all components in the assembly. Pay particular attention to oil seals, lock and spring pins and fastener bolts. Using new replacement parts for these components is recommended whenever there is any doubt at all about the condition or serviceability of original parts.

REASSEMBLY

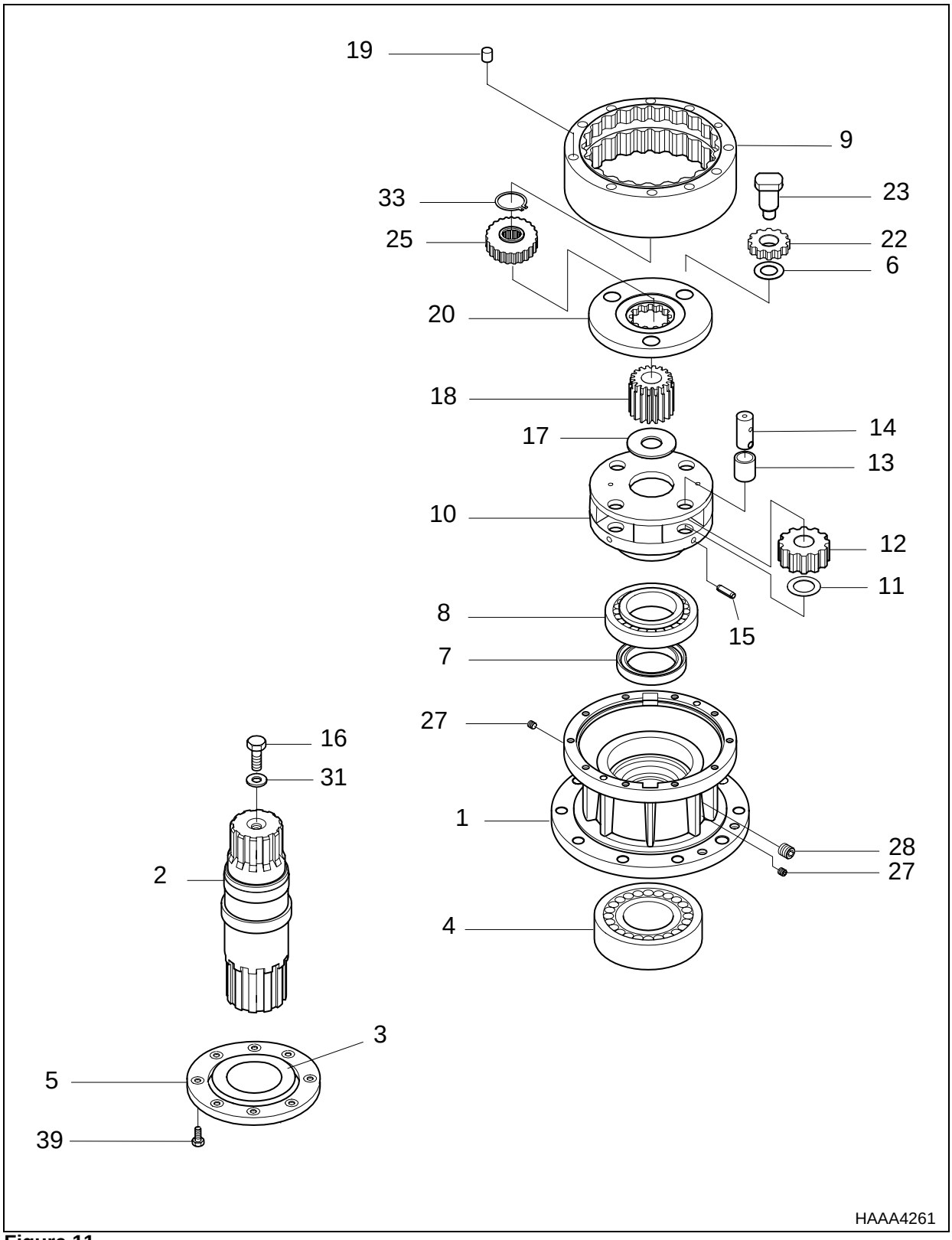


Figure 11

1. Install two plugs (27, Figure 11) and plug (28) in front casing (1), if replacement was necessary.

   NOTE: *Use Loctite #592 Pipe Sealant on plugs.*

2. Press oil seal (7, Figure 11) into casing (1).

   NOTE: *Use Loctite #277 on O.D. of seal. Be careful not to get sealant on lips of seal.*

3. Press roller bearing (8, Figure 11) into casing (1).

   NOTE: *Press only on outer bearing race.*

4. Press roller bearing (4, Figure 11) on drive shaft (2).

   NOTE: *Press only on inner bearing race.*

5. Press drive shaft (2, Figure 11) and roller bearing (4) into casing (1).

   NOTE: *Press on outer race of bearing (4*, Figure 11*) and pinion gear end of shaft (2) at the same time. Be careful not to damage threaded holes in end of shaft.*

   NOTE: *Make sure that bearing (8*, Figure 11*) remains seated on shoulder.*

6. Hand pack bearing (4, Figure 11) and grease cavity with grease. Rotate drive shaft to ensure that bearing is coated with grease.

7. Install plate (3, Figure 11) in cover plate (5).

8. Secure cover plate (5, Figure 11) to casing (1) with eight bolts (39, Figure 11).

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

   NOTE: *Tighten bolts to 700 - 740 kg•cm (51- 54 ft lb).*

9. Assemble No. 2 carrier (10, Figure 11).

   A. Position No. 2 bushing (13, Figure 11) in No. 2 planet gear (12). Position gear and bushing, No. 2 thrust washer (11) and No. 2 pin (14) in No.2 carrier (10).

   B. Align spring pin hole in No. 2 pin (14, Figure 11) with hole in No. 2 carrier (10).

   NOTE: *Figure 12, shows how end of holes in pin (14, Figure 11) should be turned, in relation to the drive shaft.*

   C. Press spring pin (15, Figure 11) into No. 2 carrier (10) and No. 2 pin (14).

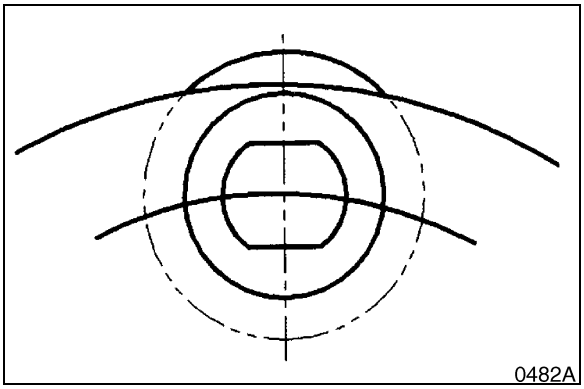


Figure 12

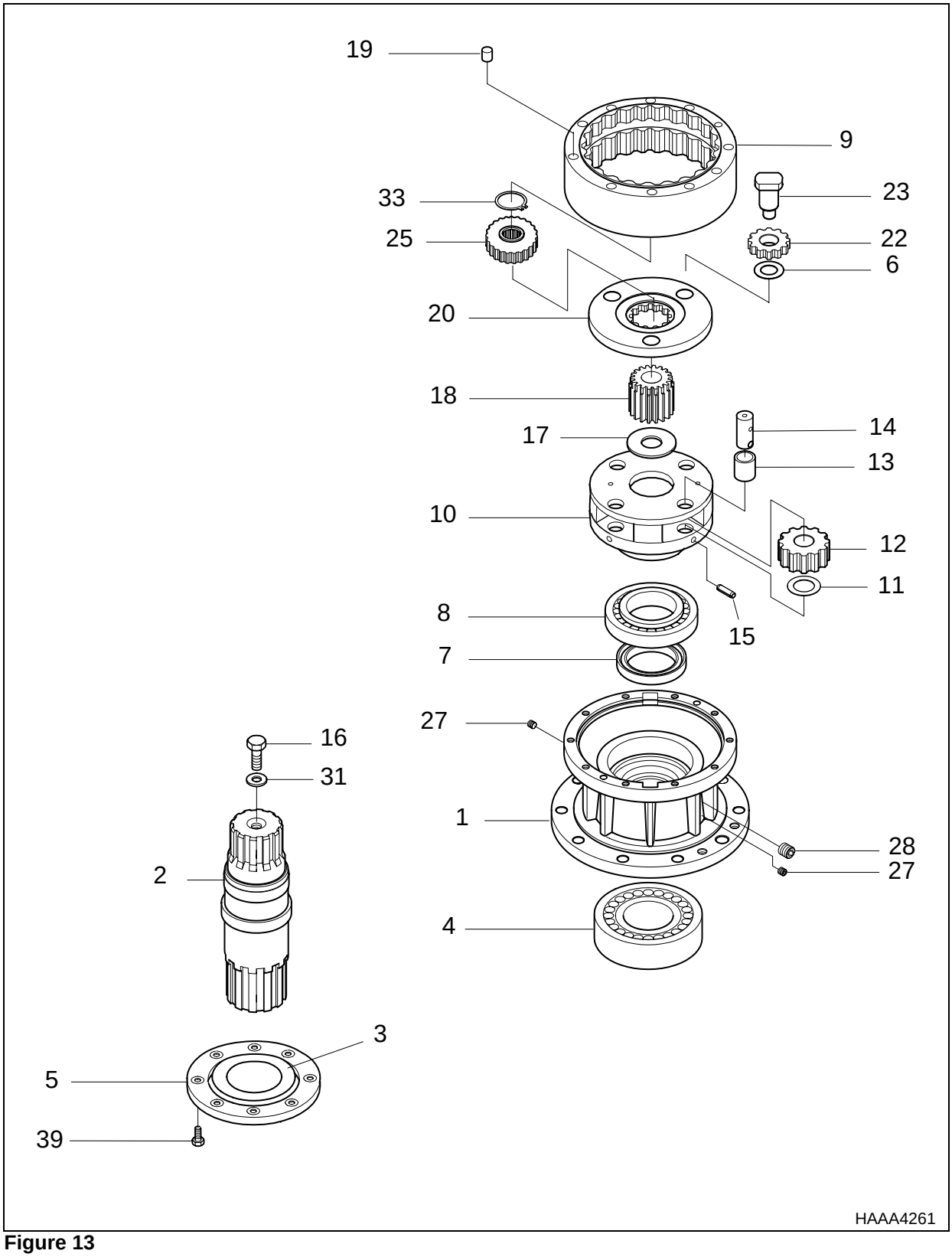

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Figure 13

D. As shown in Figure 14, use a punch to stake spring pins (15, Figure 13) (inserted in the previous step) into place.

E. Repeat procedure for remaining planetary gear assemblies.

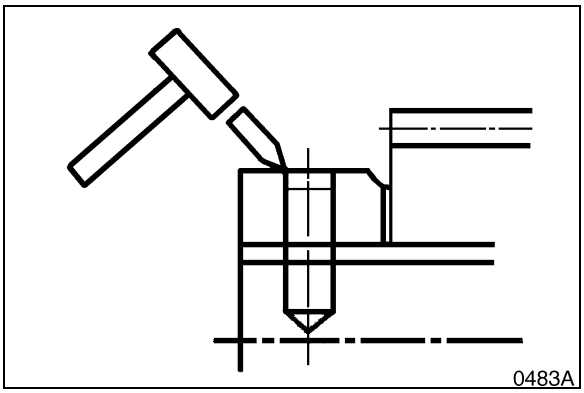


Figure 14

10. Position No. 2 carrier (10, Figure 13) on drive shaft (2).

11. Secure No. 2 carrier (10, Figure 13) to drive shaft (2) with No. 3 thrust washer (17), new double tab washer (31) and bolt (16).

    NOTE: *Tighten bolt to 3,000 - 3,070 kg•cm (217 - 222 ft lb).*

    NOTE: *Bend tabs on washer to hold bolt into position.*

12. Position No. 1 ring gear (9, Figure 13) on casing (1).

    NOTE: *Install knock pin (19*, Figure 13*) in No. 1 ring gear (9) if replacement was necessary.*

    NOTE: *Coat mating faces of casing and ring gear with Loctite #609.*

13. Attach No. 1 thrust washer (6, Figure 13), No. 1 planet gear (22) and new pin (23) to No. 1 carrier (20),. Repeat procedure for remaining planetary gear assemblies.

    NOTE: *Keep all components together in proper orientation so that wear patterns match during assembly. Do not mix previously used parts.*

14. Install No. 2 sun gear (18, Figure 13) on top of No. 3 thrust washer (17).

15. Position No. 1 carrier (20, Figure 13) into No. 1 ring gear (9) and engage No.2 sun gear (18).

16. Set No. 1 sun gear (25, Figure 13) into No. 1 carrier (20) and on end of No. 2 sun gear (18).

17. Install snap ring (1, Figure 13) on swing motor shaft, if replacement was necessary.

18. Align match marks and position swing motor (2, Figure 15) on gearbox (8). Install twelve socket head bolts (15) to secure swing motor to gearbox.

    NOTE: *Coat mating faces of swing motor (2*, Figure 15*) and ring gear (3*, Figure 11*) with Loctite* #609*.*

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

    NOTE: *Tighten bolts to 1,440 - 1,500 kg•cm (104 - 108 ft lb).*

19. Coat I.D. of spacer ring (13, Figure 15) with Loctite #609. Slide spacer into position on drive shaft (14).

    NOTE: *Make sure that Loctite does not come into contact with oil seal (33, Figure 11) or an leak failure may occur.*

20. Install lock plate (11, Figure 15), four lock washers and drilled head bolts (10) on drive shaft (14).

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

    NOTE: *Tighten bolts to 27 kg•m (195 ft lb).*

21. Use lock wire (9, Figure 15) to secure drilled head bolts (10) into position.

22. Install adapters (6 and 7, Figure 15) in gearbox (8). (Solar 470LC-V)

    -or-

    Install reducer and drain cock (not shown) in gearbox (8, Figure 15). (S450LC-V

23. Install breather (5, Figure 15) on breather pipe (3) if remove during disassembly.

24. Install adaptor (4, Figure 15) and breather pipe (3, Figure 15) in swing motor (2).

25. Install dipstick tube (1, Figure 15) and oil level dipstick on swing motor (2).

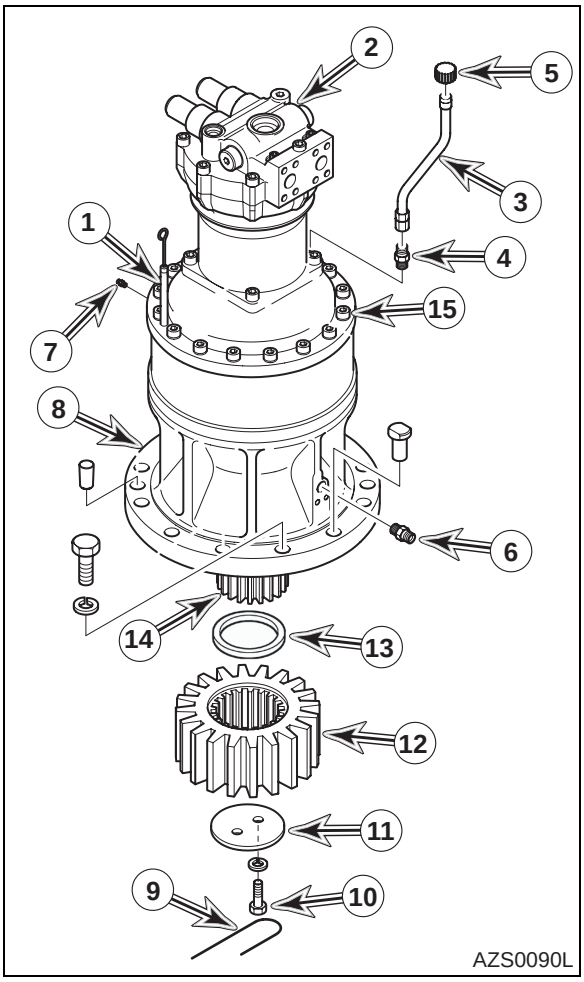


Figure 15 SOLAR 470LC-V

INSTALLATION

1. Coat pinion gear with grease. Refer to operation manual for specifications.
2. Make sure two alignment pins (6, Figure 16) are installed in flange of swing reduction gearbox (5).
3. Using a suitable lifting device, sling swing motor (1, Figure 16) and position swing motor and reduction gearbox (5) as an assembly on unit.
4. Install twenty-two bolts and washers (4, Figure 16) to secure swing reduction gearbox (5) to frame.

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

5. Connect tube (2, Figure 16) to reduction gear box (5). (Solar 470LC-V)

   -or-

   Connect tube to drain cock (not shown). (Solar 450LC-V)
6. Connect grease lubrication line (3, Figure 16) from reduction gearbox (5).
7. Connect hoses as tagged during removal to swing motor (1, Figure 16).
8. Fill swing reduction gearbox with oil. Refer to operation manual for specifications.

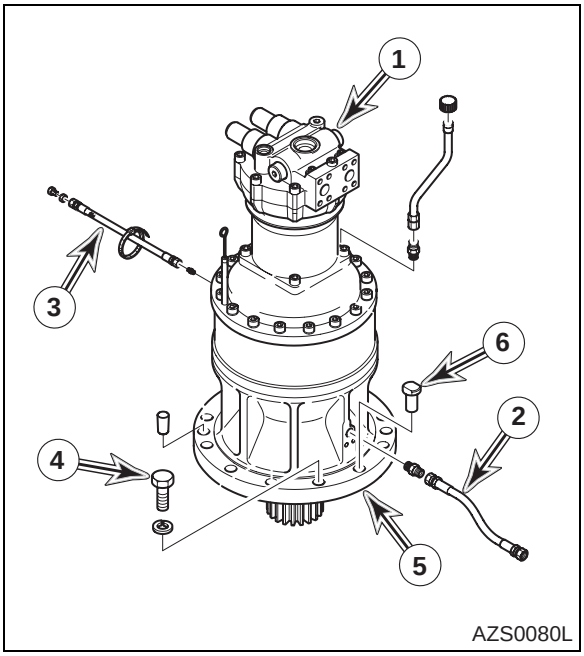


Figure 16 SOLAR 470LC-V

START-UP PROCEDURE

IMPORTANT

If air is not vented from hydraulic 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 the left and right.
4. Shut down engine 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.

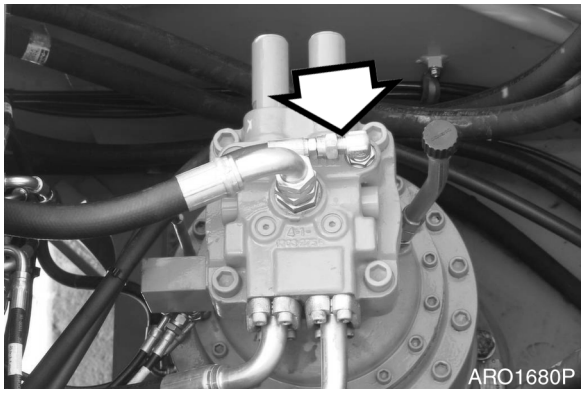


Figure 17

LOWER STRUCTURE AND CHASSIS

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

TRACK ASSEMBLY

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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May 2002

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Track Spring and Track Adjusting Cylinder 25
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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 grease cylinder 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.

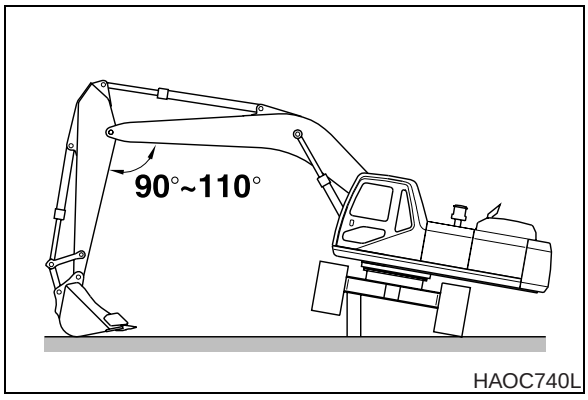


Figure 1

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 380 - 430 mm (14.93 - 16.90 in)

   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.*

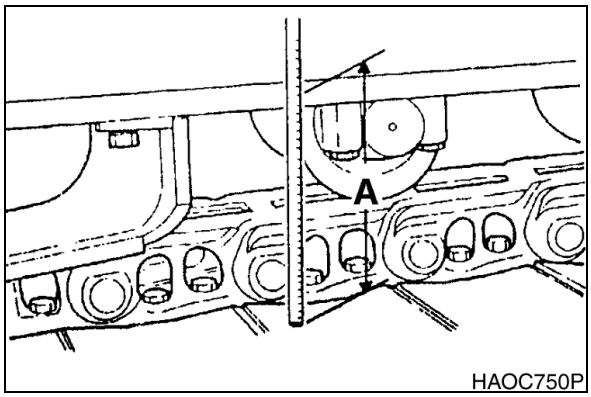


Figure 2

3. Too little sag in the crawler track (less than 380 mm (14.96 in) clearance) 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 430 - 460 mm (16.90 - 18.11 in). The clearance should be approximately 460 mm (18.11 in) for operation over gravel, rocky terrain, or over sand or snow.

Terrain Type	Distance "A"
Normal	380 - 430 mm (14.93 - 16.90 in)
Muddy	430 - 460 mm (16.90 - 18.11 in)
Gravel, Rocky, Sand or Snow	460 mm (18.11 in)

WARNING!

The track adjusting mechanism is under very high pressure. NEVER release pressure too suddenly. The grease cylinder valve should never be backed off more than 1 complete turn from the fully snugged 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 thru hole in adjustment cylinder (2, Figure 3).

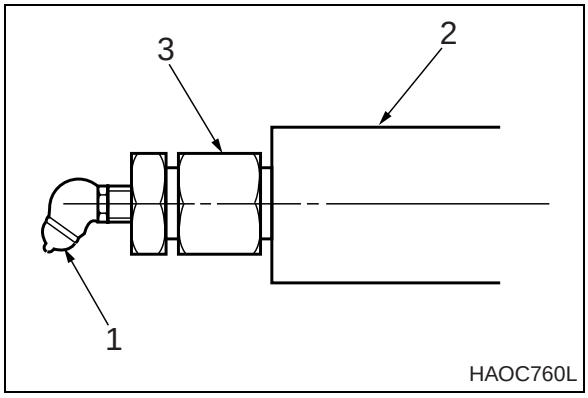


Figure 3

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

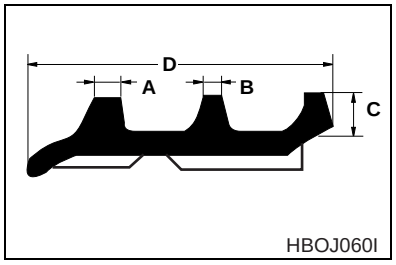
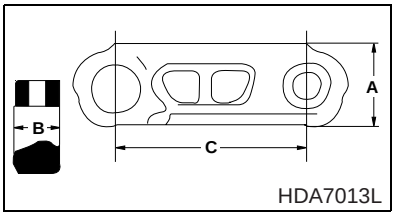
⚠ CAUTION!

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.

Component / Reference Dimensions	Reference	Normal (New) Dimension	Recommended Limit for Maintenance	Limit for Use (Repair - P or Replace - R)
Standard 600 mm (23.62 in) Shoe  **Figure 4**	A	24 mm (0.94 in)		
	B	18 mm (0.71 in)		
	C	36 mm (1.42 in)	32 mm (1.26 in)	30 mm [P] (1.18 in)
	D	247 mm (9.72 in)		
Track link, master link  **Figure 5**	A	129 mm (5.08 in)	126 mm (4.96 in)	122 mm [P] (4.80 in)
	B	62 mm (2.44 in)	56 mm (2.20 in)	50 mm [P] (1.97 in)
	C*	215.9 mm (8.50 in)	220 mm (8.66 in)	222 mm [R] (8.74 in)
	*Check and record the pitch of at least 5 links. Use average of all measurements to assess required service or action. Master links must be replaced, they cannot be renewed or rebuilt.			

Component / Reference Dimensions	Reference	Normal (New) Dimension	Recommended Limit for Maintenance	Limit for Use (Repair - P or Replace - R)
Track link, master pin bushing, master bushing	A	71 mm (2.80 in)	68 mm (2.68 in)	66 mm [R] (2.60 in)
	B	47 mm (1.85 in)	49 mm (1.93 in)	50 mm [R] (1.97 in)
	C	47 mm (1.85 in)	45 mm (1.77 in)	44 mm [R] (1.73 in)
	D*	46.83 mm (1.84 in)	44.83 mm (1.76 in)	43.83 mm (1.73 in)
	* Master pin			

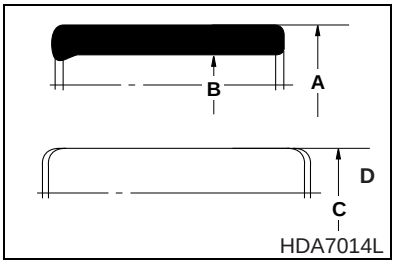


Figure 6

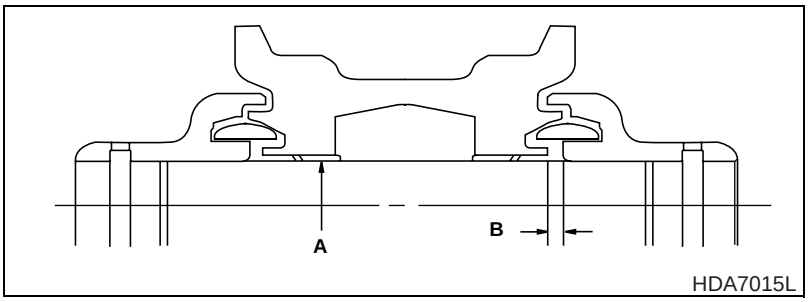


Figure 7

Lower roller, axle	A	85 mm (3.35 in)	84.5 mm (3.33 in)	84.2 mm [R] (3.31 in)
Lower roller, bushing	A	85 mm (3.35 in)	85.5 mm (3.37 in)	86 mm [R] (3.39 in)
Axle-bushing, clearance			0.39 mm (0.0154 in)	0.51 mm (0.0201 in)
Gap between bushing and side collar. (Total amount for both sides.)	B		1 mm (0.039 in)	1.8 mm (0.071 in)
Flange thickness	B	5 mm (0.20 in)	4.5 mm (0.18 in)	4.2 mm (0.17 in)

Lower roller dimensions	A	278 mm (10.94 in)		
	B	209.2 mm (8.24 in)	228 mm (8.98 in)	242 mm [P] (9.53 in)
	C	200 mm (7.87 in)	194 mm (7.64 in)	190 mm [P] (7.48 in)
	D	250 mm (9.84 in)	234 mm (9.21 in)	227 mm [P] (8.94 in)

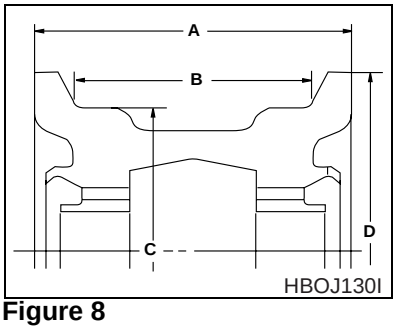
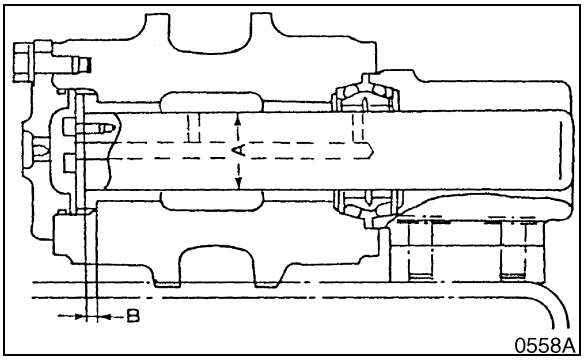
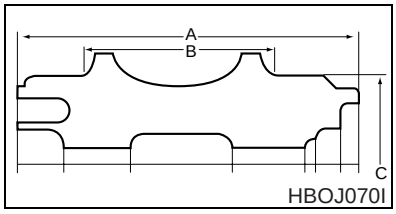
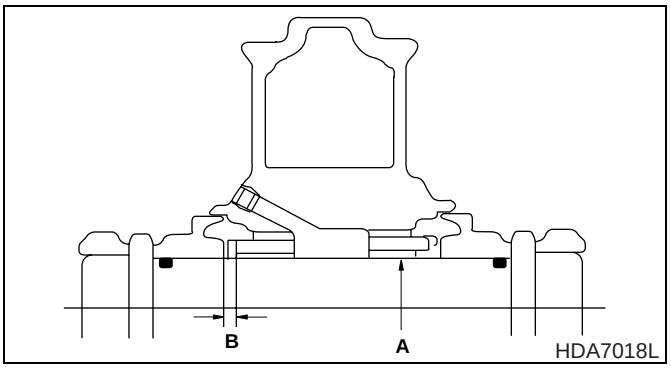
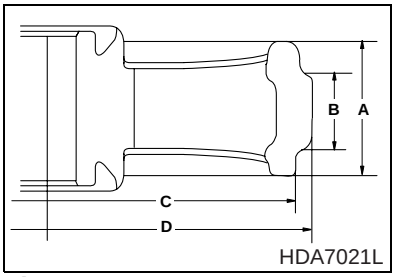


Figure 8

Component / Reference Dimensions	Reference	Normal (New) Dimension	Recommended Limit for Maintenance	Limit for Use (Repair - P or Replace - R)
 **Figure 9**				
Upper roller, axle	A	60 mm (2.36 in)	59.5 mm (2.34 in)	59.2 mm [R] (2.33 in)
Upper roller, bushing	A	60 mm (2.36 in)	60.5 mm (2.38 in)	61 mm [R] (2.40 in)
Axle-bushing, clearance			1 mm (0.039 in)	1.8 mm [R] (0.07 in)
Upper roller, axle	B		1 mm (0.039 in)	1.5 mm (0.06 in)
Upper roller, bushing	B	8 mm (0.31 in)	5.5 mm (0.22 in)	5 mm [R] (0.20 in)
Upper roller  **Figure 10**	A	190 mm (7.48 in)		
	B	95 mm (3.74 in)		
	C	180 mm (7.09 in)	171 mm (6.73 in)	165 mm [P] (6.50 in)

Component / Reference Dimensions	Reference	Normal (New) Dimension	Recommended Limit for Maintenance	Limit for Use (Repair - P or Replace - R)
 **Figure 11**				
Front idler, axle	A	85 mm (3.35 in)	84.5 mm (3.33 in)	84.2 mm [R] (3.31 in)
Front idler, bushing	A		85.5 mm (3.37 in)	86 mm [R] (3.39 in)
Axle-bushing, clearance			1 mm (0.039 in)	1.8 mm (0.071 in)
Gap between bushing and side collar. (Total amount for both sides.)	B		1 mm (0.039 in)	1.5 mm (0.06 in)
Bushing flange thickness	B	8 mm (0.315 in)	7 mm (0.276 in)	6.6 mm [R] (0.26 in)
Front idler  **Figure 12**	A	200 mm (7.87 in)	192 mm (7.56 in)	188 mm [P] (7.40 in)
	B	99 mm (3.90 in)	95 mm (3.74 in)	93 mm [P] (3.66 in)
	C	600 mm (23.62 in)	590 mm (23.23 in)	585 mm [P] (23.03 in)
	D	25 mm (0.98 in)	30 mm (1.18 in)	32.50 mm [P] (1.28 in)

TRACK SHOES AND LINKS

PARTS LIST

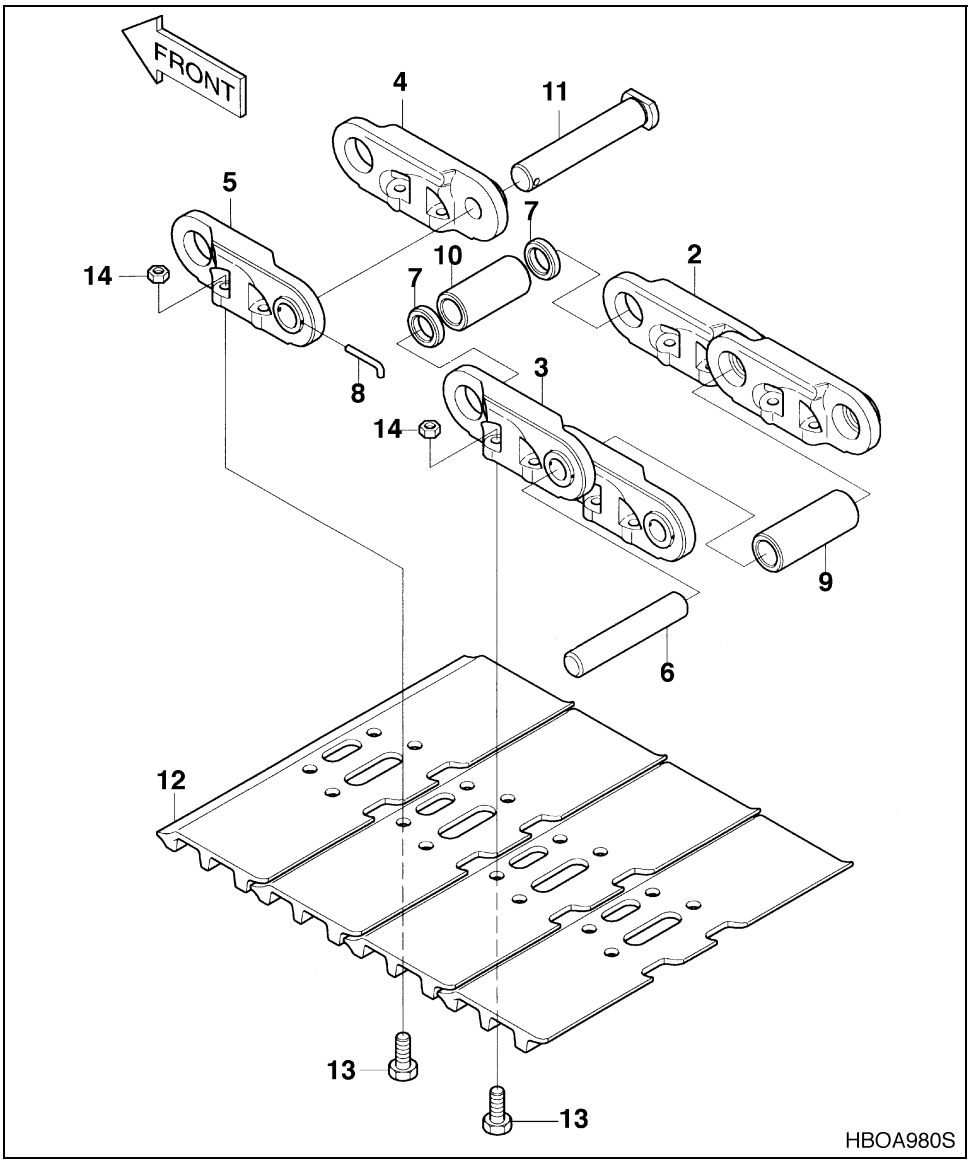


Figure 13

Reference Number	Description
1	Track Link Assembly
2	Link; Track (R.H.)
3	Link; Track (L.H.)
4	Link; Master (R.H.)
5	Link; Master (L.H.)
6	Pin
7	Spacer

Reference Number	Description
8	Pin; Lock
9	Bushing
10	Bushing; Master
11	Pin; Master
12	Shoe 600 mm (24 in)
13	Bolt
14	Nut

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) is positioned at approximately 10 o'clock from top position on travel reduction gearbox.
4. Remove four nuts and bolts (2) holding shoe to link. Remove enough shoes to make access to lock pin easier.

   NOTE: *Support track shoes with blocking so that when master pin (4) is removed tack will not fall.*
5. Straighten lock pin (3) and remove it from master pin (4). Discard lock pin.
6. Remove master pin from master links.
7. Move unit forward until entire track is laying on ground.

   NOTE: *Do not drive unit off track.*
8. Rotate upper structure to 90° from track. Use bucket and boom to raise track frame off track.
9. Position blocking under frame.

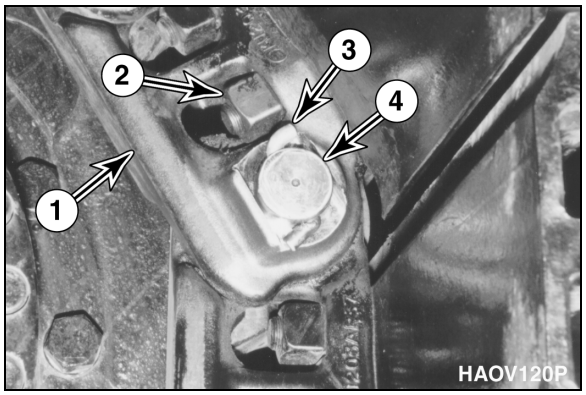


Figure 14

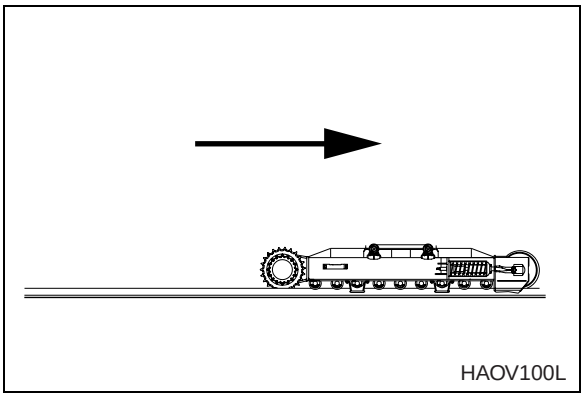


Figure 15

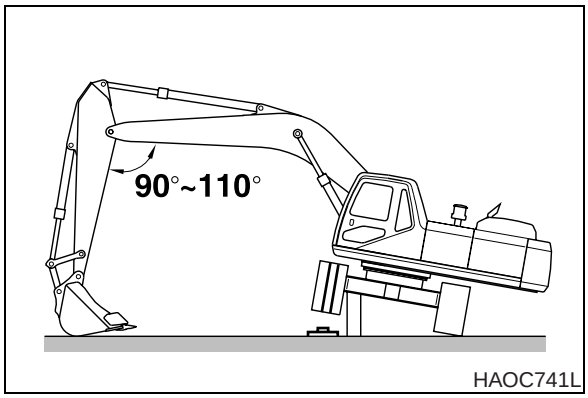


Figure 16

TRACK INSTALLATION

1. Lay rebuilt or new track into position under track frame. End of track should be positioned under front idler roller.
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.

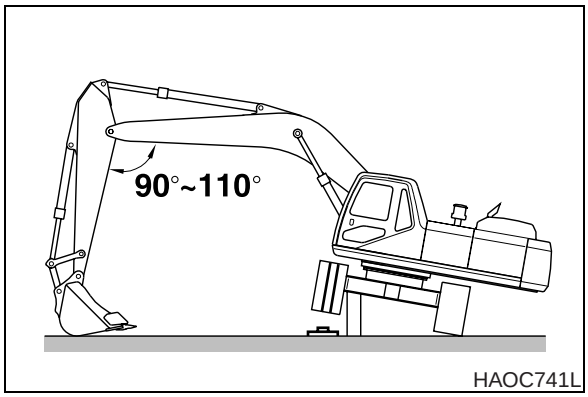


Figure 17

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

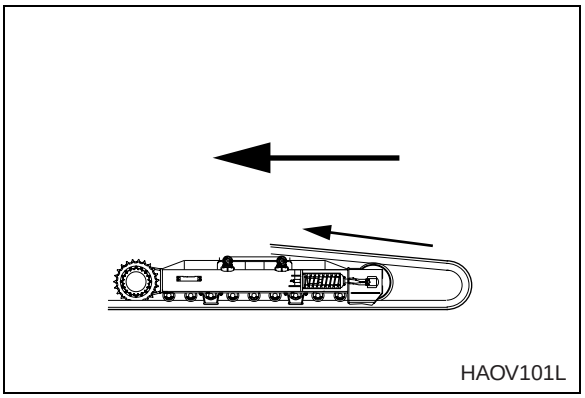


Figure 18

FRONT IDLER ROLLER

PARTS LIST

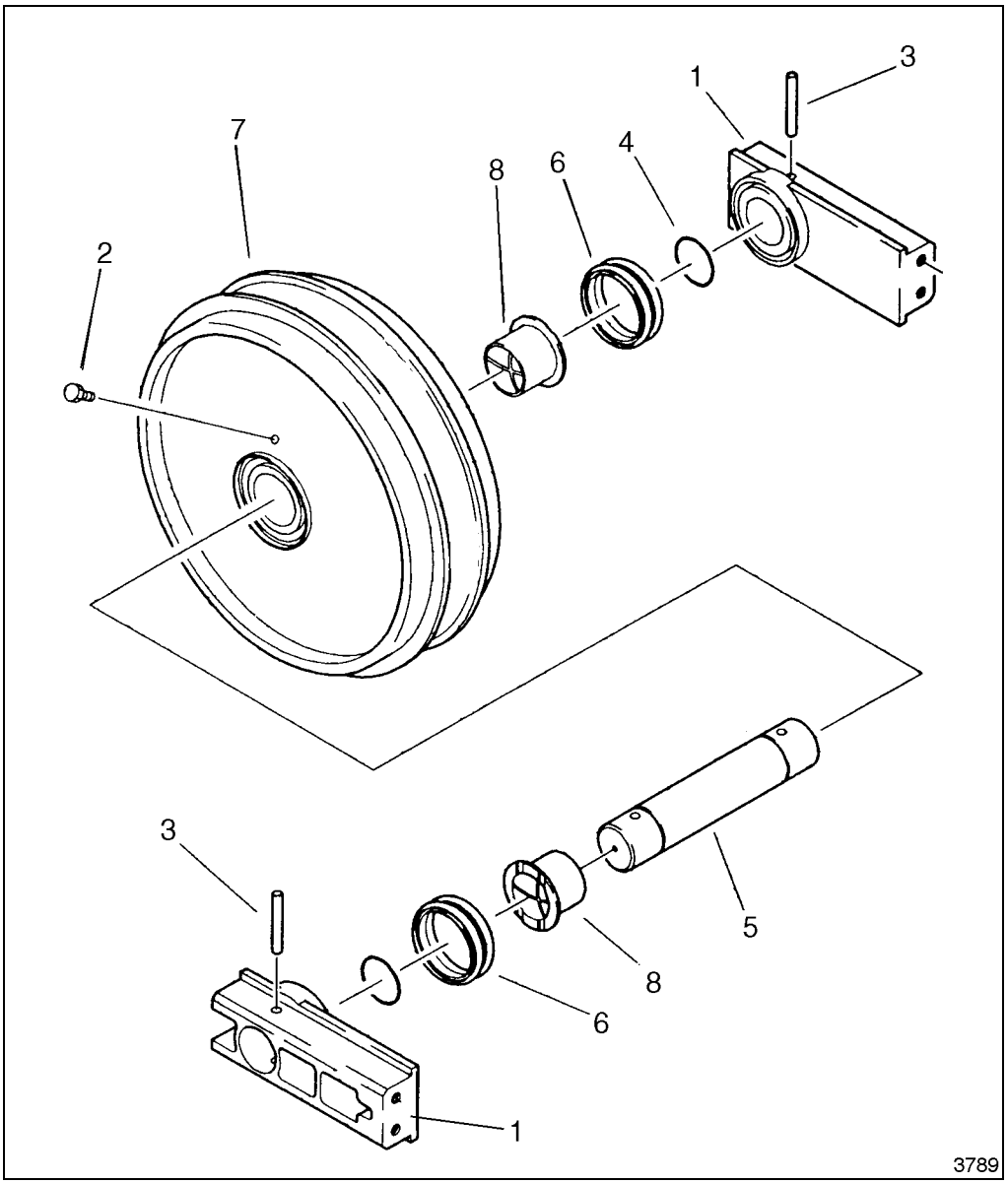


Figure 19

Part No.	Part	Quantity
1	Bearing	2
2	Plug	1
3	Pin	2
4	O-ring	2

Part No.	Part	Quantity
5	Axle	1
6	Group Seal	2
7	Idler	1
8	Bushing	2

FRONT IDLER ROLLER DISASSEMBLY

1. Remove plug (2, Figure 20) and drain oil from idler (7, Figure 20).

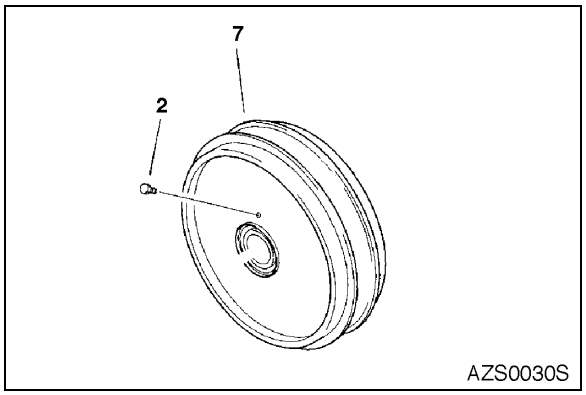


Figure 20

2. Separate the pin (3, Figure 21) from the bearing (1).

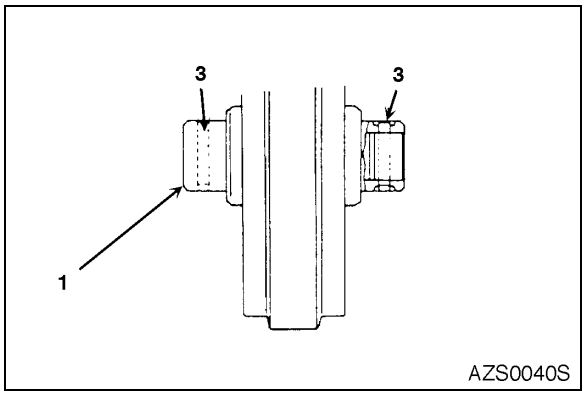


Figure 21

3. Use a press to remove the bearing from the axle. Separate the O-ring (4, Figure 22) from the axle and insert it into the bearing.

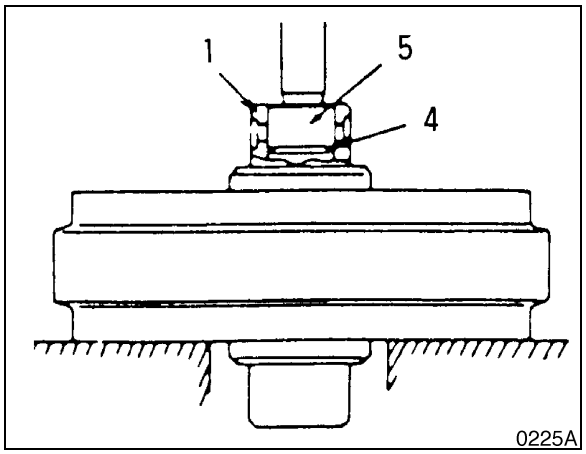


Figure 22

4. Detach the group seal (6, Figure 23) from the idler (7) and bearing (1).

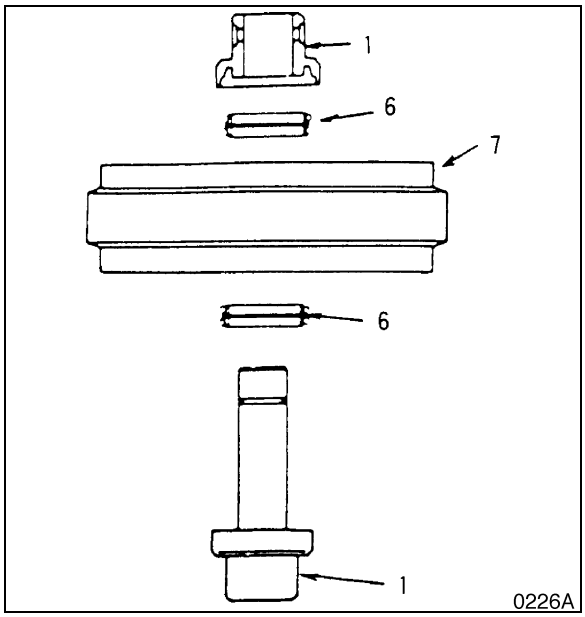


Figure 23

5. Use a press to separate the axle (5, Figure 24), O-ring (4) and bearing (1).

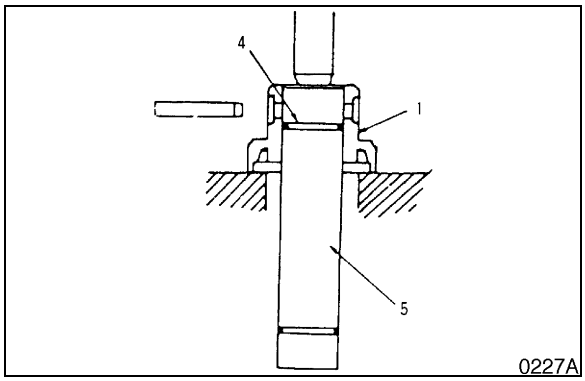


Figure 24

6. Remove bushing (8, Figure 25) with the press and special tool (ST-1909).

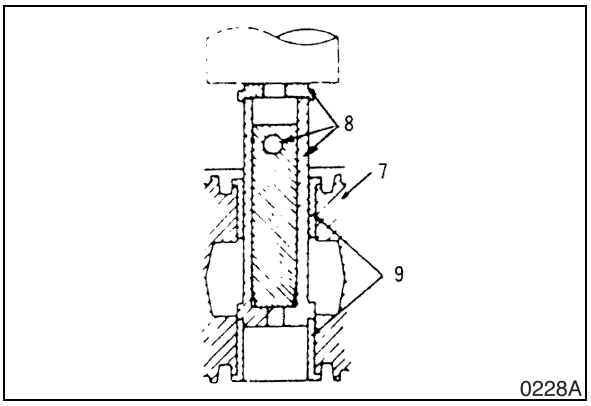


Figure 25

FRONT IDLER ROLLER REASSEMBLY

1. Degrease, clean and dry all parts before reassembly. Insert bushing (8, Figure 26) into the idler (7).
2. Grease O-ring (4, Figure 26) and insert it into the axle.
3. Align the bearing (1, Figure 26) and axle (5) holes and pin (3) them together.

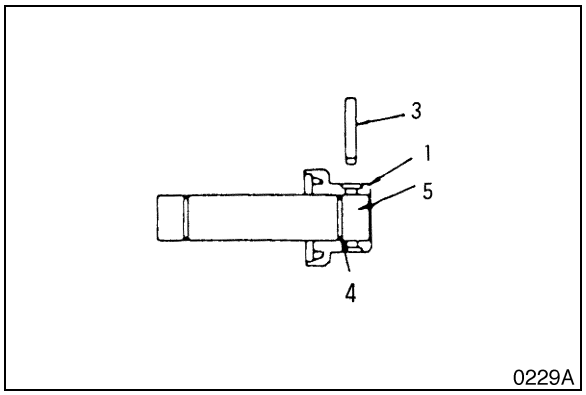


Figure 26

4. Install group seal (6, Figure 27) inside the idler (7) and bearing (1).

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

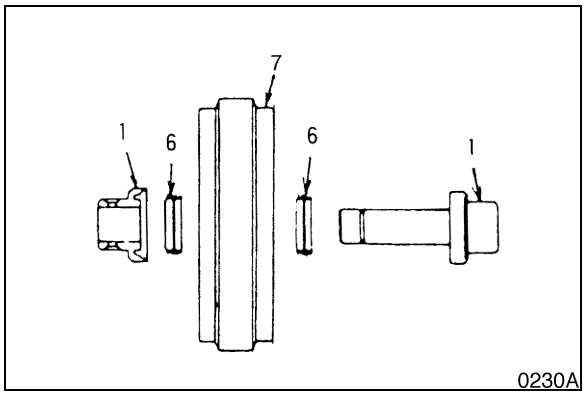


Figure 27

5. Install idler (7, Figure 28) on the axle.
6. Install bearing (1, Figure 28) and pin (3) to the axle.

   NOTE: *Fill the idler assembly with new engine oil with approximately 300 cc (10 fluid ounces).*

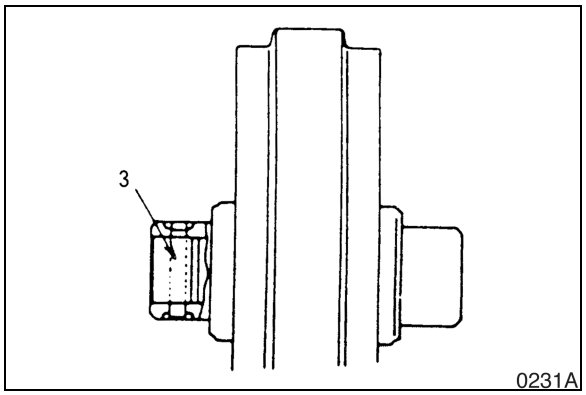


Figure 28

LOWER ROLLER

Heat treatment of the lower rollers provides improved wear resistance and hardness. High quality bushings and seals will ensure long service life if lubricant is replaced at recommended intervals.

NOTE: *An exploded view of the lower roller is shown in Figure 29.*

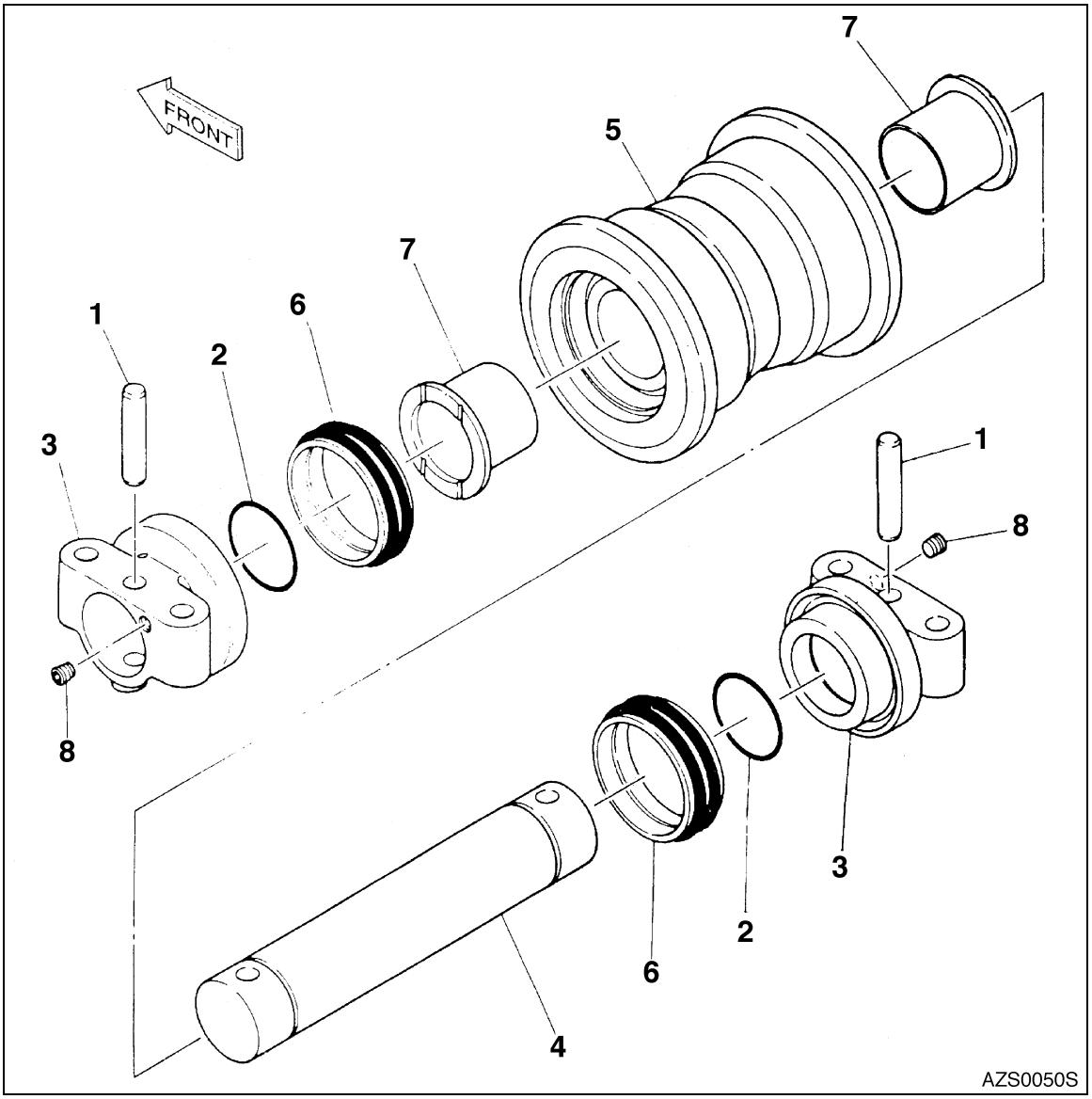


Figure 29

Reference Number	Description
1	Pin
2	O-ring
3	Collar
4	Axle

Reference Number	Description
5	Roller
6	Group Seal
7	Bushing
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.*

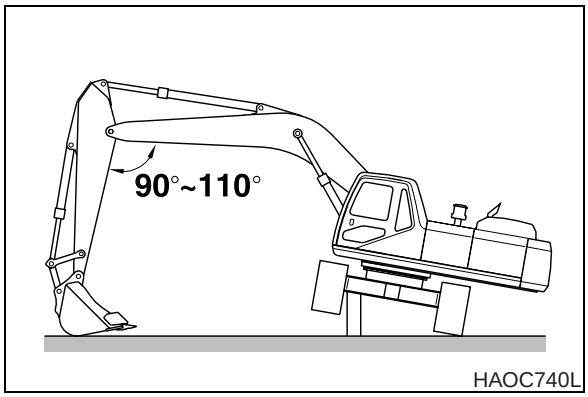


Figure 30

LOWER ROLLER DISASSEMBLY

1. Remove plug from the collar and drain oil.
2. Pull the pin (1, Figure 31) from the collar.

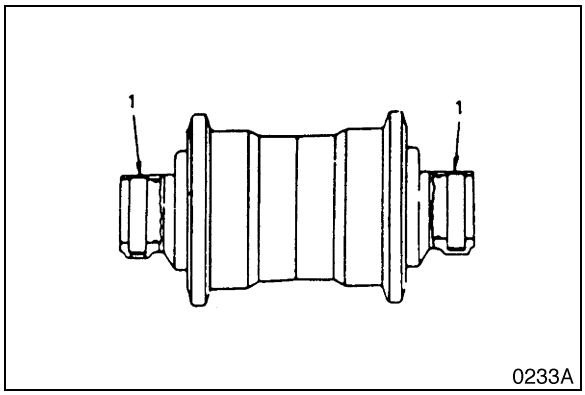


Figure 31

3. Separate the collar (3, Figure 32) from the axle, using a press.

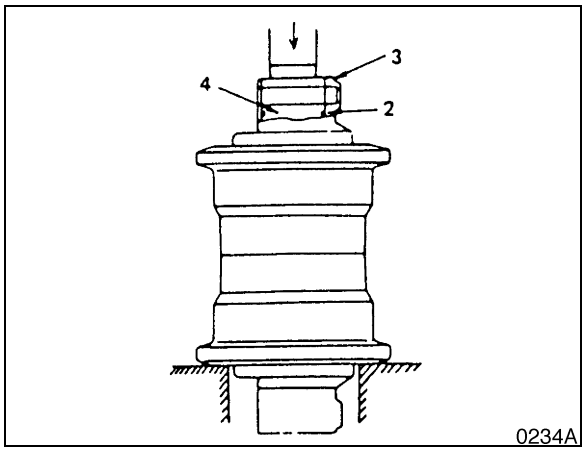


Figure 32

4. Detach O-rings (2, Figure 33) from the axle.
5. Separate group seals (6, Figure 33) from the collar and roller (5).
6. Detach collar (3, Figure 33) and O-rings (2) from the axle, using a press.

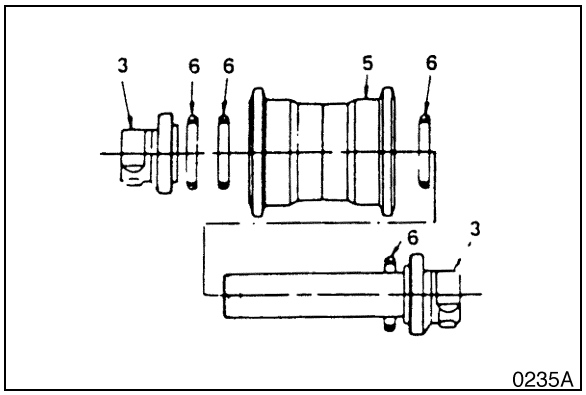


Figure 33

LOWER ROLLER REASSEMBLY

1. Degrease, clean and dry all parts before reassembly. Insert bushing (7, Figure 34) into roller.
2. Apply grease to the O-rings (2, Figure 34) and insert into axle.

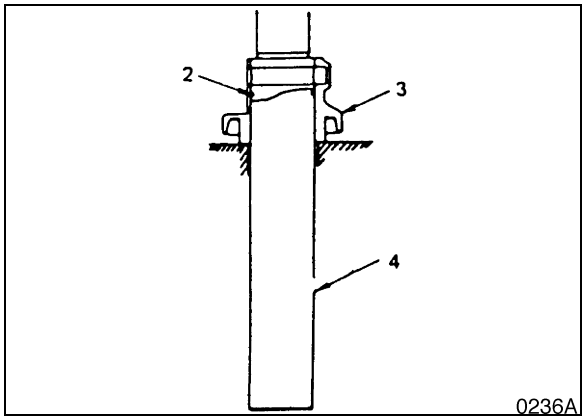


Figure 34

3. Align collar (3, Figure 35) and axle (4) pin holes and pin (1) the collar.

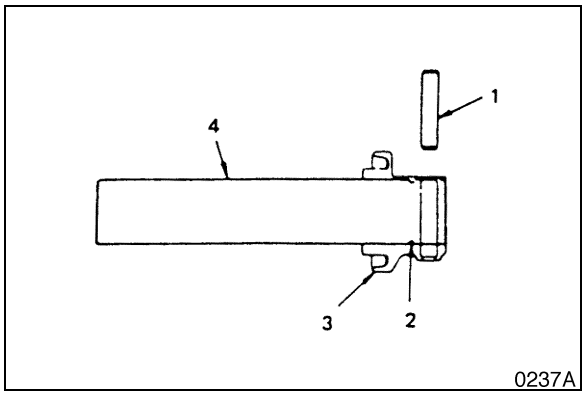


Figure 35

4. Insert group seals (6, Figure 36) into the roller (5) and collar (3).

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

5. Slide the axle inside the roller.

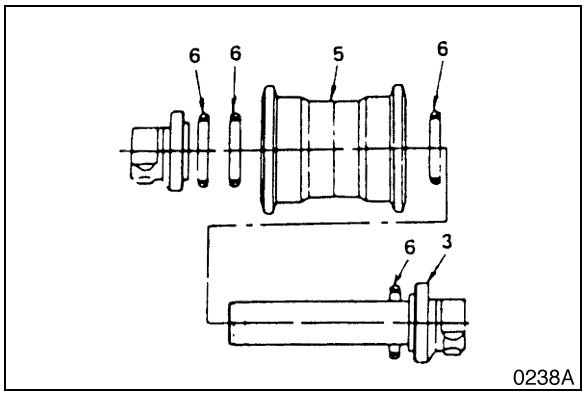


Figure 36

6. Install the collar (3, Figure 37), O-ring (2), and pin (1) on the remaining side.
7. Fill with clean engine oil with approximately *300 cc (10.1 fluid ounces)*.

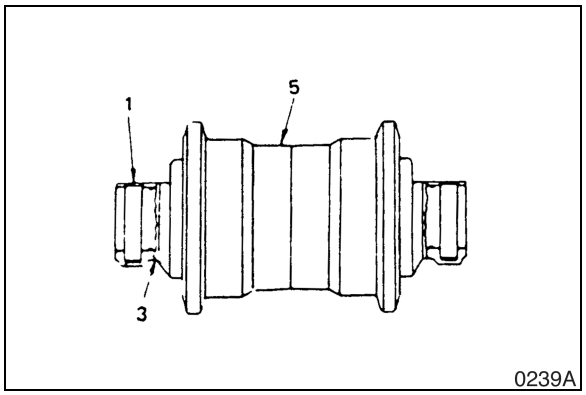


Figure 37

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.*

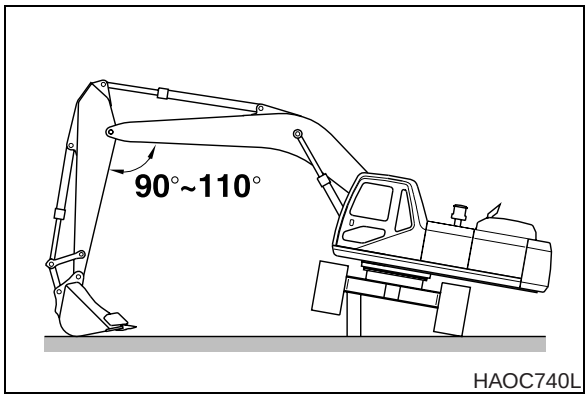


Figure 38

UPPER ROLLER

NOTE: *An exploded view of the upper roller is shown in Figure 39.*

PARTS LIST

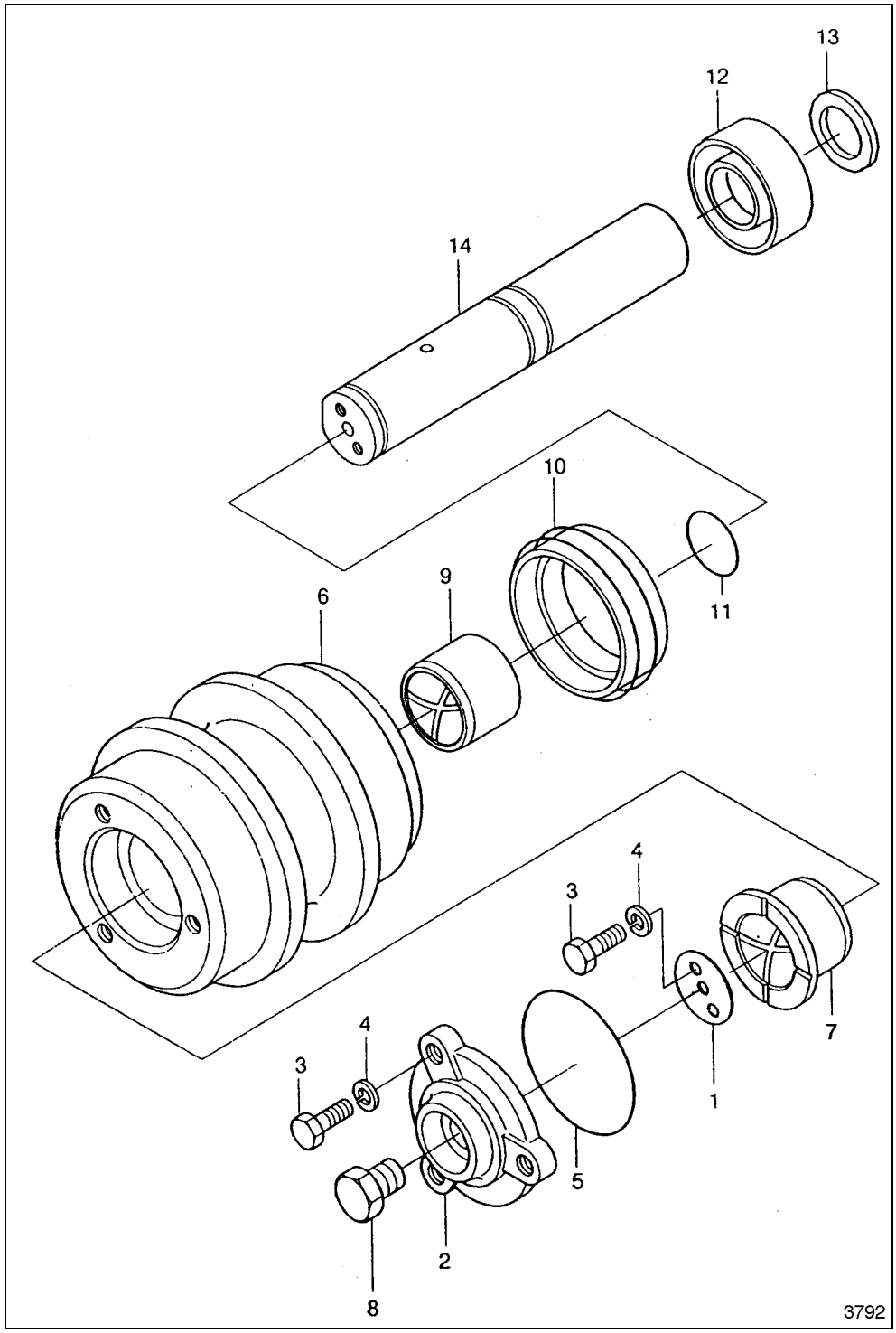


Figure 39

Part No.	Part	Quantity
1	Washer	1
2	Cover	1
3	Bolt	6
4	Spring Washer	6
5	O-ring	1
6	Body	1
7	Bushing	1

Part No.	Part	Quantity
8	Plug	1
9	Bushing	1
10	Floating Seal	1
11	O-ring	1
12	Thrust Ring	1
13	Spacer	1
14	Shaft	1

UPPER ROLLER REMOVAL

1. Relieve track tension. See This will allow track to be raised so that 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 40

UPPER ROLLER DISASSEMBLY

1. Remove the plug (1, Figure 41) from the cover and drain oil.

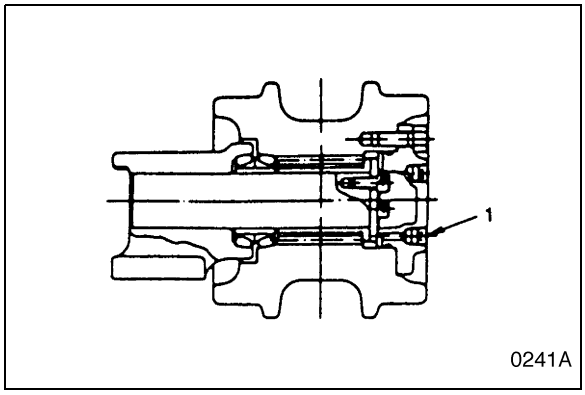


Figure 41

2. Remove the bolts and cover (3, Figure 42). Detach bolts (4) and washer (5).

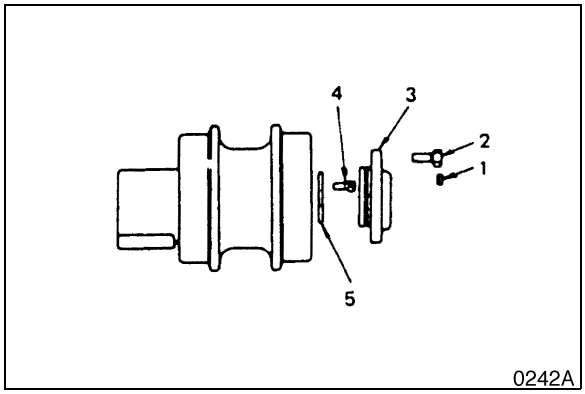


Figure 42

3. Separate the roller (6, Figure 43) from the axle (7).

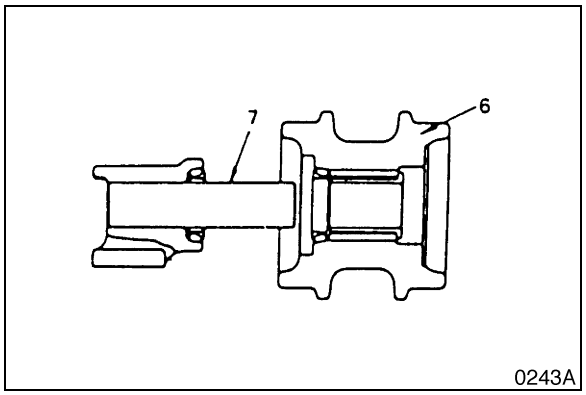


Figure 43

4. Separate the group seal (8, Figure 44) from the roller and bracket (9).

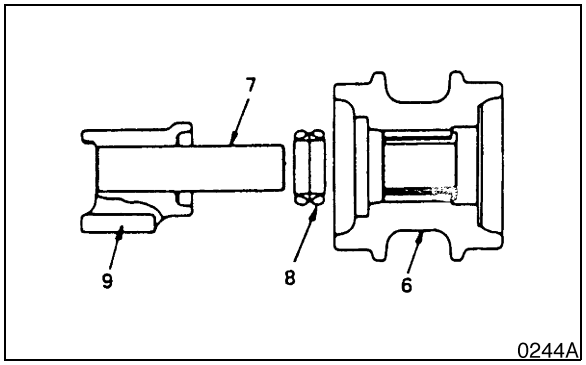


Figure 44

5. Separate the bushing (10, Figure 45) from the roller with a press and special tool (ST-1919).

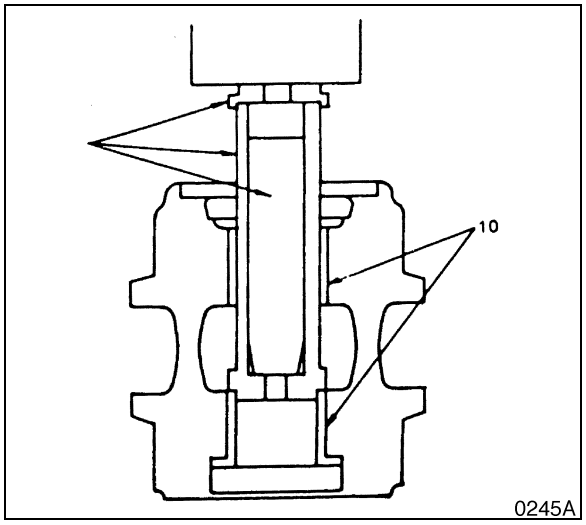


Figure 45

UPPER ROLLER REASSEMBLY

1. Degrease, clean and dry all parts before reassembly. Insert bushing (10, Figure 46) into the roller (6).

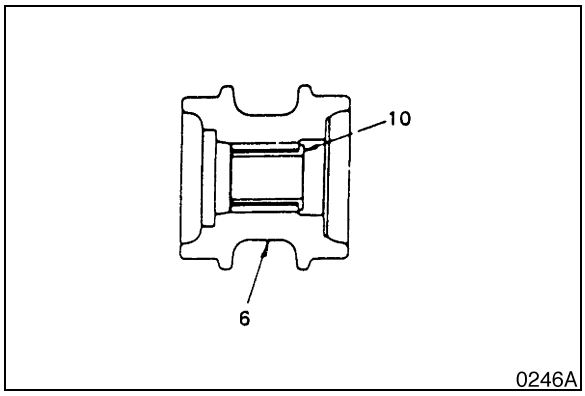


Figure 46

2. Insert group seal (8, Figure 47) into the roller (6) and bushing.

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

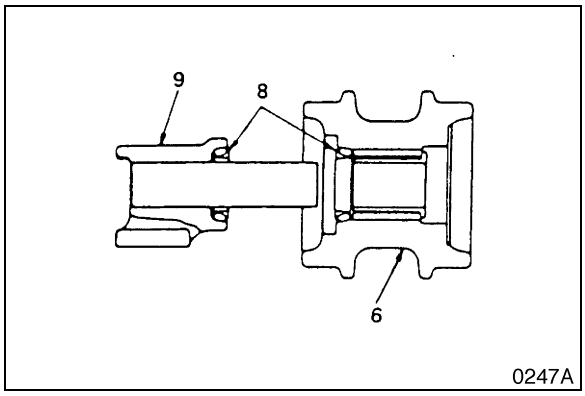


Figure 47

3. Install the axle, washer (5, Figure 48) and bolt (4).
4. Attach O-ring (11, Figure 39) to the roller (6, Figure 48) and cover (3).
5. Insert the O-ring (11, Figure 48) to the cover. Attach cover (3) and bolt (2) to the roller.
6. Fill with 200 cc (6.8 fluid ounces) of engine oil.

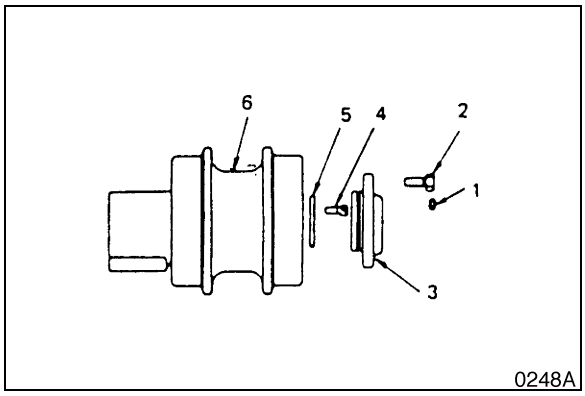


Figure 48

7. Tighten plug (1, Figure 49).

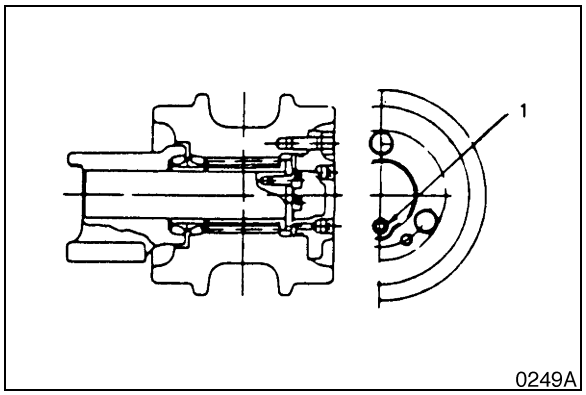


Figure 49

TRACK SPRING AND TRACK ADJUSTING CYLINDER

PARTS LIST

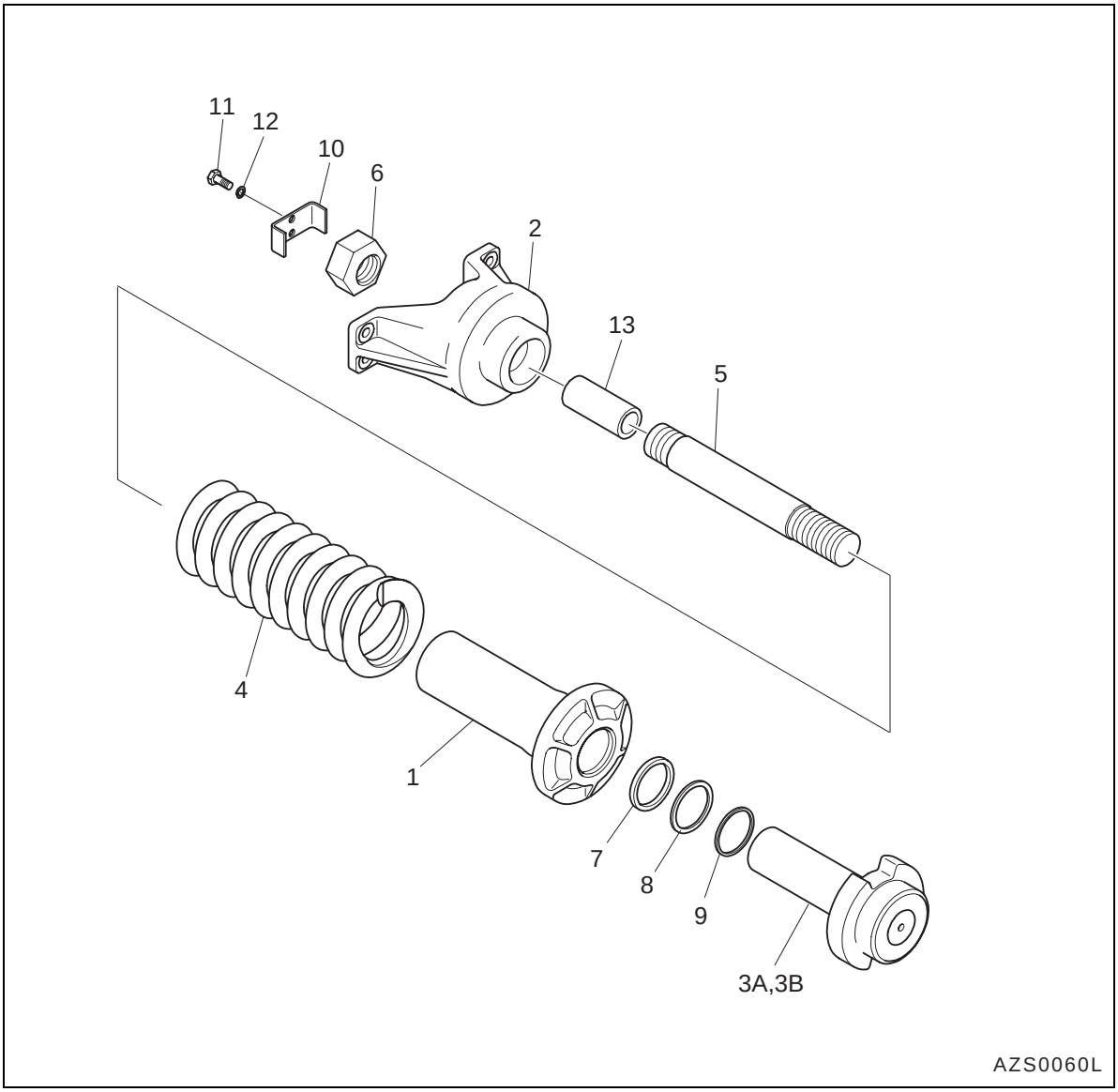


Figure 50

Reference Number	Description
1	Body
2	Bracket
3A	Rod
3B	Rod Plate
4	Spring
5	Tie Bar
6	Nut

Reference Number	Description
7	Rod Packing
8	Back Up Ring
9	Dust Seal
10	Plate
11	Bolt
12	Spring Washer
13	Stopper

ENGINE AND DRIVE TRAIN

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

AIR-CONDITIONER

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 340LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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GENERAL DESCRIPTION

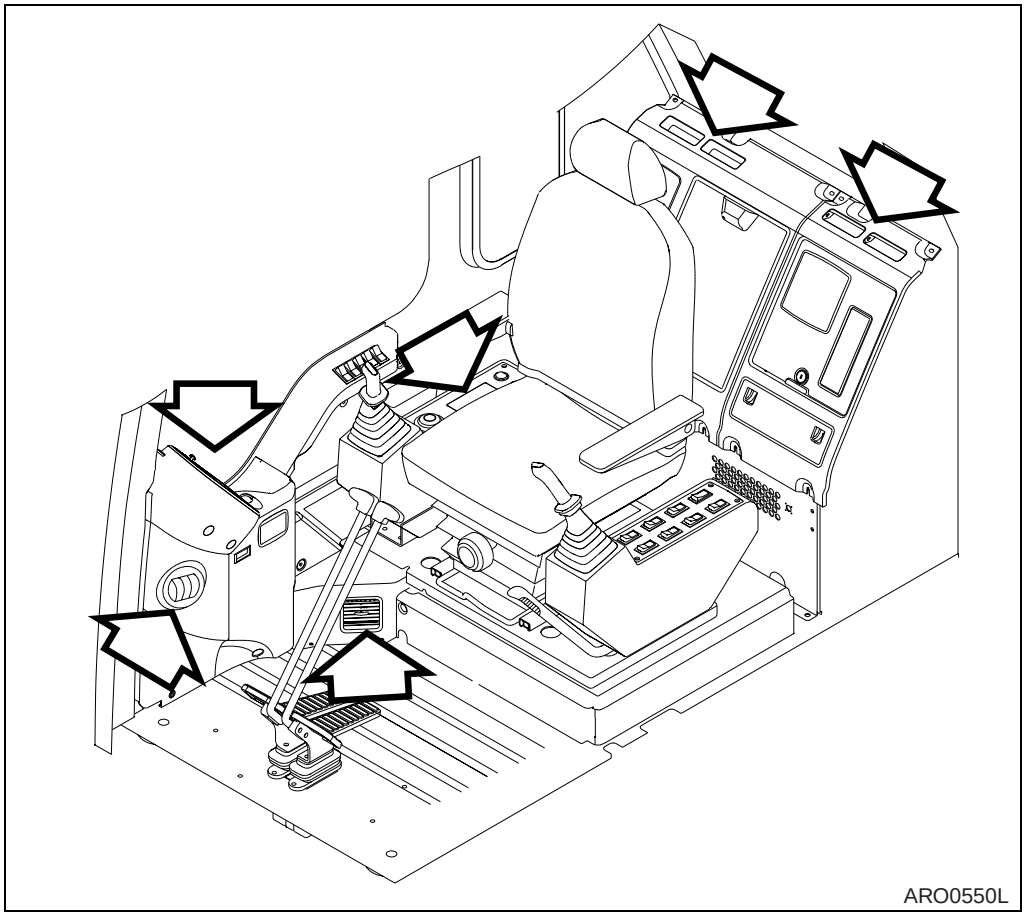


Figure 1

The heater and air-conditioner are combined into one unit in the rear cover behind the operator's seat. If necessary, the operator can control inner temperature using the operation panel installed in the right-hand control stand.

The unit is equipped with an air filtration system which filters out dirt and dust particles from air being circulated into operator’s cab. This filter should be cleaned out every 500 hours.

NOTE: *In the event that the unit is being operated in a dusty environment, the cleaning and replacement should be performed more frequently. If filter element is damaged, replace damaged filter by a new one.*

WARNING!

All service and inspection of air conditioning system should be performed with the starter switch in the "O" (OFF) position.

WARNING!

If using compressed air to clean the element, make sure that proper eye protection is worn.

NOTE: *All right and left call outs are based on the operator being seated in the operator's seat facing the front.*

1. Turn the key cylinder (1, Figure 2) to open cover (2, Figure 2) behind operator's seat.
2. Disconnect speaker harness.
3. Remove cover (2, Figure 2) from the rear box.
4. Remove filter cover (3, Figure 2) from air conditioning unit.

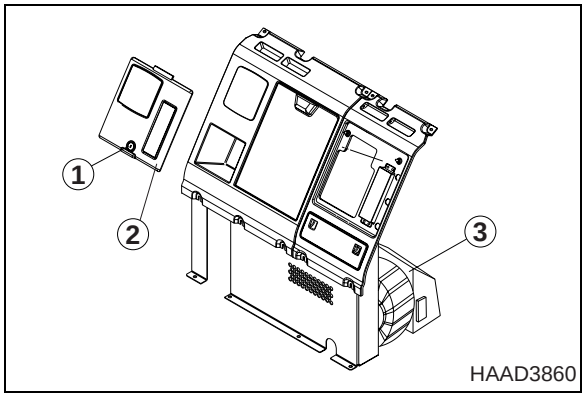


Figure 2

5. Remove filter element (1, Figure 3) and inspect for any damage.
6. Use compressed air to clean filter element. If filter element is very dirty use a mild soap or detergent and water to clean it.

   NOTE: *If water was used to clean filter, be certain it is completely dry before installing.*

   NOTE: *When assembling the filter again, install so that the arrow on top of filter is facing the inside of the cab.*

   NOTE: *Refer to appropriate Operation and Maintenance Manual for latest service intervals.*

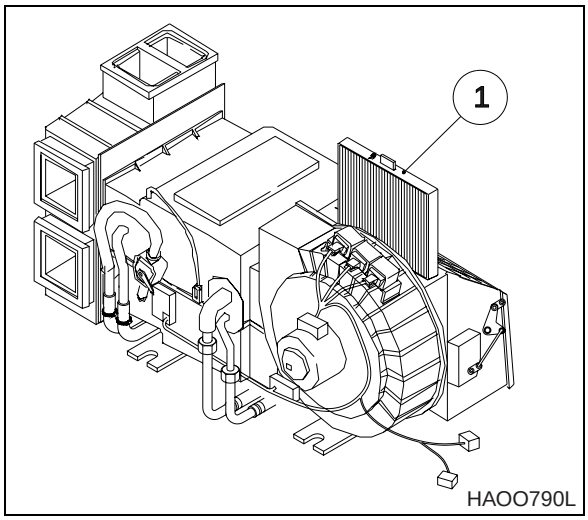


Figure 3

REFRIGERANT CIRCULATION

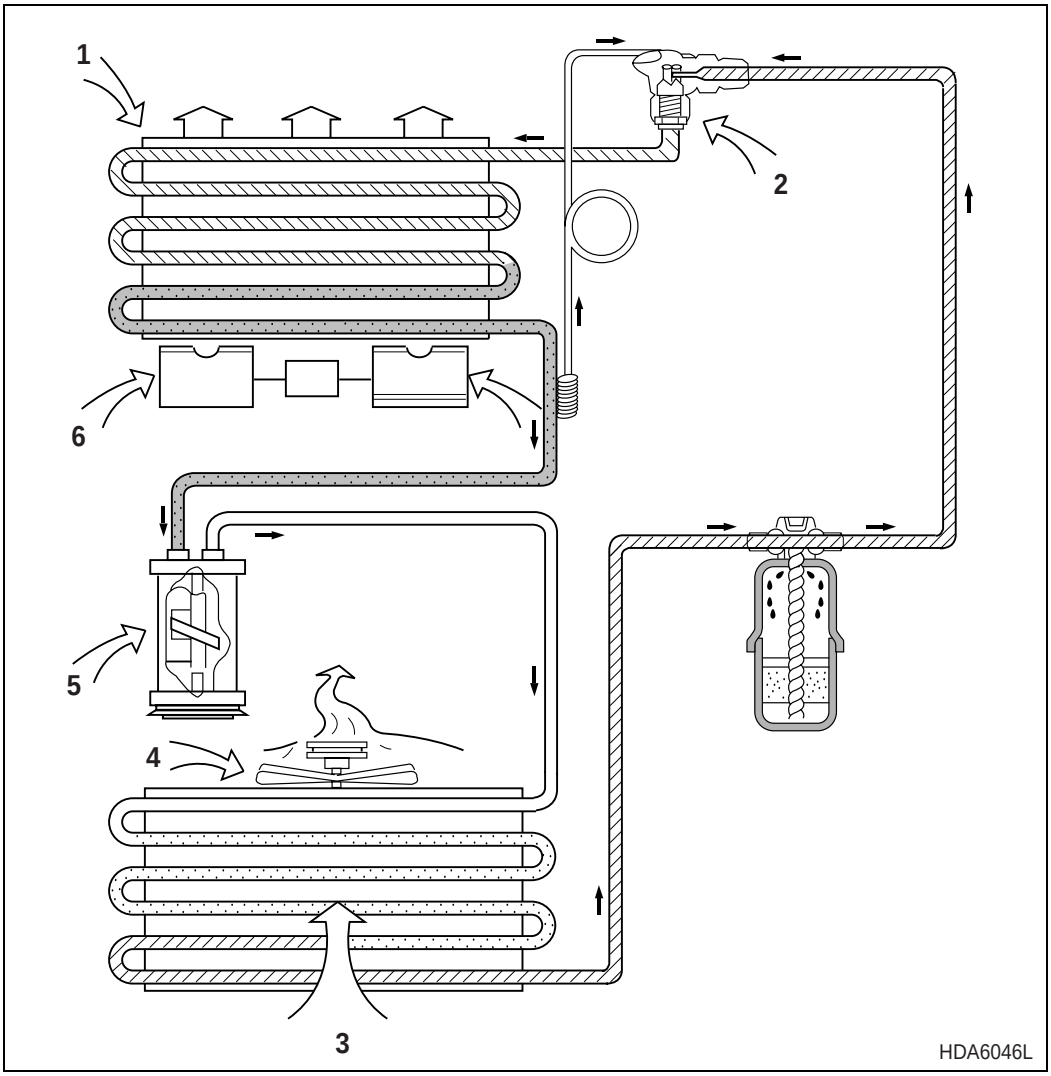
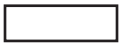


Figure 4

Reference Number	Description
1	Evaporator
2	Expansion Valve
3	Condenser
4	Condenser Fan

Reference Number	Description
5	Compressor
6	Blower Fan
7	Receiver Dryer

Shading	Temperature	Refrigerant State
	High	High Pressure Gas
	High	High Pressure Liquid
	Low	Low Pressure Liquid
	High	High Pressure Gas/Liquid
	Low	Low Pressure Gas

- Refrigerant (R134a) is compressed to approximately 15.0 kg/cm^2 (213 psi) within the compressor.
- The compressed refrigerant flows into the condenser at high temperature (approximately 80°C (176°F)).
- The refrigerant in the condenser is cooled to approximately 60° by the condenser fan. At this time the refrigerant changes from the gas to the liquid state, even though the temperature has only been reduced 20°C (68°F). (From 80° - 60°C (176° - 140°F)).
- The refrigerant in its liquid form is injected into the evaporator through the expansion valve. At this time the pressure is reduced by approximately 2.0 kg/cm^2 (28 psi) and the temperature is also reduced. As a result, the refrigerant absorbs the heat from the air surrounding the evaporator creating a cooling effect and changes from the gas to the liquid state.
- The refrigerant once again flows into the compressor in the gaseous state and the process is repeated.

⚠ WARNING!

Refrigerant gas is pressurized and sealed in the air conditioning system. Special precautions are required for the proper recharging or release of refrigerant. Release of refrigerant into the atmosphere is strictly regulated by law. Make sure that you are in compliance with all mandated federal, state and municipality requirements, before starting any service or repair of the air conditioner. Refrigerant gas used in the system must meet or exceed specifications for R134a refrigerant, or any subsequently issued environmentally-mandated standard.

CONTROL PANEL

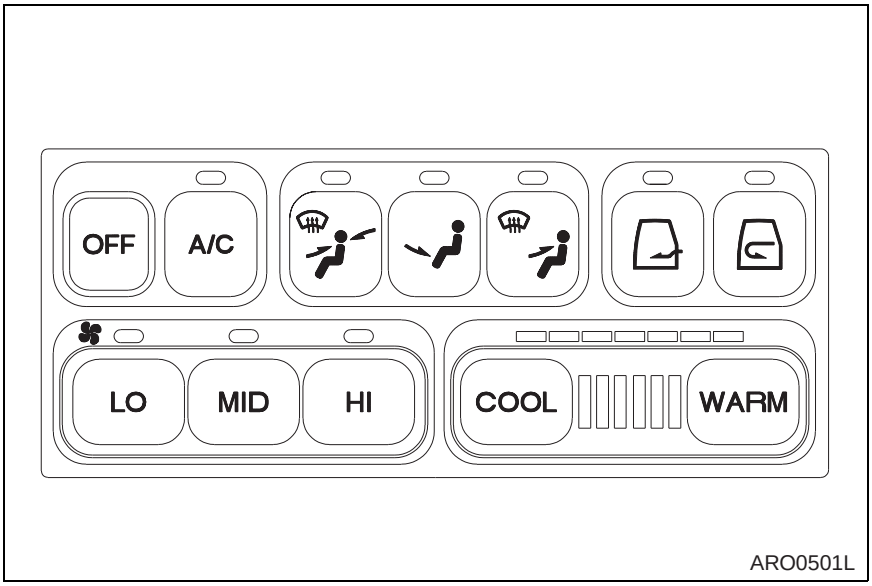


Figure 5

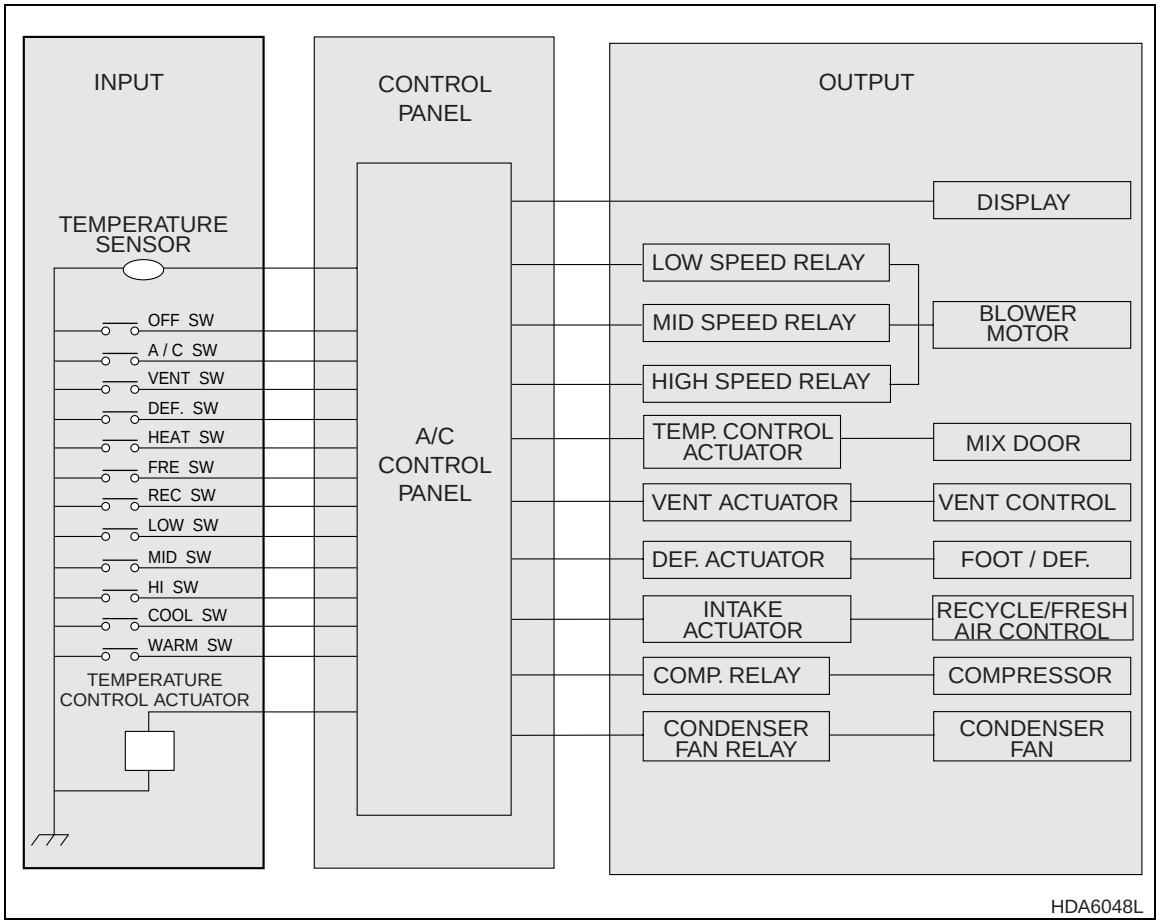
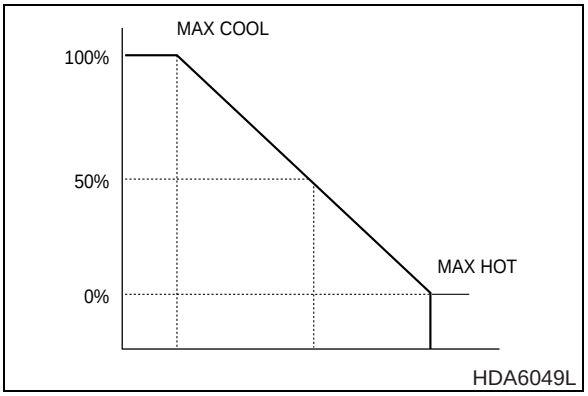
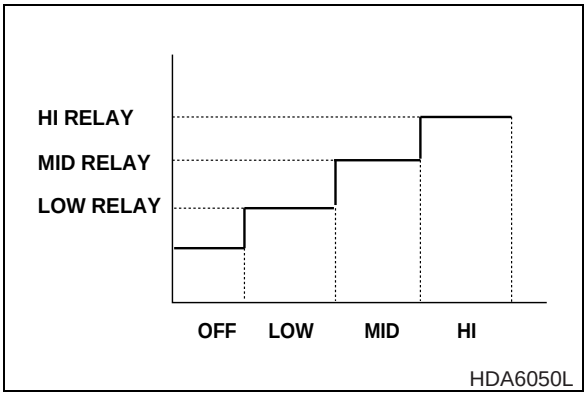
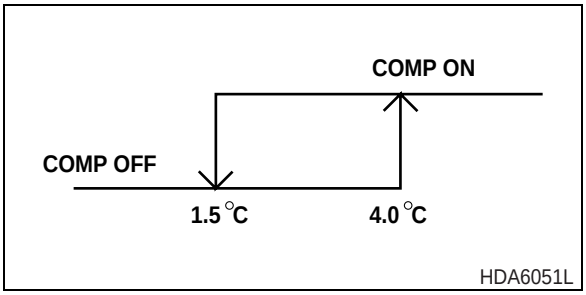


Figure 6

CONTROL SPECIFICATIONS

Control Item	Control Switch	Control Specifications
Temperature Control	'COOL' Switch 'WARM' Switch	 **Figure 7** Temperature control switch consists of a 24 step variable selector. The display uses 7, Green / Red two-color LEDs to display the selected temperature.
Blower Fan Speed Control	'OFF' Switch 'LOW' Switch 'MID' Switch 'HI' Switch	 **Figure 8**
Compressor Control	Temperature Sensor	 **Figure 9**

TEMPERATURE LEVEL CONTROL AND DISPLAY

Step	LED 1	LED 2	LED 3	LED 4	LED 5	LED 6	LED 7	Position Sensor Voltage	Remark
0	Green	Green	Green	Green	Green	Green	Green	4.50 V ± 0.2	MAX. COOL
1	Green	Green	Green	Green	Green	Green	Green	4.33 V ± 0.2	
2	Green	Green	Green	Green	Green	Green	Green	4.15 V ± 0.2	
3	Red	Green	Green	Green	Green	Green	Green	3.98 V ± 0.2	
4	Red	Green	Green	Green	Green	Green	Green	3.80 V ± 0.2	
5	Red	Green	Green	Green	Green	Green	Green	3.63 V ± 0.2	
6	Red	Red	Green	Green	Green	Green	Green	3.46 V ± 0.2	
7	Red	Red	Green	Green	Green	Green	Green	3.28 V ± 0.2	
8	Red	Red	Green	Green	Green	Green	Green	3.11 V ± 0.2	
9	Red	Red	Red	Green	Green	Green	Green	2.93 V ± 0.2	
10	Red	Red	Red	Green	Green	Green	Green	2.76 V ± 0.2	
11	Red	Red	Red	Green	Green	Green	Green	2.59 V ± 0.2	
12	Red	Red	Red	Red	Green	Green	Green	2.41 V ± 0.2	
13	Red	Red	Red	Red	Green	Green	Green	2.24 V ± 0.2	
14	Red	Red	Red	Red	Green	Green	Green	2.07 V ± 0.2	
15	Red	Red	Red	Red	Red	Green	Green	1.89 V ± 0.2	
16	Red	Red	Red	Red	Red	Green	Green	1.72 V ± 0.2	
17	Red	Red	Red	Red	Red	Green	Green	1.54 V ± 0.2	
18	Red	Red	Red	Red	Red	Red	Green	1.37 V ± 0.2	
19	Red	Red	Red	Red	Red	Red	Green	1.20 V ± 0.2	
20	Red	Red	Red	Red	Red	Red	Green	1.02 V ± 0.2	
21	Red	Red	Red	Red	Red	Red	Red	0.85 V ± 0.2	
22	Red	Red	Red	Red	Red	Red	Red	0.67 V ± 0.2	
23	Red	Red	Red	Red	Red	Red	Red	0.50 V ± 0.2	MAX. HOT

AIR DISCHARGE ACCORDING TO PATH SELECTION

Face, Rear, and Defroster

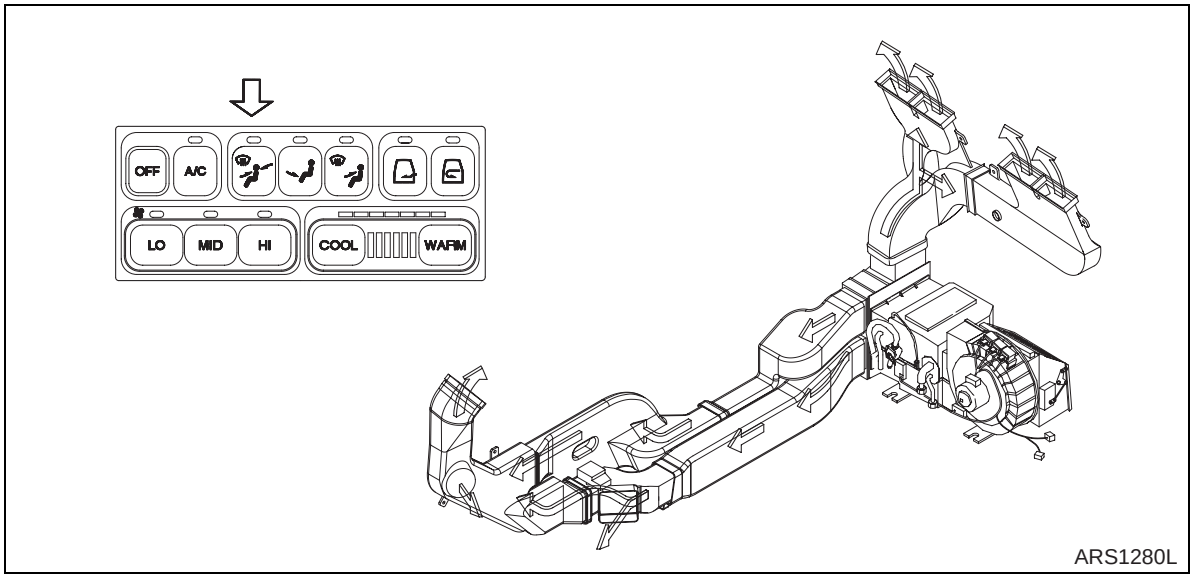


Figure 10

Foot

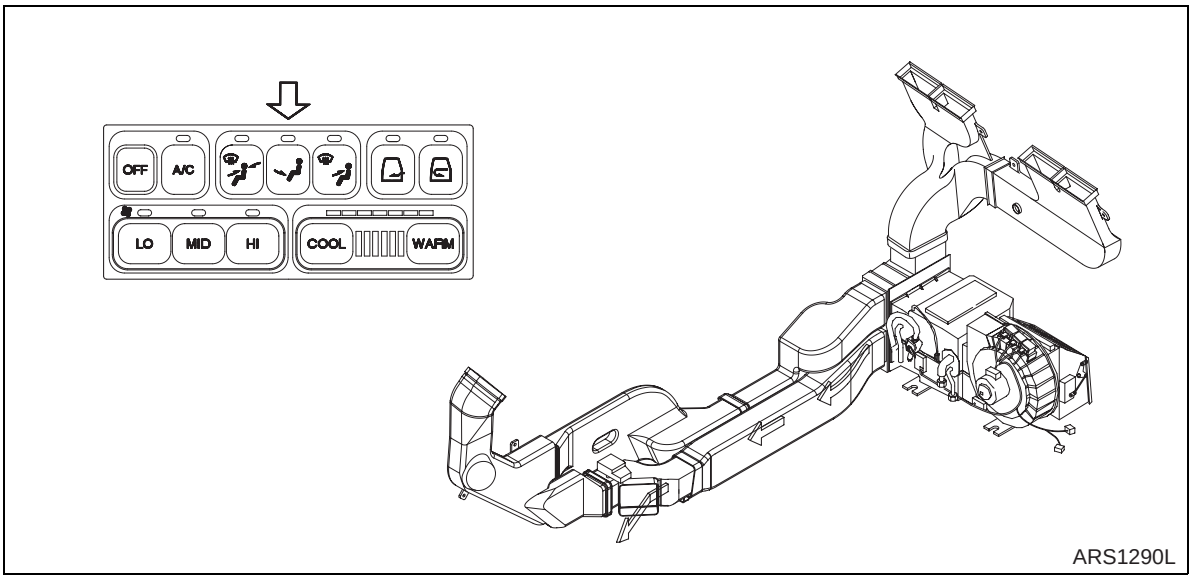


Figure 11

Face and Defroster

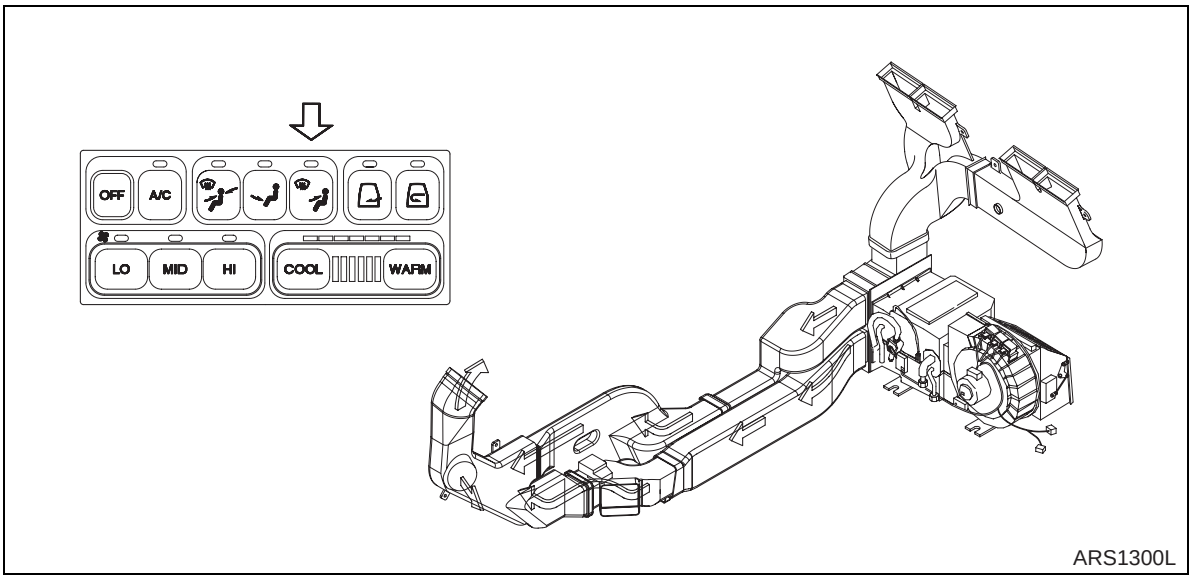


Figure 12

AIR-CONDITIONING SYSTEM CIRCUIT DIAGRAM

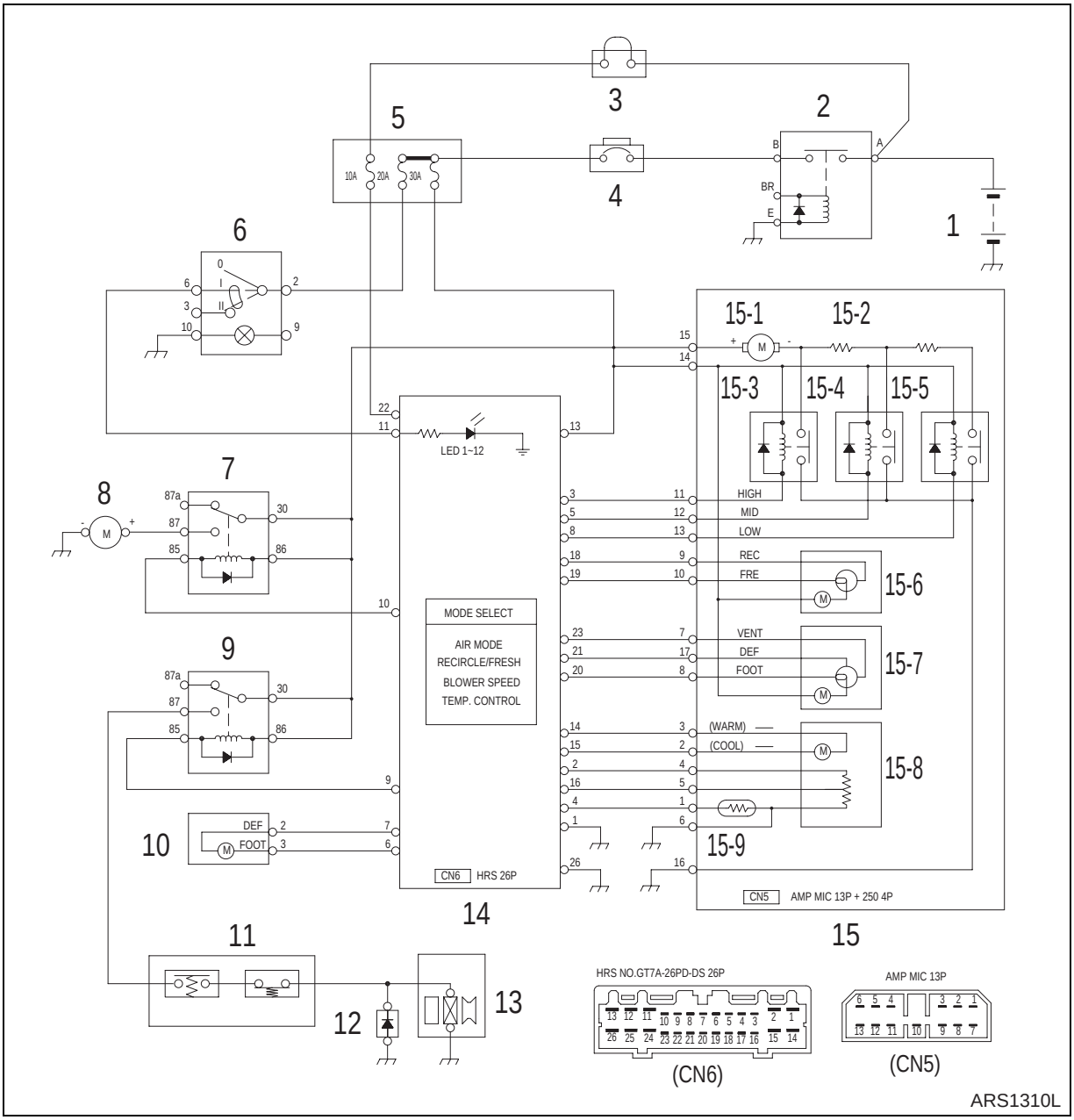


Figure 13

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Fuse
6	Lamp Switch
7	Condenser Fan Relay
8	Condenser Fan Motor
9	Compressor Relay
10	Foot / Defrost Control Actuator
11	Receiver Dryer (Low / High Pressure Cut Off Switch)
12	Diode

Reference Number	Description
13	Compressor
14	A/C Control Panel
15	A/C Unit
15-1	Blower Motor
15-2	Resister
15-3	High Speed Relay
15-4	Mid Speed Relay
15-5	Low Speed Relay
15-6	Recirculate / Fresh Air Control Actuator
15-7	Vent Actuator
15-8	Temperature Control Actuator
15-9	Temperature Sensor (Evaporator)

TROUBLESHOOTING

Refrigerant Pressure Check

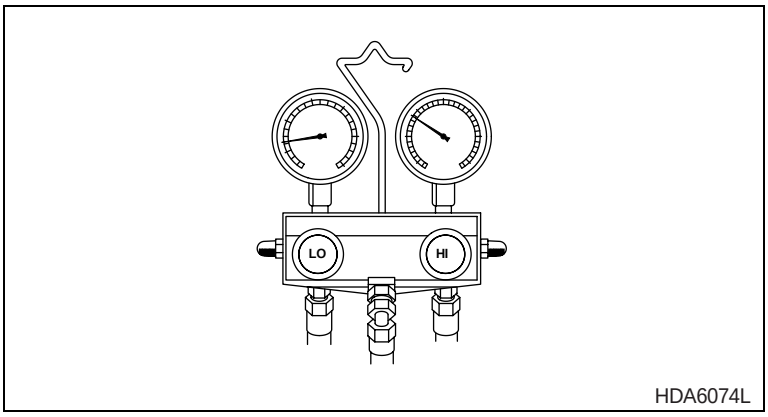


Figure 14

1. Open all doors and windows.
2. Install manifold gauge set.
3. Start engine and maintain engine speed at 1,800 - 2,000 RPM.
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 period of 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 period of 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 due to 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 due to poor compressor compression	
Inspect and replace compressor if necessary.	

WEIGHT OF R134A GAS USED IN MACHINES

Model	Weight of Gas
Mega 130	850 ±20 grams (30 ±0.7 oz.)
Mega 160	850 ±20 grams (30 ±0.7 oz.)
Mega 200-III	850 ±20 grams (30 ±0.7 oz.)
Mega 200-V	850 ±20 grams (30 ±0.7 oz.)
Mega 250-III	850 ±20 grams (30 ±0.7 oz.)
Mega 250-V	850 ±20 grams (30 ±0.7 oz.)
Mega 300-III	950 ±20 grams (33 ±0.7 oz.)
Mega 300-V	850 ±20 grams (30 ±0.7 oz.)
Mega 400-III	950 ±20 grams (33 ±0.7 oz.)
Mega 400-III PLUS	850 ±20 grams (30 ±0.7 oz.)
Mega 400-V	850 ±20 grams (30 ±0.7 oz.)
Mega 500-V	850 ±20 grams (30 ±0.7 oz.)
Solar 130-III	950 ±20 grams (33 ±0.7 oz.)
Solar 130LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 130W-III	950 ±20 grams (33 ±0.7 oz.)
Solar 130W-V	850 ±20 grams (30 ±0.7 oz.)
Solar 170LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 170W-III	1100 ±20 grams (38 ±0.7 oz.)
Solar 200W-III	1100 ±20 grams (38 ±0.7 oz.)
Solar 200W-V	850 ±20 grams (30 ±0.7 oz.)
Solar 220LC-III	950 ±20 grams (33 ±0.7 oz.)
Solar 220LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 220LL	850 ±20 grams (30 ±0.7 oz.)
Solar 250LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 280LC-III	1250 ±20 grams (44 ±0.7 oz.)
Solar 290LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 290LL	850 ±20 grams (30 ±0.7 oz.)
Solar 300LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 300LL	850 ±20 grams (30 ±0.7 oz.)
Solar 330-III	1250 ±20 grams (44 ±0.7 oz.)
Solar 330LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 340LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 400LC-III	1250 ±20 grams (44 ±0.7 oz.)
Solar 400LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 420LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 450LC-III	1250 ±20 grams (44 ±0.7 oz.)
Solar 450LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 470LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 70-III	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

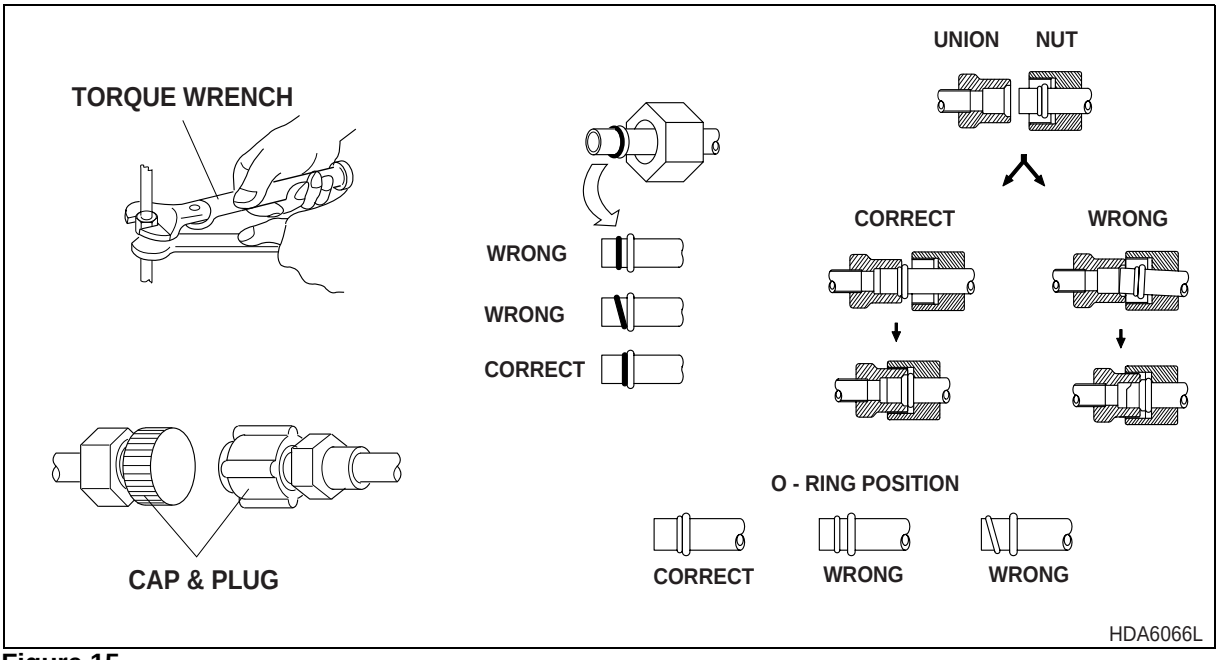


Figure 15

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 into 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.*

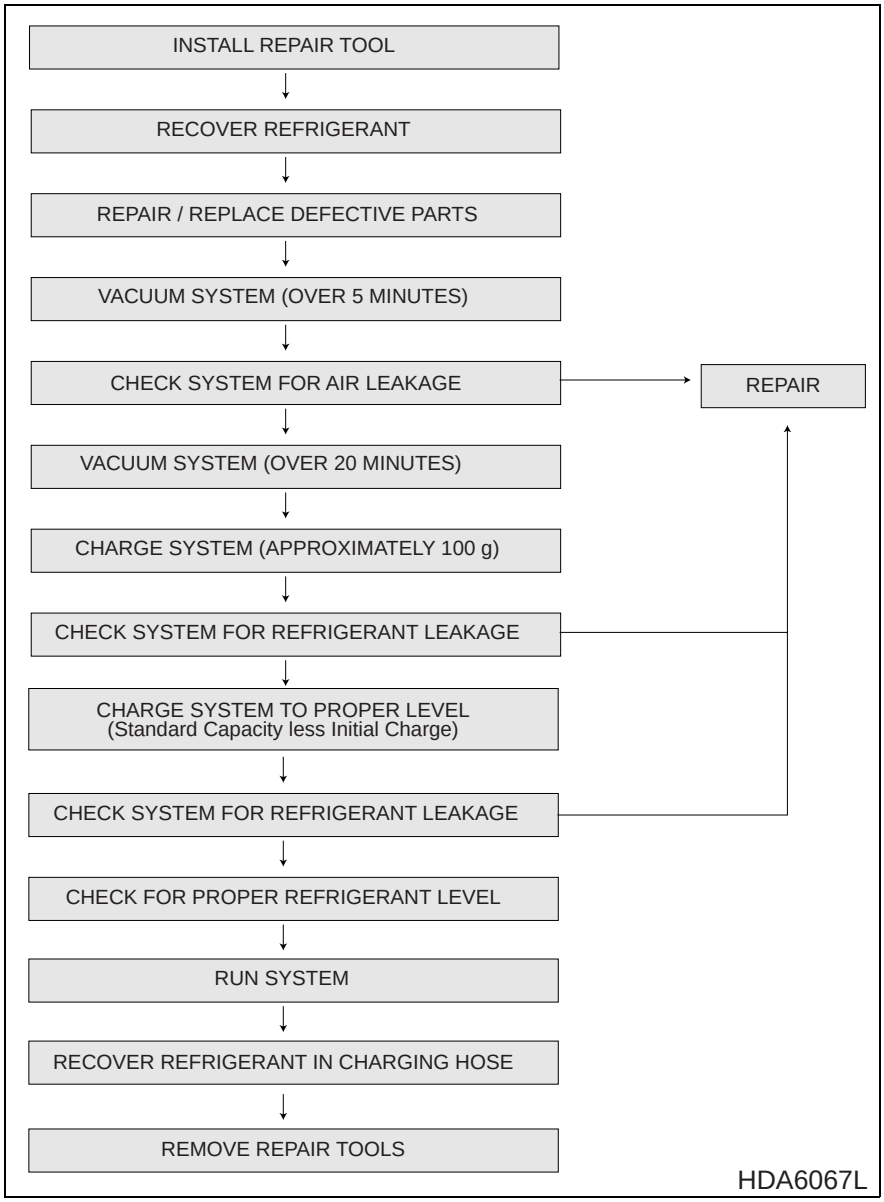

INSTALL REPAIR TOOL
RECOVER REFRIGERANT
REPAIR / REPLACE DEFECTIVE PARTS
VACUUM SYSTEM (OVER 5 MINUTES)
CHECK SYSTEM FOR AIR LEAKAGE
REPAIR
VACUUM SYSTEM (OVER 20 MINUTES)
CHARGE SYSTEM (APPROXIMATELY 100 g)
CHECK SYSTEM FOR REFRIGERANT LEAKAGE
CHARGE SYSTEM TO PROPER LEVEL
(Standard Capacity less Initial Charge)
CHECK SYSTEM FOR REFRIGERANT LEAKAGE
CHECK FOR PROPER REFRIGERANT LEVEL
RUN SYSTEM
RECOVER REFRIGERANT IN CHARGING HOSE
REMOVE REPAIR TOOLS
HDA6067L

Figure 16

REFRIGERANT RECOVERY

Reference Number	Description
1	To Compressor
2	Low Pressure Side
3	High Pressure Side
4	From Receiver
5	Refrigerant Recovery Tank

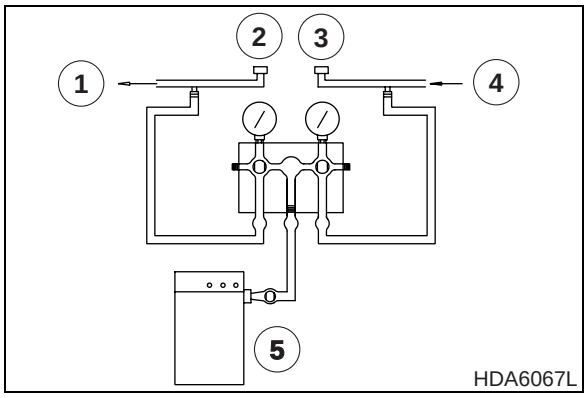


Figure 17

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

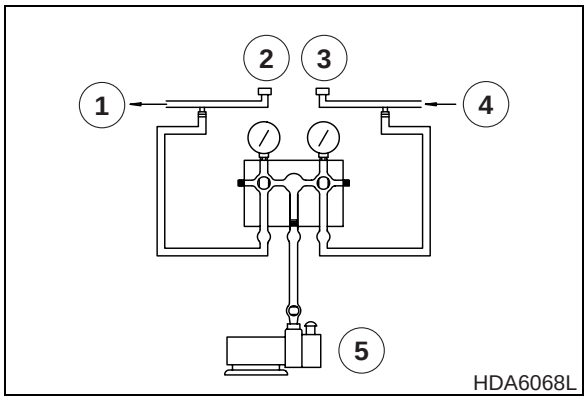


Figure 18

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.

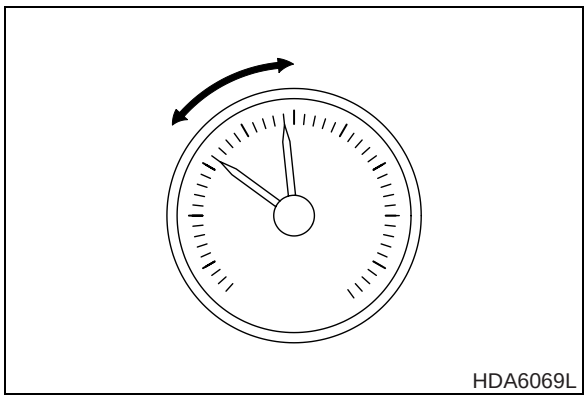


Figure 19

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

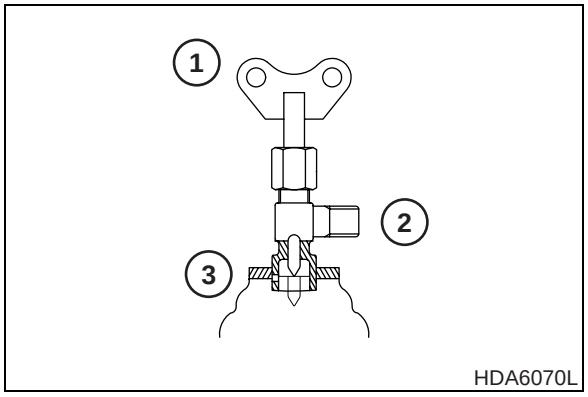


Figure 20

   A. Before mounting valve on the container, make sure the handle is in the counter clockwise 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 disc 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 counter clockwise 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.

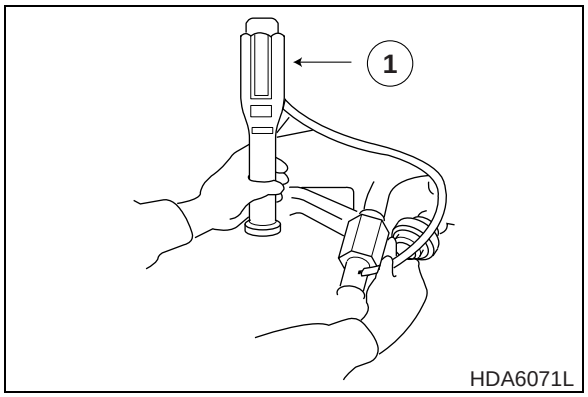


Figure 21

⚠ 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

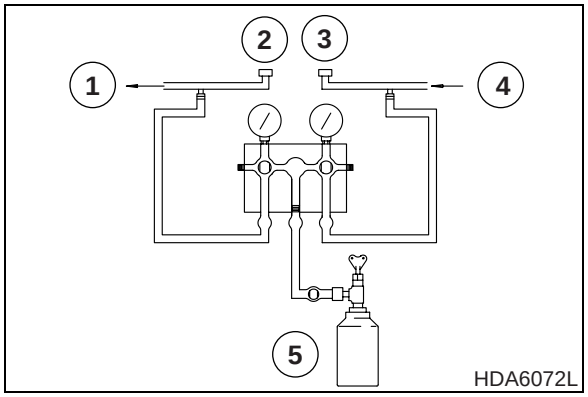


Figure 22

2. Charge the system by opening the manifold gauge low side valve.

   Initial charge amount: 100 g (3.5 ounces).

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 a accurate test.*

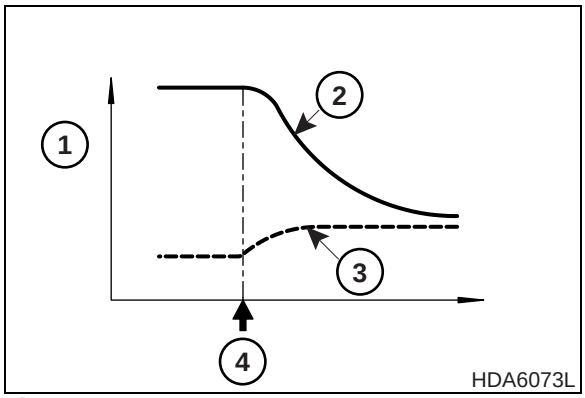


Figure 23

Reference Number	Description
1	Pressure
2	High Pressure
3	Low Pressure
4	Compressor Stop

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.*

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DRIVE COUPLING (MAIN PUMP)

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 340LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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DRIVE COUPLING

When installing the main pump on the engine, it is very important to properly adjust clearance between the face of the coupling hub and end of pump drive shaft ("Measurement H" shown in the following procedure) to a specific value.

Figure 1 thru Figure 2, show typical drive coupling installations.

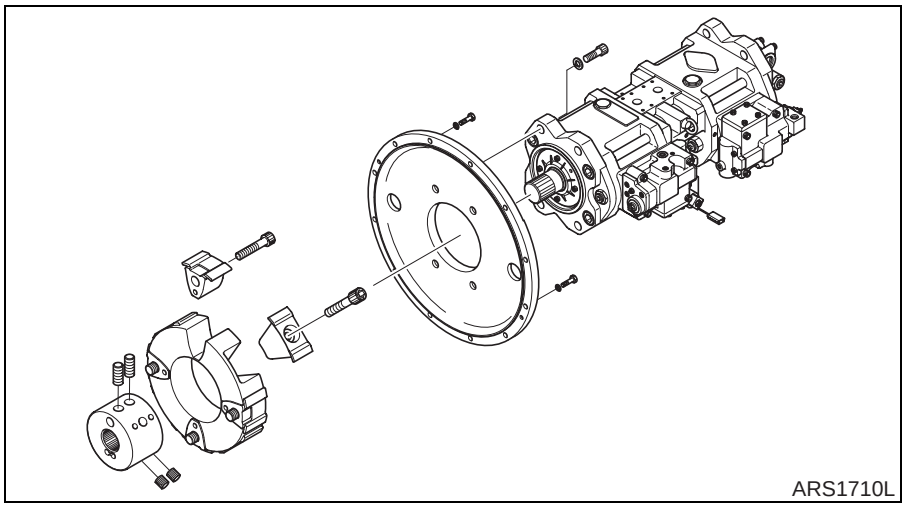


Figure 1 KAWASAKI

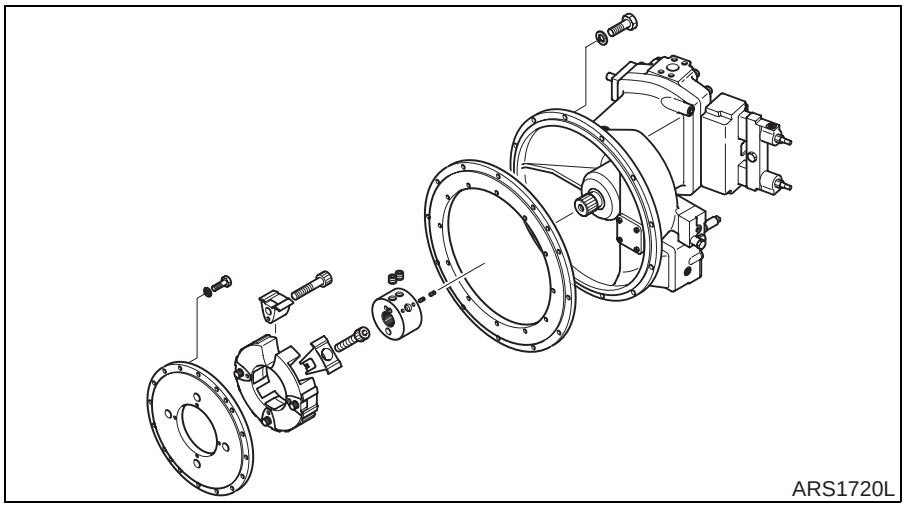


Figure 2 REXROTH

SPECIAL TOOLS

This tool is used to control the distance between the end of the pump drive shaft and the front face of the drive coupling hub (Figure 3 and Figure 5). This distance will be referred to as "Measurement H" in the installation instructions that follow.

NOTE: *In manufacturing drawings (Figure 4), dimension "A" and "B" equal the "Measurement H." The two tools shown are designed to be used on various models of equipment. Only one end of the tool is used for a specific model of equipment.*



Figure 3

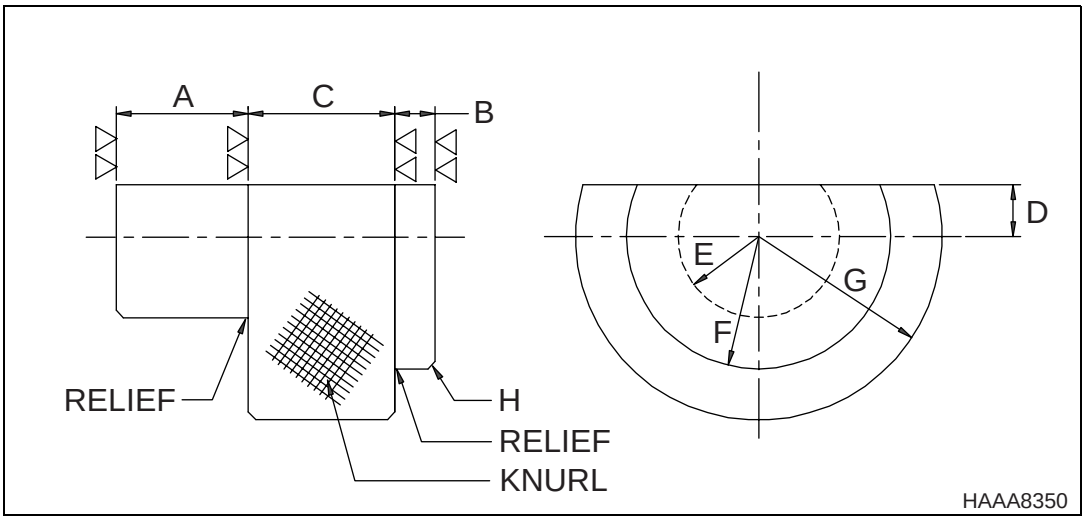


Figure 4

Dimensional Details for Figure 4		
Dimension	**Measurement**	**Models**
A	6 ±0.1 mm (0.2362 ±0.0039 in)	S300LC-V, S300LL
B	7 ±0.1 mm (0.2756 ±0.0039 in)	S340LC-V, S420LC-V, S470LC-V
C	20.0 mm (0.787 in)	
D	7.0 mm (0.275 in)	
E	18.0 mm (0.708 in) Radius	
F	22.0 mm (0.866 in) Radius	
G	30.0 mm (1.181 in) Radius	
H	1.0 mm (0.039 in) x 45° Chamfer	

DRIVE COUPLING INSTALLATION

Whenever the drive coupling for main pump is installed, the following mounting dimensions and installation procedures must be observed.

NOTE: *If these procedures are not followed, noise will occur and/or the service life of drive coupling or main pump will be reduced.*

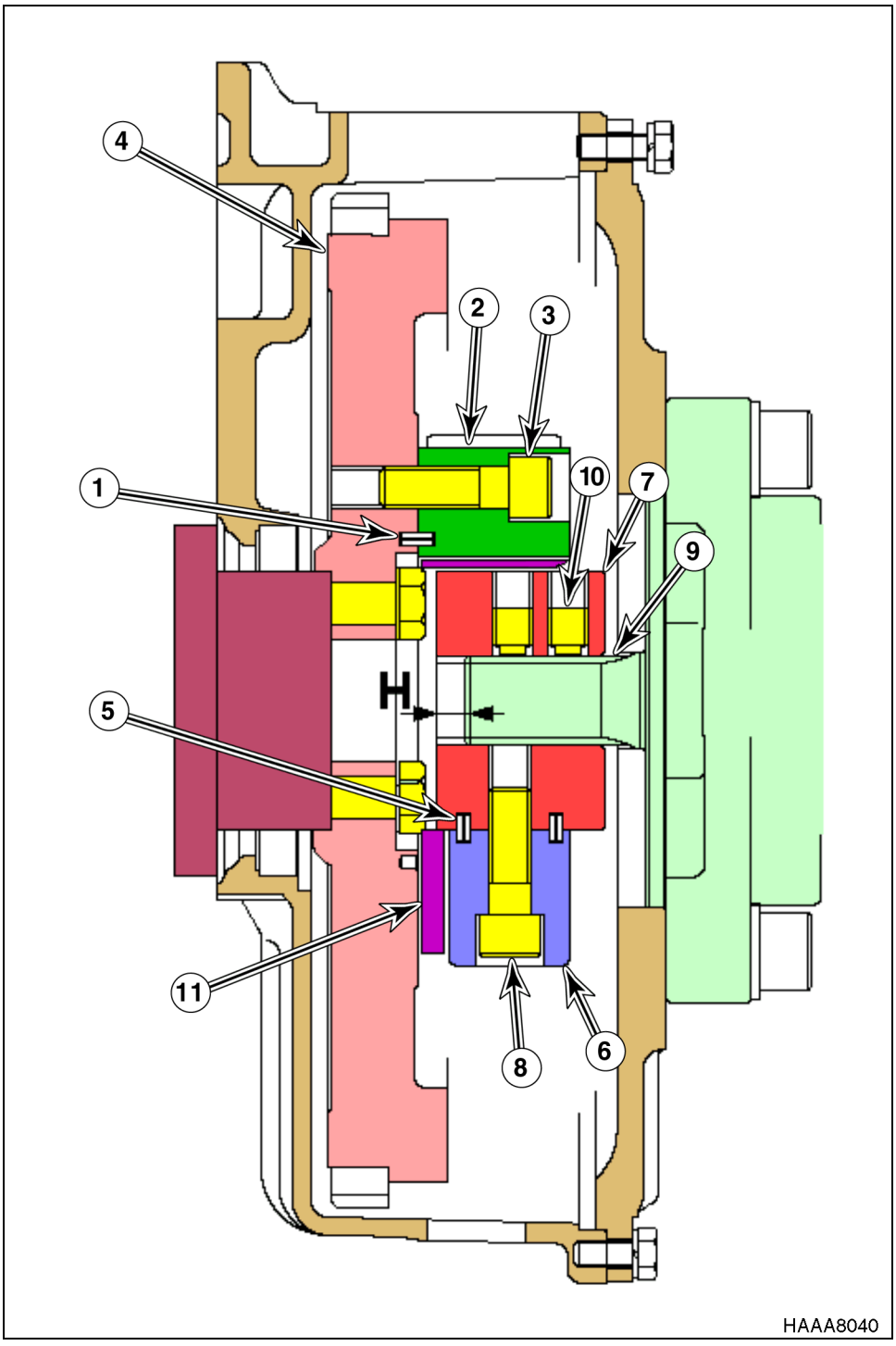


Figure 5 DRIVE COUPLING INSTALLATION

Table 1 Parts Information and Torque for Figure 5			
Reference Number	**Description**	**Qty.**	**Torque (See Table 2)**
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	Clamping screw	2	Tb
11	Element	1	

Specification for "Measurement H," from front hub face to pump shaft end, and TIGHTENING TORQUE of bolts and screws written in the "Table 2" must be observed.

Table 2 Specification for "Measurement H" and Torque (Refer to Figure 5)				
Model	**Coupling Part Number**	**"Measurement H"**	**Torque Value for "Ta"**	**Torque Value for "Tb"**
S300LC-V	414-00040	5.5 - 6.5 mm (0.216 - 0.256 in)	44 - 49 kg•m (318 - 354 ft lb)	20 - 22 kg•m (145 - 159 ft lb)
S300LL				
S340LC-V	414-00041	6.5 - 7.5 mm (0.256 - 0.295 in)	44 - 49 kg•m (318 - 354 ft lb)	20 - 22 kg•m (145 - 159 ft lb)
S420LC-V				
S470LC-V				

INSTALLATION PROCEDURE

NOTE: *Refer to Figure 5 while using following procedure.*

1. Install spring pin (1) and attach insert (2) with bolt (3) to engine flywheel (4).

   NOTE: *Tighten bolts to value "Ta" in the tables.*

2. Install two spring pins (5) and attach insert (6) to hub (7) bolts (8).

   NOTE: *Tighten bolts to value "Ta" in the tables.*

3. Attach flywheel cover to the main pump with bolts. (S300LC-V, S340LC-V only.)

4. Slide hub (7) into place on pump shaft (9) as specified in the "Table 2" for "Measurement H" and secure it in position with clamping screws (10).

   NOTE: *Tighten clamping screws to value "Tb" in the tables.*

   NOTE: *Coat clamping screws (10) with Loctite #262.*

5. Install element (11) between inserts (2) on engine flywheel (4)

6. Install main pump and hub (7) by pushing it softly into element (11).

7. Attach flywheel cover / pump housing to flywheel housing with bolts

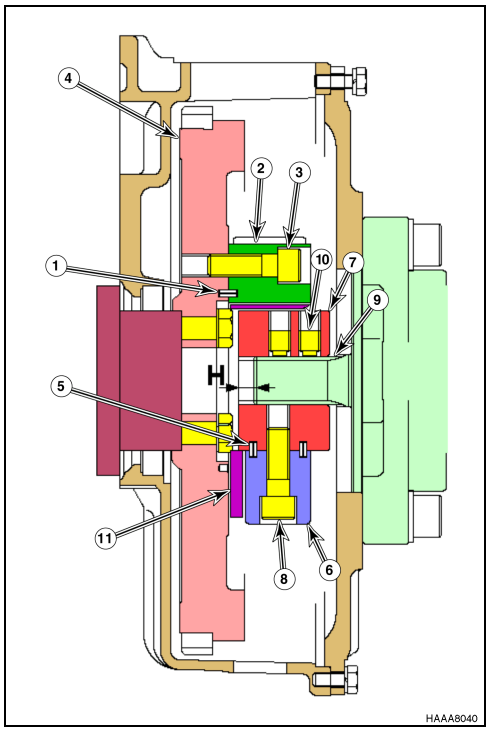


Figure 6 DRIVE COUPLING INSTALLATION

CAUTION!

1. **Bolts (3 and 8) are coated against loosening with a bonding compound. Do not use any additional bonding compounds, oils or cleaning solvents on them.**
2. **Element (11) is non-resistant to bonding compounds, oil or grease. Be careful not to expose it to them.**
3. **Remove oil or dirt from flywheel cover and pump shaft before assembly.**
4. **Misalignment between pump and engine should be controlled to less than 0.6 mm (0.023 in).**

HYDRAULICS

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HYDRAULIC SYSTEM TROUBLESHOOTING, TESTING AND ADJUSTMENT

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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HYDRAULIC SYSTEM - GENERAL NOTES

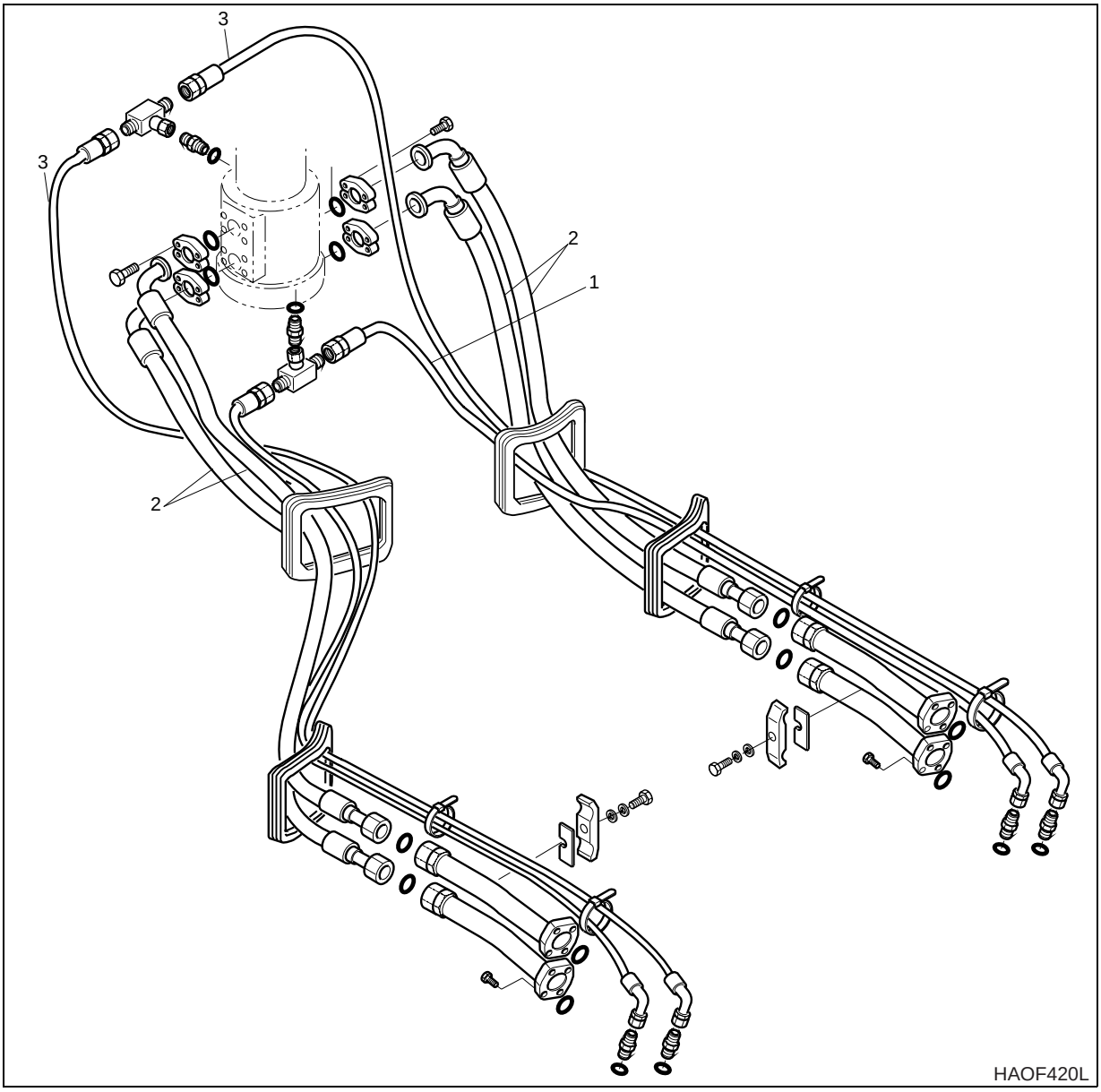


Figure 1 Pattern of Drawing (Solar 470LC-V)

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 a number of 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, swing, boom up 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, bucket, boom 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 anti-vacuum 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 as a result 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 damage as a result of overloads or shocks to the boom. Additional protection - to prevent cavitation of the cylinder - is provided by a make-up 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.

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 - 10 kg/cm^2 (100 - 142 psi), boom control valve spools open and oil from both pumps goes to the boom cylinder.

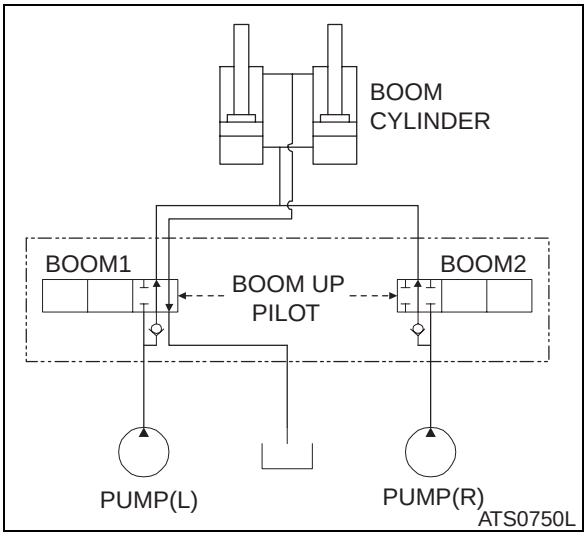


Figure 2

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 BOOM1 spool of the valve. When secondary pilot pressure reaches 7 - 10 kg/cm^2 (100 - 142 psi), the BOOM1 spool on the left side of the control valve opens so that oil from only one pump (PUMP(L)) assembly goes to the boom cylinder for boom lowering.

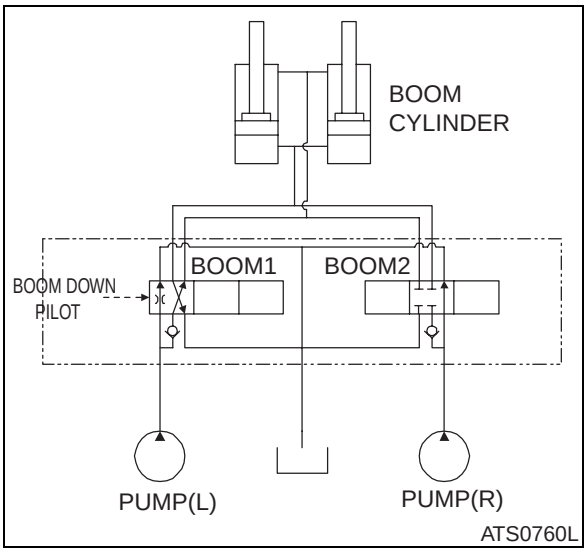


Figure 3

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, arm regeneration valve, 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 crowd and dump cylinder ports on ARM1 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 make-up 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 ARM1 and ARM2 of the control valve simultaneously.

When secondary pilot pressure reaches 7 - 10 kg/cm^2 (100 - 142 psi), the arm control valve spools ARM1 and ARM2 open. Output flow from both pumps 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 head 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.

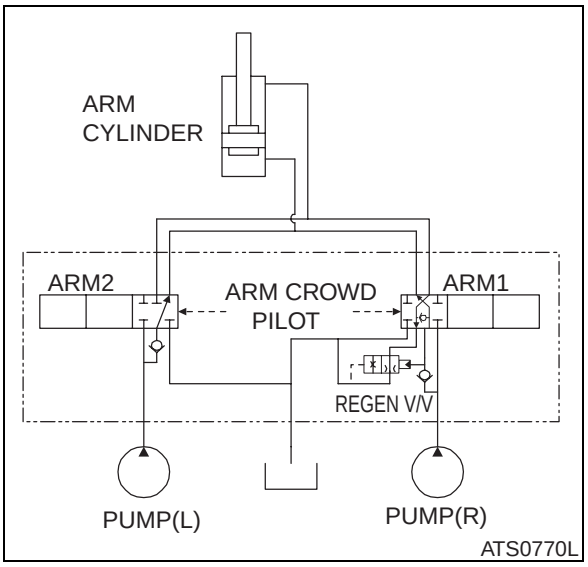


Figure 4

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 ARM1 and ARM2 of the control valve simultaneously.

When pilot pressure reaches 7 - 10 kg/cm^2 (100 - 142 psi), the control spools open, allowing oil from PUMP(L) and PUMP(R) to flow to the arm cylinder.

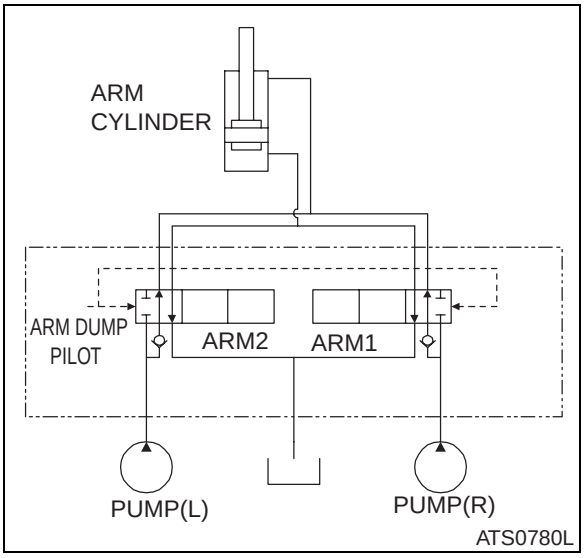


Figure 5

BUCKET OPERATING CIRCUIT

The bucket operating circuit includes the right and left main pumps, the both sides of the control valve and the bucket cylinder. 360 kg/cm^2 (5,112 psi) overload relief valves located at crowd and dump cylinder ports on BUCKET of the control valve protect the circuit and its components from damage.

BUCKET CROWD CIRCUIT

When the bucket control lever is placed in the crowd position, the right side pilot valve generates secondary bucket crowd pilot pressure that is transmitted to BUCKET and BC spool of the control valve. When secondary pilot pressure reaches 7 - 10 kg/cm^2 (100 - 142 psi), the BUCKET and BC spools open so that oil from both pumps goes to the bucket cylinder.

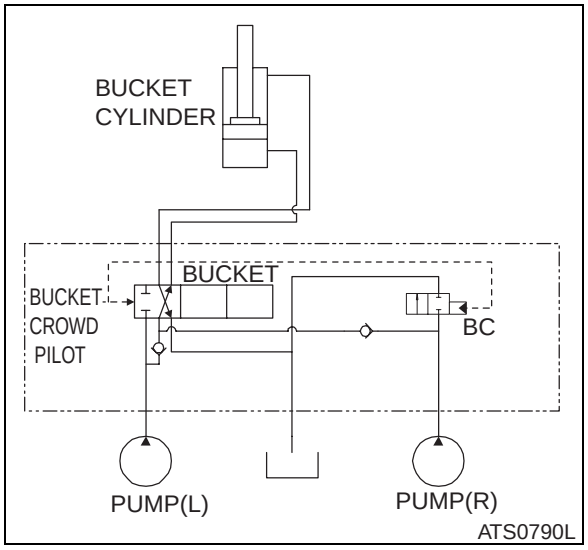


Figure 6

BUCKET DUMP CIRCUIT

When the bucket control lever is put in the dump mode, the right side pilot valve generates secondary bucket dump pilot pressure that is transmitted to BUCKET spool of the control valve. When secondary pilot pressure reaches 7 - 10 kg/cm^2 (100 - 142 psi), the bucket spool opens so that oil form PUMP(L) goes to the bucket cylinder.

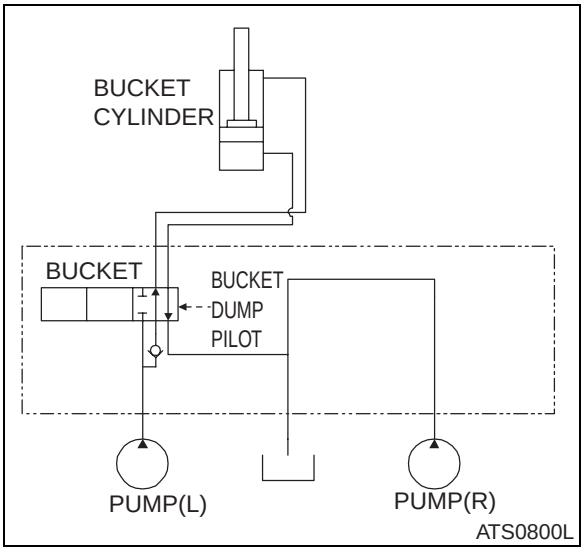


Figure 7

SWING OPERATING CIRCUIT

The swing operating circuit consists of the right main pump in the pump assembly, the right 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.

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 SWING spool of the control valve. Output flow from PUMP(R) is goes to the swing motor.

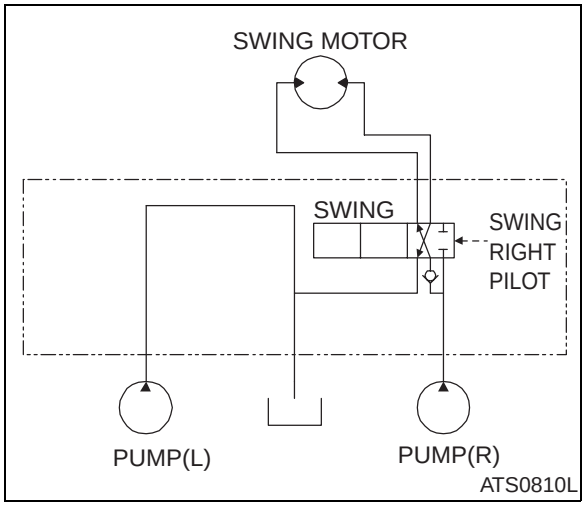


Figure 8

LEFT SWING OPERATING CIRCUIT

When the swing control lever is pushed to the left swing position, pilot pressure from the left side pilot valve is directed to SWING spool of the control valve moves in the opposite direction and output flow from the PUMP(R) is goes to the swing motor.

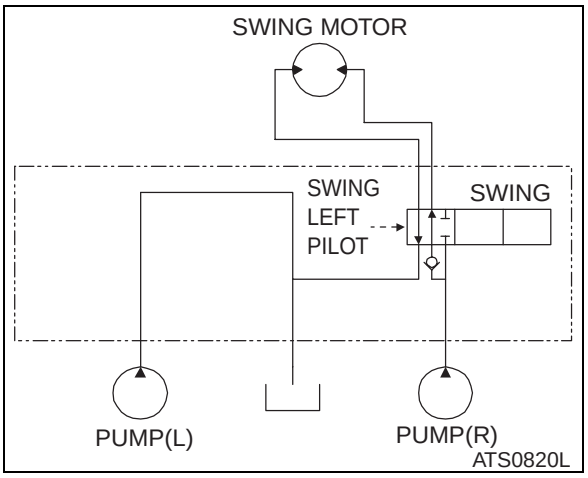


Figure 9

SWING RELIEF VALVE AND MAKE-UP 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 relief valve is installed in the swing motor and a large-capacity make-up valve is connected to the entrance port of the hydraulic reservoir, helping maintain acceptable pressures on both sides of the circuit.

NOTE: *Relief Valve Setting Pressure:*
S420LC-V: 270.0 kg/cm^2 (3,840 psi)
S470LC-V: 280.0 kg/cm^2 (3,980 psi)

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 TRAVEL (R) and TRAVEL (L) spools on the control valve, through the upper works center joint, to the travel motors on each side of the machine.

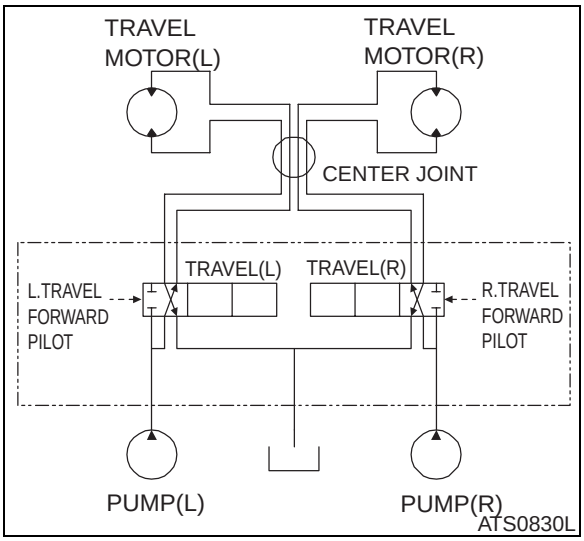


Figure 10

REVERSE TRAVEL CIRCUIT

When the right and left travel control levers are pushed backward, output from both main pumps is directed through the TRAVEL (R) and TRAVEL (L) spools on the control valve, through the upper works center joint, to the travel motors.

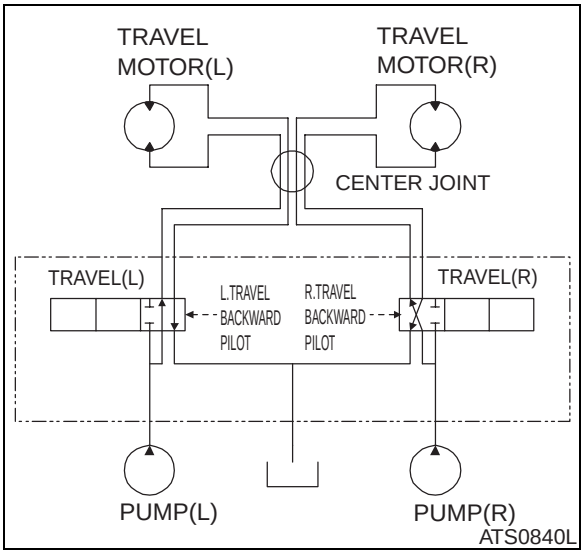


Figure 11

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 2,190 RPM with no load
- at 2,000 RPM stall load

If engine RPM drops excessively with a load or fails to surpass rated speed (1,900 RPM), performance problems may be due to 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; crowd, bucket, boom, 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 lock nut 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)	40 ±5 bar (580 ±73 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 located 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 multi-lead jumper harness is required. The jumper harness (which is available through Daewoo After Sales Service, or could be spliced together from commonly available, purchased parts) has extra leads so that a VOM meter can be connected to the circuit.

To set up the testing equipment, turn off the 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 lock nut on the end of the valve, turn the adjusting screw 1/4 turn and re-check current and pressure. Repeat adjustment as required to obtain specified performance and retighten the valve lock nut.*

Mode	Engine RPM	Current	Pressure
Power Mode	High Idle: 2,190 RPM	600 ±20 mA	1.5 bar (22 psi)
Standard Mode	High Idle: 2,190 RPM	0 mA	18 bar (261 psi)

BOOM/FRONT PRIORITY VALVE

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 front priority control valves are located inside the compartment behind the cabin.

The same jumper harness used for testing the power mode (EPOS) control valve is used to test these two valves. Turn off the 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 back into the system if excessive fluid was lost.*

Operate the swing and boom simultaneously. Measure signal current and hydraulic pressure through the valve and record the highest and lowest values. Reset the work mode control to "digging" mode, and then to "trenching" mode and repeat the same tests.

VALVE FUNCTION	DIGGING MODE 		TRENCHING MODE 	
	VOLTAGE	PRESSURE	VOLTAGE	PRESSURE
Front Priority	0 V	0 - 40 bar (0 - 580 psi)	20 - 30 V	0 bar (0 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) lock nut 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 inner-most (smallest diameter) screw clockwise to increase the setting, or counterclockwise to decrease it. Pressure should be at least 320 bars (4,641 psi), but less than 325 bars (4,714 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	320 bar + 5 bar (4,641 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 located alongside the swing priority solenoid and arm speed control solenoid, in compartment rear of the operator's cab, 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 on to make any changes of adjustment settings,

- **Verify engine output to the rated speed - 2,150 ±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.

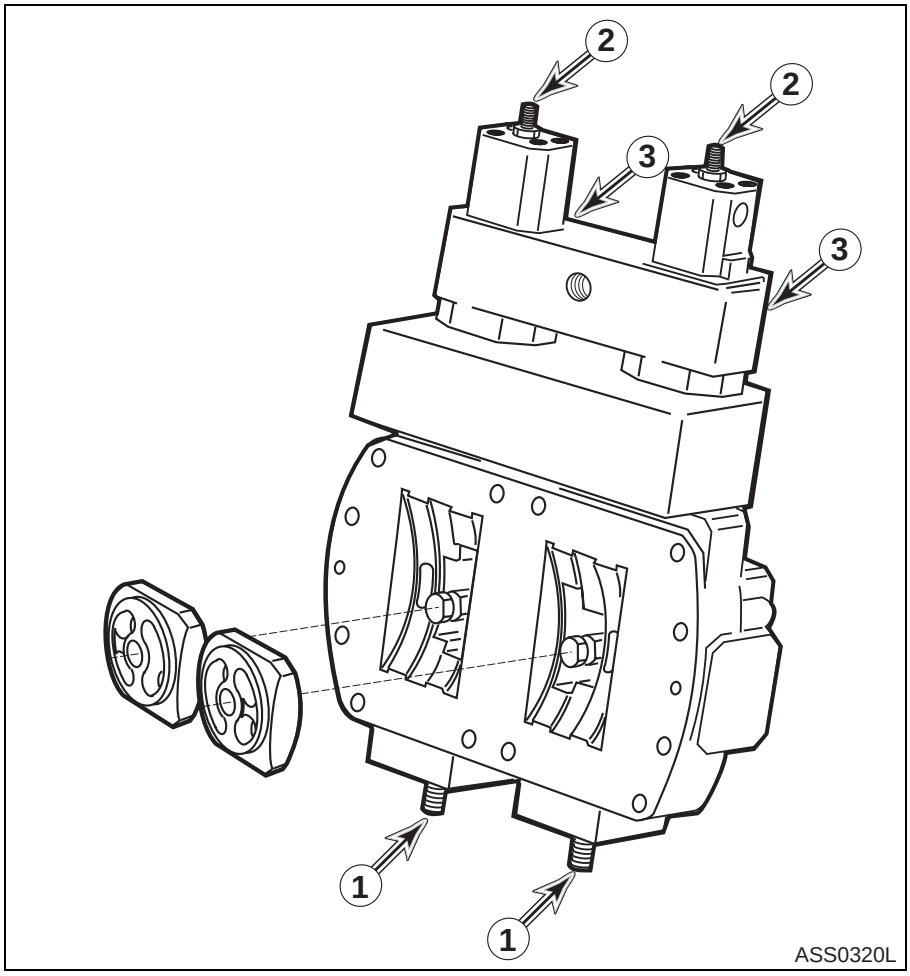


Figure 12

Refer to the illustration of the pump regulator control valve (Figure 12) for the location of adjustment screws (1, 2 and 3). There are three different adjustments, Qmax, Pi-Q Pd-Q, adjustment screws (1, 2 and 3). 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, adjust screw 2 clockwise to shift the Pi-Q control valve curve decrease compensating control pressure.

A 1/2 turn on the adjusting screw is equal to approximately -0.7 kg/cm^2 of Pi.

NOTE: *For each full turn of adjustment on the screw (2), the square-tipped adjusting screw should be turned in the opposite direction turns to avoid changing inner spring adjustment.*

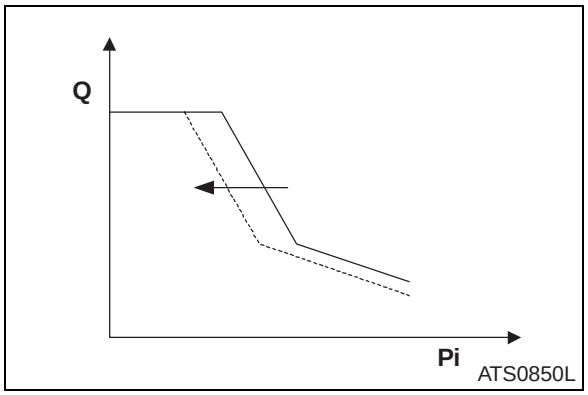


Figure 13

Pump input power adjustments are normally made in small increments, 1/4 turn (90°) or less, each time.

Turning the screw (3) clockwise shift Pd-Q curves right and increase input horse power. 1/2 turn on the screw (3) is equal to approximately +33 kg/cm^2 of Pd.

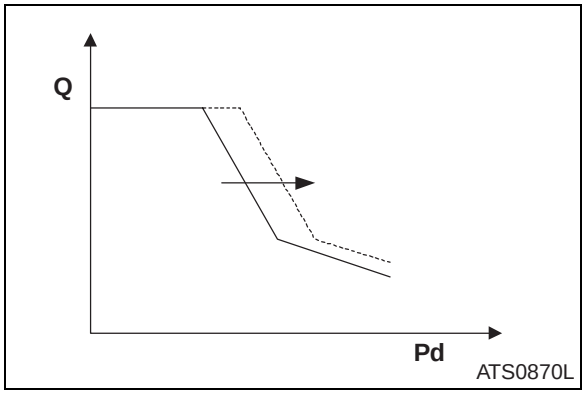


Figure 14

The adjusting screw (1) affects the delivery rate (Q) of the pump. Turning the adjusting screw shift the maximum cut flow (as shown in Figure 15).

Balance both pumps for equal output.

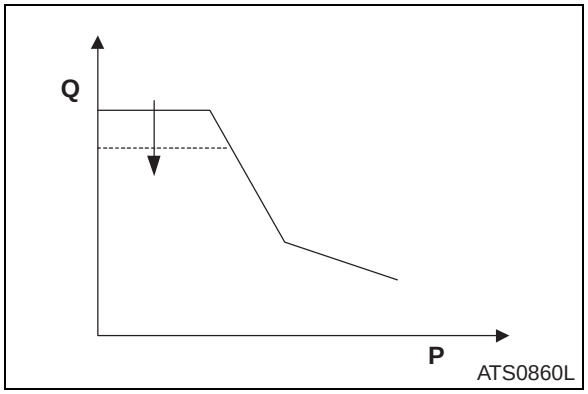


Figure 15

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 Daewoo 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

- Turn off the 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.
- Bolt up a pre-measured 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 de-aerate 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 III 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 Note, below	

Compare recorded values with output shown in the P-Q curve in the specifications section of this book.

If test results do not measure up to 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 320 kg/cm^2 (4,550 psi), not 350.0 kg/cm^2 (4,978 psi).*

SWING SYSTEM TROUBLESHOOTING

PRECAUTIONS/INITIAL CHECKS

1. Stop work. Release all weight or any type of load safely before proceeding. Avoid risking injury or adding to damage.
2. Turn off 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 to a clean, clear container. Look for metal shavings/grit, cloudiness/water or foam/air bubbles in the oil.
- 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 270 - 280 bar (3,916 - 4,061 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 4 bar (58 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 falls 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, drive train 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 4 bar (58 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 falls 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 drive train 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. Refer to the Electrical section of this book for more information.*

TROUBLESHOOTING - SWING GEARBOX

Problem	Possible Causes	Remedies
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.

Problem	Possible Causes	Remedies
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 drive train.	Replace broken gears and drive train assemblies.
	Overload.	Reduce load weight.
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.
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 drive shaft 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 noises, 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 Causes	Remedies
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.

Problem	Possible Causes	Remedies
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.
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 work load 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 make-up 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.

Problem	Possible Causes	Remedies
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 Causes	Remedies
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.

Problem	Possible Causes	Remedies
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:		
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 lock nut and adjusting screw.	Readjust
	Components worn out, past wear limits.	Replace

TROUBLESHOOTING - TRAVEL CONTROL VALVE

Problem	Possible Causes	Remedies
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 re-route 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 Causes	Remedies
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 pre.ssure 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 locate damaged seals or gaskets that could be the cause of air leaks.*		

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

ACCUMULATOR

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 340LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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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

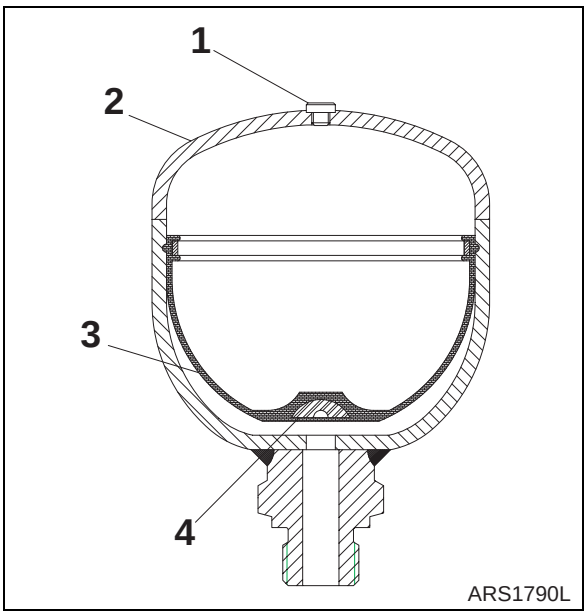


Figure 1

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 pre-charging or expelling gas from the compressible, pre-charged 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.

There are six possible positions the diaphragm can be in and 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 pre-pressure 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.

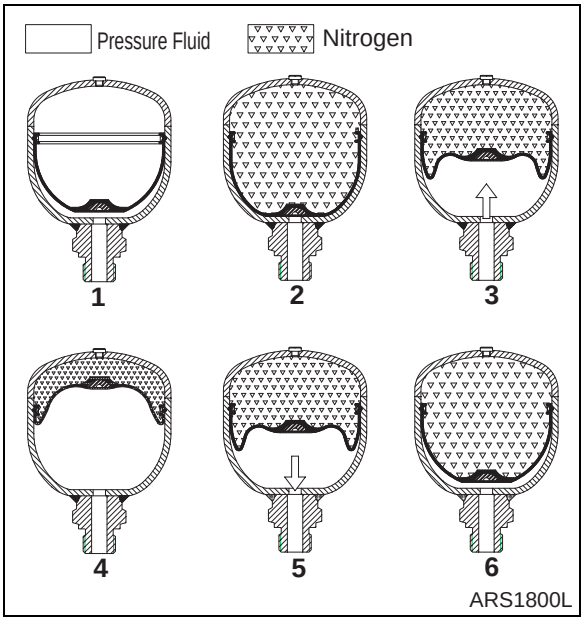


Figure 2

NOTE: *Pre-charge 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 pre-charge 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 counter-pressure from system oil - the valve 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 pre-charge 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 pre-charge 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 pre-charge pressure and hydraulic system oil pressure achieve a rough balance. In this condition a minimal amount of oil is stored in the accumulator.

SPECIFICATIONS

Model	Serial Number	System	Charge Pressure	Volume
Solar 300LC-V	S/N 1001 thru 1099	Pilot / Travel	10 kg/cm^2 (140 psi)	320 cc (19.53 in^3)
	S/N 1100 and Up			750 cc (45.77 in^3)
Solar 300LL	S/N 1100 and Up	Pilot / Travel	10 kg/cm^2 (140 psi)	750 cc (45.77 in^3)
Solar 340LC-V	S/N 1001 thru 1059	Pilot / Travel	10 kg/cm^2 (140 psi)	320 cc (19.53 in^3)
	S/N 1060 and Up			750 cc (45.77 in^3)
Solar 420LC-V	S/N 1001 thru 1029	Pilot / Travel	10 kg/cm^2 (140 psi)	320 cc (19.53 in^3)
	S/N 1030 and Up			750 cc (45.77 in^3)

Model	Serial Number	System	Charge Pressure	Volume
Solar 470LC-V	S/N 1001 thru 1049	Pilot / Travel	10 kg/cm^2 (140 psi)	320 cc (19.53 in^3)
	S/N 1050 and Up			750 cc (45.77 in^3)

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CENTER JOINT (SWIVEL)

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 470LC-V	1001 and Up

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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.

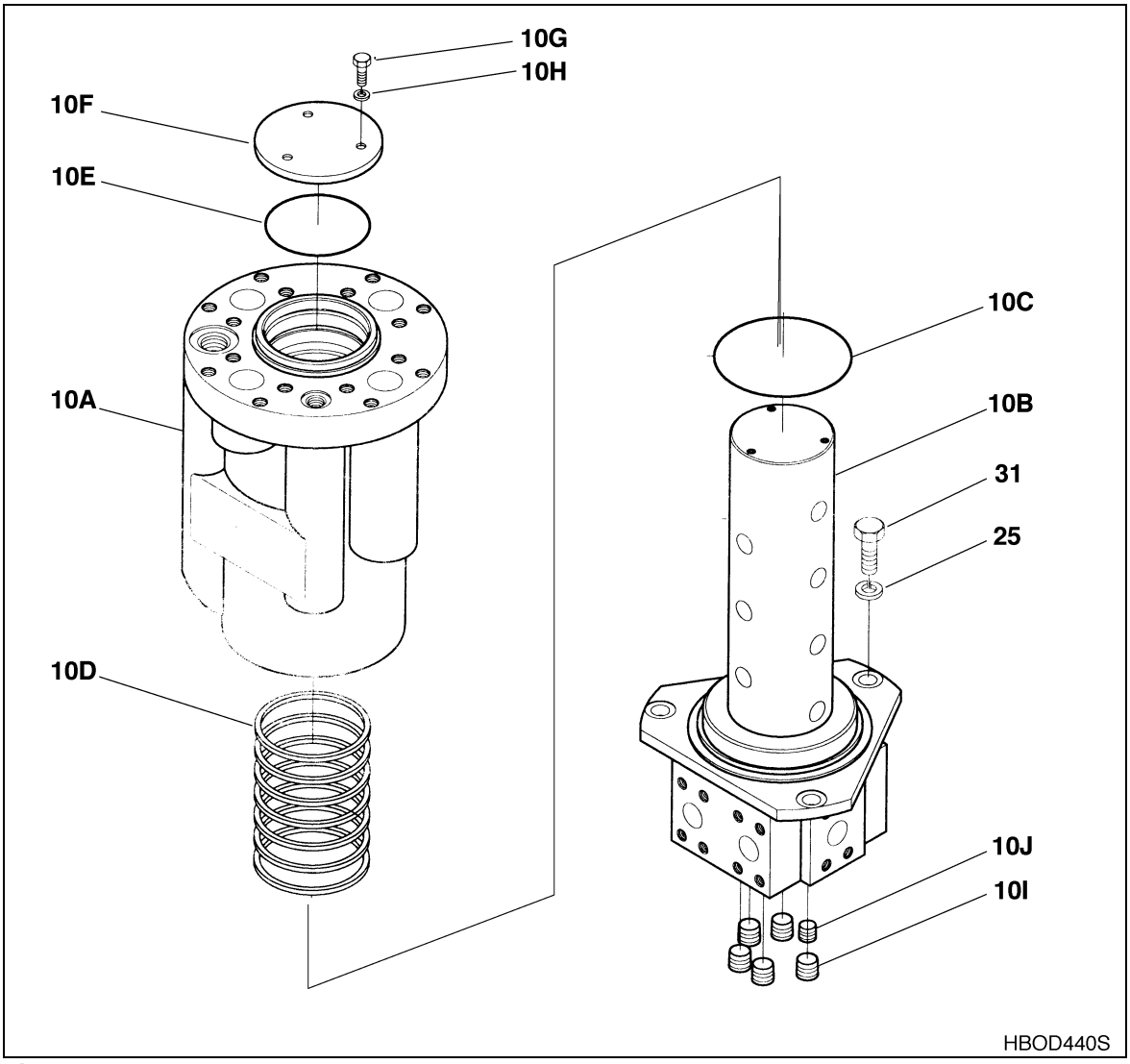


Figure 1

Reference Number	Description
10A	Center Joint Body
10B	Spindle
10C	O-ring
10D	Slipper Seal
10E	O-ring
10F	Cover

Reference Number	Description
10G	Hex Bolt
10H	Spring Washer
10I	Plug
10J	Plug
25	Spring Washer
31	Bolt

INSPECTION

The center joint should be checked for evidence of external oil leakage every 2,000 hour of operation. 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 change-over valve.

Install the change over 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 change-over 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).*

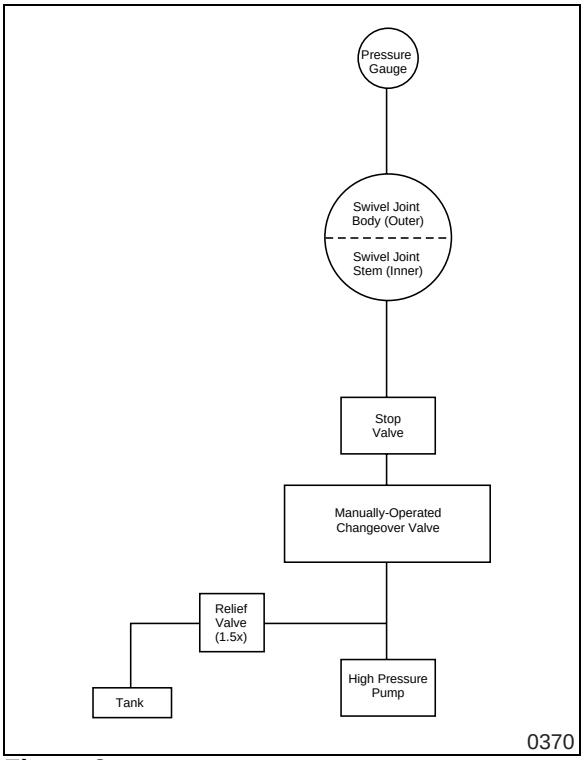


Figure 2

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 three 8 mm fasteners holding the cover. Use a vise or v-block to hold the assembly in place.
4. Remove the cover, withdraw the spindle.
5. If the spindle doesn't separate easily when cover and fastener bolts 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 teardown, use a thin but rounded-tip, smooth-edge scraper or spatula to remove O-rings or seals, to avoid causing damage to those that must be reused.

   NOTE: *The O-ring (10E) shown in the assembly drawing (above the swivel joint stem 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 Center Joint.*

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. Pre-lubricate 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 spindle and inner surface of the center swivel body. Apply slow, even-handed pressure, using both hands, to slowly push the spindle into the body. Seals may be damaged if the spindle is pushed in too quickly.**

2. Thoroughly clean all other component surfaces of dirt or grease prior to reassembly.
3. Reverse disassembly steps for reassembly.
4. Clean threads of fasteners before pre-applying Loctite #243 to the threads, and before torquing the cover bolts.
5. Pre-fill the center swivel with clean hydraulic fluid prior to reassembly of high-pressure and drain line piping. Clean and pre-fill 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.

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CYLINDERS

⚠ CAUTION!

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Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 130LC-V	0001 and Up
Solar 130W-V	0001 and Up
Solar 170LC-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 220LC-V	0001 and Up
Solar 250LC-V	1001 and Up
Solar 290LC-V	0001 and Up
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 330LC-V	1001 and Up
Solar 340LC-V	1001 and Up
Solar 400LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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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 B (Figure 1).

$$F_1 = P \times \frac{\pi B^2}{4}$$

(P: Pressure, p = 3.14, B: Cylinder Inside Diameter)

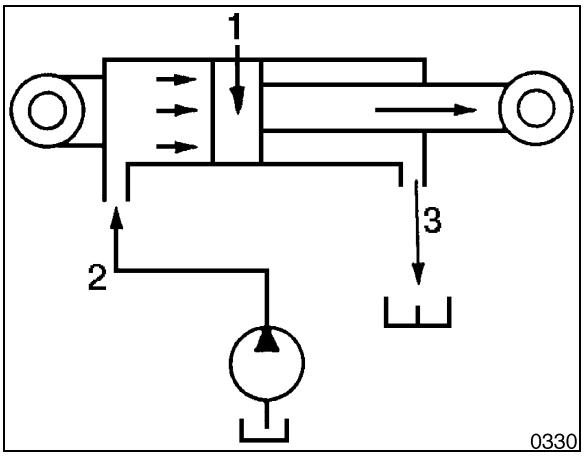


Figure 1

1.	**Cylinder Inside Diameter - B**
2.	**Oil Path A**
3.	**Oil Path B**
4.	**Rod Diameter**

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.

$$F_2 = P \times \frac{\pi(B^2-R^2)}{4}$$

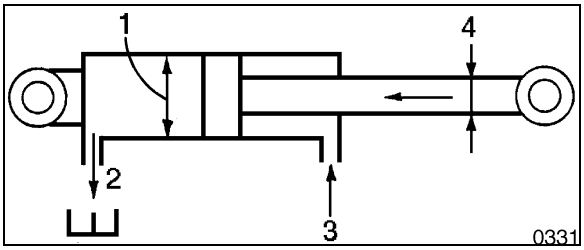


Figure 2

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 decrease cylinder stroke length than it does to lengthen it.

$$Q_1 = S \times \frac{\pi(B^2)}{4}$$

$$Q_2 = S \times \frac{\pi(B^2-R^2)}{4}$$

$Q_1 > Q_2$

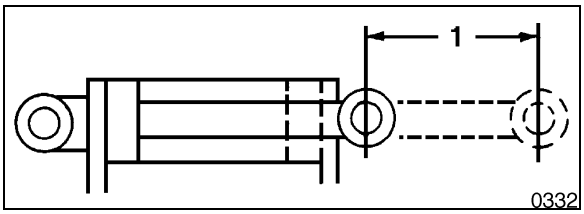


Figure 3

PARTS LIST

The following parts list is a partial listing only; for full and 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.

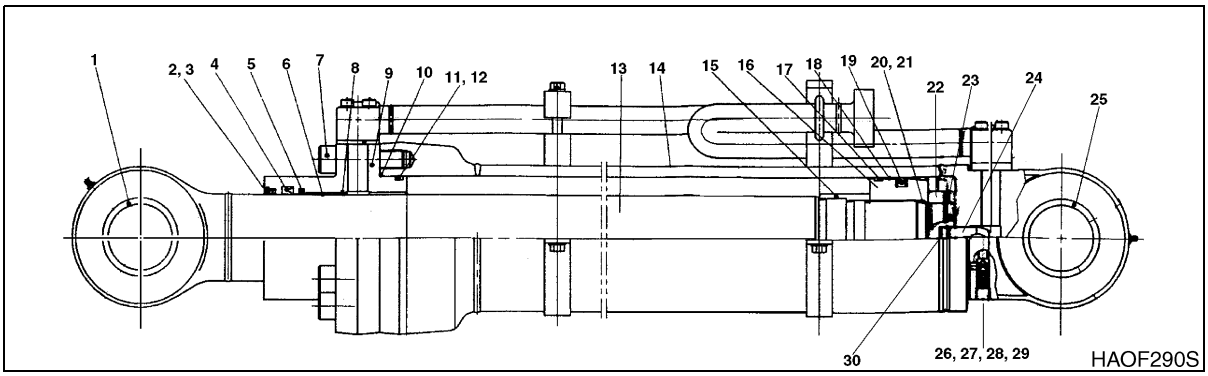


Figure 4

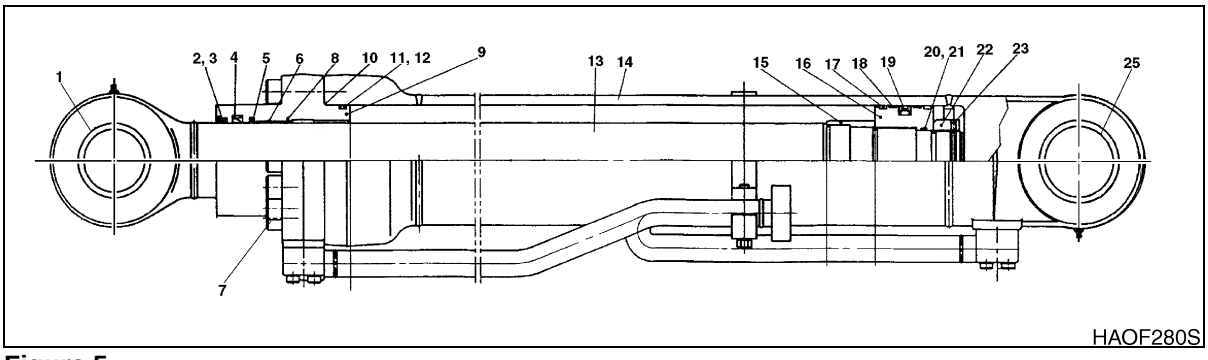


Figure 5

Reference Number	Description
1	Bushing
2	Dust Wiper
3	Retaining Ring
4	U-Packing
5	Buffer Seal
6	Rod Bushing
7	Bolt
8	Retaining Ring
9	Rod Cover
10	O-ring
11	O-ring
12	Backup Ring
13	Piston Rod
14	Cylinder Tube
15	Cushion Ring

Reference Number	Description
16	Piston
17	Slide Ring
18	Wear Ring
19	Slipper Seal
20	O-ring
21	Backup Ring
22	Piston Nut
23	Set Screw
24	Cushion Plunger
25	Bushing
26	Check Valve
27	Spring Support
28	Spring
29	Plug
30	Stop Ring

SPECIAL TOOLS AND MATERIALS

PISTON NUT

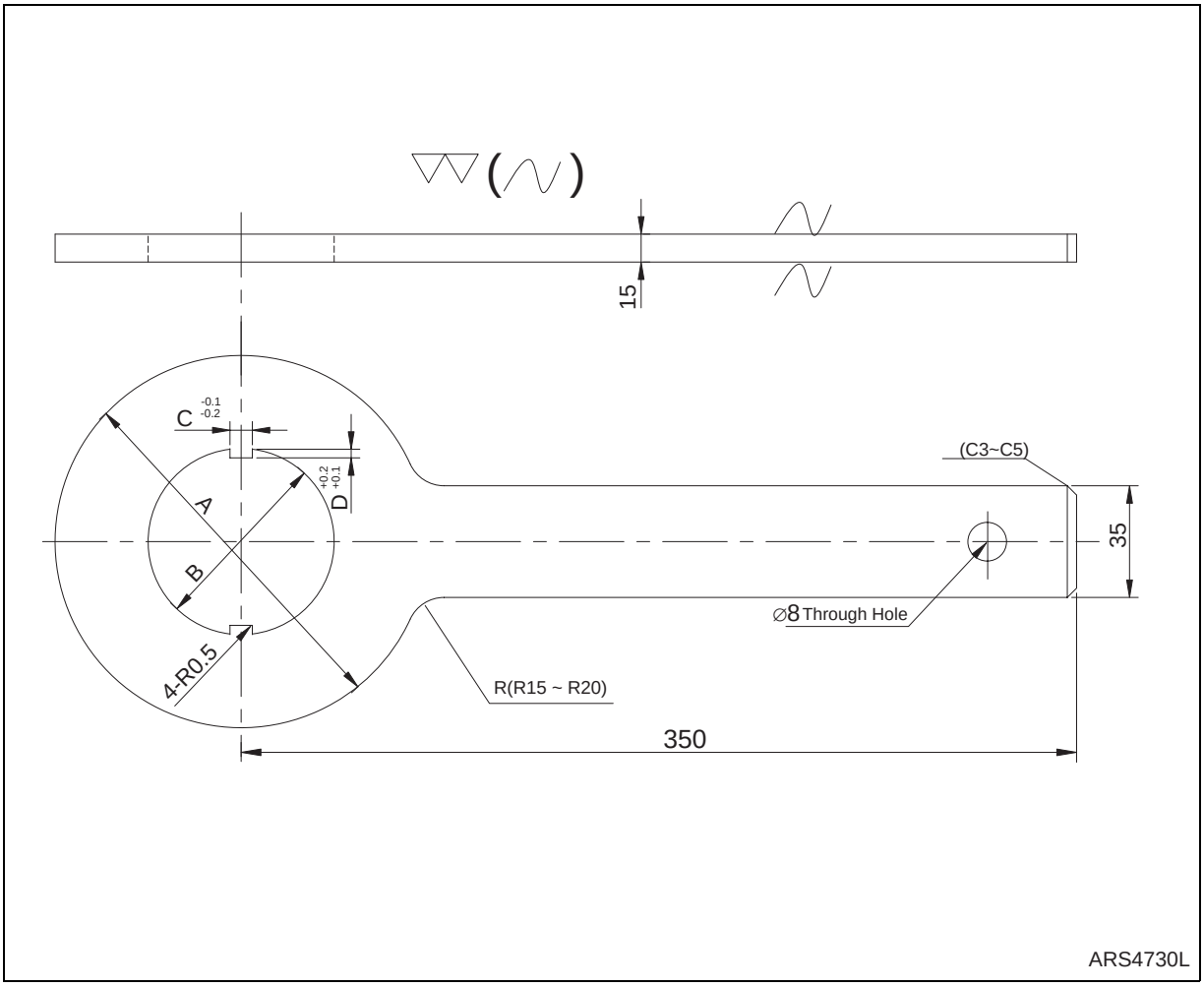


Figure 6

Material SM45C (AISI 1045)

Rockwell Harden from 22 - 27

Oil Quench

MODEL	CYLINDER	øA	øB	C	D	MODEL (CYLINDER)
S55-V	ARM	110.0 mm (4.33 in)	69.0 mm (2.72 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	S55-V (BOOM, BOOM (OP))
	SWING	100.0 mm (3.94 in)	58.0 mm (2.23 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
	BUCKET	110.0 mm (4.33 in)	69.0 mm (2.72 in)	10.0 mm (0.39 in)	5.0 mm (0.20 in)	S80W-II (DOZER) MEGA 400 (P/S)
S130LC-V	ARM	130.0 mm (5.12 in)	90.0 mm (3.54 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	S130W-V (ARM (EURO)) S170LC-V (BOOM) S170W-V (BOOM) S200W-V (BOOM) S200LC-V (BOOM) S200N-V (BUCKET) (OPTION)
	BOOM (OP)	125.0 mm (4.92 in)	85.0 mm (3.35 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	S130W-V (ARM) S130LC-V (SHORT ARM) S170W-V (BUCKET) S220LC-V (BUCKET) S220LL (BUCKET)
	BUCKET	115.0 mm (4.53 in)	75.0 mm (2.95 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
S220LL	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)	S330LC-V (ARM) S340LC-V (ARM) S370LC-V (ARM) S400LC-V (BOOM, BUCKET) S420LC-V (BOOM, BUCKET) S450LC-V (BOOM, BUCKET) S470LC-V (BOOM, BUCKET)
	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)	S200N-V (ARM (OP)) S220LC-V (ARM) S290LC-V (BOOM) S300LC-V (BOOM)
	BUCKET	125.0 mm (4.92 in)	102.0 mm (4.02 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	S170LC-V (BOOM) S200W-V (BUCKET)

MODEL	CYLINDER	øA	øB	C	D	MODEL (CYLINDER)
S250LC-V	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)	S290LL (BOOM, BUCKET) S330LC-V (BUCKET (OP), BOOM, BUCKET) S340LC-V (BUCKET (OP), BOOM, BUCKET) S370LC-V (BUCKET (OP), BUCKET) S390LL (BOOM, BUCKET)
S290LC-V	S/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)	S290LC-V (ARM) S300LC-V (ARM, S/ARM) S370LC-V (BOOM)
S290LL	ARM	155.0 mm (6.10 in)	115.0 mm (4.53 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	S400LC-V (ARM) S420LC-V (ARM)
S450LC-V	ARM	170.0 mm (6.69 in)	129.0 mm (5.08 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	S470LC-V (ARM)
S55W-V	ARM	106.0 mm (4.17 in)	66.0 mm (2.60 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
S80W-II	ARM	120.0 mm (4.72 in)	79.0 mm (3.11 in)	10.0 mm (0.39 in)	5.0 mm (0.20 in)	S70-III (ARM) S80W-II (BOOM) MEGA 130-III (LIFT)
	BOOM	120.0 mm (4.72 in)	79.0 mm (3.11 in)	10.0 mm (0.39 in)	5.0 mm (0.20 in)	S70-III (BOOM, DOZER) S130LC-V (DOZER) MEGA 200-III TC (BUCKET) MEGA 130-III (BUCKET)
	BUCKET	110.0 mm (4.33 in)	69.0 mm (2.72 in)	10.0 mm (0.39 in)	5.0 mm (0.20 in)	S70-III (BUCKET)
S130W-V	BOOM	120.0 mm (4.72 in)	80.0 mm (3.15 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
S170W-V	ARM	140.0 mm (5.52 in)	98.0 mm (3.86 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	S170LC-V (ARM) S250LC-V (BOOM, BUCKET) S290LC-V (S/BUCKET, BUCKET) S300LC-V (S/ BUCKET, BUCKET)
P/S: Power Steering						

PISTON JIG

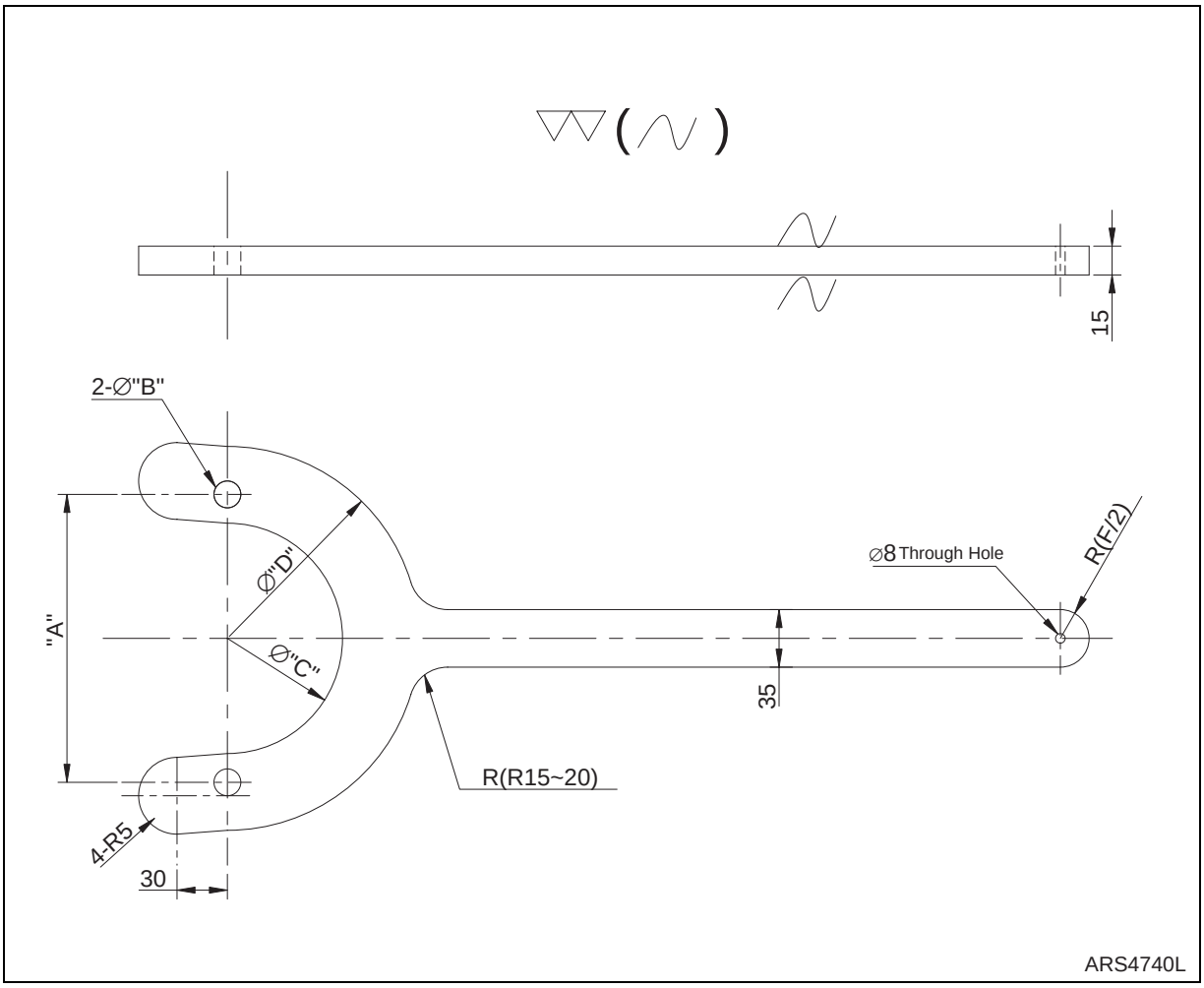


Figure 7

Material SM45C (AISI 1045)

Rockwell Harden from 22 - 27

Oil Quench

MODEL	CYLINDER	A (±0.1)	øB	øC	øD	MODEL (CYLINDER)
S55-V	BOOM	80.0 mm (3.15 in)	11.0 mm (0.43 in)	45.0 mm (1.77 in)	100.0 mm (3.94 in)	S55-V (BOOM (OP)) S55W-V (BOOM)
	SWING	58.0 mm (2.28 in)	11.0 mm (0.43 in)	38.0 mm (1.50 in)	80.0 mm (3.15 in)	MEGA 300 (P/S)
S70-III	ARM	70.0 mm (2.76 in)	11.0 mm (0.43 in)	51.0 mm (2.01 in)	95.0 mm (3.74 in)	S80W-II (ARM)
	BUCKET	60.0 mm (2.36 in)	11.0 mm (0.43 in)	43.0 mm (1.69 in)	85.0 mm (3.35 in)	S80W-II (BUCKET, DOZER)
	DOZER	70.0 mm (2.76 in)	11.0 mm (0.43 in)	53.0 mm (2.09 in)	95.0 mm (3.74 in)	S130LC-V (DOZER)
S220LC-V	ARM	110.0 mm (4.33 in)	13.0 mm (0.51 in)	76.0 mm (2.99 in)	140.0 mm (5.51 in)	S220LC-V (BOOM) S220N-V (ARM (OP)) S250LC-V (ARM) S290LC-V (BOOM, BUCKET) S300LC-V (BOOM, BUCKET)
	BUCKET	90.0 mm (3.54 in)	11.0 mm (0.43 in)	63.0 mm (2.48 in)	115.0 mm (4.53 in)	S70-III (BOOM) S80W-II (BOOM) S130W-V (ARM (EURO)) S130LC-V (S/ARM, BOOM (OP), ARM) S170LC-V (BOOM) S170W-V (BUCKET, BOOM) S220LC-V (BUCKET) MEGA 200-III (LIFT)
S290LC-V	ARM S/ARM	120.0 mm (4.72 in)	13.0 mm (0.51 in)	85.0 mm (3.35 in)	150.0 mm (5.91 in)	S290LL (BUCKET, BOOM) S300LC-V (ARM, S/ARM) S330LC-V (BOOM, BUCKET) S340LC-V (BUCKET, BOOM, BUCKET (OP)) S370LC-V (BUKCET, BUCKET (OP))
S330LC-V	ARM	130.0 mm (5.12 in)	13.0 mm (0.51 in)	93.0 mm (3.66 in)	165.0 mm (6.50 in)	S340LC-V (ARM) S400LC-V (ARM, BOOM) S420LC-V (ARM, BOOM, BUCKET) S450LC-V (BOOM, BUCKET) S470LC-V (BOOM, BUCKET)
S450LC-V	ARM	150.0 mm (5.91 in)	13.0 mm (0.51 in)	103.0 mm (4.06 in)	180.0 mm (7.09 in)	S470LC-V (ARM)
S55W-V	ARM	63.0 mm (2.48 in)	11.0 mm (0.43 in)	43.0 mm (1.69 in)	90.0 mm (3.54 in)	S55-V (ARM, BUCEKT) S55W-V (BUCKET)
S130W-V	BOOM	75.0 mm (2.95 in)	11.0 mm (0.43 in)	53.0 mm (2.09 in)	100.0 mm (3.94 in)	S130LC-V (BOOM)
S170W-V	ARM	96.0 mm (3.78 in)	13.0 mm (0.51 in)	69.0 mm (2.72 in)	130.0 mm (5.12 in)	S170LC-V (ARM) S200W-V (O/R, DOZER) S250LC-V (BUCKET, BOOM)
	BUCKET	80.0 mm (3.15 in)	11.0 mm (0.43 in)	58.0 mm (2.28 in)	110.0 mm (4.33 in)	S70-III (BOOM) S80W-II (BOOM) S130W-V (ARM) S130LC-V (S/ARM, BOOM (OP))
S200W-V	BOOM	90.0 mm (3.54 in)	13.0 mm (0.51 in)	63.0 mm (2.48 in)	115.0 mm (4.53 in)	S220LC-V (BOOM) S220N-V (BUCKET (OP))

MODEL	CYLINDER	A (±0.1)	øB	øC	øD	MODEL (CYLINDER)
P/S: Power Steering *O/R: Out Rigger*						

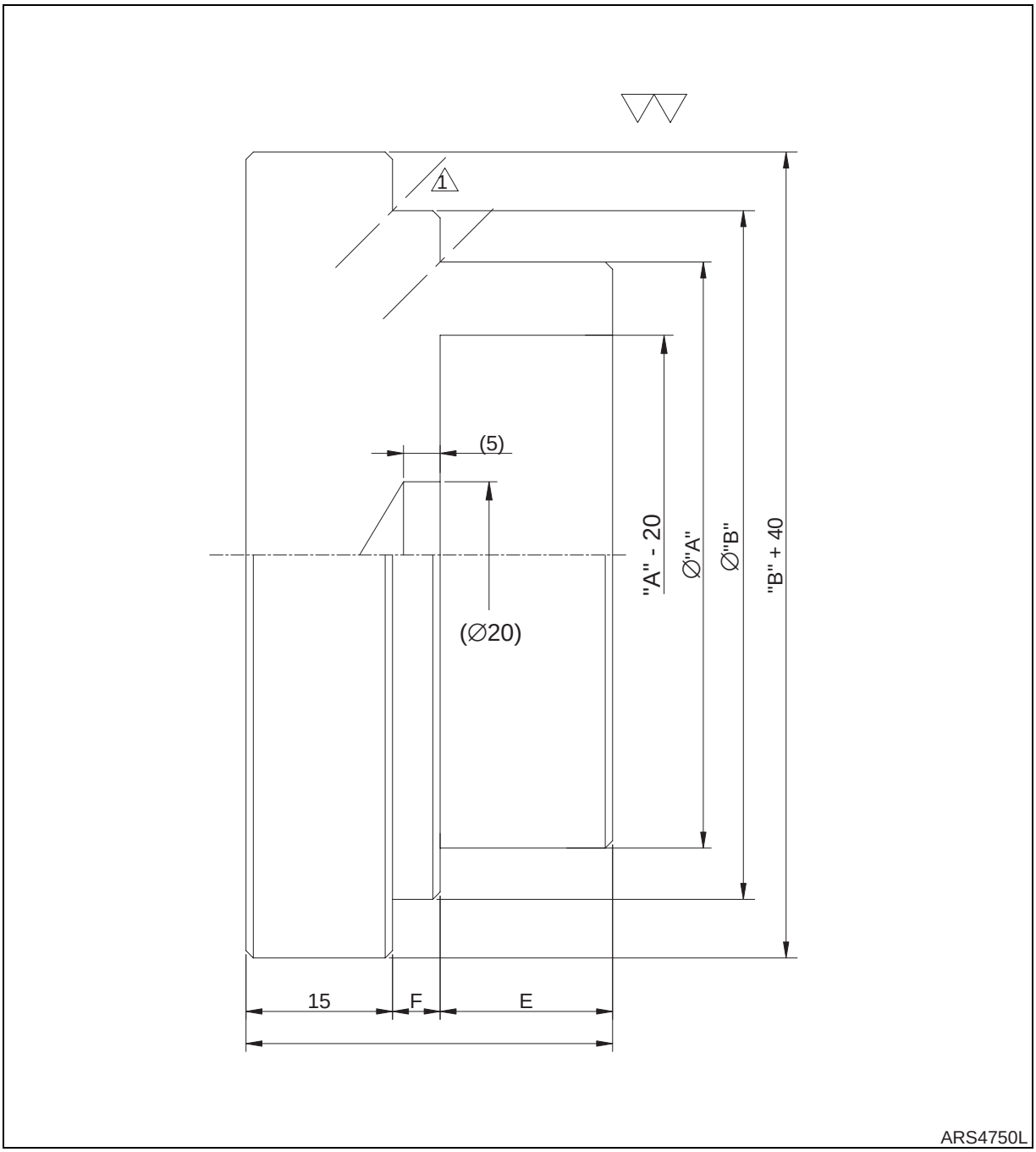


Figure 8

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)
S55-V	BOOM	50.0 mm (1.97 in)	65.0 mm (2.56 in)	30.0 mm (1.18 in)	-		S55W-V (BOOM)
	SWING	40.0 mm (1.58 in)	50.0 mm (1.97 in)	20.0 mm (0.79 in)	-		
	DOZER	65.0 mm (2.56 in)	70.0 mm (2.76 in)	30.0 mm (1.18 in)	-		
S70-III	DOZER	50.0 mm (1.97 in)	60.0 mm (2.36 in)	40.0 mm (1.58 in)	0		
	BUCKET	50.0 mm (1.97 in)	60.0 mm (2.36 in)	25.0 mm (0.98 in)	5.0 mm (0.20 in)	H/C	S55-V (ARM)
	BUCKET	55.0 mm (2.17 in)	68.0 mm (2.68 in)	30.0 mm (1.18 in)	5.5 mm (0.22 in)	K/C	S80W-II BUCKET (K/C)
S130LC-V	DOZER	60.0 mm (2.36 in)	70.0 mm (2.76 in)	30.0 mm (1.18 in)	-		
	BUCKET	65.0 mm (2.56 in)	80.0 mm (3.15 in)	30.0 mm (1.18 in)	6.0 mm (0.24 in)		S70-III (ARM, BOOM) MEGA 200-III (LIFT) MEGA 200-III TC (H/C)
S220LL	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)		S290LC-V (S/ARM, ARM) S290LL (BOOM, BUCKET) S300LC-V (S/ARM, ARM) MEGA 250-III (BUCKET) MEGA 400 (LIFT (H/C), BUCKET) MEGA 400-V (LIFT (H/C)) MEGA 500-III
	BOOM	80.0 mm (3.15 in)	95.0 mm (3.74 in)	35.0 mm (1.38 in)	6.5 mm (0.26 in)		S200W-V (BOOM, DOZER, O/R) S220N-V (ARM (OP), BUCKET (OP)) S220LC-V (ARM, BOOM, BUCKET) S250LC-V (ARM, BUCKET) MEGA 160 (BUCKET) MEGA 200-III (BUCKET) MEGA 200 (BUCKET) MEGA 300 (BUCKET) MEGA 300-V (LIFT)
	BUCKET	65.0 mm (2.56 in)	80.0 mm (3.15 in)	35.0 mm (1.38 in)	6.5 mm (0.26 in)		
S250LC-V	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)		S290LC-V (S/BUCKET, BOOM, BUCKET) S300LC-V (S/BUCKET, BOOM, BUCKET)
S290LL	ARM (STICK)	100.0 mm (3.94 in)	115.0 mm (4.53 in)	70.0 mm (2.76 in)	6.5 mm (0.26 in)		

MODEL	CYLINDER	øA $^{-0.05}_{-0.15}$	øB (±0.1)	E	F $^{+0.05}_{0}$	Part	MODEL (CYLINDER)
S330LC-V	BUCKET (OP)	100 mm (3.94 in)	115 mm (4.53 in)	45 mm (1.77 in)	7.5 mm (0.30 in)		S330LC-V (ARM, BOOM, BUCKET) S340LC-V (ARM, BOOM, BUCKET) S370LC-V (ARM, BOOM, BUCKET) MEGA 300-V (BUCKET) MEGA 400-V (BUCKET) MEGA 500-III (LIFT (H/C))
S450LC-V	ARM	120 mm (4.72 in)	140 m (5.51 in)	75 mm (2.95 in)	11 mm (0.43 in)		S470LC-V (ARM)
	BOOM	110 mm (4.33 in)	130 mm (5.12 in)	70 mm (2.76 in)	11 mm (0.43 in)	H/C	S400LC-V (ARM, BOOM (H/C), BUCKET) S420LC-V (ARM, BOOM (H/C), BUCKET) S450LC-V (BUCKET) S470LC-V (BOOM, BUCKET)
	BOOM	120 mm (4.72 in)	140 m (5.51 in)	70 mm (2.76 in)	11 mm (0.43 in)	K/C	S420LC-V (BOOM (K/C)) S400LC-V (BOOM (K/C))
S55W-V	BUCKET	50.0 mm (1.97 in)	60.0 mm (2.36 in)	30.0 mm (1.18 in)	-		S55-V (ARM, BOOM (OP),BUCKET)
	DOZER	65.0 mm (2.56 in)	75.0 mm (2.95 in)	30.0 mm (1.18 in)	-		
S80W-II	BUCKET	50.0 mm (1.97 in)	60.0 mm (2.36 in)	25.0 mm (0.98 in)	5.5 mm (0.22 in)	H/C	
S130W-V	BOOM	71.0 mm (2.80 in)	86.0 mm (3.39 in)	40.0 mm (1.58 in)	6.5 mm (0.26 in)		S130LC-V (BOOM, BOOM (OP))
	ARM (EURO)	71.0 mm (2.80 in)	86.0 mm (3.39 in)	40.0 mm (1.58 in)	7.0 mm (0.28 in)		S130W-V (ARM) S130LC-V (S/ARM, ARM)
S170W-V	ARM	71.0 mm (2.80 in)	86.0 mm (3.39 in)	50.0 mm (1.97 in)	6.0 mm (0.24 in)		S170W-V (BOOM, BUCKET) S170LC-V (ARM, BOOM)
H/C: Head Cover K/C: Knuckle Cover							

DUST WIPER JIG

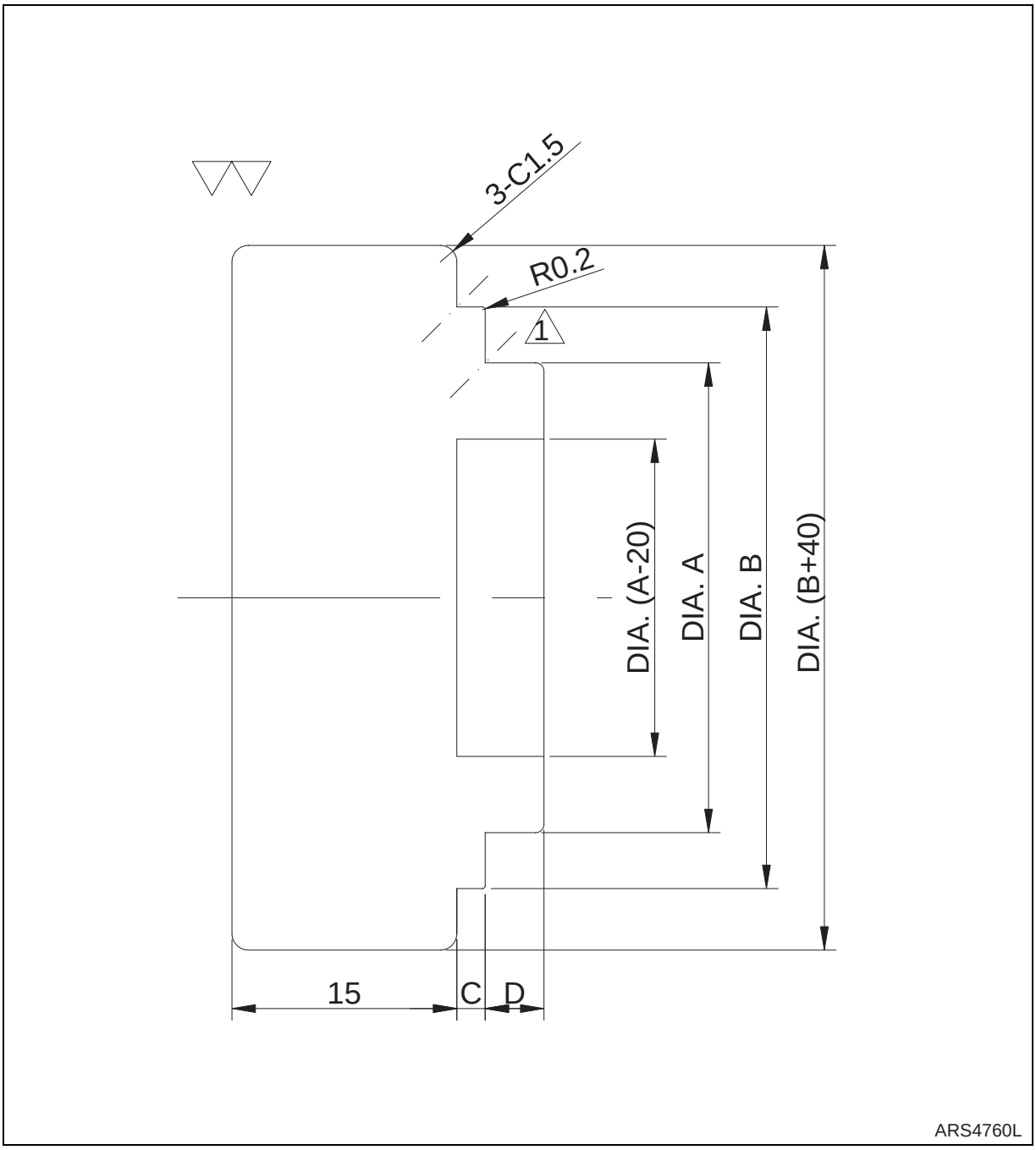


Figure 9

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)
DD80L	TILT	35.0 mm (1.38 in)	47.0 mm (1.85 in)	0	6.0 mm (0.24 in)	
	DOZER	45.0 mm (1.77 in)	57.0 mm (2.24 in)	0.5 mm (0.02 in)	6.0 mm (0.24 in)	DD80L (ANGLE)
	ANGLE	45.0 mm (1.77 in)	57.0 mm (2.24 in)	0.5 mm (0.02 in)	6.0 mm (0.24 in)	
S55-V	ARM	55.0 mm (2.17 in)	69.0 mm (2.72 in)	5.0 mm (0.20 in)	6.0 mm (0.24 in)	
	BOOM	55.0 mm (2.17 in)	69.0 mm (2.72 in)	5.0 mm (0.20 in)	6.0 mm (0.24 in)	
	BOOM (OP)	55.0 mm (2.17 in)	69.0 mm (2.72 in)	5.0 mm (0.20 in)	6.0 mm (0.24 in)	
	BUCKET	55.0 mm (2.17 in)	69.0 mm (2.72 in)	5.0 mm (0.20 in)	6.0 mm (0.24 in)	
	SWING	40.0 mm (1.58 in)	52.0 mm (2.05 in)	3.5 mm (0.14 in)	6.0 mm (0.24 in)	S55W-V (SWING)
	DOZER	60.0 mm (2.36 in)	74.0 mm (2.91 in)	7.0 mm (0.28 in)	6.0 mm (0.24 in)	
S70-III	ARM	65.0 mm (2.56 in)	79.0 mm (3.11 in)	5.5 mm (0.22 in)	6.0 mm (0.24 in)	S80W-III (ARM)
	BOOM	70.0 mm (2.76 in)	84.0 mm (3.31 in)	5.5 mm (0.22 in)	6.0 mm (0.24 in)	S80W-III (BOOM) S130W-V (BOOM) S130LC-V (BOOM) MEGA 160-III (BUCKET)
	BUCKET	55.0 mm (2.17 in)	69.0 mm (2.72 in)	5.0 mm (0.20 in)	6.0 mm (0.24 in)	S55-V (ARM, BOOM, BOOM (OP), BUCKET) S55W-V (ARM) S80W-III (BUCKET) MEGA 130-III (LIFT)
	DOZER	60.0 mm (2.36 in)	74.0 mm (2.91 in)	5.0 mm (0.20 in)	6.0 mm (0.24 in)	S55W-V 9BOOM) MEGA 130-III (BUCKET) MEGA 160-III (LIFT) MEGA 200-III TC (BUCKET)
S80-III	DOZER	60.0 mm (2.36 in)	74.0 mm (2.91 in)	7.0 mm (2.28 in)	6.0 mm (0.24 in)	S55-V (DOZER) S55W-V (DOZER)
S130LC-V	ARM	80.0 mm (3.15 in)	94.0 mm (3.70 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	S170W-V (BOOM) S220N-V (BOOM (OP))
	BOOM	70.0 mm (2.76 in)	84.0 mm (3.31 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	BOOM (OP)	75.0 mm (2.95 in)	89.0 mm (3.50 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
S220LC-V	ARM	95.0 mm (3.74 in)	109.0 mm (4.29 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	S220N-V (ARM(OP)) S290LC-V (BOOM) S300LC-V (BOOM)
	BOOM	85.0 mm (3.35 in)	99.0 mm (3.90 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	BUCKET	75.0 mm (2.95 in)	89.0 mm (3.50 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	

MODEL	CYLINDER	øA $^{-0.2}_{-0.3}$	øB $^{-0.2}_{-0.3}$	C $^{0}_{-0.1}$	D	MODEL (CYLINDER)
S220LL	ARM (STICK)	115.0 mm (4.53 in)	131.0 mm (5.16 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	S340LC-V (ARM) S420LC-V (BOOM) S470LC-V (BOOM, BUCKET) S370LC-V (ARM) S360LC-V (ARM) S400LC-V (BOOM) S450LC-V (BOOM, BUCKET)
	BOOM (HOIST)	90.0 mm (3.54 in)	104.0 mm (4.10 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	BUCKET (HEEL)	75.0 mm (2.95 in)	89.0 mm (3.50 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
S220N-V	ARM (OP)	95.0 mm (3.74 in)	109.0 mm (4.29 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	BOOM (OP)	80.0 mm (3.15 in)	94.0 mm (3.70 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
S250LC-V	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)	S360LC-V (BOOM, BUCKET, BUCKET (OP)) S340LC-V (BOOM, BUCKET, BUCKET (OP)) S370LC-V (BUCKET, BUCKET (OP)) S290LL (BOOM (HOIST), BUCKET (HEEL))
	BOOM	90.0 mm (3.54 in)	104.0 mm (4.10 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	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)	
S290LC-V	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)	S290LC-V (S/ARM) S300LC-V (ARM, S/ARM) S370LC-V (BOOM)
	S/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)	
	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)	
	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	90.0 mm (3.54 in)	104.0 mm (4.10 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
S290LL	ARM (STICK)	120.0 mm (4.72 in)	136.0 mm (5.35 in)	9.0 mm (0.35 in)	7.0 mm (2.28 in)	
	BOOM (HOIST)	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 (HEEL)	100.0 mm (3.94 in)	114.0 mm (4.49 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
S360LC-V	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)	
	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)	
	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)	
	BUCKET(OP)	100.0 mm (3.94 in)	114.0 mm (4.49 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	

MODEL	CYLINDER	øA $^{-0.2}_{-0.3}$	øB $^{-0.2}_{-0.3}$	C $^{0}_{-0.1}$	D	MODEL (CYLINDER)
S400LC-V	ARM	120.0 mm (4.72 in)	136.0 mm (5.35 in)	9.0 mm (0.35 in)	7.0 mm (2.28 in)	S420LC-V (ARM) S290LL (ARM (STICK))
	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)	
	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)	S420LC-V (BUCKET)
S450LC-V	ARM	130.0 mm (5.12 in)	146.0 mm (5.75 in)	6.5 mm (0.26 in)	7.0 mm (2.28 in)	S470LC-V (ARM)
	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)	
	BUCKET	115.0 mm (4.53 in)	131.0 mm (5.16 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
S55W-V	ARMS	55.0 mm (2.17 in)	69.0 mm (2.72 in)	5.0 mm (0.20 in)	6.0 mm (0.24 in)	
	SWING	40.0 mm (1.58 in)	52.0 mm (2.05 in)	3.5 mm (0.14 in)	6.0 mm (0.24 in)	
	BOOM	60.0 mm (2.36 in)	74.0 mm (2.91 in)	5.0 mm (0.20 in)	6.0 mm (0.24 in)	
	BUCKET	50.0 mm (1.97 in)	62.0 mm (2.44 in)	4.5 mm (0.18 in)	6.0 mm (0.24 in)	
	DOZER	60.0 mm (2.36 in)	74.0 mm (2.91 in)	5.0 mm (0.20 in)	6.0 mm (0.24 in)	
S80W-III	ARM	65.0 mm (2.56 in)	79.0 mm (3.11 in)	5.5 mm (0.22 in)	6.0 mm (0.24 in)	
	BOOM	70.0 mm (2.76 in)	84.0 mm (3.31 in)	5.5 mm (0.22 in)	6.0 mm (0.24 in)	
	BUCKET	55.0 mm (2.17 in)	69.0 mm (2.72 in)	5.0 mm (0.20 in)	6.0 mm (0.24 in)	
S130W-V	ARM	75.0 mm (2.95 in)	89.0 mm (3.50 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	S130W-V (S/ARM) S130LC-V (BOOM (OP)) S170W-V (BUCKET) S220LC-V (BUCKET) S220LL (BUCKET (HEEL))
	S/ARM	75.0 mm (2.95 in)	89.0 mm (3.50 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	BOOM	70.0 mm (2.76 in)	84.0 mm (3.31 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	BUCKET	65.0 mm (2.56 in)	79.0 mm (3.11 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
S170W-V	ARM	90.0 mm (3.54 in)	104.0 mm (4.10 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	S220LL (BOOM (HOIST)) S250LC-V (BOOM, BUCKET) S290LC-V (BUCKET, S/BUCKET) S300LC-V (BUCKET, S/BUCKET)
	BOOM	80.0 mm (3.15 in)	94.0 mm (3.70 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	BUCKET	75.0 mm (2.95 in)	89.0 mm (3.50 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
S200W-V	BOOM	85.0 mm (3.35 in)	99.0 mm (3.90 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	S220LC-V (BOOM)

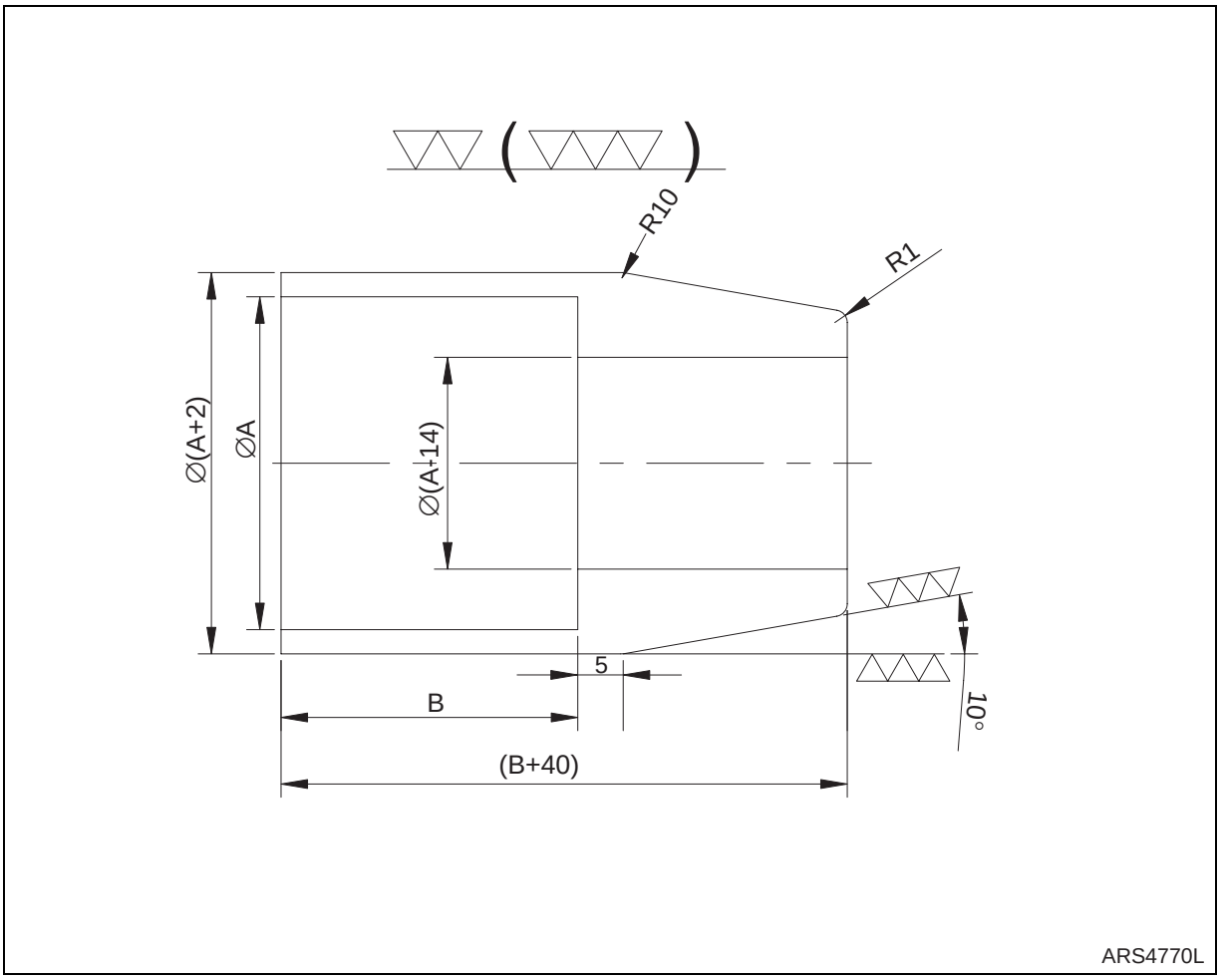


Figure 10

MODEL	CYLINDER	øA $^{+0.2}_{+0.1}$	B $^{+0.2}_{+0.1}$	MODEL (CYLINDER)
S55-V	ARM	85.0 mm (3.35 in)	32.0 mm (1.26 in)	S55W-V (ARM)
	BOOM	110.0 mm (4.33 in)	21.5 mm (0.85 in)	S55-V (BOOM (OP)) S55W-V (BOOM)
	SWING	80.0 mm (3.15 in)	30.0 mm (1.18 in)	S55W-V (BUCKET, SWING) MEGA 300-III (P/S)
	DOZER	100.0 mm (3.94 in)	18.0 mm (0.71 in)	S55W-V (DOZER)
S70-III	BUCKET	85.0 mm (3.35 in)	28.5 mm (1.12 in)	S55-V (ARM) S80W-II (BUCKET, DOZER)
S130LC-V	ARM	115.0 mm (4.53 in)	28.5 mm (1.12 in)	S170W-V (BOOM) S220LC-V (BUCKET) S220LL (BUCKET (HEEL))
S220LC-V	BOOM	120.0 mm (4.72 in)	28.5 mm (1.12 in)	S220N-V (BUCKET (OP))
S220LL	ARM (STICK)	165.0 mm (6.50 in)	34.5 mm (1.36 in)	S400LC-V (BOOM) S420LC-V (BOOM)
S250LC-V	ARM	140.0 mm (5.51 in)	28.5 mm (1.12 in)	S300LC-V (BOOM, BUCKET. S/BUCKET) S220LL (BOOM (HOIST)) S290-V (BOOM, BUCKET, S/BUCKET)
	BOOM	130.0 mm (5.12 in)	28.5 mm (1.12 in)	S250LC-V (BUCKET)
S290LC-V	ARM	150.0 mm (5.91 in)	28.5 mm (1.12 in)	S290LL (BOOM (HOIST), BUCKET (HEEL)) S290LC-V (S/ARM) S300LC-V (ARM, S/ARM) S340LC-V (BOOM, BUCKET, BUCKET (OP)) S360LC-V (BOOM, BUCKET, BUCKET (OP)) S370LC-V (BOOM, BUCKET, BUCKET (OP))
S360LC-V	ARM	170.0 mm (6.69 in)	34.5 mm (1.36 in)	S340LC-V (ARM) S370LC-V (ARM) S450LC-V (BOOM, BUCKET) S470LC-V (BOOM, BUCKET)
S400LC-V	ARM	180.0 mm (7.09 in)	41.5 mm (1.63 in)	S290LL (ARM (STICK)) S420LC-V (ARM)
	BUCKET	160.0 mm (6.30 in)	34.5 mm (1.36 in)	S420LC-V (BUCKET)
S450-V	ARM	190.0 mm (7.48 in)	41.5 mm (1.63 in)	S470LC-V (ARM)
S130W-V	ARM	110.0 mm (4.33 in)	28.5 mm (1.12 in)	S70-III (BOOM) S80W-III (BOOM) S130W-V (S/ARM) S130LC-V (BOOM (OP)) S170W-V (BUCKET)
	BOOM	100.0 mm (3.94 in)	28.5 mm (1.12 in)	S70-III (ARM, DOZER) S80W-III (ARM) S130W-V (BOOM) S130LC-V (BOOM (OP))
	BUCKET	95.0 mm (3.74 in)	28.5 mm (1.12 in)	
S170W-V	ARM	125.0 mm (4.92 in)	28.5 mm (1.12 in)	

MODEL	CYLINDER	øA $^{+0.2}_{+0.1}$	B $^{+0.2}_{+0.1}$	MODEL (CYLINDER)
S200W-V	BOOM	135.0 mm (5.32 in)	28.5 mm (1.12 in)	S220LC-V (ARM) S220N-V (ARM (OP))
P/S: Power Steering				

SLIPPER SEAL STRAIGHTENING JIG

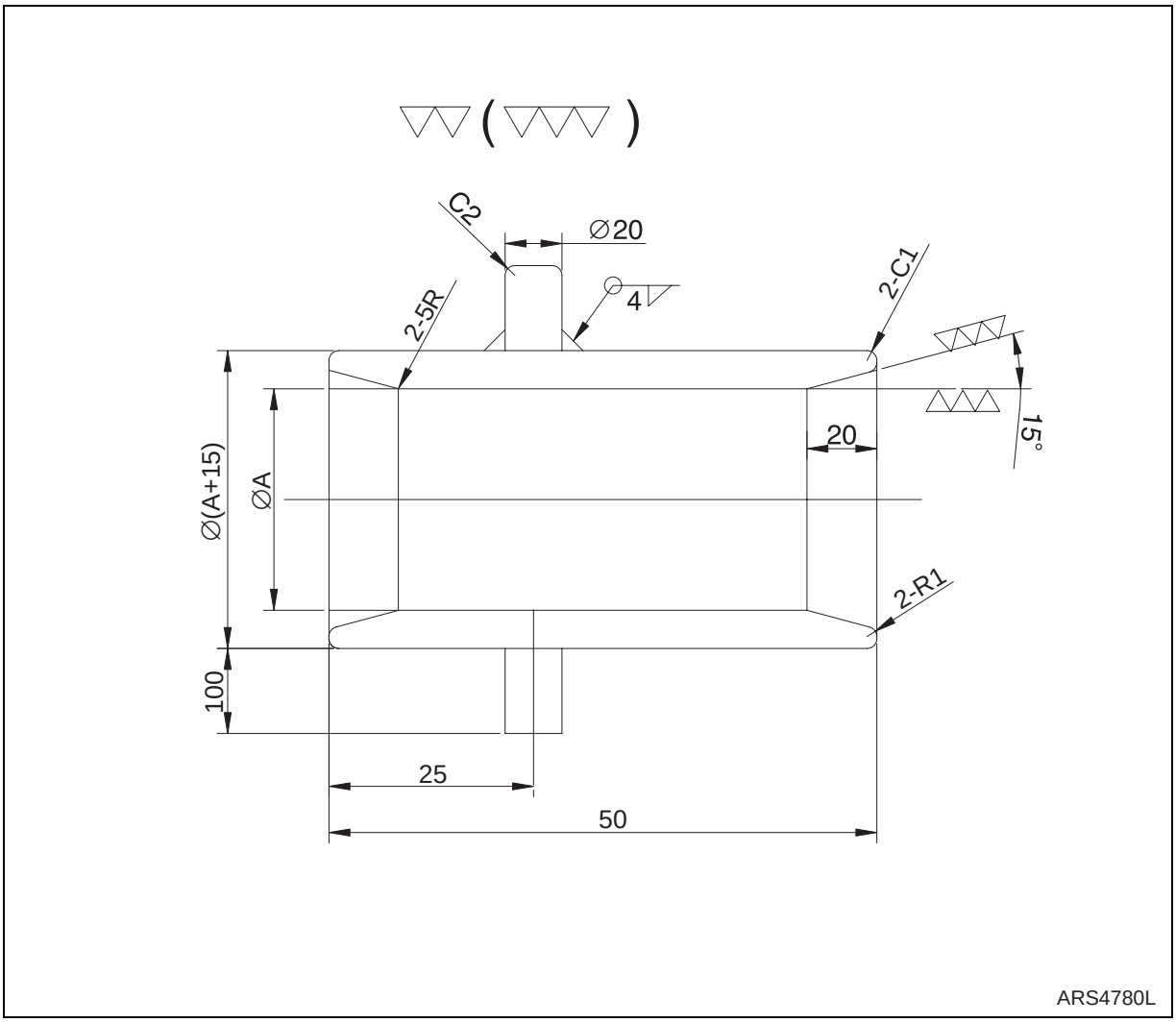


Figure 11

	CYLINDER	øA $^{+0.2}_{+0.1}$	MODEL (CYLINDER)
S55-V	ARM	85.0 mm (3.35 in)	S55W-V (ARM)
	BOOM	110.0 mm (4.33 in)	S55-V (BOOM (OP)) S55W-V (BOOM)
	SWING	80.0 mm (3.15 in)	S55W-V (BUCKET, SWING) MEGA 300-III P/S
	DOZER	100.0 mm (3.94 in)	S55W-V (DOZER)
S70-III	BUCKET	85.0 mm (3.35 in)	S55-V (ARM) S80W-III (BUCKET) S80-III (DOZER)
S130LC-V	ARM	115.0 mm (4.53 in)	S170W-V (BOOM) S220LC-V (BUCKET) S220LL (BUCKET (HEEL))
S220LC-V	BOOM	120.0 mm (4.72 in)	S220N-V (BUCKET (OP))
S220LL	ARM (STICK)	165.0 mm (6.50 in)	S400LC-V (BOOM) S420LC-V (BOOM)
S250LC-V	ARM	140.0 mm (5.51 in)	S300LC-V (BOOM, BUCKET, S/BUCKET) S220LL (BOOM (HOIST)) S290-V (BOOM, BUCKET, S/BUCKET)
	BOOM	130.0 mm (5.12 in)	S250-V (BUCKET)
S290LC-V	ARM	150.0 mm (5.91 in)	S300LC-V (ARM, S/ARM) S340LC-V (BOOM, BUCKET. BUCKET (OP)) S370LC-V (BOOM, BUCKET, BUCKET (OP)) S290-V (S/ARM) S360-V (BOOM, BUCKET, BUCKET (OP)) S290LL (BOOM (HOIST), BUCKET (HEEL))
S360-V	ARM	170.0 mm (6.69 in)	S340LC-V (ARM) S370LC-V (ARM) S470LC-V (BOOM, BUCKET) S450-V (BOOM, BUCKET)
S400LC-V	ARM	180.0 mm (7.09 in)	S420LC-V (ARM) S290LL (ARM (STICK))
	BUCKET	160.0 mm (6.30 in)	S420LC-V (BUCKET)
S450LC-V	ARM	190.0 mm (7.48 in)	S470LC-V (ARM)
S130W-V	ARM	110.0 mm (4.33 in)	S130W-V (S/ARM) S130-V (BOOM (OP)) S70-III (BOOM) S170W-V (BUCKET) S80W-III (BOOM)
	BOOM	100.0 mm (3.94 in)	S130W-V (BOOM) S130-V (BOOM) S70-III (ARM, DOZER) S80W-III (ARM)
	BUCKET	95.0 mm (3.74 in)	
S170W-V	ARM	125.0 mm (4.92 in)	

	CYLINDER	øA $^{+0.2}_{+0.1}$	MODEL (CYLINDER)
S200W-V	BOOM	135.0 mm (5.32 in)	S220LC-V (ARM) S220N-V (ARM (OP))
P/S: Power Steering			

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 back 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 that piping ports are on top, to allow trapped air to vent.

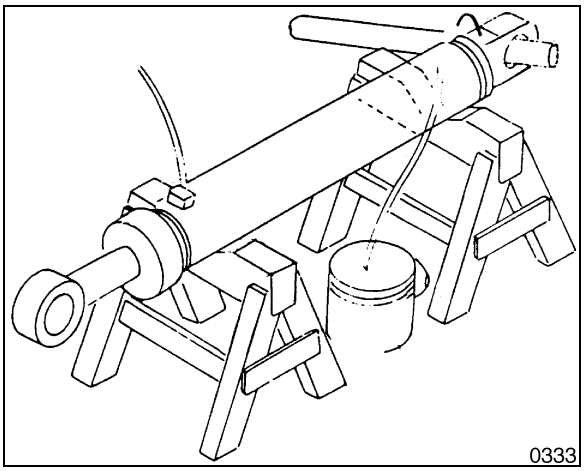


Figure 12

2. Position piston rod so that it is extended approximately one half meter (20").

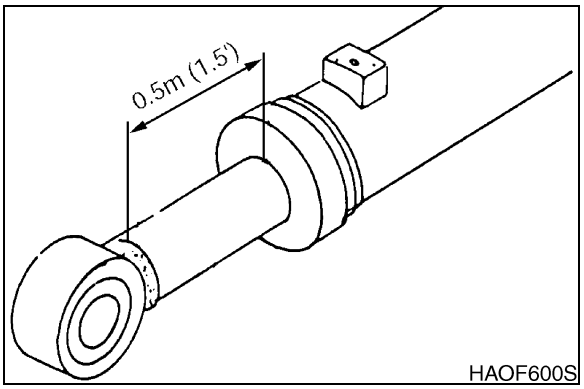


Figure 13

3. Remove bolts (7) 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.*

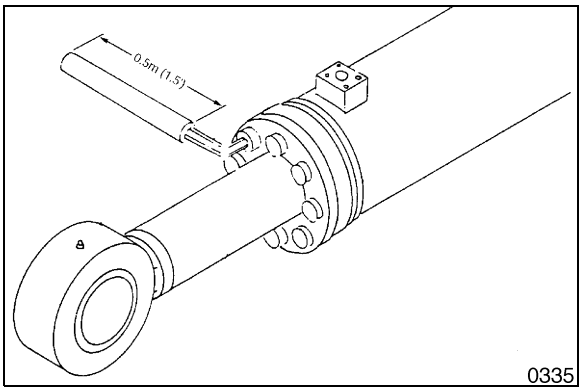


Figure 14

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.

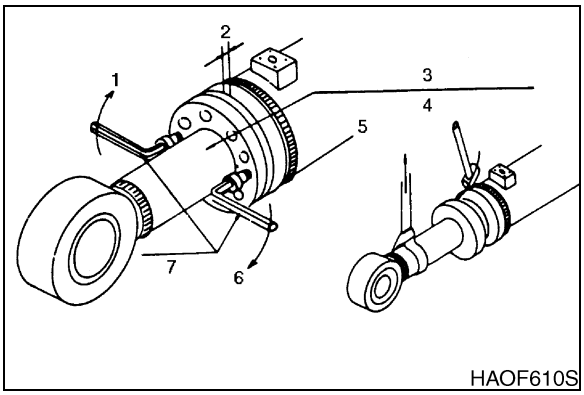


Figure 15

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.

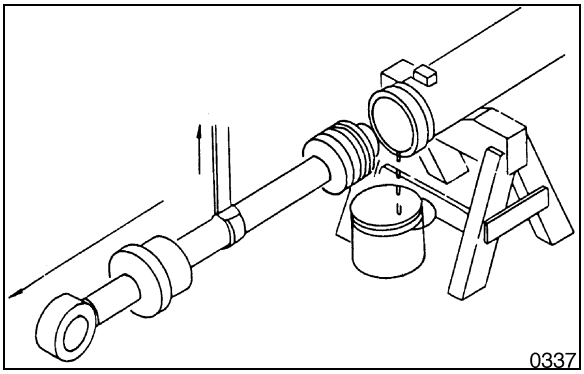


Figure 16

6. Lower piston rod to support blocks and detach wear ring (outer surface) (18) from end of rod.

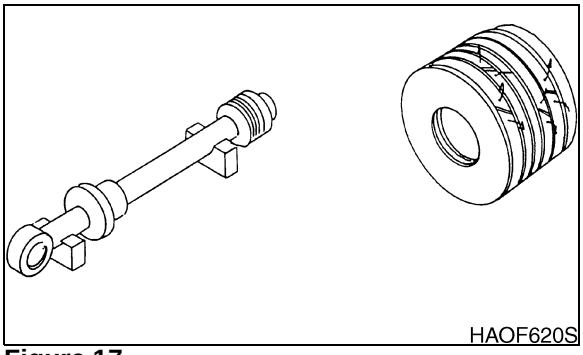


Figure 17

7. Immobilize piston rod by inserting a wooden or other non-scoring, non-metallic support through end of rod.

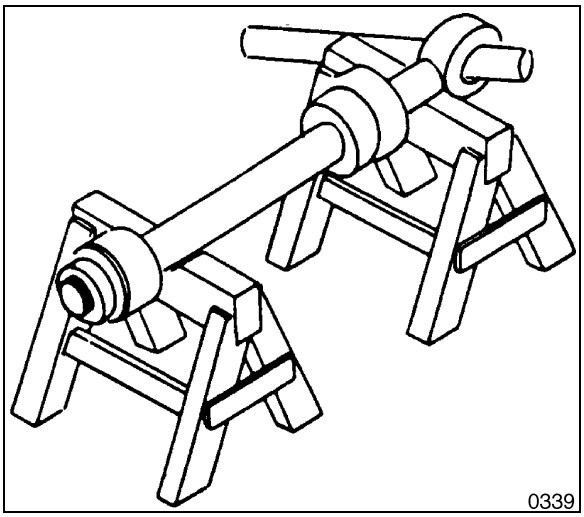


Figure 18

8. Remove set screw by using a socket wrench.

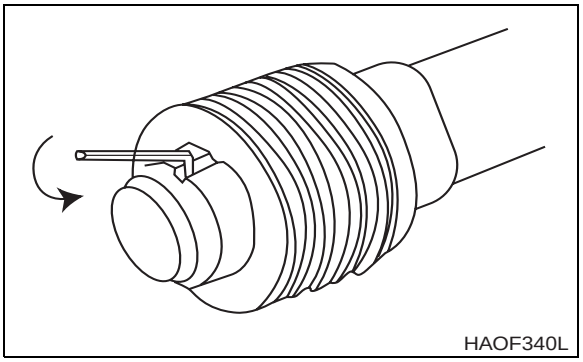


Figure 19

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 Daewoo Parts distributor). Remove nut from end of piston.

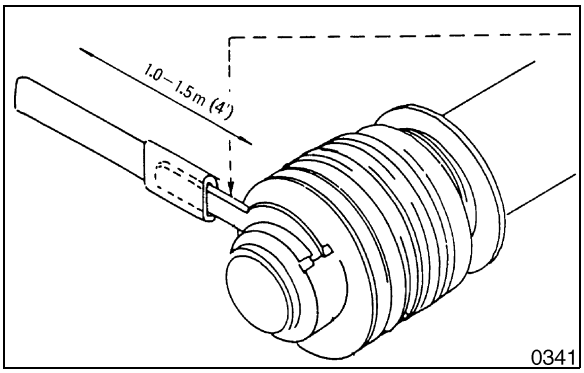


Figure 20

10. Use second piston tool described at beginning of this procedure to separate piston. Detach cushion ring (15), taking care not to damage cushion ring.

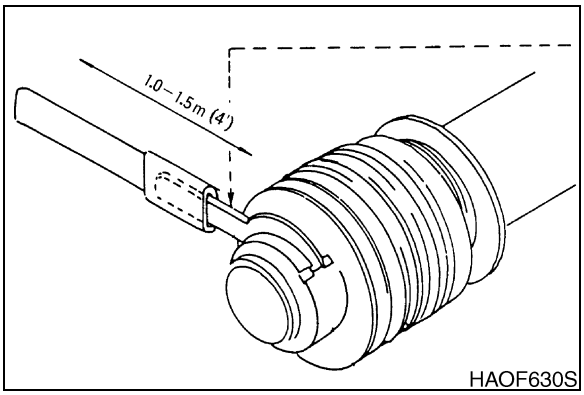


Figure 21

11. Use a plastic hammer to evenly pull off rod cover (9) from end of piston rod. Be careful not to damage rod bushing (6) and dust wiper, U-packing and other seals.

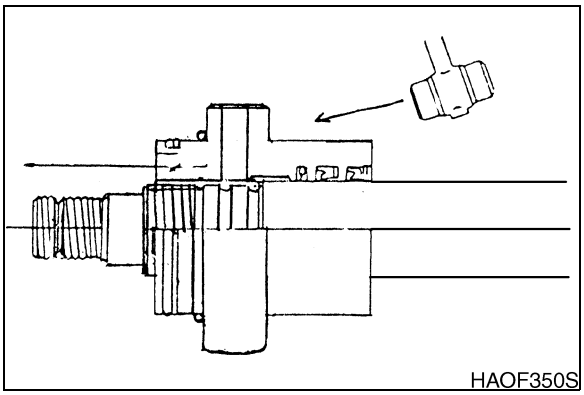


Figure 22

12. Use a dull, rounded-tip tool to pry off O-ring (11) and backup ring (12).

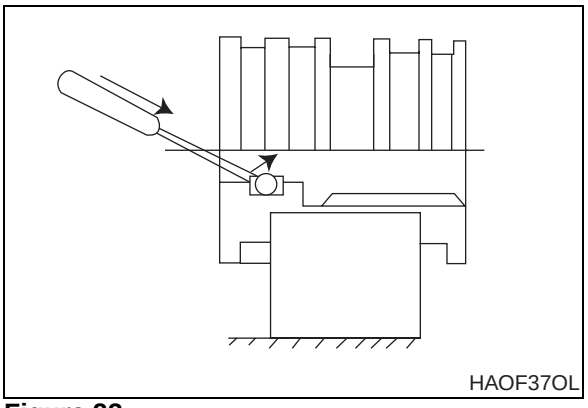


Figure 23

13. Find a screwdriver with an appropriate width tip to facilitate removal of slipper seal (19), wear ring (18) and slide ring (17) from piston (16).

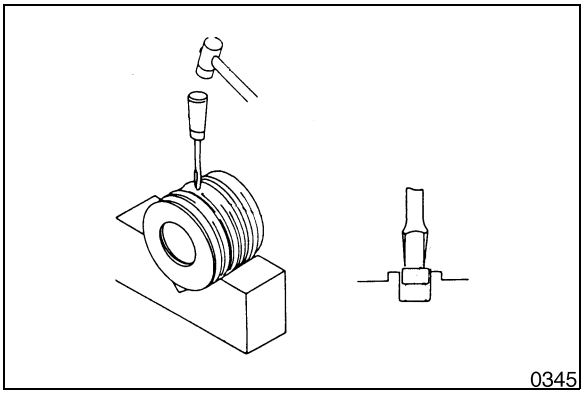


Figure 24

14. Pull off O-ring (20) and backup ring (21) from cylinder head.

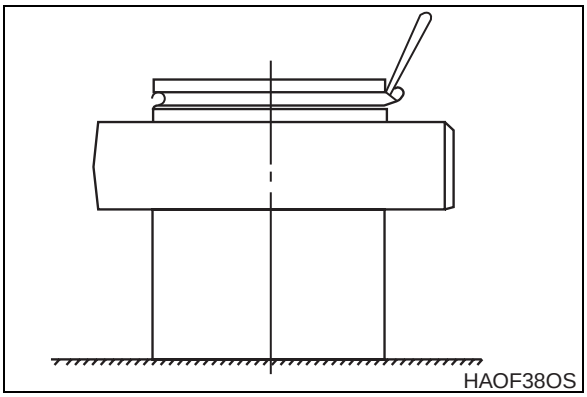


Figure 25

15. During disassembly of cylinder head, be careful not to damage buffer seal (5) and U-packing (4).

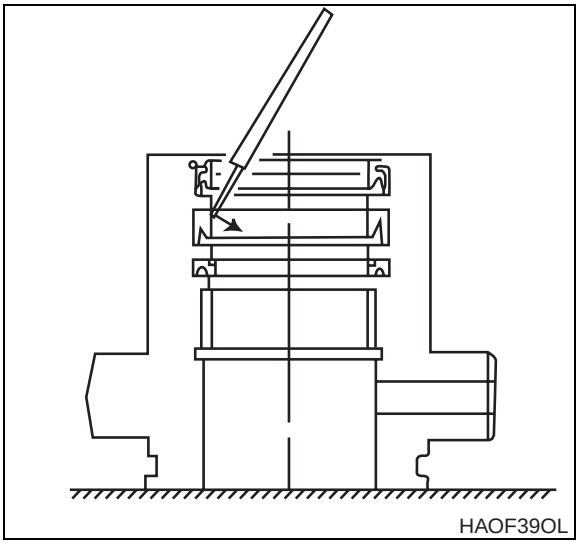


Figure 26

16. Disassemble retaining ring (3) and dust wiper (2). Separate retaining ring (8) and rod bushing (6).

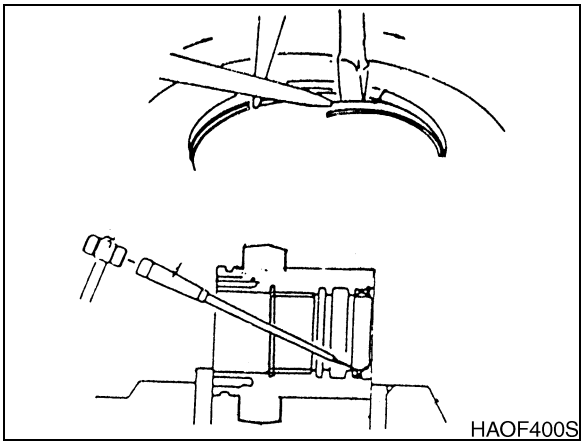


Figure 27

17. Force out pin bushing (1) from body of cylinder.

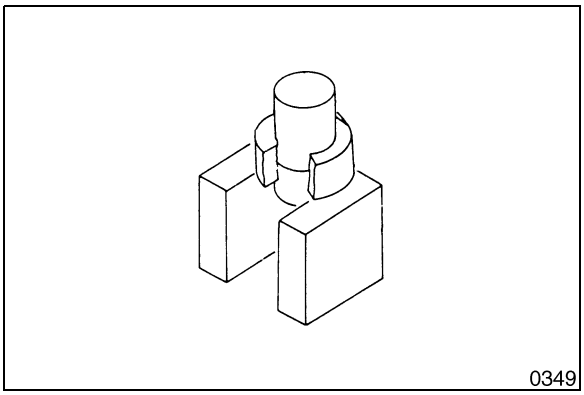


Figure 28

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 (1) to piston rod (13) and body of cylinder (14).

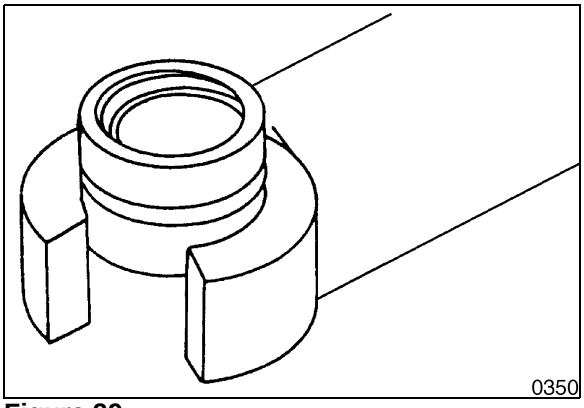


Figure 29

2. Following reassembly of rod cover components, install the dust wiper (2) and rod bushing (6) to the rod cover (9). Insert retaining rings (3 and 8).

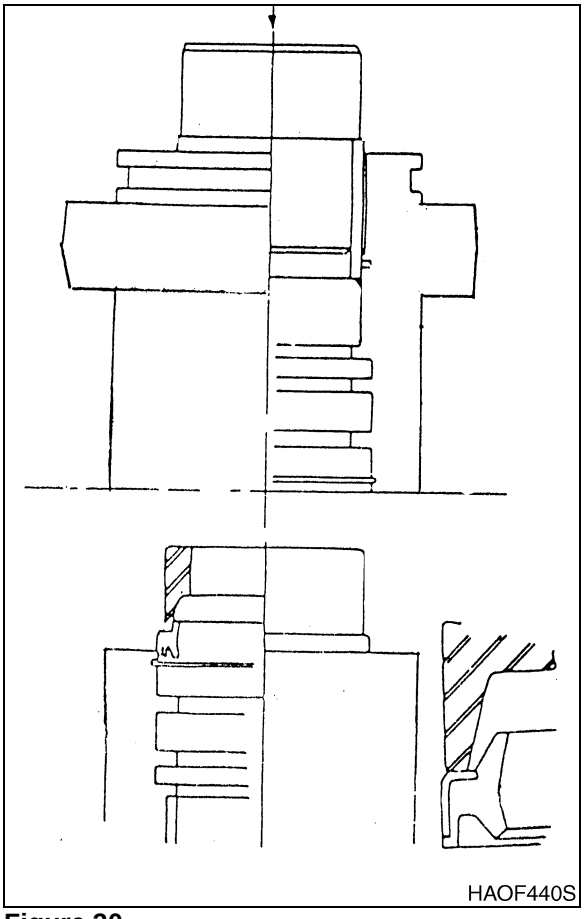


Figure 30

3. Pre-lubricate O-rings and seals before reassembly (Figure 31).

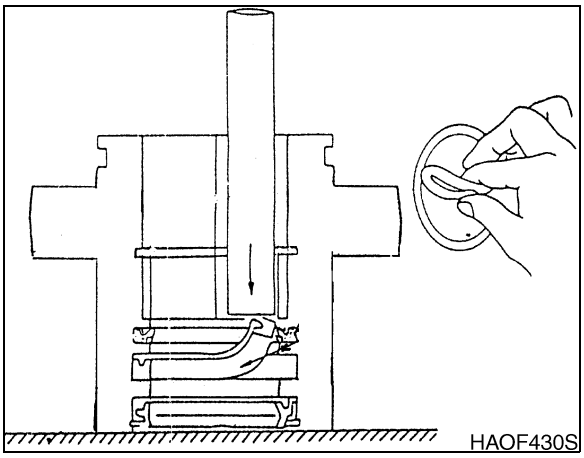


Figure 31

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.

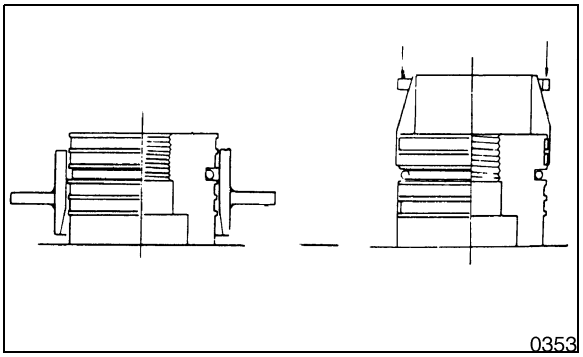


Figure 32

5. Immobilize piston rod on solid support blocks. Assemble O-ring (20) and backup ring (21). Prepare to attach rod cover assembly to piston rod. Push rod cover by tightening piston nut (22).

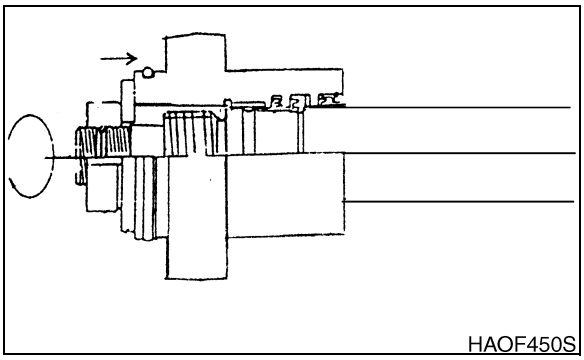


Figure 33

6. Assemble cushion ring (15) and attach piston assembly to piston rod.

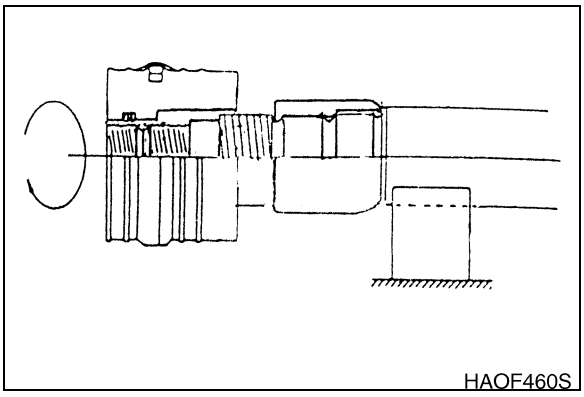


Figure 34

7. Use specially fabricate or factory-sourced tool to tighten piston nut (22).

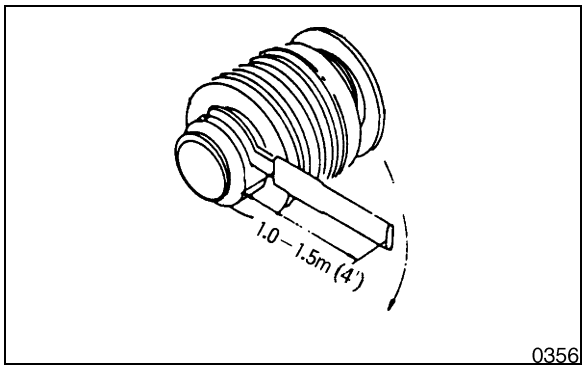


Figure 35

8. Assemble wear ring (18), slide ring (17) and set screw (23) to piston assembly.

Reference Number	Description
1	Set Screw

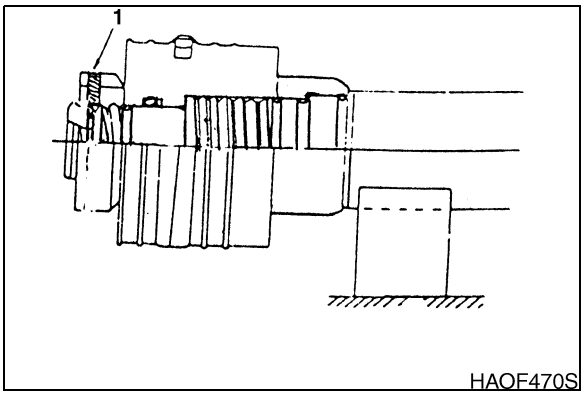


Figure 36

9. Immobilize body of cylinder before reassembly.

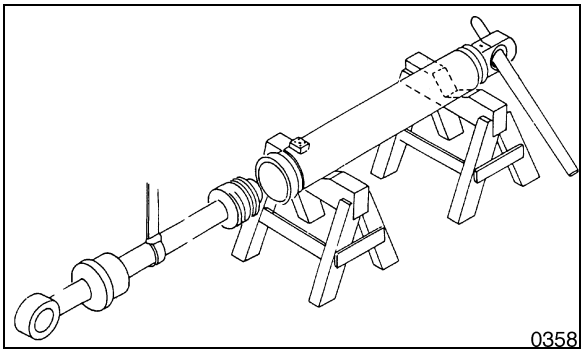


Figure 37

10. Pre-apply 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.

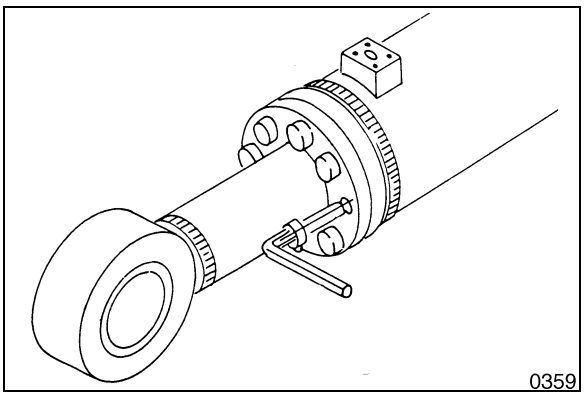


Figure 38

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

SWING MOTOR

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 170LC-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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May 2002

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- Parts List 8
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Disassembly 12
Cleaning and Inspection (Wear Limits and Tolerances) 19
Reassembly 21

GENERAL DESCRIPTION

THEORY OF OPERATION

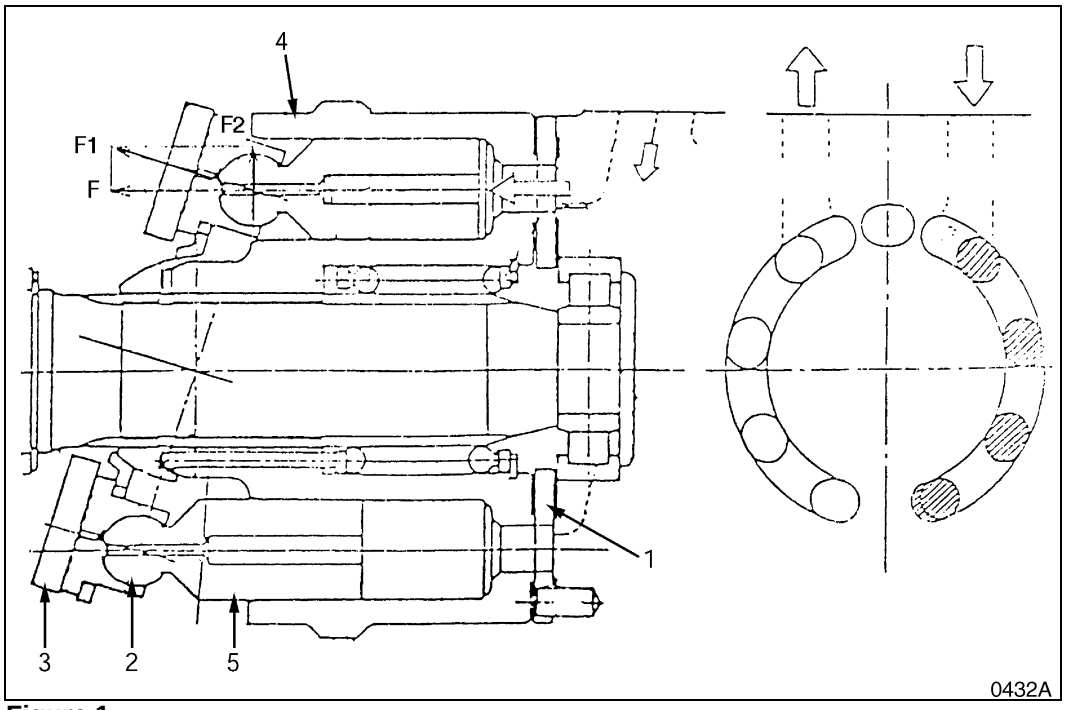


Figure 1

Reference Number	Description
1	Valve Plate
2.	Shoe
3.	Swash Plate

Reference Number	Description
4.	Cylinder Block
5.	Piston

The cross sectional views of the swing motor, show most of the main components of an axial-piston type hydraulic motor. Arrows indicating direction of flow and other graphic symbols provide a general guide for understanding basic operation (Figure 1).

When high-pressure oil enters the cylinder through the inlet port of the valve plate (1, Figure 1), the sliding piston inside the cylinder is driven back, generating force "F" against the shoe behind the piston (2).

Force "F" acts in two different directions, as indicated by the arrows (Figure 1). Force F1 exerts pressure directly on the swash plate (3) to generate oil flow through the motor, while force F2 pushes laterally - at a right angle - against the drive shaft, providing the rotational energy to turn the cylinder block around the drive shaft.

All nine pistons in the cylinder block have equal width bore, length and volume. They are configured in a concentric layout around the drive shaft, as shown in the cross section end-view. As oil is forced through the inlet port, pistons rotating past the pressurized (supply) side of the motor (indicated as the shaded cylinders) transmit drive torque - one after the next, each in turn - to the swash plate (through F1, direct output force) and to the cylinder block (F2, lateral force to keep the block rotating).

If oil flow to the motor is directed to the opposite port (so that the supply side becomes the exhaust side and vice versa), the rotation of the motor is reversed.

Trench mode allows the operator to "prioritize" hydraulic oil flow between swing function and boom and arm function. Turning "ON" the trench mode boosts oil flow to swing circuit components, increasing swing speed, as boom up/arm dump speed is reduced. If trench mode is turned "OFF" - diminishing the size of the opening through the swing priority valve - boom/arm speed increases as slew rate falls off.

Connected through the e-EPOS controller, the switch of the trench mode changes the voltage of the electronic signal sent to the solenoid valve.

IMPORTANT

The trench mode setting only has a noticeable effect if both functions are used at the same time, when the right and the left joysticks are each engaged simultaneously, to control swing and boom/arm functions.

When the trench mode is engaged, an engaged voltage signal to the solenoid valve shifts the "swing priority" spool valve to increase oil flow through the swing motor. With trench mode "OFF," voltage is disengaged while current flow is reduced, shifting the spool in the priority valve for increased oil flow to the boom/arm side of the circuit.

SWING MOTOR ANTI-CAVITATION MAKE-UP VALVE

Unlike those designs for hydraulic swing motor application which incorporate a separate, external counterbalance valve, the problem of motor rotational speed overtaking or surpassing oil flow rate at the motor’s supply-side inlet is answered with pressure-control valving that is incorporated in the motor casing.

An anti-cavitation "make-up" valve is incorporated into each relief valve (Figure 2) to prevent oil starvation on whichever side of the motor is serving as the supply side by allowing greater oil flow through one side of the circuit. There is one valve for each side of the motor. When swing motor case drain pressure increases past the set value of the make-up valves, oil flow is increased through that side of the motor circuit.

RELIEF VALVE

The relief valve is one in a set of two, and is Item "51" of the swing motor assembly.

Return line pressure (the normal pressurization of the hydraulic reservoir, also referred to as "tank pressure") pushes the valve piston to open ports "R" and "P" at the end of the valve whenever the hydraulic system is operating.

This valve initially reacts to the engagement of hydraulic function (and pressurization of the tank) by opening momentarily, so that there is no pressure developed through the valve at all.

Tank pressure at "pressurized area A2" is set against spring pressure inside the valve, opening the relief valve until pressure at the spring chamber ("g") momentarily reduces "g" chamber pressure "Pg." "Pg" subsequently increases until the piston reaches the end of travel inside the valve bore at "h."

After the piston reaches "h" and its normally closed, pressurized operating position, pressure through the valve can be continually increased up to the relief valve maximum pressure ("Ps").

$$Ps = \frac{Fsp}{A_1 - A_2}$$

Where Fsp: Spring Force

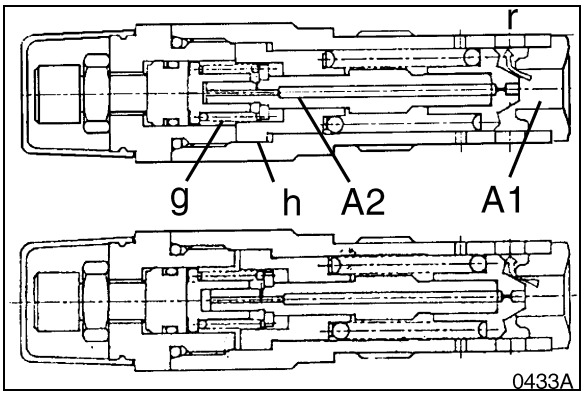


Figure 2

SWING BRAKE OPERATION

The swing brake is normally held in the applied position - preventing the upper deck revolving superstructure from rotating - whenever the hydraulic system is not operated (pressurized). The brake system is automatically released whenever the swing controls are engaged to swing in one direction or the other.

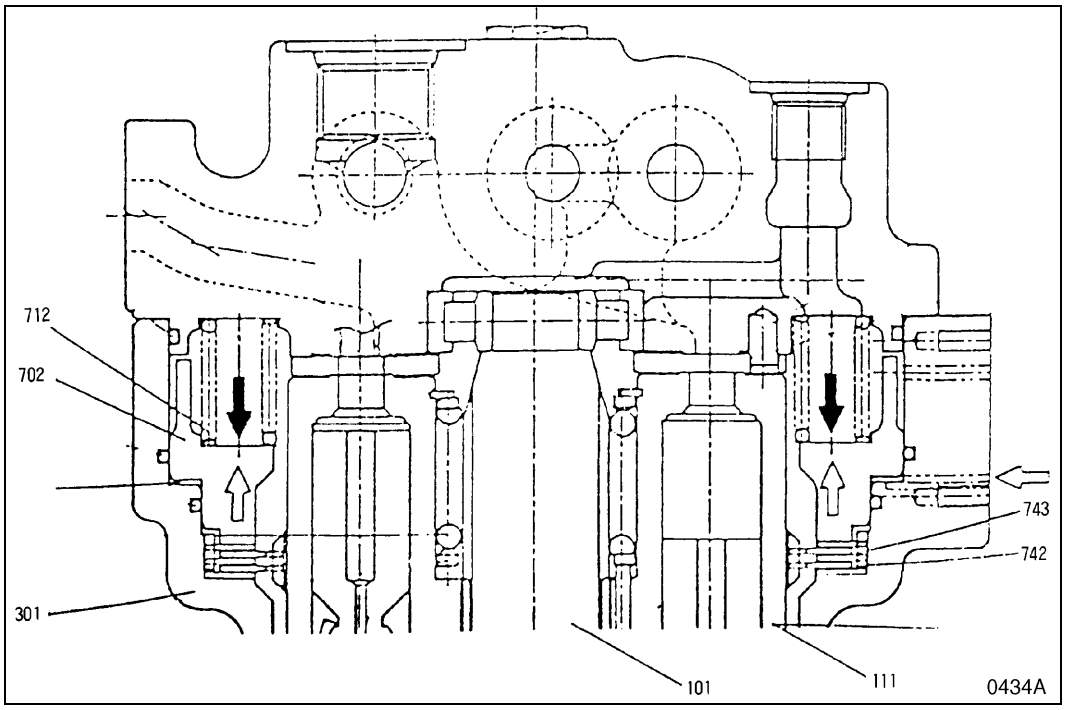


Figure 3

The swing brake is applied when the brake spring (712, Figure 3) locks up the friction plate (742), split plate (743) and swing motor casing (301), preventing the motor drive shaft from turning. When hydraulic pressure is forced to the back side of the brake piston, the friction plate and swing motor casing are separated, releasing the brake.

IMPORTANT

Along with the swing brake, a two-position positive swing lock has also been provided. It should be secured whenever the upper deck revolving superstructure must be locked down and positively kept from rotating - including maintenance and/or repair intervals. (Do not rely on the swing brake alone to hold the superstructure in position for repairs, transport, maintenance or normal storage.

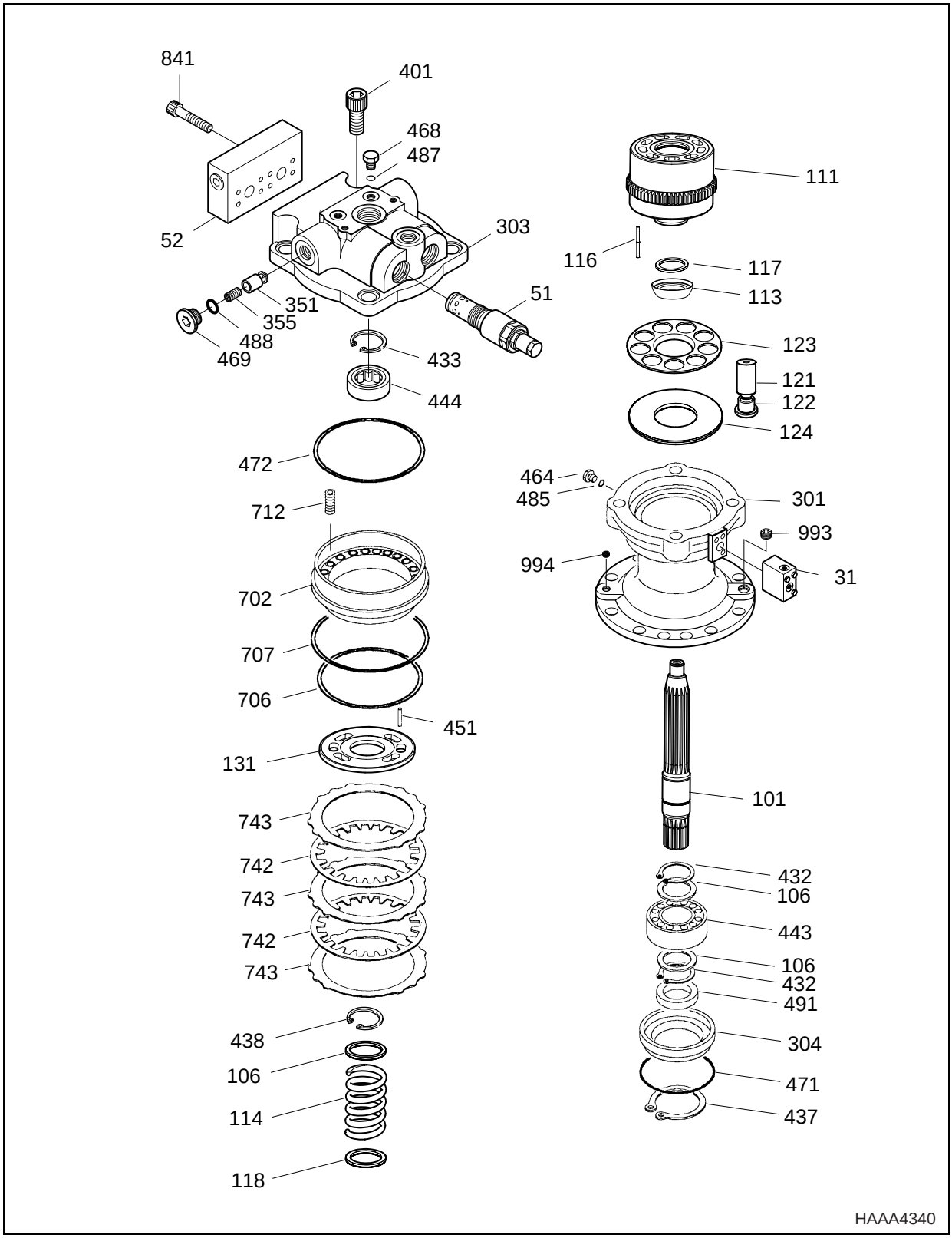

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437
118
HAAA4340

Figure 4

Reference Number	Description
31	Brake Valve
31-1	O-ring
31-2	O-ring
51	Relief Valve
51-1	O-ring
51-2	Backup Ring
52	Reactionless Swing Valve
52-1	O-ring
101	Drive Shaft
106	Spacer
111	Cylinder Block
113	Spherical Bushing
114	Cylinder Spring
116	Push Rod
117	Front Spacer
118	Rear Spacer
*	Piston Assembly
121	Piston
122	Shoe
123	Retainer
124	Shoe Plate
131	Valve Plate
301	Casing
303	Valve Casing
304	Front Cover
351	Plunger
355	Spring

Reference Number	Description
401	Socket Bolt
432	Snap Ring
433	Snap Ring
437	Snap Ring
438	Snap Ring
443	Roller Bearing
444	Roller Bearing
451	Spring Pin
464	VP Plug
468	VP Plug
469	RO Plug
471	O-ring
472	O-ring
485	O-ring
487	O-ring
488	O-ring
491	Oil Seal
702	Brake Piston
706	O-ring
707	O-ring
712	Brake Spring
742	Friction Plate
743	Separation Plate
993	PT Plug
994	PT Plug
841	Socket Bolt

SPECIFICATIONS

Item	Specification		
	Solar 170W-V Solar 220LC-V Solar 220LL	**Solar 170LC-V**	**Solar 450LC-V Solar 470LC-V**
Type	Axial Piston		
Displacement	121.6 cc/rev (18.85 in^3/rev.)	128.0 cc/rev (7.81 in^3/rev.)	2 x 128.0 cc/rev (2 x 7.81 in^3/rev.)
Crossover Relief Valve Setting	280 kg/cm^2 (3,980 psi)	280 kg/cm^2 (3,980 psi)	280 kg/cm^2 (3,980 psi)
Maximum Supply Flow Rate @ 2000 rpm	227 lpm (60 gpm)	210 lpm (55 gpm)	2 x 210 lpm (2 x 55 gpm)
Max. Motor Shaft Speed	1,867 rpm	1,640 rpm	1,640 rpm
Rated Motor Shaft Torque	54.2 kg•m (392 ft lb)	57 kg•m (412 ft lb)	114 kg•m (825 ft lb)
Weight	56.5 kg (125 lb)	62 kg (137 lb)	2 x 62 kg (2 x 137 lb)

SPECIAL TOOLS

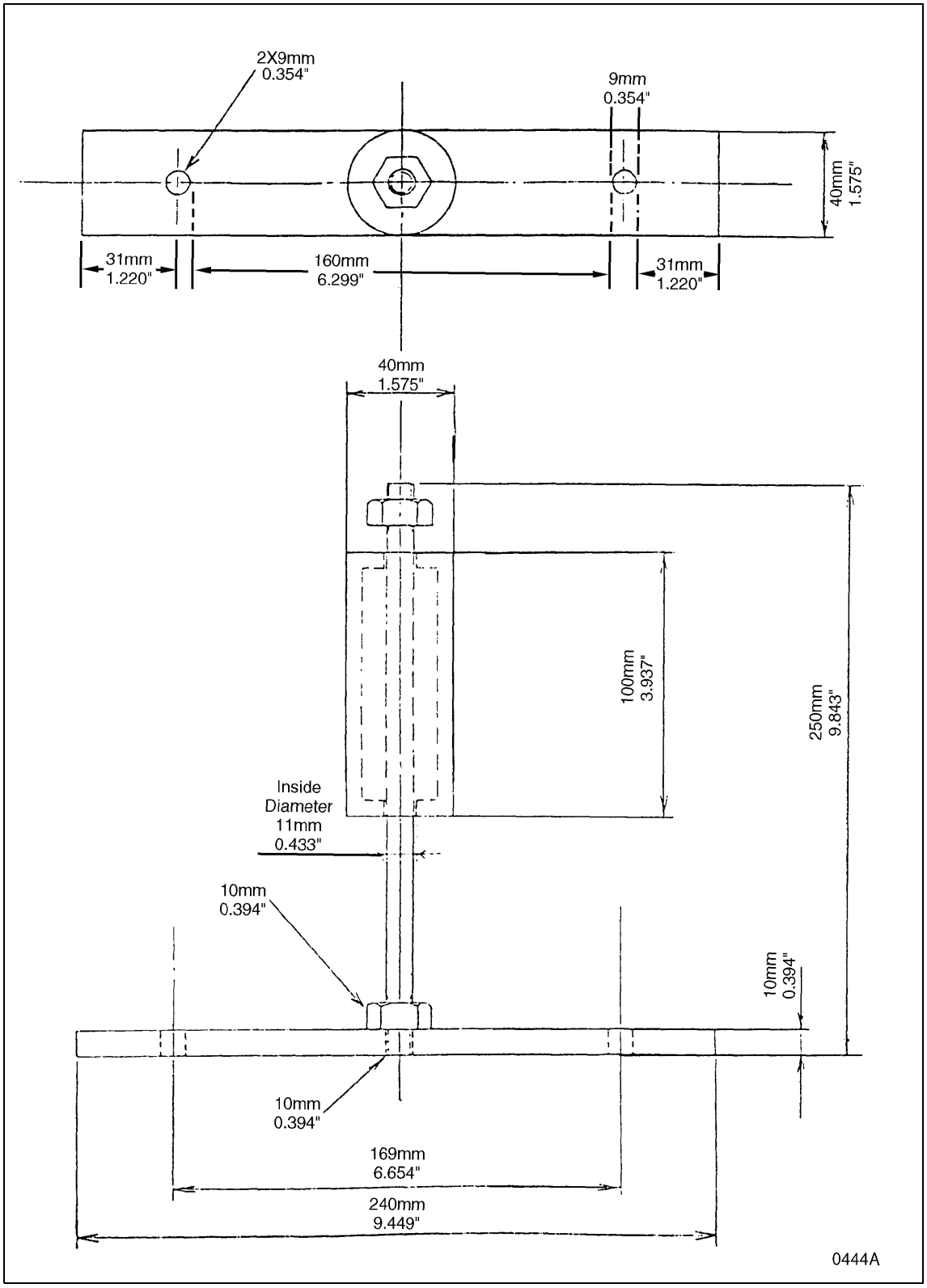


Figure 5

DISASSEMBLY

1. The area where the motor is going to be rebuilt should be well lighted, clean and protected from dust and/or wind gusts that could carry grit or dust. Use a rubber mat or other protective covering on the workbench area to prevent damage or scratching of any precision machined components.

IMPORTANT
Clean all of the exterior surfaces of the motor before disassembly. There should not be any visible dirt, grease, or other type of accumulation on the outside of the casing. Clean off or blow dry all traces of cleaner or solvent before starting work and cap off or use other types of protective seals, plugs or wrapping on temporarily disconnected hoses, piping or ports.

2. Open drain plug and drain all oil from motor casing.

NOTE: *Swing Motor component parts (numbered in parentheses) are keyed to Figure 4.*

IMPORTANT
Use a clean, dry container to catch gear oil. A clean container allows an evaluation to be made of the used oil. The presence or lack of metal wear shavings in the used oil or obvious deterioration or contamination of the oil can provide a useful indicator of the motor's general condition.

NOTE: *Used oil is an environmental contaminant and should be disposed of promptly at approved recycling facilities. Prolonged physical contact with used oil has been thought by some to pose a health risk. Clean oil residue from hands and clothing promptly, and don't allow used oil containers to accumulate.*

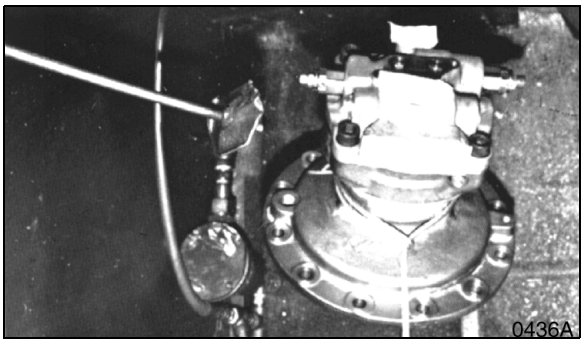


Figure 6

3. After oil has been drained completely, motor should be positioned so that exposed end of drive shaft faces downwards.

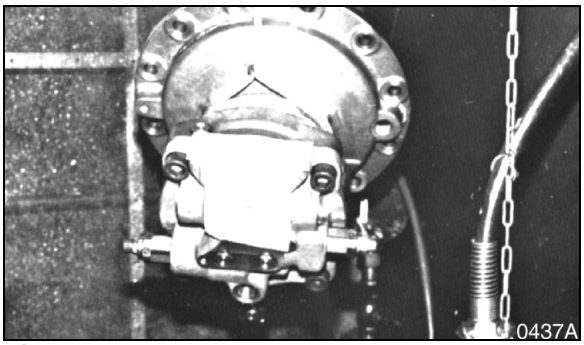


Figure 7

4. Make two permanent marks on exterior of motor to indicate assembly position of motor casing (301) and upper valve casing (303).

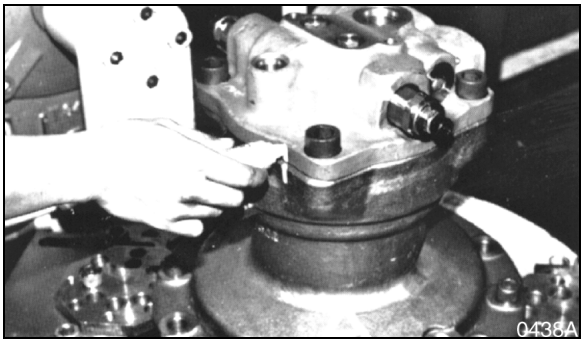


Figure 8

5. Disassemble brake valve (31) from side of casing.

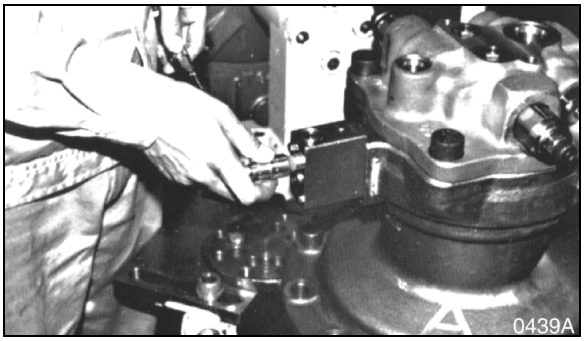


Figure 9

6. Remove relief valve assemblies (51) from upper valve casing (303).

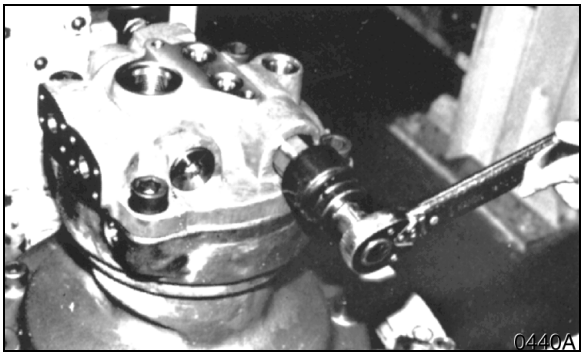


Figure 10

7. Remove RO plug (469) from upper valve casing (303). That will allow subsequent separation of spring (355) and plunger (351).

IMPORTANT
Use extra care to avoid damaging the plunger seat.

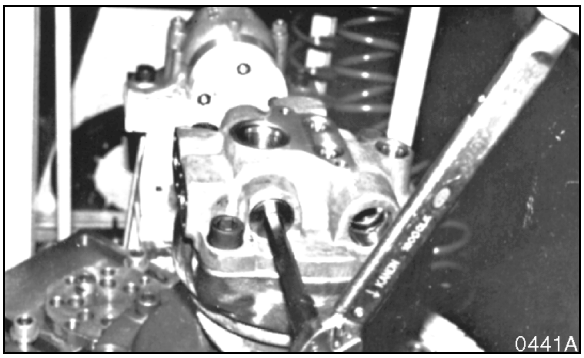


Figure 11

8. Remove all four socket head bolts (401) and separate upper valve casing (303) from lower casing (301).

   NOTE: *Valve plate (131) inside upper valve casing (303) must be separated from assembly but take extra care to make sure that it is not scratched or damaged by an accidental fall, after cover is removed.*

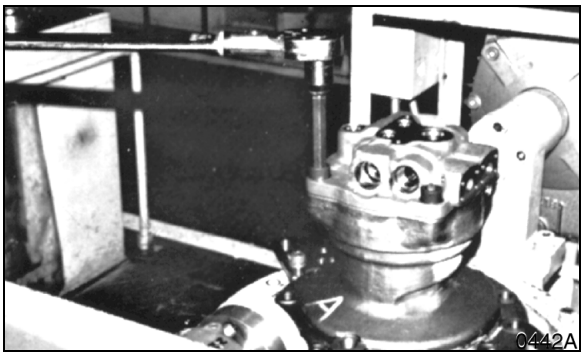


Figure 12

9. Remove all twenty brake springs.

   NOTE: *If brake springs are to be reused and not replaced, check and record spring free height. If a test stand is available, check height of all twenty springs under consistent loading. Replace all springs that show excessive variation or weakness.*

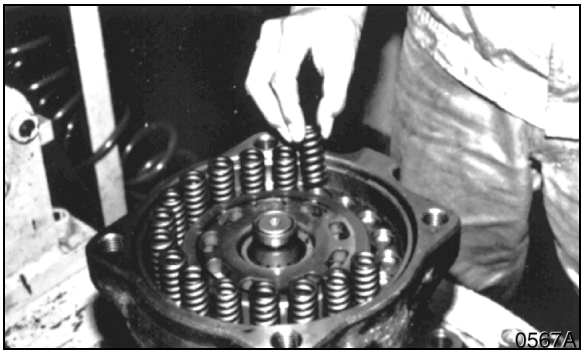


Figure 13

10. Disassemble brake piston assembly using special tool and corresponding piston bolt hole.

    NOTE: *See "Special Tools" portion of this section for manufacturing details of special tool.*

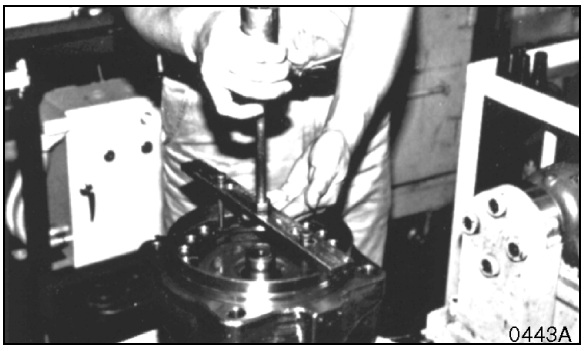


Figure 14

11. Reposition motor so that end of drive shaft faces out to one side. Pull out cylinder block (111) and disassemble pistons (121), retainer plate (123), spherical bushing (113), front spacer (117) and shoe plate (124). Be careful not to make any scratches or leave nicks on reciprocating parts.

    NOTE: *Record or mark piston position or store them in order in which they were removed so that they can be returned to same cylinder bores they were taken out of. Service life could be extended incrementally by maintaining previous wear-pattern relationships by avoiding new ones.*

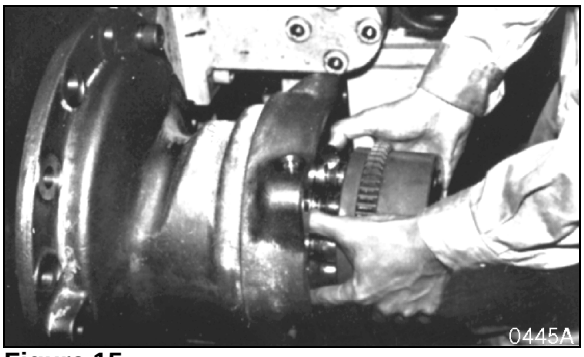


Figure 15

12. Pull out friction plates (742) and separator plates (743) from area behind cylinder block.

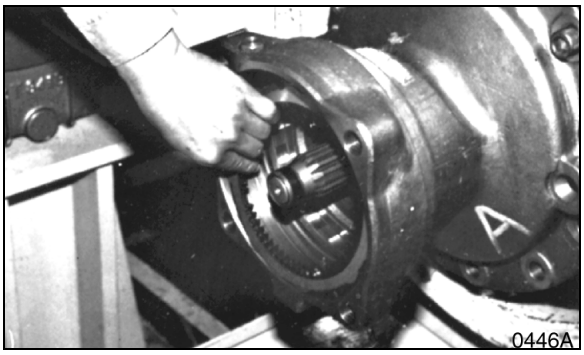


Figure 16

13. Remove lock ring (437) from around drive shaft. Use a large enough pair of snap-ring pliers to properly tension ring and pull it away from locking groove.

    Use extra caution in pulling off front cover (304) behind snap ring. Drive shaft oil seal (491) underneath cover must be replaced if it is damaged during disassembly. Use a little bit of extra caution (and a very large set of channel locks, a puller or extra wide adjustable wrench) to carefully withdraw cover straight back off drive shaft.

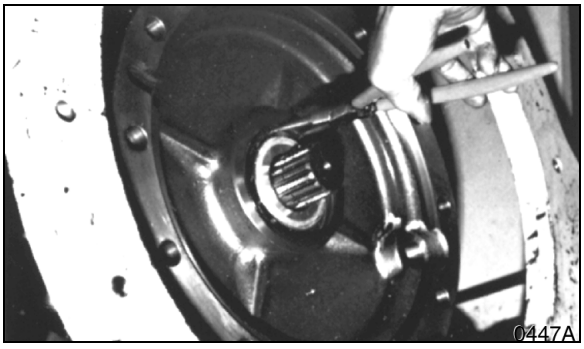


Figure 17

14. Separate casing and drive shaft (101). Tap upper end of drive shaft with a soft-faced, plastic hammer. To avoid damaging drive shaft, do not use excessive force.

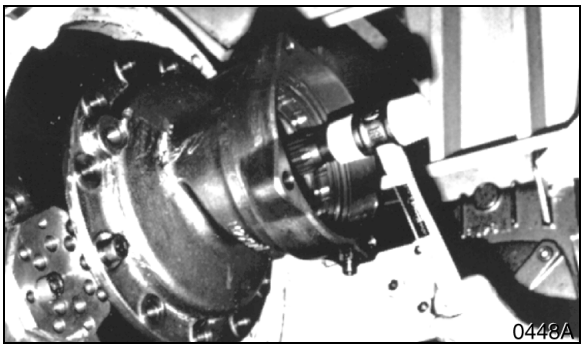


Figure 18

15. Tap bearing race out of casing.

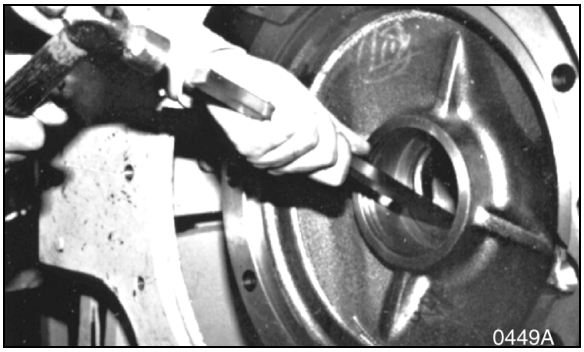


Figure 19

16. Disassembly of motor has now been completed, unless there is any reason to suppose that drive shaft bearing has become excessively worn.

    If it is necessary, replace bearing by pulling away stop ring (432) and spacer (106). Put drive shaft in a press to separate bearing cage from drive shaft.

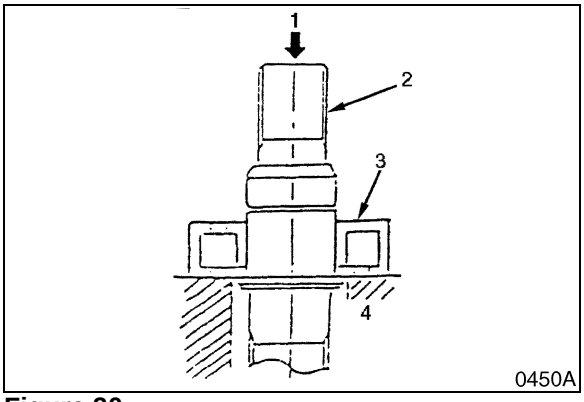


Figure 20

Reference Number	Description
1	Press
2	Drive Shaft
3	Roller Bearing
4	Base of Press

NOTE: *Final disassembly of individual components may also require:*

A. Disassemble oil seal from the front cover if they were not separated during removal. Apply force (2, Figure 21) and use a plug (1) to hammer through drive shaft opening in cover.

Reference Number	Description
1	Plug
2	Applied Force

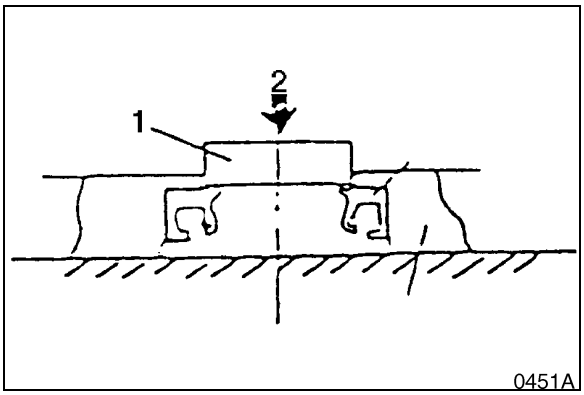


Figure 21

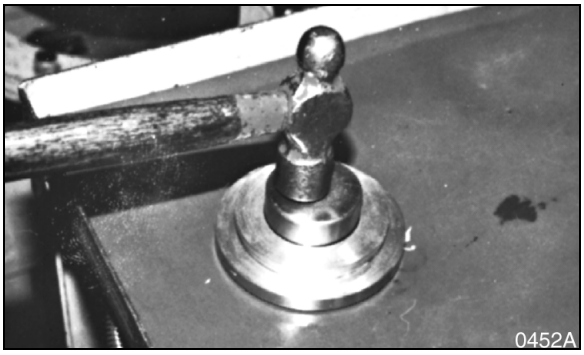


Figure 22

B. If upper bearing is going to be replaced, whether as a general precaution as part of normal rebuilding or because of unmistakable wear, separate bearing from cover.



Figure 23

C. Relief valves can be replaced in sets by ordering one part number through your authorized Daewoo dealer/parts distributor. To disassemble relief valves, pull out plug (201, Figure 4), disassemble bushing (343), spring (322) and spring seat (331) from rod (303). Position valve housing facing down and separate piston (302), rod (303), spring (321), spring seat (331) and plunger (301).

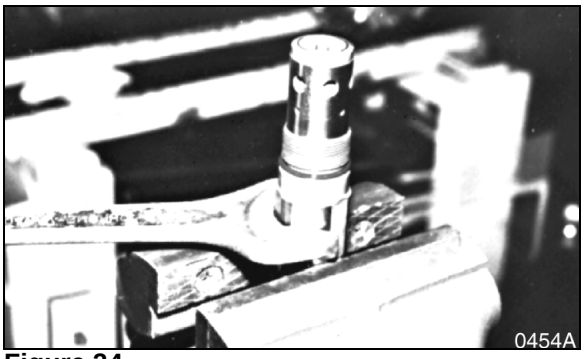


Figure 24

IMPORTANT

Do not touch the adjusting screw and lock nut. Replace the valve as a complete unit if any parts have been damaged.

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

Inspect all components and precision surfaces, to confirm that they haven't been worn beyond service limits. Refer to table below for dimensional specifications.

All parts should be cleaned, air-dried and re-lubricated with clean, approved-type hydraulic fluid, before final reassembly or as the final step after the unit has been put back together.

Replacement of all O-rings and oil seals with new parts is generally recommended, unless motor has had minimal use. Inspect O-rings and oil seals very carefully for cuts, nicks, brittleness or softness, or any other type of damage or distortion, before final reassembly.

NOTE: *When parts exceed the standard, replace them. When there is conspicuous surface damage, it is always safer to replace parts, whether standards are exceeded or not.*

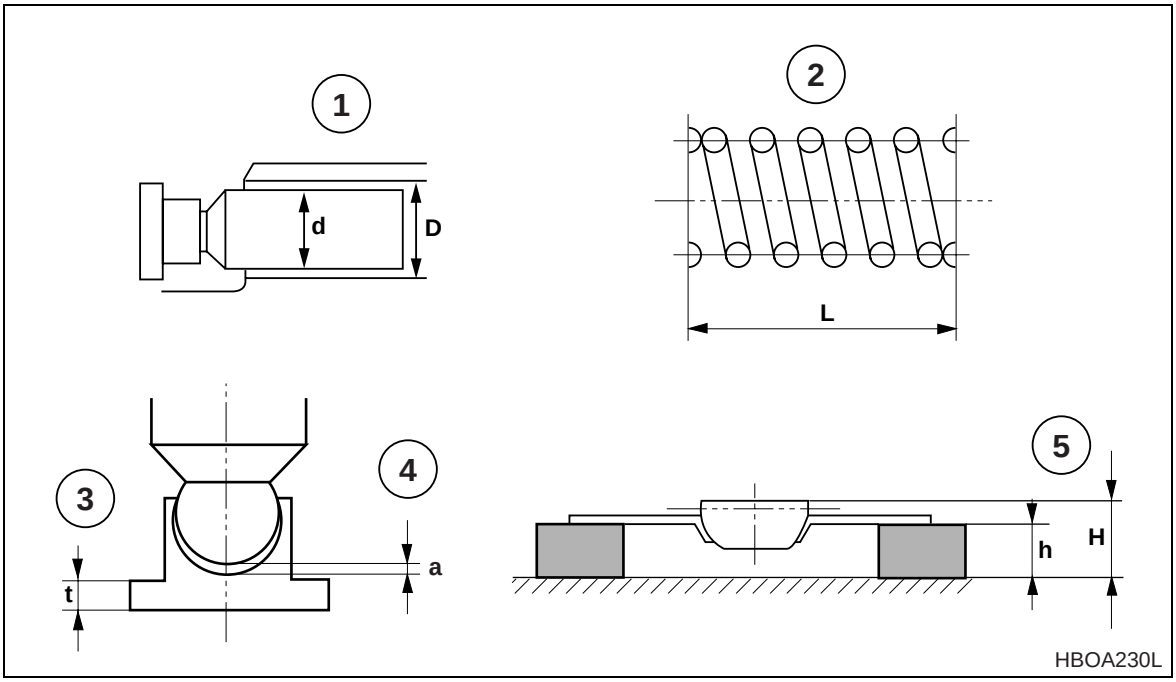


Figure 25

NOTE: *Spherical bushing and push plate must always be replaced as a set. If either one requires replacement, replace the other*

1. *Clearance Between Piston and Cylinder Bore (D-d)*
2. *Spring Free Length (L)*
3. *Thickness of Shoe (t)*
4. *Piston Ball - Shoe Socket Clearance (a)*
5. *Height Between Round Bushing and Push Plate (H-h)*

Service Standards for Replacing Worn Parts

NOTE: *When parts exceed the standard, replace them. When there is conspicuous surface damage, it is always safer to replace parts, whether standards are exceeded or not.*

Item	Standard Value mm (In)	Replacement Limit mm (In)	Remedy
Clearance between cylinder bore and piston (D-d)	0.028 mm (0.0011 in)	0.058 mm (0.0023 in)	Replace piston or cylinder
Clearance between piston and shoe socket	0 mm (0 in)	0.30 mm (0.0118 in)	Replace piston, shoe assembly parts
Thickness of shoe (t)	5.5 mm (0.2166 in)	5.30 mm (0.2087 in)	Replace piston, shoe assembly parts
Height of push plate, round bushing assembly (H-h)	6.5 mm (0.256 in)	6.0 mm (0.236 in)	Replace set; spherical bushing and retainer
Thickness of friction plate	4.0 mm (0.157 in)	3.6 mm (0.142 in)	Replace

Inspect O-rings and oil seals very carefully for cuts, nicks, brittleness, softness or any other type of damage or distortion, before final reassembly if any must be reused.

REASSEMBLY

Reassembly of the motor is basically accomplished by reversing disassembly steps.

Use a torque wrench to make sure that assembly fasteners are tightened to specified values. Always begin a bolt tightening sequence from the innermost part of the assembly, working outward toward the ends in careful, even rotation.

1. Position motor casing face down (Figure 26).

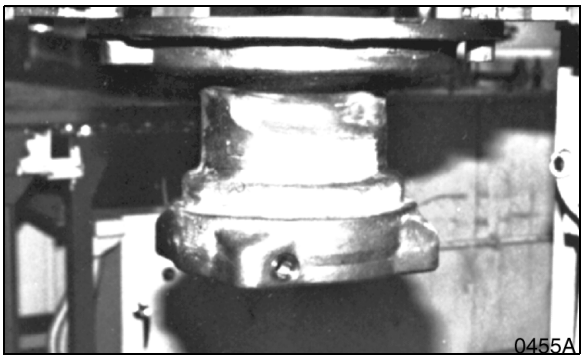


Figure 26

2. If drive shaft roller bearings were not disassembled, go onto next phase of assembly. Bearing reassembly begins with replacement of stop ring (432) (Figure 4 and its accompanying Parts List) and spacer (106) on drive shaft (101).

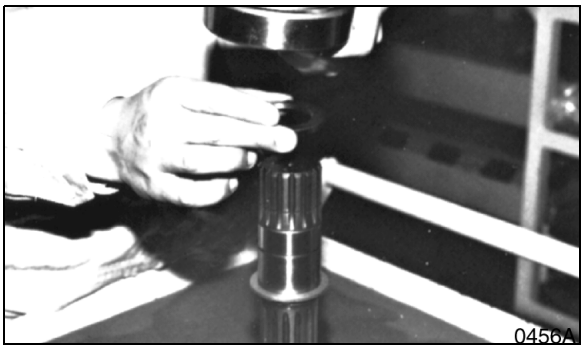


Figure 27

Make sure that bearing raceways (collars) are facing right direction. The drawing shows one side of the bearing collar (1, Figure 28), marked "R," which should be assembled next to spacer (2) on lower end of drive shaft.

A. Both bearing cages (inner roller assemblies) will probably require heating in oil before reassembly. Heat bearings to cause sufficient expansion of their inner diameters to allow reassembly on drive shaft.

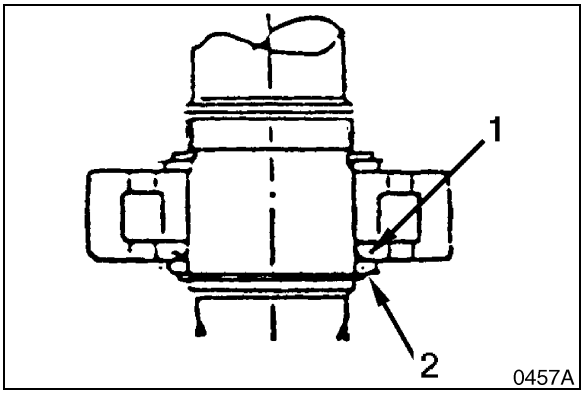


Figure 28

3. Reassemble drive shaft (101, Figure 4), roller bearing (443) and lower casing (301). Pay attention to bearing alignment inside bore of case. Make sure it is fully seated.

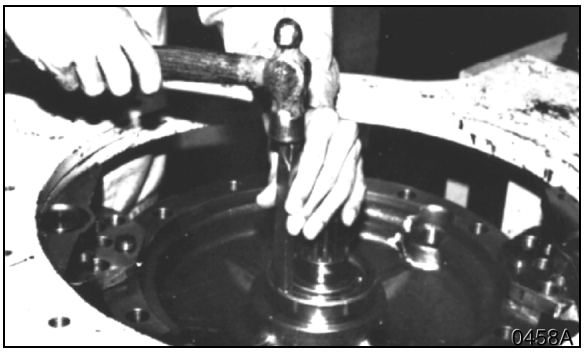


Figure 29

4. There is a "right side" and "wrong side" on oil seal. Be careful that you install seal inside cover with correct side facing in.

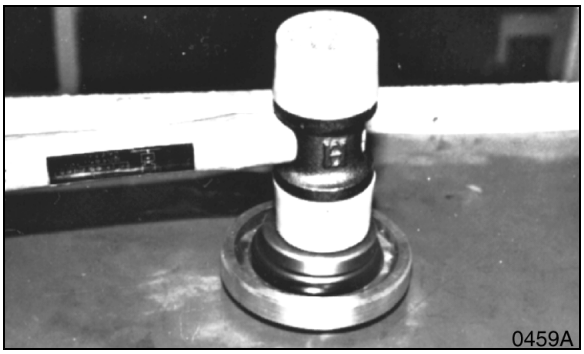


Figure 30

5. Before replacing O-ring (471) in lower casing (301), grease O-ring (and/or inside of groove) very lightly, to facilitate assembly and to help protect O-ring from accidental damage.

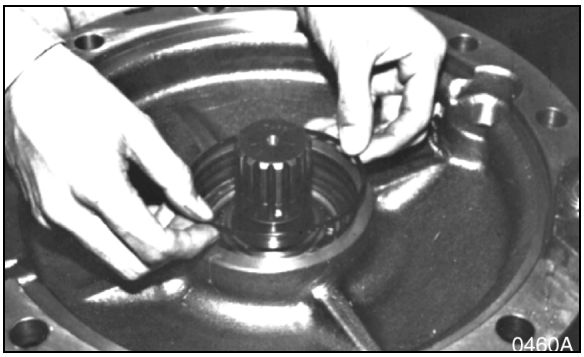


Figure 31

6. Put a little grease on lip of front cover oil seal before replacing front cover and tapping it lightly into place with plastic hammer.

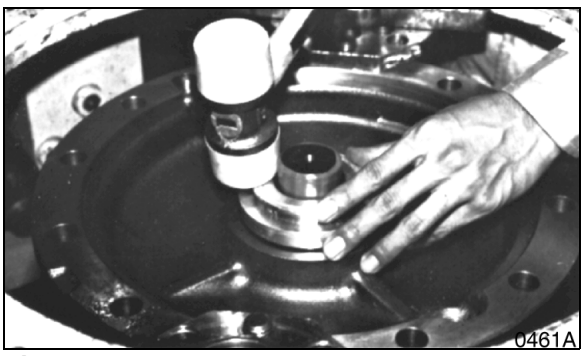


Figure 32

7. Use snap-ring pliers to replace lock ring (437) into lower casing (301).

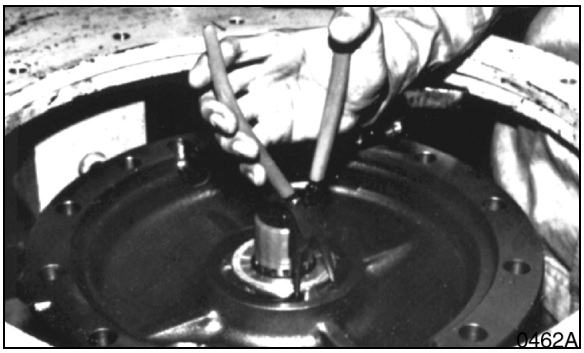


Figure 33

8. Turn motor sideways and assemble shoe plate (124), placing it in motor housing in same position it was in before removal. Using grease on assembled side can help keep individual components in place.

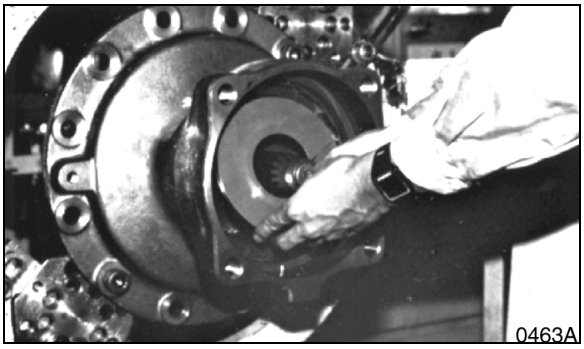


Figure 34

9. Carefully examine cylinder block for any evidence of damage around rotating parts. Put push rods (116) and front spacer (117) back into cylinder block and replace spherical bushing (113).

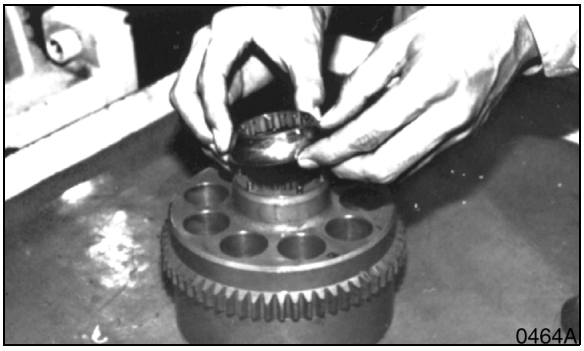


Figure 35

10. Using reference notes or marks made earlier, replace all of the pistons and shoes (121, 122) back in their original cylinder bores.

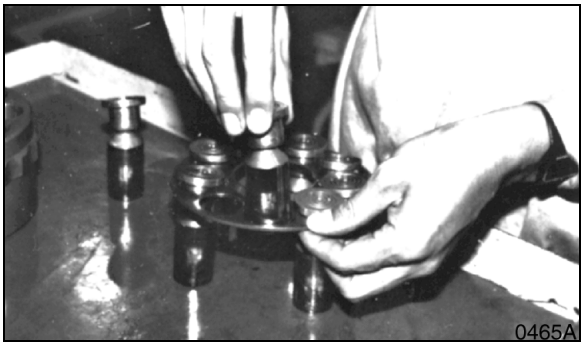


Figure 36

11. Put cylinder block (111) and retainer plate (123) back in motor. Spherical bushing and grooves of cylinder block splines should fit together without undue difficulty. (Do not try to force or pound parts together.)

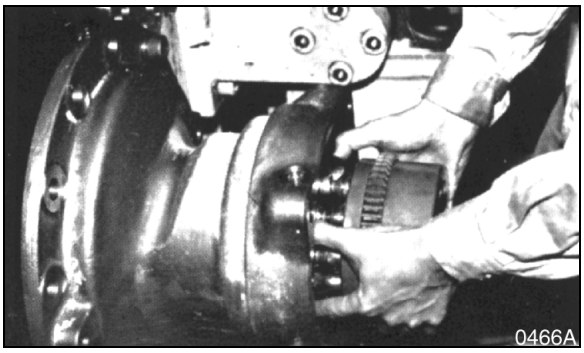


Figure 37

12. Turn motor so that front cover side (304) is down. Put separator plates (743) and friction plates (742) back in same order in which they were removed. There are three separator plates (743) and two friction plates (742), which should be positioned as shown in drawing below, with clearance towards side of casing with brake valve (1, Figure 38).

Reference Number	Description
1	Brake Valve

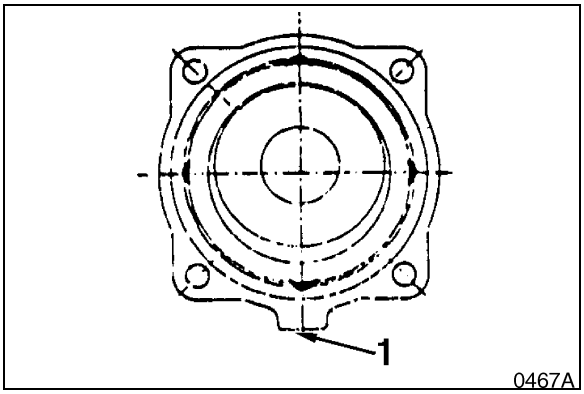


Figure 38 \

13. Very lightly grease larger O-rings (706 and 707, Figure 4) before replacing them in casing (301).

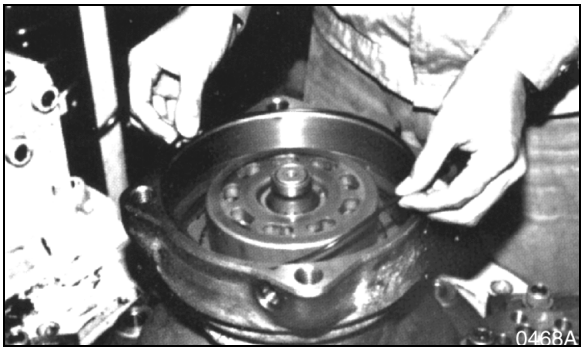


Figure 39

14. Position brake piston (1, Figure 40) in casing. The diagram shows position of four piston grooves (2) in relation to valve-connected side (3), and two 8 mm bolts which should be tightened in an even, progressive rotation.

Reference Number	Description
1	Brake Piston
2	Groove
3	Valve-connected Side

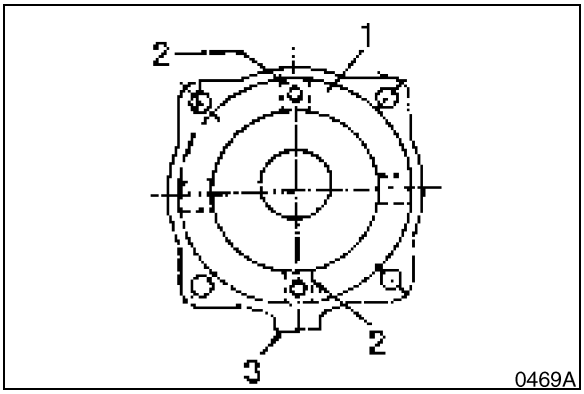


Figure 40

15. Reinstall brake springs, making sure that each gets fully seated on piston.

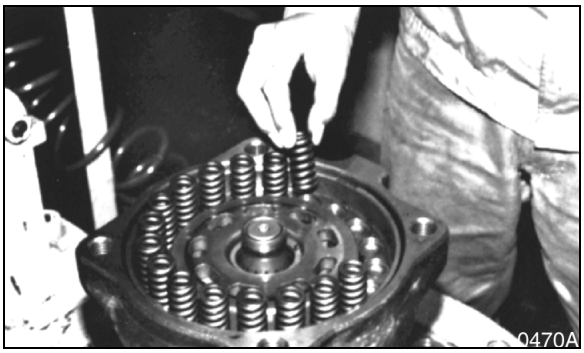


Figure 41

16. Tap roller bearing (444) race back into upper valve casing (303), using hammer and copper rod specified in tool list.

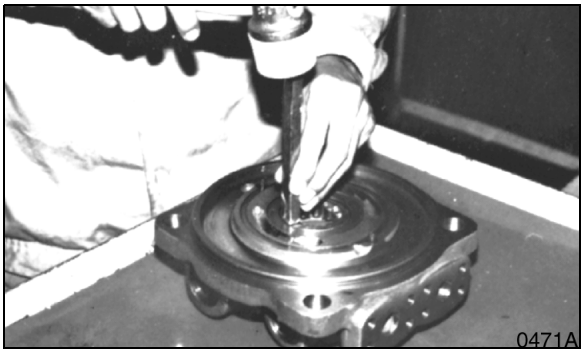


Figure 42

17. Assemble valve plate (131), O-ring and upper valve casing (303). Refer to assembly that shows "R" part (2, Figure 43) of the valve plate turned away from mounting flanges (1) on side of valve plate. Lightly grease O-ring to help keep it in place during assembly.

Reference Number	Description
1	Flange Side
2	R Port

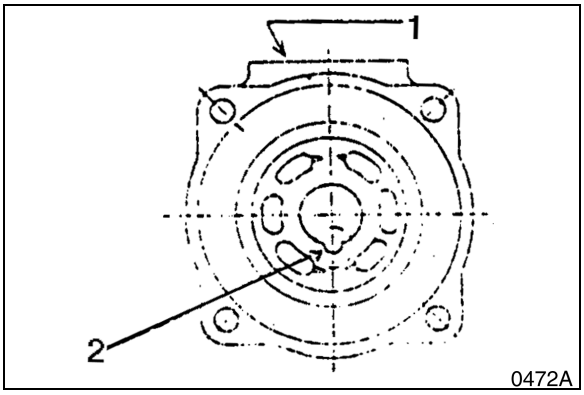


Figure 43

18. Bolt up two halves of motor casing (301 and 303, Figure 4). Be careful not to lose or damage O-ring. Tighten four 20 mm socket head bolts using a progressive, even rotation. Make sure that all brake springs are fully seated and that valve casing inlet and output ports are correctly matched.

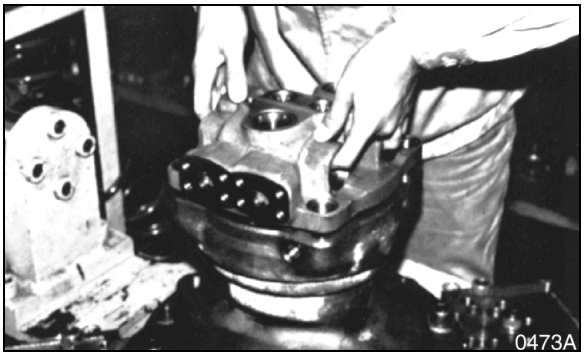


Figure 44

19. Put plungers (351), springs (355), O-rings (488), and RO plugs (469) back in casing. Make sure that both plungers are free to move back and forth.

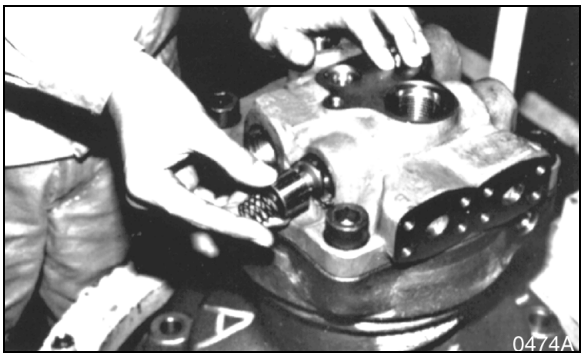


Figure 45

20. Reassemble relief valves (51) by putting rod, spring, stop and piston back together, then turning plunger side of valve up to reassemble valve body and all components of piston: spring seat, spring, bushing, retainer, O-ring and plug.



Figure 46

IMPORTANT

Be careful not to damage the plunger and spring seat.



Figure 47

21. Before replacing relief valves (51) in upper valve casing (303), install backup rings and O-rings.

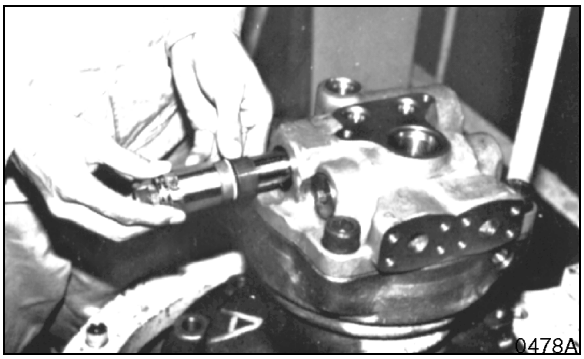


Figure 48

22. Replace the VP plugs (464, 468) and O-rings (485, 487) on each of the three plugs. Reinstall the brake cutoff valve (31).

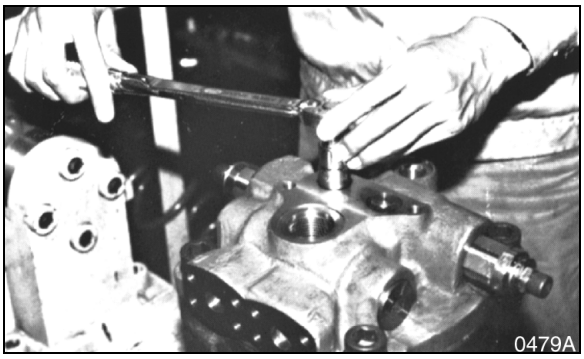


Figure 49

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

TRAVEL MOTOR (WITH GEARBOX) (A6V160HD)

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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May 2002

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GENERAL DESCRIPTION

THEORY OF OPERATION

Refer to the assembly cross-section at the end. Travel motor consists of the hydraulic motor and reduction gearbox.

Hydraulic motor consists of the rotary part, cross relief valve, negative brake, counter balance valve and tilting parts. The reduction gearbox consists of a 3-speed planetary gearbox. The next figure shows the motor as a symbol.

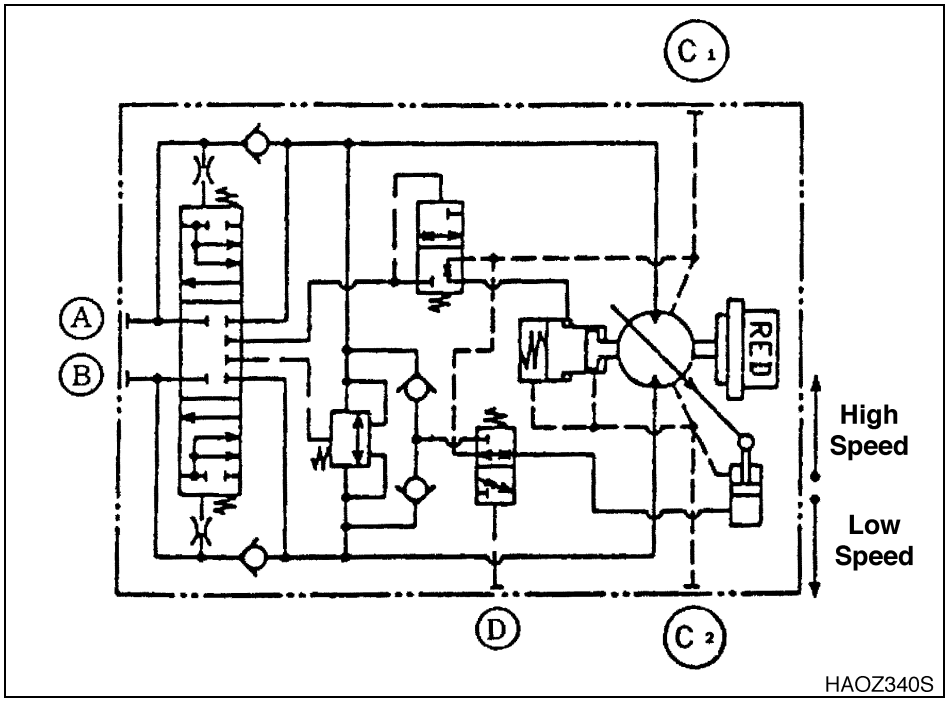


Figure 1

HYDRAULIC MOTOR OPERATION

1. Hydraulic Motor operation.

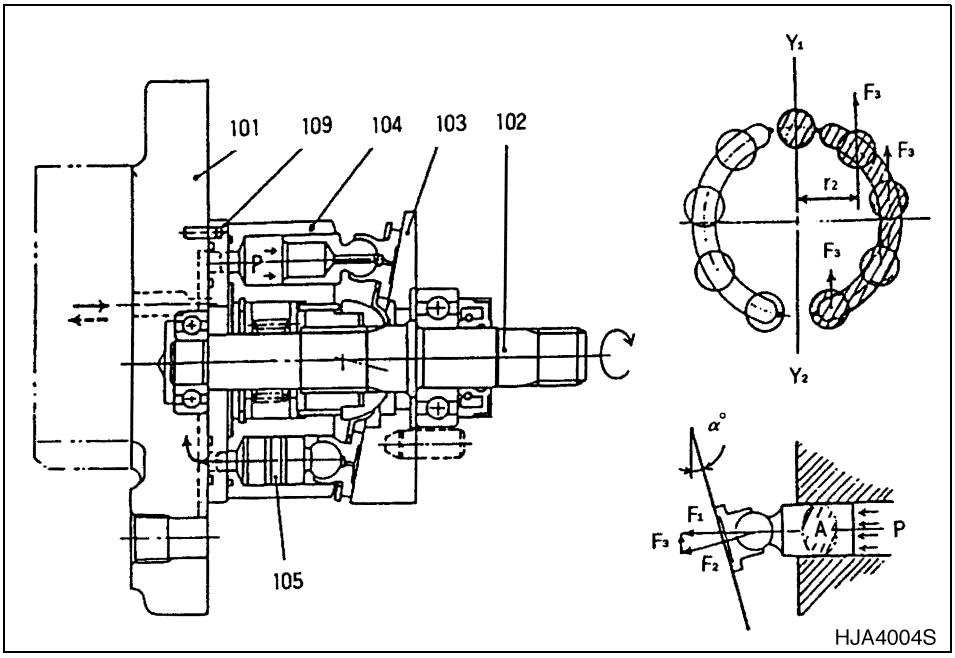


Figure 2

The high pressure oil from the hydraulic pump goes to the cylinder block (104) through the rear flange (101) of the motor and the brake valve device and the timing plate (109). This high pressure oil acts only on the single side of the line Y1-Y2 which connects the bottom dead center and the top dead center of the piston (105) stroke. The oil, after flowing into the side of the cylinder block (104), exerts force on each piston (4 or S pieces) and generates force F (p kg/ cm x A cm^2). The force F is exerted on the swash plate (103): as the swash plate (103) is tilted with respect to the driving shaft (102) by a degrees, the force F is divided into two resultant forces F2 and F3. Among these forces, radial force F3 develops torque T (F3 x ri) with respect to each Yl-Y2 line. The combined torque T(Z(F3 x ri)), which is a rotation force, rotates the cylinder block through pistons (105). The cylinder block is coupled with the driving shaft by a spline, and the driving torque is transferred to the shaft.

2. Brake Valve

A. During Travel.

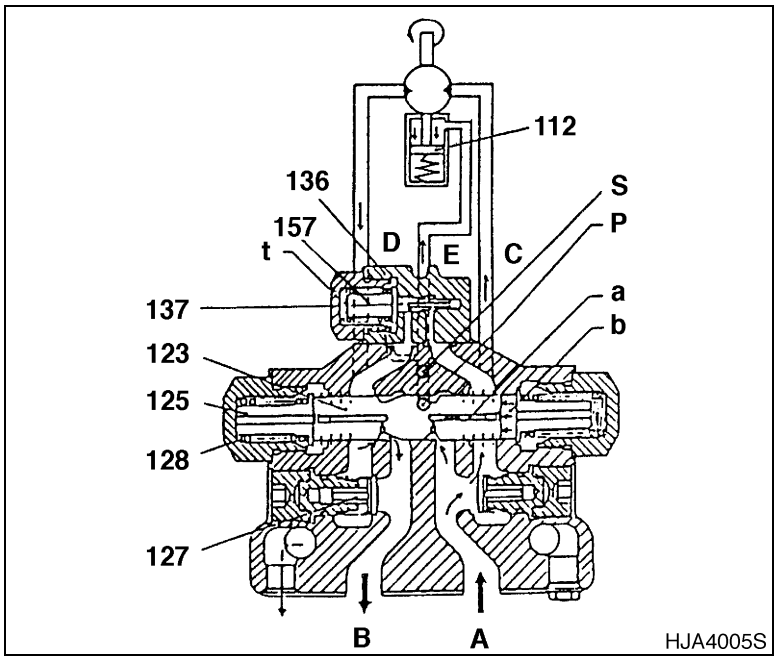


Figure 3

If the pressure oil is supplied from port A, this oil opens the valve (130), flows into the inlet port C of the hydraulic motor, and turns the hydraulic motor.

At the same time, the oil, which flows from a small hole of the spool (126) to the chamber b through passage a, exerts pressure on the spool section, and moves the spool to the left over spring (128) force.

As the spool moves, port D at the return side of the motor and part B at the tank are connected together by a hole in the spool, and the motor turns as the return oil from motor flows into the tank.

By the movement of spool (126), the pressure oil goes into port P and S. In port P, the pressure oil releases the parking brake force and moves the piston of parking brake.

In port S. the pressure oil goes into chamber t, presses the stopper (157) of the inner surface of the main body, prevents the spool (137) from moving, and closes port C during driving. If the pressure oil is supplied from port B, the spool (120) and the valve (130) operate in reverse, and rotate in the opposite direction.

B. When Stopping by Deceleration.

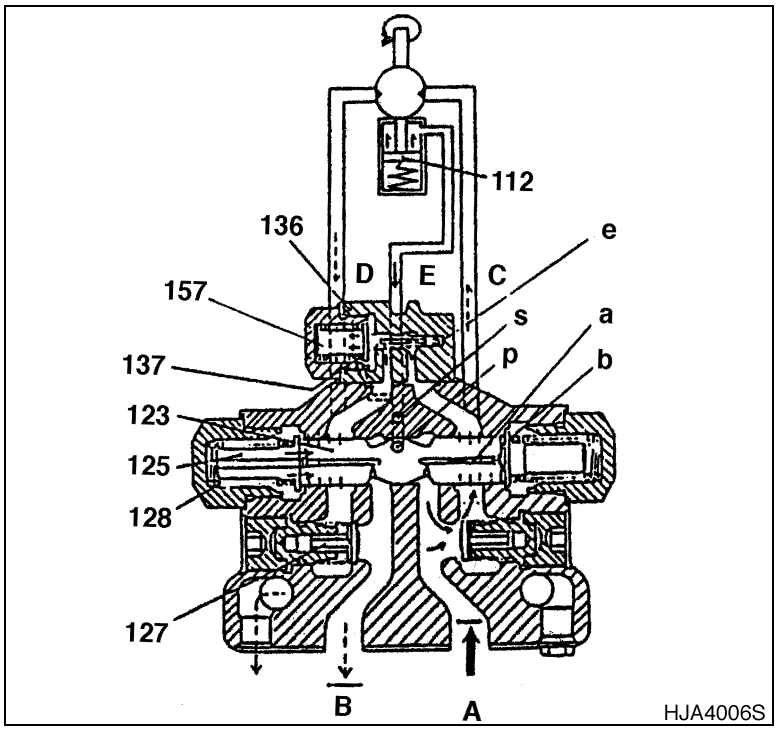


Figure 4

If the pressure oil supplied by the port A is cut off during drive. there will be no hydraulic force. Then, the spool (126) returns to the right (neutral position) through the stopper (125) by the spring (128).

The hydraulic oil in chamber b goes through passage a into port A, and back pressure, which is generated by throttling of passage a controls the return speed of spool (126).

At the same time, the hydraulic motor rotates by inertia force even without the pressure oil.

So the return oil from port D returns to port B through a gap between the spool hole and the rear flange.

If the spool returns to the neutral position, hydraulic motor stops because all passages are closed completely.

Like this, the spool's returning speed controls the return oil from motor gradually according to the spool's shape, and stops the hydraulic motor.

As the hydraulic motor rotates because of inertia force, it tries to absorb the hydraulic oil. But hydraulic oil cannot be supplied because the oil is blocked. So the hydraulic motor will be damaged by cavitation. But, at the same time, the pressure at port D rises because the return oil from the hydraulic motor is closed.

By this pressure, the spool (137) slides to the left, the ports D, C are connected. And, by this, cavitation and pressure rising is prevented.

(Function of the surge cut valve and anti-cavitation valve)

The valve (127) is operated by a little secondary pressure, opens the oil passage between the port A and the motor suction part, and it prevents the hydraulic motor from cavitation.

3. Parking Brake

C. During Travel.

If the pressure oil is supplied by the brake valve, the brake valve spool of the hydraulic motor part is operated, and the passage into the parking brake is opened.

So the pressure oil flows into the cylinder a which consists of a spindle and a piston.

If the pressure rises above 11 kg/cm^2, it over comes the spring force, and the piston (112) moves.

By the movement of the piston, the force exerted by the piston (112) on the separator plate (116) and the friction plate (115) is released, and the friction plate (115) can move freely. So the brake force acting on the hydraulic motor's cylinders is released.

If the pressure rises above 45 kg/cm^2, the pressure is reduced by the and the pressure at the chamber a is fixed at 45 kg/cm^2. A safety valve which is set up at 100 kg/cm^2 as a limit is installed to the reduction valve.

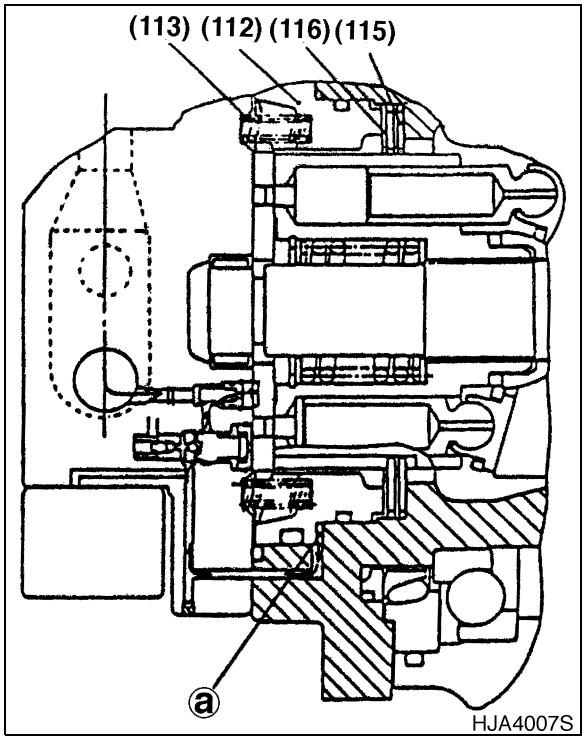


Figure 5

D. During Braking.

If the pressure of the cylinder drops below 11 kg/cm^2 because the pressure oil of the brake valve is blocked, the piston (112) returns by the spring (113) force.

If the piston (112) is pushed by the spring force, the separator plate (116) and the friction plate (115) are pushed to the spindle of the reduction device.

The friction force generated by this push generates braking torque (49.3 kg•m) to hydraulic motor shaft by removing turning force of the cylinder. It operates smoothly because of proper oil paths.

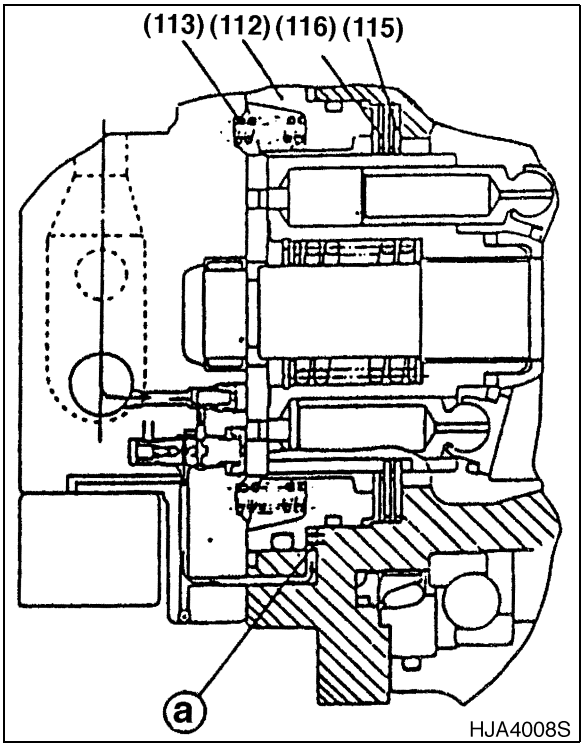


Figure 6

4. High and Low Speed Switching Device

E. At low speed (If the pilot pressure is lower than 10 kg/cm^2)

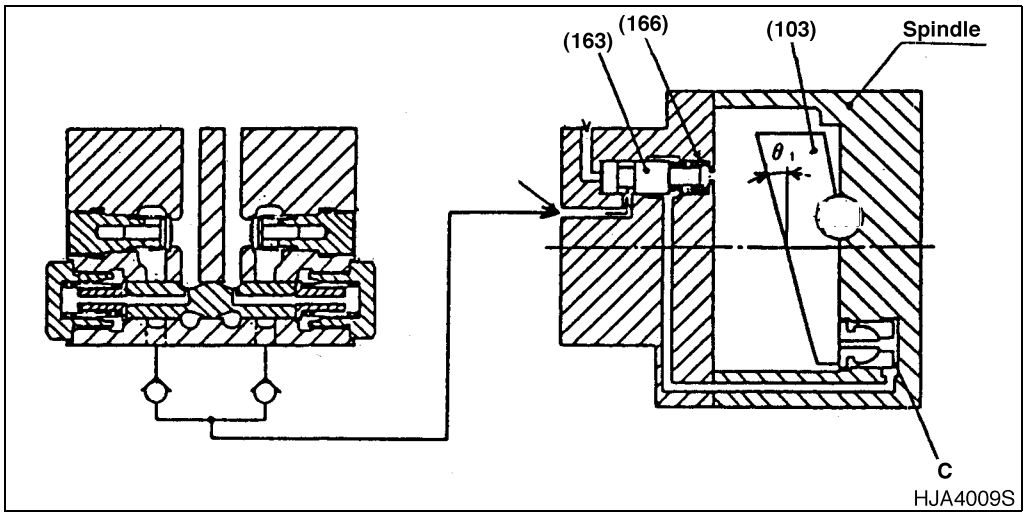


Figure 7

If pilot pressure is not applied from port A (If the pressure is lower than 10 kg/cm^2), the valve (163) is pushed to the left by the spring (I66) force, the pressure oil from the supply port B is blocked, and the oil of the chamber C flows through the valve (I63) into the motor case. So it rotates at low speed because the swash plate (103) is tilted to the maximum angle, and the piston stroke volume is maximized.

F. At high speed (If the pilot pressure is higher than 20 kg/cm^2)

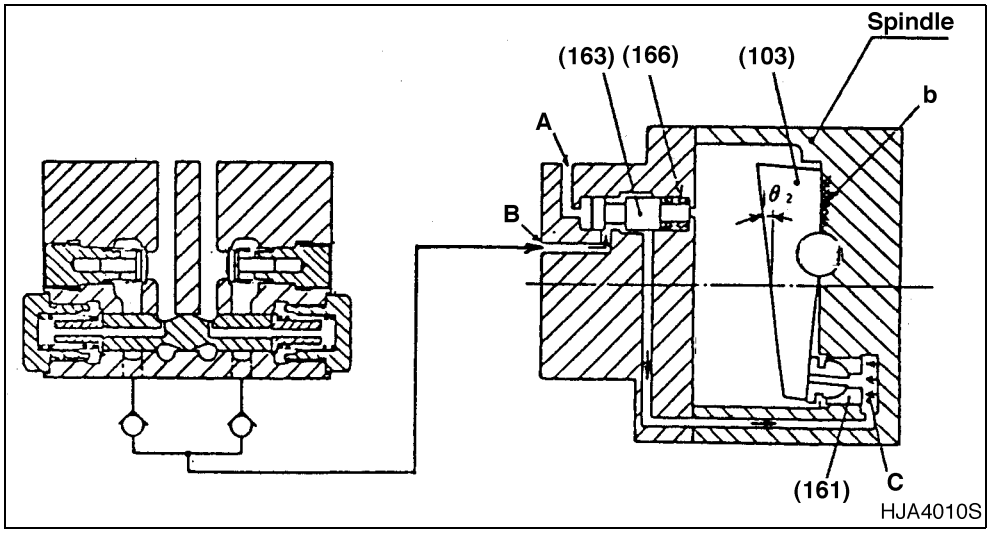


Figure 8

If pilot pressure is supplied from port A (If the pressure is higher than 20 kg/cm^2), the valve (163) is pushed to the right bv the spring (166) force, the pressure oil from the supply port B goes through valve (163) into the chamber C. So the piston (161) is fixed because the swash plate (103) is pushed to the plate b of the spindle. At this time, it rotates at high speed because the slope of the swash plate (103) becomes minimum and the piston's displacement volume becomes minimized (c: 20 kg/cm^2).

REDUCTION GEARBOX OPERATION

This reduction gear is a combined system of planetary gear and differential gear, It reduces rotational speed, while increasing output torque of the hydraulic motor, and rotates the gear case.

1. Planetary gear

   If the sun gear (S) connected to the input shaft rotates, the planetary gear (P) turns around the teeth of the ring gear (R) while the shaft rotates. The planetary gear device transmits torque to the carrier (K) by transmitting this rotation.

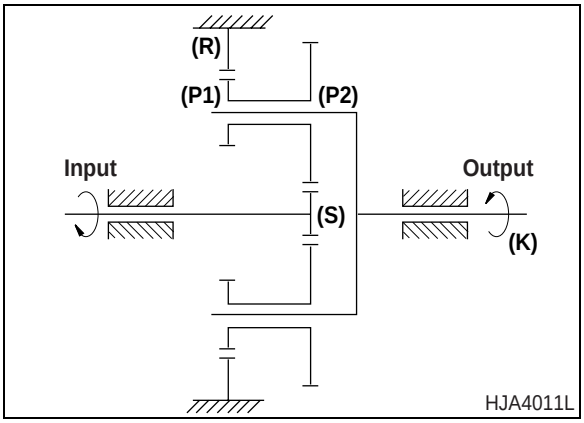


Figure 9

2. Differential gear

   If the carrier combined to the input shaft rotates, the planetary gears (Pl, P2) turn. If the gear ratios between (R) and (P1), (Pl) and (P2) are properly different, the co-axial gears (P1) and (P2) transmit torque by generating different rotation with the gear (D).

$$i_2 = \frac{1}{1 - \frac{R \cdot P_2}{D \cdot P_1}}$$

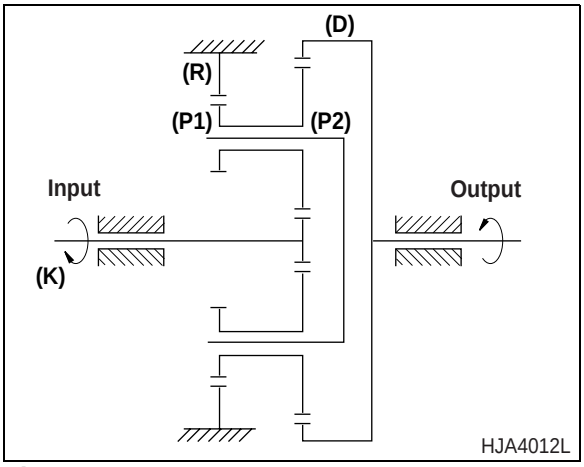


Figure 10

3. Combined device of planetary and differential device.

   If the sun gear (S and R), and (P1), and the carrier rotates by the planetary motion of the gear (P1).And the rotation of the carrier causes the differential motion between gears (R) and (P1), and between (P2) and (D), and causes the rotation of the ring gear, and so torque is transmitted.

$$i = i_1 \times i_2$$

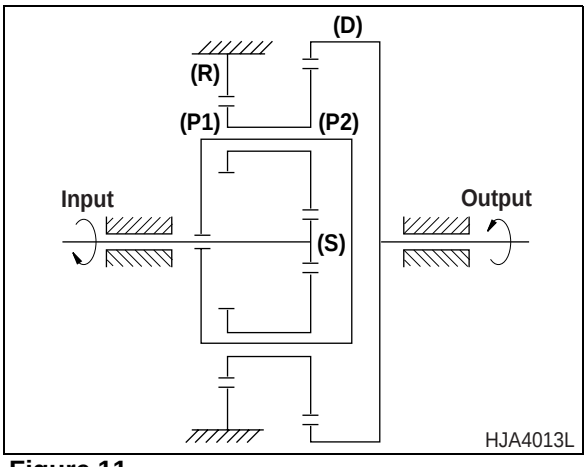


Figure 11

Travel Motor

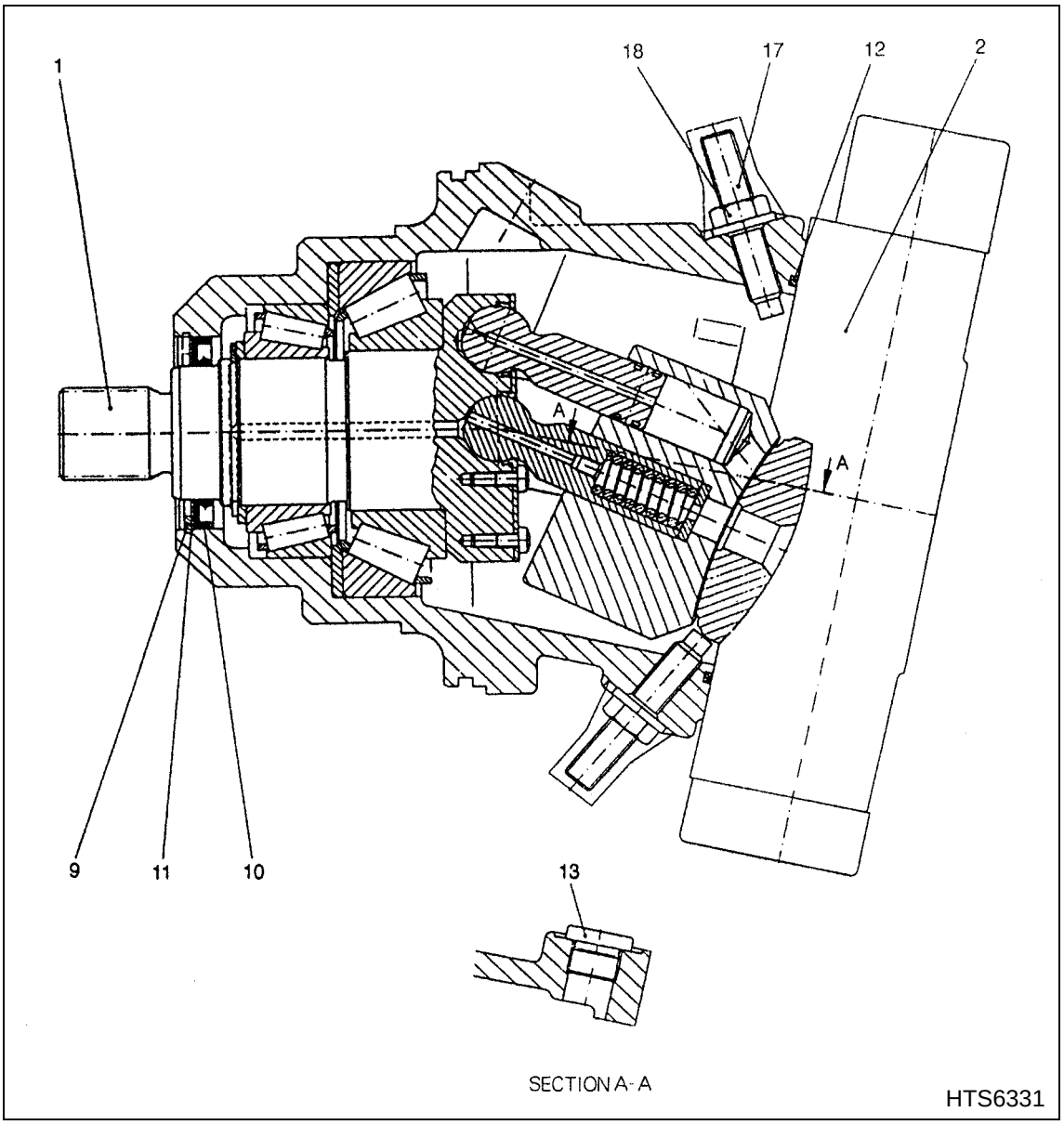


Figure 12

Reference Number	Description	Qty.
6315--	Travel Motor	2
1	Rotary Group	1
2	Control	1
5	Housing	1
9	Retaining Ring	1
10	Shaft Seal Ring	1

Reference Number	Description	Qty.
11	Backup Plate	1
12	O-ring	1
13	Rocking Screw	1
17	Threaded Pin	2
18	Seal Lock Nut	2

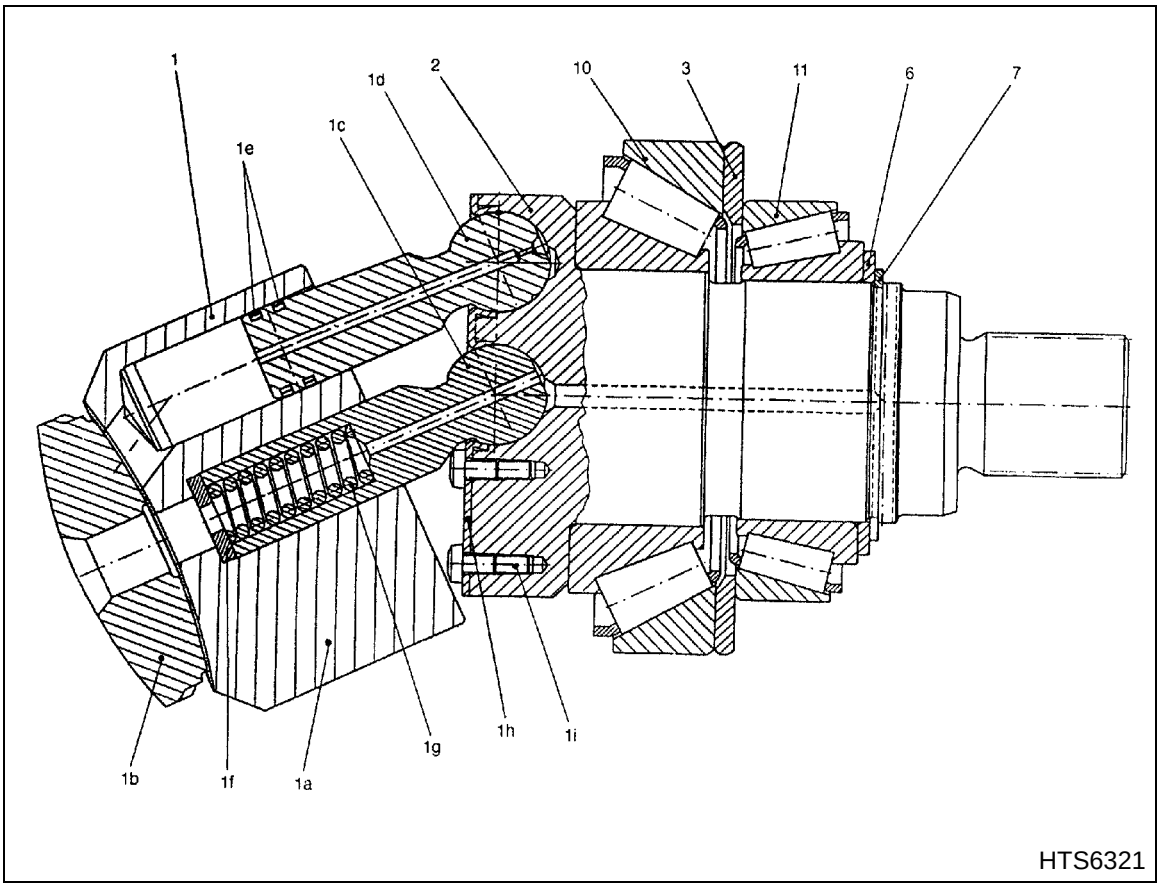


Figure 13

Reference Number	Description	Qty.
6325--	Rotary Group	1
1	Rotary	1
1a	Cylinder	1
1b	Control Lens	1
1c	Center Pin	1
1d	Piston	7
1e	Steel Sealing Ring	14
1f	Adjustment Shim	1
1g	Pressure Spring	1

Reference Number	Description	Qty.
1h	Retaining Plate	1
1i	Screw	14
2	Drive Shaft	1
3	Shim	1
6	Backup Plate	1
7	Retaining Ring	1
10	Tapered Roller Bearing	1
11	Tapered Roller Bearing	1

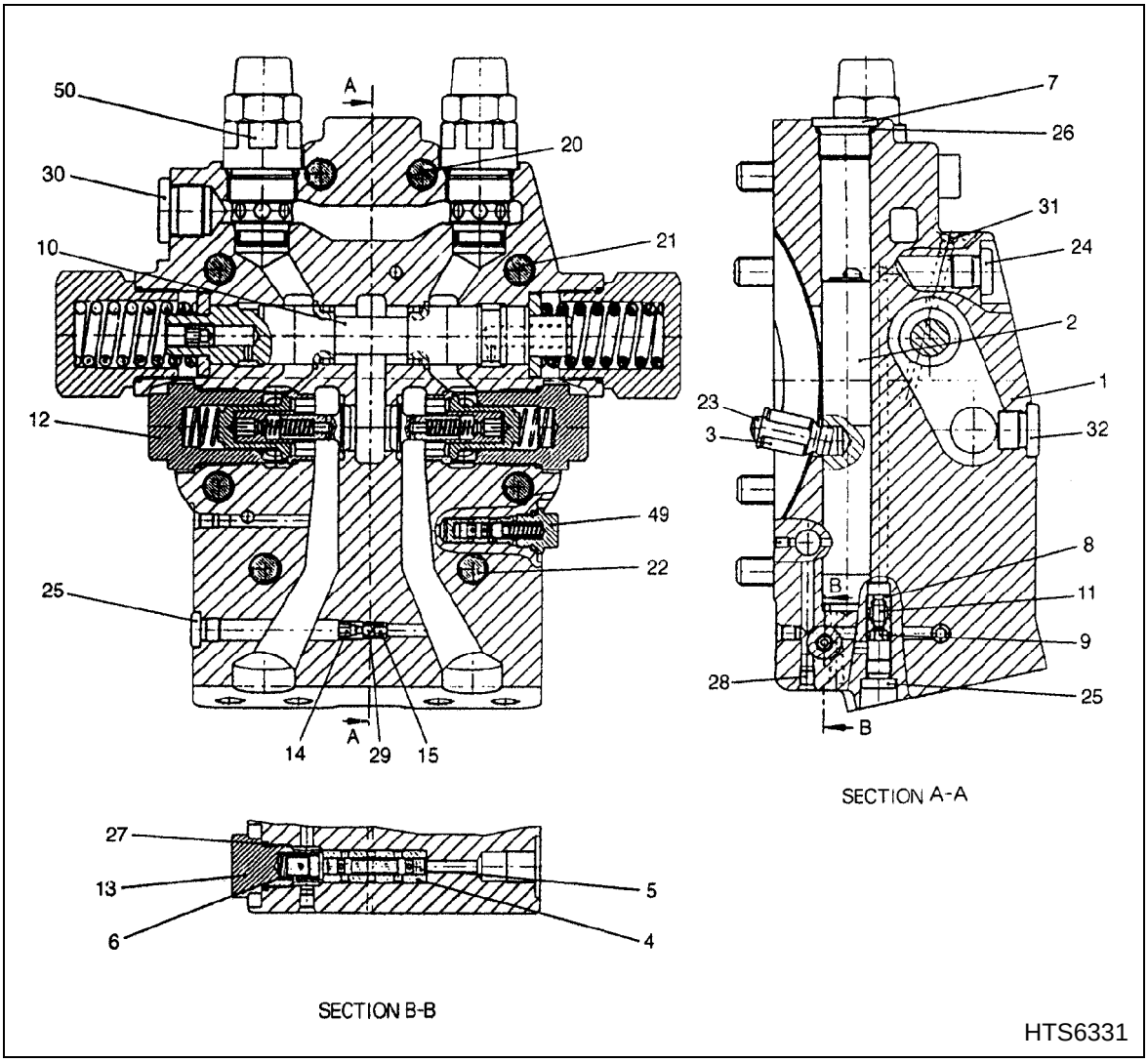

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12
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A
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SECTION B-B
7
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31
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2
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23
3
32
8
11
9
28
25
B
B
SECTION A-A
HTS6331

Figure 14

Reference Number	Description	Qty.
6335--	Control	1
10	Brake Valve	1
11	Throttle Pin	1
12	Valve	2
49	Pressure Control Valve	1
50	Pressure Relief Valve	2
1	Port Plate	1
2	Positioning Piston	1
3	Positioning Trunnion	1
4	Control Bush	1
5	Control Piston	1
6	Pressure Spring	1
7	Rocking Screw	1
8	Throttle Screw	1
9	Throttle Screw	1
13	Rocking Screw	1
14	Valve Screw	1

Reference Number	Description	Qty.
15	Bush	1
20	Socket - Head Screw	2
21	Socket - Head Screw	2
22	Socket - Head Screw	4
23	Cylinder Pin	2
24	Rocking Screw	3
25	Rocking Screw	2
26	O-ring	1
27	O-ring	1
28	Double Break-Off Pin	5
29	Ball	1
6335--	Control	1
30	Rocking Screw	1
31	Double Break-Off Pin	2
32	Rocking Screw	1

Travel Motor Speed Reduction Gearbox Assembly

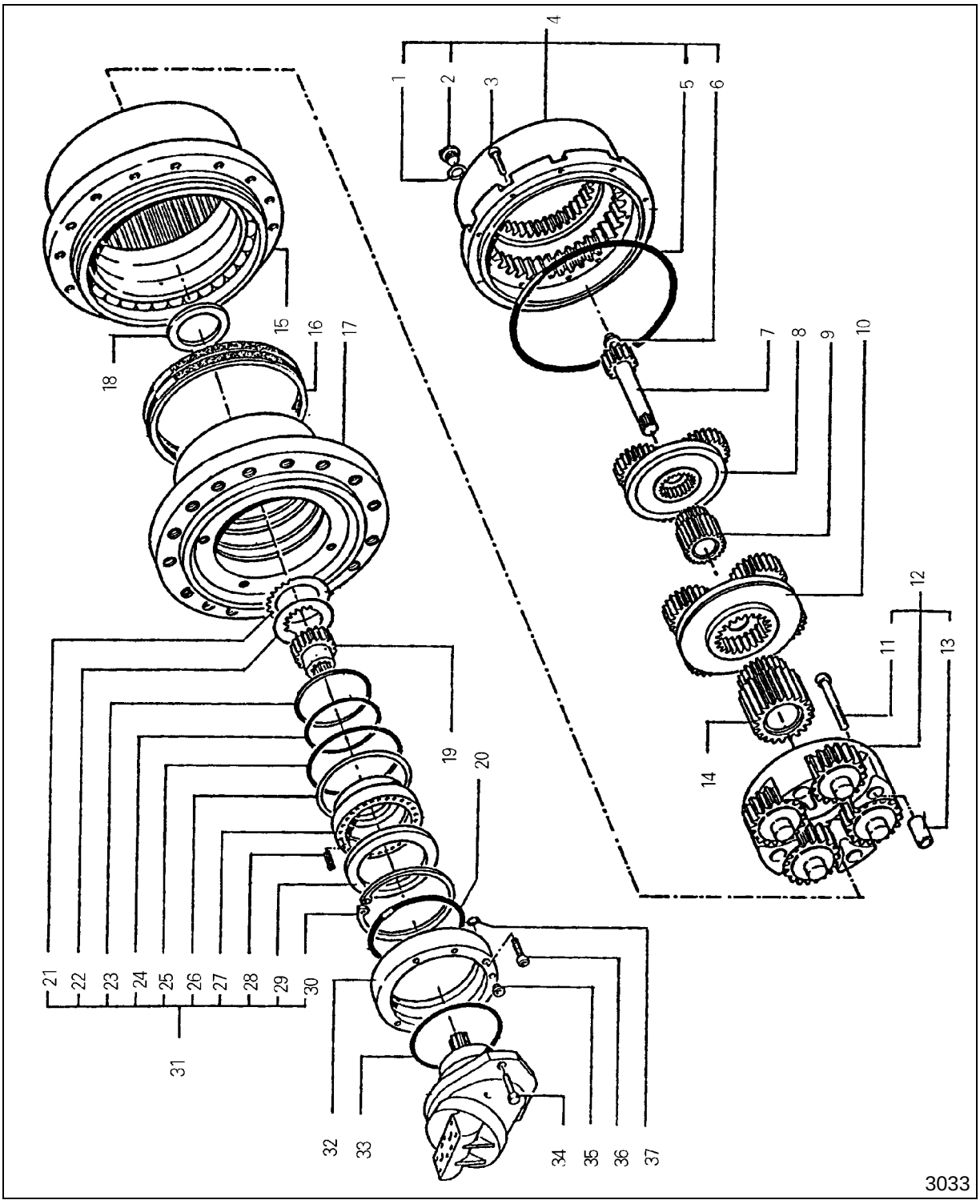


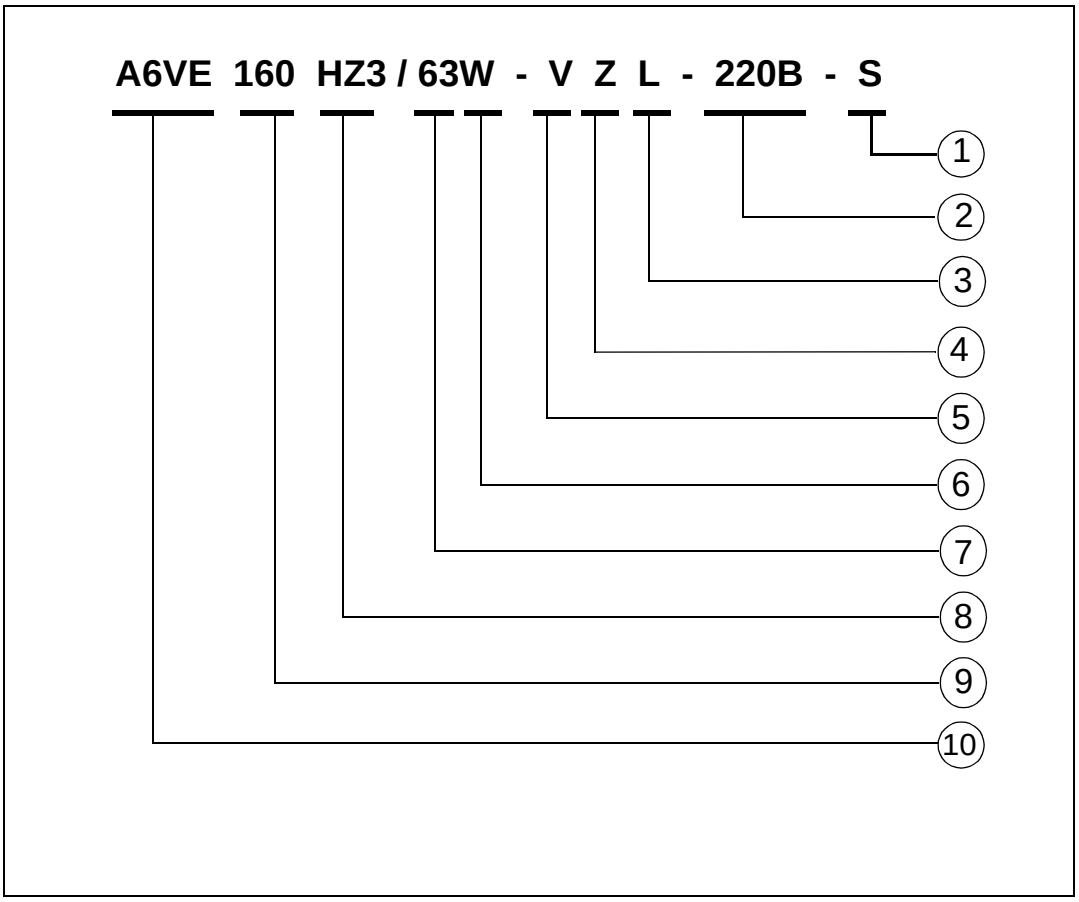
Figure 15

Reference Number	Description	Qty.
1	Washer	2
2	Breather Plug	2
3	Screw	16
4	Cover Set	1
5	O-ring	1
6	Pad	1
7	Sun Gear	1
8	1st Red Assembly	1
9	Sun Gear	1
10	2nd Red Gear Assembly	1
11	Screw, Uni 5931	4
12	3rd Red Gear Assembly	1
13	Bushing	4
14	Sun Gear	1
15	Bearing Assembly	1
16	Gasket, Lifetime	1
17	Hub	1

Reference Number	Description	Qty.
18	Spacer	1
19	Brake Shaft	1
20	O-ring	1
21	Disc	7
22	Ring, Steel	6
23	Ring, Backup	1
24	O-ring	1
25	O-ring	1
26	Ring, Spiral	1
27	Piston	1
28	Spring	21
29	Spacer	1
30	Retaining Ring	1
31	Brake Assembly	1
32	Flange	1
33	O-ring	1
34	Screw	2
35	O-ring	1
36	Screw	8
37	O-ring	1

SPECIFICATIONS

Name Plate Identification



Reference Number	Description
1	Unit With CBV, Brake Release Valve and Relief Valves Incorporated
2	Beginning of Regulation At Max Displacement
3	2 hole Flange
4	Drive Shaft 45 mm Diameter
5	Vitron Seals
6	Alternating Direction of Rotation
7	Series
8	Two-point Control
9	Max Displacement 160 cc/rev
10	Beat Axis Plug-in Type Motor

Component specifications are shown in following table.

Item	Unit	Specification
Rated Torque	kg•m	81.5
Max Rotation Rate	rpm	3680@99 cc/rev
Max Output/rev	cc/rev	160
Operating Rotation	rpm	2900
Max Output Pressure	kg/cm^2	320
2 Speed Switching Pressure	kg/cm^2	Auto. Switching
Parking Brake Torque	kg•m	11.140 kg•m
Parking Brake Releasing Pressure	kg/cm^2	12.5 kg/cm^2

TIGHTENING TORQUES

Tightening Torques For Shaft Bolts

(Metric ISO Standard Thread)

The valve for tightening torques shown in the table are valid only for shaft bolts with metric ISO-standard threads and head support surface dimensions in accordance with DIN 912, DIN 931 and DIN 933. These values are also valid only for light or unoiled, untreated surface and for use only with torque-indicating wrenches and force limiting tools.

Thread Size	Strength Classes					
	8.8	10.9	12.9	8.8	10.9	12.9
	Tightening Torques (lb.ft)			Tightening Torques (Nm)		
M3	0.8	1.2	1.4	1.1	1.6	1.9
M4	2.1	3.0	3.6	2.9	4.1	4.9
M5	4.4	6.3	7.4	6	8.5	10
M6	7.4	10.3	12.5	10	14	17
M8	18.4	25.8	30.2	25	96	41
M10	36.1	50.9	61.2	49	69	83
M12	63.4	88.4	106.9	86	120	145
M14	99.5	140.0	169.5	135	190	230
M16	154.8	217.4	261.6	210	295	355
M18	213.7	298.5	357.4	290	405	485
M20	302.2	427.5	508.5	410	580	690
M22	405.4	574.9	685.4	550	780	930
M24	523.5	737.0	884.4	710	1000	1200
M27	773.9	1105.5	1326.6	1050	1500	1800
M30	1068.7	1474.0	1768.8	1450	2000	2400

Tightening Torques For Locking Screws Vsti (Metric ISO Fine Thread)				
Thread Size	**Designation**		**Tightening Torques (lb.ft)**	**Tightening Torques (Nm)**
M 8 x 1	VSTI 8x1	-ED/SA	=4	=5
M 10 x 1	VSTI 10x1	-ED	=7	=10
M 12 x 1,5	VSTI 12x1,5	-ED	=15	=20
M 14 x 1,5	VSTI 14x1,5	-ED	=22	=30
M 16 x 1,5	VSTI 16x1,5	-ED/SA	=22	=30
M 18 x 1,5	VSTI 18x1,5	-ED/SA	=29	=40
M 20 x 1,5	VSTI 20x1,5	-ED/SA	=37	=50
M 22 x 1,5	VSTI 22x1,5	-ED	=44	=60
M 26 x 1,5	VSTI 16x1,5	-ED/SA	=51	=70
M 27 x 2	VSTI 27x2	-ED	=66	=90
M 30 x 1,5	VSTI 30x1,5	-ED/SA	=74	=100
M 33 x 2	VSTI 33x2	-ED/SA	=88	=120
M 42 x 2	VSTI 42x2	-ED/SA	=147	=200
M 48 x 2	VSTI 48x2	-ED	=220	=300

Tightening torques for seal-lock nuts (Metric ISO Standard Thread)							
The values for tightening torques shown in the table are valid only for seal-lock nuts of the strength class 8.8 and with metric ISO-standard thread.	**Thread Size**	**Strength Classes**					
		8.8	**10.9**	**12.9**	**8.8**	**10.9**	**12.9**
		Tightening Torques (lb.ft)			**Tightening Torques (Nm)**		
	M6	7,4			10		
	M8	16,2			22		
	M10	29,5			40		
	M12	50,9			69		
	M14	81,1			110		
	M16	125,3			170		

Tightening Torques For Cross-slotted Lens Head Screws Din 7985 (Metric ISO Standard Thread)							
The values for tightening torques shown in the table are valid only for cross-slotted lens head screws DIN 7985 of the strength class 8.8 and with metric ISO-standard thread.	**Thread Size**	**Strength Classes**					
		8.8	**10.9**	**12.9**	**8.8**	**10.9**	**12.9**
		Tightening Torques (lb.ft)			**Tightening Torques (Nm)**		
	M3	0,8			1.1		
	M4	2,1			2.9		
	M5	4,4			6		
	M6	7,4			10		
	M8	18,4			25		
	M10	36,1			49		

TRAVEL MOTOR DISASSEMBLY

SECTIONAL VIEW

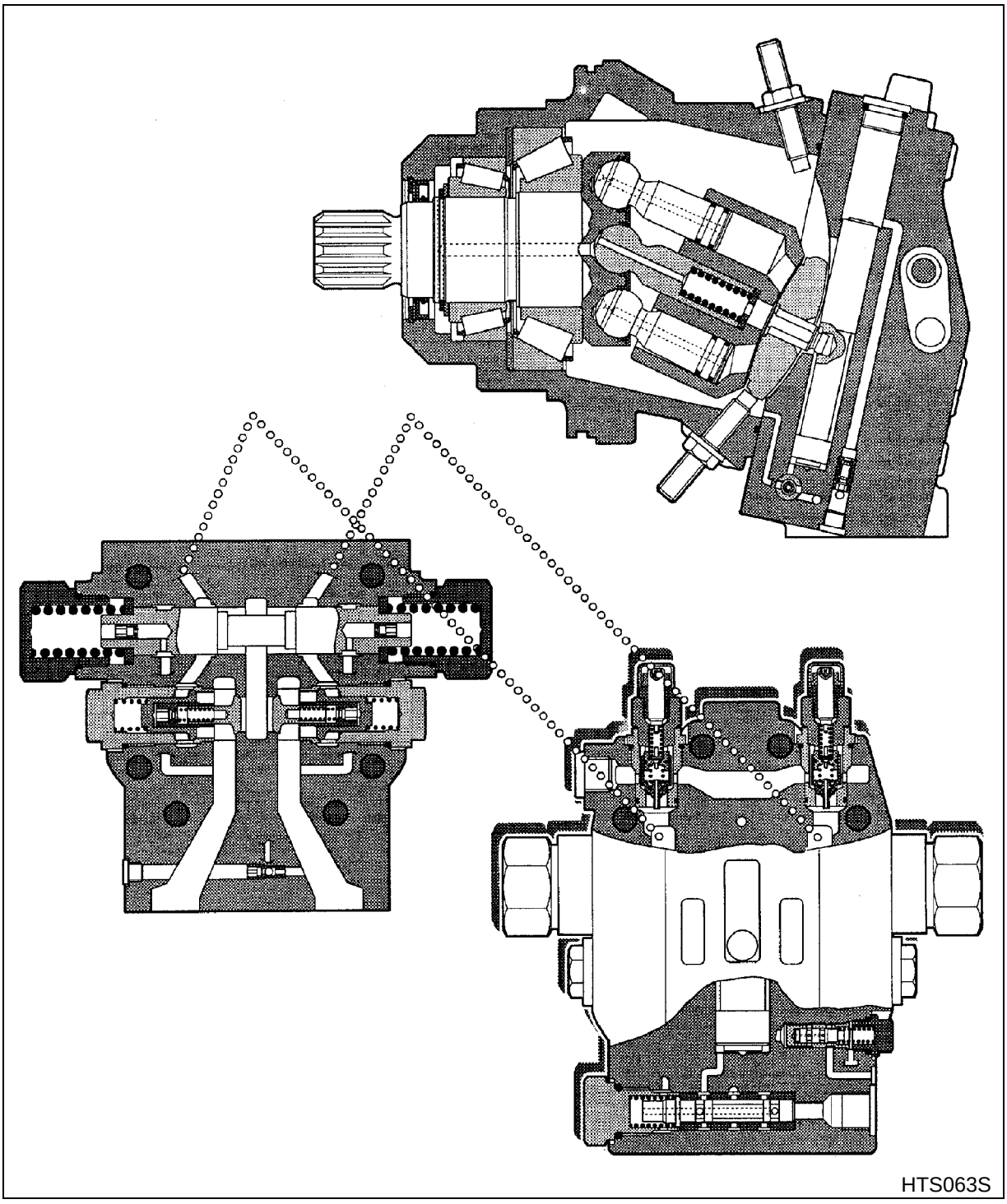


Figure 16

SEAL KITS AND COMPONENT GROUPS

NOTE: *Observe the following notices when carrying out repair work at hydraulic aggregates!*

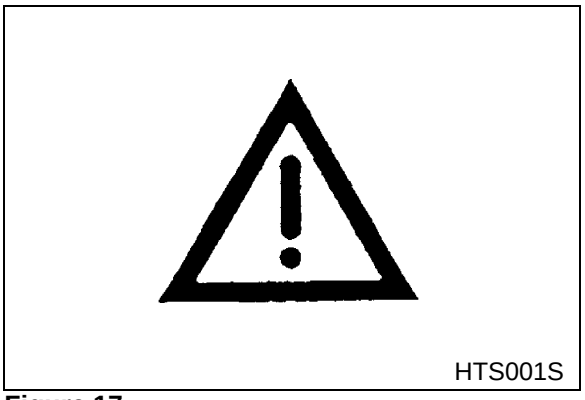


Figure 17

1. Close all points of the hydraulic aggregates.

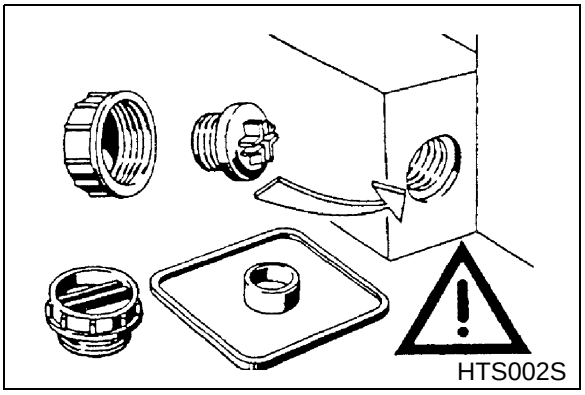


Figure 18

2. Replace all seals.

   NOTE: *Use only original spare parts.*

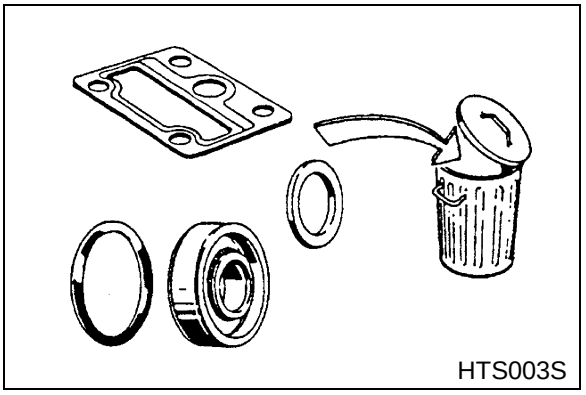


Figure 19

3. Check all seal and sliding surfaces for w ear.

   NOTE: *Rework of sealing area f. ex. with crocus cloth can damage surface.*

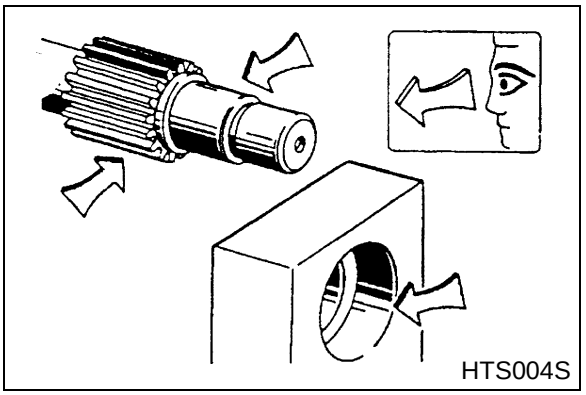


Figure 20

4. Full up hydraulic aggregates with hydraulic oil before start-up.

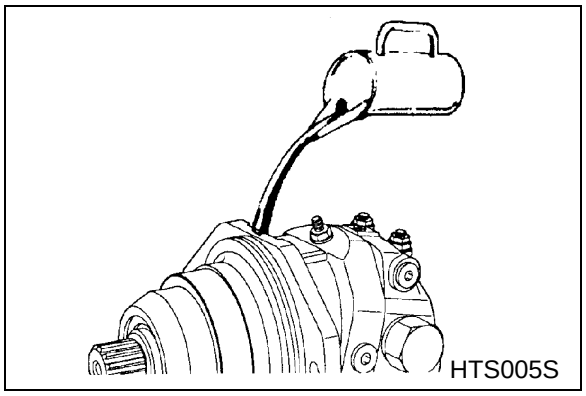


Figure 21

5. Seal kit for drive shaft.

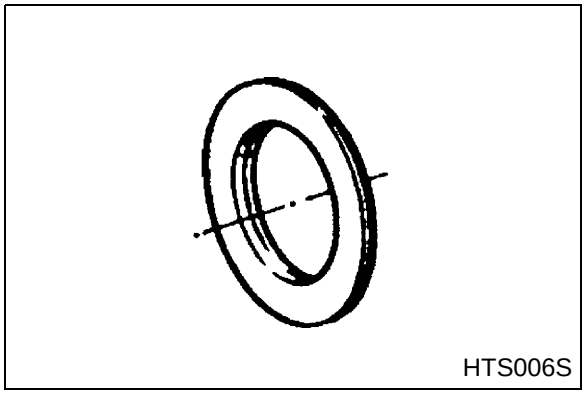


Figure 22

6. External seal kit.

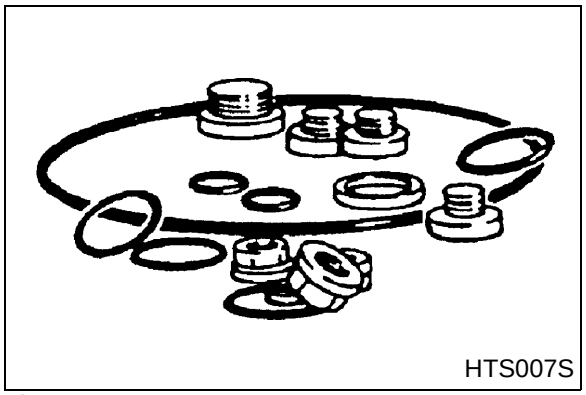


Figure 23

7. Housing.

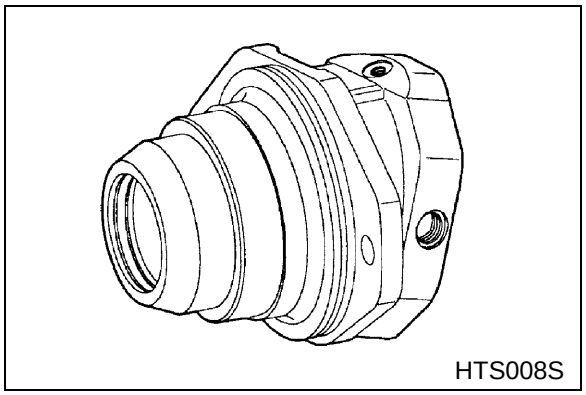


Figure 24

8. Complete rotary group.

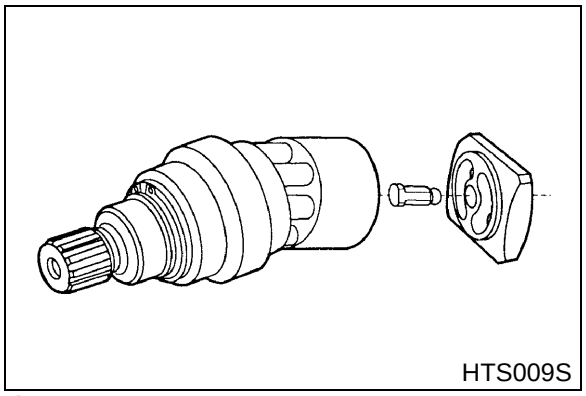


Figure 25

9. Port plate with control piston and counter-balance valve.

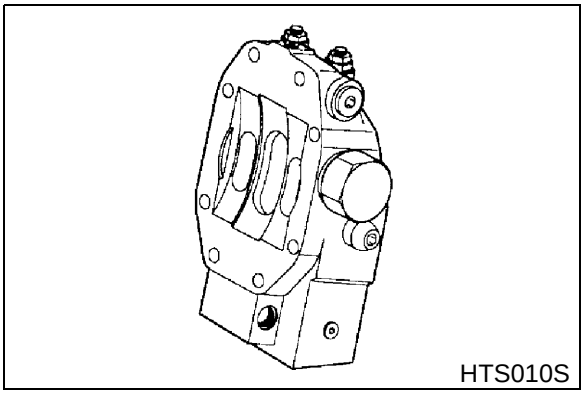


Figure 26

10. Relief valve / Make up check valve.

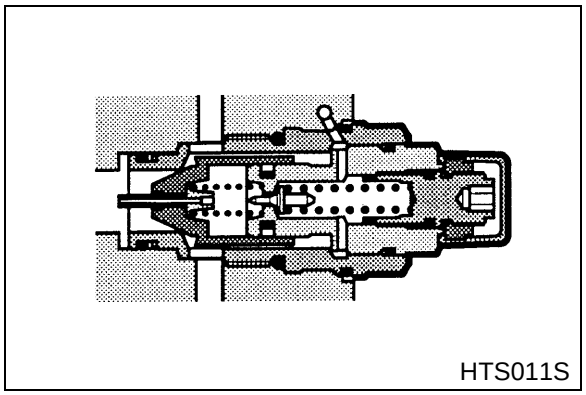


Figure 27

11. Replace seal nut.

    NOTE: *First measure and record setting height.*

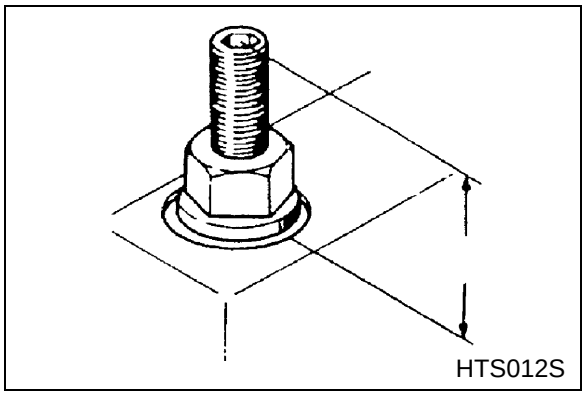


Figure 28

12. When tightening, counter hold setting screw, then check setting height.

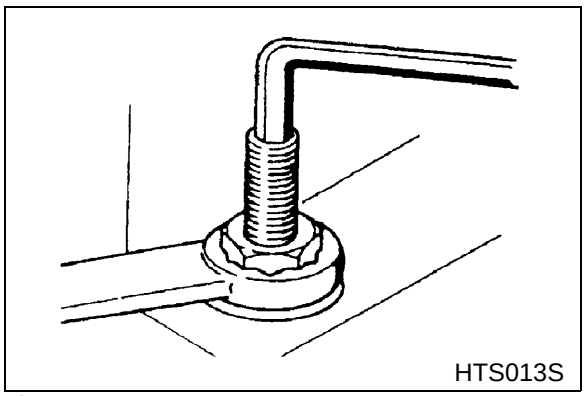


Figure 29

SEALING DRIVE SHAFT

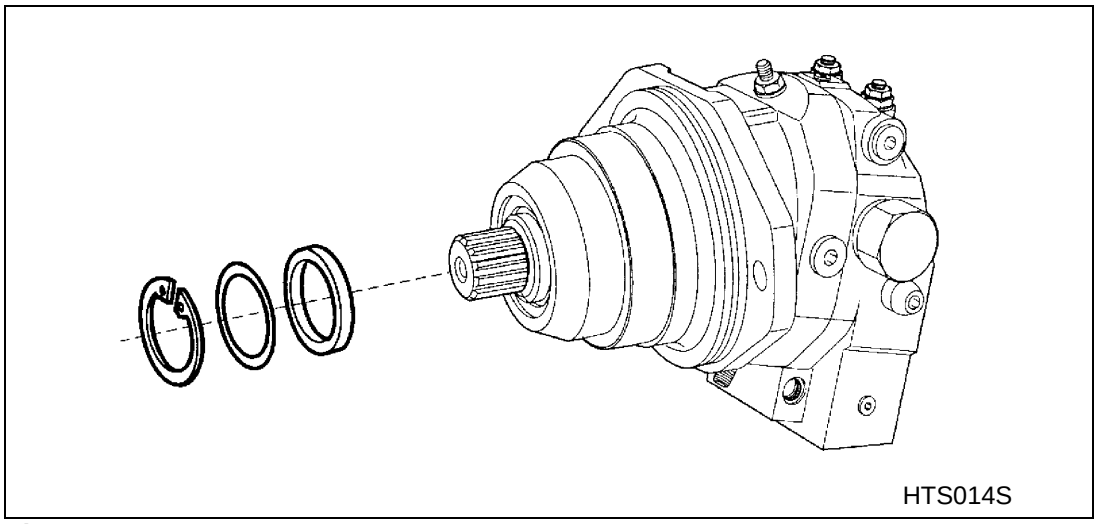


Figure 30

1. Protecting the drive shaft.
2. Remove retaining ring and shim.

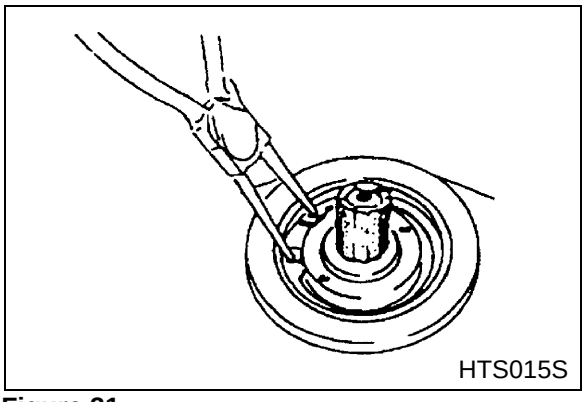


Figure 31

3. Screw in sheet metal screw into the holes fitted with rubber.
4. Pull out seal with pliers.

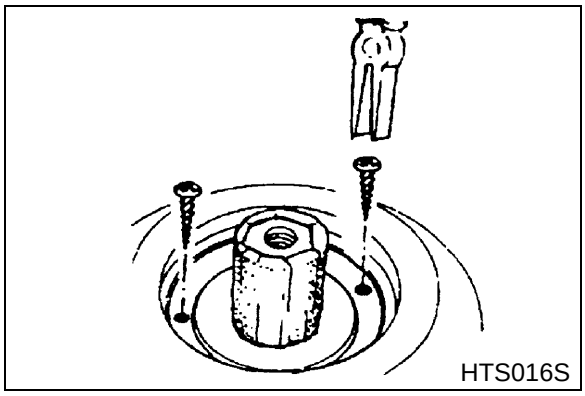


Figure 32

5. Press in shaft seal and shim with bush to stop.

   NOTE: *Pay attention to pressing depth! * Mark for pressing depth. Assemble retaining ring.*

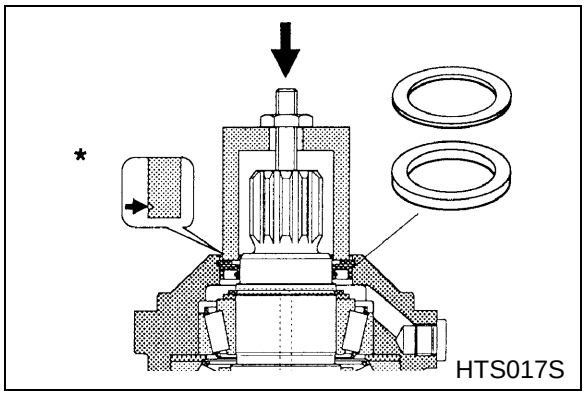


Figure 33

SEALING CONTROL PARTS

1. H-Z- Controller.

   NOTE: *Inspect O-ring, O-ring groove, housing.*

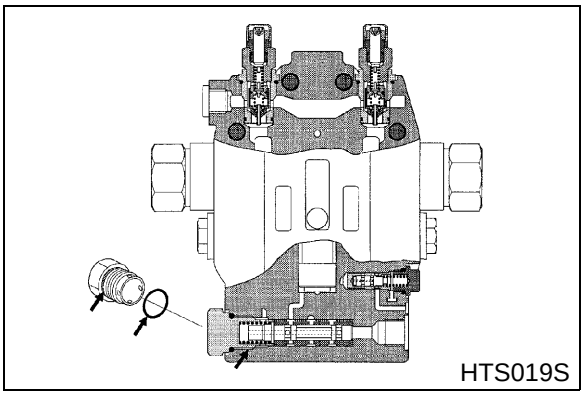


Figure 34

SEALING RELIEF VALVE

1. Remove relief valve.

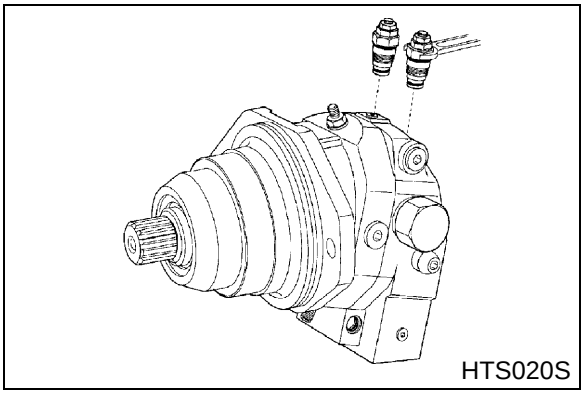


Figure 35

2. Inspect O-ring.

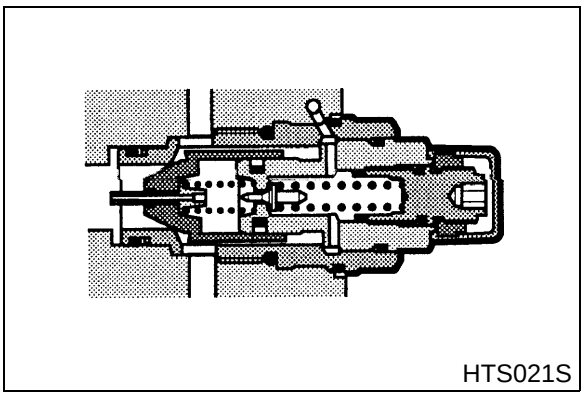


Figure 36

DISASSEMBLY PORT PLATE

1. Note dimension X.
2. Remove Q_{min}-screw.

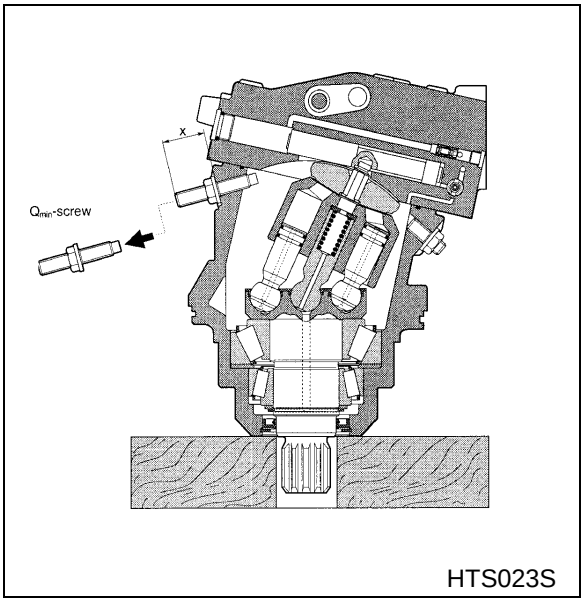


Figure 37

3. For disassembly of the port plate, swivel always rotary group to zero position.

4. Piston rings to hang out the cylinder boring. Swivel rotary group to zero position with screw Q max.

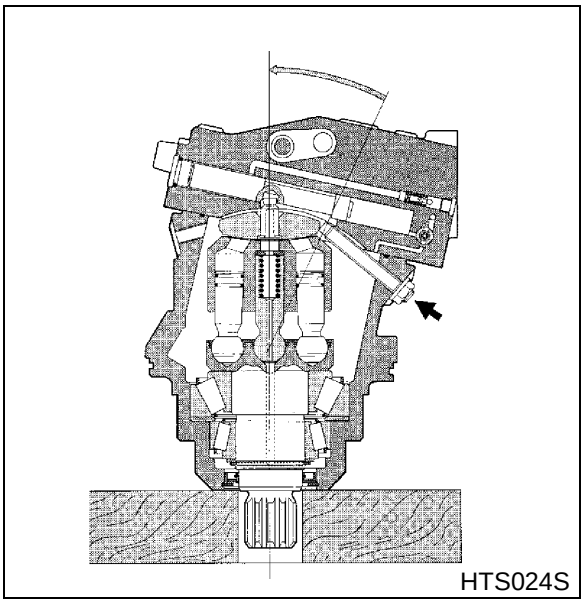


Figure 38

5. Port plate.
   A. Mark position.
   B. Loosen screws.
   C. Remove.

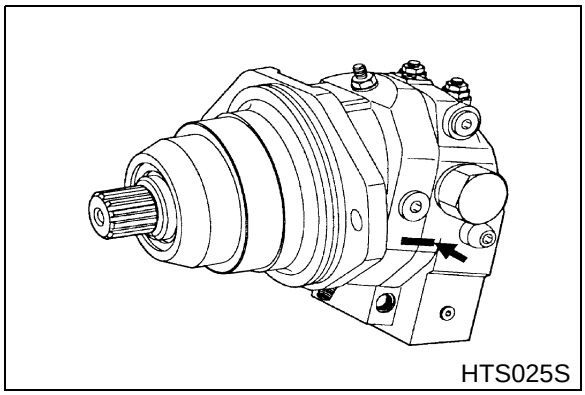


Figure 39

6. Check O-ring.

   NOTE: *Coat new O-ring with some grease. Do not swivel rotary group. Piston rings to hang out from the cylinder boring.*

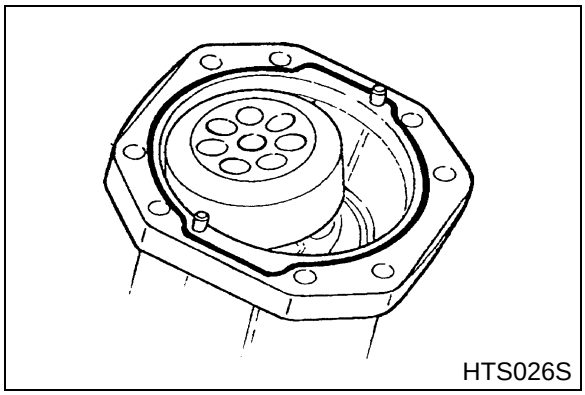


Figure 40

7. Braking valve.

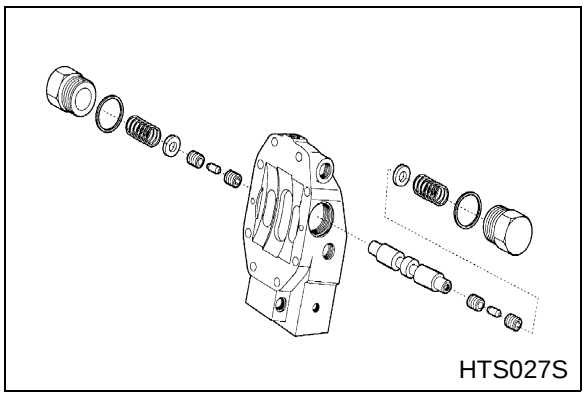


Figure 41

8. Throttle pin.

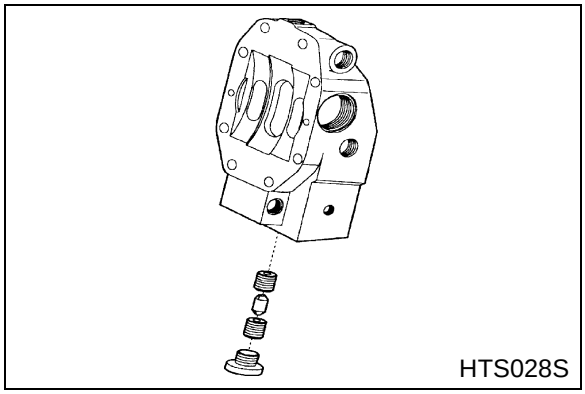


Figure 42

9. Valve.

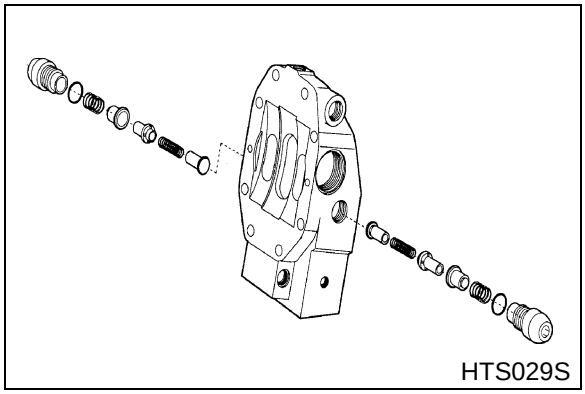


Figure 43

10. Pressure control valve.

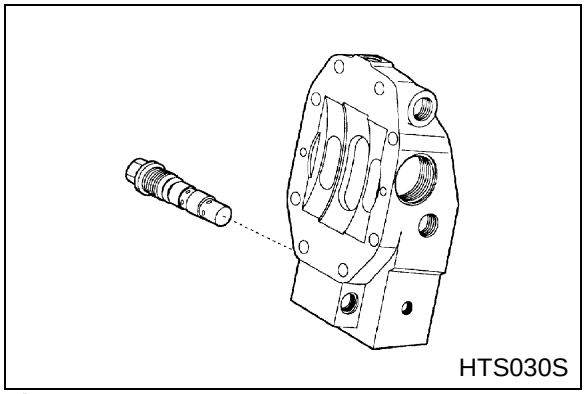


Figure 44

11. Pressure relief valve.

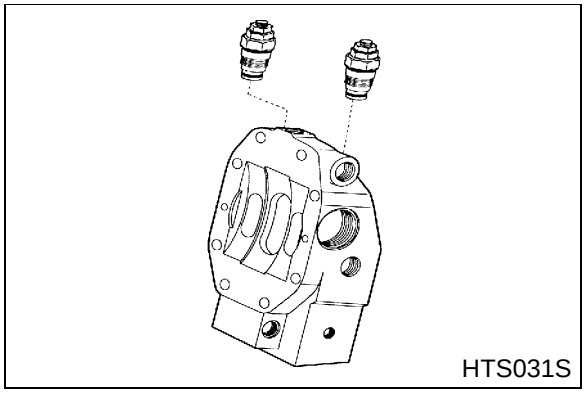


Figure 45

12. Positioning piston.

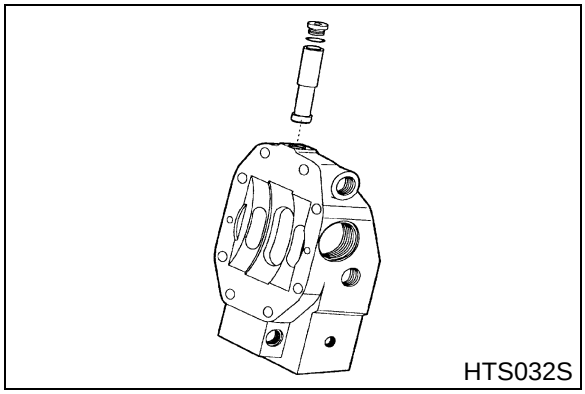


Figure 46

13. H-Z- control.

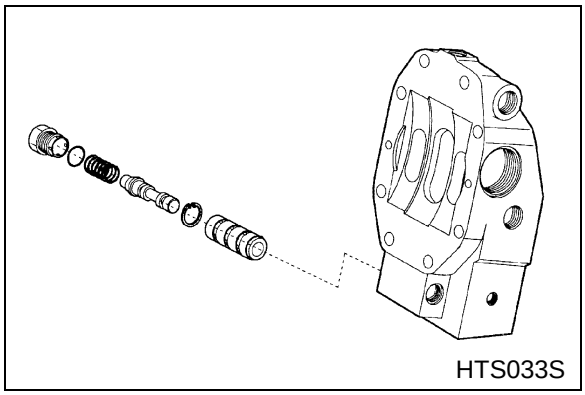


Figure 47

14. Check valve.

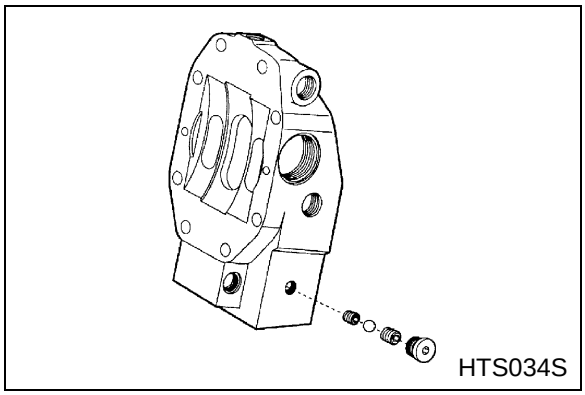


Figure 48

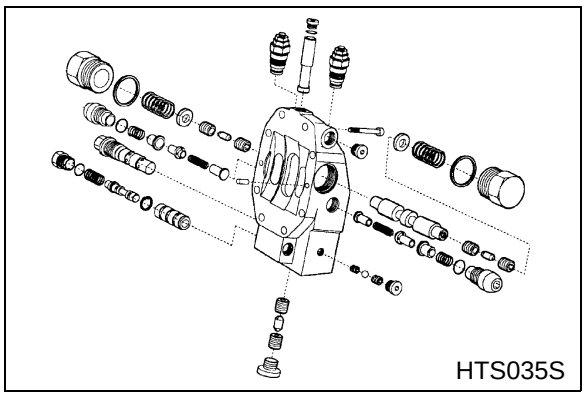


Figure 49

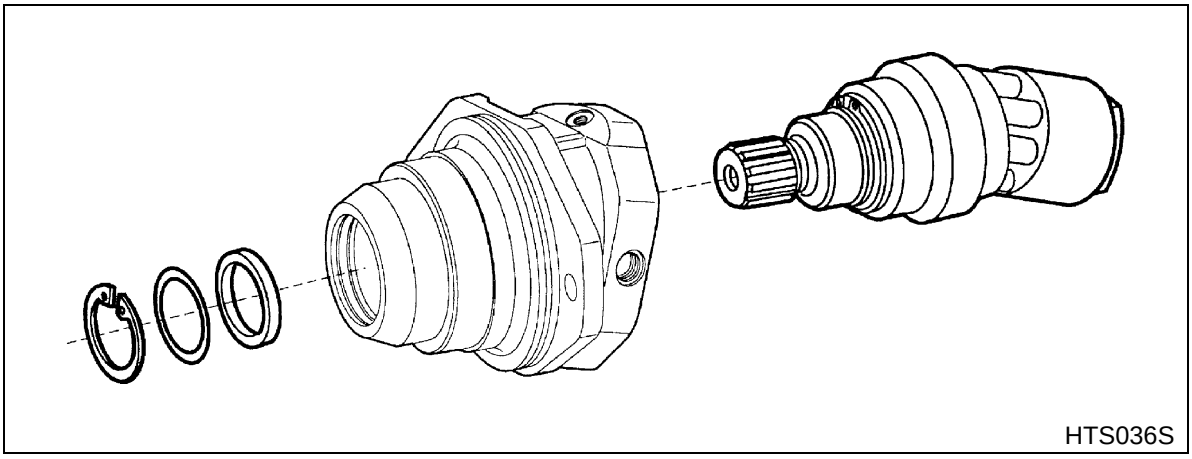


Figure 50

15. Screw in threaded pin into center pin.
16. Fix the cylinder with disc and locknut.

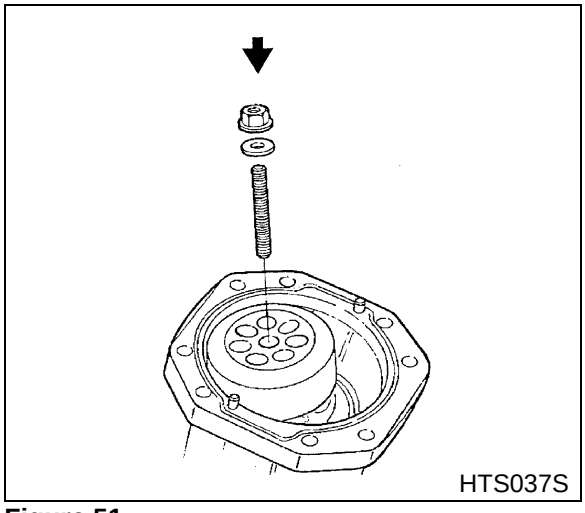


Figure 51

17. Press out rotary group.

NOTE: *If the bearings are used again do not hit on the drive shaft.*

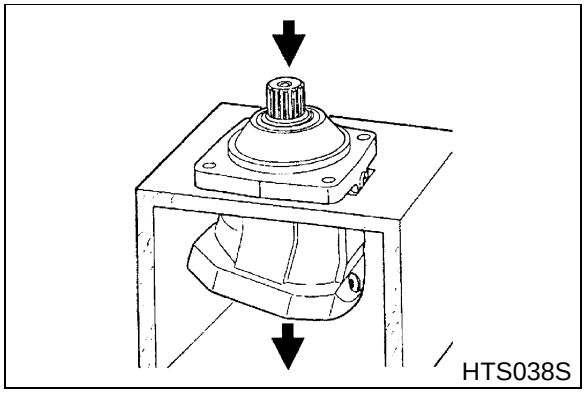


Figure 52

EXCHANGING ROTARY GROUP

1. Complete rotary group.

NOTE: *Setting of hydraulic part necessary.*

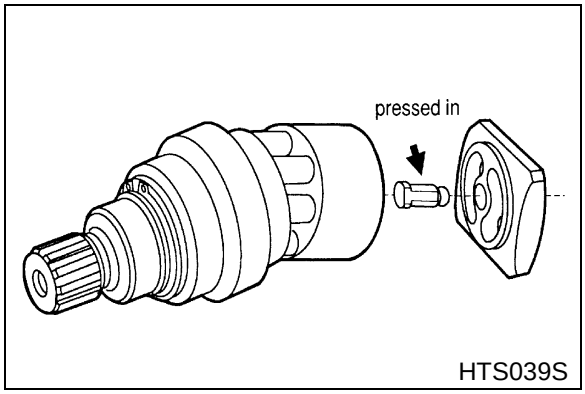


Figure 53

2. Rotary group.
   - Mechanical part; Adjust drive shaft with bearing.
   - Hydraulic part; Adjustment necessary.

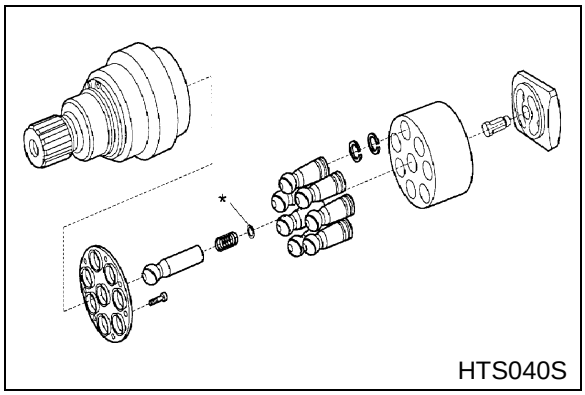


Figure 54

3. Remove fixing screw (cylinder).
4. Remove cylinder.

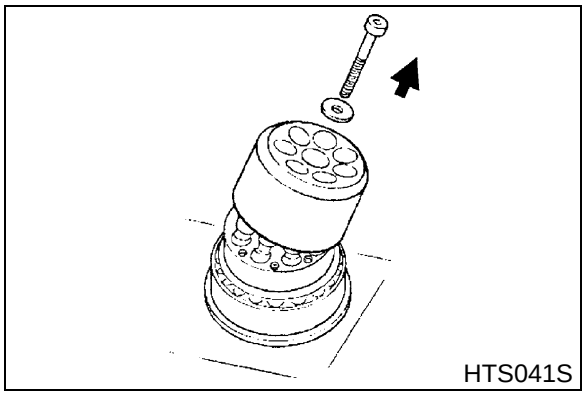


Figure 55

5. Disassemble retaining plate.

   NOTE: *screws are glued. Use Torx-tools.*

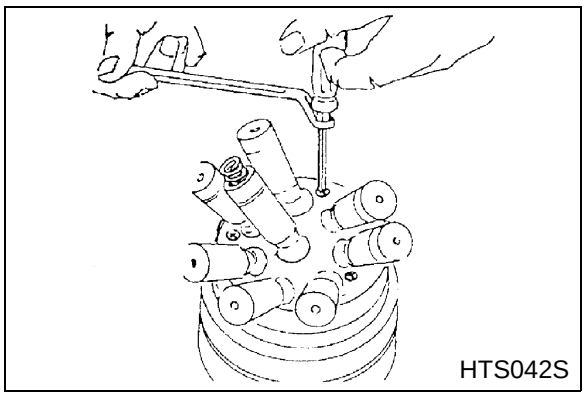


Figure 56

6. Free of corrosion, erosion or fretting; No damage to splines or keyways.

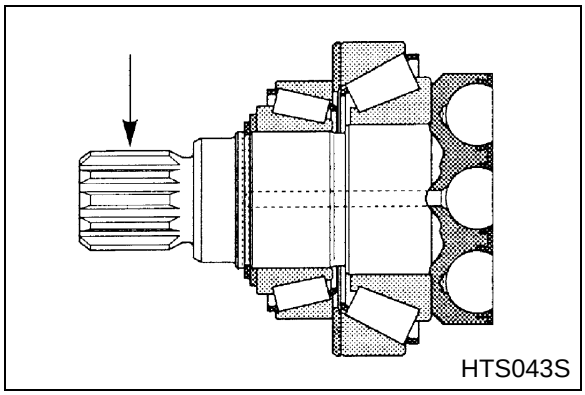


Figure 57

7. Pistons; No scoring and no pitting.

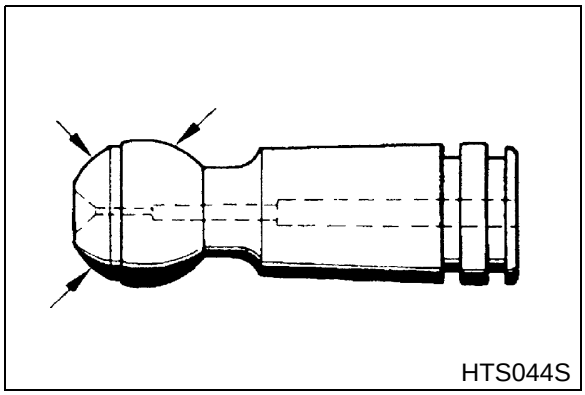


Figure 58

8. Center pin; No scoring and no pitting.

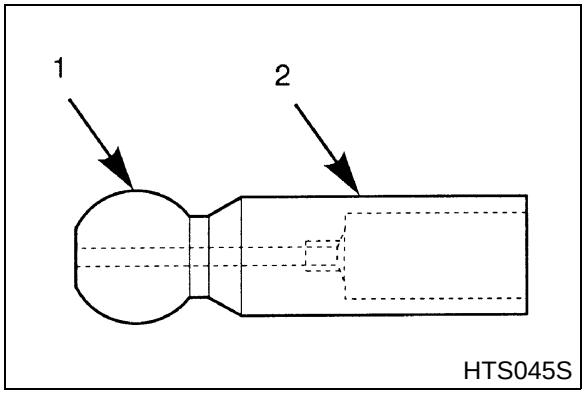


Figure 59

9. Retaining plate; No scoring and no evidence of wear.

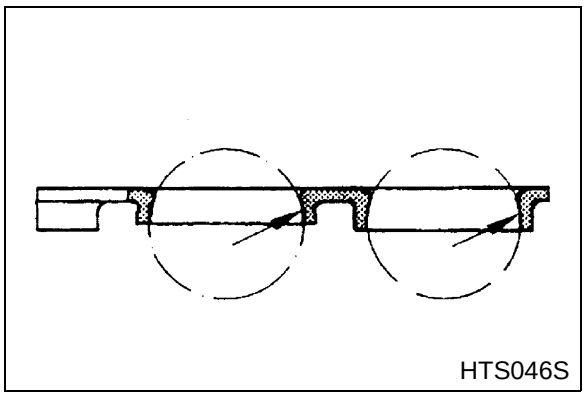


Figure 60

10. Cylinder block / control lens;

    Bores free of scoring, no evidence of wear.

    Faces smooth and even, free of cracks and scoring.

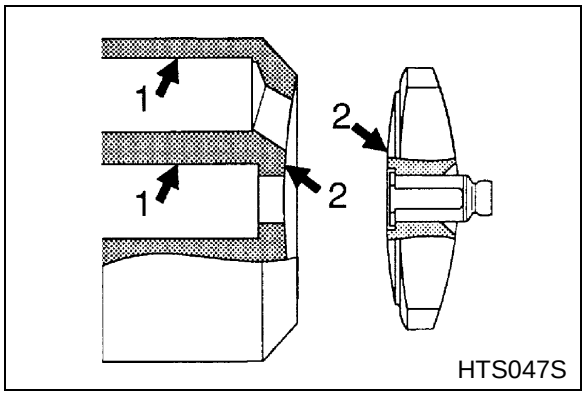


Figure 61

11. Control housing; Sliding surface and side guides free of scoring and no wear.

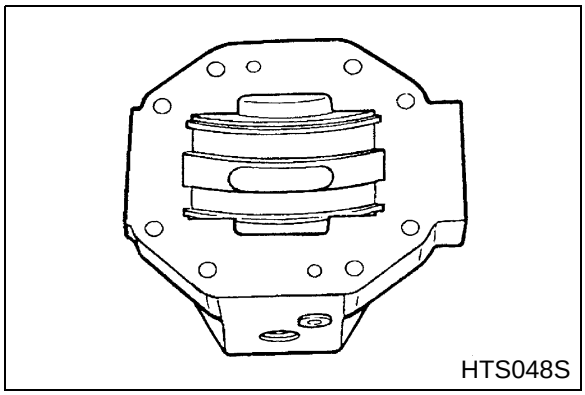


Figure 62

12. Visual check; Bearing areas free of scoring and no evidence of wear.

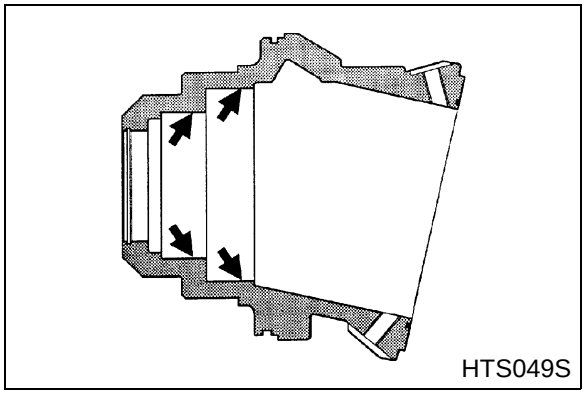


Figure 63

TRAVEL MOTOR SPEED REDUCTION GEARBOX DISASSEMBLY

1. Drain gear oil and remove travel motor and O-ring.
2. Remove motor flange (8 socket bolts, M16 x 35). Figure 64.

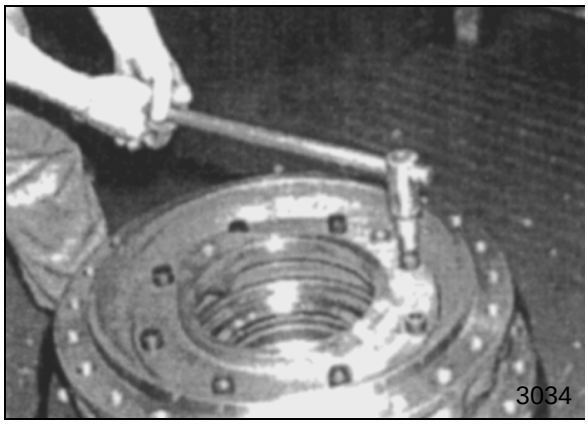


Figure 64

3. Remove O-ring from motor flange. Figure 65.

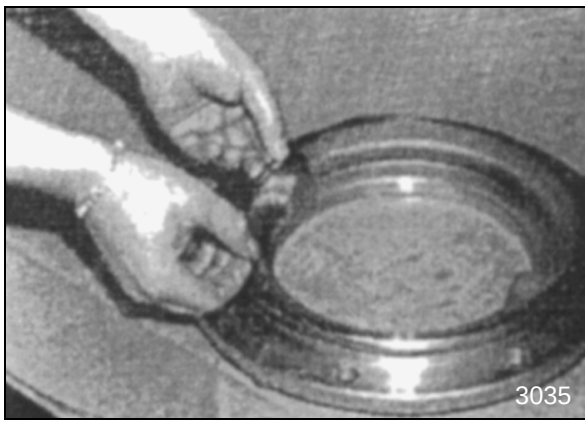


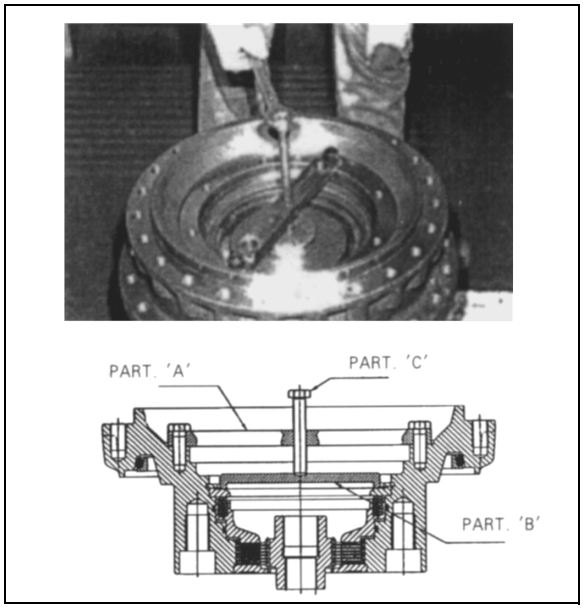
Figure 65

4. Remove O-ring from hub groove. Figure 66.



Figure 66

5. Attach disc (B, Figure 67) to spring retainer; fasten pusher (A) to hub and install screw rod (C).



3037

Figure 67

6. Remove retaining ring from hub groove using pliers. Figure 68.

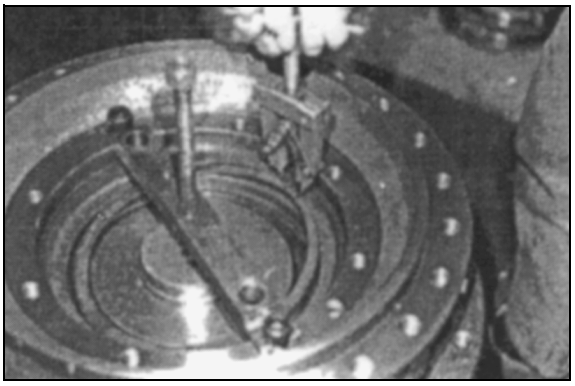


Figure 68

7. Remove jig and retaining ring. Figure 69.

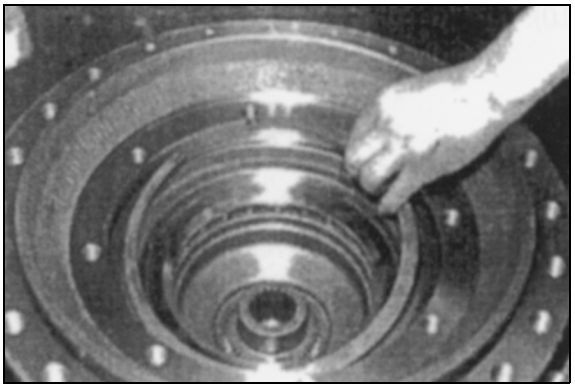


Figure 69

8. Remove spring retainer. Figure 70.



Figure 70

9. Pull spring from groove. Figure 71.



Figure 71

10. Blow air into brake port hole and remove brake piston using pliers. Figure 72.

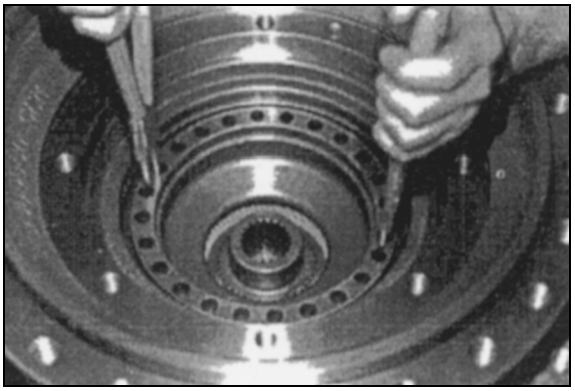


Figure 72

11. Remove brake shaft. Figure 73.

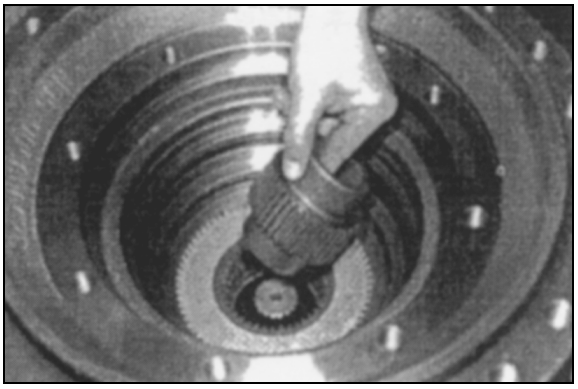


Figure 73

12. Remove disc. Figure 74.

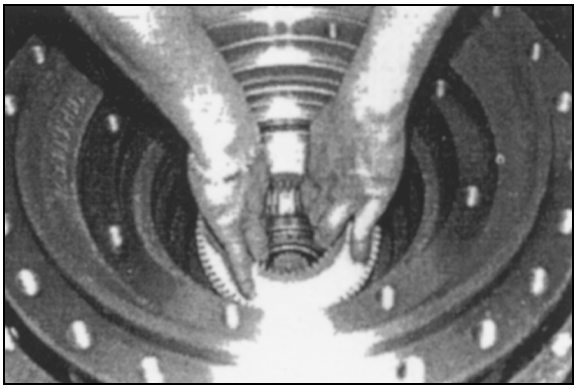


Figure 74

13. Remove O-ring and backup ring. Figure 75.

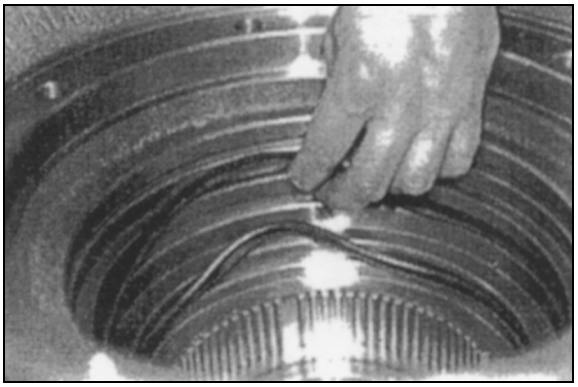


Figure 75

14. Turn reduction gear assembly over and remove 2 plugs (M22 x 1.5). Figure 76.

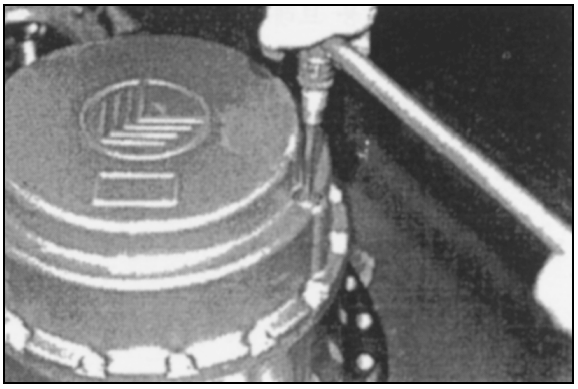


Figure 76

15. Remove 16 socket bolts (M14 x 40). Figure 77.

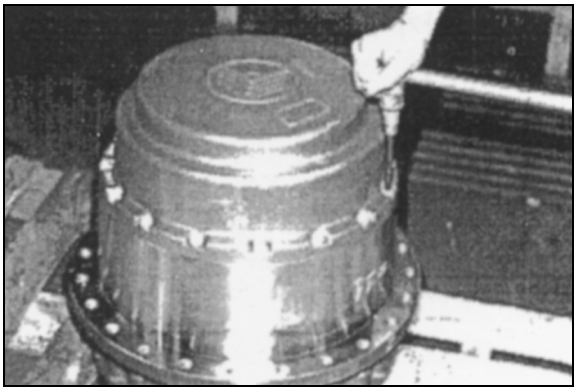


Figure 77

16. Remove end cover, using puller. Figure 78.

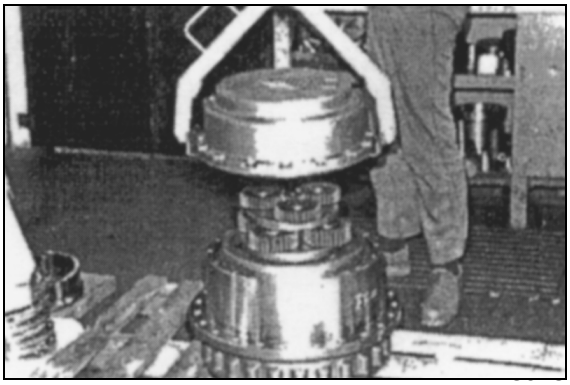


Figure 78

17. Remove O-ring from end cover groove. Figure 79.

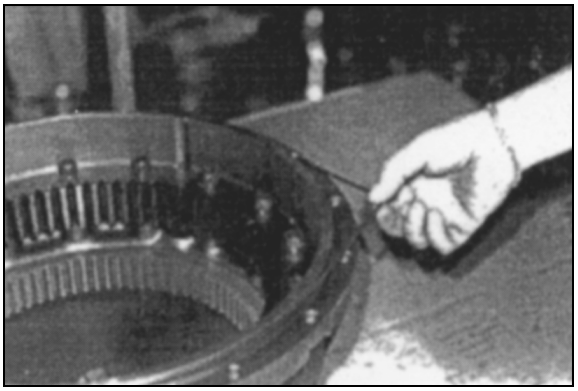


Figure 79

18. Remove first sun gear. Figure 80.

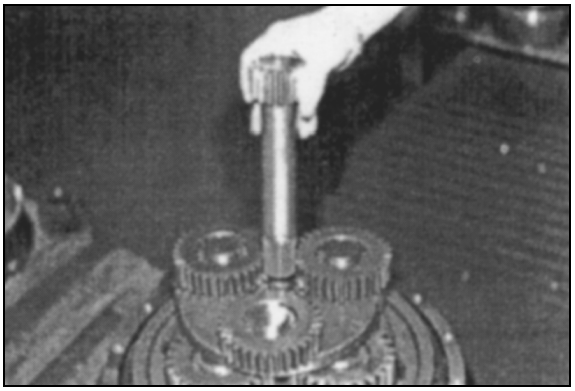


Figure 80

19. Remove first planetary gear assembly. Figure 81.

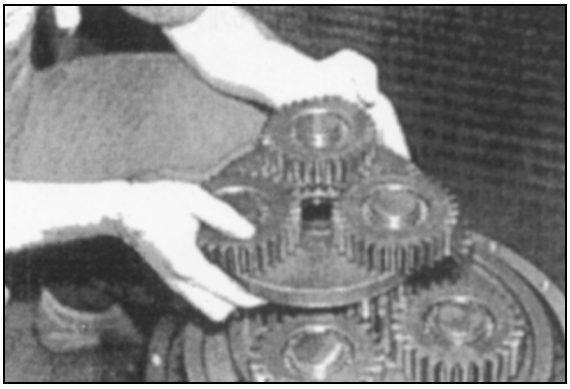


Figure 81

20. Remove second sun gear. Figure 82.

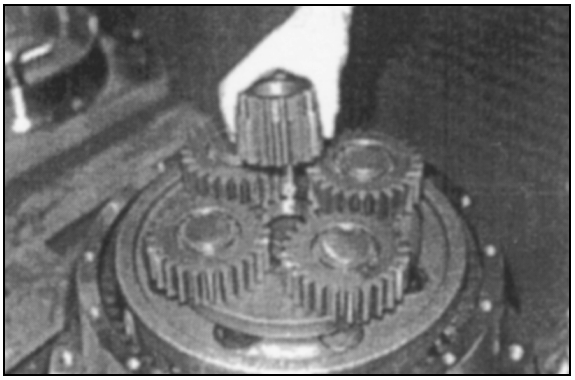


Figure 82

21. Remove second planetary gear assembly. Figure 83.

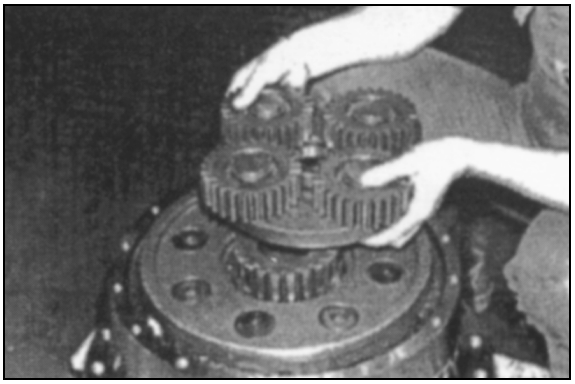


Figure 83

22. Remove third sun gear. Figure 84.

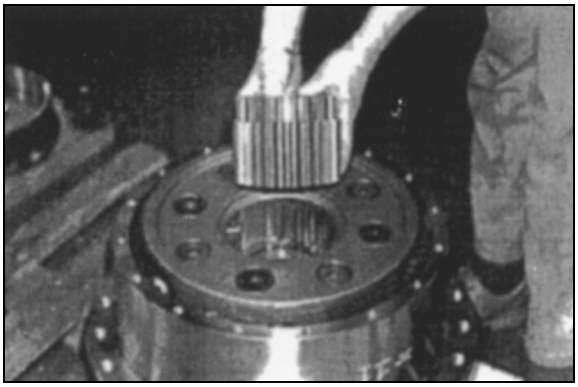


Figure 84

23. Remove bolts (4, M 30 x 150) from third planetary gear assembly. Figure 85.

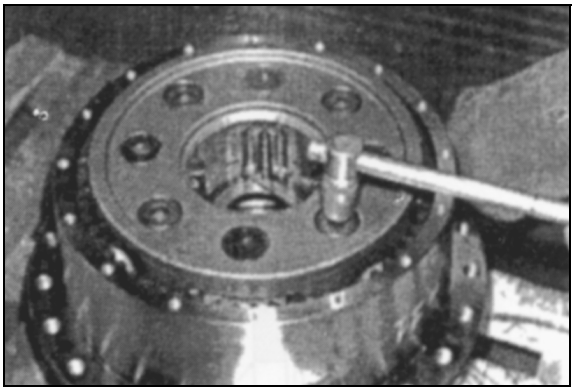


Figure 85

24. Remove bolts. Figure 86.

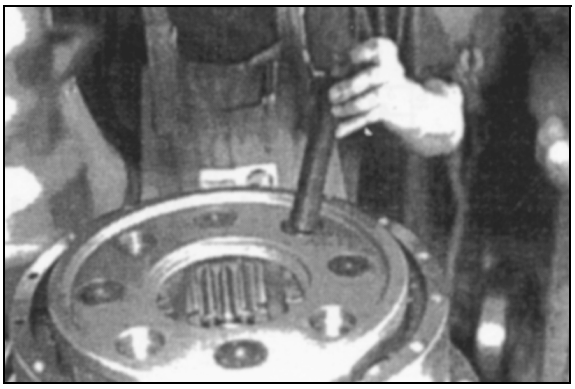


Figure 86

25. Separate hub from reduction gear housing, using press and stopper. Figure 87.

    NOTE: *Do not remove main ball bearing.*

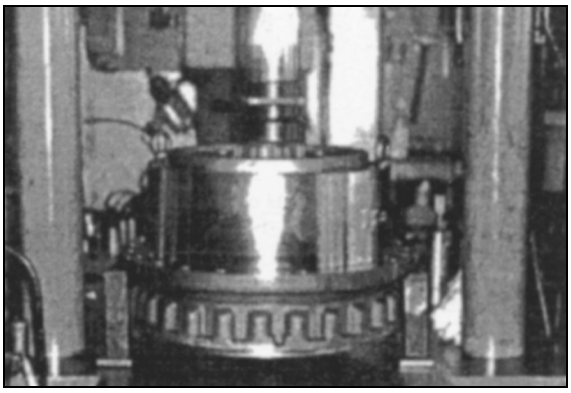


Figure 87

26. Remove third shift assembly from hub. Figure 88.

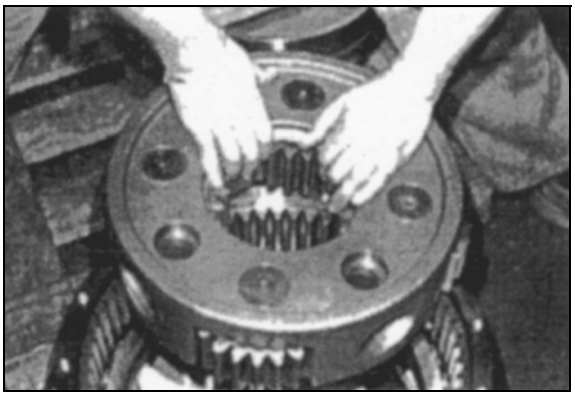


Figure 88

27. Remove bushing from hub using a jig. Figure 89.

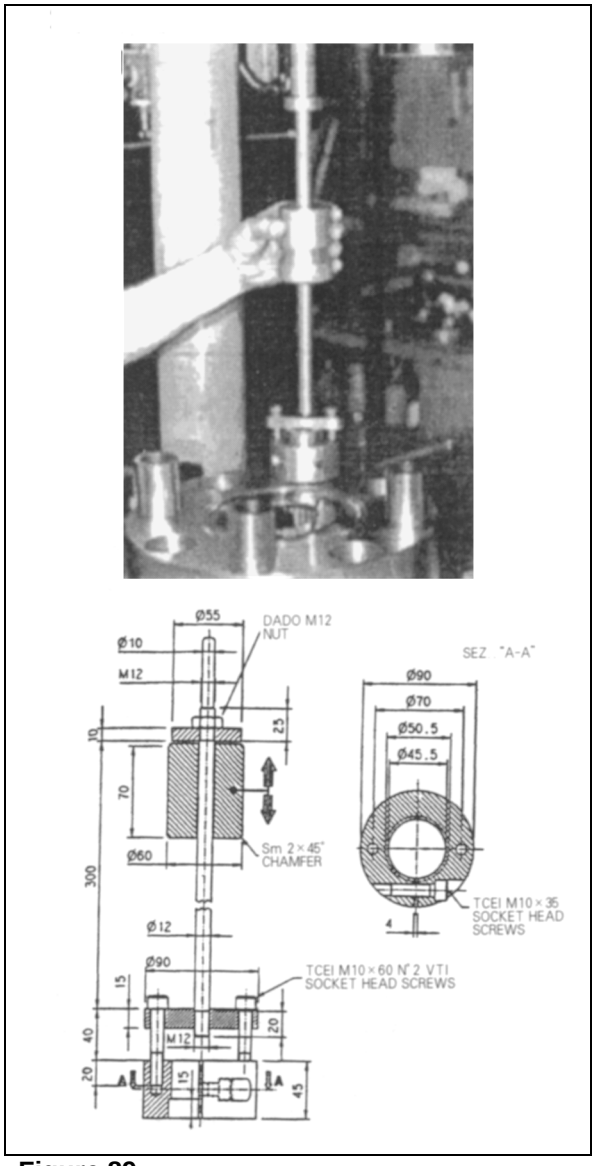


Figure 89

28. Remove bearing inner race and spacer from hub, using puller. Figure 90.

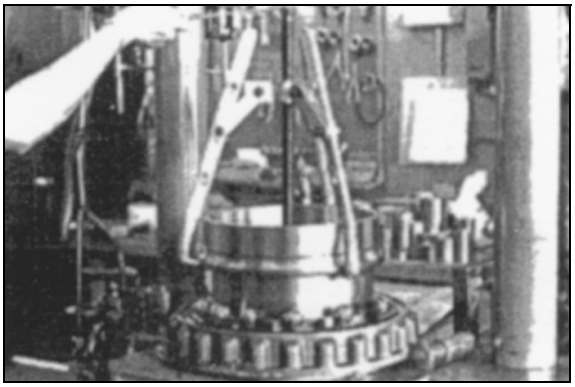


Figure 90

29. Remove gasket. Figure 91.

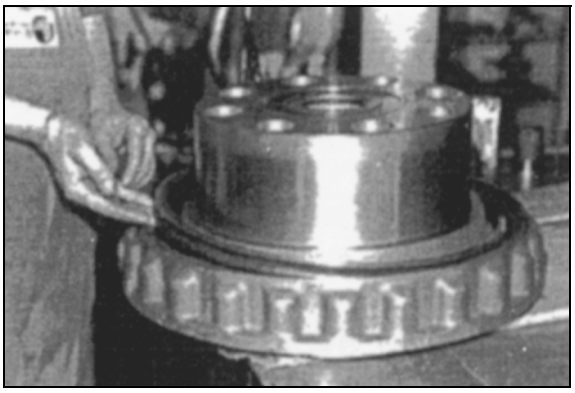


Figure 91

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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

Gearbox Inspection

1. If a gear is damaged, replace the damaged gear and the interlocking gear next to it. If one planetary gear is damaged, replace the entire planetary gear assembly.
2. Replace O-rings.
3. Apply grease to assembly side of O-rings to make assembly easier.

TRAVEL MOTOR SPEED REDUCTION GEARBOX REASSEMBLY

1. Install seal to jig. Figure 92.

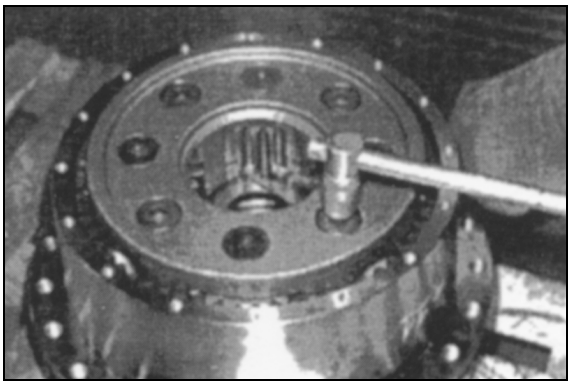


Figure 92

2. Install jig to housing. Figure 93.



Figure 93

3. Clean seal surface. Figure 94.



Figure 94

4. Install seal to hub using jig used in Step 1. Figure 95.

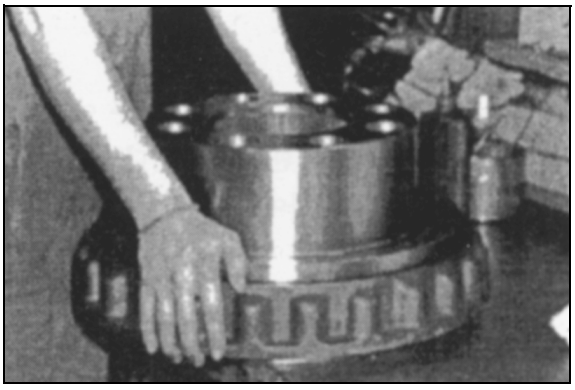


Figure 95

5. Apply lubricant to seal surface. Figure 96.



Figure 96

6. Support ball bearing housing with spacers (1 and 2, Figure 97) and install bearing into housing. Install spacer between balls, noting diameter shown in illustration.

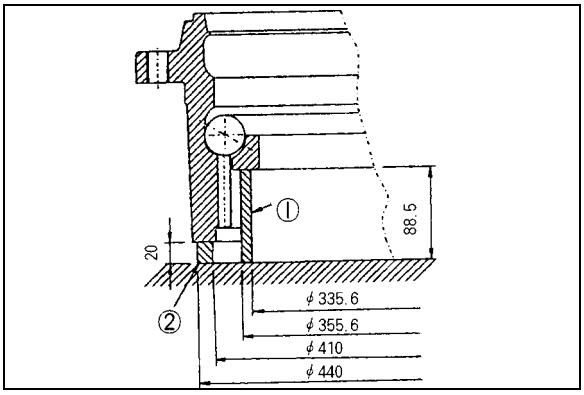


Figure 97

7. Install upper balls and upper housing. Figure 98.

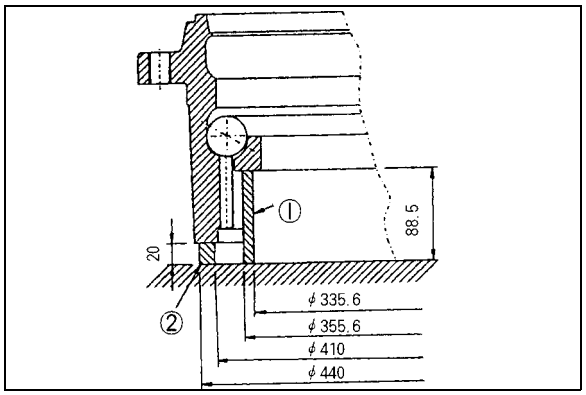


Figure 98

8. Install hub to housing. Figure 99.

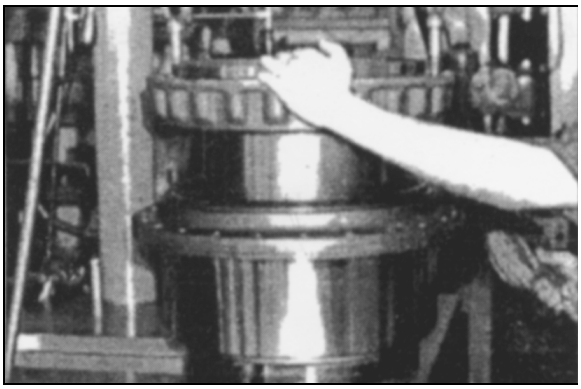


Figure 99

9. Press hub into housing using a press and a stopper. Figure 100.

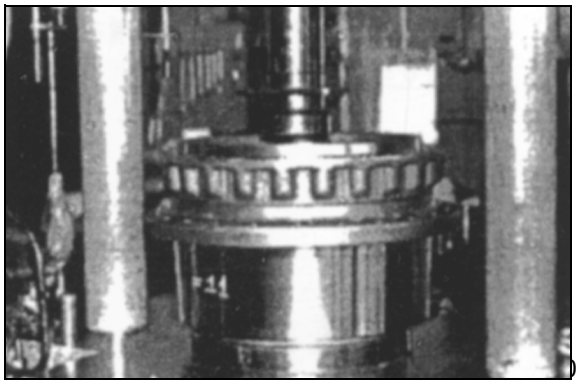


Figure 100

10. Install four bushings using a press. Figure 101.

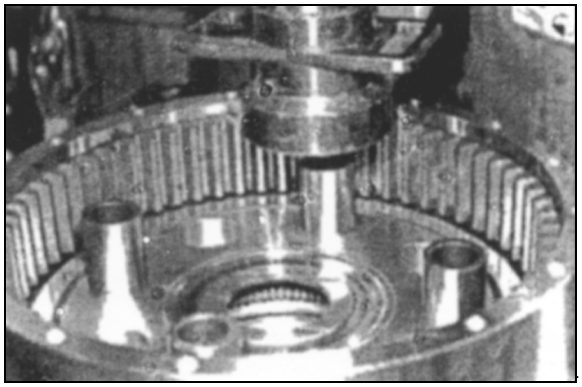


Figure 101

11. Assemble planetary gear assembly. Figure 102.

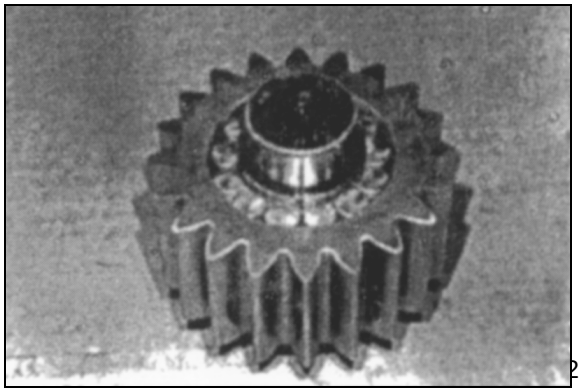


Figure 102

12. Install four planetary gear assemblies, using press. Figure 103.

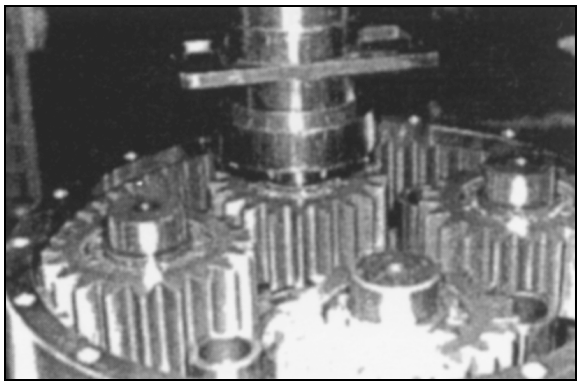


Figure 103

13. Tighten gear box of planetary gear assembly to 150 Nm (110.7 ft lb). Figure 104.

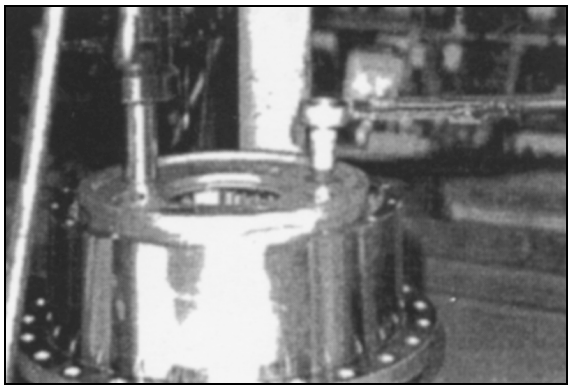


Figure 104

14. Assemble third shift sun gear. Figure 105.

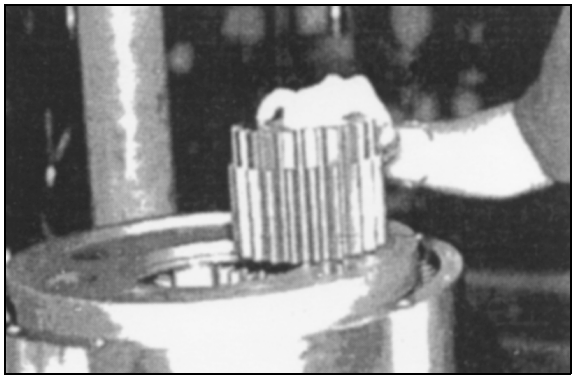


Figure 105

15. Assemble the second shift reduction assembly. Figure 106.

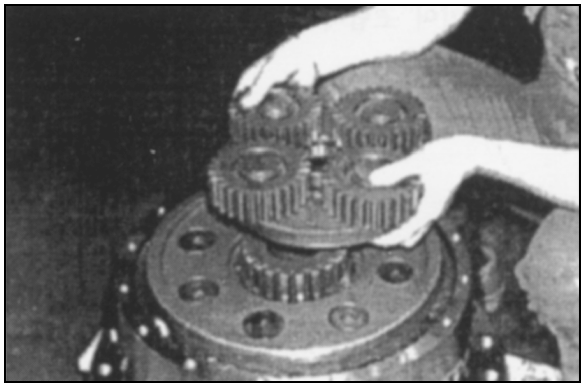


Figure 106

16. Place planetary gear carrier on hub. Figure 107.



Figure 107

17. Press planetary gear carrier into hub. Figure 108.

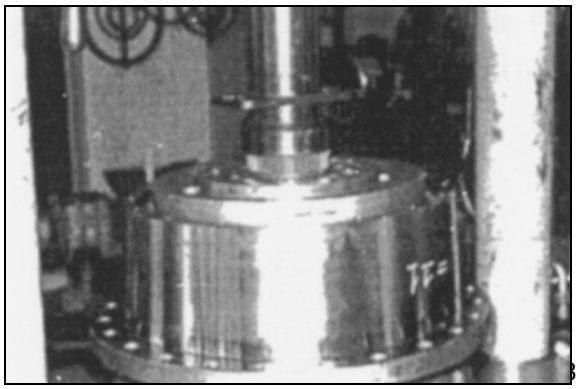


Figure 108

18. Apply loctite to planetary gear carrier fastening bolts.
19. Install and tighten bolts. Figure 109.

    NOTE: *In next step, the O-ring and backup rings are different. Be careful not to switch them.*



Figure 109

20. Install O-ring to end cover. Figure 110.

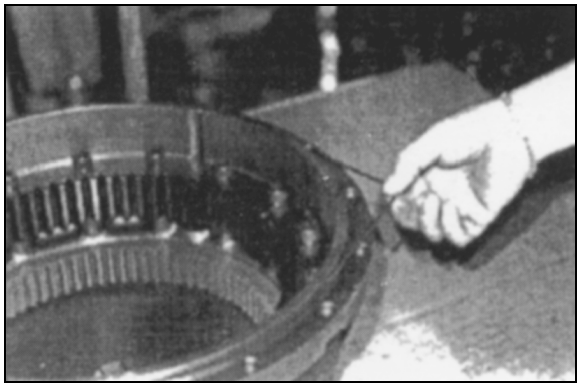


Figure 110

21. Install end cover to housing.

NOTE: *Apply Loctite 243 to bolts and torque to 10 Nm (7.38 ft lb). Figure 111*

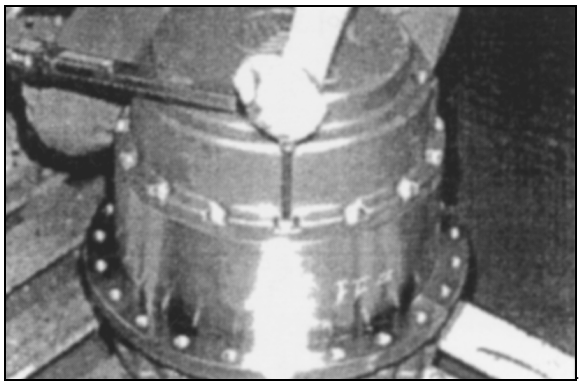


Figure 111

22. Tighten plugs to 6 - 8 Nm (4.42 - 5.90 ft lb). Figure 112.

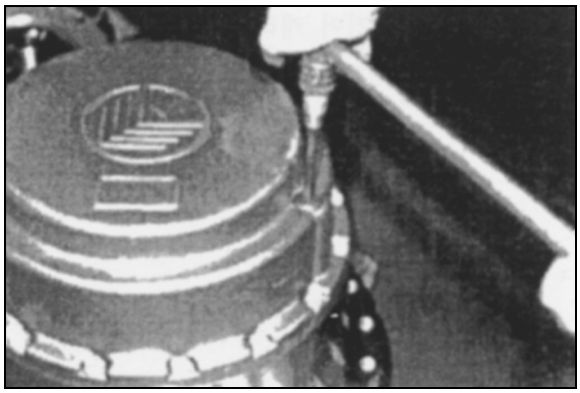


Figure 112

23. Turn housing over and install second shift sun gear. Figure 113.

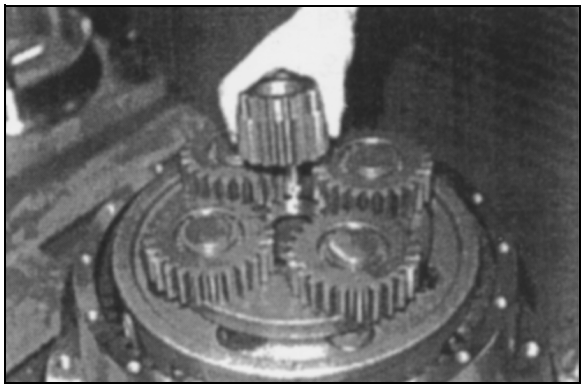


Figure 113

24. Install first shift planetary gear assembly. Figure 114.

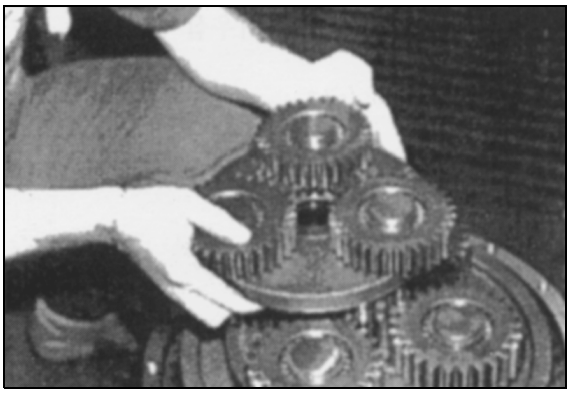


Figure 114

25. Install first shift sun gear. Figure 115.

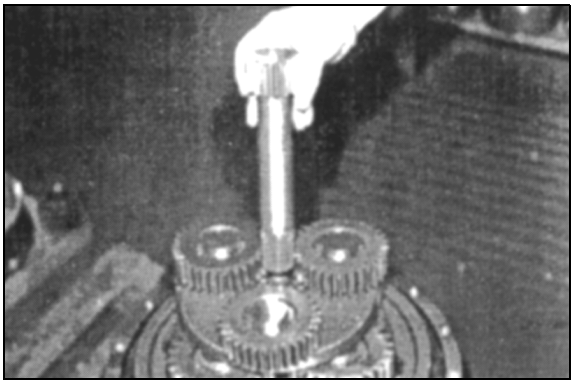
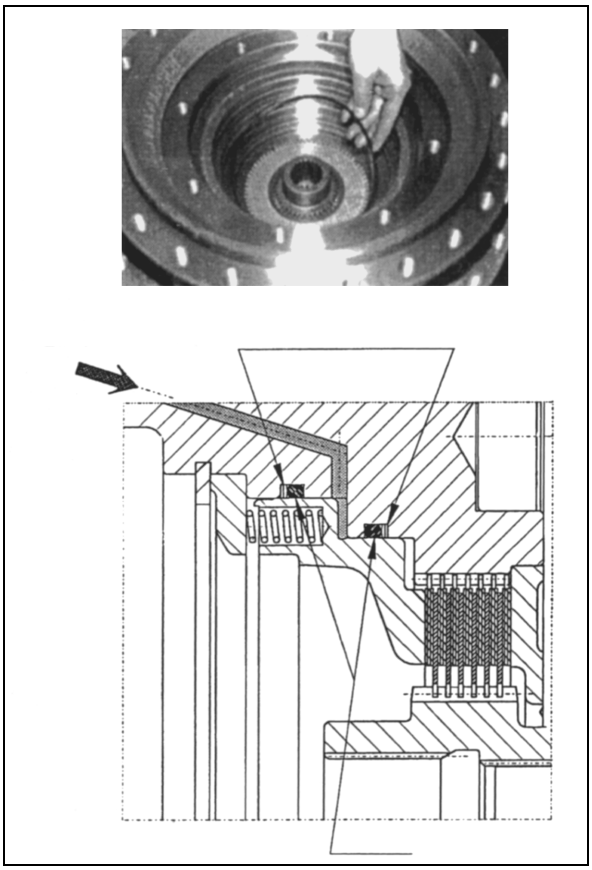


Figure 115

26. Install O-ring (1, Figure 116) and backup ring (2) into hub groove.

    NOTE: *The O-ring and backup rings are different. Be careful not to switch them.*



3086

Figure 116

27. Install brake shaft while turning the reduction gear assembly. Figure 117.

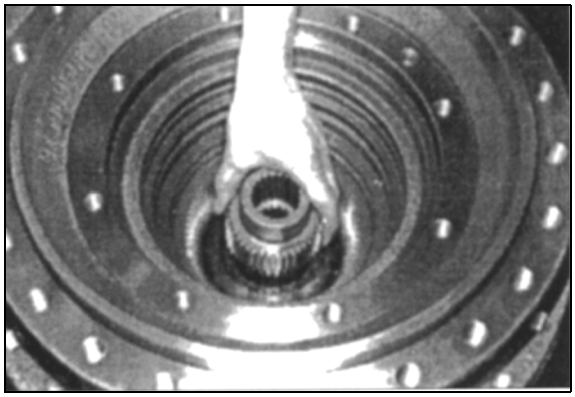


Figure 117

28. Install brake disc assembly, starting with a copper disc (seven pieces) and alternating with steel discs (six pieces). Figure 118 and Figure 119.

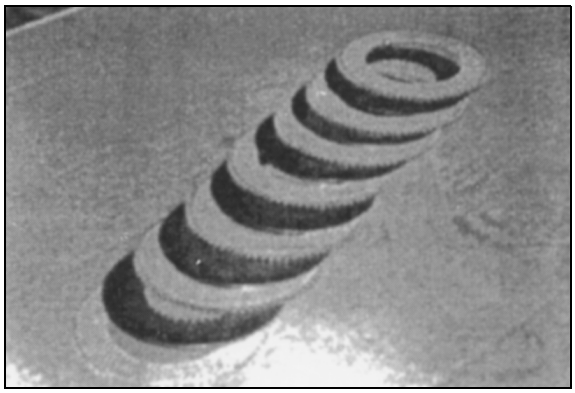


Figure 118

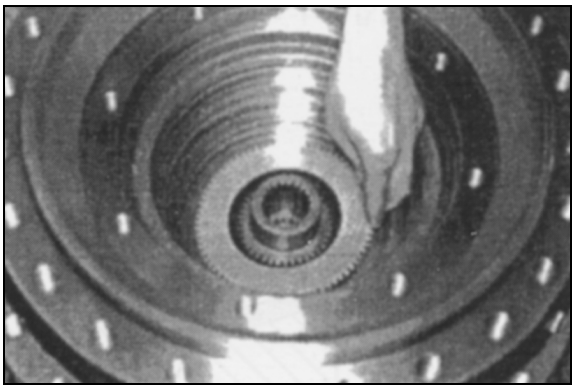


Figure 119

29. Install jig to hub and insert spring retainer disc under left side of retaining ring. Figure 120.

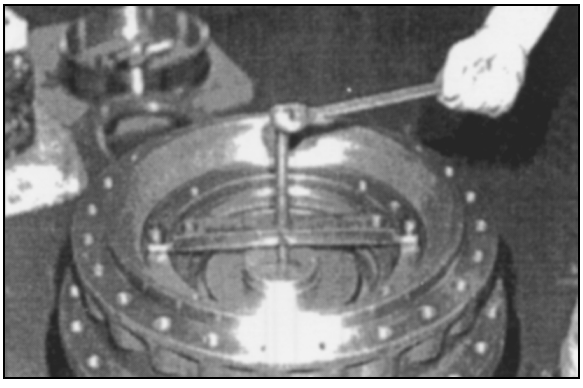


Figure 120

30. Install retaining ring using retaining ring pliers. Figure 121.

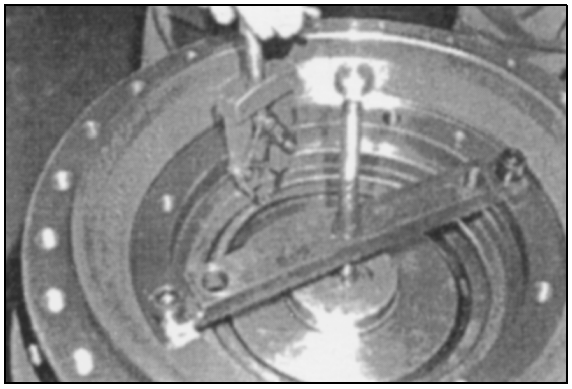


Figure 121

31. Install O-ring to hub groove. Figure 122.



Figure 122

32. Place brake piston inside hub being careful not to damage seal. Figure 123.

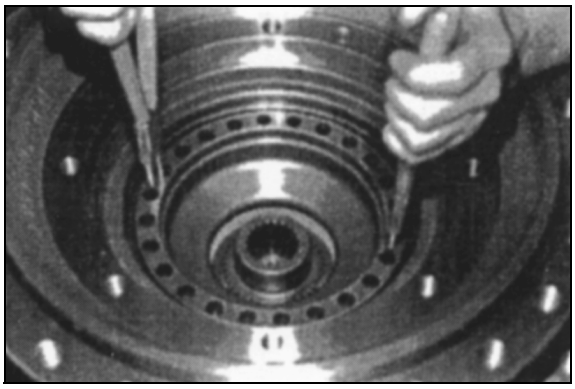


Figure 123

33. Insert springs into brake piston holes. Figure 124.



Figure 124

34. Install retainer disc. Figure 125.

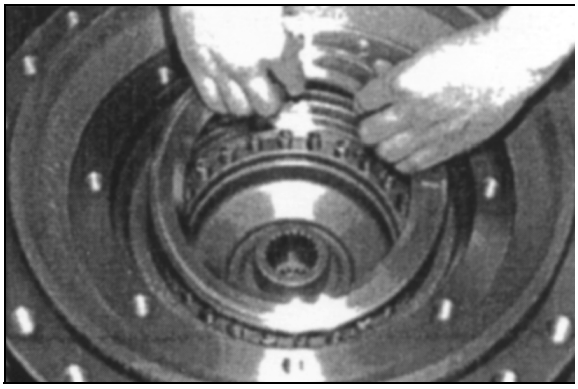


Figure 125

35. Install O-ring to motor flange groove. Figure 126.



Figure 126

36. Tighten motor flange to hub. Figure 127.

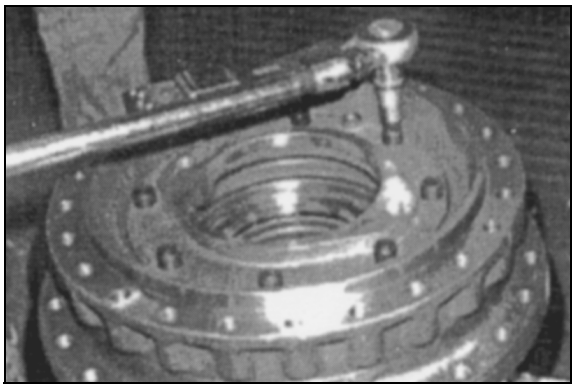


Figure 127

TRAVEL MOTOR REASSEMBLY

ROTARY GROUP ASSEMBLY

1. Rotary group completely assembled ready for assembly.

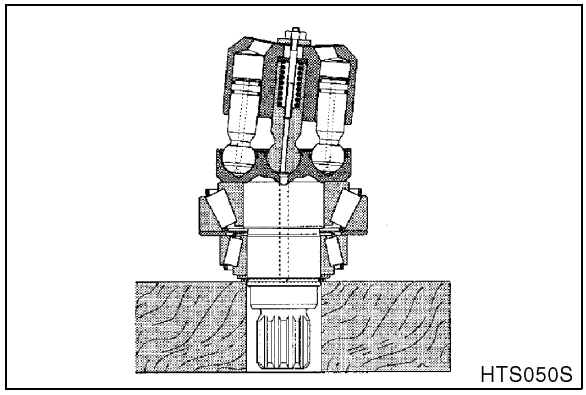


Figure 128

2. Place assembly sleeve.

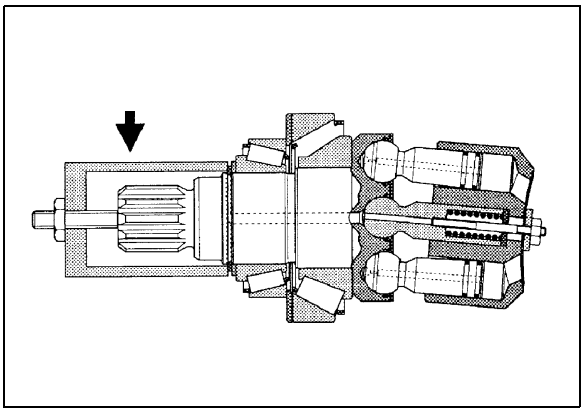


Figure 129

3. Warm up housing to 80°C (176°F).

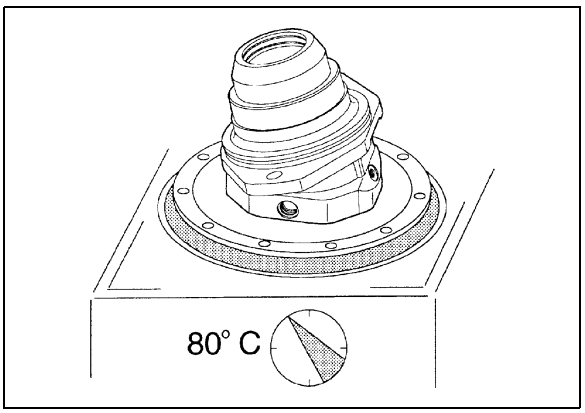


Figure 130

4. Insert rotary group into housing to seat position.

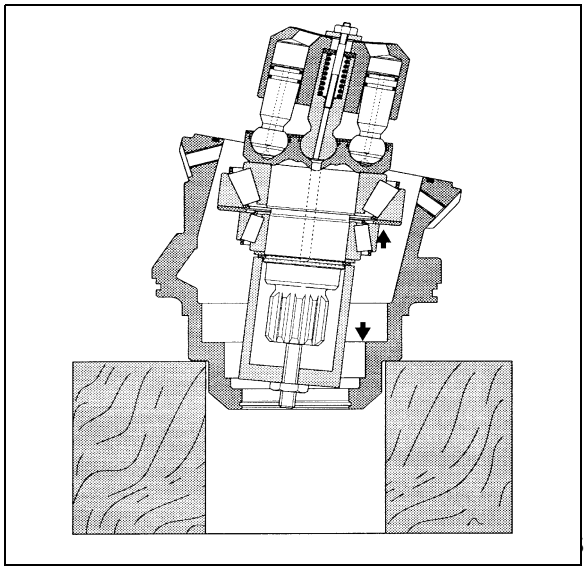


Figure 131

5. Fix zero position of cylinder with Q_{max}-screw.
6. Disassemble cylinder fixing screw.
7. Insert O-ring.

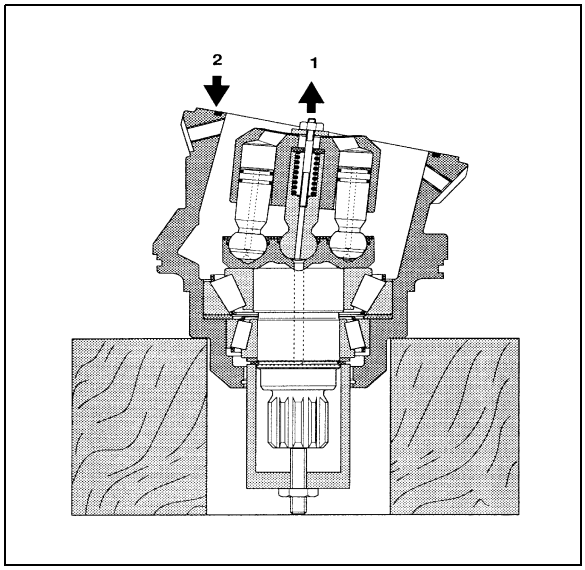


Figure 132

ROTARY GROUP ADJUSTMENT (SEE SERVE INFORMATION)

1. Determine cylinder swivel range to max. angle with screw.

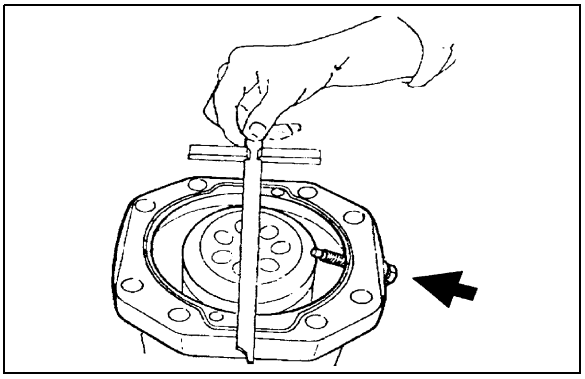


Figure 133

2. Disc.

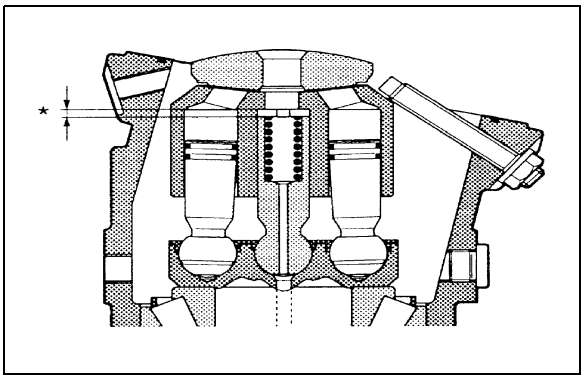


Figure 134

3. Place centering disc.

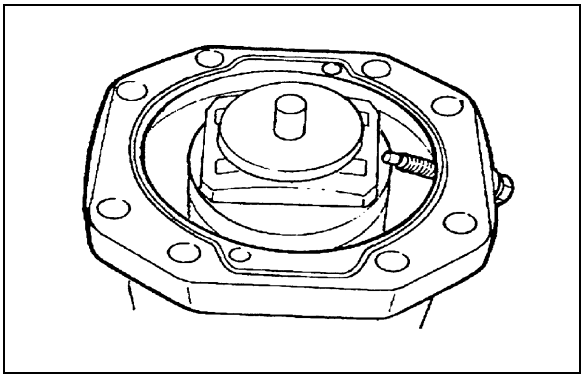


Figure 135

4. Mount measuring device.

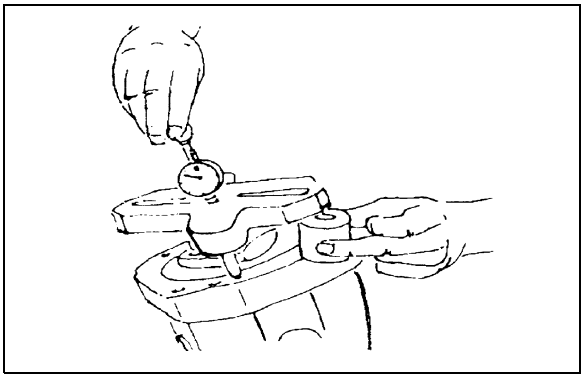


Figure 136

5. Check dimension X.

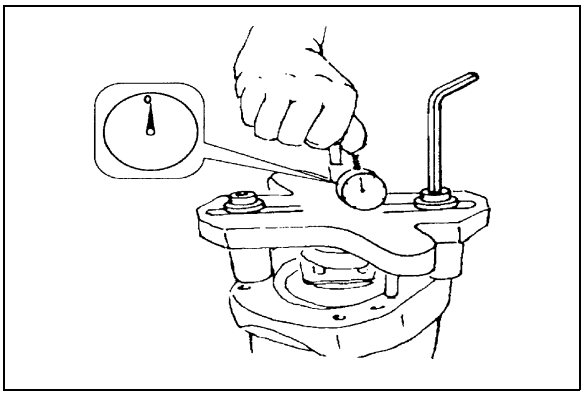


Figure 137

ASSEMBLY OF PORT PLATE

1. Stick control lens in sliding surface with grease.
2. Assemble in reversal order.
3. Mount port plate.

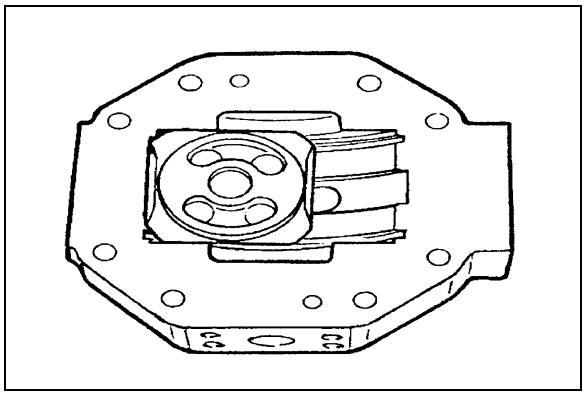


Figure 138

4. Assemble port plate.

   NOTE: *Take care of assembly design! Tighten fixing screws with torque.*

5. Set Q_{min}-screw to dimension (*).
6. Assemble plug.
7. Remove assembly sleeve.

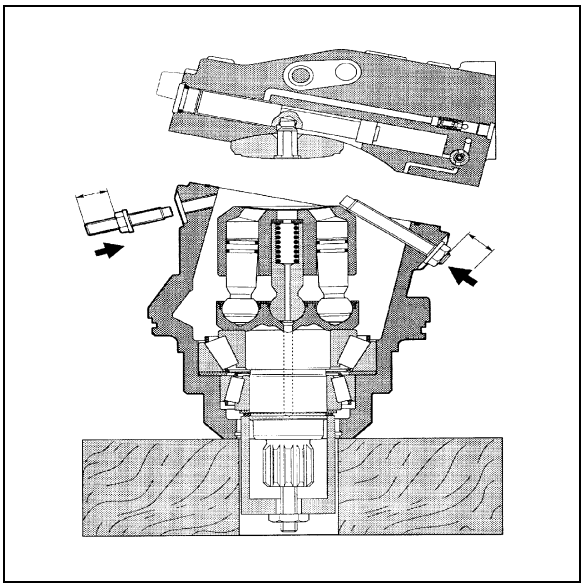


Figure 139

8. Assemble shaft seal, disc and safety ring. Press-in with assembly sleeve.

   NOTE: *Take care of press-in depth.*

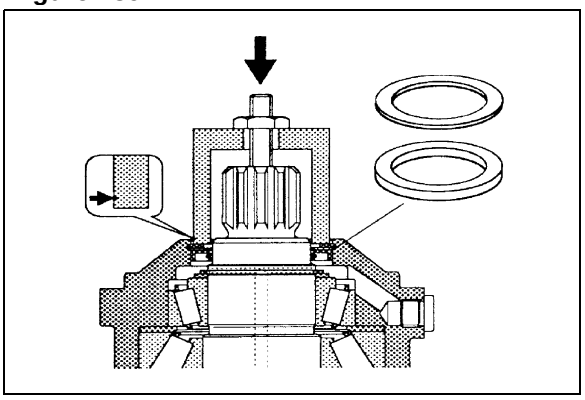


Figure 140

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

MAIN PUMP (REXROTH)

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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May 2002

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SECTIONAL VIEW

A8VO200LA1KH1/63

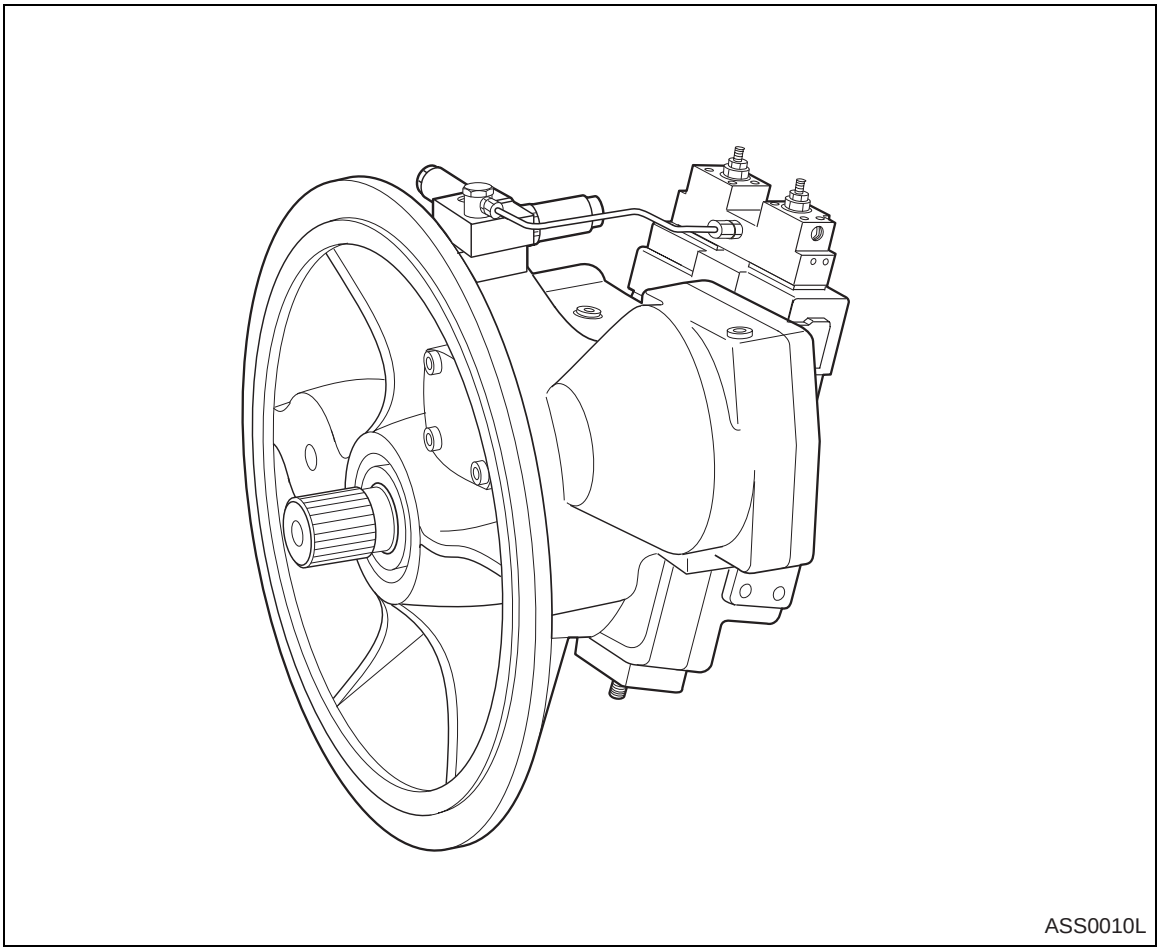


Figure 1

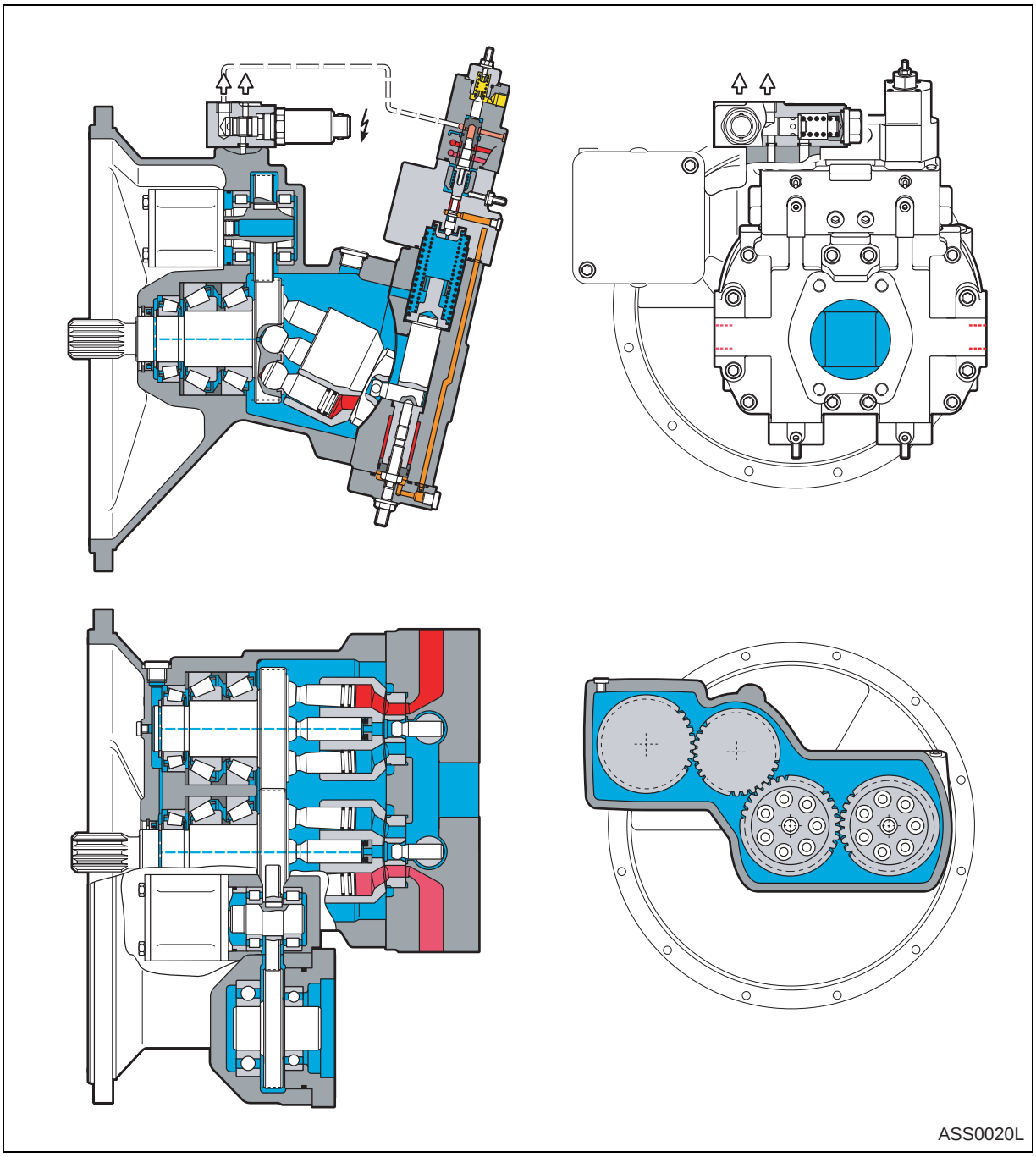


Figure 2

GENERAL REPAIR GUIDELINES

NOTE: *Observe the following cautions when carrying out repairs on hydraulic units.*



Figure 3

1. Close off all openings of hydraulic unit.

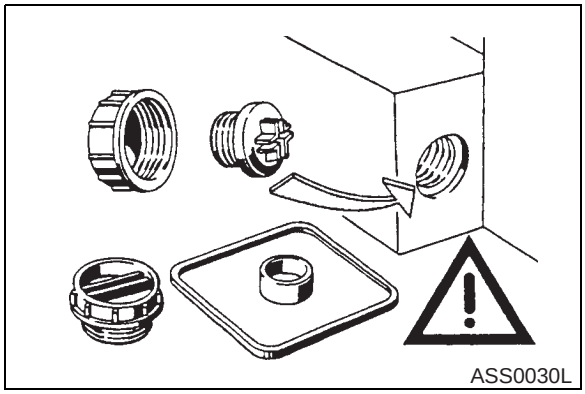


Figure 4

2. Replace all seals.

   Use only original spare parts.

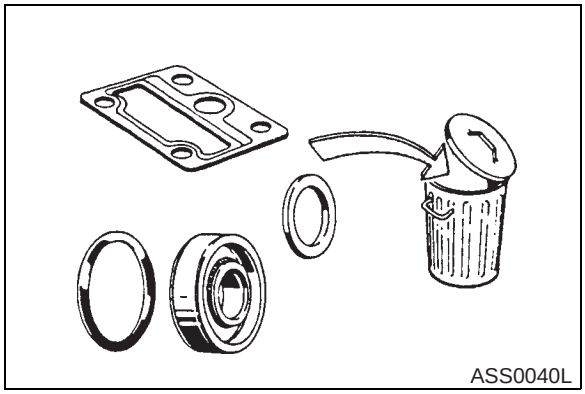


Figure 5

3. Check all sealing and sliding surfaces for wear.

   NOTE: *Rework of sliding surfaces using crocus cloth or other similar materials, can damage the surface.*

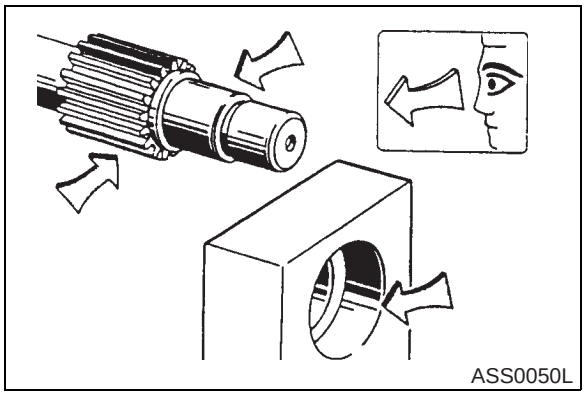


Figure 6

4. Fill hydraulic unit with hydraulic oil before putting into operation.

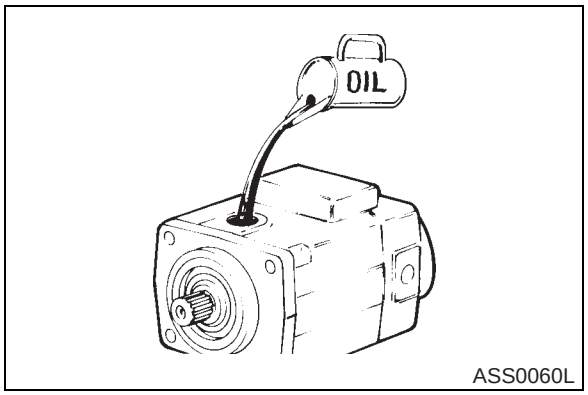


Figure 7

SEAL KITS AND SUB-ASSEMBLIES

1. Seal kit for drive shaft.

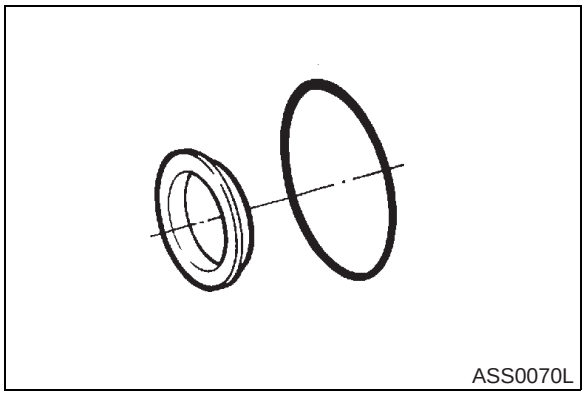


Figure 8

2. Peripheral seal kit.

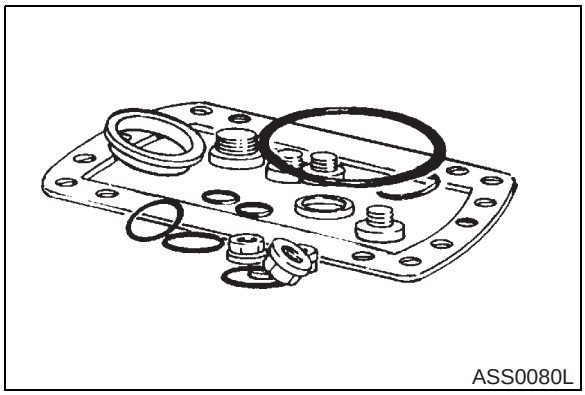


Figure 9

3. Rotary group 1, ready to install.

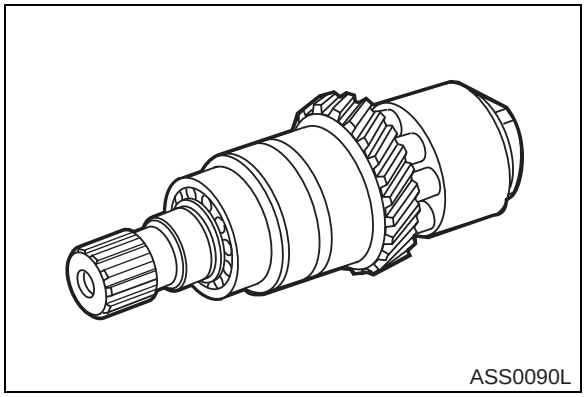


Figure 10

4. Rotary group 2, ready to install.

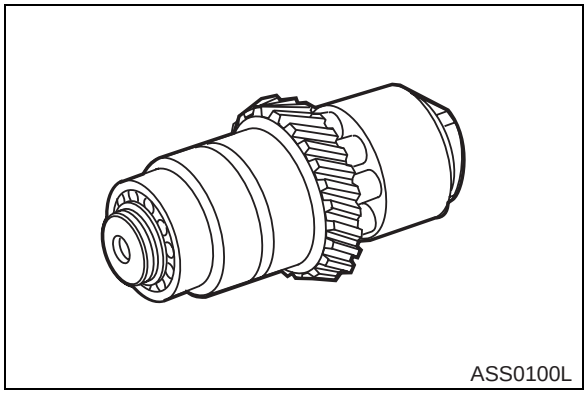


Figure 11

5. Rotary group, hydraulic component (order rotary groups 1 and 2 separately).

   NOTE: *Adjustment is necessary. Pay attention to direction of rotation.*

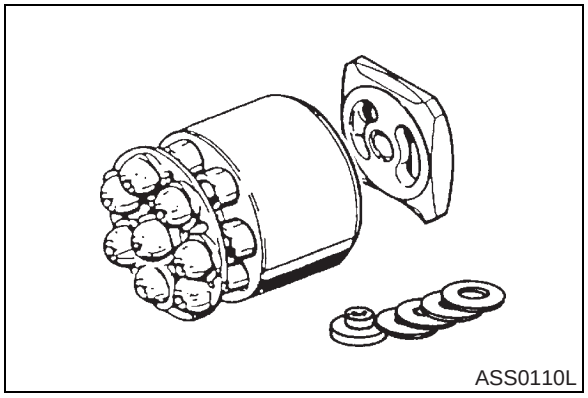


Figure 12

6. Rotary group 1, mechanical section, ready to install.

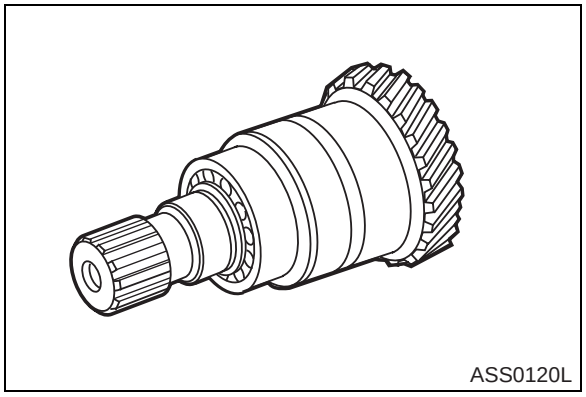


Figure 13

7. Rotary group 2, mechanical section, ready to install.

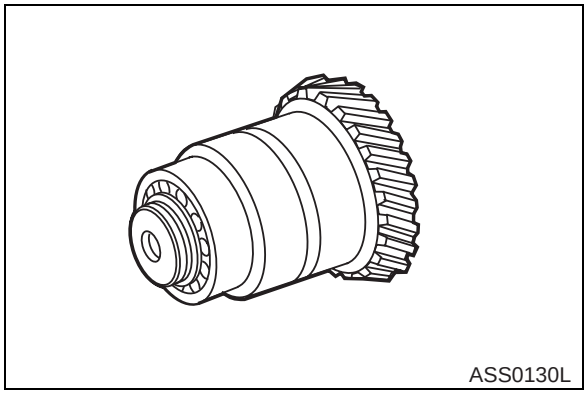


Figure 14

8. Control, pre-adjusted.

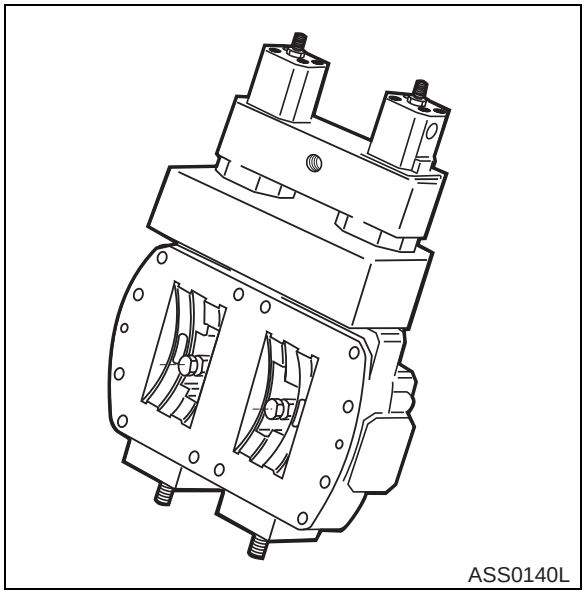


Figure 15

9. Gear pump, complete.

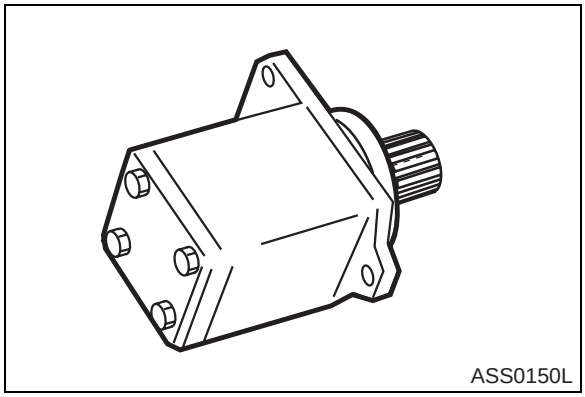


Figure 16

10. Intermediate gear.

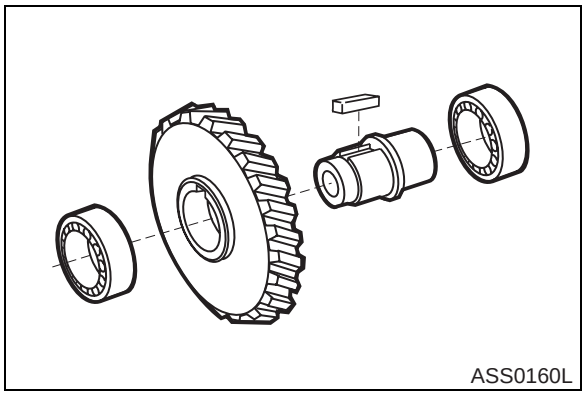


Figure 17

11. Auxiliary drive.

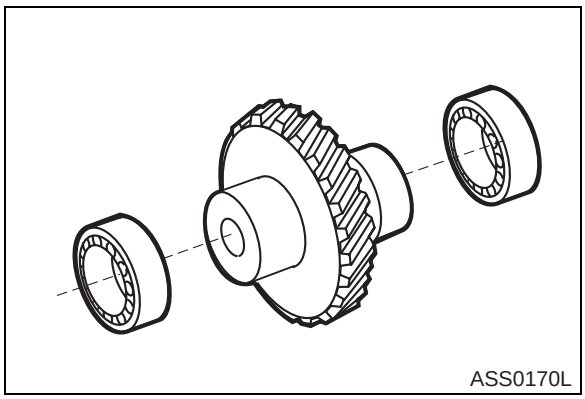


Figure 18

12. Valve plate with valves.

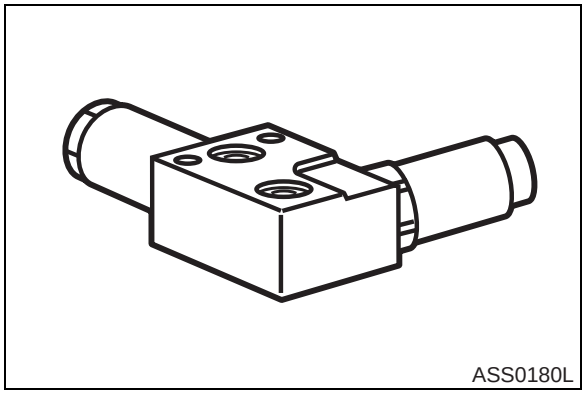


Figure 19

13. Pipe, complete with fittings.

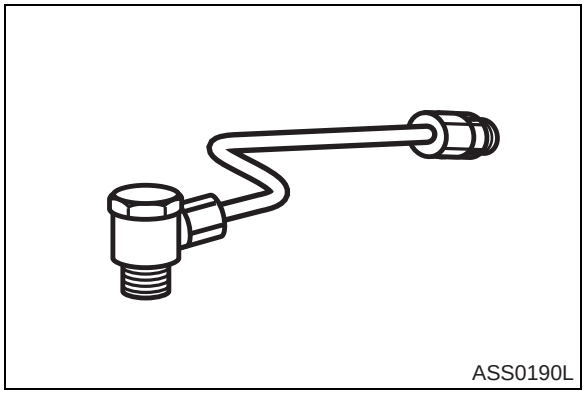


Figure 20

SEALING THE DRIVE SHAFT

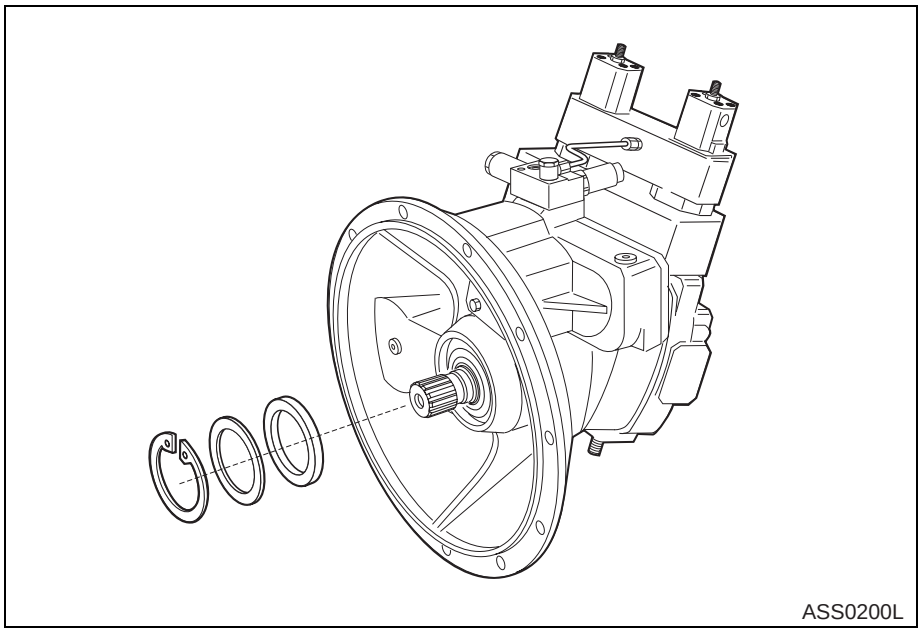


Figure 21

1. Protect drive shaft. (e.g. with tape).

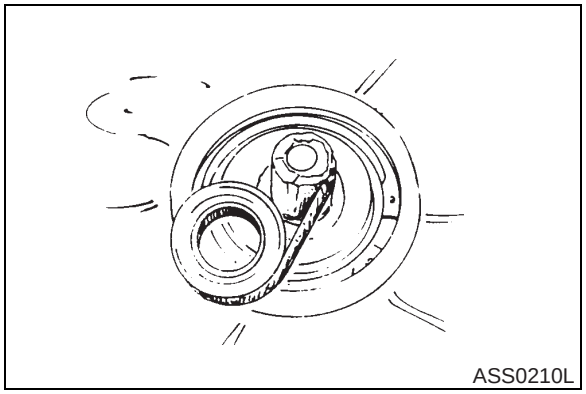


Figure 22

2. Remove retaining ring and shim.

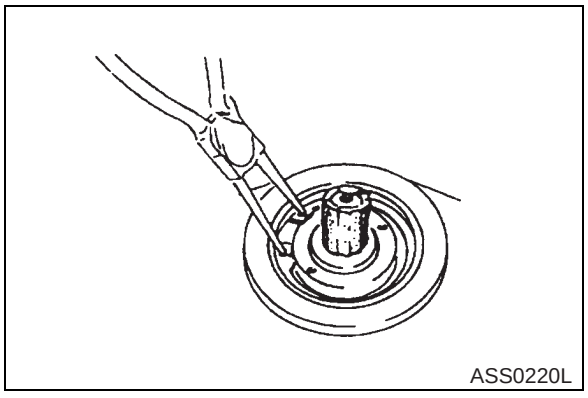


Figure 23

3. Screw sheet metal screw(s) into holes fitted with rubber.

   Pull out seal with pliers.

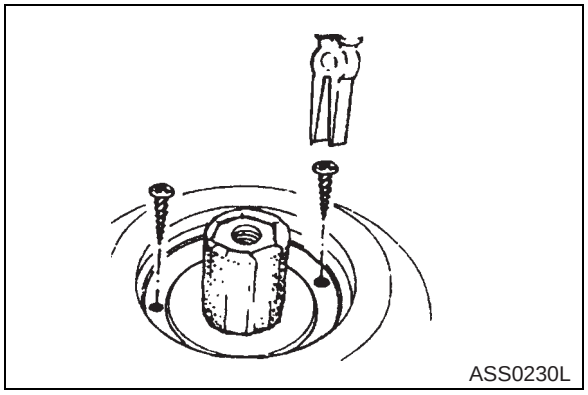


Figure 24

4. Press in shaft seal ring and shim with bushing to stop.

   NOTE: *Take note of press-in depth. Install mark for press-in depth of safety ring.*

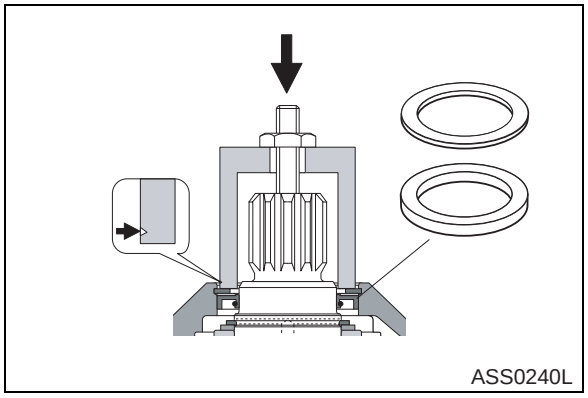


Figure 25

GEAR PUMP SEALING

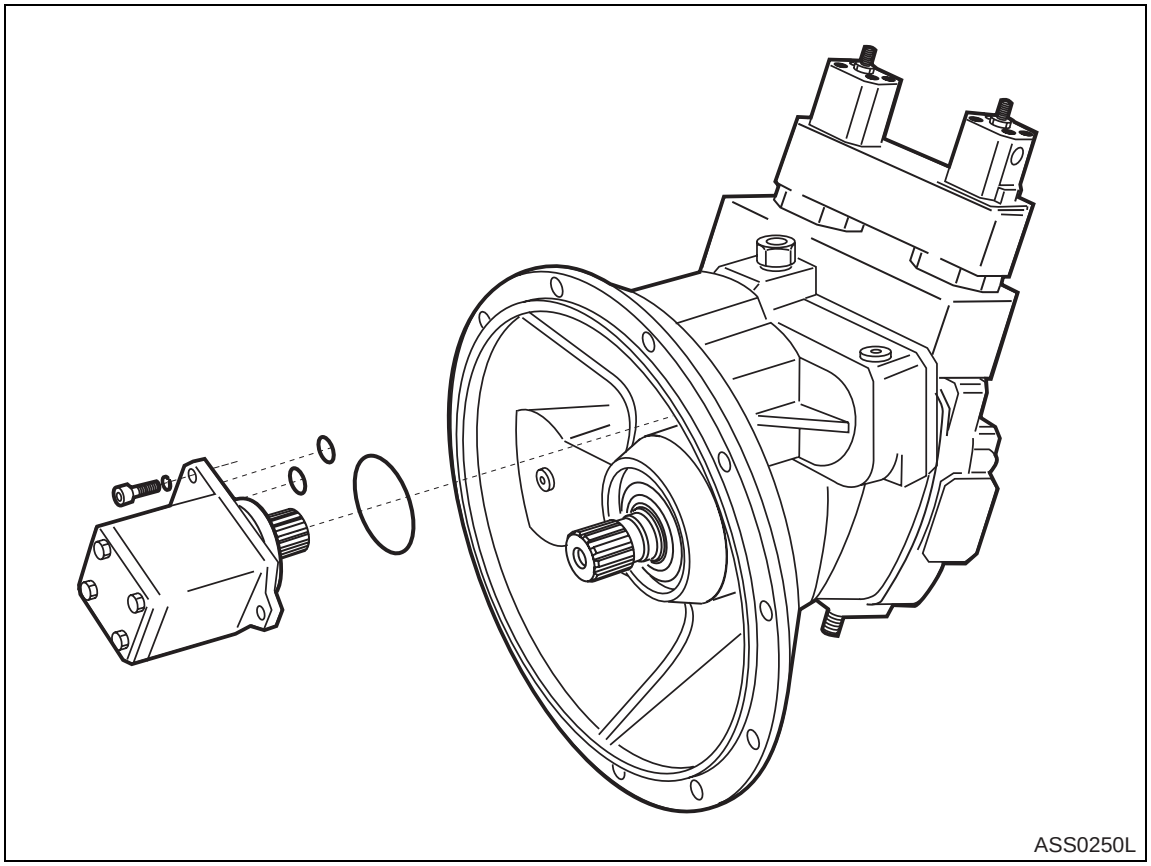


Figure 26

Remove gear pump.

Visually check:

1. O-ring (1, Figure 27).

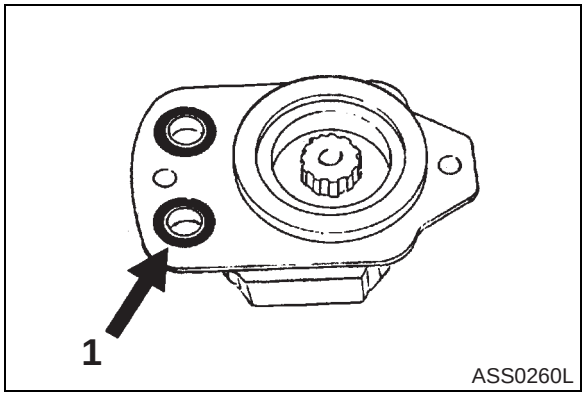


Figure 27

2. Sealing surface of housing (2, Figure 27).

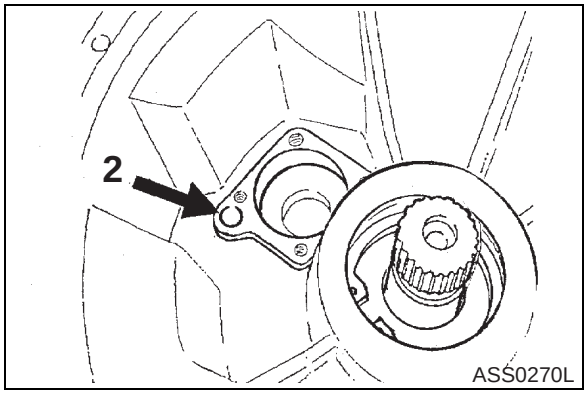


Figure 28

REMOVE THE CONTROL HOUSING

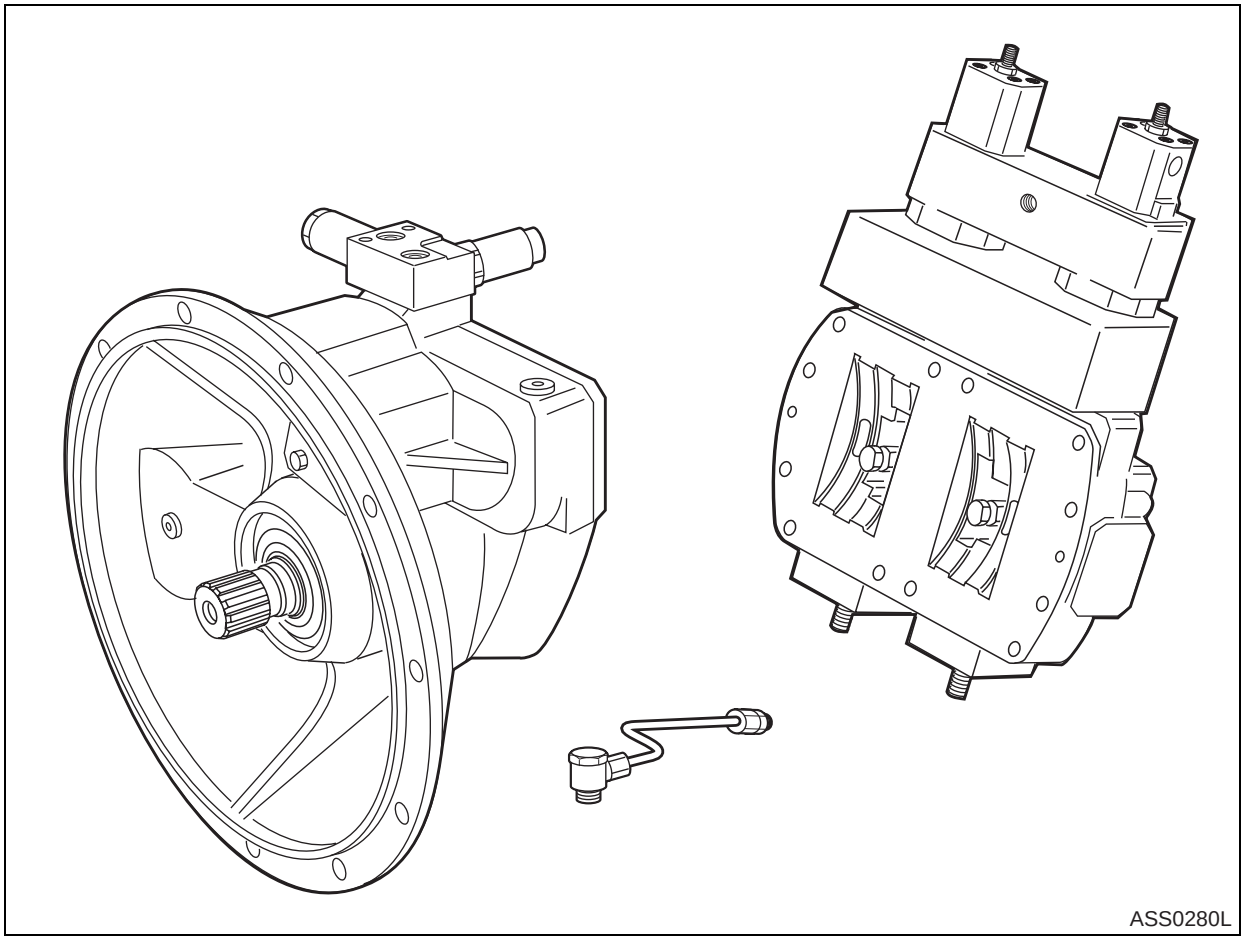


Figure 29

1. Place pump into a disassembly / assembly device with a crane and secure it into position.

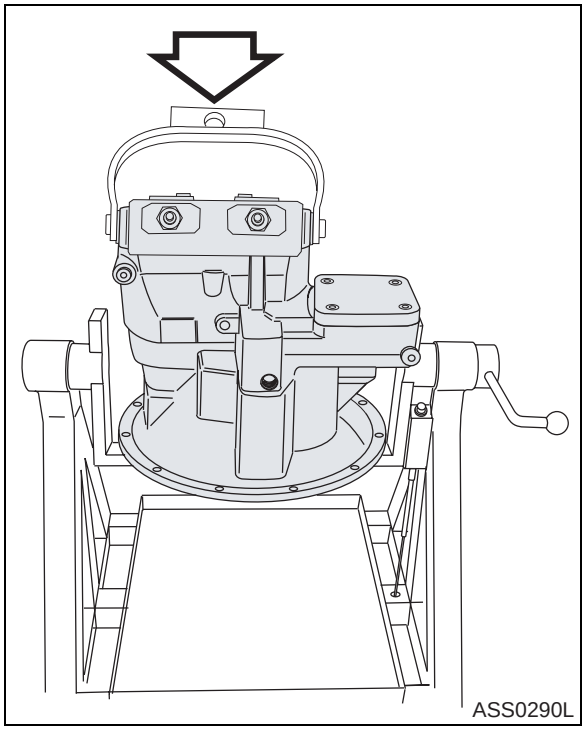


Figure 30

2. Remove screws holding port plate.
3. Using a suitable lifting device, remove port plate.

   NOTE: *Mark installation position.*

   NOTE: *Be careful, control lenses can fall out.*

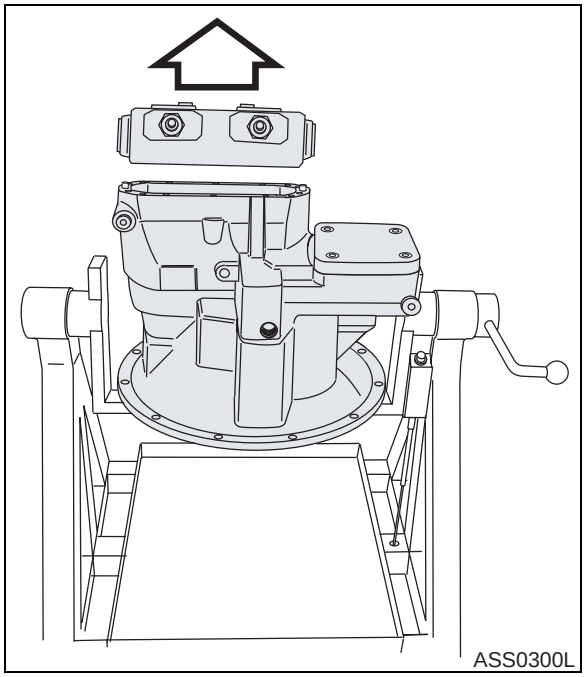


Figure 31

4. Remove paper seal, and clean sealing surface.

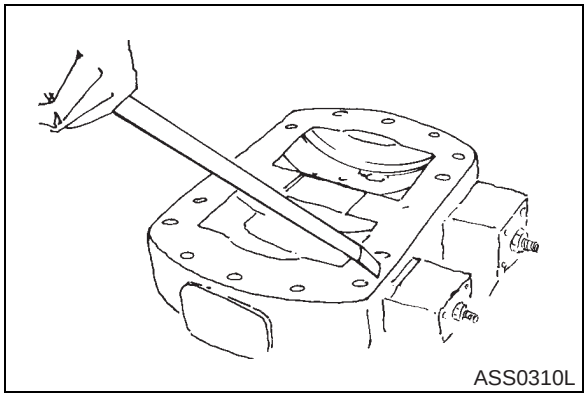


Figure 32

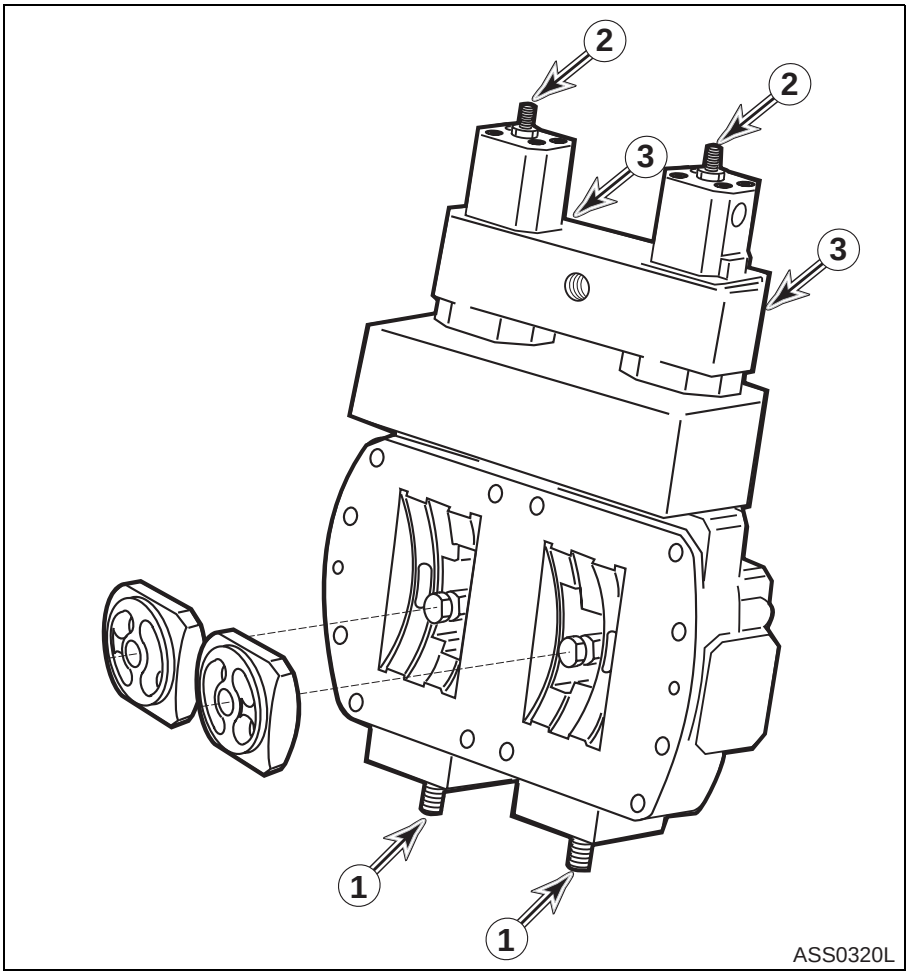


Figure 33

Number	Description
1	Setting Screw: Q_{max}
2	Setting Screw: Hydraulic Stroke Limitation
3	Setting Screw: Power Characteristic (Begin of Regulation)

NOTE: *Before carrying out setting or disassembly of regulator, measure distance "X" of adjustment screw and record value.*

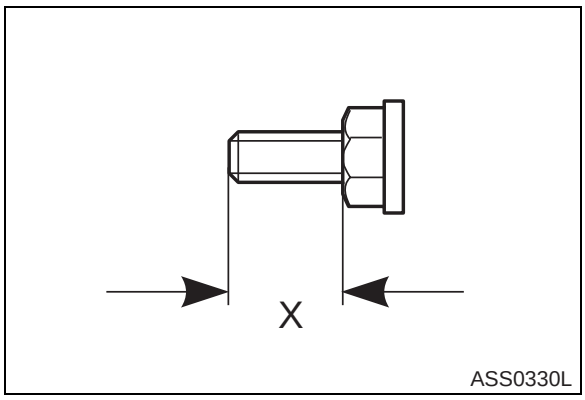


Figure 34

CONTROL MODULE

CONTROL MODULE LR

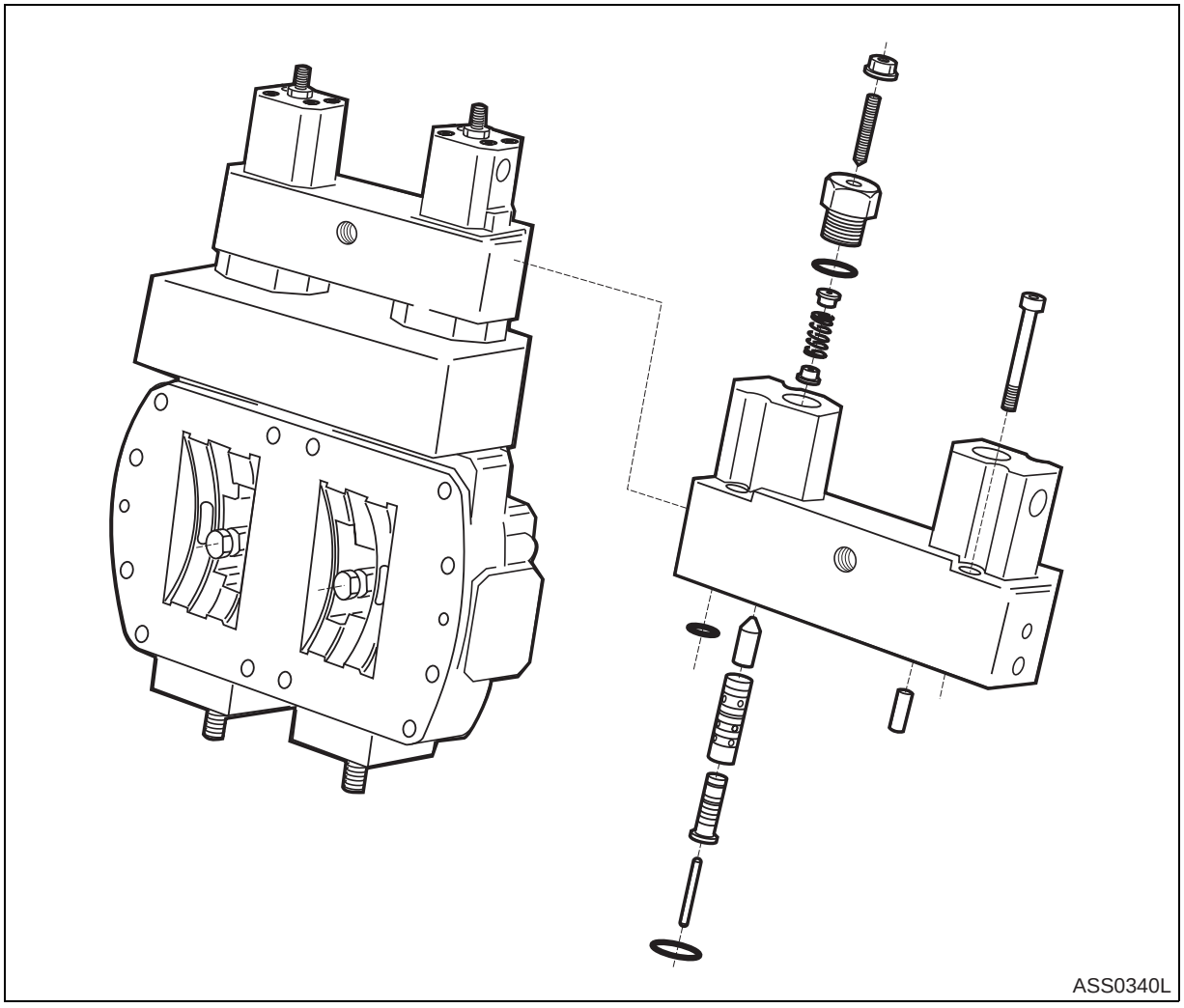


Figure 35

Remove and disassemble control module LR.

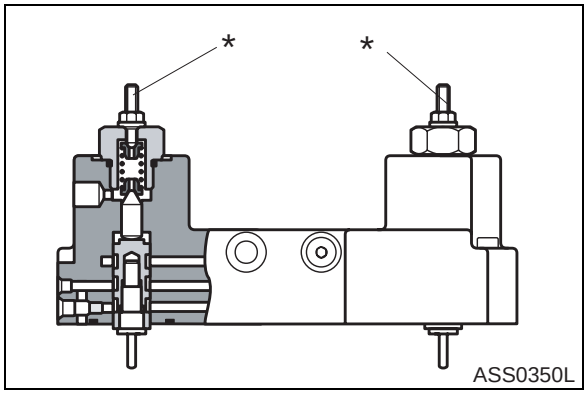


Figure 36

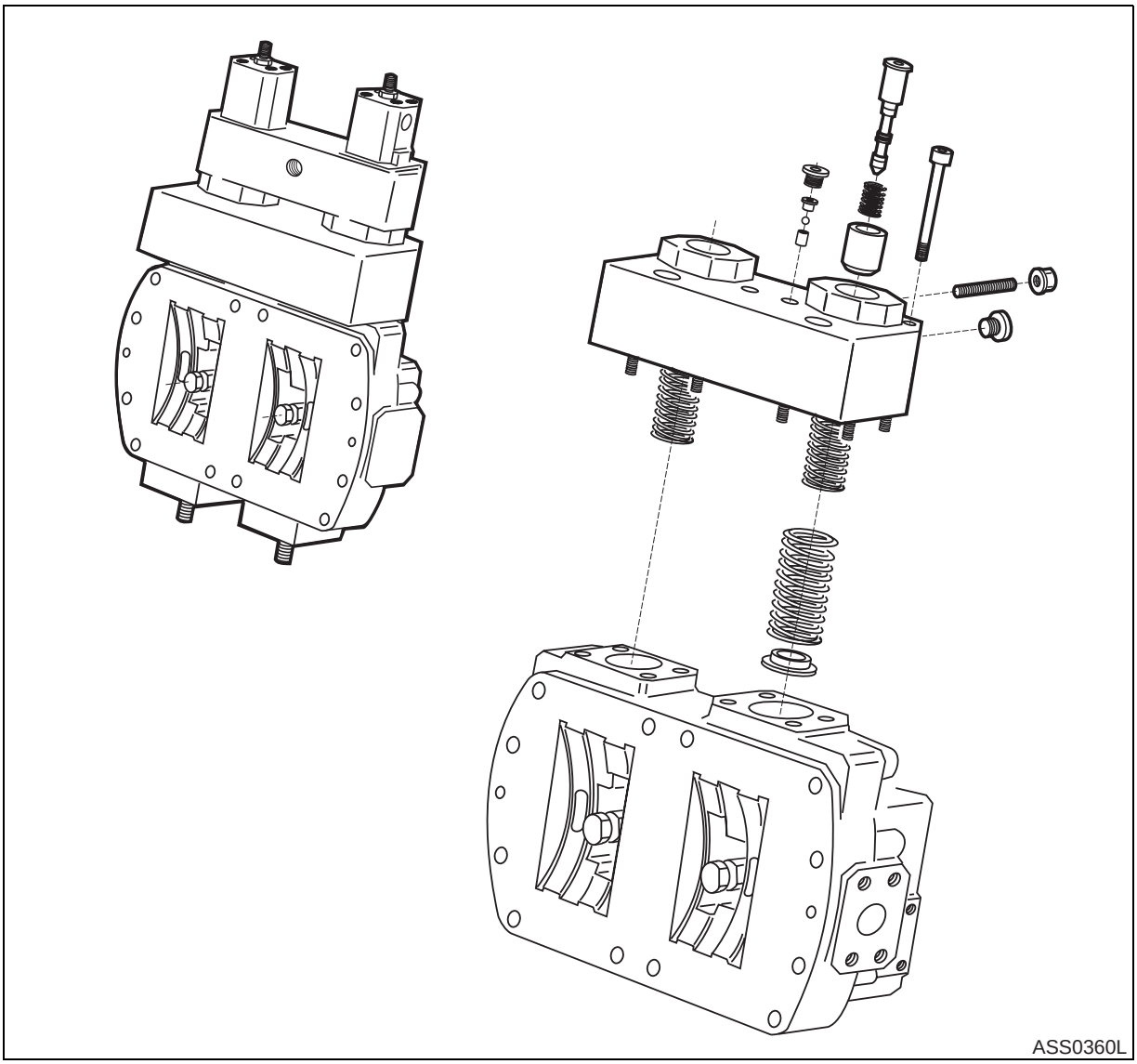


Figure 37

Remove and disassemble control module H.

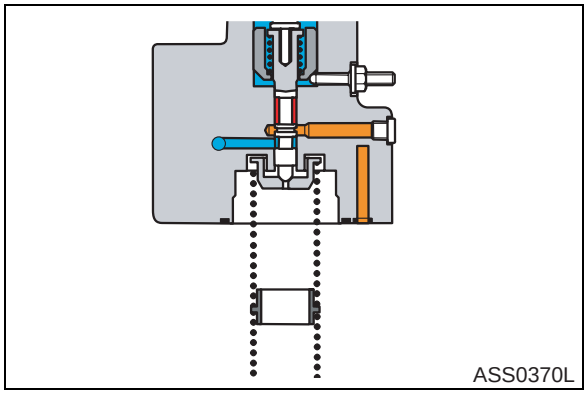


Figure 38

REMOVING THE CONTROLLER

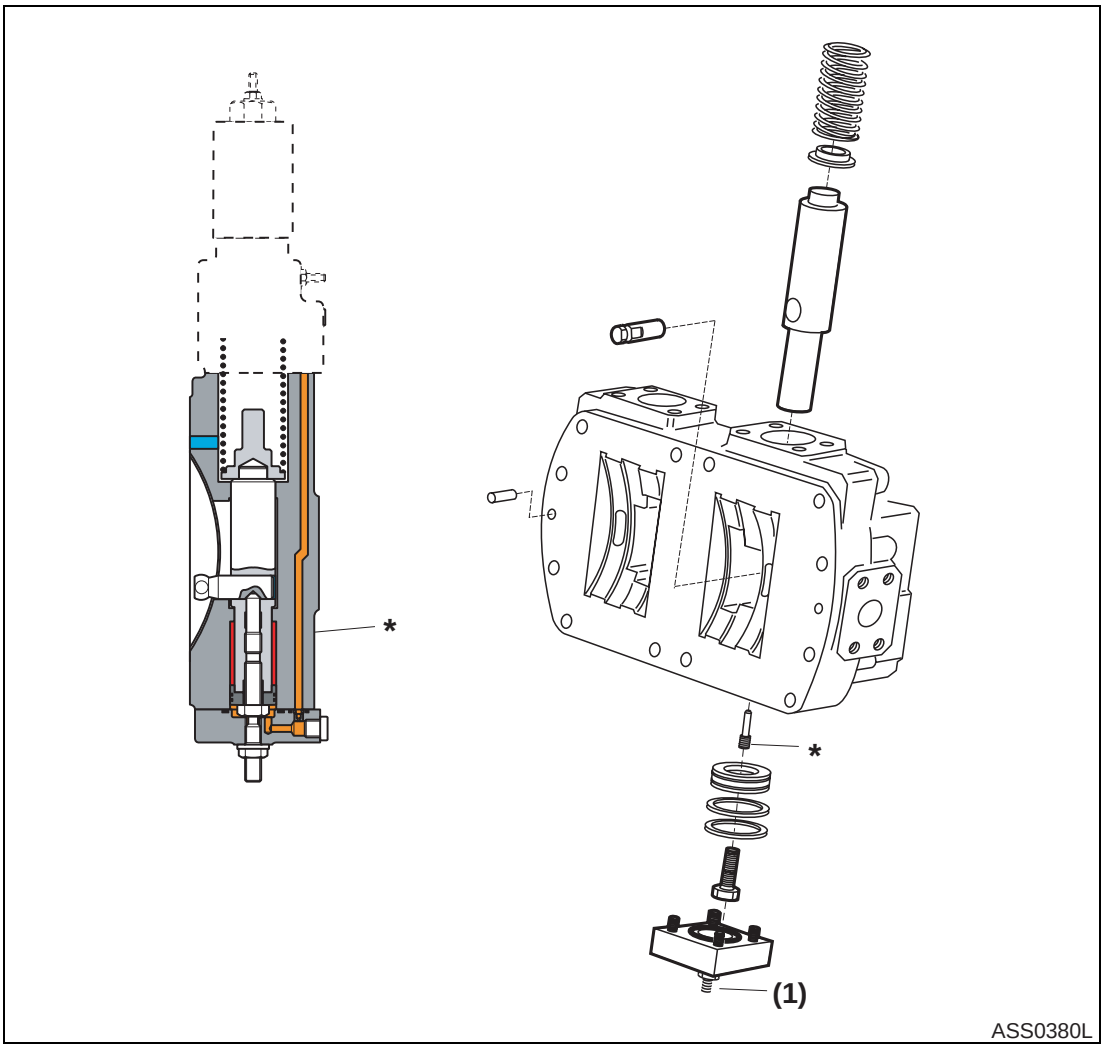


Figure 39

1. Remove cover.

   NOTE: *Do not change the setting of adjustment screw (1, Figure 39).*

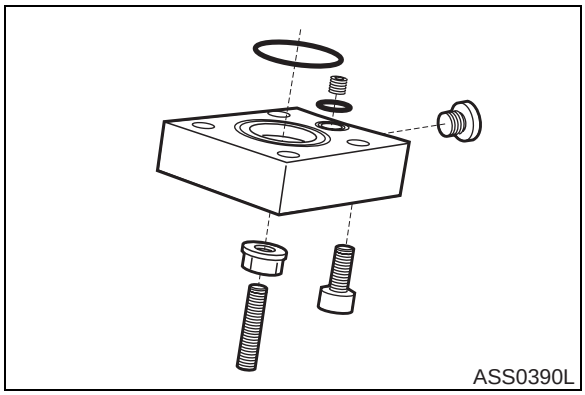


Figure 40

2. Remove screws.

   NOTE: *Install control lens - torque support.*

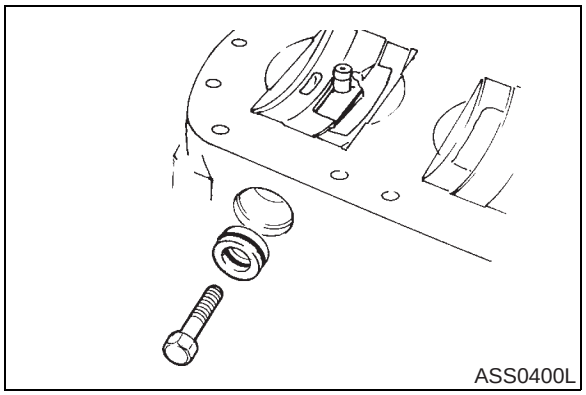


Figure 41

3. Remove locking screw and replace with a new one.

   NOTE: *Loosen adhesive with a "gentle" flame (approximately 120°C).*

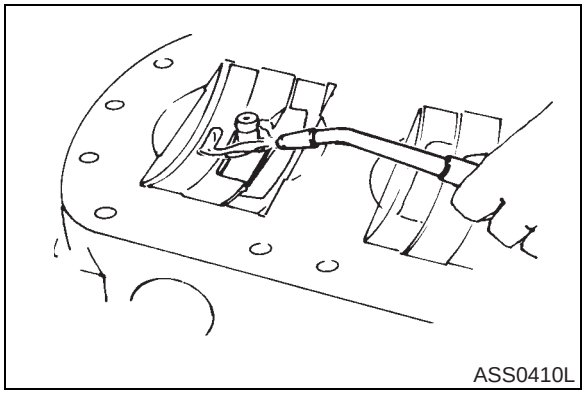


Figure 42

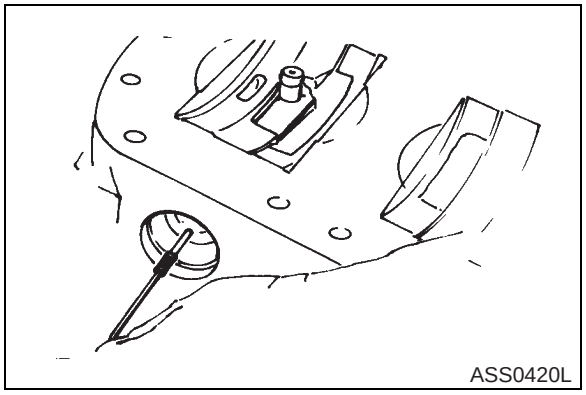


Figure 43

4. Remove swivel pin.

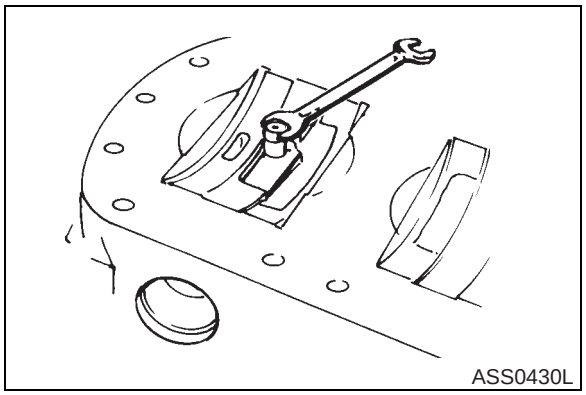


Figure 44

VALVE PLATE WITH VALVES

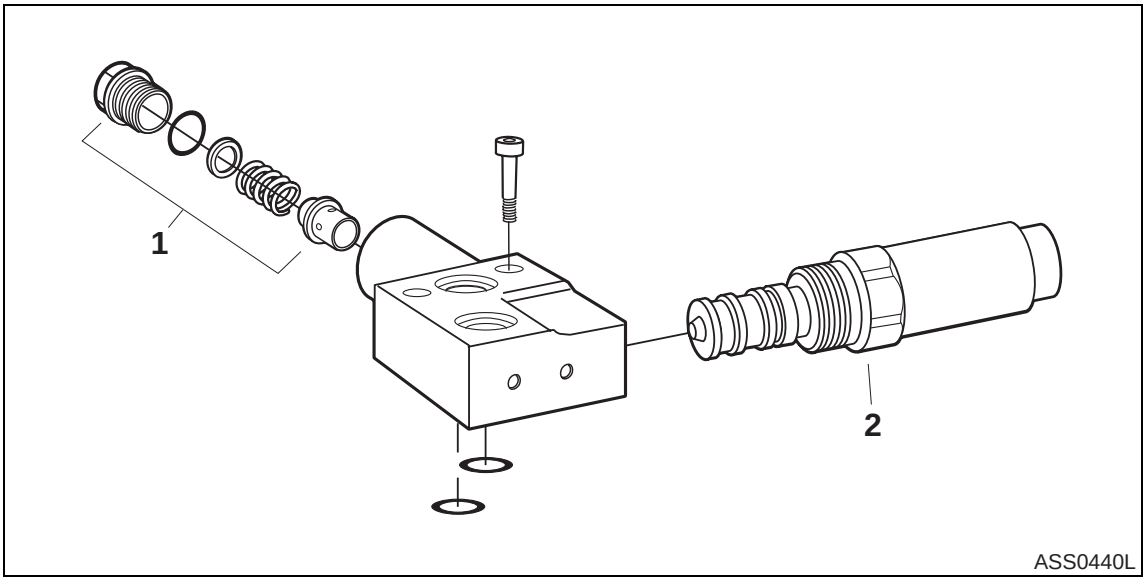


Figure 45

1. Pressure relief valve.
2. Electro- proportional pressure reducing valve (EPPR).

REMOVE THE ROTARY GROUPS

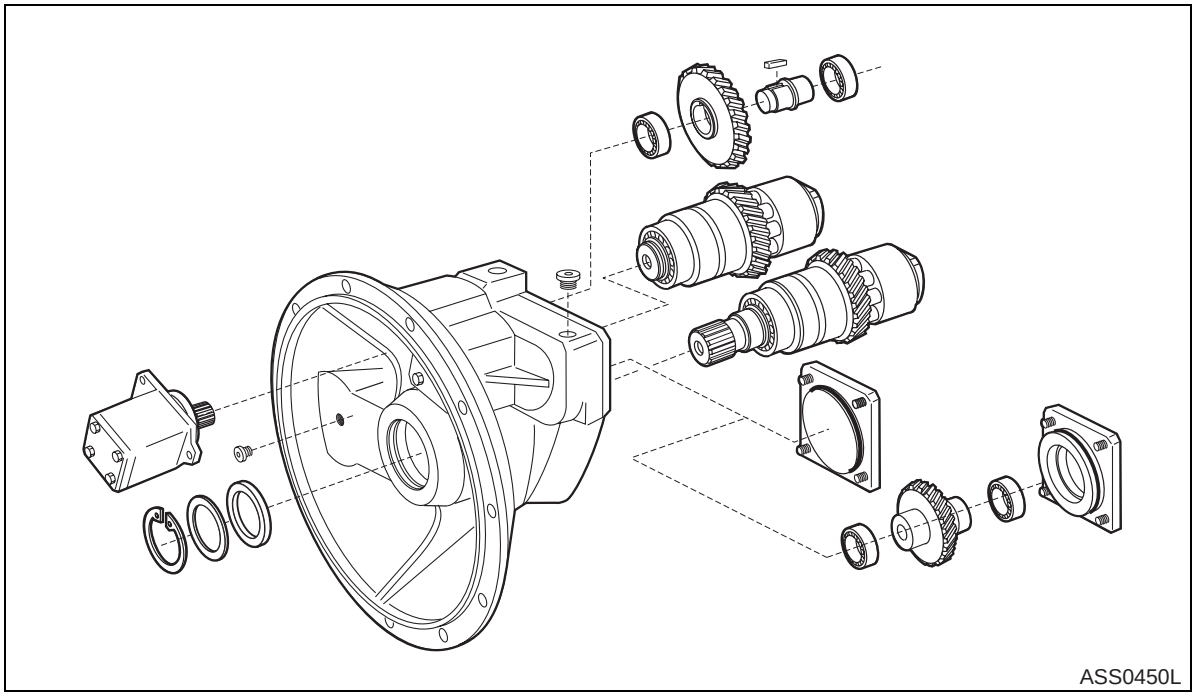


Figure 46

1. Keep cylinder with device (Remove it completely along with drive shaft).

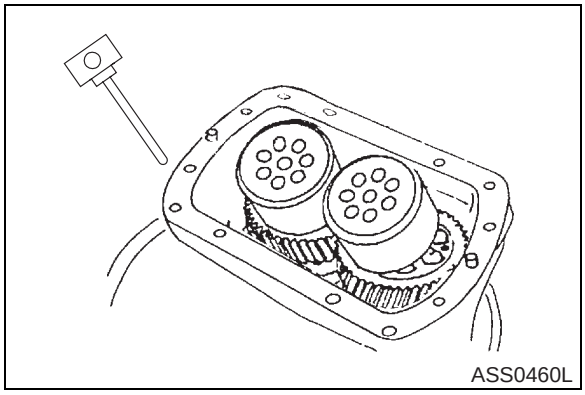


Figure 47

2. Remove cylinder (Take out the drive shaft without cylinder).

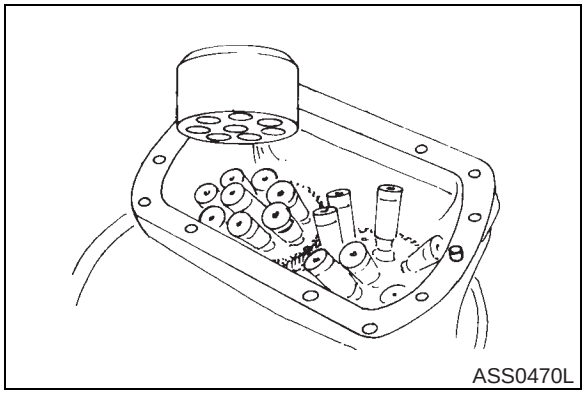


Figure 48

3. Remove cup springs 1 and spring cup 2.

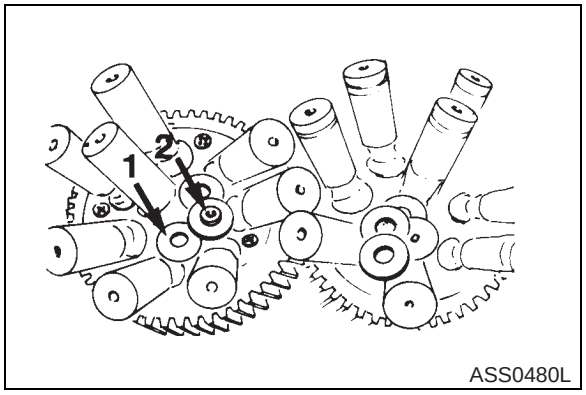


Figure 49

4. Note disassembly position: (1, 2 and 3, Figure 50).

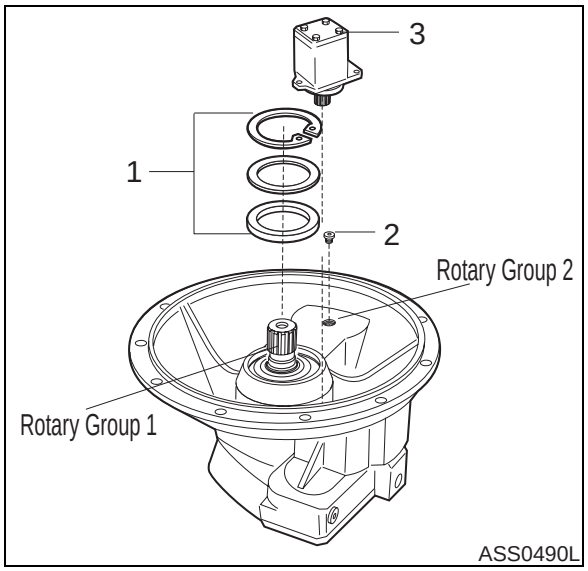


Figure 50

5. Press out rotary group with an appropriate device.

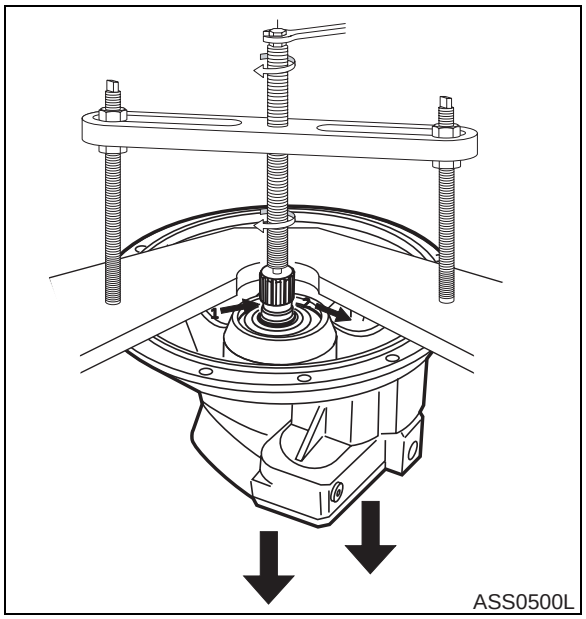


Figure 51

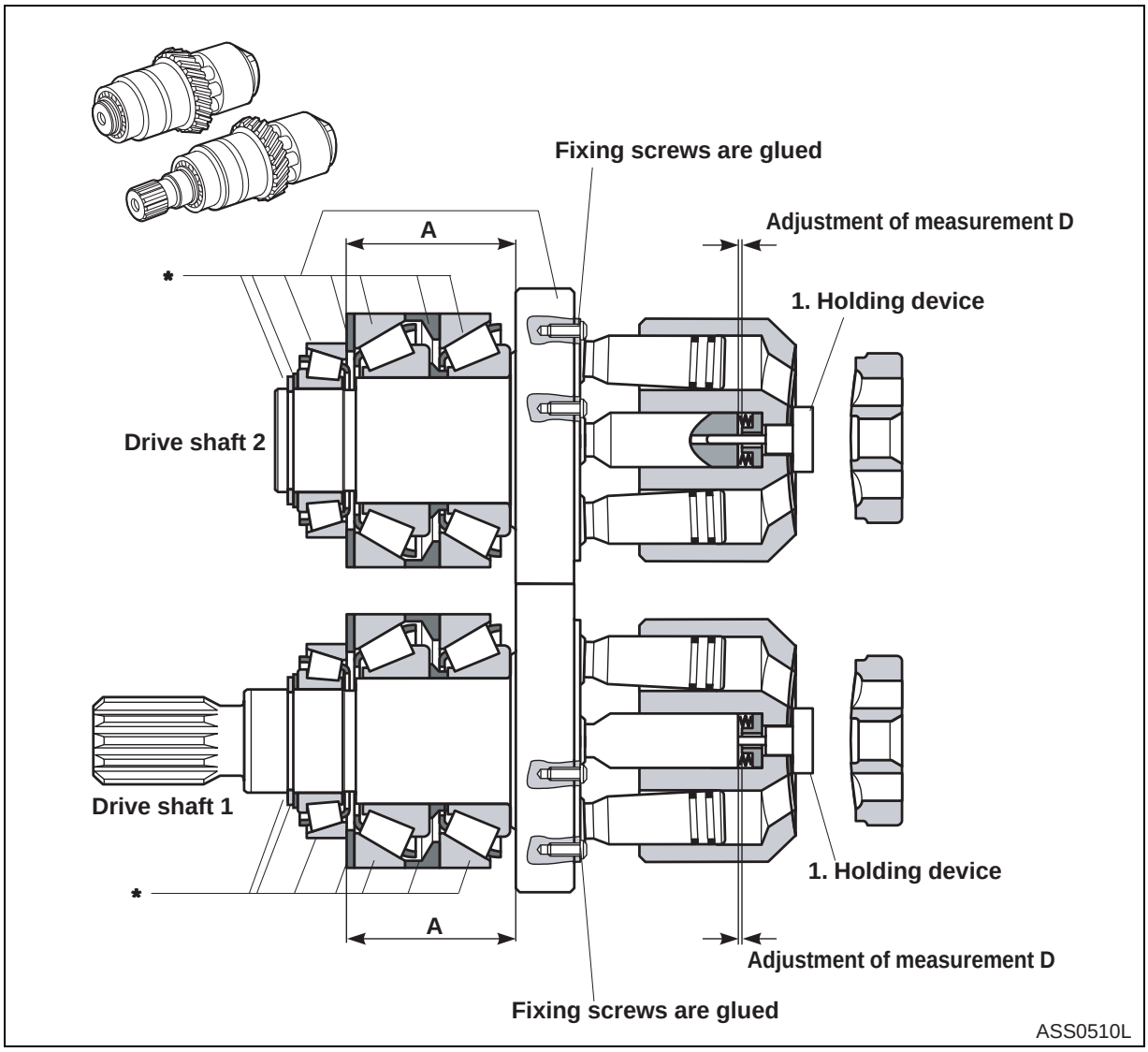


Figure 52

NOTE: *1) Position (*) drive shafts with bearing set are the smallest assembly group.*

2) The assembly group is adjusted to measurement A.

3) The tapered roller bearings are adjusted to the specified through-torque.

NOTE: *1) Fixing screw - Retaining device.*

2) Removal of screws is only possible if drive shaft is warmed up to a temperature of approximately 120°C for 1/2 hour in an oil bath or heat air furnace.

3) Remove screw quickly.

REMOVE THE INTERMEDIATE WHEEL

1. Press bolt (*, Figure 53) into gear wheel. (Fixed pressing fit).

   NOTE: *Can only be disassembled with a hydraulic press.*

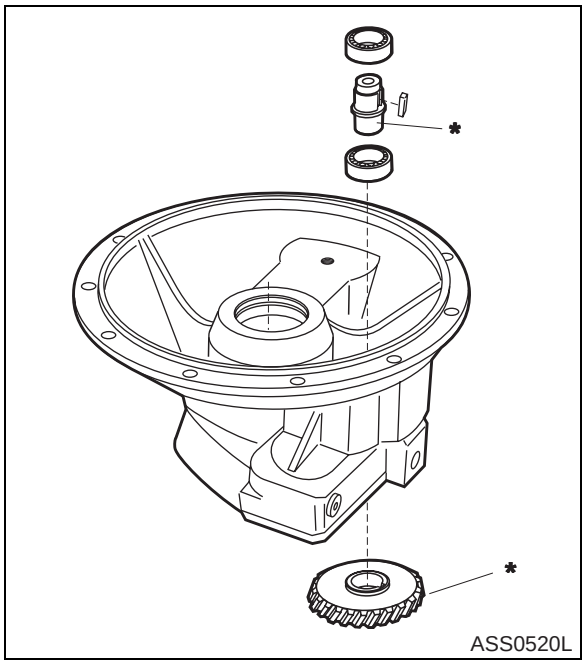


Figure 53

2. Install sleeve.

   NOTE: *Press out bolt with a hydraulic press.*

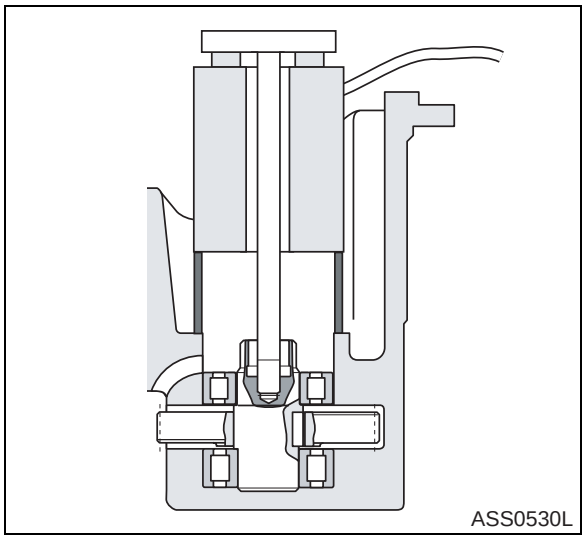


Figure 54

3. Remove gear wheel through side drive opening.

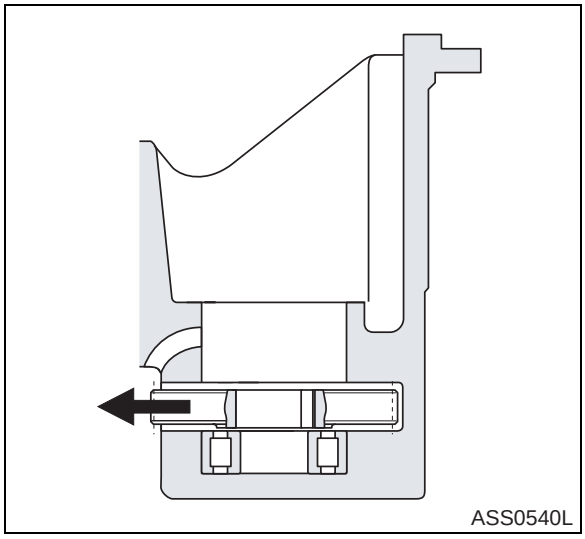


Figure 55

4. Remove bearing with extraction device.

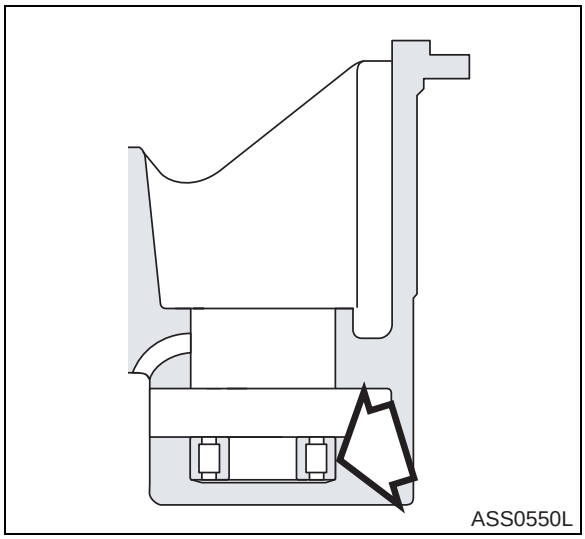


Figure 56

REMOVE AUXILIARY DRIVE

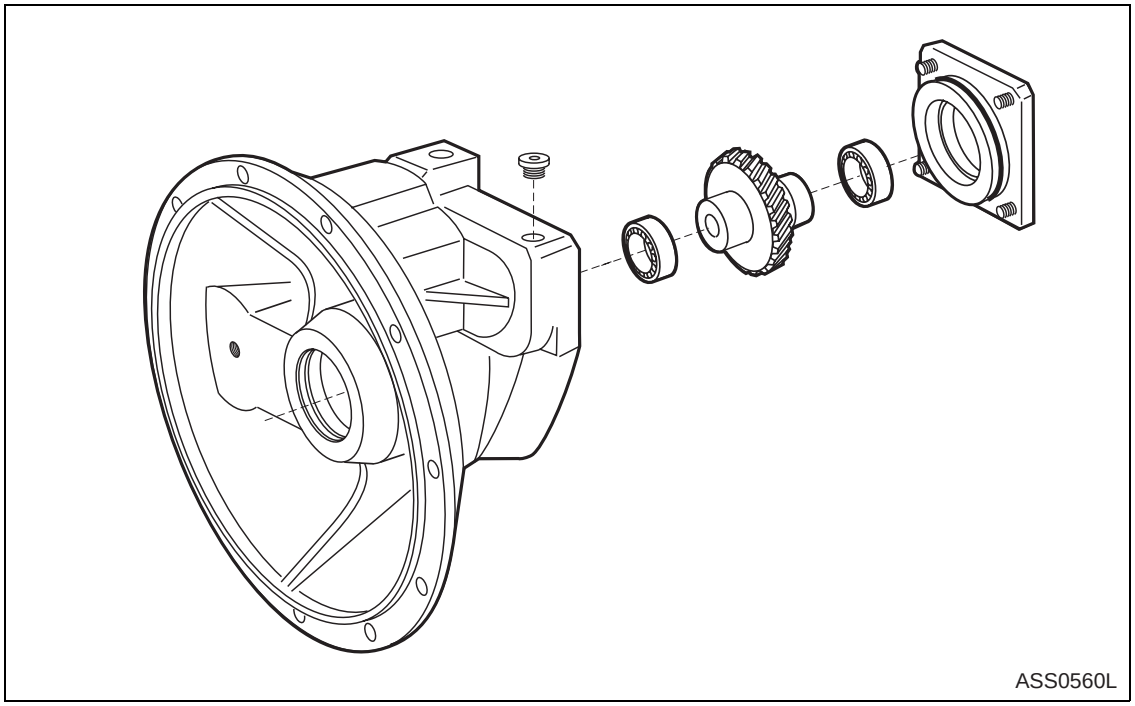


Figure 57

1. Remove screws and auxiliary drive.

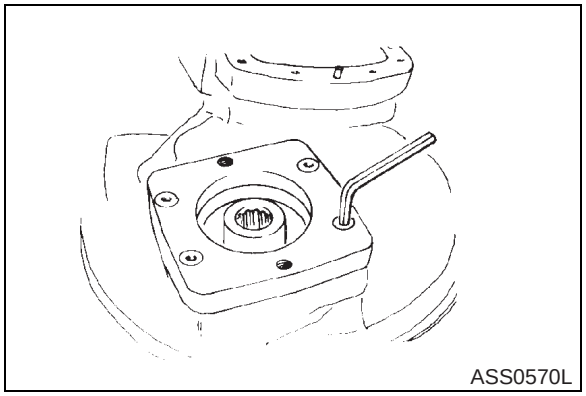


Figure 58

2. Press off bearing cap.

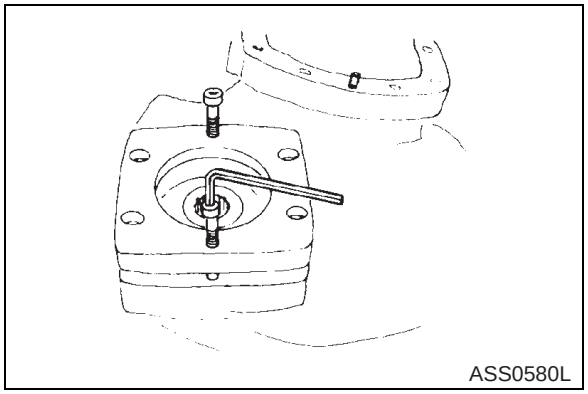


Figure 59

3. In the event of oil leakage, visually check O-ring, housing and groove.

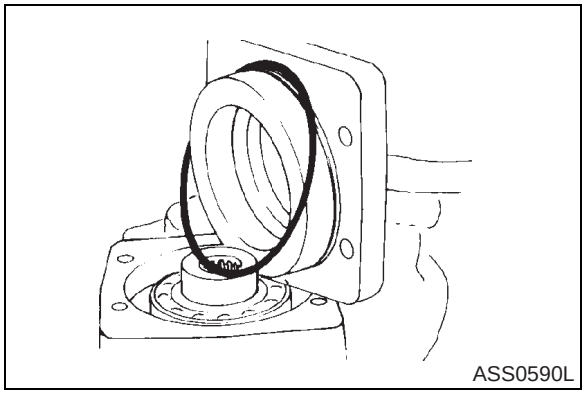


Figure 60

4. Install extractor device.

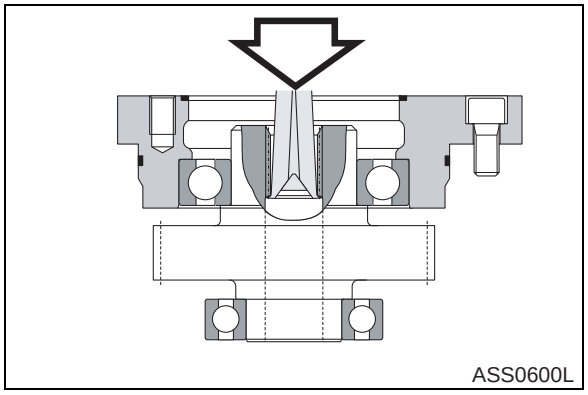


Figure 61

5. Pull out output pinion.

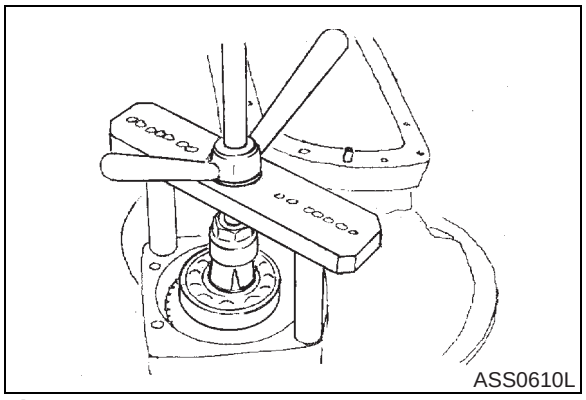


Figure 62

6. Install bearing extractor device.

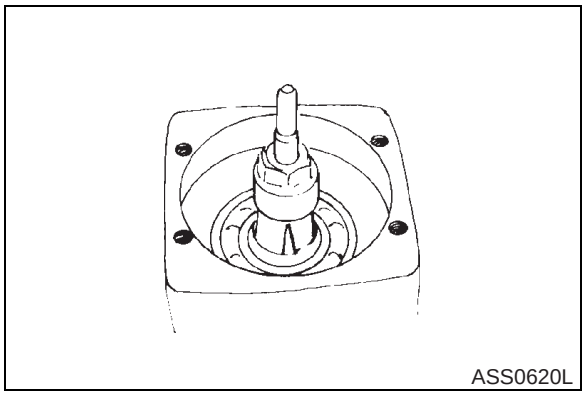


Figure 63

7. Completely mount device and pull out bearing.

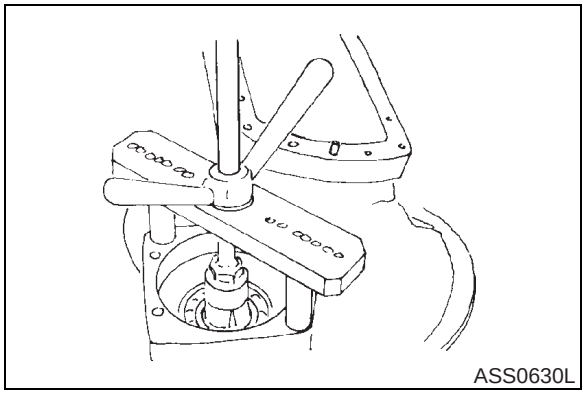


Figure 64

8. Pull out pinion bearing.

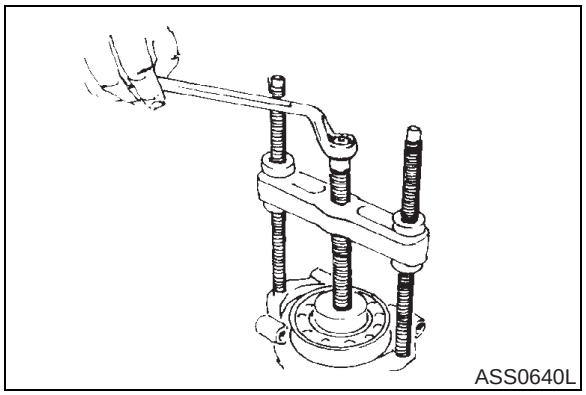


Figure 65

INSPECTION

1. Check to see that bearing bore is free of scores and that there is no evidence of wear.

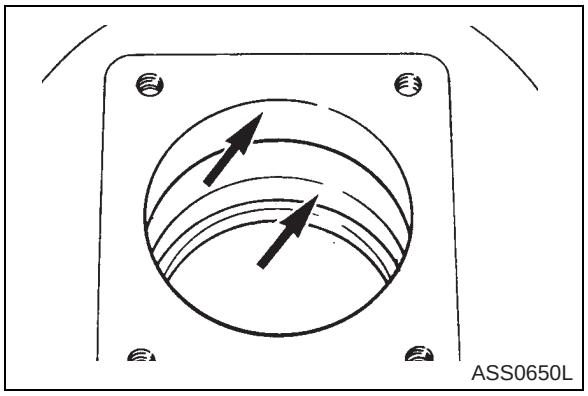


Figure 66

2. Visually check:

   To ensure that bearing seats are free of scores.

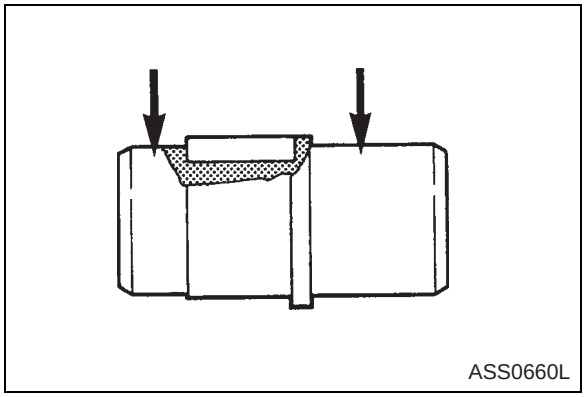


Figure 67

3. Visually check:

   Check to see that bearing bores are free of scores and that there is no evidence of wear.

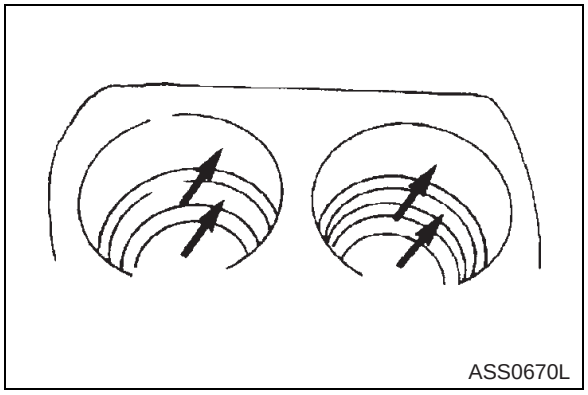


Figure 68

4. Axial piston play:

   Checked with retaining plate installed.

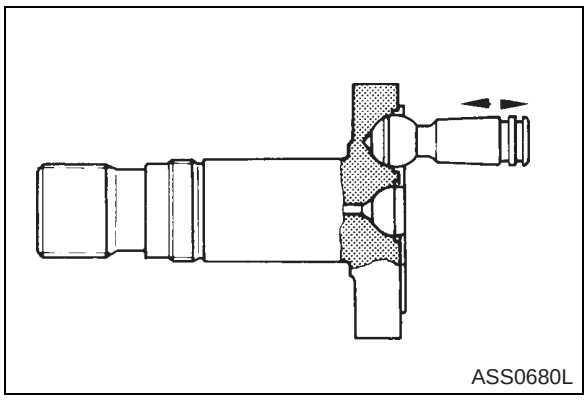


Figure 69

5. Drive shafts:

   Check to ensure that cups are free of scores and that there is no pitting (1. Figure 70).

   Check to see that there is no evidence of corrosion and wear steps (2, Figure 70).

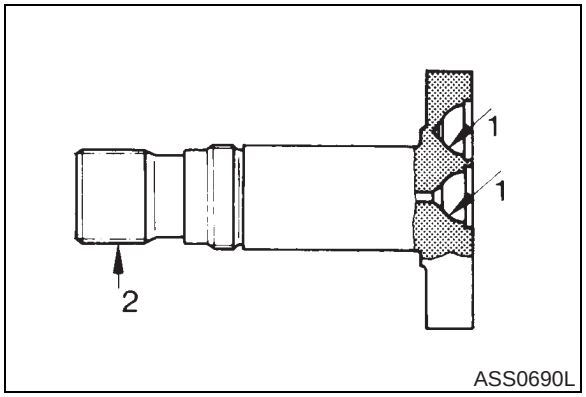


Figure 70

6. Piston:

   Check to ensure that they are free of scores and that there is no pitting.

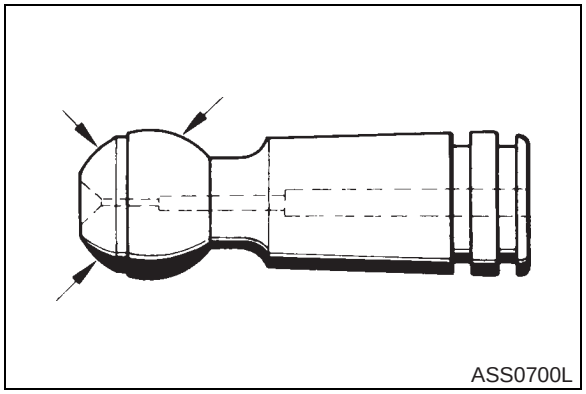


Figure 71

7. Central pin:

   Check to ensure that it is free of scores and that there is no pitting.

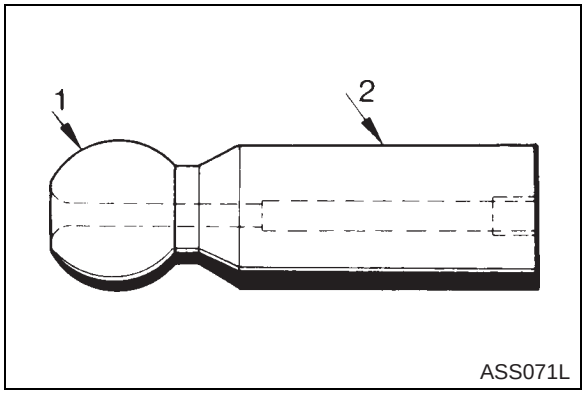


Figure 72

8. Retaining plate:

   Check to ensure that it is free of scores and that there is no evidence of wear.

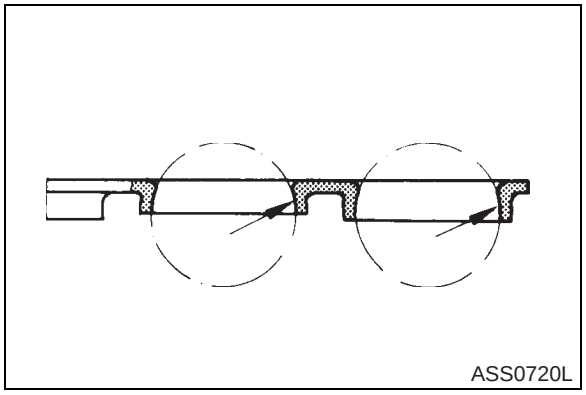


Figure 73

9. Check cylinder block / control lens.

   Bores (1, Figure 74) are free of scores, no evidence of wear.

   Faces (2, Figure 74) are even, that there are no cracks, no scores.

   Side guides (3, Figure 74) show no evidence of wear, free of scores.

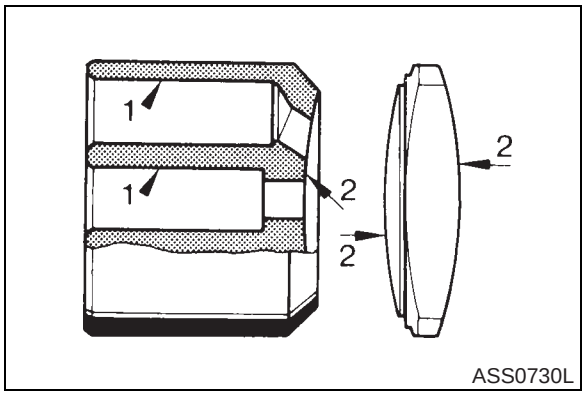


Figure 74

10. Check:

    Control land (1, Figure 75), internal control drilling (2, Figure 75) and pin cups (3, Figure 75).

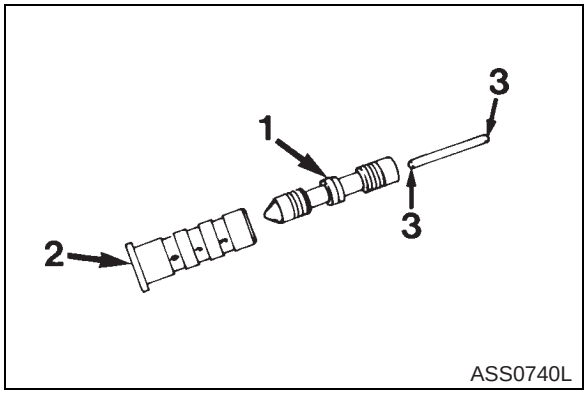


Figure 75

11. Check:

    That sliding surfaces (1, Figure 76) are free of scores.

    Seal (2, Figure 76).

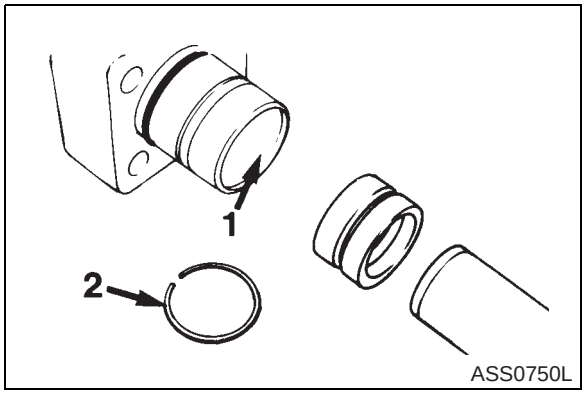


Figure 76

12. Complete rotary group.

NOTE: *Adjustment of the hydraulic component is necessary.*

Mechanical component: drive shaft is adjusted with the bearing (1, Figure 77).

Hydraulic component (2, Figure 77): Adjustment is necessary (*, Figure 77).

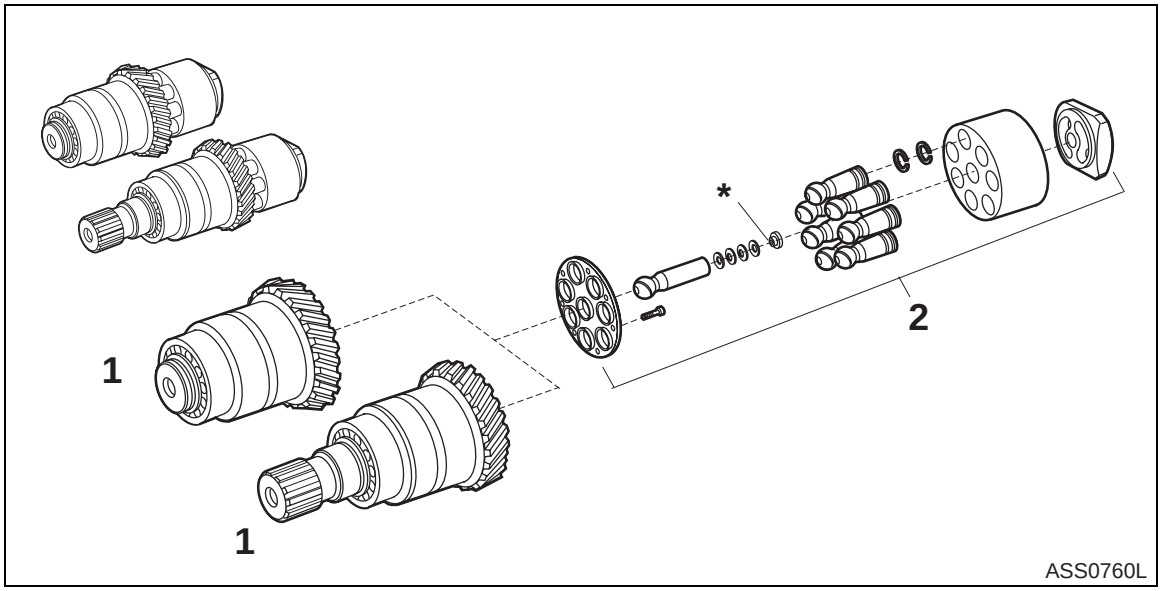


Figure 77

13. Rotary group: All of the components.

    * Adjustment (Figure 78).

    For adjustment values and torque values, see service information.

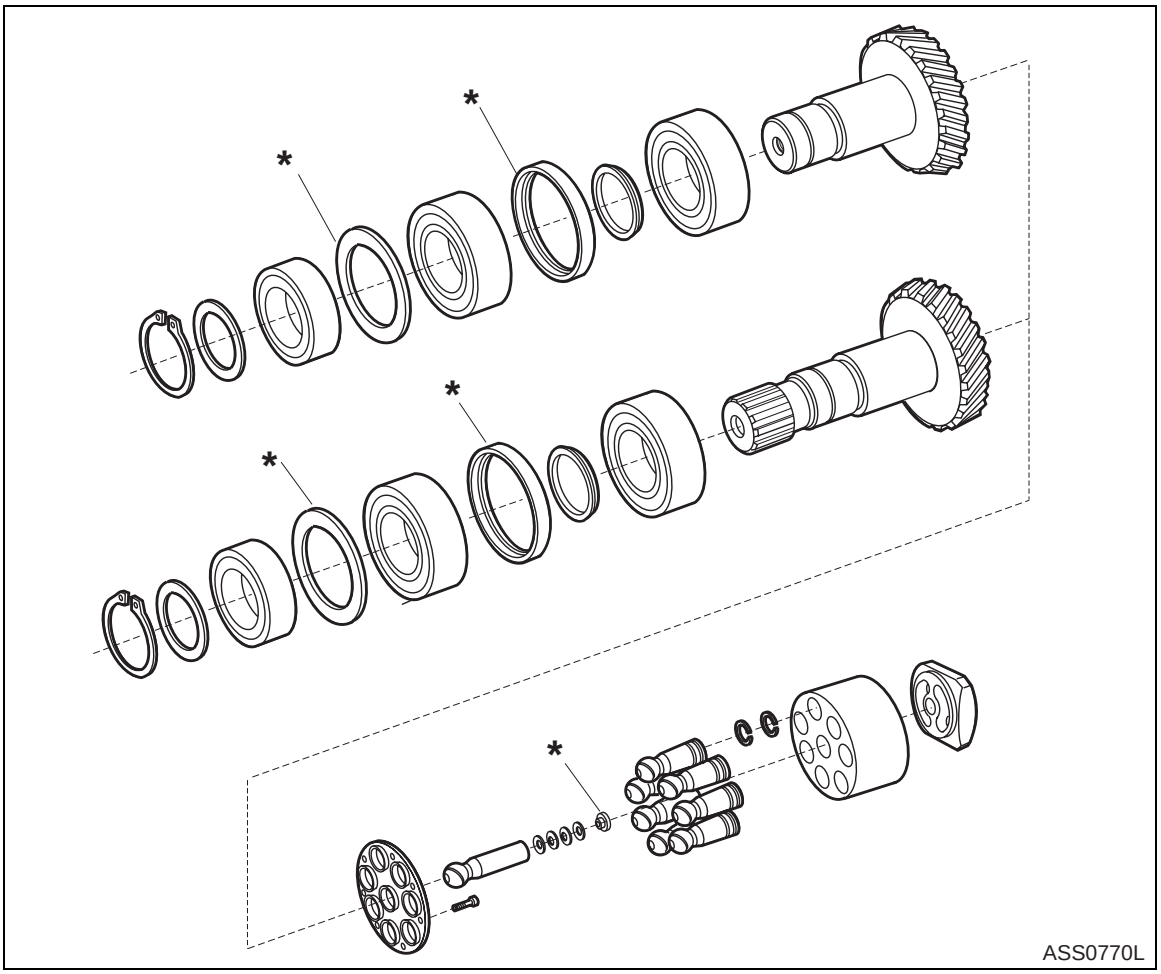


Figure 78

RE-FITTING THE ROTARY GROUP

1. Threads must be free of oil, grease, dust or any other contaminants which may impair locking of screws.

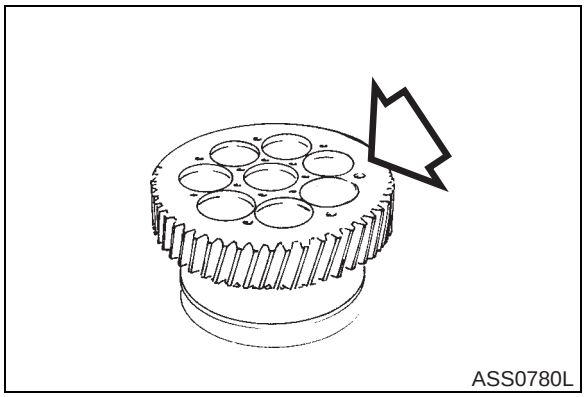


Figure 79

2. Assemble retaining plate with pistons and center pin in position. Use screws that have a Precoat coating.

   NOTE: *For tightening torques, see service information.*

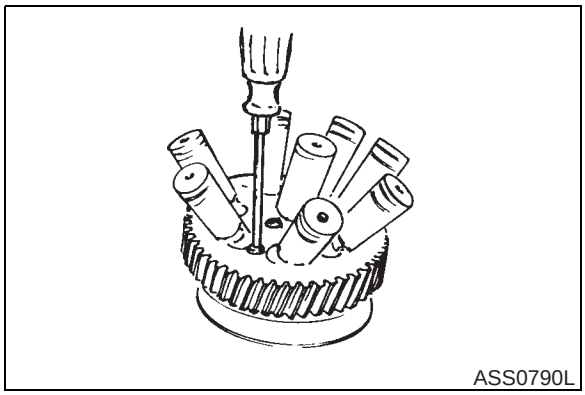


Figure 80

3. Insert spring plate (1, Figure 81) and cup springs (2, Figure 81) into their correct position (and orientation) using grease to hold them into place.

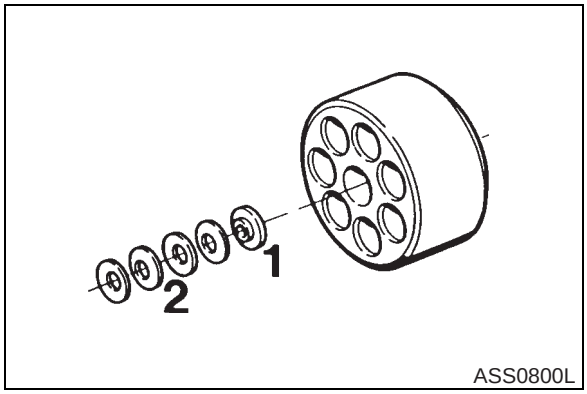


Figure 81

4. Ensure that all parts are assembled in correct order and orientation.

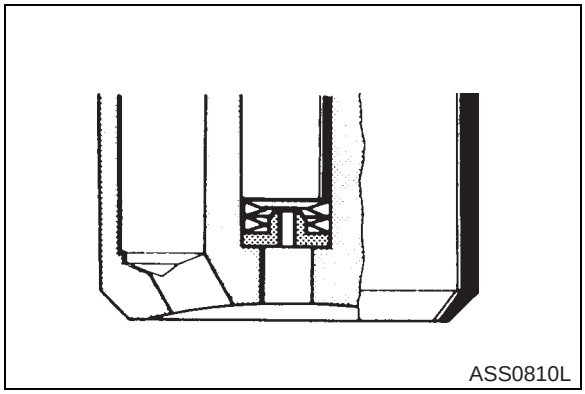


Figure 82

5. Insert pistons into cylinder. Using a soft surface as a support to prevent sliding surfaces from being damaged. Pre-assemble both rotary groups in this manor.

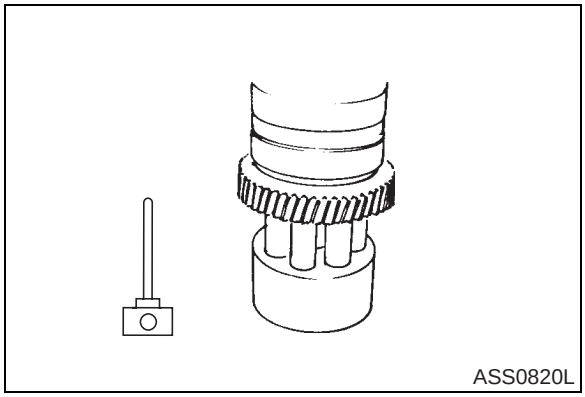


Figure 83

PUMP ASSEMBLY

1. Warm up housing to approximately 80°C.

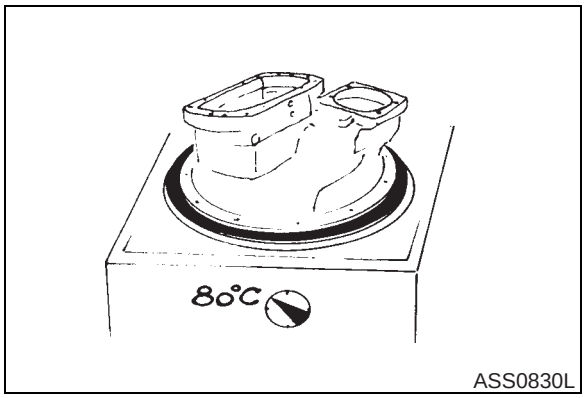


Figure 84

2. Insert pre-assembled rotary group 2, being sure to align gear tooth marks.

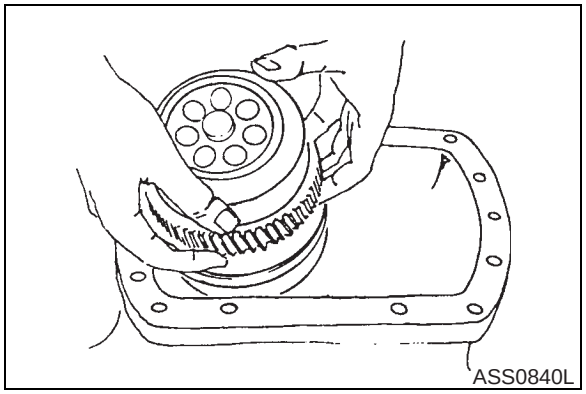


Figure 85

3. Insert rotary group 1. Align the marked gear teeth.

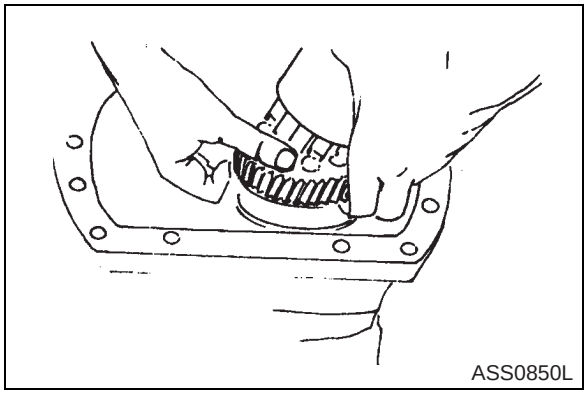


Figure 86

4. Gear tooth marks must align with each other.

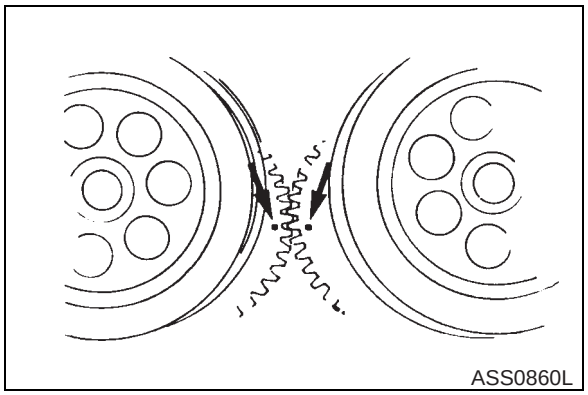


Figure 87

5. Adjustment of measurement D.

NOTE: *Hydraulic control portion.*

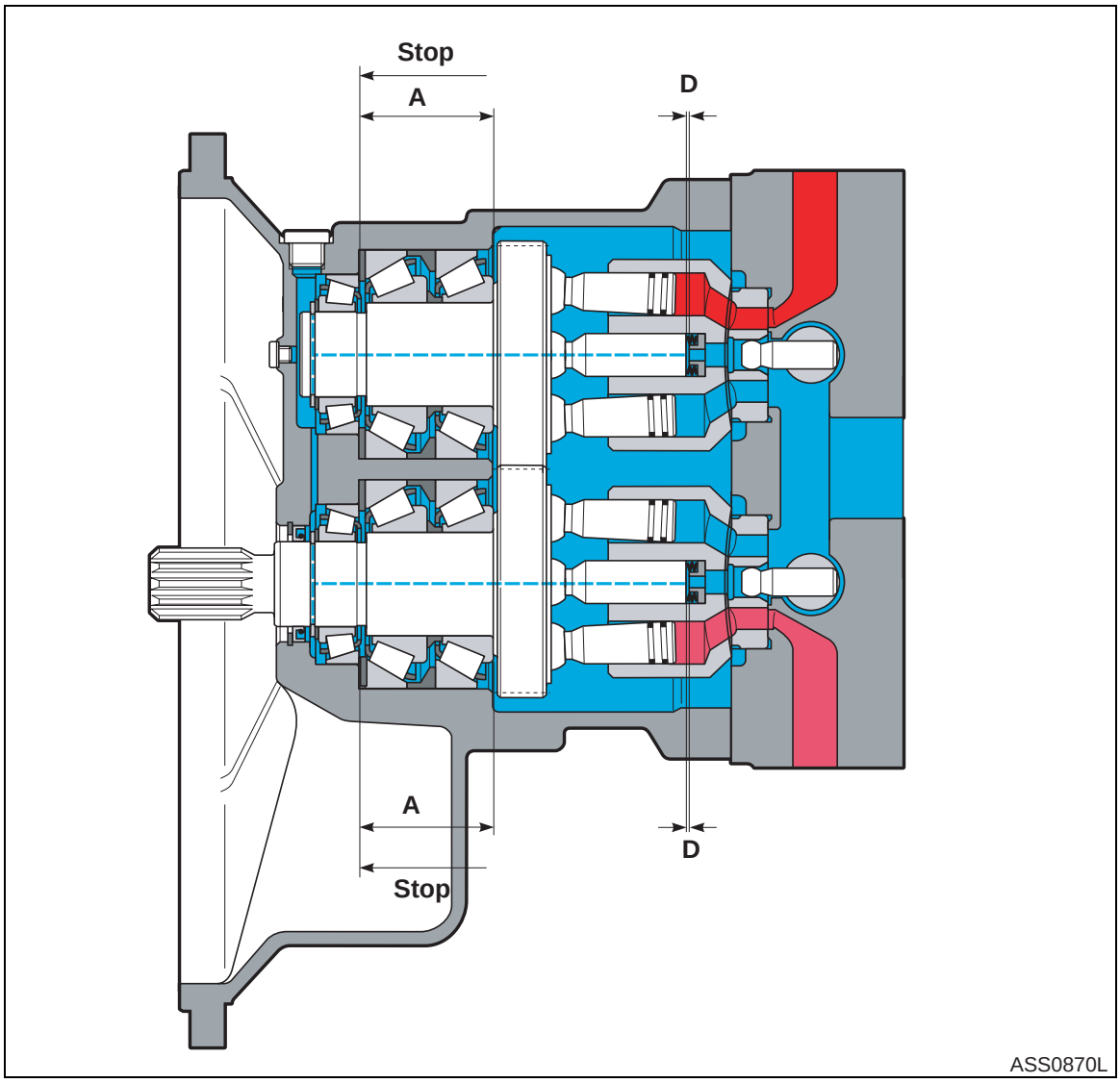


Figure 88

NOTE: *Drive shafts with bearing set.*

The assembly group is adjusted to dimension (A). The tapered roller bearings are adjusted to the stipulated breakaway torque.

Assembly Guideline

Retaining force:

After rotary group has been installed into housing, it has to be pressed in until the end stop is reached. Allow housing to cool down from its assembly temperature (approximately 80°C) to room temperature.

Adjustment of the Hydraulic Component of the Rotary Group

The adjustment of dimension "D" is carried out using spring plates of differing thickness, so that the correct clearance is achieved between the rotary group which is installed in housing and center pin, and spring plates.

NOTE: *Dimension (D) = 0.4 ±0.1 mm.*

After assembling complete unit, the breakaway torque of the rotary group has to be checked with a torque wrench.

HYDRAULIC COMPONENT - MEASUREMENT "D"

MEASURING DEVICE - HYDRAULIC COMPONENT 452 269

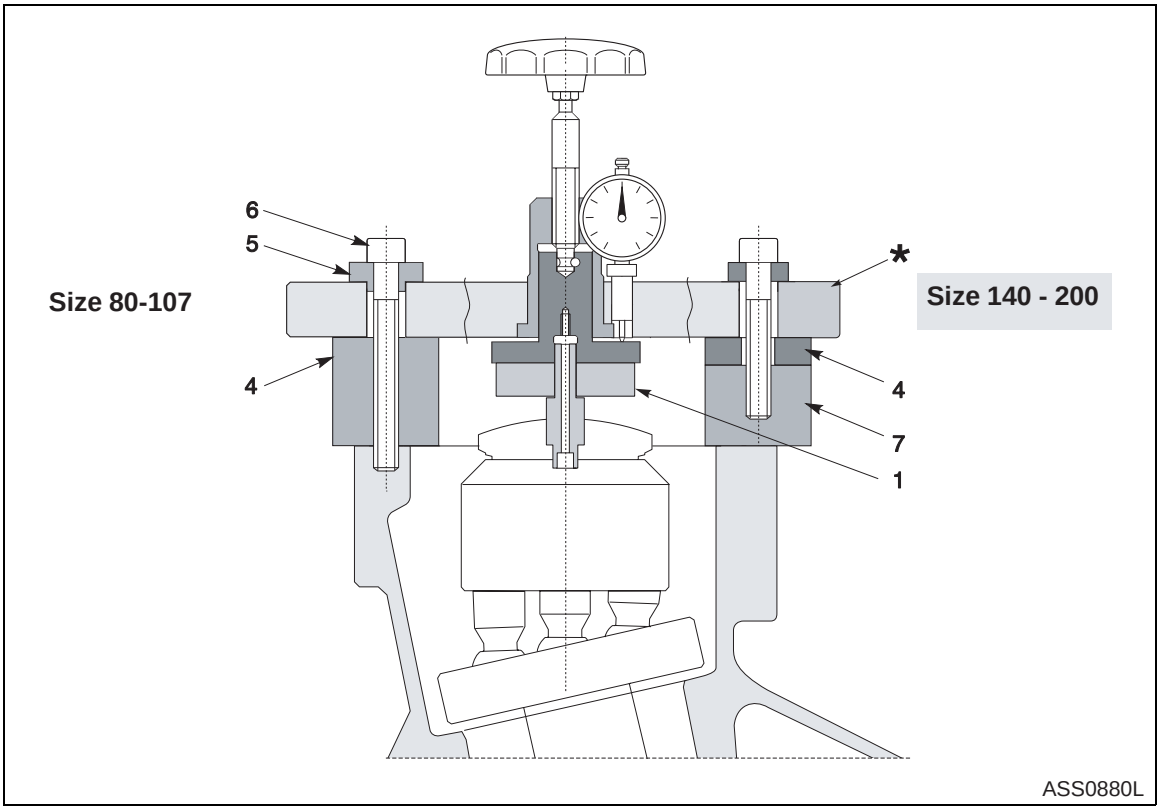


Figure 89

Size	Measuring Device (*)	Centering Device (1)	Intermediate Ring (4)	Shim (5)	S.H.C.S (6)	Intermediate Plate (7)
		1x	2x	2x	2x	2x
80	9452269	9452019	9452014	9083277	9083105	
107	9452269	9452022	9452014	9083277	9083105	
140	9452269	9452026	9452015	9083279	9083134	2775186
200	9452269	9452025	9452015	9083279	9083134	2775187

MOUNTING POSITION

NOTE: *Be sure that the correct mounting position is used. The numbers on the top of the measuring device (*, Figure 89) refer to the piston diameter.*

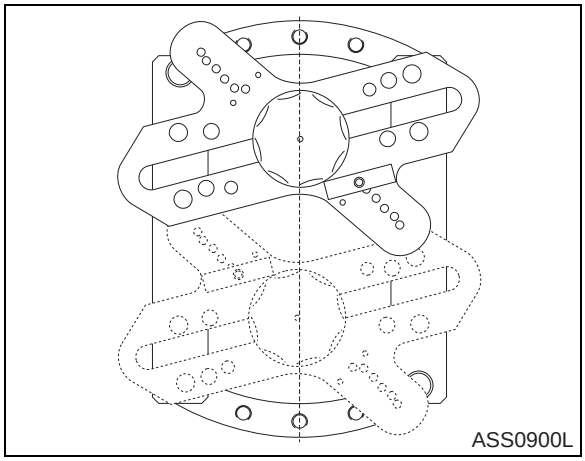


Figure 90

Size	Mounting Position
80	22
107	25
140	28
200	28

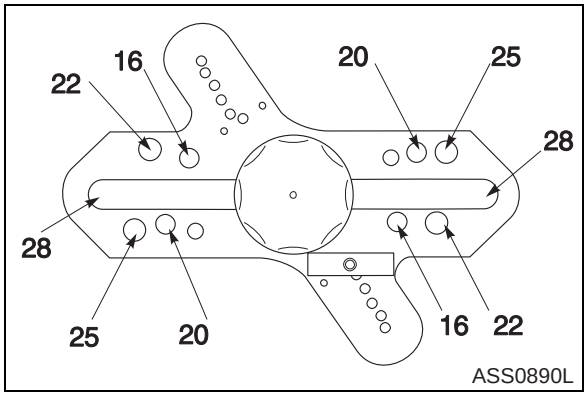


Figure 91

1. Install intermediate ring or plates onto the housing.

   A. Size 80 - 107 (Figure 92).

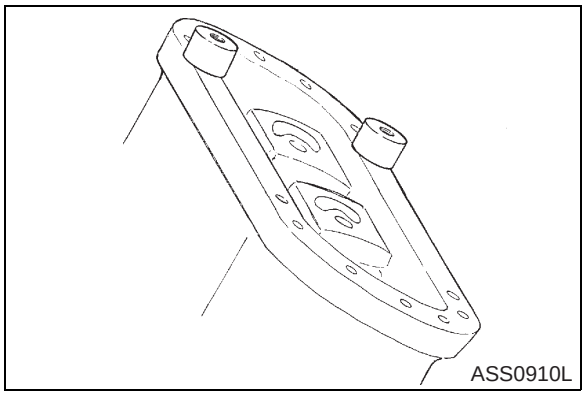


Figure 92

B. Only Size 140 - 200 (Figure 93).

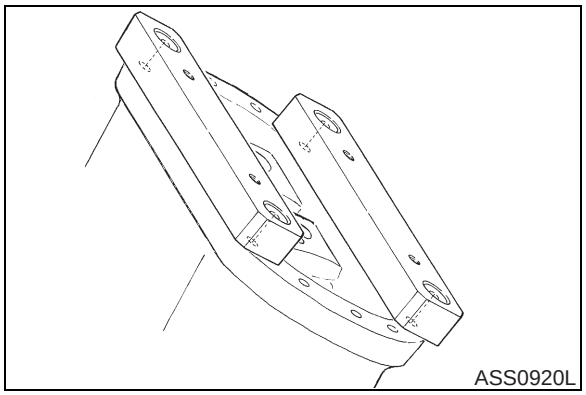


Figure 93

2. Zero adjustment - measuring device.

   Turn using the hand wheel until the stop is reached. Set dial gauge to zero.

   A. Size 80 - 107 (Figure 94).

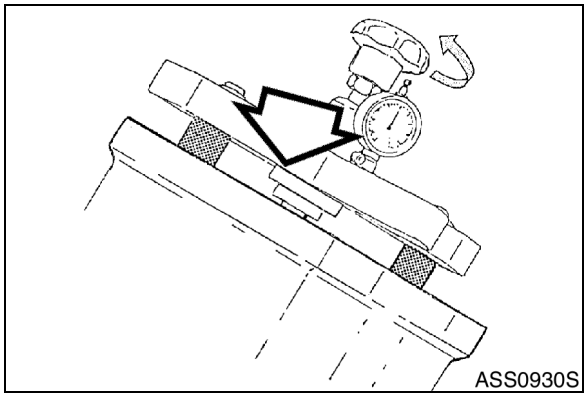


Figure 94

   B. Size 140 - 200 (Figure 95).

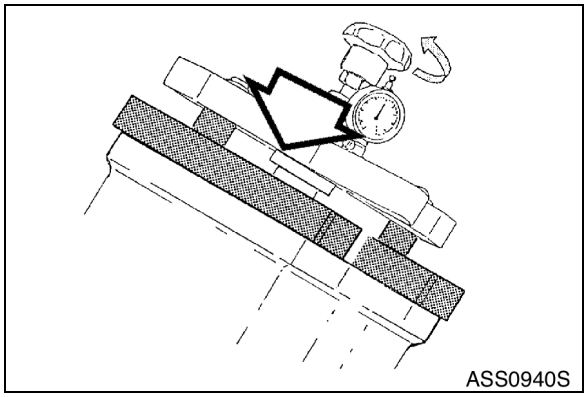


Figure 95

MEASURING PROCEDURE

1. Turn down by 4 turns on the dial gauge.

   Check: 2 mm clearance, set dial gauge to "Zero."

   NOTE: *Clearance: Size 28 - 160 0.4 mm ± 0.1.*

   A. Size 82 - 107 (Figure 96).

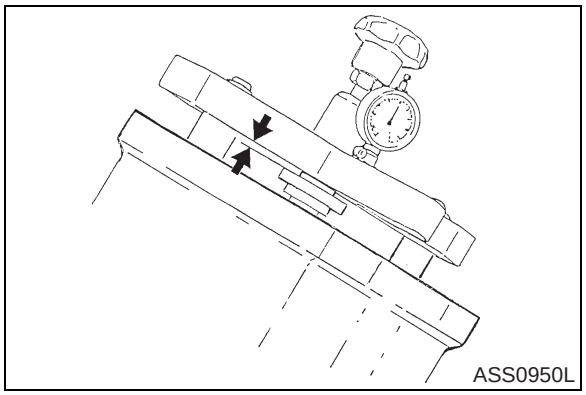


Figure 96

B. Size 140 - 200 (Figure 97).

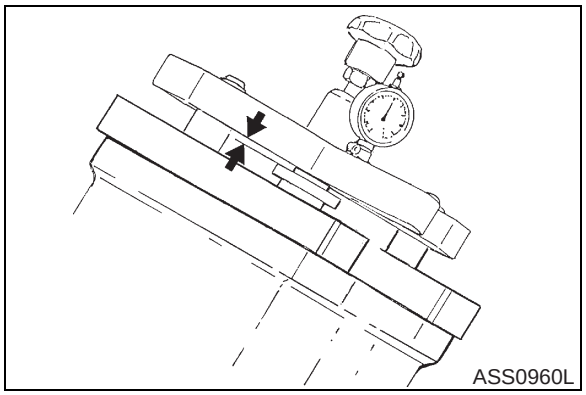


Figure 97

2. Turn down, using the hand wheel, until resistance is met. Read the measured value.

   NOTE: *Do not use excessive force.*

   A. Size 82 - 107 (Figure 98).

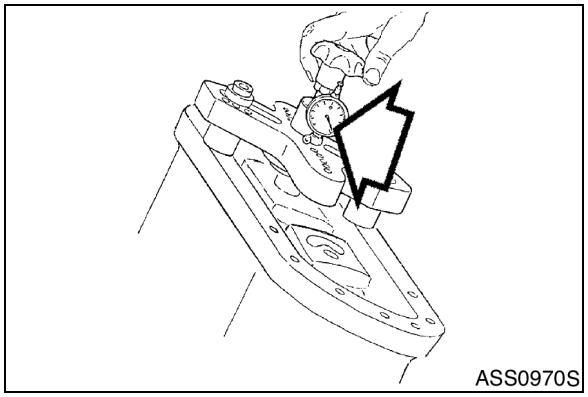


Figure 98

   B. Size 140 - 200 (Figure 99).

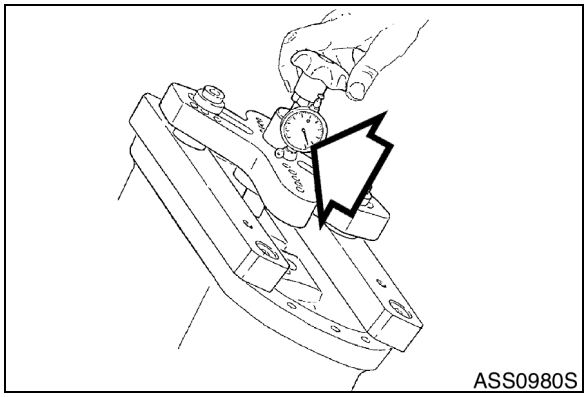


Figure 99

INSTALLATION OF CONTROL HOUSING

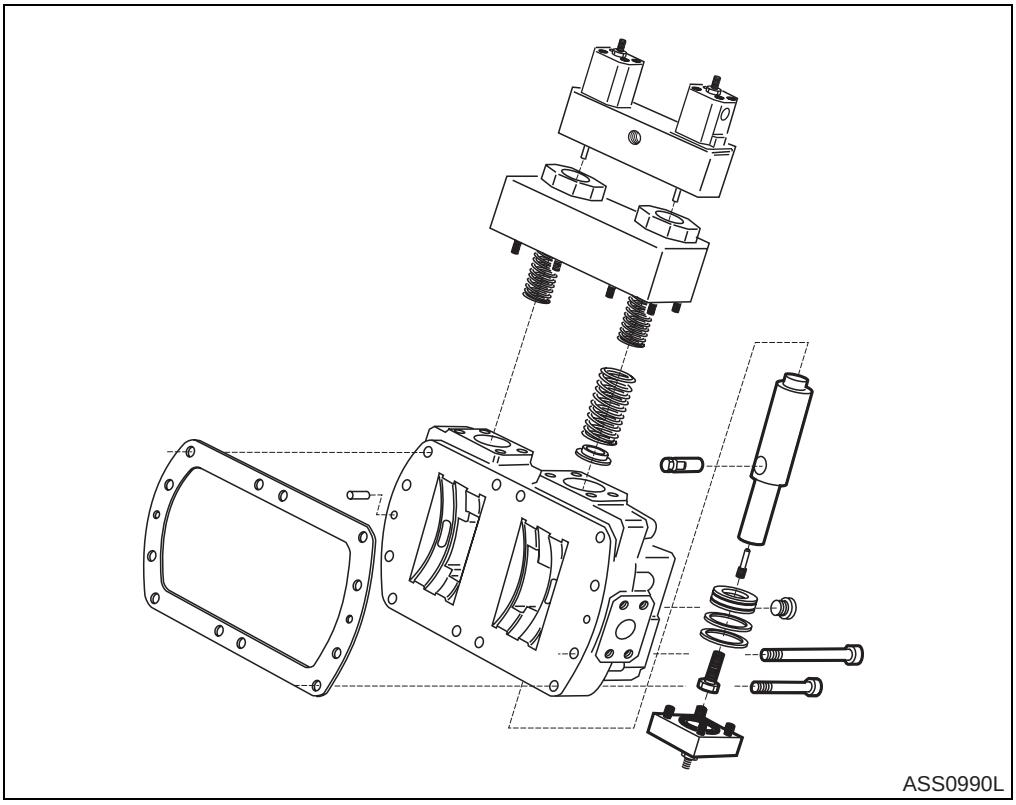


Figure 100

1. Install swivel pin into correct position and orientation. Take hardening time and tightening torque into account.

   NOTE: *Tightening Torques (*):*
   M6 = 8.5 Nm (0.87 kg•m (6.27 ft lb))
   M8 = 14 Nm (1.43 kg•m (10.33 ft lb))
   M10 = 35 Nm (3.57 kg•m (25.81 ft lb))
   M12 = 69 Nm (7.04 kg•m (50.89 ft lb))

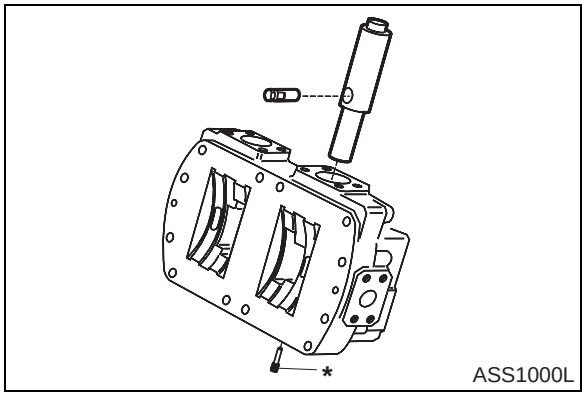


Figure 101

2. Push on piston ring by hand. Fix adjustment piston. Take the tightening torques into account.

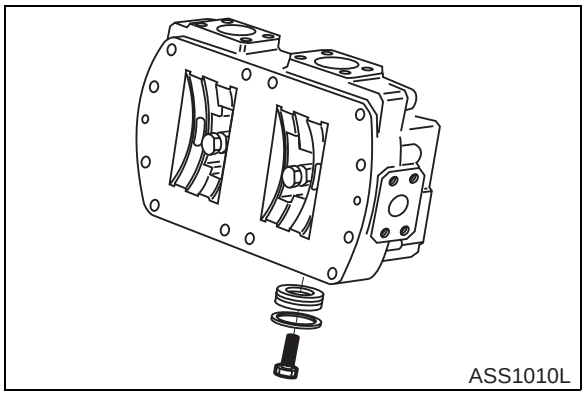


Figure 102

3. Install control housing.

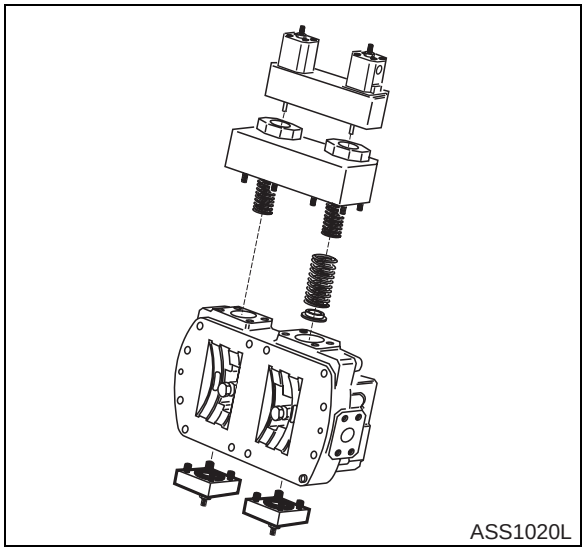


Figure 103

4. Install control lens in their correct position using grease to hold them in place.

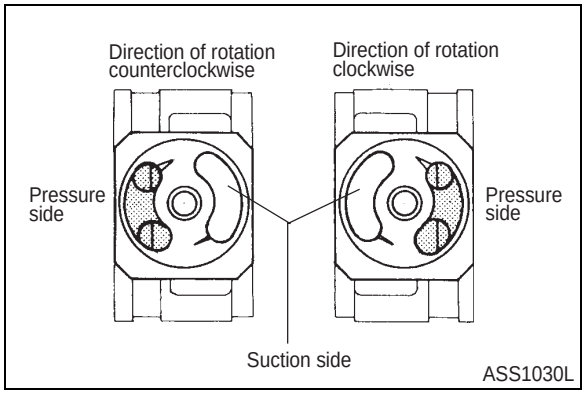


Figure 104

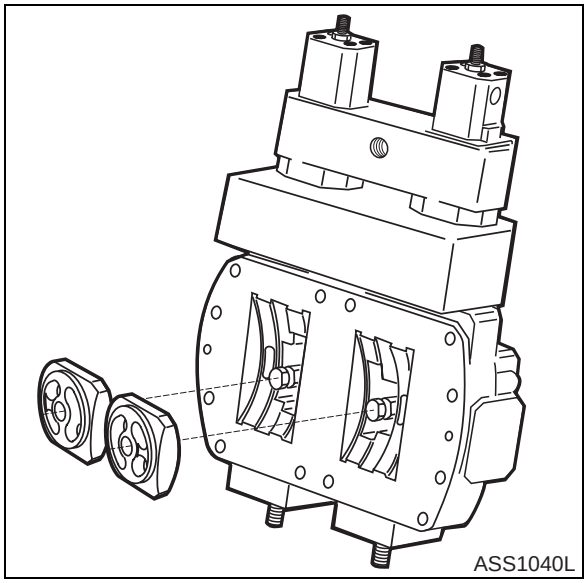


Figure 105

5. Install seal and controller.

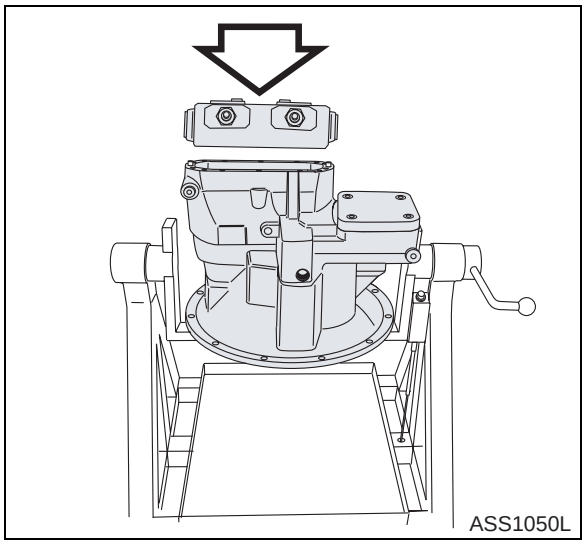


Figure 106

ASSEMBLY OF INTERMEDIATE WHEEL

1. Press bearing (1, Figure 107) into housing.
2. Install and align intermediate wheel (2, Figure 107) through side drive opening.
3. Cool down bolt (3, Figure 107) with nitrogen and install it.
4. Press in bearing (4, Figure 107).

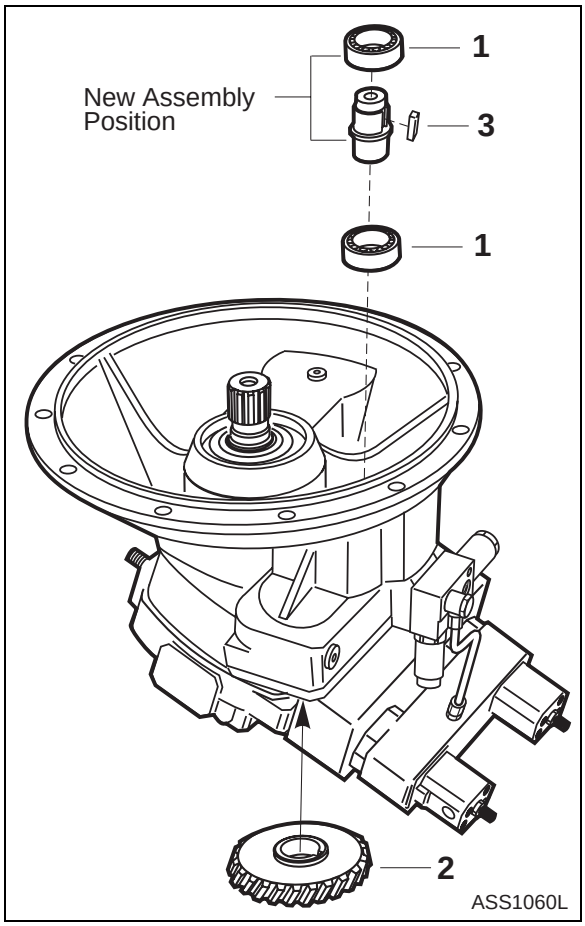


Figure 107

5. Press bearing into housing.

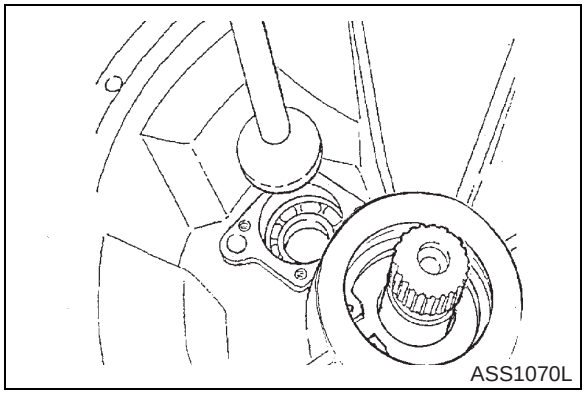


Figure 108

INSTALLATION OF GEAR PUMP

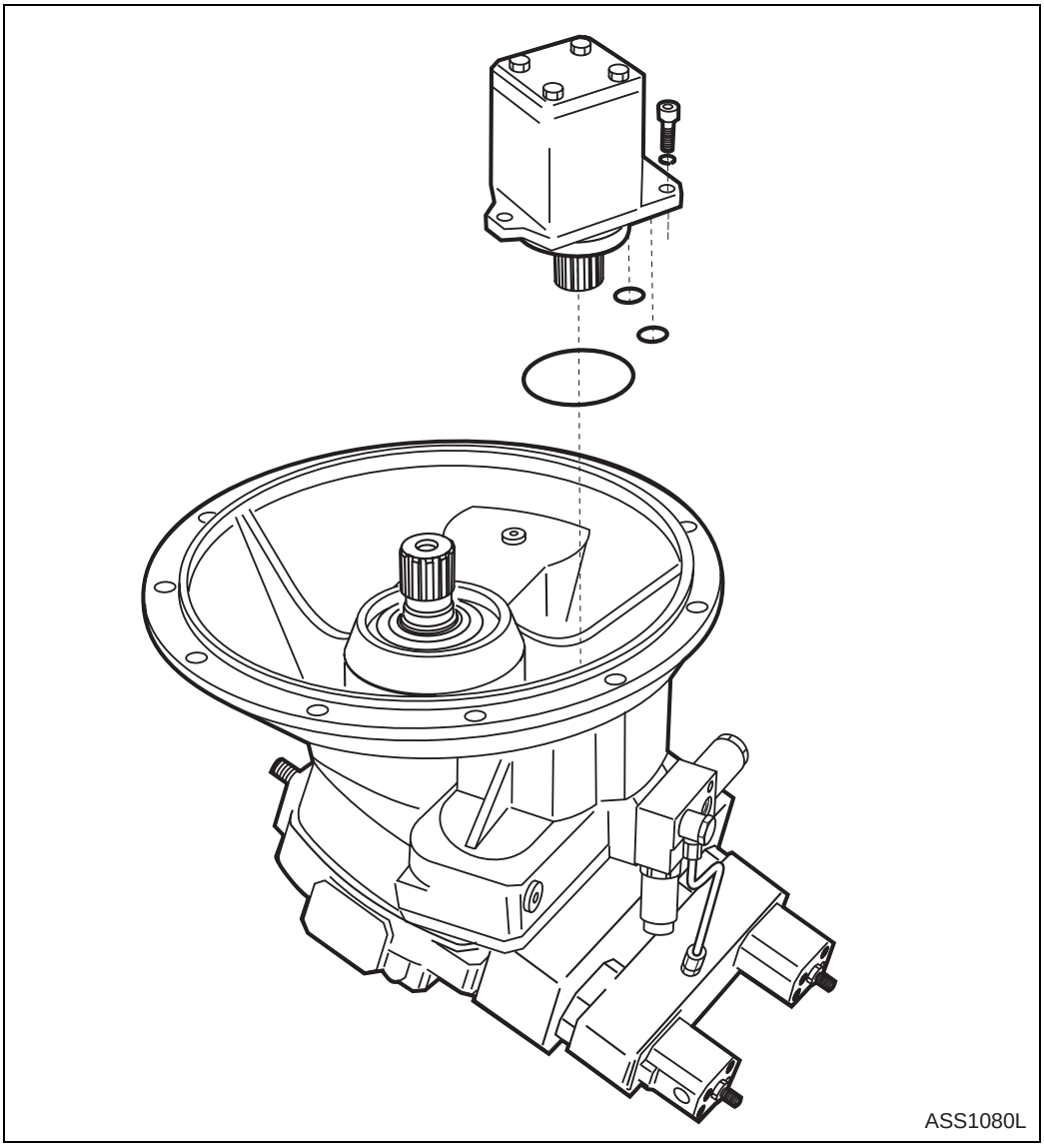


Figure 109

1. Assemble shaft seal, disc and safety ring. Press-in with assemble sleeve.

   NOTE: *Take care of press-in depth!*

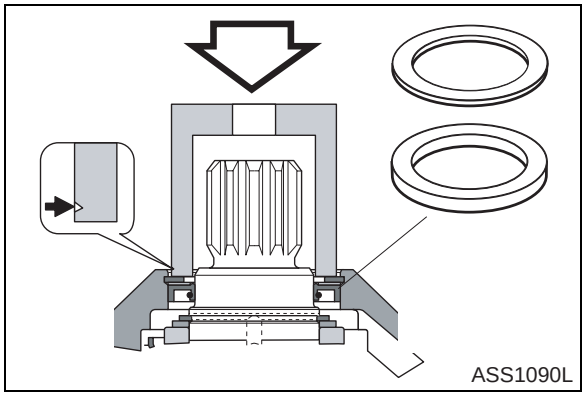


Figure 110

INSTALLATION OF COVER / AUXILIARY DRIVE

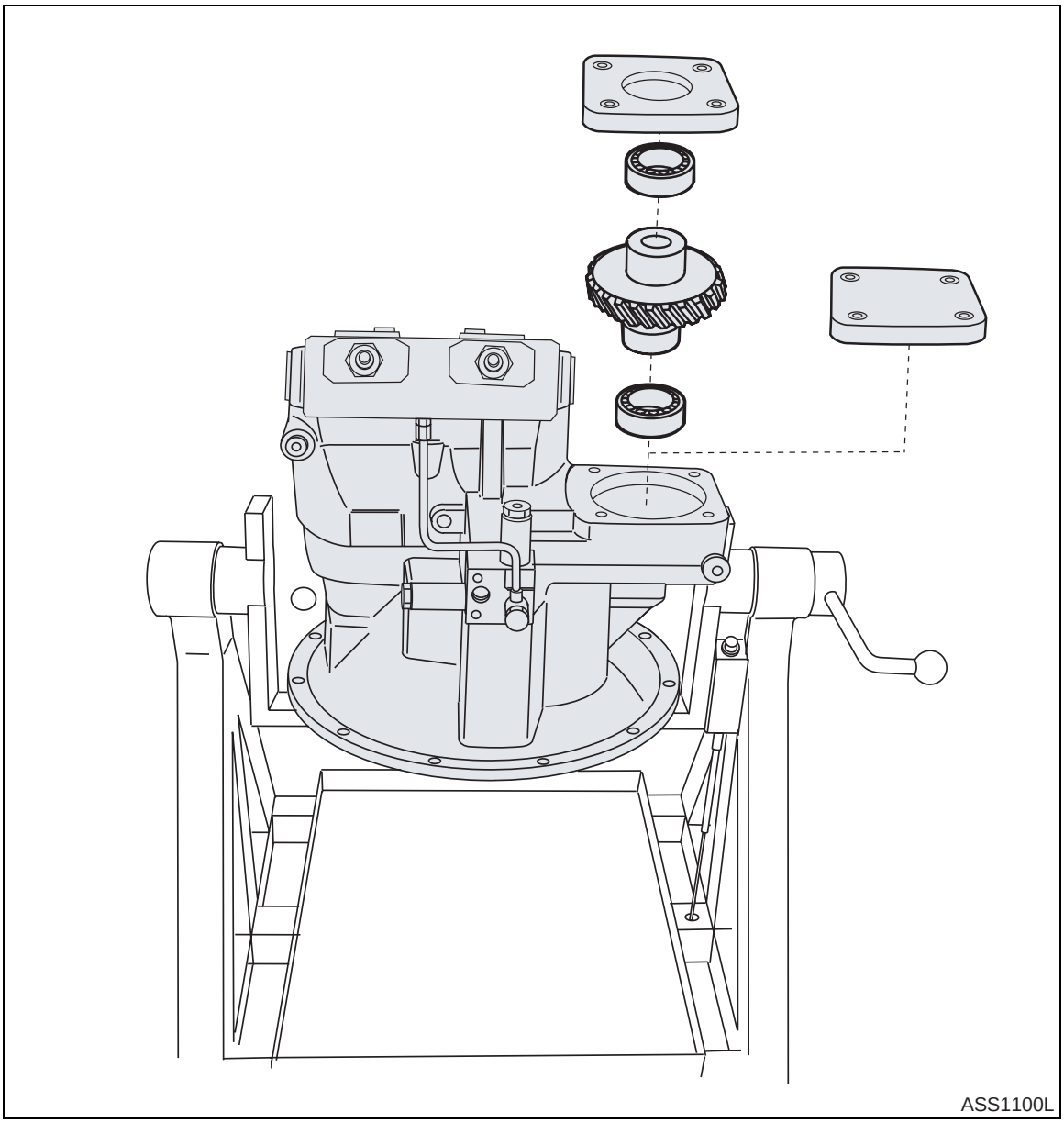


Figure 111

ASSEMBLY GUIDELINES FOR TIGHTENING TORQUES

BOLTS (TO N 08.001)

Values stated are valid for bolts with metric ISO threads to DIN 13 part 13, as well as head areas to DIN 912 socked head cap screws, DIN 931 hexagon bolt or DIN 933 hexagon bolts with threads up to the head.

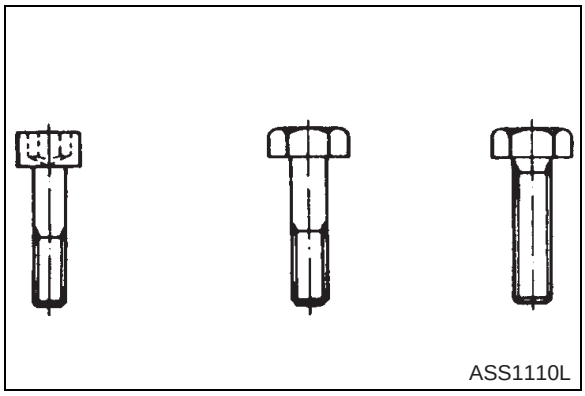


Figure 112

Thread	Tensile Strength Class		
	8.8	10.9	12.9
	Tightening Torque M_A In Nm		
M 3	1.1	1.6	1.9
M 4	3.1	4.5	5.3
M 5	6.1	8.9	10.4
M 6	10.4	15.5	18
M 8	25	37	43
M 10	51	75	87
M 12	87	130	150
M 14	140	205	240
M 16	215	310	370
M 18	300	430	510
M 20	430	620	720
M 22	480	830	970
M 24	740	1060	1240

PLUGS WITH INTERNAL HEXAGON AND PROFILE SEAL RING (TO N 02.009).

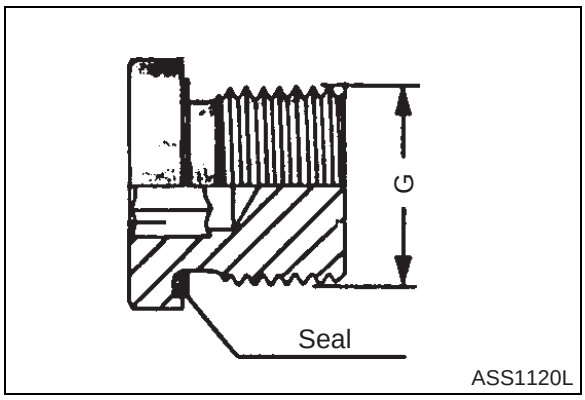


Figure 113

Thread	Tightening Torque M_A In Nm	Thread	Tightening Torque M_A In Nm
M8 x 1	5	G 1/8 A	10
M10 x 1	10	G 1/4 A	30
M12 x 1.5	20	G 3/8 A	35
M14 x 1.5	30	G 1/2 A	60
M16 x 1.5	35	G 3/4 A	90
M18 x 1.5	40	G 1 A	140
M20 x 1.5	50	G 1 1/4 A	240
M22 x 1.5	60	G 1 1/2 A	300
M26 x 1.5	70		
M27 x 2	90		
M30 x 1.5	100		
M33 x 2	140		
M42 x 2	240		
M48 x 2	300		

SEAL-LOCK - SEALING NUTS (TO N 02.100)

Thread	Tightening Torque M_A In Nm
M6	10
M6 x 0.5	11
M8	22
M8 x 1	24
M10	40
M10 x 1	44
M12	69
M12 x 1.5	72
M14	110
M14 x 1.5	120
M16	170
M16 x 1.5	180

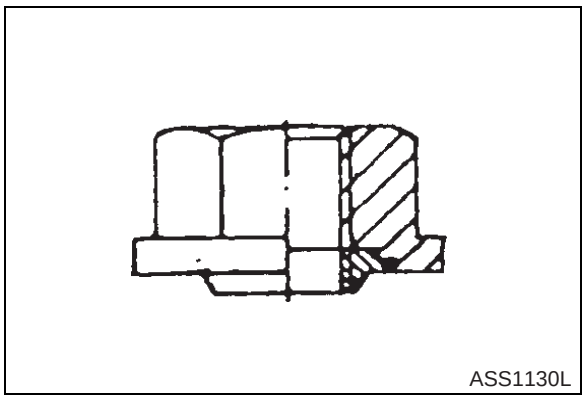


Figure 114

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

CONTROL VALVE (KAYABA MODEL KVMG-400-DA)

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 420LC-V	1001 and Up
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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May 2002

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GENERAL DESCRIPTION

WHEN ALL SPOOLS ARE IN NEUTRAL

Neutral Passage (Figure 1 and Figure 2)

1. Oil supplied to port (P1) flows through neutral passage (L1) to low pressure relief valve throttle (Lc1), to tank passage (Ta), and returns to ports (T1 and T3).
2. Oil supplied to port (P2) flows through neutral passage (R1), to low pressure relief valve throttle (Rc1), to tank passage (Ta), and returns to ports (T1 and T3).
3. The pressures of low pressure relief valve chambers (L2 and R2) reach through ports (Ps1 and Ps2) to pumps, and control displacement of pumps (P1 and P2).
4. If too much oil flows into neutral passages, low pressure relief valves are activated, and protect ports (Ps1 and Ps2) from rising pressures.

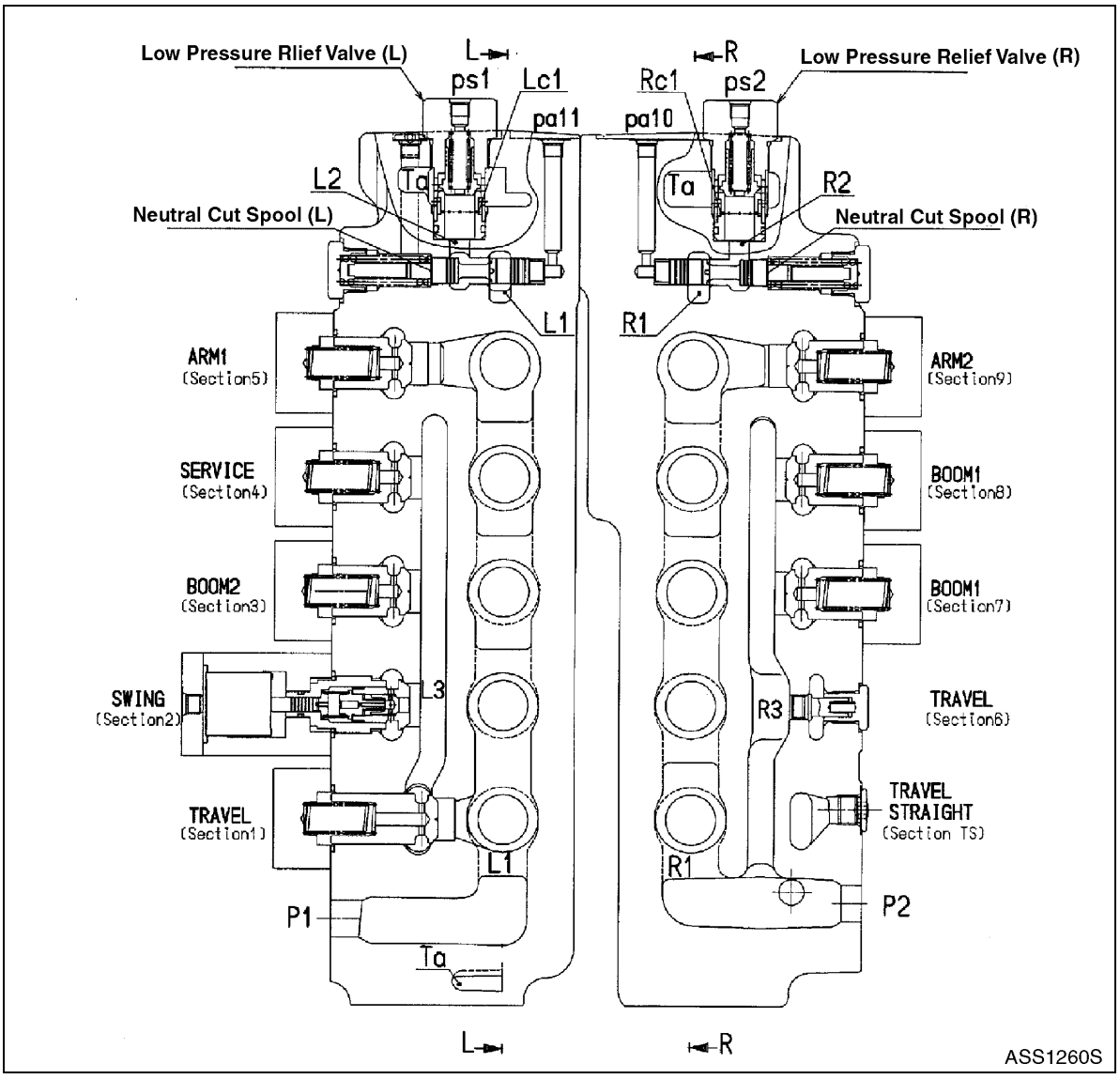

Low Pressure Rlief Valve (L)
L
ps1
Lc1
pa11
Rc1
pa10
ps2
R
Low Pressure Relief Valve (R)
L2
Ta
Ta
R2
Neutral Cut Spool (L)
Neutral Cut Spool (R)
L1
R1
ARM1
(Section5)
ARM2
(Section9)
SERVICE
(Section4)
BOOM1
(Section8)
BOOM2
(Section3)
BOOM1
(Section7)
SWING
(Section2)
L3
R3
TRAVEL
(Section6)
TRAVEL
(Section1)
TRAVEL
STRAIGHT
(Section TS)
L1
R1
P1
P2
Ta
L
R
ASS1260S

Figure 1

Signal Passage (Figure 2)

1. Oil supplied to port (PP, Figure 2), after passing through orifice (Lc3), is divided into two flows. One flow is sent to port (PT), and the other flows through land (Lc4) and passage (5) to land (Rc3) and into tank passage (Ta).
2. The same oil supplied from port (PP), after passing through orifice (Lc5), flows partly to port (PA) and passes partly through passages (L4), (8) and (R4), to boom spool 1 land (Rc4) and flows into tank passage (Ta).
3. The oil passing through orifice (Lc6) flows partly from land (Lc7), to tank passage (Ta), and passes partly through passage (4) to travel spool land (Rc5) and flows into tank passage (Ta).

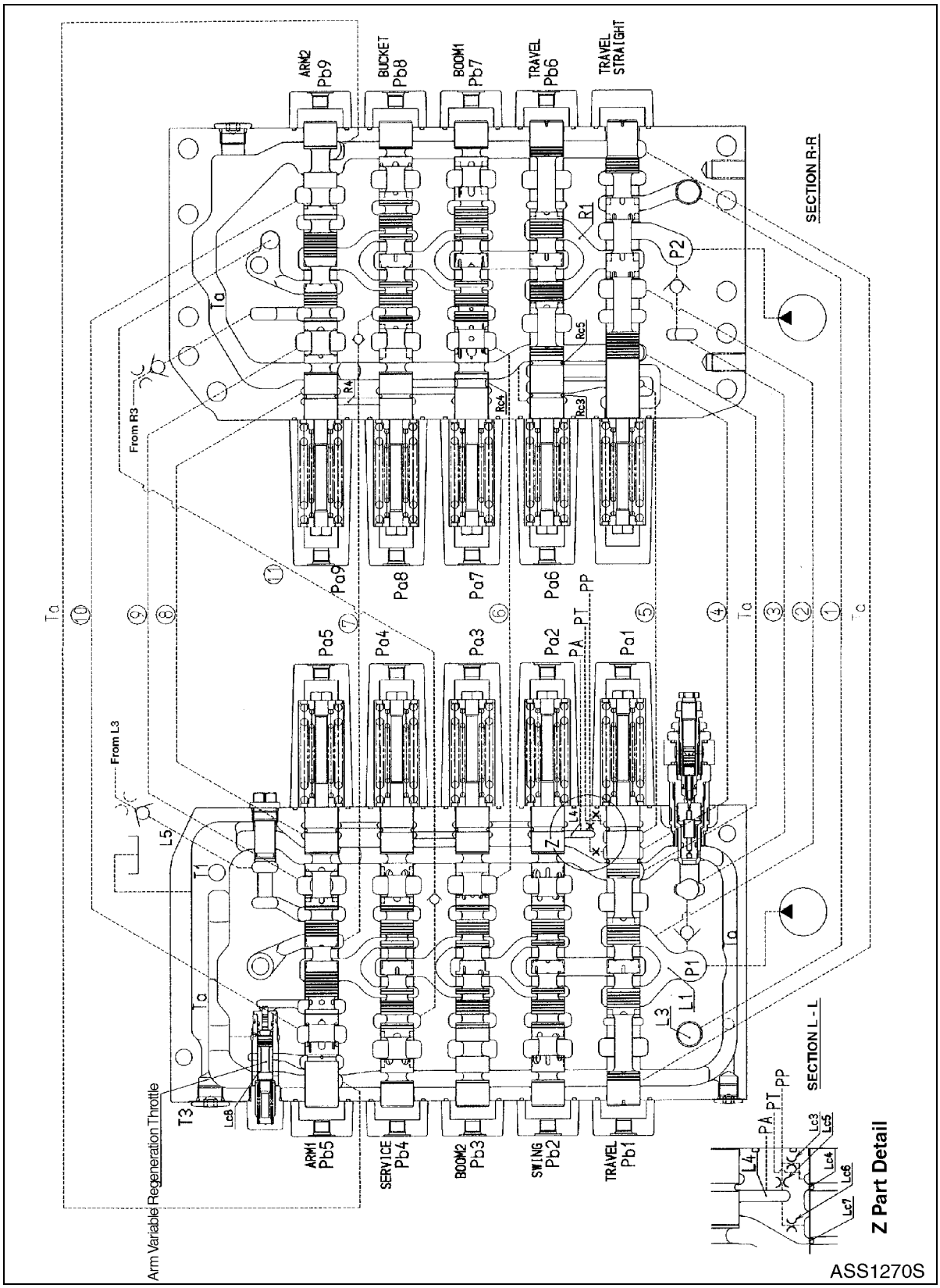

ARM2 Pb9
BUCKET Pb8
BOOM1 Pb7
TRAVEL Pb6
TRAVEL STRAIGHT
SECTION R-R
From R3
From L3
Arm Variable Regeneration Throttle
ARM1 Pb5
SERVICE Pb4
BOOM2 Pb3
SWING Pb2
TRAVEL Pb1
SECTION L - L
Z Part Detail
ASS1270S

Figure 2

SINGLE OPERATION

Travel Spool Shifting (Figure 3 and Figure 4)

1. 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).
2. 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), and spool, to passage (S6-1) and flows to port (B6 (A6)). At this time poppet (S6-2) is not opened because parallel passage (R3) pressure equals passage pressure (S6-1). Return oil flows through port (A6 (b6)) to spool and returns to tank passage (Ta).
3. 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 that pressure at port (PT) rises.

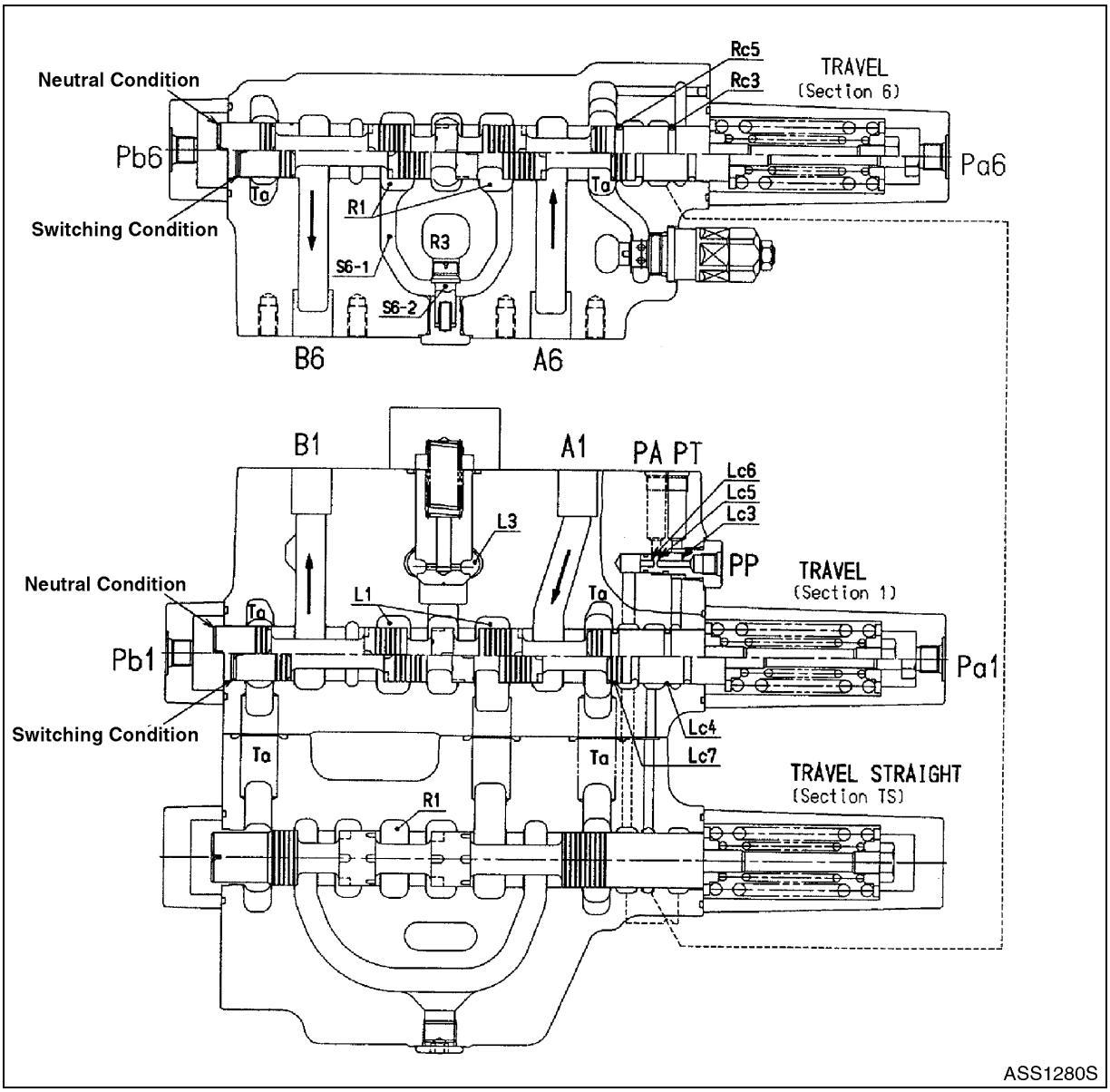

Neutral Condition
Switching Condition
Pb6
Pa6
Rc5
Rc3
TRAVEL
(Section 6)
Ta
R1
R3
S6-1
S6-2
B6
A6
B1
A1
PA PT
Lc6
Lc5
Lc3
L3
PP
TRAVEL
(Section 1)
L1
Pb1
Pa1
Lc4
Lc7
TRAVEL STRAIGHT
(Section TS)
ASS1280S

Figure 3

Swing Spool Shifting (Figure 4)

1. When shifting swing spool by increasing pressure of swing (section 2) pilot port (Pb2 (Pa2)), neutral port (L1) is closed. Oil supplied to port (P1) flows through, parallel passage (L3), load check valve (S2-1), and spool to port (B2 (A2)). Return oil flows through port (A2 (B2)), to spool, and returns to tank passage (Ta).

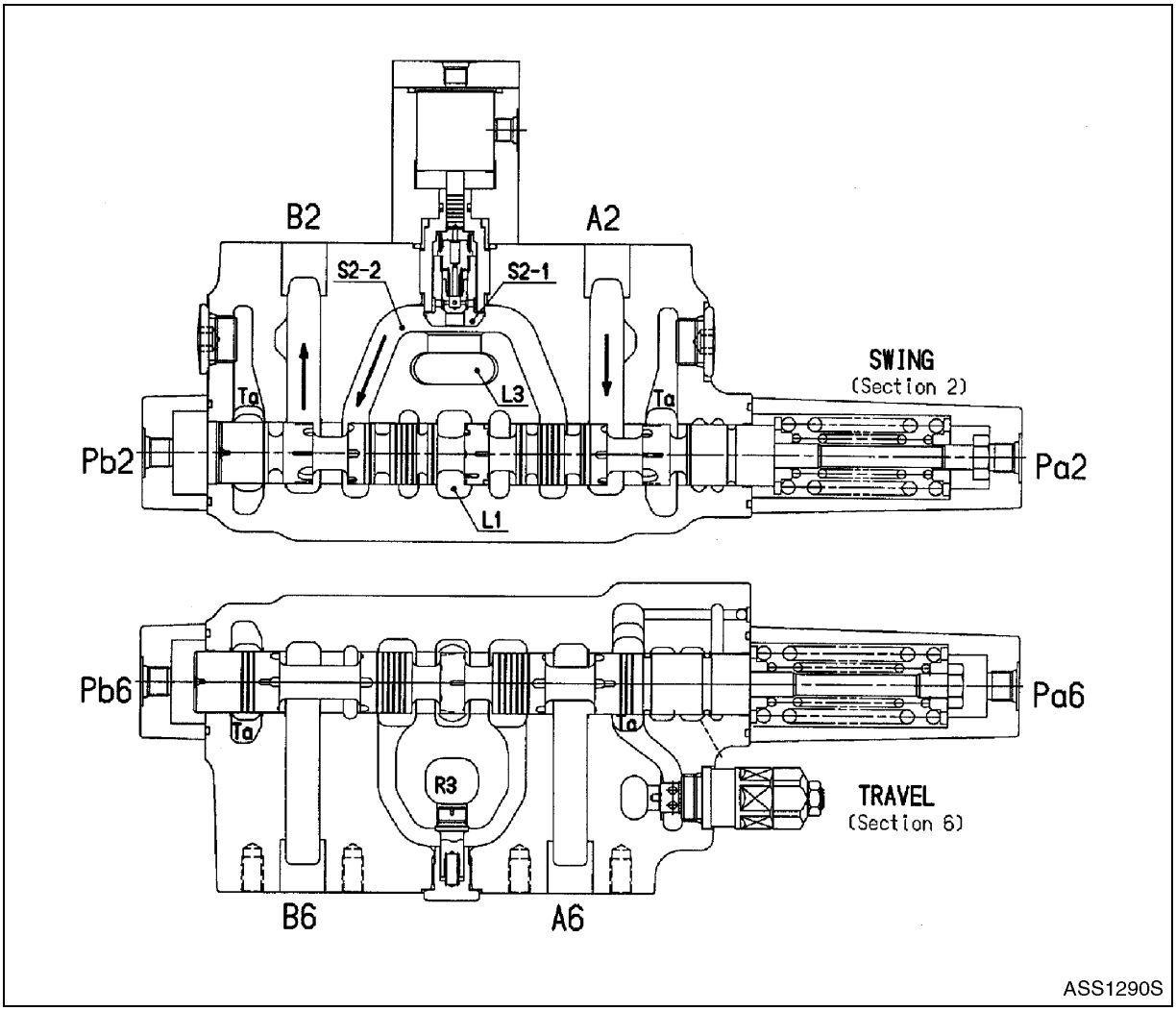


Figure 4

Boom Spool Shifting

1. Neutral (Figure 5)

   This valve also works with anti drift valves that are installed on the bottom side of each boom cylinder.

   When in neutral, poppet (AD1) is closed by pressure from port (A7), that is sent through passage (AD2), spool (AD3), and passage (AD4) to poppet (AD1).

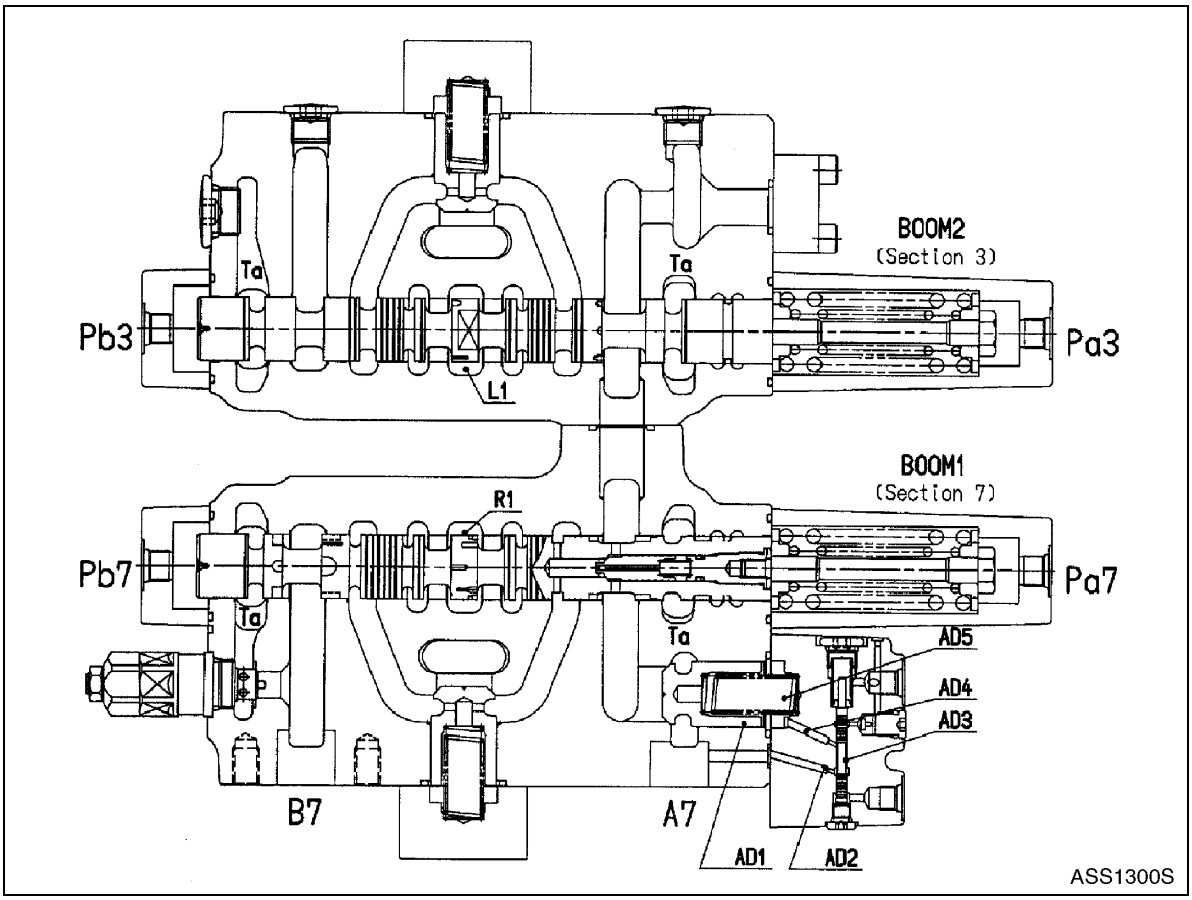


Figure 5 Neutral Condition

2. Boom up (2 speed junction) (Figure 6)

When boom spool 1 (section 7) is shifted by increasing pressure of boom 1 pilot port (Pa7), neutral passage (R1) is closed. Oil supplied to port (P2) flows through parallel passage (R3), and load check valve (S7-1), to spool and flows into port (A7). When boom 2 (section 3) spool is shifted by increasing pressure of boom 2 pilot port (Pa3) also, neutral passage (L1) is closed. Oil supplied to port (P1) flows through parallel passage (L3), load check valve (S3-1), and spool to passage (6) and it then joins at port (A7). Return oil flows through port (B7) to spool and returns to tank passage (Ta).

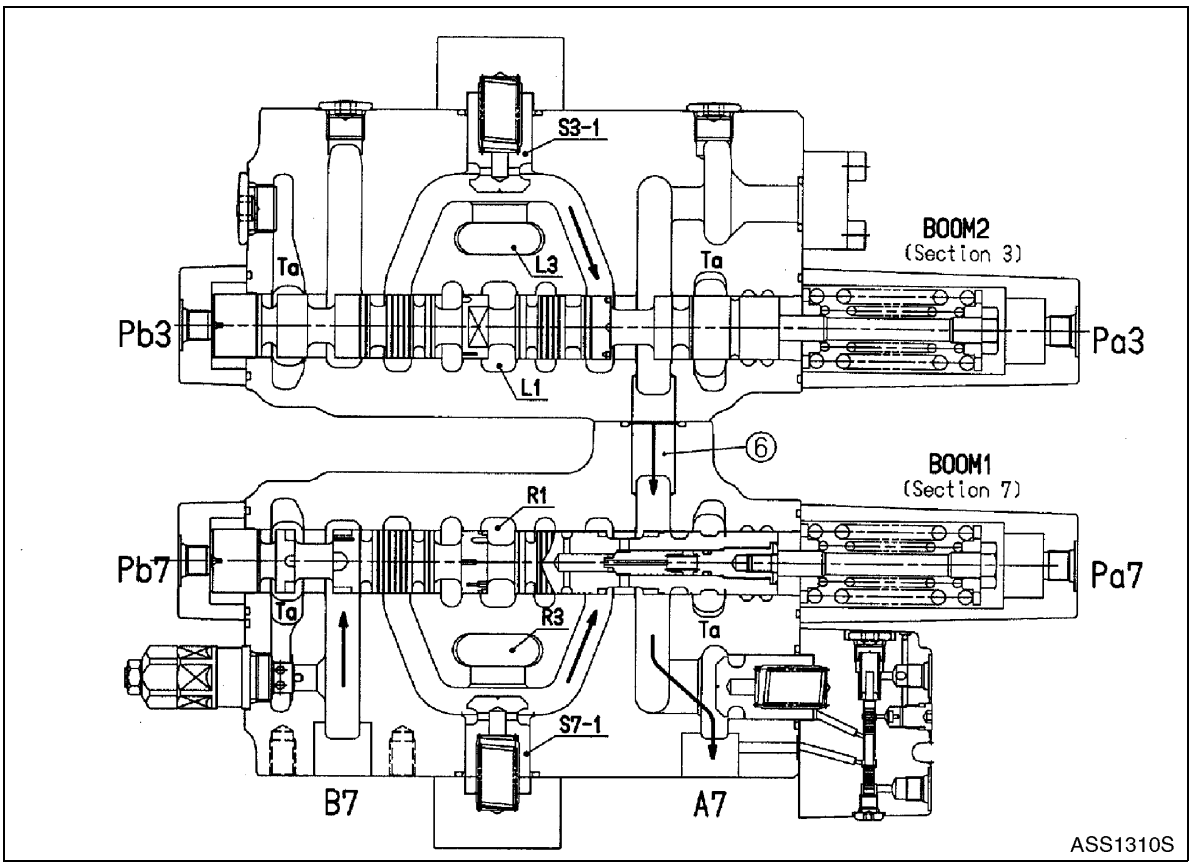


Figure 6 Boom Up

3. Boom down (regeneration) (Figure 7)

When boom spool 1 (section 7) is shifted by increasing pressure of boom 1 pilot port (Pb7), neutral passage (R1) is closed. Oil supplied to port (P2), flows through parallel passage (R3), and load check valve (S7-1), to spool, and flows into port (B7). When spool (AD3) of anti drift valve is shifted by increasing pressure of port (Pc2) also, poppet (AD1) is opened by decreasing of pressure in spring chamber (AD5), and return oil from port (B7) returns to tank passage. Some return oil opens poppet (S7-3), in boom 1 spool, flows through passage (S7-2), it then joins with port (B7), and prevents cavitation on cylinder rod side.

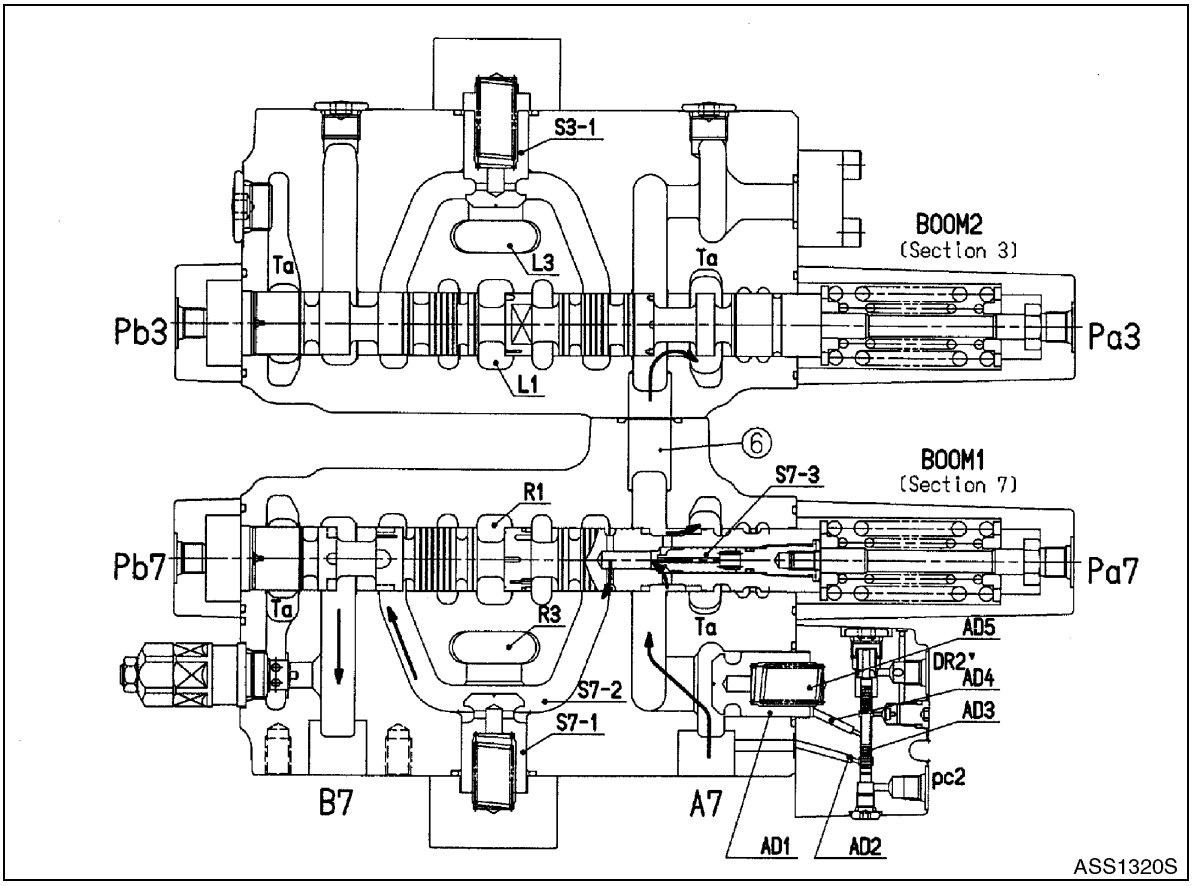


Figure 7 Boom Down

Spare Spool Shifting (Figure 8)

1. When spare spool is shifted by increasing pressure of spare (section 4) pilot port (Pb4 (Pa4)), neutral passage (L1) is closed. Oil supplied to port (P1) flows through, parallel passage (L3), load check valve (S4-1), passage (S4-2), and spool, into port (B4 (A4)). When neutral-cut spool (R) is shifted by increasing pressure of port (pa10) (Figure 1) also, oil supplied from port (P2) flows through passage (11), and poppet (S4-3), it then joins with passage (S4-2). Return oil returns through port (A4 (B4)) and spool to tank passage (Ta).

Bucket Spool Shifting (Figure 8)

1. When bucket spool is shifted by increasing pressure of bucket (section 8) pilot port (Pb8 (Pa8)), neutral passage (R1) is closed. Oil supplied to port (P2), flows through, parallel passage (R3), load check valve (S8-1), passage (S8-2), and spool, into port (B8 (A8)). When neutral-cut spool (L) is shifted by increasing pressure of port (Pa11) (Figure 1) also, oil supplied from port (P1) flows through passage (7) and poppet (S8-3), it then joins with passage (S8-2). Return oil returns through port (A8 (B8)) and spool to tank passage (Ta).

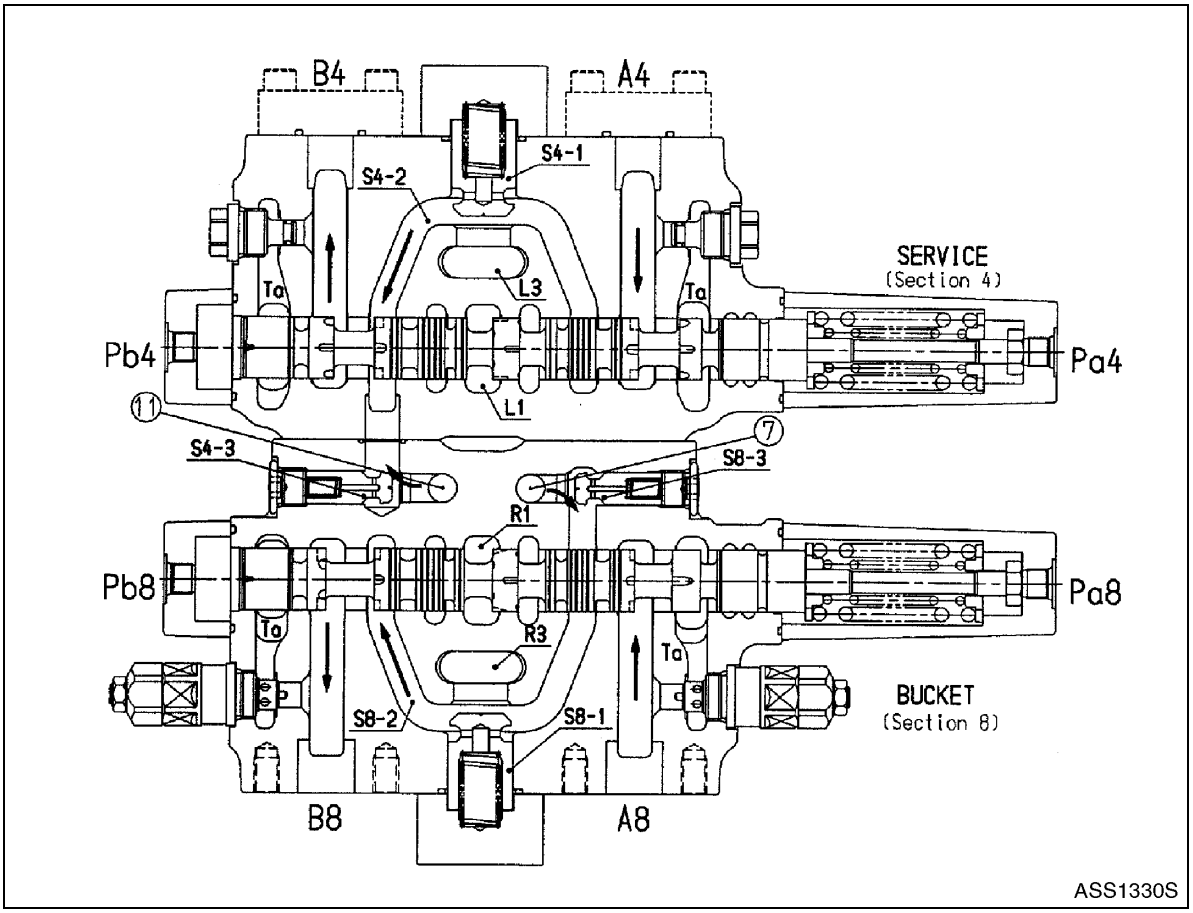


Figure 8

Arm Spool Shifting

1. Arm dump (2 speed junction) (Figure 9)

   When arm spool 1 is shifted by increasing pressure of arm 1 (section 5) pilot port (Pb5), oil supplied from port (P1) flows through, neutral passage (L1), load check valve (S5-1), passage (S5-2), and spool, into port (B5). When arm 2 spool is shifted by increasing pressure of arm 2 (section 9) pilot port (pb9) also, oil supplied from port (P2) flows through neutral passage (R1), load check valve (S9-1), passage (S9-2), spool, and passage (10), it then joins with port (B5). Return oil returns through port (A5) and spool to tank passage (Ta).

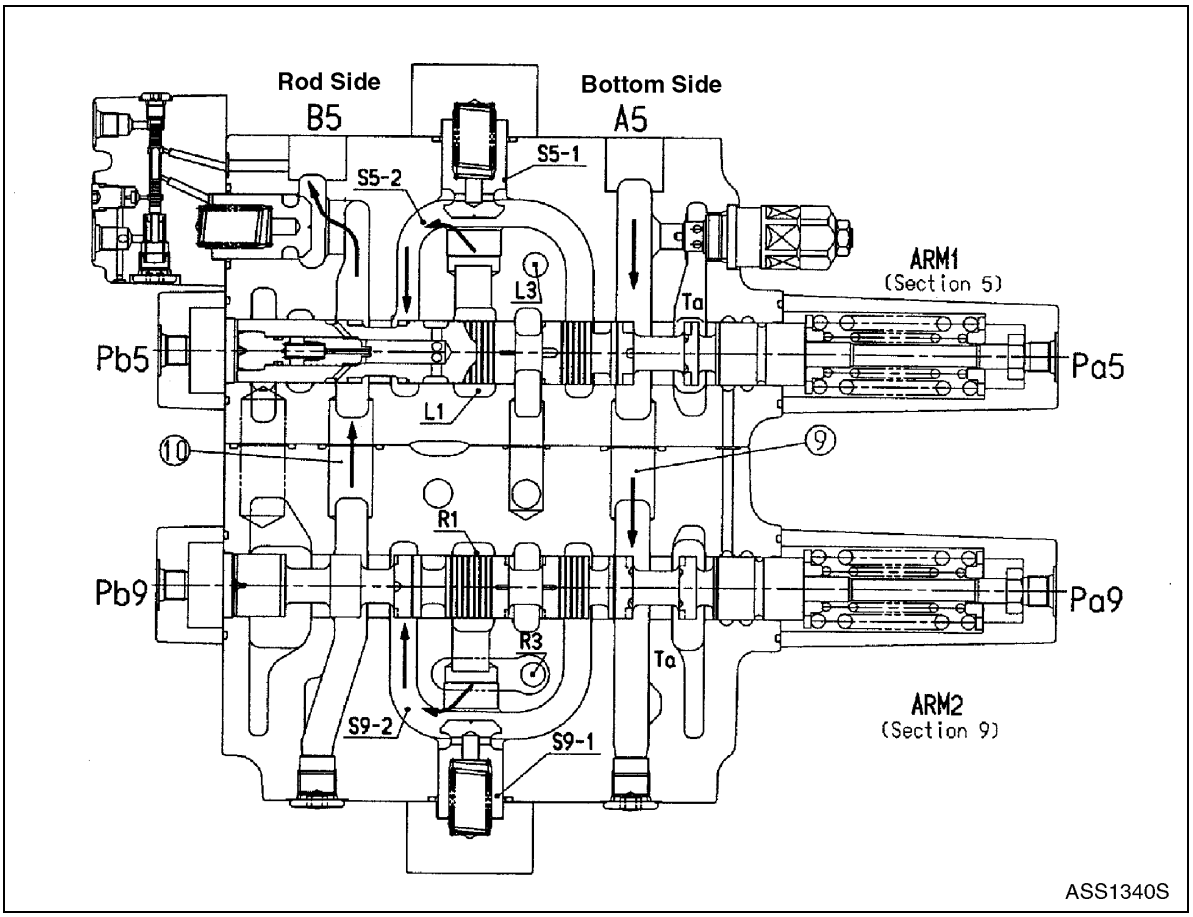


Figure 9 Dump

2. Arm crowd (2 speed junction)

   When arm spool 1 is shifted by increasing pressure of arm 1 (section 5) pilot port (Pa5), oil supplied from port (P1) flows through, neutral passage (L1), load check valve (S5-1), passage (S5-2), and spool, into port (A5). When arm 2 spool is shifted by increasing pressure of arm 2 (section 9) pilot port (pa9) also, oil supplied from port (P2) flows through neutral passage (R1), load check valve (S9-1), passage (S9-2), spool and passage (9), it then joins with port (A5). When spool (AD3) of anti drift valve is shifted by increasing pressure of port (pc1) also, poppet (AD1) is opened by decreasing of pressure of spring chamber (AD5), and return oil from port (B5) returned through spool, passage (S5-3) and arm variable regeneration throttle (Lc8) to tank passage (Ta). Some of return oil open poppet (S5-4) in boom 1 spool, flows through passage (S5-2), it then joins with port (A5), increases cylinder speed, and then prevents cavitation on cylinder bottom side.

3. Variable regeneration (when crowding) (Figure 10)

   When crowding arm, spool (S5-6) is stroked according to pressure of passage (S5-2) connected to passage (S5-5), and opening size of arm variable regeneration throttle (Lc8) varies. When pressure of passage (S5-2) is high, stroke of spool (S5-6) is increased, so that opening size of throttle (Lc8) is increased. In contrary, when pressure of passage (S5-2) is low, stroke of spool (S5-6) is decreased, so that opening size of throttle (Lc8) is decreased. Therefore regeneration flow varies according to pressure of bottom of arm cylinder.

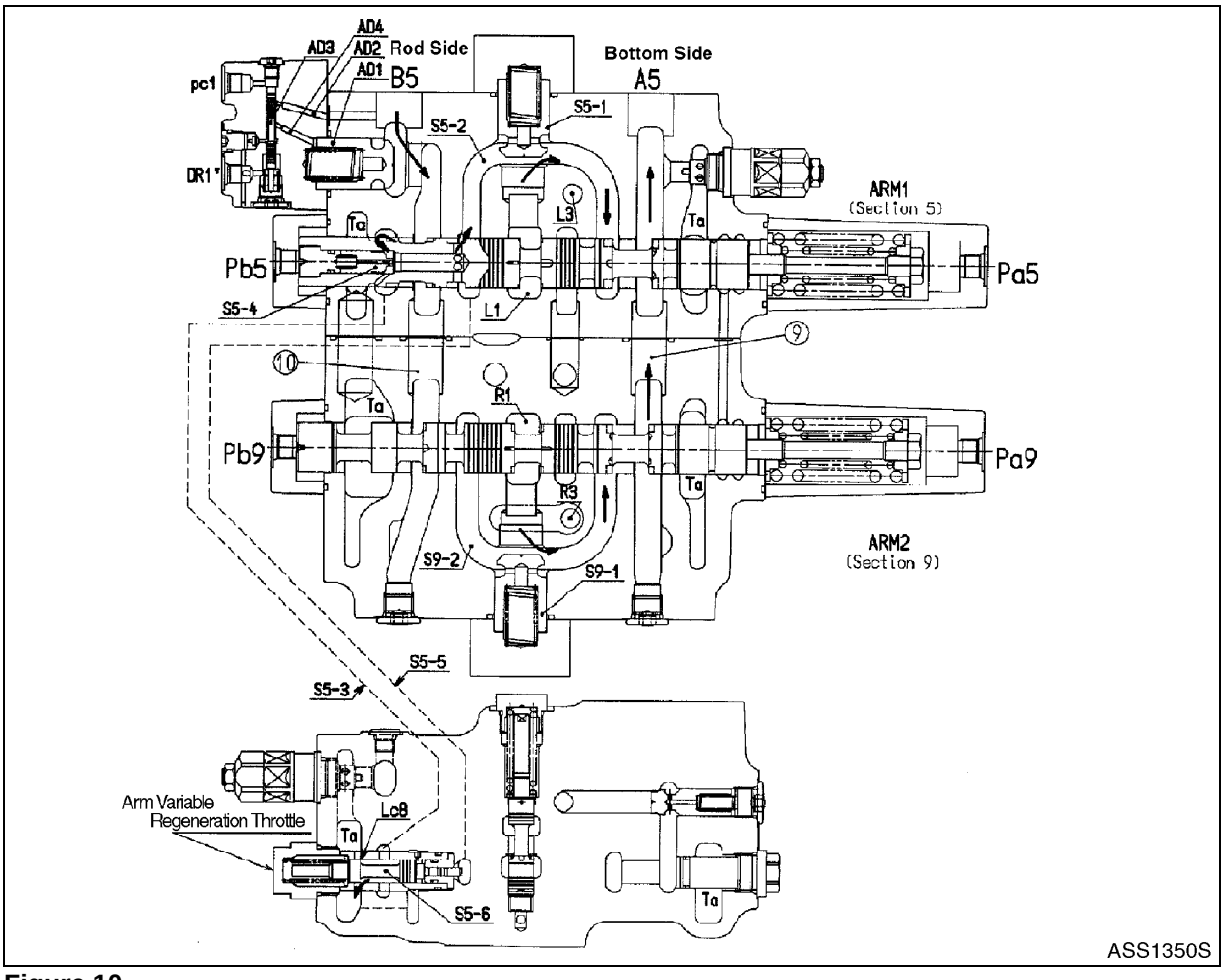


Figure 10

Neutral-cut Spool Shifting (Figure 11)

1. This valve has a neutral-cut spool that is installed in lowest flow side (the upper flow side of low pressure relief valve). When spool (L (R)) is shifted by increasing pressure of port (pa10 (pa11)), neutral passage (L1 (R1)) is closed. Oil supplied to port (P1) flows through passage (7) and poppet (S8-3, Figure 8), it then joins with bucket (section 8) passage (S8-2, Figure 8). Oil supplied to port (P2) flows through passage (11) and poppet (S4-3, Figure 8), it then joins with spare (section 4) passage (S4-2, Figure 8).

Parallel Throttle for Arm (Figure 11)

1. The throttle, that is installed in the parallel circuit for arm of this valve, one in each of arm 1 (section 5) and the arm 2 (section 9) prevents the arm speed from increasing during combined operation.
2. The parallel circuit of arm 2 (section 9), after narrowing at the throttle (Rc6) in poppet (S9-3) allows oil from parallel passage (R3), to join with oil in passage (S9-2, Figure 11).
3. The parallel circuit of arm 1 (section 5), after narrowing at the throttle (Lc9) in poppet (S5-8) allows oil from parallel passage (L3), to join with oil in passage (S5-2, Figure 10).

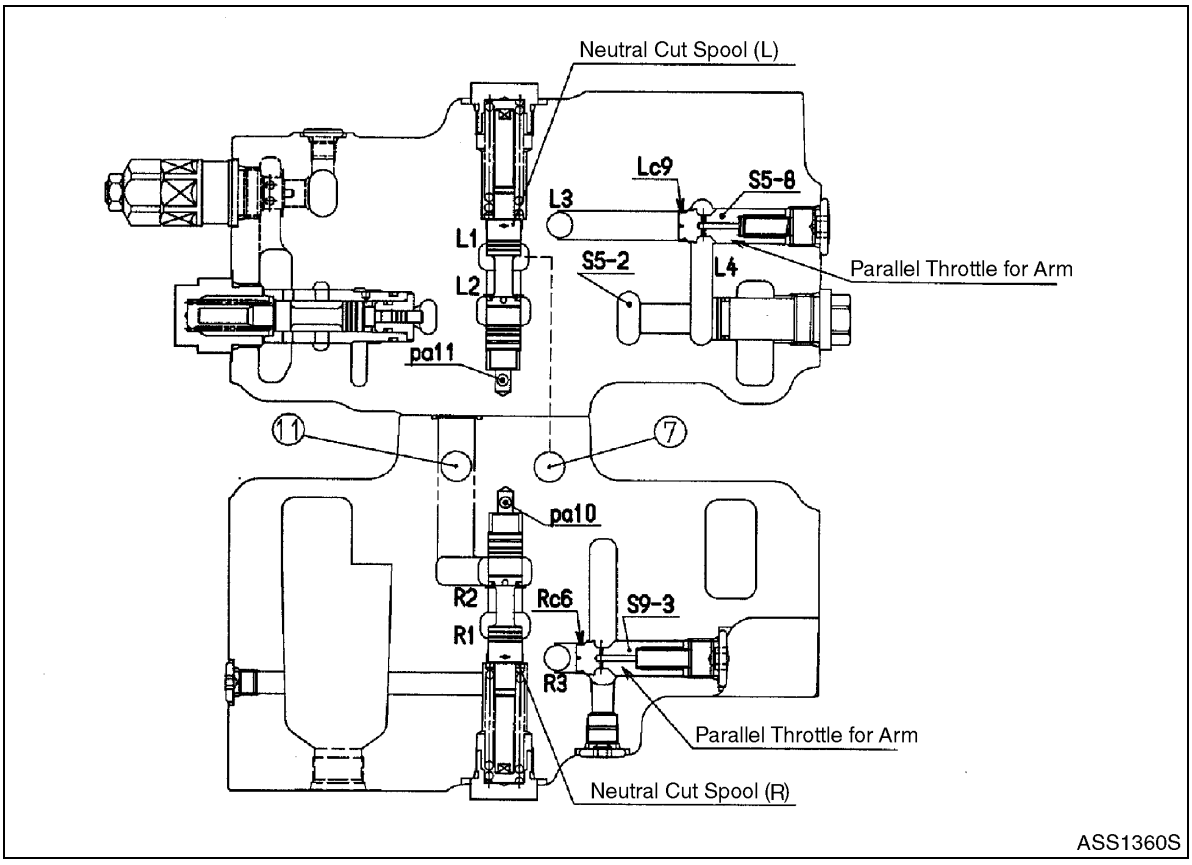


Figure 11

Relief Valve

1. Main relief valve (Figure 12)

   Oil supplied to port (P1) flows through poppet (LP), oil supplied from port (P2), flows through poppet (RP), and passage (3) also, it then joins with the main relief valve. The highest pressure of pump (P1) and (P2) is controlled by actuating of main relief valve.

2. Over load relief valve

   The over load relief valve, that is installed in each cylinder port of boom 1, arm 1 and bucket, prevent the actuator pressure from increasing to extremely high pressures by external forces.

   This relief valve, when pressure of cylinder port is a negative pressure, also has the function to prevent cavitation by drawing oil from the tank.

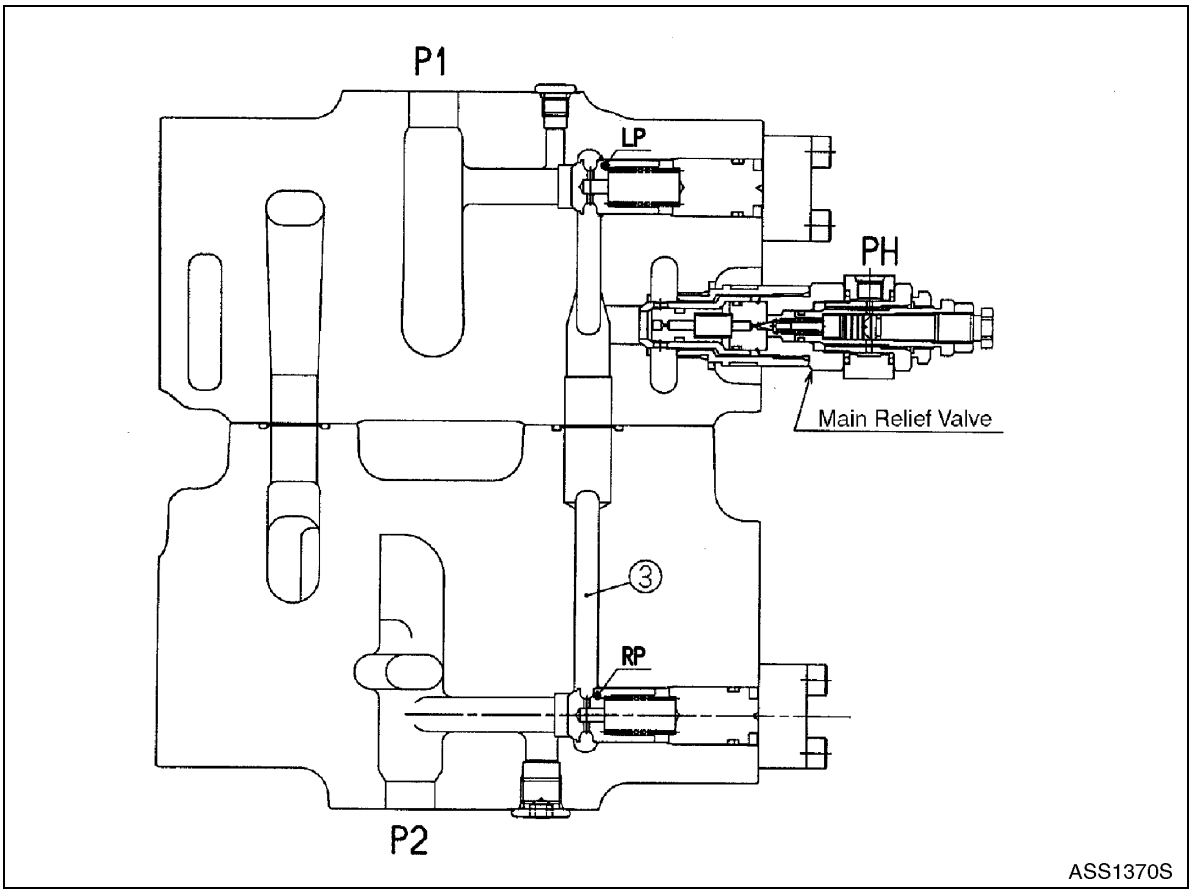


Figure 12

COMBINED OPERATION

Travel Combined Operation (Figure 13)

1. When applying simultaneously the operation except travel while travel left and right simultaneous operating (while forward traveling, backward traveling, or pivot turning) or when applying travel left and right simultaneous operating while applying the operation except travel, oil supplied from port (PP) is disconnected with the tank passage (Ta) at the signal land part of section of exception of travel shifted with the land (Lc4) (Lc7) (Rc3) (Rc5), and the pressure of signal passage increases up to the relief setting pressure of pressure source for signal.

   By increasing of signal pressure, the travel straight spool is shifted and the pressures of ports (PT) and (PA) increase.

   When travel straight spool is shifted, oil supplied from port (P1) flows through neutral passage (L1), to travel (section 1), and simultaneously flows through, passage (2), travel straight spool, and passage (R1), into travel (section 6). Oil supplied to port (P2) flows through, travel straight spool and passage (1) into parallel passage (L3).

   If the section load pressure except the travel is higher than the travel (section 6) load pressure, some oil supplied from port (P2) opens poppet (S6-2), it then joins through throttle in head of poppet with passage (S6-1).

   Because travel (section 1 and 6) is activated by oil supplied from port (P1) and the implement except the travel is activated by oil supplied from port (P2), when applying the combined operation with the travel left and right simultaneous operation and the implement operation except the travel, the travel is prevented from veering.

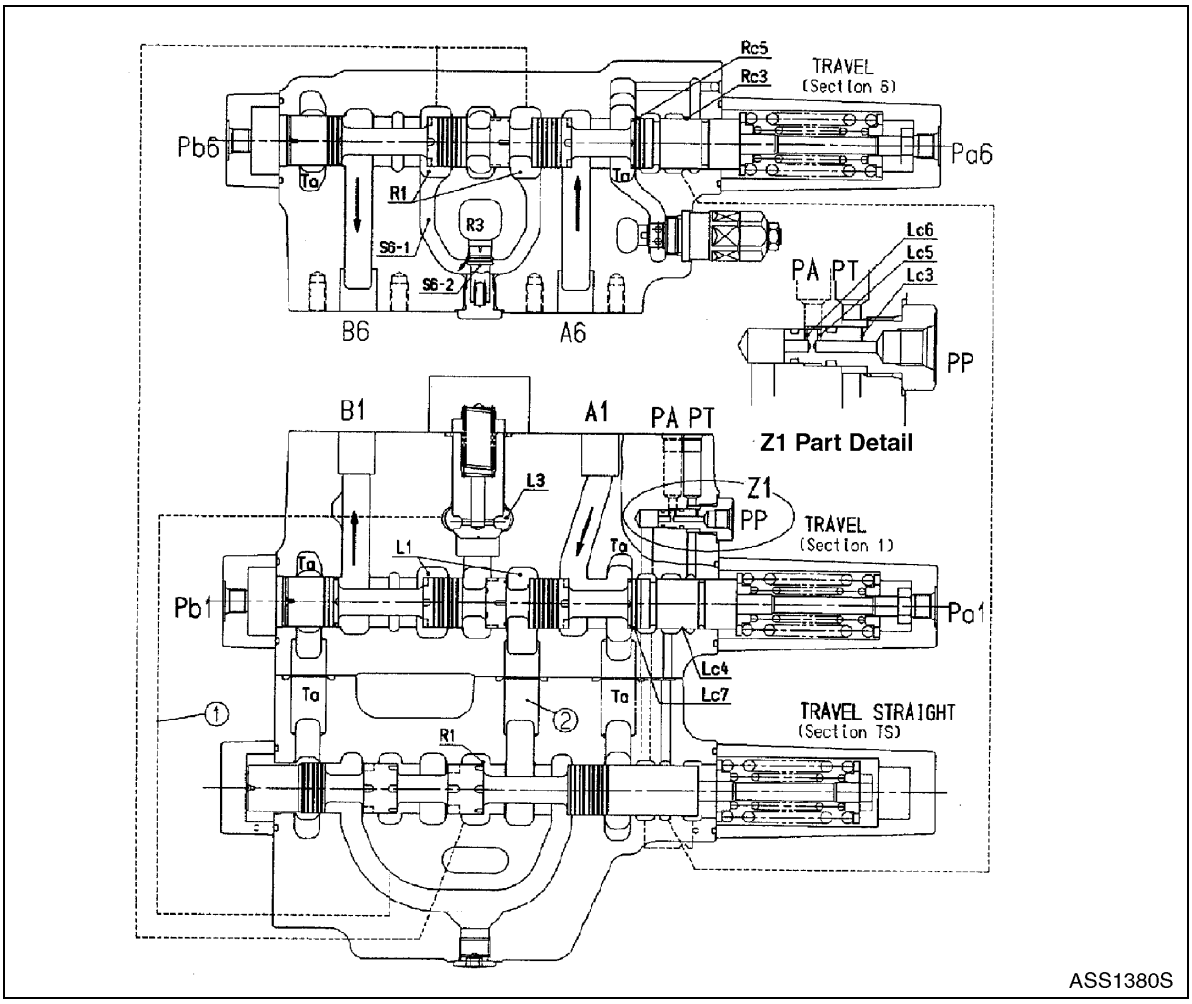

Rc5
Rc3
TRAVEL
(Section 5)
Pb6
Pa6
Ta
R1
R3
S6-1
S6-2
B6
A6
Lc6
Lc5
Lc3
PA PT
PP
Z1 Part Detail
B1
A1
PA PT
L3
Z1
PP
TRAVEL
(Section 1)
L1
Pb1
Pa1
Lc4
Lc7
TRAVEL STRAIGHT
(Section TS)
R1
ASS1380S

Figure 13

Swing Combined Operation (Figure 14)

1. When applying the combined operation with the swing and another implement, poppet (S2-1) is fixed by increasing port (pc6) pressure, poppet (S2-3) is opened, and pressure supplied to port (L3) is increased through throttle (S2-4). Accordingly, even in the case that the swing load pressure is low, the simultaneous operation character with the other implement can be secured.

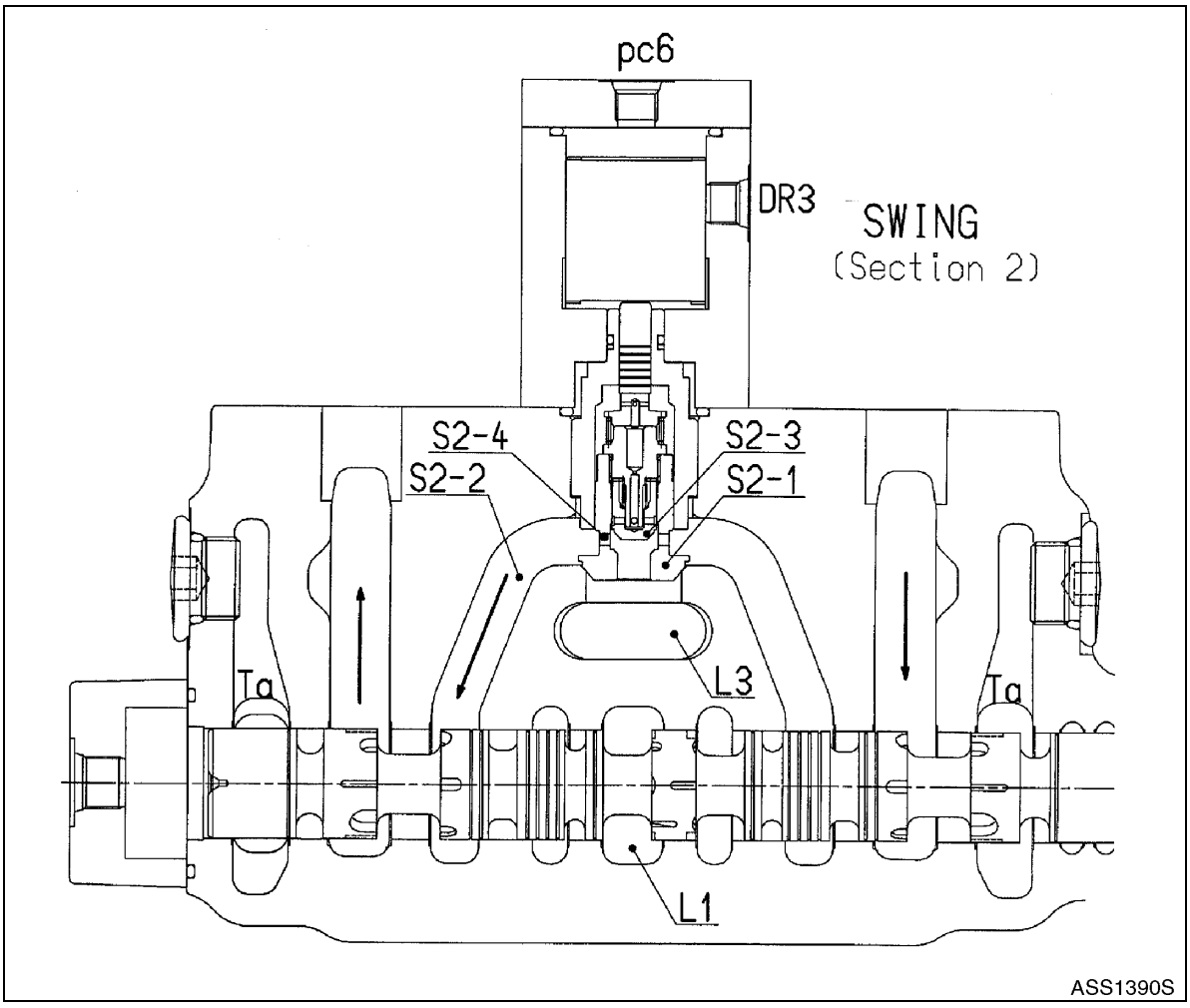


Figure 14

ANTI DRIFT VALVE

1. The anti drift valve is installed in the cylinder port of arm rod (boom bottom) side to prevent the arm (boom) cylinder from natural lowering.

   In neutral condition (Figure 15), cylinder port pressure is sent through passage (AD2), spool (AD3), and passage (AD4) to spring chamber (AD5).

   Poppet (AD1) is completely closed by spring strength or pressure differential due to difference of poppet sizes.

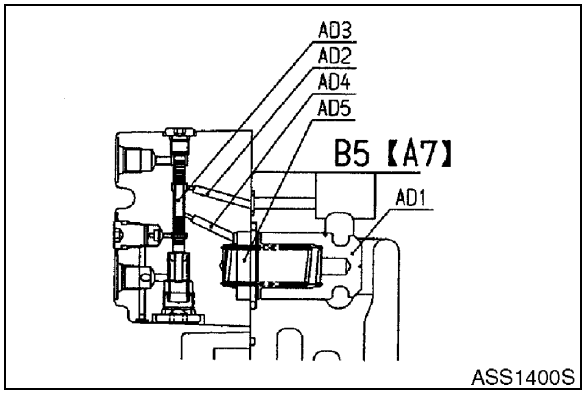


Figure 15 Neutral Condition

   When arm dumping (boom up) (Figure 16) oil supplied from pump opens poppet (AD1) it allows oil to flow to cylinder port.

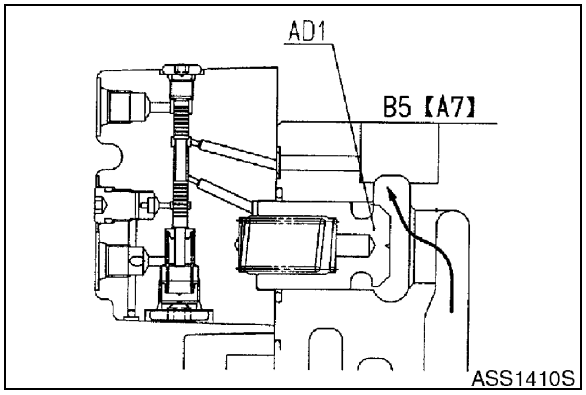


Figure 16 Arm Dump (Boom Up)

   When crowding arm (boom down) (Figure 17), spool (AD3) is shifted by increasing pressure of port (pc1 (pc2)), and oil in spring chamber (AD5) is allowed to flow through, passage (AD6) to drain port (DR1' (DR2')) This allows poppet (AD1) to open and let return oil flow into tank passage (Ta).

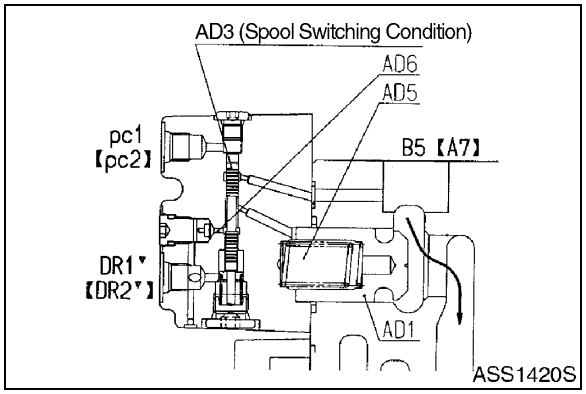


Figure 17 Arm Crowd (Boom Down)

MAIN RELIEF VALVE

1. The main relief valve is located between neutral oil passage (HP, Figure 18) 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).

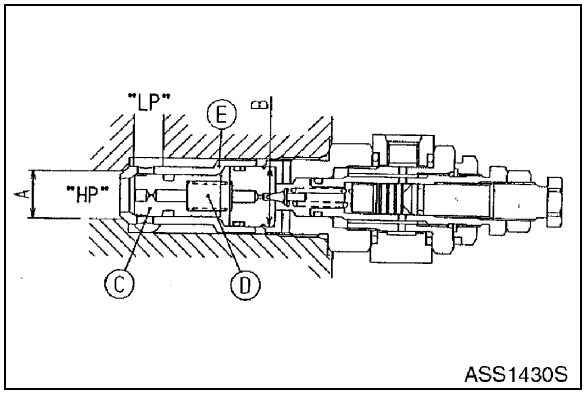


Figure 18

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).

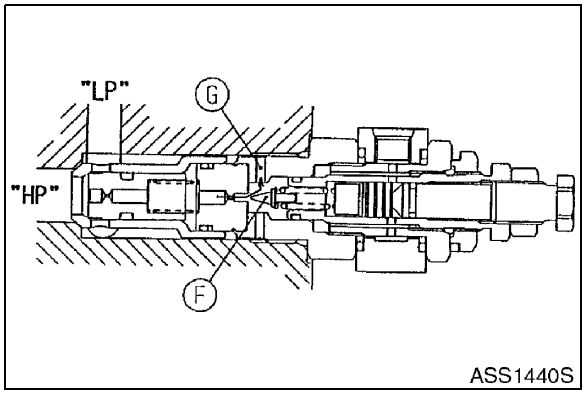


Figure 19

3. As pilot poppet (F) opens, pressure in internal cavity (D) lowers to move main poppet (C) so that pressurized oil flows into neutral oil passage (HP) and directly into low pressure oil passage (LP).

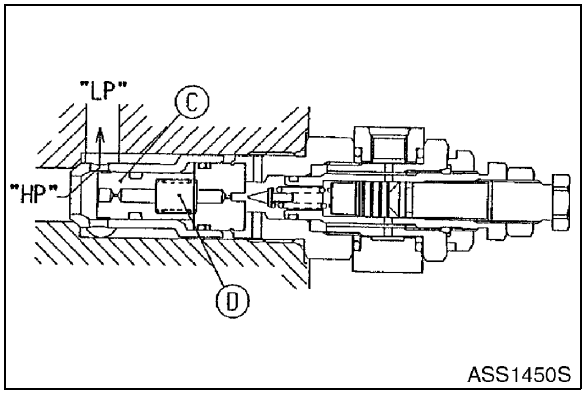


Figure 20

4. Pressure up operation

   When pressure at pilot port (Pi) is increased, piston (H) moves to the pressure setting position of plug (I) so that the force of spring increases, thus increasing pressure in the neutral oil passage (HP).

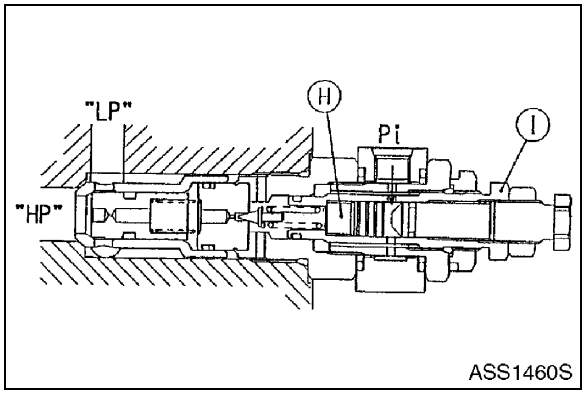


Figure 21

OVERLOAD RELIEF VALVE

1. The overload relief valve is located 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).

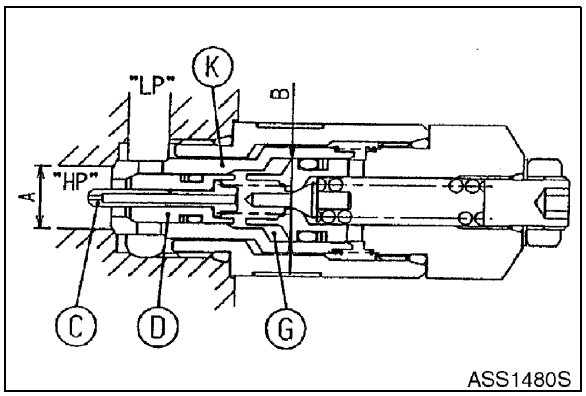


Figure 22

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).

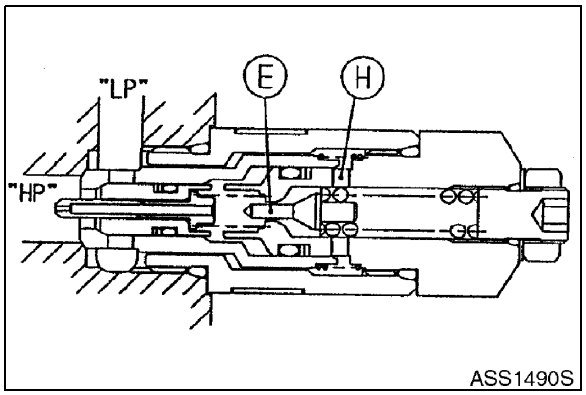


Figure 23

3. As pilot poppet (E) opens, pressurized oil flows through orifice (I) so that pressure on back of piston (C) lowers to move piston (C). As a result, piston (C) seats on pilot poppet (E).

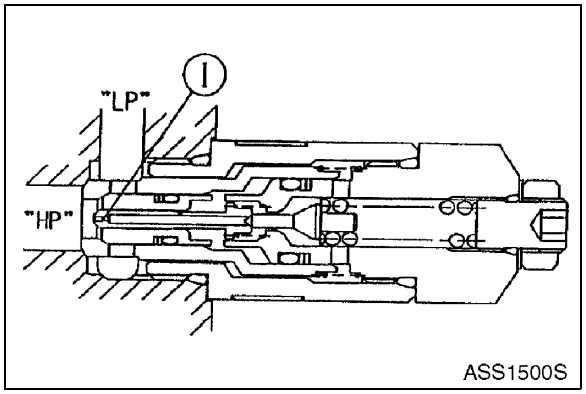


Figure 24

4. Pressurized oil in passage (HP) flows through orifice (F) in piston (C) so that pressure on back of main poppet (D) moves main poppet (D). Pressurized oil then flows into passage (HP) and directly into passage (LP).

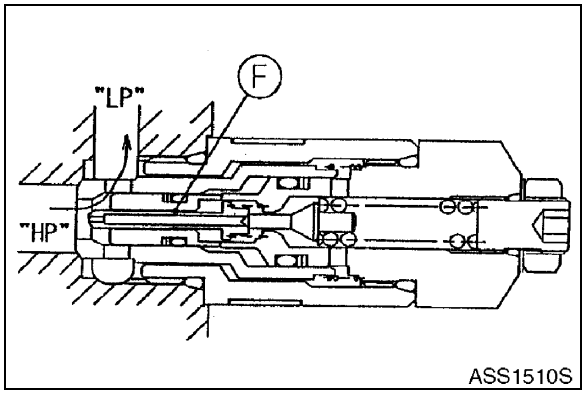


Figure 25

5. Sucking operation

An anti void 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 that oil is supplied from the low pressure oil passage (LP) to cylinder port (HP) to eliminate cavitation.

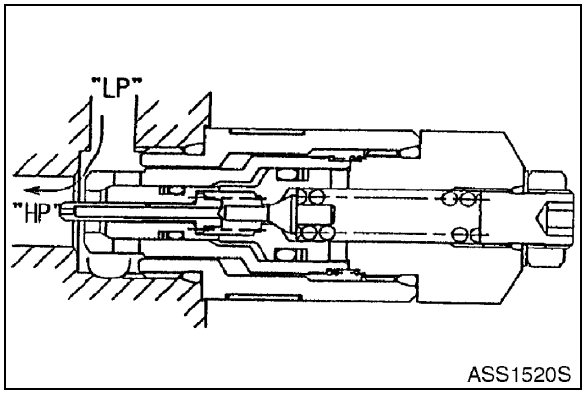


Figure 26

LOW PRESSURE RELIEF VALVE

1. When oil does not pass

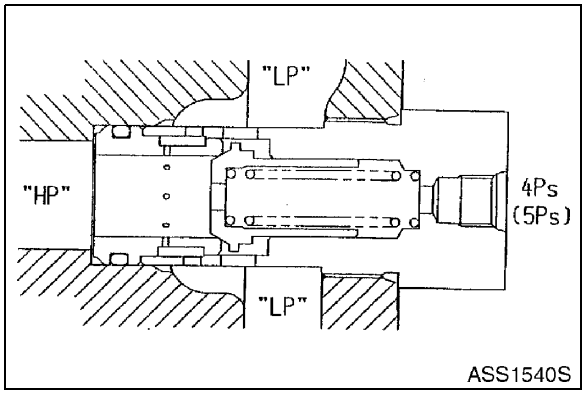


Figure 27

2. When spool is in neutral

Oil in neutral oil passage (HP) flows through signal orifice (A) into low pressure oil passage (LP). The pressure of the signal port (4Ps (5Ps)) increases by the negacon signal orifice (A).

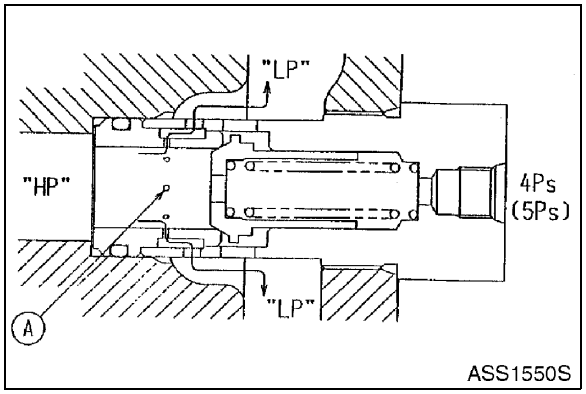


Figure 28

3. Low pressure relief valve operation

When the excessive quantities of oil in the neutral oil passage (HP) flow, pressure in neutral oil passage (HP) exceeds spring setting pressure (C). This causes poppet (B) to open. Oil then flows from neutral oil passage (HP) into low pressure oil passage (LP) so excessive pressure is prevented in neutral oil passage (HP).

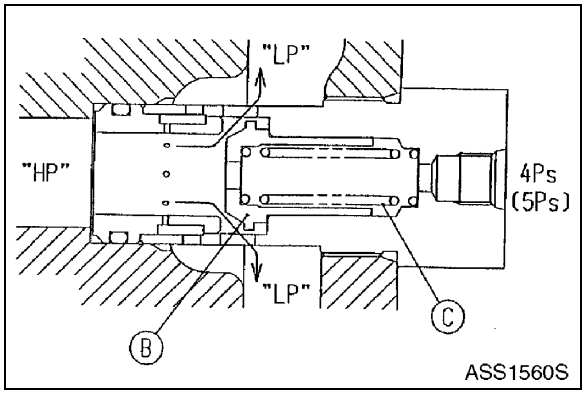


Figure 29

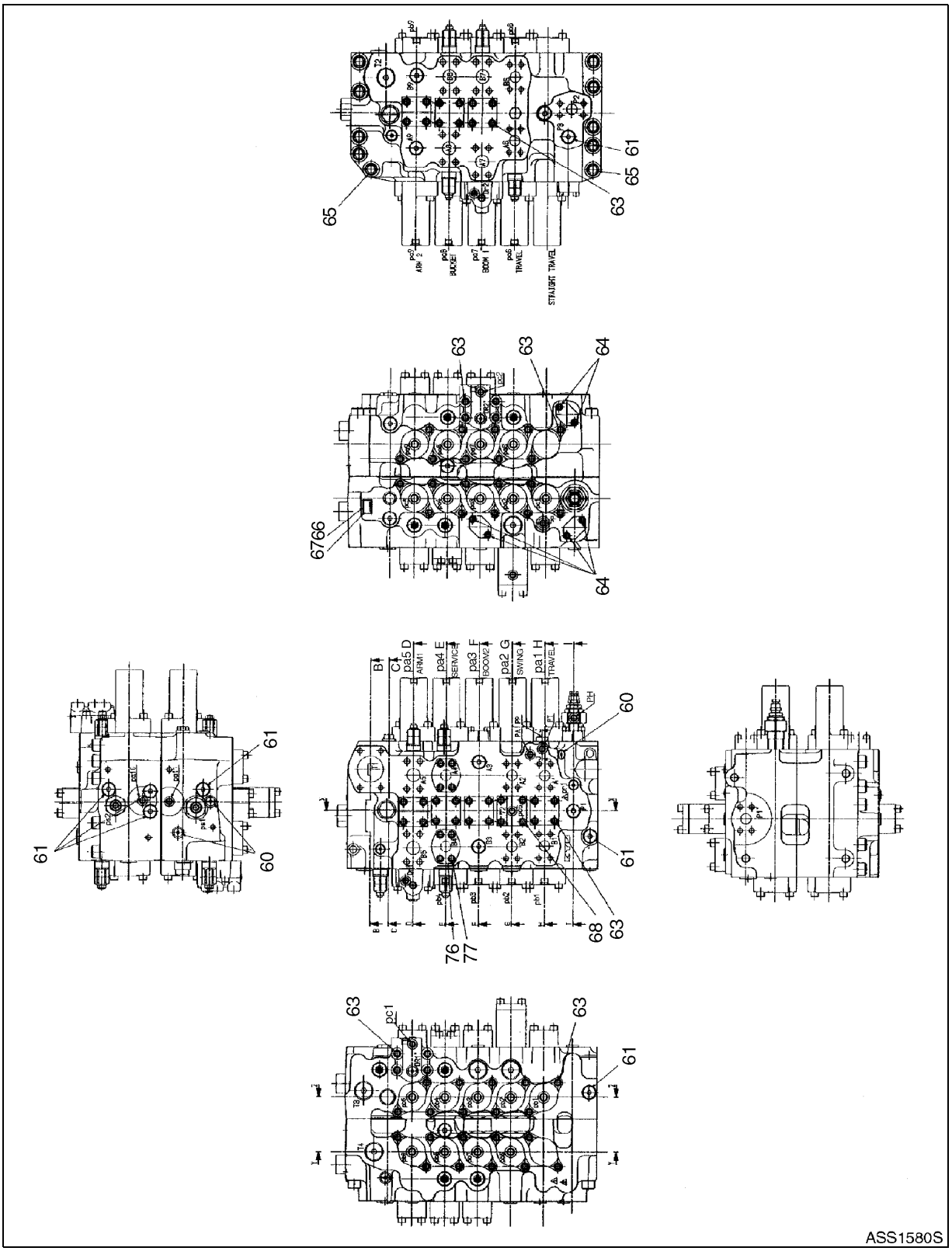

61
65
65
63
63
64
63
64
66
67
64
B1
C1
pa5 D
ARM1
pa4 E
SERVICE
pa3 F
BOOM2
pa2 G
SWING
pa1 H
TRAVEL
LH
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61
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60
68
63
76
77
63
pc1
63
61
ASS1580S

Figure 30

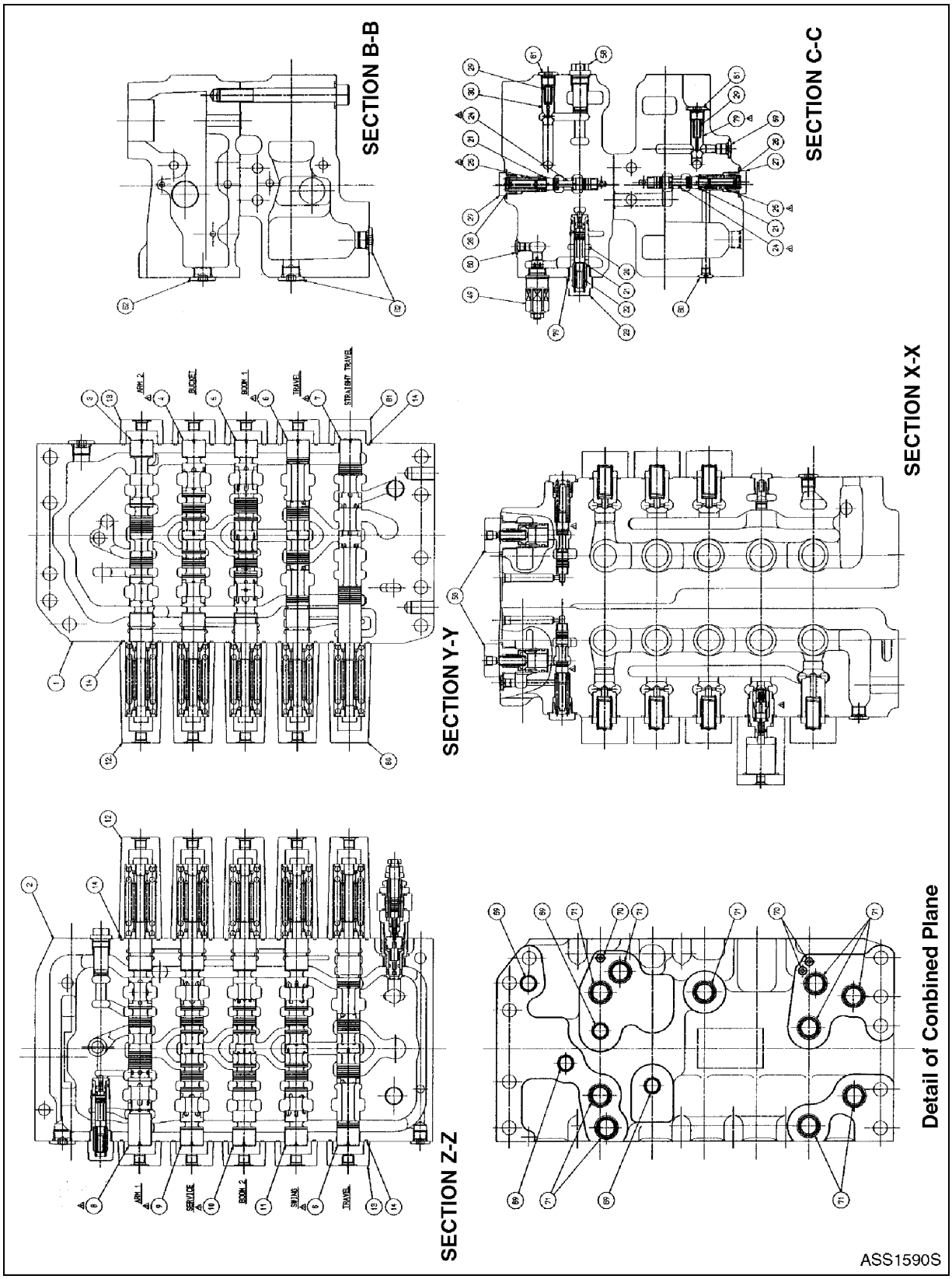

SECTION B-B
SECTION C-C
SECTION X-X
SECTION Y-Y
SECTION Z-Z
Detail of Conbined Plane
ASS1590S

Figure 31

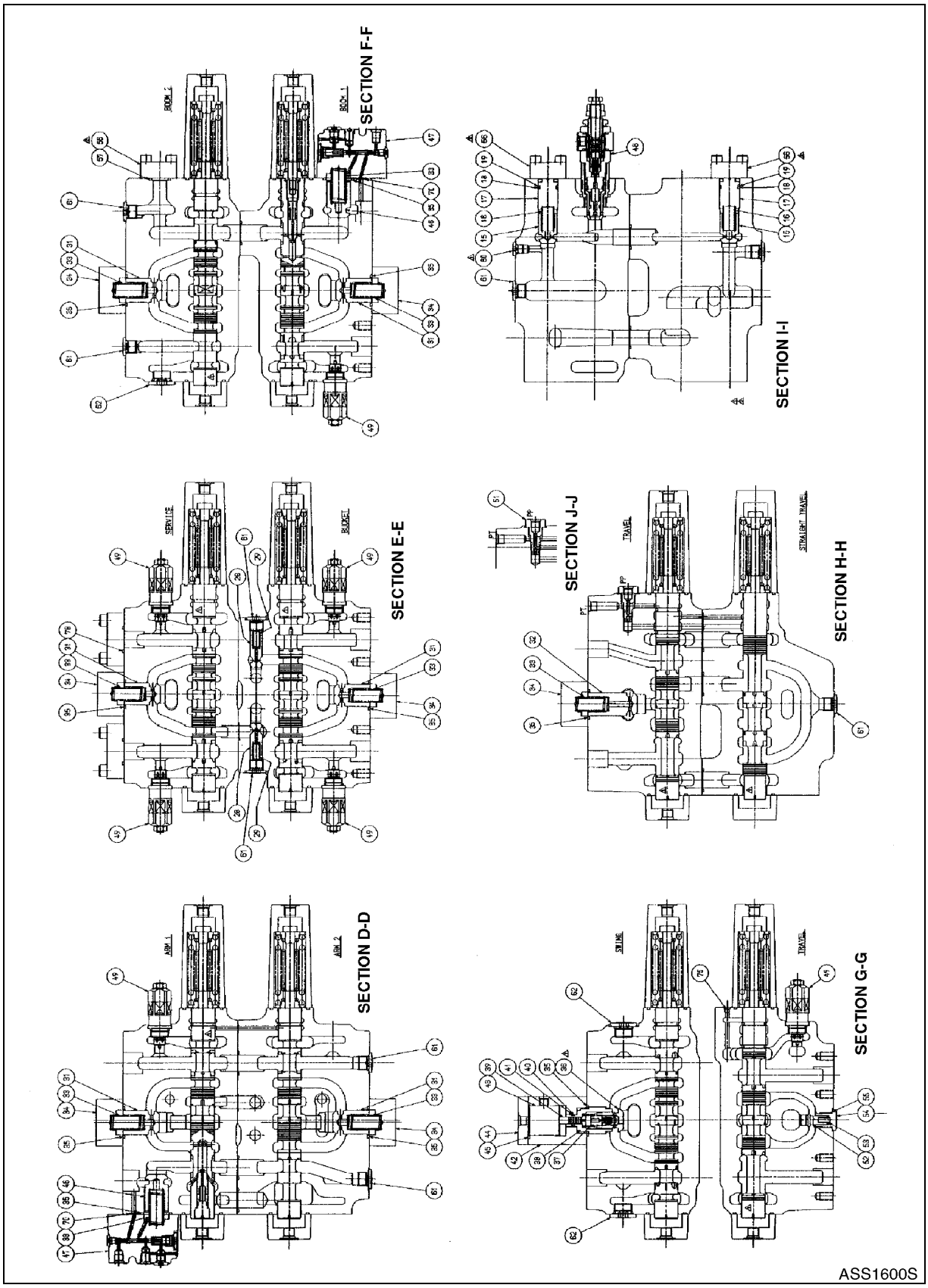

SECTION F-F
SECTION I-I
SECTION E-E
SECTION J-J
SECTION H-H
SECTION D-D
SECTION G-G
ASS1600S

Figure 32

Reference Number	Description
1	Valve Housing
2	Valve Housing
3	Spool Assembly (Arm-2)
4	Spool Assembly (Bucket)
5	Spool Assembly (Boom 1)
6	Spool Assembly (Travel)
7	Spool Assembly (Straight Travel)
8	Spool Assembly (Arm-1)
9	Spool Assembly (Service)
10	Spool Assembly (Boom 2)
11	Spool Assembly (Swing)
12	Cap
13	Cap
14	O-ring
15	Poppet
16	Spring
17	Spacer
18	O-ring
19	Backup Ring
20	Spool Assembly
21	Spring Seat (A)
22	Spring
23	Plug
24	Spool Assembly
25	Spring
26	O-ring
27	Plug
28	Poppet
29	Spring
30	Poppet
31	Poppet
32	Poppet
33	Spring
34	Flange
35	O-ring
36	Poppet Assembly
37	Spring
38	Sleeve
39	Piston

Reference Number	Description
40	O-ring
41	Backup Ring
42	Body
43	Piston
44	Flange
45	O-ring
46	Poppet
47	Body Assembly
48	Relief Valve Assembly
49	Relief Valve Assembly
50	Relief Valve Assembly
51	Plug Assembly
52	Poppet
53	Spring
54	Plug
55	O-ring
56	Flange
57	O-ring
58	Plug Assembly
59	Plug Assembly
60	Plug Assembly
61	Plug Assembly
62	Plug Assembly
63	Socket-Head Bolt
64	Socket-Head Bolt
65	Socket-Head Bolt
66	Name Plate
67	Drive Screw
68	Socket-Head Bolt
69	O-ring
70	O-ring
71	O-ring
72	O-ring
73	Cap
74	Cap
75	Steel Ball
76	Flange Cap
77	Socket-Head Bolt
78	O-ring
79	Poppet

Spool Assembly (4, Bucket)

Reference Number	Description
1	Spool
2	Spring Seat
3	Spring
4	Spring
5	Spool End

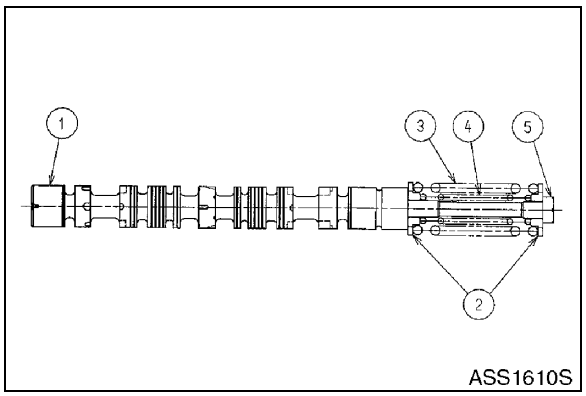


Figure 33

Spool Assembly (5, Boom)

Reference Number	Description
1	Spool
2	Spring Seat
3	Spring
4	Spring
5	Spool End
6	Poppet
7	Spring
8	Plug
9	O-ring
10	Backup Ring

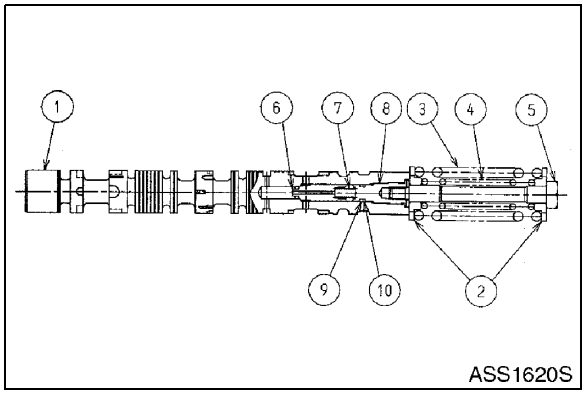


Figure 34

Spool Assembly (6, Travel)

Reference Number	Description
1	Spool
2	Spring Seat
3	Spring
4	Spring
5	Spool End

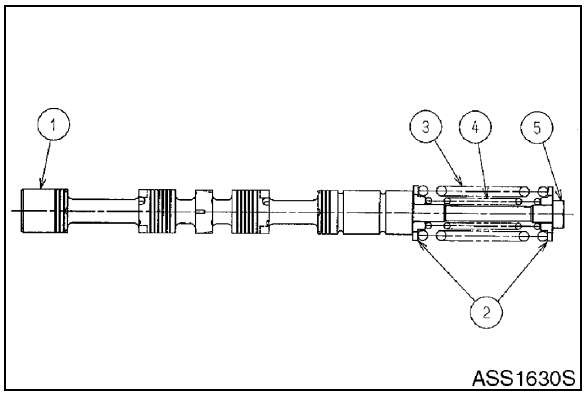


Figure 35

Spool Assembly (7, Straight Travel)

Reference Number	Description
1	Spool
2	Spring Seat
3	Spring
4	Spring
5	Spool End

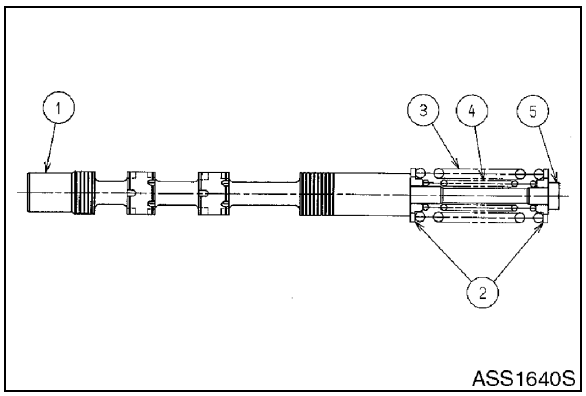


Figure 36

Spool Assembly (8, Arm1)

Reference Number	Description
1	Spool
2	Spring Seat
3	Spring
4	Spring
5	Spool End
6	Poppet
7	Spring
8	Plug
9	O-ring
10	Backup Ring

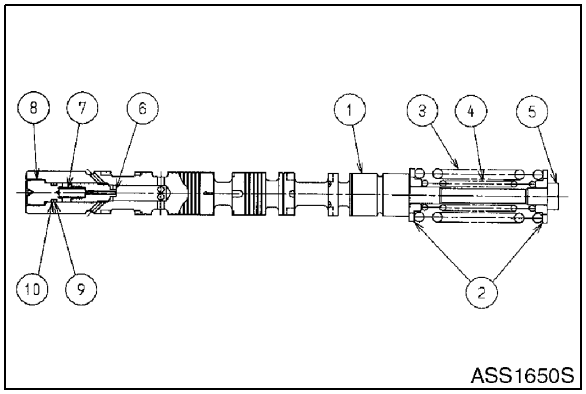


Figure 37

Spool Assembly (9, Service)

Reference Number	Description
1	Spool
2	Spring Seat
3	Spring
4	Spring
5	Spool End

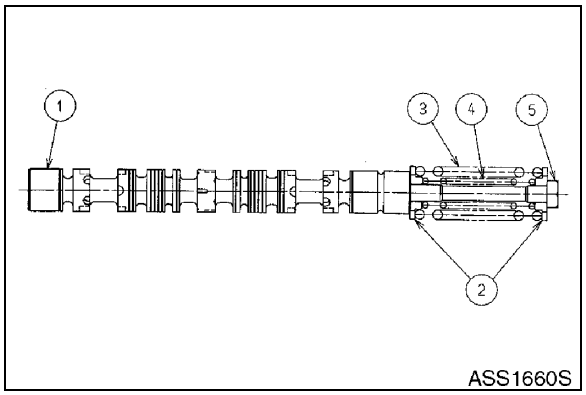


Figure 38

Spool Assembly (10, Boom 2)

Reference Number	Description
1	Spool
2	Spring Seat
3	Spring
4	Spring
5	Spool End

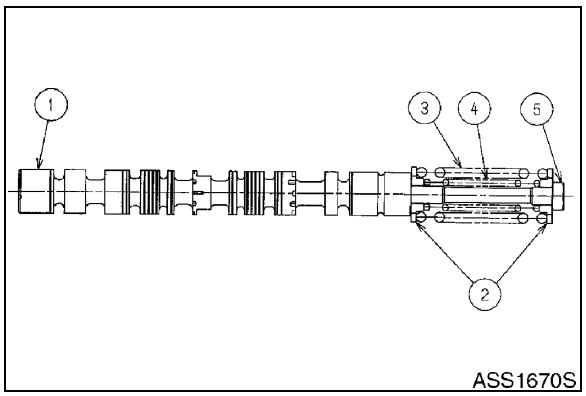


Figure 39

Spool Assembly (11, Swing)

Reference Number	Description
1	Spool
2	Spring Seat
3	Spring
4	Spring
5	Spool End

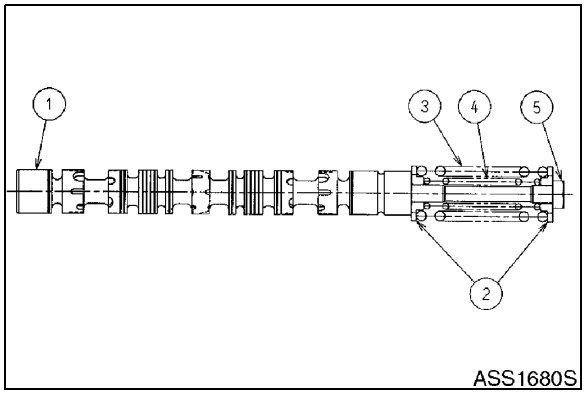


Figure 40

Spool Assembly (3, Arm 2)

Reference Number	Description
1	Spool
2	Spring Seat
3	Spring
4	Spring
5	Spool End

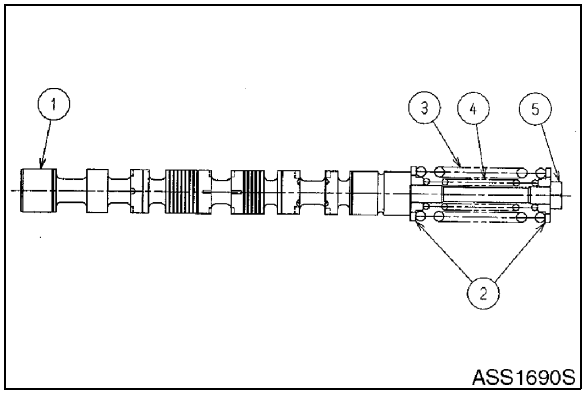


Figure 41

Spool Assembly (20, Arm Regeneration Release Valve

Reference Number	Description
1	Spool
2	Sleeve
3	Sleeve
4	Piston
5	O-ring
6	Backup Ring
7	O-ring
8	Backup Ring

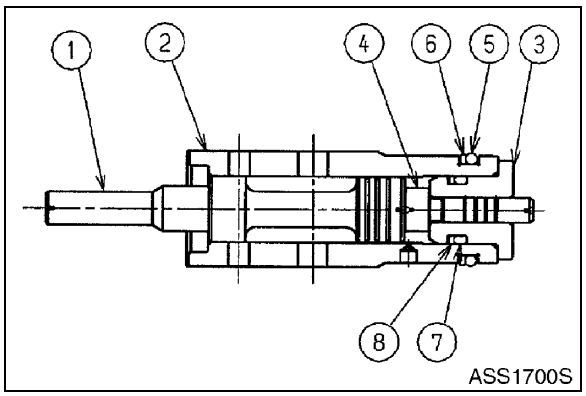


Figure 42

Spool Assembly (24)

Reference Number	Description
1	Spool
2	Spool End

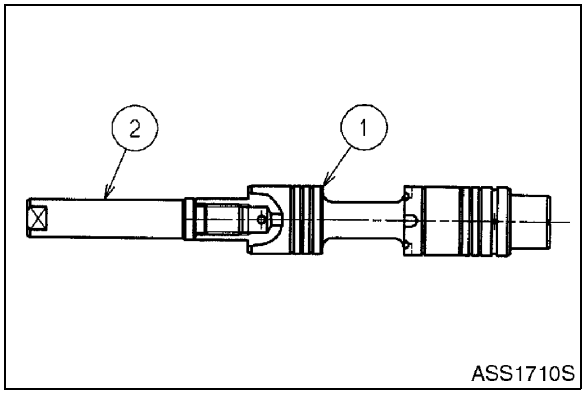


Figure 43

Poppet Assembly (36)

Reference Number	Description
1	Poppet
2	Poppet
3	Spring
4	Plug

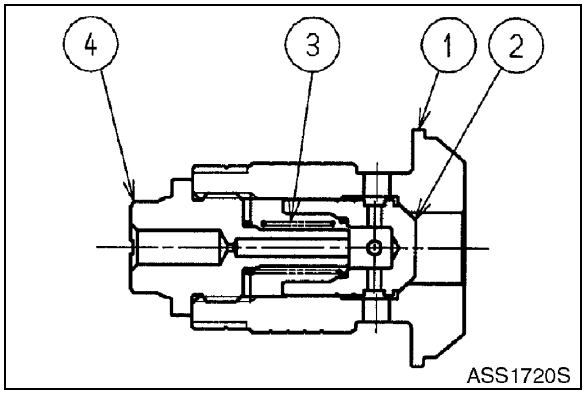


Figure 44

Plug Assembly (51)

Reference Number	Description
1	Plug
2	O-ring
3	O-ring
4	O-ring

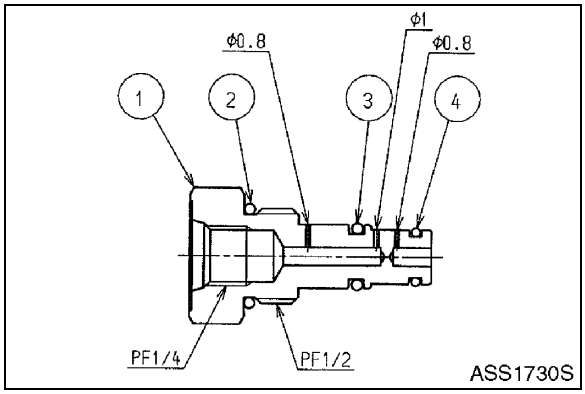


Figure 45

Plug Assembly (58)

Reference Number	Description
1	Plug
2	O-ring
3	O-ring
4	Backup Ring

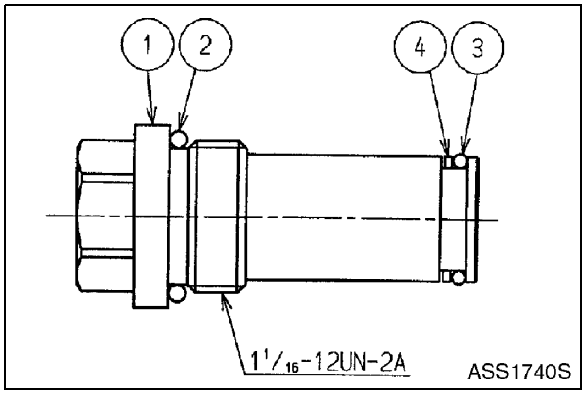


Figure 46

Relief Valve Assembly (48)

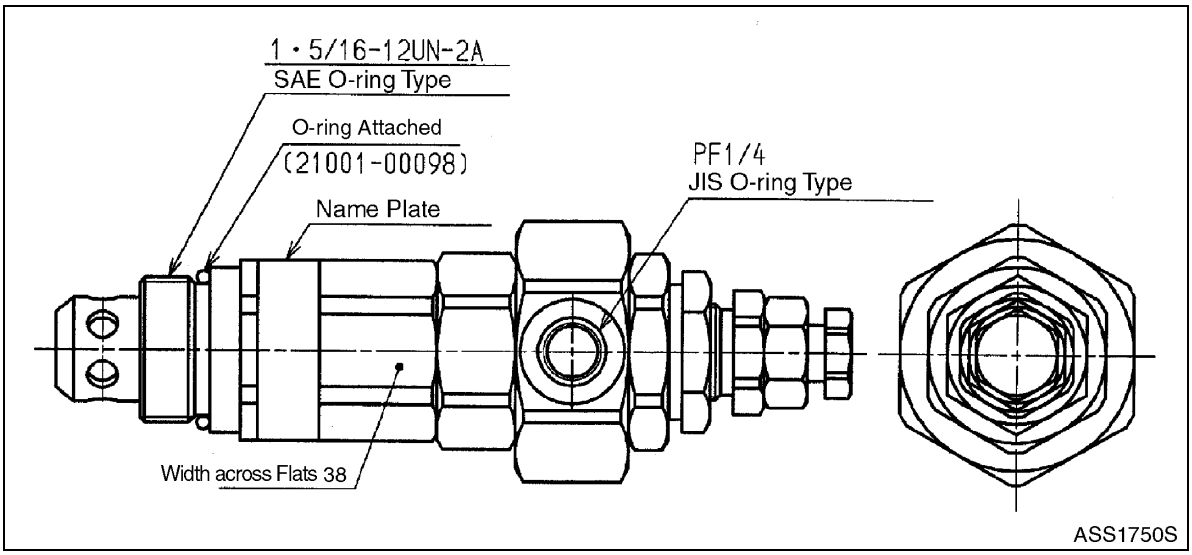


Figure 47 S/N 1001 thru 1050

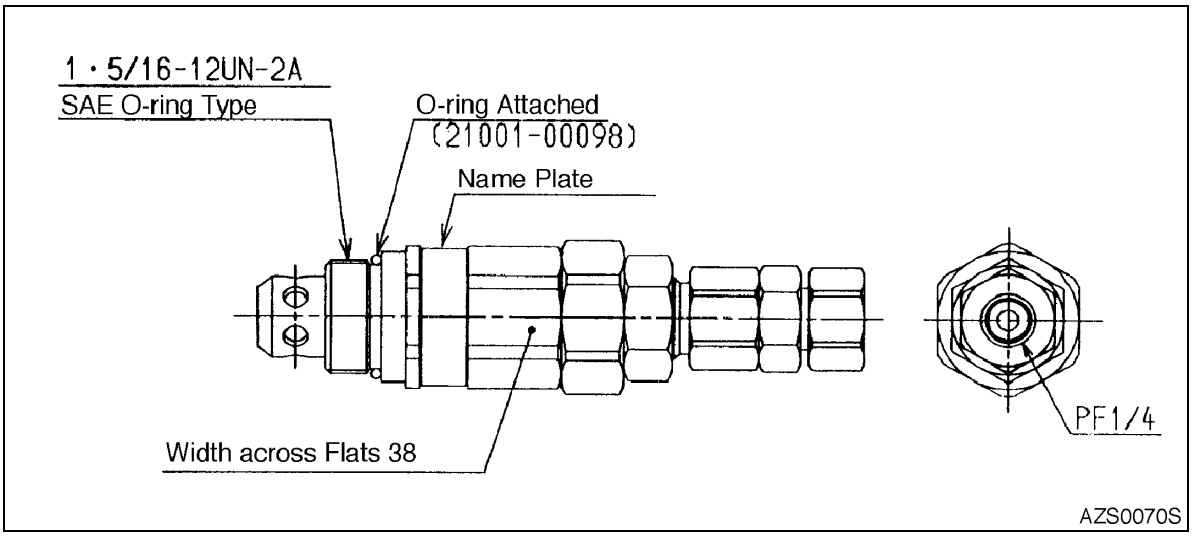


Figure 48 S/N 1051 and Up

Item	Specification	
Serial No.	1001 thru 1050	1051 and Up
Relief Valve Pressure	Hi: 34.3 ± 0.5 MPa Low: 31.4 ± 0.5 MPa	Hi: 34.3 ± 0.5 MPa Low: 31.4 ± 0.3 MPa
Flow	250 liter/min.	150 liter/min.

Relief Valve Assembly (49)

Reference Number	Description
1	O-ring
2	O-ring
3	O-ring
4	Backup Ring
5	O-ring
6	Backup Ring
7	O-ring

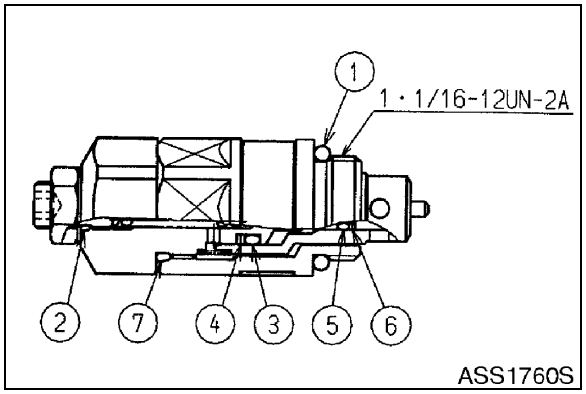


Figure 49

Item	Specification
Relief Valve Pressure	35.3 ± 0.5 MPa
Flow	20 liter/min.

Relief Valve Assembly (50)

Reference Number	Description
1	Plug
2	Spring
3	Poppet
4	Sleeve
5	O-ring
6	O-ring

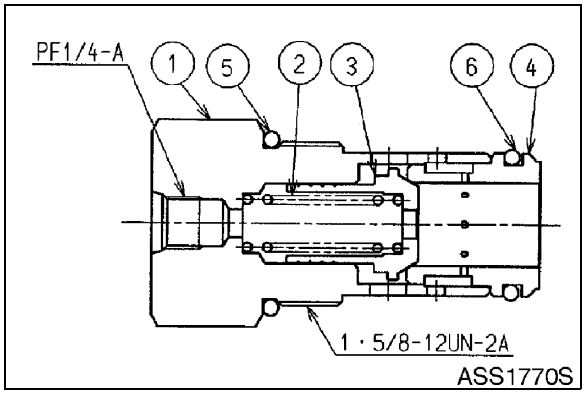


Figure 50

SPECIFICATIONS

Component Name	Specification
Rated Flow	400 liter/min. 500 liter.min at Neutral
Max. Pressure	31.9 MPa
Allowable Back Pressure	Peak Pressure: Below 1.5 MPa Normal Pressure: Below 0.5 MPa
Allowable Working Temperature Range	-20 ~ 90°C

TROUBLESHOOTING, TESTING AND ADJUSTMENT

GENERAL

Problem	Possible Cause	Remedy
Spool does not stroke.	Hydraulic oil excessively hot.	Remove blockage in oil piping.
	Hydraulic oil contaminated.	Change oil and clean oil passages.
	Overtightened piping port fittings.	Check torque.
	Valve housing deformed when assembling.	Remove assembling bolts and check.
	Pressure too high.	Check pump port pressure and cylinder port pressure with pressure gauge.
	Spool bent.	Replace valve assembly.
	Return spring damaged.	Replace damaged parts.
	Spring or cap crisscrossed.	Remove and center cap.
	Valve temperature uneven.	Warm up entire system.
	Dirt in valve.	Clean valve.
	Lack of pilot pressure.	Check pilot valve and pilot relief pressure.
Fails to bear load	Leaky cylinder.	Check seal parts of cylinder.
	Leaky spool.	Check spool.
	Leaky overload relief valve.	Clean valve housing and relief valve seat parts.
	Leaky anti drift valve.	Remove anti drift valve and clean every seat parts. If seat parts are damaged, replace poppet or lap poppet and seat parts. If drift valve is out of order, replace spool and sleeve at the same time.
Load drops when changing the spool from neutral to up.	Dirt in load check valve.	Remove and clean check valve.
	Poppet or seat parts in check valve damaged.	Remove poppet or lap poppet and seat parts.

RELIEF VALVE

Problem	Possible Cause	Remedy
Pressure does not rise.	Pressure does not rise.	Replace relief valve.
Pressure unstable	Pressure unstable	
Relief pressure is incorrect.	Seat parts worn due to dirt.	
	Lock nut and adjuster deformed.	Reset pressure and tighten lock nut in rated torque.
Oil leaks	Relief valve seat parts damaged.	Replace relief valve.
	Every parts stuck due to dirt.	
	O-ring worn.	Replace adjuster or O-ring.

HYDRAULIC SYSTEM

Problem	Possible Cause	Remedy
Hydraulic system is poor or none of the controls function	Hydraulic pump failed.	Check pressure or replace pump.
	Relief valve failed.	Replace pump.
	Some kinds of cylinders failed.	Repair or replace.
	Pump load pressure too high.	Check circuit pressure.
	Valve cracked.	Replace valve assembly.
	Spool does not fully stroke.	Check spool operation.
	Hydraulic oil level in tank too low.	Add hydraulic oil.
	Filter in circuit plugged.	Clean or replace filter.
	Circuit piping snarled.	Check piping.

ADJUSTMENT OF RELIEF VALVE

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 over load relief valve is higher than the pressure of the main relief valve.*

4. High pressure adjustment (See Figure 52 on page 47).

   A. Loosen lock nut (5) and tighten plug (6) until piston contacts the end (* mark) of plug (4). Plug (6) should be torqued below 2 kg•m (15 ft lb). While plug (6) is tightened, plug (4) should not be turned. The distance A (See Figure 18 on page 26) should be more than 15 mm (0.59 in). Tighten lock nut (5).

B. Loosen lock nut (3) and turn adjusting plug (4) clockwise to raise relief pressure at the condition of step A. Turn adjusting plug (4) counterclockwise to lower relief pressure. One turn varies pressure by approximately 25.7 MPa. Tighten lock nut (3) after pressure has been adjusted.

5. Low pressure adjustment

   A. Loosen lock nut (5) and turn adjusting plug (6) counterclockwise to lower relief pressure at step 4. One turn varies pressure by approximately 21.3 MPa.Tighten lock nut (5) after pressure has been adjusted.

   B. Recheck the setting pressure by raising pressure.

Over Load Relief Valve

IMPORTANT
If pressure of main relief valve is higher than the specified pressure for it, change main relief valve assembly setting without adjusting over load relief valve.

1. Shift the control valve spool and read the pressure gauge from the stroke end of the cylinder.
2. Loosen lock nut (3) and turn adjusting plug clockwise to raise pressure. One turn varies pressure by approximately 21.2 MPa.
3. Tighten lock nut (3) after pressure has been adjusted. Lock nut (3) should be torqued to 2.80 - 3.2 kg•m (20 - 23 ft lb).
4. Recheck the pressure setting again.

DISASSEMBLY

GENERAL INSTRUCTIONS FOR DISASSEMBLY

1. Stop engine at low actuator pressure.

   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, it 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 ensure 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 (3) - (11)

1. Remove socket head bolt (63, width across flats: 10 mm) and long cap (12 and 73). Remove O-ring (14) from valve housing.
2. Remove all spool subassemblies from valve housing.

> **⚠ WARNING!**
>
> **When removing spool, be careful not to damage it.**
>
> **Attach label to each spool in order to install it in the correct position when reassembling.**

3. Remove socket head bolts (63) and short cap (13 and 74). Remove O-ring from valve housing.
4. Remove spool end (further part number - 5, width across flats: 22 mm) of spool (3, 4, 6, 7, 9 10 and 11), spring seat (further part number - 2) and spring (further part number - 3 and 4).
5. Remove spool end (5-5, width across flats: 22 mm) of spool (5), spring seat (5-2) and spring (5-3,4). Remove plug (5-8: groove width; 3 mm), O-ring (5-9) and backup ring (5-10).
6. Remove spool end (8-5, width across flats: 22 mm) of spool (8), spring seat (8-2) and spring (8-3,4). Remove plug (8-8: groove width; 3 mm), spring (8-7) and poppet (8-6).

7. Disassembly of spool

IMPORTANT

Work with spool gripped in vise with wood (see Figure 51) 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.

If it is over heated, change spring to new one.

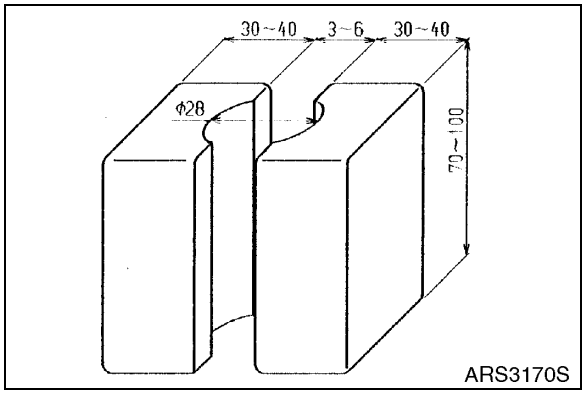


Figure 51

DISASSEMBLY OF SUBSPOOL (24)

1. Remove plug (27, width across flats: 36 mm), spring (25), spring seat (21), and spool (24). Remove the other spool in a similar manner.
2. Remove O-ring (26) from plug.
3. Spool (24-1) and spool end (24-2) are secured with Loctite. Heat spool end to loosen it (Heating temperature: 200 - 250°C) to prevent damage of thread.

DISASSEMBLY OF SUBSPOOL (20)

1. Remove plug (23, width across flats: 32 mm) and O-ring (72).
2. Remove spring (22), spring seat (21) and spool (20-1).
3. Pull off sleeve (20-2,3) and piston (20-4).

DISASSEMBLY OF ANTI DRIFT VALVE OF BOOM AND ARM

1. Remove socket head bolt (63) and body assembly (47) and O-ring (35 and 70).

⚠ WARNING!

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.

2. Remove spring (33) and poppet (46).
3. Grip body assembly (47, width across flats: 8 mm) in vise taking care not to scratch O-ring (35 and 70) surface.
4. Remove plug (47-5) and O-ring (47-10).
5. Remove spring (47-4), spool (47-2) and O-ring (47-3).

6. Remove plug assembly (47-7, width across flats: 6 mm) and O-ring.

IMPORTANT
The filter in plug assembly (47-7) is pressed into place and can not be removed. If filter replacement is necessary, replace it with a new plug assembly.

7. Remove plug (47-8, width across flats: 8 mm) and O-ring.
8. Remove plug (47-9, width across flats: 5 mm) and O-ring.

   NOTE: *Steel ball (75) should not be disassembled since it is a press fit.*

DISASSEMBLY OF SWING LOAD CHECK

1. Remove socket head bolt (68, width across flats: 10 mm) and flange (44).
2. Remove body (42), piston (43) and O-ring (45).
3. Pull off sleeve (38) and remove spring (37) and piston (39).
4. Remove O-ring (40, 35) and backup ring (41).
5. Remove poppet assembly (36).
6. Grip plug (36-4, width across flats: 12 mm) in vise and remove poppet (36-1), spring (36-3) and poppet (36-2).

DISASSEMBLY OF LOAD CHECK

1. Remove travel semi parallel check from port P2. Remove plug (54, width across flats: 27 mm). Remove O-ring (54) from plug. Remove spring (53) and poppet (52).

⚠ WARNING!
At this time, be careful not to drop spring into passage. If valve is operated with spring in passage, a broken piece may penetrated in main spool sliding surface and a serious accident may occur by a runaway or not being able to stop.

2. Remove travel load check from port P1. Remove socket head bolt (63, width across flats: 10 mm) and flange (34). Remove poppet (32), spring (33) and O-ring (35).
3. Remove the remaining load check. Remove socket head bolt (63, width across flats: 10 mm) and flange (34). Remove poppet (31), spring (33) and O-ring (35).

DISASSEMBLY OF OTHER CHECK VALVES

1. Remove two common check valves from main relief valve. Remove socket head bolt (64, width across flats: 8 mm) and flange (56). Pull off collar from spacer (17). Remove O-ring (18) and backup ring (19). Remove spring (16) and poppet (15).
2. Remove parallel check valve from spare junction, bucket junction and arm one. Remove plug (61, width across flats: 10 mm) and O-ring.
3. Remove spring (29) and poppet (28).

4. Remove semi parallel check valve from arm two. Remove plug (61, width across flats: 10 mm) and O-ring. Remove spring (29) and poppet (30).

DISASSEMBLY OF FLANGE

1. Remove flange from spare port. Remove socket head bolt (77, width across flats: 10 mm) and flange (76) and O-ring (78).
2. Remove flange from boom two. Remove socket head bolt (64, width across flats: 8 mm) and flange (56) and O-ring (57).

DISASSEMBLY OF RELIEF VALVE

1. Remove eight overload relief valves (49, (8 places, width across flats: 32 mm)).
2. Remove main relief valve (48, width across flats: 41 mm).
3. Remove two negacon relief valves (50, width across flats: 46 mm).

DISASSEMBLY OF OTHER FLANGE

1. Remove plug assemblies (60, 61, 62, 58, 52, 59) and O-rings.

Reference Number	Size	Quantity
60	6 mm	5
61	10 mm	17
62	12 mm	6
58	24 mm	1
52	27 mm	
59	8 mm	

NOTE: *Valve housings (1 and 2) should not be disassembled because O-rings and housings can be deformed and mating surfaces can be crisscrossed when reassembling them.*

Steel ball (75) should not be disassembled since it is a press fit.

DISASSEMBLY OF MAIN RELIEF VALVE

1. This relief valve should be replaced as an assembly. When replacing it, loosen cap (8, width across flats: 41) and O-ring (1, Figure 52). If oil leaks from nut (3), remove nut (3) and plug (4) and replace O-ring and backup ring.

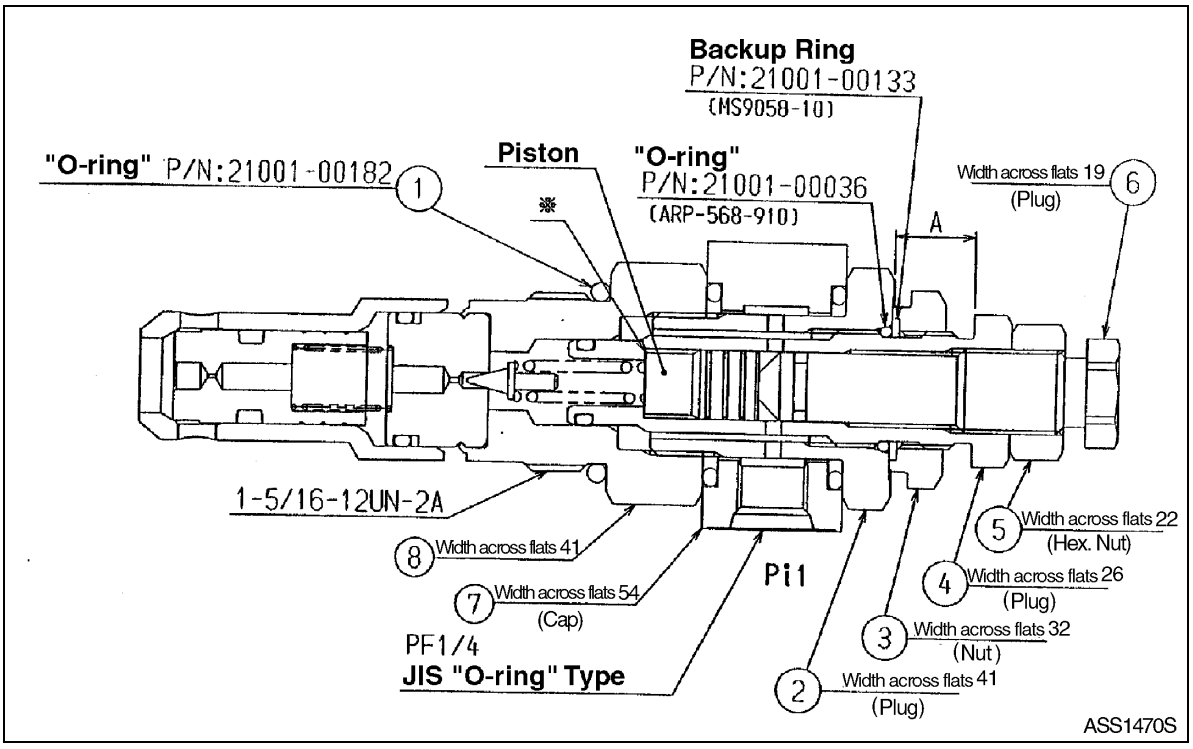


Figure 52 S/N 1001 thru 1050

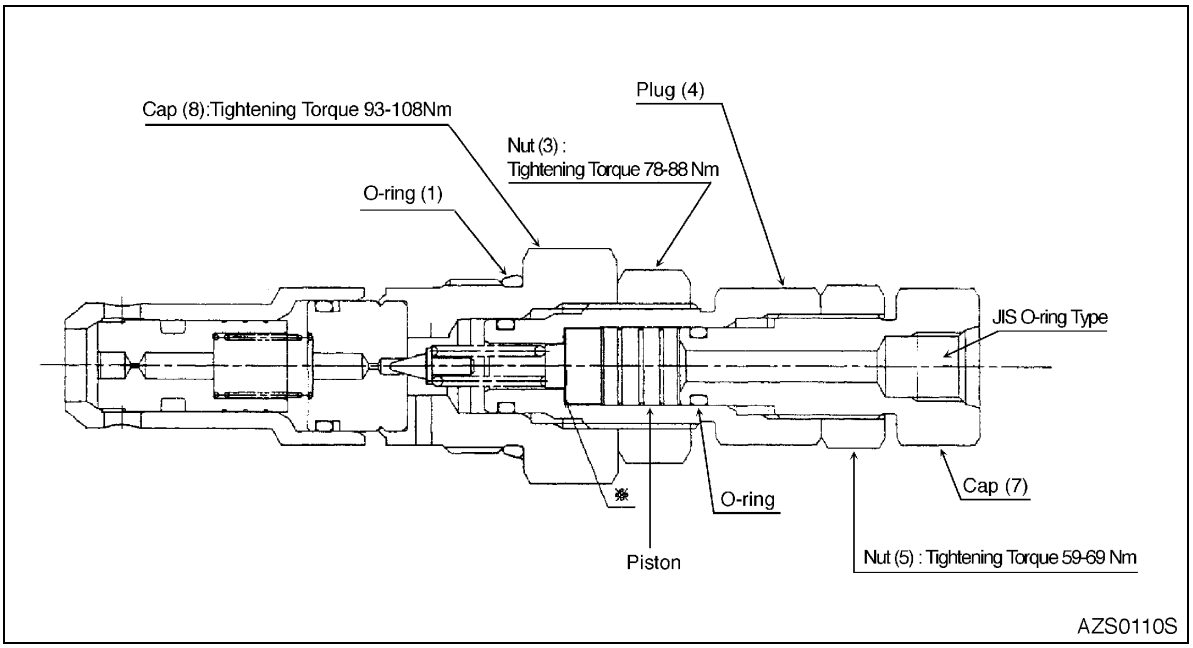


Figure 53 S/N 1051 and Up

DISASSEMBLY OF OVERLOAD RELIEF VALVE

1. This relief valve should be replaced as an assembly. When replacing it, loosen cap (1, width across flats: 31.75 mm) and O-ring (2). If oil leaks from nut (3), remove adjusting kit and replace O-ring (4).

   NOTE: *When disassembling adjusting kit, be careful not to allow components to spring out by force of spring or to lose the poppet.*

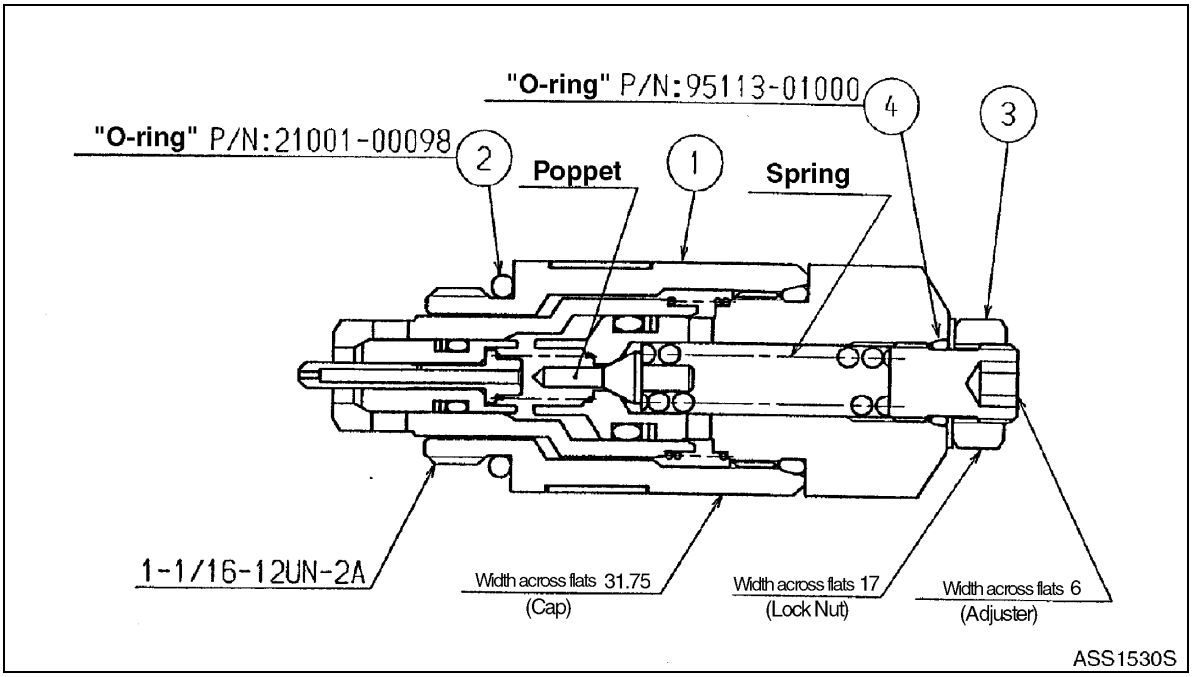


Figure 54

DISASSEMBLY OF LOW PRESSURE RELIEF VALVE

1. This relief valve is a press fit at area (D) making it a non-serviceable item, that should be replaced as a whole assembly.

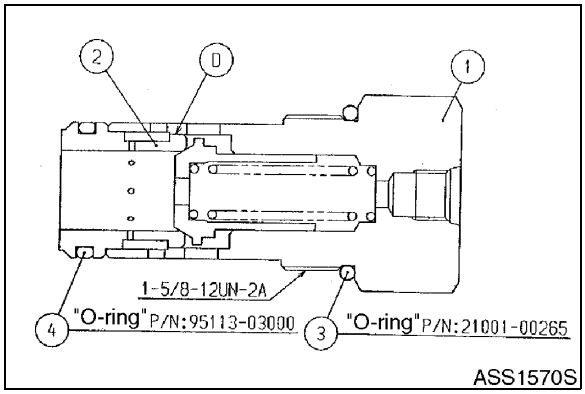


Figure 55

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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 surface for inspection.

INSPECTION

Inspect all parts for scratches, notches and the 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. Inspect all grooves and passages of sliding parts for foreign materials.
4. Replace any springs that are damaged, heavy deformed or worn.
5. If relief valve malfunctions, inspect it by using relief valve procedure (see page).
6. Replace all O-rings and backup rings with new ones.
7. After disassembling cap or plug, check whether there are paint chips around valve body hole or plug. If paint chips penetrate into valve, they can cause malfunction or leaks to occur.

REASSEMBLY

NOTE: *Before reassembling, confirm number of components, reassembling position, tools and etc.*

SUBASSEMBLY

Before reassembling valve housing, subassemble parts as needed.

Main Spool (3) - (11)

1. Apply Loctite to threads of spools (3, 4, 6, 7, 9, 10 and 11). Assemble spring seat (above parts numbers - 2), spring (above parts numbers - 3, 4) and spool end (above parts numbers - 5), and assemble spool end in spool that is gripped in vise with wood. Torque is 2.45 - 2.65 kg•m (18 - 19 ft lb).

IMPORTANT
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.**

2. After assembling poppet (above parts numbers - 6) and spring (above parts numbers - 7) in middle hole of spool (5), apply Loctite to thread of spool. Grip spool in vise with wood. Assemble plug (5-8) into which O-ring (5-9) and backup ring (5-10) are inserted. Torque is 2.45 - 2.65 kg•m (18 - 19 ft lb). Assemble spring seat (5-2), spring (5-3, 4) and spool end (5-5) and tighten spool end. Torque is 2.45 - 2.65 kg•m (18 - 19 ft lb).
3. Assemble poppet (8-6) and spring (8-7) in middle hole of spool (8). Apply Loctite to thread of spool and assemble plug (8-8). Torque is 2.45 - 2.65 kg•m (18 - 19 ft lb). Apply Loctite to thread of spool. Grip spool in vise with wood. Assemble spring seat (8-2), spring (8-3, 4) and spool end (8-5) and tighten spool end. Torque is 2.45 - 2.65 kg•m (18 - 19 ft lb).

Subspool (20)

1. Assemble backup ring (20-8) and O-ring (20-7) in sleeve (20-3). Assemble backup ring (20-6) and O-ring (20-5) in sleeve (20-2).
2. Assemble piston (20-4) in sleeve (20-3) with O-ring.
3. Assemble piston in sleeve (20-2).

Subspool (24)

1. Apply Loctite to thread of spool (24-1).

IMPORTANT
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.**

2. Tighten spool end (24-2) in spool (24-1). Torque is 1.94 - 2.24 kg•m (14 - 16 ft lb).

Boom, Arm Anti Drift Valve

1. Grip body in vise, taking care not to scratch O-ring (35 and 70) surface of body (47-1).
2. Insert spring seat (47-3) in spool (47-2), and insert spool in body (47-1) hole.
3. Assemble spring (47-4).
4. Tighten plug (47-5) with O-ring (47-10) in body (47-1). Torque is 2.86 - 3.06 kg•m (21 - 22 ft lb).
5. Tighten plug (47-9) with O-ring to body (47-1). Torques 1.43 - 1.73 kg•m (10 - 23 ft lb). Tighten plug (47-8) with O-ring in body (47-1). Torque is 2.86 - 3.06 kg•m (21 - 22 ft lb).
6. Tighten plug (47-7) with O-ring and filter in body (47-1). Torque is 2.86 - 3.06 kg•m (21 - 22 ft lb).

Swing Load Check

1. Insert poppet (36-2) and spring (36-3) in poppet (36-1), and tighten plug (36-4). Torque is 3.98 - 4.38 kg•m (29 - 32 ft lb).

IMPORTANT
Insert spring into poppet. Large end of spring should be facing the poppet. If spring is not inserted properly, it can break.

REASSEMBLY OF CONTROL VALVE

Reassembly of Load Check Valve

1. Assemble travel semiparallel check for P2 port. Assemble poppet (52) and spring (53), and fasten plug (54) with O-ring (55). Torque is 10.50 - 11.52 kg•m (76 - 83 ft lb).
2. Assemble travel load check for P1 port. Assemble poppet (32), spring (33) and O-ring (35), and fasten flange (34) with socket head bolt (63). Torque is 10.50 - 11.52 kg•m (76 - 83 ft lb).

IMPORTANT
When fastening flange, spring (33) should be inserted into flange. If it is not properly installed, the spring can be broken. When tightening socket head bolts, they should be tightened evenly.

3. Assemble remaining load check. Assemble poppet (31), spring (33) and O-ring, and fasten flange (34) with socket head bolts (63). Torque is 10.50 - 11.52 kg•m (76 - 83 ft lb).

Reassembly of Swing Load Check

1. Install O-ring (40) and backup ring (41) on sleeve (38).
2. Install piston (39), spring (37) and poppet assembly (36) in sleeve (38).
3. Install sleeve assembly in body. Install O-ring (35) on body.
4. Install piston (43) and O-ring (45) in body (42).
5. Install body assembly in sleeve (38).

6. Fasten flange (44) and body (42) with socket head bolt (68). Torque is 10.81 - 11.52 kg•m (78 - 83 ft lb).

Reassembly of Other Check Valve

1. Assemble two common check valves of main relief valve. Install poppet (15) and spring (16). Insert spacer (17) with O-ring (18) and backup ring (19). Fasten flange (56) with socket head bolts (64). Torque is 5.91 - 6.53 kg•m (43 - 47 ft lb).

IMPORTANT
Be careful of installation position of O-ring and backup ring. If they are reversed, the O-ring can break and an oil leak can result.

2. Assemble parallel check valve for spare junction, bucket junction and arm one. Install poppet (28) and spring (29), and tighten plug (61) with O-ring. Torque is 11.83 - 13.05 kg•m (86 - 94 ft lb).
3. Assemble arm two semiparallel check valve. Install poppet (28) and spring (29), and tighten plug (61) with O- ring. Torque is 11.83 - 13.05 kg•m (86 - 94 ft lb).

Reassembly of Flange

1. Assemble flange for spare port. Install O-ring (78) on flange (76), and fasten flange with socket head bolts (77). Torque is 10.50 - 11.52 kg•m (76 - 83 ft lb).
2. Assemble flange for boom two. Install O-ring (57) on valve housing, and fasten flange (56) with socket head bolt (64). The good surface of flange should be facing the O-ring side. Torque is 5.91 - 6.53 kg•m (43 - 47 ft lb).

Reassembly of Boom and Arm Anti Drift Valve

1. Install poppet (46) and spring (57), and fasten body assembly (47) with socket head bolt (63). Torque is 10.50 - 11.52 kg•m (76 - 83 ft lb).

IMPORTANT
When installing body assembly (47), spring (33) should be completely installed in spring position of body assembly.

Reassembly of Relief Valve

1. Tighten eight over load relief valves (49). Torque is 7.95 - 8.97 kg•m (58 - 65 ft lb).
2. Tighten main load relief valve (48). Torque is 9.48 - 11.01 kg•m (69 - 80 ft lb).
3. Tighten negacon relief valve (50). Torque is 10.50 - 11.52 kg•m (76 - 83 ft lb).

Reassembly of Subspool (24)

1. Install spool (24) in valve hole it was removed from during disassembly.
2. Install spring seat (24) and spring (25).
3. Tighten plug (27) with O-ring. Torque is 9.48 - 11.01 kg•m (69 - 80 ft lb).

IMPORTANT

Insert spool in hole perpendicularly. Make sure that spool is in correct position. If it is not in correct position, a malfunction can occur.

Reassembly of Subspool (20)

1. Install spool assembly in valve hole it was removed from during disassembly.
2. Install spring seat (21) and spring (22).
3. Tighten plug (23) with O-ring (72). Torque is 9.48 - 11.01 kg•m (69 - 80 ft lb).

Reassembly of Main Spool (3) - (11)

1. Install O-ring on valve housing (1,2).
2. Fasten short cap (74) with socket head bolt (63) for travel straight spool (7). Fasten short cap (13) with socket head bolt (63) for the other travel straight spools. Torque is 10.50 - 11.52 kg•m (76 - 83 ft lb).
3. Install spools (3 - 11) in valve holes they were removed from during disassembly.
4. Fasten long cap (73) with socket head bolt (63) on travel straight spool (7). Fasten long cap (12) with socket head bolt (63) on other travel straight spools. Torque is 10.50 - 11.52 kg•m (76 - 83 ft lb).

IMPORTANT

When assembling, be careful not to drop O-ring from mating surface.

Reassembly of Other Plugs

1. Tighten plug assembly (60) with O-ring. Torque is 3.16 - 4.28 kg•m (23 - 31 ft lb).
2. Tighten plug assembly (61) with O-ring. Torque is 11.83 - 13.05 kg•m (86 - 94 ft lb).
3. Tighten plug assembly (62) with O-ring. Torque is 7.44 - 8.06 kg•m (54 - 58 ft lb).
4. Tighten plug assembly (58) with O-ring and backup ring. Torque is 7.95 - 8.97 kg•m (58 - 65 ft lb).
5. Tighten plug assembly (51) with O-ring. Torque is 10.50 - 11.52 kg•m (76 - 83 ft lb).
6. Tighten plug assembly (59) with O-ring. Torque is 7.44 - 8.06 kg•m (54 - 58 ft lb).

IMPORTANT

After reassembly is completed, recheck tightening torque of all components. If they are not properly tightened, an oil leak can occur. The torque values are based on the threads being lubricated.

Reassembly of Main Relief Valve

Check whether there is dirt or paint chips around plug (2 and 4, Figure 56) and nut (3). Reassemble with new O-rings. Clean the installation portion of relief valve and install it. Tighten cap (8: Width across flats 41). Torque is 9.48 - 11.01 kg•m (69 - 80 ft lb).

When adjusting the position of port (Pi), adjust it before adjusting pressure and tightening plug (2, Width across flats 41 mm). After adjusting plug (2), move cap (7, Width across flats 54 mm). Torque is 7.95 - 8.97 kg•m (58 - 65 ft lb). If plugs are disassembled, Adjust pressure by referring to “Main Relief Valve” on page -41.

NOTE: *The torque values are based on the threads being lubricated.*

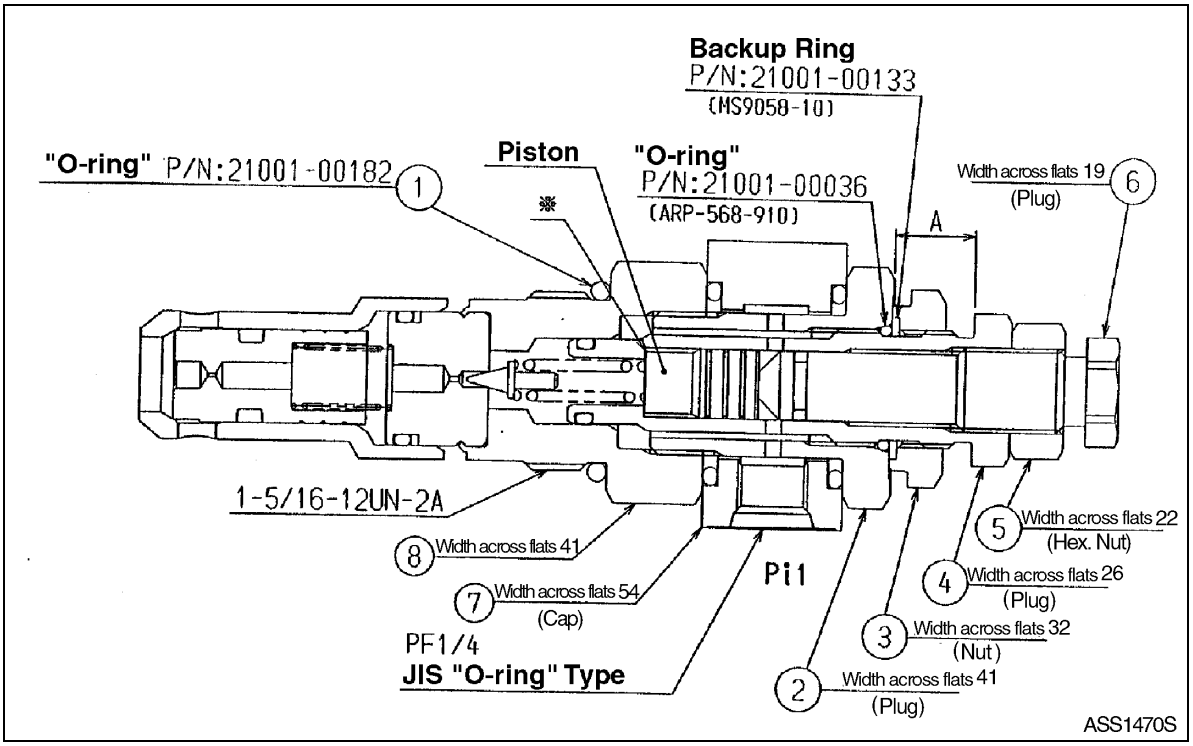


Figure 56 S/N 1001 thru 1050

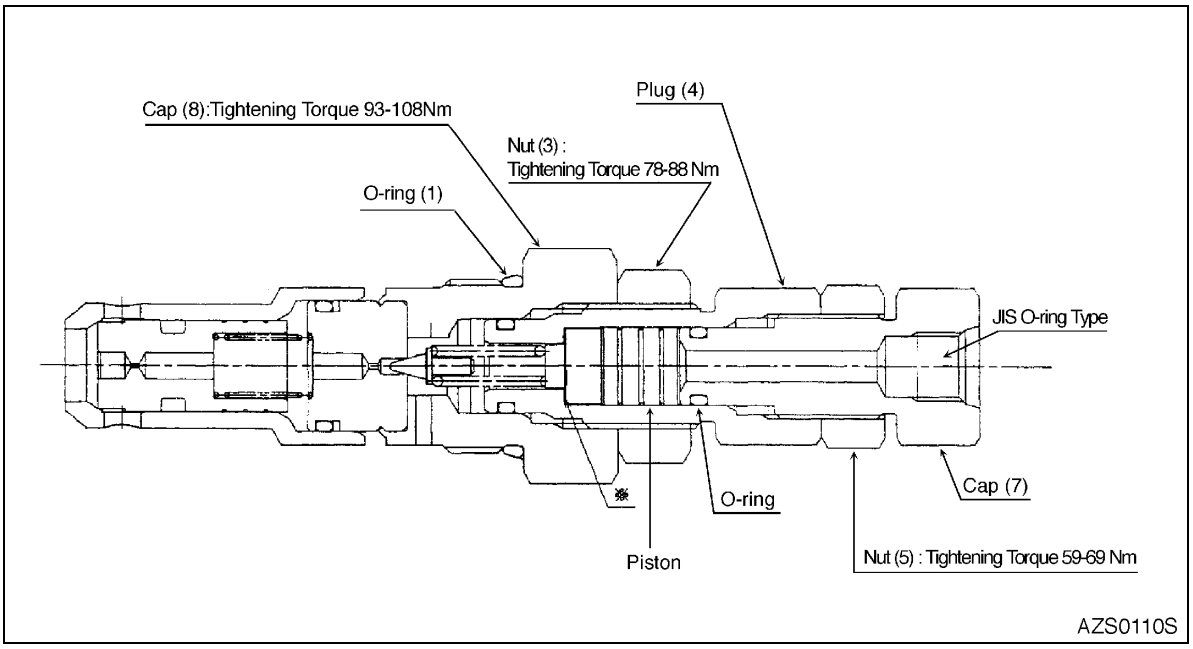


Figure 57 S/N 1051 and Up

Reassembly of Overload Relief Valve

Check whether there is dirt or paint chips around cap (1, width across flats: 31.75 mm) and reassemble with a new O-ring. Clean the installing part of relief valve and install it. Tighten cap (1). Torque is 7.95 - 8.97 kg•m (58 - 65 ft lb).

If adjusting kit is disassembled, clean around threads and adjust pressure by referring to “Over Load Relief Valve” on page -42.

NOTE: *The torque values are based on the threads being lubricated.*

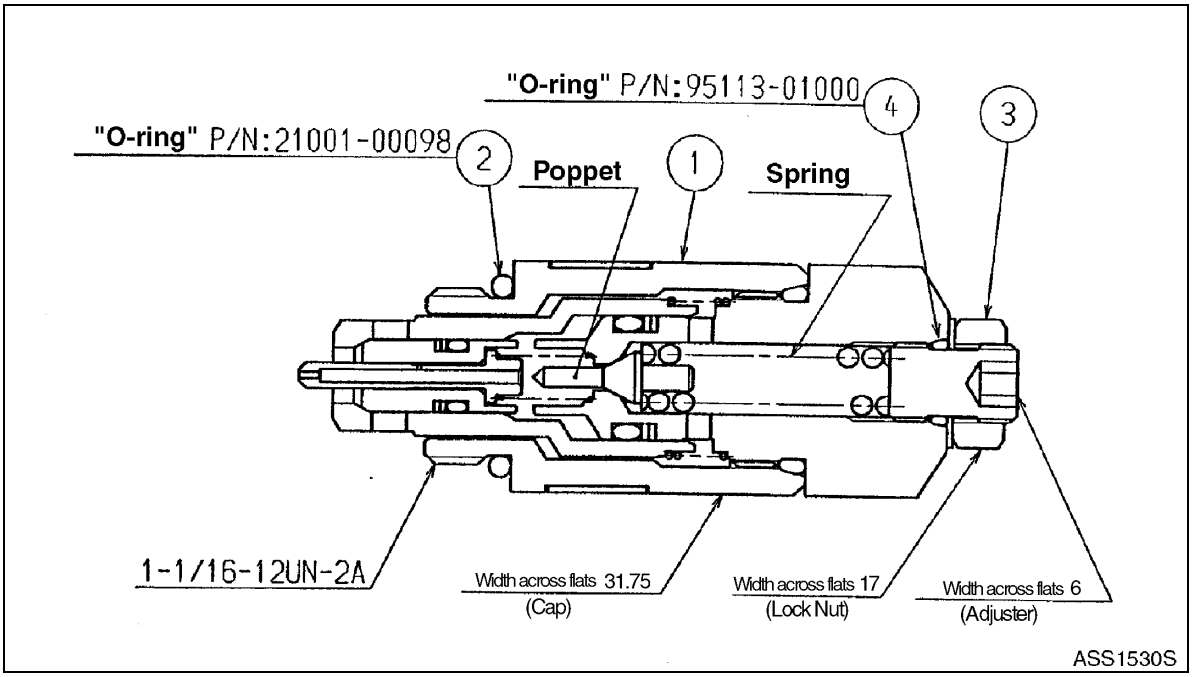


Figure 58

Reassembly of Low Pressure Relief Valve

Check whether there is dirt or paint chips around plug (1, width across flats: 46 mm) and reassemble it with new O-rings (3 and 4).

NOTE: *The torque values are based on the threads being lubricated.*

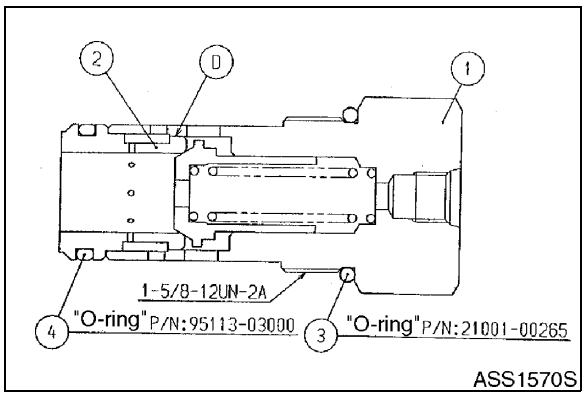


Figure 59

INSTALLATION

1. Be careful not to work other foreign strength to control valve by pipe laying.
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. Clean the installation portion of relief valve and install it. Tighten plug (1). Torque: 10.50 - 11.52 kg•m (76 - 83 ft lb).
5. 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 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 over load relief valve setting pressure should not be over 2.0 MPa.
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 due to heat shock.

   NOTE: *Do not operate main relief valve or over load 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.*

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

PILOT CONTROL VALVE (WORK LEVER / JOYSTICK)

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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May 2002

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GENERAL DESCRIPTION

THEORY OF OPERATION

Structure

The remote control valve contains four push rods, spring holders, spools and return springs, which are located 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 switch is installed in the valve handle. Gear pump pressure is used for operating control spools.

Function

1. Neutral Mode

   When the lever is in neutral mode, the spool is thrust upward by return spring, and 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 Mode

   When push rod is pushed, the balance spring begins to compress, and spring force is conveyed to the spool. Ports P and T are then connected together and the pilot pressure is conveyed to the area. Output pressure works on the bottom of the spool, thrusting the spool upward until it is balanced with the power of the balance spring. The secondary pressure (output pressure), therefore, changes in proportion to the compression force of the balance spring.

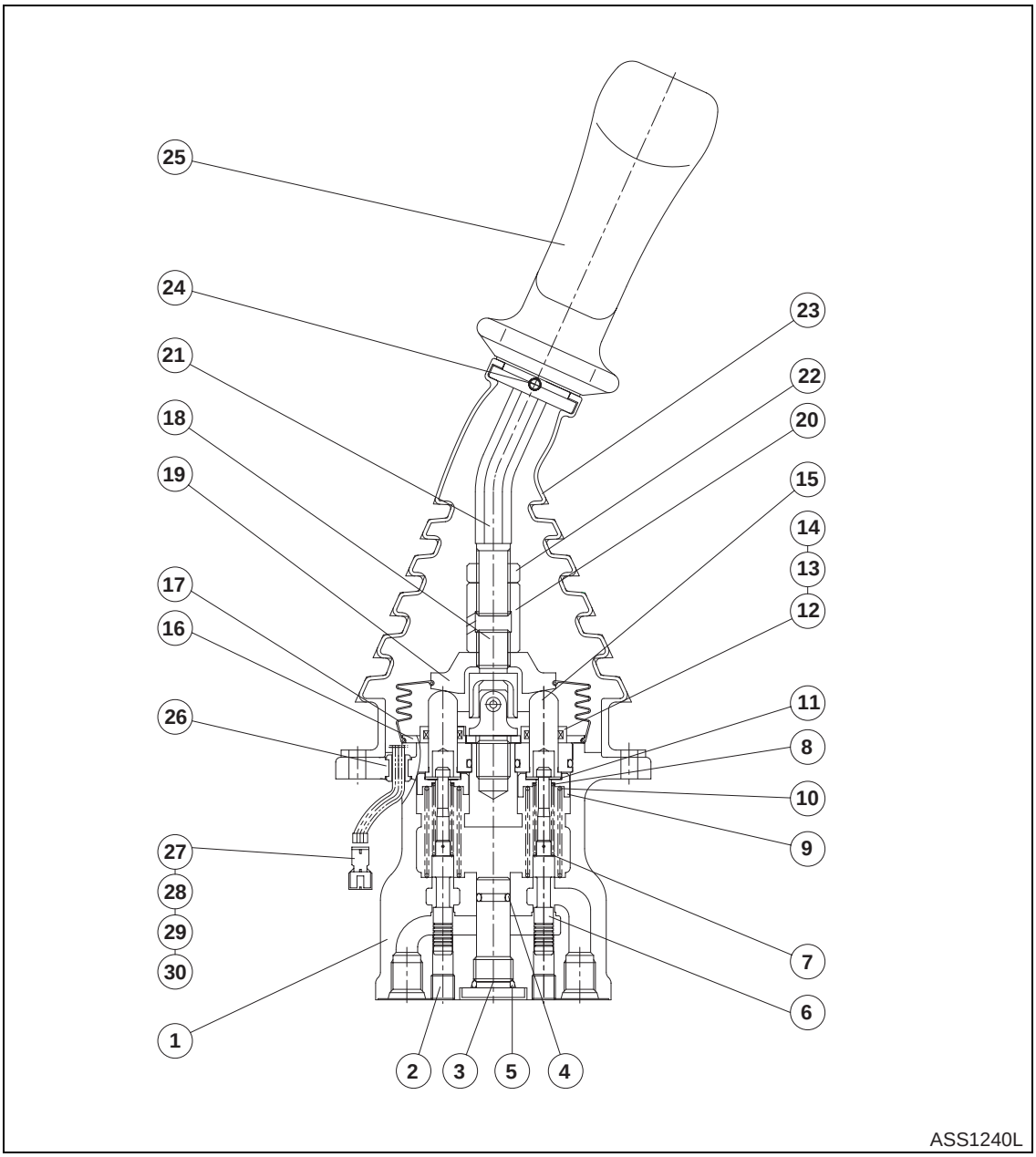

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ASS1240L

Figure 1

Reference Number	Description
1	Case
2	Plug
3	Plug
4	O-ring
5	O-ring
6	Spool
7	Shim
8	Spring
9	Spring Seat
10	Spring
11	Stopper
12	Plug
13	O-ring
14	Rod Seal
15	Push Rod

Reference Number	Description
16	Plate
17	Boot
18	Joint Assembly
19	Swash Plate
20	Hex Nut
21	Handle Bar
22	Nut
23	Boot
24	Spring Pin
25	Handle Assembly
26	Bushing
27	Terminal
28	Seal Wire
29	Housing
30	Rear Holder

SPECIFICATIONS

Component Name	Specification
Type	Pilot Control
Pressure / Stroke	28 kg/cm^2 @ 6.5 mm stroke (398 psi @ 0.256 in Stroke)
Weight	4.8 kg (10.58 lb)

Torques

Reference Number	Bolt Size	Tool	Torque
2	PT 1/8	5 mm L-Wrench	150 kg•cm (11 ft lb)
3	PF 3/8	8 mm L-Wrench	500 kg•cm (36 ft lb)
19	M14	27 mm Spanner	1,660 kg•cm (12 ft lb)
20	M14	22 mm Spanner	1,240 kg•cm (90 ft lb)
22	M14	22 mm Spanner	1,240 kg•cm (90 ft lb)

Performance

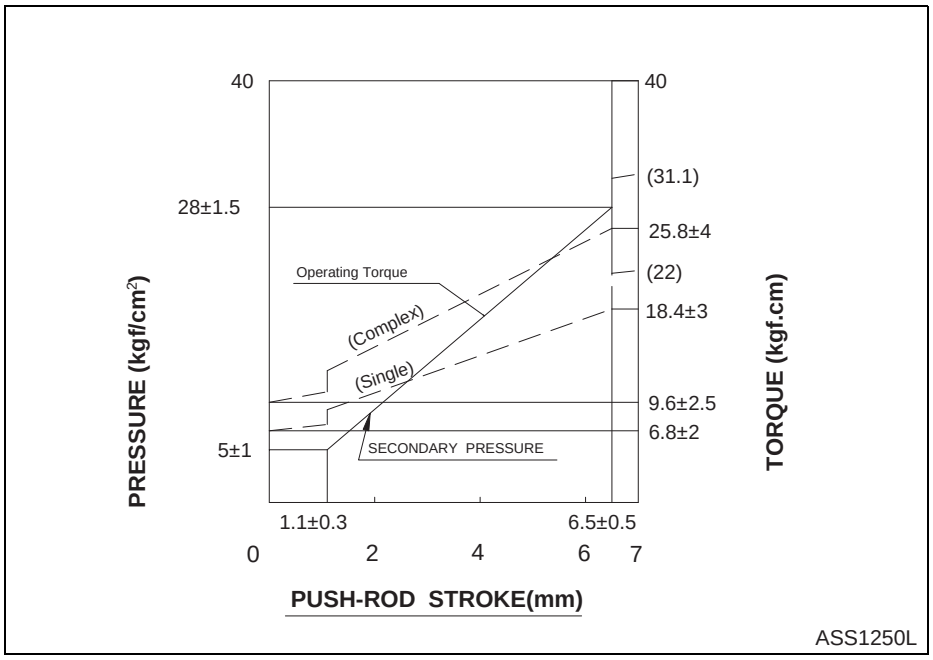


Figure 2

REMOVAL

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

> **WARNING!**
>
> **If engine must be run while performing maintenance, use extreme care. Always have one person in the cab at all times. Never leave the cab 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 "OFF" position and remove from starter switch.
9. Hang maintenance warning tag on controls.
10. Disconnect negative (-) battery cable leading to frame from battery.
11. Remove left and right control stand case (1 and 2, Figure 4).
12. Remove four socket bolts (3, Figure 4) holding joystick (5, Figure 4) to stand bracket.
13. Remove plate (4, Figure 4).
14. Using hand, lift joystick (5, Figure 4).

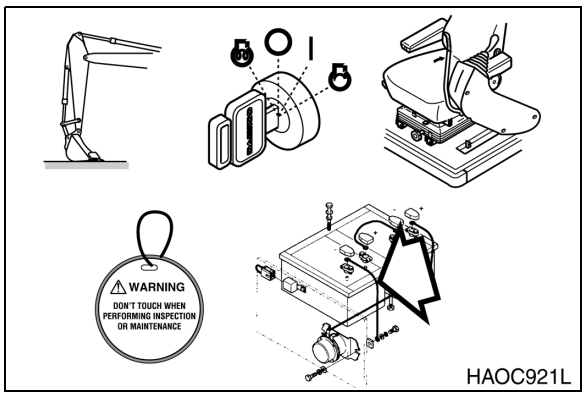


Figure 3

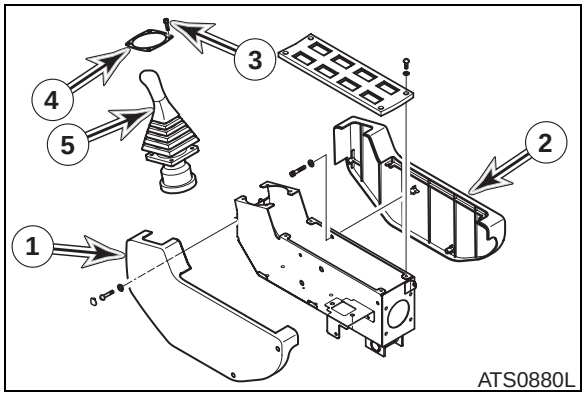


Figure 4

15. Tag and disconnect hoses from joystick valve (1, Figure 5).
16. Remove six fittings (3, Figure 5) and O-rings (2, Figure 5).

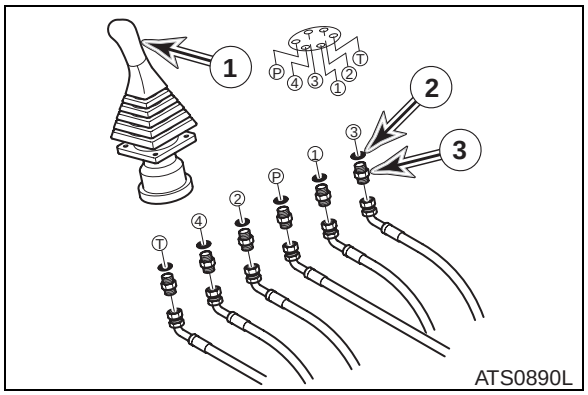


Figure 5

DISASSEMBLY

1. Lift up boot (23) and pull switch cord through hole in case (1).

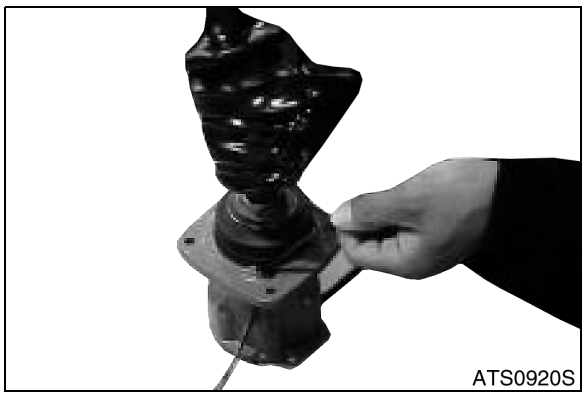


Figure 6

2. Loosen nut (22) from hex nut (20) and remove handle assembly (25).

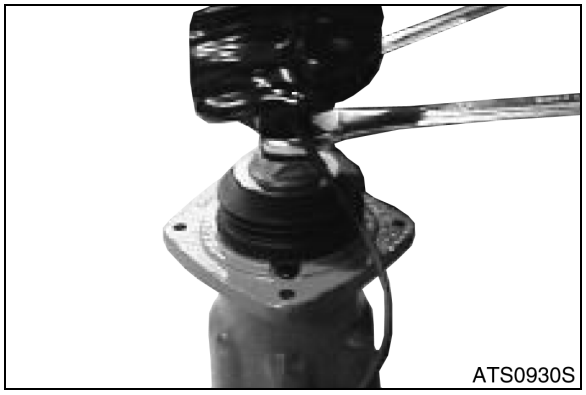


Figure 7

3. Remove hex nut (20) and swash plate (19).

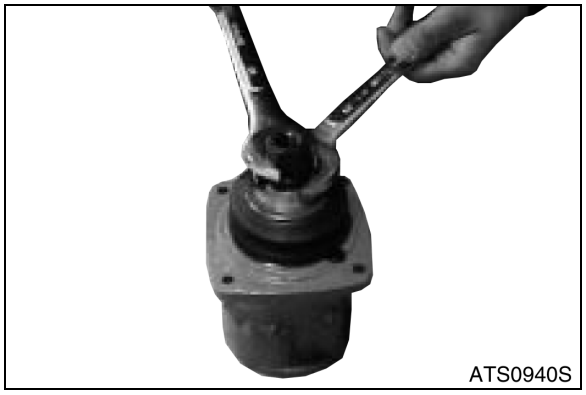


Figure 8

4. Remove boot (17).



Figure 9

5. Remove joint assembly (18) from case (1).

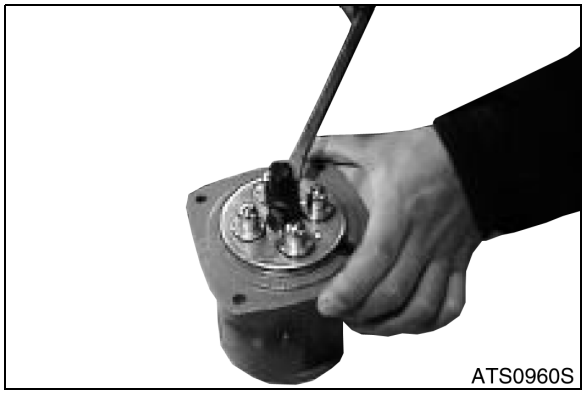


Figure 10

6. Remove plate (16).

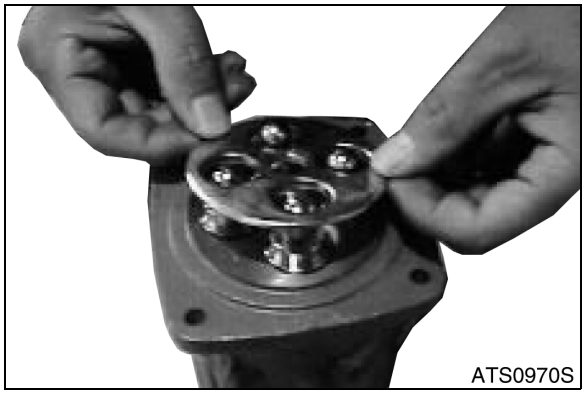


Figure 11

7. Press spring (10) and remove plug (12).

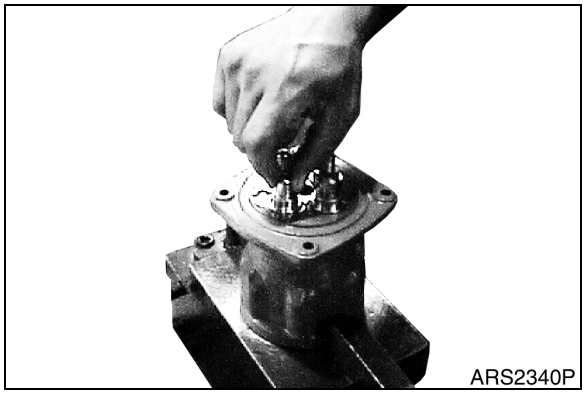


Figure 12

8. Remove pressure reduction valve (6, 7, 8, 9, 11) and spring (10).

IMPORTANT
Mark valve disassembling position (port).

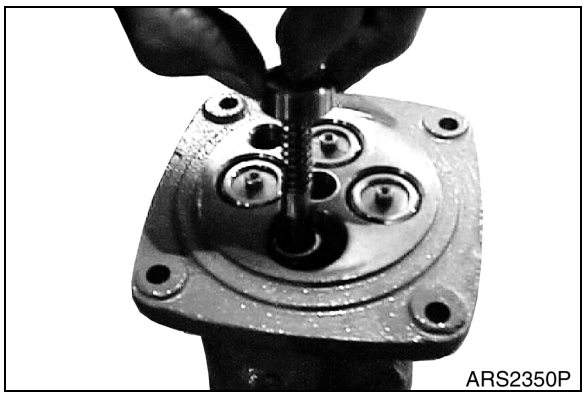


Figure 13

9. Remove plug (3).

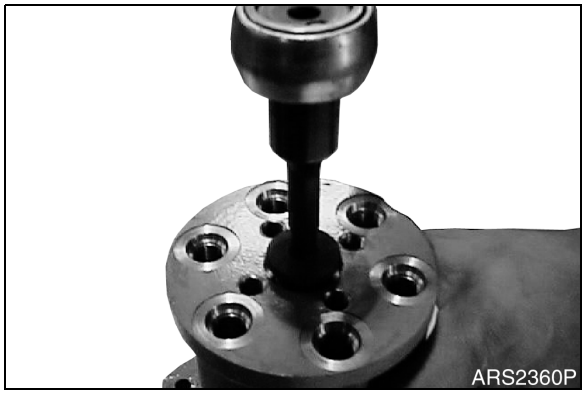


Figure 14

10. Remove stopper (11) from pressure reduction valve (6, 7, 8, 9, 11).

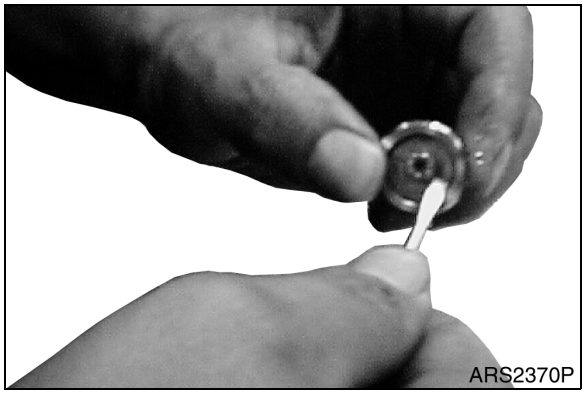


Figure 15

11. Remove spool (6), spring seat (9), spring (8) and shim (7).

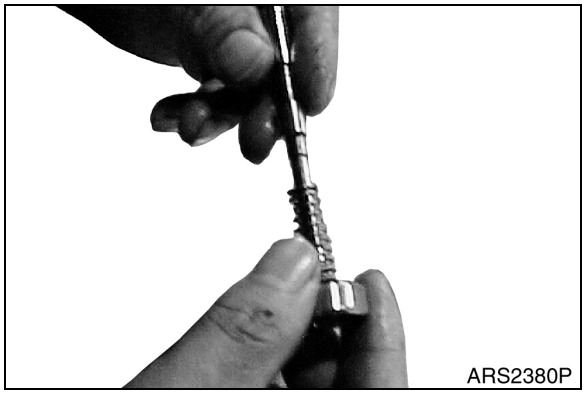


Figure 16

12. Remove push rod (15) and plug (12).

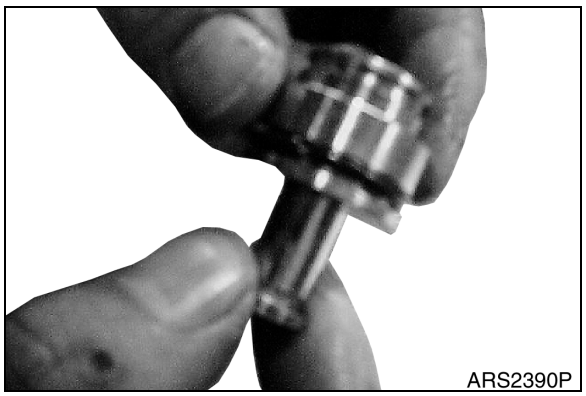


Figure 17

13. Remove O-ring (13) from plug (12).

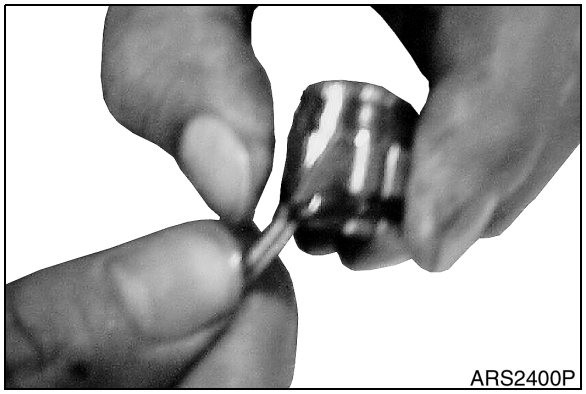


Figure 18

14. Remove seal (14) from plug (12).

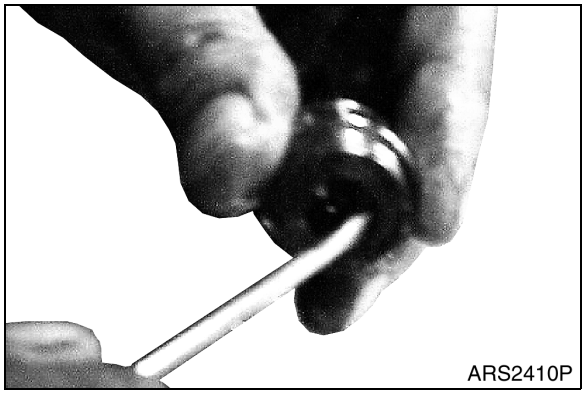


Figure 19

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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

Clean all parts and dry them with compressed air. Keep all parts free from dust. Lubricate all moving parts.

REASSEMBLY

1. Tighten plug (3) slowly.

   NOTE: *Torque: 350 kg•cm (25 ft lb).*

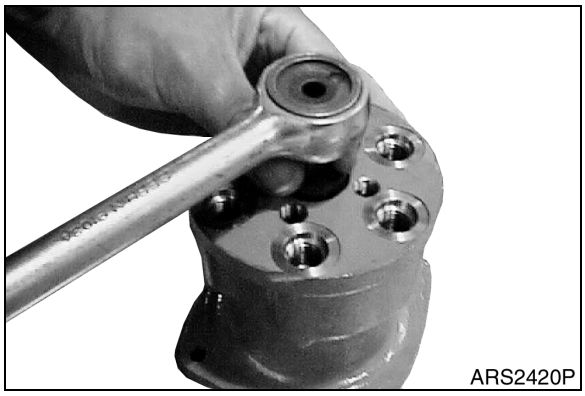


Figure 20

2. Install shim (7), spring (8), spring seat (9), and spool (6).

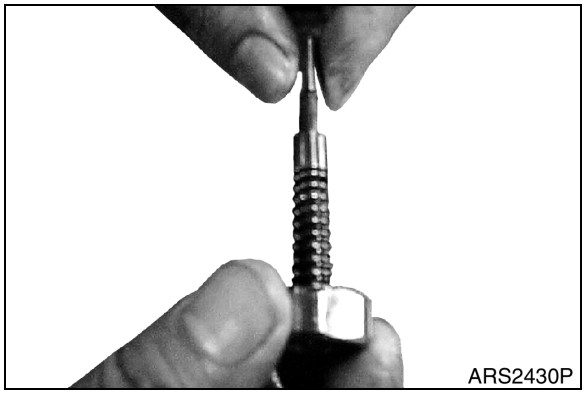


Figure 21

3. Press spring (10) and install stopper (11).



Figure 22

4. Install spring (10) in case (1) and pressure reducing valve assembly (6, 7, 8, 9, 11).

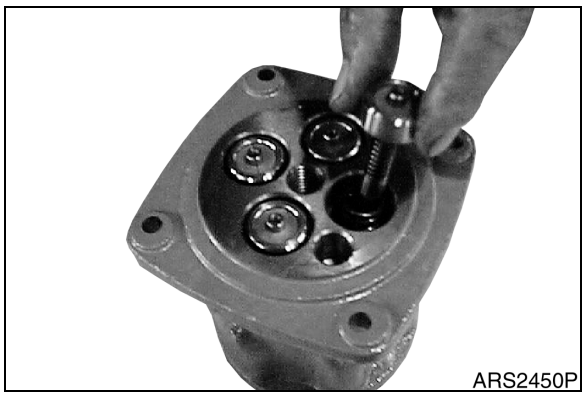


Figure 23

5. Install seal (14) on plug (12).



Figure 24

6. Install O-ring (13) on plug (12).



Figure 25

7. Install push rod (15) on plug (12).

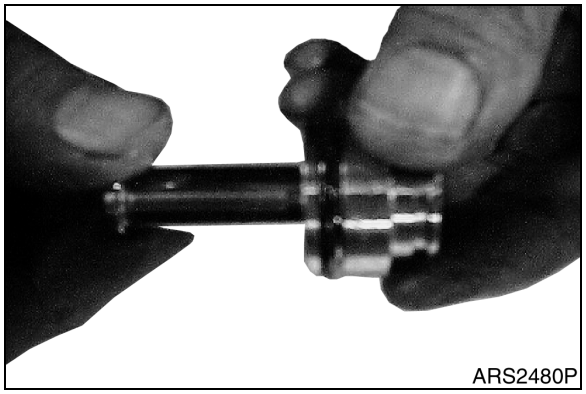


Figure 26

8. Install plug (12) in case (1).



Figure 27

9. Install plate (16).

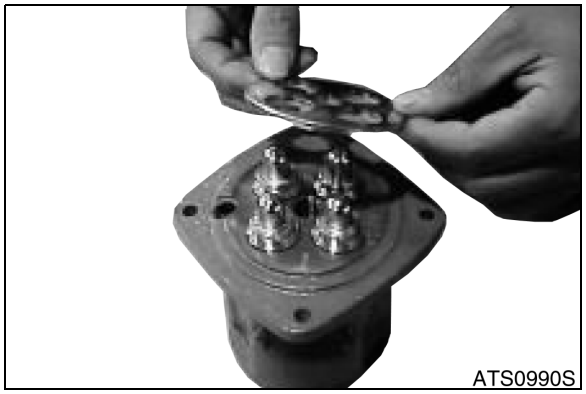


Figure 28

10. Tighten joint assembly (18).

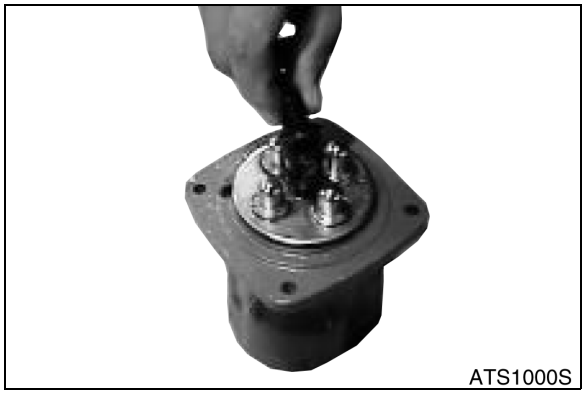


Figure 29

11. Install swash plate (19) on joint (18).

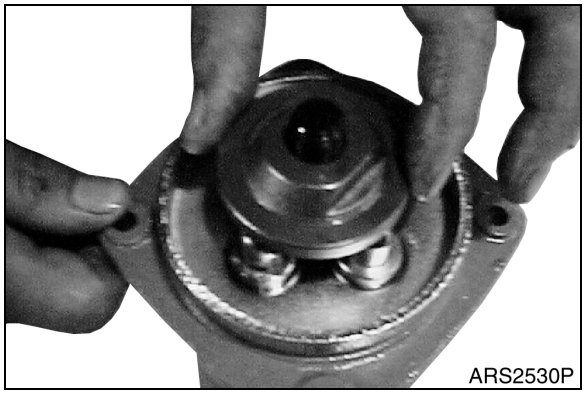


Figure 30

12. Install hex nut (20) and tighten swash plate (19).

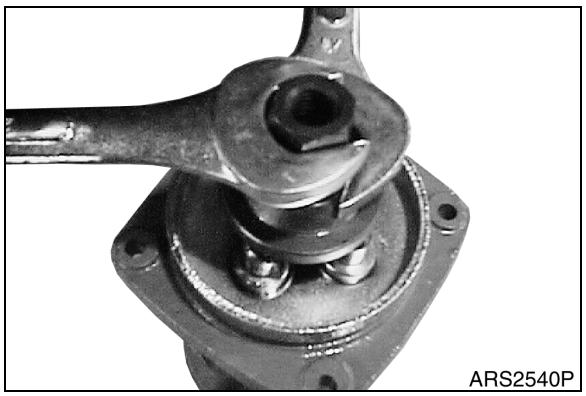


Figure 31

13. Grease joint (18), swash plate (19) and push rod (15).

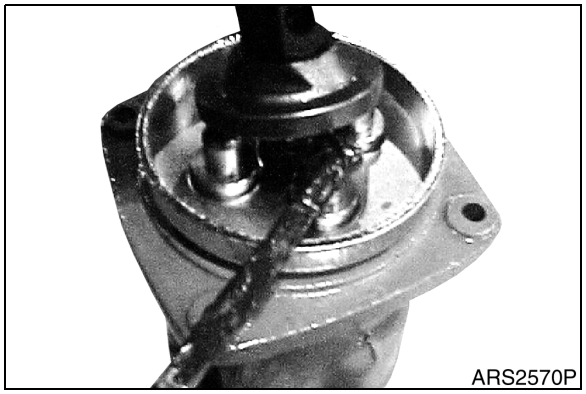


Figure 32

14. Install boot (17).

    NOTE: *Apply grease onto fitting surface swash plate and push rod.*



Figure 33

15. Align direction of handle (25) and tighten hex nut (20) and nut (22).

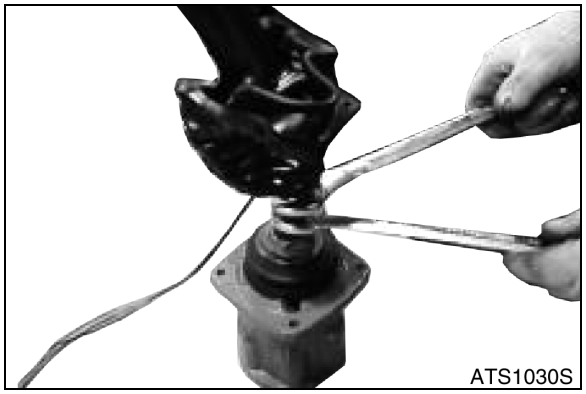


Figure 34

16. Push switch cord through hole in case (1).



Figure 35

17. Install boot (23).

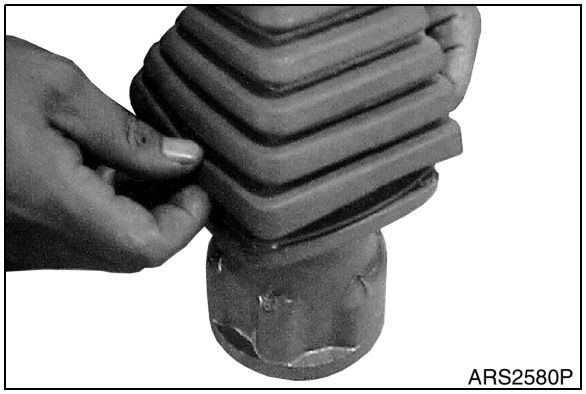


Figure 36

INSTALLATION

1. Install six fittings (3, Figure 37) and O-rings (2, Figure 37).
2. Connect hoses to joystick valve (1, Figure 37).

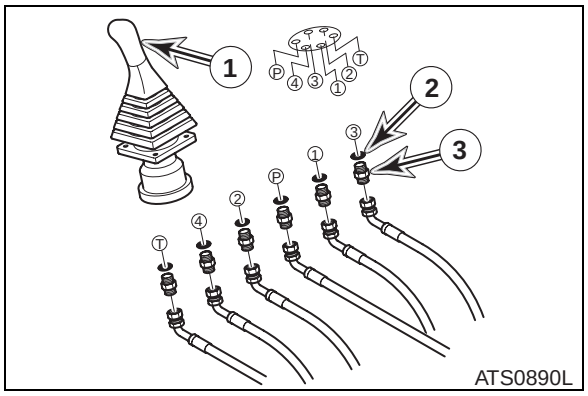


Figure 37

3. Install plate and four socket bolts top secure joystick (5, Figure 38) valve to control stand bracket.
4. Install left and right control stand case (1 and 2, Figure 38).

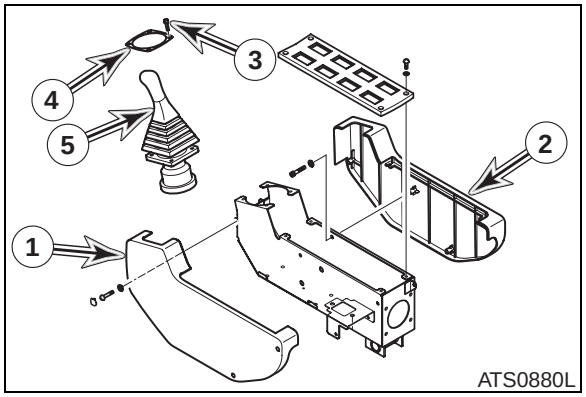


Figure 38

START-UP PROCEDURES

1. Start engine and set throttle at "LOW IDLE".
2. Set safety lever on "UNLOCK" position.

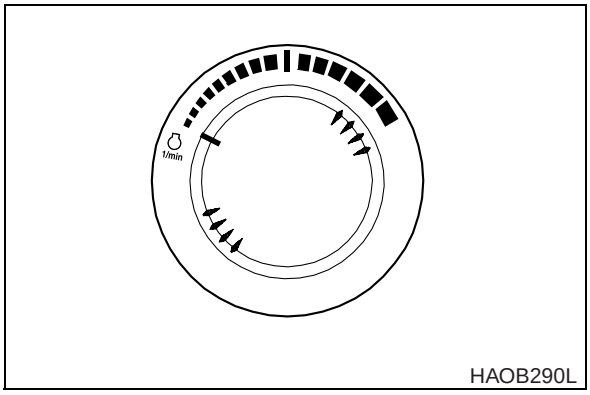


Figure 39

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 5 minutes.

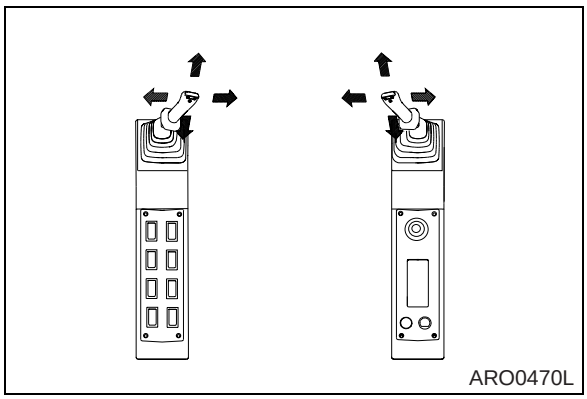


Figure 40

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

TRAVEL CONTROL VALVE (WITH DAMPER)

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 340LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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May 2002

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Start-up Procedures 24

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.

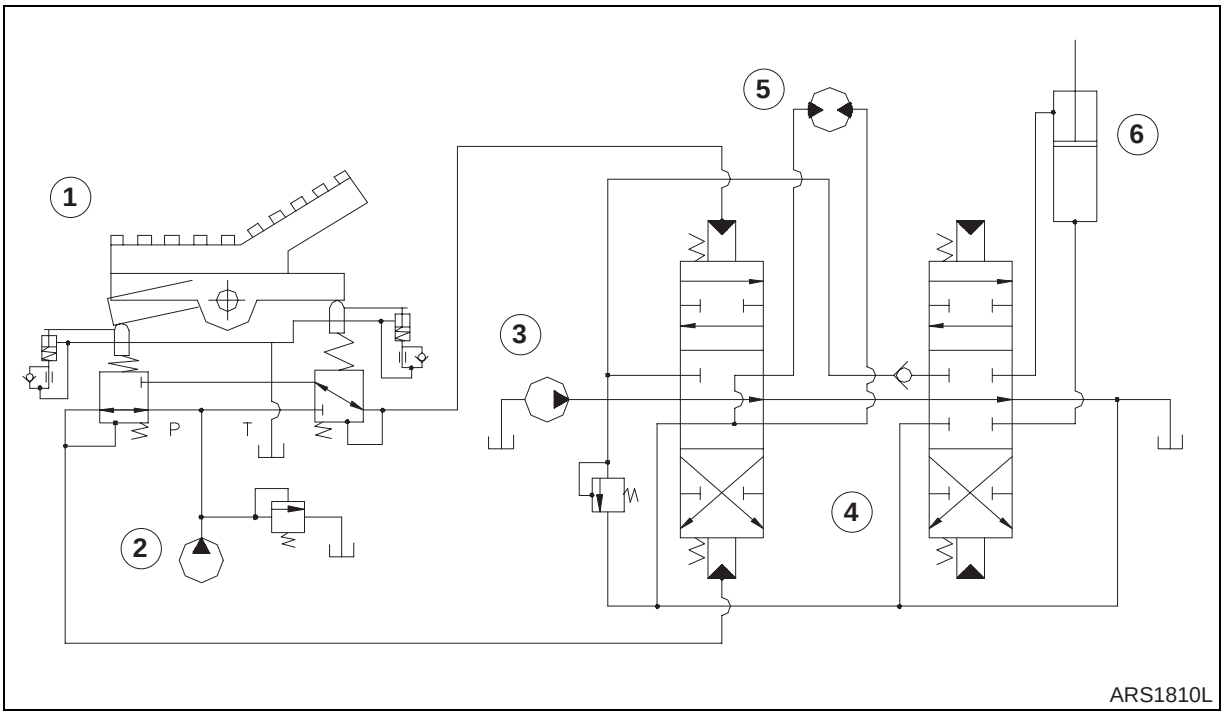


Figure 1

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

Pressure Reducing Valve

1. Neutral Condition

   If pedal is in neutral, spool is pushed up by return spring and spring seat. Port (P) is blocked by bottom part of spool and four operating ports (left forward and backward, right forward and backward) are connected to port (T) through inner hole of spool.

2. Half Operation Condition

   If pedal is moved, push rod moves down, and they transmit this force through spring seat and control spring to spool. If spool is moved, primary pressure is transmitted through an inner hole of spool to operating port. If lever is stopped in middle position, compressed control spring force and secondary pressure transmitted through hole acts at bottom part of spool, balance is maintained by hydraulic force acted upward, and then this pressure is transmitted to traveling spool of control valve. That is,

primary pressure is transmitted to operating port as secondary pressure equivalent to control spring force compressed by spool.

3. Full Operating Condition

   If pedal is moved to a maximum, bottom part of push rod presses spool seat to a maximum, and compresses control spring to a maximum. Primary pressure is transmitted through inner hole of spool to operating port, secondary pressure transmitted through spool overcomes control spring force and pushes spool up, but spool is restricted by push rod and does not move any more. That is, when pedal lever is moved to a maximum, control spring does not function, spool is restricted by push rod, and then primary pressure equalizes to secondary pressure.

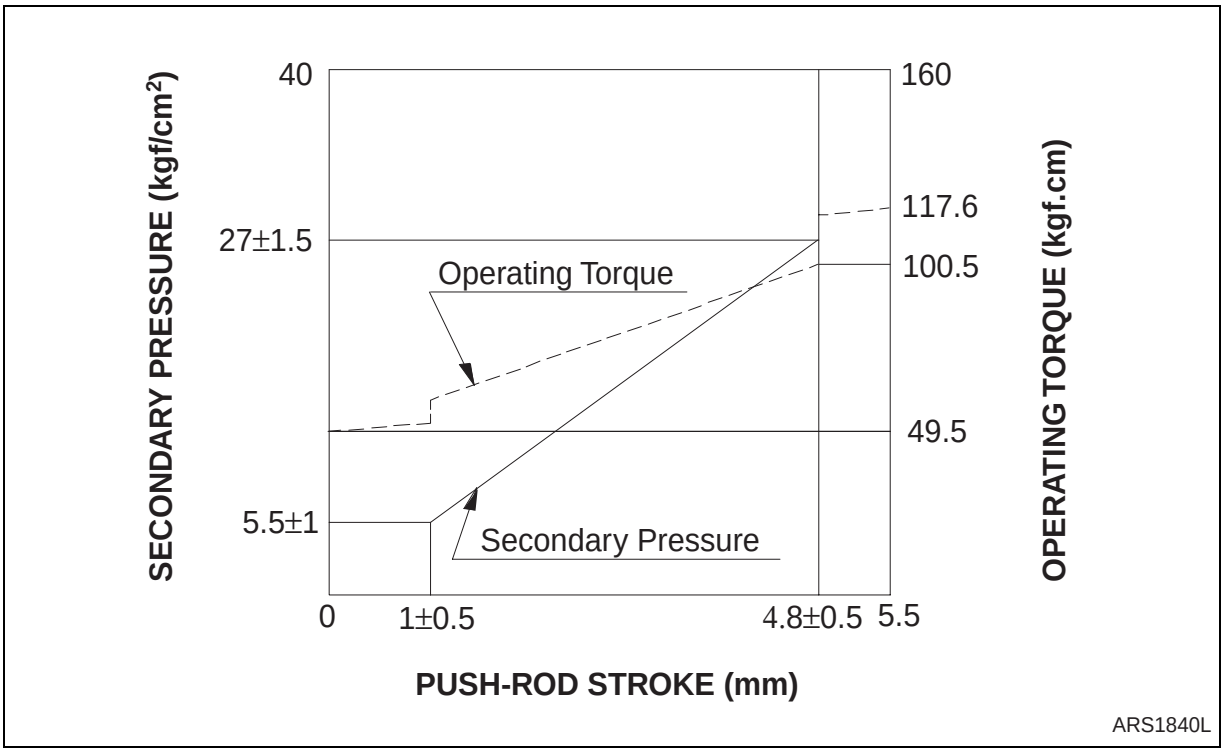


Figure 2

Operating Theory of Damper Mechanism

1. Operation When Operating Lever

   When pushing pedal, pushing force pushing push rod and spool presses cylinder, return spring and hydraulic oil in cylinder is compressed, piston coming down with push rod compresses vibration prevention chamber of lower part, oil of vibration prevention chamber of lower part is flowed through orifice to oil pressure vibration prevention chamber of upper part of low pressure, at this time, ball check valve becomes closing condition because high pressure operates to vibration prevention chamber of lower part.

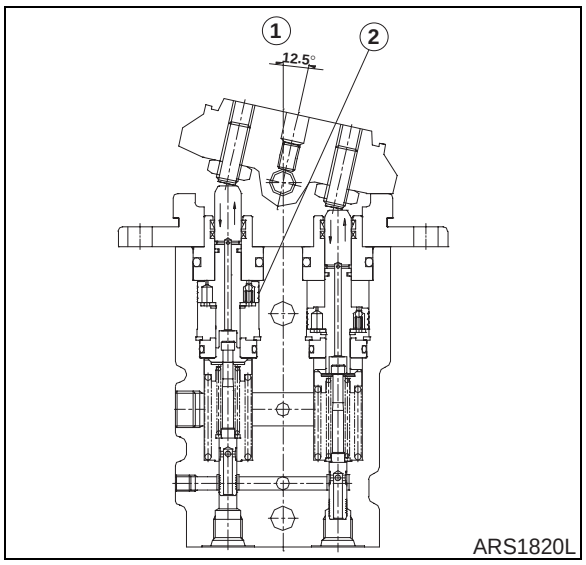


Figure 3

2. Operation When Operating Lever In Neutral Condition

   Climbing restoring force acting on push rod, raises piston in oil pressure prevention chamber and compresses upper oil pressure prevention chamber. This compression operation of upper oil pressure prevention chamber prevents the push rod from quickly rising by restoring spring, and the damping force is generated.

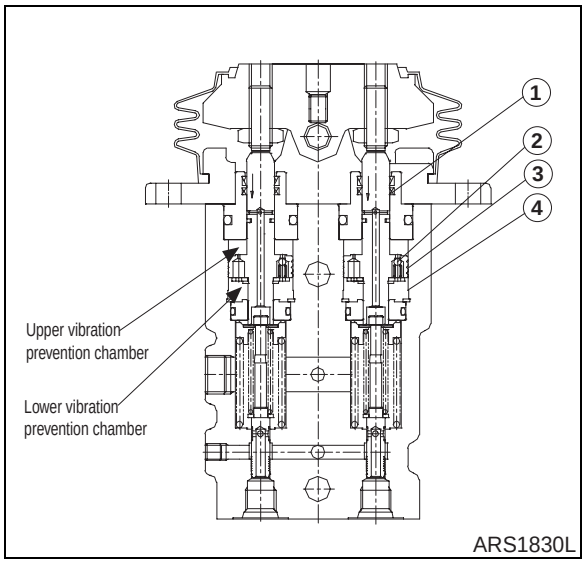


Figure 4

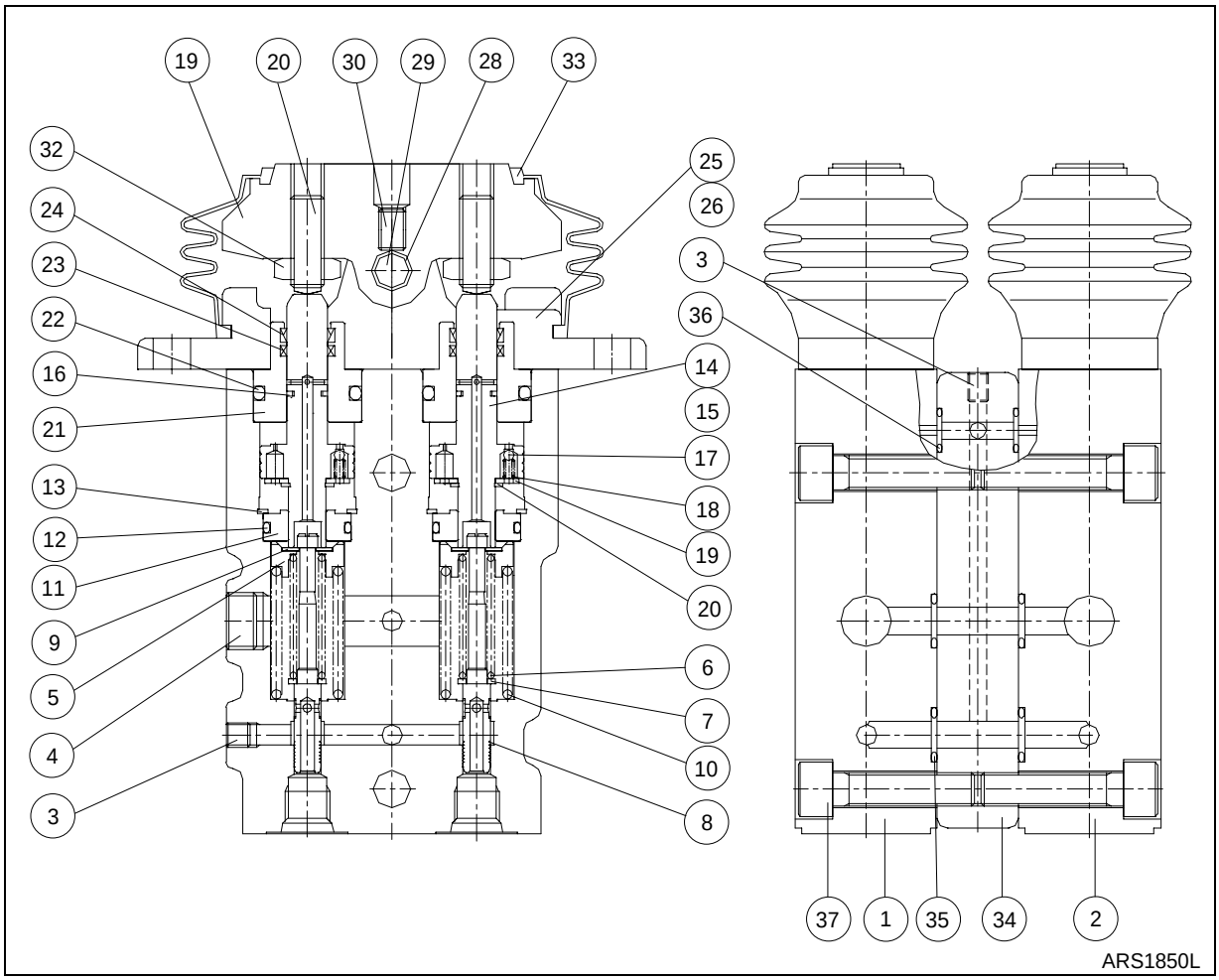


Figure 5

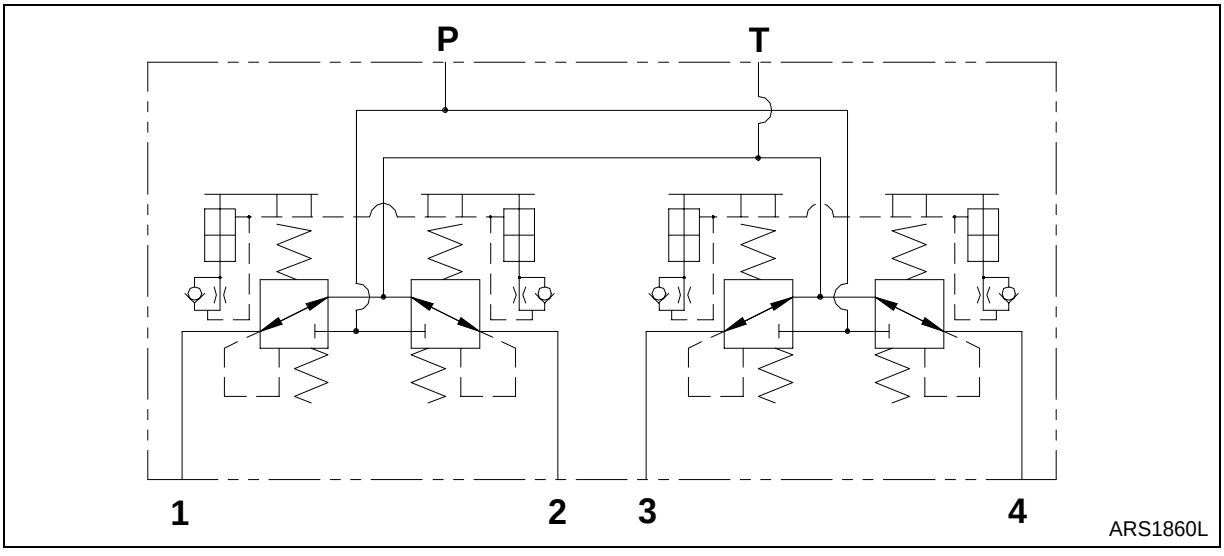


Figure 6

Reference Number	Description
1	Body (1)
2	Body (2)
3	Plug
4	Plug
5	Spring Seat
6	Spring
7	Spring Seat
8	Spool
9	Stopper
10	Spring
11	Rod Guide
12	O-ring
13	Snap Ring
14	Push Rod
15	Spring Pin
16	Seal
17	Steel Ball
18	Spring
19	Plate

Reference Number	Description
20	Snap Ring
21	Plug
22	O-ring
23	Rod Seal
24	Dust Deal
25	Cover
26	Wrench Bolt
27	Cam
28	Bushing
29	Camshaft
30	Set Screw
31	Set Screw
32	Hex Nut
33	Bellows
34	Space
35	O-ring
36	O-ring
37	Wrench Bolt

SPECIFICATION

Travel Control Valve	Specification
Type	Pilot Control (With Damper)
Pressure / Stroke	27 kg/cm^2 @ 4.8 mm Stroke (384 psi @ 1.890 in. Stroke)
Weight	7.8 kg (17.2 lb)

TORQUE

Part Reference Number	Bolt Size	Tool	Tightening Torque
26	M6	5 mm L-Wrench	88 kg•cm (6.37 ft lb)
30	M8	4 mm L-Wrench	100 kg•cm (7.23 ft lb)
32	M10	17 mm Spanner	440 kg•cm (31.8 ft lb)
37	M10	8 mm L-Wrench	440 kg•cm (31.8 ft lb)

TROUBLESHOOTING, TESTING AND ADJUSTMENT

At times pinpointing the source of the problem may be difficult. The following table lists some possible problems, causes and remedies. Refer to this table for possible causes and remedies to help in correcting problems.

The table only lists general problems, causes and 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 listed 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 spool and casing is abnormally large.	Replace 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 unconnected parts.	Repair/replace cause of jamming.
No damping.	Jamming of interconnected parts.	Repair/replace cause of jamming.
	Worn damping piston and housing.	Replace damping piston and housing assembly.
	Defective/damaged check valve.	Disassemble and examine check valve.
	Worn damping piston orifice.	Replace damping piston.
Damping piston feels heavy.	Defective interconnected components.	Repair/replace defective parts.
	Restricted movement of damping piston.	Repair/replace damaged piston.
	Plugged orifice.	Replace related parts.

REMOVAL

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

> **WARNING!**
>
> **If engine must be run while performing maintenance, use extreme care. Always have one person in the cab at all times. Never leave the cab 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 "OFF" position and remove from starter switch.
9. Hang 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 8). Plug and cap hoses and ports to prevent contamination from entering hydraulic system or component.

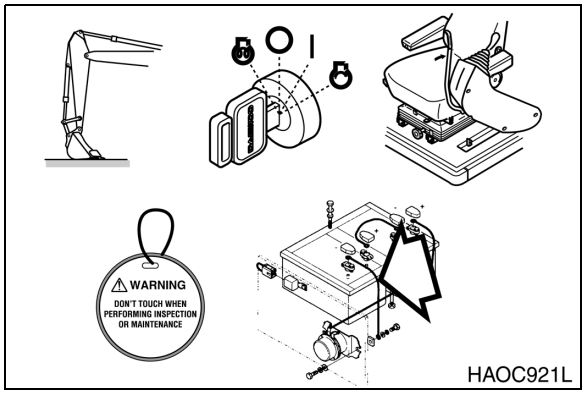


Figure 7

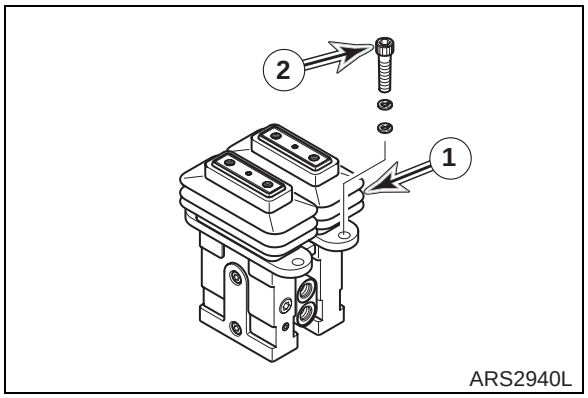


Figure 8

13. Remove rubber boots (1, Figure 9).
14. Remove four bolts and washers (2, Figure 9), pedal brackets (3) with levers.

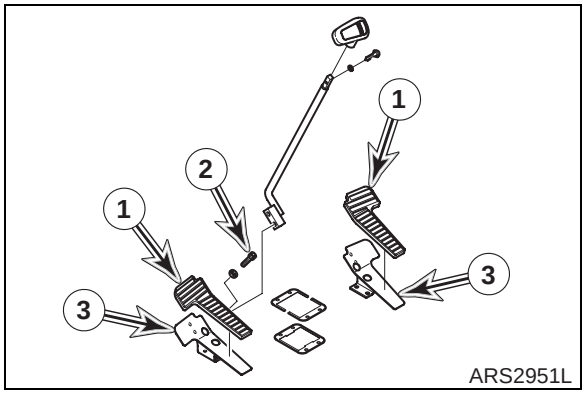


Figure 9

15. Remove four bolts and washers (2, Figure 10), and pedal valve (1).

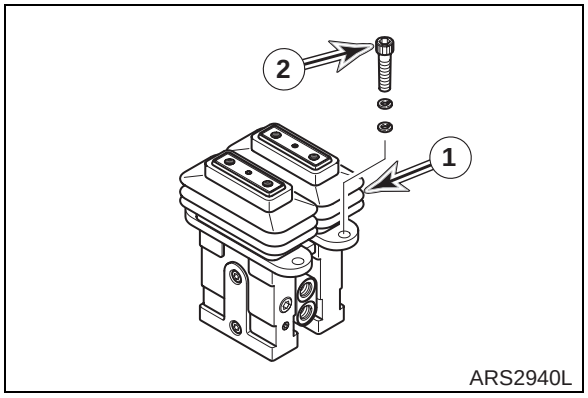


Figure 10

DISASSEMBLY

IMPORTANT

1. **Prepare a clean, well lit, stable work bench where disassembly can be performed.**
2. **Prepare the necessary tools, materials and a container in which disassembled parts can be stored.**
3. **All precision parts must be handled with great care and all parts must be reassembled to their original position.**
4. **All parts must be carefully reassembled and not be forced. Damaged parts will cause oil leaks and poor performance of the equipment.**
5. **Do not leave parts exposed to air during or after disassembly. Exposed parts will come in contact with contaminants and will cause rust and damage.**

1. Remove bellows (33).

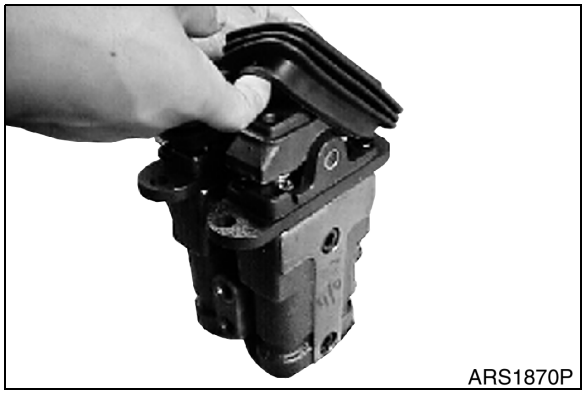


Figure 11

2. Remove set screw (30) by using L wrench.

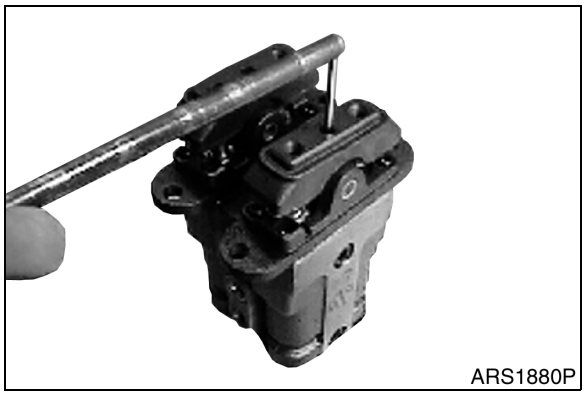


Figure 12

3. Remove cam shaft (29) and bushing (28) from cam (27).

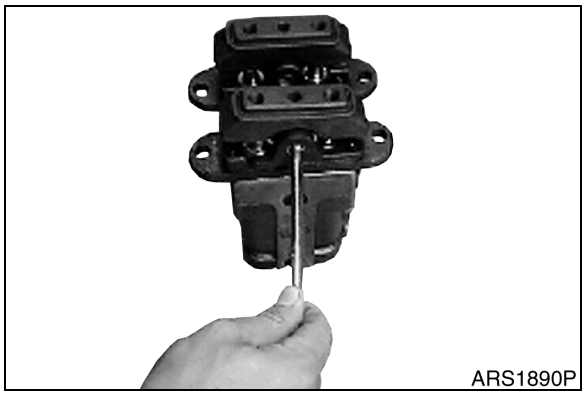


Figure 13

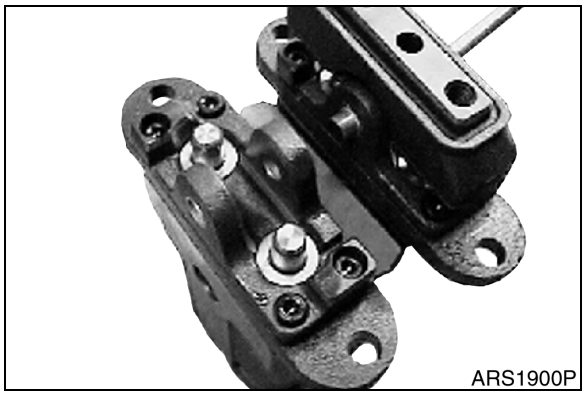


Figure 14

4. Remove cam (27) from cover (25).

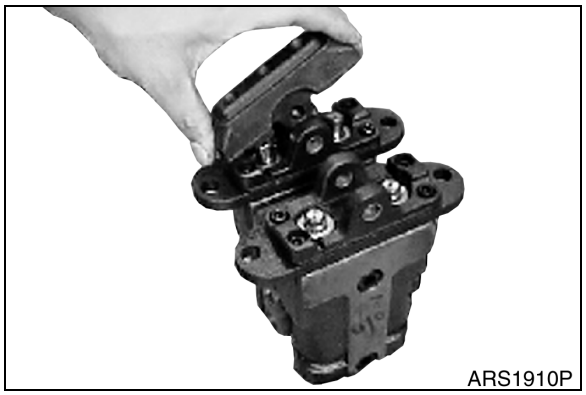


Figure 15

5. Remove wrench bolt (26) by using tool.

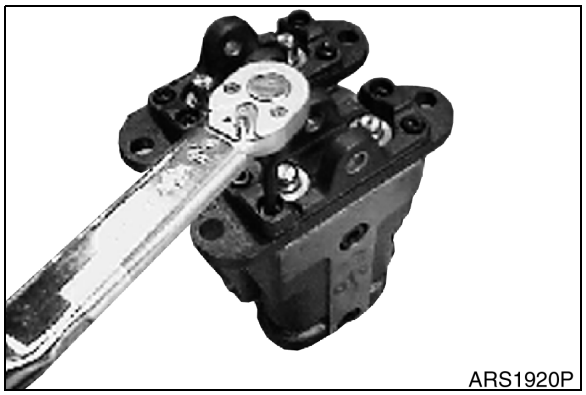


Figure 16

6. Remove cover (25) from body (1 and 2).

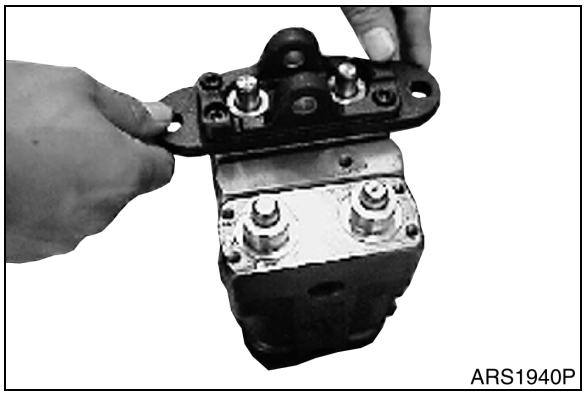


Figure 17

7. Remove plug assembly (21 - 24) with push rod assembly (14 - 20).

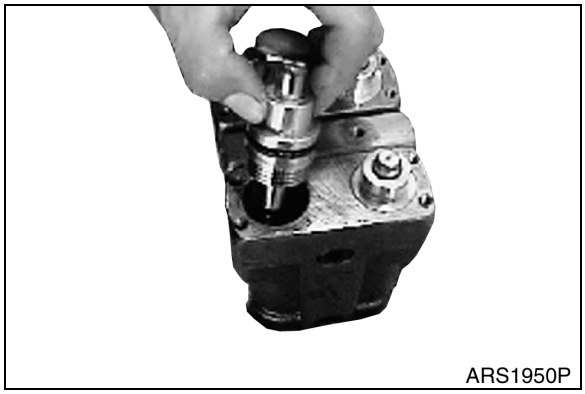


Figure 18

8. Remove snap ring (13).

IMPORTANT
Be careful not to spring rod guide (11).

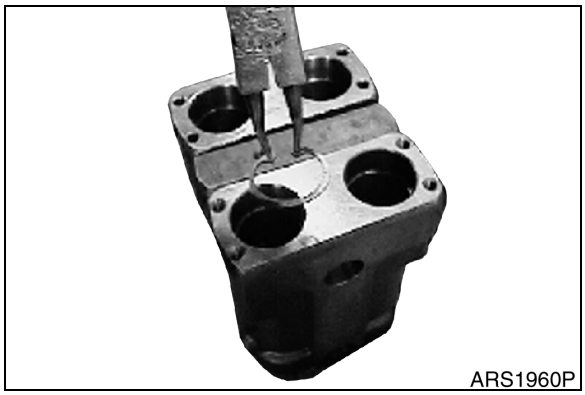


Figure 19

9. Remove rod guide (11).

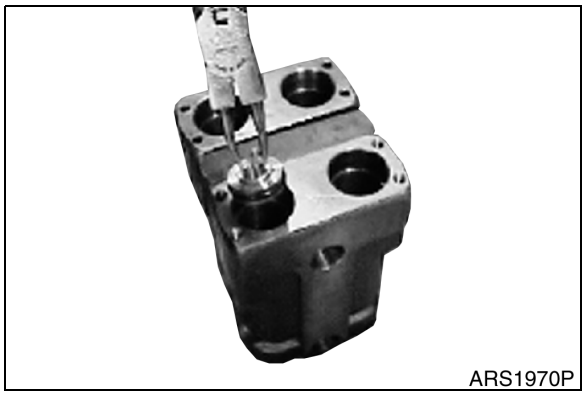


Figure 20

10. Remove spool assembly (5 - 9).

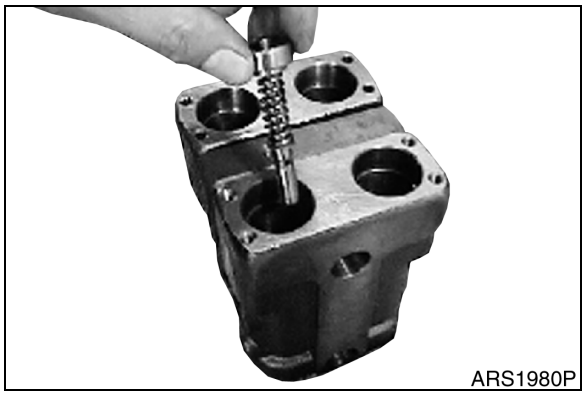


Figure 21

11. Remove spring (10).

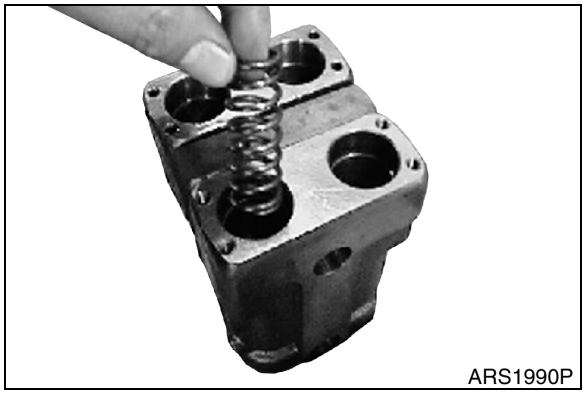


Figure 22

12. Remove stopper (9), spring (6) and spring seat (7) from spool assembly (5 - 9).

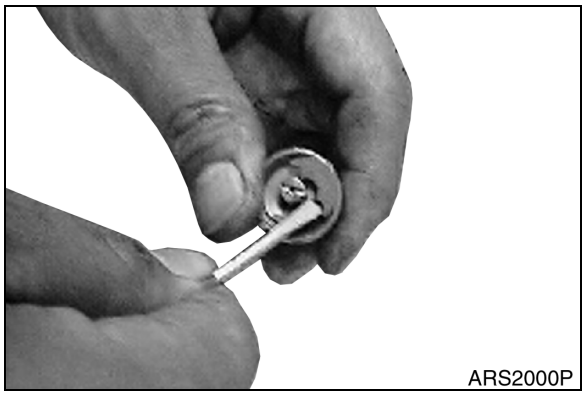


Figure 23

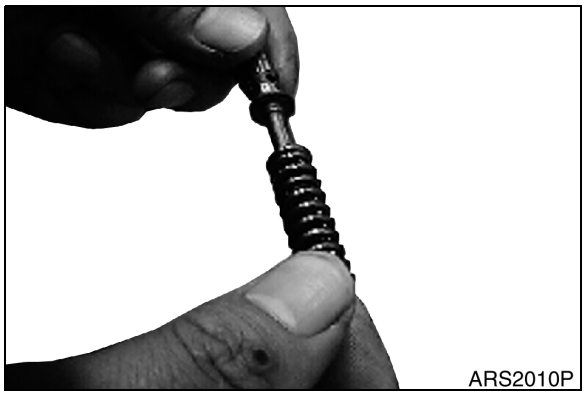


Figure 24

13. Remove plug assembly (21 - 24) from push rod assembly (14 - 20).

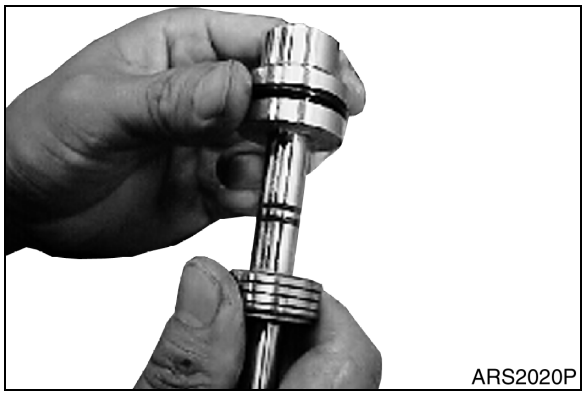


Figure 25

14. Remove seal (23 and 24) from plug (21).



Figure 26

15. Remove O-ring (22) from plug (21).

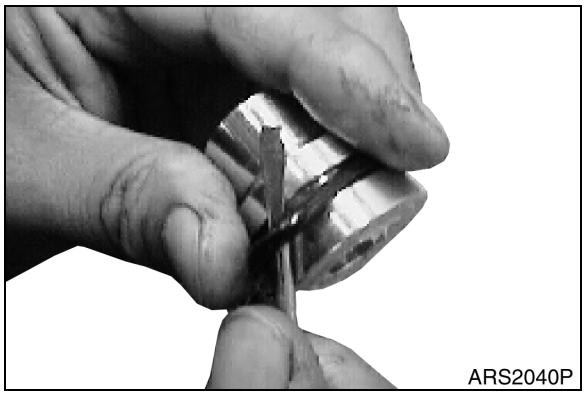


Figure 27

16. Remove seal (16) from push rod (14).

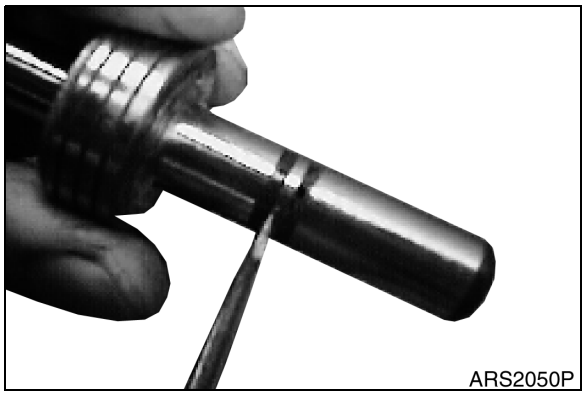


Figure 28

17. Remove snap ring (20) from push rod (14).

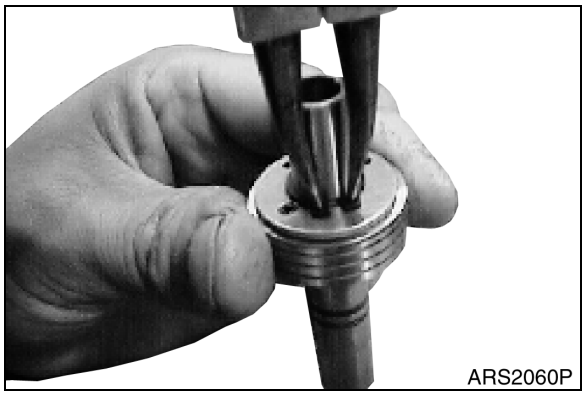


Figure 29

18. Remove plate (19) from push rod (14).

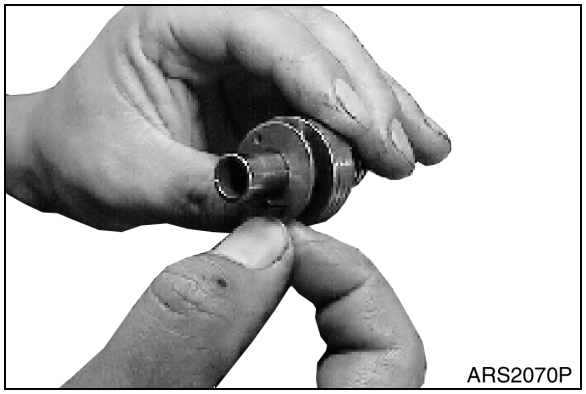


Figure 30

19. Remove spring (18) from push rod (14).



Figure 31

20. Remove steel ball (17) from push rod (14).

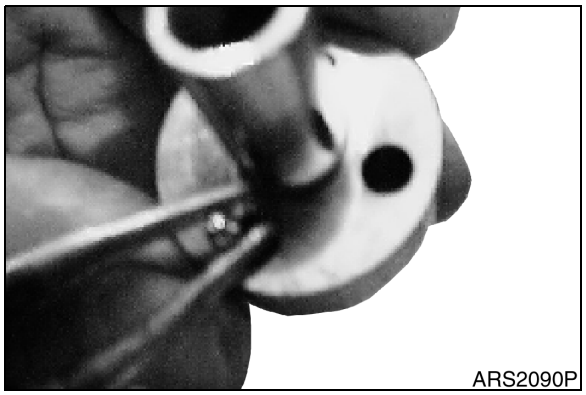


Figure 32

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

1. Cleaning disassembled parts.

    1. Place parts in a container with cleaning solvent.

    - Allow all parts to soak in solvent until grease and other foreign substances have dissolved and become loose, before cleaning.

    - Contaminated cleaning solvent may cause damage to parts and may cause poor equipment performance. Be sure to use clean, uncontaminated solvent when cleaning precision parts.

    2. Clean parts thoroughly by gently turning the solvent. Dry and clean each part with a clean cloth.

    - Do not use compressed air to dry parts. Foreign material and moisture present in compressed air may cause damage or rust.

2. Anti-corrosive treatment of disassembled parts.

    Apply an anti-corrosive lubricant to all disassembled parts.

    - Leaving cleaned parts exposed to contaminants and moisture in the air will cause rust and may cause poor equipment performance.

REASSEMBLY

IMPORTANT

1. **Prepare a clean, well lit, stable work bench where assembly can be performed.**
2. **Prepare the tools and materials necessary for reassembly process.**
3. **Inspect all parts, making sure that all parts are free from dirt and damage. If minor surface scratches are visible, use a very fine crocus cloth to clean it off.**
4. **Replace all O-rings and NHU packings with new ones. Use care when assembling O-rings and NHU packings.**
5. **Apply a light coat of approved lubricant to aid in smooth assembly.**
6. **Tighten all bolts to the specified torque rating as outlined in the torque table.**
7. **Seal all opens ports to prevent foreign material from entering the valve assembly.**
8. **All precision parts must be handled with great care and all parts must be reassembled to their original position.**
9. **All parts must be carefully reassembled and not be forced. Damaged parts will cause oil leaks and poor performance of the equipment.**
10. **Do not leave parts exposed to air during or after disassembly. Exposed parts will come in contact with contaminants and will cause rust and damage.**
11. **Grease must be applied to the top portion of each push rod.**
12. **Grease must be filled into each grease cup.**
13. **Spray Anti-rust lubricant into each bellows.**

1. Clean body (1 and 2) and all parts.
2. Install spring (10) on body (1 and 2).

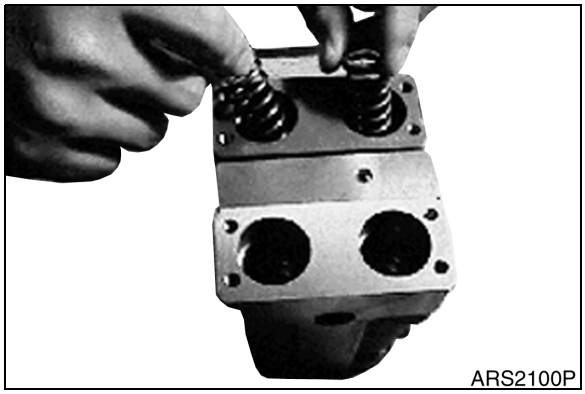


Figure 33

3. Clean plug (21) with thinner, inspect burrs and install rod seal (23) and dust seal (24) on both sides of plug by using tool.

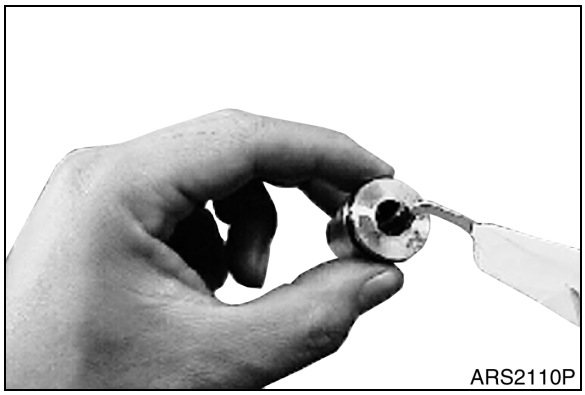


Figure 34

4. Install O-ring (22) on outside diameter of plug (21) and check plug whether it is abnormal.



Figure 35

5. Install spring seat (7), spring (6) and spring seat (5) on spool (8).

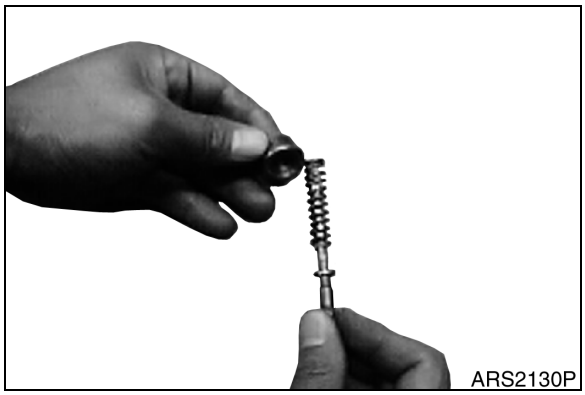


Figure 36

6. Install O-ring (12) on rod guide (11).

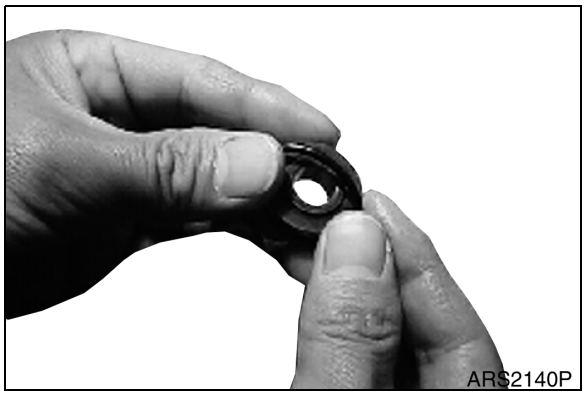


Figure 37

7. Install steel ball (17), spring (18), plate (19) and spring pin (15) on push rod (14).

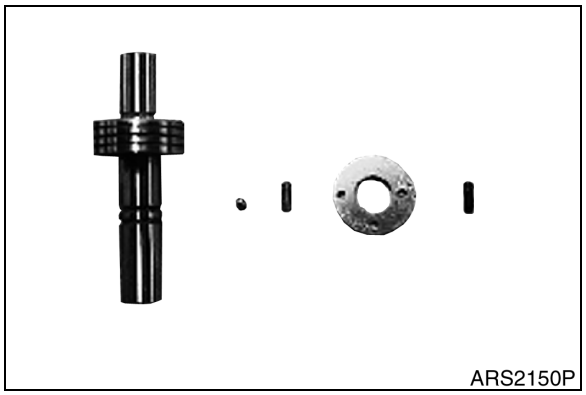


Figure 38

8. Install snap ring (20) on push rod assembly (14 - 19).



Figure 39

9. Install seal (16) on push rod (14).

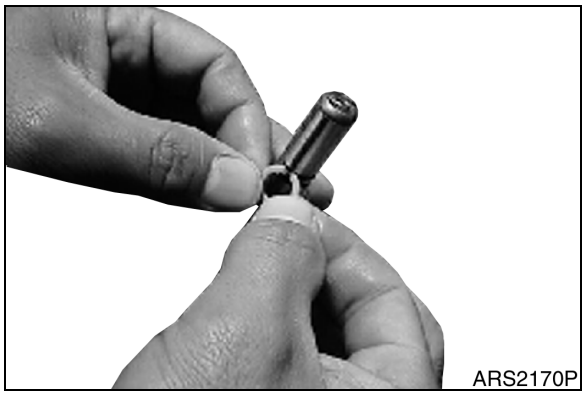


Figure 40

10. After installing spool assembly (5 - 9) on body (1 and 2), insert rod guide (11) and install snap ring (13).



Figure 41

11. Install plug assembly (21 - 24) with push rod assembly (14 - 20) on body (1 and 2).

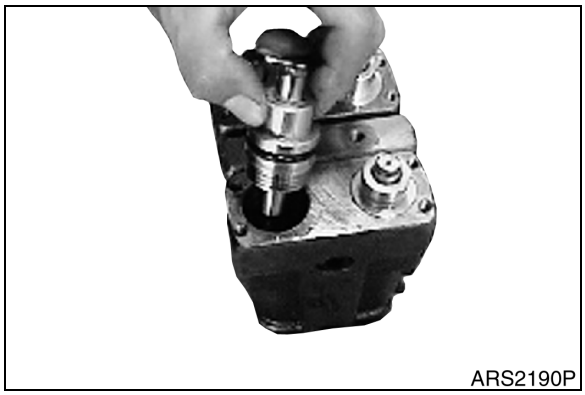


Figure 42

12. Install cover (25) on the upside of body (1 and 2).

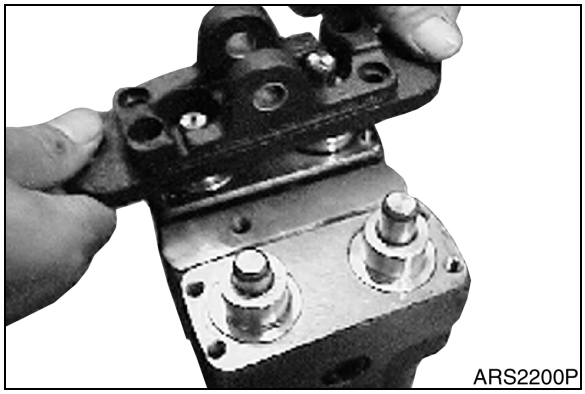


Figure 43

13. Tighten wrench bolt (26).

    NOTE: *Tightening torque: 88 kg•cm (6.37 ft lb).*

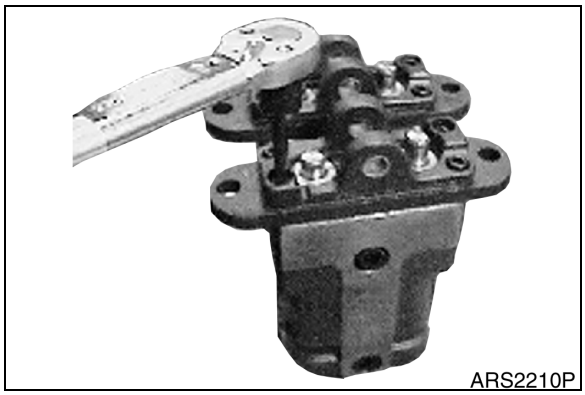


Figure 44

14. Put cam (27) on cover (25) and install cam shaft (29).

IMPORTANT
Check whether there is a play of cam.

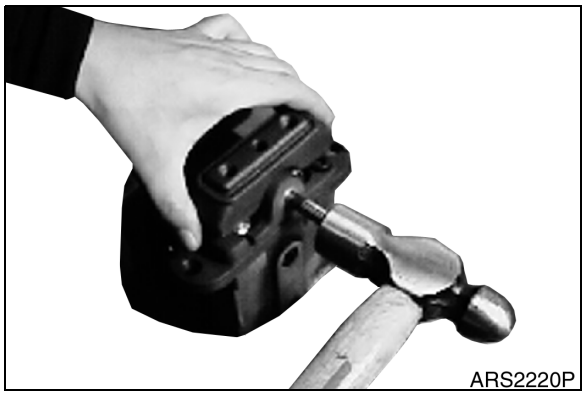


Figure 45

15. Tighten set screw (30) on center of cam (27) not to loose cam (27) and cam shaft (29) by using wrench.

    NOTE: *Tightening torque: 88 kg•cm (6.37 ft lb).*

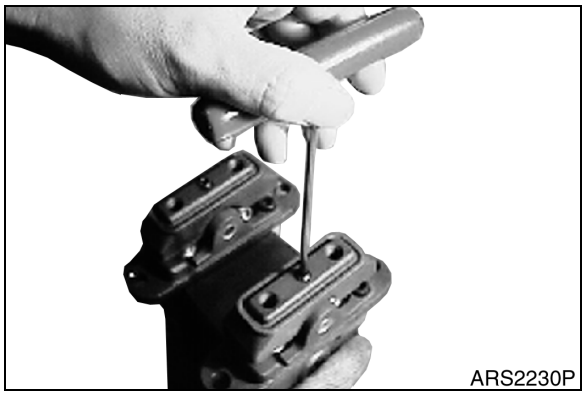


Figure 46

16. One side holds L wrench and the other side holds spanner and tighten set screw (31) and hex nut (32) attached to cam (27) not to loose.

IMPORTANT
Check whether there is a play of cam.

    NOTE: *Tightening torque: 440 kg•cm (31.8 ft lb).*

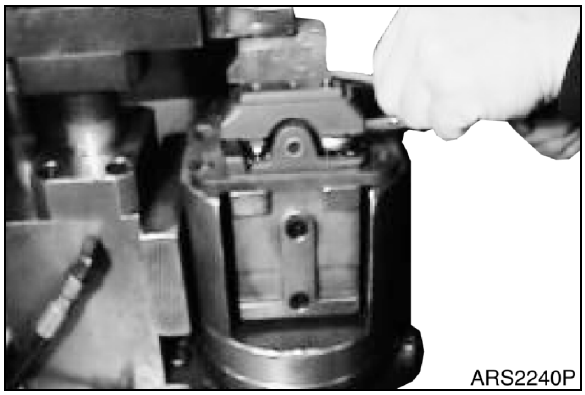


Figure 47

17. Install bellows.

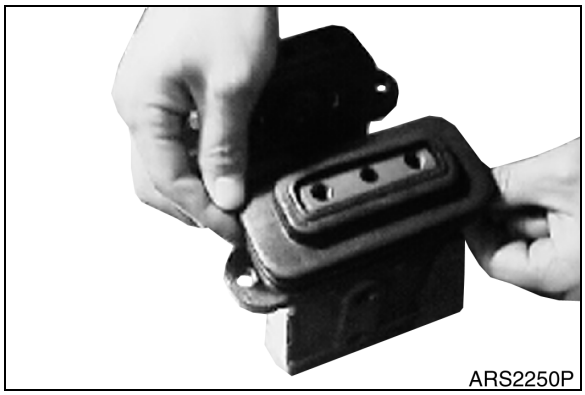


Figure 48

INSTALLATION

1. Position pedal valve (1, Figure 49) on cabin floor plate and install four bolts and washers (2).

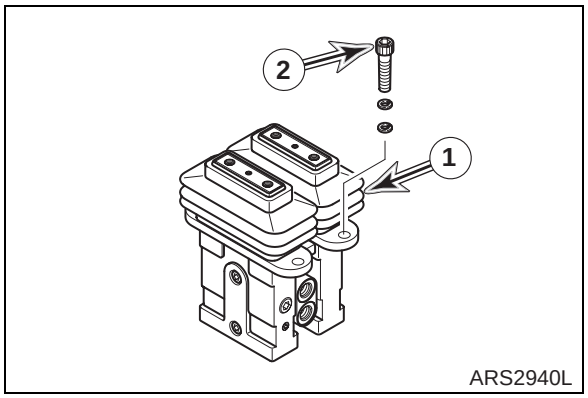


Figure 49

2. Install pedal brackets (3) and levers (4, Figure 50) on pedal valve and install four bolts and washers (2).
3. Install rubber boots (1, Figure 50).

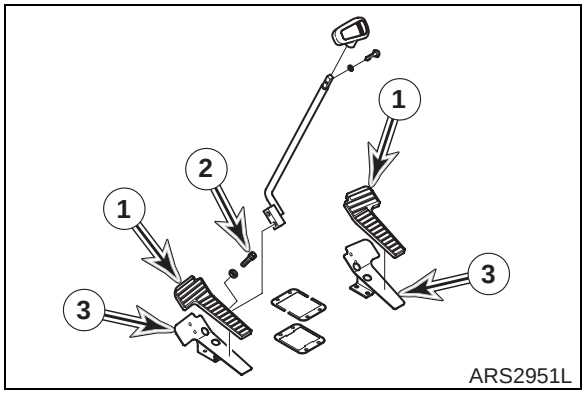


Figure 50

4. Connect hoses as tagged during removal to pedal valve (1, Figure 51).
5. Install cabin under cover by tightening bolts.

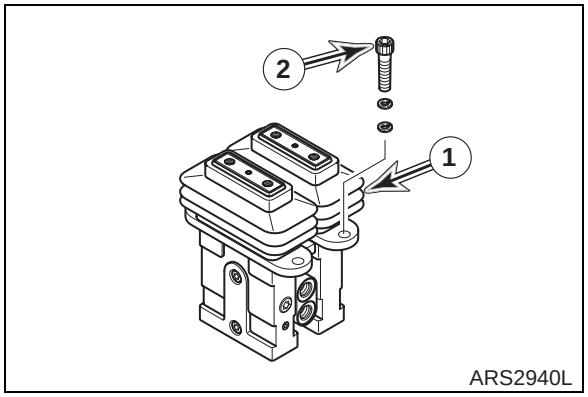


Figure 51

START-UP PROCEDURES

1. Start engine and set throttle at "LOW IDLE."
2. Set safety lever on "UNLOCK" position.

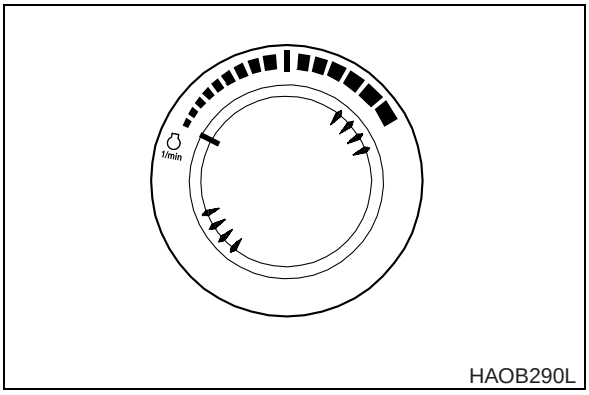


Figure 52

3. Slowly push and pull both travel lever about five times without a load to vent air from pilot lines.

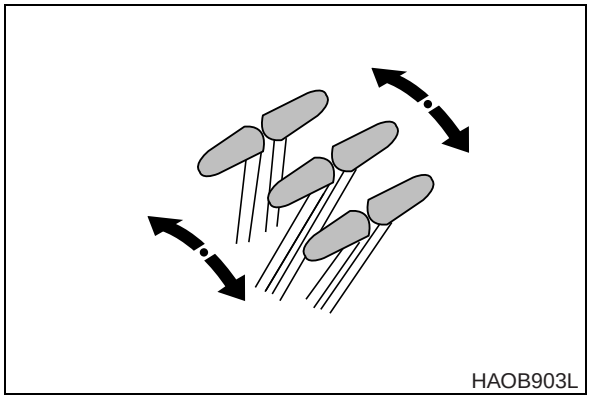


Figure 53

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

HYDRAULIC SCHEMATIC (S470LC-V)

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 470LC-V	1001 and Up

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May 2002

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GENERAL DESCRIPTION

Schematic(s) presented in this section are laid out on facing pages.

An overlapping edge has been taken into consideration so that a photocopy can be made and pasted together to make a complete schematic.

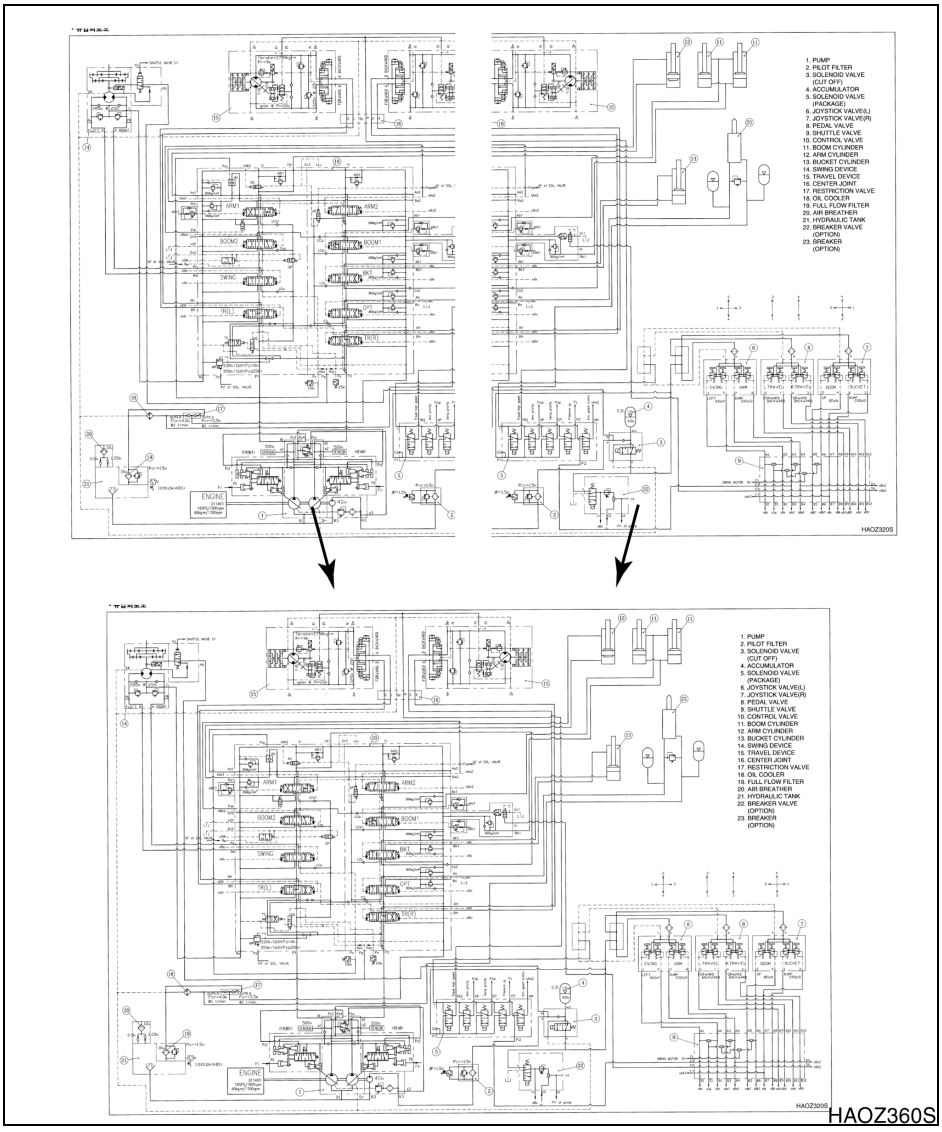


Figure 1

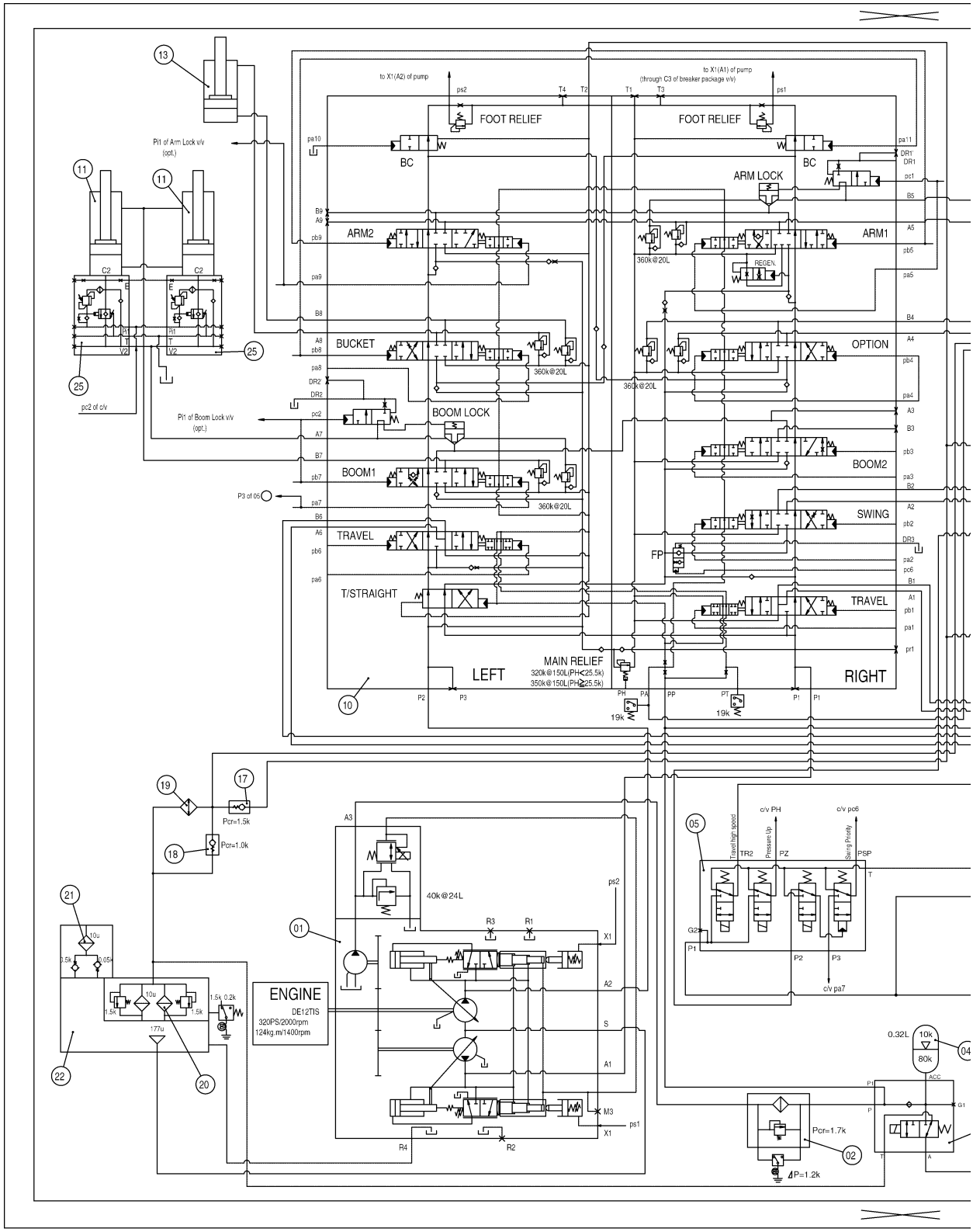
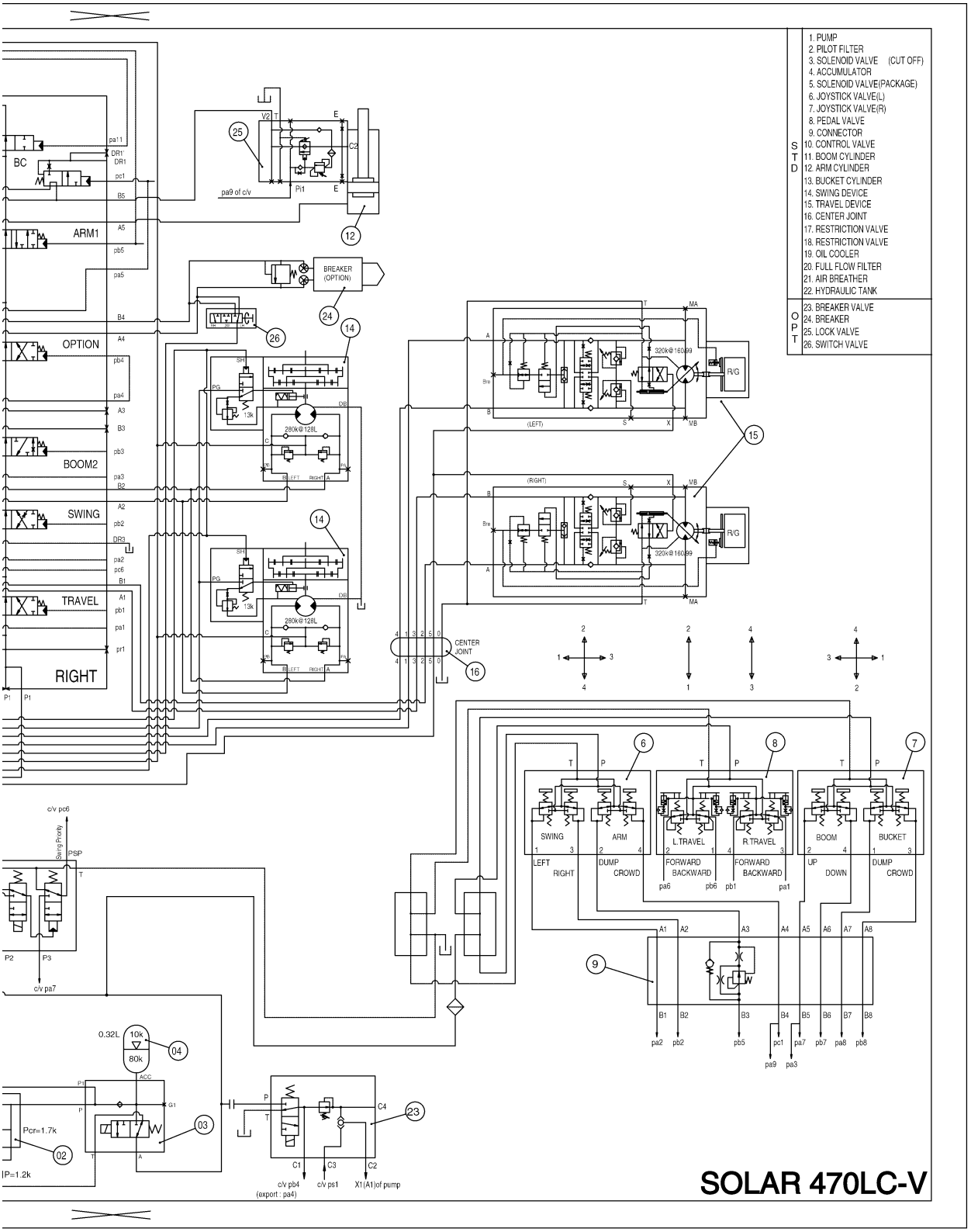

FOOT RELIEF
FOOT RELIEF
BC
BC
ARM LOCK
ARM2
ARM1
BUCKET
OPTION
BOOM LOCK
BOOM1
BOOM2
SWING
TRAVEL
T/STRAIGHT
TRAVEL
FP
LEFT
RIGHT
MAIN RELIEF
320k@150L(PH<25.5k)
350k@150L(PH≥25.5k)
360k@20L
REGEN.
ENGINE
DE12TIS
320PS/2000rpm
124kg.m/1400rpm
40k@24L
Pcr=1.5k
Pcr=1.0k
Pcr=1.7k
ΔP=1.2k
19k
c/v pa7

Figure 2


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. CONNECTOR
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. BREAKER VALVE
24. BREAKER
25. LOCK VALVE
26. SWITCH VALVE
BC
ARM1
OPTION
BOOM2
SWING
TRAVEL
RIGHT
BREAKER (OPTION)
CENTER JOINT
SWING
ARM
L.TRAVEL
R.TRAVEL
BOOM
BUCKET
LEFT
RIGHT
DUMP
CROWD
FORWARD
BACKWARD
UP
DOWN
PSP
c/v pa7
c/v pb4 (export : pa4)
c/v ps1
X1(A1)of pump
SOLAR 470LC-V

ASS1160L

ELECTRICAL SYSTEM

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

ELECTRICAL SYSTEM

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 340LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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Overload Warning Device Circuit Diagram 76

TROUBLESHOOTING - ELECTRICAL SYSTEM

Problem	Possible Causes	Remedies
Battery will not stay charged.	Internal battery short.	Replace battery.
	Short in other part of circuit.	Repair wiring or replace component.
Battery does not charge.	Battery worn out or defective.	Replace battery.
	Defective alternator or belt.	Repair or replace.
	Cable connection loose or severely corroded. Circuit ground corroded or weak.	Repair or replace.
Engine rpm not controllable.	Engine speed potentiometer or dial defective.	Repair or replace.
	Engine control cable broken or loose.	Repair or replace.
	Engine control motor defective or not connected.	Repair connection or replace component.
	Engine throttle controller defective or not connected.	Repair connection or replace component.
	Blown fuse.	Replace fuse. Check connections and circuit components for shorts or other damage.
	Wiring harness or connector defective or damaged.	Repair or replace.
Power mode selection does not change.	Blown fuse.	Replace fuse. Check connections and circuit components for shorts or other damage.
	Instrument Panel switch broken.	Repair or replace.
	Wiring harness or connector defective or damaged.	Repair or replace.
	e-EPOS controller defective.	Replace.
	Speed sensor defective.	Replace.
Work mode selection does not change.	Blown fuse.	Replace fuse. Check connections and circuit components for shorts or other damage.
	Instrument Panel switch broken.	Repair or replace.
	Wiring harness or connector defective or damaged.	Repair or replace.
	e-EPOS controller defective.	Replace.
	Solenoid valve defective.	Replace.

OVERVIEW

The electrical system for this equipment is DC 24 volts. The rated voltage for all electric components is 24 volts with the exception of the car 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 electric 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.

Electric Wire Color

Symbol	Color
W	White
G	Green
Or	Orange
B	Black
L	Blue
Lg	Light green

Symbol	Color
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*

ELECTRIC 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 (6).

1. Cabin light, fuel pump switch, No. 1 terminal of DC-DC converter (backup for car stereo memory)
2. "B" terminal of starter switch and No. 22 terminal of air conditioner control panel.
3. No. 17 terminal of instrument panel (backup for instrument panel).
4. Power terminal "B" of engine stop motor.

When the starter switch (5) is in the preheat, on and start positions, the current flows from the battery (1) → fusible link (3) → fuse (6) → starter switch (5) "B" terminal/starter switch (5) "BR" terminal → battery relay (2) "BR" terminal 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).

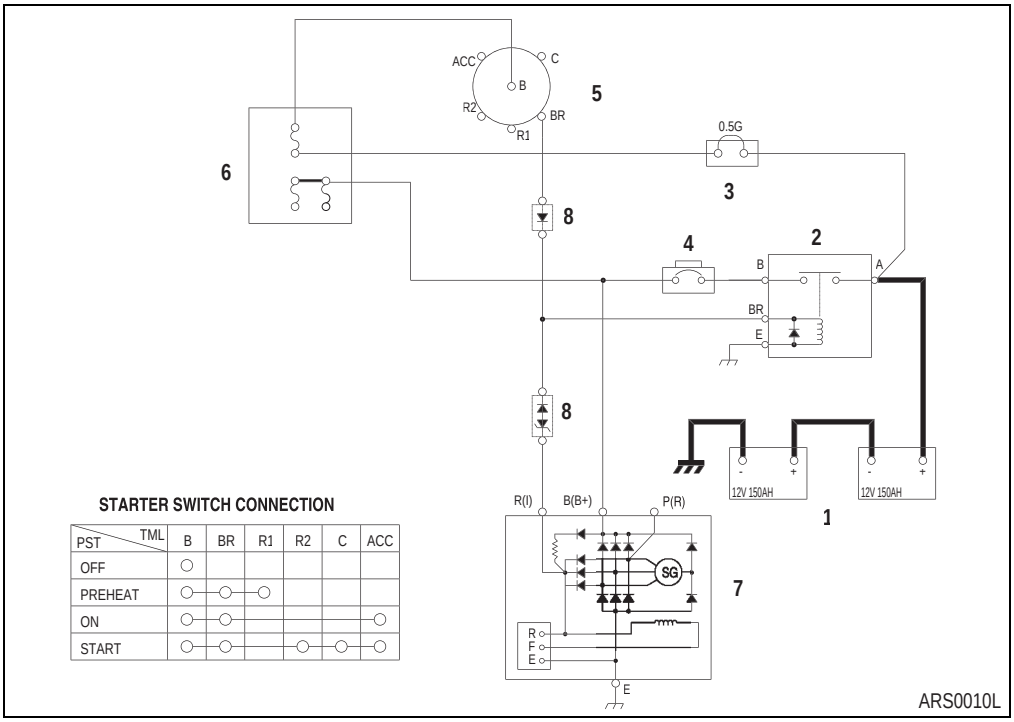


Figure 1 ELECTRIC POWER CIRCUIT DIAGRAM

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

OPERATION DURING START PROCESS

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, Figure 2) → fusible link (3) → "B" terminal of the starter switch (5) → "C" terminal of the starter switch (5) → "C" terminal of the starter relay (8) → "D" terminal of starter relay (8) → "S" terminal of starter controller (7) → "E" terminal of the starter controller (7) → ground.

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 2) → "B" terminal of the starter (9). The starter motor is rotated and the engine is started.

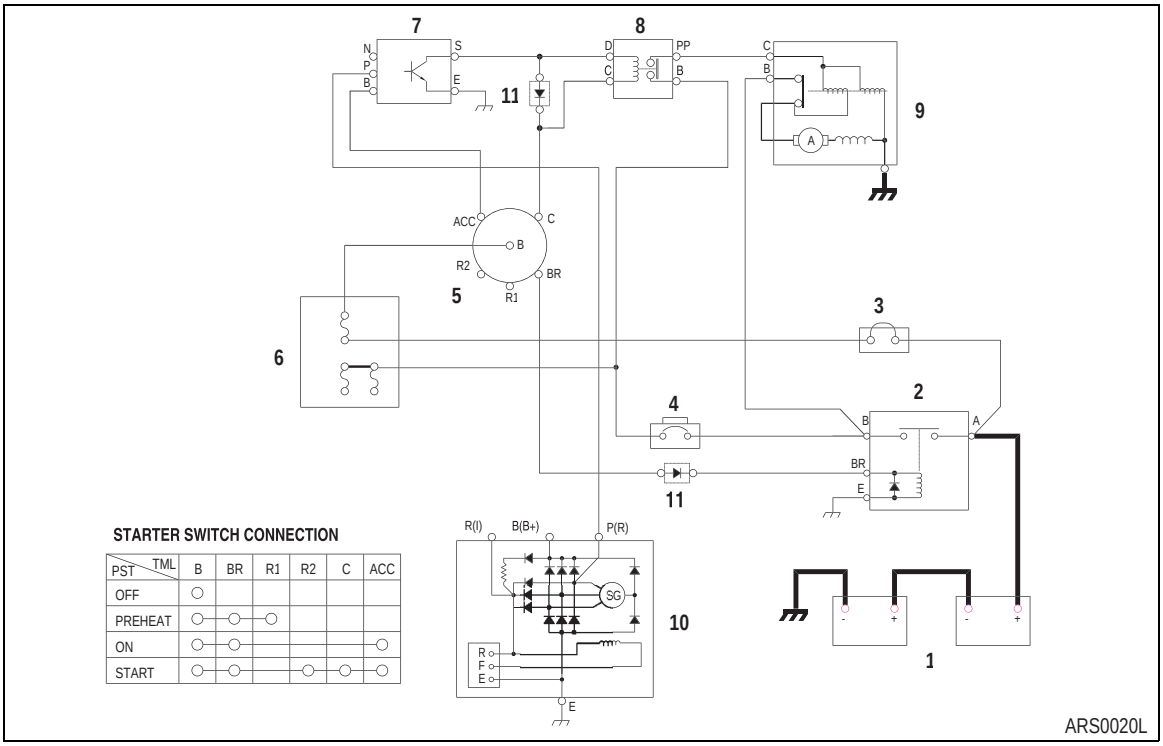


Figure 2 STARTER CIRCUIT (1) - WHILE STARTING

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch
6	Fuse Box

Reference Number	Description
7	Starter Controller
8	Starter Relay
9	Starter
10	Alternator
11	Diode

OPERATION AFTER START PROCESS

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 equivalent to 500 rpm is sensed 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.

Operation of the Start Circuit (2) - Immediately After Start

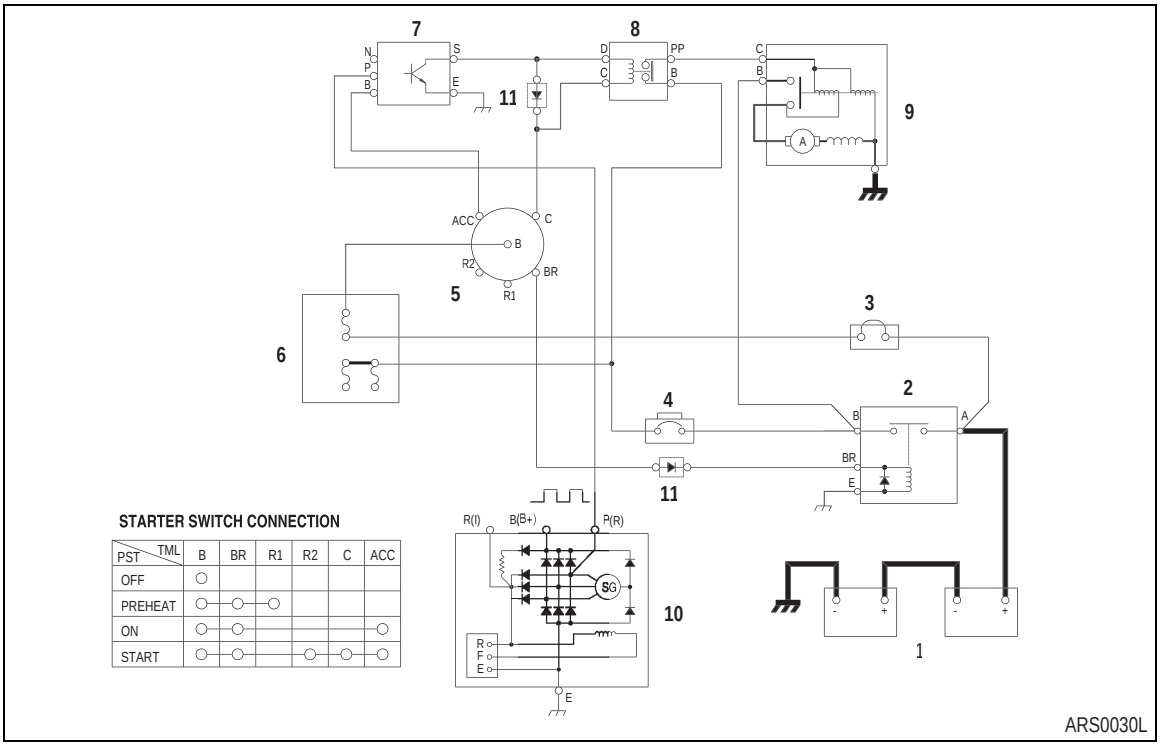


Figure 3 OPERATION OF START CIRCUIT (2) - IMMEDIATELY AFTER START

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch
6	Fuse Box

Reference Number	Description
7	Starter Controller
8	Starter Relay
9	Starter
10	Alternator
11	Diode

ENGINE PREHEATING SYSTEM

An air heater (8) device is installed in the intake manifold of the engine.

When the starter switch (5) is turned to the "Preheat" position, the current flows from the battery (1) → fusible link (3) → "B" terminal of starter switch (5) → "R1" terminal of starter switch (5) → "C" terminal of preheat relay (7) → ground and the contact points of the preheat relay are closed.

When the contact points of the preheat relay (7) are closed, the heating coils of the air heating device are heated by current flowing from the battery (1) → battery relay (2) → preheat relay (7) → air heater (8) → ground.

The preheat time is approximately 19 seconds. A built-in timer in the instrument panel will activate an indicator light approximately 19 seconds after the preheat process has been selected.

Even after the starter switch (5) has been moved to the start position the current will continue to flow through the "R2" terminal of the starter switch (5) to the coil of the preheat relay (7) without disruption of the preheat process.

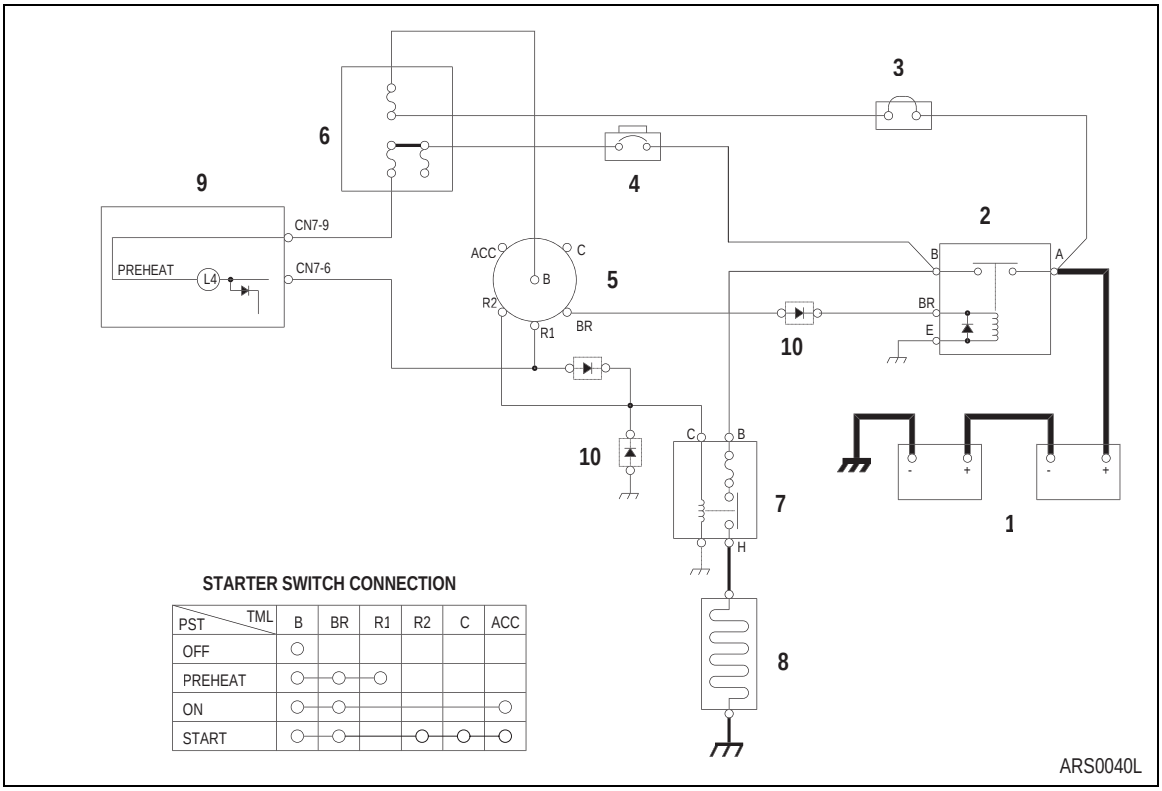


Figure 4 ENGINE PREHEAT CIRCUIT

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch

Reference Number	Description
6	Fuse Box
7	Preheat Relay
8	Air Heater
9	Indicator Lamp
10	Diode

ENGINE STOP SYSTEM

The engine stop circuit consists of a starter switch (5), engine stop motor (9) and engine stop relay (8). There are two modes of operation - engine running and engine stop.

The worm gear built into the motor reduces the engine stop motor's speed and changes motor's revolution to reciprocation. The fuel shut off lever is pushed or pulled by this change.

When the start switch is in the "ON" position, the engine stop motor rotates 180° and comes to a stop due to the cam switch. When the start switch is in the "OFF" position, the engine stop motor moves 180° from the running mode position and is stopped by the cam switch.

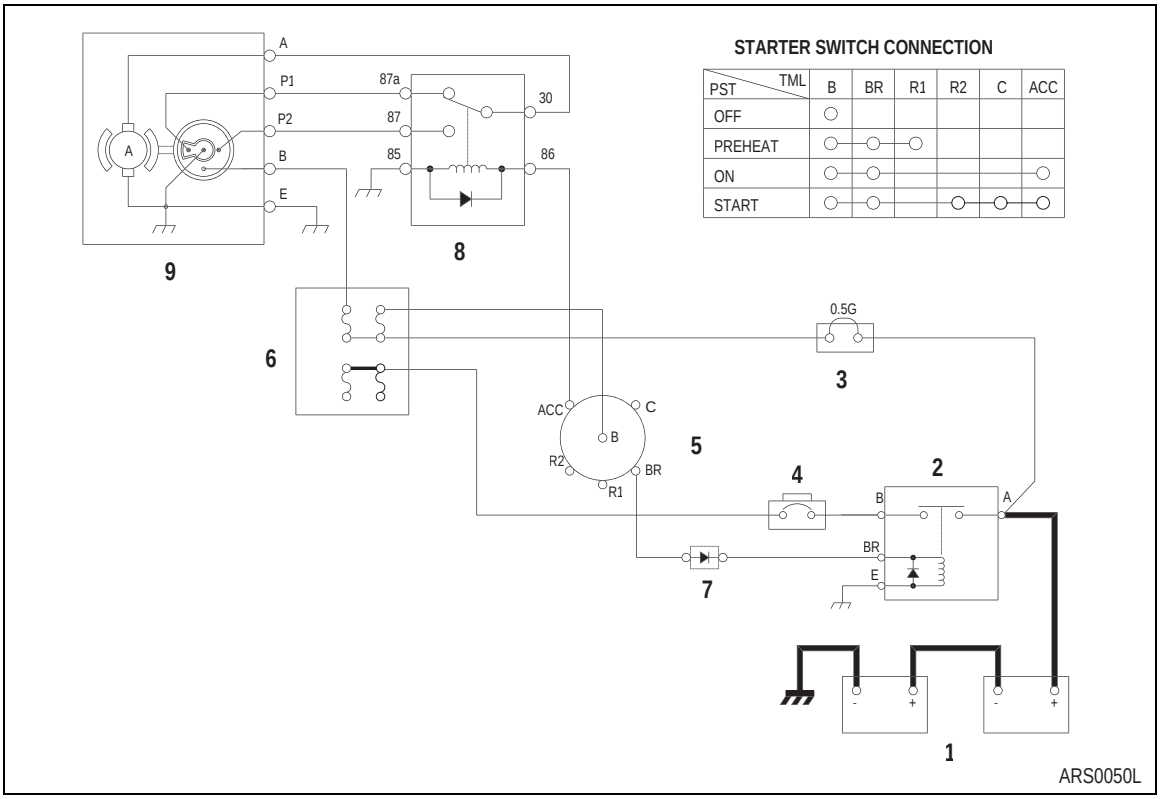


Figure 5 ENGINE STOP CIRCUIT

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 Stop Relay
9	Engine Stop Motor

Operation In Engine Running Mode

When the starter switch (3) is turned to the "ON" position, the contact points "30" and "87" of the engine stop relay (5) are closed due to current flowing from the battery (1) → fusible link (2) → "B" terminal of starter switch (3) → "ACC" terminal of starter switch (3) → "86" terminal of engine stop relay (5) → "85" terminal of engine stop relay (5) → ground.

As a result, the engine stop motor (6) is rotated by the current flow from the battery (1) → fusible link (2) → "B" terminal of the engine stop motor (6) → "P2" terminal of engine stop motor (6) → "87" terminal of engine stop relay (5) → "30" terminal of the engine stop relay (5) → "A" terminal of engine stop motor (6) → "E" terminal of engine stop motor (6) → ground. The engine stop motor opens (pushes) the fuel shut off lever of the fuel injection pump and the system is in the running mode. The engine stop motor rotates 180° and comes to a stop due to the cam switch which shuts off the current to the motor.

When the starter switch is in the "ON" position, the internal components of the engine stop motor's cam switch is in running mode position.

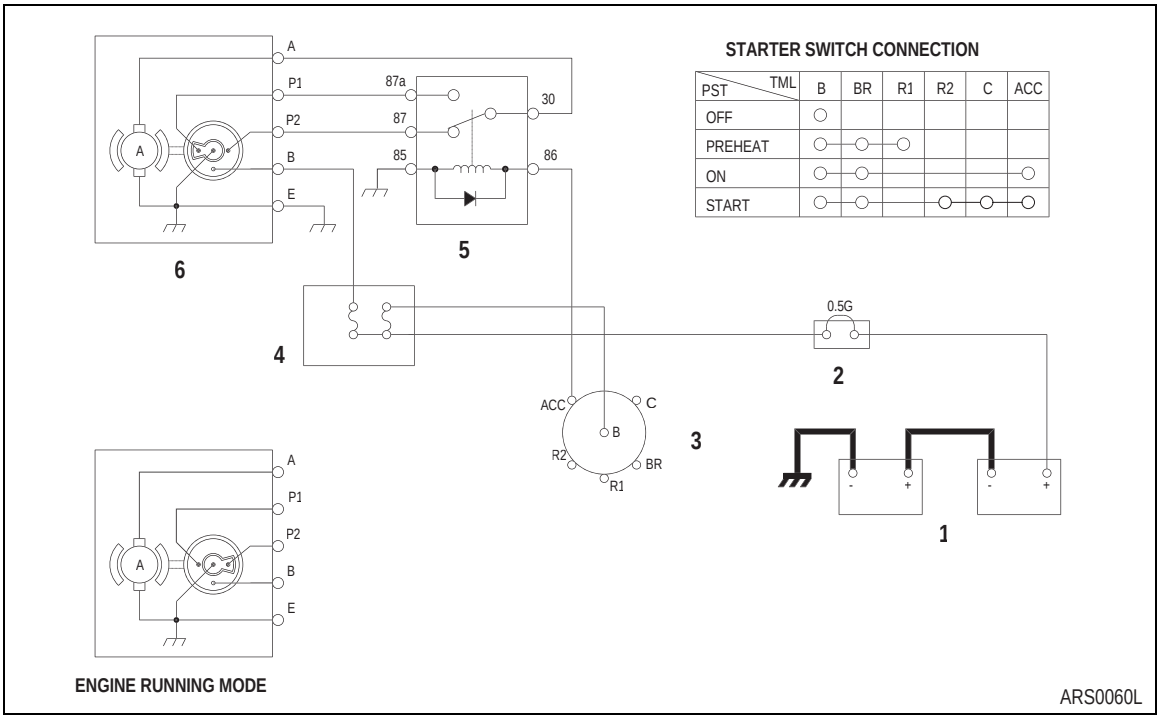


Figure 6 ENGINE STOP CIRCUIT - RUNNING MODE

Reference Number	Description
1	Battery
2	Fusible Link
3	Starter Switch

Reference Number	Description
4	Fuse Box
5	Engine Stop Relay
6	Engine Stop Motor

Operation In Engine Stop Mode

When the starter switch (3) is in the "OFF" position, the electric current flow to the coil of the engine stop relay (5) is shut off.

As a result, the "30" and "87a" contact point of the engine stop relay are connected and current is supplied to the engine stop motor from the battery (1) → fusible link (2) → "B" terminal of engine stop motor (6) → "P1" terminal of engine stop motor (6) → "87a" terminal of engine stop relay (5) → "30" terminal of engine stop relay (5) → "A" terminal of engine stop motor (6) → "E" terminal of engine stop motor (6) → ground and the motor is rotated.

The shut off lever of the fuel injection pump, linked to the engine stop motor by a cable, is moved to the close (pull) position and the engine is stopped. The engine stop motor moves 180° from the running mode position and is stopped by the internal cam switch which cuts off the current to the motor.

When the starter switch is in the "OFF" position, the internal components of the engine stop motor's cam switch is in the stop mode position.

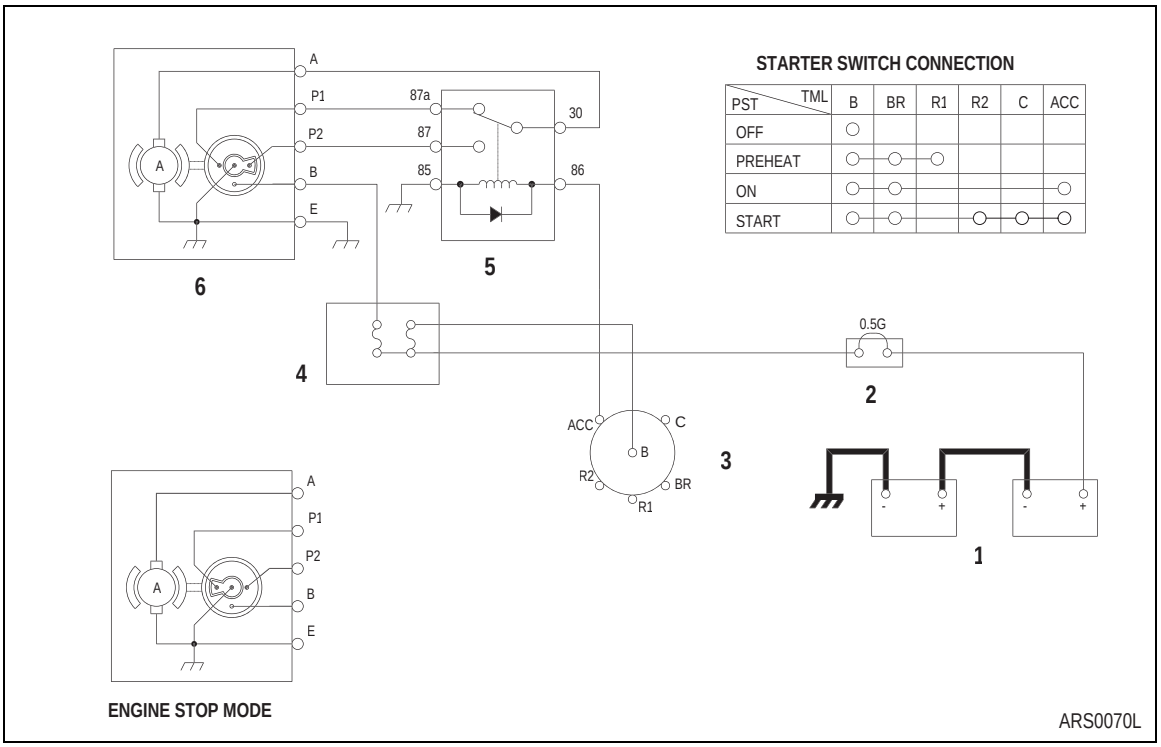


Figure 7 ENGINE STOP CIRCUIT - STOP MODE

Reference Number	Description
1	Battery
2	Fusible Link
3	Starter Switch

Reference Number	Description
4	Fuse Box
5	Engine Stop Relay
6	Engine Stop Motor

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" 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 electric system.

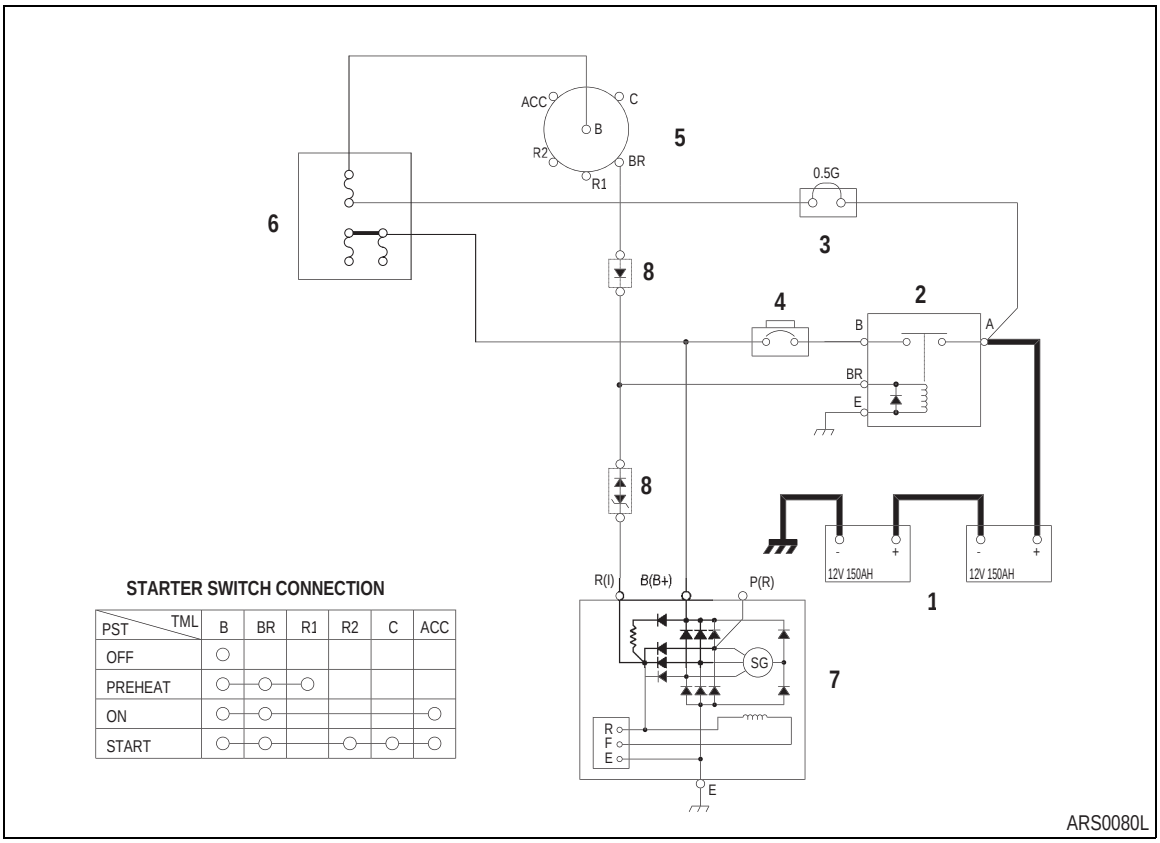


Figure 8 CHARGING CIRCUIT

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

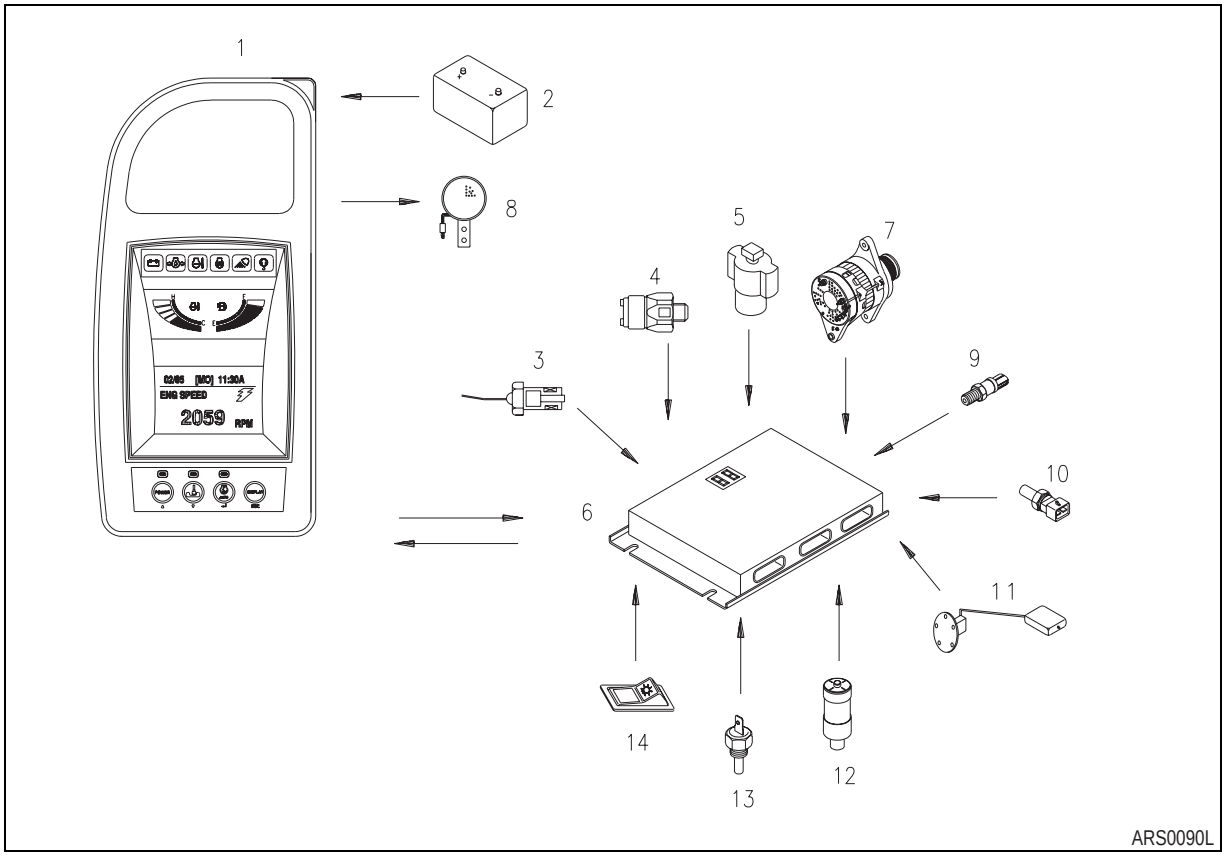


Figure 9

Reference Number	Description
1	Instrument Panel
2	Battery
3	Engine Speed Sensor
4	Return Filter Switch
5	Pilot Filter Switch
6	e-EPOS Controller
7	Alternator
8	Warning Buzzer

Reference Number	Description
9	Pump Discharge Pressure Sensor
10	Engine Coolant Temperature Sensor
11	Fuel Sensor
12	Air Cleaner Indicator
13	Engine Oil Pressure Switch
14	Light Switch

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.

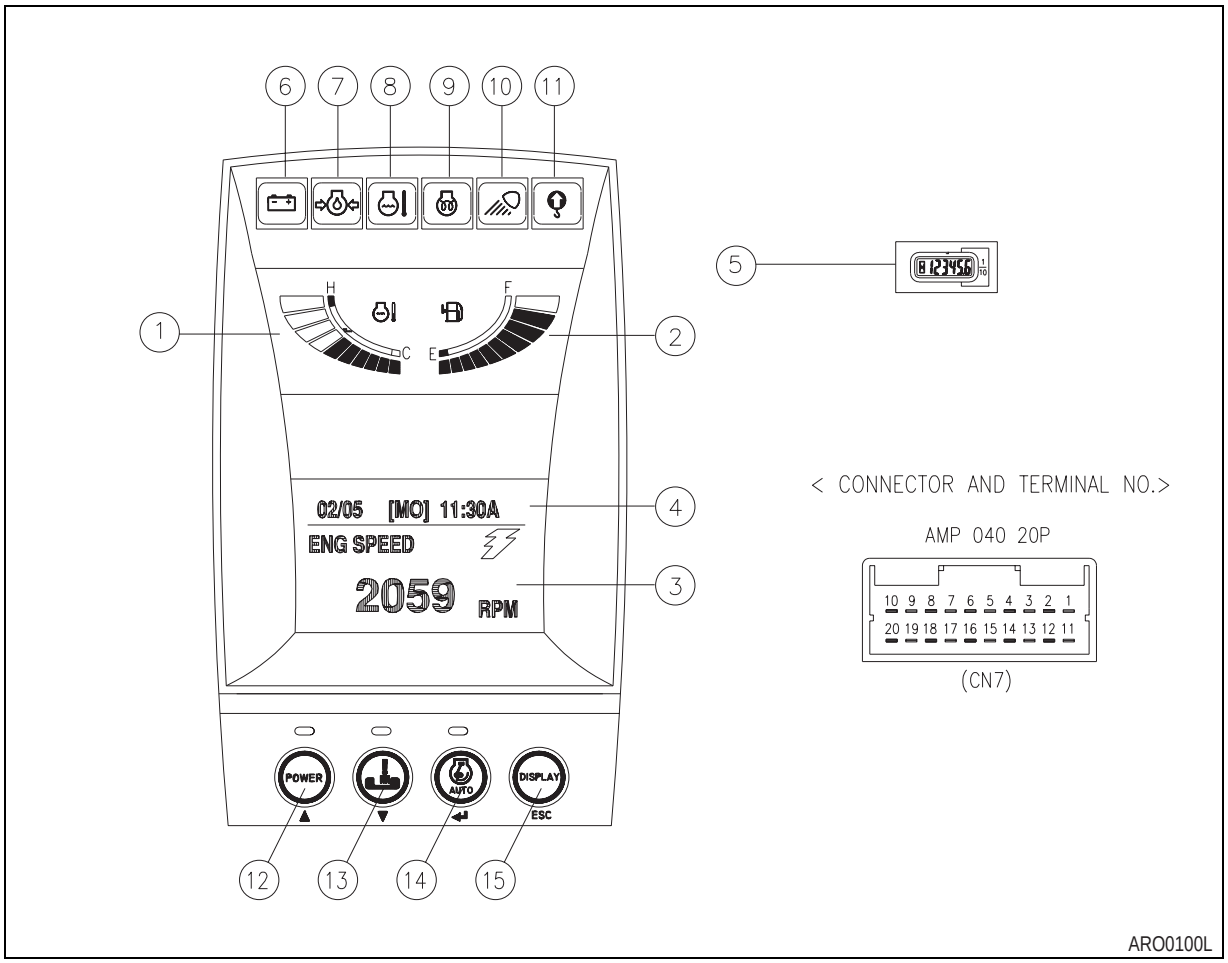


Figure 10

Gauges	Warning Lights	Mode Select Switches
1. Engine Coolant Temp. Gauge	6. Charge Warning Light	12. Power Mode Select Switch (Up Arrow Button)
2. Fuel Gauge	7. Engine Oil Pressure Warning Light	13. Trenching Mode Select Switch (Down Arrow Button)
3. Multi-function Gauge and Graphic Information Area	8. Coolant Temp. Warning Light	14. Auto Idle Switch (Enter Button)
4. Digital Clock	9. Preheat Completion Light	15. Display Select Switch (Escape Button)
5. Service Hour Meter	10. Work Light Indicator Light	
	11. Overload Warning Light	

When the engine starter switch is turned to the "I" (ON) position, all bands of gauges, indicator lights of switches/buttons and indicator/warning lights will turn "ON" and the alarm buzzer will sound for about 2 seconds.

During this time, a moving excavator will appear on the digital clock and graphic information area (3 and 4, Figure 10).

MONITORING SYSTEM SCHEMATIC

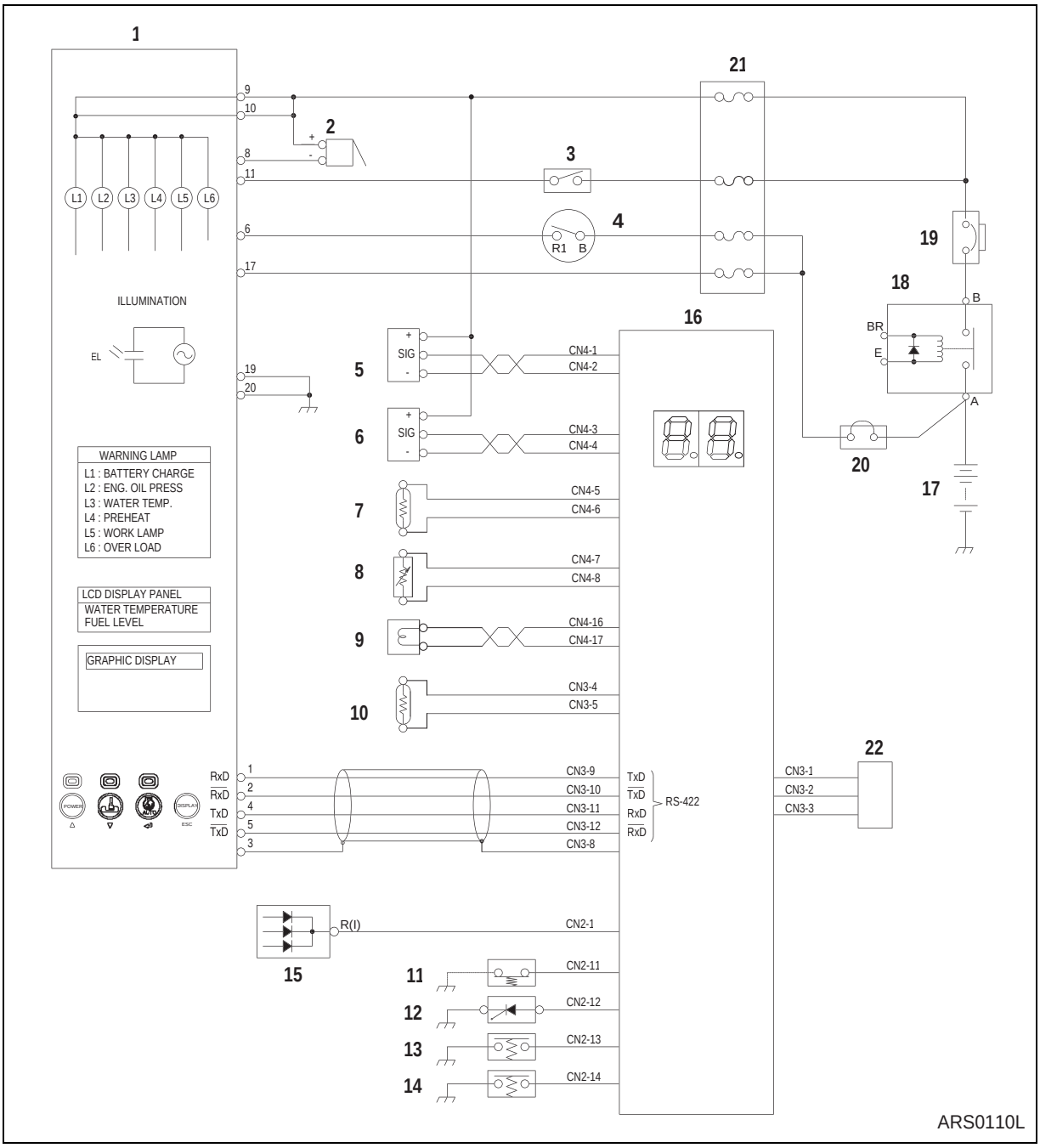


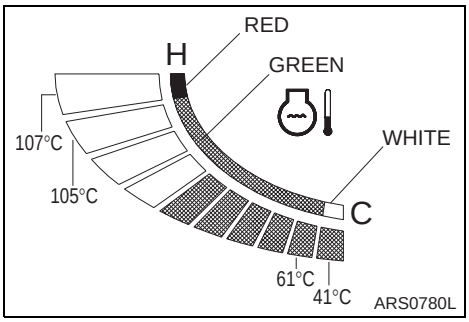
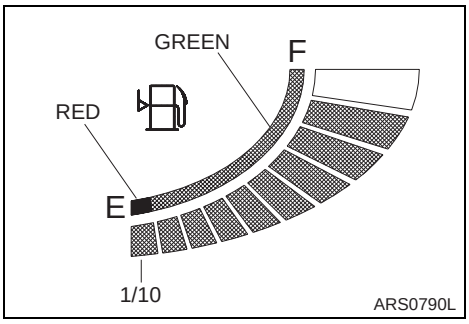
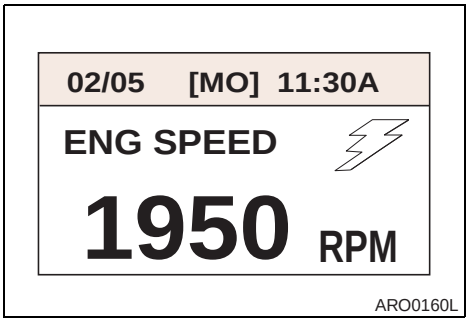
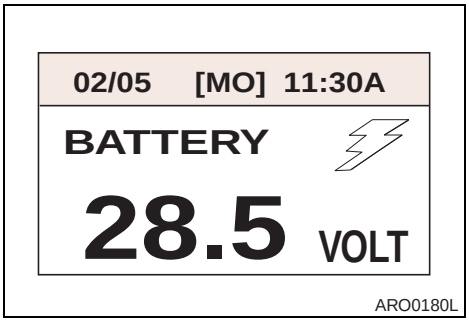
Figure 11

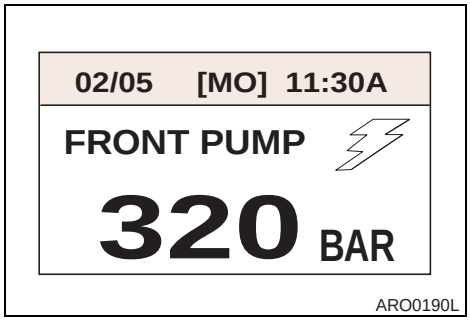
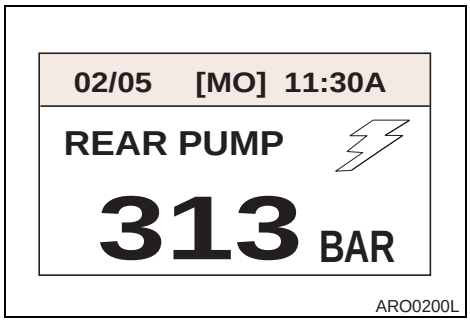
Reference Number	Description
1	Instrument Panel
2	Pilot Buzzer
3	Light Switch
4	Start Switch
5	Front Pump Pressure Sensor
6	Rear Pump Pressure Sensor
7	Engine Coolant Temperature Sensor
8	Fuel Gauge
9	Engine Speed Sensor
10	Hydraulic Oil Temp. Sensor

Reference Number	Description
11	Engine Oil Pressure Switch
12	Air Cleaner Indicator
13	Return Filter Switch
14	Pilot Filter Switch
15	Alternator
16	e-EPOS Controller
17	Battery
18	Battery Relay
19	Circuit Breaker
20	Fusible Link
21	Fuse Box
22	Check Connector

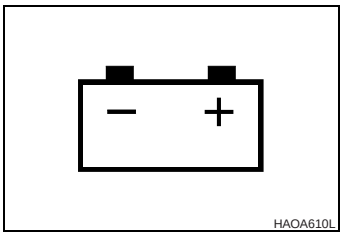
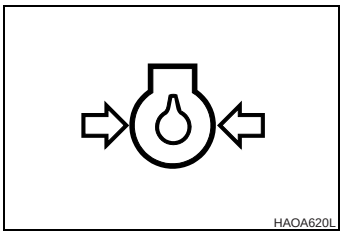
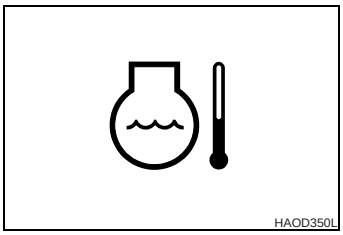
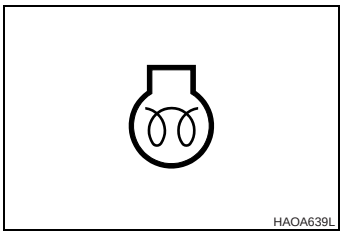
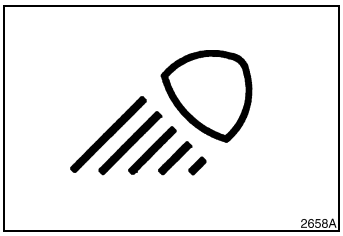
OPERATION

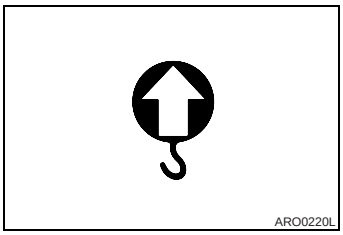
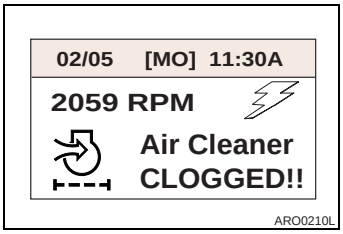
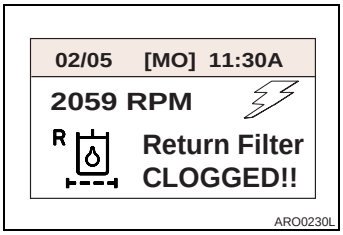
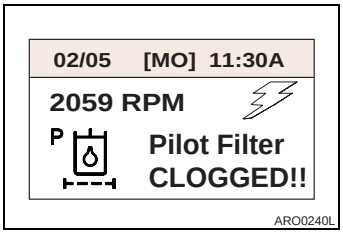
INSTRUMENTS

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Engine Coolant Temperature		CN4-5 CN4-6	41°C (106°F) → 1,372 ohms 61°C (142°F) → 855 ohms 102°C (216°F)→ 160 ohms 105°C (221°F) → 147 ohms 107°C (225°F) → 128 ohms
Fuel Level		CN4-7 CN4-8	1/10 LCD Blinking → over 5K ohms FULL → under 525 ohms
Tachometer		CN4-16 CN4-17	N = 146 f / 60 (S300LC-V) N = 146 f / 60 (S300LL) N = 152 f / 60 (S340LC-V) N = 152 f / 60 (S420LC-V) N = 152 f / 60 (S470LC-V) N = Engine speed (rpm) f = Frequency of engine speed sensor (Hz)
Voltmeter		CN7-9 CN7-19	0 - 32 VDC

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Main pump discharge pressure (front pump)		CN4-1 CN4-2	V = 0.00816 x P + 1.0 V: Sensor output voltage (V) P: Displayed pressure (Bar)
Main pump discharge pressure (rear pump)		CN4-3 CN4-4	

WARNING AND INDICATOR LIGHTS

Description	Symbol	Input Terminal	Operation	Remarks
Charge	 HAOA610L	CN2 - 1	Lights up when not charging [R(I) terminal output drops below 12±1V] and over charging [R(I) terminal output increase over 33 V].	Lights up before engine start up and shut off once engine is running.
Engine Oil Pressure	 HAOA620L	CN2 - 11	Lights up when engine oil pressure switch is turned "ON" (Oil pressure drops below 0.7 kg/ cm^2 (10 psi).	After starting engine, if engine oil pressure is insufficient after 8 seconds, a warning buzzer will sound.
Engine Coolant Temperature	 HAOD350L	CN4 - 5 CN 4 - 6	Lights up when the resistance of engine coolant temperature sensor drops below 128 ohms.	
Preheat	 HAOA639L	CN7 - 6	Lights up when preheat process is completed. (Approximately 19 seconds from start)	
Work Light	 2658A	CN2 - 7	Lights up when work light switch is turned "ON."	

Description	Symbol	Input Terminal	Operation	Remarks
Overload (Optional)		CN1 - 3 CN1 - 4	Lights up when lifting load exceeds limit. (When the over load warning switch is turned "ON," output voltage increases over reading in remarks.)	Warning buzzer will sound. 2.80 V (S300LC-V) 2.80 V (S300LL) 2.80 V (S340LC-V) 2.88 V (S420LC-V) 2.80 V (S470LC-V)
Graphic Information Area				
Air Cleaner		CN2 - 12	Lights up when air cleaner is clogged	Symbol is blinking.
Return Filter		CN2 - 13	Lights up when return filter pressure increases over 1.5 kg/cm^2 (21 psi).	Symbol is blinking.
Pilot Filter		CN2 - 14	Lights up when pilot filter pressure increases over 1.0 kg/cm^2 (14 psi).	Symbol is blinking.

INITIAL OPERATION

Item	Input (Terminal)	Output (Operation and initial setting mode)
Initial Operation	When battery voltage is input to CN7 - 9 (starter switch is turned from "OFF" to "ON" position).	• All LCD, 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). • Numerical display: Engine speed. • Clock: Current time display.

NOTE: *Refer to the clock setting method of operation manual for time setting.*

MODE SELECT SWITCH

Power Mode / Trenching Mode Switch

Operation Mode		Output Check (Operation mode display LED)	e-EPOS Output		
			Pump Discharge Volume Control Valve Current (mA)	Swing Priority Solenoid Valve	7-Segment Display
Power Mode	Power Mode	ON	Variable Output	-	9 x
	Standard Mode	OFF	0	-	7 x
Work Mode	Trenching Mode	ON	-	ON	x 2
	Digging Mode	OFF	-	OFF	x 0

Auto Idle Switch

Operation Mode		Output Check (Operation mode display LED)	e-EPOS Output (CN1 - 7 Terminal)
Auto Idle	Activation	ON	H (11 ±1.5V)
	Cancellation	OFF	L (0 - 1V)

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 select buttons.

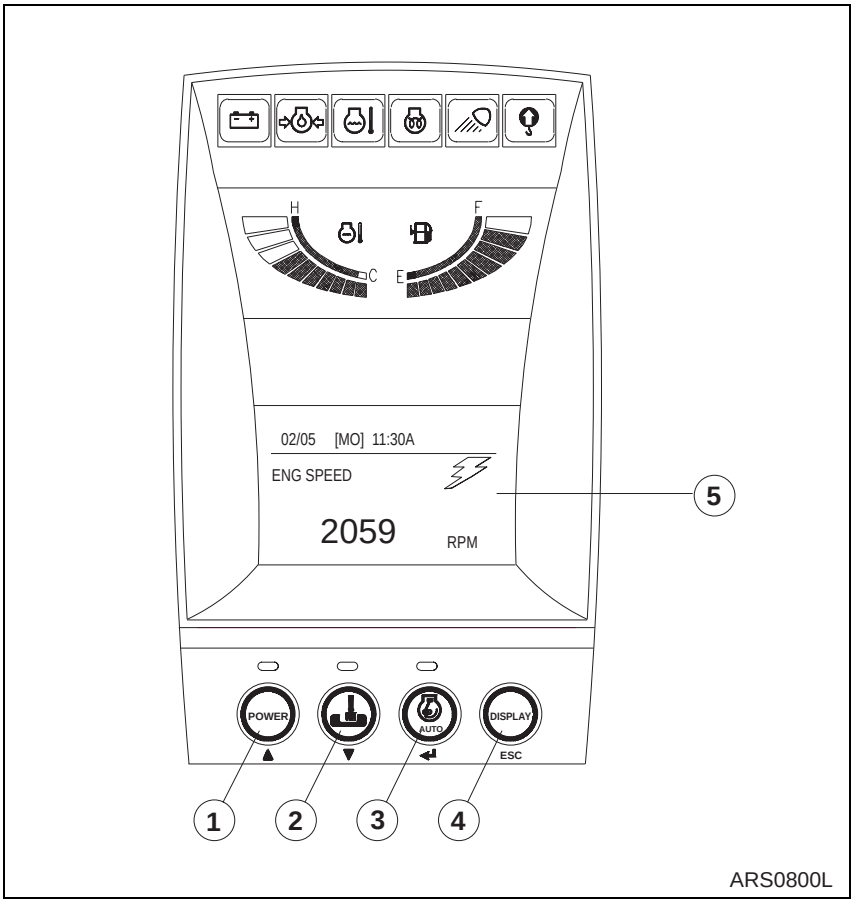


Figure 12

Selection 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
2. Special menu: Information of machine status, failure information, Information of machine operation.

MENU SELECTION 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 select 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 three sub-menus (language setting, time setting, or filter/oil information) to the operator.

Refer to the "Operation and Maintenance Manual" for details.

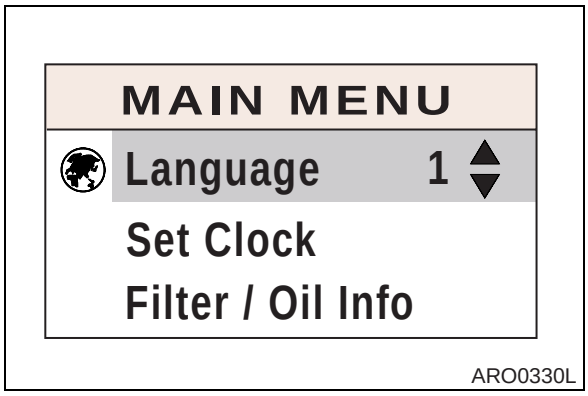


Figure 13

LANGUAGE SETTING

This mode is used for setting desired language.

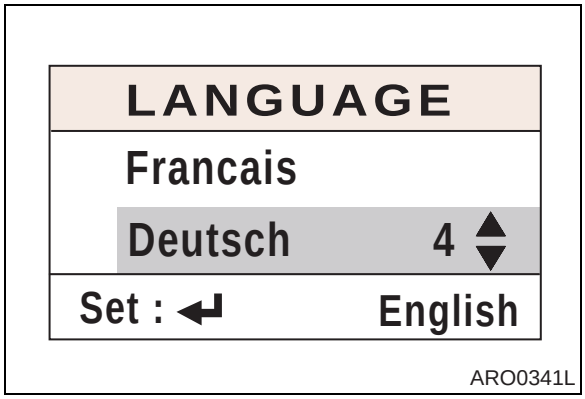


Figure 14

TIME SETTING

This mode is used for setting time on the digital clock.

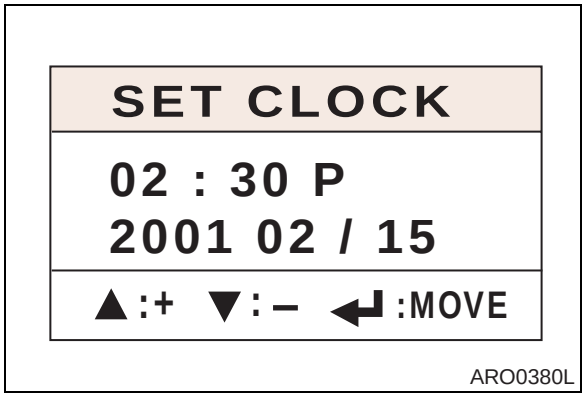


Figure 15

FILTER/OIL INFORMATION

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.

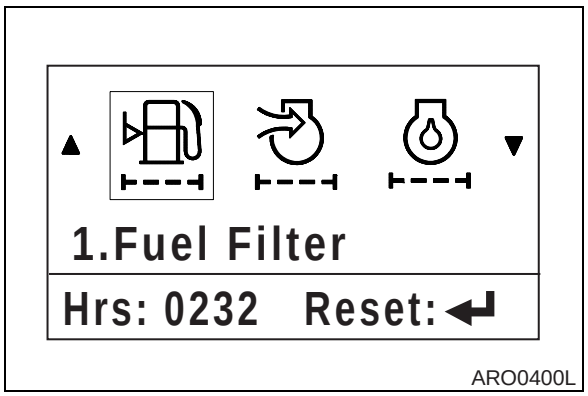


Figure 16

Menu Display Order and Icon Explanation

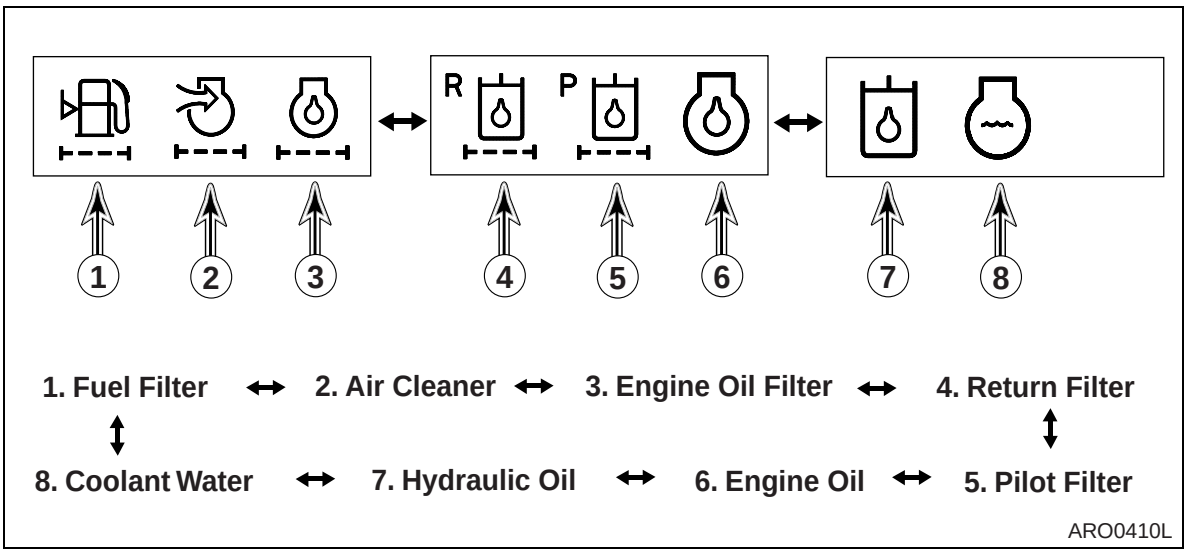


Figure 17

SPECIAL MENU

In this menu, many types of operating conditions and functions can be accessed and disp[layed, including the e-EPOS controller. This menu is mainly used for machine testing and failure diagnostics.

The special menu offers three sub-menus;

1. Machine status.
2. Failure information.
3. Information on machine operation

ENTERING/ACCESSING AND EXITING/ESCAPING MENUS

Entering/Accessing Menus

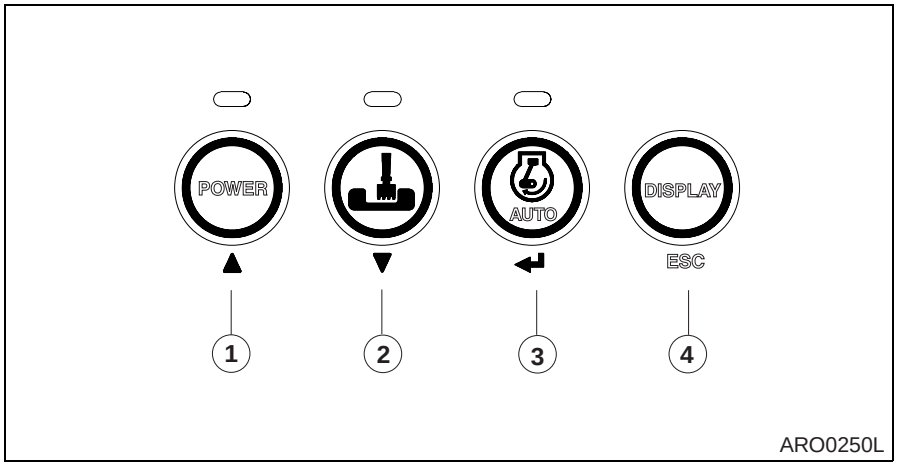


Figure 18

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 19) will be changed to special menu screen (Figure 20).

Normal Mode Screen

NOTE: *Normal mode screen can display many kinds of display mode by selecting, for example, engine revolution (RPM), battery voltage (V), front pump pressure (BAR), rear pump pressure (BAR) and so on by selecting.*

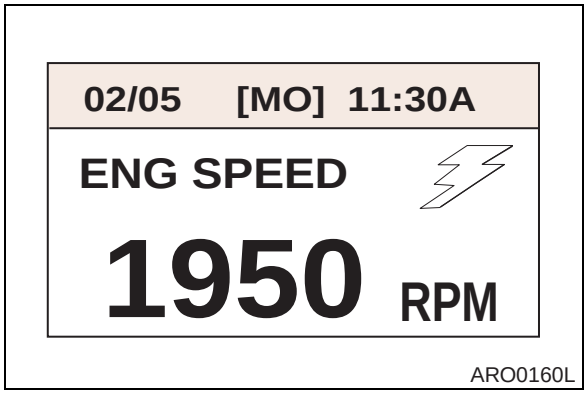


Figure 19

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.

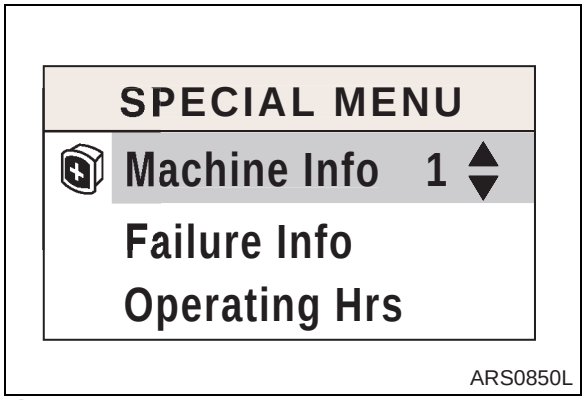


Figure 20

Exiting/Escaping Menus

1. If escape button (ESC, 4 on Figure 18) 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

Sub-menu Selection Method

Various sub-menus can be selected by pressing "Up (▲, 1 on Figure 18)" and "Down (▼, 2 on Figure 18)" 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 18)" button for menu selection.

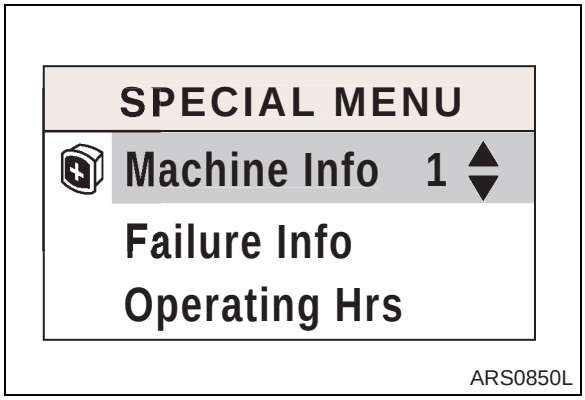


Figure 21

Information of Machine Status

1. Entering Sub-menus: When cursor is located on "Machine Info" of special menu screen, press "Enter (↵, 3 on Figure 18)" button and the "Machine Info Sub-menu" will be displayed.
2. Exiting Sub-menus: If escape button (ESC, 4 on Figure 18) is pressed for more than 1 second, display will be turned to previous sub-menu.

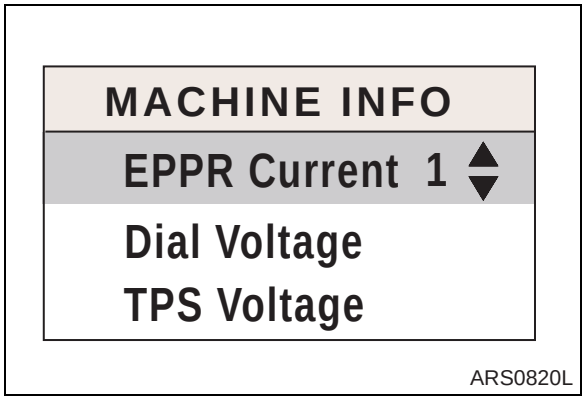


Figure 22

Contents of Machine Status

Display Item of Machine State Information			Display	Remarks
1. EPPR Current			"mA"	EPPR valve current
2. Dial Voltage			"mV"	Dial voltage
3. TPS Voltage			"mV"	TPS voltage
4. Input State	1. Alternator	8. Pressure (Px)	On or Off	Input status delivered from switches and sensors to e-EPOS controller is displayed as on or off. * Number 3 (Work/Travel Solenoid) is used only wheel type machine. * Number 13 (OWD Select) is optional part.
	2. Power Max	9. E/G Oil Press.		
	3. Work/Travel Solenoid	10. Air Cleaner		
	4. Hi Speed Solenoid	11. Return Filter		
	5. Auto Travel	12. Pilot Filter		
	6. Work Lamp	13. OWD Select		
	7. Pressure (Py)			
5. Output State	1. Relief Press Up	4. Spare Out 1	On or Off	Output status delivered from e-EPOS controller to solenoid valves is displayed as on or off.
	2. High Speed	5. Spare Out 2		
	3. Swing Priority			
6. Hydraulic Oil Temp			°C (°F)	Hydraulic oil temperature.
7. Boom Pressure (Opt)			BAR	On machine with overload warning device, it displays cylinder pressure.
8. T/M Pressure (Wheel Type)			BAR	At this machine, it is always displayed as "O."

Sub-menu Selections

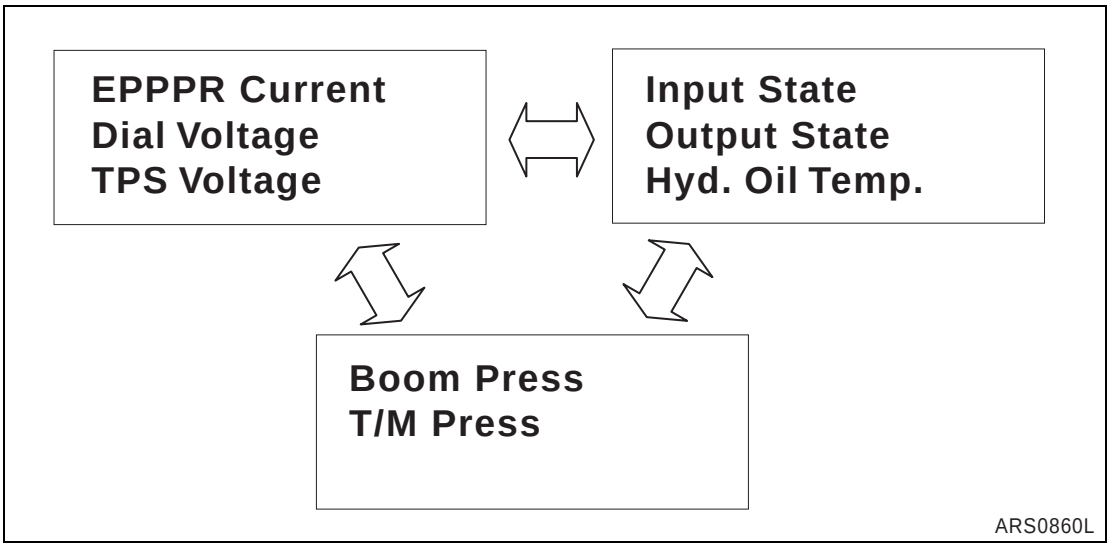


Figure 23

Display Example: Machine Status Information

1. EPPR Valve Current

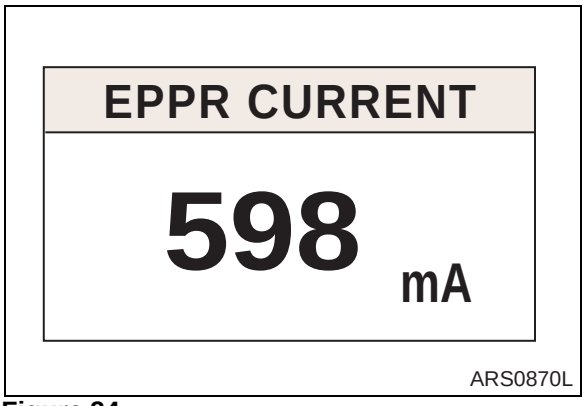


Figure 24

2. Dial Voltage

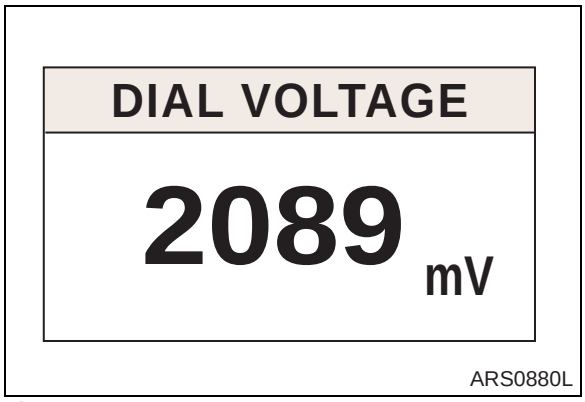


Figure 25

3. TPS Voltage

   Output voltage of potentiometer built into engine control motor.

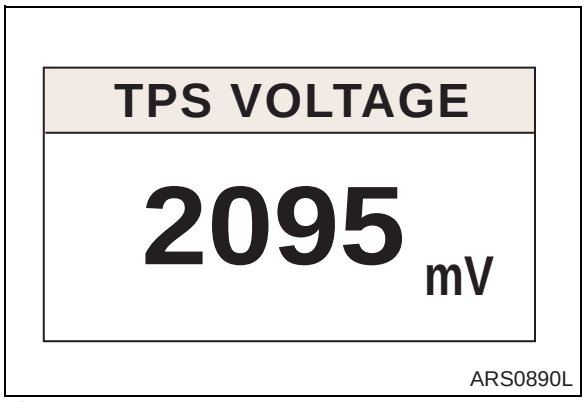


Figure 26

4. Input Status

"YES" or "NO" for alternator's generation (Generation: "ON"/ Non-generation: "OFF"), selection status of select switch (Selection: "ON"/ Non-selection: "OFF") and the other statuses of on/off type sensors.

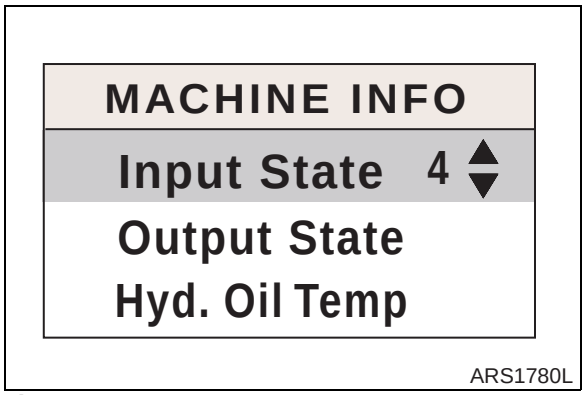


Figure 27

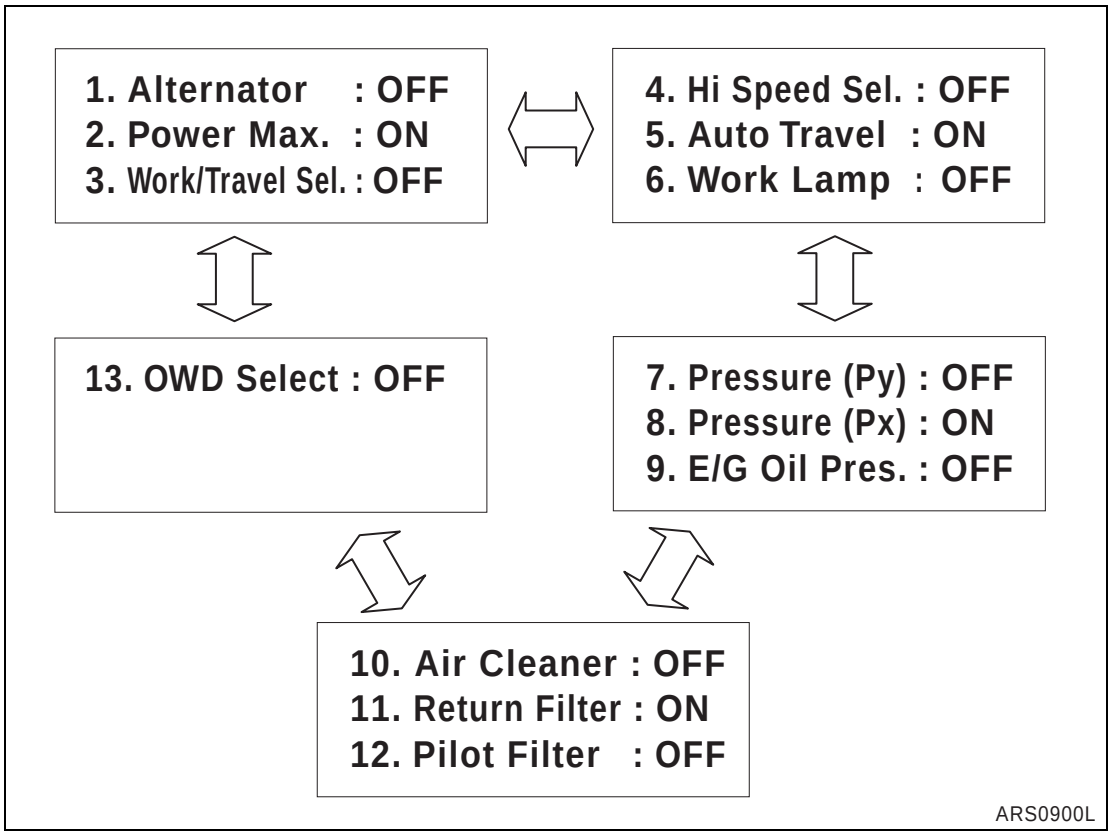


Figure 28

5. Output Status: Output status of solenoid valves and spare valves are displayed. (Output: "ON"/ Non-output: "OFF")

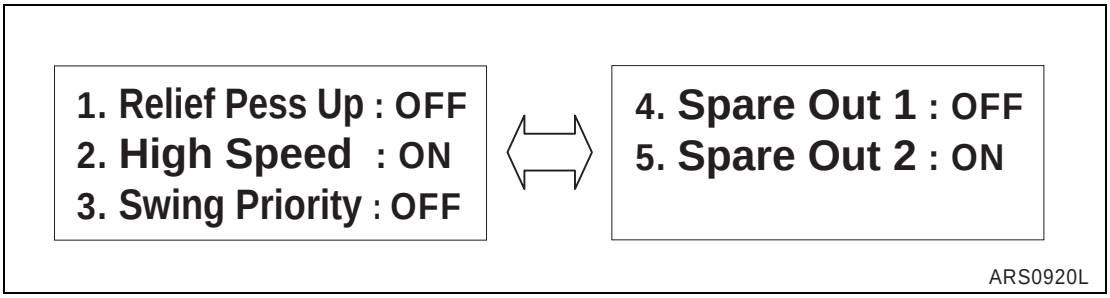


Figure 29

6. Hydraulic Oil Temperature

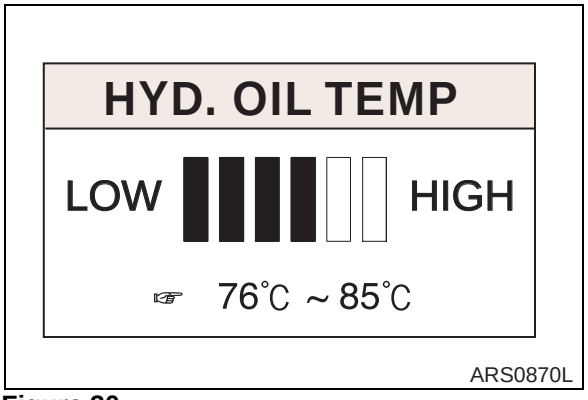


Figure 30

- Display Specification

BAR Graph Display	Input Terminal	Sensor Input Specification	Remarks
1/6 BAR Lit	CN 3 - 4 CN 3 - 5	Over 1,510 Ω	Below 30°C (Below 86°F)
1/6 ~ 2/6 BAR Lit		745 ~ 1,510 Ω	31 ~ 50°C (87 - 122°F)
1/6 ~ 3/6 BAR Lit		332 ~ 745 Ω	51 ~ 75°C (123 - 167°F)
1/6 ~ 4/6 BAR Lit		244 ~ 332 Ω	76 ~ 85°C (168 - 185°F)
1/6 ~ 5/6 BAR Lit		181 ~ 244 Ω	86 ~ 95°C (186 - 203°F)
1/6 ~ 6/6 BAR Lit		Under 181 Ω	Over 96°C (Over 204°F)

7. Boom Pressure (Optional)

   On machine with OWD (Overload Warning Device), detected pressure from boom cylinder is displayed with numeric values (Unit: Bar).

   The relative equation between the, output voltage of pressure sensor, and the pressure of boom cylinder, is as follows.

   - V = 0.00816P + 1

   V: Output voltage of pressure sensor (V).
   P: Displayed pressure (Bar).

   NOTE: *At standard machine, "0 BAR" is always displayed.*

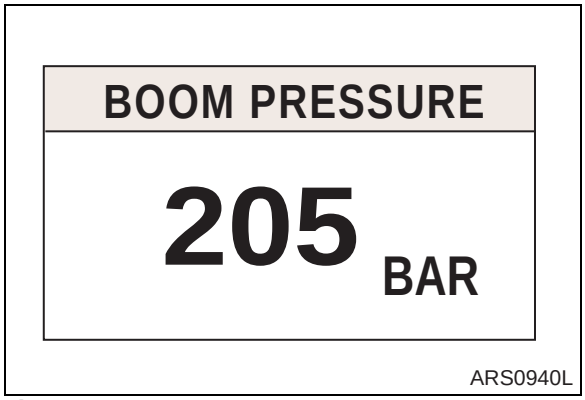


Figure 31

Failure Information

1. Entering Sub-menus: When a cursor is located in "Failure Info" of special menu screen press enter button (↵, 3 on Figure 18) and "Failure Info" screen is displayed.
2. Exiting Sub-menus: If escape button (ESC, 4 on Figure 18) is pressed for more than 1 second, this information screen will be returned to previous screen.

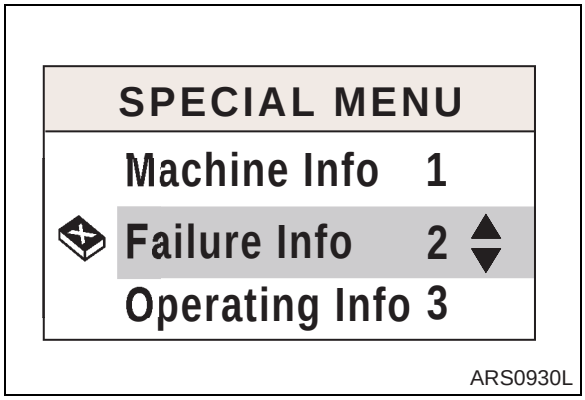


Figure 32

* 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 of the memorized record of past failure.

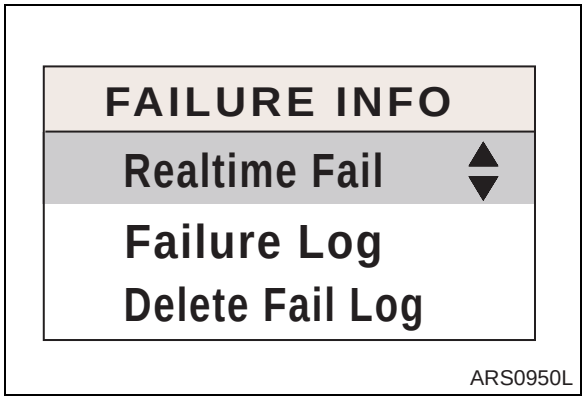


Figure 33

A. Current failure information

Current status of failure is displayed (Failure code, failure contents).

When a number of failures are produced, failure information can be checked by using "PRV" (▲, 1 on Figure 18) or "NXT" (▼, 2 on Figure 18) button.

* CODE: 12: Unique code of failure information.
* 01/02: A serial number of current failure/ total quantity of failure.

This example shows one of two failures.

B. Past failure information

Memorized record of past failure is displayed (Failure code, failure contents).

When a number of failures are produced, failure information can be checked by using "PRV" (▲, 1 on Figure 18) or "NXT" (▼, 2 on Figure 18) button.

NOTE: *" N: xxx " : "xxx" means that the totally counted number of the same failure.*

" xxxx Hr " : It will display the operation hour until the failure is generated. (Above example screen shows that breaking of a wire of pressure solenoid valve is generated at 75Hr.)

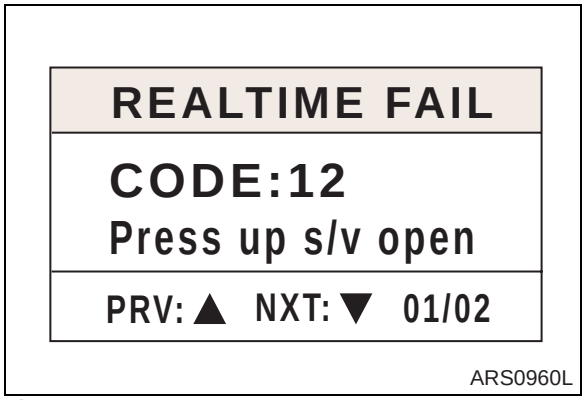


Figure 34

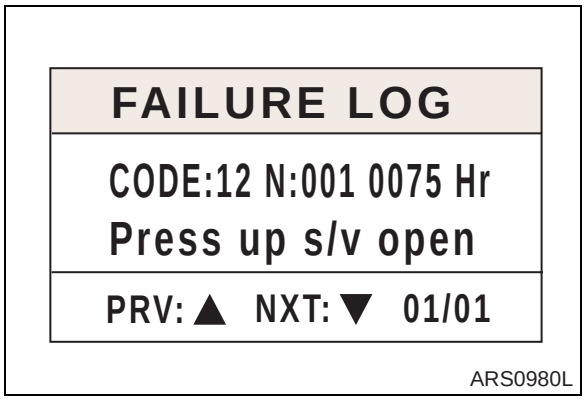


Figure 35

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 18) 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.

When "NO" (ESC, 4 on Figure 18) button is pressed, the screen will recover to previous menu without deletion.



Figure 36

Code Description of Failure Information

Code	State
0 x	Short Circuit
1 x	Open circuit
2 x	Output error
3 x	Output error
8 x	Communication

Display Contents of Failure Information Code

Code	Contents	Cause	Operation	Reset Procedure
82	Communication Err!!	Communication error between e-EPOS controller and instrument panel	* Note	Automatic reset when problem is corrected
01	EPPR v/v short	Short Circuit	Cut off output current (0 mA)	After correcting problem, turn start switch from "OFF" to "ON."
02	Press Up s/v short	Short Circuit		
03	Swing pri. s/v short	Short Circuit		

Code	Contents	Cause	Operation	Reset Procedure
11	EPPR v/v open	Open Circuit	-	Automatic reset when problem is corrected
12	Press Up s/v open	Open Circuit	-	
13	Swing pri. s/v open	Open Circuit	-	
21	Dial Voltage Err (H)	Output voltage Over 4.6±0.2 V	-	
22	Dial Voltage Err (L)	Output voltage Over 0.4±0.2 V	-	
23	TPS Voltage Err (H)	Output voltage Over 4.6±0.2 V	Cut off EPPR v/ v current (0 mA)	
24	TPS Voltage Err (L)	Output voltage Over 0.4±0.2 V	Cut off EPPR v/ v current (0 mA)	
25	Fpump Sensor Err (H)	Output voltage Over 4.6±0.2 V	-	
26	Fpump Sensor Err (L)	Output voltage Over 0.4±0.2 V	-	
27	Rpump Sensor Err (H)	Output voltage Over 4.6±0.2 V	-	
28	Rpump Sensor Err (L)	Output voltage Over 0.4±0.2 V	-	
29	Speed Sensor Err	Under 1067±20Hz (On condition that alternator output exceeds over 12±1V)	-	
31	Fuel shot to GND	Sensor's resistance between two terminals is under 150±100Ω	-	
32	Fuel Sensor open	Sensor's resistance between two terminals is under 6.5±0.5 kΩ	-	
33	Alternator too high	Output voltage of alternator exceeds 33 V for more than 3 seconds	-	
34	Alternator too low	When the output voltage is maintained under 18±1 for more than 3 seconds (On condition that speed sensor output exceeds over 1,067Hz)	-	

NOTE:

1. *If a communication error is generated during operation, the power mode, work mode and auto idle mode will be maintained at the last mode setting before the failure took place until the unit is shutdown.*
2. *When start switch is turned to the "ON" position during a period of a communication error, the e-EPOS controller will operate in the following modes.*
   - *Power mode: Standard mode*

- *Work mode: Digging mode*
- *Auto idle: "ON" (Selection state)*

3. *The above mentioned two statuses are applicable to normal condition of an e-EPOS controller.*
4. *Under the abnormal condition of an e-EPOS controller, communication cable or instrument panel failure, "Failure code: 82" can be generated.*

Information of Machine Operation

Accumulated operation hour of each mode and status is displayed.

1. Operating Hour Information

   A. Entering Sub-menus: When a cursor is located in "Operating Info" of special menu screen (Figure 37) press enter button(↵, 3 on Figure 18) and "Operating Info" screen will be displayed (Figure 38).

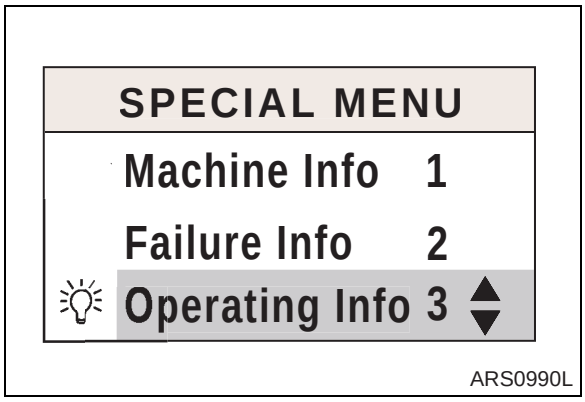


Figure 37

   B. Information screen of machine operation (Figure 38).

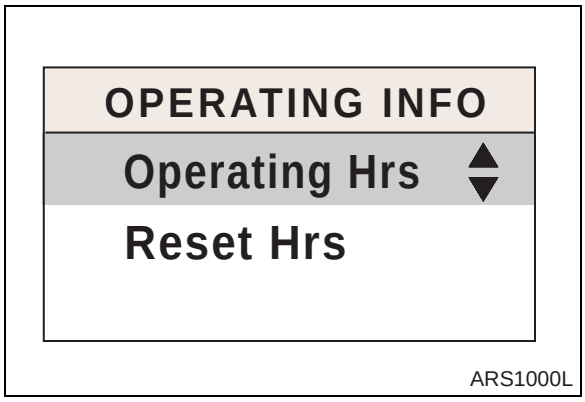


Figure 38

   C. Operation Hour Screen

   D. Exiting Sub-menus: If escape button (ESC, 4 on Figure 18) is pressed for more than 1 second, this information screen will be returned to previous screen.

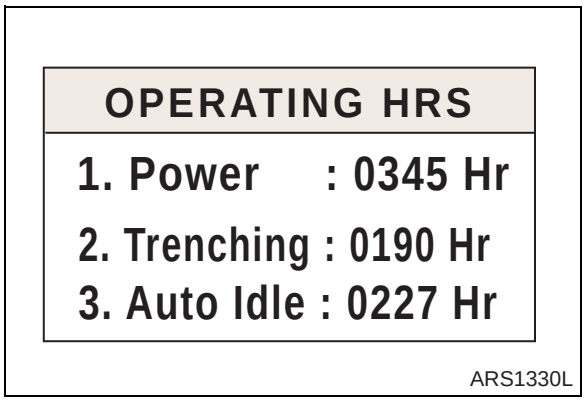


Figure 39

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 (CN2-1)
Trenching Mode	Operation hours used trenching mode are displayed.	Trenching mode switch (Instrument panel) - "ON" status and Alternator signal (CN2-1)
Auto Idle	Operation hours used auto idle status are displayed.	Auto idle switch (Instrument panel) - "ON" status and Alternator signal (CN2-1)
Travel Speed: - Low speed - High speed	Operation hours used low speed and high speed are displayed	Low speed: High speed s/v "OFF" status and travel pressure switch "Py" (control valve) - "ON" status High speed: 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)
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)

Menu Selection of Operation Hour Information

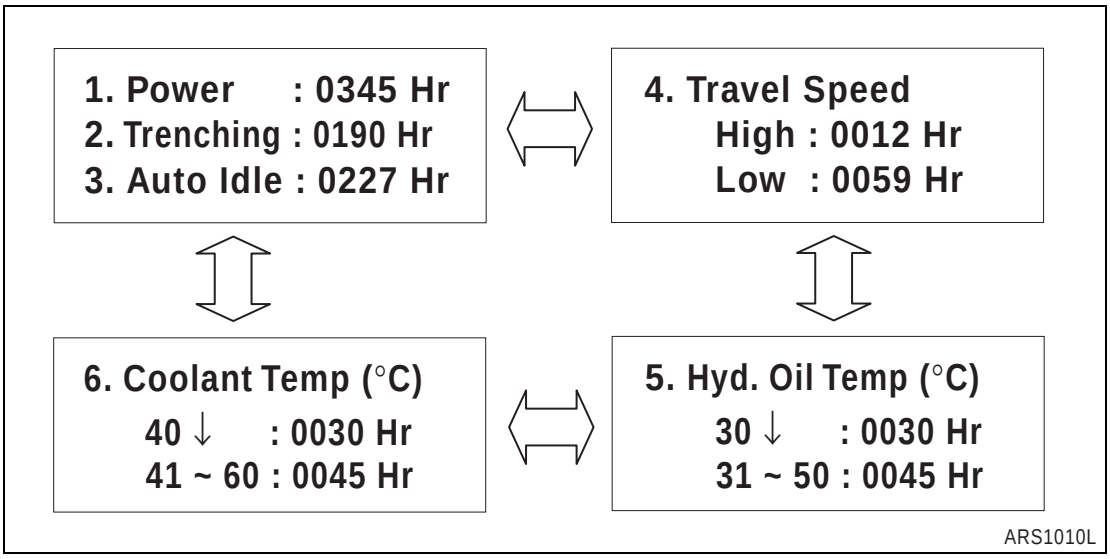


Figure 40

2. Operation hour reset

   A. Entering Sub-menus: When cursor is located in "Reset Hrs" of information screen of operation hour press enter button (↵, 3 on Figure 18) and "Reset Hrs" screen will be displayed.

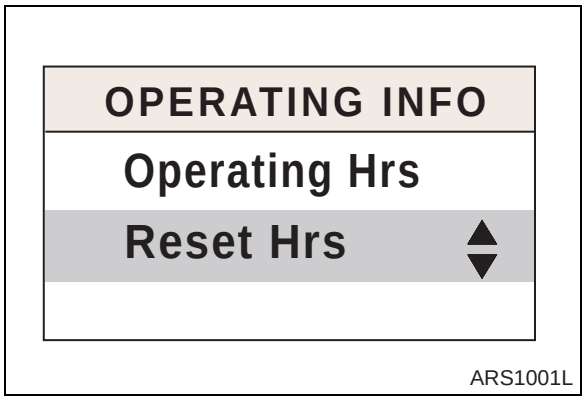


Figure 41

   B. Reset screen of operation hour

   C. Exiting Sub-menus: If escape button (ESC, 4 on Figure 18) is pressed for more than 1 second, this information screen will be returned to previous screen.



Figure 42

NOTE: *When "YES" (↵, 3 on Figure 18) 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.*

ELECTRONIC HYDRAULIC CONTROL SYSTEM (E-EPOS)

CONTROL SYSTEM SCHEMATIC

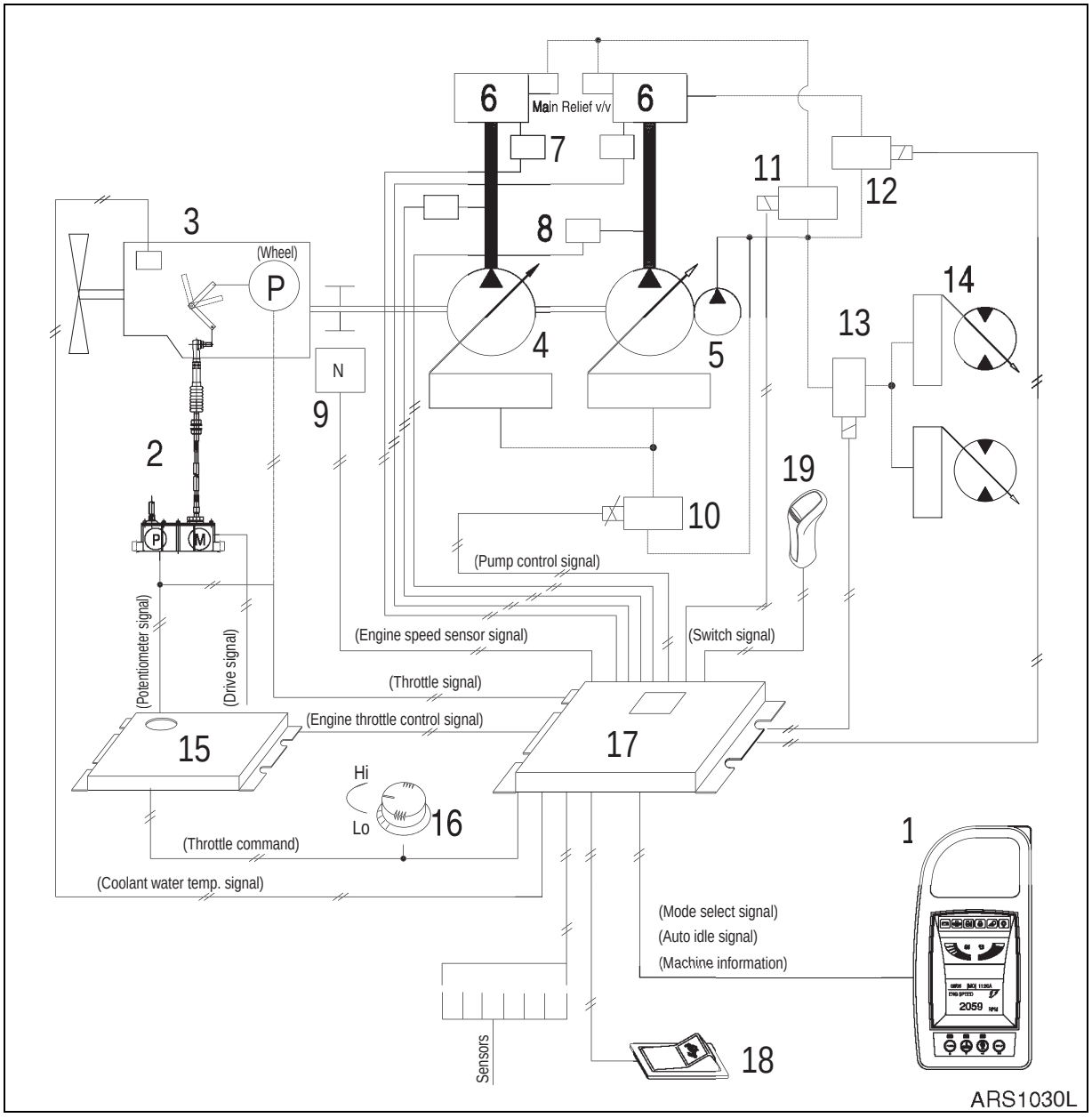


Figure 43

Reference Number	Description
1	Instrument Panel
2	Engine Control Motor
3	Engine
4	Main Hydraulic Pump
5	Control Pump
6	Control Valve
7	Pressure Switch
8	Pump Pressure Sensor
9	Engine Speed Sensor
10	Electro-magnetic Proportional Pressure Reducing Valve (E.P.P.R. Valve)

Reference Number	Description
11	Solenoid Valve (Pressure Up)
12	Solenoid Valve (Swing Priority)
13	Solenoid Valve (High Speed)
14	Travel Motor
15	Engine Throttle Control
16	Engine Control Dial
17	e-EPOS Controller
18	Auto Travel Select Switch
19	Boost Switch (Right Work Lever)

POWER MODE CONTROL

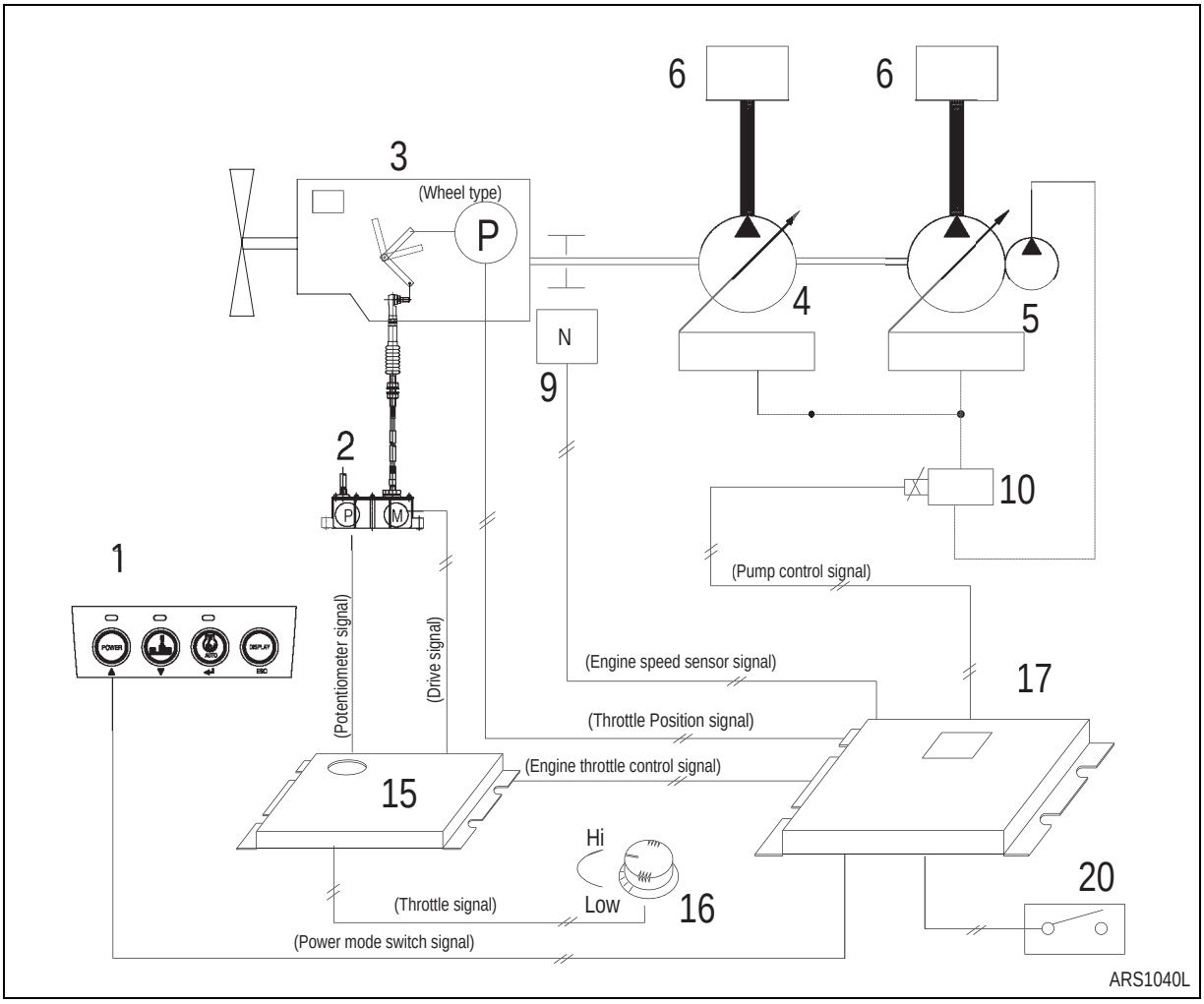


Figure 44

Reference Number	Description
1	Instrument Panel (Power Mode Selection Switch)
2	Engine Control Motor
3	Engine
4	Main Hydraulic Pump
5	Control Pump
6	Control Valve

Reference Number	Description
9	Engine Speed Sensor
10	E.P.P.R. Valve
15	Engine Throttle Controller
16	Engine Control Dial
17	e-EPOS Controller
20	Work / Travel Selection Switch (Wheel Type)

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 start switch is turned "ON," the power mode is automatically defaulted to standard mode. The desired mode can be selected by pressing the select button on the instrument panel. When the power mode is selected, the indicator lamp 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%

OPERATION

1. Power Mode

This mode should be selected for high speed work. In this mode the engine output is most efficiently utilized due to 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. (Electric Proportional Pressure Reducing) valve which in turn varies the pump output quantity.

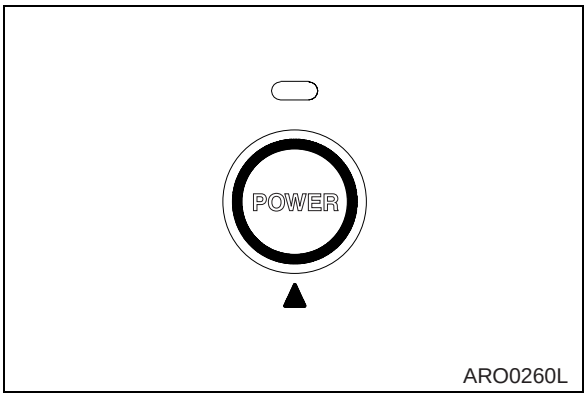


Figure 45

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 that maximum power can be generated.

In Power Mode, the controller receives engine speed signals from the engine speed sensor and the throttle position sensor (sensor is built into engine control motor) 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.

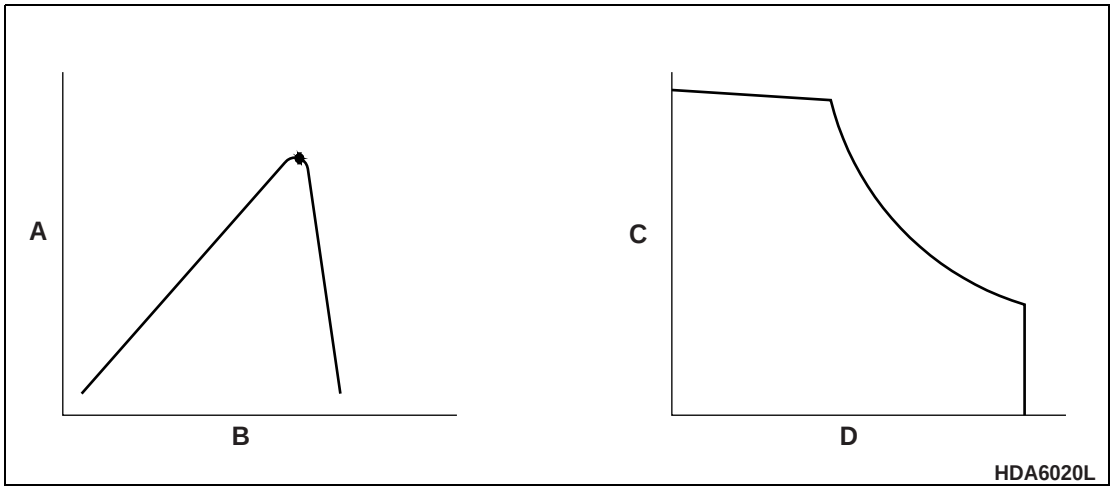


Figure 46

Reference Number	Description
A	Engine Horsepower (hp)
B	Engine Speed (rpm)
C	Pump Discharge Volume (lpm)

Reference Number	Description
D	Pump Discharge Pressure (kg/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.

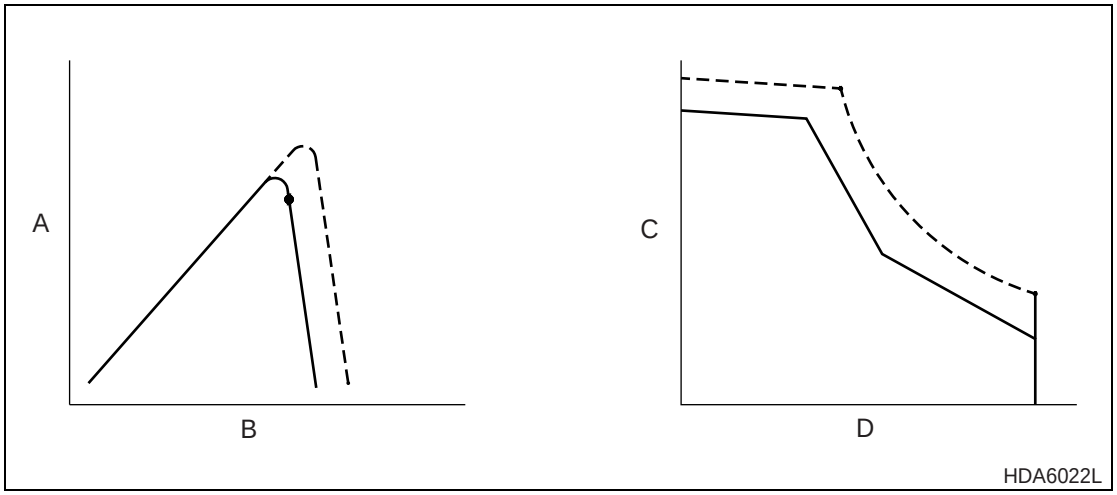


Figure 47

Reference Number	Description
A	Engine Horsepower (hp)
B	Engine Speed (rpm)
C	Pump Discharge Volume (lpm)

Reference Number	Description
D	Pump Discharge Pressure (kg/cm^2)

POWER MODE CONTROL - CIRCUIT DIAGRAM

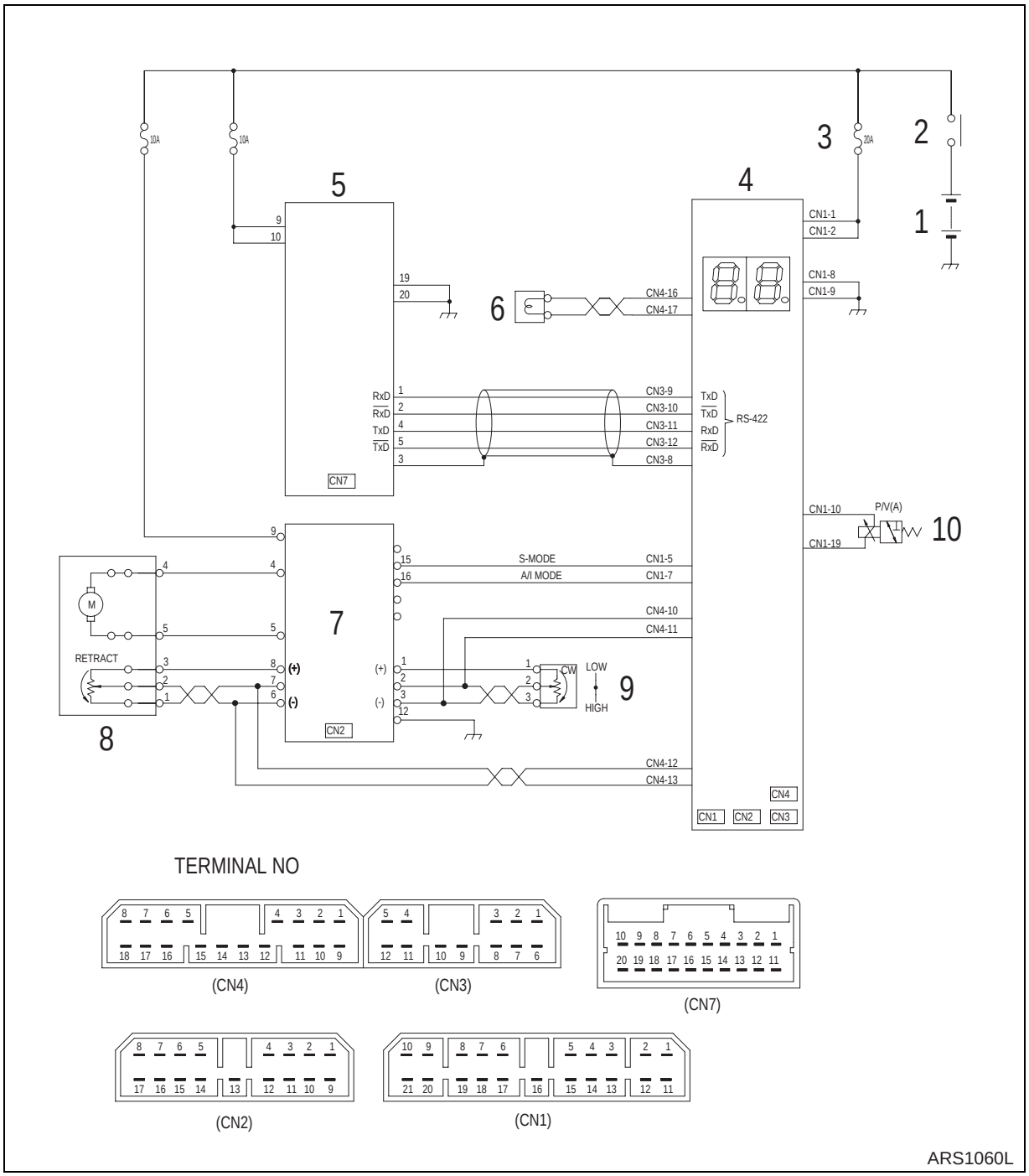


Figure 48

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse
4	e-EPOS Controller
5	Instrument Panel

Reference Number	Description
6	Engine Speed Sensor
7	Engine Throttle Controller
8	Engine Control Motor
9	Engine Control Dial

TRENCHING MODE CONTROL

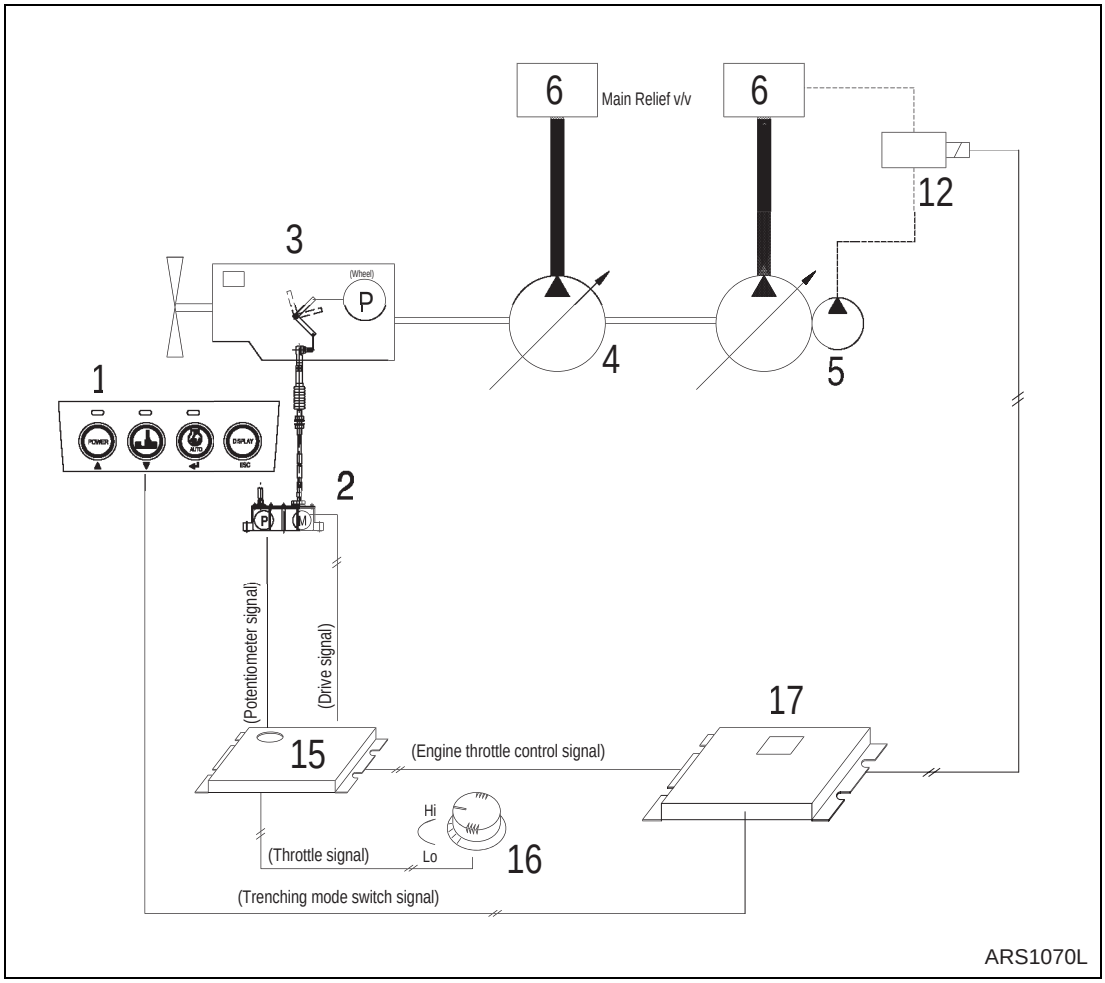


Figure 49

Reference Number	Description
1	Instrument Panel (Trenching Mode Select Switch)
2	Engine Control Motor
3	Engine
4	Main Hydraulic Pump
5	Control Pump

Reference Number	Description
6	Control Valve
12	Solenoid Valve
15	Engine Throttle Control
16	Engine Control Dial
17	e-EPOS Controller

Depending on the working condition, one of two work modes, "DIGGING" or "TRENCHING" can be selected from the instrument panel.

When the engine start 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.

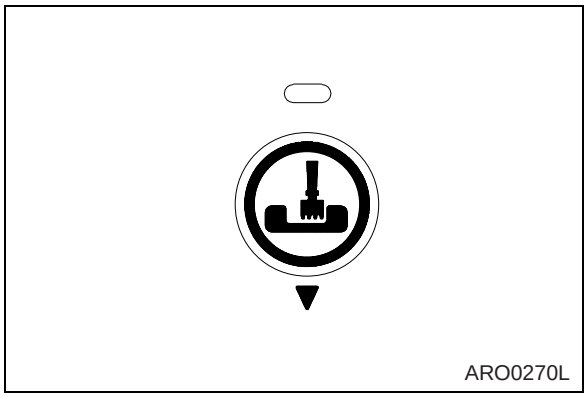


Figure 50

TRENCHING MODE CONTROL - CIRCUIT DIAGRAM

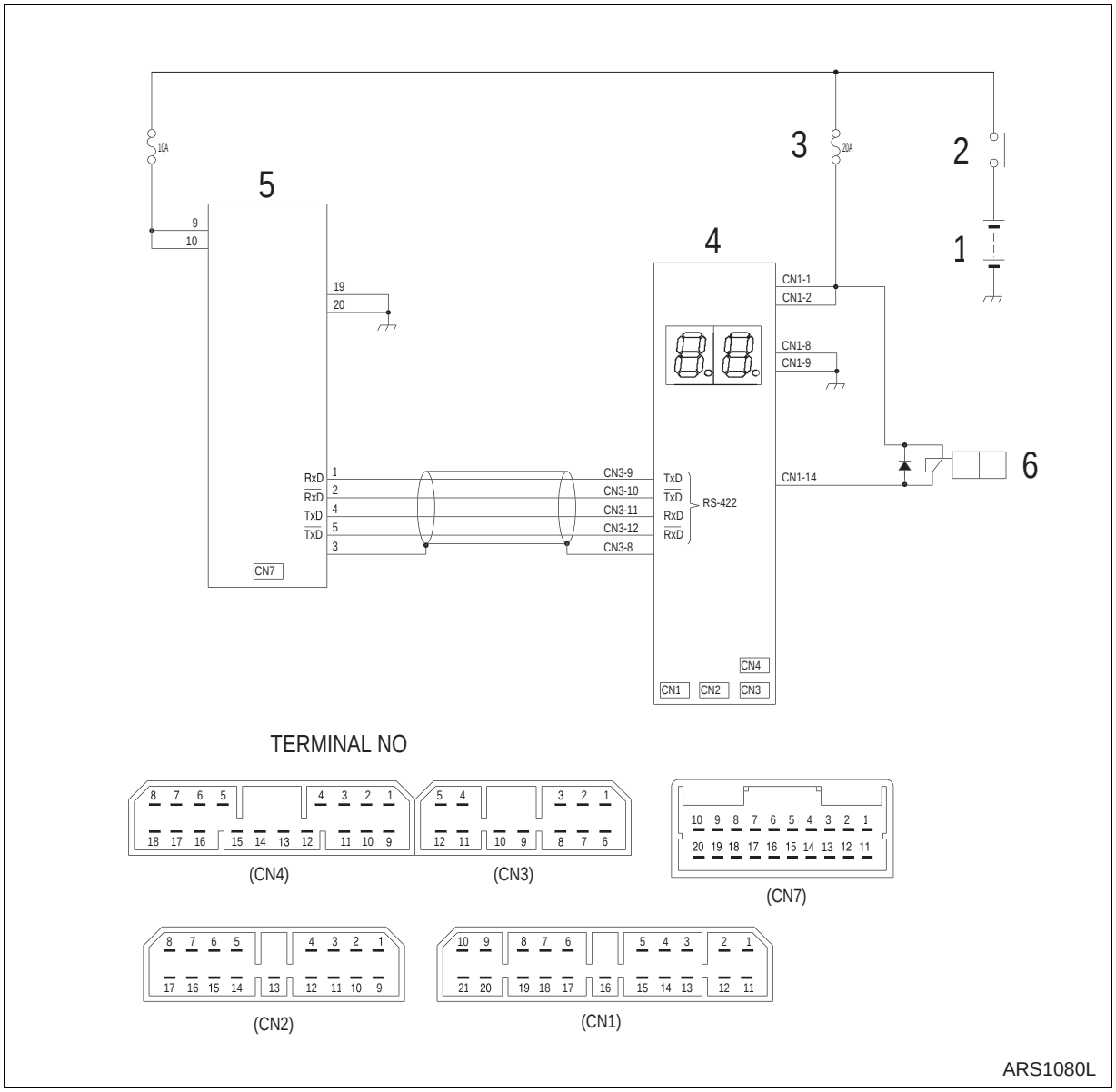


Figure 51

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse

Reference Number	Description
4	e-EPOS Controller
5	Instrument Panel
6	Solenoid Valve (Swing Priority)

ENGINE CONTROL SYSTEM

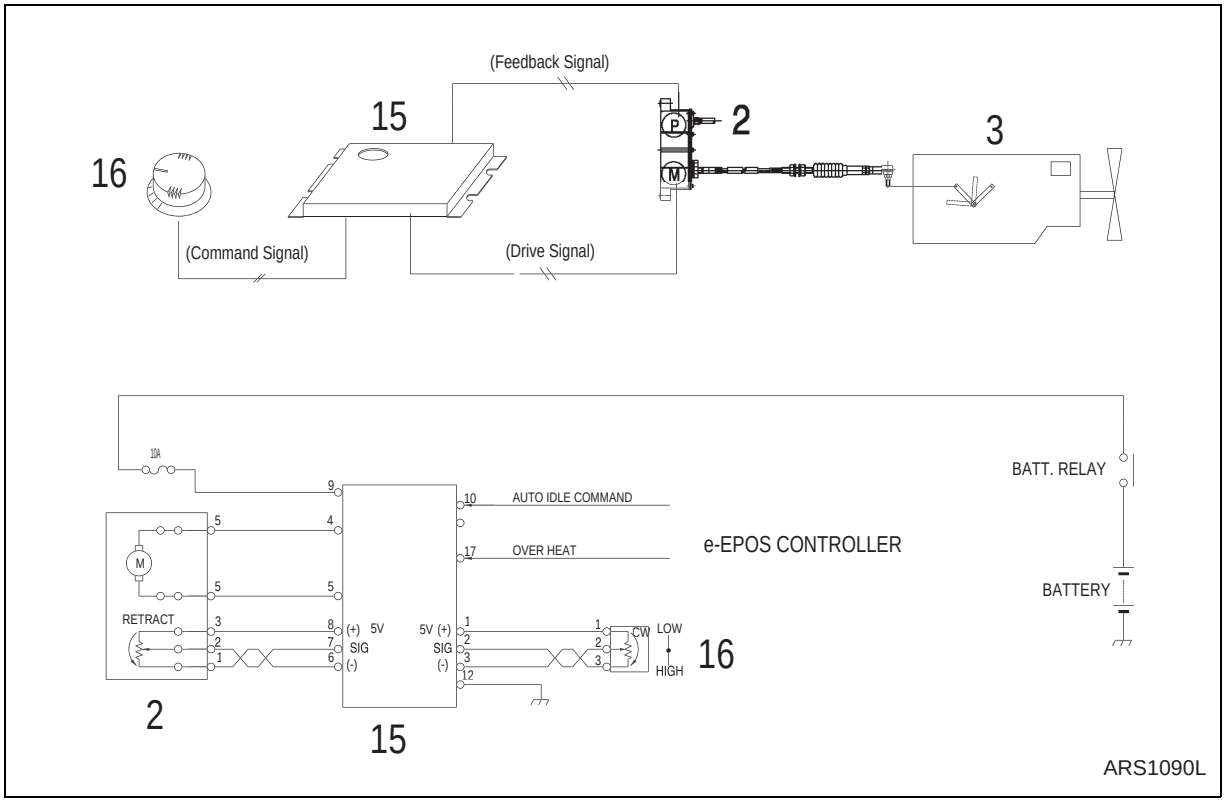


Figure 52

Reference Number	Description
2	Engine Control Motor
3	Engine

Reference Number	Description
15	Engine Throttle Controller
16	Engine Control Dial

When the engine control dial is moved the output voltage changes according to the dial position. This signal is input to the engine throttle controller. The engine throttle controller then compares the input voltage from the engine speed dial with the feedback signal from the throttle position sensor built into the engine control motor and drives the motor to the position set by the control dial. When the command signal and the potentiometer feed back signals are the same the engine controller shuts off the current to the control motor. The engine control motor cable is a solid type and is connected to the engine fuel injection control lever. The engine speed is controlled by the movement of the fuel injection lever which is directly linked with the rotation of the control motor.

ENGINE CONTROL MOTOR

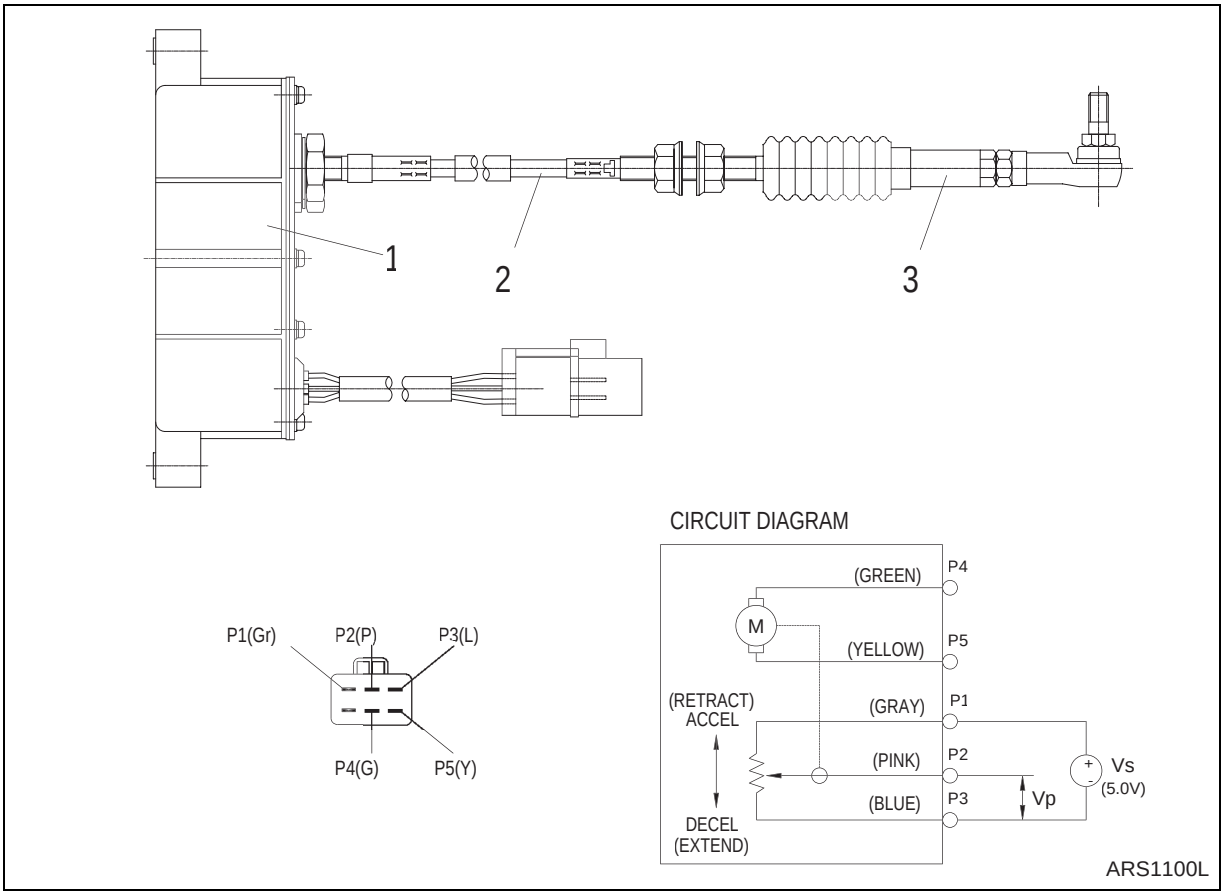


Figure 53

Reference Number	Description
1	Motor Assembly
2	Cable
3	Spring Assembly

The engine control motor uses a D.C. motor with a built in potentiometer to sense the position of the control cable. If an abnormal load (worn or kinked control cable) is sensed in the control motor, the engine controller cuts off the electric current flowing to the engine control motor to protect the system. In such a case, the engine control motor will not operate even though the engine control dial is moved.

The starter switch should be turned off and the cause of abnormal load should be repaired and the starter switch can be turned on again. The engine control dial can once again be used to control the engine speed.

IMPORTANT

When the engine control motor has been replaced or repaired refer to Adjusting the Engine Control Device for correct adjustment of the engine control system. The engine will not perform to its maximum efficiency if it is not adjusted properly.

ENGINE CONTROL DIAL

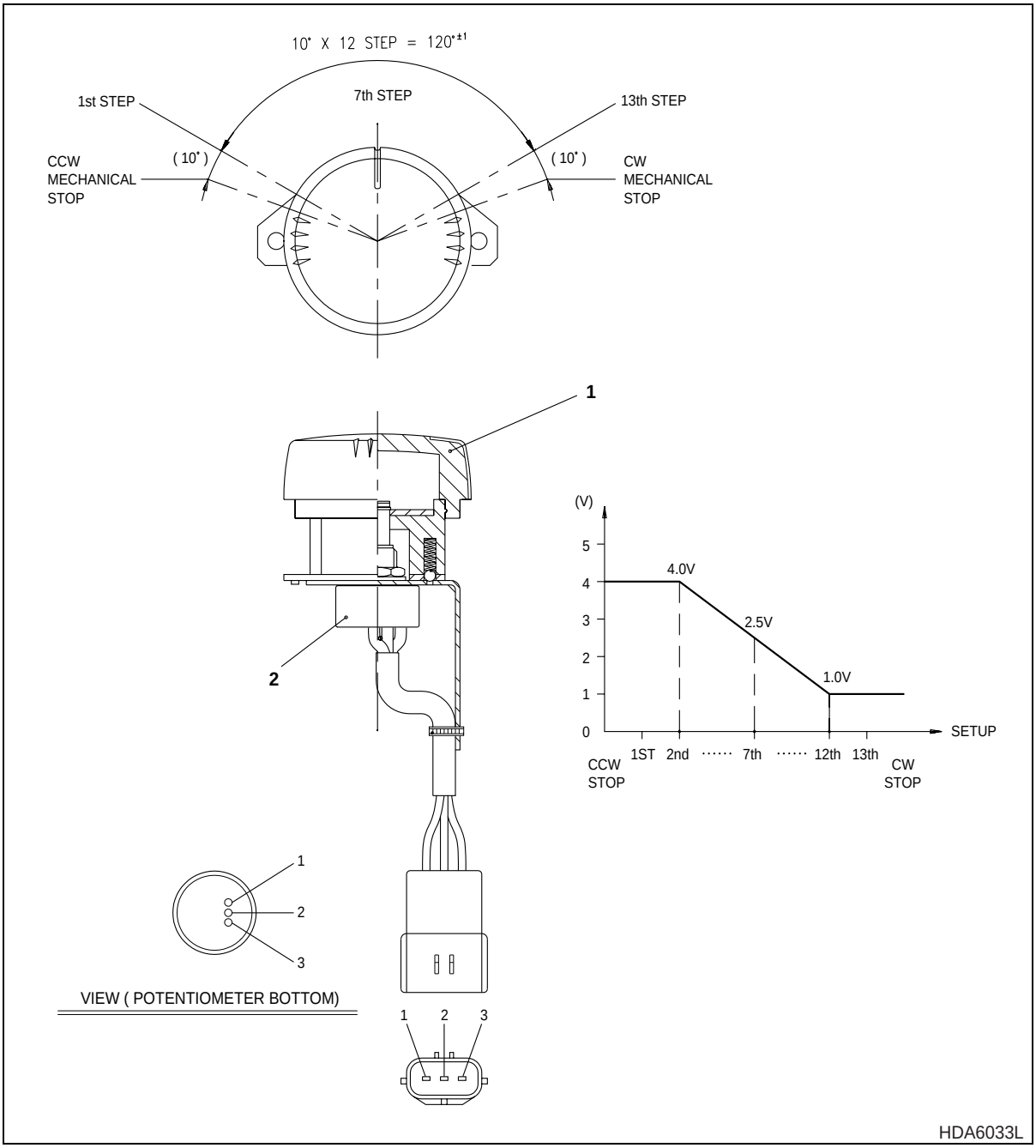


Figure 54

Reference Number	Description
1	Knob
2	Potentiometer (Variable Resistor)

The engine control dial has a built in potentiometer. When the control knob is moved the output voltage (through terminals 2 and 3) will vary from the 5 V supplied from the throttle controller as shown in the graph.

ENGINE CONTROL CIRCUIT DIAGRAM

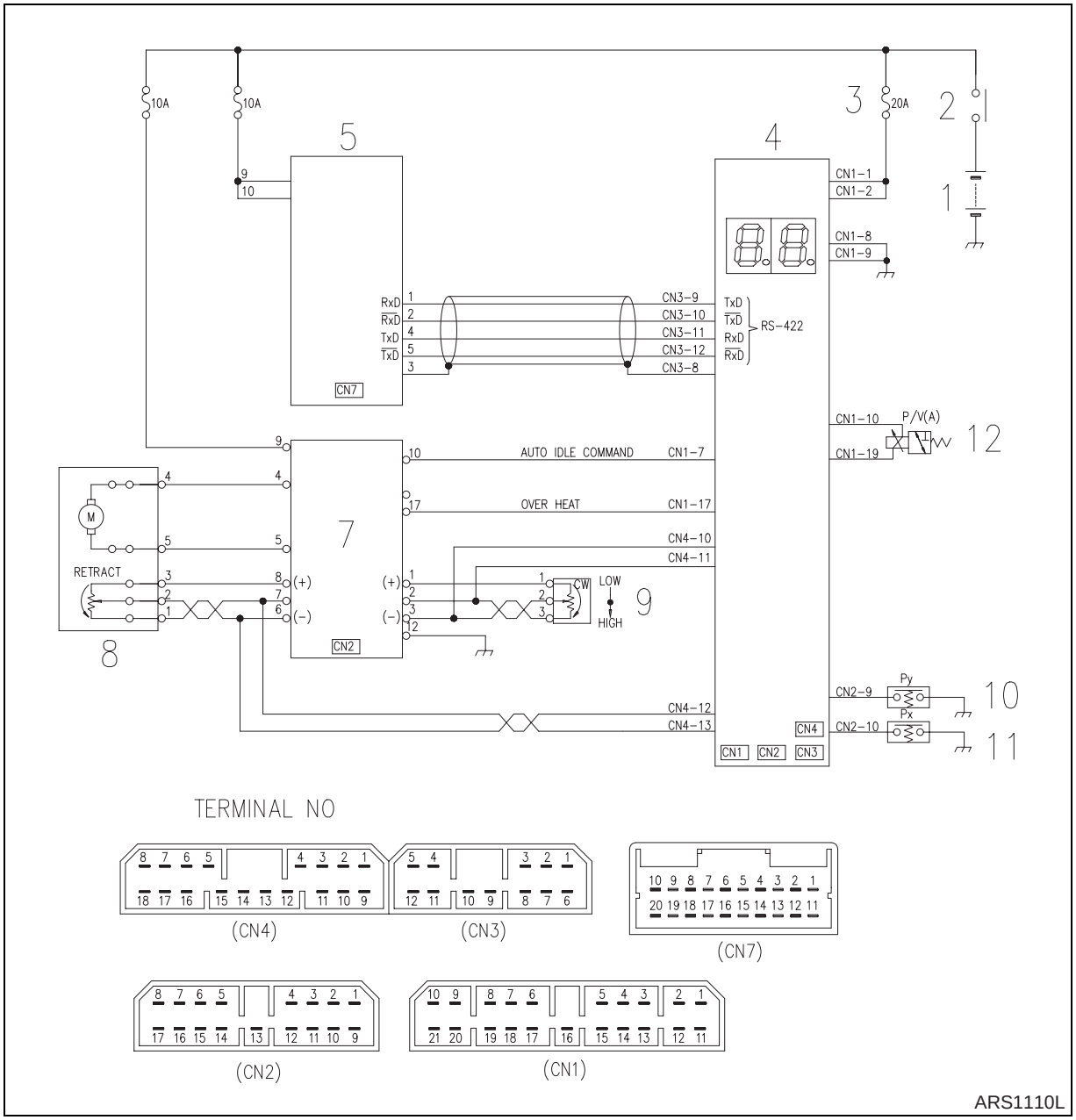


Figure 55

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse
4	e-EPOS Controller
5	Instrument Panel
6	Engine Speed Sensor

Reference Number	Description
7	Engine Throttle Controller
8	Engine Control Motor
9	Engine Control Dial
10	Pressure Switch (Py Port)
11	Pressure Switch (Px Port)

AUTOMATIC DECELERATION CONTROL (AUTO IDLE CONTROL)

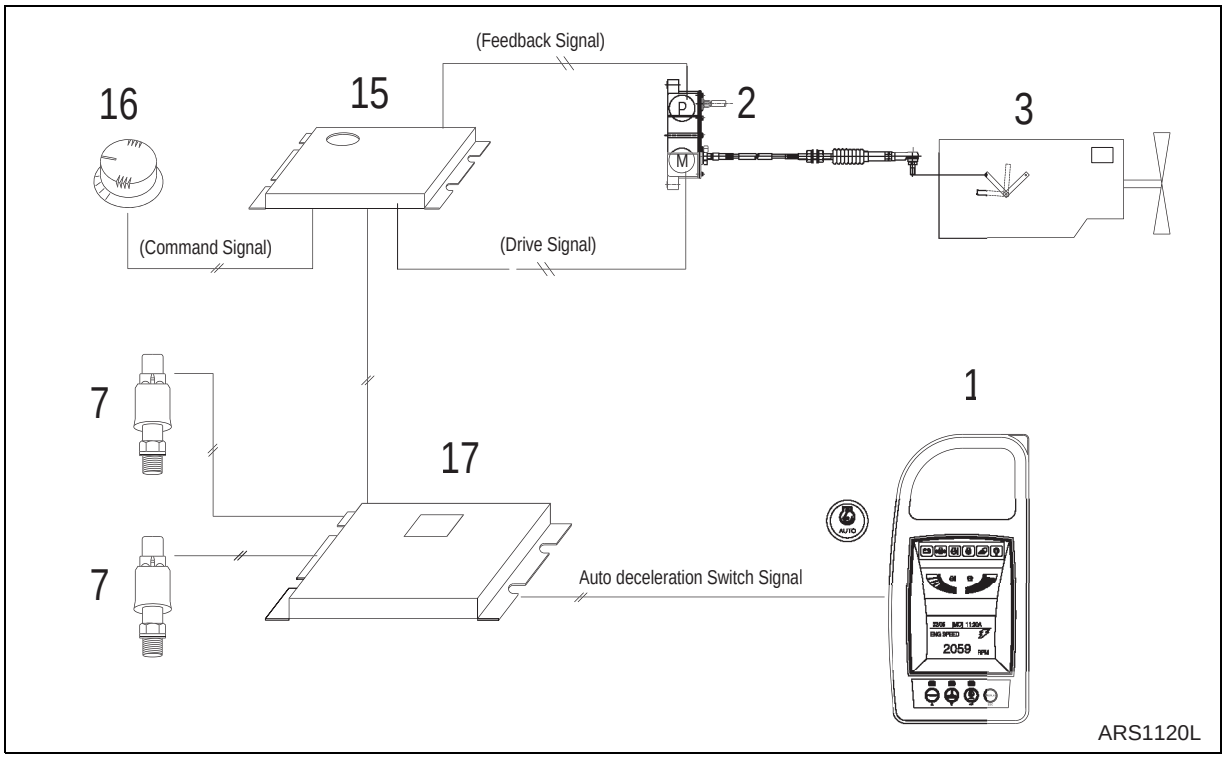


Figure 56

Reference Number	Description
1	Instrument Panel
2	Engine Control Motor
3	Engine
7	Pressure Switch

Reference Number	Description
15	Engine Throttle Controller
16	Engine Control Dial
17	e-EPOS Controller

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 cancelled through the Auto Idle Select 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 sends an automatic reduction signal to the throttle controller. When the engine throttle controller receives this signal, it is compared with the signal set by the engine control dial. The lower of the two signals is selected and the engine control motor is adjusted to this 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

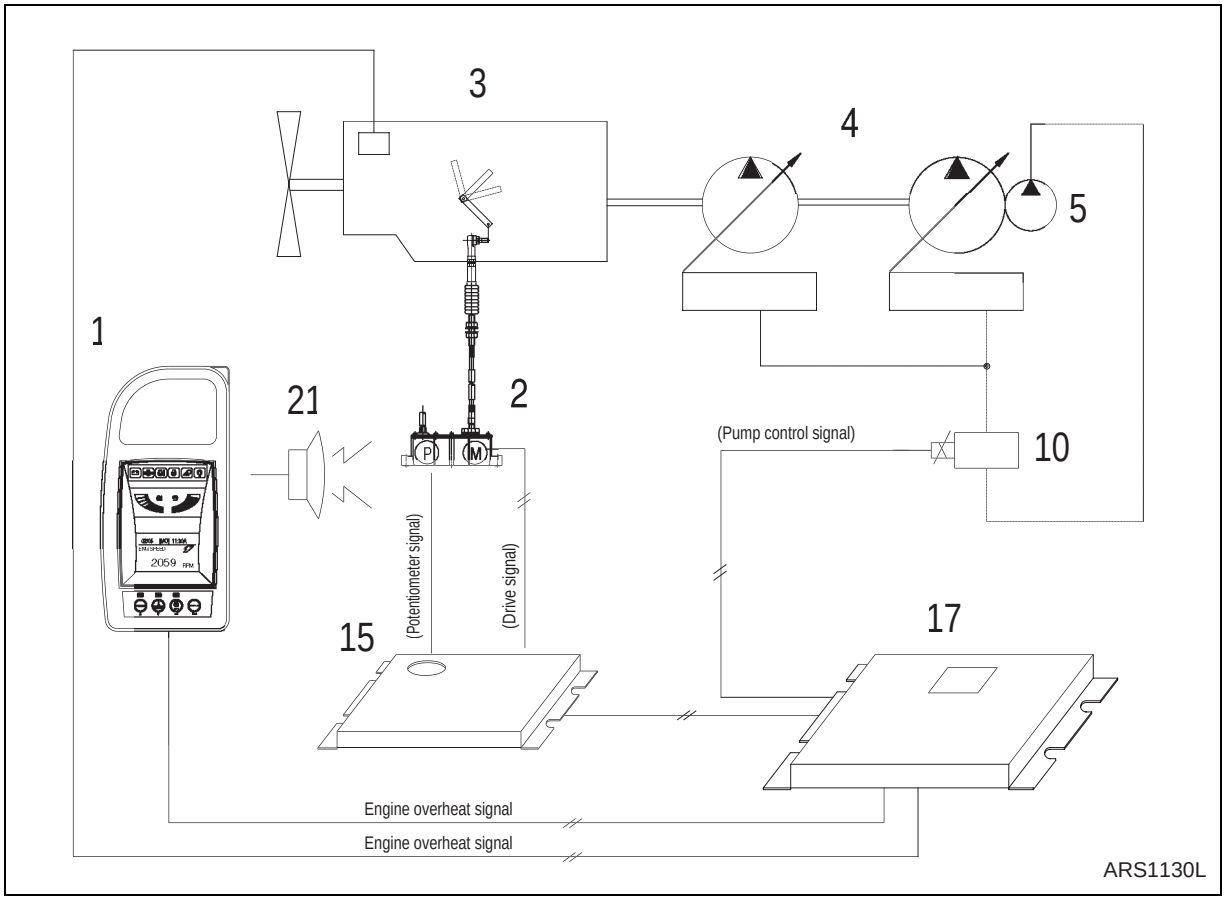


Figure 57

Reference Number	Description
1	Instrument Panel
2	Engine Control Motor
3	Engine
4	Main Pump
5	Control Pump

Reference Number	Description
10	E.P.P.R. Valve
15	Engine Throttle Controller
17	e-EPOS Controller
21	Warning Buzzer

When the engine coolant temperature increases to over 107°C (225°F), the sensor mounted in the coolant line will send a signal to the instrument panel. A overheat signal is also sent to the e-EPOS controller and the overheat warning buzzer will sound. The e-EPOS controller will send a signal to the engine throttle controller and the engine speed is adjusted to standard mode. The engine throttle controller will signal the engine control motor to decrease the engine speed.

When the coolant is overheated, the warning buzzer will sound, standard mode is selected and low engine speed will be selected.

When the coolant temperature falls below 95°C (203°F), normal operation will resume.

POWER BOOST MODE

OPERATION

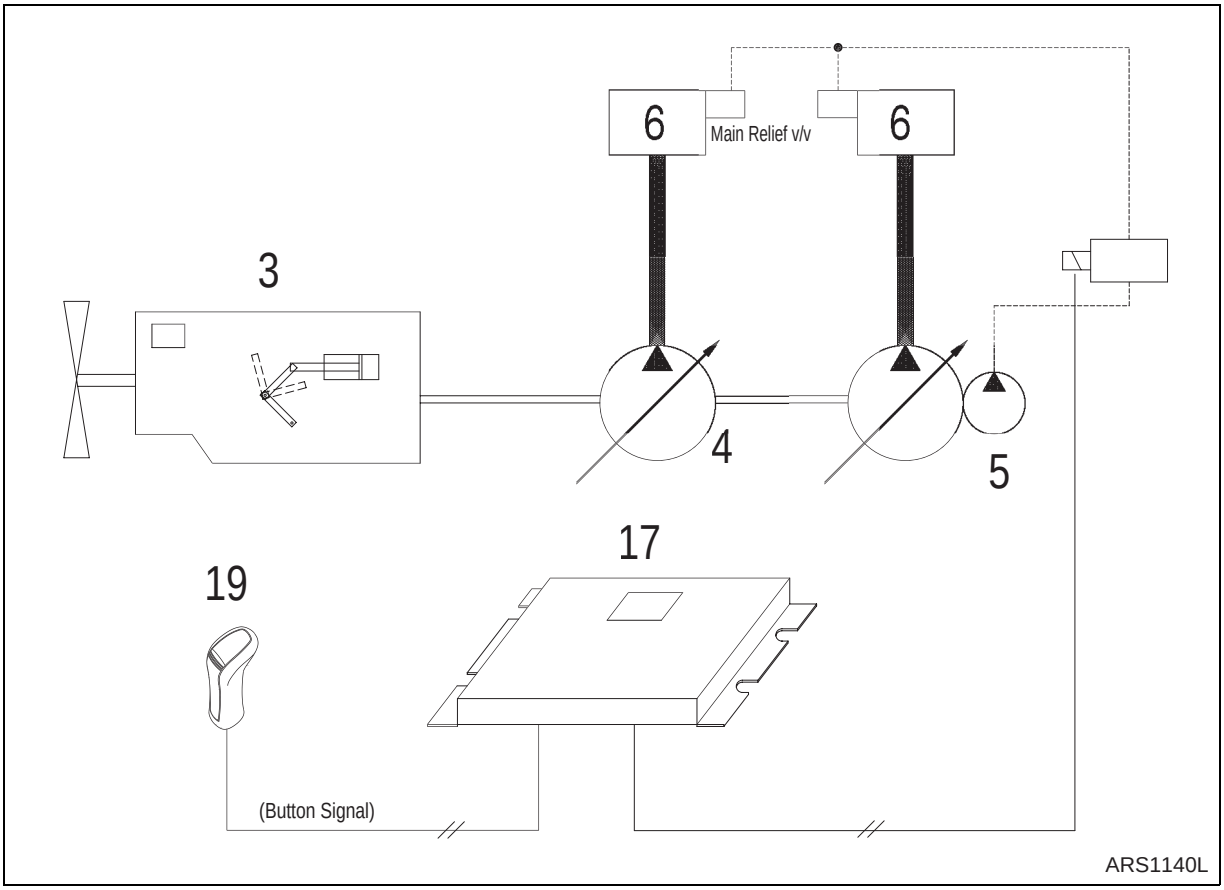


Figure 58

Reference Number	Description
3	Engine
4	Main Pump
5	Control Pump
6	Control Valve

Reference Number	Description
11	Solenoid Valve
17	e-EPOS Controller
19	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 switch button on top of the right work lever 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%.

NOTE: *Do not use this switch for more than 10 seconds.*

POWER BOOST CONTROL - CIRCUIT DIAGRAM

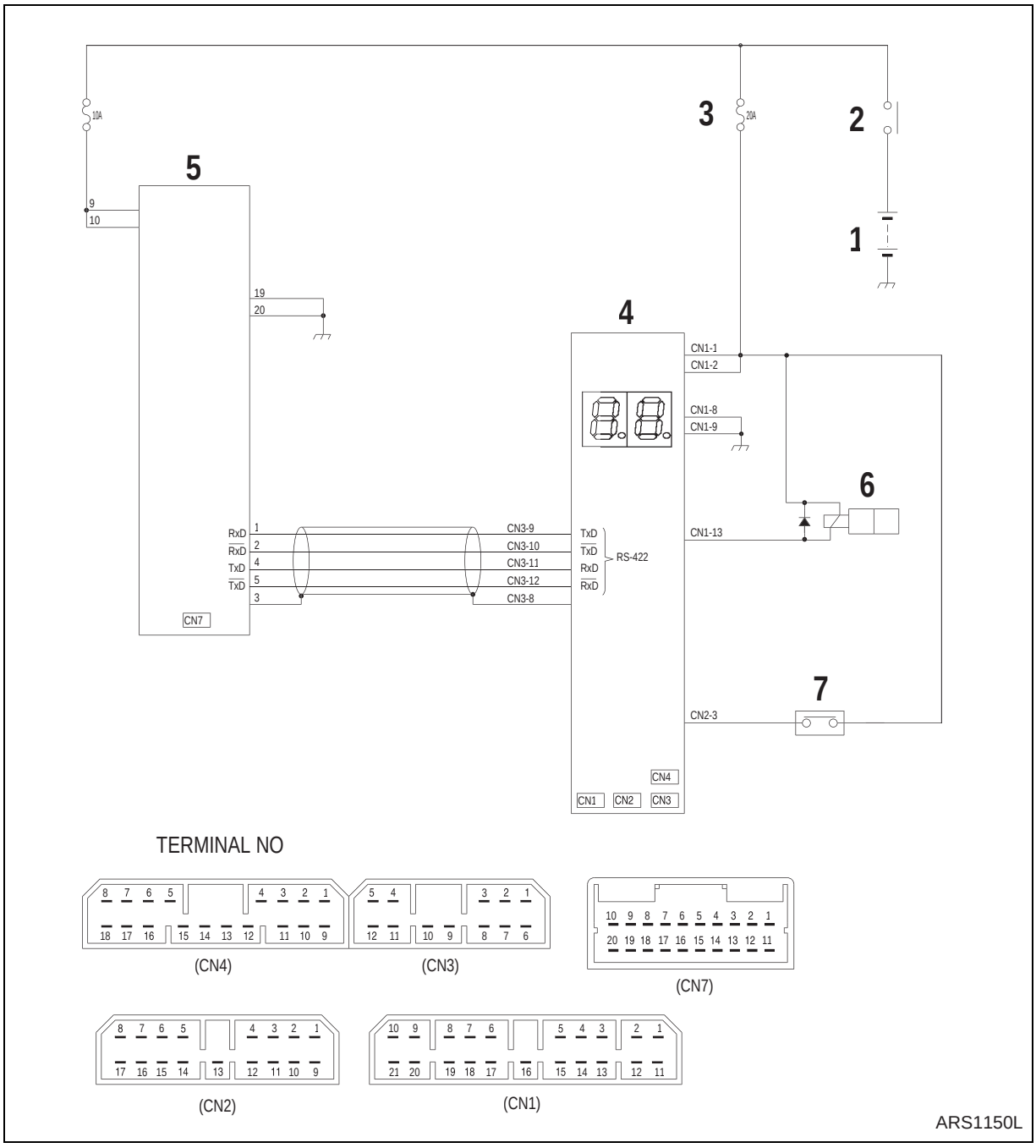


Figure 59

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse
4	e-EPOS Controller

Reference Number	Description
5	Instrument Panel
6	Solenoid Valve (Pressure Up)
7	Power Boost Switch (Top of Right Work Lever)

AUTOMATIC TRAVEL SPEED CONTROL

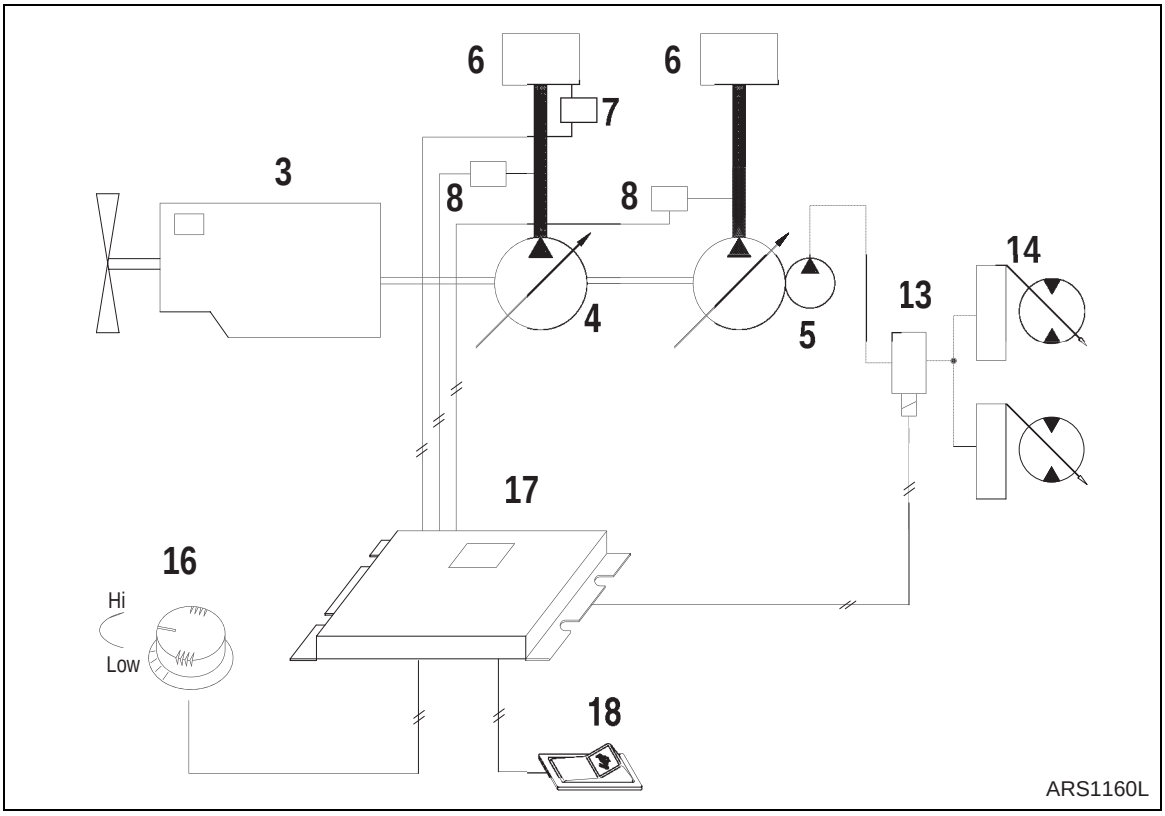


Figure 60

Reference Number	Description
3	Engine
4	Main Pump
6	Control Valve
7	Pressure Switch (Py)
8	Pump Pressure Sensor

Reference Number	Description
13	Solenoid Valve (High speed)
14	Travel Motor
16	Engine Control Dial
17	e-EPOS Controller
20	Selection 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 selection switch is set to the "I" position, the travel motor will run in the II-speed (high speed) range. If the selection 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.

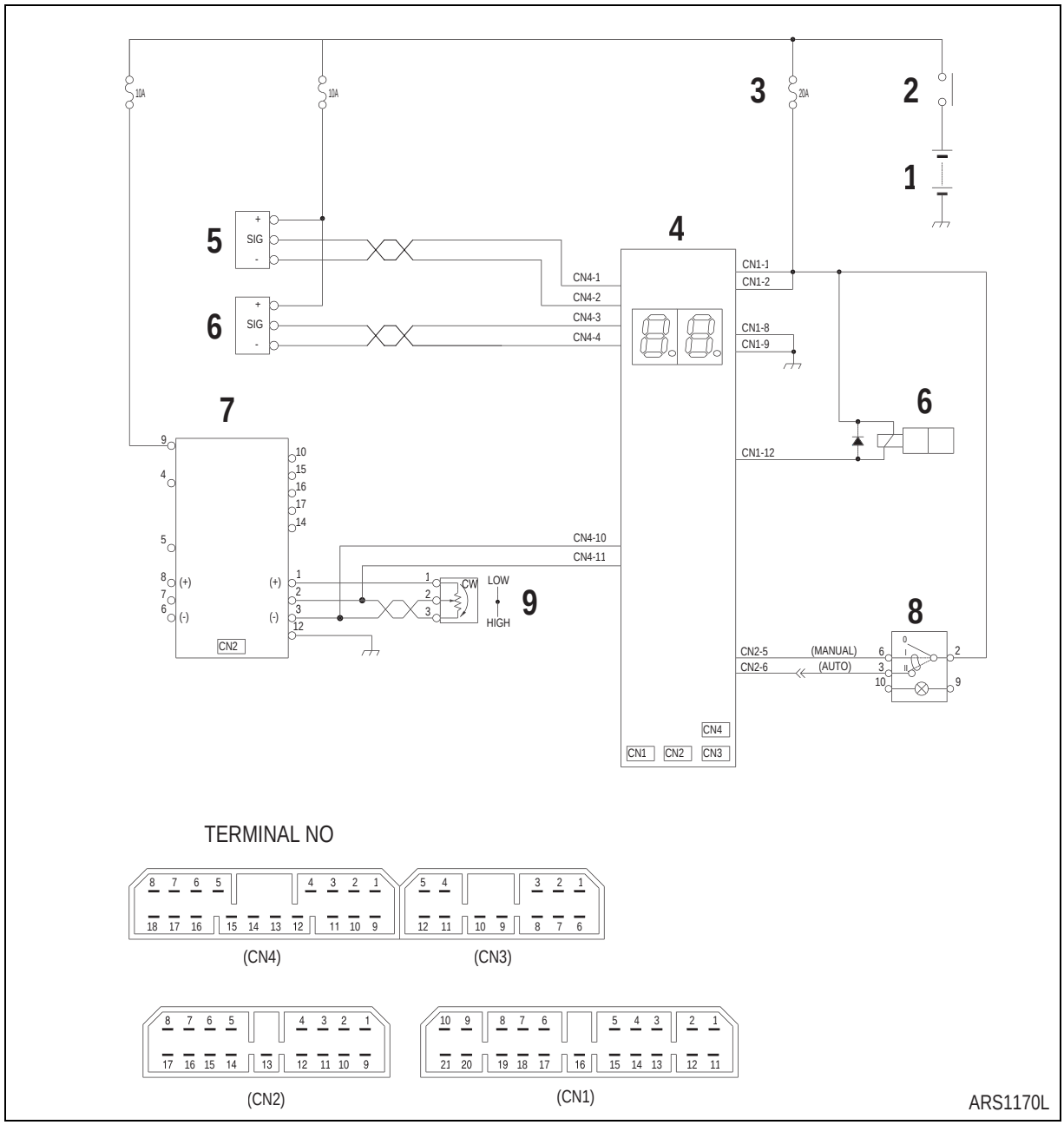


Figure 61

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse
4	e-EPOS Controller
5	Pressure Sensor (Front Pump)

Reference Number	Description
6	Pressure Sensor (Rear Pump)
7	Engine Throttle Controller
8	Automatic Travel Select Switch
9	Engine Control Dial
10	Solenoid Valve (High Speed)

ENGINE CONTROL DEVICE - ADJUSTMENT

Engine speed adjustment should be made by following the procedures listed below. (Under no load conditions)

1. Adjusting The High Idle Speed

1. Turn the starter switch to the "ON" position. Select Power Mode from the instrument panel. Turn the engine speed control dial to the "HIGH IDLE" position to reduce the (3) motor cable to the shortest length.
2. Adjust the (3) motor cable linked with the (2) bracket so that the engine governor lever touches the maximum position of the stopper.

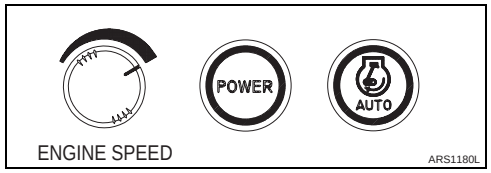
2. Adjusting The Low Idle Speed

1. Turn the engine speed control dial to the "LOW IDLE" position so that the (3) motor cable is extended to the maximum length. (The maximum stroke range for the lever and cable is 37.0 mm (1.46 in).)
2. Check that the engine governor is at the minimum stopper position and the cable slack is acceptable.
3. A. If the lever is not in the minimum position and touching the stopper, move the (3) cable to one hole lower on the lever. If the cable slack is excessive, move the (3) cable to one hole above the original hole on the lever. Repeat above steps 1 and 2.

   B. Shorten the (3) motor cable 1 - 1.25 mm (0.0394 - 0.0591 in) by turning the cable adjustment nut for motor cable (3), 2/3 - 1 turn in the high idle position.

3. Adjusting The Automatic Deceleration System and Power Mode (First perform Adjustments 1 and 2 before performing this adjustment.)

1. Automatic Deceleration (Auto Idle)
   A. Turn engine speed control dial to "HIGH IDLE" position.
   B. Turn power mode and auto idle buttons to "ON" position.
   C. Adjust engine speed by slowly turning variable resistor screw "VR1." (See Figure 64.)
2. Standard Mode
   A. Turn engine speed control dial to "HIGH IDLE" position.
   B. Turn power mode and auto idle buttons to "OFF" position.
   C. Adjust engine speed by slowly turning variable resistor screw "VR2." (See Figure 64.)

Mode	Variable Resistor	Dial Position and Mode Setting	Engine Speed Setting
Automatic Deceleration (Auto Idle)	VR1		Refer to throttle controller name plate (3, Figure 64).
Standard Mode	VR2		Refer to throttle controller name plate (3, Figure 64).

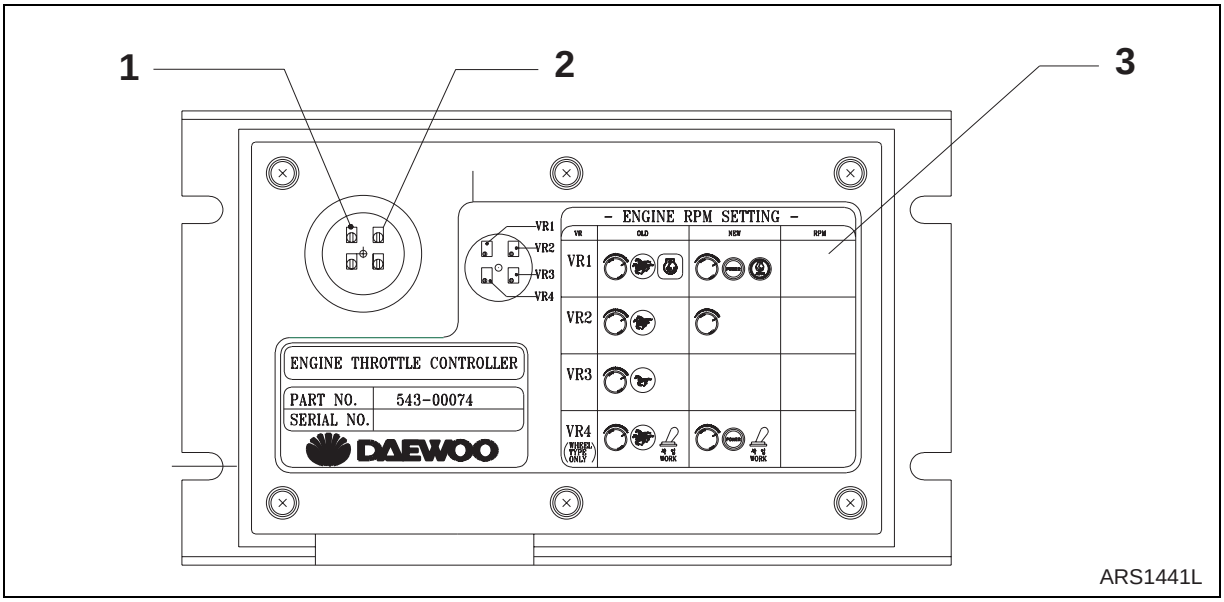


Figure 64

Reference Number	Description
1	VR1 (Automatic Deceleration Adjusting Variable Resistor)
2	VR2 (Stand Mode Adjusting Variable Resistor)
3	Name Plate

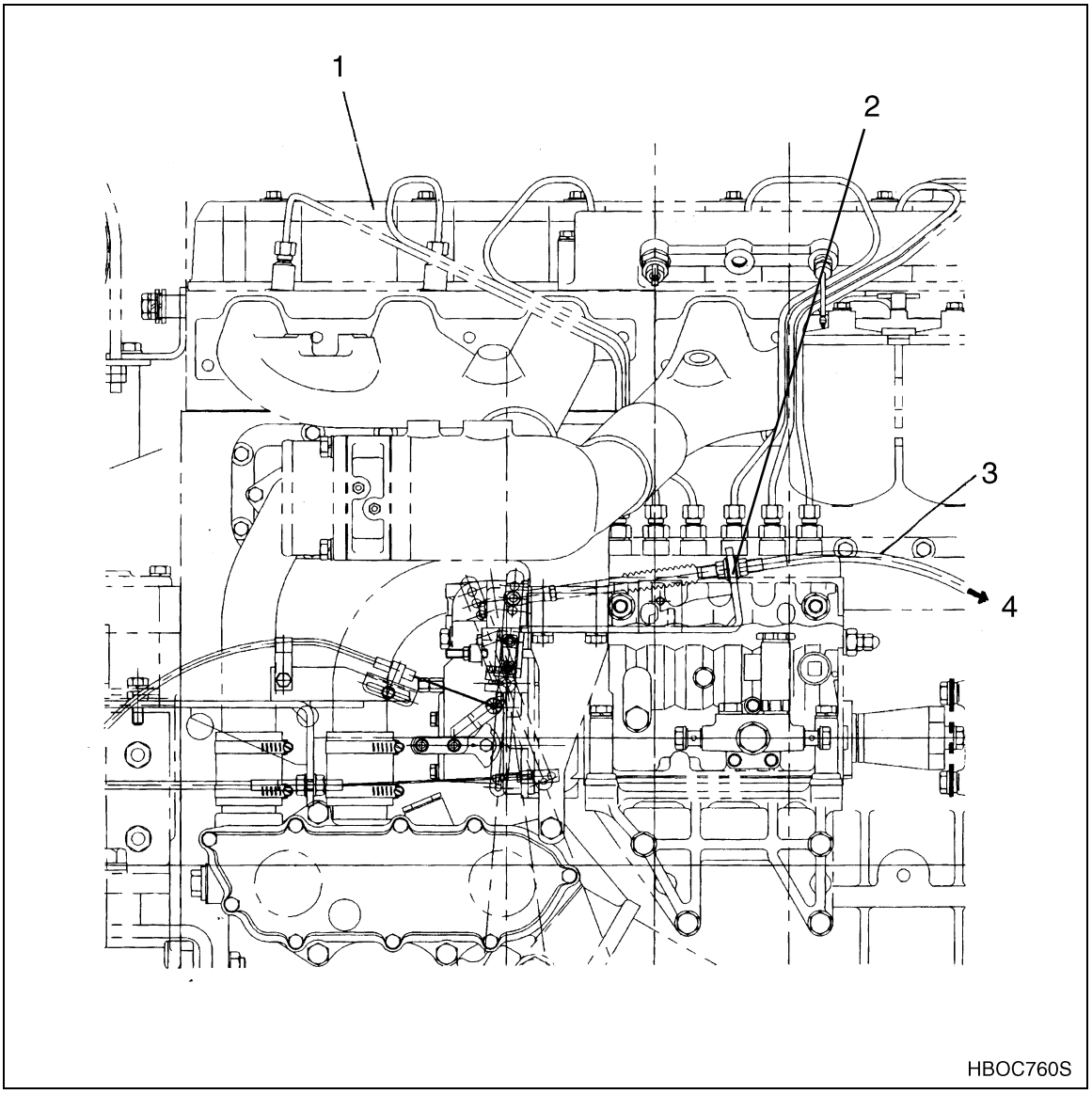


Figure 65

Reference Number	Description
1	Engine - Fuel Control Lever Area
2	Control Motor Cable Bracket

Reference Number	Description
3	Engine Speed Control Cable
4	To Engine Control Motor

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 in the drawer under the operator's seat.

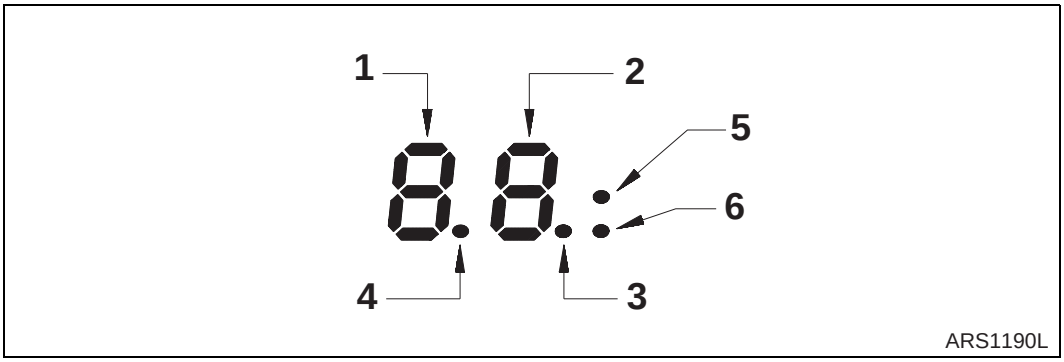


Figure 66

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,)
5	Communication Monitor LED (Flash when normal condition)
6	

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.

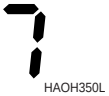
2. Engine Speed Monitor

This LED light flashes according to the engine speed. The flashing interval is proportional to the engine speed.

3. Communication Monitor

These LED lamps flash when normal state of communication between main controller and instrument panel.

4. 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

5. Malfunction Display and Reset Procedure

The malfunction codes displayed on the top of the e-EPOS controller and reset procedure are the same with failure information codes a part of failure information.

Refer to the failure information part of letter information display for details.

ENGINE THROTTLE CONTROLLER

Under the rubber cap on the surface of the engine controller, there are three LEDs. Based on the equipment status the following LEDs will turn "ON."

Throttle Controller Input Signal	Status	LED Status			Voltage At Control Motor Terminal
		Red	Green	Yellow	
Dial Voltage < Motor Potentiometer Voltage	While Control Motor Is Operating (Increasing rpm)	**X**	Δ	**O**	Approximately +24 V
Dial Voltage > Motor Potentiometer Voltage	While Control Motor Is Operating (Decreasing rpm)	Δ	**X**	**O**	Approximately -24 V
Dial Voltage = Motor Potentiometer Voltage	Control Motor Stopped	**O**	**O**	**O**	0 V
	Motor Overload (Cut Off Motor Current)	**X**	**X**	**O**	0 V
	Abnormal Controller Power Voltage (Low Or No Input)	**X**	**X**	**X**	0 V

Δ	**O**	**X**
Brightly Lit	**ON**	**OFF**

NOTE:

1. *Control Motor Voltage is Measured at throttle controller 4 (+) and 5 (-) terminals.*
2. *Yellow LED indicates power status (ON, OFF).*
3. *To protect the control motor from overloads, the control motor automatically cuts off supply voltage to the motor when there is a heavy load on the motor and the possibility of motor damage or burn out exists.*
4. *After the malfunction is corrected, turn the starter switch from "OFF" to the "ON" position and normal operation will resume.*

WIPER SYSTEM

WIPER CIRCUIT

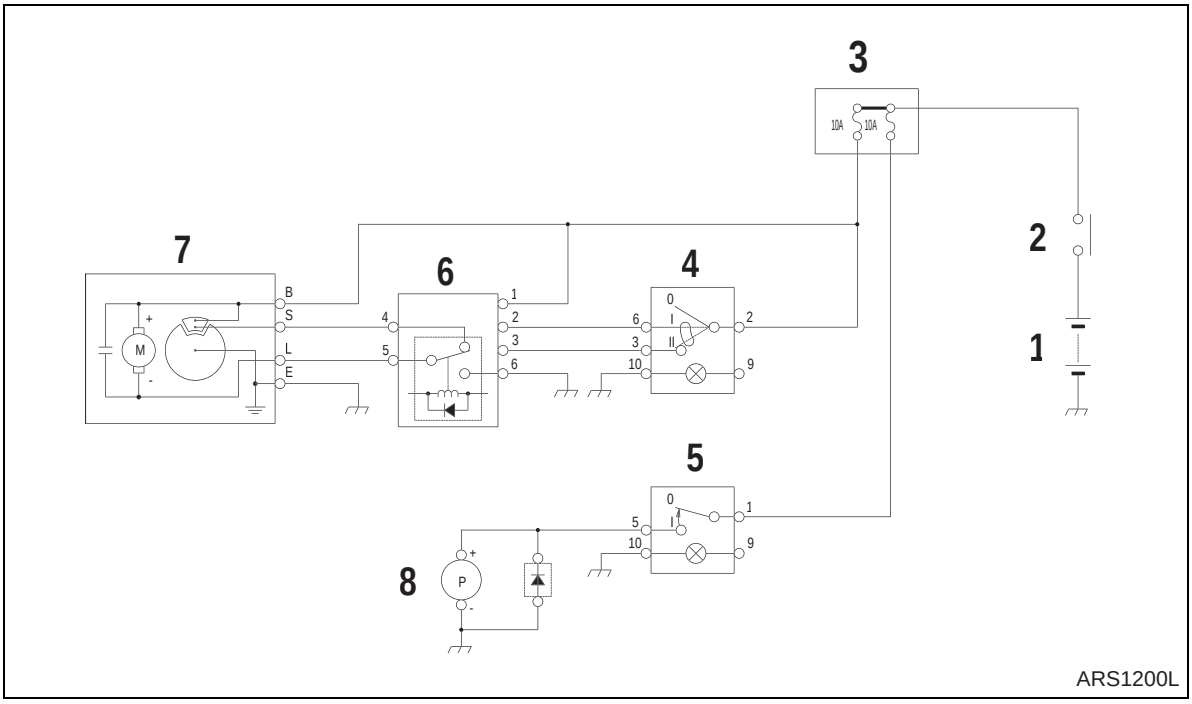


Figure 67

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse
4	Wiper Switch

Reference Number	Description
5	Washer Switch
6	Wiper Timer
7	Wiper Motor
8	Window Washer

WIPER OPERATION

Intermittent Operation (I - position)

When the wiper switch (4) is turned "I" position, the current flows from the fuse (3) → "B" terminal of wiper motor (7) → "L" terminal of wiper motor (7) → "5" terminal of wiper timer (6) → "6" terminal of wiper timer (6) → ground and the wiper motor operates intermittently by the timer built in wiper timer. (On: approximately 1 second, Off: approximately 5 seconds)

Continuous Operation (II - Position)

When the wiper switch (4) is turned "I" position, the current flows from the fuse (3) → "B" terminal of wiper motor (7) → "L" terminal of wiper motor (7) → No. 5 terminal of wiper timer (6) → No. 6 terminal of wiper timer (6) → ground and the contact points No. 5 and No. 6 of wiper timer (6) are connected continuously, the wiper motor operates continuously.

When the wiper switch (4) is turned "OFF," the current flows from the fuse (3) → "B" terminal of wiper motor (7) → "L" terminal of wiper motor (7) → No. 5 terminal of wiper timer (6) → No. 4 terminal of wiper timer (6) → "S" terminal of wiper motor (7) → "B" terminal of wiper motor (7) and the wiper motor is stopped at the auto stop position.

WINDOW WASHER OPERATION

When the window washer switch is turned "ON," the current flows from the fuse (3) → No. 1 terminal of washer switch (5) → No. 5 terminal of washer switch (5) → "+" terminal of window washer (8) → ground and windshield washer fluid is sprayed.

LIGHTING SYSTEM

LIGHTING SYSTEM CIRCUIT DIAGRAM

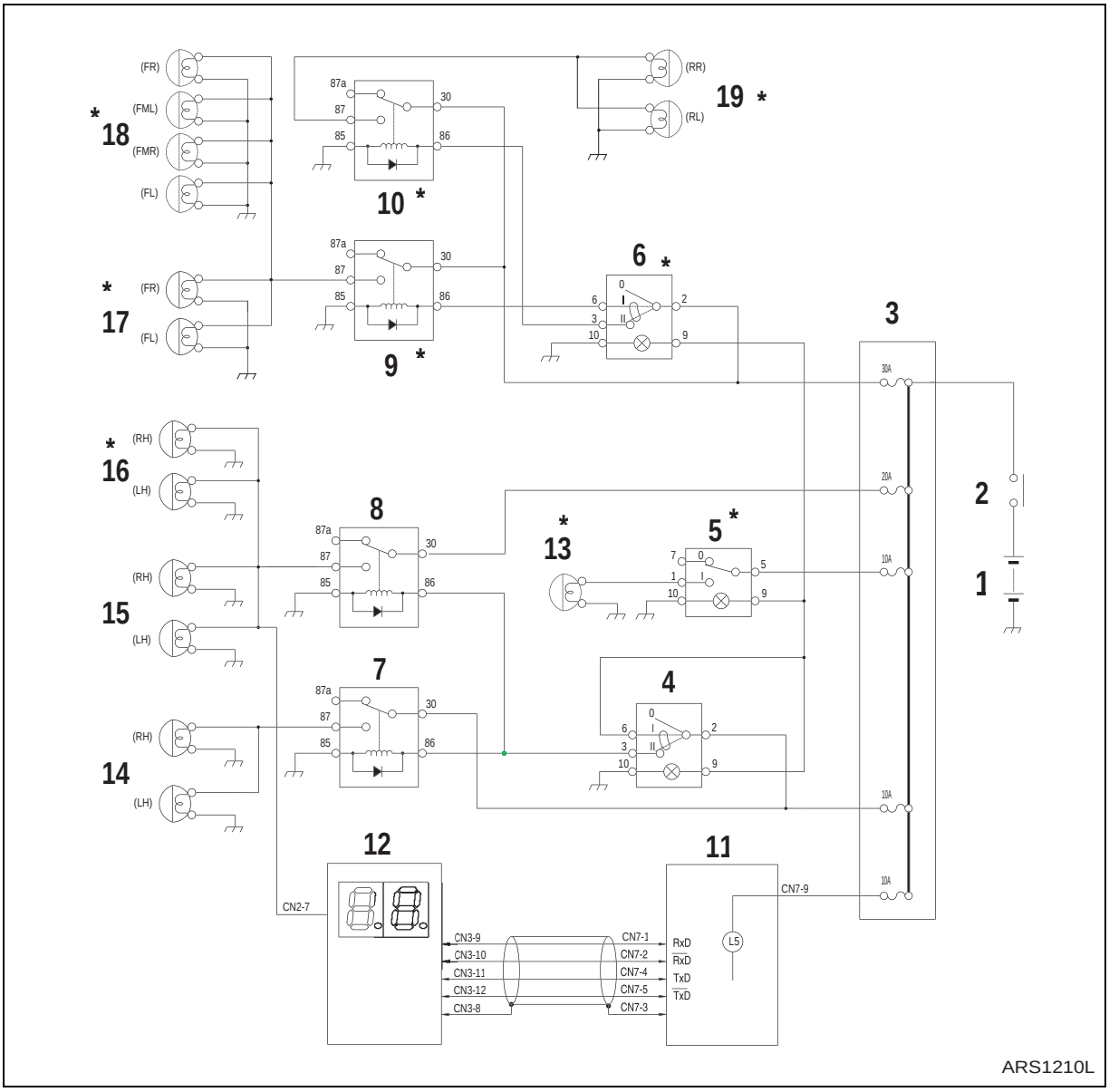


Figure 68

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse Box
4	Light Switch
*5	Warning Light Switch
6	Cabin Light Switch
7	Headlight Relay (Work Light Indicate Light)
8	Work Light Relay
*9	Front Cabin Light Relay

Reference Number	Description
*10	Rear Cabin Light Relay
11	Instrument Panel
12	e-EPOS Controller
*13	Rotating Warning Light
14	Headlight (2 ea.)
15	Work Light (2 ea.)
*16	Additional Work Light (2 ea.)
*17	Front Cabin Light (2 ea.)
*18	Front Cabin Light (4 ea.)
*19	Rear Cabin Light (2 ea.)

NOTE: *The "*" mark (5, 9, 10, 13, 16, 17, 18, 19) are optional parts.*

KIND OF LIGHT

The lighting system is consists of headlights, work lights, cabin lights (optional), rotating warning light (optional), relays and switches.

OPERATION

Switch	Position	Connected Terminal of switch	Activated Relay	Lit Light
Light Switch	1	2-6 Terminal	-	Illumination Light of Switch
	2	2-6 Terminal	-	Illumination Light of Switch
		2-3 Terminal	Headlight Relay	Headlight (2 Ea.)
			Work Relay	Work Light (2 Ea.), Additional Work Light (2 Ea.) Indicator Light of Work Light (L5)
Cabin Light Switch	1	2-6 Terminal	Front Cabin Light Relay	Front Cabin Light (2 Ea.) or Front Cabin Light (4 Ea.)
	2	2-6 Terminal	Front Cabin Light Relay	Front Cabin Light (2 Ea.) or Front Cabin Light (4 Ea.)
		2-3 Terminal	Rear Cabin Light Relay	Rear Cabin Light (2 Ea.)
Warning Light Switch	-	5-1 Terminal	-	Rotating Warning Light

OVERLOAD WARNING DEVICE

OVERLOAD WARNING DEVICE CIRCUIT DIAGRAM

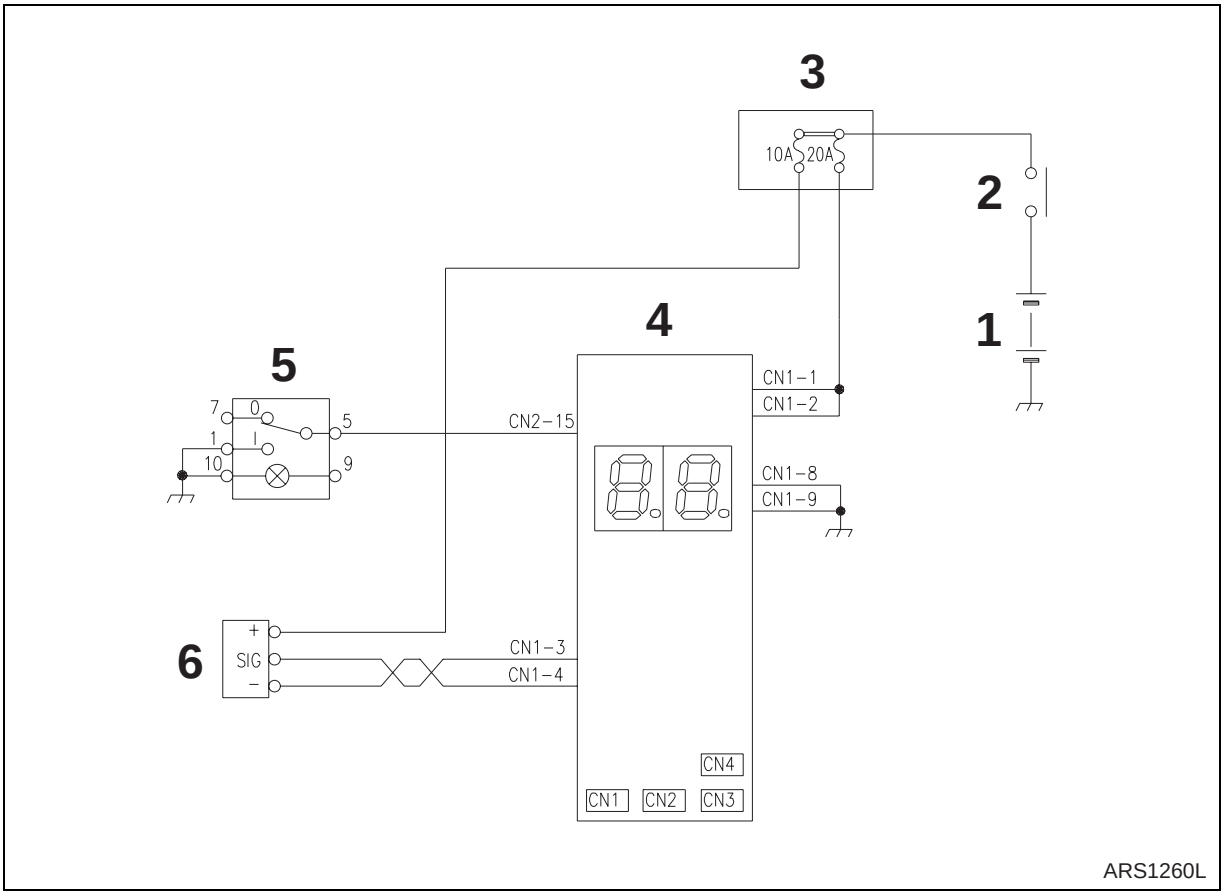


Figure 69

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse Box

Reference Number	Description
4	e-EPOS Controller
5	OWD Select Switch
6	Pressure Sensor

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ELECTRICAL SCHEMATIC (S470LC-V)

⚠ 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 is in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 470LC-V	1001 and Up

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GENERAL DESCRIPTION

Schematic(s) presented in this section are laid out on facing pages.

An overlapping edge has been taken into consideration so that a photocopy can be made and pasted together to make a complete schematic.

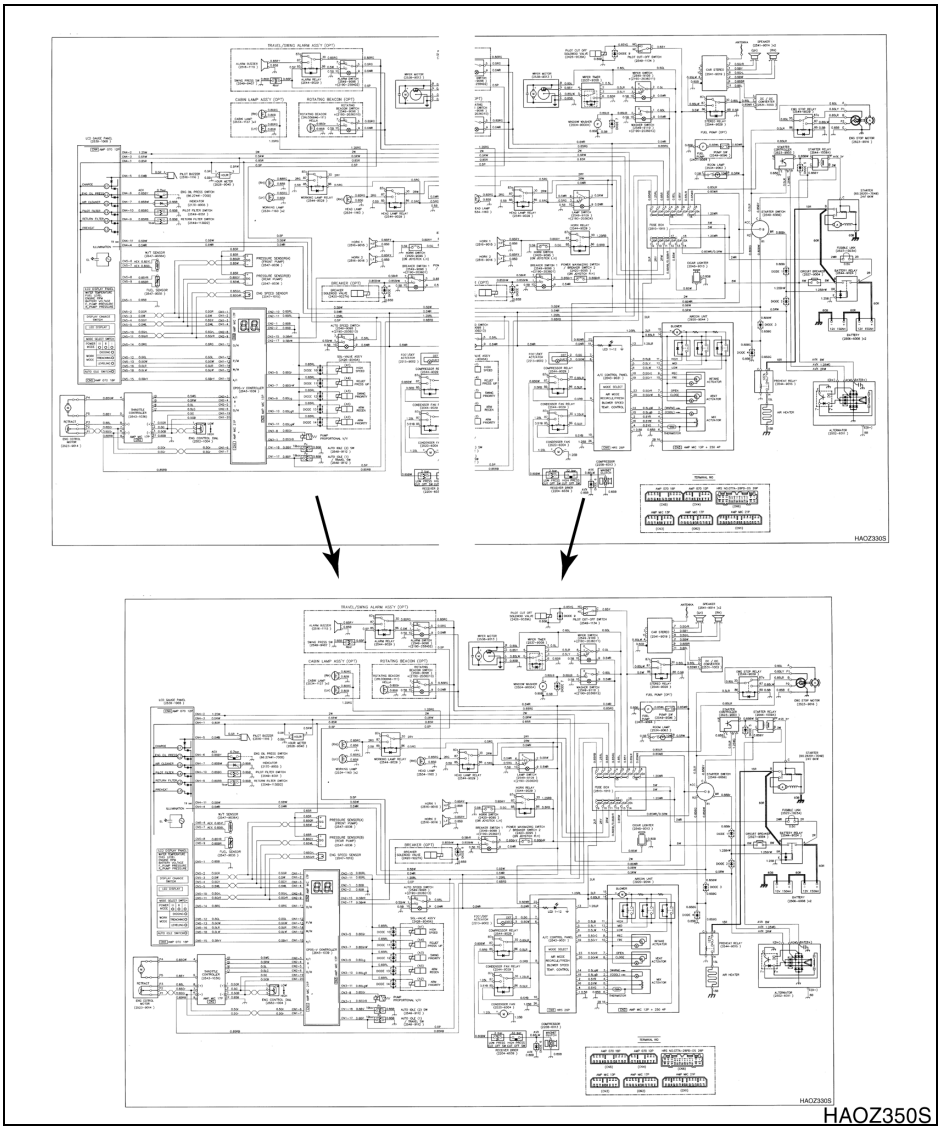


Figure 1

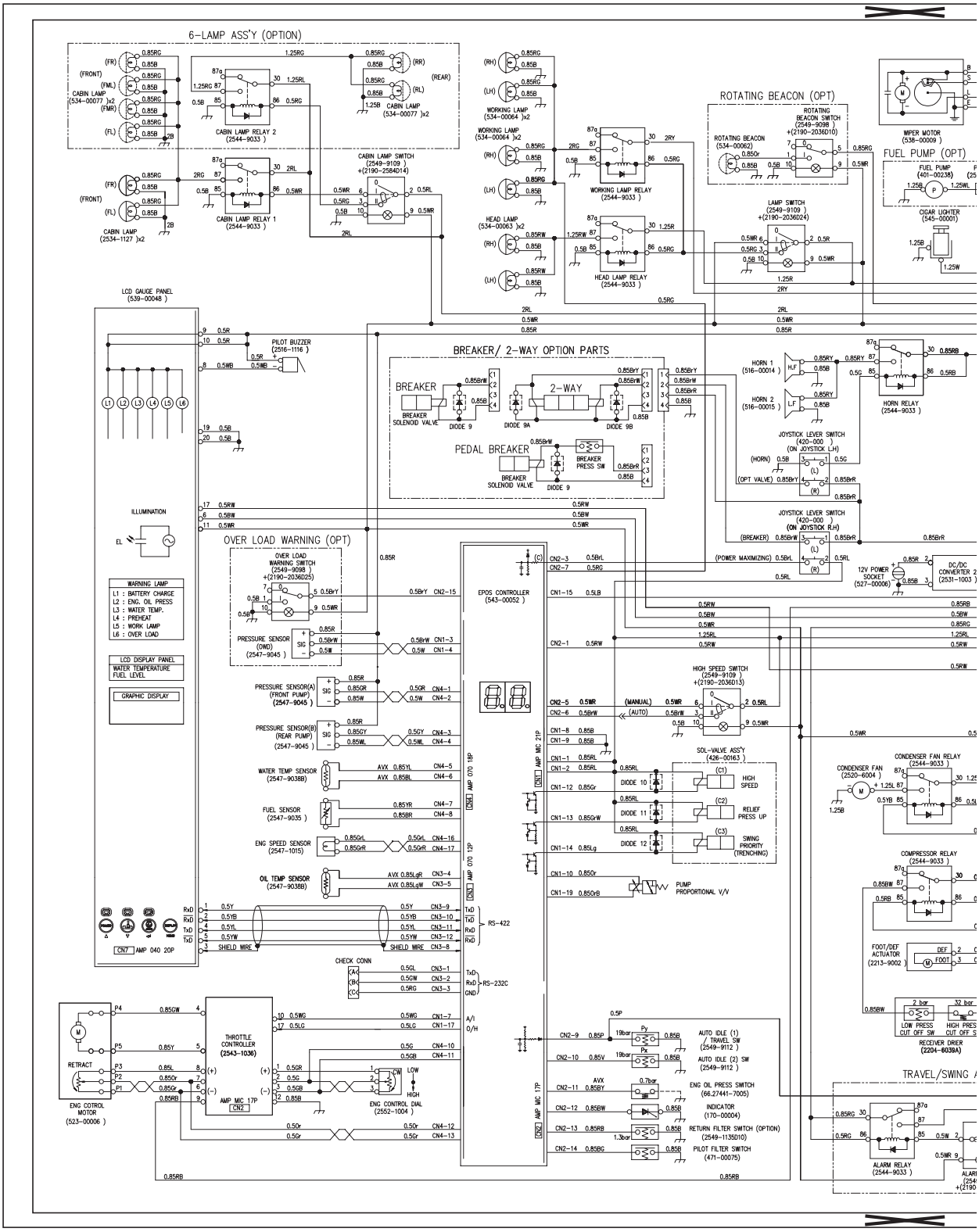
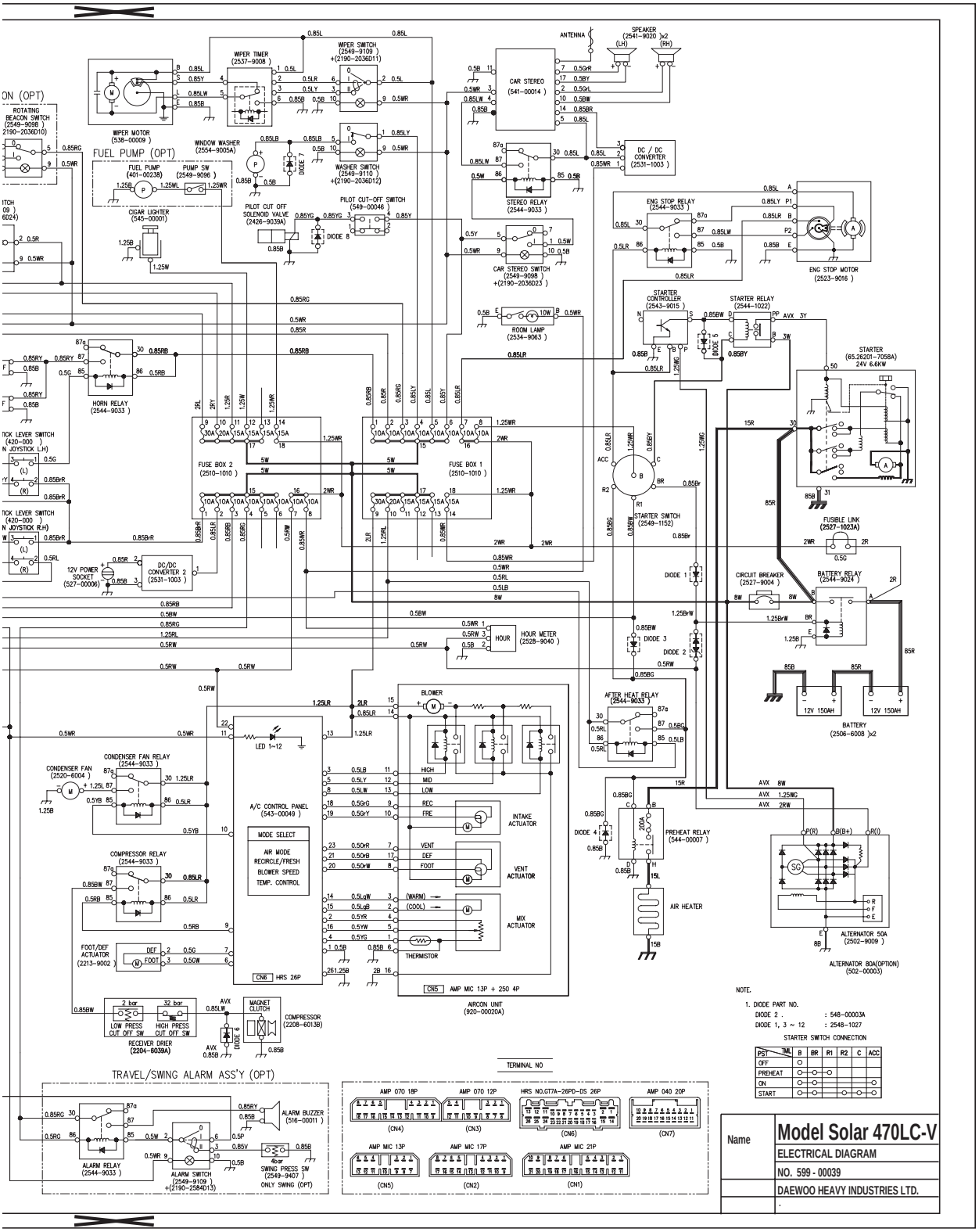

6-LAMP ASS'Y (OPTION)
CABIN LAMP (534-00077)x2
CABIN LAMP (2534-1127)x2
CABIN LAMP RELAY 2 (2544-9033)
CABIN LAMP RELAY 1 (2544-9033)
CABIN LAMP SWITCH (2549-9109 +(2190-2564D14)
ROTATING BEACON (OPT)
ROTATING BEACON (534-00062)
ROTATING BEACON SWITCH (2549-9098 +(2190-2036D10)
WIPER MOTOR (538-00009)
FUEL PUMP (OPT)
FUEL PUMP (401-00238)
CIGAR LIGHTER (545-00001)
WORKING LAMP (534-00064)x2
WORKING LAMP RELAY (2544-9033)
HEAD LAMP (534-00063)x2
HEAD LAMP RELAY (2544-9033)
LAMP SWITCH (2549-9109) +(2190-2036D24)
LCD GAUGE PANEL (539-00048)
PILOT BUZZER (2516-1116)
BREAKER/ 2-WAY OPTION PARTS
BREAKER
BREAKER SOLENOID VALVE
2-WAY
PEDAL BREAKER
BREAKER PRESS SW
DIODE 9
DIODE 9A
DIODE 9B
HORN 1 (516-00014)
HORN 2 (516-00015)
HORN RELAY (2544-9033)
JOYSTICK LEVER SWITCH (420-000) (ON JOYSTICK L.H)
JOYSTICK LEVER SWITCH (420-000) (ON JOYSTICK R.H)
12V POWER SOCKET (527-00006)
DC/DC CONVERTER 2 (2531-1003)
ILLUMINATION
WARNING LAMP
L1 : BATTERY CHARGE
L2 : ENG. OIL PRESS
L3 : WATER TEMP.
L4 : PREHEAT
L5 : WORK LAMP
L6 : OVER LOAD
LCD DISPLAY PANEL
WATER TEMPERATURE
FUEL LEVEL
GRAPHIC DISPLAY
OVER LOAD WARNING (OPT)
OVER LOAD WARNING SWITCH (2549-9098) +(2190-2036D25)
PRESSURE SENSOR (OWD) (2547-9045)
PRESSURE SENSOR(A) (FRONT PUMP) (2547-9045)
PRESSURE SENSOR(B) (REAR PUMP) (2547-9045)
WATER TEMP SENSOR (2547-9038B)
FUEL SENSOR (2547-9035)
ENG SPEED SENSOR (2547-1015)
OIL TEMP SENSOR (2547-9038B)
EPOS CONTROLLER (543-00052)
HIGH SPEED SWITCH (2549-9109) +(2190-2036D13)
SOL-VALVE ASS'Y (426-00163)
HIGH SPEED
RELIEF PRESS UP
SWING PRIORITY (TRENCHING)
PUMP PROPORTIONAL V/V
CONDENSER FAN (2520-6004)
CONDENSER FAN RELAY (2544-9033)
COMPRESSOR RELAY (2544-9033)
FOOT/DEF ACTUATOR (2213-9002)
RECEIVER DRIER (2204-6039A)
RS-422
RS-232C
CHECK CONN
THROTTLE CONTROLLER (2543-1036)
ENG CONTROL MOTOR (523-00006)
ENG CONTROL DIAL (2552-1004)
AUTO IDLE (1) / TRAVEL SW (2549-9112)
AUTO IDLE (2) SW (2549-9112)
ENG OIL PRESS SWITCH (66.27441-7005)
INDICATOR (170-00004)
RETURN FILTER SWITCH (OPTION) (2549-1135D10)
PILOT FILTER SWITCH (471-00075)
TRAVEL/SWING
ALARM RELAY (2544-9033)

Figure 2


FUEL PUMP (OPT)
TRAVEL/SWING ALARM ASS'Y (OPT)
Name
Model Solar 470LC-V
ELECTRICAL DIAGRAM
NO. 599 - 00039
DAEWOO HEAVY INDUSTRIES LTD.

HAAD4180

ATTACHMENTS

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BOOM AND ARM

⚠ CAUTION!

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MODEL	SERIAL NUMBER RANGE
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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Installation 7
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    Boom Installation Procedure 7
Start-up Procedures 8

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 Daewoo After Sales Service for information on wear tolerances and replacement limits for mounting pins.*

Mounting Pin	Diameter, mm (Inches)	Length, mm (Inches)
A	125.0 mm (4.92 in)	1,140.0 mm (44.88 in)
B	120.0 mm (4.72 in)	1,119.0 mm (44.06 in)
C	120.0 mm (4.72 in)	307.0 mm (12.09 in)
D	125.0 mm (4.92 in)	681.0 mm (26.81 in)
E	110.0 mm (4.33 in)	295.0 mm (11.61 in)
F	110.0 mm (4.33 in)	295.0 mm (11.61 in)
G	110.0 mm (4.33 in)	653.0 mm (25.71 in)
H	110.0 mm (4.33 in)	655.0 mm (25.79 in)
I	100.0 mm (3.94 in)	568.0 mm (22.36 in)
J	110.0 mm (4.33 in)	568.0 mm (22.36 in)
K	110.0 mm (4.33 in)	289.0 mm (11.38 in)

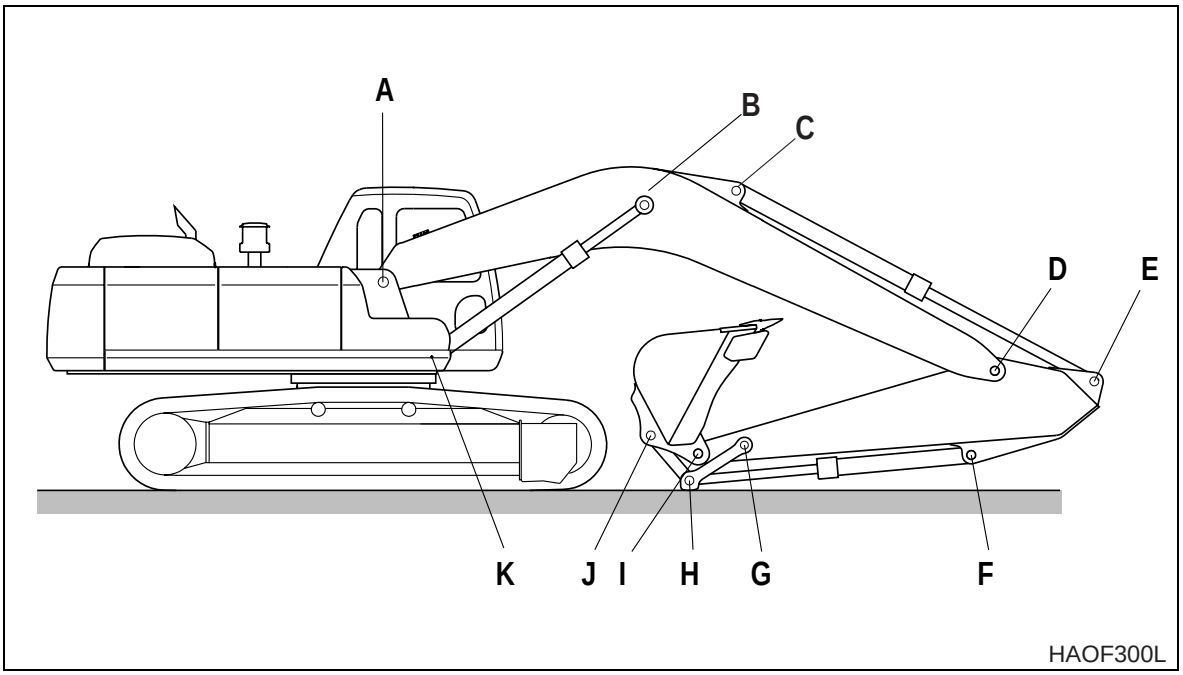


Figure 1

FRONT ATTACHMENT - REMOVAL AND INSTALLATION

DANGER!

Daewoo 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. Daewoo 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.

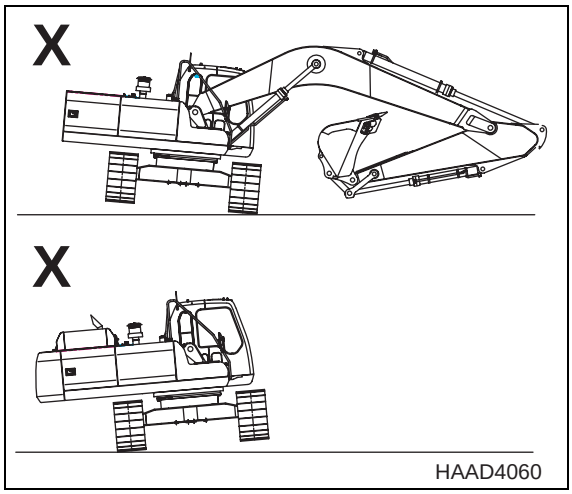


Figure 2

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 Daewoo distributor or Daewoo 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 that 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 cab 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 2,000 kg [4,400 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 and all 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 that 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 also 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 cab is taken off the turntable deck first. Refer to the Operator's Cab 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

Re-attach 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 Daewoo 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. Pre-grease 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 the sling from around the rod end arm cylinder pin, withdraw the pin and lift the body of the arm cylinder to re-pin 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.

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BUCKET

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MODEL	SERIAL NUMBER RANGE
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 340LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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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.

TYPE 1

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 pin hole.
- 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.

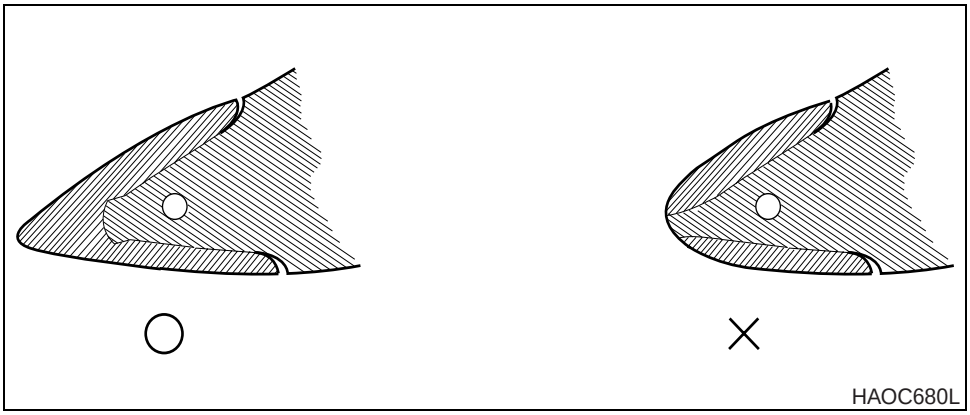


Figure 1

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 4.
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.

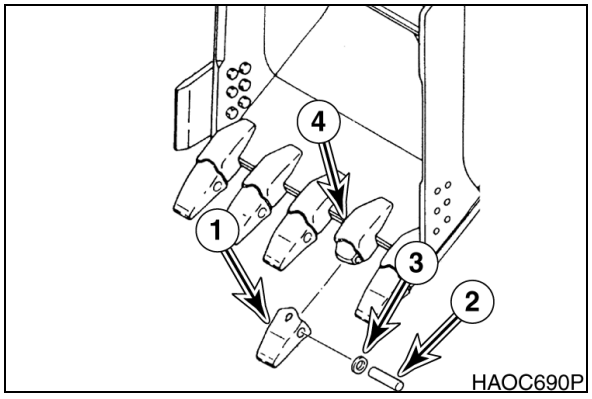


Figure 2

TYPE 2

⚠ WARNING!

Due to the possibility of flying metal objects, always wear safety helmet, protective gloves and eye protection when changing bucket teeth.

Curl the bucket upwards and place the round rear surface of the bucket firmly on the ground. Place wooden blocks under front of bucket. Shut the engine off and lock out the hydraulic controls before working on the bucket.

Inspect locking pin assembly and replace it if the following conditions exist;

1. The locking pin is too short when both surfaces are aligned.
2. The rubber has been torn and bosses of the steel balls are liable to slip off.
3. Pressing steel ball causes the boss to go inside.

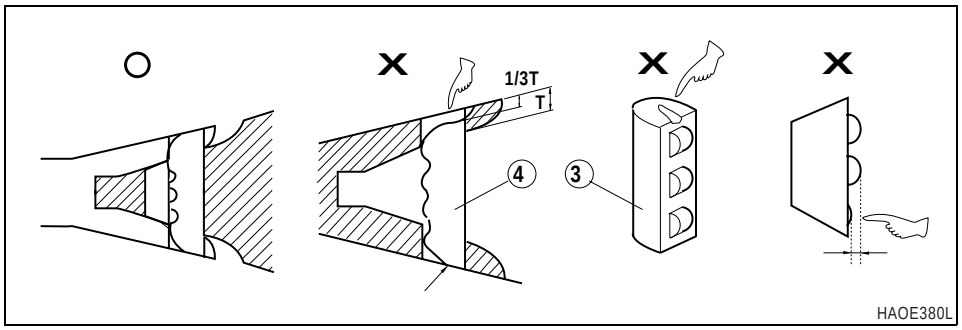


Figure 3

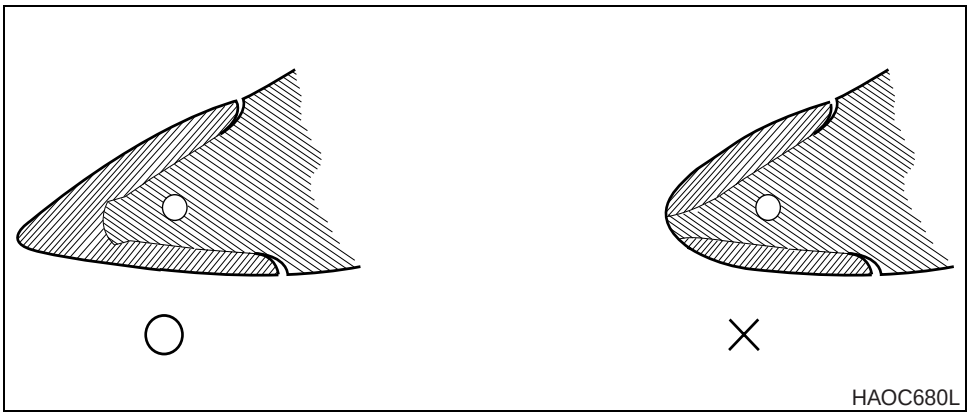


Figure 4

1. On a routine basis, inspect bucket teeth to make sure that tooth wear or breakage has not developed. Do not allow replaceable bucket teeth to wear down to a point that bucket adapter is exposed. See Figure 4.
2. To replace a tooth, use a hammer (1, Figure 5) and punch (2) to drive locking pin assembly out of tooth and tooth adapter.
3. Once the worn tooth has been removed, use a putty knife to scrape adapter as clean as possible.
4. Slide new tooth into position and insert locking pin assembly.

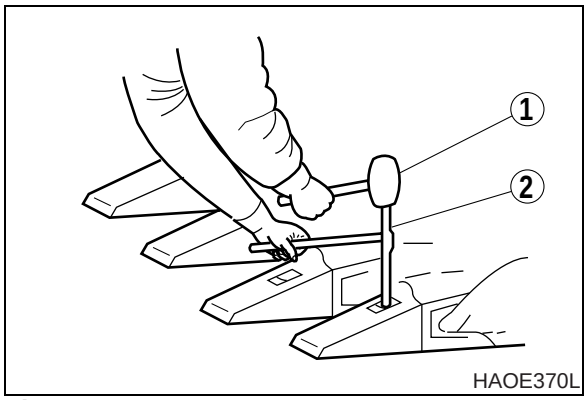


Figure 5

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.

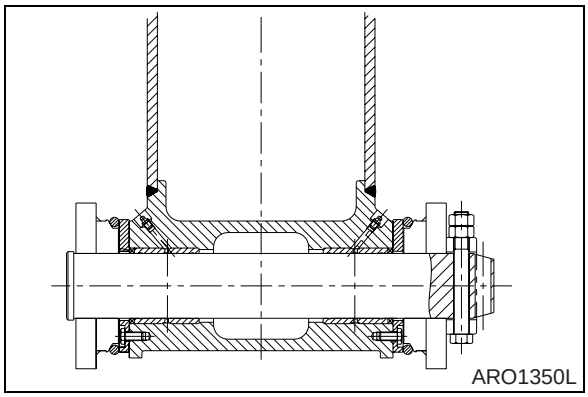


Figure 6

2. Roll the old O-ring (1, Figure 7) onto the boss (2) around the bucket pin (3). Remove the bucket pin and move the arm or bucket link (4) out of the way.

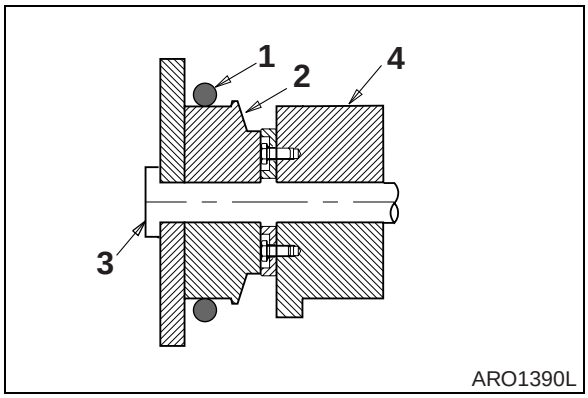


Figure 7

3. Remove the old O-ring and temporarily install the new O-ring (1, Figure 8) 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 pin hole and insert the bucket pin (3, Figure 7).

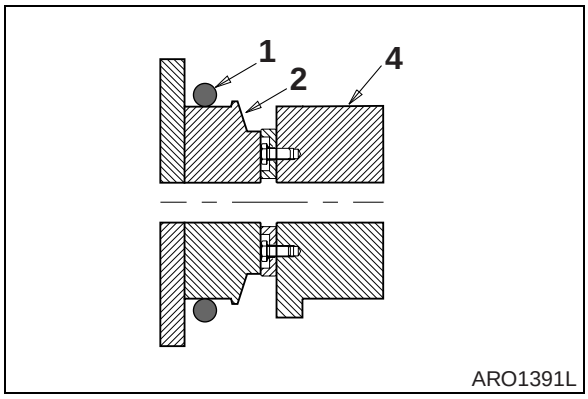


Figure 8

5. Roll the new O-ring (1, Figure 9) into the O-ring groove.

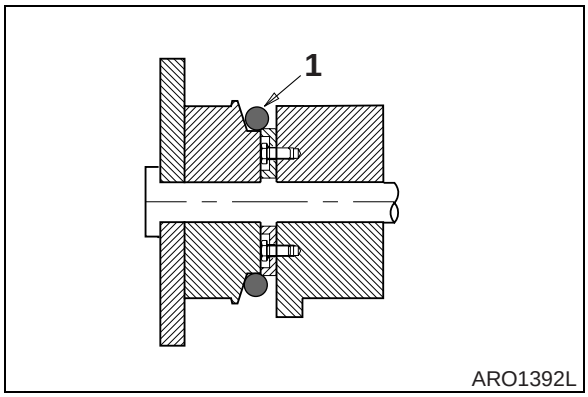


Figure 9

BUCKET SHIMMING PROCEDURES

NEW BUCKET INSTALLATION

1. If a new bucket is being installed on the excavator, measure the inside dimension between the bucket ears and the outside dimension across the arm mounting boss.
2. Subtract the clearance on both sides from the difference of the two and shim accordingly, prior to assembly.

⚠ WARNING!

To check end play (side-to-side) clearance at bucket attachment point, the bucket must be free to move but at all other times lower it to the ground or use support blocks to immobilize this assembly. Shut off engine and tag and lock out controls to prevent movement during this procedure.

Shimming Procedures for Installed Bucket

1. With bucket attached, curl bucket and arm outward and lower boom so that bucket teeth are pointing away from excavator, just a few inches off ground. This position provides easy accessibility for dimensional measurements.
2. Force bucket to one side and check for end play (side-to-side) clearance under O-rings at attachment point. Total clearance should be 1 mm (0.04 in) between side face of boss and inside edge of ear bushing (Y, Figure 10). Too tight a fit (less than 1 mm (0.04 in)) can cause excessive wear while too much clearance may produce excessive noise and potentially hazardous slack control.
3. Recheck end play by forcing bucket towards opposite side and repeating clearance measurements.
4. If an adjustment is required, remove two jam nuts (1, Figure 10) and bolt (2) from pin (3). Add or remove shims (4) as required. Use equal amount of shims on each side. Install bolt (2) and two jam nuts (1). Jam nuts must clear boss by 1 - 2 mm (0.04 - 0.08 in) at point (X).

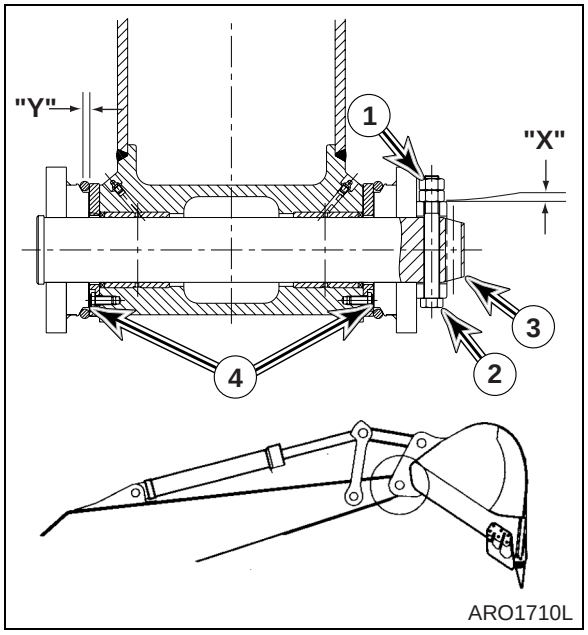


Figure 10

BUCKET ATTACHMENT, REMOVAL AND REVERSAL

DETACHING THE BUCKET

Park the excavator away from obstructions on clear, flat, level ground. Lower the bucket carefully to pre-assembled blocking on the ground. Brace the bucket so that 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 that 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. Pre-lube 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.

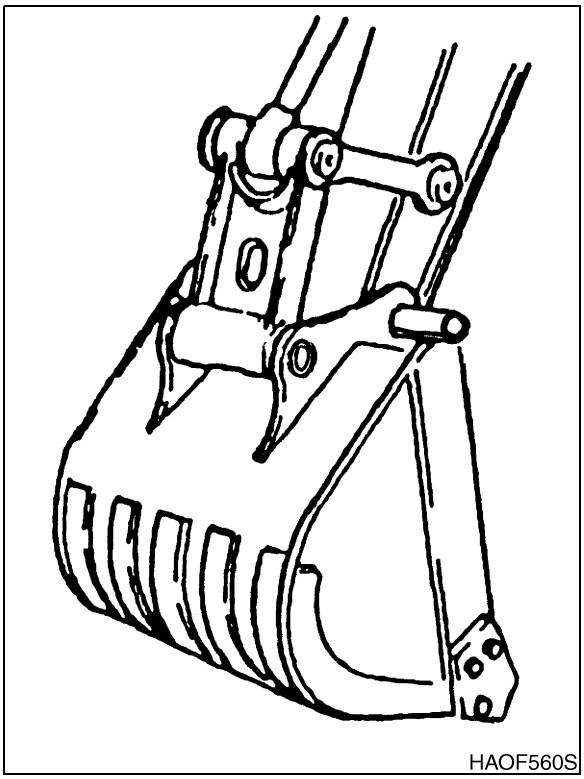


Figure 11

When the link pin has been installed, withdraw the temporary support rod from the bucket pin holes, lower and raise the arm and boom and install the bucket pin.

⚠ WARNING!

When making linkage alignments, never insert fingers into pin holes. 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.

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.

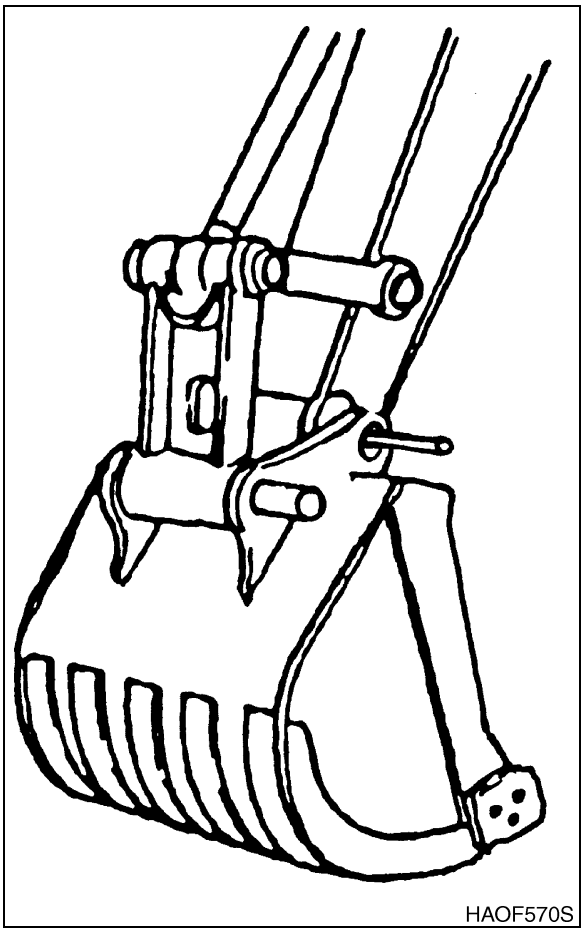


Figure 12

PUBLICATION REQUEST FOR PROPOSED REVISION

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

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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 DAEWOO SERVICE REPRESENTATIVE: YES NO

IF YES - WHO:

(It is advised to discuss this with a Daewoo service representative to ensure that the above correction is appropriate and valid.)

Mail to:

Daewoo Heavy Industries America Corporation
2905 Shawnee Industrial Way
Suwanee, GA 30024
Attention: Publications