# DX140LC

Shop Manual

K1034080E

Serial Number 5001 and Up

*DOOSAN* 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.

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## Track Excavator Safety

## MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |
| DX300LC | 5001 and Up |
| DX340LC | 5001 and Up |

# TO THE OPERATOR OF A 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:

## WARNING!

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

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

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

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

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

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

***DOOSAN* delivers machines that comply with all applicable regulations and standards of the country to which it has been 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 *DOOSAN* or your *DOOSAN* distributor before operating the machine.**

## SAFETY ALERT SYMBOL

**Be Prepared - Get to Know All Operating and Safety Instructions.**

**This is the Safety Alert Symbol. Wherever it appears in this manual or on safety signs on the machine you 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 -11 on.

*DOOSAN* cannot predict every circumstance that might involve a potential hazard in operation and maintenance. Therefore the safety messages in this manual and on the machine may not include all possible safety precautions. If any procedures or actions not specifically recommended or allowed in this manual are used, you must be sure that you and others can do such procedures and actions safely and without damaging the machine. If you are unsure about the safety of some procedures, contact a *DOOSAN* 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 *DOOSAN* for proper installation and application. Lifting-work applications (unless restricted or prohibited by local regulations) are permitted in approved lift configuration, to rated capacity only, with no side-loading. DO NOT use the machine for activities for which it was not intended. DO NOT use the bucket for lifting work, unless lift slings are used in the approved configuration.

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

## Lifting Capacity Rating Configuration

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

## IMPORTANT

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

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

## WARNING!

**NEVER wrap a tag line around your hands or body.**

**NEVER rely on tag lines or make rated lifts when wind gusts are more than 48.3 km/h (30 MPH). Be prepared for any 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 *DOOSAN* representative.**

# UNAUTHORIZED MODIFICATIONS

Any modification made without authorization or written approval from *DOOSAN* 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 *DOOSAN* 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 cabin.

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.

HAOA020L

**Figure 1**

## Breathing Masks, Ear Protection May Be Required

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

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

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

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

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

## Vibration Level Information

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

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

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

## Recommendations for Limiting Vibrations

1. Select the right machine, equipment and attachments for a particular application.
2. Replace any damaged seat by a genuine *DOOSAN* part. Keep the seat maintained and adjusted.
   - Adjust the seat and suspension for the weight and size of the operator.
   - Inspect and maintain the suspension and adjustment mechanisms of the seat regularly.
3. Check that the machine is properly maintained.
   - Tire pressure, brakes, steering, linkages, etc.
4. Steer, brake, accelerate, shift gears, move the attachments and load the attachments smoothly.
5. Adjust the machine speed and travel path to reduce the vibration level.
   - Slow down if it is necessary when passing rough terrain.
   - Drive around obstacles and excessive rough terrain conditions.
6. Keep the terrain on work sites where the machine is working and traveling in good condition.
   - Remove any large rocks or obstacles.
   - Fill any ditches and holes.
   - Provide machines for and schedule time to maintain the terrain conditions.
7. Travel over longer distance (e.g. on public roads) at adjusted (medium) speed.
   - Always adjust the speed for preventing bouncing.

## Mounting and Dismounting

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

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

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

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

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

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

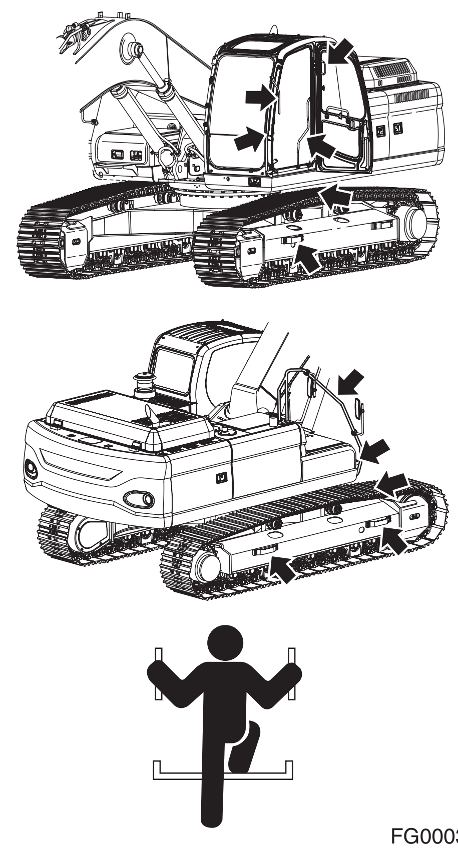

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Figure 2

## 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.

ARO1050S

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.

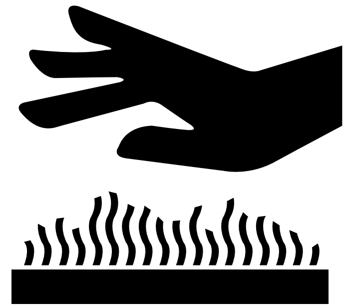

HAOA050L

**Figure 4**

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

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


HAOA060L

**Figure 5**

## Asbestos Dust Hazard Prevention

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

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


ARO1770L

**Figure 6**

## Injury from Work Equipment

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

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

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

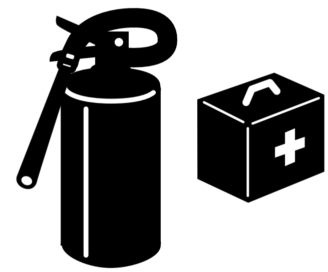
HDO1010L

**Figure 7**

## Fire Extinguisher and First Aid Kit

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

- Be sure that fire extinguishers have been provided and read the labels to ensure that you know 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 cabin. Check and service the fire extinguisher at regular intervals and make sure that all work site crew members are adequately trained in its use.
- Provide a first aid kit in the storage compartment and keep another at the work site. Check the kit periodically and make any additions if necessary.
- Know what to do in case of injury from fire.
- Keep emergency numbers for doctor, ambulance service, hospital and fire department near your telephone.



HDO1009L

**Figure 8**

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

- Turn the starter switch to the "O" (OFF) position and shut down engine.
- If there is time, use the fire extinguisher to 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 cabin select a guard to match the operating conditions to protect the operator.

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

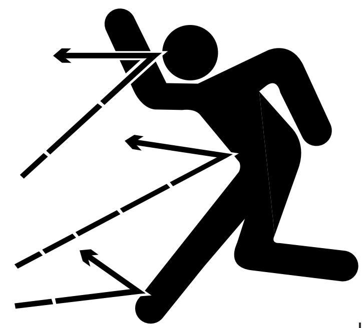



**Figure 9**

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.


**Figure 10**

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

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

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

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

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

## Attachment Precautions

Option kits are available through your dealer. Contact *DOOSAN* for information on available one-way (single-acting) and two-way (double-acting) piping / valving / auxiliary control kits. Because *DOOSAN* cannot anticipate, identify or test all of the attachments that owners may wish to install on their machines, please contact *DOOSAN* 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 *DOOSAN* distributor.
- Wear safety goggles and protective gloves when working on an accumulator. Hydraulic oil under pressure can penetrate the skin and cause serious injuries.

## Indoor Ventilation

Engine exhaust gases can cause fatal accidents, and unconsciousness, loss of alertness, 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.

ARO1770L

**Figure 11**

## Emergency Exit

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

**WARNING!**

**Protect your eyes when breaking the glass.**

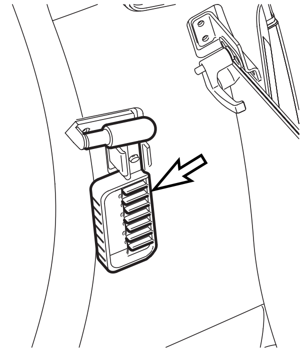


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**Figure 12**

# BEFORE STARTING ENGINE

## Work Site Precautions

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

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

Make 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.

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.

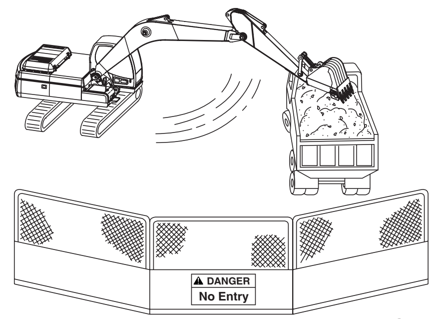


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**Figure 13**

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.

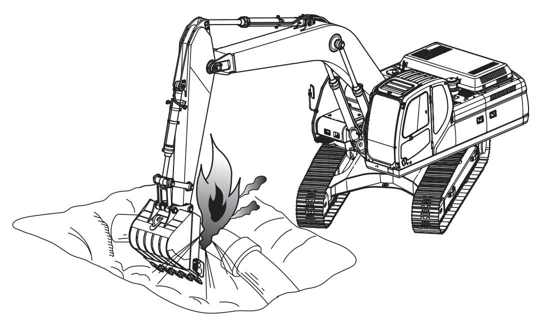

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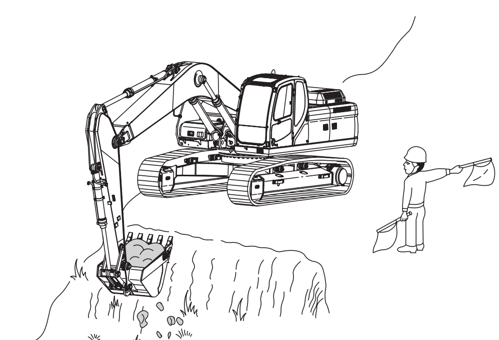
**Figure 14**

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

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



FG000372

**Figure 15**

Avoid operating your machine 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 cabin. Look for evidence of leaking fluid, loose fasteners, misaligned assemblies or any other indications of possible equipment hazard.

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

Look around the work site area for potential hazards, people or 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 cabin.

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

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

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

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

Start and operate the machine only while seated.

## Before Operating Machine

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

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

- Check the operating condition of the equipment, and the 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 cabin and the drive sprockets to the rear. When the undercarriage is in the reversed position, the travel controls must be operated in opposite directions.

## When Swinging or Changing Direction of Travel

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

- Start and operate the machine only while seated.
- When changing 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.

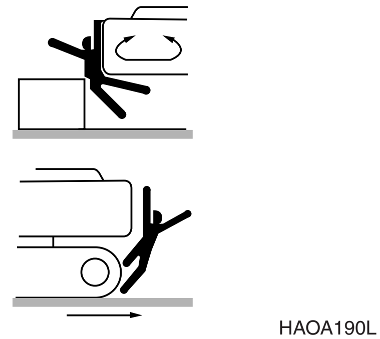



**Figure 16**

## 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 center line 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.

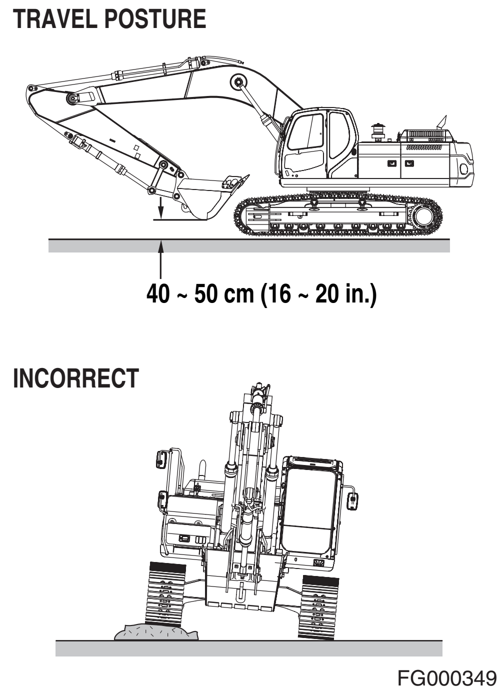



Figure 17

## 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.

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.

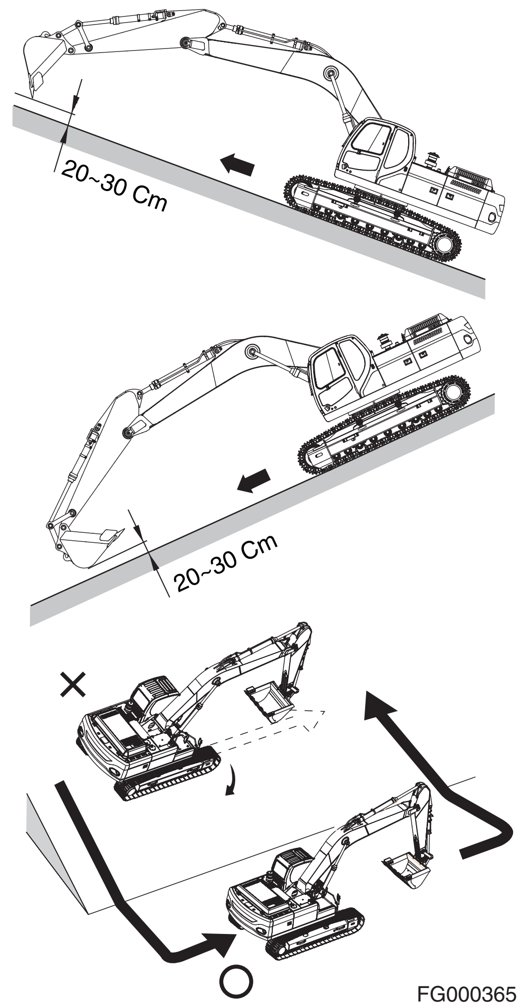



**Figure 18**

## Prohibited Operations

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

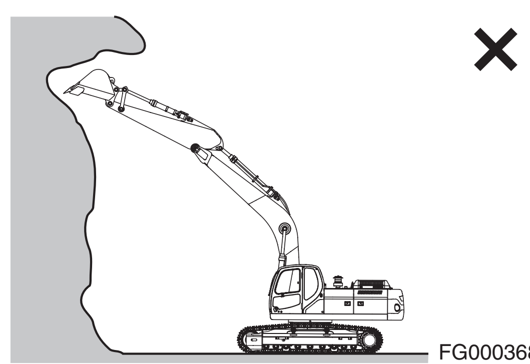



**Figure 19**

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

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

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

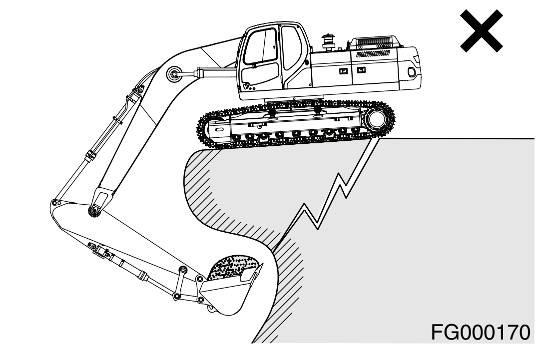



**Figure 20**

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

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

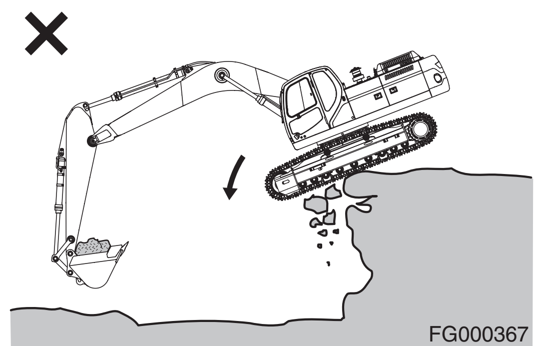



**Figure 21**

## Precautions for Operation

Be careful not to 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.

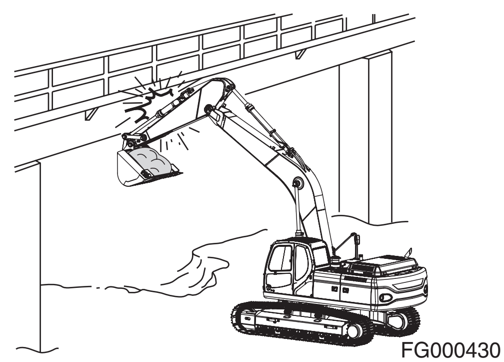



**Figure 22**

## 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") |

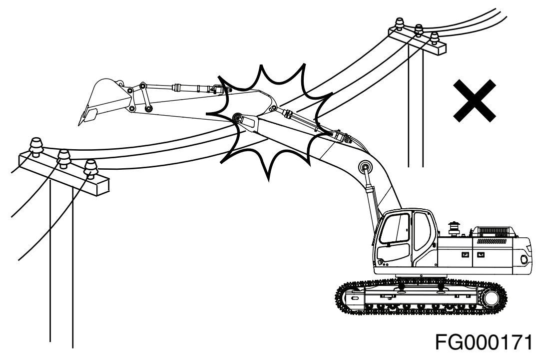



**Figure 23**

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.*

## Protecting Cabin from Falling Object (Optional)

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

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

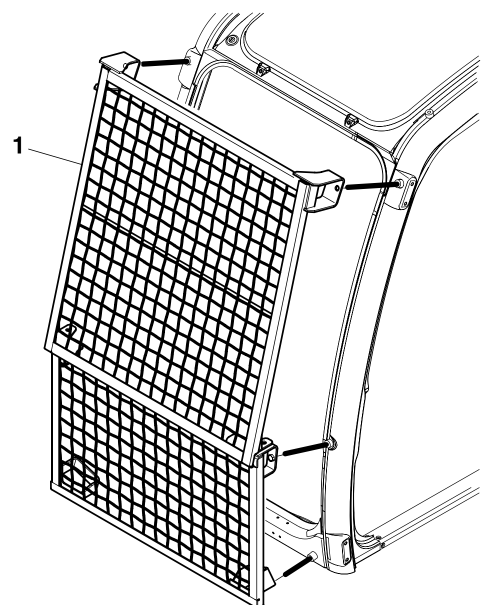



**Figure 24**

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

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

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

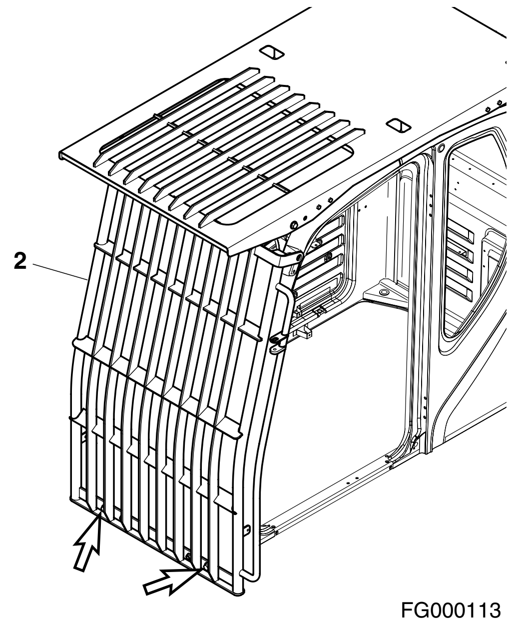



**Figure 25**

## 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.

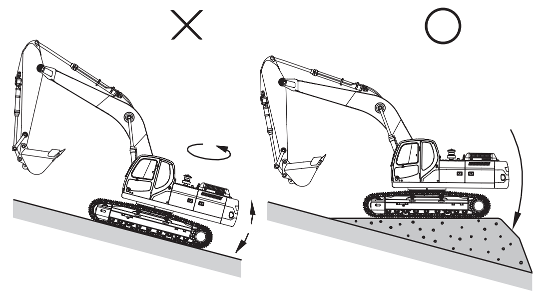
## Operations on Slopes

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.



FG000212

**Figure 26**

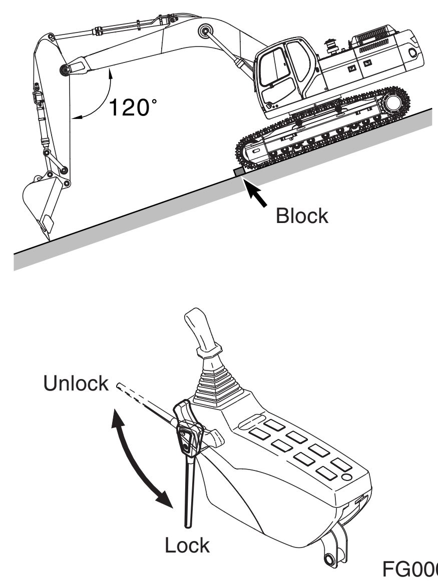
## Parking Machine

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.

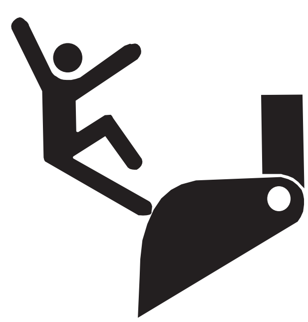



FG000666

**Figure 27**

## Never Let Anyone Ride on Attachment

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



ARO1310L

**Figure 28**

# MAINTENANCE

## Warning Tag

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

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


ARO1320L

**Figure 29**

## Clean Before Inspection or Maintenance

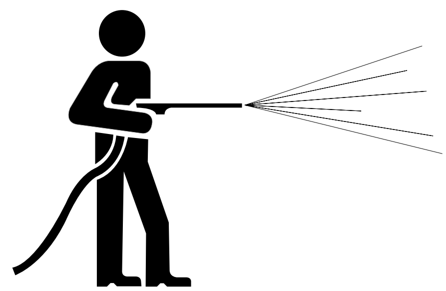
Clean the machine before carrying out inspection and maintenance. This prevents dirt from getting into the machine and also ensures safety during maintenance.

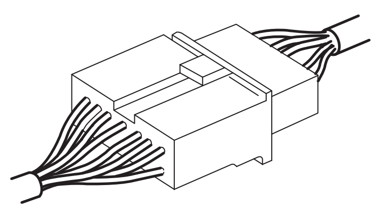
If inspection and maintenance are carried out when the machine is dirty, it will become more difficult to locate the problems, and also there is danger that you may get dirt or mud in your eyes or that you may slip and injure yourself.

When washing the machine, do the following:

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

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.



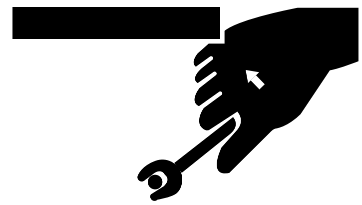


ARO1330L

**Figure 30**

## 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.



HDO1037L

**Figure 31**

## Use of Lighting

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

HDO1040L

**Figure 32**

## Fire Prevention and Explosion Prevention

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

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

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

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

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

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

Remove all flammable materials before they accumulate on the machine.

HDO1015I

**Figure 33**

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

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

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

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

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

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

Remove 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.

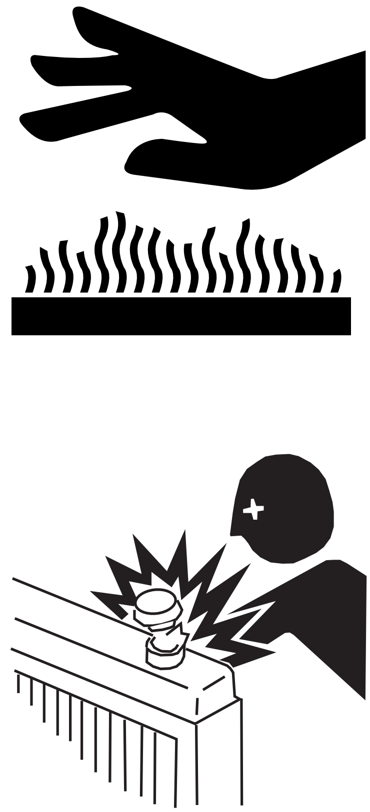
Relieve all pressure in the hydraulic oil system, in the fuel system, or in the cooling system before you disconnect any lines, fittings, or related items.

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.



HAAE1980

**Figure 34**

## Welding Repairs

**CAUTION!**

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

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

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

### Treatment for Electrical Welding to the Body Structure

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

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

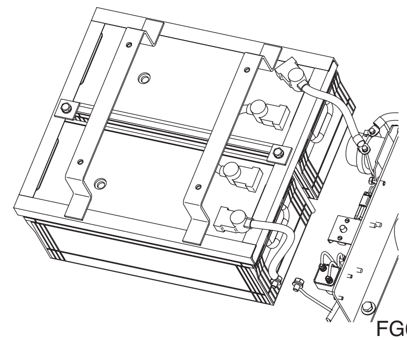


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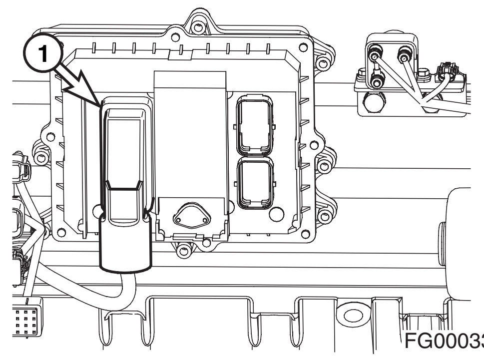
**Figure 35**




FG000335

**Figure 36**

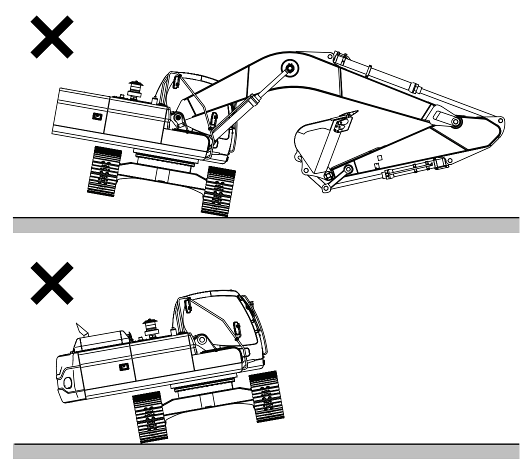
## Warning for Counterweight and Front Attachment Removal

**DANGER!**

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

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

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



FG000371

**Figure 37**

## 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.

HDO1041L

**Figure 38**

## 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 nonslip pads.

ARO1380L

**Figure 39**

## Lock Inspection Covers

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

If maintenance work is carried out with the inspection cover open but not locked, there is 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.

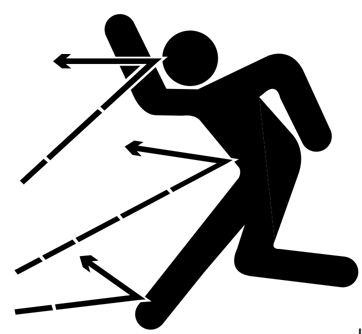



**Figure 40**

## Supports and Blocking for Work Equipment

Do not allow weight or equipment loads to remain suspended.

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

Do not use hollow, cracked or unsteady wobbling supports.

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

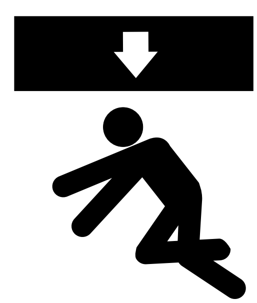



**Figure 41**

## Action When Abnormality Is Found During Inspection

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

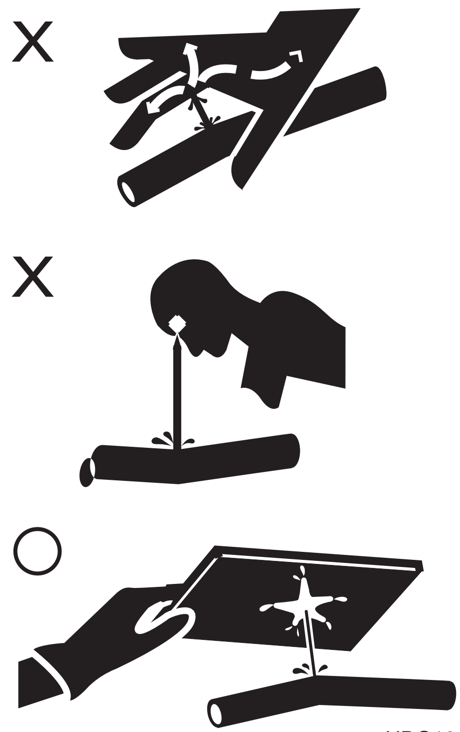
If necessary depending on the type of failure, please contact your *DOOSAN* distributor for repairs.

## Precautions with High-pressure Lines, Tubes and Hoses

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

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

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



HDO1045I

**Figure 42**

## Waste Materials

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

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

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

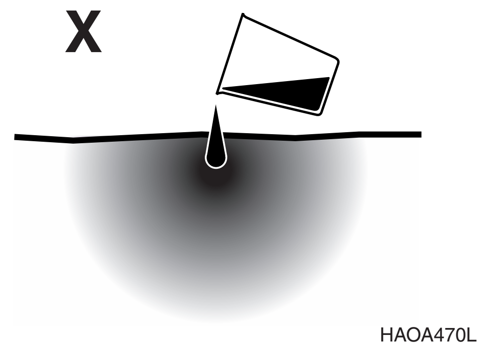


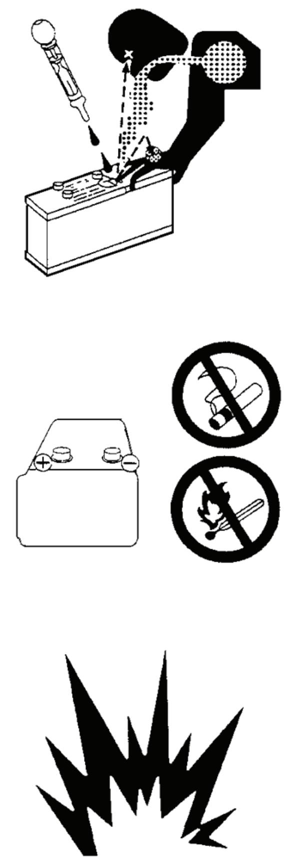

**Figure 43**

# BATTERY

## Battery Hazard Prevention

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

- Do not smoke or bring any flame near the battery.
- When working with batteries, ALWAYS wear safety glasses and rubber gloves.
- If you spill battery electrolyte on yourself or your clothes, immediately flush the area with water.
- If battery electrolyte gets into your eyes, flush them immediately with large quantities of water and see a doctor at once.
- If you accidentally drink battery electrolyte, drink a large quantity of water or milk, raw egg or vegetable oil. Call a doctor or poison prevention center immediately.
- When cleaning the top surface of the battery, wipe it with a clean, damp cloth. Never use gasoline, thinner, or any other organic solvent or detergent.
- Tighten the battery caps securely.
- If the battery electrolyte is frozen, do not charge the battery or start the engine with power from another source. There is 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.



HAAE2100

**Figure 44**

## Boost Starting or Charging Engine Batteries

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

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

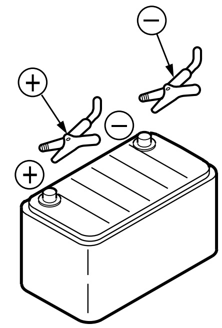



**Figure 45**

# TOWING

## Precautions When Towing

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

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

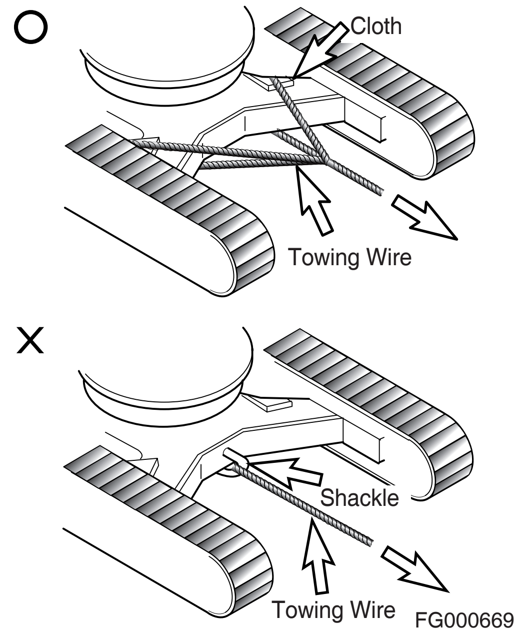



**Figure 46**

# SHIPPING AND TRANSPORTATION

## Obey State and Local Over-the-Road Regulations

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

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

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

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

# LIFTING WITH SLING

## WARNING!

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

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

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

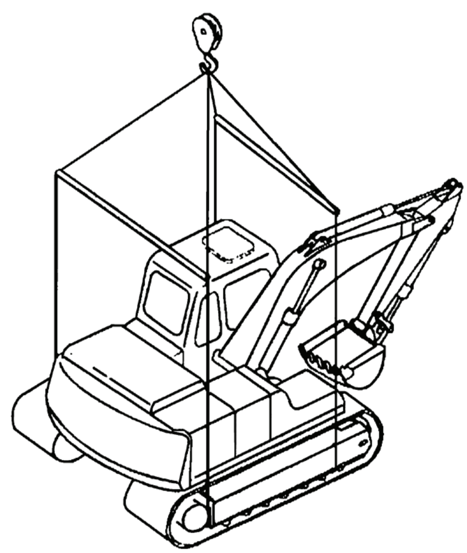



**Figure 47**

# Specifications

# Specification for DX140LC

Edition 1

# Table of Contents

## Specification for DX140LC

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| | |
| | |
| | |

# 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 -6.)

# COMPONENT LOCATIONS

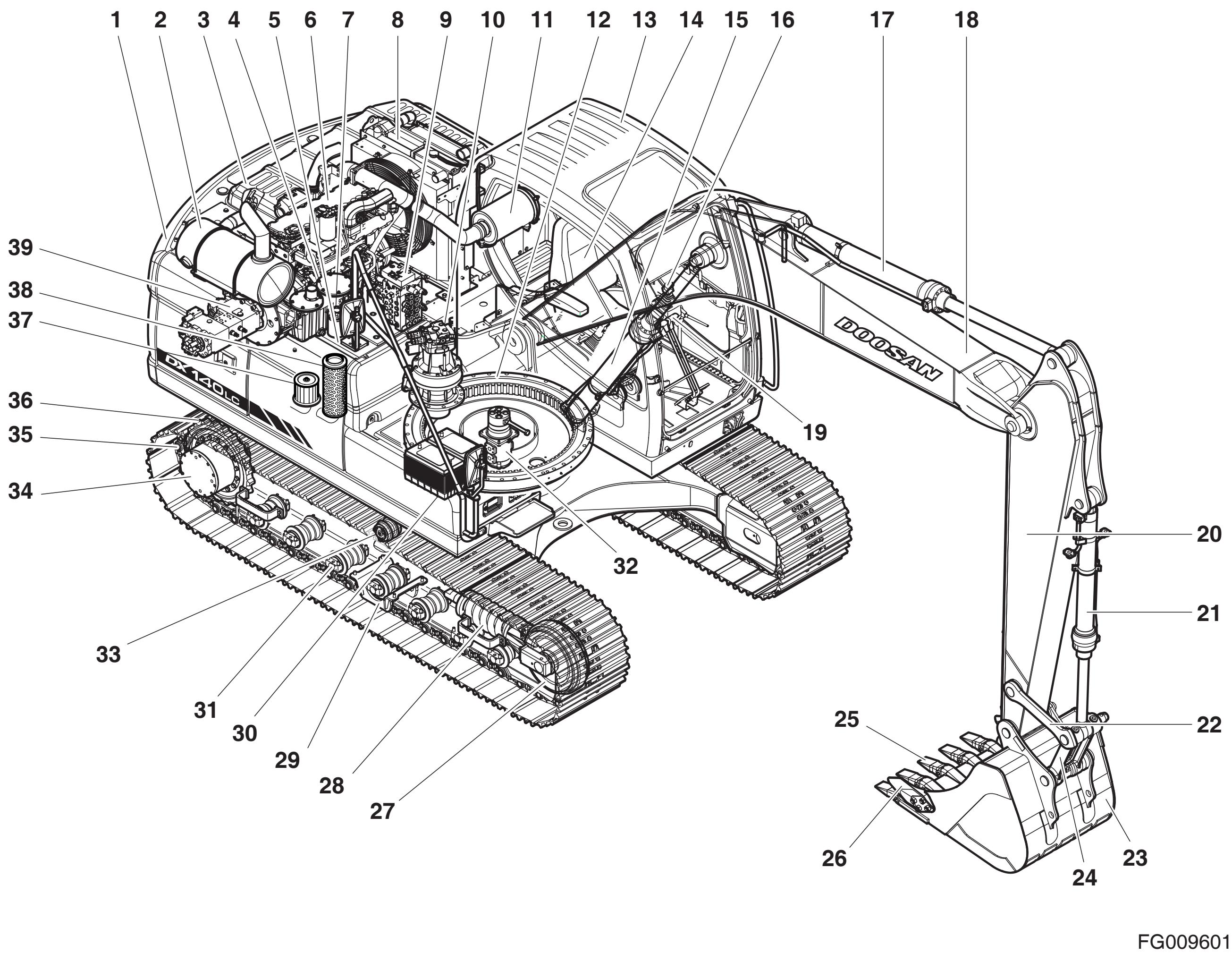



**Figure 1**

| Reference Number | Description |
|---|---|
| 1 | Counterweight |
| 2 | Muffler |
| 3 | Hood |
| 4 | Hydraulic Oil Tank |
| 5 | Fuel Tank |
| 6 | Engine |
| 7 | Fuel Tank Fill Cap |
| 8 | Radiator and Oil Cooler |
| 9 | Control Valves |
| 10 | Swing Motor |
| 11 | Air Cleaner |
| 12 | Swing Bearing |
| 13 | Cabin |
| 14 | Seat |
| 15 | Boom Cylinder |
| 16 | Work Lever (Joystick) Controls |
| 17 | Arm Cylinder |
| 18 | Boom |
| 19 | Travel Lever |
| 20 | Arm |

| Reference Number | Description |
|---|---|
| 21 | Bucket Cylinder |
| 22 | Guide Link |
| 23 | Bucket |
| 24 | Push Link |
| 25 | Tooth Point |
| 26 | Side Cutter |
| 27 | Idler |
| 28 | Track Adjuster |
| 29 | Track Guide |
| 30 | Battery |
| 31 | Lower Roller |
| 32 | Center Joint |
| 33 | Upper Roller |
| 34 | Travel Motor |
| 35 | Track Link and Shoe |
| 36 | Sprocket |
| 37 | Suction Filter |
| 38 | Return Filter |
| 39 | Pumps |

# GENERAL DIMENSIONS

## One - Piece Boom

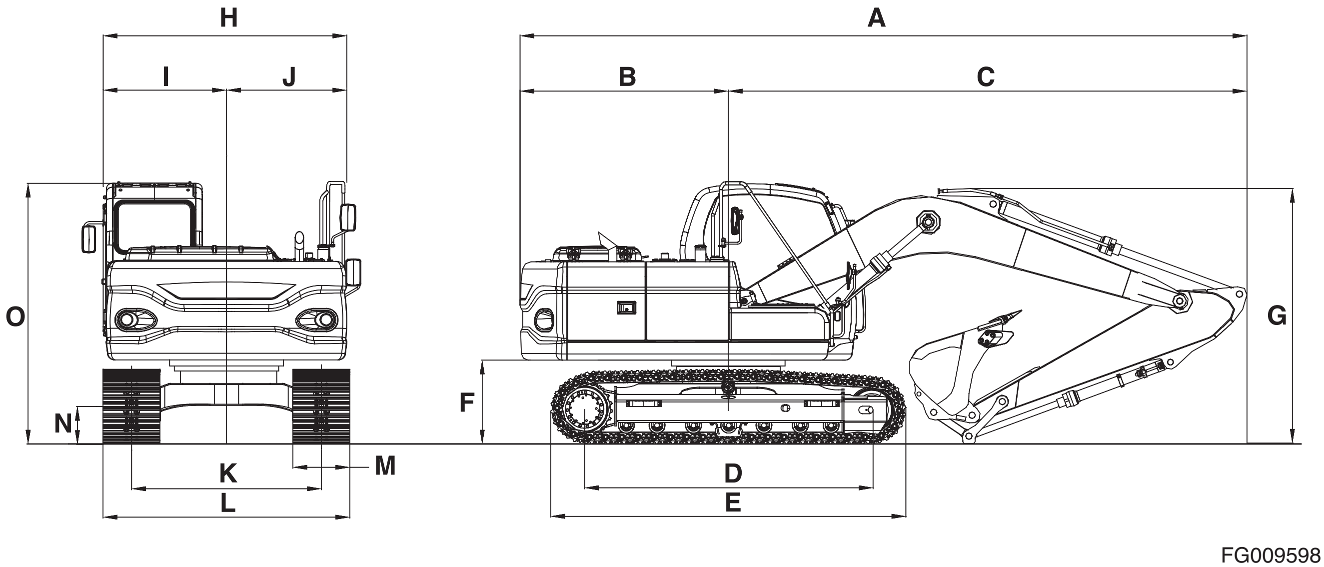



**Figure 1**

| DIMENSION | 4.6 M (15' 1") BOOM | | |
|---|---|---|---|
| | **2.1 M (6' 11") ARM** | **2.5 M (8' 2") ARM** | **3.0 M (9' 10") ARM** |
| A | 7,690 mm (25' 3") | 7,680 mm (25' 2") | 7,640 mm (25' 0") |
| B | 2,200 mm (7' 2") | | |
| C | 5,490 mm (18' 0") | 5,480 mm (17' 11") | 5,440 mm (17' 10") |
| D | 3,034 mm (9' 11") | | |
| E | 3,755 mm (12' 4") | | |
| F | 894 mm (2' 11") | | |
| G | 2,570 mm (8' 5") | 2,710 mm (8' 10") | 3,090 mm (10' 1") |
| H | 2,540 mm (8' 4") | | |
| I | 1,270 mm (4' 2") | | |
| J | 1,270 mm (4' 2") | | |
| K | 1,990 mm (6' 6") | | |
| L | 2,590 mm (8' 6") | | |
| M | 600 mm (2' 0") | | |
| N | 410 mm (1' 4") | | |
| O | 2,773 mm (9' 1") | | |

## Two - Piece Boom

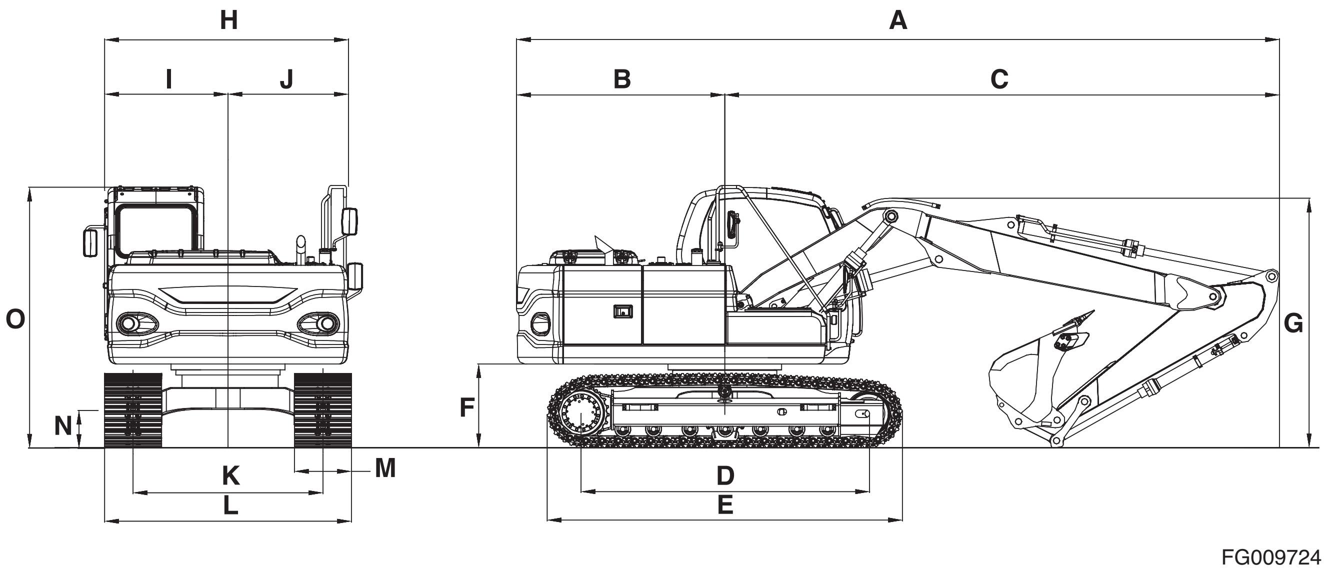



**Figure 1**

| DIMENSION | 4.98 m (16' 4") Two - Piece BOOM | |
|---|---|---|
| | 2.1 m (6' 11") Arm | 2.5 m (8' 2") Arm |
| A | 8,060 mm (26' 5") | 8,015 mm (26' 4") |
| B | 2,200 mm (7' 2") | |
| C | 5,860 mm (19' 3") | 5,815 mm (19' 1") |
| D | 3,180 mm (10' 4") | |
| E | 3,968 mm (13' 0") | |
| F | 1,035 mm (3' 4") | |
| G | 2,655 mm (8' 9") | 2,770 mm (9' 1") |
| H | 2,540 mm (8' 4") | |
| I | 1,270 mm (4' 2") | |
| J | 1,270 mm (4' 2") | |
| K | 2,200 mm (7' 2") | |
| L | 2,800 mm (9' 2") | |
| M | 600 mm (2' 0") | |
| N | 455 mm (1' 5") | |
| O | 2,925 mm (9' 6") | |

# WORKING RANGE

## One - Piece Boom

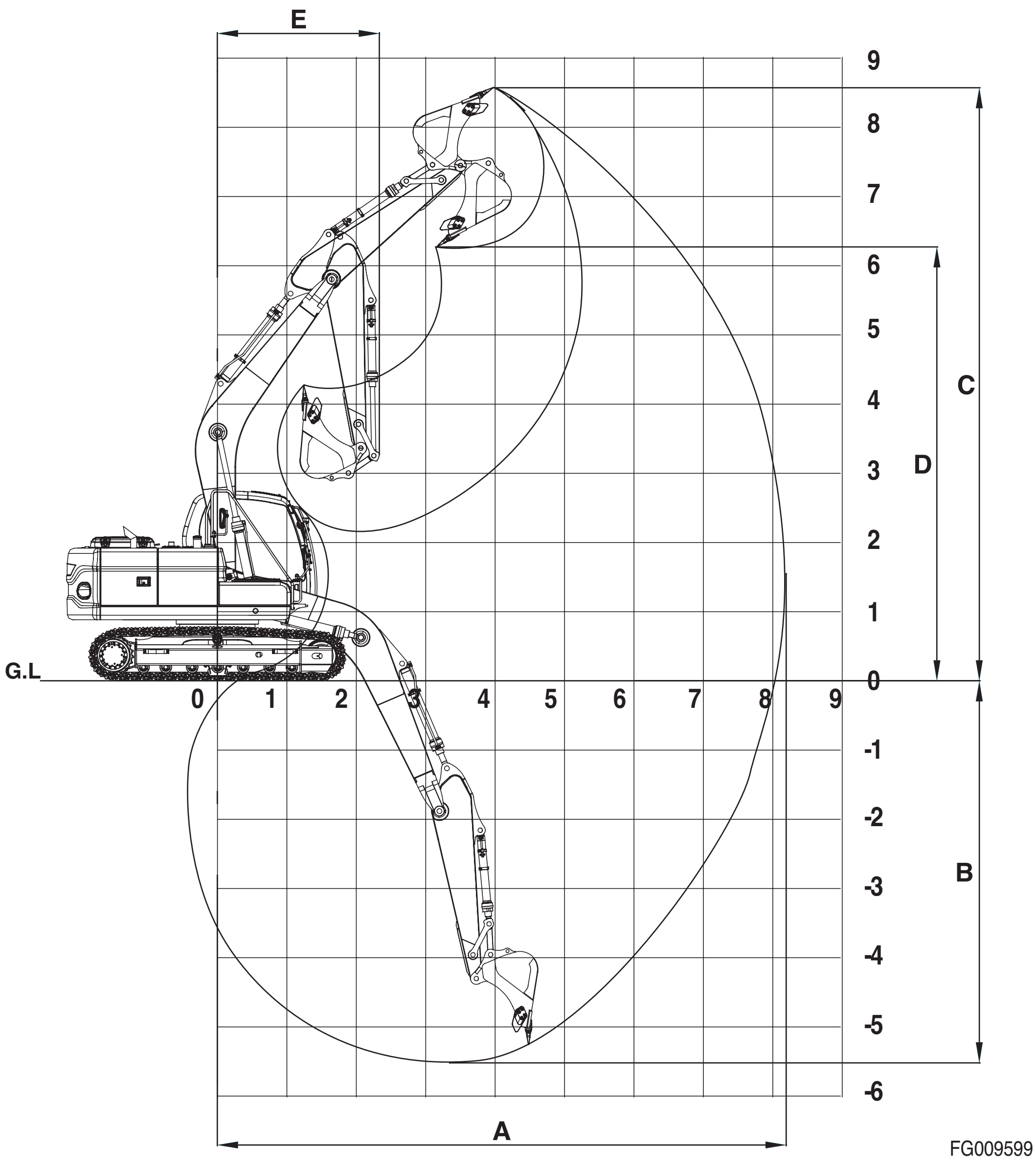



**Figure 2**

| DIM. | | 4.6 m (15' 1") One - Piece BOOM | | |
|---|---|---|---|---|
| | | **2.1 m (6' 11") Arm** | **2.5 m (8' 2") Arm** | **3.0 m (9' 10") Arm** |
| A | Max. Digging Reach | 7,845 mm (25' 9") | 8,300 mm (27' 3") | 8,680 mm (28' 6") |
| B | Max. Digging Depth | 5,250 mm (17' 3") | 5,645 mm (18' 6") | 6,150 mm (20' 2") |
| C | Max. Digging Height | 8,195 mm (26' 11") | 8,675 mm (28' 5") | 8,745 mm (28' 8") |
| D | Max. Loading Height | 5,875 mm (19' 3") | 6,300 mm (20' 8") | 6,415 mm (21' 0") |
| E | Min. Swing Radius | 2,345 mm (7' 8") | 2,375 mm (7' 9") | 2,585 mm (8' 6") |

## Two - Piece Boom

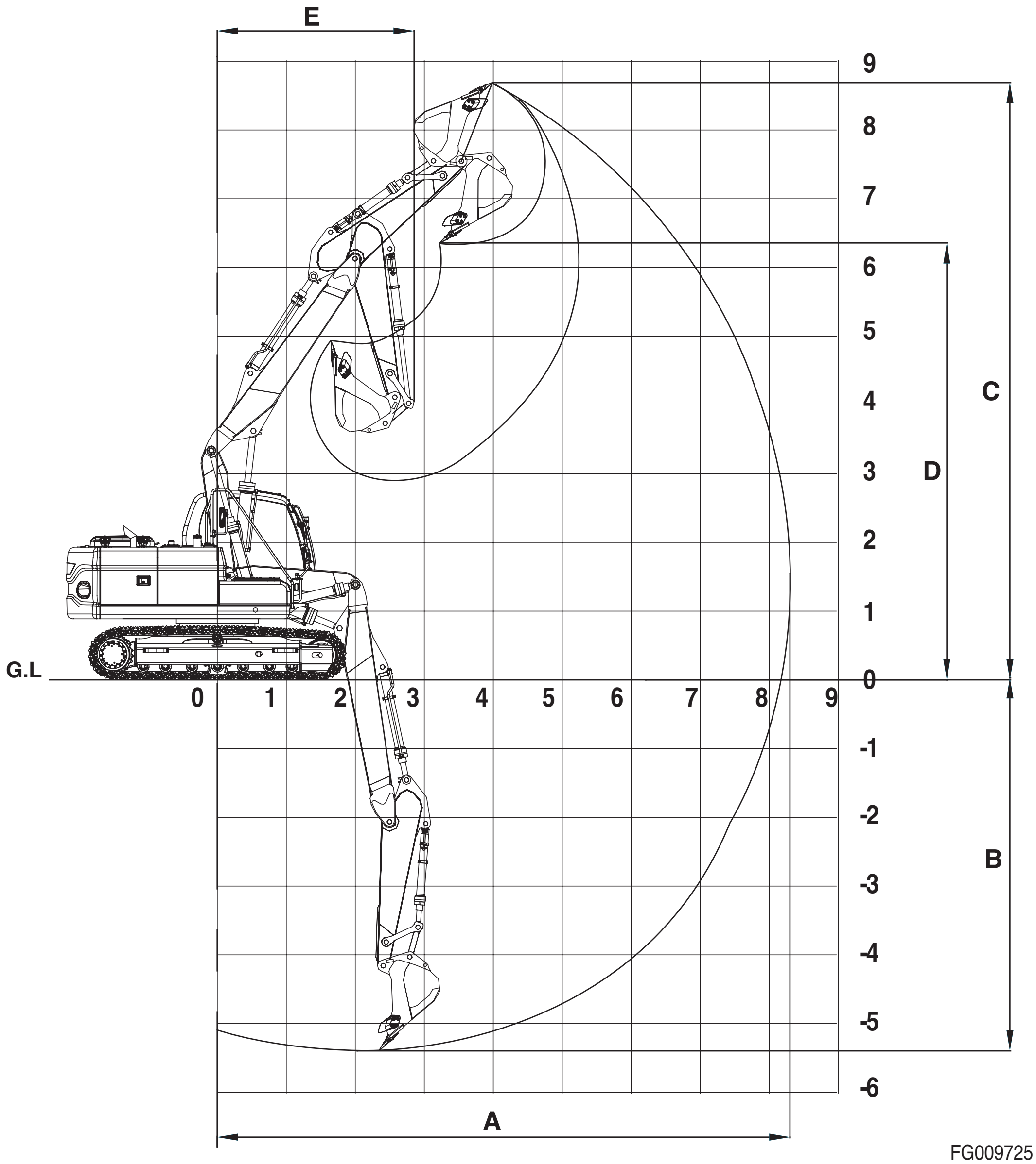



**Figure 3**

| DIM. | | 4.98 m (16' 4") Two - Piece BOOM | |
|---|---|---|---|
| | | 2.1 m (6' 11") Arm | 2.5 m (8' 2") Arm |
| A | Max. Digging Reach | 8,380 mm (27' 6") | 8,805 mm (28' 11") |
| B | Max. Digging Depth | 5,440 mm (17' 10") | 5,850 mm (19' 2") |
| C | Max. Digging Height | 8,820 mm (28' 11") | 9,235 mm (30' 4") |
| D | Max. Loading Height | 6,420 mm (21' 1") | 6,810 mm (22' 4") |
| E | Min. Swing Radius | 2,925 mm (9' 7") | 2,935 mm (9' 8") |

# GENERAL SPECIFICATIONS

| | |
|---|---|
| Shipping Weight | 14.0 metric tons (30,860 lb), includes 10% fuel, 4,600 mm (15' 1") boom, 2,500 mm (8' 2") arm, standard backhoe bucket and standard shoes |
| Operating Weight | Add weight of full fuel tank and operator |
| Shipping Weights With Optional Track Shoes | Add 310 kg (683 lb) for 500 mm (19.7") shoes |
| | Add 440 kg (970 lb) for 700 mm (34") shoes |
| Major Component Weights | Standard Boom 756 kg (1,667 lb) |
| | 2,100 mm (6' 11") Arm 367 kg (809 lb) |
| | 2,500 mm (8' 2") Arm 412 kg (908 lb) |
| | 3,000 mm (9' 10") Arm 450 kg (992 lb) |
| | Boom Cylinders 122 kg (269 lb) each |
| | Arm Cylinder 145 kg (320 lb) |
| | Bucket Cylinder 92 kg (207 lb) |
| | Counterweight 2,200 kg (4,850 lb) |
| | Upper Turntable 4,100 kg (9,039 lb) |
| | Lower - below Swing Bearing 5,300 kg (11,685 lb) |
| Digging Forces (At Power Boost): | |
| Bucket Cylinder | 94 KN or 9,600 kg (21,200 lb) - (with either 3,000 mm [9' 10"] or 2,500 mm [8' 2"] or 2,100 mm [6' 11"] arm) |
| Arm Cylinder | 62 KN or 6,300 kg (13,900 lb) with 2,500 mm (8' 5") standard arm |
| Fuel Tank Capacity | 267 liters (70.5 U.S. gal) |
| Hydraulic System Capacity | 148 liters (39 U.S. gal) |
| Hydraulic Reservoir Capacity | 99 liters (26 U.S. gal) |
| Bucket Heaped Capacity Range | PCSA 0.24 - 0.76 $m^3$ (0.31 - 0.99 $yd^3$) |
| | **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 (23.5") - standard |
| | 700 mm (28") - optional |
| | 500 mm (19.7") - optional |
| Ground Pressure Ratings: | |
| Standard 600 mm (23.6") shoe - | 0.36 $kg/cm^2$ (5.1 psi) |
| Optional 700 mm (28.0") shoe - | 0.30 $kg/cm^2$ (4.3 psi) |
| Optional 500 mm (19.7") shoe - | 0.43 $kg/cm^2$ (6.1 psi) |
| Optional Dozer Blade Sizes | 2,490 mm (8' 2") with 500 mm (19.7") |
| | 2,590 mm (8' 6") with 600 mm (23.5") |
| | 2,690 mm (8' 10") with 700 mm (28") |
| Transport Dimensions | |
| Overall Shipping Length (standard boom and arm) | 7,680 mm (25' 2") |
| Overall Shipping Width (standard shoes) | 2,590 mm (8' 6") |
| Overall Shipping Height (to top of cylinder hose) | 2,710 mm (8' 10") |

| | |
|---|---|
| Track Shipping Length | 3,755 mm (12' 4") |
| Transport Trailer Capacity | 20 tons (22 short 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)

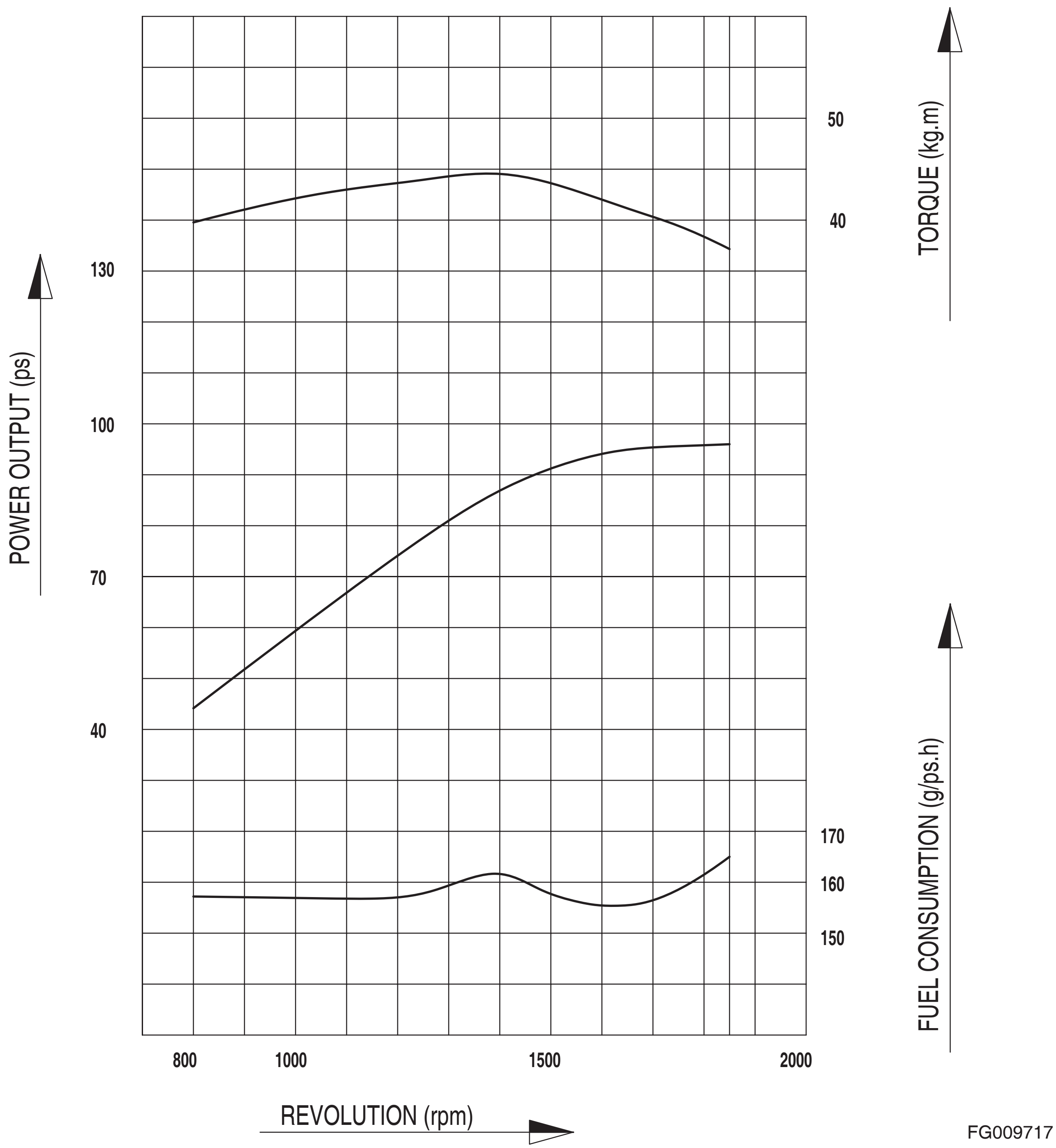



Figure 4

| Condition | Specification |
|---|---|
| Engine Model | DL06 |
| Barometric Pressure | 760 mmHg (20°C (68°F)) |
| Cooling Fan | ø595 mm, SUCKER (23.4 in) |
| Alternator | 24V x 50A |
| Air Cleaner | Installed |
| Muffler | Installed |

| | |
|---|---|
| Performance Standard | DIN 6270 |
| Power | 96 ps @ 1,850 rpm (95 hp @ 1,850 rpm) |
| Max. Torque | 44.5 kg•m @ 1,400 rpm (322 ft lb @ 1,400 rpm) |
| Fuel Consumption (Rated) | 165 g/ps•h (5.47 oz/hp•h) |

# APPROXIMATE WEIGHT OF WORKLOAD MATERIALS

## IMPORTANT

**Weights are approximations of estimated average volume and mass. Exposure to rain, snow or 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$^3$) | --------------------- |
| Earth, DRY, packed | --------------------- | 1,522 kg/m$^3$ (2,565 lb/yd$^3$) | --------------------- |

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

# PERFORMANCE TESTS

1. Main Relief Pressure

   normal operation: 330 kg/cm$^3$ (4,689 psi)

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

2. Actuator Speeds

| Operation | | Unit | Standard Mode | Power Mode |
|---|---|---|---|---|
| Boom | Up | sec | 3.3 ± 0.4 | 3.0 ± 0.4 |
| | Down | sec | 2.6 ± 0.3 | 2.6 ± 0.3 |
| Arm | Dump | sec | 2.2 ± 0.3 | 2.0 ± 0.3 |
| | Crowd | sec | 2.9 ± 0.4 | 2.8 ± 0.4 |
| Bucket | Dump | sec | 2.3 ± 0.3 | 2.1 ± 0.3 |
| | Crowd | sec | 4.0 ± 0.4 | 3.8 ± 0.4 |
| Swing (3 Revolutions) | | sec | 17.6 ± 1.5 | 16.7 ± 1.5 |
| Jack-up Speed (3 Turns) | High | sec | 18.9 ± 1.5 | 18.0 ± 1.5 |
| | Low | sec | 29.8 ± 2.0 | 28.4 ± 2.0 |
| Travel Speed 20 m (66 ft) | High | sec | 16.0 ± 1.0 | 15.3 ± 1.0 |
| | Low | sec | 25.0 ± 1.5 | 24.0 ± 1.5 |
| Travel Deviation 20 m (66 ft) | High | mm (in) | 150 (6) | 150 (6) |
| | Low | mm (in) | 150 (6) | 150 (6) |

# EXCAVATOR PERFORMANCE STANDARDS

Evaluation of equipment performance and operating condition can be made by running the excavator through a series of different tests, and recording results with a 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, firm supporting ground surface.
2. All recommended, applicable maintenance and adjustment service should be completed before testing.
3. Hydraulic fluid and engine oil should be of appropriate viscosity for ambient weather conditions. Warm up hydraulic oil to standard operating temperature, between 45°C - 55°C (112°F - 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.

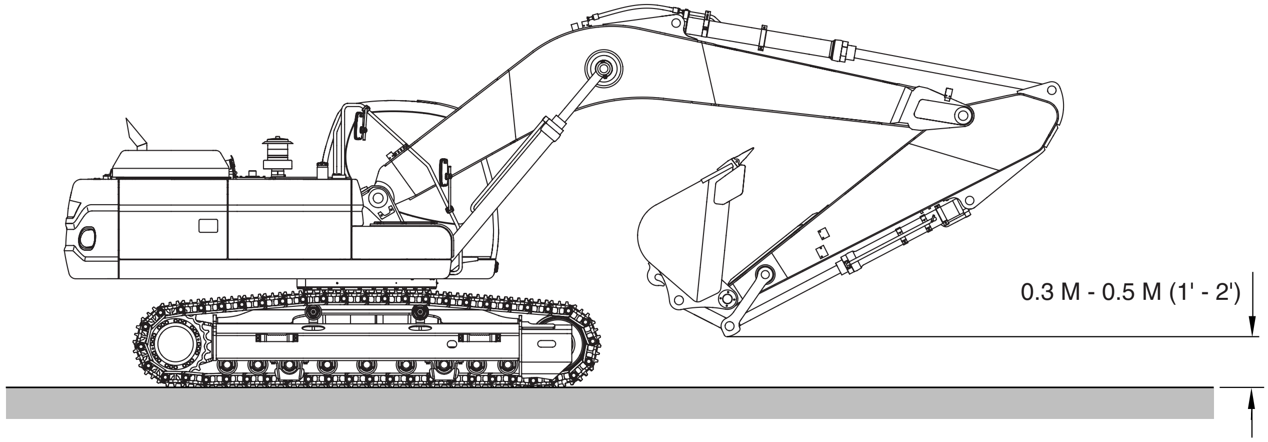



**Figure 5**

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 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 | 16.0 ± 1.0 sec | 15.3 ± 1.0 sec |
| Low Speed | 25.0 ± 1.5 sec | 24.0 ± 1.5 sec |

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

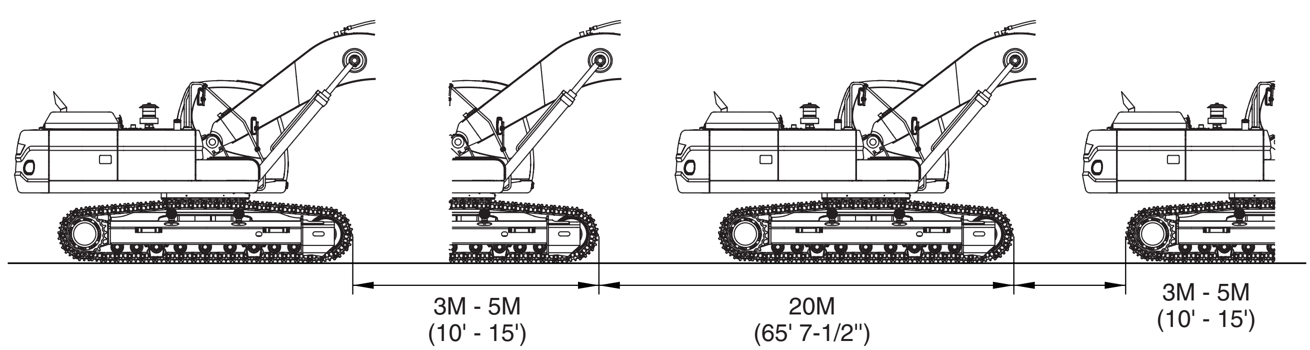



**Figure 6**

### Travel Deviation

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

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

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

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

## Swing Speed and Deceleration Force Test

### Swing Speed Test

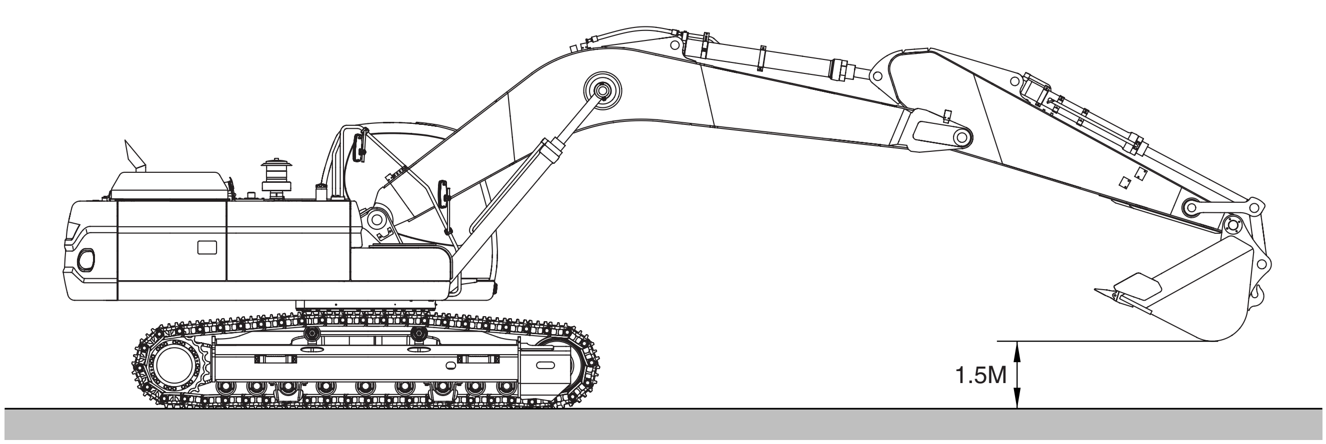



**Figure 7**

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 and 19 seconds in Standard Mode, 15 and 18 seconds in Power Mode.

### Swing Deceleration Force Test

With the boom, arm and bucket in the same position as for the swing speed test, rotate the turntable so 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 607 mm (23.9"), in both Power Mode and Standard Mode.

| Reference Number | Description |
|---|---|
| 1 | Start Swing |
| 2 | 90° Swing |
| 3 | Lever Stop |
| 4 | Swing Stop |

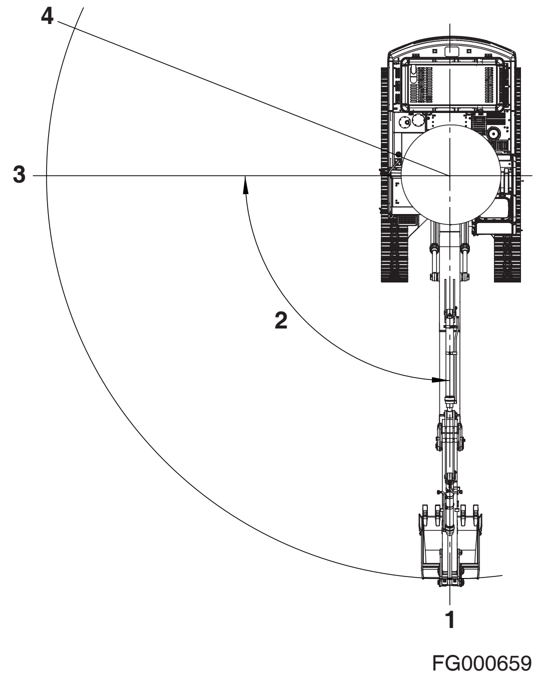



Figure 8

# Cylinder Performance Tests

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

### Boom Cylinders Test

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

### Arm Cylinder Test

Start with the boom up and the arm cylinder fully retracted. Test movement in both directions several times, between the "crowd" and "dump" positions, and average the results of both tests, in both standard and 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 | 2.9 - 3.7 sec | 2.6 - 3.4 sec |
| Boom Down | 2.3 - 2.9 sec | 2.3 - 2.9 sec |
| Arm Dump | 1.9 - 2.5 sec | 1.7 - 2.3 sec |
| Arm Crowd | 2.5 - 3.3 sec | 2.4 - 3.2 sec |
| Bucket Dump | 2.0 - 2.6 sec | 1.8 - 2.4 sec |
| Bucket Crowd | 3.6 - 4.4 sec | 3.4 - 4.2 sec |

### Hydraulic Cylinder Natural Drop Test

To check boom and arm cylinder tightness against the specified performance standard for new cylinders, put a full load of dirt in the bucket and move the attachment cylinders so 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.

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

### Travel Motor Jack-up Test

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

| Operation | Standard Mode | Power Mode |
|---|---|---|
| High Speed | 17.4 - 20.4 sec | 16.5 - 19.5 sec |
| Low Speed | 27.8 - 31.8 sec | 26.4 - 30.4 sec |

# General Maintenance

# General Maintenance Procedures

Edition 1

MEMO

# Table of Contents

## General Maintenance Procedures

## MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| ALL MODELS | ALL RANGES |
| | |
| | |
| | |

# WELDING PRECAUTIONS AND GUIDELINES

## IMPORTANT

**To avoid accidents, personal injury and the possibility of causing damage to the machine or to components, welding must only be performed by properly trained and qualified personnel, who possess the 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 *DOOSAN* 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 cabin window areas or any other assemblies that could be damaged by weld spatters, use adequate shielding protection in front of the assembly.**
5. **During equipment setup, always attach ground cables directly to the area or component being welded to prevent arcing through bearings, bushings, or spacers.**
6. **Always use correct welding rods for the type of weld being performed and observe recommended precautions and time constraints. AWS Class E7018 welding rods for low alloy to medium carbon steel must be used within two hours after removal from a freshly opened container. Class E11018G welding rods for T-1 and other higher strength steel must be used within 1/2 hour.**

# HYDRAULIC SYSTEM - GENERAL PRECAUTIONS

Always maintain oil level in the system at recommended levels. Assemblies that operate under heavy loads, at high speed, with extremely precise 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 prefilling with fresh, clean oil if the protective seal on replacement parts has obviously been broken or if seal integrity may have been compromised. When protective seals are removed before installation and reassembly, inspect all replacement parts carefully, before they are installed. If the replacement part is bone dry (with no trace of factory prelube) or has been contaminated by dirt or by questionable oils, flushing and prefilling with clean hydraulic fluid is recommended.

Vibration, irregular or difficult movement or unusual noise from any part of the hydraulic system could be an indication of air in the system (and many other types of problems). As a general precaution (and to help 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 prestart equipment safety inspection, including a quick visual scan for any exterior evidence of leaking hydraulic fluid, can help extend the service life of system components.

# IMPORTANT

**Hydraulic system operating conditions (repetitive cycling, heavy 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 preclean any exterior surface of the system before it is exposed to air. For example, the reservoir fill cap and neck area, hoses that have to be disassembled, and the covers and external surfaces of filter canisters should all be cleaned before disassembly.**

# MAINTENANCE SERVICE AND REPAIR PROCEDURE

## General Precautions

Fluid level and condition should always be checked whenever any other 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 prefill the assembly before bolting together the drain line piping connections. Run the system at low rpm.

# HYDRAULIC SYSTEM CLEANLINESS AND OIL LEAKS

## Maintenance Precautions for Hydraulic System Service

Whenever maintenance, repairs or any other 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, noncombustible, 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.*

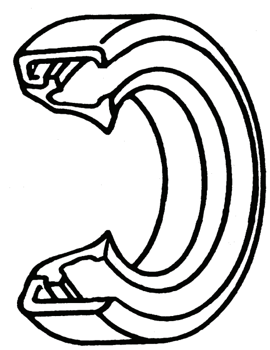



**Figure 1**

# 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.

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## WARNING!

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

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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 retaining 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.

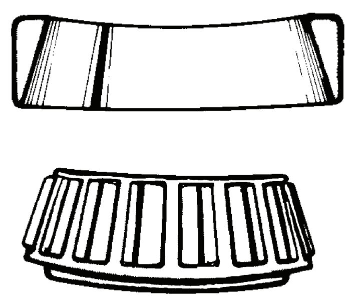
If available, use magna-flux or similar process for checking for cracks that are not visible to the naked eye.

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.

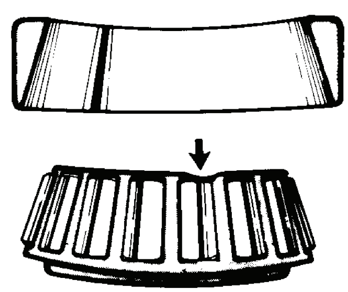


HASA620S

**Figure 2**

### Bent Cage

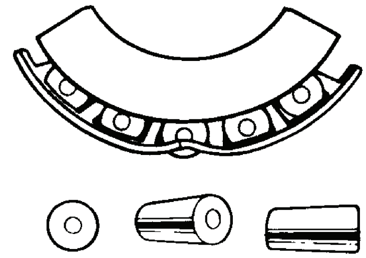
Cage damage due to improper handling or tool usage.



HASA460S

**Figure 3**

Replace bearing.



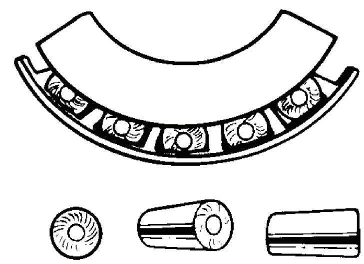
HASA470S

**Figure 4**

**Galling**

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

Replace bearing - check seals and check for proper lubrication.



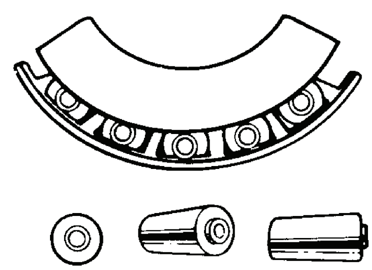
HASA480S

**Figure 5**

**Abrasive Step Wear**

Pattern on roller ends caused by fine abrasives.

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



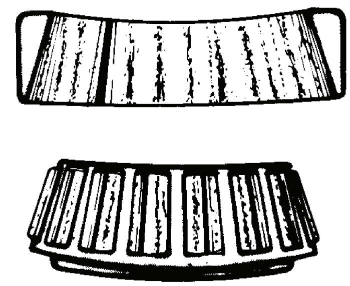
HASA490S

**Figure 6**

### Etching

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

Replace bearings - check seals and check for proper lubrication.



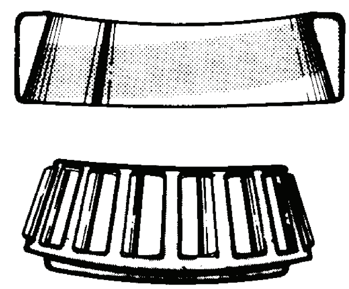
HASA500S

**Figure 7**

### Misalignment

Outer race misalignment due to foreign object.

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



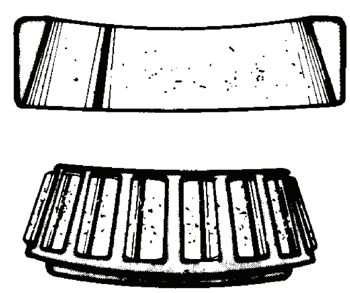
HASA510S

**Figure 8**

### Indentations

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

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



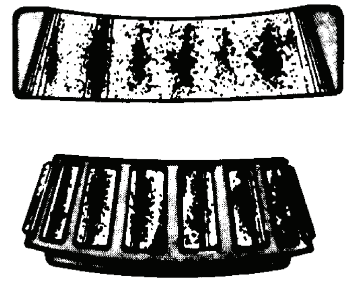
HASA520S

**Figure 9**

### Fatigue Spalling

Flaking of surface metal resulting from fatigue.

Replace bearing - clean all related parts.



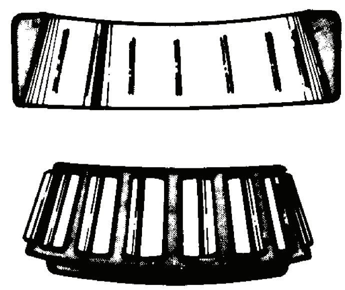
HASA530S

**Figure 10**

### Brinelling

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

Replace bearing if rough or noisy.



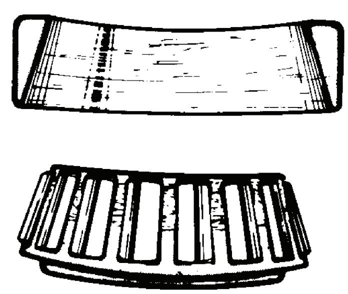
HASA540S

**Figure 11**

### Cage Wear

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

Replace bearings - check seals.



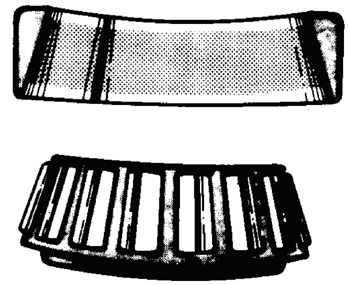
HASA550S

**Figure 12**

### Abrasive Roller Wear

Pattern on races and rollers caused by fine abrasives.

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



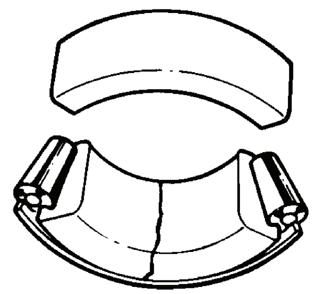
HASA560S

**Figure 13**

### Cracked Inner Race

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

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



HASA570S

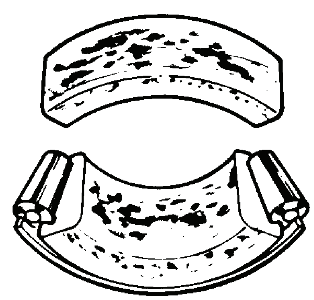
**Figure 14**

### Smears

Smearing of metal 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.



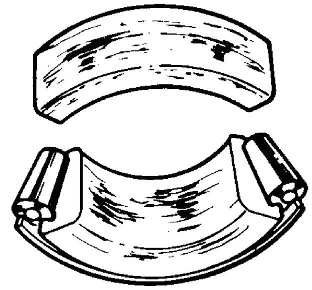
HASA580S

**Figure 15**

**Frettage**

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

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



HASA590S

**Figure 16**

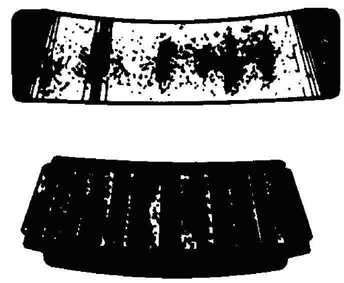
**Heat Discoloration**

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

Excessive heat can cause softening of races or rollers.

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

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



HASA600S

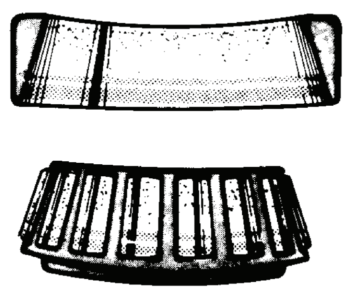
**Figure 17**

**Stain Discoloration**

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

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

Check seals and other related parts for damage.



HASA610S

**Figure 18**

# Standard Torques

Edition 1

# MEMO

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## Standard Torques

## MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

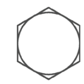
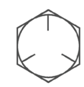
| MODEL | SERIAL NUMBER RANGE |
|---|---|
| ALL MODELS | ALL RANGES |
| | |
| | |
| | |

# TORQUE VALUES FOR STANDARD METRIC FASTENERS

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

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

# TORQUE VALUES FOR STANDARD U.S. FASTENERS

| Type | S.A.E. Grade | Description | Bolt Head Marking |
|---|---|---|---|
| 1 | 1 OR 2 | WILL HAVE NO MARKINGS IN THE CENTER OF THE HEAD.<br><br>Low or Medium Carbon Steel Not Heat Treated. |  |
| 5 | 5 | WILL HAVE THREE RADIAL LINES.<br><br>Quenched and Tempered Medium Carbon Steel. |  |
| 8 | 8 | WILL HAVE 6 RADIAL LINES.<br><br>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 nonlubricated (dry) threads.*

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

**NOTE:** *If any bolts and nuts are found loose or at values less than 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:

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:

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

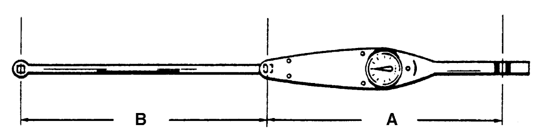



Figure 1

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

- If the extension itself absorbs some of the tightening force and starts to bend or bow out.
- If an extension has to be fabricated that is not 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. *DOOSAN* does not specifically endorse a specific manufacturer or brand name but the following table of "Loctite" applications is included for which cross-references to other makers' products should also be widely available.**

## IMPORTANT

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

## I. "Loctite" Fastener Adhesives

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

## II. "Loctite" Pipe Thread Sealant

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

## III. "Loctite" gasket/flange sealer

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

## IV. "Loctite" retaining compounds

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

## V. "Loctite" Adhesives

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

# Upper Structure

# Cabin

Edition 1

# MEMO

# Table of Contents

## Cabin

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |
| DX300LC | 5001 and Up |
| DX300LL | 5001 and Up |
| DX340LC | 5001 and Up |
| DX420LC | 5001 and Up |
| DX480LC | 5001 and Up |
| DX520LC | 5001 and Up |

# REMOVAL

## CAUTION!

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

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

## WARNING!

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

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

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

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

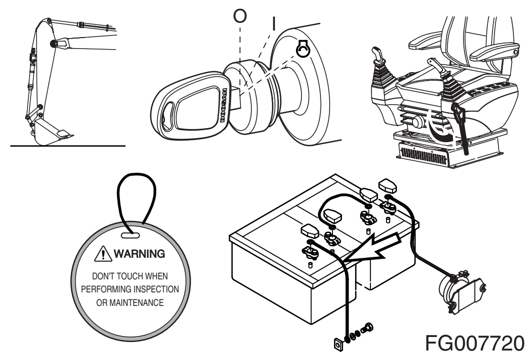



**Figure 1**

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

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

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

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

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

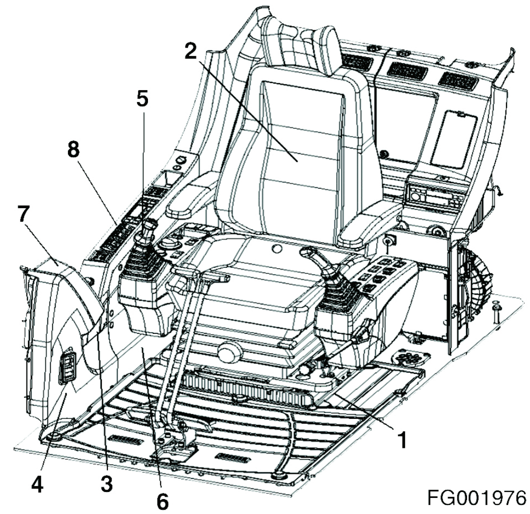



**Figure 2**

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

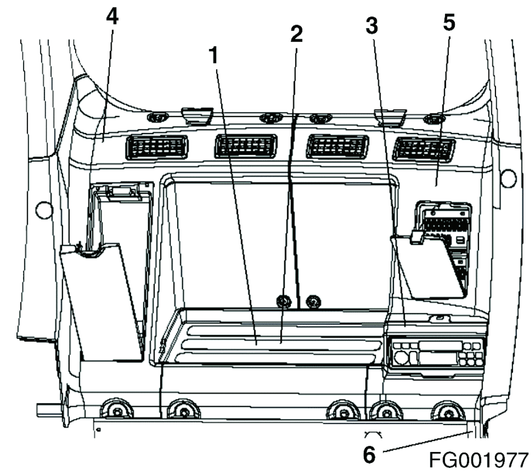



**Figure 3**

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

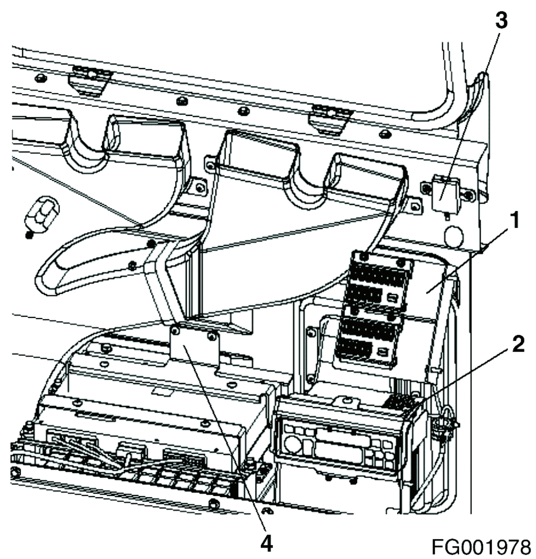



**Figure 4**

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

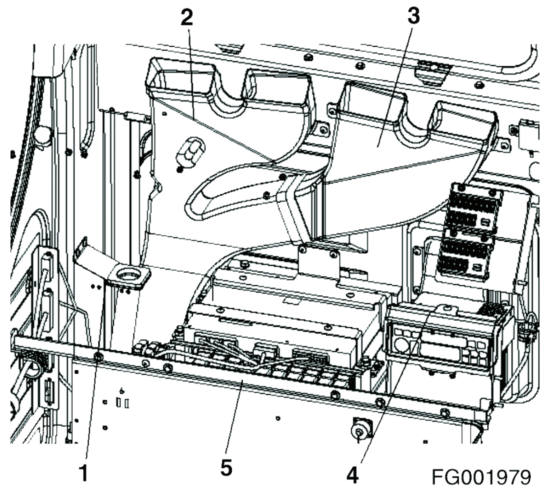



Figure 5

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

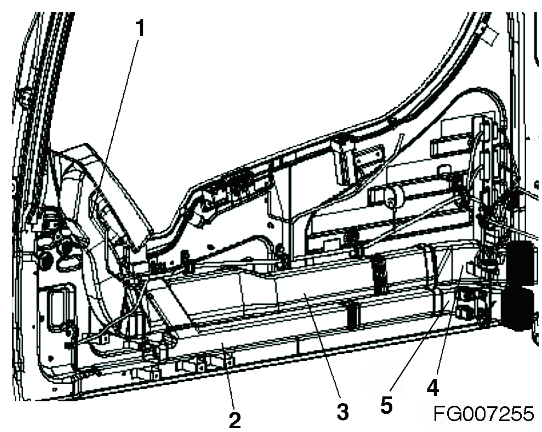



Figure 6

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

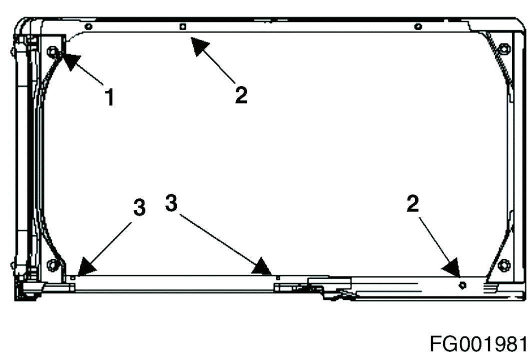



Figure 7

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

    **NOTE:** *Cabin weights approximately 315 kg (700 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 prepared safe blocking support.

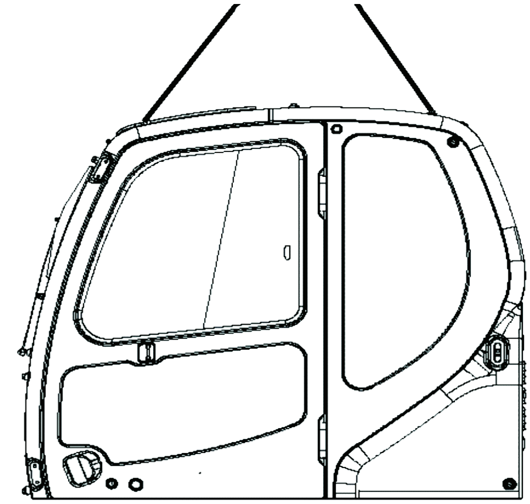



**Figure 8**

# INSTALLATION

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

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

2. Lower cab into position on cab floor.

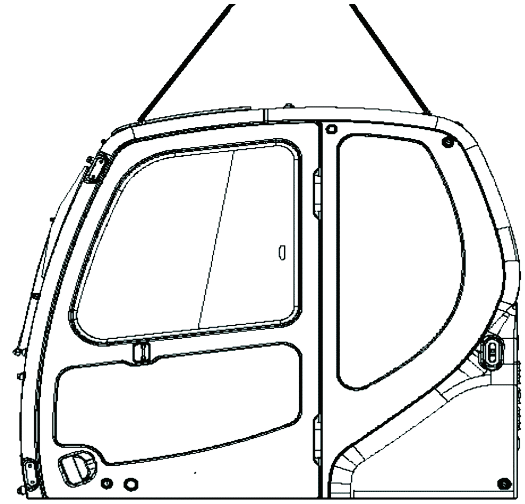




**Figure 9**

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

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

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

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

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

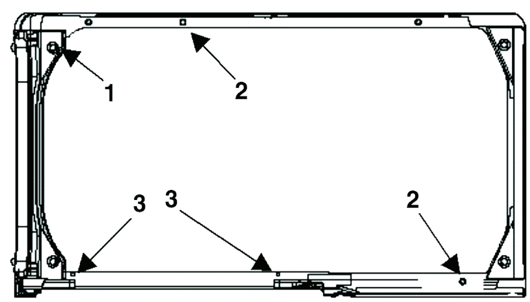




**Figure 10**

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

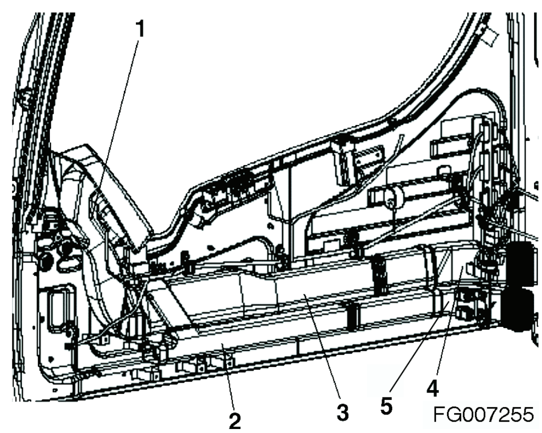




**Figure 11**

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

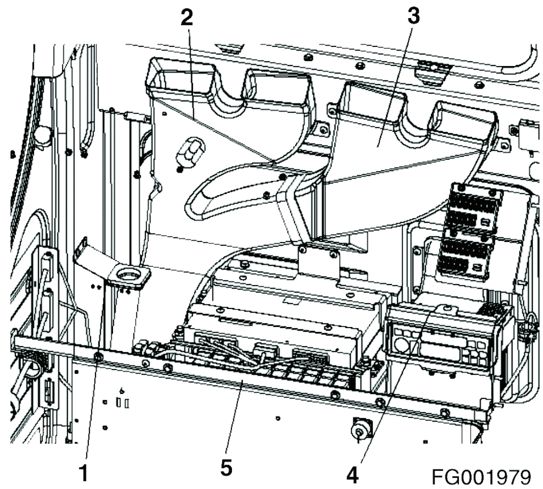


Figure 12

11. Install electric box (4, Figure 13).
12. Install cassette bracket (2, Figure 13) and connet antenna and speaker wire.
13. Connect cabin gound cable located near fuse box bracket.
14. Install fuse box bracket (1, Figure 13) to left side wall of the cab.

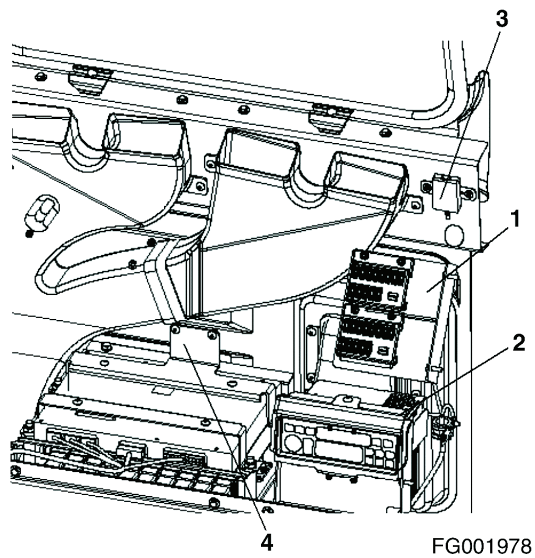


Figure 13

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

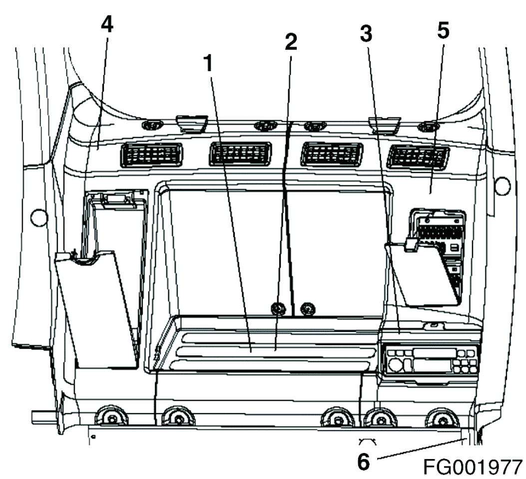


Figure 14

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

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

18. Install floor mat (1, Figure 15).
19. Connect negative (-) battery cable leading to frame from battery.

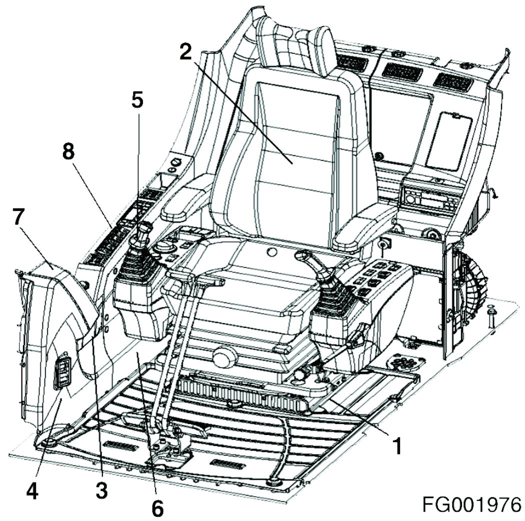



**Figure 15**

# Counterweight

Edition 1

# MEMO

# Table of Contents

## Counterweight

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

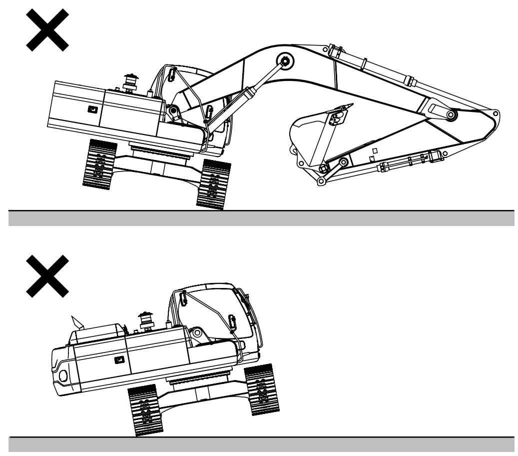
**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |
| DX300LC | 5001 and Up |
| DX340LC | 5001 and Up |

## Warning for Counterweight and Front Attachment Removal



FG000371

**Figure 1**

### DANGER!

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

**Never remove 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.**

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 |
|---|---|
| DX140LC | 2,200 kg (4,850 lb) |
| DX180LC | 3,000 kg (6,614 lb) |
| DX225LC | 4,100 kg (9,039 lb) |
| | 5,300 kg (11,685 lb) (Optional) |
| DX225NLC | 4,100 kg (9,039 lb) |
| | 4,700 kg (10,361 lb) (Optional) |
| DX255LC | 4,700 kg (10,361 lb) |
| DX300LC | 5,300 kg (11,685 lb) |
| | 5,900 kg (13,007 lb) (Optional) |
| DX340LC | 6,800 kg (14,991 lb) |

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

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

## WARNING!

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

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

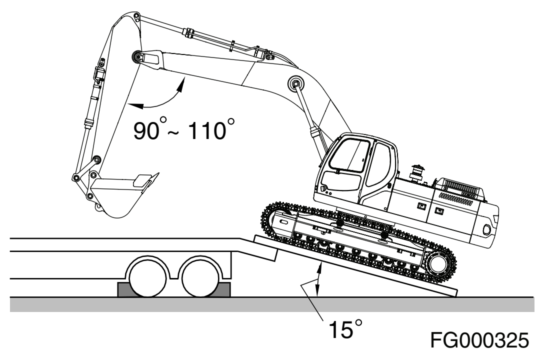
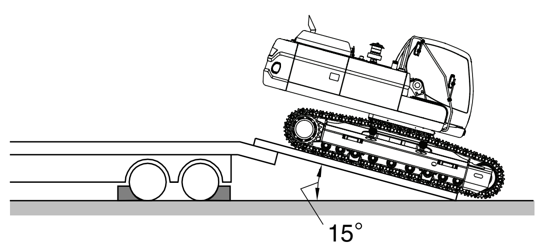



**Figure 1**

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




FG000326

**Figure 2**

# REMOVAL

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

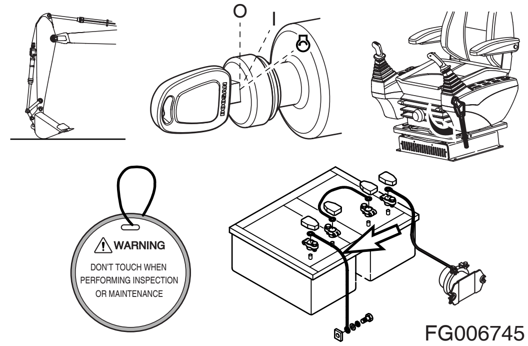



Figure 3

## WARNING!

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

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

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 |
|---|---|
| DX140LC | M48x5.0 |
| DX180LC | |
| DX225LC | |
| DX225NLC | |
| DX255LC | |
| DX300LC | |
| DX340LC | |

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

    **NOTE:** *Heat bolts if necessary, to free them.*

16. When bolts (4, Figure 4) and washers (5) have been removed, lift counterweight (2) a very short distance above support frame (6) and stop. Check slings and make sure counterweight is being supported evenly.

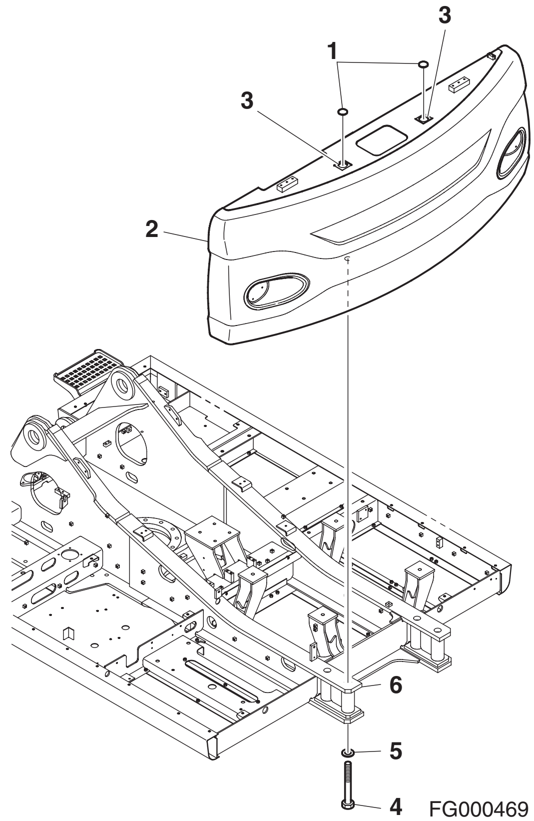



Figure 4

# INSTALLATION

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

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

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

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

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

| Model | Bolt Torque |
|---|---|
| DX140LC | 115 kg•m (832 ft lb) |
| DX180LC | 150 kg•m (1,085 ft lb) |
| DX225LC | |
| DX225NLC | |
| DX255LC | |
| DX300LC | 250 kg•m (1,807 ft lb) |
| DX340LC | |

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

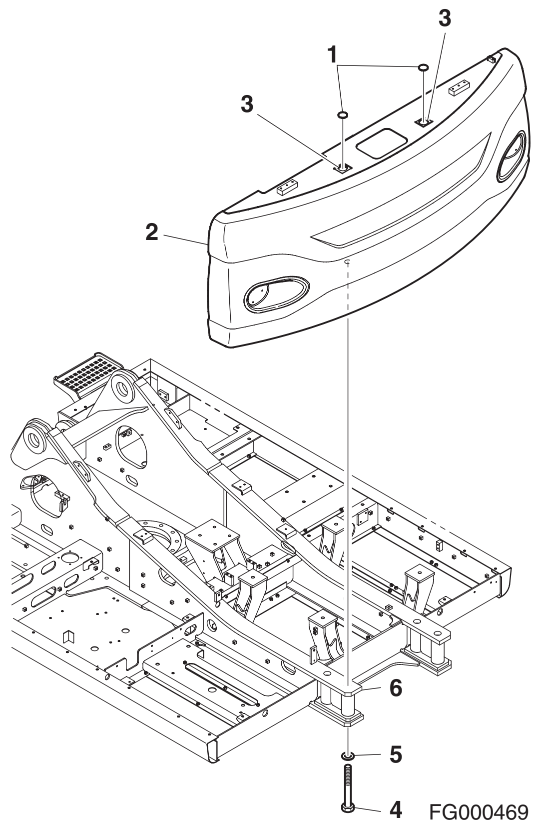



Figure 5

# Fuel Tank

Edition 1

# MEMO

# Table of Contents

## Fuel Tank

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |

# GENERAL DESCRIPTION

## WARNING!

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

## Parts List

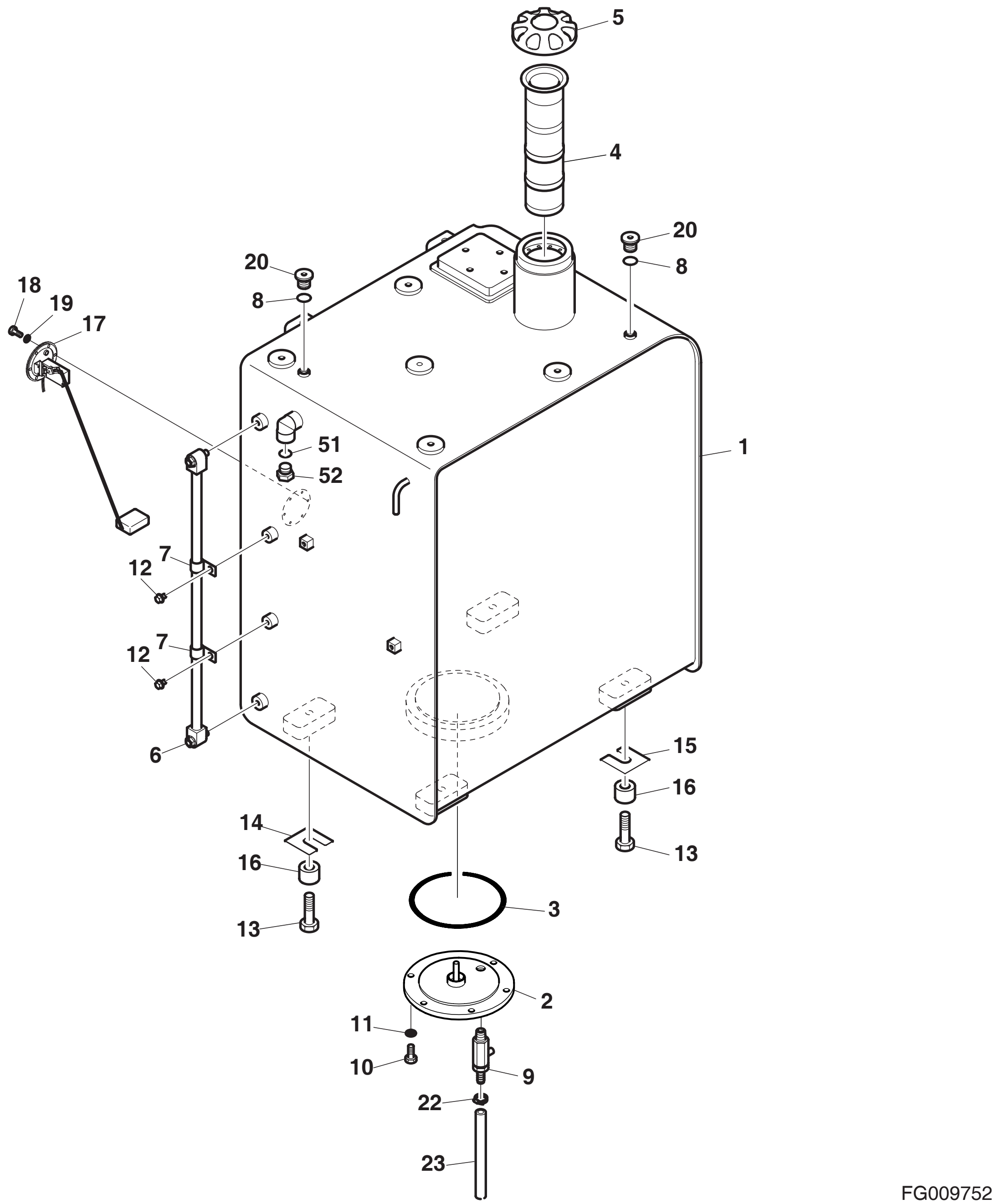



Figure 1

| Reference Number | Description |
|---|---|
| 1 | Fuel Tank |
| 2 | Cover |
| 3 | O-ring |
| 4 | Fuel Strainer |
| 5 | Fuel Cap |
| 6 | Level Gauge |
| 7 | Clip |
| 8 | O-ring |
| 9 | Drain Valve |
| 10 | Bolt |
| 11 | Spring Washer |
| 12 | Bolt |

| Reference Number | Description |
|---|---|
| 13 | Bolt |
| 14 | Shim |
| 15 | Shim |
| 16 | Spacer |
| 17 | Fuel Sender |
| 18 | Bolt |
| 19 | Spring Washer |
| 20 | Plug |
| 22 | Hose Clamp |
| 23 | Hose |
| 51 | O-ring |
| 52 | Plug |

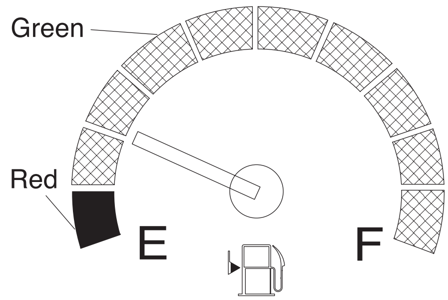
## Specifications

Fuel tank capacity is 267 liters (70.5 U.S. gal).

# REMOVAL

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

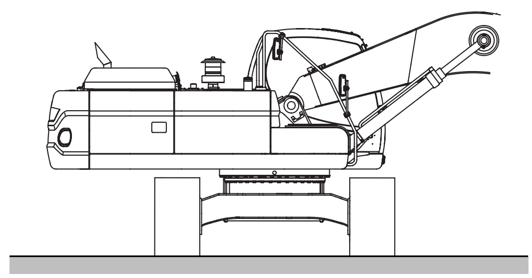
   **NOTE:** *If possible, work excavator until available fuel supply in tank has been run down as far as possible.*




FG000608

**Figure 2**

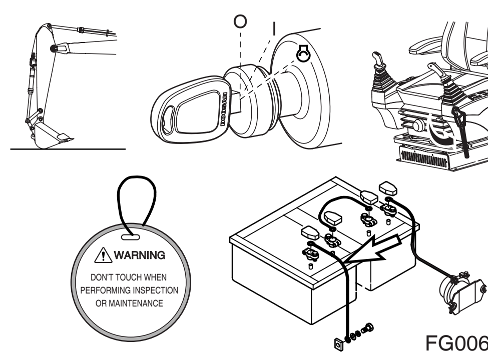
2. Park on firm and level ground and swing turntable to approximately a 90° with respect to tracks. See Figure 3.



FG000471

**Figure 3**

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




FG006745

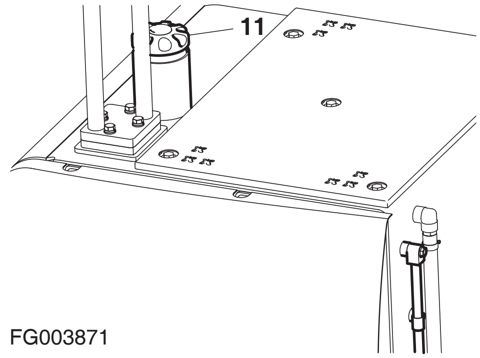
**Figure 4**

## WARNING!

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

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

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

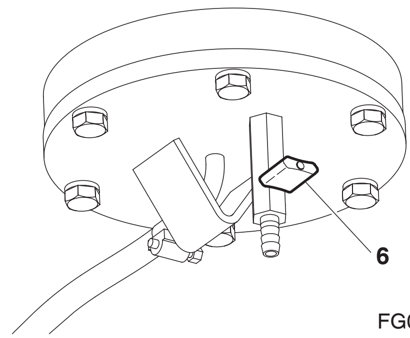



FG003871

**Figure 5**

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

**NOTE:** *Fuel tank capacity is 267 liters (70.5 U.S. gal).*

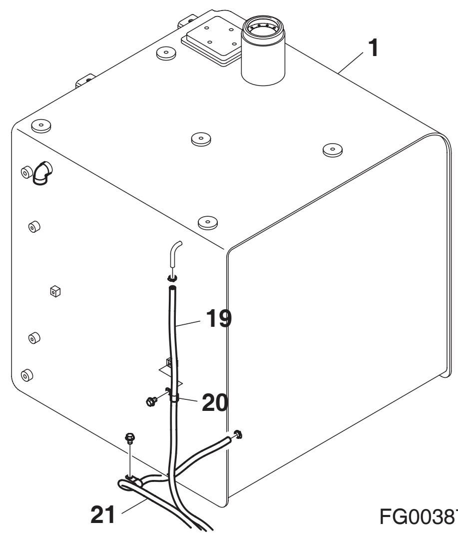



FG003872

**Figure 6**

14. Tag and disconnect fuel supply line (21, Figure 7) and fuel return line (19) from fuel tank (1) and carefully drain remaining fuel from lines.

15. Remove clamp (20, Figure 7) holding fuel return line (19) to tank (1).




FG003873

**Figure 7**

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

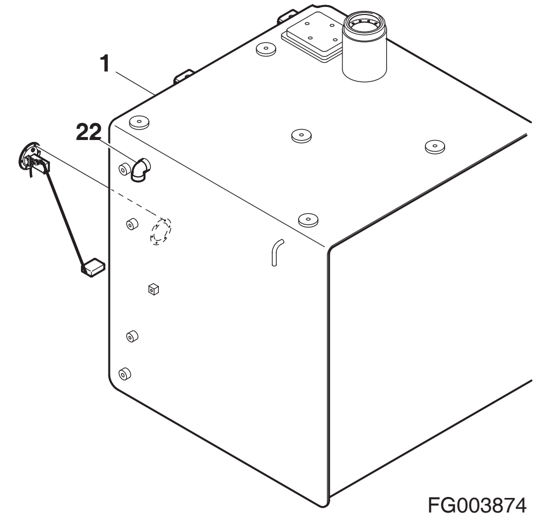



Figure 8

17. Remove six bolts (1 and 2, Figure 9) and stay (3) from fuel tank and frame.

    Remove four bolts (4 and 5) and fuel tank cover (6) from fuel tank.

    Remove two bolts (7) and bracket (8) from tank.

    Remove four bolts (9) and battery cover (10) from frame.

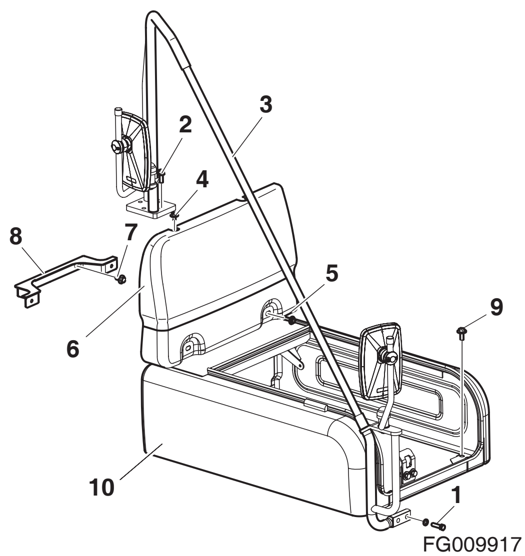



Figure 9

18. Tag and disconnect wires leading to fuel sender (16, Figure 10) on side of fuel tank (1).

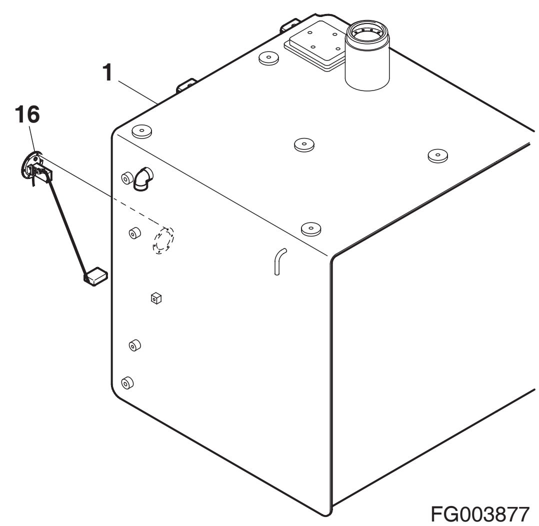



Figure 10

19. Remove four bolts (35 and 36, Figure 11) and cover (37) from fuel tank and support.

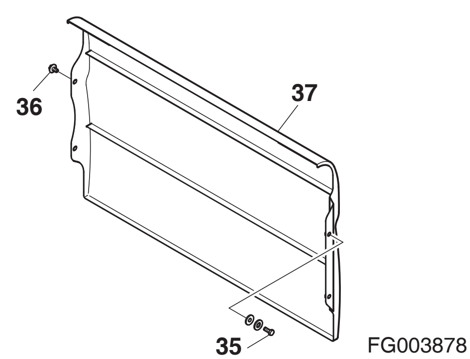



Figure 11

20. Install two 12 mm eyebolts in threaded holes (38 and 39, Figure 12). Using a suitable lifting device, sling eyebolts.
21. Remove six bolts (7) and spacers (13, Figure 12) holding tank (1) to frame. Lift tank 25 mm (1") 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.*

22. Remove shims (9, Figure 12).

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

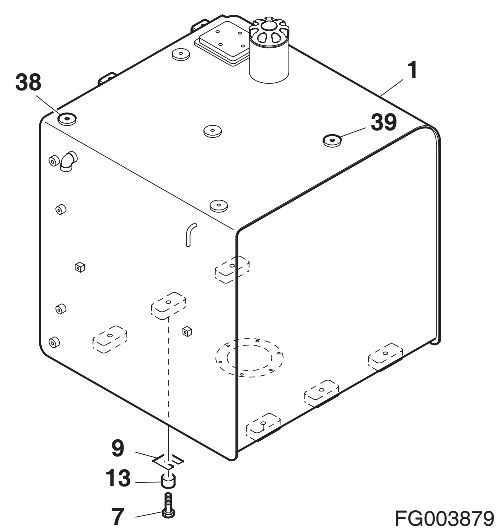



Figure 12

# INSTALLATION

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

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

3. Install shims (9, Figure 13) as needed to prevent tank (1) from rocking or stress from mounting bolts (7).
4. Tighten mounting bolts (7, Figure 13) after shims are installed.

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

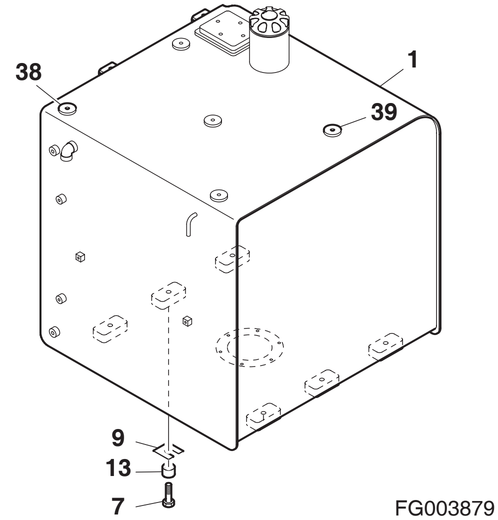



**Figure 13**

5. Install four bolts (35 and 36, Figure 14) and cover (37) on fuel tank and support.

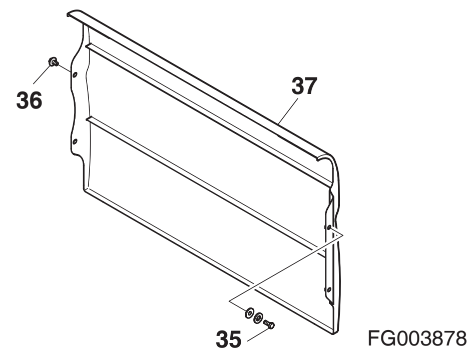



**Figure 14**

6. Connect wires as tagged to fuel sender (16, Figure 15) on side of fuel tank (1).

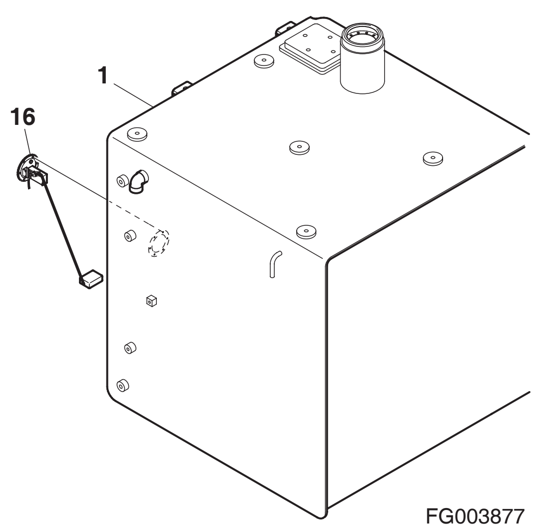



**Figure 15**

7. Install four bolts (9, Figure 16) and battery cover (10) on frame.

   Install two bolts (7) and bracket (8) on fuel tank.

   Install four bolts (4 and 5) and fuel tank cover (6) on fuel tank.

   Install six bolts (1 and 2) and stay (3) on fuel tank and frame.

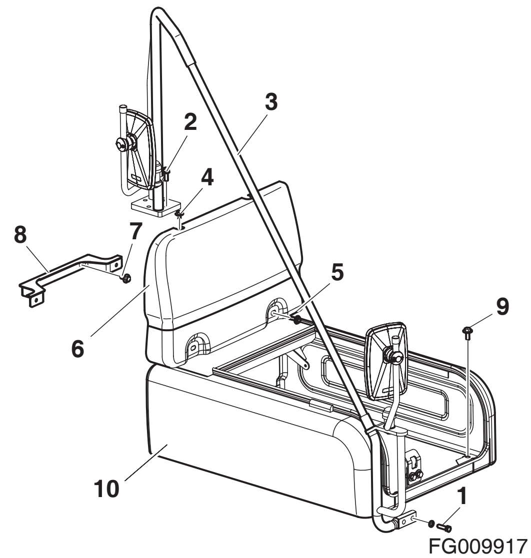



Figure 16

8. Install five bolts (23, Figure 17) and cover (24) on fuel tank.

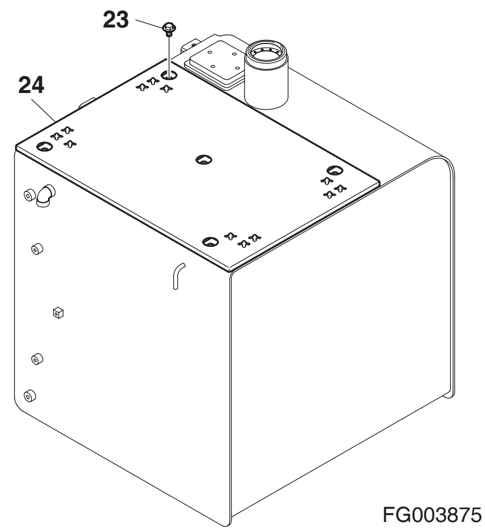



Figure 17

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

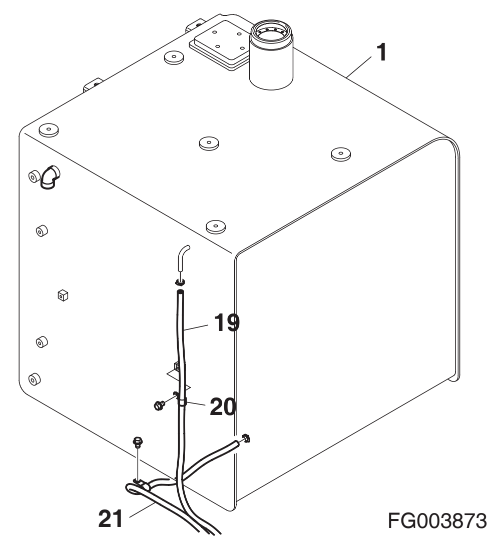



Figure 19

12. Make sure fuel tank drain valve (6, Figure 20) on bottom of tank is closed.
13. Fill fuel tank and check for signs of leaks. Correct any problems found.
14. Connect negative (-) battery cable to battery.

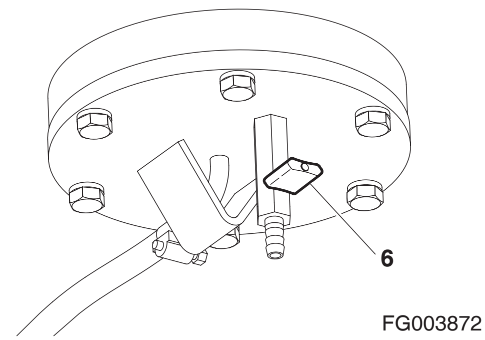



Figure 20

# START-UP PROCEDURES

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

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

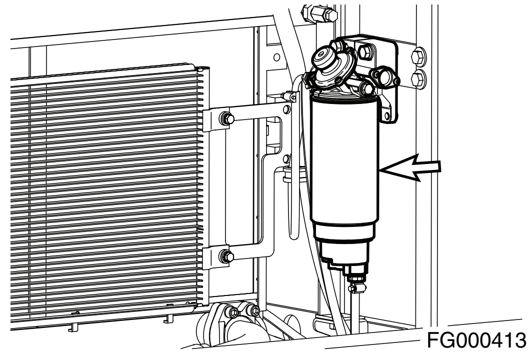



Figure 21

3. Loosen plug (1, Figure 22) on top of fuel filter head.
4. Pump hand operated primer pump (2, Figure 22) by the fuel injection pump. Pump primer until fuel is present at plug hole in fuel filter head.
5. Tighten plug in fuel filter head.
6. Continue to pump primer pump until a strong resistance is felt.
7. Start engine and look for signs of leaks.

Repeat procedure if necessary.

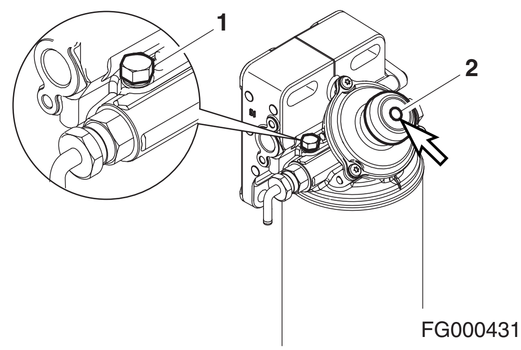



Figure 22

# Fuel Transfer Pump

Edition 1

# MEMO

# Table of Contents

## Fuel Transfer Pump

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |
| DX300LC | 5001 and Up |

# GENERAL DESCRIPTION

## Theory of Operation

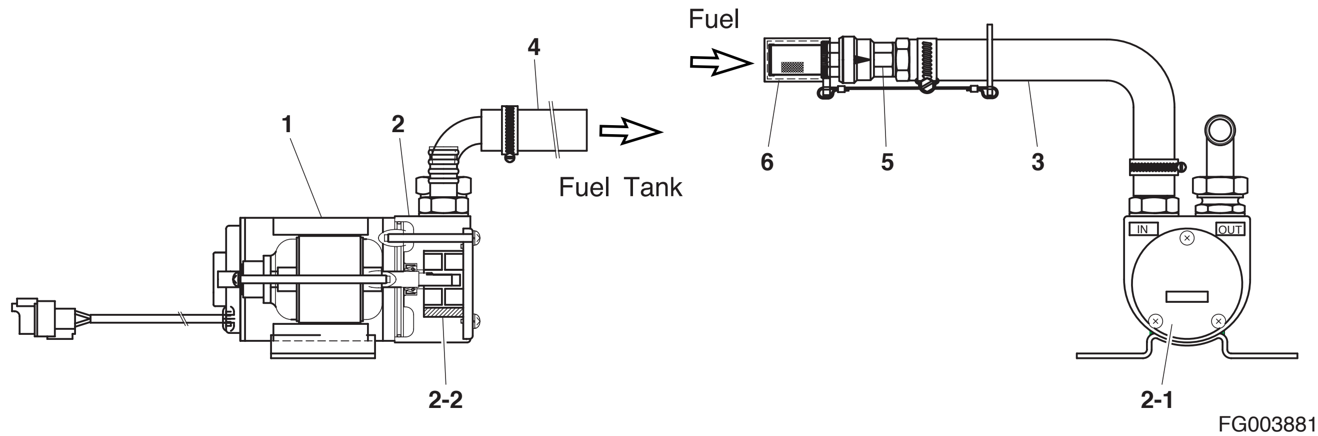



**Figure 1**

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

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

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

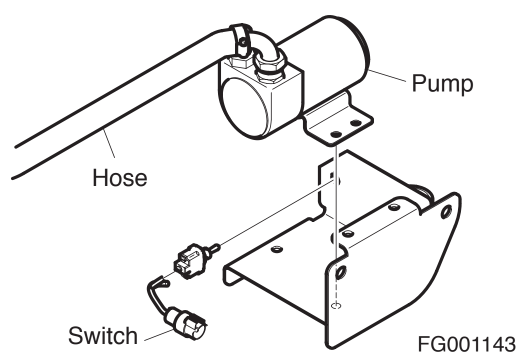



**Figure 2**

# TROUBLESHOOTING

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

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

**NOTE:** *OPEN TEMP: 150 ±5°C (302 ±41°F). After circuit is automatically shut off 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.*

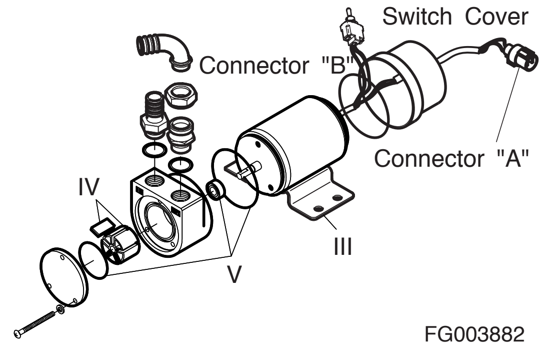



**Figure 3** WITH TOGGLE SWITCH

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

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

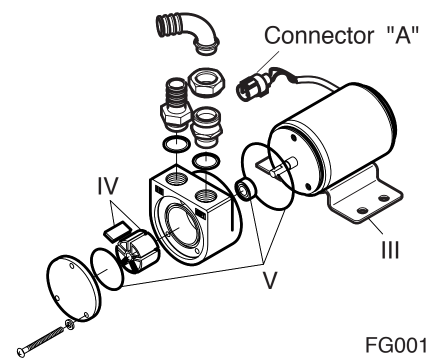



**Figure 4** WITHOUT TOGGLE SWITCH

# REPLACEMENT OF ROTOR AND VANE

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

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

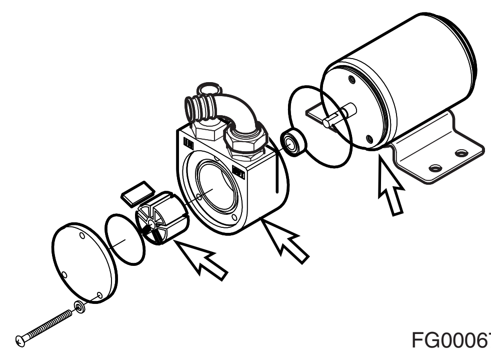



**Figure 5** WITHOUT TOGGLE SWITCH

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

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

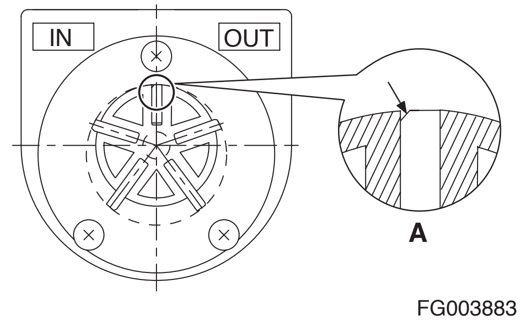



Figure 6

# 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 the brush and insert it to the armature. Then fit the hole of screw in the housing.

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

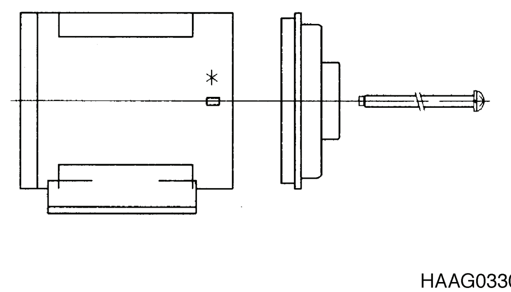



Figure 7

# 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 1-8, for installation of the rear cover.

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

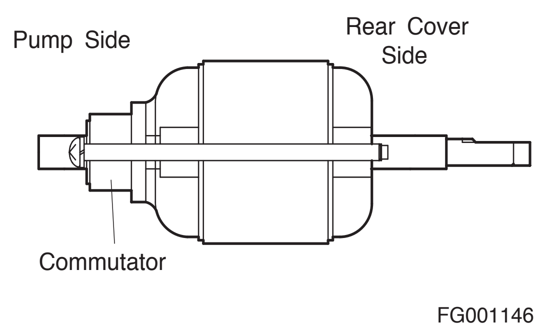



Figure 8

# Swing Bearing

Edition 1

# MEMO

# Table of Contents

## Swing Bearing

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX300LC | 5001 and Up |
| DX340LC | 5001 and Up |

# SWING BEARING MAINTENANCE

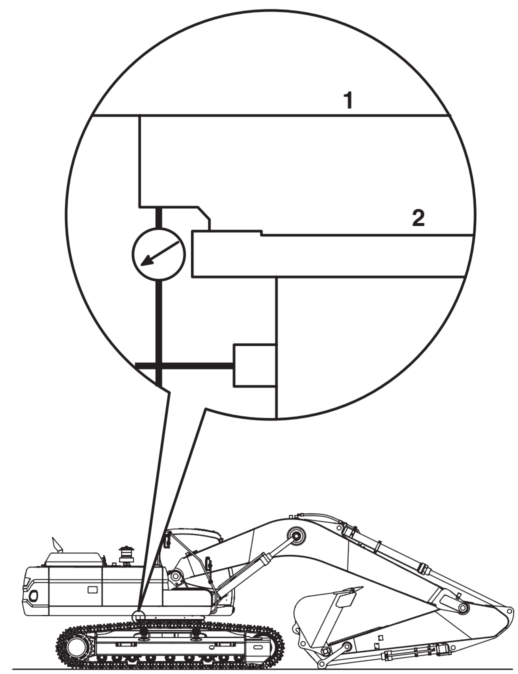
## Operating Recommendation

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.



FG000533

**Figure 1**

## Measuring Bearing Lateral Play

When vertical checks are made, the side to side play in the bearing can be checked by fully retracting the arm and bucket cylinders and extending the tip of the bucket as far forward as it will go. With the excavator parked on a flat, level surface and the bucket tip just off the ground, push against the bucket sideways to take up all 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 | Outer Ring |
| 2 | Inner Ring |
| 3 | Tapered Pin |
| 4 | Plug |
| 5 | Ball |
| 6 | Retainer |
| 7 | Seal A |

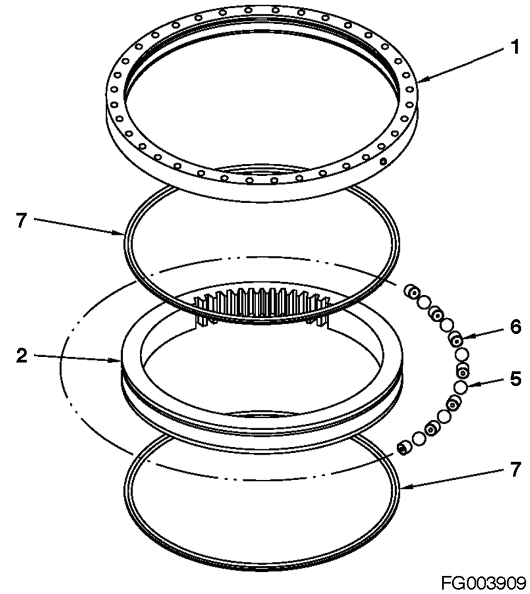



Figure 2

## Rebuilding Swing Bearing

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

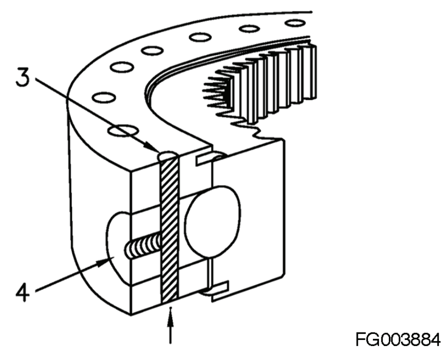



Figure 3

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

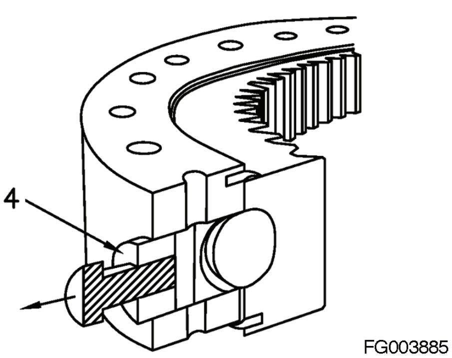



Figure 4

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

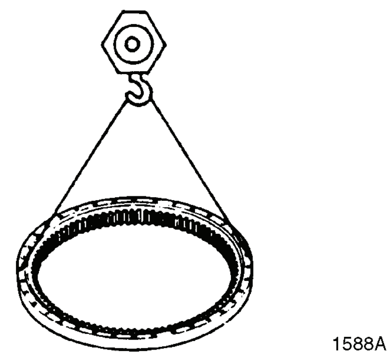



**Figure 5**

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

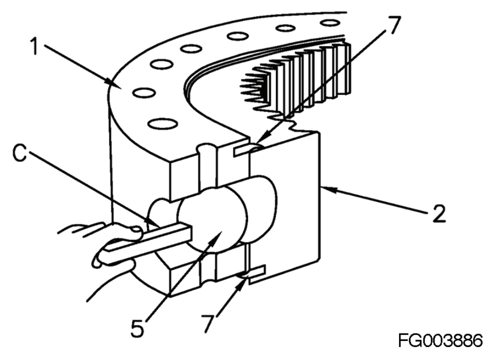



**Figure 6**

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

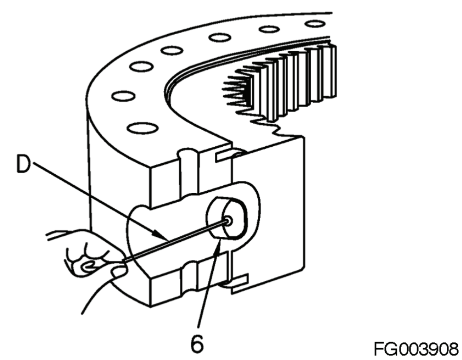



**Figure 7**

# Swing Reduction Gear

Edition 1

## MEMO

# Table of Contents

## Swing Reduction Gear

## MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX140W | 5001 and Up |
| DX160W | 5001 and Up |

# GENERAL DESCRIPTION

## Theory of Operation

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

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

# REASSEMBLY

## Parts List

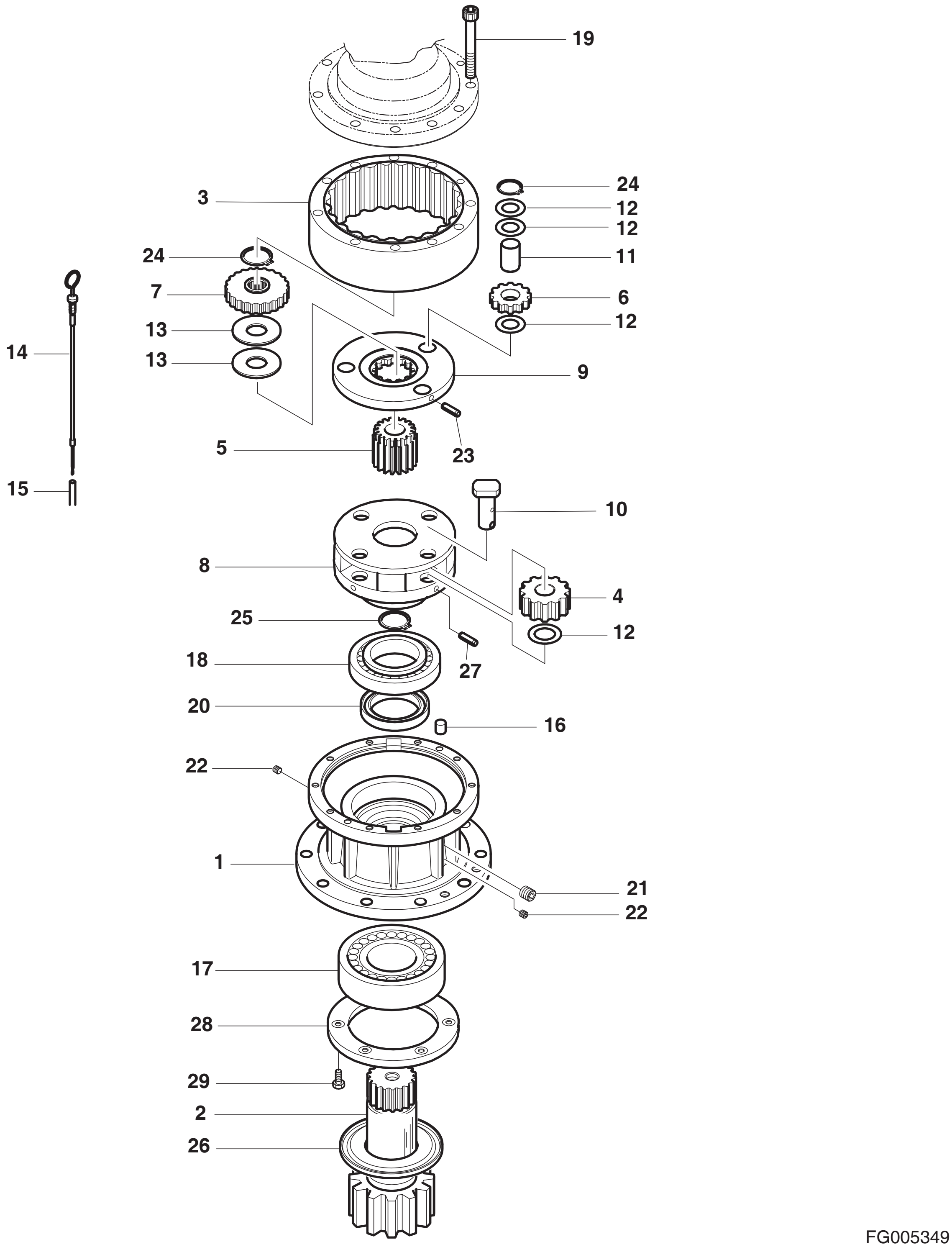



**Figure 1**

| Reference Number | Description |
|---|---|
| 1 | Casing |
| 2 | Driveshaft |
| 3 | Ring Gear |
| 4 | Planetary Gear |
| 5 | Sun Gear 2 |
| 6 | Planetary Gear |
| 7 | Sun Gear 1 |
| 8 | Carrier 2 |
| 9 | Carrier 1 |
| 10 | Pin Assembly |
| 11 | Pin Assembly |
| 12 | Adjustment Washer |
| 13 | Adjustment Washer |
| 14 | Level Bar |
| 15 | Level Gauge Piping |

| Reference Number | Description |
|---|---|
| 16 | Pin |
| 17 | Roller Bearing |
| 18 | Roller Bearing |
| 19 | Socket Bolt |
| 20 | Oil Seal |
| 21 | Plug |
| 22 | Plug |
| 23 | Spring Pin |
| 24 | Retainer Ring |
| 25 | Retainer Ring |
| 26 | Ring |
| 27 | Spring Pin |
| 28 | Support Plate |
| 29 | Screw Bolt |

# SHRINKAGE FITTING OF SHAFT AND FLEXIBLE BEARING

1. Washing of shaft

   Remove fluids like anticorrosive fluid applied to the shaft and use an air conditioner to remove foreign substances.

2. Insert the support plate and the NILOS ring into the prepared shaft as shown in the figure and heat bearings (#22314, 2109-1041) on the heater.

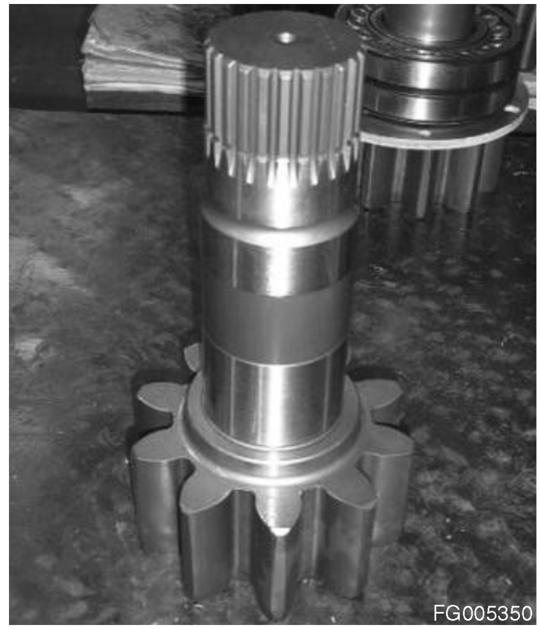



Figure 2


Figure 3


Figure 4

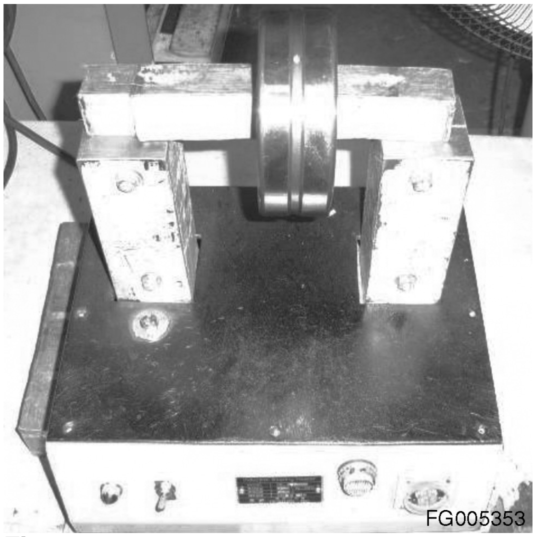



Figure 5

3. When bearing is heated up to 90°C - 100°C, remove it from the heater, hold it with both hands, and insert it into the shaft evenly.

   To do so, slowly insert bearing 4-5 mm that it seats itself and then push it strongly to contact the NILOS ring.

## CAUTION!

**Do not heat bearing above 120°C.**

4. After assembling the bearing, let it cooled fully in the air for 1 to 2 hours.


Figure 6

Figure 7

# REASSEMBLY OF CARRIER SUB

1. Washing of carrier

   Put in a steam washer the carrier whose burr is removed completely with corner face-milling and place it on the assembly die after checking if there is not left any foreign substance in it.

2. Washing of planetary gear

   Check if planetary gear parts are washed or dented, and put them on the assembly die.

3. Reassembly of carrier #1 assembly

   A. Place the carrier #1 assembly on the assembly jig, insert the thrust washer in it, and fix it to the hole of carrier.


**Figure 8**


**Figure 9**

   B. Put a pressure jig on the pin and use a press to insert it.

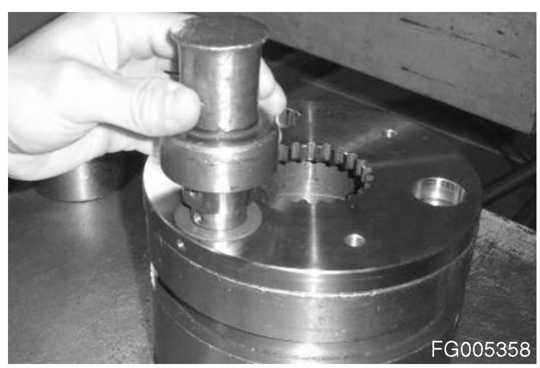



**Figure 10**

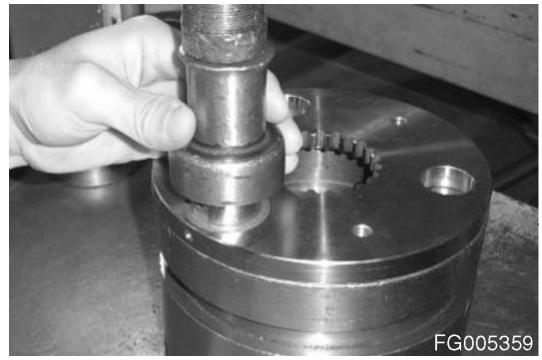



**Figure 11**

C. Place the carrier with the pin being pressed in on the jig vertically, use a hammer to insert the spring pin (ø6 x 25 liter§), and drain valve it.


**Figure 12**

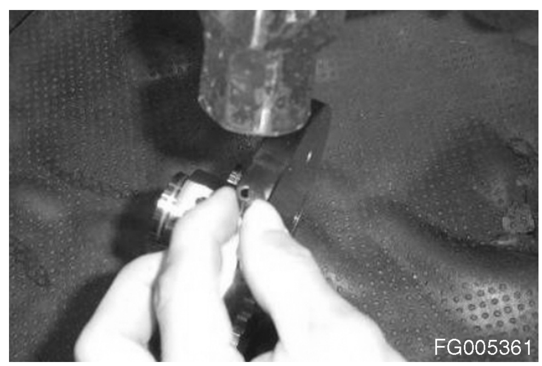



**Figure 13**

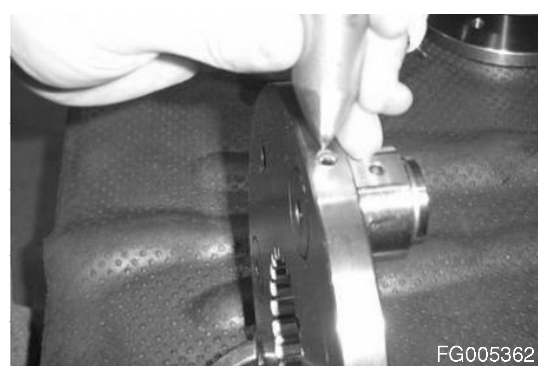



**Figure 14**


Figure 15

D. Assemble 2 other parts in the same way.

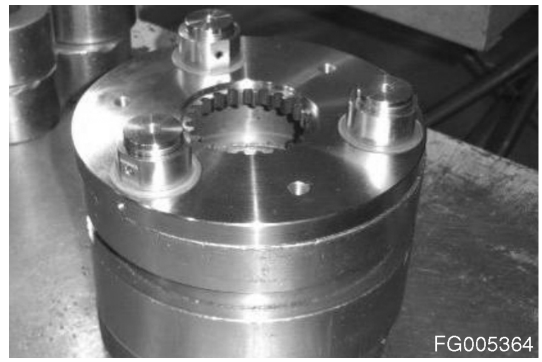



Figure 16

E. Put the thrust washer (B) in the middle of the carrier with all of pins being pressed in.


Figure 17

F. Insert planetary gear #1 in 3 pins and put two thrust washers on them as shown in the figure.

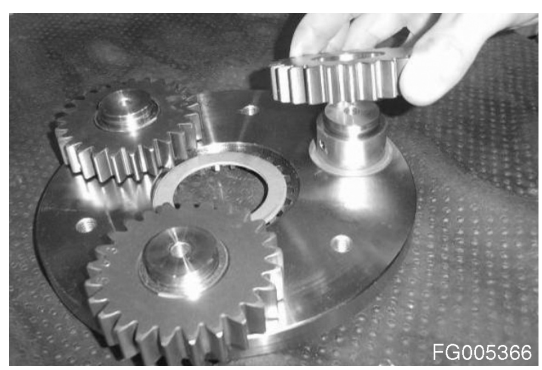



Figure 18

G. Install a retaining ring (ø30, C type, and for shaft) on each and check if gear rotates smooth.

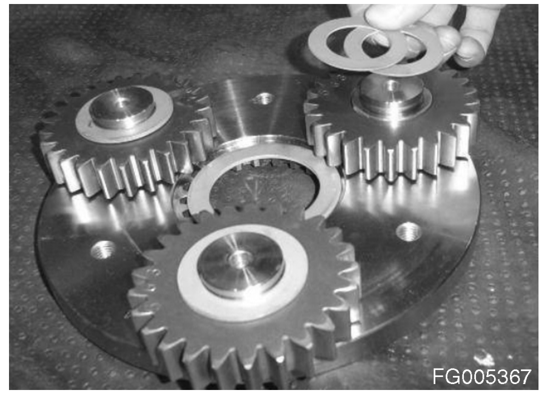


**Figure 19**

**Figure 20**

**Figure 21**

4. Reassembly of carrier #2 assembly

   A. Place the carrier #2 assembly on the assembly die, attach the thrust washer on a side of the planetary gear #2, and insert it in the carrier with the washer facing downward.

## ⚠ CAUTION!

**The calibers of gear and washer should be fit to holes of the carrier pins.**

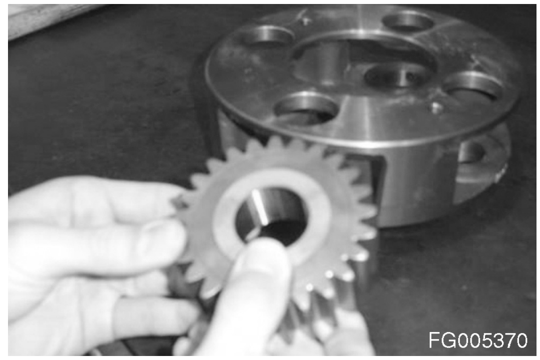



**Figure 22**

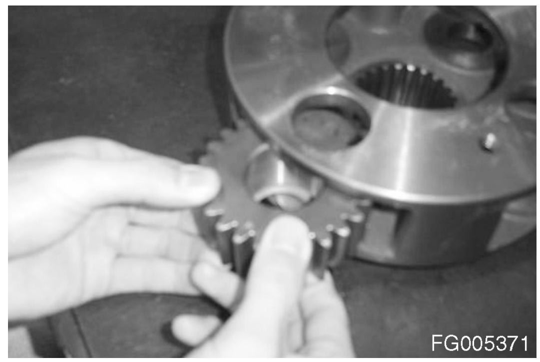



**Figure 23**


**Figure 24**

   B. Place the pin #2 assembly on the assembly die that the pinhole of the spring faces the same direction as the carrier shaft, and insert it by pressing with hands or gently knocking with hammer.

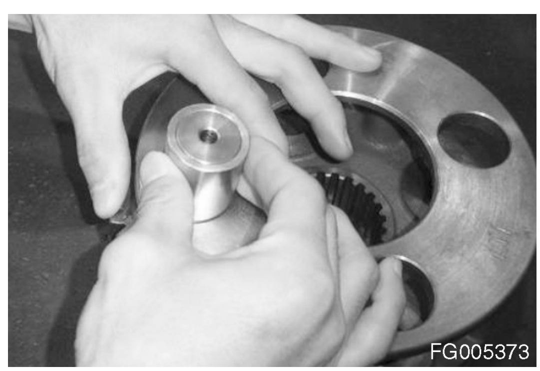



**Figure 25**

**Figure 26**

**Figure 27**

C. After inserting the pin assembly, set the carrier vertically as shown in the figure, insert the spring pin (ø6 x 25 mm) by gently knocking with hammer, and push it to the end with a jig.

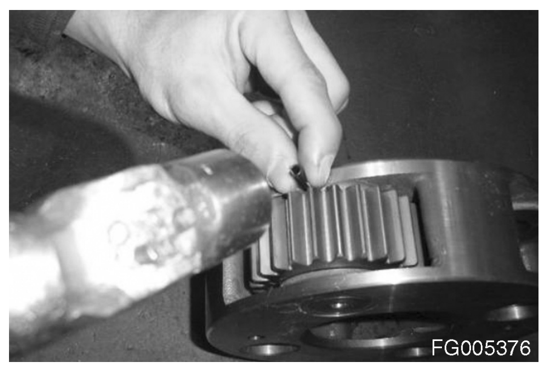


**Figure 28**

**Figure 29**

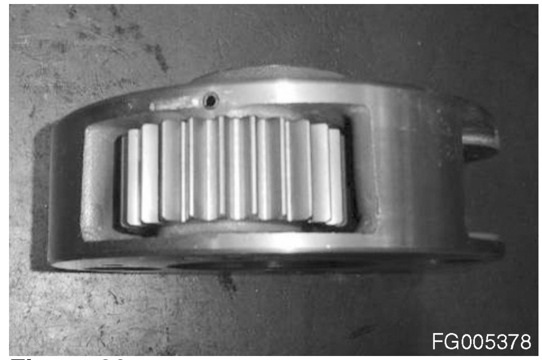



**Figure 30**

D. Use a punch to drain valve 2 or 3 places near hole where spring pin is inserted.

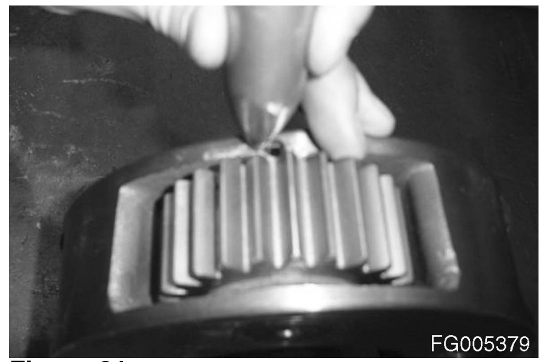



**Figure 31**

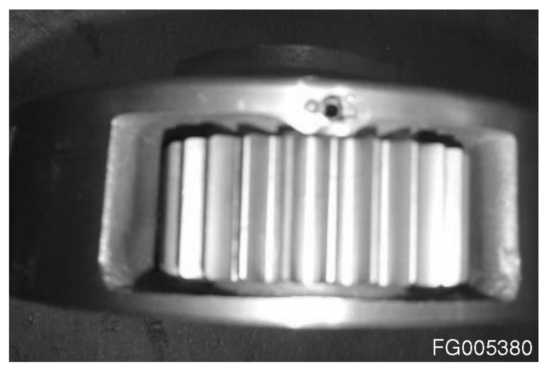



**Figure 32**

E. Assemble other 3 parts and check if the gear runs smooth.

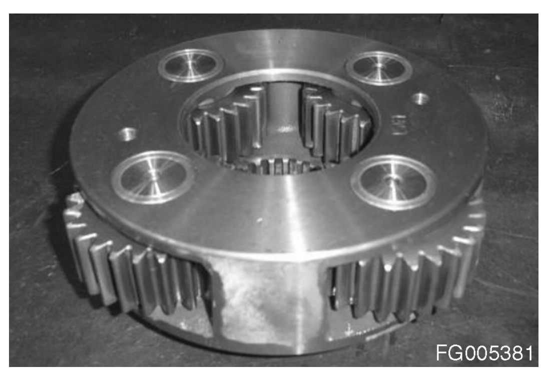



**Figure 33**

# ASSEMBLY OF THE MAIN

1. Washing of casing and other parts

   Wash casing and other parts with steam to remove remaining foreign substance after casting and machining.

   - Washing fluid: PK6540 (alkali)
   - Concentration : 3-5%
   - Temperature: 60 - 70°C

2. Assembly of shaft and bearing

   A. Fix the washed casing on the turnover machine and rotate the turnover machine that the press fitting side of the shaft looks upward.

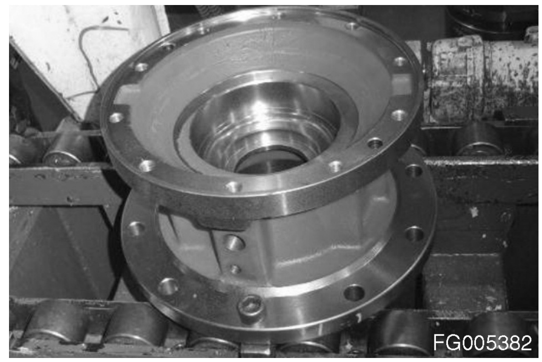



Figure 34


Figure 35

   B. Place the driveshaft assembly where bearing (#22314) is assembled on the case assembly, put a press jig on it, and use press to insert it.

## CAUTION!

**Make sure that bearing is not tilted for correct press fitting before using press.**


Figure 36

Figure 37

Figure 38

C. Remove the bearing press jig, align the support plate with the bolt tap of the case, and install 6 Loctite (#262) applied flat head bolts (M8 x 15 mm) and tighten them with torque wrench (torque :320 kg•cm).

Figure 40

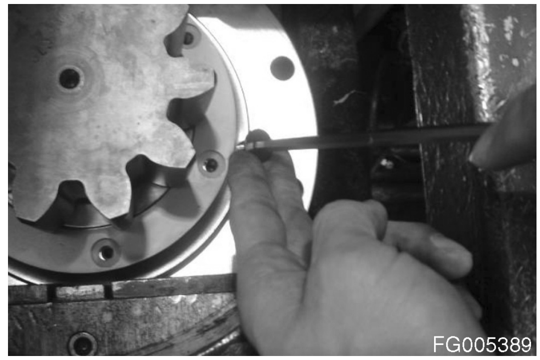


**Figure 41**

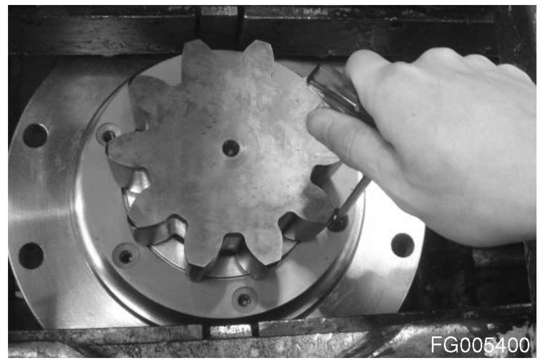


**Figure 42**

**Figure 43**

D. After installing the support plate, rotate the turnover machine that the case is situated as shown in the figure.

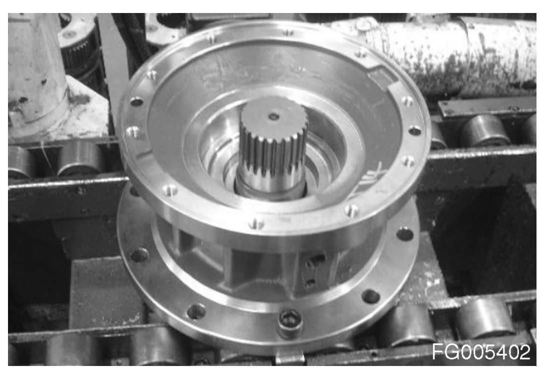


**Figure 44**

E. Apply grease to the lip of the oil seal (TC70 x 95 x 13, 2180-1254), insert it in the case, adjust it evenly, put jig on it, and use press to fit it. After press fitting, remove the jig and check its fitting state.

**Figure 45**

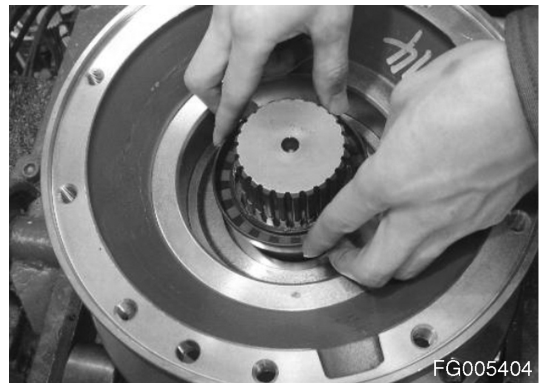


**Figure 46**

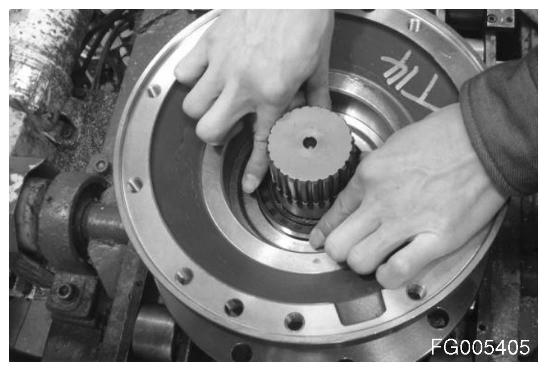


**Figure 47**

**Figure 48**

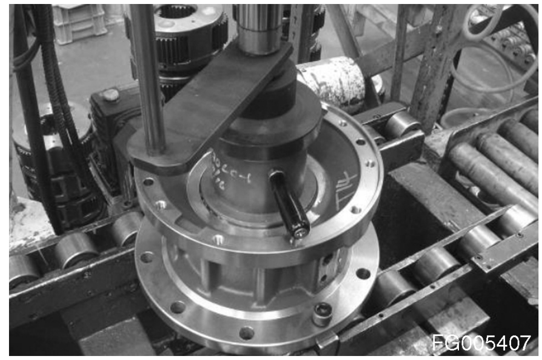


**Figure 49**

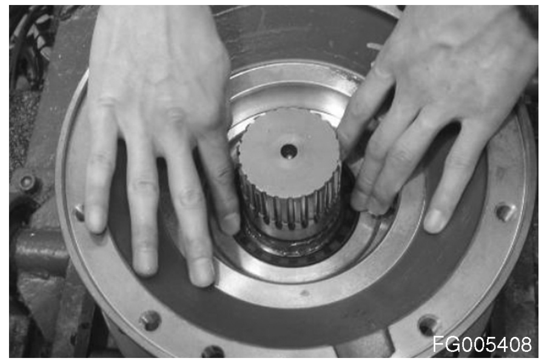


**Figure 50**

F. Place bearing (2109-1042, NJ313) evenly, put jig on it, and use press to fit it.

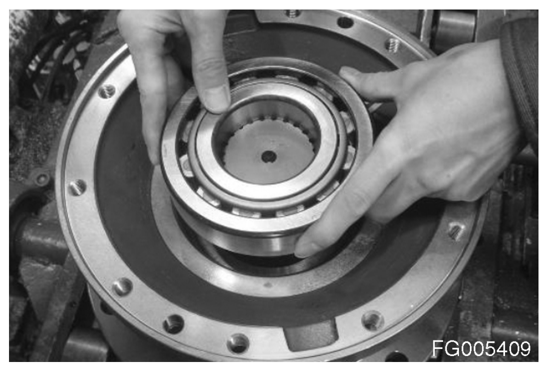


**Figure 51**

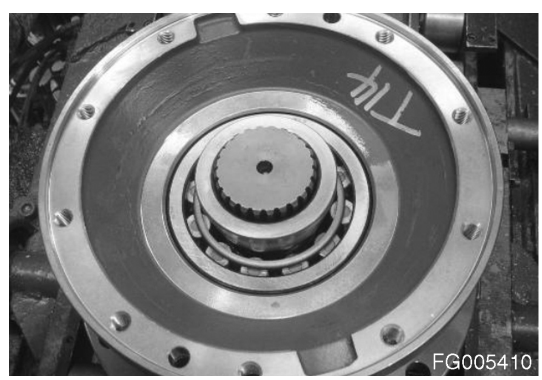


**Figure 52**


**Figure 53**


**Figure 54**

G. After the assembly of the bearing, fix retaining ring (ø65, shaft ring, C type, S6500650) on the shaft.

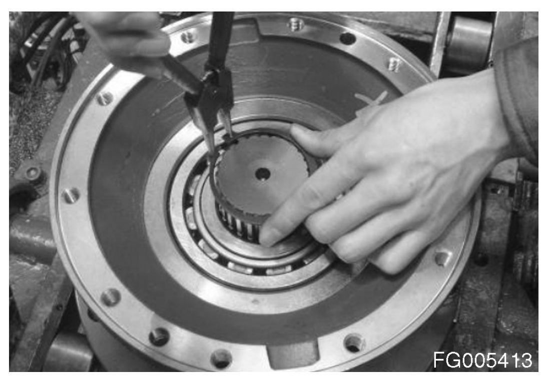
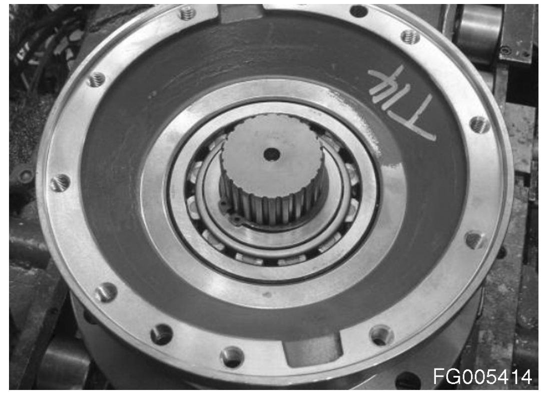



**Figure 55**




H. Install drain valve on PT3/8 tap of the side of the case.

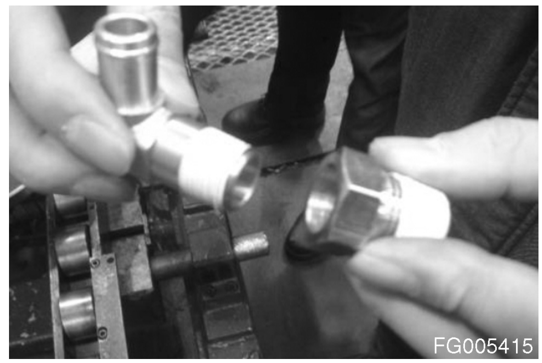


**Figure 57**

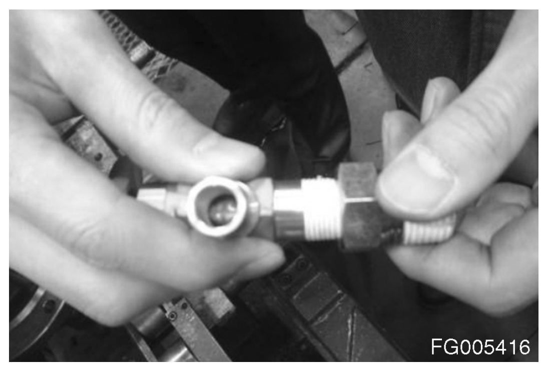


**Figure 58**

**Figure 59**

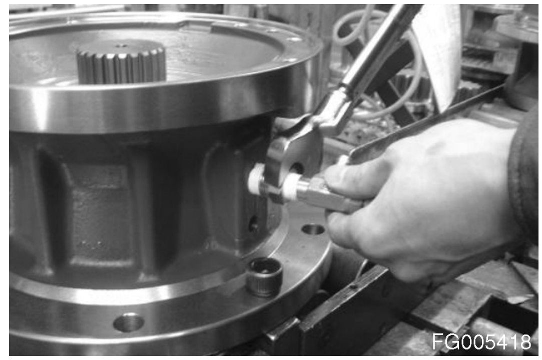



Figure 60

3. Reassembly of ring gear and carrier assembly

   A. Apply liquid gasket (#1104) to the ring gear assembly parts of the case, lift the ring gear, and insert it with its groove facing downward as shown in figures.

**CAUTION!**

**Do not rotate the ring gear after it seats itself.**

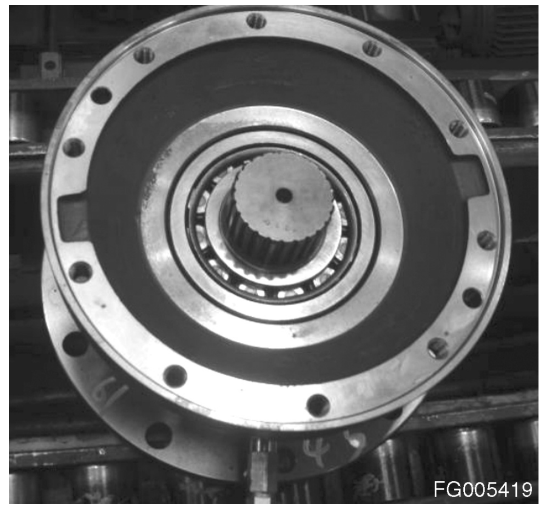



Figure 61

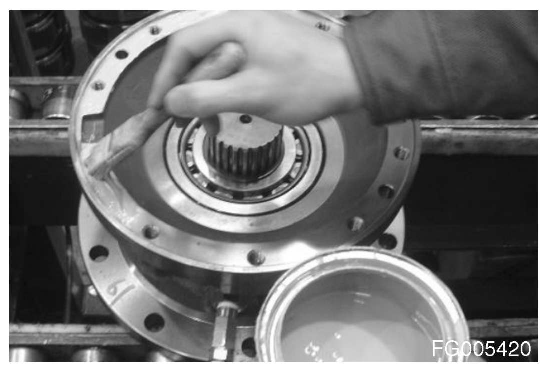



Figure 62

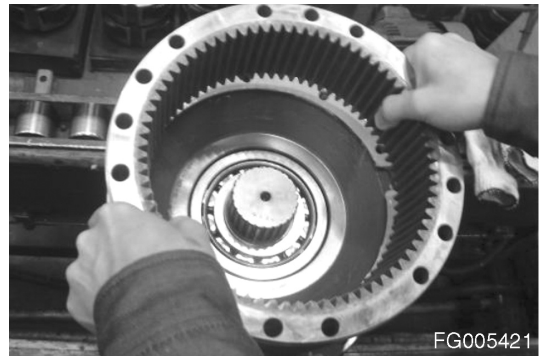


**Figure 63**

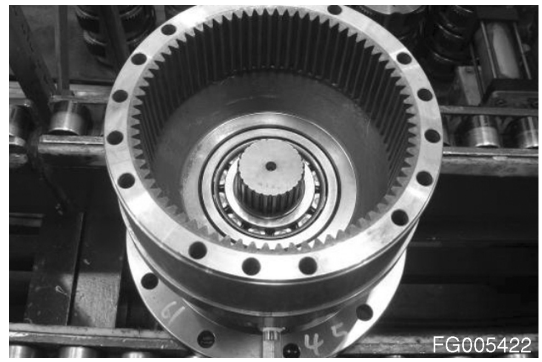


**Figure 64**

B. Put lock pins on the assigned 4 places, use jig and hammer to insert them, and install bolts symmetrically.

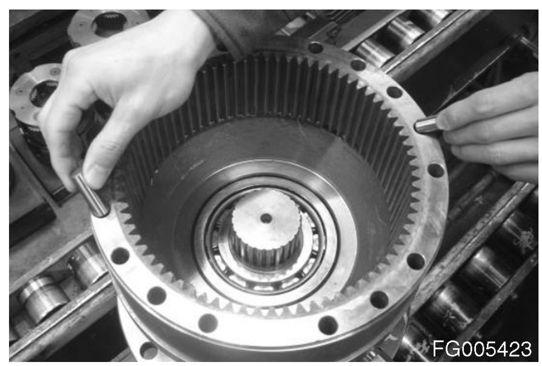


**Figure 65**

**Figure 66**

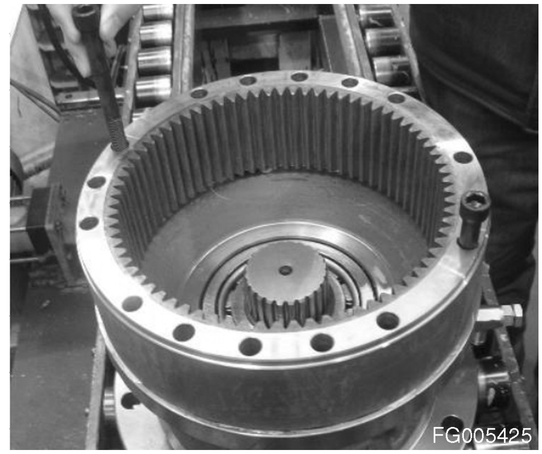


**Figure 67**

**Figure 68**

C. Put the prepared carrier #2 assembly on the ring gear and turn it slowly right and left to have it engaged with gear. Assemble the spool line part of the carrier to the shaft in the same way.

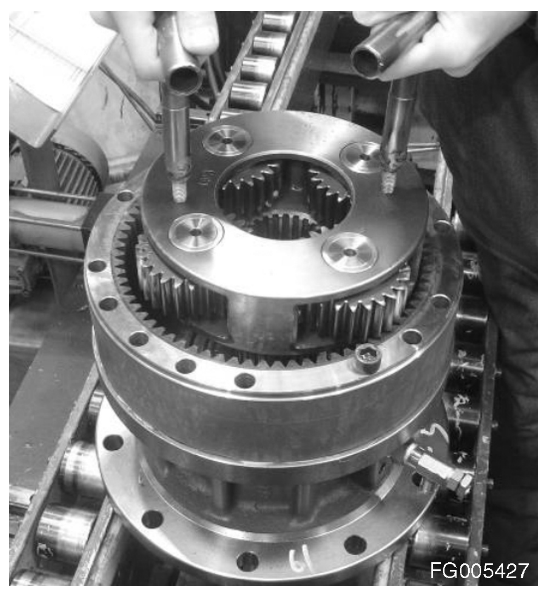


**Figure 69**

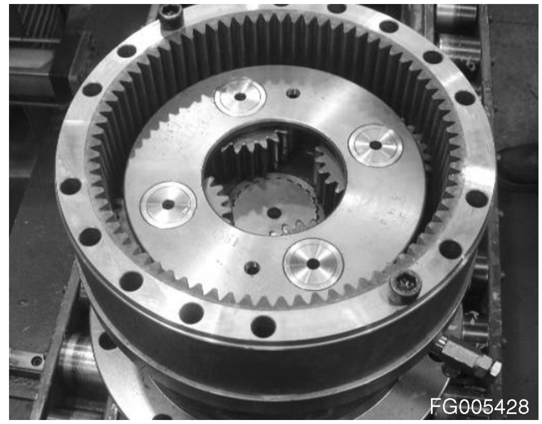



**Figure 70**

D. Install the sun gear #2 in the way as shown in figures.

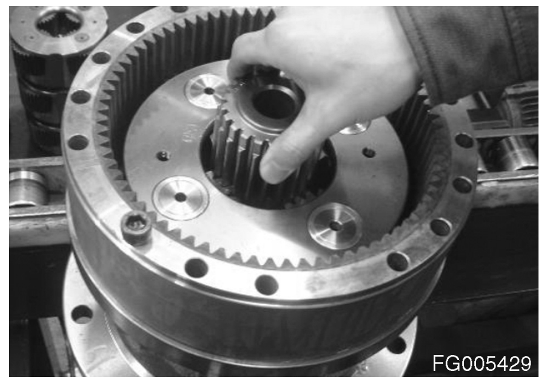



**Figure 71**

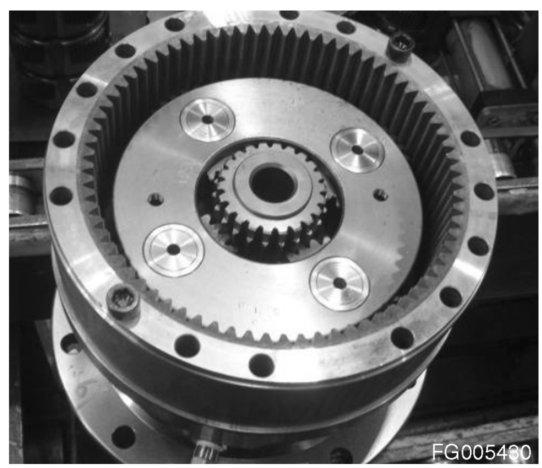



**Figure 72**

E. Assemble the carrier #1 assembly in the same way as for the carrier #2.

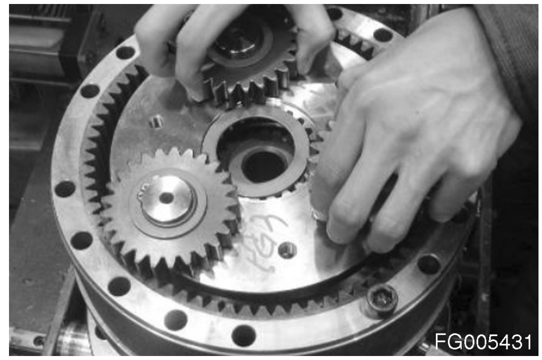


Figure 73

Figure 74

F. Assemble the sun gear #1.

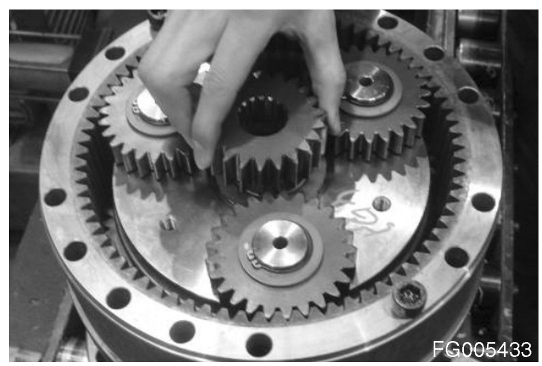


Figure 75

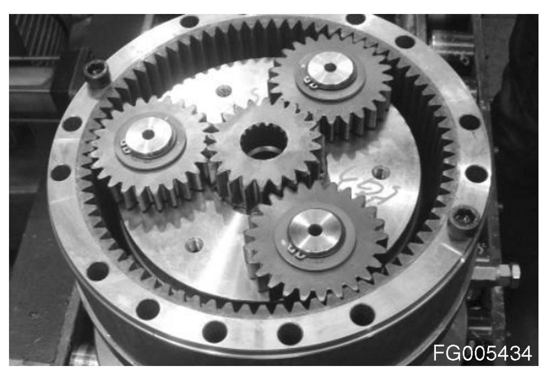


Figure 76

# TEST

1. Pneumatic pressure test

   A. After the reassembly of the carrier and the sun assemblies, loose bolts of the ring gear, place the pneumatic test jig, and tighten 4 bolts again. At this time, make sure that the pressure gauge is set to zero.


**Figure 77**

   B. Supply air through valve until the pressure gauge points 2 kg•cm$^2$ and check if there is any change in the pressure gauge for 3 minutes.

   C. Remove the jig after the pneumatic pressure test.

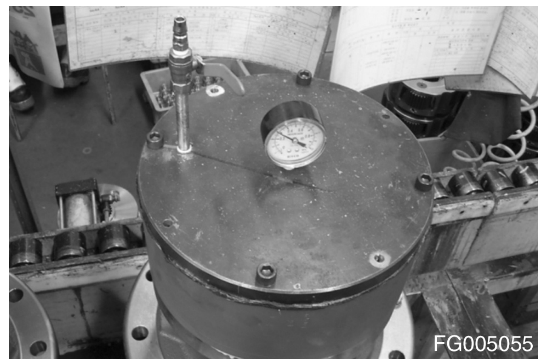



**Figure 78**

2. Noise and abnormal sound test

   A. After the pneumatic pressure test, fill the reduction gear with gear oil of 1 liter and connect it to test motor.

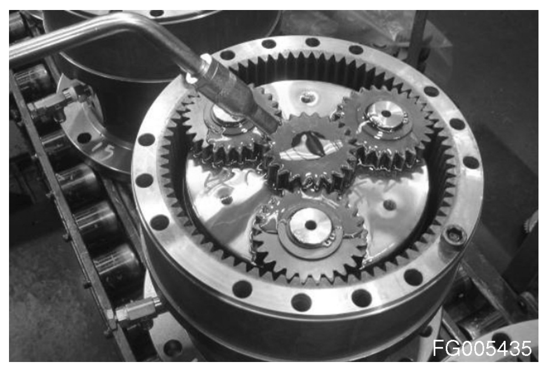



**Figure 79**

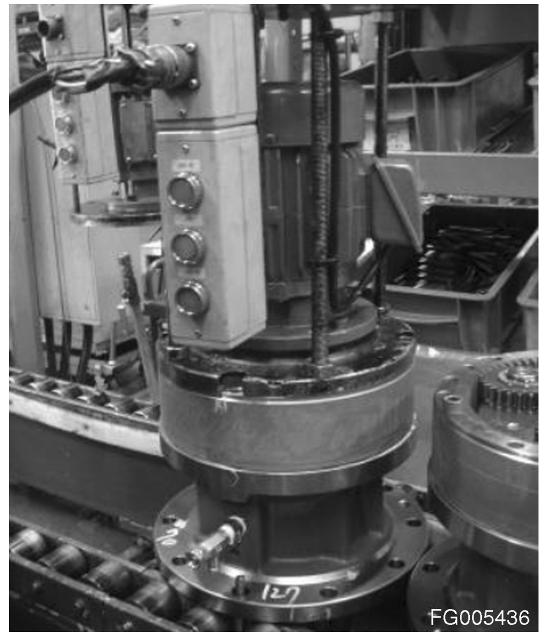



Figure 80

B. Start motor in the advance and reverse directions (1,875 ±90 rpm, no idle) and check any noise or abnormal sound carefully. (Standard noise is 90dB at 30cm away.)


Figure 81

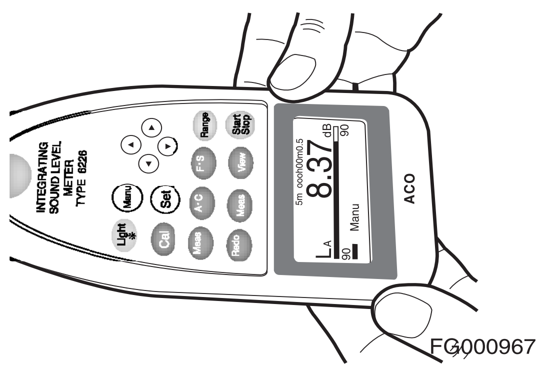



Figure 82

C. At the end of the test open plug of drain port to remove contaminated gear oil completely and wipe remaining oil on the case surface with cloth.


Figure 83

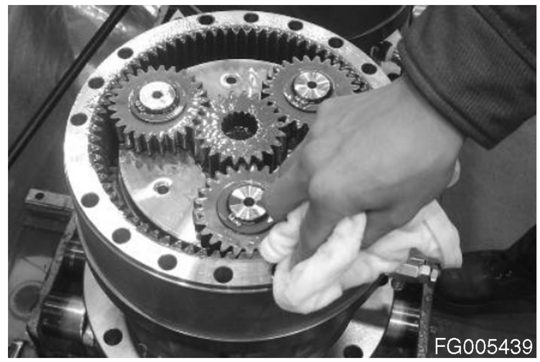



Figure 84

# REASSEMBLY OF MOTOR

1. Reassembly of motor

    A. Remove retaining bolts of ring gear, wipe the motor assembly cleanly with cloth, and apply fluid gasket (#1104).


**Figure 85**

    B. Use hoist to lift the motor, clean reassembled parts, and install retaining ring (ø30, shaft ring, and C type) in the shaft.


**Figure 86**

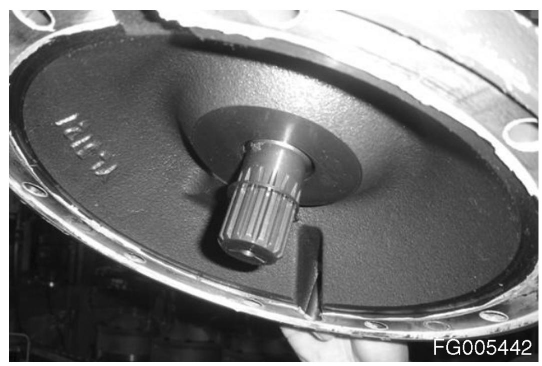



**Figure 87**

C. Place the motor carefully on the reduction gear while arranging its direction as shown in figures (with caution not to have flange of the motor contact the applied fluid gasket). Assemble it by slowly turning it right and left that the spool line of the shaft engages with the threads of the sun gear #1.

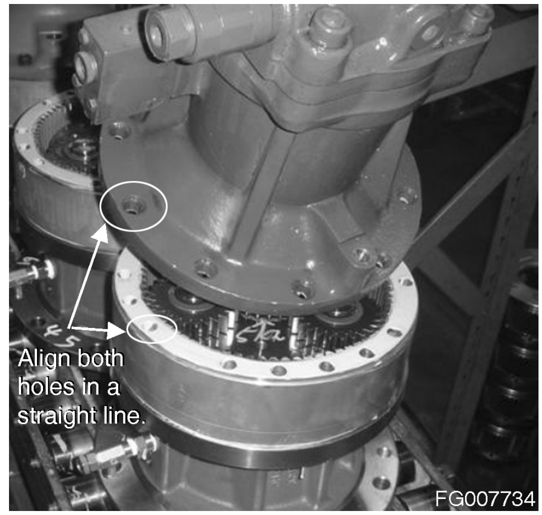



**Figure 88**

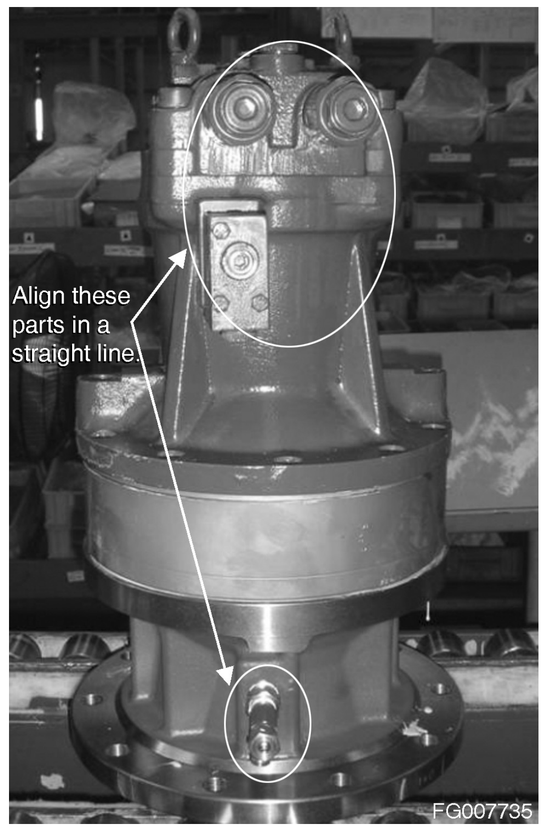



**Figure 89**

D. Insert 10 Loctite (#262) applied socket bolts (M12 x 110 mm) in holes and use impact wrench to tighten them (torque : 1,100 kg•cm). After tightening bolts, use torque wrench their tightening torque.

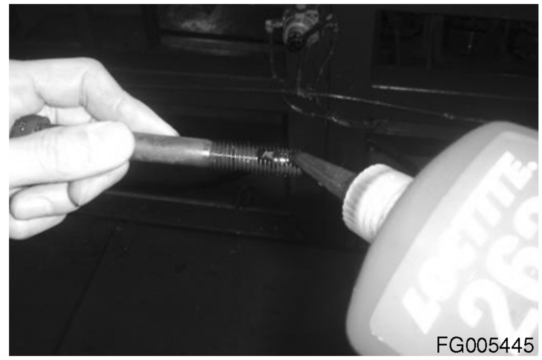



**Figure 90**

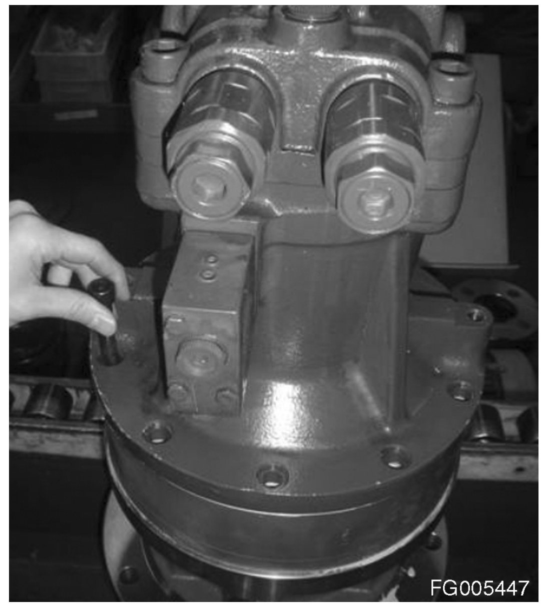



**Figure 91**

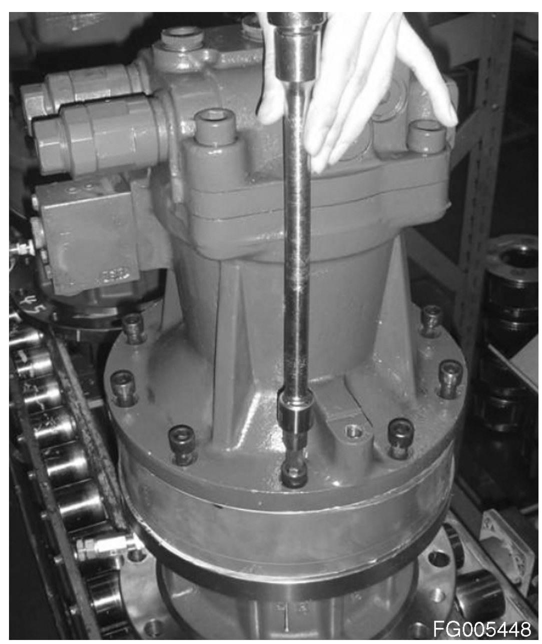



**Figure 92**

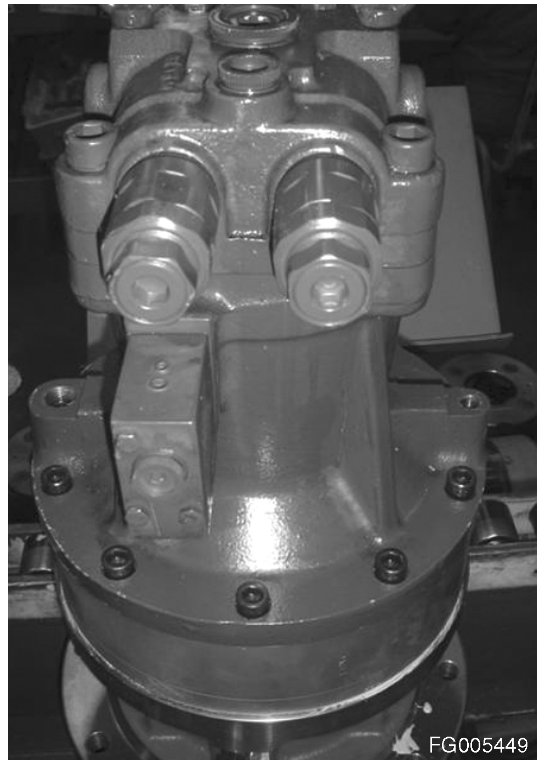



Figure 93

E. Seal the level gauge port of the motor with teflon tape and use pipe wrench to tighten the level gauge pipe.

**CAUTION!**

**Do not insert the level gauge before filling gear oil.**


Figure 94

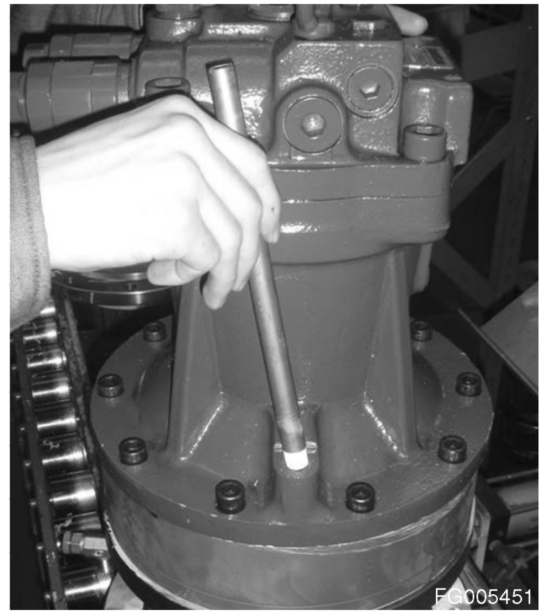



Figure 95

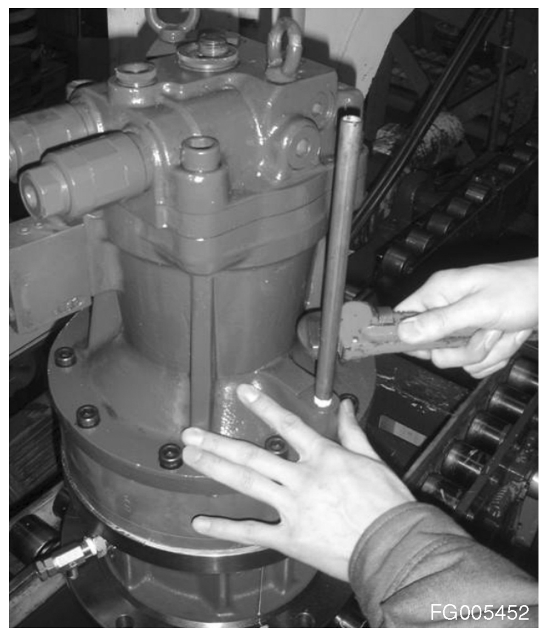



Figure 96

2. Filling of gear oil and grease

   A. Open oil nipple, fill gear oil (EP80W/90) of 2.4 liter, install PT1/2 plug again, insert the level gauge, and check oil level.

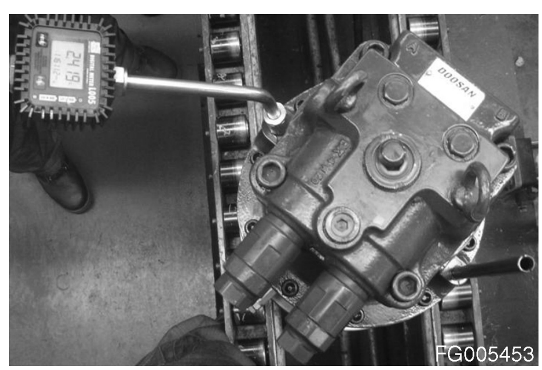



Figure 97

B. Fill grease through grease fitting until grease is observed through the opposite hole and install PT1/8 plugs at both sides.

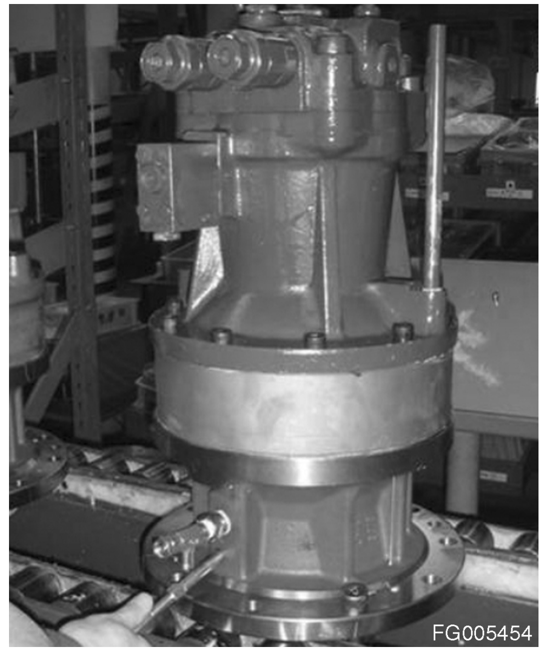



Figure 98

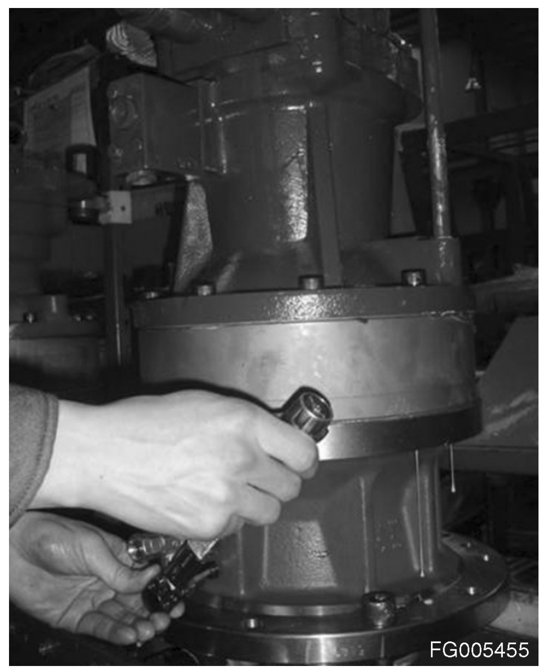



Figure 99

C. Wipe grease and foreign substance with cloth and check the motor reassembly position again.

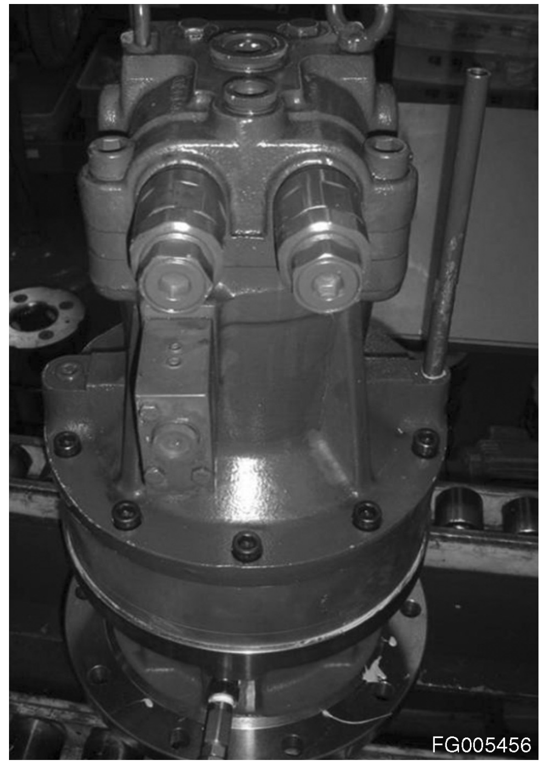


Figure 100

# Lower Structure and Chassis

# Track Assembly

Edition 1

## MEMO

# Table of Contents

## Track Assembly

## MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| | |

# GENERAL DESCRIPTION

The track assembly is composed of the following major components:

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

# TRACK TENSION

## WARNING!

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

**The track adjusting mechanism is under very high-pressure. NEVER release pressure too suddenly. The 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.

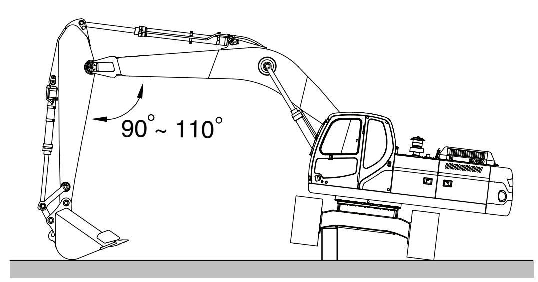



**Figure 1**

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 distance "B" on below table.

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

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

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

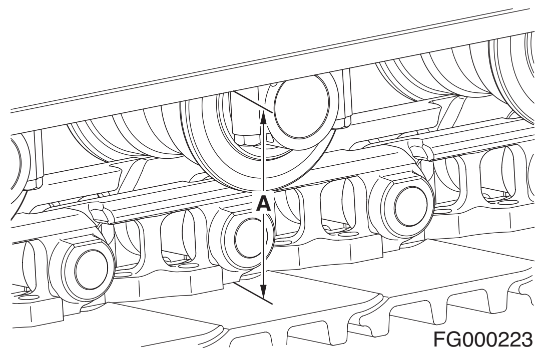



**Figure 2**

| Terrain Type | Distance "A" |
|---|---|
| | DX140LC |
| Normal "B" | 190 - 210 mm<br>(7.50 - 8.27 in) |
| Minimum "C" | 190 mm<br>(7.50 in) |
| Muddy "D" | 210 - 240 mm<br>(8.27 - 9.45 in) |
| Gravel, Rocky, Sand or Snow "E" | 240 mm<br>(9.45 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 tightened down position. Bleed off pressure slowly and keep your body away from the valve at all times.**

5. Track tension adjustments are made through the grease fitting (1, Figure 3) in the middle of each side frame. Adding grease increases the length of an adjustment cylinder (2). The longer the adjustment cylinder, the greater the pressure on the tension spring pushing the track idler wheel outward.
6. If there is not enough slack or clearance in the tracks and the adjustment is too tight, the idler wheel and adjusting cylinder can be retracted by bleeding off grease through hole in adjustment cylinder (2, Figure 3).

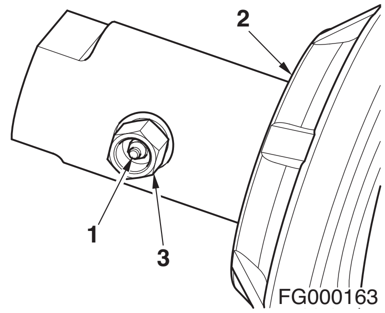



**Figure 3**

# 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.

## Track Shoe

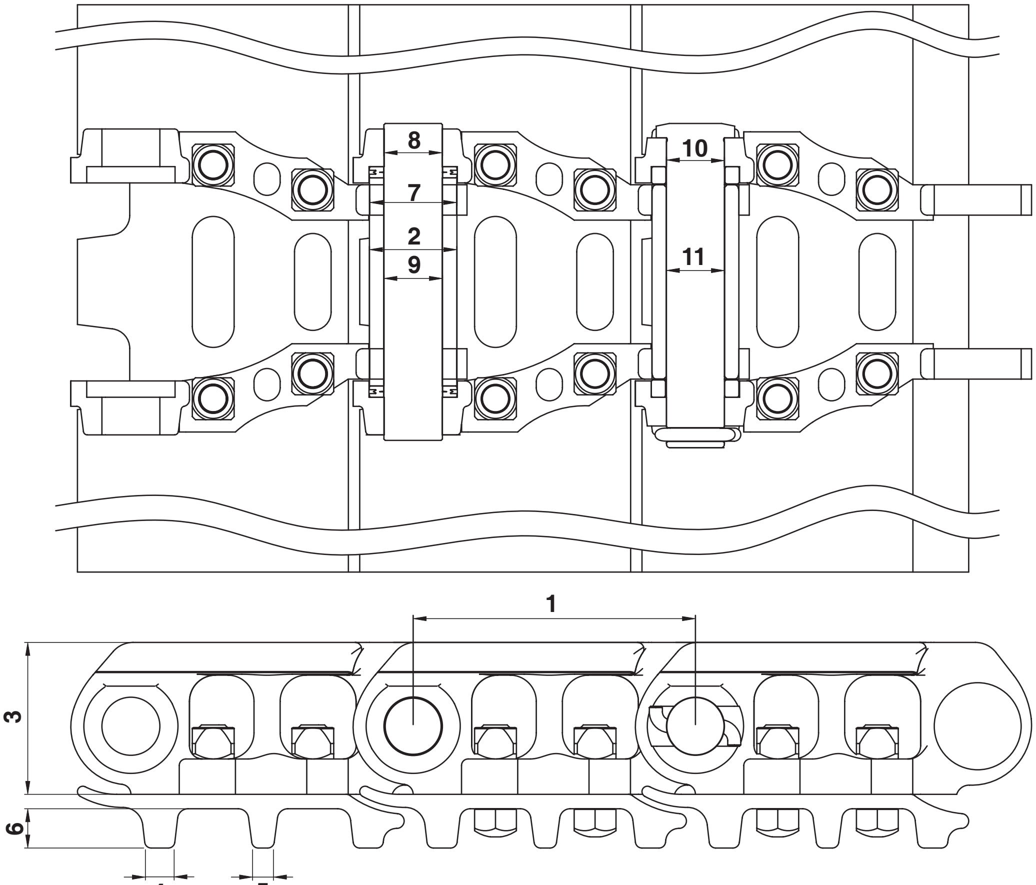



**Figure 4**

<table>
<tr><th>No.</th><th>Check Item</th><th colspan="2">Standard Dimension</th><th colspan="2">Recommended Limit for Maintenance</th><th>Limit for Use (Repair - P or Replace - R)</th></tr>
<tr><td>1</td><td>Link Pitch</td><td colspan="2">171.5 mm<br>(6.752")</td><td colspan="2"></td><td></td></tr>
<tr><td>2</td><td>Bushing Outside Diameter</td><td colspan="2">53.7 mm<br>(2.114")</td><td colspan="2">50 mm<br>(1.969")</td><td>47 mm [R]<br>(1.850")</td></tr>
<tr><td>3</td><td>Link Height</td><td colspan="2">94.5 mm<br>(3.720")</td><td colspan="2">89 mm<br>(3.504")</td><td>85 mm [P]<br>(3.346")</td></tr>
<tr><td>4</td><td>Length at Tip</td><td colspan="2">18 mm<br>(0.709")</td><td colspan="2"></td><td></td></tr>
<tr><td>5</td><td>Length at Tip</td><td colspan="2">11 mm<br>(0.433")</td><td colspan="2"></td><td></td></tr>
<tr><td>6</td><td>Height</td><td colspan="2">25 mm<br>(0.984")</td><td colspan="2">20 mm<br>(0.787")</td><td>18 mm<br>(0.709")</td></tr>
<tr><td rowspan="3">7</td><td rowspan="3">Interference between bushing and link</td><td rowspan="2">Standard Dimension</td><td colspan="2">Tolerance</td><td rowspan="2">Standard Interference</td><td rowspan="2">Repair Limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>53.7 mm<br>(2.114")</td><td>+0.055<br>+0.045</td><td>-0.126<br>-0.7</td><td>0.171 - 0.755</td><td></td></tr>
<tr><td rowspan="3">8</td><td rowspan="3">Interference between regular pin and link</td><td rowspan="2">Standard Dimension</td><td colspan="2">Tolerance</td><td rowspan="2">Standard Interference</td><td rowspan="2">Repair Limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>36.6 mm<br>(1.441")</td><td>+0.05<br>+0</td><td>-0.2<br>-0.25</td><td>0.2 - 0.3</td><td></td></tr>
<tr><td rowspan="3">9</td><td rowspan="3">Clearance between regular pin and bushing</td><td rowspan="2">Standard Dimension</td><td colspan="2">Tolerance</td><td rowspan="2">Standard Clearance</td><td rowspan="2">Repair Limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>36.6 mm<br>(1.441")</td><td>+0.05<br>+0</td><td>+0.75<br>+0.35</td><td>0.3 - 0.75</td><td></td></tr>
<tr><td rowspan="3">10</td><td rowspan="3">Interference between master pin and bushing</td><td rowspan="2">Standard Dimension</td><td colspan="2">Tolerance</td><td rowspan="2">Standard Interference</td><td rowspan="2">Repair Limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>36.4 mm<br>(1.433")</td><td>-0.005<br>-0.035</td><td>+0<br>-0.05</td><td>0.0 - 0.045</td><td></td></tr>
<tr><td rowspan="3">11</td><td rowspan="3">Clearance between master pin and bushing</td><td rowspan="2">Standard Dimension</td><td colspan="2">Tolerance</td><td rowspan="2">Standard Clearance</td><td rowspan="2">Repair Limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>36.4 mm<br>(1.433")</td><td>-0.005<br>-0.035</td><td>+0.95<br>+0.55</td><td>0.555 - 0.985</td><td></td></tr>
</table>

# Lower Roller

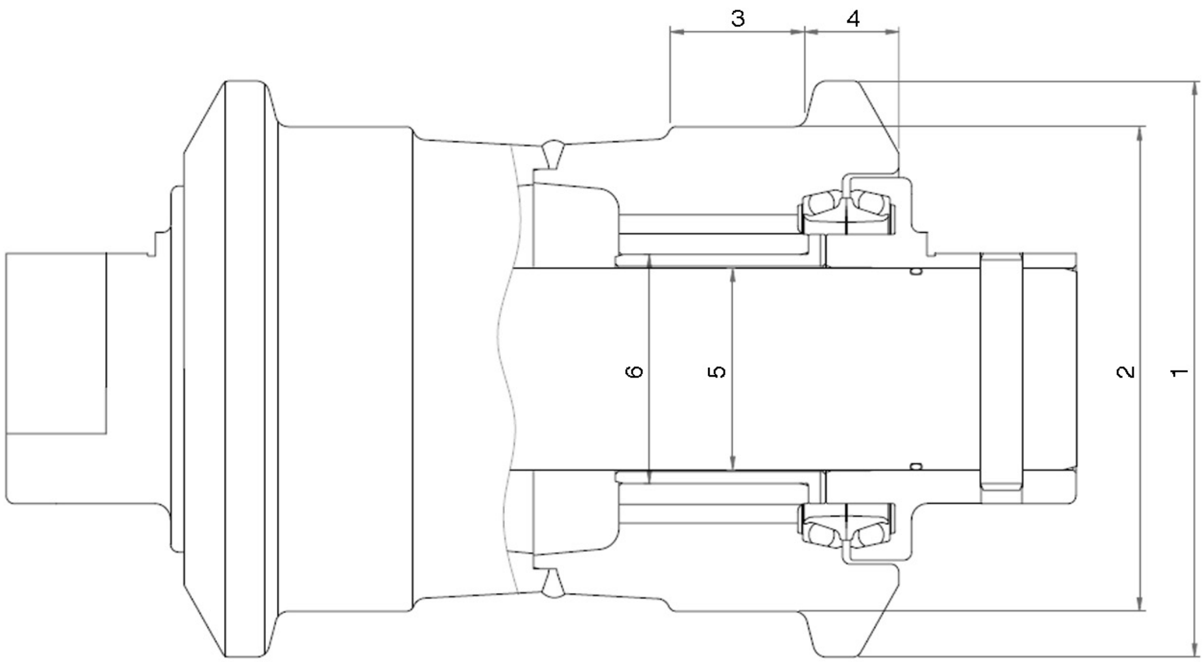



**Figure 5**

<table>
<tr><th>No.</th><th>Check Item</th><th colspan="2">Standard Dimension</th><th colspan="2">Recommended Limit for Maintenance</th><th>Limit for Use (Repair - P or Replace - R)</th></tr>
<tr><td>1</td><td>Outside Diameter of Flange</td><td colspan="2">170 mm<br>(6.693")</td><td colspan="2"></td><td></td></tr>
<tr><td>2</td><td>Outside Diameter of Tread</td><td colspan="2">140 mm<br>(5.512")</td><td colspan="2">128 mm<br>(5.039")</td><td>125 mm [P]<br>(4.921")</td></tr>
<tr><td>3</td><td>Width of Tread</td><td colspan="2">36.5 mm<br>(1.437")</td><td colspan="2">42 mm<br>(1.654")</td><td>44 mm [P]<br>(1.732")</td></tr>
<tr><td>4</td><td>Width of Flange</td><td colspan="2">22.5 mm<br>(0.886")</td><td colspan="2"></td><td></td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Clearance between shaft and bushing</td><td rowspan="2">Standard Dimension</td><td colspan="2">Tolerance</td><td rowspan="2">Standard Interference</td><td rowspan="2">Repair Limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>50 mm<br>(1.969")</td><td>-0.05<br>-0.08</td><td>+0.24<br>+0.20</td><td>+0.32<br>+0.25</td><td></td></tr>
<tr><td rowspan="3">6</td><td rowspan="3">Interference between roller and bushing</td><td rowspan="2">Standard Dimension</td><td colspan="2">Tolerance</td><td rowspan="2">Standard Interference</td><td rowspan="2">Repair Limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>57 mm<br>(2.244")</td><td>+0.103<br>+0.078</td><td>+0.03<br>-0.02</td><td>+0.048<br>+0.123</td><td></td></tr>
</table>

## Upper Roller

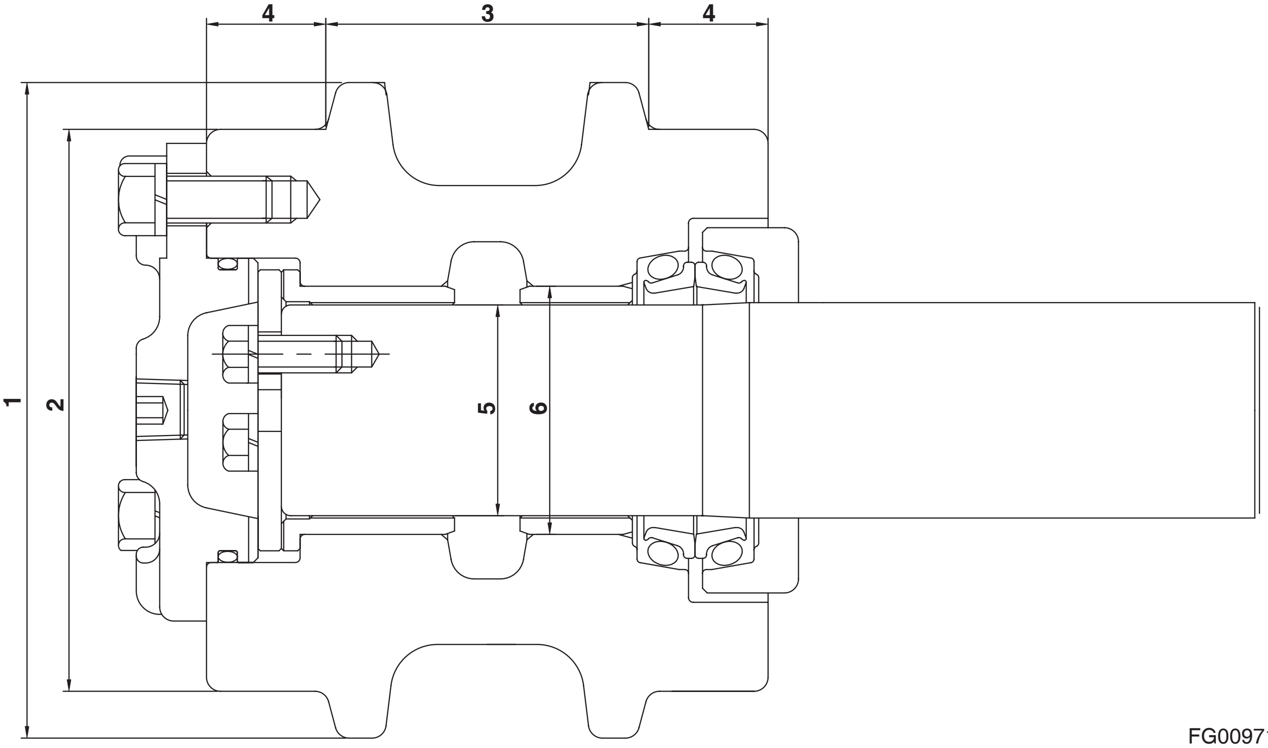
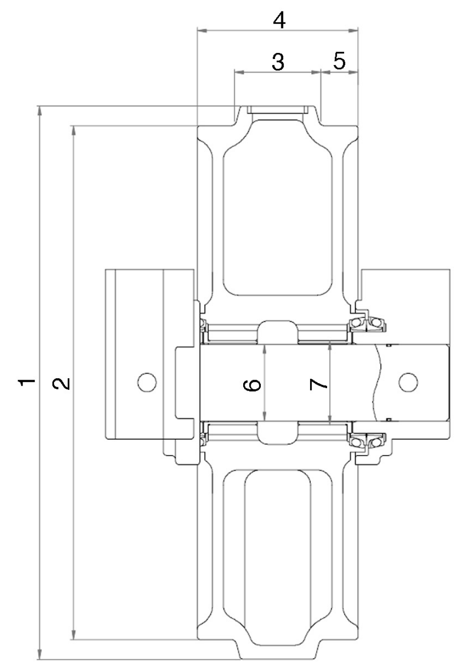



**Figure 6**

<table>
<tr><th>No.</th><th>Check Item</th><th colspan="2">Standard Dimension</th><th colspan="3">Recommended Limit for Maintenance</th><th>Limit for Use (Repair - P or Replace - R)</th></tr>
<tr><td>1</td><td>Outside Diameter of flange</td><td colspan="2">140 mm<br>(5.512")</td><td colspan="3"></td><td></td></tr>
<tr><td>2</td><td>Outside Diameter of Tread</td><td colspan="2">120 mm<br>(4.724")</td><td colspan="3">112 mm<br>(4.409")</td><td></td></tr>
<tr><td>3</td><td>Width of Tread</td><td colspan="2">69 mm<br>(2.717")</td><td colspan="3"></td><td></td></tr>
<tr><td>4</td><td>Width of Tread</td><td colspan="2">25.5 mm<br>(1.004")</td><td colspan="3">29 mm<br>(1.142")</td><td></td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Clearance between shaft and bushing</td><td rowspan="2">Standard Dimension</td><td colspan="2">Tolerance</td><td rowspan="2">Standard Interference</td><td rowspan="2" colspan="2">Repair Limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>45 mm<br>(1.772")</td><td>-0.05<br>-0.08</td><td>+0.25<br>+0.2</td><td>+0.33<br>+0.25</td><td colspan="2"></td></tr>
<tr><td rowspan="3">6</td><td rowspan="3">Interference between roller and bushing</td><td rowspan="2">Standard Dimension</td><td colspan="2">Tolerance</td><td rowspan="2">Standard Interference</td><td rowspan="2" colspan="2">Repair Limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>53 mm<br>(2.087")</td><td>+0.10<br>+0.05</td><td>+0.03<br>-0.02</td><td>+0.12<br>+0.02</td><td colspan="2"></td></tr>
</table>

# Front Idler




FG007855

**Figure 7**

<table>
<tr><th>No.</th><th>Check Item</th><th colspan="2">Standard Dimension</th><th colspan="2">Recommended Limit for Maintenance</th><th>Limit for Use (Repair - P or Replace - R)</th></tr>
<tr><td>1</td><td>Outside Diameter of flange</td><td colspan="2">489 mm<br>(19.252")</td><td colspan="2"></td><td></td></tr>
<tr><td>2</td><td>Outside Diameter of Tread</td><td colspan="2">454 mm<br>(17.874")</td><td colspan="2">443 mm<br>(17.441")</td><td>440 mm [P]<br>(17.323")</td></tr>
<tr><td>3</td><td>Width of Protrusion</td><td colspan="2">68 mm<br>(2.677")</td><td colspan="2"></td><td></td></tr>
<tr><td>4</td><td>Total Width</td><td colspan="2">135 mm<br>(5.315")</td><td colspan="2"></td><td></td></tr>
<tr><td>5</td><td>Width of Tread</td><td colspan="2">33.5 mm<br>(1.319")</td><td colspan="2">39 mm<br>(1.535")</td><td>41 mm<br>(1.614")</td></tr>
<tr><td rowspan="3">6</td><td rowspan="3">Clearance between shaft and bushing</td><td rowspan="2">Standard Dimension</td><td colspan="2">Tolerance</td><td rowspan="2">Standard Interference</td><td rowspan="2">Repair Limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>75 mm<br>(2.953")</td><td>0<br>-0.03</td><td>+0.40<br>+0.35</td><td>+0.43<br>+0.35</td><td></td></tr>
<tr><td rowspan="3">7</td><td rowspan="3">Interference between roller and bushing</td><td rowspan="2">Standard Dimension</td><td colspan="2">Tolerance</td><td rowspan="2">Standard Interference</td><td rowspan="2">Repair Limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>85 mm<br>(3.346")</td><td>+0.17<br>+0.13</td><td>+0.035<br>0.0</td><td>+0.17<br>+0.095</td><td></td></tr>
</table>

# TRACK SHOES AND LINKS

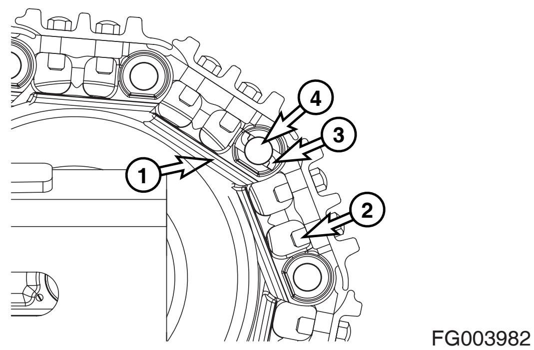
## Track Removal

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

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

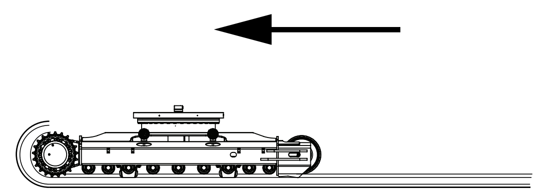
5. Straighten lock pin (3, Figure 8) and remove it from master pin (4). Discard lock pin.
6. Remove master pin from master links.
7. Move unit backward until entire track is laying on ground.

   **NOTE:** *Do not drive unit off track.*




FG003982

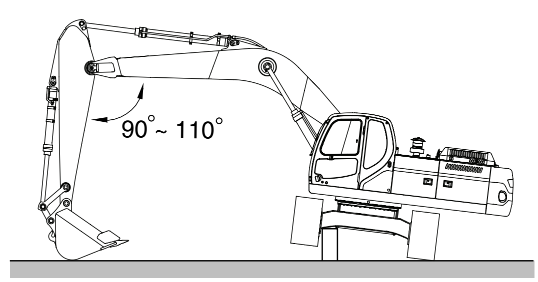
**Figure 8**



FG003911

**Figure 9**

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

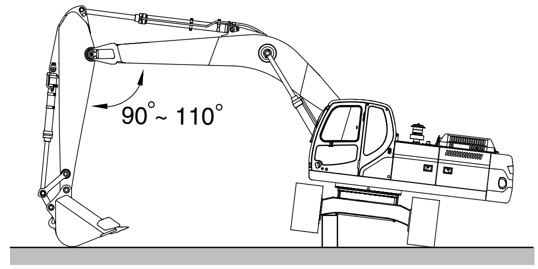



FG000345

**Figure 10**

# Track Installation

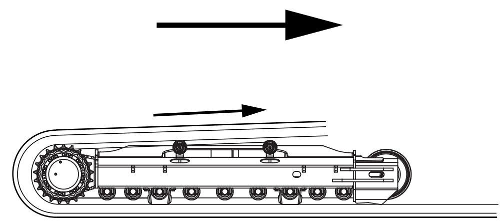
1. Lay rebuilt or new track into position under track frame. End of track should be positioned under drive sprocket.
2. With upper structure at 90° to track frame. Use bucket and boom to raise track frame off blocking.
3. With blocking removed, lower track frame onto track. Make sure all rollers are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




FG000345

**Figure 11**

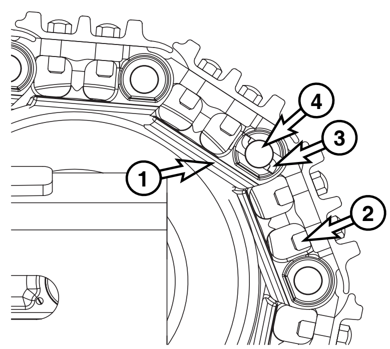
4. Move unit forward while feeding track up over drive sprocket. Continue to pull track back until it engages front idle roller.



FG003912

**Figure 12**

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




FG003982

**Figure 13**

# FRONT IDLER

## Parts List

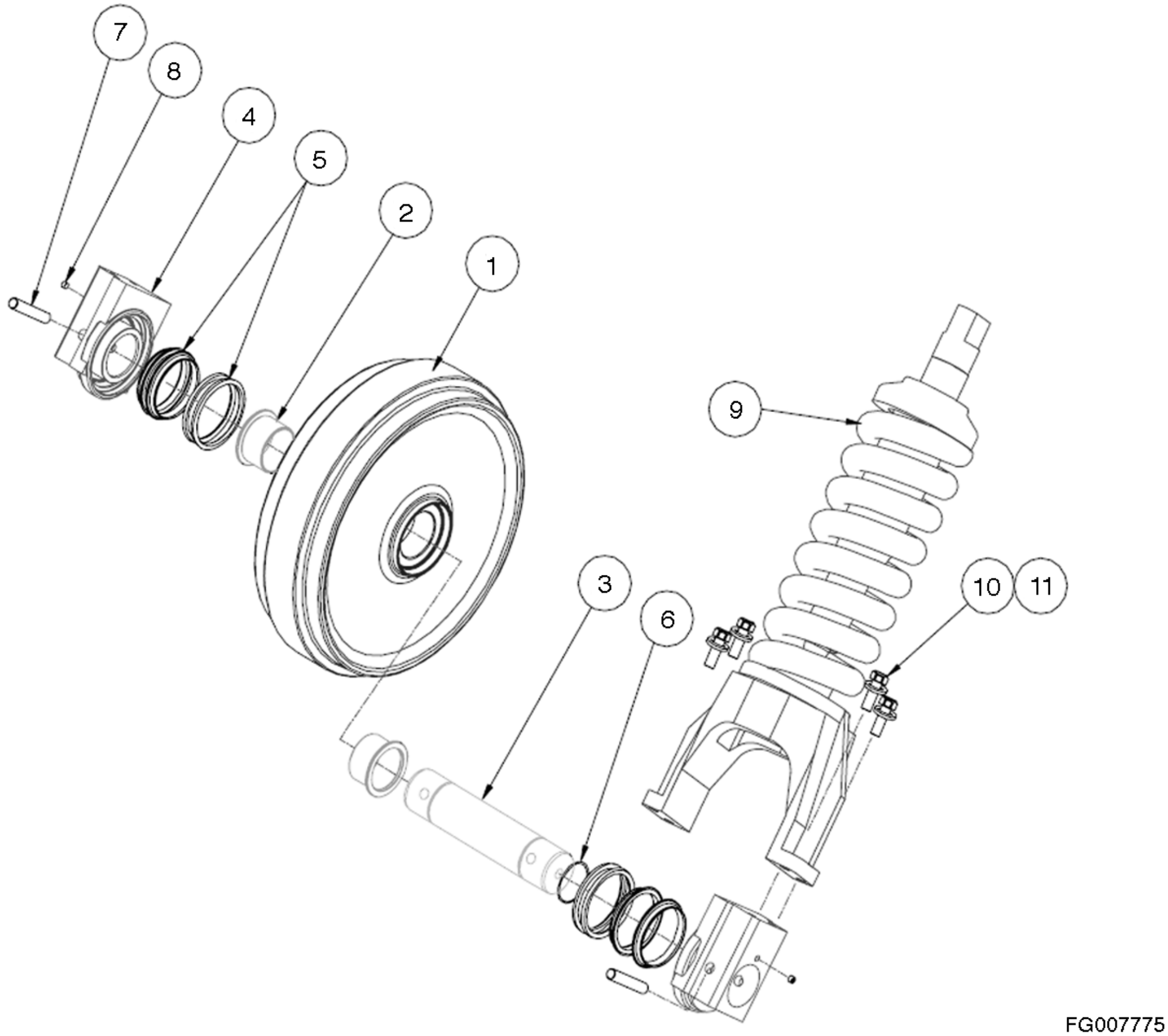



**Figure 14**

| Reference Number | Description |
|---|---|
| 1 | Front |
| 2 | Bushing |
| 3 | Shaft |
| 4 | Bearing |
| 5 | Floating Seal |
| 6 | O-ring |

| Reference Number | Description |
|---|---|
| 7 | Pin |
| 8 | Plug |
| 9 | Track Spring Assembly |
| 10 | Bolt |
| 11 | Washer |

# Disassembly of Front Idler

1. Detach T/Spring assembly from Idler assembly.

   Remove 4-M16 bolts and washers (10, 11, Figure 15).

2. Remove the plug (8, Figure 14) from the bearing (4, Figure 14) (using 6mm "L" wrench).

   **NOTE:** *About 330cc of oil will be discharged. Prepare an oil cloth or pan to prevent spillage on the ground.*

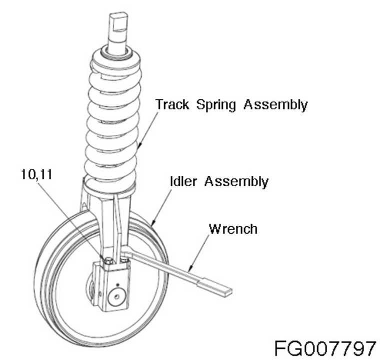



**Figure 15**

3. Using a hammer and pin-removing tool, remove the pin(7, Figure 16) on one side.
4. Remove the bearing (4, Figure 14) on the side from which the pin (7, Figure 16) has been removed.
5. From the removed bearing (4, Figure 14) and front (1, Figure 14), separate the floating seal (5, Figure 14).
6. From the shaft (3, Figure 14), separate the O-ring (6, Figure 14).

   **NOTE:** *If the O-ring is not removed, the bearing sub-assembly on the opposite side will be difficult to separate*

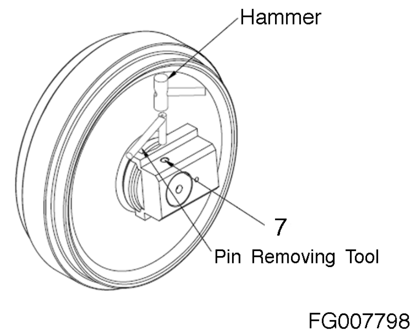



**Figure 16**

7. Separate the bearing sub-assembly on the opposite side of the front (1, Figure 14).
8. Separate the floating seal (5, Figure 14) from the separated bearing sub-assembly and front (1, Figure 14).
9. Separate the pin (7, Figure 14) from the separated bearing sub-assembly.
10. Separate the shaft (3, Figure 14) from the bearing (4, Figure 14).
11. Separate the O-ring (6, Figure 14) from the shaft (3, Figure 14).

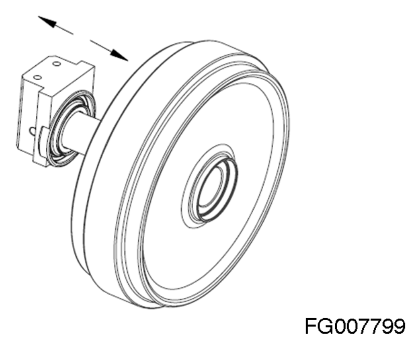



**Figure 17**

12. Separate the bushing (2, Figure 18) from the front (1, Figure 18).

    **NOTE:** *Insert jig 2, and press jig 1 to separate.*

    *Use the hydraulic press for pressing the jig. Be careful of sputtering.*

13. Turn the front upside down. Separate the bushing (2, Figure 18) in the same manner as described above (Figure 18).

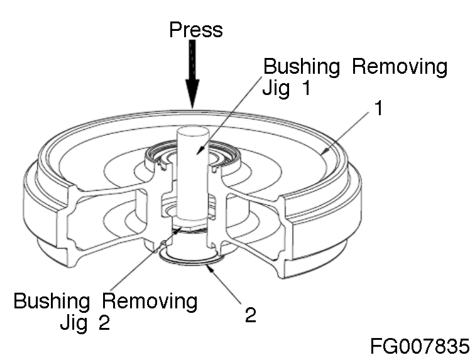



**Figure 18**

## Reassembly of Front Idler

1. Take care that foreign matters do not enter the front part. Wash all parts for assembly.
2. Using the hydraulic press, assemble two bushings (2, Figure 19) at front (1, Figure 19).
   Use the hydraulic press. Take care to prevent accidents.

   **NOTE:** *Apply a volatile lubricant on the bushing surface before insertion.*
   *There must be no dent marks on the flange.*

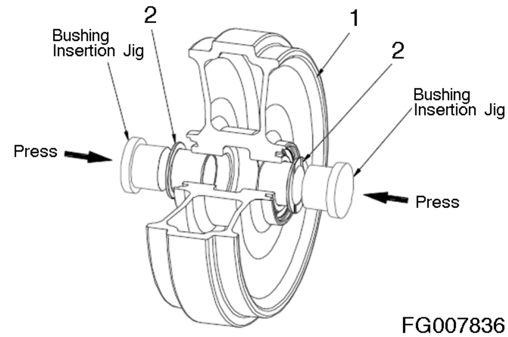



**Figure 19**

3. Assemble two bearings (4, Figure 20) with the floating seal (5, Figure 20).

   In order not to twist the O-ring, use assembling jig to assemble the floating seal, as shown in Figure 20. Check that the floating seal is parallel. Clean up its lapped surface.

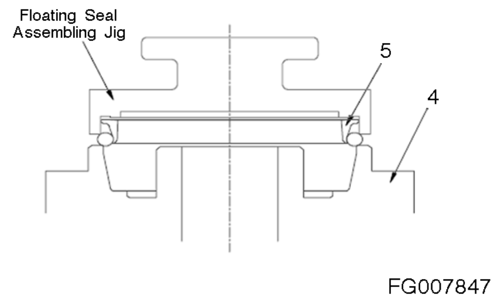



**Figure 20**

4. On one side of the shaft (3, Figure 21), assemble the O-ring (6, Figure 21) applied with thin oil (Figure 21).
5. Assemble the shaft (3, Figure 21) with the bearing to which floating seal has been attached.
6. Insert pin (7, Figure 21)into the bearing on which the shaft has been assembled.

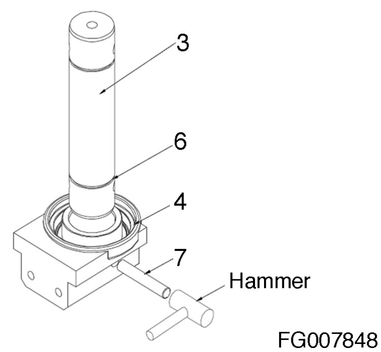



**Figure 21**

7. Using the assembling jig, assemble floating seal (5, Figure 14) at the front on which bushing has been assembled.
8. Apply oil to the lapped surface of the floating seal (5, Figure 14) which was assembled with the bearing.

   **NOTE:** *Use engine oil SAE #30/CD or higher grade.*

9. Assemble bearing sub-assembly with the front to which the bushing and floating seal have been assembled (Figure 22).

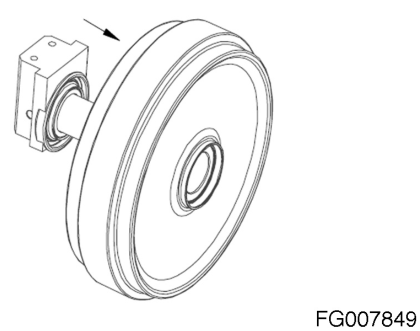



**Figure 22**

10. Assemble shaft (3, Figure 14) with O-ring (6, Figure 14). Apply oil to O-ring to prevent damage when assembling bearing.
11. Apply oil to the lapped surface of the floating seal which was assembled with the bearing.
12. Assemble the bearing (4, Figure 23) on which the floating seal has been assembled.
13. Insert pin (7, Figure 23).
14. Rotate front or bearing by 3 rounds to left and right.
15. Assemble plug (8, Figure 23) to the bearing (4, Figure 23) on one side.

    **NOTE:** *Use 6mm L wrench to assemble plug, at torque 200kgf•cm*

16. Inject oil through the plug hole.

    **NOTE:** *Oil quantity: 320cc (10.8 oz) ± 20cc*

17. Assemble bearing (4, Figure 23) with plug (8, Figure 23).

    **NOTE:** *Use 6mm L wrench to assemble plug, at torque of 200kgf-cm*

18. Assemble Idler Assembly with Track Spring assembly (Figure 24).

    Assemble bolt and washer (10 and 11, Figure 24).

    **NOTE:** *Apply Loctite #243 to the bolt and washer (10 and 11, Figure 24).*
    *Torque: 2700kgf-cm*

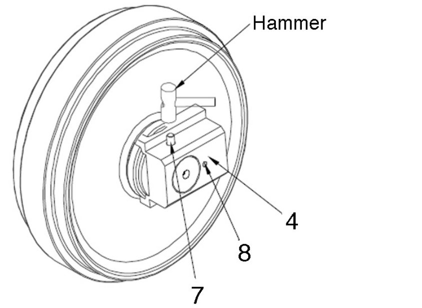



**Figure 23**

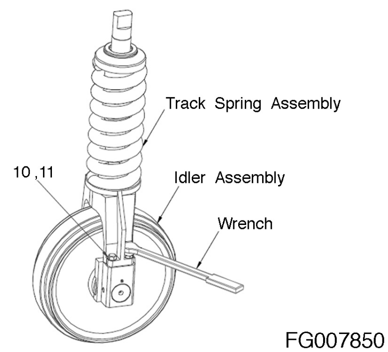



**Figure 24**

# LOWER ROLLER

## Parts List

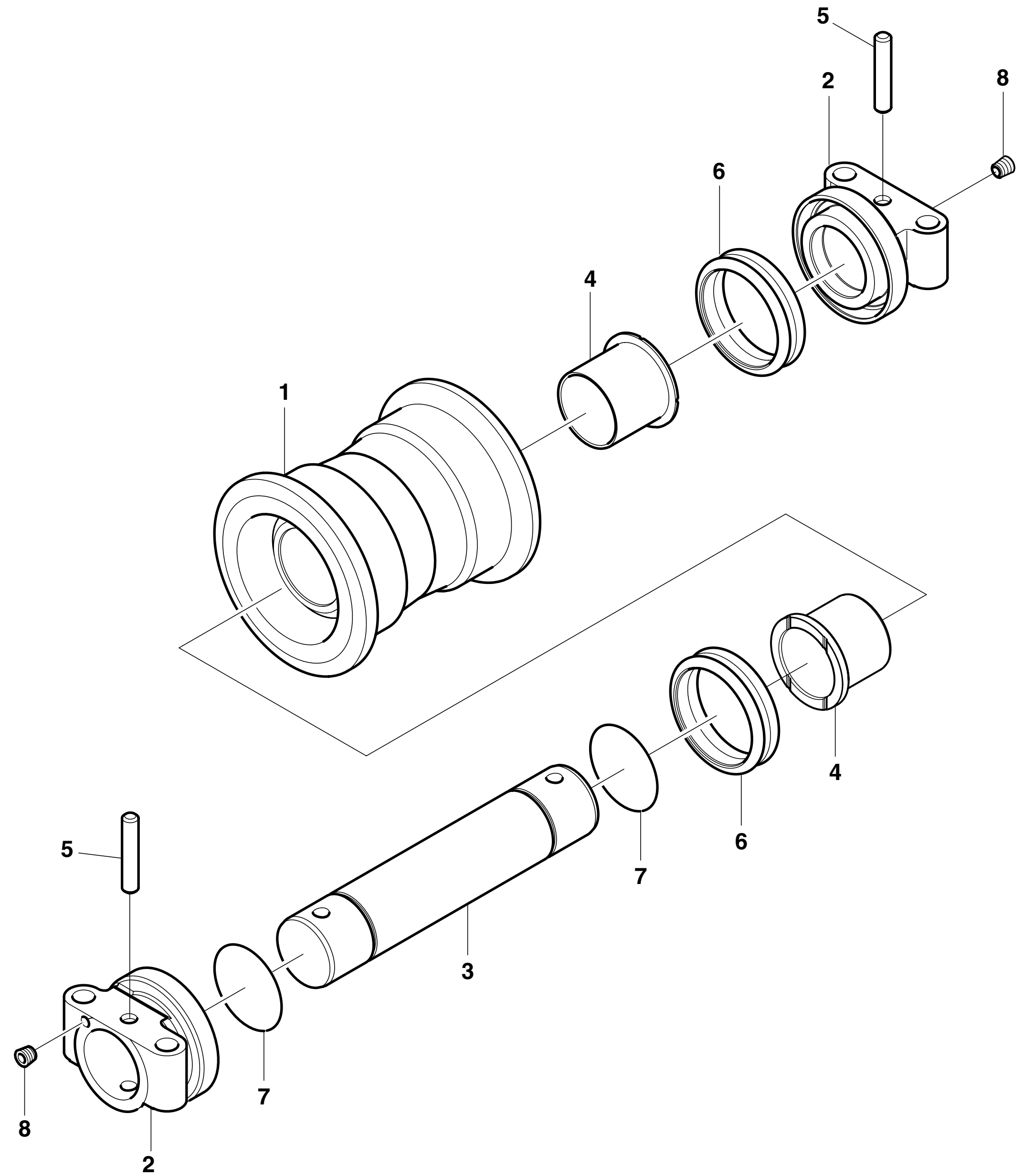



**Figure 25**

| Reference Number | Description |
|---|---|
| 1 | Roller |
| 2 | Collar |
| 3 | Shaft |
| 4 | Bushing |

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

## Lower Roller Removal

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

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

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

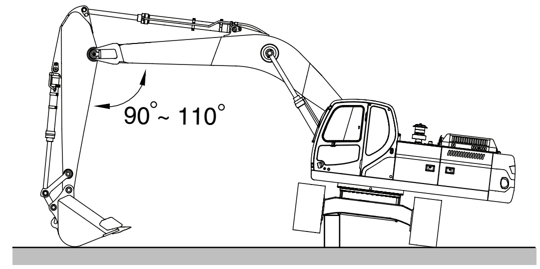



**Figure 26**

## Lower Roller Disassembly

1. Remove plug (8, Figure 27) from the collar and drain oil.
2. Pull the pin (5, Figure 27) from the collar.

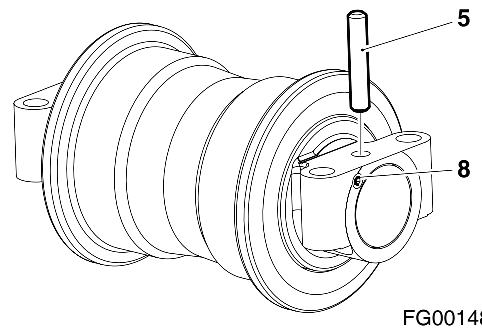



**Figure 27**

3. Separate the collar (2, Figure 28) from the axle, using press.

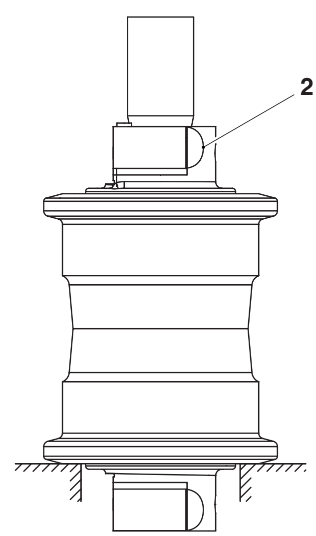



**Figure 28**

4. Detach O-rings (7, Figure 29) from the axle.
5. Separate floating seals (6, Figure 29) from the collar and roller (1).
6. Detach collar (2, Figure 29) and O-rings (7) from the axle, using press.

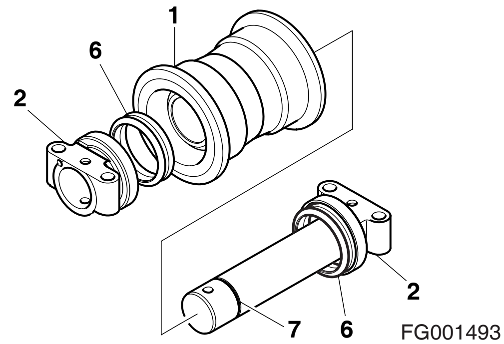



Figure 29

## Lower Roller Reassembly

1. Degrease, clean and dry all parts before reassembly. Insert bushing (4, Figure 30) into roller.

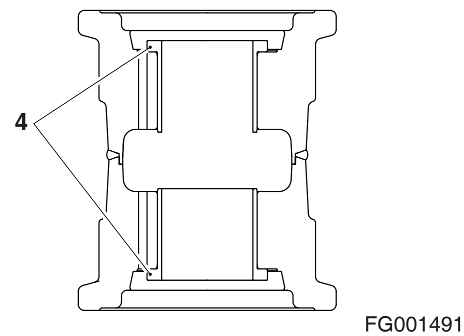



Figure 30

2. Apply grease to the O-rings (7, Figure 30) and insert into axle.
3. Align collar (2, Figure 31) and axle (3) pin holes and pin (5) the collar.

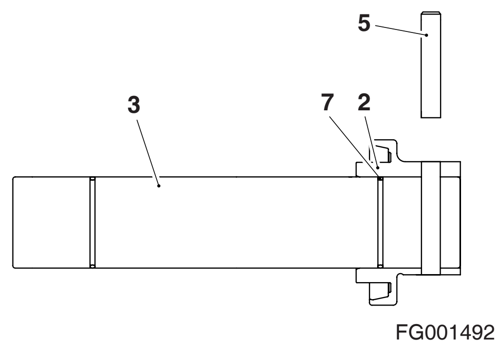



Figure 31

4. Insert floating seals (6, Figure 32) into the roller (1) and collar (2).

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

5. Slide the axle inside the roller.

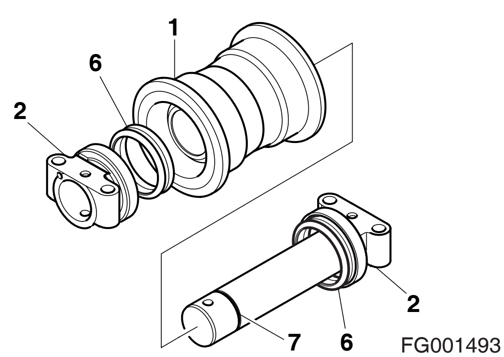



Figure 32

6. Install the collar (2, Figure 33), O-ring (7), and pin (5) on the remaining side.
7. Fill with clean engine oil with approximately 330 cc (11.2 oz).
8. Install plug (8, Figure 33) on the collar.

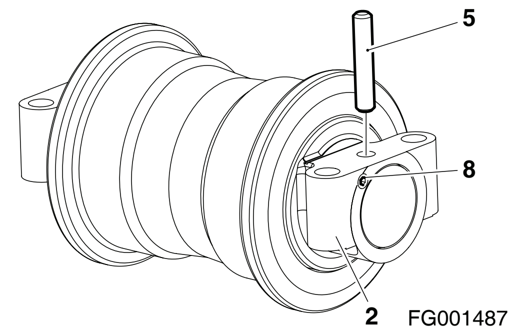



Figure 33

## 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.*

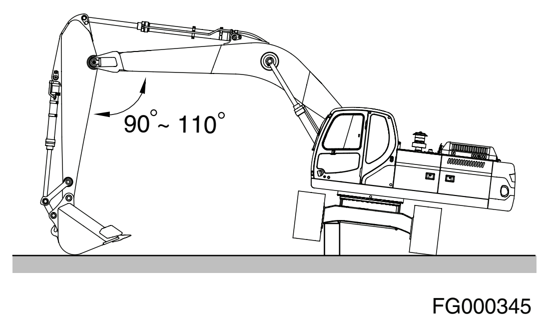



Figure 34

# UPPER ROLLER

## Parts List

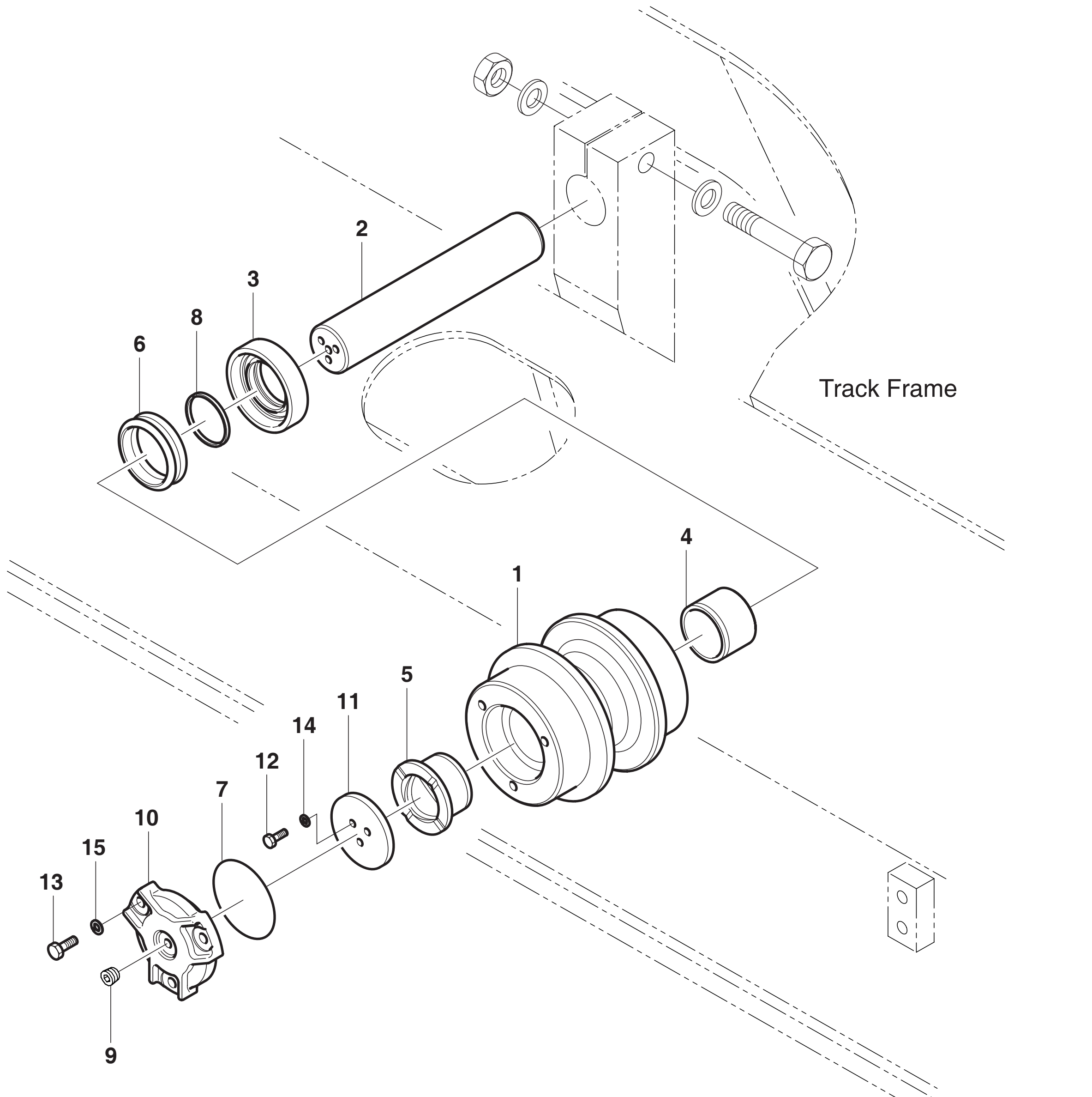



**Figure 35**

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

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

## Upper Roller Removal

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

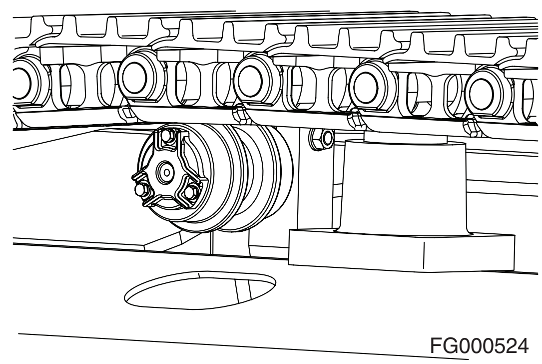



**Figure 36**

## Upper Roller Disassembly

1. Remove the plug (9, Figure 37) from the cover and drain oil.

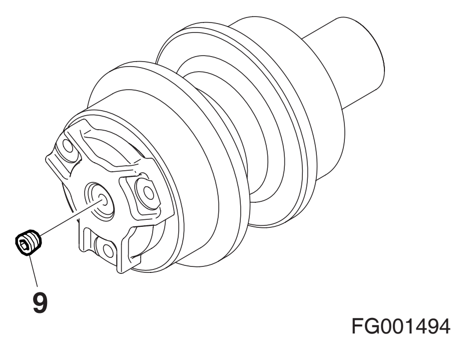



**Figure 37**

2. Remove the bolts (13, Figure 38) and cover (10). Detach bolts (12) and washer (11).

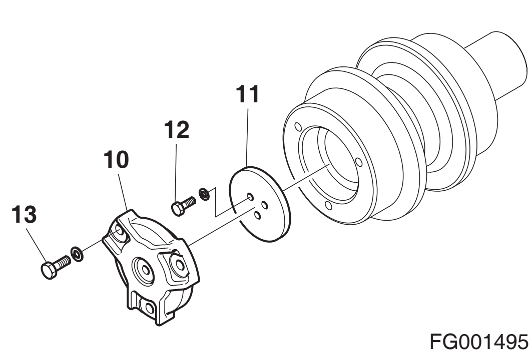



Figure 38

3. Separate the roller (1, Figure 39) from the axle (2).

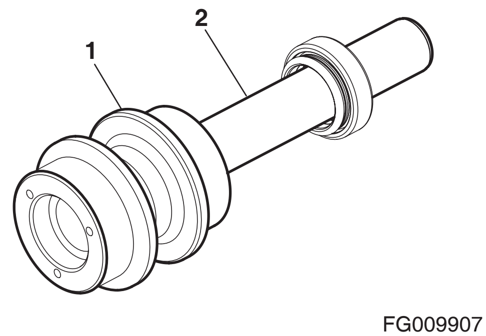



Figure 39

4. Separate the floating seal (6, Figure 40) from the roller.
5. Separate the O-ring (8) and thrust ring (3) from the axle.

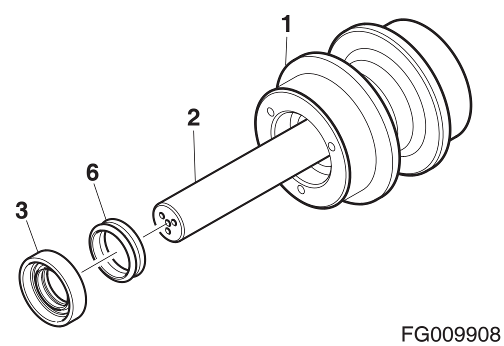



Figure 40

6. Separate the bushing (4 and 5, Figure 41) from the roller with a press and special tool (ST-1919).

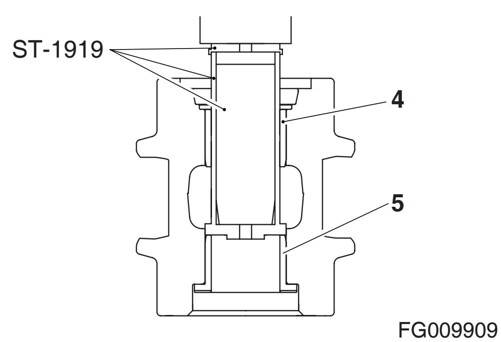



Figure 41

# Upper Roller Reassembly

1. Degrease, clean and dry all parts before reassembly. Insert bushing (4 and 5, Figure 42) into the roller (1).

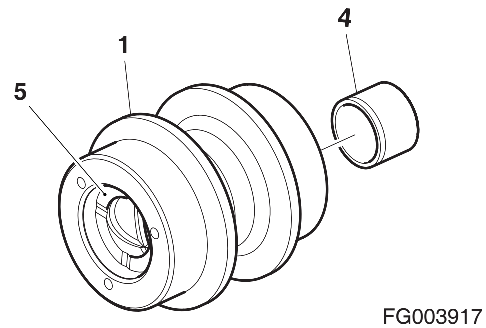



Figure 42

2. Insert floating seal (6, Figure 43) into the roller (1) and bushing.

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

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

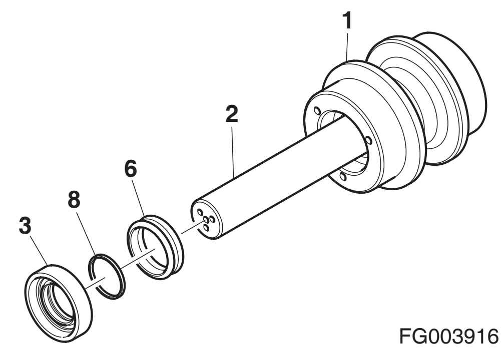



Figure 43

4. Install washer (11, Figure 44) and bolt (12).
5. Insert the O-ring (7, Figure 44) to the cover (10). Attach cover (10) and bolt (13) to the roller.
6. Fill with engine oil with 60cc.
7. Tighten plug (9, Figure 44).

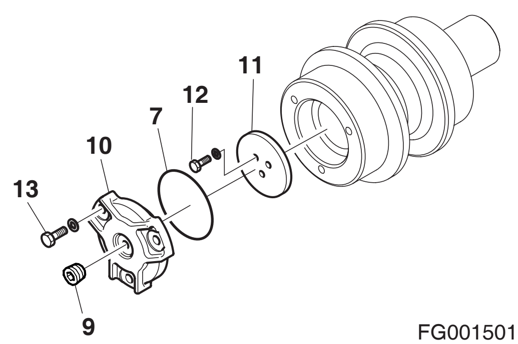



Figure 44

# TRACK SPRING AND TRACK ADJUSTING CYLINDER

## Parts List

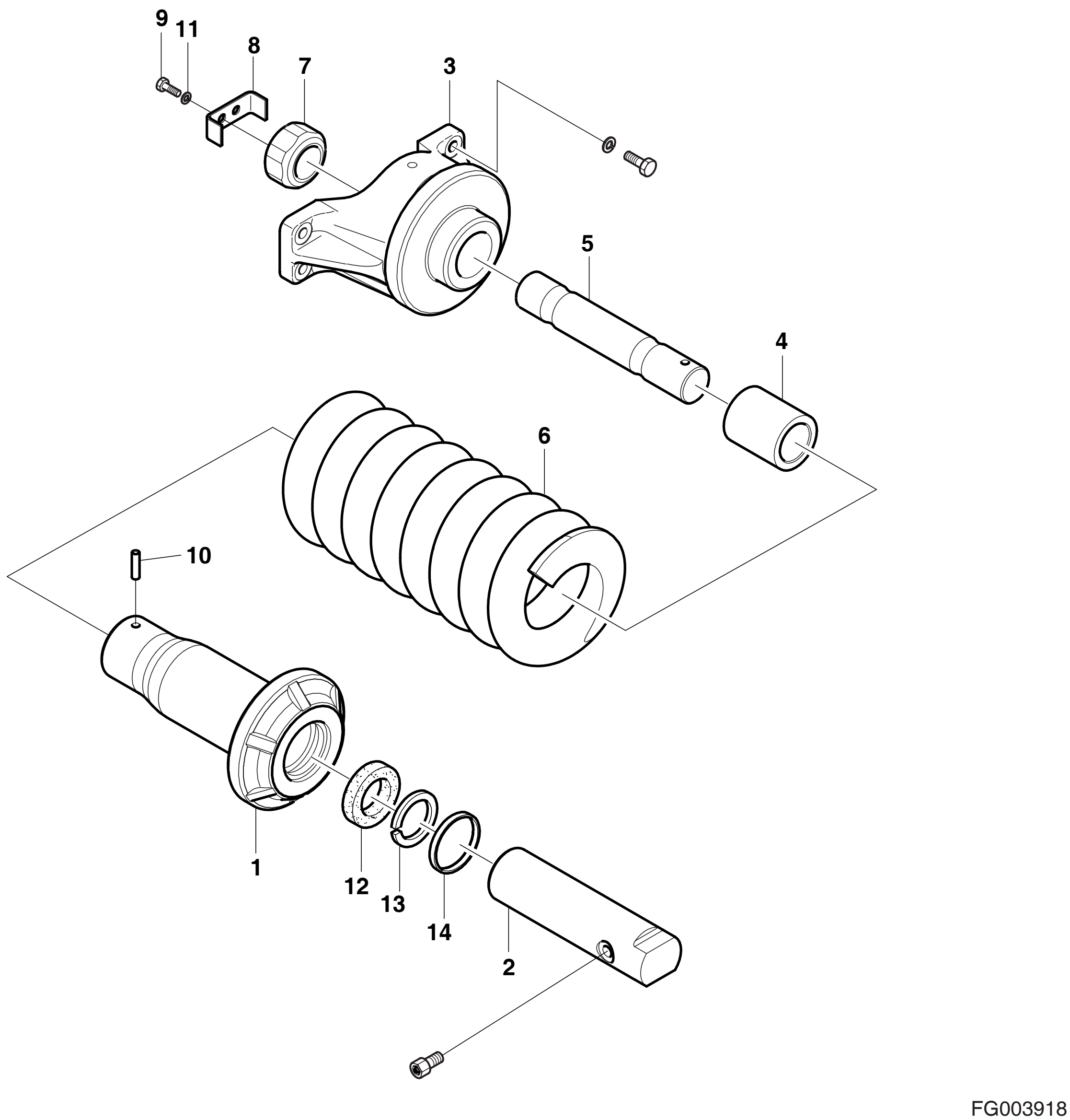



Figure 45

| Reference Number | Description |
|---|---|
| 1 | Cylinder |
| 2 | Piston Rod |
| 3 | Yoke |
| 4 | Spacer |
| 5 | Shaft |
| 6 | Spring |
| 7 | Lock Nut |

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

# Engine and Drive Train

# Drive Coupling (Main Pump)

Edition 1

# Table of Contents

## Drive Coupling (Main Pump)

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |

# DRIVE COUPLING

It is very important to set specified clearance between the end of the pump drive shaft (the "Dimension H" described below) and the coupling hub surface when installing the main pump in the engine.

The Figure 1 shows installation of a typical drive coupling.

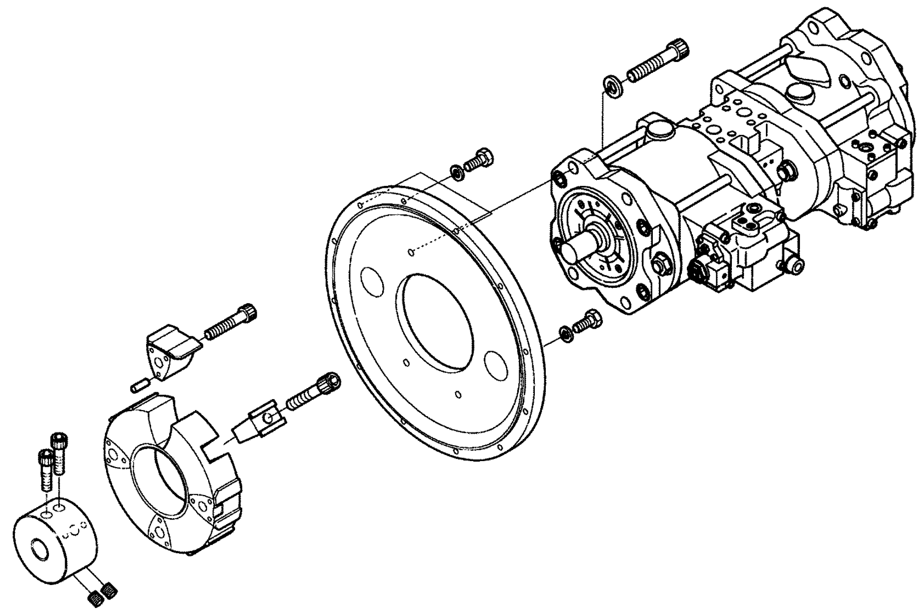



**Figure 1**

# SPECIAL TOOLS

This tool is used to adjust the clearance, referred to as "Measure H" in the installation instructions below, between the pump drive shaft and the front side of the drive coupling hub (4, Figure 2).

**NOTE:** *Dimensions A and B are the same as Measure H in* Figure 3*. Two tools in the figure below are designed for various models, while only their one end may be used in some special models.*

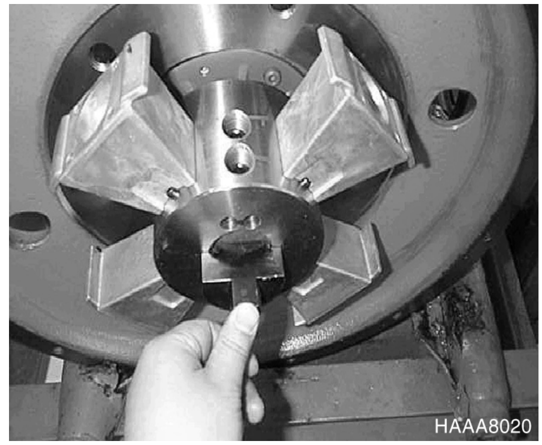



**Figure 2**

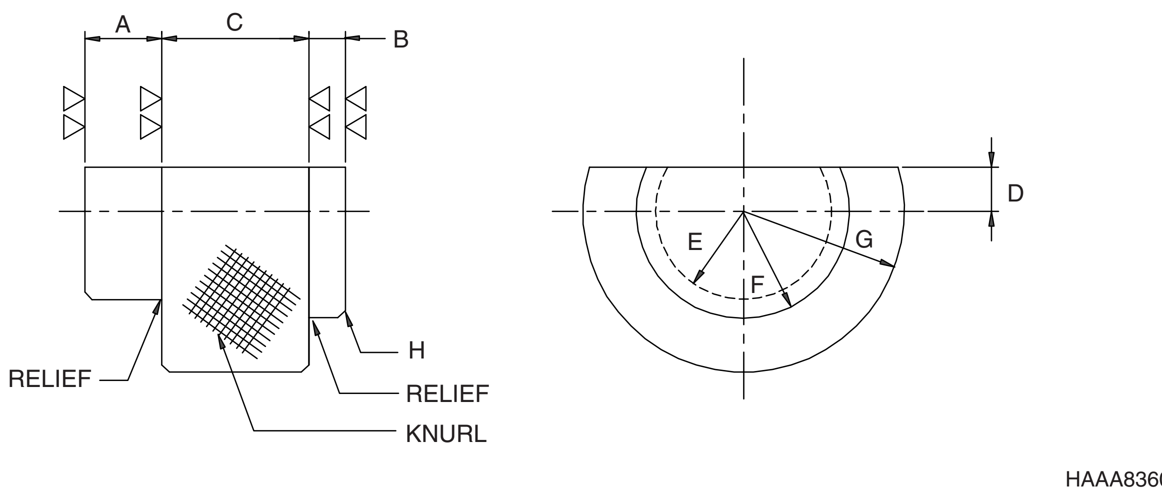



**Figure 3**

| MODEL | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| DX140LC | 10.5 ± 0.1mm | 5.0 ± 0.1mm | 20.0mm | 7.0 mm | Radius, 12.0 mm | Radius, 14.0 mm | Radius, 25.0 mm | 1.0 mm X 45° |

# INSTALLATION OF DRIVE COUPLING

Follow the installation dimensions and procedures whenever installing the drive coupling in the main pump.

**NOTE:** *Failure to follow the procedures results in noise and the shortage of the service life of the drive coupling or the main pump.*

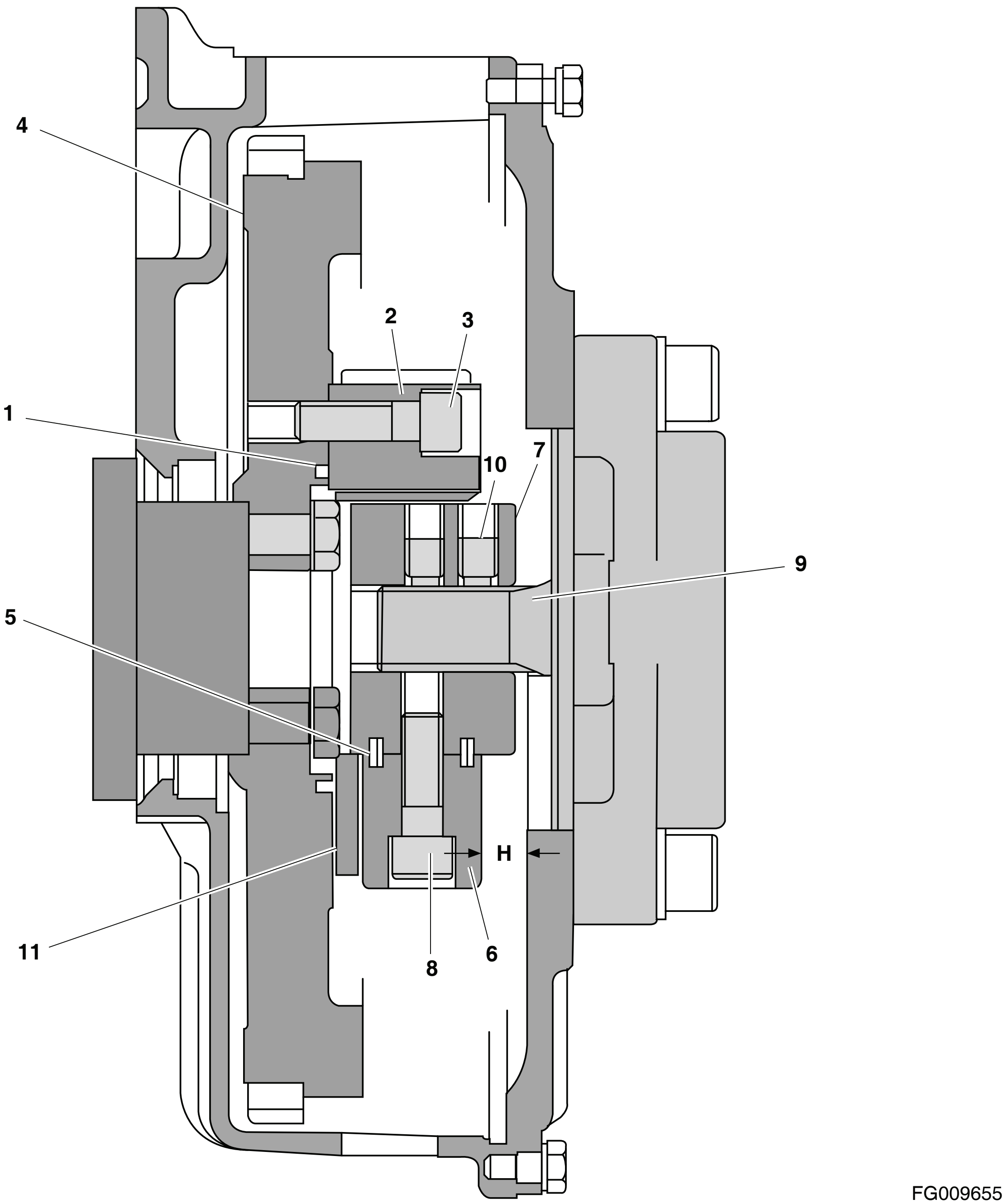



**Figure 4** INSTALLATION OF DRIVE COUPLING

| Parts and Torques | | | |
|---|---|---|---|
| References | Parts | Q'ty | Torque |
| 1 | Spring Pin | 4 | |
| 2 | Insert | 4 | |
| 3 | Bolt | 4 | Ta |
| 4 | Fly Wheel | 1 | |
| 5 | Spring Pin | 8 | |
| 6 | Insert | 4 | |
| 7 | Hub | 1 | |
| 8 | Bolt | 4 | Ta |
| 9 | Pump Shaft | 1 | |
| 10 | Fixing Nut | 2 | Tb |
| 11 | Element | 1 | |

Ensure to follow the specification of Measure H from the front hub surface to the pump shaft and tightening torques of bolts and screws.

| MODEL | Coupling Part Reference | Measure H | Torque of Ta | Torque of Tb |
|---|---|---|---|---|
| DX140LC | 2414-9009A | 3.0 - 7.0 mm | 21 - 23 kgf•m | 10 - 12 kgf•m |

## Installation Procedure

**NOTE:** *Refer to Figure 5 for the installation procedure.*

1. Install spring pin (1) and then insert (2) with bolt (3) into engine fly wheel (4).

   **NOTE:** *Tighten the bolt using the torque Ta value specified in the table.*

2. Install two spring pins (5) and then insert (6) in bolt (8) of hub (7).

   **NOTE:** *Tighten the bolt using the torque Ta value specified in the table.*

3. Install the fly wheel cover in the main pump with bolts.
4. Connect hum (7) with pump shaft (9) as referred to as Measure H in Table 1 and fix its position with screws (10).

   **NOTE:** *Tighten the screws using the torque Tb value specified in the table.*

   **NOTE:** *Apply Loctite #262 to fixing screws (10).*

5. Install element (11) in between the engine fly wheel (4) and the insert.
6. Install the main pump and hub (7) by gently pushing them with element (11).
7. Bolt down the fly wheel cover and the pump housing on the fly wheel housing.

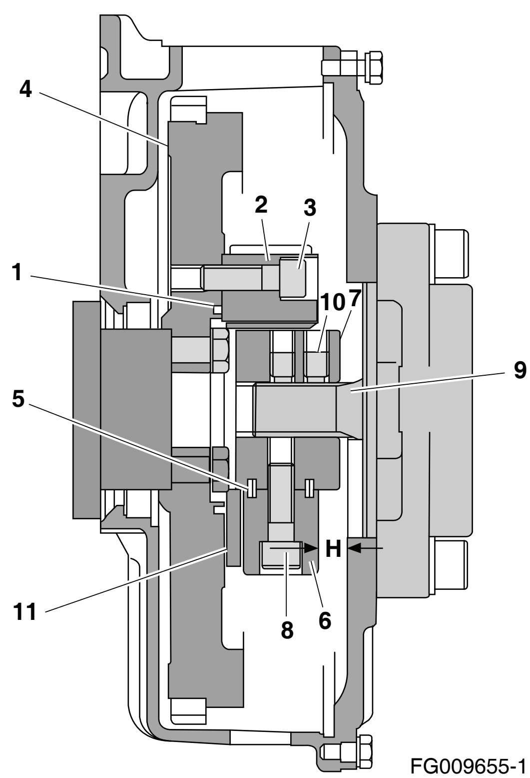



Figure 5

**CAUTION!**

**Apply the adhesive to bolts (3 and 8) to prevent the loosening of seals. Do not use additional adhesive nor any oil or cleaning solvent. As element (11) cannot resist adhesive, oil, and grease, take care not have it exposed to such materials.**

**Remove oil and dust on the fly wheel cover and the pump shaft before assembly.**

**Adjust the arrangement allowance between the pump and the engine at below 0.6 mm (0.023 in).**

# Hydraulics

# Hydraulic System Troubleshooting, Testing and Adjustment

Edition 1

# MEMO

# Table of Contents

## Hydraulic System Troubleshooting, Testing and Adjustment

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |

# HYDRAULIC SYSTEM - GENERAL NOTES

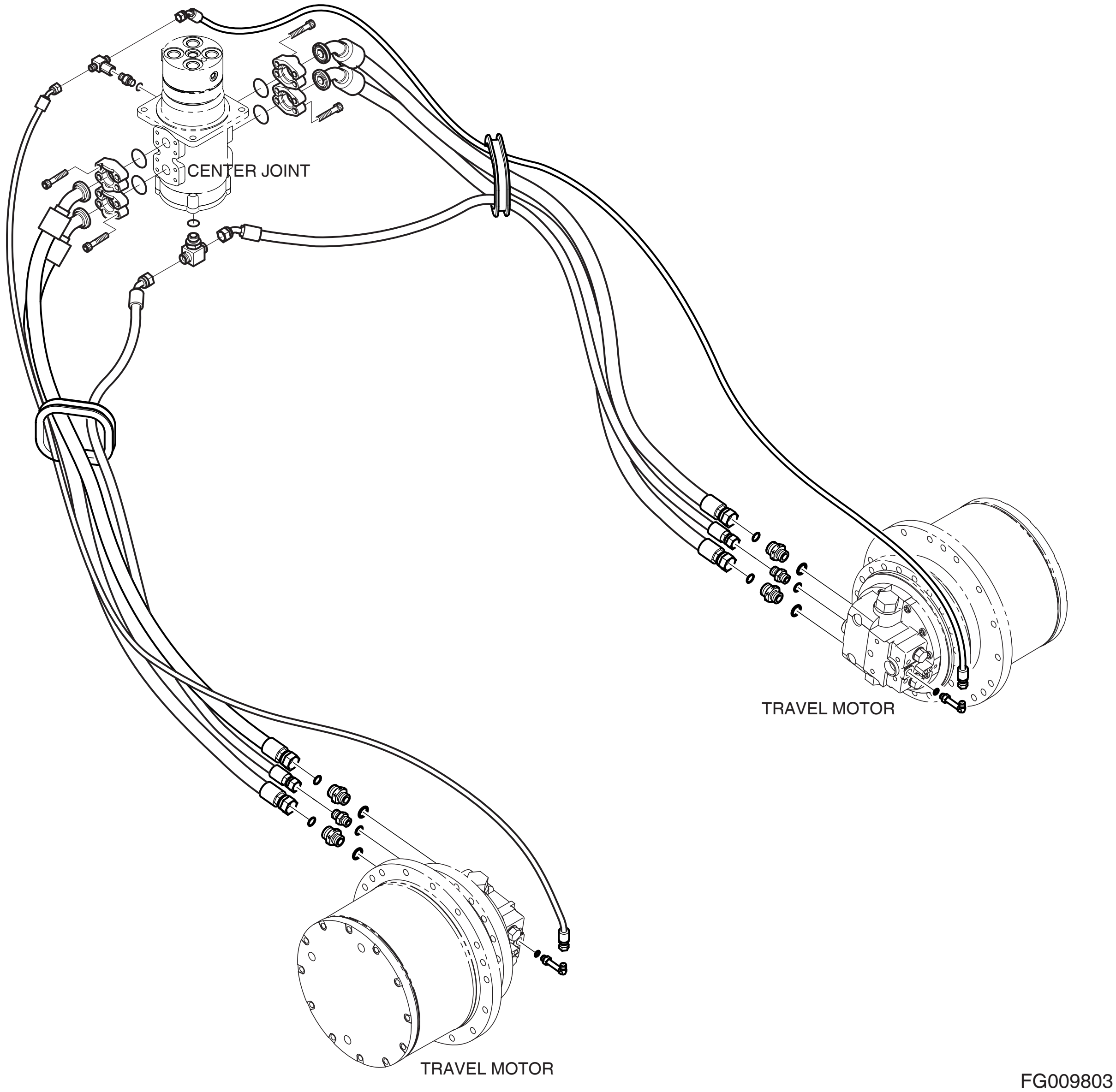



**Figure 1**

The hydraulic system has several improvements over conventional hydraulic systems - including cross-sensing total horsepower control - to maximize output efficiency.

The system features an electronically controlled output optimization system, which allows the operator to choose between two, distinctly different power modes: high-output/rapid cycling maximum speed power mode, and a standard power mode for most types of general operation.

Electronic management of hydraulic control valves assists in optimizing the application speed and overall operator control of hydraulic actuators and functions.

# HYDRAULIC SCHEMATIC

The hydraulic schematic(s) is available in the "Hydraulic and Electrical Schematic Shop Manual." This manual is a collection of diagrams and schematics for 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 anticavitation valves which protect the hydraulic system from vacuum that could result from external shocks or other unusual conditions. Boom, Arm, and Bucket cylinder circuit are also protected by overload relief valves. Whenever high-pressure is generated 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 being damaged as a result of overloads or shocks to the boom.

## Boom Up Circuit

When you pull the boom control lever backward, the right side pilot valve generates secondary boom up pilot pressure that is transmitted to the BOOM1 and BOOM2 spools of the control valve simultaneously. When secondary pilot pressure reaches 7 - 9 kg/cm$^2$ (100 - 130 psi), boom control valve spools open and oil from both pumps goes to the boom cylinder.

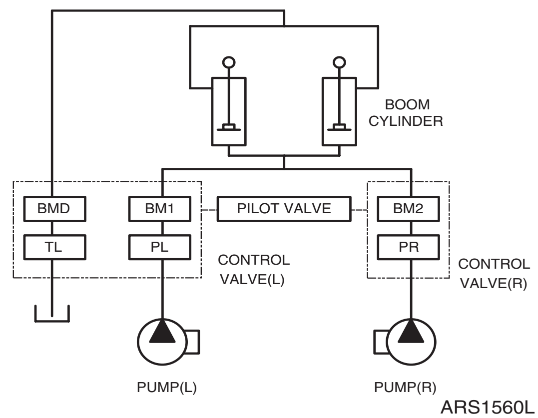



**Figure 2**

## Boom Down Circuit

When the boom control lever is pushed forward, the right side pilot valve generates secondary boom down pilot pressure that is transmitted only to the BOOM1 spool of the control valve. When secondary pilot pressure reaches 7 - 9 kg/cm$^2$ (100 - 130 psi), the BOOM1 spool on the 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.

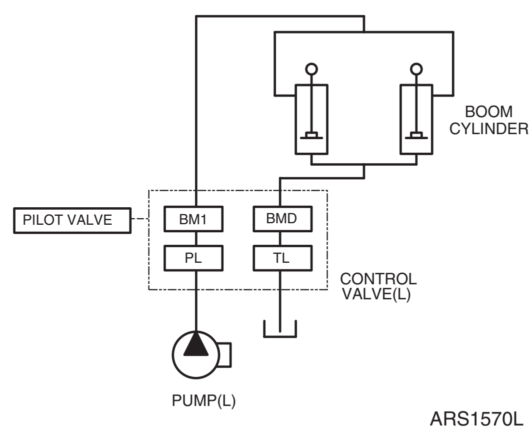



**Figure 3**

## 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, a slow return orifice, and the arm cylinder. The circuit can be operated in the two-stage speed control mode which works through both halves of the control valve and doubles the volume of oil flowing to the cylinder.

Overload relief valves set at 360 kg/cm$^2$ (5,112 psi) have been installed at the AM 1 and AMD 1 ports on the right side of the control valve to protect the circuit and system components from possible damage caused by shocks and/or overload pressure. Additional protection - to prevent cavitation of the cylinder - is provided by a makeup valve and reservoir return circuit, which ensures that the volume of oil going to the cylinder will not exceed the volume of oil coming out.

## Arm Crowd Circuit

When the arm control lever is put in the crowd mode, the left side pilot valve generates secondary pressure that is transmitted to the AM1 and AM2 spools of the control valve simultaneously.

When secondary pilot pressure reaches 7 - 9 kg/cm$^2$ (100 - 130 psi), the arm control valve spools AM1 and AM2 open. Output flow from both halves of the pump assembly is directed to the arm cylinder.

When working in the arm crowd mode, under certain conditions, oil in the arm cylinder could suddenly be forced out by the weight of the arm and bucket. Insufficient oil flow to the cylinder could lead to cavitation in the cylinder and/or surging or irregular movement. This is prevented by a regeneration valve attached to the control valve which maintains the balance between oil flowing into the cylinder and oil flowing out.

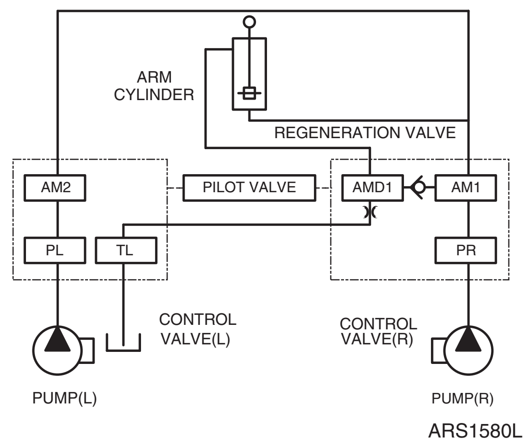



**Figure 4**

## Arm Dump Circuit

When the arm control lever is put in "dump" mode, the left side pilot valve generates secondary pilot pressure that goes to both spools AM1 and AM2 of the control valve simultaneously.

When pilot pressure reaches 7 - 9 kg/cm$^2$ (100 - 130 psi), the control spools open, allowing oil from PUMP (L) and PUMP (R) to flow to the arm cylinder.

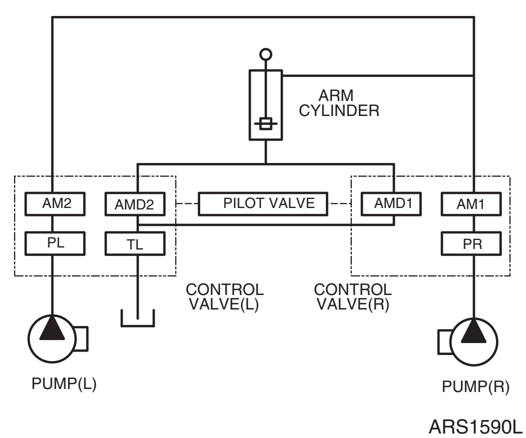



**Figure 5**

## Bucket Operating Circuit

The bucket operating circuit includes the left main pump, the left half of the control valve and the bucket cylinder. 360 kg/cm$^2$ (5,112 psi) overload relief valves at BKT and BKTD 1 ports of the control valve protect the circuit and its components from being damaged.

## Bucket Crowd Circuit

When the bucket control lever is placed in the crowd position, the bucket control valve spool on the left side of the control valve opens and oil from left main pump flows to the bucket cylinder.

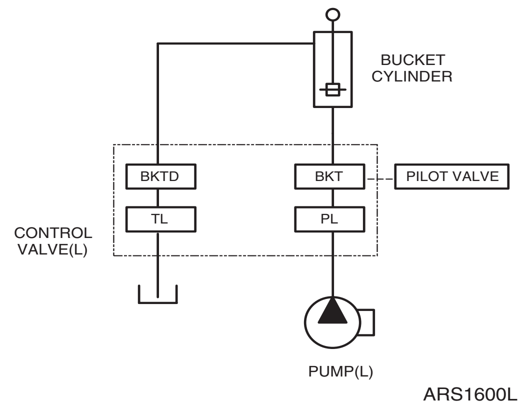



**Figure 6**

## Bucket Dump Circuit

When the bucket control lever is put in the dump mode, the bucket control valve spool in the left half of the control valve opens to supply oil from the left main pump to the cylinder.

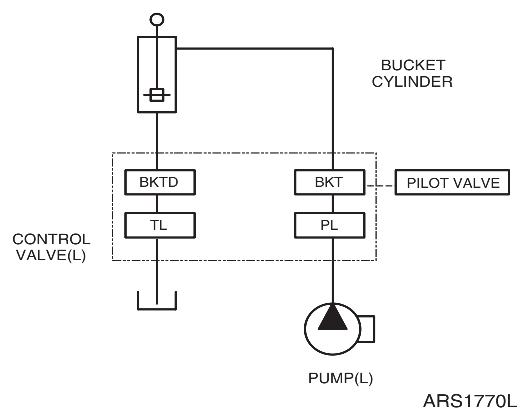



**Figure 7**

## 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 the right side pump regulator and right half of the control valve. Output flow from the right pump is then directed through the PR and SWR ports of the control valve to the swing motor.

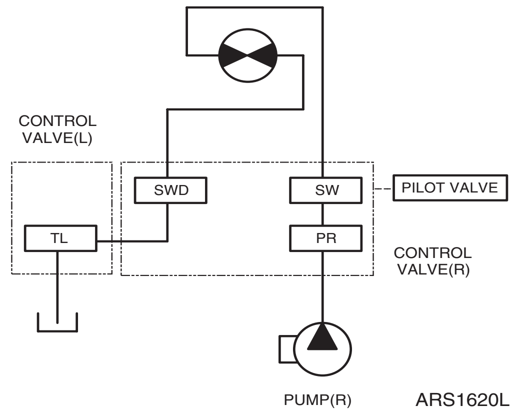



**Figure 8**

## Left Swing Operating Circuit

When the swing control lever is pushed to the left swing position, the control valve spool at the right side of the control valve moves in the opposite direction and output flow from the right pump is directed through the PR and SWL ports of the control valve to the swing motor.

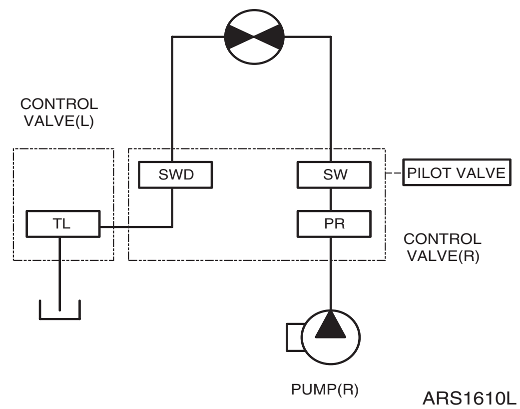



**Figure 9**

## Swing Relief Valve and Makeup Valve

Whenever the spool is shifted to the neutral mode during swing operation, the possibility exists that surge pressure in the circuit - caused by inertial momentum of the upper works and correspondingly reduced pressure at the opposite motor port - could produce cavitation in the circuit. To keep that from happening, a 245 kg/cm$^2$ (3,485 psi) relief valve is installed in the swing motor and a large capacity makeup valve is connected to the entrance port of the hydraulic reservoir, helping maintain acceptable pressures on both sides of the circuit.

## Travel Operating Circuit

Output flow from both halves of the pump assembly is directed to the right and left travel motors through the right and left sides of the control valve, and the upper works center joint.

## Forward Travel Circuit

When the right and left travel control levers are pushed forward, output from both of the main pumps is directed through the PR, PL, TRRF, and TRLF ports on the control valve, through the upper works center joint, to the travel motors on each side of the machine.

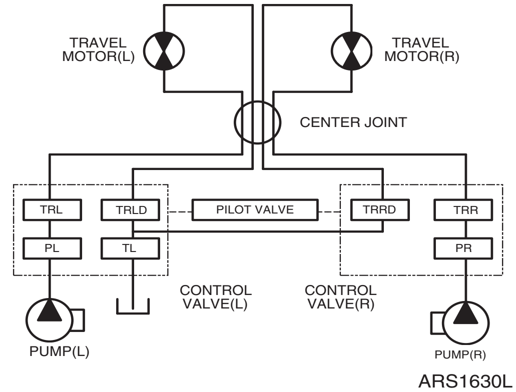



**Figure 10**

## Reverse Travel Circuit

When the right and left travel control levers are pushed backward, output from both main pumps is directed through the PR, PL, TRRR, and TRLR ports on the control valve, through the upper works center joint, to the travel motors.

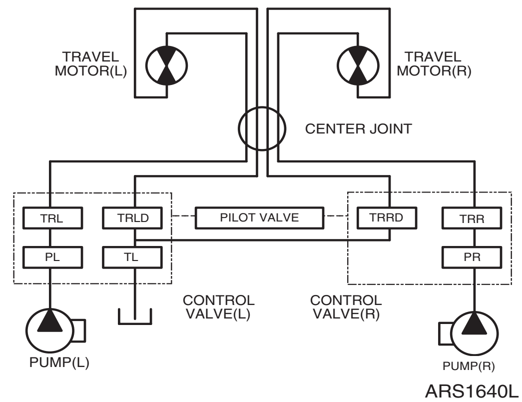



**Figure 11**

# PROCEDURAL TROUBLESHOOTING BASELINE RECOMMENDATIONS

## Initial Checks and Tests to Establish Operating Condition of the Excavator

### Triage Summary

An excavator that fails to deliver designed performance should be checked for the following:

- Hydraulic flow, first, and.
- Hydraulic pressure, afterwards, in a specified order of priority through different points of the system.

To verify adequate available hydraulic flow, before any other tests are performed through the circuit:

Check engine operation -

- at 1,950 rpm with no load.
- at 1,950 rpm stall load.

If engine rpm drops excessively with a load or fails to surpass rated speed (1,850 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; boom, arm, bucket, swing, and travel)
- Power boost circuit.
- Standard performance tests; cylinder speed, hydraulic motor (travel and swing) speed, cylinder oil tightness "permissible drift" test.

**NOTE:** *System specification performance tests of individual activator function are determined by flow rate through the component or circuit, not the control pressure or system pressure available to the actuator. Poor flow through the individual circuit may indicate that the component is worn beyond tolerance limits, while all other hydraulic functions are adequate.*

# IMPORTANT

**It is suggested that the troubleshooter maintain the testing sequence of the preceding list. Checks and adjustments nearer the middle or the end of the list may depend on adequate functioning of systems tested nearer the top of the list.**

# PILOT PRESSURE

## Adjustment and Testing

### WARNING!

**This procedure should be done with two people. To reduce the chance of accident or unintended start-up, one person should remain at the operator's control stand while checks and adjustments are made.**

Vent hydraulic pressure from the reservoir before breaking the seal on fittings to install two in-line "T-style" adapters and test gauges (60 bar/1,000 psi) at the gear pump outlet port, and at the joystick control valve pilot line.

Start the engine and turn the engine speed control dial to the maximum setting. After the excavator has been operated long enough to reach normal operating temperature, back off the engine control dial to minimum rated rpm speed. With all controls in neutral, make sure the left console control stand is locked in the down (operating) position and check pressure at the gear pump outlet port and at the joystick.

If gear pump pressure is outside the tolerance specified in the table, adjust gear pump relief pressure by loosening the 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 on the underside of the pumps (not visible in the harness connections drawing, because it is underneath the assembly), near the engine/pump flexible coupling, adjacent to the pump return line. To test and adjust power shift current and pressure through the power mode valve a multilead jumper harness is required. The jumper harness (which is available through *DOOSAN* After Sales Service, or could be spliced together from commonly available, purchased parts) has extra leads so that a VOM meter can be connected to the circuit.

To set up the testing equipment, shut down engine and disconnect the single electrical lead from the power mode valve. Attach the jumper harness to the terminal on the valve, connect the test leads of the multimeter to the extra leads on the harness and reconnect the valve electrical lead.

Vent the lever on top of the hydraulic tank to relieve pressure and connect an in-line "T-style" adapter to the valve pressure port. Install a 60 bar (1,000 psi) test gauge in the adapter.

Restart the engine and increase engine rpm by turning the speed control to the maximum speed setting. Warm up the engine and hydraulic system until hydraulic oil temperature is at least 45°C (113°F). Select Power Mode on the Instrument Panel. Check current readings (in milliamps) on the VOM meter and hydraulic pressure gauge readings and make sure both conform to the values in the table below.

**NOTE:** *If recorded values do not conform to the specified current or pressure in the table, back off the lock nut on the end of the valve, turn the adjusting screw 1/4 turn and recheck current and pressure. Repeat adjustment as required to obtain specified performance and retighten the valve lock nut.*

| Mode | Engine RPM | Current | Pressure |
|---|---|---|---|
| Power Mode | High Idle: 1,950 rpm | 150 ± 20 mA<br>Mid-range value corresponding to engine rpm for both current and hydraulic pressure readings. | 0 bar<br>(0 psi) |
| Standard Mode | High Idle: 1,850 rpm | 250 mA | 9 bar<br>(130.5 psi) |

# SWING 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 swing priority control valve is inside the compartment behind the cabin.

The same jumper harness used for testing the power mode (EPOS) control valve is used to test this valve. Shut down engine, disconnect either of the electrical leads and connect the test equipment to that side of the valve. An in-line "T-style" gauge adapter can be used to connect a 60 bar/870 psi (1,000 psi) test gauge to the outlet (pressure) side of the valve. Set the engine control speed dial to maximum and warm up the engine to at least 45°C (113°F) before making any tests.

**NOTE:** *Vent air from the hydraulic system before installing test equipment. Use the lever on the reservoir, while the engine is running. Pour clean replacement fluid back into the system if excessive fluid was lost.*

To verify operation of the swing priority solenoid valve, connect test equipment and begin testing with the work mode switch set to "digging" (the state turning off the "trenching" light) and the engine speed control dial at the maximum rpm position.

Operate the swing motor in both directions. Measure signal current and hydraulic pressure through the valve and record the highest and lowest values as the swing motor rotate clockwise and counterclockwise several times. Reset the work mode control to "trenching" mode and repeat the same tests.

| Valve Function / Work Mode | Signal Voltage | Hydraulic Pressure |
|---|---|---|
| Swing Priority / Digging | 0 V | 0 bar (0 psi) |
| Swing Priority / Trenching | 20 - 30 V | 20 - 40 bar (290 - 580 psi) |

**NOTE:** *If recorded values do not conform to the specified current or pressure in the table, readjust as required.*

# PRESSURE UP VALVE

## Checks and Adjustments

**WARNING!**

**This procedure should be done with two people. To reduce the chance of accident or unintended start-up, one person should remain at the operator's control stand while checks and adjustments are made.**

Vent hydraulic pressure from the reservoir to install an in-line "T-style" adapter and test gauge (60 bar/1,000 psi) at the pilot pump signal port relief valve outlet.

Start the engine and turn the engine speed dial to maximum. When normal operating temperature is reached:

- Check pilot pressure and readjust it, if required:
- Select the Instrument Panel rear pump "pressure display".
- Select Power Mode.
- Stall the boom cylinder (towards the extend side).
- Read rear pump pressure on the Instrument Panel display.

Repeat all tests with and without "pressure up" selected through the console rocker switch and joystick button.

If the two-stage main relief valve was not set correctly and main relief high-stage pressure ("pressure up") is outside the tolerance range, begin valve adjustment by loosening the outside (widest diameter) 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 innermost (smallest diameter) screw clockwise to increase the setting, or counterclockwise to decrease it. Pressure should be at least 330 bars (4,785 psi), but less than 335 bars (4,858 psi).

**IMPORTANT**

**Pressure adjustments and checks cannot be made if pilot pressure is outside the specified range. Refer to the pilot pump adjustment procedure if required, then proceed with any necessary adjustments to main relief pressure settings.**

| Power Mode | Operation | Main Pressure and Tolerance | Pilot Pressure and Tolerance |
|---|---|---|---|
| Power Mode | Neutral, No Operation | 20 - 40 bar (290 - 580 psi) | 30 bar +10 bar (435 psi +145 psi) |
| Power Mode | Cylinder Stall | 330 bar +5 bar (4,785 psi +75 psi) | 30 bar +10 bar (435 psi +145 psi) |
| Power Mode W/ Pressure Up | Cylinder Stall | 350 bar +10 bar 5,075 psi +145 psi | 30 bar +10 bar (435 psi +145 psi) |

**NOTE:** *The electrical pressure up (power boost) solenoid valve alongside the swing priority solenoid and arm speed control solenoid, in compartment rear of the operator's cabin, must be operating correctly, or pressure tests and further adjustments cannot be made.*

# PUMP INPUT POWER CONTROL

## Pump Regulator Adjustment

**WARNING!**

**This procedure should be done with two people. To reduce the chance of accident or unintended start-up, one person should remain at the operator's control stand while checks and adjustments are made.**

To perform these adjustments accurately the use of a flow meter is strongly recommended, as is consulting the factory (before starting work) to validate the need for making regulator adjustments. Vent hydraulic pressure from the reservoir before breaking the seal on fittings to install the flow meter kit. (Refer to the "Flow meter Installation and Testing" procedure.)

**IMPORTANT**

**Before starting this procedure or going onto make any changes of adjustment settings:**

- **Verify engine output to the rated speed – 1,950 ± 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.

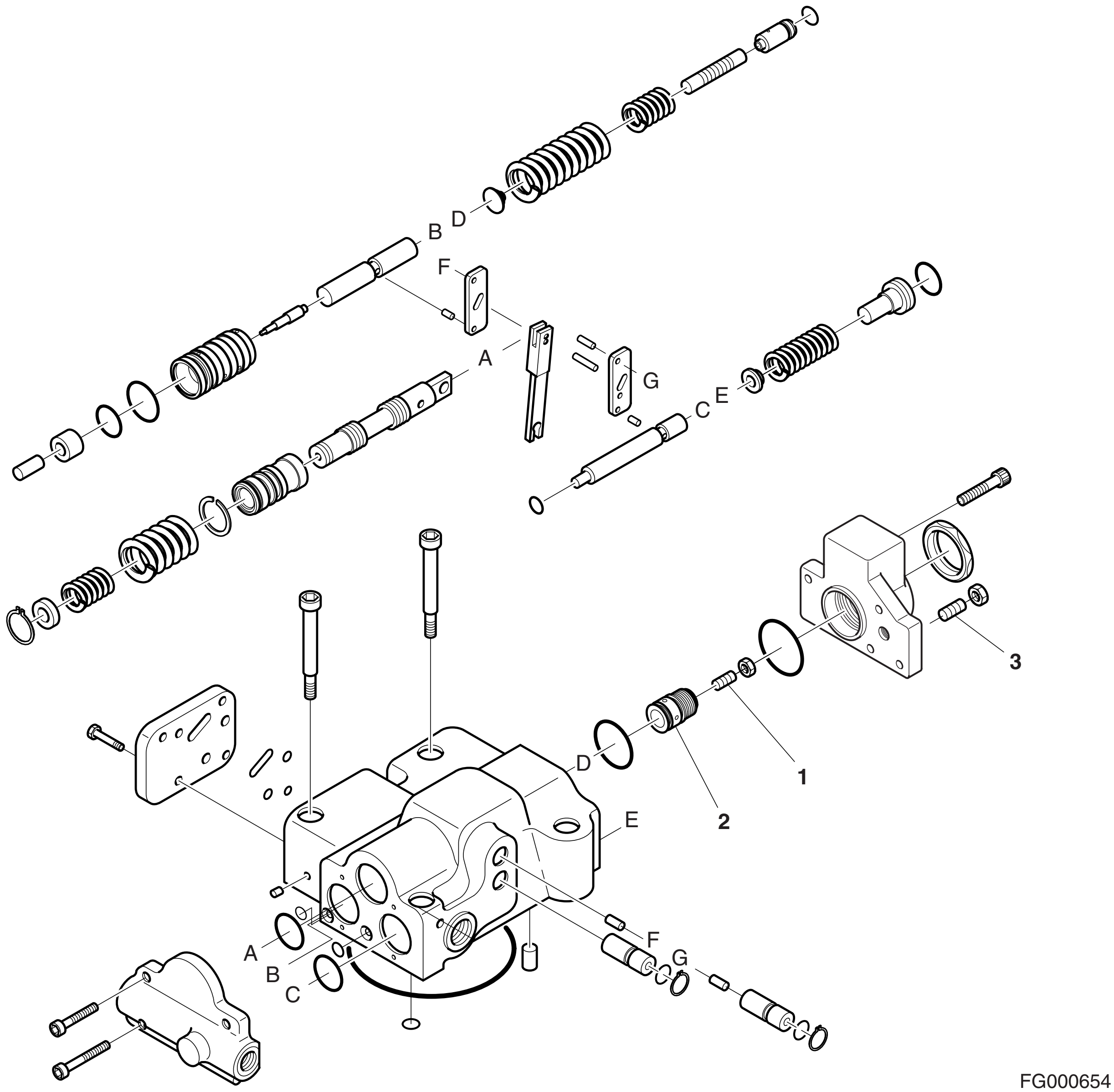



**Figure 12**

Refer to the illustration of the pump regulator control valve (Figure 12) for the location of adjustment screws (1, 2 and 3). There are two different adjustments, along with the Negacon, negative control, adjustment screw (3, directly below 1 and 2). Each one of the adjustment procedures could affect the setting of the others.

Check and record the arm dump speed performance test before and after input power adjustment, whether or not a flow meter is used.

**NOTE:** *Regulator adjustments affect total cumulative horsepower, since each regulator compensates for the output of the other. It is not necessary to adjust both regulators at the same time, but after checking or adjusting one of them, the remaining unit should also be checked.*

Start the engine and turn the engine speed dial to maximum. When normal operating temperature is reached, loosen the largest diameter lock nut around the adjustment screw (2) for the outer regulator spring. Tightening the screw shifts the P/Q (Pressure/Flow) control curve to the right, and increases compensating control pressure.

On the other hand, if the persistent cause of performance problems is engine overloading, decreasing the adjustment by turning the larger diameter adjusting screw (2) out will decrease pump input horsepower. 1/4 turn on the adjusting screw is equal to approximately 17 horsepower.

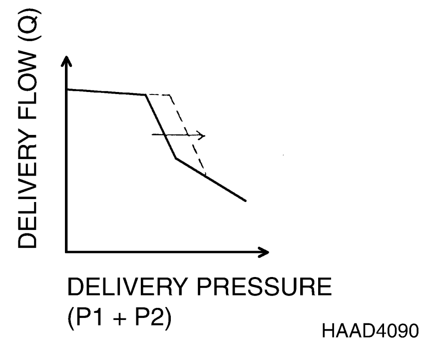



**Figure 13**

# IMPORTANT

**Because changing the position of adjusting screw (2) also affects the setting of the adjustment for the inner spring, the smaller diameter adjusting screw (1), turn in the inner screw 198° (slightly more than 1/2 turn, 180°) before screw (2) is backed out 1/4 turn (90°).**

**NOTE:** *For each full turn of adjustment on the larger diameter screw (2), the square-tipped adjusting screw should be turned in the opposite direction 2.2 turns to avoid changing inner spring adjustment.*

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

Turning the square-tipped, smaller diameter screw (1) clockwise moves the flow curve up, increasing flow and then input horsepower.

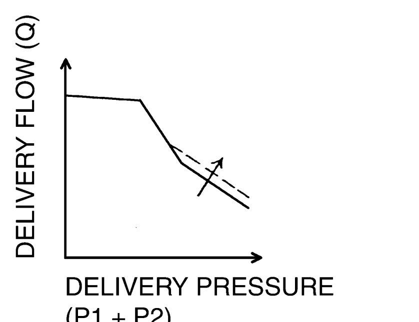



**Figure 14**

The adjusting screw (1, Figure 12) affects the delivery rate (Q) of the pump. Tightening the adjusting screw decreases the maximum cut flow (as shown in Figure 15) while backing out the screw increases cut flow delivery rate.

Balance both pumps for equal output.

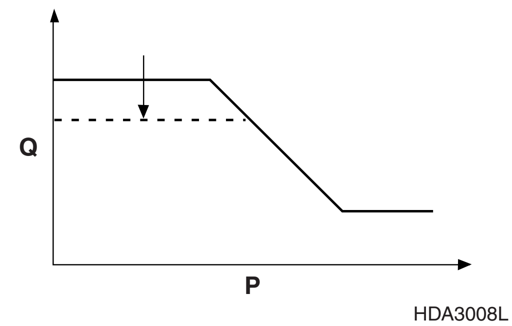



Figure 15

# FLOW METER AND FLOW METER KIT INSTALLATION AND TESTING

Checking regulator and pump output, to assess the output balance between the front and rear pumps and to verify operating adjustment of each regulator, will require installation of a flow meter.

The After Sales Service department of the nearest local *DOOSAN* dealer can assist you with these tests or, if you prefer carrying out your own testing, they should be able to help in putting together a hose and fitting kit (or the required dimensions and specifications for hoses and fittings) to allow you to install a flow meter downstream from the main pump assembly.

**Installation and Testing Procedure**

- Shut down engine and operate controls to release hydraulic pressure from the accumulator.
- Vent the reservoir to release all pressure from the hydraulic system.
- Remove guard panels from around the main pump assembly.
- Disconnect the main pump discharge output line. Install the input flange of the flow meter on the pump end of the output line.
- Cap off the unused (input) end of the pump discharge line with a blocking flange.
- Connect a premeasured length of hydraulic hose, between the output end of the flow meter assembly and the top of the reservoir. Use appropriate fittings and adapter flanges to guarantee a pressure tight seal.

  **NOTE:** *Be sure to maintain even tightening torque on all flange fittings. Use Loctite brand "PST 545" (or an alternate manufacturer's hydraulic system joint seal) if required, to give an airtight seal.*

- An assistant – who must remain at the operator's control station at all times – should restart the engine and run it long enough (at minimum rpm) to 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 and the work mode selector at digging mode:

- Unloaded maximum engine speed baseline test (all controls in neutral).
- Front pump test – operate "travel right" lever. Record values at all specified pressures.
- Rear pump test – operate "travel left" lever. Record values at all specified pressures.

Record the values for each of the three tests (neutral, travel right and travel left) at the following pump pressure levels, with travel speed control set at "high speed."

| Engine RPM | Pressure | Flow |
|---|---|---|
| | 100 kg/cm$^2$ (1,422 psi) | |
| | 135 kg/cm$^2$ (1,930 psi) | |
| | 180 kg/cm$^2$ (2,560 psi) | |
| | 240 kg/cm$^2$ (3,413 psi) | |
| | 320 kg/cm$^2$ (4,550 psi)* | |
| | *See below note. | |

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

If test results do not 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 330 kg/cm$^2$ (4,785 psi), not 350 kg/cm$^2$ (5075 psi).*

# SWING SYSTEM TROUBLESHOOTING

## Precautions/Initial Checks

1. Stop work. Release all weight or any type of load safely before proceeding. Avoid risking injury or adding to damage.
2. Shut down engine and disengage control functions until initial tests are ready to be made.

**WARNING!**

**Prevent possible injury and/or loss of operating control. Stop work and park the excavator at the first indication of:**

1. **Equipment breakdown.**
2. **Inadequate control response.**
3. **Erratic performance.**

Stop the machine, put the boom and arm in the inoperative (overnight park) position and begin by making the fastest, simplest checks first:

- Check oil level.
- Check for overheating, oil leaks, external oil cooler clogging or broken fan belt. Consult service record for prior repair/service work.
- Drain some tank oil into a clean, clear container. Look for metal shavings/grit, cloudiness/water or foam/air bubbles in the oil.

  **NOTE:** *Dispose of drained fluids according to local regulations.*

- Check for wobble through the engine/pump flex coupling. Run engine with the pump input hydraulic power control nut turned to the lowest power to check the engine.
- Investigate unusual operating noises or vibration. Check for loose bolts, connections.

## Swing Relief Valve Checking and Adjustment

Make a check of operating pressures through the swing relief valve if:

- The swing motor fails to turn.
- Swings in one direction only.
- Swings but continues to coast.
- There is drifting on a slope.

1. Check operation by connecting:

   A. Two 600 bar (8,700 psi) pressure gauges to the inlet and outlet measuring ports on top of the swing motor.

   Pressure should be between 270 and 280 bar (3,916 psi and 4,060 psi), with both swing locks engaged. With swing locks released, during full acceleration and deceleration, pressure should approach 250 bar (3,625 psi) in each direction.

   B. Connect a 60 bar (870 psi) pressure gauge at the "SH" port of the hydraulic brake.

   Pressure should always stay at or above 13 bar (190 psi) when operating swing, boom or arm.

   C. Connect a 10 bar (145 psi) gauge at the motor makeup valve.

   Pressure should stay consistently above 2.5 bar (36 psi). If pressure 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 13 bar (190 psi) level, check the shuttle valve in the rear compartment behind cabin.

When pressure through the port is at the recommended level, the brake release valve should disengage the swing brake, allowing the swing motor to rotate the excavator. If pressure adjustment to the valve has been restored but the brake still fails to release, the brake piston or friction plate may be frozen, requiring disassembly of the motor and parts repair/replacement.

4. If pressure tested at the motor makeup valve 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. Pull out the e-EPOS indicator panel from underneath the operator's seat and perform the self-diagnostic test. If the display panel reads code "0.2," it is reporting that the swing priority proportional valve is not functioning, except in the minimum "fail-safe" mode. Refer to the Electrical section of this book for more information.*

# TROUBLESHOOTING – SWING GEARBOX

| Problem | Possible Cause | Remedy |
|---|---|---|
| Swing motor fails to operate and: | | |
| Three pressure tests at motor, brake or makeup valve show low reading(s). | Swing relief valve defective Brake release valve defective Motor makeup valve defective. | Adjust pressure to recommended range in affected valve.<br>OR<br>Disassemble and clean valve assembly. Replace all valve components that show damage. |
| All three pressure checks are OK but left travel also fails to run. | Exchange front and rear pump inlet and outlet hoses to test pump function. | If swing and left travel are restored but right travel stops working, replace or repair P1 pump. |
| All three pressure tests are OK, but machine fails to swing at all. | Brake assembly or motor friction plate failing to release. | Check for binding. Disassemble and repair. |
| | Pilot (control) pressure low or swing control valve stuck. | Disassemble / Repair pilot pressure swing spool (305) and / or swing control valve. |
| | Swing motor defective. | Test motor drain rate. Replace / Repair motor. |
| | Gear train defective. | Refer to "Swing Gear Troubleshooting" procedure. |
| Swing functions but only at reduced rpm. | Causes listed above could also produce dragging swing, OR hot or wrong oil OR worn-out parts. | Check above list; then replace oil, test motor drain rate and check for "03" reading (e-EPOS self-test). |
| Left travel speed is also reduced. | Low output at P1 pump or external pilot piping leaks/is clogged. | Clean and repair piping or repair or replace pump P1. |
| Swing control movement is reversed. | Inlet / outlet piping reversed. | Reset controls or reverse piping. |
| Machine swings but continues coasting on past stopping point. | Swing control valve spool not centered. | Replace return spring; clean/ repair valve piston and spool. |
| | Pilot pressure may be outside range. | Disassemble, clean or replace pilot relief valve or pilot valve. |
| | Swing relief valve may be faulty. | Repair/Replace swing relief valve. |
| Swing movement is in one direction only. | Check to see that pilot pressure is the same right and left. | If pilot pressure is unequal, clean or repair piping or repair/replace valve. |
| | Swing control valve spool may be stuck. | Repair/Replace the swing control valve. |
| | Swing relief valve may be faulty. | Repair/Replace the swing relief valve. |
| No rotation and: | | |
| Pressure at swing motor inlet increases. | Swing brake not releasing. | Check brake engagement and disengagement; check release pressure. |
| | Internal damage to gearbox drive train. | Replace broken gears and drive train assemblies. |
| | Overload. | Reduce load weight. |

| Problem | Possible Cause | Remedy |
|---|---|---|
| Pressure at swing motor inlet shows no increase, and the swing motor is making irregular noises. | Swing motor 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 noise (s), during operation. | Low oil level. | Replace oil; refill to specified level. |
| | Bearings or gears worn but not completely inoperative. | Repair or replace gearbox. |

# TROUBLESHOOTING – HYDRAULIC PROBLEMS

| Problem | Possible Cause | Remedy |
|---|---|---|
| Attachment cylinders, swing and travel motors are all inoperable. Loud noises are heard from main pump assembly. | Main pump(s) malfunction. | Repair or replace. |
| | Low oil level in hydraulic system. | Refill. |
| | Main pump inlet (oil supply) piping or hose damaged. | Repair or replace. |
| Attachment cylinders, swing and travel motors are all inoperable. No usual or loud noises can be heard. | Pilot pump malfunction. | Repair or replace. |
| | Pilot cutoff solenoid stuck. | Repair or replace. |
| | Pilot cutoff switch faulty. | Repair or replace. |
| | Engine/pump flex coupling damaged. | Replace flex coupling. |
| Sluggish performance of all hydraulic functions – attachment, swing and travel. | Main pump(s) damaged or worn. | Repair or replace. |
| | Main relief valve pressure off. | Readjust pressure. |
| | Low oil level in hydraulic system. | Refill. |
| | Hydraulic reservoir intake strainer clogged. | Clean. |
| | Pump inlet (supply side) piping or hose allowing air into hydraulic system. | Tighten connection. |

| Problem | Possible Cause | Remedy |
|---|---|---|
| Oil temperature abnormally high. | Oil cooler clogged or air circulation to cooler blocked. | Clean. |
| | Cooling fan belt tension too loose. | Readjust belt tension. |
| | Relief valve set too low. | Readjust valve. |
| | Relief valve in constant use. | Reduce or slow 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 makeup valve. | Clean, repair. |
| | Control valve spool damaged. | Repair or replace. |
| | Dirt in control valve spool. | Clean or replace. |
| | Actuator (joystick, foot pedal) damaged or worn. | Repair or replace. |
| | Internal seal leak in cylinder. | Repair or replace. |
| | Cylinder rod damaged. | Repair or replace. |
| | Pilot valve or piping malfunction. | Repair or replace. |
| | Mechanical linkage frozen, loose or damaged. | Repair or replace. |
| Travel motors inoperable. | Center joint damaged. | Repair or replace. |
| | Parking brake not releasing. | Repair or replace. |
| | Travel motor worn or damaged. | Repair or replace. |
| | Travel motor pilot piping damaged. | Repair or replace. |
| Travel motors operate very slowly. | Track tension poorly adjusted Low oil in idlers or rollers. | Readjust tension Refill. |
| | Travel brake dragging. | Repair. |
| | Track frame out of alignment, deformed or twisted. | Repair. |
| Swing motor inoperable. | Swing brake not releasing. | Repair or replace. |
| | Relief valve malfunction. | Repair or replace. |
| | Pilot piping damaged. | Repair or replace. |
| Swing motor operates unevenly. | Swing gear, bearing or mounting loose or worn. | Repair or replace. |
| | Lubricant worn away, inadequate. | Grease. |
| | Swing relief valve may be faulty. | Repair/Replace the swing relief valve. |

# TROUBLESHOOTING – CONTROL VALVE

Check control valve problems only after other hydraulic circuit operational tests have been made. Refer to the "Troubleshooting Baseline Recommendations" procedure. Pump flow, pilot pressure, Negacon pressure, main relief pressure, and port relief pressure should all be checked before starting to work on the control valve. Make sure the hydraulic system is topped up to the required level and free of oil leaks or air in the system that could cause cavitation problems.

| Problem | Possible Cause | Remedy |
|---|---|---|
| Main relief valve. | Particulate contamination. | Disassemble, clean main poppet. |
| | Broken or damaged spring. | Replace. |
| | Adjusting screw loose. | Readjust. |
| | Main poppet sticking. | Repair/replace. |
| | Clogged orifice in pilot passage to control valve. | Clean/replace. |
| Cylinder goes down in spool neutral. | Excessive clearance between casing and spool. | Replace spool or casing. |
| | Spool does not return to neutral/ sticking spool. | Check secondary pilot pressure. |
| | Spool does not return to neutral because of dirt or other contaminants. | Clean. |
| | Broken or damaged spring. | Replace. |
| | Main relief or port relief not operating properly. | See above. |
| | Impurities in pilot circuit. | Clean. |
| Cylinder drops before start at boom up operation. | Rod check valve damaged or clogged. | Clean/replace. |
| | Poppet sticking. | Clean/replace. |
| | Broken or damaged spring. | Replace. |
| Slow operation or response. | Excessive clearance between spool or casing. | Check pilot pressure and/or replace spool or casing. |
| | Sticking spool. | Clean/replace. |
| | Broken or damaged spring. | Replace. |
| | Main or port relief valve damaged. | Check pressure/replace. |
| Swing priority not operating correctly. | Sticking spool. | Clean/replace. |
| | Solenoid valve faulty. | Replace. |
| Boom and arm cylinders do not perform normally in combined operation. | Priority valve faulty or spool sticking. | Check pilot pressure. |
| | Broken or deformed spring. | Replace. |
| | Excess clearance between right and left casing and valve spool. | Clean/replace. |
| | Clogged spool passage. | Clean/replace, replace filter. |
| Relief valve malfunctions: | | |

| Problem | Possible Cause | Remedy |
|---|---|---|
| Pressure does not increase at all. | Main poppet or pilot poppet stuck open. | Clean/replace. |
| Irregular or uneven pressure. | Poppet seat damaged or pilot piston sticking to main poppet. | Clean/replace. |
| | Loose lock nut and adjusting screw. | Readjust. |
| | Components worn out, past wear limits. | Replace. |

# TROUBLESHOOTING – TRAVEL CONTROL VALVE

| Problem | Possible Cause | Remedy |
|---|---|---|
| Secondary pressure does not increase. | Low primary pressure. | Check primary pressure. |
| | Broken spring. | Replace spring. |
| | Spool sticking. | Clean, repair or replace. |
| | Excess spool to casing clearance. | Replace spool casing. |
| | Worn or loose universal joint (handle) subassembly. | Repair or replace U-joint subassembly. |
| Secondary pressure too high. | Dirt, other interference between valve parts. | Clean, repair or replace. |
| | Return line pressure too high. | Redirect return line. |
| Secondary pressure does not hold steady. | Dirt, other interference between valve parts, or worn spool sticking intermittently. | Clean, repair or replace. |
| | Interference or binding on spool return spring. | Clean, repair or replace. |
| | Interference, restriction or unsteady pressure in tank return line. | Repair or reroute tank return line. |
| | Air bubbles in piping (temporary) or air leak. | Vent air, or repair leak. |
| **NOTE:** *Look for evidence of leaking oil.* | | |

# TROUBLESHOOTING – JOYSTICK CONTROL VALVE

| Problem | Possible Cause | Remedy |
|---|---|---|
| Secondary pressure does not increase. | Low primary pressure. | Check primary pressure. |
| | Broken spring. | Replace spring. |
| | Spool sticking. | Clean, repair or replace. |
| | Excess spool to casing clearance. | Replace spool casing. |
| | Worn or loose handle subassembly. | Repair or replace handle subassembly. |
| Secondary pressure too high. | Dirt, other interference between valve parts. | Clean, repair or replace. |
| | Return line pressure too high. | Redirect return line. |
| Secondary pressure does not hold steady. | Dirt, other interference between valve parts, or worn spool sticking intermittently. | Clean, repair or replace. |
| | Interference or binding on spool return spring. | Clean, repair or replace. |
| | Unsteady pressure in tank return line. | Redirect return line. |
| | Air bubbles in piping (temporary) or air leak. | Vent air, or repair leak. |
| **NOTE:** *Look for evidence of leaking oil to help locate damaged seals or gaskets that could be the cause of air leaks.* | | |

# Accumulator

Edition 1

MEMO

# Table of Contents

## Accumulator

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |
| DX300LC | 5001 and Up |
| DX340LC | 5001 and Up |
| DX420LC | 5001 and Up |
| DX480LC | 5001 and Up |
| DX520LC | 5001 and Up |

# GENERAL DESCRIPTION

The accumulator is a gas-charged storage device designed to hold a reserve quantity of hydraulic fluid under pressure. Accumulators are used in hydraulic circuits in much the same way that condensers (or capacitors) are used to collect, store and maintain electrical charge in a circuit.

In a hydraulic circuit, minor variations or lags in pump output that might otherwise cause unsteady or irregular operation are made up from the supply of pressurized oil in the accumulator.

| Reference Number | Description |
|---|---|
| 1 | Screw Plug |
| 2 | Steel Pressure Vessel |
| 3 | Diaphragm |
| 4 | Fluid Valve |

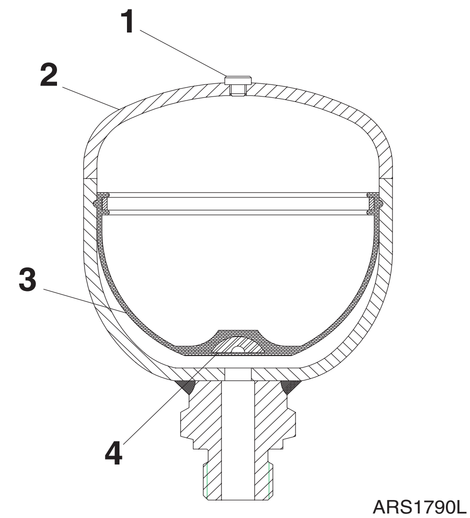



**Figure 1**

Accumulators are solidly constructed to resist the high operating pressures of the fluids they contain. There are only three main moving parts: a plug at the top allows precharging or expelling gas from the compressible, precharged upper chamber; a valve assembly at the bottom of the accumulator for passing hydraulic fluid in and out, and an elastic diaphragm to separate the two chambers. The flexible diaphragm changes shape to conform to the changing pressures and volumes of the two fluids in the upper and lower chambers.

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 prepressure charge of gas (usually nitrogen) is introduced through the port at the top of the accumulator, the diaphragm expands to maximum size. The valve button in the center of the diaphragm pushes into the fluid opening in the bottom chamber, sealing off the lower valve. If the pressure of the gas charge exceeds system oil pressure, no fluid enters the accumulator. The button also keeps the diaphragm from protruding into the lower valve opening.

   **NOTE:** *Precharge pressure is referred to as the "P1" pressure. The accumulator manufacturer's "P1" rated pressure should be stamped or marked on the accumulator's rating plate. Annual checks of actual precharge pressure should be made by tapping a hydraulic pressure gauge (and 3-way adapter coupling) into the valve on the bottom of the accumulator.*

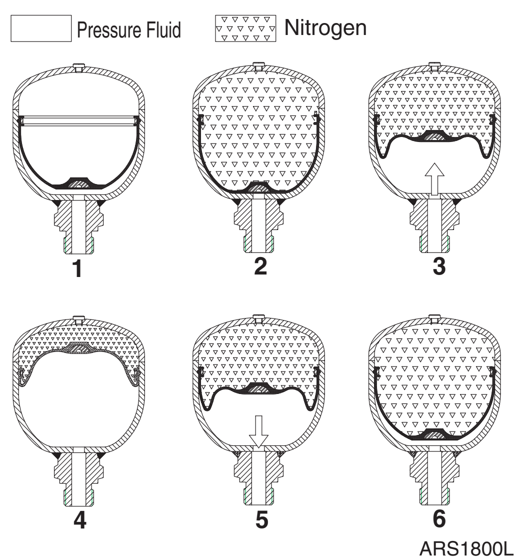



**Figure 2**

*When hydraulic fluid is pushed out the lower valve opening by the pressure of the gas charge on the other side of the diaphragm - and there is no counterpressure from system oil - the valve button on the bottom of the diaphragm eventually seals off the lower oil passage. Just after the needle on the gauge reaches its highest point (when there is 0 bar (0 psi) resistance from hydraulic system pressure) pressure on the gauge will drop sharply to zero, as the accumulator is completely emptied of oil and the diaphragm button closes.*

Record the highest gauge reading and compare to the "P1" rated precharge pressure on the accumulator manufacturer's data label. Repeat this test at least once a year to verify proper functioning of the accumulator.

3. As hydraulic system pressure overcomes accumulator precharge pressure, the flexible diaphragm begins to retract upward.
4. When system oil is at highest working pressure and the accumulator fills to maximum reserve capacity, the flexible diaphragm is pushed up into the top of the upper chamber.

   The highest working pressure is sometimes referred to as the "P3" pressure and can also be referenced on the manufacturer's data label on the exterior of the accumulator.
5. If system oil pressure begins to fall off or is momentarily checked or interrupted, the energy stored on the other side of the diaphragm, in the form of compressed gas, pushes oil back out of the lower chamber, maintaining oil pressure of the circuit.
6. With minimal system pressure, an equilibrium point may be reached in which accumulator precharge pressure and hydraulic system oil pressure achieve a rough balance. In this condition a minimal amount of oil is stored in the accumulator.

## Specifications

| Model | Serial Number | System | Charge Pressure | Volume |
|---|---|---|---|---|
| DX140LC | S/N 5001 and Up | Pilot | 10 $kg/cm^2$ (140 psi) | 320 cc (19.53 $in^3$) |
| DX180LC | S/N 5001 and Up | Pilot | 10 $kg/cm^2$ (140 psi) | 320 cc (19.53 $in^3$) |
| DX225LC | S/N 5001 and Up | Pilot | 10 $kg/cm^2$ (140 psi) | 320 cc (19.53 $in^3$) |
| DX225NLC | S/N 5001 and Up | Pilot | 10 $kg/cm^2$ (140 psi) | 320 cc (19.53 $in^3$) |
| DX255LC | S/N 5001 and Up | Pilot | 10 $kg/cm^2$ (140 psi) | 320 cc (19.53 $in^3$) |
| DX300LC | S/N 5001 and Up | Pilot | 10 $kg/cm^2$ (140 psi) | 320 cc (19.53 $in^3$) |
| DX340LC | S/N 5001 and Up | Pilot | 10 $kg/cm^2$ (140 psi) | 320 cc (19.53 $in^3$) |
| DX420LC | S/N 5001 and Up | Pilot | 10 $kg/cm^2$ (140 psi) | 320 cc (19.53 $in^3$) |
| DX480LC | S/N 5001 and Up | Pilot | 10 $kg/cm^2$ (140 psi) | 320 cc (19.53 $in^3$) |
| DX520LC | S/N 5001 and Up | Pilot | 10 $kg/cm^2$ (140 psi) | 320 cc (19.53 $in^3$) |

# Center Joint (Swivel)

Edition 1

# MEMO

# Table of Contents

## Center Joint (Swivel)

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |
| DX300LC | 5001 and Up |

# GENERAL DESCRIPTION

The center joint (swivel) is designed to allow hydraulic oil from the upper structure to flow to components in the lower structure.

It is capable of allowing continuous 360° rotation of the upper structure in relationship to the lower structure.

# Parts List

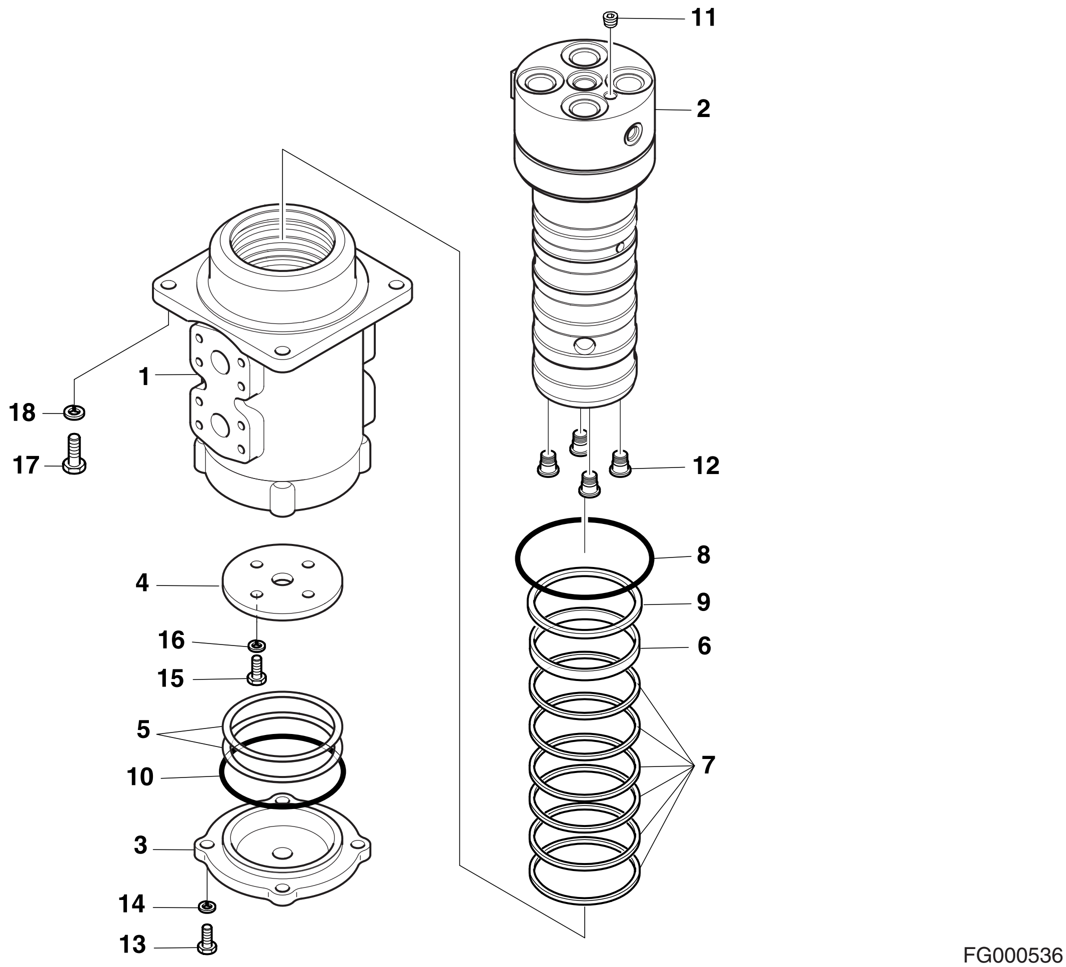


**Figure 1**

| Reference Number | Description |
|---|---|
| 1 | Body |
| 2 | Spindle |
| 3 | Cover |
| 4 | Spacer |
| 5 | Shim |
| 6 | Wear Ring |
| 7 | Slipper Ring |
| 8 | O-ring |
| 9 | O-ring |

| Reference Number | Description |
|---|---|
| 10 | O-ring |
| 11 | Plug |
| 12 | Plug |
| 13 | Bolt |
| 14 | Spring Washer |
| 15 | Bolt |
| 16 | Spring Washer |
| 17 | Bolt |
| 18 | Spring Washer |

# TROUBLESHOOTING, TESTING AND ADJUSTMENT

## Inspection

The center joint should be checked for evidence of external oil leakage every 2,000 operating hours. Leaking or defective O-rings are an indication that dirt and other contaminants could be getting inside the assembly, which will promote accelerated, abnormal wear and may cause early failure of the assembly.

If internal seals or other sliding surface components are worn and there is internal fluid leakage, complete overhaul and repair or replacement of the center joint may be required.

## Testing

To check pressure through the center joint, make up a test kit from the following equipment list:

- 700 bar (10,000 psi) pressure gauge.
- Adapters, connectors, piping and flange block-off plates conforming to those used in high-pressure piping connections of the excavator.
- A high-pressure relief valve with a setting pressure 1.5 times maximum system pressure.
- A stop valve.
- A manually operated, in-line changeover valve.

Install the changeover valve upstream from one of the stem high-pressure ports. Connect the pressure gauge downstream from one of the body ports. Install the stop valve between the changeover valve and the stem of the center joint. Other components should be installed according to the layout in the block diagram. The test kit is used to pressurize the center swivel above normal working pressure and lock in the higher pressure (as the stop valve is closed manually) for a leak down test.

**NOTE:** *The same type of kit can also be made up for the drain port (return line) side of the center joint. Use appropriate piping, connectors, test gauges, etc., and follow the same block diagram general layout (Figure 2).*

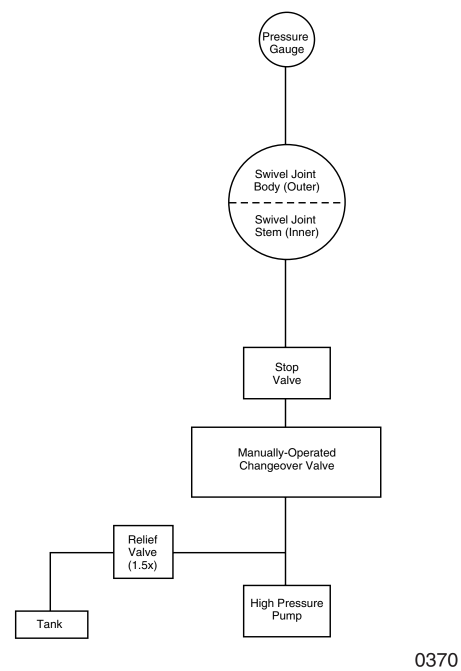


**Figure 2**

# DISASSEMBLY

Refer to the assembly drawing of the swivel joint for component references (Figure 1).

## IMPORTANT

**Do not unbolt the center joint from the lower car body until an adequate number of piping block-off plates are available, for disconnected piping lines. Be sure that system pressure has been vented - including the hydraulic accumulator and tank reserve pressure - before disassembly is started.**

1. Clean off the exterior of the swivel joint after it has been removed.
2. Scribe or otherwise mark a line across the cover and the body of the center joint, to allow reassembly in the same configuration.
3. Unbolt the four 12 mm fasteners holding the cover. Use a vise or V-block to hold the assembly in place.
4. Remove the cover, withdraw the O-ring and remove the retaining ring holding the thrust plate, taking care to support the spindle assembly, so that it will not separate and fall out when retaining ring is removed.
5. If the spindle assembly doesn't separate easily when the thrust plate and retaining ring are removed, use a wooden block and hammer to drive it out of the housing.
6. O-rings and seals should be replaced whenever the assembly is being overhauled or rebuilt. For repair procedures or emergency tear down, use a thin but rounded tip, smoothedge scraper or spatula to remove O-rings or seals, to avoid causing damage to those that must be reused.

   **NOTE:** *The "backup ring" shown in the assembly drawing (above the swivel joint spindle lower seals) should not be overlooked. It is tucked behind the top slip ring, doubled up inside the same groove in the body of the spindle.*

7. Before reassembling the center swivel, visually inspect ball bearing surfaces for visible signs of wear, damage or discoloration and replace any worn component.

   Check clearance between the spindle and thrust plate. Replace any component that shows more than 0.5 mm (0.020") of visible wear.

   Clearance between the spindle and body of the center swivel must be tight. Replace or repair either component if there is more than 0.1 mm (0.0039") of measurable wear.

# REASSEMBLY

1. Prelubricate O-rings with hydraulic oil, white grease or petroleum jelly.

## CAUTION!

**Apply a very light film of white grease or petroleum jelly to the lower rim of the stem and inner surface of the center swivel body. Apply slow, even-handed pressure, using both hands, to slowly push the stem into the body. Seals may be damaged if the stem is pushed in too quickly.**

2. Thoroughly clean all other component surfaces of dirt or grease before reassembly.
3. Reverse disassembly steps for reassembly.
4. Clean threads of fasteners before preapplying Loctite #243 to the threads, and before torquing the thrust plate and cover bolts.
5. Prefill the center swivel with clean hydraulic fluid before reassembly of high-pressure and drain line piping. Clean and prefill piping line ends to reduce the amount of air in the system. Bleed air from the hydraulic system and verify hydraulic tank fluid level before returning the excavator to service.

# Cylinders

Edition 1

## MEMO

# Table of Contents

## Cylinders

MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |
| DX300LC | 5001 and Up |
| DX340LC | 5001 and Up |
| DX420LC | 5001 and Up |

# 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 |

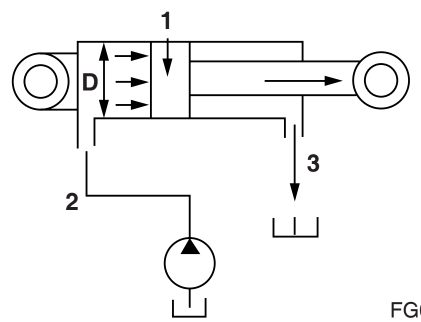


Figure 1

Cylinder piston rods are extended or retracted by oil flow to the back side of the cylinder (shown as ("oil path A") or to the front of the cylinder ("oil path B").

The cylinder rod is extended as oil flow is pumped through the circuit to the back side of the piston. The force (F1) of the piston stroke can be expressed by the formula below, where P = circuit oil pressure and the inside diameter of the cylinder is expressed by D (Figure 1).

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

(P: Pressure, $\pi$ = 3.14, D: Cylinder Inside Diameter)

| | |
|---|---|
| 1 | Cylinder Inside Diameter - D |
| 2 | Oil Path A |
| 3 | Oil Path B |
| 4 | Rod Diameter - R |

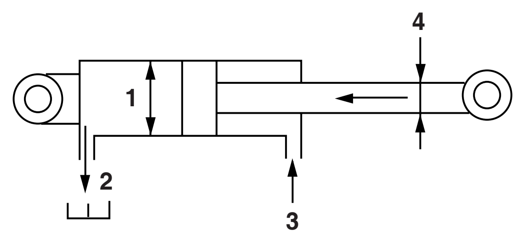


Figure 2

When the cylinder rod is retracted, oil flow through the circuit from the pump to the front side of the cylinder generates a force (F2) that can be expressed by the formula in which the diameter of the piston rod is expressed by R, and the other two terms are the same as in the preceding expression.

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

Because the volume of oil needed to lengthen the cylinder rod (Q1) is greater than the volume of oil required to retract the cylinder rod, it takes more time to extend a cylinder than it does to retract it.

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

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

$Q_1 > Q_2$

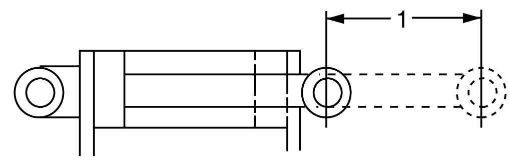


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**Figure 3**

## 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.

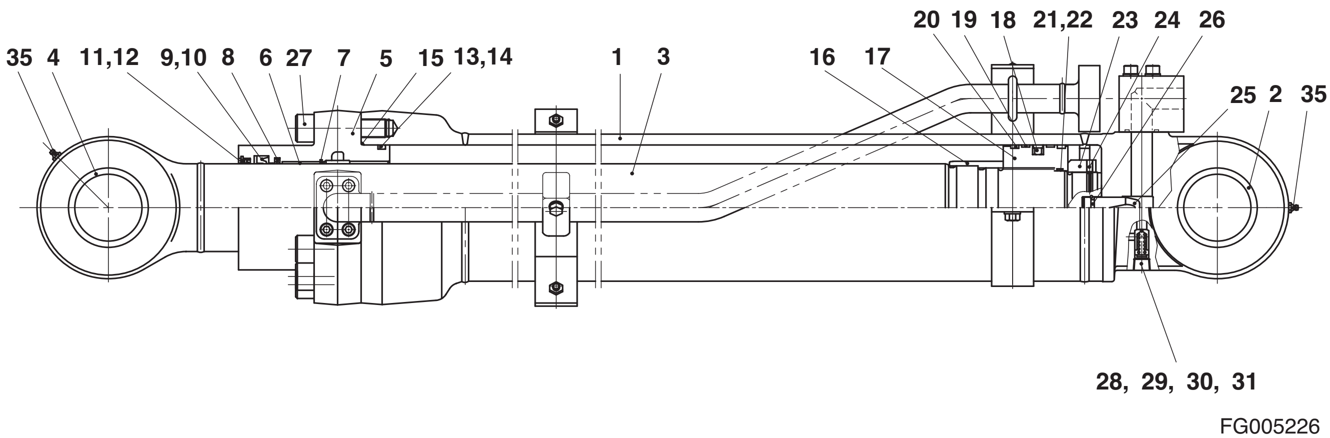



**Figure 4**

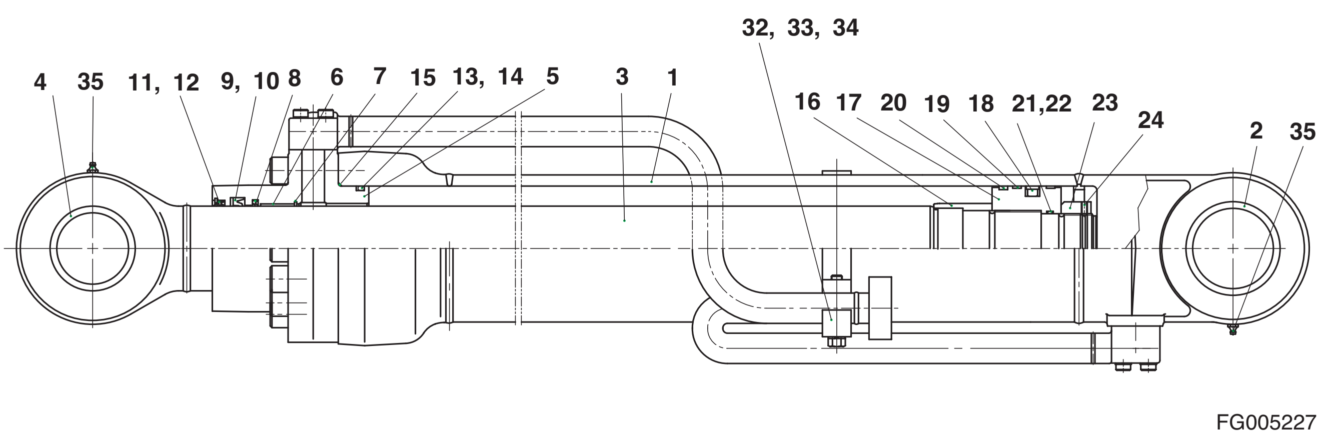



**Figure 5**

| Reference Number | Description |
|---|---|
| 1 | Tube Assembly |
| 2 | Bushing |
| 3 | Rod Assembly |
| 4 | Bushing |
| 5 | Rod Cover |
| 6 | DD-Bushing |
| 7 | Retaining Ring |
| 8 | Buffer Seal |
| 9 | U-Packing |
| 10 | Backup Ring |
| 11 | Dust Wiper |
| 12 | Retaining Ring |
| 13 | O-ring |
| 14 | Backup Ring |
| 15 | O-ring |
| 16 | Cushion Ring |
| 17 | Piston |
| 18 | Slipper Seal |

| Reference Number | Description |
|---|---|
| 19 | Wear Ring |
| 20 | Ring |
| 21 | O-ring |
| 22 | Backup Ring |
| 23 | Piston Nut |
| 24 | Set Screw |
| 25 | Socket Head Bolt |
| 26 | Pipe Band Assembly |
| 27 | Hex Socket Bolt |
| 28 | Check Valve |
| 29 | Spring |
| 30 | Spring Support |
| 31 | Hex Socket Plug |
| 32 | Spring Washer |
| 33 | Hex Bolt |
| 34 | Pipe Assembly |
| 35 | Grease Nipple |

# SPECIAL TOOLS AND MATERIALS

## Piston Nut

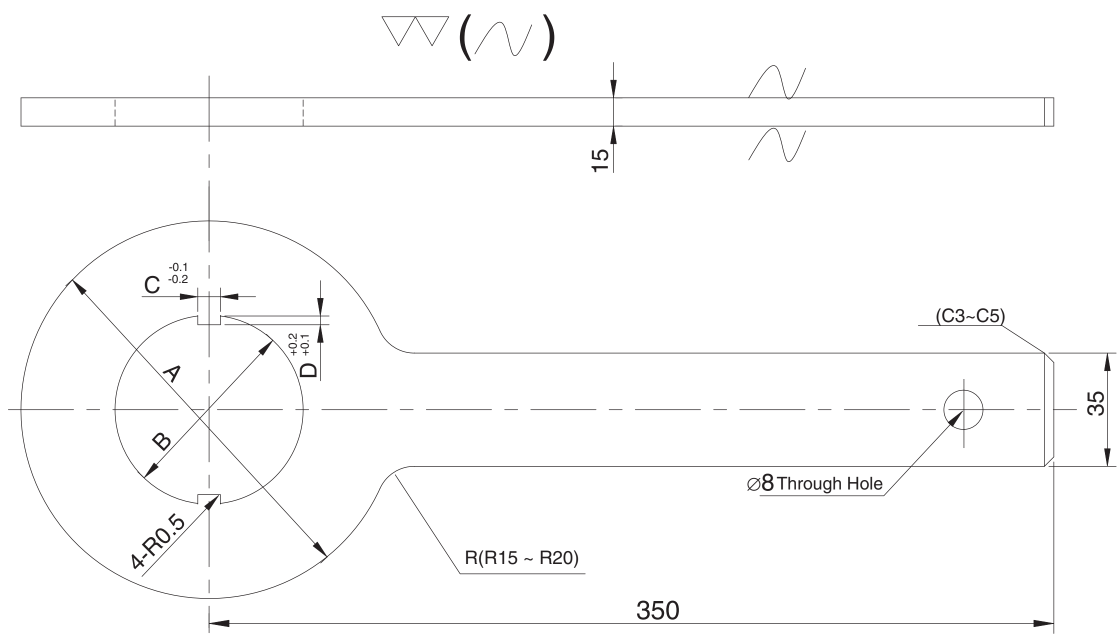



**Figure 6**

Material SM45C (AISI 1045)

Rockwell Harden from 22 - 27

Oil Quench

| MODEL | CYLINDER | ∅A | ∅B | C | D | MODEL (CYLINDER) |
|---|---|---|---|---|---|---|
| DX140LC | BOOM | 125.0 mm (4.92 in) | 85.0 mm (3.35 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| | 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) | |
| | 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) | |
| DX180LC | BOOM | 130.0 mm (5.12 in) | 90.0 mm (3.54 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| | 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) | |
| | BUCKET | 125.0 mm (4.92 in) | 85.0 mm (3.35 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| DX225LC | BOOM | 145.0 mm (5.71 in) | 105.0 mm (4.13 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| | ARM | 145.0 mm (5.71 in) | 105.0 mm (4.13 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| | BUCKET | 130.0 mm (5.11 in) | 89.0 mm (3.50 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| DX225NLC | BOOM | 145.0 mm (5.71 in) | 105.0 mm (4.13 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| | ARM | 145.0 mm (5.71 in) | 105.0 mm (4.13 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| | BUCKET | 130.0 mm (5.11 in) | 89.0 mm (3.50 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| DX255LC | BOOM | 140.0 mm (5.52 in) | 98.0 mm (3.86 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| | ARM | 145.0 mm (5.71 in) | 105.0 mm (4.13 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| | BUCKET | 140.0 mm (5.52 in) | 98.0 mm (3.86 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| DX300LC | BOOM | 142.0 mm (5.59 in) | 102.0 mm (4.02 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| | ARM | 147.0 mm (5.79 in) | 107.0 mm (4.21 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | S/ARM |
| | BUCKET | 140.0 mm (5.52 in) | 98.0 mm (3.86 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | S/BUCKET |
| DX340LC | BOOM | 145.0 mm (5.71 in) | 105.0 mm (4.13 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | OPT BOOM |
| | ARM | 147.0 mm (5.79 in) | 107.0 mm (4.21 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | OPT ARM |
| | BUCKET | 145.0 mm (5.71 in) | 105.0 mm (4.13 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | OPT BUCKET |
| DX420LC | BOOM | 147.0 mm (5.79 in) | 107.0 mm (4.21 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| | ARM | 147.0 mm (5.79 in) | 107.0 mm (4.21 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |
| | BUCKET | 155.0 mm (6.10 in) | 115.0 mm (4.53 in) | 12.0 mm (0.47 in) | 5.0 mm (0.20 in) | |

## Piston Jig

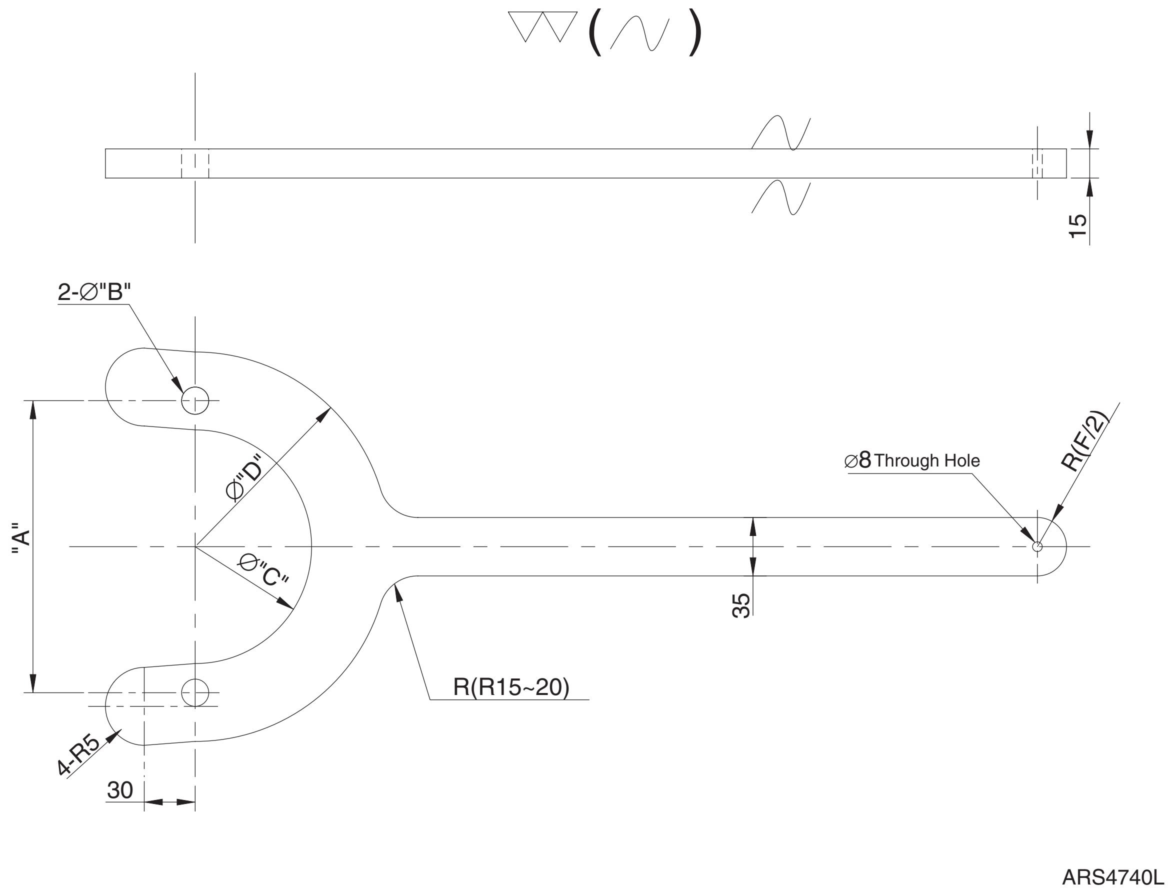



**Figure 7**

Material SM45C (AISI 1045)

Rockwell Harden from 22 - 27

Oil Quench

| MODEL | CYLINDER | A ( ±0.1) | ∅B | ∅C | ∅D | MODEL (CYLINDER) |
|---|---|---|---|---|---|---|
| DX140LC | BOOM | 80.0 mm (3.15 in) | 11.0 mm (0.43 in) | 58.0 mm (2.28 in) | 110.0 mm (4.33 in) | |
| | ARM | 80.0 mm (3.15 in) | 11.0 mm (0.43 in) | 58.0 mm (2.28 in) | 110.0 mm (4.33 in) | |
| | BUCKET | 70.0 mm (2.76 in) | 11.0 mm (0.43 in) | 46.0 mm (1.81 in) | 95.0 mm (3.74 in) | |
| DX180LC | BOOM | 90.0 mm (3.54 in) | 11.0 mm (0.43 in) | 63.0 mm (2.48 in) | 115.0 mm (4.53 in) | |
| | ARM | 96.0 mm (3.78 in) | 13.0 mm (0.51 in) | 69.0 mm (2.72 in) | 130.0 mm (5.12 in) | |
| | 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) | |
| DX225LC | BOOM | 90.0 mm (3.54 in) | 11.0 mm (0.43 in) | 63.0 mm (2.48 in) | 115.0 mm (4.53 in) | |
| | ARM | 110.0 mm (4.33 in) | 13.0 mm (0.51 in) | 75.0 mm (2.95 in) | 140.0 mm (5.51 in) | |
| | BUCKET | 90.0 mm (3.54 in) | 11.0 mm (0.43 in) | 63.0 mm (2.48 in) | 115.0 mm (4.54 in) | |
| DX225NLC | BOOM | 90.0 mm (3.54 in) | 11.0 mm (0.43 in) | 63.0 mm (2.48 in) | 115.0 mm (4.53 in) | |
| | ARM | 110.0 mm (4.33 in) | 13.0 mm (0.51 in) | 75.0 mm (2.95 in) | 140.0 mm (5.51 in) | |
| | BUCKET | 90.0 mm (3.54 in) | 11.0 mm (0.43 in) | 63.0 mm (2.48 in) | 115.0 mm (4.54 in) | |
| DX255LC | BOOM | 96.0 mm (3.78 in) | 13.0 mm (0.51 in) | 69.0 mm (2.72 in) | 130.0 mm (5.12 in) | |
| | 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) | |
| | BUCKET | 96.0 mm (3.78 in) | 13.0 mm (0.51 in) | 69.0 mm (2.72 in) | 130.0 mm (5.12 in) | |
| DX300LC | BOOM | 110.0 mm (4.33 in) | 13.0 mm (0.51 in) | 76.0 mm (2.99 in) | 140.0 mm (5.51 in) | |
| | ARM | 120.0 mm (4.72 in) | 13.0 mm (0.513 in) | 85.0 mm (3.35 in) | 150.0 mm (5.91 in) | S/ARM |
| | BUCKET | 110.0 mm (4.33 in) | 13.0 mm (0.51 in) | 76.0 mm (2.99 in) | 140.0 mm (5.51 in) | S/BUCKET |
| DX340LC | BOOM | 120.0 mm (4.72 in) | 13.0 mm (0.51 in) | 85.0 mm (3.35 in) | 150.0 mm (5.91 in) | OPT BOOM |
| | ARM | 130.0 mm (5.12 in) | 13.0 mm (0.513 in) | 93.0 mm (3.66 in) | 165.0 mm (6.50 in) | OPT ARM |
| | BUCKET | 120.0 mm (4.72 in) | 13.0 mm (0.51 in) | 85.0 mm (3.35 in) | 150.0 mm (5.91 in) | OPT BUCKET |
| DX420LC | BOOM | 130.0 mm (5.12 in) | 13.0 mm (0.51 in) | 93.0 mm (3.66 in) | 165.0 mm (6.50 in) | |
| | ARM | 130.0 mm (5.12 in) | 13.0 mm (0.513 in) | 93.0 mm (3.66 in) | 165.0 mm (6.50 in) | |
| | BUCKET | 130.0 mm (5.12 in) | 13.0 mm (0.51 in) | 93.0 mm (3.66 in) | 165.0 mm (6.50 in) | |

## Steel Bushing Jig

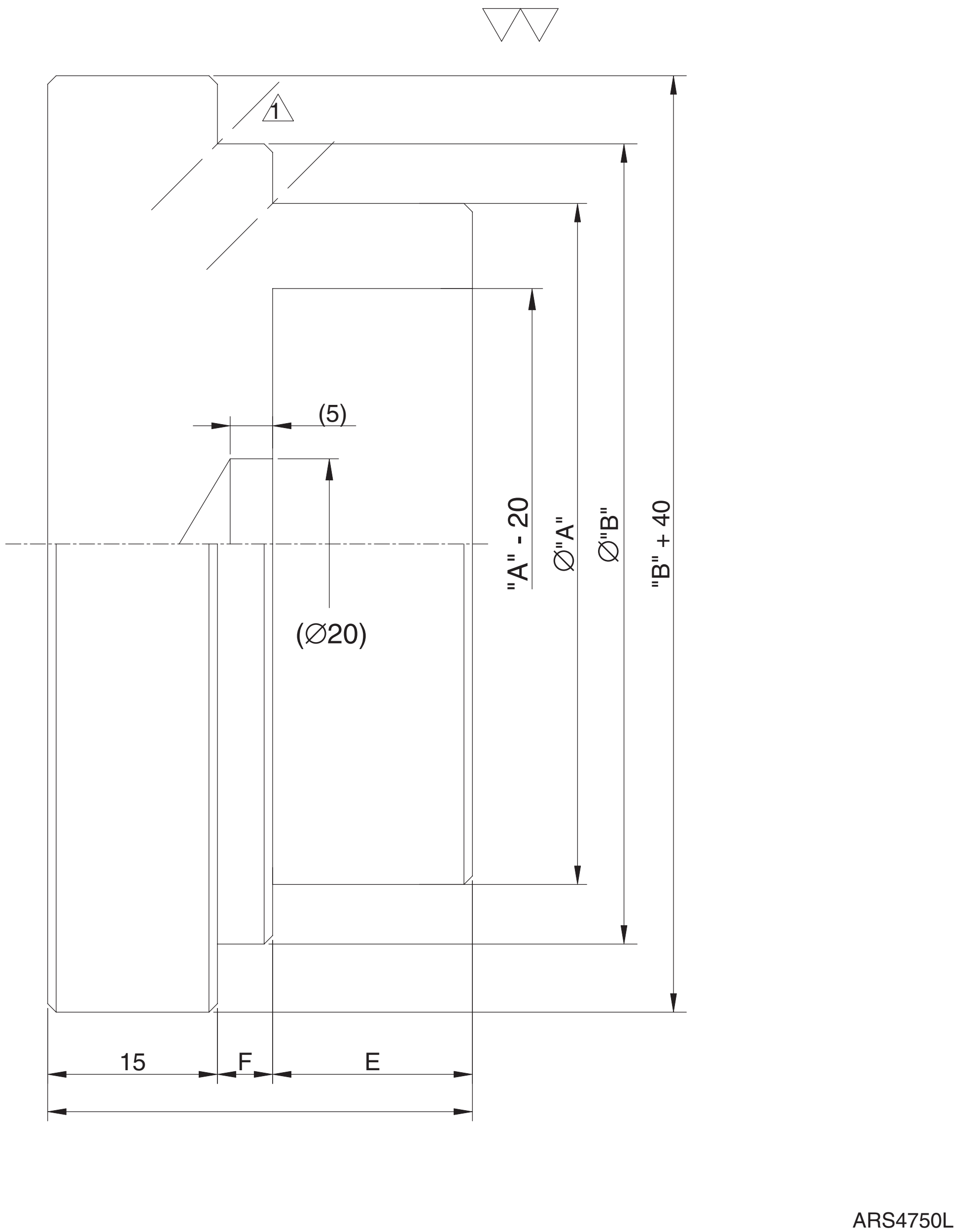



**Figure 8**

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 | $\varnothing A^{-0.05}_{-0.15}$ | $\varnothing$B ( ±0.1) | E | $F^{+0.05}_{0}$ | Part | MODEL (CYLINDER) |
|---|---|---|---|---|---|---|---|
| DX140LC | BOOM | 71.0 mm (2.80 in) | 86.0 mm (3.39 in) | 40.0 mm (1.57 in) | 6.5 mm (0.26 in) | | |
| | ARM | 71.0 mm (2.80 in) | 86.0 mm (3.39 in) | 40.0 mm (1.57 in) | 7.0 mm (0.28 in) | | |
| | BUCKET | 65.0 mm (2.56 in) | 80.0 mm (3.14 in) | 30.0 mm (1.81 in) | 6.0 mm (0.24 in) | | |
| DX180LC | BOOM | 71.0 mm (2.80 in) | 86.0 mm (3.39 in) | 50.0 mm (1.97 in) | 6.0 mm (0.24 in) | | |
| | 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) | | |
| | BUCKET | 71.0 mm (2.80 in) | 86.0 mm (3.39 in) | 50.0 mm (1.97 in) | 6.0 mm (0.24 in) | | |
| DX225LC | BOOM | 80.0 mm (3.15 in) | 95.0 mm (3.74 in) | 40.0 mm (1.58 in) | 6.5 mm (0.26 in) | | |
| | ARM | 80.0 mm (3.15 in) | 95.0 mm (3.74 in) | 40.0 mm (1.58 in) | 6.5 mm (0.26 in) | | |
| | BUCKET | 80.0 mm (3.15 in) | 95.0 mm (3.74 in) | 40.0 mm (1.58 in) | 6.5 mm (0.26 in) | | |
| DX225NLC | BOOM | 80.0 mm (3.15 in) | 95.0 mm (3.74 in) | 40.0 mm (1.58 in) | 6.5 mm (0.26 in) | | |
| | ARM | 80.0 mm (3.15 in) | 95.0 mm (3.74 in) | 40.0 mm (1.58 in) | 6.5 mm (0.26 in) | | |
| | BUCKET | 80.0 mm (3.15 in) | 95.0 mm (3.74 in) | 40.0 mm (1.58 in) | 6.5 mm (0.26 in) | | |
| DX255LC | BOOM | 90.0 mm (3.54 in) | 105.0 mm (4.13 in) | 40.0 mm (1.58 in) | 7.0 mm (0.28 in) | | |
| | ARM | 80.0 mm (3.15 in) | 95.0 mm (3.74 in) | 35.0 mm (1.38 in) | 6.5 mm (0.26 in) | | |
| | BUCKET | 80.0 mm (3.15 in) | 95.0 mm (3.74 in) | 35.0 mm (1.38 in) | 6.5 mm (0.26 in) | | |
| DX300LC | BOOM | 90.0 mm (3.54 in) | 105.0 mm (4.13 in) | 40.0 mm (1.58 in) | 7.0 mm (0.28 in) | | |
| | ARM | 90.0 mm (3.54 in) | 105.0 mm (4.13 in) | 40.0 mm (1.58 in) | 6.5 mm (0.26 in) | | S/ARM |
| | BUCKET | 90.0 mm (3.54 in) | 105.0 mm (4.13 in) | 40.0 mm (1.58 in) | 7.0 mm (0.28 in) | | S/BUCKET |
| DX340LC | BOOM | 100.0 mm (3.94 in) | 115.0 mm (4.53 in) | 45.0 mm (1.77 in) | 7.5 mm (0.30 in) | | OPT BOOM |
| | ARM | 100.0 mm (3.94 in) | 115.0 mm (4.53 in) | 45.0 mm (1.77 in) | 7.5 mm (0.30 in) | | OPT ARM |
| | BUCKET | 100.0 mm (3.94 in) | 115.0 mm (4.53 in) | 45.0 mm (1.77 in) | 7.5 mm (0.30 in) | | OPT BUCKET |
| DX420LC | BOOM | 110.0 mm (4.33 in) | 130.0 mm (5.12 in) | 70.0 mm (2.76 in) | 11.0 mm (0.43 in) | | |
| | ARM | 110.0 mm (4.33 in) | 130.0 mm (5.12 in) | 70.0 mm (2.76 in) | 11.0 mm (0.43 in) | | |
| | BUCKET | 110.0 mm (4.33 in) | 130.0 mm (5.12 in) | 70.0 mm (2.76 in) | 11.0 mm (0.43 in) | | |

## Dust Wiper Jig

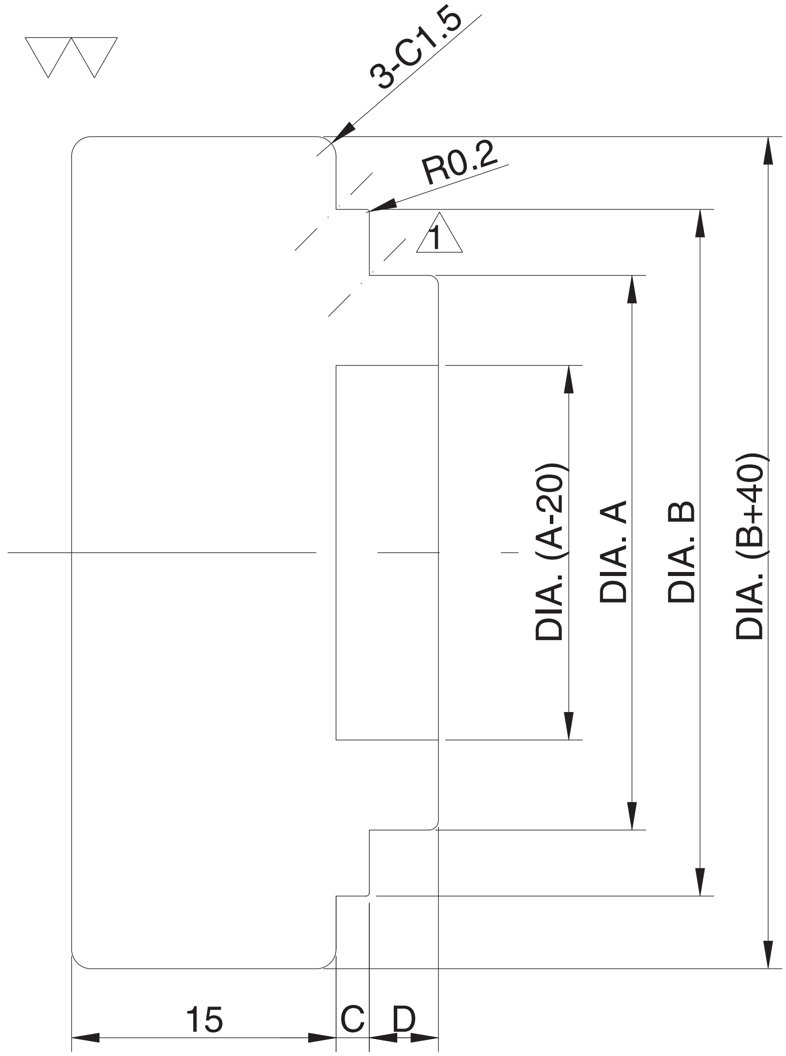



**Figure 9**

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 | $\varnothing A^{-0.2}_{-0.3}$ | $\varnothing B^{-0.2}_{-0.3}$ | $C^{0}_{-0.1}$ | D | MODEL (CYLINDER) |
|---|---|---|---|---|---|---|
| DX140LC | BOOM | 75.0 mm (2.95 in) | 89.0 mm (3.50 in) | 6.0 mm (0.24 in) | 7.0 mm (0.28 in) | |
| | ARM | 80.0 mm (3.15 in) | 94.0 mm (3.70 in) | 6.0 mm (0.24 in) | 7.0 mm (0.28 in) | |
| | BUCKET | 65.0 mm (2.56 in) | 79.0 mm (3.11 in) | 6.0 mm (0.24 in) | 7.0 mm (0.28 in) | |
| DX180LC | BOOM | 80.0 mm (3.15 in) | 94.0 mm (4.29 in) | 6.0 mm (0.24 in) | 7.0 mm (0.28 in) | |
| | ARM | 90.0 mm (3.54 in) | 104.0 mm (4.10 in) | 6.0 mm (0.24 in) | 7.0 mm (0.28 in) | |
| | BUCKET | 75.0 mm (2.95 in) | 89.0 mm (3.50 in) | 6.0 mm (0.24 in) | 7.0 mm (0.28 in) | |
| DX225LC | BOOM | 100.0 mm (3.94 in) | 114.0 mm (4.49 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |
| | ARM | 100.0 mm (3.94 in) | 114.0 mm (4.49 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |
| | BUCKET | 80.0 mm (3.15 in) | 94.0 mm (3.70 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |
| DX225NLC | BOOM | 100.0 mm (3.94 in) | 114.0 mm (4.49 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |
| | ARM | 100.0 mm (3.94 in) | 114.0 mm (4.49 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |
| | BUCKET | 80.0 mm (3.15 in) | 94.0 mm (3.70 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |
| DX255LC | 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) | |
| | ARM | 100.0 mm (3.94 in) | 114.0 mm (4.49 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |
| | BUCKET | 90.0 mm (3.54 in) | 104.0 mm (4.10 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |
| DX300LC | BOOM | 95.0 mm (3.74 in) | 109.0 mm (4.29 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |
| | ARM | 105.0 mm (4.13 in) | 121.0 mm (4.76 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | S/ARM |
| | BUCKET | 90.0 mm (3.54 in) | 104.0 mm (4.10 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | S/BUCKET |
| DX340LC | BOOM | 100.0 mm (3.94 in) | 114.0 mm (4.49 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | OPT BOOM |
| | ARM | 115.0 mm (4.53 in) | 131.0 mm (5.16 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | OPT ARM |
| | BUCKET | 100.0 mm (3.94 in) | 114.0 mm (4.49 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | OPT BUCKET |
| DX420LC | BOOM | 115.0 mm (4.53 in) | 131.0 mm (5.16 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |
| | ARM | 120.0 mm (4.72 in) | 136.0 mm (5.35 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |
| | BUCKET | 110.0 mm (4.33 in) | 126.0 mm (4.96 in) | 6.0 mm (0.24 in) | 7.0 mm (2.28 in) | |

## Slipper Seal Jig

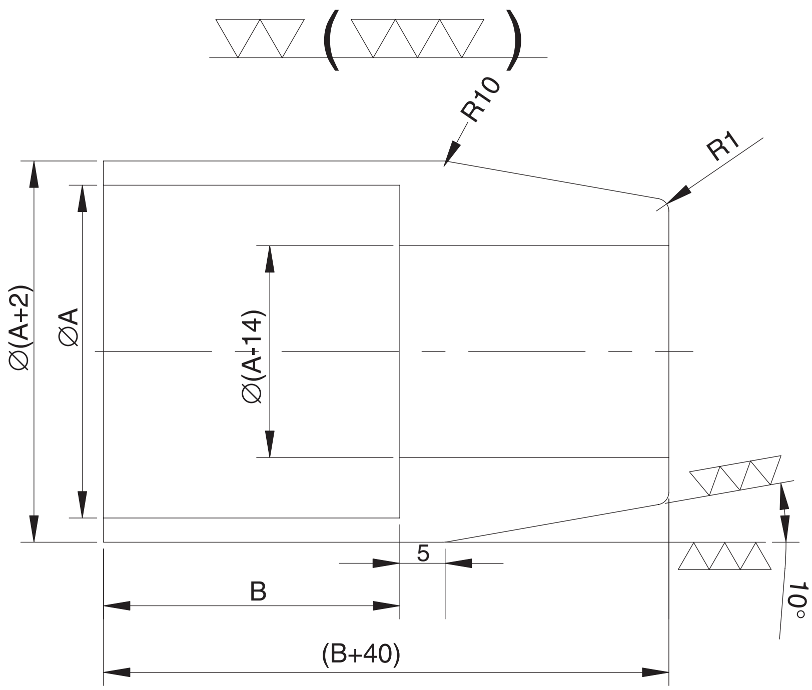



**Figure 10**

| MODEL | CYLINDER | $\varnothing A^{+0.2}_{+0.1}$ | $B^{+0.2}_{+0.1}$ | MODEL (CYLINDER) |
|---|---|---|---|---|
| DX140LC | BOOM | 110.0 mm (4.33 in) | 28.5 mm (1.12 in) | |
| | ARM | 115.0 mm (4.53 in) | 28.5 mm (1.12 in) | |
| | BUCKET | 95.0 mm (3.74 in) | 28.5 mm (1.12 in) | |
| DX180LC | BOOM | 115.0 mm (4.53 in) | 28.5 mm (1.12 in) | |
| | ARM | 125.0 mm (4.92 in) | 28.5 mm (1.12 in) | |
| | BUCKET | 110.0 mm (4.33 in) | 28.5 mm (1.12 in) | |
| DX225LC | BOOM | 140.0 mm (5.51 in) | 28.5 mm (1.12 in) | |
| | ARM | 150.0 mm (5.91 in) | 28.5 mm (1.12 in) | |
| | BUCKET | 120.0 mm (4.72 in) | 28.5 mm (1.12 in) | |
| DX225NLC | BOOM | 140.0 mm (5.51 in) | 28.5 mm (1.12 in) | |
| | ARM | 150.0 mm (5.91 in) | 28.5 mm (1.12 in) | |
| | BUCKET | 120.0 mm (4.72 in) | 28.5 mm (1.12 in) | |
| DX255LC | BOOM | 130.0 mm (5.12 in) | 28.5 mm (1.12 in) | |
| | ARM | 140.0 mm (5.51 in) | 28.5 mm (1.12 in) | S/ARM |
| | BUCKET | 130.0 mm (5.12 in) | 28.5 mm (1.12 in) | S/BUCKET |
| DX300LC | BOOM | 140.0 mm (5.51 in) | 28.5 mm (1.12 in) | |
| | ARM | 150.0 mm (5.91 in) | 28.5 mm (1.12 in) | S/ARM |
| | BUCKET | 140.0 mm (5.51 in) | 28.5 mm (1.12 in) | S/BUCKET |
| DX340LC | BOOM | 150.0 mm (5.91 in) | 28.5 mm (1.12 in) | OPT BOOM |
| | ARM | 170.0 mm (6.69 in) | 34.5 mm (1.36 in) | OPT ARM |
| | BUCKET | 150.0 mm (5.91 in) | 28.5 mm (1.12 in) | OPT BUCKET |
| DX420LC | BOOM | 165.0 mm (6.50 in) | 34.5 mm (1.36 in) | OPT BOOM |
| | ARM | 180.0 mm (7.09 in) | 41.5 mm (1.63 in) | OPT ARM |
| | BUCKET | 160.0 mm (6.30 in) | 34.5 mm (1.36 in) | OPT BUCKET |

# Slipper Seal Straightening Jig

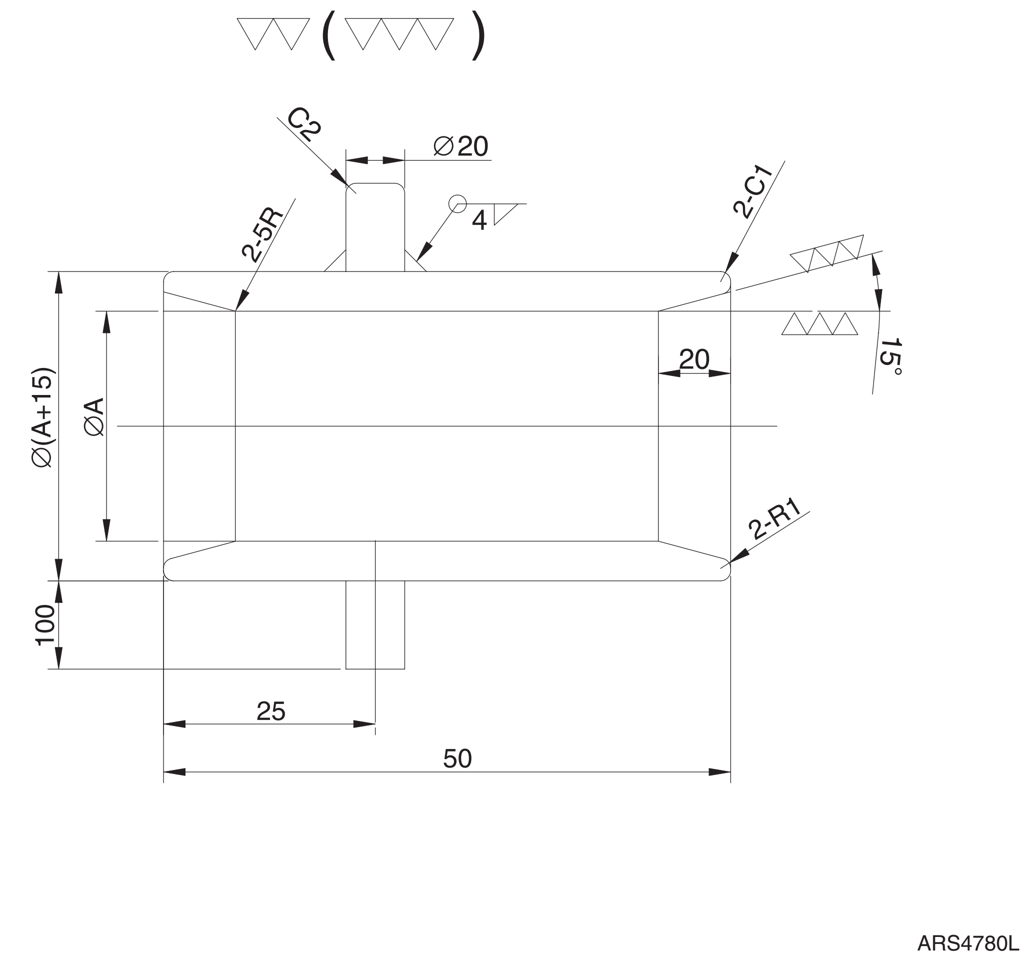



**Figure 11**

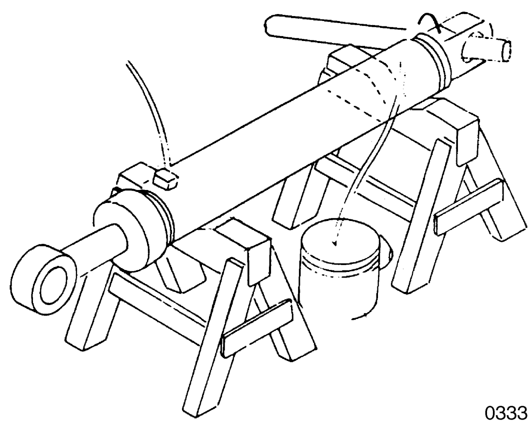
| MODEL | CYLINDER | $\varnothing A^{+0.2}_{+0.1}$ | MODEL (CYLINDER) |
|---|---|---|---|
| DX140LC | BOOM | 110.0 mm (4.33 in) | |
| | ARM | 115.0 mm (4.53 in) | |
| | BUCKET | 95.0 mm (3.74 in) | |
| DX180LC | BOOM | 115.0 mm (4.53 in) | |
| | ARM | 125.0 mm (4.92 in) | |
| | BUCKET | 110.0 mm (4.33 in) | |
| DX225LC | BOOM | 140.0 mm (5.51 in) | |
| | ARM | 150.0 mm (5.91 in) | |
| | BUCKET | 120.0 mm (4.72 in) | |
| DX225NLC | BOOM | 140.0 mm (5.51 in) | |
| | ARM | 150.0 mm (5.91 in) | |
| | BUCKET | 120.0 mm (4.72 in) | |
| DX255LC | BOOM | 130.0 mm (5.12 in) | |
| | ARM | 140.0 mm (5.51 in) | S/ARM |
| | BUCKET | 130.0 mm (5.12 in) | S/BUCKET |
| DX300LC | BOOM | 140.0 mm (5.51 in) | |
| | ARM | 150.0 mm (5.91 in) | S/ARM |
| | BUCKET | 140.0 mm (5.51 in) | S/BUCKET |
| DX340LC | BOOM | 150.0 mm (5.91 in) | OPT BOOM |
| | ARM | 170.0 mm (6.69 in) | OPT ARM |
| | BUCKET | 150.0 mm (5.91 in) | OPT BUCKET |
| DX420LC | BOOM | 165.0 mm (6.50 in) | OPT BOOM |
| | ARM | 180.0 mm (7.09 in) | OPT ARM |
| | BUCKET | 160.0 mm (6.30 in) | OPT BUCKET |

# DISASSEMBLY

## CAUTION!

**Vent air from the hydraulic system before disconnecting cylinder piping connections. Use the lever on the reservoir, while the engine is running. Discharge the hydraulic accumulator and vent residual tank pressure after the engine is shut off. Pour clean replacement fluid back into the system if excessive fluid is lost.**

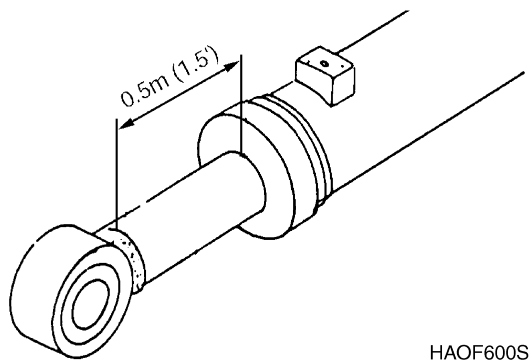
1. Following removal of cylinder from excavator attachment, support cylinder on some type of sturdy work platform and drain all oil. Rotate cylinder so that piping ports are on top, to allow trapped air to vent.



0333

**Figure 12**

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

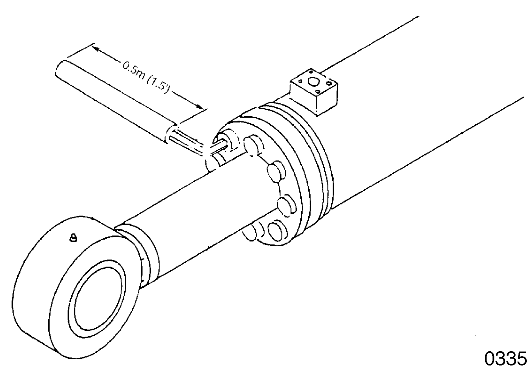



HAOF600S

**Figure 13**

3. Remove bolts (27) on the end of cylinder.

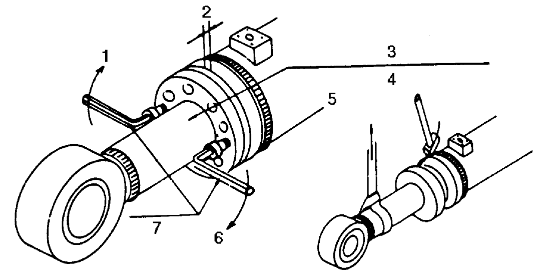
   **NOTE:** *Wrap a cloth or other protective material around piston rod, to avoid possibility of accidentally scratching or scoring rod surface while fasteners are being loosened and removed. Component parts (numbered in parentheses) are keyed to Figure 4.*




0335

**Figure 14**

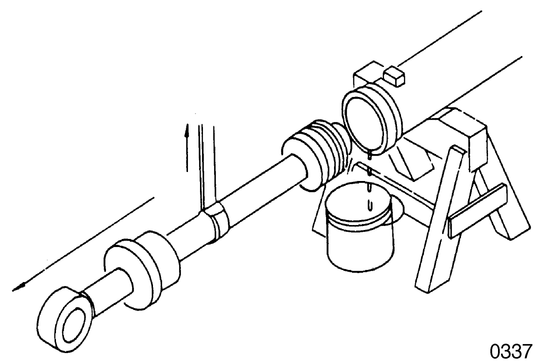
4. Tap two bolts into cover of cylinder head, 180° apart. Tighten them in a staggered, even sequence, to back off piston rod end cover from edge of cylinder wall. Look for adequate clearance between cover and end of cylinder wall before using a plastic or other soft-faced hammer for final disassembly.




HAOF610S

**Figure 15**

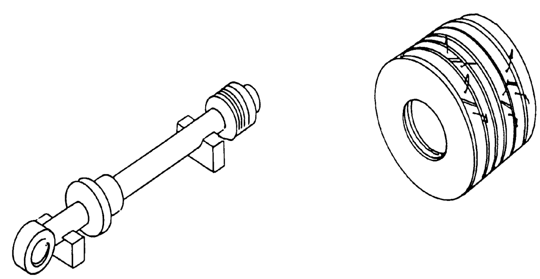
5. Begin withdrawing piston rod assembly, away from cylinder. Attach a lifting support when final 1/3 of rod is still inside barrel of cylinder. Prepare support blocks for piston rod before it has been completely withdrawn.



0337

**Figure 16**

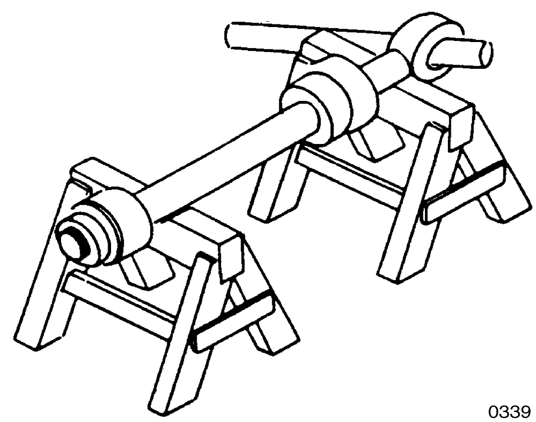
6. Lower piston rod to support blocks and detach wear ring (outer surface) (19) from end of rod.



HAOF620S

**Figure 17**

7. Immobilize piston rod by inserting a wooden or other nonscoring, nonmetallic support through end of rod.



0339

**Figure 18**

8. Remove set screw using socket wrench.

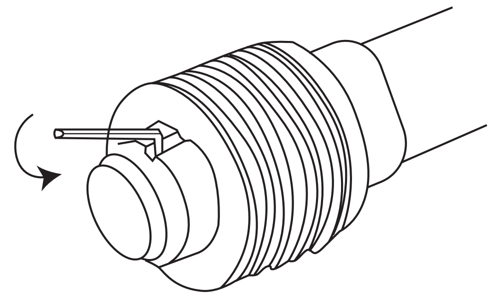



**Figure 19**

9. Fabricate or purchase a piston nut removal wrench. (Dimensions are called off at beginning of this procedure. This tool may also be ordered through your local *DOOSAN* Parts distributor). Remove nut from end of piston.

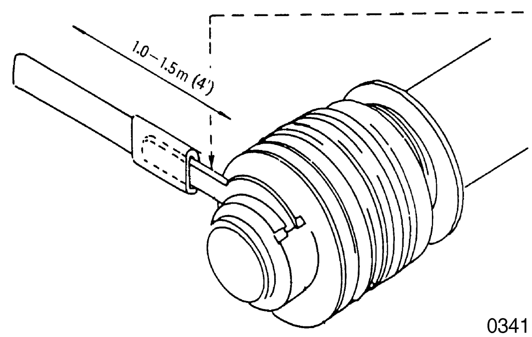



**Figure 20**

10. Use second piston tool described at beginning of this procedure to separate piston. Detach cushion ring (16), taking care not to damage cushion ring.

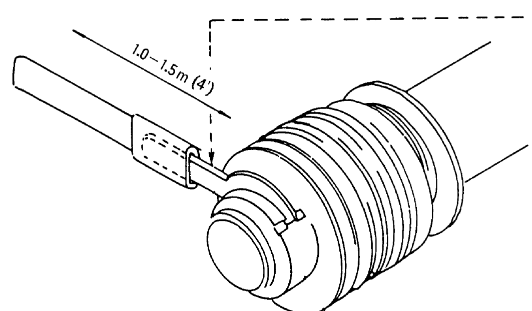



**Figure 21**

11. Use a plastic hammer to evenly pull off rod cover (5) from end of piston rod. Be careful not to damage rod bushing (6) and dust wiper, U-packing and other seals.

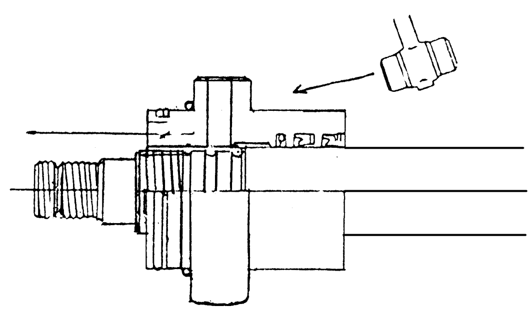



**Figure 22**

12. Use a dull, rounded tip tool to pry off O-ring (13) and backup ring (14).

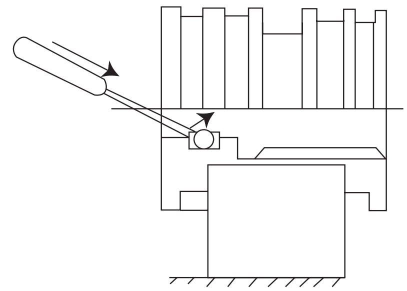



**Figure 23**

13. Find a screwdriver with an appropriate width tip to facilitate removal of slipper seal (18), wear ring (19) and slide ring (20) from piston (17).

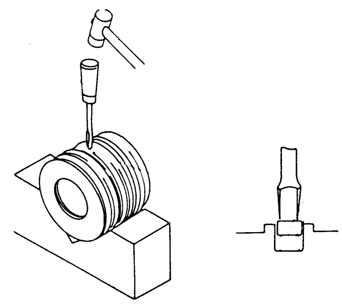



**Figure 24**

14. Remove O-ring (21) and backup ring (22) from cylinder head.

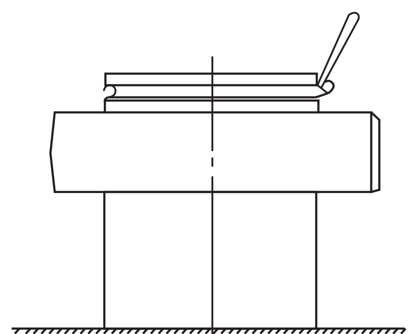



**Figure 25**

15. During disassembly of cylinder head, be careful not to damage buffer seal (8) and U-packing (9).

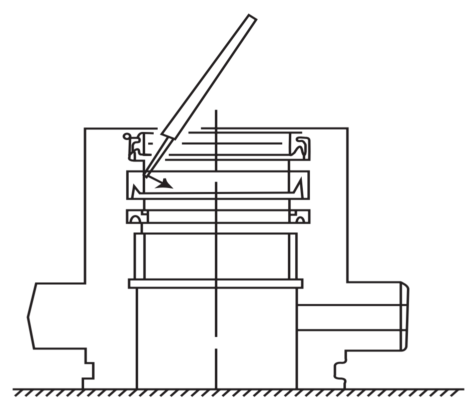



**Figure 26**

16. Disassemble retaining ring (12) and dust wiper (11). Separate retaining ring (7) and rod bushing (6).

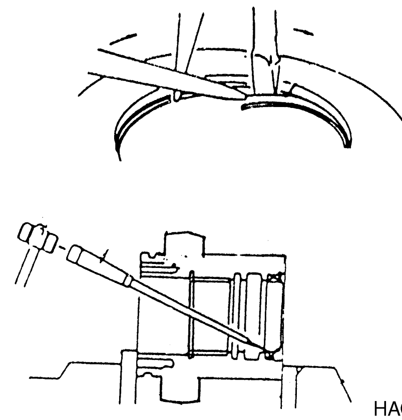



Figure 27

17. Force out pin bushing (2), (4) from body of cylinder.

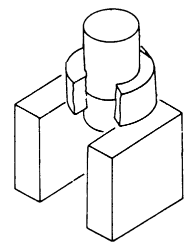



Figure 28

# REASSEMBLY

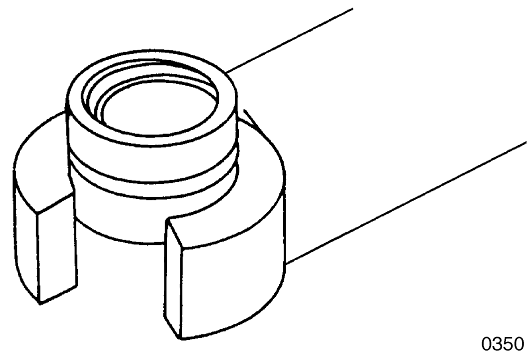
## IMPORTANT

**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.*

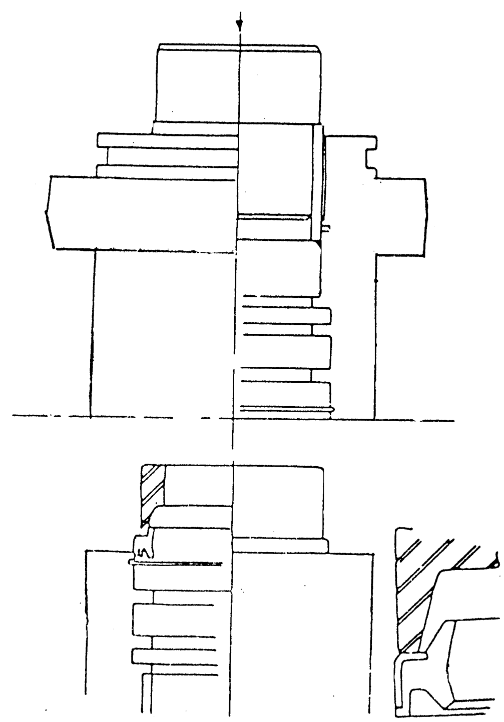
1. Reassemble pin bushing (2), (4) to piston rod and body of cylinder.



0350

**Figure 29**

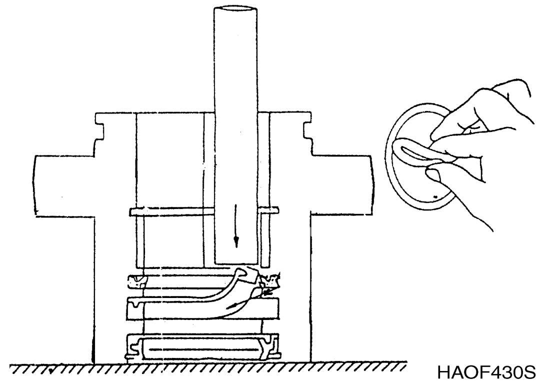
2. Following reassembly of rod cover components, install the dust wiper (11) and rod bushing (6) to the rod cover (5). Insert retaining rings (7 and 12).



HAOF440S

**Figure 30**

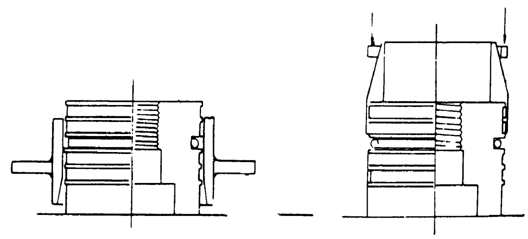
3. Prelubricate O-rings and seals before reassembly (Figure 31).



HAOF430S

**Figure 31**

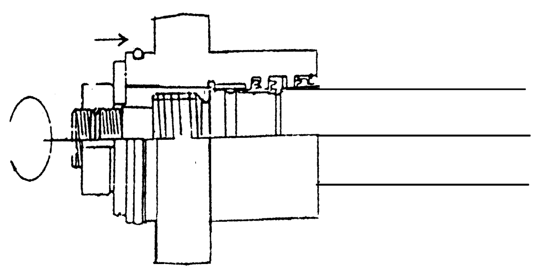
4. Before starting to rebuild piston assembly, heat slipper seal for 5 minutes in an oil bath warmed to 150° - 180°C (302° - 356°F). Use special slipper seal jig (third item in list of specialized tools at the beginning of this procedure) to attach seal. Cool seal by pushing a retracting jig against seal for several minutes. Apply a strip of clean, see-through sealing tape around slipper seal to keep it free of dust.



0353

**Figure 32**

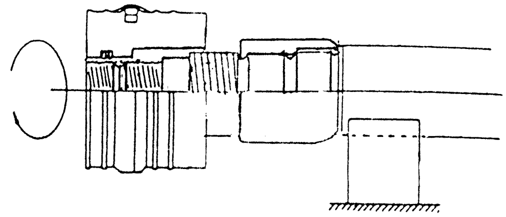
5. Immobilize piston rod on solid support blocks. Assemble O-ring (21) and backup ring (22). Prepare to attach rod cover assembly to piston rod. Push rod cover by tightening piston nut (23).



HAOF450S

**Figure 33**

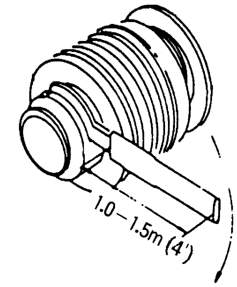
6. Assemble cushion ring (16) and attach piston assembly to piston rod.



HAOF460S

**Figure 34**

7. Use specially fabricate or factory sourced tool to tighten piston nut (23).

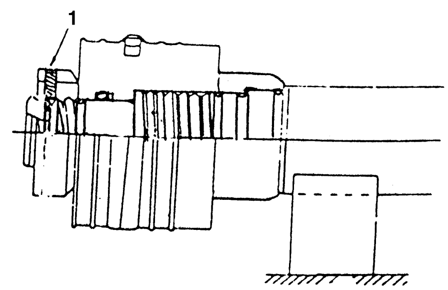



0356

Figure 35

8. Assemble wear ring (19), slide ring (20) and set screw (24) to piston assembly.

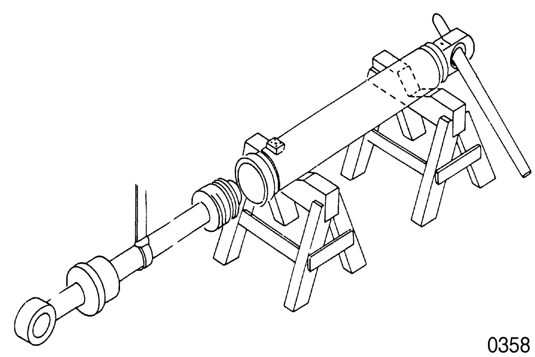
| Reference Number | Description |
|---|---|
| 1 | Set Screw |




HAOF470S

Figure 36

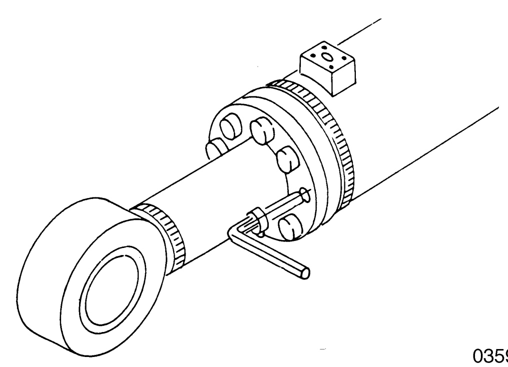
9. Immobilize body of cylinder before reassembly.



0358

Figure 37

Preapply fastener locking compound (Loctite #242 or #243 or an alternate manufacturer's equivalent product) to all end cover retaining bolts. Wrap a protective cushion around end of rod while tightening fasteners, to prevent possible damage to polished surface of rod, should a wrench slip during retightening.



0359

Figure 38

# Swing Motor

Edition 1

# MEMO

# Table of Contents

## Swing Motor

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX140W | 5001 and Up |
| DX160W | 5001 and Up |

## Indication of Type

TSM 140 CH B — 10 A -01 / 270

Relief Valve
Setting Pre.

Design Code

Specification
A: Swing Specification

Shaft Geometry
10 : Male Spline
20 : Female Spline

Mechanical Brake Yes Or No
B : Brake Built-in

Valve Cover Code

Displacement
64 : 64 cc/rev
72 : 72 cc/rev
86 : 86 cc/rev
128 : 127.9 cc/rev
140 : 140.5 cc/rev

Motor Type

## Specifications

| Model | | TSM64 | TSM72 | TSM86 | TSM128 | TSM140 |
|---|---|---|---|---|---|---|
| Displacement | | 64 | 72 | 86 | 127.9 | 140.5 |
| Pressure (kg•cm$^2$) | Rated | 330 | 330 | 330 | 330 | 330 |
| | Max | 400 | 400 | 400 | 400 | 400 |
| Maximum speed (min$^{-1}$) | | 2500 | 2200 | 1900 | 2000 | 1800 |
| *1 Theoretical output torque (kg•m) | | 33.6 | 37.8 | 45.1 | 67.1 | 73.7 |
| *2 Theoretical output power (KW) | | 75.8 | 85.2 | 86.0 | 134.2 | 134.5 |
| Brake torque (kg•m) | | 36.8 | 36.8 | 36.8 | 70 | 70 |
| Brake release pressure (kg•cm$^2$) | | 24 | 24 | 24 | 26 | 26 |
| Weight (kgf) | | 42.3 | 42.3 | 42.3 | 62 | 62 |

**NOTE:** **1. The theoretical value at the rated pressure, not including mechanical efficiency.*

**2. The theoretical value at the rated pressure and the max. speed.*

**NOTE:** *TSM86 series can be applied from 64cc/rev to 86cc/rev by the change of displacement.*

*TSM140 series can be applied from 127.9cc/rev to 140.5cc/rev by the change of displacement.*

# Construction and Principles of Working

## Construction

The Construction

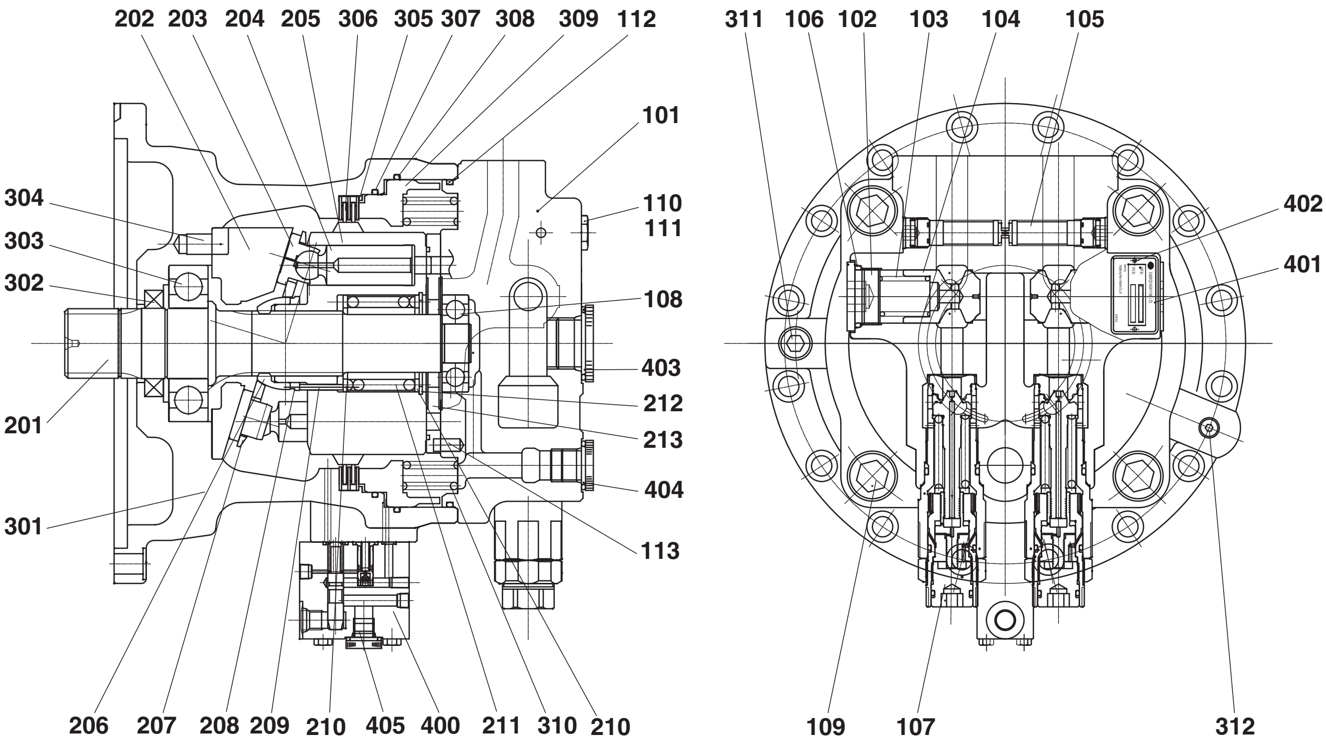



**Figure 1** Construction of Motor

Parts No. and Names

| Reference Number | Description |
|---|---|
| 101 | Valve Casing |
| 102 | Plug |
| 103 | Spring |
| 104 | Plunger |
| 105 | Swing Reactionless Valve Ass'y |
| 106 | O-ring |
| 107 | Relief Valve |
| 108 | Ball Bearing |
| 109 | Socket Bolt |
| 110 | Vp Plug |
| 111 | O-ring |
| 112 | O-ring |
| 113 | Pin Spring |
| 201 | Driveshaft |
| 202 | Swash Plate |
| 203 | Shoe |
| 204 | Piston |
| 205 | Cylinder Block |
| 206 | Thrust Ball |
| 207 | Retainer Plate |
| 208 | Collar |

| Reference Number | Description |
|---|---|
| 209 | Roller |
| 210 | Washer |
| 211 | Spring |
| 212 | Ring Snap |
| 213 | Valve Plate |
| 301 | Casing |
| 302 | Oil Seal |
| 303 | Ball Bearing |
| 304 | Parallel Pin |
| 305 | Separation Plate |
| 306 | Friction Plate |
| 307 | O-ring |
| 308 | O-ring |
| 309 | Brake Piston |
| 310 | Brake Spring |
| 311 | PT-plug |
| 312 | PT-plug |
| 400 | Brake Valve |
| 401 | Nameplate |
| 402 | Rivet Screw |

**Principles of Working**

Motor Part

High-pressure oil from the control valve is routed through valve casing and valve plate to pistons. When the oil enters the cylinder bores through port, it forces the pistons against the fixed inclined swash plate (F1,F2). The force (F2) causes the piston shoes to slide on the swash plate forcing the rotating group to turn, thereby rotating the output shaft.

During the second half of the motor's revolution, low-pressure oil is discharged as the pistons ride to toward a higher position on the shoe plate.

A small amount of supply oil flows through the center of each piston to lubricate the piston ball joint and the piston shoe face. The motor is internally lubricated from leakage inside the motor.

To reverse rotation, system oil flow is changed from inlet port to outlet port and viceversa. Theoretical output torque is as follow formula.

$$T = \frac{p \times q}{2 \times \pi}$$

p : Effective Pressure (kg•cm$^2$)

q : Displacement (cc/rev)

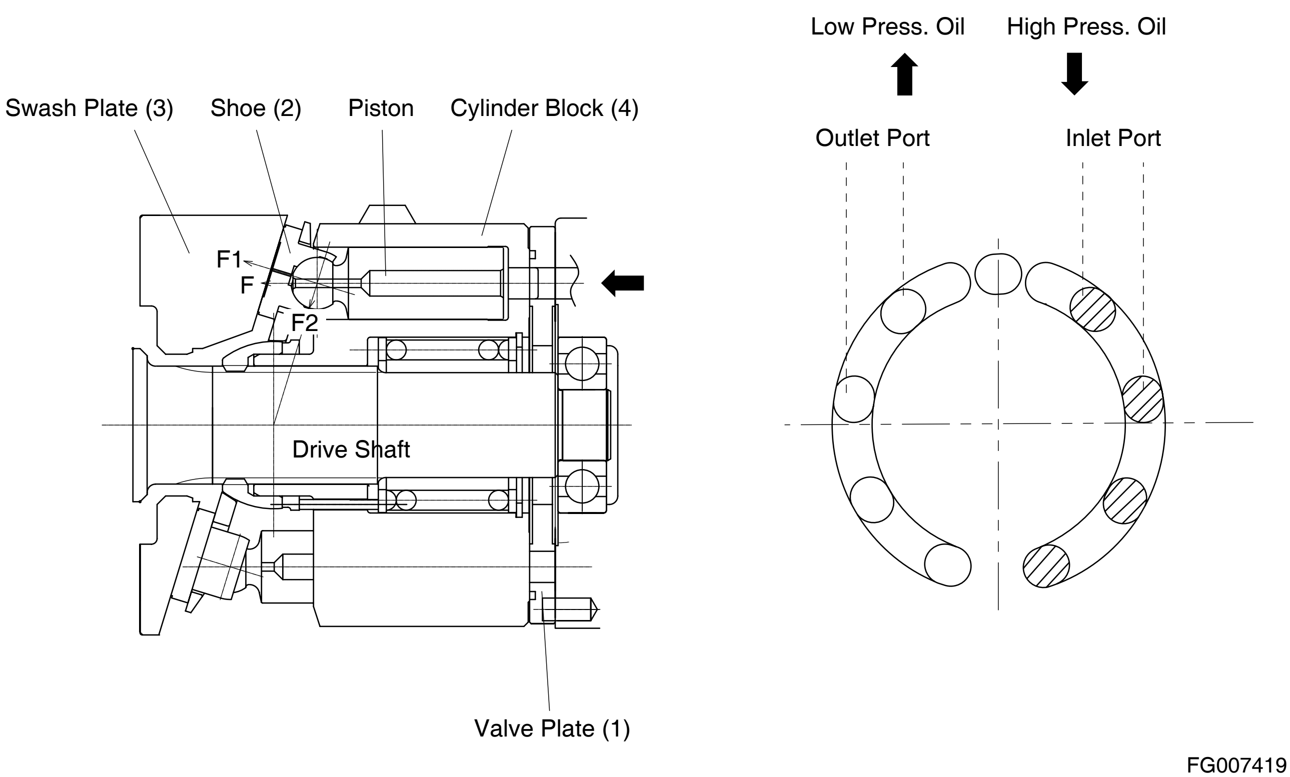



**Figure 2** Diagram Showing the Working Explanation

1. Anticavitation Check Valve

   The motor can be rotated faster than supplied oil flow because there is no counterbalancing valve to prevent over speed ;

   to prevent cavitation of the motor, oil compensation insufficient flow is drawn through the anti-cavitation check valve.

2. Relief Valve: KRD22EK10C (See Figure 4 on page -13)

   We consider that port P is applied pressure by tank pressure.

   Port P, R are affected by tank pressure at first, as shown fig. 3-(1). The relief valve starts operating when the force that is determined by multiply the pressure area (A1) of plunger (301) by pressure P1 is equal to the sum spring (321) force (Fsp) and the force that is determined by multiply the pressure area (A2) by pressure Pg of room 'g' in the plunger (301).

   Here, Pg is the pressure of room 'g' applied pressure by passing oil through orifice m. If Pg arrives at the pressure which is determined by spring (321) pushing the piston (302), the piston move to left side. when piston (302) move left side, room 'h' operates as damping room because of orifice (n) which is designed at the side of adjustment plug (401) and piston (302). Because of this mechanism, the pressure of room 'g' increases smoothly while the piston (302) reaches end of adjustment plug (401). (Figure 4-(2))

$$P1 \times A1 = Fsp + Pg \times A2$$

$$P1 = \frac{Fsp + Pg \times A2}{A1}$$

   If the piston (302) reaches end of adjustment plug (401), it doesn't move left side anymore. So, the pressure of room 'g' is Ps and spring (321) force is Fsp. (Figure 4-(3)) Therefore, the pressure P changes as shown Figure 4-(4). The pressure (Ps) of last state is following equation.

$$P1 \times A1 = Fsp' + Pg \times A2$$

$$P1 = \frac{Fsp'}{A1 - A2}$$

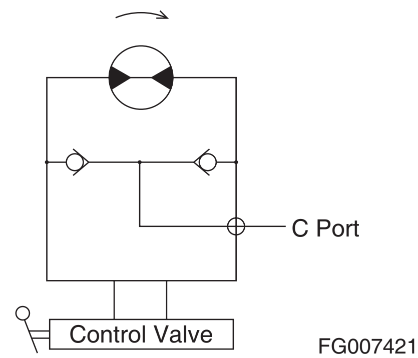



**Figure 3**

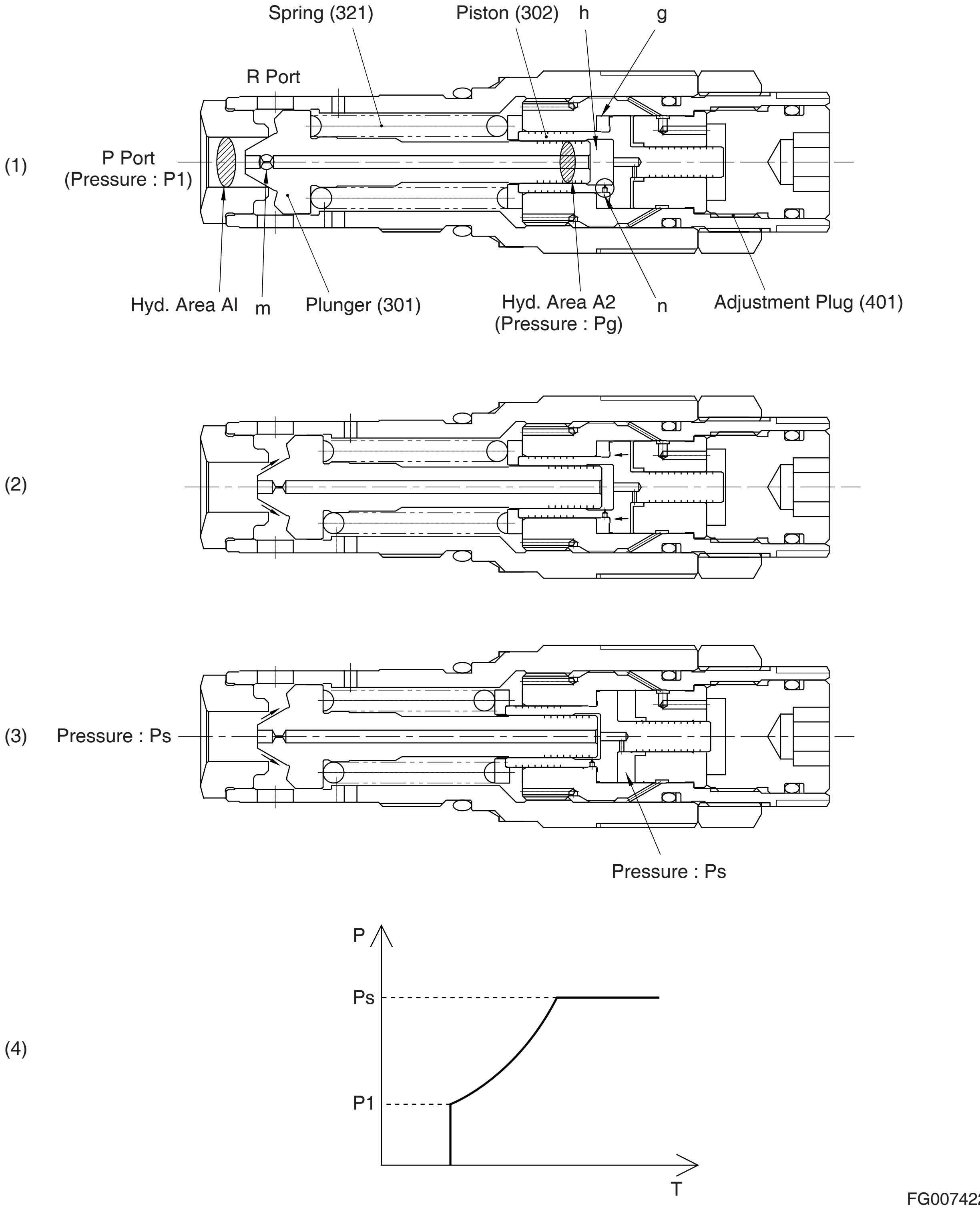



**Figure 4** Relief Valve : KRD22EK10C Working Description

3. Swing Reactionless Valve

By the spool's shift in the main control valve, oil is supplied to Hydraulic motor's A port (or B port), and moving the poppet of reactionless valve, blocks the bypass and operates swing-device. (Figure 5-(1))

Returning the spool to neutral position, block the two ports of Hydraulic motor, but the swing-device tends to swing by inertia-force. The swing force is transmitted to hydraulic motor by reduction gear. After stops the swing-device by brake pressure which is created in B port (or A port) and tends to shift to the opposite direction. Because of the brake pressure, the swing device stop, first, and tends to reverse. Although the oil pressure of B port tries to shift the poppet to left side, delays the operating by the orifice of the A port. At this time, forms bypass between A port and B port, and the pressure oil in B port flows into A port through the bypass. (Figure 5-(2))

And the B side poppet moves to left side till blocking the bypass. (Figure 5-(3)) At the reverse pressure generating process of B port, this process prevents the reverse and stop the motor by bypassing the pressure oil to A port.

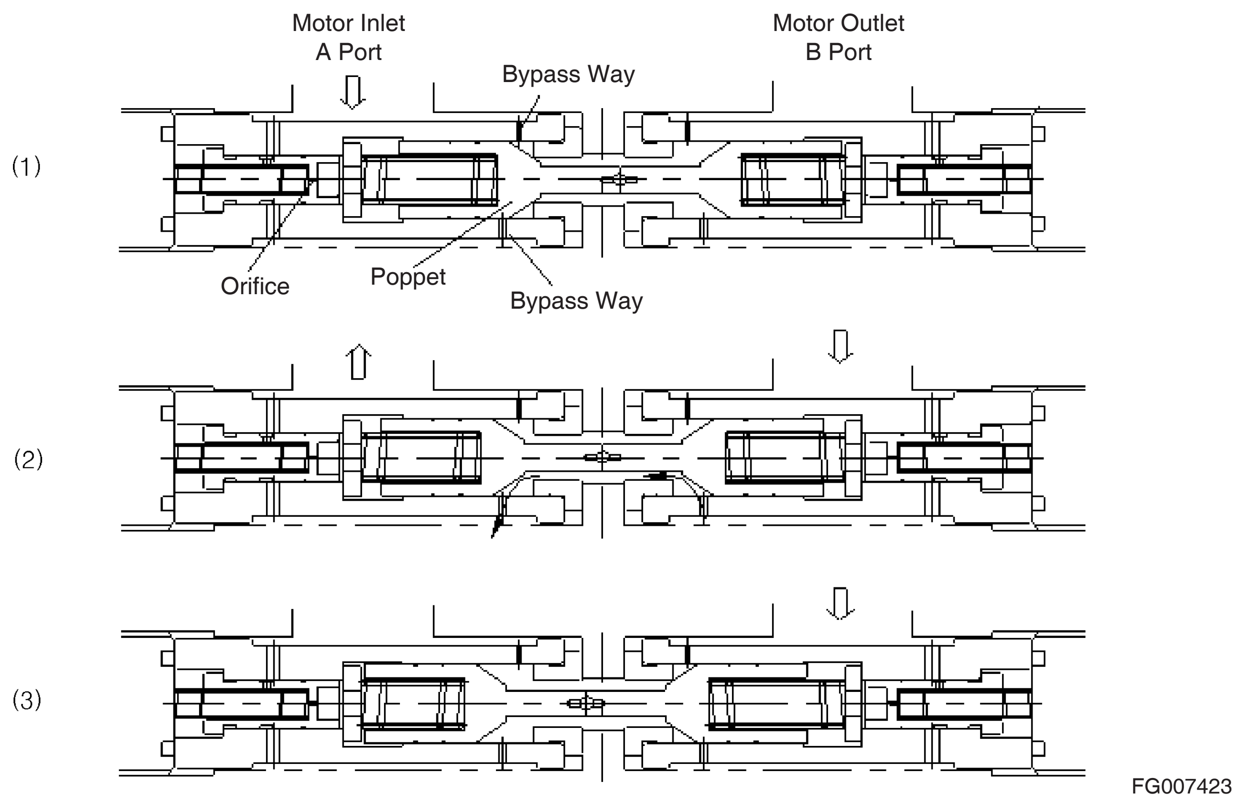
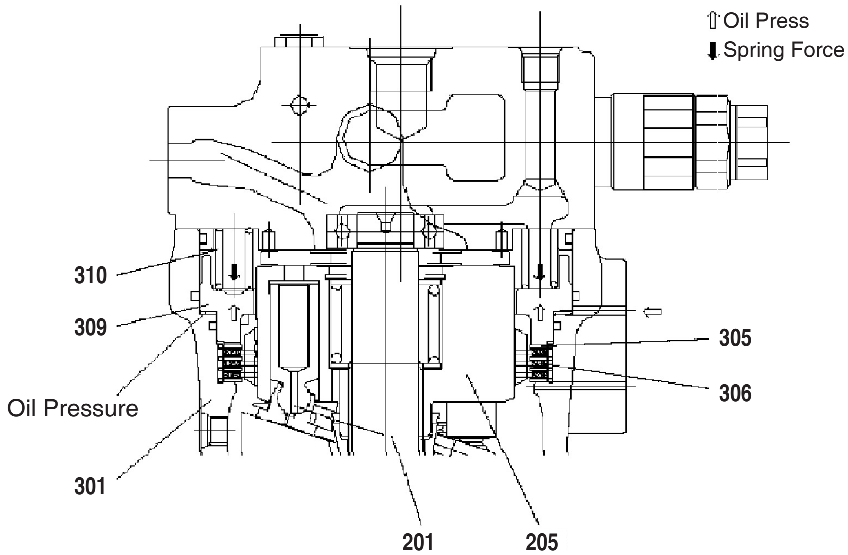



**Figure 5** Swing Reactionless Valve Working Description

4. Brake Part

The swing brake is spring applied and hydraulically released. Friction plate are splined to and rotate with cylinder block (111). separation plates (743) are splined to the motor casing (301). When the swing controller blocks pilot pressure at port (SH), the brake springs (712) force on brake piston (702) squeeze the separation and friction plates together to prevent the upper structure from swinging.




FG007424

**Figure 6** Brake Working Description

# Precaution in Use

### Inspection

Before installation of a new motor, inspect the following items.

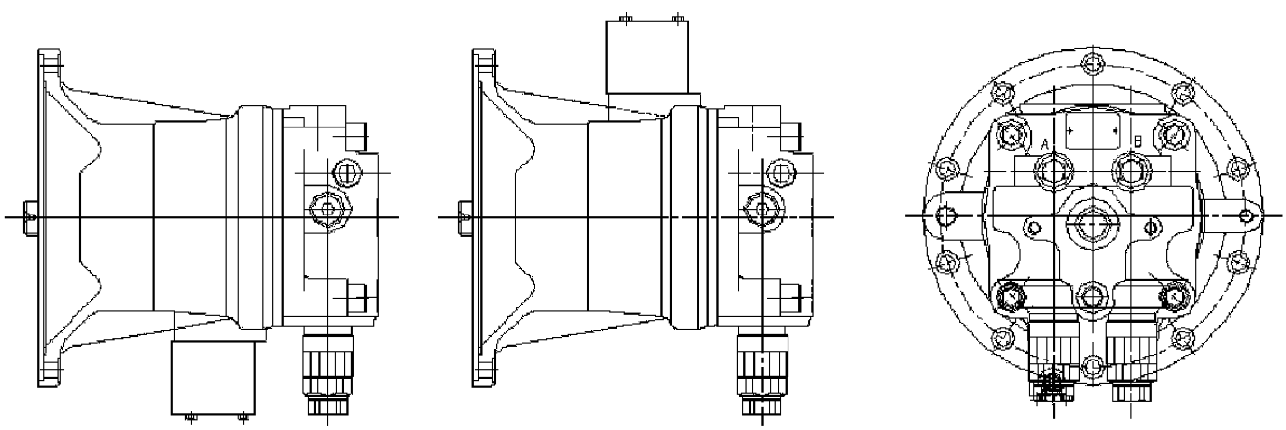
1. Inspect whether or not there is any damage during transit, or if any parts are lost missing.
2. Inspect each tightened part is loosened or not.
3. Check whether or not covers for flange surface and drain port are perfect, and the inside of the motor is dirty with intruded dust.

### Rotation Direction

The relation between the oil flow and the revolutionary direction of the shaft is self-explanatory as shown in Figure 7 and table.

The revolutionary direction of a motor vary according to the slope surface of casing.

Pay attention to discriminate between geometry of casing and the direction of flange as the direction of tilting angle.




Anti-clockwise

Clockwise (Attach a label M type)

FG007425

**Figure 7** Brake Working Description

| Direction | Inlet Port | Outlet Port | Revolutionary Direction of Shaft Facing the Shaft Side |
|---|---|---|---|
| counterclockwise | A | B | Right-handed |
| Clockwise | B | A | Left-handed |

**External Load of Shaft**

Pay attention to the shaft of motor in order not to applied radial and thrust load.

**Hydraulic Fluids and Range of Temperature**

1. Mineral Oil

   Please use a highly viscosity index working fluid which has additions of anti-foam agent, oxidation inhibitors, corrosion inhibitors, viscosity index improvers, oiliness agent and the oil with a high viscosity.

2. Optimum viscosity and temperature (Figure 8)

   To obtain the highest performance of the motor, oil which has a viscosity in a range of 10 to 200 cst is most suitable. But, it can be used a viscosity in a range of 10 to 1000 cst. The range of working temperature is limits to -25 °C - -100 °C because of the oil seal, O-ring. Further, the deterioration of the working fluid becomes excessive beyond 65 °C ; therefore, it is desirable not to exceed 60 °C.

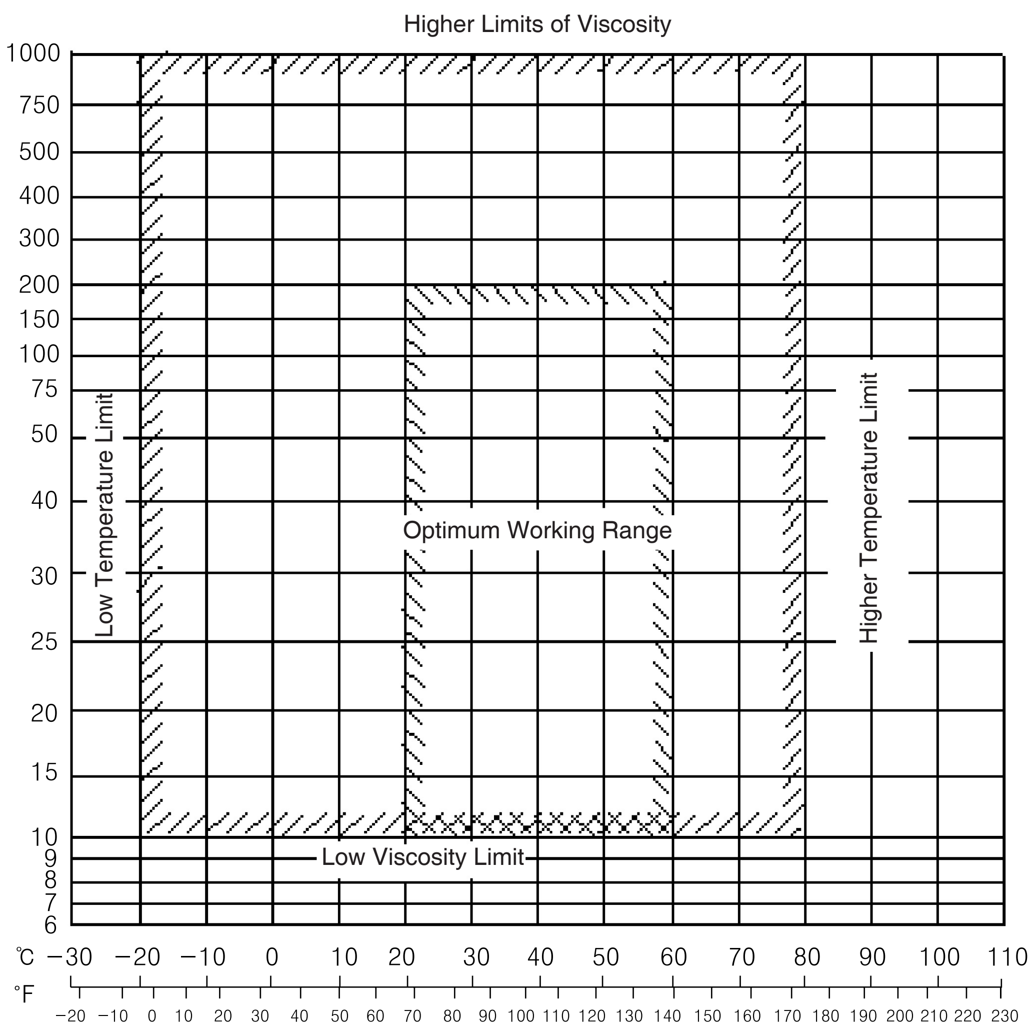



**Figure 8** The Proper Range of Viscosity and Temperature

FG007426

3. Except Mineral Oil

   Incase if using special fluid (phosphate ester compounds, water-glycol, fluid fatly acid ester compound, etc.), please consult us for instruction before use.

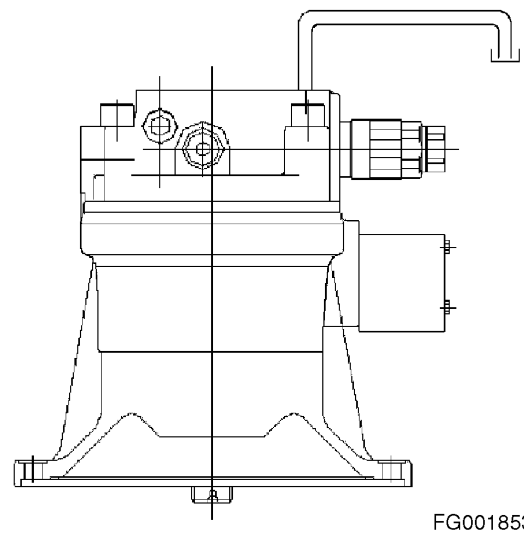
### Filter

If fine particles of dirt and metal are mixed with oil, they enter into sliding surfaces and accelerate wear in each part, and in the worst case seizure will be likely to occur.

It is recommended, therefore, that the customer not only will take necessary measures to prevent oil from contamination with such fine particles but also to provide an oil filter in the circuit without fail. For satisfactory service life of these motors in application, the operating fluid should be continuously filtered to the minimum cleanliness level of class 9 of NAS. Also, install a 10µ filter in the hydraulic circuit and MILLIPRE FILTER pollution level recommends below 2 - 4mg/100cc.

### Installation and Piping

1. When the motor is installed that its shaft turns downside.
2. The motor should be installed that it is concentricity below 0.05 mm.
3. The tightening torque of bolts for fixing the motor to the bracket is shown in assembly drawing the customer's reference.
4. Since the casing inside is always kept filled with oil, the drain must be returned to the tank through the return pipe which is once raised higher tank that of the motor itself as shown in Figure 9.
5. Motors will tolerate in the casing pressure up to maximum 3 kg•cm$^2$, but for common pressure, 2 kg•cm$^2$ below should be kept.
6. Piping should be cleaned and flashing well.
7. Be care to as the installation to piping.
8. Use the drain pipe bigger than the port size and form shortly as possible as.



FG001853

**Figure 9**

**Oil Filling and Air Bleeder**

1. Fill in the casing with oil using the drain port before the operating.

   In the motor, there are many kinds of high-speed sliding surface like bearing, piston, shoe, spherical bushing, and etc. So If there isn't enough oil, can make some problem like sticking or breaking in those parts.

   Use the PF 1/4 port for venting air.

2. All the air in the motor and circuit must be removed, otherwise, it will be likely to be causes of imperfect working or a damage of the motor.

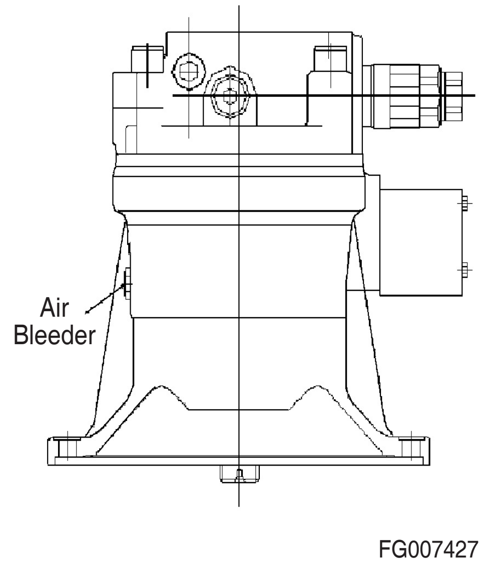



**Figure 10**

**Precaution in Starting Operations**

1. If the direction of revolution is correct or not.
2. Whether or not there is any leakage of oil from the motor.
3. If the equipment vibrates abnormally or not during operation or when the revolution direction is changed.
4. If the oil temperature rises rapidly in spite of running for a short period of time.
5. Whether the pressure varies to a great extent as compared with the established one.
6. If the piping is fully connected or not.

# Troubleshooting

### General Cautions

Here, counter-measures to be taken when troubles have happened while the motor is in operation are described.

As for general precaution.

1. Consider a cause of the trouble before repairing Before setting to work, think whether the same thing has happened before or not.

   Also, think again whether it is the motor that is in trouble.

2. Be careful of dust

   It is not too much to say that most troubles are ascribed to dust so measures for dust prevention is taken into consideration with utmost care in the case of partial disassembling.

3. Handling part

   Pay attention to the handling of parts not to injure them, especially to moving parts such as pistons, bearing and valves etc.

4. Pay attention to work the handling of O-ring, gasket Once seals have been disassembled, they should be replaced even if damage is not observed.

### Investigation Manner of the Motor Body

It is extremely difficult to trace trouble in the hydraulic circuits. Inspect the following items and investigation whether or not the fault is caused by the motor.

1. Inspection the oil in casing

   Remove the drain plug and inspect the hydraulic oil in the casing. If a large amount of metallic particles come out with the oil, you should suspect a failure of internal parts.

2. Presence of abnormal noise

   Check whether the motor emits an abnormal noise.

3. Pressure measurement of various points.

   Measure pressures at various points and check for faults, instead of disassembling parts at random.

4. Measurement of drain quantity

   A. In the case of locking the swing and adding the pressure oil to motor, it's normal the drain rate would be about under 25 (10)lpm

   B. In normal swing mode, the drain rate would be under 2 (1)lpm

      Where ( ) is TSM72.

**Condition and Countermeasures of Troubles**

1. Motor does not rotation

| Condition | Cause | Remedy |
|---|---|---|
| The pressure of the circuit is not increasing | 1. Setting pressure of relief valve is incorrect.<br>2. Working defectiveness of relief valve.<br>1) Plunger stick.<br>2) Close up an orifice hole of plunger.<br>3. Seat defectiveness of plunger. | 1. Reset the pressure to correct value.<br>2.<br>1) Revise or exchange of stick face.<br>2) disassembly or cleaning.<br>3. Replace for damaged seat part. |
| The pressure of the circuit is increasing | 1. Overload.<br>2. Stick of motion portion.<br>3. The brake does not release.<br>4. Stick of brake piston.<br>5. Stick of friction plate. | 1. Load removes.<br>2. Do repair or inspect the piston/shoe, cylinder block, valve plate etc.<br>3.<br>1) Do repair or inspect circuit<br>2) Check for the break valve.<br>3) Assembly and inspection.<br>4) Assembly and inspection.<br>Replace for the stick parts. |

2. The revolutionary direction is reverse

| Condition | Cause | Remedy |
|---|---|---|
| The revolutionary direction is reverse | 1. The revolutionary direction of motor is reverse.<br>2. The inlet and outlet in piping is reversely connected. | 1. Reassemble them after disassembling.<br>2. Correct piping. |

3. The number of revolution does not reach the established value

| Condition | Cause | Remedy |
|---|---|---|
| The number of revolution does not reach the established value | 1. The volume of flowing is not sufficient.<br>2. The temperature is too high and too much oil is leaking.<br>3. Valves/pistons/rings etc. are worn away and broken. | 1. Check discharge volume of pump and circuit up to the motor.<br>2. Reduce the oil temperature.<br>3. Replace it. |

4. Brake torque is not sufficient.

| Condition | Cause | Remedy |
|---|---|---|
| Brake torque is not sufficient | 1. Friction plates are worn.<br>2. Brake piston is becoming stick.<br>3. Brake releasing pressure is not working.<br>4. Spline of friction plates are damaged. | 1. Disassembly or inspection.<br>When it is worn better than standard, replace it.<br>2. Disassembly or inspection<br>3. 1) Check for the circuit.<br>2) Check for the brake valve<br>4. Disassembly or inspection.<br>1) Replace for damaged parts. |

5. Motor is much slip

Investigates the DRAIN quantity for motor.

Normal: app. 200cc/min (TSM140:500cc/min)

| Condition | Cause | Remedy |
|---|---|---|
| Motor is much slip | 1. Working defectiveness of relief valve is the same 1) an item.<br>2. Seat defectiveness of plunger. | 1. It is the same 1) an item<br>2. Replace it. |

6. Oil Leak

A. Oil leak from the oil seal

| Condition | Cause | Remedy |
|---|---|---|
| Oil leak from the oil seal | 1. The lip is dirty or damaged.<br>2. The shaft may be damaged or worn out.<br>3. The lib is damaged too high-pressure in the casing.<br>4. The shaft is rusty. | 1. Replace the oil seal.<br>2. Replace the driving shaft or defective centering of the driving shaft.<br>3. It repairs the drain piping which is closed up.<br>4. Disassemble, repair, and replace the oil seal. |

B. Oil leak from the blind and union

| Condition | Cause | Remedy |
|---|---|---|
| Oil leak from the blind and union | 1. O-ring is not in.<br>2. O-ring is broken.<br>3. Seal face is defective.<br>4. The bolt is loose or not tightened. | 1. Insert O-ring.<br>2. Replace it.<br>3. Disassemble or repair.<br>4. Tighten adequately or replace it. |

## Disassembling and Assembling

### Tightening Torque of Bolts

In table 1. is shown tightening torque of bolts used in motor. In case of reassembling, tighten accurately each bolt in accordance with table 1.

**Table 1**

( ) : TSM72

| Bolt Size | Name | Tightening Torque (kg•cm) | Part No. |
|---|---|---|---|
| M6 | Hexagon Bolt | 120 ± 20 | 400 |
| M20 (M16) | Hexagon Socket Bolt | 4400 ± 660 (2400 ± 360) | 109 |
| M22 | RO Plug | 1100 ± 100 | 105 |
| M36 (M24) | RO Plug | 2450 ± 250 (1300 ± 100) | 105 |
| PF 1/4 | Plug | 370 ± 20 | 111 |
| M33 | Relief Valve | 1800 ± 100 | 105 |

**Necessary Tools**

In table 2, 3 Figure 11. is shown necessary tools for disassembling and reassembling.

**Table 2**

( ) : TSM72

| Name | Size | 2-face width | Application part | Tool |
|---|---|---|---|---|
| Hexagon bolt | M6 | 10 | Brake valve | Hexagon wrench socket wrench |
| Hexagon socket bolt | M20 (M16) | 17 (14) | | Hexagon wrench |
| Plug | M22 | 10 | RO plug | Hexagon wrench |
| Plug | M36 (M24) | 17 (12) | RO plug | Hexagon wrench |
| Plug | VP-1/4 | 19 | VP plug | Hexagon wrench socket wrench |
| | | 36 | Relief valve | Hexagon wrench socket wrench |

**Table 3** etc.

( ) : TSM72

| Spec. / Tool | Dimensions |
|---|---|
| Pliers (For lock ring) | For Ø65 axis (Ø50) |
| Driver | - Type 2EA |
| Steel rod | About 10 x 8 x 200 1EA |
| Hammer | One each of plastic hammer and metal hammer. |
| Torque wrench | Torque range<br>• For 100 - 450 kg•cm<br>• For 400 - 1,800 kg•cm<br>• For 1,200 - 4,800 kg•cm |
| Slide hammer bearing pliers | |
| Special tool for removing the break piston | 25page reference |

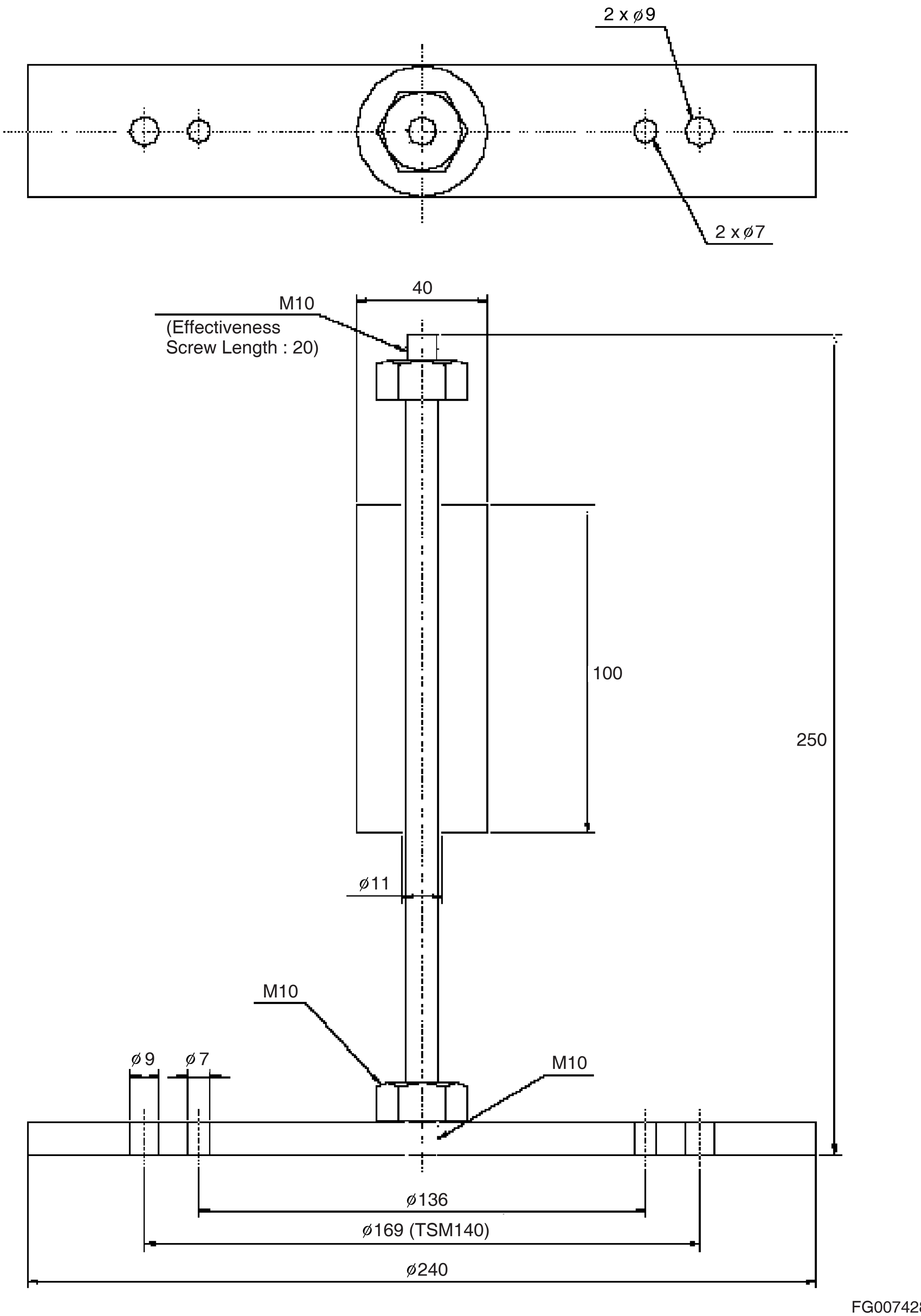



**Figure 11** Special Tool for Removing the Brake Piston

**Procedures for Disassembly**

Please use the following procedures for the inspection and repair of the motor.

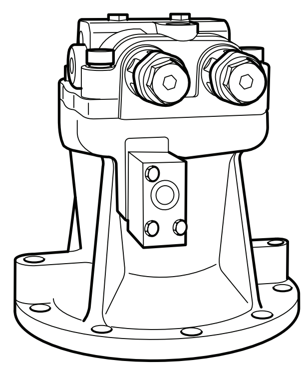
Numerals given in parentheses following the parts names indicate the parts number shown by the drawing in the instruction and maintenance manual.

1. Wind the wire rope at motor outside, lift up the motor, and clean the motor with cleaning oil.

   After cleaning, dry with compressed air.

2. Draw the oil out of the casing (301).
3. Mount on a suitable table for the driven-axis (201) below.

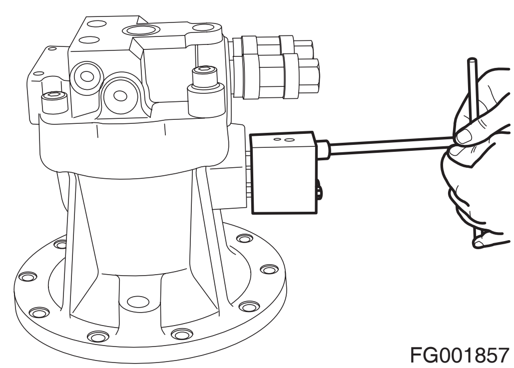
   Before disassembling make a match mark on motor casing (301) and valve casing (101).



FG001856

Figure 12

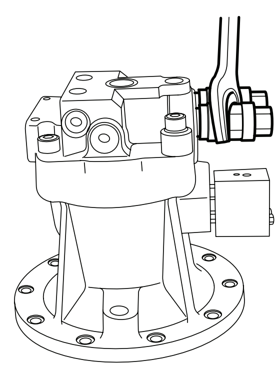
4. Remove brake valve (400).



FG001857

Figure 13

5. Remove relief valve (107) from valve casing (101).



FG001858

Figure 14

6. Remove RO plug (102) and take out spring (103) and plunger (104) from valve casing (101).

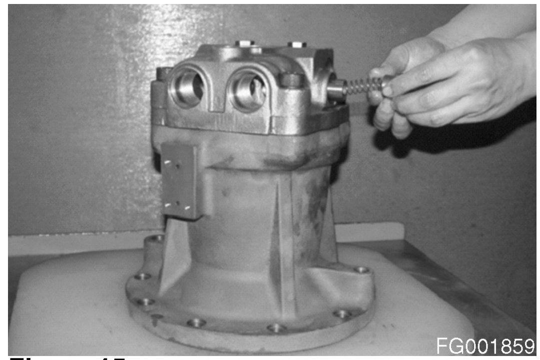



**Figure 15**

7. Remove swing reactionless valve ass'y (105) from valve casing (101).

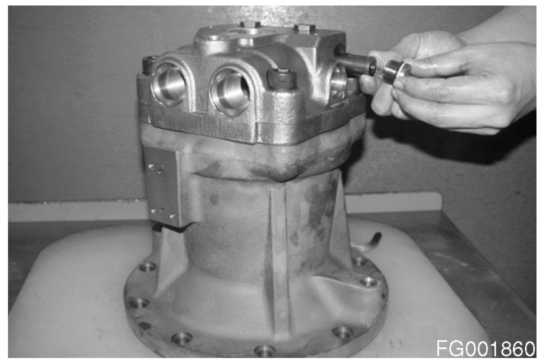



**Figure 16**

8. Remove hex socket bolts (109, 110) and disassemble valve casing (101) from casing (301) (When loosening bolts, the valve casing will be raised by brake springs (310). Remove valve plate (213) from the valve casing (101).

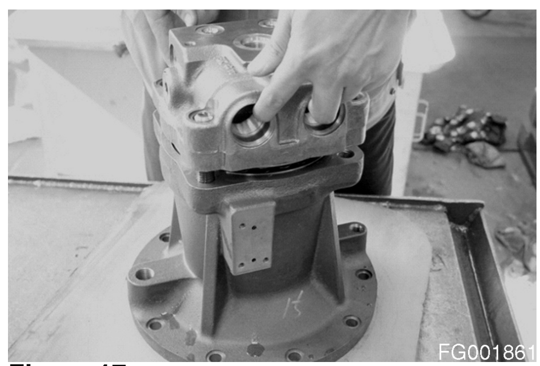
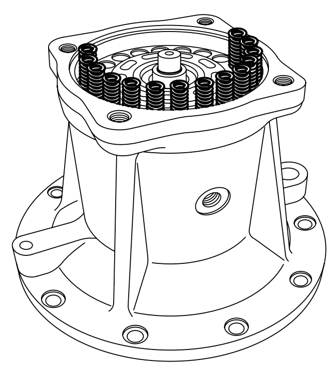



**Figure 17**

9. Remove brake springs (310) from the brake piston (309).



FG001862

**Figure 18**

10. Disassemble brake piston (309) from casing (301) by using the special tool for removing the brake piston.

    Lit it up straight by using the bolt hole in the brake piston.


Figure 19

11. After placing the motor horizontally, take out cylinder block (205) from casing (301).

    Remove piston ass'y (203, 204), retainer (207), spherical bushing (206), spacer (208).

    When taking out the cylinder block, be careful not to pull out roller (209).

    Be careful not to damage the sliding parts of the cylinder block, spherical bushing and shoe.

    And washer (210, 2EA), spring (211), retaining ring (212) are not disassemble at the disassembled cylinder block.

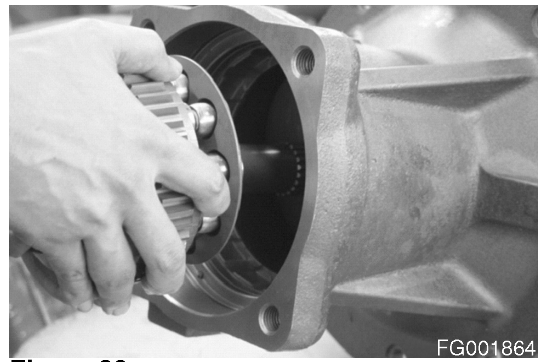



Figure 20

12. Pull out friction plate (306, 2EA) and separation plate (305, 3EA) from casing (301).

    (TSM72 : friction plate : 3EA

    separation plate : 4EA)

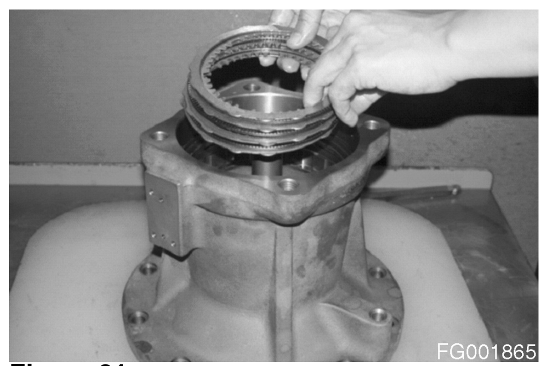



Figure 21

13. Remove swash plate (202) and driveshaft with ball bearing (303) from casing (301)

    Be careful not to damage the ball bearing (303) and oil seal contact surface.

    If you beat a driveshaft end with plastic hammer, it is easy to be disassembled.

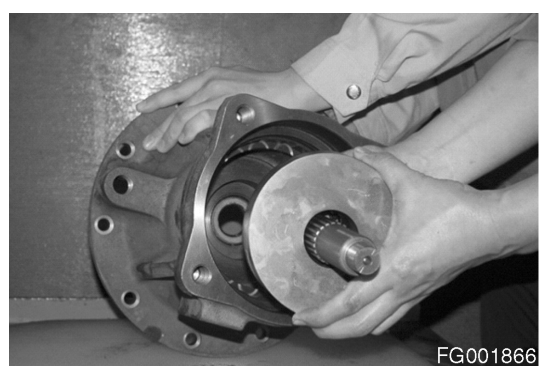
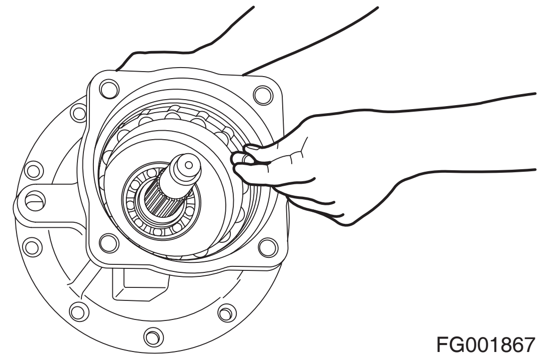



Figure 22

14. Do next step if required.

A. Remove parallel pin (304) from casing (301).

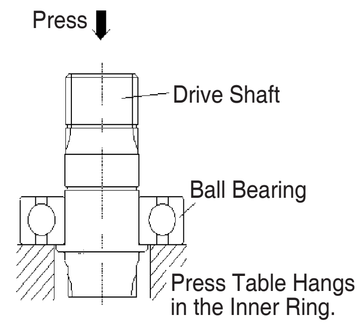


FG001867

**Figure 23**

B. Remove ball bearing (303) with a press from the driveshaft (201).

Strike the rod lightly and do not reuse the disassembling bearing.

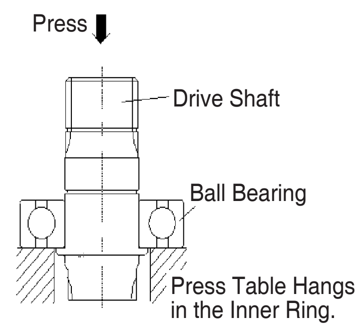



FG007429

**Figure 24**

C. Take out oil seal (302) from the casing (301) with a using of tool.

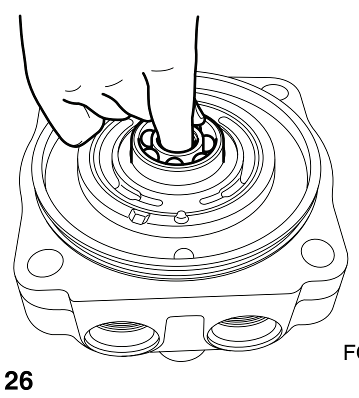
Do not reuse the disassembling oil seal (302).




FG007429

**Figure 25**

D. Take out ball bearing from the valve casing (303).



FG001870

**Figure 26**

15. Disassembling is finished, check each component throughly.

**Procedures for Assembly**

Following are caution to be specially borne in mind.

A. Rework damaged parts and before assembling, prepare all parts to be replaced.

B. Clean all parts and dry with compressed air.

C. Coat the sliding parts and bearing with clean hydraulic oil.

D. Replace O-ring, oil seal.

E. For the mounting of bolts to install the various parts, please use a torque wrench, etc. and tighten the bolts with the torque shown in table 1.

1. Place casing (301) on the work table with the valve casing side downward.

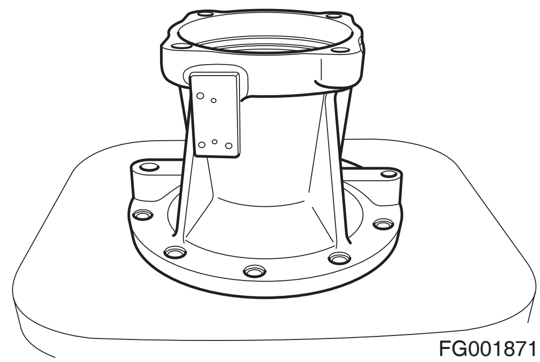



**Figure 27**

2. (It is necessary when oil seal was disassembled from the casing.)

   Insert oil seal (302) at the casing (301) with a using of tool.

   (Be careful to note the direction of oil seal. and insert until fully seated at the casing end.)

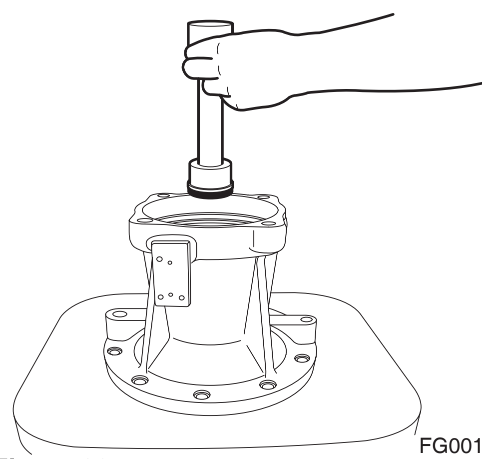



**Figure 28**

3. (It is necessary when ball bearing was disassembled from the driveshaft.)

   Ball bearing (303) is press fit by the heat to driveshaft (201).

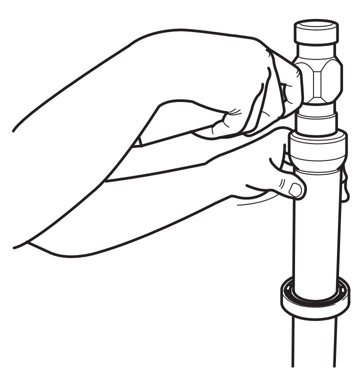



**Figure 29**

4. Insert the driveshaft (101) complete with ball bearing into casing (301).

   Impact the outside surface of outer loop uniformly till stop at casing section.

   Coat the lip of the oil seal with grease and tape the shaft spline for the protection of spline.

   Tap evenly.


**Figure 30**

5. (It is necessary when parallel pin was disassembled from the casing.)

   Assemble parallel pin (304) to casing (301).

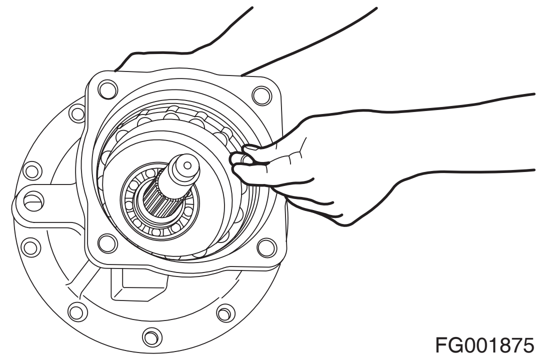



**Figure 31**

6. Assemble swash plate (202) to casing (301).

   If casing is horizontal position from the bottom, It is easy to work.

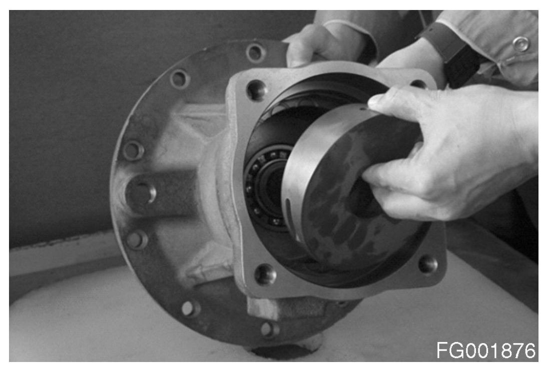



**Figure 32**

7. Insert roller (209) to cylinder block (205).

   Make sure that cylinder block is assembled with all component.

   (washer (210), spring (211), ring snap (212))

   (Be careful not to damage the sliding surface of the cylinder block. Insert roller to each hole one by one.)

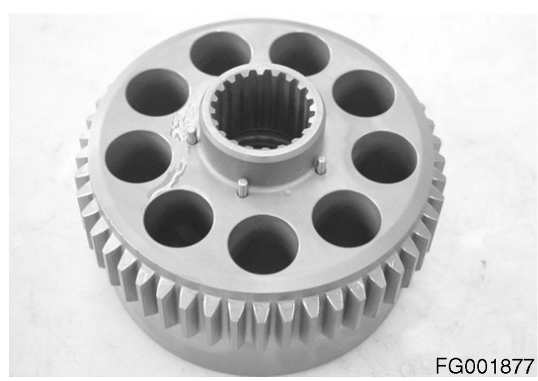



**Figure 33**

8. Place spacer (208), spherical bushing (206) to the cylinder block (205).

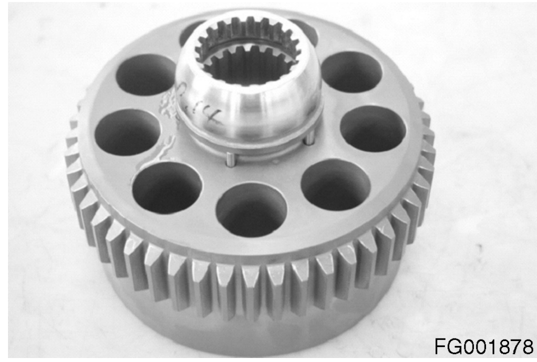



**Figure 34**

9. Assemble the retainer with the piston sub assembly (203, 204) unit to the cylinder block (205).

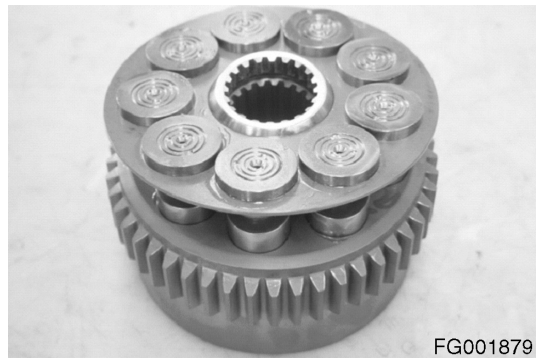



**Figure 35**

10. Insert cylinder block to driveshaft (101) aligning the spline.

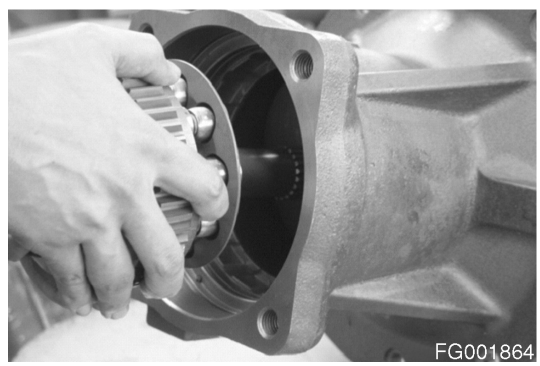



**Figure 36**

11. Place casing (301) downward and assemble separation plate (305, 3EA) and friction plate (306, 2EA) in sequence.

    Align 4 tangs to the notches.

    Align cut the jaw and assemble that part.

    (TSM72 : friction plate : 3EA

    separation plate : 4EA)

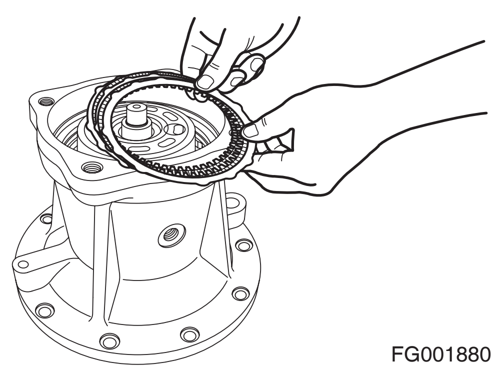
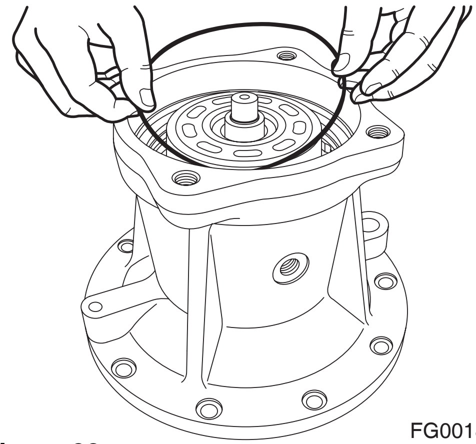



**Figure 37**

12. Mount O-ring (307, 308) to casing (301).

    (Coat the O-rings with grease. O-ring can be protected by grease.)

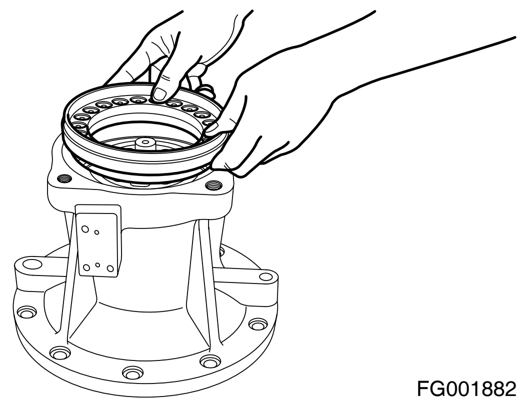


FG001881

**Figure 38**

13. Assemble brake piston (309) to casing (301).

    The piston is difficult to assemble because of the restriction of the O-ring; screw in two M8 bolts on the brake piston and tap them gently with plastic hammer.

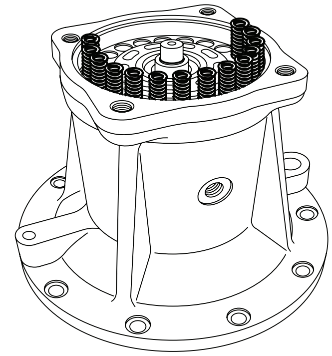


FG001882

**Figure 39**

14. Assemble brake springs (310) into brake piston (309).

    Confirm the springs are fitted to the brake piston completely.



FG001862

**Figure 40**

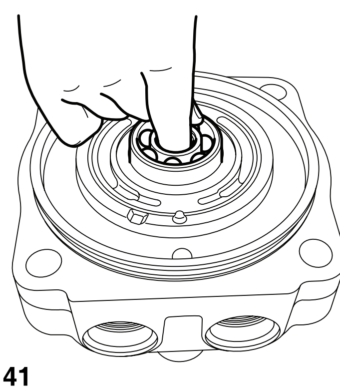
15. (It is necessary when ball bearing (108) was disassembled from the valve casing.)

    Assemble of ball bearing (108).

    Insert it to valve casing (101) while tapping it lightly.

    Tap evenly on the outer diameter of the outer race with a brass drift until it completely stops.

    Do not use a steel punch or bar on the bearing since it can chip or crack the race.



FG001884

**Figure 41**

16. Assemble valve plate (231) to valve casing (101) and fit O-ring (113).

    Be careful to note the direction of the valve plate.

    Mount the valve plate with its round part toward the opposite side of the flange.

    Coat lightly with grease.

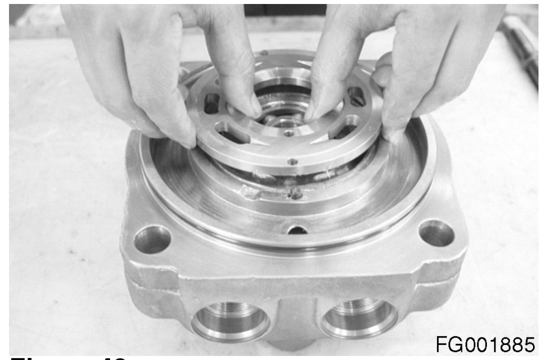


**Figure 42**

17. Mount valve casing (101) to casing (301) and tighten hex socket bolts (109, 110) to specification.

    Be careful to note the mounting direction of the valve casing.

    (Reference to the drawing)

    Be careful not to drop the valve plate or let the brake springs pop out.

    Tighten the bolts evenly.

**Figure 43**

18. Install plunger (104) and spring (103) to valve casing (101) and tighten RO plug (102) with O-ring (106).

    Confirm the smooth movement of the plunger before installing the plug.

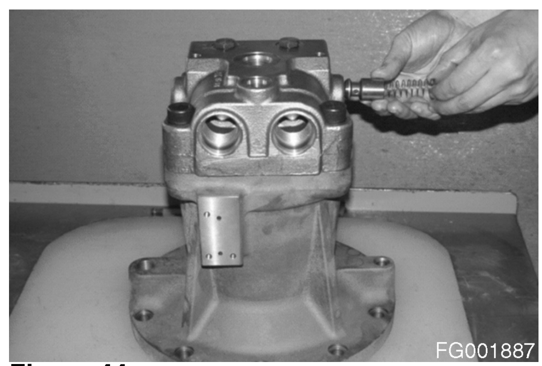


**Figure 44**

19. Install swing reactionless valve ass'y (105) to valve casing (101).

    Confirm the spring in the swing reactionless valve ass'y (105).

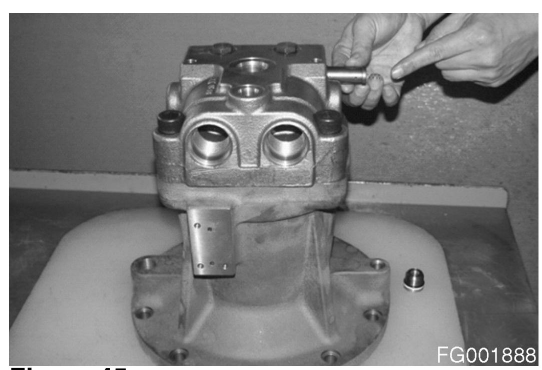
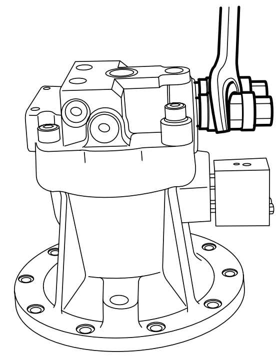


**Figure 45**

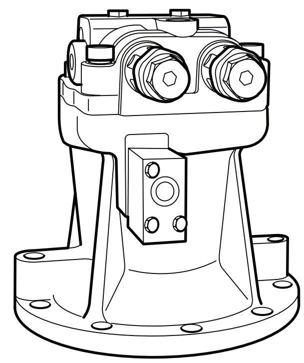
20. Assemble relief valve (107) with O-ring to valve casing (101).



FG001858

Figure 46

21. Assemble brake valve (400) to casing (301) and tightening the hex socket bolts to specified torque.



FG001856

Figure 47

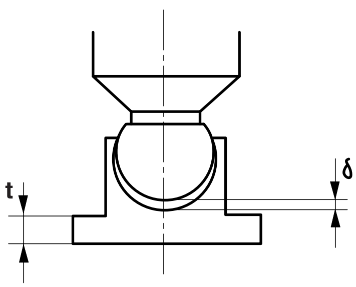
22. The assembly is completed.

# Maintenance Standards

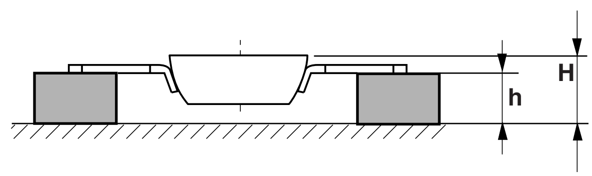
### Standards for Replacement of Worn Parts

If the various parts of the motor have been worn out beyond the following standard values, please replace them. But this shall apply only to those cases when is no remarkable outside damage.

| Item | Standard dimension (mm) | Recommended value for replacement (mm) | Remedy |
|---|---|---|---|
| Clearance between piston and cylinder bore | 0.025 (0.036) | 0.055 (0.066) | Replace piston or cylinder block. |
| Gap between piston and caulked part of shoe (δ) | 0.05 | 0.2 | Replace piston or shoe. |
| Thickness of shoe (t) | 4.5 (6.5) | 4.3 (6.2) | Replace piston or shoe. |
| Assembled height of retainer (H-h) | 10.8 (13.0) | 10.3 (12.5) | Replace sperical bushing and retainer as a pair. |
| Thickness of friction plate | 3.5 | 3.1 | Replace it. |




Gap between piston and caulked part of shoe (δ).
Thickness of shoe (t)




Assembled height of retainer (H-h)

### Standard for Correcting Sliding Surfaces

If the surface roughness of the sliding surface of a part exceeds the following standard, correct it or replace the part.

**Table 4** Revise standard

| Item | Surface roughness | Roughness requiring correction |
|---|---|---|
| Shoe | 0.8 - Z (Ra=0.2) (LAPPING) | 3 - Z (Ra=0.8) |
| Swash Plate | 0.4 - Z (Ra=0.1) (LAPPING) | 3 - Z (Ra=0.8) |
| Cylinder Block | 1.6 - Z (Ra=0.4) (LAPPING) | 12.5 - Z (Ra=3.2) |
| Valve Plate | 0.8 - Z (Ra=0.2) (LAPPING) | 6.3 - Z (Ra=1.6) |

**NOTE:** *Lap each sliding surface to a standard roughness level or finer.*

*If the sliding surface of the cylinder block, valve plate, retaining plate*

SP001346

# Travel Moter

Edition 1

# MEMO

# Table of Contents

## Travel Motor

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |

# PRODUCT OVERVIEW

This product is a hydraulic driven rotary actuator.

The product contains a reduction gear, hydraulic motor, brake valve and parking brake in one compact unit. It has been developed for use as an actuator for application requiring low-rpm, high torque operation such as construction and marine machinery.

## General Specifications

| ITEM | | UNITS | Spec |
|---|---|---|---|
| Rated Output Torque | | kgf•m | 2100 |
| Max. Speed | | $min^{-1}$ | 60 |
| Reduction Ratio | | | 1/54.0 |
| Hydraulic Motor | Max. Displacement | cc/rev | 82.8 |
| | Max. Speed | $min^{-1}$ | 3000 |
| | Max. Pressure | $kgf/cm^2$ | 355 |
| | 2-speed Control Press | $kgf/cm^2$ | 20 ~ 70 |
| Parking Brake | Brake Torque (min) | kgf•m | 21 |
| | Brake Free Pressure | $kgf/cm^2$ | 7.7 |

# EXTERNAL DIMENSIONS

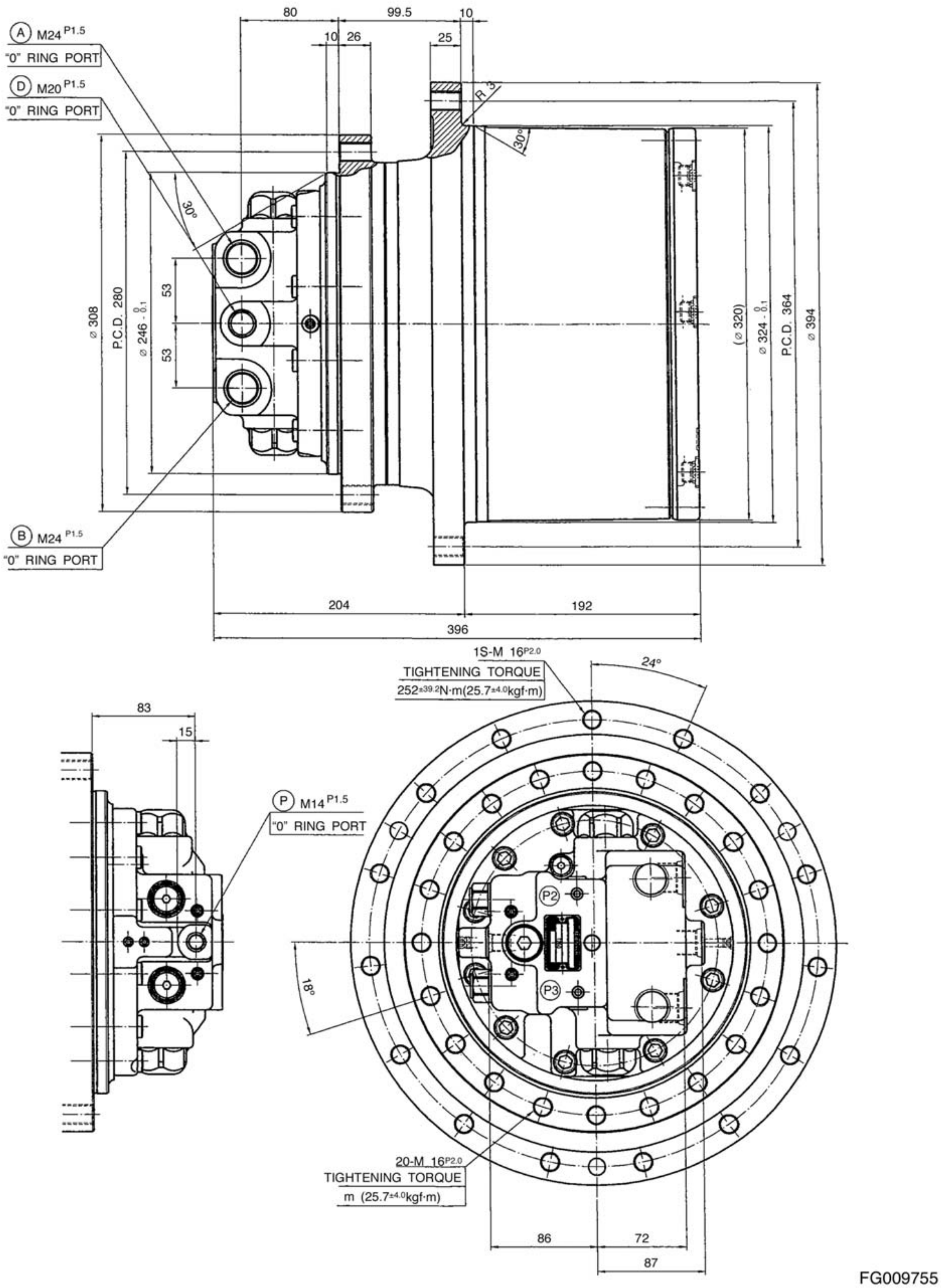



Figure 1

# GENERAL DESCRIPTION

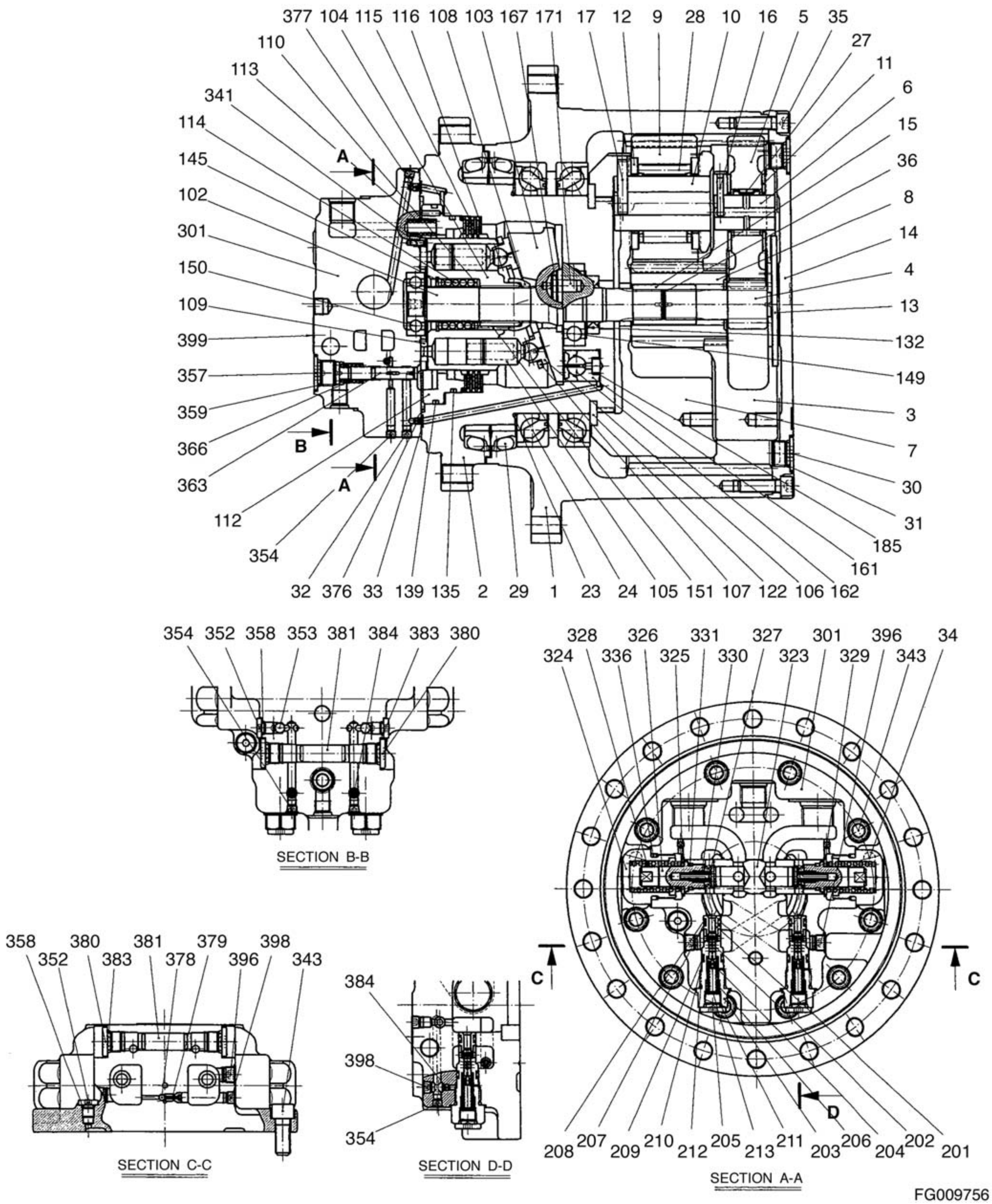



Figure 2

| Reference Number | Description | Q'ty |
|---|---|---|
| 1 | Hub | 1 |
| 2 | Spindle | 1 |
| | Carrier Assembly (1) | 1 |
| 3 | Carrier (1) | 1 |
| 5 | Planetary Gear (1) | 3 |
| 6 | Carrier Pin (1) | 3 |
| 11 | Thrust Washer (1) | 6 |
| 16 | Parallel Pin (1) | 3 |
| 27 | Needle Roller Bearing | 3 |
| | Carrier Assembly (2) | 1 |
| 7 | Carrier (2) | 1 |
| 9 | Planetary Gear (2) | 3 |
| 10 | Carrier Pin (2) | 3 |
| 12 | Thrust Washer (2) | 6 |
| 17 | Parallel Pin (2) | 3 |
| 28 | Needle Roller Bearing | 3 |
| 4 | Sun Gear (1) | 1 |
| 8 | Sun Gear (2) | 1 |
| 13 | Thrust Plate | 1 |
| 14 | Cover | 1 |
| 15 | Coupling | 1 |
| 22 | Lock Washer | 2 |
| 23 | Shim | 1 |
| 24 | Angular Ball Bearing | 2 |
| | Floating Seal Kit | 1 |
| 29 | Floating Seal | 2 |
| 30 | Plug | 3 |
| 31 | O-ring | 3 |
| 32 | O-ring | 1 |
| 33 | O-ring | 2 |
| 34 | Parallel Pin | 2 |
| 35 | Hex. Socket Bolt | 12 |
| 36 | Snap Ring for Hole | 1 |
| 102 | Shaft | 1 |
| 103 | Swash Plate | 1 |
| | Cylinder & Piston Kit | 1 |
| | Piston Kit | 1 |
| | Piston Assembly | 9 |
| 105 | Piston | 1 |
| 106 | Shoe | 1 |
| 104 | Cylinder Block | 1 |
| 107 | Retainer Plate | 1 |
| 108 | Thrust Ball | 1 |

| Reference Number | Description | Q'ty |
|---|---|---|
| 109 | Timing Plate | 1 |
| 110 | Washer | 2 |
| 112 | Piston | 1 |
| 113 | Spring | 10 |
| 114 | Spring | 1 |
| 115 | Friction Plate | 3 |
| 116 | Mating Plate | 4 |
| 132 | Oil Seal | 1 |
| 135 | O-ring | 1 |
| 139 | O-ring | 1 |
| 145 | Snap Ring | 1 |
| 149 | Ball Bearing | 1 |
| 150 | Ball Bearing | 1 |
| 151 | Needle Roller | 3 |
| | Piston Assembly | 1 |
| 161 | Piston | 1 |
| 162 | Shoe | 1 |
| 167 | Pivot | 2 |
| 171 | Parallel Pin | 2 |
| 185 | Spring | 1 |
| | Relief Assembly | 2 |
| 201 | Valve Seat | 1 |
| 202 | Valve | 1 |
| 203 | Sleeve | 1 |
| 204 | Collar | 1 |
| 205 | Plug | 1 |
| 206 | Spring | 1 |
| 207 | O-ring | 1 |
| 208 | Back up Ring | 2 |
| 209 | O-ring | 1 |
| 210 | Back up Ring | 2 |
| 211 | O-ring | 1 |
| 212 | O-ring | 1 |
| 213 | Shim | 1 |
| | Rear Flange Assembly | 1 |
| | Rear Flange Kit | 1 |
| | Spool Assembly | 1 |
| 323 | Spool | 1 |
| 326 | Plug | 2 |
| 327 | Valve | 2 |
| 330 | Spring | 2 |
| 331 | O-ring | 2 |
| 301 | Rear Flange | 1 |

| Reference Number | Description | Q'ty |
|---|---|---|
| 324 | Plug | 2 |
| 325 | Washer | 2 |
| 328 | Spring | 2 |
| 329 | Orifice | 2 |
| 336 | O-ring | 2 |
| 352 | Plug | 3 |
| 353 | Steel Ball | 2 |
| 354 | Hex. Socket Plug | 5 |
| 357 | Plug | 1 |
| 358 | O-ring | 3 |
| 359 | O-ring | 1 |
| 363 | Spool | 1 |
| 366 | Spring | 1 |
| 376 | Orifice | 1 |
| 377 | Filter | 1 |
| 378 | Steel Ball | 1 |

| Reference Number | Description | Q'ty |
|---|---|---|
| 379 | Plug | 1 |
| 380 | Plug | 2 |
| 381 | Piston | 1 |
| 383 | O-ring | 2 |
| 384 | Orifice | 2 |
| 396 | Hex. Socket Plug | 2 |
| 398 | Hex. Socket Plug | 5 |
| 399 | Name Plate | 1 |
| 341 | Parallel Pin | 1 |
| 343 | Hex. Socket Bolt | 10 |

# OPERATING DESCRIPTION

## Reduction Gear

### Function

This reduction gear unit is composed of two stage planetary gear mechanism.

The reduction gear reduces the high speed of hydraulic motor and converts it low-speed, high-torque rotation.

### Operating Description

The rotation of hydraulic motor shaft is transmitted to sun gear (4) of the first stage which is linked with shaft (102) in spline.

At that time, the hub (1) is rotated by the rotation of the planetary gears (5).

The hub (1) rotation is transmitted to carrier (3) which connected to planetary gears (5), and that causes sun gear (6) rotation of the second stage.

The rotation of sun gear (6) is transmitted to the hub via three planetary gears (7) of the second stage.

The generated rotation of reduction gear is output rotation.

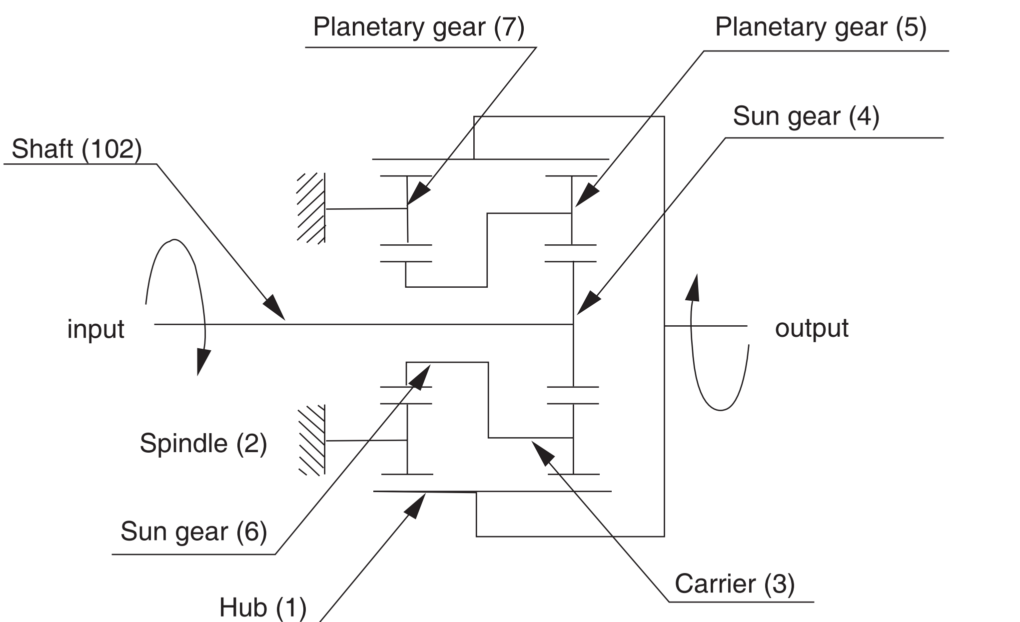



**Figure 3**

# Hydraulic Drives

### Function

1. Hydraulic Motor

   This hydraulic motor is a swash plate type axial piston motor, converting the hydraulic force from the pump to rotary motion.

2. Brake Valve

   A. Controls inertia when stopping the hydraulic motor, in order to provide smooth stopping.

   B. Prevents runaway rotation when the hydraulic motor is rotated by external force.
   This is done by preventing hydraulic cavitation.

   C. Prevents the generation of abnormally high pressure when the hydraulic motor is stopped suddenly.

3. Parking Brake

   The parking brake prevents the hydraulic motor from being rotated by external force while stopped. A friction plate type mechanism is used, constructed so as to form one unit with the hydraulic motor.

4. High-Low 2-Speed Switching Mechanism

   Switches the hydraulic motor between high speed rotation with low torque, and low speed rotation with high torque.

**Operating Principles and Description**

1. Hydraulic Motor

   Hydraulic fluid fed from the hydraulic pump enters the GM motor through the rear flange (101), passes through the brake valve and timing plate (109) and enters the cylinder block (104). This hydraulic fluid is fed only into one side of a line connecting the upper and lower dead points (Y1-Y2) of the piston stroke (105). The hydraulic fluid pushes each of the pistons (105), creating force F(=P x A). This force operates on the oblique surface of the swash plate (103). Force F is separated into components F2 and F3 according to the angle $\theta$ of the oblique surface. Of the two components, the radial component force F3 generates torque(=F3 X ri).The sum of the torque T(=$\sum$(F3 x ri) of each of the pistons (105) is the rotary force of the hydraulic motor. This rotary force passes through the pistons (105) and rotates the cylinder block (104) and the shaft (102).

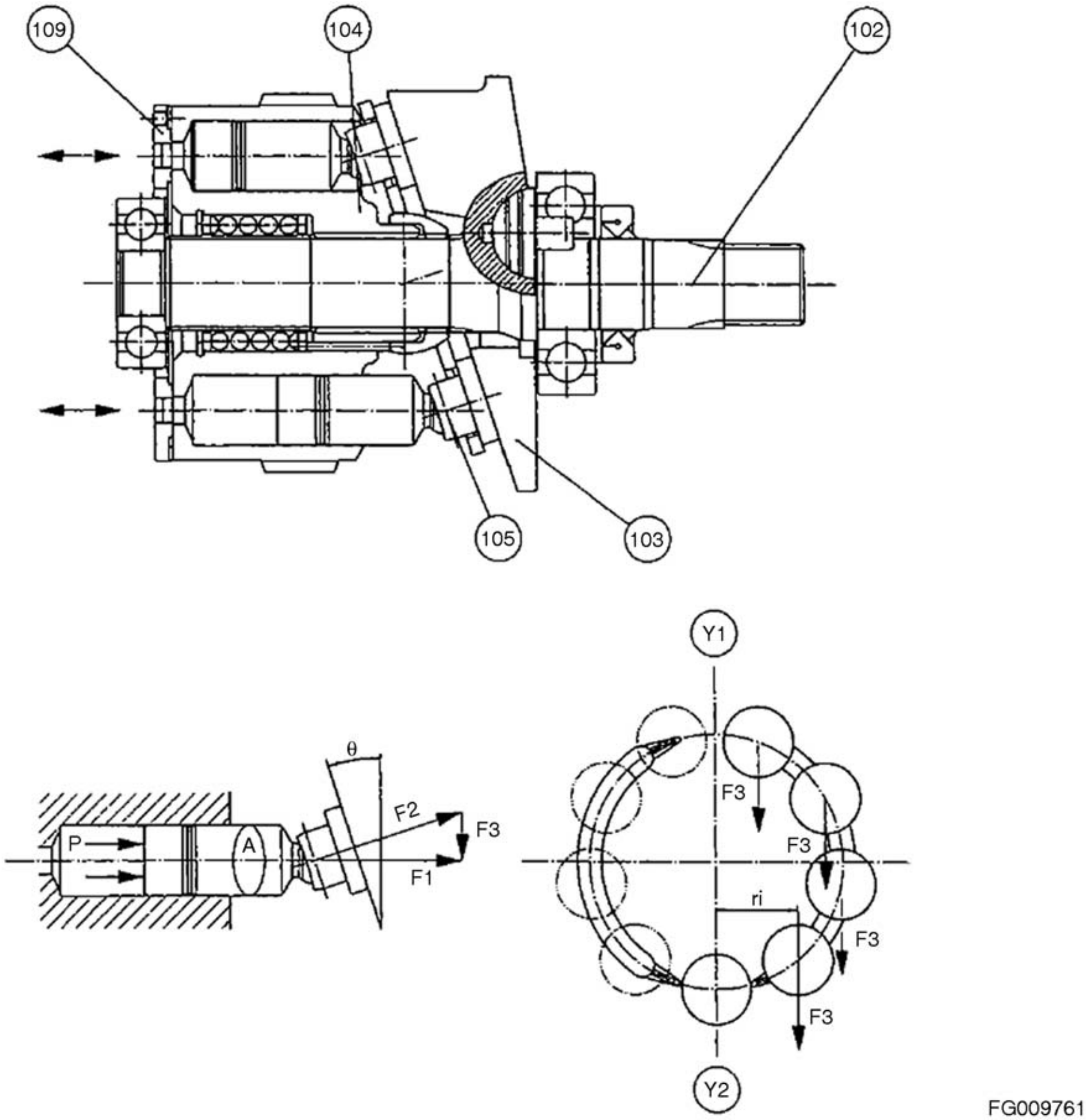



**Figure 4**

2. Brake Valve

A. Operation (Brake released)

The pressure oil is led to through port (A), opens valve (327), and led to port (C) on the section side of hydraulic motor to rotate hydraulic motor.

At the same time, the pressure oil enters chamber (a) through orifice (329), and exerts on the end of spool (323) to generate the force.

Then the force of spring (328) slides the spool (323) placed on the neutral position leftward.

The sliding of spool (323) forms the space (passage) between spool (323) and rear flange (301) with spool groove.

This passage is connected to port (D) and port (B) of the return circuit of the hydraulic motor, and the returns oil returns to tank side, enabling hydraulic motor to rotate.

Then, the sliding of spool (323) leads pressure oil to port (E). The pressure oil led to port (E) moves piston (112) of parking brake, and releases parking braking force. (For details, refer to item "Parking brake".)

If pressurized oil is supplied from port (B), the movements of spool (323) and valve (327) are reversed so that the hydraulic motor is rotated reversely.

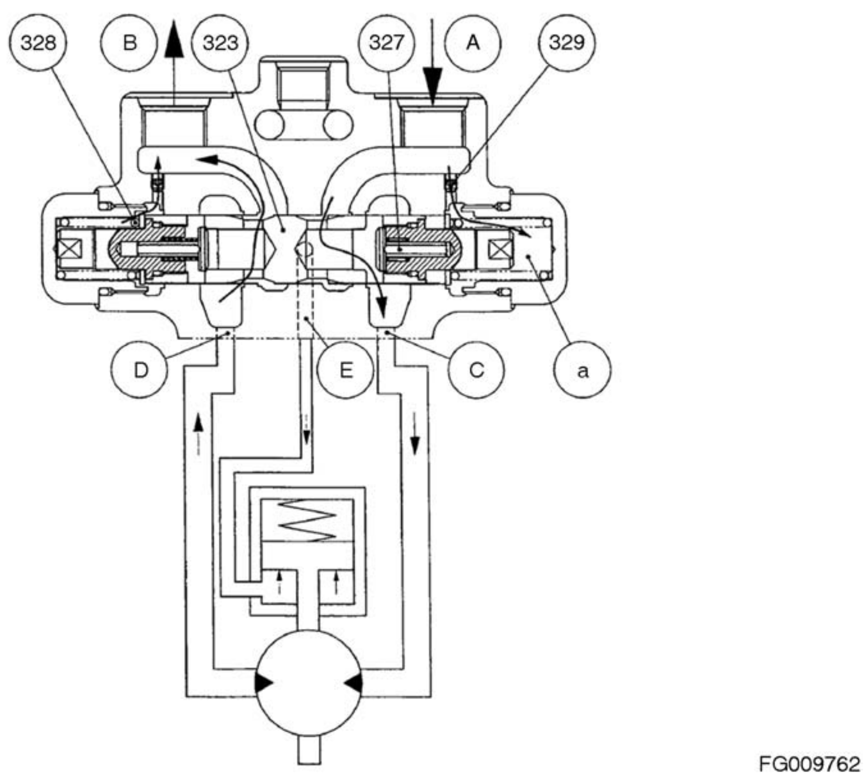



**Figure 5**

B. Stop / Stall (Braking Operation)

If pressurized oil supply through the port (A) is suspended while traveling, the hydraulic force to push up the spool (323) is lost, and the spool (323) which is slid to left side, tries to return to the neutral position due to the spring (328) force. At that time, through the oil in the chamber (a) tries to flow out to the port (A) side through the orifice (329), its flow is restricted and some back pressure is generated by the throttle effect in the orifice (329) controlling the return speed of the spool (323). At the same time, the hydraulic motor tries to rotate with its inertia force even though the pressurized oil is suspended, and the return oil from the hydraulic motor tries to return to the port (B) side from the port (D) through the passages on spool groove and rear flange(30l ).

When the spool (323) entirely return to neutral position, the passage on the hydraulic motor of the oil return side is completely closed by the spool (323), and the hydraulic motor ceases its rotation. While machine working, the brake valve smoothly stops rotation of the hydraulic motor which tries to rotate with its inertia force, by means of throttling the return side passage of the hydraulic motor, generating back pressure due to shape of the spool groove and controlling the return speed of the spool. On the other hand, when braking is operated, the hydraulic motor tries to rotate with its inertia force and to intake oil with its pumping function. However, because the intake side is closed its passage with the spool (323), the oil supply is suspended. This causes cavitation in the hydraulic motor. To prevent the cavitation, the valve (327) is operated by very slight negative pressure to open the passages of port (A) side and intake port (C) of the hydraulic motor.

And when pressurized oil is supplied through the port (B), each motion of the mentioned parts above becomes symmetrical right and left to stop the hydraulic motor.

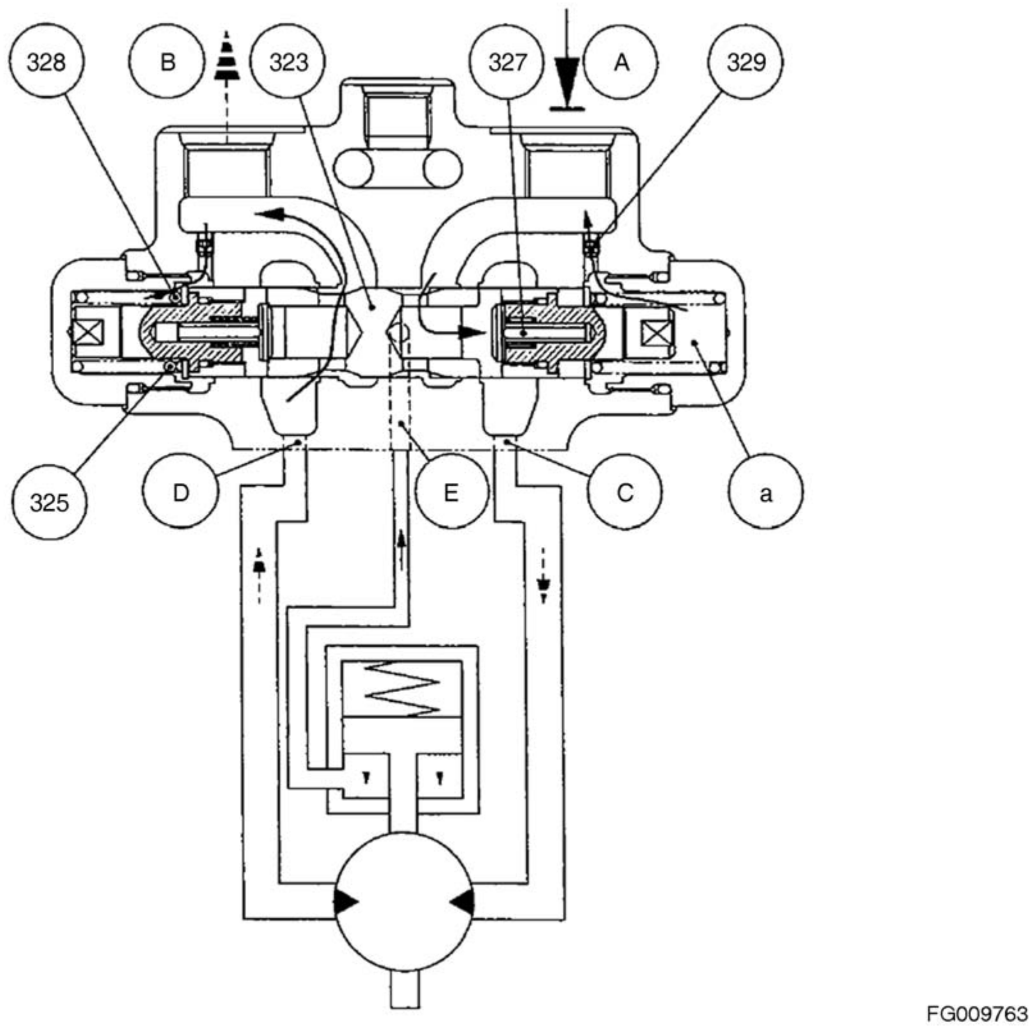



Figure 6

C. Self-traveling

While machine is being operated, as the travel speed is increased due to steep slope, the oil flow rate of the hydraulic motor is higher than the supply flow rate of the hydraulic oil pump.

The rotation of the hydraulic motor in this case is called a self-traveling. (Overrun)

While self-traveling, the pressure is lowered similar to the stopping condition. Then brake valve is moved similar to the stopping condition, throttles passage in the return side of hydraulic motor, and generate backing pressure.

In addition, the force of inertia decreases the revolution of hydraulic motor to revolution having a balance with the supply flow rate of pump.

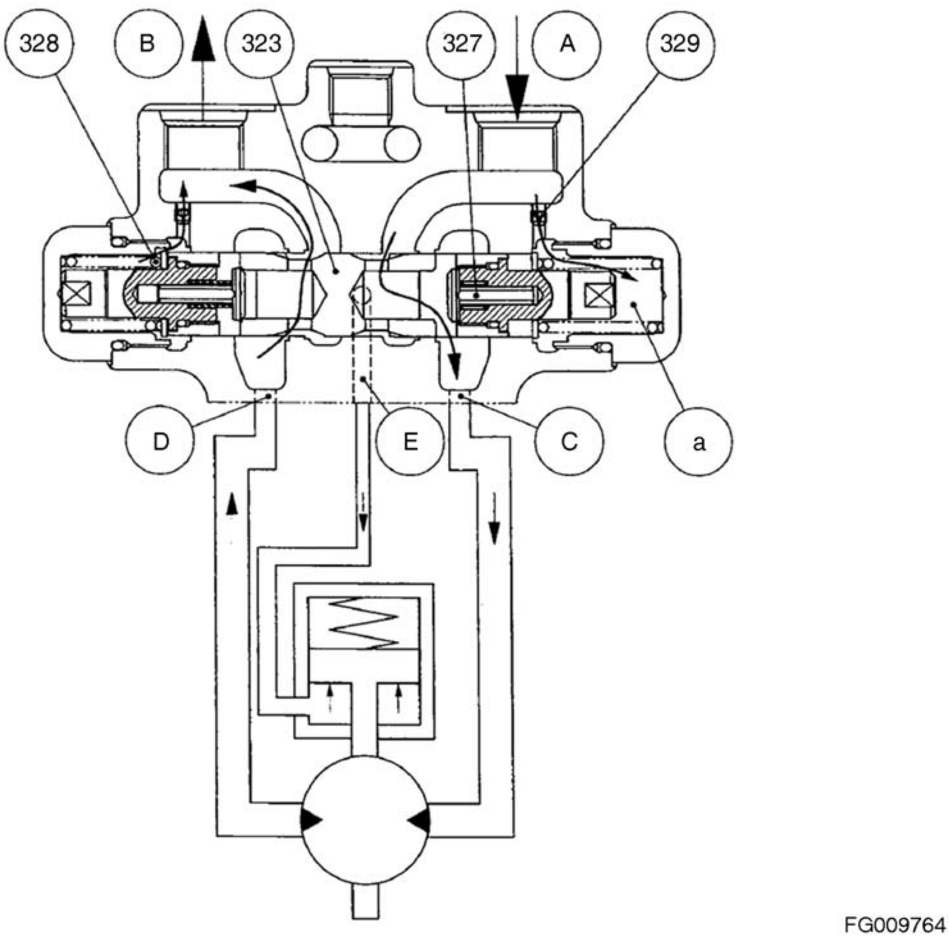



Figure 7

3. High-Low 2-Speed Switching Mechanism

A. Low Speed

When the pilot pressure is not supplied through the port (P), the valve (363) is pushed up to the upper position due to the spring (366) force and pressurized oil through the port (A) or (B), the pressurized oil is cut off at port (C), and oil in the chamber (W) is released into the drain (motor case) through the valve (363).

Accordingly, the tilt angle of the swash plate (103) becomes the maximum θ 1 resulting the maximum stroke volume and low speed rotation of the hydraulic motor.

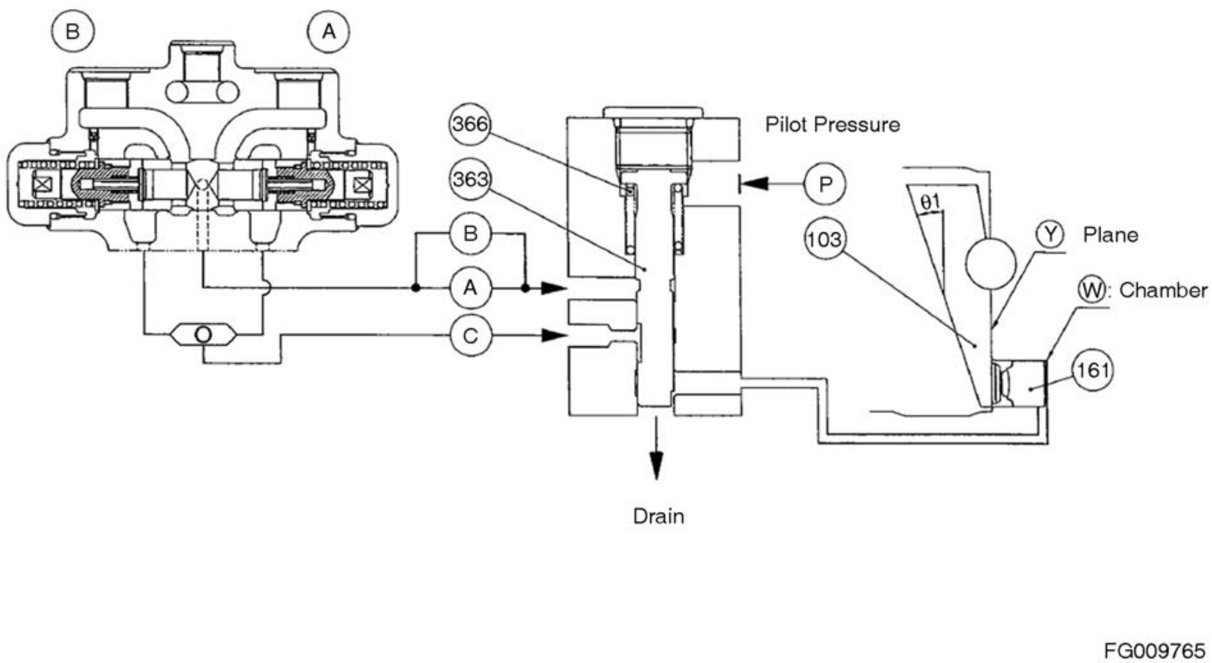



**Figure 8**

B. High Speed

When the pilot pressure is supplied through the port (D), it defeats the spring (366) force and pressurized oil through the port (A) or (B) to push down the valve (363) to lower position, the pressurized oil at the port (C) is led to the chamber (P) through the valve (363), and the piston (161) pushes the swash plate (103) up to the plane X and maintain it at its position. At that time, the tilt angle of the swash plate becomes the minimum $\theta$ 2 resulting the minimum stroke volume and high speed rotation of the hydraulic motor.

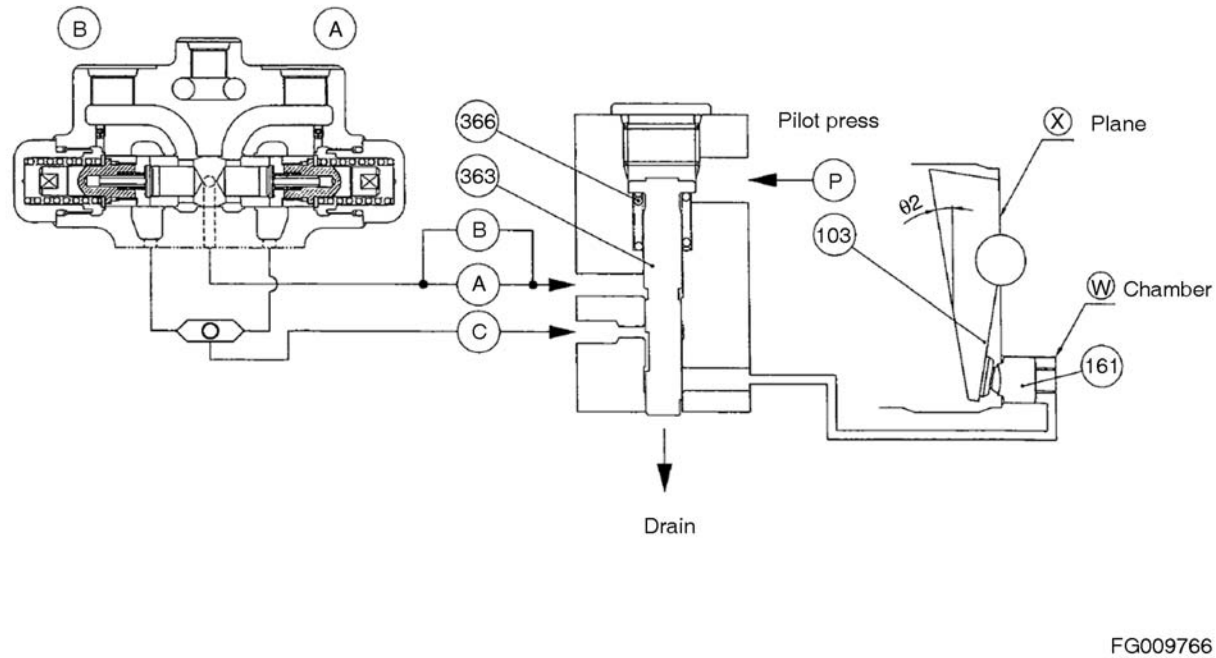



Figure 9

# PRECAUTIONS FOR USE

## Installation (Refer to Diagram of External Dimensions)

Before installation remove plugs from oil level check ports, and confirm that reduction gear oil has penetrated as far as the oil level check ports.

### CAUTION!

**When lifting a GM motor for transportation or installation, never enter the area below the GM motor. Serious injury may result.**

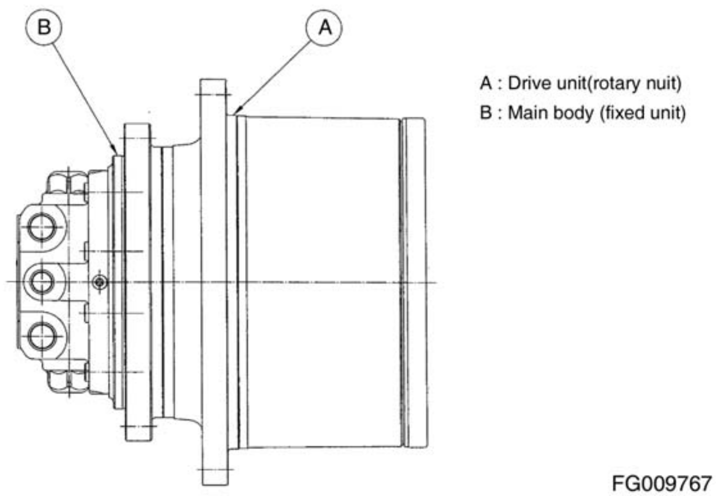



**Figure 10**

During installation, never hit the GM motor with a hammer or similar instrument.

**NOTE:** *Use mounting bolts of JIS strength class 10.9 or equivalent.*

**Mounting Bolt Torque**

| | Q'ty | Thread Dimensions | Torque | Bolts Strength Class |
|---|---|---|---|---|
| Main Unit Mounting Bolts | 20 | M16 (P2.0) | 252 ± 39.2N•m (25.7± 4.0 kg•m) | JIS B1051 Class 10.9 or Higher |
| Drive Unit Mounting Bolts | 15 | M16 (P2.0) | 252 ± 39.2N•m (25.7± 4.0 kg•m) | |

## Tubing

During delivery, ports are covered with plugs or other coverings. This is to prevent entry of dust, welding scale, etc. Coverings should be removed before connecting tubing.

## ⚠ CAUTION!

**Before connecting tubing, confirm the direction of GM motor rotation, and the position of the ports. (Refer to Diagram of External Dimensions.) Failure to do so may result in reverse rotation, or injury.**

**NOTE:** *Before operating the motor, always fill the motor casing with hydraulic fluid.*
*Required oil volume in casing : 1.0 liters*
*Failure to do this may result in early damage to the hydraulic motor.*

Select tubing sizes for drain port back pressure of 0.2MPa (2kgf/cm2) (maximum 0.69MPa (7kgf/cm2)at peak) or less.

## Fluid Selection

Selection of hydraulic fluid-recommended grades

1. Use ISO VG32 or VG46 anti-friction hydraulic fluid.
2. Control hydraulic fluid purity to NAS Class 9 or better.
3. Ensure that the working fluid operating temperature range and viscosity range do not exceed the following limits.

   Operating temperature range : -10 to +80

   Effective viscosity range : 15 to 500 mm2/s
4. Consult the manufacturer before using any hydraulic fluid other than listed below.

| **Grade** | **Viscosity (40°C)** | **32 ($mm^2/s$)** | **46 ($mm^2/s$)** | **56 ($mm^2/s$)** |
|---|---|---|---|---|
| | **ISO equivalent** | **VG 32** | **VG 46** | ***VG 56** |
| Supplier | Showa Shell | Shell Tellas Oil 32 | Shell Tellas Oil 46 | Shell Tellas Oil 56 |
| | Idemitsu | Daphne Super Hydro A32 | Daphne Hydraulic Fluid A46 | |
| | Cosmo | Cosmo Hydro AW32 | Cosmo Hydro AW46 | (Cosmo Hydro AW56) |
| | Nippon Oil | Super Highland 32 | Super Highland 46 | Super Highland 56 |
| | Mobil | DTE Oil 24 | DTE Oil 25 | |
| | Japan Energy | JOMO Hydrax 32 | JOMO Hydrax 46 | |

| Grade | Viscosity (40°C) | 32 ($mm^2/s$) | 46 ($mm^2/s$) | 56 ($mm^2/s$) |
|---|---|---|---|---|
| * VG56 is the support viscosity grade that is prescribed by JIS.<br>However, it was abolished in March, 1983.<br>Please use other viscosity grades as much as possible. | | | | |

# MAINTENANCE AND INSPECTION

## Daily Inspection

The following daily maintenance and inspection items should be verified before operating the GM motor.

## CAUTION!

**Except for confirmation of the following third abnormal sounds, maintenance and inspection must always be performed when the product is stopped. Inspection during operation may cause injury or burns. Also, confirmation of abnormal sounds should be performed in a safe area. Touching or approaching the product during operation may cause injury or burns.**

1. No oil leakage (Hydraulic fluid, lubricating oil)
2. No loose bolts
3. No abnormal sounds
4. Casing temperature not abnormally high

   (Maximum external casing temperature during continuous operation = 80°C)
5. Change interval of lubricating oil.(Refer to 5-4)

## CAUTION!

**Immediately after operation, the casing is hot. To prevent burns, use a thermometer to measure temperature and do not touch directly with the hands.**

## Changing Fluid

The standard interval for changing hydraulic fluid is every 1000 hours or one year.

Hydraulic fluid may be changed within the standard interval if there is significant reduction in volume, subject to the following standards.

| Test item | Change standard |
|---|---|
| Viscosity change (40°C) | ± 10% |
| Total oxidation (mg KOH/g) | Consult oil supplier.<br>Additive types vary according to manufacturer. |
| Water content (%) | 0.1% |
| Impurities | 10 mg/100ml |
| Impurities (%) | 0.05% |

## Changing Lubrication

Reduction gear lubricating oil (gear oil) is added at time of delivery.

1. Selecting Gear Oil - Recommended Grades
   A. Use SAE 90 equivalent gear oil (API type GL-4 or higher) with ultra-high pressure additives.
   B. Recommended product names follow:

| Supplier | Product Name |
|---|---|
| Idemitsu | Appoloil Gear HE 90 |
| Esso | Esso Gear Oil GP 90 |
| Showa Shell | Shell Spirax EP 90 |
| Cosmo | Cosmo Gear Oil GL-4 90 |
| Nippon Oil | Hypoid Gear Oil SP 90 |
| Mobil | Mobilube HD 90 |
| Japan Energy | Gear 4 |

2. Gear Oil Change Interval
   A. First change (initial change after starting operation) after 500 hours
   B. Second and following changes: after 1000 hours or one year
   C. Change standard

| Test item | Change standard |
|---|---|
| Viscosity change (40°C) ($mm^2/s$) | 10% or less of new oil. |
| Water content (%) | 0.2 % or less. |

Avoid mixing different types of lubricating oils. When changing the type of lubrication oil, be sure to flush the interior of the reduction gear.

3. Gear Oil Change Volume : 2.1 liters
4. Gear Oil Change Procedure

## CAUTION!

**Immediately after operation, the case may be extremely hot. Touching with the hands may cause burns.**

**Also, removing port plugs while hot may cause hot oil to spray out as pressure is reduced in the reduction gear, possibly causing burns. Allow the case temperature to cool sufficiently before changing oil.**

**NOTE:** *If gear oil volume is reduced for any reason, be sure to confirm the cause and take appropriate measures before filling with gear oil.*

*When removing gear oil, always dispose of old oil in an approved container rather than on the ground. Also, take care to observe applicable laws and regulations regarding disposal.*

*Oil may spray out when plugs are removed.*

*Turn the plug slowly and allow internal pressure to escape before removing.*

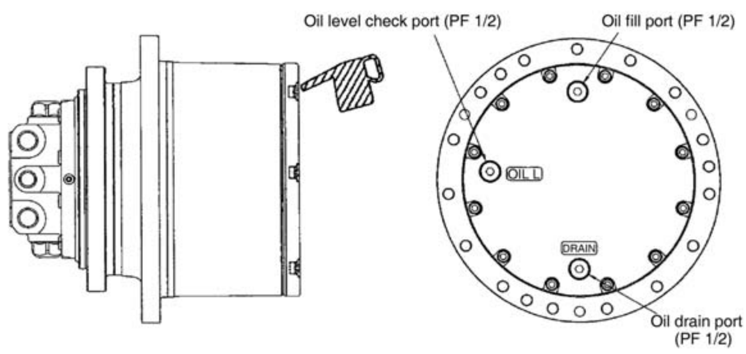



**Figure 11**

1. Stop the GM motor when the oil fill check port is at the top and the oil drain port is at the bottom (Figure 11).
2. Place the waste oil receptacle below the GM motor.
3. To change oil, remove the plugs on the 3 ports, and drain the gear oil.
   To fill oil, do not remove the plugs from the drain ports.
   - Tightening torque: 98.1 ± 19.6 N-m (10.0 ± 2.0 kgf-m)

   After draining the oil, replace the plug on the oil drain port.

- Tightening torque: 98.1 ± 19.6 N-m (10.0 ± 2.0 kgf-m)

4. Add gear oil to the oil fill port.

   Stop filling just before the gear oil overflows at the oil level check port.

5. Re-place the plugs on the oil fill ports and level check port.

   - Tightening torque: 98.1 ± 19.6 N-m (10.0 ± 2.0 kgf-m)

6. Re-place the plugs on the oil fill port.

   - Tightening torque: 98.1 ± 19.6 N-m (10.0 ± 2.0 kgf-m)

# SEALS TABLE

Handle sealing parts carefully.

Once disassembled, replace to the new parts even though no damage is observed.

| No. | Name of Part | Code | Q'ty | Remarks |
|---|---|---|---|---|
| 1 | O-ring | JIS B 2401-P18-90 | 3 | 31 |
| | | | 2 | 212 |
| | | | 1 | 359 |
| 2 | Floating Seal | ES100-209-B-A-627 | 2 | 29 |
| 3 | O-ring | ARP568-261-70 | 1 | 32 |
| 4 | O-ring | JIS B 2401-P7-90 | 2 | 33 |
| 5 | Oil Seal | TCZ28 X 48 x 10 x 11.3 | 1 | 132 |
| 6 | O-ring | 50OD2039-00 | 1 | 135 |
| 7 | O-ring | 60OD2039-00 | 1 | 139 |
| 8 | O-ring | JIS B 2401-PIOA-90 | 2 | 207 |
| 9 | O-ring | JIS B 2401-P14-90 | 2 | 209 |
| | | | 2 | 383 |
| 10 | O-ring | JIS B 2401-P11-90 | 2 | 211 |
| 11 | O-ring | JIS B 2401-P32-90 | 2 | 336 |
| 12 | O-ring | JIS B 2401-P8-90 | 3 | 358 |
| 13 | Back up Ring | JIS B 2407-T2-PIOA | 4 | 208 |
| 14 | Back up Ring | JIS B 2407-T2-P14 | 4 | 210 |

# TROUBLESHOOTING

Please contact our company, when the disposal to which "O" mark is attached is required.

| Problem 1 | Problem 2 | Possible Cause | Action | |
|---|---|---|---|---|
| Motor does not turn | Pressure will not increase | Relief set pressure is too low | Check the main relief valve | |
| | | Pump failure | Repair | |
| | | Direction switching valve is damaged | Repair | |
| | Pressure does increase | Brake valve failure | Replace or repair brake valve | O |
| | | Hydraulic motor failure | Repair | O |
| | | Gear (reduction) damage | Replace GM motor | O |
| | | Excessive load applied | Remove excessive load | |
| | | Orifice of parking brake line is blocked. | Remove the foreign materials. | |
| Oil leakage | Leaking from mating surface | Flaws in surface | Repair flaws with grinder, sand-paper, etc. | O |
| | | Bolts loose | Retighten | |
| | Leaking from case | Plug loose | Retighten | |
| | | Cracked by stone etc. | Replace GM motor | O |
| | Leaking from floating seal | Worn-out sliding surface | Replace GM motor | O |
| | | O-ring creepage | Replace GM motor | O |
| | Leaking from hydraulic motor | Bolts loose | Retighten | |
| | | O-ring damaged | Replace O-ring | O |
| | | Seal surface flawed | Repair flaws with grinder, sand-paper, etc. | O |
| During use on a sloping road, rotates under load | increased leakage of working fluid | Reduced hydraulic motor capacity | Replace GM motor | O |
| | | Increased internal brake valve leakage | Replace or repair brake valve | O |
| | Parking brake does not function | Spring damage | Replace spring | O |
| | | Friction plate worn down | Replace friction plate, mating plate | O |
| Reduction gear case surface temperature too high | | Shotage gear oil | Fit to recommended level | |
| | | Pitching in bearings | Replace GM motor | O |
| | | Working oil in gear case | Replace oil seal | O |

| Problem 1 | Problem 2 | Possible Cause | Action | |
|---|---|---|---|---|
| Meanders when used as drive motor | Occurs at low pressure | Left-right ejection volume imbalance | Repair pump | |
| | | Left-right hydraulic motor drain volume imbalance | Replace GM motor | O |
| | Occurs at high pressure | Left-right ejection volume imbalance | Repair pump | |
| | | Left-right hydraulic motor drain volume imbalance | Replace GM motor | O |
| | | Left-right brake valve operation imbalance | Replace brake valve | O |
| | | Left or right control valve has low relief pressure | Set pressure correctly, or replace relief valve | |
| Speed too slow | Pump ejection volume too low | Pump not operating property | Repair or replace pump | |
| | | High oil leakage outside pump | Repair or replace pump | |
| | | High oil leakage outside hydraulic motor | Replace GM motor | O |
| Abnormal sounds | From GM motor | Hydraulic motor or reduction gear damage | Replace GM motor | O |
| | From tubing | Tubing vibration occurring | Clamp tubing | |
| 2 -speed switching does not function | Does not switch low to high speed | High pressure selection check valve malfunction | Inspect, repair or replace | O |
| | | Switching valve malfunction | Repair or replace | O |
| | | Pilot pressure too low | Set to required pressure | |
| | | 2-speed switching piston malfunction | Repair or replace | O |
| | Does not switch from high to low speed | Switching valve malfunction | Repair or replace | O |
| | | 2-speed switching piston malfunction | Repair or replace | O |

# OUTLINE OF MAINTENANCE

## Tools

| No. | Name | Type · Specification | Q'ty |
|---|---|---|---|
| 1 | Hex-Spanner | 2.5 (M5), 3 (M6), 4 (NPTF 1/16,) 5 (PF 1/8), 6 (PF 1/4)<br>8 (M10,PF 3/8), 10 (M12,PF 1/2) | 1 |
| 2 | Socket Wrench<br>(Ratchet Handel)<br>(JIS B 4641) | Tumbler type | 1 |
| 3 | Torque Wrench<br>(JIS B 4650) | Dial type : 50[N] , Dial type : 100[N],<br>Dial type :300[N] , Dial type :560[N] | 1 |
| 4 | Adaptor for Torque Wrench | | 1 |
| 5 | Hex-Socket | Diagonal size 24 mm, 41 mm | 1 |
| 6 | Extension Bar<br>(JIS B 4637) | 150 mm | 1 |
| 7 | Hammer | Various | 1 |
| 8 | Plastic Hammer | L = 400 mm | 1 |
| 9 | O-Driver (JIS B 4609) | 50 mm, 150 mm | 1 |
| 10 | Retainer Ring Plier | For axle, For groove | 1 |
| 11 | Plier (JIS B 4623) | 200 mm | 1 |
| 12 | Lifting Device | Lifting Load : 2940[N], 300[kg] min.<br>Eye-bolt (M16)<br>Eye-bolt (M12)<br>Eye bolt (PF 1/2)<br>Hooked wire | 1 Set<br>2<br>3<br>2<br>1 |
| 13 | Container | General: W450 X D300 X 120 mm | 2 |
| 14 | Leather Gloves | | 1 Pair |

## Bolts

| No. | Name | Type · Size | Q'ty |
|---|---|---|---|
| 1 | Long Hex-Bolt | M12(P1.5) x 40 mm | 2 |

## Equipments

| Application (Use or P/N) | Name | Type · Specification | Q'ty |
|---|---|---|---|
| Assembling & Disassembling | Work Bench | | 1 |
| Washing (product & parts) | Wash Tank | Washing·final washing | 1 |
| 24, 104, 149 | Press Work Bench | 24 : press Cap. 9800[N] (1000[kgf]) min.<br>104 : press cap. 1960[N] (200[kgf]) min.<br>149 : press cap 1960[N] (200[kgf]) min. | 1 |
| 149 | Heating Tank | Heating Cap : 100°C min<br>Volume: 500 X 500 X 500 min | 1 |
| Drying after Washing | Compressed Air | 0.29~0.49 [MPa]<br>3~5 kg•cm$^2$ | 1 |

## Fabricated Tools

1. work bench for travel motor
   - For easy and safe work of disassembling and assembling travel motor.

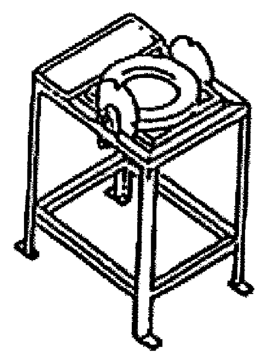


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**Figure 12**

2. Pressing Tool (Ⅰ)
   - Used for inserting Spring (114), Washer (110), or Snap Ring (145) into the Cylinder Block (104).
   - Used for removing the Spring (114) from Cylinder Block (104).

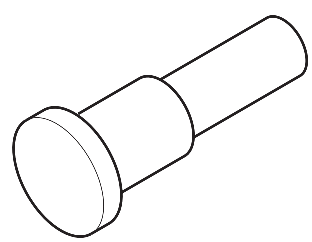

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**Figure 13**

3. Pressing Tool (II)

    - Used for removing the Deep Groove Ball Bearing (149) from Shaft (102).

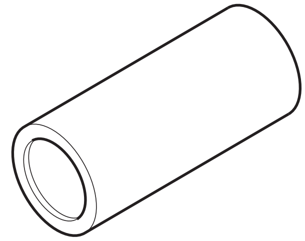

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**Figure 14**

4. Oil Seal Inserter

    - Used fro pressure-inserting Oil Seal (132) into the oil seal groove on the Spindle (2).

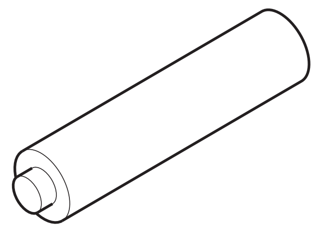

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**Figure 15**

5. Lock Washer Inserter

    - Used to insert Lock Washer (22) into the inlet of the Spindle (2).

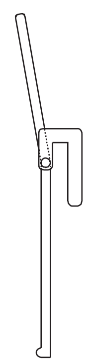

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**Figure 16**

6. Main Bearing Inserter

    - Used to insert Angular Ball Bearing (24) into the hub (1).

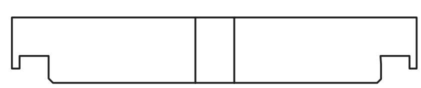

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**Figure 17**

7. Steel Rod (I)

- Used to remove Angular Ball Bearing (24) from the hub.

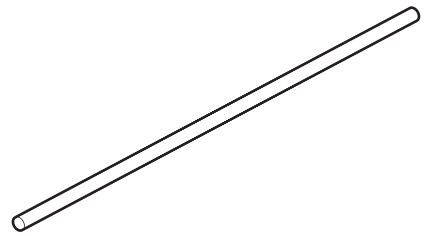

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**Figure 18**

8. Long Eye Bolt

- Used to hang Travel Motor, Spindle (2), and Hub (1).

| Use | "A" |
|---|---|
| Hub | M 16 |
| Hub | M 10 |
| Spindle | M 16 |
| Travel Motor | M 16 |

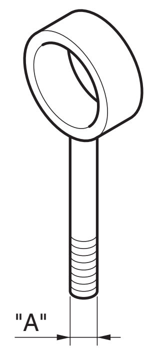


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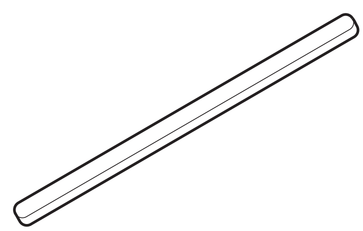
**Figure 19**

9. Blade

- Used to remove Timing Plate[109] from Rear Flange (301).

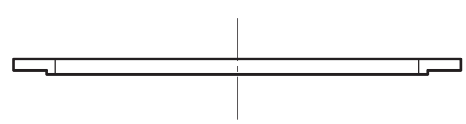


FG009812

**Figure 20**

10. Floating Seal Assembler (I)

- Used to assemble Floating Seal[29] with Hub (1).

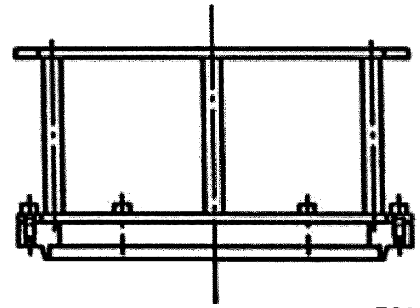


FG009813

**Figure 21**

11. Floating Seal Assembler (II)

- Use to assemble Floating Seal[29] with Hub[1] and Spindle (2).

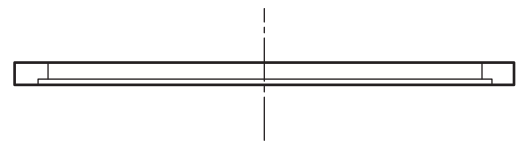


FG009814

Figure 22

12. Floating Seal Assembler (III)

- Use to assemble Floating Seal[29] with Spindle (2).



FG009815

Figure 23

## Torque

| Parts (Structural Diagram) | Bolts & Nuts | | Hex-2 Face Width ( mm) | Q'ty | Torque (N•m) |
|---|---|---|---|---|---|
| | Name | Spec. | | | |
| 30, 357 | Plug | PF 1/2 | 10 | 4 | 98.1 ± 19.6 (10.0 ± 2.0) |
| 35 | Hex Groove | M10 (P1.5) | 8 | 12 | 66.7 ± 3.92 (6.8 ± 0.4) |
| 203 | Sleeve (assembling Relief Valve) | PF 1/2 | 24 (Socket) | 2 | 98.1 ± 19.6 (10.0 ± 2.0) |
| 205 | Plug | PF 1/4 | 6 | 2 | 29.4 ± 4.90 (3.0 ± 0.5) |
| 324 | Plug | M36 (P1.5) | 41 (Socket) | 2 | 441 ± 39.2 (45.0 ± 4.0) |
| 343 | Hex Groove Bolt | M12 (P1.75) | 10 | 10 | 102 ± 15.7 (10.4 ± 1.6) |
| 352 | Plug | PF 1/8 | 5 | 3 | 12.3 ± 2.45 (1.25 ± 0.25) |
| 354 | Hex Groove Plug | NDTF 1/16 | 4 | 5 | 9.81 ± 1.96 (1.0 ± 0.2) |
| 380 | Plug | PF 3/8 | 8 | 2 | 58.8 ± 9.81 (6.0 ± 1.0) |
| 396 | Hex Groove Plug | PT 1/4 | 6 | 2 | 29.4 ±4.90 (3.0 ± 0.5) |
| 398 | Hex Groove Plug | PT 1/8 | 5 | 5 | 12.3 ± 2.45 (1.25 ± 0.25) |

## Weight Table

| Parts (Structural Diagram) | Name | Mass (kg) |
|---|---|---|
| Travel Motor Assembly | | Approx. 145 |
| 1 | Hub | Approx. 46 |
| 2 | spindle | Approx. 27 |
| 3 | Carrier (1) Assembly | Approx. 12 |
| 7 | Carrier (2) Assembly | Approx. 24 |
| 301 | Rear Flange Assembly | Approx. 13 |

**NOTE:** *Use crane to lift up heavy objects. Otherwise, may result in injury in back.*

# DISASSEMBLING

## Work Preparation

Prepare following for disassembling;

1. Work Bench
   - Prepare the work bench for Travel Motor.
   - The bench must be rigid enough for the disassembling and reassembling the internal parts of the Travel Motor.

     The bench must have sufficient area to place all the parts.

     The bench must be stabilized to prevent fall or movement of parts during work
   - The bench must be covered with rubber r vinyl sheet.
2. Tools and Devices
   - Prepare the tools and devices listed in the paragraph

## General Precautions for Work

**CAUTION!**

**Parts are slippery by gear oil or hydraulic oil.**

**Take care not to fall or drop the parts to prevent injury and damage to parts.**

**CAUTION!**

**Kerosene or other inflammable solvent is used for parts washing.**

**Take utmost care when handling such inflammable solvents to prevent fire.**

1. Prepare check list including the characteristics of anomalies before starting the disassembling work. Keep the order of disassembling.
2. All the parts are precision parts. Take care for handling, without collision or dropping.

   **NOTE:** *Take care not to cut hands when handling sharp edged parts.*

3. Even hard and rigid parts must not be knocked or exerted with excessive force. Otherwise, the part may become unable to assemble or degraded in performance. Work with patience and care.
4. Take measures of rust or dust proofing if disassembled parts have to be left unassembled for a long while. Otherwise, the part may be degraded with rust.
5. Mark the fitting surfaces during disassembling.
6. Arrange the disassembled parts in order to prevent damage or loss of the parts.
7. Seals, in principle, have to be replaced when disassembled, even though they look good. Prepare replacement parts before disassembling.
8. The photos and pictures show typical models. Certain parts may differ from the actual parts, but the order of disassembling is the same.

## Disassembling Order

**1. Washing the Travel Motor**

A. Joint and tighten eye bolts in the M16 bolt holes on the Spindle (2). Lift the Travel Motor with a crane and move it to the Wash Tank.

**NOTE:** *Place the two eye bolts symmetrically in the M16 bolt holes on the spindle.*

B. Wash the Travel Motor with brush.

**NOTE:** *Wash the groove (for floating Seal) between the Hub (1) and Spindle (2) clean, where there is dust or foreign matter.*

**2. Mounting the Travel Motor**

A. Place the Travel Motor on the work bench.

**NOTE:** *Insert the Travel Motor into the mounting hole on the work bench lightly, while matching the screw hole on the Spindle (2) with the screw hole on the work bench.*

B. Mount the Travel Motor with two hex-groove bolts on symmetric position.

---

**CAUTION!**

---

**Tighten the hex-groove bolt sufficiently. Otherwise, the Travel Motor may fall down when overturned for work.**

---

3. **Removing the Lubricant**

A. Lay down the Travel Motor(with the outlet port pointing downward).

B. Loosen the Plug (30) at the oiling port to release the pressure in the reduction gear, and tighten the plug lightly.

**NOTE:** *If the reduction gear was not depressurized, lubricant may eject out when the plug on the discharge port is loosened.*

C. Place a container at the end of the oil discharge port, take the plug out slowly to discharge the lubricant.

**NOTE:** *The container must be large enough to receive the lubricant in the reduction gear, which is 2.1L.*

D. If the lubricant does not come out smoothly, remove the plug on the oiling port slowly.

E. Remove the O-ring (31) from the Plug which was taken out.

**NOTE:** *Once disassembled, the O-ring (31) must be replaced with a new one, to prevent oil leak.*

4. **Removing the Cover**

A. Turn the Travel Motor over(with the Reduction Gear facing upwards)

B. Remove the 12-M10 bolt (35).

C. Seal is applied on the fitting surfaces of the Cover (14) and Hub (1). Insert a metal rod on the top of the Cover, knock the rod to the upside of the slope to remove the Cover.


**Figure 24**

## CAUTION!

**When knocked towards the upside of the slope, the Cover may bound up or fall down. Take care of your foot not to be hurt with the falling Cover.**

D. Joint an eye bolt at the PF1/2 Port, lift the Cover (14) up from the Hub and move it.


**Figure 25**

## 5. Removing the Thrust Plate

A. Remove the Thrust Plate (13).

Figure 26

## 6. Removing the 1st Stage Gears

A. Remove the Sun Gear (1, 4).

**NOTE:** *Take care not to drop the Sun Gear (1) down, which is slippery with lubricant.*

Figure 27

B. Join bolts in the three M12 Tabs on the Carrier (1, 3). Lift the Carrier Assembly (1) with crane and move it.

**NOTE:** *When lifting the Carrier (1) Assembly up, align the center lines of the Hub (1) and the Carrier Assembly (1), and lift up slowly in order to prevent the end of the Planetary Gear (1, 5) damaging the teeth inside the Hub.*

Figure 28

## 7. Removing the Coupling

A. Remove the Coupling (15) from the Shaft (102).

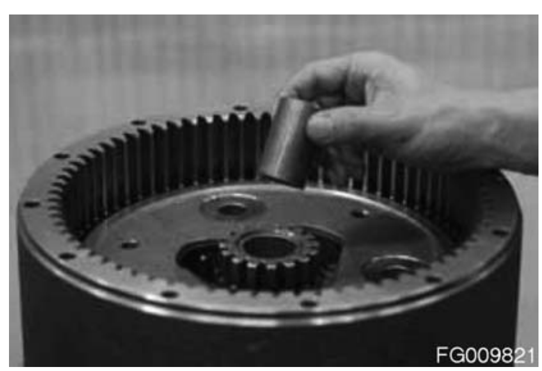


Figure 29

**8. Removing the 2nd Stage Gears**

A. Join eye bolts in the 3 M12 Tabs, for hanging, on the 3 points of the Carrier (2, 7). Lift the Carrier Assembly (2) with crane and move it.

**NOTE:** *When lifting the Carrier Assembly (2) up, align the center lines of the Hub (1) and the Carrier Assembly (2), and lift up slowly in order to prevent the end of the Planetary Gear (2, 9) damaging the teeth inside the Hub.*

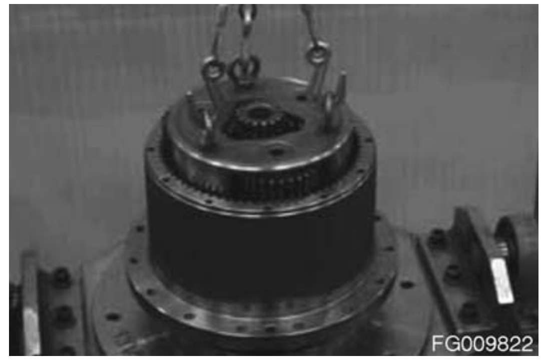



**Figure 30**

B. Remove the Sun Gear (2, 8).

**NOTE:** *Take care not to drop the Sun Gear(2) down, which is slippery with lubricant.*

**9. Removing the Lock Washer**

A. Fix on the turn-over table using the M14 hole of the Hub (1).


**Figure 31**

B. Place (-) screw drive, or an equivalent tool, at the skimmer of the 2 Lock Washers (22). Knock the driver head with a hammer towards the bottom of the slope to remove the Lock Washer.


**Figure 32**

## 10. Removing the Hub

A. Remove the hex-groove bolt joining the Hub and the turn-over table.

B. Mount an eye bolt (M10) on the Hub and lift it up with crane.

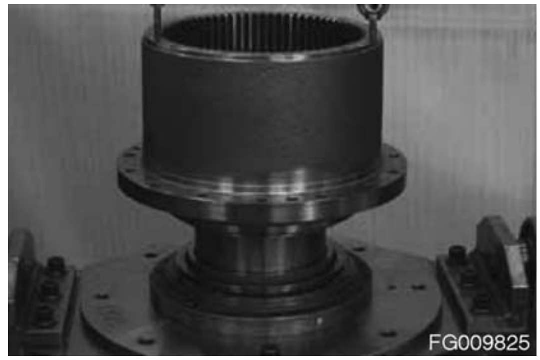



Figure 33

### WARNING!

**Lift the Hub up keeping it parallel with the Spindle shaft, slowly. If hung with an angle, large force has to be exerted, resulting in the fracture of the hanging device or eye bolt, and injury to the worker. If the Hub would not come out easily, do not hang it with excessive force, but use press to take it out safely.**

## 11. Removing the Floating Seal

A. Exert force with hand on the inner side of the Floating Seal[29] towards upside.

**NOTE:** *Wear gloves to prevent cutting hand by the edge of the Floating Seal.*

*If solidified with soil inside, remove it with (-) screw drive or similar tools as leverage.*


Figure 34

## 12. Removing the Angular Ball Bearing

A. Place a pin punch on the edge of the outer ring of the Angular Ball Bearing (24) at 3 or 5 points which divide the ring in equal intervals. Hammer the punch to take out the Bearing small by small.

**NOTE:** *Do not hammer the inner ring of the Angular Ball Bearing. If the inner ring is damaged, the Baring cannot be used. Therefore, do not knock the inner ring, unless the Bearing is to be replaced.*

*When the outer ring of the Ball Bearing (24) is out of the Hub (1), the Bearing falls down. Place a pan covered with rubber mat to receive the Bearing.*


Figure 35

## 13. Removing the Rear Flange

A. Turn the Travel Motor over(with Motor side up).

**NOTE:** *Following procedures are for removing the Plug easily, when disassembling the inside of the Rear Flange.*

*Loosen the Plug so that it can be removed with hand.*

*Do not loosen the Plug unless the Rear Flange inside is to be disassembled.*

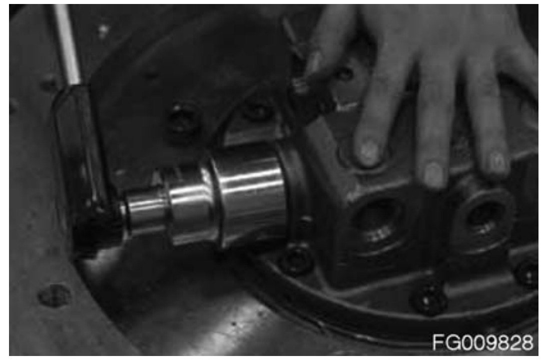



**Figure 36**

B. Loosen the two Plugs (324).

**NOTE:** *Following procedures are for removing the Plug easily, when disassembling the inside of the Rear Flange.*

*Do not loosen the Plug unless the Rear Flange inside is to be disassembled.*

*When the Plug (324) becomes loose, the Spring (328) can move easily. Therefore, the Plug (324) and the Spring (328) may be ejected out. Therefore, care must be taken for this work.*

C. Loosen the two Plugs (380).

D. Loosen the two Plugs (352).

E. Loosen the Plug (357).


**Figure 37**

F. Loosen the two Relief Valve Assemblies (including 203).


**Figure 38**

G. Remove the two Relief Valve Assemblies (including 203).

**NOTE:** *Do not reuse the removed O-rings (207, 209, 212) and Back-up Rings (208, 210).*

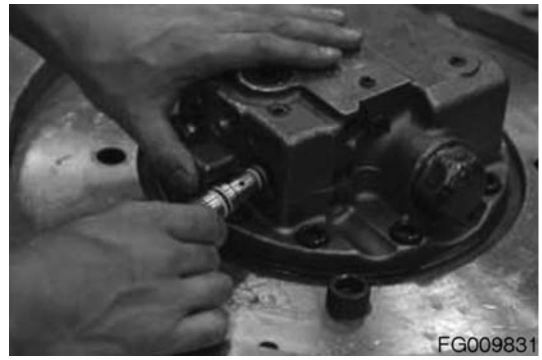


**Figure 39**

H. Unscrew the ten hex groove bolts (343) and remove them from the Rear Flange (301).

I. Remove the Rear Flange (301) from the Spindle[2].

**NOTE:** *Hold the Rear Flange with both hands, lift it up carefully to remove it. It removed with excessive force or by knocking, the Timing Plate (109) may be fall down and damaged. Care should be taken when removing the Rear Flange.*

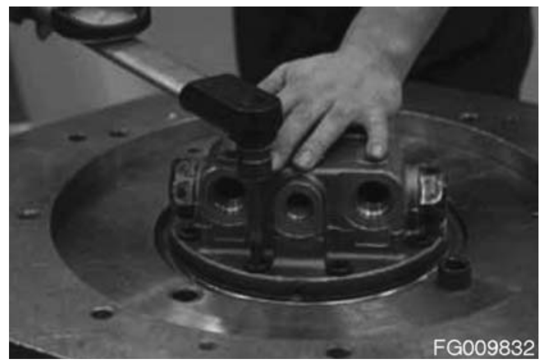


**Figure 40**

J. Remove the two parallel Pins (34) from the Spindle (2).

**Figure 41**

K. Remove the two O-rings (32, 33) from the Spindle (2).

**NOTE:** *Do not reuse the removed O-rings (32, 33).*

**Figure 42**

## 14. Disassembling the Rear Flange Assembly

A. Place the Rear Flange (301) with the fitting surface with the Spindle (2) upside.

B. Remove the Timing Plate (109) from the Rear Flange (301).

**NOTE:** *Removing the Rear Flange (301) may require some force because of the oil on the fitting surface. Insert a blade in the groove of the fitting surface on the Rear Flange (301) and lift the Timing Plate (109) up softly to remove it. Do not use sharp tools, such as screw driver, which may scratch the fitting surface, resulting in oil leak.*

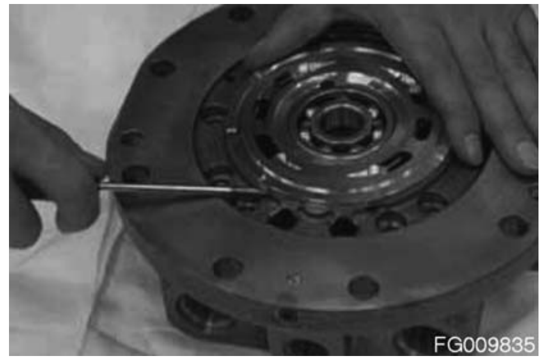



**Figure 43**

C. Remove the deep groove Ball Bearing (150) from the Rear Flange (301).


**Figure 44**

D. Remove the Parallel Pin (341) from the Rear Flange (301).


**Figure 45**

## 15. Disassembling the Brake Valve Parts in the Rear Flange

A. Remove the two Plugs (324) from the Rear Flange (301).

B. Remove the Washers (325) and springs (328), 2 each, from the Rear Flange (301).


**Figure 46**

C. Remove the Spool (323) from the Rear Flange (301).

**NOTE:** *Tilt the Plug Port of the Rear Flange (301), then the Spool (323) will slide out. Take it by lifting the front end.*


**Figure 47**

D. Remove the O-ring (336) from the Plug (324).

**NOTE:** *Do not reuse the removed O-ring (336).*


**Figure 48**

## 16. Disassembling the 2-Speed Switching Spool

A. From the Rear Flange (301), remove the Plug (357).

B. Remove the O-ring (359) from the Plug (357).

**NOTE:** *Do not reuse the removed O-ring (359).*


**Figure 49**

C. Remove the Spool (363) and spring (366) from the Rear Flange (301).


**Figure 50**

## 17. Disassembling the Piston

A. From the Rear Flange (301), remove the two Plugs (380).

B. Remove the O-ring (383) from the Plug (380).

**NOTE:** *Do not reuse the removed O-ring (383).*

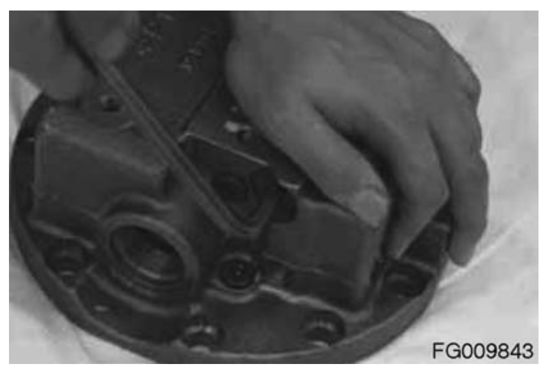



**Figure 51**

C. Remove the Piston (381) from the Rear Flange (301).


**Figure 52**

**18. Disassembling the Check Valve Ball**

A. From the Rear Flange (301), remove the two Plugs (352).

B. Remove the O-ring[358] from the Plug (352).

**NOTE:** *Do not reuse the removed O-ring (358).*


**Figure 53**

C. Remove the Steel Ball (353) from the Rear Flange (301).

**NOTE:** *If it is difficult to remove the Steel Ball, use a magnet.*


**Figure 54**

**19. Disassembling the Packing Brake**

**CAUTION!**

**If compressed air is injected in rapidly, the Piston (112) may be ejected out from the Spindle (2), resulting in injury or damage. Cover the Piston (112) to protect it.**

A. Inject the compressed air into the hole in the Packing Brake path of the Spindle 2, and take the Piston (112) out from the Spindle 2.

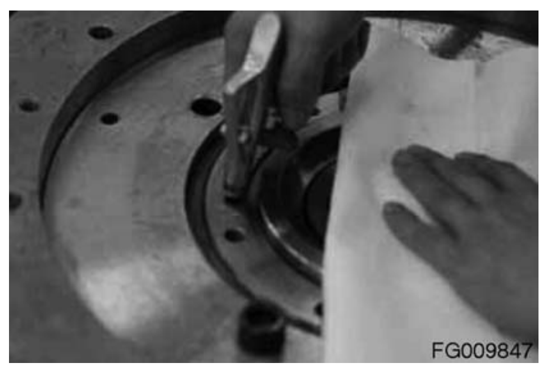



**Figure 55**

B. Remove the O-rings (135, 139) out from the Piston (112).

**NOTE:** *Do not reuse the removed O-rings (135, 139).*

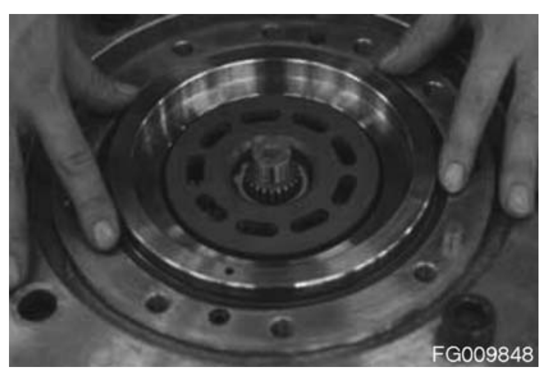



**Figure 56**

## 20. Disassembling the Hydraulic Motor Parts

**NOTE:** *Oil will come out when the Travel Motor is laid down. Place an oil pan under the Travel Motor.*

A. Lay the Travel Motor down in 90 degrees.

B. Remove the oil in the Travel Motor.

C. Select the four Opposite Plates (116) and the three Friction Plates (115).


Figure 57

D. Turn the Cylinder Block (104) by 2~3 rounds with hands, and remove the Shoe[106] attached to the Swash Plate (103).

**NOTE:** *If the Cylinder Block (104) is removed in this state, the Shoe (106) remains in the Swash Plate (103), and the parts (Piston (105), Shoe (106) etc.) will be separated from the Cylinder Block (104) and fall inside the Spindle (2). So care must be taken in this state.*


Figure 58

E. Remove the Cylinder Block (104) from out of the Shaft (102).

F. Remove the Piston Assembly (Piston (105), Shoe (106)) and the Retainer Plate (107) from the Cylinder Block (104).

**NOTE:** *Remove the Piston Assembly together with the Retainer Plate (107) by holding the Retainer Plate with both hands.*

*The Piston (105) and the Shoe (106) are jointed by being tightened on the spherical surface of the Piston. The Shoe (106) cannot be separated from the Piston (105) without damaging the Shoe (106).*

*Therefore, if replacement is required, replace them as a single unit(hereinafter, will be referred to as the Piston Assembly.*


Figure 59

G. From the Retainer Plate (107), take the Piston Assemblies (105, 106) out (9 sets).

**Figure 60**

H. Remove the Thrust Ball (108) from the Cylinder Block (104).

**Figure 61**

I. Remove the three Collars (151) from the Cylinder Block (104).

**Figure 62**

**21. Removing the Spring from the Cylinder Block**

A. Place the Cylinder Block (104) on the press work bench.

**NOTE:** *Spring (114) should be taken out only for replacement.*

*To remove the Spring (114), align the axes of the press tool(•×) and the Washer (110), to prevent damage to the Cylinder Block (104) by contact.*

*Cover the Cylinder Block (104) up with vinyl sheet to prevent damage on the surface of the Cylinder Block (104).*

**Figure 63**

B. Place the press tool (1) on the Washer (110), press the tool (1) strongly with a press, and remove the THS Snap Ring (145) out from the snap ring groove on the Cylinder Block (104), with a snap ring plier.

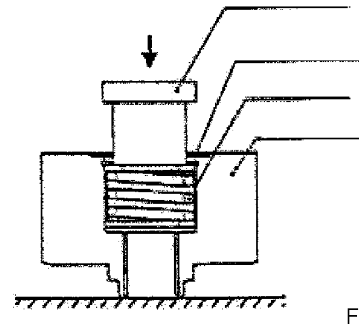



Figure 64

## ⚠ CAUTION!

**Release the press slowly. If released suddenly, the Spring (114) may be ejected out giving injury.**

C. From the Cylinder Block (104), remove the THS Snap Ring (145), Washer (110), Spring (114), and Washer (110).

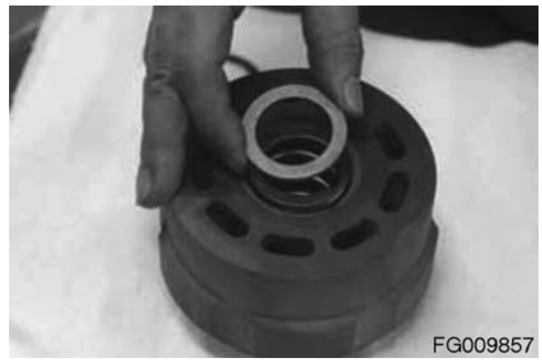



Figure 65

**22. Removing the Swash Plate**

A. Remove the Swash Plate (103) from the Shaft (102).

**NOTE:** *Take care when removing the Swash Plate (103), because the Pivot (167) may be attached to the Swash Plate (103).*


Figure 66

B. Remove the Shaft (102) from the Spindle (2).

At this time, the deep grooved Ball Bearing (149) will be separated being attached on the Shaft.

**NOTE:** *Shaft (102) can be easily removed by knocking the end of the Shaft on the Reduction Gear side with a plastic hammer. Take care not to strike the Shaft, or it may bound.*

C. Remove two (each) Pivots (167) and Parallel Pins (171) from the Spindle (2).


Figure 67

D. Remove the 2-speed switching Piston Assembly and the Spring (185) from the Spindle (2).


**Figure 68**

## 23. Removing the Deep Grooved Ball Bearing

**NOTE:** *Remove the Deep Grooved Ball Bearing only for replacement.*

A. Place a press tool (II) on the press work bench, and insert the Shaft (102) in it.

B. Press the end of the Shaft with the press to remove the Inner Ring[149] of the Deep Grooved Ball Bearing from the Shaft[102].

**NOTE:** *Do not reuse the Deep Grooved Ball Bearing.*

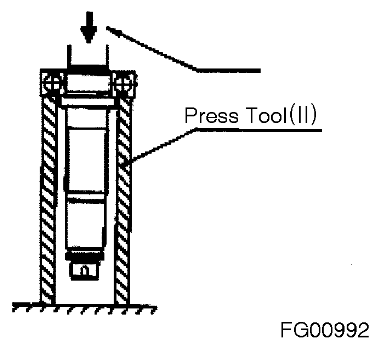



**Figure 69**

## 24. Removing the Parts on the Spindle

A. Remove the Seal (23) from the Spindl (2).


**Figure 70**

B. Remove the Floating Seal (29) from the Spindle (2).

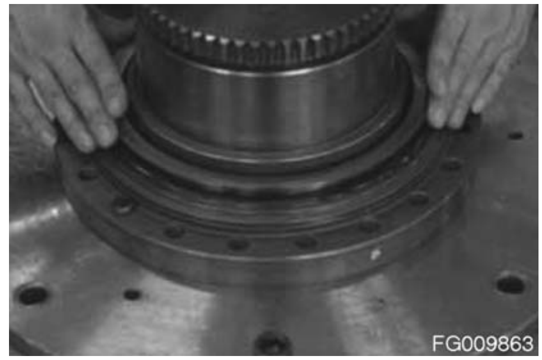



Figure 71

C. Remove the Oil Seal 132 from the Spindle (2).

**NOTE:** *Do not reuse the removed Floating Seal (29) and Oil Seal (132).*

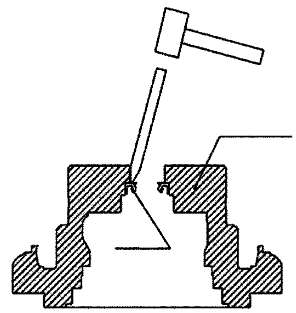



Figure 72

**25. Washing the Parts**

A. Classify the Hub[1], Spindle (2), Cover[14], Rear Flange (301) and other pats.

B. Wash the Hub (1) Spindle (2) Cove (14) Rear Flange (301) in the wash tank.

**NOTE:** *Remove soil on the surface carefully.*

*Kerosene used for washing is highly inflammable. Be careful to prevent fire.*

**NOTE:** *if the parts are dirty, leave it in the solvent for a while, until the dust, soil, and grease are separated and float up. Do not wash dirty parts from the start, or the dirt may scratch the surfaces.*


Figure 73

C. Wash the other parts in a wash tank with kerosene.

## 26. Final Washing

A. Put the parts in the finish washing tank containing kerosene. Rotate the parts slowly, wash them clean to the inside.

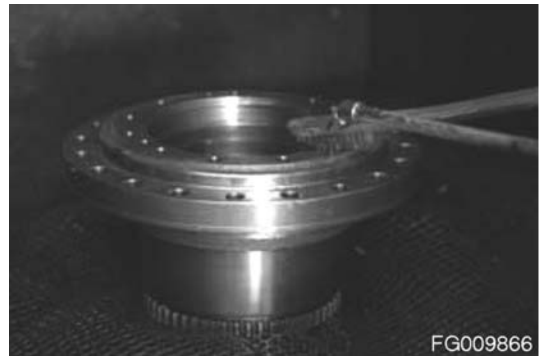



**Figure 74**

B. Wipe the kerosene on the parts with clean cloth.

**NOTE:** *Dry the inside of the Hub[1] and Spindle[2] with compressed air, where there is no dust and moisture.*

*After drying, apply hydraulic oil on the surface of the parts.*

*Leave the Rear Flange[301], hydraulic motor parts, and gears in a place free from dust and moisture to dry up. When dried, apply hydraulic oil on their surfaces.*


**Figure 75**

# MAINTENANCE STANDARDS

GM Motor has to be disassembled and inspected in compliance with this standard. Take utmost care not to scratch on the moving and reciprocating surfaces.

## Seals

Seals (O-ring, oil seals, floating seas) must be replaced with new seals, regardless of the damage, once disassembled.

## Maintenance Standards for Wearable Parts

1. Any parts which show visible defect must be replaced with new ones.
2. Replace the parts which show following defects.

| Part No. | Name | Defect Description | Standard Size | Allowable Range |
|---|---|---|---|---|
| 1 | Hub | · Any major visible defect.<br>· Pinching on the tooth of ring gear.<br>· Abnormal wear such as scratch. | - | - |
| 2 | Spindle | · Any major visible defect.<br>· Abnormal wear such as scratch. | - | - |
| 3, 7 | Carrier Assembly | · Abnormal wear such as scratch. | | |
| 4<br>8<br>5<br>9 | Sun Gear 1<br>Sun Gear 2<br>Planetary Gear 1<br>Planetary Gear 2 | · Pinching on tooth.<br>· Breaking on the working surface of bearing. | - | - |
| 24 | Ball Bearing | · Dent.<br>· Breaking.<br>· Biased wear. | - | - |
| 301 | Rear Flange | Scratch on the reciprocating surface between the Spools (323, 363) and Piston (381). | - | - |
| 102 | Shaft | · Wear on the fitting surface with the Oil Seal [132].<br>· Worn spline. | - | - |
| 103 | Swash Plate | Sooting. | - | - |
| 104 | Cylinder Block | · Worn spline.<br>· Serious wear on the inside of the bore.<br>· Scratch or biased wear on the reciprocating surface with the Timing Plate (109). | - | - |
| 105<br>106 | Piston Assembly<br>Piston<br>Shoe | · Skimmer on the axial direction of the Piston (105) and Shoe (106).<br>· Abnormal, biased wear of Shoe (106). | Skimmer<br>0.15 mm | Skimmer<br>0.15 mm |

| Part No. | Name | Defect Description | Standard Size | Allowable Range |
|---|---|---|---|---|
| 107 | Retainer Plate | · Biased wear on the reciprocating surface with the Shoe (106)<br>· Scratch or biased wear on the reciprocating surface with the Thrust Ball (108). | - | - |
| 108 | Thrust Ball | · Biased wear on the spherical reciprocating surface with the Retainer Plate (107). | - | - |
| 109 | Timing Plate | · Sooting or biased wear on the reciprocating surface. | - | - |
| 115<br>116 | Friction Plate<br>Opposite Plate | · Biased wear on both ends.<br>· The torque is different from the specified value.<br>· Sooting. | Braking Torque 206 N•m (21.0 kgf•m), min. | Braking Torque 206 N•m (21.0 kgf•m), min. |
| 105 | Piston | · Scratch or dent on outer surface. | - | - |
| 149<br>150 | Deep Grooved Ball Bearing | · Dent.<br>· Breaking.<br>· Wear. | - | - |
| 161<br>162 | 2-Speed Piston Kit<br>Piston<br>Shoe | · Abnormal wear on outer surface.<br>· Abnormal, biased wear on Shoe. | - | - |
| 323<br>363 | Spool | · Biased wear on outer surface.<br>· Dent on outer surface. | - | - |
| 381 | Piston | · Scratch on outer surface. | - | - |

# ASSEMBLING

Assembling, in principle, shall be carried out in the reverse order of the disassembling.

## Preparation

Prepare work table, tools, devices, same as those described in the Disassembling Section.

## General Precautions for Assembling Work

1. Cautions for assembling work, in principle, are same as those defined in the Disassembling Section.
2. Remove any metallic particle and foreign matters from all the parts. Check and remove rust or scratch with oil stone.
3. Replace O-ring, Oil Seals and Floating Seals with new ones.
4. Remove the residual adhesive in the screw holes (12) on the Hub (1) through the M10 P1.5 tab.

   Wash, degrease the screw holes, blow the holes with compressed air to remove residual wash liquid.

   Replace the hex-groove bolts (35) with new ones.
5. When assembling the O-ring, Oil seals and floating seals, take care not to damage them (apply a small amount of grease for smoothness).
6. Be sure to apply clean machine oil (NAS Class 9 or better) on the moving and reciprocating surfaces of the hydraulic motor and valves
7. Do not wear cloth gloves while assembling to prevent malfunction by residual fibers.
8. Tighten the bolts and Plugs by the torque specified in the See “Torque” on page -34.
9. Plug all ports to prevent dust after assembling.
10. The photos and pictures are on the typical model. Partial difference may exist, however, the order of assembling procedures are the same.

# Order of Assembling

When replacing and reassembling parts, pre-pressure adjustment of Ball Bearing is required. Therefore, make sure that the parts below have been replaced before assembling.

**NOTE:** *Replacement parts for pre-pressure adjustment of Ball Bearing .Hub (1), Spindle (2), Ball Bearing (24)*

**NOTE:** *When replacing and reassembling the above listed parts, make sure to use the pre-adjusted parts. Otherwise, the Travel Motor may mal function resulting in earlier damage.*

**1. Assembling the Hub**

A. Place the Hub[1] on the press work bench.

B. Insert the Ball Bearing (24) into the Hub[1]. Place the press fitting tool on the outer ring of the Ball Bearing (24), press it with press to insert into the Hub[1].

C. Turn the Hub (1) upside down.

D. Press fit the Ball Bearing (24) into the Hub (1), in the same method as B.

**NOTE:** *Take care that the Ball Bearing (24) is assembled in the correct direction.*

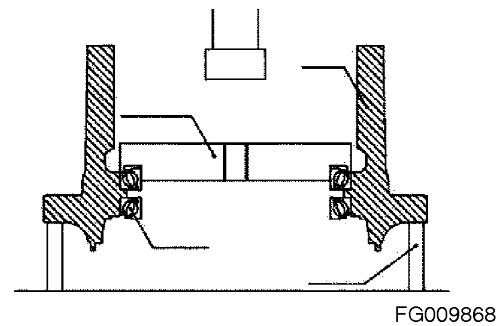



**Figure 76**

E. Apply grease on the O-ring of the Floating Seal (29). Insert the Floating Sel[29] into the groove on the Hub (1).

**NOTE:** *When applying grease on the O-ring of the Floating Seal (29), take the O-ring off of the Floating Seal (29) and apply grease on the whole surface of the O-ring, thin and evenly.*

**NOTE:** *To assemble the Floating Seal[29], place the F/S assembling tool (I), Floating Seal[29], and F/S assembling tool (II), in the listed order, and press until the F/S assembling tool (II) touches the F/S assembling tool (I). Remove the F/S assembling tools and confirm that the end surface of the Hub is within 1 mm difference with the floating seal surface.*

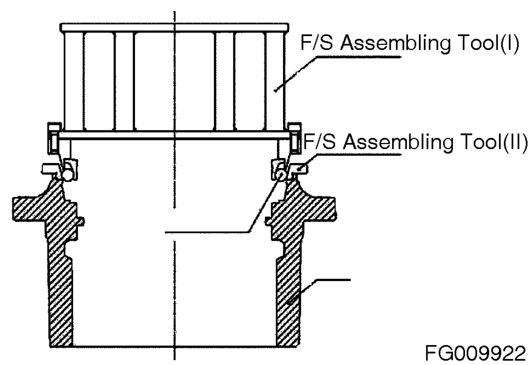



**Figure 77**

## 2. Assembling the Spindle Part

A. Apply grease on the O-ring of the Floating Seal[29]. Insert the Floating Seal (29) into the floating seal groove on the Spindle (2).

**NOTE:** *To assemble the Floating Seal (29), place the F/S assembling tool (I), Floating Seal (29), and F/S assembling tool (II), in the listed order, and press until the F/S assembling tool (II) touches the F/S assembling tool (I). Remove the F/S assembling tools and confirm that the end surface of the Hub is within 1 mm difference with the floating seal surface.*

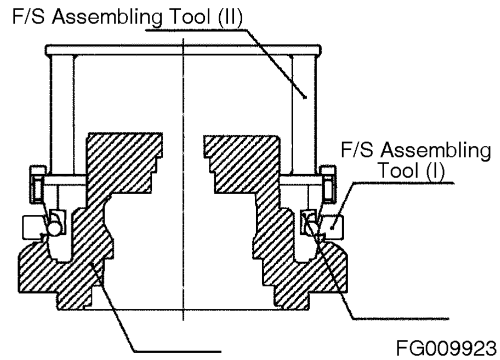



**Figure 78**

B. Join two eye bolts on the Spindle (2) at symmetric position.

C. Place the Spindle (2) on the work bench with the hex-groove bolts are on symmetric position.

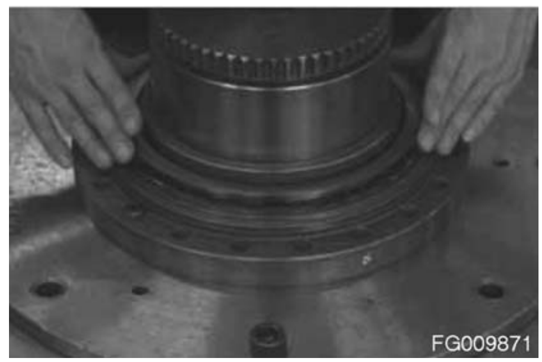



**Figure 79**

# CAUTION!

**Tighten the hex-groove bolt sufficiently. Otherwise, the Travel Motor may fall down when turned over.**

## 3. Adjusting the Pre-pressure of the Angular Ball Bearing

**NOTE:** *When the Hub (1), Angular Ball Bearing (24) or Spindle (2) is replaced, carry out pre=pressure adjustment. If the pre-pressure is not appropriate, the Angular Ball Bearing may be fractured soon.*

A. Insert the Lock Washer (22) in the Spindle (2), and measure size C.

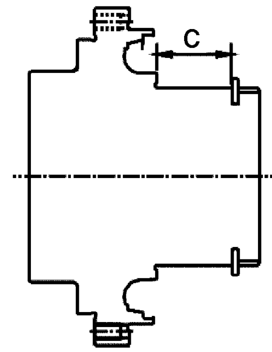



Figure 80

B. Measure the width D of the Angular Ball Bearing.

**NOTE:** *Turn Hub (1) and Angular Ball Bearing (24) by a few rounds to remove loose, before measuring the size.*

C. Deduct size C with D. Select the Seam (23) for which the skimmer is +0.13 mm ~ +0.17 mm in the Table below.

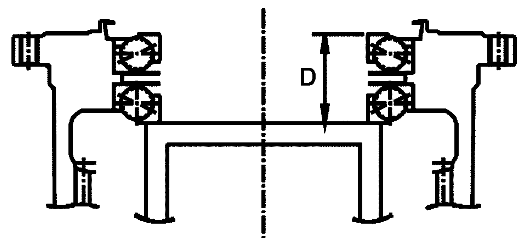



Figure 81

| Symbol | T mm |
|---|---|
| A | 0.9 |
| B | 1.0 |
| C | 1.1 |
| D | 1.2 |
| E | 1.3 |
| F | 1.4 |
| G | 1.5 |
| H | 1.6 |
| I | 1.7 |
| J | 1.8 |
| K | 1.9 |
| L | 2.0 |

D. Mount the Seam (23) on the Spindle (2).

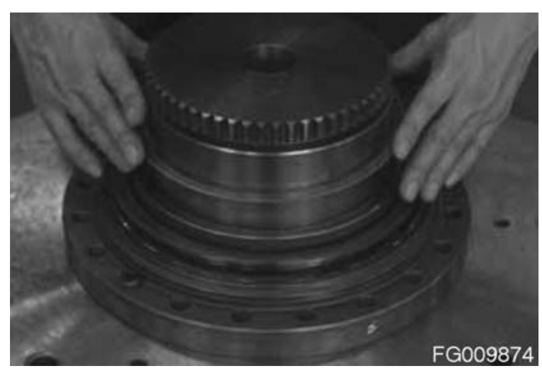



Figure 82

## 4. Assembling the Hub

A. Align the central axes of the hung Hub[1] and Spindle (2) straight, lower the Spindle (2) slowly and insert into the Angular Ball Bearing (24).

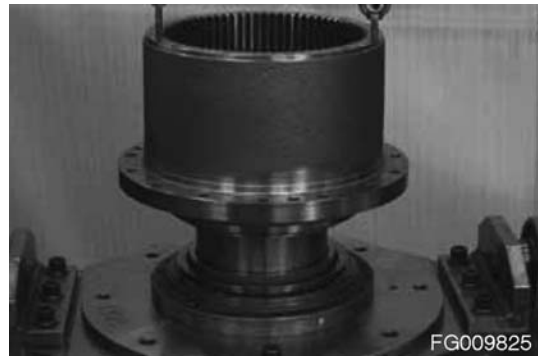



**Figure 83**

B. Tighten a lock hex-groove bolt in the Ø14 hole of the Hub to fix with the work bench.

C. Place a metal rod on the inner ring of the Angular Ball Bearing (24) on the reduction gear side, knock it lightly with a hammer to remove looseness of the inner ring.


**Figure 84**

D. Place the Lock Washer (22) on the groove on the Spindle (2).

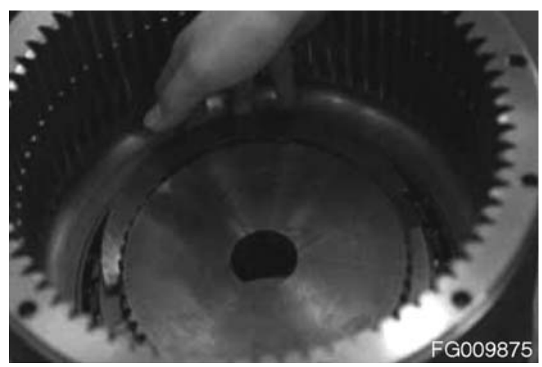



**Figure 85**

E. Insert the Lock Washer (22) into the Spindle groove with a tool.

**NOTE:** *When assembling the Carrier (2, 7), insert the Lock Washer (22) fully into the groove to avoid interference with the Lock Washer (22).*

F. Remove the Lock Hex-Groove Bolt which has been connecting the Hub (1) with the workbench.

G. Turn the Hub (1) by 2-3 turns.

**NOTE:** *Turning the Hub (1) will settle the fitting surface of the Floating Seal (29) to prevent leak.*

H. Turn the work bench so that the Motor faces upward.


**Figure 86**

## 5. Assembling the Motor Parts in the Spindle

A. Insert the Oil Seal (132) into the Spindle[2] using oil seal press-fitting tool and hammer.

**NOTE:** *When assembling the Oil Seal, apply lithium grease on the Oil Seal lip*

*Take care that the assembling direction of the Oil Seal (132) is correct.*

B. Assemble the two Parallel Pins (171) into the pin holes of the Spindle (2).

C. Apply lithium grease on the semi-spherical surface of the two Pivots (167) and press-fit them into the Parallel Pins (171) which are inserted in the Spindle (2).

D. Apply grease on the Spring (185) and assemble it with the Piston Assembly Piston (161), Shoe (162).

E. Apply machine oil on the reciprocating surface of the Piston Assembly and mount it into the Piston hole on the Spindle (2).

F. Insert the two Parallel Pins (34) into the pin groove on the fitting surface of the Rear Flange of the Spindle (2).

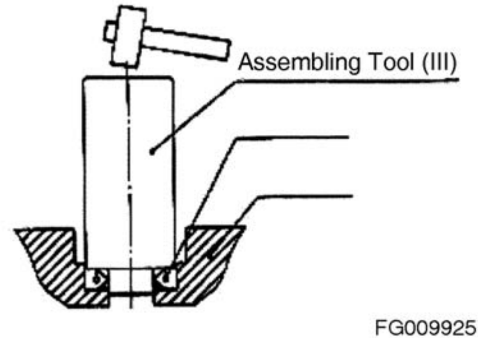



**Figure 87**


**Figure 88**

## 6. Assembling the Shaft

**CAUTION!**

**Wear leather gloves during the inserting work, to prevent burn.**

A. Put the Deep Grooved Ball Bearing (149) into the heating tank, heat it for 10 minutes at 100 ± 10°C, and insert it onto the Shaft (102).

B. Turn the Travel Motor by 90 degrees.

C. Insert the Shaft (102) into the Spindle (2).

**NOTE:** *Insert the Shaft[102] slowly into the Spindle (2) so that the lip of the Oil Seal (132) inserted into the Spindle is not damaged.*

*Damaged lip will cause oil leak, resulting in the earlier failure of the Travel Motor.*

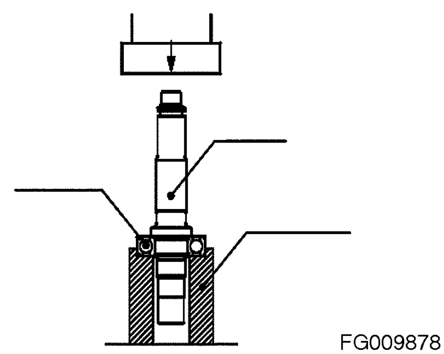



**Figure 89**


**Figure 90**

D. Insert the Swash Plate (103) into the Spindle (2).

**NOTE:** *Apply grease on the fitting surface of the Swash Plate (103) with the Spindle (2).*

*Insert the Swash Plate (103) into the Spindle (2) by matching the pivot mounting grooves on the Swash Plate (103) with the two Pivots (167) inserted onto the Spindle (2).*


**Figure 91**

**7. Assembling the Inner Parts of the Cylinder Block**

**NOTE:** *Insert the THS Snap Ring (145) with its sharp edge facing the inlet.*

*Insert the Washer (110) which contacts with the Fix Ring (145) with its sharp edge facing the Fix Ring (145).*

A. Insert the Washer (110), Spring (114), Washer (110), and THS Snap Ring, in the said order, into the Cylinder Block (104).

B. Place the Cylinder Block (104) on the press work bench.

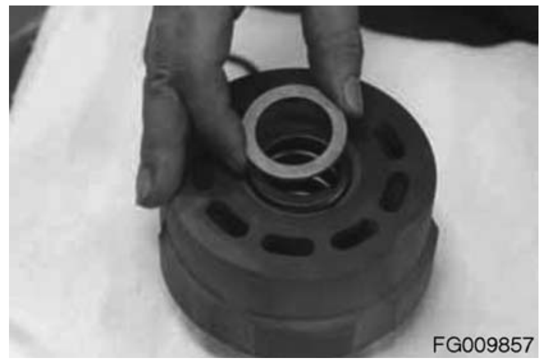



**Figure 92**

## CAUTION!

**Take care to prevent the ejection of the Fix Ring which may occur if the plier tip slips out of the groove of the Fix Ring, when assembling the THS Snap Ring (145).**

**NOTE:** *The pressure of the Spring (114) must be 112N (115kgf) or more.*

*Protect the Cylinder Block (104) with a vinyl cover sheet to prevent damage on the contact surface with the Timing Plate (109).*

C. Place a press tool (I) on the Washer (110), press the tool with press, and assemble the THS Snap Ring (145) into the fix Ring Groove on the Cylinder Block (104) using fix ring plier.


**Figure 93**

## 8. Assembling the Hydraulic Motor Parts

A. Insert the three needle-type Collars (151) into the groove on the Cylinder Block (104), and place the Thrust Ball (108) on them.

**Figure 94**

B. Insert the nine Piston Assemblies into the Retainer Plate (107).

**NOTE:** *Soak the whole assembly in machine oil.*

C. Assemble the Retainer Plate (107) and the nine Piston Assemblies with the Cylinder Block (104).

**NOTE:** *Align the Retainer Plate (107) and the spherical surface of the Thrust Ball (108).*

**Figure 95**

D. Insert the Cylinder Block (104) into the Shaft (102).

**NOTE:** *Align the splines on the Cylinder Block (104) with those on the Shaft (102).*

**Figure 96**

E. After assembling the Cylinder Block (104), turn the Cylinder Block (104) with hands to check if there is any looseness or clicking.

If it clicks, check the assembly.

**NOTE:** *The Cylinder Block[104] cannot be lifted up after assembling.*

*If lifted up, the Thrust Ball[108] will be dropped, unable to rotate normally.*

**Figure 97**

## 9. Assembling the Packing Brake

**NOTE:** *Soak the Friction Plate (115) in machine oil before assembling.*

A. Turn the work bench by 90 degrees.

B. On the Cylinder Block (104), assemble the four Opposite Plates (116) and the three Friction Plates in turns.

C. Apply grease thinly and insert the O-rings (135, 139) into the O-ring groove on the Piston (112).


Figure 98

D. Assemble the Piston (112) in the Spindle (2).

**NOTE:** *In the event that the Piston (112) would not be inserted into the Spindle (2) due to the friction of the O-rings (135, 139), knock the end of the Piston (112) lightly with a plastic hammer.*

*Take care to prevent scratch on the O-ring when assembling the Piston (112).*

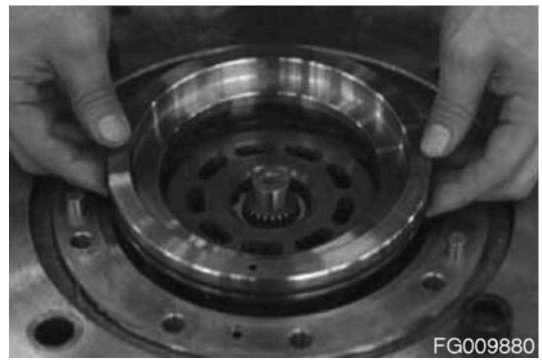



Figure 99

## 10. Assembling the 2-Speed Switching Spool in the Rear Flange

**NOTE:** *Insert the Spring (366) and Spool (363) into the Rear Flange (301).*

A. Assemble the O-ring (359) on the Plug (357).

**NOTE:** *Apply grease on the O-ring (359).*


Figure 100

B. Insert the Plug (357) into the Rear Flange (301).

C. Tighten the Plug (357) with the Rear Flange (301) using a hex-wrench, temporarily.


Figure 101

## 11. Assembling the Check Ball Part

A. Assemble the two O-rings (358) with the two Plugs (352).

**NOTE:** *Apply grease on the O-ring (358).*

B. Insert the Steel Ball (353) into the Rear Flange (301).


**Figure 102**

C. Tighten the Plug (352) with the Rear Flange (301) using a hex-wrench, temporarily.


**Figure 103**

## 12. Assembling the Piston

A. Assemble the two O-rings (383) with the two Plugs (380).

**NOTE:** *Apply grease on the O-ring (383).*

B. Insert the Piston (381) into the Rear Flange (301).


**Figure 104**

C. Tighten the Plug (380) with the Rear Flange (301) using a hex-wrench, temporarily.

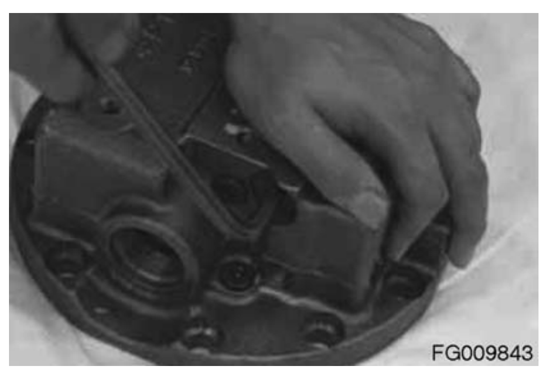



**Figure 105**

## 13. Reassembling the Brake Valve

A. Insert the Spool (323) into the Rear Flange (301).

**NOTE:** *Apply machine oil on the Spool (323) and insert the Spool (323) into the Rear Flange (301).*

*Align the center lines of the Spool (323) and the Rear Flange (301) to prevent the damage on the inner surface of the Rear Flange (301) and the outer surface of the Spool (323) by contact.*

*If the groove of the Rear Flange (301) or outer surface of the Spool (301) is damaged, internal leak may occur after the reassembling, resulting in the performance degradation of the Travel Motor.*


**Figure 106**

B. Assemble the O-ring (336) on the Plug (324).

**NOTE:** *Apply grease on the O-ring (336).*

C. Insert Washer (325) and Spring (328) into the Plug (324).


**Figure 107**

D. Insert the two Plugs (324) into the Rear Flange (301).

**NOTE:** *Take care when inserting the Plug (324) into the Rear Flange (301) to prevent the deformation of the Spring (328).*

E. Tighten the two Plugs (324) on the Rear Flange (301) temporarily.

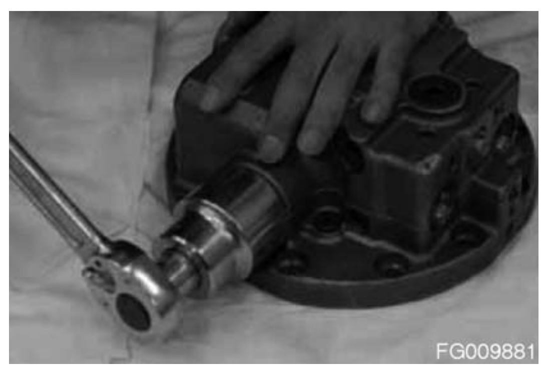



**Figure 108**

14. **Assembling the Rear Flange Components**

A. Apply machine oil on the Deep Grooved Ball Bearing (150) and insert the Ball Bearing (150) into the Rear Flange (301).

B. Insert the Parallel Pin (341) into the pin groove of the Rear Flange (301).

C. Apply grease on the fitting surface of the Timing Plate (109) with the Rear Flange (301).


**Figure 109**

D. Assemble the Timing Plate (109) with the Rear Flange (301) using the Parallel Pin (341) as the guide.

**NOTE:** *Mount the Timing Plate (109) until it contacts with the Rear Flange (301). The contacting will prevent the Timing Plate (109) from being separated from the Rear Flange (301) when mounting the Rear Flange (301) on the Spindle (2).*


**Figure 110**

E. Mount the ten Springs (113) on the Rear Flange (301).

**NOTE:** *Apply grease on the Springs (113) sufficiently to prevent being separated from the Rear Flange (301).*

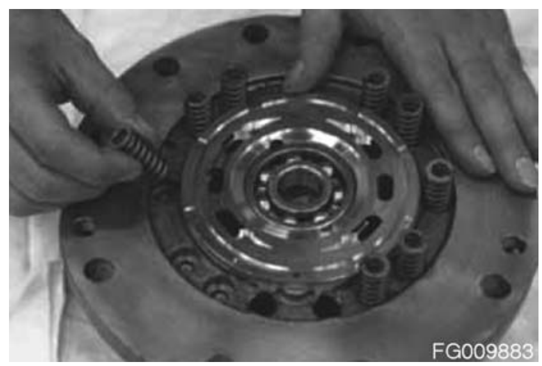



**Figure 111**

15. **Connecting between the Rear Flange and Spindle**

A. Insert the two O-rings (32, 33) into the O-ring grooves on the Spindle (2).

**NOTE:** *Do not apply grease on the O-rings (32, 33). If grease is applied, it may smear on the fitting surface between the Rear Flange (301) and Spindle (2) during Motor operation. The smearing may be mistaken as the oil leak.*

B. Pour 1.0 liter of hydraulic oil in the Spindle (2).


**Figure 112**

C. Insert the Rear Flange (301) into the Spindle[2], aligning the pin groove on the Rear Flange (301) and the two Parallel pins inserted in the Spindle (2).

D. Tighten the ten hex-grooved Bolts (343) to the Spindle (2) temporarily, using hex-wrench.


**Figure 113**

**16. Tighten all parts by the specified torques.**

A. Tighten the ten hex-grooved Bolts (343) to the Spindle (2) by specified torque.

Torque : 102 ± 15.7 N•m (10.4 ± 1.6 kgf•m)

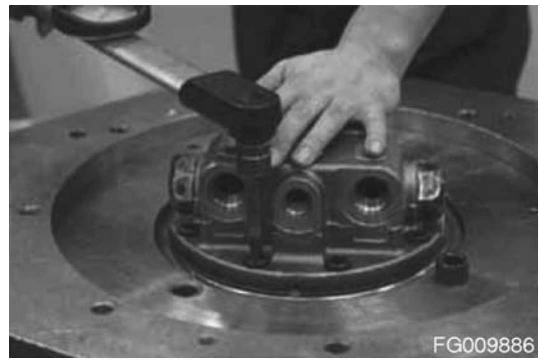



**Figure 114**

B. Tighten the Plug (324) by specified torque.

Torque : 441 ± 39.2 N•m (45.0 ± 4.0 kgf•m)


**Figure 115**

C. Tighten the Plug (380) by specified torque.

Torque : 58.8 ± 9.81 N•m (6.0 ± 1.0 kgf•m)


**Figure 116**

D. Tighten the Plug (352) by specified torque.

Torque : 12.3 ± 2.45 N•m (1.25 ± 0.25 kgf•m)


Figure 117

E. Tighten the Plug (357) by specified torque.

Torque : 98.1 ± 19.6 N•m (10.0 ± 2.0kgf•m)


Figure 118

**17. Assembling the Relief Valve Assembly**

A. Mount the two Relief Valve Assemblies (including 203).

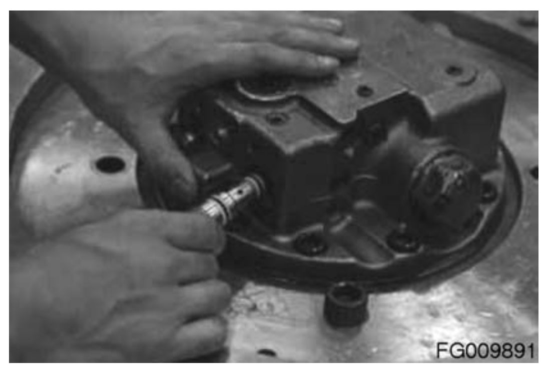



Figure 119

B. Tighten the two Relief Valve Assemblies (including 203) by specified torque.

Torque : 98.1 ± 19.6 N•m (10.0 ± 2.0 kgf•m)


Figure 120

## 18. Assembling the 2-Step Gears

A. Turn the work bench so that the Reduction Gear faces upwards.

B. Assemble the Sun Gear(2, 8) with the Carrier (2, 7).

C. Install eye bolts in the three M12 tabs for hanging on the Carrier(2, 7), use a crane to insert the Carrier Assembly (2).

**NOTE:** *When inserting the Carrier Assembly (2), align the center lines of the Hub (1) and the Carrier Assembly (2) so that the edge of the Planetary Gear (2, 9) does not damage the inner teeth of the Hub (1), and insert the Carrier Assembly slowly.*

*Arrange the Planetary Gea (2, 9) and the Rear Flange (301) port as shown in the figure on left.*

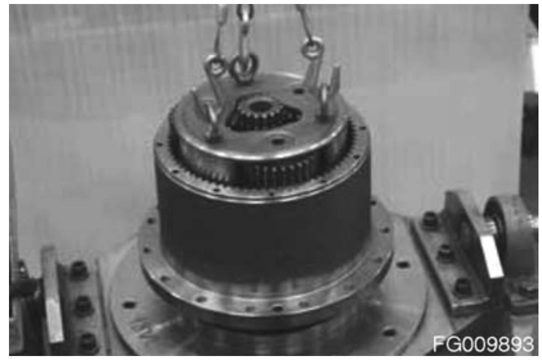



**Figure 121**

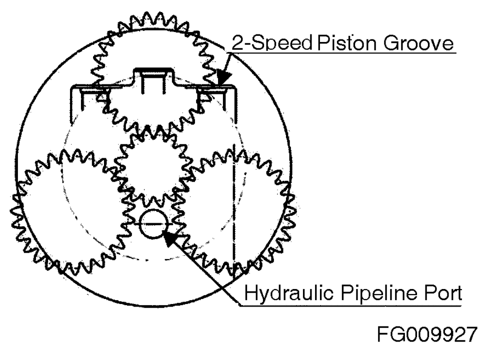



**Figure 122**

## 19. Assembling the Coupling

A. Assemble the Coupling (15) to the Shaft (102).

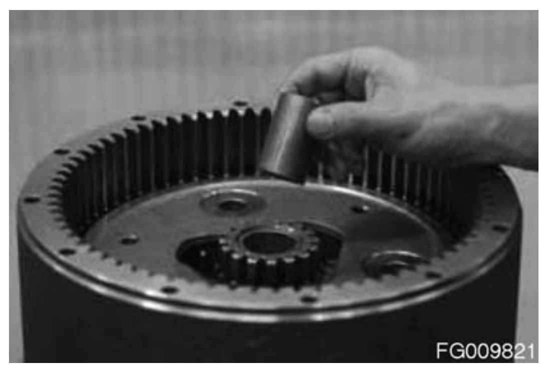



**Figure 123**

## 20. Assembling the 1st Stage Gears

A. Insert the Carrier Assembly (1) for hanging in the Hub (1).

**NOTE:** *When inserting the Carrier Assembly (1), align the center lines of the Hub (1) and the Carrier Assembly (1) so that the edge of the Planetary Gear (1, 5) does not damage the inner teeth of the Hub (1), and insert the Carrier Assembly slowly.*


**Figure 124**

B. Insert the Sun Gear (1, 4) into the Coupling (15), aligning the splines.

**NOTE:** *In the event that the Sun Gear (1, 4) cannot be inserted because the spline of the Sun Gear touches the teeth end of the Planetary Gear, as the gears are positioned such, slowly lift the Carrier Assembly (1) up until the Sun Gear (2, 8) leaves the Coupling, and then insert the Sun Gear (1, 4).*


Figure 125

C. Assemble the Thrust Plate (13) with the Carrier (1, 3).


Figure 126

**21. Assembling the Cover**

A. Apply Locktite 515, which is a sealant, on the fitting surface with the Cover (14) of the Hub (1).

**NOTE:** *Apply the sealant without interval.*

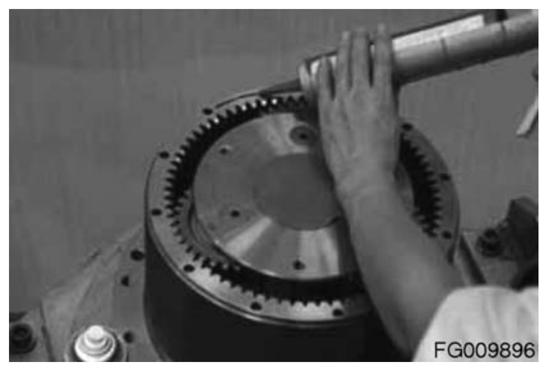



Figure 127

B. Join eye bolts on the PF1/2 Port, place the Cover (14) on the Hub (1), matching the bolt groove position.


Figure 128

C. Apply Locktite 242 on the tip of the hex-grooved Bolt (35), and tighten with specified torque.

Torque : 66.7 ± 3.92 N•m (6.8 ± 0.4 kgf•m)

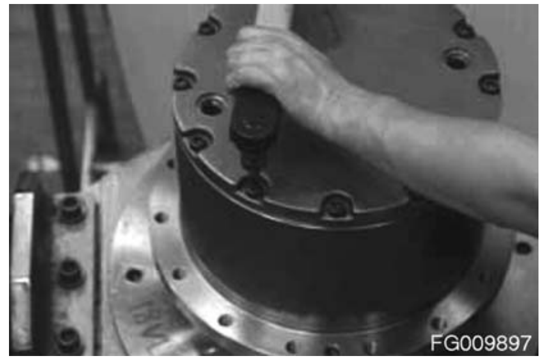


Figure 129

## 22. Lubricant

A. Supply lubricant through the lubricating port.

**NOTE:** *Supply 2.1 liter of lubricant.*

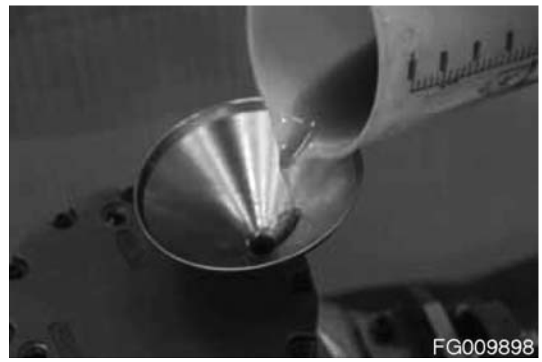


Figure 130

B. Mount Plug (30) on each port and tighten with specified torque.

Torque : 98.1 ± 19.6 N•m (10.0 ± 2.0 kgf•m)

Figure 131

## 23. Removing the Travel Motor

A. Turn the Travel Motor upside down (with the Motor side facing upward).

B. Remove the Travel Motor fixing bolts from the work bench.

C. Tighten the Eye Bolt (M16) in the screw hole of the Spindle (2).

D. Join the hook and wire with the eye bolt, remove the Travel Motor from the work bench using a crane.

**Performance Test**

- When the maintenance work of the GM Travel Motor has been completed, conduct performance testing as follows.

1. Required Instruments

| | | |
|---|---|---|
| 1 | Pressure Gauge 3.43 MPa (35 kgf / $cm^2$) | 2 |
| 2 | Mass Cylinder (5 liter) | 1 |
| 3 | Stop Watch | 1 |

2. Test procedures

1 GM Motor mounting & piping

Mount the GM Motor on the frame and connect piping.
Do not put on cover.
[For the performance(unloaded) testing of the GM Motor]

Note) 1. Install the pipeline with the pressure gauge(main circuit) and to enable the measuring of the drain volume from the hydraulic motor.
2. Mount the GM Motor softly, using the bolt groove. Do not knock with hammer.

2 GM Motor Test Operation

| Switching | GM Motor rpm | Pressure | Direction of Rotation | Operating Time |
|---|---|---|---|---|
| Low Speed | 10 $min^{-1}$ | Unloaded | Left · Right | 1 minute min. |
| High Speed | 20 $min^{-1}$ | | | |

3 GM Motor Performance Test

| | |
|---|---|
| 1 | Warming up operation — — — — Warm up to following temperatures.<br>Hydraulic oil temperature : 45~55°C<br>Outside temperature of the Reduction Gear Hub : 40~80°C |
| 2 | Testing — — — — — Take following measurements to decide acceptance.<br>Acceptance Criteria – Differential Pressure of the GM Motor : 1.57MPa (16kgf/$cm^2$), max., at 10$min^{-1}$<br>Drain from Hydraulic Motor : 1.2L/min at 10$min^{-1}$ |

Pass → Put cover on.

Reject → Disassemble and adjust again.

SP001329

# Main Pump

Edition 1

# MEMO

# Table of Contents

## Main Pump

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |

# GENERAL DESCRIPTION

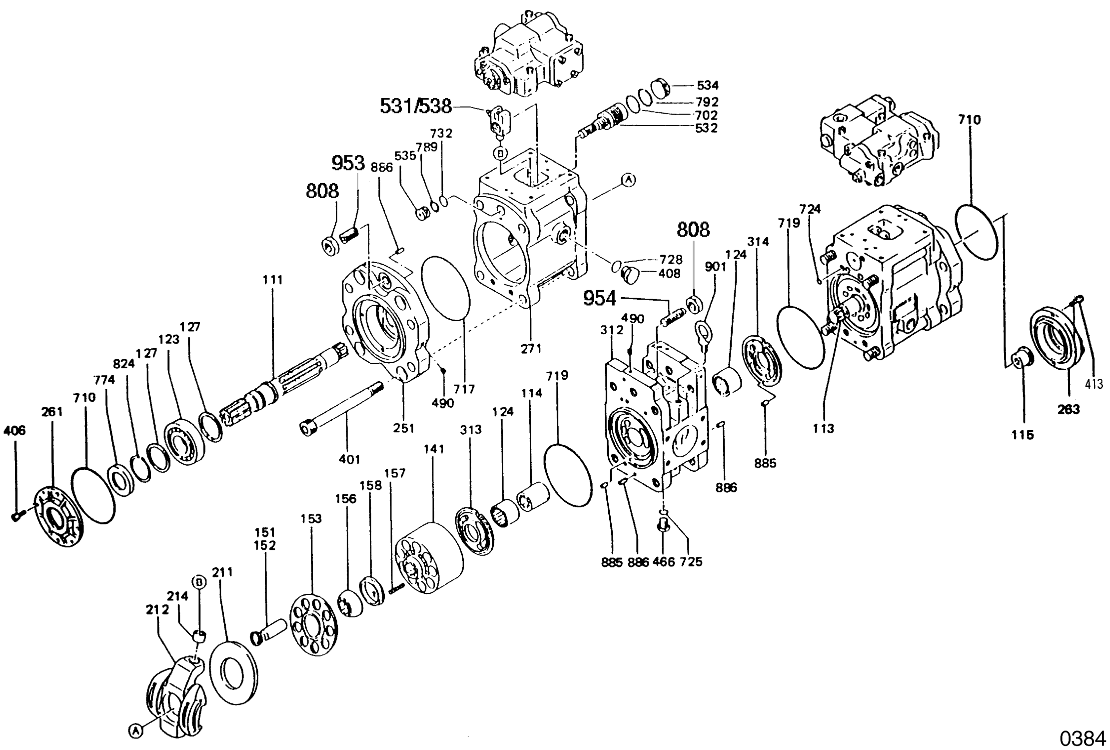



**Figure 1**

The main pump assembly contains two variable displacement axial piston pumps connected in series, driven through a flexible coupling off the back of the engine. A regulator mounted on each pump controls the flow output of that pump. A gear type pilot pump is mounted on the second main pump (farther away from the engine) and supplies oil to the two regulators and the control valve.

The axial piston pumps in the main pump assembly are units that incorporate three main functional subassemblies:

- The rotary group includes a drive shaft, cylinder block, piston, shoe, push plate, and spherical bush.
- The rotary group drive shaft is driven directly off the engine and turns at the same rate as engine rpm. The cylinder block and pistons revolve around the drive shaft, producing oil flow through the pump whenever the angle of the swash plate is tilted past the 0 degree (vertical) angle. Whenever the pump swash plate angle is at 0 degrees, piston stroke length is reduced to 0, and there is no output from the pump.
- The swash plate group includes the shoe plate, swash plate support, and servo pistons.

- The pump regulator controls the tilt angle of the swash plate. Increasing the swash plate tilt angle increases the length of piston stroke, boosting both the output flow and output pressure of the pump.
- The valve group consists of the valve block, valve plate and plate pin, providing intake and exhaust port assemblies for the pump.
- The pump cylinder block slides into the valve plate whenever piston stroke is tilted past the "0" swash plate angle, to allow flow of supply oil (input) and positive discharge (output) through the pump.

Main Pump Output: 63 cc/rev. (3.84 $in^3$/rev.) (1 pump)

Gear (Pilot) Pump Output: 15 cc/rev. (0.92 $in^3$/rev.)

Pilot Pump Relief Valve: Relief pressure set at 40 $kg/cm^2$ (569 psi).

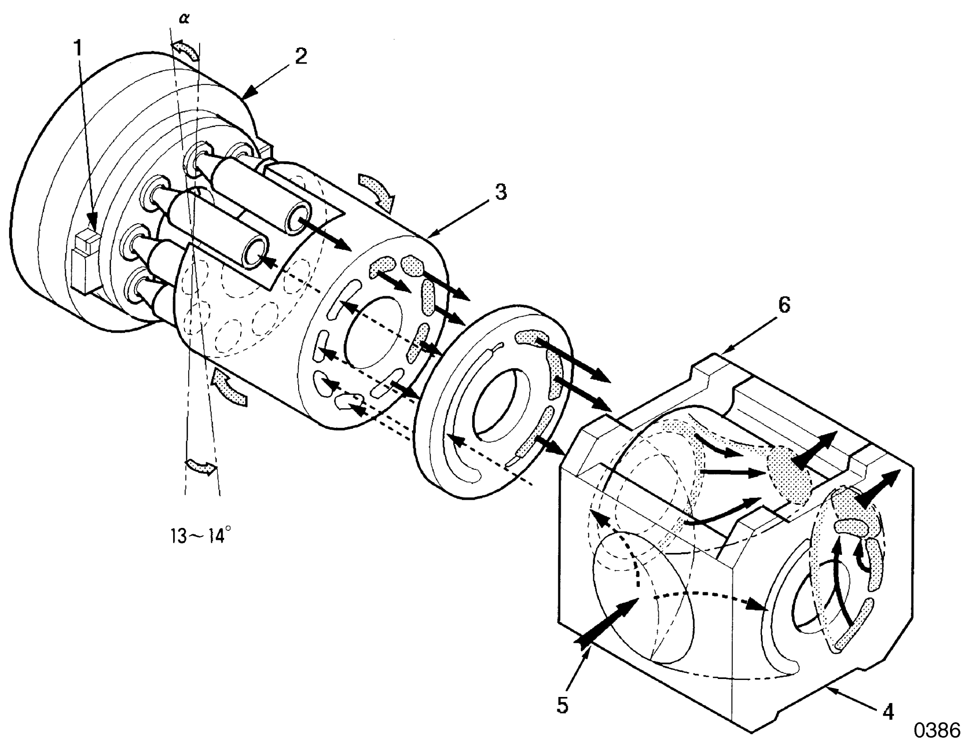
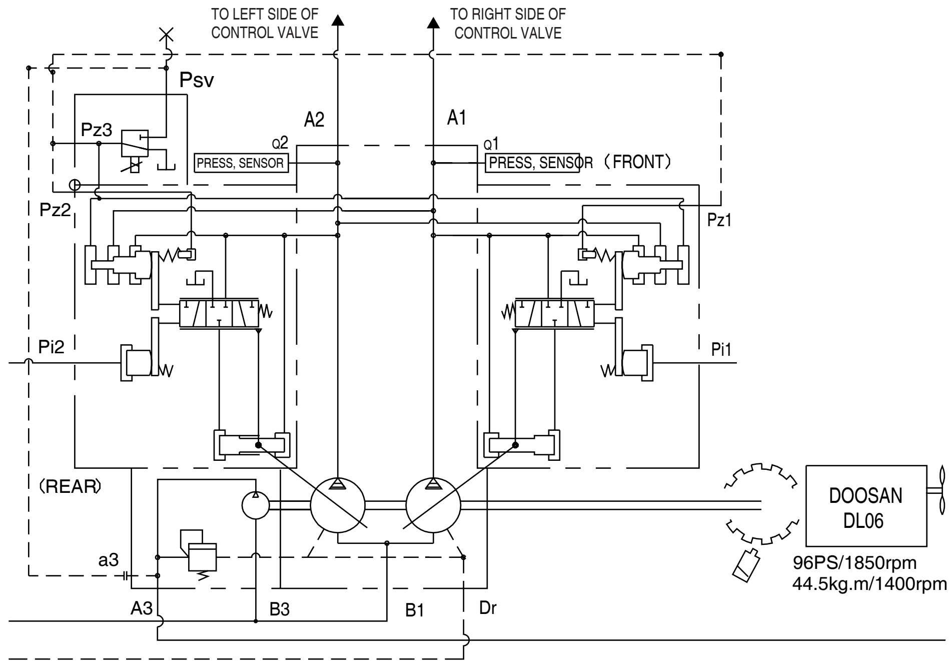



**Figure 2**



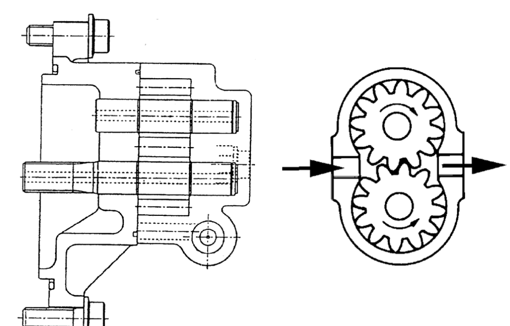

FG009798

**Figure 3**

## Gear (Pilot ) Pump

The pilot pump is a gear type pump, driven off the output end of the second main pump. Gear rotation inside the pump case produces oil flow from the intake side of the pump to the output side of the pump.

The function of the pilot pump in the hydraulic circuit is to maintain a flow of oil - independent of main pump oil flow output - for the operation of control valves.

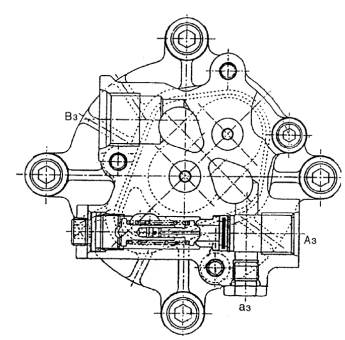


HBOJ080P

**Figure 4**

## Relief Valve

When the discharge pressure of the pilot pump exceeds 40 kg/cm$^2$ (569 psi), the ball and spool at the top of the valve shift to the right - maintaining pressure below the targeted 40 kg/cm$^2$ (569 psi) limit - as excess oil returns to the drain port.




HBOJ090P

**Figure 5**

## Relief Valve Pump Regulator Description

A regulator control valve is integrally mounted to the housing of each of the two variable displacement hydraulic pumps (Figure 1). The regulator valves perform the task of controlling the rate of pump discharge for the main pump assembly. Pump output may need to be varied as a result of increased or decreased work load demand, operator input changes to control lever position and/or to maintain balanced output between pumps, increasing or decreasing the discharge rate at one pump to compensate for the output of the other pump.

The two regulators work in conjunction, varying pilot pressure (Pi) through three different control functions - "Horsepower Control," "Powershift Control," and "Negative Control."

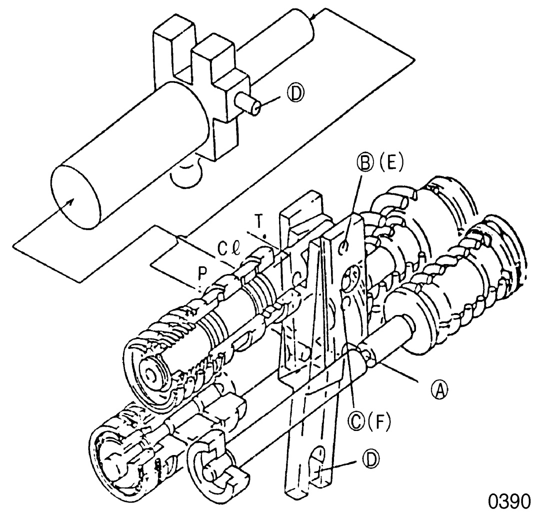



Figure 6

## Horsepower Control

This hydraulic system design feature provides balanced pump output, maintaining steady and consistent power production through the hydraulic system.

If there is a momentary increase of outlet pressure (P1) at one pump, the tilt angle of the swash plate in the remaining pump is automatically reduced - decreasing the other pump's outlet pressure (P2) - to equalize system output. The advantage of this design feature is that it keeps available horsepower through the system constant, directly proportional to the input rotational speed (rpm) of the engine.

## Power Shift Control

This design feature modifies the total available power output of the hydraulic system through microprocessor controlled application of electronic controls. Supplementary electronic control of the hydraulic system provides increased operating flexibility.

The electronic proportional reducing valve through which the system operates is just upstream from the 2 pump regulators. It responds directly to signals from the EPOS-V microprocessor and relays control signals to each of the 2 pump regulators to optimize each pump's power output, according to changes in secondary pressure, Pf ("Powershift pressure").

Pf pressure is monitored from interior pump passages, through the horsepower control part of each pump regulator. It allows simultaneous control of horsepower output at both pumps, for optimum, efficient response to changing workload demand.

## Negative Oil Discharge (Pump Bypass) Control

The volume of main pump bypass oil is automatically controlled by pilot pressure, which is regulated by the position of the spool in the control valve. When the control valve spool is in the neutral position (high pilot pressure, high bypass), the tilt angle of the swash plate decreases, reducing the volume of bypass oil through the main pump. When the control valve spool is at maximum stroke (low pilot pressure), the tilt angle of the swash plate increases, boosting main pump bypass oil volume.

## Pump Regulator Operation

The relationship between Pump Displacement Flow (Q on the vertical axis) and Pilot Pressure (Pi on the horizontal axis). Pump output discharge is controlled by increasing or decreasing pilot pump pressure (Figure 7).

**NOTE:** *Component parts (numbered in parentheses) correspond to those in Figure 8.*

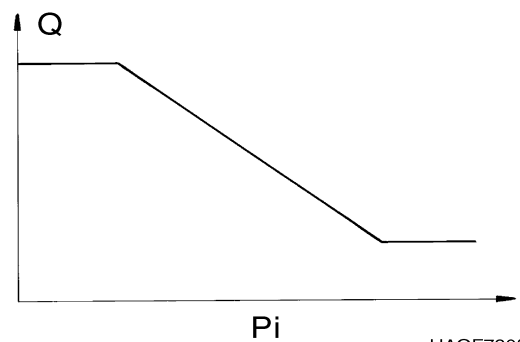



**Figure 7**

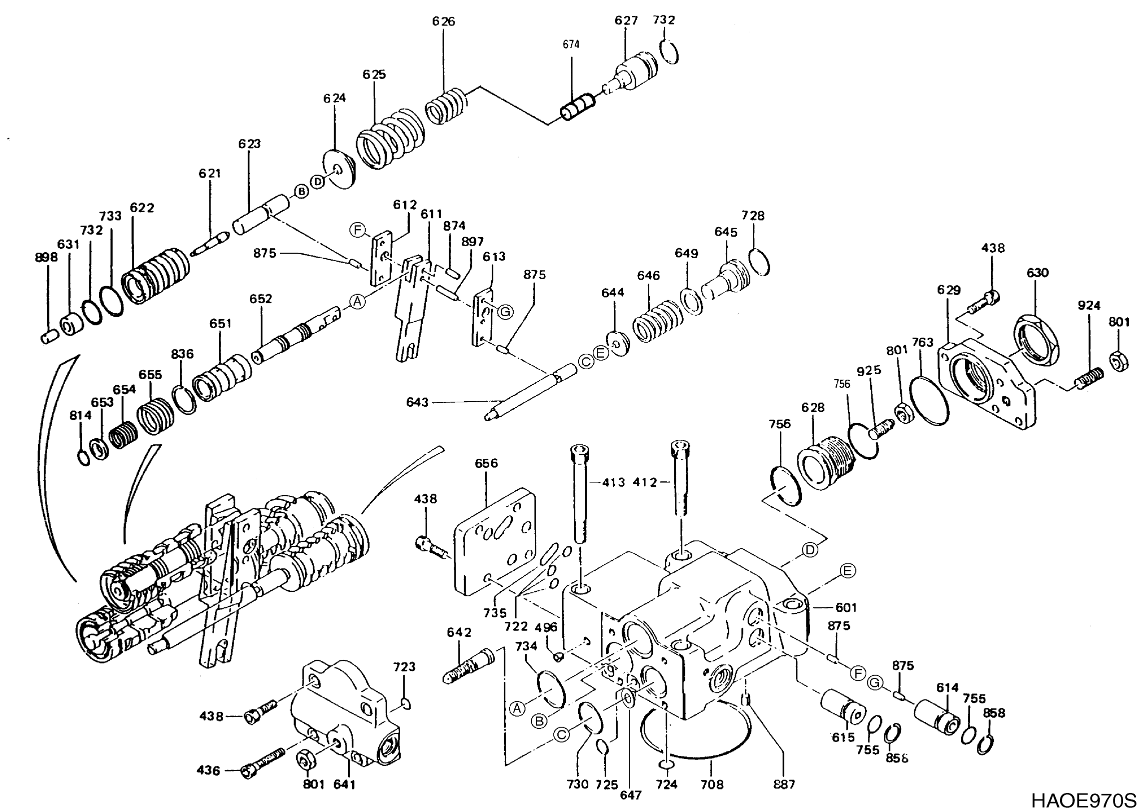



**Figure 8**

## Pump Output Decrease

When pilot pressure (Pi) increases, the pilot piston (643) shifts toward the right, stopping at that point at which pilot pressure and the force of the return spring (646) cancel each other out. Movement of the pilot piston pushes the pin (875) attached to the feedback lever assembly (613, 611, 897) around the "B-point plug" (614) and the pin (875) on the opposite side of the feedback lever assembly. The pin at the lower end of the feedback lever is attached to the tilting pin of the swash plate (531/538 in Figure 1).

**NOTE:** *In Figure 6, the circled capital letter "D" at the lower end of the feedback lever shows the approximate location where the assemblies shown in Figure 1, Figure 6 and Figure 8 react as the pin (897) at the top of the feedback lever moves and the piston shifts, maintaining dynamic balance through the valve between pilot pressure (Pi) and discharge output flow (Q) as shown in Figure 7.*

## Pump Discharge Decrease

The regulator feedback lever assembly is also pin connected to the outermost spool (652) in the discharge port (Cl) of the regulator (Figure 8). As that spool moves toward the right, in response to differences in servo pressure, the servo piston moves to the right, resulting in a decreased swash plate tilt angle and reduced pump output flow. The system is balanced and control movement of the spool (and servo piston) stops when the outermost spool (652) and spool sleeve (651) close into each other, shutting off oil movement.

## Pump Discharge Increase

When pilot pressure (Pi) decreases, the pilot piston shifts toward the left and the feedback lever assembly pivots around point "D" (Figure 6), pushing the spool and servo piston left. Swash plate tilt angle is heightened and pump output flow begins to increase as a result. Control movement of the spool and servo piston stops when the feedback lever assembly rotates around point "C" (Figure 6), moving the spool to the right until it slides into the sleeve (651) and oil movement is blocked.

## Horsepower Control

Horsepower control function occurs as each regulator responds to changes in the output of the opposite pump. As increases or decreases in pump output occur (as outlined in the preceding paragraphs) at one pump, it is necessary for the output of the remaining pump to compensate to allow equalizing of the total discharge rate.

The relationship between changes in pressure and changes in output flow when the operation of both pumps (P1 and P2) is measured (Figure 9).

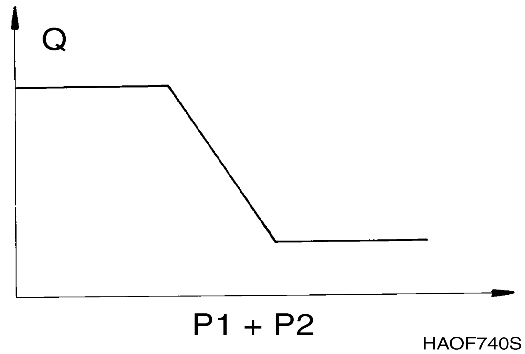



Figure 9

## Overload Protection

Overload protection occurs automatically, in response to increased pressure on the piston (621) and compensator rod (623). Whenever the discharge pressure of Pump 1 and Pump 2 (P1 and P2) are increased beyond a certain point, the higher pressure acts on the piston and compensator rod (621 and 623), pushing both toward the right, until hydraulic pressure and the return force of the inner and outer springs balance out. The feedback lever assembly pivots around Point "D" and the spool (652) is pushed toward the right, decreasing pump discharge to prevent engine overloading.

When discharge output of both pumps (P1 and P2) decreases, the compensator rod (623) is released, moving the feedback lever assembly in response to the pressure of the inner and outer return springs. The regulator "Cl" port is connected to the tank port. Discharge flow recovery results in an increase of discharge flow.

## Regulator Adjustment

Maximum and minimum discharge flow, horsepower control characteristics and discharge control characteristics can all be modified by changing the position of adjustment screws built into the pump housing (Figure 1) and the end plate of the regulator valve (Figure 8).

Maximum and minimum discharge flow can be modified by loosening lock nuts (808, Figure 1). To decrease maximum discharge flow (by approximately 5.6 l/min [0.025 gpm]), tighten adjusting screw (954) by 1/4 turn. Figure 10 shows the effect of this adjustment on the output characteristics of the pump.

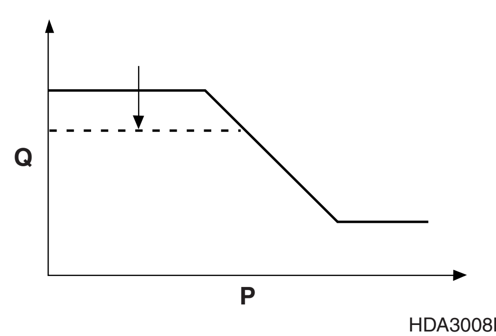



Figure 10

To increase minimum discharge flow (also by 5.6 l/min [0.025 gpm]), tighten adjusting screw (953) by 1/4 turn. Figure 11 shows the effect of this adjustment on the output characteristics of the pump.

**NOTE:** *Other characteristics of operation should not be affected, when adjustments to maximum or minimum discharge flow are made, but very large changes to the adjustment position of either adjustment screw could cause changes in the maximum discharge pressure, and require a corresponding adjustment of the main relief valve pressure setting.*

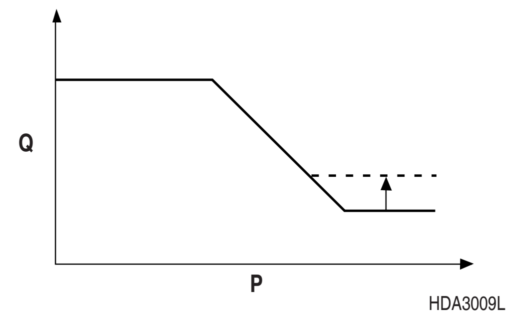



Figure 11

## Pump Input Power Control Adjustment

# IMPORTANT

**Input horsepower adjustments that are made to one pump should also be carried out on the remaining pump, so that both are adjusted to the same input range.**

Horsepower control characteristics can be changed by loosening the large, thin nut (630) on the end of the regulator. The larger (outer) adjusting screw (628) affects adjustment of the outer return spring in the regulator outer spool. Tightening the outer screw approximately 1/4 turn increases compensator control pressure approximately 18 kg/cm$^2$ (256 psi), for a torque increase of 4 kg•m (29 ft lb). Changing the adjustment position of the outer screw (628) affects the adjustment position of the inner screw (924), which is the adjustment device for the inner spring of the regulator outer spool. Loosen the inner screw and back it out enough to compensate for the tightening adjustment made to the outer screw, to maintain the original setting. Changing the adjustment position of the inner screw 1/4 turn affects the working resistance of the inner spring. Increases in oil flow of approximately 10 l/min (0.04 gpm) and about 4.8 kg•m (35 ft lb) of input torque are the result.

The third adjustment screw on the side of the regulator (924) can be repositioned after the smaller lock nut (801) is loosened. Changing the position of the third adjustment screw (924) affects pilot pressure. Turning the screw in 1/4 turn increases pilot pressure by 1.5 kg/cm$^2$ (21 psi), and consequently, as a result of the increase in pilot pressure, the discharge flow from the main pump assembly will increase by about 16 l/min (0.07 gpm)

## Electric Proportional Reducing Valve

- Current/Pressure Operating Characteristics

  Condition: Primary Pressure 50 kg/cm$^2$

  Load Discharge Flow 0 l/min

  70 Hz, 400 - 600 mA

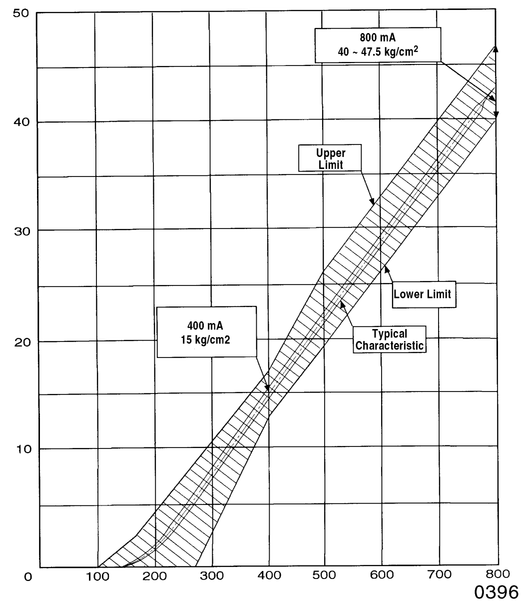



**Figure 12**

# Part List

## Main Pump

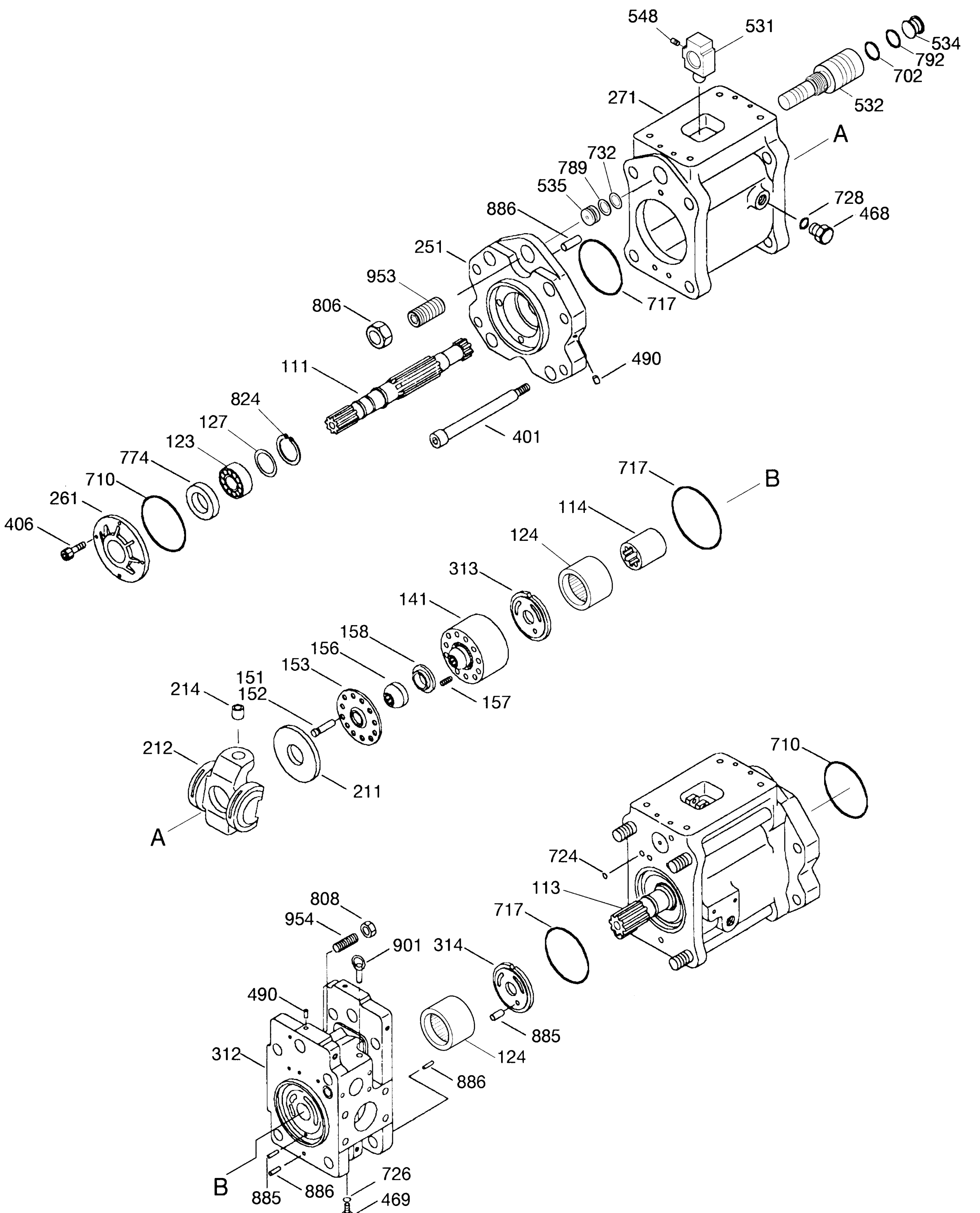



Figure 13

| Reference Number | Description |
| --- | --- |
| 4 | Gear Pump |
| 111 | Shaft (F) |
| 113 | Shaft (R) |
| 114 | Spline Coupling |
| 123 | Roller Bearing |
| 124 | Needle Bearing |
| 127 | Bearing Spacer |
| 141 | Cylinder Block |
| 151 | Piston |
| 152 | Shoe |
| 153 | Push Plate |
| 156 | Spherical Bushing |
| 157 | Cylinder Spring |
| 158 | Spacer |
| 211 | Shoe Plate |
| 212 | Swash Plate |
| 214 | Tilting Bushing |
| 251 | Support Plate |
| 261 | Seal Cover (F) |
| 263 | Rear Cover |
| 271 | Pump Casing |
| 312 | Valve Block |
| 313 | Valve Plate (R) |
| 314 | Valve Plate (L) |
| 401 | Socket Bolt |
| 406 | Socket Bolt |
| 413 | Socket Bolt |

| Reference Number | Description |
| --- | --- |
| 466 | VP Plug |
| 468 | VP Plug |
| 490 | Expander |
| 531 | Tilting Pin |
| 532 | Servo Piston |
| 534 | Stopper (L) |
| 535 | Stopper (S) |
| 548 | Feedback Pin |
| 702 | O-ring |
| 710 | O-ring |
| 717 | O-ring |
| 719 | O-ring |
| 724 | O-ring |
| 726 | O-ring |
| 728 | O-ring |
| 732 | O-ring |
| 774 | Oil Seal |
| 789 | Backup Ring |
| 792 | Backup Ring |
| 808 | Nut |
| 824 | Retaining Ring |
| 885 | Pin |
| 886 | Spring Pin |
| 901 | Eye Bolt |
| 953 | Set Screw |
| 954 | Adjusting Screw |

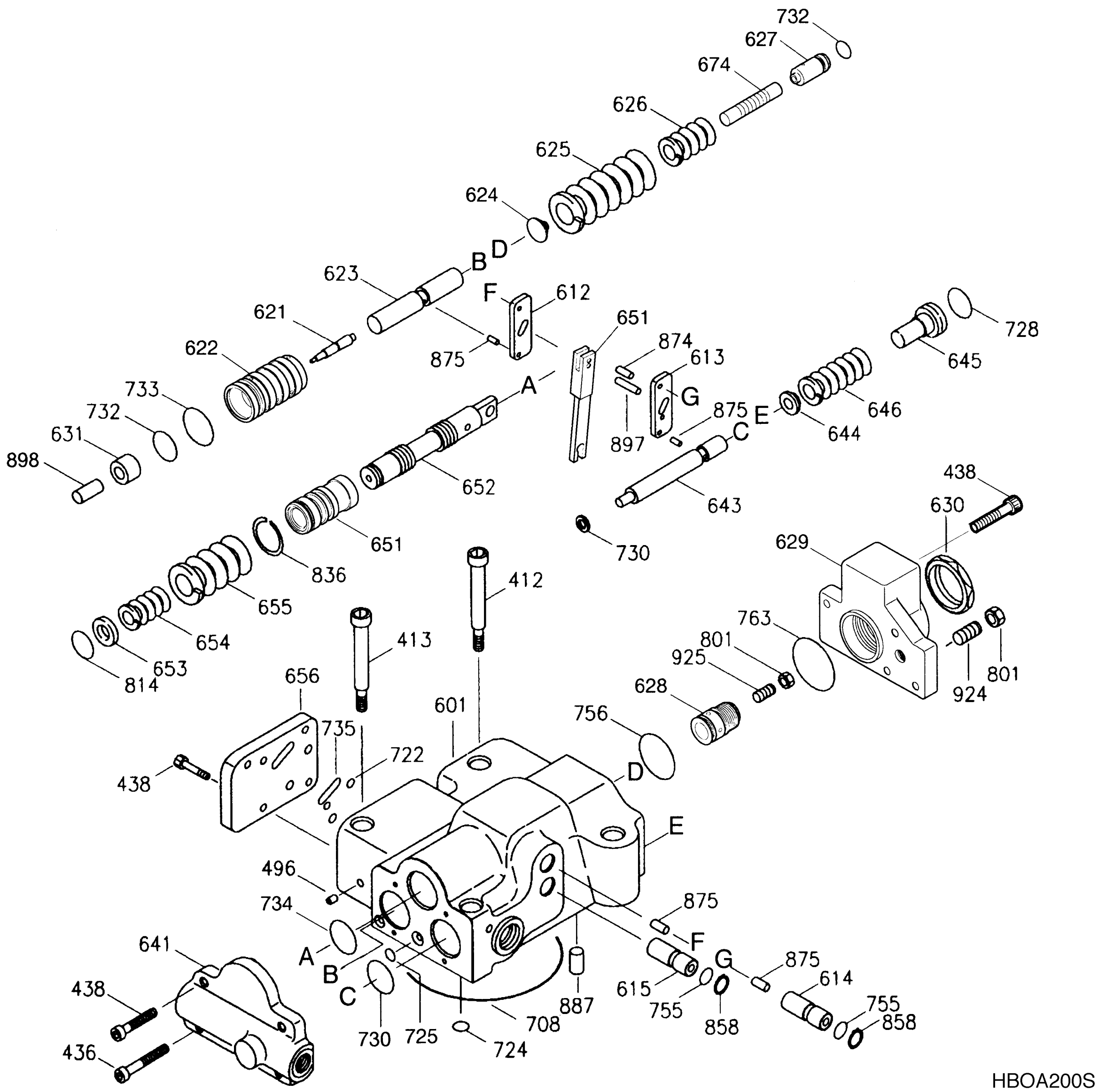

732
627
674
626
625
624
D
B
623
F
612
621
651
874
613
622
875
G
733
A
875
E
646
728
645
732
C
644
631
897
898
652
643
438
651
630
730
836
629
412
655
763
801
413
925
654
801
653
814
628
924
656
756
601
735
722
438
D
E
496
875
734
F
A
641
B
G
875
614
438
C
615
755
755
887
858
858
730
725
708
724
436
HBOA200S

Figure 14

| Reference Number | Description |
|---|---|
| 412 | Socket Bolt |
| 413 | Socket Bolt |
| 436 | Socket Bolt |
| 438 | Socket Bolt |
| 496 | Expander |
| 601 | Casing |
| 611 | Feedback Lever |
| 612 | Lever (1) |
| 613 | Lever (2) |
| 614 | Portion Plug |
| 615 | Adjusting Plug |
| 621 | Compensator Piston |
| 622 | Piston Case |
| 623 | Piston Rod |
| 624 | Spring Seat (C) |
| 625 | Outer Spring |
| 626 | Inner Spring |
| 627 | Adjusting Ring (C) |
| 628 | Adjusting Screw (C) |
| 629 | Cover→ (* C *) |
| 630 | Lock Nut |
| 631 | Pf Sleeve |
| 641 | Pilot Cover |
| 643 | Pilot Piston |
| 644 | Spring Seat (Q) |
| 645 | Adjusting Ring (Q) |
| 646 | Pilot Spring |
| 647 | Adjusting Screw Bushing |
| 651 | Sleeve |
| 652 | Spool |

| Reference Number | Description |
|---|---|
| 653 | Spring Seat |
| 654 | Return Spring |
| 655 | Set Spring |
| 656 | Cover |
| 674 | Pf Piston |
| 708 | O-ring |
| 722 | O-ring |
| 724 | O-ring |
| 725 | O-ring |
| 728 | O-ring |
| 730 | O-ring |
| 732 | O-ring |
| 733 | O-ring |
| 734 | O-ring |
| 735 | O-ring |
| 755 | O-ring |
| 756 | O-ring |
| 763 | O-ring |
| 801 | Nut |
| 814 | Retaining Ring |
| 836 | Retaining Ring |
| 858 | Retaining Ring |
| 874 | Pin |
| 875 | Pin |
| 887 | Pin |
| 897 | Pin |
| 898 | Pin |
| 924 | Adjusting Screw |
| 925 | Adjusting Screw (Qi) |

## Specifications

| | | |
|---|---|---|
| Main Pump | Quantity: | 2 |
| | Displacement: | 63 cc/rev (3.84 $in^3$/rev) |
| | Max Flow Rate: | 114  l/min x 2 pumps |
| | Flow Regulator Type: | Negative Control |
| | Pressurization: | Air Breather |
| | Weight: | 85 kg |

| | | |
|---|---|---|
| Pilot Pump | Displacement: | 15 cc/rev (0.9 $in^3$/rev) |
| | Max Flow Rate: | 27.7 l/min (0.121 gpm) |
| | Relief Valve: | 40 $kg/cm^2$ (569 psi) |

## Hydraulic Pump Performance Characteristics

### Main Pump Pressure/Flow Output

| Engine Speed | 1850 rpm (High Mode) | 1750 rpm (Standard Mode) |
|---|---|---|
| Pump Input Horsepower | 90 ps (88.8 hp) (High Output Power Mode) | 76.6 ps (75.6 hp) (Standard Output Standard Mode) |
| Main Pump Total Displacement | 63 cc/rev (3.84 $in^3$/rev) x 2 pumps | |
| Main Pump Pressure | 350 $kg/cm^2$ (4,550 psi) (for pressure up) | |
| Pilot Pump Displacement | 15 cc/rev (0.9 $in^3$/rev) | |
| Pilot Pump Pressure | 40 $kg/cm^2$ (569 psi) | |

**NOTE:** *Values in the graph marked "K" are pressure, in $kg/cm^2$.*

**NOTE:** *Values in the graph marked "L" are flow, in Liters/minute.*

H-MODE

INPUT RPM : 1850 rpm

INPUT POWER (INCLUDING GEAR PUMP) : 90PS

INPUT TORQUE (INCLUDING GEAR PUMP) : 38.8Kg.m

S-MODE

INPUT RPM : 1750 rpm

INPUT POWER (INCLUDING GEAR PUMP) : 76.6PS

INPUT TORQUE (INCLUDING GEAR PUMP) : 31.3Kg.m

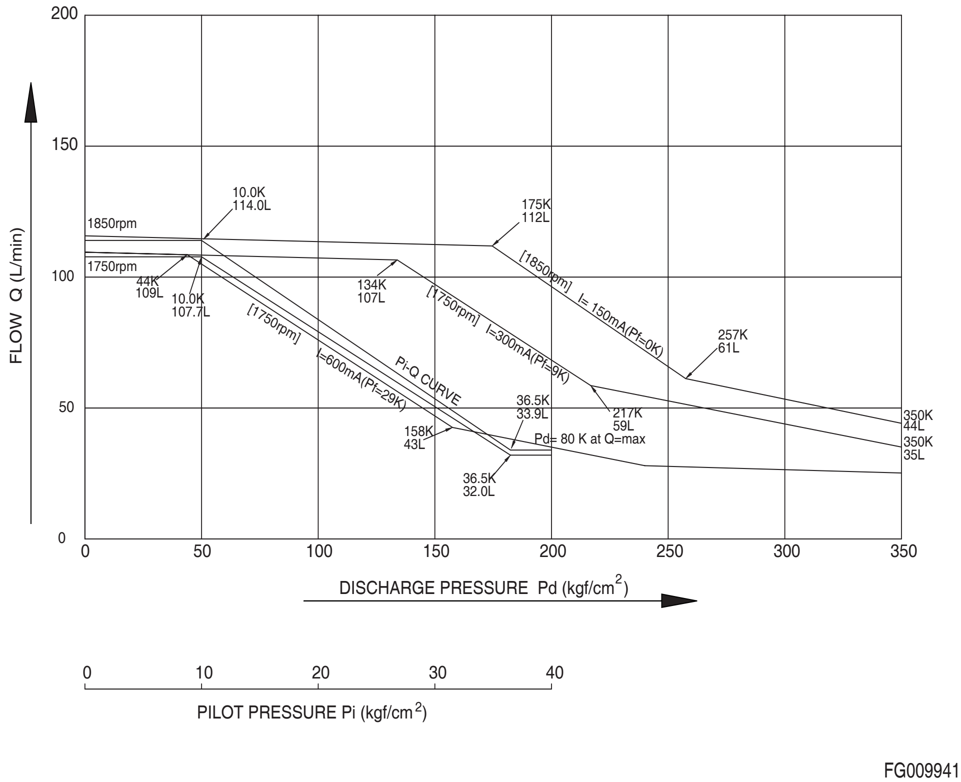



**Figure 15**

# TROUBLESHOOTING, TESTING AND ADJUSTMENT

## Main Pump

| Problem | Possible Causes | Remedies |
|---|---|---|
| Engine overloading | Engine RPM control off | Readjust RPM control |
| | Pump regulator set too high | Readjust |
| | Pump inner parts worn or damaged | Look for impurities or particles inside the filter and rebuild, replace pump components, as required |
| | Pump regulator piping clogged or leaking | Repair or replace piping |
| Overloading on one pump only | Regulator | Regulator compensator piston or pin (898) sticking. Disassemble, clean. |
| Pump discharge output reduced, pressure does not increase | Pump regulator faulty or piping clogged, leaking or kinked | Repair or replace regulator or piping |
| | Pump inner parts worn or damaged | Look for particles inside the filter and rebuild or replace pump components |
| | Gear pump (pilot pump) worn or faulty | Check pilot pressure and make sure pilot piston, spool and/or QMC are not sticking before repairing or replacing pilot pump |
| | Accessory control valve faulty | Inspect valve (poppet, seat, spring) |
| Excessive vibration or noise | Cavitation | Look for leaks or evidence of air intrusion. Disconnect return lines, add clean oil and reassemble to bleed air |
| | Regulator or relief valve hunting | Check pressures and inspect for clogged or damaged inlet piping |
| | Broken or damaged piston, shoe, cylinder | Repair or replace damaged component. |

HAOE950L

# DISASSEMBLY

## General Disassembly

This procedure assumes that the main pump assembly will be removed from the upper deck plate. Use the eyebolts in the center valve block assembly to move the valve block and the assembled pumps (still bolted together) to the prepared work area.

The area where the pumps are to be rebuilt should be well lighted, clean and protected from dust and/or wind gusts that could carry in dust or grit. 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 pump before disassembly. There should not be any visible dirt, grease or other type of accumulation on the outside of the pump case. Clean off or blow dry all traces of cleaner and solvent before starting work.**

Open the drain plugs to drain oil from the pump cases before disassembly.

## IMPORTANT

**If at all possible, 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 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 pumps' 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 do not allow used oil containers to accumulate.*

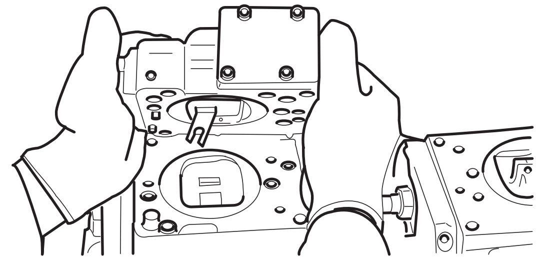
**NOTE:** *Main Pump component parts (numbered in parentheses) are keyed to Figure 14.*

**NOTE:** *Dispose of drained fluids according to local regulations.*

1. Loosen socket bolts (412, 413) to begin separation of regulator valves from two pumps.

   **NOTE:** *See “Pump Regulator Disassembly” on page 1-26 of this section for disassembly procedures.*

2. Unbolt gear pump (rear pilot pump) at rear of main pump assembly.



HDM3016P

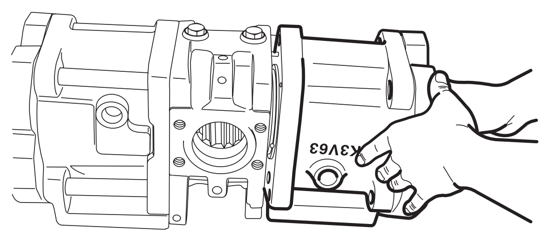
**Figure 16**

3. When pilot pump and valve regulators have been removed from assembly, the two pump cylinder blocks (271) can be unbolted from center valve support plate (251) and valve block (312). A total of eight 17 mm Allen head hex bolts hold pump assemblies together - four on each side.

4. Before unbolting eight pump block fasteners, flip pump assembly top to bottom so that regulator mounting surfaces are facing down.

5. Unbolt all eight 17 mm hex bolts and separate both pumps from center valve block, taking care not to damage O-rings (719) or lose or damage either one of spring pins (886), between valve block and pump casings.

   **NOTE:** *When pump assembly has been disassembled to three main component sections (center valve block, front pump and rear pump), the procedure can be continued in either one of two ways. Because both pumps, on either side of the center valve block are identical, both can be disassembled simultaneously, repeating the same steps on opposite ends of the assembly at the same time. If the rebuilding procedure is at all unfamiliar, though, or there are any other reasons to take a less aggressive approach, one pump can be disassembled, rebuilt and completely reassembled while the other pump is left for reference, until rebuilding of the first pump has been completed.*

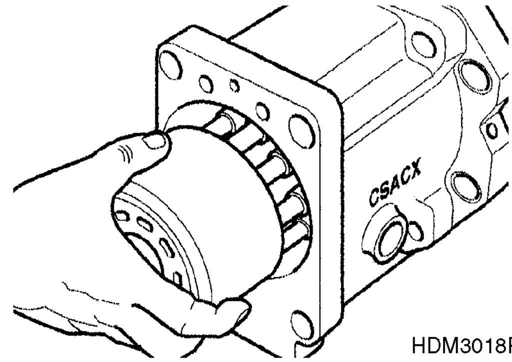


HDM3017L

**Figure 17**

# Main Pump Disassembly

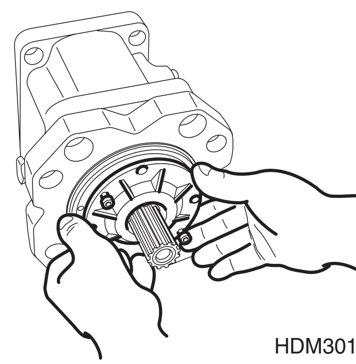
1. Pull out cylinder block (141) from pump casing (271), together with all nine pistons (151), nine cylinder springs (157) and nine shoes (152), including push plate (153) and round bushing (156).




HDM3018P

Figure 18

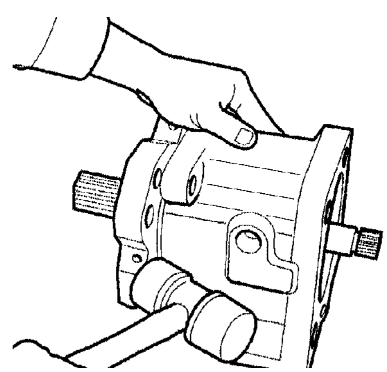
2. Unscrew two Allen head hex head bolts from front seal cover plate (261). To separate cover plate from rest of assembly, screw 6 mm cap screws into threaded holes tapped into cover. Tighten all four cap screws in a slow, staggered tightening sequence, taking wrench off of each cap screw after just a fraction of a turn and proceeding to next - in regular rotation - until cover drops out.



HDM3019L

Figure 19

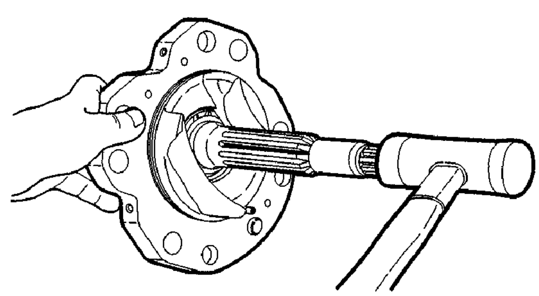
3. Separate pump casing (271) from support plate (251) by tapping lightly with a plastic hammer. Be careful not to damage either mating surface or O-ring (717).



HDM3020P

Figure 20

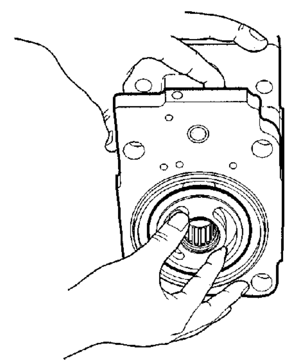
4. Withdraw drive shaft (111 and 113) on opposite sides of center valve block) from swashplate support and pull away valve plates (313 or 314).



HDM3022P

Figure 21

**NOTE:** *If a complete tear down and reassembly is being performed, the only parts which should NOT be loosened or removed are the hex nut (808) spring pin servo piston stoppers in the swash plate supports. (The preset discharge value would require calibration if they were removed.) All other remaining parts may be withdrawn from valve block - needle bearing (124), spline coupling (114) and pump casing - along with stoppers (534, 535), servo piston (532) and tilting pin (531) from the top of the pump casing.*



HDM3023P

Figure 22

## IMPORTANT

**Separation of servo pistons (532) and tilting pins (531) must be done with a special fixture. Loctite #609 is required for reassembly - on servo piston/tilting pin/ feedback pin (538).**

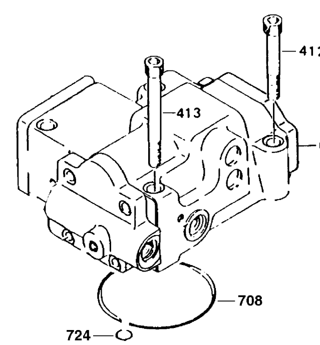
**NOTE:** *Do not disassemble the needle bearings (124). They can only be replaced with new parts if they are excessively worn or have been damaged.*

## Pump Regulator Disassembly

1. Remove four Allen head bolts (412, 413) and pump regulator assembly from pump body. Remove and inspect O-ring gaskets (708, 724) found between regulator casing and pump body.

   **NOTE:** *The regulator mounting bolts are uneven in length and should be noted and replaced to the same location.*

   Once regulator has been removed from pump, go to a clean, well lighted, protected area for further disassembly. Use a rubber mat or other protective covering on the workbench area to prevent damage or scratching of any precision machined components.

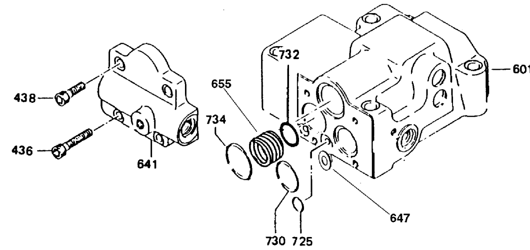



HAOE980S

Figure 23

2. Remove four Allen head bolts (436, 438) and pilot cover (641) from regulator casing. Remove and inspect O-rings (725, 730, 732, 734) found between cover and regulator casing. Remove feed back lever set spring (655) and adjusting screw bushing (647).

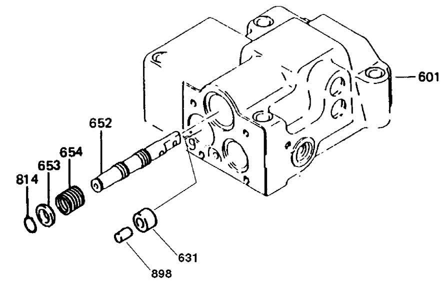
   **NOTE:** *These bolts are uneven in length and should be noted and replaced to the same location. The pilot cover is under pressure from feed back lever set spring and care should be used when removing it.*




HAOE990S

Figure 24

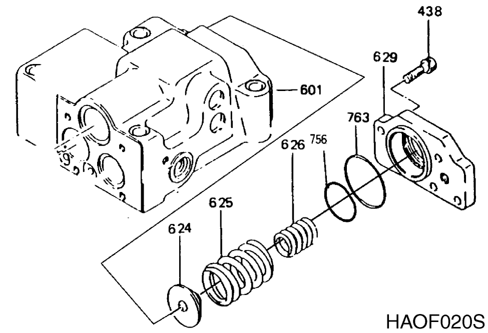
3. Remove retaining ring (814), spring seat (653) and return spring (654) from feed back lever spool (652).
4. Remove pin (898) and Pf sleeve (631) from compensator piston bore.




HAOF010S

**Figure 25**

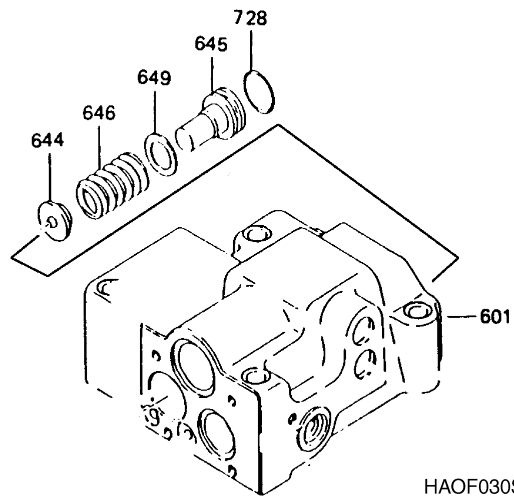
5. Remove four Allen head bolts (438) and pilot piston lower cover (629) from regulator casing. Remove and inspect O-rings (756, 763). Remove inner spring (626), outer spring (625) and spring seat (624) from Pf piston bore.




HAOF020S

**Figure 26**

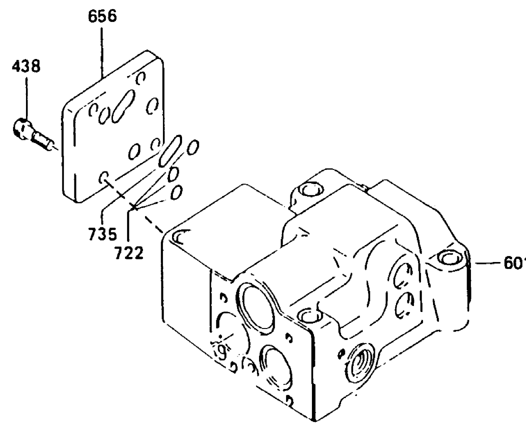
6. Remove adjusting ring (645) from bore by threading a 4 mm x 50 mm bolt into center of adjusting ring and gently pulling it out. Remove and inspect O-ring (728). The shim (649), pilot spring (646) and spring seat (644) will become loose and slide out of the bore.




HAOF030S

**Figure 27**

7. Remove four Allen head bolts (438) and cover (656) from opposite side of portion and adjusting plugs. Remove and inspect O-rings (722, 735).

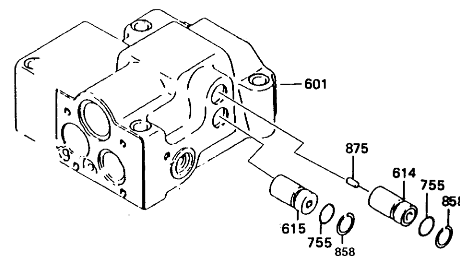



HAOF040S

**Figure 28**

8. Remove two retaining rings (858), portion plug (614) and adjusting plug (615) from bore. A 4 mm x 50 mm bolt can be threaded into these plugs and gently pulled out, if they do not freely slide out of the bore. Remove and inspect O-rings (755).

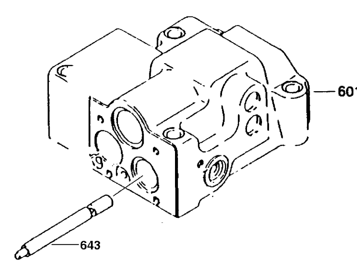
   **NOTE:** *The portion plug (614) and adjusting plug (615) can be differentiated from each other by the pin (875) at bottom of the portion plug (614).*




HAOF050S

**Figure 29**

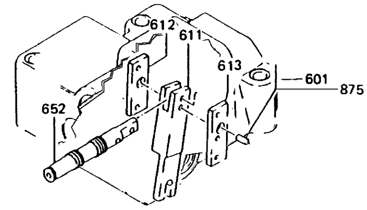
9. Remove pilot piston (643) from bore.




HAOF090S

**Figure 30**

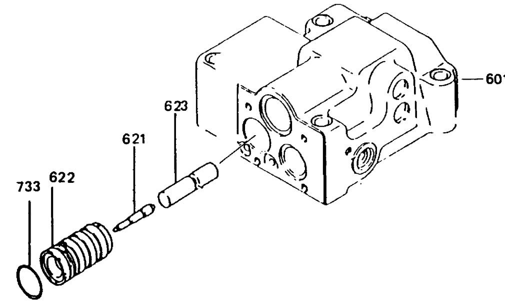
10. Disassemble feedback lever (611) assembly by separating side levers (612, 613). A 2 mm punch can be used to drive out pins (875) from levers.




HAOF100S

**Figure 31**

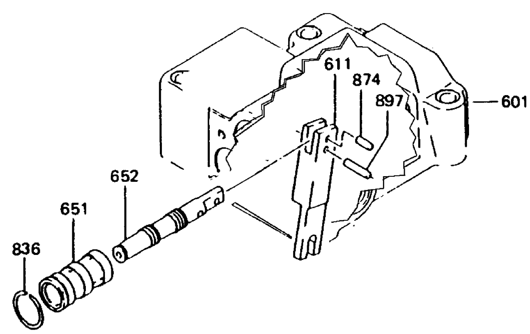
11. Remove piston case (622), compensator piston (621) and piston rod (623) from piston bore. Remove and inspect O-ring (733) from piston case (622).




HAOF110S

**Figure 32**

12. Remove spool (652) and sleeve (651) from bore by driving out pin (874). This will release feedback lever (611) from housing. Inspect retaining ring (836) on sleeve.




HAOF120S

**Figure 33**

# CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

**NOTE:** *Inspect all components and precision surfaces to confirm that they haven't been worn beyond service limits. Check the table below for dimensional specifications.*

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

Replacement of all O-rings and oil seals with new parts is generally recommended, unless pump has had very few operating hours of use.

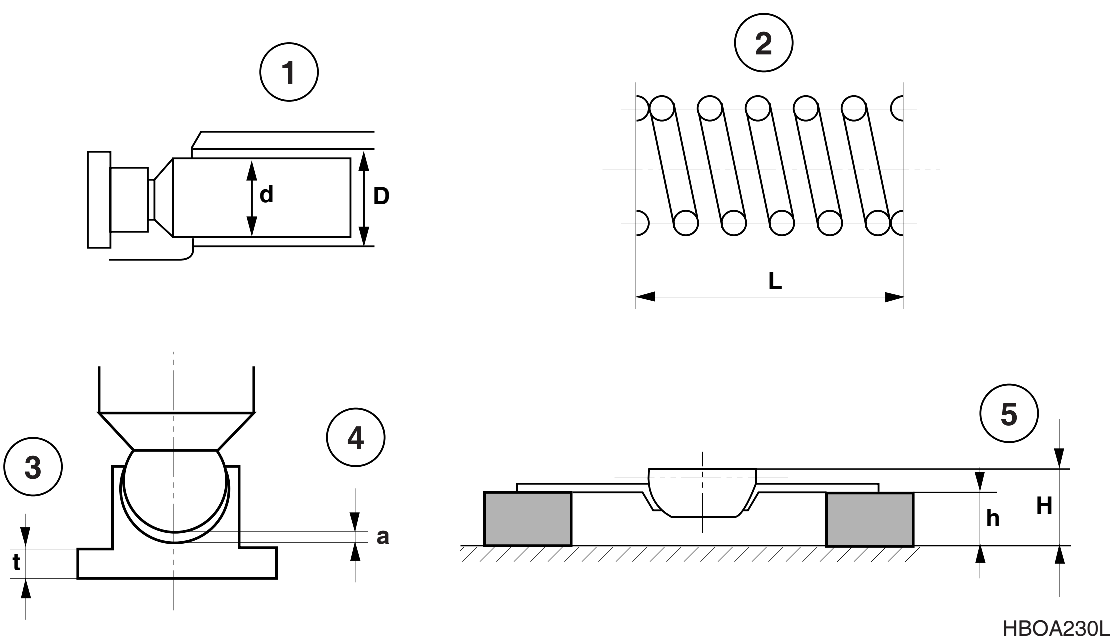



**Figure 34**

**NOTE:** *Rounded bushings and push plates must always be replaced in sets. If either one requires replacement, also 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.*

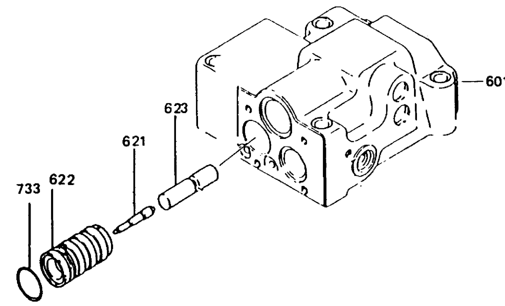
| Reference Number | Item | Standard Value mm (In) | Replacement Limit mm (In) | Remedy |
|---|---|---|---|---|
| 1 | Clearance between cylinder bore and piston (D-d) | 0.032 mm (0.00126 in) | 0.064 mm (0.00252 in) | Replace piston or cylinder |
| 2 | Free-length of cylinder spring (L) | 47.9 mm (1.88 in) | 40.30 mm (1.85 in) | Replace spring |
| 3 | Thickness of shoe (t) | 5.0 mm (0.1968 in) | 4.80 mm (0.1889 in) | Replace piston, shoe assembly parts |
| 4 | Piston ball - shoe socket clearance (a) | 0 - 0.1 mm (0.00394 in) | 0.30 mm (0.01 in) | Replace piston or shoe assembly |
| 5 | Height of push plate, round bushing assembly (H-h) | 13.5 mm (0.531 in) | 12.5 mm (0.492 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

## Pump Regulator Reassembly

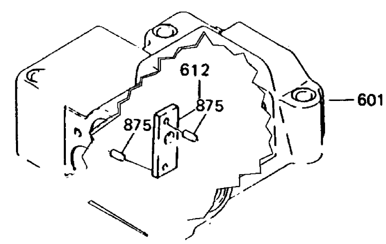
1. Install O-ring (733) and compensator piston (621) to piston case (622). Insert assembly into compensator bore.
2. Insert compensator piston rod (623) into piston bore.




HAOF110S

**Figure 35**

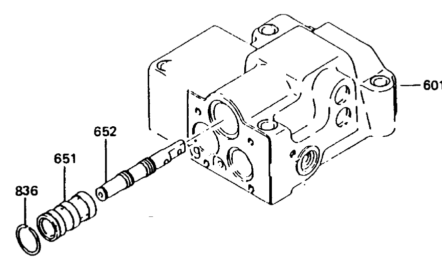
3. Assemble lever (612) to casing using pin (875).




HAOF170S

**Figure 36**

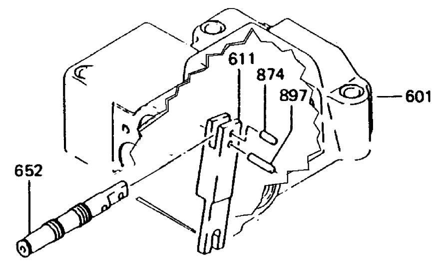
4. Install retaining ring (836) onto spool sleeve (651) and insert sleeve into spool bore. Insert spool (652) into sleeve (already installed in block).




HAOF180S

**Figure 37**

5. Attach feedback lever (611) to spool (652) using pin (874).



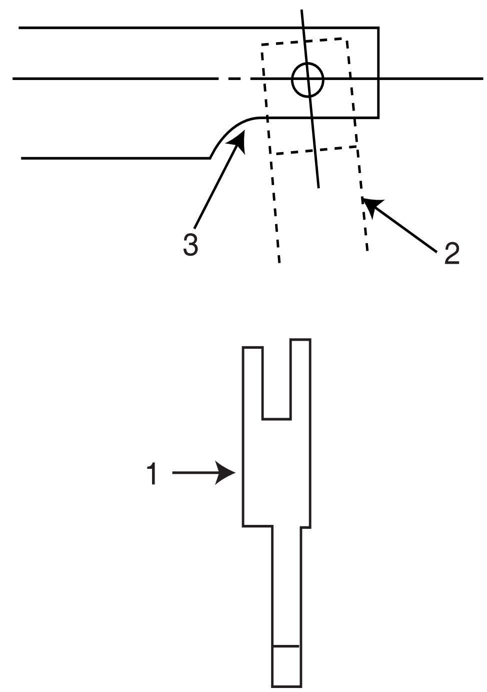

HAOF190S

**Figure 38**

**NOTE:** *The notched portion of spool should face down when mated into feedback lever for correct pin alignment.(Figure 39)*

*1, 2 - Feedback lever (611)*

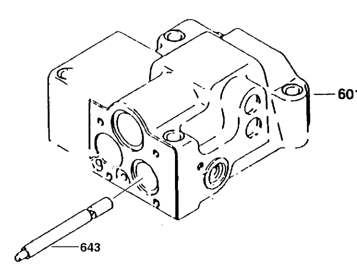
*3 - Spool (652)*




HAOF220L

**Figure 39**

6. Insert pilot piston (643) into bore.




HAOF090S

**Figure 40**

7. Assemble lever (613) onto feedback lever (611).

   **NOTE:** *Make certain pin (875) at the lower portion of lever (613) is properly mated with groove in piston (643).*

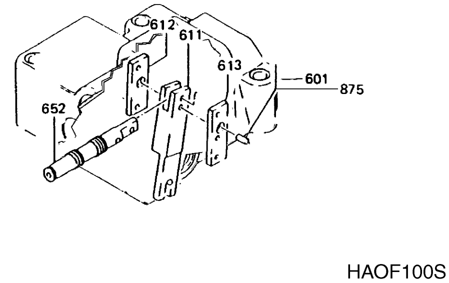



**Figure 41**

8. Install O-rings (755) onto portion (614) and adjusting (615) plugs. Insert pin (875) into portion plug. Install both plugs into their proper bore and secure with retaining rings (858).

   **NOTE:** *Be certain to install plugs into correct bore. Feedback lever should move freely and not bind up.*

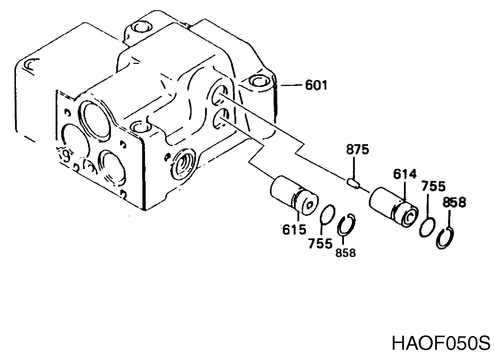



**Figure 42**

9. Install O-rings (722, 735) into cover and mount cover (656) onto block using four Allen head bolts (438).

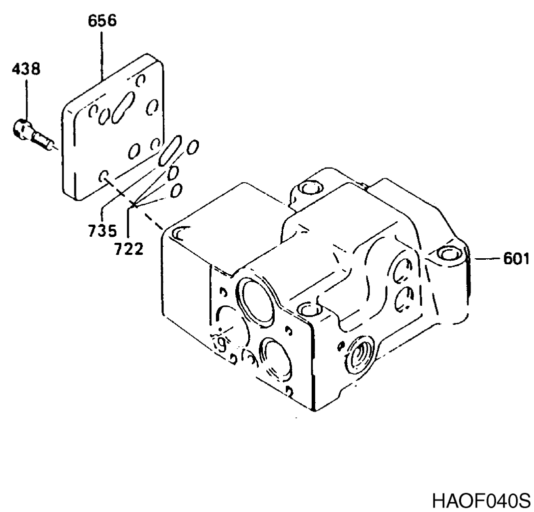



**Figure 43**

10. Install O-ring (728) onto adjusting ring (645). Insert spring seat (644), pilot spring (646) and adjusting ring (645) into adjusting ring bore.

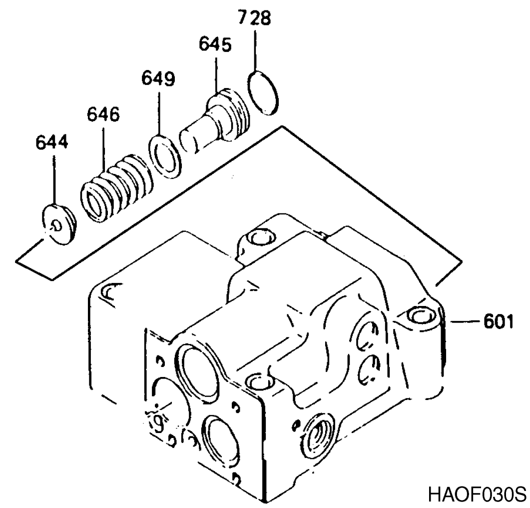



Figure 44

11. Insert spring seat (624), outer spring (625) and inner spring (626) into Pf piston bore. Install O-rings (756, 763) into pilot piston lower cover (629). Mount cover onto regulator casing by using four Allen head bolts (438).

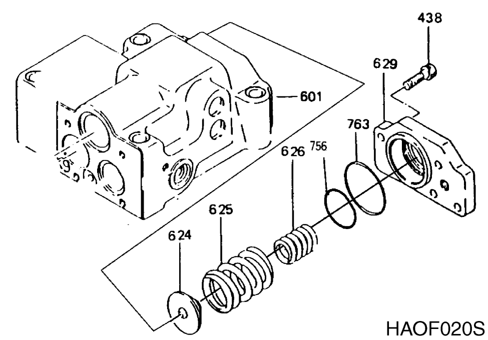



Figure 45

12. Install Pf sleeve (631) and pin (898) into compensator piston bore.
13. Install return spring (654), spring seat (653) and retaining ring (814) onto feed back lever spool (652). Insert feed back lever set spring (655) around spool.

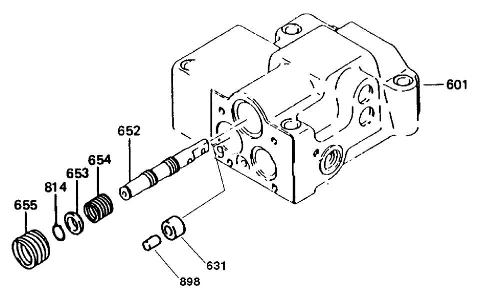
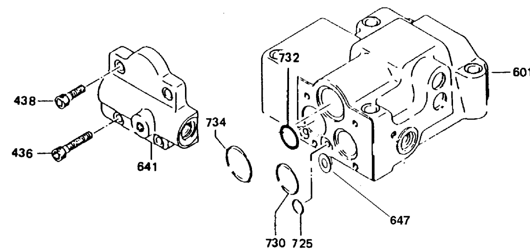



Figure 46

14. Insert adjusting screw bushing (647) into pilot piston bore. Install O-rings (725, 730, 732, 734) into their proper locations. Mount pilot cover (641) onto regulator casing by using four Allen head bolts (436, 438).

    **NOTE:** *Cover mounting bolts (436, 438) are uneven in length and should be replaced to their proper location.*

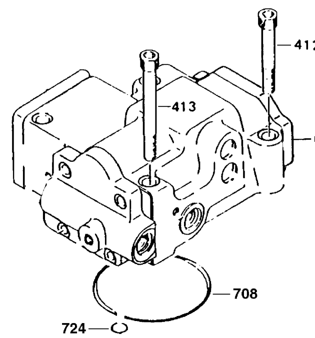



HAOF240S

**Figure 47**

15. Install O-rings (708, 724) to regulator casing base and mount regulator to pump body using four Allen head bolts (412, 413)

    **NOTE:** *The regulator mounting bolts (412, 413) are uneven in length and should be replaced to their proper location.*




HAOE980S

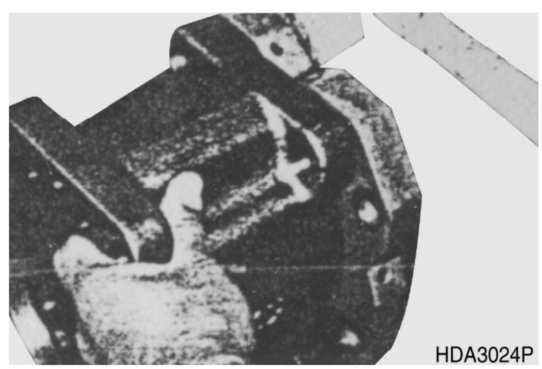
**Figure 48**

## Main Pump Reassembly

**NOTE:** *Reassembly should be done by reversing disassembly steps.*

1. Begin reassembly with servo piston (532), tilting pin (531) and feedback pin (538) at top of pump case. Use Loctite #609 to hold tilting pin and servo piston if those parts have been disassembled.
2. Bolt swash plate support (251) to pump casing (271). Tighten four Allen head mounting bolts.
3. Turn pump case upside down, with regulator mounting surface on work surface. Insert tilting bushing (214) of swash plate into tilting pin (531) and assemble swash plate assembly (212/211) to support (251).

    **NOTE:** *Apply lubricant to all parts of swash plate assembly to make assembly work easier. Use both hands to check and verify complete free movement of assembly after parts have been reinstalled.*



HDA3024P

**Figure 49**

4. Subassemble drive shaft (111 or 113) with roller bearing (123), bearing spacer (127) and retaining ring (824). Install drive shaft into swash plate support (251).

# IMPORTANT

**Do not use excessive force, hammer blows or other mechanical advantage to reinstall the drive shaft. The subassembly can be returned to place with only normal hand pressure.**

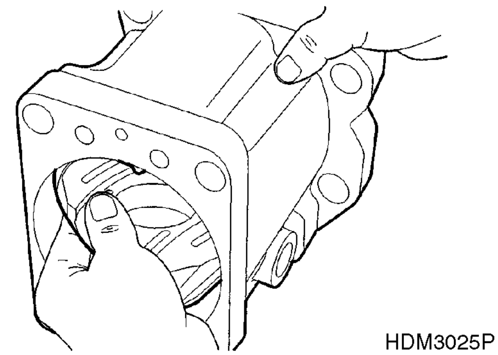



Figure 50

5. Mount outer wheel of bearing on end of drive shaft with plastic hammer. Use brass rod as a drift to push outer wheel into final position. Install retaining ring (824).

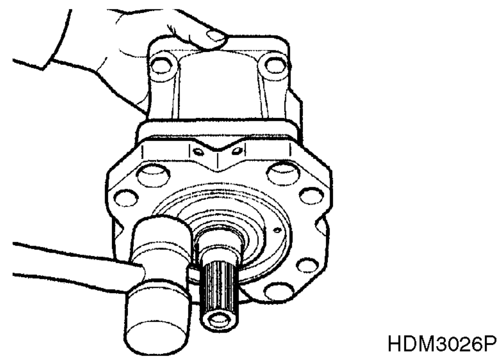



Figure 51

6. Grease O-ring (710) and oil seal (774) for protection; then install seal cover (261) and tighten mounting screws.

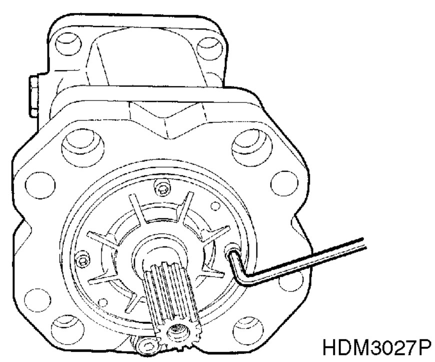



Figure 52

7. Assemble pistons (151) and shoes (152) and cylinder parts push plate (153), round bushing (156) and spacer (158) in cylinder (141) and install assembly in pump casing. Mount valve plate (313 or 314) on valve block (312) and verify valve plate inlet and outlet port alignment.

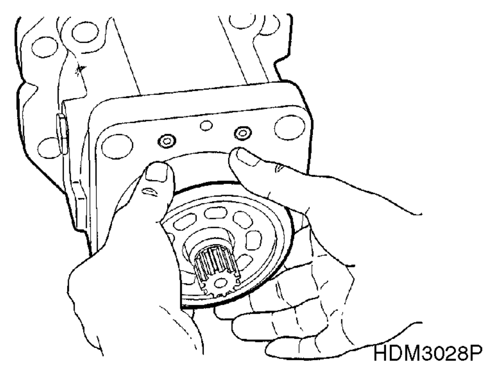



Figure 53

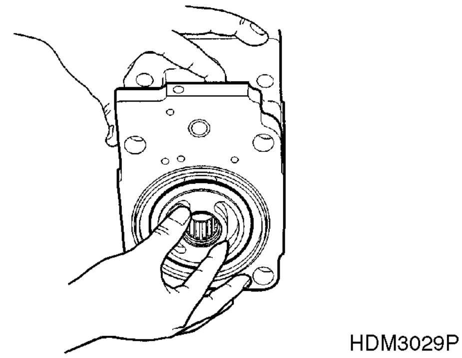



**Figure 54**

8. When both front and rear pump have been completely reassembled, verify direction of valve block. Install rear pump first.

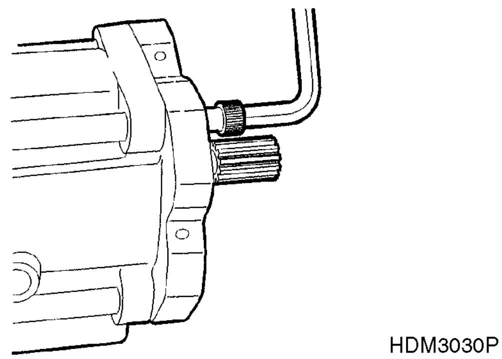



**Figure 55**

9. Install regulators after pump assembly is bolted together and replace case drain plugs.

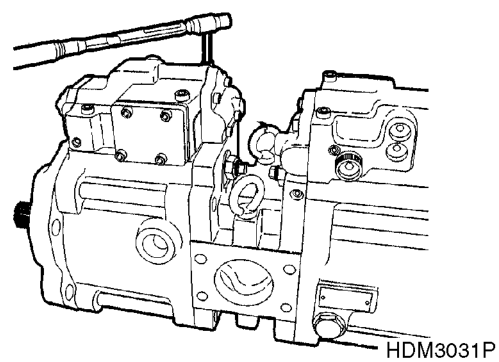



**Figure 56**

# Main Control Valve

Edition 1

# MEMO

# Table of Contents

## Main Control Valve

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| | |

# GENERAL DESCRIPTION

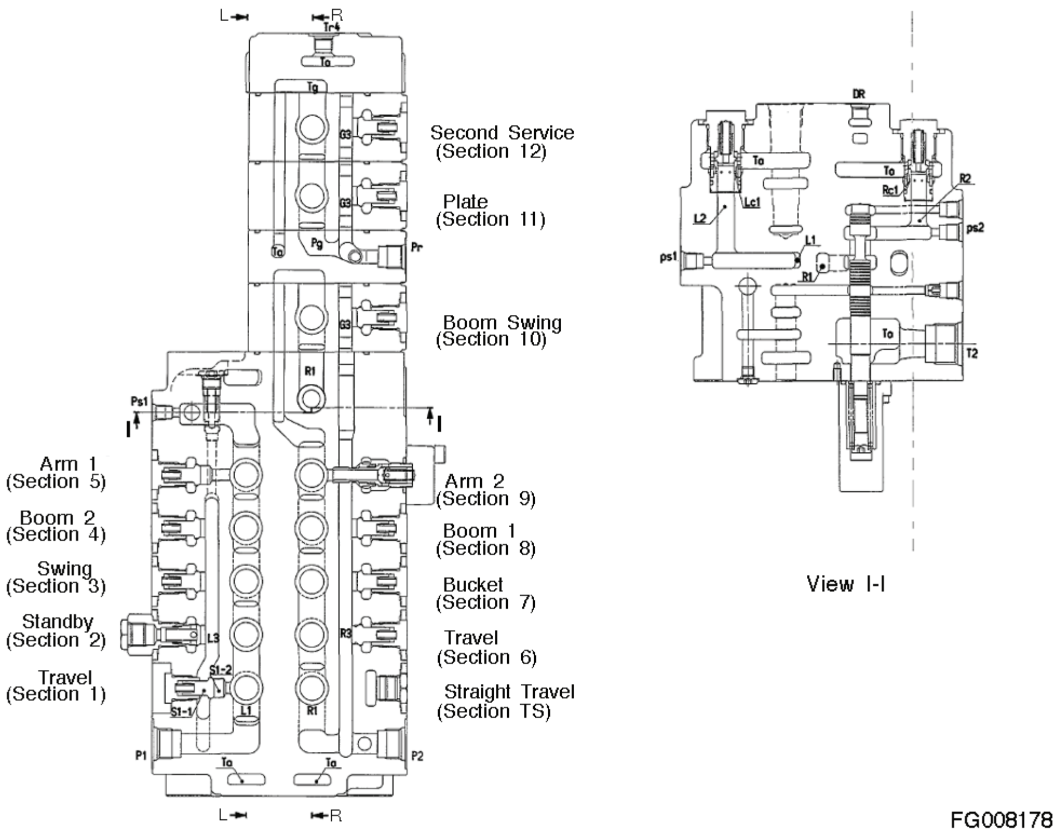



**Figure 1**

### Service Spool Movement

Remove the stopper plug of both pilot caps before using this section.

When necessary, replace the shut-off valve with an overload relief valve and remove the plug at port (P4).

When the spool is moved by being pressurized through the pilot port (pb2) (pa2) of the first service (Section 2), the neutral path (L1) will be closed. The oil supplied through port (P1) flows through the parallel path (L3) load check valve (S2-1), path (S2-2), and spool head to port (B2) (A2). Lubricant oil returns from (A2) (B2) to the tank path Ta via the spool head.

This section makes use of the load check valve which allows external joining at the (P4) port.

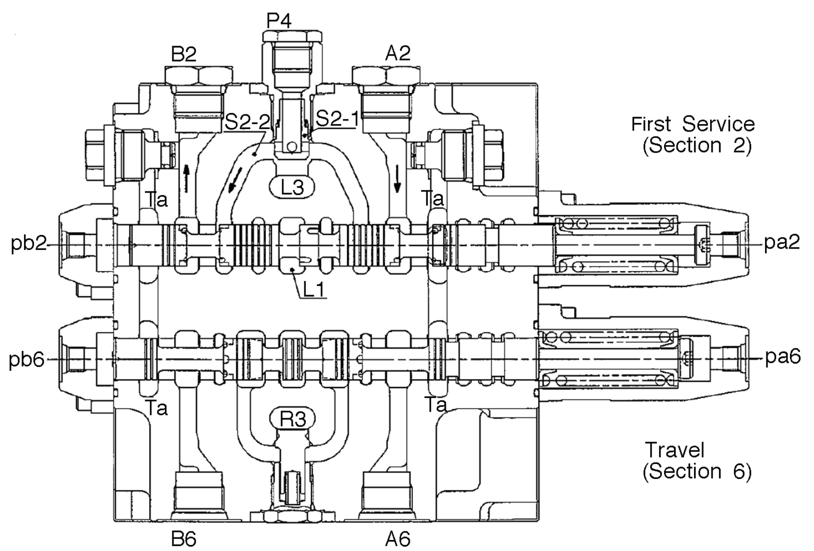



Figure 2

**Swing Spool Movement**

When the swing spool is moved by being pressurized through the pilot port (pb3) (pa3) of the swing (Section 3), the neutral path (L1) will be closed.

The oil supplied through port P1 flows from the parallel path (L3), via the load check valve (S3-1), path (S3-2), and the spool head to the (B3) (A3) port.

Lubricant oil returns to the tank path Ta from (A3) (B3) via the spool head.

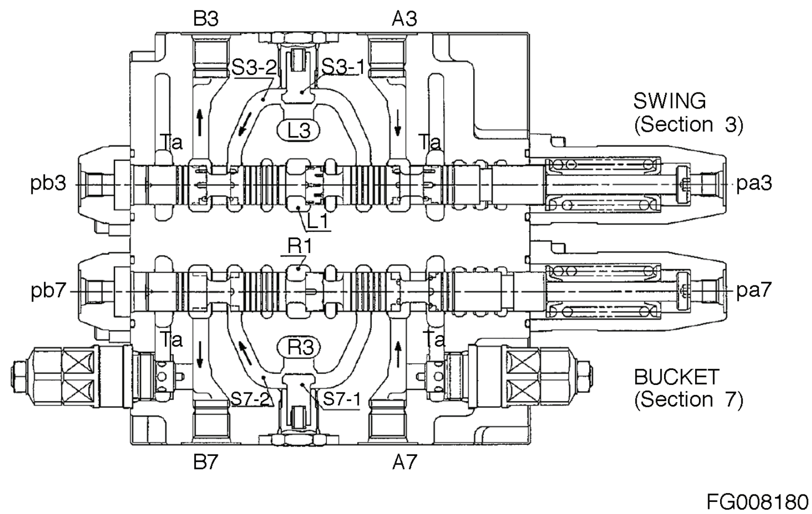



**Figure 3**

**Bucket Spool Movement**

When the bucket spool is moved by being pressurized through the pilot port (pb7) (pb7) of the bucket (Section 7) the neutral path (R1) will be closed.

The oil supplied through port (P2) flows from the parallel path R3 to port (B7) (A7) via the load check valve (S7-1) path (S7-2) and spool head.

Lubricant oil returns to the tank path Ta from (A7) (B7) via spool head.

**Boom Spool Movement**

1. Neutral

   This valve incorporates an anti-drift valve on the bottom of the cylinder of boom 1.

   In a neutral state, the poppet (AD1) is fully seated by the pressure at port (A8) which is applied to the spring chamber (AD5) through the path (AD2), poppet (AD3), and path (AD4).

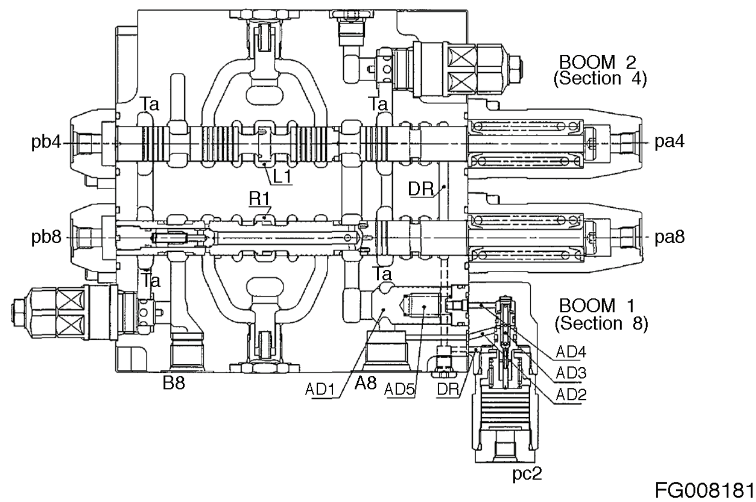



**Figure 4**

2. Upward

When the boom1 spool is moved by being pressurized through the pilot port pa8 of the boom1 (Section 8, Figure 5), the neutral path (R1, Figure 5) will be closed.

The oil supplied through port P1 flows from the parallel path (R3, Figure 5) to port (A8, Figure 5) via the load check valve (S8-1, Figure 5) and spool head.

When the boom2 (Figure 5) spool is also moved by being pressurized through the pilot port (pa4, Figure 5) of boom2, the neutral path (L1, Figure 5) will be closed. The oil supplied through port (P1, Figure 5) joins in port A8 via the parallel path (L3, Figure 5), load check valve (S4-1, Figure 5), spool head and path (7, Figure 5). Lubricant oil returns to the tank path (Ta, Figure 5) from port B8 via the spool head.

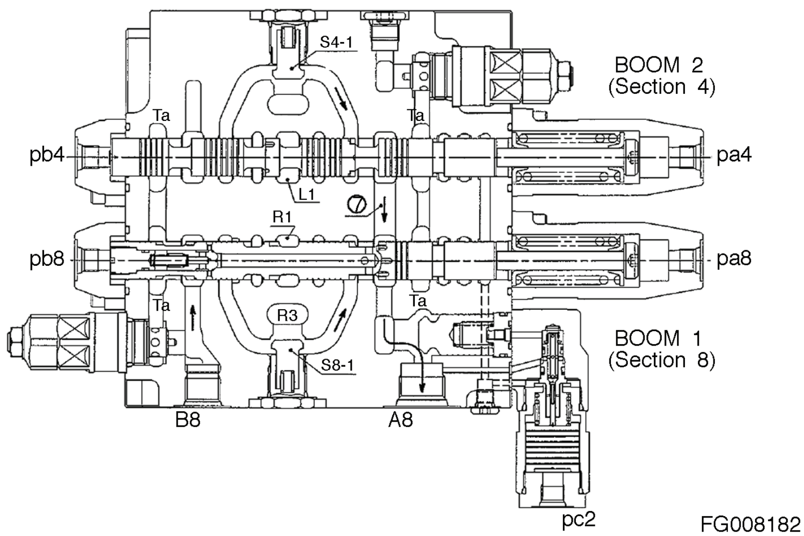



**Figure 5**

3. Downward (recycle)

When the boom1 (Section 8) spool is moved by being pressurized through the pilot port pb8 of the boom1, the neutral path (R1) will be closed.The oil supplied through port P2 flows from the parallel path (R3) to port B8 via the load check valve (S8-1) and spool head.

At the same time, when the poppet (AD3) of the anti-drift valve is moved by pressurizing port pc2 to depressurize the spring chamber (AD5), the poppet (AD1) will be opened, enabling the lubricant oil to return from port A8 to the tank path (Ta). A portion of the lubricant oil pushes open the poppet (S8-3) inside the boom1 spool, flows through path (S8-2) and joins at port B8 to prevent cavitation on the cylinder load side.

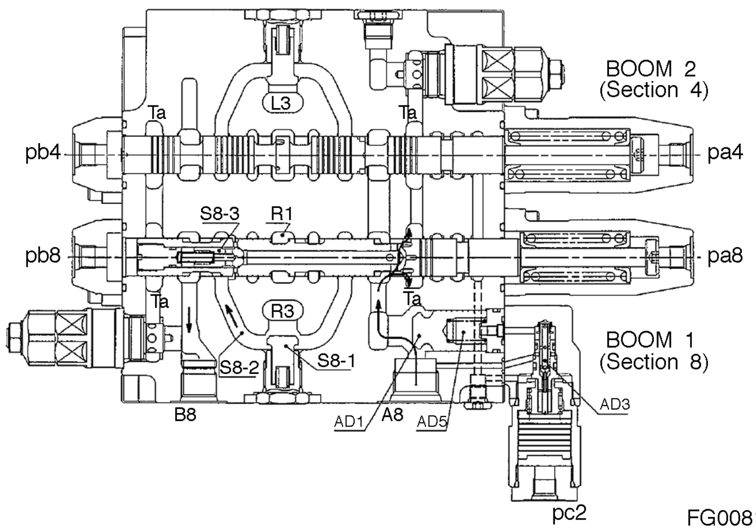



**Figure 6**

**Arm Spool Movement**

1. Dump (2 speed convergence)

   When the arm1 (Section 5) spool is moved by being pressurized through the pilot port pa5 of the arm1, the oil supplied through the P1 port flows from the neutral path (R1)to the A5 port via load the check valve (S5-1), path (S5-2) and spool head.

   When the arm2 (Section 9) spool is also moved by being pressurized through the pilot port pa9 of the arm2, the oil supplied through port P2 flows from neutral path(R1) to join at port A5 via the load check valve (S9-1) path (S9-2), spool head, and path (10). At the same time, a portion of the oil from port P2 flows from path[R3] to port A5 via the orifice (S9-3), check valve(S9-4), path (S9-2) and path (10). The lubricant oil returns to the tank path (Ta) from port B5 via the spool head of arm1; at the same time, it returns to the tank path (Ta) from path (11) via the spool head of arm2.

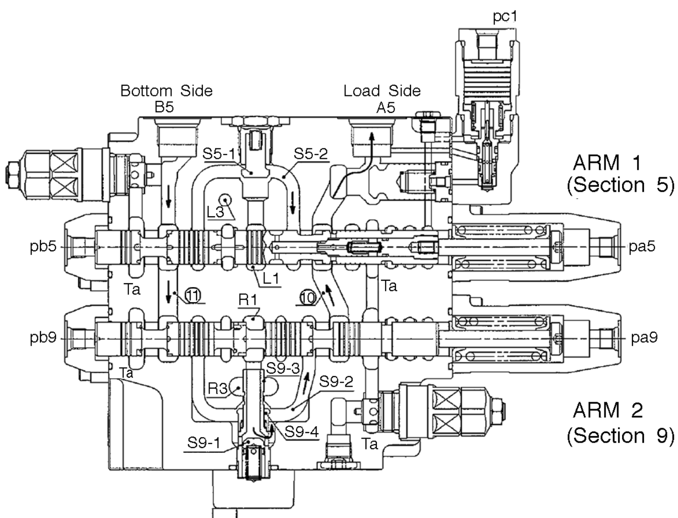



**Figure 7**

2. Crowd (2 speed convergence)

When the arm1 spool is moved by being pressurized through the pilot port pb5 of the arm1 (Section 5), the oil supplied from port P1 flows from the parallel path (L1) to port B5 via the load check valve (S5-1), path (S5-2), and spool head.

When the arm2 spool is moved by being pressurized through the pilot port pb9 of the arm2 (Section 9), the oil supplied through the P2 port will join at port B5 via the parallel path (R1), load check valve (S9-1), path (S9-2), spool head, and path (11). At the same time, a portion of the oil from port P2 flows to port B5 through the path (R3), orifice(S9-3), check valve(S9-4), path(S9-2), and path (11).

When the anti-drift valve spool (AD3) is moved by being pressurized through the Pc1 port to depressurize the spring chamber (AD5), the poppet (AD1) will be opened and the lubricant oil in the A5 port will return to the tank path (Ta) via the spool head, path (S5-3), and arm variable recycle orifice (LC8). A portion of the lubricant oil pushes the poppet (S5-4) in the arm1 spool open, flows through path (S5-2) and joins at port B5 to accelerate the cylinder, preventing cavitation on the bottom side.

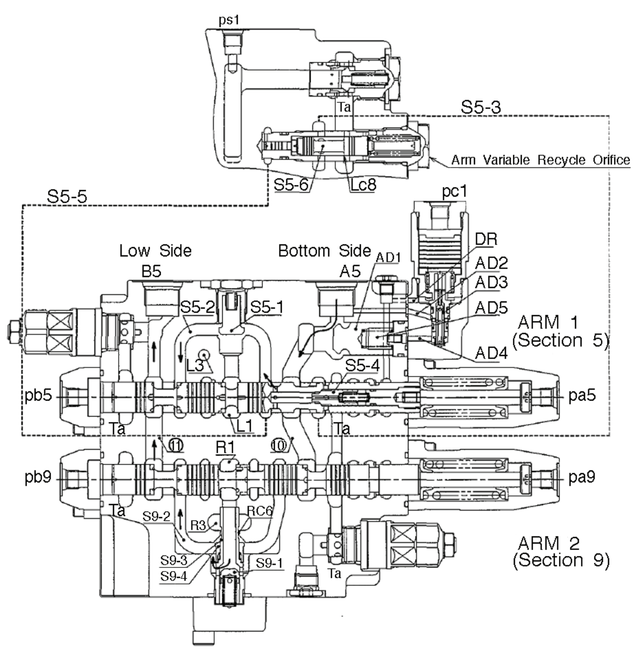



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**Figure 8**

3. Variable Recycle (at crowd control)

In arm crowd operation, the spool (S5-6) will stroke according to the pressure in the path (S5-2) induced through the path (S5-5), to change the position of the arm variable recycle orifice (Lc8). When the pressure in path (S5-2) is high, the stroke of the spool (S5-6) will be increased, which will increase the opening of the orifice (Lc8). Conversely, if the pressure in the path (S5-2) is low, the stroke of the spool (S5-6) will be decreased, which will decrease the opening of the orifice (Lc8).

Therefore, the recycle oil volume varies in accordance with the bottom pressure of the arm cylinder.

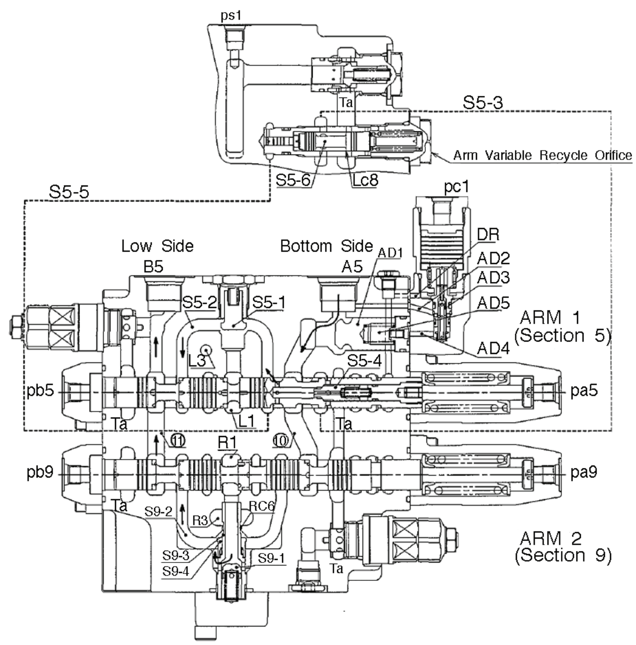


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**Figure 9**

**Parallel Orifices for Arm**

In the arm parallel circuit of this valve, both arm1 (Section 5) and arm2 (Section 9) are equipped with orifices, which control the arm speed even in composite operation. The parallel circuit of arm2 (section 9) is throttled at the orifice (Rc6) of the sleeve (S9-3) in the parallel path (R3), and connected with path (S9-2) through the poppet (S9-4).

The parallel circuit of the arm1 (Section 5) pushes open the poppet (S5-8) in the parallel path (L3), is throttled by the orifice (Lc9) of the parallel variable orifice spool, and connected with the path (S5-2, Figure 11). The throttle volume of orifice (Lc9) can be controlled by the pressure at the pilot port (pbu) (Pc3).

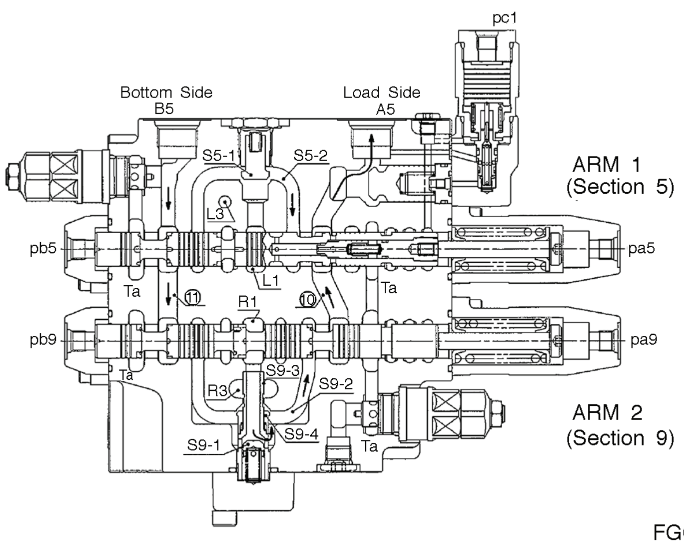


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Figure 10

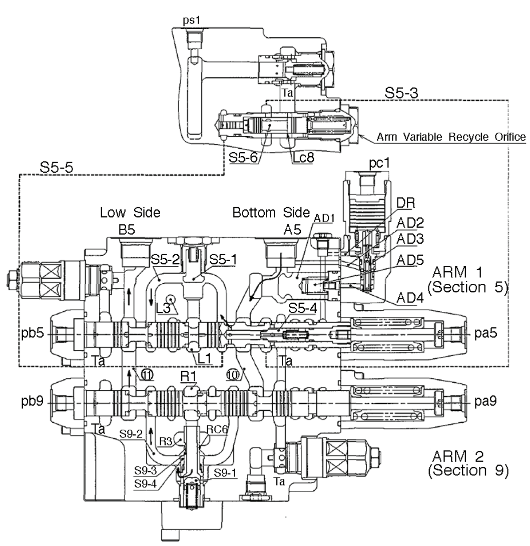


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Figure 11

**Neutral Cut Spool Movement (First Service convergence)**

This valve is equipped with a neutral cut spool at the downstream end (upstream of the low pressure relief valve) of the neutral path (R1). When port (pcc) is pressurized to move the neutral cut spool (R), the neutral path (R1) will be closed. Accordingly, the flow to the negacon relief valve (Rc1) is shut-off, changing the pressure of the ps2 signal.

In the meantime, the oil supplied through the P2 port joins into the path (S2-2) via (P4, Figure 2) with the external device check as media and via the empty part of the poppet (S2-1) of the first service.

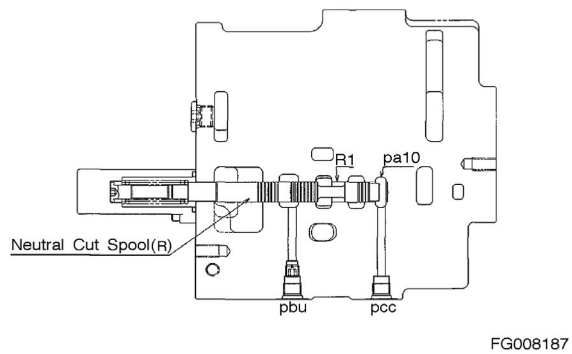


**Figure 12**

**Add-on Spool Movement**

As a representative example, the second service is illustrated.

When the spool is moved by pressure in the pilot port prb3 [pra3) of the second service (Section 12), the neutral path (pg) will be closed. The oil supplied through port Pr flows to port BR3 (AR3) via the parallel path (G3), load check valve (S12-1), path (S12-2), and spool head.

Lubricant oil returns to the tank path (Ta) from AR3 (BR3) via the spool head.

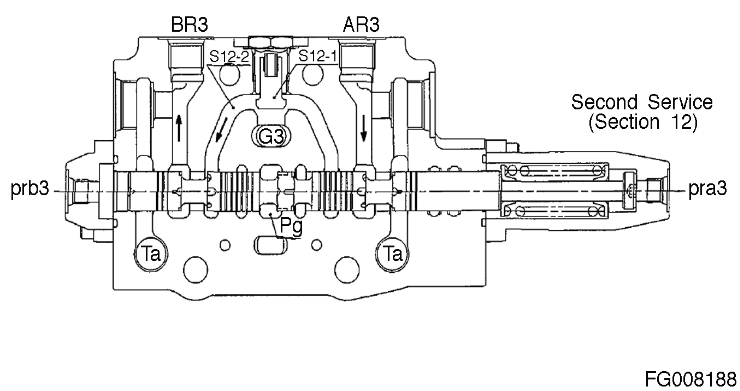


**Figure 13**

**Relief Valve**

1. Main Relief Valve in the Body

   The oil supplied through ports P1 and P2 is guided to the main relief valve via the poppet (LP), and via the poppet (RP) and path (3) respectively. The maximum pressure of the P1 and P2 side pumps is controlled by activation of the main relief valve.

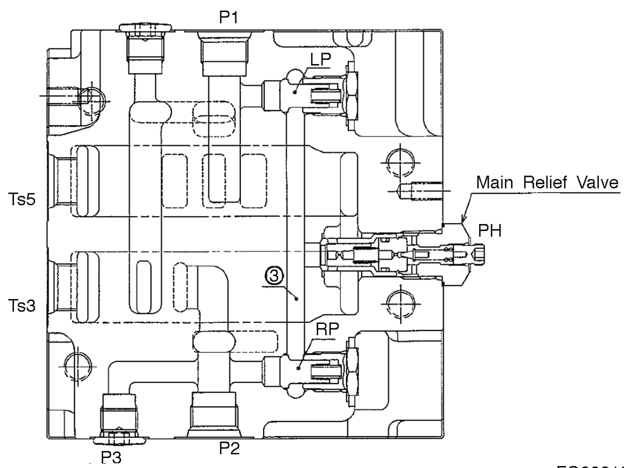


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**Figure 14**

2. Relief Valve for Add-on Pr

   The oil supplied through port Pr is guided to the main relief valve. The maximum pressure of the Pr pump is controlled by activation of the main relief valve.

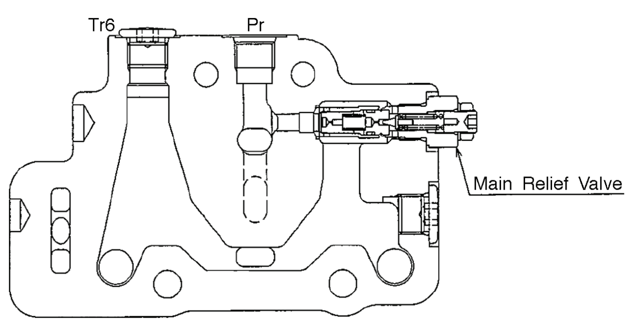


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**Figure 15**

3. Overload Relief Valve

   Each cylinder port of each section is installed with overload relief valves which prevent excessive pressure in the actuator generated by external force.

   Additionally, these relief valves prevent cavitation by sucking in oil from the tank when the cylinder port pressure is negative.

# Composite Operation

### Travel Composite Operation

During simultaneous operation of traveling and left-right turn (forward, backward or spin turn), when an operation other than travel is carried out at the same time, or during any operation except travel, when simultaneous operations of travel and left-right turn are carried out, the oil supplied from port PP is isolated from the tank path (Ta) at the signal land part of a section except the travel moved by the land (Lc4), (Lc7), (Rc3), and (Rc5), raising the pressure in the signal path up to the relief setting pressure of the signal oil source.

The straight travel spool is moved by the rise of the signal pressure, together with the pressure in the PT and PA ports. When the straight travel spool is moved, the oil supplied through port P1 flows to travel (Section1) via the neutral path (L1) and, at the same time, flows to the trave (Section 6)l through the path (2), straight travel spool head, and neutral path (R1)

The oil supplied through port P2 flows to the parallel path (L3) via the straight travel spool head and path (1).

Travel (Section1 and 6) is operated by the oil supplied through port P1, and devices other than travel are operated by the oil supplied through port P2; therefore, fluctuation in travel can be prevented even in composite operation combined with travel left-right operation and other devices.

In the event that the load pressure of other sections is higher than that of the travel (Section 6), a portion of the oil supplied through port P2 pushes open the poppet (S6-2), passes through the orifice at the end of the poppet, and joins into path (S-1), resulting in travel speed reduction shock as the movement of the straight travel valve is relieved.

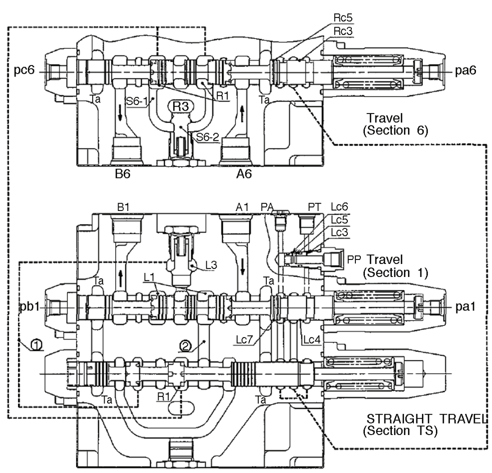


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Figure 16

## Anti-drift Valve

An anti-drift valve is installed in the cylinder port on the side of the arm load (arm bottom) which prevents the unwanted self-lowering of the arm (boom) cylinder.

In the neutral state (Figure 14), cylinder port pressure is guided to the spring chamber (AD5) through path (AD2), poppet (AD3) gap, and path (Ad4).

The poppet (AD1) is fully seated by the differential pressure generated by the spring force and the area difference of the poppet.

In arm damp (boom upward) operation (Figure 17), the oil supplied from the pump pushes the poppet (AD1) open and flows into the cylinder port.

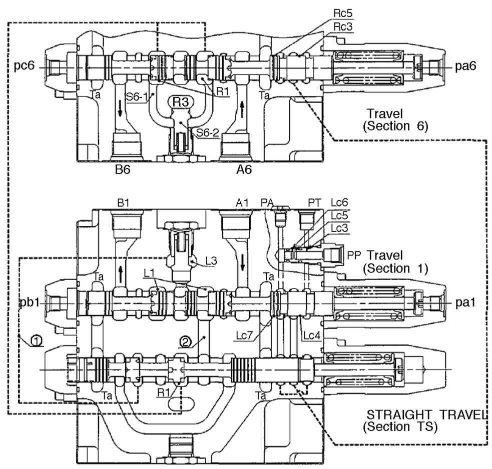


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**Figure 17**

In the arm crowd operation (boom upward), pc1 (pc2) is pressurized to move the poppet (AD3) in order to induce the oil in the spring chamber (AD5) to the drain path (DR) via the poppet (AD3) gap and spool (AD6) gap; consequently, the poppet (AD1) is opened and the lubricant oil in the cylinder port flows to the tank path (Ta) via the spool.

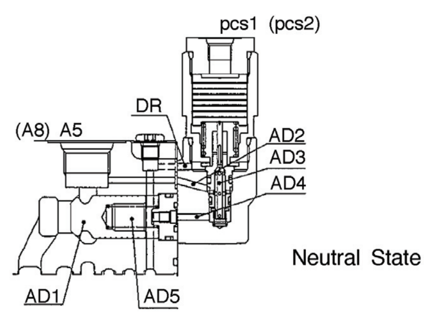


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**Figure 18**

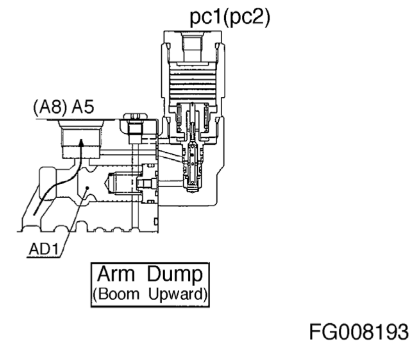



**Figure 19**

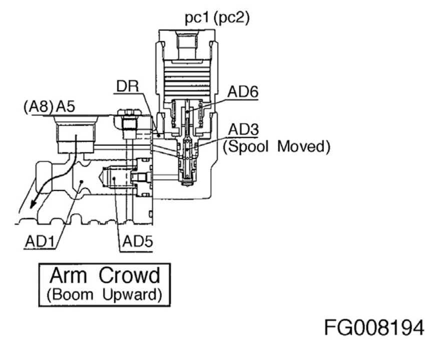



**Figure 20**

# DISASSEMBLY

## Precautions for Disassembly

1. On a level surface, place the main equipment on the level and place all other working devices on the ground.

   Ensure that neither the traveling nor the swing motion is self-activated.

   Stop the engine and release the pressure from all actuators.

   **CAUTION!**

   **If the valve assembly is replaced or the valve is disassembled under pressurized conditions, there is a danger that high pressure oil may be expulsed or parts may eject suddenly. When disassembling, ground the bucket and fully release the pressure in the oil circuit.**

2. Release air pressure from the tank.
3. Clean the working place so that no foreign matter can enter into the valve when disassembling.
4. Tag disassembled parts so that they can be easily and correctly identified for reassembling.
5. Replace all seals (o-rings, backup rings) with new ones
6. Spools are matched with the respective valve housing and sleeves. Therefore, spools must not be replaced.

## Disassembling Procedures

In this disassembly section, the parts for assembly are identified by

### Disassembly of Main Spool

1. Unscrew the socket head bolt (width across flats of hole: 6), disassemble the long cap.

   Remove the o-ring from the groove of the valve housing.
2. Unscrew the socket head bolt (width across flats of hole: 5), disassemble the cap.

   Remove the o-ring from the cap.
3. Pick out the spools as in sub-assembly state from the valve housing.

## CAUTION!

**Spools must be picked out straight so that they are not dented or scratched. Dents or scratches may damage the wall of the body hole when picking out, making reassembly difficult or impossible. Furthermore, when assembled, it may cause malfunction. Each spool has to be tagged so that it can be reassembled in the correct place. If incorrectly assembled, the actuator will not function properly and may be very dangerous.**

4. Unscrew the socket head bolt (width across flats of hole: 6), disassemble the short cap.

   Remove the o-ring from the groove of the valve housing.

5. Unscrew the spool end [said new part No.-4] (width across flats of hole: 6) from the spool, remove the spring seat [said new part No. -2] and spring [said new part No. -3].

6. Unscrew the spool end (width across flats of hole: 6) of the spool, remove the spring seat and spring.

   Disassemble the plug (groove width: 3), remove poppet, spring, O-ring, and back-up ring.

7. Unscrew the spool end (width across flats of hole: 6) of the spool, remove the spring seat and spring.

   Disassemble the plug (groove width: 3), remove the poppet, spring, O-ring, and back-up ring.

## CAUTION!

**When disassembling the spool assembly, use the wooden vise to fix the spool so that the spool is not damaged. In order to prevent the bending of the spool, grip the spool as close to the end as possible. Adhesive is applied on the thread of the spool end. Heat up the outside of the spool end (thread) with an industrial dryer or similar tool, until the spool end can be easily tightened (standard heating temperature: 200~250°C). In the event of excessive heating, the spring may be degraded by thermal deformation. In such cases, replace with a new spring. Do not touch the heated spool as you may be burnt.**

### Disassembly of Sub-Spool

1. Unscrew the spool end (width across flats: 5) of the spool, remove the spring seat and spring.
2. Adhesive is applied on the thread connecting the spool and spool end. Refer to (Caution: 3) when disassembling them.

### Disassembly of Sub-Spool

1. Disassemble the plug (width across flats: 32), remove the O-ring.
2. Remove the spring and spool.
3. Use a needle to pick the inside of the front hole of the sleeve to take out the sleeve. The piston will come out together with the sleeve.
4. Remove the back-up ring and O-ring.

### Disassembly of Boom, Arm Anti-Drift Valve

1. Unscrew the socket head bolt (width across flats: 6), remove body assembly, and remove the O-ring from the groove of the valve housing.

**CAUTION!**

**When disassembling this part with the control valve mounted on the equipment, parts may be ejected by the inner pressure. Unscrew the socket head bolt slowly, and then disassemble when it is certain that the inner pressure has been fully released.**

2. Remove space assembly using the M6x1.0 bolt, remove the O-ring and back-up ring.
3. Remove the spring and poppet.
4. Grip the body assembly with a wooden vise so that the contacting surface on the O-ring mounting side is not damaged.
5. Unscrew the plug assembly (width across flats: 38), remove the O-ring.
6. Remove the piston, spool and spring.
7. Disassemble the plug (width across flats: 38), remove the O-ring.

**CAUTION!**

**When disassembling this part with the control valve mounted on the equipment, parts may be ejected by the inner pressure. Unscrew the plug slowly, and then disassemble when it is certain that the inner pressure has been fully released.**

8. Remove the sleeve and poppet.

   From the outside of the sleeve, remove the O-rings and back-up rings.

9. Remove the spring seat and spring from the hole.

### Disassembly of Travel Right, Swing, Bucket, Boom1, 2, Arm1,Boom Swing, Blade, Second Service, Load check Valve

1. Disassemble the plug (width across flats: 27) of the load check valve, remove the O-rings.
2. Remove the spring and poppet.

### Disassembly of Check Valve in the Straight Travel Orifice (travel left section)

1. Disassemble the plug (width across flats: 27) of the straight travel orifice, remove the O-ring from the plug.
2. Remove the poppet and spring.

### Disassemble of Arm2 Load Check Valve

1. Unscrew the socket head bolt (width across flats: 8), remove the flange from the body.

   Remove the O-ring from the groove of the valve housing.

2. Take out the sleeve, springs and poppets.

**CAUTION!**

**Do not let the spring fall on the floor. If it falls, debris may enter the main spool's sliding part, which could cause the spool to stick, resulting in uncontrollable running of the actuator.**

### Disassembly of the External Convergence Check Valve of the First Service

1. Disassemble the plug (width across flats: 32), remove the O-ring from the plug.
2. Take out the spring and poppet.
3. Disassemble the plug assembly (width across flats: 27), remove the O-ring.

### Disassembly of the Common Check Valve

1. Disassemble the plug (width across flats: 27) of the check valve, remove the O-ring from the plug.
2. Take out the spring and poppet.

### Disassembly of the Arm1 Semi Para Check Valve

1. Disassemble the plug assembly (width across flats: 8), remove the O-ring.
2. Take out the spring and poppet.

### Disassembly of the Relief Valve

1. Remove the overload relief valve (width across flats: 32) from the main body valve and the spool section of the add-on.
2. Remove the main relief valve (width across flats: 32) from main body valve, remove (width across flats: 24) from the inlet section of the add-on.
3. Take out the negacon relief valve (width across flats: 32) from the main body valve.

**CAUTION!**

**The relief valve itself is not subject to disassembly. Any disassembling / reassembling / adjusting of the relief valve shall be excluded from the warranty.**

### Disassembly of the Shut-off Valve

1. Disassemble the plug assembly (width across flats: 32), remove the O-ring and back-up ring.
   - Not used in this valve.

**Disassembly of Other Plugs**

1. Disassemble the plug assembly (width across flats: 19) of PP port, remove the O-ring.
2. Disassemble the plug (width across flats: 19) in the preliminary section cap part, remove the O-ring.
3. Disassemble the G1/8 plug (width across flats: 5, 3 in all) remove the O-ring.
4. Disassemble the G3/8 plug (width across flats: 8, 4 in all), remove the O-ring.
5. Disassemble the G1/2 plug (width across flats: 10, 2 in all), remove the O-ring.
6. Disassemble the G3/4 plug (width across flats: 36, 2 in all), remove the O-ring.
7. Disassemble the 7/8-14 UN plug (width across flats: 27), remove the O-ring.

**Disassembly of the Add-on Section**

1. Remove the hex nut (width across flats: 19) (width across flats: 22).
2. Take out the outlet housing.
3. Take out the valve housing for the spool section, remove the O-ring on the contact surface.
4. Take out the inlet housing, remove the O-ring on the contact surface.
5. Remove the O-ring on the main body contact surface.
6. Unscrew the tie rod and remove from the main body valve housing.

**CAUTION!**

**When taking out the add-on section, be very careful not to dent or scratch the contact surfaces. Dents or scratches may cause an oil leak at the contacting surface, resulting in malfunction.**

**In addition, take care that foreign matter does not enter the oil path. If foreign matter touches the spool sliding surface, the spool may get stuck, causing bad seating in the load check valve and resulting in the uncontrolled running of the actuator.**

# WASHING

All disassembled parts have to be washed clean with mineral oil.

Dry with compressed air. Place them on a clean sheet of paper or a vinyl sheet.

# INSPECTION

Carry out a visual inspection on all parts for any foreign matter, scratches, or other defects.

1. Inspect the seat of the load check valve in the valve housing for any scratches, dents, dust, or corrosion. Small scratches may be removed with an oil stone.
2. Inspect the spool for any scratches or dents. Small scratches may be removed with an oil stone.
3. Test sliding surfaces by moving lightly. All grooves and paths must be free from foreign matter.
4. If a spring is broken, seriously deformed, or worn, replace it immediately.
5. If the performance of the relief valve is unsatisfactory, check in accordance with Clause 6, Relief Valve Maintenance.
6. All removed O-rings and back-up rings must be replaced with new ones.
7. Remove the cap and plug, check for any residual painting around the body holes or plugs positions (paint or coating debris left in the valve will cause malfunctions or oil leaks).

# ASSEMBLING

## CAUTION!

**Check number of parts, assembling position, and necessary tools before starting assembly.**

## Sub-Assembly

Before assembling the parts into valve housing, sub-assemble the necessary parts.

**Main Spool**

1. Apply adhesive on the threads of spool.

   Fix spring seat, spring, and spool end then fix spool with wooden vise and tighten spool end.

   Torque: 9.8~11.8N•m

   ## CAUTION!

   **Do not apply adhesive excessively. Fix the spool as near to the spool end as possible so that the tightening torque does not bend the spool. Excessive torque may result in spool expansion, causing the spool to stick and uncontrolled running of the actuator. Hereafter, heed this caution when applying adhesive.**

   ## CAUTION!

   **Note that the spring in boom 2 spool and the straight travel spool differ from other parts. Mistakes in assembly may cause a malfunction of the actuator.**

2. Assemble poppet and spring in the spool.

   Apply adhesive on the spool thread.

   Fix the spool with the wooden vise.

   Apply adhesive to the tread of the plug.

   Insert the plug which is fitted with an O-ring and back-up ring.

   Torque: 9.8~11.8 N•m.

   Assemble spring seat, spring and spool end, and fix spool end.

Torque: 9.8~11.8 N•m.

3. Insert poppet and spring into the hollow of the spool.

   Apply adhesive to the thread of the spool for plug fitting.

   Insert the plug assembled with an O-ring and back-up ring.

   Torque: 9.8~11.8 N•m.

   Apply adhesive to the thread of the spool which is assembled with the spool end.

   Fix spring seat, spring and spool end. Fix the spool with a wooden vise, and tighten the spool end.

   Torque: 9.8~11.8 N•m.

**CAUTION!**

**Be careful when the inserting positions of the O-ring and back-up ring. If they are inserted wrongly, the O-ring may be cut and will not work properly.**

**Sub Spool**

1. Apply adhesive to the thread of the spool.
2. Fix spring seat, spring and spool end. Fix spool with a wooden vise and tighten the spool end.

   Torque: 19~22 N•m.

**Sub-Spool Part**

1. Insert back-up ring and O-ring into sleeve.
2. Insert piston into the sleeve fitted with seal.
3. Insert spool into the sleeve.

**Boom, Arm Anti-Drift Valve**

1. Insert O-ring nd back-up ring into the outer groove of the sleeve.

**CAUTION!**

**Make sure the inserting positions of the O-ring and back-up ring are correct. If wrong, the O-ring may be cut causing the self-lowering of the actuator.**

2. Insert poppet and spool into the hole of the sleeve, making sure the direction is correct.

3. Attach spring seat to the groove at the end of the poppet, place spring and insert into the body hole together with the sleeve.
4. Fix the body at the contacting surface on the O-ring side using a wooden vise to prevent scratching.

**CAUTION!**

**It is recommended to apply grease on the spring and spring seat so that both can be correctly positioned on the poppet. If the spring is not correctly positioned on the spring seat, it may be damaged and spring debris may surround the oil path, resulting in malfunction.**

5. Insert spring and piston into plug.
6. Fix the plug assembly attached with the O-ring to the plug.

   Torque: 147~157 N•m.
7. Fix the plug attached with O-ring to the body.

   Torque: 147~167 N•m.

**Shut-Off Valve**

1. Assemble the O-ring and back-up ring to the plug.

**CAUTION!**

**Make sure that the O-ring and back-up ring are correctly positioned. If the positions of the two rings are reversed, the O-ring may be cut causing the actuator to malfunction.**

# Assembling Control Valve

### Assembling Add-on Section

1. Install tie rod in the main body valve housing.

**CAUTION!**

**Tighten the tie rod to effectively thread the end. If the thread cannot perform its proper function, an oil leak may occur at the contact surfaces due to the insufficient jointing force of the add-on section, causing malfunction.**

**Furthermore, the threads may be broken by overload, resulting in malfunction.**

2. Install the O-ring on the contact surface of the main body.
3. Using the tie rod as a guide, mount the inlet housing on the main body valve housing. Install the O-ring on the contact surface.
4. Using the tie rod as a guide, mount the valve housing for the spool section on the inlet housing. Install the O-ring on the contact surface.
5. Using the tie rod as a guide, mount the outlet housing on the valve hosing for spool section.

**CAUTION!**

**When inserting the add-on section, take care not to dent or scratch the contact surfaces. Otherwise, oil may leak at the contacting surface causing malfunction. Also, take care that foreign material on the contact surface do not cause the O-ring to drop out or change position.**

**CAUTION!**

**When installing the add-on section, the tie rod must be used as a guide for correct positioning. Otherwise, the O-ring on the contact surface may be separated, causing oil leak and malfunction.**

6. Insert the hex nut into the tie rod and tighten them.

   Torque: 152±7N•m

   Insert the hex nut into the tie rod and tighten them.

   Torque: 93±4N•m

**CAUTION!**

**The hex nut must be tightened to the specified torque. At smaller torque, oil may leak at the contact surface due to insufficient tightening force. At too strong torque, the spool may be stuck due to the torsion of the spool section valve housing, causing uncontrollable activation of the actuator. Tighten the two uniformly.**

**CAUTION!**

**This control valve is designed to allow the addition of the add-on section, which is supplied as a kit. When adding the add-on section, follow the instructions for disassembly and reassembly.**

**Assembling Right Travel, Swing, Bucket, Boom1, 2, Arm1, and Blade Load Check Part**

1. Insert the poppet and spring into the valve housing.
2. Insert the plug assembled with O-ring and tighten them.

   Torque: 103~113N•m.

**Assembling Arm2 Load Check Valve Part**

1. Insert the spring and poppet on the outside of the sleeve. With the poppet and spring nside the sleeve, insert them into the valve housing.
2. Mount the O-ring on the valve housing groove. Mount the flange and tighten with socket head bolt.

   Torque: 39~44N•m.

**CAUTION!**

**When assembling the flange, the spring must be inserted into the flange position. Otherwise, the spring may be damaged. Socket head bolt must be tightened uniformly and firmly. Hereinafter, when tightening flanges, follow the instructions given under Caution 20.**

**Assembling Travel Orifice (left travel section) Check Valve**

1. Insert the poppet and spring into the valve housing.
2. Insert the plug assembled with the O-ring and tighten.

   Torque: 103~113N•m

---

## CAUTION!

---

**When installing the plug [19], the spring [17] must be inserted into the plug completely. If the spring is not fully inserted, it may be broken.**

**Hereafter in this manual, plugs should be tightened in compliance with this caution.**

---

**First Service, Assembling External Joint Flow Check Valve**

1. Insert the poppet and spring into the valve housing.
2. Insert the plug assembled with the O-ring and tighten.

   Torque: 103~113N•m.
3. Insert the plug assembly inserted with the O-ring and tighten them.

   Torque: 89~97N•m.

**Assembling Common Check Valve**

1. Insert the poppet and spring into the valve housing.
2. Insert the plug inserted with the O-ring, and tighten the plug.

   Torque: 103~113N•m.

**Assembling Arm1 Semi Para Check Valve**

1. Insert the poppet and spring.
2. Tighten the plug assembled with the O-ring.

   Torque: 73~79N•m.

**Assembling Boom, Arm Anti-Drift Valve**

1. Insert the O-ring into the contact surface.
2. Insert the poppet into the valve housing
3. Insert the spacer attached with the O-ring and back-up ring into the valve housing together with the spring.

**CAUTION!**

**Insert the spring carefully so that it is located in the spacer position correctly. If the spring is not located in the spacer position correctly, it may be broken by the poppet, and its debris may clog the oil path, causing malfunction.**

4. Insert the socket head bolt into the body assembly and tighten them.

   Torque: 20~25N•m.

**Assembling Relief Valve**

1. Insert the overload relief valvesand tighten them: total 8.

   Torque: 78~88N•m.

2. Inset the main body relief valves and tighten them.

   Torque: 78~88N•m.

3. Insert the add-on main relief valves and tighten them.

   Torque: 49~59N•m.

4. Insert the negacon relief valves and tighten them.

   Torque: 103~113N•m.

**Assembling Sub-Spool**

1. Insert the spool assembly into the original place.
2. Install the cap attached with the O-ring.

   Insert the socket head bolts into the cap and tighten them.

   Torque: 8.8~10.5N•m.

**CAUTION!**

**Insert the spool slowly, right into the hole. After insertion, move the spool with the hand to check if there is any clogged or uneven feeling. If clogged or uneven, the spool may not function properly.**

**Hereinafter in this manual, follow this caution when assembling the spool.**

**Assembling Sub Spool**

1. Insert the spool assembly into the original place.
2. Insert the spring.
3. Insert the plug [attached with the O-ring, and tighten the plug.

   Torque: 103~113N•m.

**Assembling Main Spool**

1. Insert the O-ring into the valve housing.
2. Install the short cap] in the straight travel spool.

   Install to other spools.

   Insert the socket head bolt into the short cap, and tighten it.

   Torque: 20~25N•m.
3. As a sub-assembly, insert the spools into their respective (original) holes.
4. Install the long cap in the straight travel spool [10].

   Install the long cap in the other spools.

   Insert the socket head bolt into the long cap, and tighten it.

   Torque: 20~25N•m.

**CAUTION!**

**When inserting the cap, be careful not to allow the O-ring to separate on the contact surface.**

**Assembling Other Plugs**

1. Insert the plug assembly assembled with the O-ring.

   Torque: 205~227N•m.
2. Insert the plug assembly assembled with the O-ring.

   Torque: 73~79N•m.
3. Insert the plug assembly assembled with the O-ring.

   Torque: 13.5~16.5N•m.
4. Insert the plug assembly assembled with the O-ring.

   Torque: 103~113N•m.
5. Insert the plug assembly assembled with the O-ring.

   Torque: 116~128N•m.
6. Insert the plug assembly assembled with the O-ring.

   Torque: 49~59N•m.

7. Insert the plug assembly assembled with the O-ring.

   Torque: 19~22N•m.

## CAUTION!

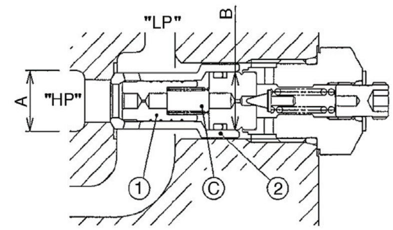
**When assembled, check for any omitted or loose parts. If loose, oil may leak. Specified torque values are all in wet condition (applied with oil).**

# RELIEF VALVE

## Main Relief Valve

### Body Main Relief Valve Operation

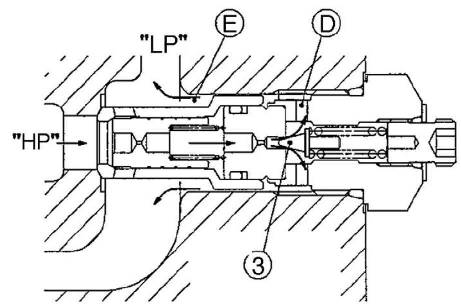
1. This relief valve is inserted between the neutral path "HP" and low pressure path "LP", oil is filled in the inner space (C) through the orifice of the main poppet (1). The sleeve (2) and main poppet (1) are securely seated by the areal difference between "A" and "B".




FG008195

**Figure 21**

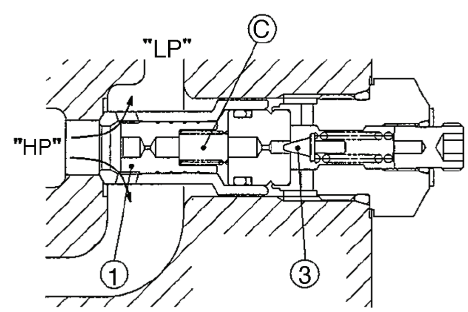
2. When the pressure in the neutral path "HP" reaches the preset pilot spring force, the pilot poppet will be opened. Oil flows around the pilot poppet (3), through the drill hole (D) and circular gap (E), and is guided to the tank path "LP".




FG008196

**Figure 22**

3. When the pilot poppet (3) is opened, the pressure in the inner space (C) is decreased to open the main poppet (1). Therefore, the oil in "HP" flows directly through path "LP".




FG008197

**Figure 23**

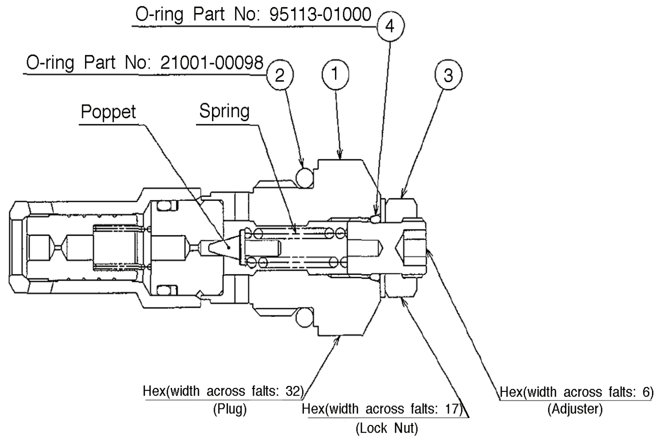



Figure 24

Disassembling

1. This part is replaced by assembly.
2. When replacing, unscrew plug <width across flats: 32> with spanner, remove O-ring.
3. If oil leaks at the adjuster kit, disassemble adjuster kit and replace O-ring.

**CAUTION!**

**When disassembling the adjuster kit, parts may be ejected by the spring. Be careful not to lose the poppet.**

Assembling

1. Check if there is dust, paint, etc., on the thread of the plug. Insert a new O-ring.
2. Clean the relief mounting part of the valve housing. Install a relief valve and insert the plug.

   Torque: 59~69N•m.
3. When the adjuster kit is disassembled, clean the threads. Adjust pressure in compliance with the clause.

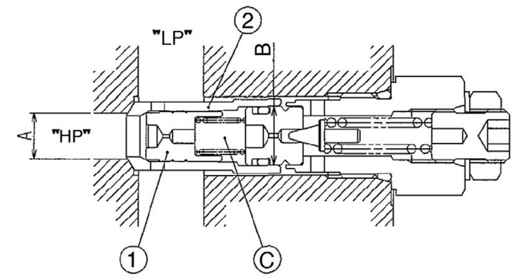
**CAUTION!**

**In the above instructions, the specified torques values are for wet conditions (applied with oil).**

### Add-on Main Relief Valve Operation

1. This relief valve is inserted between the neutral path "HP" and the tank path "LP". Oil is filled into the inner space (C) through the orifice of the main poppet .

   The sleeve (2) and main poppet (1) are securely seated by the areal difference between "A" and "B".

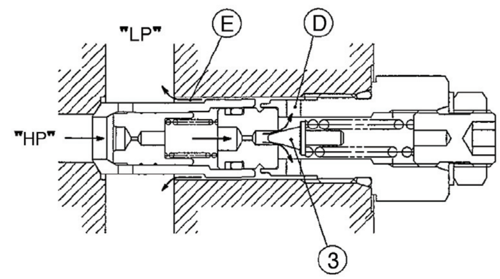



FG008199

**Figure 25**

2. When the pressure in the neutral path "HP" reaches the preset pilot spring force, the pilot poppet (3) will be opened.

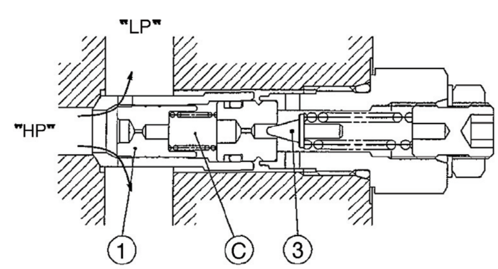
   Oil flows around the pilot poppet (3), through the drill hole (E) and circular gap (D), and is guided to the tank path "LP".




FG008200

**Figure 26**

3. When the pilot poppet (3) is opened, the pressure in the inner space (C) is decreased to open the main poppet (1). Therefore, the oil in "HP" flows directly through path "LP".




FG008201

**Figure 27**

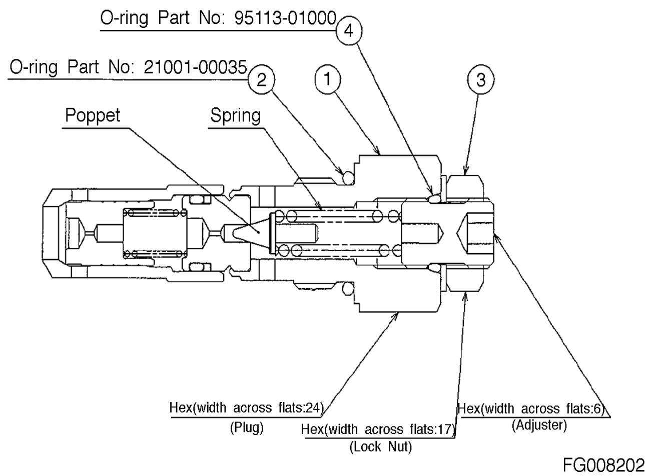



**Figure 28**

Disassembling

1. This part is replaced by assembly.
2. When replacing, unscrew the plug (width across flats: 32) with a spanner, then remove the O-ring.
3. If oil leaks at the adjuster kit, disassemble the adjuster kit and replace the O-ring.

**CAUTION!**

**When disassembling the adjuster kit, parts may be ejected by the spring. Be careful not to lose the poppet.**

Assembling

1. Check for dust, paint, etc., on the thread of the plug. Insert the new O-ring.
2. Clean the relief mounting part of the valve housing. Install the relief valve, insert plug.

   Torque: 59~69N•m.
3. When the adjuster kit is disassembled, clean the threads. Adjust pressure in compliance with the clause.

**CAUTION!**

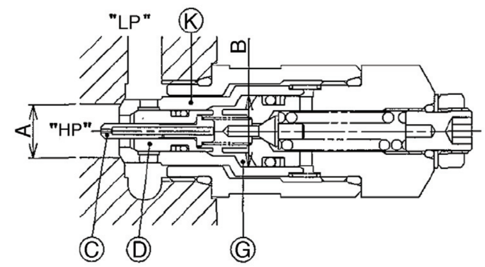
**In the above instructions, the specified torques values are for wet conditions (applied with oil).**

# Overload Relief Valve

### Relief Valve Operation

1. This relief valve is inserted between the neutral path "HP" and tank path "LP". Oil is filled in the inner space (G) through the orifice of the piston (C).

   The sleeve (K) and main poppet (D) are securely seated by the areal difference between "A" and "B".

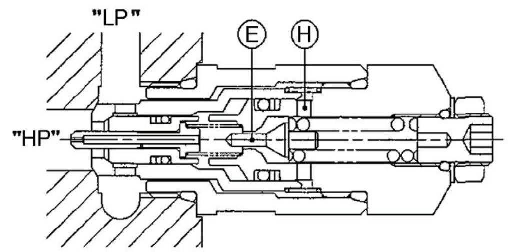



FG008203

**Figure 29**

2. When the pressure in the cylinder port "HP" reaches the preset spring force of the pilot poppet, the pilot poppet (E) will be opened.

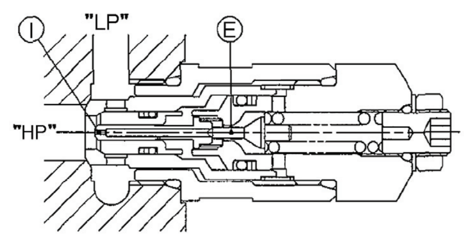
   Oil flows around the poppet, through the drill hole (H), and is guided to the low pressure path "LP".




FG008204

**Figure 30**

3. The pilot poppet (E) opens to make the oil flow through the orifice (1) of piston (C), differential pressure is generated between path "HP" and the back side of the piston (C) to move the piston (C) to seat the poppet (E).




FG008261

**Figure 31**

4. For the oil flow through the path "HP" and poppet (D), the pressure difference increases due to throttling by the poppet (D), circular gap of piston (C), and orifice. The poppet (D) is opened by the differential pressure and oil flows directly through path "LP".

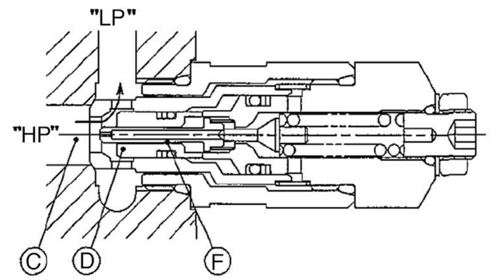



Figure 32

**Suction operation**

1. This relief valve is equipped with an anti-void unit in the cylinder port "HP", which supplies oil when cavitation occurs. In the low pressure side "LP", when the pressure in the cylinder port "HP" is low, the sleeve (K) is opened by the differential pressure generated by the areal difference between "A" and "B". Oil flows from the low pressure side "LP" into the cylinder port "HP" to prevent cavitation.

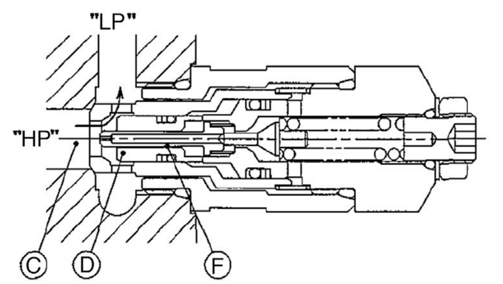



Figure 33

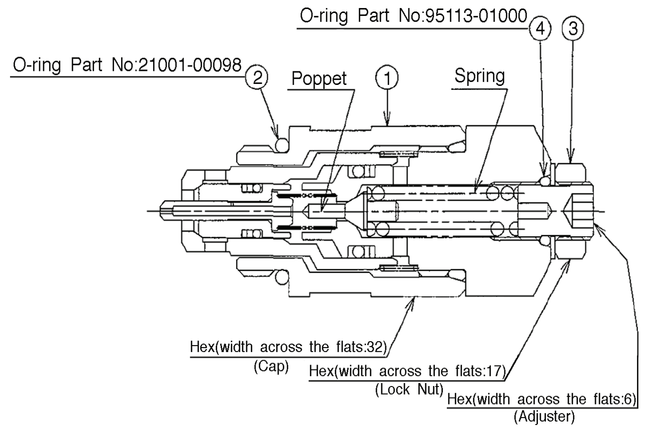



**Figure 34**

Disassembling

1. This part is designed to be replaced by assembly.
2. When replacing, unscrew the cap (hex, width across the flats: 32) with spanner, and remove the O-ring.
3. If oil leaks at the adjuster kit, unscrew the adjuster kit and replace the O-ring.

## CAUTION!

When disassembling the adjuster kit, parts may be ejected by the spring. Be careful not to lose the poppet.

Assembling

1. Check for dust, paint, or dirt on the threaded part of the cap, insert a new O-ring.
2. Clean the relief valve mounting of the valve housing, assemble the relief valve, and insert the cap (width across the flats: 32).

   Torque: 78~88N•m.
3. If the adjuster kit is disassembled, clean the threaded part and adjust the pressure in compliance with the clause.

## CAUTION!

**The specified torque values are all for wet conditions (applied with oil).**

# Negacon Relief Valve

## Negacon Relief Valve Operation

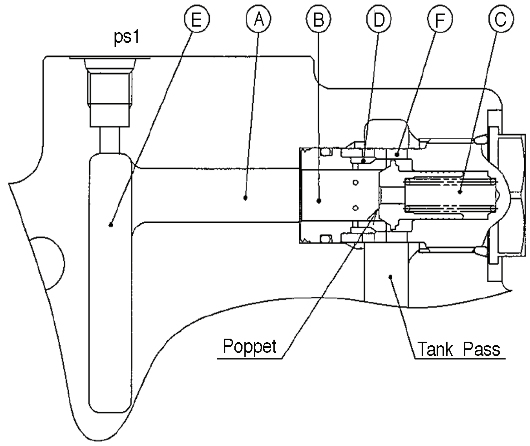



**Figure 35**

Generation of Signal Pressure

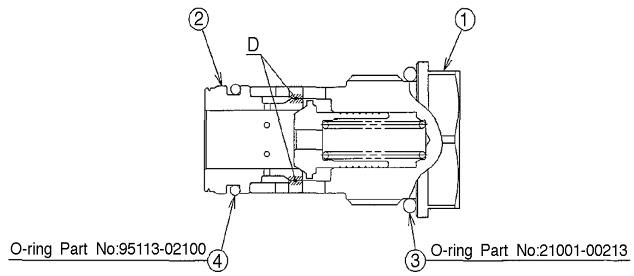
The oil supplied through the pump port (P1) flows to the tank path through the neutral path (L1) and the negacon orifice (D) at the neutral downstream path (A).

In this process, pressure is generated in the path (B) by the negacon orifice (D), and the pressure is induced in the negacon signal pressure port (Ps1) through path (E).

When the main spool that is upstream of the neutral downstream path (A) is activated, the oil flow through the neutral downstream path (A) is decreased and the cegacon signal pressure is reduced.

Relief Operation

In the event that there is excessive oil flow in the neutral downstream path (A), the pressure generated in path (B) by the negacon orifice (D) is induced to the back chamber (C) of the poppet. The poppet is activated by the differential pressure generated by the difference in the hydraulic area between the path (B) and the back chamber (C). When this poppet is activated, oil flows to the tank path (Ta) through path (B) and the drill hole path (F) of the plug, preventing excessive pressure in the negacon signal pressure port.




FG008266

Figure 36

Disassembly

1. This part is designed to be assembly-replaced without disassembly, in order for the press-in at the "D" part.

Assembling

1. Check for dust, paint or any dirt on the threaded part of the plug , and insert a new O-ring.
2. Insert a new O-ring into sleeve.
3. Clean the relief valve mounting of the valve housing, insert the plug (width across the flats: 46) of the relief assembly.

   Torque: 103~113N•m.

**CAUTION!**

**The specified torque values are all for wet conditions (applied with oil).**

## Adjusting Relief Valve

**Main Relief Valve (common for body and add-on)**

1. This part is designed for non-disassembly and is not subject to readjustment. If pressure is adjusted, we cannot guarantee its proper operation.
2. Install a precise pressure gauge at the circuit inlet.
3. Run the pump at the rated rpm.
4. Move the spool in the control valve, read the pressure gauge indication at the end of the cylinder stroke.

**CAUTION!**

**Move the spool of the actuator, for which the set pressure of the overload relief valve is higher than that of the main relief valve actuator spool.**

5. Turn the adjuster clockwise until the desired pressure is obtained.

   17.8MPa of pressure is increased by a turn of the adjuster.
6. When the desired pressure is reached, and press the adjuster so that it does not rotate, then tighten the lock nut.

   Torque: 27~31N•m
7. Raise the pressure again to check that the specified pressure is obtained.

**Overload Relief Valve**

**CAUTION!**

**If the set pressure is higher than that of the main relief valve, it will be activated during the following adjustment. Therefore, it will not be possible to adjust the overload relief valve. Do not disassemble or adjust it. Replace with a complete set of relief valves in assembly.**

1. This part is designed for non-disassembly and should not be adjusted. Replace by assembly. If the pressure has been adjusted, we cannot not guarantee its proper operation.
2. Move the control valve spool, and read the pressure gauge indication at the end of the cylinder stroke.

3. Turn the adjuster clockwise until the desired pressure is reached.

   21.2MPa of pressure is increased by each turn of the adjuster.

4. When the specified pressure is reached, press the adjuster so that it does not rotate, and tighten the lock nut.

   Torque: 27~31N.m

5. Raise the pressure again to check the rated pressure has been obtained.

# INSTALLATION

1. Piping should not exert unnecessary force on the valves.
2. Bolts must be tightened uniformly.
3. Welding work near the valves may damage the seals due to excessive heat or flame.
4. Keep the ports covered until connected with a pipe in order to prevent dust.

# OPERATION

1. Check that the hydraulic circuit and oil are clean before operation.
2. Oil must be hydraulic oil, with an aniline point of 82~113°C
3. Keep the relief valve below the specified pressure.
4. The pressure difference between the main relief valve and the overload relief valve should be set at a minimum of 2.0MPa.
5. Perform deaeration and warming up before operation.
   - In particular, when the temperatures of the hydraulic oil and valve are low, observe the following instructions in order to prevent the stick of the spool by thermal shock;
   - Do not operate the main relief valve and overload relief valve abruptly without a proper time interval. Let the hydraulic oil circulate in each actuator to warm up all the parts uniformly.
   - Fine or complex operations which may cause local overheating at the orifices of each part should not be done abruptly at low temperature.

# CONTROL VALVE SPECIFICATION

<table>
<tr><th>Item</th><th>Specification</th></tr>
<tr><td>Rated Flow(main body)</td><td>160L/min<br>(At neutral: 30L/min)</td></tr>
<tr><td>Max. Pressure(main body)</td><td>35MPa</td></tr>
<tr><td>Rated Flow(Add-on Pr)</td><td>70L/min</td></tr>
<tr><td>Max. Pressure(Add-on Pr)</td><td>28MPa</td></tr>
<tr><td>Allowable Back-pressure</td><td>Peak Pressure: 1.5MPa max.<br>(Operating Pressure: 0.5MPa max.)</td></tr>
<tr><td rowspan="3">Allowable Oil Temperature</td><td>Operating: -25~80°C</td></tr>
<tr><td>Instantaneous: 100°C max.</td></tr>
<tr><td>(seal: nitrile rubber)</td></tr>
</table>

# TROUBLESHOOTING

## Control Valve: overall

| Problem | Possible Cause | Remedy |
|---|---|---|
| Spool does not stroke. | Oil temperature is too high. | Remove obstructions in the piping line, which may resist oil flow. |
| | Hydraulic oil is contaminated. | Replace hydraulic oil, wash circuit. |
| | Piping port joint is loose. | Check torque. |
| | Valve housing is torted after installation. | Check by unscrewing joint bolts. |
| | Pressure is too high. | Install pressure gauge to check pressure at pump and cylinder port. |
| | Spool is bent. | Replace with valve assembly. |
| | Return spring is damaged. | Replace damaged part. |
| | Spring or cap is separated. | Unscrew cap to fix, and tighten it. |
| | Temperature distribution in valve is not uniform. | Warm up the whole circuit. |
| | Dust in valve. | Remove dust. |
| | Insufficient pilot pressure | Check pilot valve and pilot relief pressure. |
| Cannot maintain load. | Cylinder oil leak. | Check cylinder seal. |
| | Oil is bypassed in spool. | Check if spool is scratched. |
| | Oil leak at overload relief valve oil. | Wash valve housing seat and relief valve seat. |
| | Oil leak at anti-drift valve. | Disassemble anti-drift valve, wash all the seats clean.<br>If seat is scratched, replace the poppet, or lap the poppet and seat.<br>If the anti-drift valve spool has a problem, spool and sleeve must be replaced together (they are match-finished). |
| When the spool is moved from neutral to higher position, load carrying capacity is reduced. | Dust in load check valve. | Disassemble and wash check valve. |
| | Poppet or seat of valve is scratched. | Replace poppet or lap poppet and seat. |

## Relief valve

| Problem | Possible Cause | Remedy |
|---|---|---|
| Pressure does not rise at all | Main poppet, sleeve or pilot poppet is stuck open; or there is dust in the valve seat. | Replace relief valve. |
| Relief pressure is unstable | Pilot poppet seat is scratched. | |
| | Piston or main poppet is stuck. | |
| Relief pressure fluctuates | Seat worn by dust. | |
| | Loose lock nut or adjuster | Reset the pressure, and tighten the lock nut by specified torque. |
| Oil leak | Relief valve seat is damaged. | Replace relief valve. |
| | Parts are stuck with dust. | |
| | O-ring is worn. | Replace the O-ring in the adjuster or installation part. |

## Hydraulic System: Overall

| Problem | Possible Cause | Remedy |
|---|---|---|
| Hydraulic system is not in good condition, or does not function at all. | Pump failure | Check pressure, or replace pump. |
| | Relief valve failure | Replace relief valve. |
| | Cylinder failure | Repair or replace. |
| | Pump load pressure is too heavy. | Check circuit pressure. |
| | Valve is cracked. | Replace with valve assembly. |
| | Spool does not stroke in full travel. | Check spool movement. |
| | Tank oil level is too low. | Refill hydraulic oil. |
| | Filter in the circuit is clogged. | Wash or replace filter. |
| | Circuit piping line is throttled. | Check piping. |

# Remote Control Valve (Work Lever / Joystick)

Edition 1

# MEMO

# Table of Contents

## Remote Control Valve (Work Lever / Joystick)

## MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |
| DX300LC | 5001 and Up |
| DX340LC | 5001 and Up |

# GENERAL DESCRIPTION

## Theory of Operation

### Structure

The remote control valve contains four push rods, spring holders, spools and return springs, which are in the valve casing. The valve works as a pressure reduction valve.

The housing has six ports, which include input port P, tank port T, and four secondary pressure ports.

The electric horn button is installed in the valve handle.

Gear pump pressure is used for operating control spools.

### Function

1. Neutral Position

   When the lever is in neutral mode, the spool is pushed upward by return spring. The force of balancing spring, which determines the secondary discharge pressure, is not transmitted to the spool. The input port is closed and the pressure of the output port is the same as the pressure of the tank port T.

2. Control Switch

   Pressing of the push rod starts to press the balance spring, whose force is transferred to the spool to connect the P and T ports, transferring the pilot pressure. Output pressure acts on the bottom of the spool and press the spool upwards until it is balanced with the force of the balance spring.

   In short, the second pressure (output pressure) changes in proportion to the pressing force of the balance spring.

# Parts List

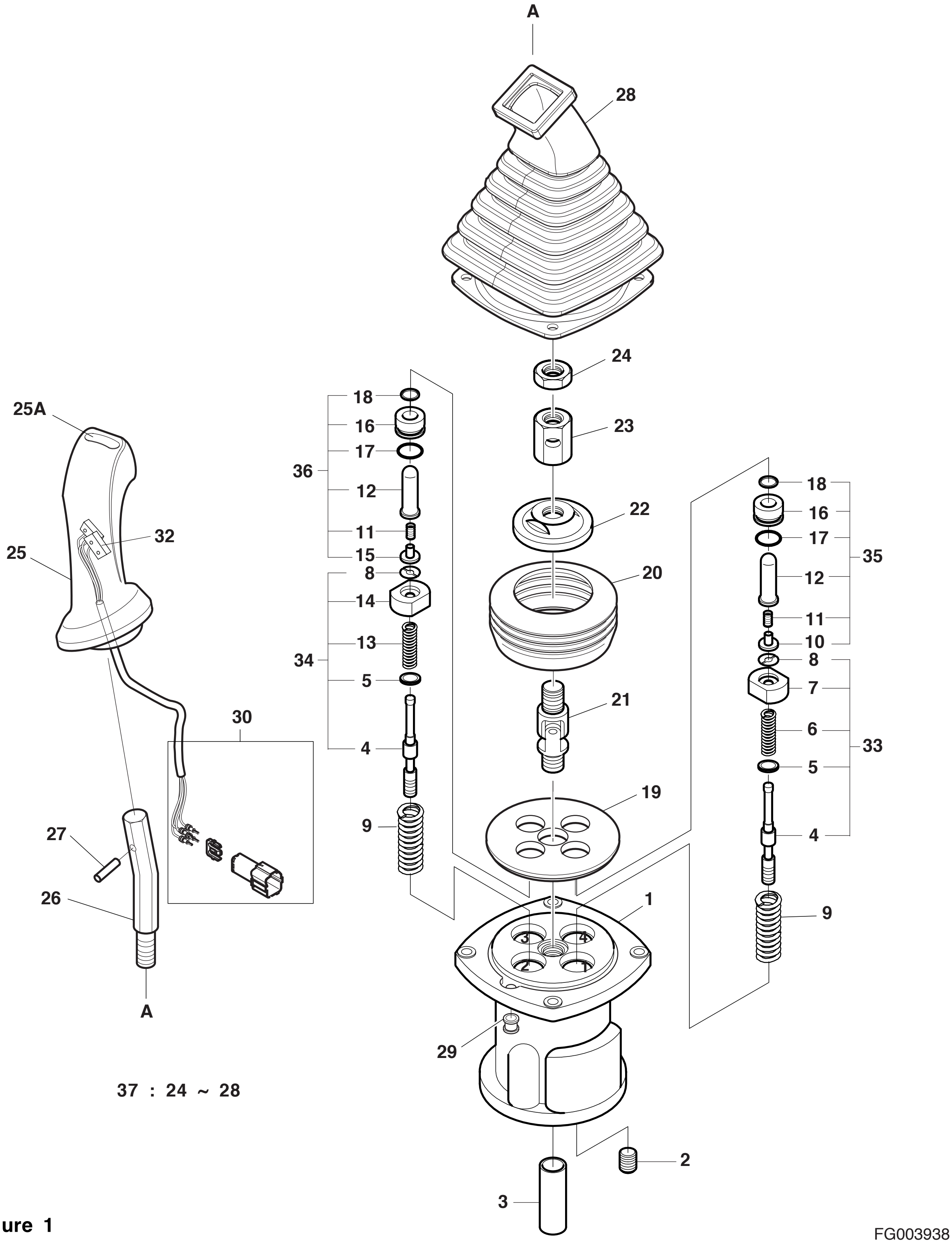



Figure 1

| Reference Number | Description |
|---|---|
| 1 | Case |
| 2 | Plug |
| 3 | Bushing |
| 4 | Spool |
| 5 | Shim |
| 6 | Spring |
| 7 | Spring Seat |
| 8 | Stopper |
| 9 | Spring |
| 10 | Stopper |
| 11 | Spring |
| 12 | Push Rod |
| 13 | Spring |
| 14 | Spring Seat |
| 15 | Stopper |
| 16 | Plug |
| 17 | O-ring |
| 18 | Rod Seal |
| 19 | Plate |
| 20 | Boot |

| Reference Number | Description |
|---|---|
| 21 | Joint Assembly |
| 22 | Swash Plate |
| 23 | Nut |
| 24 | Nut |
| 25 | Handle Assembly (L)<br>Handle Assembly (R) |
| 25A | Cap |
| 26 | Handle Bar |
| 27 | Spring Pin |
| 28 | Bellows |
| 29 | Bushing |
| 30 | Connector Assembly |
| 32 | Switch Assembly |
| 33 | Spool Kit 1, 3 |
| 34 | Spool Kit 2, 4 |
| 35 | Plug Kit 1, 3 |
| 36 | Plug Kit 2, 4 |
| 37 | Handle Kit (Left)<br>Handle Kit (Right) |

## Specifications

### Performance

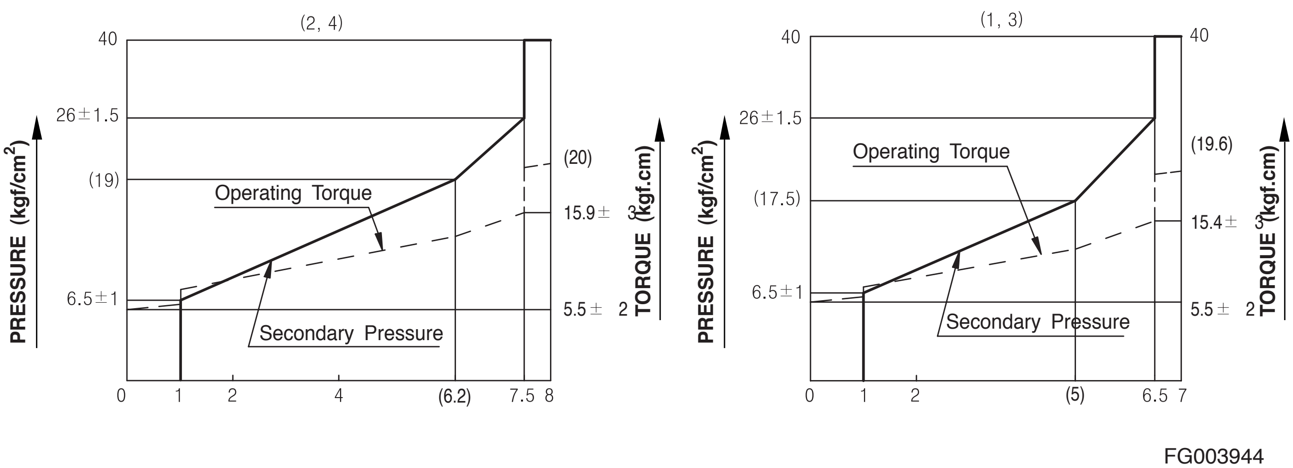



Figure 2

## Torques

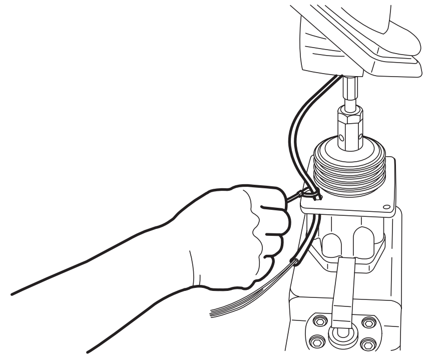
| No. | Tool | Standard | Remark |
|---|---|---|---|
| 3 | Plug | PF 3/8 | 500 kg•cm (36 ft lb) |
| 19 | Swash Plate | 27 mm | 1,660 kg•cm (120 ft lb) |
| 20 | Hex Nut | 22 mm | 1,660 kg•cm (120 ft lb) |
| 22 | Nut | 22 mm | 1,660 kg•cm (120 ft lb) |

# TOOLS AND MATERIALS

| No. | Tool | Standard | Remark |
|---|---|---|---|
| 3 | L Wrench | 8 mm | |
| 19 | Spanner | 27 mm | |
| 20 | Spanner | 22 mm | |
| 22 | Spanner | 22 mm | |

# DISASSEMBLY

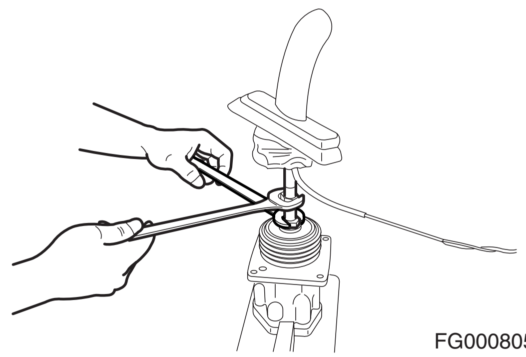
1. Remove lead wire from bushing (29).



FG000804

Figure 3

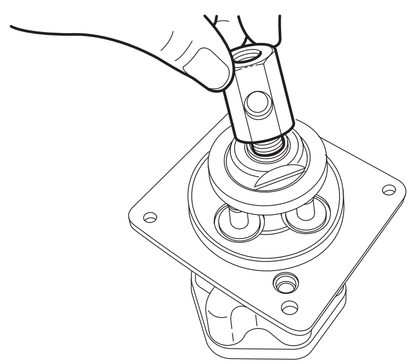
2. Remove lever assembly from case (1).



FG000805

Figure 4

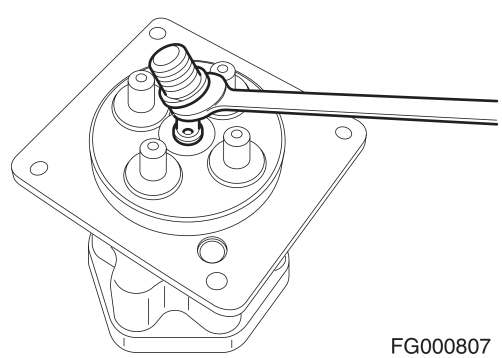
3. Remove hex nut (23) and swash plate (22) from case.



FG000806

Figure 5

4. Remove joint assembly (21) from case.



FG000807

Figure 6

5. Remove plate (19) from case (1).

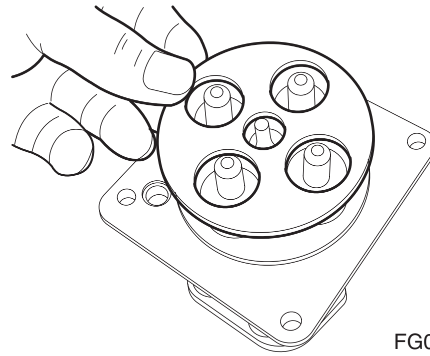



**Figure 7**

6. Remove plug kit assembly, stopper (10), and spring (11) from case (1).

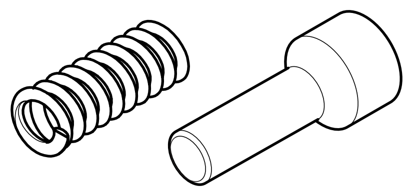



**Figure 8**

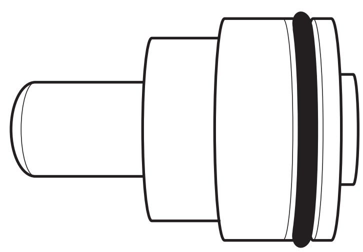



**Figure 9**

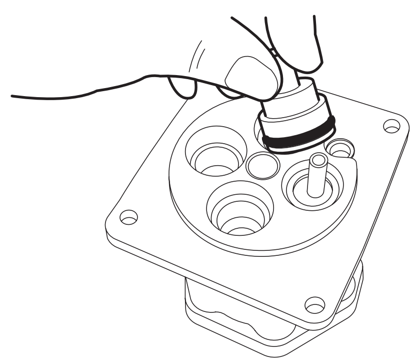
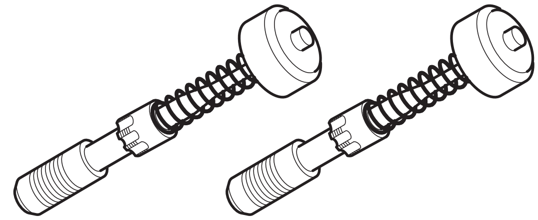


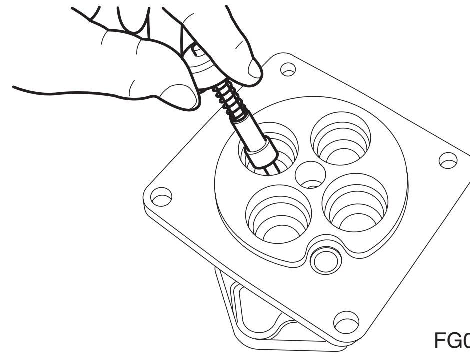

**Figure 10**

7. Remove four spool kit assemblies from case (1).



FG000812

**Figure 11**



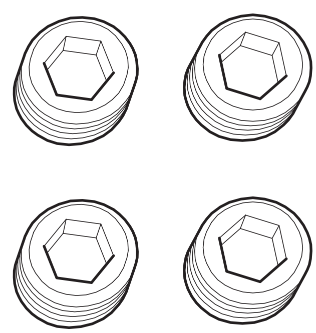
FG000813

**Figure 12**

8. The bushing (3) and plug cannot be removed from case (1).

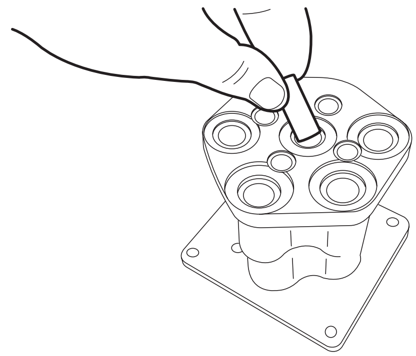
FG000814

**Figure 13**



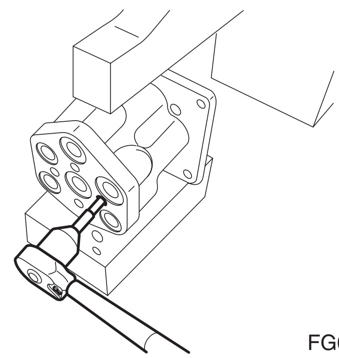
FG000815

**Figure 14**



FG000816

Figure 15



FG000817

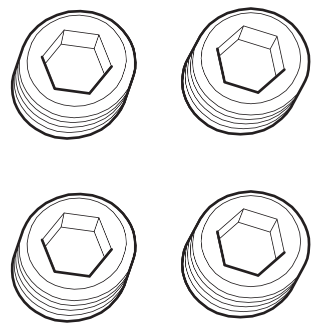
Figure 16

# CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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

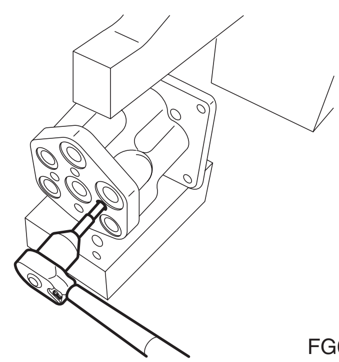
# REASSEMBLY

1. Install four plugs (2) into case (1).



FG000815

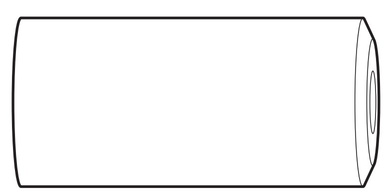
Figure 17



FG000817

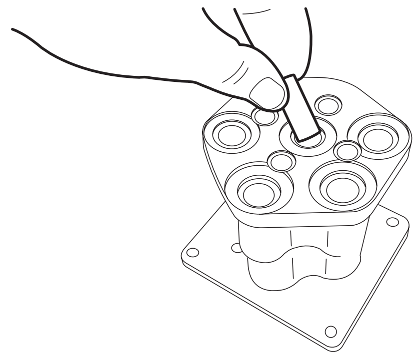
Figure 18

2. Install bushing (3) into case (1) using jig.



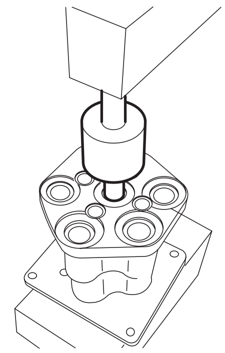
FG000814

Figure 19



FG000816

Figure 20

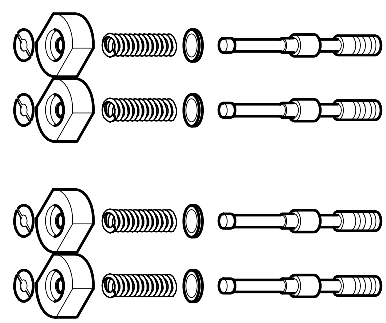


FG000818

Figure 21

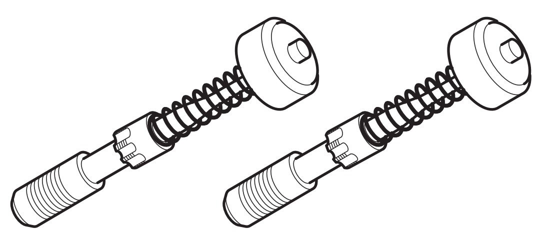
3. Take care when assembling spool kit assemblies (1 and 3, 2 and 4). They should be assembled in same way).

   The assembly order is; spool (4), shim (5), spring (6), spring seat (7), and stopper (8).



FG000819

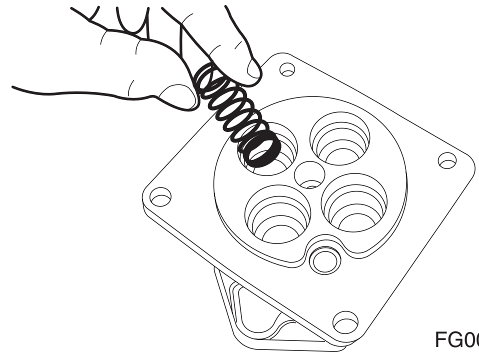
Figure 22



FG000812

Figure 23

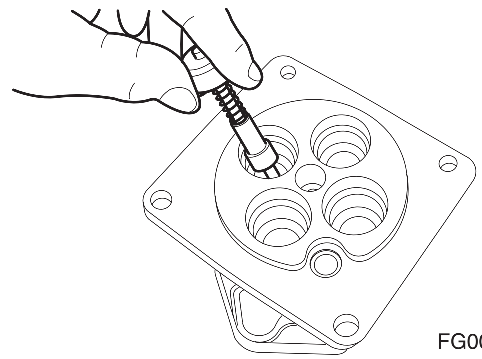
4. Install spring (9) into case (1).



FG000820

Figure 24

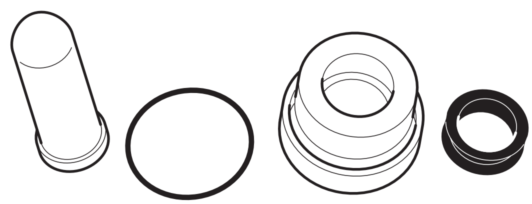
5. Install spool kit assembly into case (1). (The same way is used for four parts.)



FG000821

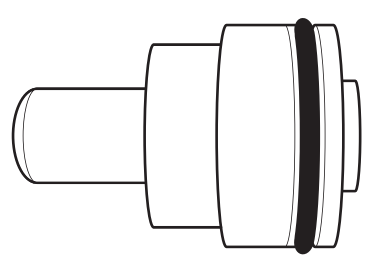
Figure 25

6. Assemble plug kit insert rod seal (18), O-ring (17), and push rod (2) into plug (16) in proper order.



FG000822

Figure 26

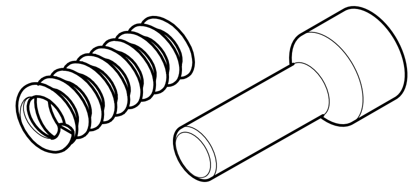


FG000810

Figure 27

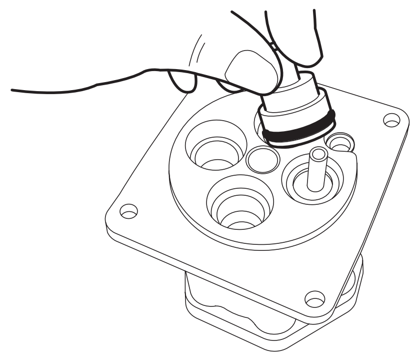
7. Assemble four springs (11) and stoppers (10) and insert assembled set in case (1) to form a plug kit assembly.

   **NOTE:** *Pay attention to measurement specifications of stoppers (1 and 3, 2 and 4).*



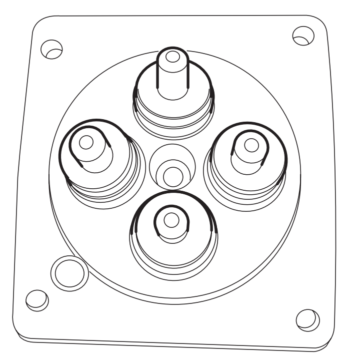
FG000809

**Figure 28**



FG000811

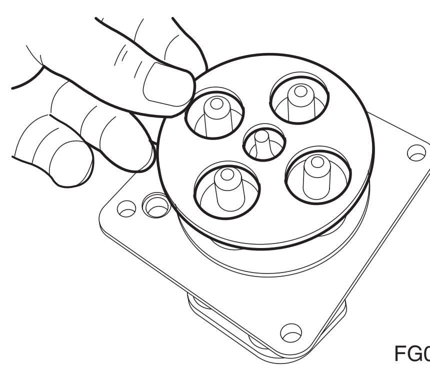
**Figure 29**



FG000823

**Figure 30**

8. Install plate (19) into case (1).



FG000808

**Figure 31**

9. Install joint assembly (21) into case (1).

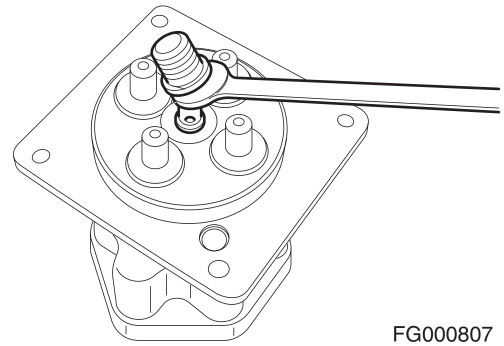



**Figure 32**

10. Install wash plate (22) and hex nut (23) into case (1).

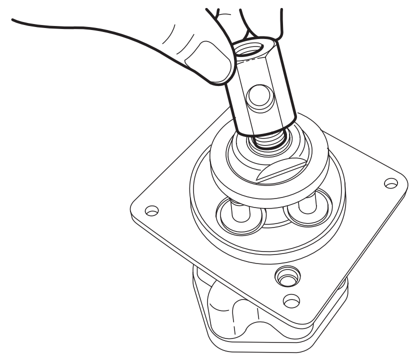



**Figure 33**

11. Insert bar and tighten it with a spanner to check balance of joint assembly.

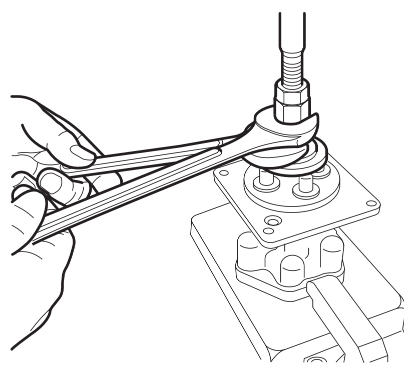



**Figure 34**

12. Install boot (20) and bushing (29) into case (1).

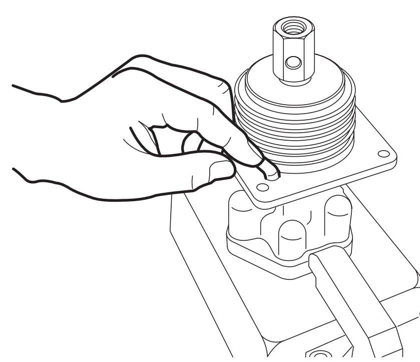
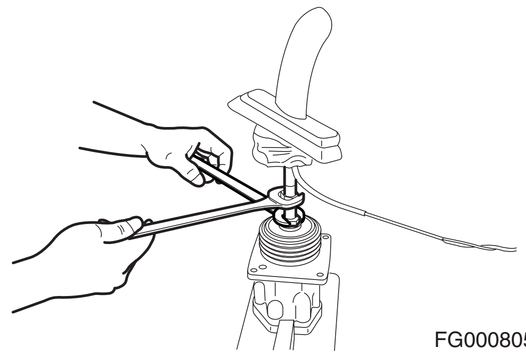



**Figure 35**

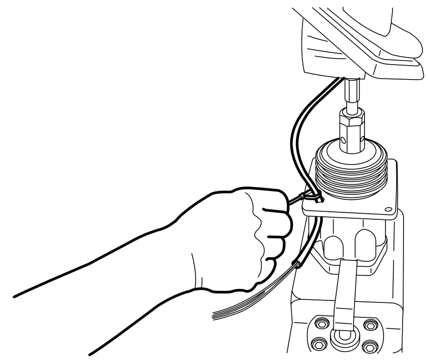
13. Install lever assembly into case (1).



FG000805

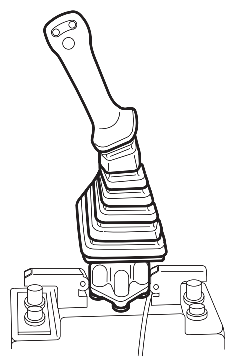
Figure 36

14. Put lead wire in bushing (29), tie it, and arrange boot.



FG000826

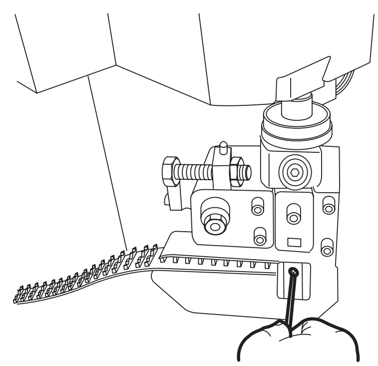
Figure 37



FG000827

Figure 38

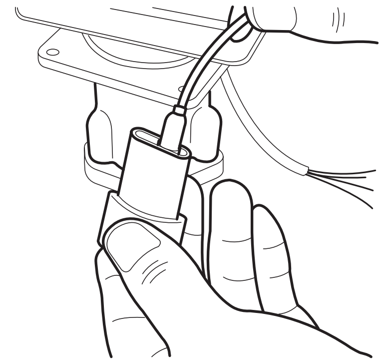
15. Install lead wire terminal into connector terminal pressing them together.



FG001097

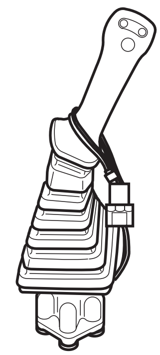
Figure 39

16. Assemble connector assembly (30), and connect it to lead wire terminal, and properly route wiring.



FG000828

Figure 40

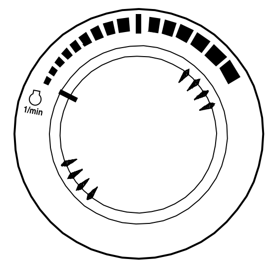


FG000829

Figure 41

# START-UP PROCEDURES

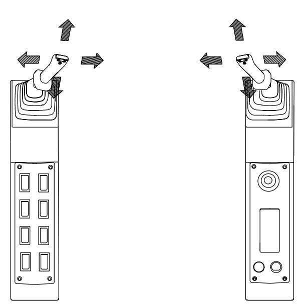
1. Start engine and set throttle at "LOW IDLE."
2. Set safety lever on "UNLOCK" position.




HAOB290L

Figure 42

3. Slowly cycle boom, arm, bucket cylinders and swing motor about five times without a load to vent air from pilot lines. Do this for five minutes.



ARO0470L

Figure 43

# Travel Control Valve (with Damper)

Edition 1

# MEMO

# Table of Contents

## Travel Control Valve (With Damper)

MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

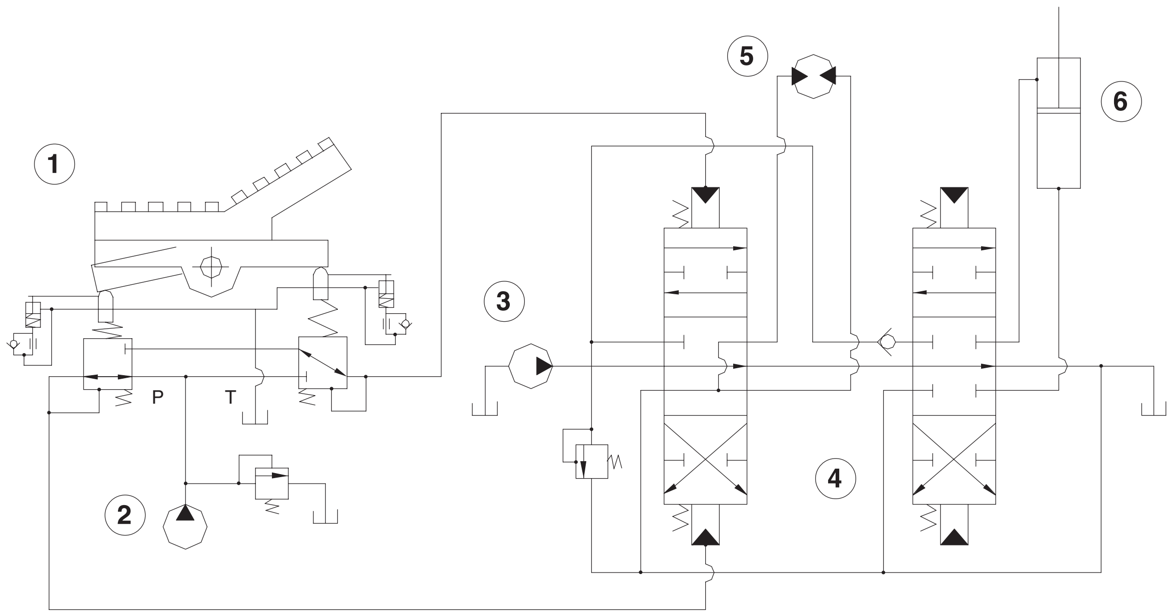
The contents of this section apply to the following models and serial number ranges.

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |
| DX300LC | 5001 and Up |
| DX340LC | 5001 and Up |
| DX420LC | 5001 and Up |
| DX480LC | 5001 and Up |
| DX520LC | 5001 and Up |

# GENERAL DESCRIPTION

## Theory of Operation

The damper valve is divided into two areas of operation. There is the pressure reducing valve (a) and the damper mechanism (b). The following hydraulic circuit is an example of a remotely located control valve.




ARS1810L

**Figure 1**

| Reference Number | Description |
|---|---|
| 1 | Remote Control Valve |
| 2 | Pilot Pump |
| 3 | Main Pump |

| Reference Number | Description |
|---|---|
| 4 | Control Valve |
| 5 | Hydraulic Motor |
| 6 | Hydraulic Cylinder |

# Deceleration Valve

1. In neutral position, the damper spool is pushed to the neutral position by return spring which is seated on the spring seat (and washer. As a result of the damper spool's switching function, the output port is connected to port T and the pressure at the output port and port T is the same.

2. When the cam of the remote control valve is operated and moved from the neutral position to the clockwise direction, the push rod and damper spool of port 1 is moved down within the constraints of washer 1, spring seat, secondary pressure select spring, washer 2 and washer 3. As a result port P and port 1 are connected and oil pressure from the pilot pump flows through port 1, generating pressure.

   When the pressure of port 1 reaches the selected pressure of the secondary pressure select spring, the oil pressure and the spring set pressure will equalize and the output pressure of port 1 is maintained at a constant rate.

   The damper spool in port 2 is in the neutral position, oil returning from the control valve is discharged through port T. In cases where the controls are operated to the maximum position, the push rod makes direct contact with the damper spool forcing port P to make a direct path with the discharge port, permitting the pressure to equalize at these ports.

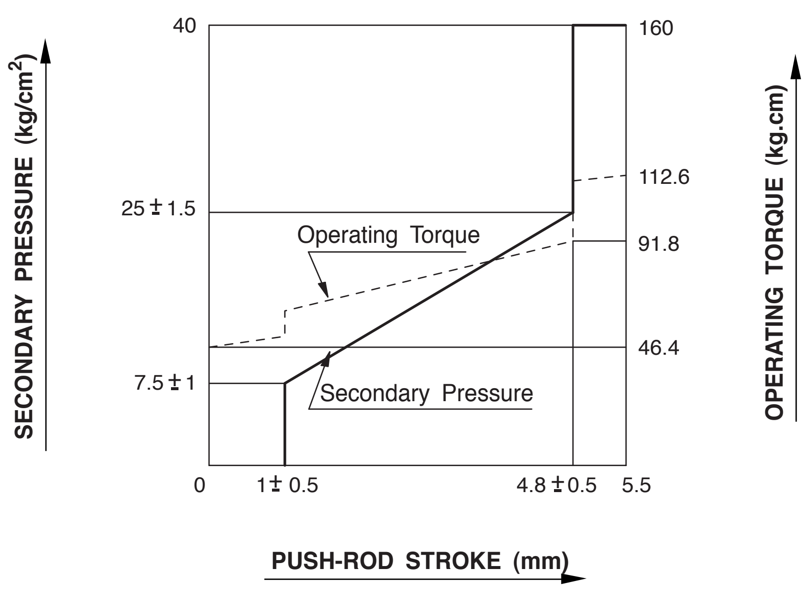



Figure 2

## Dampening Parts of the Control Section

1. In the neutral position, the push rod is pushed up to its neutral position by the return spring and damper spring.
2. When the cam is moved in the clockwise direction from the neutral position, the push rod and damper spool of port 1 are moved in a downward direction. At this time, the pressurized oil in the damper spool is discharged through the orifice and the dampening pressure is generated. Meanwhile, the push rod in port 2 moves up with the damper spring and the damper spool between them. At the same time, the oil from the oil tank passes through the check ball (3 positions) consisting of a spring and steel ball, and flows out through port T in the upper portion of the casing to tank.
3. When the operating levers are moved to the extreme opposite position: When the cam is moved to the counterclockwise position from the clockwise most position, the push rod and piston in port 2 is moved in the downward direction. As in the case described above, the oil in the damping piston chamber is discharged through the orifice and the dampening pressure is generated in this chamber, providing dampening force. In port 1, the push rod is moved up by the action of the return spring and damper spring. At the same time, the oil from the oil tank passes through the check ball (3 positions) consisting of a spring and steel ball, and flows out through port T in the upper portion of the casing to tank

The damping operation is effective in both operations, when the levers are moved from the neutral position to the maximum travel position and when the levers are moved from the maximum travel position to the neutral position as well.

A. When moving lever from the neutral position

Moving the lever from the neutral position to the right forces oil in the right damper spool to discharged through the orifice, generating pressure that creates a dampening force.

Moving the lever in the opposite direction, causes the left damper spool to assume the function of the right spool.

Thus, a dampening force is generated at both ways.

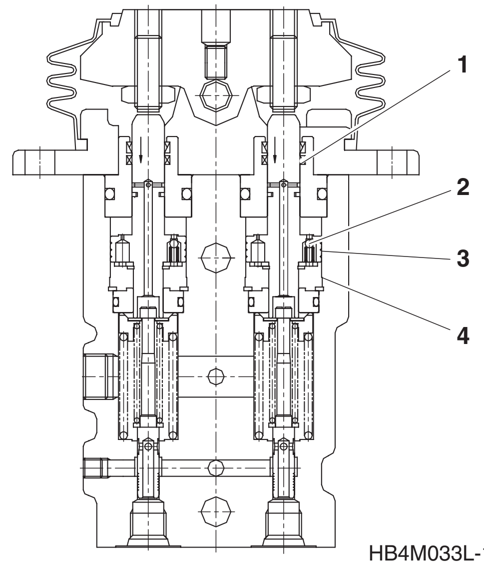



**Figure 3**

B. Operation of forward and reverse lever control

Oil outside the damper spool runs out through the channel from the top of the casing to the port (T). And oil in the damper spool is discharged through orifice, generating pressure that creates a dampening force.

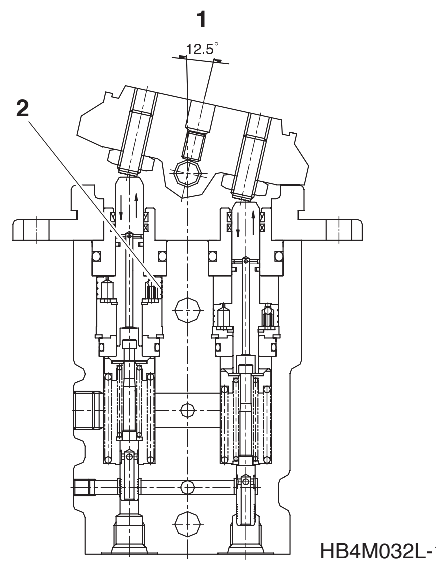



**Figure 4**

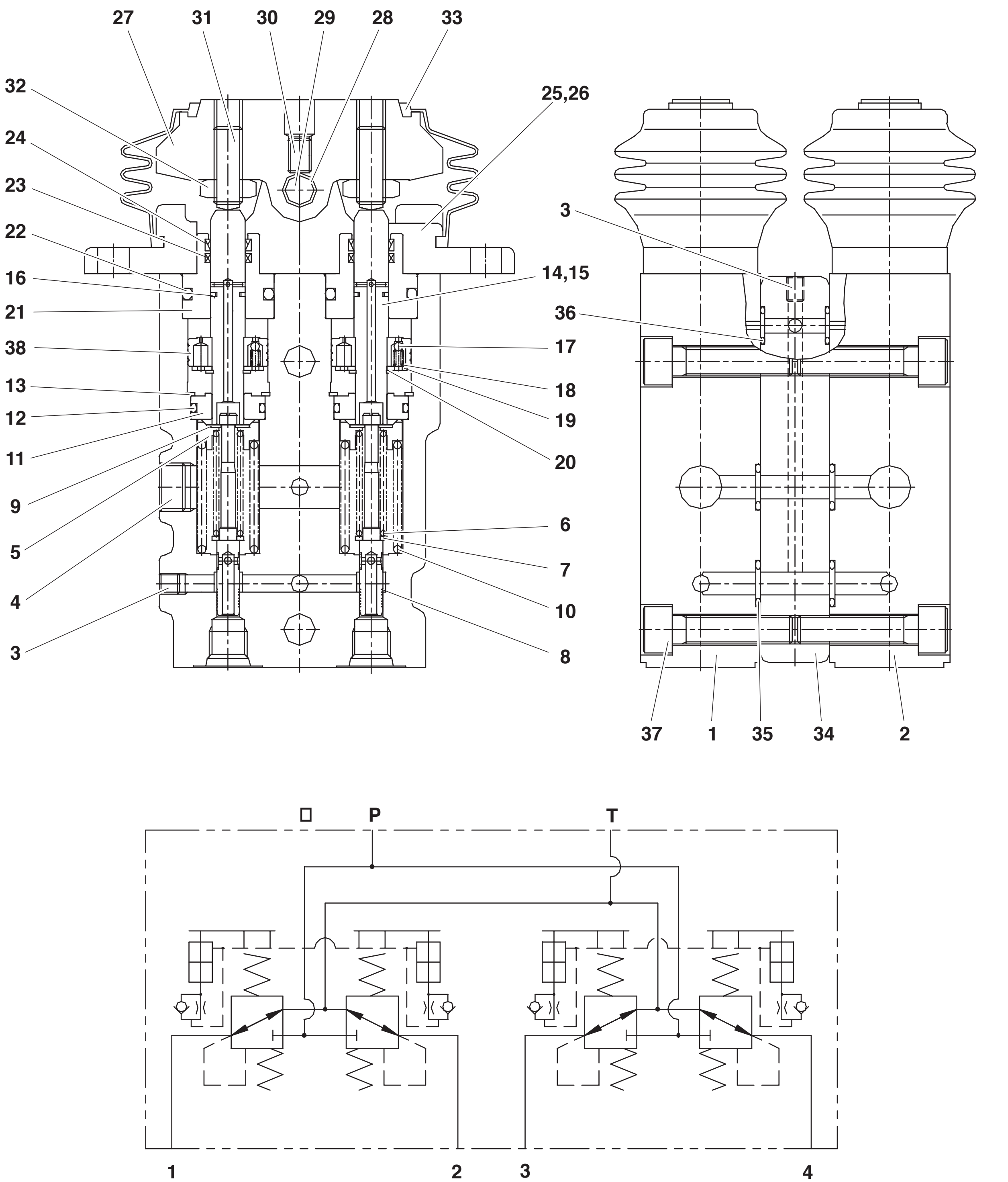
# CAUSES OF FAULTS AND MEASURES

At times it may be difficult to pinpoint the source of the problem. The following table lists some of the possible problems, possible causes and remedies. Refer to this table for possible causes and remedies to assist in correcting the sometimes difficult problems.

The table only lists some general problems, possible causes and their remedies. In many cases the problem is not caused by the failure of a single part but, may be the result of a combination of problems from related parts and their components. Possible problems other than the ones list are not being specified but that is not to say that these are the only possible problems that can occur. The technician must diagnose the problem, considering all possible causes and repair the source of the malfunction.

| Problem | Possible Cause | Remedy |
|---|---|---|
| Secondary pressure will not increase. | Low primary pressure. | Adjust primary pressure. |
| | Defective secondary pressure select spring. | Replace with new spring. |
| | Gap between damper spool and casing is abnormally large. | Replace damper spool casing assembly. |
| | Defective operating parts and components. | Disassemble/reassemble and replace defective parts. |
| Unstable secondary pressure. | Jamming of interconnected parts. | Repair/replace cause of jamming. |
| | Unstable tank line pressure. | Install direct line to hydraulic tank. |
| | Air in hydraulic lines. | Vent air from system. |
| Abnormally high secondary pressure. | High tank line pressure. | Install direct line to hydraulic tank. |
| | Jamming of interconnected parts. | Repair/replace cause of jamming. |
| No dampening. | Air in piston chamber. | Vent air from system. |
| | Jamming of interconnected parts. | Repair/replace cause of jamming. |
| | Worn damper springs. | Replace with new parts. |
| | Worn damper spool and housing. | Replace damper spool and housing assembly. |
| | Defective/damaged check valve. | Disassemble and examine check valve. |
| | Worn damper spool orifice. | Replace damper spool. |
| Damper spool feels heavy. | Defective interconnected components. | Repair/replace defective parts. |
| | Restricted movement of damper spool. | Repair/replace damaged piston. |

# Parts List




FG003925

**Figure 5**

| Reference Number | Description |
|---|---|
| 1 | Body (1) |
| 2 | Body (2) |
| 3 | Plug |
| 4 | Plug |
| 5 | Spring Seat |
| 6 | Damper Spring |
| 7 | Spring Seat |
| 8 | Damper Spool |
| 9 | Stopper |
| 10 | Return Spring |
| 11 | Rod Guide |
| 12 | O-ring |
| 13 | Retaining Ring |
| 14 | Push Rod |
| 15 | Spring Pin |
| 16 | Seal |
| 17 | Steel Ball |
| 18 | Damper Spring |
| 19 | Cam Plate |

| Reference Number | Description |
|---|---|
| 20 | Retaining Ring |
| 21 | Plug |
| 22 | O-ring |
| 23 | Rod Seal |
| 24 | Dust Seal |
| 25 | Cover |
| 26 | Hex Socket Head Bolt |
| 27 | Cam |
| 28 | Bushing |
| 29 | Camshaft |
| 30 | Set Screw |
| 31 | Set Screw |
| 32 | Hex Nut |
| 33 | Bellows |
| 34 | Spacer |
| 35 | O-ring |
| 36 | O-ring |
| 37 | Hex Socket Head Bolt |
| 38 | Piston |

## Specifications

| Travel Control Valve | Specification |
|---|---|
| Type | Pilot Control<br>(With Damper) |
| Pressure / Stroke | 25 kg/cm$^2$ @ 4.8 mm Stroke<br>(356 psi @ 0.1890 in Stroke) |
| Weight | 7.8 kg<br>(17 lb) |

## Torques

| Part Reference Number | Bolt Size | Tool | Tightening Torque |
|---|---|---|---|
| 26 | M6 | 5 mm L-Wrench | 88 kg•cm<br>(6 ft lb) |
| 30 | M8 | 4 mm L-Wrench | 100 kg•cm<br>(7 ft lb) |
| 32 | M10 | 17 mm Spanner | 440 kg•cm<br>(32 ft lb) |
| 37 | M10 | 8 mm L-Wrench | 440 kg•cm<br>(32 ft lb) |

# REMOVAL

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

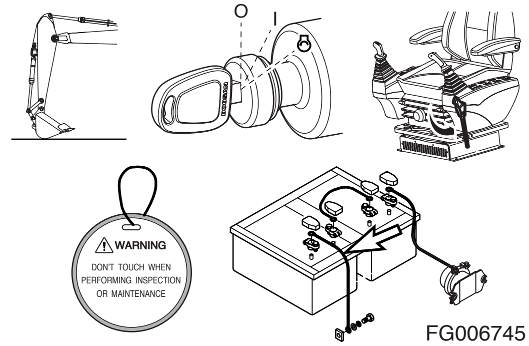



Figure 6

## WARNING!

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

6. Fully stroke work levers (joysticks) in all directions to relieve any pressure from accumulators.
7. Set safety lever on "LOCK" position.
8. Turn key to "O" (OFF) position and remove from starter switch.
9. Hang a maintenance warning tag on controls.
10. Disconnect negative (-) battery cable leading to frame from battery.
11. Remove cabin under cover by loosening bolts.
12. Tag and disconnect hoses from pedal valve (1, Figure 7). Plug and cap hoses and ports to prevent contamination from entering hydraulic system or component.

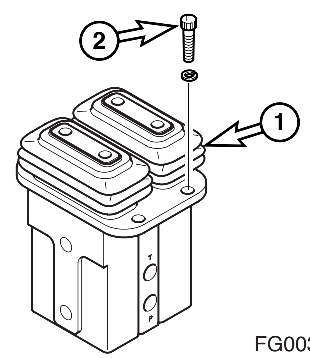



Figure 7

# DISASSEMBLY

1. Remove bellows (33).

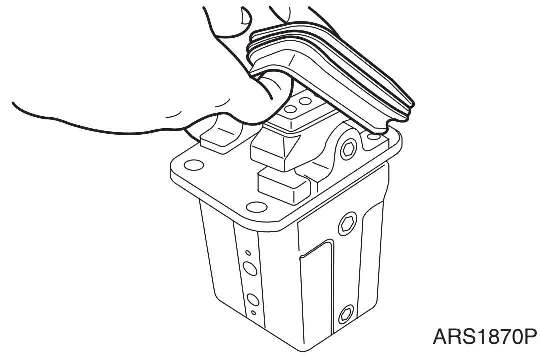



**Figure 8**

2. Remove set screw (30) from cam (27).

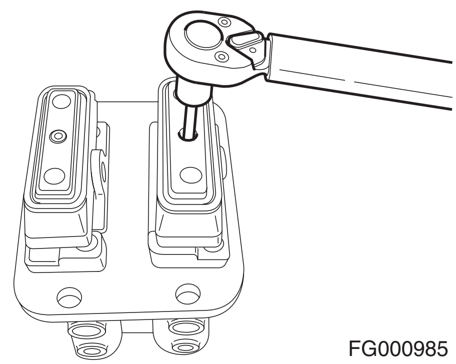



**Figure 9**

3. Remove cam shaft (29) and cover (25) from cam (27).

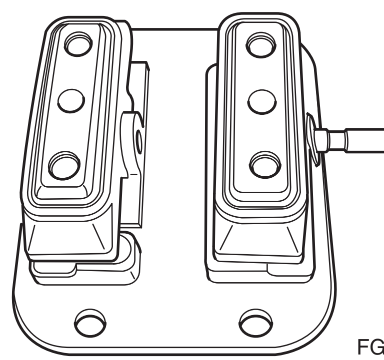



**Figure 10**

4. Remove hex nut (32) and swash plate (31) from cam.

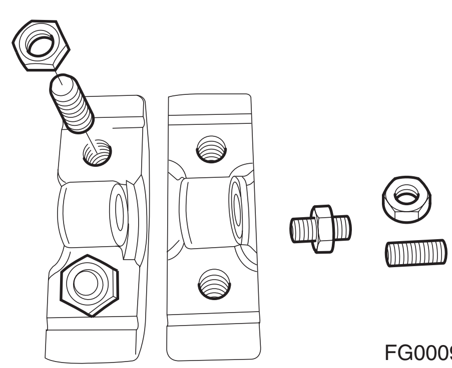
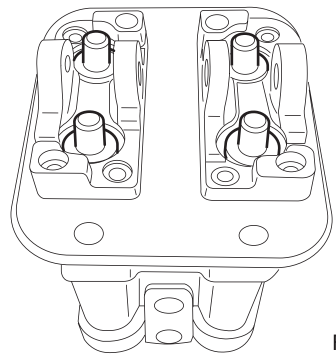


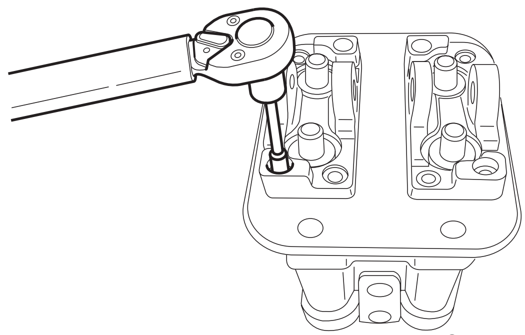

**Figure 11**

5. Remove hex socket head bolt (26) and cover (25) from each body (1 and 2).



FG000988

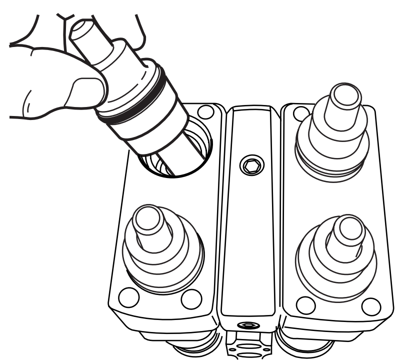
Figure 12



FG000989

Figure 13

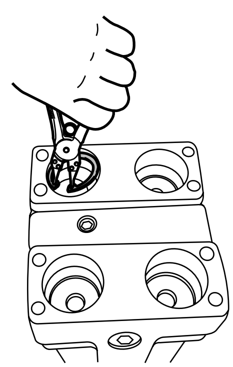
6. Remove push rod assembly from each body (1 and 2).



FG000990

Figure 14

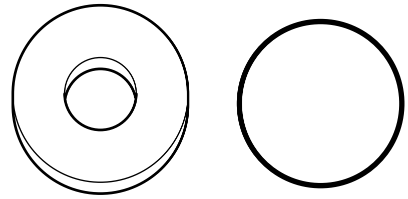
7. Remove retaining ring (13).



FG000991

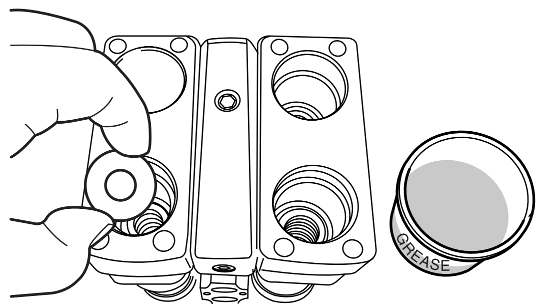
Figure 15

8. Remove rod guide (11) from each body (1 and 2).



FG000992

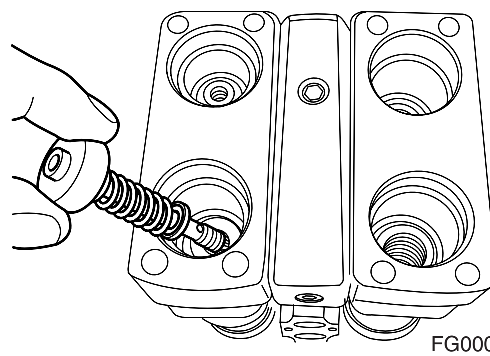
**Figure 16**




FG000993

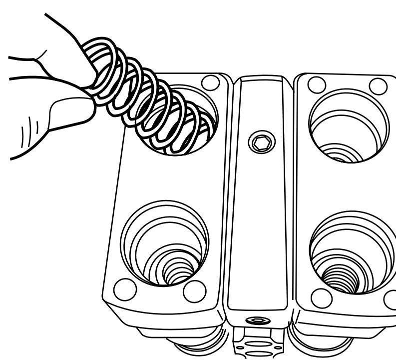
**Figure 17**

9. Remove damper spool assembly and spring (10) from each body (1 and 2).



FG000994

**Figure 18**



FG000995

**Figure 19**

10. Remove hex socket head bolt (37) from each body (1 and 2). Disassemble each body (1 and 2) and spacer (34). Remove plugs (3 and 4) and O rings (35 and 36).

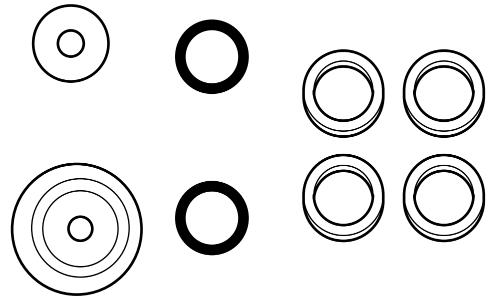



Figure 20

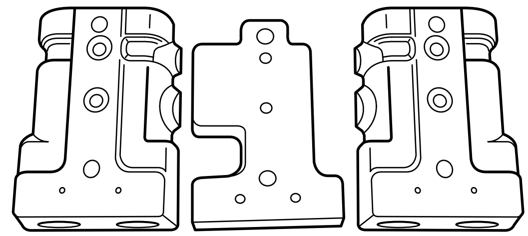



Figure 21

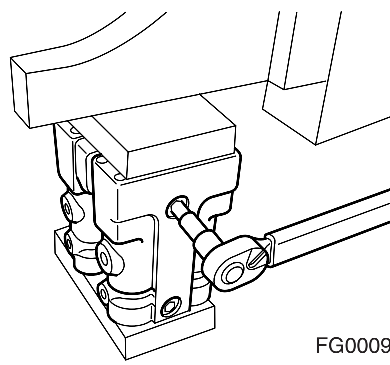


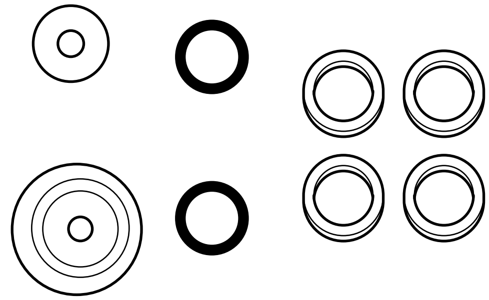

Figure 22

# CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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

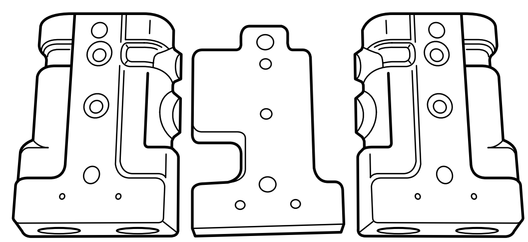
# ASSEMBLY

1. Assemble plugs (3 and 4) and O rings (35 and 36) into each body (1 and 2) and spacer (34). Install hex socket head bolt (37) using torque wrench.



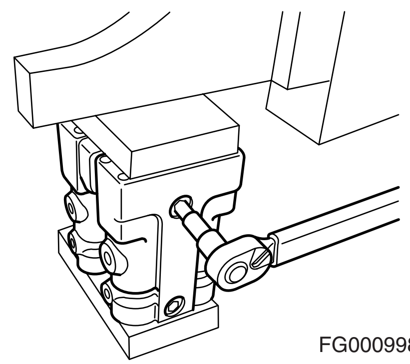
FG000996

**Figure 23**



FG000997

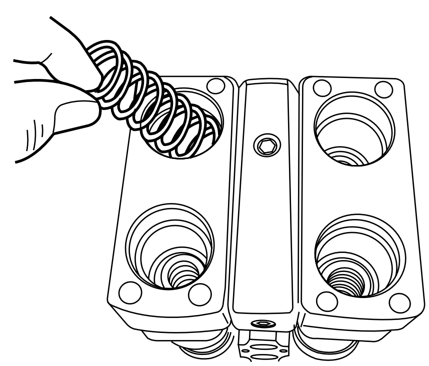
**Figure 24**



FG000998

**Figure 25**

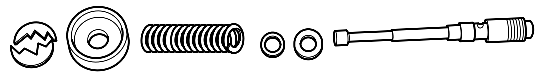
2. Insert spring (10) into each body (1 and 2).



FG000995

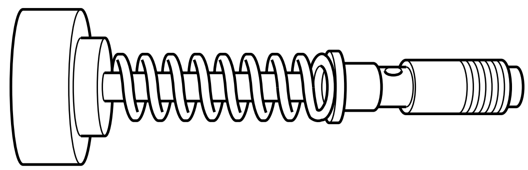
**Figure 26**

3. Assemble in proper order, damper spool (8), shim (7), spring (6), spring seat (5), and stopper (9).



FG000999

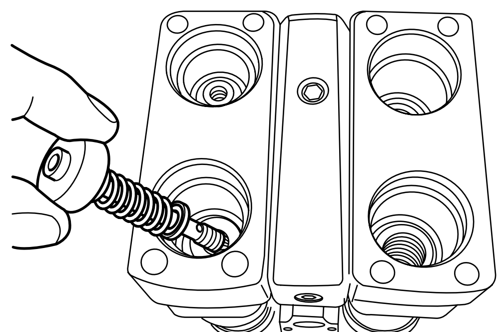
**Figure 27**



FG001000

**Figure 28**

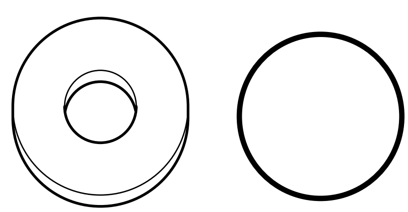
4. Install damper spool assembly into each body (1 and 2).



FG000994

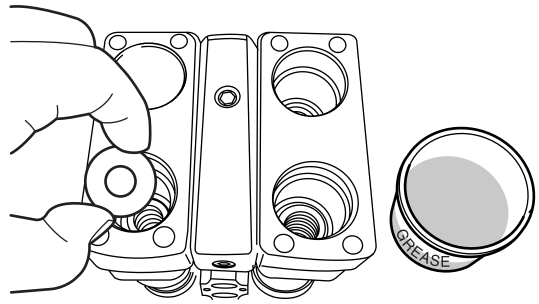
**Figure 29**

5. Install O-ring (12) on rod guide (11). Coat guide assembly with grease, and slide it into each body (1 and 2).



FG000992

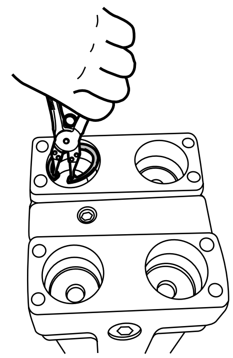
**Figure 30**




FG000993

Figure 31

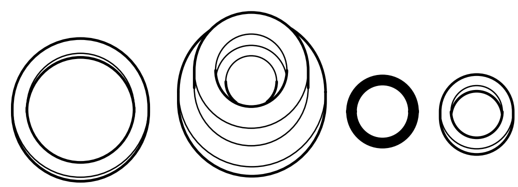
6. Install retaining ring (13). Make sure that it is properly seated.



FG000991

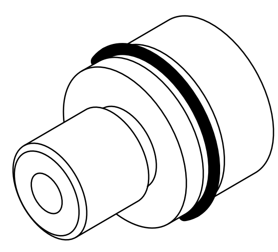
Figure 32

7. Assemble rod seal (23), dust seal (24), and O-ring (22) into plug (21).



FG001001

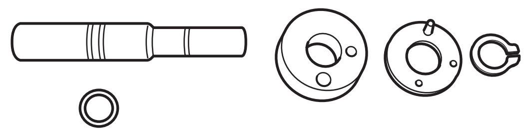
Figure 33



FG001002

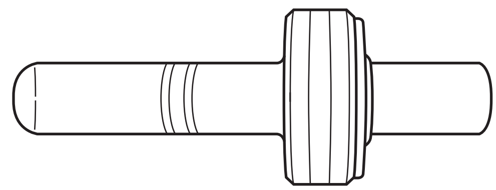
Figure 34

8. Assemble seal (16), piston (38), steel ball (17), plate (19), spring (18), and retaining ring (20) into push rod (14).



FG001003

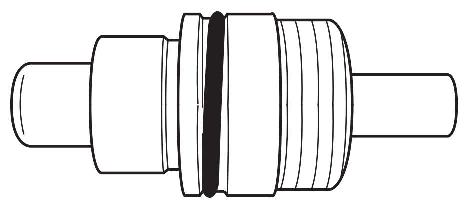
Figure 35



FG001004

Figure 36

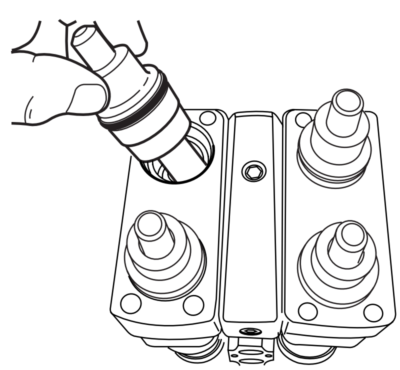
9. Assemble push rod and plug.



FG001005

Figure 37

10. Install push rod assembly into each body (1 and 2).



FG000990

Figure 38

11. Install bushing (28) in cover (25) using jig.

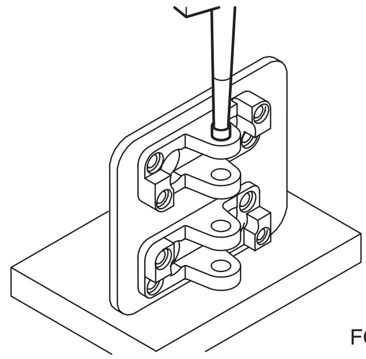

FG001006

Figure 39

12. Assemble cover (28) onto each body (1 and 2) and install hex socket head bolt (26) using torque wrench.

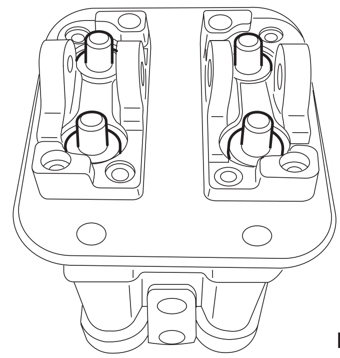

FG001007

Figure 40

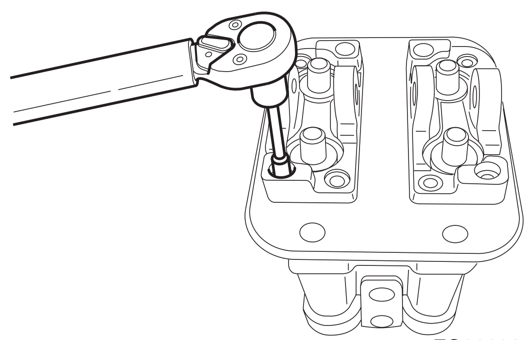

FG000989

Figure 41

13. Install set screws (31) and hex nut (32) into cam (27) and tighten it.

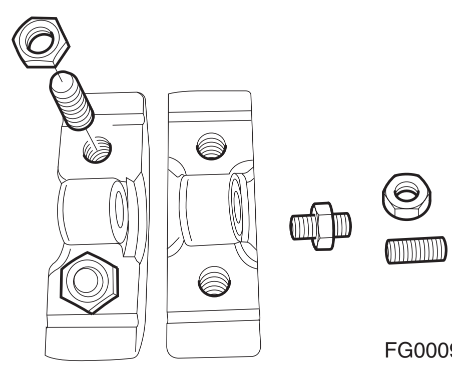
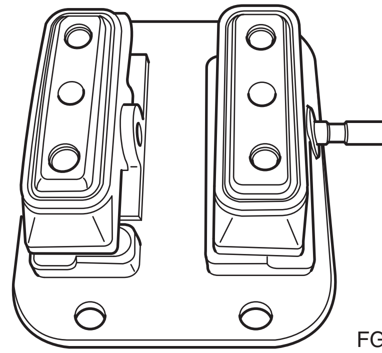

FG000987

Figure 42

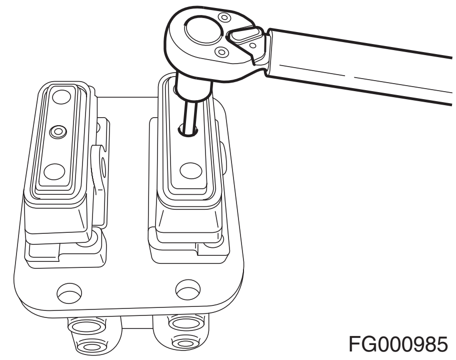
14. Position cam (27) on cover (25), and insert cam shaft (29) using hammer.



FG000986

Figure 43

15. Install set screw (30) in cam (27) and tighten it using torque wrench.



FG000985

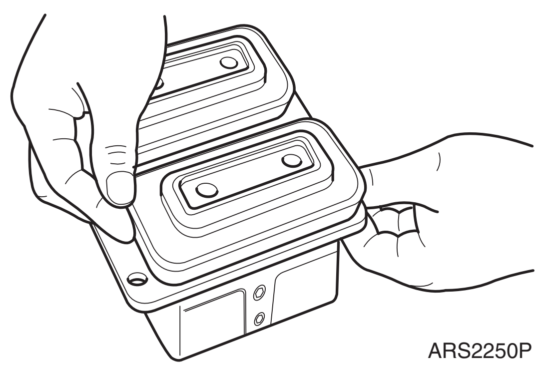
Figure 44

16. Check cam balance.

FG001009

Figure 45

17. Install bellows.



ARS2250P

Figure 46

# INSTALLATION

1. Position pedal valve (1, Figure 47) on cabin floor plate and install four bolts and washers (2).

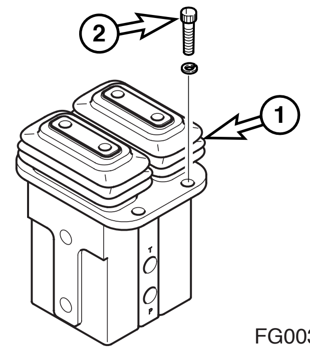



Figure 47

2. Install pedal brackets (3) and levers (4, Figure 48) on pedal valve and install four bolts and washers (2).
3. Install rubber boots (1, Figure 48).

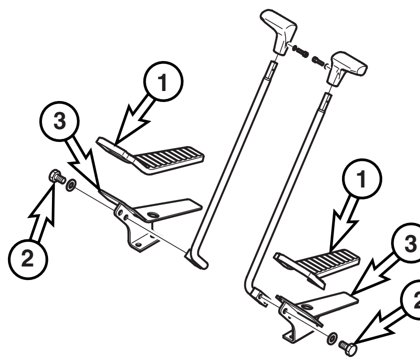



Figure 48

4. Connect hoses as tagged during removal to pedal valve (1, Figure 49).
5. Install cabin under cover by tightening bolts.

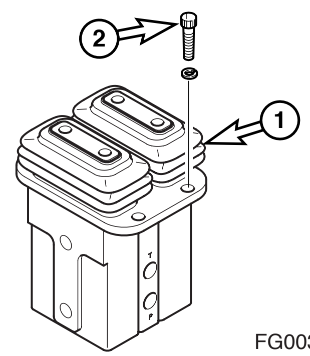
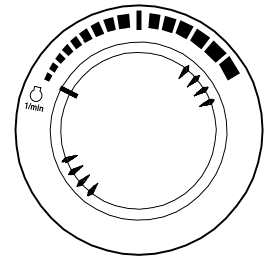



Figure 49

# START-UP PROCEDURES

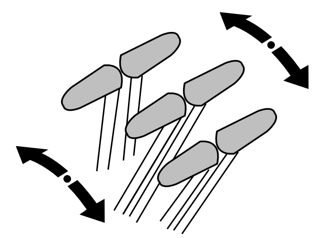
1. Start engine and set throttle at "LOW IDLE."
2. Set safety lever on "UNLOCK" position.




HAOB290L

**Figure 50**

3. Slowly push and pull both travel lever about five times without a load to vent air from pilot lines.



HAOB903L

**Figure 51**

# Solenoid Valve Assembly

Edition 1

# MEMO

# Table of Contents

## Solenoid Valve Assembly

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |
| DX300LC | 5001 and Up |
| DX340LC | 5001 and Up |

# PARTS LIST

Components used for the solenoid valve package are the same as in the parts list below.

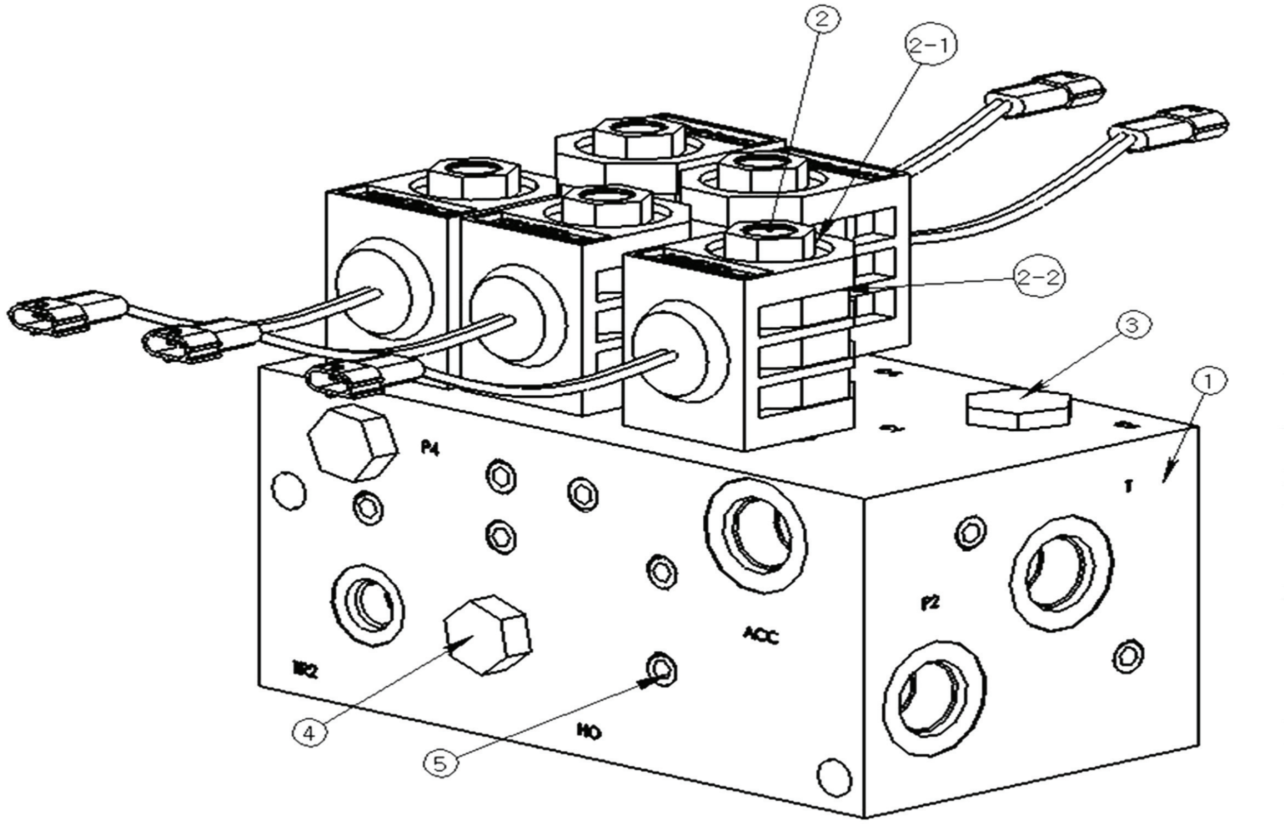



**Figure 1**

| Reference Number | Description | Sizes | Quantity | Remarks |
|---|---|---|---|---|
| 1 | Block Body | 95x110x200 | 1 | 1-A1073-05-0 |
| 2 | Solenoid valve | TF-S3A-00 | 5 | C1, C2, C3, C4, C5 |
| 3 | Check Valve | FD-DCP-0-A | 1 | C6 |
| 4 | Plug | PF 1/4" | 3 | P4, P5, H0 |
| 5 | Plug | PT 1/8" | 9 | |

# FUNCTIONS OF 5-SOLENOID VALVE ASSEMBLY PACKAGE

## Functions of Solenoid Valve Assembly Package

**This solenoid valve assembly package have the following functions.**

1. Pilot cut-off
2. Breaker pressure supply
3. High travel speed
4. Main pressure increase
5. Work modes control - Swing Priority

**Functions and Operations of Solenoid Valves**

| Reference Number | Function | Operations | Remarks |
|---|---|---|---|
| C1 | Pilot cut-off | Provides pressure and oil coming from the pilot pump for the pilot pressure supply solenoid valve to drive each work system. | |
| C2 | Breaker operation | Supplies pilot pressure for the breaker valve assembly and the breaker pressure supply solenoid valve. | |
| C3 | High travel speed | Sets low travel speed and high travel speed, of shifts speed between both depending on the state of the solenoid valve operation or a signal detected in the e-EPOS controller. | |
| C4 | Main pressure increase | Increases the pressure set for the main relief valve temporally to increase the excavation power. | |
| C5 | Work modes control | Operating the C5 solenoid valve starts the Swing Priority valve of the main control valve to improve swing operation. | |

**Detailed Functions and Operations of Solenoid Valves**

1. Pilot Cut-Off

   It provides pressure and oil coming from the pilot pump for breaker solenoid valve (C2), high travel speed solenoid valve (C3), main pressure increase solenoid valve (C4), and the work modes control solenoid valve (C5). Push down the Cut-Off lever located on the left side of the driver's seat, and the electrical signal of the limit switch starts the pilot cut-off valve to supply pressure and oil to each pilot pressure supply solenoid valve.

2. Breaker pressure supply

   Pressing the breaker switch on the joystick operates the breaker solenoid valve (C2) to supply pilot pressure to the option valve of the main control valve. The pressure switches the spool of the option valve, which transfers pressure and oil from the main pump to the breaker system for excavation.II

3. High travel speed control

   When the automatic travel switch is "Off", the travel speed switches to "0" (low speed); when the switch turned to the 1st place, the travel speed switches to " I " (high speed); when the switch turned to the 2nd place, the travel speed switches to " II ", automatically. In this case, the high travel speed control shows "Off" when the automatic travel switch is "Off", "On" when it is in the 1st place, and "On/Off" when it is in the 2nd place. Specifically speaking, turning the automatic travel switch to the 2nd place, the e-EPOS controller detects the discharge pressure from the main pump, and automatically turns the high travel speed control "On" or "Off" depending on if the travel load is high or low to switch the travel speed to speed 1 or 2. The travel load is detected by 2 pressure sensors located on the discharge line of the front and rear pumps. If the load is high (pressure about 300 kgf•cm$^2$), the solenoid valve turns "Off" for the travel at low; If the load is low (pressure about 160 kgf•cm$^2$), the solenoid valve turns "On" for the travel at high. If the engine control dial is set equal and below 1400 RPM, however, the solenoid valve always turns "On" for the travel at low, though the automatic travel switch is set to the automatic travel (2nd place).

4. Boost main pressure

   It increases the pressure of the main relief valve temporally to increase the excavation power. Pressing the power boost switch on the work lever sends a signal of the e-EPOS controller to start the pressure increase solenoid valve. Then, as it turns "On", the pressure of the main relief valve increases about 330 kgf•cm$^2$ to 350 kgf•cm$^2$, which in turn increases the excavation power.

5. Work modes control

   A work mode can be choses as either Excavation or Trenching mode using a Trenching mode switch on the operation panel.

   Turning on the Start-on switch, Excavation is automatically accepted as the work mode and the Swing Priority solenoid valve turns "Off".

   This Excavation mode is used for ordinary excavation work, loading, and fast levelling work.

   Choosing the Trenching mode on the operation panel the Swing Priority solenoid valve for the control valve turns "On" and starts to work, reducing the oil lines to booms and arms to increase the swing capacity.

## Assembly Diagram and Tools Required

Table 1 shows assembly torques recommended for components of the solenoid valve package. Designated tools and torques should be followed.

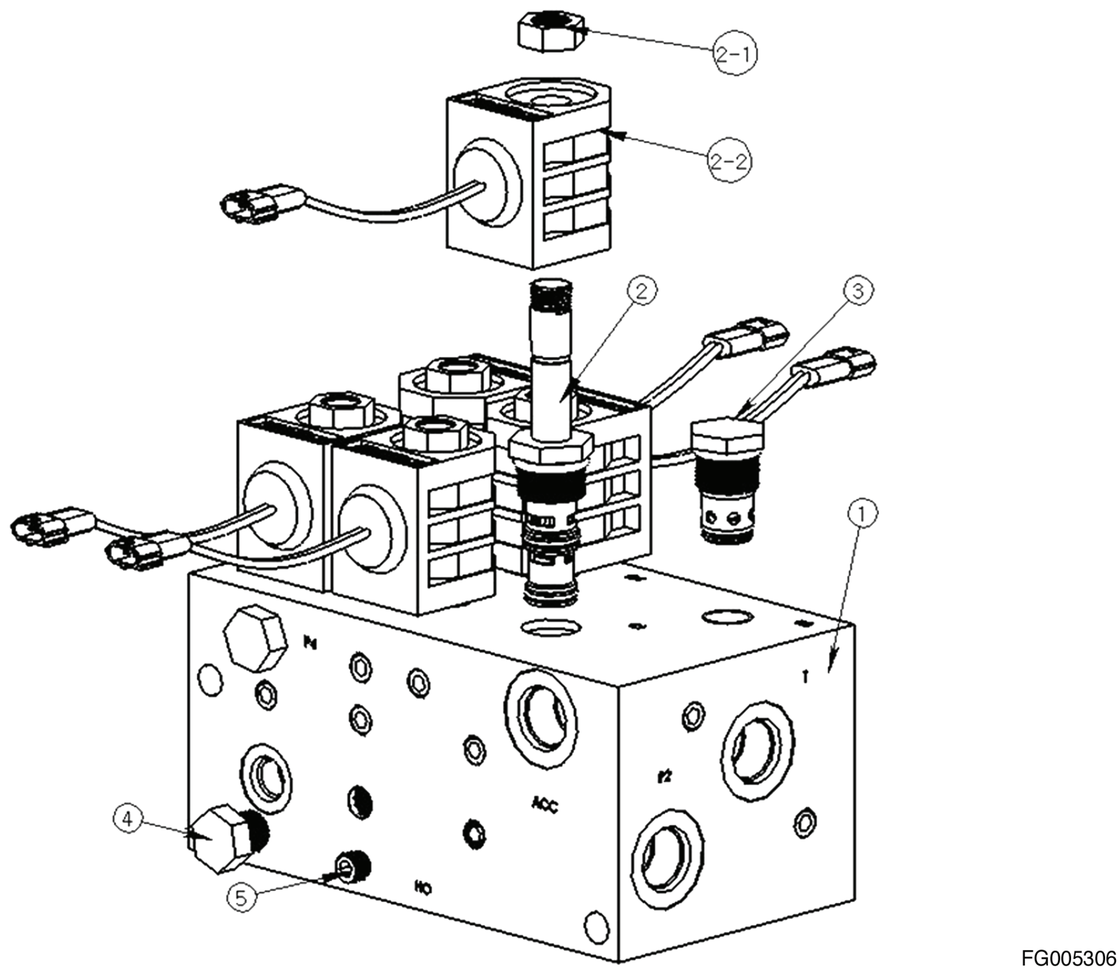



**Figure 2**

| Reference Number | Components | Screw Sizes | Torques (kg/cm) | Tools |
|---|---|---|---|---|
| 2 | Solenoid valve | UNF7/8 - 14" | 200 ± 25 | Hex torque wrench/1", socket |
| 2-1 | Coil Lock Nut | UNF1/2 -20" | 60 ± 2 | Hex torque wrench/19 mm, socket |
| 3 | Check Valve | UNF7/8 - 14" | 400 ± 2 | Hex torque wrench/1", socket |
| 4 | PT 1/4" Plug | PF 1/4 19" | 250 ± 25 | Torque wrench/ 19 mm, socket |
| 5 | PT 1/8" Plug Bolt | PT 1/8 28" | 280 | Torque wrench/ 5 mm, wrench socket |

## Cautions During Disassembly and Reassembly

1. Wipe dust and dirt in the area where disassembly and reassembly will be performed.
2. For disassembly and reassembly, standard torques and tools stated in Table in should be used.
3. The directions of disassembly and reassembly are same as the "Disassembly Direction" and "Reassembly Direction" as shown in Figure 2.
4. Disassembly and reassembly of the solenoid valve
   A. Remove the coil lock nut (2-1) by turning it in the Disassembly Direction.
      – Take care not to damage the valve tube and the retainer when disassembling the coil lock nut.
      – If the valve tube or the retainer is damaged (bent or deformed), the solenoid valve may not operate.
   B. Grip the coil (2-2) with a hand and pull it out.
   C. Remove the solenoid valve (2) by turning it in the Disassembly Direction.
   D. Check disassembled components, and reassemble them in the reverse order of the disassembly.
   E. Torque should not be excessive when assembling he solenoid valve and coil.
      – Excessive torque may damage the solenoid valve.
5. Take care not allow any contaminant to flow into the package valve during reassembly after disassembly and check procedures.
6. Every component should be washed out before reassembly.

## Solenoid Valve Diagram

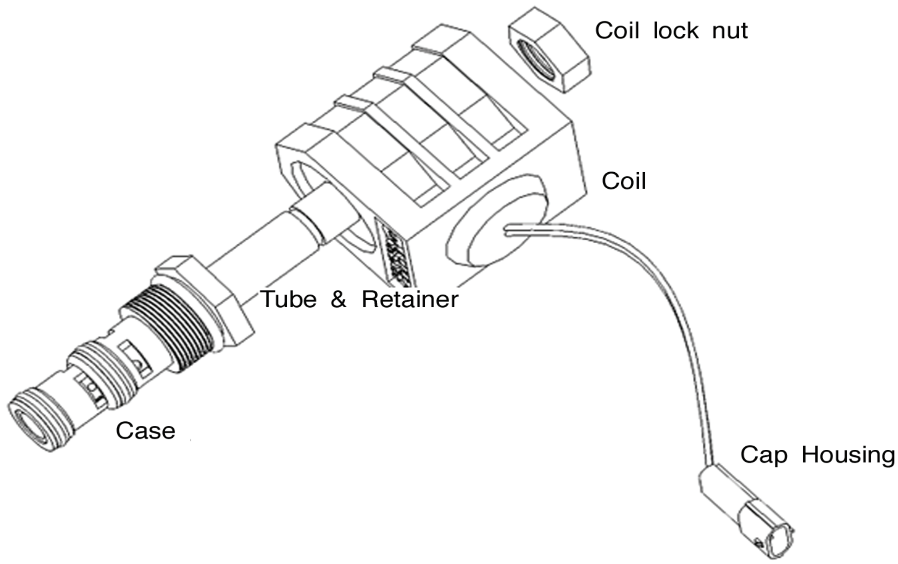



**Figure 3**

## Check Points and Solutions for Problems

| Symptoms | Causes | How to Check | Solutions |
|---|---|---|---|
| Malfunction of solenoid valve | Foreign substance, dirt, dust in solenoid valve | Disassemble the solenoid valve concerned and check if there are any contaminant such as foreign substance and sludge between the case and the spool. | Remove contaminant, wash, and assemble compartments. |
| | Tube or retainer of solenoid valve damaged | Disassemble the solenoid valve concerned and check if there is any deformation (bending or reduction) in the tube or the retainer. | Replace the solenoid valve. |
| | Coil broken, short, or burnt | Disassemble the solenoid valve concerned and check the resistance of the coil.<br>Spec : 26.7Ω @ 20°C<br>Disconnection: ∞<br>Short: Low or excessive resistance<br>Disassemble the solenoid valve concerned and check the outside of the coil to see if its molding is burnt and melted. | Replace the coil. |
| | Connector terminal earth defect | Check if the cap housing (where coil lead is attached) and the housing (across its length) are earthed properly. | Replace housing or terminal concerned. |
| Pilot pressure fails to generate | Pilot pressure | Remove the plug of the "P5" port, set up a pressure gage, and check the pilot pressure discharged from the pilot pump when operating the cut-off (C1) valve. | Refer to Causes and How to Check of the solenoid valve above. |
| | Pilot relief valve | Check if the relief valve installed in the pilot line operates properly.<br>• Check if pressure is bypassed due to the presence of foreign substance. | Remove foreign substance, reassemble, and replace the relief valve. |
| | Pilot pump | Check if the pilot pump works properly. | Replace the pilot pump. |
| | Pilot filter | Check if the mesh screen of the pilot filter is contaminated by foreign substance. | Wash, reassemble, and replace the filter |
| Poor Actuator Performance | Pilot system | Check any defect of the pilot system considering findings from "Pilot pressure fails to generate" category. | Treat defect(s) accordingly. |
| | Solenoid valve | Set up a pressure gage at each outlet port of the solenoid valve concerned (HO, TR2, PH, and SP ports) and check the pressure value discharged from the pilot pump when operating the solenoid valve. | Refer to causes and how to check of the solenoid valve above. |
| | Main control valve | Check if main control valve of each component works properly. | Treat according to findings. |
| | Other components | Check if each component works properly. | Treat according to findings. |

**Checking of Pilot Pressure for Defects**

| Port where pressure gage set up | Screw size | Remark |
|---|---|---|
| P1, P3, P4, P5, P6, TR2, PH, HO, SP | PF1/4" O ring BOSS | Operate the solenoid valve concerned (ON). |

# Breaker EPPR Valve (Opt)

Edition 1

# MEMO

# Table of Contents

## Breaker EPPR Valve (Opt)

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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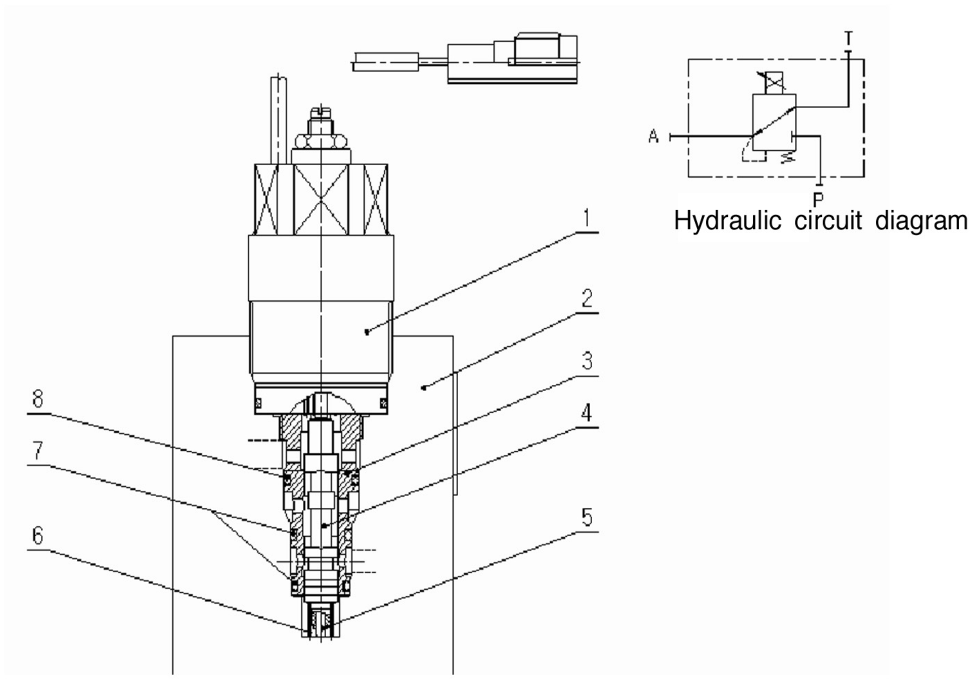
# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX140W | 5001 and Up |
| DX160W | 5001 and Up |
| DX180LC | 5001 and Up |
| DX210W | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |
| DX300LC | 5001 and Up |
| DX340LC | 5001 and Up |
| DX420LC | 5001 and Up |
| DX480LC | 5001 and Up |
| DX520LC | 5001 and Up |

# STRUCTURE

## Numbers and Names of Parts




FG004539

**Figure 4**

| Reference Number | Description |
|---|---|
| 1 | Solenoid |
| 2 | Valve casing |
| 3 | Sleeve |
| 4 | Spool |

| Reference Number | Description |
|---|---|
| 5 | Pin |
| 6 | Spring |
| 7 | O-ring |
| 8 | O-ring |

# FUNCTIONS AND OPERATION

The proportional reducing valve shall be adjusted that its reduced pressure is proportional to the current of the solenoid.

The proportional solenoid shall be changed with pressure proportional to the electrical input signal. Flow increases corresponding to the force of the solenoid. As the solenoid (1) receives pressure, the spool (4) opens and oil flows from P to A. Pressure of the port A influences the top surface of the pin (5). When it reaches the valve set of the solenoid, the spool starts to move and oil flow from P to A decreases.

# CAUTIONS FOR OPERATION

1. Wiring of the solenoid
    - The solenoid has no polarity.
2. Input electricity
    - Do not supply electric current more than 0.7A to the solenoid coil.
3. Adjustment screw
    - It was adjusted to the standard.
    - The pressure of the port A increases when turning the adjustment screw clockwise.
4. Symptoms and Solutions of Problems

| Symptoms | Causes | Solutions |
|---|---|---|
| Pressure does not increase nor change | Poor wiring | Fix wiring |
| | Solenoid damaged | Replace the solenoid |
| | Piston or spool sticked | Fix, or clean and grind |
| | Amplifier damaged | Repair or replace the amplifier |
| Unnatural pressure change | Poor opening space<br>Too wide<br>Too narrow | Readjust |
| | Piston or spool sticked | Fix, or clean and grind |
| Unnatural pressure | Poor opening space<br>Too wide<br>Too narrow | Readjust |
| Slow reaction | Low pressure supplied | Readjust |

# MAINTENANCE INSTRUCTIONS

## Maintenance

### Bolt Tightening Torque

Table 1 shows torques used to tighten bolts of the motor.

Make sure that assembly work should be done according to Table 1.

| Bolt Sizes | Names | Used Torques (kgf.cm) |
|---|---|---|
| M 35 | Hex bolt | $450 \pm 50$ |
| M 10 | Hex bolt | $200 \pm 20$ |
| NPTF 1/16 | Plug | 90 |

### Tools Used for Disassembly and Assembly

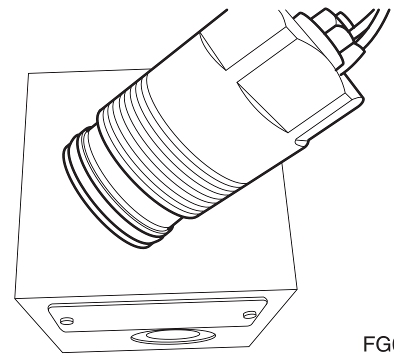
Table 2 shows tools necessary for disassembly and assembly.

As bolts and plugs to be used depend on types, they should be checked accordingly in advance.

| For | Sizes | Used Torques | Used Tools |
|---|---|---|---|
| Solenoid | M 35 | $450 \pm 50$ | Spanner |
| Sleeve | M 10 | $200 \pm 20$ | Hex bar spanner |
| NPTF plug | 1/16 | 90 | Hex bar spanner |

# Disassembly

1. Determine a place for disassembly.
   - It should be clean.
   - Lay a rubber board or a cloth on the table and take care not to damage parts.
2. Remove dust and rust of the proportional pressure reducing valve with cleansing oil.
3. Disassemble the solenoid
   - Take care not to damage O-rings of the solenoid.



FG003690

**Figure 5**

4. Disassemble the spool, the spring, and the pin.

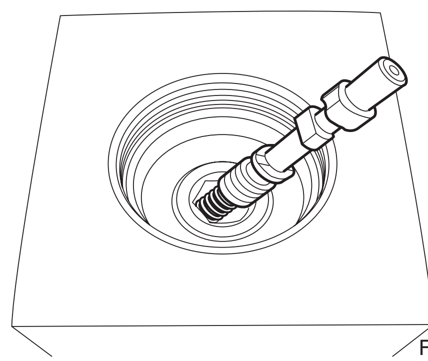


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**Figure 6**

5. Disassemble the sleeve.
   - Take care not to damage O-rings of the sleeve.

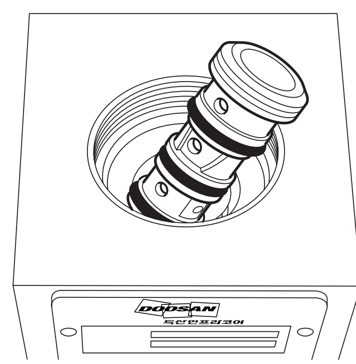


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**Figure 7**

## Assembly

Assembly shall be done in the reverse order of disassembly described above, taking into consideration the following points.

- Parts damaged during disassembly should be repaired without fail and spare parts should be prepared in advance.
- Every part should be cleaned enough with cleaning oil and dried with compressed air before starting assembly.
- Sliding parts and bearings should be applied clean active oil before their assembly.
- Basically, parts of the O-ring and the oil seal should be replaced.
- Use a torque wrench to tighten or engage bolts and plugs in accordance with reference torques as described in Maintenance Guide.

1. Assemble the sleeve.

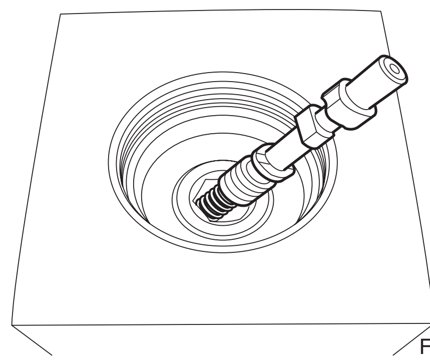



**Figure 8**

- Take care not to damage O-rings of the sleeve.

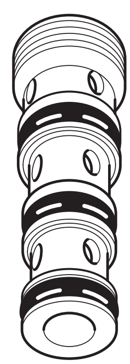
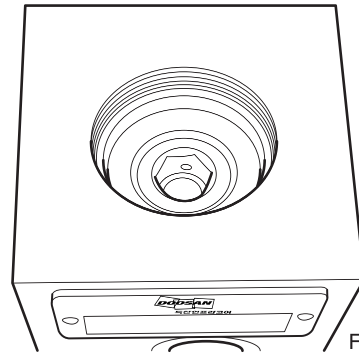



**Figure 9**

2. Assemble the spool, the spring, and the pin.



FG003693

**Figure 10**

- The spring and the pin should not be fell off.

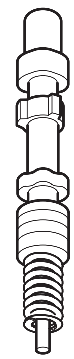


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**Figure 11**

3. Assemble the solenoid correctly.

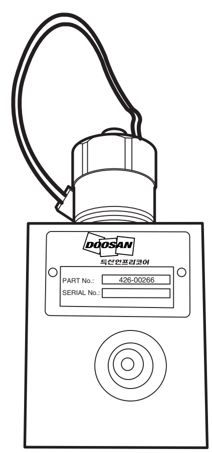

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**Figure 12**

- Take care not to damage O-rings of the solenoid.

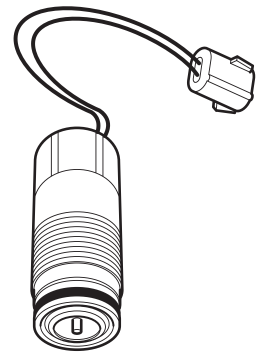


**Figure 13**

# Hydraulic Schematic (DX140LC)

Edition 1

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## Hydraulic Schematic (DX140LC)

# MEMO

# SAFETY PRECAUTIONS

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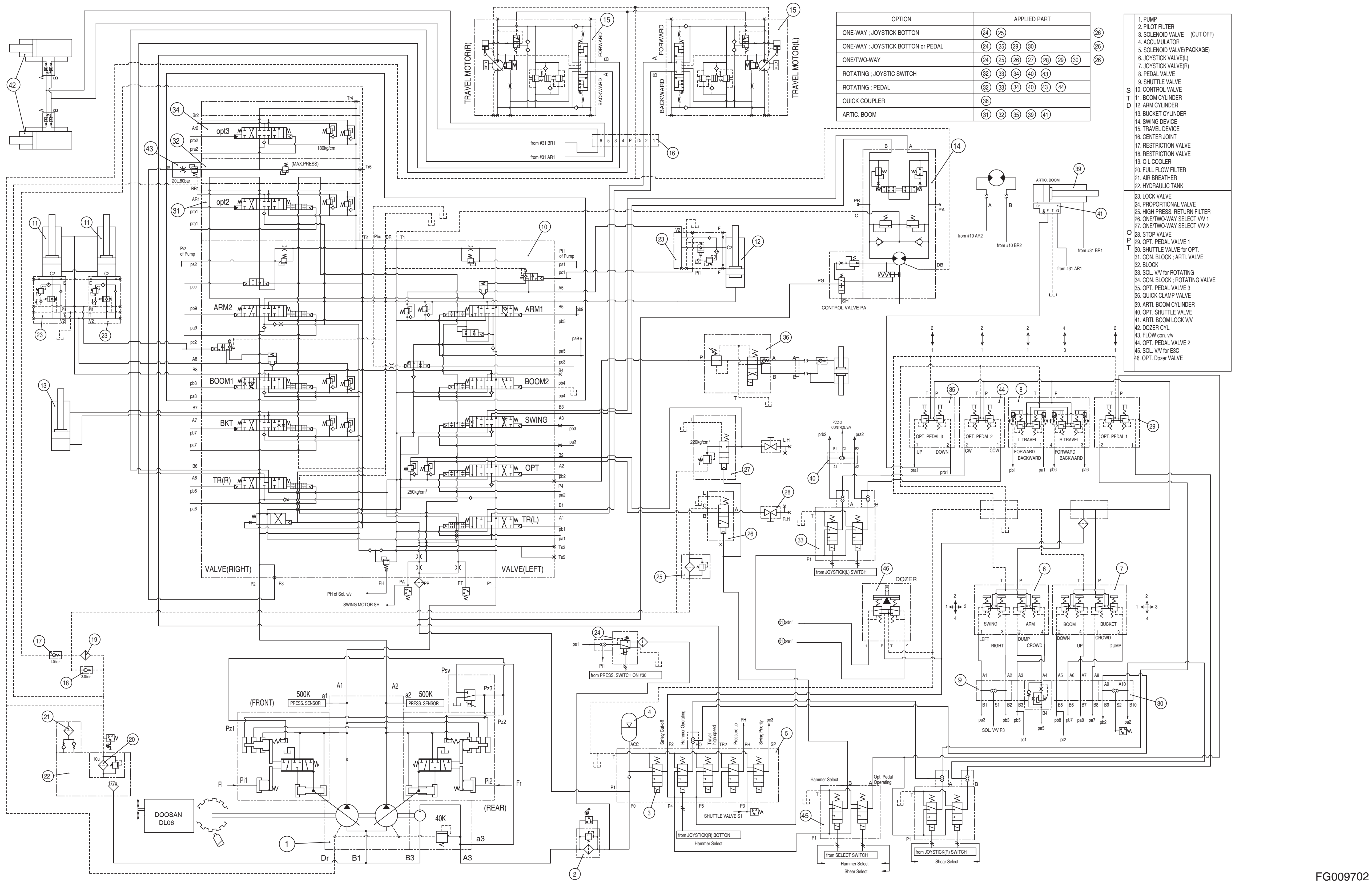
| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |

# DX140LC




| OPTION | APPLIED PART | |
|---|---|---|
| ONE-WAY ; JOYSTICK BOTTON | 24 25 | 26 |
| ONE-WAY ; JOYSTICK BOTTON or PEDAL | 24 25 29 30 | 26 |
| ONE/TWO-WAY | 24 25 26 27 28 29 30 | 26 |
| ROTATING ; JOYSTIC SWITCH | 32 33 34 40 43 | |
| ROTATING ; PEDAL | 32 33 34 40 43 44 | |
| QUICK COUPLER | 36 | |
| ARTIC. BOOM | 31 32 35 39 41 | |

| | |
|---|---|
| STD | 1. PUMP<br>2. PILOT FILTER<br>3. SOLENOID VALVE (CUT OFF)<br>4. ACCUMULATOR<br>5. SOLENOID VALVE(PACKAGE)<br>6. JOYSTICK VALVE(L)<br>7. JOYSTICK VALVE(R)<br>8. PEDAL VALVE<br>9. SHUTTLE VALVE<br>10. CONTROL VALVE<br>11. BOOM CYLINDER<br>12. ARM CYLINDER<br>13. BUCKET CYLINDER<br>14. SWING DEVICE<br>15. TRAVEL DEVICE<br>16. CENTER JOINT<br>17. RESTRICTION VALVE<br>18. RESTRICTION VALVE<br>19. OIL COOLER<br>20. FULL FLOW FILTER<br>21. AIR BREATHER<br>22. HYDRAULIC TANK |
| OPT | 23. LOCK VALVE<br>24. PROPORTIONAL VALVE<br>25. HIGH PRESS. RETURN FILTER<br>26. ONE/TWO-WAY SELECT V/V 1<br>27. ONE/TWO-WAY SELECT V/V 2<br>28. STOP VALVE<br>29. OPT. PEDAL VALVE 1<br>30. SHUTTLE VALVE for OPT.<br>31. CON. BLOCK ; ARTI. VALVE<br>32. BLOCK<br>33. SOL. V/V for ROTATING<br>34. CON. BLOCK ; ROTATING VALVE<br>35. OPT. PEDAL VALVE 3<br>36. QUICK CLAMP VALVE<br>39. ARTI. BOOM CYLINDER<br>40. OPT. SHUTTLE VALVE<br>41. ARTI. BOOM LOCK V/V<br>42. DOZER CYL.<br>43. FLOW con. v/v<br>44. OPT. PEDAL VALVE 2<br>45. SOL. V/V for E3C<br>46. OPT. Dozer VALVE |

FG009702

**Figure 1**

# Electrical System

# Electrical System

Edition 1

# MEMO

# Table of Contents

## Electrical System

# SAFETY PRECAUTIONS

## CAUTION!

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| | |

# INTRODUCTION

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 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 |
| R | Red |
| Gr | Gray |
| P | Pink |
| Y | Yellow |
| Br | Brown |
| V | Violet |

**NOTE:** *RW: Red wire with White stripe*

*R - Base Color, W - Stripe Color*

**NOTE:** *0.85G: Nominal sectional area of wire core less insulator = 0.85* $mm^2$

# ELECTRICAL SUPPLY SYSTEM

The electric power circuit supplies electric current to each electric component. It consists of a battery, battery relay, starter switch, circuit breaker, fusible link and fuse box.

The negative terminal of the battery is grounded to the vehicle body.

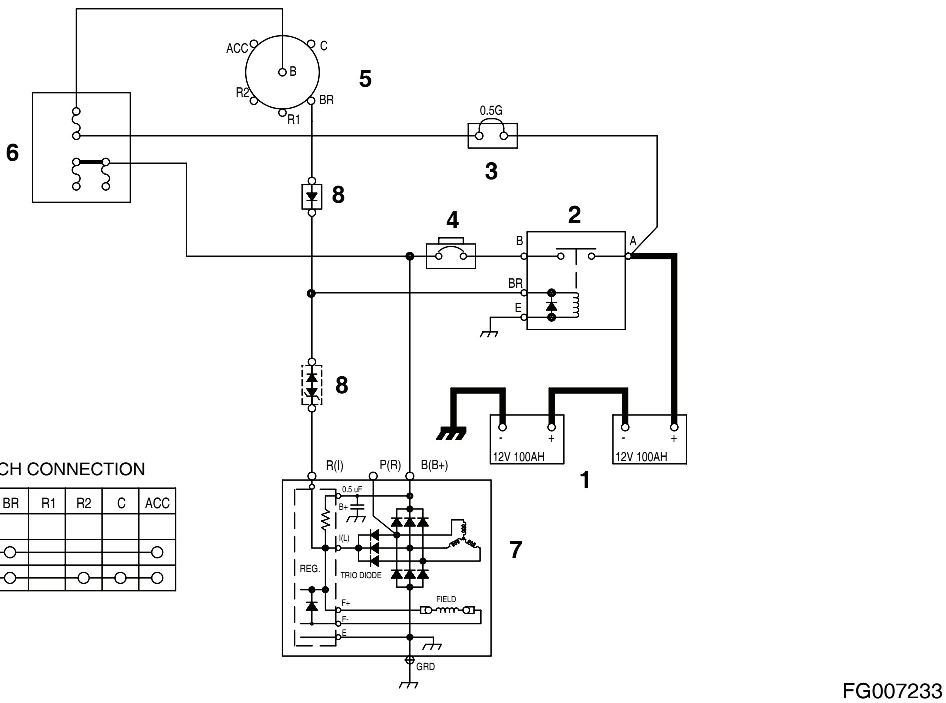
Even when the starter switch (5) is in the "OFF" position, electric current is supplied to the following components through battery (1) → fusible link (3) → fuse box (6).

1. Terminal "1" of DC-DC converter (for memory backup of stereo)
2. Terminal "B" of starter switch
3. Hour meter
4. Engine controller
5. Fuel feeder pump switch
6. Terminal "6" of wiper motor
7. Terminal "13" of wiper controller
8. Terminal "CN6-11" of instrument panel
9. Terminal "CN9-6" of air conditioner panel
10. Cabin light

When the starter switch (5) is in the "ON or START" positions, the current flows from the battery (1) → fusible link (3) → fuse box (6) → "B" terminal of starter switch (5) → "BR" terminal of starter switch (5) → "BR" terminal of battery relay (2) which activates the coil of the battery relay and the electric supply system is energized.

When the battery relay's contacts are connected, all electric devices can be operated.

While the engine is not running, the electric power for all electric devices are supplied by the battery. Once the engine is started the power is supplied from the alternator (7).




| PST \ TML | B | BR | R1 | R2 | C | ACC |
|---|---|---|---|---|---|---|
| OFF | O | | | | | |
| ON | O | O | | | | O |
| START | O | O | | O | O | O |

**Figure 1** ELECTRIC POWER CIRCUIT DIAGRAM

| Reference Number | Description |
|---|---|
| 1 | Battery |
| 2 | Battery Relay |
| 3 | Fusible Link |
| 4 | Circuit Breaker |

| Reference Number | Description |
|---|---|
| 5 | Starter Switch |
| 6 | Fuse Box |
| 7 | Alternator |
| 8 | Diode |

# ENGINE STARTING CIRCUIT

## Start Operation

When the starter switch is turned to the "START" position, the "S" and "E" terminals of the starter controller (7) are connected. At this time the contacts in the starter relay (8) are closed by the current flow from the battery (1) → fusible link (3) → fuse box (6) → "B" terminal of starter switch (5) → "C" terminal of starter switch (5) → "30" terminal of starter relay (12) - "87a" terminal → "C" terminal of starter relay (8) - "D" terminal → "S" terminal of starter controller (7) - "E" terminal → ground.

When the contact point "B" and "PP" of starter relay (8) are connected, the pinion gear of the starter (9) is pushed forward and makes contact with the ring gear of the flywheel and the internal contacts of the starter are connected. The current flows from the battery (1) → "A" terminal of the battery relay (2) → "B" terminal of the battery relay (2, Figure 3) → "B" terminal of the starter (9). The starter motor is rotated and the engine is started.

If the instrument panel has the password function activated , input number should match the set number, otherwise the start circuit closes and the engine does not start.

**NOTE:** *If the security system is "LOCKED," a four-digit password will be required to start the engine. If the system is "UNLOCKED," no password will be required and this display screen will not appear.*

*In the event the security system is locked, current flows from battery (1) → fusible link (3) → fuse box (6) → "B" terminal of starter switch (5) → "ACC" terminal of starter switch (5) → "86" terminal of starter relay (12) → "85" terminal of starter relay (12) → "CN1-15" terminal of e-EPOS (13) → ground. This current flow causes the coil in starter relay (12) to be activated, opening contacts at "87a" terminal. This prevents starter relay (8) from functioning.*

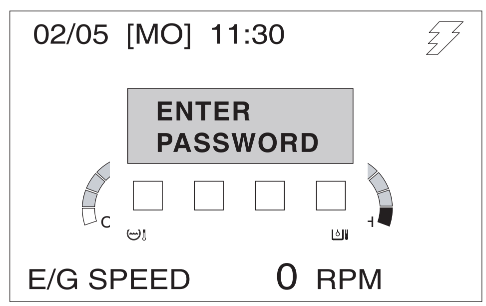



**Figure 2**

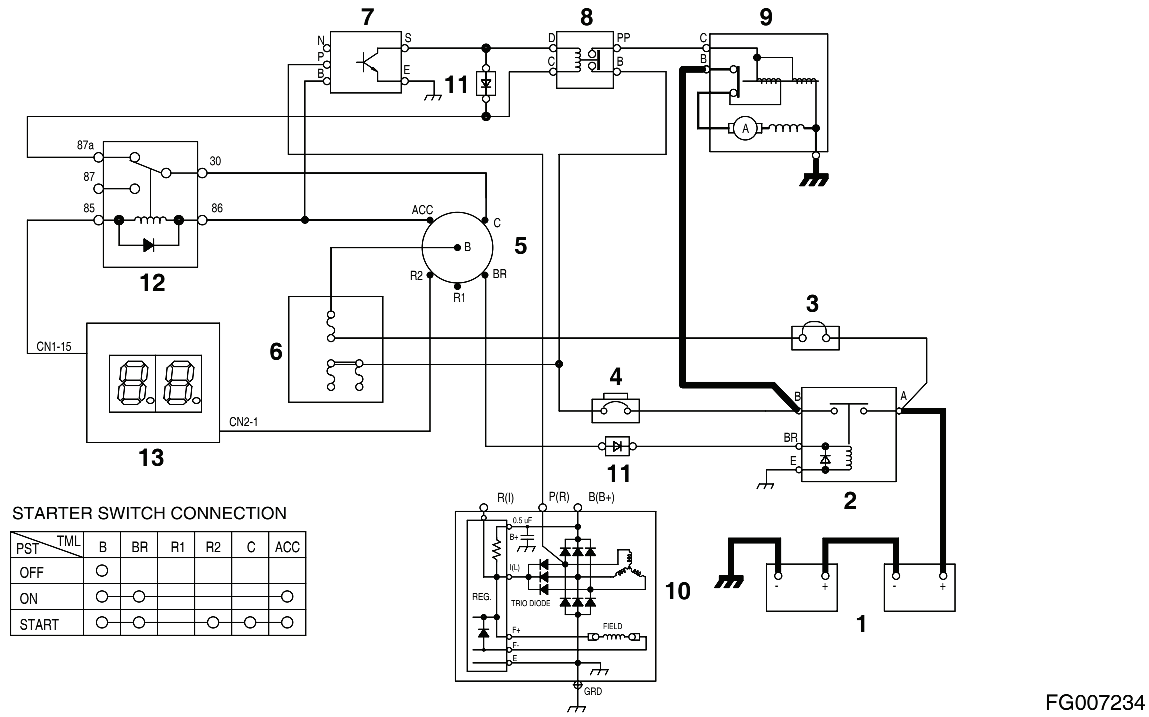



**Figure 3** STARTER CIRCUIT (1) - WHILE STARTING

| Reference Number | Description |
|---|---|
| 1 | Battery |
| 2 | Battery Relay |
| 3 | Fusible Link |
| 4 | Circuit Breaker |
| 5 | Starter Switch |
| 6 | Fuse Box |
| 7 | Starter Controller |

| Reference Number | Description |
|---|---|
| 8 | Starter Relay |
| 9 | Starter |
| 10 | Alternator |
| 11 | Diode |
| 12 | Starter Relay 2 |
| 13 | e-EPOS Controller |

## After Start

Once the engine has been started, the belt driven alternator (10) generates a current.

The output generated by the alternator (10) is a square wave pulse voltage through the "P" terminal and the frequency of the pulse voltage is proportional to the rotation of the alternator.

The starter controller (7) monitors the frequency of the output current. Once the frequency is equivalent to 500 rpm, it is sensed and the connection between "S" and "E" terminals and the connection between "B" and "PP" terminals are opened. As a result the rotation of the starter (9) is stopped. Once the engine is running, the starter (9) will not operate even if the starter switch (5) is moved to the start position, preventing possible damage to the starter.

## Operation of the Start Circuit (2) - Immediately After Start

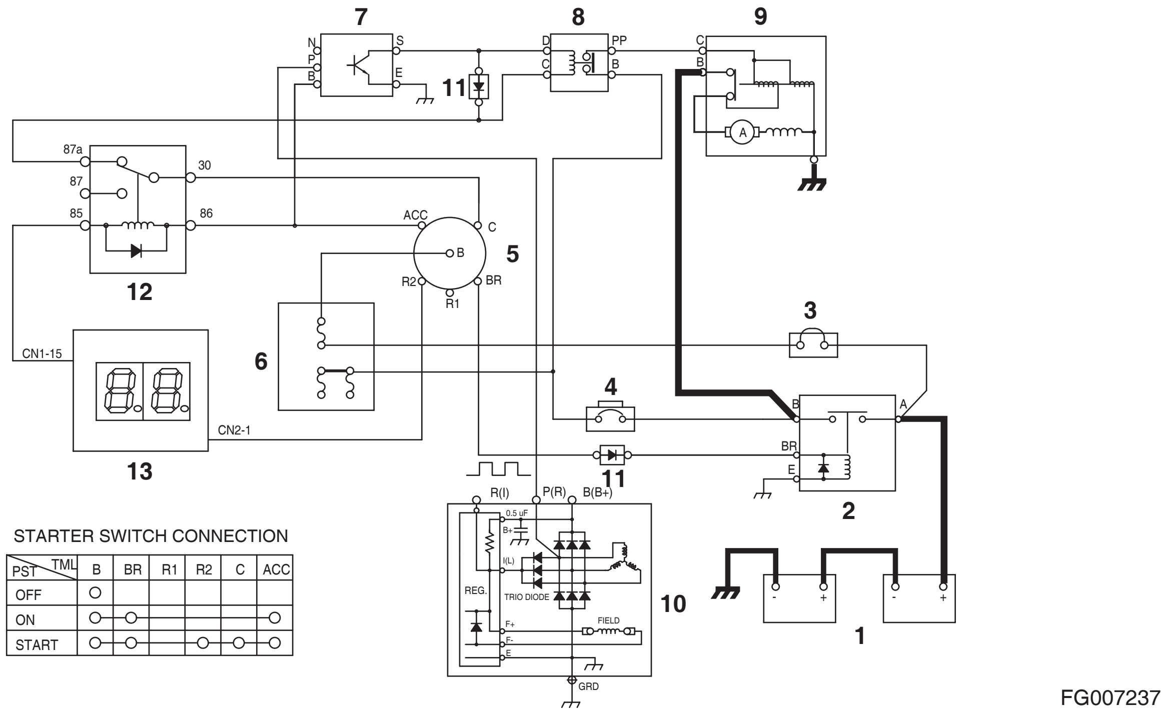



**Figure 4** OPERATION OF START CIRCUIT (2) - IMMEDIATELY AFTER START

| Reference Number | Description |
|---|---|
| 1 | Battery |
| 2 | Battery Relay |
| 3 | Fusible Link |
| 4 | Circuit Breaker |
| 5 | Starter Switch |
| 6 | Fuse Box |
| 7 | Starter Controller |

| Reference Number | Description |
|---|---|
| 8 | Starter Relay |
| 9 | Starter |
| 10 | Alternator |
| 11 | Diode |
| 12 | Starter Relay 2 |
| 13 | e-EPOS Controller |

# ENGINE PREHEATING SYSTEM

An air heater (8) is installed in the intake manifold of the engine. When the starter switch (5) is turned "ON," the current flows from the battery (1) → fusible link (3) → fuse box (6) → "B" terminal of starter switch (5) → "BR" terminalof starter switch (5) → "1-39" terminal of engine controller (12), causing current to flow though "1-16" terminal of engine controller (12) → "C and D" terminals of preheat relay (7) → "1-04" terminals of engine controller (12) → ground.

*This current flow causes the coil in preheat relay (7) to be activated, closing contacts.*

When the contacts of the preheat relay (7) are closed, the heating coils of the air heating device (8) are heated by current flowing from the battery (1) → battery relay (2) → preheat relay (7) → air heater (8) → ground.

The duration of the heating cycle depends on the temperature of engine coolant. The preheat indicator light in the instrument panel (9) will turn "ON" during preheating cycle.

The preheat relay (7) is controlled by the engine controller (12) and operates only at temperatures of 10°C (50°F) and below.

The longer the preheating period, the lower the temperature of coolant is.

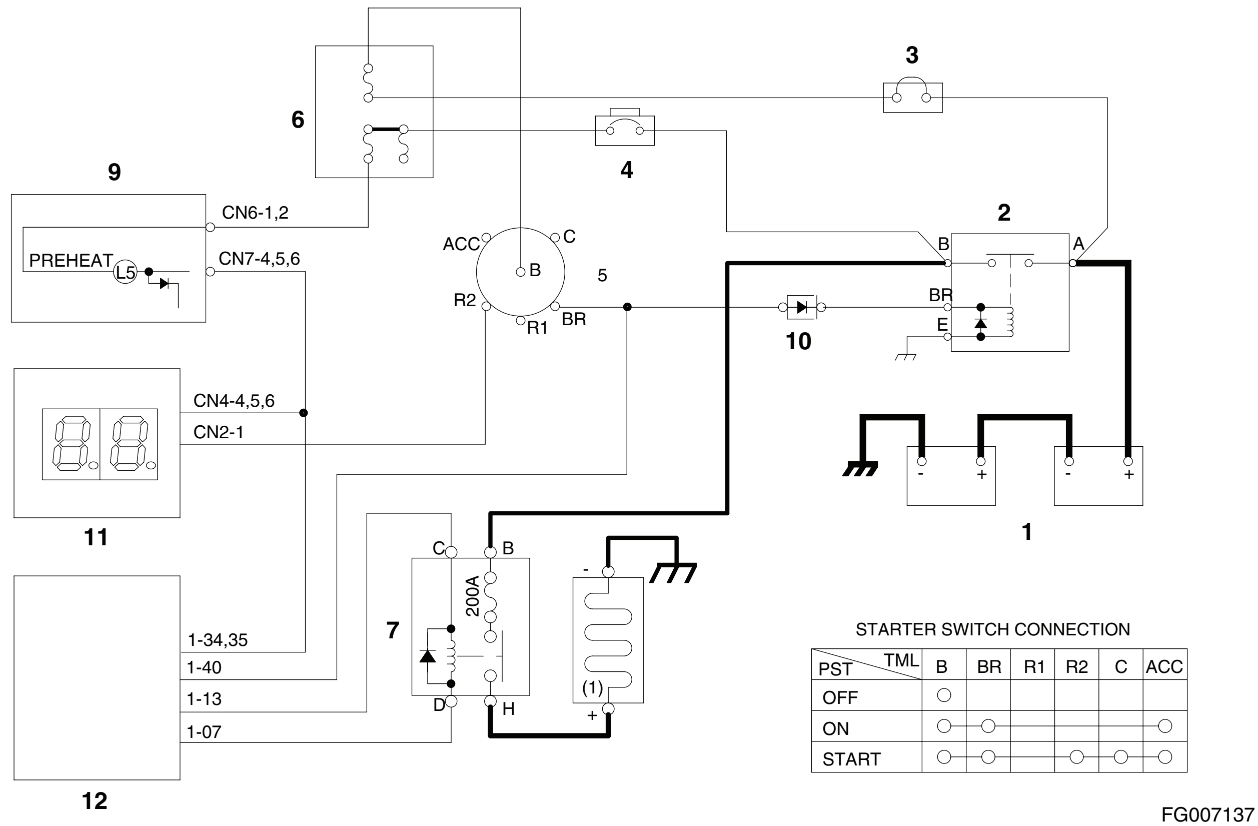



**Figure 5** ENGINE PREHEAT CIRCUIT

| Reference Number | Description |
|---|---|
| 1 | Battery |
| 2 | Battery Relay |
| 3 | Fusible Link |
| 4 | Circuit Breaker |
| 5 | Starter Switch |
| 6 | Fuse Box |

| Reference Number | Description |
|---|---|
| 7 | Preheat Relay |
| 8 | Air Heater |
| 9 | Preheat Indicator Light |
| 10 | Diode |
| 11 | e-EPOS Controller |
| 12 | Engine Controller |

# ENGINE STOP

When starter switch (5) is turned "ON" the engine controller (8) is activated. The engine controller monitors and controls the engine including the injector solenoid (9). It controls the fuel deliver rate and the injection timing for each cylinder.

**NOTE:** *There is an individual injector solenoid (9) for each of the six cylinders. Only one soleniod is shown in Figure 7.*

When starter switch (5) is turned "OFF," the engine controller stops suppling power to the injector solenoid (9). This stops fuel from being injexted into the engine cylinder, thus stopping the engine.

In the event that the engine can be shut down using the starter switch (5), an emergency stop switch (10) is provided to shut down engine. To activate the emergancy stop switch, move it to the "I" (EMERGENCY STOP) position.

The emergency stop switch (10) is in its "O" (OFF) position during normal operation. The switch must be moved and held in the "I" (EMERGENCY STOP) position until the engine stops. When released it will automatically move back to the "O" (OFF) position.

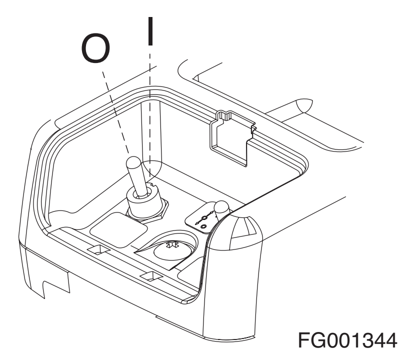



**Figure 6** ENGINE EMERGENCY STOP SWITCH

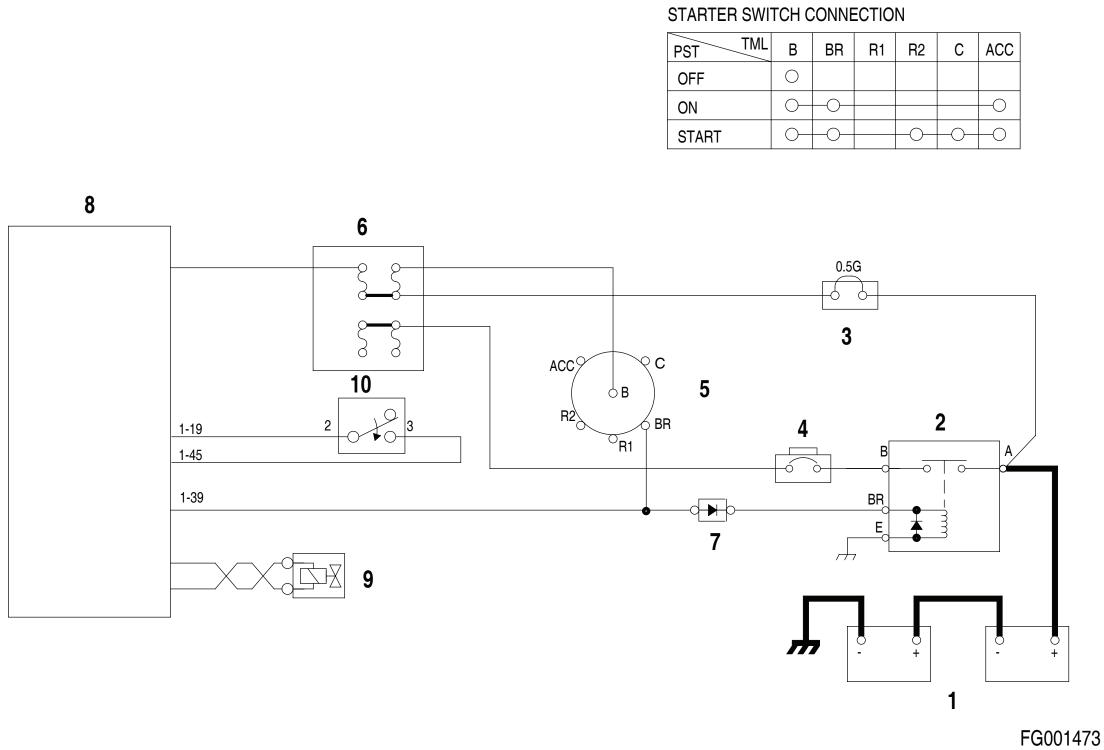



**Figure 7** ENGINE STOP CIRCUIT

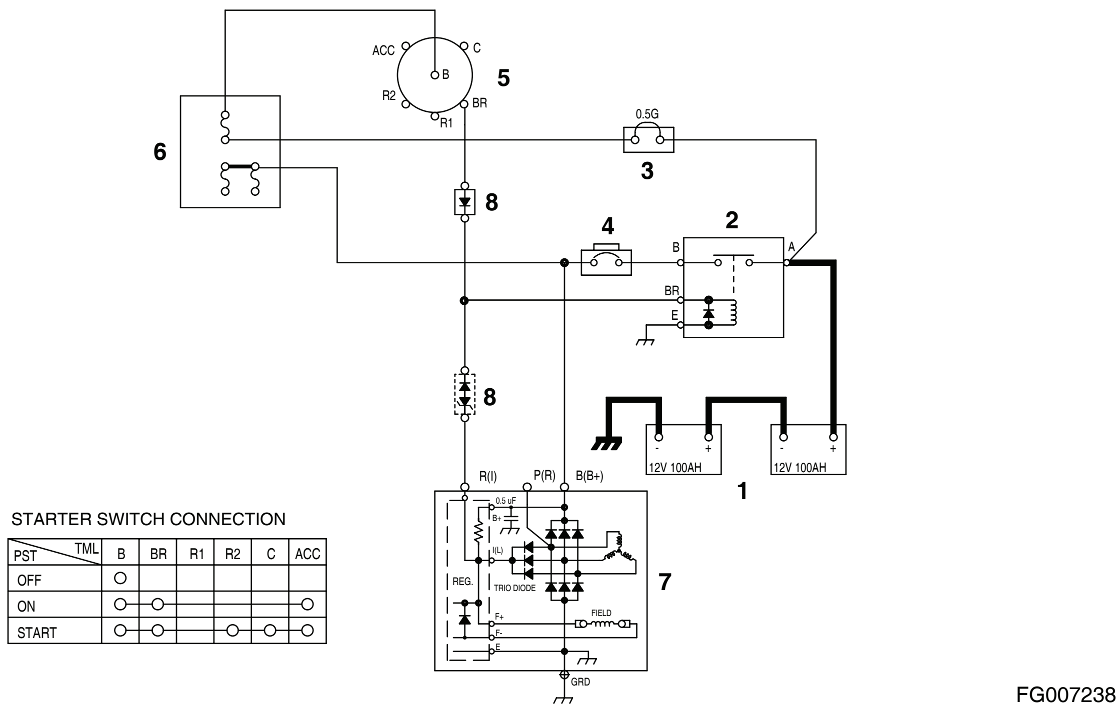
| Reference Number | Description |
|---|---|
| 1 | Battery |
| 2 | Battery Relay |
| 3 | Fusible Link |
| 4 | Circuit Breaker |
| 5 | Starter Switch |

| Reference Number | Description |
|---|---|
| 6 | Fuse Box |
| 7 | Diode |
| 8 | Engine Controller |
| 9 | Injector Solenoid |
| 10 | Emergency Stop Switch |

# CHARGING SYSTEM

When the starter switch (5) is turned to the "ON" position, an initial excited current flows to the field coil of the alternator (7) through the battery relay (2) and circuit breaker (4). When the engine is started from this condition the alternator (7) starts charging. The current flows from the "B(B+)" terminal of alternator (7) → circuit breaker (4) → battery relay (2) → battery (1).

The alternator also supplies electric current to other electrical components. When the alternator (7) starts to operate, a current flows from the "R(I)" terminal of alternator → diode (8) → battery relay (2) coil securing a path for the charging current to the battery (1). Thus preventing the possibility of a high voltage build up and possible damage to the electric system.




| PST \ TML | B | BR | R1 | R2 | C | ACC |
|---|---|---|---|---|---|---|
| OFF | O | | | | | |
| ON | O | O | | | | O |
| START | O | O | | O | O | O |

**Figure 8** CHARGING CIRCUIT

| Reference Number | Description |
|---|---|
| 1 | Battery |
| 2 | Battery Relay |
| 3 | Fusible Link |
| 4 | Circuit Breaker |

| Reference Number | Description |
|---|---|
| 5 | Starter Switch |
| 6 | Fuse Box |
| 7 | Alternator |
| 8 | Diode |

# MONITORING SYSTEM

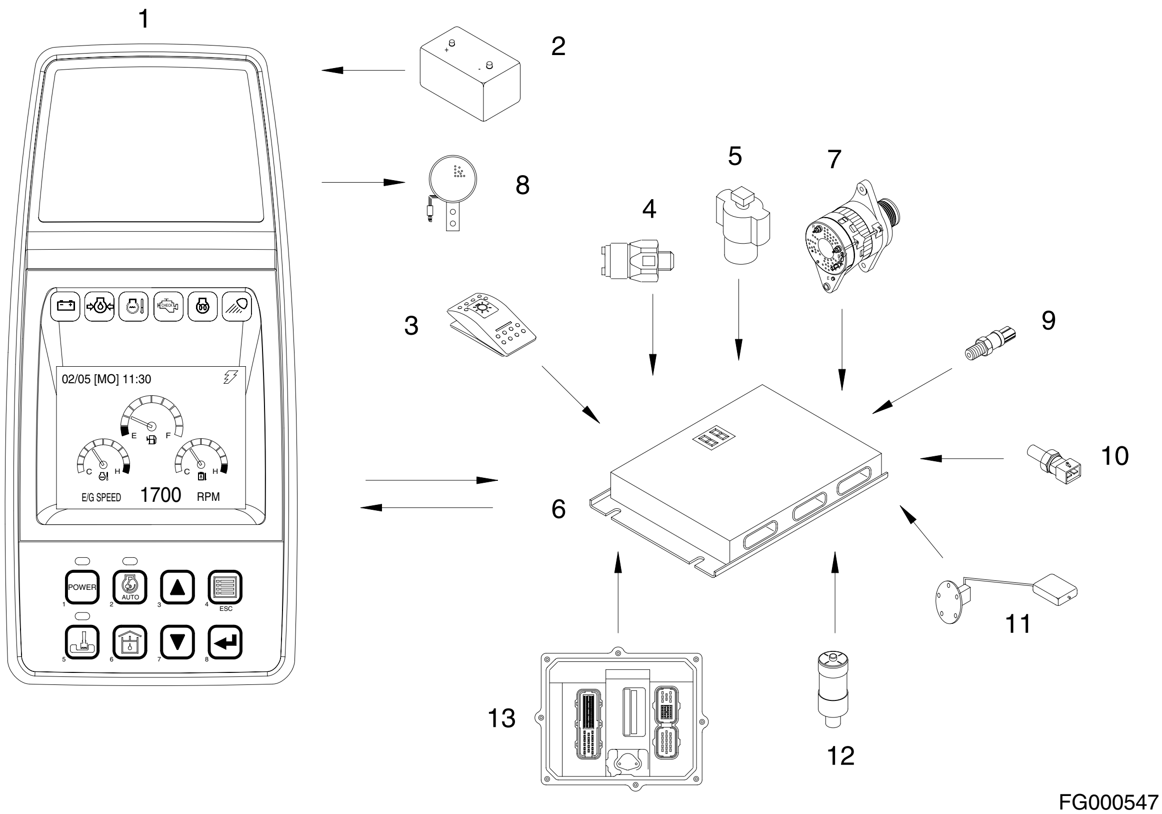


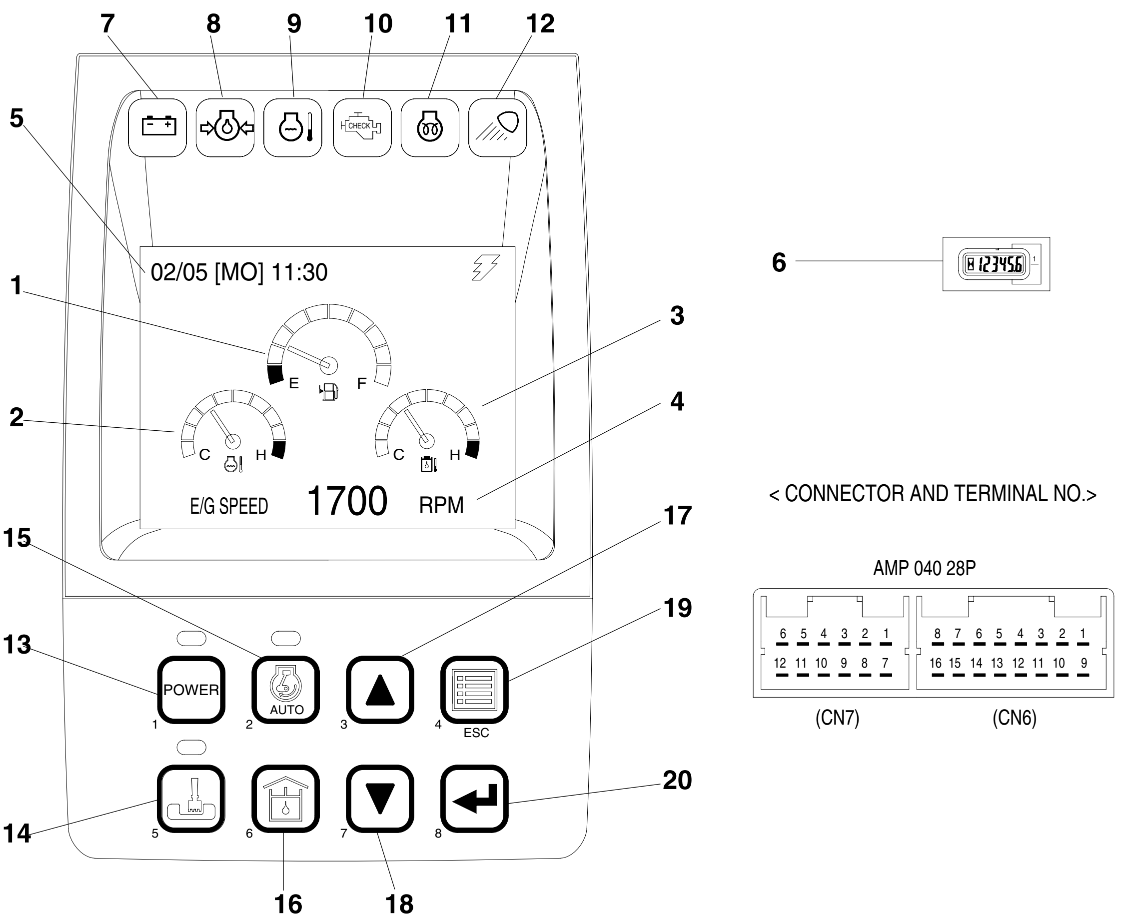

**Figure 9**

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel |
| 2 | Battery |
| 3 | Light Switch |
| 4 | Return Filter Switch |
| 5 | Pilot Filter Switch |
| 6 | e-EPOS Controller |
| 7 | Alternator |

| Reference Number | Description |
|---|---|
| 8 | Warning Buzzer |
| 9 | Pump Discharge Pressure Sensor |
| 10 | Hydraulic Oil Temperature Sensor |
| 11 | Fuel Sensor |
| 12 | Air Cleaner Indicator |
| 13 | Engine Controller |

The monitoring system displays the various data and warning signals onto the instrument panel by processing the information gathered from the e-EPOS controller. It displays information selected by the operator.

## Instrument Panel




FG000548

**Figure 10**

| Gauges | Warning Lights | Mode Selector Switches |
|---|---|---|
| 1. Fuel Gauge | 7. Charge Warning Light | 13. Power Mode Selector Switch and Indicator |
| 2. Engine Coolant Temperature Gauge | 8. Engine Oil Pressure Warning Light | 14. Work Mode Selector Switch and Indicator |
| 3. Hydraulic Oil Temperature Gauge | 9. Coolant Temperature Warning Light | 15. Auto Idle Switch and Indicator |
| 4. Multifunction Gauge and Letter Information Area | 10. Engine Check Warning Light | 16. Flow Adjusting Switch |
| 5. Digital Clock | 11. Preheat Indicator Light | 17. Up Button Switch |
| 6. Hour Meter | 12. Work Light Indicator Light | 18. Down Button Switch |
| | | 19. Display Selector Switch |
| | | 20. Selector Button Switch |

When the engine starter switch is turned to the "I" (ON) position, all gauge bands, switch/button indicator lights and indicator/ warning lights will turn "ON" and the alarm buzzer will sound about two seconds.

During this functional check, a LOGO will appear on the multi function gauge in the graphic information area

# Monitoring System Schematic

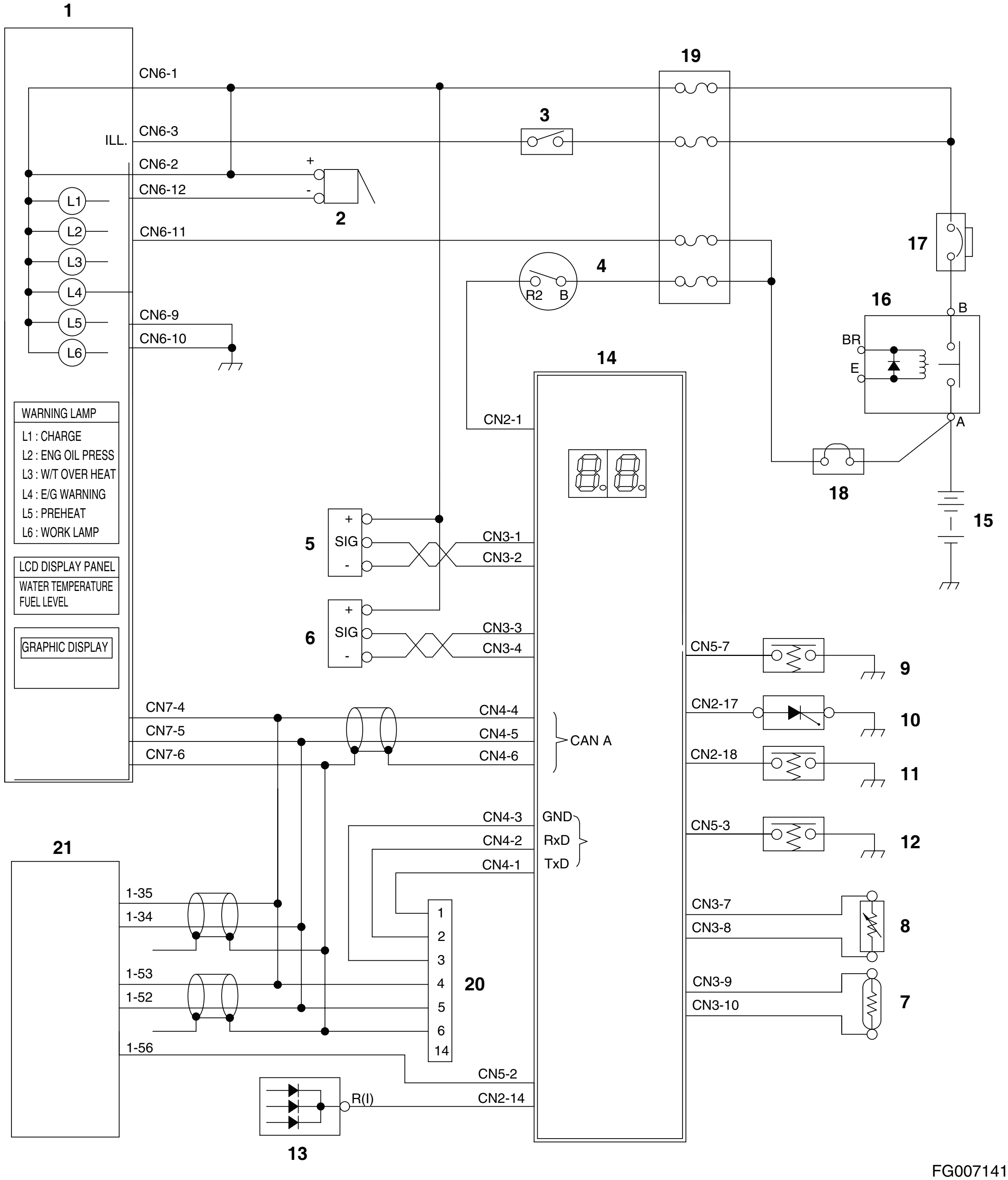


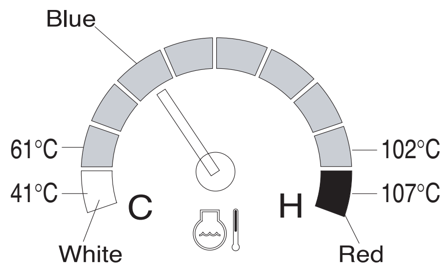
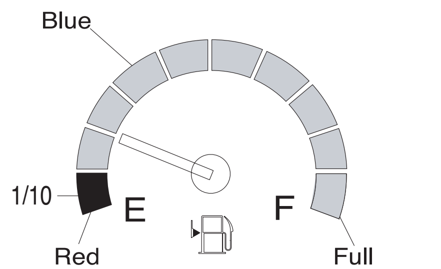
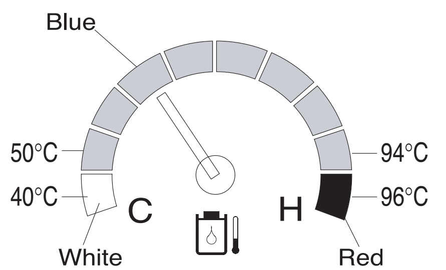
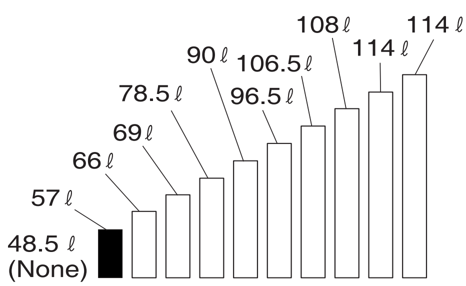

Figure 11

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel |
| 2 | Pilot Buzzer |
| 3 | Light Switch |
| 4 | Starter Switch |
| 5 | Front Pump Pressure Sensor |
| 6 | Rear Pump Pressure Sensor |
| 7 | Hydraulic Oil Temperature Sensor |
| 8 | Fuel Sensor |
| 9 | Pedal Pressure Switch (Optional) |
| 10 | Air Cleaner Indicator |

| Reference Number | Description |
|---|---|
| 11 | Pilot Filter Switch |
| 12 | Return Filter Switch |
| 13 | Alternator |
| 14 | e-EPOS Controller |
| 15 | Battery |
| 16 | Battery Relay |
| 17 | Circuit Breaker |
| 18 | Fusible Link |
| 19 | Fuse Box |
| 20 | Check Connector |
| 21 | Engine Controller |

# OPERATION

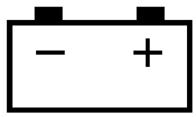
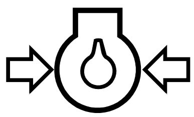
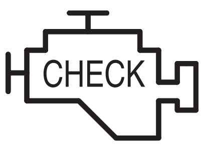
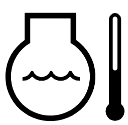
## Instruments

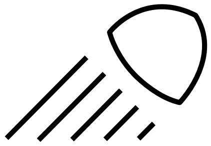
| Function | Display | Sensor Specification | |
|---|---|---|---|
| | | **Input Terminal** | **Input Specification** |
| Coolant Temperature |   FG000550 | ECU-CAN Communication | |
| Fuel Level |   FG000552 | CN3-7<br>CN3-8 | 1/10 LCD (Red Zone) Blinking → over 5K ohms<br>FULL → under 525 ohms |
| Hydraulic Oil Temperature |   FG000551 | CN3-9<br>CN3-10 | 40°C (104°F) → 1,397 ohms<br>50°C (122°F) → 1,139 ohms<br>60°C (140°F) → 881 ohms<br>94°C (201°F) → 190 ohms<br>96°C (205°F) → 177 ohms<br>(When reading increase) |
| Flow Adjusting |   FG009964 | (Output Terminal)<br>CN1-19<br>CN1-20 | 48.5 l/min → 610 mA<br>57 l/min → 583 mA<br>66 l/min → 555 mA<br>78.5 l/min → 466 mA<br>(Default Set)<br>108 l/min → 343 mA<br>114 l/min → 290 mA |

| Function | Display | Sensor Specification | |
|---|---|---|---|
| | | Input Terminal | Input Specification |
| Tachometer | **E/G SPEED 1700 RPM**<br>FG000049 | ECU-CAN Communication | N = 162 f / 60<br>N = Engine speed (rpm)<br>f = Frequency of engine speed sensor (Hz) |
| Voltmeter | **BATTERY 28.0 VOLT**<br>FG000050 | CN2-14 | 0 - 32 VDC |
| Main pump discharge pressure (front pump) | **FRONT PUMP 320 BAR**<br>FG000051 | CN3-1<br>CN3-2 | V = 0.00816 x P + 1.0<br>V: Sensor output voltage (V)<br>P: Displayed pressure (Bar) |
| Main pump discharge pressure (rear pump) | **REAR PUMP 313 BAR**<br>FG000052 | CN3-3<br>CN3-4 | |

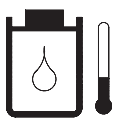
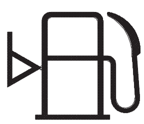
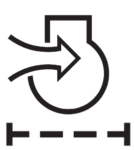
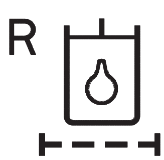
# WARNING AND INDICATOR LIGHTS

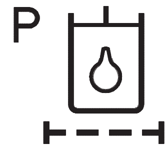
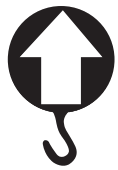
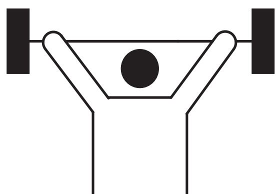
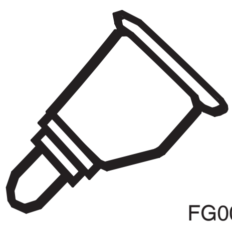
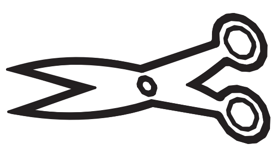
## Indication of Warning Lights

| Description | Symbol | Input Terminal | Operation | Remarks |
|---|---|---|---|---|
| Charge |  HAOA610L | CN2 - 14 | It lights in case of no charge [voltage of "R(I)" terminal is below 12 ±1V] or overcharge [voltage of "R(I)" terminal is above 33(V)]. | Normally, it lights when starting engine and is out after engine starts. |
| Engine Oil Pressure |  HAOA620L | ECU-CAN Communication | It lights when engine oil pressure is below the reference. | After starting engine, if engine oil pressure is insufficient after 8 seconds, a warning buzzer will sound. |
| Engine Check |   FG000045 | ECU-CAN Communication | It lights in case of failure in engine system. | |
| Coolant Temperature |  HAOD350L | ECU-CAN Communication | It lights when engine coolant temperature sensor resistant is below about 128 ohms. | |
| Preheating |  HAOA639L | CN5-2 | It lights during preheating ("CN5-2" terminal voltage is below 2V) and turns "OFF" after completion of preheating. | Preheating period depends on coolant temperature.<br>No preheating at above 10°C<br>10 sec preheating at 5°C<br>20 sec preheating at below 0°C |

| Description | Symbol | Input Terminal | Operation | Remarks |
|---|---|---|---|---|
| Work Light |  HB4O2003 | CN2 - 6 | It lights when work light turns "ON" (24V applied). | |

## Indication of Multifunction Gauge and Letter Information Area

| Description | Symbol | Input Terminal | Operation | Remarks |
|---|---|---|---|---|
| Hydraulic Oil Temperature |  FG000056 | CN3-9<br>CN3-10 | When hydraulic oil temperature is above about 96°C. | |
| Fuel Exhausted |  FG000057 | CN3-7<br>CN3-8 | When fuel is almost exhausted. | |
| Air Cleaner |  FG000053 | CN2-17 | When air cleaner is clogged. | |
| Return Filter |  FG000054 | CN5-3 | When return filter pressure is above about 1.50 kg/$cm^2$ (21 psi) | |

| | | | | |
|---|---|---|---|---|
| Pilot Filter |  FG000055 | CN2-18 | When pilot filter pressure is above about 1 kg/cm² (14 psi) | |
| Overload Warning |  FG000253 | CN3-5<br>CN3-6 | Warning buzzer also starts when boom pressure sensor output voltage is about 2.7V while overload warning switch is "ON." | It flickers in case of 2.71V and above and lights continuously in case of 2.8V and above (and warning buzzer also starts). |
| Boost |  FG000554 | CN2-2 | It lights when boost is selected. | |
| Breaker |  FG001470 | CN2-10 | It lights when breaker is selected. | |
| Shear |  FG001471 | CN2-9 | It lights when shear is selected. | |

# INITIAL OPERATION

| Item | Input (Terminal) | Output (Operation and initial setting mode) |
|---|---|---|
| Initial Operation | When "CN6-1,2" is applied battery voltage (starter switch shifts from "OFF" to "ON" | • LCD, all of LED and warning lights are turned "ON" and turned "OFF" after about 2 seconds.<br>• Warning buzzer is activated and turned "OFF" after about 2 seconds.<br>• Power mode: Standard mode.<br>• Work Mode: Digging mode.<br>• Auto Idle: High Output (Activation).<br>• Display: Indicating coolant temperature, Fuel level, Hydraulic oil temperature, Engine speed.<br>• Clock: Current time display. |

**NOTE:** *Refer to method for setting clock in operation manual for setting time.*

# MODE SELECTOR SWITCH

**Power Mode / Trenching Mode Switch**

| Operation Mode | | Output Check (Operation mode display LED) | e-EPOS Output | | |
|---|---|---|---|---|---|
| | | | **Electromagnetic Proportional Pressure Reducing Valve (E.P.P.R Valve) Current (mA)** | **Swing Priority Solenoid Valve** | **7-Segment Display** |
| Power Mode | Power Mode | ON | No-load: 150 ±20mA<br>Load: Variable output<br>(Max. current: 600 ±20mA) | - | 9 x |
| | Standard Mode | OFF | No-load: 250 ±20mA<br>Load: Variable output<br>(Max. current: 600 ±60mA) | - | 7 x |
| Work Mode | Trenching Mode | OFF | - | ON | x 2 |
| | Digging Mode | ON | - | OFF | x 0 |

**NOTE:** *When the engine speed is below 1,000 rpm, the output current of E.P.P.R valve is fixed to be 600 ±60mA.*

**Auto Idle Switch**

| Operation Mode | | Output Check (Operation mode display LED) |
|---|---|---|
| Auto Idle | Activation | ON |
| | Cancellation | OFF |

# GRAPHIC INFORMATION AREA DISPLAY

## Overview

Many kinds of condition of machine are displayed on the letter information display department. The information display department is divided into two menus. One is main menu for user and the other is special menu for specialist. These menus can be moved from normal display mode by the combination of selector buttons.

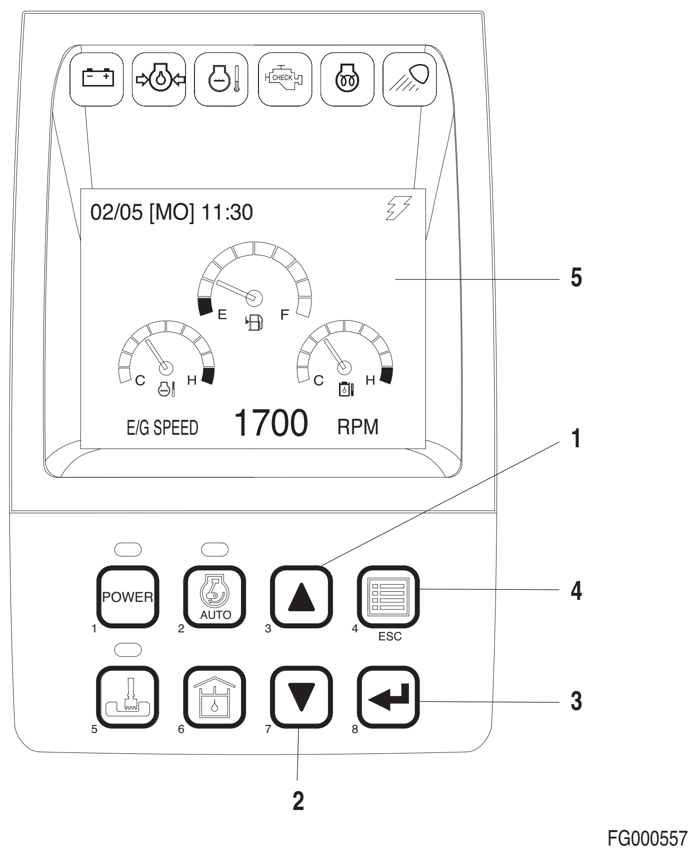



**Figure 12**

| Selector Buttons | Graphic Display Area |
|---|---|
| 1. Up Arrow Button<br>2. Down Arrow Button<br>3. Enter Button<br>4. Escape Button | 5. Letter Information Display Department |

## Main Menus for the Graphic Display Area

1. Main menu: Language setting, Time setting, Filter/Oil information, Brightness adjustment, Password
2. Special menu: Information of machine status, failure information, Information of machine operation.

## Menu Selector Buttons

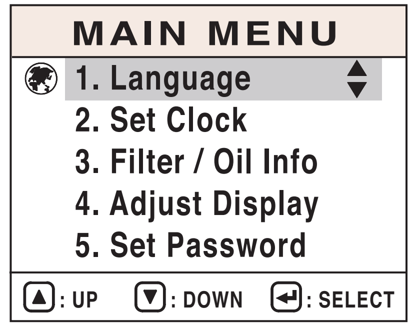
1. Up Arrow Button (▲, 1 on Figure 12): Move the cursor to up, left and previous screen.
2. Down Arrow Button (▼, 2 on Figure 12): Move the cursor to down, right and next screen.
3. Enter Button (↵, 3 on Figure 12): Move the menu to selected mode. When setting the menu, this button is used to function as the selector button.
4. Escape Button (ESC, 4 on Figure 12): Move a screen to previous menu or main menu.

# MAIN MENU

When the "ESC" button is pressed for more than 3 seconds, the main menu screen is displayed.

Main menu offers sub-menus (language setting, time setting, or filter/oil information, brightness adjustment, password) to the operator.

Refer to the "Operation and Maintenance Manual" for details.




FG000072

**Figure 13**

## Language

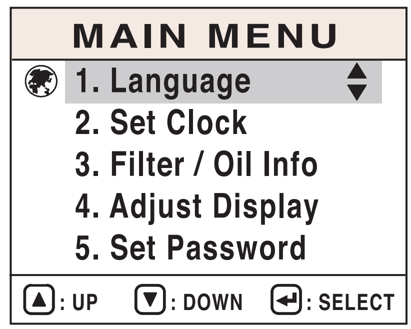
Put the cursor on Language in the main menu and put the Enter Button (↵, 3 on Figure 12) and the language select view appears.

The default language is Korean, but it will memorize and use the newly set language.

Use the Up Arrow Button (▲, 1 on Figure 12) or Down Arrow Button (▼, 2 on Figure 12) to move cursor to a language to be selected on the Language Select display and press the Enter Button (↵, 3 on Figure 12) and the selected language is indicated in the right bottom of the screen.

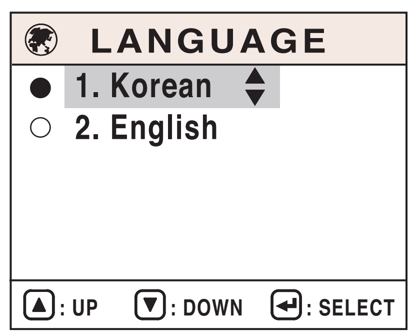
At this point pressing the Enter Button (↵, 3 on Figure 12) or the Escape Button (ESC, 4 on Figure 12) more than 1 second brings the main menu with changed language and then pressing the ESC button again shows the default view.

Without pressing a button more than 20 seconds, the default view appears.




FG000072

**Figure 14**




FG000783

**Figure 15**

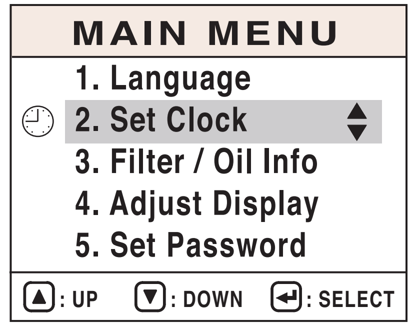
## Set Clock

It is used to adjust time of the digital clock.

Pressing the Enter Button (↵, 3 on Figure 12) in the Main Menu after putting cursor on Set Clock brings Set Clock display.

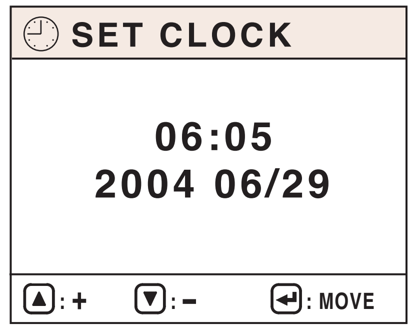
Without pressing a button more than 20 seconds, the default view appears.

Please refer to the Operation Manual for detailed information on Time Setting.




FG000075

**Figure 16**



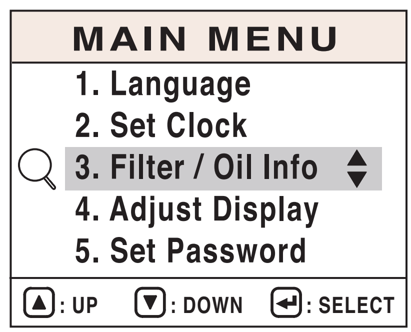

FG000076

**Figure 17**

## Filter/Oil Info

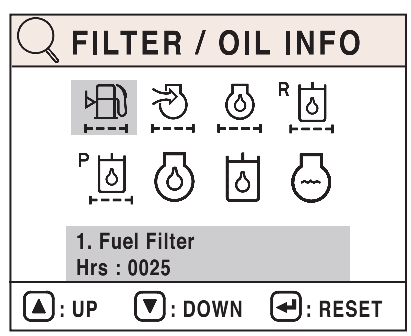
This mode displays total operating hours of filters and oils.

After changing the filter and oil, reset the operating hour and then the operating hours until the next service interval can be easily checked.



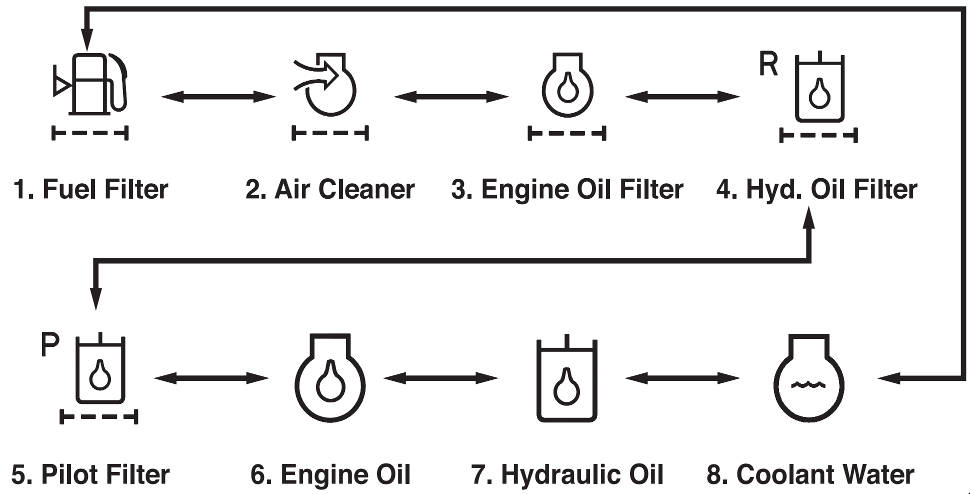

FG000077

**Figure 18**




FG000078

**Figure 19**




FG001358

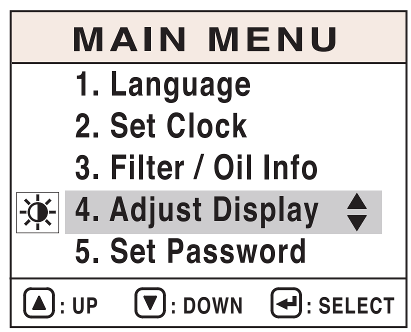
Figure 20

## Adjust Display

Pressing the Enter Button (↵, 3 on Figure 12) in the main menu after putting cursor on Adjust Display brings Adjust Display.

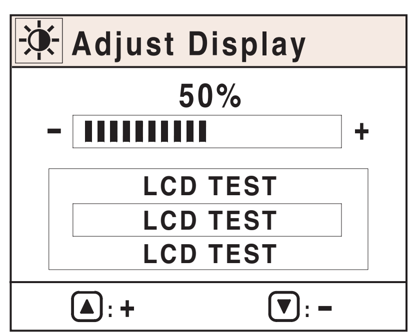
Screen brightness can be adjusted using the Up Arrow Button (▲, 1 on Figure 12) or the Down Arrow Button (▼, 2 on Figure 12).

The default brightness is set to 50%.




FG000080

Figure 21



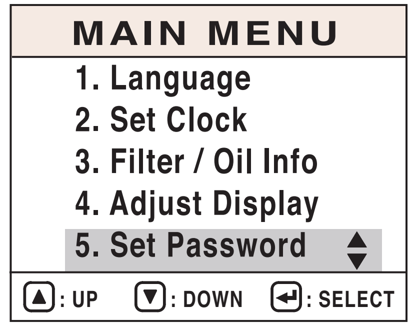

FG000081

Figure 22

## Set Password

This menu is used to apply (lock), release, or change password.

Please refer to the Operation Manual for detailed information on Password Setting.




FG000227

**Figure 23**

# SPECIAL MENU

In this menu, many types of operating conditions and functions can be accessed and displayed, including the e-EPOS controller. This menu is mainly used for machine testing and failure diagnostics.

The special menu offers three sub-menus:

1. Machine status.
2. Failure information.
3. Information on machine operation.

## Entering/Accessing and Exiting/Escaping Menus

### Entering/Accessing Menus

When normal mode screen is displayed, if the enter button (↵, 3) and escape button (ESC, 4) are pressed simultaneously for more than 3 seconds, normal mode screen (Figure 25) will be changed to special menu screen (Figure 26).

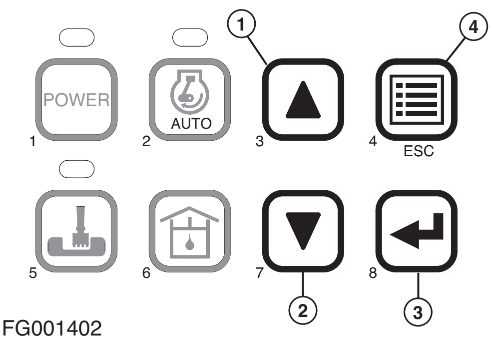
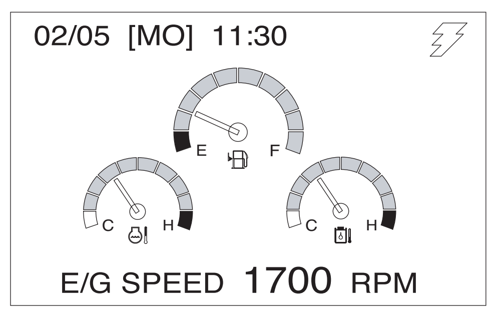



**Figure 24**

Normal Mode Screen

**NOTE:** *Normal mode screen can display many kinds of display mode by selecting, for example, engine speed (RPM), battery voltage (VOLT), front pump pressure (BAR), rear pump pressure (BAR) and so on by selecting.*



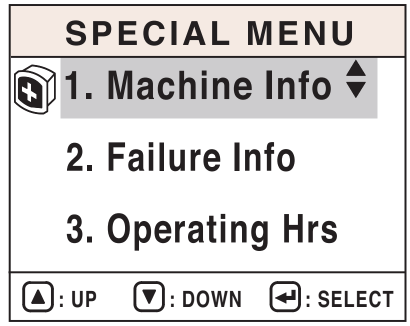

FG000043

**Figure 25**

Special Menu Screen

**NOTE:** *Displayed language on the special menu screen consists of Korean and English.*

*If any language except for Korean is selected during language selection mode of main menu, only English will be displayed on special menu screen.*




FG000558

**Figure 26**

**Exiting/Escaping Menus**

1. If escape button (ESC, 4 on Figure 24) is pressed for more than 1 second, the special menu screen will be returned to the normal mode screen.
2. If this special menu is "ON" without any activity, for more than 20 seconds, it will turn to the normal mode screen.
3. After the turning starter switch to the "OFF" position, turn it back to the "ON" position, and the normal mode screen displayed once again.

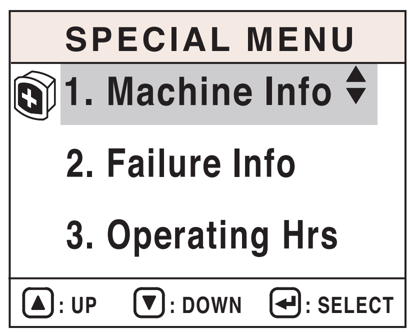
## Special Menu Selections

**Submenu Selection Method**

Various sub-menus can be selected by pressing "Up (▲, 1 on Figure 24)" and "Down (▼ , 2 on Figure 24)" button.

Move the cursor to desired menu and a selected menu will be inverse displayed.

When the selected menu is inverse displayed, press the "Enter (↵, 3 on Figure 24)" button for menu selection.

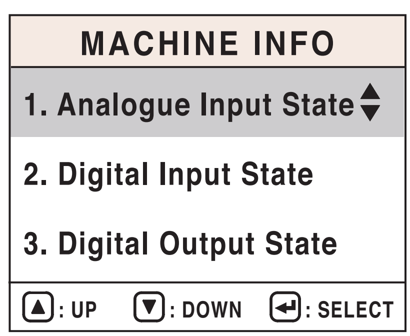



FG000558

**Figure 27**

**Information of Machine Status**

1. Entering Sub-menus: When cursor is located on "Machine Info" of special menu screen, press "Enter (↵, 3 on Figure 24)" button and the "Machine Info" will be displayed.
2. Exiting Sub-menus: If escape button (ESC, 4 on Figure 24) is pressed for more than 1 second, display will be turned to previous screen.




FG000559

**Figure 28**

**Analog Inputs Description**

| Analog Input Items | Display | Remark |
|---|---|---|
| 1. Pump P/V | mA | Current in pump proportional valve. |
| 2. Cooling Fan P/V | mA | N.A. |
| 3. Flow Control P/V | mA | N.A. |
| 4. Dial | mV | Indicating dial voltage. |
| 5. TPS | mV | N.A. |
| 6. E/G Control Motor | mV | N.A. |
| 7. Boom Pressure | BAR | Boom cylinder head pressure. |
| 8. Pilot Gear Pump Press | BAR | N.A. |
| 9. Boost Pressure | BAR | Pump pressure for boost. |
| 10. Intake Manifold Temperature | °C | Temperature of air incoming to intake manifold. |
| 11. E/G Oil Pressure | BAR | Engine oil pressure. |
| 12. Fuel Temperature | °C | Fuel temperature. |
| 13. E/G Oil Temperature | °C | Engine oil temperature. |
| 14. Load At Cur. Spd | % | Current load ratio of equipment. |

**Submenu Selections**

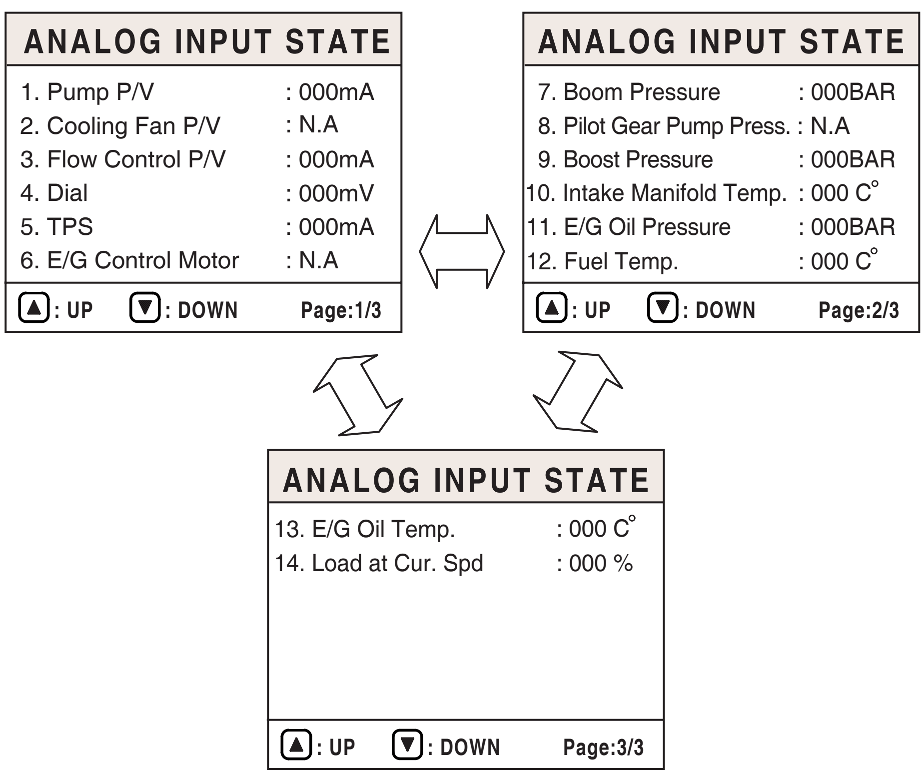
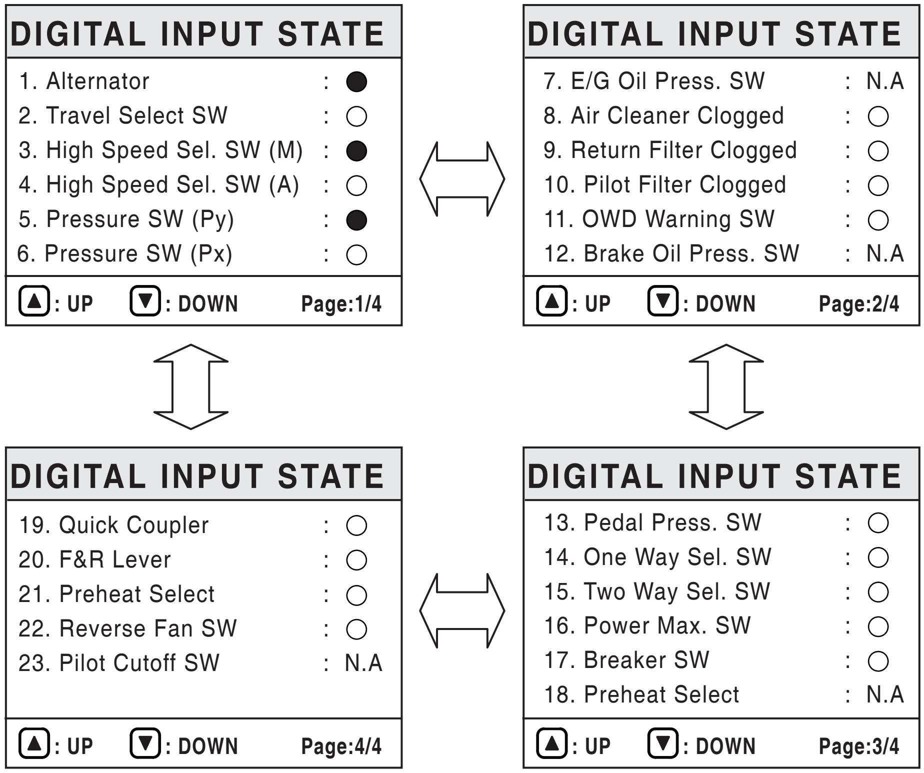



**Figure 29**

**Digital Inputs Descriptions**

| Digital Inputs Items | Mark | Remark |
|---|---|---|
| 1. Alternator | ON / OFF | Lights up when output at alternator "R(I)" terminal is above 12 ±1V. |
| 2. Travel Select SW | | N.A. (only for wheel type equipment) |
| 3. High Speed Sel. SW (M) | | Lights up when the travel speed selector switch is set to the "I" position. |
| 4. High Speed Sel. SW (A) | | Lights up when the travel speed selector switch is set to the "II" position. |
| 5. Pressure SW (Py) | | Lights up when the pressure switch (Py) is "ON." |
| 6. Pressure SW (Px) | | Lights up when the pressure switch (Px) is "ON." |
| 7. E/G Oil Press. SW | | N.A. (only for mechanical engine) |
| 8. Air Cleaner Clogged | | Lights up when the air cleaner indicator contact is "ON." |
| 9. Return Filter Clogged | | Lights up when the return filter pressure switch is "ON." |
| 10. Pilot Filter Clogged | | Lights up when the pilot filter pressure switch is "ON." |
| 11. OWD Warning SW | | Lights up when the overload warning selector switch is "ON." |
| 12. Brake Oil Press. SW | | N.A. (only for wheel type equipment) |
| 13. Pedal Press. SW | | Lights up when the pedal pressure switch is ON. |
| 14. One Way Sel. SW | | Lights up when the selector switch is turned to breaker. |
| 15. Two-way Sel. SW | | Lights up when the Selector Switch is turned to "SHEAR." |
| 16. Power Max. SW | | Lights up when the boost button is "ON" with the Select switch turned to "BOOST." |
| 17. Breaker SW | | Lights up when the boost button is "ON" with the selector switch turned to "BREAKER." |
| 18. Preheat Select | | N.A. |
| 19. Quick Coupler | | Lights up when the Quick Coupler switch is "ON." |
| 20. F and R Lever | | N.A. (only for wheel type equipment) |
| 21. Preheat Select | | Lights up during preheating (CN5-2) terminal voltage is below 2V. |
| 22. Reverse Fan SW | | N.A. |
| 23. Pilot Cutoff SW | | N.A. |

**Menu Select**



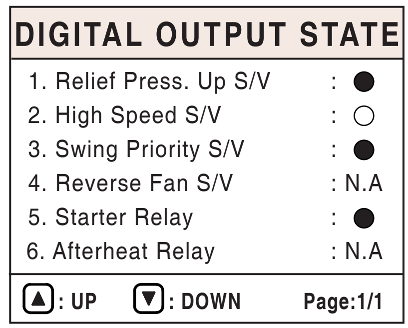

FG008136

**Figure 30**

**Digital Outputs Descriptions**

| Digital Outputs Items | Mark | Remark |
|---|---|---|
| 1. Relief Press. Up S/V | ON / OFF | Lights up when the relief press up solenoid valve is "ON." |
| 2. High Speed S/V | | Lights up when the high speed solenoid valve is "ON." |
| 3. Swing Priority S/V | | Lights up when the swing priority solenoid valve is "ON." |
| 4. Reverse Fan S/V | | N.A. |
| 5. Starter Relay | | When the starter relay is "ON." |
| 6. After Heat Relay | | N.A. |

**Menu Select**

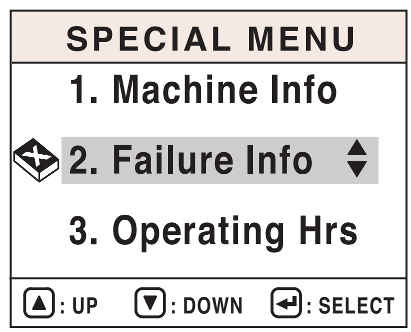


FG003930

**Figure 31**

**Failure Information**

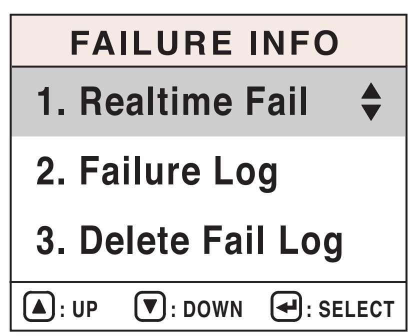
1. Entering Sub-menus: When a cursor is located in "Failure Info" of special menu screen press enter button (↵, 3 on Figure 24) and "Failure Info" screen is displayed.
2. Exiting Sub-menus: If escape button (ESC, 4 on Figure 24) is pressed for more than 1 second, this information screen will be returned to previous screen.



FG000563

**Figure 32**

* Real-time Failure:
  Current status of failure is displayed.
* Failure Log:
  Memorized record of past failure is displayed.
* Delete Fail Log:
  This mode is used to delete all of the memorized record of past failure.



FG000564

**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 using "UP" (▲, 1 on Figure 24) or "DOWN" (▼, 2 on Figure 24) button.

* 1/2: A serial number of current failure/ total quantity of failure.

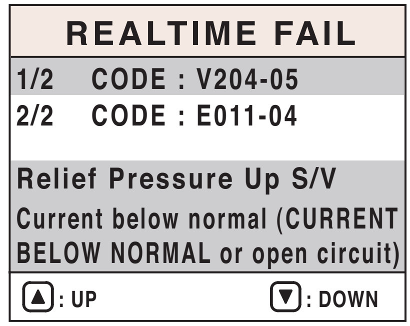
* Vxxx-xx: Vxxx is a unique code and xx is a FMI (Failure Mode Identifier) number.

- V: Machine related failure code

- E: Engine related failure code

Refer to the failure information code for unique codes and FMI numbers.

This example shows one of two failures.



FG000565

**Figure 34**

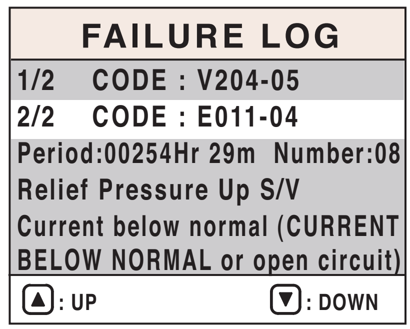
B. Past failure information

Memorized record of past failure is displayed (Failure code, failure contents).

When a number of failures are produced, failure information can be checked using "UP" (▲, 1 on Figure 24) or "DOWN" (▼, 2 on Figure 24) button.

**NOTE:** *" Number: xxx ": "xxx" means that the totally counted number of the same failure.*

*" Period:xxxxxHrxxm ": It indicates the period for which machine has operated until a failure takes place. (For more than two occurrences of the same failure, until the first occurrence time.)*



FG000566

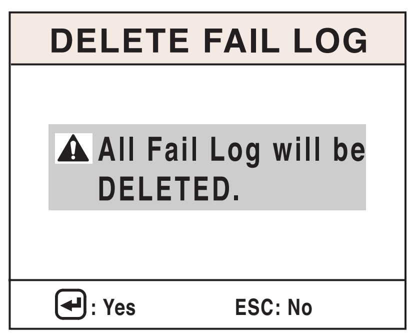
**Figure 35**

C. Failure record deletion

This mode is used to delete the memorized record of past failure. If this mode is selected, all records will be deleted.

When "YES" (↵, 3 on Figure 24) button is pressed, the memorized record will be deleted.
At this time, deletion signal will be displayed and the screen will move to previous menu after deletion.

This screen will be displayed during 3 seconds.



FG000567

**Figure 36**

Input your password with one of No. 1 - 8 switches.

When "NO" (ESC, 4 on Figure 24) button is pressed, the screen will recover to previous menu without deletion.

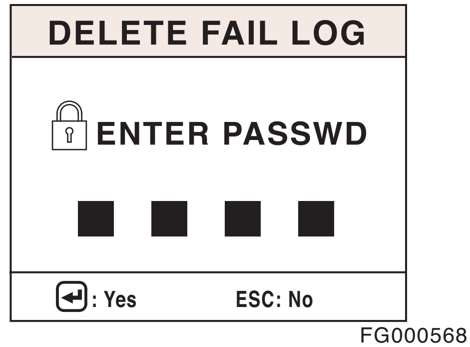



Figure 37

Delete Completed screen will appear 3 seconds and the screen will move to Failure Info screen.

It has been shown 3 seconds upon deleting Fail Log.

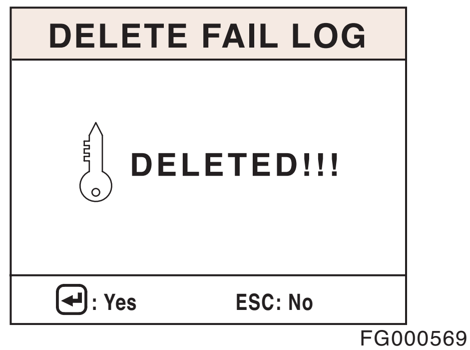



Figure 38

The screen shown on the left will appear 3 seconds in case of wrong password input and then Enter Password screen appears again.

It has been shown 3 seconds in case of password failure.

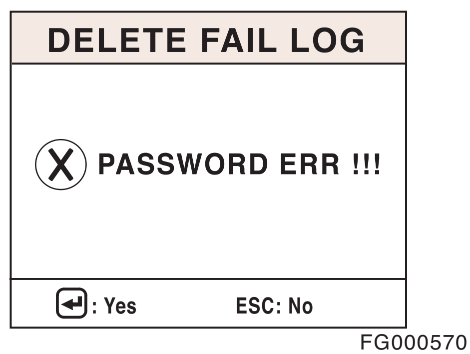



Figure 39

**Failure Information Code at Machine Side**

| Code | Failure Component | Measuring Points | Correct Value | | Remarks |
|---|---|---|---|---|---|
| | | | Active | Passive | |
| **V201** | Gauge Panel Communication Error | CN7-4<br>CN7-5 | - | R = 60 ±5 Ω | It is a composite resistance of CAN line. This value has to be measured by connected condition of CAN line. |
| **V202** | Ecu Communication Error | CN4-4<br>CN4-5 | - | R = 60 ±5 Ω | |
| **V210** | Pump P/V | CN1-10<br>CN1-21 | - | R = 18 ±2 Ω (25°C (77°F)) | Pump proportional pressure reducing valve. |
| **V211** | Cooling Fan P/V | | - | - | N.A. |
| **V212** | Flow Control P/V | CN1-19<br>CN1-20 | - | R = 14 ±2 Ω (25°C (77°F)) | Flow control proportional pressure reducing valve. |
| **V213** | Relief Pressure Up S/V | CN1-1<br>CN1-11 | V = V_volt (Note 4.) | R = 26.2 ±2 Ω (25°C (77°F)) | Breaker/boost/ shear selector switch has to be selected as a boost function and the boost switch on the right-hand joystick is "ON" status. |
| **V214** | High Speed S/V | CN1-1<br>CN1-12 | V = V_volt | R = 26.2 ±2 Ω (25°C (77°F)) | Voltage is only measured when the pressure switch (Py) is turned "ON." |
| **V215** | Swing Priority S/V | CN1-1<br>CN1-13 | V = V_volt | R = 26.2 ±2 Ω (25°C (77°F)) | Work mode has to be selected as a trenching mode. |
| **V216** | Reverse Fan Speed S/V | | - | - | N.A. |
| **V217** | Starter Relay | CN1-1<br>CN1-15 | V = V_volt | - | It has to be measured in engine start up state. |
| **V218** | After Heat Relay | | - | - | N.A. |

| Code | Failure Component | Measuring Points | Correct Value | | Remarks |
|---|---|---|---|---|---|
| | | | Active | Passive | |
| **V220** | Front Pump Press. Sensor | CN3-1<br>CN3-2 | V = IV | - | It has to be measured in engine stop state. |
| **V221** | Rear Pump Press. Sensor | CN3-3<br>CN3-4 | V = IV | - | |
| **V222** | Hyd. Oil Temperature Sensor | CN3-9<br>CN3-10 | - | R = 2.45 ±0.25 kΩ (25°C (77°F))<br>R = 320 ±32 Ω (80°C (176°F)) | |
| **V223** | Water Temperature Sensor | | - | - | N.A. |
| **V224** | Engine Speed Sensor | | - | - | N.A. |
| **V225** | Fuel Level Sensor | CN3-7<br>CN3-8 | - | Empty: 5 ±0.25 kΩ<br>Full: 320 ±32 Ω | |
| **V226** | Alternator Potential | CN2-14<br>CN1-8 | V = 2 ±1V | - | It has to be measured in engine stop state. |
| **V227** | Dial | CN3-16<br>CN3-7 | - | R = 1.0 ±0.3 kΩ<br>R = 4.0 ±1.5 kΩ | |
| **V228** | Tps (Wheel) | | - | - | N.A. |
| **V229** | Parking Brake Press. Sensor | | - | - | N.A. |
| **V230** | E/g Control Motor Sensor | | - | - | N.A. |

**NOTE:** *1. Active value: Starter switch has to be turned "ON"*

*Measuring points between component and wire harness have to be connected.*

*2. Passive value: Starter switch has to be turned "OFF"*

*Measuring points between component and wire harness have to be disconnected.*

*3. Measuring points are engine controller's points and passive value is each component's value.*

*4. V–batt: Source power of equipment.*

**Failure Information Code at Engine Side**

| Code | Failure Component | Measuring Points | Current Valve | | Remarks |
|---|---|---|---|---|---|
| | | | Active | Passive | |
| **E011** | Coolant temperature sensor | 2-26<br>2-15 | - | R=186 ±5 Ω (100°C (212°F)) | |
| **E012** | Fuel temperature sensor | 2-26<br>2-35 | - | R=186 ±5 Ω (100°C (212°F)) | |
| **E013** | Boost air temperature sensor | 2-36<br>2-25 | - | R=186 ±5 Ω (100°C (212°F)) | |
| **E014** | Boost air pressure sensor | 2-33<br>2-34 | V = 1,071 ±58mV (at 23°C (73°F) and absolute pressure 1bar) | - | It has to be measured in engine running state. |
| **E017** | E/G oil temperature sensor | 2-28<br>2-24 | - | R=186 ±5 Ω (100°C (212°F)) | |
| **E018** | E/G oil pressure sensor | 2-32<br>2-27 | V = 2,318 ±80mV (at 23°C (73°F) and absolute pressure 3bar) | - | It has to be measured in engine running state. |
| **E021** | Battery voltage | 1-03<br>1-06 | V = V–volt (Note 4.) | - | |
| **E022** | Fuel pressure sensor | 3-09<br>3-10 | V = 1,833 ±28mV (at 23°C (73°F) and absolute pressure 300bar) | - | It has to be measured in engine running state. |
| **E032** | Fuel pressure monitoring MPROP | 2-14<br>2-12 | - | R=2.60 ±3.15 Ω (20°C (68°F)) | |
| **E037** | CAN module | 1-53 and 1-52<br>1-35 and 1-34 | - | R=60 ±5 Ω (20°C (68°F)) | It is a composite resistance of CAN line.<br>This value has to be measured by connected condition of CAN line. |
| **E038** | Engine overspeed | | - | - | |
| **E039** | Main relay (ECU) | | - | - | |
| **E041** | Redundant shutoff path | | - | - | Abnormal engine stop. |
| **E042** | E/G speed (Crankshaft) | 2-23<br>2-19 | - | R=860 ±6 Ω (20°C (68°F)) | |
| **E043** | E/G speed (Camshaft) | 2-09<br>2-10 | - | - | |

| Code | Failure Component | Measuring Points | Current Valve | | Remarks |
|---|---|---|---|---|---|
| | | | Active | Passive | |
| **E044** | Engine speed sensor | | - | - | Synchronizing error between crank shaft speed sensor and cam shaft speed sensor. |
| **E045** | EEPROM | | - | - | Data storing error when engine stop. |
| **E046** | Recovery | | - | - | |
| **E047** | Monitoring of PRV | | - | - | When the pressure sensor of common rail or high-pressure pump has a defect. |
| **E048** | Power supply | 1-03<br>1-06 | V = V–volt | - | |
| **E049** | Booster voltage C1 | | - | - | |
| **E051** | Booster voltage C2 (#6, 2 and 4) | | - | - | |
| **E058** | Solenoid power stage 1 | 3-13<br>3-04 | - | R=0.31 ±0.42 Ω (20°C (68°F)) | |
| **E059** | Solenoid power stage 2 | 3-11<br>3-06 | - | - | |
| **E061** | Solenoid power stage 3 | 3-05<br>3-12 | - | - | |
| **E062** | Solenoid power stage 4 | 3-03<br>3-14 | - | - | |
| **E063** | Solenoid power stage 5 | 3-01<br>3-16 | - | - | |
| **E064** | Solenoid power stage 6 | 3-02<br>3-15 | - | - | |
| **E066** | Preheat light (E/G: Lowside Power stage 2) | 1-56<br>1-06 | - | - | |
| **E072** | Preheat relay (E/G: Highside Power stage 1) | 1-13<br>1-07 | V = V–volt | R=40 ±5 Ω (25°C (77°F)) | Voltage is only measured when afterheat function is operating status. |

| Code | Failure Component | Measuring Points | Current Valve | | Remarks |
|---|---|---|---|---|---|
| | | | Active | Passive | |
| **E083** | Fuel HI pressure pump (E/G: Current controlled Highside power stage 1) | - | - | - | Fuel metering unit error of high-pressure pump. |
| **E091** | System start-up test for shutoff path | - | - | - | Power supply error<br>Engine controller error. |
| **E092** | Monitoring of misfire cylinder 1 | - | - | - | Injector error<br>Speed signal error of cam shaft speed sensor or crank shaft speed sensor. |
| **E093** | Monitoring of misfire cylinder 2 | - | - | - | |
| **E094** | Monitoring of misfire cylinder 3 | - | - | - | |
| **E095** | Monitoring of misfire cylinder 4 | - | - | - | |
| **E096** | Monitoring of misfire cylinder 5 | - | - | - | |
| **E097** | Monitoring of misfire cylinder 6 | - | - | - | |
| **E098** | Monitoring of misfire multiple cylinder | - | - | - | |
| **E099** | Monitoring of overrun | - | - | - | |
| **E101** | Engine speed redundant | - | - | - | |

**NOTE:** *1. Active value: Starter switch has to be turned "ON"*

*Measuring points between component and wire harness have to be connected.*

*2. Passive value: Starter switch has to be turned "OFF"*

*Measuring points between component and wire harness have to be disconnected.*

*3. Measuring points are engine controller's points and passive value is each component's value.*

*4. V–batt: Source power of equipment.*

**FMIs (Failure Mode Identifier)**

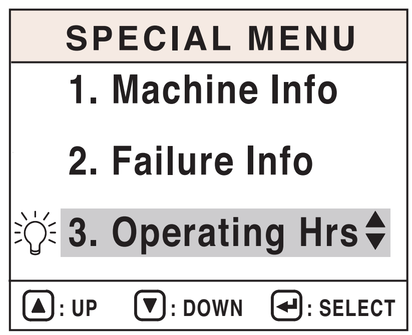
| | |
|---|---|
| **FMI 0** | Above normal range (DATA VALID but ABOVE NORMAL OPERATIONAL RANGE) |
| **FMI 1** | Below normal range (DATA VALID but BELOW NORMAL OPERATIONAL RANGE) |
| **FMI 2** | Incorrect signal (DATA ERRATIC, INTERMITTENT OR INCORRECT) |
| **FMI 3** | Voltage above normal (VOLTAGE ABOVE NORMAL OR SHORTED TO HIGH SOURCE) |
| **FMI 4** | Voltage below normal (VOLTAGE BELOW NORMAL OR SHORTED TO LOW SOURCE) |
| **FMI 5** | Current below normal (CURRENT BELOW NORMAL OR OPEN CIRCUIT) |
| **FMI 6** | Current above normal (CURRENT ABOVE NORMAL OR GROUNDED CIRCUIT) |
| **FMI 8** | Abnormal signal (ABNORMAL FREQUENCY OR PULSE WIDTH OR PERIOD) |
| **FMI 11** | Failure mode not identifiable (ROOT CAUSE NOT KNOWN - Malfunction) |
| **FMI 31** | NOT AVAILABLE OR CONDITION EXISTS |

**Information of Machine Operation**

Accumulated operation hour of each mode and status is displayed.

1. Operating Hour Information

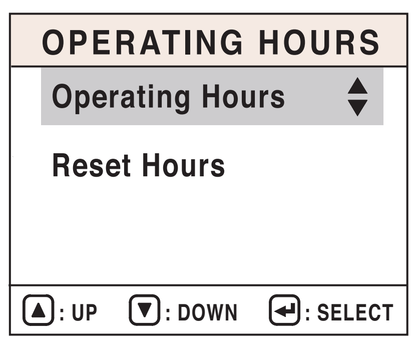
   A. Entering Sub-menus: When a cursor is located in "Operating Hrs" of special menu screen (Figure 40) press enter button (↵, 3 on Figure 24) and "Operating Hrs" screen will be displayed (Figure 41).




FG000571

**Figure 40**

   B. Information screen of machine operation (Figure 41).

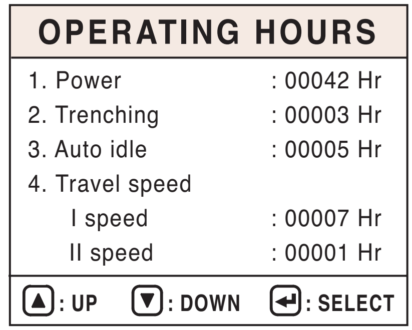



FG000572

**Figure 41**

C. Operating Hours Screen

D. Exiting Sub-menus: If escape button (ESC, 4 on Figure 24) is pressed for more than 1 second, this information screen will be returned to previous screen.



FG000573

**Figure 42**

**Information contents of operation hour**

| Item | Information Contents | Detection Method |
|---|---|---|
| Power Mode | Operation hours used power mode are displayed. | Power mode switch (Instrument panel) - "ON" status and Alternator signal (CN2-14) is "HI" |
| Trenching Mode | Operation hours used trenching mode are displayed. | Trenching mode switch (Instrument panel) - "ON" status and Alternator signal (CN2-14) is "HI" |
| Auto Idle | Operation hours used auto idle status are displayed. | Auto idle switch (Instrument panel) - "ON" status and Alternator signal (CN2-14) is "HI" |
| Travel Speed:<br>-1st<br>- 2nd | Operation hours used low speed and high speed are displayed. | 1st: High speed s/v "OFF" status<br>2nd: High speed s/v and travel pressure switch "Py" (control valve) - "ON" status. |
| Hydraulic Oil Temperature Distribution (°C (°F)) | Temperature of hydraulic oil is classified 6 steps. And operation hours of each step are displayed<br>Under 30°C (87°F)<br>31 - 50°C (88 - 123°F)<br>51 - 75°C (124 - 168°F)<br>76 - 85°C (169 - 186°F)<br>86 - 95°C (187 - 203°F)<br>Over 96°C (204°F) | The resistance delivered from temperature sensor of hydraulic oil is classified 6 steps. And operation hours of each step are displayed. (Alternator output HI status) |
| Coolant Temperature Distribution (°C (°F)) | Temperature of coolant is classified 6 steps. And operation hours of each step are displayed.<br>Under 40°C (105°F)<br>41 - 60°C (106 - 141°F)<br>61 - 85°C (142 - 186°F)<br>86 - 95°C (187 - 204°F)<br>96 - 105°C (205 - 222°F)<br>Over 106°C (223°F) | The resistance delivered from coolant sensor is classified 6 steps. And operation hours of each step are displayed. (Alternator output HI status) |

**Menu Selection of Operation Hour Information**

1. Power Mode ↔ 2. Trenching Mode ↔ 3. Auto Idle ↔ 4. Travel Speed 1st, 2nd

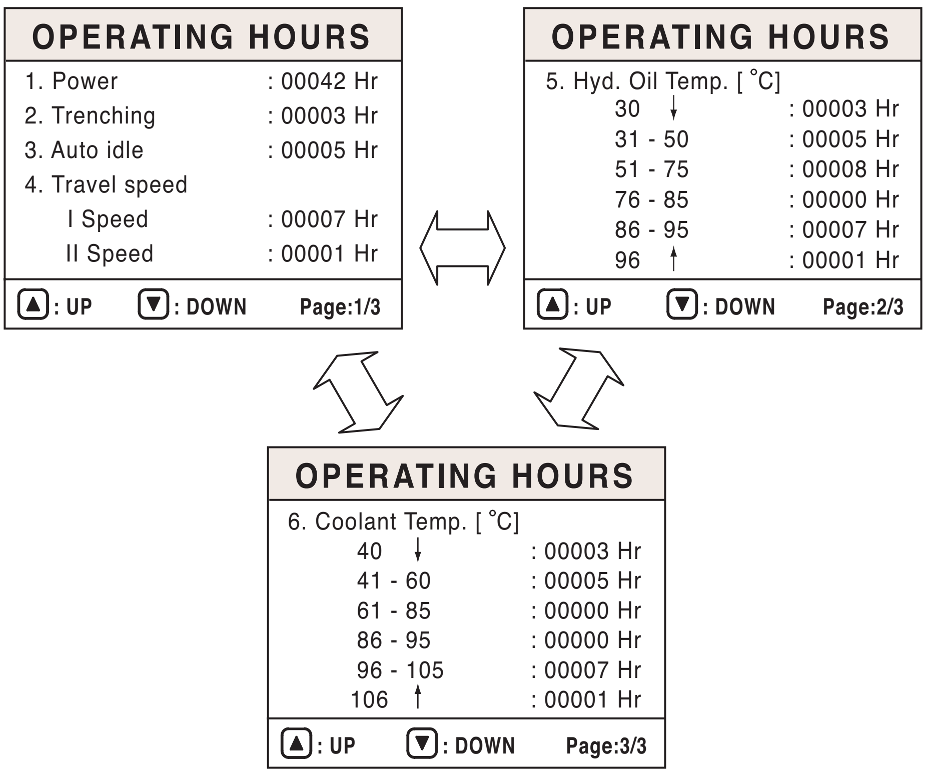
↕ ↕

6. Coolant Temperature Distribution ↔ 5. Hydraulic Oil Temperature Distribution

FG000574

**Figure 43**

**Example of Machine Operation Info Screen**

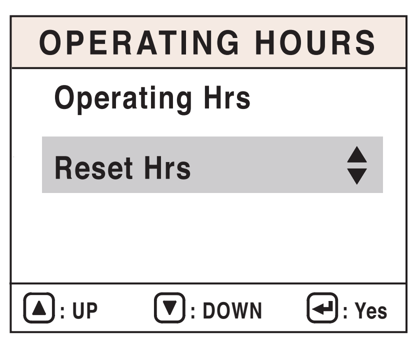



FG000575

**Figure 44**

2. Operation hour reset

   A. Entering Sub-menus: When cursor is located in "Reset Hrs" of information screen of operating hours press enter button (↵, 3 on Figure 24) and "Machine Operation Info" screen will be displayed.




FG000578

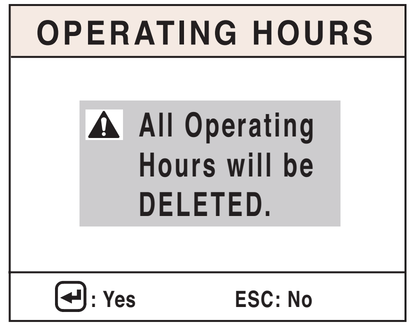
**Figure 45**

B. Reset screen of operation hour

C. Exiting Sub-menus: If escape button (ESC, 4 on Figure 24) is pressed for more than 1 second, this information screen will be returned to previous screen.

**NOTE:** *When "YES" (↵, 3 on Figure 24) button is pressed, operation hours will reset. At this time, resetting signal will be displayed and the screen will move to previous menu after resetting.*

**NOTE:** *When "NO" (ESC, 4) button is pressed, the screen will recover to previous menu without resetting.*

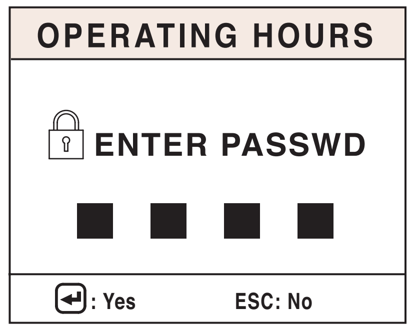



FG000579

**Figure 46**

**Machine Operation Info Screen**

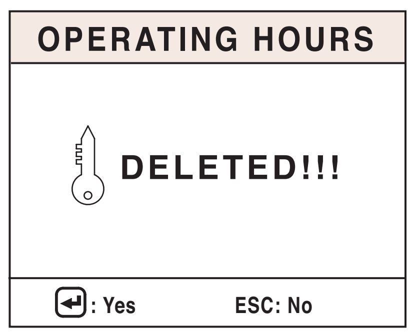
1. If you press the YES" (↵, 3 on Figure 24) button, password entrance screen appears.




FG000576

**Figure 47**

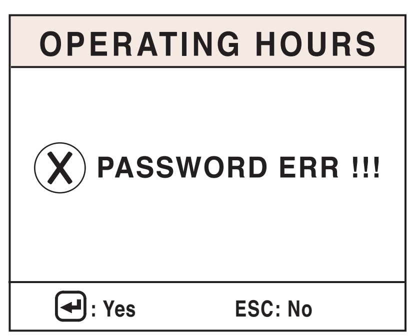
2. When right password is input, machine operation periods will be deleted and Reset Completed screen will appear 3 seconds.




FG000577

**Figure 48**

3. If you press the "NO" (ESC, 4) button, the previous screen appears without resetting operation periods.




FG001086

**Figure 49**

# ELECTRONIC HYDRAULIC CONTROL SYSTEM (e-EPOS)

## Control System Schematic

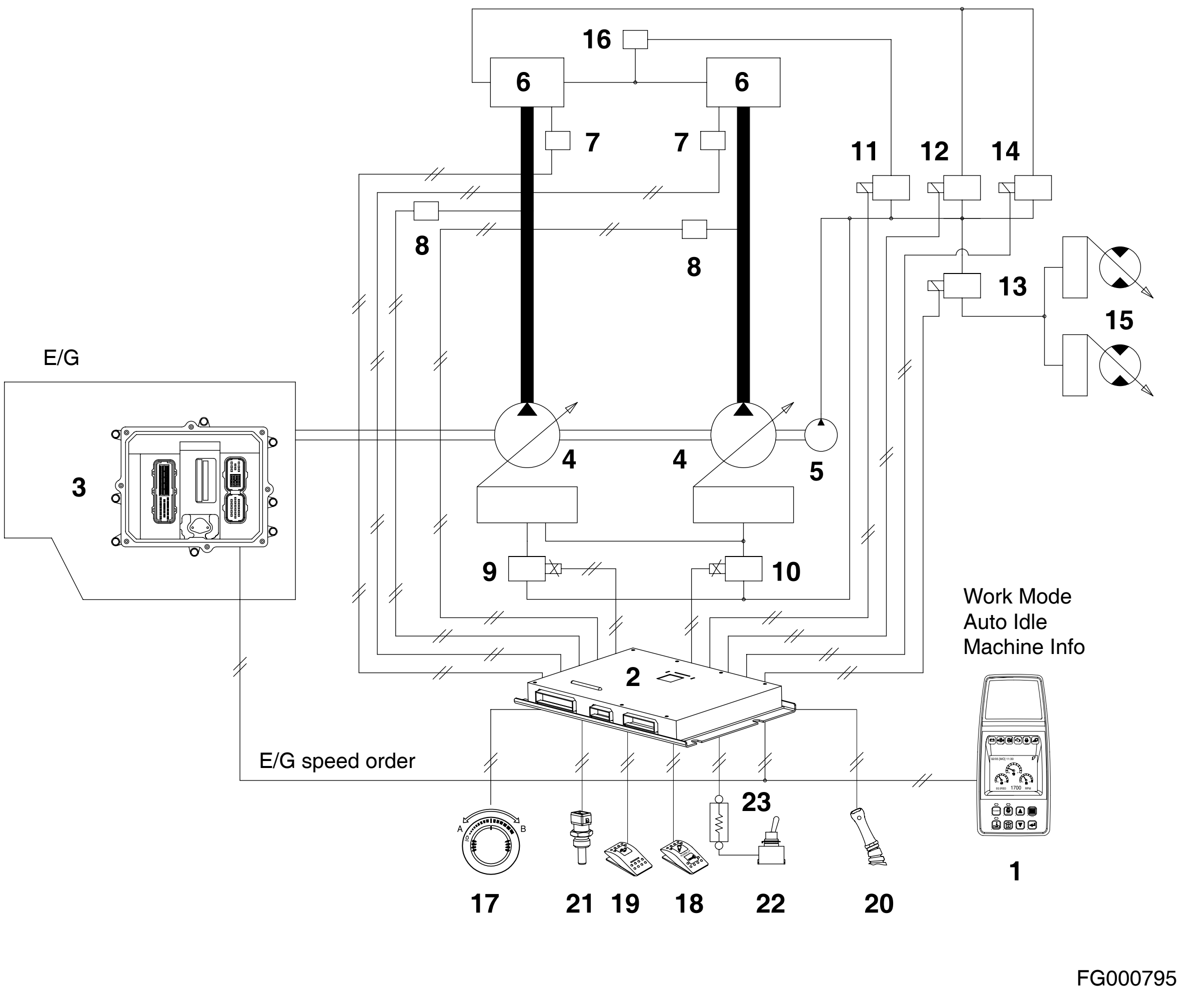



**Figure 50**

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel |
| 2 | e-EPOS Controller |
| 3 | Engine Controller (ECU) |
| 4 | Main Pump |
| 5 | Aux Pump |
| 6 | Control Valve |
| 7 | Pressure Switch |
| 8 | Pump Pressure Sensor |
| 9 | Electromagnetic Proportional Pressure Reducing Valve (Attachment) |
| 10 | Electromagnetic Proportional Pressure Reducing Valve (Mode Control) |
| 11 | Solenoid Valve (Boost) |

| Reference Number | Description |
|---|---|
| 12 | Solenoid Valve (Swing Priority) |
| 13 | Solenoid Valve (High Speed) |
| 14 | Solenoid Valve (Breaker) |
| 15 | Travel Motor |
| 16 | Main Relief Valve |
| 17 | Engine Control Dial |
| 18 | Breaker/Boost/Shear Selector Switch |
| 19 | Auto Travel Selector Switch |
| 20 | Boost Switch (Right Work Lever) |
| 21 | Sensor |
| 22 | Aux Mode Switch |
| 23 | Aux Mode Resistor |

# POWER MODE CONTROL

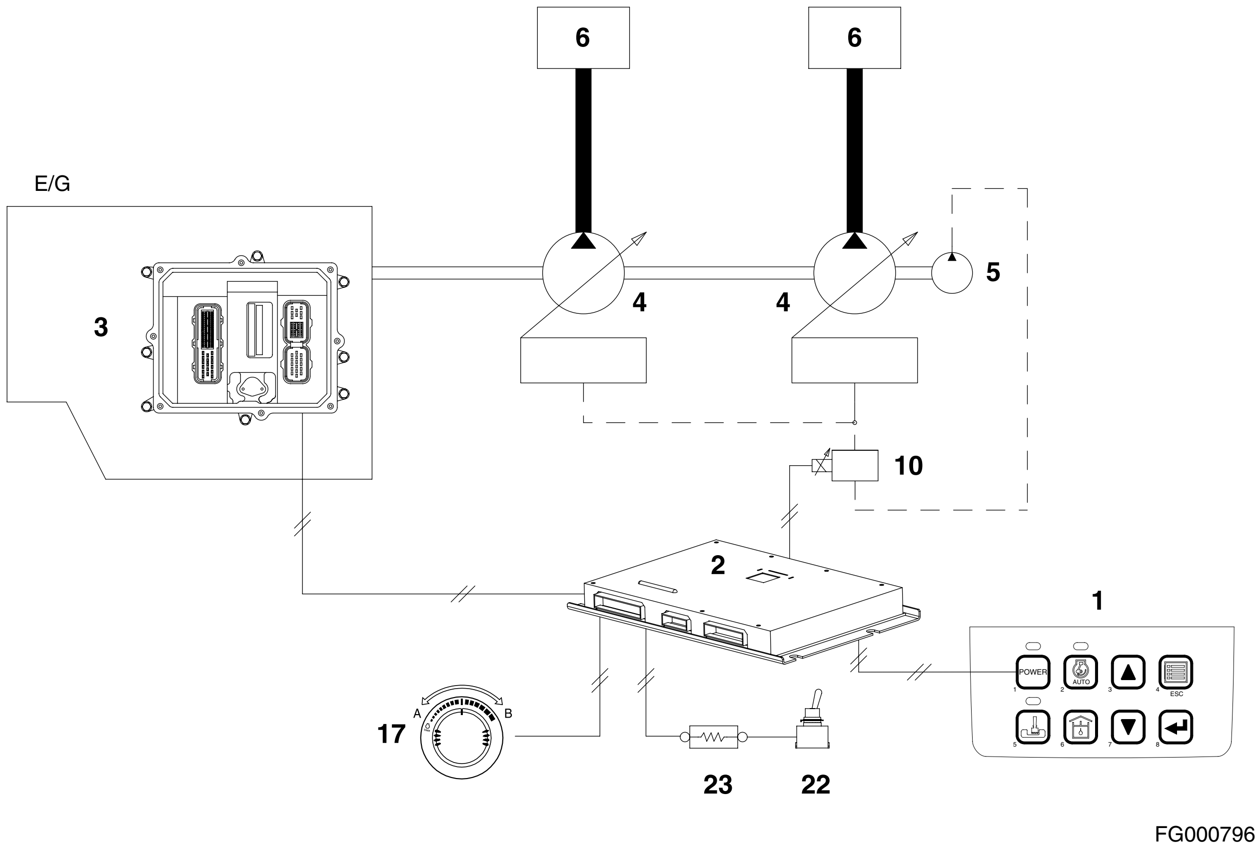



**Figure 51**

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel (Power Mode Selector Switch) |
| 2 | e-EPOS Controller |
| 3 | Engine Controller (ECU) |
| 4 | Main Pump |
| 5 | Aux Pump |
| 6 | Control Valve |

| Reference Number | Description |
|---|---|
| 10 | Electromagnetic Proportional Pressure Reducing Valve (Mode Control) |
| 17 | Engine Control Dial |
| 22 | Aux Mode Switch |
| 23 | Aux Mode Resistor |

The power mode switch permits the selection of the appropriate engine power depending on the working condition. One of the two, Power Mode or Standard Mode, setting can be selected. When the engine starter switch is turned "ON," the power mode is automatically defaulted to standard mode. The desired mode can be selected by pressing the selector button on the instrument panel. When the power mode is selected, the indicator light will turn "ON" to display the selected mode.

The quantity of oil discharged by the pump and the engine speed are determined by the mode selected by the operator. The pump output in each mode is determined by the mode selection and is listed in the following table

| Mode | Standard Mode | Power Mode |
|---|---|---|
| **Output (%)** | Approximately 85% | 100% |

# Operation

**1. Power Mode**

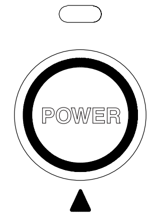
This mode should be selected for high speed work. In this mode the engine output is most efficiently utilized due to the discharged oil volume being controlled based on the equivalent horsepower curve at various loaded pressures. The e-EPOS controller compares the target engine speed with the actual engine speed and controls the signal to the E.P.P.R. (Electromagnetic Proportional Pressure Reducing) valve which in turn varies the pump output quantity.

If the load increases, the engine speed will fall below the rated speed. When this occurs, the controller senses this decrease and immediately reduces the pump discharge volume to maintain the engine speed at the rated level.

On the other hand, if the load is decreased the controller increases the discharge volume of the pump to maintain the engine speed at the rated level.

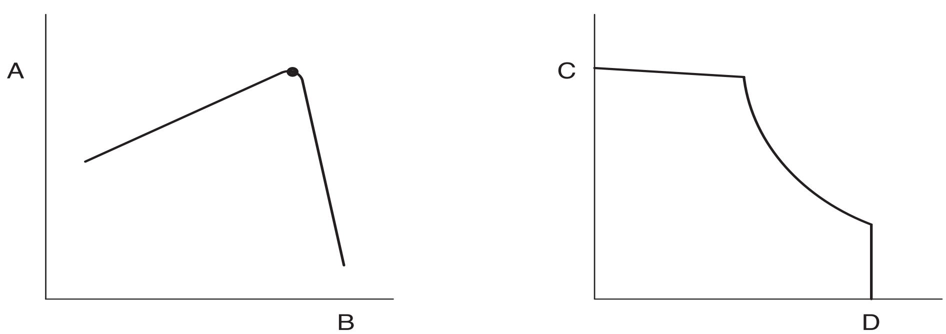
By repeating these control operations, the engine speed is maintained at the rated speed so that maximum power can be generated.

In Power Mode, the e-EPOS controller receives engine speed signals from the engine control dial and the engine controller (ECU) and converts it to an operating signal current and is then transferred to the pump's E.P.P.R valve. At this time the E.P.P.R. valve converts the electric signal to the corresponding control pressure and sends it to the two pumps, adjusting the pump discharge volume to the desired level.




ARO0260L

**Figure 52**




FG000580

**Figure 53**

| Reference Number | Description |
|---|---|
| A | Engine Horsepower (hp) |
| B | Engine Speed (rpm) |
| C | Pump Discharge Volume (lpm) |

| Reference Number | Description |
|---|---|
| D | Pump Discharge Pressure ($kg/cm^2$) |

## 2. Standard Mode

Standard Mode is used for general work. When this mode is selected it will reduce noise and fuel consumption in comparison with Power Mode. The current to the E.P.P.R. valve is shut off and pump discharge volume is controlled by pump regulator.

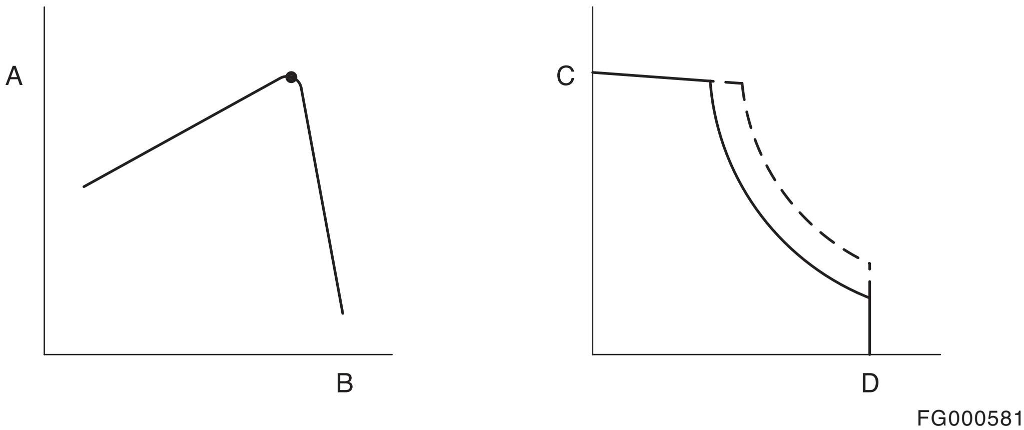



**Figure 54**

| Reference Number | Description |
|---|---|
| A | Engine Horsepower (hp) |
| B | Engine Speed (rpm) |
| C | Pump Discharge Volume (lpm) |

| Reference Number | Description |
|---|---|
| D | Pump Discharge Pressure ($kg/cm^2$) |

### 3) Operation in case of failure in the control system (Aux mode operation

Though it is impossible to control current of the E.P.P.R (Electromagnetic Proportional Pressure Reducing) Valve controlling the discharge volume of pump due to fault in control system, the machine can be operated in the aux mode.

Upon turning "ON" the aux mode switch, the E.P.P.R Valve controlling the discharge volume of pump comes into contact with the aux mode resistor to let current of a certain value flow. At this time, the discharge volume of pump follow the control by the pump regulator, nearly at quantity roughly similar to that in the standard mode.

# POWER MODE CONTROL - CIRCUIT DIAGRAM

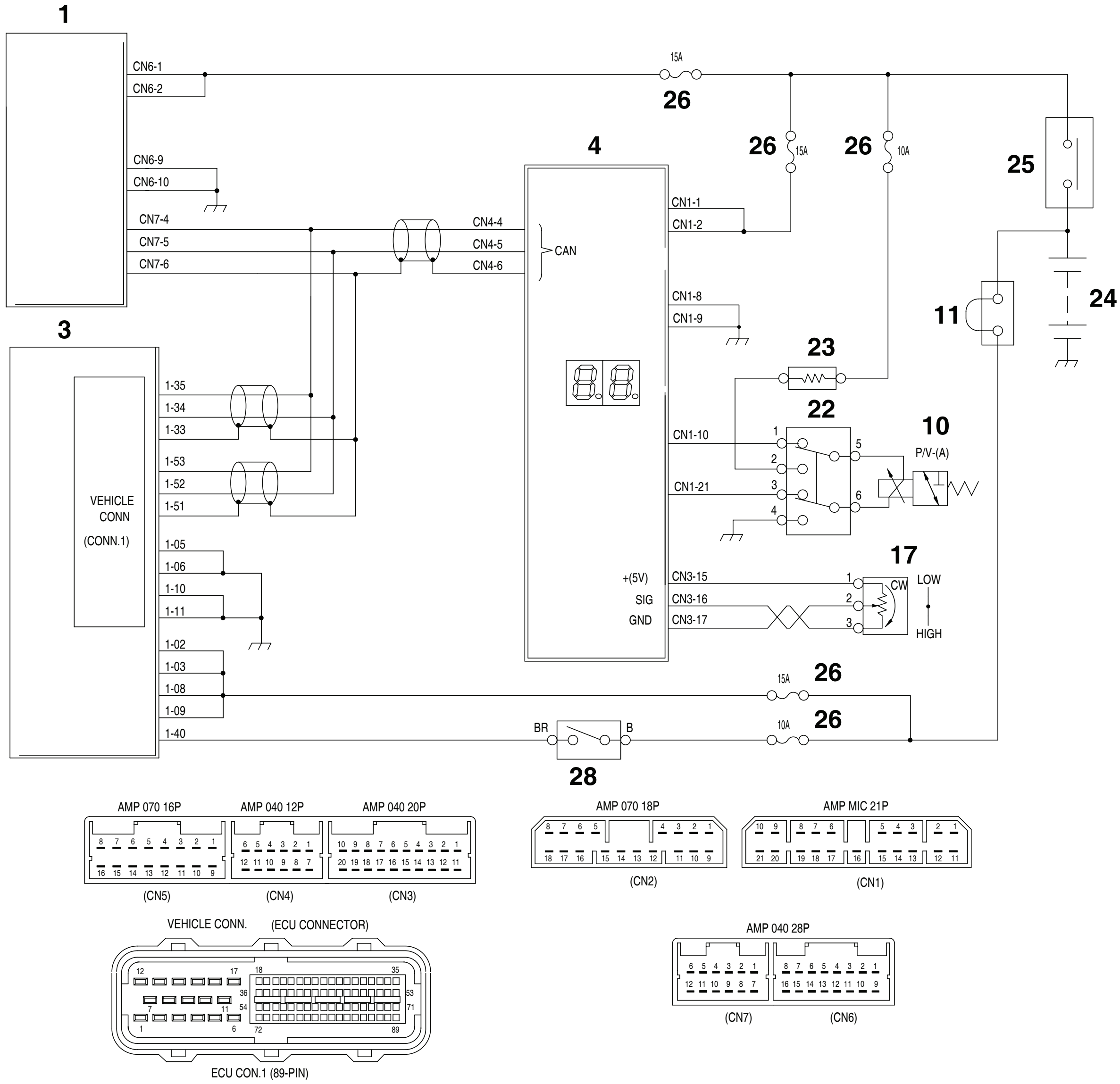



Figure 55

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel |
| 3 | Engine Controller |
| 4 | e-EPOS Controller |
| 10 | E.P.P.R. Valve (Electromagnetic Proportional Pressure Reducing) |
| 17 | Engine Control Dial |
| 22 | Aux Mode Switch |

| Reference Number | Description |
|---|---|
| 23 | Aux Mode Resistor |
| 24 | Battery |
| 25 | Battery Relay |
| 26 | Fuse |
| 27 | Fusible Link |
| 28 | Starter Switch |

# WORK MODE CONTROL

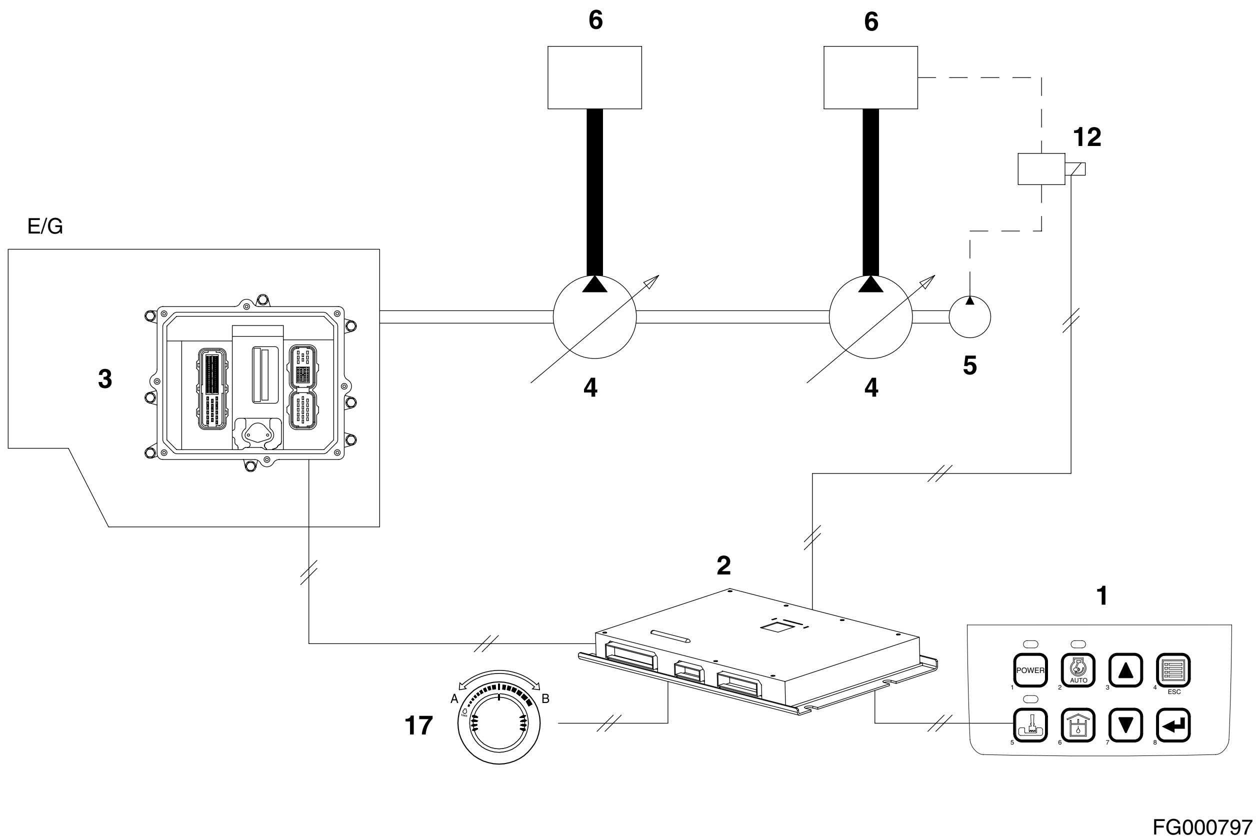



**Figure 56**

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel (Trenching Mode Selector Switch) |
| 2 | e-EPOS Controller |
| 3 | Engine Controller |
| 4 | Main Pump |

| Reference Number | Description |
|---|---|
| 5 | Aux Pump |
| 6 | Control Valve |
| 12 | Solenoid Valve |
| 17 | Engine Control Dial |

Depending on the working condition, one of two work modes, "DIGGING" or "TRENCHING" can be selected from the instrument panel.

When the engine starter switch is turned "ON," the work mode is automatically defaulted to digging mode.

Depending on the trenching mode selected, the control valve solenoid adjusts the assignment of hydraulic oil flow to each device on the equipment.

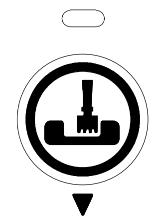
## Operation

1. **Digging Mode**

   This mode is used for general digging work, loading work and ground leveling work requiring quick stops. The current to the solenoid valve for swing priority is shut off.

2. **Trenching Mode**

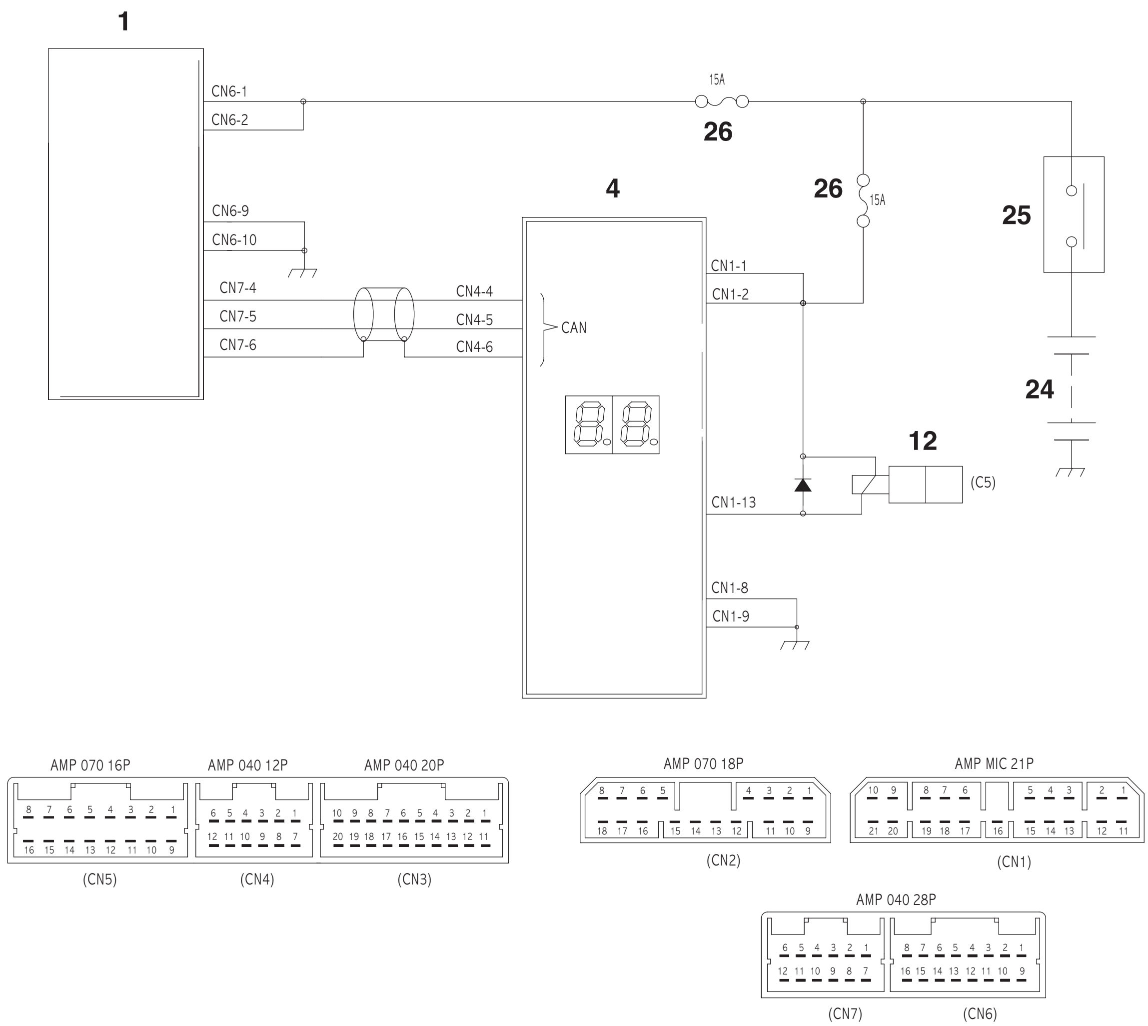
   This mode is used for heavy duty ditch digging work or for loading work requiring big swing angles. The voltage is assigned to the swing priority control valve activating the swing control valve restricting the flow of oil to the boom and the arm.



ARO0270L

**Figure 57**

# WORK MODE CONTROL - CIRCUIT DIAGRAM




FG000583

**Figure 58**

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel |
| 2 | e-EPOS Controller |
| 12 | Solenoid Valve (Swing Priority) |

| Reference Number | Description |
|---|---|
| 24 | Battery |
| 25 | Battery Relay |
| 26 | Fuse |

# ENGINE CONTROL SYSTEM

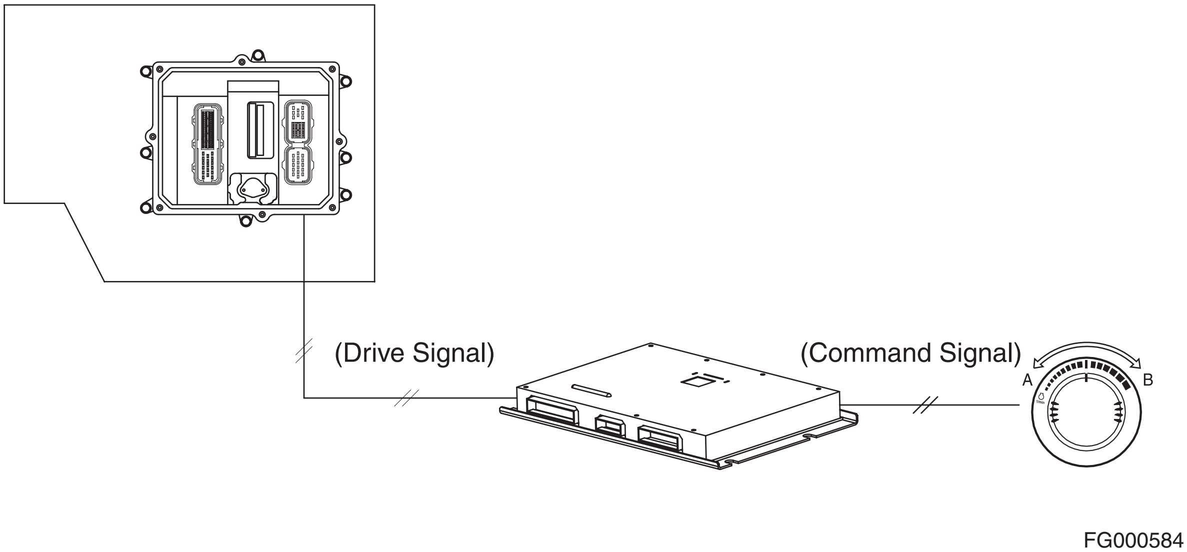



**Figure 59**

| Reference Number | Description |
|---|---|
| 3 | Engine Controller |
| 4 | e-EPOS Controller |

| Reference Number | Description |
|---|---|
| 17 | Engine Control Dial |

When the engine control dial is moved the output voltage changes according to the dial position.

The e-EPOS controller converts this output voltage of dial to digital signal and sends it to the engine controller by CAN line. According to the dial command, the quantity of fuel injection is adjusted.

# ENGINE CONTROL DIAL

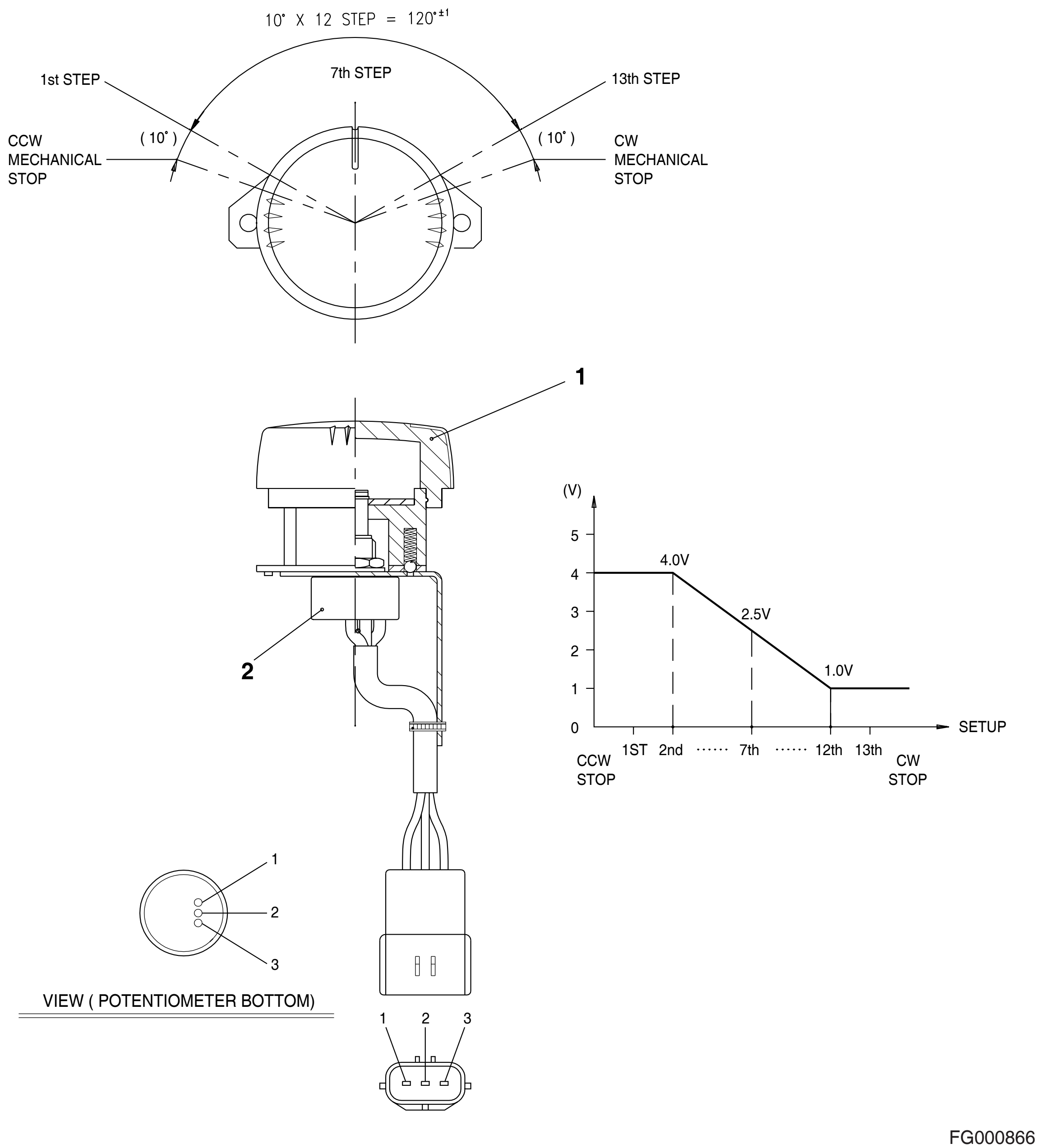



**Figure 60**

| Reference Number | Description |
|---|---|
| 1 | Knob |

| Reference Number | Description |
|---|---|
| 2 | Potentiometer (Variable Resistor) |

The engine control dial has a built in potentiometer. When the control knob is moved the output voltage (through "2 and 3" terminals) will vary from the 5 V supplied from the e-EPOS controller as shown in the graph.

# ENGINE CONTROL CIRCUIT DIAGRAM

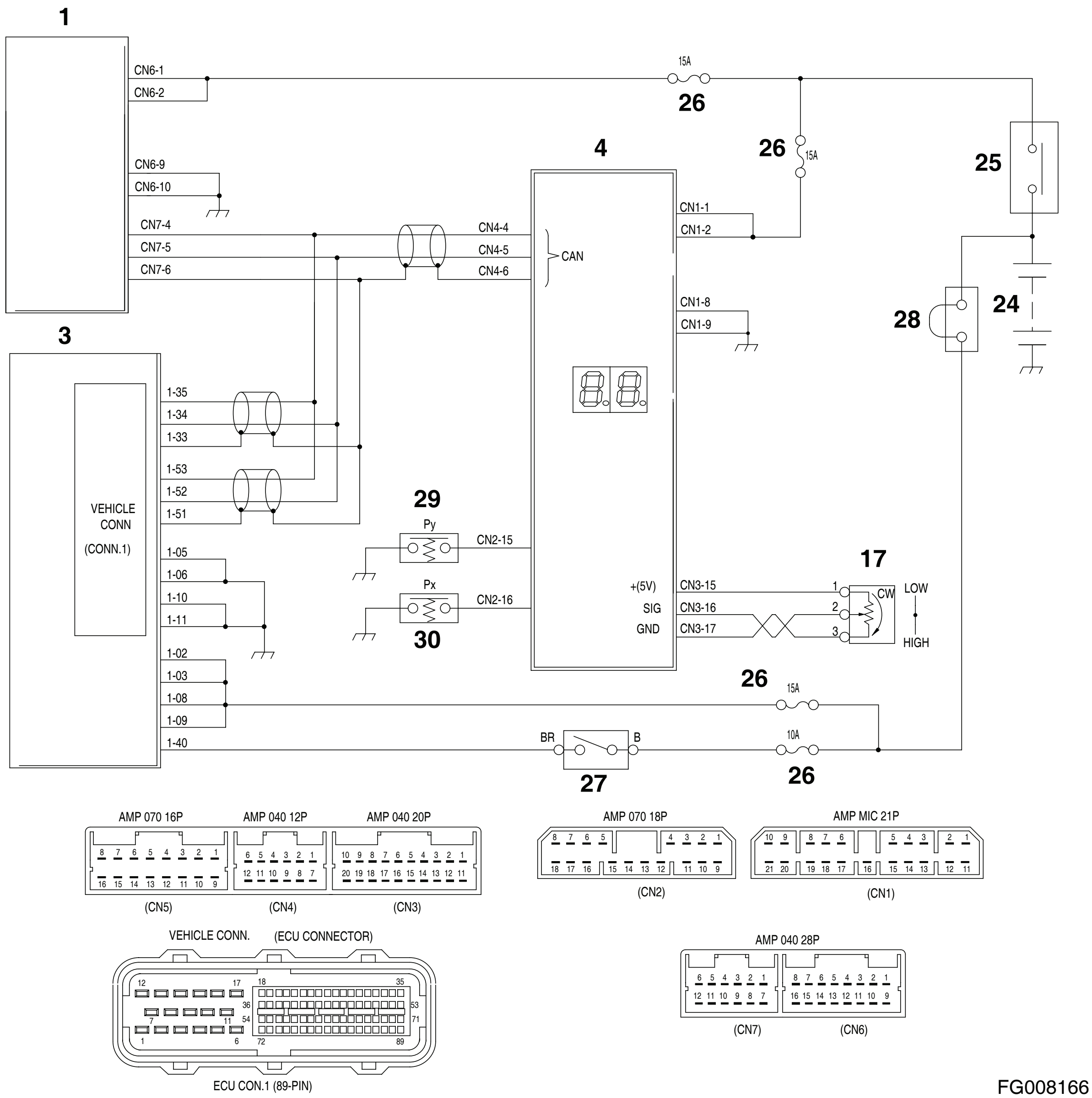



**Figure 61**

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel |
| 3 | Engine Controller |
| 4 | e-EPOS Controller |
| 17 | Engine Control Dial |
| 24 | Battery |
| 25 | Battery Relay |

| Reference Number | Description |
|---|---|
| 26 | Fuse |
| 27 | Starter Switch |
| 28 | Fusible Link |
| 29 | Pressure Switch (Py) |
| 30 | Pressure Switch (Px) |

# AUTOMATIC DECELERATION CONTROL (AUTO IDLE CONTROL)

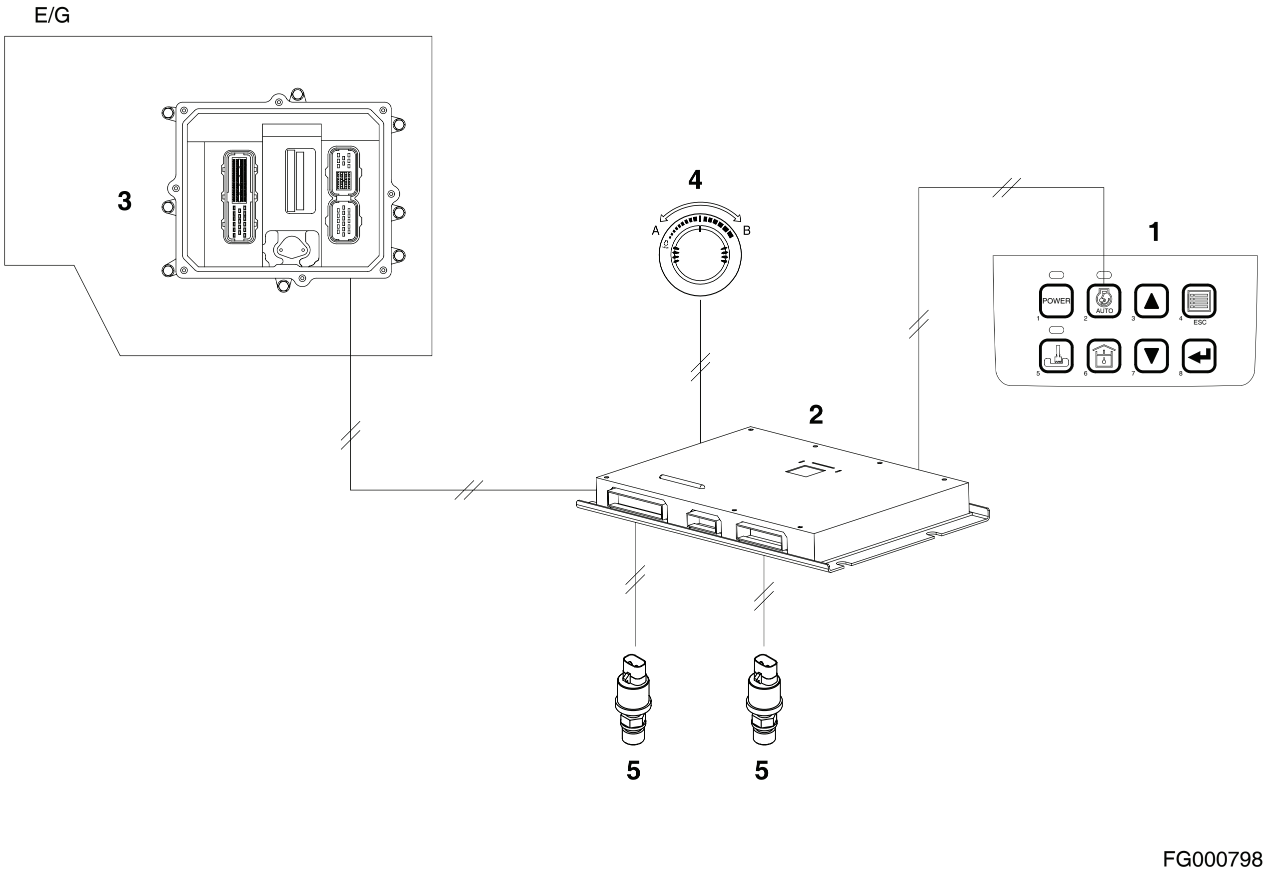



**Figure 62**

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel (Auto Idle Switch) |
| 2 | e-EPOS Controller |

| Reference Number | Description |
|---|---|
| 3 | Engine Controller |
| 4 | Engine Control Dial |
| 5 | Pressure Switch |

If the machine is idling without the controls being operated or is waiting for a dump truck the engine speed is automatically lowered. Once the controls are operated and work is being started the machine will be restored to the previous settings. As a result, noise and fuel consumption will be reduced. This function can be selected or cancelled through the Auto Idle Selector Switch on the instrument panel.

The initial setting at start-up is with this switch in the select position. Approximately 4 seconds after this function is selected, if all work levers are in the neutral position, the e-EPOS controller compares the automatic reduction signal with the signal set by engine control dial. The lower of the two signals is selected, the e-EPOS controller sends a signal to the engine controller to control the engine speed.

The neutral status of the machine is detected by the two pressure switches in the control valve. When the work levers are in the neutral position, the switch is in the "OFF" position.

# ENGINE OVERHEAT PROTECTION SYSTEM

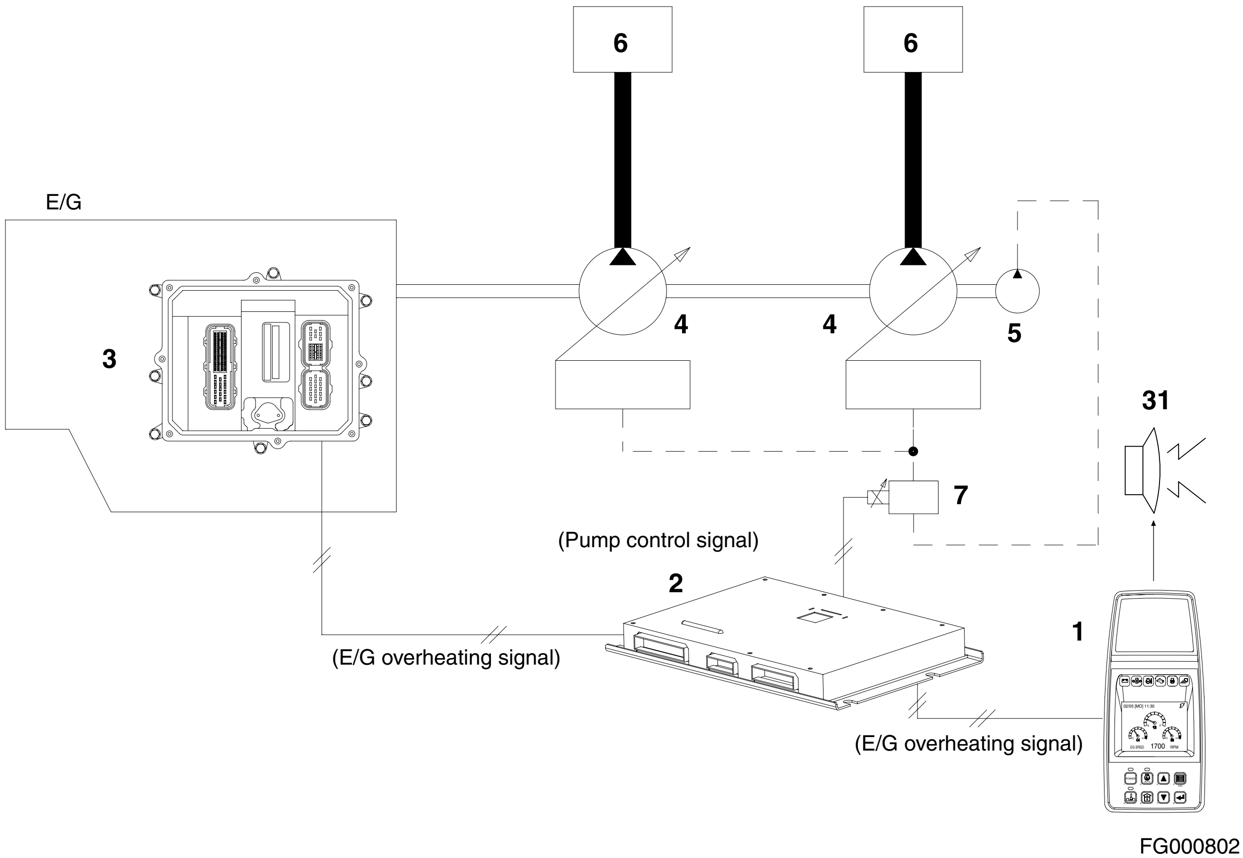



**Figure 63**

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel |
| 2 | e-EPOS Controller |
| 3 | Engine Controller |
| 4 | Main Pump |
| 5 | Aux Pump |

| Reference Number | Description |
|---|---|
| 6 | Control Valve |
| 10 | E.P.P.R. Valve (Electromagnetic Proportional Pressure Reducing Valve) |
| 31 | Warning Buzzer |

When the engine coolant temperature increases to over 107°C (225°F), the engine controller detects it from the sensor mounted in the coolant line and will send a signal to the e-EPOS controller. The e-EPOS controller sends a overheat signal to the instrument panel turning "ON" the warning light and buzzer simultaneously.

Also, the e-EPOS controller returns an overheat signal to the engine controller and changes power mode to standard mode. The engine speed is then set to a low speed by the engine controller.

When coolant temperature falls below 95°C (203°F), normal operation will resume.

# POWER BOOST MODE

## Operation

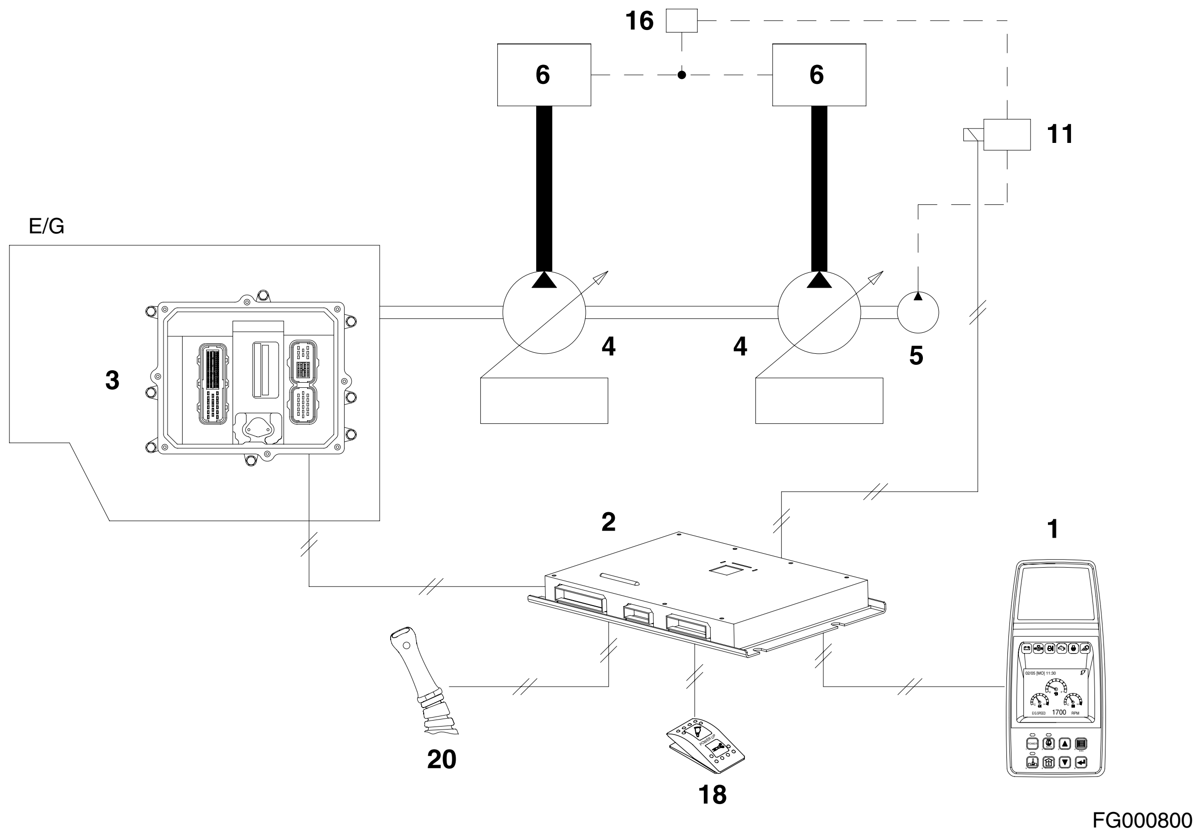



**Figure 64**

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel |
| 2 | e-EPOS Controller |
| 3 | Engine Controller |
| 4 | Main Pump |
| 5 | Aux Pump |
| 6 | Control Valve |

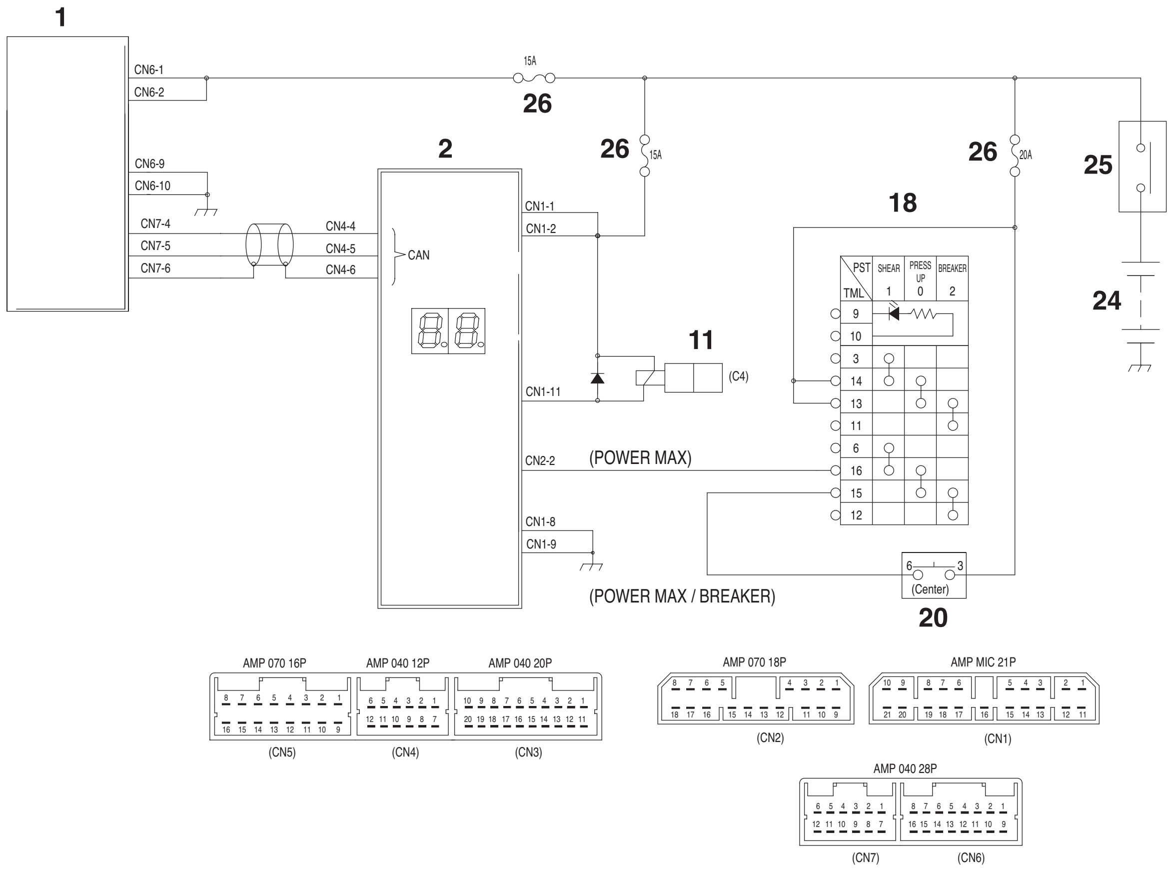
| Reference Number | Description |
|---|---|
| 11 | Solenoid Valve (Boost) |
| 16 | Main Relief Valve |
| 18 | Breaker/Boost/Shear Selector Switch |
| 20 | Power Boost Switch (Top of Right Work Lever) |

The Power Boost function is used to temporarily increase the main relief pressure to enhance excavation ability. When the breaker/boost/shear selector switch is set to "BOOST" and the power boost button on the center of the right-hand work lever (joystick) is pressed during work, the e-EPOS controller will activate the power boost solenoid valve and increase the relief valve pressure from 330 - 350 kg/cm$^2$ (4,700 - 5,000 psi). The excavation ability is increased by approximately 6%.

When the power boost function is in activated, a power boost symbol appears on the information display department of instrument panel.

**NOTE:** *Do not use this switch for more than 10 seconds.*

# Power Boost Control - Circuit Diagram




FG000586

**Figure 65**

| Reference Number | Description |
|---|---|
| 1 | Instrument Panel |
| 2 | e-EPOS Controller |
| 11 | Solenoid Valve (Pressure Up) |
| 18 | Breaker/Boost/Shear Selector Switch |

| Reference Number | Description |
|---|---|
| 20 | Power Boost Switch (Top of Right Work Lever) |
| 24 | Battery |
| 25 | Battery Relay |
| 26 | Fuse |

# AUTOMATIC TRAVEL SPEED CONTROL

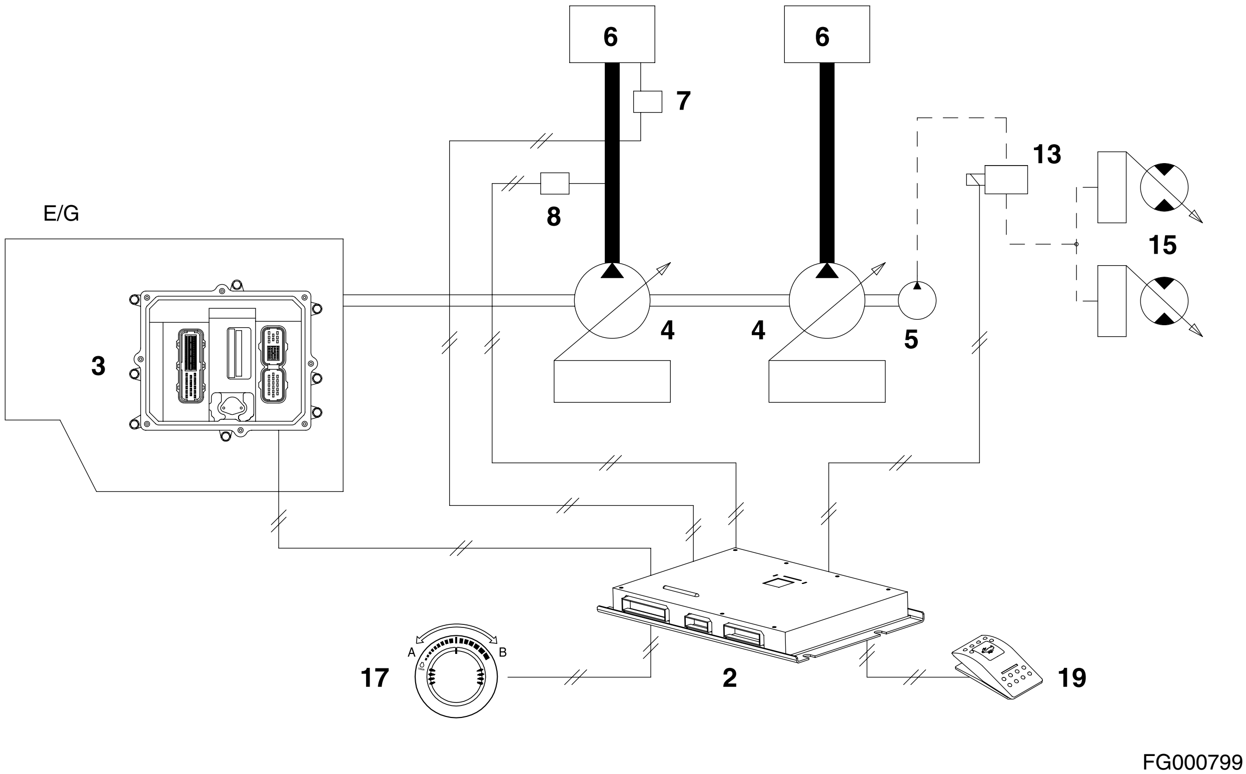



Figure 66

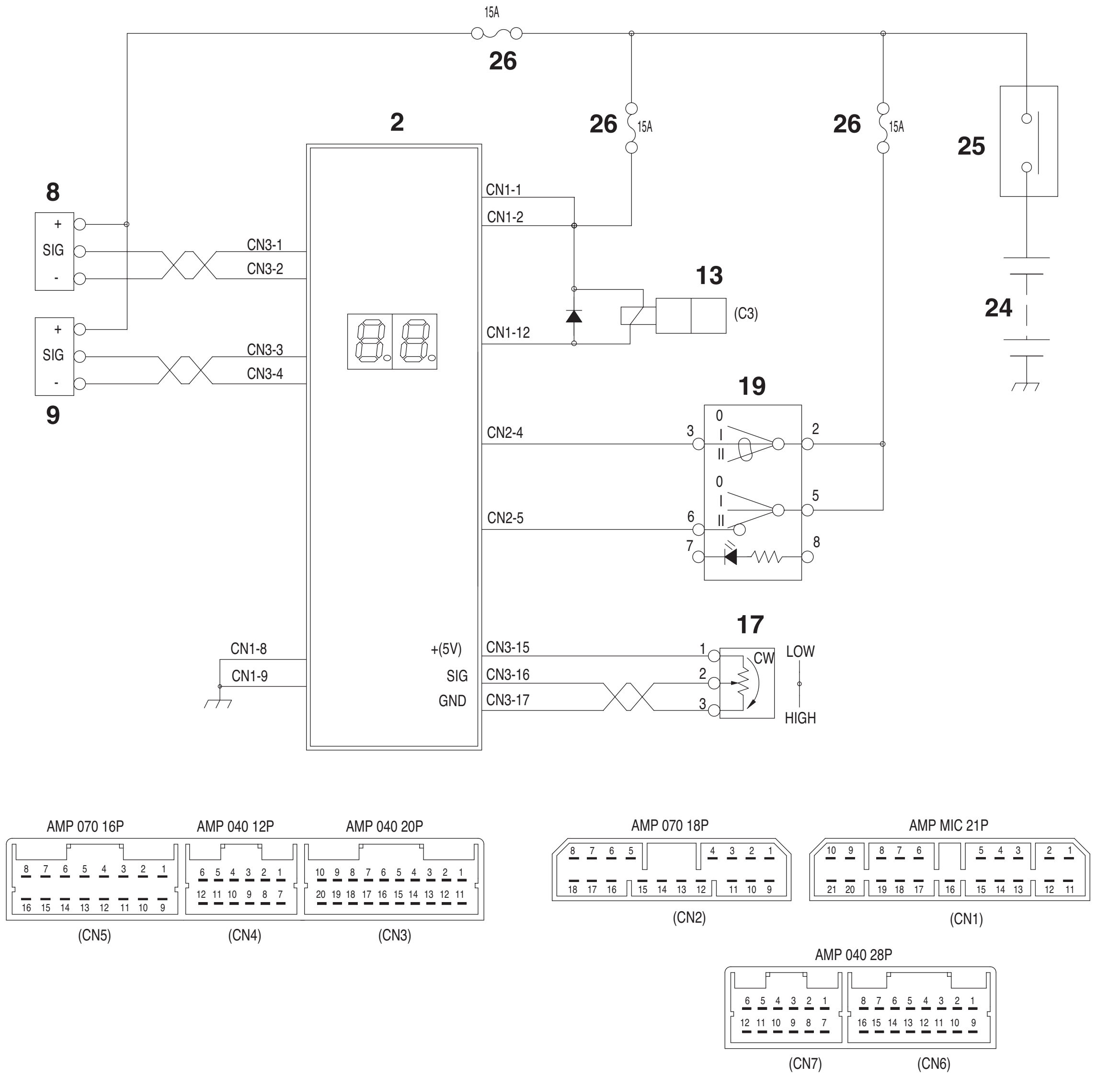
| Reference Number | Description |
|---|---|
| 2 | e-EPOS Controller |
| 3 | Engine Controller |
| 4 | Main Pump |
| 5 | Aux Pump |
| 6 | Control Valve |
| 7 | Pressure Switch (Py Port) |

| Reference Number | Description |
|---|---|
| 8 | Pump Pressure Sensor |
| 13 | Solenoid Valve (High speed) |
| 15 | Travel Motor |
| 17 | Engine Control Dial |
| 19 | Selector Switch For Automatic Travel |

If the automatic travel speed control switch is set to the "OFF" position, the travel motor will run in the I-speed (low speed) range. If the selector switch is set to the "I" position, the travel motor will run in the II-speed (high speed) range. If the selector switch is set to the "II" position, the e-EPOS controller will monitor the main pump discharge pressure and automatically select the "ON" - "OFF" status of the II - speed travel solenoid valve based on the travel load. The travel speed is changed between the I-speed and the II-speed mode.

The travel load is monitored by the two pressure sensors in the discharge lines of the front (upper) and rear (lower) pumps. When the travel load is high (pressure over 300 $kg/cm^2$ (4,300 psi) the solenoid valve is turned "OFF" and I-speed (low) is selected. In the case when the travel load is low (pressure under 160 $kg/cm^2$ (2,280 psi), the solenoid valve will be turned "ON" and the II-speed will be selected. But, if the engine speed control switch dial is set below approximately 1400 rpm, the travel speed will be set to I-speed mode.

# Automatic Travel Speed Control - Circuit Diagram




FG000587

**Figure 67**

| Reference Number | Description |
|---|---|
| 2 | e-EPOS Controller |
| 8 | Pressure Sensor (Front Pump) |
| 9 | Pressure Sensor (Rear Pump) |
| 13 | Solenoid Valve (High speed) |
| 17 | Engine Control Dial |

| Reference Number | Description |
|---|---|
| 19 | Selector Switch For Automatic Travel |
| 24 | Battery |
| 25 | Battery Relay |
| 26 | Fuse |

# SELF-DIAGNOSTIC FUNCTION

## e-EPOS Controller

The system operation status and malfunction codes can be checked through the display on top of the e-EPOS controller box the rear cover behind the operator's seat.

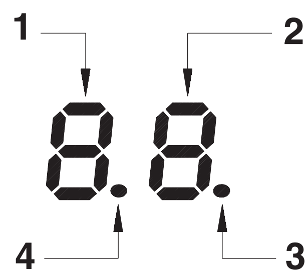



**Figure 68**

| Reference Number | Description |
|---|---|
| 1 | Upper Digit |
| 2 | Lower Digit |
| 3 | Engine Speed Monitor LED (Flash Interval Increases With Engine Speed.) |

| Reference Number | Description |
|---|---|
| 4 | Power Monitor (Stays "ON" While Power Is In Normal Range,) |

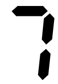
1. **Power Monitor**

   This LED is turned "OFF" when the input voltage to the e-EPOS controller is below 18.5 ±1 V or above 32.5 ±1 V. Stays "ON" while in normal range.

2. **Engine Speed Monitor**

   This LED light flashes according to the engine speed. The flashing interval is proportional to the engine speed.

## 3. Normal Operation Display Readout

| Mode Selection | | Display Readout | | Operation Status |
|---|---|---|---|---|
| | | Upper Digit | Lower Digit | |
| Power Mode | Power Mode |  HAOH340L | | Normal Operation Power Mode |
| | Standard Mode |  HAOH350L | | Normal Operation Standard Mode |
| Work Mode | Digging | |  HAOH370L | Normal Operation Digging Mode |
| | Trenching | |  HAOH380L | Normal Operation Trenching Mode |

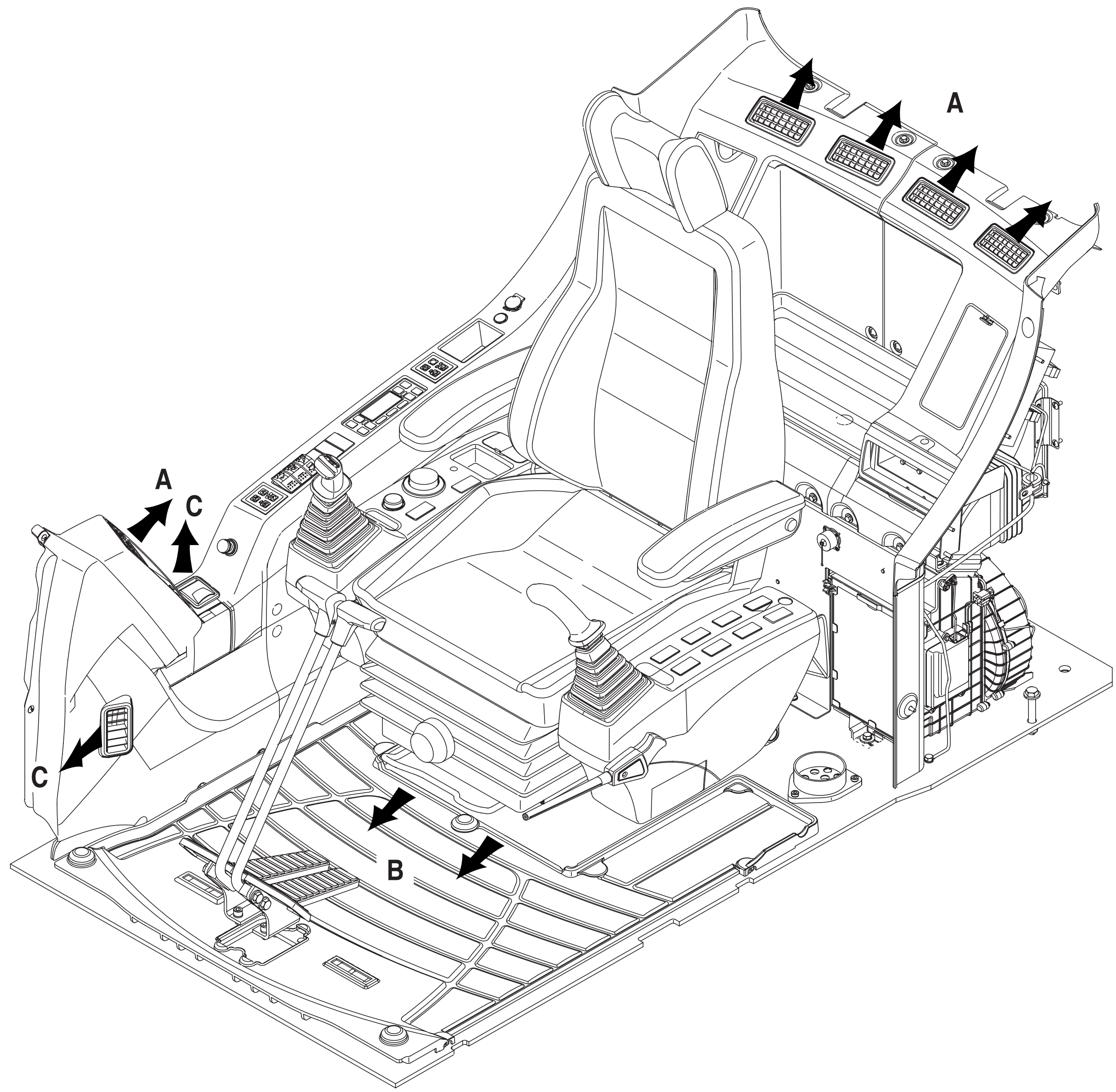
## 4. Communication Monitor

What are shown in the 7-SEGMENT LED are same as those in the Error Codes.

| Error Code | Indication Code | Fault Location |
|---|---|---|
| V201 | 01 | Communication error in instrument panel. |
| V202 | 02 | Communication error in engine controller. |

# AIR CONDITIONER SYSTEM

## Outline




FG000784

**Figure 69**

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

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

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

Vent mode selects the direction of discharged air.

Outlets by vent modes

| Modes |  |  |  |  |  |
|---|---|---|---|---|---|
| Outlets | A | A+B | B | B+C | C |

## Internal and External Filters

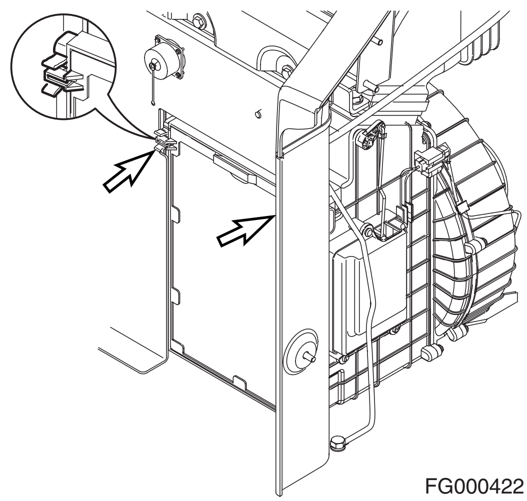
Internal and external air purification filters are installed for the operator's room.

Filters should be cleaned every 500 hours.

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

### How to Check Internal Air Filter

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

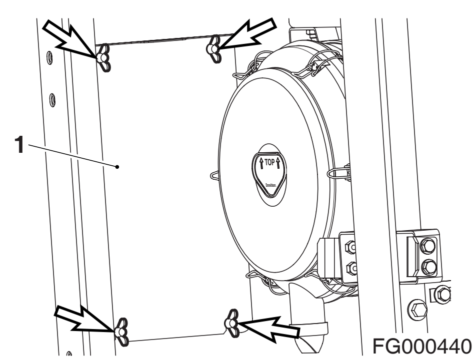


FG000422

**Figure 70**

### How to Check External Air Filter

1. Open the door at the left side of machine and loosen four marked bolts to remove the cover (1, Figure 71).




FG000440

**Figure 71**

2. Turn marked knobs (1, Figure 72) at the rear side of the cabin to open the cover.

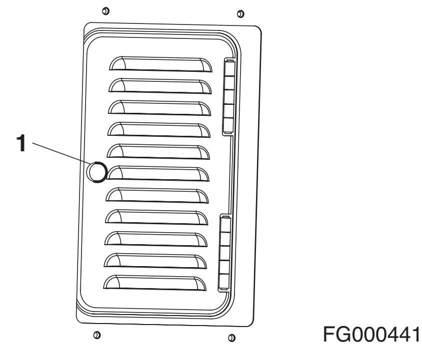



**Figure 72**

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

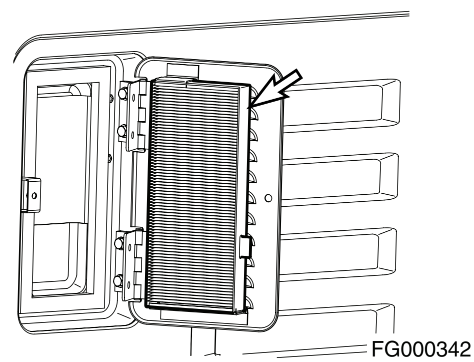



**Figure 73**

# Air-Conditioning System Layout

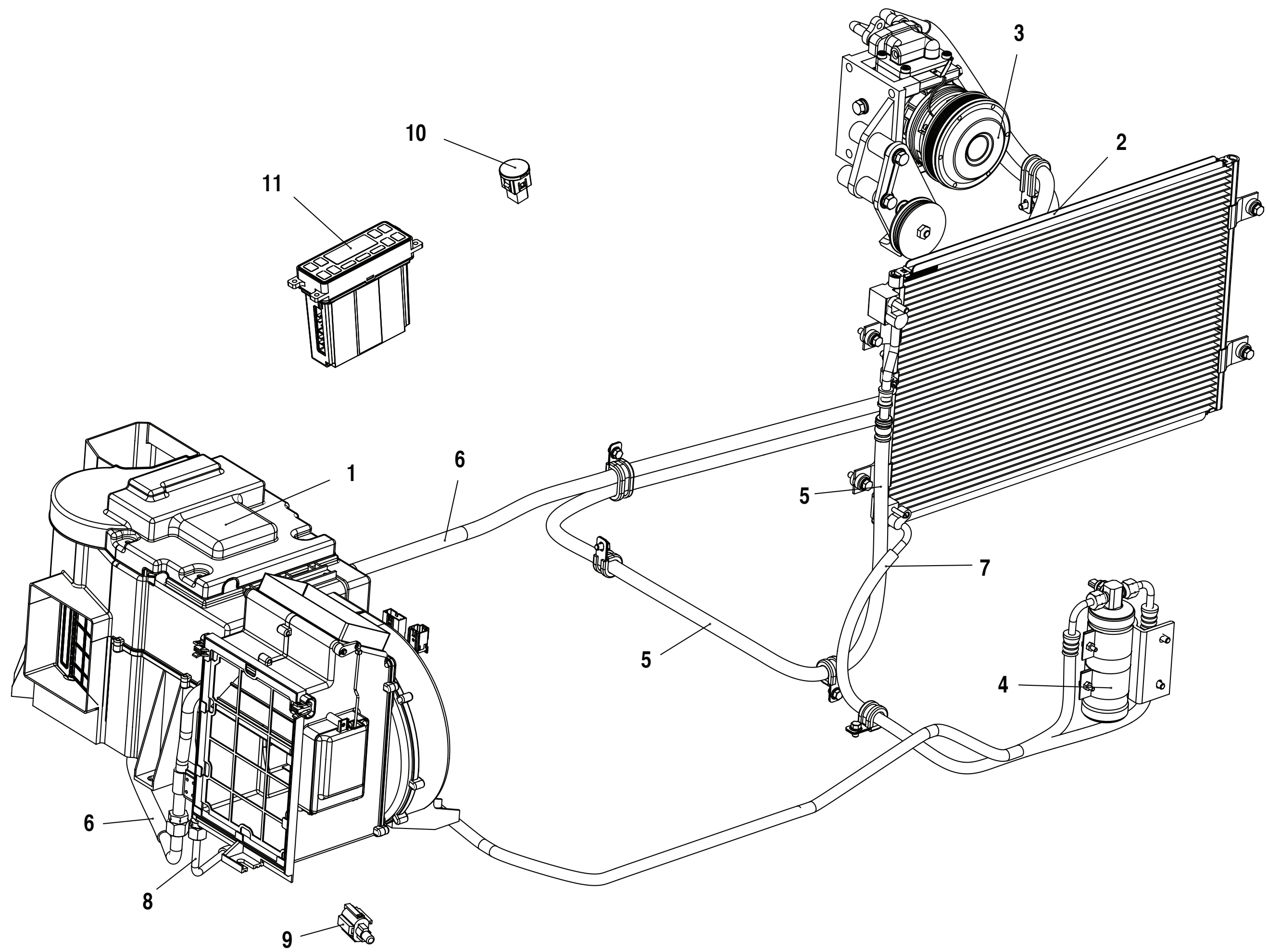



**Figure 74**

| Reference Number | Description |
|---|---|
| 1 | Air Conditioner/heater Unit |
| 2 | Condenser |
| 3 | Compressor |
| 4 | Receiver Dryer |
| 5 | Discharge Hose |
| 6 | Suction Hose |

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

# Air Conditioner/heater Circuit Diagram

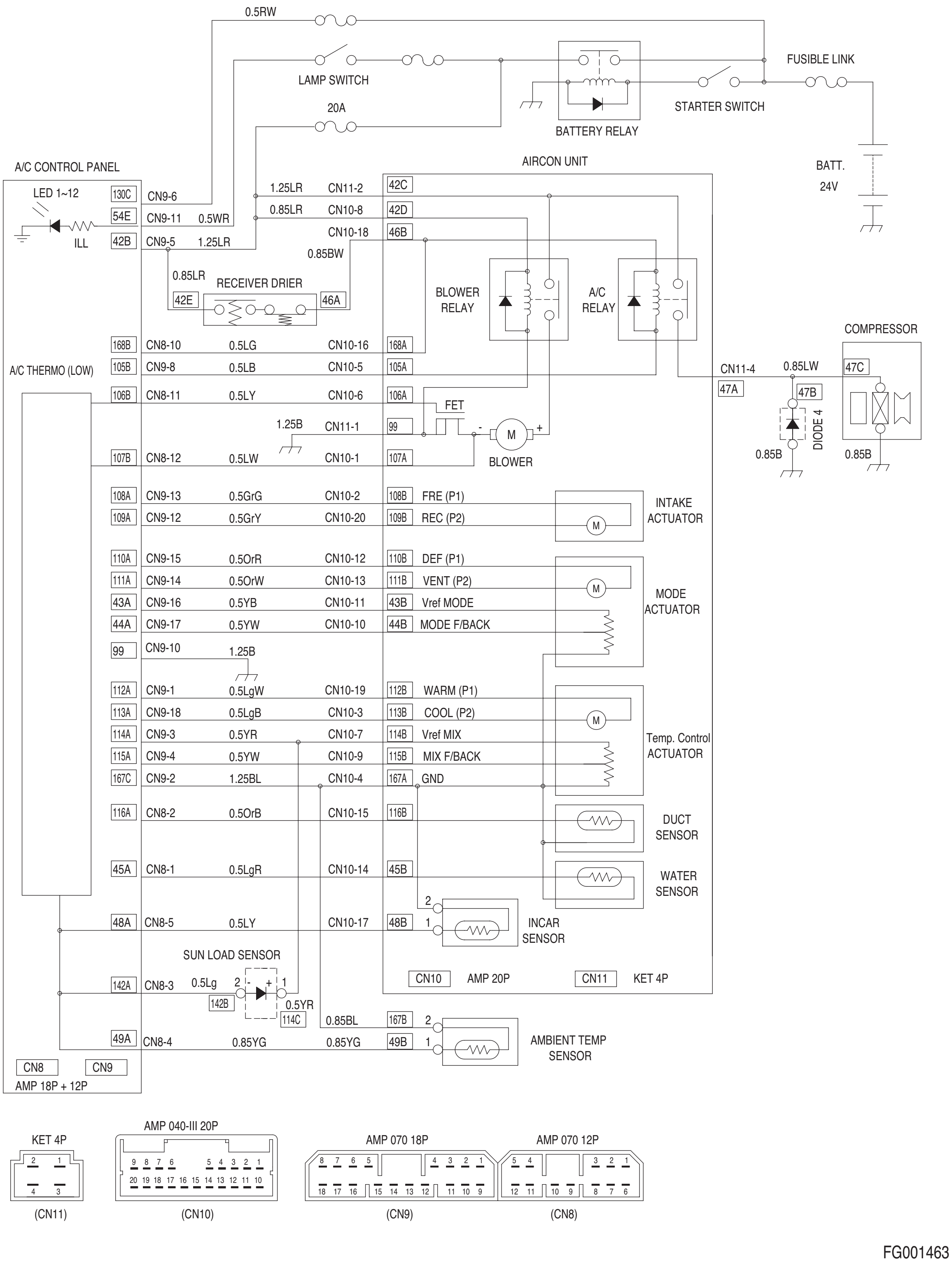



**Figure 75**

# Air Conditioner/heater Unit

## Air Flow Diagram

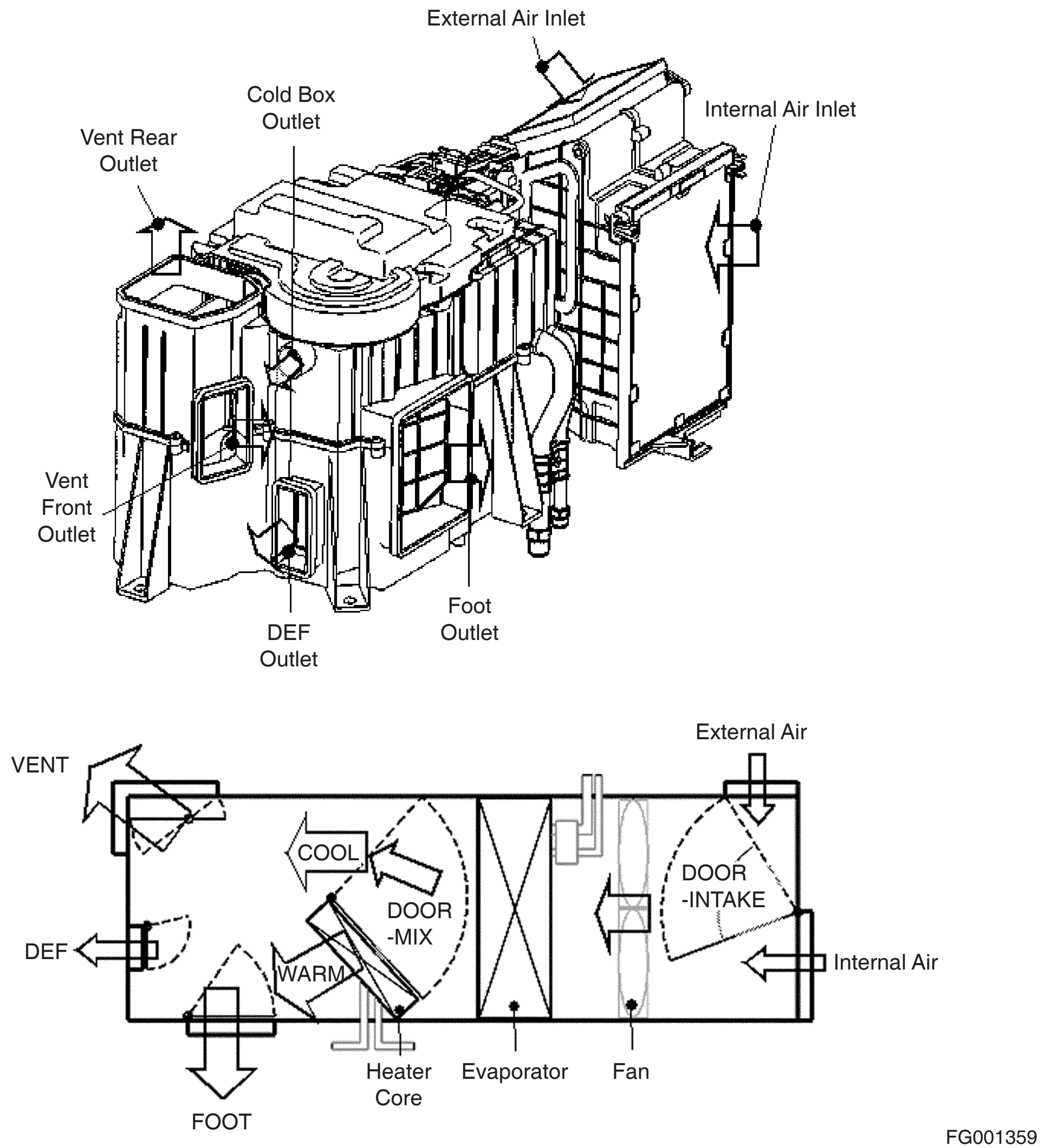



**Figure 76**

## Door Open by Vent Modes

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

## Main Components

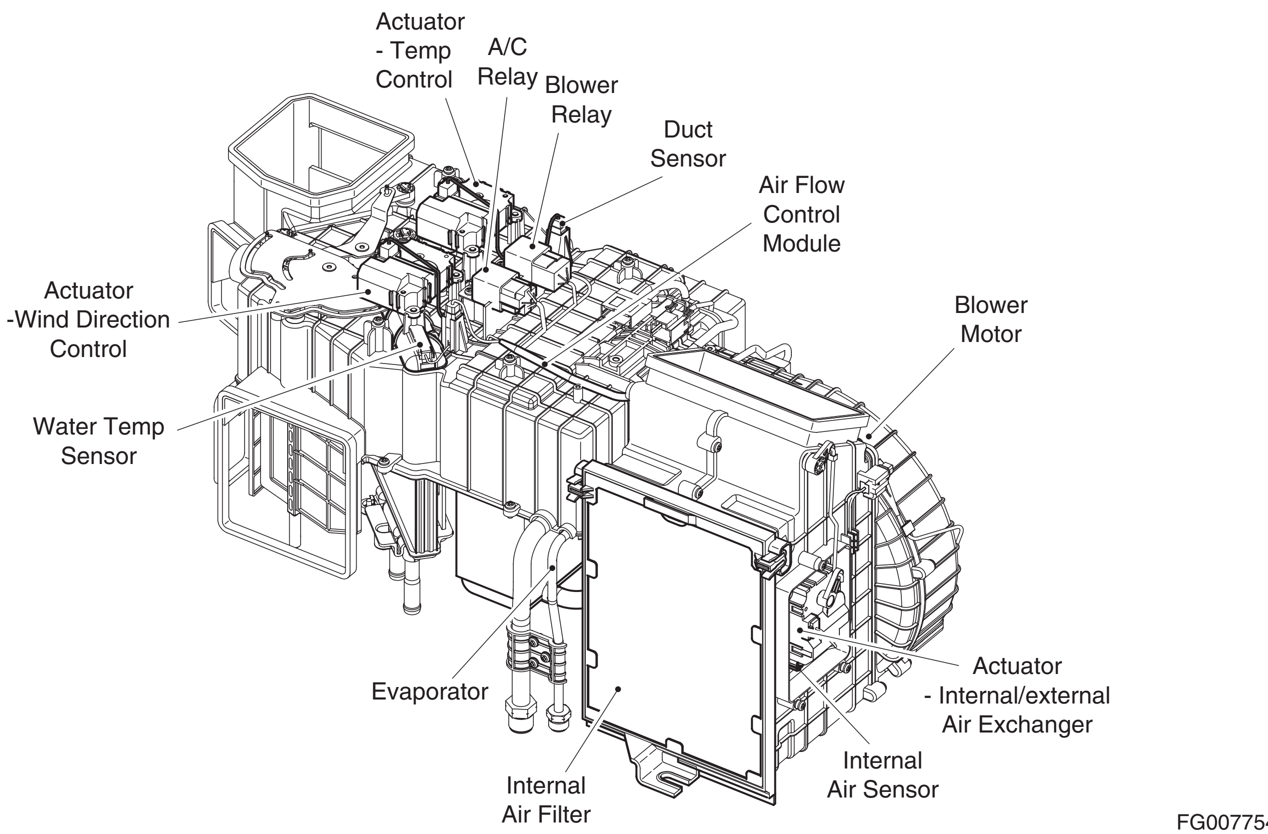



**Figure 77**

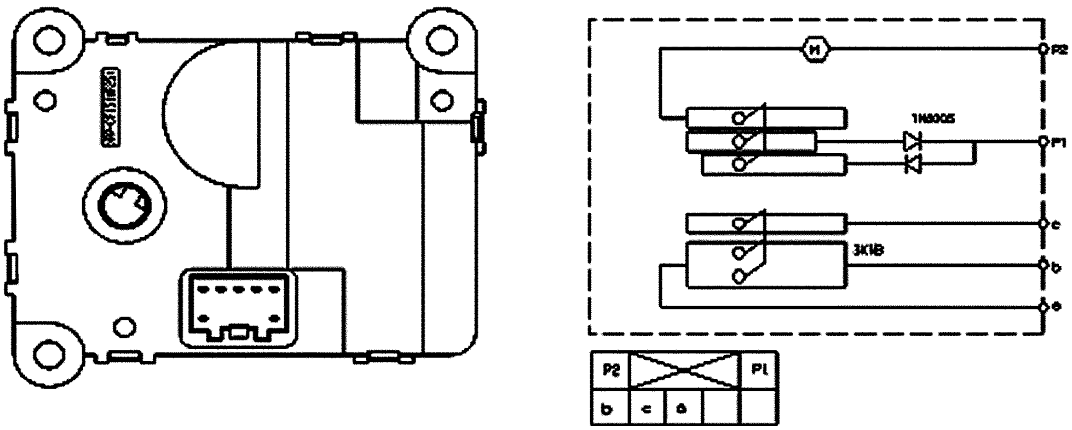
**Actuator - Wind Direction Control**

Change of discharged air flow according to selected wind direction mode

Change of wind direction: Direction changes in the order of VENT→ BI-LEVEL → FOOT → FOOT/DEF → VENT.

**Actuator - Temperature Control**

Change of discharged air temperature by controlling the position of temperature control door.




FG001361

**Figure 78**

**Actuator - Wind Direction Control**

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

**Actuator - Temperature Control**

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

**Actuator - Internal/external Air Exchange**

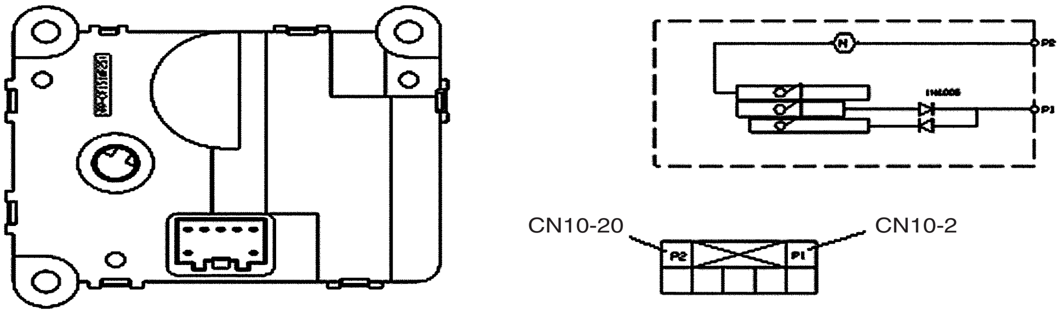



**Figure 79**

| Mode | Output Terminal | Output |
|---|---|---|
| Intake | P1(+), P2(-) | Moving of exchange door by selecting intake. |
| Recirculate | P1(-), P2(+) | Moving of exchange door by selecting recirculate. |

**Air Flow Control Module**

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

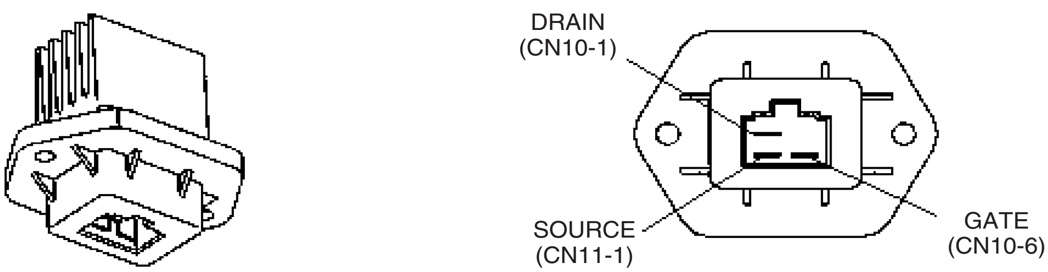



**Figure 80**

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

Input voltage is 27.5V.

The air flow is based on manual set.

**Relay - Blower:** Power is supplied to the blower motor when the system is turned "ON."

| Specifications | |
|---|---|
| Rated voltage | 24V |
| Rated current | 20A |

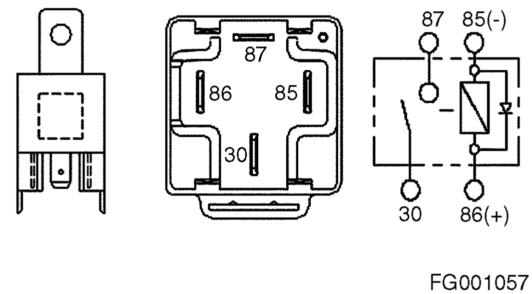



**Figure 81**

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

| Specifications | |
|---|---|
| Rated voltage | 24V |
| Rated current | 10A |

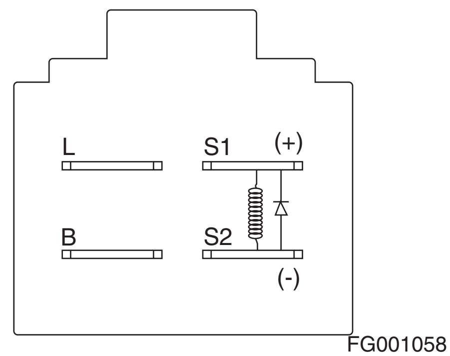



**Figure 82**

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

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

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

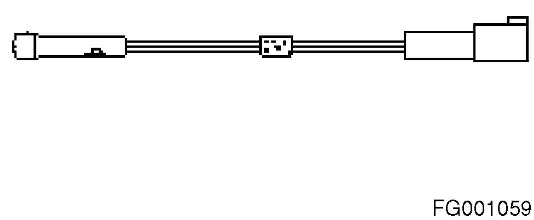



**Figure 83**

**Water Temperature Sensor:** It senses the temperature of coolant water in the heater core.

| Temperature (°C) | Resistance (KΩ) |
|---|---|
| -10 | 55.8 ± 1.7 |
| 0 | 32.9 ± 0.9 |
| 15 | 15.76 ± 0.5 |
| 25 | 10.0 ± 0.3 |
| 35 | 6.5 ± 0.2 |


**Figure 84**

**Internal Air Temperature Sensor:** Built in the internal air filter, it senses the internal temperature.

| Temperature (°C) | Resistance (KΩ) |
|---|---|
| -15 | 218.2 ± 7.5 |
| 0 | 97.83 ± 0.9 |
| 15 | 47.12 ± 0.7 |
| 25 | 30.0 ± 0.36 |
| 35 | 19.60 ± 0.3 |

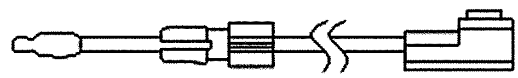



**Figure 85**

## Ambient Air Temperature Sensor

Built at the bottom of the cockpit, it senses the temperature of external air.

| Temperature (°C) | Resistance (KΩ) |
|---|---|
| -10 | 163 ± 4.9 |
| 0 | 96.9 ± 2.9 |
| 10 | 59.4 ± 1.8 |
| 20 | 37.4 ± 1.1 |
| 25 | 30 ± 0.9 |
| 30 | 24.2 ± 0.7 |

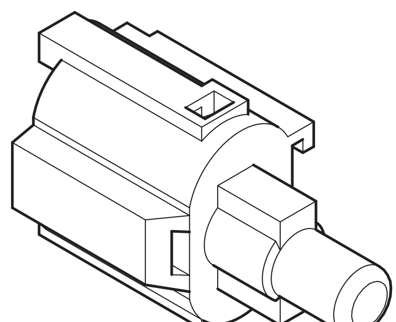
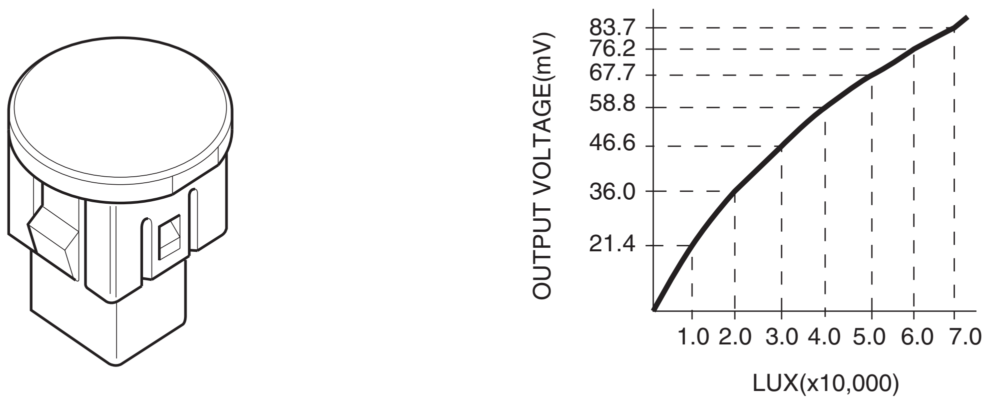



**Figure 86**

## Sun Sensor

Built beside the socket of spare power, it senses the quantity of the sun radiation to optimize discharge temperature and air flow as set by operator.

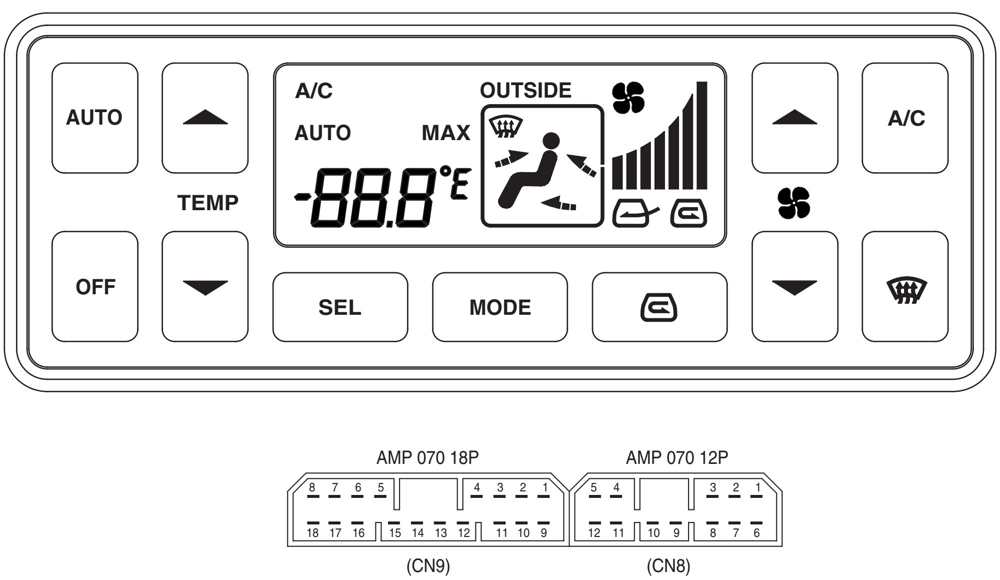



FG001062

**Figure 87**

## Control Panel

### Appearance and Terminal Arrangement




FG001063

**Figure 88**

Refer to "Air Conditioner and Heater" of operation manual.

## Terminal Terms

| CN | Term No. | Terms |
|---|---|---|
| CN9 | 1 | Temperature control (warm) |
| | 2 | Sensor ground |
| | 3 | Temperature control Power (5V) |
| | 4 | Mix feedback |
| | 5 | Power (KEY "ON") |
| | 6 | Back-up |
| | 7 | - |
| | 8 | A/C output (LOW) |
| | 9 | - |
| | 10 | Ground |
| | 11 | Illumination |
| | 12 | Intake/Recirculate (Recirculate) |
| | 13 | Intake/Recirculate (Intake) |
| | 14 | Wind direction control (VENT) |
| | 15 | Wind direction control (DEF.) |
| | 16 | Wind direction control Power (5V) |
| | 17 | Wind direction control (feedback) |
| | 18 | Temperature control (cool) |

| CN | Term No. | Terms |
|---|---|---|
| CN8 | 1 | Water temperature sensor |
| | 2 | Duct sensor |
| | 3 | Sun sensor |
| | 4 | Ambient air temperature sensor |
| | 5 | Internal air temperature sensor |
| | 6 | - |
| | 7 | - |
| | 8 | - |
| | 9 | - |
| | 10 | D.P.S CHECK |
| | 11 | Air flow module (gate) |
| | 12 | Blower motor (feedback) |

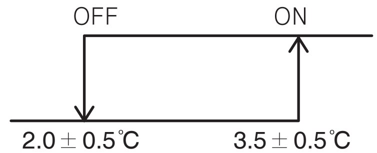
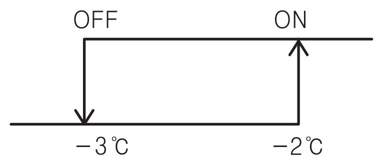
## Control Logic

| Categories | Inputs | System Operation |
|---|---|---|
| AUTO | Set temperature<br>Internal air temperature sensor<br>Ambient air temperature sensor<br>Water temperature sensor<br>Sun sensor | 1. Automatically adjust room temperature as set and then next items.<br>Temperature, Wind direction, Recirculate/Intake, Air flow, Compressor<br>2. Auto mode is released when manually setting any switch except, Temperature Control switch in Auto mode.<br>3. Upon the releasing of Auto mode, all of functions except selected switch are controlled automatically. |

<table>
<tr><th>Categories</th><th>Inputs</th><th>System Operation</th></tr>
<tr><td>Sensor compensation</td><td>Set temperature<br>Internal air temperature sensor<br>Ambient air temperature sensor<br>Water temperature sensor</td><td>1. In case of sensor failure, following defaults are applied:<br>Internal air temperature sensor: 25°C, Ambient air temperature sensor: 25°C, Duct sensor: -2°C<br>Temperature control actuator:<br>- Set Temperature 17 - 24.5°C: Max cooling, Set Temperature 25 - 32°C: Max heating<br>Wind direction mode actuator<br>- VENT: VENT fix, modes other than VENT: Fixed to DEF<br>* Sun sensor is not compensated.</td></tr>
<tr><td>Max cooling/ heating control</td><td>Auto Setting</td><td>1. Set Temperature 32°C: Max heating<br>2. Set Temperature 17°C: Max cooling
<table>
<tr><th></th><th>Max Cooling (17 °C)</th><th>Max Heating (32 °C)</th></tr>
<tr><td>Temp Control Actuator</td><td>FULL COOL</td><td>FULL HOT</td></tr>
<tr><td>Air Flow</td><td>MAX HI</td><td>AUTO HI</td></tr>
<tr><td>Compressor</td><td>Forced ON</td><td>OFF</td></tr>
<tr><td>Intake/Recircle</td><td>Recircle</td><td>Intake</td></tr>
<tr><td>Wind Direction Mode</td><td>VENT</td><td>FOOT</td></tr>
</table>
* Max cooling/heating control is possible only in Auto mode.</td></tr>
<tr><td>Starting Control of Cooling</td><td>Auto mode<br>Duct sensor</td><td>1. Prevention of discharge of hot air before discharge temperature drops enough in hot summer weather<br>2. Start conditions (AND condition)<br>(1) A/C on (AUTO or manual)<br>(2) Temperature sensed by the duct sensor is above 30°C<br>(3) Air flow: Auto mode<br>3. One time control in the cycle of engine OFF → engine run<br>4. Initial cooling control is executed when the Auto switch is "ON" in the manual status (A/C "OFF" and manual control of air flow) in 5 seconds after engine run.<br>5. Initial cooling control should be before max cooling.<br>6. Release condition (OR condition)<br>(1) A/C "OFF"<br>(2) Air flow: Manual control<br>(3) Release is possible with the "OFF" switch but not allowed within 12 seconds (after Start "ON") while the system is off using the "OFF" switch and during the time of initial cooling control.</td></tr>
</table>

<table>
<tr><th>Categories</th><th>Inputs</th><th>System Operation</th></tr>
<tr><td rowspan="2">Starting control of heating (1)</td><td rowspan="2">Water temperature sensor<br><br>Internal air temperature sensor<br><br>Auto mode<br><br>Set Temperature</td><td>1. Start condition (AND condition)<br><br>(1) When wind direction mode is one of the following modes in the Auto or manual control mode<br><br>- BI-LEVEL, FOOT or FOOT/DEF<br><br>(2) The Water temperature sensor is stable and the water temperature < 73°C<br><br>(3) Air flow: Auto mode<br><br>(4) Set temperature > Internal air temperature + 3°C<br><br>* Air flow falls gradually up to 12 seconds when operation released.</td></tr>
<tr><td>2. One time control in the cycle of engine OFF → engine run<br><br>3. Initial heating control should be before max heating.<br><br>4. Air flow is controlled only when the wind direction is in the manual mode and BI-LEVEL, FOOT, or FOOT/DEF is set.<br><br>5. Control through the water temperature sensor for start.<br><br>6. Starting control of heating (2) starts in case of fault of the water temperature sensor during controlling.<br><br>7. Operation release (OR condition)<br><br>(1) Only air flow is released if it is selected manually.<br><br>(2) When handling the wind direction mode switch, only wind direction is released but the air flow control is performed only for the remaining period of the starting control of heater.<br><br>(3) When Max Cooling (17°C) is selected.<br><br>(4) Water temperature sensor > 73°C.</td></tr>
</table>

| Categories | Inputs | System Operation |
|---|---|---|
| Starting control of heating (2) | Water temperature sensor<br>Ambient air temperature sensor<br>Internal air temperature sensor<br>Auto mode | 1. Entry condition (AND condition)<br>(1) Auto Mode<br>(2) Ambient air temperature < 5°C and difference between ambient and internal air temperature ≤ 5°C<br>(3) Failure of water temperature sensor<br>2. Only one time of engine OFF → engine run<br>3. Starting control of heating is before max heating.<br>4. Operation release (OR condition)<br>(1) Air flow: Manual selection<br>(2) When handling the wind direction mode switch, only wind direction is released but the air flow control is performed only for the remaining period of the starting control of heater.<br>(3) Difference between internal and ambient air temperature>15°C<br>(4) When Max Cooling (17°C) is selected.<br>5. Exceptional case<br>Starting control of heating is performed only once during the remaining period if the entry condition is satisfied within the starting control period that is the accumulation of initial start times.<br>(Inclusive of Auto mode "ON" case within the period of starting control of heater.)<br>* Air flow should be reduced slowly for up to 12 seconds in case of exceptional entry case. |

<table>
<tr><th>Categories</th><th>Inputs</th><th>System Operation</th></tr>
<tr><td rowspan="2">Compressor control</td><td>Duct sensor</td><td>1. Function: Magnetic clutch of compressor is turned "ON/OFF" depending on temperature of the duct sensor to prevent the freezing of the evaporator with A/C being "ON."<br>2. Control pattern.<br>
</td></tr>
<tr><td>External temperature sensor</td><td>1. Function: Prevention of compressor in winter.<br>2. Control pattern.<br>
<br>*Only for Auto mode.</td></tr>
</table>

**Self Diagnosis**

How to start self diagnosis

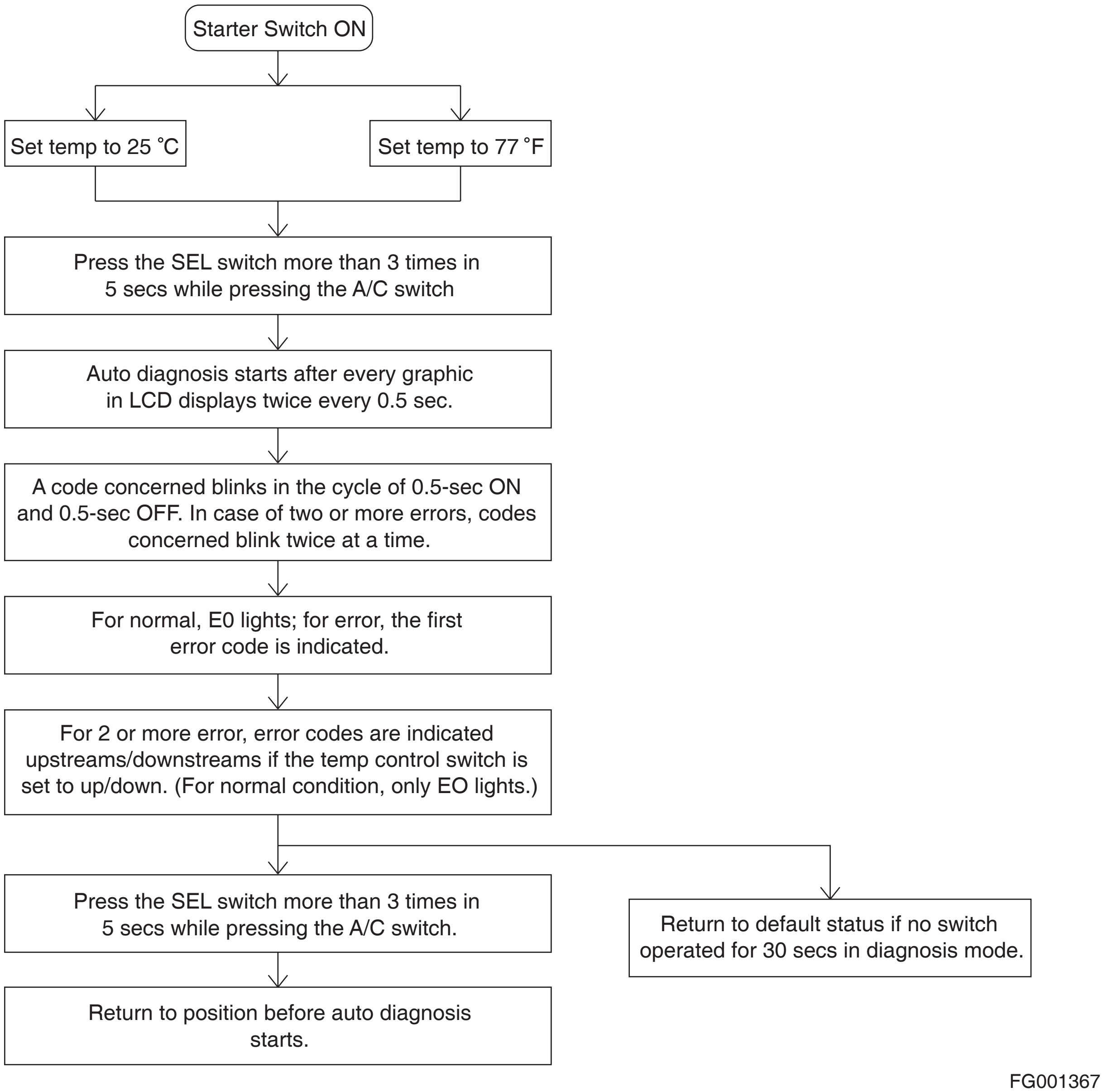



**Figure 89**

Error codes

| Code | Description |
|---|---|
| E0 | Normal |
| E1 | Internal air temperature sensor short |
| E2 | Internal air temperature sensor open |
| E3 | Ambient air temperature sensor short |
| E4 | Ambient air temperature sensor open |
| E5 | Duct sensor short |
| E6 | Duct sensor open |
| E7 | Sun sensor short |
| E8 | Sun sensor open |
| E9 | Water temperature sensor short |
| E10 | Water temperature sensor open |
| E11 | D.P.S open |
| E12 | Position error of wind direction actuator |
| E13 | Position error of temperature control actuator |

**NOTE:** *The position error means that it fails to move to designated place in 40 seconds.*

*Sun sensor displays E8 in case of no sunlight.*

*2 and more fails: Codes concerned blinks twice at a time.*

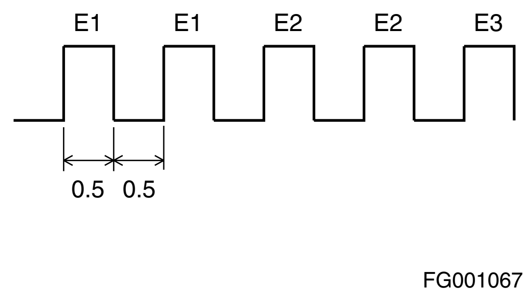



**Figure 90**

**Ambient Temperature Display**

Selection of both the SEL and MODE switch for more than 3 seconds indicates the ambient temperature in the set temperature display department.

- Range of temperature display: -40 - +60°C

**NOTE:** *Display of ambient temperature may be released in the same way for its entry way.*

*It returns automatically to default mode 5 seconds after entering the ambient air temperature display mode.*

## Compressor

| Categories | Specifications |
|---|---|
| Output | 155.3 cc/rev |
| Oil Level | 120 cc (ND-OIL8) |
| Refrigerant | R134a |
| Rated Voltage | 24V |
| Relief Valve | Open: 35 - 42.2 kg/cm$^2$G<br>Close: 28.1 kg/cm$^2$G |

Compressor sucks in refrigerant which evaporates completely in the evaporator and discharges it to the condenser.

Refrigerant undergoes repeated status change in the order of liquid, gas, and liquid in the freezing cycle, and the compressor makes evaporated refrigerant a high temperature and high-pressured gas to freeze it in the condenser.

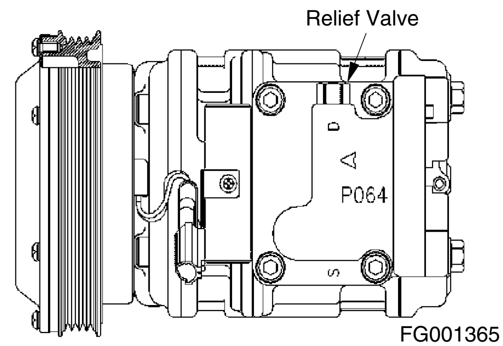



**Figure 91**

## Receiver Dryer

The receiver dryer reserves refrigerant enough to ensure smooth freezing cycle responding immediately to the change of level in the freezing cycle.

As liquid refrigerant from the condenser may contain refrigerant gas with bubbles whose presence in the expansion valve decreases the freezing power excessively, it separates liquid and gas and sends liquid only to the expansion valve.

Water in refrigerant shall be eliminated with dryer and through filter.

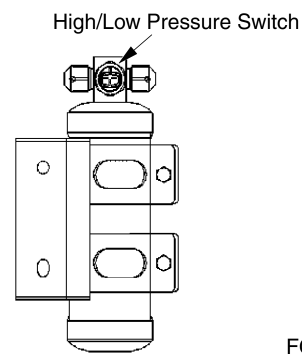



**Figure 92**

Volume of refrigerant by model

| Model | Volume of Refrigerant |
|---|---|
| DX140LC | 800 ± 20 grams |
| DX180LC | 800 ± 20 grams |
| DX225LC | 800 ± 20 grams |
| DX225NLC | 800 ± 20 grams |
| DX255LC | 800 ± 20 grams |
| DX300LC | 800 ± 20 grams |
| DX340LC | 800 ± 20 grams |
| DX420LC | 800 ± 20 grams |
| DX480LC | 800 ± 20 grams |
| DX520LC | 800 ± 20 grams |

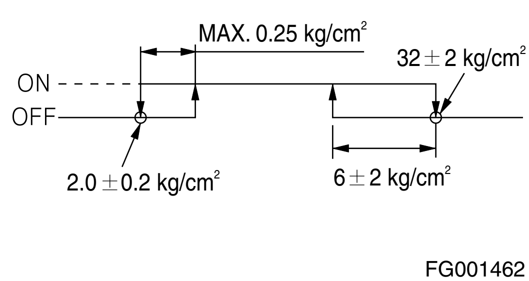
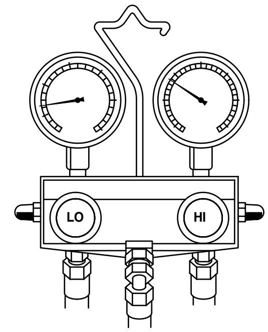



**Figure 93**

# TROUBLESHOOTING

**Refrigerant Pressure Check**

1. Open all doors and windows.
2. Install manifold gauge set.
3. Start engine and maintain engine speed at 1,800 - 2,000 rpm.




HDA6074L

**Figure 94**

4. Check high / low-pressure of refrigerant.

| **1** | **High-pressure: 8.0 - 10.0 kg/cm$^2$ (114 - 142 psi)**<br>**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)**<br>**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)**<br>**Low-pressure: Approximately 2.5 - 3.5 kg/cm$^2$ (36 - 50 psi)** |
|---|---|
| Possible Cause: Air in system. | |
| 1. Recover any remaining refrigerant.<br>2. Vacuum out system.<br>3. Recharge system.<br>**NOTE:** *If the system has been exposed to the air for a long period of time, replace the receiver dryer.* | |

<table>
<tr><td>4</td><td colspan="3">High-pressure: Over 6 kg/cm$^2$ (85 psi)<br>Low-pressure: Approximately 760 mmHg (Negative Pressure)</td></tr>
<tr><td colspan="4">Possible Cause: Refrigerant does not circulate</td></tr>
<tr><td>Step</td><td colspan="2">Inspection Item</td><td>Remedy</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">1. Connect manifold gauge and start engine.<br>2. Turn on air conditioner.<br>3. Set blower switch to HIGH position.<br>4. Turn air conditioner OFF and wait 10 minutes.<br>5. Recheck high / low-pressure readings.<br>High-pressure: 13.0 - 19.0 kg/cm$^2$ (185 - 270 psi)<br>Low-pressure: 1.5 - 3.3 kg/cm$^2$ (21.3 - 46.9 psi)</td><td>Yes</td><td>Moisture in system, replace receiver dryer.</td></tr>
<tr><td>No</td><td>Contaminated system, replace expansion valve.<br>(Replace evaporator core assembly.)</td></tr>
</table>

<table>
<tr><td>5</td><td>High-pressure: Over 6 - 18 kg/cm$^2$ (85 - 256 psi)<br>Low-pressure: 500 mmHg (Negative Pressure) - Dial indicator needle unstable.</td></tr>
<tr><td colspan="2">Possible Cause: Moisture in system has iced up the expansion valve.<br>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.</td></tr>
<tr><td colspan="2">1. Recover any remaining refrigerant.<br>2. Vacuum out system.<br>3. Recharge system.<br>NOTE: If the system has been exposed to the air for a long period of time, replace the receiver dryer.</td></tr>
</table>

<table>
<tr><td>6</td><td colspan="3">High-pressure: Over 22.0 - 23 kg/cm$^2$ (313 - 327 psi)<br>Low-pressure: 2.5 kg/cm$^2$ (36 psi)</td></tr>
<tr><td colspan="4">Possible Cause: Refrigerant pressure problem due to defective expansion valve or temperature sensor.</td></tr>
<tr><td>Step</td><td colspan="2">Inspection Item</td><td>Remedy</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Inspect whether the temperature sensor is installed properly.</td><td>Yes</td><td>Replace expansion valve.</td></tr>
<tr><td>No</td><td>Exchange duct sensor.</td></tr>
</table>

<table>
<tr><td>7</td><td>High-pressure: Over 7.0 - 11.0 kg/cm$^2$ (100 - 156 psi)<br>Low-pressure: 4.0 - 6.0 kg/cm$^2$ (57 - 85 psi)</td></tr>
<tr><td colspan="2">Possible Cause: Low refrigerant pressure due to poor compressor compression.</td></tr>
<tr><td colspan="2">Inspect and replace compressor if necessary.</td></tr>
</table>

# WEIGHT OF R134a GAS USED IN MACHINES

| Model | Weight of Gas |
|---|---|
| DX140LC | 800 ±20 grams (28 ±0.7 oz) |
| DX180LC | 800 ±20 grams (28 ±0.7 oz) |
| DX225LC | 800 ±20 grams (28 ±0.7 oz) |
| DX225NLC | 800 ±20 grams (28 ±0.7 oz) |
| DX255LC | 800 ±20 grams (28 ±0.7 oz) |
| DX300LC | 800 ±20 grams (28 ±0.7 oz) |
| DX340LC | 800 ±20 grams (28 ±0.7 oz) |
| DX420LC | 800 ±20 grams (28 ±0.7 oz) |
| DX480LC | 800 ±20 grams (28 ±0.7 oz) |
| DX520LC | 800 ±20 grams (28 ±0.7 oz) |
| | |
| | |
| | |

# REFRIGERANT SYSTEM REPAIRS

## WARNING!

**Always wear protective glasses and gloves when handling refrigerant. If refrigerant comes in contact with the skin or eyes, immediately flush with clean, running water and consult a physician.**

**Select a clean and well ventilated area to work.**

**The refrigerant container is under high-pressure and should be stored below 40°C (104°F). Be careful not to drop the container from a high location.**

**The contents are under high-pressure and should not be used with compressed air or near an open flame.**

## Refrigerant Safe Handling Procedures

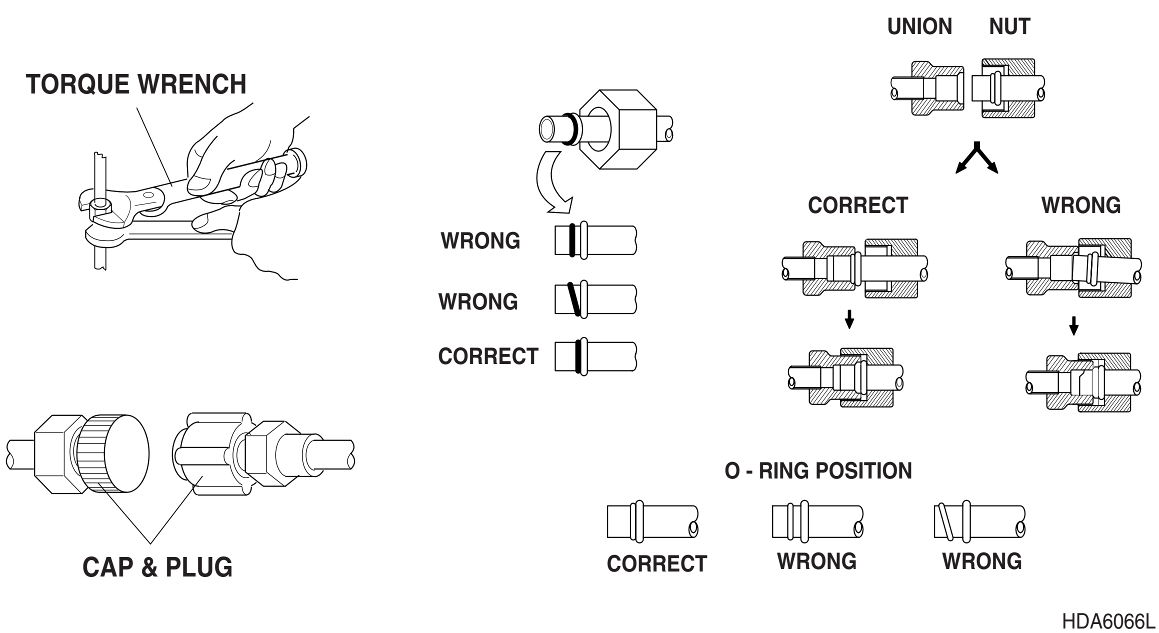



**Figure 95**

The following procedures should be observed for safe handling of refrigerant during vacuum and charging process.

1. Use an approved recovery / charging device which can safely perform vacuum and charge work simultaneously.
2. The new refrigerant has improved cooling characteristics than the old type and care should be used not to overcharge the system.

3. Do not over tighten connections when working on refrigerant system.
4. The new refrigerant system standards require new tools, equipment and parts. DO NOT attempt to use equipment use in servicing the old refrigerant system.
5. The new refrigerant oil (PAG type) has a high moisture absorption characteristic. When the refrigerant system vacuum seal has been broken, immediately plug up all openings to prevent moisture from entering 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.*

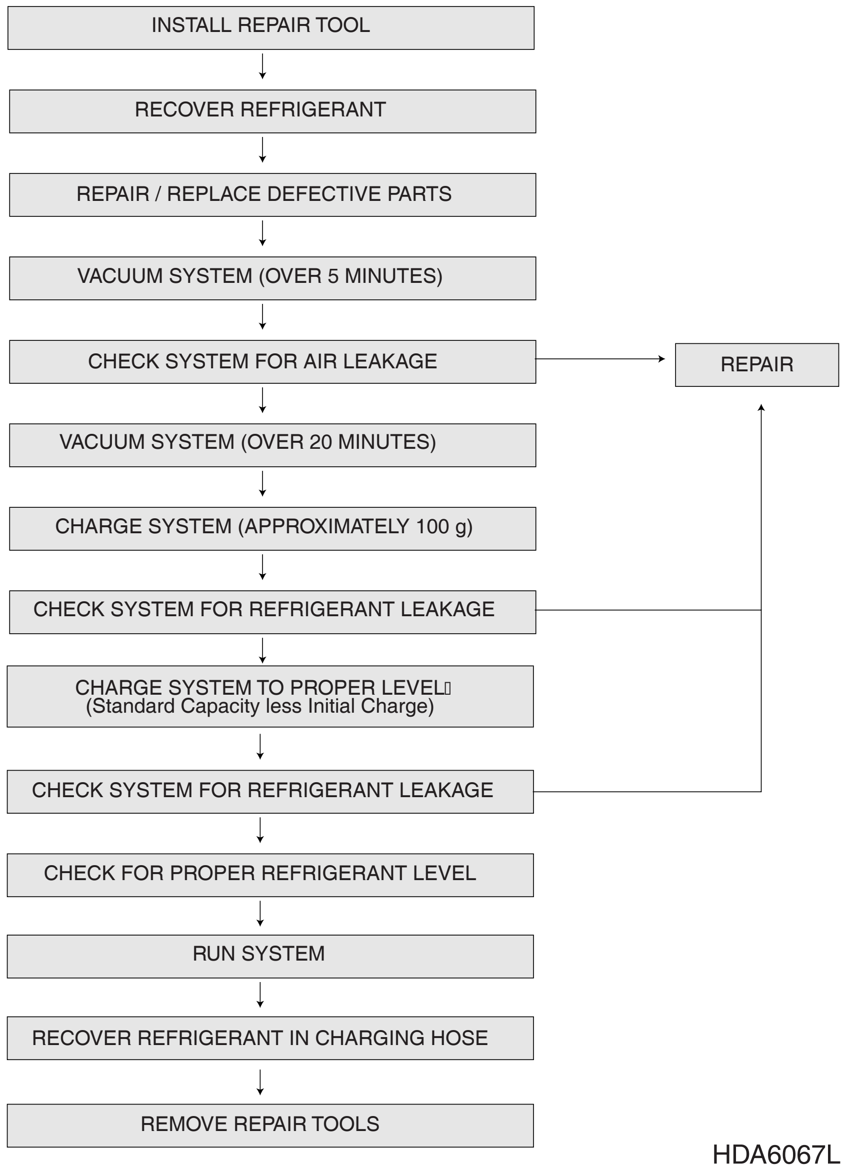

INSTALL REPAIR TOOL
RECOVER REFRIGERANT
REPAIR / REPLACE DEFECTIVE PARTS
VACUUM SYSTEM (OVER 5 MINUTES)
CHECK SYSTEM FOR AIR LEAKAGE
REPAIR
VACUUM SYSTEM (OVER 20 MINUTES)
CHARGE SYSTEM (APPROXIMATELY 100 g)
CHECK SYSTEM FOR REFRIGERANT LEAKAGE
CHARGE SYSTEM TO PROPER LEVEL
(Standard Capacity less Initial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

**Figure 96**

## Refrigerant Recovery

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

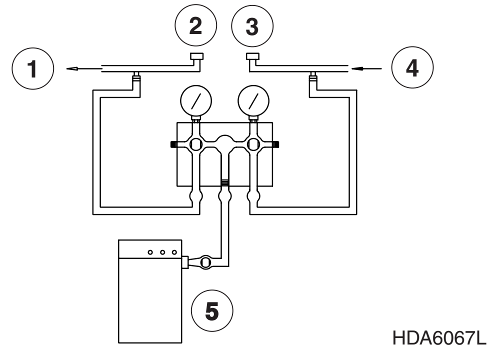



**Figure 97**

1. Attach the manifold gauges and the refrigerant recovery unit to the refrigerant lines as shown.

   **NOTE:** *Be careful not to switch the connections for the low and high-pressure valves.*

2. Open the high-pressure valve slowly to release the refrigerant to the recovery unit.

   **NOTE:** *Open the valve slowly, while checking to see that refrigerant is not leaking out.*

3. When the manifold gauge dial falls below 3.5 kg/cm$^2$ (50 psi), slowly open the low-pressure valve.
4. Open both the high and low-pressure valves slowly until the manifold gauge dials indicates 0 kg/cm$^2$ (0 psi).

## Vacuuming Refrigerant System

| Reference Number | Description |
|---|---|
| 1 | To Compressor |
| 2 | Low-pressure Side |
| 3 | High-pressure Side |
| 4 | From Receiver |
| 5 | Vacuum Pump |

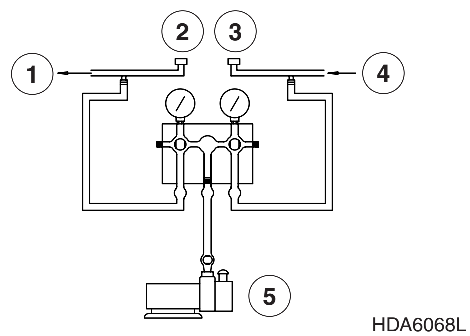



**Figure 98**

1. Vacuuming Procedure

   **NOTE:** *When the A/C system has been exposed to the air, it must be vacuumed out. Perform vacuum process for 30 minutes for complete moisture and air evacuation.*

   A. Attach the manifold gauges and vacuum pump to the refrigerant system as shown.

   B. Turn on the vacuum pump and open both valves.

   C. When the low-pressure gauge shows approximately 710 mmHg, close both valves and turn off vacuum pump.

2. Check system for vacuum leak.

   Allow system to sit for 10 minutes and check whether the system is holding the pressure. If the pressure has dropped, it must be repaired before proceeding to the next step.

3. Vacuuming Procedure

   If the system is holding the pressure and it has not changed for 10 minutes, vacuum out the system for an additional 20 minutes.

   A. Turn on the vacuum pump and slowly open both valves.

   B. Allow vacuum pump to run for additional 20 minutes until the low-pressure gauge dial reads approximately 750 mmHg.

   C. Close both valves and stop the vacuum pump.

4. Installation of Refrigerant Container

| Reference Number | Description |
|---|---|
| 1 | Handle |
| 2 | Hose Connection |
| 3 | Mounting Disk |

   A. Before mounting valve on the container, make sure the handle is in the counterclockwise most position, with the puncture pin retracted and the mounting disk is in the raised position.

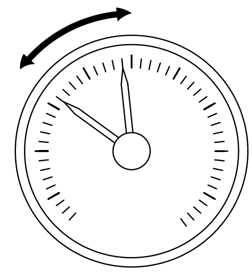
   B. Attach the manifold gauge center hose to the valve assembly.

   C. Turn the disk in the clockwise direction and securely mount valve onto refrigerant container.

   D. Turn the valve handle in the clockwise direction and puncture the container seal with the pin.

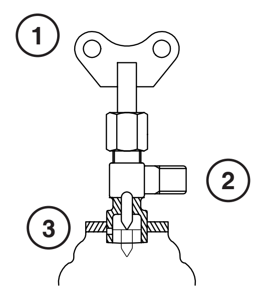
   E. Once the can has been punctured, turn the handle in the counterclockwise direction so the refrigerant can flow into the manifold gauge center hose. At this time, do not open the low and high-pressure valves of the manifold gauge.

   F. Press the manifold gauge low side valve to eliminate the trapped air in the hose.



HDA6069L

**Figure 99**




HDA6070L

**Figure 100**

## Leakage Check

**NOTE:** *Perform the leakage check after completing vacuuming process.*

1. After attaching the manifold gauge, open the high side valve.
2. Charge system until the low side gauge dial indicates a pressure of 1 kg/cm$^2$ (14 psi) and close the high side valve.
3. Using a refrigerant leak detector or soapy water check each joint for leakage.

| Reference Number | Description |
|---|---|
| 1 | Refrigerant Leak Detection Device |

4. If a leak is detected, check for O-ring damage or correct tightening torque and replace or repair as necessary.
5. If no leaks are detected, proceed with the charging process.

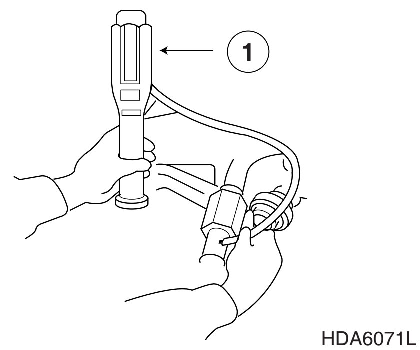



**Figure 101**

**WARNING!**

**For accurate refrigerant leak detection, perform leak detection procedure in a well ventilated area.**

## Refrigerant Charging

1. Perform the vacuuming procedure, vacuum holding and leaking tests as described in the proceeding headings.

   **NOTE:** *First charge the refrigerant system with 100g (3.5 ounces) of refrigerant with the engine off. Then using the manifold gauges as a guide fully charge the system with the engine running.*

   *When exchanging refrigerant containers, press the manifold gauge low side valve to eliminate air from the charging hose.*

| Reference Number | Description |
|---|---|
| 1 | To Compressor |
| 2 | Low-pressure Side |
| 3 | High-pressure Side |
| 4 | From Receiver |
| 5 | Refrigerant Supply Container |

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

   Initial charge amount: 100 g (3.5 ounces).

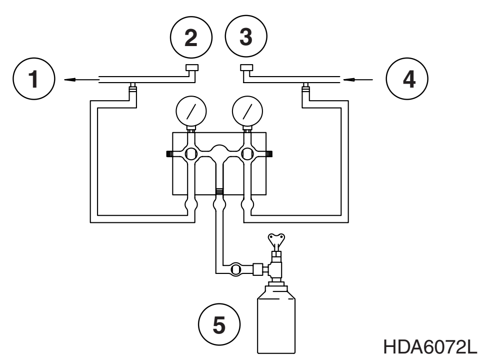



**Figure 102**

3. If refrigerant does not flow freely into system, try starting engine first before operating air conditioner.

   - Temperature control switch setting: Maximum Cooling

     Blower Speed Setting: Hi (3 step)

     Engine Speed: 1,300 - 1,500 rpm

## WARNING!

**When charging refrigerant system with the engine running:**

- **Always keep refrigerant supply container in the upright position.**
- **Never open the high side pressure valve.**

4. Open the manifold gauge low side valve and charge system to standard capacity.

| Gauge Dial | Standard Reading |
|---|---|
| High Side Gauge | 13 - 20 kg/cm$^2$ (185 - 285 psi) |
| Low Side Gauge | 1.5 - 3.5 kg/cm$^2$ (22 - 50 psi) |

**NOTE:** *These standards are for outside temperatures between 30° - 35°C (86° - 95°F). The gauge readings may vary for extreme temperature conditions.*

## WARNING!

- **When outside temperature is low, warm the refrigerant supply container with warm water not exceeding 40°C (104°F). Do not allow water to come in contact with the charging adapter valve handle.**
- **When outside temperature is high, cool off refrigerant supply container and condenser to aid the refrigerant charging process.**

5. Close low-pressure side valve.
6. Shut off engine and close refrigerant supply container adapter valve. Disconnect manifold gauge hoses from vehicle.

# Inspecting System For Leakage

After completing charging procedures, clean all joints and connections with a clean dry cloth. Using a refrigerant leak detecting device or soapy water, inspect system for leaks starting from the high-pressure side.

**NOTE:** *When the refrigerant circulation has been stopped the high-pressure will start to decrease and the low-pressure will start to increase until they are equalized. Starting the inspection from the high side will result in a accurate test.*

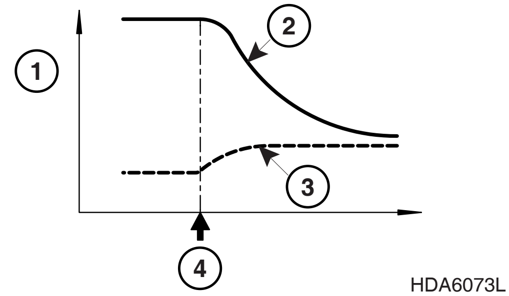



**Figure 103**

| 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.*

# WIPER SYSTEM

## Wiper Circuit

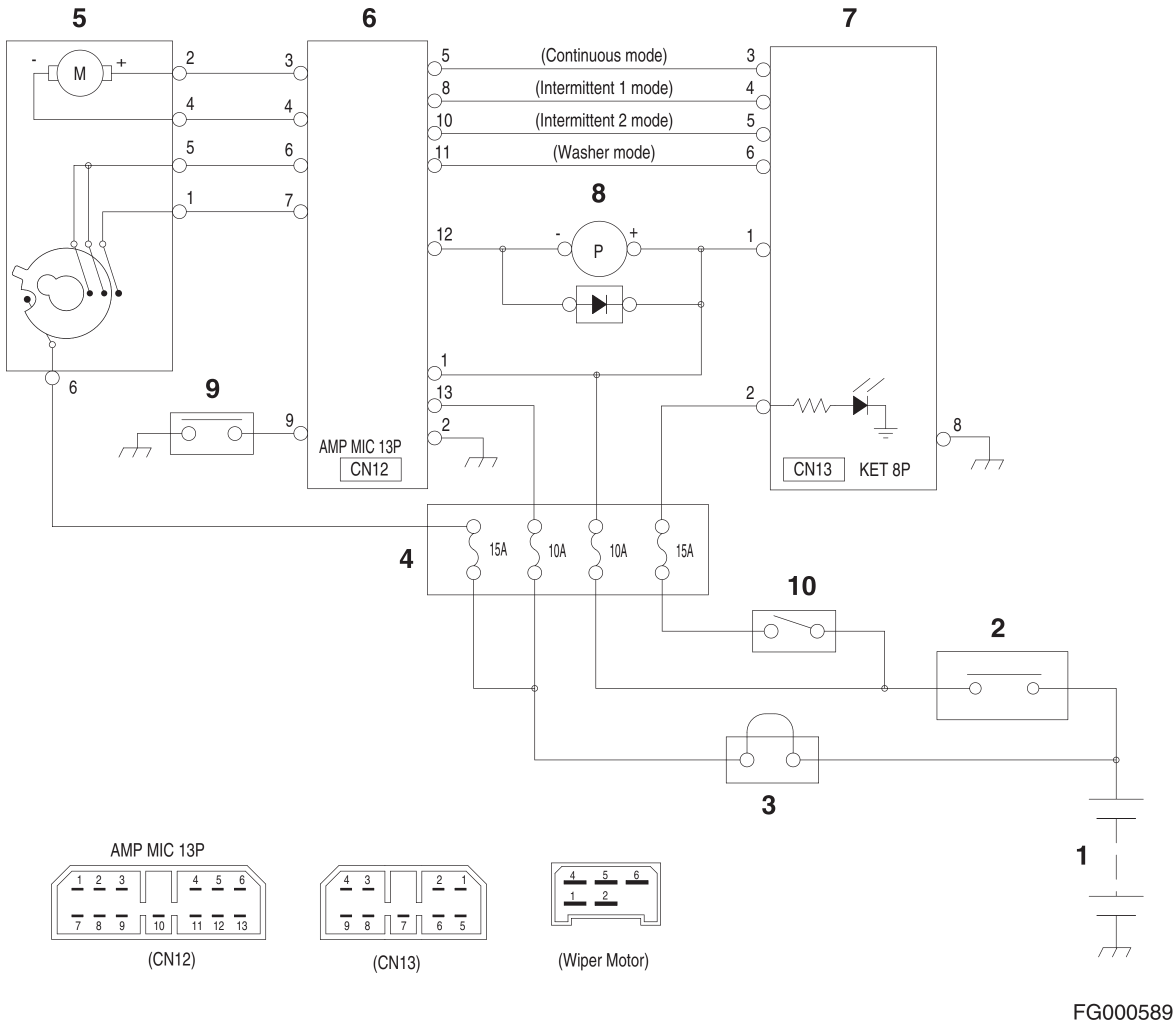



**Figure 104**

| Reference Number | Description |
|---|---|
| 1 | Battery |
| 2 | Battery Relay |
| 3 | Fusible Link |
| 4 | Fuse Box |
| 5 | Wiper Motor |

| Reference Number | Description |
|---|---|
| 6 | Wiper Controller |
| 7 | Wiper Switch Panel |
| 8 | Window Washer |
| 9 | Wiper Cutoff Switch |
| 10 | Light Switch |

## Wiper operation

#### Continuous operation

**- Operation of wiper motor**

Pressing the successive operation switch on the wiper switch panel (7) changes the voltage of the "5" terminal of the wiper controller (6) from HIGH (about 5.5 ±0.5V) to LOW (0+0.5V) and also current flows via the "3" terminal of the wiper controller (6) → the "2" and "4" terminals of the wiper motor (5) → the "4" terminal of the wiper controller (6) to run the wiper motor (5) continuously.

**- Stop of wiper motor**

Pressing again the successive operation switch on the wiper switch panel (7) changes the voltage of the "5" terminal of the wiper controller (6) from LOW (0+0.5V) to HIGH (about 5.5 ±0.5V). As the "5" and "6" terminals of the wiper motor are connected still that power is supplied to the "6" terminal of the wiper controller (6),

However, the controller (6) runs the wiper motor continuously and then rotates the motor reversely by " letting current flow via the "4" terminal of the wiper controller (6) → the "2" and "4" terminals of the wiper motor (5) → the "3" terminal of he wiper controller (6) when the "1" and "6" terminals of he wiper motor (5) are connected and thus power voltage is supplied to the "7" terminal of the wiper controller (6).

The Wiper motor (5) stops reverse revolution when the contact of a cam switch connected to the "6" terminal of the wiper motor (5) moves to an insulation area of the cam plate to disconnect the "5" and "6" terminals of the wiper motor (5).

When the wiper motor (5) stops, arm and blade connected to it move to the stop positions of the right pole in the cabin.

#### Intermittent operation

**- Intermittent 1st (3-second)**

Pressing once the Intermittent switch in the switch panel (7) changes voltage of the "8" terminal in the wiper controller (6) from HIGH (about 5.5 ±0.5V) to LOW (0+0.5V) and current flows through the "3" terminal in the wiper controller (6) → the "2" and "4" terminals in the wiper motor (5) → the "4" terminal in the wiper controller (6) to start the cycle that wiper stops 3 seconds after every operation.

**- Intermittent 2nd (6-second)**

Pressing twice the Intermittent switch in the switch panel (7) changes voltage of the "10" terminal in the wiper controller (6) from HIGH (about 5.5 ±0.5V) to LOW (0+0.5V) and current flows through the "3" terminal in the wiper controller (6) → the "2" and "4" terminals in the wiper motor (5) → the "4" terminal in the wiper controller (6) to start the cycle that wiper stops 6 seconds after every operation.

**- Stopping the intermittent action**

Pressing three times the Intermittent switch in the switch panel (7) while the wiper is operating stops the action of the wiper motor.

**NOTE:** *The wiper system does not work when the wiper cutoff switch (9) is "ON."*

# LIGHTING SYSTEM

## Lighting System Circuit Diagram

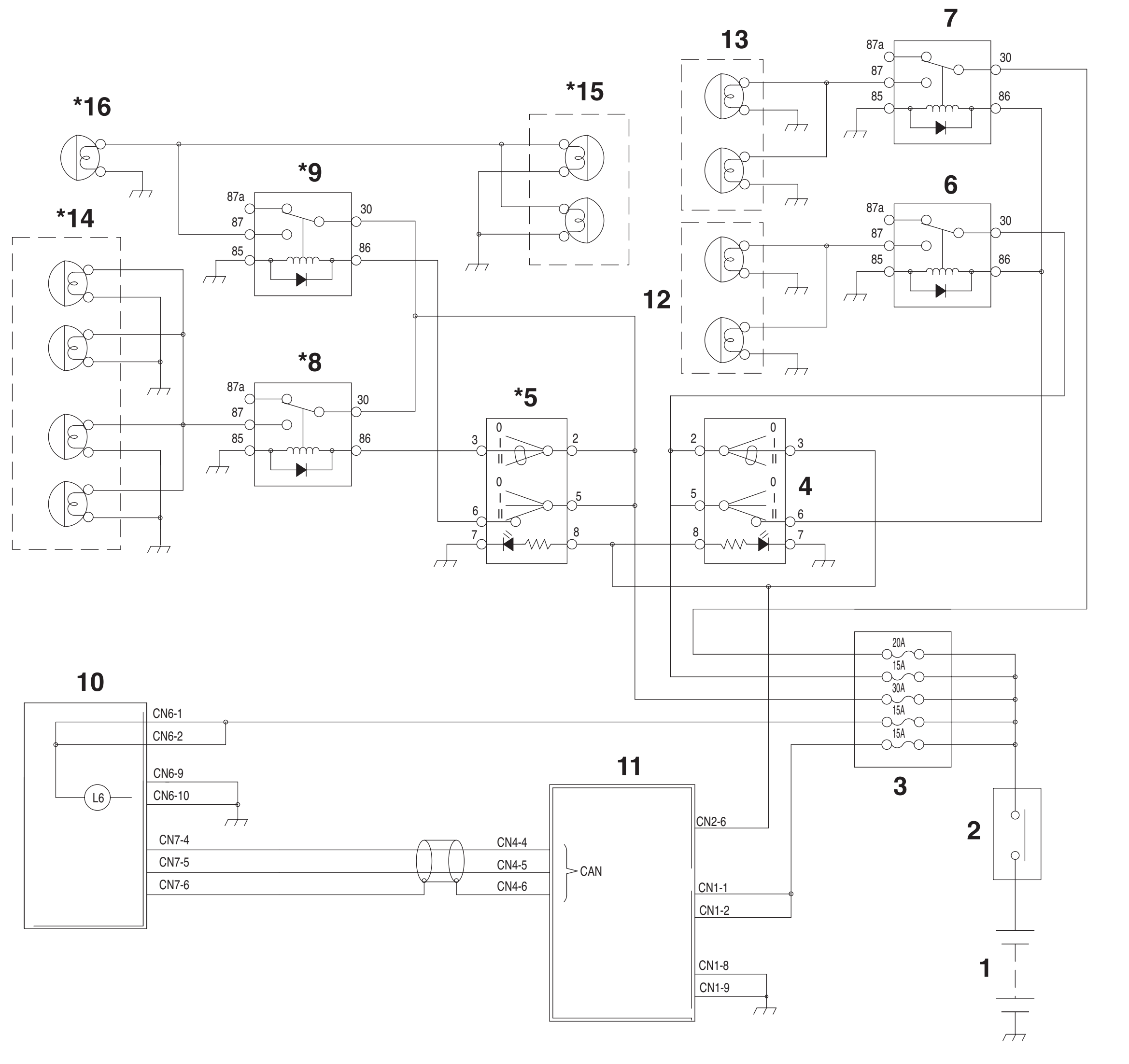



Figure 105

| Reference Number | Description |
|---|---|
| 1 | Battery |
| 2 | Battery Relay |
| 3 | Fuse Box |
| 4 | Light Switch |
| 5 | Cabin Light Switch |
| 6 | Headlight Relay (Work Light Indicate Light) |
| 7 | Work Light Relay |
| 8 | Front Cabin Light Relay |

| Reference Number | Description |
|---|---|
| 9 | Front Cabin Light / Rear Work Light Relay |
| 10 | Instrument Panel |
| 11 | e-EPOS Controller |
| 12 | Headlight (2 ea.) |
| 13 | Work Light (2 ea.) |
| 14 | Front Cabin Light (4 ea.) |
| 15 | Rear Cabin Light (2 ea.) |
| 16 | Rear Work Light (1 ea.) |

**NOTE:** *The "*" mark are optional parts.*

## Kind of Light

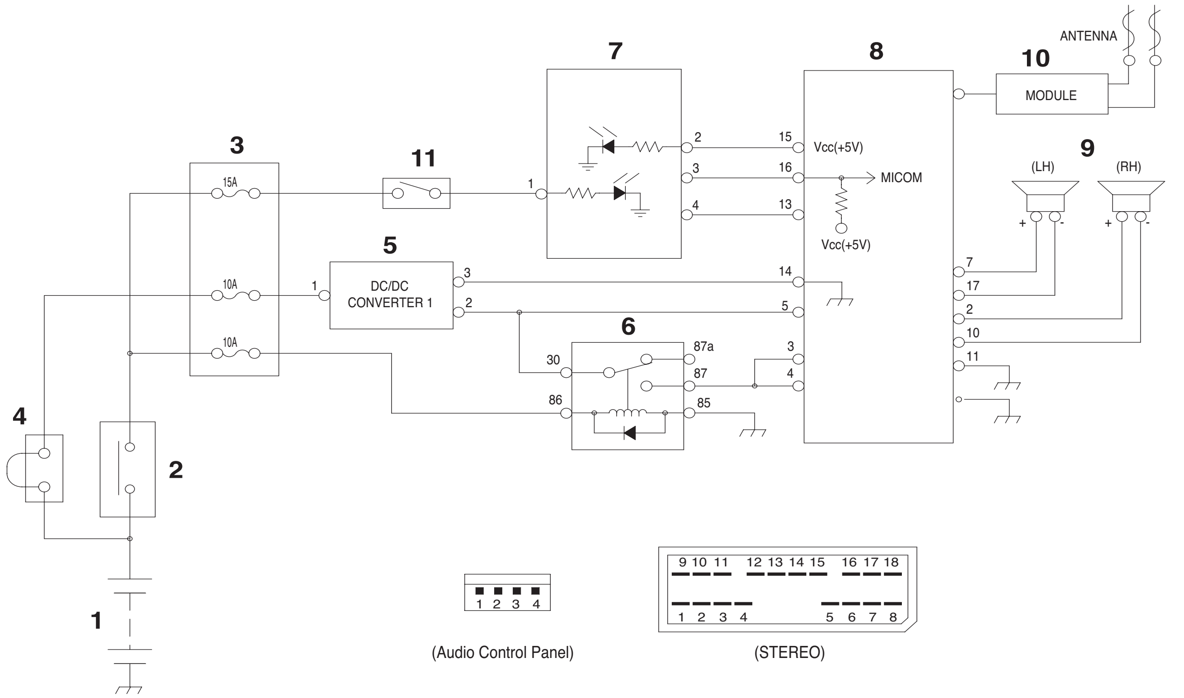
The lighting system is consists of headlights, work lights, cabin lights (optional), relays and switches.

## Operation

| Switch | Position | Connected Terminal of switch | Activated Relay | Lit Light |
|---|---|---|---|---|
| Light Switch | 1 | "2-3" Terminal | - | Illumination Light of Switch |
| | 2 | "2-3" Terminal | - | Illumination Light of Switch |
| | | "5-6" Terminal | Headlight Relay | Headlight (2 Ea.) |
| | | | Work Relay | Work Light (2 Ea.)<br>Indicator Light of Work Light (L6) |
| Cabin Light Switch | 1 | "2-3" Terminal | Front Cabin Light Relay | Front Cabin Light (2 Ea.) or Front Cabin Light (4 Ea.) |
| | 2 | "2-3" Terminal | Front Cabin Light Relay | Front Cabin Light (2 Ea.) or Front Cabin Light (4 Ea.) |
| | | "5-6" Terminal | Rear Cabin Light Relay / Rear Work Light Relay | Rear Cabin Light (2 Ea.) and Rear Work Light (1 Ea.) |

# AUDIO CONTROLLER

## Audio Controller Circuit Diagram




FG000591

**Figure 106**

| Reference Number | Description |
|---|---|
| 1 | Battery |
| 2 | Battery Relay |
| 3 | Fuse Box |
| 4 | Fusible Link |
| 5 | Converter |
| 6 | Stereo Relay |

| Reference Number | Description |
|---|---|
| 7 | Audio Control Panel |
| 8 | Stereo |
| 9 | Speaker |
| 10 | Antenna Module |
| 11 | Light Switch |

### Operations Via Audio Control Panel

| Switch | Connected Terminal of switch | Measured values | Operations |
|---|---|---|---|
| PWR | "3-4" | 4.36 ±0.2V | Stereo ON, OFF |
| ▲ | | 1.24 ±0.2V | Volume up |
| ▼ | | 0+0.2V | Volume down |
| SCAN | | 2.49 ±0.2V | Frequency selection |

# Electrical Schematic (DX140LC)

Edition 1

# MEMO

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## Electrical Schematic (DX140LC)

# MEMO

# SAFETY PRECAUTIONS

## CAUTION!

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

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

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

**Remember, that ultimately safety is your own personal responsibility.**

# APPLICABLE MODELS

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

| MODEL | SERIAL NUMBER RANGE |
|---|---|
| DX140LC | 5001 and Up |
| | |
| | |
| | |

# DX140LC

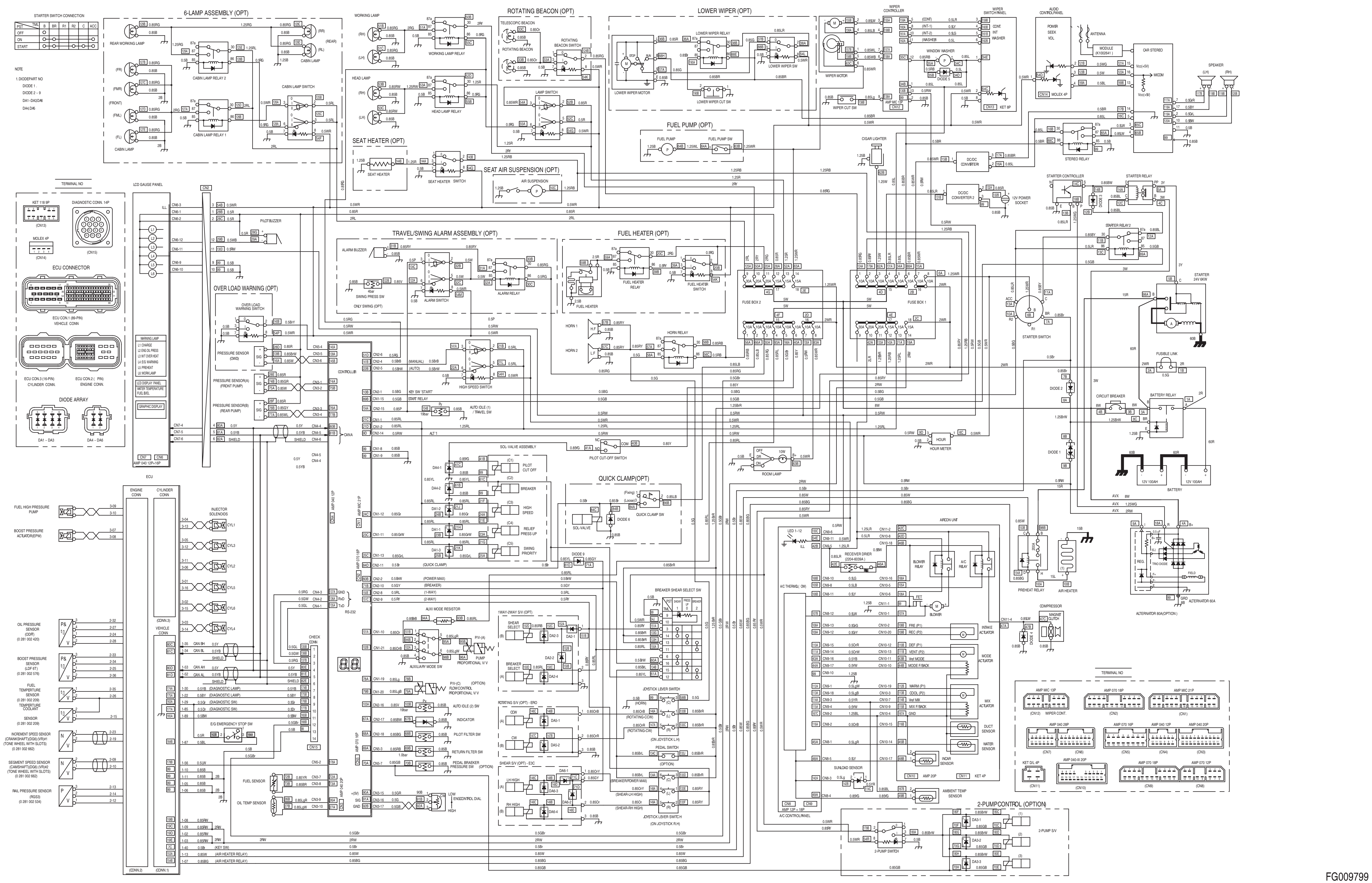


Figure 1

# Attachments

# Boom and Arm

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## Boom and Arm

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# FRONT ATTACHMENT PIN SPECIFICATIONS

The table below has a complete listing of dimensional specifications for all mounting pins used on the front attachment.

**NOTE:** *Some mounting pins must be drilled and tapped for lubrication fittings and piping, or may have other required specifications. Consult DOOSAN After Sales Service for information on wear tolerances and replacement limits for mounting pins.*

## One-Piece Boom

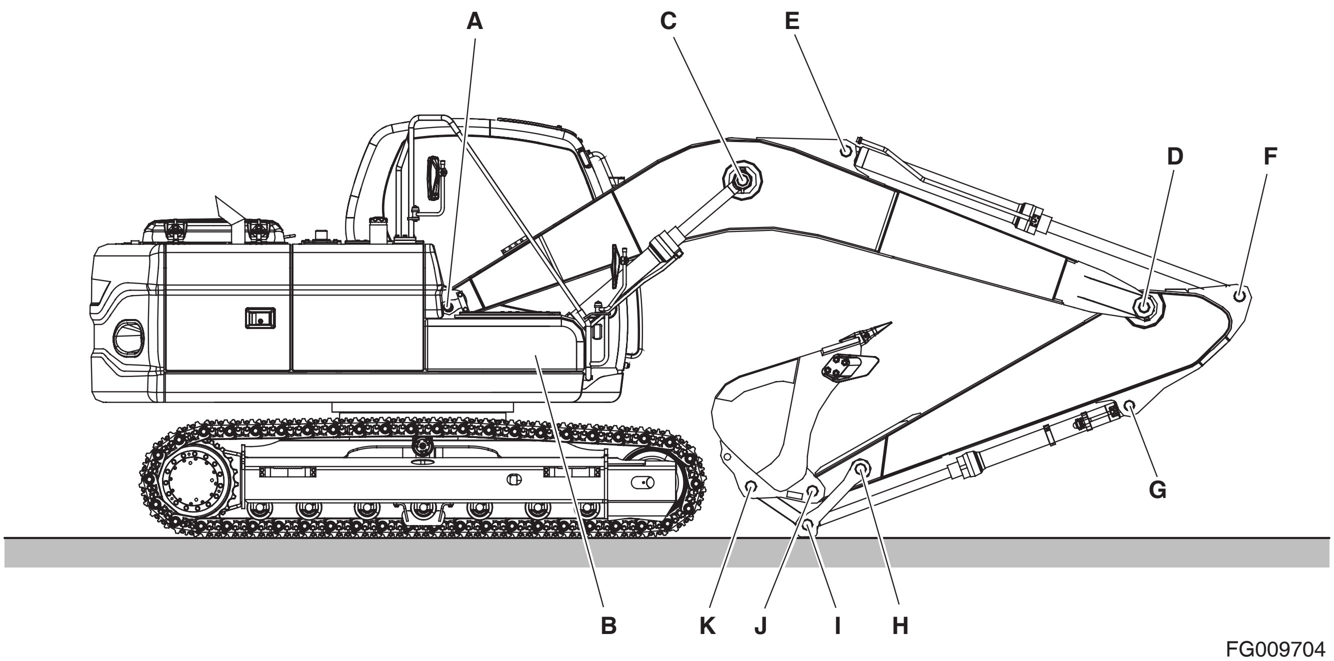


**Figure 1**

| Mounting Pin | Diameter, mm (Inches) | Length, mm (Inches) |
|---|---|---|
| A | 71 mm (2.80 in) | 678 mm (26.69 in) |
| B | 71 mm (2.80 in) | 207 mm (8.15 in) |
| C | 71 mm (2.80 in) | 670 mm (26.38 in) |
| D | 71 mm (2.80 in) | 429 mm (16.89 in) |
| E | 71 mm (2.80 in) | 217 mm (8.54 in) |
| F | 71 mm (2.80 in) | 217 mm (8.54 in) |
| G | 65 mm (2.56 in) | 203 mm (7.99 in) |
| H | 65 mm (2.56 in) | 384 mm (15.12 in) |
| I | 65 mm (2.56 in) | 441 mm (17.36 in) |
| J | 65 mm (2.56 in) | 384 mm (15.12 in) |
| K | 65 mm (2.56 in) | 441 mm (17.36 in) |

## Two-Piece Boom

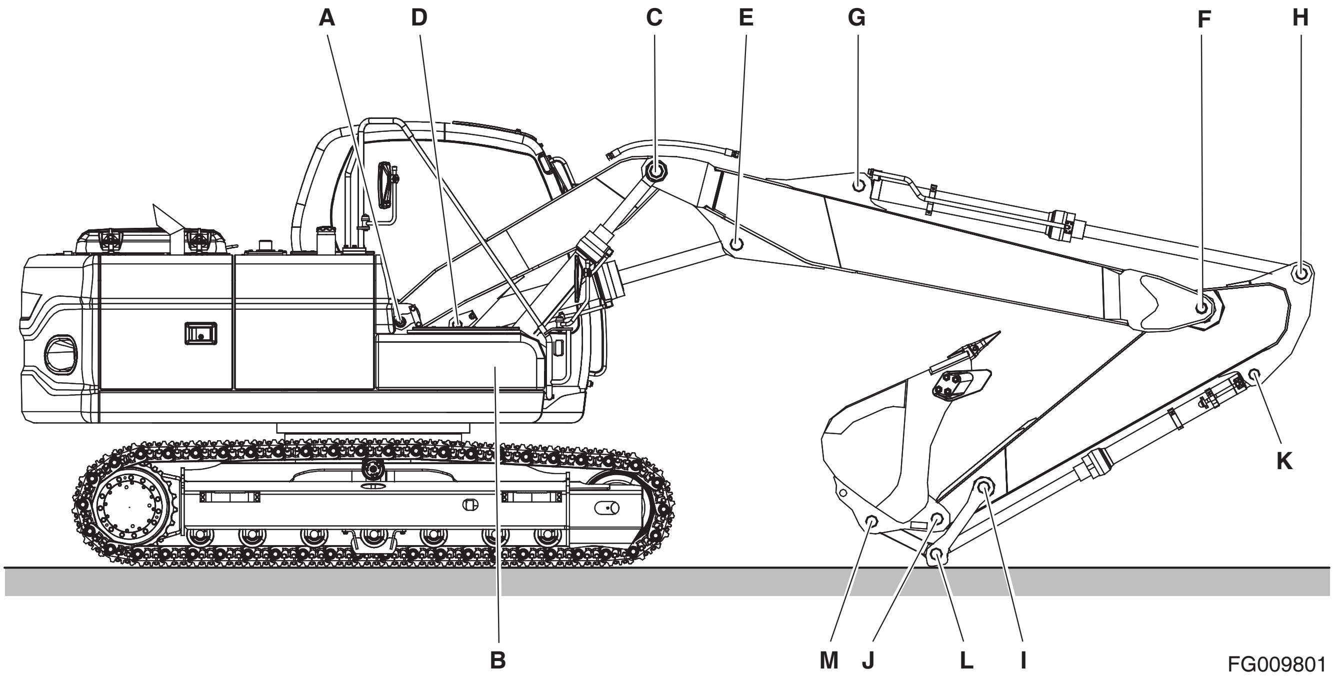


**Figure 2**

| Mounting Pin | Diameter, mm (Inches) | Length, mm (Inches) |
|---|---|---|
| A | 71 mm (2.80 in) | 678 mm (26.69 in) |
| B | 71 mm (2.80 in) | 207 mm (8.15 in) |
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| J | 65 mm (2.56 in) | 384 mm (15.12 in) |
| K | 65 mm (2.56 in) | 441 mm (17.36 in) |
| L | 65 mm (2.56 in) | 384 mm (15.12 in) |
| M | 65 mm (2.56 in) | 441 mm (17.36 in) |

# FRONT ATTACHMENT - REMOVAL AND INSTALLATION

## DANGER!

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

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

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

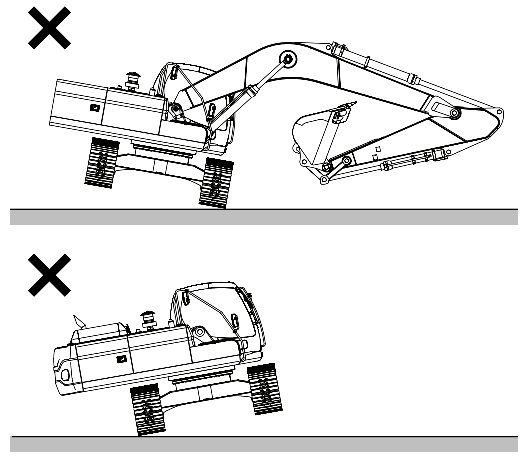

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**Figure 3**

## IMPORTANT

**Always break down the front attachment by removing outermost sections first - the bucket before the arm, the arm before the boom. Reinstallation of the attachment should begin with the boom and end with the bucket.**

Refer to the appropriate Bucket section for its removal and installation procedure before going onto the initial step of the front attachment removal or installation procedure.

## Arm Removal Procedure

## WARNING!

**This procedure is only intended for routine removal or replacement of the attachment, while working under normal, safe operating conditions. In the event of a major structural collapse of some part of the attachment, an accident or complete loss of attachment hydraulic function, DO NOT proceed with attachment disassembly unless you are completely sure of what you are doing. Please call your local *DOOSAN* distributor or *DOOSAN* After Sales Service for assistance. DO NOT allow personnel to stand underneath a weakened or only partially supported attachment section. Keep clear of hydraulic lines that may have fluid escaping at high-pressure - it can cause severe or even fatal injuries.**

Complete the bucket end removal procedure by pulling out the two bucket linkage pins and the bucket cylinder mounting pin, on the arm. Use an assist crane or hoist to lift the cylinder and relieve weight on mounting pins.

Park the excavator away from obstructions and all traffic on clear, flat, level ground. Extend the arm cylinder and crowd the arm into the boom. Partially retract the boom cylinder so 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 cabin to keep anyone from moving or inadvertently starting the engine. Restrict access to the work site while sections of the attachment are in the air, or while they are being supported by the assist crane. The safe lifting capacity of the assist crane or hoist that is used must exceed the weight of the heaviest section of the attachment, the boom (approximately 756 kg [1,667 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 cabin is taken off the turntable deck first. Refer to the Operator's Cabin Removal procedure before continuing, if both components are to be removed from the excavator.*

After the bucket, arm and arm cylinder have been removed, lower the end of the boom to a stable, secure blocking support.

Attach the assist crane sling to the body of either boom cylinder, break the mounting pin connection to the boom by tapping through the pin from the same side of the boom and repeat for the opposite cylinder.

Release hydraulic pressure and disconnect line couplings as previously outlined in the Arm Removal Procedure, observing the same precautions.

Disconnect wiring for work light assemblies and any other accessory lines or connections. Locate the sling of the assist crane near the center of gravity, optimum lift point for the boom, and use the crane to take pressure off the boom foot pin. Drive out the pin after disassembling retainers and carefully lift away the boom.

## WARNING!

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

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

# INSTALLATION

## Arm Installation Procedure

Reattach the base of the arm cylinder to the mounting point on top of the boom.

**WARNING!**

**Before assembling the front attachment, make sure that the individual boom, arm and bucket sections are all compatible and can be used safely for work intended. Refer to the General Safety Pages, Lift Ratings, Working Range Diagrams and Weights of Materials sections in the Operation and Maintenance Manual. Consult your dealer or *DOOSAN* After Sales Service for more information if you have any questions or require more information.**

Begin with the arm securely supported on blocking in front of the excavator. Pregrease the mounting pin for the rod end of the arm cylinder and push it through the ears on the end of the arm. Attach a sling around that mounting pin and lift the arm with an assist crane until it is in position for the boom-arm pin connection to be made.

Relieve hydraulic pressure from all points of the system before any hydraulic lines are opened, then carefully assemble hydraulic connections to the arm cylinder.

Remove 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.

# Bucket

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## Bucket

# MEMO

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|---|---|
| DX140LC | 5001 and Up |
| DX180LC | 5001 and Up |
| DX225LC | 5001 and Up |
| DX225NLC | 5001 and Up |
| DX255LC | 5001 and Up |

# BUCKET TOOTH INSPECTION AND REPLACEMENT

There are several different types of attachment methods for replaceable bucket teeth. Some of the most common types are shown in the following drawings.

Bucket teeth are usually replaced in sets but it may sometimes be necessary to replace individual teeth.

Look for the following indications of wear or damage:

- Lock pins protrude unevenly on one side.
- Lock pins have been worn down so far that they no longer make full contact through the length of the 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.

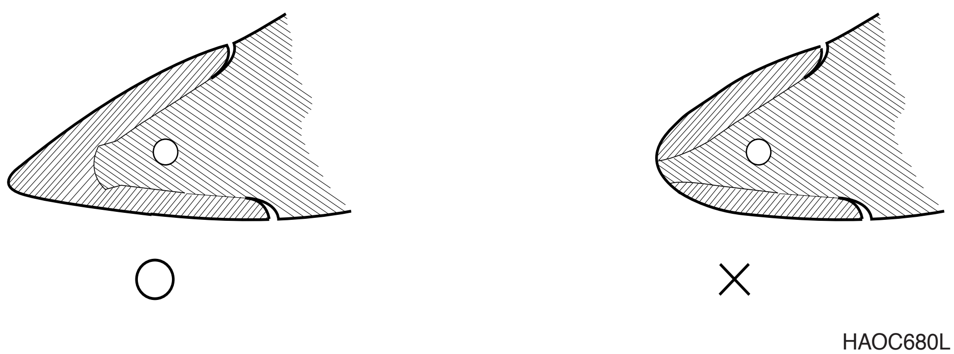


**Figure 1**

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 1.
2. To replace a tooth (1, Figure 2), use a hammer and punch to drive the locking pin (2) and lock washer (3) out of the tooth adapter (4).
3. Once the worn tooth has been removed, use a putty knife to scrape the adapter as clean as possible.
4. Slide the new tooth into position and insert the lock washer.
5. Insert the locking pin into the tooth and with a hammer, drive the pin in until the lock washer seats in the locking groove.

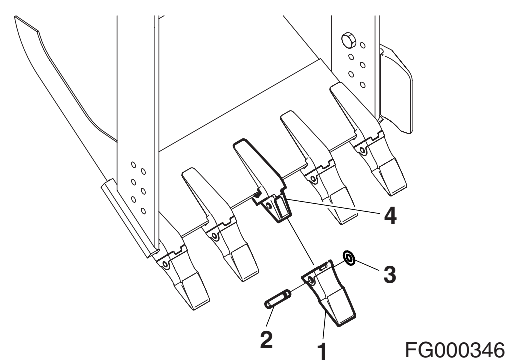


**Figure 2**

# BUCKET O-RING REPLACEMENT

## WARNING!

**Due to possibility of flying metal objects, always wear safety helmet, protective gloves and eye protection when changing pins.**

1. Inspect the bucket O-rings on a routine basis. If worn or damaged, replacement is necessary.

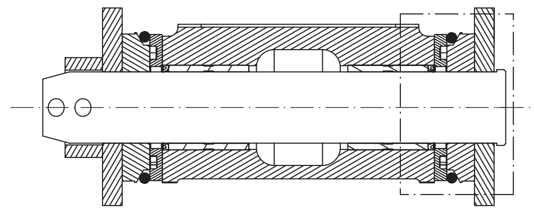

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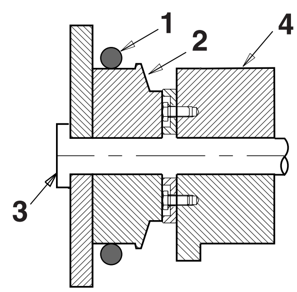
**Figure 3**

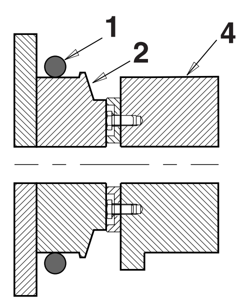
2. Roll the old O-ring (1, Figure 4) onto the boss (2) around the bucket pin (3). Remove the bucket pin and move the arm or bucket link (4) out of the way.




ARO1390L

**Figure 4**

3. Remove the old O-ring and temporarily install the new O-ring (1, Figure 5) onto the bucket boss (2). Make sure that the O-ring groove on both the bucket link (4) and boss have been cleaned.
4. Realign the arm or link with the bucket pin hole and insert the bucket pin (3, Figure 4).




ARO1391L

**Figure 5**

5. Roll the new O-ring (1, Figure 6) into the O-ring groove.

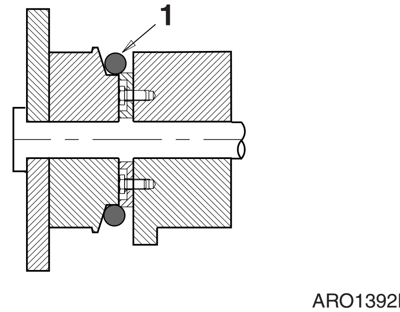



**Figure 6**

# BUCKET ATTACHMENT, REMOVAL AND REVERSAL

## Detaching the Bucket

Park the excavator away from obstructions on clear, flat, level ground. Lower the bucket carefully to preassembled blocking on the ground. Brace the bucket so 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. Prelube linkage pins before reassembly.

Use an old cylinder rod, a long breaker bar or a similar, relatively thin diameter support bar for making the first (temporary) pin connection, between the bucket and arm. If the support bar is straight, the arm can be raised and the bucket will hang level, allowing direct insertion of the bucket ear-attachment linkage pin.

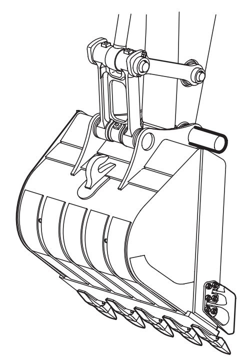


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**Figure 7**

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.**

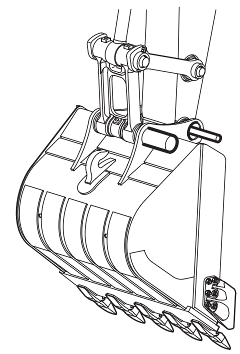
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**Figure 8**

## Reversing the Bucket

Follow instructions for "Detaching the Bucket" and remove both the bucket and link pins. Rotate the bucket 180° to change bucket configuration. This procedure is greatly simplified if some type of rotating or swiveling support can be used, on the ground underneath the bucket. Follow instructions for "Bucket Attachment" to replace pins.

## WARNING!

**Bucket curl and dump levers must be used in opposite directions, after the bucket has been reversed.**