

DX210W

Shop Manual

K1017314E

Serial Number 5001 and Up

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

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

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

DX210W

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Pub.No. K1017314E

Product Label



Instructions

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



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COMPANY NAME:	DATE:
STREET ADDRESS:	TELEPHONE:
CITY:	FAX:
STATE / PROVINCE:	
COUNTRY:	
NAME:	
MACHINE MODEL:	
SERIAL NUMBER:	
MANUAL NUMBER:	
SHOP MANUAL SECTION NUMBER:	
PROPOSED DESCRIPTION OF CORRECTION AND/OR SUGGESTION:	
Use additional paper if needed. Please include copy of current manual pages for reference. Attach any photos or illustrations. If digital photos are available, E-mail them to Bill.Bernhardt@dhiac.com (If possible, use 1024 x 768 resolution.).	
HAS THIS BEEN DISCUSSED WITH A DOOSAN SERVICE REPRESENTATIVE: YES NO	
IF YES - WHO:	
(It is advised to discuss this with a DOOSAN service representative to ensure the correction is appropriate and valid.)	

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

Safety

Wheel Excavator Safety

Edition 1

MEMO

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

TO THE OPERATOR OF A DOOSAN EXCAVATOR



DANGER!

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

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

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

1. "General Safety Essentials" on page 1-10
2. "Location of Safety Labels" on page 1-11
3. "Summary of Safety Precautions for Lifting in Digging Mode" on page 1-12
4. "Unauthorized Modifications" on page 1-13
5. "General Hazard Information" on page 1-13
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9. "Battery" on page 1-40
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11. "Shipping and Transportation" on page 1-43



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



SAFETY ALERT SYMBOL



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

This is the Safety Alert Symbol. Wherever it appears in this manual or on safety signs on the machine you 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 threat of a hazardous situation that, if not avoided, could result in minor or moderate injury. It may also be used to alert against a generally unsafe practice.



WARNING!

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



DANGER!

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

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

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

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 the other instructions, guidelines and restrictions for Safe Lifting in the Operation and Maintenance Manuals.

LOCATION OF SAFETY LABELS

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

Always replace damaged or faded decals.

SUMMARY OF SAFETY PRECAUTIONS FOR LIFTING IN DIGGING MODE



DANGER!

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

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

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

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



WARNING!

NEVER wrap a tag line around your hands or body.

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

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



WARNING!

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

UNAUTHORIZED MODIFICATIONS

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

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

GENERAL HAZARD INFORMATION

Safety Rules

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

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

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

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

Always observe strictly any other rules related to safety.

Safety Features

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

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

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

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

Inside Operator's Cabin

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

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

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

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

Do not use cellular telephones inside the operator's cabin 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 serious injury or damage.

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

Clothing and Personal Protective Items

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

Do not wear oily clothes. They are 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 *DOOSAN* genuine 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 machine is properly maintained.
 - Tire pressure, brakes, steering, linkages, etc.
4. Steer, brake, accelerate, shift gears, move the attachments and load the attachments smoothly.
5. Adjust the machine speed and travel path to reduce the vibration level.

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

Mounting and Dismounting

Before getting on or off the machine, if there is any oil, grease, or mud on the handrails, steps, 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 and steps 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 steps, and the door lock is not applied securely, the door may move and cause you to fall.

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

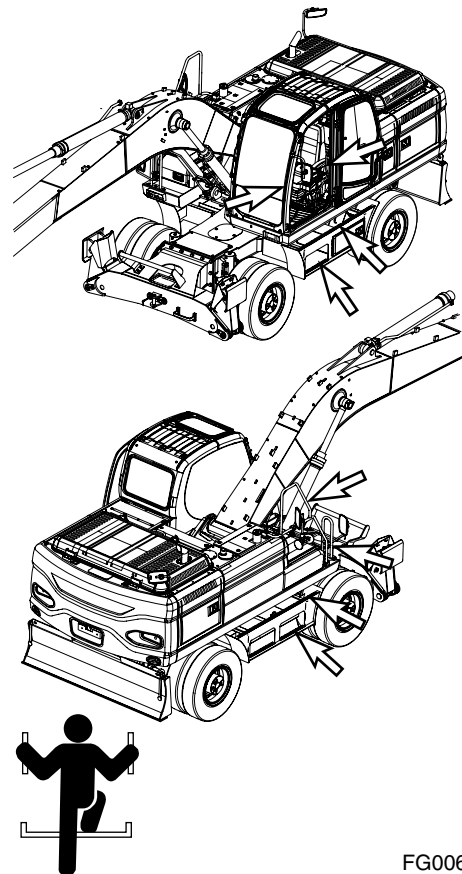


Figure 2

FG006532

Fuel, Oil and Hydraulic Fluid Fire Hazards

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

Always strictly observe the following.

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

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

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

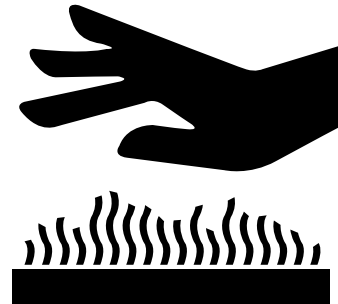


ARO1050S

Figure 3

Precautions When Handling Fluids at High Temperature

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



HAOA050L

Figure 4

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

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



HAOA060L

Figure 5

Asbestos Dust Hazard Prevention

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

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



ARO1770L

Figure 6

Injury from Work Equipment

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

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

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



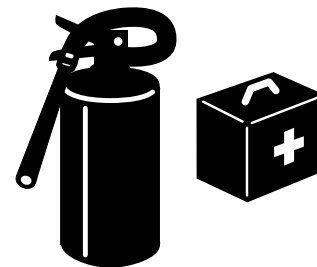
HDO1010L

Figure 7

Fire Extinguisher and First Aid Kit

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

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



HDO1009L

Figure 8

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

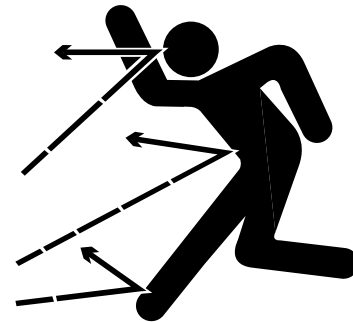
- Turn the starter switch to the "O" (OFF) position and shut down engine.
- If there is time, use the fire extinguisher to put out as much of the fire as possible.
- Use the handrails and steps to escape from the machine.

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

Protection from Falling or Flying Objects

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

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



HAOA110L

Figure 9

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

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

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

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

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

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



HAOA100L

Figure 10

Attachment Precautions

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

Accumulator

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

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

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

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

Indoor Ventilation

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

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

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



ARO1770L

Figure 11

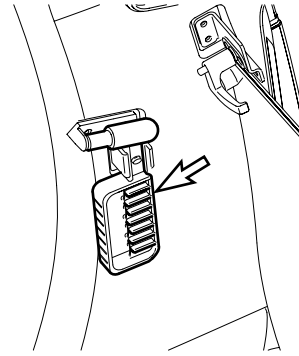
Emergency Exit

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



WARNING!

Protect your eyes when breaking the glass.



FG000178

Figure 12

BEFORE STARTING ENGINE

Work Site Precautions

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

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

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

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

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

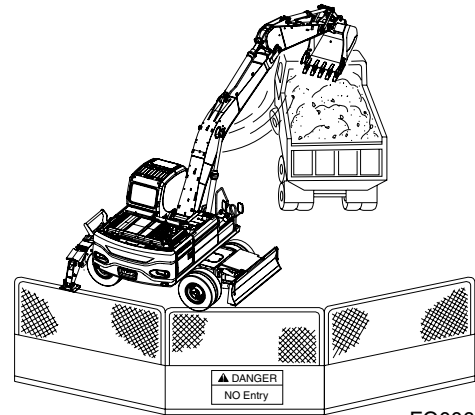
Waterlines, gas lines, phone lines and high-voltage electrical lines may be buried under the work site. Contact each utility and identify their locations. Be careful not to damage or cut any of these lines.

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

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

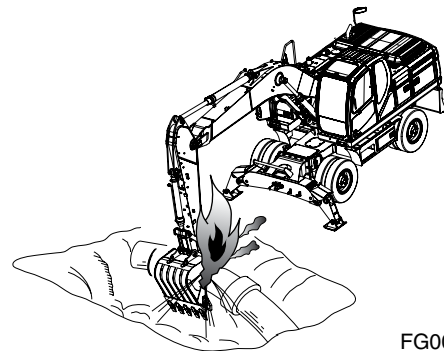
Minimum levels of insurance coverage, work permits or certification, physical barriers around the work site or restricted hours of operation may be mandated by governing authorities. There may also be regulations, guidelines, standards or restrictions on equipment that may have to be followed for local 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.



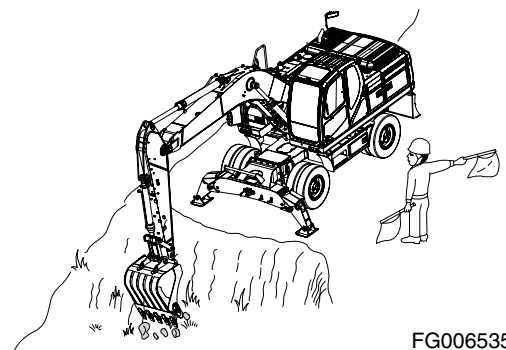
FG006533

Figure 13



FG006534

Figure 14



FG006535

Figure 15

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

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

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

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

Checks Before Starting Engine

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

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

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

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

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

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

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

Engine Starting

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

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

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

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

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

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

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

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

Start and operate the machine only while seated.

Before Operating Machine

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

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

- Check the operating condition of the equipment, and the movement of the bucket, arm, boom, travel, and swing systems.
- Check the machine for any abnormal noise, vibration, heat, smell, or abnormality with the gauges. Check also for leakage of air, oil, and fuel.
- If any abnormality is found, repair the problem immediately. If the machine is used without repairing the problems, it may lead to unexpected injury or failure.
- Clear all personnel from directly around machine and from the area.
- Clear all obstacles from the machine's path. Beware of hazards.
- Be sure that all windows are clean. Secure the doors and the windows in the open position or in the shut position.
- Adjust the rearview mirrors for best visibility close to the machine. Make sure that horn, the travel alarm (if equipped), and all other warning devices are working properly.
- Fasten the seat belt securely.
- Warm up the engine and hydraulic oil before operating machine.
- Before moving the machine, check undercarriage position. The normal travel position is with idler wheels to the front under the cabin and the drive sprockets to the rear. When the undercarriage is in the reversed position, the travel controls must be operated in opposite directions.

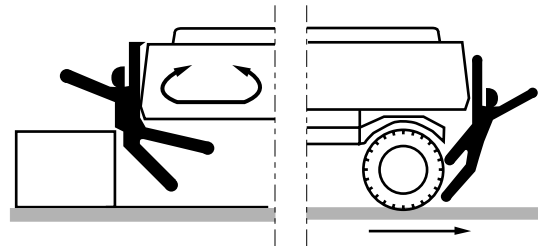
MACHINE OPERATION

When Swinging or Changing Direction of Travel

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

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

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



HGB1014L-1

Figure 16

Travel Precautions

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

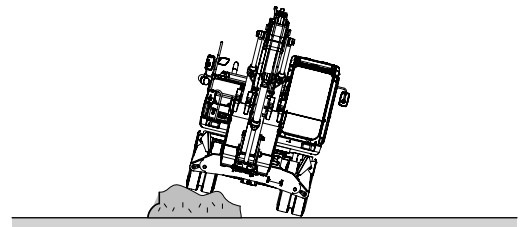
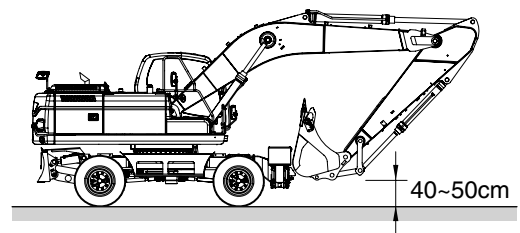
Attachment control levers should not be operated while traveling.

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

Fold in work equipment so the outer end of the boom is as close to the machine as possible, and nut the bucket in the cradle.

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.



FG006536

Figure 17

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

Always keep to the permissible water depth. Permissible water depth is to the centerline of the axles.

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

Traveling on Slopes

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

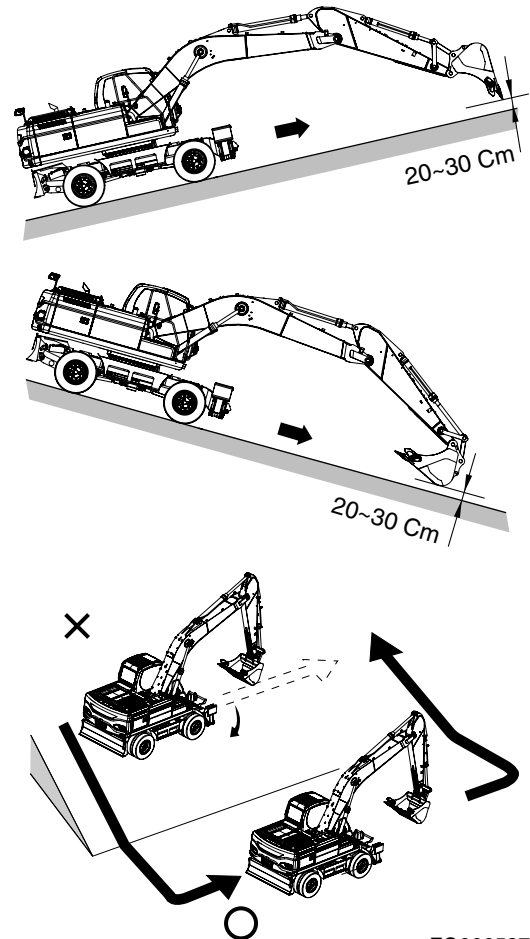
Traveling on slopes could result in the machine tipping over or slipping.

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 machine is always traveling directly up or down the slope.

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

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



FG006537

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.

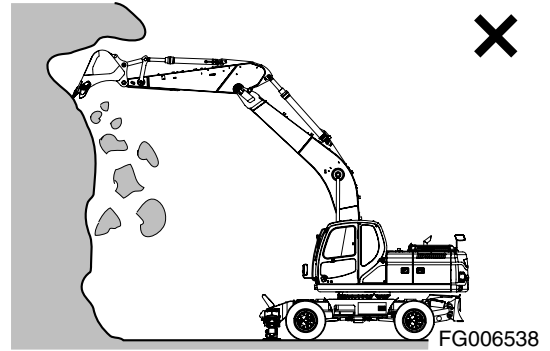


Figure 19

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 rely on lift jacks or other inadequate supports when work is being done. Block tires fore and aft to prevent any movement.

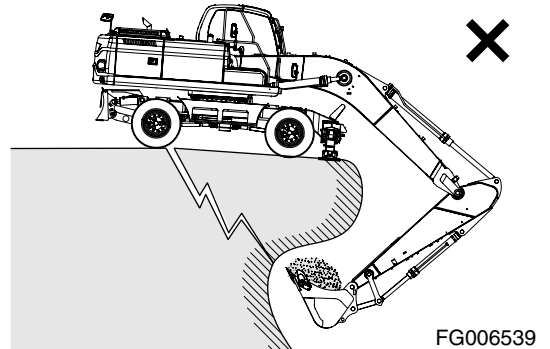


Figure 20

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

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

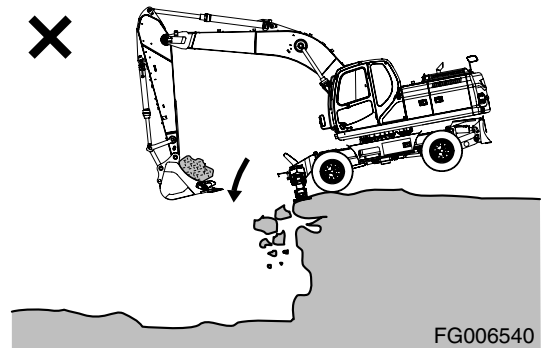


Figure 21

Precautions for Operation

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

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

To ensure a good view, always do the following:

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

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

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

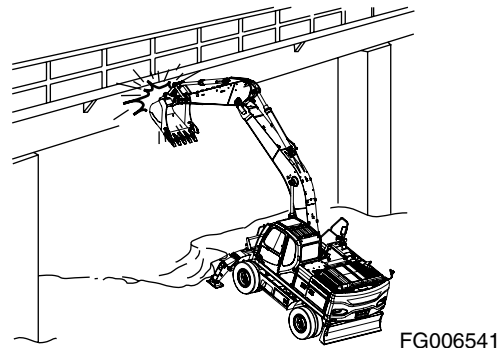


Figure 22

Avoid High-voltage Cables

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

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

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

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

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

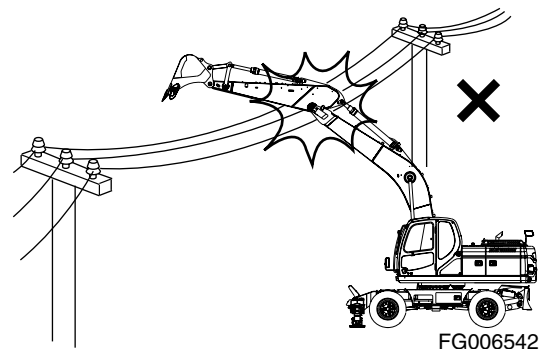
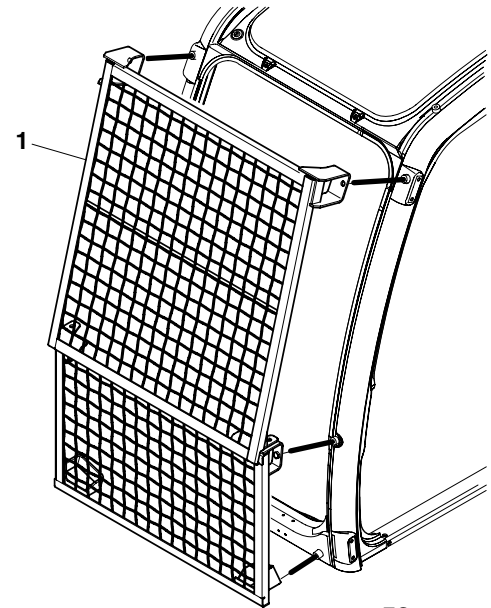


Figure 23

Protecting Cabin from Falling Object (Optional)

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

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



FG000112

Figure 24

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

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

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

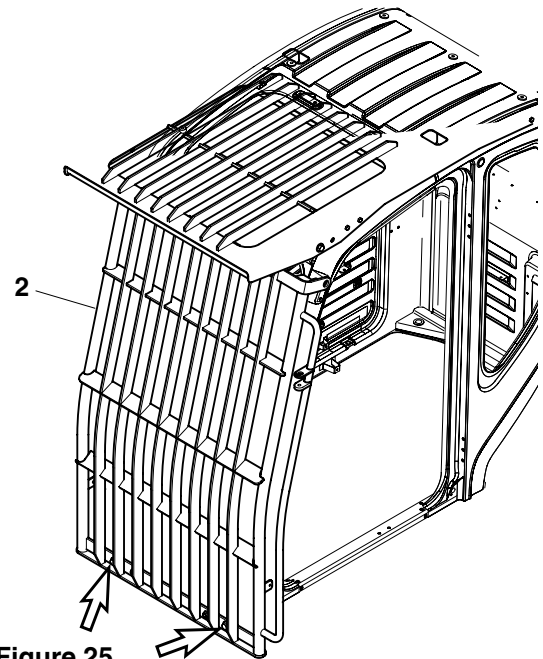


Figure 25

FG000111

Operate Carefully on Snow, Ice and in Very Cold Temperatures

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

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

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

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

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

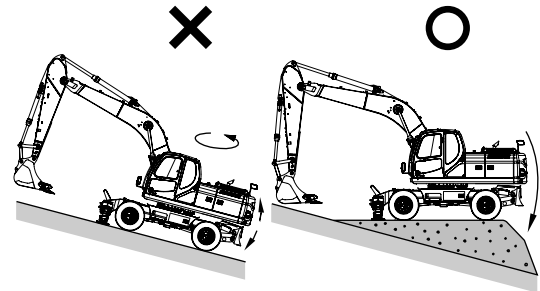
Operations on Slopes

When working on slopes, there is a danger that 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.



FG006543

Figure 26

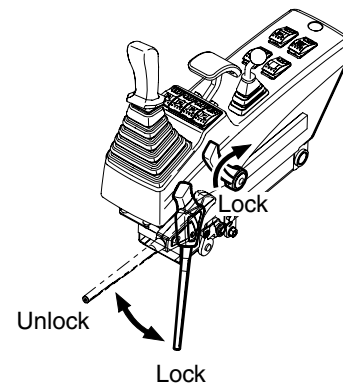
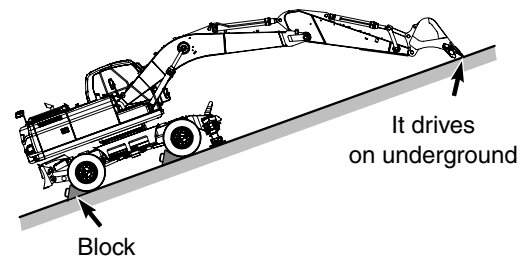
Parking Machine

Avoid making sudden stops, or parking the machine wherever it happens to be at the end of the workday. Plan so the excavator will be on firm, level ground away from traffic and away from high walls, cliff edges and any area of potential water accumulation or runoff. If parking on inclines is unavoidable, block the wheels 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. Park the machine so the machine, flags, and fences do not obstruct traffic.

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

Always close the door of the operator's cabin.

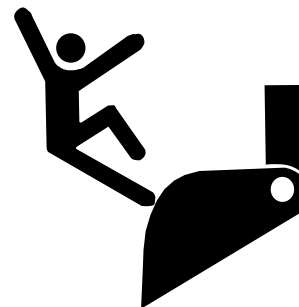


FG006544

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

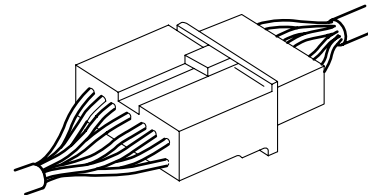
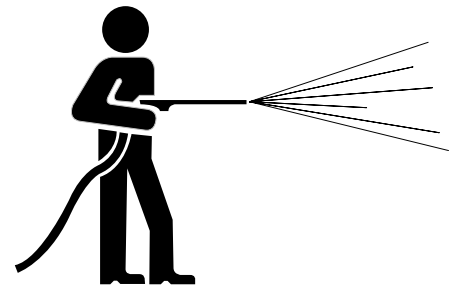
Clean Before Inspection or Maintenance

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

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

When washing the machine, do the following:

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



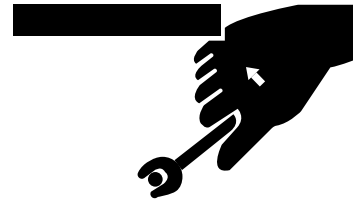
ARO1330L

Figure 30

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

Proper Tools

Use only tools suited to the task. Using damaged, low quality, 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 a 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 battery gas may catch fire and cause an explosion.



HDO1040L

Figure 32

Fire Prevention and Explosion Prevention

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

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

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

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

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

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

Remove all flammable materials before they accumulate on the machine.

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



HDO1015I

Figure 33

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

Burn Prevention

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

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

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

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

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

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

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

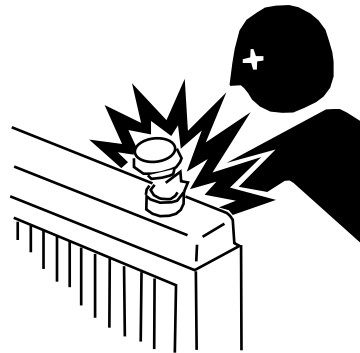
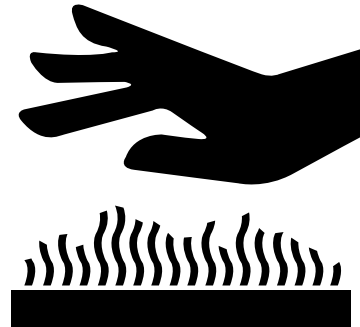
Relieve all pressure in the hydraulic oil system, in the fuel system, or in the cooling system before you disconnect any lines, fittings, or related items.

Batteries give off flammable fumes that can explode.

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

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

Always wear protective glasses when you work on batteries.



HAAE1980

Figure 34

Welding Repairs



CAUTION!

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

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

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

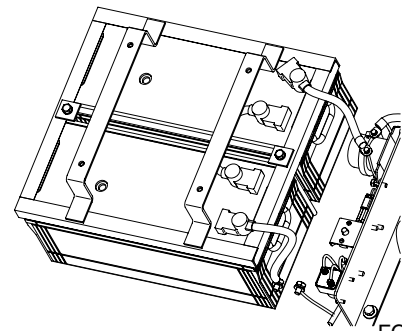
The qualified welder must do the following:

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

Treatment for Electrical Welding to the Body Structure

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

1. Open the door of the battery cover.
2. Detach the cover after loosening the bolts on the battery.
3. Detach the positive and negative terminal cables from the battery.
4. Detach the undercover, and after that detach the connector (1) from the ECU that are installed at the engine.
5. Proceed with welding.



FG000312

Figure 35

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.

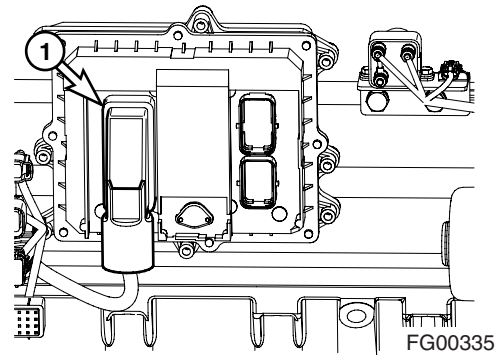


Figure 36

Warning for Counterweight and Front Attachment Removal

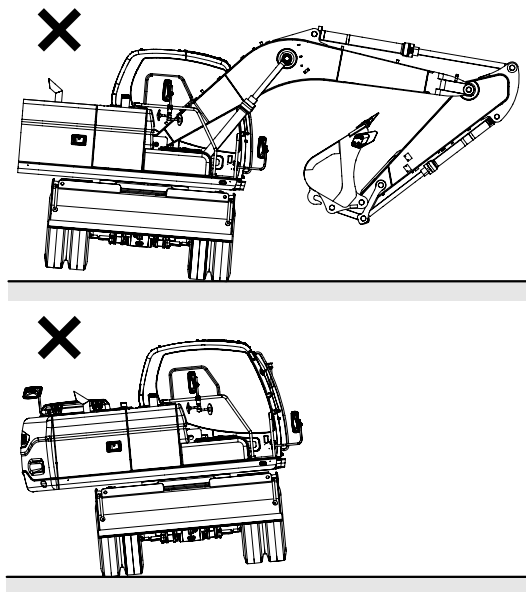


DANGER!

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

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

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



FG007095

Figure 37

Precautions for Removal, Installation, and Storage of Attachments

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

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

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



HDO1041L

Figure 38

Precautions When Working on Machine

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

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

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

If the job requires it, wear protective clothing.

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



ARO1380L

Figure 39

Lock Inspection Covers

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

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

Prevention of Crushing and Cutting

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

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

Stay clear of all rotating parts and moving parts.

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

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

When you strike a retainer pin, the retainer pin might fly out. The loose retainer pin can injure personnel. Make sure that 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.

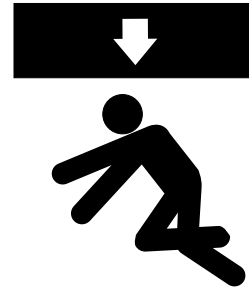
Supports and Blocking for Work Equipment

Do not allow weight or equipment loads to remain suspended.

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

Do not use hollow, cracked or unsteady wobbling supports.

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



HDO1042L

Figure 40

Action When Abnormality Is Found During Inspection

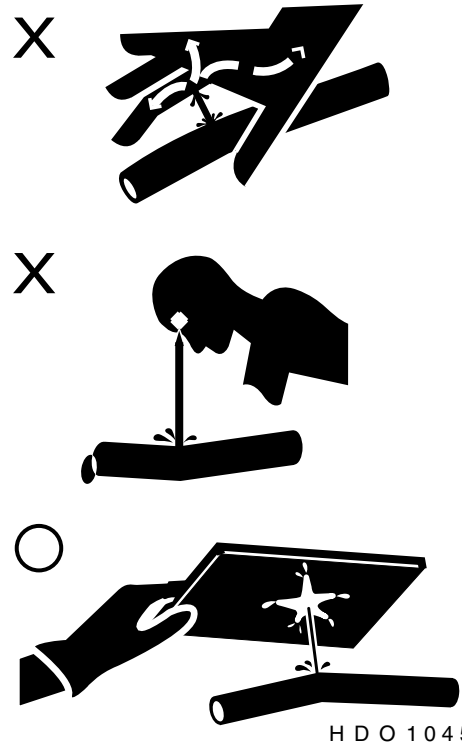
If any abnormality is found during inspection, always carry out repairs. In particular, if the machine is used when there are still problems with the brake or work equipment systems, it may lead to serious injury.

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

Precautions with High-pressure Lines, Tubes and Hoses

When inspecting or replacing high-pressure piping or hoses, check to verify that 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.



H D O 1 0 4 5 I

Figure 41

- There is twisting or crushing at movable parts of hose.
- Foreign material is embedded in the covering.
- Hose end is deformed.

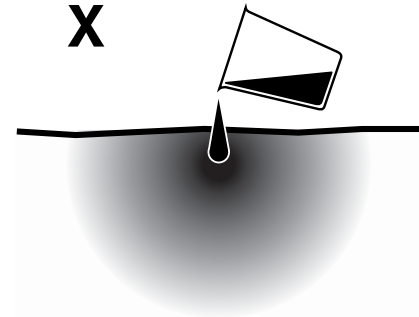
NOTE: Refer to "Hose In-service Lifetime Limit (European Standard ISO 8331 and EN982 CEN)" in Operation and Maintenance Manual, for additional European regulations.

Waste Materials

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

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

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



HAOA470L

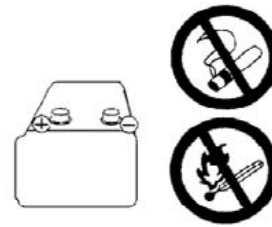
Figure 42

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 battery may catch fire.
- When charging the battery or starting with power from another source, let the battery electrolyte melt and check that there is no leakage of battery electrolyte before starting the operation.
- Always remove battery from the machine before charging.



HAAE2100

Figure 43

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 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 faraway from the batteries as possible.

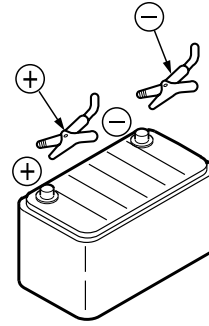


Figure 44

HAOA310L

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.
- Always release the parking brake (manual mode).
- 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.
- 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.
- Insert protective material such as thick cloths between track frame and wire rope to prevent the wire rope from being damage.
- Towing speed must be below 10 km/h (6.21 MPH) and towing distance must not exceed 5 km/h (3.11 MPH). When towing distance is over 5 km/h (3.11 MPH) use a trailer.

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.

Specifications

Specification for DX210W

Edition 1

MEMO

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Specification for DX210W

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX210W	5001 and Up

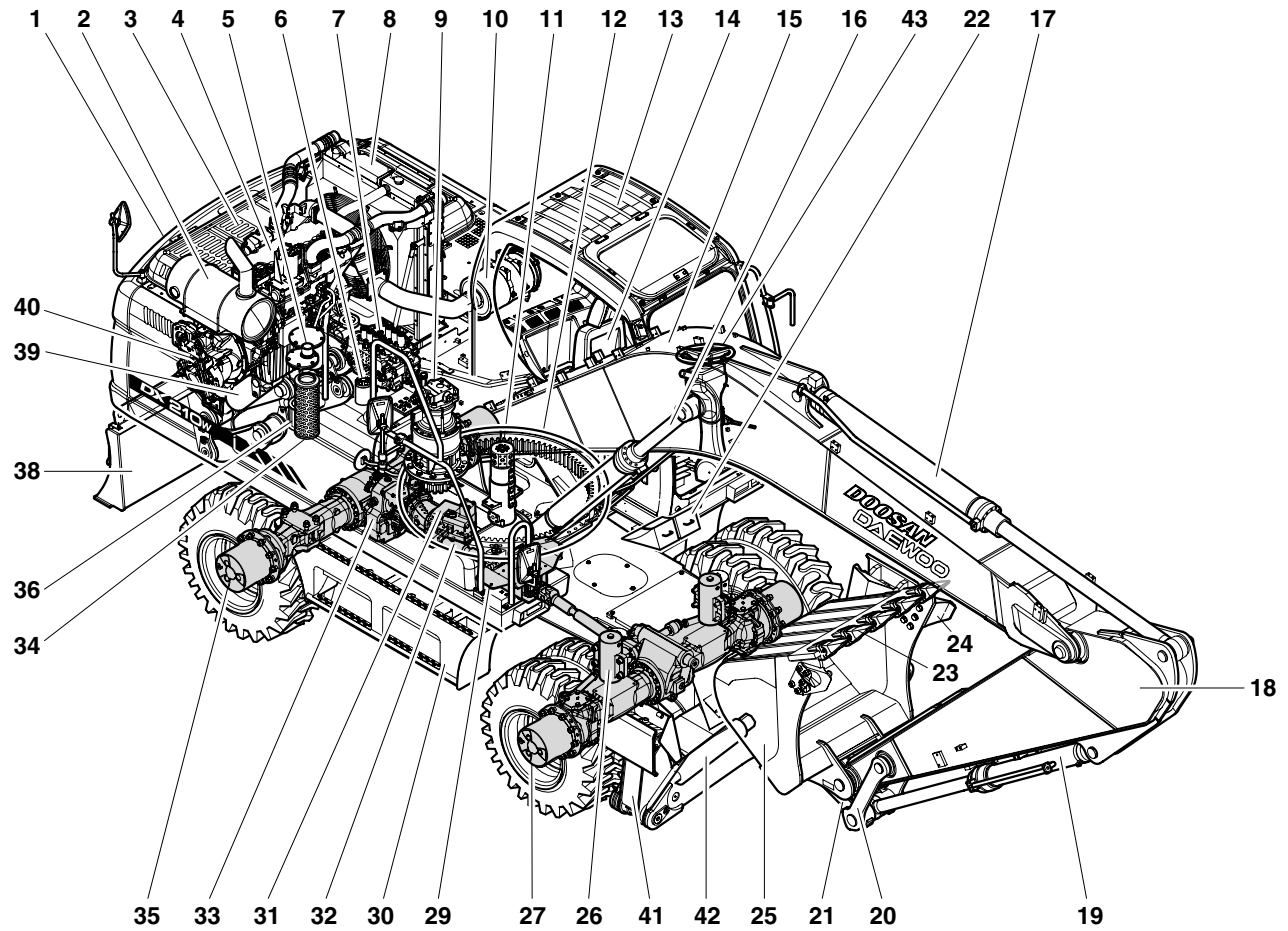
GENERAL DESCRIPTION

The excavator has three main component sections:

- The Upper Turntable
- The Lower Undercarriage and Chassis Frames
- The Excavator Front-end Attachment

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

COMPONENT LOCATIONS



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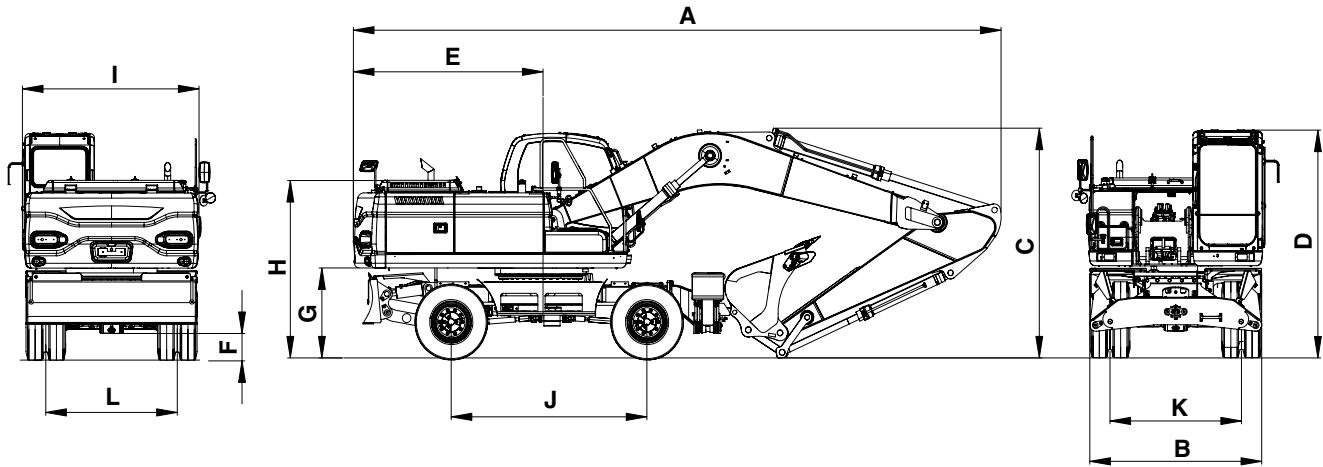
Figure 1

Reference Number	Description
1	Counterweight
2	Muffler
3	Engine Cover
4	Engine
5	Hydraulic Oil Tank
6	Fuel Tank
7	Control Valve
8	Radiator And Oil Cooler
9	Swing Motor
10	Air Cleaner
11	Swivel Joint
12	Swing Bearing
13	Cabin
14	Seat
15	Boom
16	Boom Cylinder
17	Arm Cylinder
18	Arm
19	Bucket Cylinder
20	Guide Link
21	Push Link

Reference Number	Description
22	Wheel Chocks
23	Bucket Tooth
24	Side Cutter
25	Bucket
26	Ram Cylinders
27	Front Axle
28	Swing Lock
29	Step
30	Travel Motor
31	Driveshaft
32	Transmission
33	Return Filter
34	Rear Axle
35	Strainer
36	Dozer Blade
37	Dozer Blade Cylinders
38	Pumps
39	Outrigger
40	Outrigger Cylinder
41	Steering Column

GENERAL DIMENSIONS

One-piece Boom

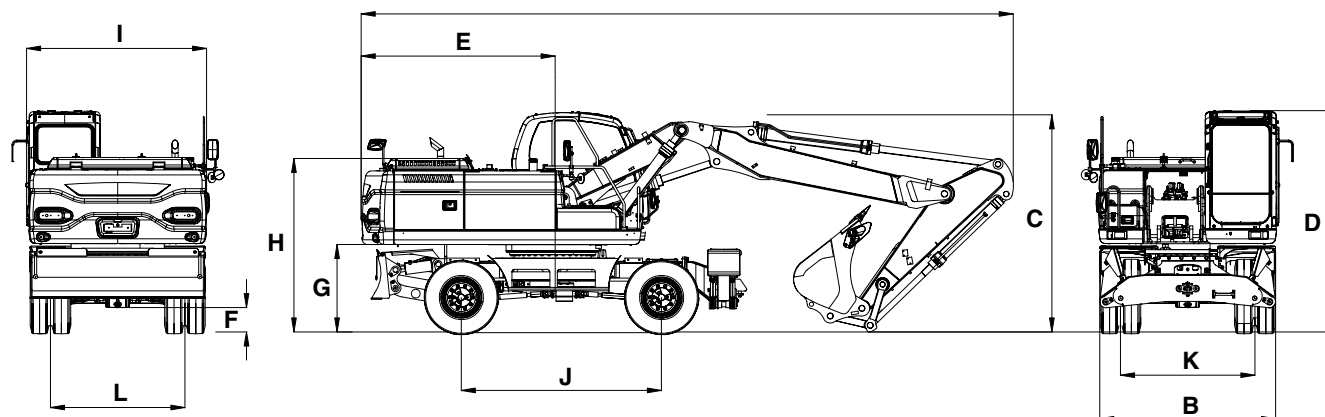


FG008161

Figure 2

No.	Description	Dimension							
		5.6 m (18' 4") One-piece Boom							
		3.0 m (9' 10") Arm		2.75 m (9') Arm		2.4 m (7' 10") Arm		2.0 m (6' 7") Arm	
A	Shipping Length	9,400 mm	30' 10"	9,420 mm	30' 11"	9,470 mm	31' 8"	9,520 mm	31' 3"
B	Shipping Width	2,500 mm	8' 2"	2,500 mm	8' 2"	2,500 mm	8' 2"	2,500 mm	8' 2"
C	Shipping Height (Boom)	3,490 mm	11' 5"	3,200 mm	10' 6"	3,200 mm	10' 6"	3,250 mm	10' 8"
D	Height Over Cabin	3,140 mm	10' 4"	3,140 mm	10' 4"	3,140 mm	10' 4"	3,140 mm	10' 4"
E	Counterweight Swing Clearance	2,750 mm	9'	2,750 mm	9'	2,750 mm	9'	2,750 mm	9'
F	Ground Clearance	350 mm	1' 2"	350 mm	1' 2"	350 mm	1' 2"	350 mm	1' 2"
G	Frame Clearance	1,259 mm	4' 2"	1,259 mm	4' 2"	1,259 mm	4' 2"	1,259 mm	4' 2"
H	Engine Cover Height	2,485 mm	8' 2"	2,485 mm	8' 2"	2,485 mm	8' 2"	2,485 mm	8' 2"
I	Upper Housing Width	2,530 mm	8' 4"	2,530 mm	8' 4"	2,530 mm	8' 4"	2,530 mm	8' 4"
J	Wheel Base	2,850 mm	9' 4"	2,850 mm	9' 4"	2,850 mm	9' 4"	2,850 mm	9' 4"
K,L	Tread Width	1,914 mm	6' 3"	1,914 mm	6' 3"	1,914 mm	6' 3"	1,914 mm	6' 3"

Two-piece Boom



FG008162

Figure 3

No.	Description	Dimension			
		5.4 m (17' 9") Two-piece Boom			
		2.4 m (7' 10") Arm		2.0 m (6' 7") Arm	
A	Shipping Length	9,210 mm	30' 3"	9,275 mm	30' 5"
B	Shipping Width	2,500 mm	8' 2"	2,500 mm	8' 2"
C	Shipping Height (Boom)	3,140 mm	10' 4"	3,140 mm	10' 4"
D	Height Over Cabin	3,140 mm	10' 4"	3,140 mm	10' 4"
E	Counterweight Swing Clearance	2,750 mm	9'	2,750 mm	9'
F	Ground Clearance	350 mm	1' 2"	350 mm	1' 2"
G	Frame Clearance	1,259 mm	4' 2"	1,259 mm	4' 2"
H	Engine Cover Height	2,485 mm	8' 2"	2,485 mm	8' 2"
I	Upper Housing Width	2,530 mm	8' 4"	2,530 mm	8' 4"
J	Wheel Base	2,850 mm	9' 4"	2,850 mm	9' 4"
K,L	Tread Width	1,914 mm	6' 3"	1,914 mm	6' 3"

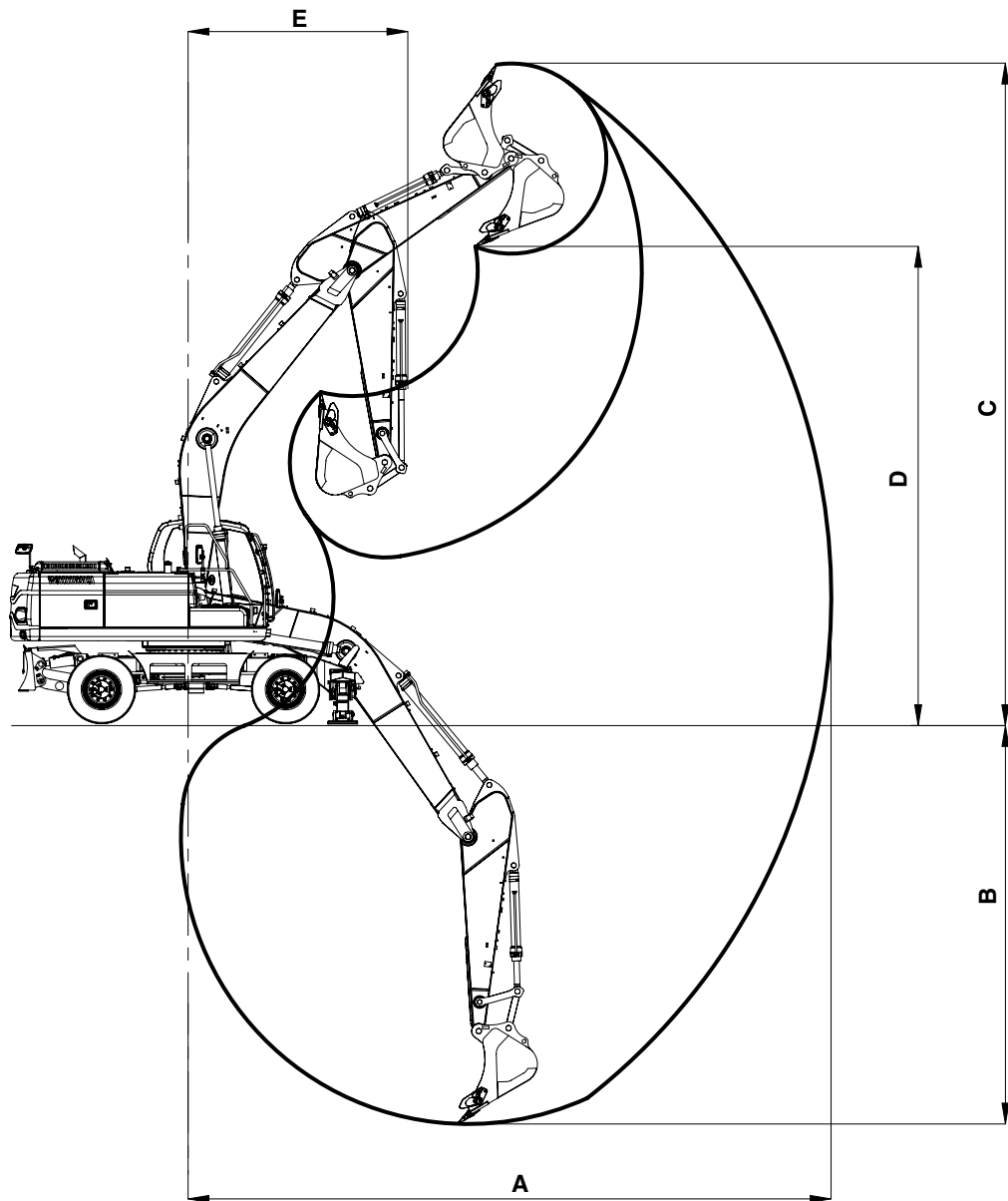
WORKING RANGE



WARNING!

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

One-piece Boom

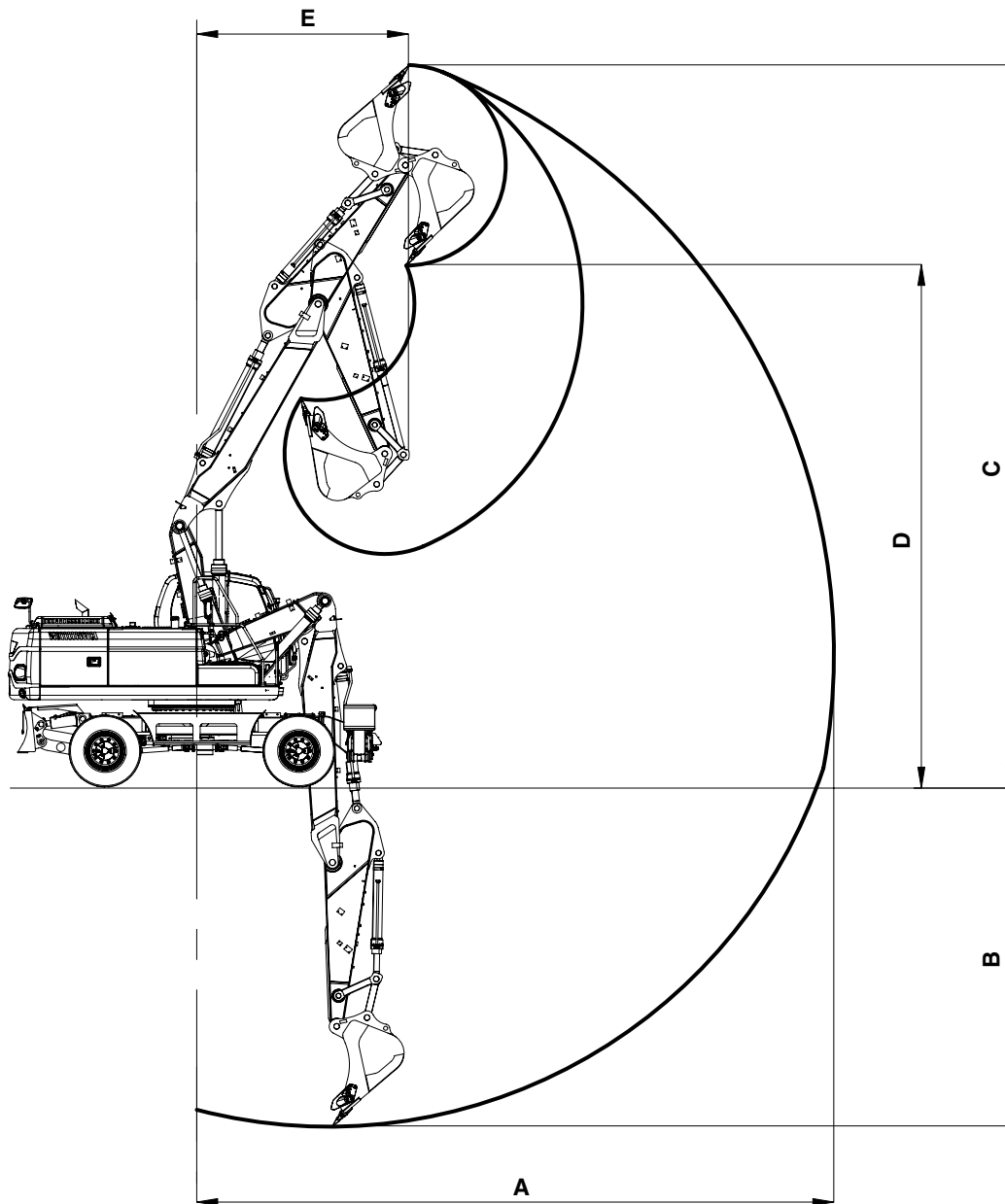


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Figure 4

No.	Description	Dimension			
		5.6 m (18' 4") One-piece Boom			
		3.0 m (9' 10") Arm	2.75 m (9') Arm	2.4 m (7' 10") Arm	2.0 m (6' 7") Arm
A	Max. Digging Reach	10,000 mm (32' 10")	9,730 mm (31' 11")	9,430 mm (30' 11")	9,050 mm (29' 8")
B	Max. Digging Depth	6,255 mm (20' 6")	6,010 mm (19' 9")	5,655 mm (18' 7")	5,255 mm (17' 3")
C	Max. Digging Height	10,050 mm (32' 12")	9,800 mm (32' 2")	9,690 mm (31' 9")	9,435 mm (30' 11")
D	Max. Loading Height	7,250 mm (23' 9")	7,020 mm (23' 0")	6,890 mm (22' 7")	6,650 mm (21' 10")
E	Min. Swing Radius	3,440 mm (11' 3")	3,375 mm (11' 1")	3,390 mm (11' 1")	3,680 mm (12' 1")

Two-piece Boom



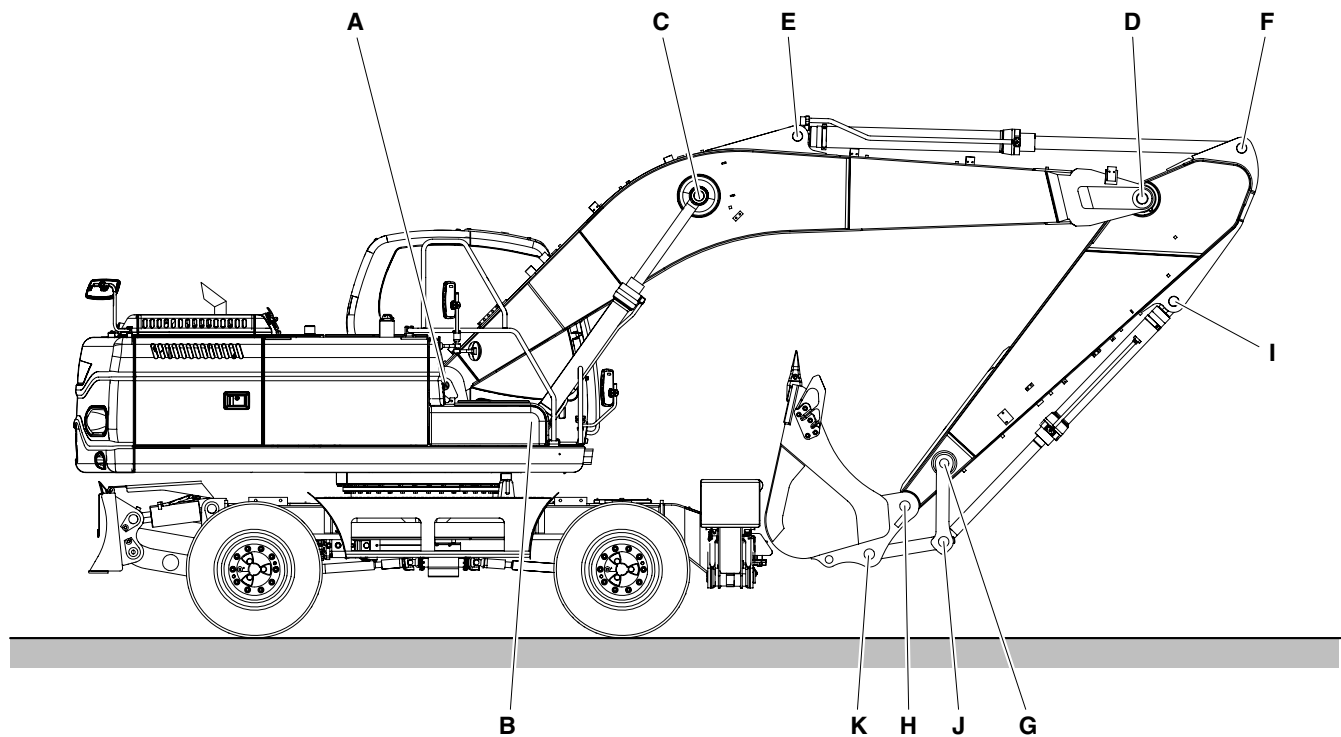
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Figure 5

No.	Description	Dimension	
		5.4 m (17' 9") Two-piece Boom	
		2.4 m (7' 10") Arm	2.0 m (6' 7") Arm
A	Max. Digging Reach	9,405 mm (30' 10")	9,005 mm (29' 6")
B	Max. Digging Depth	5,625 mm (18' 5")	5,225 mm (17' 2")
C	Max. Digging Height	10,560 mm (34' 8")	10,210 mm (33' 6")
D	Max. Loading Height	7,620 mm (24' 12")	7,275 mm (23' 10")
E	Min. Swing Radius	3,185 mm (10' 5")	3,380 mm (11' 1")

FRONT PIN SIZE

One-piece Boom

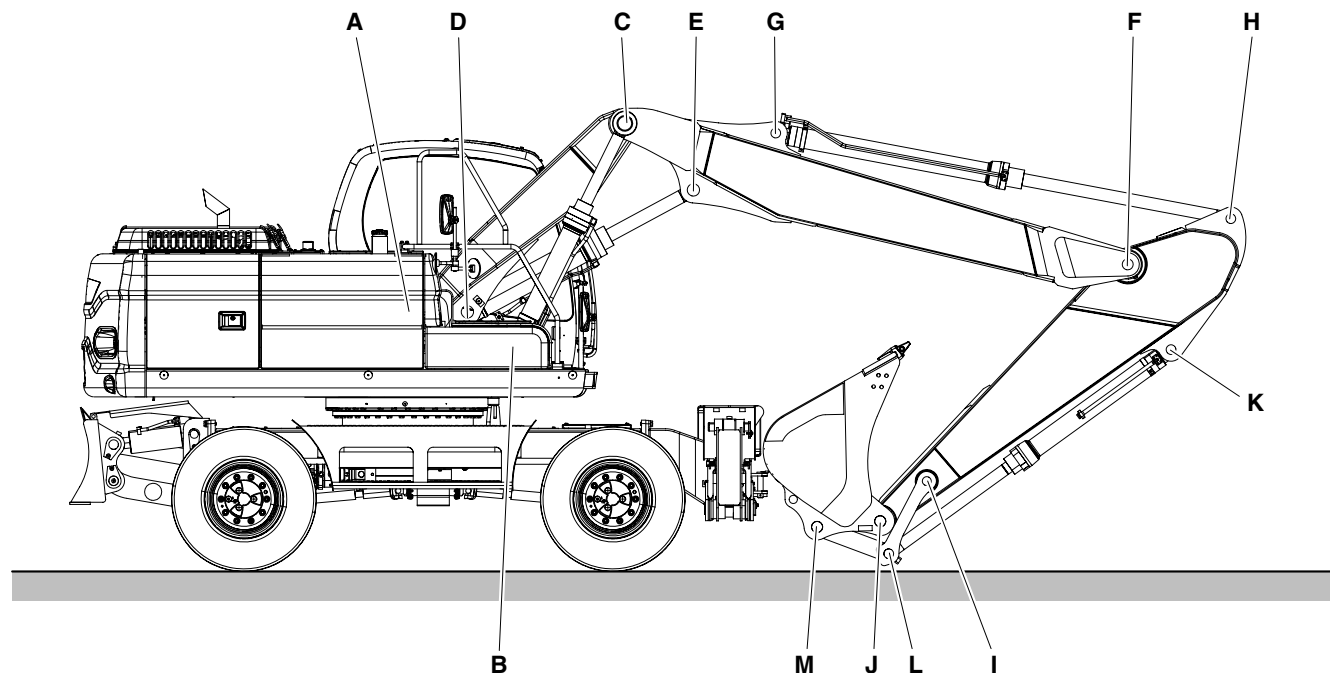


FG009222

Figure 6

Mounting Pin	Diameter, mm (Inches)	Length, mm (Inches)
A	90 mm (3.54 in)	811 mm (31.93 in)
B	80 mm (3.15 in)	221 mm (8.7 in)
C	80 mm (3.15 in)	792 mm (31.18 in)
D	90 mm (3.54 in)	548 mm (21.57 in)
E	80 mm (3.15 in)	241 mm (9.49 in)
F	80 mm (3.15 in)	274 mm (10.79 in)
G	71 mm (2.80 in)	460 mm (18.11 in)
H	80 mm (3.15 in)	519 mm (20.43 in)
I	80 mm (3.15 in)	236 mm (9.29 in)
J	80 mm (3.15 in)	460 mm (18.11 in)
K	80 mm (3.15 in)	519 mm (20.43 in)

Two-piece Boom



FG009246

Figure 7

Mounting Pin	Diameter, mm (Inches)	Length, mm (Inches)
A	90 mm (3.54 in)	811 mm (31.93 in)
B	80 mm (3.15 in)	221 mm (8.70 in)
C	100 mm (3.94 in)	791 mm (31.14 in)
D	90 mm (3.54 in)	306 mm (12.05 in)
E	90 mm (3.54 in)	306 mm (12.05 in)
F	90 mm (3.54 in)	548 mm (21.57 in)
G	80 mm (3.15 in)	246 mm (9.69 in)
H	80 mm (3.15 in)	274 mm (10.79 in)
I	71 mm (2.80 in)	460 mm (18.11 in)
J	80 mm (3.15 in)	519 mm (20.43 in)
K	80 mm (3.15 in)	227 mm (8.94 in)
L	80 mm (3.15 in)	460 mm (18.11 in)
M	80 mm (3.15 in)	519 mm (20.43 in)

HYDRAULIC CYLINDERS

	Boom	Arm	Bucket	Blade	Outrigger	Chocking	Two-piece Boom
Quantity	2	1	1	2	2	2	1
Bore	120 mm (4.72")	135 mm (5.31")	115 mm (6.9")	130 mm (5.12")	130 mm (5.12")	100 mm (3.94")	170 mm (6.69")
Stroke	1,225 mm (4' 0")	1,450 mm (4' 9")	1,060 mm (3' 6")	245 mm (9.6")	391 mm (1' 3")	153 mm (6.02")	748 mm (2' 5")
		1,470 mm (4' 10")	1,025 mm (3' 4")				
Rod Dia.	85 mm (3.35")	95 mm (3.74")	80 mm (3.15")	80 mm (3.15")	80 mm (3.15")	100 mm (3.94")	105 mm (4' 13")
Closed Length	1,800 mm (5' 11")	1,990 mm (6' 6")	1,630 mm (5' 4")	680 mm (2' 3")	858 mm (2' 10")	267 mm (10.51")	1,253 mm (4' 1")
		2,010 mm (6' 7")	1,525 mm (5' 0")				
Retract. Cushion	X	O	X	X	X	X	X
Extend. Cushion	O	O	O	X	X	X	X
Maker	Dongyang	Dongyang	Dongyang	Dongyang	Dongyang	Dongyang	Dongyang

* DIMENSIONS ARE FOR OPTION BOOM CYLINDERS FOR TWO-PIECE BOOM.

GENERAL SPECIFICATIONS

Shipping Weight	20.8 metric tons (45,856 lb), includes 10% fuel, 5,600 mm (18' 5") one-piece boom, 3,000 mm (9' 10") arm, 0.86 m ³ (1.12 yd ³) bucket and front outrigger and rear dozer.
Count Weight	3,800 kg (8,377 lb)
Upper Turntable Weight	5,650 kg (12,456 lb)
Lower (Below Swing Bearing) Weight	7,340 kg (16,182 lb)
Operating Weight	Add weight of full fuel tank and operator.
Major Component Weight	Standard Boom 1,335 kg (2,943 lb)
	Boom Cylinder 166 kg (366 lb)
	Arm (Standard) 675 kg (1,488 lb)
	Arm Cylinder 239 kg (527 lb)
	Bucket (Standard) 675 kg (1,488 lb)
	Bucket Cylinder 153.5 kg (338 lb)
	Dozer (Standard) 660 kg (1,455 lb)
	Dozer Cylinder 83 kg (183 lb)
	Outrigger Cylinder 107 kg (236 lb)
Digging Force	
Bucket Cylinder	124.6 KN or 12,701 kg (28,000 lb) - (with 3,000 mm arm)
Arm Cylinder	92.7 KN or 9,449 kg (20,832 lb) - (with 5,600 mm boom, 3,000 mm arm)
Fuel Tank Capacity	350 liters (92.5 U.S. gal)
Hydraulic System Capacity	280 liters (74 U.S. gal)
Bucket Heaped Capacity Range	PCSA 0.66 - 0.86 m ³ (0.86 - 1.13 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 weight.
Travel Dimension:	
Ground Clearance	350 mm (1' 2")
Wheel Base	2,850 mm (9' 4")
Dozer Blade Width x Height	2,498 mm x 620 mm (8' 2" x 2')
Tire Size	8 x 10.0 - 20 - 14PR
Transport Dimension:	
Overall Length	9,400 mm (30' 10")
Overall Width	2,500 mm (8' 2")
Overall Height	3,490 mm (11' 5")
Transport Loading Ramp Allowable Slope	15° angle CAUTION: Refer to Transport Maximum Procedure for Safe Shipping Instructions.

HYDRAULIC SYSTEM COMPONENT SPECIFICATIONS

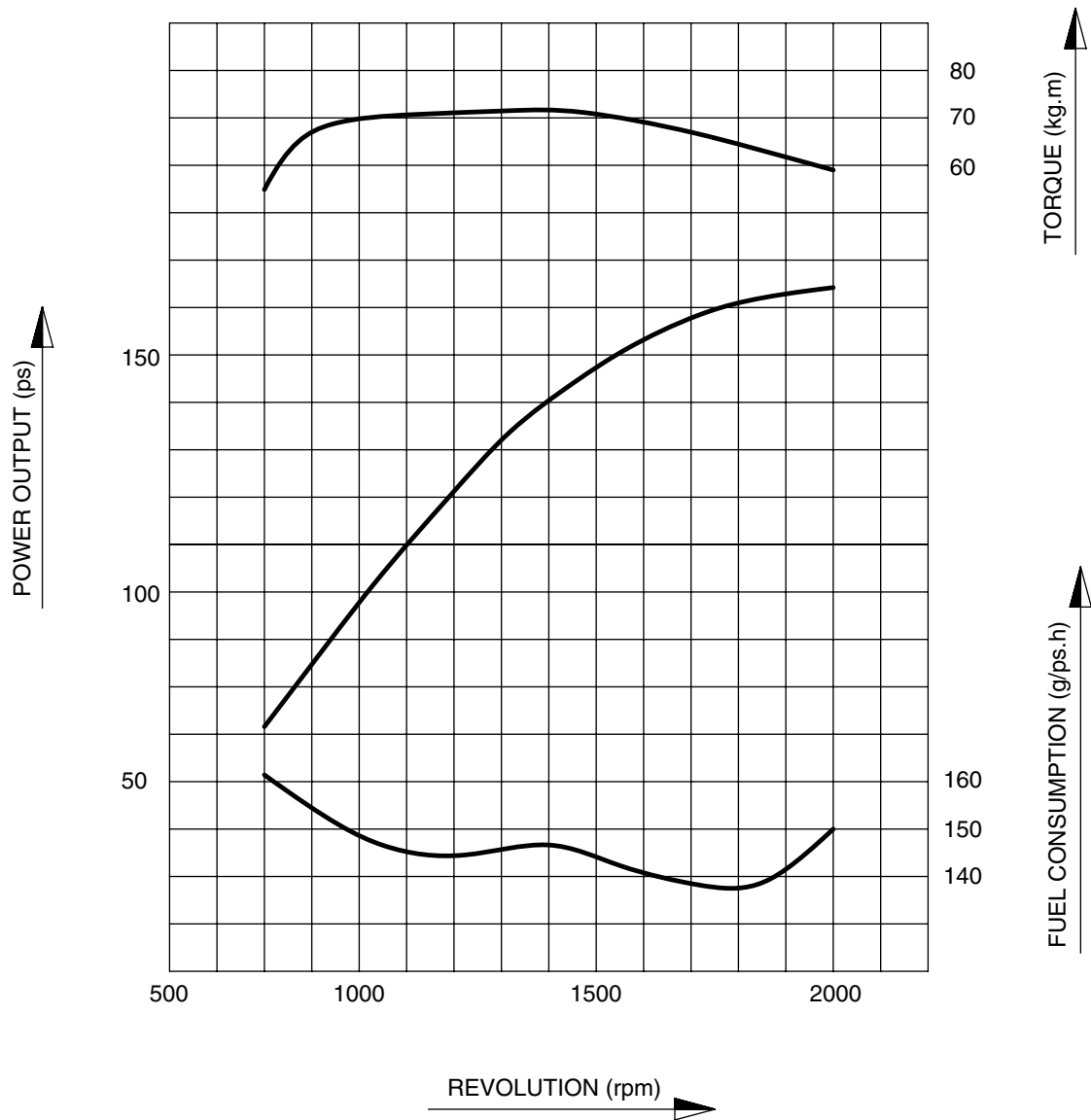
Control Valve Relief Valves (Main): Left Side Spools: (28 mm [1.10"] diameter) Right Side Spools: (28 mm [1.10"] diameter) Overload Relief Pressure:	350 kg•cm² (4,978 psi) - travel 330/350 kg•cm² (4,694/4,978 psi) - all other Dozer/Outrigger Swing Boom 2 Arm 1 Travel Option Bucket Boom 1 Arm 2 360 kg•cm² (5,120 psi) Boom, Arm, Bucket, Dozer/Outrigger
Remote Travel Control Valve Type: Pressure/Stroke:	Pilot Control 28 kg•cm² (398 psi) at 3.8 mm (0.15") stroke
Remote Implement Control Valve Type: Pressure/Stroke:	Pilot Control 26 kg•cm² (370 psi) at 6.5 mm (0.256") or 7.5 mm (0.295") stroke
Pilot Accumulator PilotNitrogen Charge: Volume:	15 kg•cm² (213 psi) 320 cc (19.5 in³)
Brake Accumulator Nitrogen Charge: Volume:	30 kg•cm² (427 psi) 750 cc (45.8 in³)

SYSTEM COMPONENT SPECIFICATIONS

DRIVE SYSTEM	
Driveshaft (Front and Rear) Max. Allowable Torque Max. Joint Angle Max. Rotating Speed	425 kg•m (3,074 ft lb) 22.5° 5,000 rpm
Tire and Wheel; Standard Type Tire Rim Disk Offset	Double 10.00 - 20 - 14PR, OTR, Tube 7.5V x 20 155 mm (6.1 in)
SWING MECHANISM	
Swing Reduction Gear Drive Type Reduction Ratio Max. Output Speed Max. Output Torque	2-Stage Planetary Gear 19.636 81 rpm 1,178 kg•m (8,521 ft lb)
Pinion Gear (Built in Reduction Gear) Type Gear P.C.D No. of Teeth Module	Spur Gear Dia 156 mm (6.14 in) 13 12
Swing Bearing Type Gear P.C.D No. of Teeth Ball Dia. Race O.D. Race Height Static Thrust Load Weight	Ball Bearing, Internal Gear Dia 1,104 mm (43.46 in) 92 Dia 31.75 mm (1.25 in) Dia 1,327 mm (52.24 in) 111.5 mm (4.39 in) 39,500 kg (87,083 lb) 255 kg (562 lb)
Swing Performance Max Swing Speed Max Swing Torque	11 rpm 6,387 kg•m (46,197 ft lb)
Parking Brake Control Type Brake Torque Brake Release Pressure	Pilot Pressure, Mechanical 63 kg•m (456 ft lb) 23.0 kg•cm ² (327 psi)

Swing Safety Lock Type	Manual Pin Locking
Motor Accessory Brake Time Delayer Makeup Valve Characteristic	5 (+3 / -0) Sec. 3 kg•cm ² (43 psi) at 120 lpm (31.7 gpm)
BRAKE SYSTEM	
Accumulator Nitrogen Charge Pressure Volume	30 kg•cm ² (427 psi) 0.75 Liter (0.79 qt)
Service Brake Valve Max Output Pressure	80.0 ±3.0 kg•cm ² (1,137.9 ±42.7 psi)
Brake Filter Filtration Rating Bypass Valve Pressure	20 micron, 1,000 cm ² 3.5 kg•cm ² (50 psi) at 5 lpm
System and Pressure System Service Brake Pressure Brake Distance	Full Hydraulic, Dual Line 80.0 kg•cm ² (1,137.9 psi) 6.56 m (21' 6") at 24 km/h (15 MPH)
STEERING SYSTEM	
Steering Cylinder (Built-in Front Axle) Bore Size Rod Diameter Stroke Maximum Pressure	100.0 mm (3.94 in) 50.0 mm (1.97 in) 86.0 mm (3.39 in) 180.0 kg•cm ² (2,560 psi)
CHOCKING SYSTEM	
Chocking Valve Maximum Working Pressure Check Valve Cracking Pressure Makeup Pressure	400 kg•cm ² (5,689 psi) 2.0 kg•cm ² (28.4 psi) 3.0 kg•cm ² (42.7 psi)
Oscillating Angle	±8°

ENGINE PERFORMANCE CURVES (PER DIN 6270 STANDARD)



FG007171

Figure 8

Condition	Specification
Engine Model	DL06
Barometric Pressure	760 mmHg (20°C (68°F))
Cooling Fan	ø660.4 mm, SUCKER (26 in)
Alternator	24V x 60A
Air Cleaner	Installed
Muffler	Installed

Performance Standard	DIN 6270
Power	164 ps @ 2,000 rpm (162 hp @ 2,000 rpm)
Max. Torque	72 kg•m @ 1,400 rpm (521 ft lb @ 1,400 rpm)
Fuel Consumption (Rated)	150 g/ps•h (5.36 oz/hp•h)

APPROXIMATE WEIGHT OF WORKLOAD MATERIALS

IMPORTANT

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

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

Material	Low Weight or Density 1,100 kg•m³ (1,850 lb/yd³), or Less	Medium Weight or Density 1,600 kg•m³ (2,700 lb/yd³), or Less	High Weight or Density 2,000 kg•m³ (3,370 lb/yd³), or Less
Earth, WET, muddy	-----	-----	1,762 kg•m ³ (2,970 lb/yd ³)
Gypsum, calcined, (heated, powder)	961 kg•m ³ (1,620 lb/yd ³)	-----	-----
Gypsum, crushed to 3 inch size	-----	1,522 kg•m ³ (2,565 lb/yd ³)	-----
Gravel, DRY, packed fragments	-----	-----	1,810 kg•m ³ (3,051 lb/yd ³)
Gravel, WET, packed fragments	-----	-----	1,922 kg•m ³ (3,240 lb/yd ³)
Limestone, graded above 2	-----	1,282 kg•m ³ (2,160 lb/yd ³)	-----
Limestone, graded 1-1/2 or 2	-----	1,362 kg•m ³ (2,295 lb/yd ³)	-----
Limestone, crushed	-----	1,522 kg•m ³ (2,565 lb/yd ³)	-----
Limestone, fine	-----	-----	1,602 kg•m ³ (2,705 lb/yd ³)
Phosphate, rock	-----	1,282 kg•m ³ (2,160 lb/yd ³)	-----
Salt	929 kg•m ³ (1,566 lb/yd ³)	-----	-----
Snow, light density	529 kg•m ³ (891 lb/yd ³)	-----	-----
Sand, DRY, loose	-----	1,522 kg•m ³ (2,565 lb/yd ³)	-----
Sand, WET, packed	-----	-----	1,922 kg•m ³ (3,240 lb/yd ³)
Shale, broken	-----	1,362 kg•m ³ (2,295 lb/yd ³)	-----
Sulfur, broken	529 kg•m ³ (1,620 lb/yd ³)	-----	-----

PERFORMANCE TESTS AND STANDARDS

1. Main Relief Pressure

normal operation: 320 kg•cm² (4,551.5 psi)

with high travel "Pressure Up": 350 kg•cm² (4,970 psi)

2. Actuator Speeds

Operation		Unit	Power Mode	Standard Mode
One-piece Boom	Up	seconds	3.2 ±0.4	3.6 ±0.4
	Down	seconds	2.1 ±0.4	2.2 ±0.4
Two-piece Boom	Up	seconds	5.8 ±0.5	6.0 ±0.5
	Down	seconds	5.8 ±0.5	5.8 ±0.5
Arm	Dump	seconds	2.5 ±0.4	2.6 ±0.4
	Crowd	seconds	2.9 ±0.4	3.0 ±0.4
Bucket	Dump	seconds	2.1 ±0.4	2.3 ±0.4
	Crowd	seconds	3.5 ±0.4	3.6 ±0.4
Dozer	Up	seconds	2.2 ±0.3	2.2 ±0.3
	Down	seconds	1.9 ±0.3	1.9 ±0.3
Swing (3 Revolutions)		seconds	16.5 ±1.0	16.4 ±1.0
Outrigger	Up	seconds	4.2 ±0.3	4.2 ±0.3
	Down	seconds	3.8 ±0.3	3.8 ±0.3
Driveshaft	High	rpm (min.)	3,090 ±50	
	Low	rpm (min.)	771 ±50	
	Creep	rpm (min.)	314 ±50	
Braking Distance		m	6.56 m (21' 6") at 24 km/h (15 MPH)	

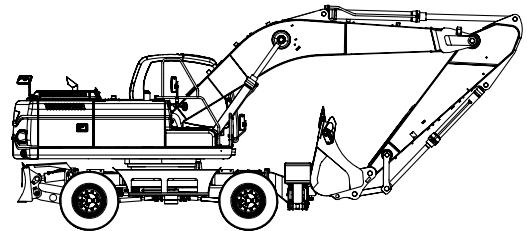
EXCAVATOR PERFORMANCE STANDARDS

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

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

Test Conditions

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



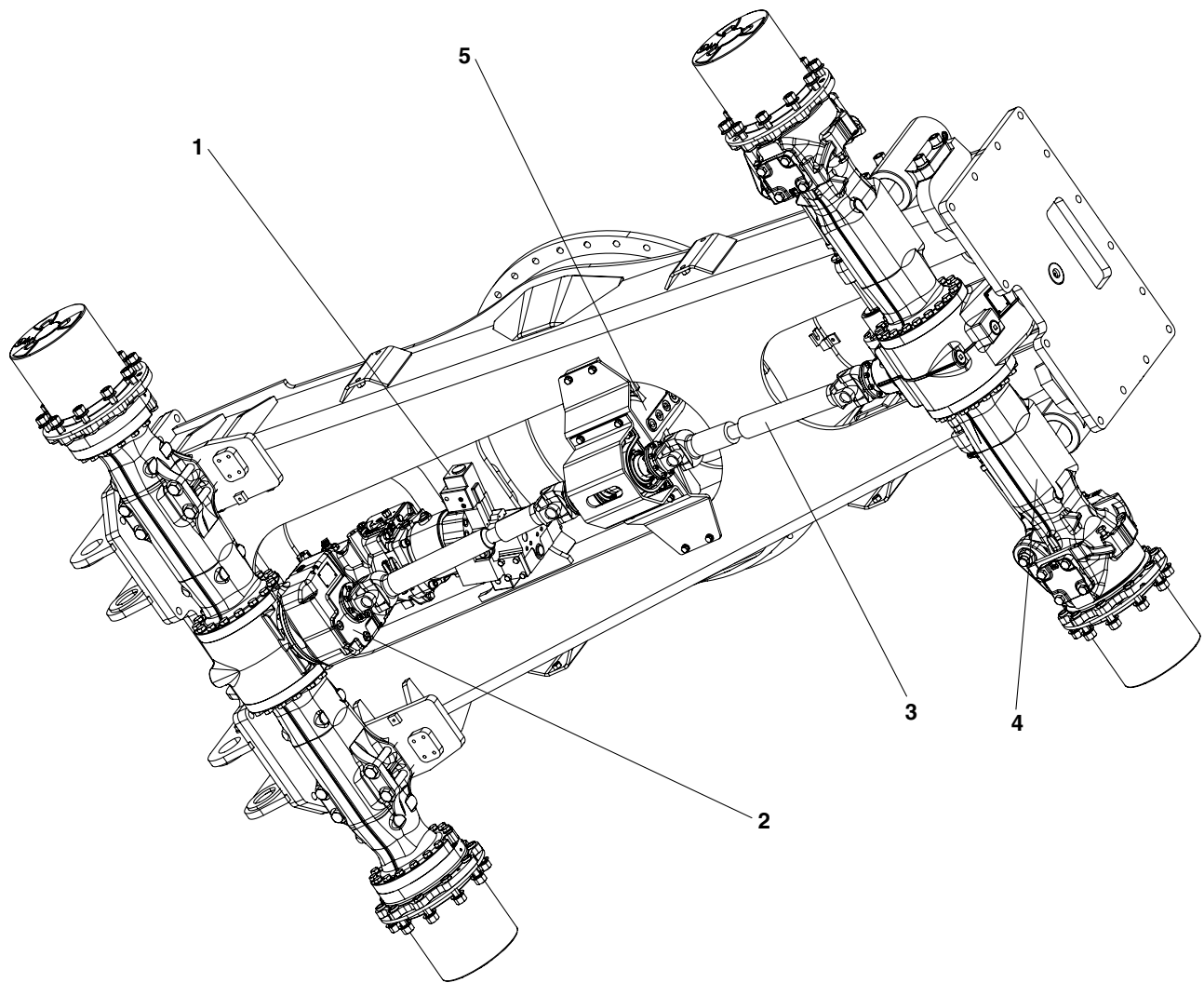
FG007172

Figure 9

Travel Speed Tests

Travel Mode	Speed
High-speed (III)	36.9 km/h (22.9 MPH)
Low Speed (II)	9.2 km/h (5.72 MPH)
Creep Speed (I)	3.7 km/h (2.3 MPH)

1. Block up all wheels securely.
2. Check that rpm at driveshaft is above;
3,090 ±50 rpm at high-speed.
771 ±50 rpm at low speed.
314 ±50 rpm at creep speed.



FG007173

Figure 10

1	Travel Motor
2	Transmission
3	Driveshaft
4	Front Axle
5	Swivel Joint

Swing Speed and Deceleration Force Test

Swing Speed Test

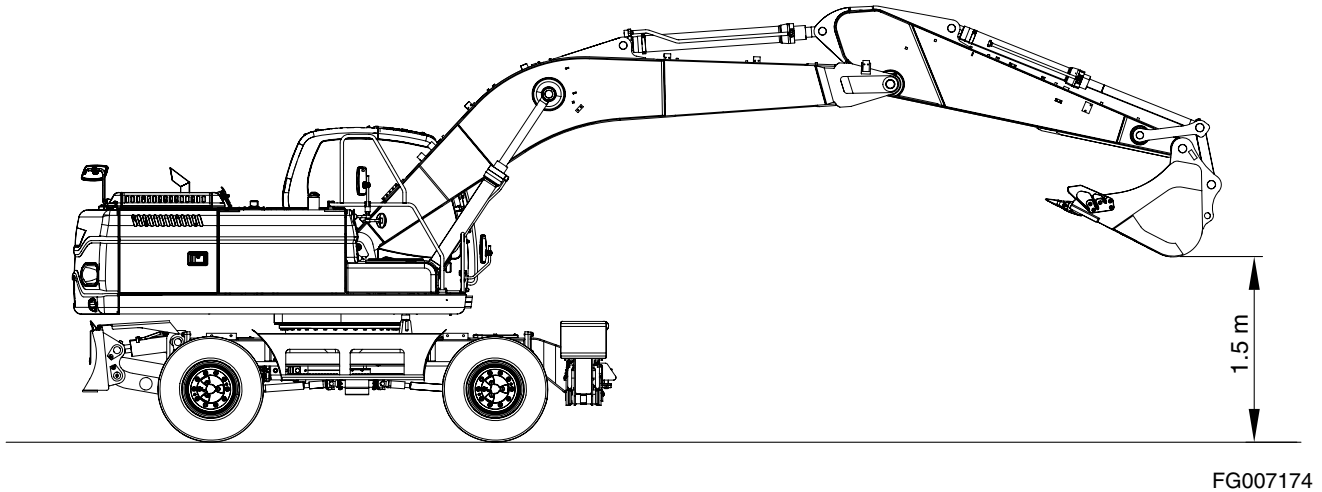


Figure 11

Extend the bucket cylinder completely and retract the arm cylinder, as shown in Figure 11, to test swing speed. The lowest point of the bucket will be approximately 1.5 m (4' 11") 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 16.4 and 16.5 seconds in Standard and Power Mode.

Swing Deceleration Force Test

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

Make several attempts to rotate the turntable exactly 90°, starting from the boom straight ahead position. Engage the swing lever and brake at the 90° point, shown as "swing stop" in Figure 12.

Record how far the turntable drifts past the stop point, measuring the distance between paint marks. Maximum distance should be less than 700 mm (47-1/4"), in both Power Mode and Standard Mode.

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

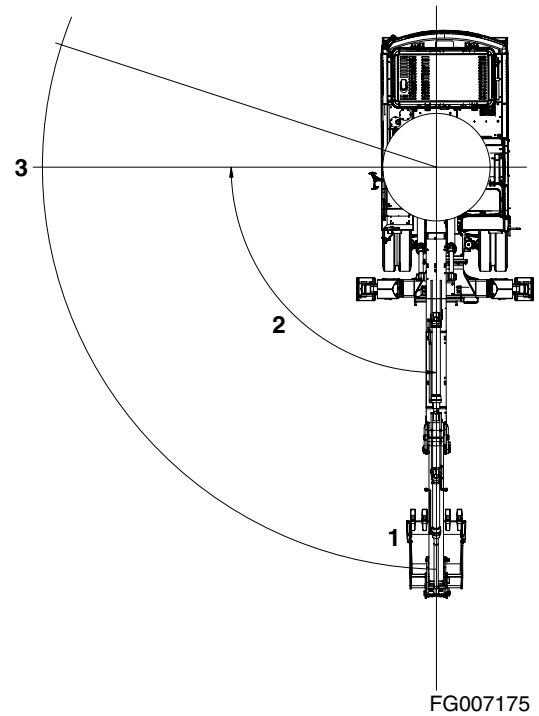


Figure 12

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 Power Mode S and Power Mode H.

Arm Cylinder Test

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

Bucket Cylinder Test

Start with the boom up and the teeth of the bucket hanging vertically, 500 mm (1.5' - 2') above the ground. Dump and crowd the bucket several times, and average results, for both standard and extraduty power modes.

Measurement in Seconds

Operation	Power Mode	Standard Mode
One-piece Boom Up	3.2 ±0.4	3.6 ±0.4
One-piece Boom Down	2.1 ±0.4	2.2 ±0.4
Two-piece Boom Up	5.8 ±0.5	6.0 ±0.5
Two-piece Boom Down	5.8 ±0.5	5.8 ±0.5
Arm Dump	2.5 ±0.4	2.6 ±0.4
Arm Crowd	2.9 ±0.4	3.0 ±0.4
Bucket Dump	2.1 ±0.4	2.3 ±0.4
Bucket Crowd	3.5 ±0.4	3.6 ±0.4

Hydraulic Cylinder Natural Drop Test

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

Shut down engine and measure cylinder drop after 5 minutes. Maximum cylinder drops are as follows: boom and bucket 20 mm (0.787"); arm 40 mm (1.57"); and blade 10 mm (0.39").

General Maintenance

General Maintenance Procedures

Edition 1

MEMO

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General Maintenance Procedures

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
ALL MODELS	ALL RANGES

WELDING PRECAUTIONS AND GUIDELINES

IMPORTANT

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

WARNING!

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

CAUTION!

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

 CAUTION!

Observe the following safety precautions:

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

HYDRAULIC SYSTEM - GENERAL PRECAUTIONS

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

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

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

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

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

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

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

IMPORTANT

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

MAINTENANCE SERVICE AND REPAIR PROCEDURE

General Precautions

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

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

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

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

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

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

HYDRAULIC SYSTEM CLEANLINESS AND OIL LEAKS

Maintenance Precautions for Hydraulic System Service

Whenever maintenance, repairs or any other troubleshooting or service is being performed, it's important to remember that 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 life of individual components) can be noticeably reduced if proper precautions are not observed:

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

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

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

IMPORTANT

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

Oil Leakage Precautions

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

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

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

NOTE: *Grease lip seals before assembly.*

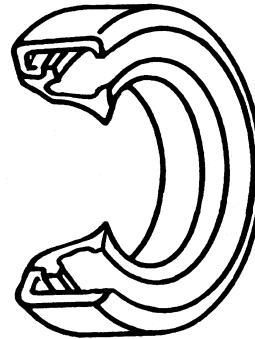


Figure 1

0565A

CLEANING AND INSPECTION

General Guidelines

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



WARNING!

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

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

For those bearings that are to be inspected in place; inspect bearings for roughness of rotation, scoring, pitting, cracked or chipped races. If any of these defects are found, replace bearings. Also, inspect defective bearing housing and/or shaft for grooved, galled or burred conditions that indicate bearing has been turning in its housing or on its shaft.

4. It is more economical to replace oil seals, O-rings, sealing rings, gaskets and retaining rings when unit is disassembled than waiting for premature failures; refer to latest Micro Fiche and/or Parts Book for replacement items. Be careful when installing sealing members, to avoid cutting or scratching. Curling under of any seal lip will

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

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

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

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

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

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

Bearing Inspection

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

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

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

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

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

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

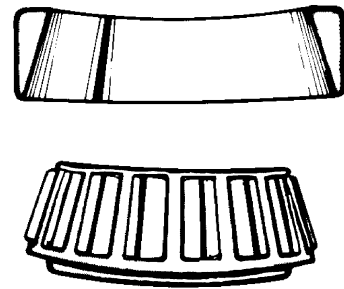
If available, use magna-flux or similar process for checking for cracks that are not visible.

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

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

Normal Bearing

Smooth even surfaces with no discoloration or marks.

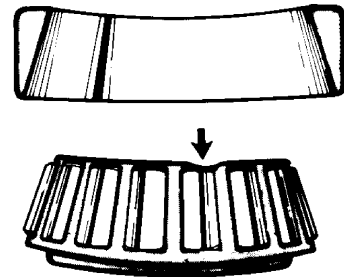


HASA620S

Figure 2

Bent Cage

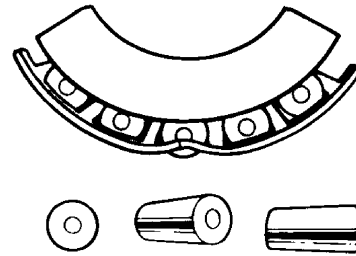
Cage damage because of improper handling or tool usage.



HASA460S

Figure 3

Replace bearing.



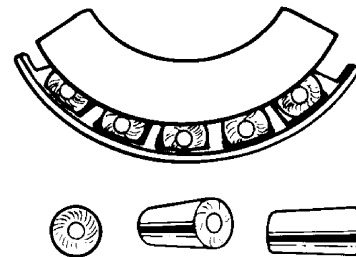
HASA470S

Figure 4

Galling

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

Replace bearing - check seals and check for proper lubrication.



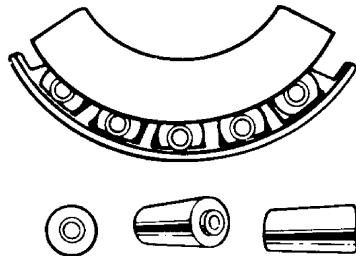
HASA480S

Figure 5

Abrasive Step Wear

Pattern on roller ends caused by fine abrasives.

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



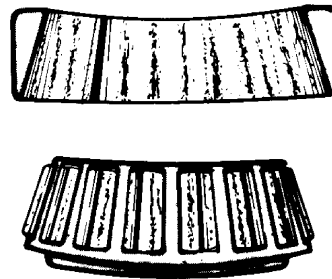
HASA490S

Figure 6

Etching

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

Replace bearings - check seals and check for proper lubrication.



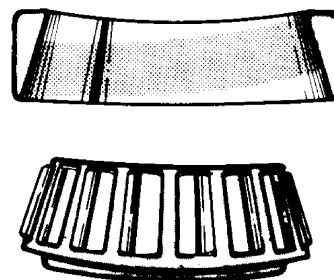
HASA500S

Figure 7

Misalignment

Outer race misalignment because of foreign object.

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



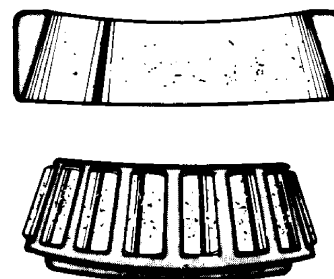
HASA510S

Figure 8

Indentations

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

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



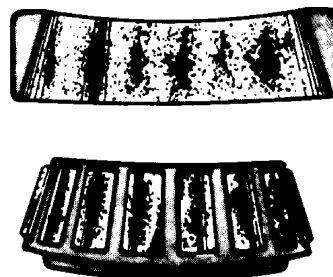
HASA520S

Figure 9

Fatigue Spalling

Flaking of surface metal resulting from fatigue.

Replace bearing - clean all related parts.



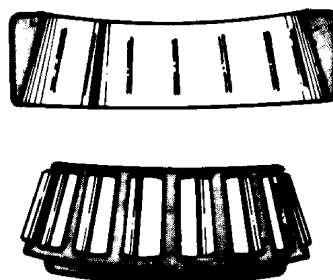
HASA530S

Figure 10

Brinelling

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

Replace bearing if rough or noisy.



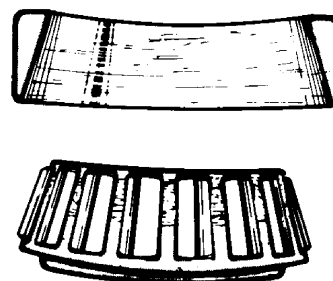
HASA540S

Figure 11

Cage Wear

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

Replace bearings - check seals.



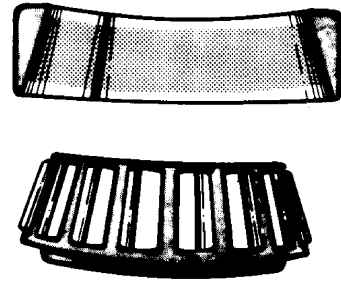
HASA550S

Figure 12

Abrasive Roller Wear

Pattern on races and rollers caused by fine abrasives.

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



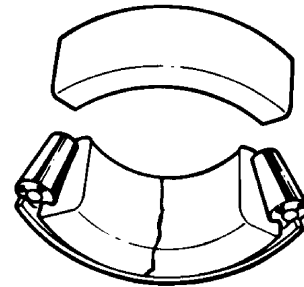
HASA560S

Figure 13

Cracked Inner Race

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

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



HASA570S

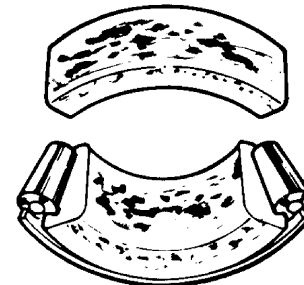
Figure 14

Smears

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

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

Replace shaft if damaged.



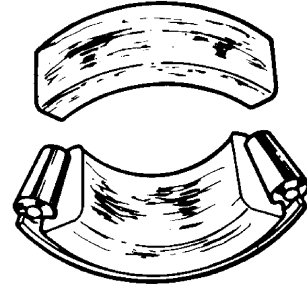
HASA580S

Figure 15

Frettage

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

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



HASA590S

Figure 16

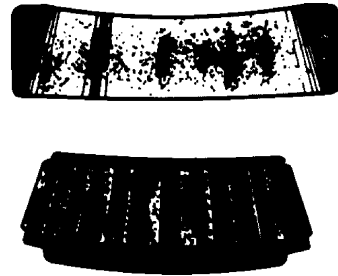
Heat Discoloration

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

Excessive heat can cause softening of races or rollers.

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

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



HASA600S

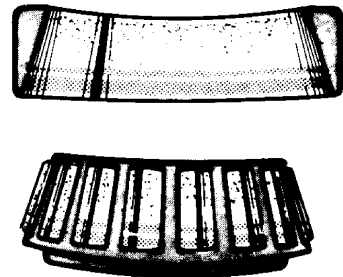
Figure 17

Stain Discoloration

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

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

Check seals and other related parts for damage.



HASA610S

Figure 18

Standard Torques

Edition 1

MEMO

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Standard Torques

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SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
ALL MODELS	ALL RANGES

TORQUE VALUES FOR STANDARD METRIC FASTENERS

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

Dia. x Pitch (mm)	Grade										
	3.6 (4A)	4.6 (4D)	4.8 (4S)	5.6 (5D)	5.8 (5S)	6.6 (6D)	6.8 (6S)	6.9 (6G)	8.8 (8G)	10.9 (10K)	12.9 (12K)
M5 x Std.	0.15 (1.08)	0.16 (1.15)	0.25 (1.80)	0.22 (1.59)	0.31 (2.24)	0.28 (2.02)	0.43 (3.11)	0.48 (3.47)	0.50 (3.61)	0.75 (5.42)	0.90 (6.50)
M6 x Std.	0.28 (2.02)	0.30 (2.16)	0.45 (3.25)	0.40 (2.89)	0.55 (3.97)	0.47 (3.39)	0.77 (5.56)	0.85 (6.14)	0.90 (6.50)	1.25 (9.04)	1.50 (10.84)
M7 x Std.	0.43 (3.11)	0.46 (3.32)	0.70 (5.06)	0.63 (4.55)	0.83 (6.00)	0.78 (5.64)	1.20 (8.67)	1.30 (9.40)	1.40 (10.12)	1.95 (14.10)	2.35 (16.99)
M8 x Std.	0.70 (5.06)	0.75 (5.42)	1.10 (7.95)	1.00 (7.23)	1.40 (10.12)	1.25 (9.04)	1.90 (13.74)	2.10 (15.18)	2.20 (15.91)	3.10 (22.42)	3.80 (27.48)
M8 x 1	0.73 (5.28)	0.80 (5.78)	1.20 (8.67)	1.00 (7.23)	1.50 (10.84)	1.35 (9.76)	2.10 (15.18)	2.30 (16.63)	2.40 (17.35)	3.35 (24.23)	4.10 (29.65)
M10 x Std.	1.35 (9.76)	1.40 (10.12)	2.20 (15.91)	1.90 (13.74)	2.70 (19.52)	2.35 (19.99)	3.70 (26.76)	4.20 (30.37)	4.40 (31.18)	6.20 (44.84)	7.20 (52.07)
M10 x 1.25	1.50 (10.84)	1.60 (11.57)	2.50 (18.08)	2.10 (15.18)	3.10 (22.42)	2.80 (20.25)	4.30 (31.10)	4.90 (35.44)	5.00 (36.16)	7.00 (50.63)	8.40 (60.75)
M12 x Std.	2.40 (17.35)	2.50 (18.08)	3.70 (26.76)	3.30 (23.86)	4.70 (33.99)	4.20 (30.37)	6.30 (45.56)	7.20 (52.07)	7.50 (54.24)	10.50 (75.94)	12.50 (90.41)
M12 x 1.25	2.55 (18.44)	2.70 (19.52)	4.00 (28.93)	3.50 (25.31)	5.00 (36.16)	4.50 (32.54)	6.80 (49.18)	7.70 (55.69)	8.00 (57.86)	11.20 (81.00)	13.40 (96.92)
M14 x Std.	3.70 (26.76)	3.90 (28.20)	6.00 (43.23)	5.20 (37.61)	7.50 (54.24)	7.00 (50.63)	10.00 (72.33)	11.50 (83.17)	12.00 (86.79)	17.00 (122.96)	20.00 (144.66)
M14 x 1.5	4.10 (29.65)	4.30 (31.10)	6.60 (47.73)	5.70 (41.22)	8.30 (60.03)	7.50 (54.24)	11.10 (80.28)	12.50 (90.41)	13.00 (94.02)	18.50 (133.81)	22.00 (159.12)
M16 x Std.	5.60 (40.50)	6.00 (43.39)	9.00 (65.09)	8.00 (57.86)	11.50 (83.17)	10.50 (75.94)	15.50 (112.11)	17.90 (129.47)	18.50 (133.81)	26.00 (188.05)	31.00 (224.22)
M16 x 1.5	6.20 (44.84)	6.50 (47.01)	9.70 (70.16)	8.60 (62.20)	12.50 (90.41)	11.30 (81.73)	17.00 (122.96)	19.50 (141.04)	20.00 (144.66)	28.00 (202.52)	35.50 (256.77)
M18 x Std.	7.80 (56.41)	8.30 (60.03)	12.50 (90.41)	11.00 (79.56)	16.00 (115.72)	14.50 (104.87)	21.00 (151.89)	27.50 (198.90)	28.50 (206.14)	41.00 (296.55)	43.00 (311.01)
M18 x 1.5	9.10 (65.82)	9.50 (68.71)	14.40 (104.15)	12.50 (90.41)	18.50 (133.81)	16.70 (120.79)	24.50 (177.20)	27.50 (198.90)	28.50 (206.14)	41.00 (296.55)	49.00 (354.41)
M20 x Std.	11.50 (83.17)	12.00 (86.79)	18.00 (130.19)	16.00 (115.72)	22.00 (159.12)	19.00 (137.42)	31.50 (227.83)	35.00 (253.15)	36.00 (260.38)	51.00 (368.88)	60.00 (433.98)
M20 x 1.5	12.80 (92.58)	13.50 (97.64)	20.50 (148.27)	18.00 (130.19)	25.00 (180.82)	22.50 (162.74)	35.00 (253.15)	39.50 (285.70)	41.00 (296.55)	58.00 (419.51)	68.00 (491.84)
M22 x Std.	15.50 (112.11)	16.00 (115.72)	24.50 (177.20)	21.00 (151.89)	30.00 (216.99)	26.00 (188.05)	42.00 (303.78)	46.00 (332.71)	49.00 (354.41)	67.00 (484.61)	75.00 (542.47)
M22 x 1.5	17.00 (122.96)	18.50 (133.81)	28.00 (202.52)	24.00 (173.59)	34.00 (245.92)	29.00 (209.75)	47.00 (339.95)	52.00 (44.76)	56.00 (405.04)	75.00 (542.47)	85.00 (614.80)
M24 x Std.	20.50 (148.27)	21.50 (155.50)	33.00 (238.68)	27.00 (195.29)	40.00 (289.32)	34.00 (245.92)	55.00 (397.81)	58.00 (419.51)	63.00 (455.67)	82.00 (593.10)	92.00 (655.43)
M24 x 2.0	23.00 (166.35)	35.00 (253.15)	37.00 (267.62)	31.00 (224.22)	45.00 (325.48)	38.00 (202.52)	61.00 (441.21)	67.00 (484.61)	74.00 (535.24)	93.00 (672.66)	103.00 (744.99)

TORQUE VALUES FOR STANDARD U.S. FASTENERS

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

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

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

NOTE: *Multiply the standard torque by:*

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

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

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

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

NOTE: *If any bolts and nuts are found loose or at values less than the chart states, it is recommended that 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 $\pm 10\%$	
	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:

$I = A \times T / A + B$ 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:

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

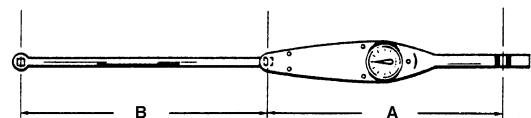


Figure 1

0552A

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

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

Other Uses for Torque Wrench Extension Tools

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

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

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

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

Tightening Torque Specifications (Metric)

(For coated threads, prelubricated assemblies.)



CAUTION!

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

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

IMPORTANT

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

I. "Loctite" Fastener Adhesives

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

II. "Loctite" Pipe Thread Sealant

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

III. "Loctite" gasket/flange sealer

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

IV. "Loctite" retaining compounds

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

V. "Loctite" Adhesives

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

Upper Structure

Cabin

Edition 1

MEMO

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Cabin

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	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 and stand 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 and stand on "LOCK" position.
8. Set parking brake switch to the "I" position
9. Apply the service brake with full stroke several time to relieve pressure from accumulator functioning braking.
10. Turn key to "O" (OFF) position and remove from starter switch.
11. Hang maintenance warning tag on controls.
12. Disconnect the battery cable from the negative (-) battery terminal.
13. 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.

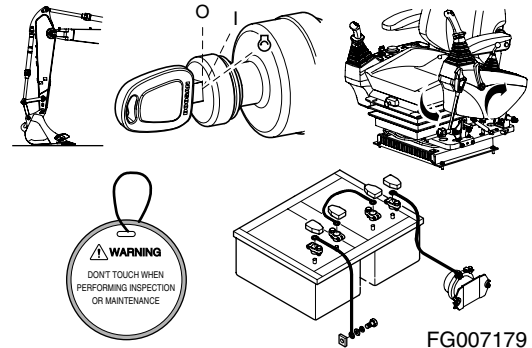


Figure 1

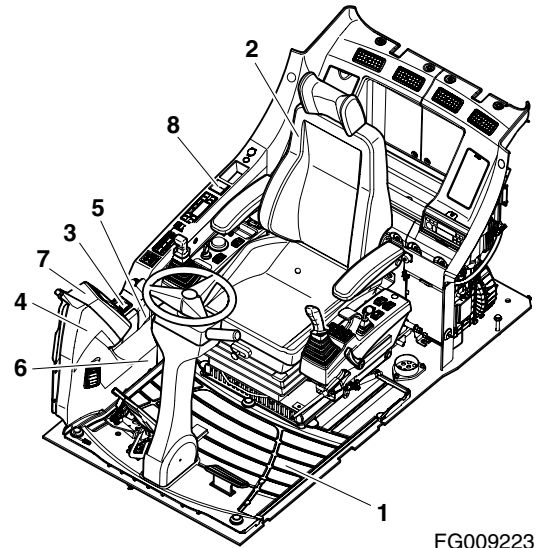
14. Remove floor mat (1, Figure 2)

15. Remove seat (2, Figure 2).

NOTE: Be careful not to damage seat covering.

16. Remove cup holder (3, Figure 2).
Remove front cover (4, Figure 2) and side covers (5 and 6, Figure 2). Before removing front cover (4), disconnect hour meter connector.

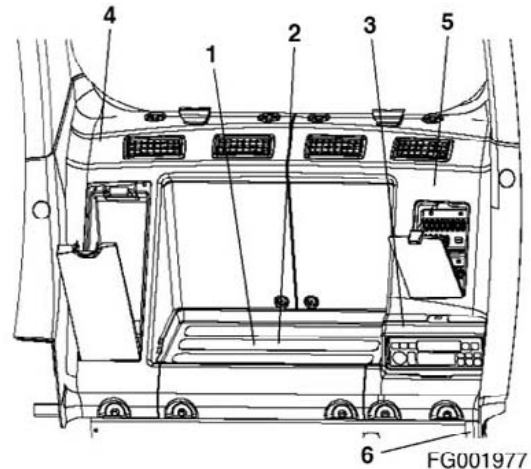
NOTE: Don't remove monitor panel (7, Figure 2) and switch panel (8, Figure 2)



FG009223

Figure 2

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



FG001977

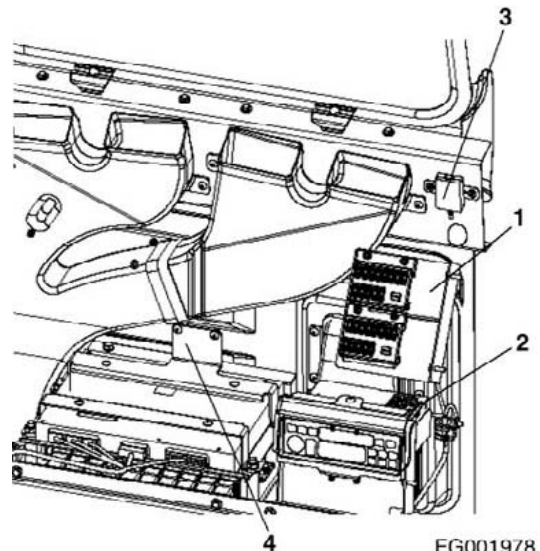
Figure 3

18. Remove fuse box bracket (1, Figure 4) from left sidewall without disassembly harness connector.

19. Disconnect cabin ground cable near fuse box bracket.

20. Remove cassette bracket (2, Figure 4) and disconnect antenna and speaker wire.

21. Remove electric box (4, Figure 4) without disassembly harness connectors.



FG001978

Figure 4

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

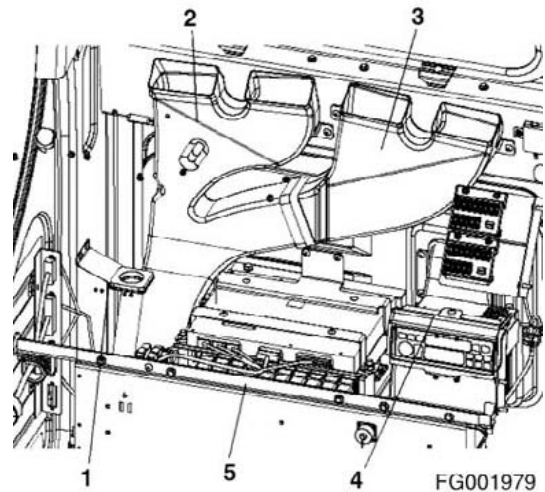


Figure 5

24. Remove air ducts (1, 2, 3 and 4, Figure 6) at the right side of cabin sequentially from the front duct.
25. Disconnect washer hose at floor plate bottom.
26. Disconnect cabin wiring connectors from main harness.

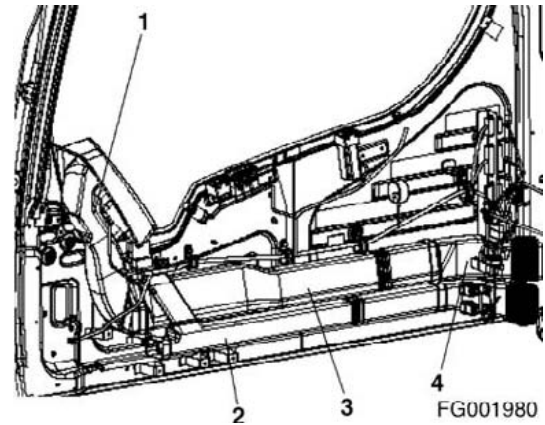


Figure 6

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

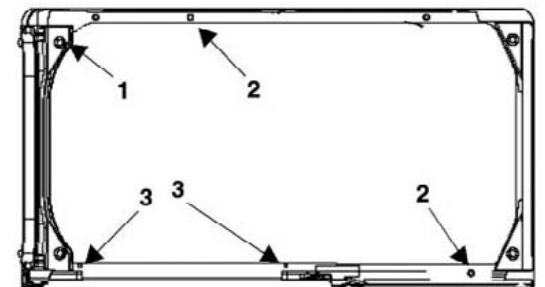
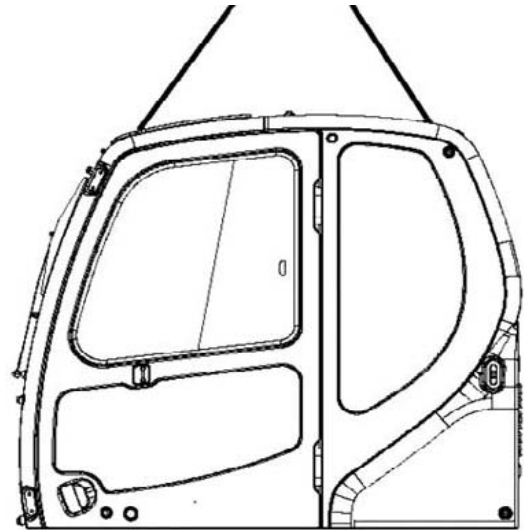


Figure 7

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

NOTE: Cabin weight is approximately 315 kg (700lb).

30. Lift cabin from 25 -50 mm (1" -2") above deck height. Check that all electrical connections have been disconnected and all other items unbolted.
31. Continue lifting with the assist crane to remove cabin shell. Lower the shell to a prepared safe blocking support.



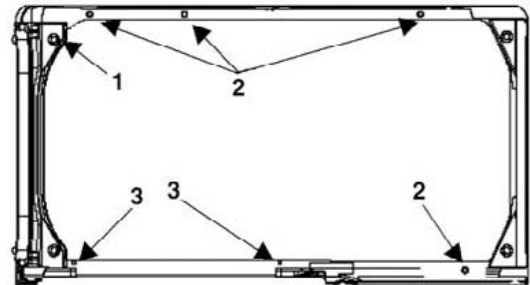
FG001982

Figure 8

INSTALLATION

Install in reverse order of removal.

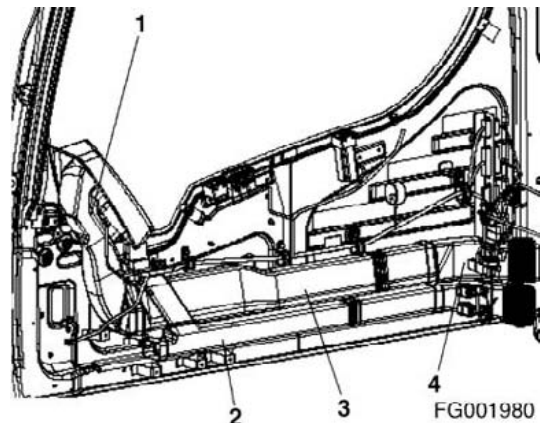
1. Install four mounting nuts from four corners of cabin floor (1, Figure 9)
 - Mounting nut torque 21 kg•m (205 Nm, 150 ft lb)
2. Install four M12 hex bolts (2, Figure 9)
 - Mounting bolt torque 11 kg•m (108 Nm, 80 ft lb)
3. Install four M10 hex bolts (3, Figure 9)
 - Mounting bolt torque 6.5 kg•m (64 Nm, 47 ft lb)



FG001983

Figure 9

4. Connect cabin wiring connectors from main harness.
5. Connect washer hose at floor plate bottom.
6. Install air ducts (1,2,3 and 4, Figure 10) at the right side of cabin sequentially from the front duct.



FG001980

Figure 10

7. Install cross bar (5, Figure 11) between left and right side of cabin.
8. Install air ducts (1,2,3 and 4, Figure 11) to cabin rear panel.

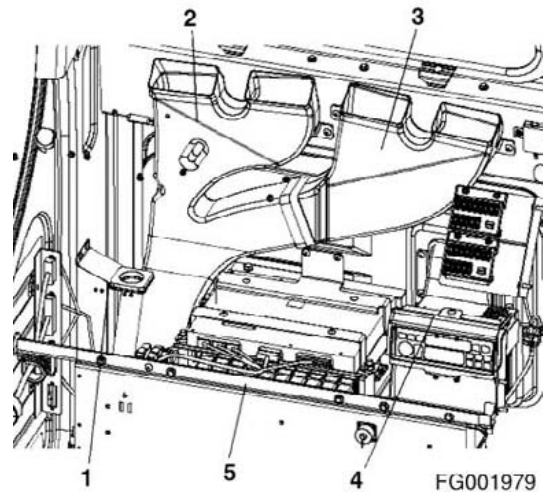


Figure 11

9. Install electric box (4, Figure 12).
10. Install cassette bracket (2, Figure 12) and connect antenna and speaker wire.
11. Connect cabin ground cable located near fuse box bracket.
12. Install fuse box bracket (1, Figure 12) from left sidewall.

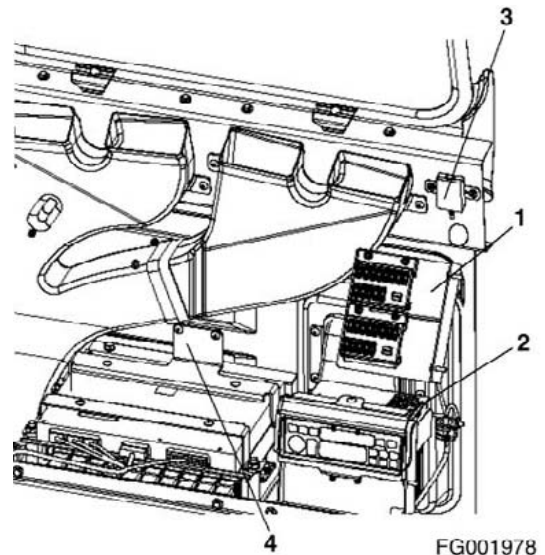


Figure 12

13. Install rear side covers (4 and 5, Figure 13) and install cassette cover (3, Figure 13).
14. Install rear center cover (2, Figure 13) and install rear mat (1, Figure 13) sequentially.

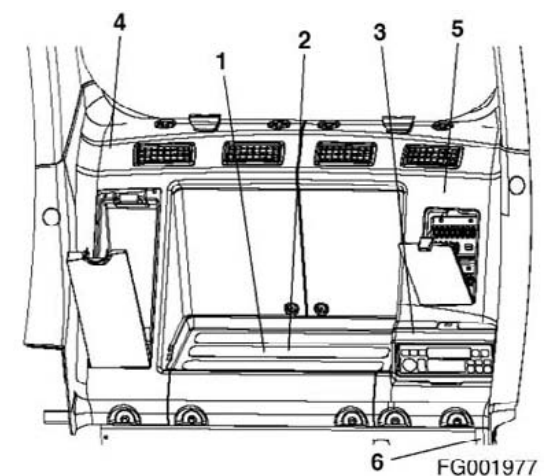
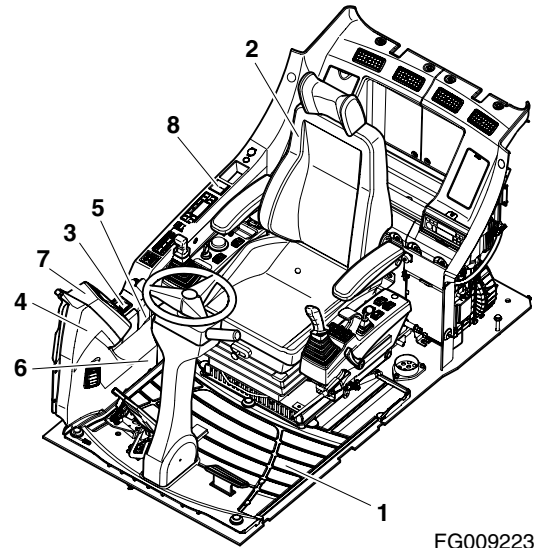


Figure 13

15. Install front cover (4, Figure 14) and side covers (5 and 6, Figure 14). Before installing front cover (4), connect hour meter connector.
16. Install cup holder (3, Figure 14).
17. Install seat (2, Figure 14) on the seat plate.
- NOTE:** *Be careful not to damage seat covering.*
18. Install floor mat (1, Figure 14).



FG009223

Figure 14

Counterweight

Edition 1

MEMO

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Counterweight

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX210W	5001 and Up

GENERAL

Warning for Counterweight and Front Attachment Removal



DANGER!

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

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

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

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



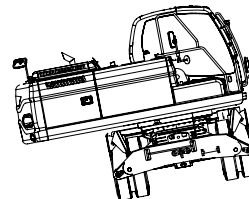
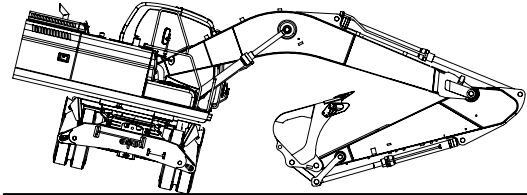
WARNING!

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

Model	Weight of Counterweight
DX210W	3,800 kg (8,378 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.



FG007176

Figure 1

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.

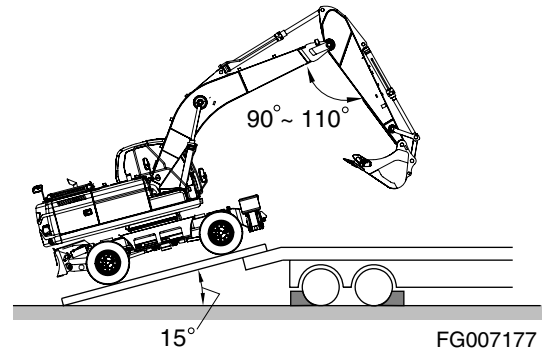


Figure 2

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 2).

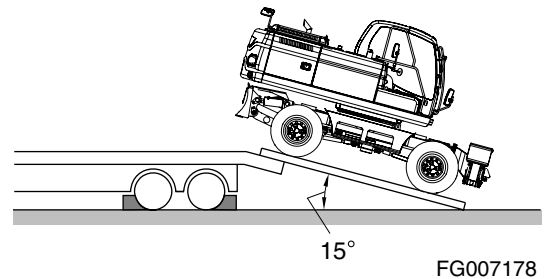


Figure 3

REMOVAL

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



WARNING!

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

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

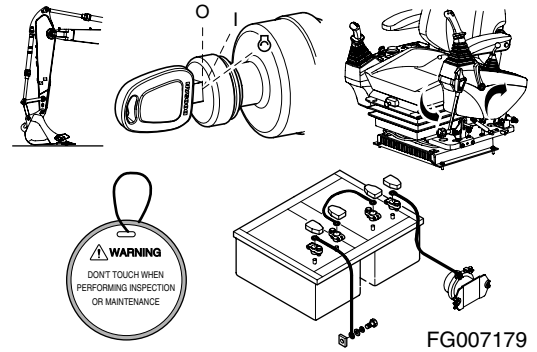


Figure 4

12. Remove two caps (1, Figure 5) from counterweight (2).
13. Install two lifting eyes in lifting holes (3, Figure 5).

Model	Lifting Eye Size
DX210W	M48 x 5.0

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

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

16. When bolts (4, Figure 5) 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.

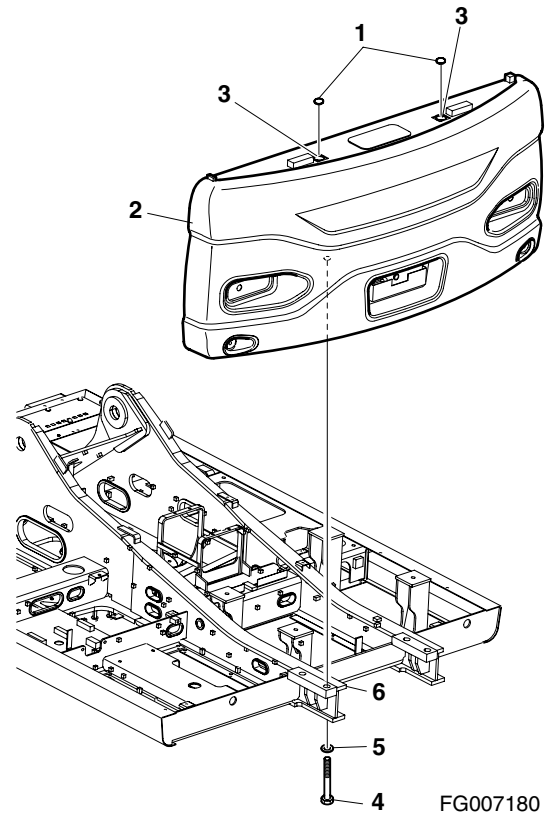


Figure 5

INSTALLATION

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

NOTE: Leave counterweight (2, Figure 6) suspended 3 mm (0.12") above support frame (6) until all four mounting bolts (4) are started in counterweight mounting holes.

2. Slide washers (5, Figure 6) onto bolts (4). Apply Loctite #242 to mounting bolt threads.
3. Install four bolts (4, Figure 6) 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 6) to values shown in following table.

Model	Bolt Torque
DX210W	250 kg•m (1,808 ft lb)

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

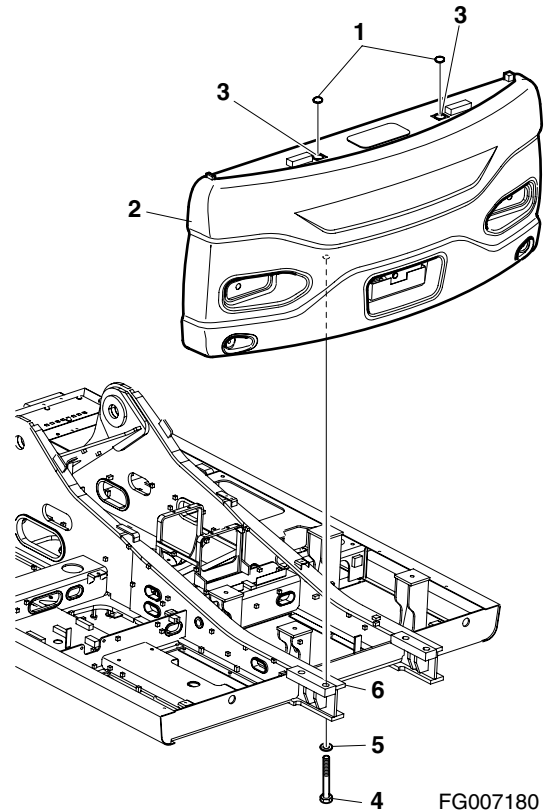


Figure 6

Fuel Tank

Edition 1

MEMO

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Fuel Tank

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

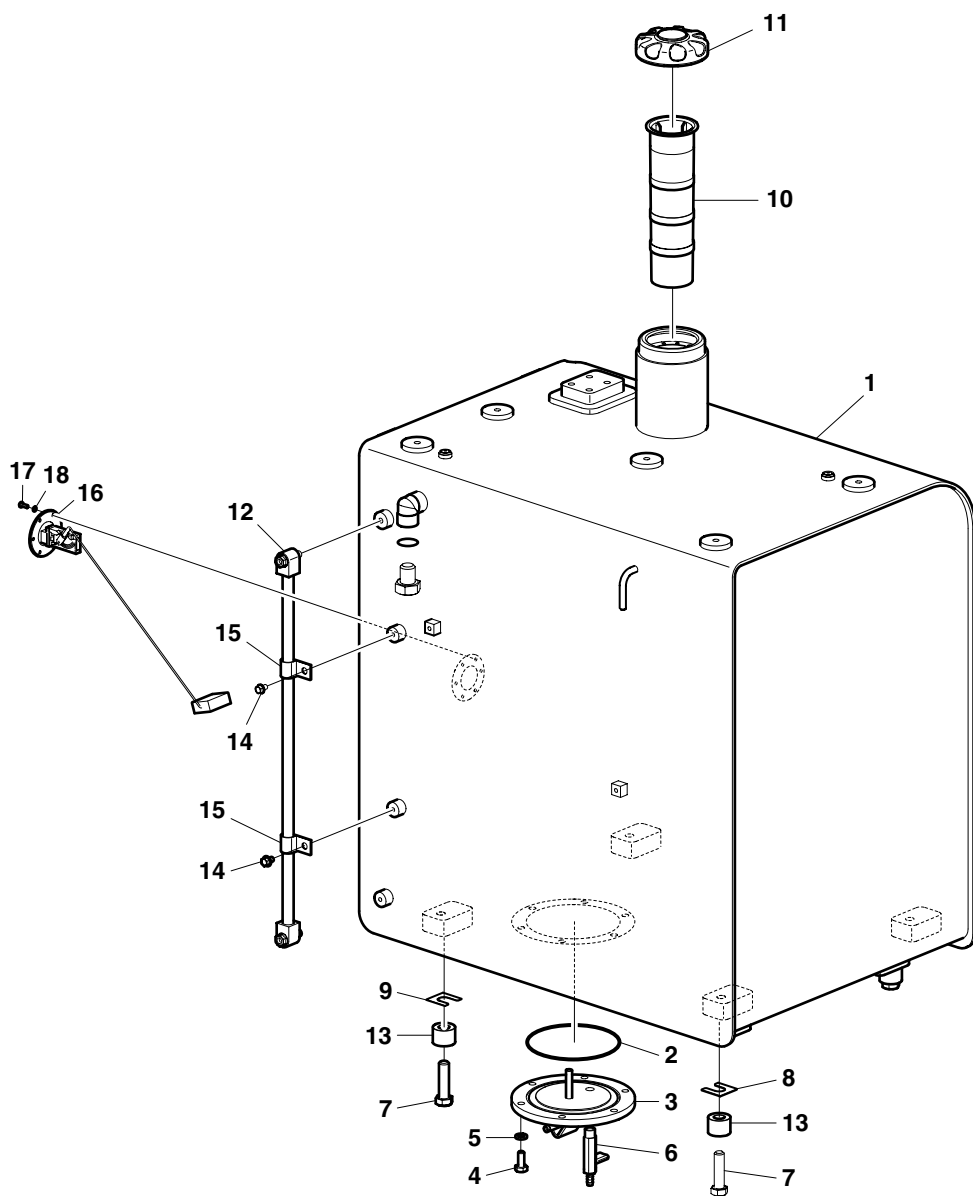
MODEL	SERIAL NUMBER RANGE
DX210W	5001 and Up

GENERAL DESCRIPTION



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



FG007181

Figure 1

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

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

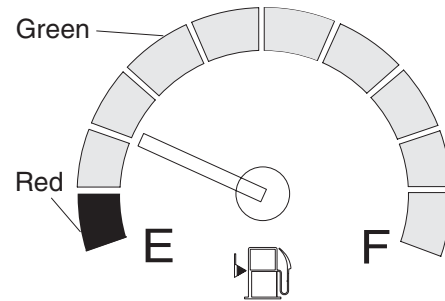
Specifications

Fuel tank capacity is 350 liters (92.5 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.

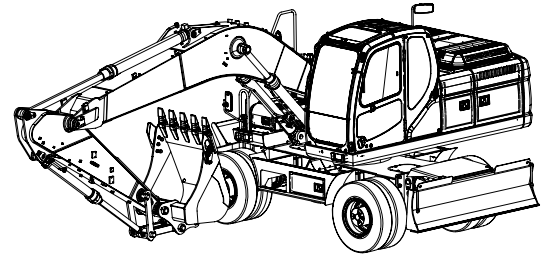
NOTE: *If possible, work excavator until available fuel supply in tank has been run down as far as possible.*



FG000608

Figure 2

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



FG007193

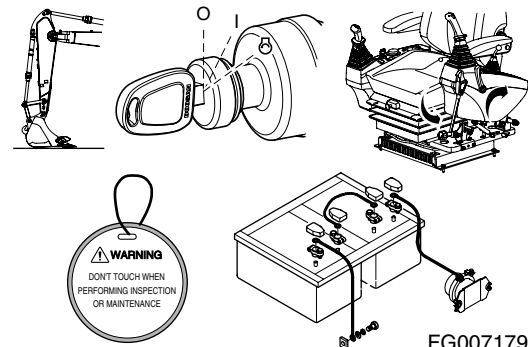
Figure 3

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



WARNING!

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



FG007179

Figure 4

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.

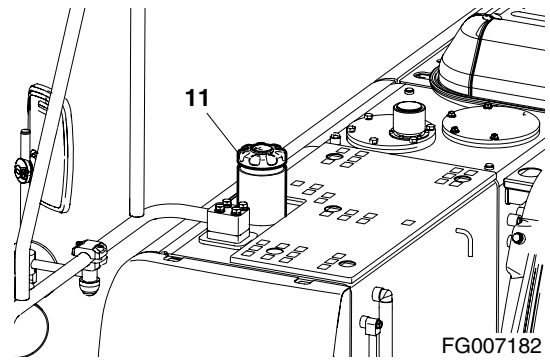


Figure 5

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 350 liters (92.5 U.S. gal).

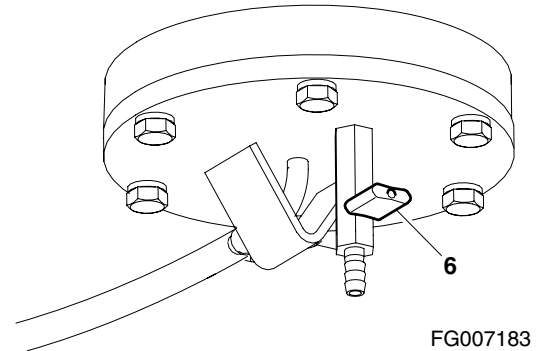


Figure 6

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

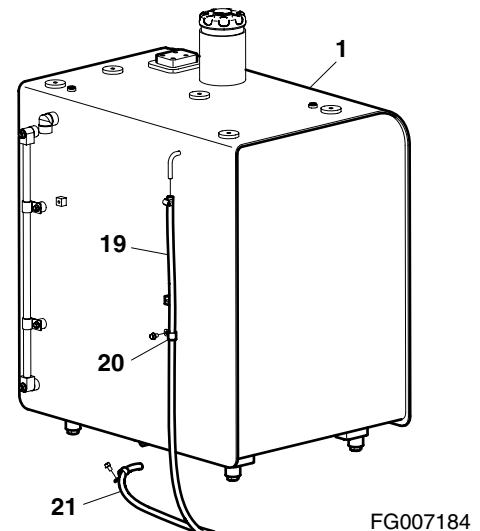
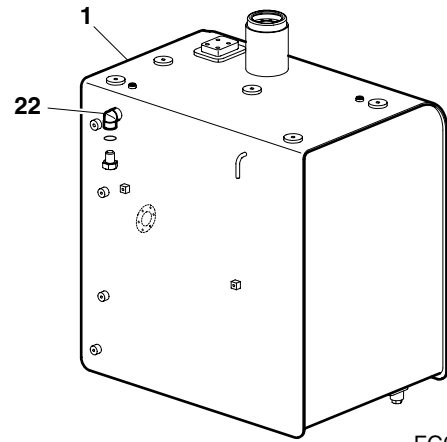


Figure 7

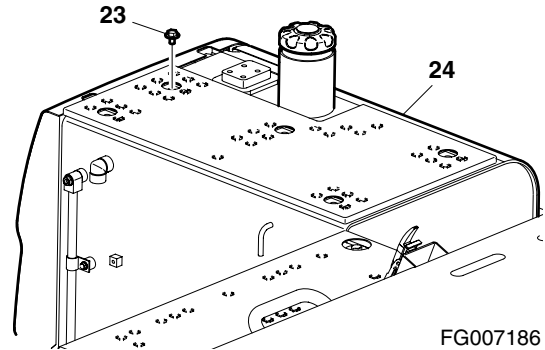
16. If equipped, remove components from fuel filler pump port (22, Figure 8) on side of fuel tank (1).



FG007185

Figure 8

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



FG007186

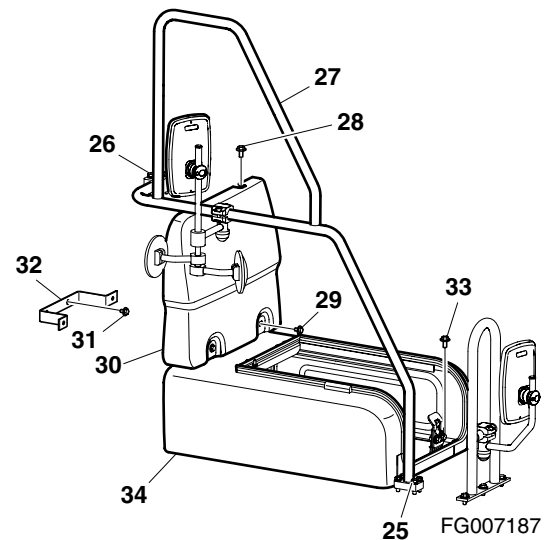
Figure 9

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

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

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

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



FG007187

Figure 10

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

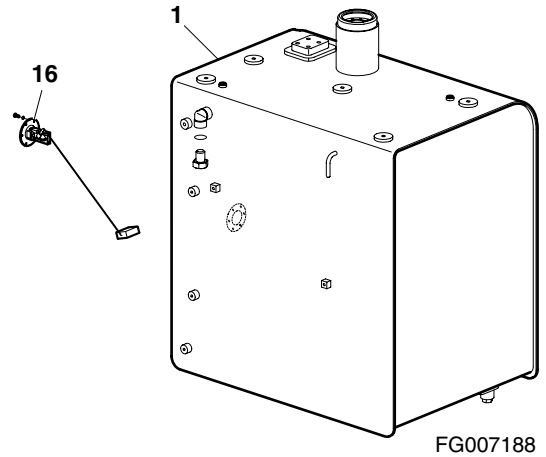


Figure 11

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

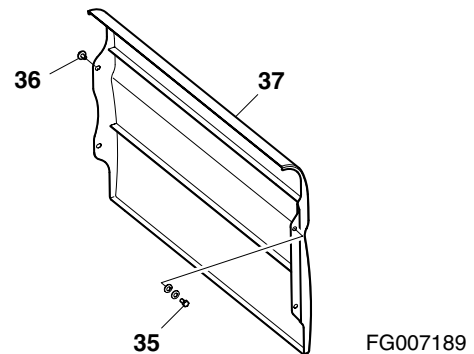


Figure 12

21. Install two 12 mm eyebolts in threaded holes (38 and 39, Figure 13). Using a suitable lifting device, sling eyebolts.
22. Remove six bolts (7) and spacers (13, Figure 13) holding tank (1) to frame. Lift tank 25 mm (1") and make sure it is balanced. Make sure there are no other electrical wires or hoses connected to tank. 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.

23. Remove shims (9, Figure 13).

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

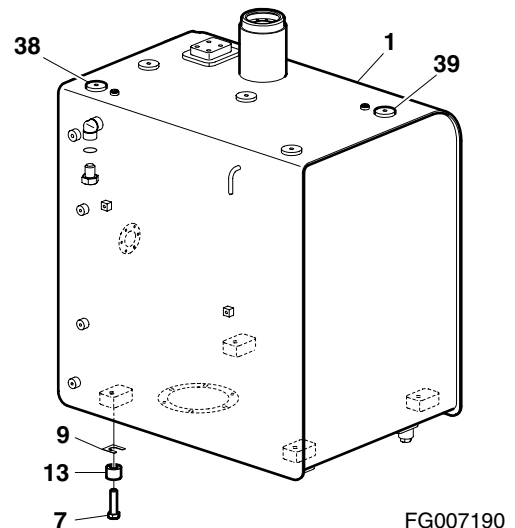


Figure 13

INSTALLATION

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

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

3. Install shims (9, Figure 14) as needed to prevent tank (1) from rocking or stress from mounting bolts (7).
4. Tighten mounting bolts (7, Figure 14) after shims are installed.

NOTE: *Bolt torque is 27 kg•m (195 ft lb).*

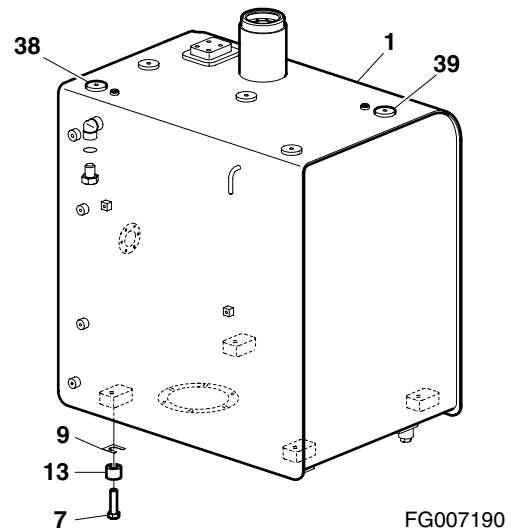


Figure 14

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

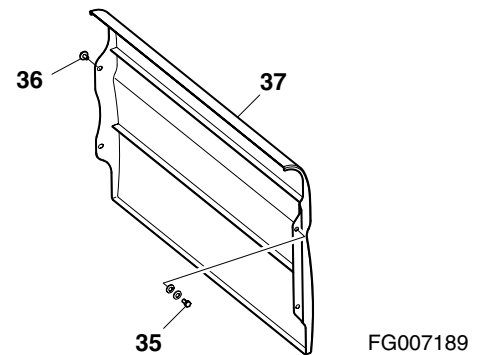


Figure 15

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

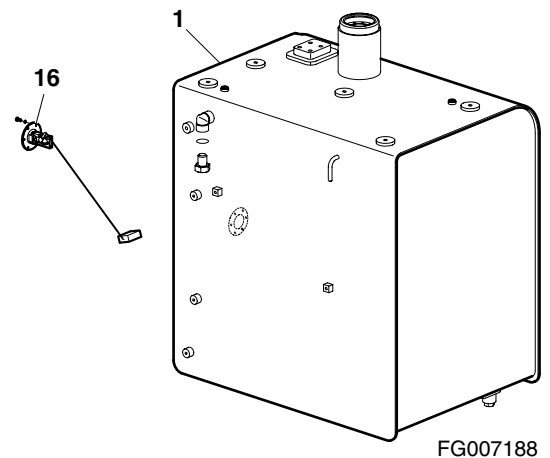


Figure 16

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

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

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

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

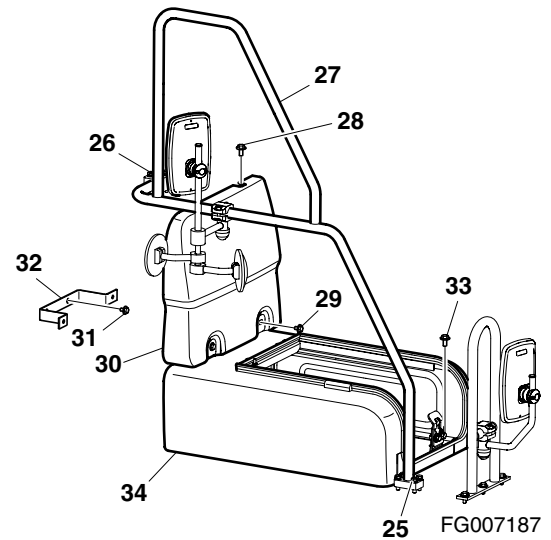


Figure 17

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

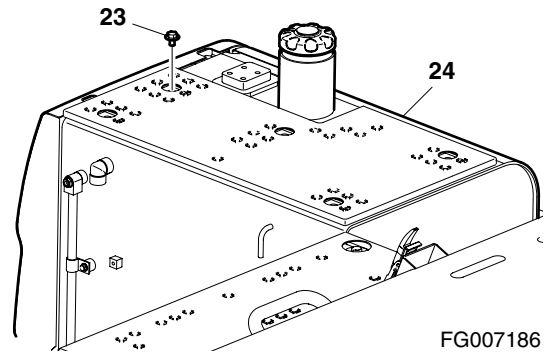


Figure 18

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

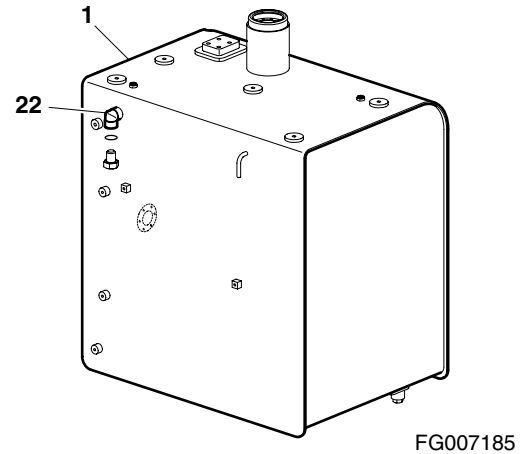
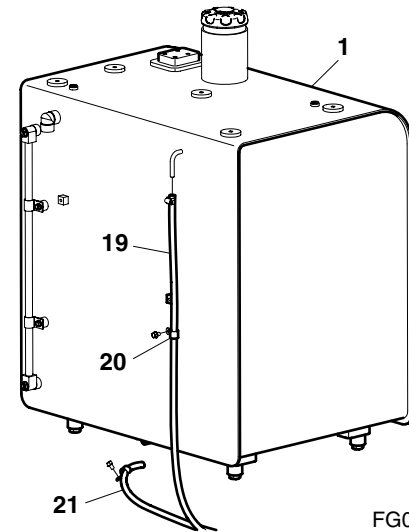


Figure 19

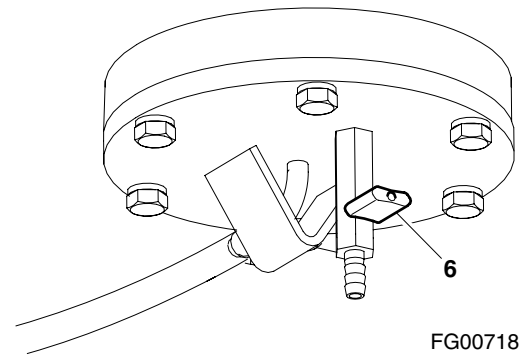
10. Connect as tagged, fuel supply line (21, Figure 20) and fuel return line (19) to fuel tank (1).
11. Install clamp (20, Figure 20) to hold fuel return line (19) to tank (1).



FG007184

Figure 20

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



FG007183

Figure 21

START-UP PROCEDURES

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

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

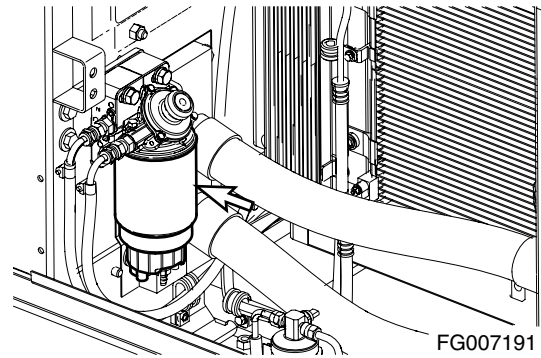


Figure 22

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

Repeat procedure if necessary.

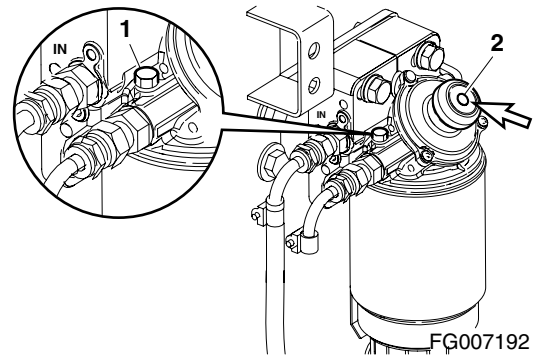


Figure 23

Fuel Transfer Pump

Edition 1

MEMO

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Fuel Transfer Pump

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Replacement of Rear Cover	8
Replacement of Armature.....	8

MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX180LC	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX300LL	5001 and Up

GENERAL DESCRIPTION

Theory of Operation

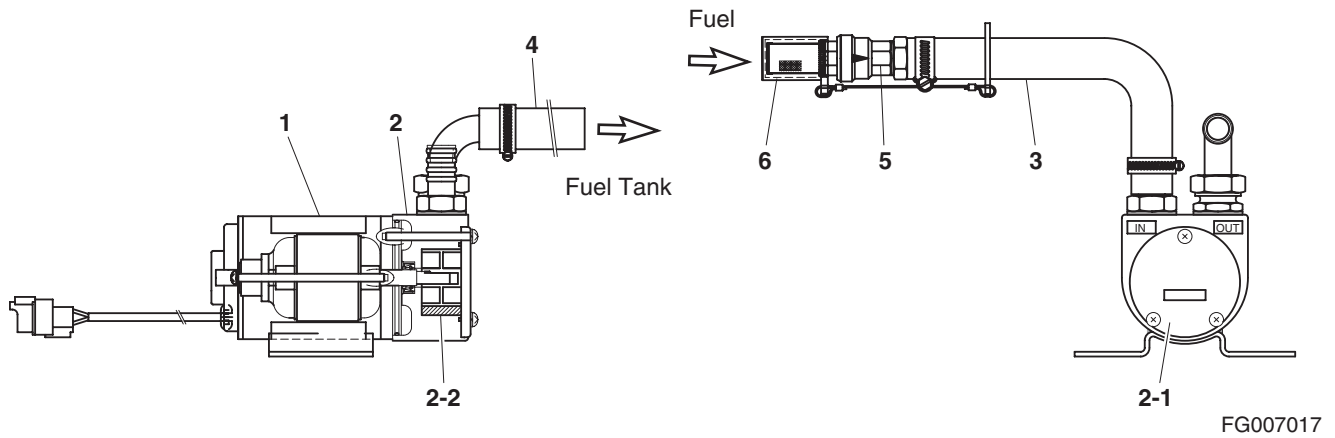


Figure 1

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.

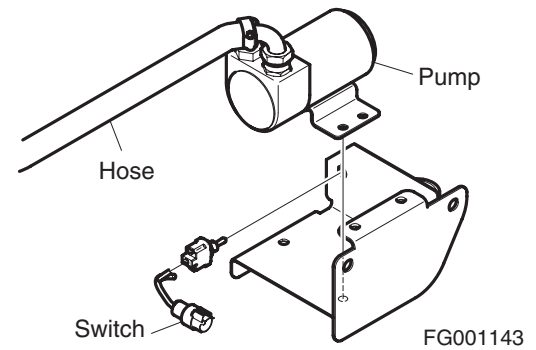


Figure 2

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: $150 \pm 5^{\circ}\text{C}$ ($302 \pm 41^{\circ}\text{F}$). After circuit is automatically shut off because of overheating the pump will stop running. When temperature drops below 143°C (289°F) the circuit will reactivate allowing the pump to restart.*

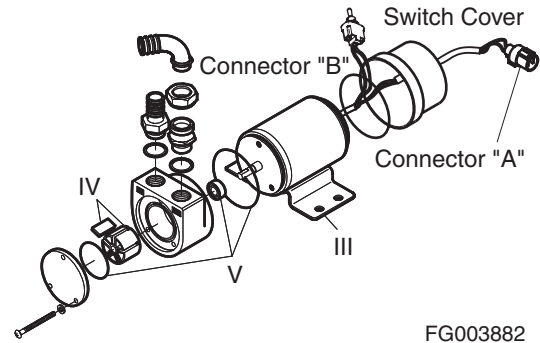


Figure 3 WITH TOGGLE SWITCH

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

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

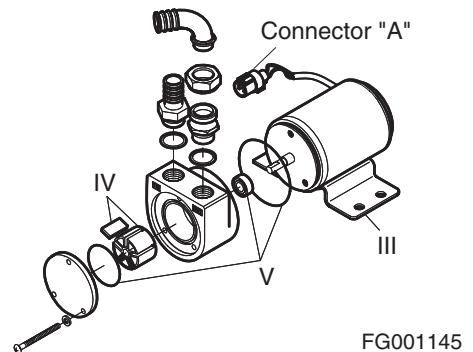


Figure 4 WITHOUT TOGGLE SWITCH

REPLACEMENT OF ROTOR AND VANE

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

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

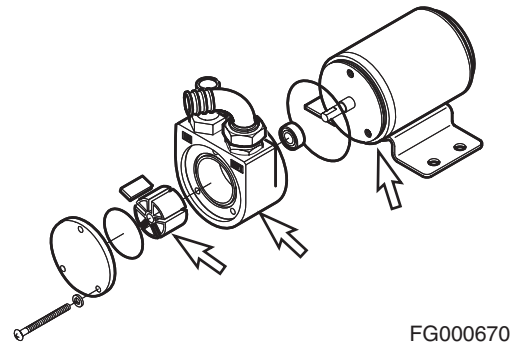
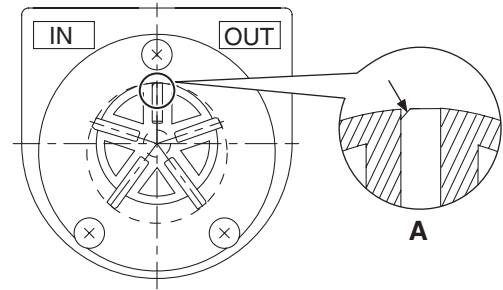


Figure 5 WITHOUT TOGGLE SWITCH

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

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



FG003883

Figure 6

REPLACEMENT OF REAR COVER

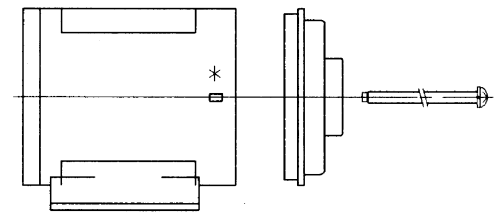
Brush assembly and a thermal limiter are installed in the rear cover. If you find any damage, replace them with new ones.

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

Remove cover.

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

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



HAAG0330

Figure 7

REPLACEMENT OF ARMATURE

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

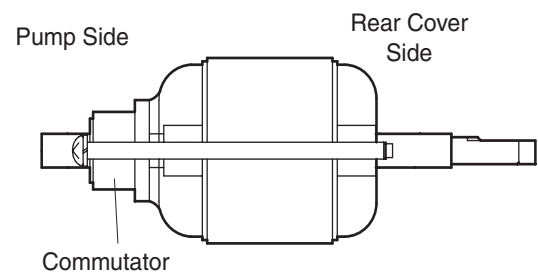
Remove switch cover and rear cover, then remove armature from the housing.

Remove pump cover and remove rotor and vane.

Insert a new armature into the housing.

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

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



FG001146

Figure 8

Swing Bearing

Edition 1

MEMO

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Swing Bearing

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Measuring Swing Bearing Axial Play	7
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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX210W	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.

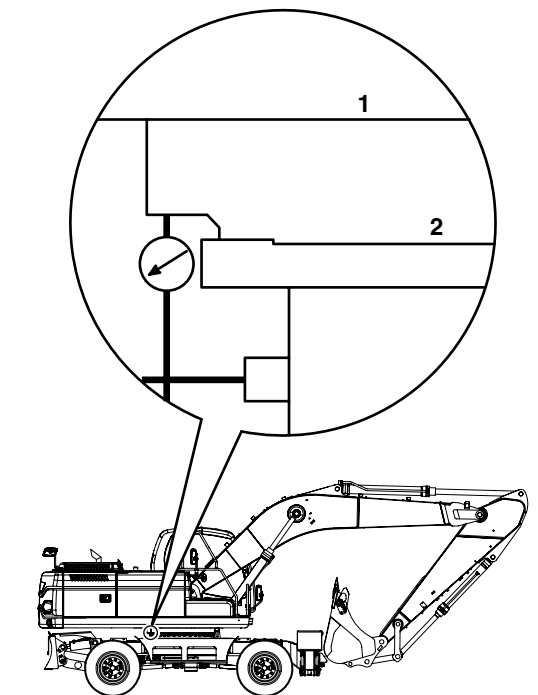
Measuring Swing Bearing Axial Play

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.

Measuring Bearing Lateral Play

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



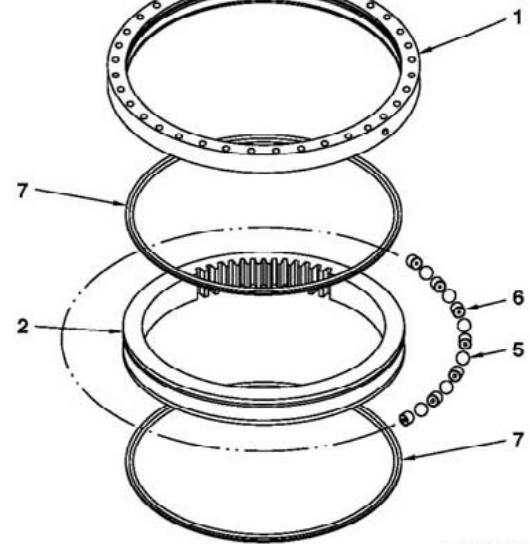
FG009224

Figure 1

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

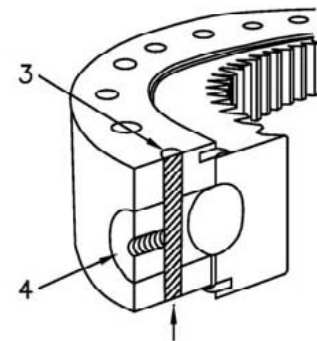


FG003909

Figure 2

Rebuilding Swing Bearing

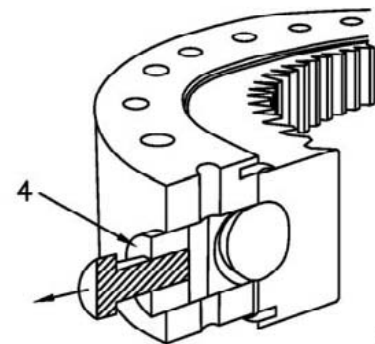
1. Remove tip of tapered pin (3, Figure 3) using grinder and tap lightly to remove debris.



FG003884

Figure 3

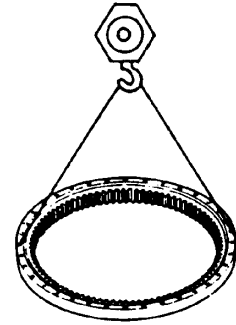
2. Remove plug (4, Figure 4) using a M10 x 1.25 bolt.



FG003885

Figure 4

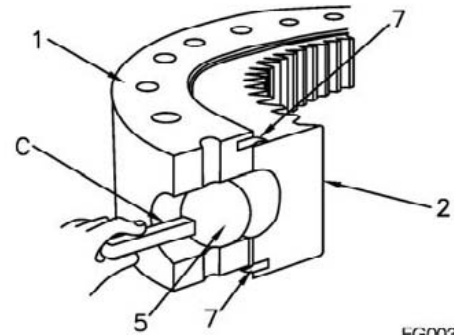
3. Lift outer ring and check that inner ring can move freely.
See Figure 5, if not, replace seal (7, Figure 6).



1588A

Figure 5

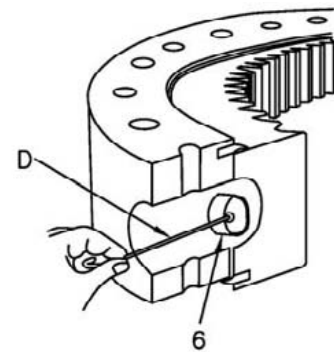
4. Turn inner ring and use magnet bar (C, Figure 6) to remove steel balls (5).



FG003886

Figure 6

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



FG003908

Figure 7

Swing Reduction Gear

Edition 1

MEMO

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Swing Reduction Gear

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX190W	5001 and Up
DX210W	5001 and Up

GENERAL DESCRIPTION

Theory of Operation

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

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

Parts List

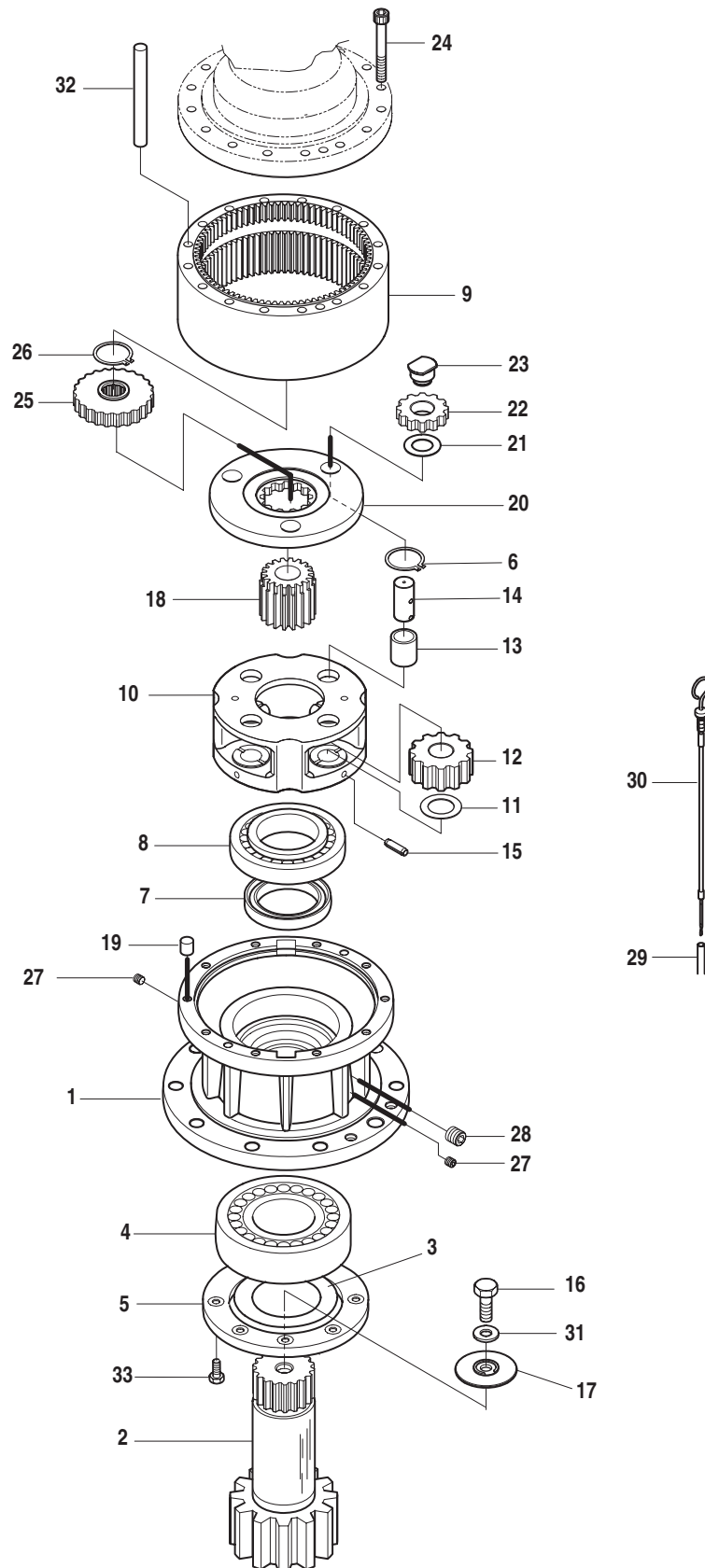


Figure 1

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

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

Specifications

Swing Reduction Gearbox	Specification
Drive Type	Two-stage Planetary Gear
Reduction Ratio	19.636
Maximum Output Speed	81 rpm
Maximum Output Torque	1,178 kg•m (8,521 lb•ft)
Weight	182 kg (401 lb)

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

TROUBLESHOOTING, TESTING AND ADJUSTMENT

Symptoms	Possible Causes	Remedies
1. No rotation and – a. Pressure at swing motor inlet <i>increases</i> b. Pressure at swing motor inlet shows <i>no increase</i>, and the swing motor is making irregular noises c. Pressure at swing motor inlet shows <i>no increase</i>, but without irregular noises from the swing motor	Swing brake not releasing Internal damage to gearbox drive train Overload Swing motor drive shaft damage Internal damage to gearbox drive train Hydraulic pump or valve broken	Check brake engagement and disengagement, check release pressure Replace broken gears, drive train assemblies Reduce load weight Replace swing motor Repair/replace broken or faulty assemblies Troubleshoot hydraulic system
2. Oil leakage a. From drive shaft b. 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
3. Excess heat Gearbox casing becomes excessively hot, with or without irregular noise(s) during operation	Low oil level Bearings or gear worn but not completely inoperative	Replace oil, refill to specified level Repair or replace gearbox

HAOE960L

REMOVAL

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



WARNING!

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

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

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

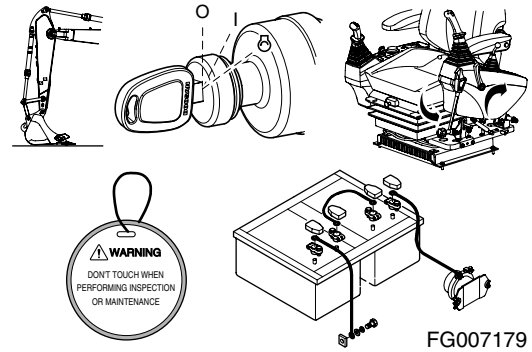


Figure 2

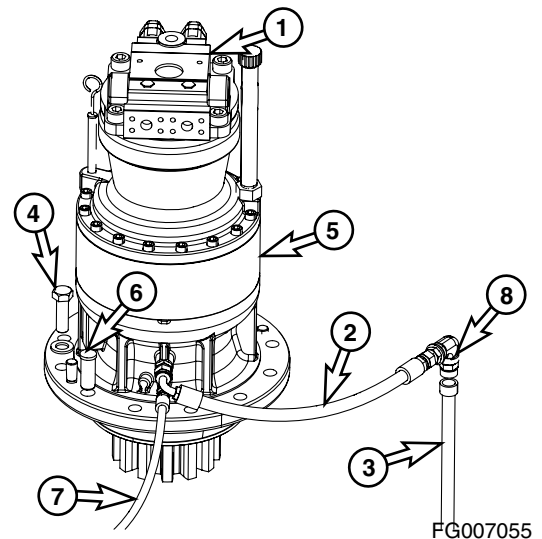


Figure 3

DISASSEMBLY

IMPORTANT

Select a clean place.

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

1. Remove bolts and motor from swing reduction case.



CAUTION!

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



Figure 4



CAUTION!

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

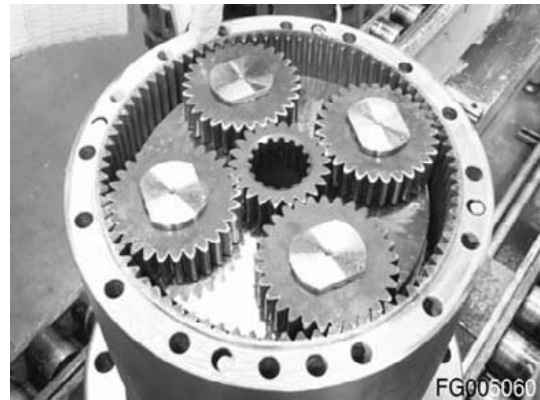


Figure 5

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



CAUTION!

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

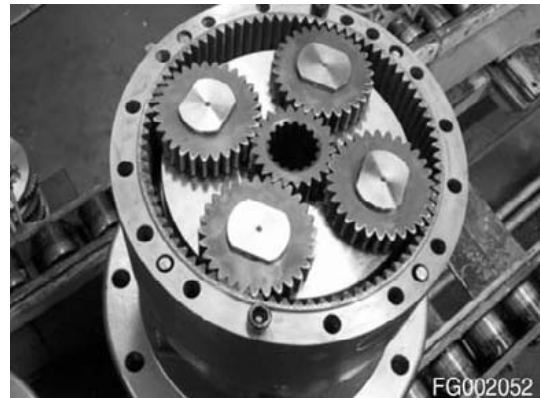


Figure 6

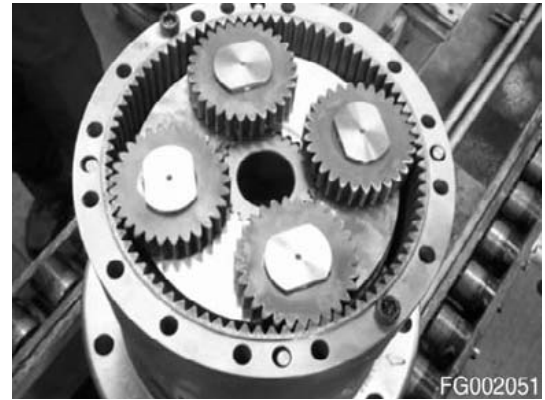


Figure 7

3. Remove No. 1 carrier.

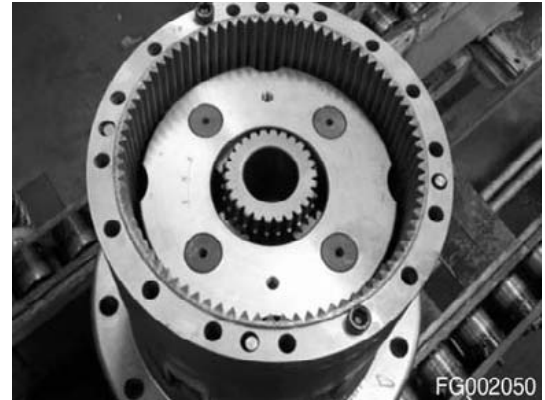


Figure 8

4. Remove washer and No. 2 sun gear.



CAUTION!

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



Figure 9

5. Remove bolt in No. 2 carrier.



Figure 10

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

! CAUTION!

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



Figure 11

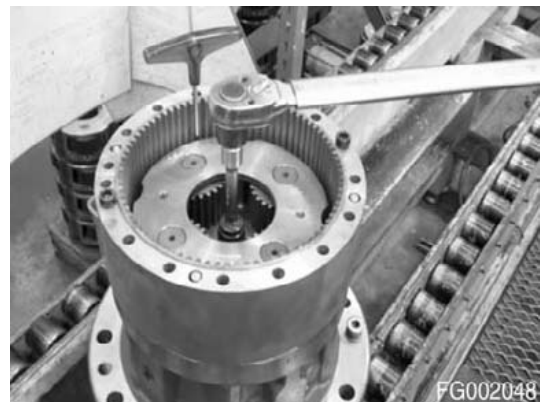


Figure 12

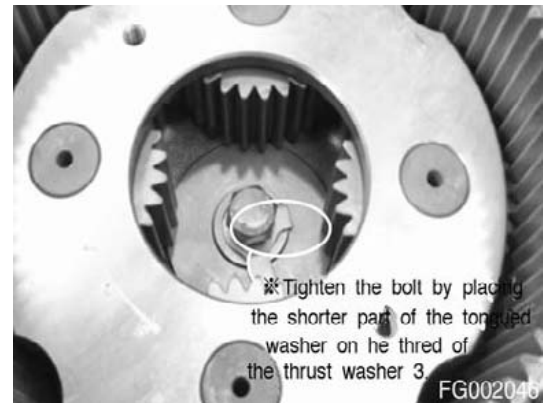


Figure 13

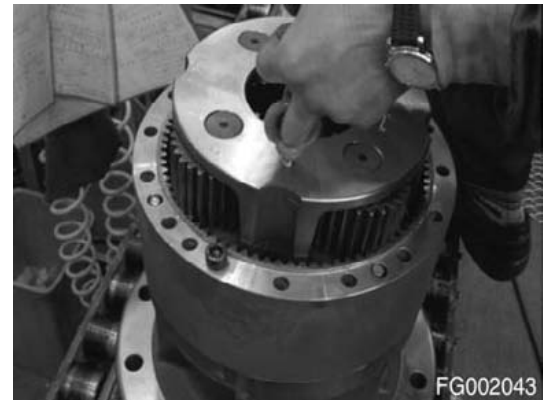


Figure 14

7. Install eyebolts in ring gear and remove it.



CAUTION!

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



Figure 15

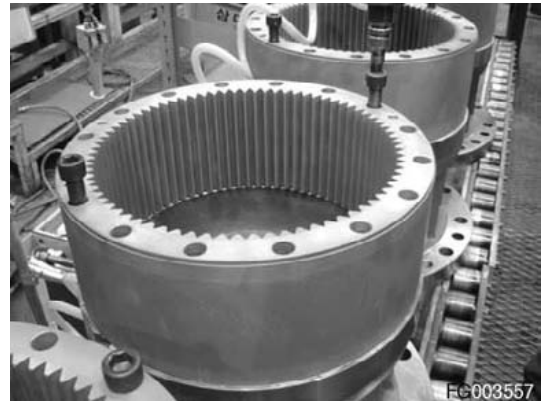


Figure 16

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

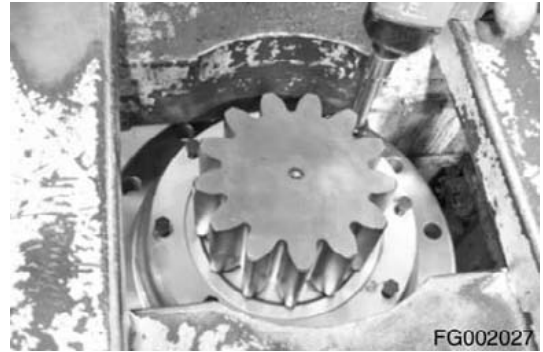


Figure 17

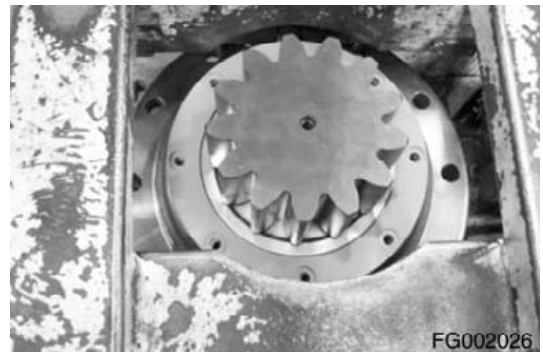


Figure 18



Figure 19

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



CAUTION!

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



Figure 20



Figure 21

11. Remove bearing from case.



Figure 22

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



Figure 23



Figure 24

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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

REASSEMBLY

Shaft and S/R Bearing Heat-fit

1. To cleaning shaft, remove any remnants of anticorrosion liquid applied on shaft and remove all of foreign substances using an air gun.
2. Insert spacer on cleaned shaft as shown in Figure 25 below and heat bearing on a special heater.



Figure 25



Figure 26

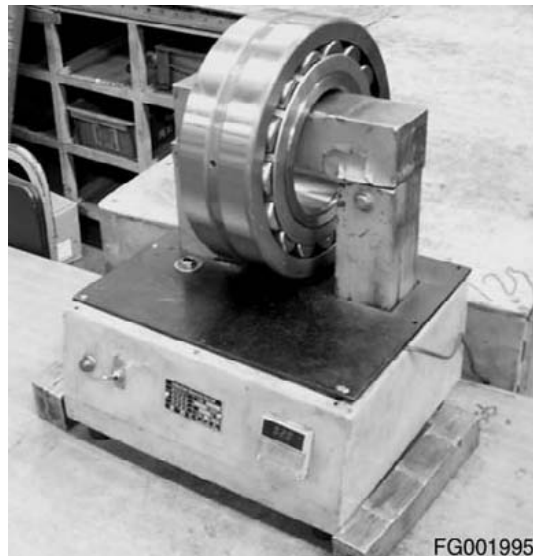


Figure 27

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



Figure 28

Assembly of Carrier Subassemblies

Cleaning Carrier

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

Cleaning Planet Gear

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

Assembly of No. 1 Carrier

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

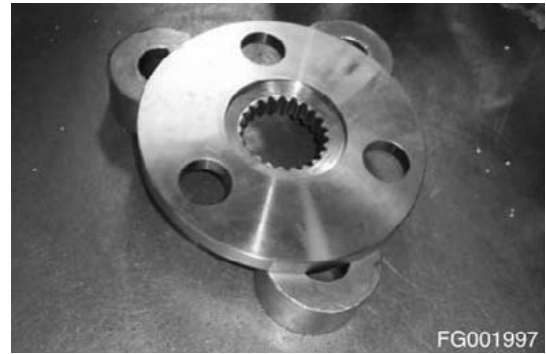


Figure 29

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



Figure 30



Figure 31



Figure 32

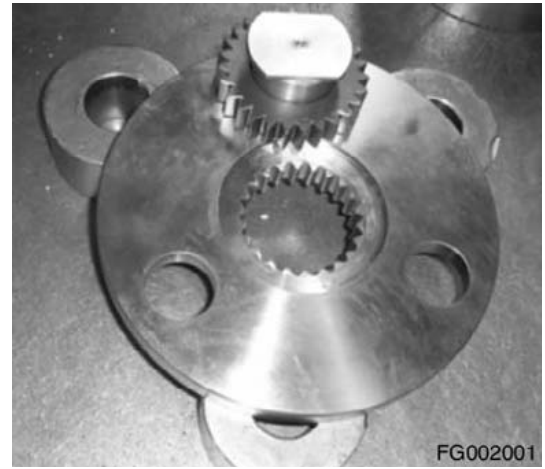


Figure 33

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



Figure 34

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



Figure 35



Figure 36

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



Figure 37



Figure 38

Assembly of No. 2 Carrier

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

NOTE: *Lifting eyehole should be facing up.*

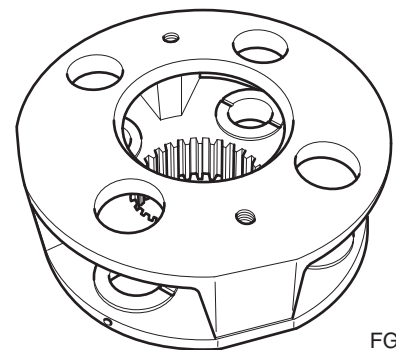
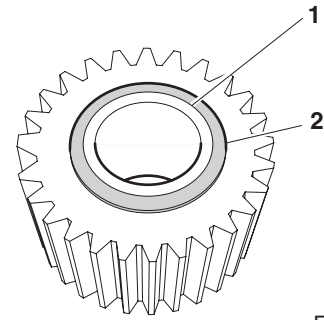


Figure 39

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

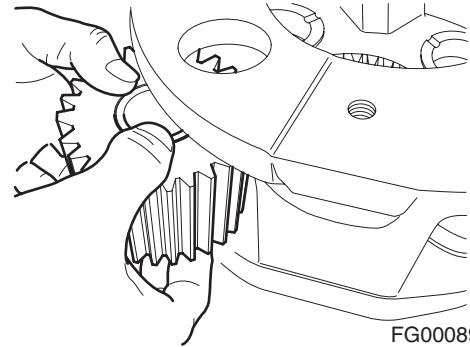


FG000889

Figure 40

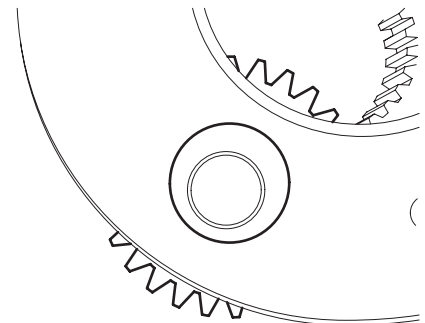
3. Turn over gear assembly and insert it into No. 2 carrier. Align bushing hole with carrier holes.

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



FG000890

Figure 41

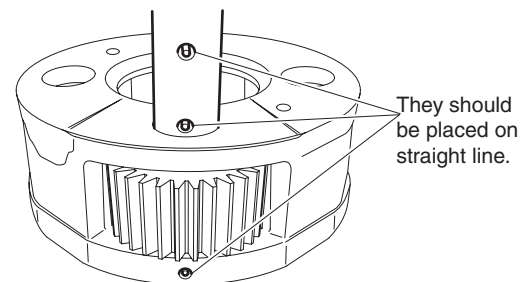


FG000891

Figure 42

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

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



FG001354

Figure 43

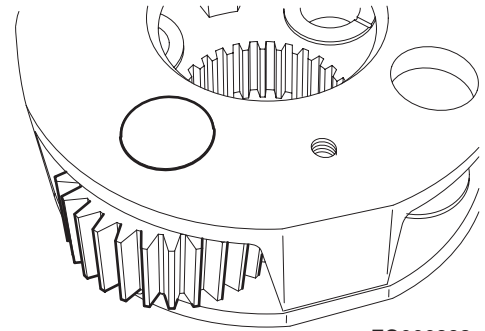


Figure 44

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

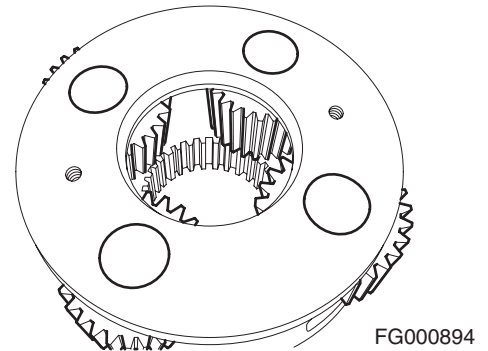


Figure 45

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

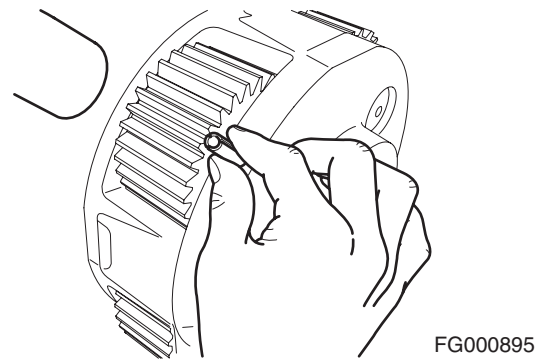


Figure 46

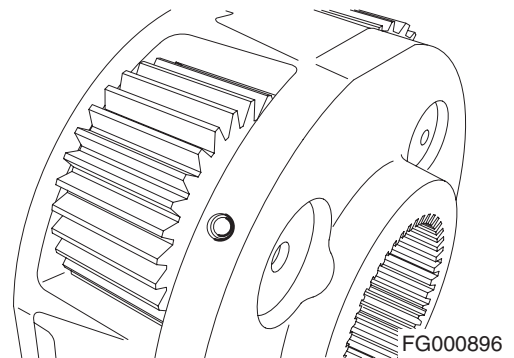
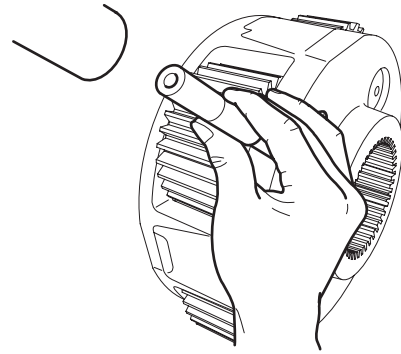


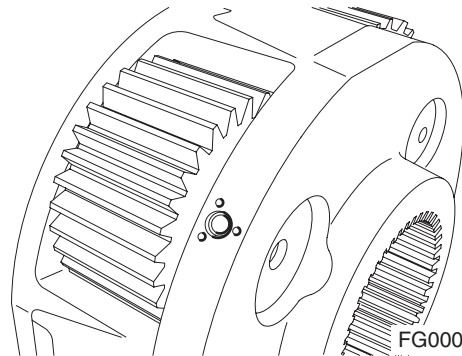
Figure 47

7. Using a hammer and punch, calking spring pin into position.



FG000897

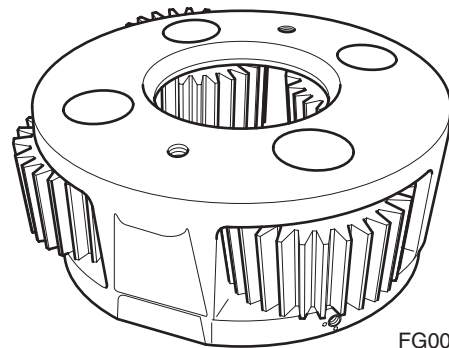
Figure 48



FG000898

Figure 49

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



FG000899

Figure 50

Assembly of Main Case

Cleaning Casing and Other Parts

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

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

Assembly of Shaft and Pinion

1. Insertion of shaft subassembly:
 - A. Set gear case as shown in Figure 51.
 - B. Using a suitable lifting device, lower shaft subassembly into case.
 - C. Using special jig, keep bearing level and press it into case.



Figure 51



Figure 52

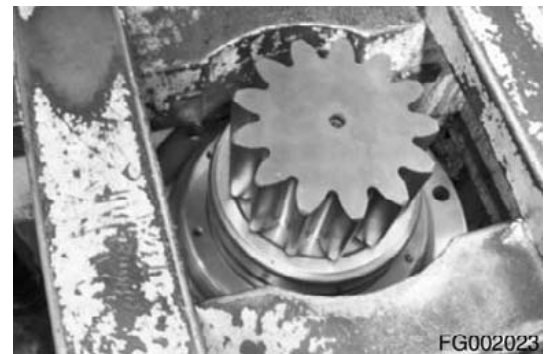


Figure 53

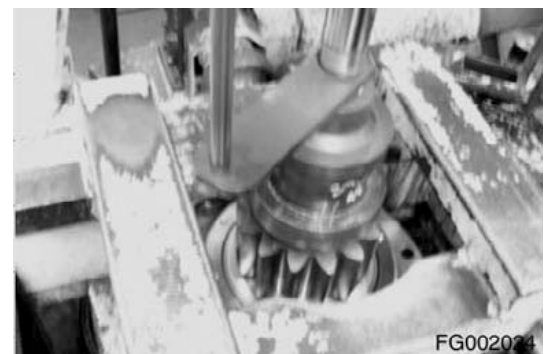


Figure 54

2. Remove bearing press fitting jig, place the cover plate as shown in Figure 55, and tighten 8 Loctite (#262) applied bolts (M10x25L) (with torque of 700 kg•cm).

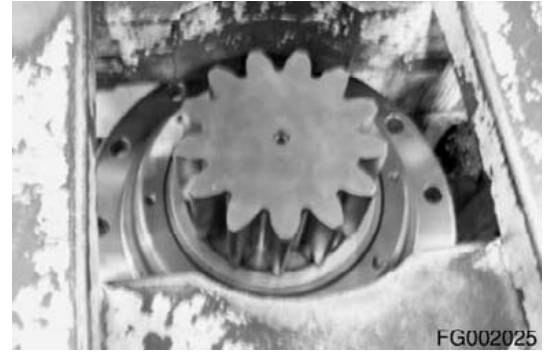


Figure 55

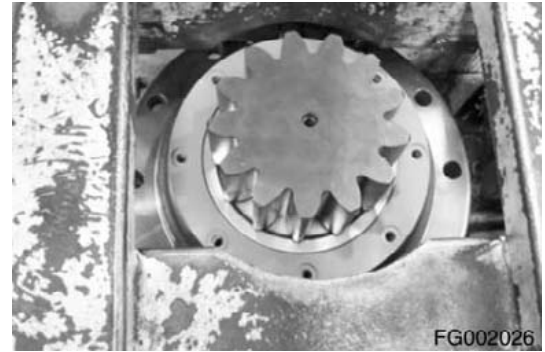


Figure 56

Assembly of Seal and Bearing

1. Position case so pinion gear is pointing down.

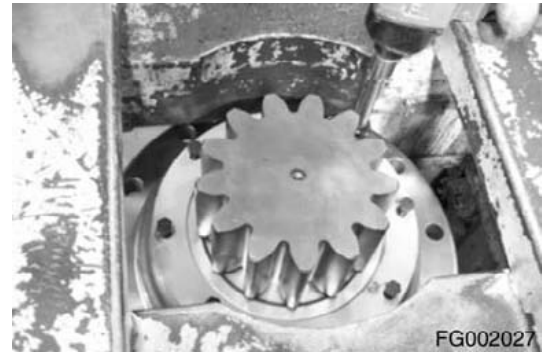


Figure 57

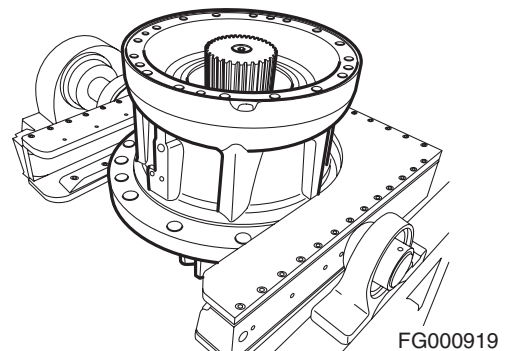
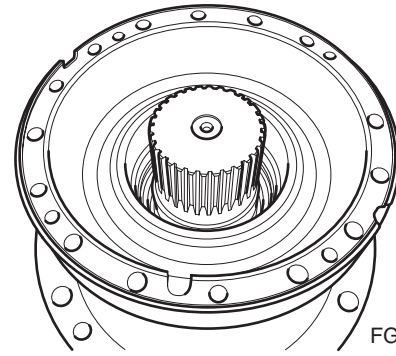


Figure 58

2. Make sure there is no foreign substance left on seal assembly, apply grease to and around lip of oil seal (TC5001300) as in Figure 59 and Loctite #609 to its external part.
3. Using seal installation jig, press seal into case, keeping it level during installation. Make sure that seal is fully seated.

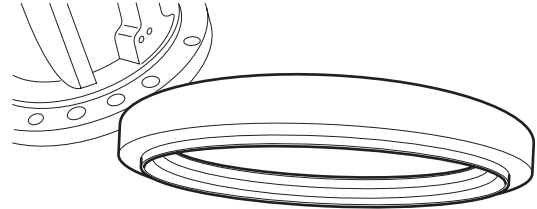


FG000920

Figure 59

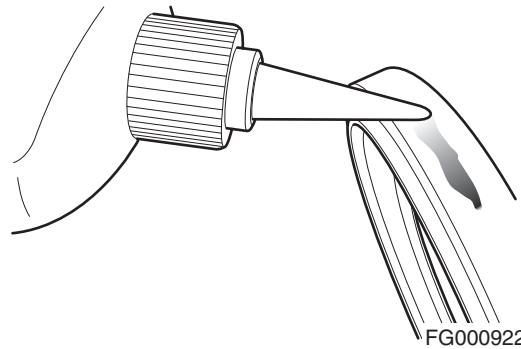
! CAUTION!

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



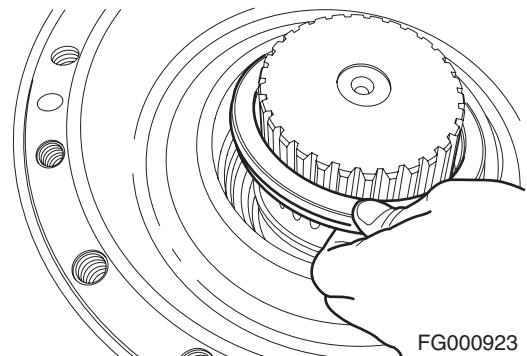
FG000921

Figure 60



FG000922

Figure 61



FG000923

Figure 62

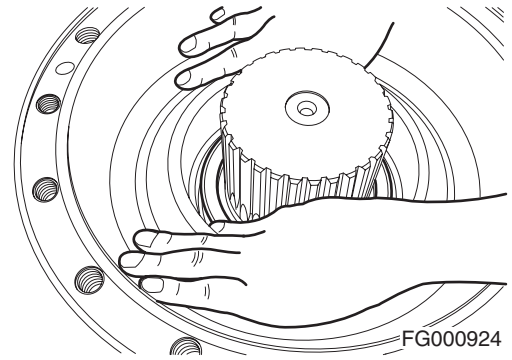


Figure 63

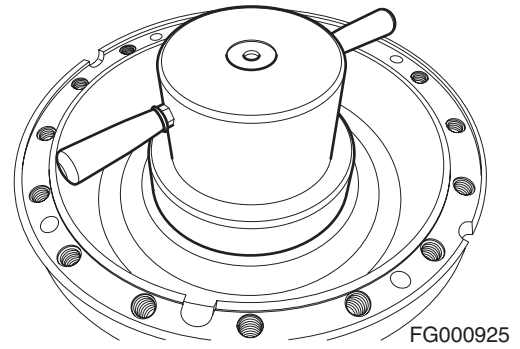


Figure 64

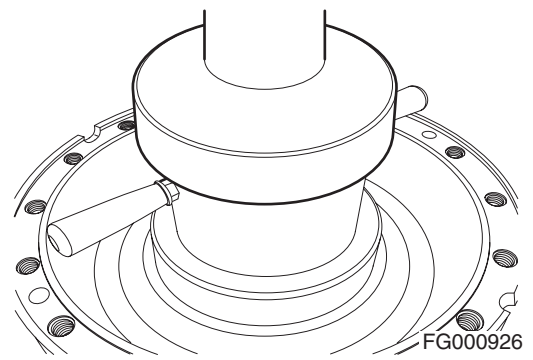


Figure 65

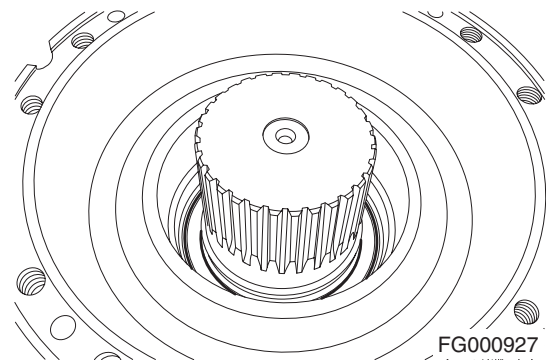


Figure 66

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

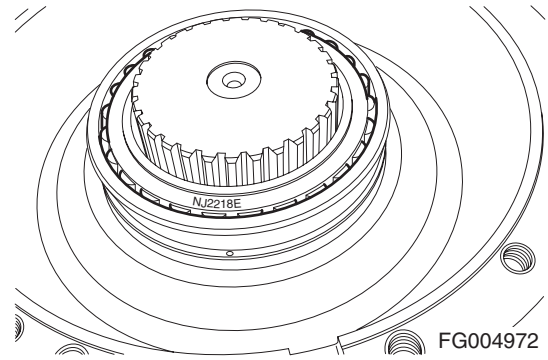


Figure 67

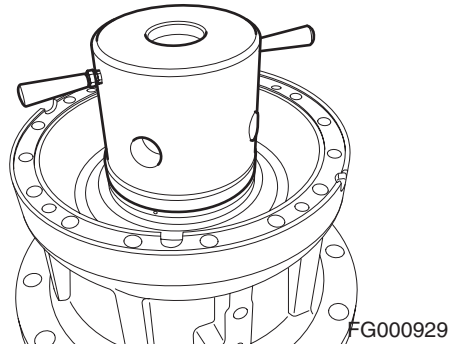


Figure 68

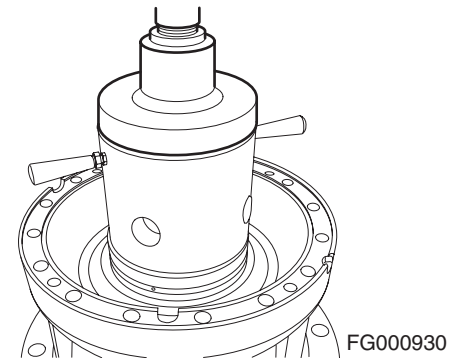


Figure 69

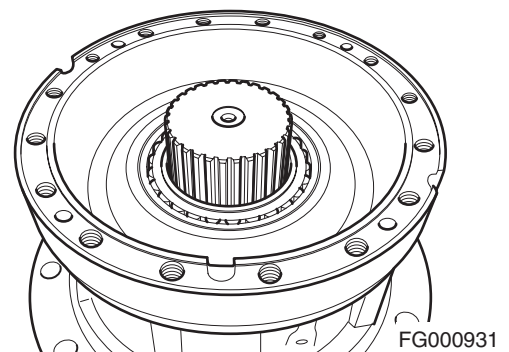


Figure 70

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

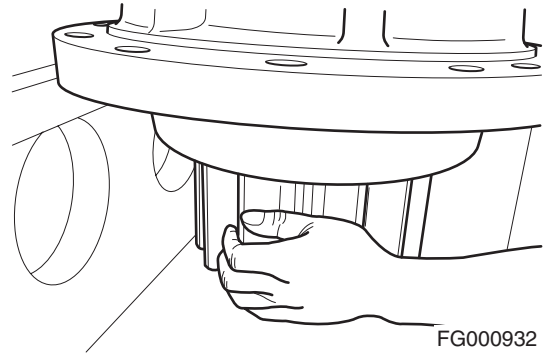


Figure 71

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

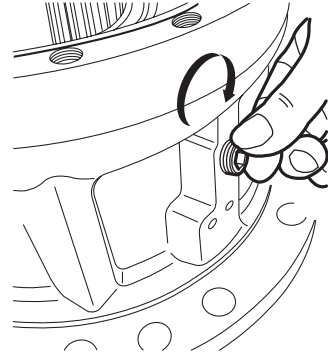


Figure 72

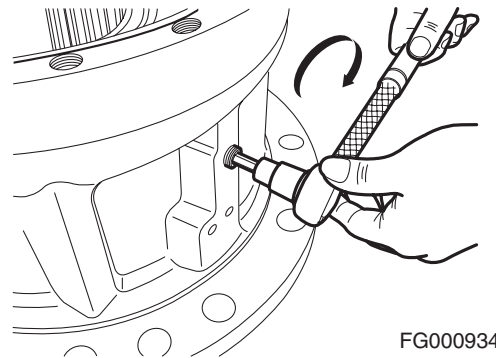


Figure 73

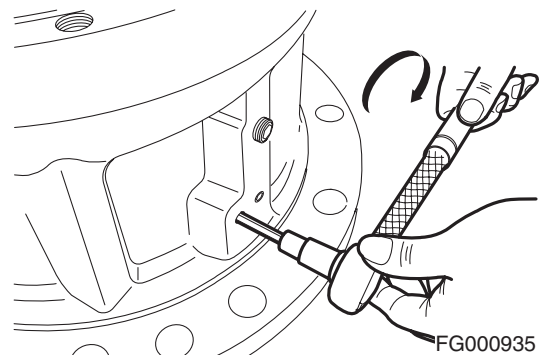


Figure 74

Assembly of Ring Gear

1. Insertion of lock pin.

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

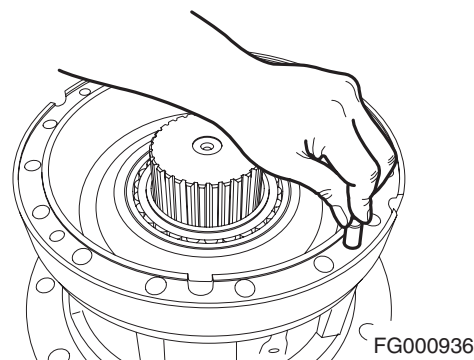


Figure 75

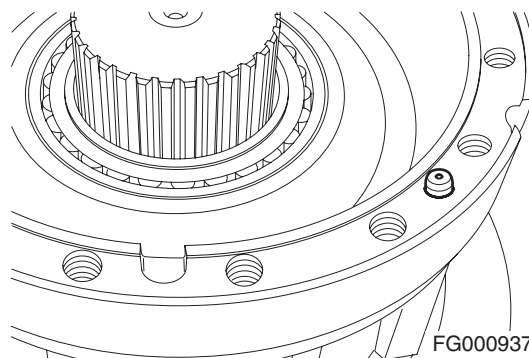


Figure 76

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

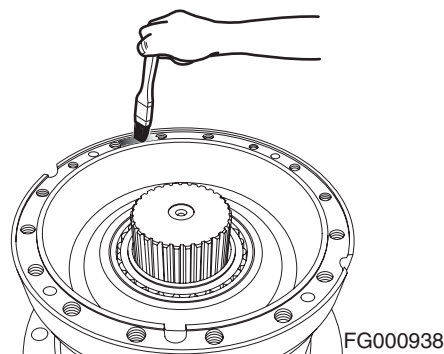


Figure 77

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

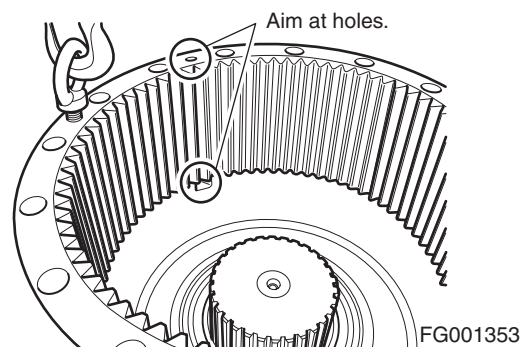
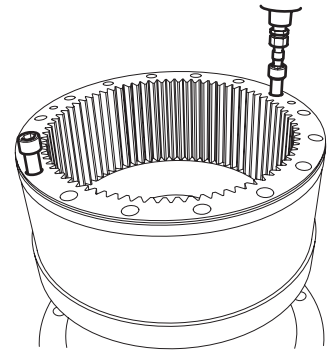


Figure 78



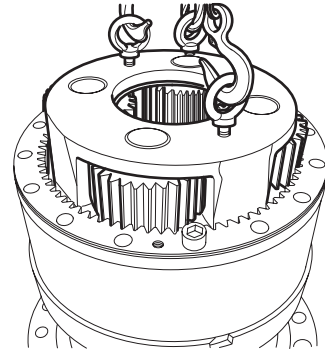
FG000940

Figure 79

Assembly of Carrier.

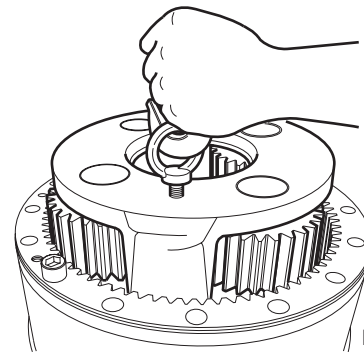
1. Using a suitable lifting device, lower No. 2 carrier assembly into ring gear, making sure that planetary gears are engaged. Continue to lower carrier and engaging it onto splines of pinion shaft. Make sure that carrier is resting on bearing.

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



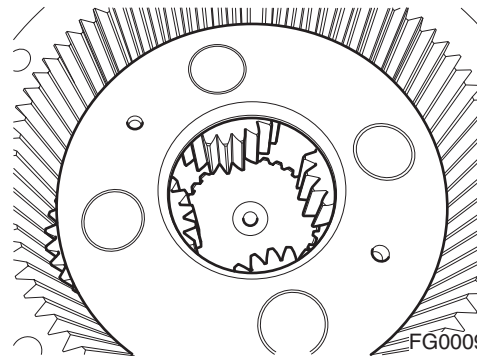
FG000941

Figure 80



FG000942

Figure 81



FG000943

Figure 82

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



CAUTION!

The shorter part of the tongued washer should be placed on the thread of the thrust washer 3 and then bolt tightened. To prevent the washer from moving, use a proper device like one shown in Figure 84 below to press a part of the washer and tighten the bolt.



Figure 83

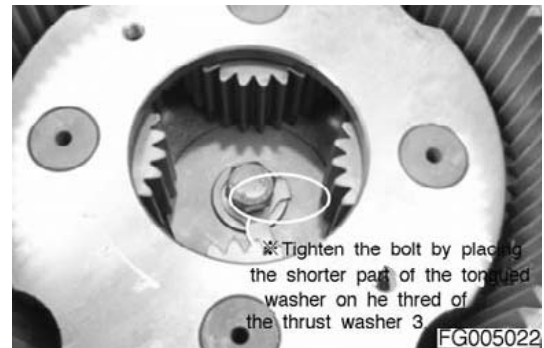


Figure 84

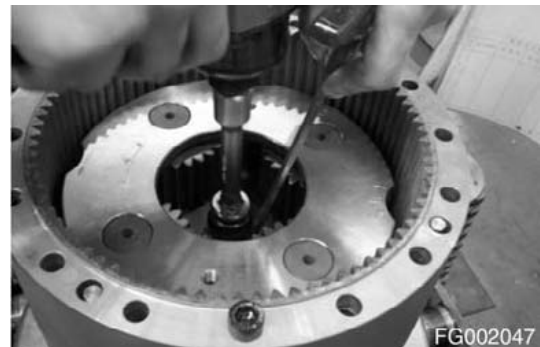


Figure 85

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

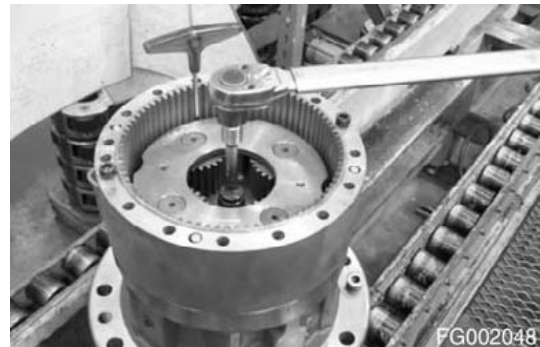


Figure 86

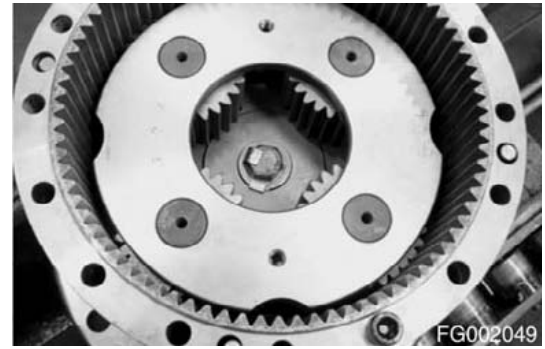


Figure 87

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

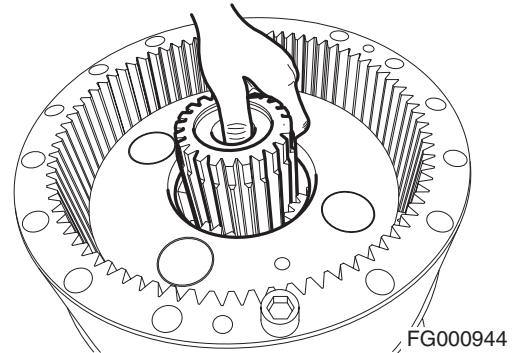


Figure 88

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



Figure 89

6. Assemble the sun gear 1.

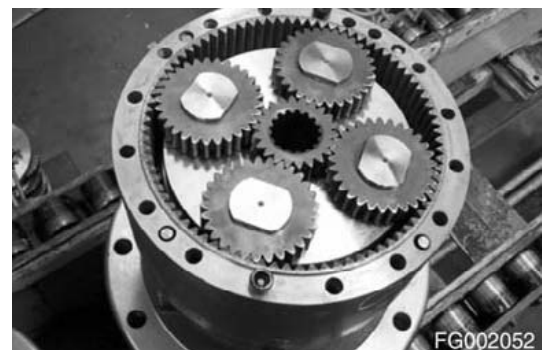


Figure 90

Assembly of the Motor

Assembly of the motor

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

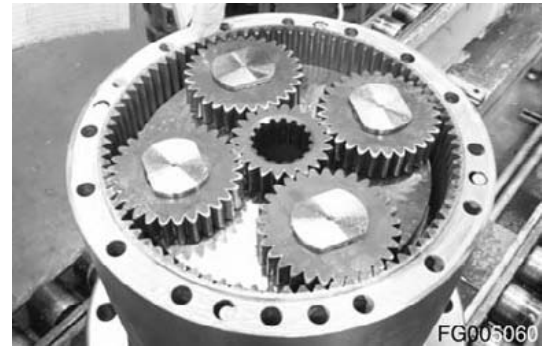


Figure 91

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



Figure 92

3. Put the motor on the reduction gear carefully with the adjustment of its direction as shown in the Figure 94 below (care should be taken not to have its flange touch the surface of the ring gear to which liquid gasket was applied). Assembly the motor by turning it clockwise or counterclockwise gently that spline of the shaft shall be engaged with the sun gear 1.



Figure 93

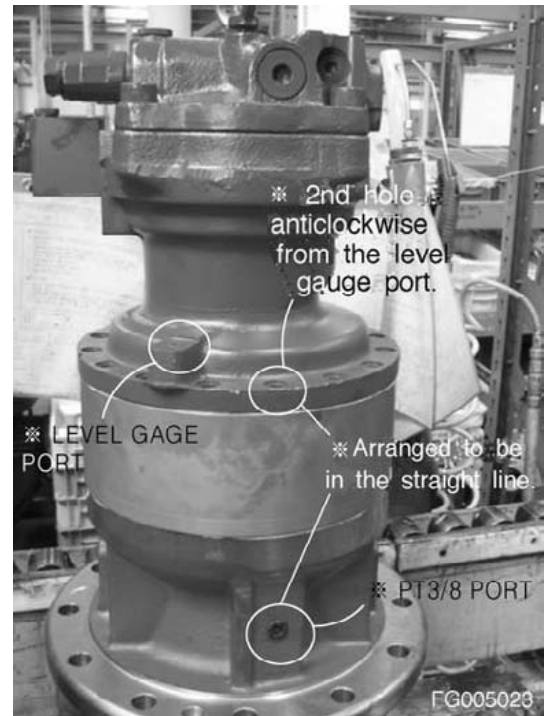


Figure 94

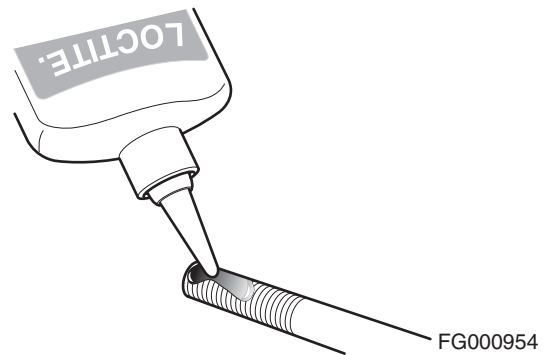


Figure 95

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



Figure 96

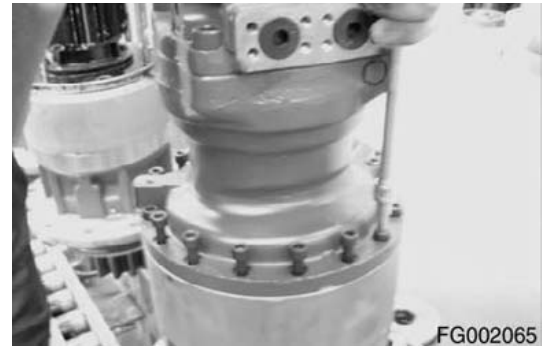


Figure 97



Figure 98



Figure 99

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



WARNING!

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



Figure 100

Supply of Gear Oil and Grease

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



Figure 101



Figure 102



Figure 103

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



Figure 104

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



Figure 105

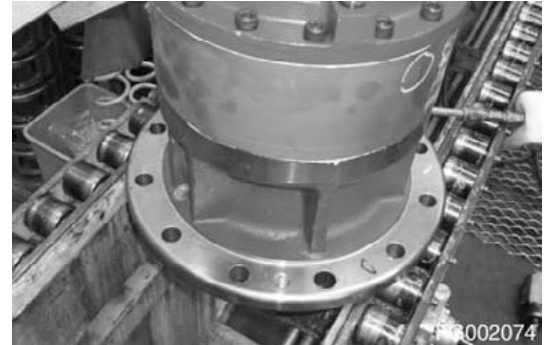


Figure 106

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



Figure 107



Figure 108

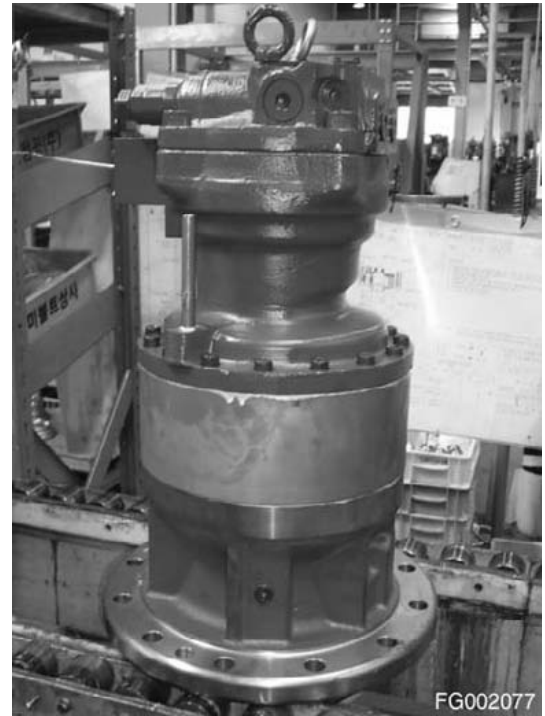


Figure 109



Figure 110

INSTALLATION

1. Coat pinion gear with grease. Refer to operation manual for specifications.
2. Make sure a alignment pin (6, Figure 111) is installed in flange of swing reduction gearbox (5).
3. Using a suitable lifting device, sling swing motor (1, Figure 111) and position swing motor and reduction gearbox (5) as an assembly on unit.
4. Install eleven bolts and washers (4, Figure 111) to secure swing reduction gearbox (5) to frame.

NOTE: Apply Loctite #262 to bolt threads.

NOTE: Tighten bolt to 55 kg•m (398 ft lb).

5. Connect hose (2, Figure 111) to reduction gearbox (5).
6. Connect grease lubrication line (7, Figure 111) to reduction gearbox (5).
7. Connect hoses as tagged during removal to swing motor (1, Figure 111).
8. Fill swing reduction gearbox with oil. Refer to operation manual for specifications.

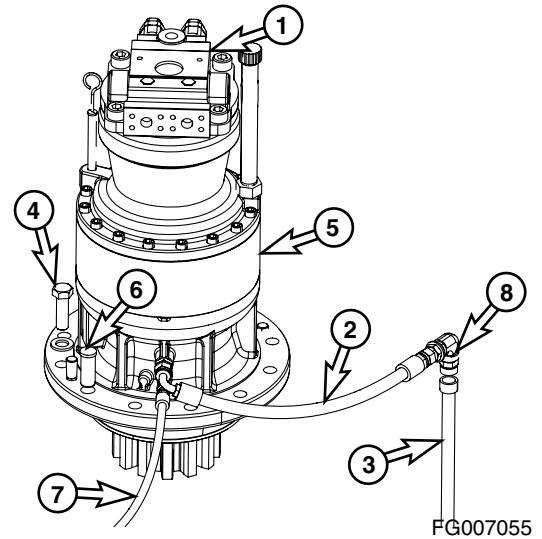


Figure 111

START-UP PROCEDURES

IMPORTANT

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

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

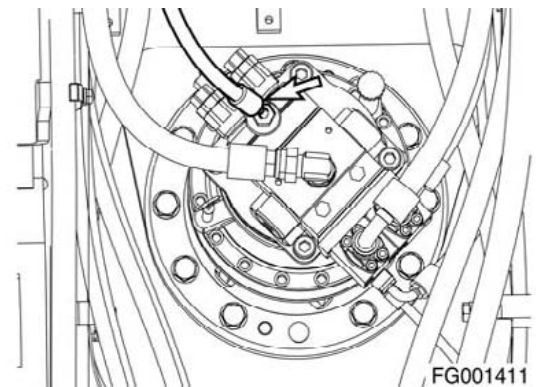


Figure 112

Lower Structure and Chassis

Ram Lock Valve

Edition 1

MEMO

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Ram Lock Valve

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

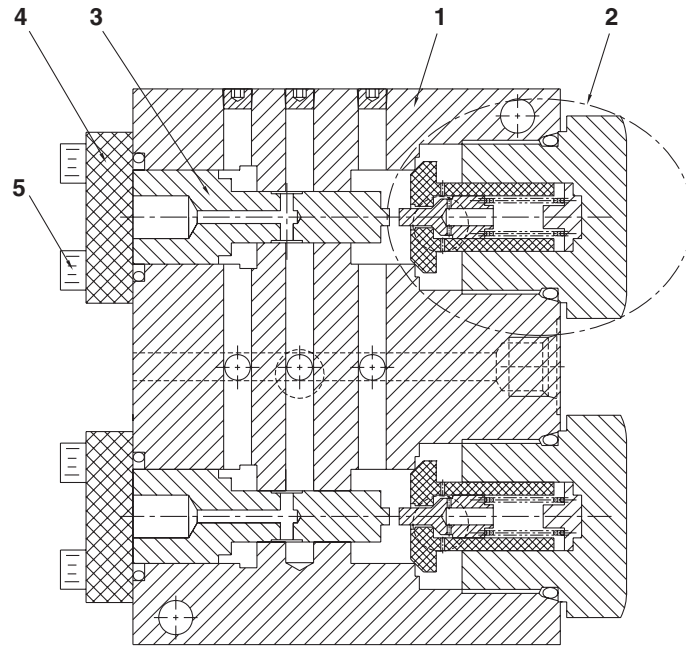
Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

SECTIONAL DRAWING AND PART NAMES



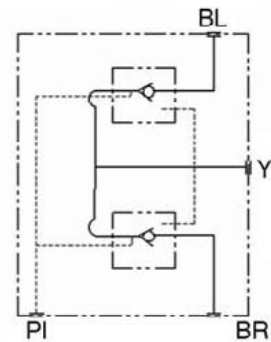
FG007630

Figure 1

Reference Number	Description
1	Body
2	Cartridge Assembly
3	Plunger

Reference Number	Description
4	Cover Plate
5	Bolt

HYDRAULIC CIRCUIT



FG007631

Figure 2

OPERATIONAL PRINCIPLE

In Case of No Pilot Pressure at PI Port

The hydraulic oil from the BR port and the BL port cannot flow to the Y port as the check valves block the oil passage.

In Case of Pilot Pressure (Approx. 20 kg•cm²) at PI Port

The pressure at the P port opens each check valve to make the hydraulic oil from the BR port and BL port flow to the Y port.

(BR → Y, BL → Y)

DISASSEMBLY AND ASSEMBLY

General Cautions

It is the principle that manufacturer carry out disassembly and assembly of this valve. In case you inevitably need to disassemble or assemble the valve elsewhere, please observe the following cautions.

1. This chocking valve is precisely processed and the gaps among each part are extremely tiny. Thus, disassembly and assembly should be performed very carefully so any foreign material such as dust or sand cannot intrude into the valve.
2. For disassembly, you should start disassembly after fully understanding the structure of this chocking valve with structural drawings and reference drawings.
3. When you need to leave the disassembled parts of this chocking valve unassembled for a while, be sure to apply rust prevent oil to the parts and seal them to prevent rusting.
4. Do not hit or treat any part of the product roughly even in case disassembly and assembly is not performed smoothly.
5. After disassembly, attach ID tags to each part for accurate assembly.
6. It is recommended to use new O-rings for replacement, and be sure not to damage one during assembly. (Apply a small portion of grease on the parts for smooth assembly.)
7. Fasten bolts with the specified standard torque.
8. Be careful not to damage or scratch the O-ring contacting parts of this valve for preventing oil leakage.

Assembly and Disassembly of Chocking Valve

1. Assemble the main poppet, the pilot poppet, the spring and the spring seat in order. Insert the subassembly to the block and fasten the hex head plug.

Hex head (41 mm) plug fastening torque: 7.0 kg•m

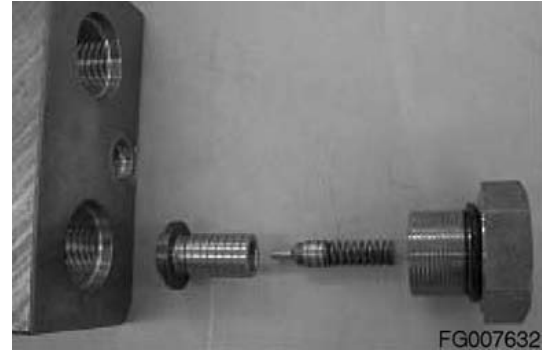


Figure 3

2. Insert each of the two plungers to each of the holes of the block.

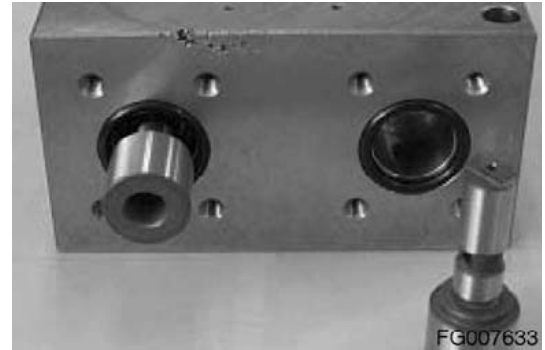


Figure 4

3. Mount the O-rings to the block and fasten the plate with bolts.
 - A. O-ring: 1B-P24
 - B. Wrench bolt (5 mm) fastening torque: 1.2 kg•m



Figure 5

NOTE: Follow the reverse procedure for disassembly.

PERFORMANCE TEST

Carry out performance tests as follows based on the operational principle of this valve (refer to #3 "Operational Test").

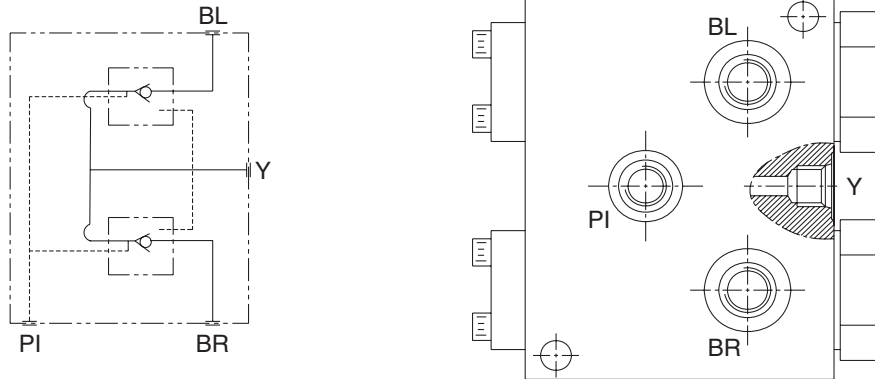


Figure 6

FG007635

Oil Leakage Test

NOTE: The PI port should be opened.

1. Apply pressure of $350 \text{ kg}\cdot\text{cm}^2$ to the BR port.
2. Oil leakage amount from the Y Port should be less than 1 cc/min .
3. Apply pressure of $350 \text{ kg}\cdot\text{cm}^2$ to the BL port.
4. Oil leakage amount from the Y Port should be less than 1 cc/min .

Operational Test

1. Apply pressure of $350 \text{ kg}\cdot\text{cm}^2$ to the BR port.
2. When gradually increasing the pressure at the PI port, the hydraulic oil should flow out to the Y port at pressure of $19 \text{ kg}\cdot\text{cm}^2$ or less.
3. Apply pressure of $350 \text{ kg}\cdot\text{cm}^2$ to the BL port.
4. When gradually increasing the pressure at the PI port, the hydraulic oil should flow out to the Y port at pressure of $19 \text{ kg}\cdot\text{cm}^2$ or less.

Selector Valve

Edition 1

MEMO

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Selector Valve

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

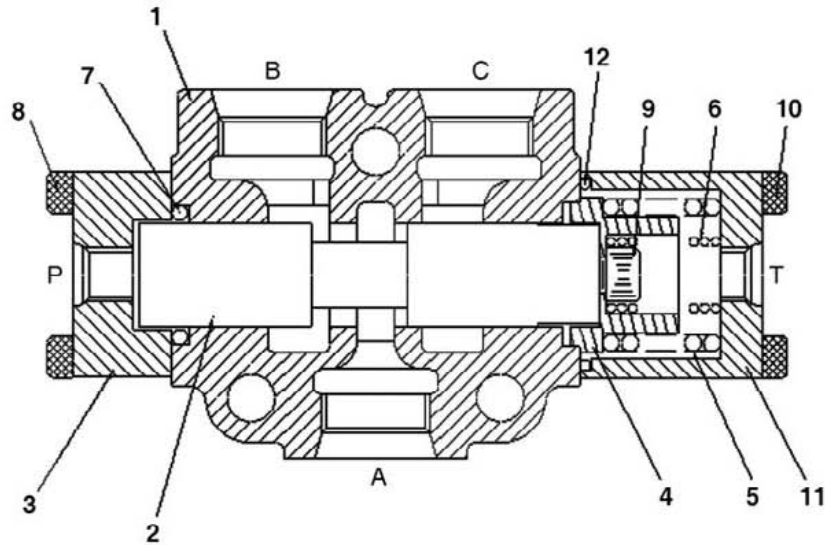
Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

SECTIONAL DRAWING AND PART NAMES



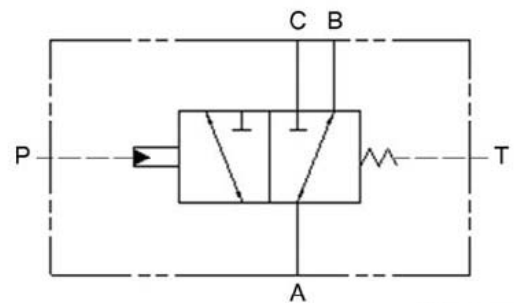
FG007636

Figure 1

Reference Number	Description
1	Body
2	Spool
3	Cover 1
4	Spring Seat
5	Spring
6	Spring

Reference Number	Description
7	O-ring (1BP28)
8	Bolt 1 (M6 X 35L)
9	Spacer Bolt (M8 X 10L)
10	Bolt 2 (M6 X 55L)
11	Cover 2
12	O-ring (1BP41)

HYDRAULIC CIRCUIT



FG007637

Figure 2

OPERATIONAL PRINCIPLE

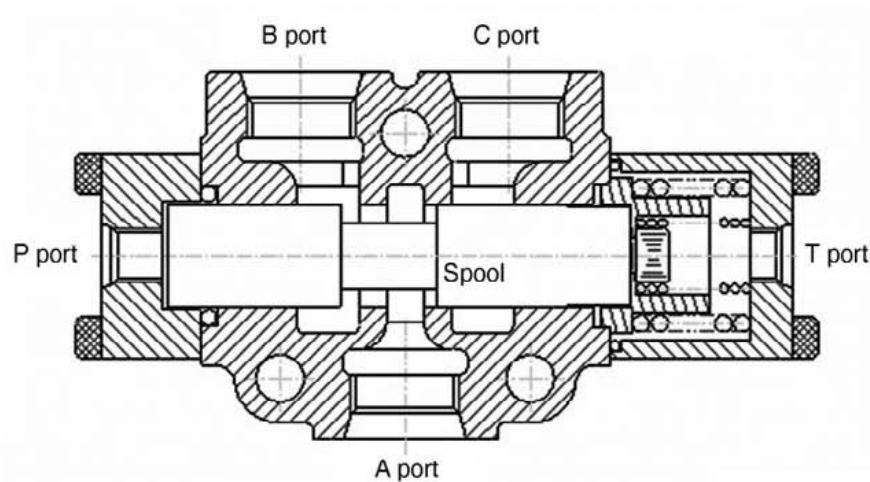
Neutral Position: A → B

Hydraulic oil, flowing into the A port, passes through the spool to flow out to the B port.

Selective Position: A → C

When pilot pressure is applied to the P port, the spool moves to the right. This operation blocks the oil passage to the B port and opens the oil passage to the C port, which makes the hydraulic oil from the A port discharged to the C port.

NOTE: *The leaked oil, generated in process of this operation, drains out to the T port.*



FG007638

Figure 3

DISASSEMBLY AND ASSEMBLY

General Cautions

It is the principle that manufacturer carry out disassembly and assembly of this valve. In case you inevitably need to disassemble or assemble the valve elsewhere, please observe the following cautions.

1. This selector valve is precisely processed and the gaps among each part are extremely tiny. Thus, disassembly and assembly should be performed very carefully so any foreign material such as dust or sand cannot intrude into the valve.
2. For disassembly, you should start disassembly after fully understanding the structure of the valve with structural drawings and reference drawings.
3. When you need to leave the disassembled parts unassembled for a while, be sure to apply rust prevent oil to the parts and seal them to prevent rusting.
4. Do not hit or treat any part of the product roughly even in case disassembly and assembly is not performed smoothly.
5. After disassembly, attach ID tags to each part for accurate assembly.
6. It is recommended to use new O-rings for replacement, and be sure not to damage one during assembly. (Apply a small portion of grease on the parts for smooth assembly.)
7. Fasten bolts with the specified standard torque.
8. Be careful not to damage or scratch the O-ring contacting parts of this valve for preventing oil leakage.

Assembly and Disassembly of Selector Valve

1. Insert a spring seat in the spool and fasten it with a spacer bolt.
 - A. Be careful not to damage the exterior of the spool during fastening.
 - B. Fastening Torque: 1.7 - 2.1 kg•m



Figure 4

2. Assemble the spool assembly to the body.
 - A. Insert the assembly to the hole of the C port direction.
 - B. Insert the spool assembly to the spool hole of the body precisely and be careful not to allow intrusion of foreign material. Do not apply excessive force for assembly.



Figure 5

3. Assemble the return spring #1 and #2 to the body, insert the O-ring into the cover #1 and fasten the cover to the body with bolts.
 - A. Fastening O-RING: 1B-P41
 - B. Bolt Fastening Torque: 0.8 kg•m - 1.2 kg•m



Figure 6

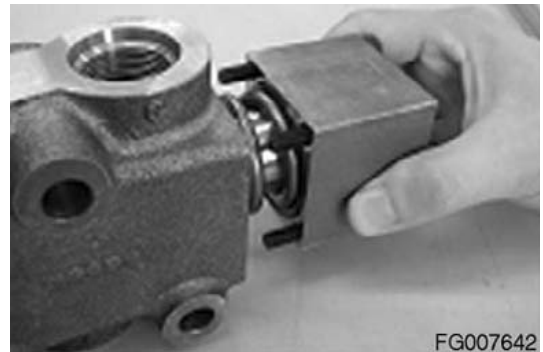


Figure 7

4. Insert the O-ring into the cover #2 for the opposite side and fasten the cover #2 to the body with bolts.
 - A. Bolt Fastening Torque: 0.8 kg•m - 1.2 kg•m

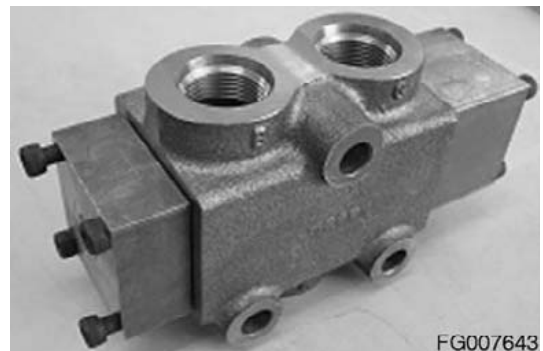


Figure 8

NOTE: Follow the reverse procedure for disassembly.

PERFORMANCE TEST

Carry out performance tests as follows based on the operational principle of this valve (refer to #3 Operational Test").

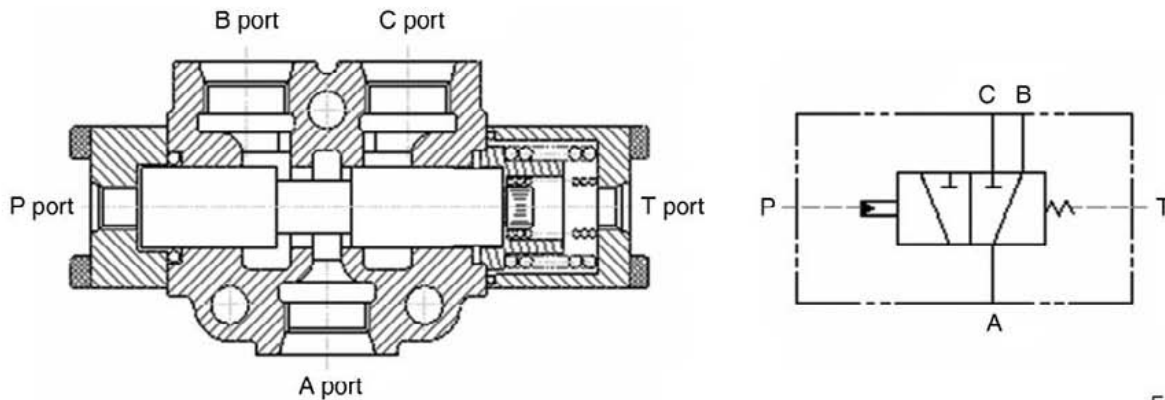


Figure 9

FG007644

Oil Leakage Test

1. Apply pressure of $40 \text{ kg}\cdot\text{cm}^2$ to the P port. (Change Spool)
2. Apply pressure of $140 \text{ kg}\cdot\text{cm}^2$ to the A port.
3. Oil Leakage Amount at B Port: 30cc/min or Less

Operational Test

1. Apply pressure of $140 \text{ kg}\cdot\text{cm}^2$ and 120 lpm to the A port.
2. Check if the spool changes when applying pressure of $40 \text{ kg}\cdot\text{cm}^2$ to the P port.
3. Check if the position of the spool is restored when reducing the pressure at the P port to $5 \text{ kg}\cdot\text{cm}^2$.

Double Pilot Check Valve

Edition 1

MEMO

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Double Pilot Check Valve

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

SECTIONAL DRAWING AND PARTS

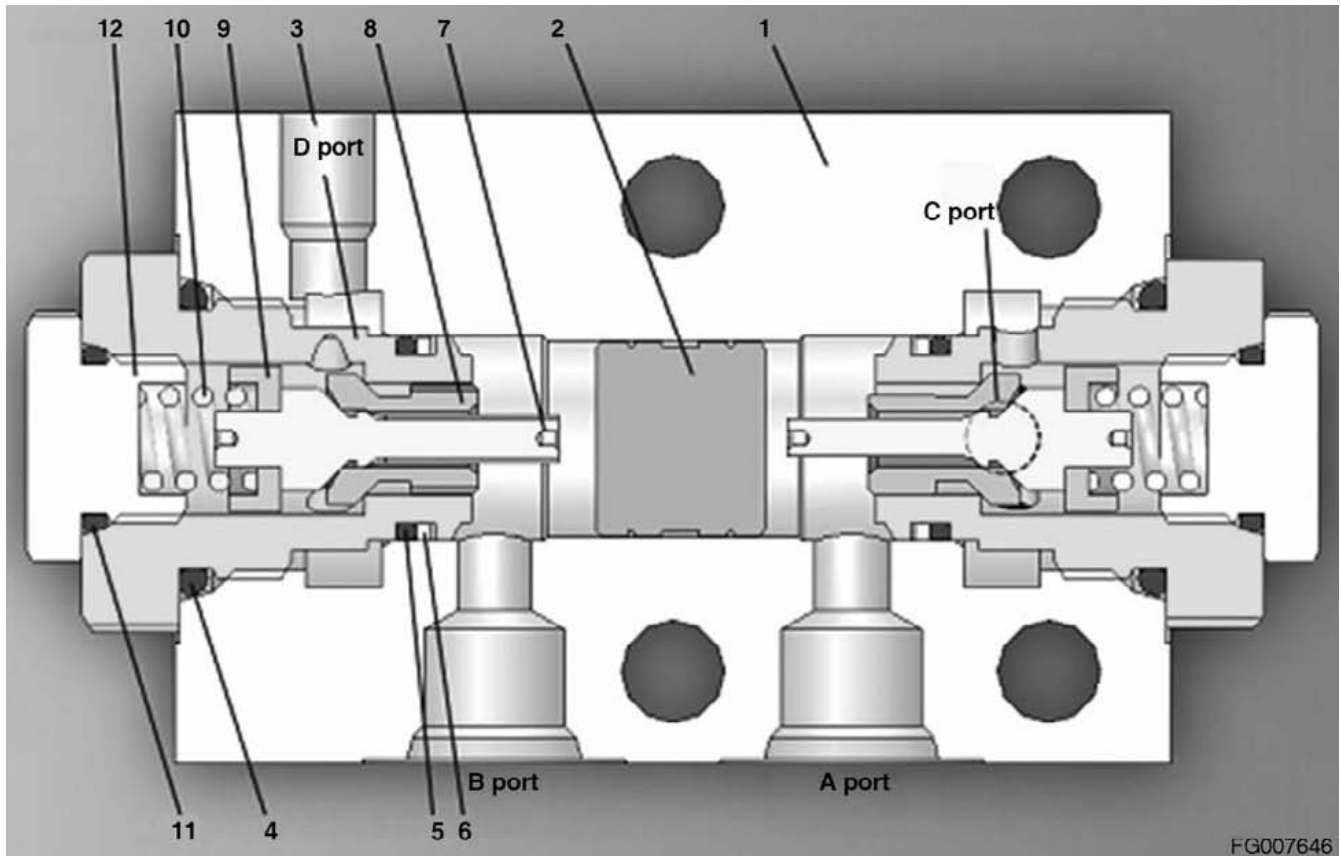


Figure 1

Reference Number	Description
1	Body
2	Plunger
3	Nipple (2 ea.)
4	O-ring (1B-P28, 2 ea.)
5	O-ring (1B-P18, 2 ea.)
6	Backup Ring (1B-P18, 2 ea.)

Reference Number	Description
7	Poppet (2 ea.)
8	Sleeve (2 ea.)
9	Spring Seat (2 ea.)
10	Spring (2 ea.)
11	O-ring (1B-P16, 2 ea.)
12	Plug (2 ea.)

HYDRAULIC DIAGRAM

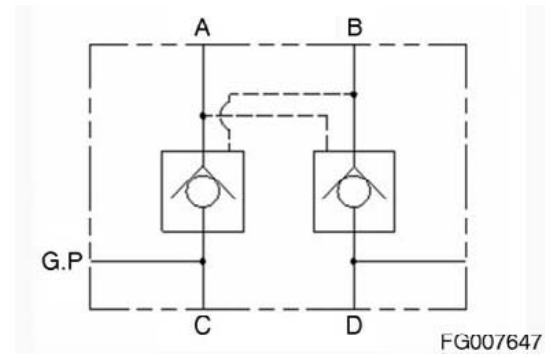


Figure 2

OPERATIONAL PRINCIPLE

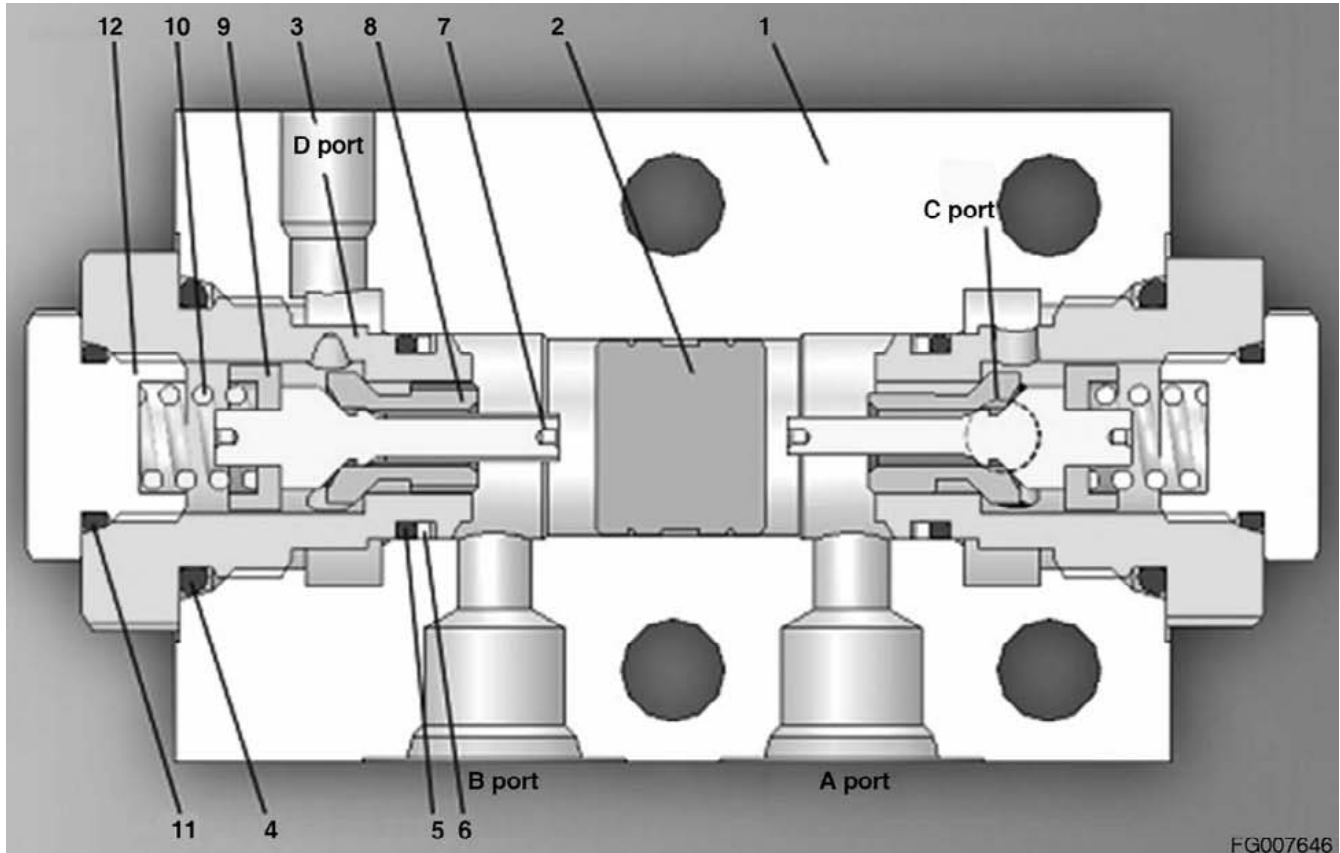


Figure 3

FG007646

A → C, D → B

The pressured oil, flowed in through the A port, is to be flowed out to the C port through oil passage of the side of the nipple (3) while pressing the poppet (7) and the sleeve (8) simultaneously. The pressure of the hydraulic oil, flowed in through the A port, pushes the plunger (2) of the center to the left side, and if the pressure is greater than the spring (10) force, the poppet is to be pushed back to make a gap between the sleeve (8) and the plunger (2) and it discharges the hydraulic oil, flowed in from the D port, to the B port.

B → D, C → A

The same principle of 3.1 is to be applied to case of the hydraulic oil, flowed in through the port B.

DISASSEMBLY AND ASSEMBLY

General Cautions

It is the principle that disassembly and assembly of the Double Pilot Check Valve (hereinafter referred as DPC V/V) should be carried out by the manufacturer. In case disassembly and assembly is inevitably required elsewhere, the following cautions must be observed.

1. The DPC V/V is precisely processed and the clearances among each part are extremely tiny. Thus, disassembly and assembly should be performed very carefully at a clean place so any foreign material such as dust or sand cannot intrude into the DPC V/V.
2. For disassembly of DPC V/V, a technician should start disassembly after fully understanding the structure of the valve with structural drawings and reference drawings.
3. In case the DPC V/V needs to be placed unassembled for a while, it must be treated with rust prevent oil and sealed to prevent rusting.
4. Even in case disassembly and assembly of DPC V/V is not performed smoothly, do not hit or treat any part of the product roughly.
5. After disassembly, attach ID tags to each part for accurate assembly.
6. For O-rings and backup rings, it is the principle to use new ones, and be sure not to damage one during assembly. (Apply a small portion of grease on the parts for smooth assembly.)
7. Fasten bolts, nipples and plugs with the specified standard torque.
8. Be careful not to damage the O-ring contacting parts of the DPC V/V for preventing oil leakage.

Assembly and Disassembly of Double Pilot Check Valve

1. Insert the poppet into the sleeve and put the spring seat into the poppet.

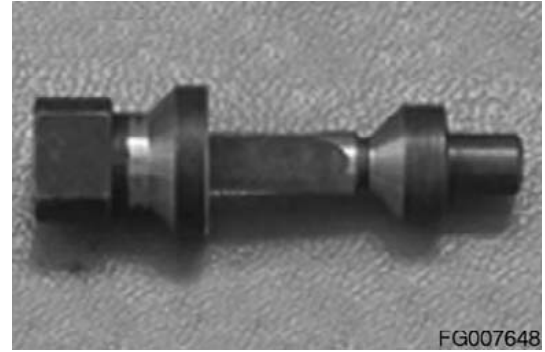


Figure 4



Figure 5

2. Insert the above subassembly into the nipple, and then insert the spring accordingly.

NOTE: Previously mount the O-ring and the backup ring to the nipple. (1B-p28 and 1B-P18)



Figure 6

3. Mount the plug to the subassembly. (Temporary assembly of the check cartridge assembly is completed.)

NOTE: *Previously install the O-ring to the plug. (1B-P16)*



Figure 7

4. Mount the check cartridge assembly to the body at the specified standard torque with a torque wrench (38 Hex).

Standard torque: 5 kg•m

5. Fasten the plug of the check cartridge assembly at the specified standard torque with a torque wrench (24 Hex).

Standard torque: 3.5 kg•m

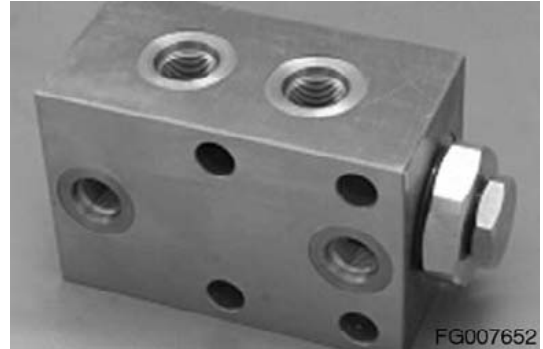


Figure 8

6. Insert the plunger into the opposite port.



Figure 9

7. Assemble the remaining check cartridge assembly to the opposite port according to the above procedure #1 - #5.

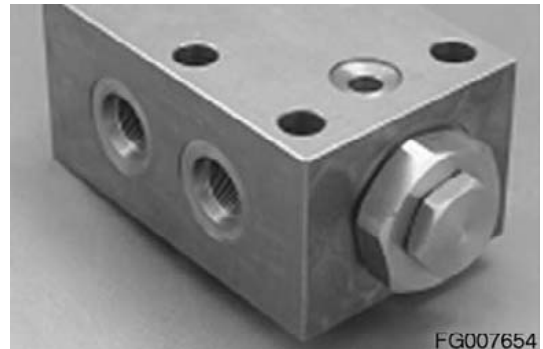


Figure 10

NOTE: *Disassembly can be performed in the reverse order.*

PERFORMANCE TEST

Carry out the performance tests as follows based on the operational principle of this valve (refer to #3 "Operational Test").

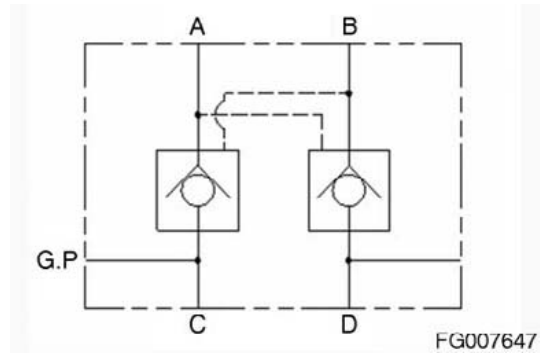


Figure 11

Cracking Pressure Test for Check Cartridge Assembly

1. Supply hydraulic oil to the A port and increase the pressure gradually from "0" $\text{kg}\cdot\text{cm}^2$.
2. Check if the pressure at the A port is $1.5 \text{ kg}\cdot\text{cm}^2$ when the hydraulic oil begins to be flowed out through the C port.
3. Supply hydraulic oil to the B port and increase the pressure gradually from "0" $\text{kg}\cdot\text{cm}^2$.
4. Check if the pressure at the B port is $1.5 \text{ kg}\cdot\text{cm}^2$ when the hydraulic oil begins to be flowed out through the D port.

Pilot Cracking Pressure Test

1. Supply hydraulic oil to the C port at $210 \text{ kg}\cdot\text{cm}^2$ while the D port is plugged.
2. Supply hydraulic oil to the B port and increase the pressure gradually from "0" $\text{kg}\cdot\text{cm}^2$.
3. Check if the pressure at the B port is $30 \pm 3 \text{ kg}\cdot\text{cm}^2$ when the hydraulic oil begins to be flowed out through the A port.
4. Supply hydraulic oil to the D port at $210 \text{ kg}\cdot\text{cm}^2$ while the C port is plugged.
5. Supply hydraulic oil to the A port and increase the pressure gradually from "0" $\text{kg}\cdot\text{cm}^2$.
6. Check if the pressure at the A port is $30 \pm 3 \text{ kg}\cdot\text{cm}^2$ when the hydraulic oil begins to be flowed out through the B port.

Oil Leakage Test

1. Supply hydraulic oil to the C port at 140 kg•cm².
2. Check if the amount of leaked oil through the A port is less than 1 cc/min.
3. Supply hydraulic oil to the D port at 140 kg•cm².
4. Check if the amount of leaked oil through the B port is less than 1 cc/min.

Solenoid Valve

Edition 1

MEMO

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Solenoid Valve

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Troubleshooting of Each Part	14

MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

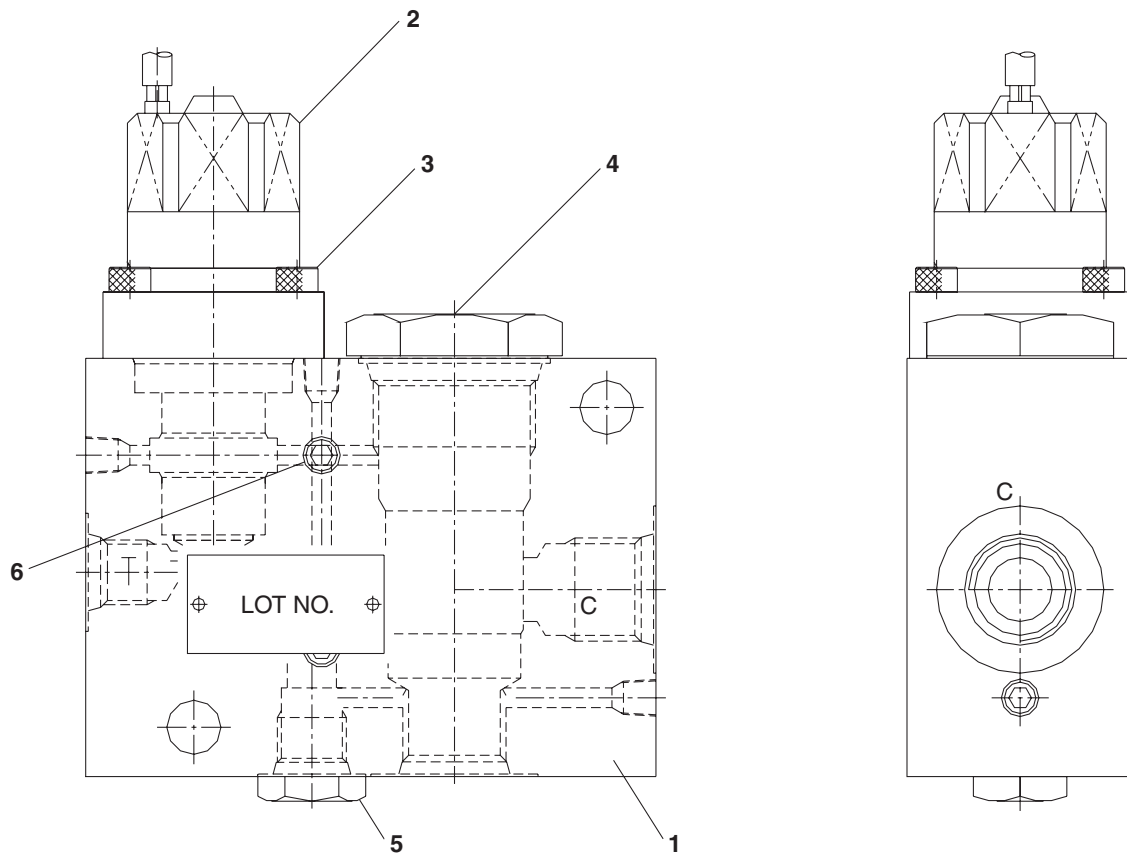
APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

SINGLE SOLENOID VALVE DIAGRAM

The single solenoid valve consists of parts in the table below.



FG007737

Figure 1

No.	Parts	Sizes	Qty	Remarks
1	Block	116 x 85 x 46	1	
2	Solenoid Valve	DC 24V	1	
3	Retaining Bolt	M5 x 20L	4	Torque:55-75 kg•cm (Torque wrench: M5 hex.)
4	Logic Valve	M33 x P2	1	Torque:600-700 kg•cm (Torque wrench: M33 hex. socket)
5	Shuttle Valve	M14 x P1.5	1	Torque:1400-1650 kg•cm (Torque wrench: M14 hex. socket)
6	Taper Plug	NPTF 1/16	5	Torque:60-75 kg•cm (Torque wrench: M5 hex.)

FUNCTIONS OF SINGLE SOLENOID VALVE

This valve lifts and lowers the dozer blade and outrigger legs of wheeled excavator. When it is in the middle position, a flow channel is created between A and C ports; when it is powered on, its pilot pressure shuts off the logic valve to terminate the oil flow.

Functions of Each Valve

No.	Valve Functions	Descriptions	Remarks
2	Pilot cut-off	Closes the drain line of logic valve (4). When supplying DC 24V, pilot pressure is generated behind the logic valve to terminate the oil flow between A and C ports.	
4	Creation and termination of oil flow	Creates and terminates the oil flow generated by the dozer blade cylinder. As controlled by the pilot pressure, it is used for large oil flow and high-pressure and has less leakage.	
5	Control of both directions of oil flow (A→C, C→A)	No matter where pressure is generated at either A→C or C→A of the oil flow, it ensures to generate the pilot line behind the logic valve.	

DISASSEMBLY AND REASSEMBLY DIAGRAMS

Table of page -7 shows torques of each part for the single solenoid valve.

Use specified tools and torques.

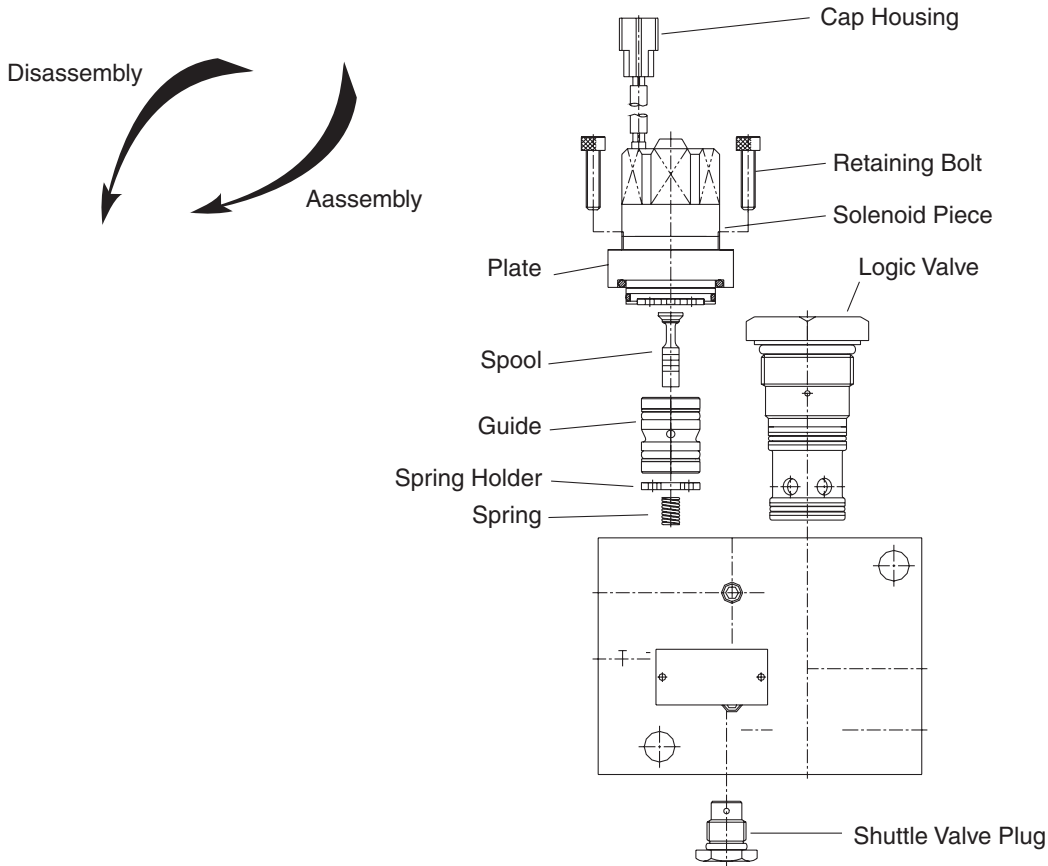


Figure 2

FG007738



CAUTION!

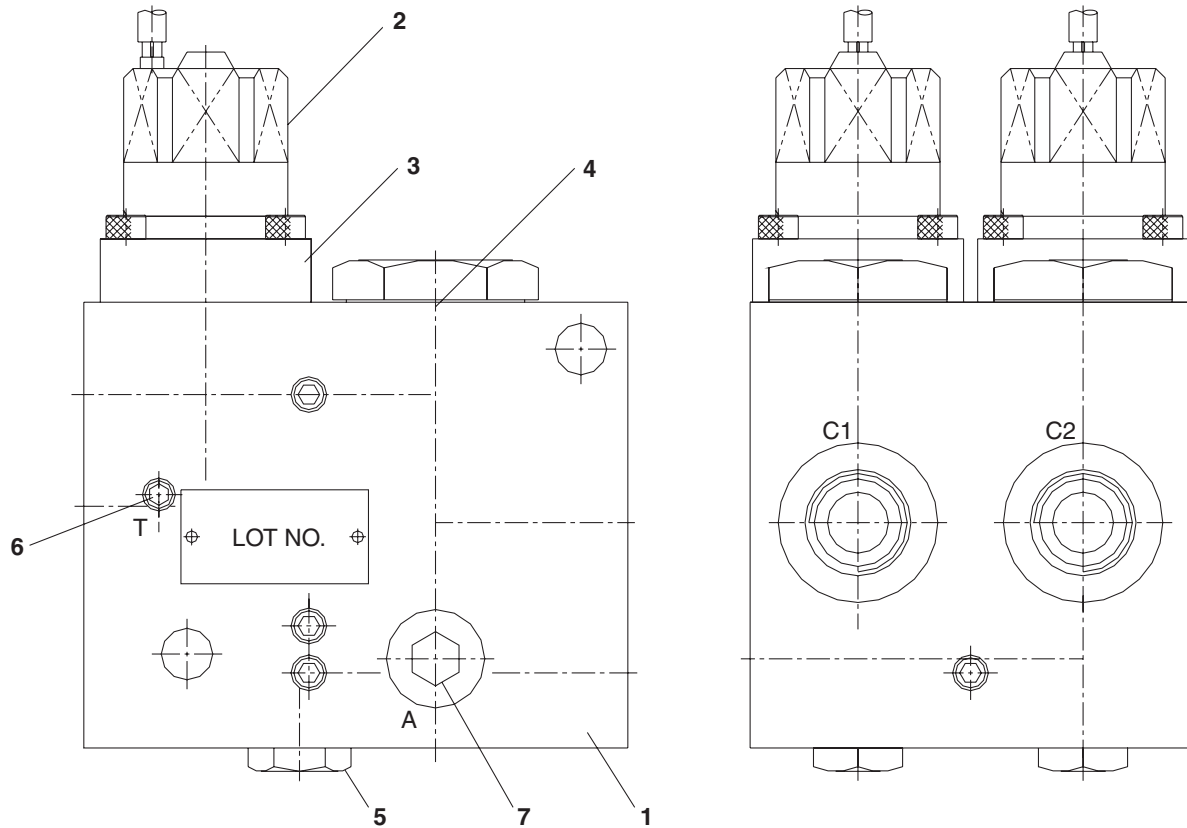
1. Clean the work area completely before starting disassembly and reassembly.
2. For disassembly and reassembly, always follow references in table of page -7.
3. Do not remove plates installed with coil.
4. Do not remove logic valve.
5. Take care to prevent entering of contaminating substances into valves after disassembly and reassembly.
6. Always wash every removed part before its reassembly.

TROUBLESHOOTING OF EACH PART

Valves	Check Points	What and How to Check	Remedies
Solenoid	1. Manual status	1. Press the rubber part of coil to the end and check the normal action.	Repair coil
	2. Foreign or contaminating substances in the solenoid valve	2. Disassemble the solenoid valve to check if there are any contaminating substances in the spool and the guide.	Remove contaminating substances, wash, and reassemble
	3. Breakage, short, or burn of coil	A. Disassemble the solenoid valve and check the resistance of coil. Resistance: 39W at 20°C Breakage: ∞ (unlimited) resistance Short: Low or over resistance	Change coil
		B. Disassemble the solenoid valve and check if a molding part burns and melts because of heat.	
	4. Grounding of the contact or terminal	4. Check if the cap housing (where coil lead is connected) and the (extended) housing terminal are earthed correctly.	Change housing and/or terminal.
Logic	5. Foreign or contaminating substances in the logic valve	5. Disassemble the logic valve, and check if poppet is normally returned when pressed and released and if there are any contaminating substances in the sleeve and the plug.	Remove contaminating substances and wash.

DOUBLE SOLENOID VALVE DIAGRAM

The double solenoid valve consists of parts in the table below.



FG007739

Figure 3

No.	Parts	Sizes	Qty	Remarks
1	Block	116 x 95 x 94	1	
2	Solenoid Valve	DC 24V	2	
3	Retaining Bolt	M5 x 20L	8	Torque:55-75 kg•cm (Torque wrench: M5 hex.)
4	Logic Valve	M33 x P2	2	Torque:600-700 kg•cm (Torque wrench: M33 hex. socket)
5	Shuttle Valve	M14 x P1.5	2	Torque:1400-1650 kg•cm (Torque wrench: M14 hex. socket)
6	Taper Plug	NPTF 1/16	12	Torque:60-75 kg•cm (Torque wrench: M5 hex.)
7	Taper Plug	NPTF 1/2	1	Torque:640-700 kg•cm (Torque wrench: M10 hex.)

FUNCTIONS OF DOUBLE SOLENOID VALVE

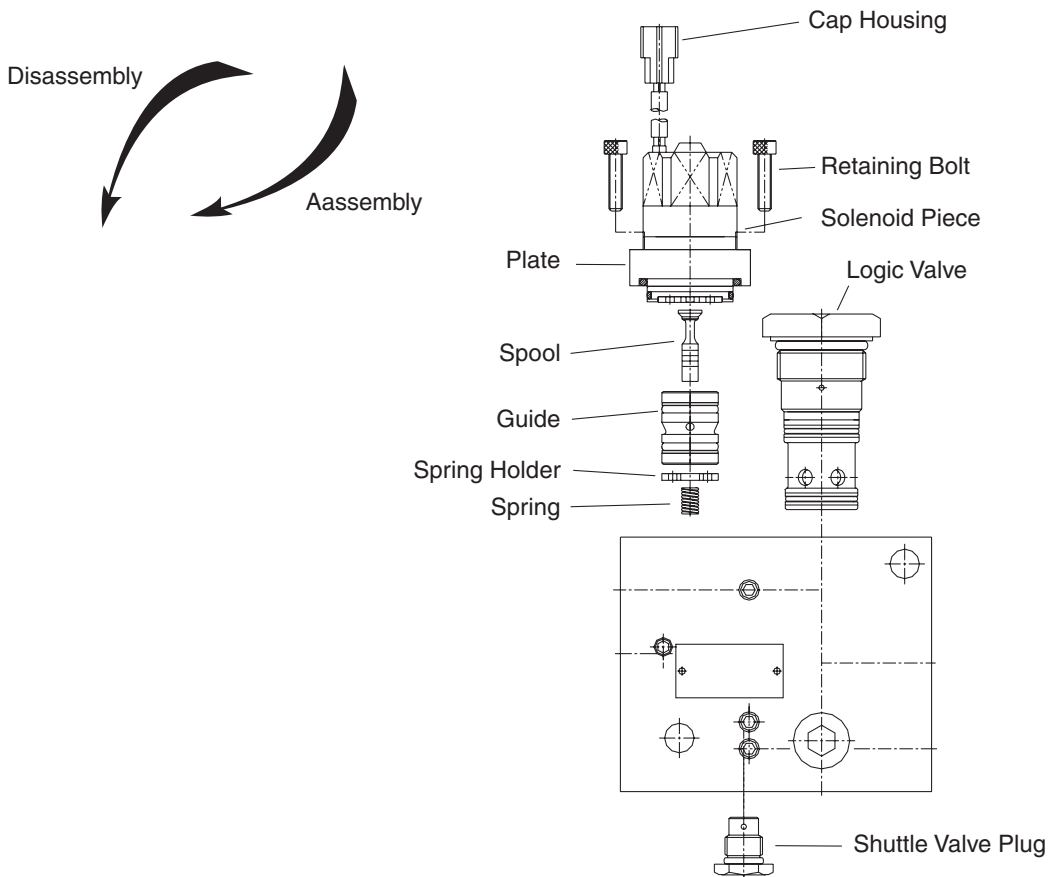
This valve lifts and lowers the outrigger of wheeled excavator. When it is in the middle position, a flow channel is created among A, C1, C2 ports; when it is powered on, its pilot pressure shuts off the logic valve to terminate the oil flow.

Functions of Each Valve

No.	Valve Functions	Descriptions	Remarks
2	Pilot cut-off	Closes the drain line of logic valve (4). When supplying DC 24V, pilot pressure is generated behind the logic valve to terminate the oil flow between A and C1, C2 ports.	
4	Creation and termination of oil flow	Creates and terminates the oil flow generated by the dozer blade cylinder. As controlled by the pilot pressure, it is used for large oil flow and high-pressure and has less leakage.	
5	Control of both directions of oil flow (A→C1, C2, C1, C2→A)	No matter where pressure is generated at either A→C1, C2 or C1, C2→A of the oil flow, it ensures to generate the pilot line behind the logic valve.	

DISASSEMBLY AND REASSEMBLY DIAGRAMS

Table of page -11 shows torques of each part for the double solenoid valve.



FG007740

Figure 4



CAUTION!

1. Clean the work area completely before starting disassembly and reassembly.
2. For disassembly and reassembly, always follow references in table of page -11.
3. Do not remove plates installed with coil.
4. Do not remove logic valve.
5. Take care to prevent entering of contaminating substances into valves after disassembly and reassembly.
6. Always wash every removed part before its reassembly.

TROUBLESHOOTING OF EACH PART

Valves	Check Points	What and How to Check	Remedies
Solenoid	Manual status	Press the rubber part of coil to the end and check the normal action.	Repair coil
	Foreign or contaminating substances in the solenoid valve	Disassemble the solenoid valve to check if there are any contaminating substances in the spool and the guide.	Remove contaminating substances, wash, and reassemble
	Breakage, short, or burn of coil	Disassemble the solenoid valve and check the resistance of coil. Resistance: 39W at 20°C Breakage: ∞ (unlimited) resistance Short: Low or over resistance	Change coil
		Disassemble the solenoid valve and check if a molding part burns and melts because of heat.	
	Grounding of the contact or terminal	Check if the cap housing (where coil lead is connected) and the (extended) housing terminal are earthed correctly.	Change housing and/or terminal.
Logic	Foreign or contaminating substances in the logic valve	Disassemble the logic valve, and check if poppet is normally returned when pressed and released and if there are any contaminating substances in the sleeve and the plug.	Remove contaminating substances and wash.

Front Axle

Edition 1

MEMO

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Front Axle

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MEMO

SAFETY PRECAUTIONS



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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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Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

Examples of Gear Tooth Contact Patterns for the Gleason Gear Tooth System

Ideal tooth contact pattern i.e. pinion distance is correct

Coast side (concave)

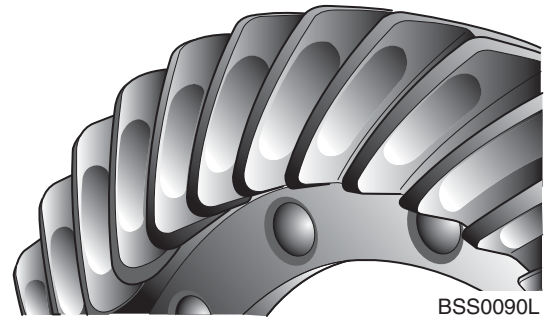


Figure 1

Drive side (convex)

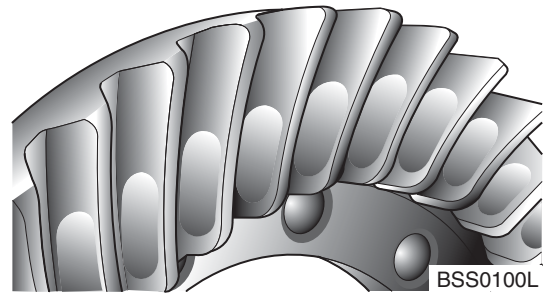


Figure 2

Pinion distance must be increased

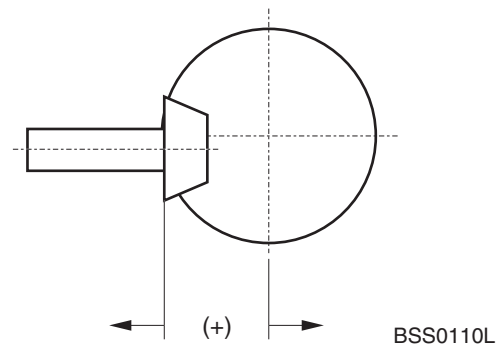


Figure 3



Figure 4

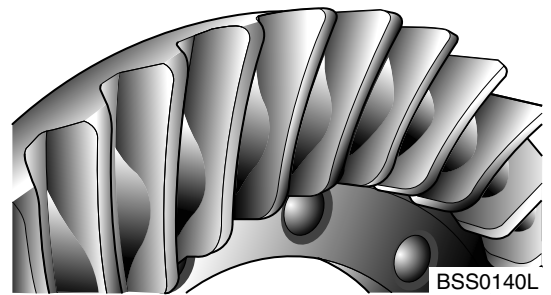


Figure 5

Pinion distance must be decreased

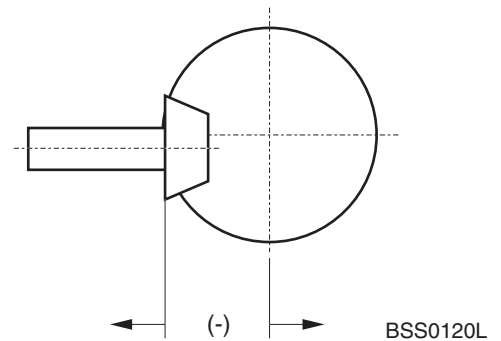


Figure 6

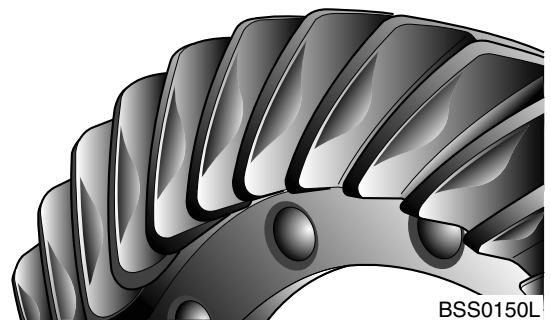


Figure 7

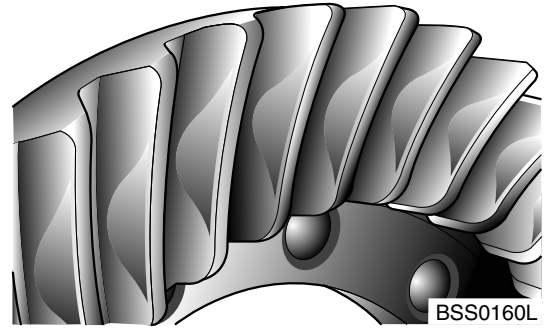


Figure 8

LUBRICATION AND MAINTENANCE SPECIFICATIONS FOR AXLE MS-E 3050/3060/3070

Oil Grade

Oils according to the "Table of Recommended Lubricants" pages of operation manual are permitted for axles MS-E 3050/3060/3070.

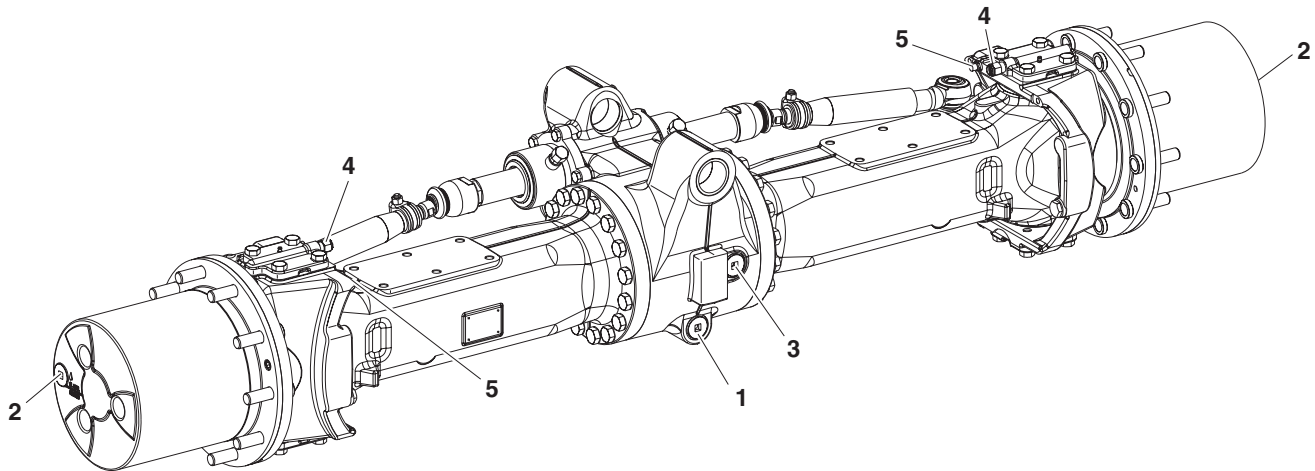
Oil Change

A horizontal installation position of the axle in every direction is precondition for an oil change according to specifications!

Place vehicle in a horizontal position!

Carefully clean all drain -, filler- and control plugs before opening!

Drain oil only right after a longer travel period!



FG002279

Figure 9

Reference Number	Description
1	Oil Drain Hole (M36x1.5 Axle Drive Housing)
2	Oil Drain/Oil Filler Hole (M36x1.5 Output Units)

Reference Number	Description
3	Oil Filler/Oil Check Hole (M36x1.5 Axle Drive Housing)
4	Brake Connection Pipe
5	Brake Breather Valve

1. Oil Drain From Axle
Loosen oil drain plugs (1) and drain oil from axle.
2. Oil Drain From Outputs



WARNING!

To avoid injury when opening the oil drain and oil fill plug (2), because of a possible pressure buildup in the oil system of the planetary carrier, bring drain hole to topmost position (12 o'clock) and carefully unscrew oil drain and oil fill plug (2).

Then bring drain hole to lowermost position (6 o'clock) and drain oil from outputs.

3. Oil Filling of Axle

Provide drain plug (1, with solenoid insert) with a new O-ring and mount it.

Tightening torque (M36x1.5) $M_A = 50 \text{ Nm}$

Fill up oil to the overflow of the filler hole (3).

Filling quantity: MS-E 3050 = approx. 9.00 liter, MS-E 3060 = approx. 10.5 liter, MS-E 3070 = approx. 11.00 liter

4. Check

Check oil level after some minutes and fill up to the specified level, until level remains constant.

Provide filling and checking plugs (3) with new O-ring and mount them.

Tightening torque (M36x1.5) $M_A = 50 \text{ Nm}$

5. Oil Filling of Outputs

Position both oil drain and oil filler hole (2) (reference line horizontally to road level) and fill oil up to overflow.

Filling quantity per output: MS-E 3050/3060/3070 = approx. 2.5 liter

Provide drain and fill plug (2) with new O-ring and mount it.

Tightening torque (M36x1.5) $M_A = 50 \text{ Nm}$

Oil Change Interval

First oil change after 500 operating hours, any further one after 2000 (i.e. after 2500/4500/6500) operating hours, however, at least once per year.

Oil Level Check

Check oil level every month, in particular, however, after putting a vehicle into operation with new or repaired axles or axle parts.

Brake

The following oils are admissible for the pneumatic/hydraulic operated or accumulator operated brake actuator.

1. Motor oils SAE 10W according to specification MIL-L 2104 C, MIL-L 46152, API-CC, CD, SC, SD, SE
2. ATF. oils type A, Suffix A, Dexron II D

BRAKE WEAR MEASUREMENT ON AXLES OF MT/MS-E 3050/ 3060/3070 RANGE



WARNING!

The measurement of wear on the multidisk brake only gives limited information on the total state of the plate pack.

without disassembling the output.

Make measurement of lining wear at least once per year, in particular, however, in case of a different braking behavior, like:

- Brake noises
- Reduced braking power
- Different deceleration
- Different brake oil level
- Different braking pressure



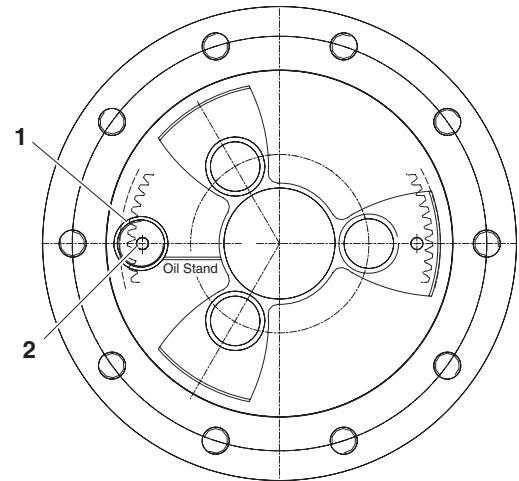
CAUTION!

To avoid injury when opening the oil drain/oil fill plug (1), because of a possible pressure buildup in the planetary carrier bring drain hole to topmost position (12 o'clock) and carefully unscrew oil drain and fill plug (1).

Then turn output until oil filler/ oil drain hole (1) is on 9 o'clock position. Figure 10.

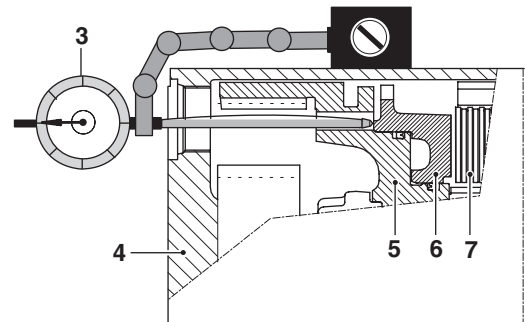
Illustrations in Figure 11 and Figure 12 are shown turned 90° Legend for Figure 10, Figure 11 and Figure 12

Reference Number	Description
1	Oil filler-/oil drain hole
2	Gauge hole (Ø = 10 mm) in ring gear - 9 o'clock position
3	Dial indicator with solenoid support
4	Planetary carrier
5	Ring gear
6	Piston
7	Plate pack
X	Piston stroke



FG006855

Figure 10



FG002281

Figure 11

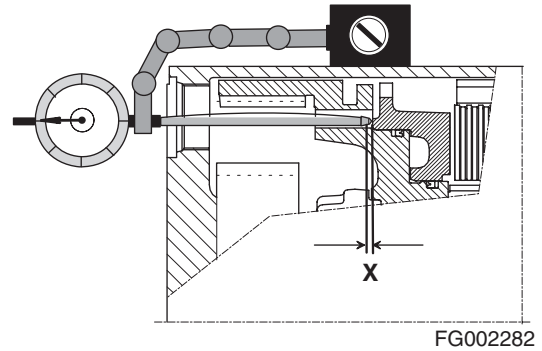


Figure 12

Lining Wear Measurement of Multidisk Brake

With unapplied brake, piston is in contact with ring gear by compression spring return. see Figure 11

- get dial indicator (3) into touch with piston (6) through oil filler /oil drain hole (1) and gauge hole (2).
- Apply pressure on brake and determine piston stroke (X. see Figure 12) using dial indicator
- Take limit value of piston stroke (at max. wear) from the chart below

Axle type	Lined disks	Piston stroke with new disks	Limit value of piston stroke (X) at max. wear
MT-E 3050	8 pcs.	1.2 -1.8 mm	7.0 mm
MT-E 3060	6 pcs.	0.7 - 1.3 mm	6.0 mm
MT-E 3070	7 pcs.	0.7 - 1.3 mm	6.5 mm
MS-E 3050	8 pcs.	1.2 - 1.8 mm	7.0 mm
MS-E 3060	6 pcs.	1.2 - 1.8 mm	6.0 mm
MS-E 3070	7 pcs.	1.2 - 1.8 mm	6.5 mm

Make lining wear measurement on both outputs!

Then provide oil drain/fill plug with new O-ring and install it.

Tightening torque (M36x1.5) MA = 50 Nm

DISASSEMBLY

Total view - axle installed on assembly truck.

Illustration shows version "MS-E 3060."



WARNING!

Secure axle using a support (arrow).



FG002296

Figure 13

Steering

1. View - Steering installed in axle.



FG002297

Figure 14

2. Loosen hex nuts on both tie rods.



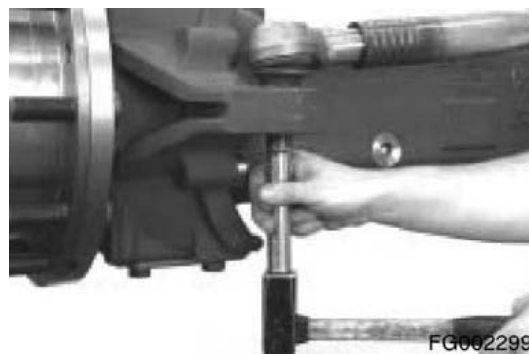
FG002298

Figure 15



WARNING!

Drive out tie rod from bevel seat.
use suitable mandrel (brass/aluminium).



FG002299

Figure 16

3. Warm up threaded joint area of piston rod/axial joint.

disassembly is more difficult (thread/axial joint is installed with locking compound/Loctite no. 243).



FG002300

Figure 17

4. Separate both tie rods (assembly) from piston rod.

! CAUTION!

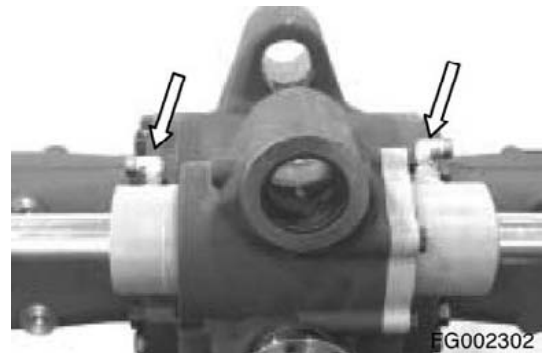
If work is just to be done on sealing elements and/or piston rod or guide, no disassembly of the steering cylinder assembly is required and you may continue with Figure 24.



FG002301

Figure 18

5. Disassemble both elbows (see arrows) or screw necks, depending on version.



FG002302

Figure 19

6. Loosen threaded joint of steering/axle drive housing.



Figure 20

7. Steering cylinder is fixed with locking compound - disassembly is more difficult!

Heat up both application areas of locking compound (see arrows) of the axle drive housing using a hot air blower.



Figure 21

8. Drive out steering cylinder assembly from axle drive housing using a plastic/aluminium hammer.



Figure 22

9. Unsnap the retaining ring and remove flange.



Figure 23

10. Unsnap retaining ring.



Figure 24

11. Drive the guide into the cylinder tube (direction of arrow) until the retaining ring can be removed (see Figure 26).

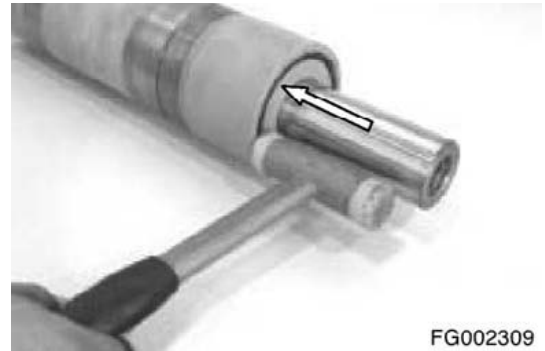


Figure 25

12. Unsnap retaining ring.

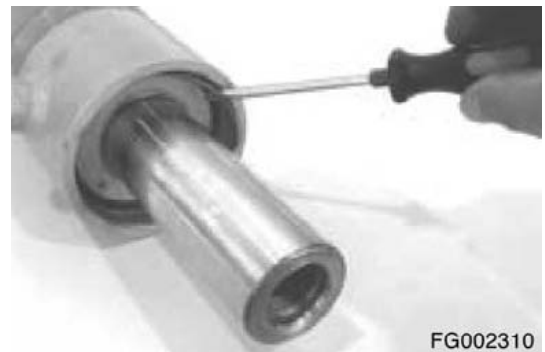


Figure 26

13. Drive out piston rod with guide from cylinder tube.



Figure 27

14. Remove guide from piston rod.

Remove all sealing elements from piston, guide and cylinder.



Figure 28

Output

1. Loosen screw plug and drain oil from the axle.

CAUTION!

Use suitable collecting basin - environmental protection!



Figure 29

WARNING!

To avoid injury because of a possible pressure buildup in the oil system of the planetary carrier, bring oil filler and control plug to 12 o'clock position and carefully unscrew! use suitable mandrel (brass / aluminium).

Then bring drain hole to 6 o'clock position and drain the oil!



Figure 30

CAUTION!

Use suitable collecting basin - environmental protection!

CAUTION!

Following illustration shows the complete disassembly of the output (Figure 32 -Figure 57)

- if work is required on the differential and/or pinion, you may disassemble the output as one unit. as shown on the adjacent photo.

2. Please take the required work steps (such as dismantling the tie rod, bearing pins etc. ...) from chapters
 - “Steering” on page 15 and
 - “Knuckle Housing” on page 24.
-

WARNING!

Pay attention to seal ring in the axle housing - risk of damage!



Figure 31

Planetary Carrier

1. Loosen both cylinder screws and separate planetary carrier from hub.
2. Unsnap retaining ring.



Figure 32



Figure 33

3. Remove planetary gear using a two-armed puller.



Figure 34

FG002318

4. Unsnap retaining ring and remove washer.
Then remove roller bearing, second retaining ring and washer from planetary gear.



Figure 35

FG002319

Brake / Hub

1. Unsnap retaining ring and remove both thrust washers.



Figure 36

FG002320

2. Remove slotted nut mount (cylinder screw).



Figure 37

FG002321

3. Loosen slotted nut.



Figure 38

4. Press off ring gear with piston.
Pay attention to the releasing O-ring (arrow).



Figure 39

5. Loosen hex. screws, remove spring sleeves and compression springs.



Figure 40

6. Press off piston from ring gear.



Figure 41

7. Remove sealing elements (arrows) from ring gear.



Figure 42

8. Remove plate pack.



Figure 43

9. Remove O-ring (arrow) and lift off disk carrier with lever, then remove releasing O-ring.



Figure 44

10. Pull hub from hub carrier using pressure piece and two-armed puller.



Pay attention to the releasing bearing inner ring



Figure 45

11. Lift off shaft seal (arrow) with lever and remove both bearing outer rings from hub.



Figure 46

12. Just for axle type MS-E 3060:
Remove spacer bushing.



Figure 47

13. Pull bearing inner ring from hub.



Figure 48

Knuckle Housing

1. Legend for Figure 49

Reference Number	Description
1	Bearing Pin
2	Knuckle Housing
3	Axle Housing
4	Shim (Only on Lower Bearing Pin)
5	O-ring
6	Sealing Cap
7	Taper Roller Bearing

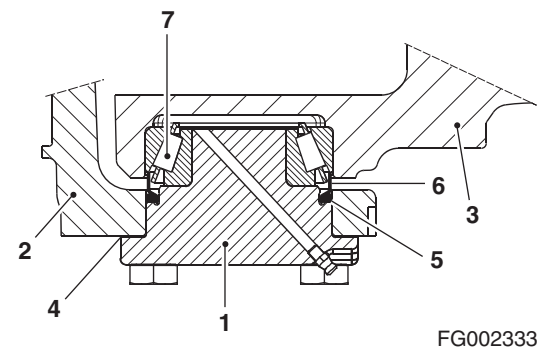


Figure 49

2. Loosen threaded connection and remove upper bearing pin.



WARNING!

Remove lower bearing pin - using lifting device / see Figure 51 - not before securing the knuckle housing.



Figure 50

3. Secure knuckle housing using lifting device and dismantle lower bearing pin.



CAUTION!

Pay attention to releasing shim.



Figure 51

4. Remove bearing inner ring (7), O-ring (5), sealing cap (6) and brake connection screw neck (8) from bearing pin (1).



Figure 52

5. Separate knuckle housing with double u-joint shaft from axle housing.



WARNING!

Pay attention to seal ring in the axle housing - risk of damage



Figure 53

6. Pull out double u-joint shaft from knuckle housing.



WARNING!

Pay attention to seal ring in the axle housing - risk of damage



Figure 54

7. Pull out seal ring and afterwards the bushing behind from the knuckle housing.



Figure 55

FG002338

8. Pull out seal ring and afterwards the bushing behind from the axle housing.



Figure 56

FG002340

9. Pull out both bearing outer rings from the swivel bearing holes.



Figure 57

FG002341

Differential - Input

If work is required on the differential and/or pinion, you may disassemble the output(s) as one unit. as shown on the adjacent photo.

Please take the required work steps (such as dismantling the tie rod-, bearing pins etc. ...) from chapters

- "Steering" on page 15 and
- "Knuckle Housing" on page 24 1/10.



Figure 58

FG002342



WARNING!

Pay attention to the seal ring in the axle housing - risk of damage.

1. Fix axle housing part / II using a lifting strap, loosen threaded joint of axle housing half on crown wheel side (differential) and separate axle housing half part / II from axle drive housing.



WARNING!

Pay attention to the releasing differential.



Figure 59

FG002343

2. Remove bearing outer ring (arrow 1) and the shim behind and O-ring (arrow 2) from axle housing part / II.



CAUTION!

Mark shim (regarding position / bearing allocation) - assembly aid.

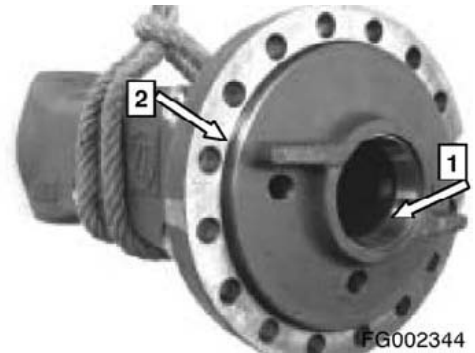


Figure 60

FG002344

3. Lift off the differential from the axle drive housing.

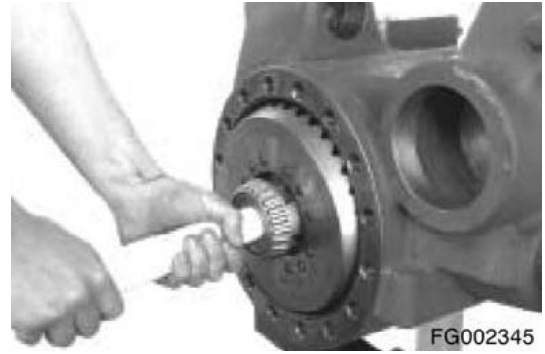


Figure 61

4. Pull out bearing outer ring and the shim behind from the bearing hole of axle housing part/I.



Mark shim (regarding position / bearing allocation) - assembly aid.

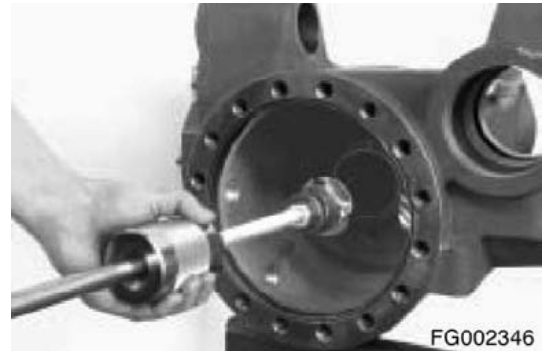


Figure 62

Differential Version "D-500" and "D-750"

1. The illustration shows version "D-500."
Pull both taper roller bearings from differential carrier.



Figure 63

2. Loosen threaded joint (position "X").

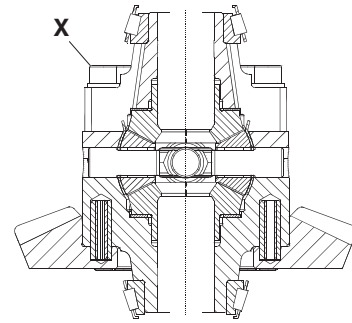


n version "D-750" the hex. screws are installed with locking compound (Loctite) - disassembly is more difficult - if required, warm up area of threaded joint (disassembly aid).



Figure 64

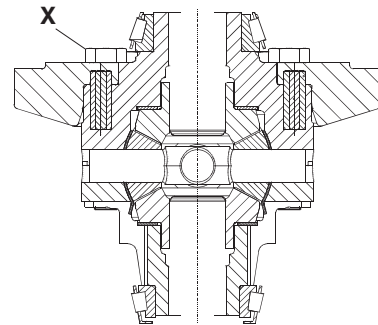
A. Version "D-500"



FG002349

Figure 65

B. Version "D-750"



FG002350

Figure 66

3. Separate differential carrier halves and remove releasing single components.



FG002351

Figure 67

4. Press off crown wheel from differential carrier half.



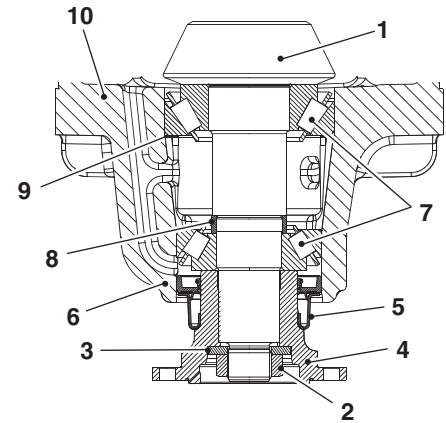
FG002352

Figure 68

Input

- Legend for Figure 69.

Reference Number	Description
1	Input Pinion
2	Hex. Nut
3	Washer
4	Input Flange
5	Screen Sheet
6	Seal Ring
7	Taper Roller Bearing
8	Spacer Ring (Bearing Rolling Moment)
9	Shim (Contact Pattern)
10	Input Housing



FG002353

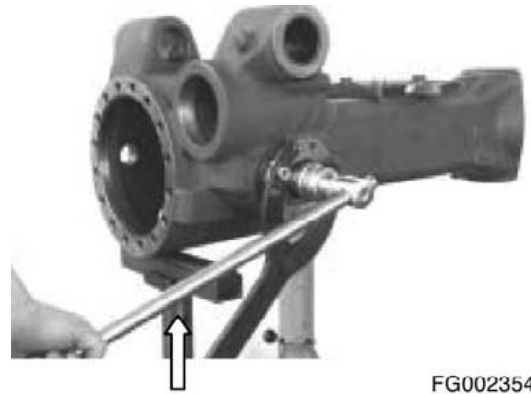
Figure 69

- Loosen hex. nut and remove washer behind.



WARNING!

Pay attention to support of axle housing (arrow).



FG002354

Figure 70

- Remove flange.
If required. remove screen sheet from output flange.



FG002355

Figure 71

4. Lift off seal ring with lever.

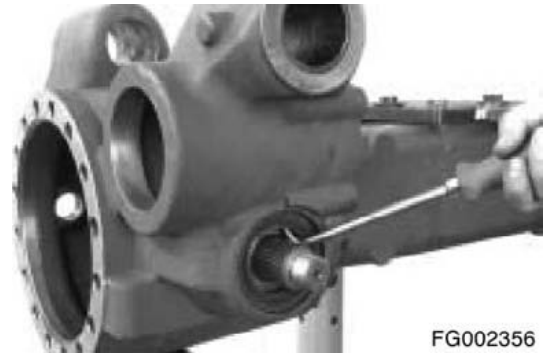


Figure 72

5. Drive out input pinion.

! CAUTION!

If taper roller bearings should not be replaced, pay attention that outside bearing inner ring - with all its rolls - is in contact with bearing outer ring when driving out the input pinion.



Figure 73

6. Remove spacer ring.



Figure 74

7. Press off bearing inner ring from input pinion.



Figure 75

8. Extract outside bearing outer ring.



Figure 76

9. Drive out bearing outer ring from the inner bearing hole - pay attention to the shim behind.



Mark shim (reg. position / bearing allocation) - assembly aid.



Figure 77

Pivot Bearing

If required:

Provide bushings with a separating slot - see arrow - (bushings are destroyed by this).

Then remove bushings from holes.



Figure 78

REASSEMBLY

Input

Legend for Figure 79.

Reference Number	Description
1	Drive Pinion
2	Differential (With Crown Wheel)
3	Shim for Contact Pattern (Bevel Gear Set)
4	Spacer Ring (Bearing Rolling Moment / Pinion Bearing)
5	Shim For Backlash
6	Shim (Bearing Rolling Moment / Differential Bearing)
7	Input Flange
8	Seal Ring
9	Axle Drive Housing
10	Axle Housing / Part I (Loa = O-ring)
11	Axle Housing / Part II (Crown Wheel Side)

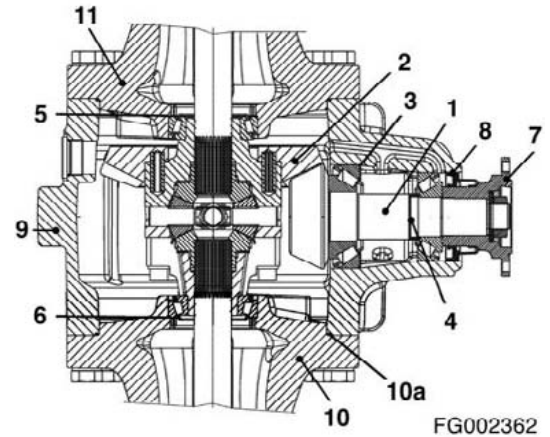


Figure 79

FG002362

Just for "New part" assembly or if disassembled:

Install O-ring (10a) on axle housing/part I (10) and mount axle drive housing (9) - observe installation position.

Tightening torqueMA = 390 Nm (M 18/10.9)

Determine Shim for Pinion Positioning to Obtain An Optimum Contact Pattern of Crown Wheel/pinion - Refer to Contact Pattern Examples, (See page -7-11)

1. Read dimension "I" (Position - see arrow) from axle drive housing.

Dimension "I" e.g 149.09 mm

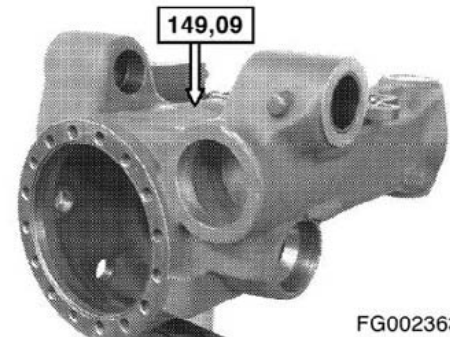


Figure 80

FG002363

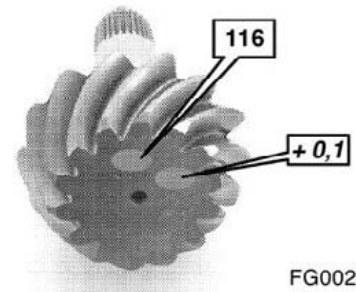
2. Read pinion dimension (basic distance) "X" from pinion (see arrow) or measure it in case of a + or - deviation of the pinion dimension caused by the production (value concerned is marked by hand on the pinion, e.g.+ 0.1).

Pinion dimension "X" (without + or -deviation) = 116.0 mm

Pinion dimension "X" with an indicated + 0.1 deviation = 116.1 mm

Pinion dimension "X" with an indicated - 0.1 deviation = 115.9 mm

Dimension "II" (Pinion basic distance) e.g. 116.00 mm



FG002364

Figure 81

CAUTION!

Measure dimension "III" bearing width, observing that rollers are located without any play (rotate bearing inner ring in both directions several times - roller setting).

3. Since the installed roller bearing is subject to a preload in installation position, consider an experience deduction of - 0.1 mm!

Dimension "III" = e.g. 32.00 mm - 0.1 mm → 31.90 mm

Calculation Example:

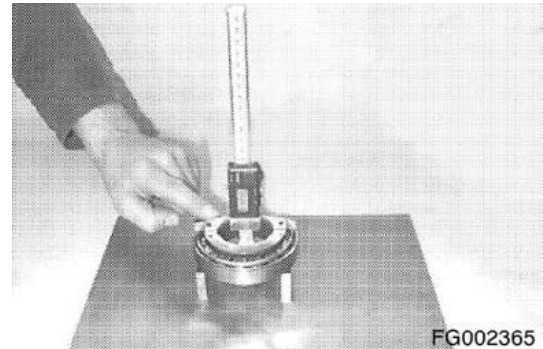
Dimension "I" 149.09 mm

Dimension "II + III" (116.00 + 31.90) -148.10 mm

Result = 1.01 mm

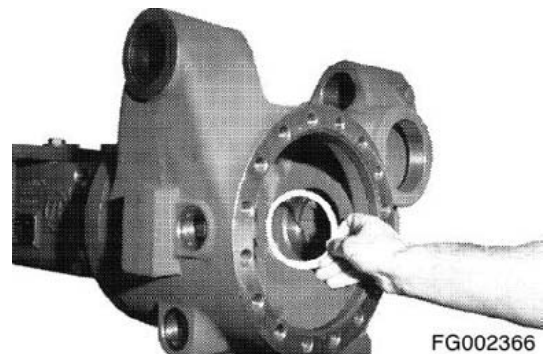
Shim required "S" 1.00 mm

4. Insert the determined shim (e.g. "S" = 1.00 mm) into the inner bearing hole/pinion bearing.



FG002365

Figure 82



FG002366

Figure 83

5. Supercool bearing outer ring (see arrow) and bring it into contact position in the inner bearing hole/pinion bearing using the fixture.

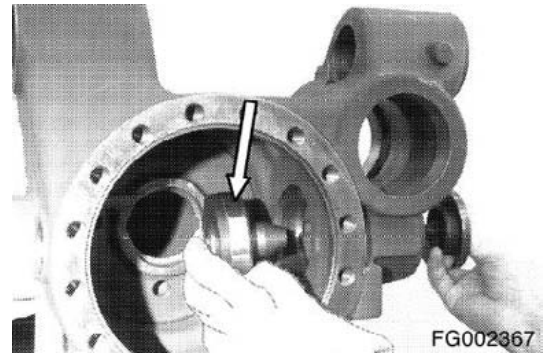


Figure 84

6. Instal outside bearing outer ring/pinion bearing.

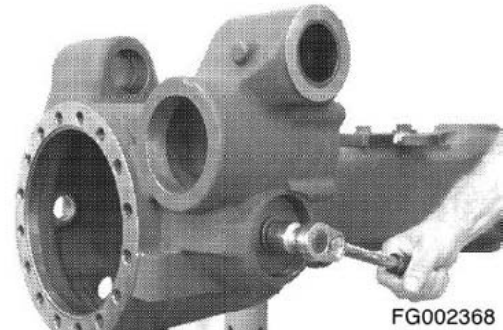


Figure 85

7. Mount heated bearing inner ring until contact is obtained and readjust after cooling down.



Figure 86

**Adjust Rolling Moment of Drive Pinion Bearing 1.0 - 2.0 Nm
(Without Seal Ring):**

1. Mount spacer ring (s = optional).

! CAUTION!

We would recommend to reinstall the spacer ring found during disassembly. If, however, the required rolling moment of 1.0 - 2.0 Nm (without seal ring) is not achieved - see bearing rolling moment test - correct the bearing rolling moment using a corresponding spacer ring.

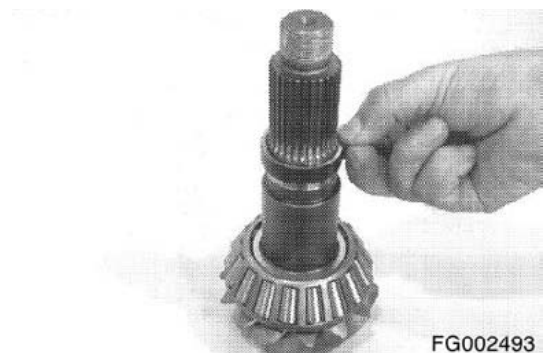


Figure 87

2. Insert the preassembled drive pinion, mount the heated bearing inner ring until contact is obtained.

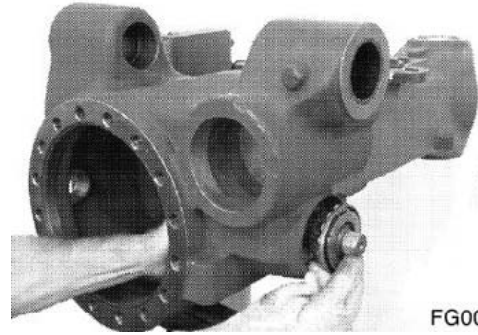


Figure 88

3. Mount flange, fix with washer and hex. nut.
Tightening torque (M27x1.5) $M_A = 600 \text{ Nm}$

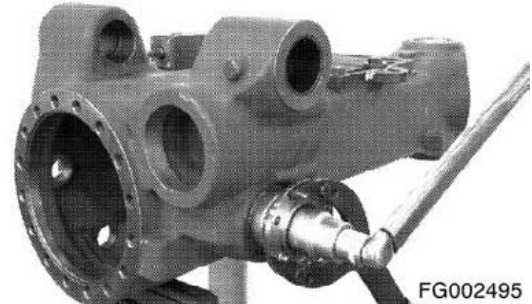


Figure 89

4. Check rolling moment of pinion bearing.
Bearing rolling moment (without seal ring) 1.0 - 2.0 Nm
Try to achieve upper value.

! CAUTION!

If the rolling moment differs from the required value, correct it with a suitable spacer ring (See Figure 21 on page -17).

! CAUTION!

Reassemble seal ring - as shown in page -45-74 (after completed differential assembly and positive contact pattern check).

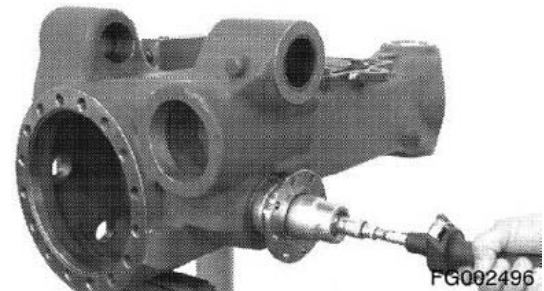


Figure 90

Differential Version "D-500" and "D-750"

1. Illustration shows version "D-500."

Mount slotted pins (arrows) into differential carrier half, considering the assembly specification, see Figure 26.

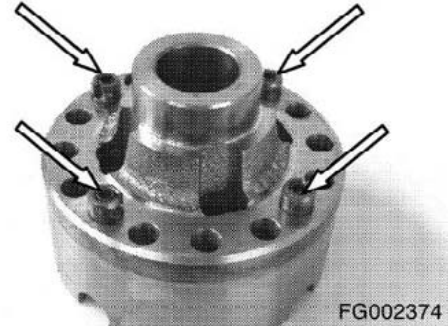


Figure 91

2. Assembly Specification:

Bring slotted pin(s) in a position where slot shows into the direction of force (arrow).

In case of double slotted pins - bring the slots in a 180 degrees offset position to each other.

Legend for Figure 92.

Reference Number	Description
1	Differential Carrier
2	Slotted Pin
3	Slotted Pin (Just for Double Slotted Pin Version)
X	Direction of Force

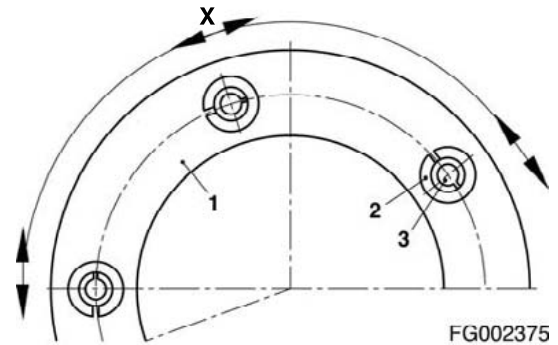


Figure 92

3. Press differential carrier until contact is obtained.

Assembly aid - (just for version "D-500") Insert two adjusting screws into crown wheel.

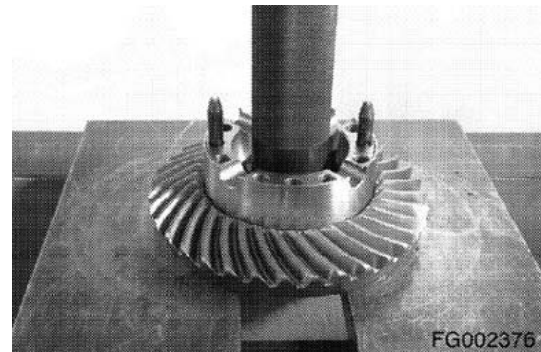


Figure 93

4. Insert thrust washer and axle bevel gear.



Put driving lugs of thrust washer into driving holes/ differential carrier - do not locate in oil supply recesses.

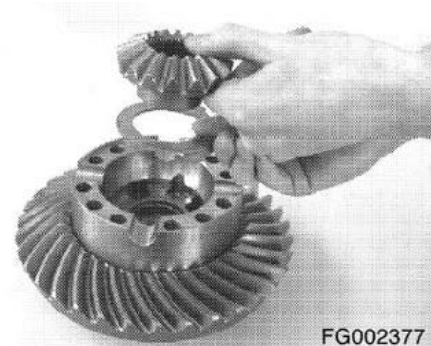


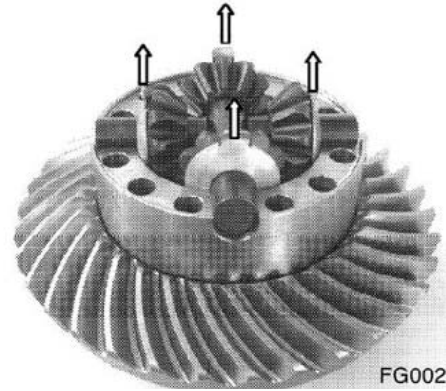
Figure 94

5. Install differential bevel gears and thrust washers on differential spider and insert in differential carrier half I.



Ensure radial installation position of thrust washers.

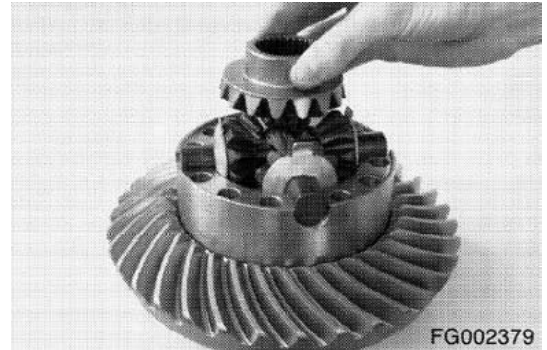
Lug is looking vertically upward (see arrow).



FG002378

Figure 95

6. Insert second axle bevel gear.



FG002379

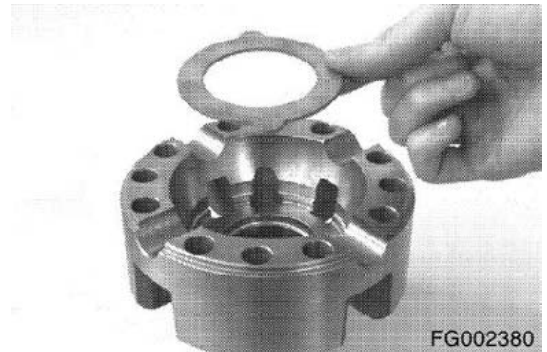
Figure 96

7. Install thrust washer with grease (assembly aid) into differential carrier half II.

Locate differential carrier half II on differential carrier half I.



Put driving lugs of thrust washer into driving holes / differential carrier - do not locate in oil supply recesses.



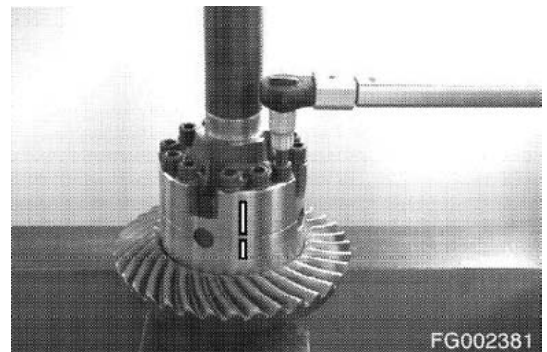
FG002380

Figure 97

8. Fasten differential carrier halves with cylinder. screws and washers (D-500, Pos. X) and with hex. screws (D-750, Pos.X).



Ensure radial installation position - designation (ZF-Nr. ...) at the same time corresponds to radial position marking.



FG002381

Figure 98

A. Version "D-500"

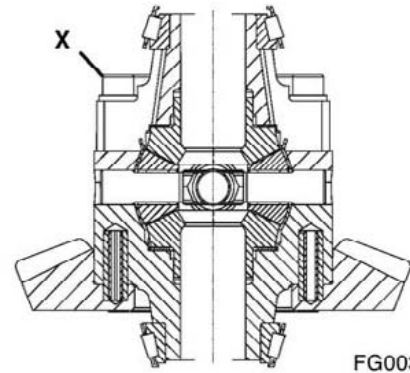


Figure 99

FG003054

B. Version "D-750"



Just for version "D-750," insert hex screws with locking agent Loctite-no.262).

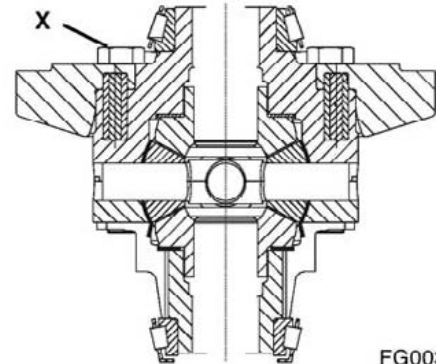


Figure 100

FG003055

Version "D-500"

Tightening torque (M 12x1.5/12.9) $M_A = 145 \text{ Nm}$

Version "D-750"

Tightening torque (M 12x1.5/10.9) $M_A = 122 \text{ Nm}$

Tightening torque (M 16x1.5/10.9) $M_A = 300 \text{ Nm}$

Install both bearing inner rings (arrows).

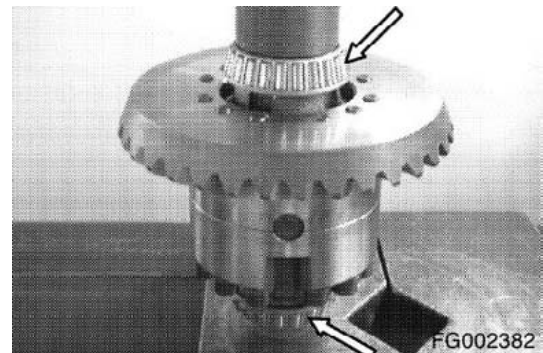


Figure 101

FG002382

9. Wet some tooth flanks of the crown wheel with marking ink (for contact pattern check - See Figure 112 on page -43).



Figure 102

FG002383

Adjust Backlash of Bevel Gear Set and Bearing Rolling Moment of Differential Bearing

Backlash (crown wheel/drive pinion)

MS-E 3050/3060 = 0.12 - 0.24 mm

MS-E 3070 = 0.15 - 0.27 mm

Differential bearing preload = 0.10 - 0.15 mm

(corresponds to a bearing rolling moment of 1 - 4 Nm)

CAUTION!

Bring axle drive housing/axle housing into upright position.

1. Insert shim (backlash) into hole of axle housing/part I and install bearing outer ring until contact is obtained.

We would recommend to install the shim (experience value = approx. 1.25 mm) found during disassembly - also refer to disassembly instructions, See Figure 131 on page -49.

CAUTION!

However, the required backlash is decisive for the shim(s) be used.

2. Insert preassembled differential.

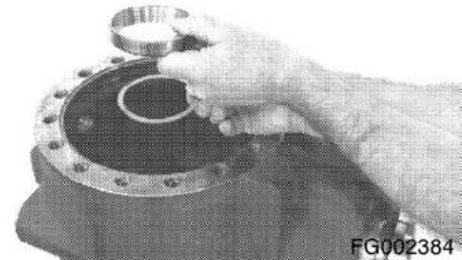


Figure 103

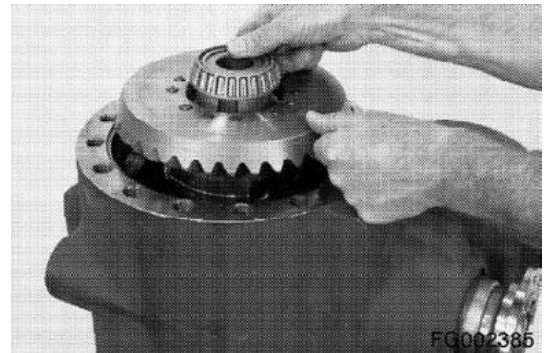


Figure 104

3. Place bearing outer ring.

CAUTION!

Locate the bearing outer ring on the bearing inner ring, until all rollers are located without any play.

For this purpose rotate differential and bearing outer ring both directions several times - roller setting.

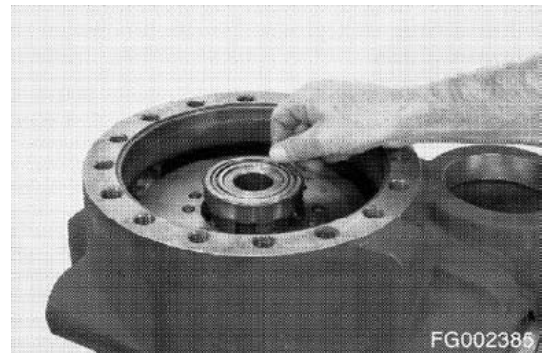


Figure 105

! CAUTION!

A correct positioning of bearing outer ring and differential imperative for the following measuring operation.

4. Determine dimension "I," from mounting face of axle drive housing to bearing contact.

Dimension "I" e.g. 18.10 mm

! CAUTION!

Make measurement on several points and calculate mean value.

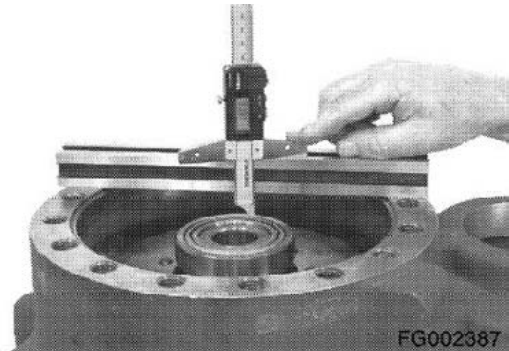


Figure 106

5. Determine dimension "II," from mounting face of axle housing part II to contact face/bearing outer ring.

Dimension "II" e.g. 17.20 mm

Calculation Example:

Dimension "I" e.g. 18.10 mm

Dimension "II" e.g. - 17.20 mm

Difference = 0.90 mm

Required bearing preload (0.10 - 0.15 mm) + 0.13 mm

Result = 1.03 mm

Required shim "S" → = 1.05 mm

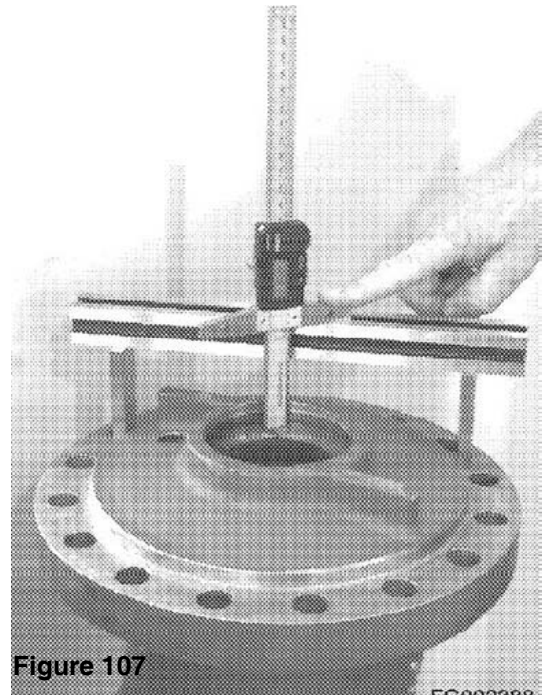


Figure 107

6. Insert determined shim(s) e.g. "S" = 1.05 mm into bearing hole of axle housing/part II and instal bearing outer ring so contact is obtained.

! CAUTION!

Install outer bearing ring into hole with grease - assembly aid.



Figure 108

7. Locate preassembled axle housing/part II (without O-ring) (observe radial installation position) and temporarily fix with hex. screws.

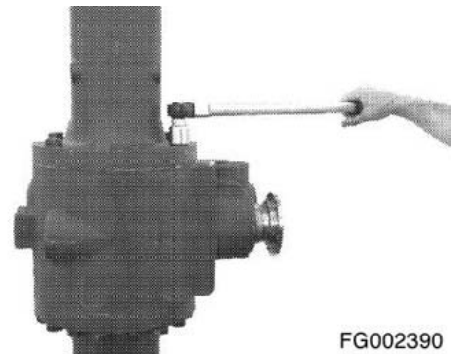


Figure 109

FG002390

Backlash and Contact Pattern Check

1. Place dial indicator at right angles to a tooth flank of the crown wheel (within the outer diameter area) through oil drain hole and check backlash.

Backlash

MS-E 3050/3060 = 0.12 - 0.24 mm

MS-E3070 = 0.15 - 0.27 mm

! CAUTION!

In case of a deviation from the specified backlash, correct it with a suitable shim (See Figure 103).

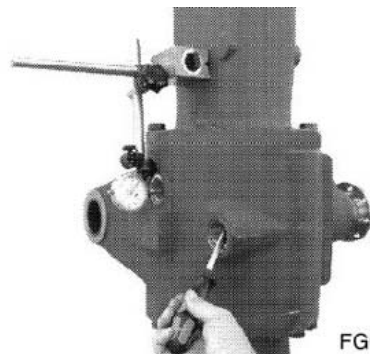


Figure 110

FG002391

! CAUTION!

A correction of shim / backlash also requires a correction of shim / bearing rolling moment to the opposite direction (See Figure 108).

2. Rotate drive pinion in both directions several times over crown wheel / differential (contact pattern impression - in this connection see Figure 112).

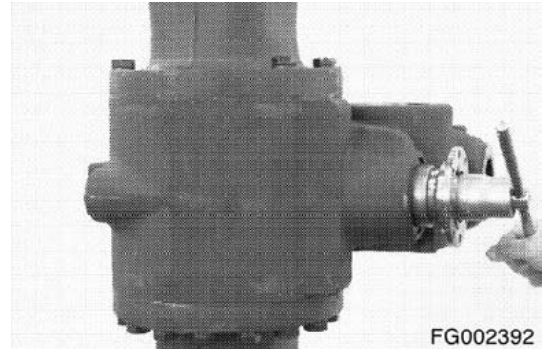


Figure 111

3. Remove differential.

Compare contact pattern (see arrow) with contact pattern examples on page -7-9).

! CAUTION!

If the contact pattern differs considerably, an error was made when measuring the shim (See Figure 103 on page -40), which needs to be corrected by all means.

4. Oil O-ring and mount on collar (arrow) of axle housing half / part II.

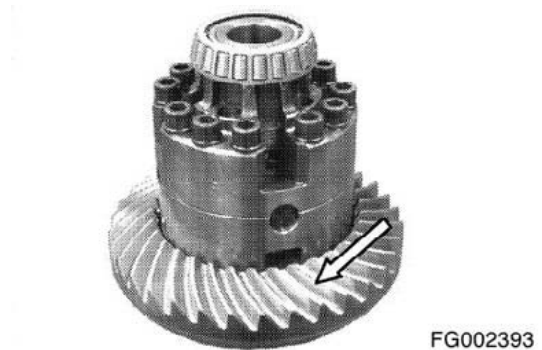


Figure 112

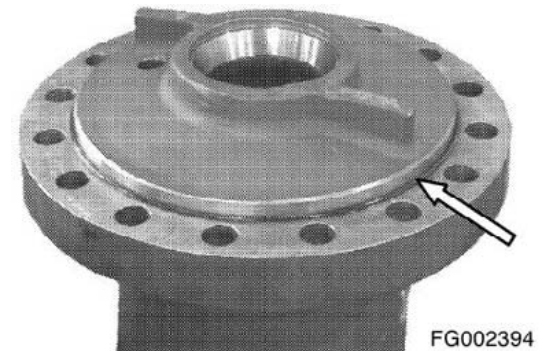


Figure 113

5. Reinstall differential.

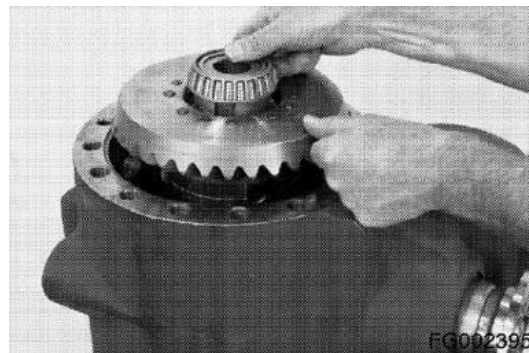


Figure 114

6. Instal preassembled axle housing half (observe radial installation position), fix with hex. screws and washers.

Tightening torque (M18/10.9) $M_A = 390 \text{ Nm}$

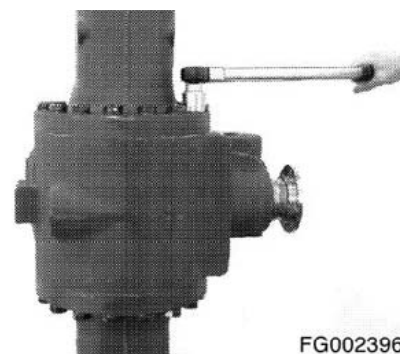


Figure 115



WARNING!

Bring axle into horizontal position and secure with a support (arrow).

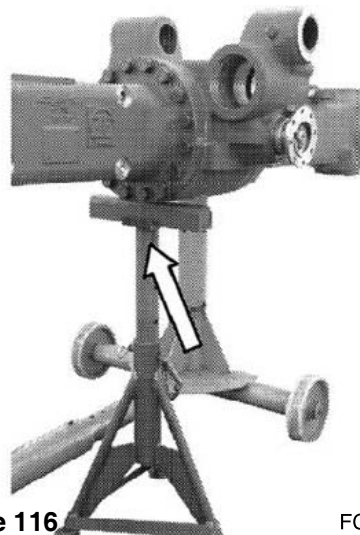


Figure 116

7. Disassemble flange.

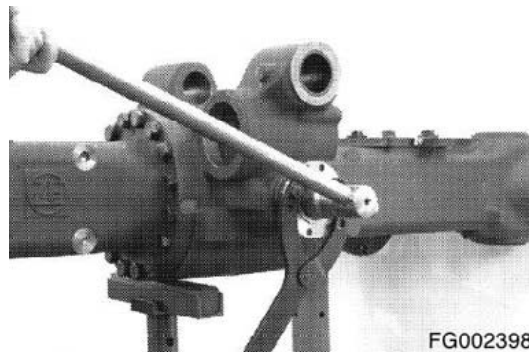


Figure 117

Input Flange

Comment on Figure 118 - Figure 121

Reference Number	Description
1	Drive Pinion
2	Hex. Nut
3	Washer
4	Input Flange
5	Screen
6	Seal Ring
7	Bevel Roller Bearing
8	Spacer Ring
9	Input Housing
X	Installation Dimension MS-E 3050/3060 → 13.0 ^{+0.2} mm MS-E 3070 → 13.5 ^{+0.2} mm

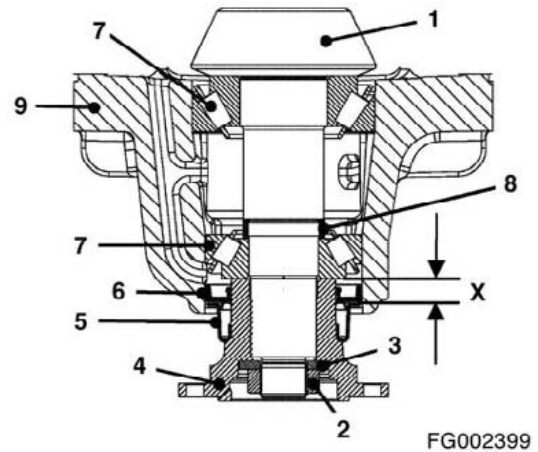


Figure 118

FG002399

CAUTION!

Illustration shows version - MS-E 3060

- Place seal ring (6), considering the required installation position (dimension "X") - see Figure 118.

Contact face (outer diameter) of seal ring:

- wet it with spirit (assembly aid) if rubber coated
- apply sealing compound (Loctite # 574) if made of metal

Apply grease on seal and dust lip of the seal ring.

(Grease e.g. "PETAMO GHY 133 N" ZF-order no. 0671 190 099)

CAUTION!

Ensure plane installation position of seal ring - use suitable driver.

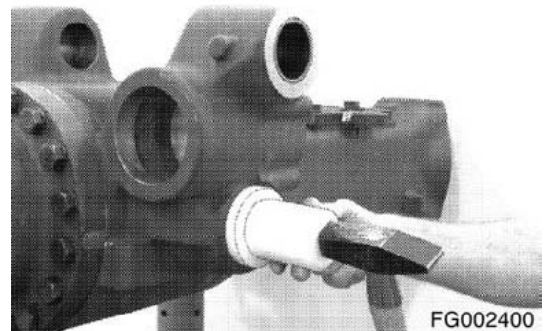


Figure 119

FG002400

2. Press screen / thrust plate (5) on the input flange until contact is obtained - also see Figure 118.

! CAUTION!

Screen / thrust plate must not be deformed when mounted - use suitable driver.

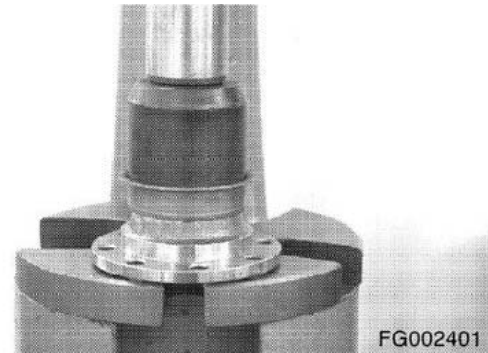


Figure 120

3. Install preassembled input flange (4+5) and washer (3), fix with hex. nut (2).

! WARNING!

Secure hex. nut with locking agent (Loctite # 262).

Tightening torque (M27x1.5) MA = 600 Nm

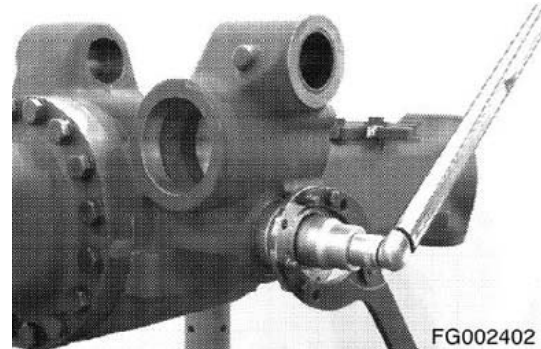


Figure 121

Output

1. Comment on Figure 122

Reference Number	Description
1	Axle Housing
2	Knuckle Housing
3	Hub
4	Multidisk Brake
5	Planetary Carrier

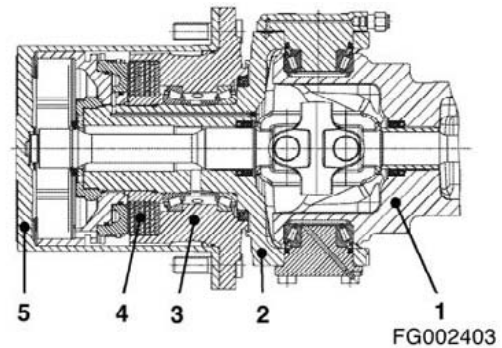


Figure 122

2. Mount just for output - Figure 123
Locate the output on the axle - by installing the U-joint shaft in the differential splines.

! WARNING!

Pay attention to seal ring in the axle housing - risk of damage.

Other required work steps (bearing pin and tie rod assembly) can be taken in extracts from the complete assembly ("Knuckle Housing" on page 48 - 53 and "Steering" on page 66).

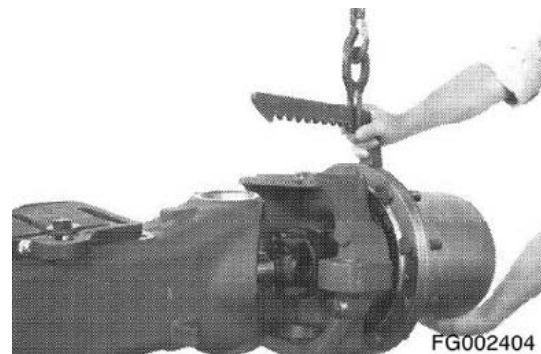


Figure 123

Preassembly Axle Housing

- Legend for Figure 124 thru Figure 128

Reference Number	Description
1	Axle Housing
2	Bushing (Observe Installation Position)
3	Seal Ring (Observe Installation Position)
4	Bearing Outer Rings (Pivot Bearing)
X	Oil Chamber Side

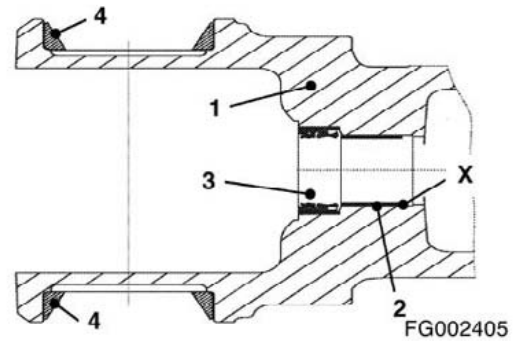


Figure 124

Bushing - lubrication groove outlet installed in 6 o'clock position (referred to the axle mounted in the vehicle).

- Flush mount bushing in the axle housing hole, considering the installation position (see Figure 126).

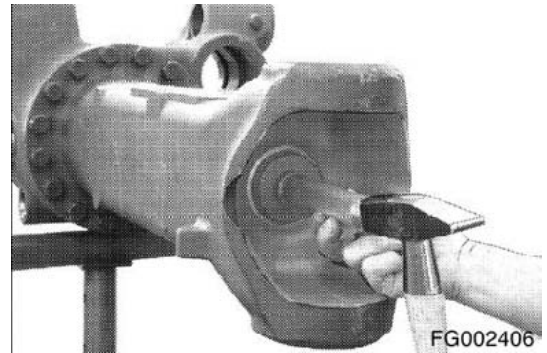
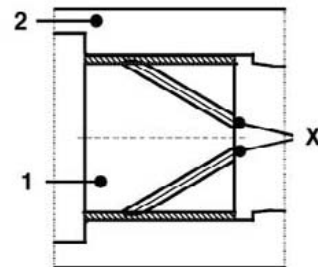


Figure 125

Detailed Figure 126 - 90° offset:

Reference Number	Description
1	Axle Housing
2	Bushing
X	Oil Chamber Side Observe Installation Position of Bushing

lubrication groove outlet in 6 o'clock position (referred to axle mounted in vehicle).



FG002509

Figure 126

- Flush mount seal ring (item 3 - See Figure 124) into axle housing hole, with seal lip showing to oil chamber.

CAUTION!

Contact face (outer diameter) of seal ring:

- Wet it with spirit (assembly aid) if rubber coated
- Apply sealing compound (Loctite # 574) if made of metal

Apply grease on seal and dust lip of the seal ring.

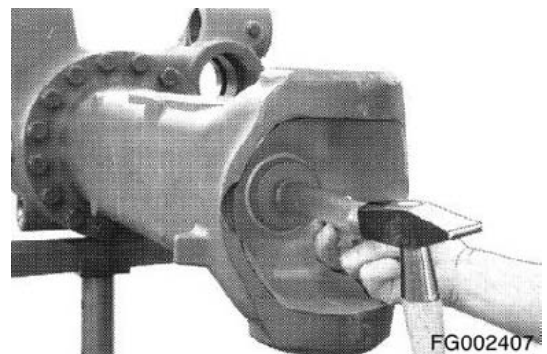


Figure 127

! CAUTION!

Ensure plane installation position of seal ring - use suitable driver.

4. Mount both bearing outer rings (Item 4- See Figure 124) into pivot bearing holes of the axle housing.

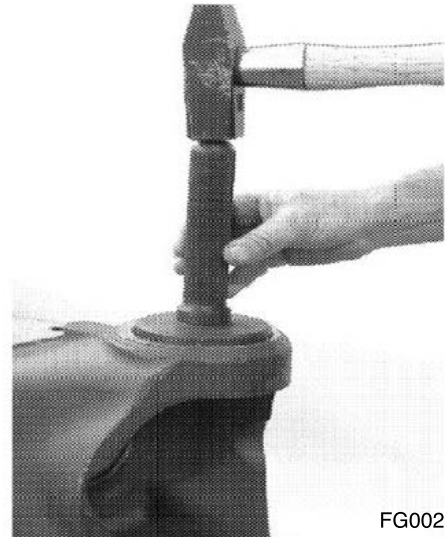


Figure 128

FG002408

! WARNING!

Carefully install u-joint shaft (Risk of damage - seal ring).

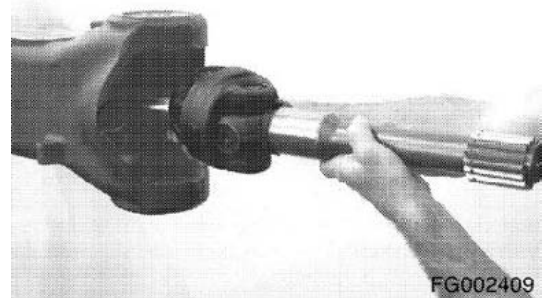


Figure 129

FG002409

Knuckle Housing

1. Just for assembly of a new knuckle housing (Figure 130):
Shut machining openings (3x - see arrows) of oil supply holes with plugs.

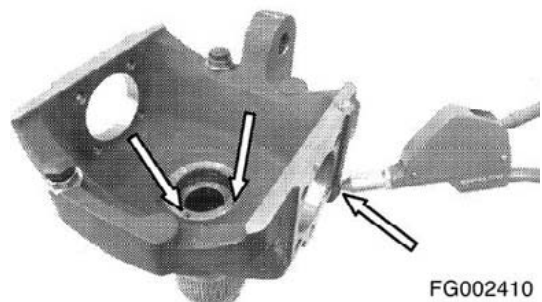


Figure 130

FG002410

2. Legend for Figure 131 - Figure 134:

Reference Number	Description
1	Knuckle Housing
2	Bushing (Observe Installation Position)
3	Seal Ring (Observe Installation Position)
E	Installation Dimension (Seal Ring) MS-E 3050 → Flush MS-E 3060/3070 → $4.00 + 0.3 \text{ mm}$
X	Installation position of bushing Lubrication groove outlet in 6 o'clock position (referred to knuckle housing / axle mounted in vehicle).

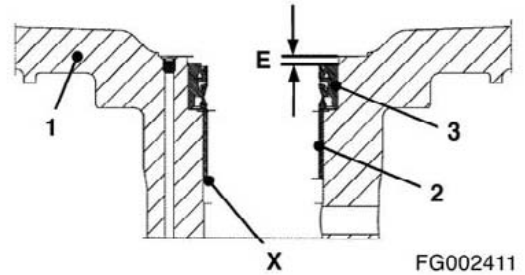


Figure 131

3. Flush mount bushing into knuckle housing hole, considering the installation position (See Figure 131 and detailed Figure 132).

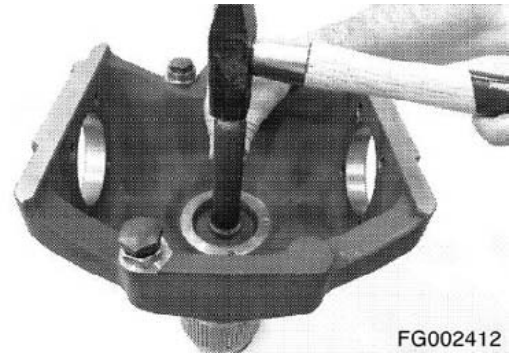


Figure 132

Detailed Figure 132:

Reference Number	Description
1	Knuckle housing
2	Bushing
X	Oil chamber side Observe installation position of bushing Lubrication groove outlet in 6 o'clock position (referred to knuckle housing / axle mounted in vehicle).

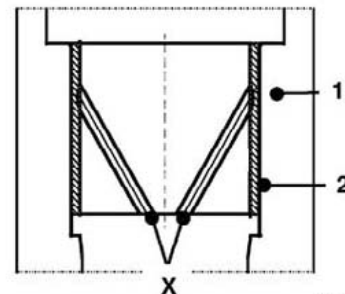


Figure 133

4. Mount seal ring (item 3 - See Figure 131) into knuckle housing hole - considering installation dimension "E" (See Figure 131) and installation position (seal lip showing to oil chamber).

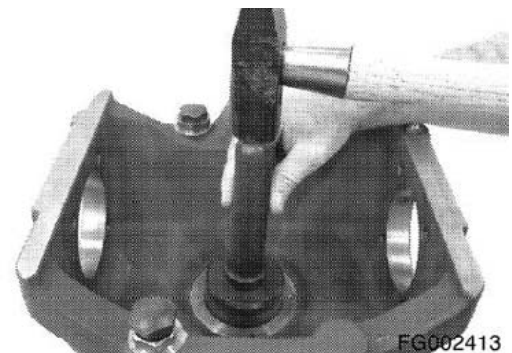


Figure 134

CAUTION!

Contact face (outer diameter) of seal ring:

- wet it with spirit (assembly aid) if rubber coated
- apply sealing compound (Loctite # 574) if made of metal

Apply grease on seal and dust lip of the seal ring.

(Grease e.g. "PETAMO GHY 133 N" ZF-order no. 0671 190 099)

CAUTION!

Ensure plane installation position of seal ring - use suitable driver.

CAUTION!

Locate preassembled knuckle housing on axle housing, carefully mount u-joint shaft Seal ring - risk of damage).

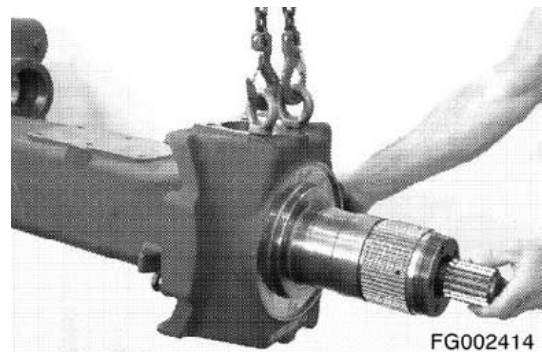


Figure 135

5. Legend for Figure 136 - Figure 139:

Reference Number	Description
1	Bearing Pin
2	Sealing Cap
3	O-ring
4	Bevel Roller Bearing
5	Shim (just on Lower Bearing Pin)
6	Lubrication Nipple
7	Knuckle Housing
8	Axle Housing
X	Area/Anticorrosive Agent

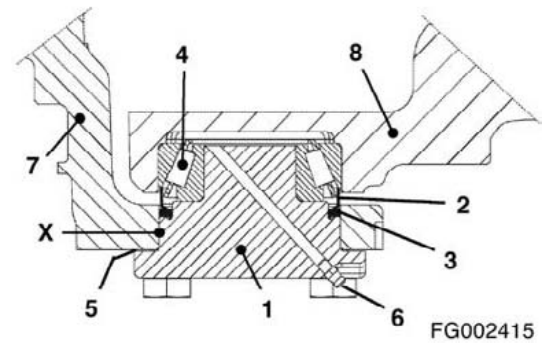


Figure 136

6. Mount sealing cap
observe installation position (See Figure 136).

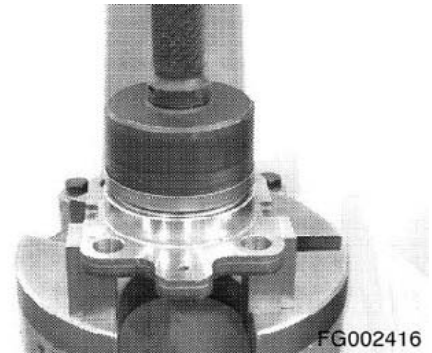


Figure 137

7. Instal O-ring (arrow - 1) and apply anticorrosive agent, "Weicon Anti Seize" (Never-Seez) ZF-order no. 0671 196001 on bearing pin collar (arrow-2).

Mount bearing inner ring.

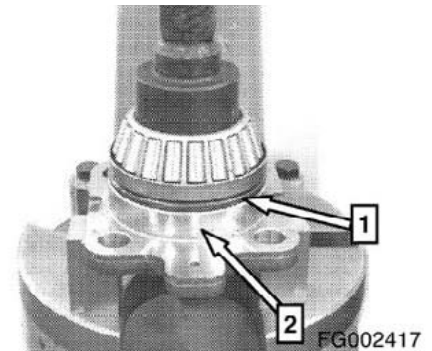


Figure 138

8. Just on lower bearing pin:
Instal shim for pivot bearing roller moment setting.
e.g. $S = 0.80 \text{ mm}$ (experience value) on lower bearing pin.

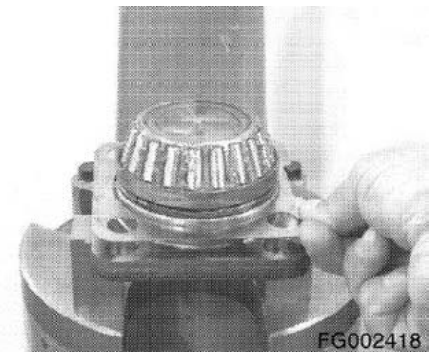


Figure 139

9. Instal preassembled lower bearing pin and fix with hex. screws.



Observe installation position - mount bearing pin with lubrication nipple showing to axle center.

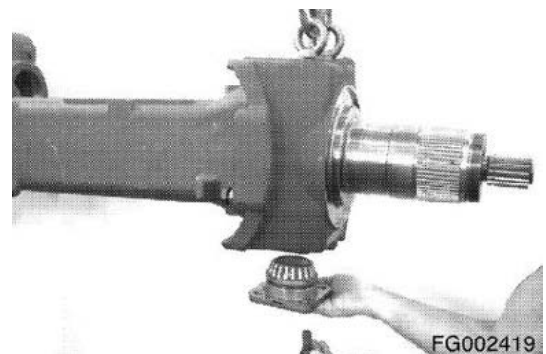


Figure 140

10. Instal O-ring.

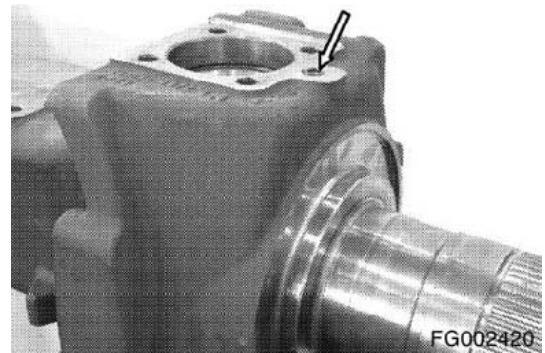


Figure 141

11. Instal preassembled upper bearing pin (Figure 137 and Figure 138).



Observe installation position - oil supply holes for multidisk brake.

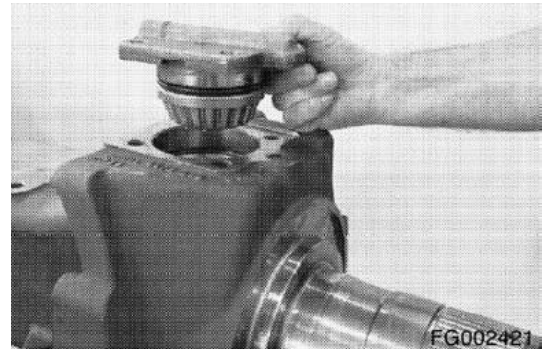


Figure 142

12. Fix both bearing pins definitively.

Tightening torque (M 16/10.9) $M_A = 280 \text{ Nm}$

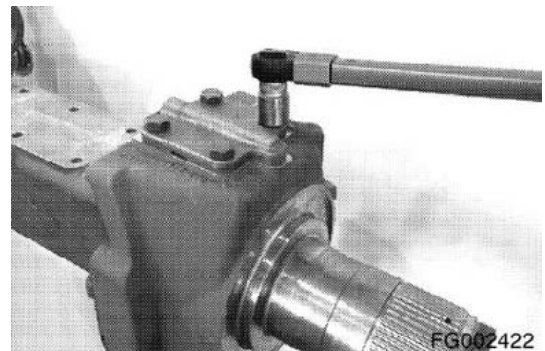


Figure 143

13. Mount lubrication nipple (arrow 1) in both bearing pins and provide pivot bearing with grease (grease according to ZF lubrication list "TE-ML 05," e.g. RENOLIT 283 EP 2).

Tightening torque (M 6x1) $M_A = 6 \text{ Nm}$

Just on upper bearing pin:

Mount screw neck (arrow-2) with O-ring

Tightening torque (M 14x1.5) $M_A = 35 \text{ Nm}$

Mount breather valve (arrow-3) and apply dust cap.

Tightening torque (M 14x1.5) $M_A = 20 \text{ Nm}$

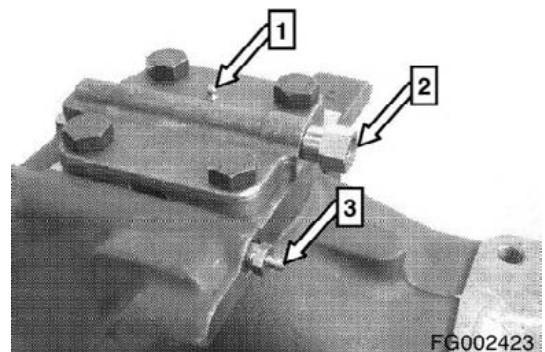


Figure 144

14. Check rolling moment of pivot bearing.

For this purpose locate torque wrench on a hex. screw, align at bearing pin center and determine bearing rolling moment considering the following formula.

Bearing rolling moment → 50 - 60 Nm



Try to achieve the upper value of bearing roller moment.

In case of a deviation from the specified bearing rolling moment, correct it with a suitable shim. (See Figure 139)

Reference Number	Description
TE	Effective torque on the central swivel point (bearing pin center)
L	Distance - from torque wrench point of attach (hex. screw center) to grip center (torque wrench) e.g. L = 300 mm (0.3 m)
A	Distance - from torque wrench socket (hex. screw center) to bearing pin center (central swivel point) e.g. A = 60 mm (0.06 m)
TS	Value of the torque to be read from the scale

$$TE = \frac{TS \times (L + A)}{L}$$

$$TS = \frac{TE \times L}{L + A}$$

As a result the scale of the torque wrench must indicate a value of 46 - 50 Nm, which corresponds to an effective bearing rolling moment of 50 - 60 Nm in the swivel bearing.

Hub

1. Install heated bearing inner ring until contact is obtained.

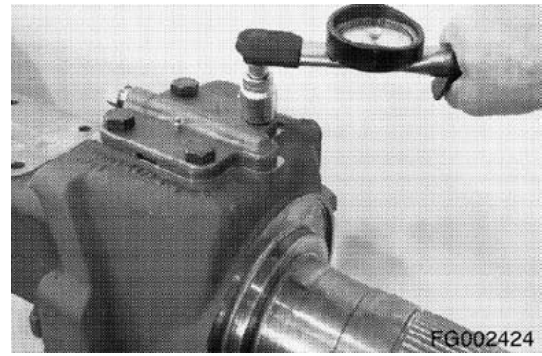


Figure 145

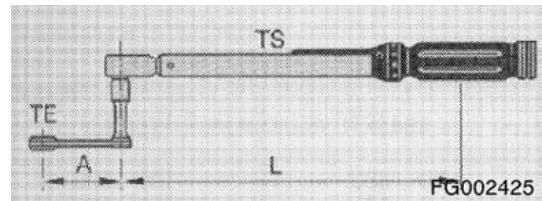


Figure 146

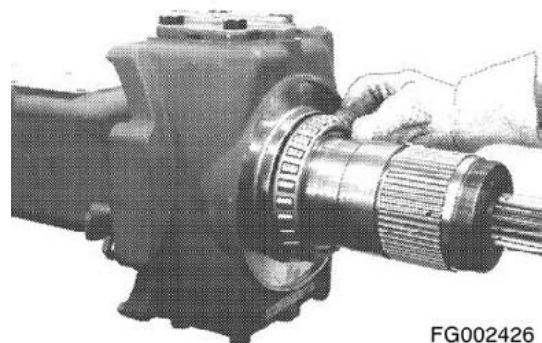


Figure 147

2. Just for axle type MS-E 3060:

Install spacer bushing.

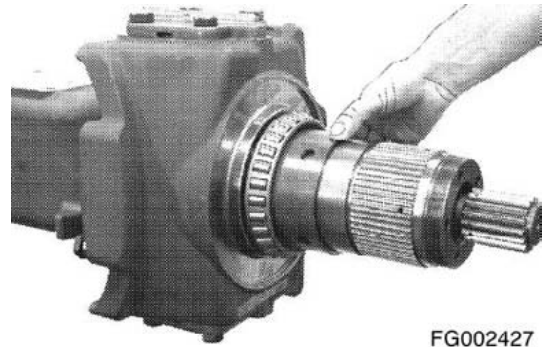


Figure 148

3. Mount wheel bolts (l).

Install both bearing outer rings (2) of hub bearing until contact is obtained.

Oil O-ring (3) and locate in annular groove of hub.

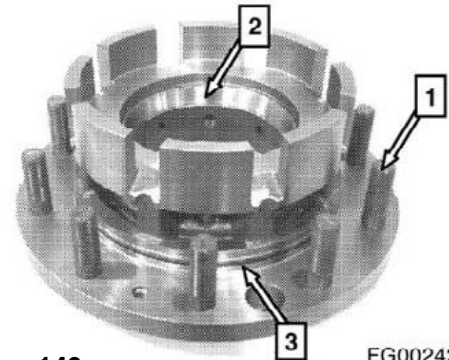


Figure 149

4. Mount shaft seal, considering installation position (marking OUT · SIDE looking upward / outward) and installation dimension "X" - see detailed Figure 150.

Legend for Figure 151 and Figure 152:

Reference Number	Description
1	Hub
2	Shaft Seal
X	Installation Dimension

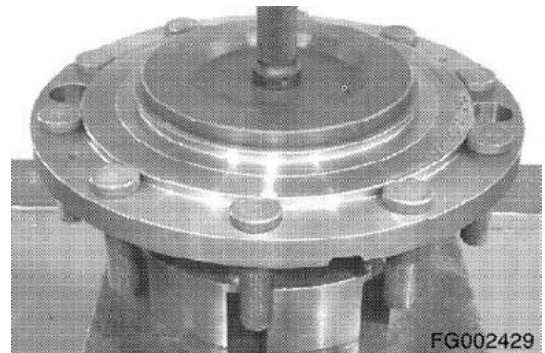


Figure 150

- A. Version MT-E 3050/3060

X = 0.0 - 0.3 mm

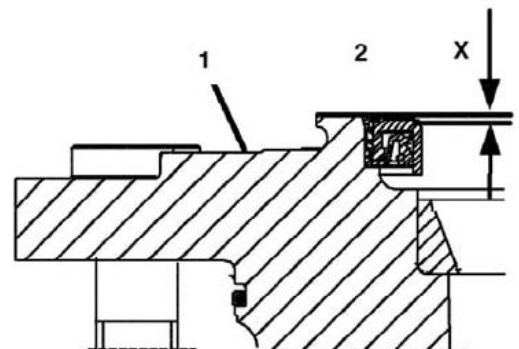


Figure 151

B. Version MT-E 3070

$$X = 6.0^{+0.2}_{-0} \text{ mm}$$

! CAUTION!

Apply sealing compound (Loctite #574) to contact face shaft seal/hub.

! CAUTION!

Wet contact face of shaft seal/hub carrier with spirit at the very beginning of the assembly - assembly aid.

5. Install preassembled hub until contact is obtained and fix with heated outer bearing inner ring.

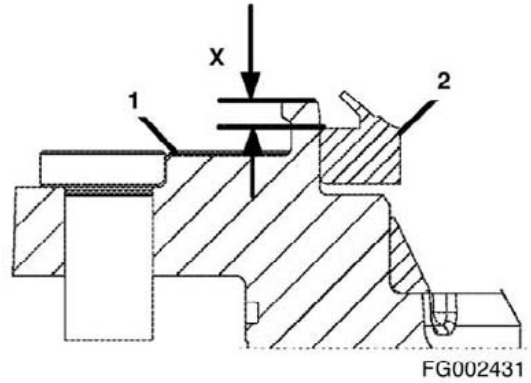


Figure 152

6. Oil O-rings and locate in annular groove (arrow) of knuckle housing.
Then install disk carrier.

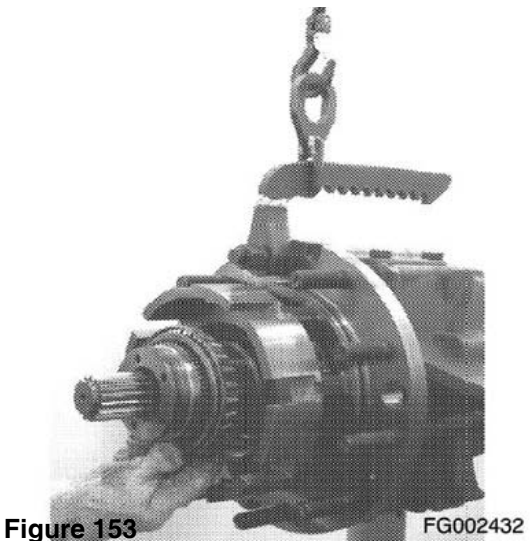


Figure 153

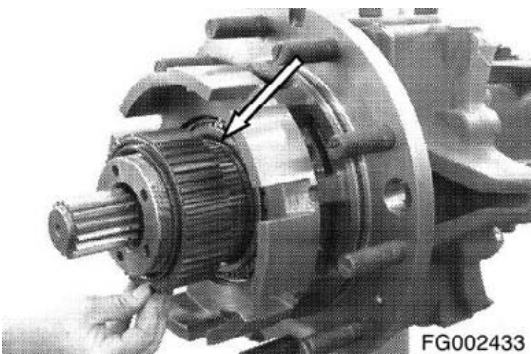


Figure 154

7. Bring hub bearing into contact position (Figure 155 - 157):
Install ring gear (without sealing elements).

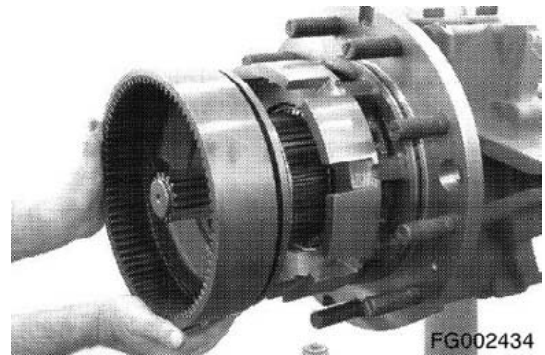


Figure 155

8. Bring hub bearing into contact position - for this purpose tighten slotted nut with a tightening torque of max. 1400 Nm.

! CAUTION!

Apply lubricant (e.g. MOLYCOTE PASTE 1000) to thread - knuckle housing/slotted nut.

! CAUTION!

While tightening the slotted nut rotate hub in both directions several times - roller setting.

9. Loosen slotted nut again and remove ring gear.

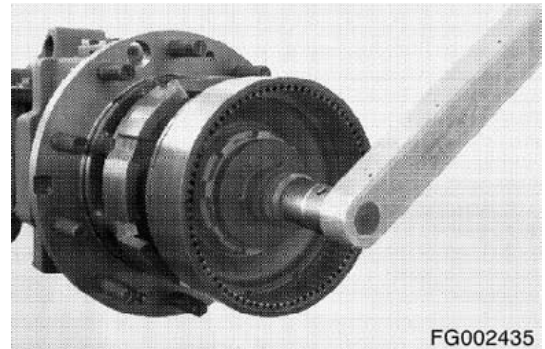


Figure 156

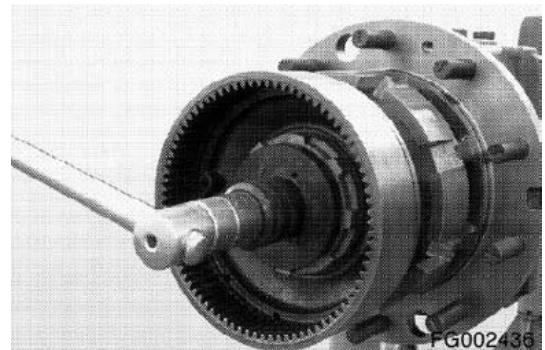


Figure 157

Multidisk Brake

1. Install disk pack alternately starting with an outer disk.

CAUTION!

Pay attention to installation position of inner disks - See Figure 159.

CAUTION!

Take the actually required disk fitting from the corresponding spare parts list.

2. Installation position of inner disks:

WARNING!

Bring inner clutch disks in a position where one of the tooth recesses (arrow) is in 6 o'clock position - with axle being installed in the vehicle.

CAUTION!

Inner clutch disks $s = 2.5$ mm (Standard)

Install inner clutch disks with $s =$ alternatively (2.0-2.5-3.0 mm) - required for disk clearance adjustment - on the outside of the disk pack.

3. Oil O-ring and locate in annular groove of disk carrier.

CAUTION!

Install O-ring using grease - assembly aid.

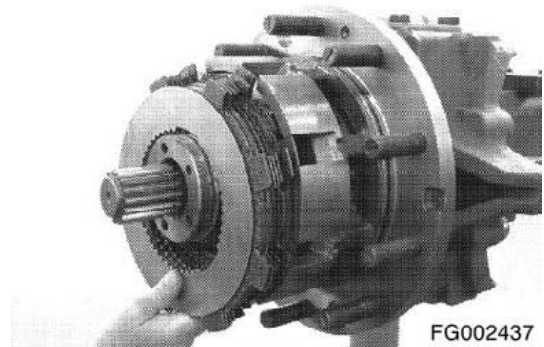


Figure 158

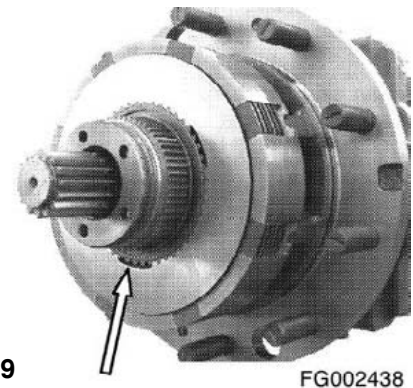


Figure 159

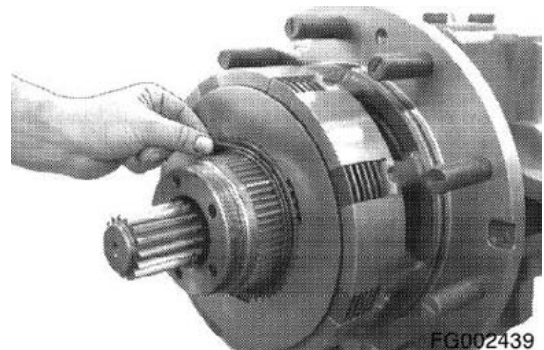


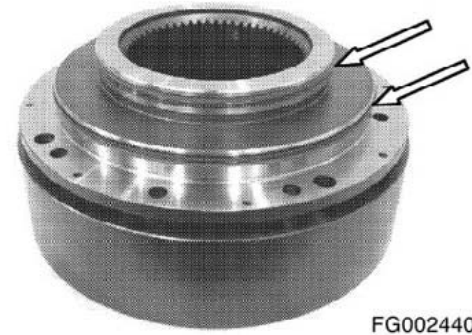
Figure 160

4. Oil sealing elements and locate in annular grooves (arrows) of the ring gear - as shown in the detailed Figure 162.



CAUTION!

Pay attention to installation position and arrangement of sealing elements.

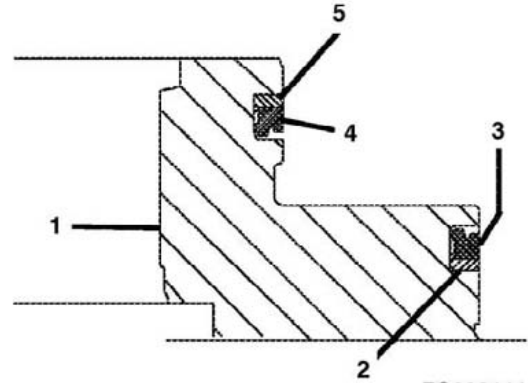


FG002440

Figure 161

Legend for Figure 161 and detailed Figure 162:

Reference Number	Description
1	Ring Gear
2	Support Ring
3	U-ring
4	U-ring
5	Support Ring



FG002444

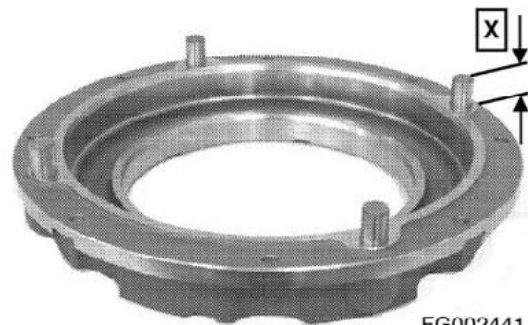
Figure 162

5. Just for "assembly of new parts" or if disassembled:
Mount cylindrical pins into piston, considering installation dimension "X"

MS-E 3050 = 18.00 mm

MS-E 3060 = 16.00 mm

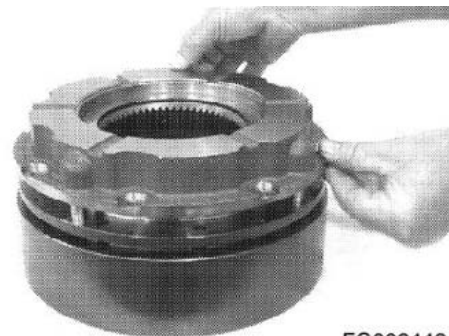
MS-E 3070 = 16.00 mm



FG002441

Figure 163

6. Install piston on preassembled ring gear.



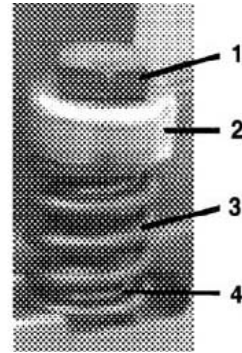
FG002442

Figure 164

Legend for Figure 165, Detail "A" Figure 166:

Reference Number	Description
1	Hex. Screw
2	Spring Sleeve
3	Compress. Springs (Outer)
4	Compress. Springs (Inner)

Fix piston with spring sleeve (2), compression springs (3 and 4) and "new" hex screws (1).



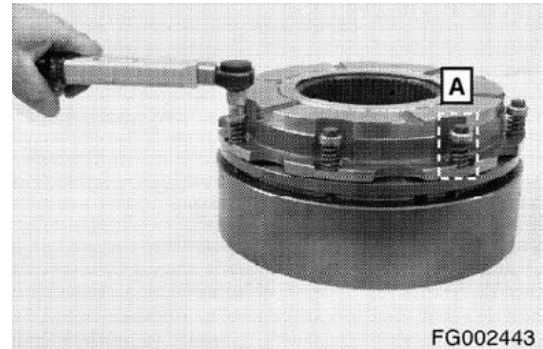
FG002445

Figure 165

CAUTION!

Use hex. screws just once for assembly.

Tightening torque (M 6/8.8) $M_A = 11 \text{ Nm}$



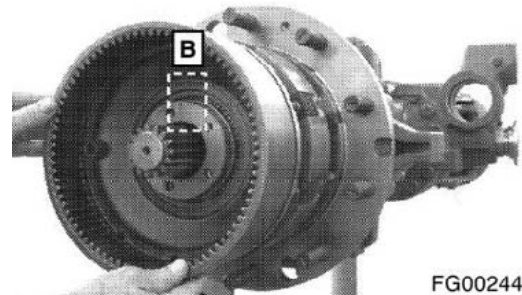
FG002443

Figure 166

7. Mount preassembled ring gear considering the installation position (markings 0 in 12 o'clock position - see arrows, detail "B").

CAUTION!

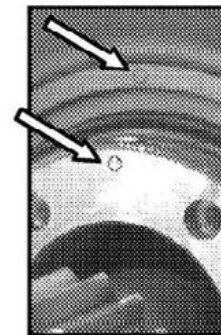
Ensure exact tooth position of oil supply holes - knuckle housing/ring gear (pressure oil supply to brake piston).



FG002446

Figure 167

Detail "B"



FG002450

Figure 168

8. Oil O-ring and insert in recess (arrow).

! CAUTION!

Apply lubricant (e.g. MOLYCOTE PASTE 1000) on thread - knuckle housing / slotted nut.

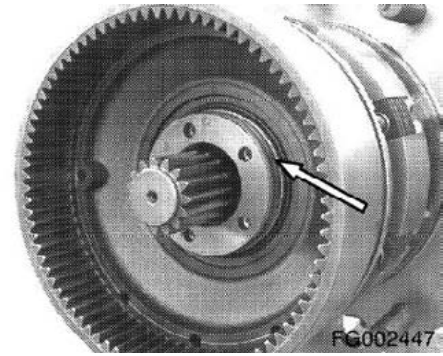


Figure 169

9. Fix ring gear with slotted nut.

! CAUTION!

First tighten slotted nut with 1400 Nm, then retighten slotted nut until a fixing hole overlaps a threaded hole in the knuckle housing - in this connection also refer to Figure 176.

! CAUTION!

While tightening the slotted nut rotate hub in both directions several times - roller setting.

Tightening torque (M 110 x 1.5)..... $M_A = 1400^{+20}_0$ Nm

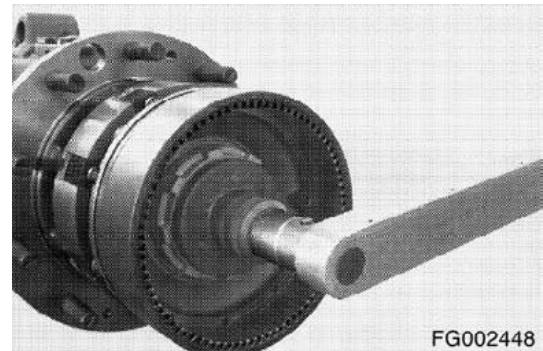


Figure 170

Make Leakage Test of Multidisk Brake

Mount breather valve (arrow) and connect HP-Pump (to connection hole/bearing pin).

! CAUTION!

Breathe brake completely before starting the test.

- Test media:
Motor oils SAE-10 W correspond to, MIL-L 2104 C, MIL-L 46152, API-CC, CD, SC, SD, SE, ATF oils Type A, Suffix A Dexron of II D
- High-pressure test:
Build up test pressure $p = 100$ bar and close locking valve of HP-Pump.
A pressure drop by max.3 bar is permissible during a 5-minute test duration.
- Low-pressure test:

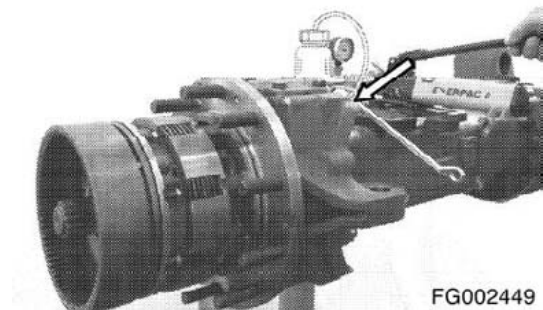


Figure 171

Reduce test pressure to $p = 5$ bar and close locking valve.

No pressure drop is allowed during a 5-minute testing duration.

Adjust and Check Disk Clearance/Piston Stroke

Disk clearance/piston stroke "X" = 1.2 - 1.8 mm

Legend for Figure 172, Figure 173 and 174:

Reference Number	Description
1	Ring Gear
2	Piston
3	Compress. Springs (Outer)
4	Disk Clearance / Piston Stroke

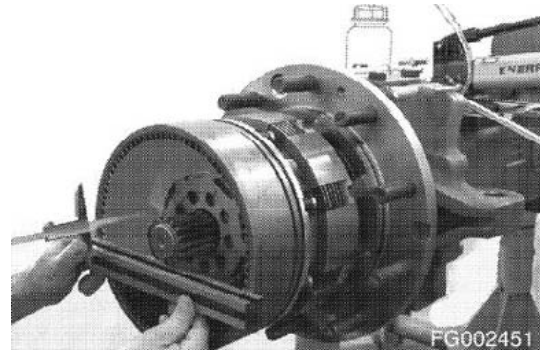


Figure 172

CAUTION!

Breathe brake completely before starting the test.

Build up braking pressure (100 bar) and find dimension "A," from face / ring gear (1) through measuring hole (2) - See Figure 172 and Figure 173 - to face / piston (3).

Dimension "A" e.g. = 83.50 mm

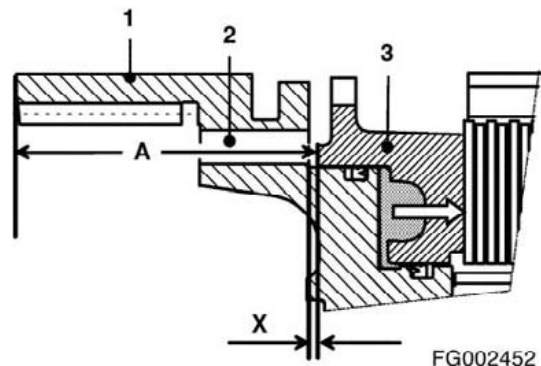


Figure 173

Release pressure from brake - i.e. no pressure applied on brake, piston is in contact with ring gear (reset piston through compression springs) - and find dimension "B" from face / ring gear (1) through measuring hole (2) - See Figure 172 and Figure 174 - to face / piston (3).

Dimension "B" e.g. = 82.10 mm

Calculation Example:

Dimension "A" e.g. 83.50 mm

Dimension "B" e.g. - 82.10 mm

Result → disk clearance = 1.40 mm

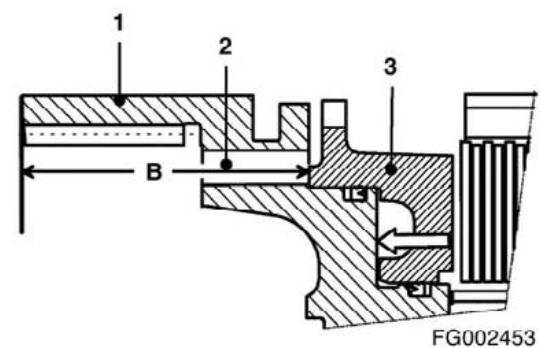


Figure 174

CAUTION!

If the required disk clearance / piston stroke ($X = 1.2 - 1.8$ mm) is not achieved, correct it with corresponding inner clutch disk(s) - See Figure 159.

Dismantle HP-Pump.

Just for transport protection, install screw plug with O-ring in oil supply hole.

Tightening torque (M 14 x 1.5) $M_A = 23 \text{ Nm}$

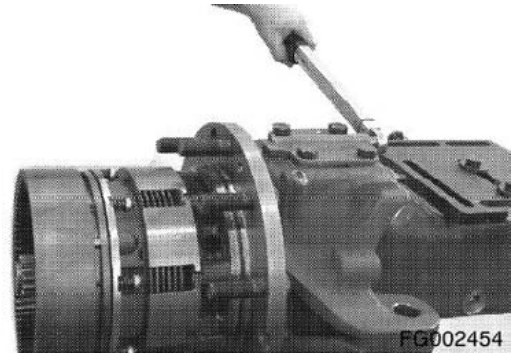


Figure 175

Secure slotted nut with cylinder screw - in this connection refer to comment on Figure 170.

Tightening torque (M 10/8.8) $M_A = 32 \text{ Nm}$

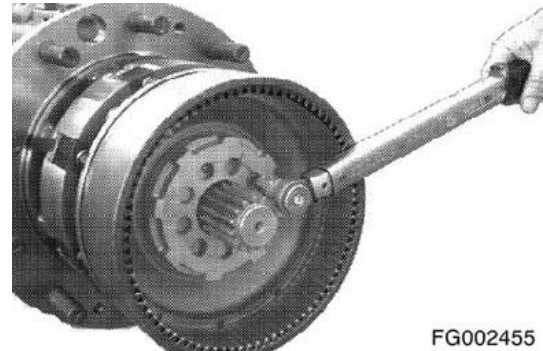


Figure 176

Install thrust washer.



Observe installation position - ensure that both lugs of the thrust washer are engaged each in a spare fixing hole of the slotted nut.

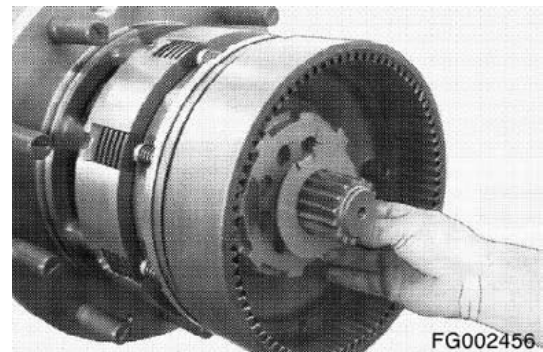


Figure 177

Mount thrust washer (retaining ring fixing) - with shoulder showing to retaining ring - then snap retaining ring.

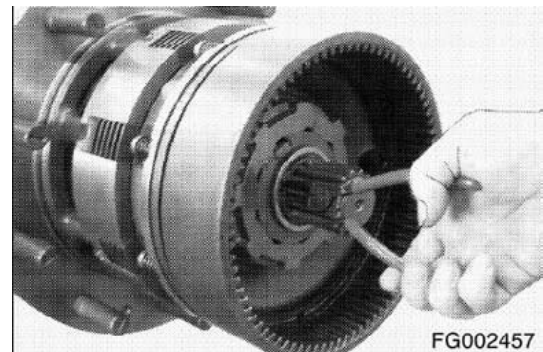


Figure 178

Planetary Carrier

Adjust axial play of sun gear shaft: 0.3 - 1.0 mm (Figure 179 - Figure 186)

1. Determine dimension I from mounting face of planetary carrier to contact face of thrust washer.

Dimension I, e.g. 260.65 mm

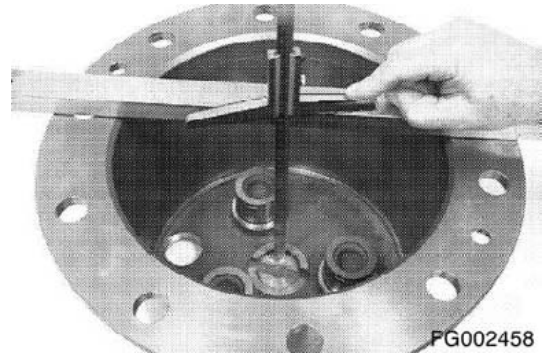


Figure 179

2. Determine dimension II, from face (arrow) of sun gear to mounting face of hub.

Dimension II, e.g. 255.70 mm

Calculation Example:

Dimension I e.g. 260.65 mm

Dimension II e.g. - 255.70 mm

Difference. 4.95 mm

Required axial play (average) e.g. - 0.65 mm

Result = requir.thrust washer(s) e.g. s = 4.30 mm

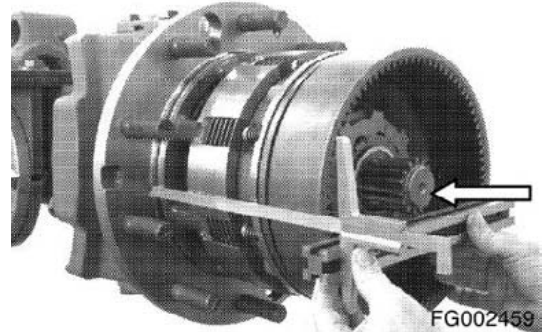


Figure 180

3. Insert thrust washer(s) (e.g. s = 4.30 mm) into planetary carrier and press into contact position.

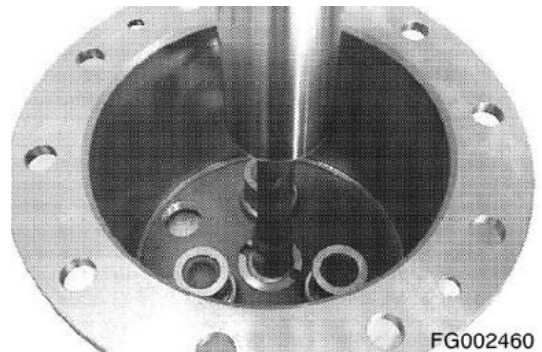


Figure 181

4. Preassemble planetary gear - depending on version - as shown in Figure 182.

Legend for Figure 182 and Figure 183 - version MS-E 3060/3070:

Reference Number	Description
1	Planetary Gear
2	Roller Bearing
3	Washer
4	Retaining Ring

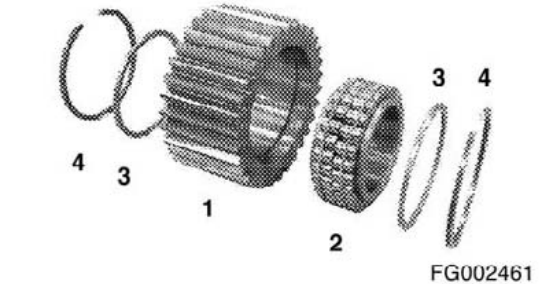


Figure 182

Legend for Figure 182 and Figure 183 - version MS-E 3050:

Reference Number	Description
1	Planetary Gear
2	Bearing Inner Ring with Cylinder Rollers
3	Plastic Ring (Assembly Aid)
4	Angle Ring

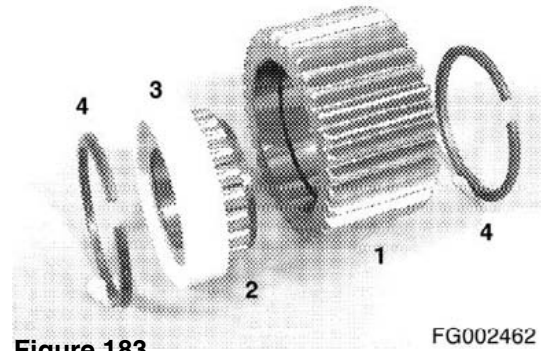


Figure 183

FG002462

- Warm up bearing inner ring and install preassembled planetary gear until contact is obtained.



Mount planetary gear or bearing inner ring with large radius looking to planetary carrier (downwards).

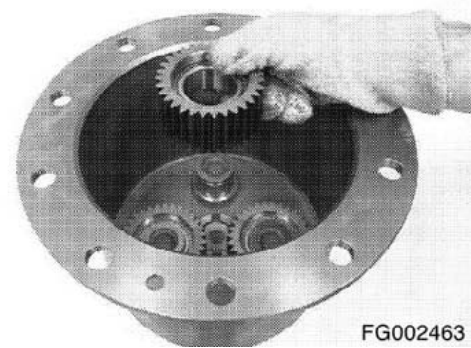


Figure 184

FG002463

- Fix planetary gear using retaining ring.

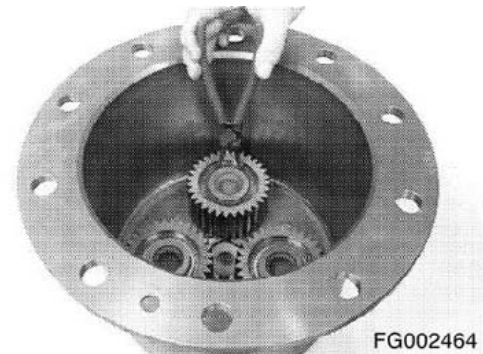


Figure 185

FG002464

- Install preassembled planetary carrier and fix with cylinder screws.

Tightening torque (M12/8.8) $M_A = 55 \text{ Nm}$

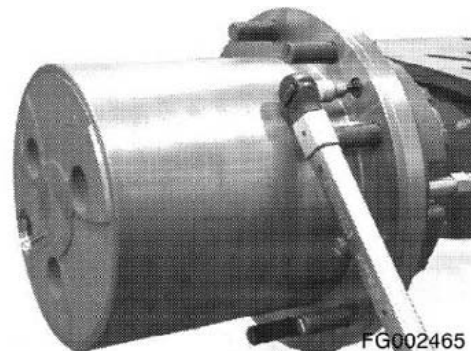


Figure 186

FG002465

8. Install screw plug with new O-ring.

Tightening torque (M 36 x 1.5) $M_A = 50 \text{ Nm}$

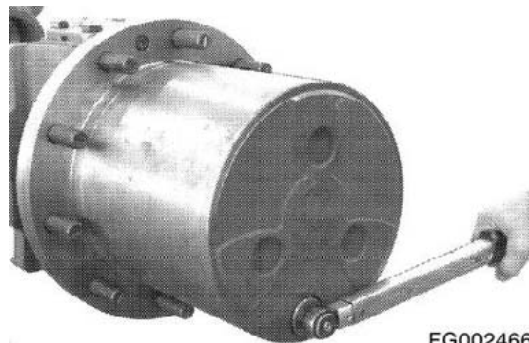


Figure 187

Pivot Bearing

Heat pivot bearing hole using hot air blower and insert cooled bushing(s).



Observe installation position for bushing version with slot,
insert bushings - with slot in 12 o'clock position.

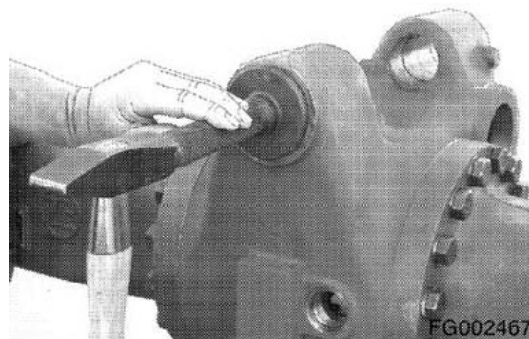
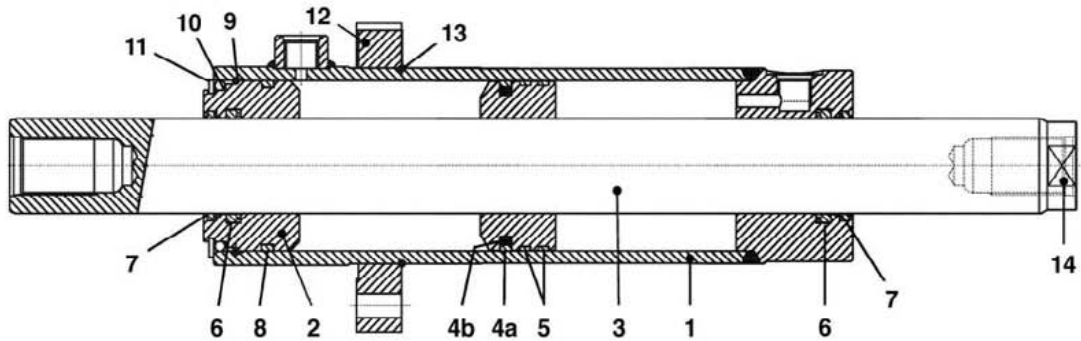


Figure 188

Steering



FG002468

Figure 189

Legend for Figure 189 - Figure 203

Reference Number	Description
1	Steering Cylinder (Cylinder Tube with Brake Head)
2	Brake Head (Loose Part)
3	Piston Rod
4a	O-ring
4b	Form Seal Ring
5	Guide Ring
6	U-ring

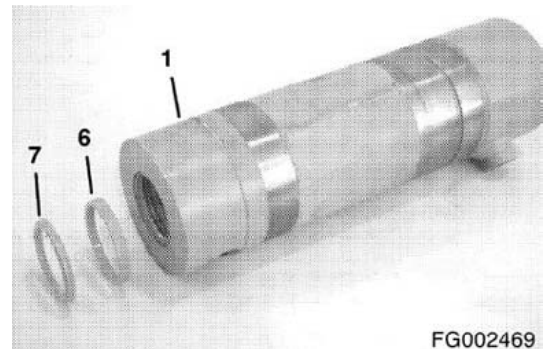
Reference Number	Description
7	Rod Wiper
8	Dual Ring
9	Retaining Ring
10	O-ring
11	Retaining Ring
12	Flange
13	Retaining Ring
14	Wrench Socket (Piston Rod)

1. Mount U-ring (6) and wiper (7) in the steering cylinder (1).



CAUTION!

Observe installation position - in this connection see detailed Figure 191.



FG002469

Figure 190

Detailed **Figure 191**:

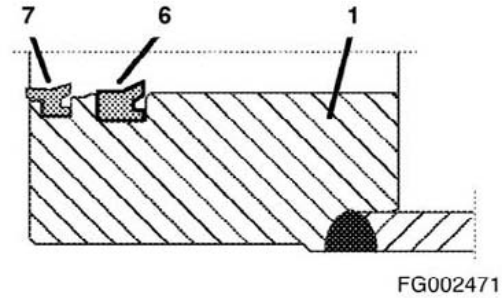


Figure 191

2. Position inner installer (S1) on piston rod (3), install O-ring (4b) and press with inner installer (S2) into annular groove (arrow) of piston (3).

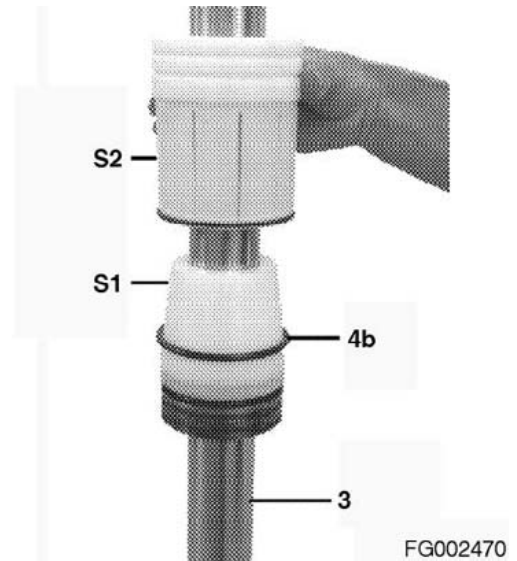


Figure 192

3. Install form seal ring (4a) and press with inner installer (S2) into annular groove (arrow) of piston (3).

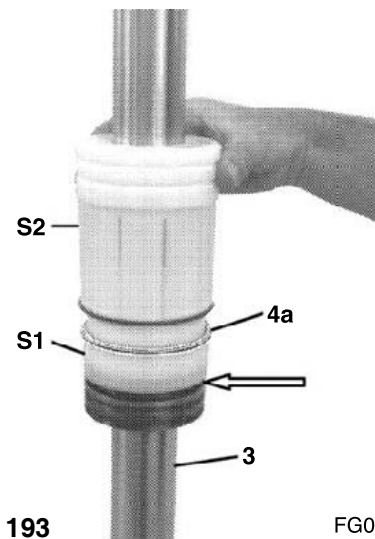


Figure 193

4. Calibrate form seal ring (4a) using calibration bushing (S3).

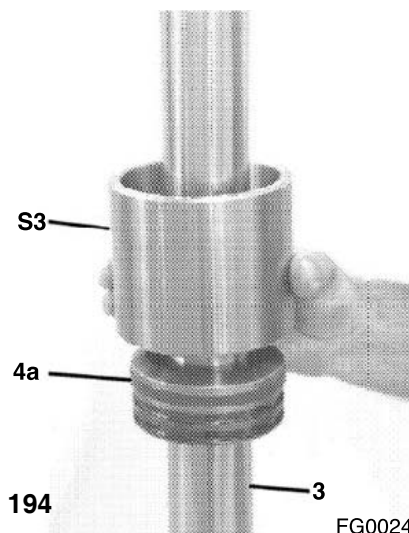


Figure 194

FG002473

5. Place both guide rings (5) into annular grooves of the piston rod.

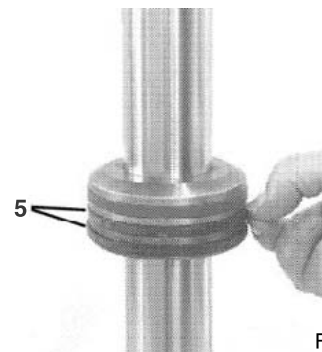


Figure 195

FG002474

6. Insert preassembled piston rod in the preassembled steering cylinder.

! CAUTION!

Observe installation position - insert piston rod (3) with wrench point of attach (14 - See Figure 189) showing in direction of arrow.

! CAUTION!

Slightly oil all sealing elements before installing the piston rod.

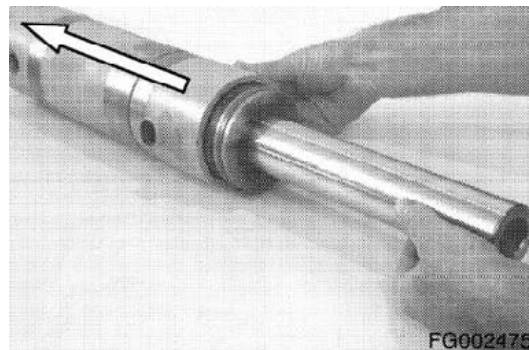


Figure 196

FG002475

7. Insert u-ring (6), rod wiper (7) and dual ring (8) in brake head (2).

Observe installation position - in this connection refer to detailed Figure 198.

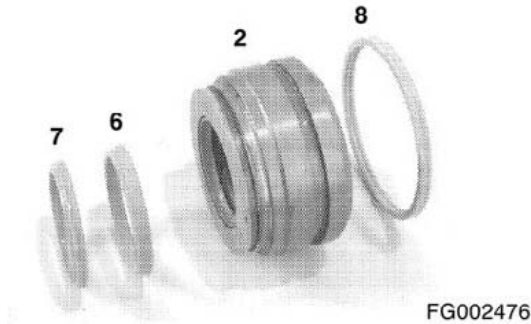


Figure 197

Detailed Figure 198:

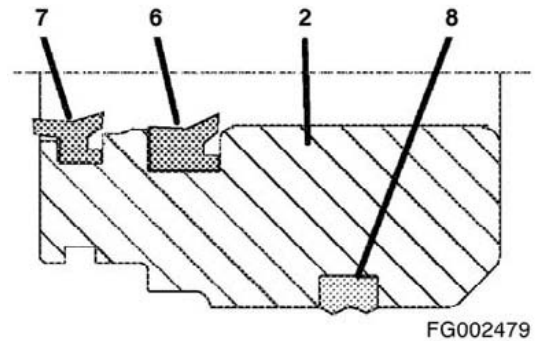


Figure 198

8. Install preassembled brake head.



Slightly oil all sealing elements before inserting the brake head.



Figure 199

9. Push brake head into the steering cylinder (arrow) so the retaining ring (9) can be mounted.

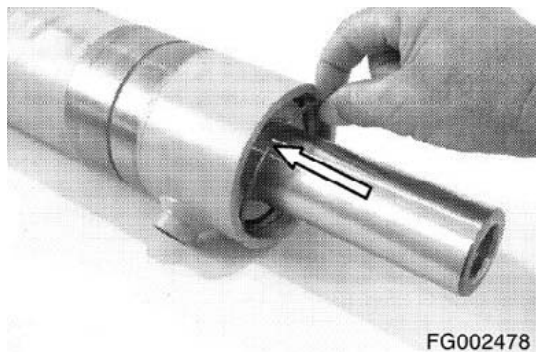


Figure 200

10. Bring the inserted brake head (8) into contact position (arrow) on the snapped retaining ring (9).
Oil O-ring (10) and insert into recess.

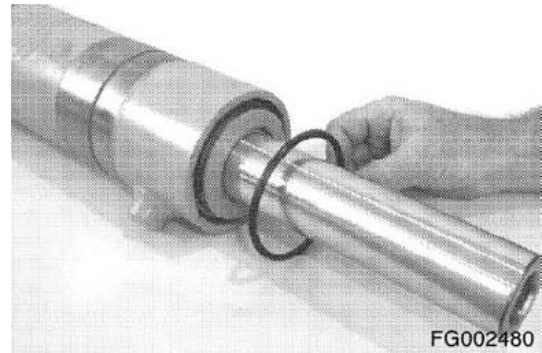


Figure 201

11. Fix brake head (8) with retaining ring (11).

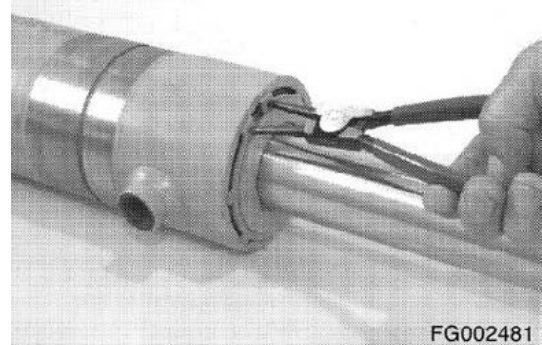


Figure 202

12. Install flange (12) and snap retaining ring (13).



Observe installation position of flange - chamfer (retaining ring contact arrow) to show towards retaining ring.

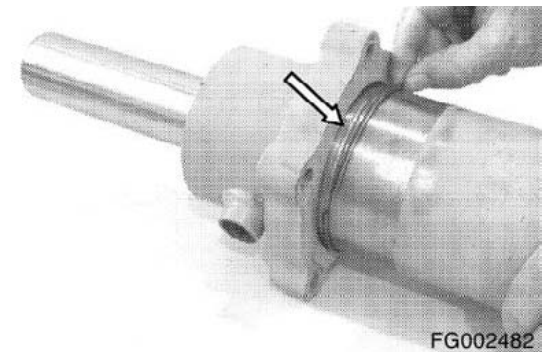


Figure 203

13. Provide both contact faces (steering cylinder/axle drive housing) with sealing compound (Loctite #574).

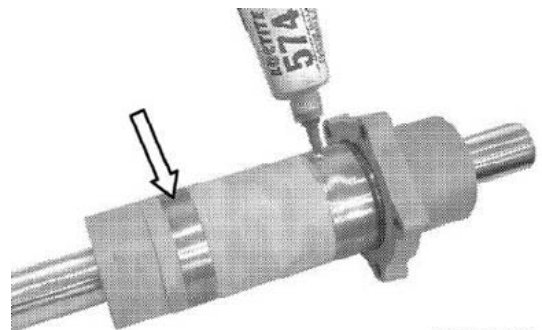


Figure 204

14. Insert preassembled steering cylinder and fix with hex. screws.

Fix hex screws with locking agent (Loctite # 243).

Tightening torque (M 12/8.8) $M_A = 79 \text{ Nm}$

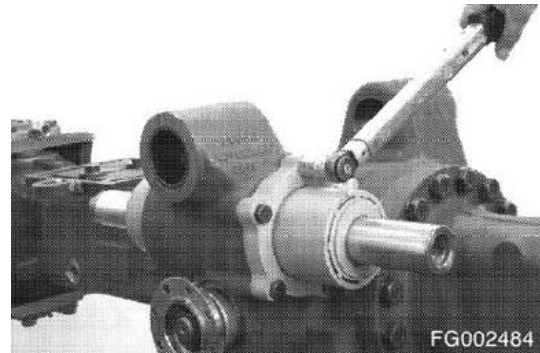


Figure 205

15. If required - preassemble both tie rods.

Legend for Figure 206:

Reference Number	Description
1	Axial Joint
2	Ball Joint with Tube
3	Clamp

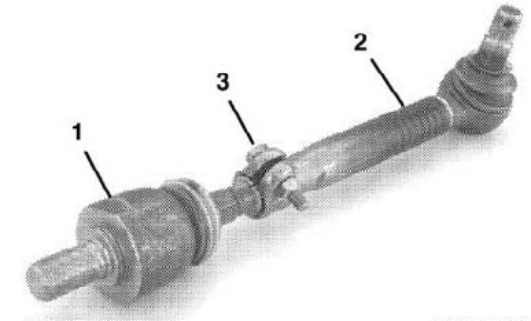


Figure 206

16. Do not tighten the screw of the clamp before setting the track.

Tightening torque (M 12x1.5) $M_A = 75 \text{ Nm}$

17. Provide connection - axial joint/piston rod (approximately 3 threads)- with locking agent (Loctite # 243).

CAUTION!

Observe installation position of tie rods - offset to show towards knuckle housing / axle housing (see arrow).

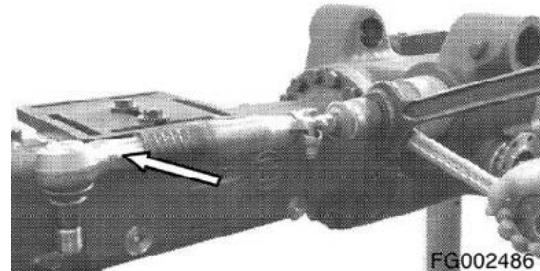


Figure 207

18. Fix both tie rods on steering.

Tightening torque (M 30x1.5) $M_A = 450 \text{ Nm}$

19. Hang up tie rod and fix with "new" locking nut.

CAUTION!

Use locking nut just once for assembly.

Tightening torque (M 27x1.5) $M_A = 100 \text{ Nm} + 200^\circ$

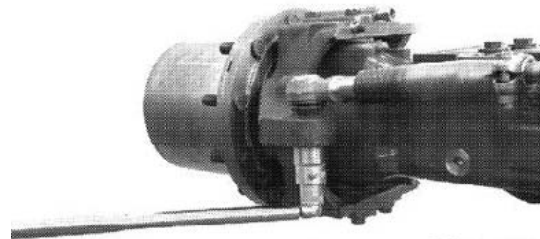
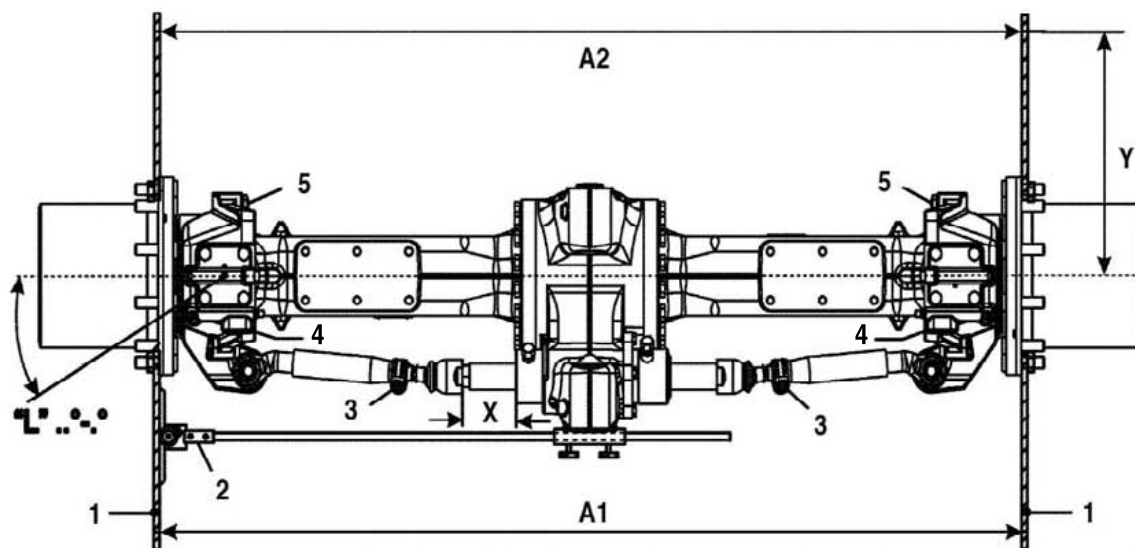


Figure 208

Steering Setting and Checking



FG002488

Figure 209

Reference Number	Description
1	Straightedge
2	Measuring Device
3	Clamp

Reference Number	Description
4	Stop Screw with Stop Washer (Internal)
5	Stop Screw (Outer)

Basic Track Setting

Bring piston rod to central position = Dimension "X"

Determine dimension = "X" (measured from face/steering cylinder to face /axial joint).

Piston (rod) stop/LH in cylinder "Dimension I" z.B. 215 mm

Piston (rod) stop/RH in cylinder "Dimension II" z.B. 25 mm

Result = $190 \text{ mm} \div 2$

Dimension "X" z.B. = 95 mm



CAUTION!

During track setting, the axial position of the piston rod must not be changed any more.

Mount straight edges (1) in horizontal and central axis position.

Fix measuring device (2) on input flange.

Loosen nut/clamp (3) and set length of tie rod (axial joint) until the measuring device (2) indicates 0° (corresponds to a track setting of "zero" mm).



CAUTION!

Make setting on both sides.

Check track setting (0°):

Determine dimension "A1."

Rotate both outputs by 180° - dimension "A2" must be equal to "dimension A1."

Dimension "Y" = distance - wheel center to rim flange.



CAUTION!

For a toe-in and toe-out setting, which might be required, install to the vehicle manufacturer's specification.

Afterwards fix both tie rods/axial joint again using a clamp (3).

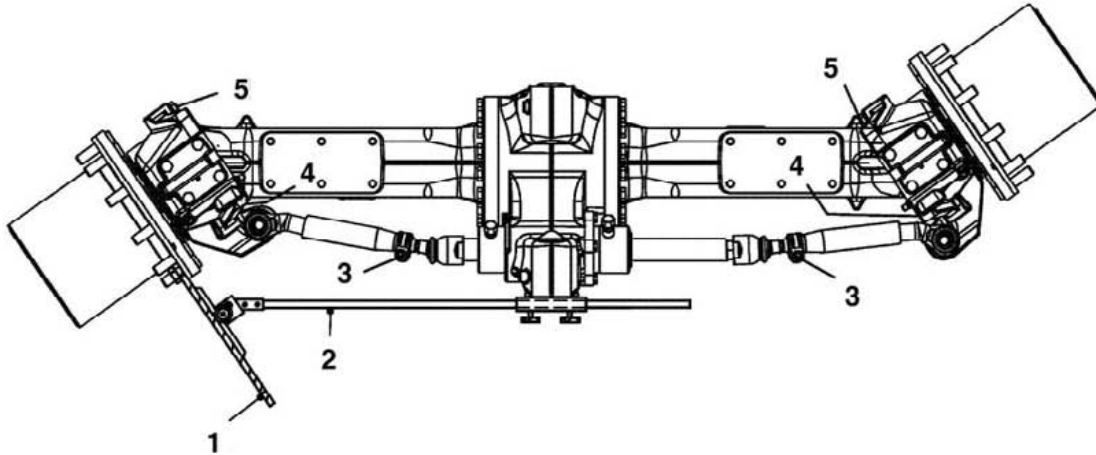
Tightening torque (M 12x1.5) $M_A = 75 \text{ Nm}$

Steering Angle Setting

CAUTION!

Set steering angle - not before track setting is completed.

Set steering angle always on the curve inner output side.



FG002489

Figure 210

Slew output until the required steering angle is achieved on the measuring device (2/Figure 210)

(Measuring device must have parallel contact with the straight edge (1/Figure 210)).

CAUTION!

Take the value of the steering angle "L" to be set (See Figure 209) from the vehicle manufacturer's specification.

Set inner stop through setting screw (4) with stop washer (s = optional).

Tightening torque (M18/10.9) MA = 390 Nm

Fix outer stop through setting screw (5) with counter nut.

Tightening torque (M18/10.9) MA = 170 Nm

Make setting on both output sides.

Check leakage of steering:

Test pressure: 250 bar

Test medium: Motor oil SAE IOW

MIL-L 2104 C 1MIL-L 46152

Connect HP-Pump, Build up test pressure $P = \text{max. } 250$ bar (bleed pressure chamber).

Close locking valve of HP-Pump.

A 5 bar pressure drop is permissible during a test duration of 20 sec.

An outer leakage is not permissible.

Make leakage test of steering in both steering directions.

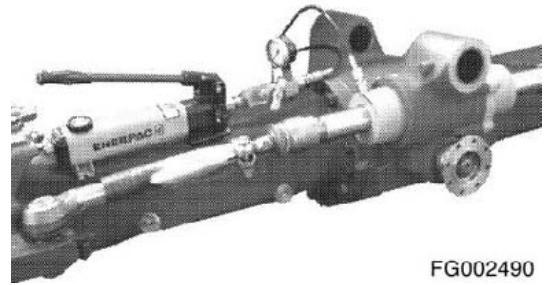


Figure 211

Oil Drain, Oil Filler and Oil Control Plugs and Grease Lubrication Points

1. Mount oil drain plug with solenoid insert (1) - fitted with "new" O-ring.
2. Mount oil filler and oil control plug (2) - fitted with "new" O-ring.

Tightening torque (M 36 x 1.5) $M_A = 50 \text{ Nm}$

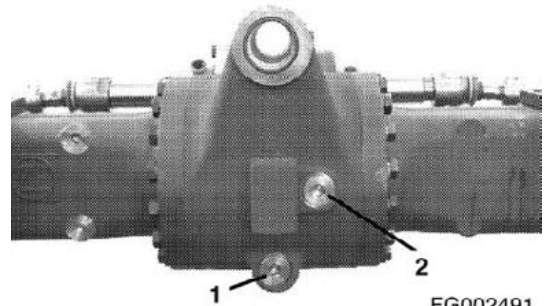


Figure 212

3. Mount oil drain, oil filler and oil control plug with solenoid insert (3) - fitted with "new" O-ring - in both outputs.

Tightening torque (M 36 x 1.5) $M_A = 50 \text{ Nm}$

CAUTION!

Before putting the axle into operation, observe ZF lubrication and maintenance instructions - see page 0/8 and 0/9 - and the vehicle manufacturer's regulations and instructions.

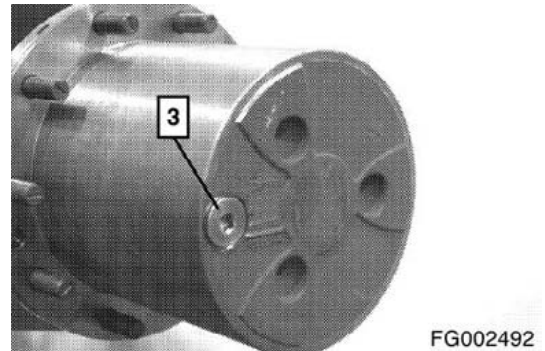


Figure 213

Rear Axle

Edition 1

MEMO

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Rear Axle

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

Examples of Gear Tooth Contact Patterns for the Gleason Gear Tooth System

Ideal tooth contact pattern i.e. pinion distance is correct

Coast side (concave)

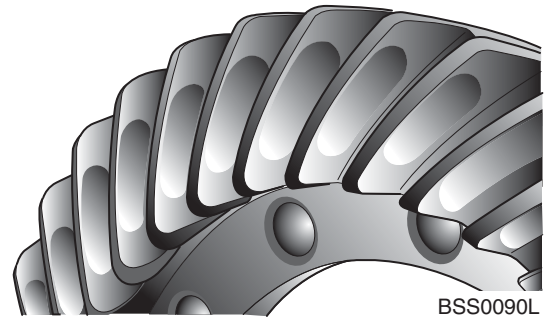


Figure 1

Drive side (convex)

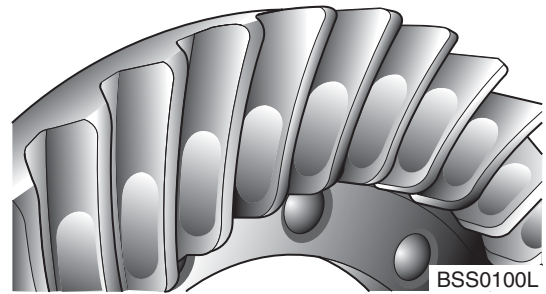


Figure 2

Pinion distance must be increased

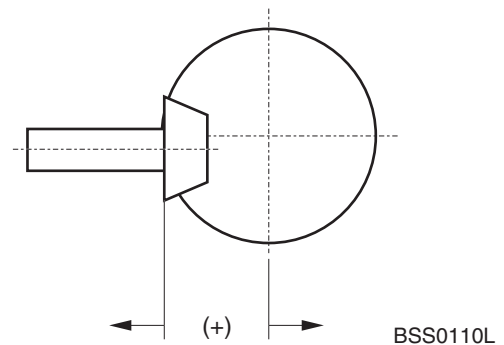


Figure 3



Figure 4

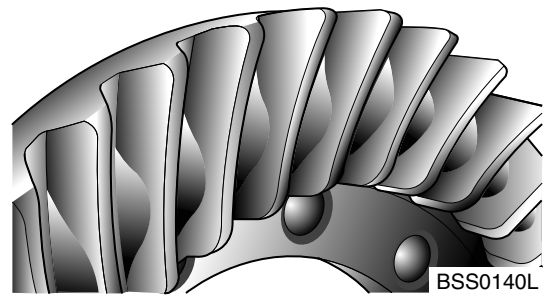


Figure 5

Pinion distance must be decreased

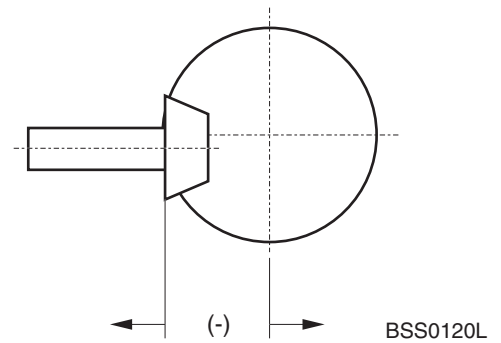


Figure 6

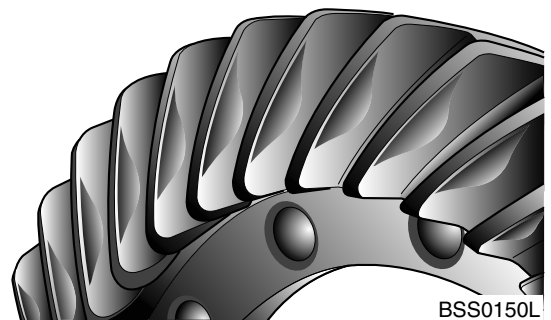


Figure 7

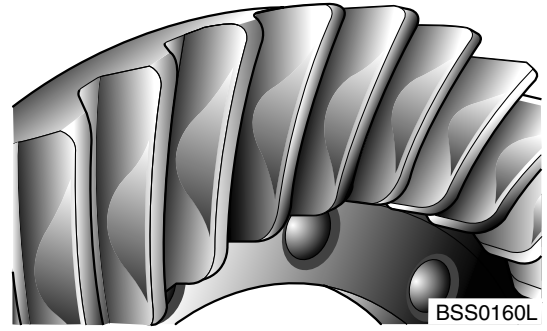


Figure 8

LUBRICATION AND MAINTENANCE SPECIFICATIONS FOR AXLE MT-E 3050/3060/3070

Oil Grade

Oils according to the "Table of Recommended Lubricants" pages of operation manual are permitted for axles MT-E 3050/3060/3070.

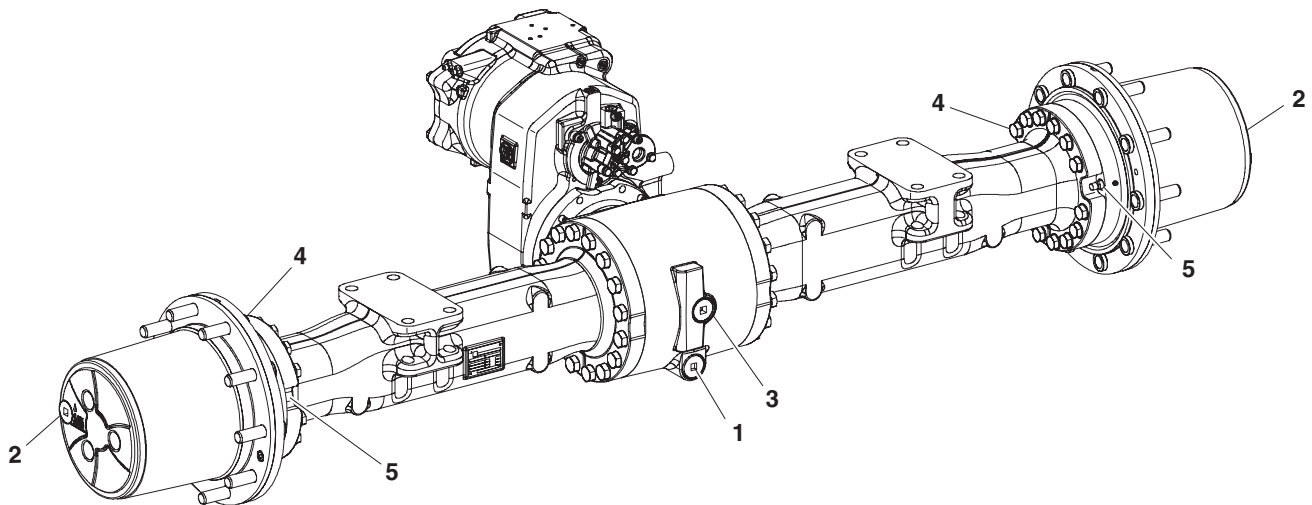
Oil Change

A horizontal installation position of the axle in every direction is precondition for an oil change according to specifications.

Place vehicle in a horizontal position.

Carefully clean all drain -, filler- and control plugs before opening.

Drain oil only right after a longer travel period.



FG002507

Figure 9

Reference Number	Description
1	Oil Drain Hole (M36x1.5 Axle Drive Housing)
2	Oil Drain/Oil Filler Hole (M36x1.5 Output Units)

Reference Number	Description
3	Oil Filler/Oil Check Hole (M36x1.5 Axle Drive Housing)
4	Brake Connection Pipe
5	Brake Breather Valve

1. Oil Drain from Axle
Loosen oil drain plugs (1) and drain oil from axle.
2. Oil Drain from Outputs



WARNING!

To avoid injury when opening the oil drain and oil fill plug (2), because of a possible pressure buildup in the oil system of the planetary carrier, bring drain hole to topmost position (12 o'clock) and carefully unscrew oil drain and oil fill plug (2),

Then bring drain hole to lowermost position (6 o'clock) and drain oil from outputs.

3. Oil Filling of Axle

Provide drain plug (1, with solenoid insert) with a new O-ring and mount it.

Tightening torque (M36x1.5)MA = 50 Nm.

Fill up oil to the overflow of the filler hole (3).

Filling quantity approx. MT-E 3050 = ca. 11.20 liter MT-E 3060 = ca. 14.00 liter MT-E 3070 = ca. 14.50 liter

4. Check

Check oil level after some minutes and fill up to the specified level, until level remains constant.

Provide filling and checking plugs (3) with new O-ring and mount it.

Tightening torque (M36x1.5)MA = 50 Nm

5. Oil Filling of Outputs

Position both oil drain and oil filler hole (2) (reference line horizontally to road level) and fill up oil to overflow.

Filling quantity approx. MT-E 3050 = 2.4 liter MT 3060/3070 = ca. 2.5 liter per output.

Provide drain and filling plug (2) with new O-ring and mount it.

Tightening torque (M36x1.5)MA = 50 Nm

Oil Change Interval

First oil change after 500 operating hours, any further one after 2000 (i.e. after 2500/4500/6500) operating hours, however, at least once per year.

Oil Level Check

Check oil level every month, in particular, however, after putting a vehicle into operation with new or repaired axles or axle parts.

Brake

The following oils are admissible for the pneumatic/hydraulic operated or accumulator operated brake actuation:

1. Motor oils SAE 10 W according to specification MIL-L 2104 C, MIL-L 46152, API-CC, CD, SC, SD, SE
2. ATF. oils type A, Suffix A, Dexron of II D

BRAKE WEAR MEASUREMENT ON AXLES OF MT/MS-E 3050/ 3060/3070 RANGE

WARNING!

The measurement of wear on the multidisk brake only gives limited information on the total state of the plate pack - without disassembly of output.

Make measurement of lining wear at least once per year, in particular, however, in case of modified braking behavior, like:

- Brake noises
- Reduced braking power
- Modified deceleration
- Modified brake oil level
- Modified braking pressure

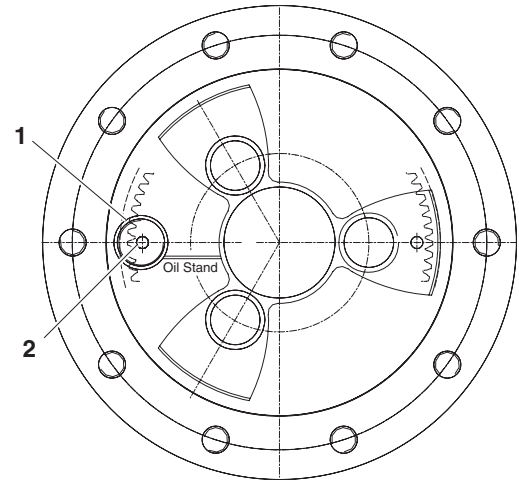
CAUTION!

To avoid injury when opening the oil drain/oil fill plug (1), because of a possible pressure buildup in the planetary carrier bring drain hole to topmost position (12 o'clock) and carefully unscrew oil drain and oil fill plug (1),

Then turn output until oil filler/oil drain hole (1) is on 9 o'clock position - Figure 10.

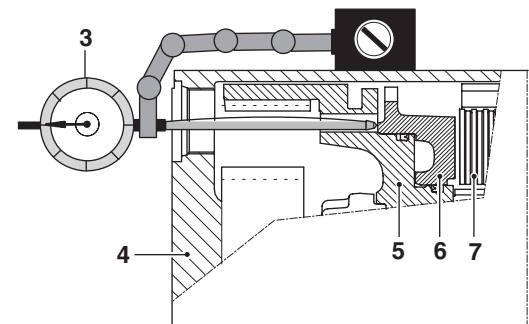
Drawings in Figure 11, Figure 12 are shown turned by 90°
Legend for Figure 10, Figure 11 and Figure 12

Reference Number	Description
1	Oil Filler / Oil Drain Hole
2	Gauge Hole ($\varnothing = 10$ mm) in Ring Gear - 9 o'clock Position
3	Dial Indicator With Solenoid Support
4	Planetary Carrier
5	Ring Gear
6	Piston
7	Plate Pack
X	Piston Stroke



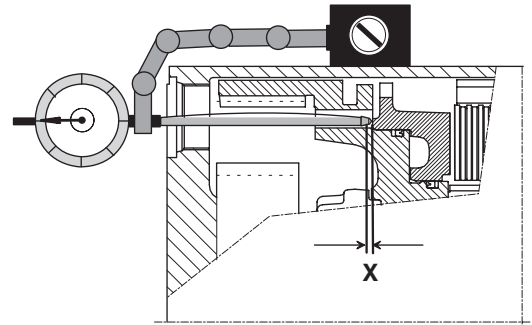
FG006855

Figure 10



FG002281

Figure 11



FG002282

Figure 12

Lining Wear Measurement of Multidisk Brake

With unapplied brake, piston is in contact with ring gear by compression spring return - Figure 11

- get dial indicator (3) into touch with piston (6) through oil filler/oil drain hole (1) and gauge hole (2).
- Apply pressure on brake and determine piston stroke (X. Figure 12) using dial indicator
- Take limit value of piston stroke (at max. wear) from the chart below

Axle type	Lined disks	Piston stroke with new disks	Limit value of piston stroke (X) at max. wear
MT-E 3050	8 pcs.	1.2 - 1.8 mm	7.0 mm
MT-E 3060	6 pcs.	0.7 - 1.3 mm	6.0 mm
MT-E 3070	7 pcs.	0.7 - 1.3 mm	6.5 mm
MS-E 3050	8 pcs.	1.2 - 1.8 mm	7.0 mm
MS-E 3060	6 pcs.	1.2 - 1.8 mm	6.0 mm
MS-E 3070	7 pcs.	1.2 - 1.8 mm	6.5 mm

Make lining wear measurement on both outputs!

Then provide oil drain/fill plug with new O-ring and install it.

Tightening torque (M36x1.5)MA = 50 Nm

DISASSEMBLY

1. Mount the axle to the assembly truck.
(Illustration shows axle version MT-E 3060 with attached HL transmission)



Figure 13

FG002518

2. Loosen oil drain plug and drain oil from the axle - use suitable collecting basin.



Figure 14

FG002519



WARNING!

To avoid injury when opening the oil drain and oil fill plug, because of a possible pressure buildup in the oil system of the planetary carrier

- bring drain hole to topmost position (12 o'clock) and carefully unscrew oil drain and oil fill plug.

Then bring drain hole to lowermost position (6 o'clock) and drain oil from outputs - use suitable collecting basin! Then bring drain hole to 6 o'clock position and drain the oil.



Figure 15

FG002520

CAUTION!

When working on the differential/input, you can disassemble the output as a unit (Figure 16) and no complete disassembly is required as illustrated in Figure 17 - Figure 35.

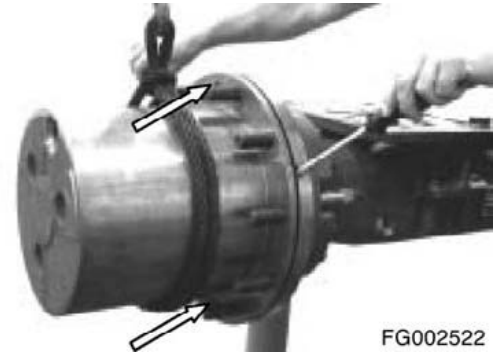
For this purpose secure output assembly using lifting bracket, loosen threaded connections and separate output assembly from axle housing.



FG002521

Figure 16

3. Secure planetary carrier using lifting strap, loosen both cylinder screws (arrows) and separate planetary carrier from hub.



FG002522

Figure 17

4. Unsnap retaining ring.



FG002523

Figure 18

5. Remove planetary gear using two-armed puller.



FG002524

Figure 19

A. Version MT-E 3060/3070

Unsnap retaining ring and remove washer behind.

Then remove roller bearing, second retaining ring and washer from planetary gear.



FG002525

Figure 20

B. Version MT-E 3050

Unsnap the angle rings and pull out of the planetary gear.



FG002526

Figure 21

6. Remove slotted nut mount (cylinder screw).



FG002527

Figure 22

7. Loosen slotted nut.



FG002528

Figure 23

8. Remove sun gear shaft and stub shaft.



Figure 24

9. Press off ring gear with piston.

! CAUTION!

Pay attention to the releasing O-ring (arrow)

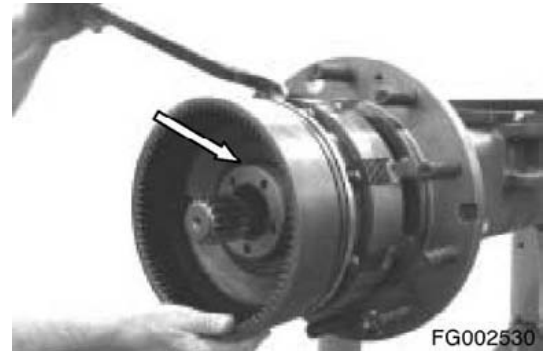


Figure 25

10. Loosen hex screws, remove spring sleeves and compression springs.



Figure 26

11. Press piston from ring gear.



Figure 27

12. Remove sealing elements (arrows) from ring gear.



Figure 28

13. Remove plate pack.



Figure 29

14. Remove O-ring (arrow) and lift off disk carrier with lever, then remove releasing O-ring.

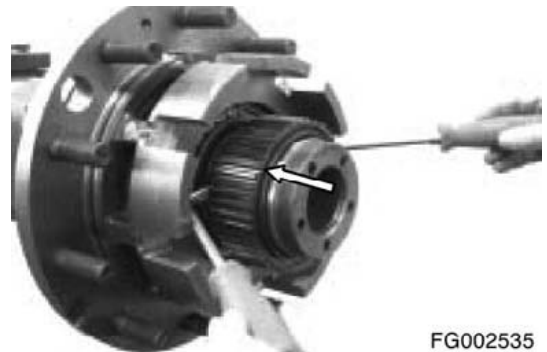


Figure 30

15. Secure hub using lifting bracket, pull hub from hub carrier using pressure piece and two-armed puller.



CAUTION!

Pay attention to the releasing bearing inner ring



Figure 31

16. Lift off shaft seal (arrow) with lever and remove both bearing outer rings from hub.



Figure 32

17. Only for axle type MT-E 3060:
Remove spacer bushing.



Figure 33

18. Pull bearing inner ring from hub.



Figure 34

19. Fix hub carrier using a strap, loosen threaded connection and separate hub carrier from axle housing.
Then remove single components such as screw neck, breather valve and O-ring from hub carrier.

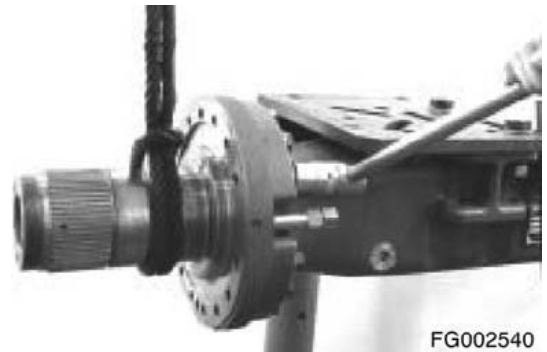


Figure 35

REASSEMBLY

Legend for Figure 36

Reference Number	Description
1	Axle Housing
2	Hub Carrier
3	Hub
4	Multidisk Brake
5	Planetary Carrier

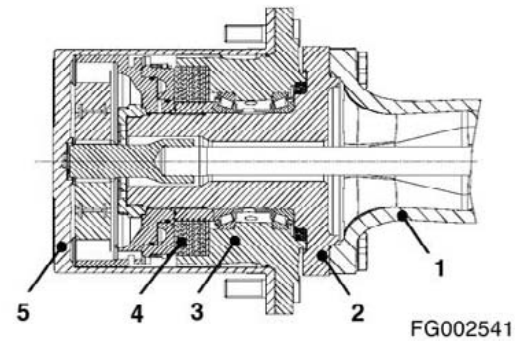


Figure 36

Hub Carrier/Hub

1. Oil O-ring (1) and install on hub carrier.
Only applicable for assembly of a new hub carrier
Close machining apertures (2) of the oil supply holes with blanking plug.

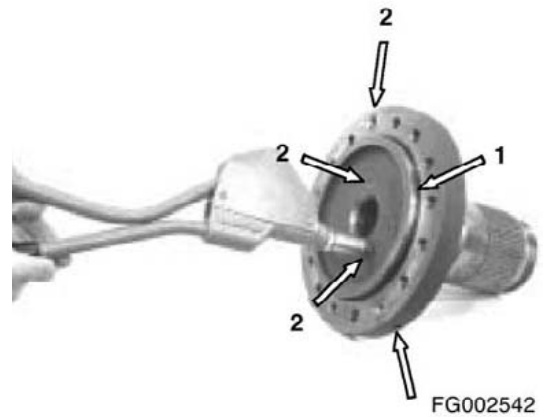


Figure 37

2. Install preassembled hub carrier to axle housing, considering the installation position - stamped circle in 12 o'clock position (see arrow) - fix with hex screws and washers
Tightening torque (M16/10.9)MA = 280 Nm



Figure 38

3. Install heated bearing inner ring until contact.

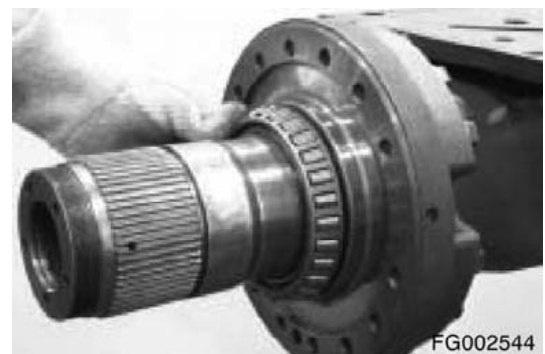


Figure 39

4. Only for axle type MT-E 3060:

Install spacer bushing.



Figure 40

5. Mount wheel bolts (1).

Insert both bearing outer rings (2) of the hub bearing until contact.

Oil O-ring (3) and locate in annular groove of hub.

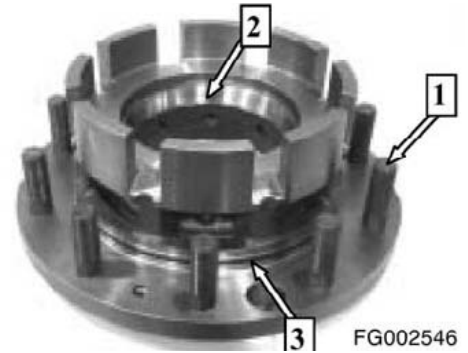


Figure 41

6. Mount shaft seal, considering installation position (marking OUTSIDE looking upward/outward) and rim offset "X" - see detailed Figure 43.



Figure 42

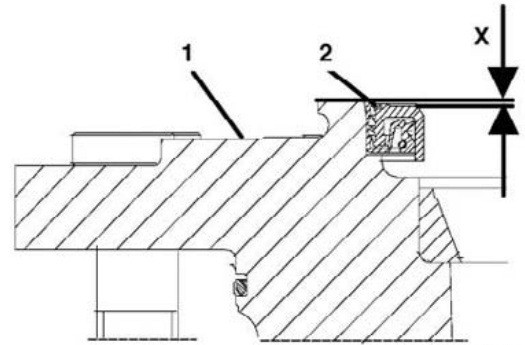
7. Legend for Figure 43 and Figure 44.

Reference Number	Description
1	Hub
2	Shaft Seal
X	Rim Offset

MT-E 3050/3060 → $X = 0.0 - 0.3 \text{ mm}$

MT-E 3070 → $X = 6.0^{+0.2} \text{ mm}$

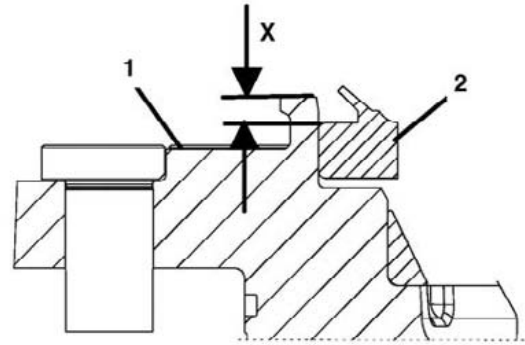
A. Version MT-E 3050/3060



FG002571

Figure 43

B. Version MT-E 3070



FG002572

Figure 44

! CAUTION!

Apply sealing compound (Loctite #574) to contact face of shaft seal/hub.

! CAUTION!

Wet contact face of shaft seal/hub carrier with spirit at the very beginning of the assembly - assembly aid.

8. Install preassembled hub until contact and fix with heated outer bearing inner ring.



FG002548

Figure 45

9. Oil O-ring and locate in annular groove (arrow) of disk carrier.

Then install disk carrier.



Figure 46

FG002549

10. Bring hub bearing into contact position (Figure 47 - 50):
Install ring gear (without sealing elements).



Figure 47

FG002550

11. Insert stub shaft and sun gear shaft
(support for slotted nut wrench - Figure 49).



Figure 48

FG002551

12. Bring hub bearing into contact position. for this purpose
tighten slotted nut with a tightening torque of max.
1,400 Nm.

! CAUTION!

Apply thread - hub carrier/slotted nut - with lubricant

! CAUTION!

While tightening the slotted nut rotate hub in both
directions several times - roller setting



Figure 49

FG002552

13. Loosen slotted nut again and remove ring gear.



Figure 50

Multidisk Brake

1. Install disk pack alternately starting with an outer disk.

! CAUTION!

Pay attention to installation position of inner disks - Figure 52

! CAUTION!

Take the actual necessary plate arrangement from the corresponding spare parts list.

2. Installation position of inner disks

! CAUTION!

Position inner disks in such a way that one of the tooth recesses (arrow) is in 6 o'clock position - when axle is installed in vehicle

! CAUTION!

Inner clutch disks $s = 2.5$ mm (standard)

Install inner disks with $s =$ alternatively (2.0-2.5-3.0 mm) - required to set the disk clearance - on outside position in disk pack



Figure 51



Figure 52

3. Oil O-ring and locate in annular groove of disk carrier.



Install O-ring using grease - assembly aid.



Figure 53

4. Oil sealing elements and locate in annular grooves (arrows) of ring gear as shown in the detailed Figure 55.



Pay attention to installation position and arrangement of sealing elements.



Figure 54

Legend for Figure 55.

Reference Number	Description
1	Ring Gear
2	Support Ring
3	U-ring
4	U-ring
5	Support Ring

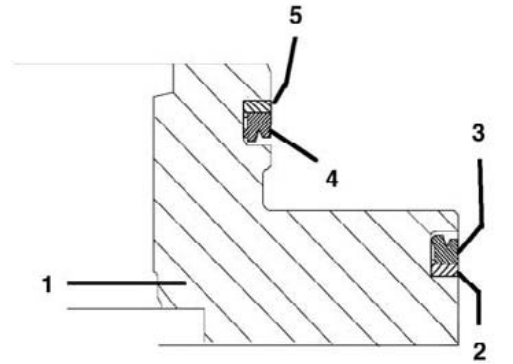


Figure 55

5. Just for. assembly of new parts. or if disassembled.
Mount all cylindrical pins into piston considering installation dimension "X"
MT-E 3050 = 18.00 mm
MT-E 3060 = 16.00 mm
MT-E 3070 = 16.00 mm



Figure 56

6. Install piston on preassembled ring gear.



Figure 57

FG002559

Detail "A"

Reference Number	Description
1	Hex. Screw
2	Spring Sleeve
3	Compression Springs (Outer)
4	Compression Springs (Inner)

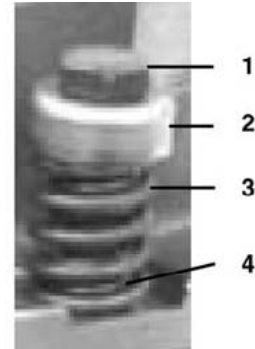


Figure 58

FG002562

7. Fix piston with spring sleeve (2), compression springs (3 and 4) and. new. hex. screws (1).

CAUTION!

Use hex. screws just once for assembly

Tightening torque (M6/8.8)MA = 11 Nm

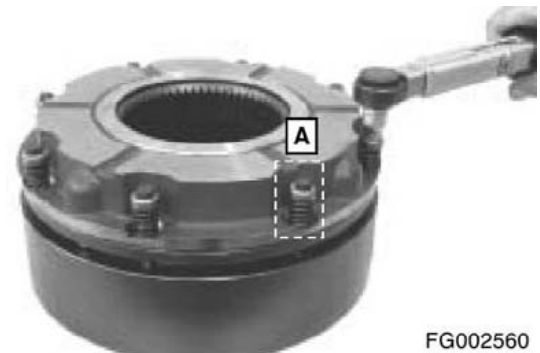


Figure 59

FG002560

8. Mount preassembled ring gear, considering installation position (markings O in 12 o'clock position - see arrows, Detail "B")

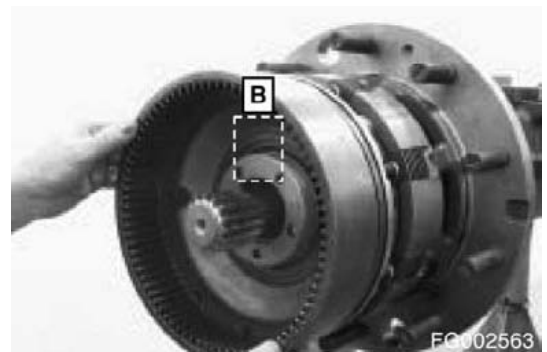
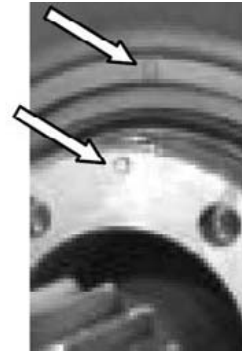


Figure 60

FG002563

Detail "B"



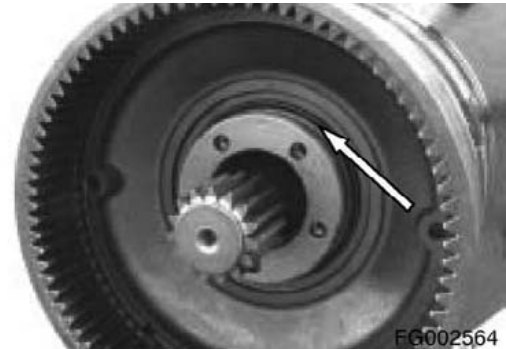
FG002567

Figure 61

9. Oil the O-ring and insert it in recess (arrow).

! CAUTION!

Apply thread - hub carrier/slotted nut - with lubricant



FG002564

Figure 62

10. Fix ring gear with slotted nut.

! CAUTION!

First tighten slotted nut with 1,400 Nm, then retighten slotted nut until a fixing hole overlaps a threaded hole in the hub carrier - in this connection also refer to Figure 69

! CAUTION!

While tightening the slotted nut rotate hub in both directions several times - roller setting

Tightening torque (M110 x 1.5) $M_A = 1,400^{+200}$ Nm



FG002565

Figure 63

Make Leakage Test of Multidisk Brake

1. Mount breather valve (arrow) and connect HP-Pump (to connection hole on input side/hub carrier).

Breathe brake completely before starting the test.

Test media

Motor oils SAE-10W correspond, MIL-L 2104 C, MIL-L 46152, API-CC, CD, SC, SD, SE, ATF oils Type A, Suffix A, Dexron of II D

A. High-pressure test

Build up testing pressure $p = 100$ bar and close locking valve of HP-Pump.

The pressure is allowed to fall by max. 3 bar during a 5-minute test duration.

B. Low-pressure test

Reduce testing pressure to $p = 5$ bar and close locking valve.

The pressure is not allowed to fall during a 5-minute testing duration!



Figure 64

FG002566

Adjust and Check Disk Clearance/Piston Stroke

1. Disk clearance/piston travel "X" = 1.2- 1.8 mm

Legend for Figure 65, Figure 66 and Figure 67

Reference Number	Description
1	Ring Gear
2	Measuring Hole
3	Piston
X	Disk Clearance/Piston Stroke



Figure 65

FG002568

Breathe brake completely before starting the test.

Build up braking pressure (100 bar) and find dimension "A," from front face/ring gear (1) through measuring hole (2) - Figure 65 and Figure 66 - to front face/piston (3).

Dimension A. e.g. = 83.50 mm

Release pressure from brake - i.e. no pressure applied on brake, piston is in contact with ring gear (reset piston through compression springs) - and find dimension "B" from front face/ring gear (1) through measuring hole (2) - Figure 65 and Figure 67 - to front face/piston (3).

Dimension "B" z.B. = 82.10 mm

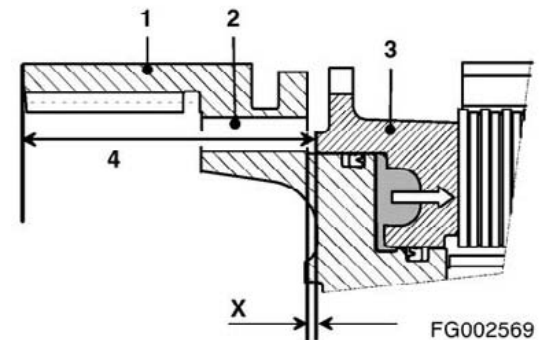


Figure 66

FG002569

Calculation Example:

Dimension "A" z.B. 83.50 mm
 Dimension "B" z.B. - 82.10 mm
 Result → disk clearance = 1.40 mm



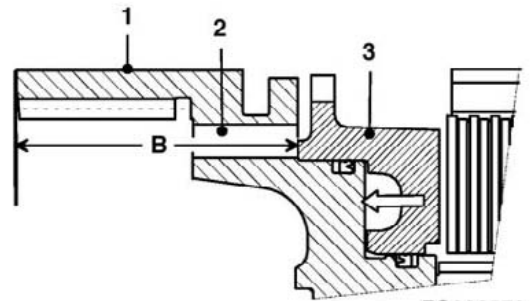
If the required disk clearance/piston stroke ($X = 1.2 - 1.8 \text{ mm}$) is not achieved, correct it with corresponding inner clutch disk(s) - Figure 52!

2. Dismantle HP-Pump and mount screw neck with O-ring. (Just for transport protection - mount protection cap with O-ring on screw neck).

Tightening torque (M 14x1.5) $M_A = 23 \text{ Nm}$

3. Secure slotted nut with cylinder screw - in this connection refer to note on Figure 63!

Tightening torque (M 10/8.8) $M_A = 32 \text{ Nm}$



FG002570

Figure 67



FG002573

Figure 68



FG002574

Figure 69

Planetary Carrier

adjust axial play of sun gear shaft: 0.3 - 1.0 mm (Figure 70- 80)

1. Determine dimension I, from mounting face of planetary carrier to contact face of thrust washer.

Dimension I, e.g. 260.65 mm



FG002575

Figure 70

2. Determine dimension II, from front face (arrow) of sun gear to mounting face of hub.

Dimension II, e.g. 255.70 mm

Calculation Example:

Dimension I e.g. 260.65 mm

Dimension II e.g. - 255.70 mm

Difference = 4.95 mm

Required axial play (average) e.g. - 0.75 mm

Result = required thrust washer(s) e.g. s = 4.20 mm

3. Insert thrust washer(s) (e.g. s = 4.20 mm) into planetary carrier and press into contact position.



Figure 71



Figure 72

4. Preassemble planetary gear, as shown in Figure 73 - see different versions.

Legend for Figure 73 and Figure 74 - version MT-E 3060/3070:

Reference Number	Description
1	Planetary Gear
2	Roller Bearing
3	Washer
4	Retaining Ring

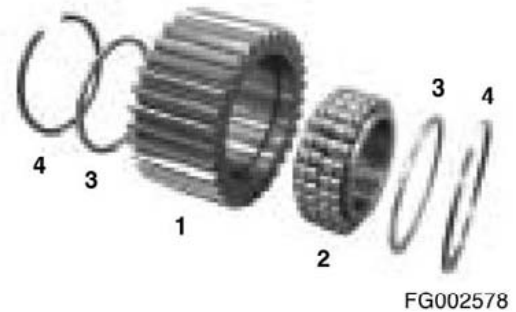


Figure 73

Legend for Figure 73 and Figure 74 - version MT-E 3050:

Reference Number	Description
1	Planetary Gear
2	Bearing Inner Ring
3	Plastic Ring (Assembly Aid)
4	Angel Ring



Figure 74

5. Warm up bearing inner ring and install preassembled planetary gear until contact.



Mount planetary gear or bearing inner ring with large radius looking to planetary carrier (downwards).



Figure 75

6. Fix planetary gear using retaining ring.



Figure 76

7. Install planetary carrier and fix with cylindrical screws.
Tightening torque (M12/8.8) $M_A = 55 \text{ Nm}$



Figure 77

Assembly of An Output Assembly (Figure 78)

Bring output assembly into position on axle housing by installing stub shaft into differential (axle bevel gear) - and fix with hex.

screws and washers

Tightening torque (M16/10.9) $M_A = 280 \text{ Nm}$



Figure 78



WARNING!

Before putting the axle into operation fill it with oil - for this purpose use lubrication and maintenance instructions, page 10.

In addition observe the vehicle manufacturer's regulations and instructions.

DISASSEMBLY

Differential / Input

1. Loosen oil drain plug and drain oil from the axle - use suitable collecting basin.



Figure 79



WARNING!

To avoid injury when opening the oil drain and oil fill plug because of a possible pressure buildup in the oil system of the planetary carrier - bring drain hole to topmost position (12 o'clock) and carefully unscrew oil drain and oil fill plug.

Then bring drain hole to lowermost position (6 o'clock) and drain oil from outputs - use suitable collecting basin.



Figure 80



CAUTION!

When working on the differential you can dismantle the output(s) as a complete unit (Figure 81).

2. Secure output assembly using lifting bracket, loosen threaded connection and separate output assembly from axle housing.



Figure 81

Input - HL Transmission

1. Fix HL transmission using a lifting strap and loosen threaded connection. (HL transmission / axle drive housing).



Figure 82

FG002587

2. Separate HL transmission from axle.

! CAUTION!

For assembly and disassembly of the HL transmission stick to Repair Manual "2 HL 250/270/290."



Figure 83

FG002588

3. Loosen threaded connection of axle housing half on crown wheel side.

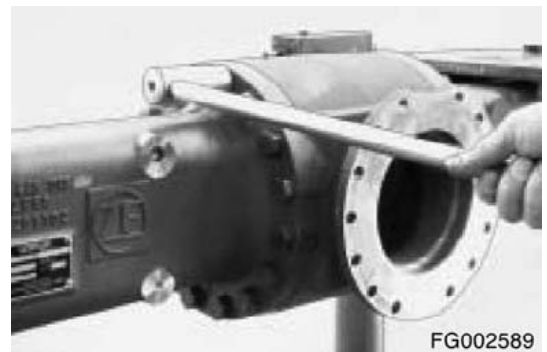


Figure 84

FG002589

! CAUTION!

Secure axle using a support (arrow).

4. Carefully separate axle housing half.

! CAUTION!

Pay attention to releasing differential.

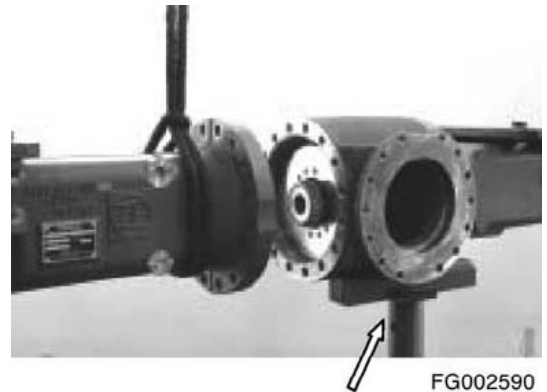


Figure 85

FG002590

5. Lift off differential assembly from axle drive housing.

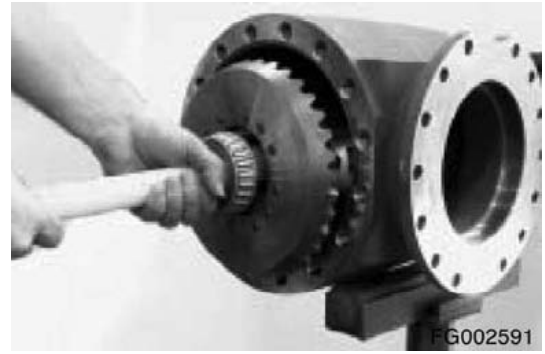


Figure 86

6. Pull bearing outer ring out of hole using a striker and remove shim behind (backlash).

! CAUTION!

Mark shim (installation position / bearing allocation) - assembly aid.

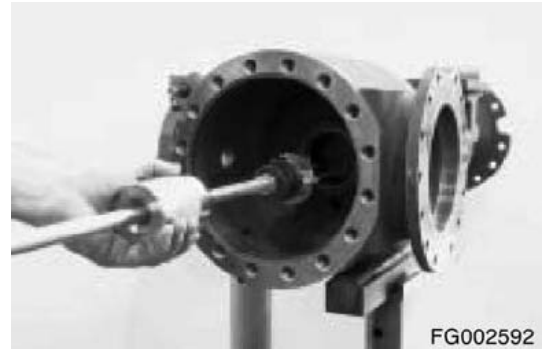


Figure 87

7. Remove bearing outer ring and shim behind (rolling torque differential bearing) from second axle housing half.

! CAUTION!

Mark shim (installation position / bearing allocation) - assembly aid!



Figure 88

Differential Type "D 500" and "D-750"

1. Illustration shows differential version "D-500."
Pull both taper roller bearings from differential carrier.



Figure 89

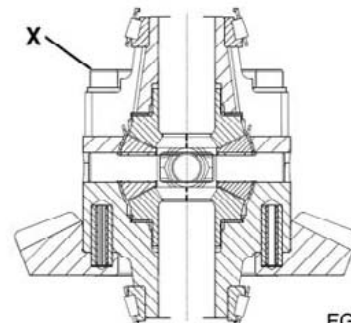
2. Loosen threaded connection (see position "X").



FG002595

Figure 90

- A. Version "D-500"



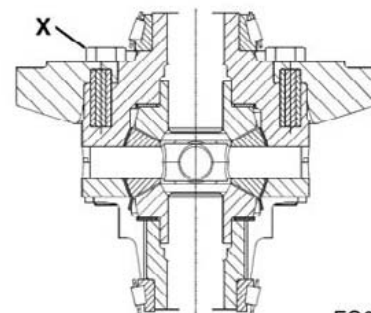
FG002598

Figure 91

- B. Version "D-750"



At Version "D-750" screw connection are insert with Loctite - difficult disassembly - heating up if necessary.



FG002599

Figure 92

3. Separate differential carrier halves and remove releasing single components.



Figure 93

4. Push crown wheel off from differential carrier half.

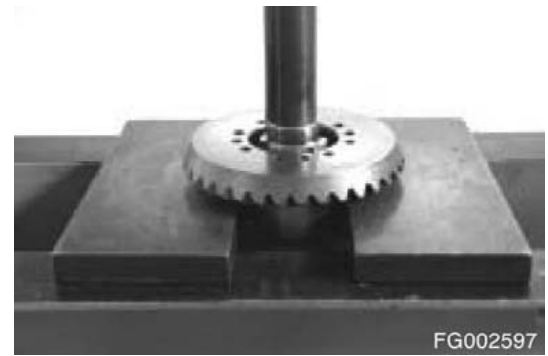


Figure 94

REASSEMBLY

Differential / Input

Differential - Type "D-500" and "D-750"

1. Illustration shows differential version "D-500"

Mount slotted pins (arrows) - considering the assembly specification, Figure 96 - into differential carrier half.



Figure 95

Assembly Specifications

Position slotted pin(s) so slot is looking into the direction of force (arrow). In case of double slotted pins - bring the slots in a 180° degrees offset position to each other.

See Figure 96.

Reference Number	Description
1	Differential Carrier
2	Slotted Pin
3	Slotted Pin (Just for Double Slotted Pin Version)
4	Force Direction

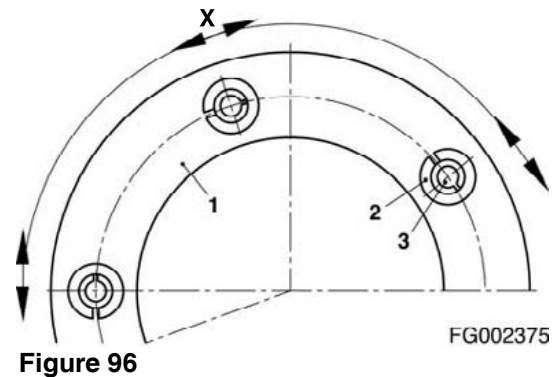


Figure 96

2. Insert two adjusting screws into crown wheel and press differential carrier until contact.



Figure 97

3. Insert thrust washer and axle bevel gear.

! CAUTION!

**Put driving lugs of thrust washer into driving holes/
differential carrier - do not position in oil supply
recesses.**



Figure 98

4. Install differential bevel gears and thrust washers on differential spider and insert in differential carrier half I.

! CAUTION!

Ensure radial installation position of thrust washers.

Lug is looking vertically upward (see arrows).

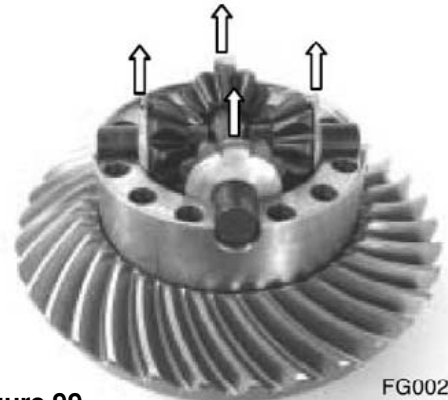


Figure 99

5. Insert second axle bevel gear.



Figure 100

6. Stick thrust washer with grease (assembly aid) into differential carrier half II.

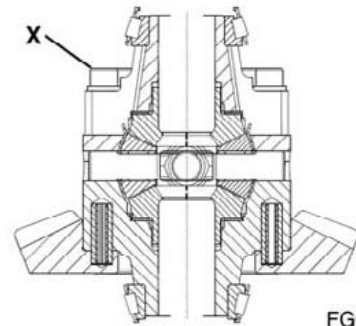
! WARNING!

**Put driving lug of thrust washer into driving bores/
differential carrier - do not position in oil supply
recesses.**



Figure 101

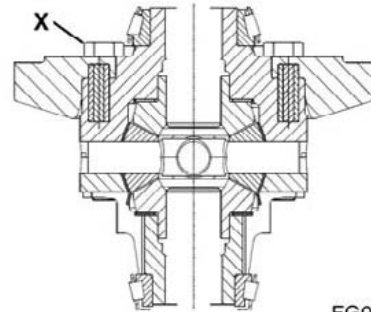
A. Version "D-500"



FG002598

Figure 102

B. Version "D-750"



FG002599

Figure 103

7. Fasten differential carrier halves with cylinder. screws and washers (version D-500, pos. X) resp. with hex. screws (version D-750, pos. X).



CAUTION!

Only version "D-750" - insert the hex. screws with locking compound (Loctite # 262).



WARNING!

Ensure radial installation position - designation corresponds to radial position marking.

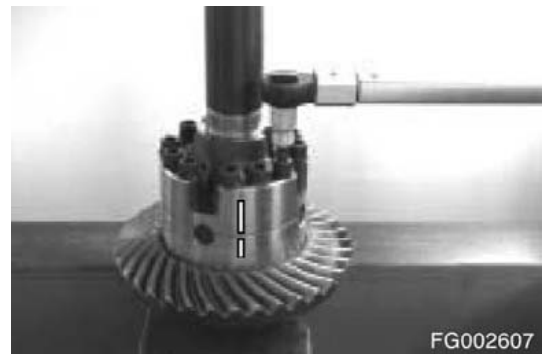
A. Version "D-500"

Tightening torque (M 12x1.5/12.9)..... $M_A = 145 \text{ Nm}$

B. Version "D-750"

Tightening torque (M 12x1.5/10.9)..... $M_A = 122 \text{ Nm}$

Tightening torque (M 16x1.5/10.9)..... $M_A = 300 \text{ Nm}$



FG002607

Figure 104

8. Install both bearing inner rings (arrows).

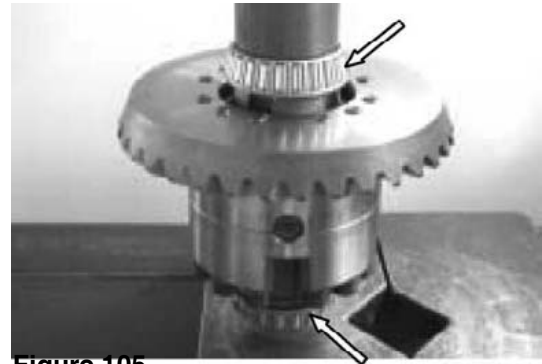


Figure 105

FG002610

9. Wet some tooth flanks of the crown wheel with marking ink (for contact pattern check - See Figure 119 on page -47).



Figure 106

FG002611

Determine Shim for Backlash (Crown Wheel/Drive Pinion)

Backlash

MT-E 3050/3060 = 0.12 - 0.24 mm

MT-E 3070 = 0.15 - 0.27 mm

Legend for Figure 107 thru Figure 117

Reference Number	Description
1	Axle Drive Housing
2	Shim Ring (Ø = 160 mm)
3	Differential (Crown Wheel)
4	Shim (Backlash)
5	Axle Housing Half
6	O-ring
7	Hexagon Screws (With Washer)
A	Mounting Face/Axle Drive Housing Until Shim Ring (Outer Diameter)
B	½ Ø Of Shim Ring
C	Mounting Face/axle Drive Housing Until Plane Face/Crown Wheel
D	Distance - Plane Face/Crown Wheel Until center/Differential (Imprinted On Crown Wheel)
X	Mounting Face/Axle Drive Housing Until Center/Axle Drive Housing (Drive Pinion Bore)

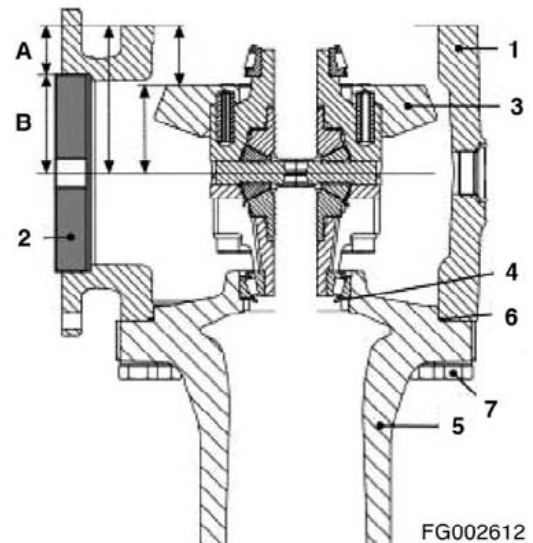


Figure 107

FG002612

Only for "New Part" Assembly or If Disassembled:

Install O-ring (6) and mount axle drive housing (1) - Pay attention to installation position axle drive housing (1) versus axle housing half (5).

Tightening torque (M18/10.9) $M_A = 390 \text{ Nm}$

1. Insert shim (backlash) into hole of axle housing half and install bearing outer ring until contact.

We would recommend to install the shim (e.g. $s = 1.20 \text{ mm}$), found during disassembly - also refer to disassembly instructions page 36, Figure 87.



WARNING!

However, the required backlash is decisive for the shim(s) to be used.

2. Install shim ring (arrow, $\varnothing = 160 \text{ mm}$) and determine dimension "A" - Figure 107, then remove shim ring.

Dimension "A" e.g. 39.92 mm

Calculation Example:

Dimension "A" z.B. 39.92 mm

Dimension "B" 80.00 mm

Result = Dimension "X" $= 119.92 \text{ mm}$

3. Install preassembled differential.



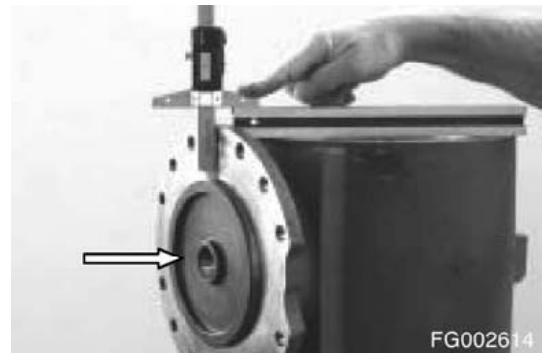
CAUTION!

Ensure that inserted differential is perfectly positioned (for this purpose rotate in both directions several times - roller setting).



FG002613

Figure 108



FG002614

Figure 109



FG002615

Figure 110

4. Determine dimension "C" - take measurements at several points and find out mean value.

! CAUTION!

Upon determination of dimension "C" take a corrective value of + 0.07 mm ($\frac{1}{2}$ value of bearing preload of differential bearing) into consideration.

Dimension "C" e.g. 48.98 mm

Corrective value - 0.07 mm

Result = 48.91 mm

5. Read dimension "D" (distance) from crown wheel, or measure it in case of a + or - deviation of the distance because of production (the concerned value is marked by hand on the crown wheel).

Distance "D" (without a + or - deviation) = 71.0 mm

Distance "D" with an indicated $+0.1$ deviation = 71.1 mm

Distance "D" with an indicated -0.1 deviation = 70.9 mm

Calculation Example:

Dimension "X" z.B. 119.92 mm

Dimension "C"(48.91)+ "D"(71.00) = 119.91 mm

Result = 0.01 mm

! CAUTION!

If the value of dimension "X" is not achieved, use a corresponding shim for correction (see item 4 - Figure 107).

! CAUTION!

Position the bearing outer ring on the bearing inner ring, until all rollers are located without any play.

For the following determination of dimension pay attention to an exact contact of the bearing outer ring and to a correct positioning of the differential.

6. Determine dimension "Y" - from mounting face/axle drive housing to front face / bearing outer ring (take measurements at several points and determine mean value).

Dimension "Y" e.g. 18.11 mm



Figure 111



Figure 112

7. Determine dimension "Z" - from mounting face / axle housing to bearing hole/bearing outer ring contact.

Dimension "Z" e.g. 17.25 mm

Calculation Example:

Dimension "Y" e.g. 18.11 mm

Dimension "Z" e.g. - 17.25 mm

Difference 0.86 mm

Bearing preload ($0.15 \wedge 3.0 - 4.0 \text{ Nm} + 0.15 \text{ mm}$)

Result = 1.01 mm

Required shim(s) = 1.00 mm



A bearing preload of 0.15 mm corresponds to a bearing rolling moment of approx. 3.0 - 4.0 Nm, when using new taper roller bearings.



Figure 113

FG002618

8. Insert the determined shim (e.g. $s = 1.00 \text{ mm}$) into bearing hole and install bearing outer ring until contact.



Figure 114

FG002619

9. Install preassembled axle housing half (pay attention to radial installation position), fix with hex. screws and washers.

Tightening torque (M18/10.9) $M_A = 390 \text{ Nm}$



Figure 115

FG002620



WARNING!

Bring axle into horizontal position and secure with support.

10. Position HL transmission on the axle and fix it.
Tightening torque (M12/8.8) $M_A = 79 \text{ Nm}$



Figure 116

Check Backlash and Contact Pattern

1. Place dial indicator through oil drain hole at right angles to a tooth flank of the crown wheel (in the outer diameter area) and check backlash.

Backlash

MT-E 3050/3060 = 0.12 - 0.24 mm

MT-E 3070 = 0.15 - 0.27 mm



Figure 117



CAUTION!

If, in case of a deviation, the required backlash is not achieved, correct it with a suitable shim (Figure 108).

A correction of the shim/backlash also requires a correction to the opposite direction of shim/bearing rolling moment (Figure 114).

2. Disassemble HL transmission again.



Figure 118

3. Remove differential.

Compare contact pattern (see arrow) with contact pattern examples on page 7 - 9.

! CAUTION!

If contact pattern differs considerably, check pinion distance of HL transmission - for this purpose refer to repair manual 2 HL-250/270/290 accordingly.

4. Reinstall differential.

5. Oil O-ring and install on axle housing half (arrow).

6. Bring axle housing half into correct position (pay attention to correct installation position), fix with hex screws and washers.

Tightening torque (M18/10.9) $M_A = 390 \text{ Nm}$



Figure 119

FG002624

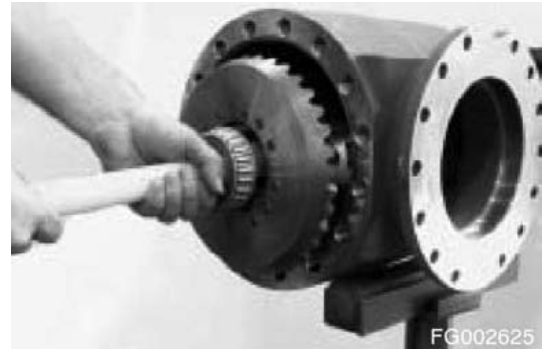


Figure 120

FG002625



Figure 121

FG002626



Figure 122

FG002627

Reassembly of Output Assembly (Figure 123 - 125)

1. Install plug shaft into splines of axle bevel gear.

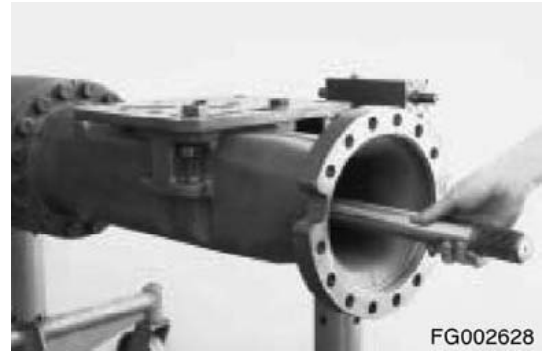


Figure 123

2. Bring output assembly on axle housing into correct position, by mounting the plug shaft into the sun gear shaft.



Observe O-ring (arrow).

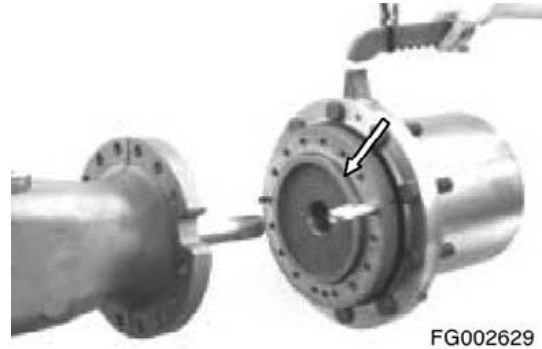


Figure 124

3. Fix output unit with hex screws and washers.
Tightening torque (M16/10.9) $M_A = 280 \text{ Nm}$
4. Mount the second drive in the same way.



Before putting the axle into operation fill it with oil - for this purpose stick to the lubrication and maintenance instructions, page 10 - 12.

In addition observe the vehicle manufacturer's regulations and instructions.



Figure 125

Engine and Drivetrain

Transmission

Edition 1

MEMO

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SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

LAYOUT 2 HL 250/270/290 AXLE ATTACHMENT

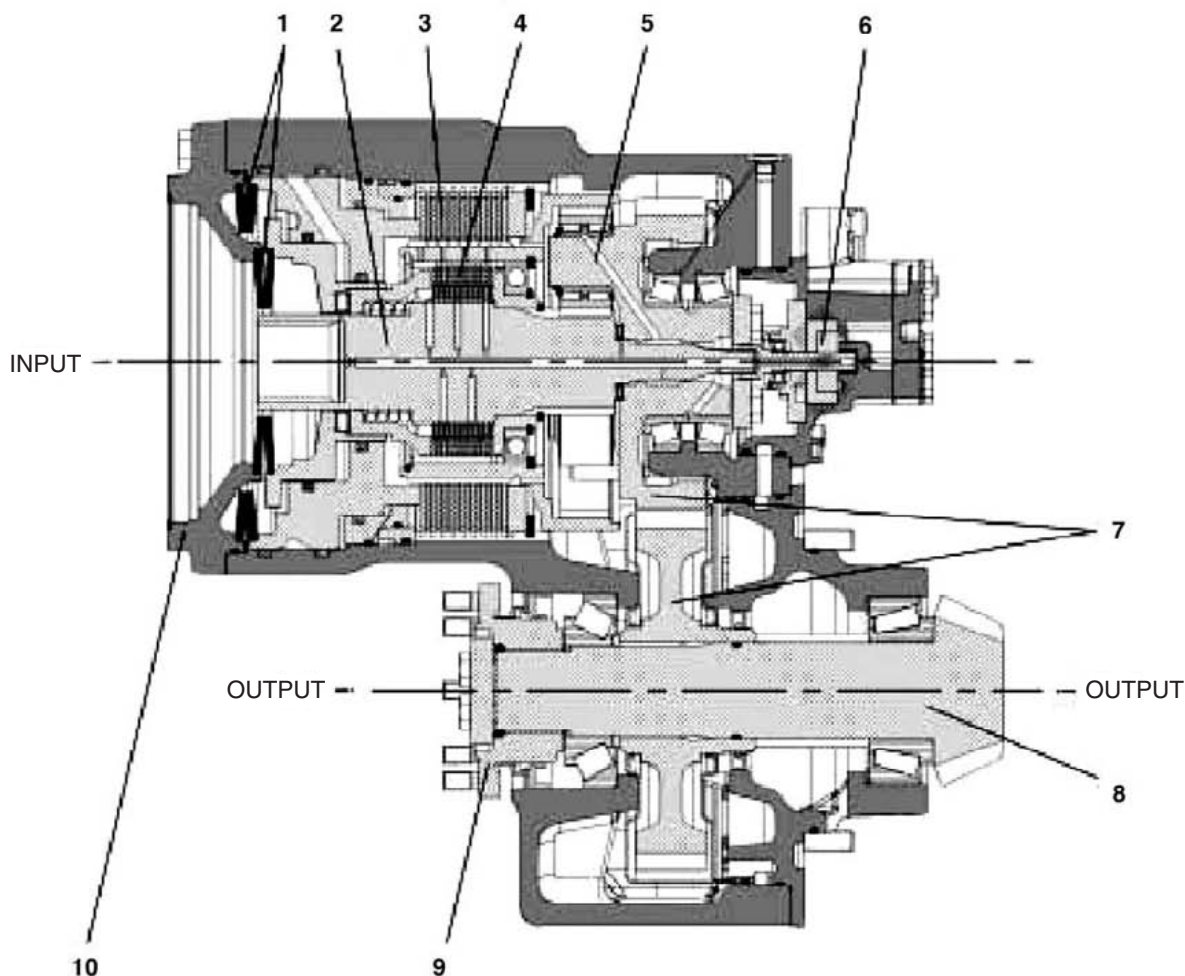


Figure 1

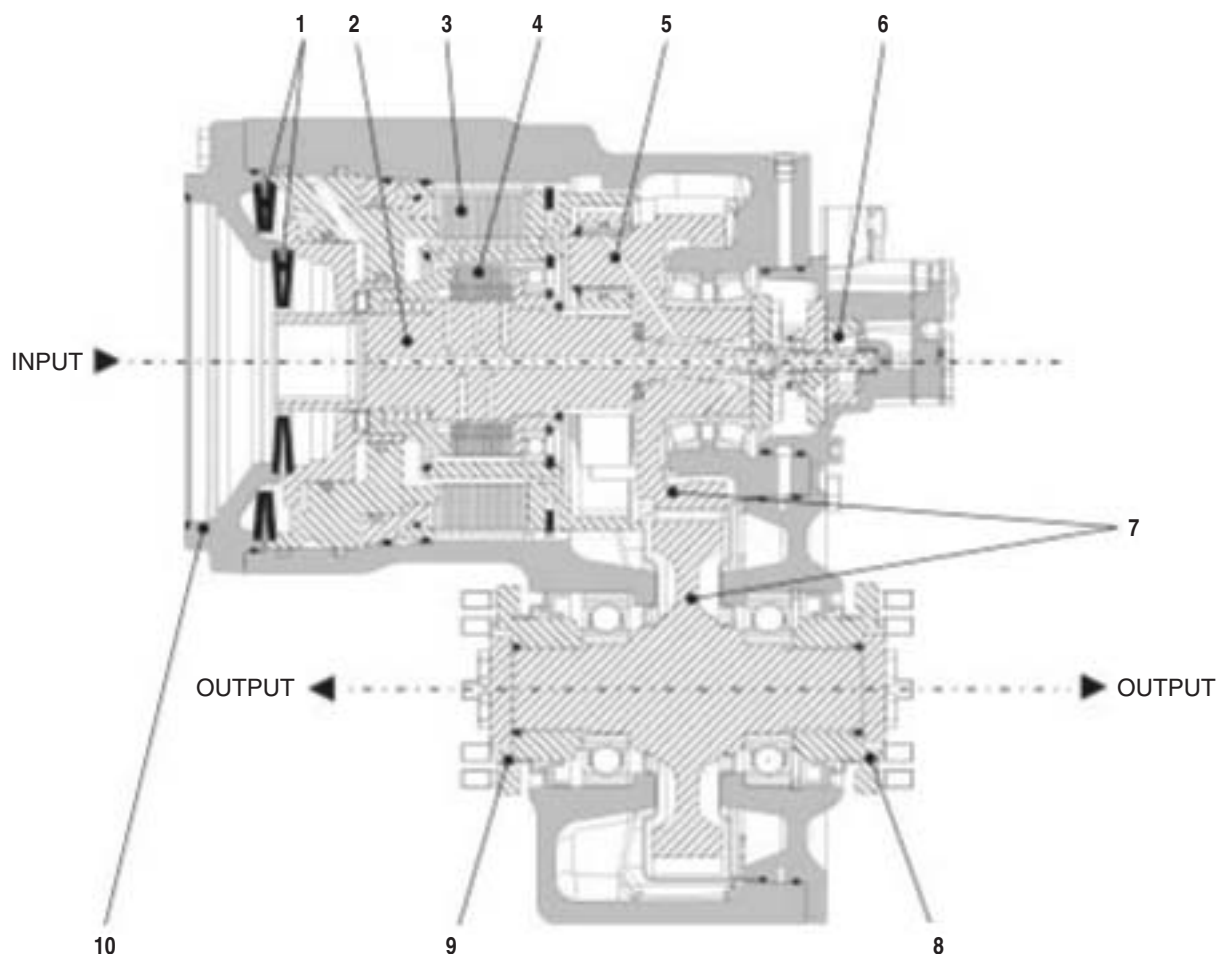
FG007281

Reference Number	Description
1	Cup Springs for Multidisk Brake and Multidisk Clutch
2	Input Shaft
3	Multidisk Brake
4	Multidisk Clutch
5	Planetary Drive

Reference Number	Description
6	Lube Oil Pump
7	Spur Gear Drive
8	Output Pinion - Rear Axle Direct Attachment
9	Output Flange - Front Axle
10	Attachment Hydro - Motor

LAYOUT 2 HL 250/270/290

SEPARATE INSTALLATION



FG007282

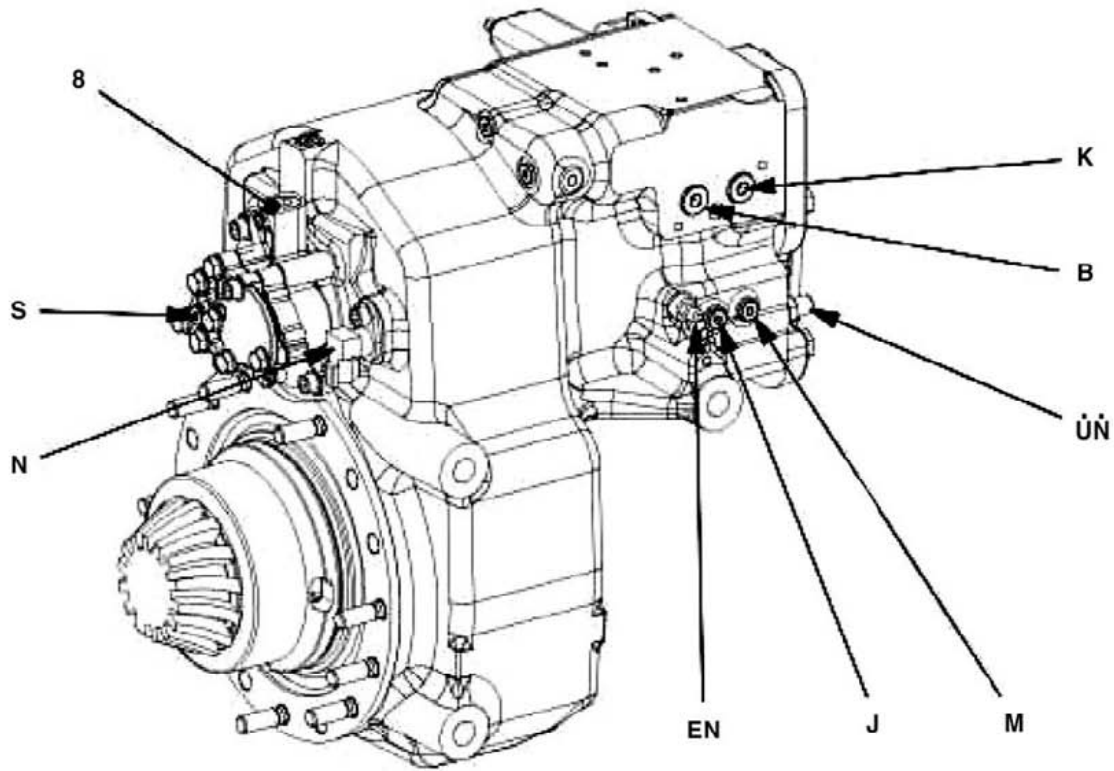
Figure 2

Reference Number	Description
1	Cup Springs for Multidisk Brake and Multidisk Clutch
2	Input Shaft
3	Multidisk Brake
4	Multidisk Clutch
5	Planetary Drive

Reference Number	Description
6	Lube Oil Pump
7	Spur Gear Drive
8	Output Flange - Rear Axle
9	Output Flange - Front Axle
10	Attachment Hydro - Motor

MEASURING POINTS AND CONNECTIONS OR INSTALLATION VIEW 2 HL 250/270/290 LAYOUT "AXLE ATTACHMENT"

(With electric downshift interlock integrated in the vehicle)

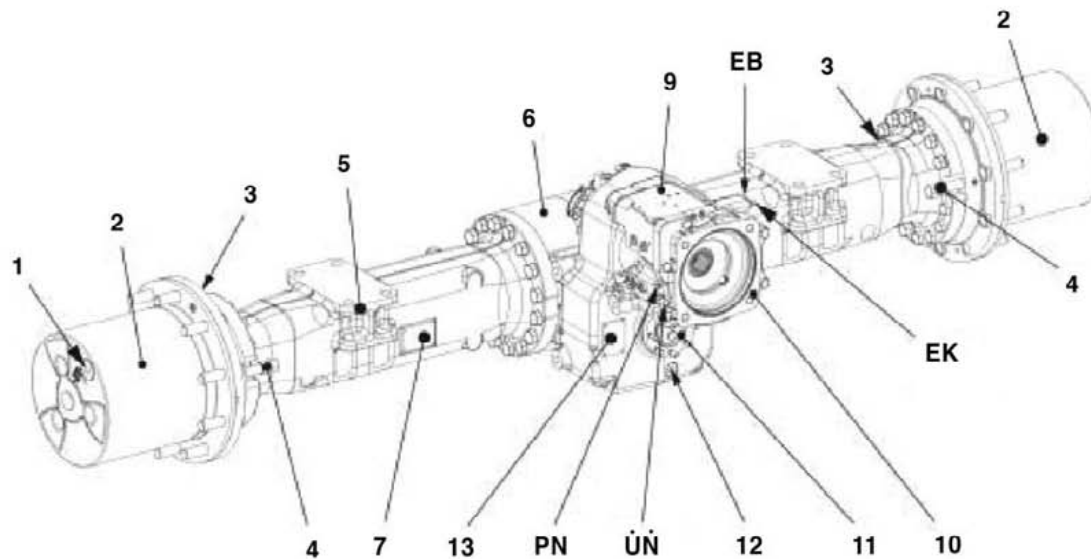


FG002635

Figure 3

Reference Number	Description
8	Lube Oil Pump
B	Brake (M16x1.5)
K	Clutch (M16x1.5)
J	Road Speed (Brake - M10x1)
M	Off-road Speed (Clutch - M10x1)

Reference Number	Description
N	Speed Transmitter (Output Speed)
S	Lubrication Pressure (M10x1)
EN	Bleeder Valve (Emergency Actuation Parking Brake)
UN	Pressure Relief Valve (Emergency Actuation Parking Brake)



FG002636

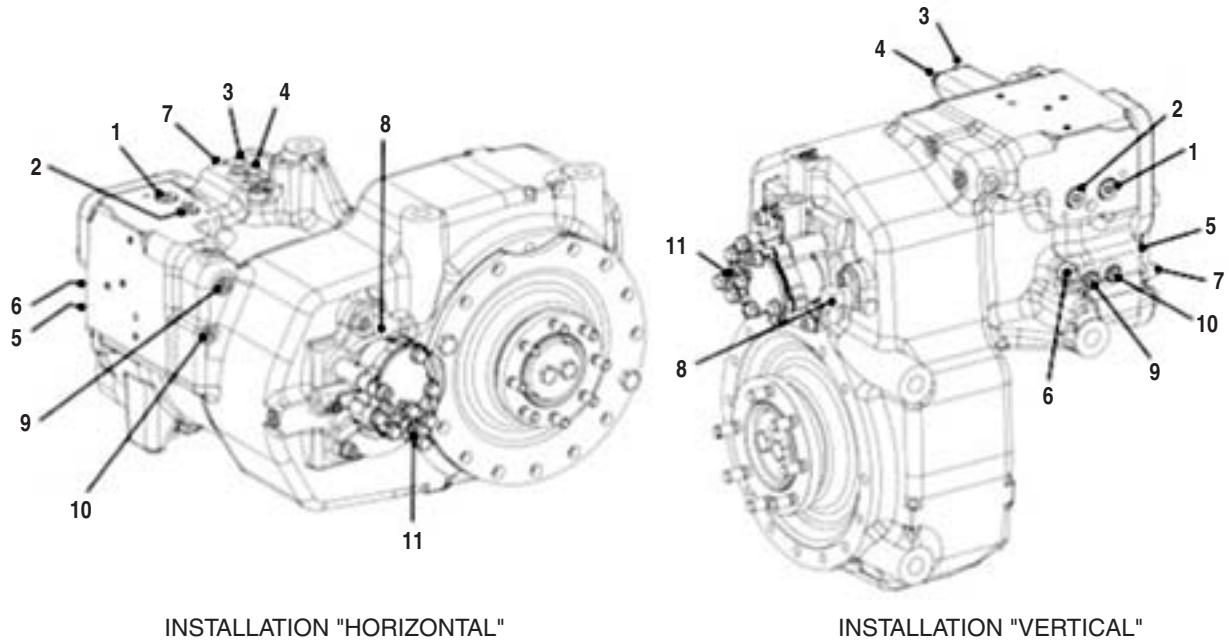
Figure 4

Reference Number	Description
1	Oil Filter and Oil Drain Plug (M36x1.5)
2	Wheel Head LH and RH
3	Bleeder Service Brake
4	Connection Service Brake (13/16 - 16 UNF)
5	Axle Casing
6	Axle Drive Housing
7	Model Identification Plate - Axle
8	Lube Oil Pump
9	Transmission 2 HL 250/270/290
10	Connection Hydro-motor
11	Output Flange - Front Axle

Reference Number	Description
12	Oil Drain Plug - Transmission (M24x1.5)
13	Model Identification Plate - Transmission
EB	Bleeder Valve (Brake)
EK	Bleeder Valve (Clutch)
PN	Emergency Actuation Parking Brake (Grease Fitting - Connection to Din 71 412)
UN	Pressure Relief Valve (Emergency Actuation Parking Brake)

MEASURING POINTS AND CONNECTIONS ON THE 2 HL 250/270/290 TRANSMISSION - VERSION "SEPARATE INSTALLATION"

(With electric downshift interlock integrated in the vehicle)



FG007283

Figure 5

Reference Number	Description
1	Pressure Oil Connection - Multidisk Clutch
2	Pressure Oil Connection - Multidisk Brake
3	Bleeder Valve - Clutch
4	Bleeder Valve - Brake
5	Lubrication Nipple (Emergency Release Parking Brake)
6	Bleeder Valve (Emergency Release Parking Brake)

Reference Number	Description
7	Bleeder Pressure Relief Valve (Emergency Release Parking Brake)
8	Speed Transmitter
9	Measuring Point - Road Speed (Brake)
10	Measuring Point - Off-road Speed (Clutch)
11	Measuring Point - Lubrication Pressure

NOTES TO THE REQUIRED OIL QUALITY AND OIL FILLING CAPACITY

Oil Quality / Oil Grade

Only oils according to the "Table of Recommended Lubricants" pages of operation manual.

Oil Filling Capacity for Power Shift Transmissions (2 HL-250/270/290)

- vertical installation position: approx. 2.5 liters
- horizontal installation position: approx. 3.0 liters

oil sump volume - in the transmission to be filled initially (i.e. after dis - and reassembly).

The values indicated are approximate values.

Specifications - as to oil level check, oil and filter change - are indicated in the Operating Instructions.

For the Version "Axle Attachment"

Oil level check and oil change for the Axle see the respective lubrication and maintenance instructions in the relating repair manuals!

SEPARATE THE HL-TRANSMISSION FROM THE AXLE CASING

(Only for the Version "Axle Attachment")

1. Drain oil from the axle casing.
use a suitable collector.



FG002644

Figure 6

2. Pickup the HL-Transmission using the lifting tackle, loosen the bolt connection and the complete HL-Transmission from the axle casing.



FG002645

Figure 7

DISASSEMBLY - BRAKE / CLUTCH / PLANET CARRIER

1. Mount the transmission to the assembly truck.



CAUTION!

Illustration shows the HL-Version "Axle Attachment"



FG002646

Figure 8

2. Loosen the screw plug and drain the oil - use a suitable collector.



FG002647

Figure 9

Lube Oil Pump/Downshift Interlock

Version "Lube Oil Pump"

Remove lube oil pump or the downshift interlock (depending on the version) (Illustration shows - Version "Lube Oil Pump").



CAUTION!

Disassembly of the lube oil pump/downshift interlock - See "Disassembly - Lube Oil Pump/Downshift Interlock" on page -82..



FG002648

Figure 10

Speed Transmitter

Loosen the screw and pull off the speed transmitter.



Figure 11

Emergency Release (Parking Brake)

(Illustration - Figure 12 - 15 - shows Version "Transmission Installation Position Vertical")

CAUTION!

Position of the single connection or bleeder valves / lubrication nipples etc., as to the Version "Transmission Installation Position Horizontal" - See Figure 215 on page - 79.

1. Remove bleeder.
2. Remove compression spring and the ball.



Figure 12



Figure 13

3. Remove threaded element (see Detail "X") with O-ring from the bore.



Figure 14

4. Remove lubrication nipple, both screw plugs and the bleeder valve - see arrow.

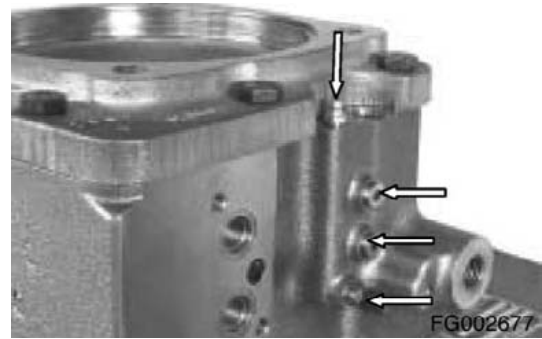


Figure 15

Input Housing and Modulation Valve



Loosen the bolt connection of the input housing equally - the input housing is subject to a cup spring and compression spring preload.



Figure 16

1. Take off the input housing and remove O-ring (arrow).



Figure 17

2. Modulation valve:

Remove compression spring and the O-ring (arrow).

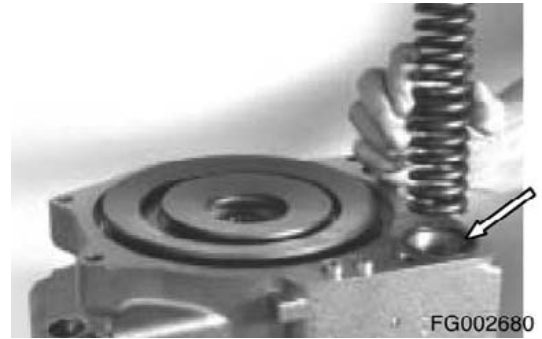


Figure 18

3. Pull the complete piston out of the bore.



Figure 19

Brake / Clutch

1. Remove cup springs from the brake.



Figure 20

2. Remove cup springs from the clutch.



Figure 21

3. Remove piston.



Figure 22

4. Remove both cylinder pins (arrows).

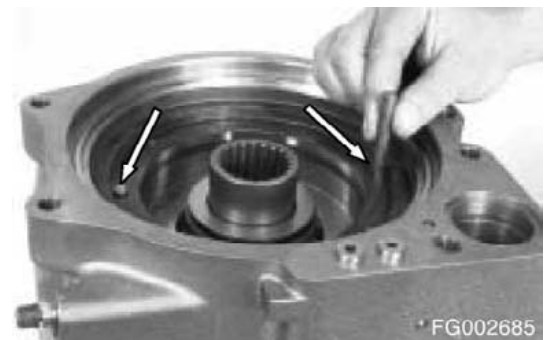


Figure 23



WARNING!

Attach 2 (two) eyebolts and pull the piston cautiously out of the housing - risk of damage.



Figure 24

5. Remove both seals (arrows) from the piston.



Figure 25

6. Remove axial roller cage with both thrust washers.



Figure 26

7. Remove pressure piece and the compression spring.



Figure 27



WARNING!

Remove pressure ring with ring - also See Figure 29 - cautiously using lever action - risk of damaging the sealing surfaces.



CAUTION!

Ring can also remain in the housing - disassemble the ring separately.



Figure 28



WARNING!

Remove pressure ring from the ring cautiously using lever action - risk of damaging the sealing surfaces.



Figure 29

8. Remove gasket and O-rings from the pressure ring.



Figure 30

9. Take the disk set of the brake with end shim(s) out of the housing.



CAUTION!

Illustration shows version / components of the 2 HL-290.



Figure 31

10. Unsnap the retaining ring.



Figure 32

11. Remove retaining ring and the shim.



Figure 33

12. Take the disk set of the clutch (with end shim(s)) out of the internal gear.



Illustration shows version / components of the 2 HL-290.



Figure 34

13. Remove input shaft with internal gear from the housing.



Figure 35

14. Unsnap the retaining ring.



Figure 36

15. Press the input shaft out of the ball bearing/internal gear.



Figure 37

FG002699

16. Unsnap the retaining ring.



Figure 38

FG002700

17. Press the centering disk from the input shaft.



CAUTION!

In case of an extremely fixed seat - heat the centering disk - disassembly aid.

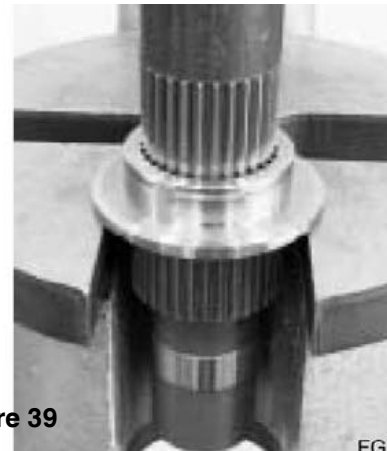


Figure 39

FG002701

18. Unsnap the retaining ring and remove ball bearing.



Figure 40

Planet Carrier

1. Remove axial needle cage with both thrust washers.



Figure 41

2. If not yet disassembled before ñ remove lube oil pump or the downshift interlock (depending on the version) (illustration shows - version - "Lube Oil Pump").

CAUTION!

Disassembly of the lube oil pump/downshift interlock - See "Disassembly - Lube Oil Pump/Downshift Interlock" on page -82.



Figure 42

3. Loosen the bolt connection and remove washer - fasten the output flange using the fixture.



Figure 43

4. Press the planet carrier out of the roller bearing.

CAUTION!

Pay attention to the released planet carrier and the bearing inner ring.



Figure 44

5. Pull the second bearing inner ring from the planet carrier.



Figure 45

FG002707

6. If required - expel both bearing outer rings (arrow) from the bearing bore.

! CAUTION!

If the taper roller bearings are reused - pay attention to the bearing location, i.e. respective bearing inner ring to bearing outer ring.



Figure 46

FG002708

7. Unsnap the retaining ring.



Figure 47

FG002709

8. Remove planetary gear using lever action - pay attention to the released shim and the cylindrical rollers.

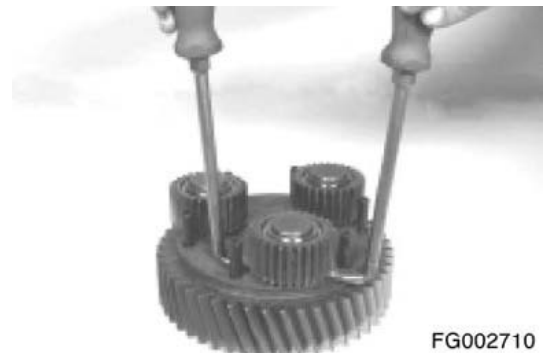


Figure 48

FG002710

9. Remove the bearing inner ring ñ in case of an extremely fixed seat heat the bearing inner ring.



Figure 49

FG002711

10. Remove both seals (1).

Remove both bleeder valves (2) and all screw plugs (3) with sealing and O-ring respectively.

(Illustration shows the positions for the transmission version "Installation Position Vertical")



Figure 50

FG002712

11. Only for the Version "Transmission Installation Position Horizontal" (Figure 51 and Figure 52)

Loosen the countersunk screws and remove screen sheet.



Countersunk screws are installed with locking compound (Loctite) - heating for disassembly, if necessary.



Figure 51

FG002713

12. Remove screen sheet (2) from the planet carrier (1).

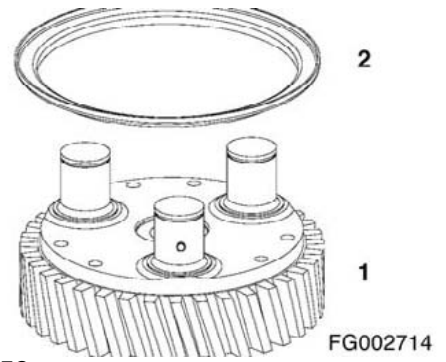


Figure 52

DISASSEMBLY - OUTPUT

Version - Axle Attachment

(HL-Transmission mounted directly to the axle)

1. Loosen the bolt connection, remove cover and the O-ring.

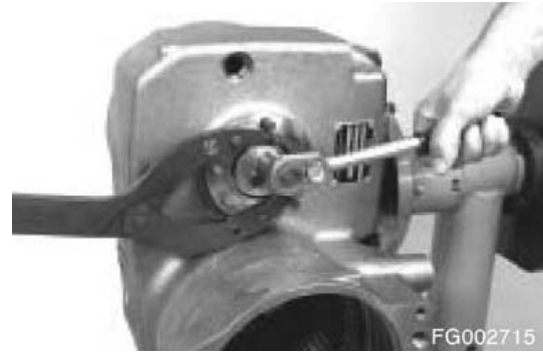


Figure 53

2. Remove the flange.



Figure 54

3. Remove shaft seal by lever action.



Figure 55

4. Fasten the pinion using the device and press it off.



Pay attention to the released bearing inner ring and the adjusting ring (rolling moment/pinion bearing) behind it.



Figure 56

5. Remove O-ring (arrow) and the bushing from the pinion.



FG002718

Figure 57

6. Remove and press off respectively the bearing inner ring.



FG002719

Figure 58

7. Pull the bearing outer ring out of the bearing cover.



CAUTION!

Pay attention to the shim behind it (pinion gap setting).



FG002720

Figure 59

8. Remove the bearing cover.



Figure 60

9. Remove O-rings (arrows).



Figure 61

10. Remove shaft seal.



Figure 62

11. Lift the output gear with oil baffle plate out of the housing.
Remove oil baffle plate from the output gear.



Figure 63

12. Remove screen sheet.



Figure 64

FG002725

13. Expel the bearing outer ring from the housing bore (arrow).

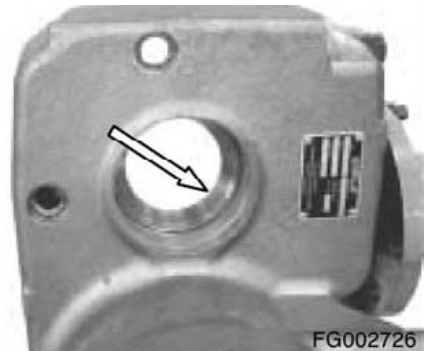


Figure 65

FG002726

14. Remove stud bolts, if necessary.



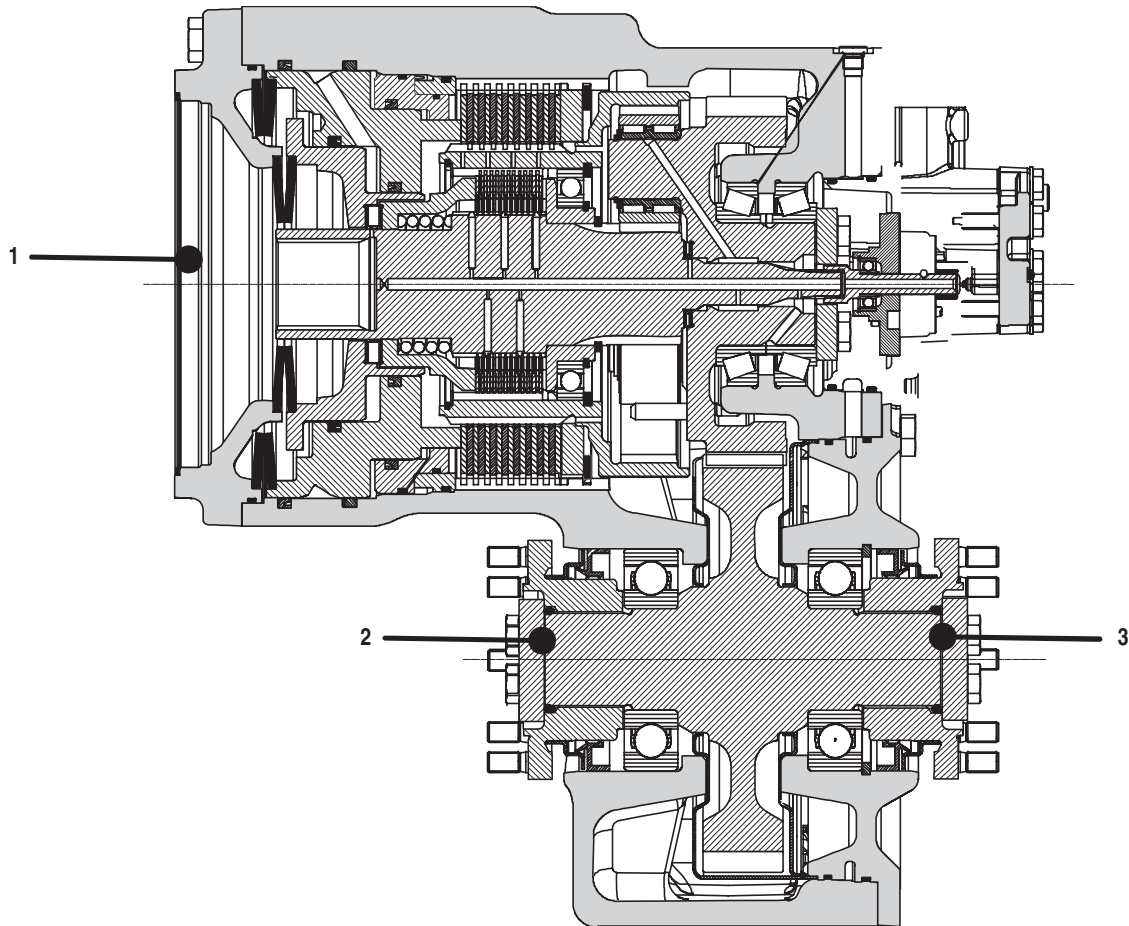
Figure 66

FG002727

Version - "Separate Installation"

(HL-Transmission installed separately from the axle)

In case of the transmission version "Separate Installation" it is possible, differently from the transmission version "Axle Attachment," to remove and to install the output - without the previous disassembly of brake/clutch and planet carrier.



FG007292

Figure 67

1. Legend for Figure 67

Reference Number	Description
1	Input
2	Output - Front Axle
3	Output - Rear Axle

2. Fasten the output flange using the fixture.

Loosen the bolt connection ñ pull off washer, O-ring and flange.

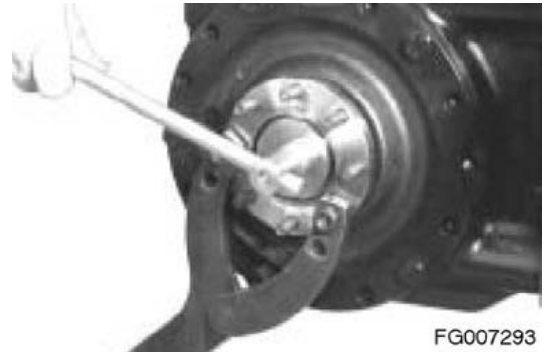


Figure 68

3. Press off the shaft seal by lever action.



CAUTION!

Install the second output flange and the shaft seal analogously.



Figure 69

4. Loosen the bolt connection.

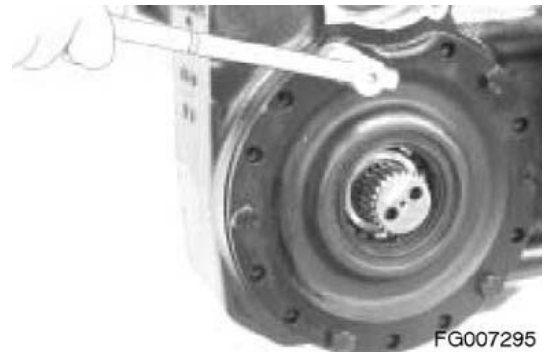


Figure 70

5. By means of lifting tackle separate the output gear with cover from the transmission housing.



Figure 71

6. Press the output gear out of the ball bearing/cover. remove released oil baffle plate.



Figure 72

7. Unsnap the retaining ring and expel the ball bearing from the cover.

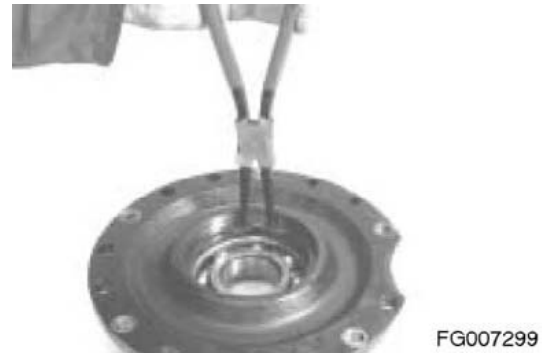


Figure 73

8. Remove both O-rings (arrows) from the cover.



Figure 74

9. Remove screen sheet from the transmission housing.



Figure 75

10. Expel the ball bearing from the housing bore.



Figure 76

REASSEMBLY - OUTPUT

Only when a new housing is installed (Figure 77):

Seal the finished holes (8x) of the oil supply bores with screw plugs.

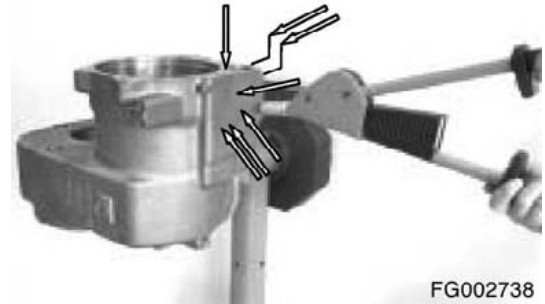


Figure 77

Version - Axle Attachment

(HL-Transmission directly attached to the axle)

1. Install the stud bolts.



Observe the installation position. See Figure 78.

Tightening torque $M_A = 20 \text{ Nm}$

2. Insert the bearing outer ring until contact.



Figure 78



Figure 79

3. Insert the slotted pin (arrow).

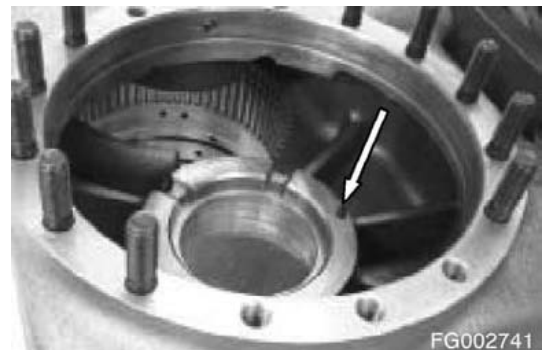


Figure 80

4. Position the screen sheet - with slotted pin (See Figure 80) into the fixing bore (arrow).

! CAUTION!

Observe the installation position - slotted pin = radial fixing of the screen sheet.



Figure 81

5. Insert the output gear - Observe the installation position.



Figure 82

6. Contact face (external shell of the shaft seal) if:
 - rubberized ? to be wet with spirit
 - metal ? to be provided with sealing compound (Loctite # 586).

! CAUTION!

Installation position of the shaft seal - Sealing lip showing to the oil sump (See Figure 84).



Figure 83

! CAUTION!

Install the shaft seal (1) considering the required installation position (Dim. "X" - See Figure 84).

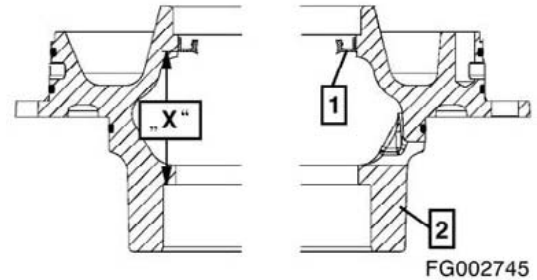
! CAUTION!

Grease the shaft seal in the area around the sealing and dust lip.

7. Exact installation position of the shaft seal is guaranteed by use of the specified mounting tool.

Legend for Figure 84:

Reference Number	Description
1	Shaft seal
2	Bearing cover
X	Installation Dimension → 69.5 $\pm$ 0.5 mm



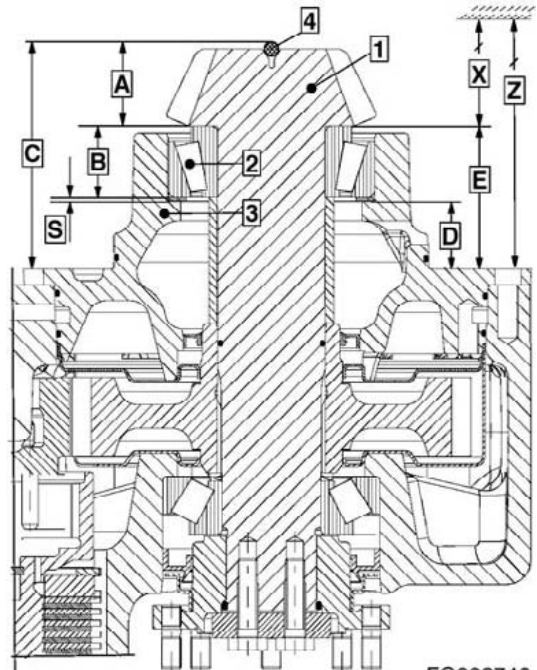
FG002745

Figure 84

Determine Adjusting Shim for Pinion Gap

1. Legend for Figure 85 thru 96:

Reference Number	Description
1	Pinion
2	Roller Bearing
3	Bearing Cover
4	Ball ($\varnothing = 7$ mm)
A	Auxiliary Dimension
B	Bearing Width
C	Reference Dimension
D	Contact Surface/ Bearing Cover to Contact/ Bearing Bore
E	73.0 mm (Constant Value)
X	Pinion Dimension (Engraved on the Pinion)
Z	189.0 mm (Contact Surface/ Bearing Cover to Center/ axle Casing)



FG002746

Figure 85



For a correct installation and positioning of the pinion, the following steps are to be carried out as exactly as possible.

2. Determine the auxiliary dimension "A."

Position the ball ($\varnothing = 7 \text{ mm}$) into the centering bore of the pinion and determine Dim. "A," from the contact surface / pinion shoulder to the ball.

Auxiliary dimension "A" = e.g. 42.56 mm



Auxiliary dimension "A" is obligatory to determine the reference dimension "C" - on the installed pinion (Figure 112).



Figure 86

FG002747

3. Read pinion dim. "X" on the pinion (see arrow) or measure it in case of manufacturing specific + or - deviation from the pinion dim. (relating value is marked by hand on the pinion e.g. + 0.1).

Pinion dim. "X" (without + or - deviation) = 116.0 mm

Pinion dim. "X" with an indicated deviation $+0.1 = 116.1 \text{ mm}$

Pinion dim. "X" with an indicated deviation $-0.1 = 115.9 \text{ mm}$

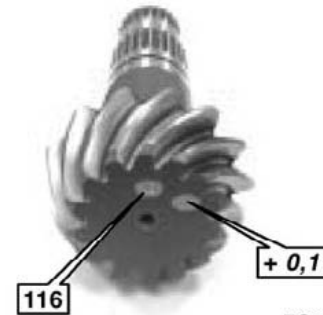


Figure 87

FG002748

4. Determine Dim. "D" bearing width, paying attention that rollers are seated without clearance (aligning of rollers - rotate the bearing inner ring in both directions several times).



Since the installed roller bearing is subject to a preload, deducting an empirical value of -0.1 mm is to be considered.



Figure 88

FG002749

Dim. "B" = e.g. 36.65 mm - 0.1 mm $\rightarrow$ 36.55 mm

5. Determine Dim. "D" (contact surface / bearing cover to contact/bearing bore).

Dim. "D" = e.g. 34.50 mm



Figure 89

FG002750

EXAMPLE:

Dim. "Z" 189.00 mm

Dim. "X" z.B. - 116.00 mm

Result → Dim. "E" = 73.00 mm

Dim. "E" 73.00 mm

Dim. "B+D" (e.g. 36.55 + 34.50) - 71.05 mm

Result → required shim "S" = 1.95 mm

6. Insert the determined shim(s) "S" = e.g. 1.95 mm and install the bearing outer ring subsequently until contact is obtained.



Figure 90

7. Oil the O-rings (arrows) and insert them into the ring grooves of the bearing cover.

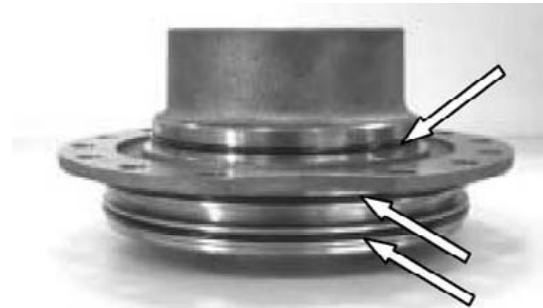


Figure 91

8. Bend the edges of the fixing straps of the oil baffle plate slightly - assembly aid (sheet is fixed to the bearing cover - See Figure 93).



Figure 92

9. Mount the oil baffle plate on the bearing cover.



Observe the installation position - locate the fixing lug of the oil baffle plate into the recess of the bearing cover (see arrow).



Figure 93

10. Oil the contact face/oil baffle plate/housing (assembly aid).
Mount the preassembled bearing cover and using hexagon nuts (use washers) locate it equally until contact.
Then remove hexagon nuts again.



Figure 94

11. Mount the heated bearing inner ring until contact and after cooling down install it subsequently until contact is obtained.



Figure 95

12. Mount the bushing, oil the O-ring (arrow) and put it into the ring groove.



FG002757

Figure 96

13. Mount the preassembled pinion.



FG002758

Figure 97

14. Fasten the pinion using the clamping bar.



FG002759

Figure 98

Determine the Adjusting Ring for Rolling Moment/Pinion Bearing

1. Rotate the transmission by 180°.
Mount the adjusting ring (s = optional).

CAUTION!

It is recommended to reinstall the adjusting ring (e.g. $s = 1.35 \text{ mm}$) from the disassembly, if however the required rolling moment of 1.5 - 3.0 Nm (without shaft seal) is not obtained - see bearing rolling moment check Figure 104 - the bearing rolling moment is to be corrected with an adequate adjusting ring.

2. Mount the heated bearing inner ring and install it subsequently until contact.



Figure 99



Figure 100

3. Mount the flange.



Figure 101

4. Put on the washer and fasten the flange with hexagon screws.

CAUTION!

Rotate the pinion - when tightening - in both directions (aligning of rollers) several times.

Tightening torque (M 10/8.8) $M_A = 46 \text{ Nm}$



Figure 102

5. Turn back the pinion fastening and remove clamping bar respectively.

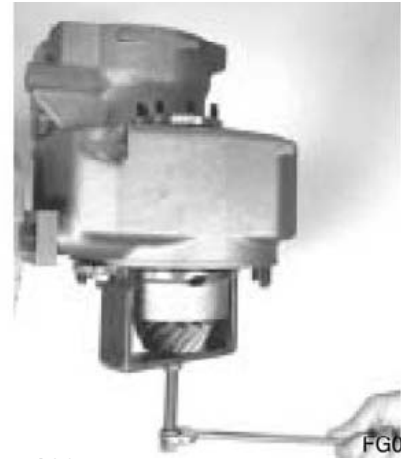


Figure 103

Check the Rolling Moment of the Pinion Bearing

1. Bearing rolling moment (without shaft seal) 1.5 - 3.0 Nm
(When using new roller bearings - upper value should be achieved)

! CAUTION!

If the required rolling moment deviates, it is to be corrected with an adequate adjusting ring (See Figure 99).



Figure 104

2. Remove flange again.



Figure 105

Shaft Seal/Output Flange

1. Contact face (external shell of the shaft seal) if
 - rubberized ? to be wet with spirit
 - metal ? to be provided with sealing compound (Loctite # 586).



Installation position of the shaft seal. Sealing lip showing to the oil sump (See Figure 107).

Install the shaft seal (1) considering the required installation position (Dim. "M" - See Figure 107).

Grease the shaft seal in the area around the sealing and dust lip.

Exact installation position of the shaft seal is guaranteed by use of the specified mounting tool.

Legend for Figure 107:

Reference Number	Description
1	Shaft Seal
2	Screen Sheet
3	Flange
4	Roller Bearing
5	Bearing Cover
M	Installation Dimension → 17.6 - 0.5 mm
N	Installation Dimension → 27.5 + 0.3 mm

2. Only for installation of a new flange or if stud bolts were removed (Figure 108) Install the stud bolts

Installation position - Stud bolts with short thread length into flange.

Tightening torque (M10x1)MA = 20 Nm



Figure 106

FG002768

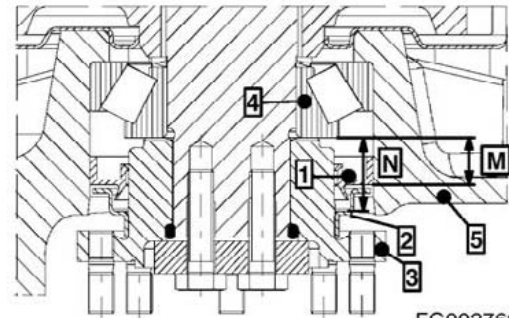


Figure 107

FG002769



Figure 108

FG002770

3. Only for installation of a new flange/screen sheet or if removed (Figure 109) Install the screen sheet (2), considering the required installation position (Dim. "N" - See Figure 107).

Exact installation position of the screen sheet is guaranteed by use of the specified mounting tool.



Figure 109

4. Mount the preassembled flange and put the O-ring into the recess.



Figure 110

5. Place the washer and fasten it using hexagon screws.
Tightening torque (M 10/8.8)MA = 46 Nm



Figure 111

Check the Pinion Gap

1. Position the ball [use $\varnothing = 7 \text{ mm}$ → ball $\varnothing$ like for the determination of auxiliary dimension "A"] into the centering bore of the pinion and determine Dim. "C" (See Figure 85), from the contact surface/bearing cover to the ball.

Example:

Reference dimension "C" e.g. 115.58 mm

Auxiliary dimension "A" (See Figure 86) e.g..... - 42.56 mm

Result (Dim. "E") = 73.02 mm



Figure 112



CAUTION!

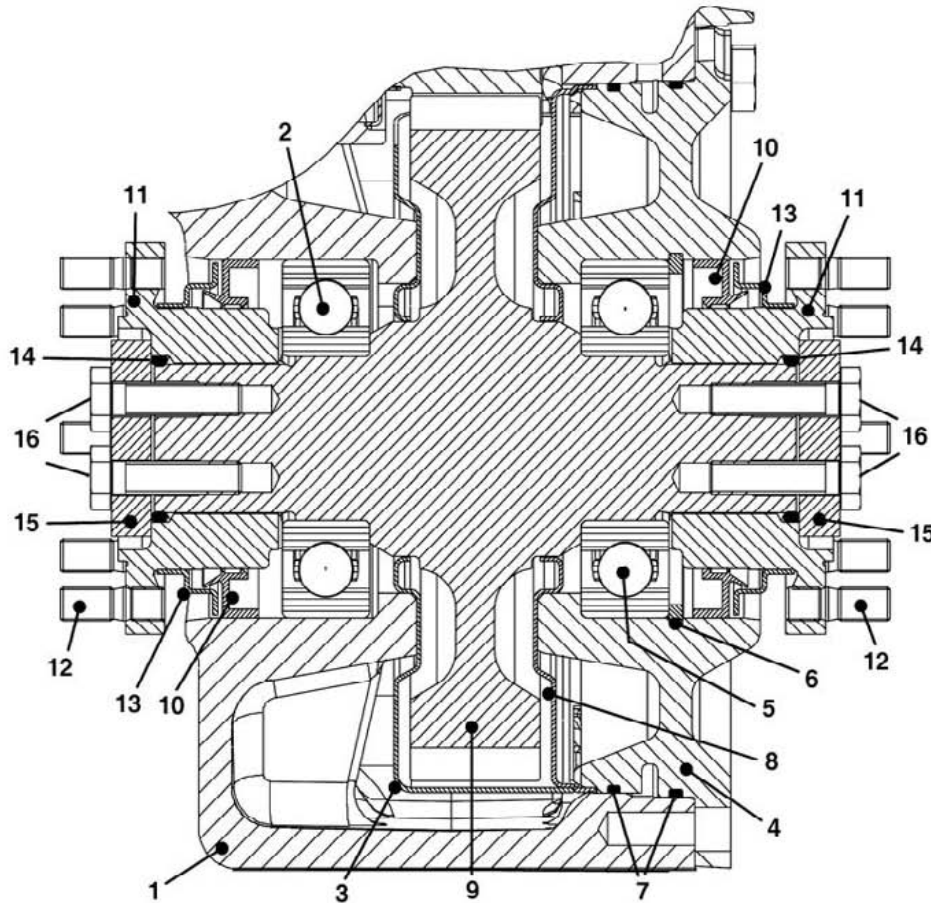
If the constant value of Dim. "E" = 73.00 ± 0.05 mm is not achieved, it is to be corrected with an adequate shim / pinion gap (See Figure 90).

2. For a correction of the shim/pinion gap, a counter correction of the adjusting ring of the rolling moment / pinion gap - Figure 99 is also to be considered.

Version Separate Installation

(HL-Transmission installed separately from the axle)

In case of the transmission version "Separate Installation" it is possible, differently from the transmission version "Axle Attachment," to remove and to install the output - without the previous disassembly of brake/clutch and planet carrier.



FG007305

Figure 113

Legend for Figure 113 thru Figure 132

Reference Number	Description
1	Transmission Housing
2	Ball Bearing
3	Screen Sheet
4	Cover
5	Ball Bearing
6	Retaining Ring
7	O-ring
8	Oil Baffle Plate

Reference Number	Description
9	Output Gear
10	Shaft Seal
11	Output Flange
12	Stud Bolt
13	Dirt Deflector
14	O-ring
15	Washer
16	Hexagon Screw

1. Insert ball bearing (2) until contact is obtained.



Figure 114

2. Rotate the transmission by 180°. Insert the slotted pin (arrow).

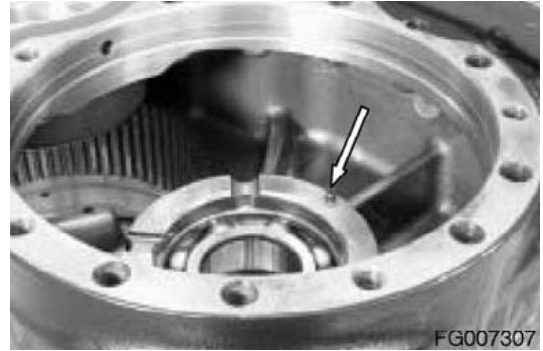


Figure 115

3. Position the screen sheet - with slotted pin (See Figure 115) into the fixing bore (arrow).



CAUTION!

Observe the installation position - slotted pin = radial fixing of the screen.



Figure 116

4. Insert the ball bearing into the cover and fasten it using the retaining ring.



Figure 117

5. Oil both O-rings (arrows) and put it into the ring grooves of the planet carrier.



Figure 118

FG007310

6. Bend the edges of the fixing straps of the oil baffle plate slightly - assembly aid (sheet is fixed to the bearing cover - See Figure 120).



Figure 119

FG007311

7. Mount the oil baffle plate on the bearing cover.

! CAUTION!

Observe the installation position - locate the fixing lug (arrow) into the recess of the bearing cover (radial fixing).



Figure 120

FG007312

8. Press the output gear into the ball bearing/bearing cover.

! CAUTION!

Rest the ball bearing against the bearing inner ring.



Figure 121

FG007313

9. Heat the bearing inner ring of the ball bearing.



Figure 122

10. Attach two adjusting screws (M12) and mount the preassembled bearing cover/output gear until contact is obtained.



Figure 123

! CAUTION!

Observe the installation position of the bearing cover (2) in the transmission (1) - Transmission Installation "Vertical" or "Horizontal" - see Figure 124.

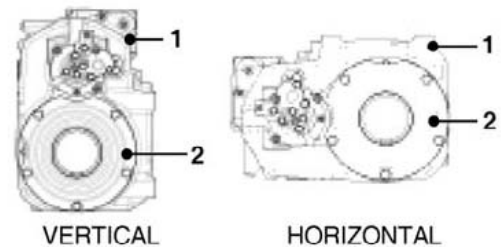


Figure 124

FG007316

11. Fasten the bearing cover using hexagon screws.
Tightening torque (M 12/8.8) $M_A = 80 \text{ Nm}$

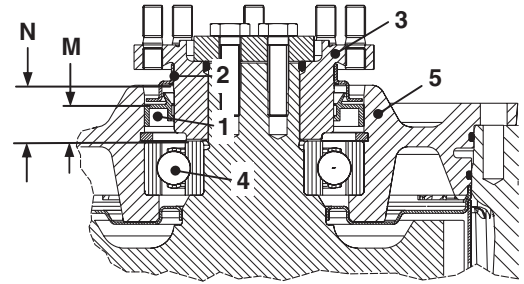


Figure 125

Shaft Seal/Output Flange

1. Legend for Figure 126:

Reference Number	Description
1	Shaft Seal
2	Screen Sheet
3	Flange
4	Ball Bearing
5	Bearing Cover
M	Installation Dimension → 17.6 - 0.5 mm
N	Installation Dimension → 27.5 + 0.3 mm



FG007318

Figure 126

2. Contact face (external shell of the shaft seal) if

- rubberized ? to be wet with spirit
- metal ? to be provided with sealing compound (Loctite # 586).

! CAUTION!

Installation position of the shaft seal - Sealing lip showing to the oil sump (See Figure 126).

! CAUTION!

Install the shaft seal (1) considering the required installation position (Dim. "M" - See Figure 126).

Grease the shaft seal in the area around the sealing and dust lip.

! CAUTION!

Exact installation position of the shaft seal is guaranteed by use of the specified mounting tool.



FG007319

Figure 127

3. Only for installation of a new flange or if stud bolts were removed (Figure 128)

! CAUTION!

Install the stud bolts.

Installation position - Stud bolts with short thread length into flange.

Tightening torque (M10x1)MA = 20 Nm

4. Only for installation of a new flange/screen sheet or if removed (Figure 129)

Install the screen sheet (2), considering the required installation position (Dim. "N" - See Figure 127).

! CAUTION!

Exact installation position of the screen sheet is guaranteed by use of the specified mounting tool.

5. Mount the preassembled output flange.

6. Insert the O-ring.



Figure 128

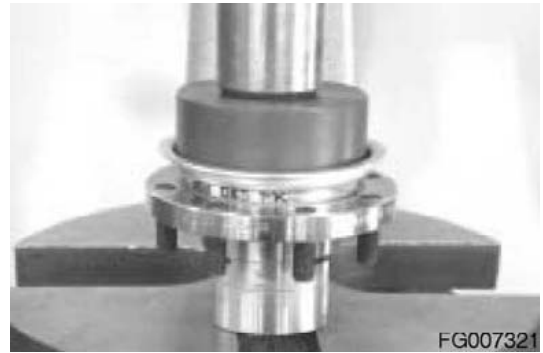


Figure 129



Figure 130



Figure 131

7. Position the washer and fasten the output flange using hexagon screws.

! CAUTION!

Install the second shaft seal/output flange (front axle output) analogously.

! WARNING!

Before put the unit into operation the specifications and regulations respectively and the instructions of the operating and maintenance instructions and the specifications and instructions of the vehicle manufacturer have to be observed.



Figure 132

REASSEMBLY - BRAKE / CLUTCH / PLANET CARRIER

Planet Carrier

1. Illustration shows the HL-Version "Axle Attachment."
Install the bearing outer ring until contact.

CAUTION!

Observe the bearing location - bearing inner ring to bearing outer ring - also see instructions for disassembly page -24, Figure 46.



Figure 133

2. Rotate transmission by 180°.
Install the second bearing outer ring until contact.

CAUTION!

Observe the bearing location - bearing inner ring to bearing outer ring - also see instructions for disassembly page -24, Figure 46.



Figure 134

3. Only for the Version "Transmission Installation Position Horizontal" (Figure 135 and 144)

CAUTION!

Insert the screen sheet and fasten it with countersunk screws.

Secure the countersunk screws with locking compound (Loctite # 243).



Figure 135

4. Install the screen sheet (2, Figure 136) considering the installation dimension "X" (see Figure 137) onto the planet carrier (1, Figure 136).

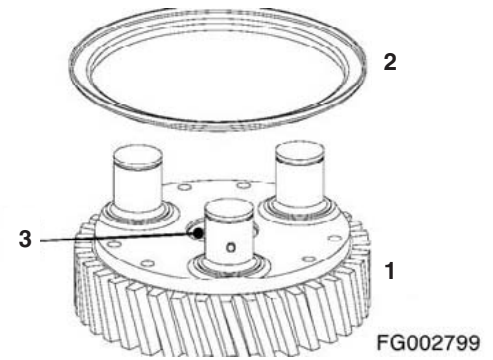


Figure 136

Legend for Figure 137:

Reference Number	Description
1	Planet Carrier
2	Screen Sheet
3	Contact Surface - Axial Needle Cage/axial Washer
X	Install. Dim. 1.5 $\pm$ 0.5 mm

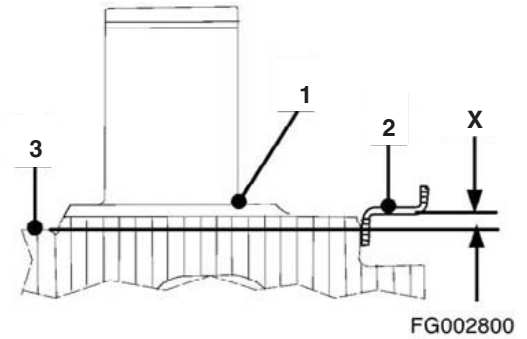


Figure 137

5. Insert the slotted pins (6x), considering the installation dimension "X" = 28.0 $\pm$ 1.0 mm and the installation position - See Figure 139 (slot is showing to the center).

CAUTION!

Before installation grease the slotted pin - assembly aid.

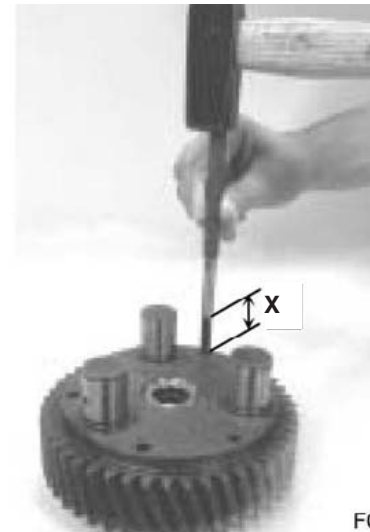


Figure 138

Legend for Figure 139:

Reference Number	Description
1	Planet Carrier
2	Slotted Pins (6x)
3	Center (Planet Carrier)

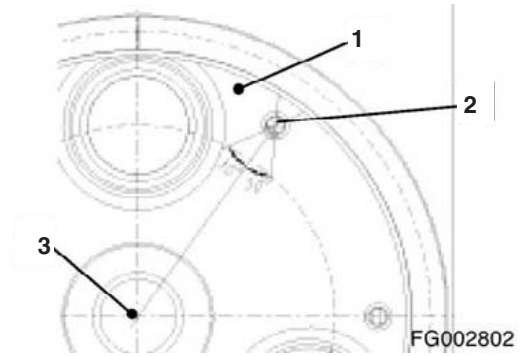


Figure 139

Legend for Figure 140 thru Figure 146:

Reference Number	Description
1	Bearing inner ring with cylinder rollers
1a	Packing Sleeve + Assembly Aid
2	Planetary Gear
3	Cylinder Rollers
3a	Packing Sleeve + Assembly Aid
4	Shim



Figure 140

6. Position the planetary gear (2) - with the marking showing downwards.

Put the bearing inner ring (1) onto the planetary gear (2) and press it until contact is obtained.

Then remove loose packing sleeve (1a).



Figure 141

FG002804

! CAUTION!

Keep the bearing inner ring to contact and rotate the planetary gear by 180°.

7. Position the cylinder rollers (3) onto the planetary gear (2).

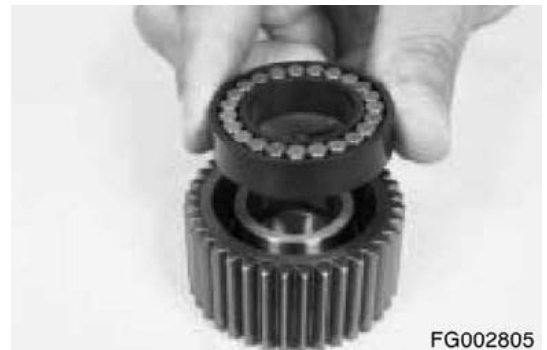


Figure 142

FG002805

8. By means of the mounting tool press the cylinder rollers (2) into the planetary gear (2).

Then remove two loose packing sleeves (3a).



Figure 143

FG002806

! CAUTION!

Keep the bearing inner ring with cylinder rollers to contact - and mount the preassembled the planetary gear to the planet carrier pin.



Figure 144

FG002807

9. Press the planetary gear (bearing inner ring) until contact.



Figure 145

FG002808

10. Mount the shim (4). marking showing upwards. and snap in the retaining ring.

! CAUTION!

Install the retaining ring subsequently until contact at the groove base is obtained.

Install the remaining planetary gears analogously.



Figure 146

FG002809

11. Press the bearing inner ring onto the planet carrier until contact is obtained.



Figure 147

12. Insert the preassembled planet carrier.



Figure 148

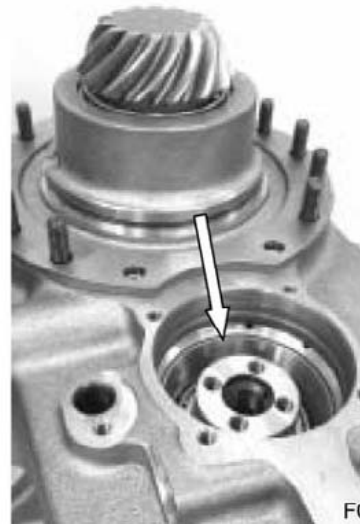
13. Fasten the planet carrier using pressure plate and clamping bar.



Figure 149

14. Rotate the transmission by 180°.

Check locating of the bearing outer ring (arrow) - installation of the bearing outer ring - See Figure 133.



FG002813

Figure 150

15. Mount the heated bearing inner ring until contact.



FG002814

Figure 151

16. Position the shim and attach the hexagon screws by hand (fixing of the planet carrier).

Then remove clamping bar - See Figure 149.



FG002815

Figure 152

17. Fasten the fixture to the output flange.

! CAUTION!

Tighten the hexagon screws equally - risk of distortion.

Tightening torque (M 10/8.8)M_A = 46 Nm

! WARNING!

When tightening the hexagon bolts rotate the planet carriers - into both directions. several times (aligning of rollers).

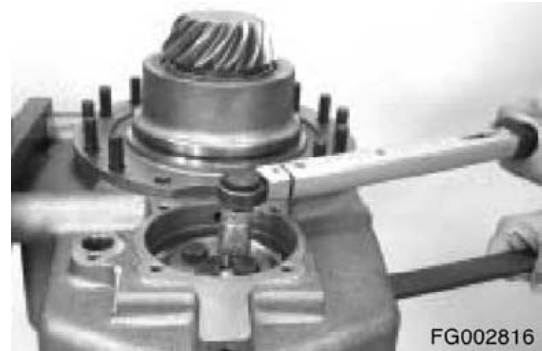


Figure 153

Brake/Clutch

1. Mount the heated centering disk and press it until contact is obtained.



Figure 154

2. Fasten the centering disk using the retaining ring.



Figure 155

3. Insert the ball bearing into the internal gear and fasten it using the retaining ring.



Figure 156

FG002819

4. Heat the bearing inner ring of the ball bearing.



Figure 157

FG002820

5. Mount the preassembled internal gear to the input shaft until contact is obtained.



Figure 158

FG002821

6. Snap in the retaining ring.



Figure 159

FG002822

7. Rotate the transmission by 180°.

Position the axial needle cage with both thrust washers (1x each, underneath and onto the axle needle cage resp. - see Figure 160).



Fix the axial needle cage and the thrust washers using grease centrally - assembly aid.



Figure 160

8. Mount the preassembled input shaft (with internal gear).



Figure 161

Disk Components Brake and Clutch

Reassembly of both disk sets in the Version "2 HL-290" - See Figure 162 and Figure 165 - Figure 170 - is shown below.

Reassembly as to the Versions "2 HL-270" and "2 HL-250" is to be made as shown in the Figure 163 and 172 respectively.

For information about number and arrangement of the disks - also see the perspective illustration in the respective spare parts list.

1. Version "2 HL-290"

Legend for Figure 162:

Reference Number	Description
A	Lower Ring Groove (2 HL-290, Item Retaining Ring -1)
B	Upper Ring Groove (2 HL-250/270, Item Retain. Ring -1)
1	Retaining Ring
2	End Shim/Brake (1 Pc.)
3	Outer Disk/Brake (9 Pcs.)
4	Inner Disk/Brake (8 Pcs.)
5	Inner Disk/Clutch (12 Pcs.)
6	Inner Disk/Clutch (11 Pcs.)
7	Transmission Housing
8	Disk Carrier/Internal Gear

Version „2 HL-290“

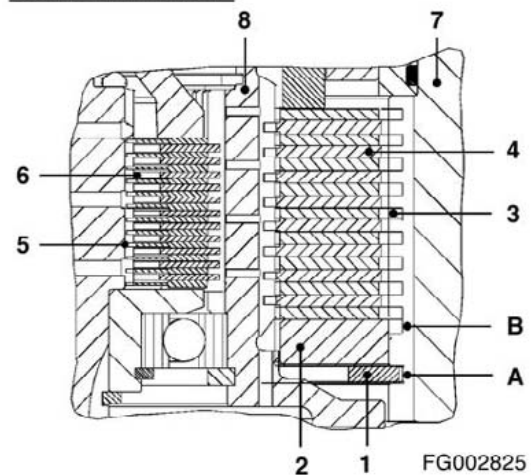


Figure 162

2. Version "2 HL-270"

Legend for Figure 163:

Reference Number	Description
A	Lower Ring Groove (2 HL-290, Item Retaining Ring -1)
B	Upper Ring Groove (2 HL-250/270, Item Retain. Ring -1)
1	Retaining Ring
2	End Shim/Brake (1 Pc.)
3	Outer Disk/Brake (6 Pcs.)
4	Inner Disk/Brake (6 Pcs.)
5	End Shim/Clutch (1 Pc.)
6	Inner Disk/Clutch (10 Pcs.)
7	Inner Disk/Clutch (9 Pcs.)
8	Transmission Housing
9	Disk Carrier/Internal Gear

Version "2 HL-270"

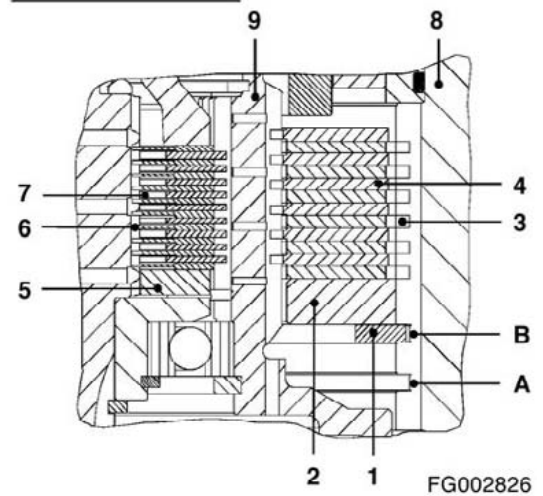


Figure 163

3. Version "2 HL-250":

Legend for Figure 164:

Reference Number	Description
A	Lower Ring Groove (2 HL-290, Item Retaining Ring -1)
B	Upper Ring Groove (2 HL-250/270, Item Retain. Ring -1)
1	Retaining Ring
2	End Shim/brake (2 Pcs.)
3	Outer Disk/brake (5 Pcs.)
4	Inner Disk/brake (4 Pcs.)
5	End Shim/clutch (2 Pcs.)
6	Inner Disk/clutch (8 Pcs.)
7	Inner Disk/clutch (7 Pcs.)
8	Transmission Housing
9	Disk Carrier/internal Gear

Version "2 HL-250"

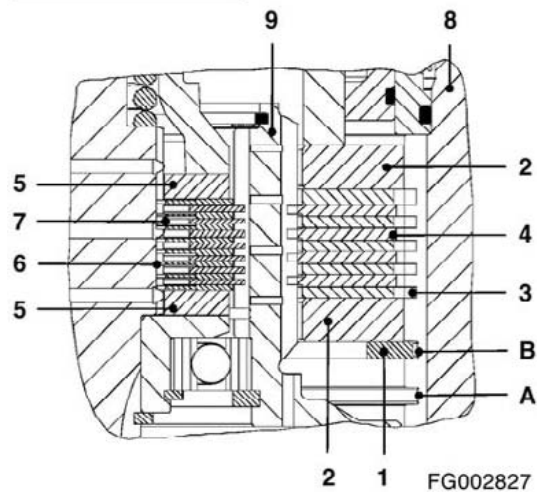


Figure 164

A. Brake

Snap the retaining ring (1) into the ring groove (A).



Observe the installation position of the retaining ring (1) - ring groove (A) only for Version "2 HL-290"



Figure 165

- B. Insert the end shim (2).



Figure 166

- C. Insert the disk set (outer/inner disks) - beginning with an outer disk - alternately.

! CAUTION!

Position the outer disk (1 Pc.) s = variable 2.8 - 3.7 mm, in the disk set on the top (piston side).

With outer disk s = variable, the disk clearance/ piston stroke will be adjusted - See Figure 180.



Figure 167

- D. Clutch:

Insert the disk set (outer/inner disks) - beginning with an outer disk - alternately.

! CAUTION!

Position the outer disk (1 Pc.) s = variable 1.2 - 1.6 mm, in the disk set on the top (piston side).

With outer disk s = variable, the disk clearance/ piston stroke will be adjusted - See Figure 179.

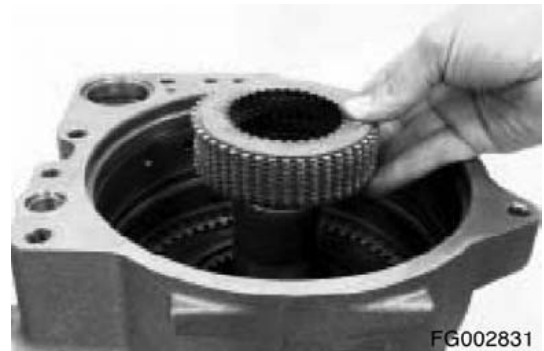


Figure 168

Adjust and check the Disk Clearance/Piston Stroke of Brake and Clutch

1. Mount the pressure piece (without compression spring).



Figure 169

2. Oil the axial roller cage and mount it with both thrust washers (1x each, positioned underneath and onto the axial needle cage respectively - see Figure 170).



Figure 170

3. Insert the piston (brake) - without sealing elements installed.



Figure 171

4. Insert the piston (clutch) - without sealing elements installed.



Figure 172

5. Insert both cup springs/clutch.
Fix the cup springs using grease and position them centrally. assembly aid.



CAUTION!

Observe the installation position - also see Figure 175.



Figure 173

6. Insert both cup springs /brake.

Fix the cup springs using grease and position them centrally. assembly aid.



Observe the installation position - also see Figure 175.



Figure 174

Legend for Figure 175 thru Figure 180:

Reference Number	Description
1	Measuring Fixture
2	Piston/Clutch
3	Cup Springs/Clutch
4	Piston/Brake
5	Cup Springs/Brake
6	Transmission Housing
I	Measuring Bore (Disk Clearance/Clutch)
II	Measuring Bore (Disk Clearance/Brake)
A	Mounting Face/Housing - Face/Piston
B	Mounting Face/Housing - Piston Contact /Housing
C	Mounting Face/Housing - Face/Piston
D	Mounting Face/Housing - Piston Contact /Housing
Y	Disk Clearance/Clutch → $2.4^{+0.3}_{-0}$ mm (Piston Stroke)
X	Disk Clearance/Brake → $1.8^{+0.3}_{-0}$ mm (Piston Stroke)

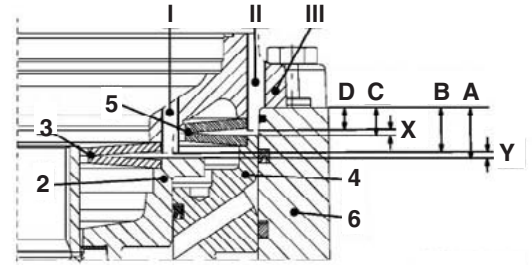


Figure 175

FG002838



Locate the measuring fixture with hexagon screws equally (risk of breakage) until contact is obtained.

Tightening torque (M 12/8.8)MA = 80 Nm



Figure 176

FG002839

7. Determine Dim. "A" (Measuring bore "I") from mounting face/housing to the face/piston (clutch).

Dim. "A" e.g. = 22.45 mm

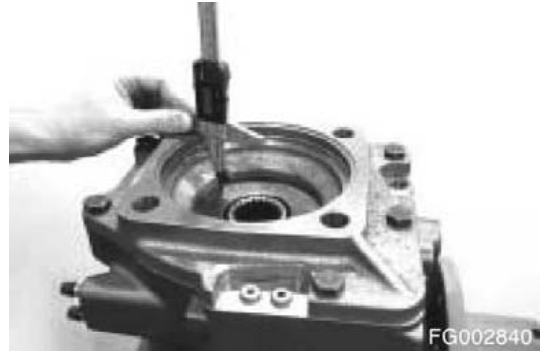


Figure 177

8. Determine Dim. "C" (Measuring bore "II") from mounting face/housing to the face/piston (brake).

Dim. "C" e.g. = 11.85 mm



Figure 178

9. Determine Dim. "B" from mounting face/housing to clutch piston contact/housing.

Dim. "B" e.g. = 19.95 mm

Example:

Dim. "A" e.g. 22.45 mm

Dim. "B" e.g. - 19.95 mm

Result = 2.50 mm

Clutch disk clearance (piston stroke) = $2.4^{+0.3}$ mm

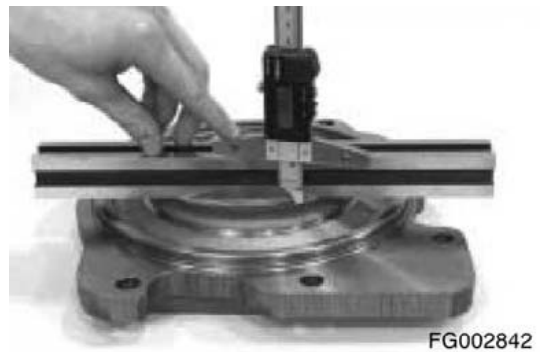


Figure 179



WARNING!

If the required disk clearance (piston stroke) is not obtained, this is to be corrected with a suitable outer disk - See Figure 168.

10. Determine Dim. "D" from mounting face/housing to brake piston contact/housing.

Dim. "D" e.g. = 9.95 mm

Example:

Dim. "C" e.g. 11.85 mm

Dim. "D" e.g. - 9.95 mm

Result = 1.90 mm

Disk clearance (piston stroke) Brake = $1.8 + ^{0.3}_{-0.3}$ mm



Figure 180



WARNING!

If the required disk clearance (piston stroke) is not obtained, this is to be corrected with a suitable outer disk n see Figure 167.

11. Remove measuring fixture again. loosen the screws equally.

Remove all cup springs, both pistons, axial roller cage with thrust washers and pressure piece.



Figure 181

12. Insert the oil baffle plate into the disk carrier and fix it with the retaining ring.



Figure 182

13. Oil the sealing faces and the O-ring.

Insert the O-ring (arrow) into the groove and insert the ring.



CAUTION!

Observe the installation position - See Figure 183.



Figure 183

14. By means of the mounting tool locate the ring until contact is obtained.



Figure 184

15. Oil the sealing faces and the sealing elements.

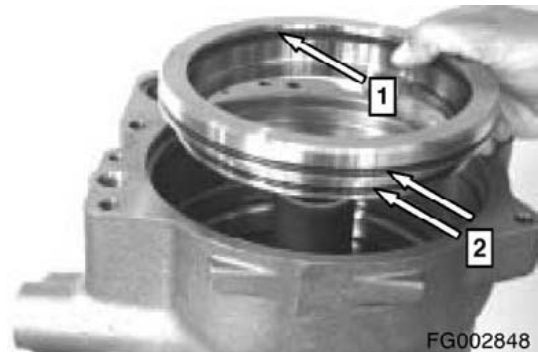


Figure 185

16. Insert the seal (1) with the sealing lip showing to the oil sump. also see Figure 186.

Put both O-rings (2) into the ring grooves of the pressure ring (3) and insert the preassembled pressure ring - observe the installation position.

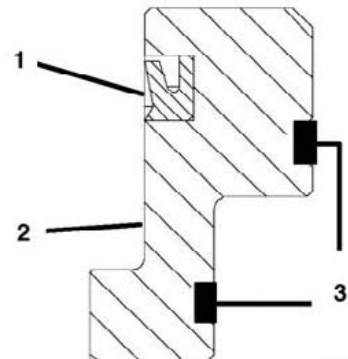


Figure 186

17. By means of the mounting tool locate the pressure ring until contact.



FG002850

18. Insert the compression spring.



FG002851

19. Insert the pressure piece.



FG002852

20. Oil the axial roller cage and mount it with both thrust washers (1x each to be positioned underneath and onto the axial needle cage respectively - See Figure 190).



Figure 190

21. Oil the sealing faces and the sealing elements.

Insert the seal (2, with the sealing lip showing to the oil sump) and the seal (3) - See Figure 192 - into the housing (1).

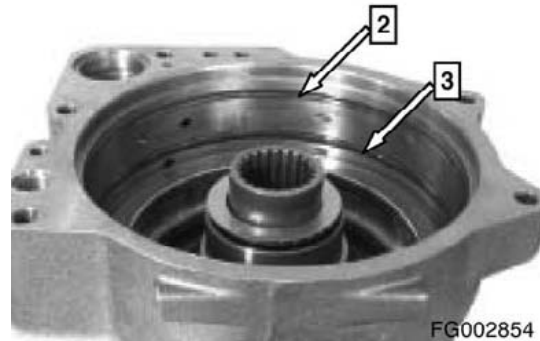


Figure 191

22. Legend for Figure 192, Figure 191 and Figure 193:

Reference Number	Description
1	Housing
2	Seal (With Sealing Lip)
3	Seal
4	Piston/Brake
5	Seal (With Sealing Lip)
6	Seal (With Sealing Lip)
7	Piston/Clutch

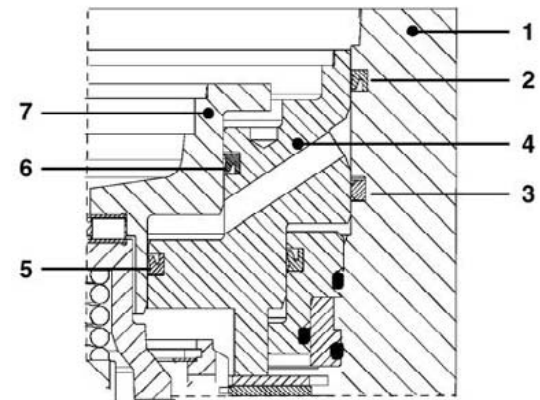


Figure 192

FG002855

23. Oil the sealing faces and the sealing elements.

Insert the seals (5 and 6, See Figure 192), with the sealing lip showing to the oil sump, into the piston/brake (4).

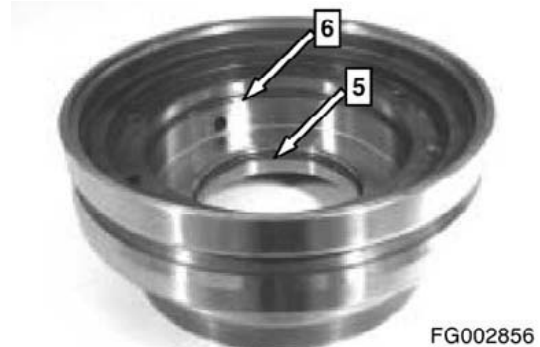


Figure 193

24. Insert the preassembled piston / brake until contact is obtained.

! CAUTION!

Piston is to be positioned that oil supply bore (arrow) - with the HL-Transmission installed into the vehicle n is at 12 o'clock position.

Observe the version as to the transmission installation position "Horizontal - Vertical."

25. By means of the mounting tool locate the piston until contact.



Figure 194



Figure 195

FG002858

26. Insert both cylinder pins (arrow).



Figure 196

FG002859

27. Insert the piston/clutch.



Figure 197

FG002860

28. Press the piston axially, contrary to the compression spring preload, and seal the pressure oil supply bore using screw plug/sealing ring (arrow) - thus the piston is kept in axial position - assembly aid for input housing assembly (Figure 204 and 213).

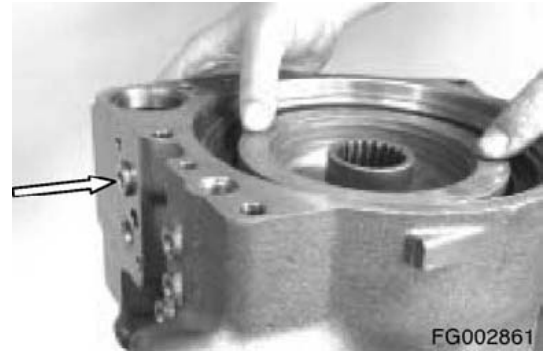


Figure 198

29. Insert both cup springs/clutch.



Observe the installation position - See Figure 199 and Figure 175 respectively.



Figure 199

30. Insert both cup springs/brake.



Observe the installation position -See Figure 200 and Figure 175.



Figure 200

Modulation Valve and Input Housing

1. Insert the modulation valve (can only be replaced as a unit).



Figure 201

2. Place the O-ring (arrow) and insert the compression spring.



Figure 202

3. Input housing:
Oil the O-ring and put it into the ring groove of the input housing.



Figure 203

4. Position the cup springs centrally - assembly aid.
Insert two adjusting screws (M 12), mount the input housing and fasten it with hexagon screws.



Figure 204



WARNING!

Locate the input housing with hexagon screws equally (risk of breakage) until contact is obtained.

Tightening torque (M 12/8.8) $M_A = 80 \text{ Nm}$

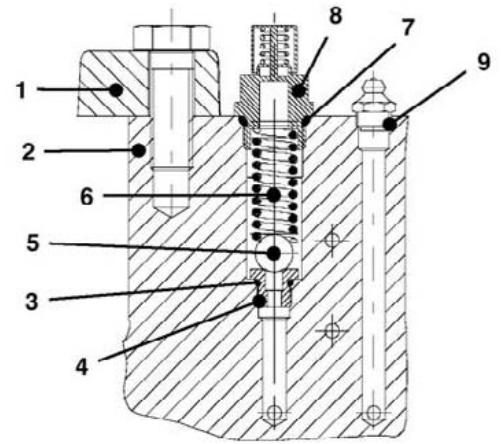


Figure 205

Emergency Release (Parking Brake)

Legend for Figure 206:

Reference Number	Description
1	Input Housing
2	Housing
3	O-ring
4	Threaded Element (Orifice)
5	Ball
6	Compression Spring
7	O-ring
8	Bleeder
9	Position of lubrication nipple for the version "Transmission Installation Position Vertical" - Position of lubrication nipple for the version "Transmission Installation Position Horizontal" -See Figure 211



FG002869

Figure 206

1. Install the threaded element (4) with O-ring (3).
Tightening torque (M 10x1)MA = 24 Nm



FG002870

Figure 207

2. Insert the ball (5).



FG002871

Figure 208

3. Insert the compression spring (6).



Figure 209

Check the Emergency Release for Leak Tightness

CAUTION!

Illustration shows the Version "Transmission Installation Position Vertical" (Figure 210)

CAUTION!

For the version "Transmission Installation Position Horizontal" the connection and positions respectively of the bleeder valves /lubrication nipple etc., are to be considered according to the illustration in Figure 211.

1. Install both bleeder valves (1), screw plugs (2) with sealing ring and screw plugs (3) with O-ring.

Tightening torque

Bleeder valve (M 10x1)M_A = 22 Nm

Screw plug (M 10x1 with sealing ring)M_A = 15 Nm

Screw plug (M 10x1 with O-ring)M_A = 25 Nm

Legend for Figure 211:

Reference Number	Description
1	Bleeder/Pressure Relief Valve (Emergency Release - Park. Brake)
2	Screw Plug
3	Bleeder Valve (Emergency Release - Parking Brake)
4	Lubrication Nipple (Emergency Release - Parking Brake)
5	Bleeder Valve (Multidisk Clutch)
6	Bleeder Valve (Multidisk Brake)
7	Pressure Oil Connection - Multidisk Brake
8	Pressure Oil Connection - Multidisk Clutch

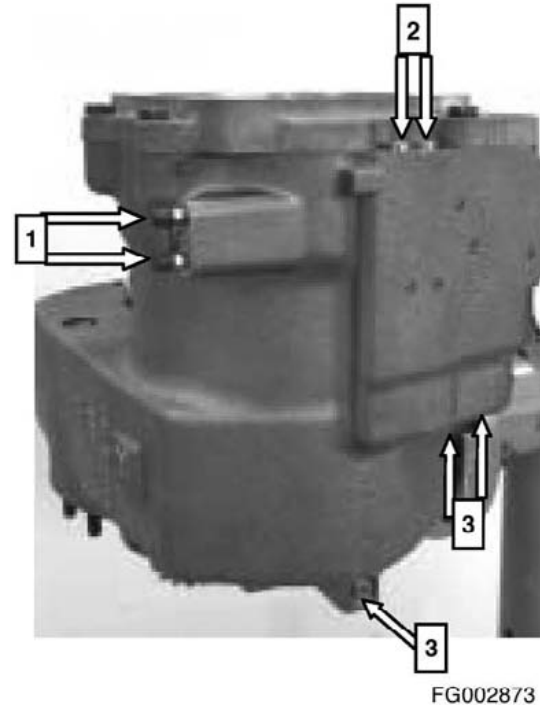


Figure 210

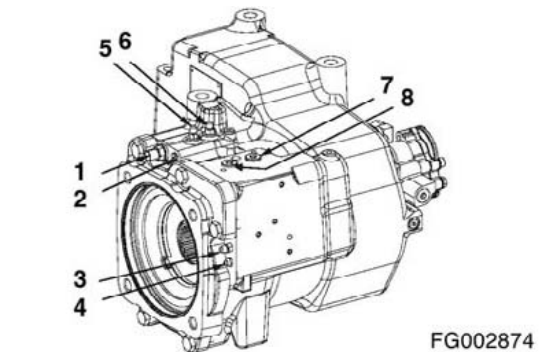


Figure 211

2. Install the bleeder valve (1), screw plugs (2) with O-ring screw plug (3) with O-ring and compressed air connection piece (4).

Tightening torque

Bleeder valve (M 10x1) $M_A = 22 \text{ Nm}$

Screw plug (M 10x1 with O-ring) $M_A = 25 \text{ Nm}$

Screw plug (M 18x1.5 with O-ring) $M_A = 35 \text{ Nm}$

Compr.air connect. piece (M 10x1) w. seal. ring) ... $M_A = 15 \text{ Nm}$

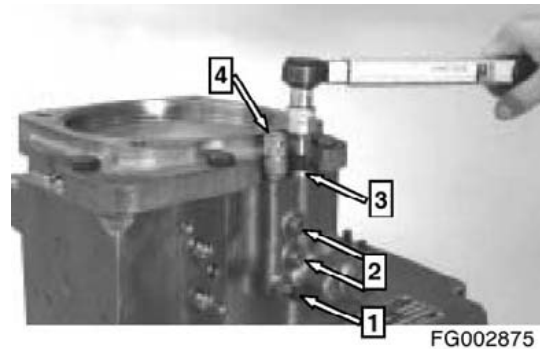


Figure 212

FG002875

3. Pressurize the emergency release with compressed air $p = 5 + 1 \text{ bar}$ and close the shutoff valve.

During a test duration of 3 minutes no pressure drop is allowed.



Figure 213

FG002876

4. Remove screw plug and the compressed air connection piece (See Figure 212).

Install the bleeder (3) with O-ring and lubrication nipple (4).

Tightening torque

Lubrication nipple (M 10x1) $M_A = 22 \text{ Nm}$

Bleeder (M 18x1.5) $M_A = 22 \text{ Nm}$

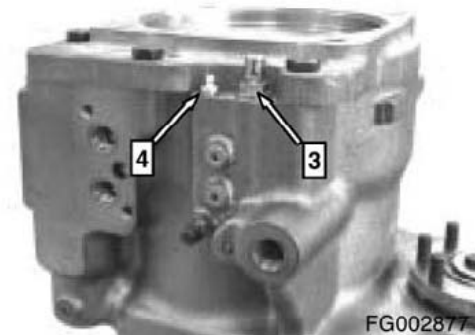


Figure 214

FG002877

Check the Multidisk Brake and Multidisk Clutch for Leak Tightness and Closing Pressure

Legend for Figure 215:

Reference Number	Description
1	Transmission Housing
2	Input Housing
AB	Pressure Oil Connection - Multidisk Brake
AK	Pressure Oil Connection - Multidisk Clutch
EB	Bleeder Valve - Multidisk Brake
EK	Bleeder Valve - Multidisk Clutch

CAUTION!

Illustration shows the version "Transmission Installation Position Vertical"

CAUTION!

For the version "Transmission Installation Position Horizontal" the connections and positions respectively of the bleeder valves / lubrication nipple etc., are to be considered according to the illustration in Figure 211.

1. Multidisk brake:

Connect the HP-Pump ("AB" - See Figure 215 and Figure 211), Build up a pressure of $p = 30 - \text{max. } 35 \text{ bar}$

- Bleed the pressure chamber (several times).

Close the shutoff valve.

During a test duration of 3 minutes no measurable pressure drop is allowed!

Test medium:

According to List of Lubricants TE-ML 07

2. Closing pressure test (Cup spring preloading force):

When measuring the closing pressure the valve block is not allowed to be attached to the transmission because of the bypass function between brake and clutch.

Connection "AK" (See Figure 215 and Figure 211 respectively) open (not closed and tank connection respectively).

Reduce the pressure slowly, when pressure range 11 - 9 bar (closing pressure) is reached, the input shaft has to be locked at a tightening torque of $50 \pm 5 \text{ Nm}$.

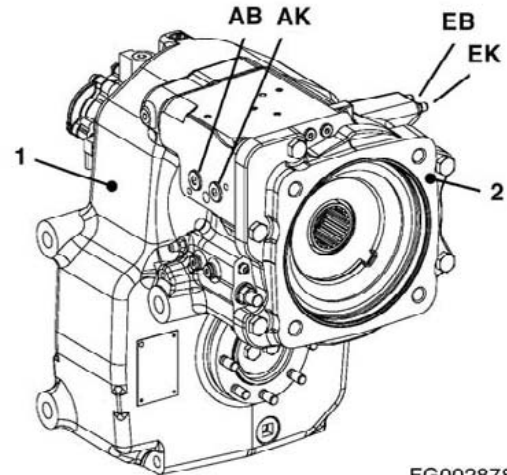


Figure 215

FG002878



Figure 216

FG002879



Figure 217

FG002880

3. Multidisk clutch:

Connect the HP-Pump ("AK" - See Figure 215 and Figure 211), Build up a pressure of $p = 30 - \text{max. } 35 \text{ bar}$

- Bleed the pressure chamber (several times).

Close the shutoff valve.

During a test duration of 3 minutes no measurable pressure drop is allowed.

Test medium:

According to the "Table of recommended lubricants" of operation manual.

4. Closing pressure test (Cup spring preloading force):

When measuring the closing pressure the valve block (only for the version "with" mounted electric downshift interlock) is not allowed to be attached to the transmission because of the bypass function between brake and clutch.

Connection "AB" (See Figure 215 and Figure 211 respectively) open (not closed and tank connection respectively).

Reduce the pressure slowly, when pressure range 15.5 - 13.5 bar (closing pressure) is reached, the input shaft has to be locked at a tightening torque of $50 \pm 5 \text{ Nm}$.



Figure 218



Figure 219

Speed Transmitter

Install the speed transmitter with O-ring.

Tightening torque (M 8/8.8) $M_A = 23 \text{ Nm}$



Figure 220

Lube Oil Pump/Downshift Interlock

1. Install the lube oil pump (with O-rings) or the downshift interlock - depending on the version - (Illustration shows - Version "Lube Oil Pump").



CAUTION!

Assembly of the lube oil pump / downshift interlock - See "Reassembly - Lube Oil Pump/Downshift Interlock" on page -89.

Tightening torque (M 8/10.9)M_A = 23 Nm



WARNING!

Before put the unit into operation the specifications and regulations respectively and the instructions of the transmission operating and maintenance instructions and the specifications and instructions of the vehicle manufacturer have to be observed



Figure 221

DISASSEMBLY - LUBE OIL PUMP/DOWNSHIFT INTERLOCK

Version "with" Lube Oil Pump

1. Loosen the bolt connection and pull off the lube oil pump.



Figure 222

2. Loosen the cover bolt connection, remove cover (1) with gasket (2) and the filter (3) from the housing (4).



Figure 223

3. Remove pressure limiting valve and both O-rings (arrows).



Figure 224

4. Loosen the pump cover bolt connection, keep the housing in vertical position - disassembly aid (also see Figure 226).



Figure 225

! CAUTION!

Keep pump to contact and rotate it by 180°. disassembly aid.

5. Then pull the pump in vertical position out of the housing - pay attention to possibly released balls/compression springs (See Figure 226 and 236).



Figure 226

6. Remove outer (1) and internal rotor (2) and take the released ball [(3) driver] out of the control housing (4).

! CAUTION!

Outer, internal rotor and control housing = rotor set

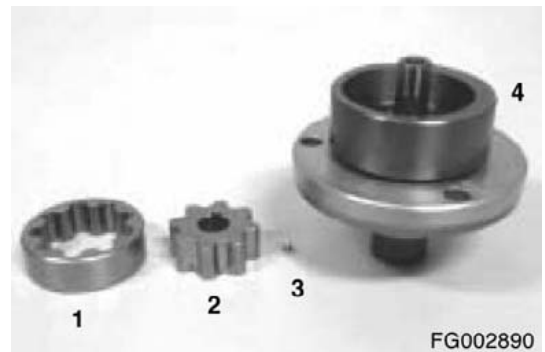


Figure 227

7. Remove control housing and the released balls and compression springs (3 pcs. each).



Figure 228

8. Unsnap the retaining ring.



FG002892

Figure 229

9. Pull the pump shaft out of the pump cover.



FG002893

Figure 230

10. Unsnap the retaining ring and press the ball bearing from the shaft.



FG002894

Figure 231

11. Pull the needle sleeve out of the housing bore.



FG002895

Figure 232

Version "with" Hydraulic Downshift Interlock

1. Disassemble both oil tubes.



Figure 233

2. Loosen the bolt connection of the shift interlock (3 x cap screws) and remove shift interlock.



Figure 234

3. Loosen the cover bolt connection, remove cover and flat gasket (also see Figure 236).



Figure 235

4. Take the filter out of the housing.

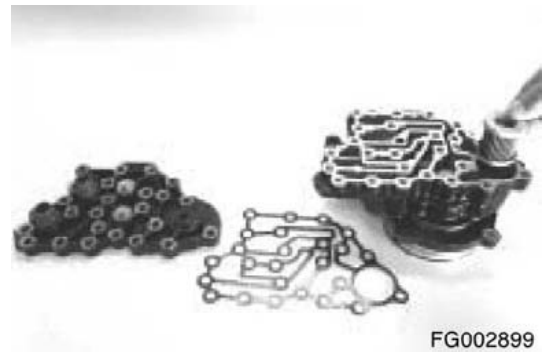


Figure 236

5. Loosen pump cover bolt connection.



Figure 237

! CAUTION!

Keep pump to contact and rotate it by 180° - disassembly aid.

6. Then pull the pump in vertical position out of the housing - pay attention to possibly released balls/compression springs (See Figure 239 and 248).



Figure 238

7. Remove outer (1) and internal rotor (2) and take the released ball [(3) driver] out of the control housing (4).

Outer, internal rotor and control housing = rotor set

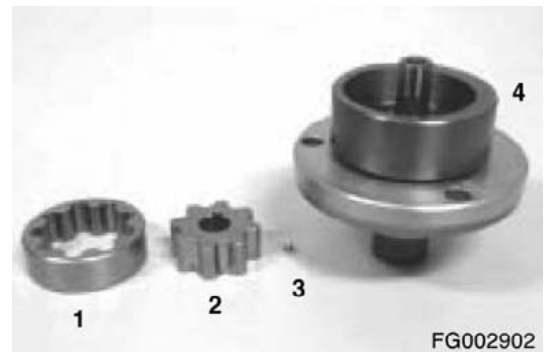


Figure 239

8. Remove control housing and the released balls and compression springs (3 pcs. each).



Figure 240

9. Unsnap the retaining ring.



FG002905

Figure 241

10. Pull the pump shaft out of the pump cover.



FG002906

Figure 242

11. Unsnap the retaining ring and press the ball bearing from the shaft.



FG002907

Figure 243

12. Pull the needle sleeve out of the housing bore.



FG002908

Figure 244

Legend for Figure 245:

Reference Number	Description
1	Housing
2	O-rings
3	Check Valve (010)
4	G.shift Piston
5	Check Valve (009)
6	Check Valve (008)
7	Pressure Limiting Valve

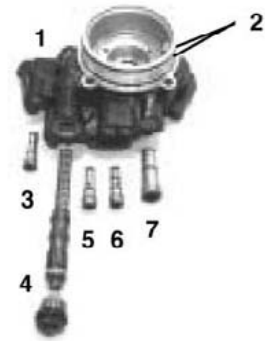


Figure 245

FG002909

13. Remove O-rings and all single parts/valves.

Version "with" Electric Downshift Interlock - Mounted to Transmission

1. Loosen the fixing bolts and remove downshift interlock.



Figure 246

FG007371

2. Remove both O-rings (arrow).



Make no further disassembly - electric downshift interlock can only be replaced as complete part.

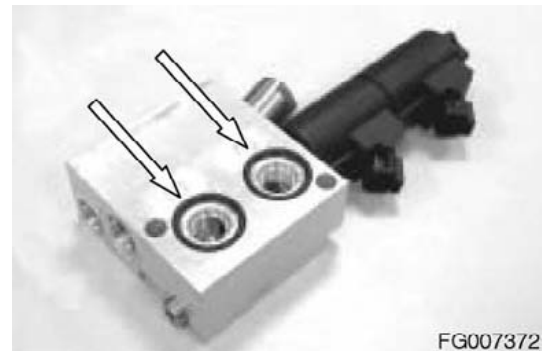


Figure 247

FG007372

REASSEMBLY - LUBE OIL PUMP/DOWNSHIFT INTERLOCK

Version "with" Lube Oil Pump

1. Mount the ball bearing onto the shaft and fasten it using the retaining ring.



Figure 248

2. Press the preassembled pump shaft into the pump cover and fasten it using the retaining ring.



Figure 249

3. Insert the compression springs (1) and ball (2) into the bores (see arrows - 3x).



WARNING!

Before installation oil single parts of the pump/rotor set (control housing, internal and outer rotor) - use oil according to the "Table of Recommended Lubricants" in operation manual.



CAUTION!

Keep the pump shaft/cover in "vertical" position - pay attention to the position of the inserted balls / compression springs - See Figure 250 - . Figure 256).

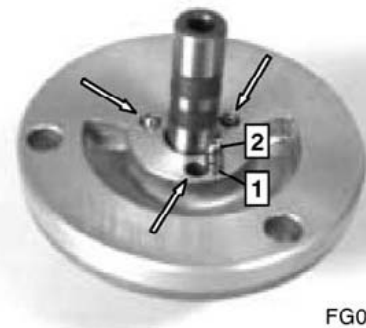


Figure 250

FG002944

4. Mount the control housing.

Control housing/internal and outer rotor = rotor set



FG002945

Figure 251

5. Position the ball - see arrow -(drive for internal rotor) with grease (assembly aid) into the recess of the pump shaft.



FG002946

Figure 252

6. Mount the internal rotor



CAUTION!

Place the groove of the internal rotor over the driving ball (see arrows).



FG002947

Figure 253

7. Assemble the outer rotor.



FG002948

Figure 254

8. Check passage of the orifice / oil bore in the housing bottom.

! CAUTION!

Insert the needle sleeve to installation dimension "X."

"X" = 0.2 - 0.7 mm below plane face/housing

! CAUTION!

The exact installation position is ensured by use of the specified mounting tool.

! CAUTION!

Insert the needle sleeve with marked face showing upwards.

9. Keep the preassembled pump in "vertical" position (See Note Figure 250) and put on the housing.



Figure 255



Figure 256

! CAUTION!

Keep the assembled pump to contact.

10. Rotate the housing by 180° and fasten the pump with hexagon screws.

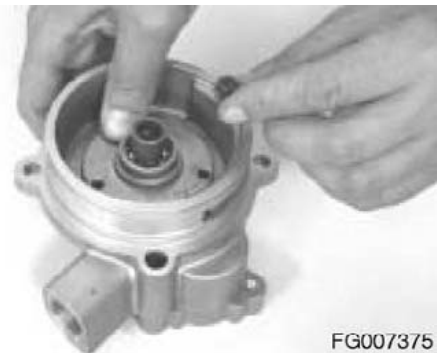


Figure 257

11. Fasten the pump finally.

Tightening torque (M6/8.8) $M_A = 9.5 \text{ Nm}$



Figure 258

FG007376

12. Functional test of the lube oil pump:

With counterrotating motions on the pump shaft, the swivelling of the control housing (stop LH/RH in the pump cover) is audible.



Figure 259

FG007377

13. Oil both O-rings (arrows) and put them into the ring groove of the housing.

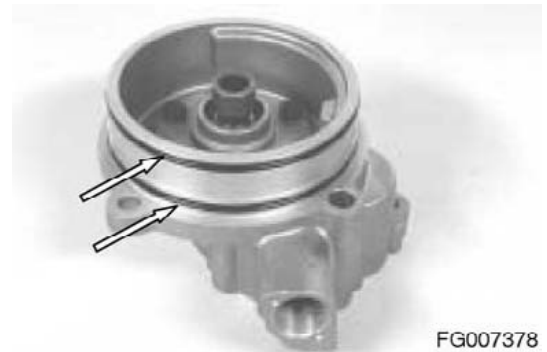


Figure 260

FG007378

14. Check the O-rings (arrows) of the pressure limiting valve and replace them, if necessary.



Figure 261

FG007379

15. Insert the pressure limiting valve.

Tightening torqueMA = 20 Nm

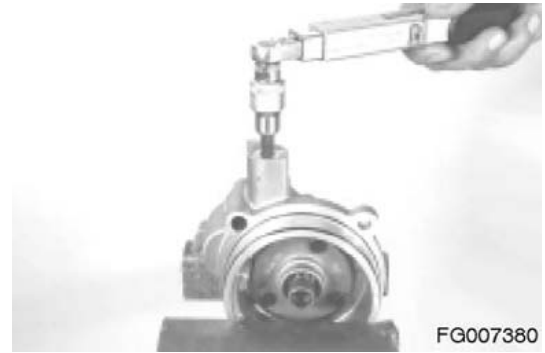


Figure 262

16. Secure the pressure limiting valve by blows with the center punch (2x).



Figure 263

17. Insert the filter. Observe the installation position.



Figure 264

18. Place the gasket.



Figure 265

19. Place the cover and fasten it with hexagon screws and washers.

Tightening torque (M8/8.8)MA = 23 Nm



Figure 266

FG007384

20. Insert the screw plug with O-ring.

Tightening torque (M10x1)MA = 15 Nm



Figure 267

FG007385

21. Mount the lube oil pump and fasten it with cap screws and washers.

Tightening torque (M8/10.9)MA = 23 Nm



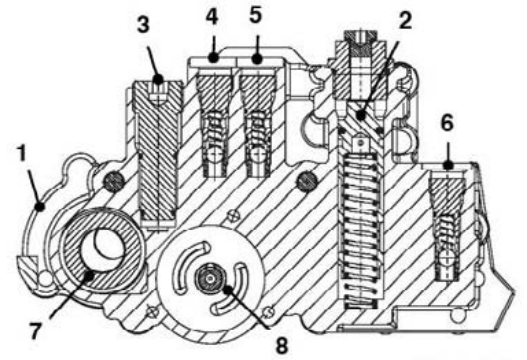
Figure 268

FG007386

Version "with" Hydraulic Downshift Interlock

Legend for Figure 269:

Reference Number	Description
1	Housing
2	G.shift Piston
3	Pressure Limiting Valve
4	Check Valve (008)
5	Check Valve (009)
6	Check Valve (010)
7	Filter
8	Lube Oil Pump



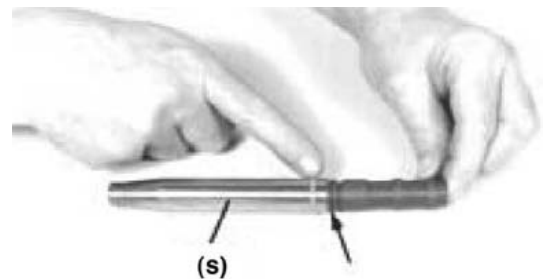
FG002933

Figure 269

Install the gasket (consisting of plastic and O-ring (Fig. No. 23 and 24)

1. Put the O-ring (see arrow) into the ring groove of the piston.

Lead the plastic ring using the mounting bushing(s) over the piston and position it at the O-ring.



FG002934

Figure 270

2. Calibrate the plastic ring using the bushing.



FG002935

Figure 271

3. Insert the compression spring, oil and mount the preassembled piston.



Figure 272

4. Fix the piston with screw plug (1- with O-ring).
Install the screw plug (2. with sealing ring).

Tightening torque:

Screw plug (M24x1.5) $M_A = 50 \text{ Nm}$

Screw plug (M10x1) $M_A = 15 \text{ Nm}$



Figure 273

5. Install the single parts according to the illustration on the left.

CAUTION!

Observe the installation position of the different check valves.

Oil the single parts according to the "table of recommended lubricants" pages of operation manual.

1 = Pressure limiting valve $M_A = 10 \text{ Nm}$

2 = Check valve $M_A = 10 \text{ Nm}$

3 = Check valve $M_A = 10 \text{ Nm}$

4 = Check valve $M_A = 10 \text{ Nm}$

6. Secure the check valves and the pressure limiting valve by two blows each with the center punch.



Figure 274

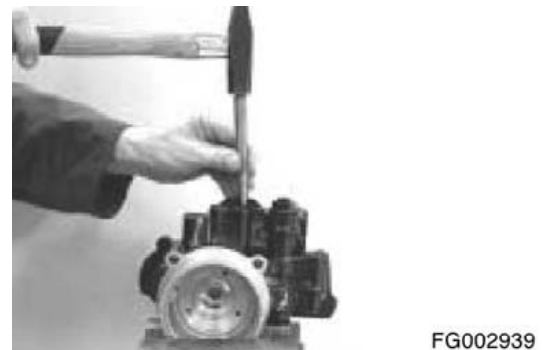


Figure 275



8. Mount the ball bearing onto the shaft and fasten it with the retaining ring.



- Press the preassembled pump shaft into the pump cover and fasten it with the retaining ring.



10. Insert the compression springs (1) and ball (2) into the bores (see arrows - 3x).



WARNING!

Before installation oil single parts of the pump/rotor set (control housing, internal and outer rotor) - use oil according to the "table of recommended lubricants" pages of operation manual.



CAUTION!

Keep the pump shaft/cover in "vertical" position - pay attention to the position of the inserted balls / compression springs - See Figure 250 - Figure 256).

11. Mount the control housing.
Control housing/internal and outer rotor

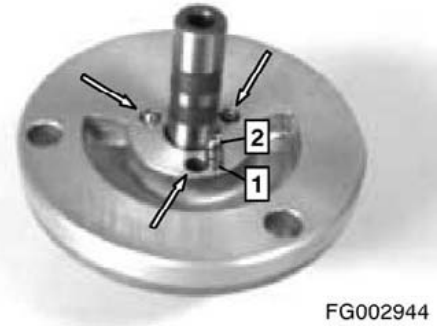


Figure 279



FG002945

Figure 280

12. Position the ball - see arrow -(drive for internal rotor) with grease (assembly aid) into the recess of the pump shaft.



Figure 281

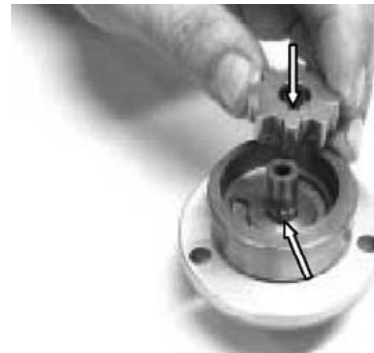
FG002946

13. Mount the internal rotor



CAUTION!

Place the groove of the internal rotor over the driving ball (see arrows).



FG002947

Figure 282

14. Assemble the outer rotor.



FG002948

Figure 283

15. Keep the preassembled pump in "vertical" position (see Instructions Figure 279) and put on the housing.



FG002949

Figure 284



CAUTION!

Keep the assembled pump to contact and rotate the housing by 180°.

Fasten the pump with hexagon screws.

Tightening torque (M6/8.8)MA = 9.5 Nm



FG002950

Figure 285

16. Insert the screen filter - Observe the installation position.



Figure 286

17. Place the gasket.

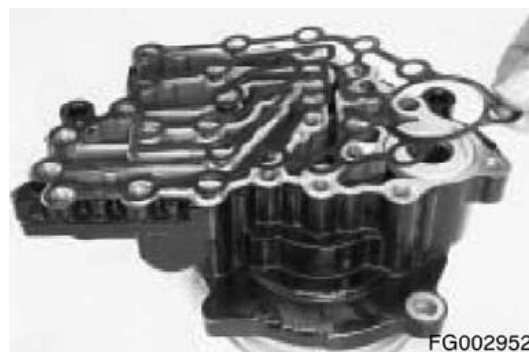


Figure 287

18. Position the cover, fasten it with hexagon screws and washers.

! CAUTION!

Pay attention to different screw length.

Tightening torque (M8/10.9)MA = 23 Nm



Figure 288

19. Oil both O-rings (arrows) and put them into the ring grooves of the housing.



Figure 289

20. Mount the preassembled downshift interlock and fasten it with cap screws and washers.



Pay attention to different screw length.

Tightening torque (M8/10.9) $M_A = 23 \text{ Nm}$

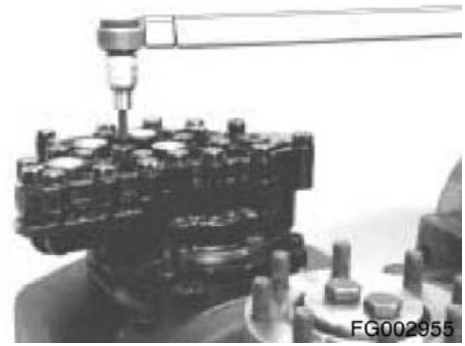


Figure 290

21. Install both screw-in sleeves and the screw plug (see arrows) - with O-rings.

Tightening torque:

Screw-in sleeve (M 16 x 1.5) $M_A = 23 \text{ Nm}$

Screw plug (M 18 x 1.5) $M_A = 35 \text{ Nm}$



Figure 291

Legend for Figure 292:

Reference Number	Description
1	Oil Tube
2	Union Screw (M 16 X 1.5)
3	Sealing Ring
4	Union Screw (M 14 X 1.5)
5	Sealing Ring

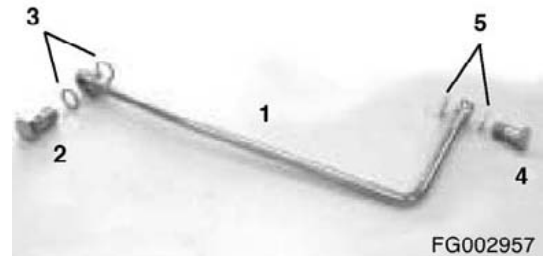


Figure 292

22. Install both oil tubes.

Tightening torque:

Union screw (M 14 x1.5) $M_A = 25 \text{ Nm}$

Union screw (M 16 x1.5) $M_A = 45 \text{ Nm}$



Figure 293

Version "with" Electric Downshift Interlock - Mounted to the Transmission

1. Position both O-rings (arrows).



Figure 294

2. Fasten the downshift interlock with cap screws and washers.

Tightening torque (M8/10.9)MA = 23 Nm



WARNING!

Before put the unit into operation the specifications and regulations respectively and the instructions of the transmission operating and maintenance instructions and the specifications and instructions of the vehicle manufacturer have to be observed.



Figure 295

ATTACH THE HL-TRANSMISSION TO THE AXLE

(only for the version "Axle Attachment")

1. Position the HL-Transmission to the axle.



Figure 296

2. Fasten the HL-Transmission to the axle using hexagon screws and nuts.

Tightening torque (M12/8.8)MA = 79 Nm



WARNING!

Before put the unit into operation the specifications and regulations respectively and the instructions of the transmission operating and maintenance instructions and the specifications and instructions of the vehicle manufacturer have to be observed.



Figure 297

MEMO

Drive Coupling (Main Pump)

Edition 1

MEMO

Drive Coupling (Main Pump)

Safety Precautions	5
Applicable Models	5
Drive Coupling	7
Special Tools	9
Drive Coupling Installation.....	10
Installation Procedure.....	12

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

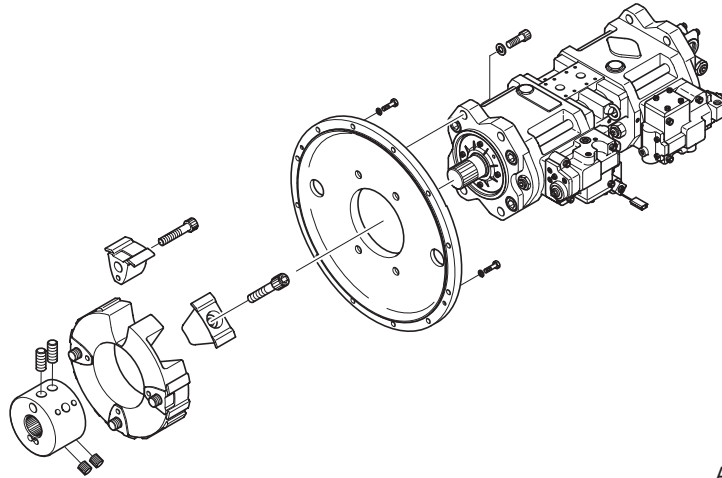
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

DRIVE COUPLING

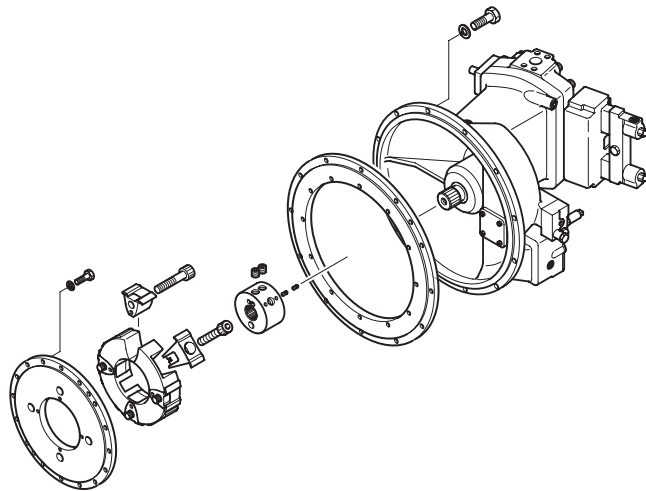
When installing the main pump on the engine, it is very important to properly adjust clearance between the face of the coupling hub and end of pump driveshaft ("Measurement H" shown in the following procedure) to a specific value.

Figure 1 thru Figure 3, show typical drive coupling installations.



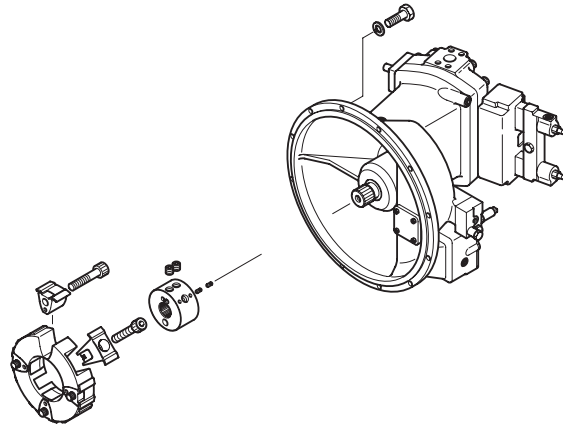
ARS1710L

Figure 1



ARS1720L

Figure 2 S340LC-V - S470LC-V



BMS0040L

Figure 3 S175LC-V, S180W-V, DX140W, DX160W, DX190W, DX210W

SPECIAL TOOLS

This tool is used to control the distance between the end of the pump driveshaft and the front face of the drive coupling hub (Figure 4 and Figure 3). This distance will be referred to as "Measurement H" in the installation instructions that follow.

NOTE: In manufacturing drawings (Figure 3), dimension "A" and "B" equal the "Measurement H." The two tools shown are designed to be used on various models of equipment. Only one end of the tool is used for a specific model of equipment.

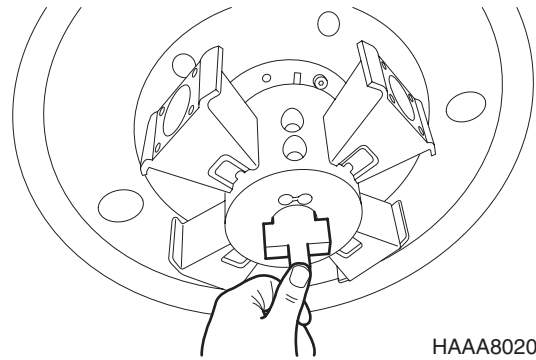


Figure 4

HAAA8020

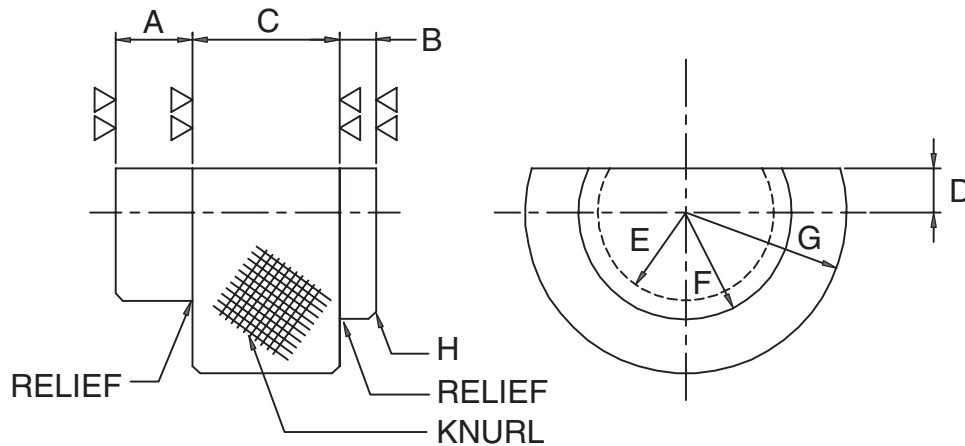


Figure 5

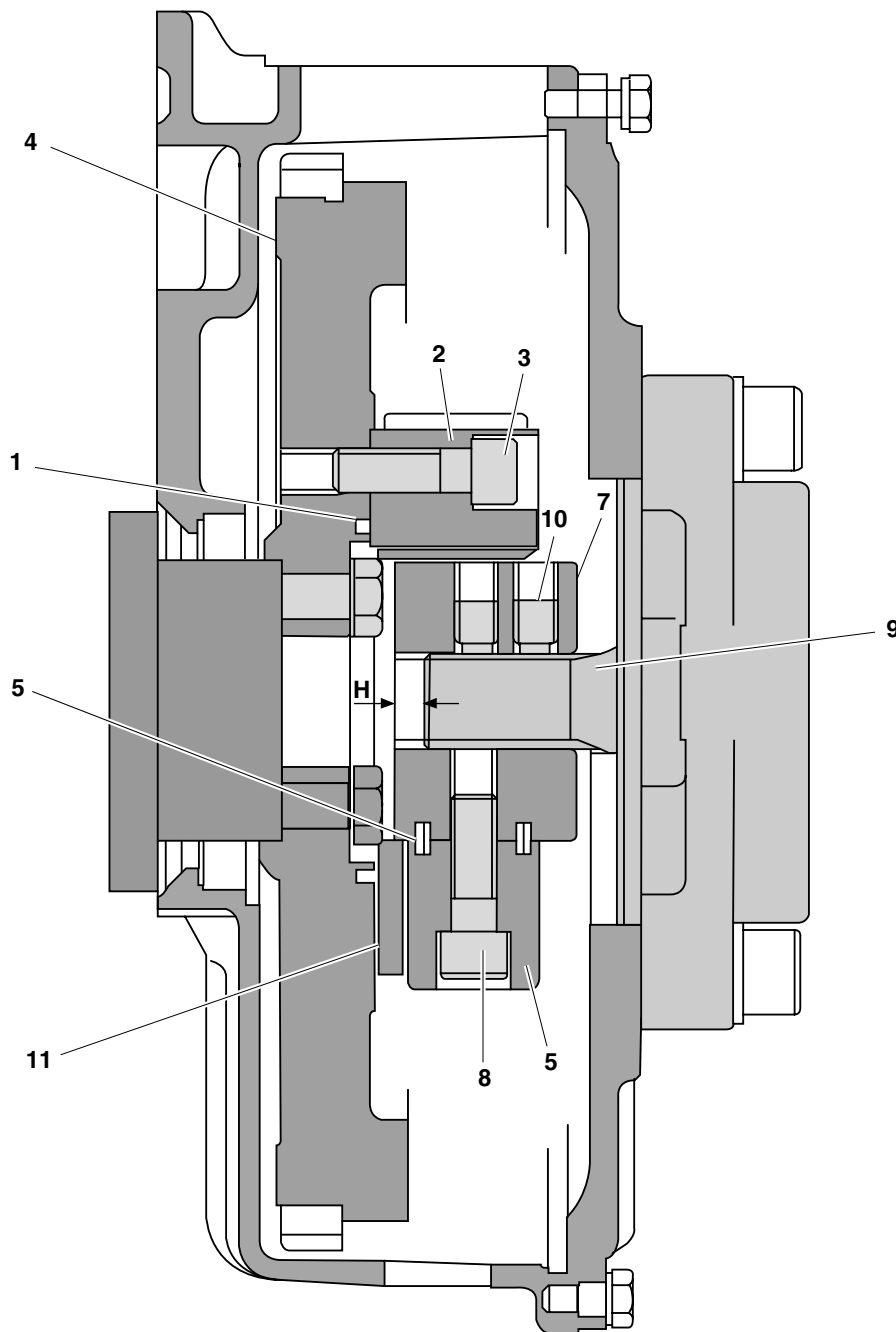
HAAA8360

Dimensional Details for Figure 5		
Dimension	Measurement	Models
A	10.5 ±0.1 mm (0.4134 ±0.0039 in)	S300LC-V, S300LL, DX190W, DX210W
B	8.5 ±0.1 mm (0.3346 ±0.0039 in)	S340LC-V, S420LC-V, S470LC-V, DX140W, DX160W
C	20.0 mm (0.787 in)	
D	7.0 mm (0.275 in)	
E	14.0 mm (0.551 in) Radius	
F	17.0 mm (0.669 in) Radius	
G	25.0 mm (0.984 in) Radius	
H	1.0 mm (0.039 in) x 45° Chamfer	

DRIVE COUPLING INSTALLATION

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

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



HAAA8040

Figure 6 Drive Coupling Installation

Table 1 Parts Information and Torque for Figure 6			
Reference Number	Description	Qty.	Torque (See Table 2)
1	Spring Pin	4	
2	Insert	4	
3	Bolt	4	Ta
4	Flywheel	1	
5	Spring Pin	8	
6	Insert	4	
7	Hub	1	
8	Bolt	4	Ta
9	Pump shaft	1	
10	Clamping screw	2	Tb
11	Element	1	

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

Table 2 Specification for "Measurement H" and Torque (Refer to Figure 6)				
Model	Coupling Part Number	"Measurement H"	Torque Value for "Ta"	Torque Value for "Tb"
DX140W	K1013823	8.0 - 9.0 mm (0.315 - 0.354 in)	21 - 23 kg•m (152 - 166 ft lb)	10 - 12 kg•m (72 - 87 ft lb)
DX160W				
DX190W	K1013827	10.0 - 11.0 mm (0.394 - 0.433 in)	21 - 23 kg•m (152 - 166 ft lb)	10 - 12 kg•m (72 - 87 ft lb)
DX210W				
S300LC-V	414-00040	5.5 - 6.5 mm (0.216 - 0.256 in)	44 - 49 kg•m (318 - 354 ft lb)	20 - 22 kg•m (145 - 159 ft lb)
S300LL				
S340LC-V	414-00041	6.5 - 7.5 mm (0.256 - 0.295 in)	44 - 49 kg•m (318 - 354 ft lb)	20 - 22 kg•m (145 - 159 ft lb)
S420LC-V				
S470LC-V				

Installation Procedure

NOTE: Refer to Figure 6 while using following procedure.

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

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

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

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

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

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

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

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

5. Install element (11) between inserts (2) on engine flywheel (4)
6. Install main pump and hub (7) by pushing it softly into element (11).
7. Attach flywheel cover / pump housing to flywheel housing with bolts

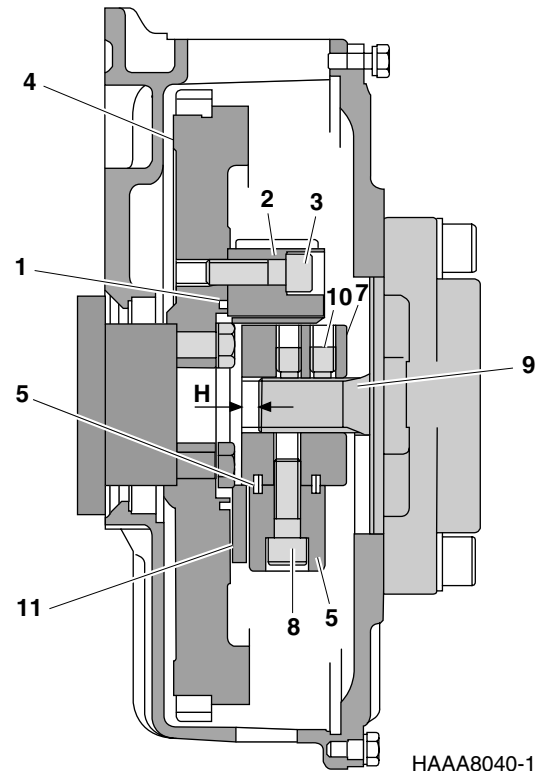


Figure 7

CAUTION!

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

Hydraulics

Hydraulic System Troubleshooting, Testing and Adjustment

Edition 1

MEMO

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SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX210W	5001 and Up

HYDRAULIC SYSTEM - GENERAL NOTES

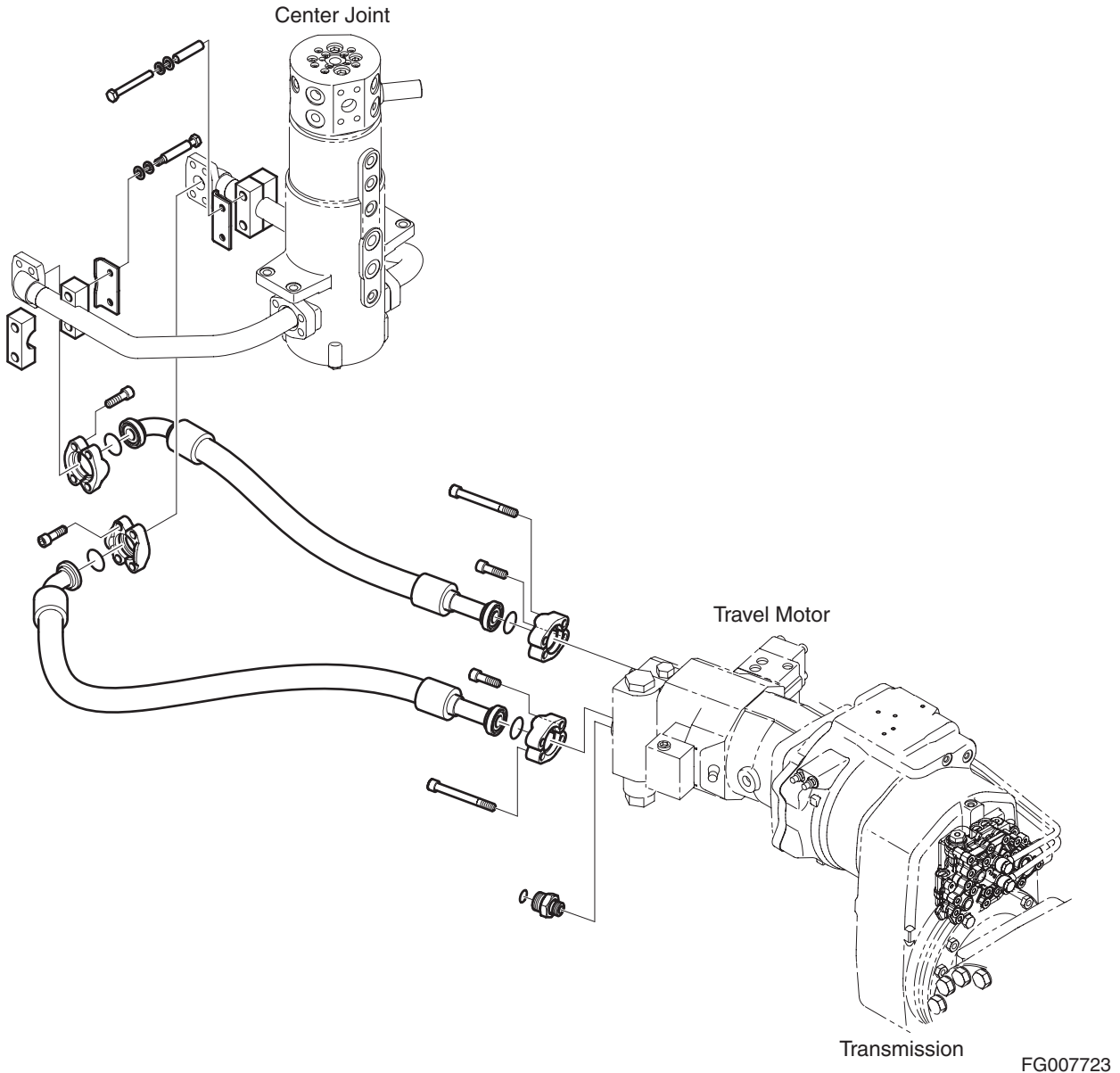


Figure 1

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 several models.

General Notes

When referring to the schematic, refer to the following items:

- As shown in the schematic, the main pump assembly is driven by the engine. Mechanical energy is converted to hydraulic power, generating the required hydraulic flow which drives the system. Two main pumps (a right side pump and a left side pump) make up the main pump assembly.
- Hydraulic output from the right side pump is transmitted to the right side of the control valve. Output from the left side pump is transmitted to the valve spools on the left side of the control valve. Hydraulic output from the pilot pump is used to control the pump and to operate pilot and solenoid valves.
- The right half of the hydraulic control valve, supplied by the right pump in the pump assembly, operates valve spools for right travel, 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 travel control spools are shifted, output from the main pump assembly passes through the center joint to the axial piston motors driving the wheel.
- The hydraulic reservoir return line and the pilot circuit both have 10 micron full flow filters. The disposable elements in these two canister type filters trap and remove impurities from the oil in the system. An 80 mesh, 177 micron reservoir intake strainer also helps

maintain system cleanliness and should be cleaned each time hydraulic fluid is drained and replaced. An oil cooler in the hydraulic system helps maintain the operating temperature of the system at approximately 50°C (122°F).

- The arm cylinder operating circuit includes anticavitation valves which protect the hydraulic system from vacuum that could result from external shocks or other unusual conditions. Boom, Arm, and Bucket cylinder circuit are also protected by overload relief valves. Whenever high-pressure is generated because of a shock or overload, excess pressure is dumped to the reservoir return circuit through the relief valve.

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 $360 \text{ kg}\cdot\text{cm}^2$ (5,112 psi) protect the hydraulic system from being damaged because of overloads or shocks to the boom.

Boom Up Circuit

When you pull the boom control lever backward, the right side pilot valve generates secondary boom up pilot pressure that is transmitted to the right and left sides of the control valve simultaneously. When secondary pilot pressure reaches $7 - 9 \text{ kg}\cdot\text{cm}^2$ (100 - 128 psi), boom control valve spools open and oil from both pumps goes to the boom cylinder.

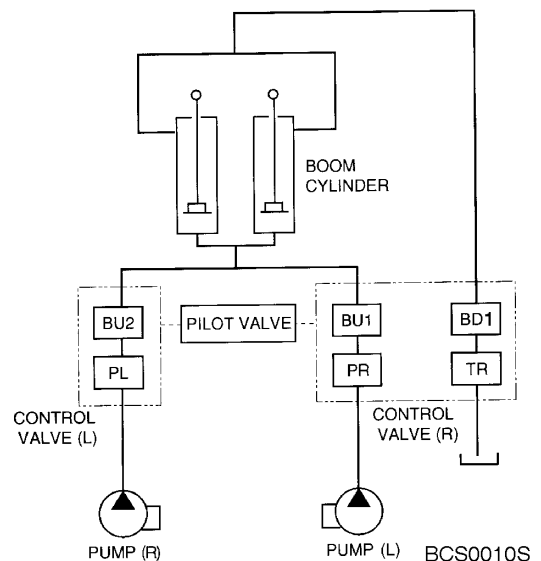


Figure 2

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 right side of the control valve. When secondary pilot pressure reaches 7 - 9 kg•cm² (100 - 128 psi), the valve spool on the right side of the control valve opens so oil from only one half of the pump assembly goes to the boom cylinder for boom lowering.

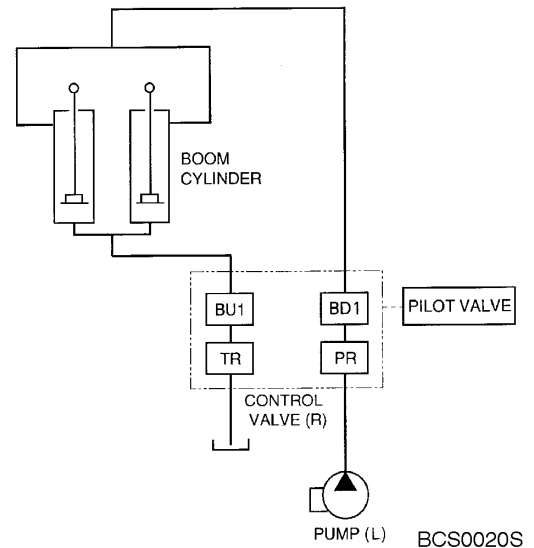


Figure 3

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.

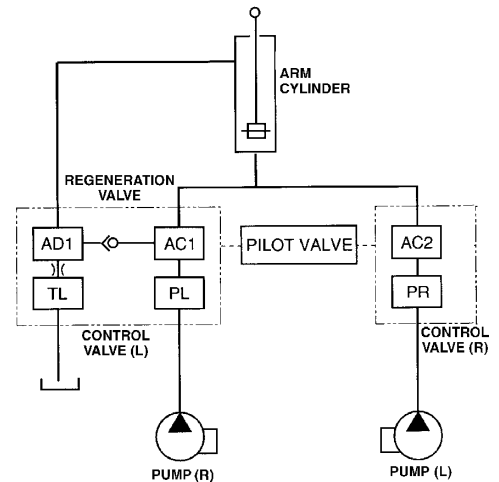
Overload relief valves set at 360 kg•cm² (5,112 psi) have been installed at the AC 1 and AD 1 ports on the left side of the control valve to protect the circuit and system components from possible damage caused by shocks and/or overload pressure. Additional protection - to prevent cavitation of the cylinder - is provided by a makeup valve and reservoir return circuit, which ensures that 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 right and left sides of the control valve simultaneously.

When secondary pilot pressure reaches 7 - 9 kg•cm² (100 - 128 psi), the arm control valve spool on the right and left sides of the control valve opens. 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 cylinder could suddenly be forced out by the weight of the arm and bucket itself. 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.



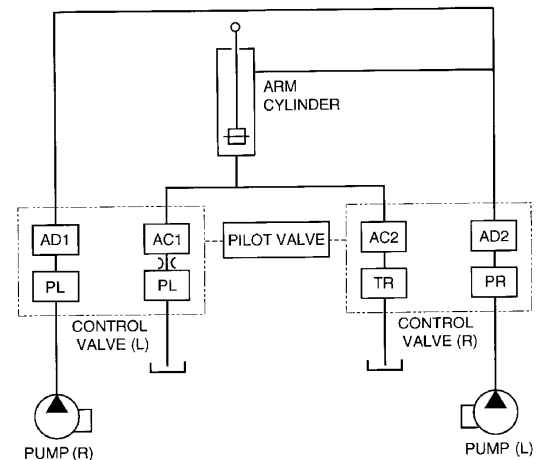
BCS0030S

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 halves of the control valve simultaneously.

When pilot pressure reaches 7 - 9 kg•cm² (100 - 128 psi), the control spools open on both sides allowing oil from the right and left pumps to flow to the arm cylinder.



BCS0040S

Figure 5

Bucket Operating Circuit

The bucket operating circuit includes the right and left main pumps, the right and left halves of the control valve and the bucket cylinder. 360 kg•cm² (5,112 psi) overload relief valves at BKC and BKD 1 ports of the control valve protect the circuit and its components from damage.

Bucket Crowd Circuit

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

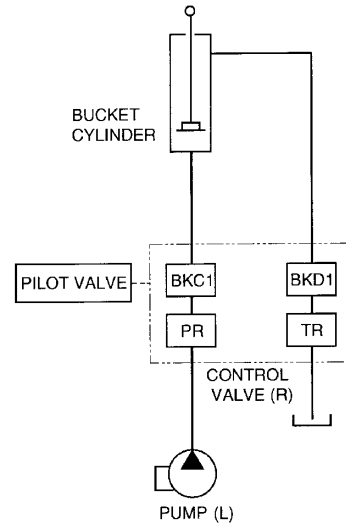


Figure 6

BCS0050S

Bucket Dump Circuit

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

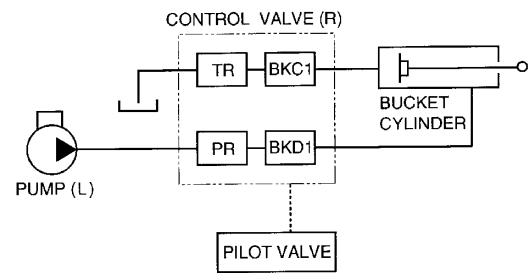


Figure 7

BCS0060S

Swing Operating Circuit

The swing operating circuit consists of the right main pump in the pump assembly, the left half of the control valve and the swing motor. To keep the upper works from coasting when the swing control is in neutral, an electrical sensor in the control circuit activates a valve to automatically engage a mechanical brake.

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 left pump is then directed through the PSR and SR ports of the control valve to the SR port of the swing motor.

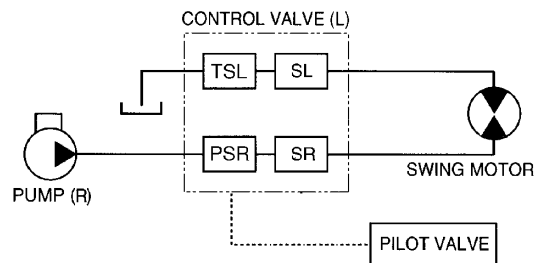
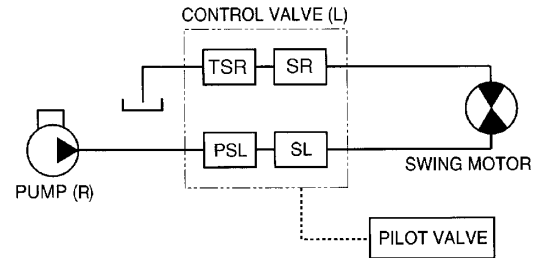


Figure 8

BCS0070S

Left Swing Operating Circuit

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



BCS0080S

Swing Relief Valve and Makeup Valve

Whenever the spool is shifted to the neutral mode during swing operation, the possibility exists that surge pressure in the circuit - caused by inertial momentum of the upper works and correspondingly reduced pressure at the opposite motor port - could produce cavitation in the circuit. To keep that from happening, a $270 \text{ kg}\cdot\text{cm}^2$ (3,840 psi) relief valve is installed in the swing motor and a large-capacity makeup valve is connected to the entrance port of the hydraulic reservoir, helping maintain acceptable pressures on both sides of the circuit.

Figure 9

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 (power mode)

- at 1,880 rpm with no load.
- at 1,800 rpm stall load.

If engine rpm drops excessively with a load or fails to surpass rated speed (1,800 rpm), performance problems may be because of inadequate hydraulic flow caused by lagging rotational speed.

NOTE: *Verify actual flow on the excavator against rated performance, with a flow meter.*

If engine tests meet specifications and adequate torque and horsepower are available at the pump drive flex coupling, pull out the electrical tray under the operator's seat to inspect the self-diagnostic display.

If the EPOS trouble code display is clear, check hydraulic functions in the following sequence:

- Pilot pressure.
- Negacon, negative control pressure.
- Main relief pressure (front and rear pump)
- Swing pressure.
- Port relief pressure (individual control functions; boom, arm, bucket, swing, and travel).
- Power boost circuit.
- Standard performance tests; cylinder speed, hydraulic motor (travel and swing) speed, cylinder oil tightness "permissible drift" test.

NOTE: *System specification performance tests of individual activator function are*

determined by flow rate through the component or circuit, not the control pressure or system pressure available to the actuator. Poor flow through the individual circuit may indicate that component is worn beyond tolerance limits, while all other hydraulic functions are adequate.

IMPORTANT

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

PILOT PRESSURE

Adjustment and Testing



WARNING!

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

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

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

If gear pump pressure is outside the tolerance specified in the table, adjust gear pump relief pressure by loosening the locknut and turning the set screw in (clockwise) to increase pressure, or turning it out to decrease it.

NOTE: *Be aware that serial number changes and variation in the joystick assemblies used on different excavators could produce slight change in actual performance characteristics. Comparison of part numbers to serial numbers stamped on your assembly may be required, if questions or doubt exists.*

IMPORTANT

Top off the hydraulic fluid reservoir if there is any measurable loss of hydraulic oil during test gauge and adapter fitting installation.

Engine rpm	Pilot Pressure @ Pump	Pilot Pressure - Joystick
Minimum Speed Setting (full left) on Speed Control Dial	40 ± 5 bar (580 ± 73 psi)	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 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/870 psi (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 III on the Instrument Panel. Check current readings (in milliamps) on the VOM meter and hydraulic pressure gauge readings and make sure both conform to the values in the table below.

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

Mode	Engine rpm	Current	Pressure
Power Mode	1,880 rpm	270 ± 20 mA Midrange value corresponding to engine rpm for both current and hydraulic pressure readings.	3.5 ± 1 bar (30.5 ± 14.5 psi)
Standard Mode "S"	1,775 rpm	350 ± 20 mA	8.3 ± 3 bar (68.2 ± 43.5 psi)

Mode	Engine rpm	Current	Pressure
Auto Idle Mode	800 rpm	650 ± 20 mA	24.2 ± 4.5 bar (320.5 ± 65.3 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 located inside the compartment behind the cabin.

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

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

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

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

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



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 2-stage main relief valve was not set correctly and main relief high stage pressure ("pressure up") is outside the tolerance range, begin valve adjustment by loosening the outside (widest diameter) locknut on the relief valve. Turn the adjusting screw clockwise to increase pressure, or counterclockwise to decrease it. Pressure must be 350 bars (5,075 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



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 – $2,070 \pm 50$ rpm.**
 - **Permanently mark setscrew positions at the current regulator control setting.**
-

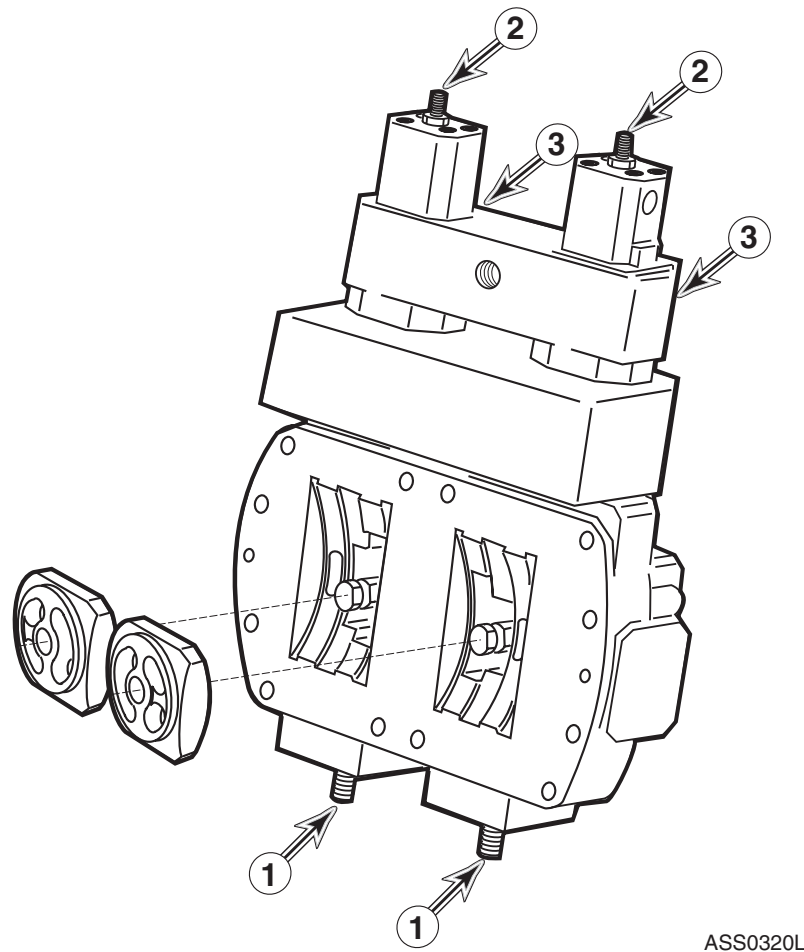
Use a scribe or other permanent marker to identify a reference point on adjusting screws with a corresponding reference on the body of the valve. The adjustment process affects a complex balance and could require some time to complete. If adjustment has to be interrupted or postponed, reference marks 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.



ASS0320L

Figure 10

Refer to the illustration of the pump regulator control valve (Figure 10) for the location of adjustment screws (1, 2 and 3). There are two different adjustments, along with the Negacon, negative control, adjustment screw (3, directly below 1 and 2). Each one of the adjustment procedures could affect the setting of the others.

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

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

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

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

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.

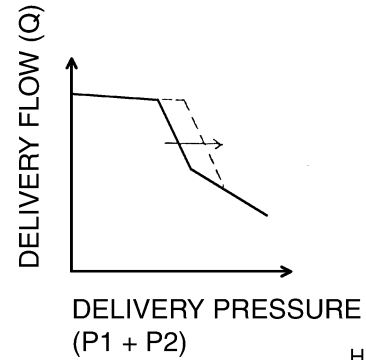


Figure 11

HAAD409I

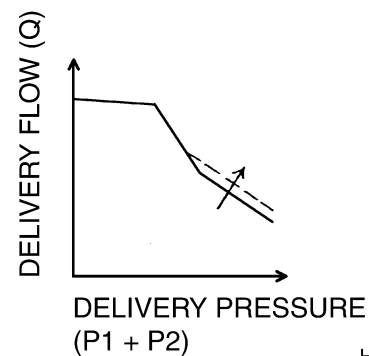


Figure 12

HAAD410I

The adjusting screw (1, Figure 10) affects the delivery rate (Q) of the pump. Tightening the adjusting screw decreases the maximum cut flow (as shown in Figure 13) while backing out the screw increases cut flow delivery rate.

Balance both pumps for equal output.

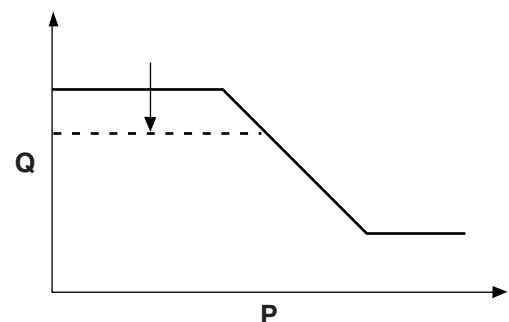


Figure 13

HDA3008I

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 length of hydraulic hose, between the output end of the flow meter assembly and the top of the reservoir. Use appropriate fittings and adapter flanges to guarantee a pressure tight seal.

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

- An assistant – who must remain at the operator's control station at all times – should restart the engine and run it long enough (at minimum rpm) to deaerate the system and warm up the engine and hydraulic system to operating temperature.

Record the values of all test results in three columns, comparing 1) pump pressure (from the instrument panel display) with 2) measured flow, in gallons or liters per minute, from the installed flow meter. The third column of test results should provide a record of engine rpm measured during each of the following tests – with the engine speed control dial set at maximum, the power mode selector at Power Mode and the work mode selector at digging mode:

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

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

Engine rpm	Pressure	Flow
	100 kg•cm ² (1,422 psi)	
	135 kg•cm ² (1,930 psi)	
	180 kg•cm ² (2,560 psi)	
	240 kg•cm ² (3,413 psi)	
	320 kg•cm ² (4,550 psi)*	
	*See below note.	

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

If test results do not meet specified values, pump output tests can be repeated using different control levers. Recheck front pump operation while stroking the bucket cylinder out lever, and the rear pump by actuating the swing control lever.

NOTE: *When testing bucket and swing functions, read maximum flow tests at 330 kg•cm² (4,785 psi), not 350 kg•cm² (5075 psi).*

SWING SYSTEM TROUBLESHOOTING

Precautions/Initial Checks

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



WARNING

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

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

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

- Check oil level.
- Check for overheating, oil leaks, external oil cooler clogging or broken fan belt. Consult service record for prior repair/service work.
- Drain some tank oil into a clean, clear container. Look for metal shavings/grit, cloudiness/water or foam/air bubbles in the oil.
- 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 260 and 280 bar (3,770 psi and 4,061 psi), with both swing locks engaged. With swing locks released, during full acceleration and deceleration, pressure should approach 270 bar (3,916 psi) in each direction.

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

Pressure should always stay at or above 4 bar (58 psi) when operating swing, boom or arm.

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

Pressure should stay consistently above 2.5 bar (36 psi). If pressure drops below the recommended minimum level, forceful acceleration of the swing motor could lead to cavitation of the circuit and stalling, slowed rotation, noise and possible damage.

2. If main inlet and outlet pressures were off in the preceding tests in Step 1, adjust swing relief valve pressure.

Following adjustment, repeat the operating pressure tests (with gauges connected to the inlet and outlet test ports on top of the swing motor) and check pressures with the swing locks engaged and released.

If pressure adjustment fails to restore adequate performance, proceed to the Troubleshooting - Swing table.

3. If pressure tests were at recommended levels through the main inlet and outlet ports, and through the "SH" port of the swing brake, the causes of poor swing performance could include a faulty swing motor, drivetrain overloading or gearbox defect, or a problem in the brake assembly or swing control valve. Proceed to the troubleshooting information in the next procedure.

If pressure through the "SH" port was tested below the minimum 13 bar (189 psi) level, check the shuttle valve in the rear compartment behind cabin. When pressure through the port is at the recommended level, the brake release valve should disengage the swing brake, allowing

the swing motor to rotate the excavator. If pressure adjustment to the valve has been restored but the brake still fails to release, the brake piston or friction plate may be frozen, requiring disassembly of the motor and parts repair/replacement.

4. If pressure tested at the motor makeup valve drops below recommended minimum level, and consequent problems with cavitation, stalling and surging are observed, check the restriction valve. If pressure adjustment to the valve has been restored but if problems with cavitation continues, disassemble the upper swing motor housing and clean or replace assembly components as required.

NOTE: *If all tested pressures are at or above recommended levels, and there are no mechanical problems in the drivetrain or in the motor/brake assembly, the problem will require further hydraulic troubleshooting. It's also possible that a defective joystick, an intermittent short in an electrical control circuit or a problem in the e-EPOS circuit is causing diminished swing performance. Pull out the e-EPOS indicator panel from underneath the operator's seat and perform the self-diagnostic test. If the display panel reads code "0.2," it is reporting that swing priority proportional valve is not functioning, except in the minimum "fail-safe" mode. Refer to the Electrical section of this book for more information.*

TROUBLESHOOTING – SWING GEARBOX

Problem	Possible Cause	Remedy
Swing motor fails to operate and:		
Three pressure tests at motor, brake or makeup valve show low reading(s).	Swing relief valve defective Brake release valve defective Motor makeup valve defective.	Adjust pressure to recommended range in affected valve. OR Disassemble and clean valve assembly. Replace all valve components that show damage.
All three pressure checks are OK but left travel also fails to run.	Exchange front and rear pump inlet and outlet hoses to test pump function.	If swing and left travel are restored but right travel stops working, replace or repair P1 pump.
All three pressure tests are OK, but machine fails to swing at all.	Brake assembly or motor friction plate failing to release.	Check for binding. Disassemble and repair.
	Pilot (control) pressure low or swing control valve stuck.	Disassemble / Repair pilot pressure swing spool (305) and / or swing control valve.
	Swing motor defective.	Test motor drain rate. Replace / Repair motor.
	Gear train defective.	Refer to "Swing Gear Troubleshooting" procedure.
Swing functions but only at reduced rpm.	Causes listed above could also produce dragging swing, OR hot or wrong oil OR worn-out parts.	Check above list; then replace oil, test motor drain rate and check for "02" reading (e-EPOS self-test).
Left travel speed is also reduced.	Low output at P1 pump or external pilot piping leaks/is clogged.	Clean and repair piping or repair or replace pump P1.
Swing control movement is reversed.	Inlet / outlet piping reversed.	Reset controls or reverse piping.
Machine swings but continues coasting on past stopping point.	Swing control valve spool not centered.	Replace return spring; clean/ repair valve piston and spool.
	Pilot pressure may be outside range.	Disassemble, clean or replace pilot relief valve or pilot valve.
	Swing relief valve may be faulty.	Repair/Replace swing relief valve.
Swing movement is in one direction only.	Check to see that pilot pressure is the same right and left.	If pilot pressure is unequal, clean or repair piping or repair/replace valve.
	Swing control valve spool may be stuck.	Repair/Replace the swing control valve.
	Swing relief valve may be faulty.	Repair/Replace the swing relief valve.
No rotation and:		
Pressure at swing motor inlet increases.	Swing brake not releasing.	Check brake engagement and disengagement; check release pressure.
	Internal damage to gearbox drivetrain.	Replace broken gears and drivetrain assemblies.
	Overload.	Reduce load weight.

Problem	Possible Cause	Remedy
Pressure at swing motor inlet shows no increase, and the swing motor is making irregular noises.	Swing motor driveshaft damage.	Replace swing motor.
	Internal damage to gearbox drivetrain.	Repair/Replace broken or faulty assemblies.
Pressure at swing motor inlet shown no increase, but without irregular noises from the swing motor.	Hydraulic pump or valve problem.	Troubleshoot hydraulic system.
Oil Leakage:		
From driveshaft From bolted connections or other assembled surfaces.	Oil seal damaged Assembly compound (joint sealer) old and not sealing, bolt not tight or flange warped.	Replace oil seal Disassemble and check mating surfaces. Reapply Loctite; torque bolts to specifications.
Excess heat:		
Gearbox casing becomes excessively hot, with or without irregular noise(s), during operation.	Low oil level.	Replace oil; refill to specified level.
	Bearings or gears worn but not completely inoperative.	Repair or replace gearbox.

TROUBLESHOOTING – HYDRAULIC PROBLEMS

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

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

TROUBLESHOOTING – CONTROL VALVE

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

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

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

TROUBLESHOOTING – TRAVEL CONTROL VALVE

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

TROUBLESHOOTING – JOYSTICK CONTROL VALVE

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

Accumulator

Edition 1

MEMO

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Accumulator

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

Remember, safety is ultimately remember, safety is your personal responsibility your own responsibility.

APPLICABLE MODELS

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

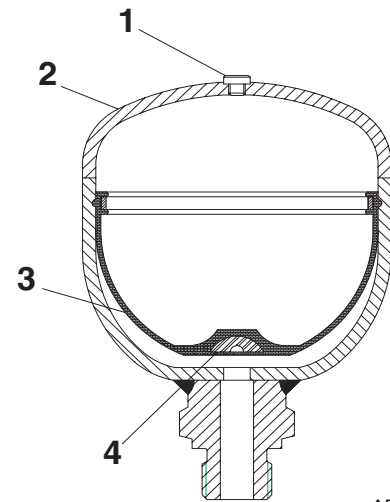
MODEL	SERIAL NUMBER RANGE
DX180LC	5001 and Up
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX300LL	5001 and Up
DX340LC	5001 and Up
DX27Z	5001 and Up
DX35Z	5001 and Up
DX420LC	5001 and Up
DX480LC	5001 and Up
DX520LC	5001 and Up

GENERAL DESCRIPTION

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

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

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



ARS1790L

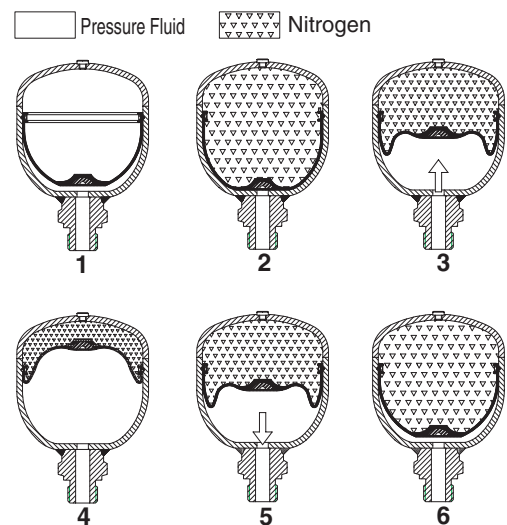
Figure 1

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

The drawings in Figure 2 display the six possible states the diaphragm can be in, they are as follows:

1. With no gas charge in the upper chamber 0 bar (0 psi, empty) and no oil in the bottom 0 bar (0 psi, dry) the elastic diaphragm hangs loosely.
2. When the prepressure charge of gas (usually nitrogen) is introduced through the port at the top of the accumulator, the diaphragm expands to maximum size. The valve button in the center of the diaphragm pushes into the fluid opening in the bottom chamber, sealing off the lower valve. If the pressure of the gas charge exceeds system oil pressure, no fluid enters the accumulator. The button also keeps the diaphragm from protruding into the lower valve opening.

NOTE: Precharge pressure is referred to as the "P1" pressure. The accumulator manufacturer's "P1" rated pressure should be stamped or marked on the accumulator's rating plate. Annual checks of actual precharge pressure should be made by tapping a hydraulic pressure gauge (and 3-way adapter coupling) into the valve on the bottom of the accumulator. When hydraulic fluid is pushed out the lower valve opening by the pressure of the gas charge on the other side of the diaphragm - and there is no counterpressure from system oil - the valve



ARS1800L

Figure 2

button on the bottom of the diaphragm eventually seals off the lower oil passage. Just after the needle on the gauge reaches its highest point (when there is 0 bar (0 psi) resistance from hydraulic system pressure) pressure on the gauge will drop sharply to zero, as the accumulator is completely emptied of oil and the diaphragm button closes.

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

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

The highest working pressure is sometimes referred to as the "P3" pressure and can also be referenced on the manufacturer's data label on the exterior of the accumulator.

5. If system oil pressure begins to fall off or is momentarily checked or interrupted, the energy stored on the other side of the diaphragm, in the form of compressed gas, pushes oil back out of the lower chamber, maintaining oil pressure of the circuit.
6. With minimal system pressure, an equilibrium point may be reached in which accumulator precharge pressure and hydraulic system oil pressure achieve a rough balance. In this state a minimal amount of oil is stored in the accumulator.

Specifications

Model	Serial Number	System	Charge Pressure	Volume
DX140W	S/N 5001 and Up	Brake	30 kg•cm ² (427 psi)	750 cc (45.77 in ³)
		Pilot	15 kg•cm ² (213 psi)	320 cc (19.53 in ³)
DX160W	S/N 5001 and Up	Brake	30 kg•cm ² (427 psi)	750 cc (45.77 in ³)
		Pilot	15 kg•cm ² (213 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)
DX190W	S/N 5001 and Up	Brake	30 kg•cm ² (427 psi)	750 cc (45.77 in ³)
		Pilot	15 kg•cm ² (213 psi)	320 cc (19.53 in ³)
DX210W	S/N 5001 and Up	Brake	30 kg•cm ² (427 psi)	750 cc (45.77 in ³)
		Pilot	15 kg•cm ² (213 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)
DX27Z	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)
DX300LL	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)
DX35Z	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

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Center Joint (Swivel)

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SAFETY PRECAUTIONS



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APPLICABLE MODELS

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

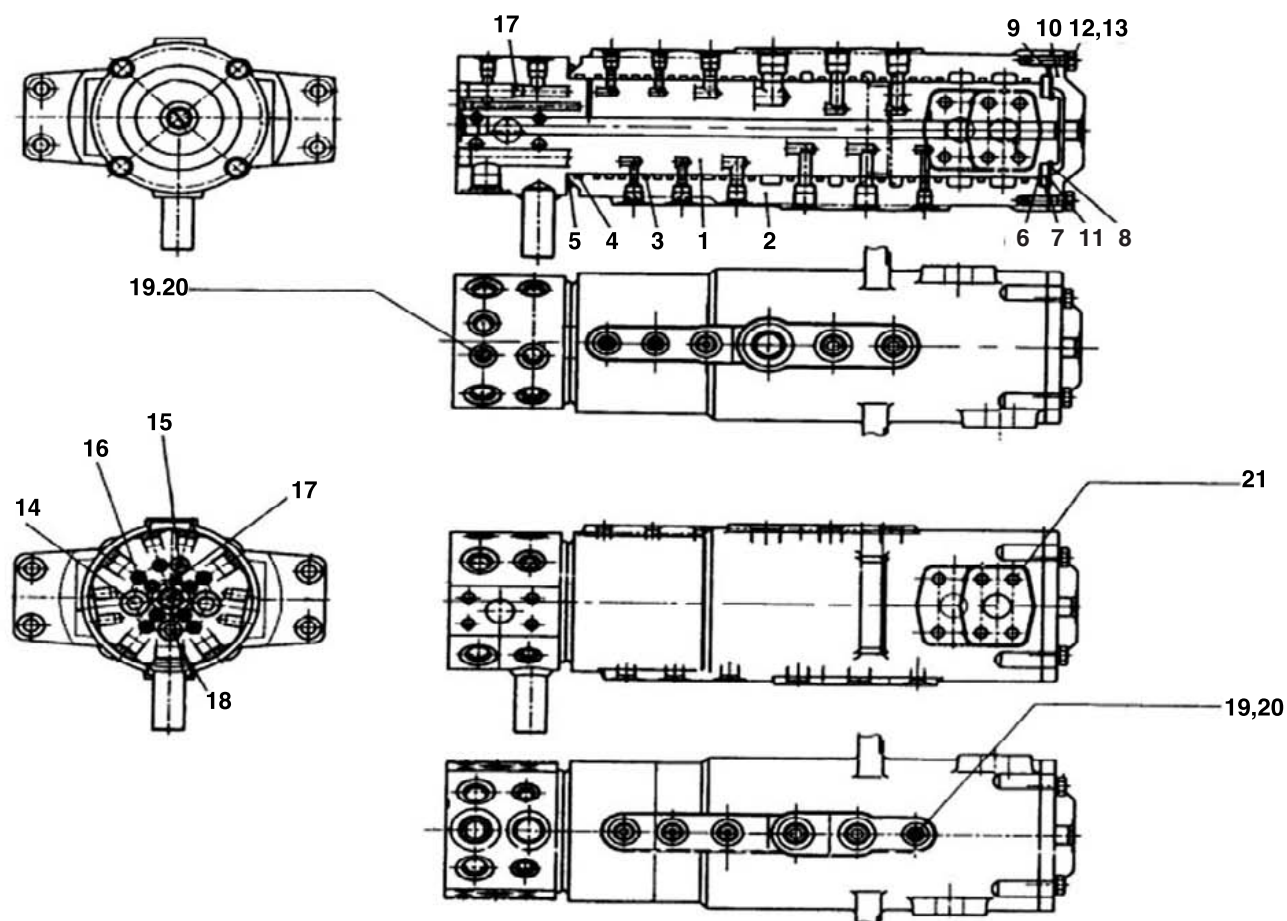
MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

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



FG003763

Figure 1

Reference Number	Description
1	Spindle
2	Body
3	Rotary Seal
4	O-ring
5	O-ring
6	Shim-A
7	Thrust Plate
8	Retaining Ring
9	O-ring
10	Cover
11	Shim-B

Reference Number	Description
12	Bolt
13	Spring Washer
14	Socket Plug
15	Socket Plug
16	Socket Plug
17	Socket Plug
18	Socket Plug
19	Plug
20	O-ring
21	Bolt

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).

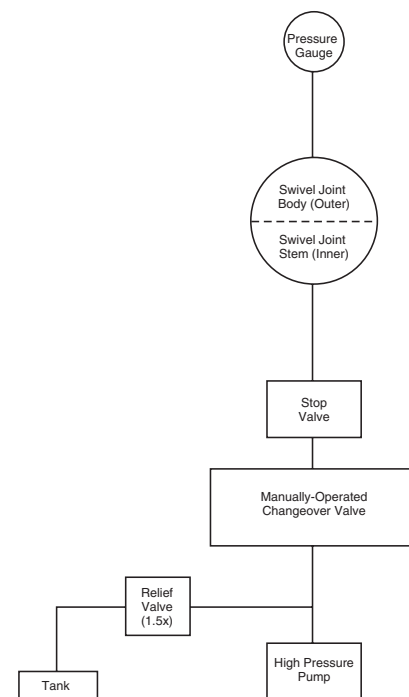


Figure 2

0371

DISASSEMBLY

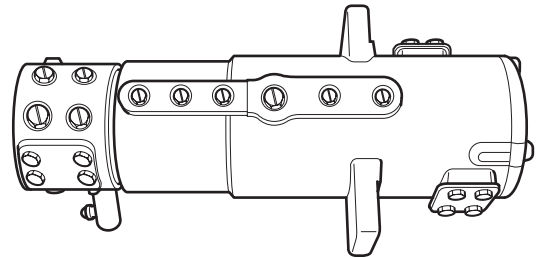
Refer to the assembly drawing of the swivel joint for component references (Figure 1).

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. Remove Swivel Joint from the Vehicle

Move the Swivel Joint removed from the vehicle to the work table using a crane.

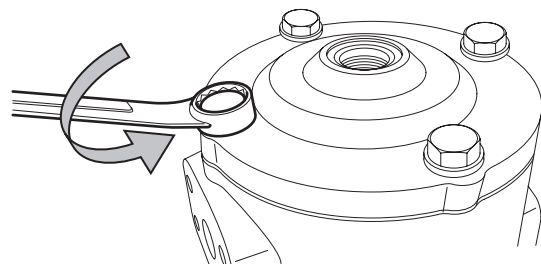


FG003764

Figure 3

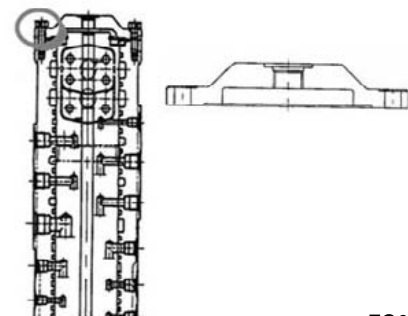
2. Remove Cover

- Remove bolts and washers using a wrench (wrench) or air impact.
- Remove cover.



FG003767

Figure 4

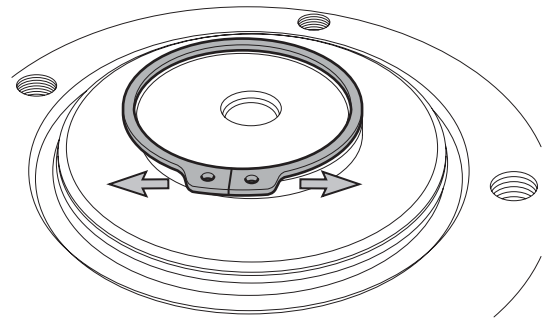


FG003768

Figure 5

3. Disassembling the Retaining Ring

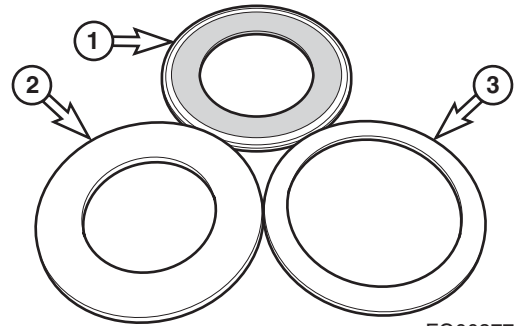
Insert an appropriate jig into the Retaining Ring holes, widen the Ring and remove it.



FG003769

Figure 6

4. Remove shim-A (1), shim-B (3) and thrust plate (2).

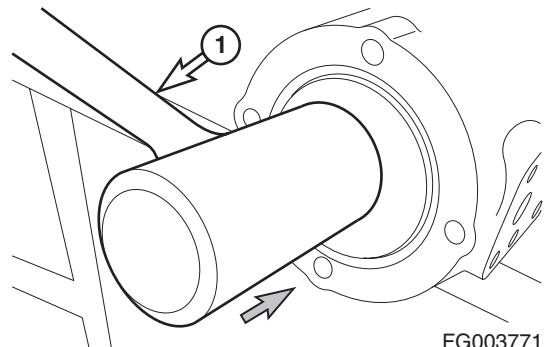


FG003770

Figure 7

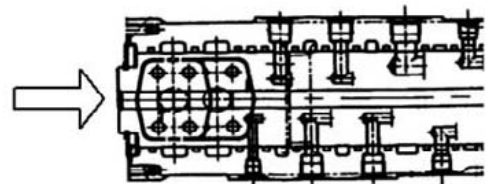
5. Disassembling the Spindle and Body

Lay the Cylinder horizontally. Drive the Spindle a little way out using a plastic hammer (1).



FG003771

Figure 8



FG003772

Figure 9

6. Disassembling the Spindle and Body

Place the jig (2) on the Spindle, disassemble the Spindle using a plastic hammer (1).

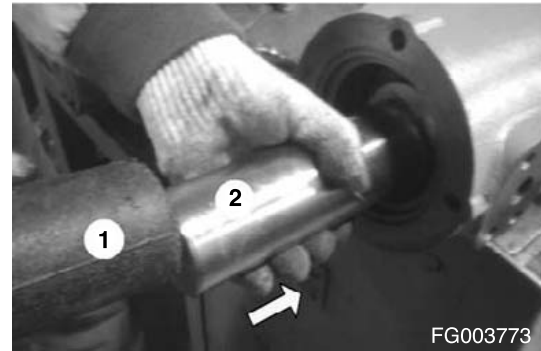


Figure 10

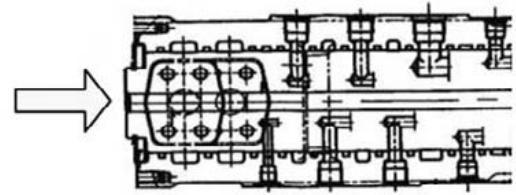


Figure 11

7. O- Disassembling the Ring and Seal

Remove seal in the groove of the Swivel Joint body. Be careful not to damage the O-ring and seal.



O-rings and seals should be replaced whenever the assembly is being overhauled or reassemble.

For repair procedures or emergency tear down, use a thin, smoothedge scraper or spatula with a rounded tip to remove O-rings or seals, to avoid causing damage to those that can be reused.

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

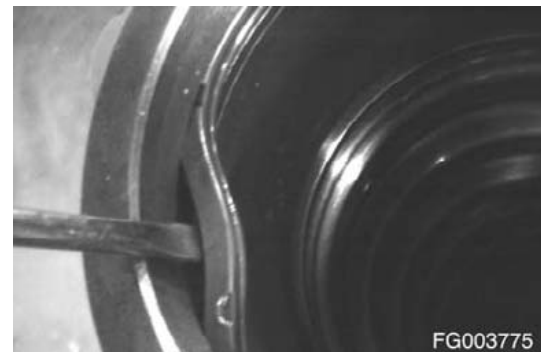


Figure 12

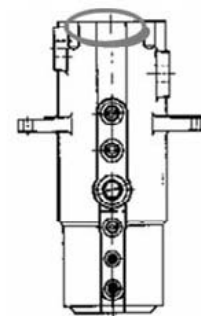


Figure 13

8. Body, Spindle, Cover

Be sure to check for any defects such as scratches or dents on the Spindle, Body, and Seals.



CAUTION!

Be sure to check for any dent like scratches in the direction of operation.

9. 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.

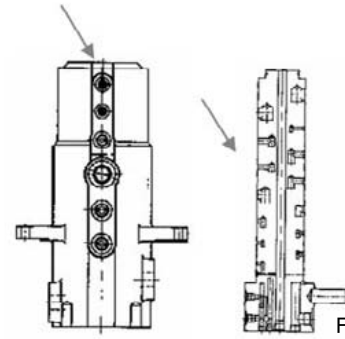


Figure 14

FG003778

REASSEMBLY

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



CAUTION!

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

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

Cylinders

Edition 1

MEMO

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Cylinders

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MEMO

SAFETY PRECAUTIONS



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APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
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
DX140W	5001 and Up
DX160W	5001 and Up

GENERAL DESCRIPTION

Two essentially similar types of hydraulic cylinders are used on the excavator. The cylinder that is used to operate the excavator boom or bucket is equipped with a rod stopper, which acts as a cushion only when the cylinder rod is fully retracted (and the bucket is pulled close to the arm). This type of cylinder is shown in the lower drawing.

Arm cylinders have a cushion or stopper for operation in both directions. This type of cylinder is shown in the upper drawing.

Theory of Operation

1	Piston
2	Oil Path A
3	Oil Path B

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

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

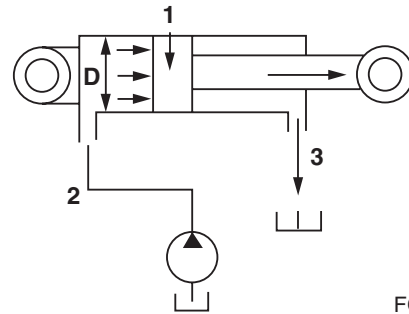
$$F_1 = P \times \frac{\pi D^2}{4}$$

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

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

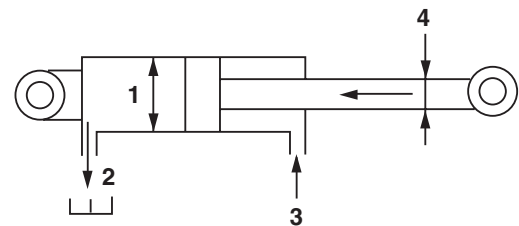
When the cylinder rod is retracted, oil flow through the circuit from the pump to the front side of the cylinder generates a force (F₂) that can be expressed by the formula in which the diameter of the piston rod is expressed by R, and the other two terms are the same as in the preceding expression.

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



FG001456

Figure 1



FG001458

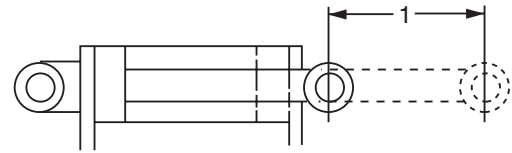
Figure 2

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

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

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

$$Q_1 > Q_2$$



FG001459

Figure 3

Parts List

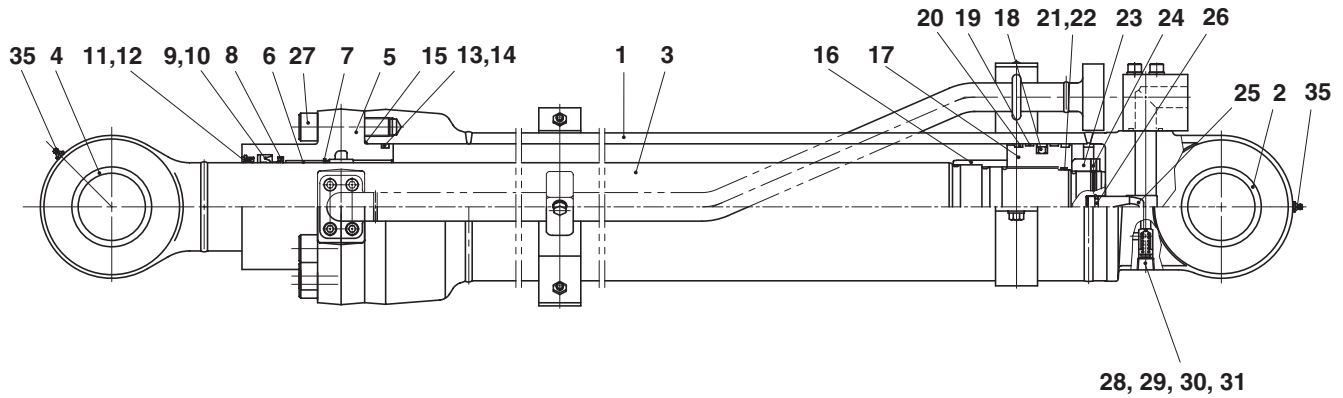
The following parts list is a partial listing only; for complete parts list information, refer to the Hydraulic Equipment Component Parts List.

Cross-section in Figure 4 shows an arm cylinder.

Cross-section in Figure 5 shows a boom cylinder.

The bucket and boom cylinders are identical and differ only in the attached pipes.

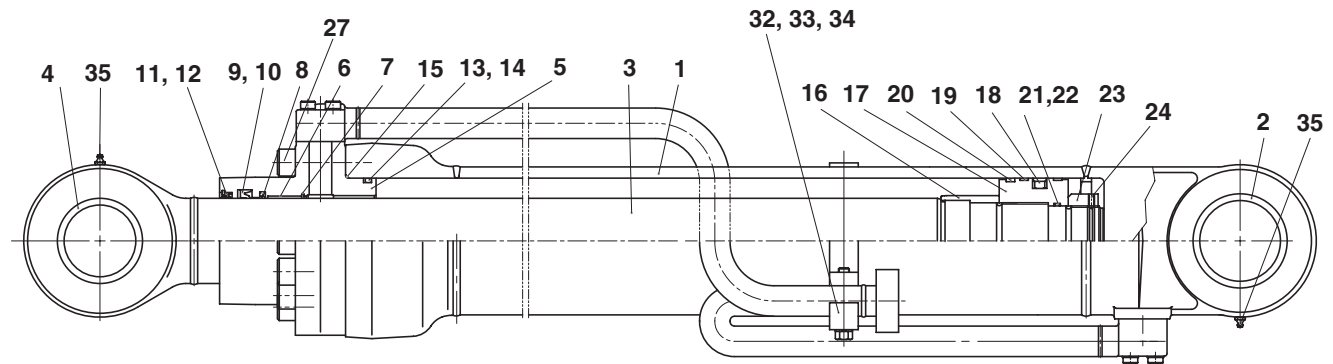
Arm Cylinder



FG005226

Figure 4

Boom and Bucket Cylinder



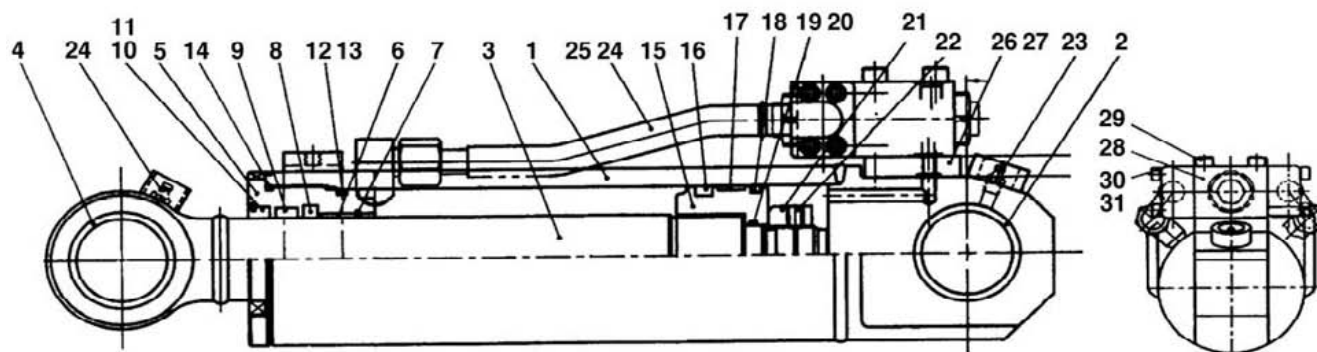
FG005227

Figure 5

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

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

Dozer Cylinder



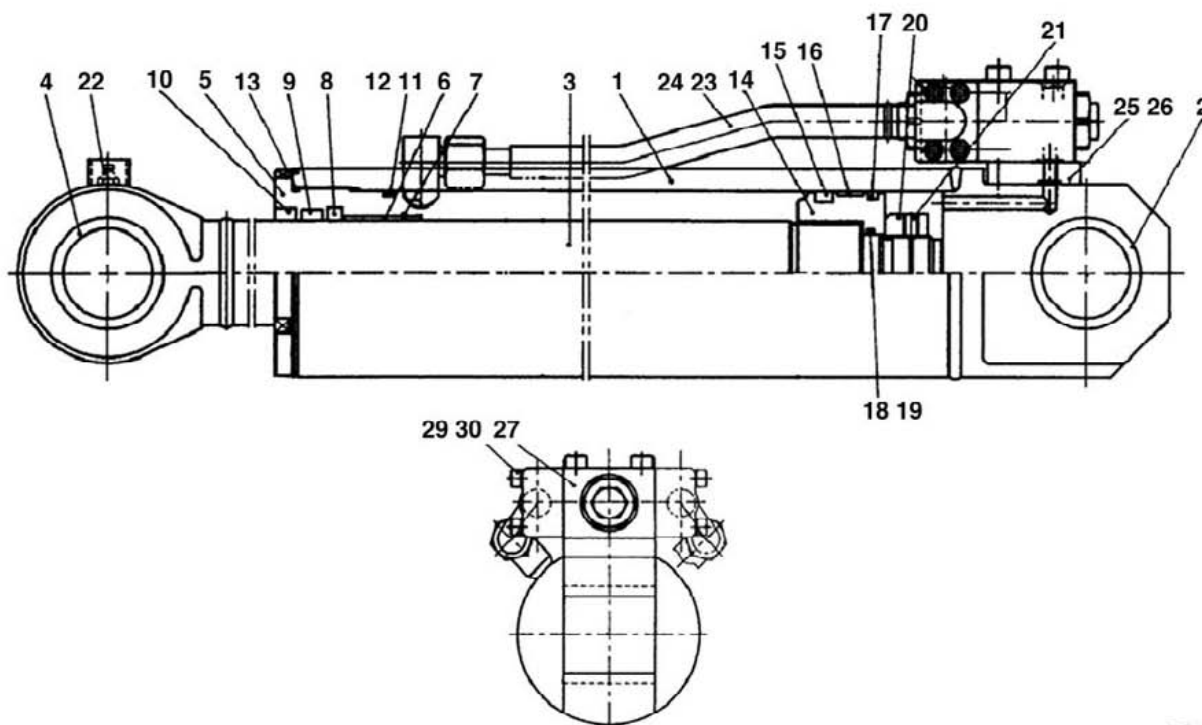
FG006856

Figure 6

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

Reference Number	Description
16	Slipper Seal
17	Wear Ring
18	Dust Ring
19	O-ring
20	Backup Ring
21	Piston Nut
22	Set Screw
23	Grease Fitting
24	Pipe Assembly
25	O-ring
26	Spacer
27	O-ring
28	Valve Assembly
29, 30	Hex Socket Bolt
31	Washer

Outrigger Cylinder



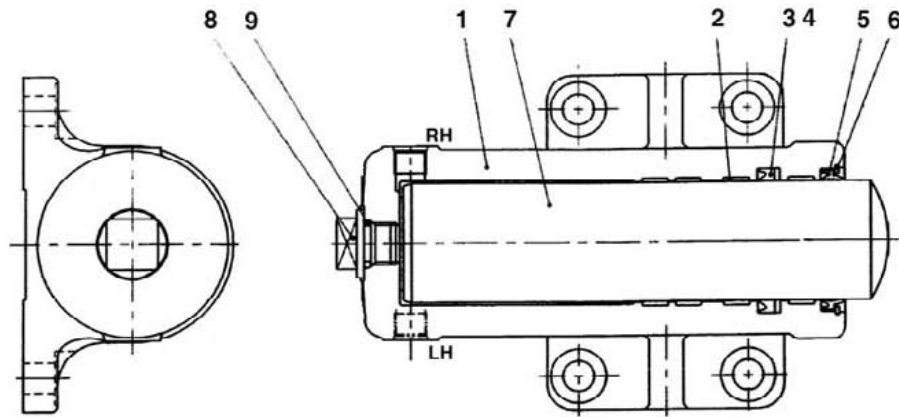
FG006857

Figure 7

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

Reference Number	Description
16	Wear Ring
17	Dust Ring
18	O-ring
19	Backup Ring
20	Piston Nut
21	Set Screw
22	Grease Fitting
23	Pipe Assembly
24	O-ring
25	Spacer
26	O-ring
27	Valve Assembly
28	Hex Socket Bolt
29, 30	Washer

Ram Cylinder



FG006858

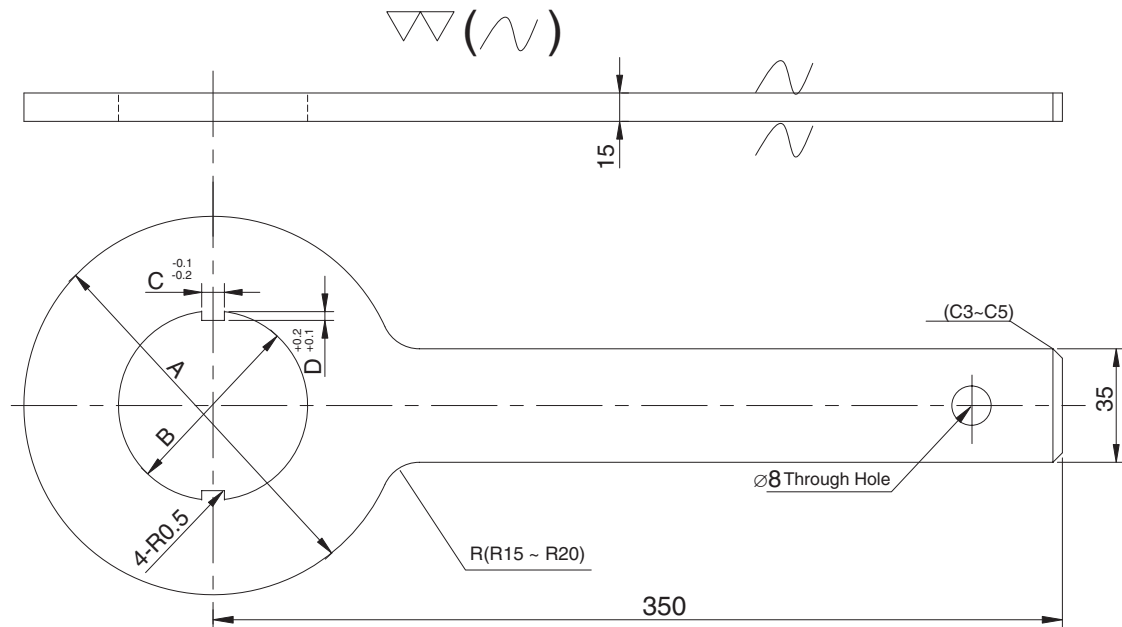
Figure 8

Reference Number	Description
1	Body
2	Wear Ring
3	U-Packing
4	Backup Ring
5	Dust Wiper

Reference Number	Description
6	Retaining Ring
7	Rod
8	Plug A
9	O-ring
10	Dust Cap

SPECIAL TOOLS AND MATERIALS

Piston Nut



ARS4730L

Figure 9

Material SM45C (AISI 1045)

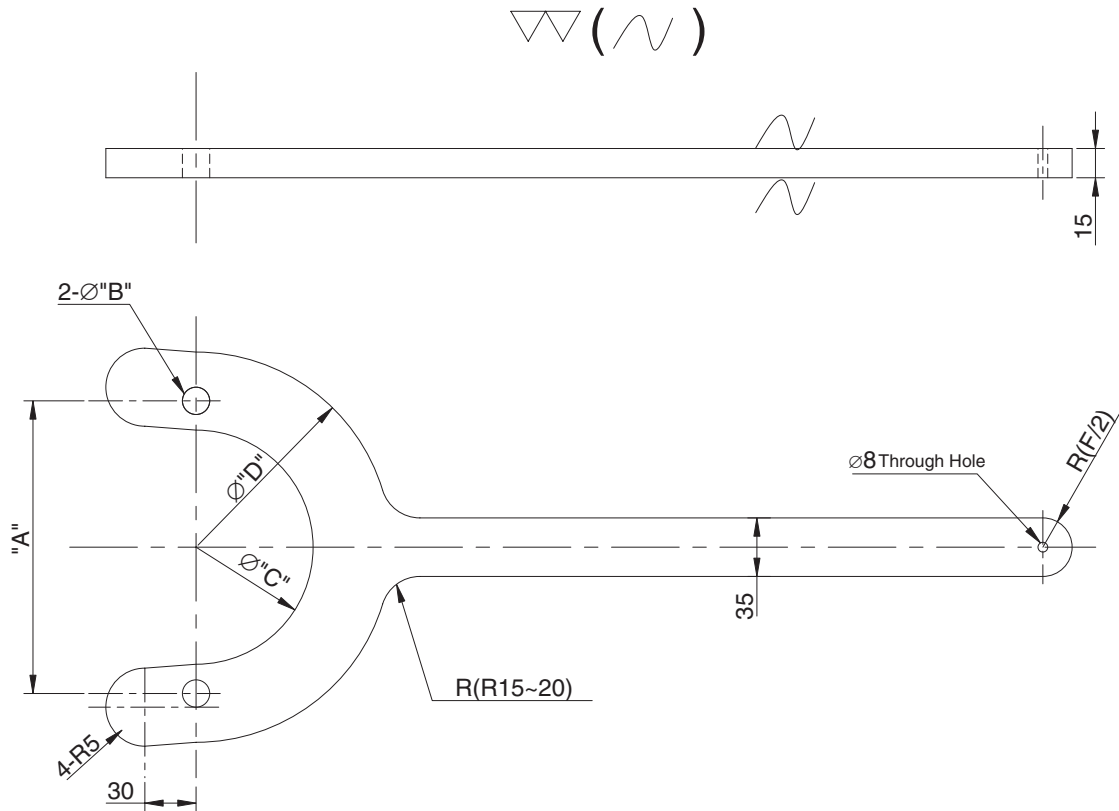
Rockwell Harden from 22 - 27

Oil Quench

MODEL	CYLINDER	ØA	ØB	C	D	MODEL (CYLINDER)
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)	

MODEL	CYLINDER	ØA	ØB	C	D	MODEL (CYLINDER)
DX140W DX160W	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)	
	DOZER	120.0 mm (4.72 in)	79.0 mm (3.11 in)	10.0 mm (0.39 in)	5.0 mm (0.20 in)	
	OUTRIGGER	125.0 mm (4.92 in)	85.0 mm (3.35 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
	TWO-PIECE BOOM	155.0 mm (4.79 in)	115.0 mm (4.21 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
DX190W	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 (5.51 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)	
	TWO-PIECE BOOM	155.0 mm (6.10 in)	115.0 mm (4.53 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
DX210W	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	142.0 mm (5.59 in)	102.0 mm (4.02 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	
	BUCKET	125.0 mm (4.92 in)	102.0 mm (4.02 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	
	TWO-PIECE BOOM	155.0 mm (6.10 in)	115.0 mm (4.53 in)	12.0 mm (0.47 in)	5.0 mm (0.20 in)	

Piston Jig



ARS4740L

Figure 10

Material SM45C (AISI 1045)

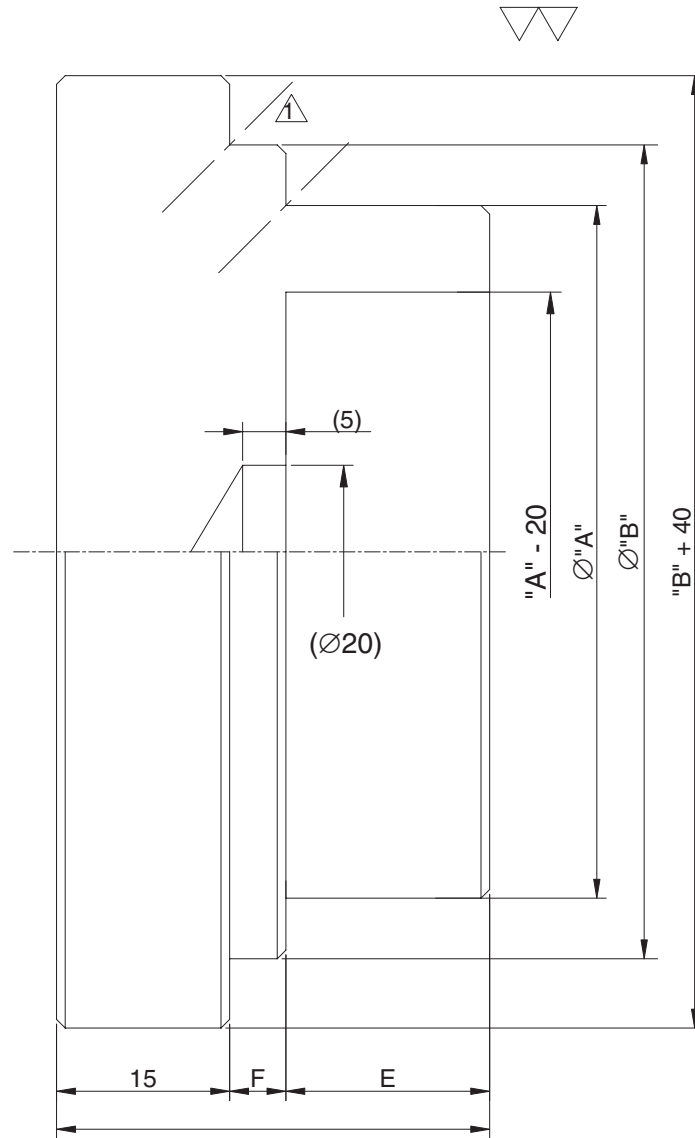
Rockwell Harden from 22 - 27

Oil Quench

MODEL	CYLINDER	A (±0.1)	ØB	ØC	ØD	MODEL (CYLINDER)
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)	

MODEL	CYLINDER	A (±0.1)	ØB	ØC	ØD	MODEL (CYLINDER)
DX140W DX160W	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)	
	DOZER	70.0 mm (2.76 in)	11.0 mm (0.43 in)	53.0 mm (2.09 in)	95.0 mm (3.74 in)	
	OUTRIGGER	80.0 mm (3.15 in)	11.0 mm (0.43 in)	58.0 mm (2.28 in)	110.0 mm (4.33 in)	
	TWO-PIECE BOOM	130.0 mm (5.12 in)	13.0 mm (0.51 in)	93.0 mm (3.66 in)	165.0 mm (6.5 in)	
DX190W	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)	
	TWO-PIECE 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)	
DX210W	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	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	90.0 mm (3.54 in)	11.0 mm (0.43 in)	63.0 mm (2.48 in)	115.0 mm (4.53 in)	
	TWO-PIECE 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)	

Steel Bushing Jig



ARS4750L

Figure 11

Material: SM45C which is done thermal refining <QT> Hrc 22 - 28

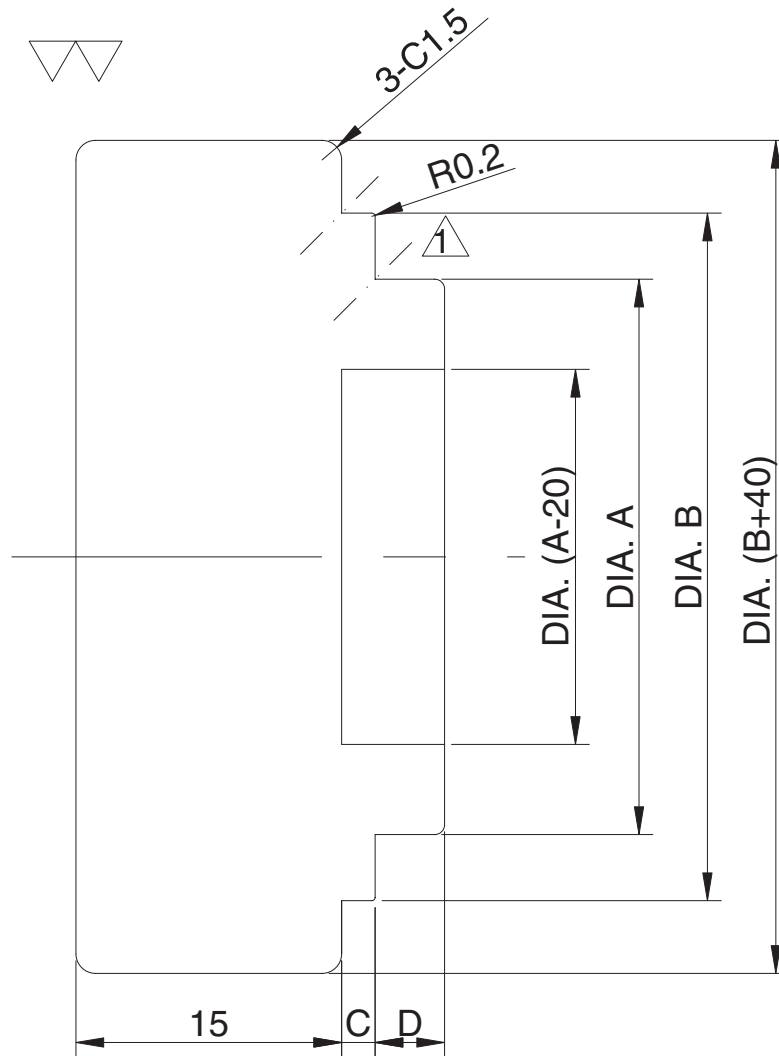
Undefined Chamfer C/R = 0.5 Max.

- 1 Place: Finally work to used DNMG Tip <Nose R0.4>

MODEL	CYLINDER	$\varnothing A_{-0.05}^{-0.15}$	$\varnothing B (\pm 0.1)$	E	$F_{+0.05}^0$	Part	MODEL (CYLINDER)
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)		
DX2250LC	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)		

MODEL	CYLINDER	$\varnothing A_{-0.15}^{-0.05}$	$\varnothing B (\pm 0.1)$	E	$F_{+0.05}^0$	Part	MODEL (CYLINDER)
DX140W DX160W	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 (1.18 in)	6.0 mm (0.24 in)		
	DOZER	60.0 mm (2.36 in)	70.0 mm (2.76 in)	30.0 mm (1.18 in)	-		
	OUTRIGGER	60.0 mm (2.36 in)	75.0 mm (2.95 in)	30.0 mm (1.18 in)	6.5 mm (0.26 in)		
	TWO-PIECE BOOM	90.0 mm (3.54 in)	105.0 mm (4.13 in)	40.0 mm (1.57 in)	6.0 mm (0.24 in)		
DX190W	BOOM	71.0 mm (2.80 in)	86.0 mm (3.39 in)	40.0 mm (1.57 in)	7.0 mm (0.28 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	71.0 mm (2.80 in)	86.0 mm (3.39 in)	40.0 mm (1.57 in)	7.0 mm (0.28 in)		
	TWO-PIECE BOOM	90.0 mm (3.54 in)	105.0 mm (4.13 in)	40.0 mm (1.57 in)	6.0 mm (0.24 in)		
DX210W	BOOM	80.0 mm (3.15 in)	95.0 mm (3.74 in)	35.0 mm (1.38 in)	6.5 mm (0.26 in)		
	ARM	90.0 mm (3.54 in)	105.0 mm (4.13 in)	40.0 mm (1.57 in)	6.5 mm (0.26 in)		
	BUCKET	65.0 mm (2.56 in)	80.0 mm (3.15 in)	35.0 mm (1.38 in)	6.5 mm (0.26 in)		
	TWO-PIECE BOOM	90.0 mm (2.54 in)	105.0 mm (4.13 in)	40.0 mm (1.57 in)	6.0 mm (0.24 in)		

Dust Wiper Jig



ARS4760L

Figure 12

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	$\varnothing A_{-0.3}^{-0.2}$	$\varnothing B_{-0.3}^{-0.2}$	$C_{-0.1}^0$	D	MODEL (CYLINDER)
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)	

MODEL	CYLINDER	$\varnothing A_{-0.3}^{-0.2}$	$\varnothing B_{-0.3}^{-0.2}$	$C_{-0.1}^0$	D	MODEL (CYLINDER)
DX140W DX160W	BOOM	75.0 mm (2.95 in)	89.0 mm (3.50 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	ARM	80.0 mm (3.15 in)	94.0 mm (3.70 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	BUCKET	65.0 mm (2.56 in)	79.0 mm (3.11 in)	6.0 mm (0.24 in)	7.0 mm (2.28 in)	
	DOZER	60.0 mm (2.36 in)	74.0 mm (2.91 in)	5.0 mm (0.20 in)	6.0 mm (0.24 in)	
	OUTRIGGER	70.0 mm (2.76 in)	84.0 mm (3.31 in)	0.5 mm (0.02 in)	6.0 mm (0.24 in)	
	TWO-PIECE 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)	
DX190W	BOOM	80.0 mm (3.15 in)	94.0 mm (3.70 in)	6.0 mm (0.24 in)	7.0 mm (0.28 in)	
	ARM	90.0 mm (3.54 in)	104.0 mm (4.09 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)	
	TWO-PIECE BOOM	115.0 mm (4.53 in)	131.0 mm (5.16 in)	6.0 mm (0.24 in)	7.0 mm (0.28 in)	
DX210W	BOOM	85.0 mm (3.35 in)	99.0 mm (3.90 in)	6.0 mm (0.24 in)	7.0 mm (0.28 in)	
	ARM	95.0 mm (3.74 in)	109.0 mm (4.29 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)	
	TWO-PIECE BOOM	115.0 mm (4.53 in)	131.0 mm (5.16 in)	6.0 mm (0.24 in)	7.0 mm (0.28 in)	

Slipper Seal Jig

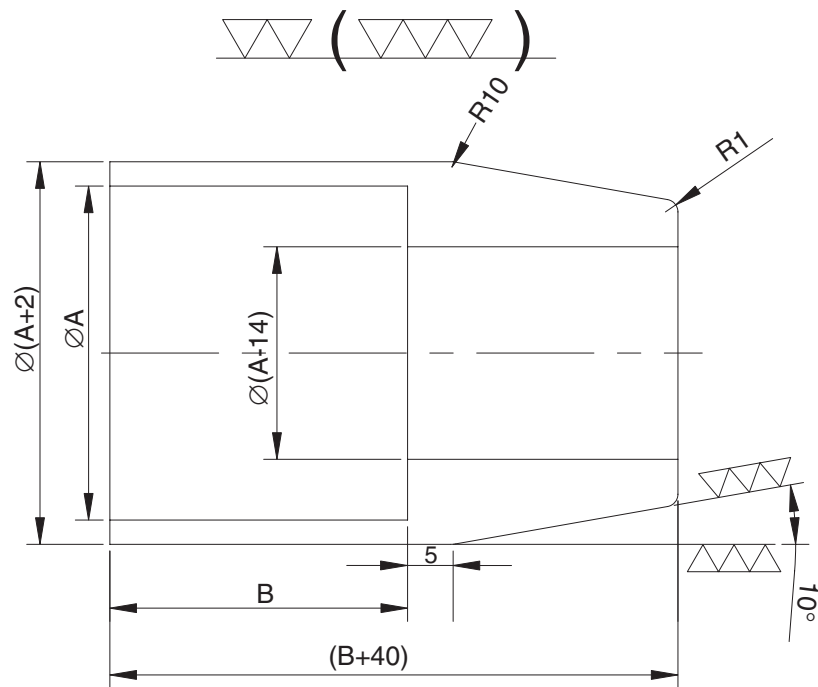


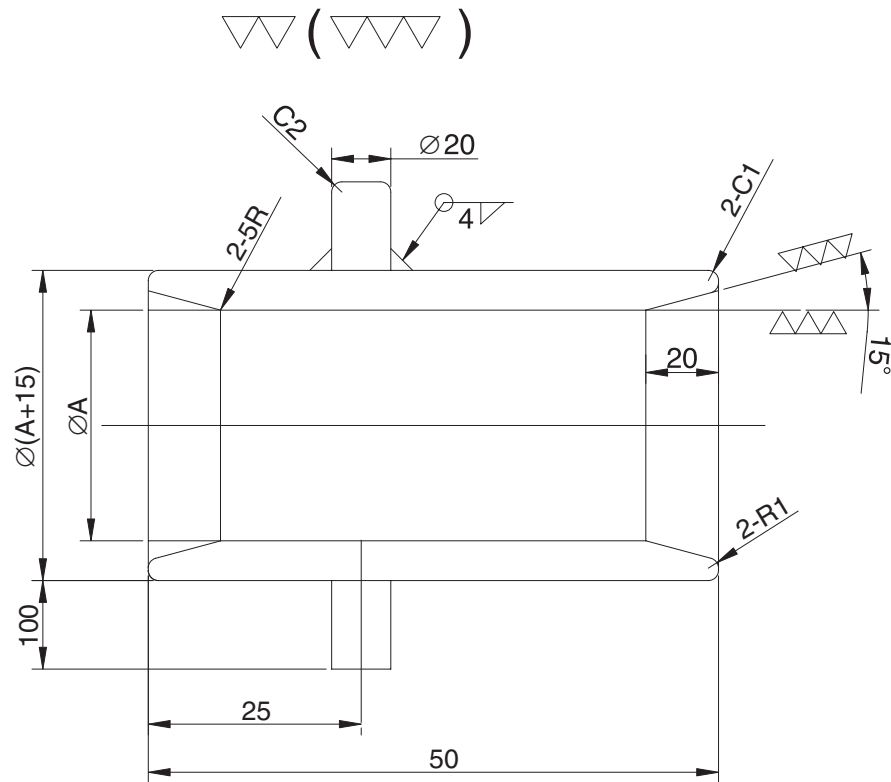
Figure 13

ARS4770L

MODEL	CYLINDER	$\varnothing A^{+0.2}_{+0.1}$	$B^{+0.2}_{+0.1}$	MODEL (CYLINDER)
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

MODEL	CYLINDER	$\varnothing A^{+0.2}_{+0.1}$	$B^{+0.2}_{+0.1}$	MODEL (CYLINDER)
DX140W DX160W	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)	
	DOZER	100.0 mm (3.94 in)	28.5 mm (1.12 in)	
	OUTRIGGER	110.0 mm (4.33 in)	28.5 mm (1.12 in)	
	TWO-PIECE BOOM	150.0 mm (5.91 in)	28.5 mm (1.12 in)	
DX190W	BOOM	115.0 mm (4.53 in)	28.5 mm (1.12 in)	
	ARM	110.0 mm (4.33 in)	28.5 mm (1.12 in)	
	BUCKET	110.0 mm (4.33 in)	28.5 mm (1.12 in)	
	TWO-PIECE BOOM	180.0 mm (7.09 in)	41.5 mm (1.63 in)	
DX210W	BOOM	135.0 mm (5.31 in)	28.5 mm (1.12 in)	
	ARM	135.0 mm (5.31 in)	28.5 mm (1.12 in)	
	BUCKET	115.0 mm (4.53 in)	28.5 mm (1.12 in)	
	TWO-PIECE BOOM	180.0 mm (7.09 in)	41.5 mm (1.63 in)	

Slipper Seal Straightening Jig



ARS4780L

Figure 14

MODEL	CYLINDER	$\varnothing A^{+0.2}_{+0.1}$	MODEL (CYLINDER)
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

MODEL	CYLINDER	$\varnothing A_{+0.2}^{+0.1}$	MODEL (CYLINDER)
DX140W DX160W	BOOM	110.0 mm (4.33 in)	
	ARM	115.0 mm (4.53 in)	
	BUCKET	95.0 mm (3.74 in)	
	DOZER	100.0 mm (3.94 in)	
	OUTRIGGER	110.0 mm (4.33 in)	
	TWO-PIECE BOOM	150.0 mm (5.91 in)	
DX190W	BOOM	115.0 mm (4.35 in)	
	ARM	125.0 mm (4.92 in)	
	BUCKET	110.0 mm (4.33 in)	
	TWO-PIECE BOOM	180.0 mm (7.09 in)	
DX210W	BOOM	135.0 mm (5.31 in)	
	ARM	135.0 mm (5.31 in)	
	BUCKET	115.0 mm (4.53 in)	
	TWO-PIECE BOOM	180.0 mm (7.09 in)	

DISASSEMBLY

CAUTION!

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

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

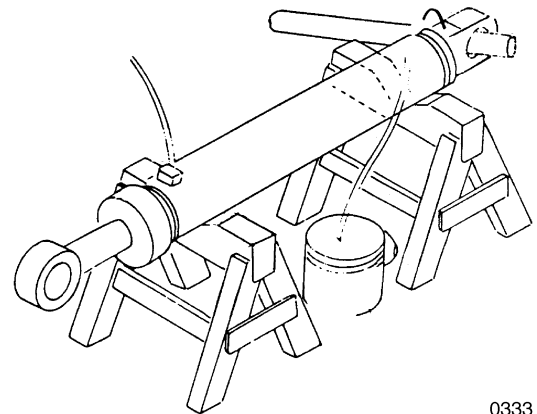


Figure 15

0333

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

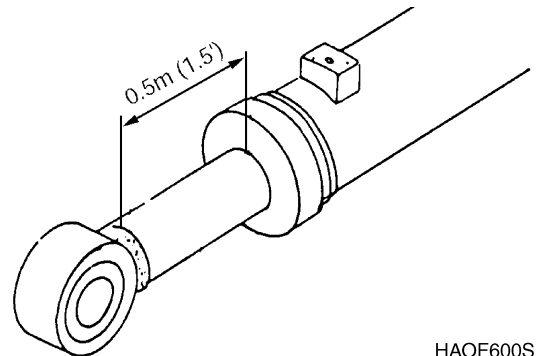


Figure 16

HAOF600S

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.

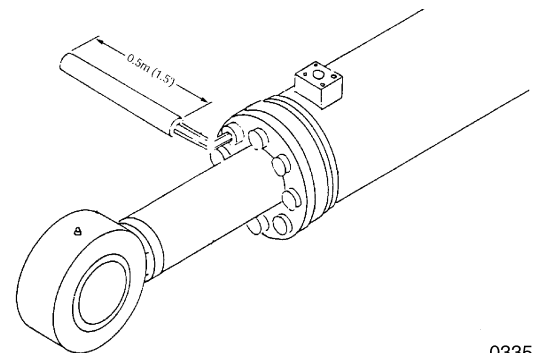
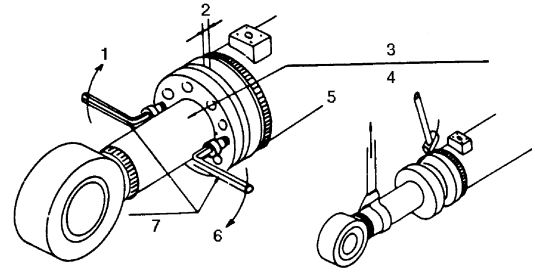


Figure 17

0335

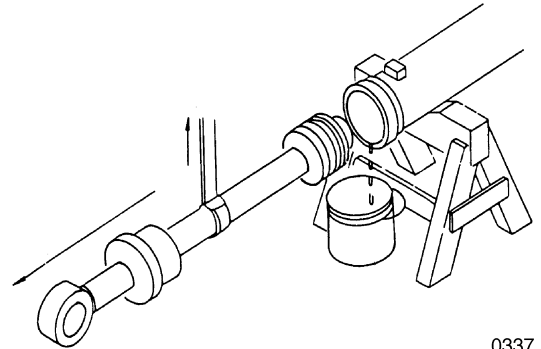
4. Tap two bolts into cover of cylinder head, 180° apart. Tighten them in a staggered, even sequence, to back off piston rod end cover from edge of cylinder wall. Look for adequate clearance between cover and end of cylinder wall before using a plastic or other soft faced hammer for final disassembly.



HAOF610S

Figure 18

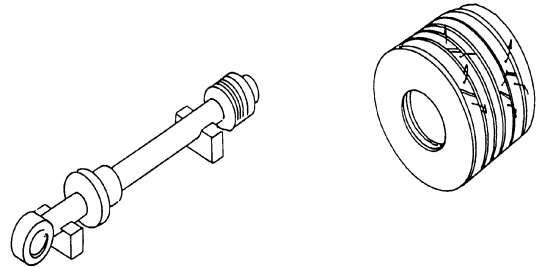
5. Begin withdrawing piston rod assembly, away from cylinder. Attach a lifting support when final 1/3 of rod is still inside barrel of cylinder. Prepare support blocks for piston rod before it has been completely withdrawn.



0337

Figure 19

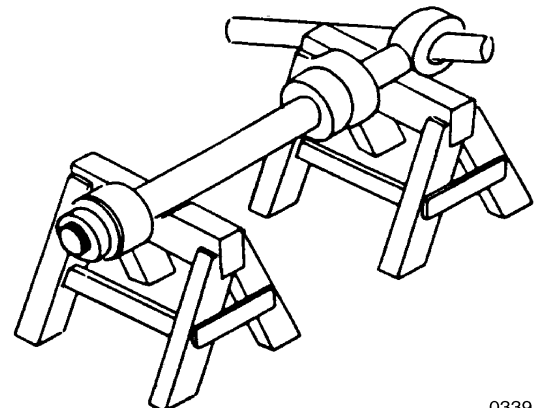
6. Lower piston rod to support blocks and detach wear ring (outer surface) (19) from end of rod.



HAOF620S

Figure 20

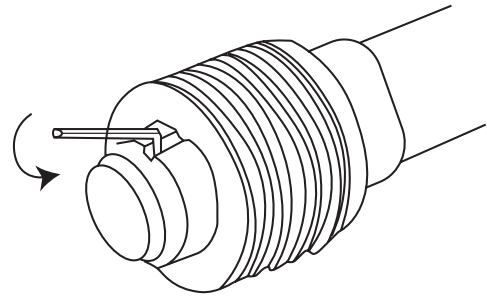
7. Immobilize piston rod by inserting a wooden or other nonscoring, nonmetallic support through end of rod.



0339

Figure 21

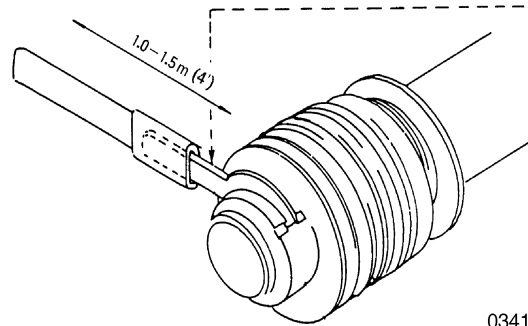
8. Remove set screw using socket wrench.



HAOF340L

Figure 22

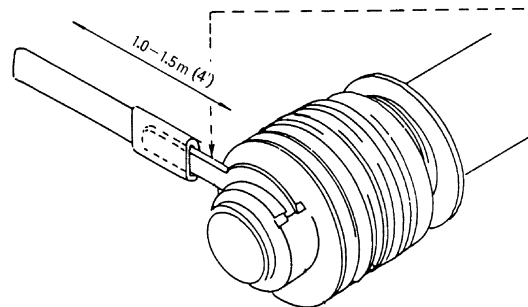
9. Fabricate or purchase a piston nut removal wrench. (Dimensions are called off at beginning of this procedure. This tool may also be ordered through your local *DOOSAN* Parts distributor). Remove nut from end of piston.



0341

Figure 23

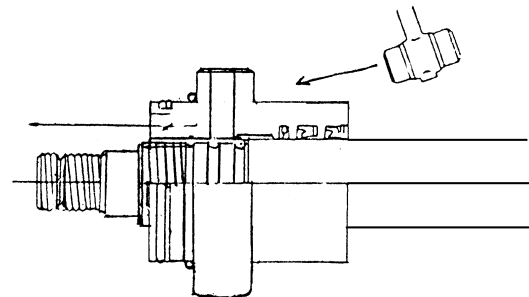
10. Use second piston tool described at beginning of this procedure to separate piston. Detach cushion ring (16), taking care not to damage cushion ring.



HAOF630S

Figure 24

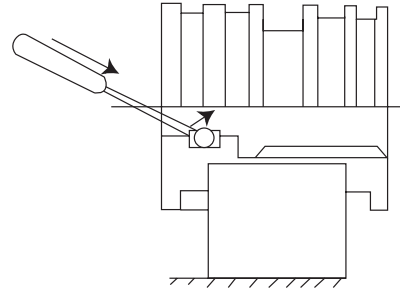
11. Use a plastic hammer to evenly pull off rod cover (5) from end of piston rod. Be careful not to damage rod bushing (6) and dust wiper, U-packing and other seals.



HAOF350S

Figure 25

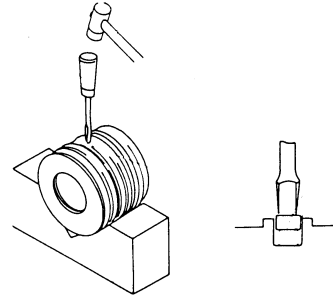
12. Use a dull, rounded tip tool to pry off O-ring (13) and backup ring (14).



HAOF37OL

Figure 26

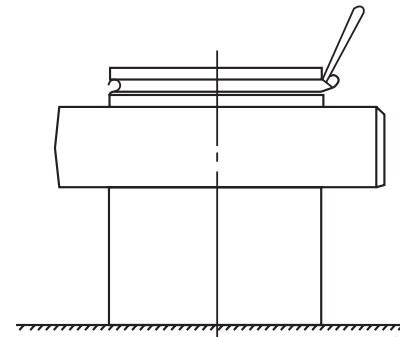
13. Find a screwdriver with an appropriate width tip to facilitate removal of slipper seal (18), wear ring (19) and slide ring (20) from piston (17).



0345

Figure 27

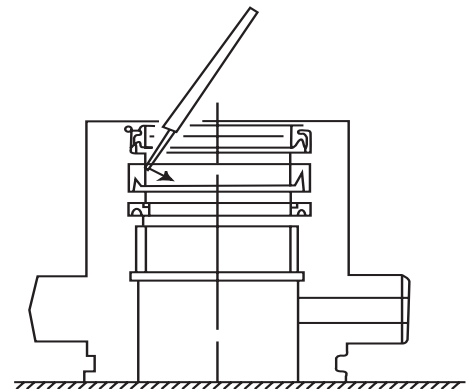
14. Remove O-ring (21) and backup ring (22) from cylinder head.



HAOF38OS

Figure 28

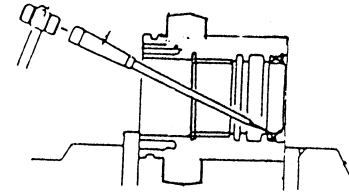
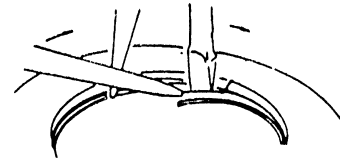
15. During disassembly of cylinder head, be careful not to damage buffer seal (8) and U-packing (9).



HAOF39OL

Figure 29

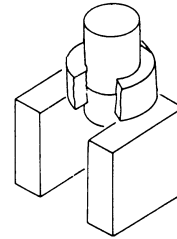
16. Disassemble retaining ring (12) and dust wiper (11).
Separate retaining ring (7) and rod bushing (6).



HAOF400S

Figure 30

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



0349

Figure 31

REASSEMBLY

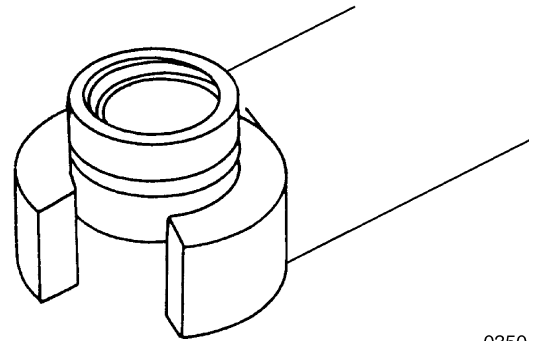
IMPORTANT

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:*

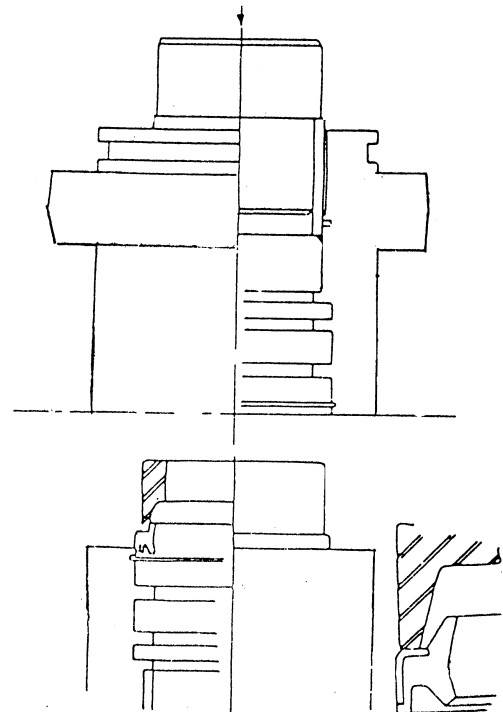
1. *Body of the cylinder.*
2. *Piston rod.*
3. *Piston assembly.*
4. *Cylinder head assembly.*

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



0350

Figure 32



HAOF440S

Figure 33

3. Prelubricate O-rings and seals before reassembly (Figure 34).

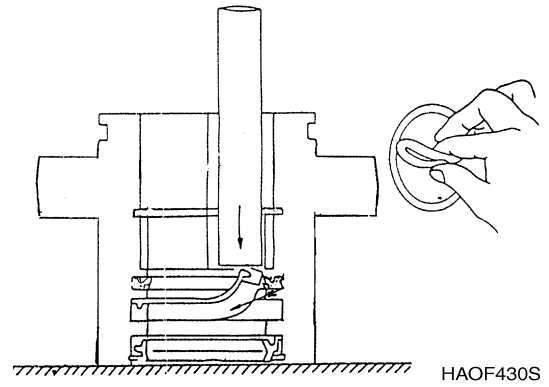


Figure 34

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

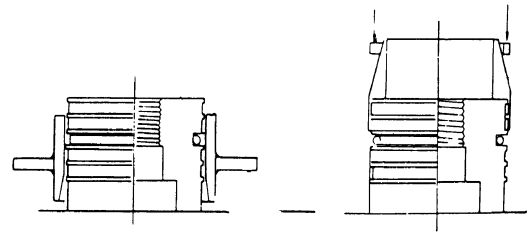


Figure 35

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

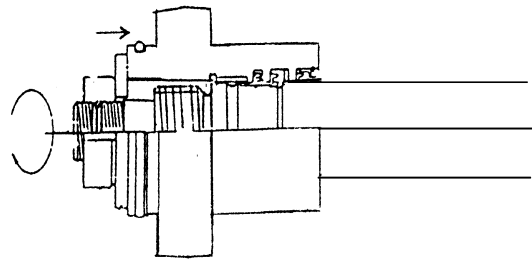


Figure 36

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

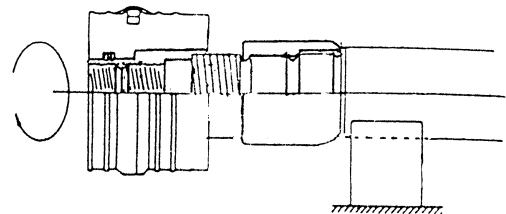
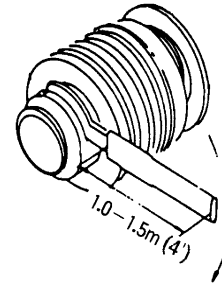


Figure 37

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

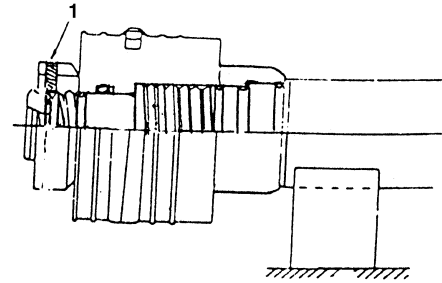


0356

Figure 38

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

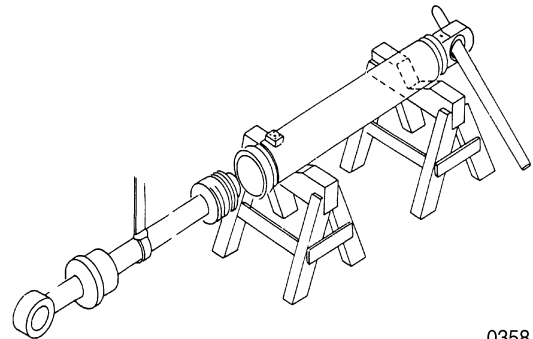
Reference Number	Description
1	Set Screw



HAOF470S

Figure 39

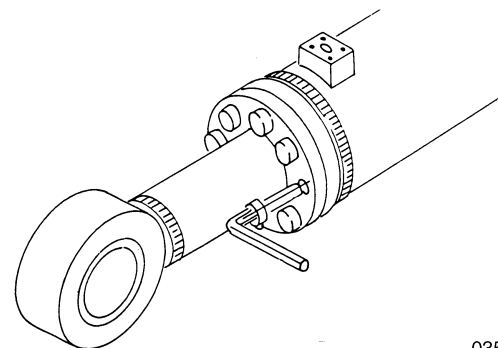
9. Immobilize body of cylinder before reassembly.



0358

Figure 40

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 41

Main Control Valve

Edition 1

MEMO

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MEMO

Check Valve 53

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
DX190W	5001 and Up
DX210W	5001 and Up

CONTROL VALVE OPERATION

Following pages show the various functions of the control valve with a brief description of each function.

They are;

1. "Arm Priority Circuit" on page 1-7
2. "Bucket (Junction) Circuit" on page 1-8
3. "Main Relief Valve" on page 1-9
4. "Overload Relief Valve" on page 1-10
5. "Arm Load Holding Valve" on page 1-12
6. "Boom Load Holding Valve" on page 1-15
7. "Arm Regeneration" on page 1-17
8. "Boom Regeneration" on page 1-19
9. "Foot Relief Valve" on page 1-20

Arm Priority Circuit

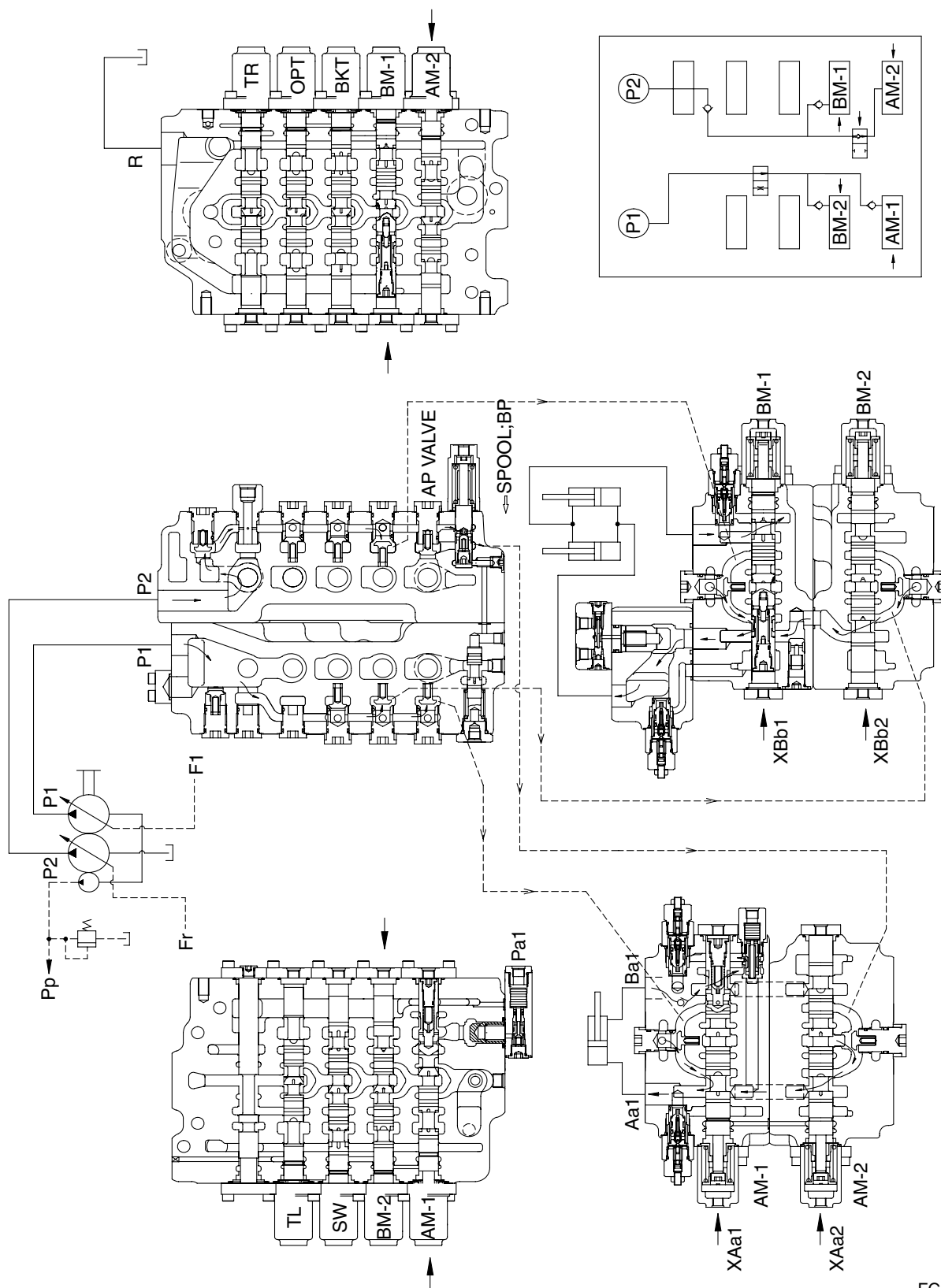


Figure 1

FG007226

Bucket (Junction) Circuit

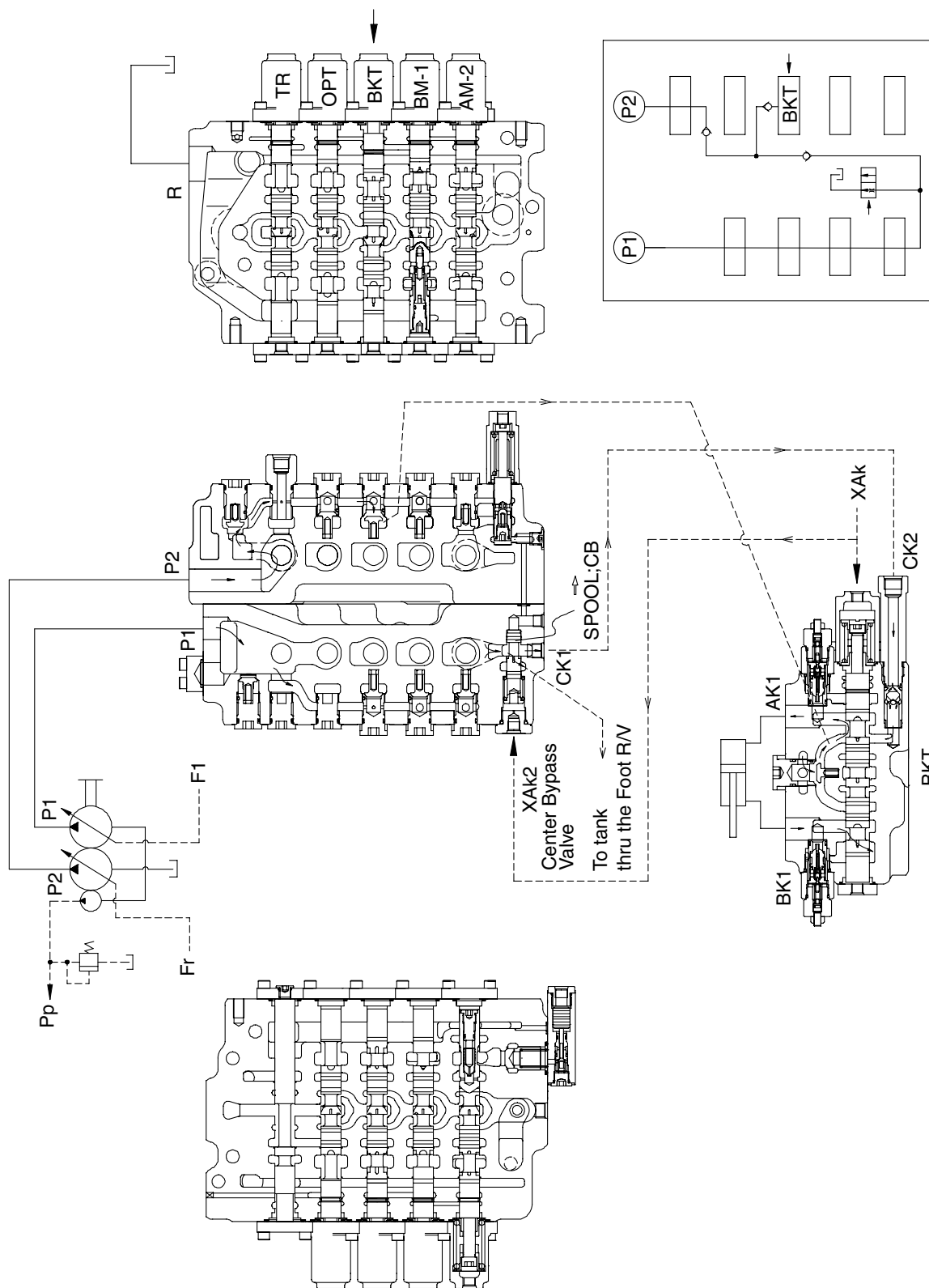


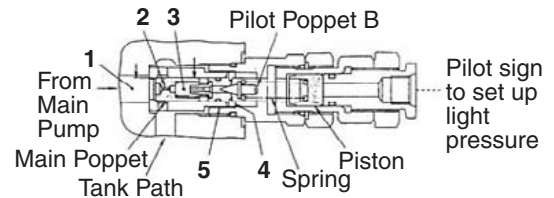
Figure 2

FG007227

1. Hydraulic oil from the P2 pump flows to the bucket. Oil from the P1 pump and the bucket plunger that controls pilot pressure act simultaneously on the center bypass valve triggering spool CB to send oil from the center bypass through an external line (CK1 => CK2) which opens the bucket pressure check valve and joins with oil flow from the P2 pump.

Main Relief Valve

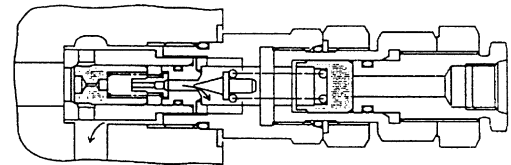
1. Normal (low-pressure) Operation (Pz pilot signal: "OFF").
 - A. Piston (d, Figure 3) is pushed to the right most position by spring (c).
 - B. The pressurized oil from the main pump flows into chamber (3, Figure 3) through the orifice (2) of the main poppet A. Main poppet A is completely closed because $d1 > d2$.



HAOG250P

Figure 3

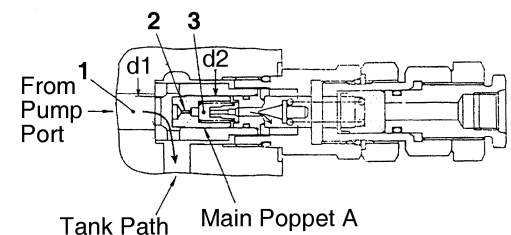
- C. When the oil pressure reaches the set pressure of spring (C, Figure 3) the pilot poppet (B) is opened and oil flows to the tank through paths (4) and (5).



HAOG260P

Figure 4

- D. During oil flow when pressure drops in front and back of orifice (2, Figure 5) and pressure of chamber (1) $d2 > d1$, main poppet A will open and pressurized oil flows to the tank.



HAOG270P

Figure 5

2. High-pressure operation (Pz pilot signal: "ON").

When piston (D, Figure 6) is in the left most position and the pressure has increased above the set pressure of spring (C), high-pressure condition is achieved.

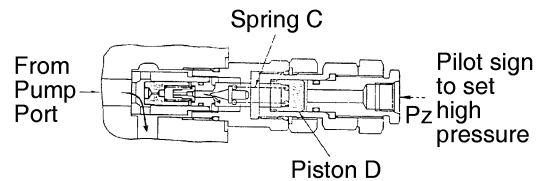


Figure 6

HAOG280P

Overload Relief Valve

1. Operation of overload relief valve.

- A. The pressurized oil from the cylinder port enter into chamber (2, Figure 7) through orifice (3) of piston (A). Main poppet (B) is closed shut because of $d1 > d2$.

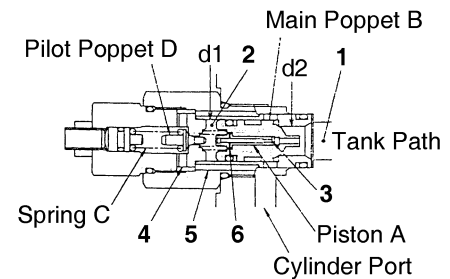


Figure 7

HAOG290P

- B. When the pressurized oil overcomes the set pressure of spring (C, Figure 7) pilot poppet (D) opens and oil flows to the tank through the transverse hole (4) and path (5).

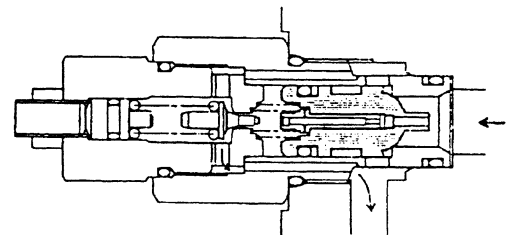


Figure 8

HAOG300P

- C. Oil flows and pressure decreases in orifice (3, Figure 9) of piston A moving the piston to the left and seating at the edge of pilot poppet (D). The oil in chamber (1) flows to the tank through orifice (6) of piston (A), traverse hole (4) and passage (5).

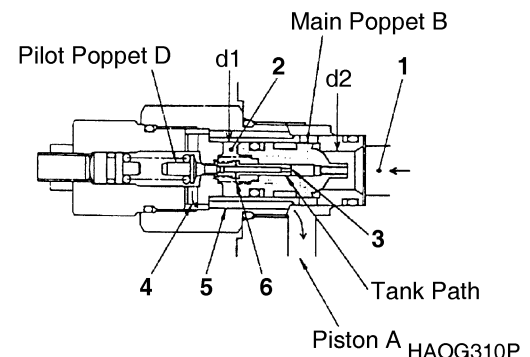
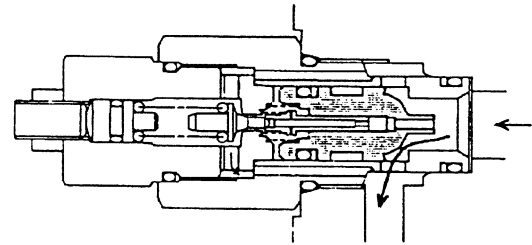


Figure 9

HAOG310P

- D. Pressure decreases behind orifice of piston A and if chamber (1, Figure 9) pressure $x_{d2} >$ chamber (2) pressure x_{d1} the main poppet (B) opens and the pressurized oil of cylinder port flows to the tank to protect the actuator.

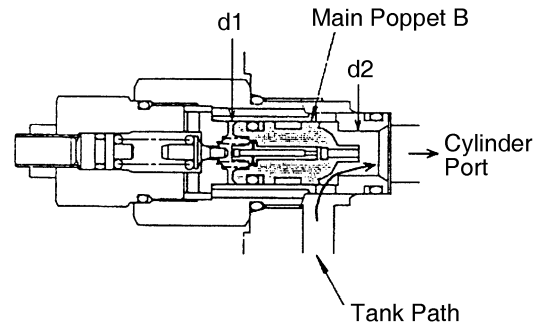


HAOG320P

Figure 10

2. Operation of makeup valve.

- A. The main poppet area $d1 > d2$ (Figure 11) and since the cylinder port pressure is usually higher than the tank pressure the main poppet will be in place. When the cylinder port pressure drops (approaches pressure load), and cylinder port pressure $<$ tank pressure the main poppet (B) opens because of the area difference $d1$ and $d2$ and the tank pressure and oil flows from the tank to the cylinder port preventing cavitation.

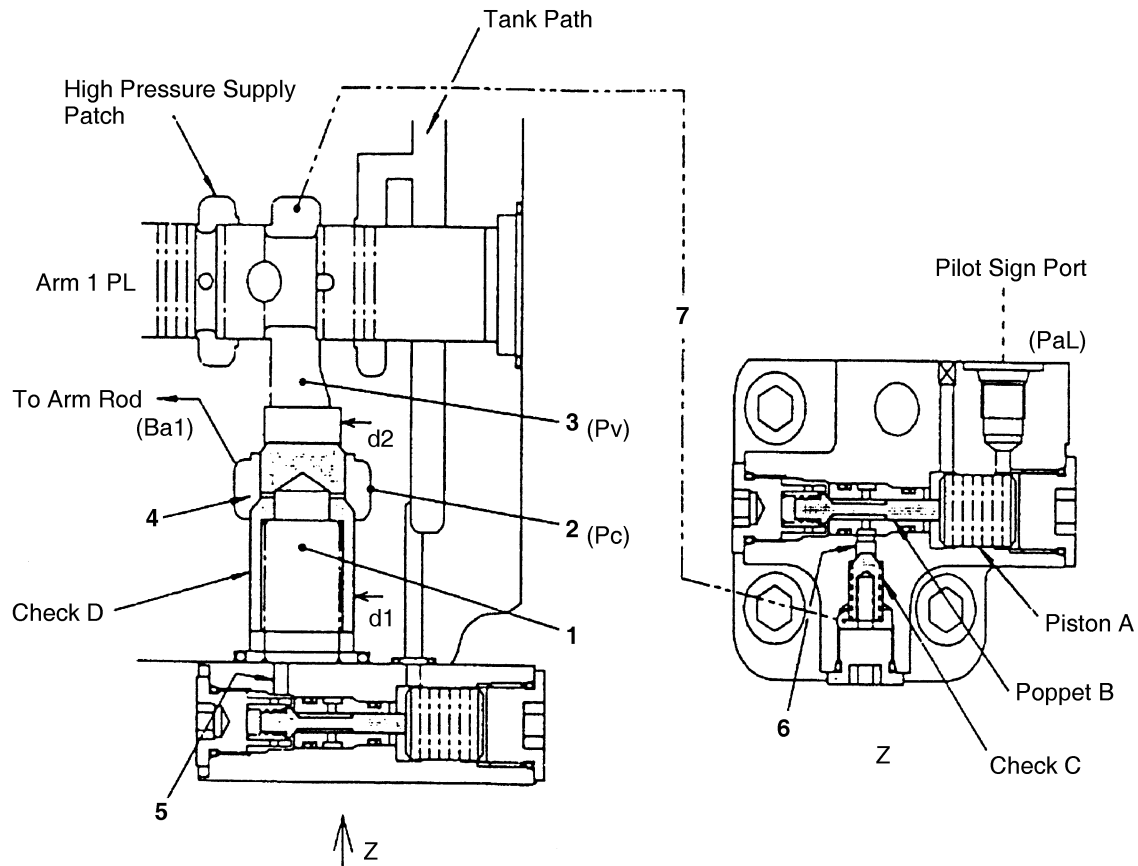


HAOG330P

Figure 11

Arm Load Holding Valve

1. When plunger is in neutral position (PaL pilot signal: "OFF").

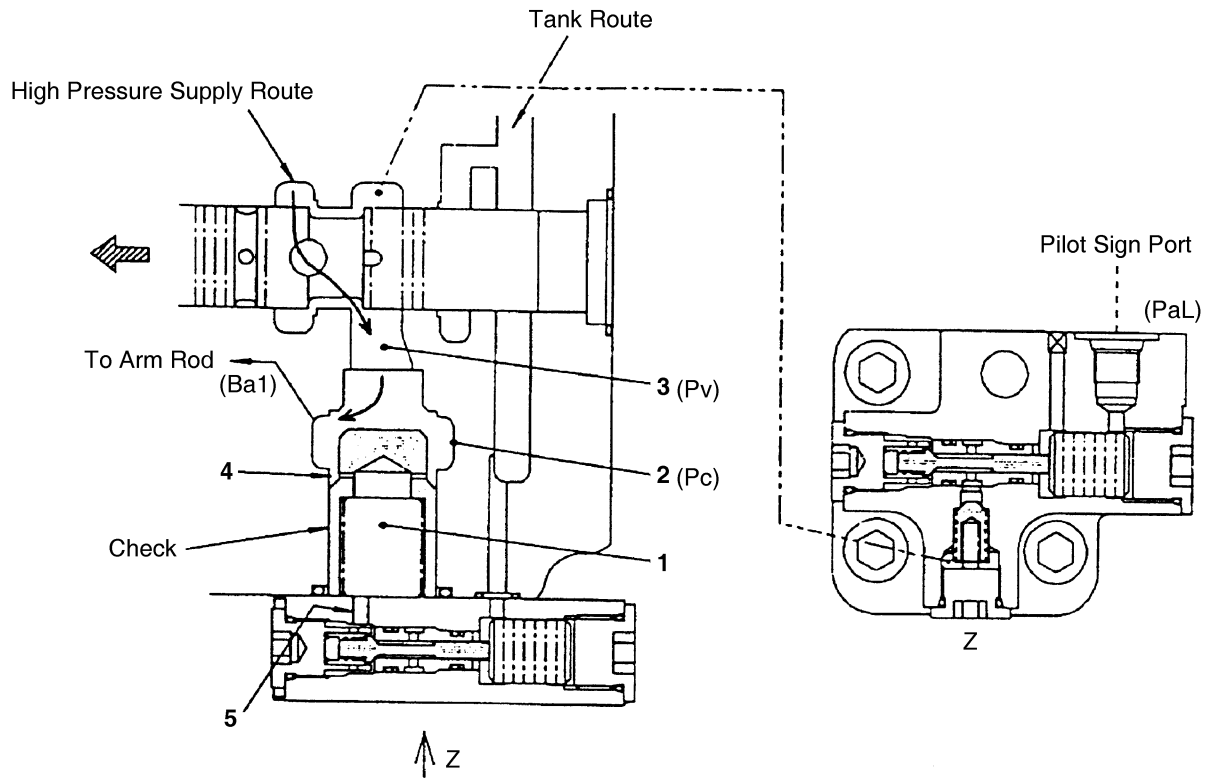


HAOG340P

Figure 12

- A. Piston (A, Figure 12) and poppet (B) are in position blocking path (5 and 6). As oil flows from chamber (1) to chamber (2), the pressure at orifice (4) is P_e . Since $d_1 > d_2$, check valve (D) is seated completely blocking out chambers (2 and 3).

2. When plunger is operated.

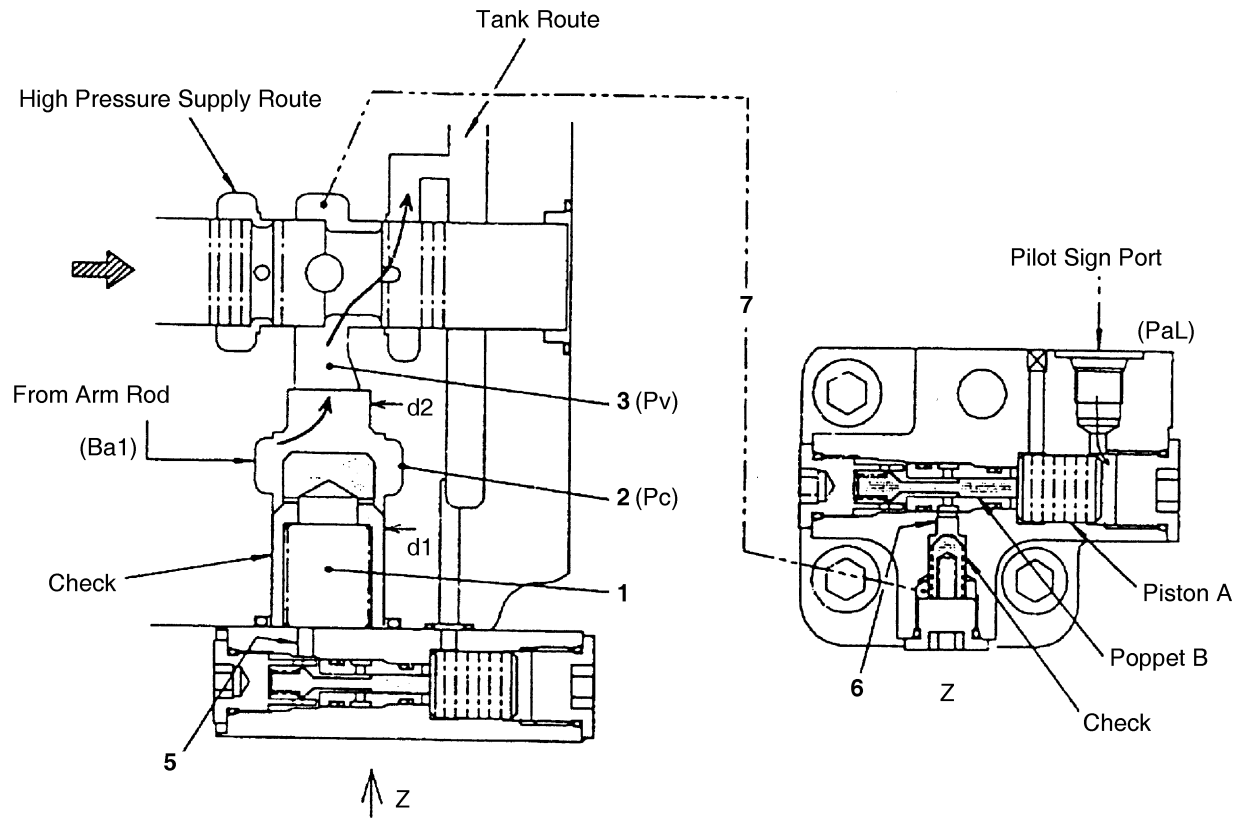


HAOG350P

Figure 13

- A. Arm Dump Operation ($p_1 > p_c$) (PaL pilot signal: "OFF")

Oil passes through path (4, Figure 13) and chamber (1) pressure becomes pressure (P_c). At squeeze (2), poppet (D) opens and high-pressure oil is supplied to rod side of the cylinder.



HAOG360P

Figure 14

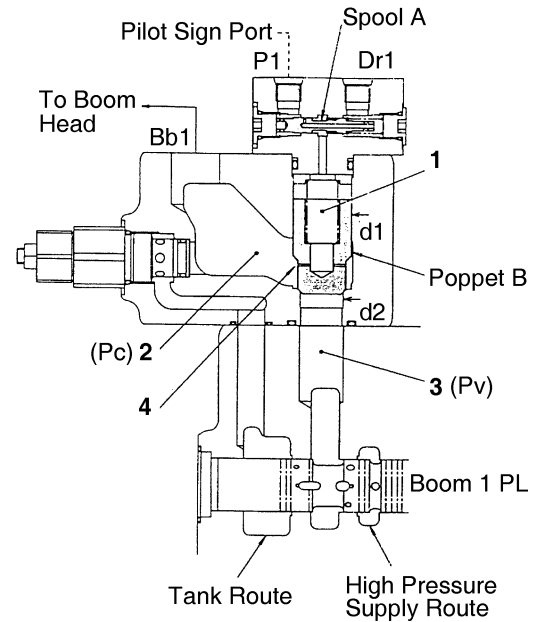
B. Arm Crowd ($P_c > P_v$) (PaL pilot signal: "ON")

Pilot signal pressure enters signal port, piston (A, Figure 14) moves to the left and poppet (B) is opened and paths (5 and 6) are connected. The oil from chamber (1) flows back to the tank through path (7). The oil pressure in chamber (1) is released allowing the poppet to open, and oil from the rod side flows to the tank.

Boom Load Holding Valve

1. When plunger is neutral (Pi pilot signal: "OFF").

Spool (A, Figure 15) is in the position as shown closing off the path between chamber (1) and drain (Dr1). Chamber (1) and chamber (2) are connected through squeeze (4) and the pressure is P_c . $d_1 > d_2$, poppet (B) is seated closing off chamber (2) and chamber (3).



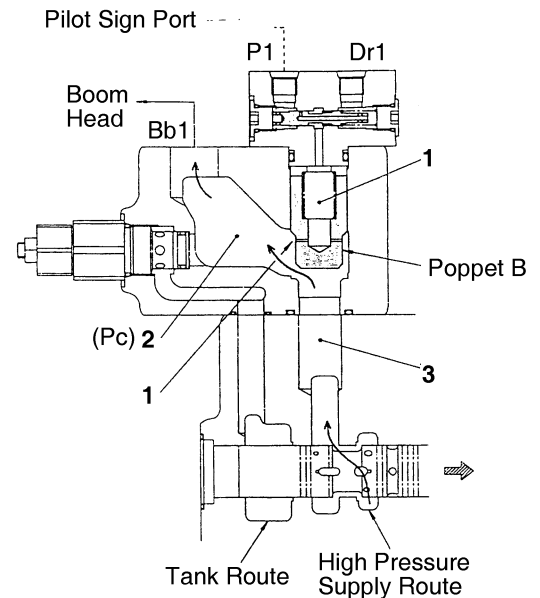
HAOG370P

Figure 15

2. When plunger is operated.

- A. Boom-up ($P_v > P_c$) (Pi pilot signal: "OFF")

As the plunger is operated, high-pressure oil flows in through chamber (3, Figure 16). Chamber (1) and chamber (2) pressures are P_c and equalized through squeeze (4). P_v overcomes set spring pressure and high-pressure oil is supplied to the cylinder head.



HAOG390P

Figure 16

B. Boom-down ($P_c > P_v$) (P_i pilot signal: "ON").

Pilot signal pressure enters signal port, spool (A, Figure 17) moves to the right and chamber (1) and drain (1) are connected allowing chamber (1) to drain. Since pressure P_c is greater than P_v , oil flows through the opened poppet (B) and flows back to the tank.

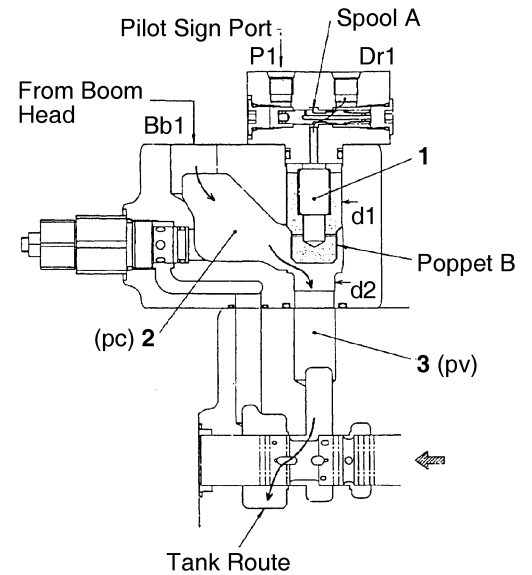
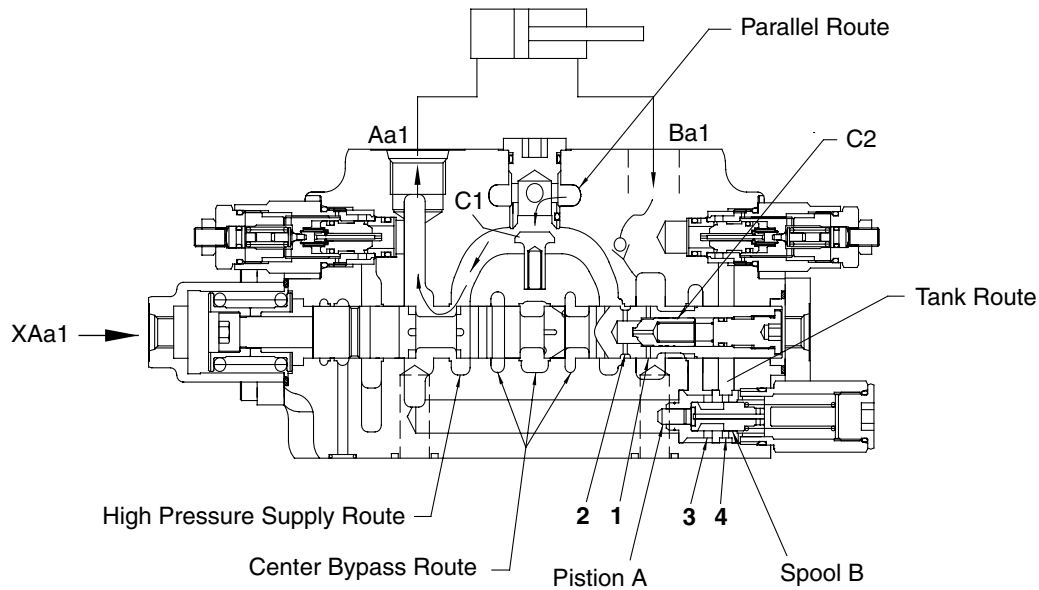


Figure 17

HAOG400P

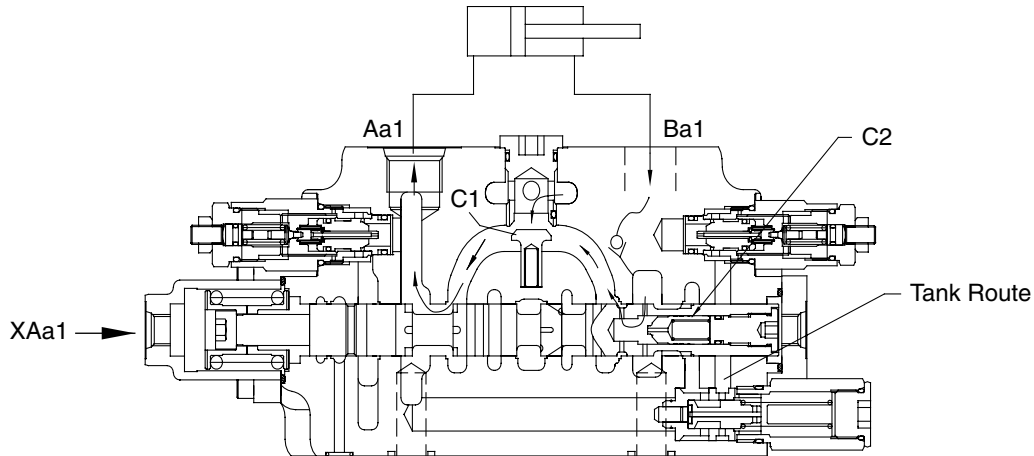
Arm Regeneration



FG003186

Figure 18

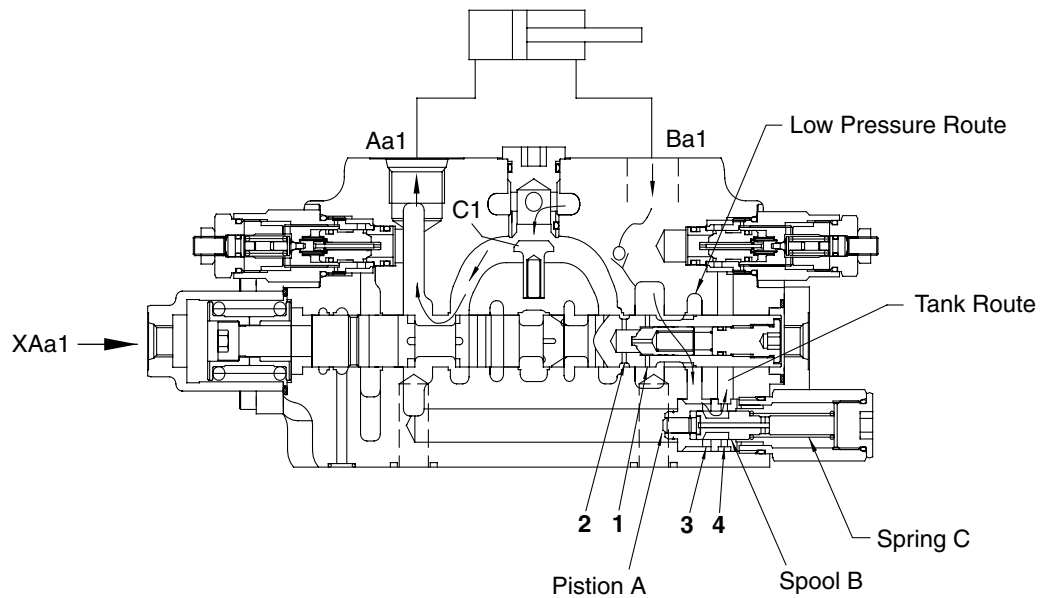
1. If the arm plunger is operated to crowd side, the plunger moves to the right side and the center bypass route is interrupted. The oil from pump opens check valve C1 from parallel route and flows to the cylinder head through the high-pressure supply route.



FG003187

Figure 19

2. Oil returning from the rod side flows back to the tank through regeneration valve route (2) to route (1).

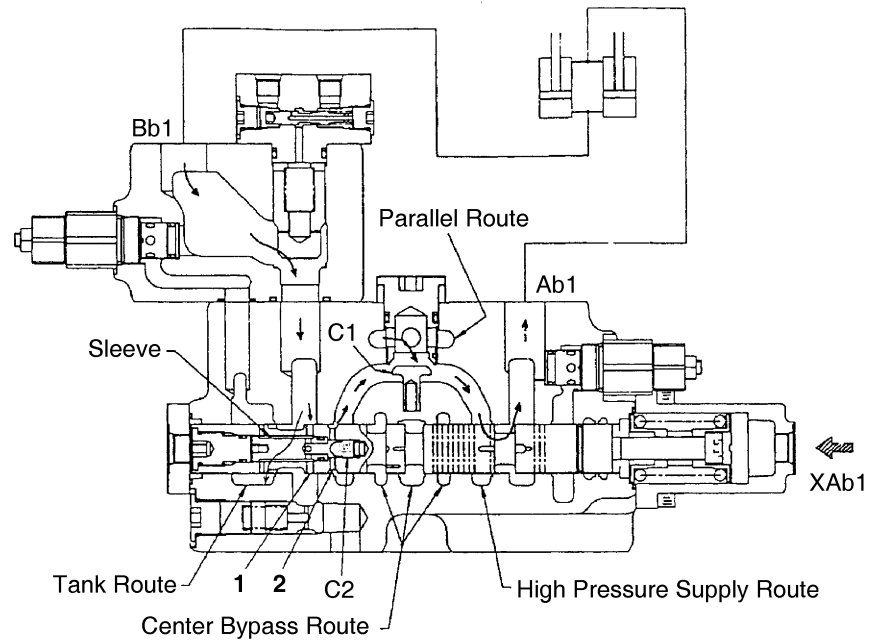


FG003188

Figure 20

3. When the pilot signal is supplied to port (XRE, Figure 20), piston (A) is moved to the left. Rod side pressure is raised up because of spool (B) closing route (1) and check valve (C2) in plunger is opened, as a result oil is regenerated to the head side through route (3) to route (4) of the plunger.

Boom Regeneration



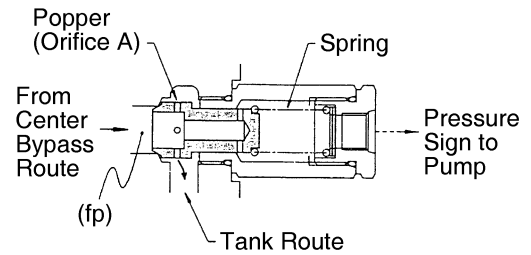
HAOG440P

Figure 21

To operate boom cylinder downward, the plunger moves to the left and the center bypass route is interrupted. Oil flowing from pump through the parallel route opens check valve (C1, Figure 21) and is supplied to the cylinder rod through the high-pressure supply route. The oil returned from the cylinder head flows to the tank route however, as the return line pressure is raised up, check valve (C2) in the plunger is opened. The oil will be regenerated to the rod side through sleeve traverse hole route (1) to route (2).

Foot Relief Valve

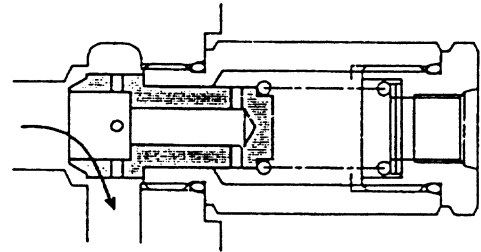
1. Oil from center bypass route flows to tank route through orifice (A, Figure 22) of poppet. The pressure (fp) generated by flow passed through orifice is fed back to the pump to control the discharge volume by the pump.



HAOG450P

Figure 22

2. A large amount of fluid flow from delayed pump response causes pressure (fp) to overcome set spring pressure and the poppet is opened, allowing oil to flow to the tank operating as a relief valve.

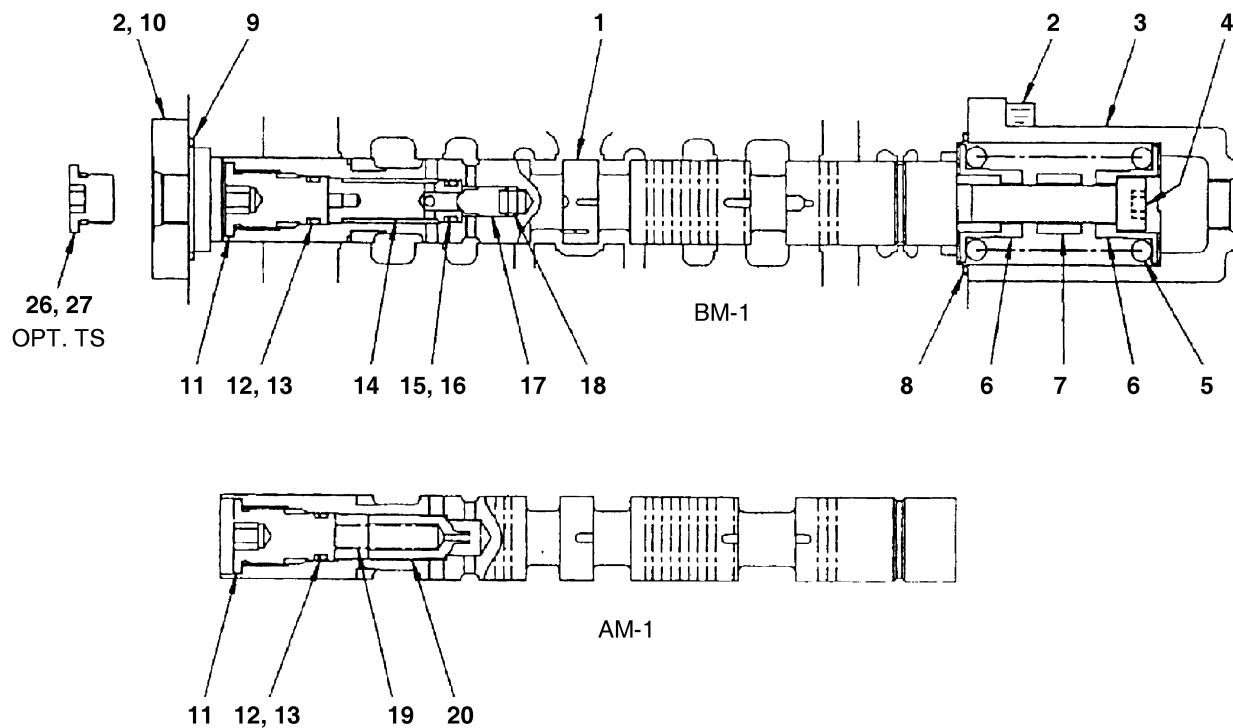


HAOH220S

Figure 23

Parts List

Main Plunger Element



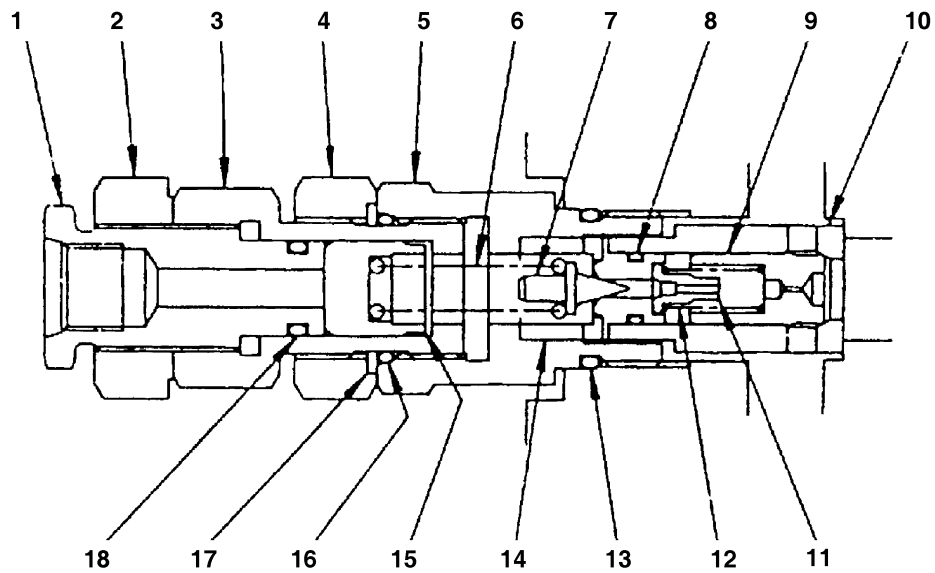
HASA151S

Figure 24

Reference Number	Description
1	Plunger
2	Bolt With Hole
3	Cover
4	Plunger Cap
5	Spring
6	Spring Guide
7	Spacer
8	O-ring
9	O-ring
10	Retainer

Reference Number	Description
11	Cap
12	Backup Ring
13	O-ring
14	Sleeve
15	Backup Ring
16	O-ring
17	Check Valve
18	Spring
19	Spring
20	Check Valve

Main Relief Valve



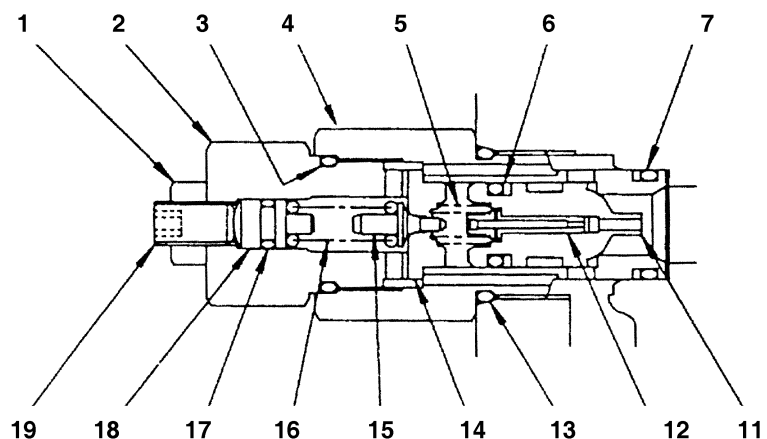
HASA160S

Figure 25

Reference Number	Description
1	Adjusting Screw
2	Hexagonal Nut
3	Adjusting Screw
4	Hexagonal Nut
5	Cap
6	Spring
7	Pilot Poppet
8	O-ring
9	Main Poppet

Reference Number	Description
10	Sleeve
11	Orifice
12	Spring
13	O-ring
14	Pilot Sheet
15	Piston
16	O-ring
17	Backup Ring
18	O-ring

Overload Relief Valve



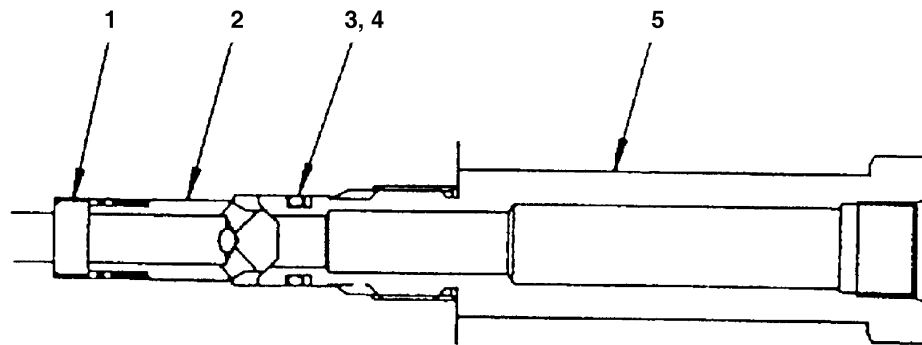
HASA170S

Figure 26

Reference Number	Description
1	Hex Nut
2	Cap
3	O-ring
4	Sleeve
5	Spring
6	Spring
7	O-ring
8	Backup Ring
9	Backup Ring
10	O-ring

Reference Number	Description
11	Main Poppet
12	Piston
13	O-ring
14	Pilot Sheet
15	Pilot Poppet
16	Spring
17	O-ring
18	Spring Tray
19	Adjusting Screw

Bucket Unity Check



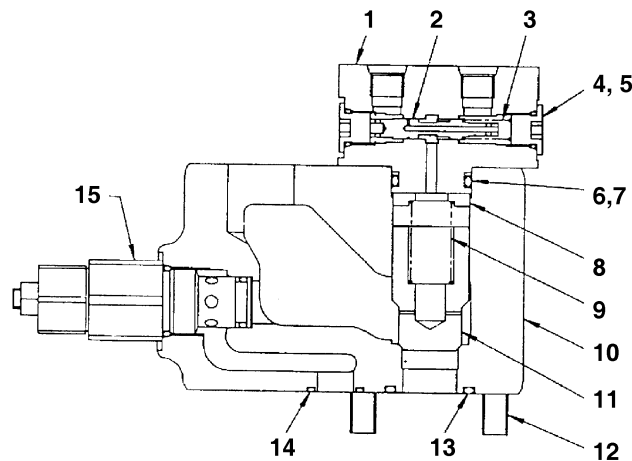
HASA180S

Figure 27

Reference Number	Description
1	Spring
2	Check
3	O-ring

Reference Number	Description
4	Backup Ring
5	Cap

Boom Load Holding Valve



HASA190S

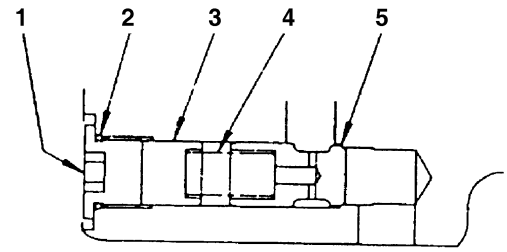
Figure 28

Reference Number	Description
1	Cover
2	Spool
3	Spring
4	Cap
5	O-ring
6	Backup Ring
7	O-ring

Reference Number	Description
8	Spring Seat
9	Spring
10	Manifold
11	Poppet
12	Bolt With Hole
13	O-ring
14	O-ring

Boom Unity Check

Reference Number	Description
1	Cap
2	O-ring
3	Stopper
4	Spring
5	Check

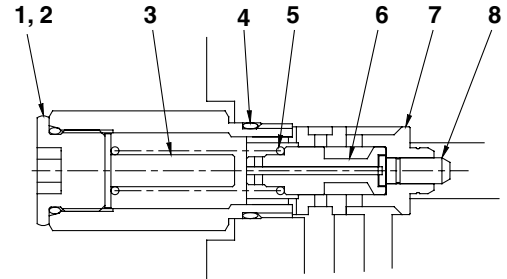


HASA200S

Figure 29

Arm Regeneration Valve

Reference Number	Description
1	Cap
2	O-ring
3	Spacer
4	O-ring
5	Spring
6	Spool
7	Sleeve
8	Piston

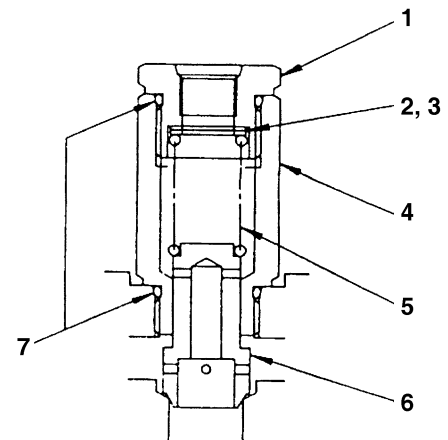


FG003197

Figure 30

Foot Relief Valve

Reference Number	Description
1	Cap
2	Shim
3	Shim
4	Cap
5	Spring
6	Poppet
7	O-ring

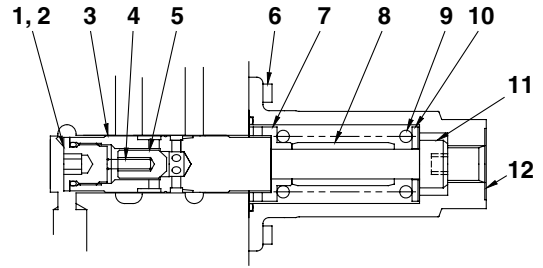


HASA220S

Figure 31

Arm Priority Valve [AP Valve]

Reference Number	Description
1	Cap
2	O-ring
3	Spool
4	Spring
5	Check
6	Bolt; Socket
7	Spring Guide
8	Spacer
9	Spring
10	Seam
11	Bolt; Socket
12	Cover

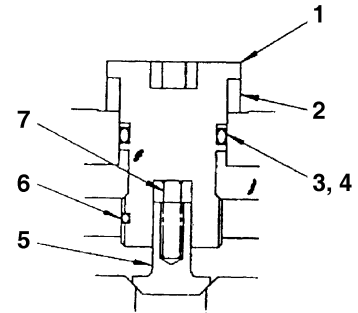


FG003199

Figure 32

Check Valve [Am-2]

Reference Number	Description
1	Cap
2	Spacer
3	Backup Ring
4	O-ring
5	Spring
6	Nylon Chip
7	Check

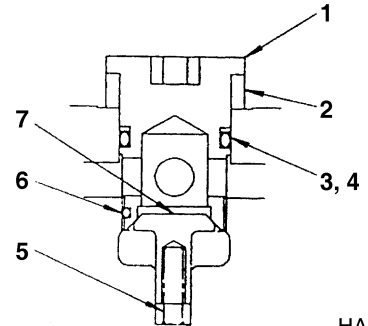


HASA230S

Figure 33

Check Valve [Opt, Bkt, Bm-1, Bm-2, Am-1]

Reference Number	Description
1	Cap
2	Spacer
3	Backup Ring
4	O-ring
5	Spring
6	Nylon Chip
7	Check

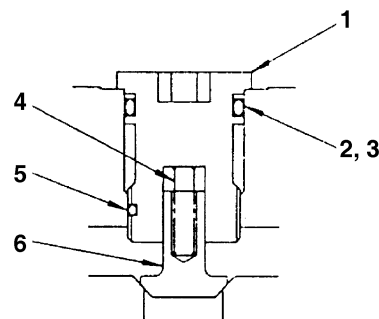


HASA240S

Figure 34

Check Valve

Reference Number	Description
1	Cap
2	Backup Ring
3	O-ring
4	Spring
5	Nylon Chip
6	Check

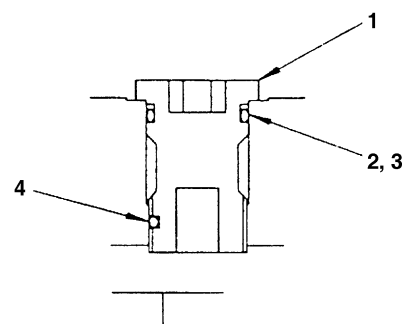


HASA250S

Figure 35

Cap

Reference Number	Description
1	Cap
2	Backup Ring
3	O-ring
4	Nylon Chip

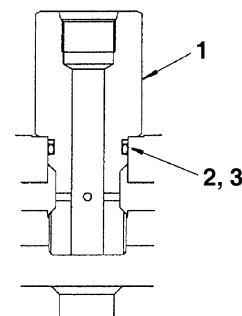


HASA260S

Figure 36

Cap

Reference Number	Description
1	Cap
2	O-ring
3	Backup Ring

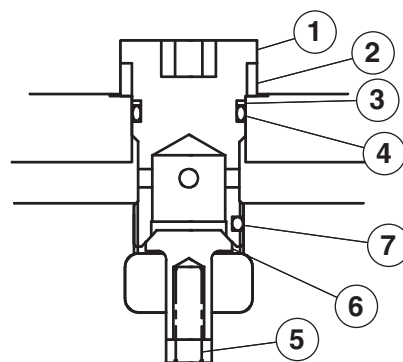


HAAA2640

Figure 37

Check Valve [Sw]

Reference Number	Description
1	Cap
2	Spacer
3	Backup Ring
4	O-ring
5	Spring
6	Check
7	Nylon Chip

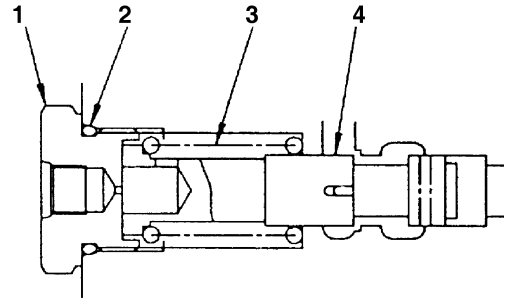


HAAA7930

Figure 38

Center Bypass Valve [Cb Valve]

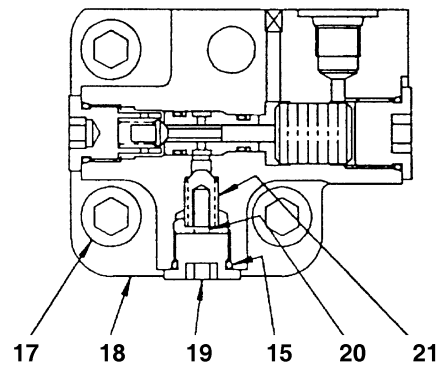
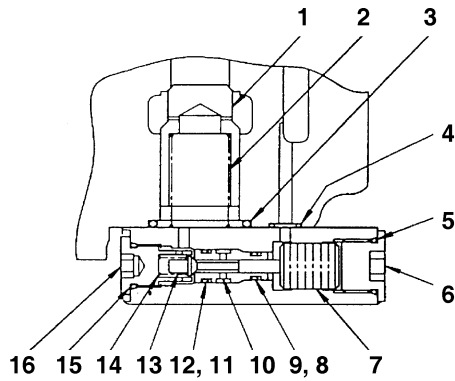
Reference Number	Description
1	Cap
2	O-ring
3	Spring
4	Cb Spool



HASA330S

Figure 39

Arm Load Holding Valve



FG007244

Figure 40

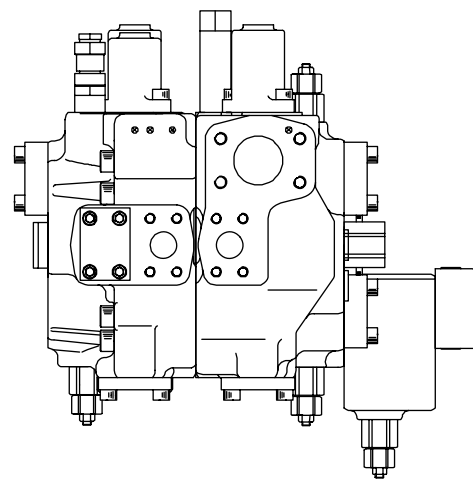
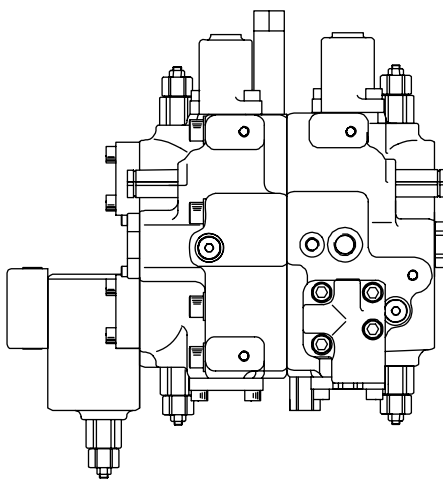
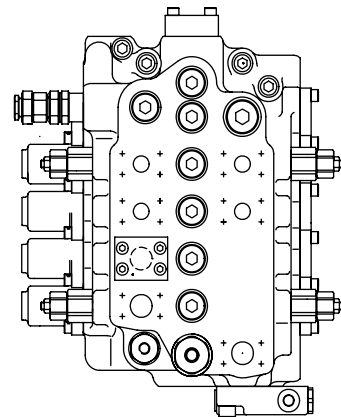
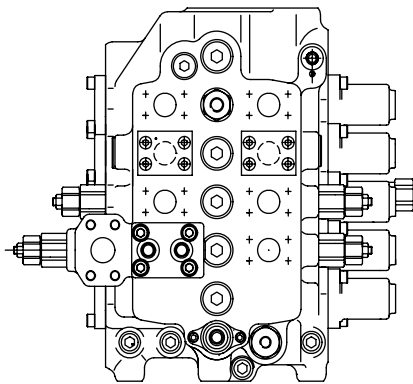
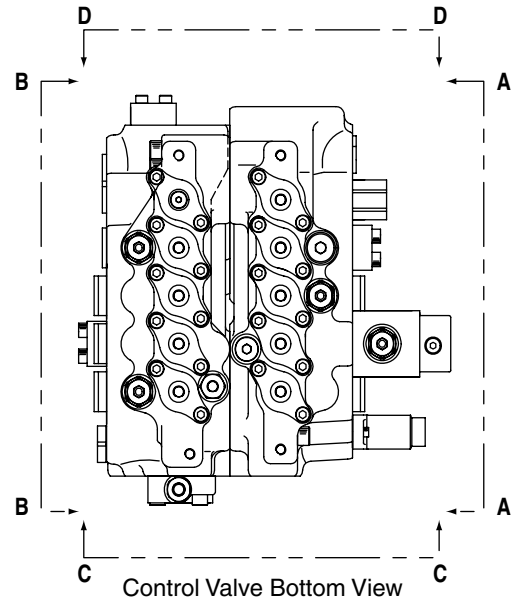
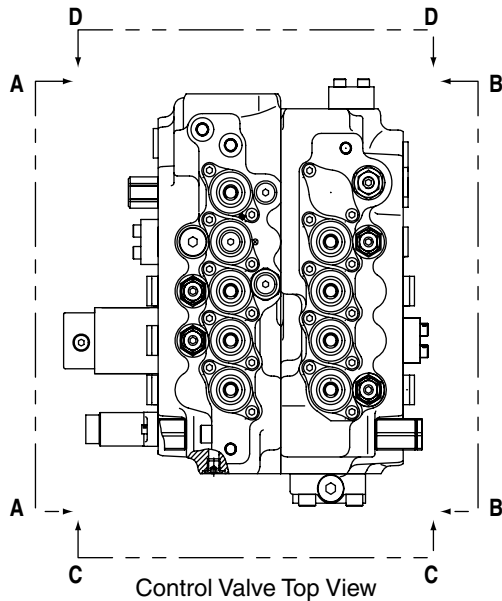
Reference Number	Description
1	Poppet
2	Spring
3	O-ring
4	O-ring
5	O-ring
6	Cap
7	Piston
8	Backup Ring
9	O-ring
10	Sleeve
11	Backup Ring

Reference Number	Description
12	O-ring
13	Poppet
14	Spring
15	O-ring
16	Cap
17	Bolt With Hole
18	Cover
19	Cap
20	Spring
21	Check

Specifications

Control Valve	Relief Valves (Main):	330 kg•cm ² (4,694 psi) - work 350 kg•cm ² (4,978 psi) - travel
	Left Side Spools: (and spool diameter)	Dozer: left 28 mm (1.1") diameter Swing: 28 mm (1.1") diameter Boom-2: 28 mm (1.1") diameter Arm-1: 28 mm (1.1") diameter
	Right Side Spools: (and spool diameter)	Travel: 28 mm (1.1") diameter Option: open 28 mm (1.1") diameter Bucket: 28 mm (1.1") diameter Boom-1: 28 mm (1.1") diameter Arm-2: 28 mm (1.1") diameter
	Overload Relief Pressure:	360 kg•cm ² (5,120 psi)

CONTROL VALVE DRAWING AND HYDRAULIC CIRCUIT



FG007245

Figure 41

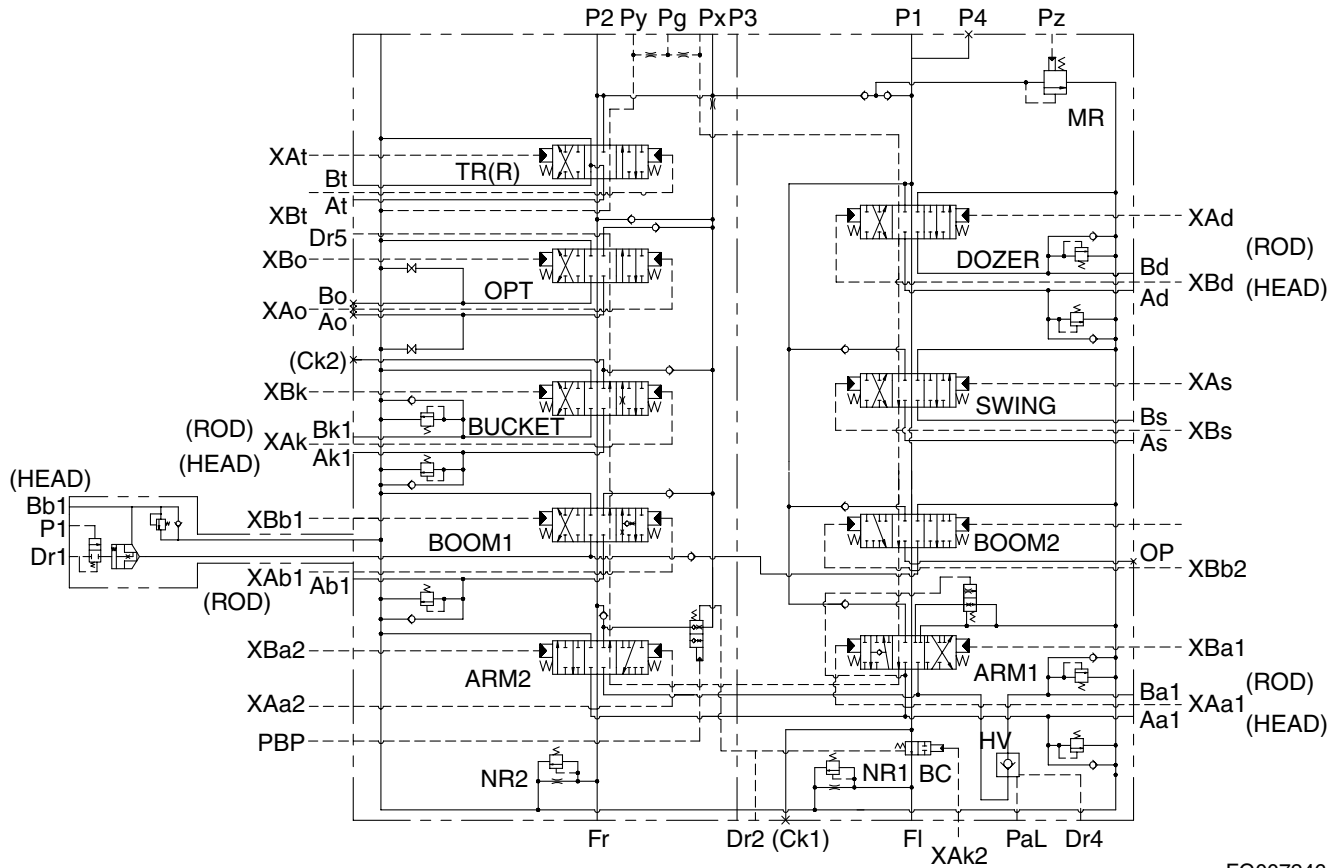


Figure 42 CONTROL VALVE HYDRAULIC CIRCUIT

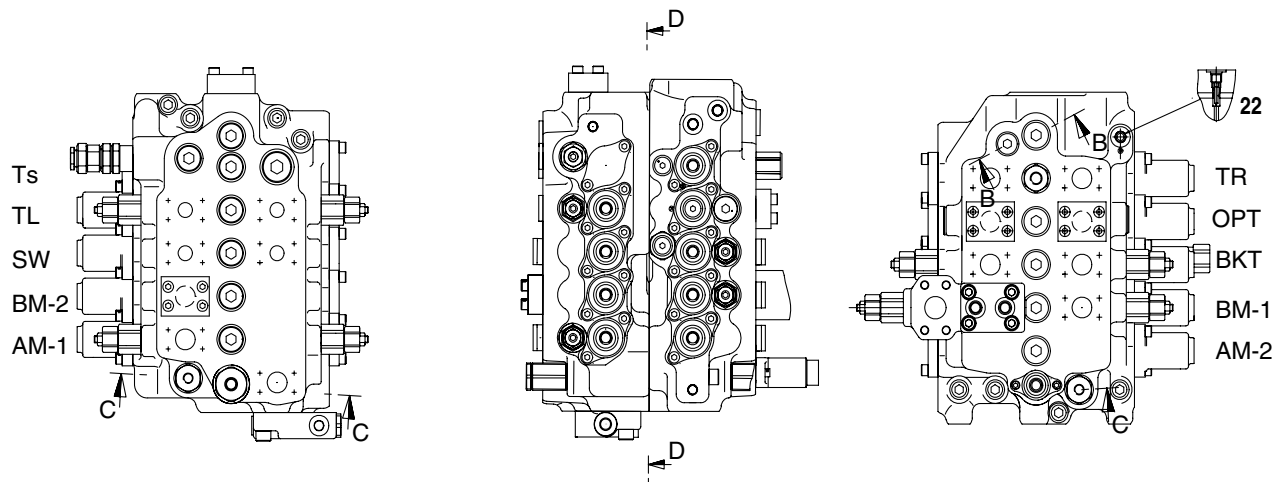
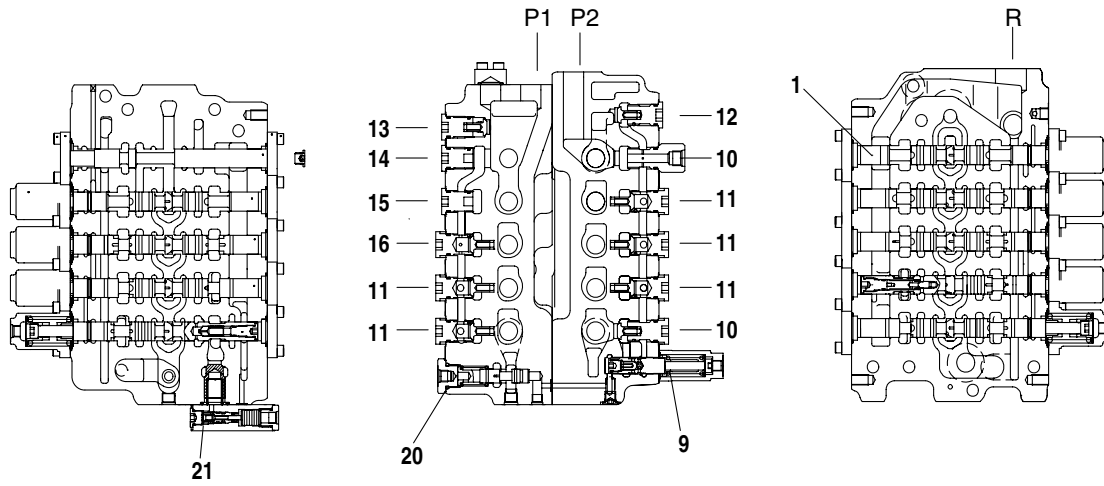


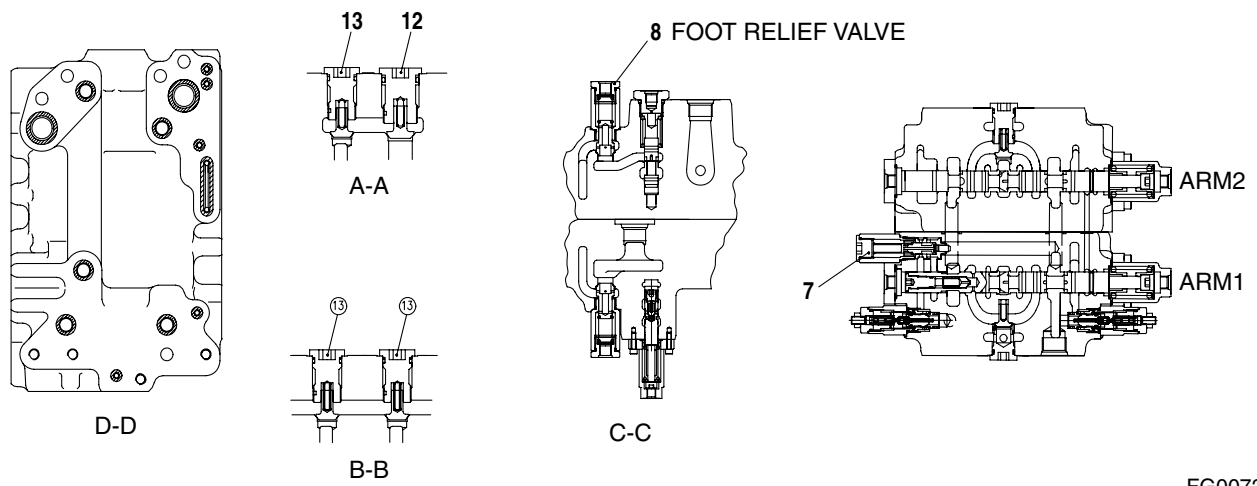
Figure 43

FG007247



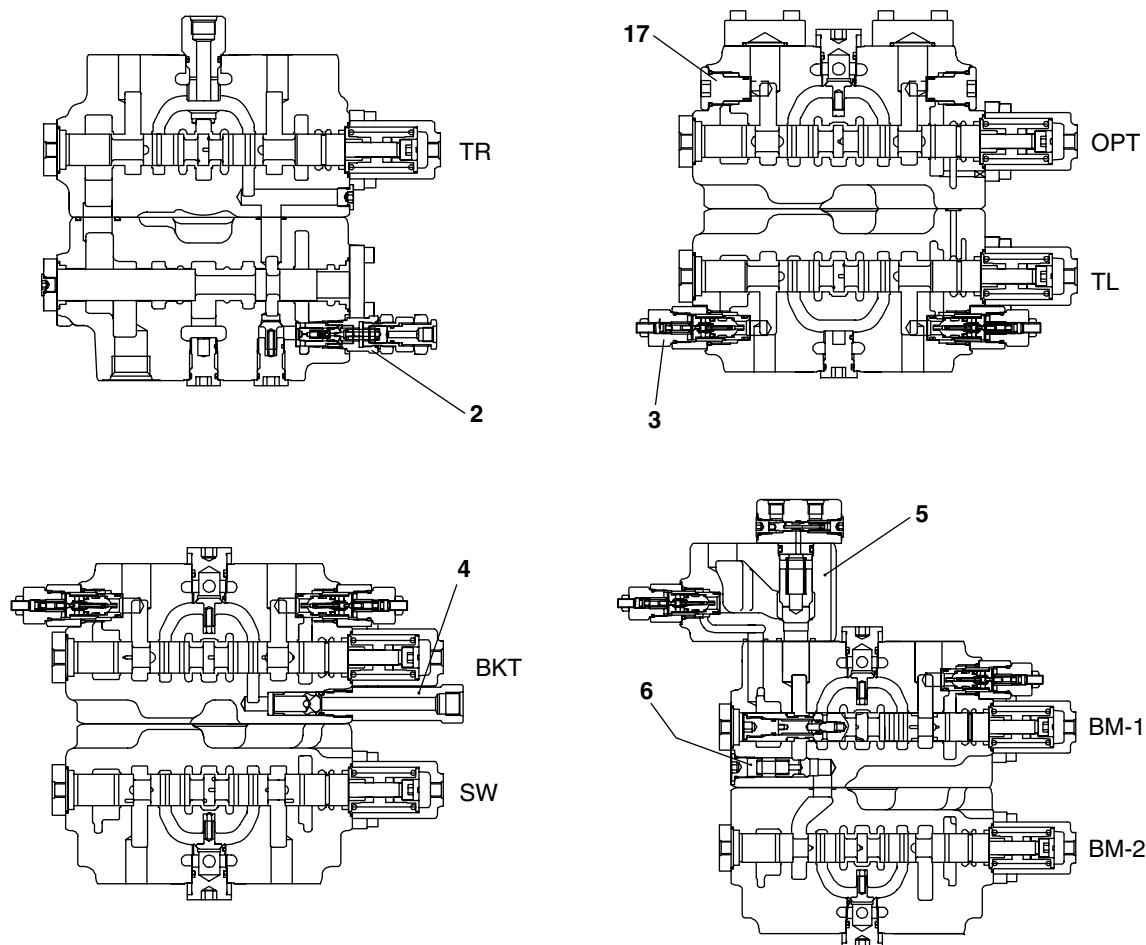
FG007248

Figure 44



FG007249

Figure 45



FG007250

Figure 46

Reference Number	Description	Quantity
1	Main Plunger	9
2	Main Relief Valve	1
3	Overload Relief Valve	8
4	Bucket 2-Speed Check	1
5	Boom Holding Valve	1
6	Boom 2-Speed Check	1
7	Arm Regeneration Valve	1
8	Foot Relief Valve	2
9	Arm Priority Valve (AP Valve)	1
10	Check Valve (AM-2)	1
11	Check Valve (OPT, BKT, BM-1, BM-2, AM-1)	5

Reference Number	Description	Quantity
12	Check Valve	1
13	Check Valve	2
14	Cap	3
15	Check Valve (TL)	1
16	Check Valve (SW)	1
17	Plug assembly	1
20	Center Bypass Valve (CB Valve)	1
21	Arm Holding Valve	1
22	Orifice (Px, Py)	1

DISASSEMBLY AND REASSEMBLY

General Disassembly

To disassemble control valve, remove bolts from left and right side of the control valve.

Socket Bolt Size	12.0 mm
------------------	---------

General Reassembly

Stand control valve on flat surface and tighten bolts with correct torque.

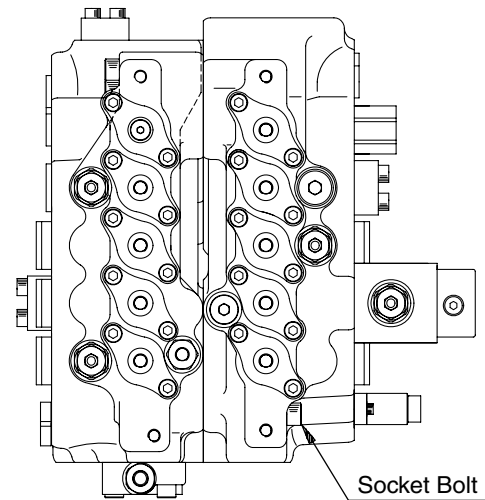
Socket Bolt Tightening Torque	15 kg•m (108 ft lb)
-------------------------------	------------------------

IMPORTANT

Be sure to use extreme care when assembling and disassembling control valve. All O-rings should be replaced with new ones. Never reuse old O-rings.

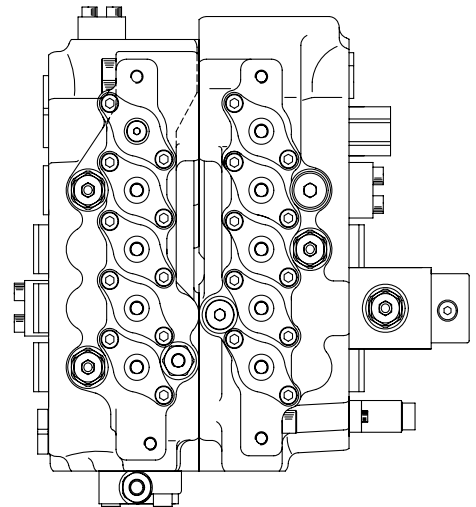
Plunger Replacement

1. The plunger is selected and toothed into the housing; as a result it is a non serviceable part and cannot be replaced on site.
 - A. If for some reason it needs to be replaced, please contact us with the following information;
Make and/or model number.
Identification color for selected teething as inscribed on the nameplate.
 - B. Identification color is painted on the right or left edge of the machine body. It is visible from the bottom if the paint has been removed.



FG007251

Figure 47



FG007252

Figure 48

Main Plunger Element - Disassembly and Assembly

IMPORTANT

When disassembling Main Plunger element tag and label each component so all parts can be reassembled in the proper order.

IMPORTANT

The hydraulic control valve used in the S200W-V uses 3 different plungers. Care should be taken when disassembling and reassembling plunger assemblies.

Tool

This holding tool is used to clamp and hold plunger for further disassembly, without damaging it. The holder is comprised of 2 halves of a hexagonal rod made from soft brass, with the appropriate size hole and outside dimensions.

Inside Diameter	Outside Diameter	Application
28.20 mm (1.1102 in)	41.0 mm (1.6142 in)	Main Plunger
Length		100.0 mm (3.9370 in)

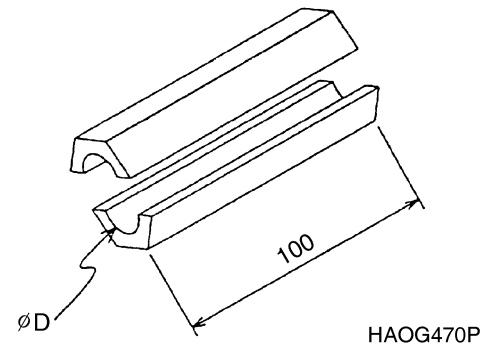
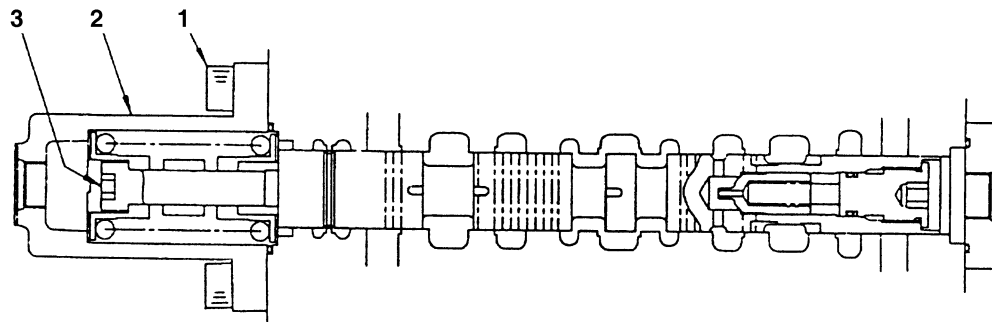


Figure 49



HAOG480P

Figure 50

Reference Number	Description
1	8 mm Hex Head Bolts
2	Plunger Cover

Reference Number	Description
3	Plunger Cap Bolt

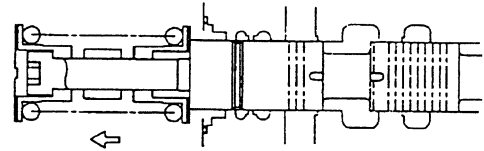
1. Remove two bolts (1, Figure 50) from cover and remove cover (2) from valve housing.

Hex Head Style Bolt	8.0 mm
Tightening Torque	5 kg•m (36 ft lb)

2. Pull out plunger subassembly from housing.

IMPORTANT

Do not force out plunger. Pull out plunger slowly, to avoid damage.

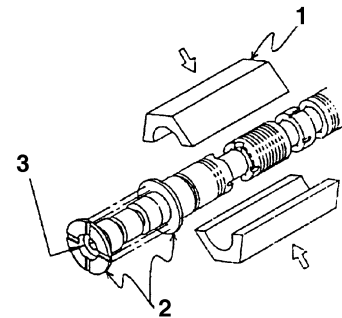


HAOG490P

Figure 51

3. Use the holder tool described above to clamp plunger assembly and loosen plunger cap bolt.

Reference Number	Description
1	Plunger Holding Tool
2	Spring Guide
3	Plunger Cap Bolt Tightening Torque: 6 kg•m (43 ft lb)



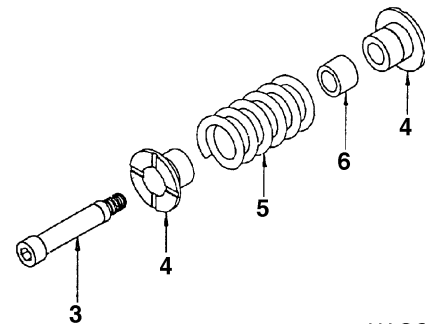
HAOG500P

Figure 52

4. Remove plunger cap bolt (3, Figure 53), upper spring guide (4), spring (5), spacer (6) and lower spring guide (4).

IMPORTANT

Use caution when disassembling and assembling plungers. The travel straight plunger does not have a spacer. In addition the spring and plunger cap bolts are different.



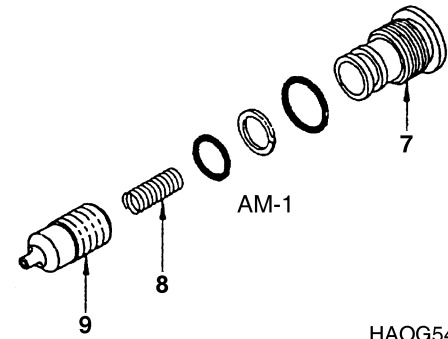
HAOG520P

Figure 53

5. Plunger (Lower side)

AM-1: Remove cap (7, Figure 54), O-rings, backup ring, spring (8) and check valve (9).

Lower Cap Hex Hole	8.0 mm
Tightening Torque	6 kg•m (43 ft lb)

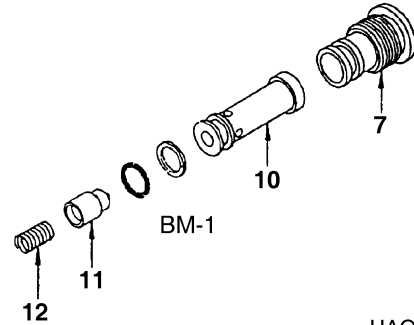


HAOG540P

Figure 54

BM-1: Remove cap (7, Figure 55), O-ring, backup ring, sleeve (10), check valve (11) and spring (12).

Lower Cap Hex Hole	8.0 mm
Tightening Torque	6 kg•m (43 ft lb)

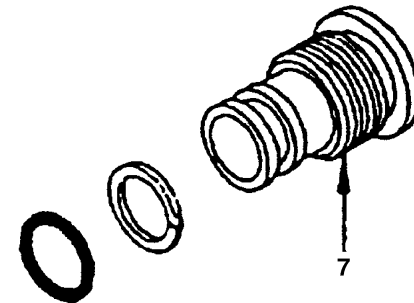


HAOG550P

Figure 55

TS: Remove cap (7, Figure 56), O-ring and backup ring.

Lower Cap Hex Hole	8.0 mm
Tightening Torque	6 kg•m (43 ft lb)



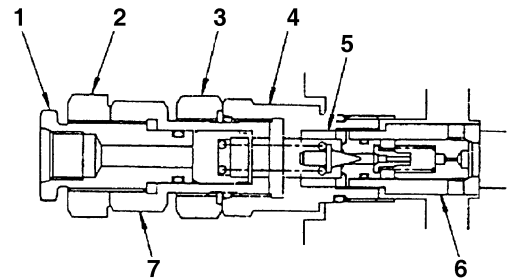
HAOH230S

Figure 56

Main Relief Valve

Disassembly

Reference Number	Description	Size
1	Adjusting Screw	22 mm
2	Hexagonal Nut	30 mm
3	Hexagonal Nut	30 mm
4	Cap	30 mm
5	Pilot Sheet	
6	Lower Sleeve	
7	Sleeve	27 mm

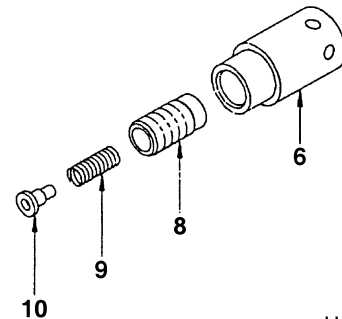


HAOG560P

Figure 57

1. Hold adjusting screw (1, Figure 57) and loosen hexagonal nut (2).
2. Hold cap (4, Figure 57) and loosen hexagonal nut (3).
3. Loosen cap (4, Figure 57) and remove valve assembly by unscrewing cap (4).

Reference Number	Description
6	Lower Sleeve
8	Piston
9	Spring
10	Orifice



HAOG580P

Figure 58

4. Remove lower sleeve (6, Figure 58) from cap (4) by gently pulling sleeve out of cap. Remove piston (8), spring (9) and orifice (10) from lower sleeve (6).

IMPORTANT

Further disassembly of pilot sheet from the cap is not recommended, as it is pressed in at the factory.

Reassembly

1. Insert piston (A) into sleeve (7). Assemble hex nut (2) onto adjust screw (1). Assemble adjust screw (1) to sleeve (7), until piston (A) is seated.
2. Insert pilot poppet (B) into pressure adjust spring (C) and insert into sleeve (7). Assemble cap (4) onto sleeve (7), making sure pilot poppet (B) is properly seated.
3. Insert orifice (10), spring (9) and piston (8) into lower sleeve (6).
4. Assemble lower sleeve (6) onto cap (4).
5. Insert assembled relief valve into control valve body and tighten cap (4).

Tightening Torque	10 kg•m (72 ft lb)
-------------------	-----------------------

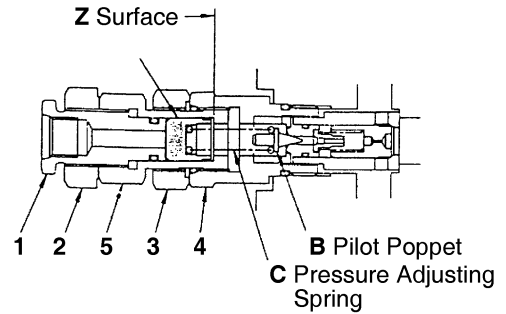
Main Relief Valve Adjustment

IMPORTANT

Improper relief valve pressure settings may cause severe damage to the hydraulic system. Extreme caution should be taken when making pressure adjustments.

IMPORTANT

Inspect all O-ring gaskets for damage and replace as necessary. Never reuse damaged or questionable O-rings.



HAOG590P

Figure 59

High-pressure Adjustment

1. Install an accurate pressure gauge at the discharge outlet of the hydraulic pump.
2. Start the engine and drive hydraulic pump at normal rpm.
3. Completely stroke one of BM-up, AM or BKT plungers and read pressure gauge.
4. Adjust pressure by turning sleeve (7) while monitoring pressure gauge. Each 1/4 turn changes pressure by approximately 45 kg•cm² (640 psi)

IMPORTANT

The relief valve is extremely sensitive and sudden extreme changes should be avoided.

5. Tighten hexagonal nut (3) while sleeve (7) is secured. Recheck high side pressure.

Tightening Torque	6 kg•m (43 ft lb)
-------------------	----------------------

Low-pressure Adjustment

1. After the High-pressure adjustment has been completed, Low-pressure adjustment can be made by turning the Adjust screw (1).
2. After the desired pressure has been adjusted, tighten hexagonal nut (2) while adjust screw (1) is secured. Recheck low side pressure.

Tightening Torque	6 kg•m (43 ft lb)
-------------------	----------------------

Overload Relief Valve

IMPORTANT

When disassembling Overload Relief Valve, tag and label each component so all parts can be reassembled in the proper order.

IMPORTANT

Do not disassemble the pressure adjustment element. The pressure is factory set and cannot be correctly adjusted on the vehicle.

IMPORTANT

Each Overload Relief Valve must be reinstalled into its original position.

1. Loosen sleeve (1) and remove valve assembly.

Reference Number	Description
1	Sleeve
2	Cap

Sleeve Hexagonal Base	32 mm
Tightening Torque	6 kg•m (43 ft lb)

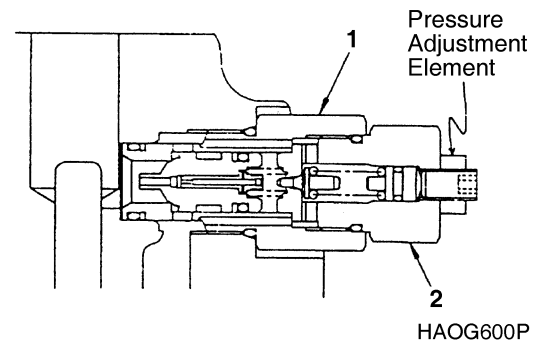


Figure 60

2. Loosen cap (1) subassembly from sleeve assembly and remove O-ring, spring (2) and pilot poppet (3).

Reference Number	Description
2	Cap
3	Spring
4	Poppet

Cap Hexagonal Base	27 mm
Tightening Torque	6 kg•m (43 ft lb)

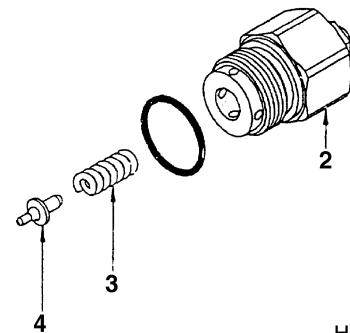
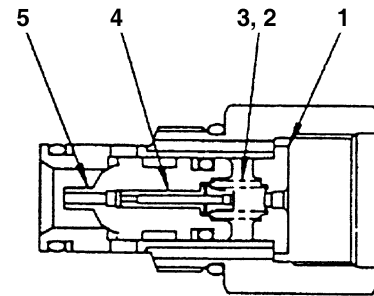


Figure 61

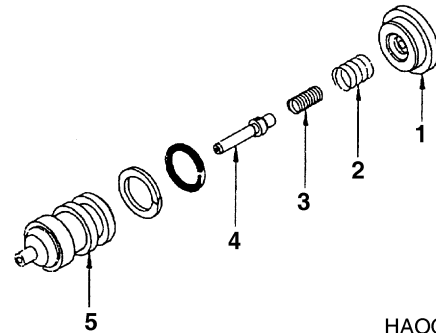
3. Remove pilot seat (1), outer spring (2), inner spring (3), piston (4), O-ring, backup ring and main poppet (5).

Reference Number	Description
1	Pilot Seat
2	Outer Spring
3	Inner Spring
4	Piston
5	Main Poppet



HAOG630P

Figure 62



HAOG640P

Figure 63

Arm Load Holding Valve

IMPORTANT

When disassembling Arm Load Holding Valve, tag and label each component so all parts can be reassembled in the proper order.

Check Valve Main Body

1. Remove allen bolts (1) and cover (2).

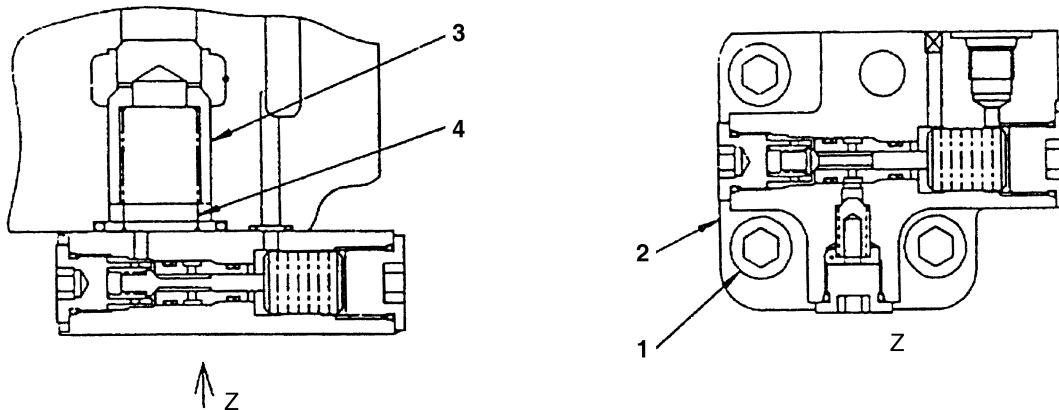


Figure 64

HAOG650P

Mounting Bolt Allen Socket	10 mm
Tightening Torque	10 kg•m (72 ft lb)

IMPORTANT

When assembling cover, inspect O-rings for any damage and replace as necessary.

2. Remove spring (3) and poppet (4).

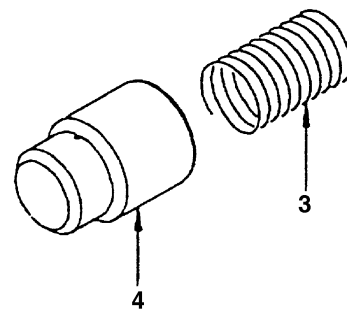


Figure 65

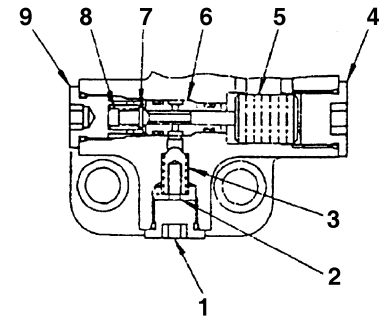
HAOG660P

Cover Assembly

Reference Number	Description
1	Cap
2	Spring
3	Check
4	Cap
5	Piston
6	Sleeve
7	Poppet
8	Spring
9	Cap

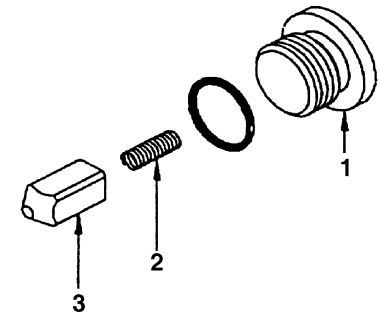
1. Loosen cap (1) and remove spring (2) and check (3).

Cap Hex Hole Size	8.0 mm
Tightening Torque	5 kg•m (36 ft lb)



HAOG670P

Figure 66

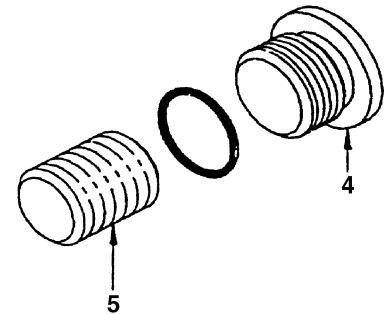


HAOG690P

Figure 67

2. Loosen cap (4) and remove piston (5).

Cap Hex Hole Size	10 mm
Tightening Torque	6 kg•m (43 ft lb)



HAOG680P

Figure 68

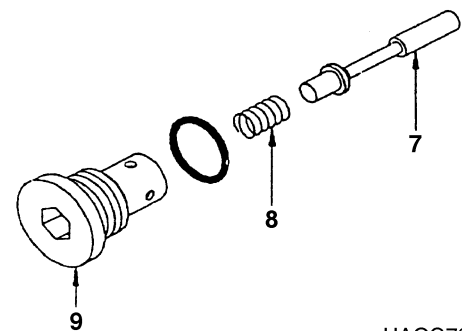
3. Loosen cap (9) and remove spring (8) and poppet (7).

Cap Hex Hole Size	8.0 mm
Tightening Torque	5 kg•m (36 ft lb)

4. Remove sleeve from poppet bore by gently tapping it from the right side.

IMPORTANT

Be careful not to damage the edges of the inner and outer surfaces of the sleeve.



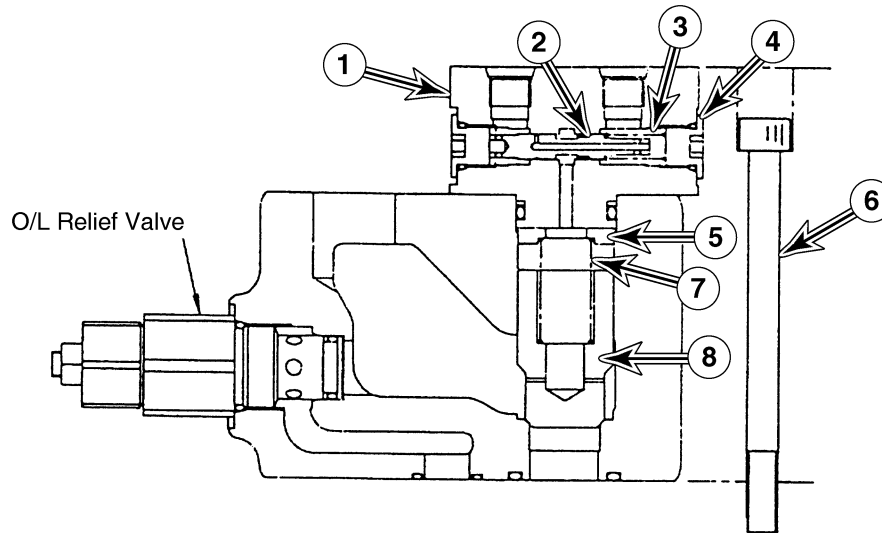
HAOG700P

Figure 69

Boom Load Holding Valve

IMPORTANT

When disassembling Boom Load Holding Valve, tag and label each component so all parts can be reassembled in the proper order.



HAOG710P

Figure 70

Reference Number	Description	Quantity
1	Cover	9
2	Spool	1
3	Spring	8
4	cap	1

Reference Number	Description	Quantity
5	Spring Tray	1
6	Allen Head Bolt	1
7	Spring	1
8	Poppet	2

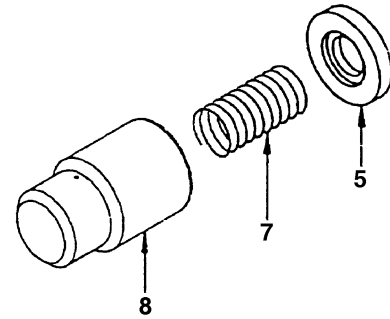
1. Remove allen head bolts (6) and remove cover (1).

Allen Head Bolt Size	8.0 mm
Tightening Torque	5 kg•m (36 ft lb)

IMPORTANT

When assembling cover, inspect O-rings for any damage and replace as necessary.

2. Remove spring tray (5), spring (7) and poppet (8) from manifold bore.

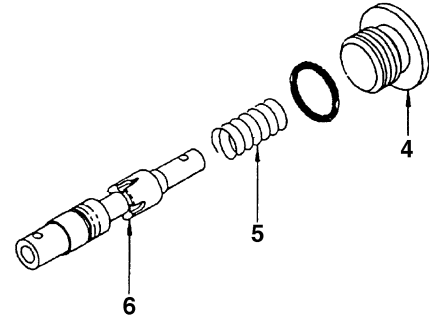


HAOG720P

Figure 71

3. Loosen cap (4) and remove spring (3) and spool (2).

Cap Allen Wrench Size	6 mm
Tightening Torque	3 kg•m (22 ft lb)



HAOG740P

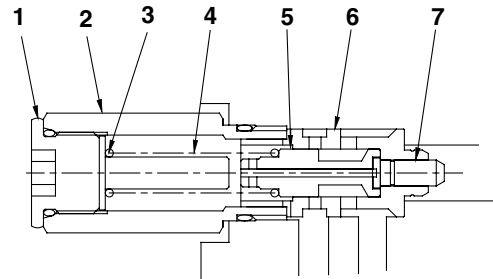
Figure 72

Arm Regeneration Valve

IMPORTANT

When disassembling Arm Regeneration Valve, tag and label each component so all parts can be reassembled in the proper order.

Reference Number	Description
1	Cap
2	Cap
3	Spring
4	Spring Guide
5	Spool
6	Sleeve
7	Piston



FG003253

Figure 73

1. Cap (1), loosen cap (2) and remove guide; spring (4)

Lower Cap Hex Hole (1)	6 mm
Tightening Torque	3 kg•m (22 ft lb)
Cap Wrench Size (2)	27 mm
Tightening Torque	10 kg•m (72 ft lb)

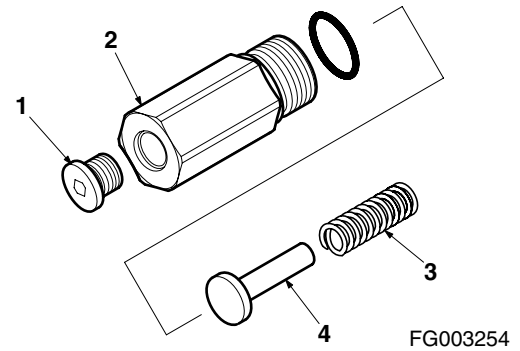


Figure 74

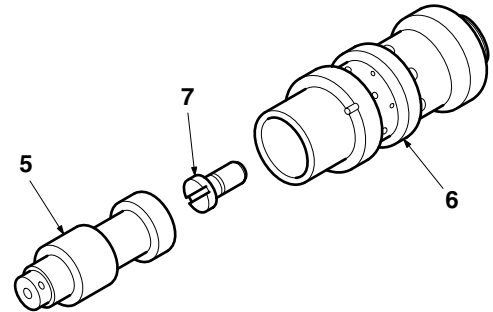


Figure 75

Bucket Unity Check

IMPORTANT

When disassembling Arm Regeneration Valve, tag and label each component so all parts can be reassembled in the proper order.

Reference Number	Description
1	Cap
2	Check
3	Spring

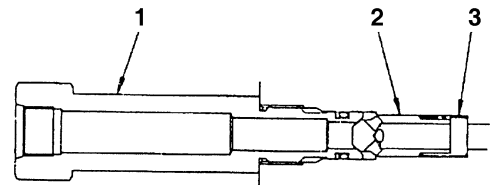
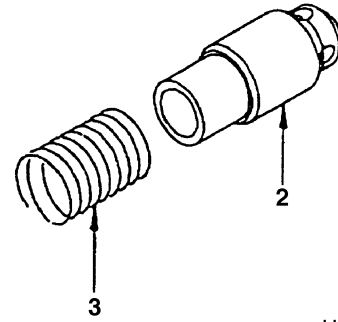


Figure 76

HAOG780P

1. Loosen cap (1) and remove check (2) and spring (3).

Cap Wrench Size	32 mm
Tightening Torque	10 kg•m (72 ft lb)



HAOG790P

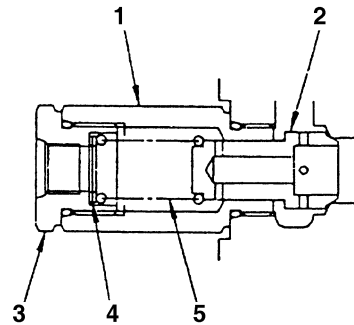
Figure 77

Foot Relief Valve

IMPORTANT

When disassembling foot relief valve, tag and label each component so all parts can be reassembled in the proper order.

Reference Number	Description
1	Cap
2	Poppet
3	Cap
4	Shim
5	Spring

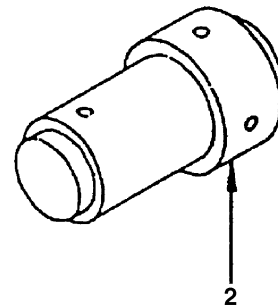


HAOG800P

Figure 78

1. Loosen cap (1) and remove poppet (2).

Cap Wrench Size	30 mm
Tightening Torque	6 kg•m (43 ft lb)



HAOG810P

Figure 79

2. Loosen cap (3) and remove shim (4) and spring (5).

Cap Wrench Size	30 mm
Tightening Torque	6 kg•m (43 ft lb)

IMPORTANT

Shim is necessary for correct pressure adjustment and must not be left out.

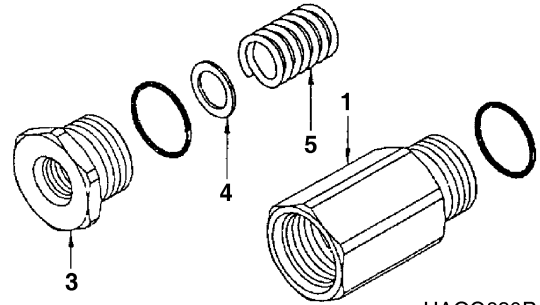


Figure 80

Center Bypass Valve (CB Valve)

IMPORTANT

When disassembling Center Bypass Valve, tag and label each component so all parts can be reassembled in the proper order.

Reference Number	Description
1	Cap
2	Spring
3	Spool

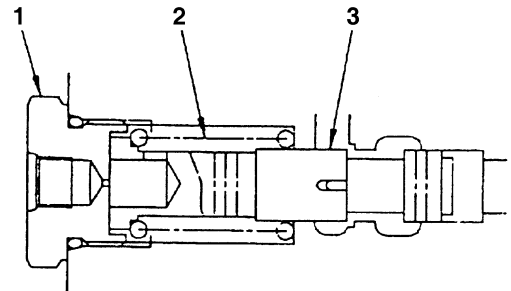


Figure 81

1. Loosen cap (1) and remove spring (2) and spool (3).

Cap Wrench Size	41 mm
Tightening Torque	10 kg•m (72 ft lb)

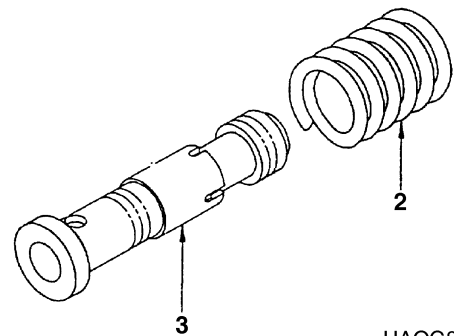


Figure 82

Boom Parallel Switch Valve

IMPORTANT

When disassembling Boom Parallel Switch Valve, tag and label each component so all parts can be reassembled in the proper order.

Special Tool

This holding tool is used to clamp and hold AP Spool for further disassembly, without damaging it. The holder is comprised of 2 halves of a hexagonal rod made from soft brass, with the appropriate size hole and outside dimensions.

Inside Diameter	Outside Diameter	Application
19.0 mm (0.7480 in)	32.0 mm (1.2598 in)	AP Spool

Length	100.0 mm (3.9370 in)
--------	----------------------

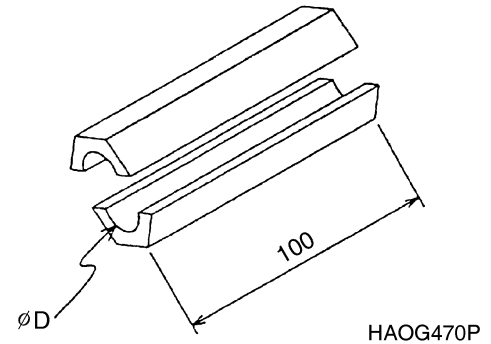


Figure 83

Reference Number	Description
1	Cap
2	Spring
3	Check
4	Spool
5	Bolt with Hole
6	Spring Guide
7	Spacer
8	Bolt with Hole
9	Spring
10	Shim
11	Cover

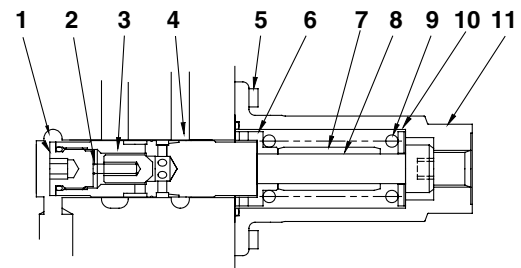


Figure 84

FG003199-1

1. Remove allen head bolts (5) and Cover (11).

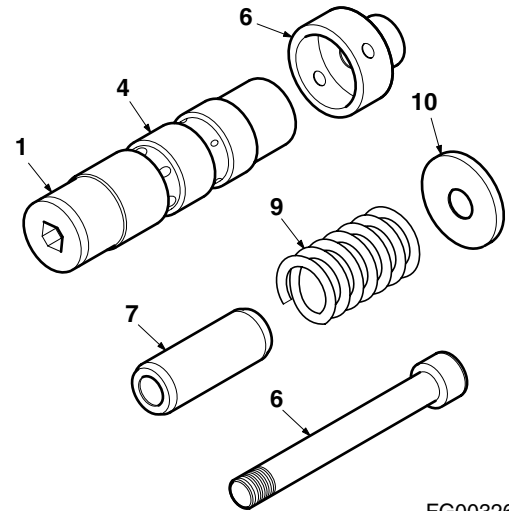
Lower Cap Hex Hole (1)	5 mm
Tightening Torque	1.2 kg•m (9 ft lb)

IMPORTANT

When assembling AP spool, inspect O-rings and backup rings for any damage and replace as necessary.

2. Side out spool assembly and using the tool described above, clamp and hold the spool assembly in space. Remove bolt with hole (8).

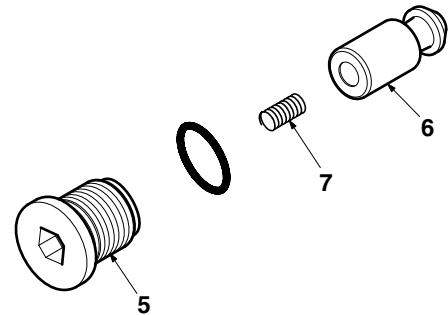
Lower Cap Hex Hole (1)	6 mm
Tightening Torque	3 kg•m (22 ft lb)



FG003263

Figure 85

3. Using the tool described above, clamp and hold the spool (4) in place. Remove cap (5), spring (6), and check (7).



FG003264

Figure 86

Boom Unity Check Valve

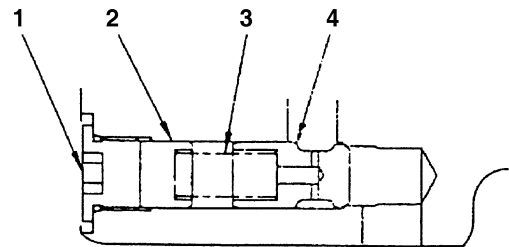
IMPORTANT

When disassembling Boom Unity Check Valve, tag and label each component so all parts can be reassembled in the proper order.

IMPORTANT

When assembling components, inspect O-rings for any damage and replace as necessary.

Reference Number	Description
1	Cap
2	Stopper
3	Spring
4	Check

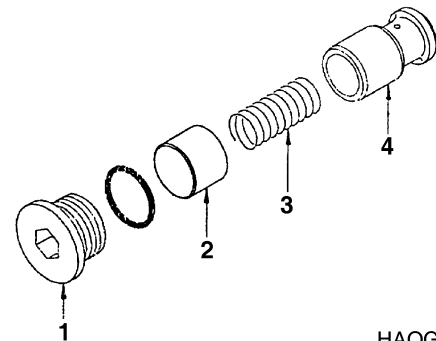


HAOG930P

Figure 87

1. Loosen cap (1), remove stopper (2), spring (3) and check (4).

Cap Wrench Size	8.0 mm
Tightening Torque	10 kg•m (72 ft lb)

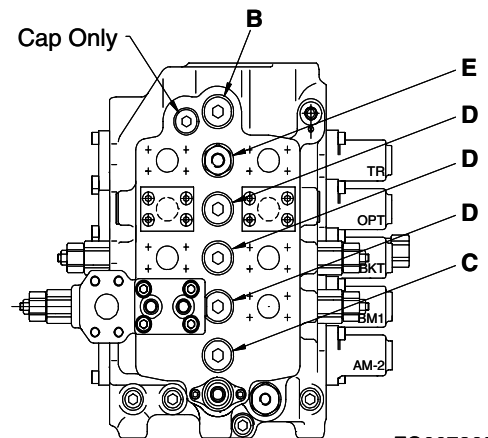


HAOG940P

Figure 88

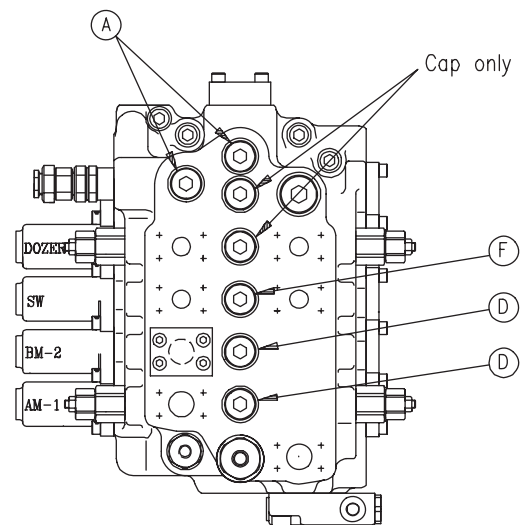
Check Valve - Locations

Valve Location Reference	Description
A	Main Relief Valve
B	P2
C	AM-2
D	OPT, BKT, BM-1, BM-2, AM-1
E	TL
F	SW



FG007269

Figure 89



HAAA766C

Figure 90

Check Valve

IMPORTANT

When disassembling Check Valves, tag and label each component so all parts can be reassembled in the proper order.

A: Check Valve (Main Relief Valve)

Reference Number	Description
1	Cap
2	Spring
3	Check

Cap Wrench Size	12 mm
Tightening Torque	10 kg•m (72 ft lb)

1. Loosen cap (1), remove spring (2) and check (3).

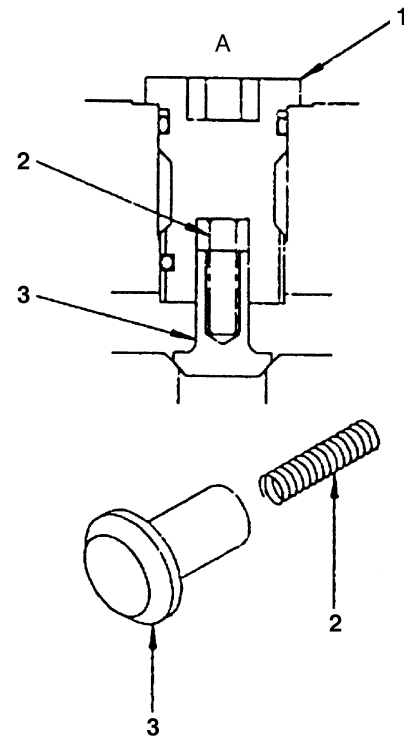


Figure 91

HAOH030P

B: Check Valve (P2)

Reference Number	Description
1	Cap
2	Spring
3	Check

Cap Wrench Size	12 mm
Tightening Torque	20 kg•m (145 ft lb)

1. Loosen cap (1), remove spring (2) and check (3).

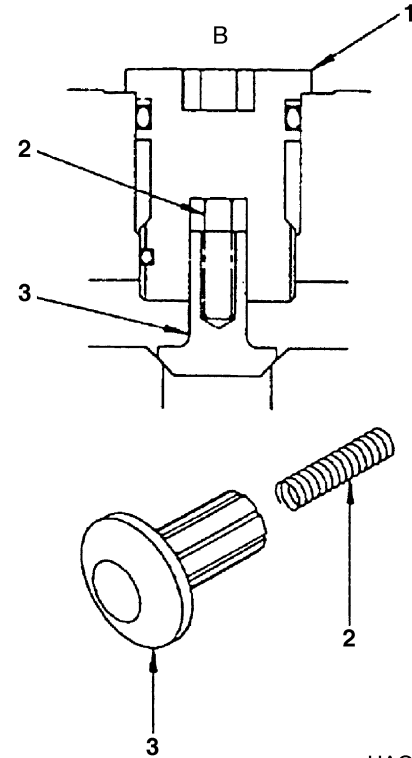


Figure 92

HAOH040P

C: Check Valve [AM-2]

Reference Number	Description
1	Cap
2	Spring
3	Check

Cap Wrench Size	12 mm
Tightening Torque	20 kg•m (145 ft lb)

1. Loosen cap (1), remove spring (2) and check (3).

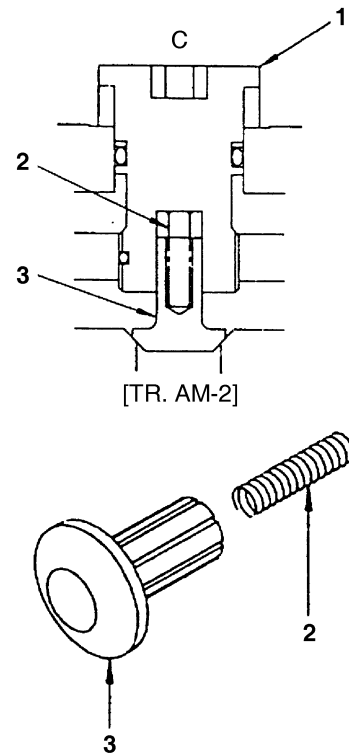


Figure 93

HAOH080P

D: Check Valve [OPT, BKT, BM-1, BM-2, AM-1]

IMPORTANT

Even though the valve caps look the same, they are different, and cannot be interchanged.

Reference Number	Description
1	Cap
2	Spring
3	Check

Cap Wrench Size	12 mm
Tightening Torque	20 kg•m (145 ft lb)

1. Loosen cap (1), remove spring (2) and check (3).

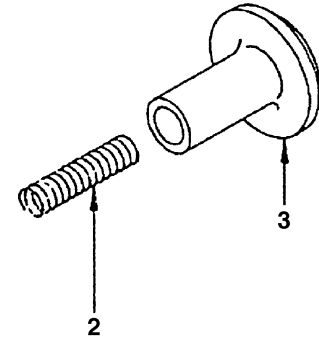
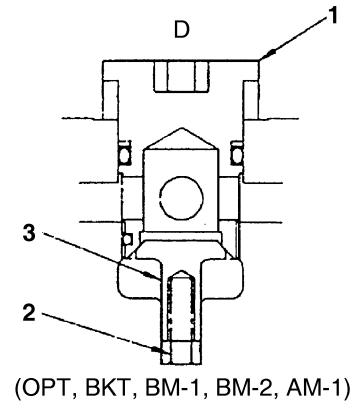


Figure 94

HAOH071P

E: Check Valve [TL]

Reference Number	Description
1	Cap
2	Backup Ring
3	O-ring

Cap Wrench Size	36 mm
Tightening Torque	10 kg•m (72 ft lb)

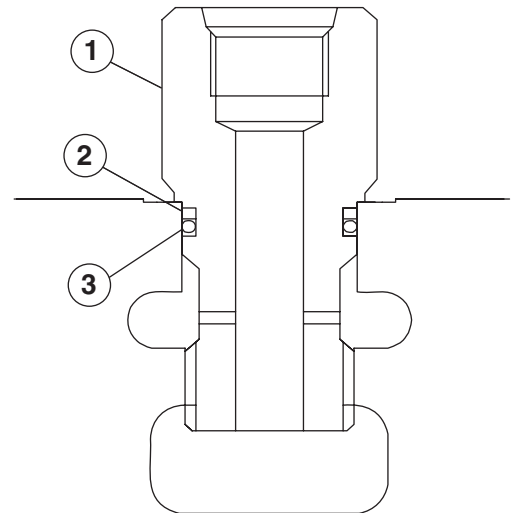


Figure 95

HAAA795C

F: Check Valve [SW]

IMPORTANT

Even though the valve caps look the same, they are different, and cannot be interchanged.

Reference Number	Description
1	Cap
2	Spring
3	Check

Cap Wrench Size	12 mm
Tightening Torque	20 kg•m (145 ft lb)

1. Loosen cap (1), remove spring (2) and check (3).

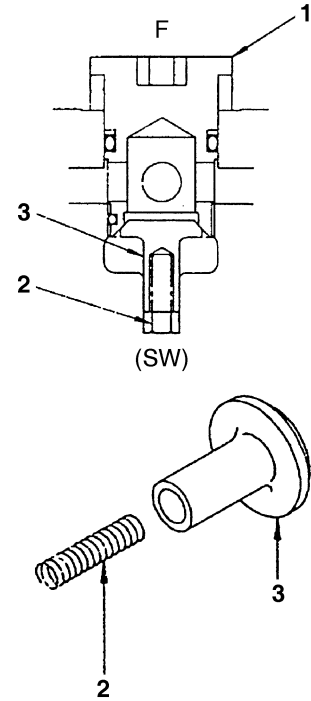


Figure 96

HAOH073P

Swing Motor

Edition 1

MEMO

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

INSTRUCTION MANUAL

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.

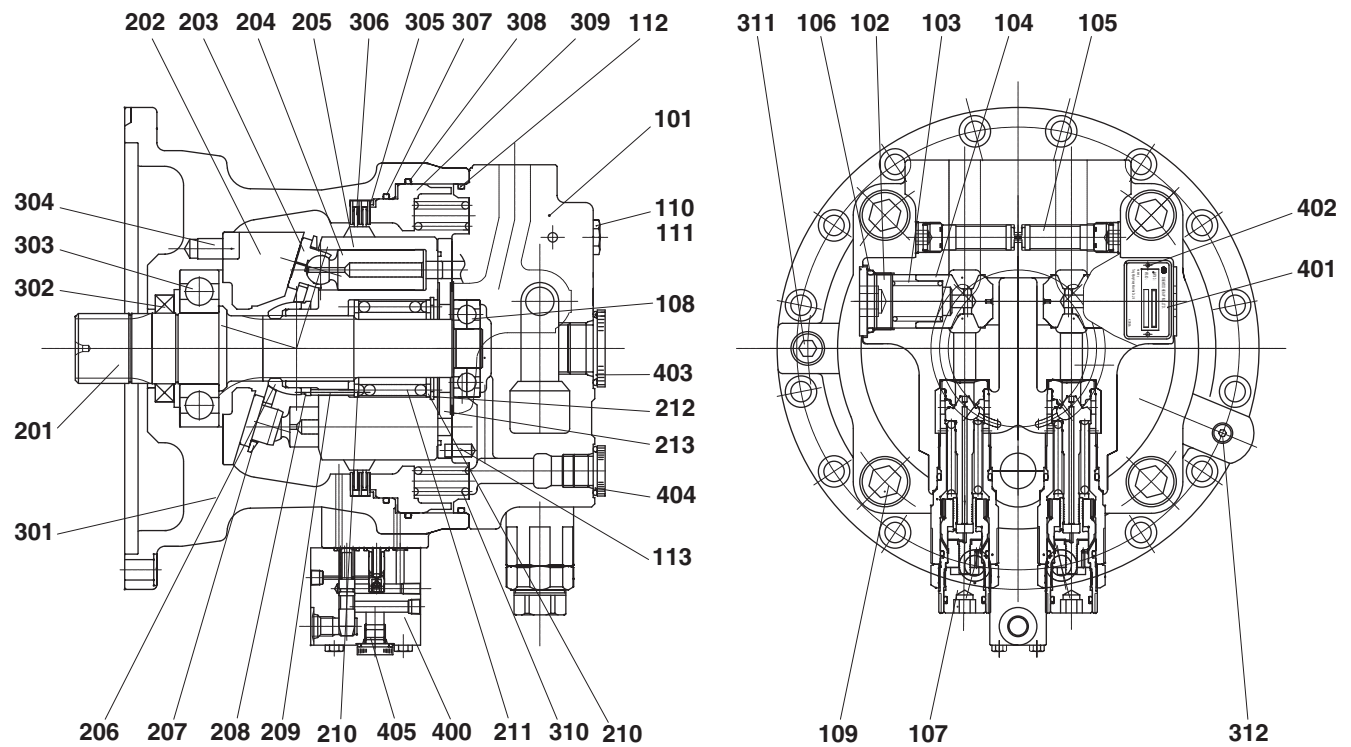
NOTE: TSM86 series can be applied from 64cc/rev to 86cc/rev by the change of displacement.

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



FG001843

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 Assembly
106	O-ring
107	Relief Valve
108	Ball Bearing
109	Socket Bolt
110	Vp Plug
111	O-ring
112	O-ring
113	Pin Spring
201	Driveshaft
202	Swash Plate
203	Shoe
204	Piston
205	Cylinder Block
206	Thrust Ball
207	Retainer Plate

Reference Number	Description
208	Collar
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 toward a higher position on the shoe plate.

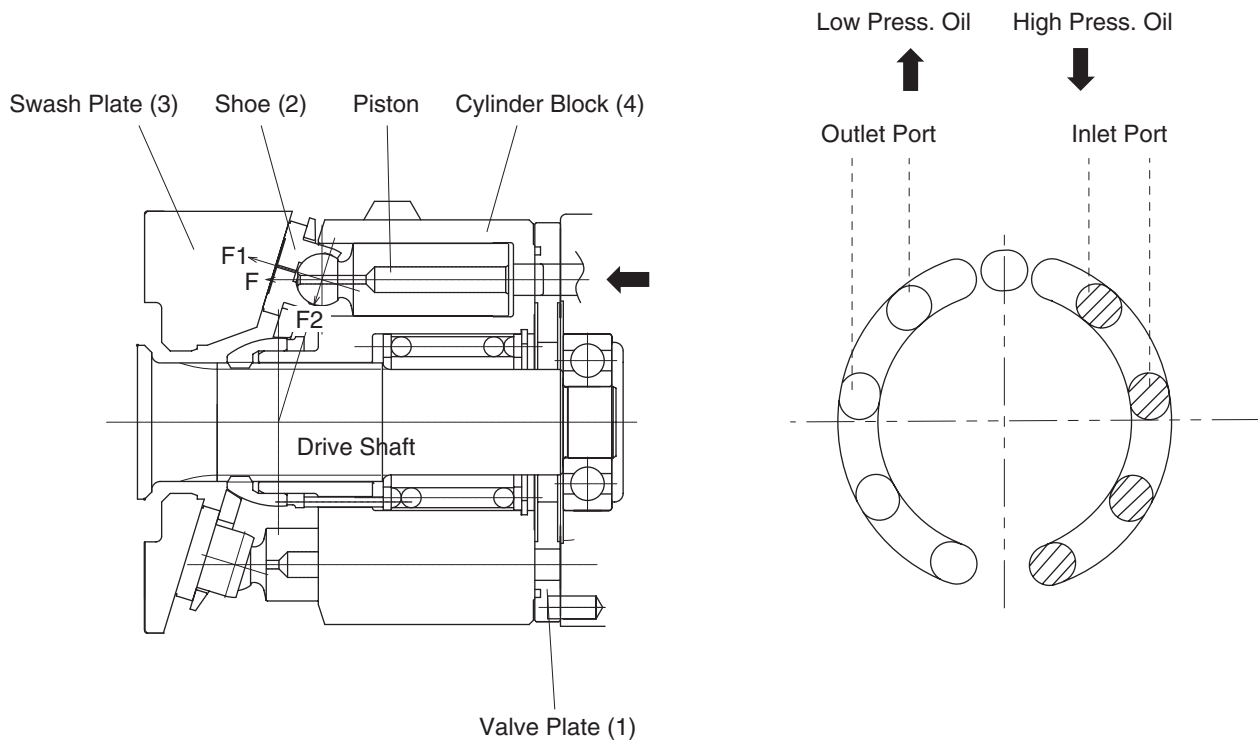
A small amount of supply oil flows through the center of each piston to lubricate the piston ball joint and the piston shoe face. The motor is internally lubricated from leakage inside the motor.

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

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

p: Effective Pressure (kg•cm²)

q: Displacement (cc/rev)



FG007419

Figure 2 Diagram Showing the Working Explanation

Valve Casing Part

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 anticavitation check valve.

2. Relief Valve: KRD22EK10C (See Figure 4 on page -12)

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.

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

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

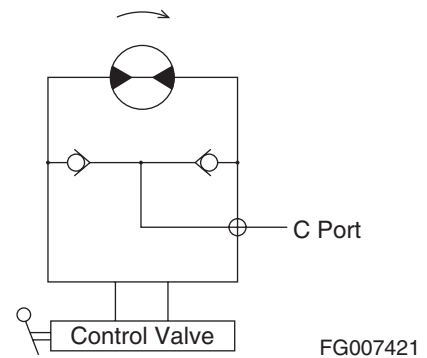
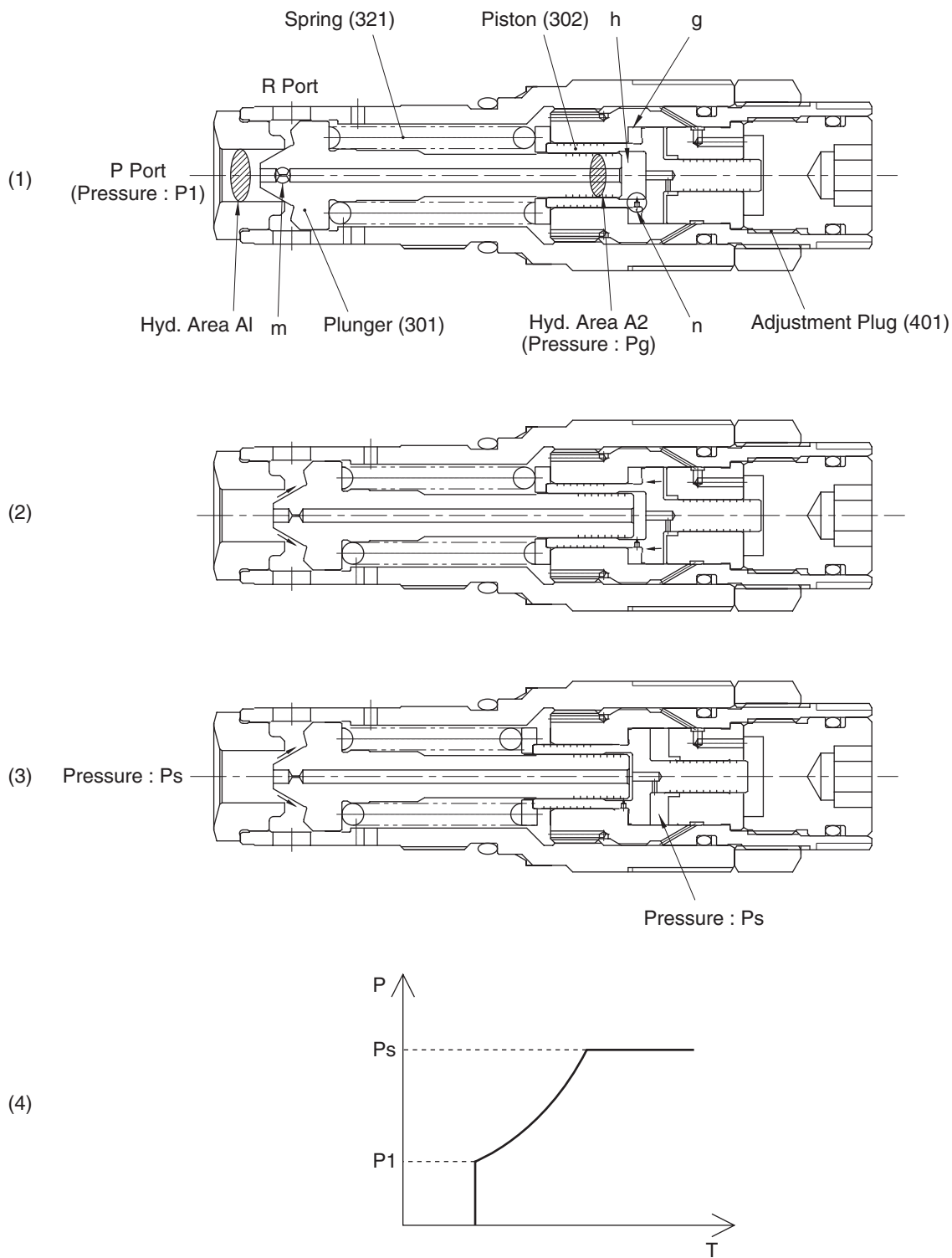


Figure 3



FG007422

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. Now, 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.

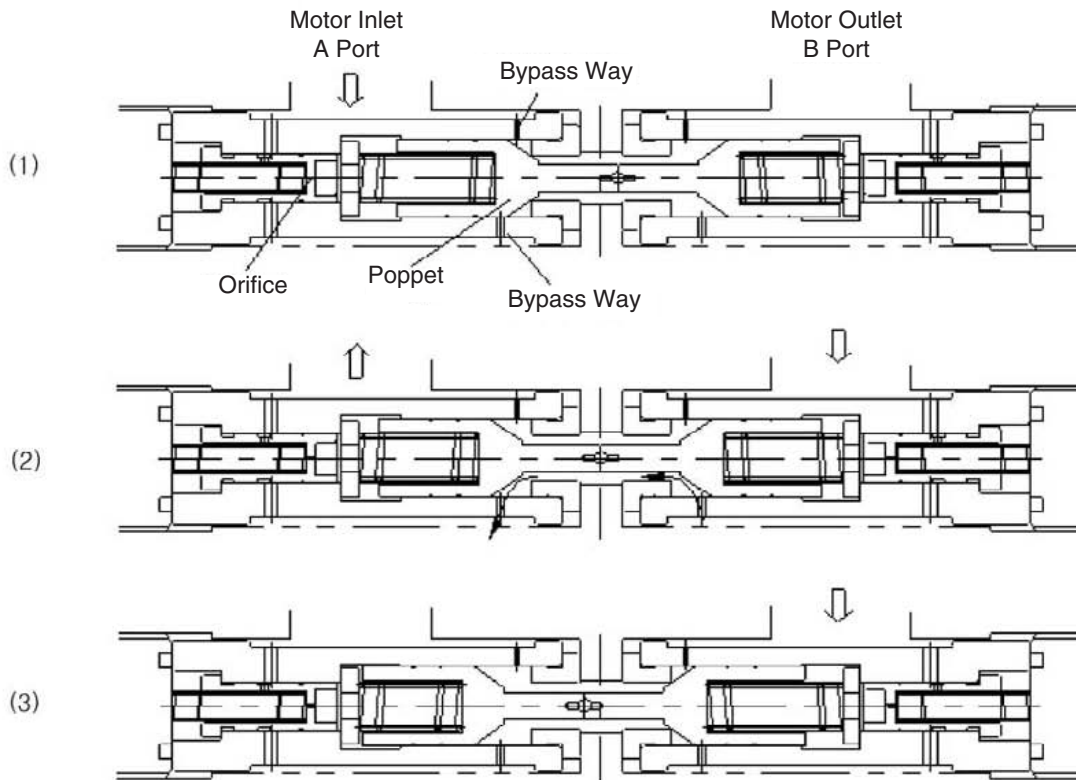
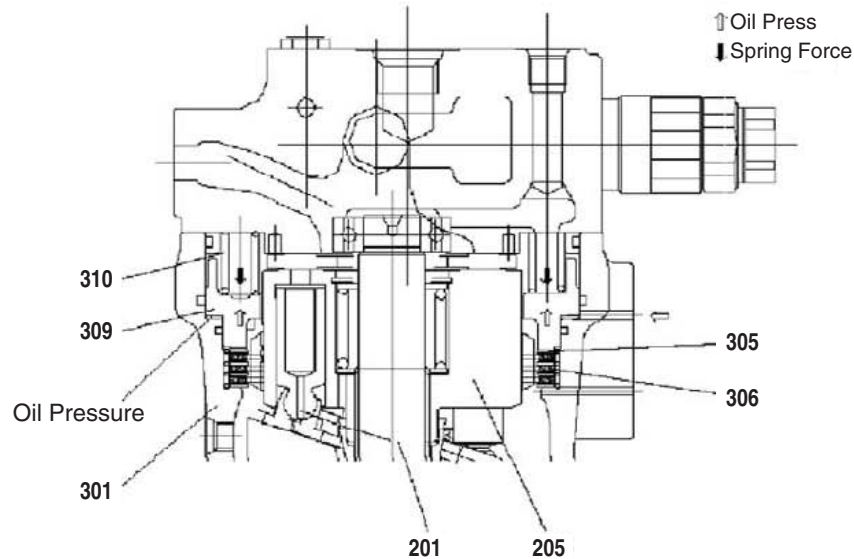


Figure 5 Swing Reactionless Valve Working Description

FG007423

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.

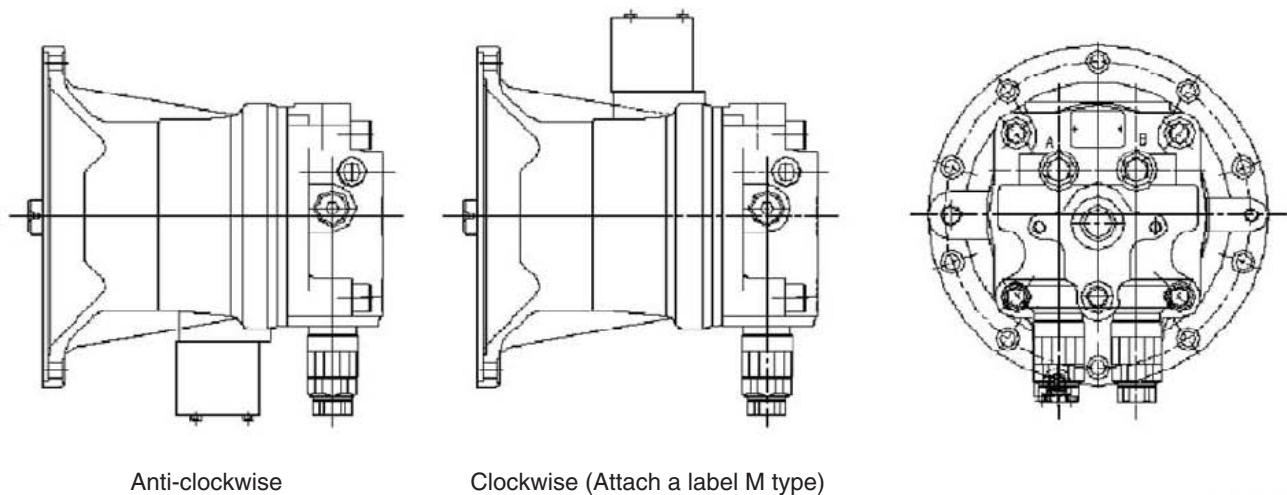
1. Inspect whether or not there is any damage during transit, or if any parts are lost missing.
2. Inspect each tightened part is loosened or not.
3. Check whether or not covers for flange surface and drain port are perfect, and the inside of the motor is dirty with intruded dust.

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.



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 antifoaming 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.

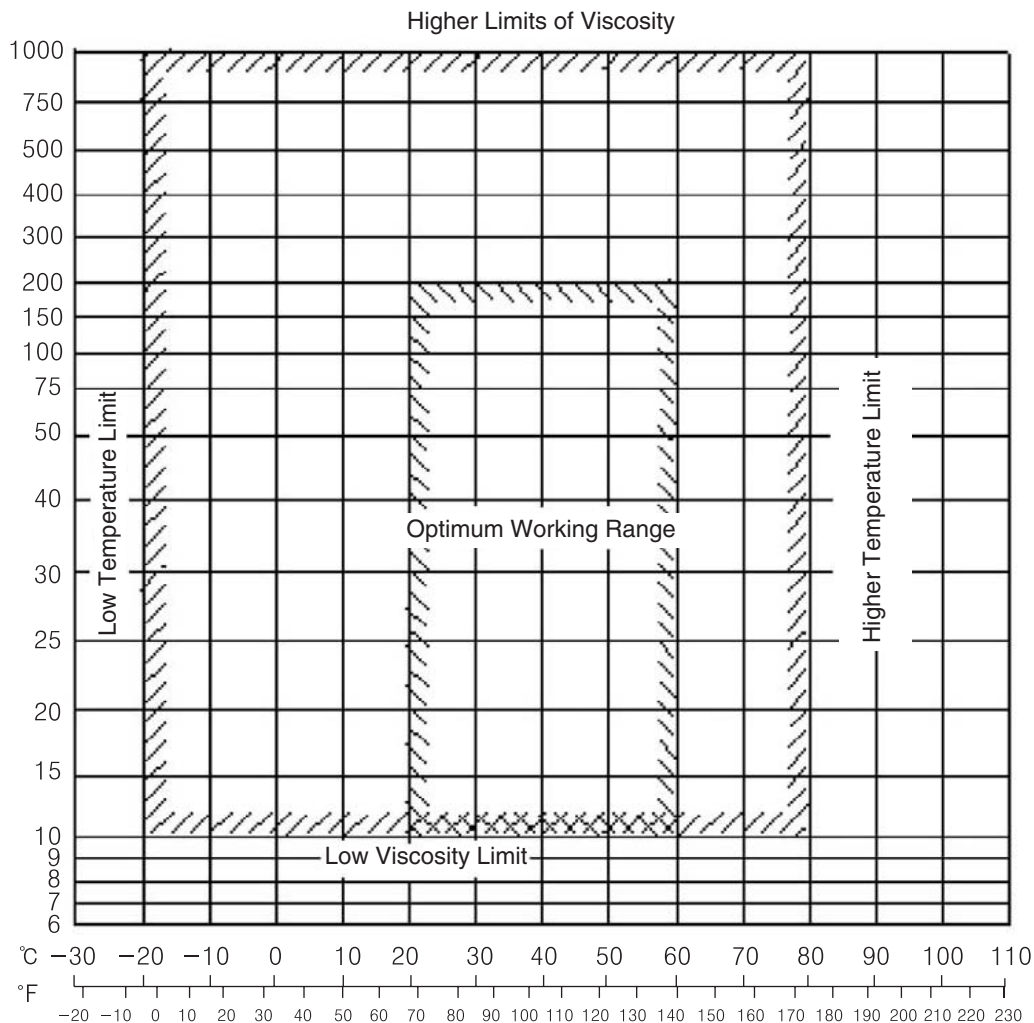


Figure 8 The Proper Range of Viscosity and Temperature

FG007426

3. Except Mineral Oil

In case if using special fluid (phosphate ester compounds, water-glycol, fluid fatty 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 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 10 μ 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•cm², but for common pressure, 2 kg•cm² 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.

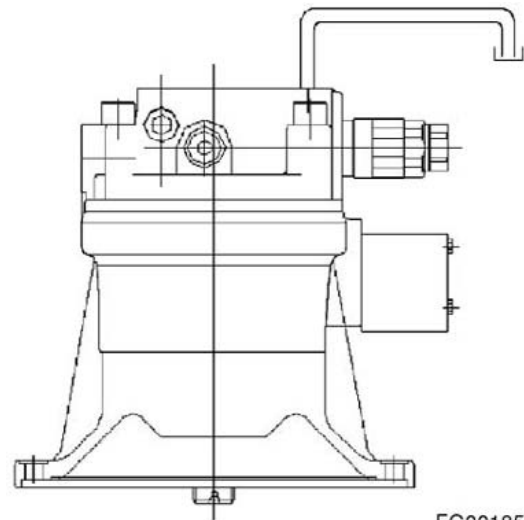


Figure 9

FG001853

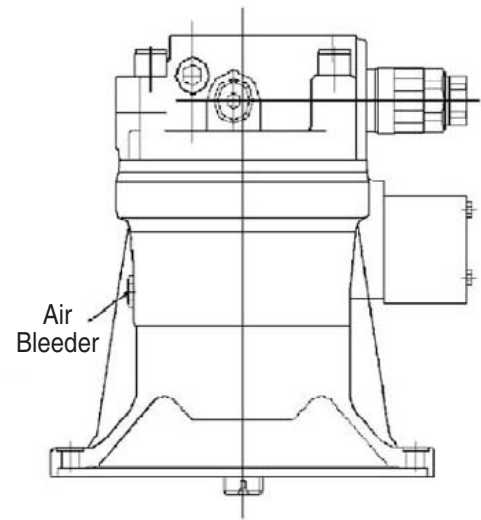


Figure 10

FG007427

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.

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 despite 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, countermeasures 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 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	- Setting pressure of relief valve is incorrect. - Working defectiveness of relief valve. - Plunger stick. - Close up an orifice hole of plunger. - Seat defectiveness of plunger.	- Reset the pressure to correct value. - Revise or exchange of stick face. - disassembly or cleaning. - Replace for damaged seat part.
The pressure of the circuit is increasing	- Overload. - Stick of motion portion. - The brake does not release. - Stick of brake piston. - Stick of friction plate.	- Load removes. - Do repair or inspect the piston/shoe, cylinder block, valve plate etc. - Do repair or inspect circuit - Check for the break valve. - Assembly and inspection. - Assembly and inspection. Replace for the stick parts.

2. The revolutionary direction is reverse

Condition	Cause	Remedy
The revolutionary direction is reverse	- The revolutionary direction of motor is reverse. - The inlet and outlet in piping is reversely connected.	- Reassemble them after disassembling. - 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	- The volume of flowing is not sufficient. - The temperature is too high and too much oil is leaking. - Valves/pistons/rings etc. are worn away and broken.	- Check discharge volume of pump and circuit up to the motor. - Reduce the oil temperature. - Replace it.

4. Brake torque is not sufficient.

Condition	Cause	Remedy
Brake torque is not sufficient	1. Friction plates are worn. 2. Brake piston is becoming stick. 3. Brake releasing pressure is not working. 4. Spline of friction plates are damaged.	1. Disassembly or inspection. When it is worn better than standard, replace it. 2. Disassembly or inspection 3. 1) Check for the circuit. 2) Check for the brake valve 4. Disassembly or inspection. 1) Replace for damaged parts.

5. Motor is much slip

Investigates the DRAIN quantity for motor.

Normal: application 200cc/min (TSM140:500cc/min)

Condition	Cause	Remedy
Motor is slipping to much.	1. Working defectiveness of relief valve is the same 1) an item. 2. Seat defectiveness of plunger.	1. It is the same 1) an item 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. 2. The shaft may be damaged or worn out. 3. The lib is damaged too high-pressure in the casing. 4. The shaft is rusty.	1. Replace the oil seal. 2. Replace the driving shaft or defective centering of the driving shaft. 3. It repairs the drain piping which is closed up. 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. 2. O-ring is broken. 3. Seal face is defective. 4. The bolt is loose or not tightened.	1. Insert O-ring. 2. Replace it. 3. Disassemble or repair. 4. Tighten adequately or replace it.

MAINTENANCE MANUAL

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

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

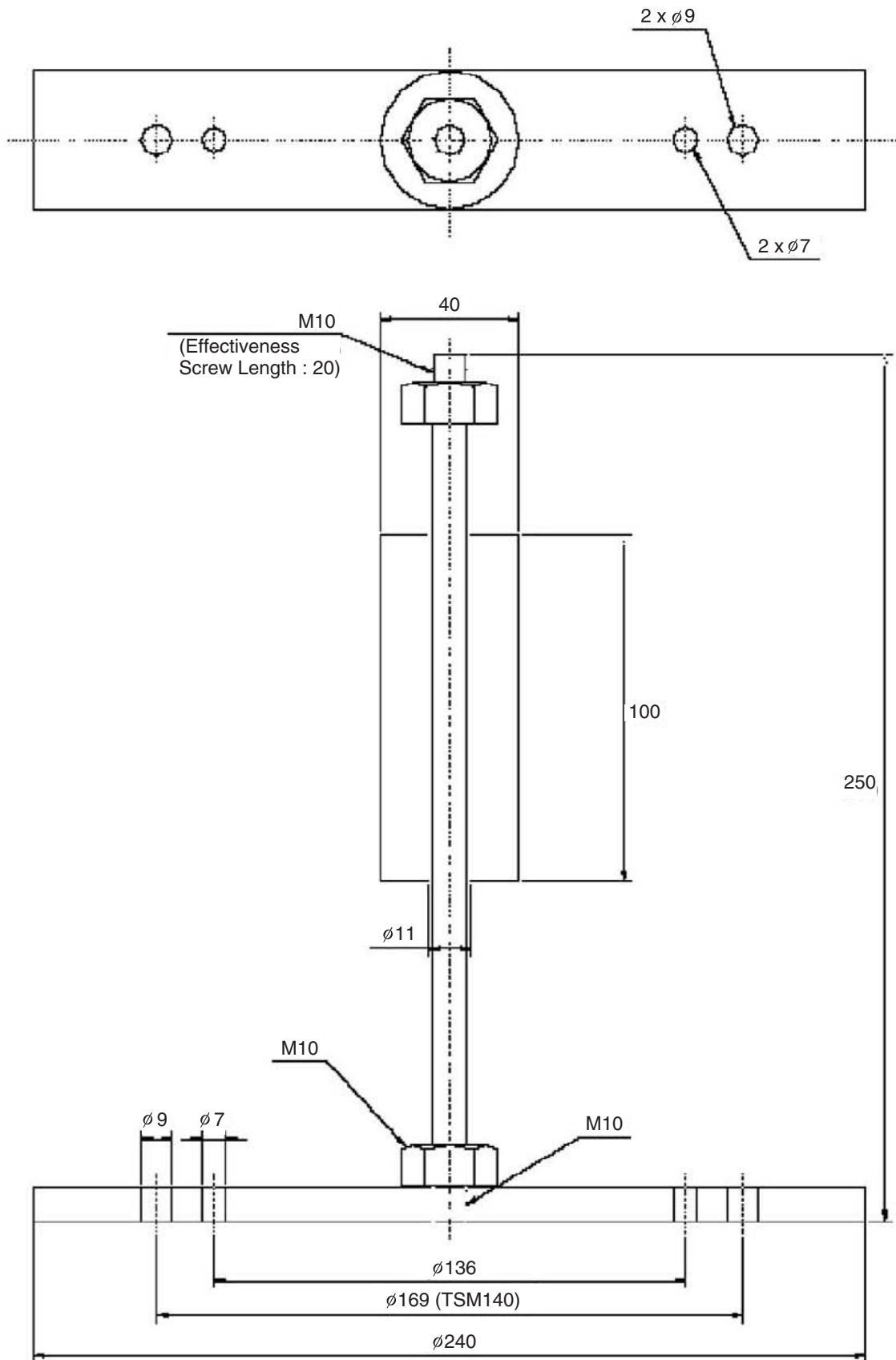
In table 2, 3 Figure 11. is shown necessary tools for disassembling and reassembling.

Table 2

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.

Tool	Spec.	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 • For 100 - 450 kg•cm • For 400 - 1,800 kg•cm • For 1,200 - 4,800 kg•cm
Slide hammer bearing pliers		
Special tool for removing the break piston		25page reference



FG007428

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.

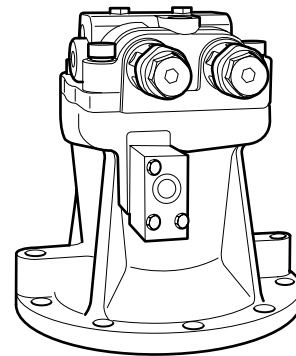
Numerals given in parentheses following the parts names indicate the parts number shown by the drawing in the instruction and maintenance manual.

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.

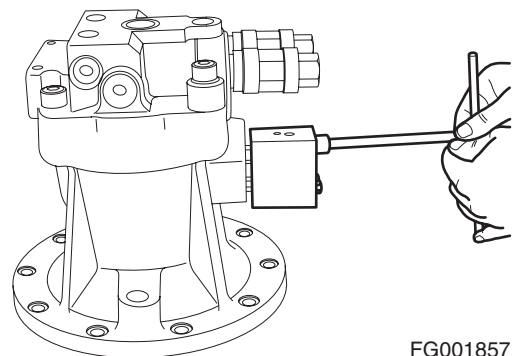
Before disassembling make a match mark on motor casing (301) and valve casing (101).



FG001856

Figure 12

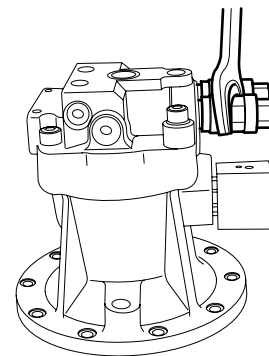
4. Remove brake valve (400).



FG001857

Figure 13

5. Remove relief valve (107) from valve casing (101).



FG001858

Figure 14

6. Remove RO plug (102) and remove spring (103) and plunger (104) from valve casing (101).

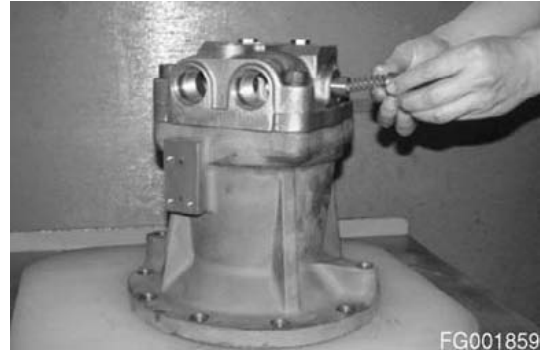


Figure 15

7. Remove swing reactionless valve assembly (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).

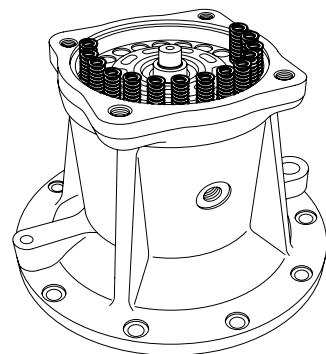


Figure 18

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, remove cylinder block (205) from casing (301).

Remove piston assembly (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.

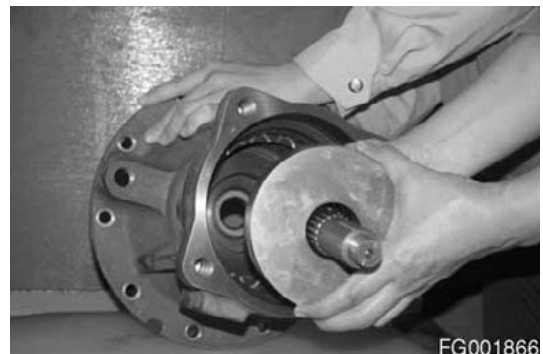


Figure 22

14. Do next step if required.

A. Remove parallel pin (304) from casing (301).

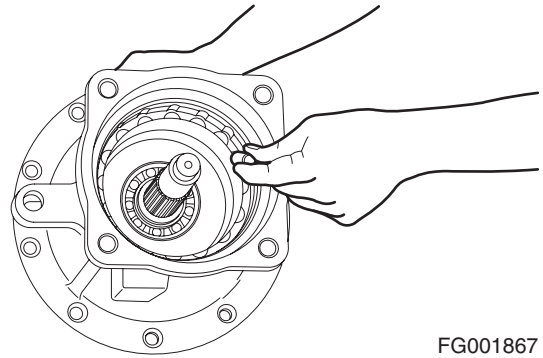


Figure 23

FG001867

B. Remove ball bearing (303) with a press from the driveshaft (201).

Strike the rod lightly and do not reuse the disassembling bearing.

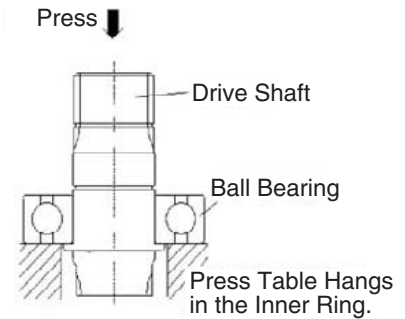


Figure 24

FG00742

C. Remove oil seal (302) from the casing (301) with a using of tool.

Do not reuse the disassembling oil seal (302).

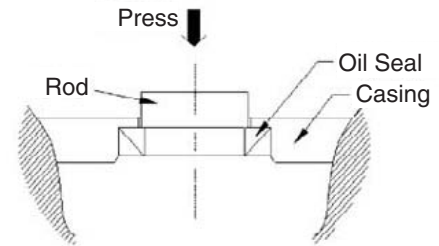


Figure 25

FG007430

D. Remove ball bearing from the valve casing (303).

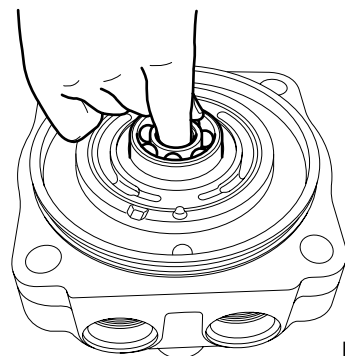


Figure 26

FG001870

15. Disassembling is finished, check each component thoroughly.

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.

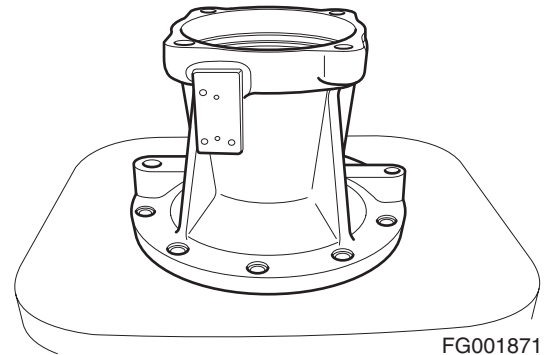


Figure 27

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.)

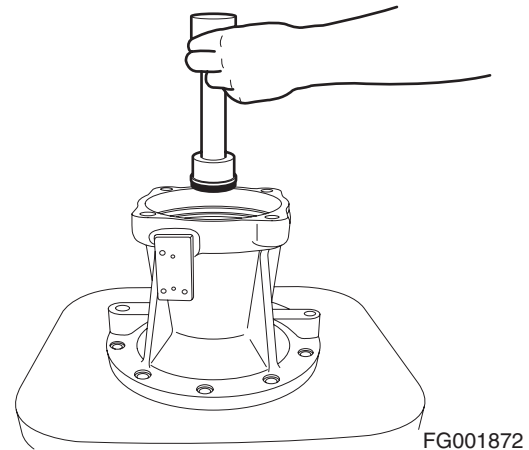


Figure 28

3. (It is necessary when ball bearing was disassembled from the driveshaft.)
Ball bearing (303) is press fit by the heat to driveshaft (201).

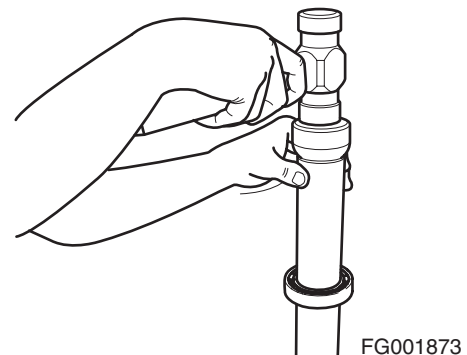


Figure 29

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).

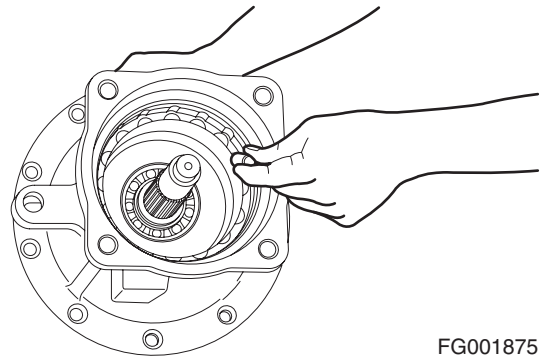


Figure 31

6. Assemble swash plate (202) to casing (301).

If casing is horizontal position from the bottom, It is easy to work.

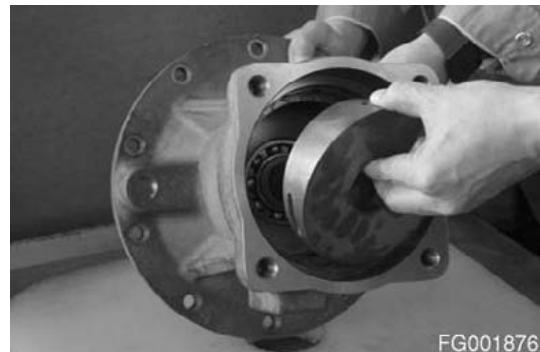


Figure 32

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).

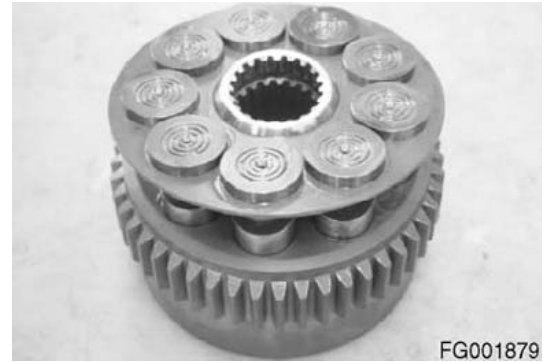


Figure 35

10. Insert cylinder block to driveshaft (101) aligning the spline.

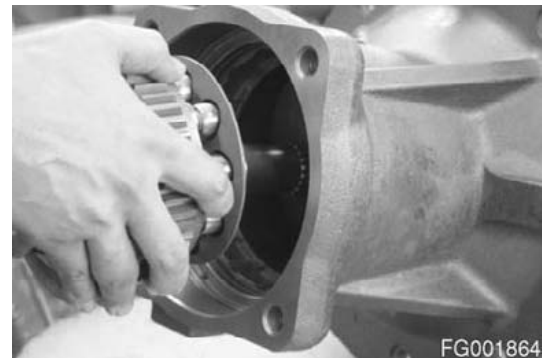


Figure 36

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)

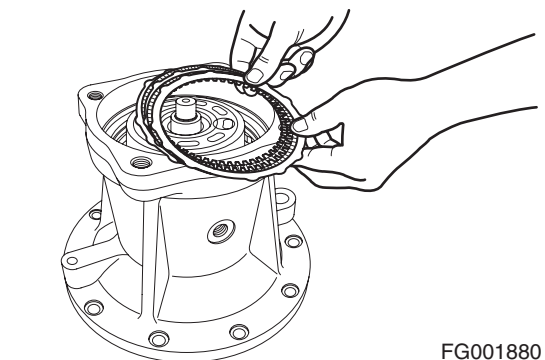


Figure 37

12. Mount O-ring (307, 308) to casing (301).

(Coat the O-rings with grease. O-ring can be protected by grease.)

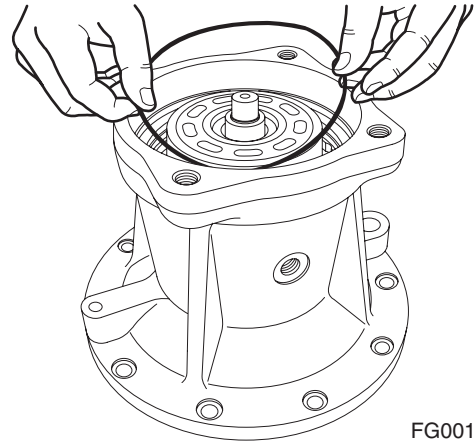


Figure 38

FG001881

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.

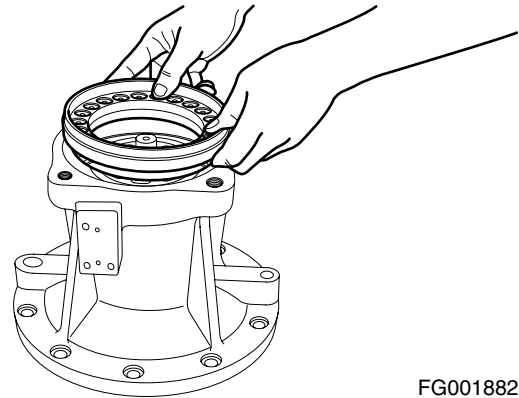


Figure 39

FG001882

14. Assemble brake springs (310) into brake piston (309).

Confirm the springs are fitted to the brake piston completely.

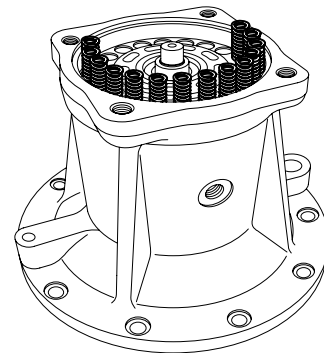


Figure 40

FG001862

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.

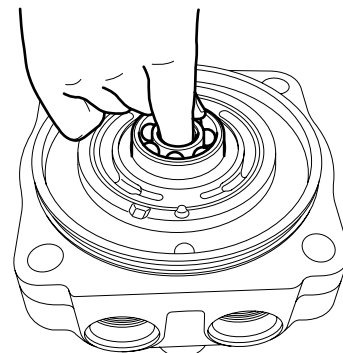


Figure 41

FG001884

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 assembly (105) to valve casing (101).

Confirm the spring in the swing reactionless valve assembly (105).



Figure 45

20. Assemble relief valve (107) with O-ring to valve casing (101).

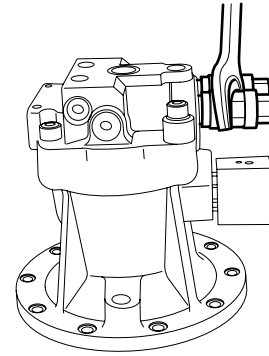


Figure 46

FG001858

21. Assemble brake valve (400) to casing (301) and tightening the hex socket bolts to specified torque.

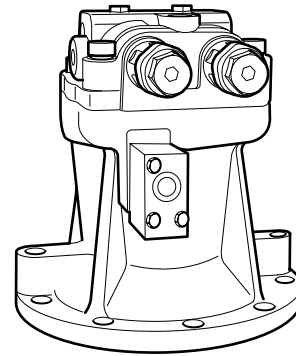


Figure 47

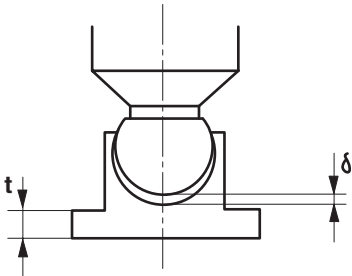
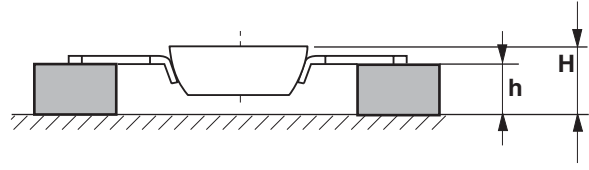
FG001856

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 spherical 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

Travel Motor

Edition 1

MEMO

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX190W	5001 and Up
DX210W	5001 and Up

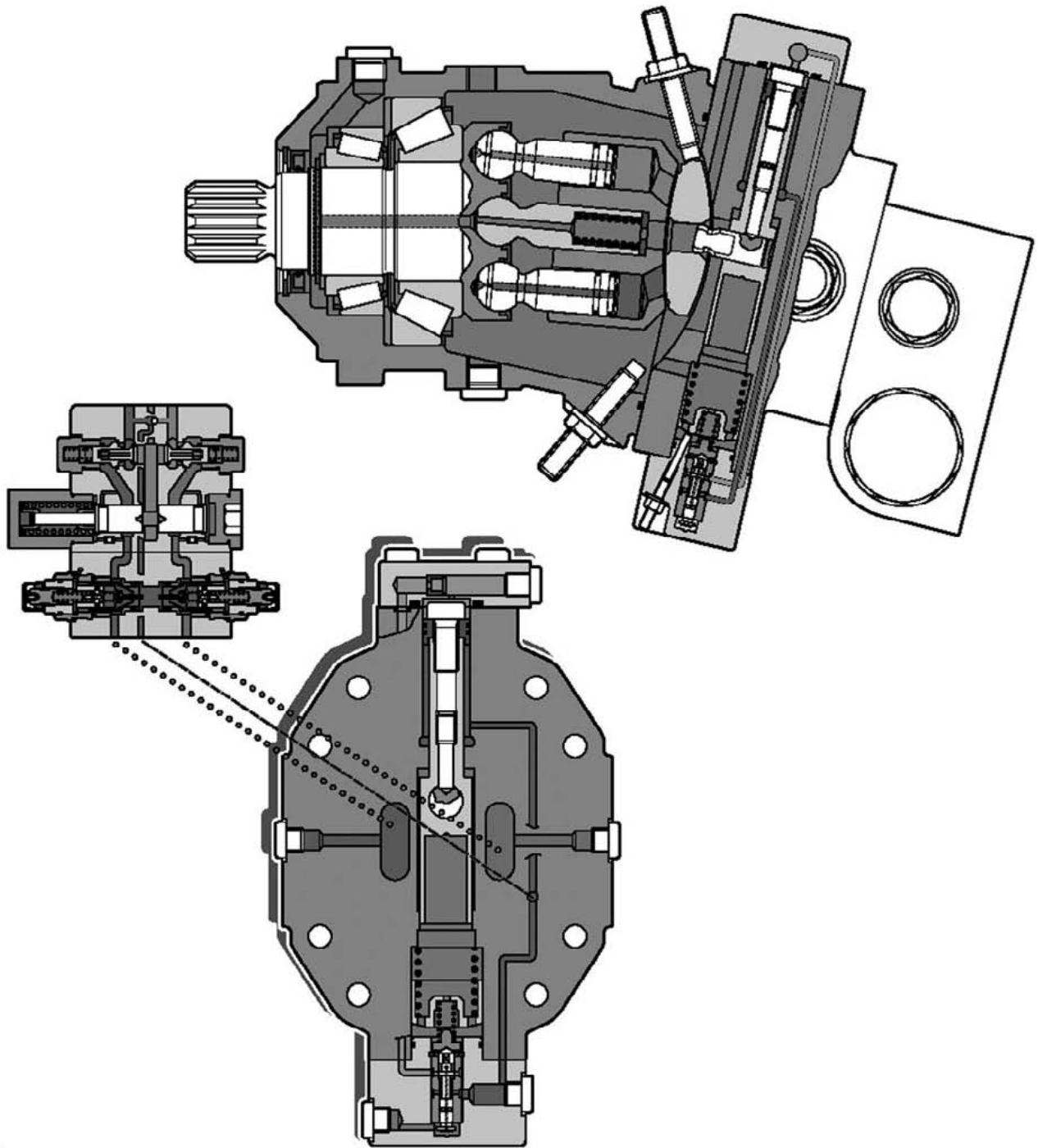


Figure 1

FG002964

GENERAL REPAIR GUIDELINES

CAUTION!

Observe the following notices when carrying out repair work at hydraulic aggregates.

1. Close all ports of the hydraulic aggregates.



Figure 2

HB7M3002

2. Replace all seals.
Use only original Hydromatik spare parts.

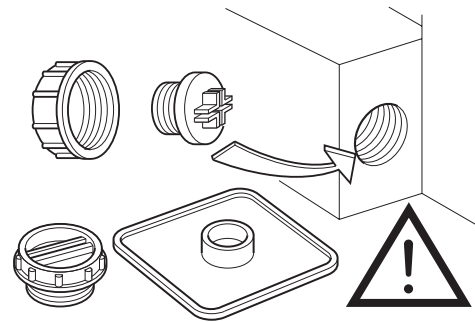


Figure 3

HB7M3003

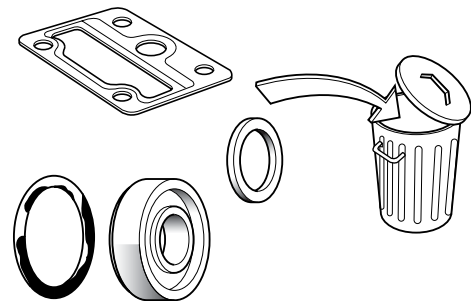


Figure 4

HB7M3004

3. Check all seal and sliding surfaces for wear.

CAUTION!

Rework of sealing area f. ex. with abrasive paper can damage surface.

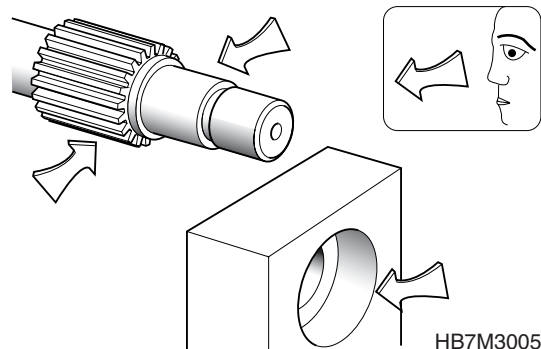


Figure 5

HB7M3005

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

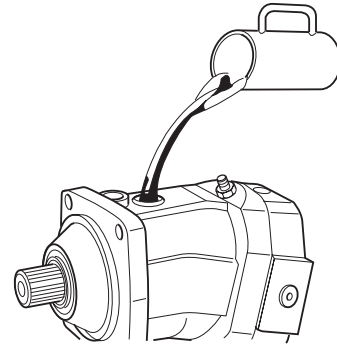


Figure 6

HB7M3006

SEAL KITS AND SUBASSEMBLIES

1. Seal Kit for Driveshaft.

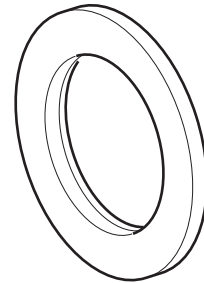


Figure 7

HB7M3007

2. External Seal Kit

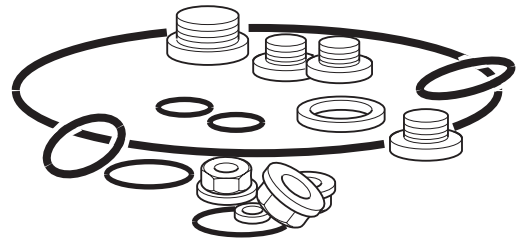


Figure 8

HB7M3008

3. Housing

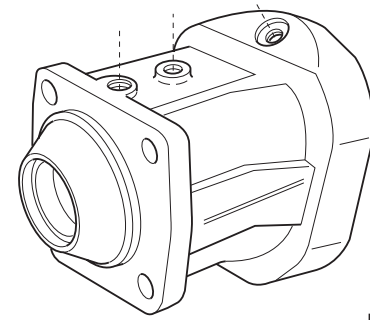


Figure 9

HB7M3009

4. Complete Rotary Group

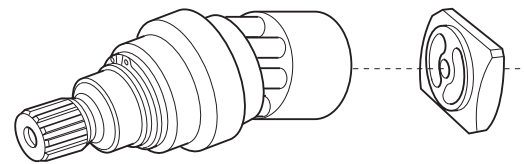


Figure 10

HB7M3010

5. Port Plate with Control Piston

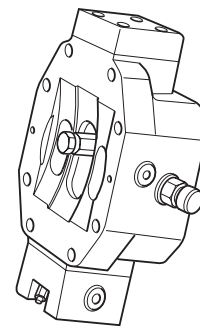


Figure 11

HB7M3011

6. Counterbalance Valve

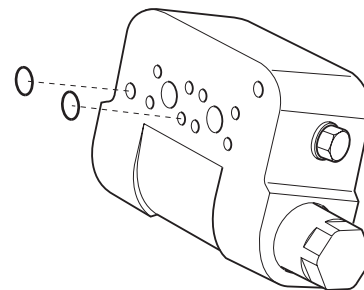
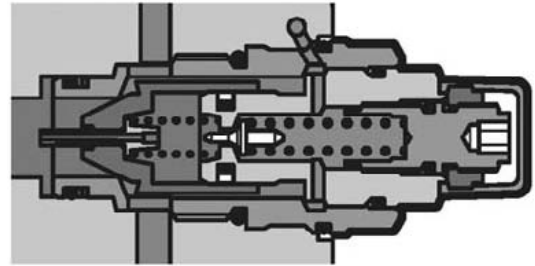


Figure 12

HB7M3012

7. Relief Valve / Make up Check Valve



FG002976

Figure 13

Replace Seal Nut

1. Replace seal nut.
First measure and record setting height.

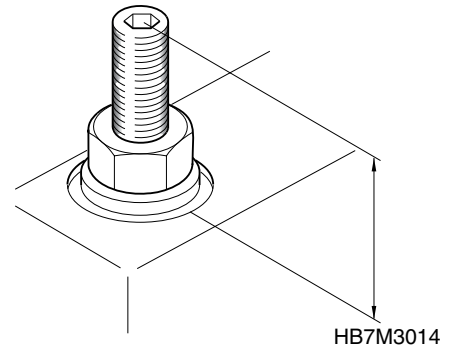


Figure 14

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

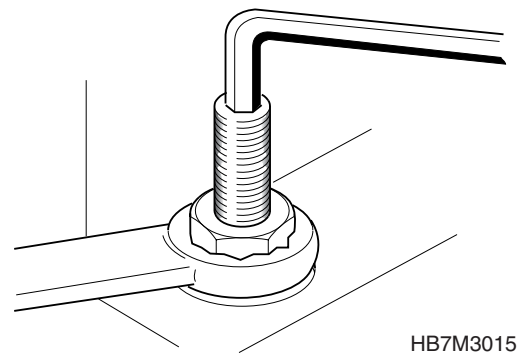
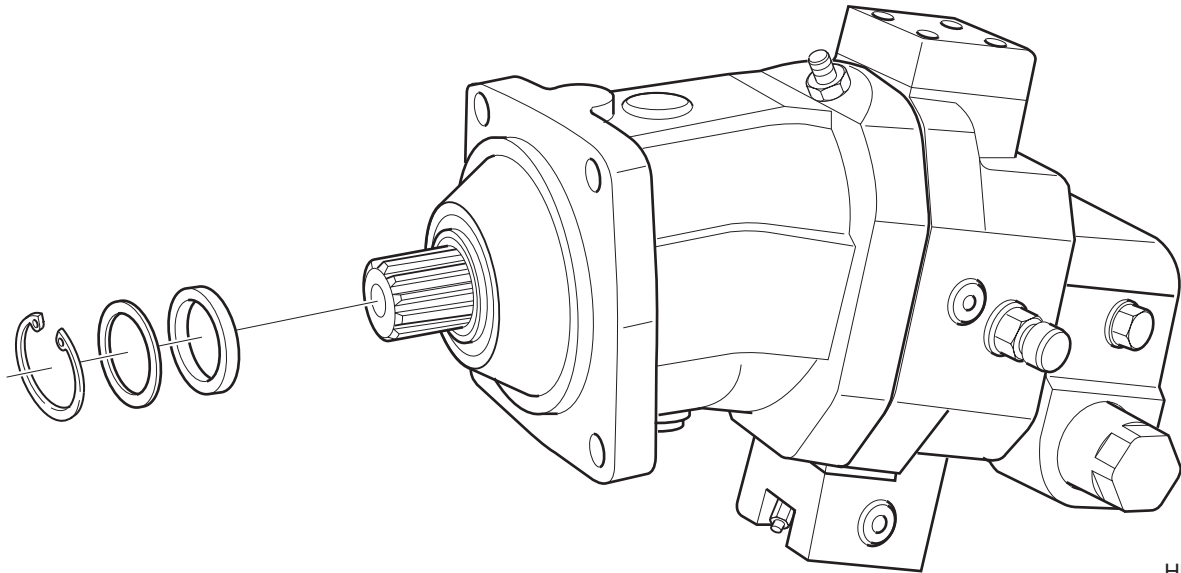


Figure 15

DISASSEMBLY

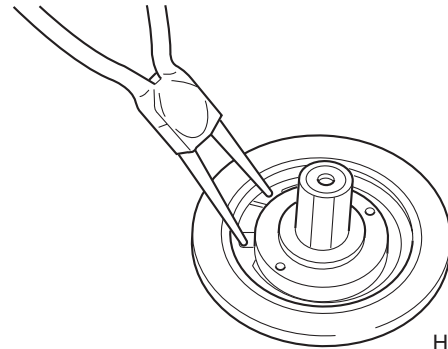
Sealing the Driveshaft



HB7M3016

Figure 16

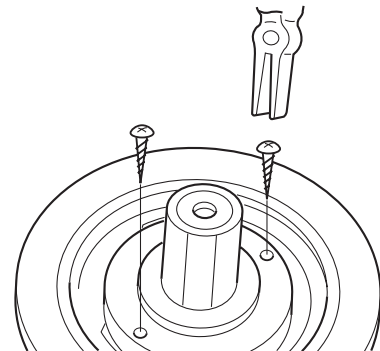
1. Protecting the driveshaft.
Remove retaining ring and shim.



HB7M3017

Figure 17

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



HB7M3018

Figure 18

3. Press in shaft seal and shim with bushing to stop.

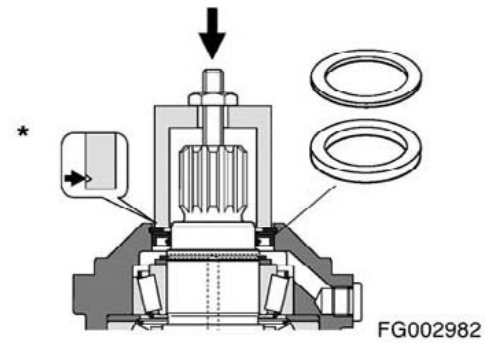
! CAUTION!

Pay attention to pressing depth

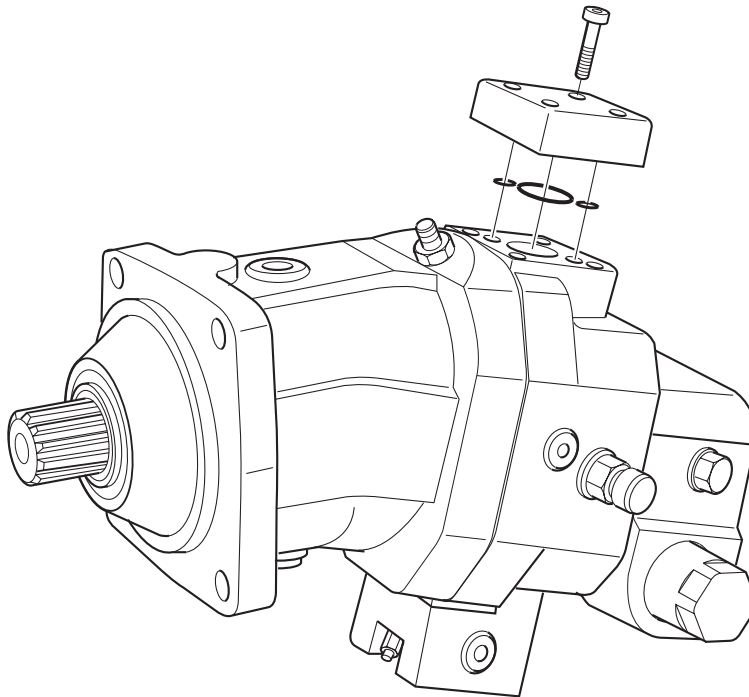
! CAUTION!

Mark for pressing depth.

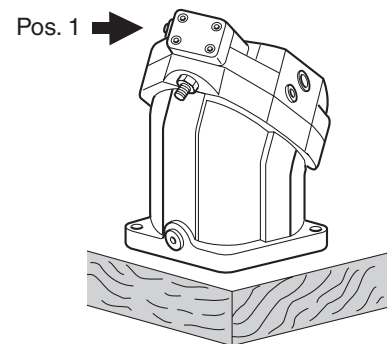
Assemble retaining ring.



Seal of the Control Parts



4. Disassembly position:
Remove cover pos. 1



Reference Number	Description
1	O-ring
2	Input Flow of Oil Control
3	Throttle Pin



Installation position differs according to the control components

Reference Number	Description
1	Input Flow of Oil Control
2	High-pressure / Low-pressure
3	High-pressure / Low-pressure
4	Leakage Oil
5	Control Piston

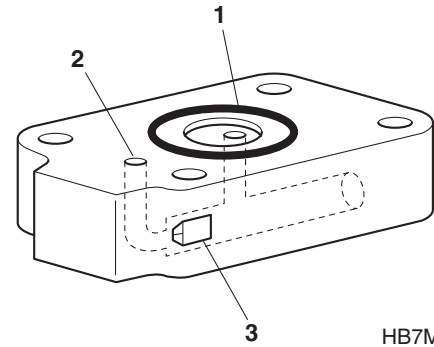


Figure 22

HB7M3022

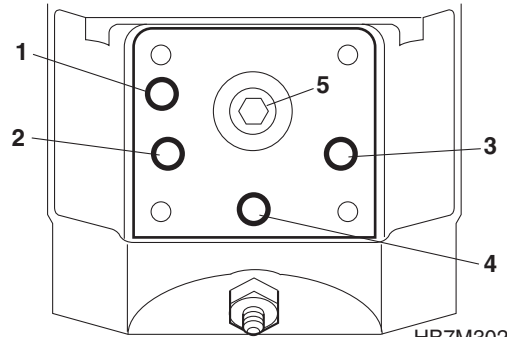


Figure 23

HB7M3023

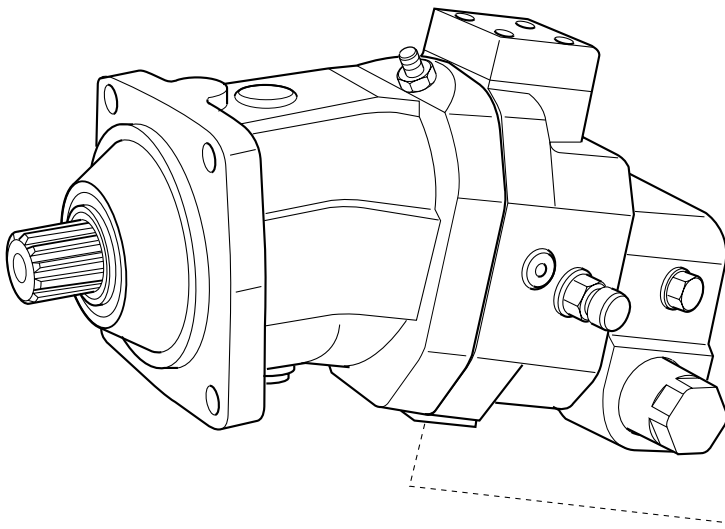
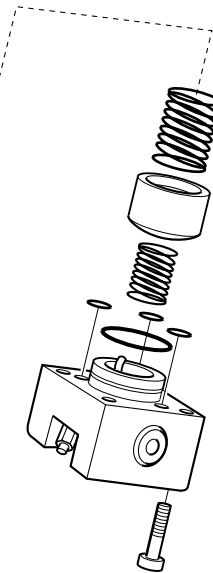


Figure 24



HB7M3024

5. Disassembly position: Remove cover pos. 2.



Attention! Spring load.

Dimension x : Note dimension (begin of regulation).

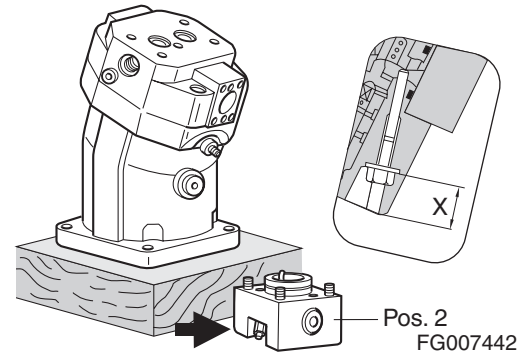
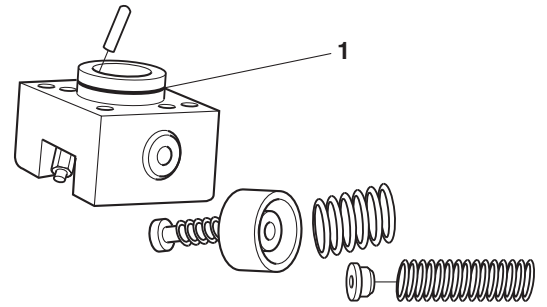


Figure 25

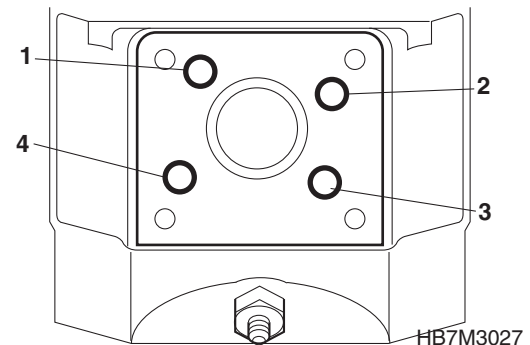
Reference Number	Description
1	Check of O-ring



HB7M3026

Figure 26

Reference Number	Description
1	O-ring / High-pressure - Small Control Piston Side
2	O-ring / Control Pressure
3	O-ring / High-pressure - Check Valve
4	O-ring / High-pressure - Check Valve

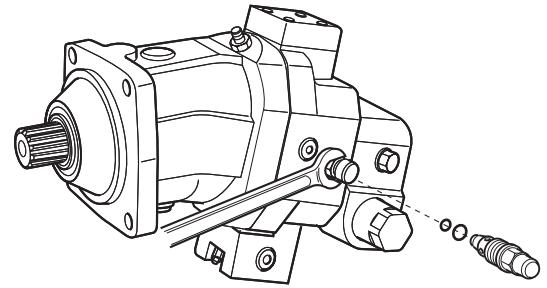


HB7M3027

Figure 27

Seal of the Relief Valve / Counterbalance Valve

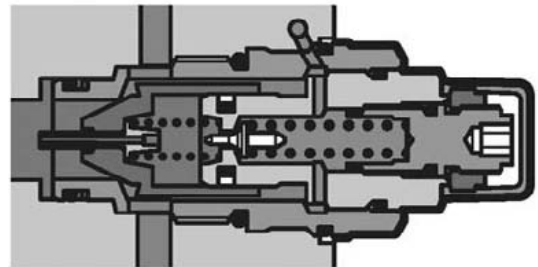
1. Remove relief valve.



HB7M3028

Figure 28

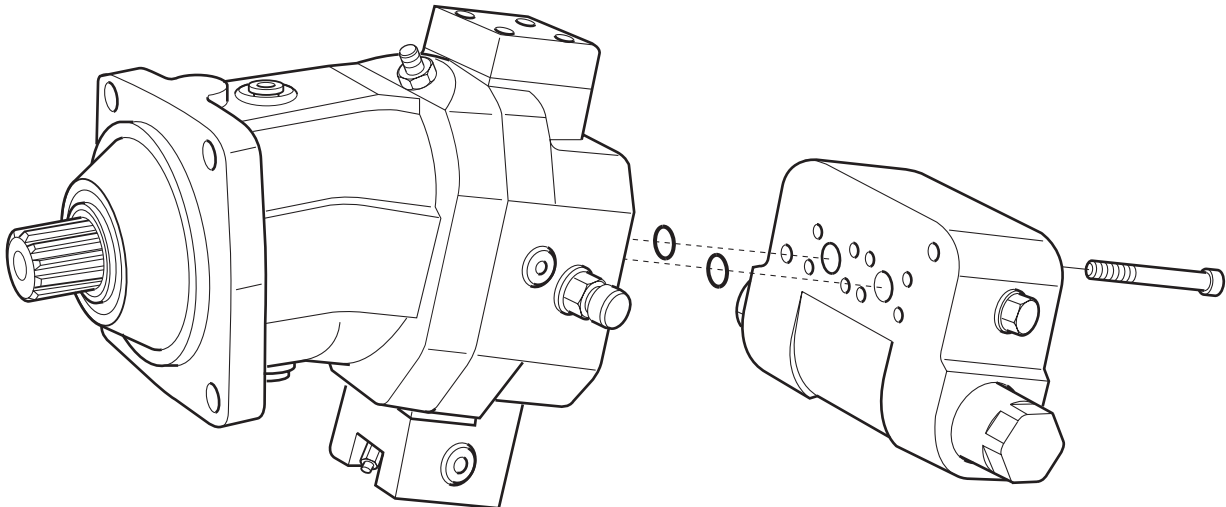
2. Inspect!
O-ring



FG002992

Figure 29

3. Remove counterbalance valve Inspect!
O-ring

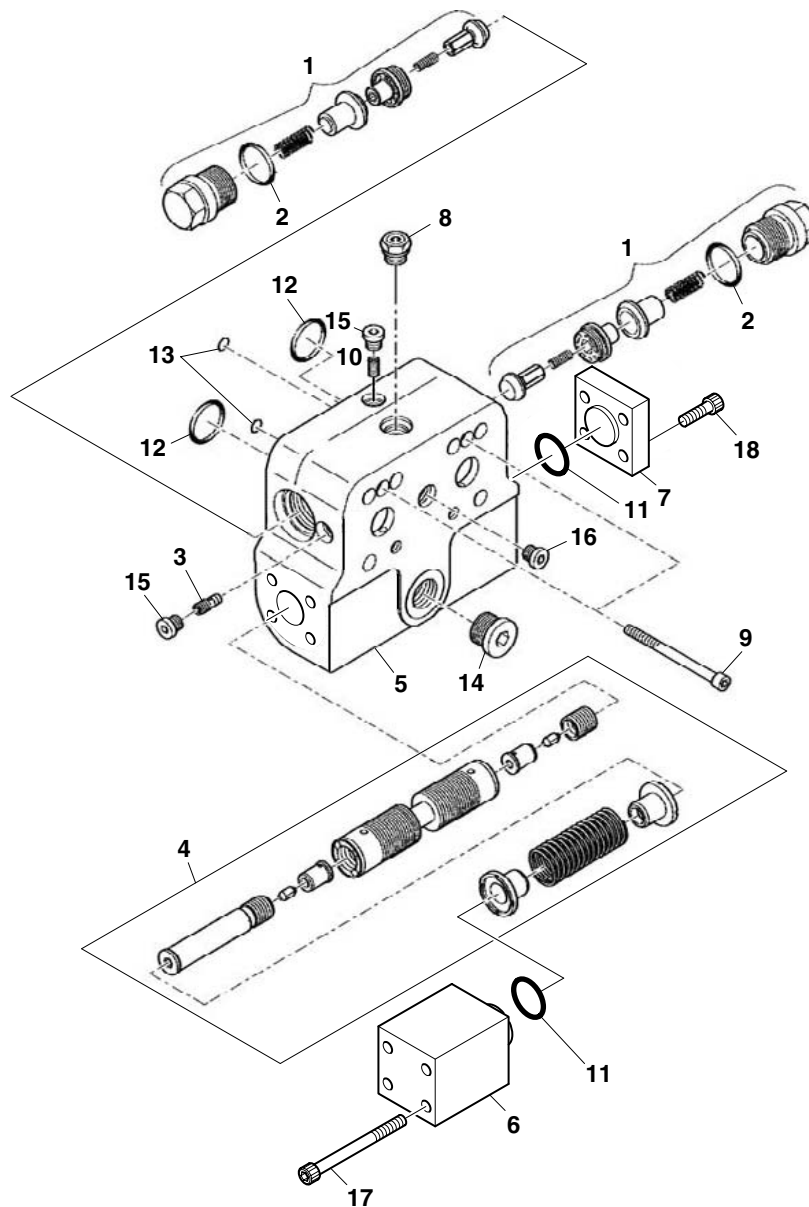


HB7M3030

Figure 30

Spare Parts List

Counterbalance Valve



FG008821

Figure 31

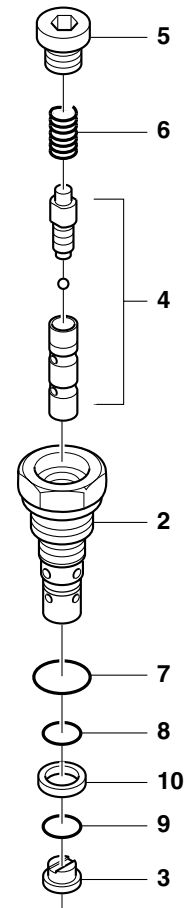
Reference Number	Description
1	Valve
2	O-ring
3	Shuttle Valve
4	Brake Valve
5	Housing
6	Cover
7	Cover
8	Plug
9	Socket Bolt

Reference Number	Description
10	Plug
11	O-ring
12	O-ring
13	O-ring
14	Plug
15	Plug
16	Screw
17	Socket Bolt
18	Socket Bolt

Brake Release Valve (Pos.50)

- These parts are not available separately.

Reference Number	Description
2	Guide
3	Sleeve
4	Spool
5	Screw plug
6	Spring
7	O-ring
8	O-ring
9	O-ring
10	Thrust Ring



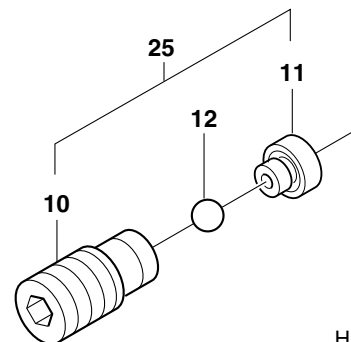
HB7M3032

Figure 32

Shuttle Valve (Pos.25)

- These parts are not available separately.

Reference Number	Description
10	Valve Seat
11	Valve Seat
12	Ball



HB7M3033

Figure 33

Disassembly of the Port Plate

1. Note dimension x.

Remove Qmin screw.

Swivel rotary group to zero position.



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

Piston rings to hang out of the cylinder boring.

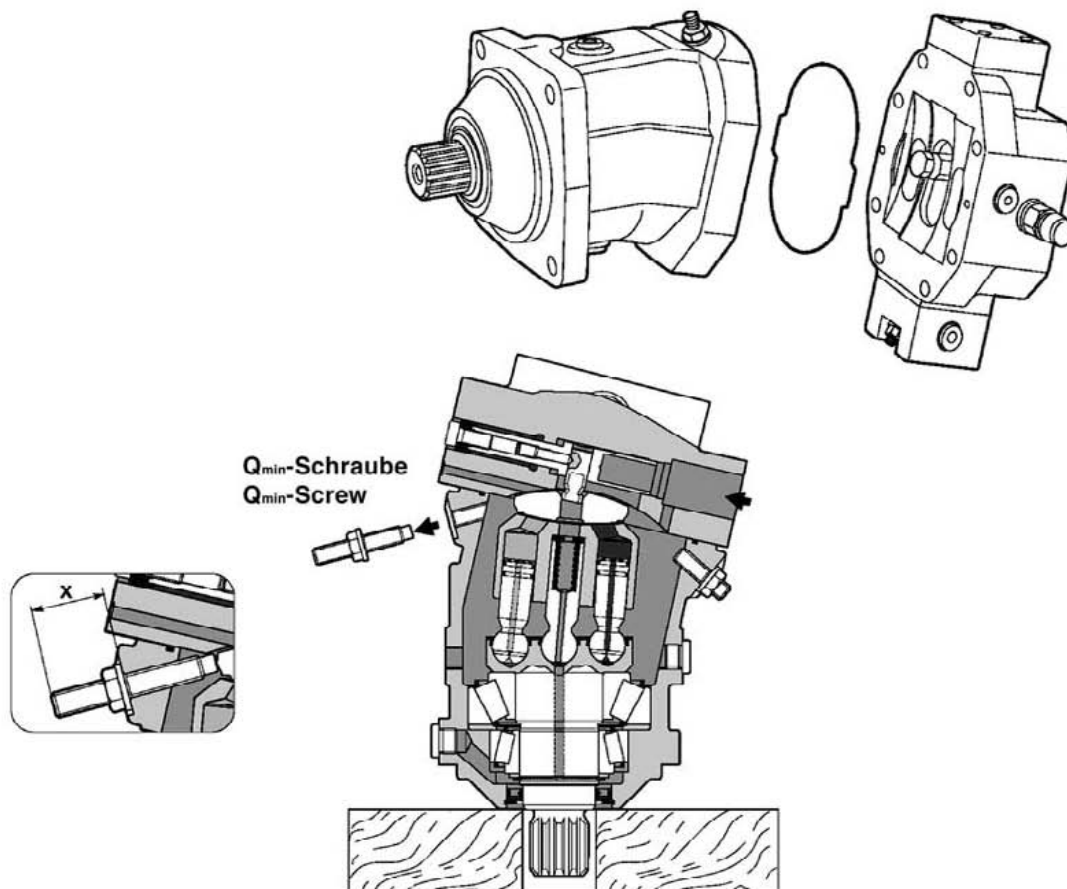


Figure 34

FG002997

2. Port plate
Mark position. Loosen screws.
Removal

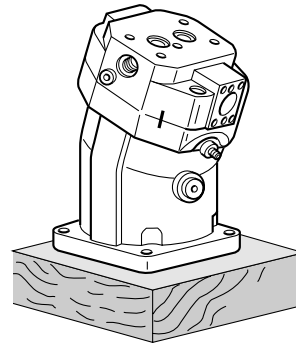


Figure 35

HB7M3035

3. Check O-ring.



Stick new O-ring with some grease.

Do not swivel rotary group.

Piston rings to hang out from the cylinder boring.

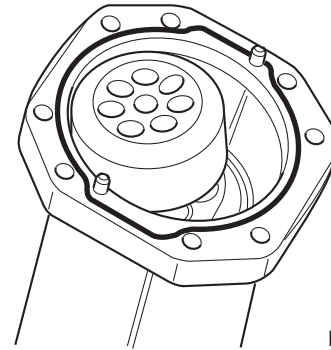


Figure 36

HB7M3036

Remove of the Positioning Piston

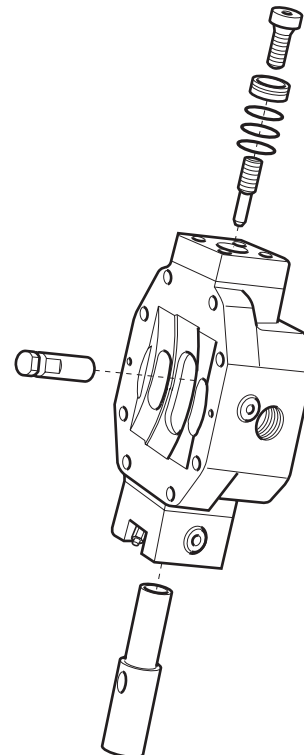


Figure 37

HB7M3037

1. Loosen fixing screw.
Use only socket wrench.

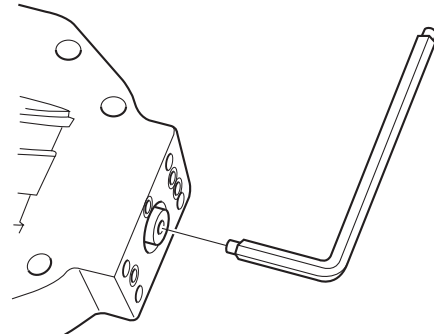


Figure 38

HB7M3038

2. Remove piston with piston ring

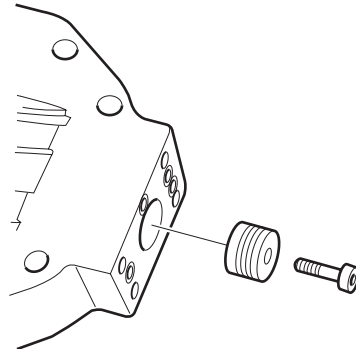


Figure 39

HB7M3039

3. Warm up fixation screw * for positioning plug
by way of boring (screw glued - to turn out).

! CAUTION!

Use new screw.

Precote coating.

Note tightening torque!

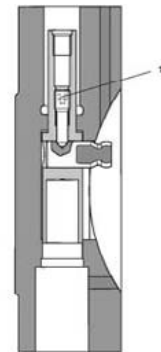


Figure 40

FG003023

! CAUTION!

Stick control lens in sliding surface with grease.

Assembly in reversal order.

Mount port plate.

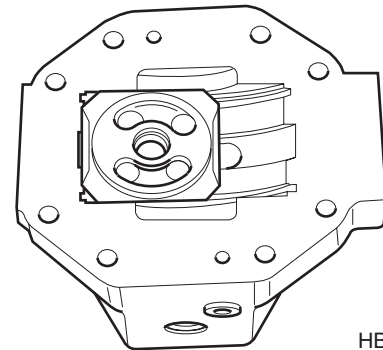


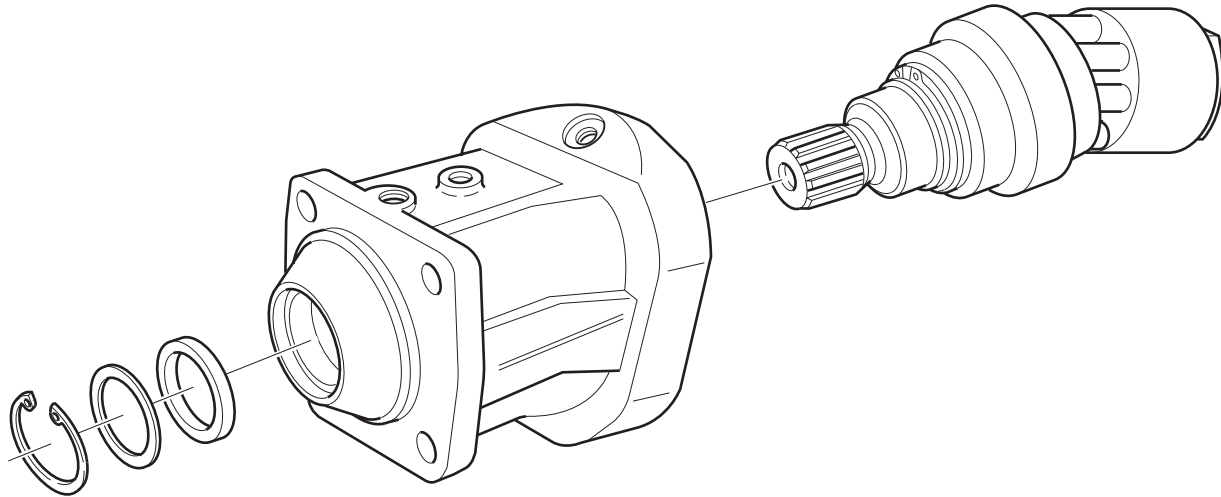
Figure 41

HB7M3041

! CAUTION!

Rotary group vertical.

Remove Rotary Group

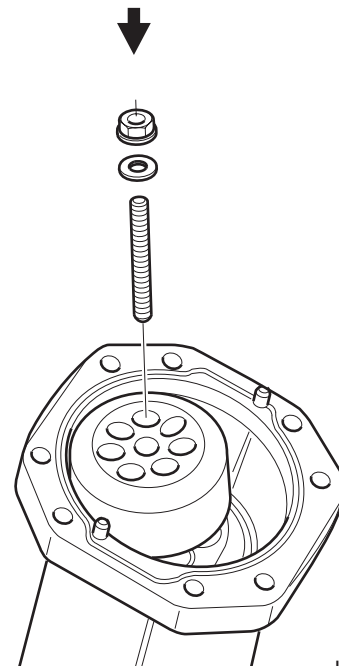


HB7M3042

Figure 42

1. Screw in threaded pin into center pin.
Fix the cylinder with disk and locknut.

Size 28 : M4 x 58 mm
55 : M5 x 71 mm
80 : M6 x 82 mm
107 : M6 x 92 mm
140 : M8 x 105 mm
160 : M8 x 105 mm
200 : M8 x 109 mm



HB7M3043

Figure 43

2. Press out rotary group!



If the bearings are used again
do not hit on the driveshaft.

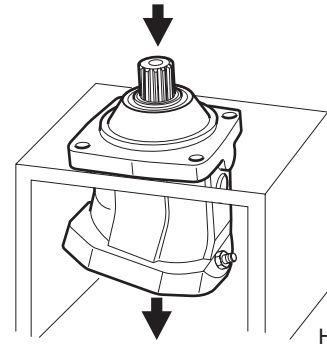


Figure 44

HB7M3044

3. Complete rotary group

Exchanging of the Rotary Group



Setting of hydraulic part necessary.

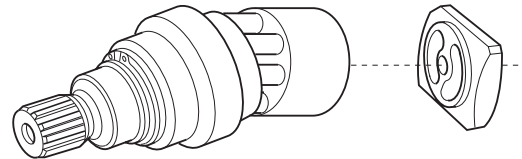


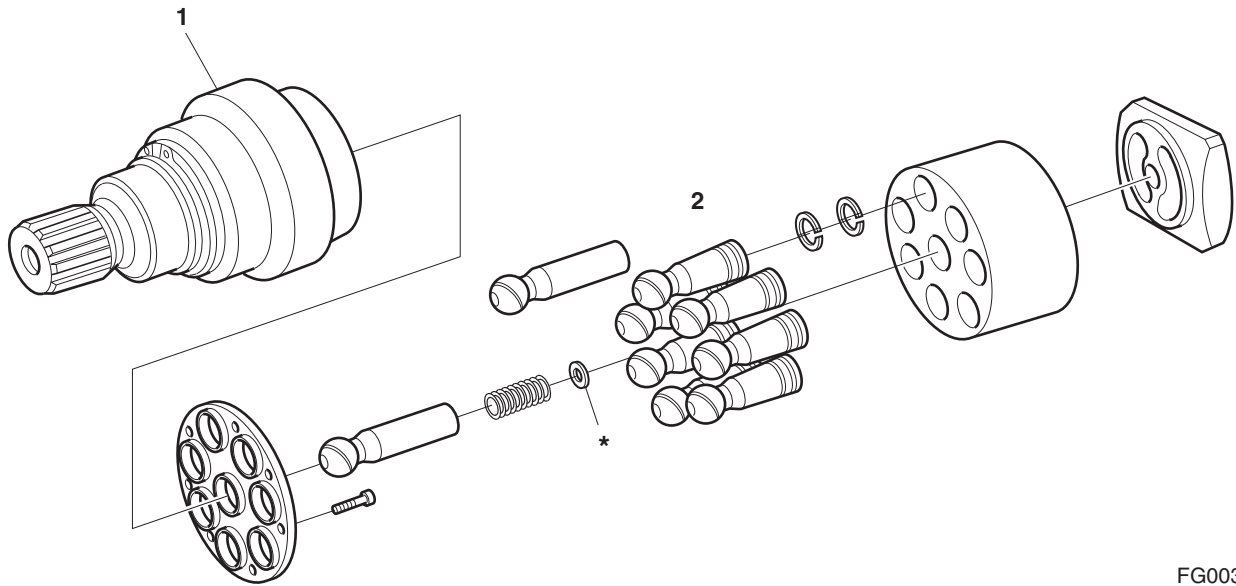
Figure 45

HB7M3010

1. Rotary group
 - A. Mechanical part: Adjust driveshaft with bearing.
 - B. Hydraulic part:



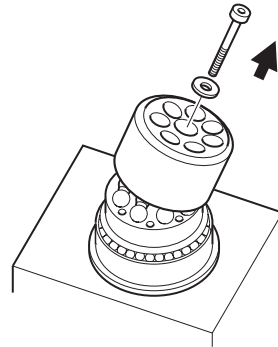
Adjustment necessary.



FG003029

Figure 46

2. Remove fixing screw (cylinder).
Remove cylinder.



HB7M3047

Figure 47

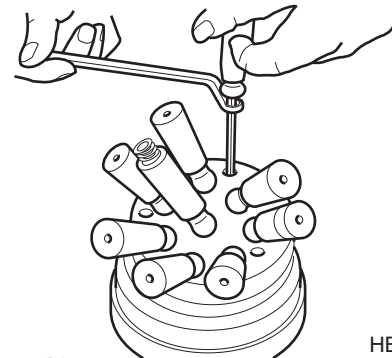
3. Disassemble retaining plate.



CAUTION!

Screws are glued.

Use Torx tools.

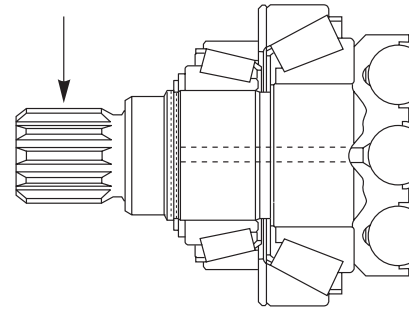


HB7M3048

Figure 48

Inspection Notes

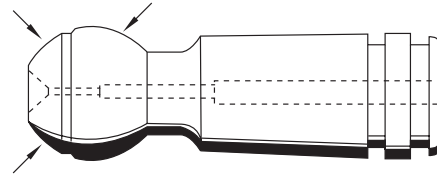
1. Free of corrosion, erosion or fretting; no damage to splines or keyways.



HB7M3049

Figure 49

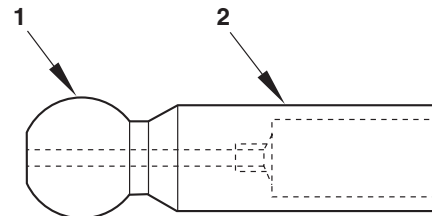
2. Pistons
No scoring and no pittings.



HB7M3050

Figure 50

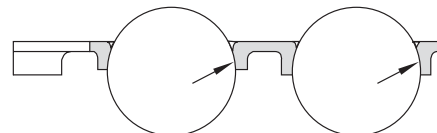
3. Center pin
No scoring and no pittings.



HB7M3051

Figure 51

4. Retaining plate
No scoring and no evidence of wear

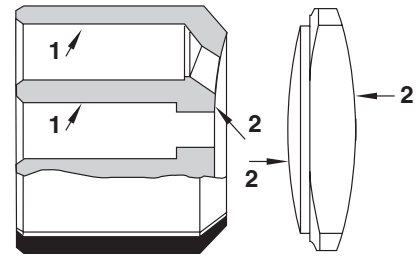


HB7M3052

Figure 52

5. Cylinder block / control lens

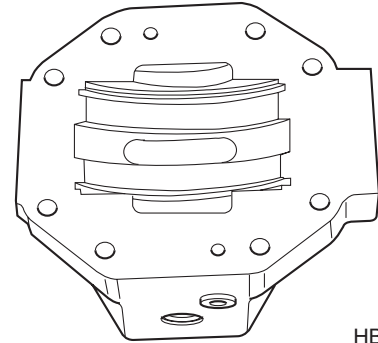
- A. Bores free of scoring, no evidence of wear.
- B. Faces smooth and even, free of cracks and scoring.



HB7M3053

Figure 53

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

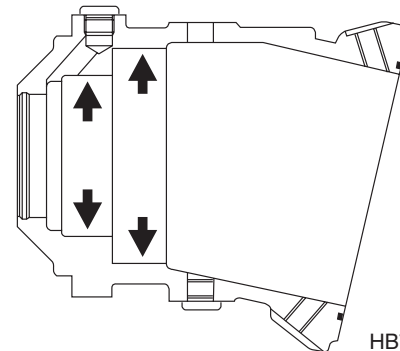


HB7M3054

Figure 54

7. Visual check:

Bearing areas free of scoring and no evidence of wear.



HB7M3055

Figure 55

ASSEMBLY

Rotary Group Assembly

1. Rotary group completely assembled ready for assembly.

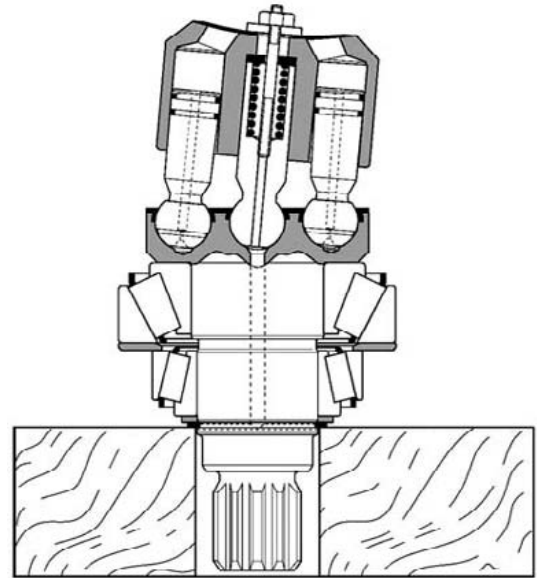


Figure 56

2. Place assembly sleeve.

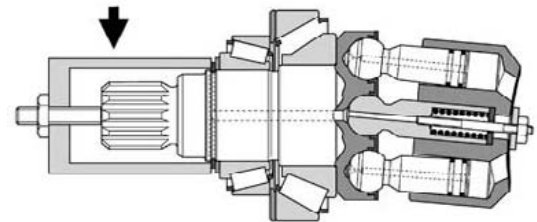


Figure 57

3. Warm up housing to 80° C.

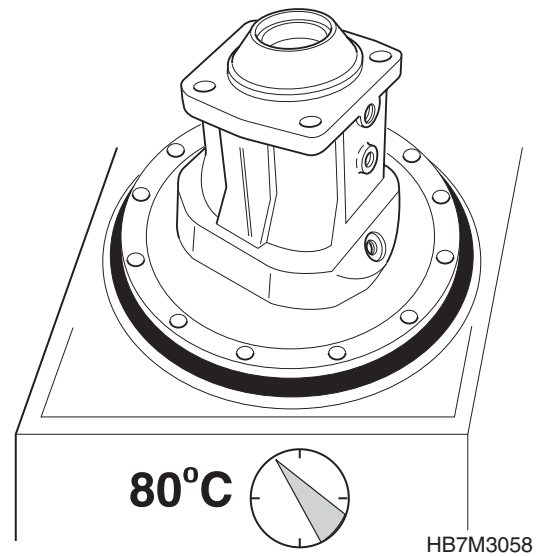


Figure 58

4. Insert rotary group into housing to seat position.

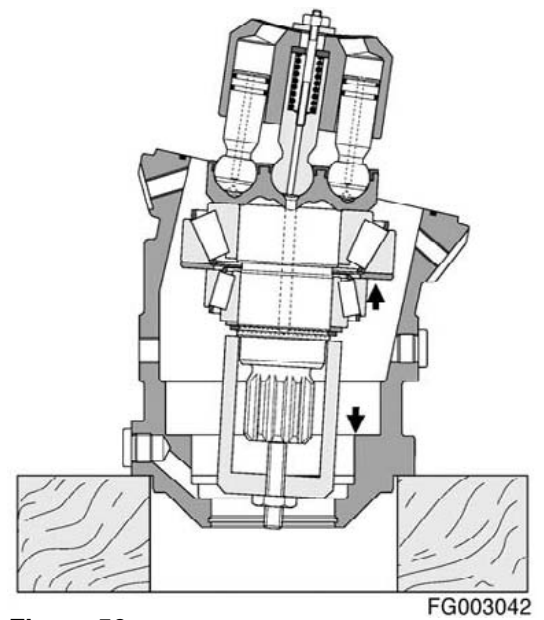


Figure 59

5. Fix zero position of cylinder with Qmax screw.
 - A. Disassemble cylinder fixing screw.
 - B. Insert O-ring.

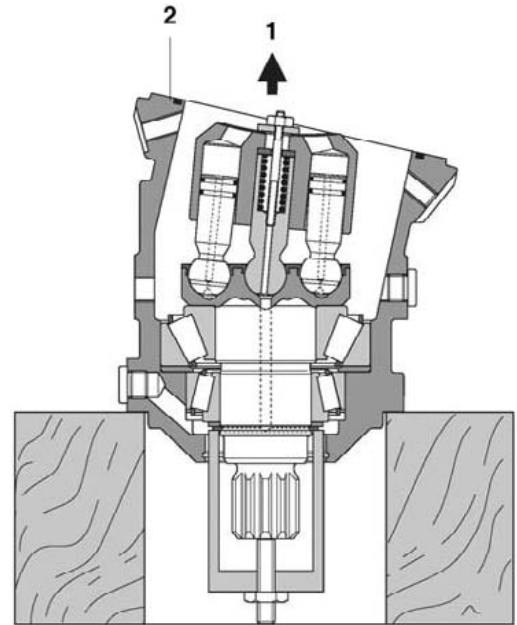


Figure 60

FG003043

Rotary Group Adjustment (See Service Information)

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

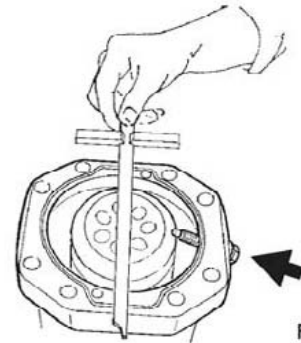


Figure 61

FG003044

2. * Disk

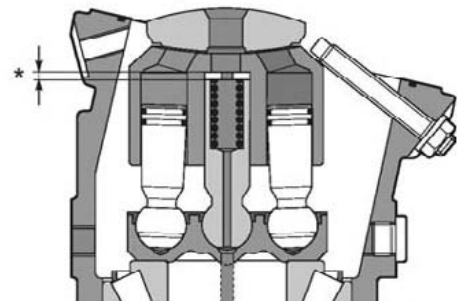


Figure 62

FG003045

3. Place centering disk.

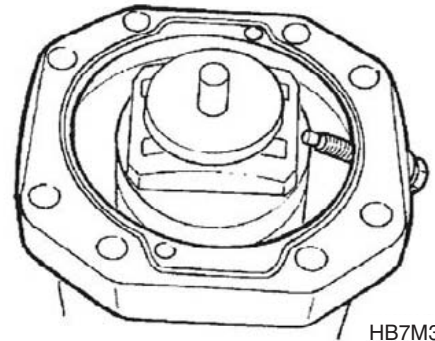


Figure 63

HB7M3063

4. Mount measuring device.

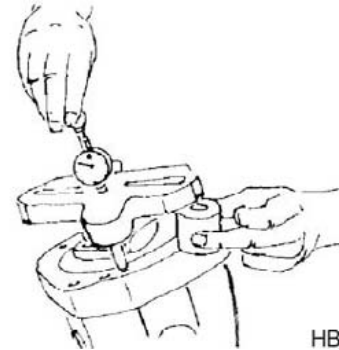


Figure 64

HB7M3064

5. Check dimension X.



Figure 65

HB7M3065

Assembly of the Port Plate

1. Assemble port plate.



Take care of assembly design.

Tighten fixing screws with torque.

2. Set Qmin -screw to dimension*.
3. Assemble plug.
4. Remove assembly sleeve.

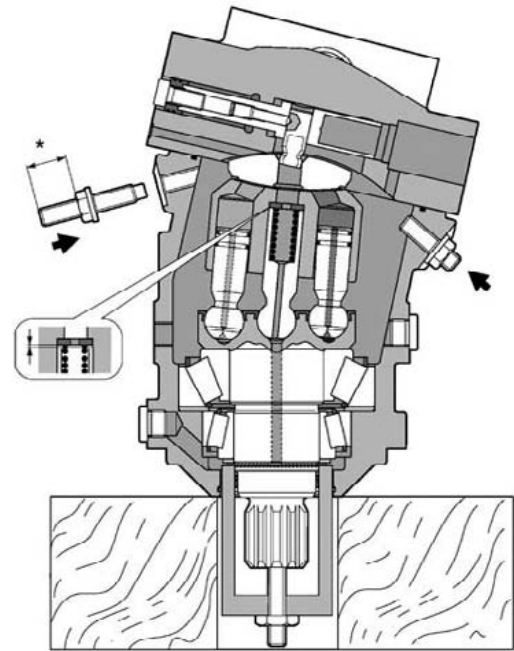


Figure 66

FG003049

5. Assemble control components.
Assemble cover.

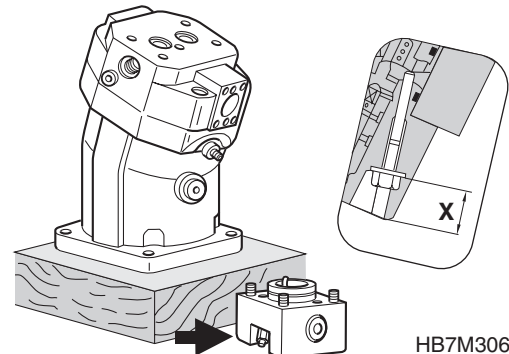


Figure 67

HB7M3067

6. Assemble cover.

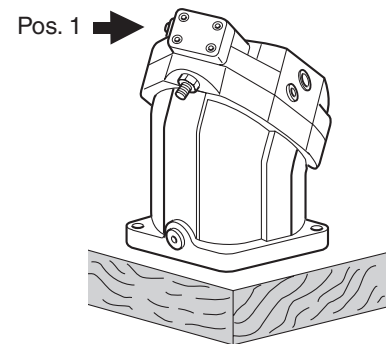


Figure 68

FG007441

7. Assemble shaft seal, disk and safety ring.
Press in with assembly sleeve.

! CAUTION!

Take care of press in depth.

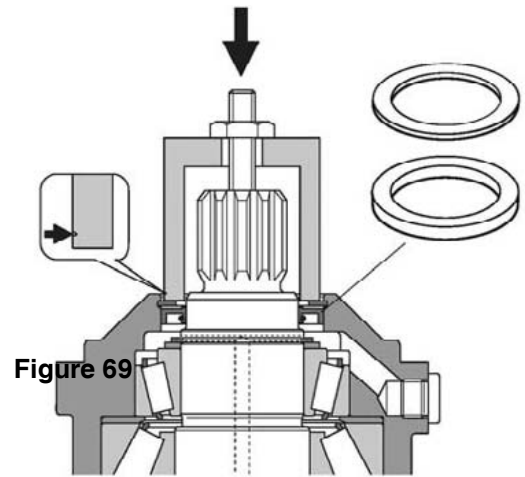


Figure 69

FG003052

8. Assemble counterbalance valve

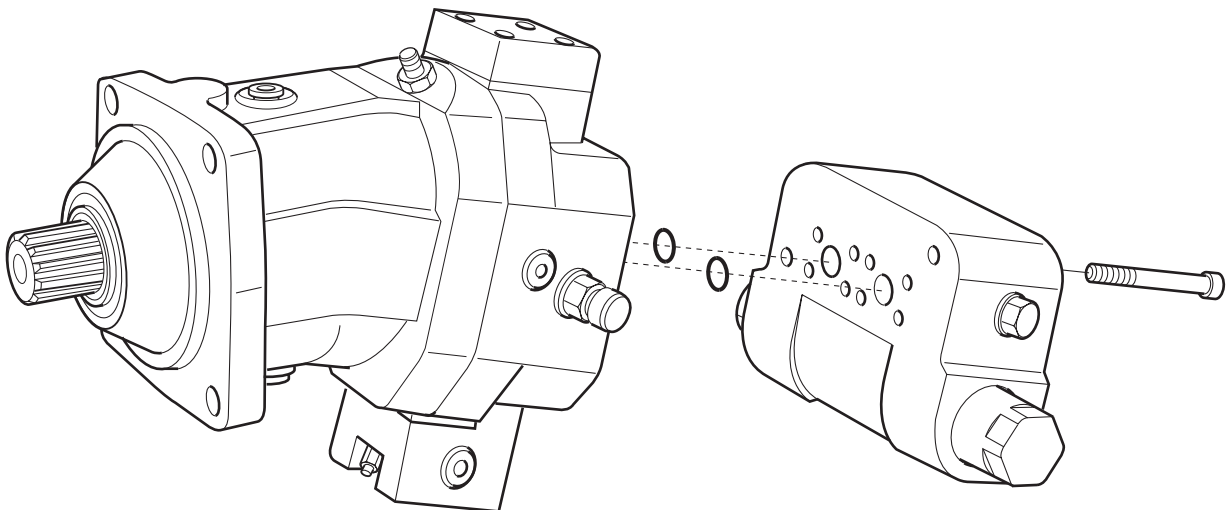


Figure 70

HB7M3030

TIGHTENING TORQUES

Shaft Bolts

(Metric ISO Standard Thread)

The values for tightening torques shown in the table are valid only for shaft bolts with metric ISO- standard threads and head support surface dimensions in accordance with DIN 912, DIN 931 and DIN 933. These values are also valid only for light or uncoiled, untreated surface and for use only with torque indicating wrenches and force limiting tools.	Thread Size	Strength Classes		
		8.8	10.9	12.9
		Tightening Torque (lb.ft)		
	M 3	0.8	1.2	1.4
	M 4	2.1	3.0	3.6
	M 5	4.4	6.3	7.4
	M 6	7.4	10.3	12.5
	M 8	18.4	25.8	30.2
	M10	36.1	50.9	61.2
	M12	63.4	88.4	106.9
	M14	99.5	140.0	169.5
	M16	154.8	217.4	261.6
	M18	213.7	298.5	357.4
	M 20	302.2	427.5	508.5
	M 22	405.4	574.9	685.4
	M 24	523.5	737.0	884.4
	M 27	773.9	1105.5	1326.6
	M 30	1068.7	1474.0	1768.8

Locking Screws VSTI

(Metric ISO fine thread)

Thread Size	Designation		Tightening Torque (lb.ft)
M 8 x 1	VS.TI 8 x 1	-ED/SA	= 4
M 10 x 1	VSTI 10 x1	-ED	= 7
M 12 x 1.5	VSTI 12 x 1.5	-ED	= 15
M 14 x 1.5	VSTI 14 x 1.5	-ED	= 22
M 16 x 1.5	VSTI 16 x 1.5	-ED/SA	= 22
M 18 x 1.5	VSTI 18 x 1.5	-ED/SA	= 29
M 20 x 1.5	VSTI 20 x 1.5	-ED/SA	= 37
M 22 x 1.5	VSTI 22 x 1.5	-ED	= 44
M 26 x 1.5	VSTI 16 x 1.5	-ED/SA	= 51
M 27 x 2	VSTI 27 x 2	-ED	= 66
M 30 x 1.5	VSTI 30 x 1.5	-ED/SA	= 74
M 33 x 2	VSTI 33 x 2	-ED/SA	= 88
M 42 x 2	VSTI 42 x 2	-ED/SA	= 147
M 48 x 2	VSTI 48 x 2	-ED	= 220

Seal Lock Nuts

(Metric ISO-Standard Thread)

The values for tightening torques shown in the table are valid only for seal lock nuts of the strength class 8.8 and with metric ISO-standard thread.	Thread Size	Strength Classes		
		8.8	10.9	12.9
		Tightening Torque (lb.ft)		
	M 6	7.4		
	M 8	16.2		
	M 10	29.5		
	M 12	50.9		
	M 14	81.1		
	M 16	125.3		

Cross-slotted Lens Head Screws DIN 7985

(Metric ISO- Standard Thread)

The values for tightening torques shown in the table are valid only for cross-slotted lens head screws DIN 7985 of the strength class 8.8 and with metric ISO standard thread.	Thread Size	Strength Classes		
		8.8	10.9	12.9
		Tightening Torque (lb.ft)		
	M 3	0.8		
	M 4	2.1		
	M 5	4.4		
	M 6	7.4		
	M 8	18.4		
	M10	36.1		

TEST PROCEDURE

Test procedure		
Oil temperature in tank: 40 ±5°C		Oil: SAE10W
		Direction of rotation: alternating
No.	Setting and testing	Specification
1	Prepare Function Test - Install the motor, fill oil In case - Connect lines - Start the motor at unload and loaded slowly	Regular
2	Set Qmin Speed $n = 1667 \text{ min}^{-1}$ ($Q_N=50 \text{ lpm}$): clockwise Pressure $P_{MA} = 10 \text{ MPa}$ $P_X = 0 \text{ MPa}$ $P_{X2} = 15 \text{ MPa}$ $P_{SP} = 3 \text{ MPa}$ Loosen the threaded pin for HA regulation	$Q_{min} = 30.0 \pm 1.1 \text{ cm}^3$
3	Check Qmin Speed $n = 1250 \text{ min}^{-1}$ ($Q_N=50 \text{ lpm}$): clockwise Pressure $P_{MA} = 10 \text{ MPa}$ $P_X = 0 \text{ MPa}$ $P_{X2} = 0 \text{ MPa}$ $P_{SP} = 3 \text{ MPa}$ Loosen the threaded pin for HA regulation	$Q_{min} = 40.0 \pm 2.1 \text{ cm}^3$
4	Check Qmin and switching. pressure Speed $n = 1250 \text{ min}^{-1}$ ($Q_N=50 \text{ lpm}$): clockwise Pressure $P_X = 0 \text{ MPa}$ $P_{X2} = 0 \text{ MPa}$ $P_{SP} = 3 \text{ MPa}$ Loosen the threaded pin for HA regulation	
5	Set Qmax Speed $n = 467 \text{ min}^{-1}$ ($Q_N=50 \text{ lpm}$): clockwise Pressure $P_{MA} = 10 \text{ MPa}$ $P_X = 0 \text{ MPa}$ $P_{X2} = 0 \text{ MPa}$ $P_{SP} = 3 \text{ MPa}$ Tighten the threaded pin for HA regulation	$Q_{max} = 107.0 \pm 1.1 \text{ cm}^3$

6	Check torque and drain flow Check torque T and suction flow Q_T on the following conditions Speed $n = 467 \text{ min}^{-1}$ ($Q_N = 50 \text{ lpm}$) $Q_{\max}$ Pressure $P_{MA} = 20.0 \text{ MPa}$ $P_X = 0 \text{ MPa}$ $P_{X2} = 0 \text{ MPa}$ $P_{SP} = 3 \text{ MPa}$ Tighten the threaded pin for HA regulation	$T \approx 289 \text{ Nm}$ $Q_T < 5.8 \text{ lpm}$
7	Set begin of HA regulation Speed $n = 1250 \text{ min}^{-1}$ ($Q_N = 50 \text{ lpm}$): clockwise Pressure $P_X = 0 \text{ MPa}$ $P_{X2} = 0 \text{ MPa}$ $P_{SP} = 3 \text{ MPa}$ Check bealn of HA regulation Speed $n = 1250 \text{ min}^{-1}$ ($Q_N = 50 \text{ lpm}$): clockwise Pressure $P_X = 1.0 \text{ MPa}$ $P_{X2} = 0 \text{ MPa}$ $P_{SP} = 3 \text{ MPa}$	
8	Check response Check response while switching PA ($\approx 25 \div 35 \text{ MPa}$) on the following conditions Speed $n = 1250 \text{ min}^{-1}$ ($Q_N = 50 \text{ lpm}$): clockwise Pressure $P_X = 0 \text{ MPa}$ $P_{X2} = 0 \text{ MPa}$ $P_{SP} = 3 \text{ MPa}$	$Q_{\min} \rightarrow Q_{\max}$: slow $Q_{\max} \rightarrow Q_{\min}$: slow
9	Set relief valves Check max. pressure Set setting pressure of relief valves on the following conditions Set both A and B Speed $n = 467 \text{ min}^{-1}$ ($Q_N = 50 \text{ lpm}$) $Q_{\max}$ Pressure $P_{SP} = 3 \text{ MPa}$	$P_{\max} = 40.0 \text{ MPa}$ $P_{MA} (P_{MB}) = 36.0 \pm 1.0 \text{ MPa}$
10	Release Function Test - All values within the tolerances - Check oil leakage with both direction of A, B - Check the noise and vibration - Close openings with the planned locking elements - Release	regular as to the outside drawing (Y120191505)



Figure 71

Counterbalance Valve

Edition 1

MEMO

Table of Contents

Counterbalance Valve

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

GENERAL DESCRIPTION

The counterbalance valve is used in such a way that it is engaged in a running travel motor for the bell-type shovel. It functions as a double counterbalance valve which prevents the vehicle body from overrunning while running forward or backward.

While Operating to Run Forward

It refers to running operation which is done using applying pressure to motor either for accelerated climbing or for running fast on a flat road like expressway. B port working on left side of spool will overpower spring, thanks to pressure, and spool will open completely, causing oil to flow through individual ports (B → B' → Motor → A' → A).

The vehicle body will run at higher speed than speed of pump discharge because of inertial force while it is in deceleration or in descent. This will result in decreasing pressure of B port, causing power pressing the right side of spool to decline, and the spool to move toward center. This will generate counter pressure at A' port, which will control port pressure up to moderate level. Now, spool will be controlled at level where pump discharged will be counterbalanced with counter pressure, and pressure of B port will be the pressure of spring which will be counterbalanced with the controlled level of spool.

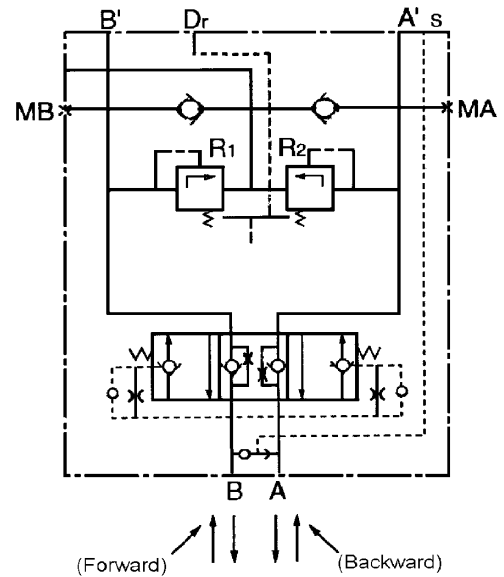


Figure 1

HGM4048S

While Operating to Stop

Stop operation involves decrease of pressure of B port, causing spool to move to neutral position where only the neutral orifice will work. This set orifice will cause A' port to generate counter pressure, allowing the vehicle body with hydraulic brake to stop.

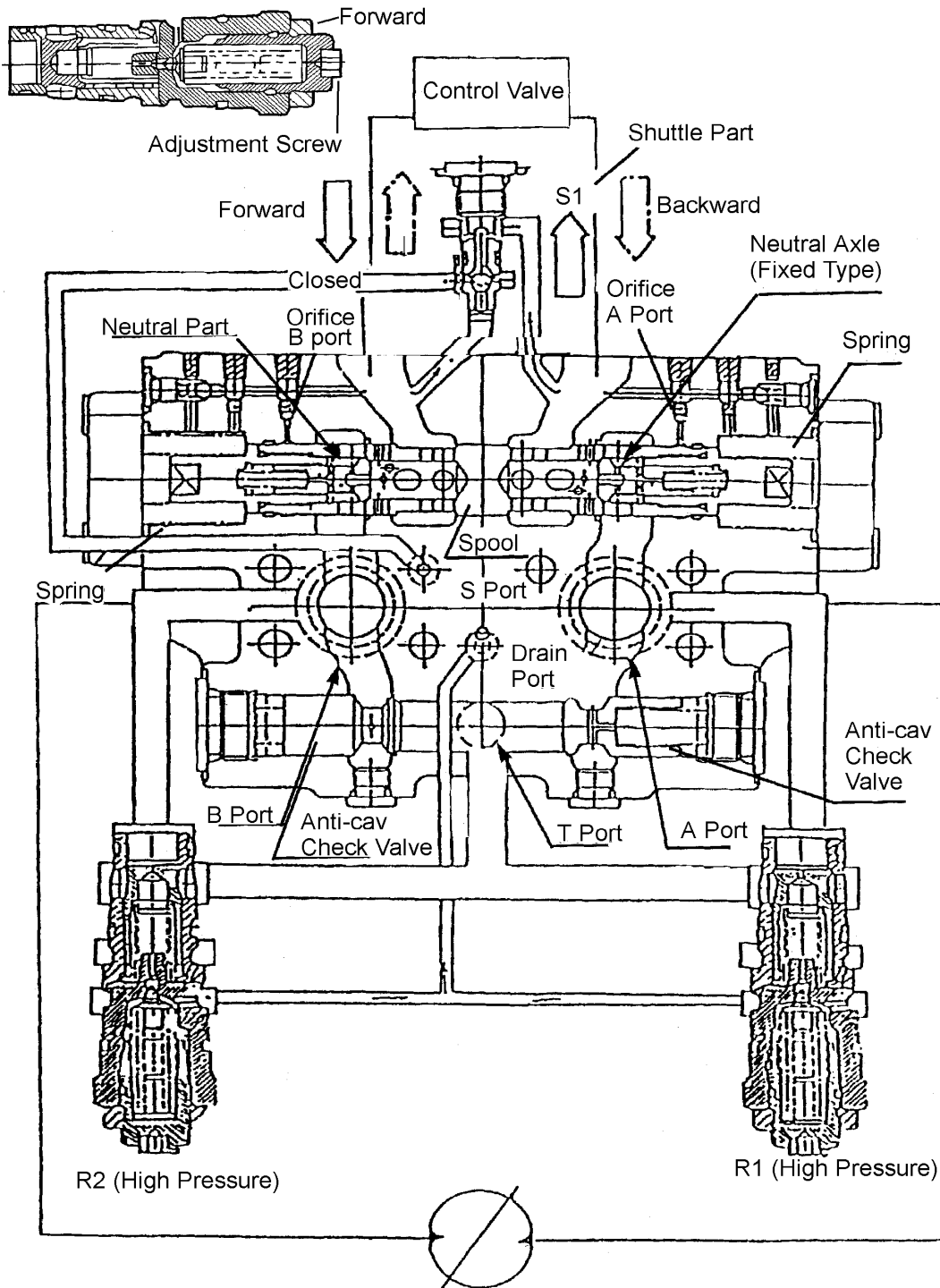
The relief valve regulates pressure of brake which came into operation when the pressure produced, at stop operation, from neutral orifice (counter pressure) reached the set pressure of valve. It also offers such operation as cutoff of surge pressure which is produced, at a rapid operation like an additional manipulation, from A port. If there occurs no cavitation at A' (B') port, oil is supplied from T port. Therefore, there are anticavitation check for both sides.

While Operating to Back

Backward operation also has counterbalancing function like forward operation. The spool moves to left when motor works either for accelerated climbing or for uniform running on a flat road, while oil flows through individual ports (B → B' to Motor to A' to A). While in deceleration and in decent, counter pressure is produced at B' port, contrary to the case of forwarding, causing vehicle body to be under control. While in operation to stop, spool moves toward neutral position and counter pressure produced from neutral orifice (at B' port) produces braking pressure of the relief valve, which forces the vehicle body to stop.

Adjustment of Relief Valve

Turning the adjusting screw right with a hexagon wrench will allow pressure to increase, and turning it left will allow pressure to decrease. One turn of an adjusting nut will make change of about $80.0 \text{ kg} \cdot \text{cm}^2$ (1,140 psi).



HGM4049S

Figure 2 Function Schematic

TROUBLESHOOTING

Problem	Possible Cause	Remedy
Motor does not operate.	Malfunction of spool (It is on status of deployment).	Torque mounting bolts. Check for damage, replace or repair.
	Malfunction of check valve of anticavitation (Impracticable to adjust).	Torque mounting bolts. Check for damage, replace or repair.
Acceleration time needs to be taken for operation of motor.	Malfunction of spool (It is on status of deployment).	Torque mounting bolts. Check for damage, replace or repair.
	Orifice damper for counterbalance is clogged.	Disassemble and clean.
	Relief valve pressure improperly adjusted.	Readjust pressure. Check for damage, replace or repair.
Deceleration of motor not performed smoothly.	Damper for counterbalance is clogged.	Disassemble and clean.
	Neutral part of spool defective	
	Relief valve pressure improperly adjusted.	Readjust pressure. Check for damage, replace or repair.
Abnormal sound with rapid deceleration at high-speed.	Damper for counterbalance is clogged.	Torque mounting bolts. Disassemble and clean.
	Neutral part of spool defective.	

COUNTERBALANCE VALVE

Recommended Tools

Hexagonal Wrench	2.5, 4, 8, 14, 30 mm
Torque Wrench	0 - 15 kg•m (0 - 115 ft lb)
Loctite	242, 572
Seal Tape	150

Disassembly

NOTE: *Disassemble counterbalance valve in reverse order of assembly.*

Order of Disassembly and Torque Values

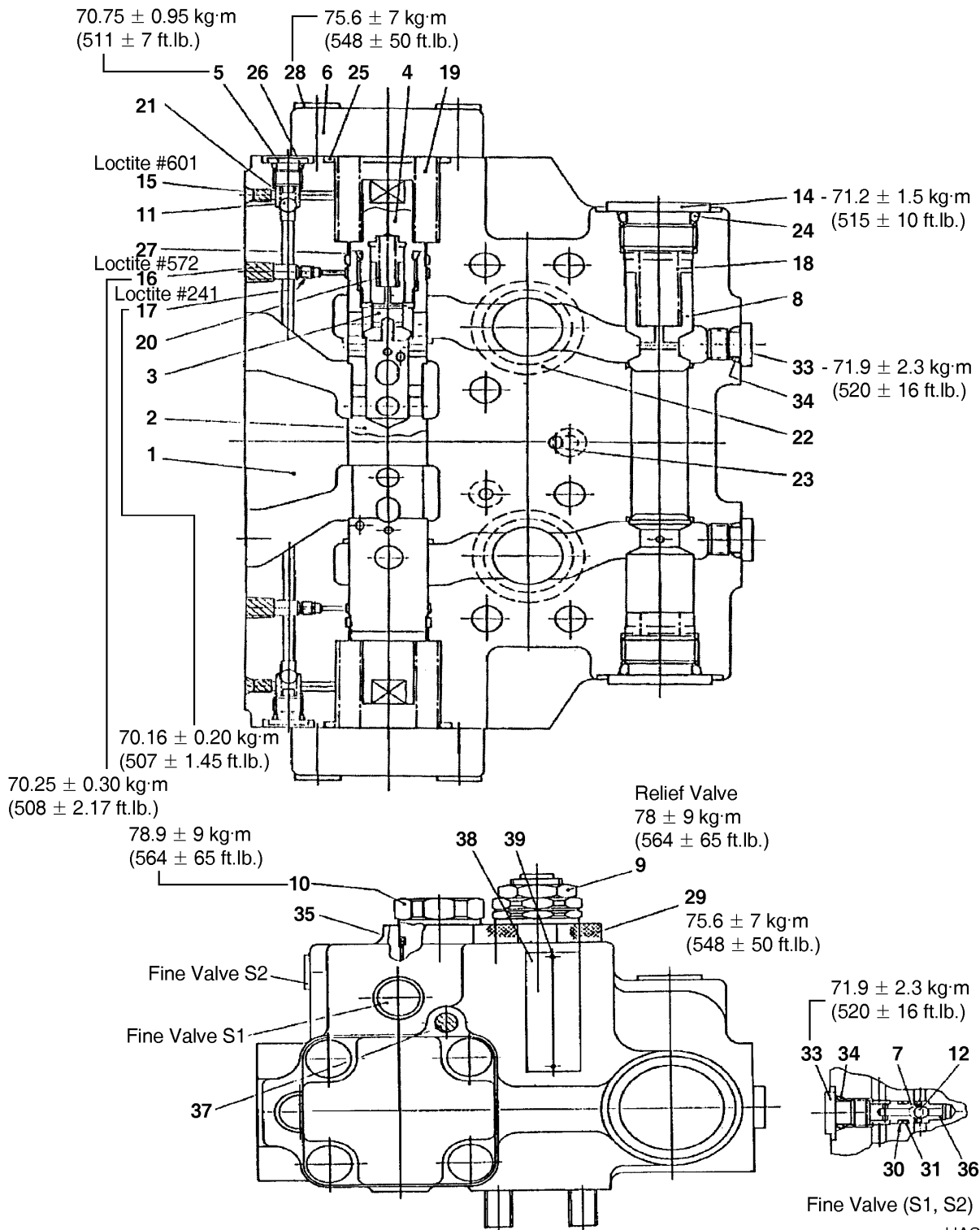


Figure 3

Reassembly

1. Install plug (3) and spring (20) to spool (2).

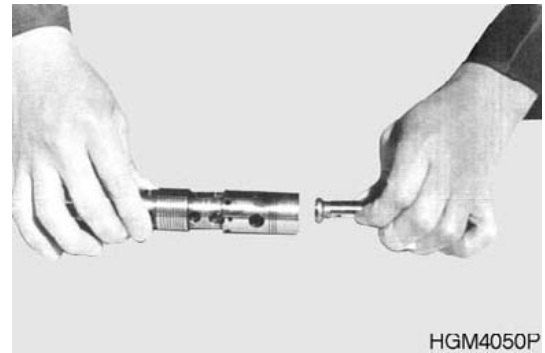


Figure 4

2. Apply Loctite #242 to plug (4) and install into spool (2). Torque to $75.5 \pm 7 \text{ kg}\cdot\text{m}$ ($548 \pm 50 \text{ ft lb}$). Install plugs on other side following steps 1 and 2.

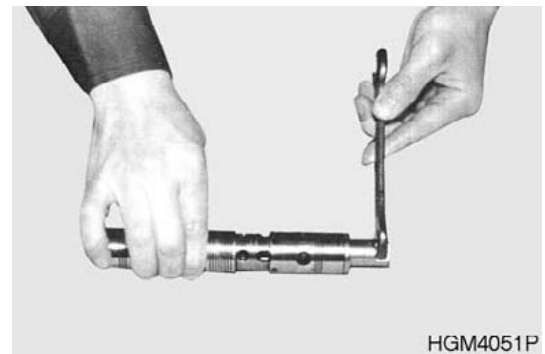


Figure 5

3. Install small ball bearings (12) into body (1).



Figure 6

4. Install guide (7) into body (1).

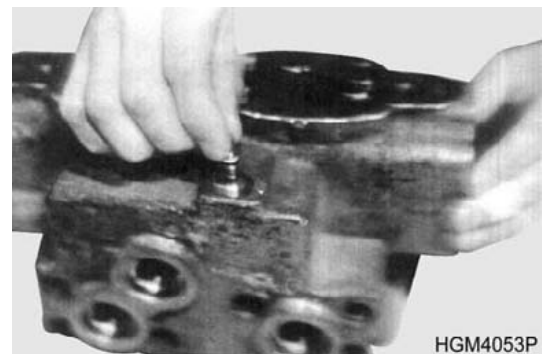


Figure 7

5. Install plug (33) into body and torque to $71.9 \pm 2.3 \text{ kg}\cdot\text{m}$ ($520 \pm 16 \text{ ft lb}$).

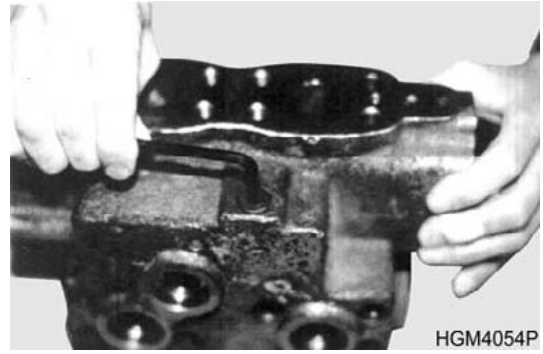


Figure 8

6. Apply Loctite #241 to orifice (17) and install into body (1) (on both sides). Torque to $70.16 \pm 0.2 \text{ kg}\cdot\text{m}$ ($507 \pm 2 \text{ ft lb}$).

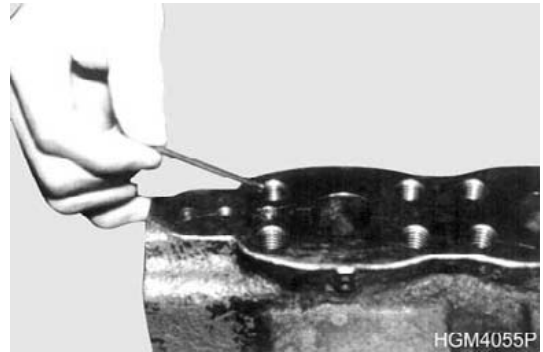


Figure 9

7. Apply Loctite #572 and wind seal tape around plug (16), and install to body (1) (both sides). Torque to $70.25 \pm 0.3 \text{ kg}\cdot\text{m}$ ($508 \pm 2 \text{ ft lb}$).

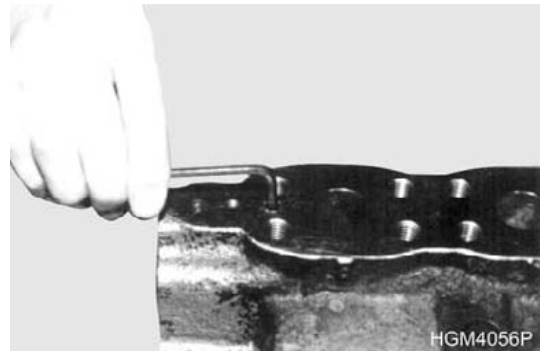


Figure 10

8. Install small ball bearings (11) and spring (21) into body (1) (both sides).



Figure 11

9. Install plug (5) into body (1) (both sides) and torque to $70.75 \pm 0.95 \text{ kg}\cdot\text{m}$ ($511 \pm 7 \text{ ft lb}$).

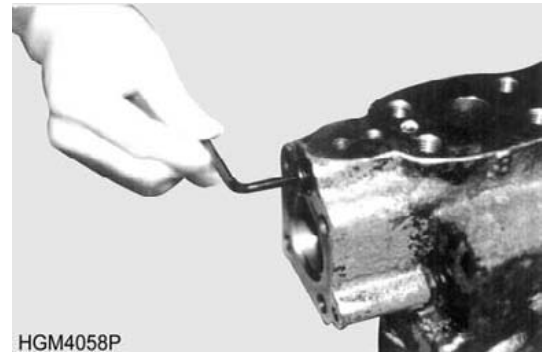


Figure 12

10. Install O-ring (25) into body (1) (both sides).
NOTE: *It is recommended to replace O-ring with new.*

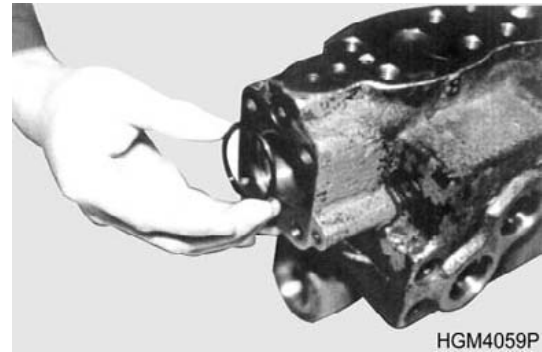


Figure 13

11. Install spool (2) into body (1).



Figure 14

12. Install spring (19) into body (1), then install cover (6).

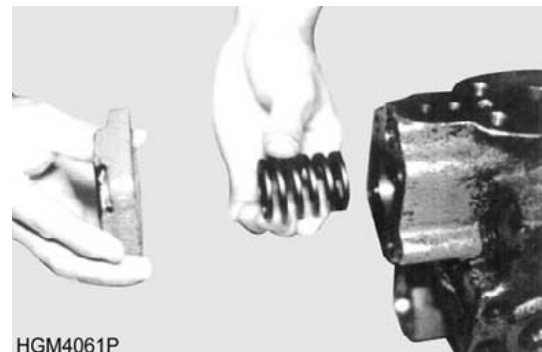


Figure 15

13. Tighten cover (6) (both sides) and torque to $75.6 \pm 7 \text{ kg}\cdot\text{m}$ ($548 \pm 50 \text{ ft lb}$).

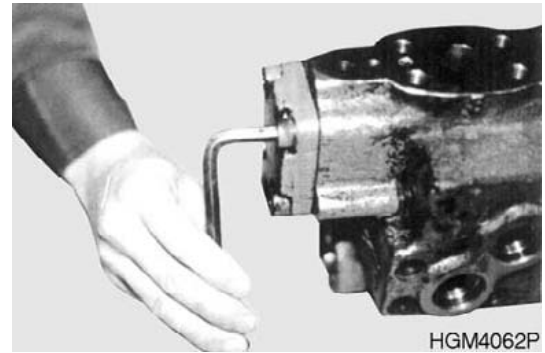


Figure 16

14. Install plunger (8) and spring (18), in that order, into body (1).

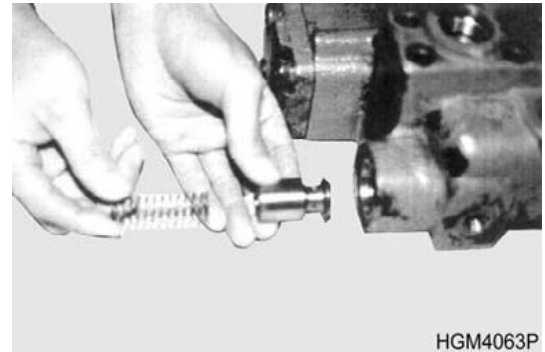


Figure 17

15. Install plug (14) into body (1) (both sides) and torque to $71.2 \pm 1.5 \text{ kg}\cdot\text{m}$ ($505 \pm 10 \text{ ft lb}$).

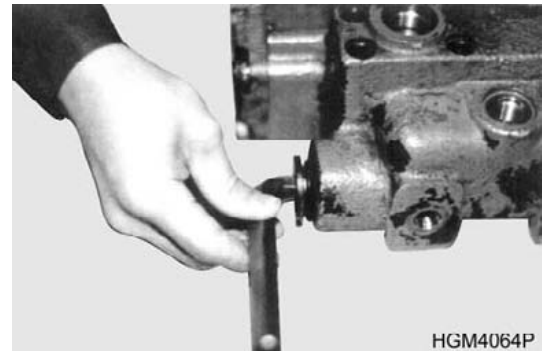


Figure 18

16. Install plug (33) into body (1) (both sides) and torque to $71.9 \pm 2.3 \text{ kg}\cdot\text{m}$ ($520 \pm 16 \text{ ft lb}$).

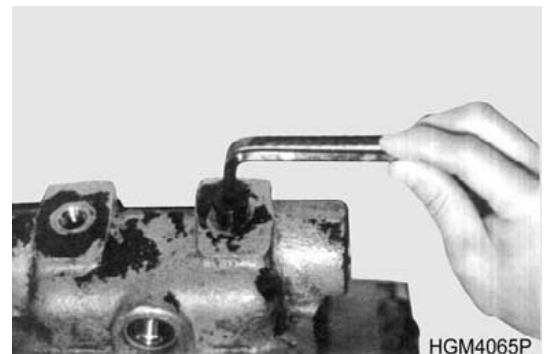


Figure 19

17. Install relief valve (9) into body (1) (both sides).

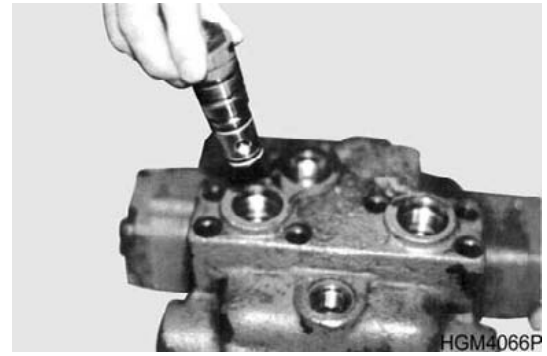


Figure 20

18. Torque to $78 \pm 9 \text{ kg}\cdot\text{m}$ ($564 \pm 65 \text{ ft lb}$).

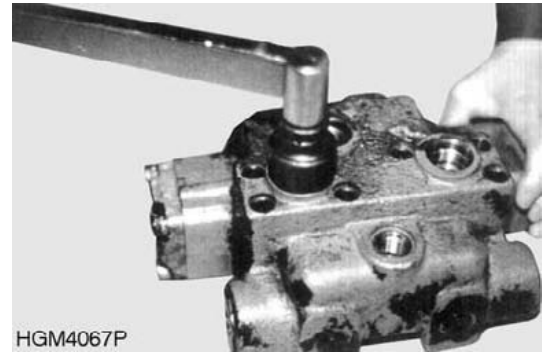


Figure 21

19. Install O-rings (22) and (23) into body (1).

NOTE: *It is recommended to replace O-rings with new.*

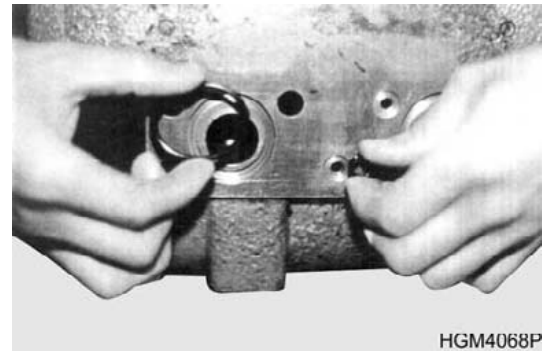


Figure 22

NOTE: *Reassembled counterbalance valve is shown.*



Figure 23

Main Pump and PTO

Edition 1

MEMO

Table of Contents

Main Pump and PTO

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

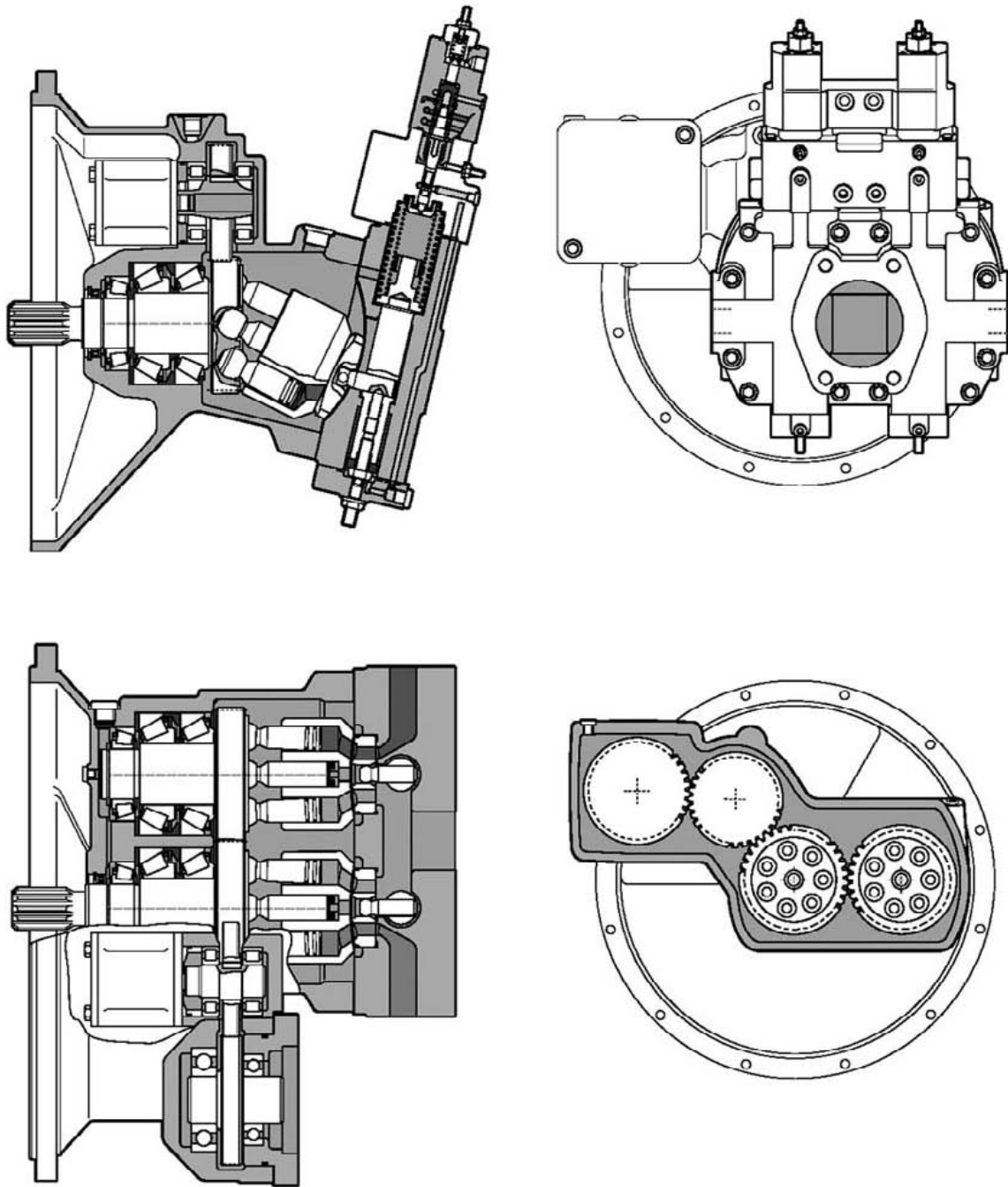
Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

SECTION



FG003057

Figure 1

GENERAL REPAIR GUIDELINES

CAUTION!

Observe the following notices when carrying out repairs on hydraulic units!

1. Close off all openings of the hydraulic unit.



Figure 2

HB7M3002

2. Replace all the seals.
Use only original HYDROMATIK spare parts.

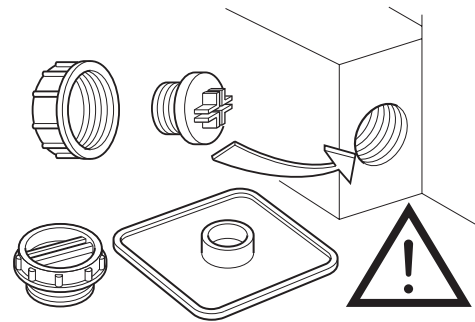


Figure 3

HB7M3003

3. Check all sealing and sliding surfaces for wear.

CAUTION!

Rework of the sliding surfaces using crocus cloth.

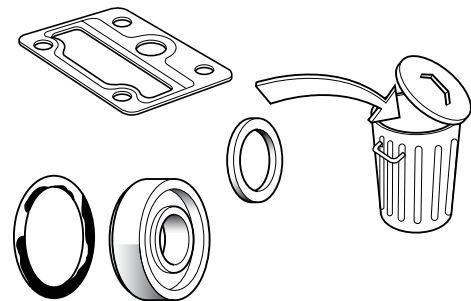


Figure 4

HB7M3004

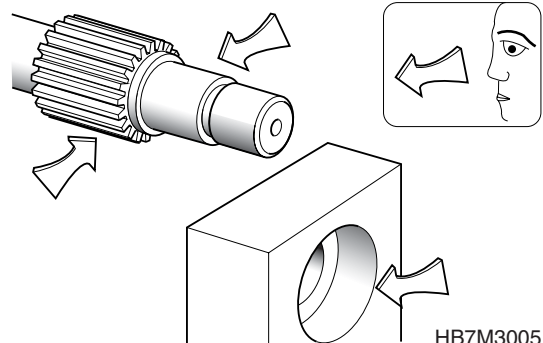


Figure 5

HB7M3005

4. Fill the hydraulic unit with hydraulic oil before commissioning.



Figure 6

FG003062

SEAL KITS AND SUBASSEMBLIES

1. Seal kit for driveshaft.

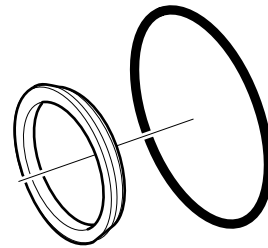


Figure 7

FG003063

2. Peripheral seal kit.

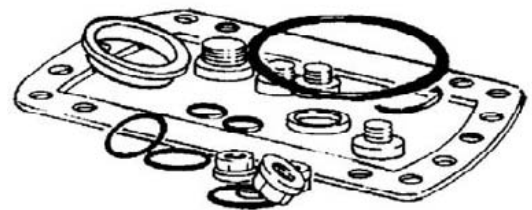


Figure 8

FG003064

3. Rotary group 1, ready to install.

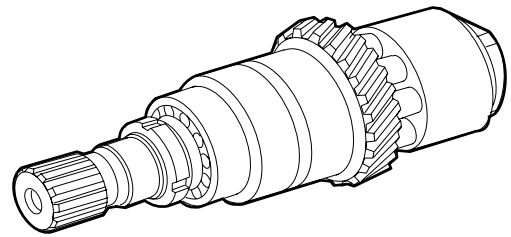


Figure 9

FG003065

4. Rotary group 2, ready to install.

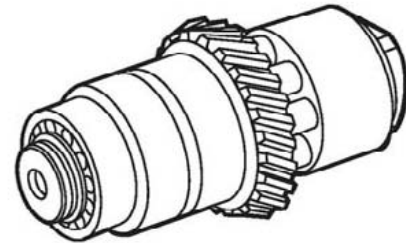


Figure 10

FG003066

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



CAUTION!

Direction of rotation.

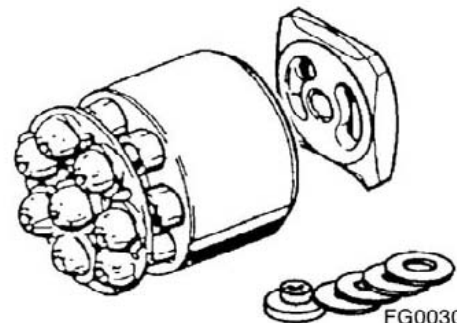


Figure 11

FG003067

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

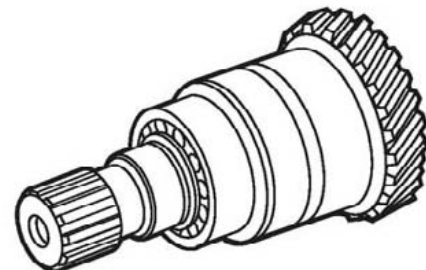


Figure 12

FG003068

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

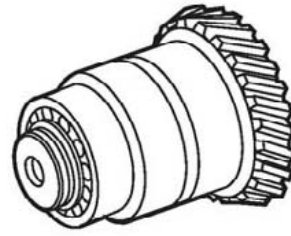


Figure 13

FG003069

8. Control, preadjusted.

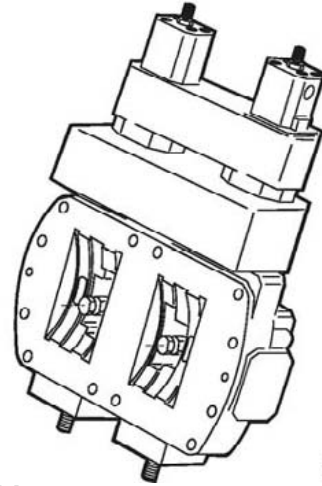


Figure 14

FG003070

9. Gear pump, complete.

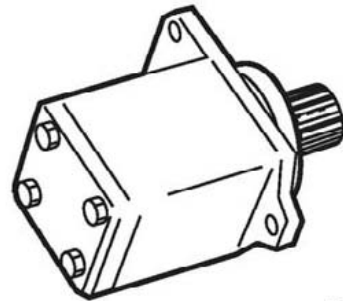


Figure 15

FG003071

10. Intermediate Gear

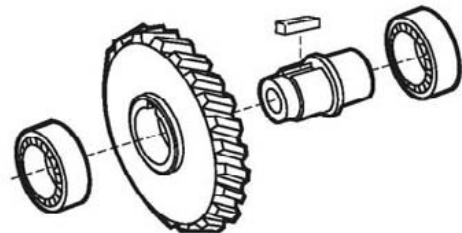


Figure 16

FG003072

11. Auxiliary Drive

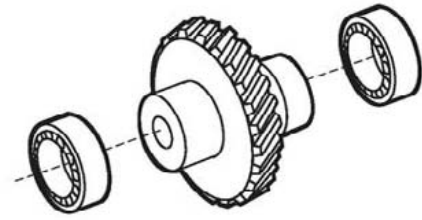
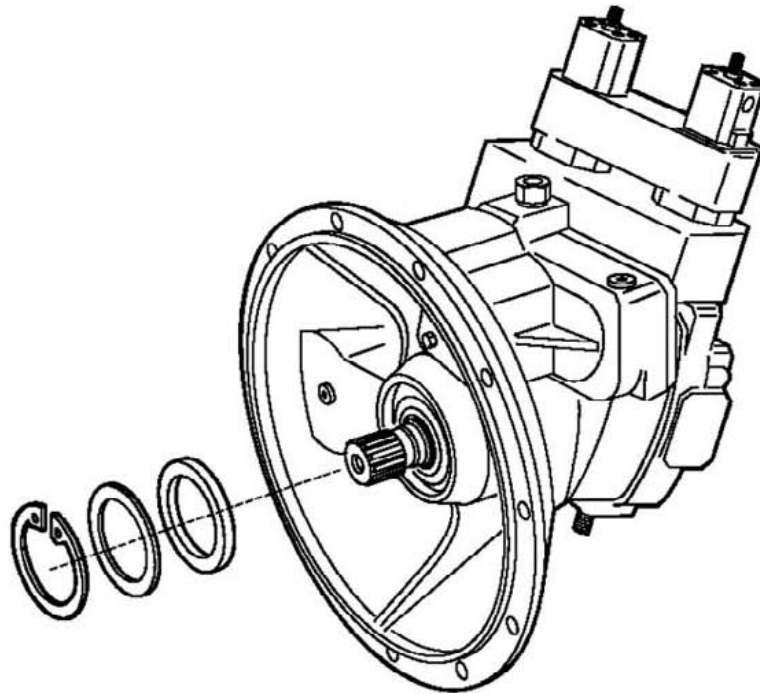


Figure 17

FG003073

DISASSEMBLY

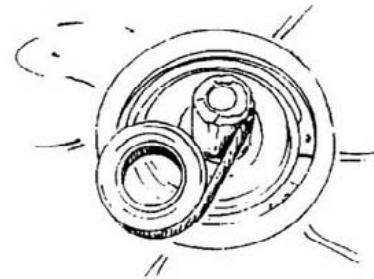
Sealing the Driveshaft



FG003074

Figure 18

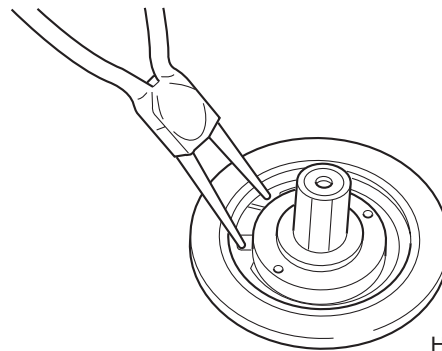
1. Protect driveshaft. (e.g. tape).



FG003075

Figure 19

2. Remove retaining ring and shim.

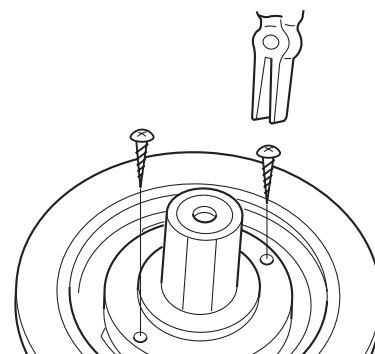


HB7M3017

Figure 20

3. Screw in sheet metal screw into the holes fitted with rubber.

Pull out seal with pliers.



HB7M3018

Figure 21

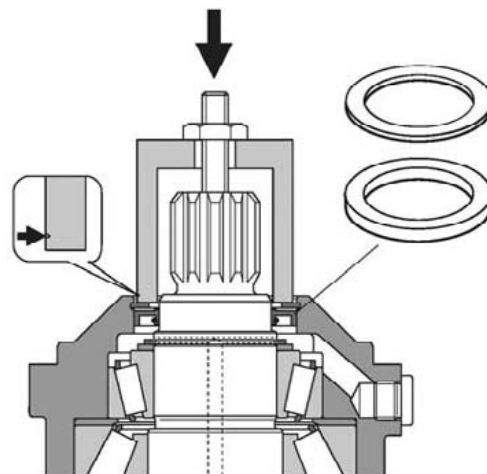
4. Press in shaft seal ring and shim with bushing to stop.



CAUTION!

Take note of press in depth!

Install mark for press in depth of safety ring.

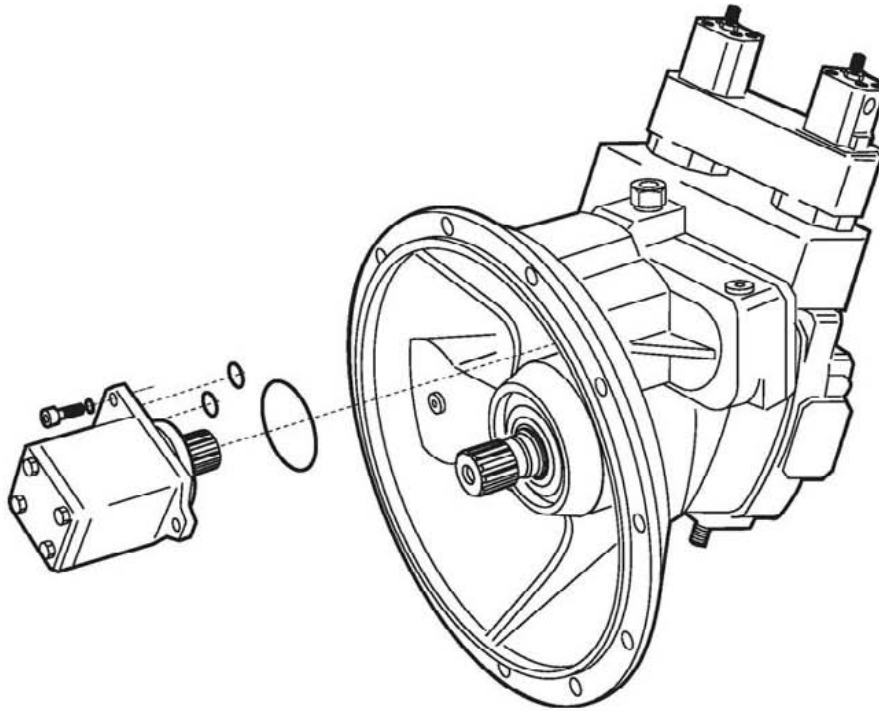


FG003052

Figure 22

Gear Pump Sealing

1. Remove gear pump.

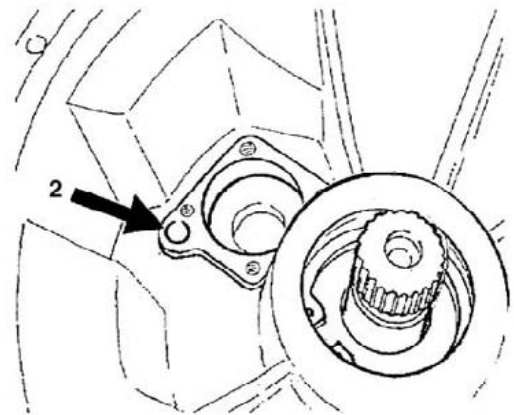
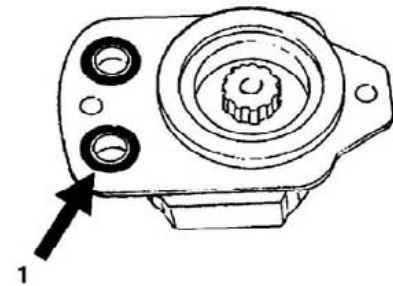


FG003079

Figure 23

Visual Check:

Reference Number	Description
1	O-ring
2	Sealing Surface of the Housing

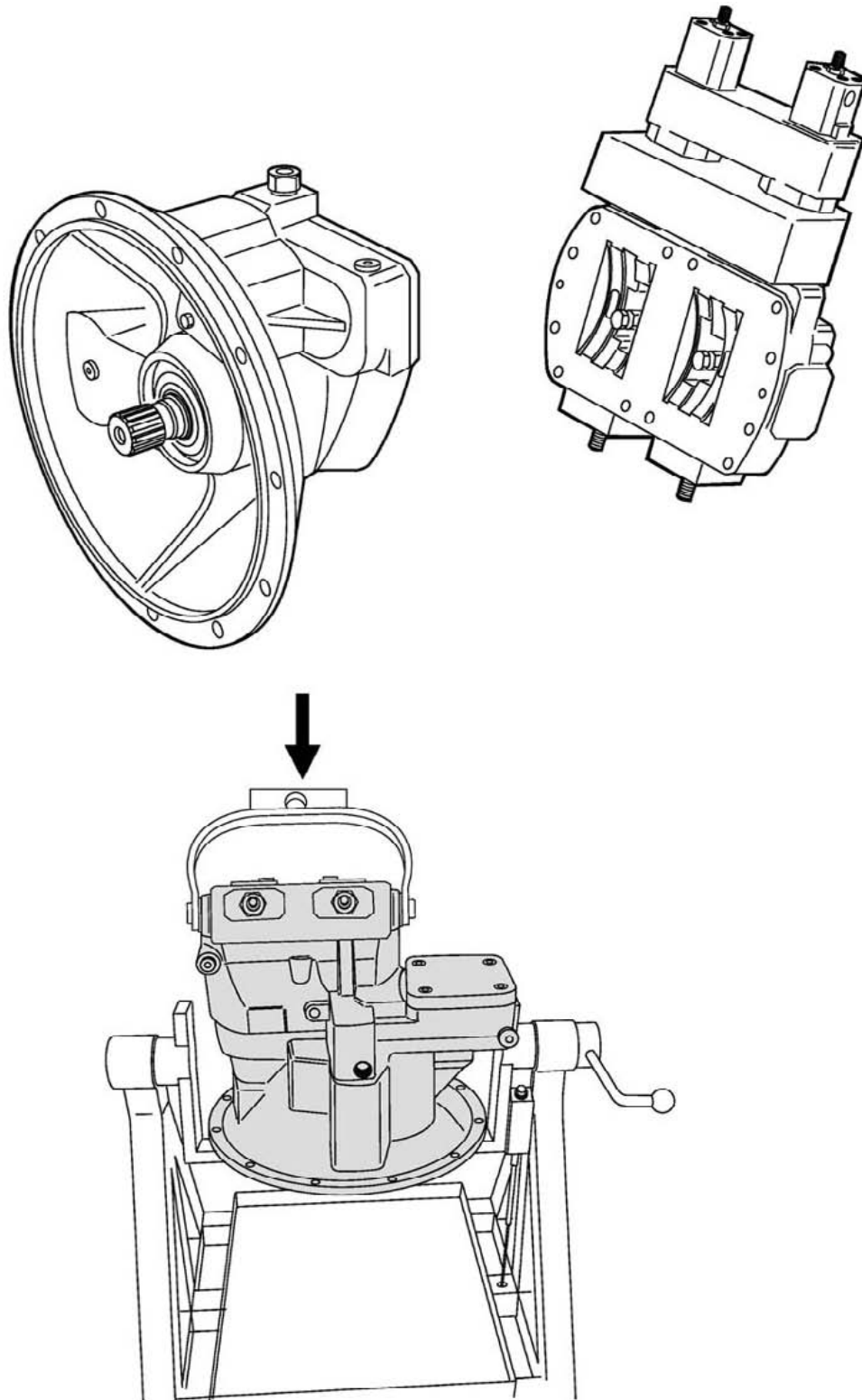


FG003080

Figure 24

Control Housing

1. Place the pump into a disassembly / assembly device with a crane and fix it.



FG003081

Figure 25

! CAUTION!

Mark installation position.

2. Loosen fixing screws of port plate and remove port plate.
Lift the port plate away with a crane.
-

! CAUTION!

Control lenses can fall down.

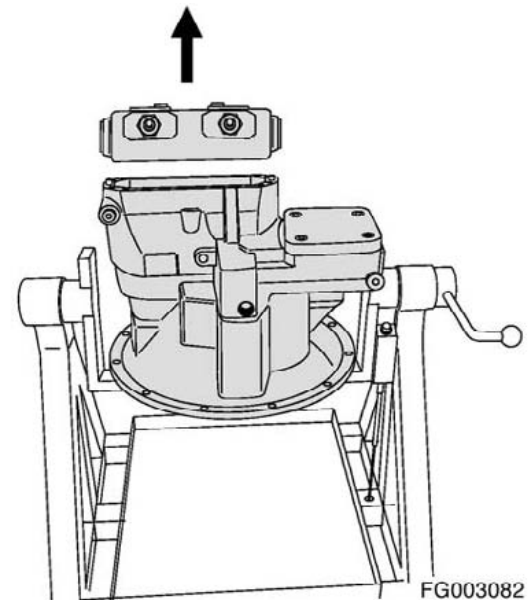


Figure 26

FG003082

3. Remove paper seal, clean sealing surface.

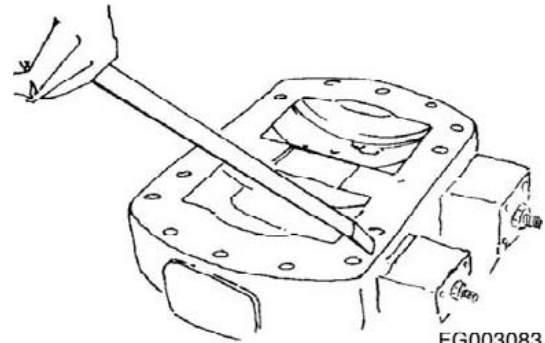


Figure 27

FG003083

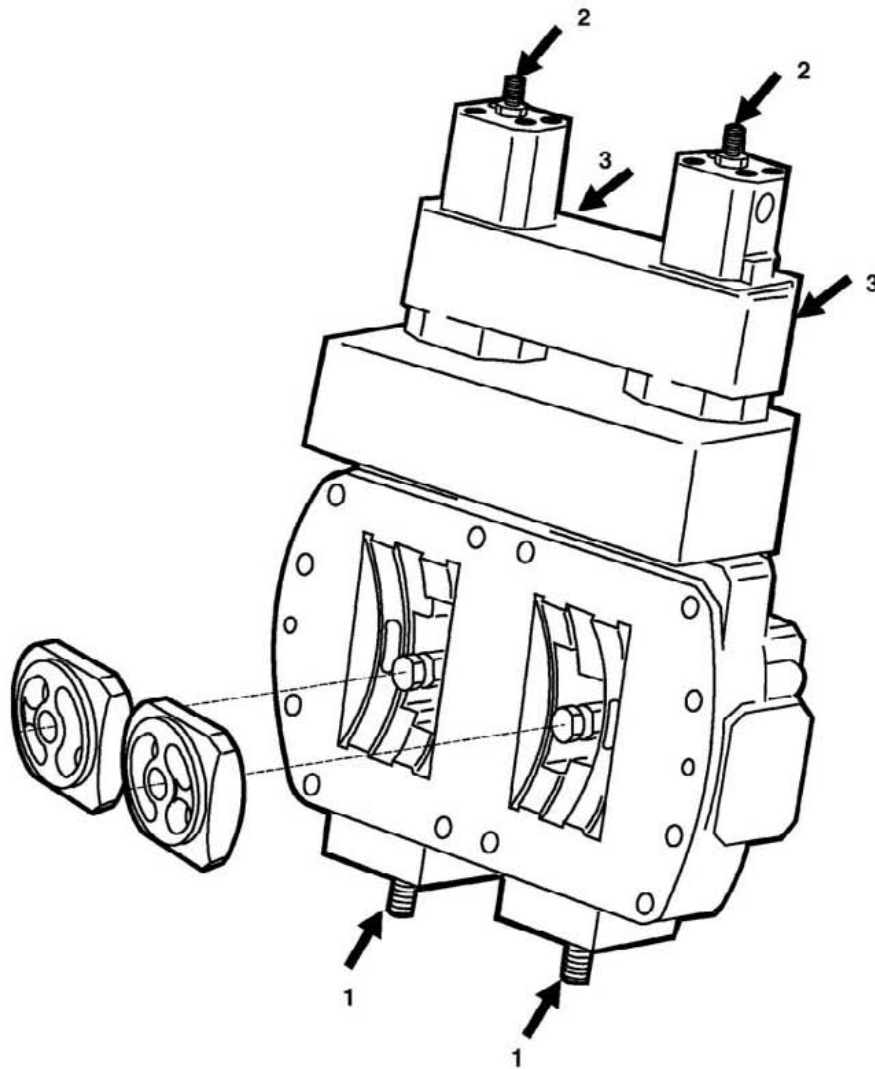


Figure 28

FG003084

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

CAUTION!

Before carrying out a setting or disassembly of the regulator, measure the measurement X and note of the setting screw.

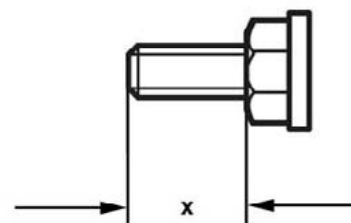
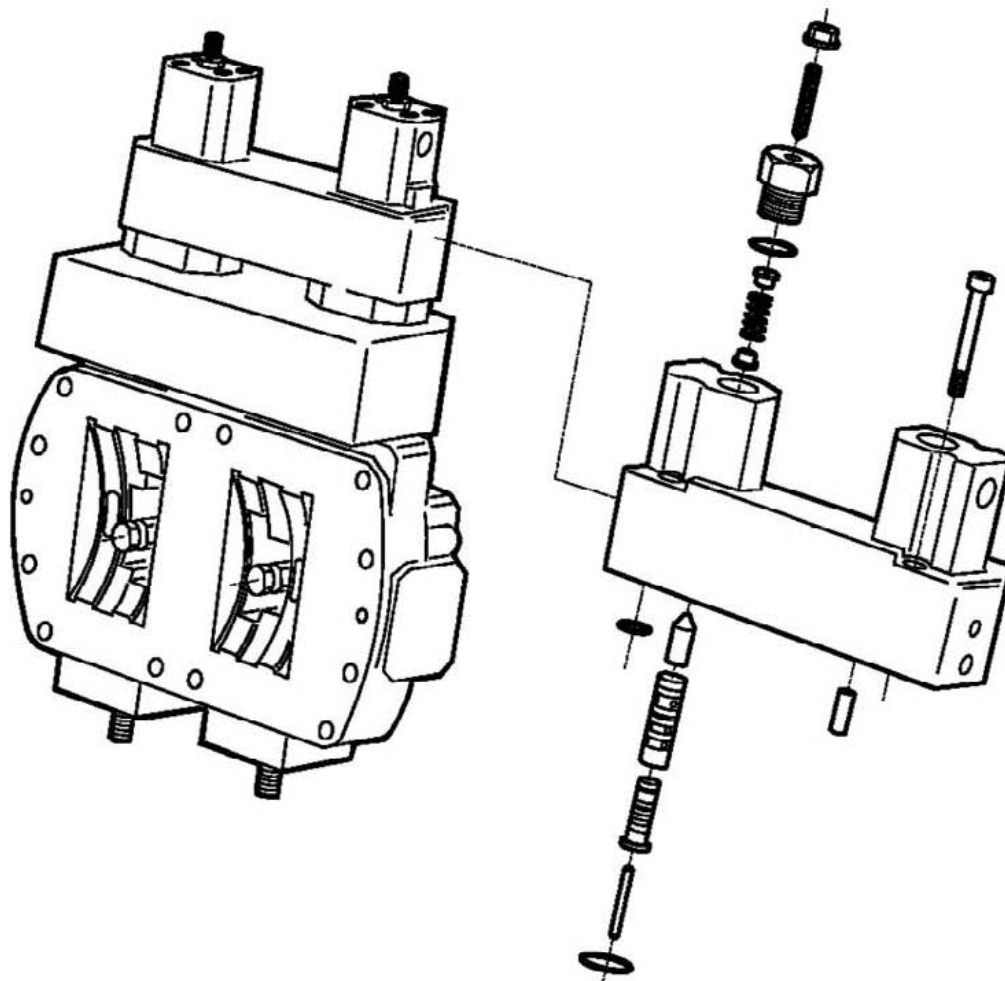


Figure 29

FG003085

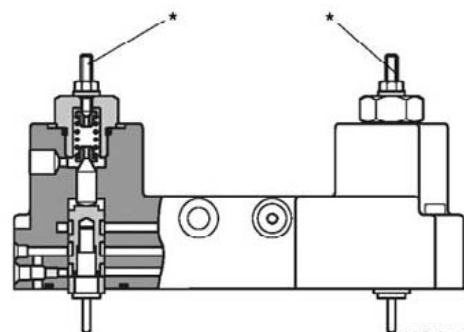
Control Module LR

1. Remove and disassemble control module LR.



FG003086

Figure 30

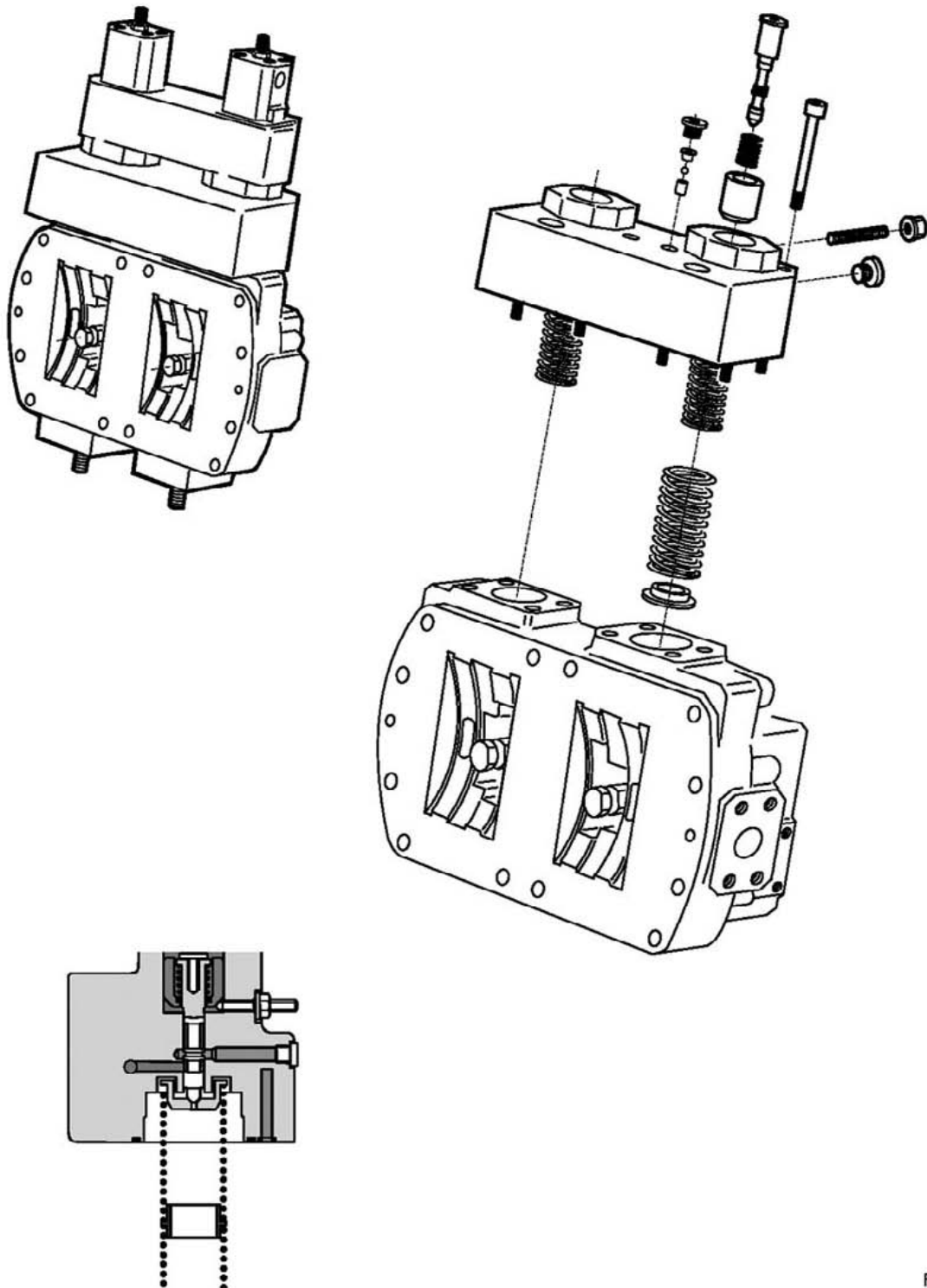


FG003087

Figure 31

Control Module H

1. Remove and disassemble control module H.



FG003088

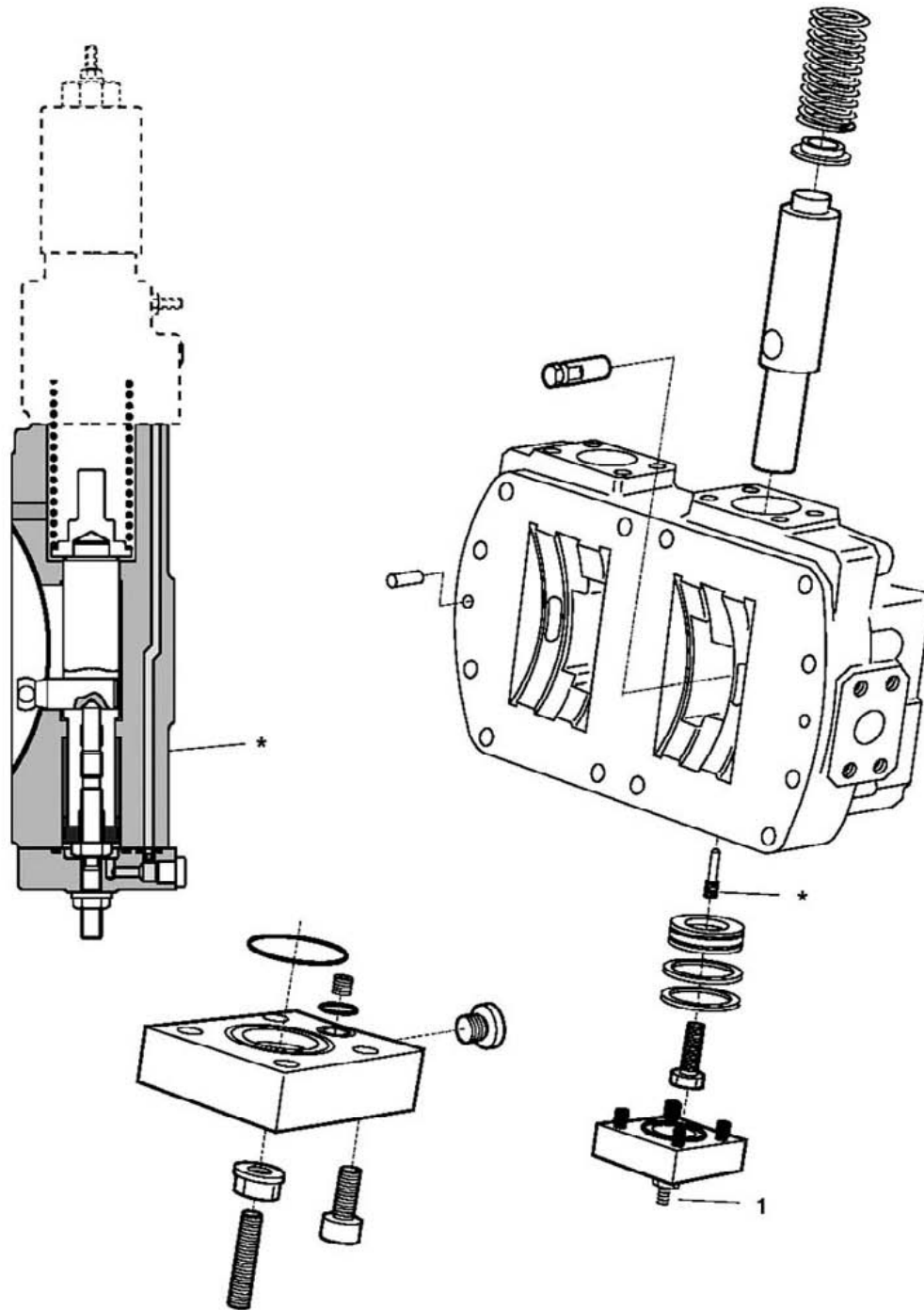
Figure 32

Controller

1. Remove cover.



Do not change the setting screw (1).



FG003089

Figure 33

2. Loosen fixing screws.

! CAUTION!

Fit control lens - torque support.

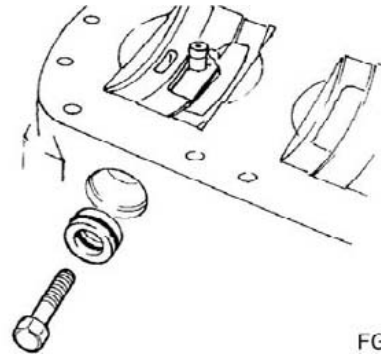


Figure 34

FG003090

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

! CAUTION!

Loosen adhesive with a "gentle" flame (approx. 120°C).

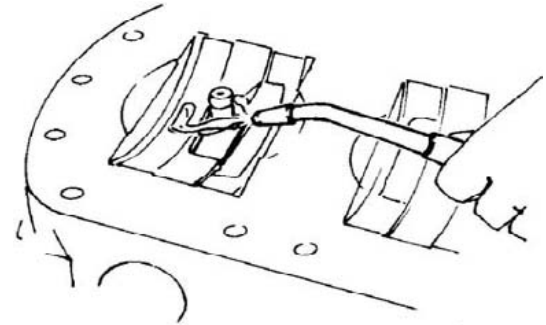


Figure 35

FG003091

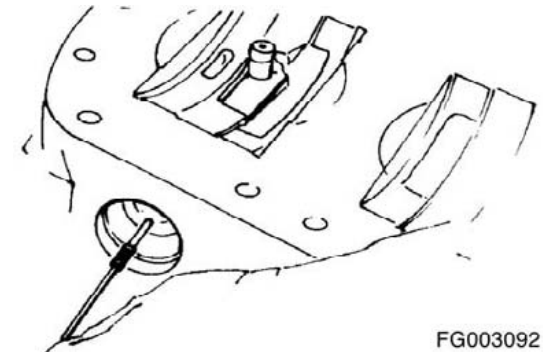


Figure 36

FG003092

4. Loosen swivel pin and then remove it.

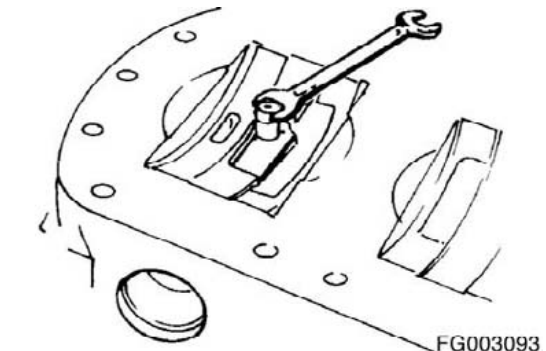
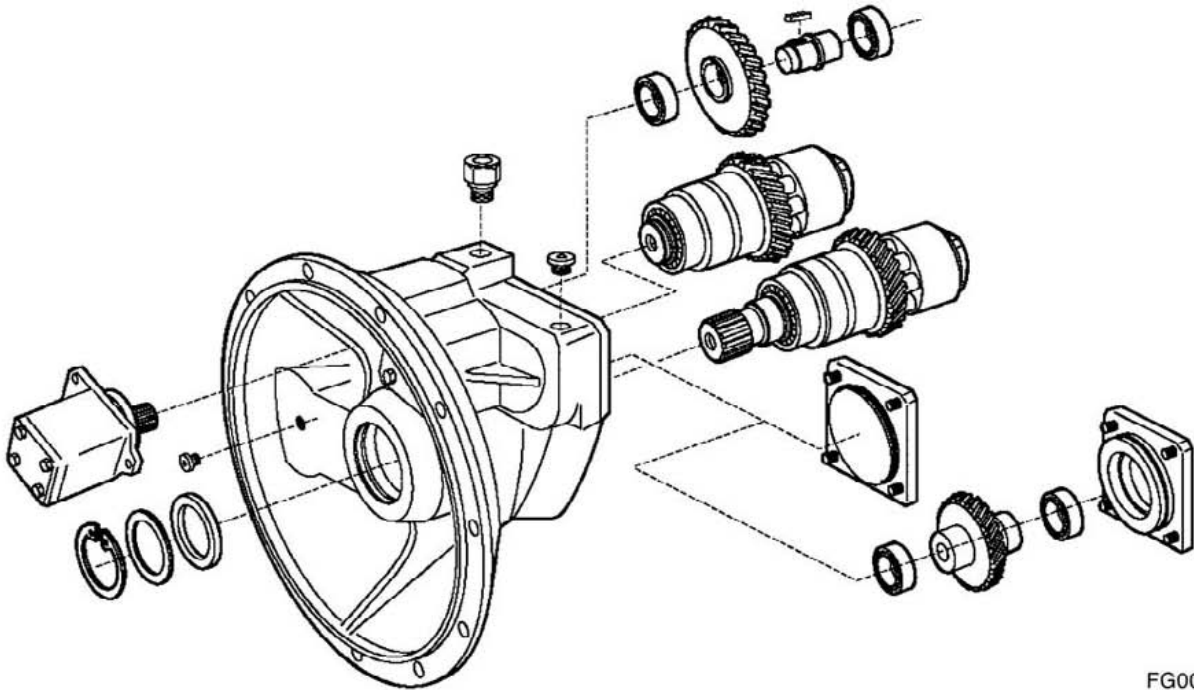


Figure 37

FG003093

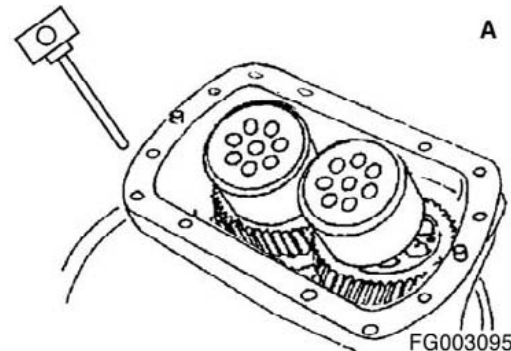
Rotary Groups



FG003094

Figure 38

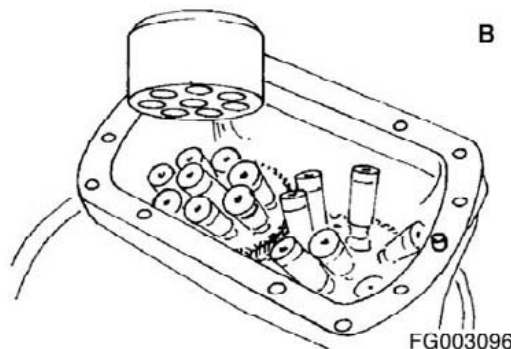
1. Keep the cylinder with a device (Remove it completely with the driveshaft).



FG003095

Figure 39

2. Remove cylinder (Remove driveshaft without cylinder).



FG003096

Figure 40

3. Remove cup springs 1 and spring cup 2.

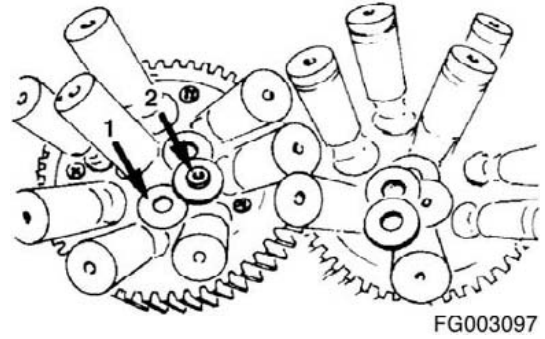


Figure 41

4. Remove positions (1,2 and 3).

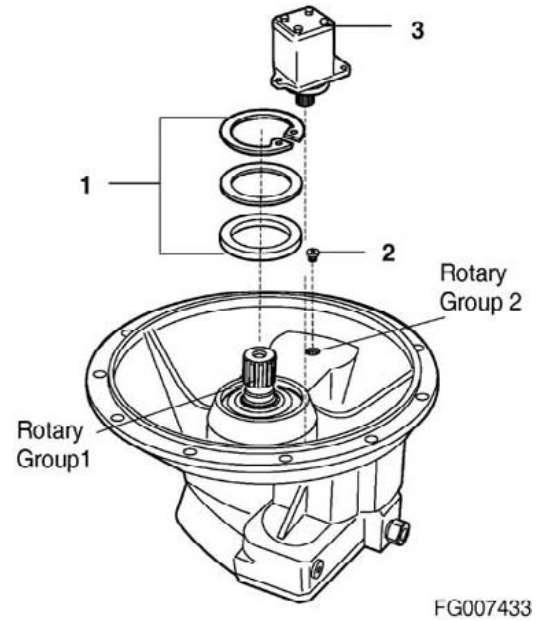


Figure 42

5. Press out hydraulically or mechanically rotary group with a tool device.

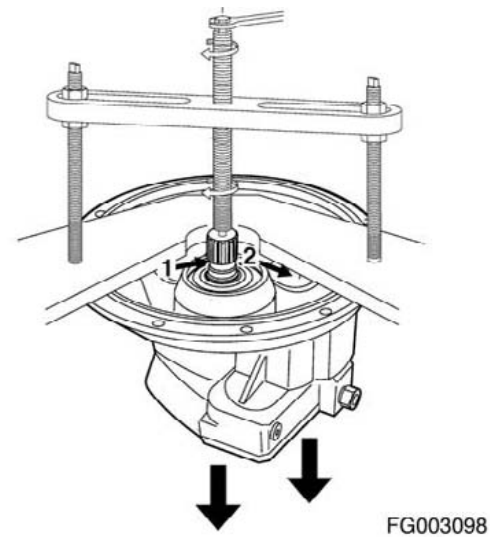
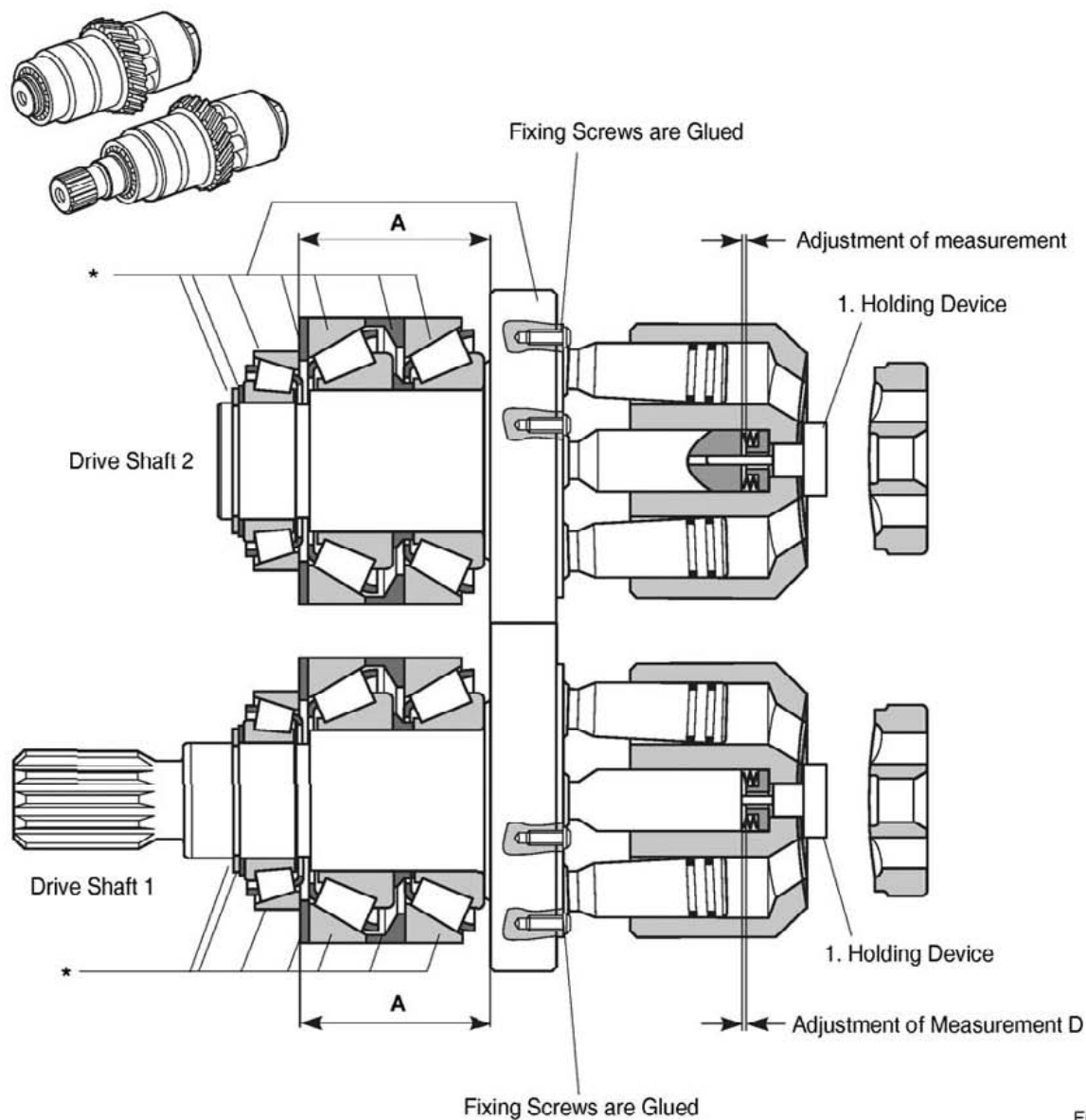


Figure 43



FG007434

Figure 44

! CAUTION!

Pos. * Driveshafts with bearing set are the smallest assembly group.

6. The assembly group is adjusted to measurement A.
The tapered roller bearings are adjusted to the specified through-torque.

! CAUTION!

Fixing screw - Retaining device

7. Loosen of the screws is only possible if the driveshaft is warmed up at a temperature of approx. 120°C 1/2 hour in an oil bath or heat air furnace.

Screw out the screw quickly.

Intermediate Wheel

1. * Press in bolt into the gear wheel. (Fixed pressing fit).

Can only be disassembled with a hydraulic press.

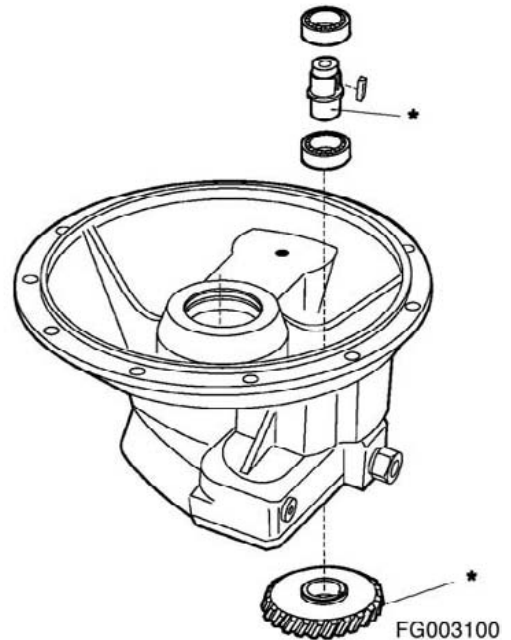


Figure 45



CAUTION!

Install sleeve.

Press out bolt with a hydraulic manual press.

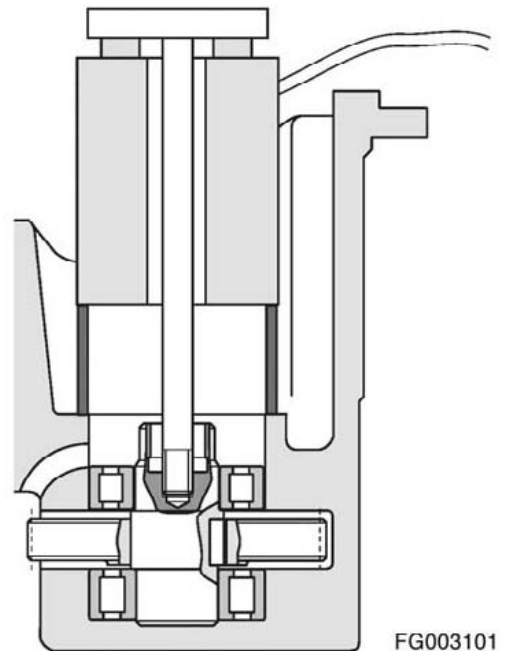
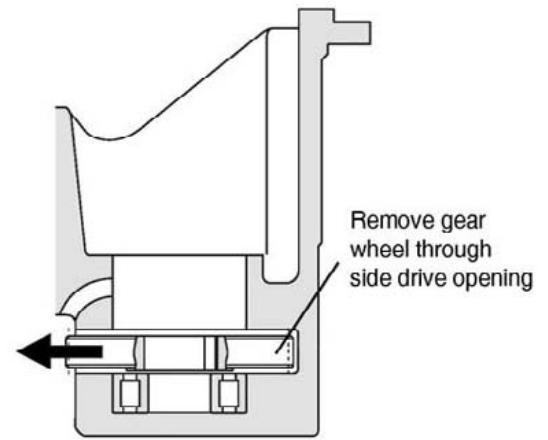
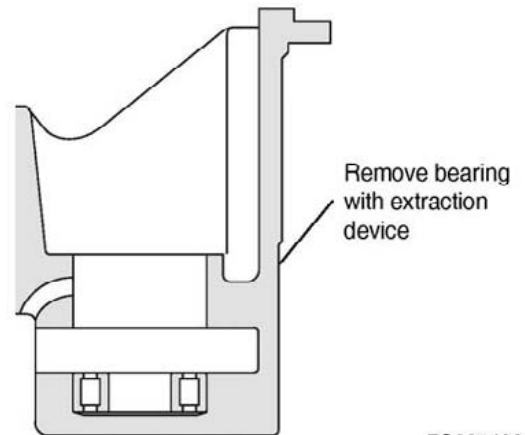


Figure 46



FG007435

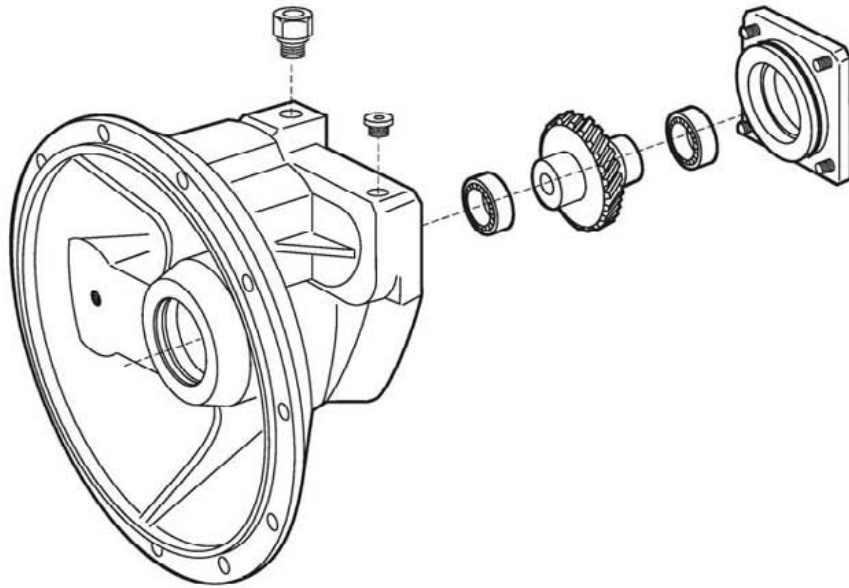
Figure 47



FG007436

Figure 48

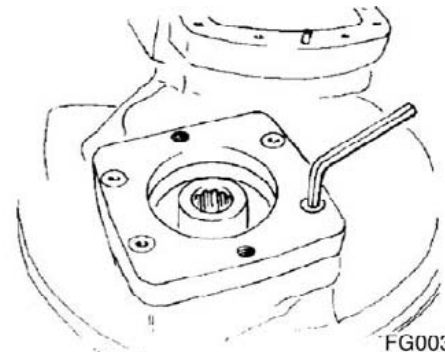
Auxiliary Drive



FG003104

Figure 49

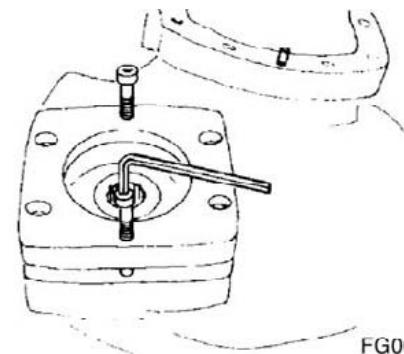
1. Remove fixing screws - auxiliary drive.



FG003105

Figure 50

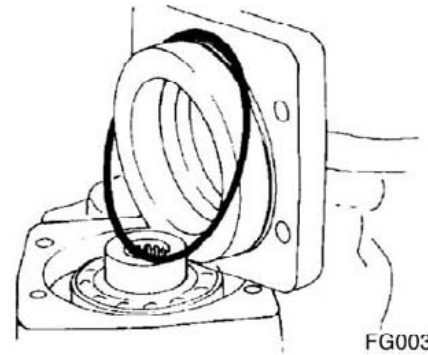
2. Press off bearing cap.



FG003106

Figure 51

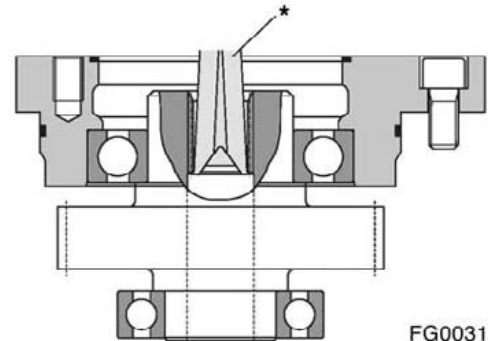
3. In the event of leakage, visual check of O-ring, housing and groove.



FG003107

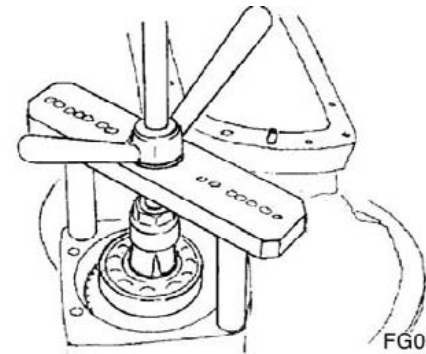
Figure 52

4. Fit extractor device.
Pull out output pinion.



FG003109

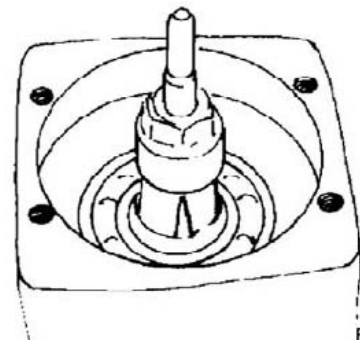
Figure 53



FG003110

Figure 54

5. Fit bearing extractor device.



FG003111

Figure 55

6. Completely mount device and pull out bearing.

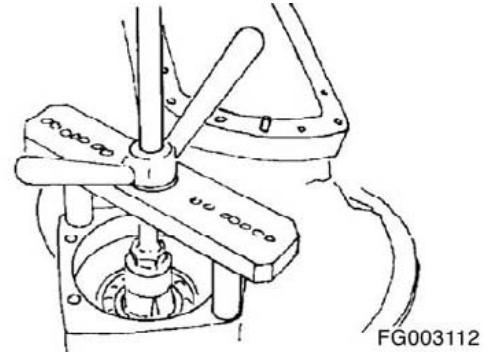


Figure 56

7. Pull out pinion bearing.

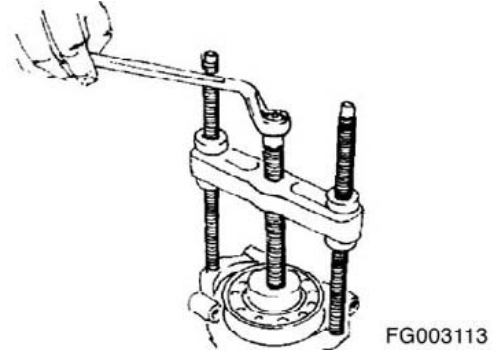


Figure 57

INSPECTION HINTS

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

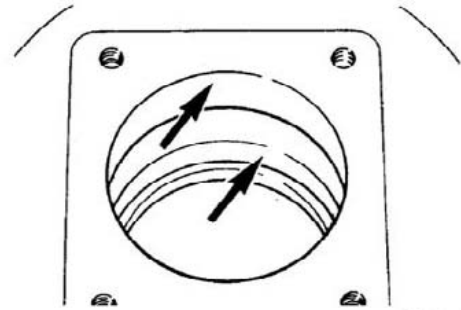


Figure 58

FG003114

2. Visual Check:
To ensure that bearing seats are free of scores.

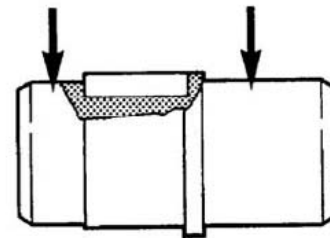


Figure 59

FG003115

3. Visual Check:
Check to see that bearing area is free of scores and that there is no evidence of wear.

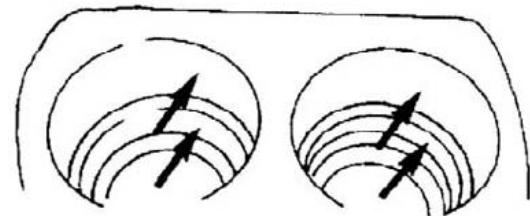


Figure 60

FG003116

4. Axial piston play. (Checked with the retaining plate fitted)

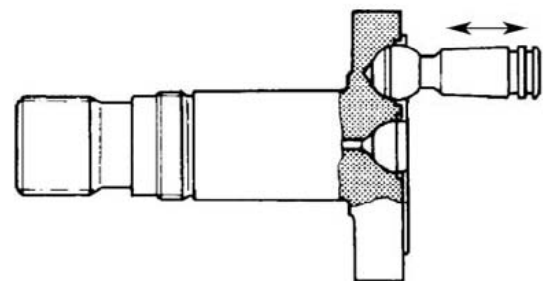


Figure 61

FG003117

5. Driveshafts

- A. Check to ensure that cups are free of scores and that there are no pittings.
- B. Check to see that there is no evidence of corrosion and wear steps.

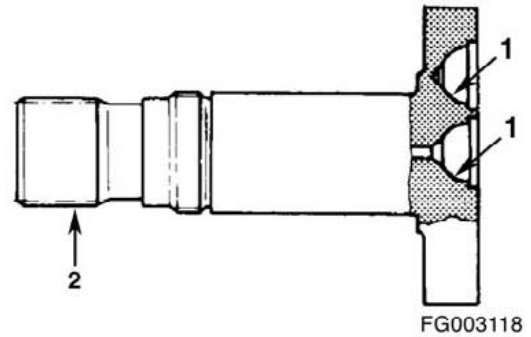


Figure 62

6. Piston

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

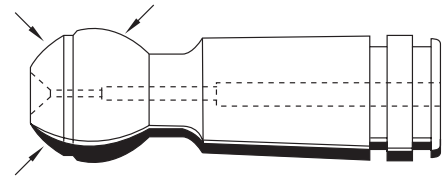


Figure 63

HB7M3050

7. Central Pin

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

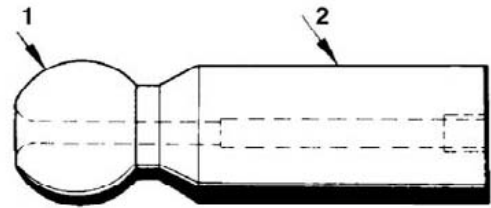


Figure 64

FG003120

8. Retaining Plate

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

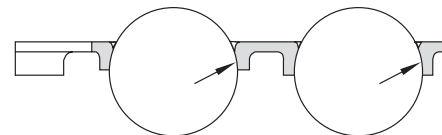


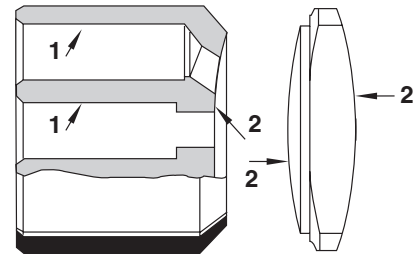
Figure 65

HB7M3052

9. Cylinder Block / Control Lens

Check to ensure that:

- A. The bores (1) are free of scores, no evidence of wear.
- B. The faces (2) are even, that there are no cracks, no scores.
- C. The side guides (3) show no evidence of wear, free of scores.

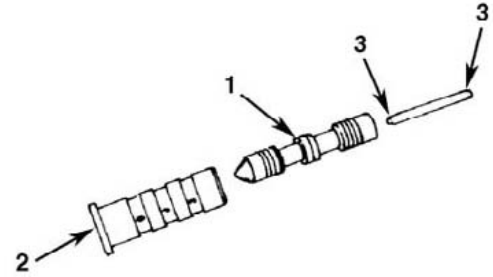


HB7M3053

Figure 66

10. Check

Control land 1, internal control drilling 2, pin cups 3.

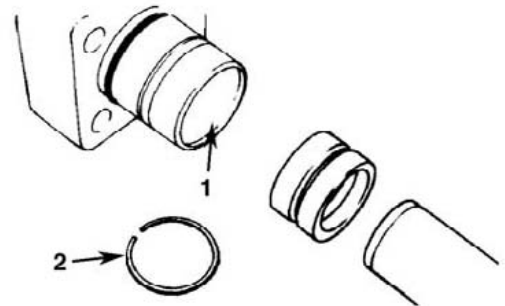


FG003123

Figure 67

11. Check

That sliding surfaces 1 are free of scores, seal 2.



FG003124

Figure 68

12. Complete Rotary Group

(1) Rotary Group

A. Mechanical component: driveshaft is adjusted with the bearing

B. Hydraulic component: Adjustment is necessary *.



Adjustment of the hydraulic component is necessary.

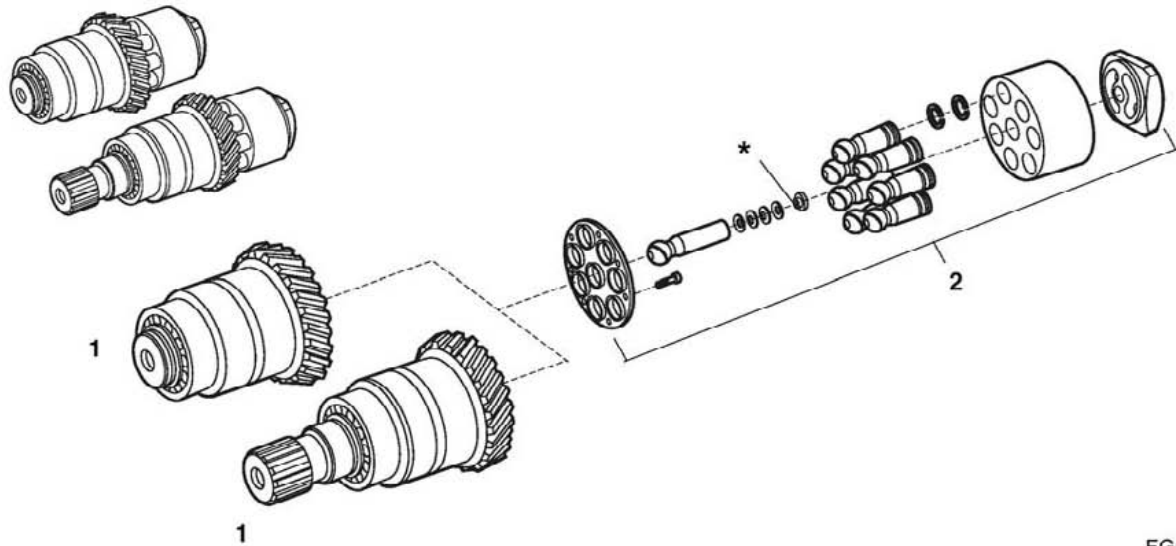


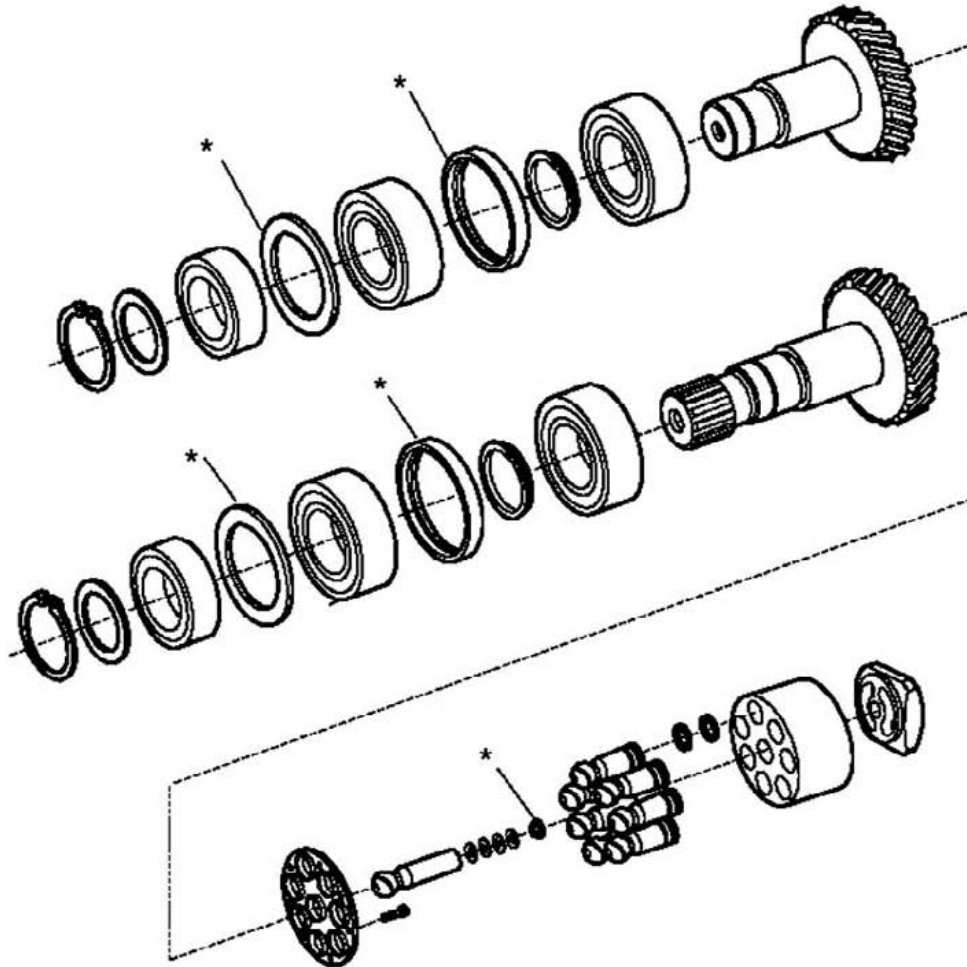
Figure 69

FG003125

(2) Rotary Group: All of the components

* Adjustment

For adjustment values, torque values, see service information



FG003126

Figure 70

ASSEMBLY

Rotary Group

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

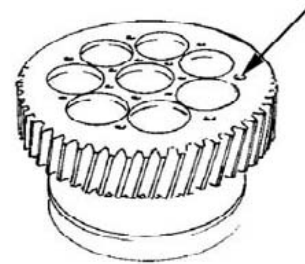


Figure 71

FG003127

2. Fit the retaining plate with pistons and center pin into place.

Use screws that have a Precote coating.

* For tightening torques, see service information.

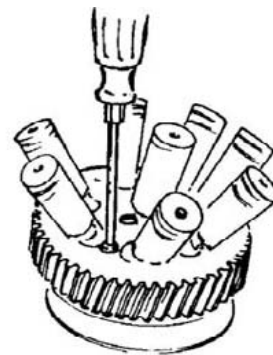


Figure 72

FG003128

3. Fit the spring plate 1 and cup springs 2 into their correct position (and orientation) using grease to hold them into place.

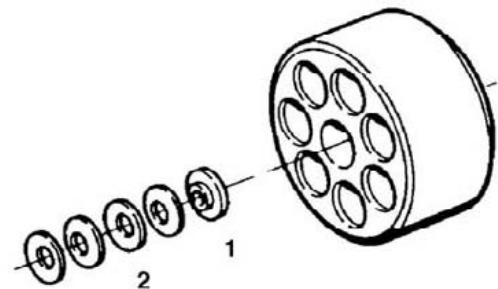
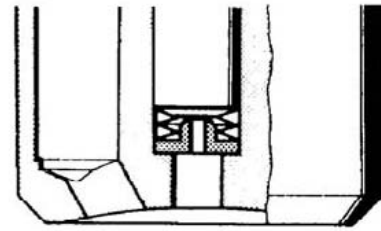


Figure 73

FG003129

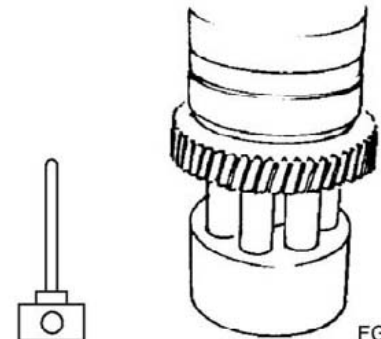
4. Ensure that all the parts are assembled in correct order and orientation.



FG003130

Figure 74

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

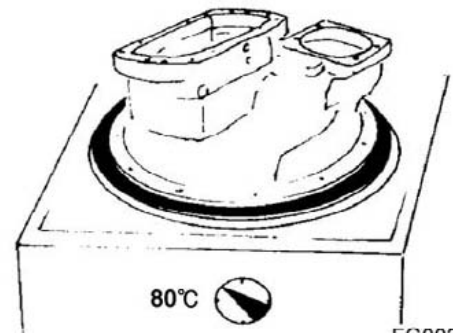


FG003131

Figure 75

Pump

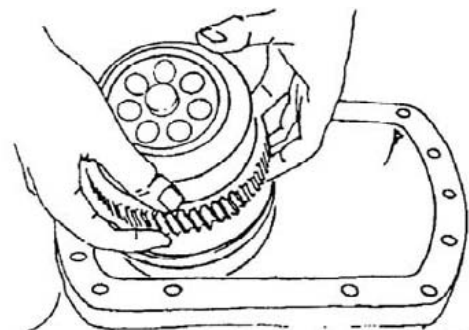
1. Warm up the housing to approx. 80 °C.



FG003132

Figure 76

2. Insert the preassembled rotary group 2, taking into account gear tooth markers.



FG003133

Figure 77

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

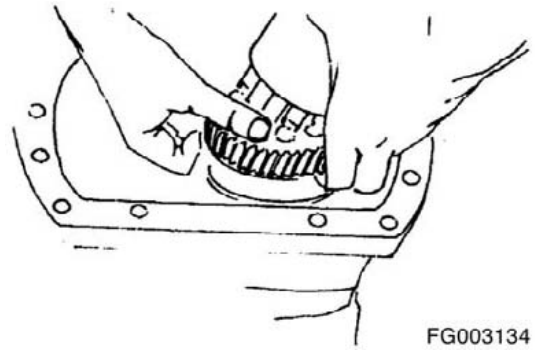


Figure 78

4. The gear tooth markers must coincide.

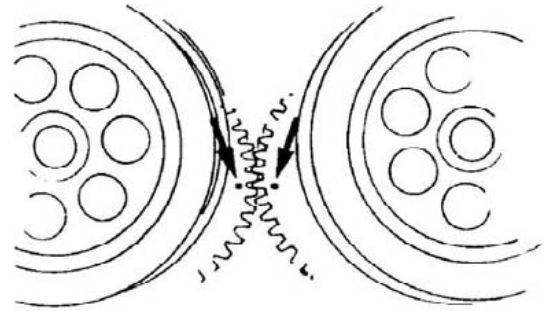


Figure 79



CAUTION!

Adjustment of measurement D.

Control hydraulic part!



Figure 80

HB7M3002



CAUTION!

Driveshafts with Bearing Set

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

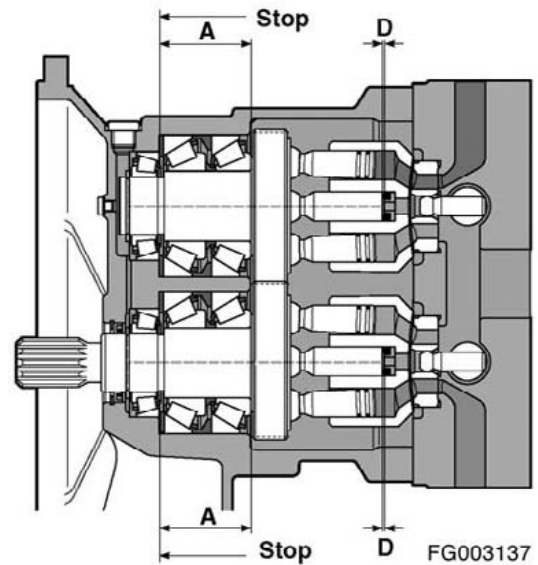


Figure 81

Assembly Guideline

1. Retaining Force

After the rotary group has been fitted into the housing, it has to be pressed in until the end stop is reached.

Allow the housing to cool down from its assembly temperature (approx. 80°C) to room temperature.

2. Adjustment of the Hydraulic Component of the Rotary Group

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

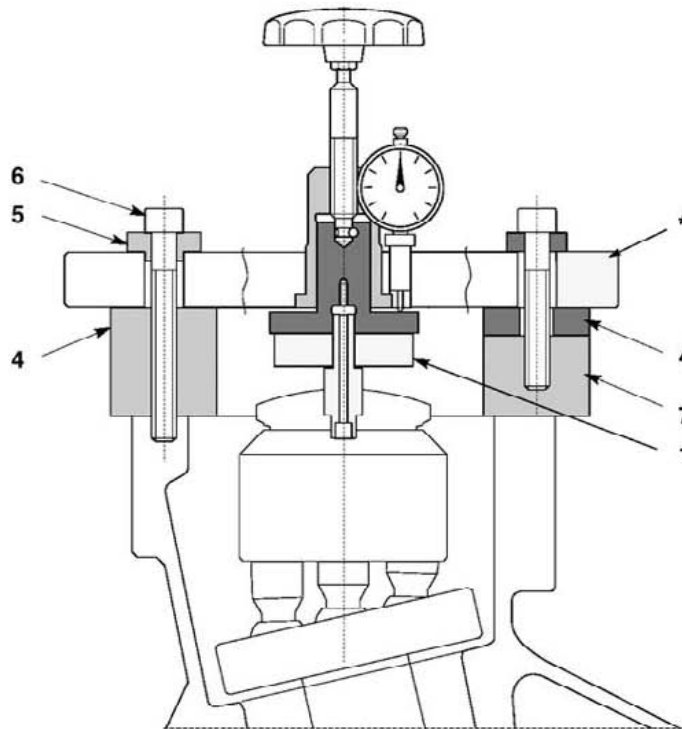
Dimension (D) = 0.4 ± 0.1 mm

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

Hydraulic Component - Measurement "D"

1. Measuring Device

Hydraulic component 452 269



FG003138

Figure 82

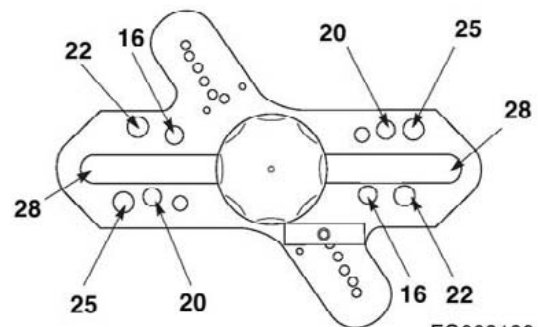
Size			80	107	140	200
Measuring Device			9452269	9452269	9452269	9452269
1	Centering Device	1x	9452019	9452022	9452026	9452025
4	Intermediate Ring	2x	9452014	9452014	9452015	9452015
5	Shim	2x	9083277	9083277	9083279	9083279
6	S.H.C.S	2x	9083105	9083105	9083134	9083134
7	Intermed. Plate	2x			2775186	2775187

2. Mounting Position

Ensure that correct mounting position is used.

The numbers on the top of the measuring device (*) refer to the piston diameter.

Size	80	107	140	200
Mounting Position	22	25	28	28



FG003139

Figure 83

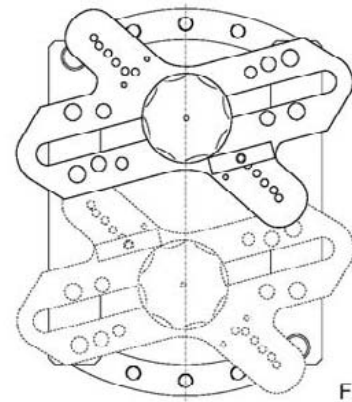


Figure 84

- A. NG / size 80 - 107

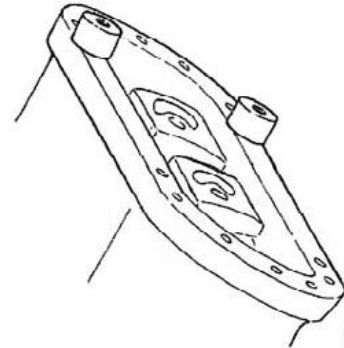


Figure 85

- B. Only size 140 - 200
Fit the intermediate plates onto the housing.

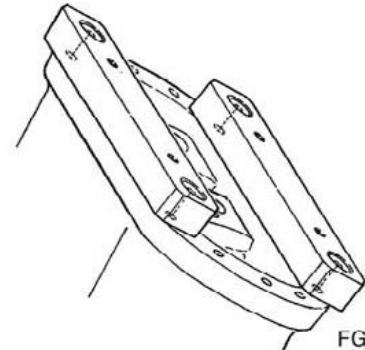


Figure 86

- 3. Zero Adjustment - measuring device
Turn using the hand wheel until the stop is reached.
- Set dial gauge to zero -
 - A. NG / size 80 - 107

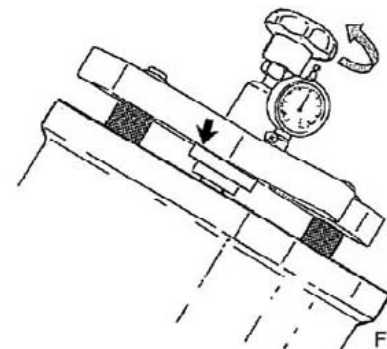


Figure 87

B. NG / size 140 - 200

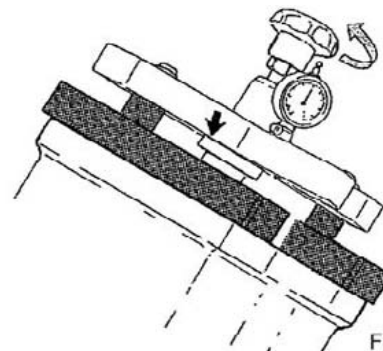


Figure 88

4. Measuring Procedure

Turn down by 4 turns on the dial gauge.

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

Clearance: Size 28 - 200 0.4 mm $\pm$ 0.1

A. NG / size 80 - 107

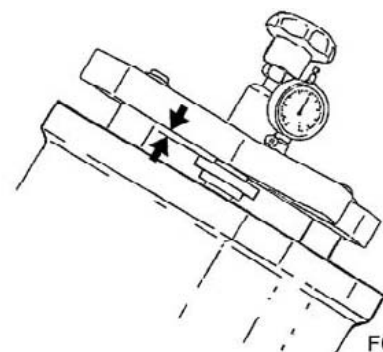


Figure 89

B. NG / size 140 - 200

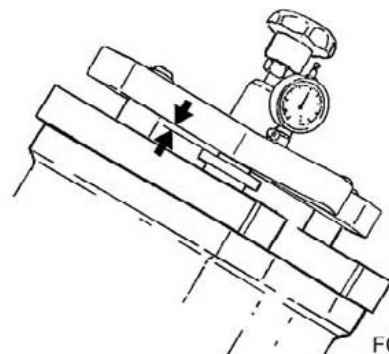


Figure 90

5. Measuring Procedure

Turn down, using the hand wheel, until resistance is met.

Read the measured value.



CAUTION!

Don't use excessive force.

A. NG / size 80 - 107

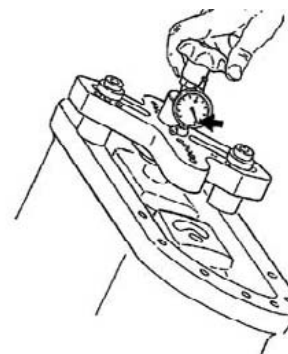


Figure 91

B. NG / size 140 - 200

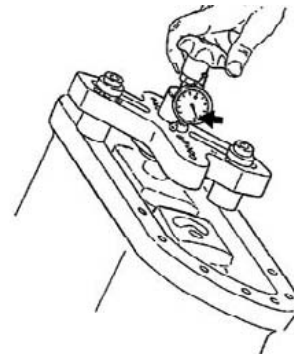


Figure 92

FG003149

Control Housing

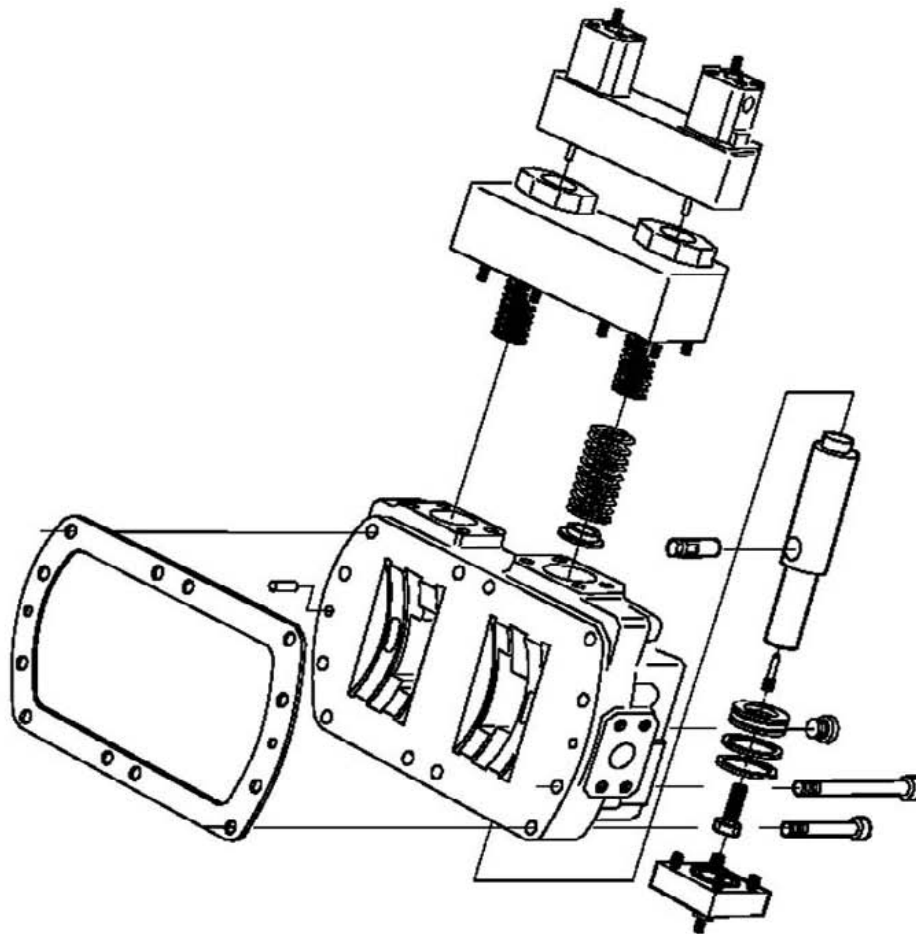


Figure 93

FG003150

1. Fit the swivel pin into correct position and orientation.

Take the hardening time and tightening torque into account.

* M6 = 8.5 Nm

M8 = 14 Nm

M10 = 35 Nm

M12 = 69 Nm

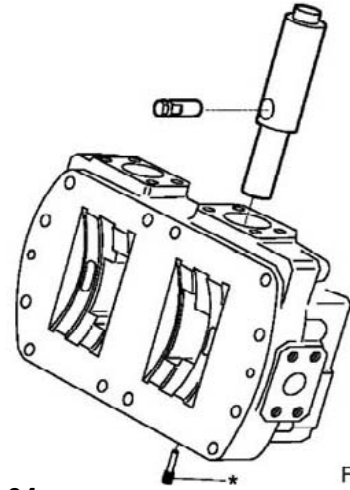


Figure 94

FG003151

2. Push on the piston ring by hand.

Fix adjustment piston.

Take the tightening torques into account.

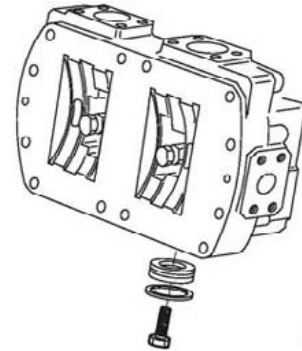


Figure 95

FG003152

3. Fit control housing.

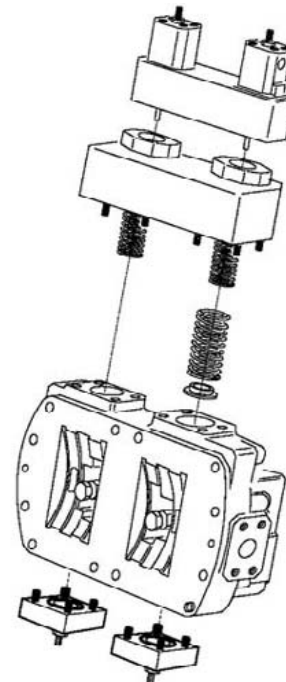


Figure 96

FG003154

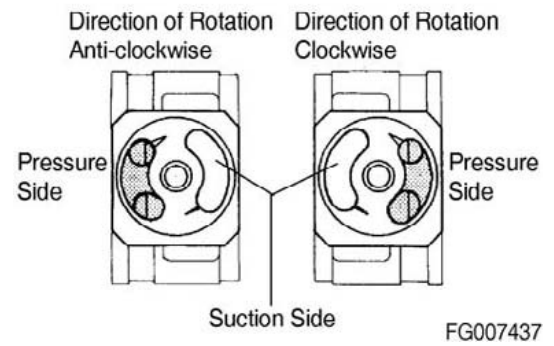


Figure 97

4. Fit the control lens in its correct position using grease to hold it in place.

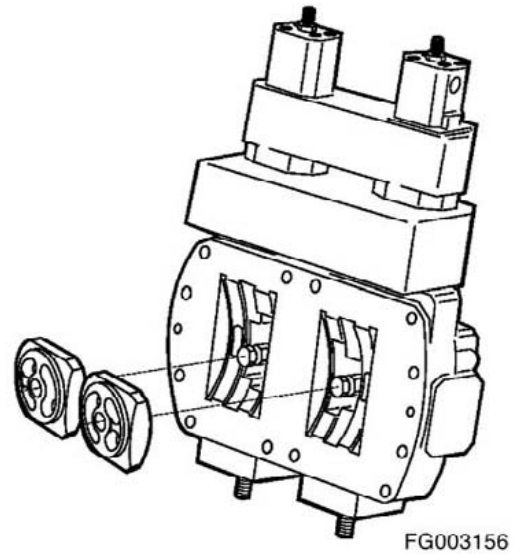


Figure 98

5. Fit seal* and controller.

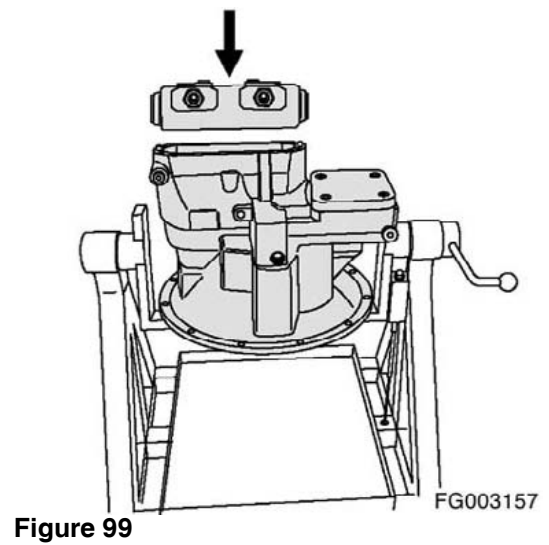


Figure 99

Intermediate Wheel

1. Press in bearing into housing.
2. Install and align the intermediate wheel through side drive opening.



CAUTION!

Cool down the bolt with nitrogen and place it.

3. Press in bearing.

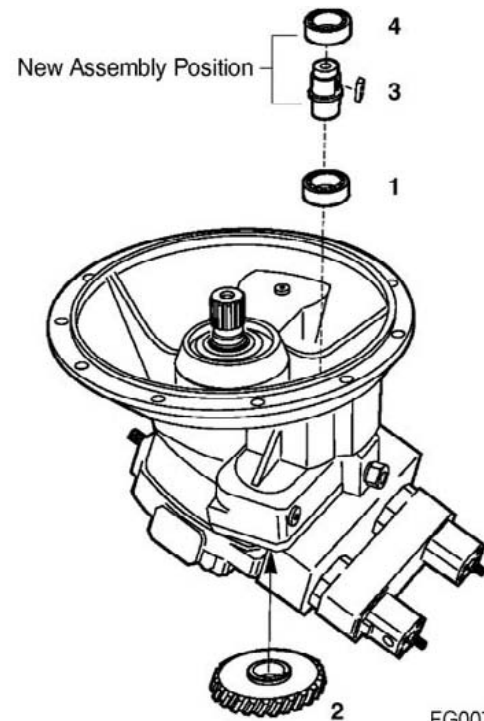


Figure 100

FG007438

4. Press in the bearing into the housing.

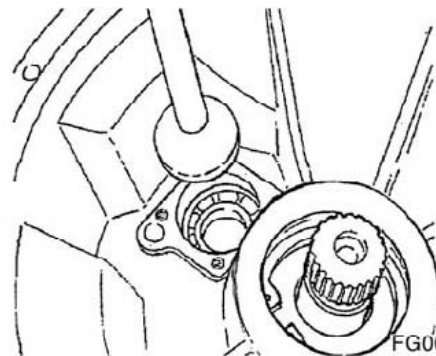
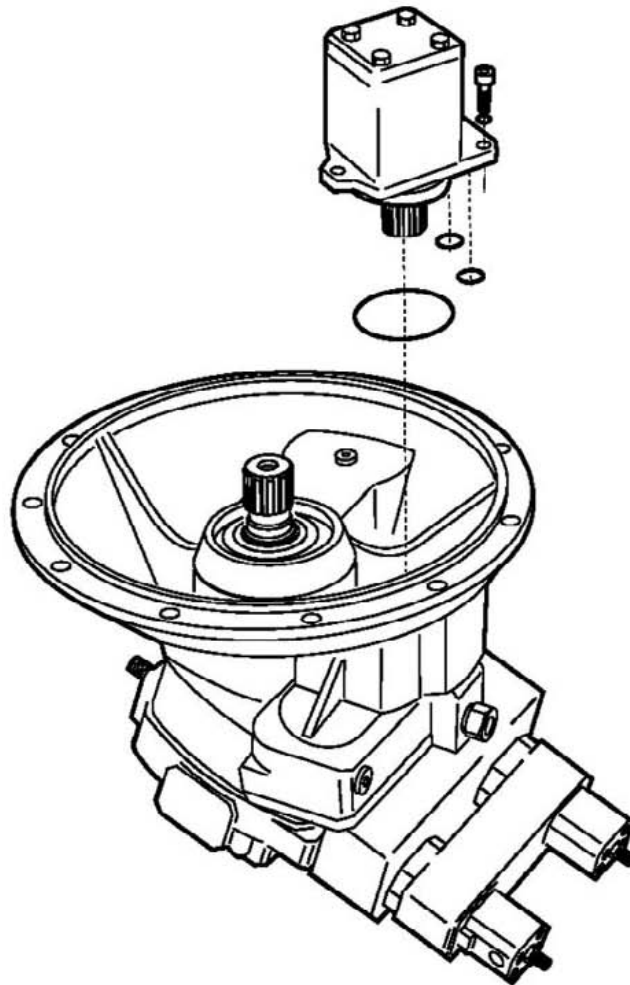


Figure 101

FG003159

Gear Pump

1. Assemble shaft seal, disk and safety ring.
Press in with assemble sleeve.

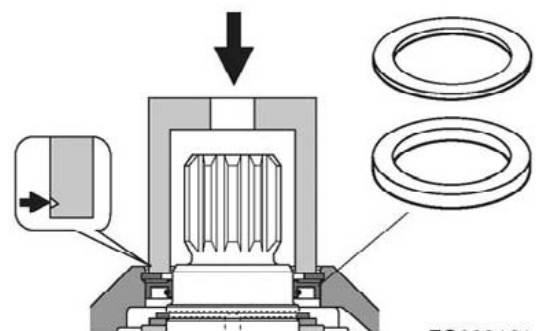


FG003160

Figure 102

! CAUTION!

Take care of press in depth!



FG003161

Figure 103

Cover / Auxiliary Drive

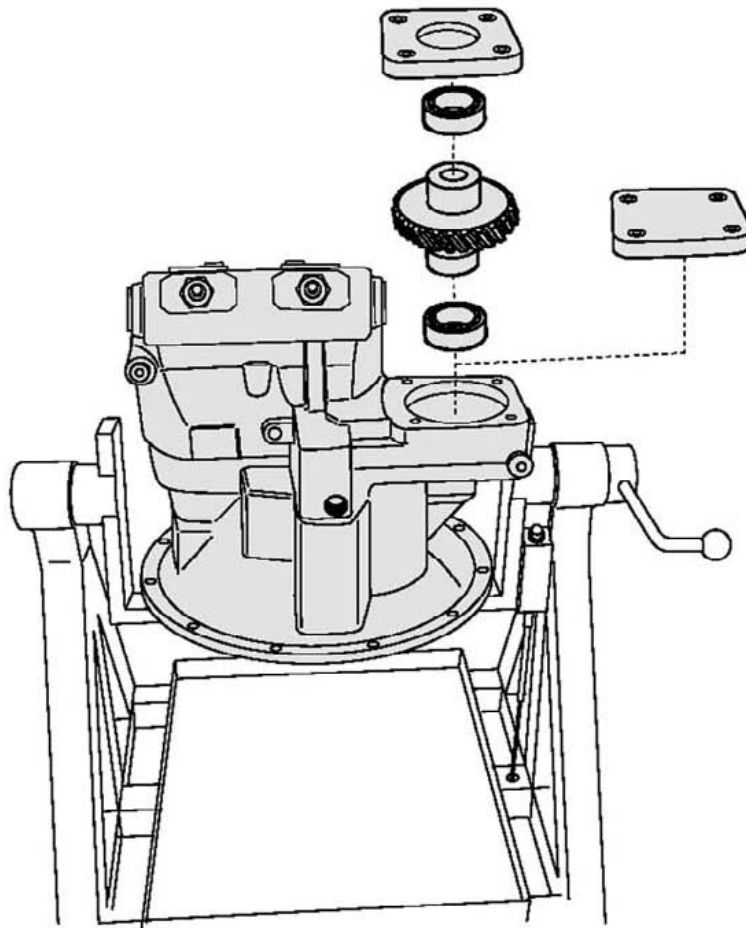


Figure 104

FG003162

ASSEMBLY GUIDELINES FOR TIGHTENING TORQUES

Bolts (to N 08.001)

The values stated are valid for bolts with metric ISO threads to DIN 13 part 13, and head areas to DIN 912 socked head cap screws, DIN 931 hexagon bolt or DIN 933 hexagon bolts with threads up to the head.

Thread	Tensile Strength Class		
	8.8	10.9	12.9
	Tightening Torque M _A in Nm		
M8 x 1	5	G 1/8 A	10
M10 x 1	10	G 1/4 A	30
M12 x 1.5	20	G 3/8 A	35
M14 x 1.5	30	G 1/2 A	60
M16 x 1.5	35	G 3/4 A	90
M18 x 1.5	40	G 1 A	140
M20 x 1.5	50	G 1 1/4 A	240
M22 x 1.5	60	G 1 1/2 A	300
M26 x 1.5	70		
M27 x 2	90		
M30 x 1.5	100		
M33 x 2	140		
M42 x 2	240		

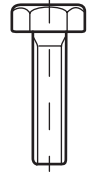
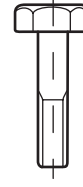
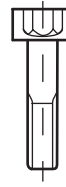


Figure 105

FG003163

Plugs with Internal Hexagon and Profile Seal Ring (to N 02.009)

Thread	Tightening Torque M_A in Nm
M8 x 1	5
M10 x 1	10
M12 x 1.5	20
M14 x 1.5	30
M16 x 1.5	35
M18 x 1.5	40
M20 x 1.5	50
M22 x 1.5	60
M26 x 1.5	70
M27 x 2	90
M30 x 1.5	100
M33 x 2	140
M42 x 2	240
M48 x 2	300
G 1/8 A	10
G 1/4 A	30
G 3/8 A	35
G 1/2 A	60
G 3/4 A	90
G 1 A	140
G 1 1/4 A	240
G 1 1/2 A	300

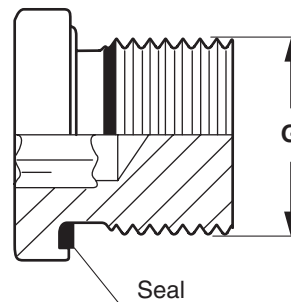


Figure 106

FG007439

Seal-lock - Sealing Nuts (to N 02.100)

Thread	Tightening Torque M_A in Nm
M6	10
M6 x 0.5	11
M8	22
M8 x 1	24
M10	40
M10 x 1	44
M12	69
M12 x 1.5	72
M14	110
M14 x 2	120
M16	170
M16 x 1.5	180

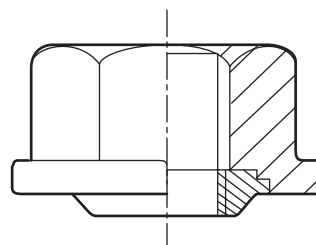


Figure 107

FG003165

Gear Pump

Edition 1

MEMO

Table of Contents

Gear Pump

Safety Precautions	5
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Single Gear Pump	6
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Reassembly	8
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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

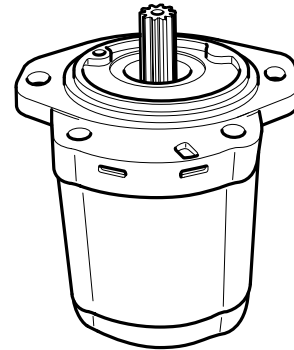
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

SINGLE GEAR PUMP

Disassembly

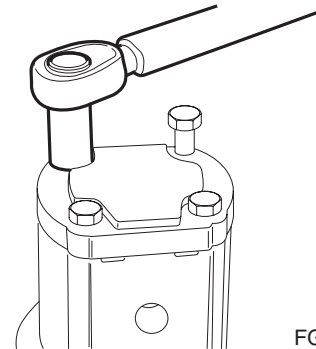
1. Clean exterior of pump.



FG001072

Figure 1

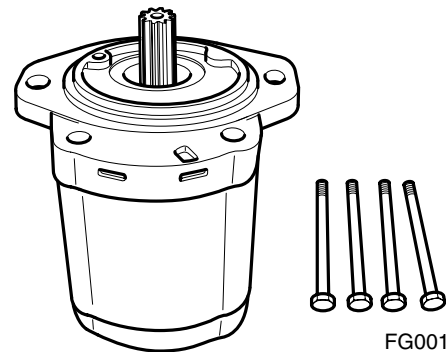
2. Remove clamp bolts.



FG001074

Figure 2

3. Cover sharp edges of driveshaft with adhesive tape and coat shaft end extension with clean grease, to avoid any damage to lip of shaft seal when removing mounting flange.



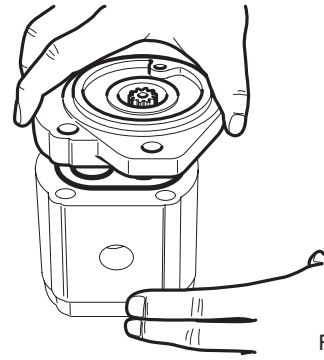
FG001073

Figure 3

4. Remove mounting flange taking care to keep flange as straight as possible during removal.

If mounting flange is stuck, tap around edge with rubber mallet to break it away from body.

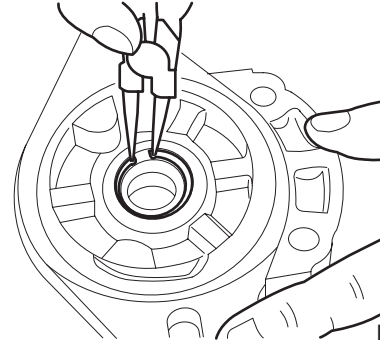
NOTE: Make sure that while removing mounting flange, shaft and other components remain in position.



FG001075

Figure 4

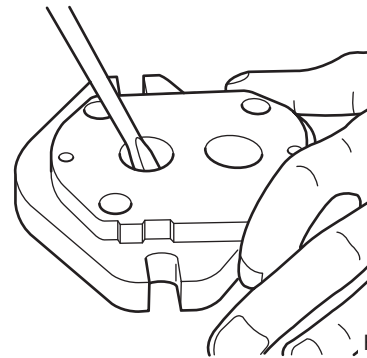
5. Remove retaining ring, if replacement is necessary.



FG000834

Figure 5

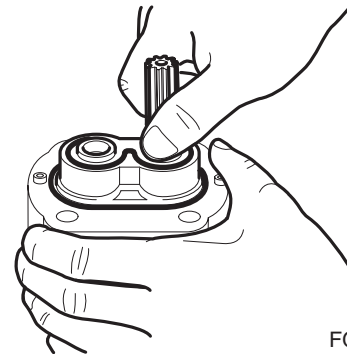
6. Remove shaft seal taking care not to damage surface of shaft hole, if replacement is necessary.



FG000835

Figure 6

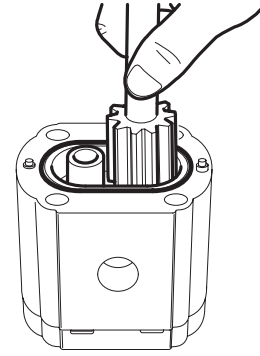
7. Pull drive gear up to facilitate removal of front plate.



FG001076

Figure 7

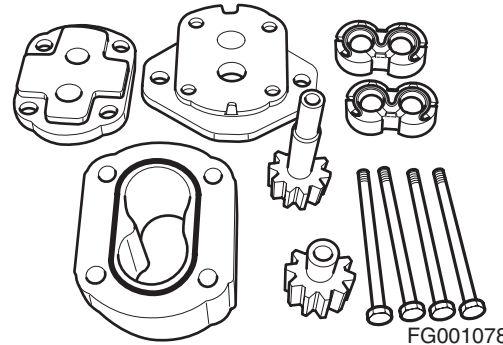
8. Remove driving gear and driven gear, keeping gears as straight as possible.



FG001077

Figure 8

9. Remove rear plate and end cover.

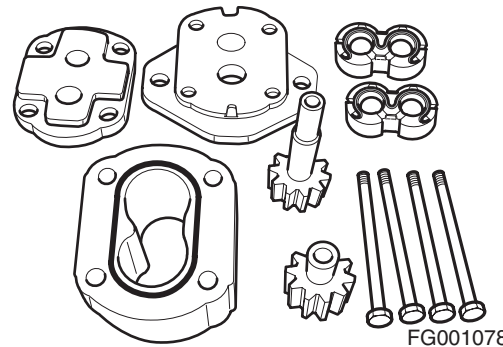


FG001078

Figure 9

Reassembly

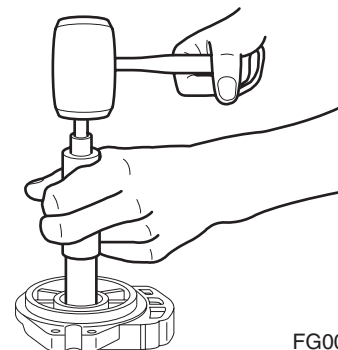
1. Clean all components with care.



FG001078

Figure 10

2. Using a suitable driver, install shaft seal in mounting flange.



FG000839

Figure 11

3. Install retaining ring in groove.

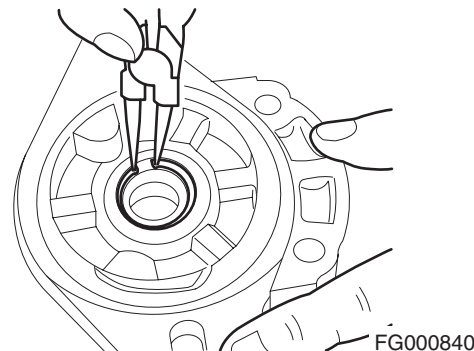


Figure 12

4. Install O-ring on both sides of rear section of body.

NOTE: Coat O-rings with grease to hold O-rings in body.

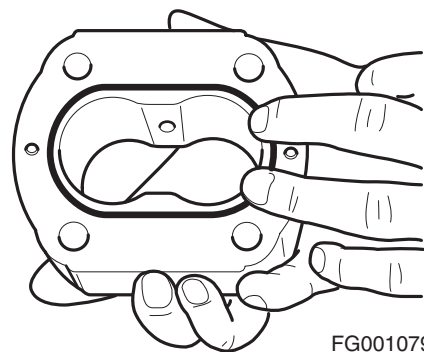


Figure 13

5. Install rear section body on rear cover.

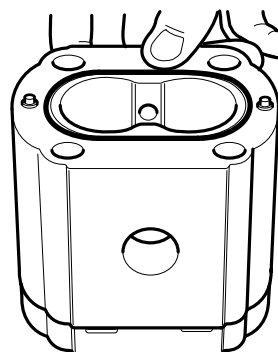


Figure 14

6. Install seals in pressure plate(s) groove. Then install backup ring in groove with seals. Coat seals with grease.

NOTE: The front and rear pressure plates and seals and backup rings are the same.

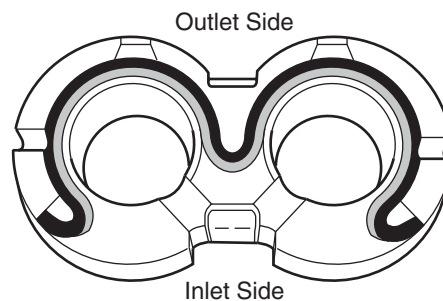
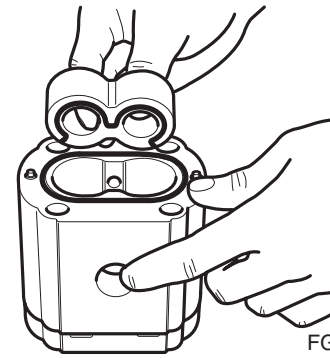


Figure 15

7. Insert pressure plate assembly into body while keeping it straight.

NOTE: Seal side should face to rear cover, opposite side of gears.

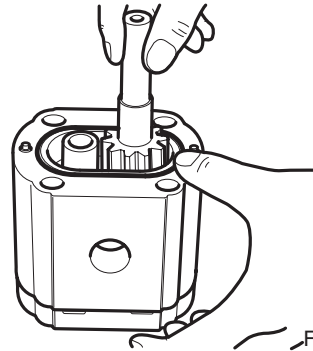
NOTE: Pay attention to installation direction of seal.



FG001081

Figure 16

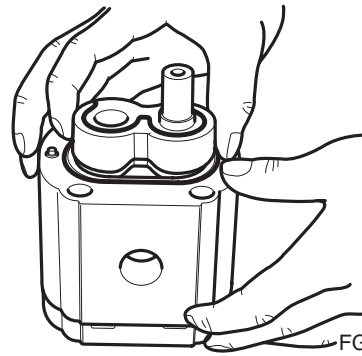
8. Install drive gear and driven gear.



FG001082

Figure 17

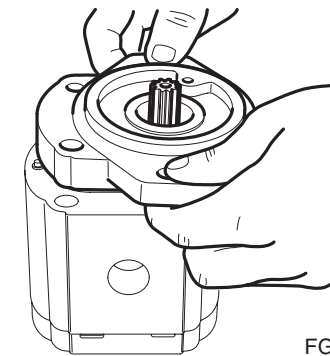
9. Insert pressure plate into body in proper direction.



FG001083

Figure 18

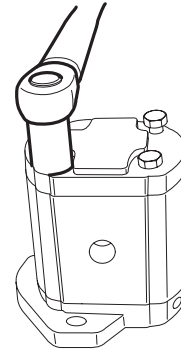
10. Locate mounting flange in right position.



FG001084

Figure 19

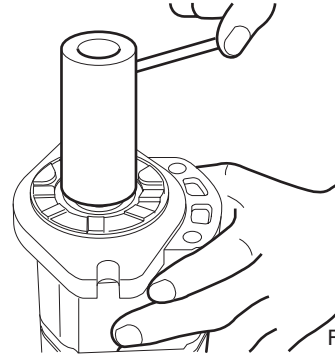
11. Tighten bolts with washer in a crisscross pattern to a torque value of 45 Nm.



FG001085

Figure 20

12. Check that pump rotates freely when driveshaft is turned by hand. If not a pressure plate seal may be pinched.



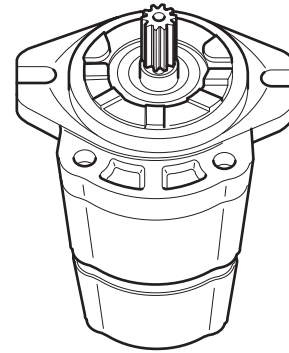
FG000851

Figure 21

DOUBLE GEAR PUMP

Disassembly

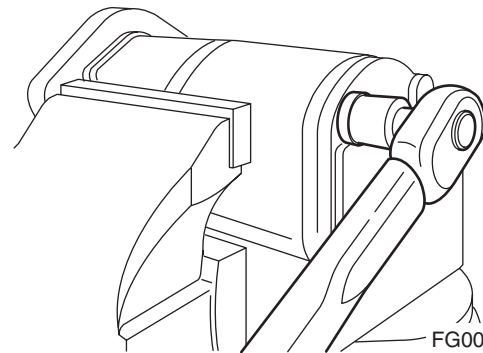
1. Clean exterior of pump.



FG000830

Figure 22

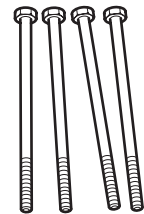
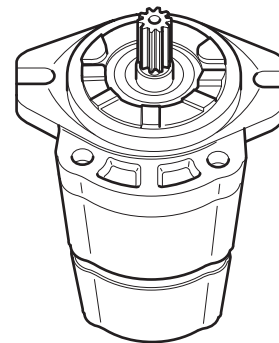
2. Remove clamp bolts.



FG000831

Figure 23

3. Cover sharp edges of driveshaft with adhesive tape, and coat shaft end extension with clean grease, to avoid any damage to lip of shaft seal when removing mounting flange.



FG000832

Figure 24

4. Remove mounting flange taking care to keep flange as straight as possible during removal.

If mounting flange is stuck, tap around edge with rubber mallet to break it away from body.

NOTE: Make sure that while removing mounting flange, shaft and other components remain in position.

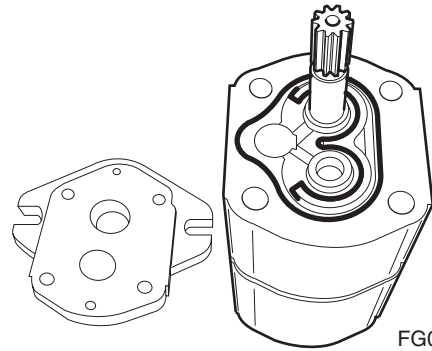


Figure 25

5. Remove retaining ring, if replacement is necessary.

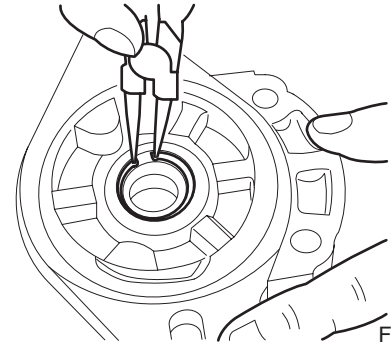


Figure 26

6. Remove shaft seal taking care not to damage surface of shaft hole, if replacement is necessary.

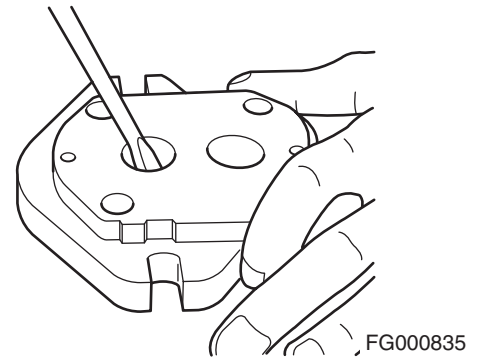


Figure 27

7. Pull drive gear up to facilitate removal front plate.
Remove drive gear, driven gear, rear plate, keeping gears as straight as possible.

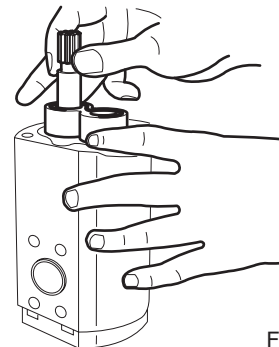
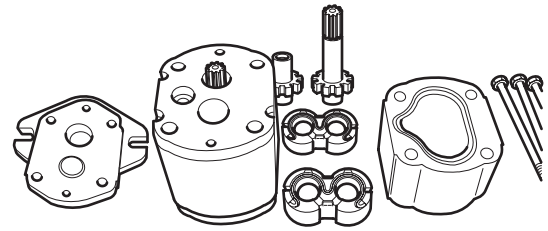


Figure 28

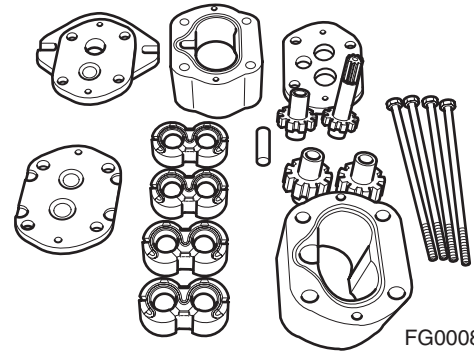
8. Remove intermediate cover and through shaft.



FG000837

Figure 29

9. Remove all remaining components in same manner as first section.

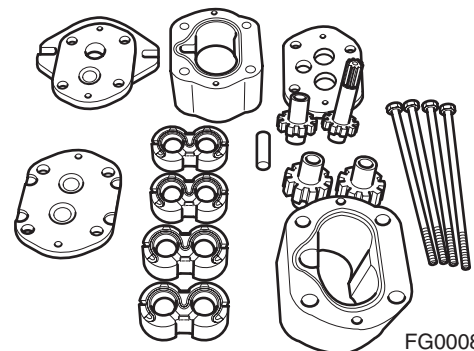


FG000838

Figure 30

Reassembly

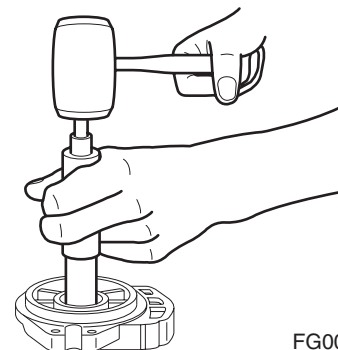
1. Clean all components with care.



FG000838

Figure 31

2. Using a suitable driver, install shaft seal in mounting flange.



FG000839

Figure 32

3. Install retaining ring in groove.

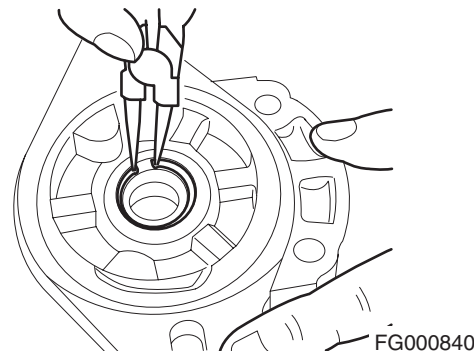


Figure 33

4. Install O-ring on both sides of rear section of body.

NOTE: *Coat O-rings with grease to hold O-rings in body.*

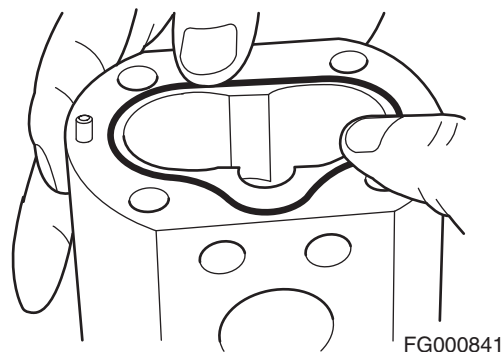


Figure 34

5. Install rear section body on rear cover.

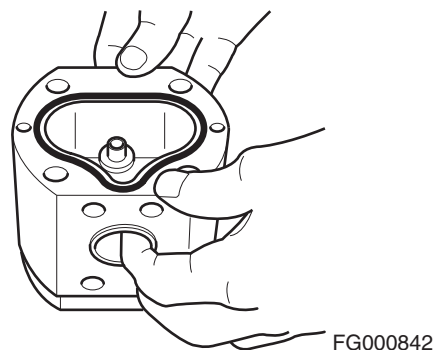


Figure 35

6. Install seals in pressure plate(s) groove. Then install backup ring in groove with seals. Coat seals with grease.

NOTE: *The front and rear pressure plates and seals and backup rings are the same.*

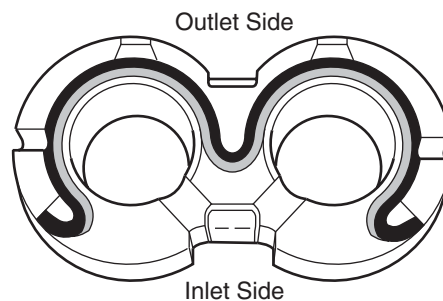
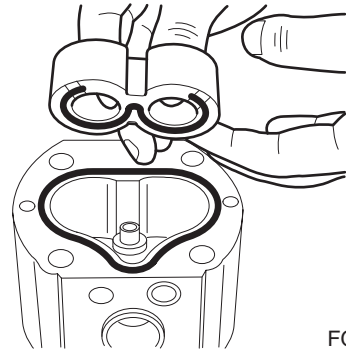


Figure 36

7. Insert pressure plate assembly into body while keeping plate straight.

NOTE: Seal side should face to rear cover, opposite side of gears.

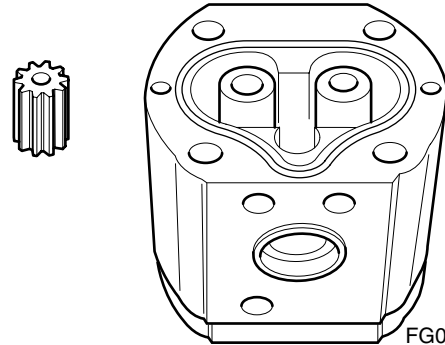
NOTE: Pay attention to direction of seal.



FG000844

Figure 37

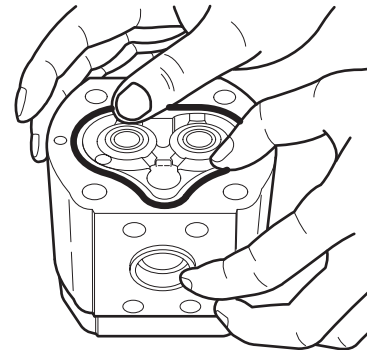
8. Install drive gear and driven gear.



FG000845

Figure 38

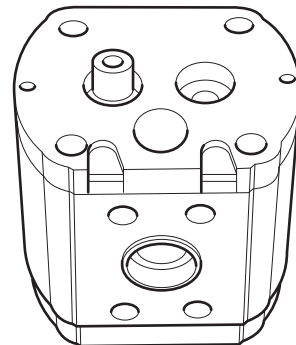
9. Insert pressure plate into body in proper direction.



FG000846

Figure 39

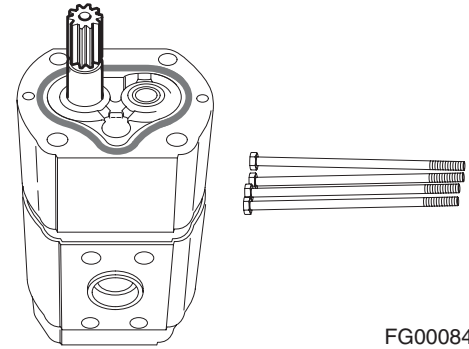
10. Install intermediate cover, one rear section, and through shaft.



FG000847

Figure 40

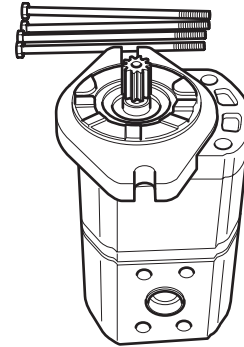
11. Install remaining section using preceding procedure.



FG000848

Figure 41

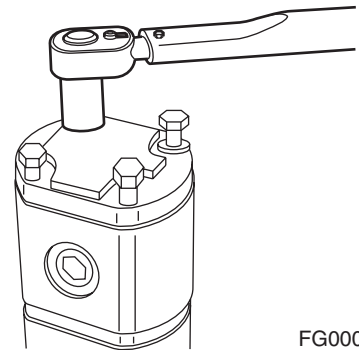
12. Locate mounting flange in right position.



FG000849

Figure 42

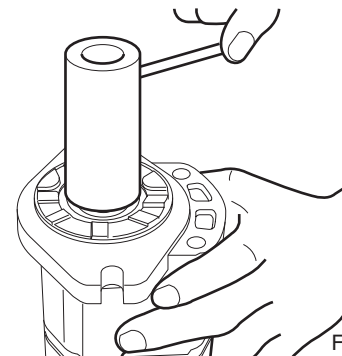
13. Tighten bolts with washer in a crisscross pattern to a torque value of 45 Nm.



FG000850

Figure 43

14. Check that pump rotates freely when driveshaft is turned by hand. If not a pressure plate seal may be pinched.



FG000851

Figure 44

Service Brake Supply Valve

Edition 1

MEMO

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Service Brake Supply Valve

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Applicable Models	5
Diagram of Brake Supply Valve Assembly Package	6
Functions of Brake Supply Valve Assembly Package	7
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Cautions for Disassembly and Reassembly	10
Troubleshooting Guide	11
How to Check Brake Pressure	12

MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

Diagram of Brake Supply Valve Assembly Package

Brake Supply Valve Assembly Package includes parts described in the table below.

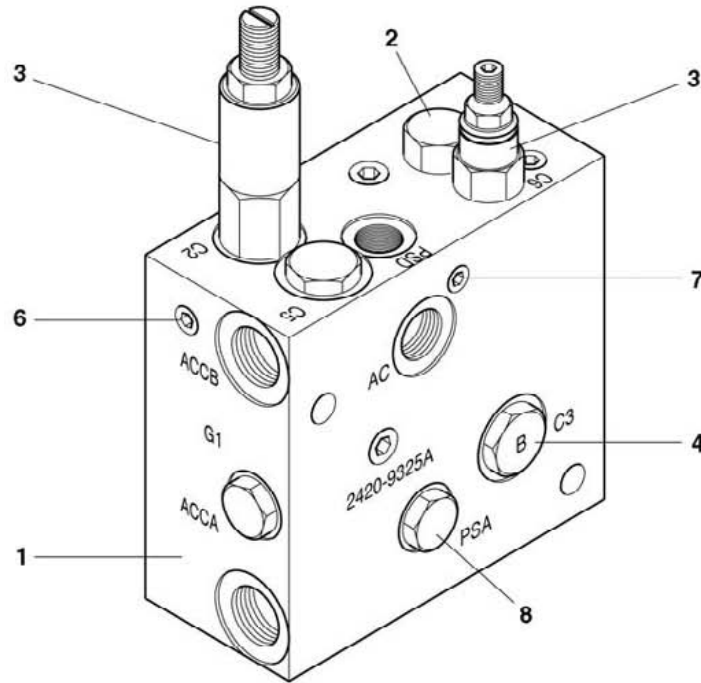


Figure 1

FG003800

No.	Part name	Part specification	Quantity	Remark
1	Manifold Block	130 * 127 * 64	1	2-A1109-94-2
2	Logic Valve	LRDA-XDN	1	C1
3	Relief Valve	DE-RVA-OO-3000	1	C2
4	Check Valve	FD-DCP-O-B	3	C3, C4, C5
5	Unloading Valve	QPAB-LAN	1	C6
6	Plug	PT 1/4"	3	
7	Plug	PT 1/8"	6	
8	Plug	PF 1/4"	3	PSA,GP,G1

Functions of Brake Supply Valve Assembly Package

Functions

This Brake Supply Valve Assembly Package has functions as below:

1. Prevents overload on brake pump saving energy.
2. Performs a function as a safety device of the brake control device.
3. Supplies brake control pressure.

Functions of Each Valve

Valve No.	Valve Name	Valve Functions	Remark
C1	Logic Valve (LRDA-XDN)	Remote controlled by set values of Unloading Valve (QPAB-LAN: C6).	
C2	Relief Valve (DE-RVA-00-3000)	Performs functions as a safety device that prevent the destructions and damages of the system resulting from overload or abnormal pressure within the brake control system.	Set pressure: 16.5 lpm @ 160 ±2 kg•cm ²
C3	Check Valve (FD-DCP-O-B)	Prevents reverse flows of the pressure and oil created by the brake control system.	
C4, C5	Check Valve (FD-DCP-O-B)	Prevents damages in the pressure and oil that are compressed in the accumulator installed at the ACC'A and ACC'B Ports.	
C6	Unloading Valve (QPAB-LAN)	Keeps the pump moving under no load by bypassing discharged pressure and oil to the tank from the pump when the brake control system is overloaded.	Cut-in set point: 16.5 lpm @ 103 ±2 kg•cm ²

Detailed Functions and Application of Brake Supply Valve Assembly Package

1. Prevents overload on brake pump saving energy.

The pressure and oil flows discharged by the brake pump is supplied to the brake control device through valves. As the engine revolution (rpm) of the vehicle goes up, the revolution of the brake pump goes up increasing the amount of pressure and oil discharge. This valve package prevents energy loss by reducing loss in sources of power and fluid energy.

In case the pressure of the brake control system exceeds the set pressure value of the Unloading Valve (QPAB-LAN:C6), the pilot spool in the Unloading Valve is operated to bypass oil flows on the drain line of the Logic Valve (LRDA-XDN:C1) to the "T" line. This releases the spool in the Logic Valve to bypass the pressure and oil discharged by the pump to the tank, allowing the pump to move under no load.

If the pressure value of the brake control system goes below a set pressure value, the pilot spool of the Unloading Valve closes. This will make the drain line have oil flows and the spool in the Logic valve closes. Then, the pressure and oil flows discharged by the pump are supplied into the brake control device.

Cut-out is when the pressure and oil flows discharged by the pump are bypassed, and cut-in is when they are supplied to the brake control device.

The default setting of the Unloading Valve is as below:

Oil Flow	Standard		Set Point	
	Cut-in	Cut-out	Cut-in	Cut-out
16.5 lpm	103 $\pm$ 2 kg $\cdot$ cm ²	125 $\pm$ 2 kg $\cdot$ cm ²	103 + 2 kg $\cdot$ cm ²	125 + 2 kg $\cdot$ cm ²

2. Performs a function as a safety device of the brake control device.

An overload within the brake control device created by external force can cause an abnormal rise in pressure resulting in damages or breakage on all brake control devices. However, the Relief Valve (DE-RVA-00-3000: C2) is installed to prevent these troubles. In case the brake pressure exceeds a set pressure value of the Relief Valve, the Relief Valve operates to maintain the set pressure value. That is, the valve returns any excess pressure over a set pressure value to the tank to cut off an abnormal rise of pressure caused by overloads inside the system, preventing damages and breakage on all devices in the system.

The default setting of the Relief Valve is as below:

Oil Flow	Standard	Set Point
16.5 lpm	160 $\pm$ 2 kg $\cdot$ cm ²	160 + 2 kg $\cdot$ cm ²

3. Supplies brake control pressure.

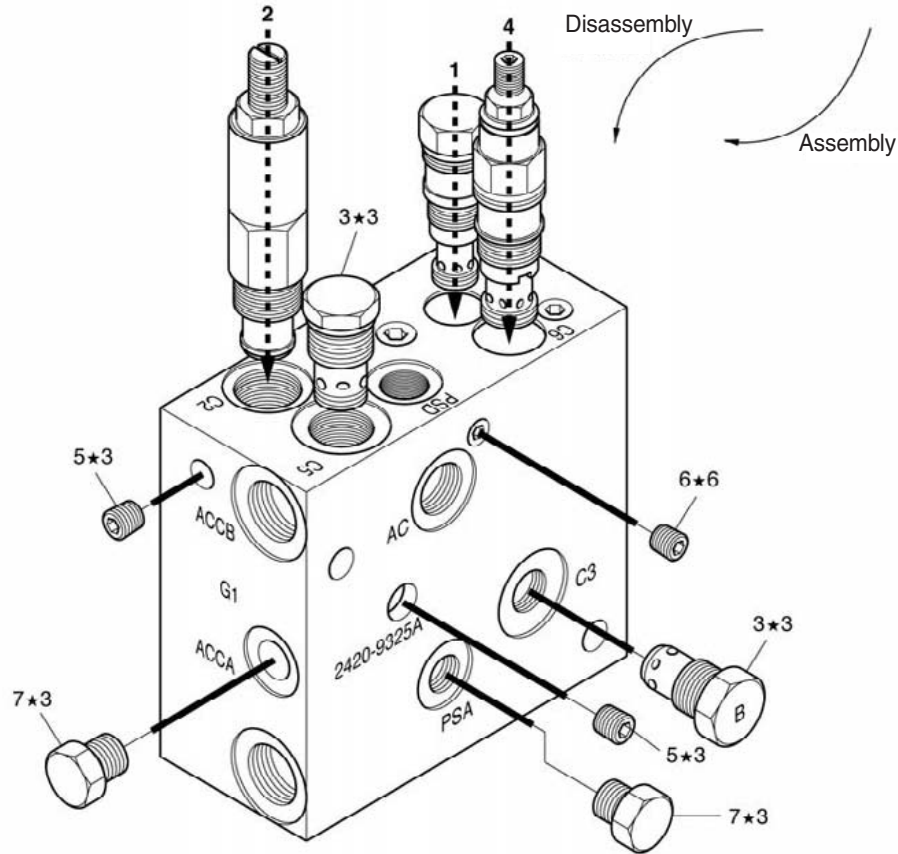
Stepping on the brake pedal, the compressed pressure in the accumulator is reduced below a cut-in set point and the pilot spool in the Unloading Valve closes, resulting in oil flows on the drain line of the Logic Valve. This oil flow keeps the spool in the Logic Valve closed.

The pressure and oil flows discharged by the pump are then supplied to the accumulator and the brake control device. In case the pressure value exceeds the cut-out set point of the Unloading Valve, the Logic Valve and the Unloading Valve operates to bypass the pressure and the oil flows discharged by the pump to the tank, allowing the pump move with no load and preventing pressure surges in the brake system. Check Valves (C4, C5) maintain brake control functions of each brake without affecting the other brake on the other side as each brake circuit is separated.

Exploded View and Tools

The assembly torque of each part in the Brake Supply Valve Assembly Package is described in <Table 1>. Observe the specified torque values using the right tool.

1. Disassembly, reassembly of Brake Supply Valve Assembly Package, and necessary tools.



FG007444

Figure 2

No.	Part Name	Screw Spec	Assembly Torque (kg•cm)	Assembling Tools
1	Logic valve	M20 * 1.5	450 ±50	Torque wrench/32 mm Hex. socket
2	Relief valve	UNF7/8-14"	450 ±50	Torque wrench/1" Hex. socket
3*3	Check Valve	UNF7/8-14"	450 ±50	Torque wrench/1" Hex. socket
4	Unloading Valve	M20 * 1.5	450 ±50	Torque wrench/32 mm Hex. socket
5*3	PT 1/4" Plug	PT 1/4-19"	500	Torque wrench/6 mm Wrench socket
6*6	PT 1/8" Plug bolt	PT 1/8-28"	280	Torque wrench/5 mm Wrench socket
7*3	PF 1/4" Plug	PF 1/4-19"	250 ±25	Torque wrench/19 mm Hex.socket

Cautions for Disassembly and Reassembly

1. Clean up the surrounding area to remove any foreign substances before disassembly and reassembly.
2. Make sure to observe the assembly torques and tools specified in table when disassembling and reassembling parts.
3. Follow the directions described in the above drawing for disassembly and reassembly.
4. Be careful not to let any contaminants go into the package when reassembling.
5. Make sure to clean parts before reassembly after disassembly.
6. Wrap the screw thread with seal tapes (teflon tapes) 3-4 times when reassembling the PT series plugs.

Troubleshooting Guide

Symptom	Checkpoints	Descriptions	Remedy
Unable to supply pressure to brake	1. Foreign materials, contaminants in the Logic Valve.	1. Disassemble the Logic Valve and check if any foreign materials or contaminants such as sludge is lodged between spool and body.	Remove foreign materials and clean the contaminated area
	2. Foreign materials, contaminants in Relief Valve	2. Disassemble the Logic Valve and check if any foreign materials or contaminants such as sludge is lodged between poppet and body.	Remove foreign materials and clean the contaminated area.
	3. Discharge pressure and its amount pumped by brake pump	3. Install a pressure gauge at the "G1" Port to measure pressure value discharged by brake pump: -under low engine rpm operations -with Unloading Valve fully closed -set point: $160 \pm 2 \text{ kg}\cdot\text{cm}^2$	Locate cause of problems and correct.
Brake light is on	1. Cut-in of the Unloading Valve	1 Check cut-in pressure of the Unloading Valve (QPAB-LAN, C6). - Install a pressure gauge at the "G1" Port to measure cut-in pressure. - Set point: $103 \pm 2 \text{ kg}\cdot\text{cm}^2$	Readjust the pressure value.
	2. Pressure switch	2. If there is no problem with the above checkpoint 1 but the brake light is still on, check the connection of the pressure switch. - set point: $60 \text{ kg}\cdot\text{cm}^2 \pm 10\%$	Locate cause of problems and correct.
	3. Contamination in brake filter	3. Check the element screen inside brake filter if it is contaminated by foreign materials.	Clean the filter and replace.
	4. Foreign materials, contaminants in the Logic Valve and the Relief Valve	4. Refer to the above Descriptions 1 and 2 for Checkpoints "Unable to supply pressure to brake."	Remove foreign materials and clean the contaminated area.
Cut-in and cut-out cycles are too fast	1. Damages in O-ring and backup rings installed in Check Valve	1. Disassemble each Check Valve (C3, C4, C5) and check up on O-ring and backup rings if damaged	Replace Check Valve.
	2. Leakage in Foot Brake Valve	2. Remove hydraulic hoses installed at outlets (Ports BR1, BR2) of Foot Brake Valve to check leakage: - with the brake pedal unpressed (Neutral) - set point: Refer to "Foot Brake Valve Leakage control."	Replace Foot Brake Valve.

How to Check Brake Pressure

Install a pressure gauge as below:

Ports	Screw Specification	Remark
GP	PF1/4" O-ring Boss	
G1	PF1/4" O-ring Boss	Remove pressure switch.

Check pressure values as below:

Ports	Unloading Valve Operations	
	Cut-in	Cut-out
GP	Within 160 kg•cm ² approx.	Within 9 kg•cm ² approx.
G1	103 ±2 kg•cm ²	125 ±2 kg•cm ²

Dozer Control Valve

Edition 1

MEMO

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Dozer Control Valve

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

STRUCTURE

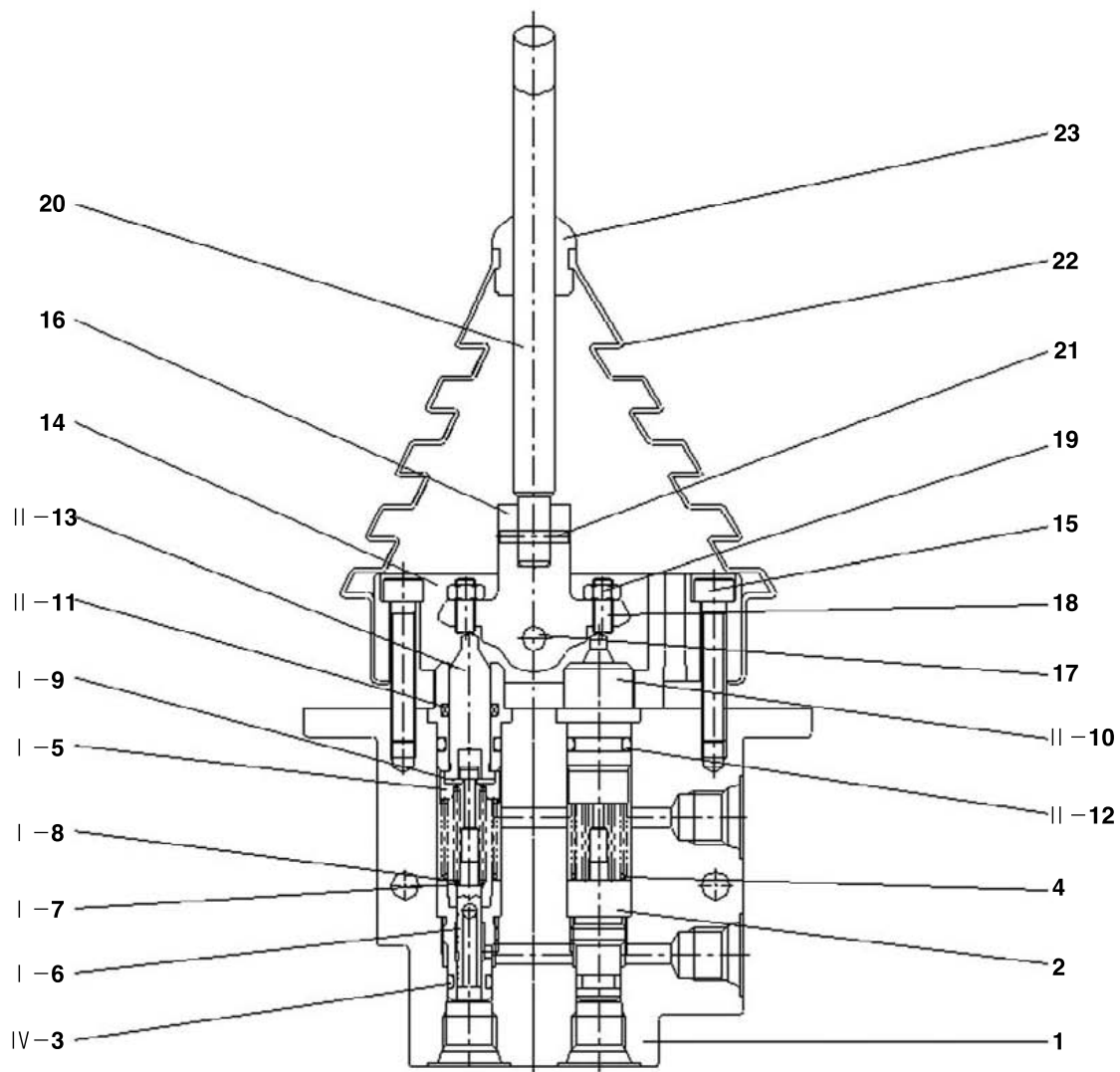


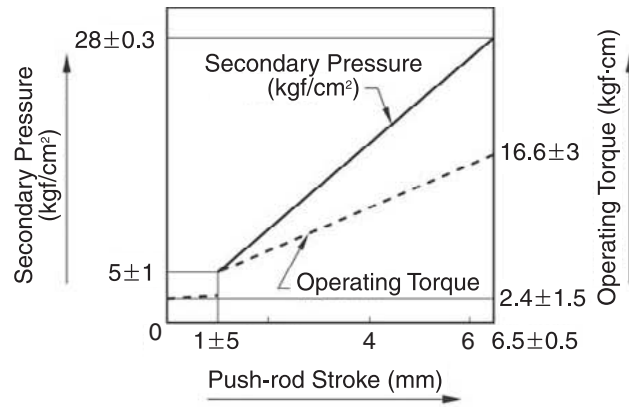
Figure 1

FG003779

PARTS LIST

NO.	Part Name	Standard	Material	Qty	Remark
1	Body			1	JA3H1001
2	Plug			2	j96h2002
III - 3	O-ring	p8	n. b. r	2	po 08
4	Spring			2	j96h2003
I	Spool Kit				j96h2020
I - 5	Spring Seat			2	ajv12d105
I - 6	Spool			2	j96h2004
I - 7	Spring Seat			2	ajv12d103
I - 8	Spring			2	j96h2005
I - 9	Stopper			2 set	ajv12d106
II	Plug Kit				jao6004
II - 10	Plug			2	j96h2006
II - 11	Rod Seal	d9r10	n. b. r	2	rsy 10
II - 12	O-ring	p14	n. b. r	2	p0 014
II - 13	Push Rod			2	j96h2007
14	Cover			1	j96h2008
15	Wrench Bolt	m6 x 35l	scm440	2	wbm0635
16	Guide			1	j96h2009
17	Pin			1	j96h2010
18	Pin	m5 x 15l		2	j96h2011
19	Socket Bolt	m5	scm440	2	hnm05
20	Nut			1	ja2c1001
21	Lever	ø3 x 18l		1	sp0318
22	Spring Pin			1	ja2c1003
23	Boot			1	ja2c1002
24	Bushing			1	ja3h1002
III	Nameplate				jaoc1003

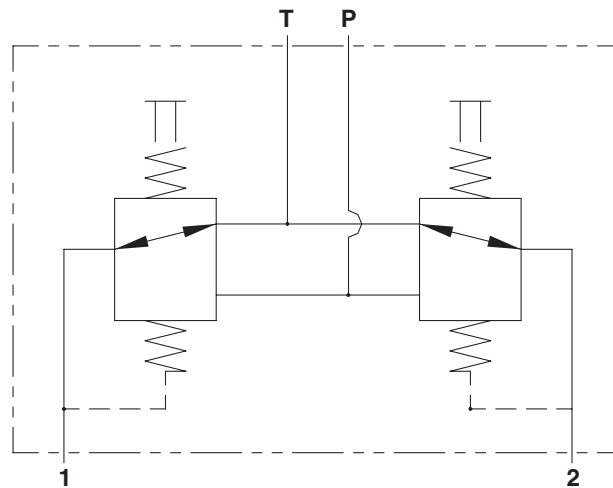
PERFORMANCE CURVE



FG007450

Figure 2

HYDRAULICS SYMBOL



FG007451

Figure 3

DISASSEMBLY AND ASSEMBLY TOOLS

NO.	Tool	Standard	Remark
2	L Wrench	10 mm	
15	L Wrench	5 mm	
18L	L Wrench	2.5 mm	
19	Wrench	8 mm	

DISASSEMBLY

1. Disassemble boot (22) and bushing (23) from the body (1).



Figure 4

2. Disassemble guide (16) and pin (17) from the cover (14).

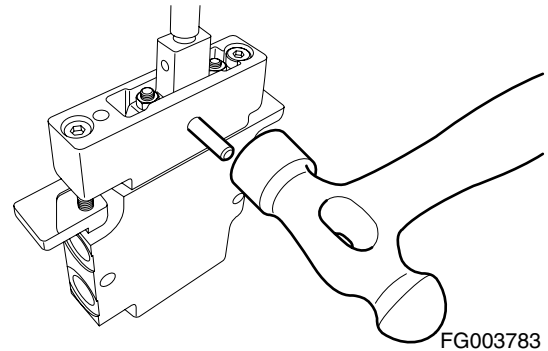


Figure 5

3. Disassemble cover (14) from the body (1).

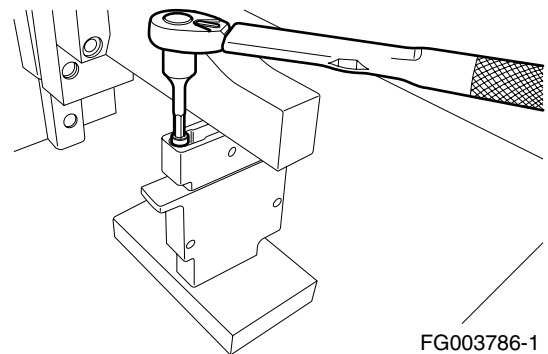


Figure 6

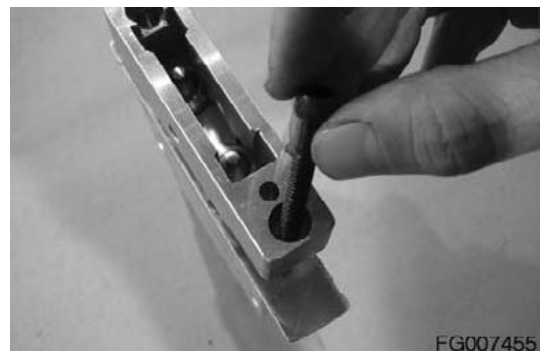


Figure 7

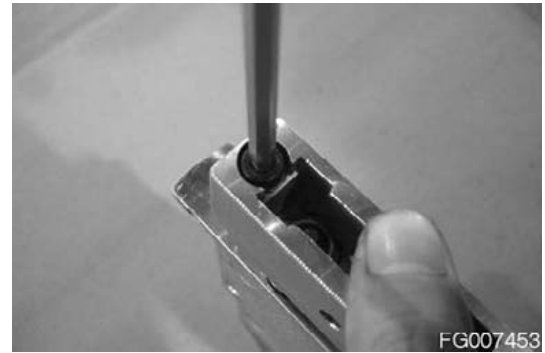


Figure 8

4. Disassemble plug kit (II) from the body (1).

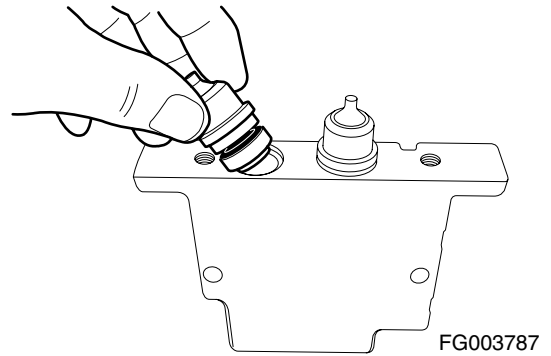


Figure 9

5. Disassemble spool kit (I) from the body (1).

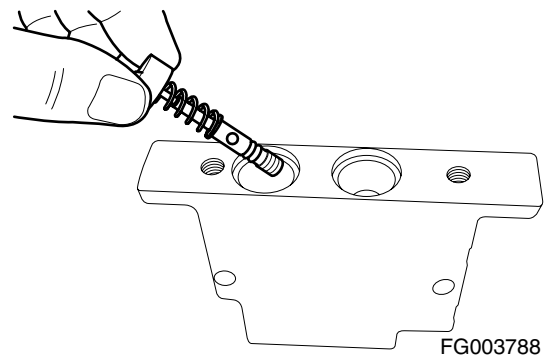


Figure 10

6. Disassemble spring (4) from the body (1).

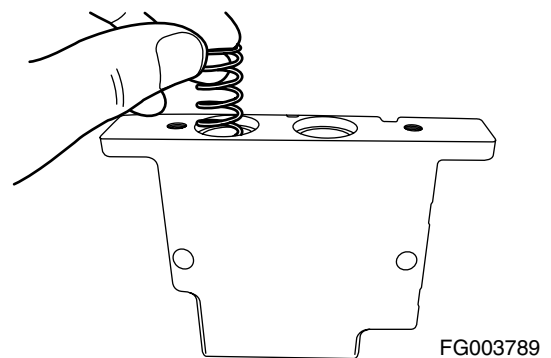


Figure 11

7. Disassemble plug (2) from the body (1).



Figure 12



Figure 13

ASSEMBLY

1. Assemble plug (2) in the body (1).



Figure 14



Figure 15

2. Assemble spring (4) in the body (1).

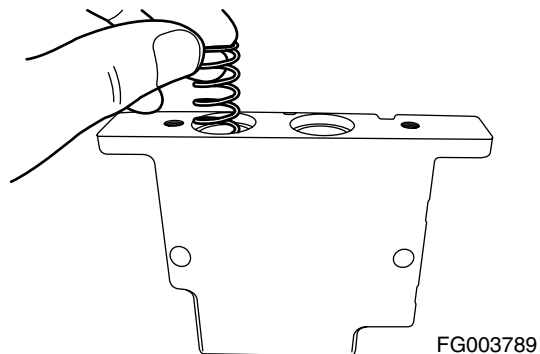


Figure 16

3. Assemble spool kit (I).

Assemble spring seat (I-7), spring (I-8), spring seat (I-5) and stopper (I-9) at spool (I-6) in the order.

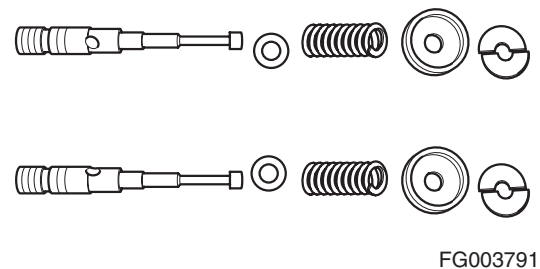


Figure 17

4. Assemble spool kit (I) in the body (1).

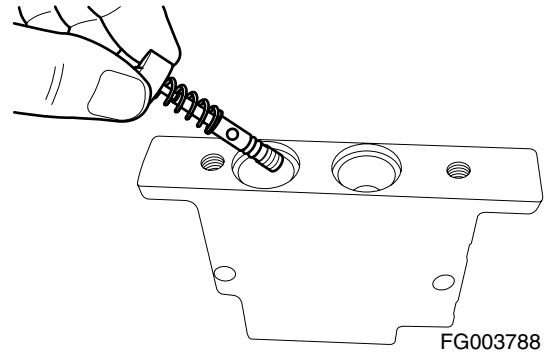


Figure 18

5. Assemble plug kit (II)
Assemble rod seal (II-11), O-ring (II-12), push rod (II-13)
and plug (II-10) in the order.

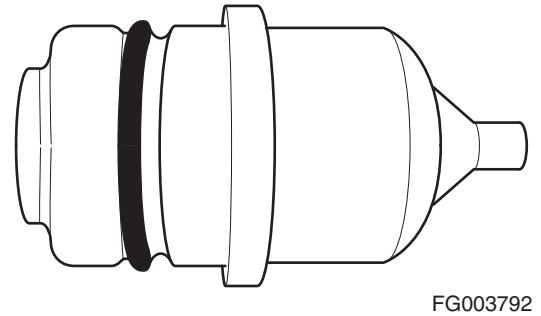


Figure 19

6. Assemble plug kit (II) in the body (1).

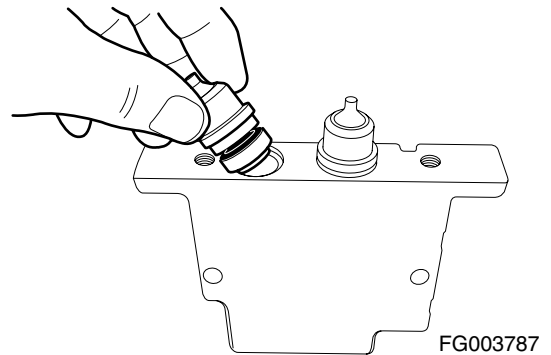


Figure 20

7. Assemble cover (14) in the body (1) with wrench bolt.

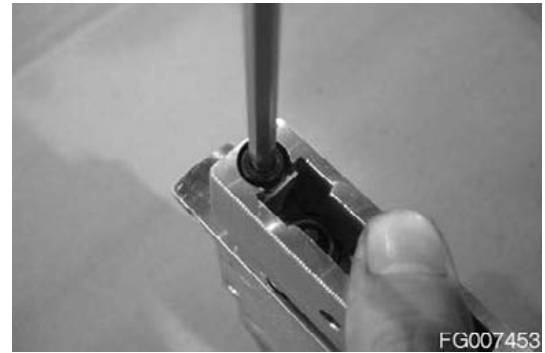


Figure 21

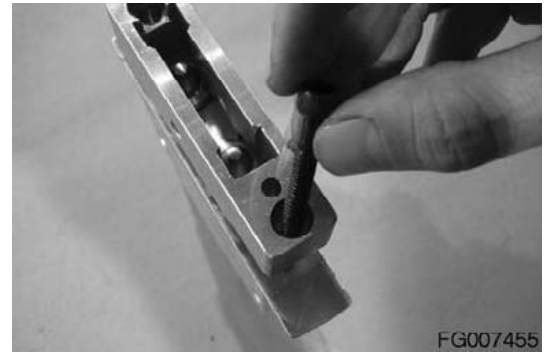


Figure 22

8. Assemble wrench bolt (15) in the body (1) with torque wrench.

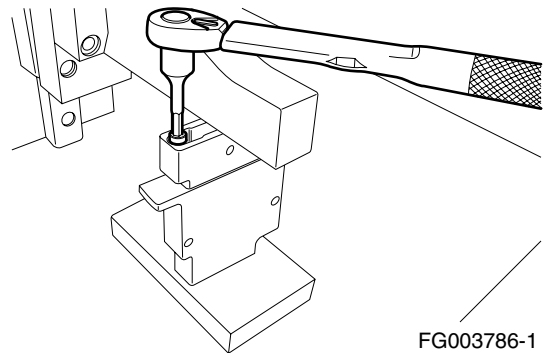


Figure 23

9. Assemble socket bolt (18) and nut (19) in the guide (16).

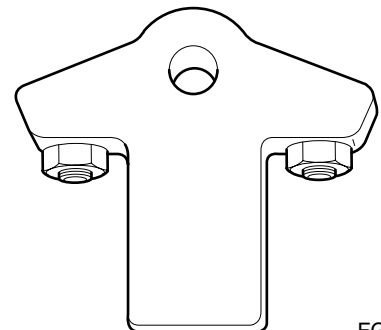


Figure 24

10. Assemble guide (16) and lever (20) with spring pin (21).

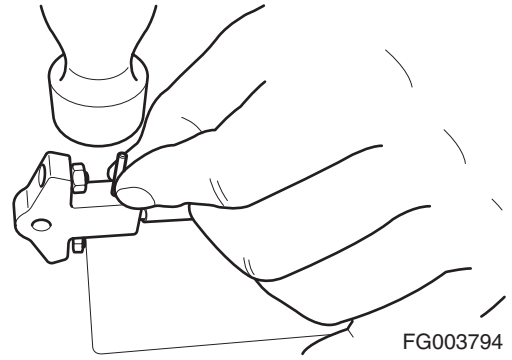


Figure 25

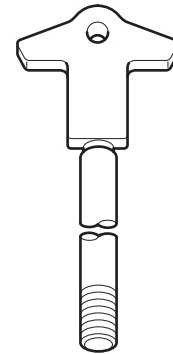


Figure 26

11. Assemble guide (16) in the cover with pin (17).

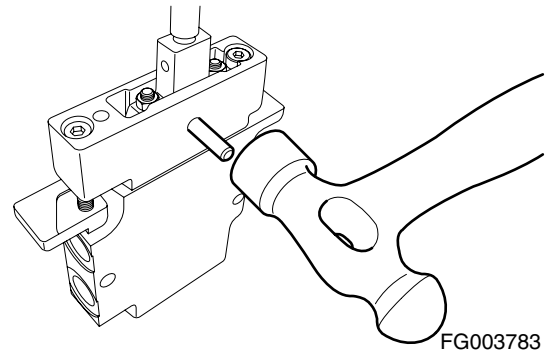


Figure 27

12. Adjust the clearance of lever (20) with wrench and wrench.

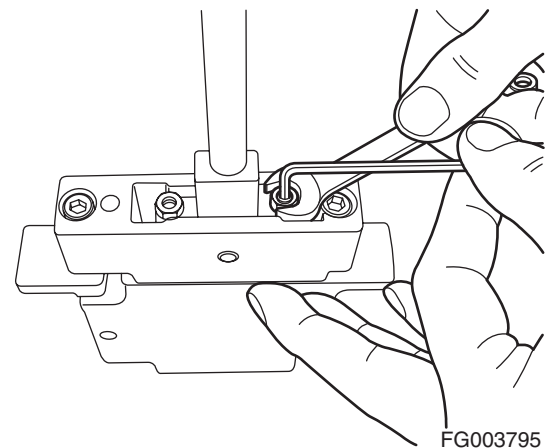


Figure 28

13. Assemble boot (22) and bushing (23) in the body (1).



Figure 29

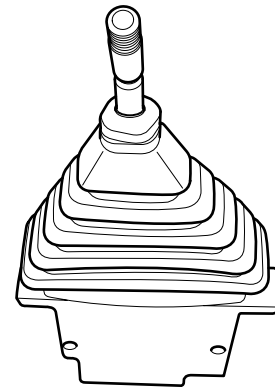


Figure 30

Steering Valve

Edition 1

MEMO

Table of Contents

Steering Valve

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

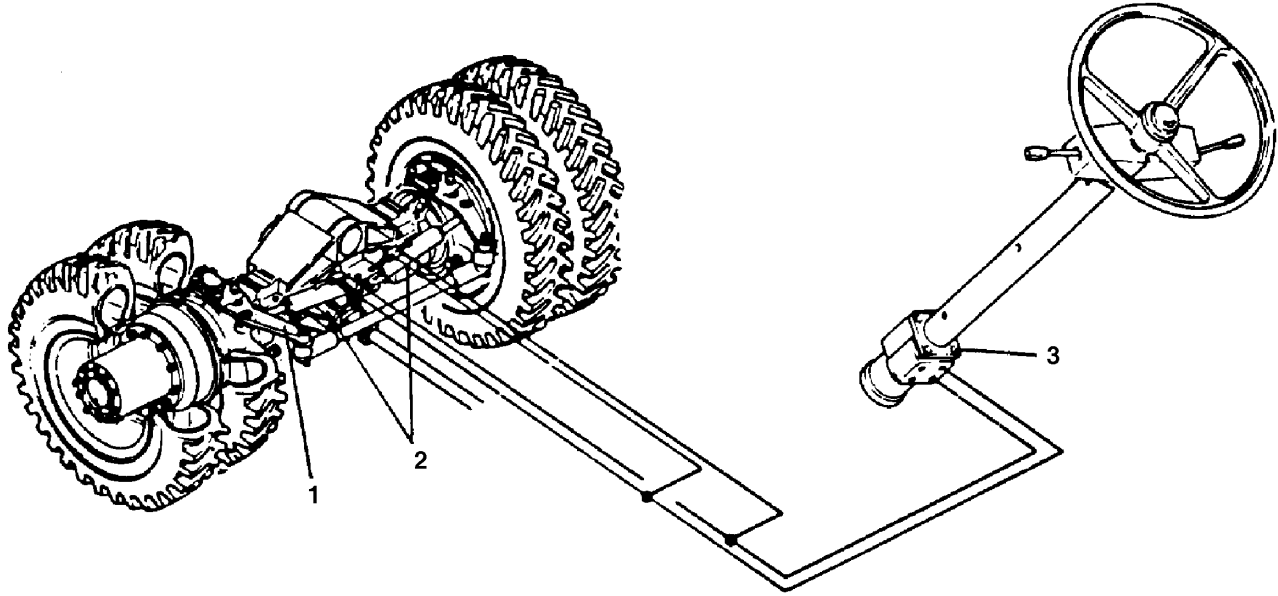
APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

GENERAL DESCRIPTION

Turning the steering wheel causes hydraulic oil to be sent from the steering gear type pump to the steering valve which directs oil to the steering cylinders.



0820

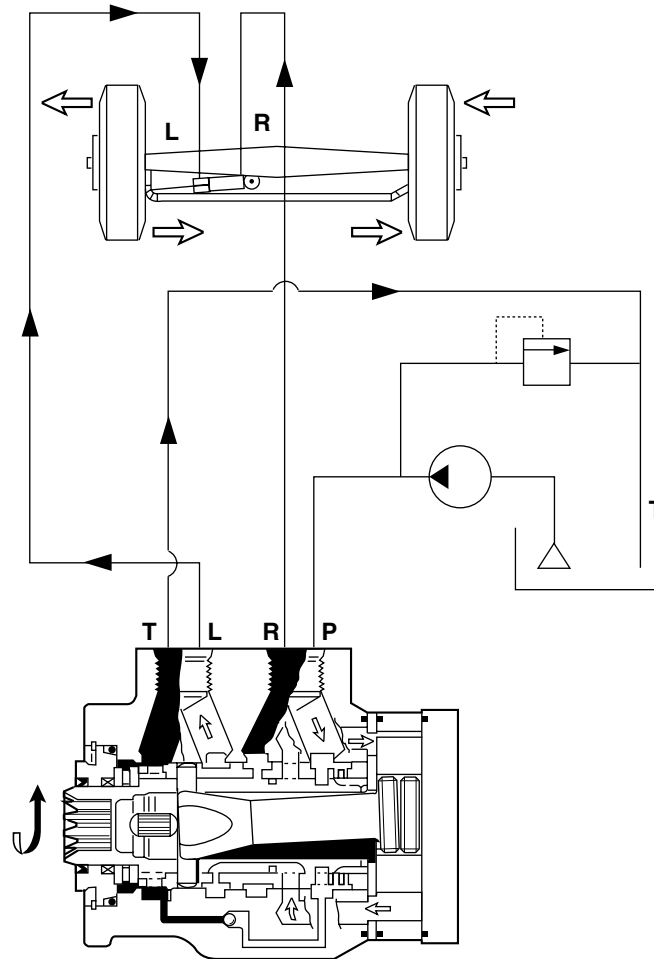
Figure 1

Reference Number	Description
1	Knuckle Arm
2	Steering Cylinder

Reference Number	Description
3	Steering Valve

Theory of Operation

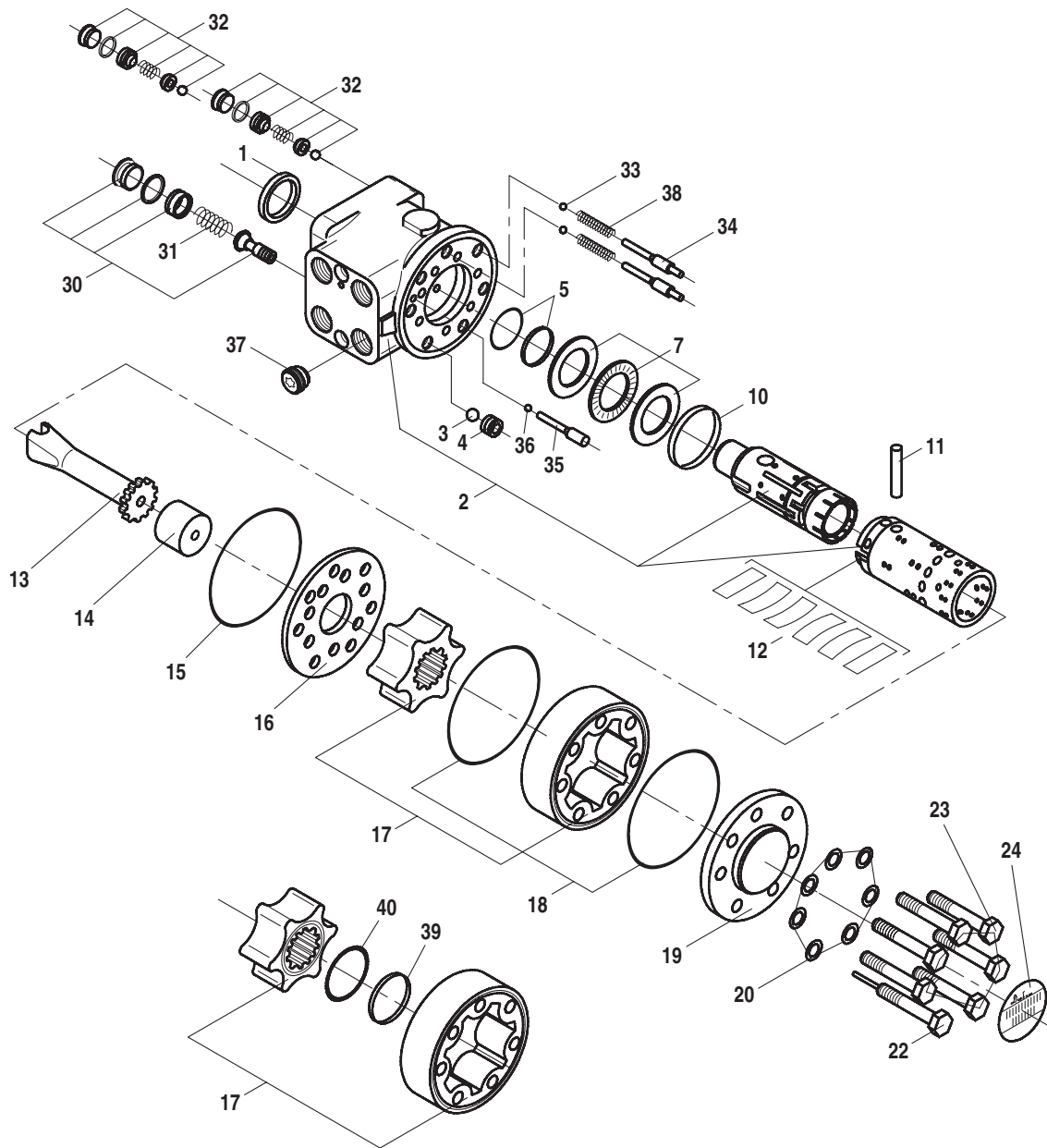
The steering valve, which directs hydraulic oil from the pump to the steering cylinder, is comprised of a housing, control sleeve, control spool and drive. Turning the steering wheel counterclockwise causes oil to flow to the steering cylinder L. Return oil goes through passage R to passage T. Oil supplied to the rotor turns the rotor and transmits oil to the control sleeve through the drive or spring. Turning the wheel clockwise sends oil through passage R, while return oil passes from L of the cylinder to passage T. With the steering wheel in a neutral position, oil returns to the tank through passages P and T.



2815

Figure 2

OSPC / OSPF



FG007462

Figure 3

TOOLS

1. Holding tool + guide ring
Code no.: SJ 150-9000-2.
Best.nr.: SJ 150-9000-16.

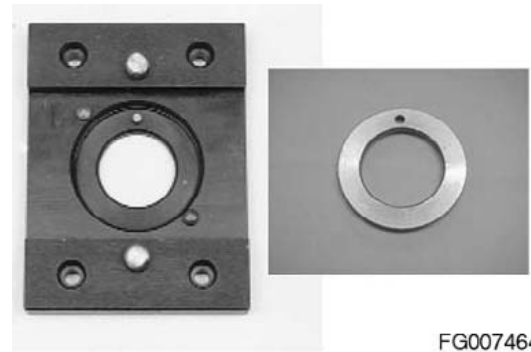


Figure 4

FG007464

2. Assembly tool for O-ring and kin-ring / Roto Glyd
Code no.: SJ 150-9000-11.
Best.nr.: SJ 150N4014-1.



Figure 5

FG007465

3. Assembly tool for lip seal.
Code no. SJ 150-9000-17.

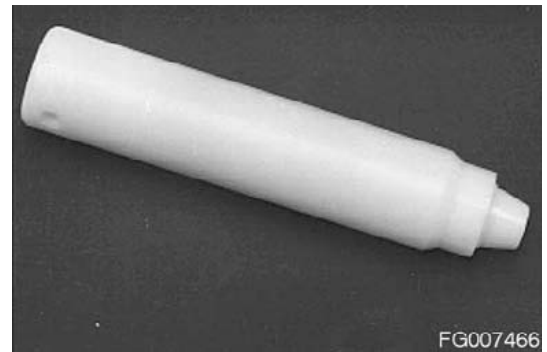


Figure 6

FG007466

4. Assembly tool for cardan shaft.
Code no. SJ 150-9000-3.



Figure 7

FG007467

5. Assembly tool for dust seal.
Code no. SJ 150-9000-22.



Figure 8

6. Torque wrench 0-7 daNm.
13 mm socket wrench.
6, 8 and 12 mm hexagon sockets.
12 mm screwdriver.
2 mm screwdriver.
13 mm ring wrench.
6, 8 and 12 mm hexagon socket spanners.
Plastic hammer.
Tweezers.
The tools named under point F are not available from Danfoss.

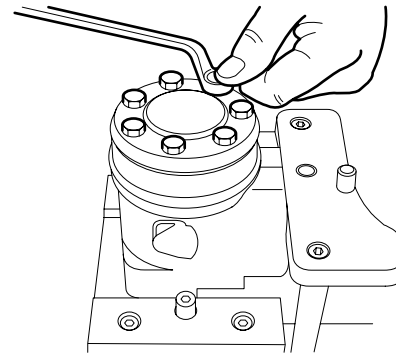


Figure 9

DISASSEMBLY

1. Dismantle steering column from steering unit and place the steering unit in the holding tool.

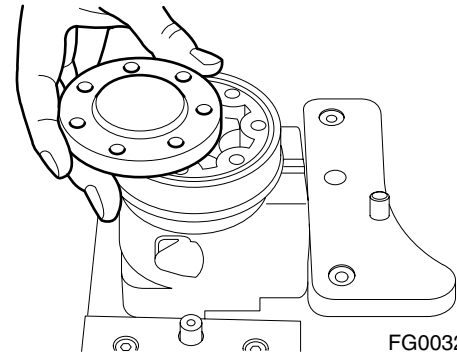
Screw out the screws in the end cover (6-off plus one special screw).



FG003286

Figure 10

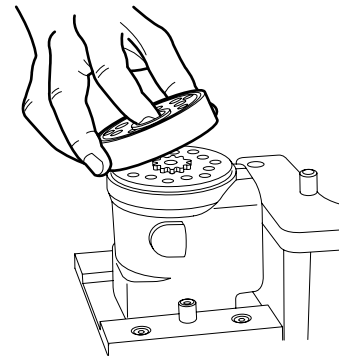
2. Remove end cover, sideways.



FG003287

Figure 11

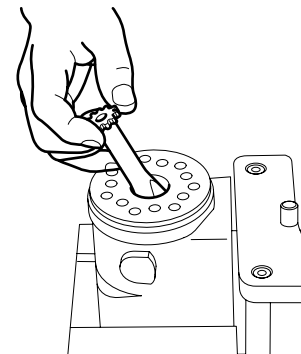
3. Lift the gearwheel set (with spacer if fitted) off the unit.
Remove two O-rings.



FG003288

Figure 12

4. Remove cardan shaft.



FG003289

Figure 13

5. Remove distributor plate.

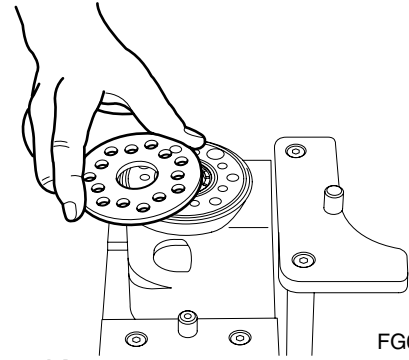


Figure 14

FG003290

6. Screw out the threaded bushing over the check valve.

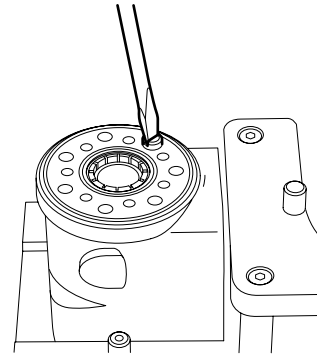


Figure 15

FG003291

7. Remove O-ring.

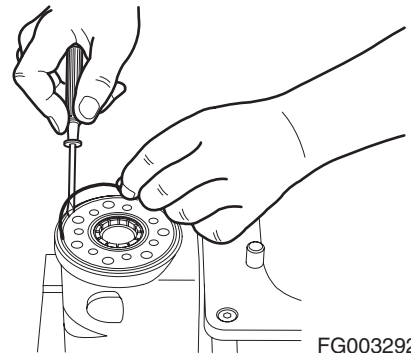


Figure 16

FG003292

8. OSPB; OSPB LS; OSPBX LS: Shake out the check valve ball (8 mm).

OSPC; OSPC LS; OSPC LSR: Shake out the check valve ball and suction valve pins and balls.



CAUTION!

On some pins in the OSPC there are two springs. See parts list for OSPC HN.21.UA.52. Replace this pins before reassembly.

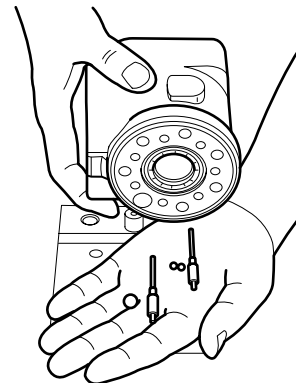


Figure 17

FG003293

9. Take care to keep the cross pin in the sleeve and spool horizontal. The pin can be seen through the open end of the spool. Press the spool inwards and the sleeve, ring, bearing races and needle bearing will be pushed out of the housing together.

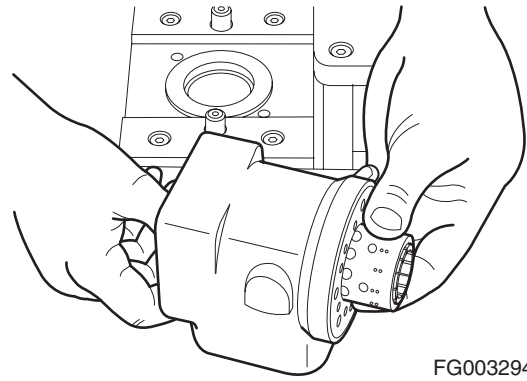


Figure 18

FG003294

10. Take ring, bearing races and needle bearing from sleeve and spool. The outer (thin) bearing race can sometimes stick in the housing, therefore check that it has come out.

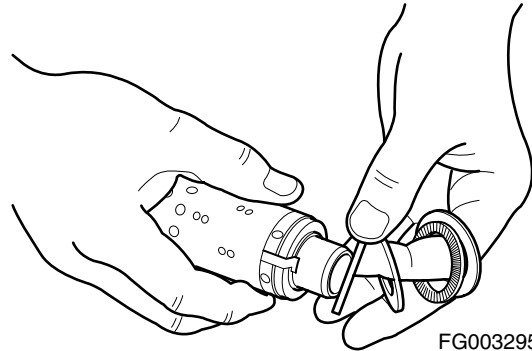


Figure 19

FG003295

11. Press out the cross pin. Use the special screw from the end cover.

Note next point/paragraph!

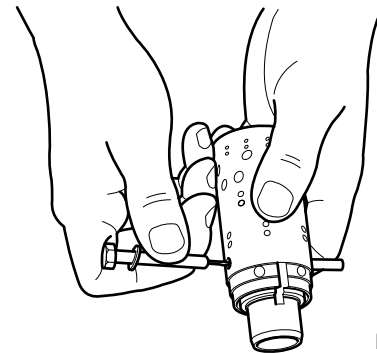


Figure 20

FG003296

12. OSPB CN and OSPC CN

A small mark has been made with a pumice stone on both spool and sleeve close to one of the slots for the neutral position springs (see drawing).

If the mark is not visible, remember to leave a mark of your own on sleeve and spool before the neutral position springs are dismantled.

For OSPF both marks should be placed opposite each other!

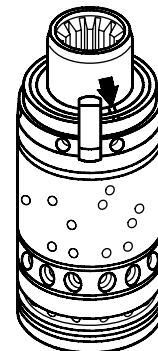


Figure 21 CN

FG003297

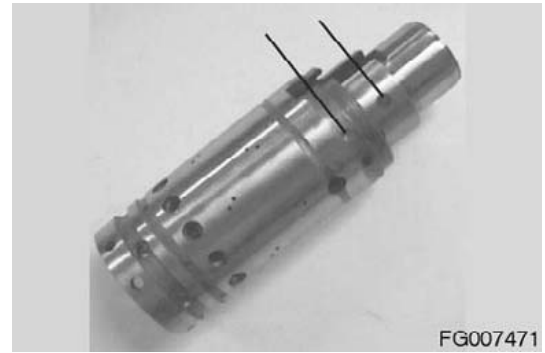


Figure 22 OSPF

13. Carefully press the spool out of the sleeve.

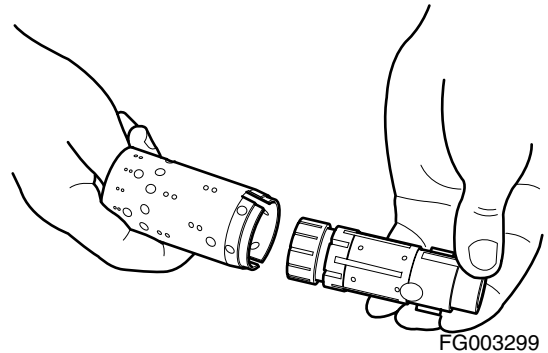


Figure 23

14. Press the neutral position springs out of their slots in the spool.

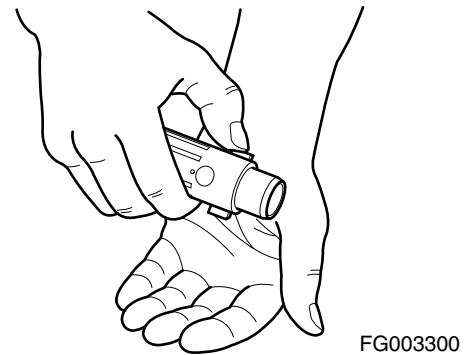


Figure 24

15. Remove dust seal and O-ring/kin-ring/Roto Glyd.

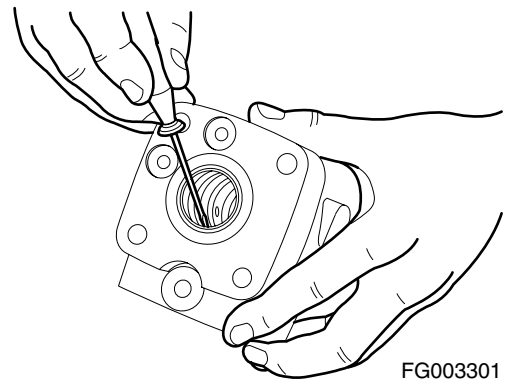


Figure 25

Dismantling the Shock Valves for OSPC/ OSPC LS

1. Remove plugs from shock valves using a 6 mm hexagon socket wrench.

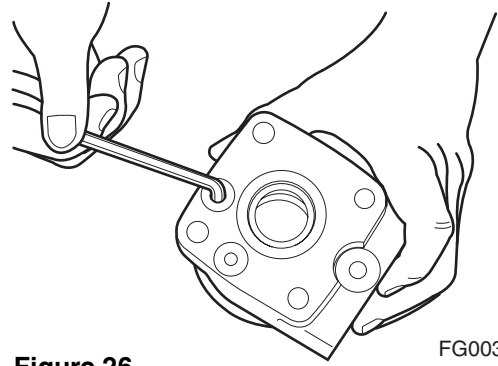


Figure 26

FG003302

2. Remove seal washers (2-off).

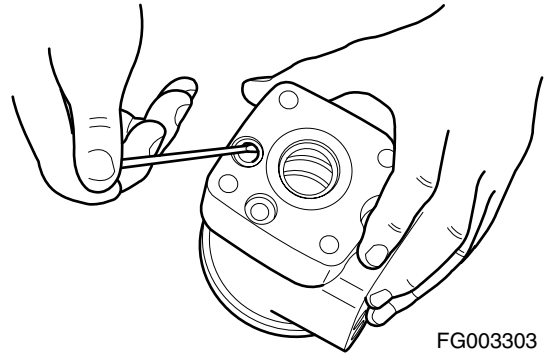


Figure 27

FG003303

3. Unscrew the setting screws using a 6 mm hexagon socket wrench.

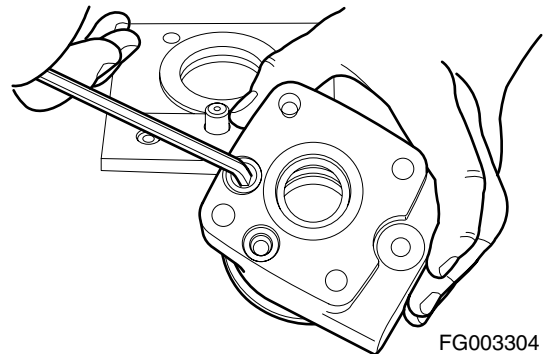


Figure 28

FG003304

4. Shake out the two springs and two valve balls into your hand. The valve seats are bonded into the housing and cannot be removed.

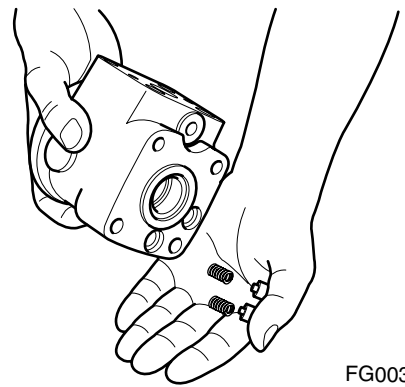
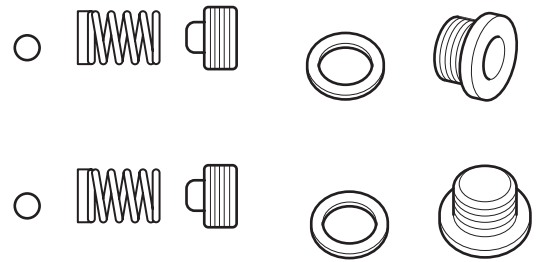


Figure 29

FG003305

5. The shock valves are now dismantled.



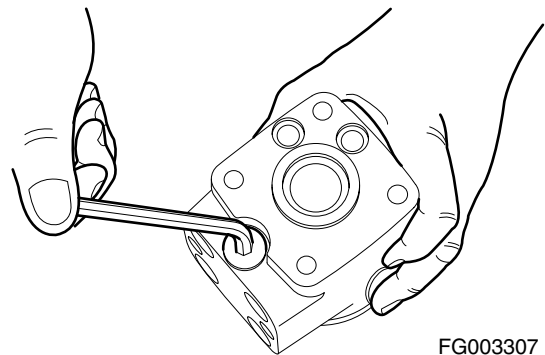
FG007473

Figure 30

Dismantling the Pressure Relief Valve for OSPC

1. Screw out the plug using an 8 mm hexagon socket wrench.

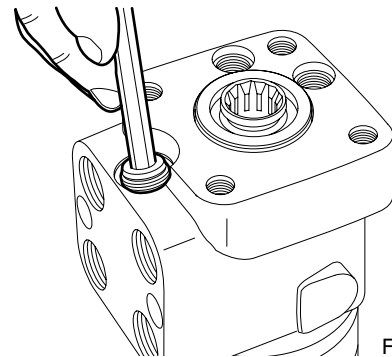
Remove seal washers.



FG003307

Figure 31

2. Unscrew the setting screw using an 8 mm hexagon socket wrench.



FG003308

Figure 32

3. Shake out spring and piston. The valve seat is bonded into the housing and cannot be removed.

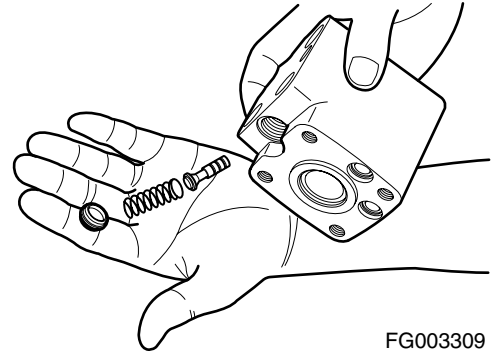


Figure 33

FG003309

4. The pressure relief valve is now dismantled.



Figure 34

FG003310

Dismantling the Pressure Relief Valve (cartridge) for OSPC LS/OSPC LSR

1. Screw out the pressure relief valve using an 8 mm hexagon socket wrench. Remove seal ring. If the valve is defective it must be replaced (see OSPC spare parts list, HN.21.UA.52).

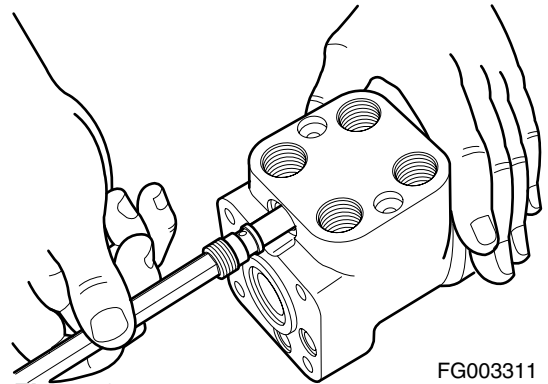


Figure 35

FG003311

2. The pressure relief valve is now dismantled.

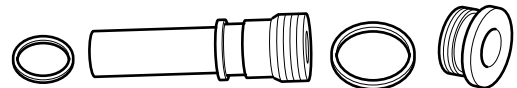


Figure 36

FG003312

3. The steering unit OSPC is now completely dismantled.

Replace this pins before the reassembly.

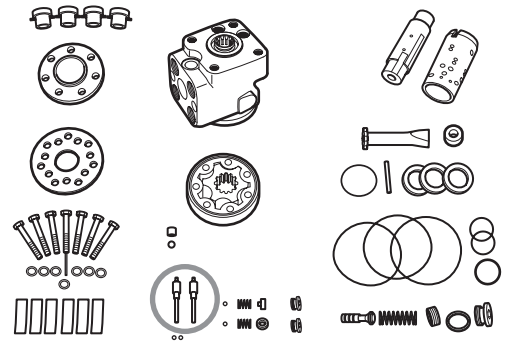


Figure 37

FG007476

4. The steering unit OSPC LS is now completely dismantled.

Replace this pins before the reassembly.

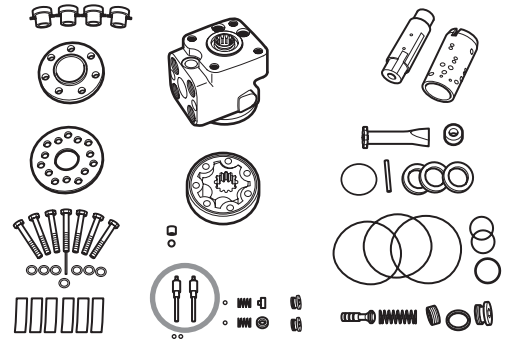


Figure 38

FG007476

Cleaning

Clean all parts carefully in Shellsol K or the like.

Inspection and Replacement

Replace all seals and washers. Check all parts carefully and make any replacements necessary.

Lubrication

Before assembly, lubricate all parts with hydraulic oil.

ASSEMBLY

1. Place the two flat neutral position springs in the slot.
2. Place the curved springs between the flat ones and press them into place.

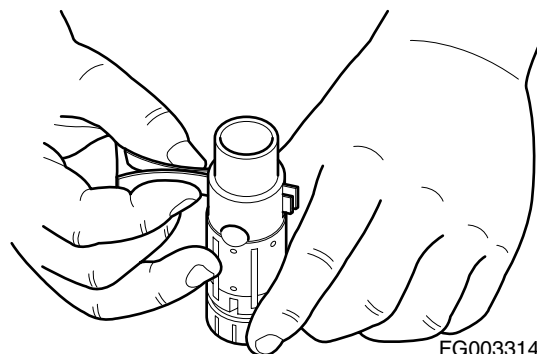


Figure 39

FG003314



Figure 40

FG003315

3. Line up the spring set.

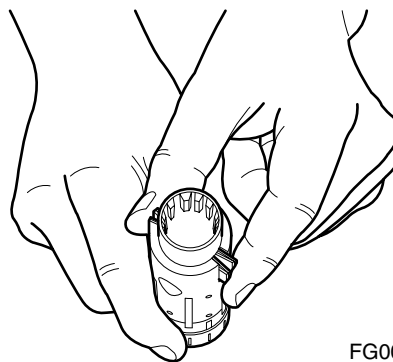


Figure 41

FG003316

4. Guide the spool into the sleeve. Make sure that spool and sleeve for OSPB LS, OSPBX LS, OSPC LS, OSPC LSR and OSPF are placed correctly in relation to each other (See page -8).

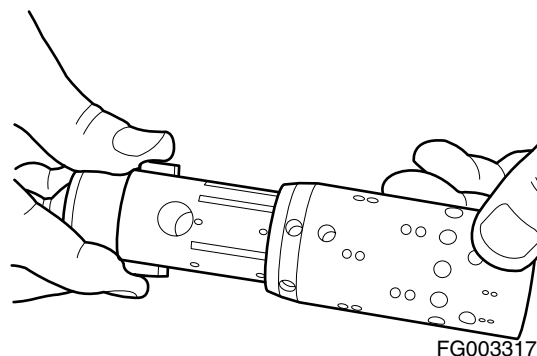


Figure 42

FG003317

5. Assemble spool and sleeve.



CAUTION!

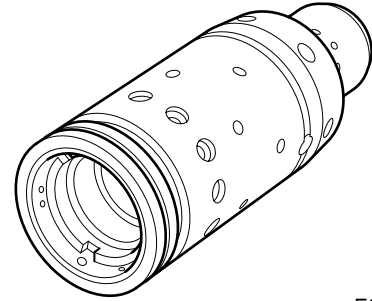
OSPB LS, OSPBX LS, OSPC LS, OSPC LSR and OSPF

When assembling spool and sleeve only one of two possible ways of positioning the spring slots is correct.

There are three slots in the spool and three holes in the sleeve in the end of the spool/sleeve opposite to the end with spring slots. Place the slots and holes opposite each other so parts of the holes in the sleeve are visible through the slots in the spool.

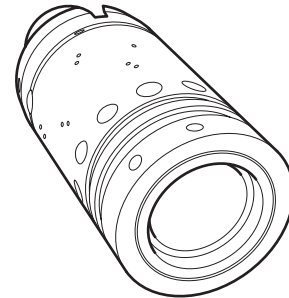
OSPB CN and OSPC CN

Assemble the spool/sleeve and make sure the marks on spool and sleeve are opposite each other.



FG003318

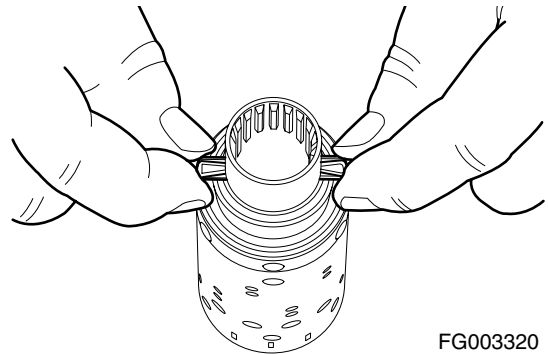
Figure 43



FG003319

Figure 44

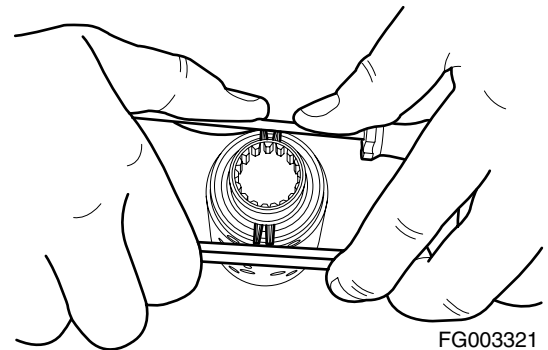
6. Press the springs together and push the neutral position springs into place in the sleeve.



FG003320

Figure 45

7. Line up the springs and center them.



FG003321

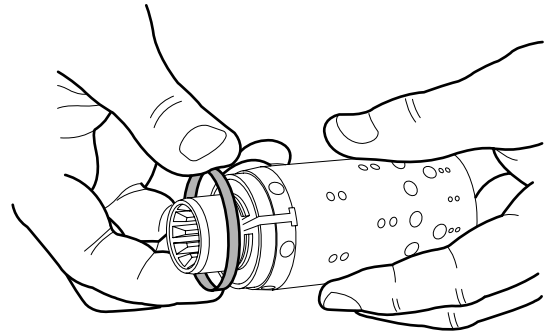
Figure 46

8. Guide the ring down over the sleeve.



CAUTION!

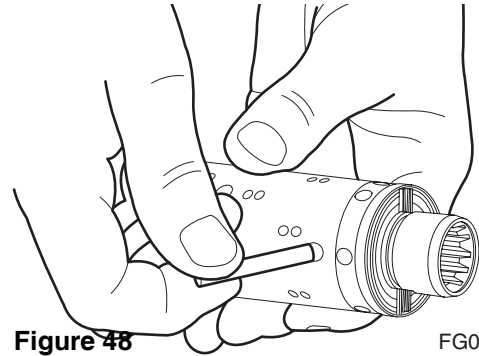
The ring should be able to move - free of the springs.



FG003322

Figure 47

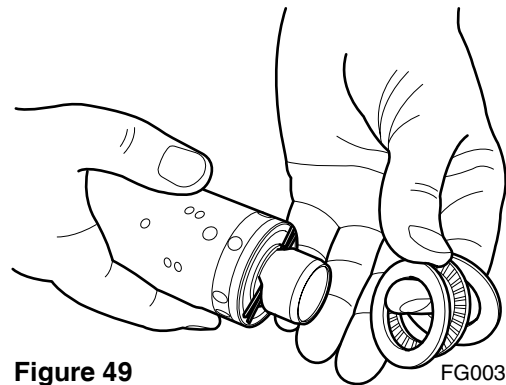
9. Fit the cross pin into the spool/sleeve.



FG003323

Figure 48

10. Fit bearing races and needle bearing as shown on below drawing.

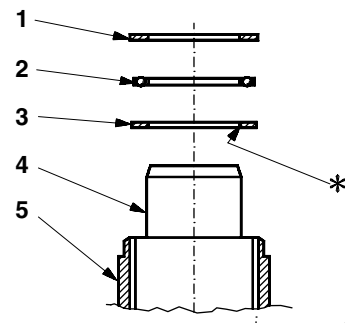


FG003324

Figure 49

Assembly Pattern for Standard Bearing

Reference Number	Description
1	Outer Bearing Race
2	Needle bearing
3	Inner Bearing Race
4	Spool
5	Sleeve



FG003325

Figure 50

Assembly Pattern for Double Bearing

Reference Number	Description
1	Washer For Axial Bearing
2	Outer Needle bearing
3	Outer Bearing Race
4	Spool
5	Sleeve
6	Inner Needle bearing
7	Inner Bearing Race

* The inside chamfer on the inner bearing race must face the inner spool.

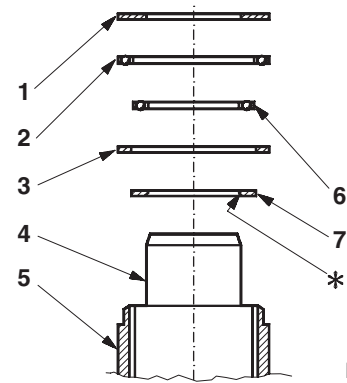


Figure 51

FG003326

Installation Instructions for O-ring/Kin-ring /Roto Glyd

1. Turn the steering unit until the bore is horizontal. Guide the outer part of the assembly tool into the bore for the spool/sleeve.

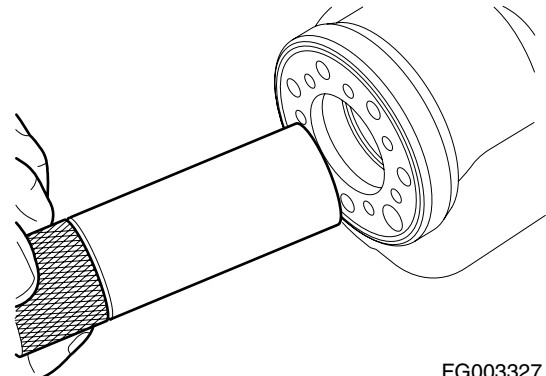


Figure 52

FG003327

2. Grease O-ring and king-ring/roto glyd with hydraulic oil and place them on the tool.

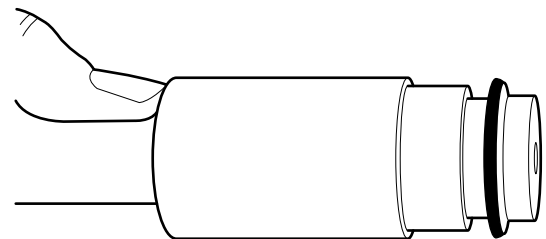


Figure 53

FG003328

3. Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool right to the bottom.

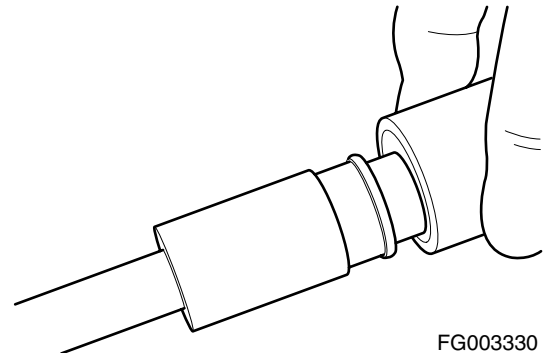


Figure 54

FG003330

4. Press and turn the O-ring/kin-ring into position in the housing.

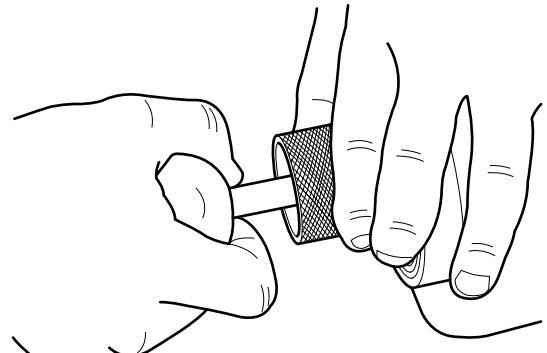


Figure 55

FG003332

5. Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.

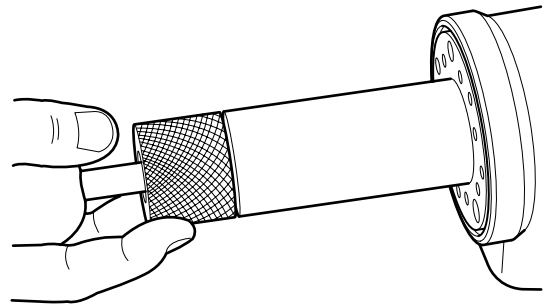


Figure 56

FG003333

Installation Instructions for Lip Seal

1. Lubricate the lip seal with hydraulic oil and place it on the assembly tool.

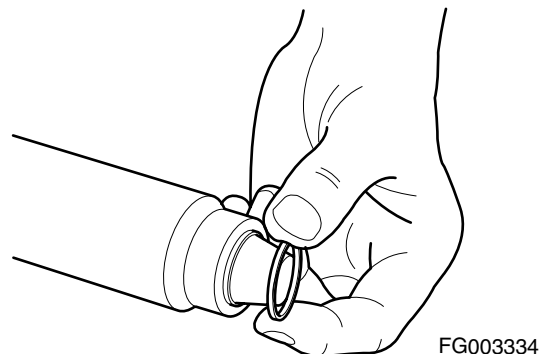


Figure 57

FG003334

2. Guide the assembly tool right to the bottom.

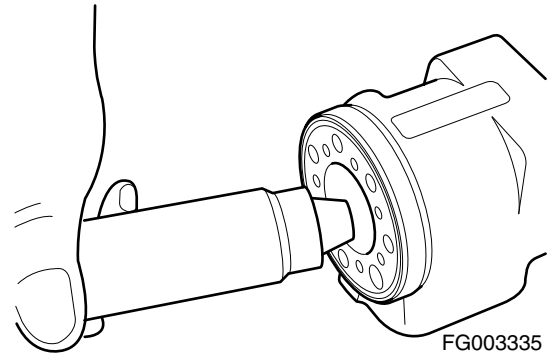


Figure 58

3. Press and turn the lip seal into place in the housing.

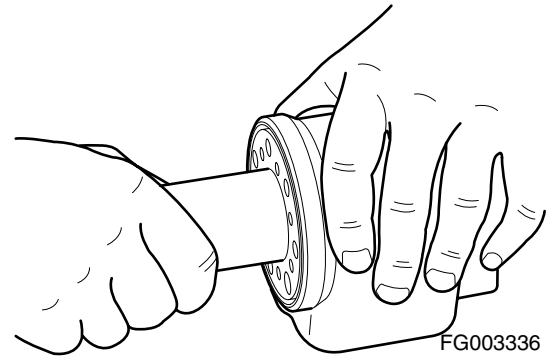


Figure 59

4. With a light turning movement, guide the spool and sleeve into the bore.



CAUTION!

Fit the spool set holding the cross pin horizontal.

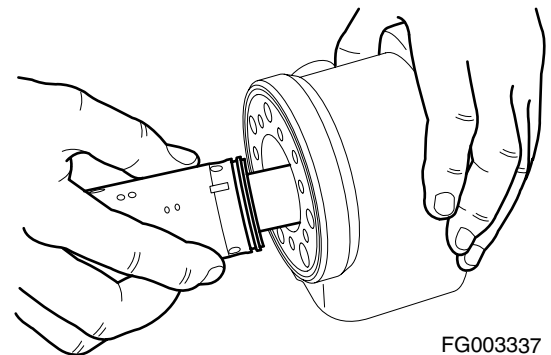


Figure 60

5. The spool set will push out the assembly tool guide. The O-ring and kin-ring/roto Glyd are now in position.

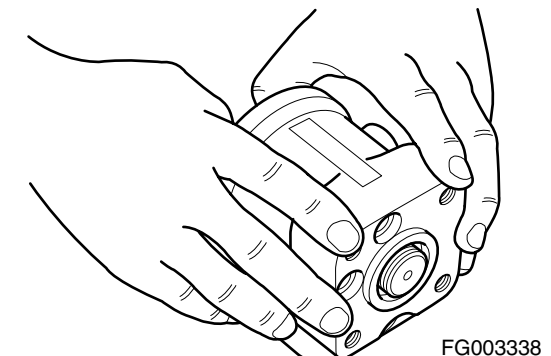


Figure 61

6. Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.

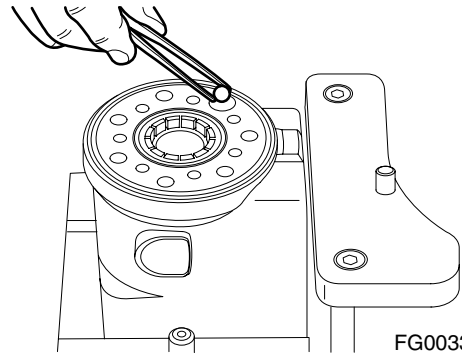


Figure 62

FG003339

7. Screw the threaded bushing lightly into the check valve bore. The top of the bushing must lie just below the surface of the housing.

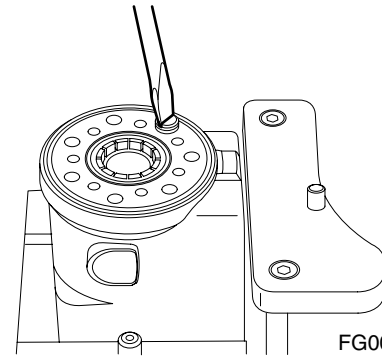


Figure 63

FG003340

8. Place a ball in the two holes indicated by the arrows.

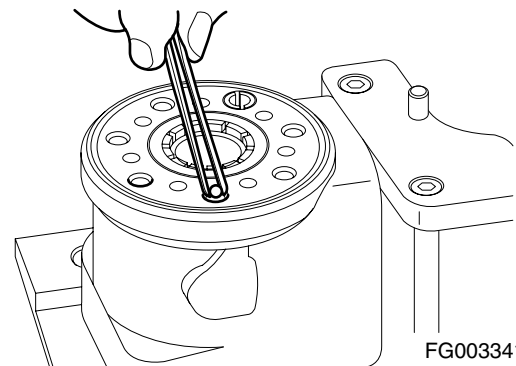


Figure 64

FG003341

9. Place a new pin in the same two holes.

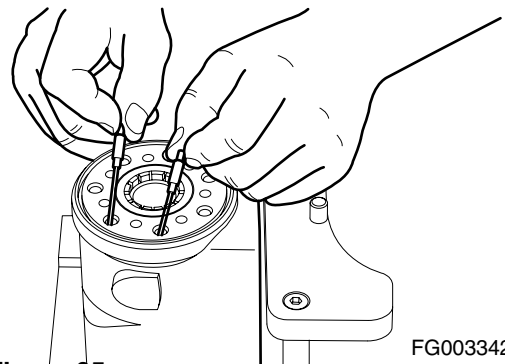


Figure 65

FG003342

10. In some cases a spring has to be fitted (Figure 66) on the pin before it is placed in the housing. (See OSPC spare parts list, HN.21.UA.52).

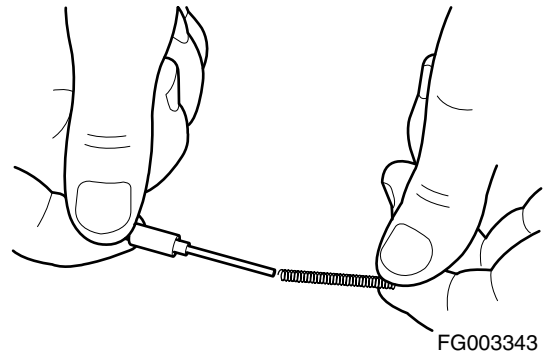


Figure 66

11. Grease the O-ring with mineral oil approx. viscosity $50^{0} \text{ mm}^2/\text{s}$ at 20°C .

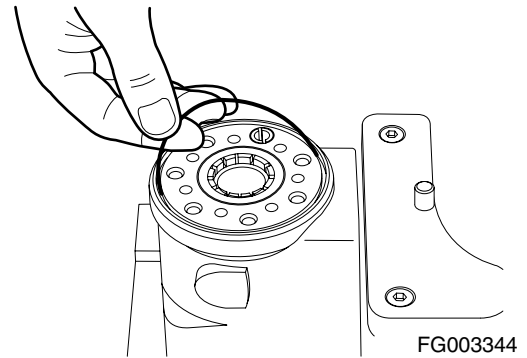


Figure 67

12. Place the distributor plate so the channel holes match the holes in the housing.

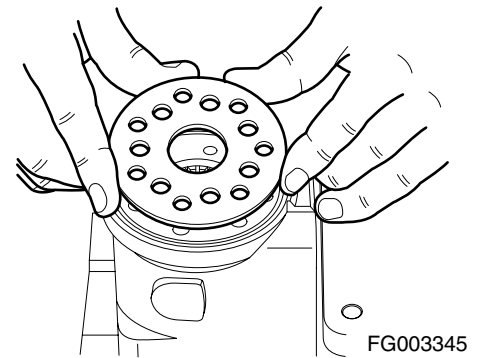


Figure 68

13. Guide the cardan shaft down into the bore so the slot is parallel with the connection flange.

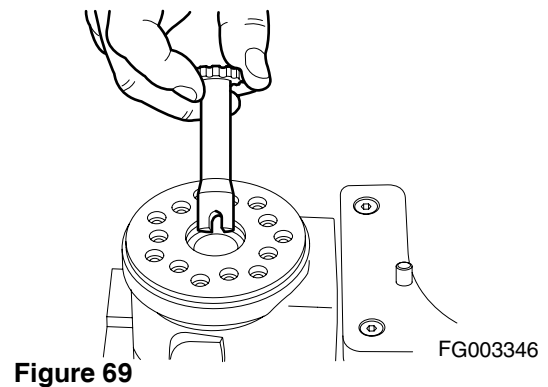


Figure 69

14. Place the cardan shaft as shown - so it is held in position by the mounting fork.

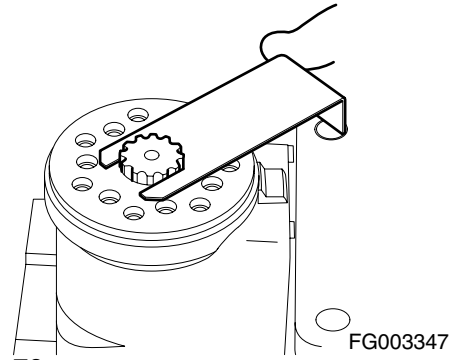


Figure 70

15. Grease the two O-rings with mineral oil approx. viscosity $50^{0\text{ mm}^2/\text{s}}$ at 20°C and place them in the two grooves in the gear rim. Fit the gearwheel and rim on the cardan shaft.

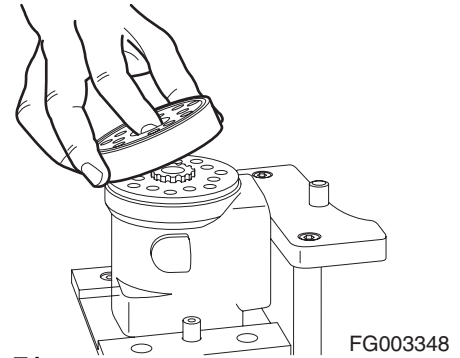


Figure 71

! CAUTION!

Fit the gearwheel (rotor) and cardan shaft so a tooth base in the rotor is positioned in relation to the shaft slot as shown. Turn the gear rim so the seven trough holes match the holes in the housing.

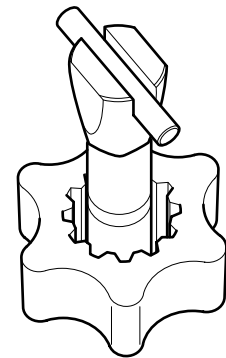


Figure 72

16. Fit the spacer, if any.

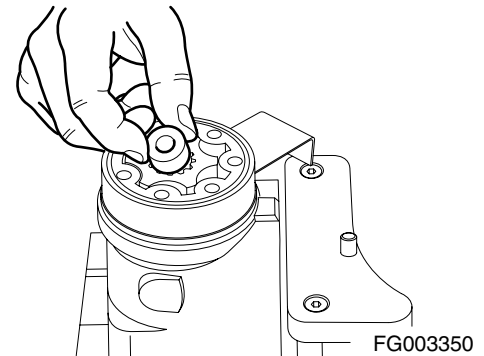


Figure 73

17. Place the end cover in position.

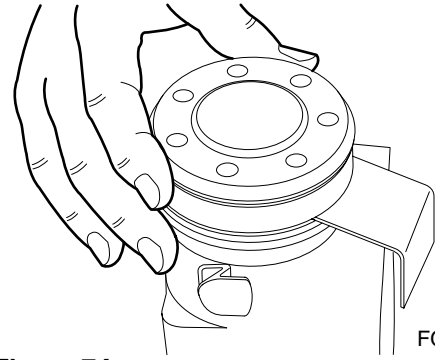


Figure 74

18. Fit the special screw with washer and place it in the hole shown.

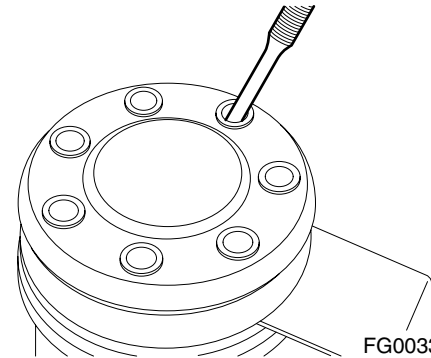


Figure 75

19. Fit the six screws with washers and insert them. Cross tighten all the screws and the rolled pin with a torque of 3.0 ± 0.6 daNm. The OSPB, OSPB LS and OSPBX LS can now be function tested.

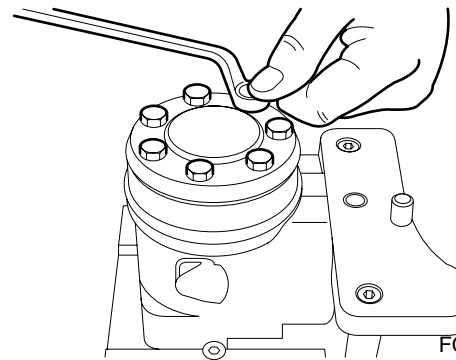
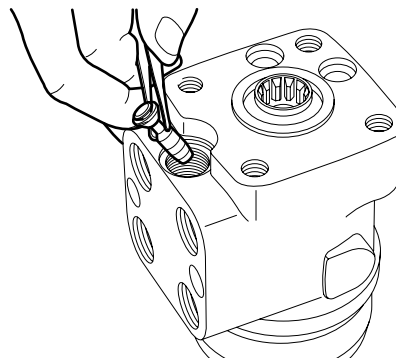


Figure 76

Assembly of the Pressure Relief Valve for OSPC

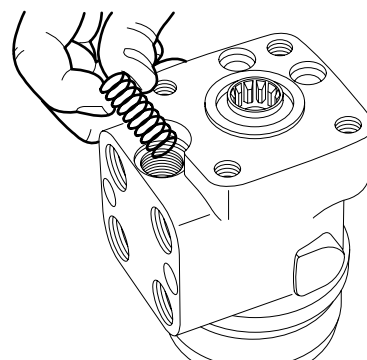
1. Fit the piston.



FG003354

Figure 77

2. Fit the spring.

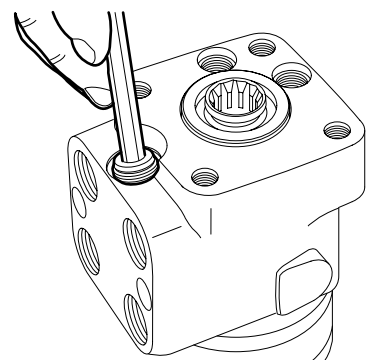


FG003355

Figure 78

3. Screw in the setting screw with an 8 mm hexagon socket wrench.

Make the pressure setting on a panel or the vehicle.

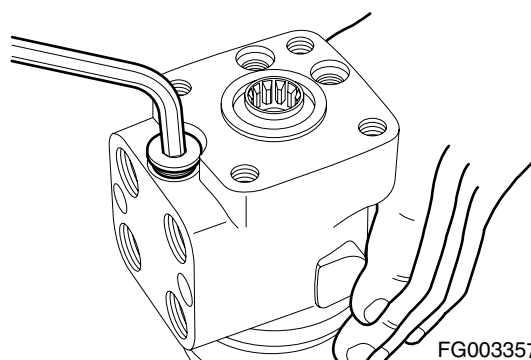


FG003356

Figure 79

4. Screw plug with dust seal into the housing using an 8 mm hexagon socket wrench.

Tightening torque: 5 +/-1 daNm.



FG003357

Figure 80

Assembly of the Shock Valves for OSPC/ OSPC LS/OSPC LSR

1. Put a ball in the two holes indicated by the arrows.

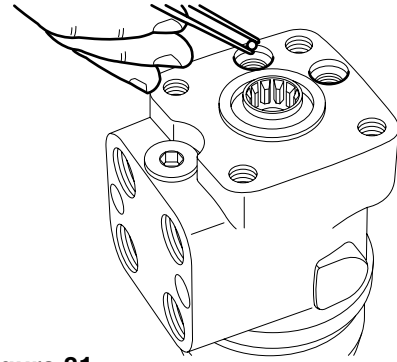


Figure 81

FG003358

2. Place springs and valve cones over the two balls.



CAUTION!

The blue spring applies to setting range 90-180 bar.
The untreated spring applies to setting range 170-260 bar. (See OSPC spare parts list HN.21.UA.52).

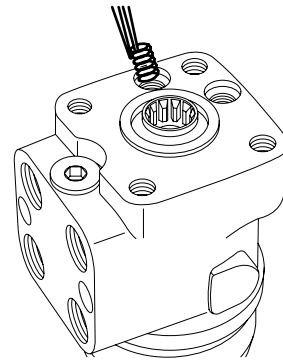


Figure 82

FG003359

3. Screw in the two setting screws using a 6 mm hexagon socket wrench. Make the pressure setting on a panel or the vehicle. (See OSPC spare parts list HN.21.UA.52).

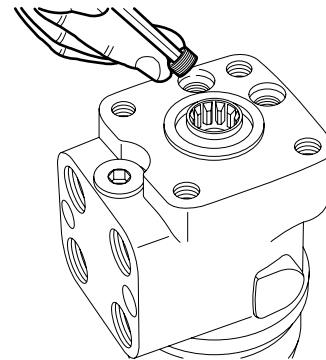


Figure 83

FG003360

4. Screw plug with seal ring into the two shock valves and tighten them with a torque of 3 +1 daNm using a 6 mm hexagon socket wrench.

Steering unit type OSPB, OSPB LS, OSPBX LS, OSPC, OSPC LS or OSPC LSR is now assembled.

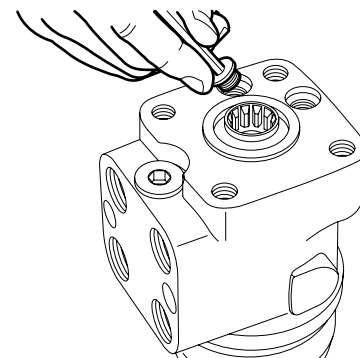


Figure 84

FG003360-1

5. Place the dust seal ring in the housing. With the OSPC, OSPC LS and OSPC LSR the dust seal ring must be placed only after the pressure relief valve and shock valves have been fitted.

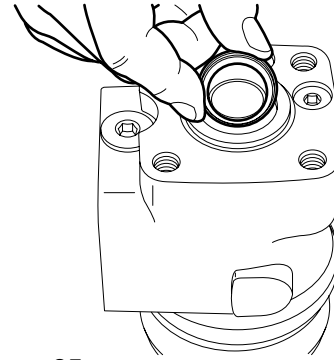


Figure 85

FG003475

6. Fit the dust seal ring in the housing using special tool SJ 150-9000-22 and a plastic hammer.

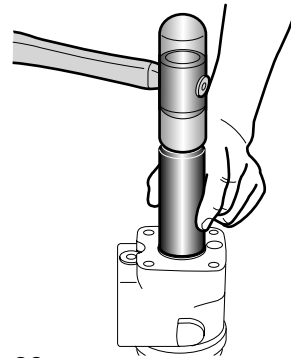


Figure 86

FG003476

7. Press the plastic plugs into the connection ports. Do not use a hammer!

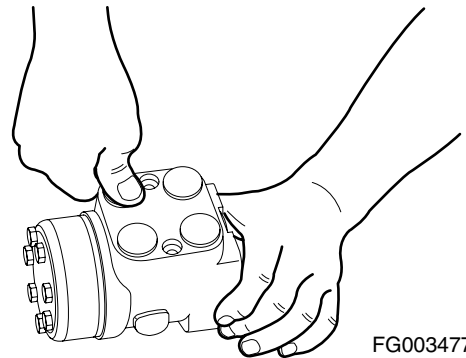


Figure 87

FG003477

Hydraulic Connections

Reference Number	Description
L	Left Port
R	Right Port
T	Tank
P	Pump

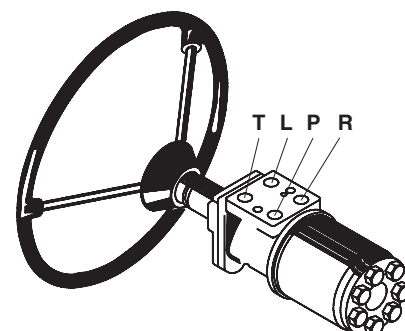


Figure 88

FG003478

Max. Tightening Torque

Screwed Connection	Max. Tightening Torque daNm (lbf in)			
	With Cutting Edge	With Copper Washer	With Aluminium Washer	With O-ring
G 1/4	4 (350)	2 (180)	3 (270)	
G 3/8	6 (530)	2 (180)	5 (440)	
G 1/2	10 (900)	3 (270)	8 (700)	
7/16-20 UNF		2 (180)		
3/4-16 UNF		6 (530)		
M12 x 1.5	4 (350)	2 (180)	3 (270)	2 (180)
M18 x 1.5	7 (620)	2 (180)	5 (440)	5 (440)
M22 x 1.5	10 (900)	3 (270)	8 (700)	7 (620)

Accelerator Pedal Valve (Hydraulic)

Edition 1

MEMO

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Accelerator Pedal Valve (Hydraulic)

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Hydraulics Symbol.....	7
Disassembly and Assembly Tools.....	7
Disassembly	8
Assembly	9

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.

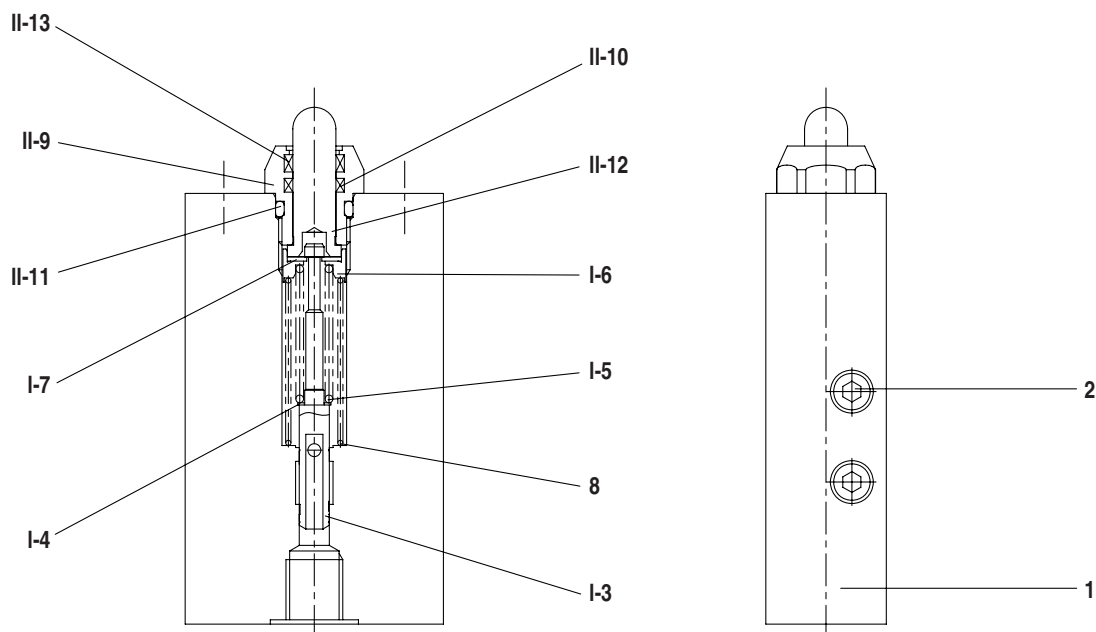
Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX190W	5001 and Up
DX210W	5001 and Up

STRUCTURE



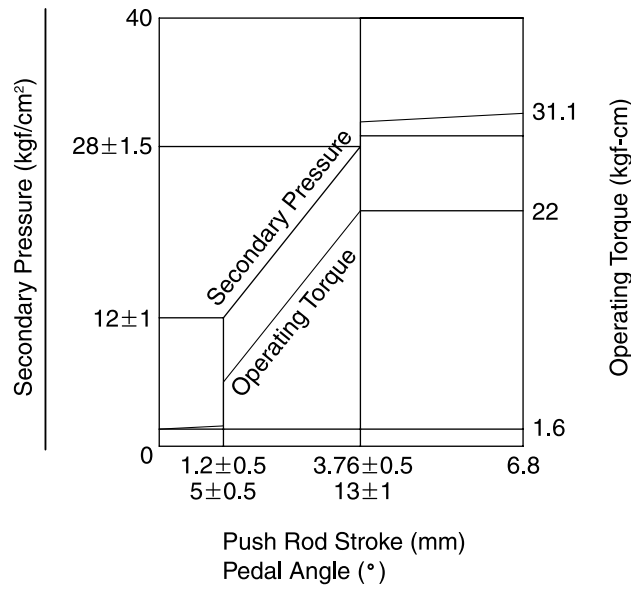
FG007504

Figure 1

PARTS LIST

No.	Part Name	Standard	Material	Qty	Remark
1	Body			1	AJV12D101
2	Plug			2	WPT18
I	Spool Kit				JA3G3010
I-3	Spool			1	AJV12D102
I-4	Spring Seat			1	AJV12D103
I-5	Spring			1	JA3G3001A
I-6	Spring Seat			1	JA3G3006
I-7	Stopper			1 set	AJV12D106
8	Spring			1	JA3G3007
II	Plug Kit				JA3G3011
II-9	Plug			1	AJV12D108
II-10	Seal	DYR10	N.B.R	1	RSY10
II-11	O-ring	P14	N.B.R	1	PO 014
II-12	Push Rod			1	JA3G3002
II-13	Dust Seal	DRP10	N.B.R	1	DSP10

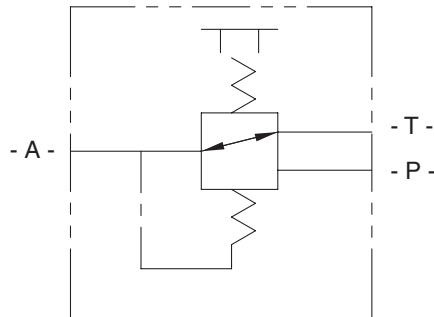
PERFORMANCE CURVE



FG009225

Figure 2

HYDRAULICS SYMBOL



FG007508

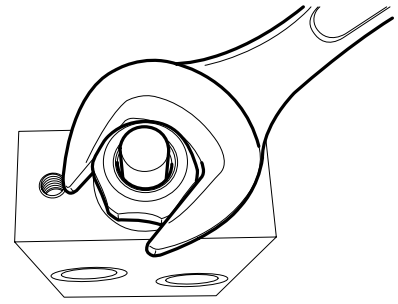
Figure 3

DISASSEMBLY AND ASSEMBLY TOOLS

NO.	Tool	Standard	Remark
2	L Wrench	5 mm	
II-9	Wrench	21 mm	

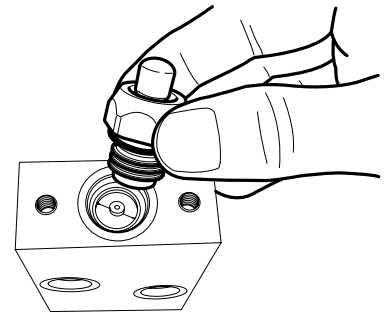
DISASSEMBLY

1. Disassemble plug kit (II) from the body (1).



FG007509

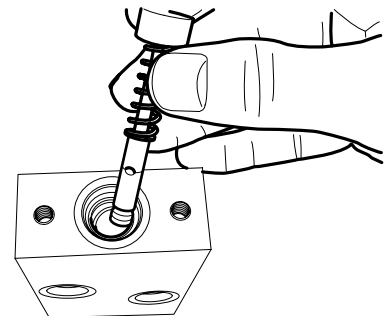
Figure 4



FG007510

Figure 5

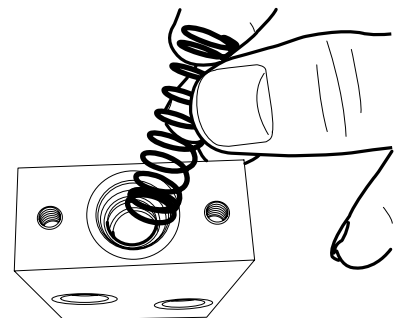
2. Disassemble spool kit (I) from the body (1).



FG007511

Figure 6

3. Disassemble spring (8) from the body (1).

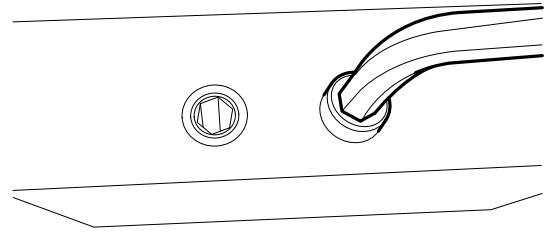


FG007512

Figure 7

ASSEMBLY

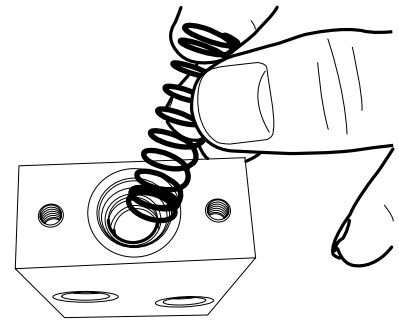
1. Assemble plug (2) in the body (1).



FG007513

Figure 8

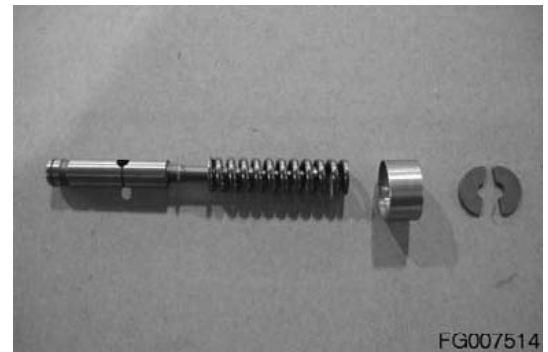
2. Assemble spring (8) in the body (1).



FG007512

Figure 9

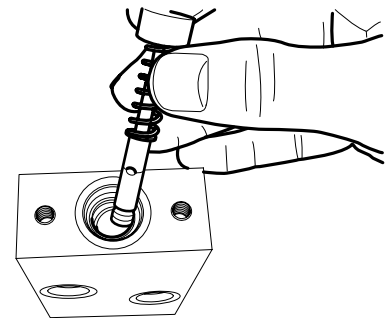
3. Assemble spool kit (I).
Assemble spring seat (I-4), spring (I-5), spring seat (I-6)
and stopper (I-7) at spool (I-3) in the order.



FG007514

Figure 10

4. Assemble spool kit (I) in the body (1).



FG007511

Figure 11

5. Assemble plug kit (II)

Assemble seal (II-10), dust seal (II-13), O-ring (II-11), push rod (II-12) in plug (II-9) in the order.



Figure 12

6. Assemble plug kit (II) in the body (1).

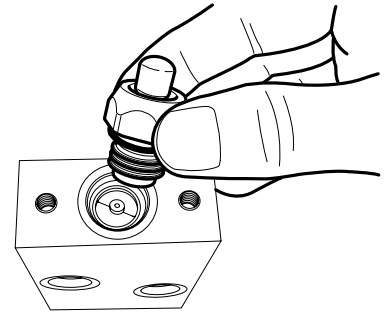


Figure 13

FG007510

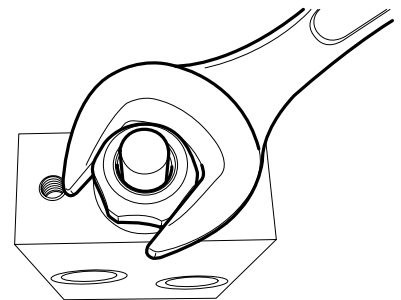


Figure 14

FG007509

One Spool Valve

Edition 1

MEMO

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One Spool Valve

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Replacement of Overload Relief Valve	12
Replacement of Sub-block Assembly.....	13

MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

OUTSIDE DRAWING

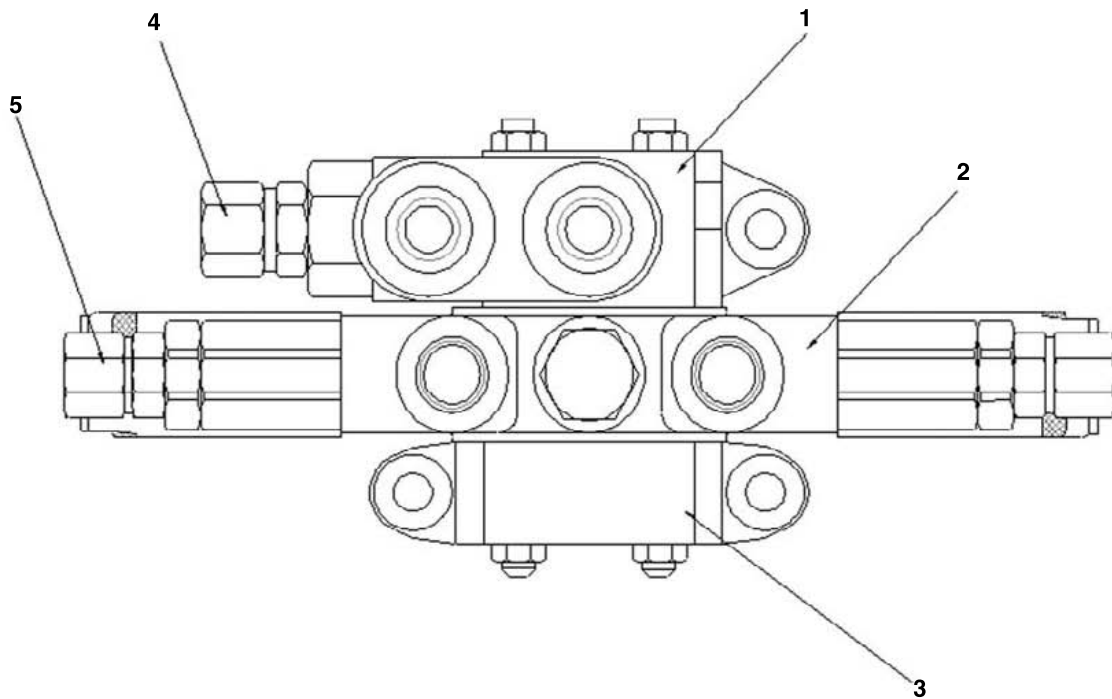


Figure 1

FG003747

HYDRAULIC CIRCUIT

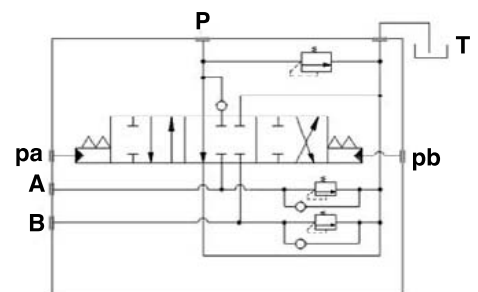


Figure 2

FG003748

OPERATIONAL PRINCIPLE

In the Neutral Condition

The hydraulic oil, supplied to the P port under the neutral condition, is to be flowed out to the tank passage through the "One Spool Valve."

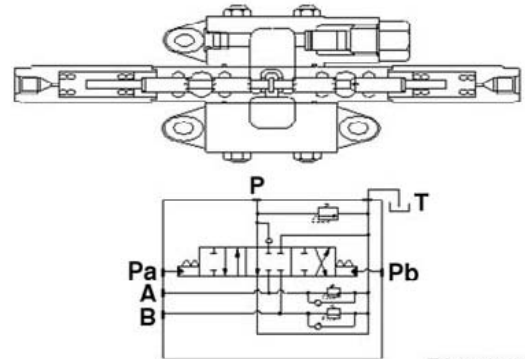


Figure 3

FG003750

Spool Operation

1. When Pilot Pressure "Pa" is impressed

When pilot pressure is impressed at the "Pa" port, the pressured oil flowed from the P port is to be discharged to the A port through the load check poppet and the spool, as the hydraulic oil passage for bypass is blocked.

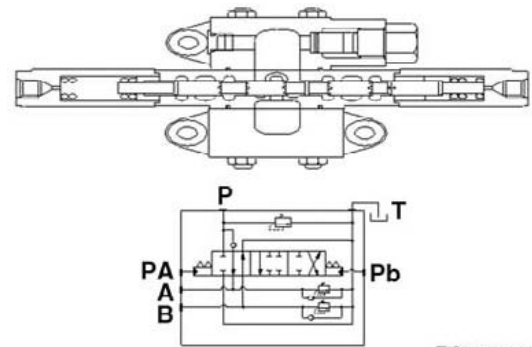


Figure 4

FG003751

2. When Pilot Pressure "Pb" is impressed

When pilot pressure is impressed at the "Pb" port, the pressured oil flowed from the P port is to be discharged to the B port through the load check poppet and the spool, as the hydraulic oil passage for bypass is blocked.

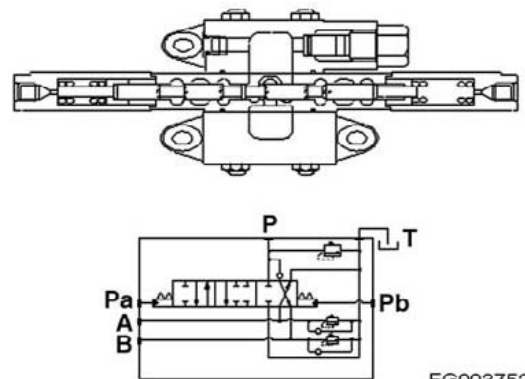


Figure 5

FG003752

DISASSEMBLY AND ASSEMBLY

General Cautions

It is the principle that disassembly and assembly of this valve should be carried out by the manufacturer. In case disassembly and assembly is inevitably required elsewhere, the following cautions must be observed.

1. This valve is precisely processed and the gaps among each part are extremely tiny. This, disassembly and assembly should be performed very carefully so any foreign material such as dust or sand cannot intrude into the valve.
2. For disassembly, a technician should start disassembly after fully understanding the structure of the valve with structural drawings and reference drawings.
3. When the valve needs to be removed from a machine, be sure to put caps on each port and to wash the exterior of the assembly after checking the caps on each port again before assembling.
4. In case the disassembled parts need to be placed unassembled for a while, they must be treated with rust prevent oil and sealed to prevent rusting.
5. Do not hold a pilot cap, a relief valve and a overload relief valve when this valve needs to be moved.
6. Even in case disassembly and assembly is not performed smoothly, do not hit or treat any part of the product roughly.
7. After disassembly, attach ID tags to each part for accurate assembly.
8. For O-rings and backup rings, it is the principle to use the new ones, and be sure not to damage one during assembly. (Apply a small portion of grease on the parts for smooth assembly.)
9. Fasten bolts, overload relief valves and main relief valves with the specified standard torque.
10. As various tests (relief characteristics test, leakage test, operational test, etc.) are essential after disassembly and assembly, do not disassemble this valve if those tests are not available.
11. Be careful not to damage the O-ring contacting parts of this valve for preventing oil leakage.
12. Be cautious about safety during operation as this valve assembly is heavy.

Replacement of Spool Assembly (Pilot Type)

CAUTION!

For replacement of a spool, it must be replaced with a subassembly of spool.

CAUTION!

During assembly operation of a spool subassembly, be careful so a foreign material cannot intrude into the subassembly.

1. Removing Pilot Cap

Unfasten the two bolts for the pilot cap with a L-wrench (5 mm) and remove cap along with the washer.
(You can remove either of them.)



Figure 6



Figure 7

2. Removing Spool

After fixing the main body and removing the return spring and the spring seat first, pull the spool in the horizontal direction (parallel to the spool hole) to remove it from the main body.

Too much impressed force for disassembly may damage the spool. When the spool is stuck, therefore, push it back smoothly and try to pull the spool while rotating it.

While removing the spool, check which end has the mark.



Figure 8

3. Assembling Spool

Insert the spool into the fixed main body. (Overloaded force may damage the main body or the spool. When the spool is stuck, pull it back and press it smoothly while rotating it.)

Check the direction of the mark, identified during the disassembly operation.

Assemble the spring seat and the spring.

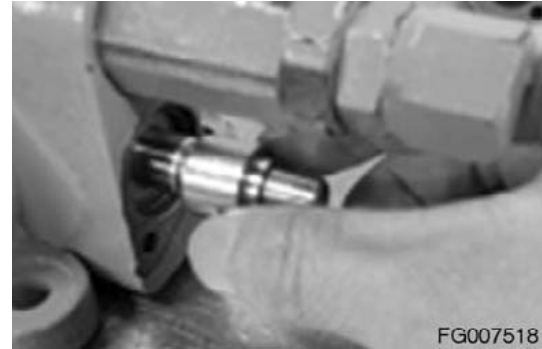


Figure 9



Figure 10

4. Assembling Pilot Cap (on Return Spring Side)

Cover the pilot cap on the return spring of the spool, previously assembled to the main body, and fasten it with two bolts at the specified standard torque using a torque wrench (5 mm). Check if there is the O-ring on the contacting surface.

Standard Torque: 1.1 kgf•m



Figure 11

Replacement of Main Relief Valve



CAUTION!

Be careful not to damage the seat of the removed main relief valve.



CAUTION!

As the main relief valve is a very important part, related to performance and safety, and hard to be set for the pressure again, be sure to replace it with an assembly if needed, not disassembling it.



CAUTION!

During assembly of a main relief valve, be careful so a foreign material cannot intrude into the main frame.

1. Removing Main Relief Valve

Fix the main body and remove main relief valve by unfastening the hexagon bolt with a wrench (30 mm). The wrench should hold the bolt as deeply as possible.



Figure 12

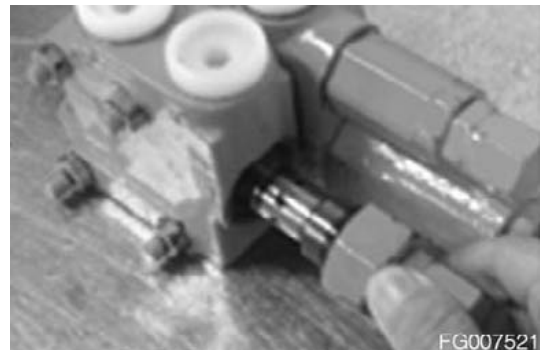


Figure 13

2. Assembling Main Relief Valve

Fasten the main relief valve to the main body at the specified standard torque using a torque wrench (30 mm). Check if there is the O-ring on the contacting surface.

Standard Torque: 6 kgf•m

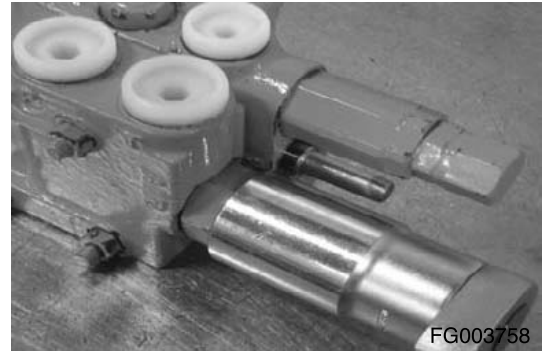


Figure 14

Replacement of Overload Relief Valve

CAUTION!

As the removed overload relief valves may have different setting values for each position, identify them for the original position with tags for accurate assembly.

CAUTION!

As the overload relief valve is a precision part, be cautious about damage or intrusion of foreign materials.

CAUTION!

As the overload relief valve is a very important part, related to performance and safety, and hard to be set for the pressure again, be sure to replace it with an assembly if needed, not disassembling it.

CAUTION!

During disassembly of a overload relief valve, be careful not to damage the return cap by the wrench.

1. Removing Overload Relief Valve

Fix the main body and remove overload relief valve by unfastening the hexagon bolt with a wrench (22 mm). The wrench should hold the bolt as deeply as possible.

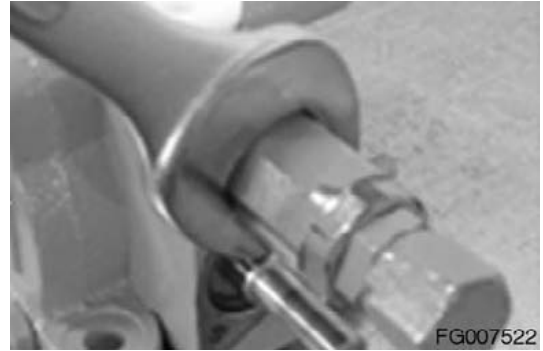


Figure 15

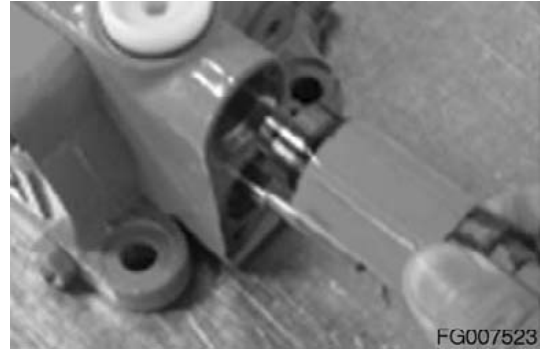


Figure 16

2. Assembling Overload Relief Valve

Fasten the overload relief valve to the main frame at the specified standard torque using a torque wrench (22 mm). Check if there is the O-ring on the contacting surface.

Standard Torque: 4 kgf•m

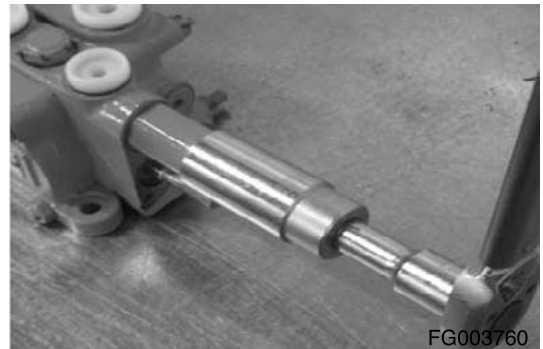


Figure 17

Replacement of Sub-block Assembly



CAUTION!

During assembly of the sub-block assembly, be careful so a foreign material cannot intrude into the main body.

1. Installation of Surface Plate

Install a surface plate on a workbench for replacement of the sub block assembly.

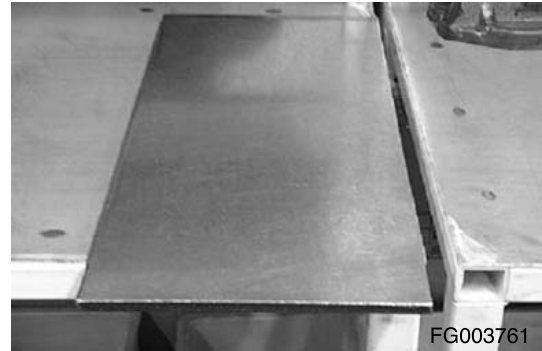


Figure 18

2. Removing Sub-Block Assembly

Place the main frame on the surface plate, installed on the workbench.

Remove assembly by unfastening the four nuts, fixing it, with a wrench or a hexagon wrench (13 mm).



Figure 19

3. Replacing Block Assembly

Replace the faulty assembly with a new one and assemble the new one in order.



Figure 20

4. Assembling Nuts

Arrange the main frame and fasten the four nuts at the specified standard torque with a torque wrench (13 mm).

Before completely fastening the nuts, check if each sub-block is properly arranged based on the surface plate.

Standard Torque: 2.05 kgf•m



Figure 21

Remote Control Valve (Work Lever / Joystick)

Edition 1

MEMO

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Standard Torques

Safety Precautions	5
Applicable Models	5
Torque Values for Standard Metric Fasteners.....	6
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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX180LC	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX300LL	5001 and Up
DX340LC	5001 and Up

GENERAL DESCRIPTION

Theory of Operation

Structure

The remote control valve contains four push rods, spring holders, spools and return springs, which are in the valve casing. The valve works as a pressure reduction valve.

The housing has six ports, which include input port P, tank port T, and four secondary pressure ports.

The electric horn button is installed in the valve handle.

Gear pump pressure is used for operating control spools.

Function

1. Neutral Position

When the lever is in neutral mode, the spool is pushed upward by return spring. The force of balancing spring, which determines the secondary discharge pressure, is not transmitted to the spool. The input port is closed and the pressure of the output port is the same as the pressure of the tank port T.

2. Control Switch

Pressing of the push rod starts to press the balance spring, whose force is transferred to the spool to connect the P and T ports, transferring the pilot pressure. Output pressure acts on the bottom of the spool and press the spool upwards until it is balanced with the force of the balance spring.

In short, the second pressure (output pressure) changes in proportion to the pressing force of the balance spring.

Parts List

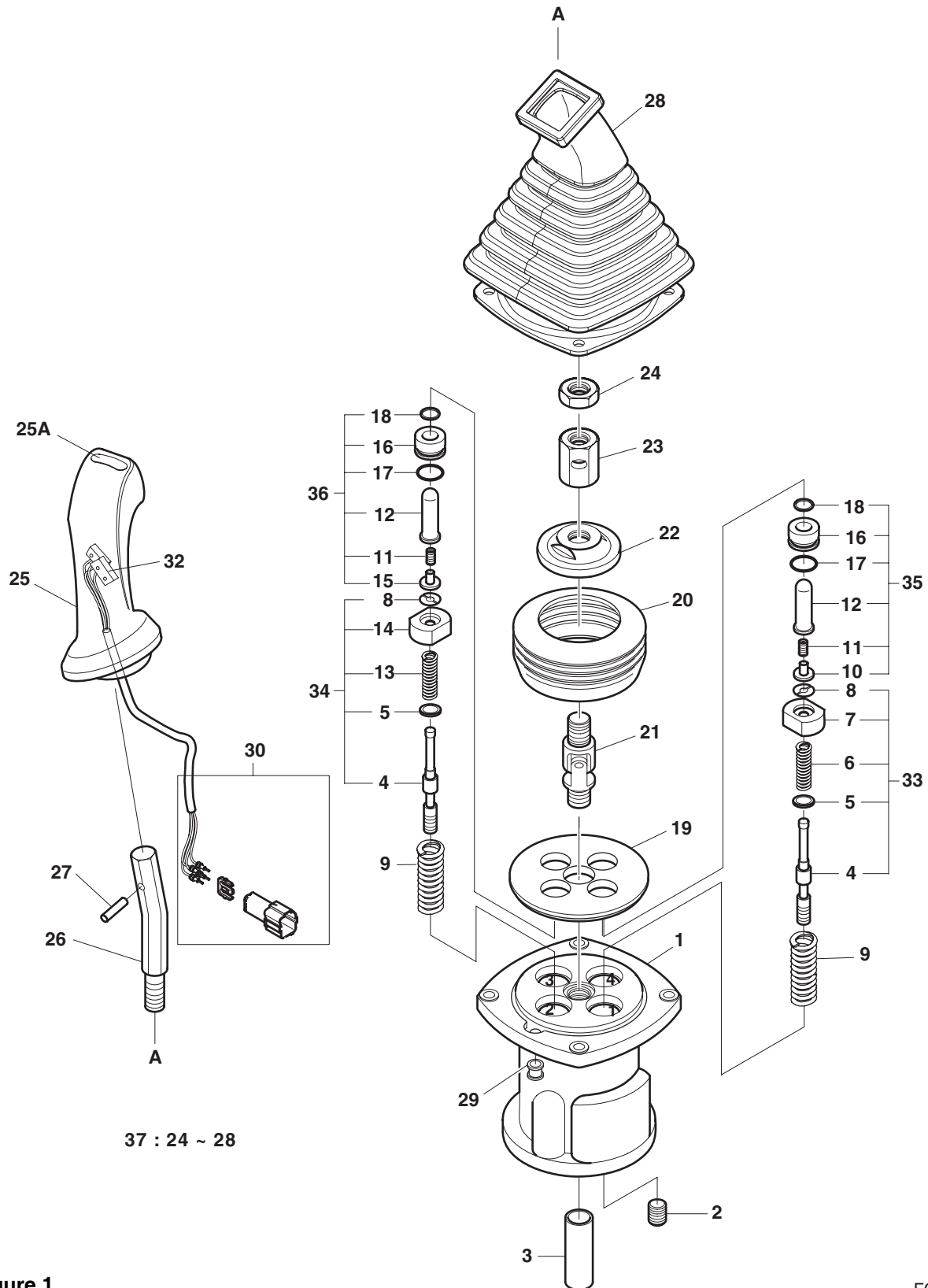


Figure 1

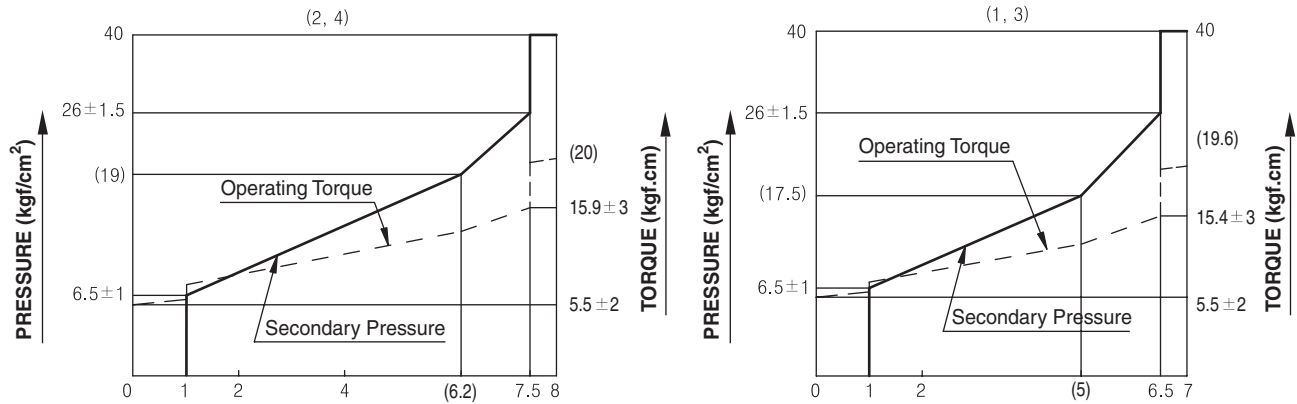
FG003938

Reference Number	Description
1	Case
2	Plug
3	Bushing
4	Spool
5	Shim
6	Spring
7	Spring Seat
8	Stopper
9	Spring
10	Stopper
11	Spring
12	Push Rod
13	Spring
14	Spring Seat
15	Stopper
16	Plug
17	O-ring
18	Rod Seal
19	Plate
20	Boot

Reference Number	Description
21	Joint Assembly
22	Swash Plate
23	Nut
24	Nut
25	Handle Assembly (L) Handle Assembly (R)
25A	Cap
26	Handle Bar
27	Spring Pin
28	Bellows
29	Bushing
30	Connector Assembly
32	Switch Assembly
33	Spool Kit 1, 3
34	Spool Kit 2, 4
35	Plug Kit 1, 3
36	Plug Kit 2, 4
37	Handle Kit (Left) Handle Kit (Right)

Specifications

Performance



FG003944

Figure 2

Torques

No.	Tool	Standard	Remark
3	Plug	PF 3/8	500 kg•cm (36 ft lb)
19	Swash Plate	27 mm	1,660 kg•cm (120 ft lb)
20	Hex Nut	22 mm	1,660 kg•cm (120 ft lb)
22	Nut	22 mm	1,660 kg•cm (120 ft lb)

TOOLS AND MATERIALS

No.	Tool	Standard	Remark
3	L Wrench	8 mm	
19	Wrench	27 mm	
20	Wrench	22 mm	
22	Wrench	22 mm	

DISASSEMBLY

1. Remove lead wire from bushing (29).

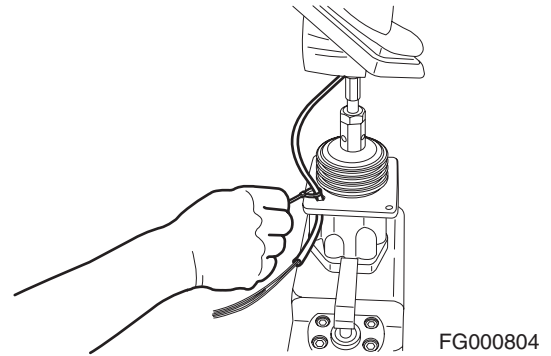


Figure 3

2. Remove lever assembly from case (1).

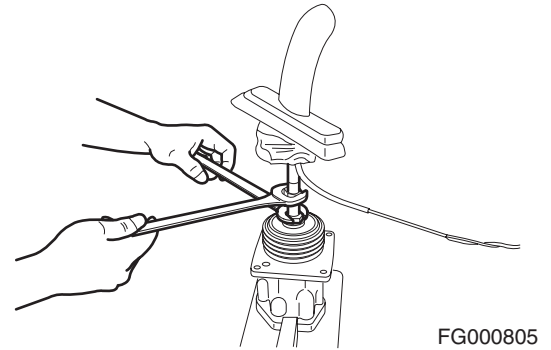


Figure 4

3. Remove hex nut (23) and swash plate (22) from case.

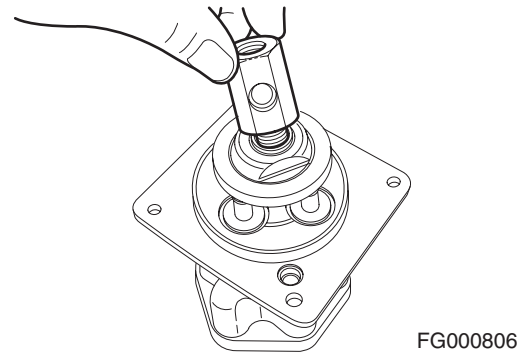


Figure 5

4. Remove joint assembly (21) from case.

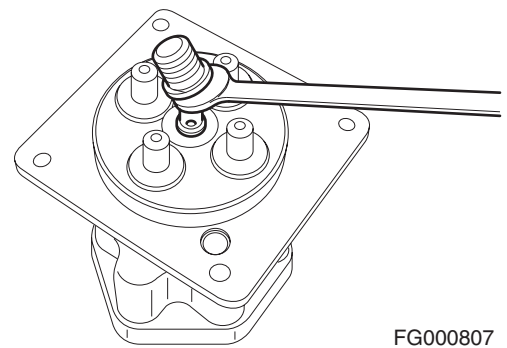


Figure 6

5. Remove plate (19) from case (1).

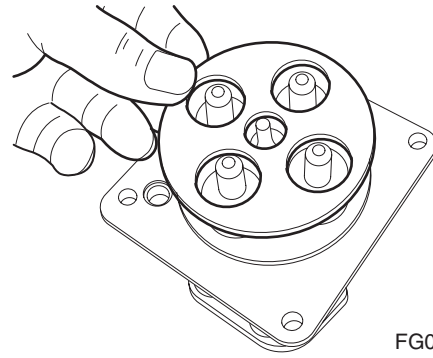


Figure 7

6. Remove plug kit assembly, stopper (10), and spring (11) from case (1).

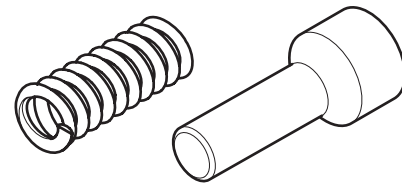


Figure 8

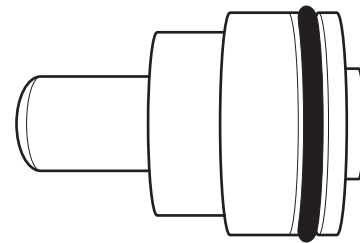


Figure 9

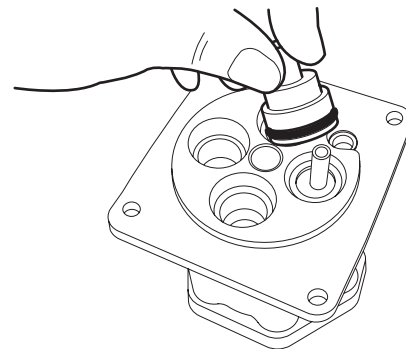
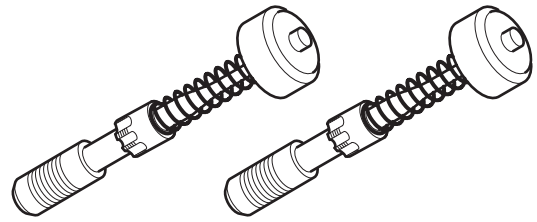


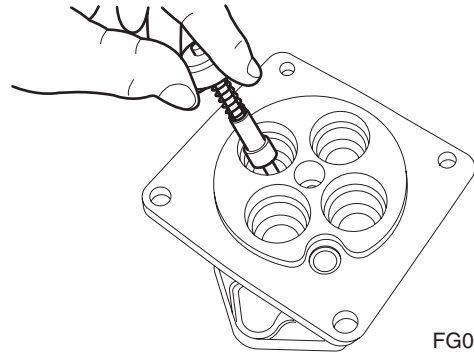
Figure 10

7. Remove four spool kit assemblies from case (1).



FG000812

Figure 11



FG000813

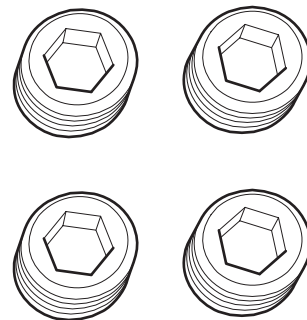
Figure 12

8. The bushing (3) and plug cannot be removed from case (1).



FG000814

Figure 13



FG000815

Figure 14

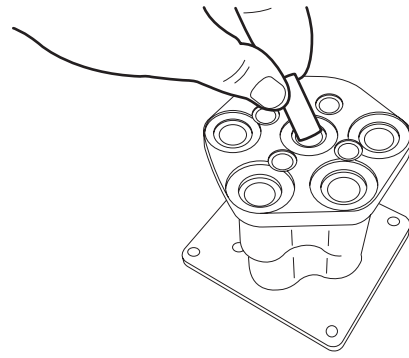


Figure 15

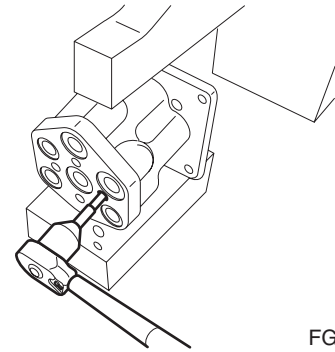


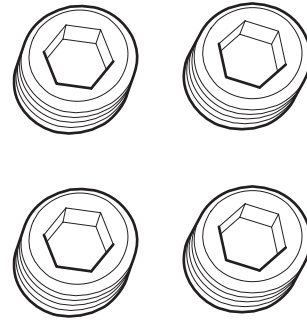
Figure 16

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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

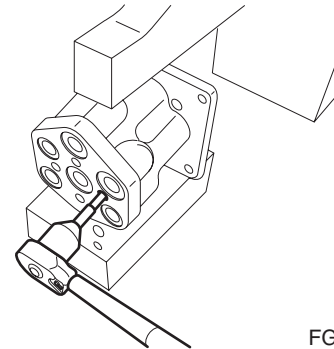
REASSEMBLY

1. Install four plugs (2) into case (1).



FG000815

Figure 17



FG000817

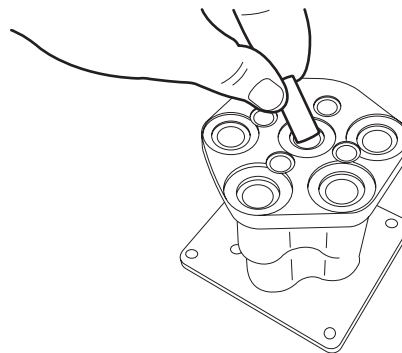
Figure 18

2. Install bushing (3) into case (1) using jig.



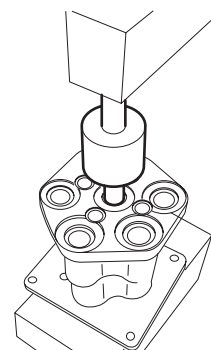
FG000814

Figure 19



FG000816

Figure 20

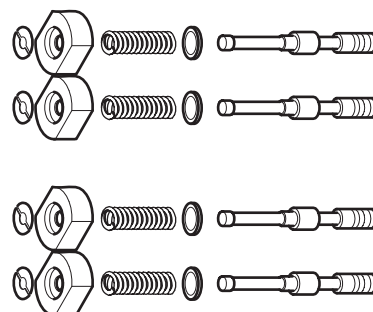


FG000818

Figure 21

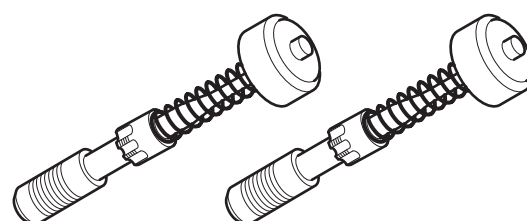
3. Be careful when assembling spool kit assemblies (1 and 3, 2 and 4). They should be assembled in same way).

The assembly order is; spool (4), shim (5), spring (6), spring seat (7), and stopper (8).



FG000819

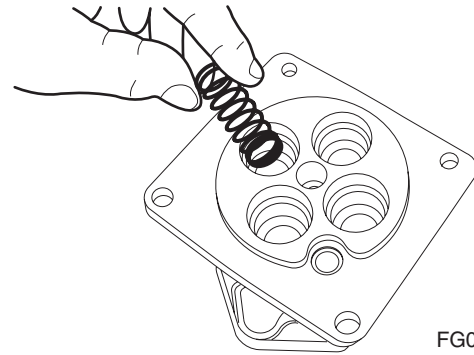
Figure 22



FG000812

Figure 23

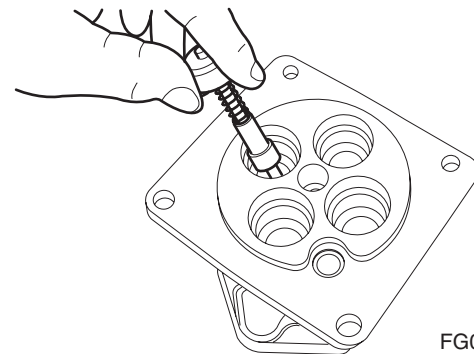
4. Install spring (9) into case (1).



FG000820

Figure 24

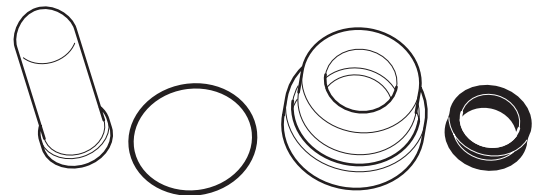
5. Install spool kit assembly into case (1). (The same way is used for four parts.)



FG000821

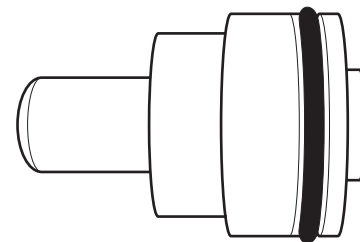
Figure 25

6. Assemble plug kit insert rod seal (18), O-ring (17), and push rod (2) into plug (16) in proper order.



FG000822

Figure 26

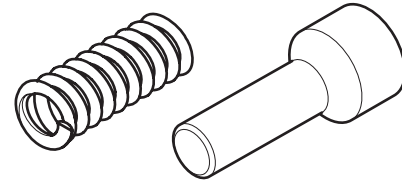


FG000810

Figure 27

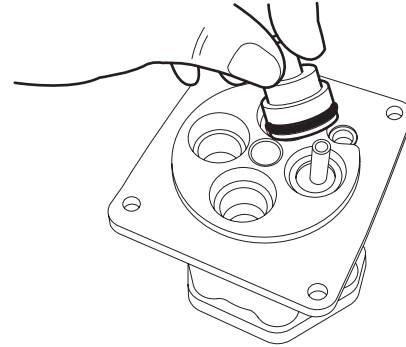
7. Assemble four springs (11) and stoppers (10) and insert assembled set in case (1) to form a plug kit assembly.

NOTE: Pay attention to measurement specifications of stoppers (1 and 3, 2 and 4).



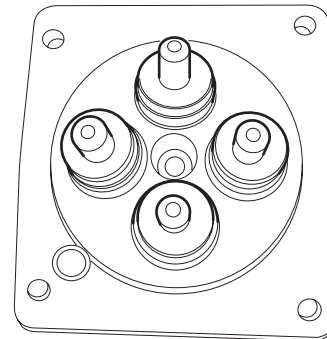
FG000809

Figure 28



FG000811

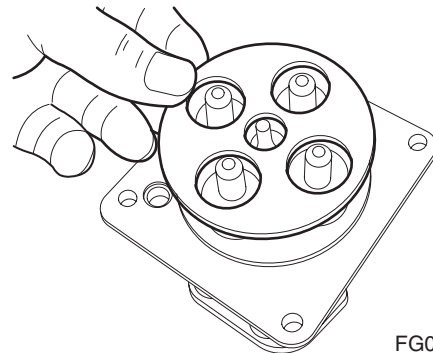
Figure 29



FG000823

Figure 30

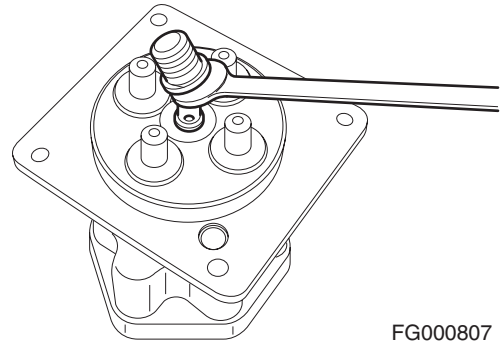
8. Install plate (19) into case (1).



FG000808

Figure 31

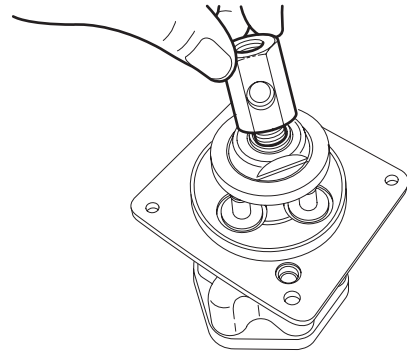
9. Install joint assembly (21) into case (1).



FG000807

Figure 32

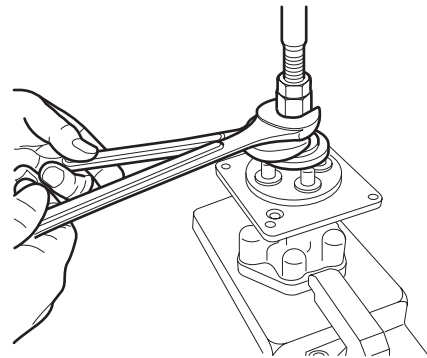
10. Install wash plate (22) and hex nut (23) into case (1).



FG000806

Figure 33

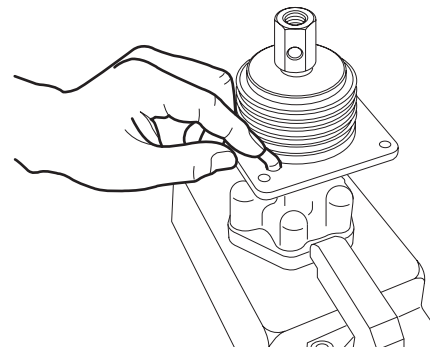
11. Insert bar and tighten it with a wrench to check balance of joint assembly.



FG000824

Figure 34

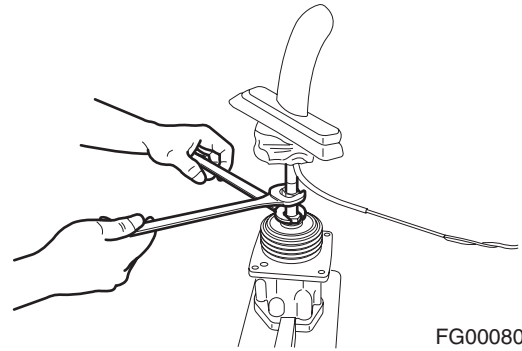
12. Install boot (20) and bushing (29) into case (1).



FG000825

Figure 35

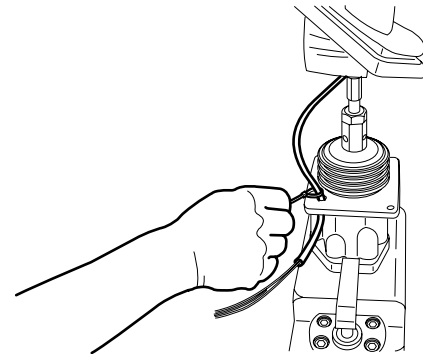
13. Install lever assembly into case (1).



FG000805

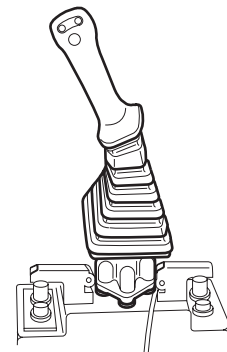
Figure 36

14. Put lead wire in bushing (29), tie it, and arrange boot.



FG000826

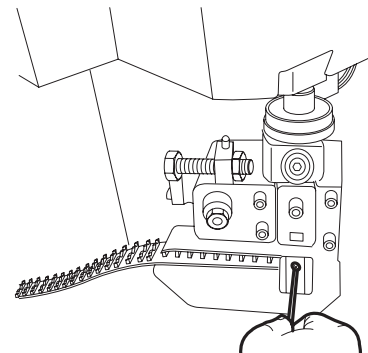
Figure 37



FG000827

Figure 38

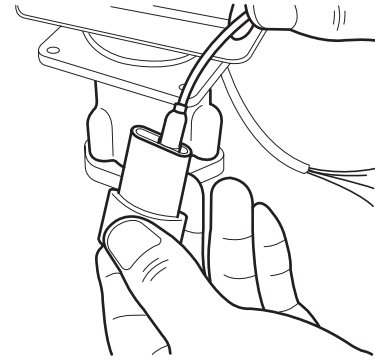
15. Install lead wire terminal into connector terminal pressing them together.



FG001097

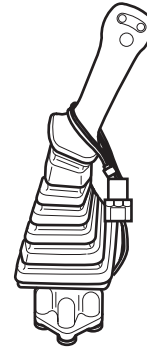
Figure 39

16. Assemble connector assembly (30), and connect it to lead wire terminal, and properly route wiring.



FG000828

Figure 40

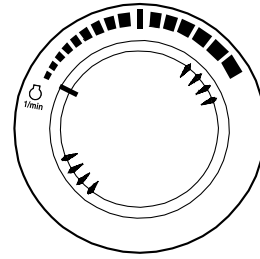


FG000829

Figure 41

START-UP PROCEDURES

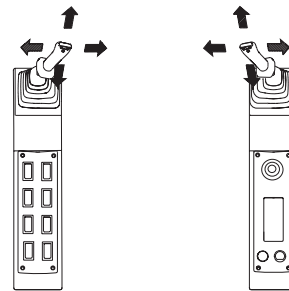
1. Start engine and set throttle at "LOW IDLE."
2. Set safety lever on "UNLOCK" position.



HAOB290L

Figure 42

3. Slowly cycle boom, arm, bucket cylinders and swing motor about five times without a load to vent air from pilot lines. Do this for five minutes.



ARO0470L

Figure 43

Breaker EPPR Valve (Opt)

Edition 1

MEMO

Table of Contents

Breaker EPPR Valve (Opt)

Safety Precautions	5
Applicable Models	5
Structure	6
Numbers and Names of Parts	6
Functions and Operation	7
Cautions for Operation	7
Maintenance Instructions.....	8
Maintenance.....	8
Disassembly	9
Assembly	10

MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

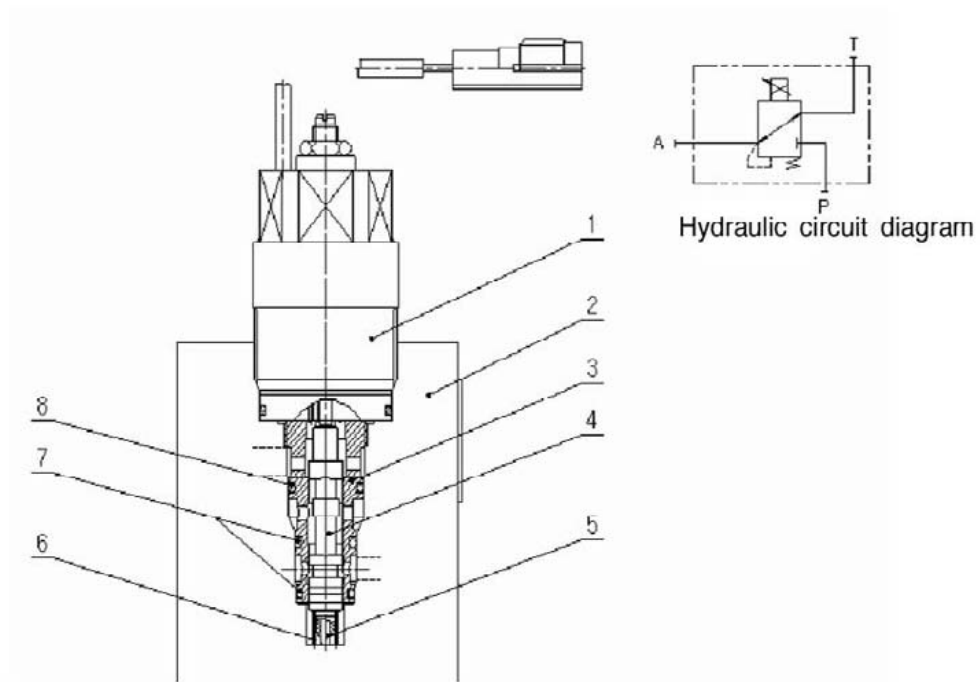
APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX180LC	5001 and Up
DX190W	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 44

Reference Number	Description
1	Solenoid
2	Valve casing
3	Sleeve
4	Spool

Reference Number	Description
5	Pin
6	Spring
7	O-ring
8	O-ring

FUNCTIONS AND OPERATION

The proportional reducing valve should be adjusted so its reduced pressure is proportional to the current of the solenoid.

The proportional solenoid should conform to a pressure proportionate to the electrical input signal. Flow increases corresponding to the force of the solenoid. As the solenoid (1) receives pressure, the spool (4) opens and oil flows from P to A. Pressure of the port A influences the top surface of the pin (5). When it reaches the valve setting of the solenoid, the spool starts to move and oil flow from P to A decreases.

CAUTIONS FOR OPERATION

1. Wiring of the solenoid
 - The solenoid has no polarity.
2. Input electricity
 - Do not supply electric current more than 0.7A to the solenoid coil.
3. Adjustment screw
 - It was adjusted to the standard.
 - The pressure of the port A increases when turning the adjustment screw clockwise.
4. Symptoms and Solutions of Problems

Problem	Possible Cause	Remedy
Pressure does not increase nor change	Poor wiring	Fix wiring
	Solenoid damaged	Replace the solenoid
	Piston or spool stuck	Fix, or clean and grind
	Amplifier damaged	Repair or replace the amplifier
Unnatural pressure change	Poor opening space Too wide Too narrow	Readjust
	Piston or spool stuck	Fix, or clean and grind
Unnatural pressure	Poor opening space Too wide Too narrow	Readjust
Slow reaction	Low-pressure supplied	Readjust

MAINTENANCE INSTRUCTIONS

Maintenance

Bolt Tightening Torque

Table 1 shows torques used to tighten bolts of the motor.

Make sure that assembly work should be done according to Table 1.

Bolt Sizes	Names	Used Torques (kg•cm)
M 35	Hex bolt	450 ±50
M 10	Hex bolt	200 ±20
NPTF 1/16	Plug	90

Tools Used for Disassembly and Assembly

Table 2 shows tools necessary for disassembly and assembly.

For	Sizes	Used Torques	Used Tools
Solenoid	M 35	450 ±50	Wrench
Sleeve	M 10	200 ±20	Hex bar wrench
NPTF plug	1/16	90	Hex bar wrench

Disassembly

1. Determine a place for disassembly.
 - It should be clean.
 - Lay a rubber board or a cloth on the table and take care not to damage parts.
2. Remove dust and rust from proportional pressure reducing valve with cleansing oil.
3. Disassemble the solenoid
 - Be careful not to damage O-rings of the solenoid.



Figure 45

4. Disassemble the spool, the spring, and the pin.



Figure 46

5. Disassemble the sleeve.
 - Be careful not to damage O-rings of the sleeve.



Figure 47

Assembly

Assembly shall be done in the reverse order of disassembly described above, taking into consideration the following points.

- Parts damaged during disassembly should be repaired without fail and spare parts should be prepared in advance.
- Every part should be cleaned thoroughly with cleaning oil and dried with compressed air before starting assembly.
- Sliding parts and bearings should be cleaned and coated with hydraulic oil before their assembly.
- Always replace O-rings and the oil seals.
- Use a torque wrench to tighten or engage bolts and plugs in accordance with reference torques as listed.

1. Assemble the sleeve.



Figure 48

- Be careful not to damage O-rings of the sleeve.



Figure 49

2. Assemble the spool, the spring, and the pin.



Figure 50

- The spring and the pin should not fall off and must remain in place during installation.



Figure 51

3. Assemble the solenoid correctly.



Figure 52

- Be careful not to damage solenoid O-rings.



Figure 53

Service Brake Pedal Valve

Edition 1

MEMO

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Service Brake Pedal Valve

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Internal Structure	8
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Reassembly of the Upper Part	13
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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

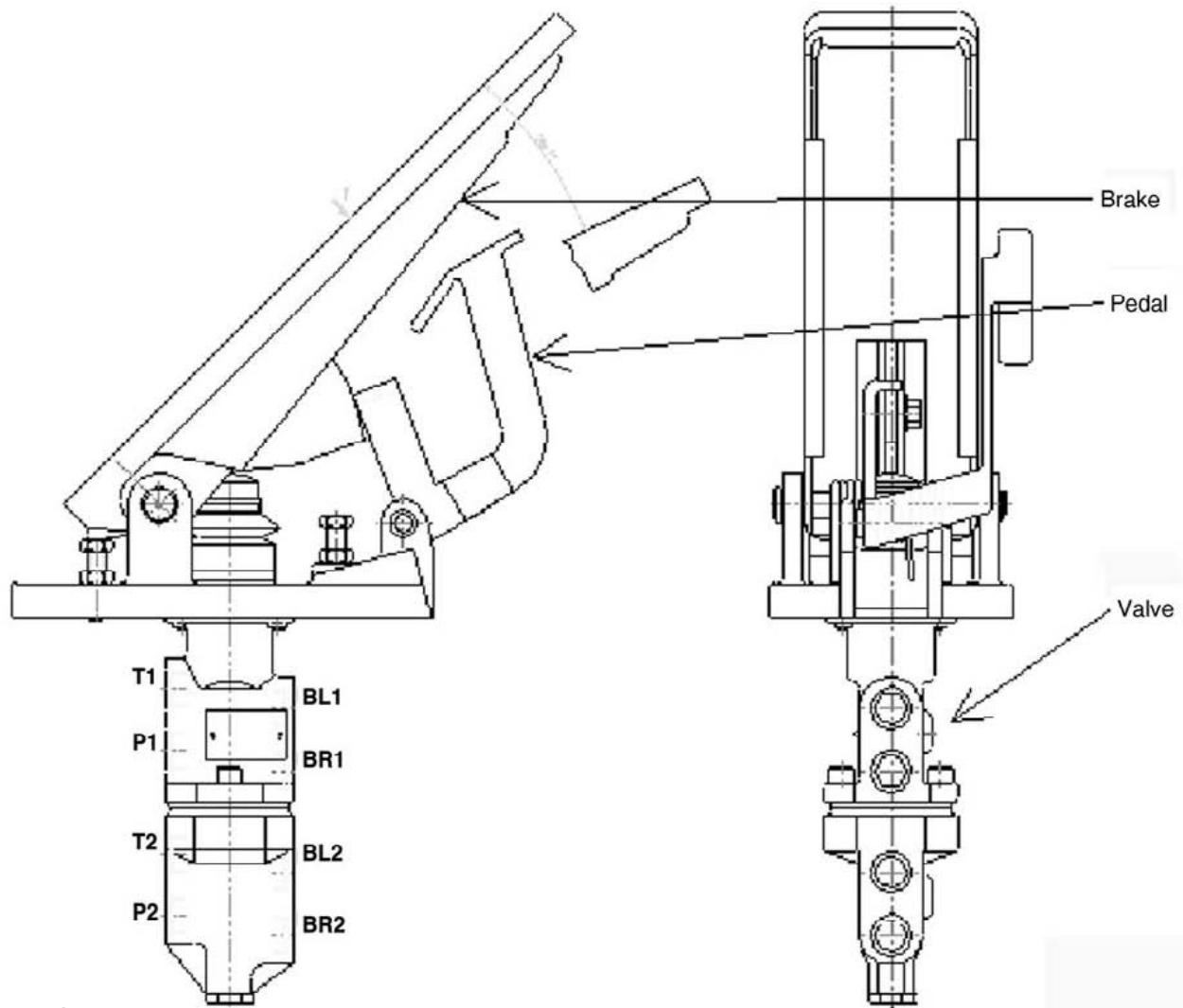
Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

FUNCTIONS OF BRAKE PEDAL



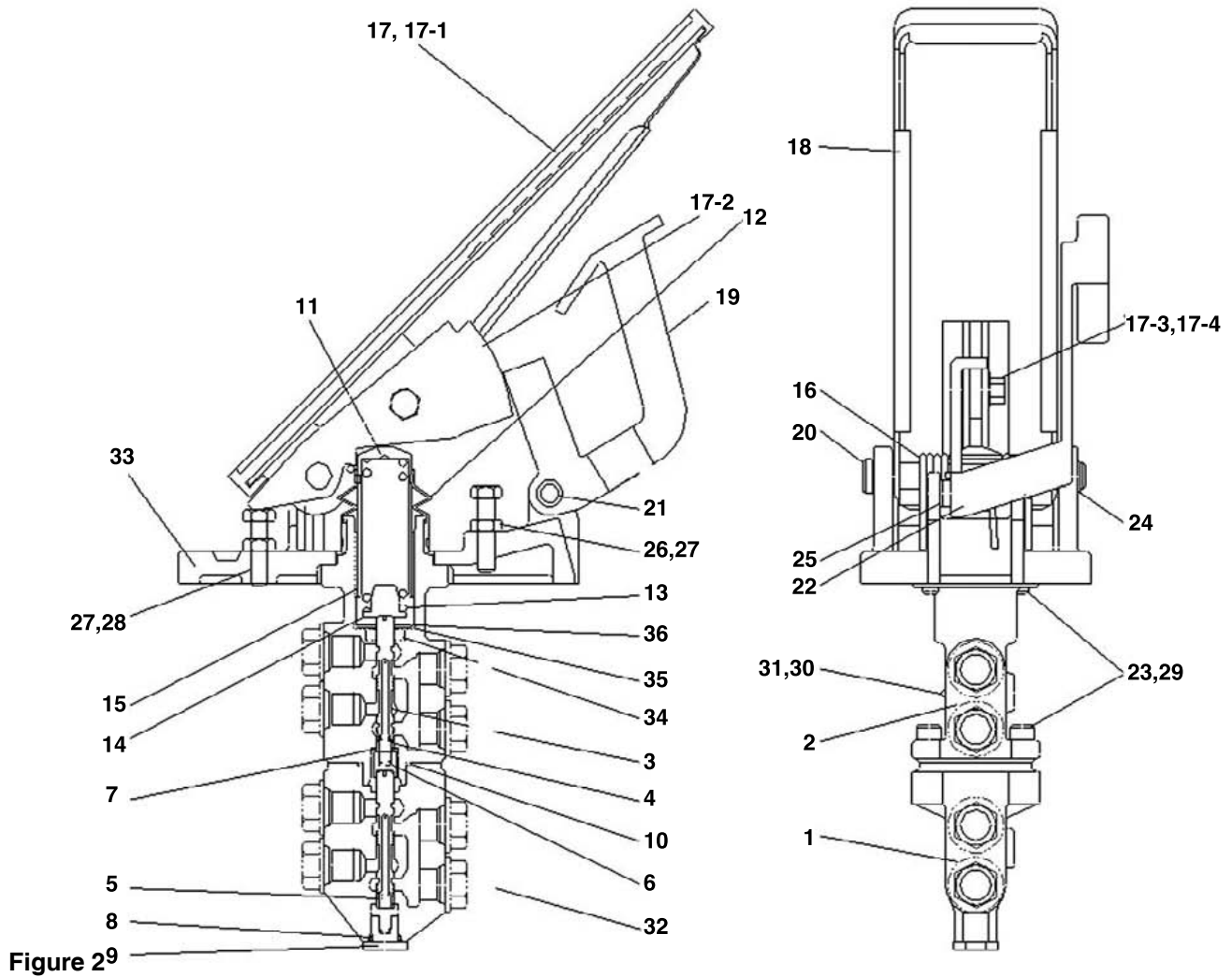
FG007747

Figure 1

The brake valve is designed for heavy-duty usage when driving an excavator on construction sites. It is hydraulic operated (see the following for operation principles) and contains an operation brake function to lock the pedal with a latch when machine is parked.

INTERNAL STRUCTURE AND OPERATION PRINCIPLES

Internal Structure



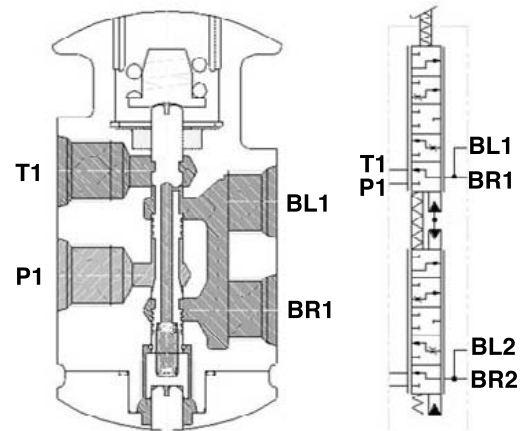
Reference Number	Description
1	Lower part
2	Upper Part
3	Spool
4	Upper Spring
5	Lower Spring 1
6	Spring Guide
7	Retaining Ring
8	O-ring
9	Plug
10	O-ring
11	Holder
12	Rubber Cover
13	Main Spring
14	Spring Retainer
15	Drive Bearing
16	Double Torsion Spring
17	Pedal Assembly
18	Rubber Pedal

Reference Number	Description
19	Latch
20	Rock Pin 1 (Pedal
21	Rock Pin 2 (Latch)
22	Torsion Spring (Wrench)
23	Hexagon Socket Head Cap Screw
24	C-type Retaining Ring
25	E-ring
26	Hexagon Bolt
27	Hexagon Nut
28	Hexagon Bolt
29	Spring Washer
30	Nameplate
31	Rivet
32	Port Plug
33	Pedal Plate
34	Oil Seal
35	Plain Washer
36	C-type Retaining Ring

Operation Principles

Brake valve is a reducing valve. Pressure to main pressure (P port) flows in the valve and reduced set pressure flows to the axle brake by way of the brake port (BR port) to stop the machine.

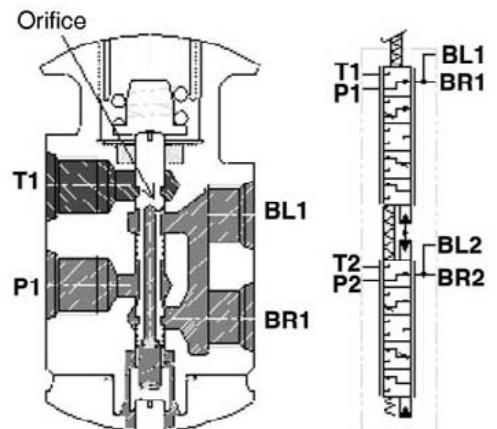
1. In Neutral Position
 - A. P port spool (3) blocks main pressure to P1 port.
 - B. T and BR ports are connected, which is the tank pressure.



FG003649

Figure 3

2. During Operation
 - A. Operation of pedal causes action of main spring (13) and spool (3). The load of spring (13) generates pressure B port seating pressure.
 - B. P and BR ports are connected and pressure is generated, which moves to orifice to act pilot pressure to the floor of spool (3).
 - C. If pilot pressure is higher than pressure set to spring (13), spool (3) moves up and pressure decreases.
 - D. If pilot pressure is lower than pressure set to spring (13), spool (3) moves down to close T port and pressure increases.
 - E. Operation angle of pedal changes load of spring (13) and thus the second pressure of BR port.



FG007748

Figure 4

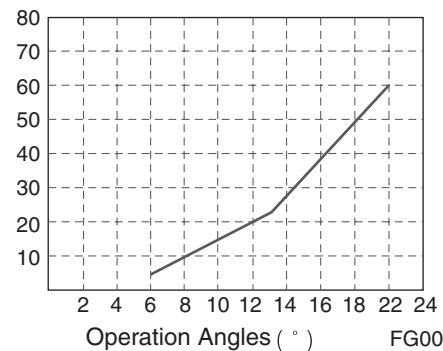
Refer to the Curve

P1, P2 ports: Supply pressure

T1, T2 ports: Tank port

BR1, BR2 ports: Brake supply port

BL1, BL2 ports: Brake pressure sensor location



FG007749

Figure 5

DISASSEMBLY

Disassembly shall be made in the reverse order of reassembly.

REASSEMBLY

Reassembly of the Lower Part

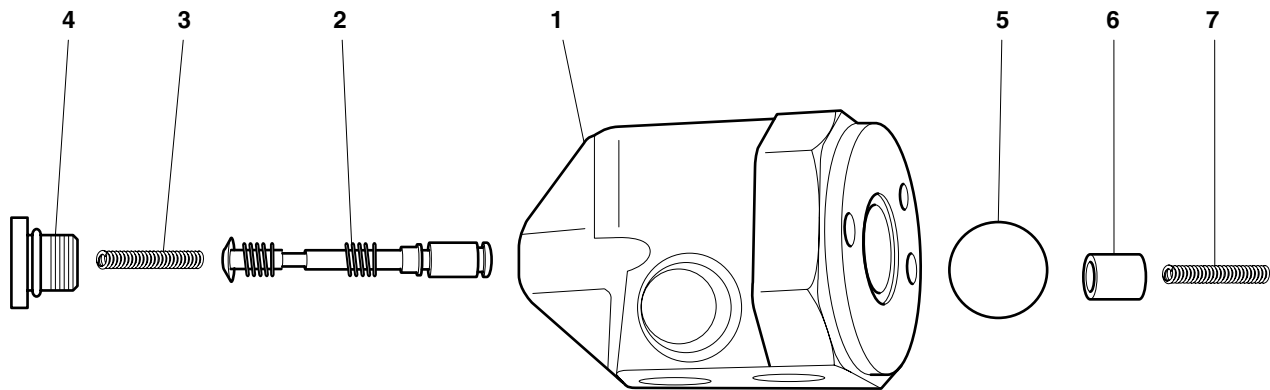


Figure 6

FG003654

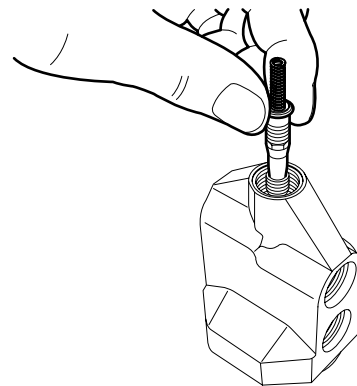
Reference Number	Description
1	Lower Part
2	Spool
3	Lower Spring
4	Plug

Reference Number	Description
5	O-ring
6	Spring Guide
7	Upper Spring

1. Insert spool (2) and lower spring (3) in lower part (1).



Take care to prevent dust or foreign substances entering valves after washing.



FG003652

Figure 7

2. Install plug (4) on lower part (1).

Tools: 19 mm wrench (Tightening torque: 1400 - 1650 kg•m)

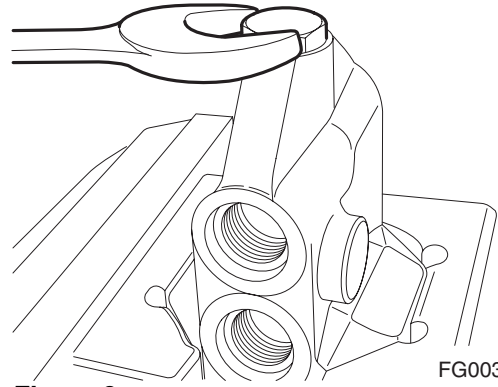


Figure 8

FG003653

3. Install O-ring (5).

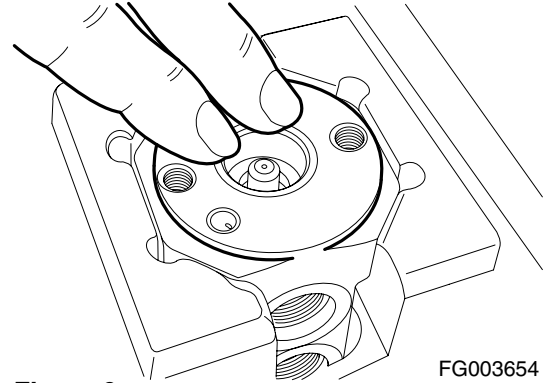


Figure 9

FG003654

4. Install spring guide (6) and upper spring (7).

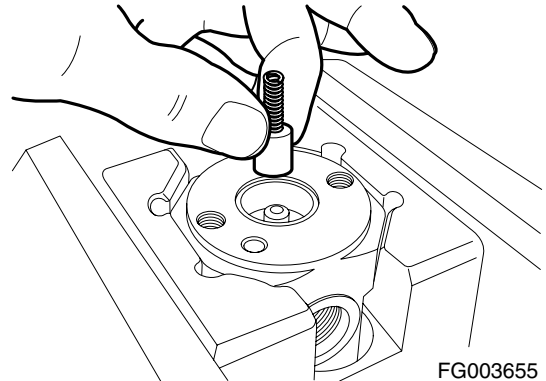
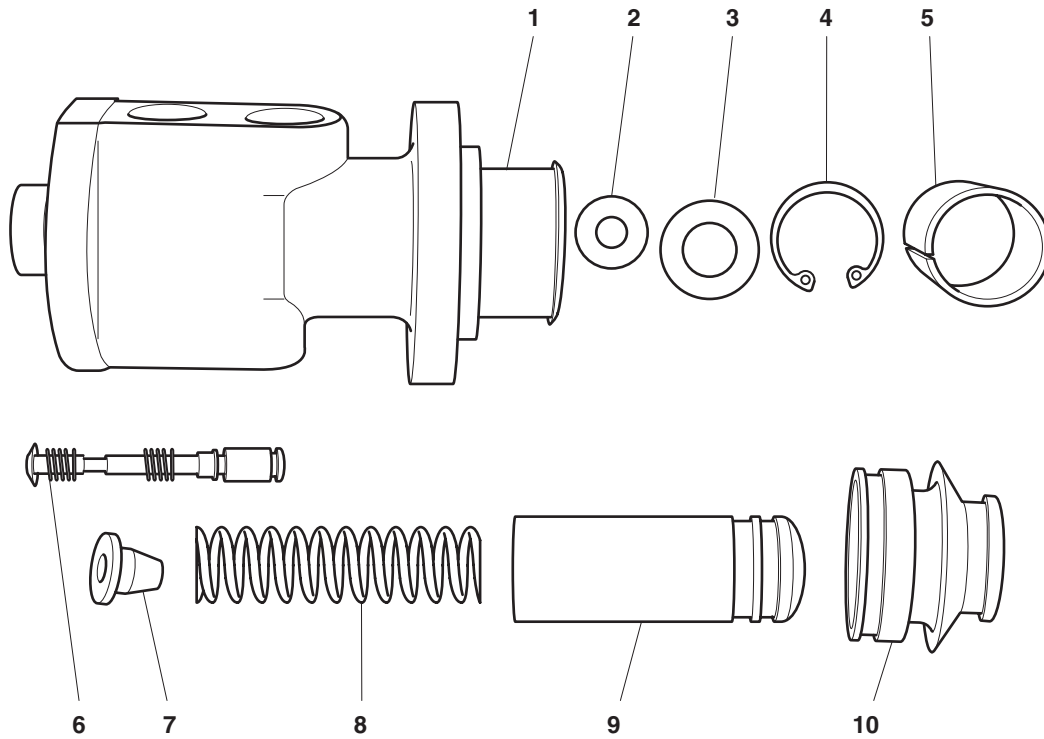


Figure 10

FG003655

Reassembly of the Upper Part



FG003656

Reference Number	Description
1	Upper Part
2	Oil Seal
3	Plain Washer
4	Retaining Ring
5	Drive Bearing

Reference Number	Description
6	Spool
7	Spring Retainer
8	Main Spring
9	Holder
10	Rubber Cover

1. Install oil seal (2), plain washer (3), retaining ring (4), and drive bearing on lower part (1).

Tools: Drive bearing jig and retaining ring pliers.



CAUTION!

Use a jig to press and push bearing.

Never remove dry bearing.

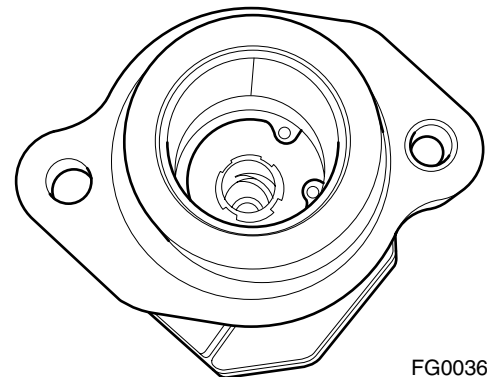


Figure 11

FG003657

2. Insert spool into the lower part.



Take care to prevent dust or foreign substances entering valves after washing.

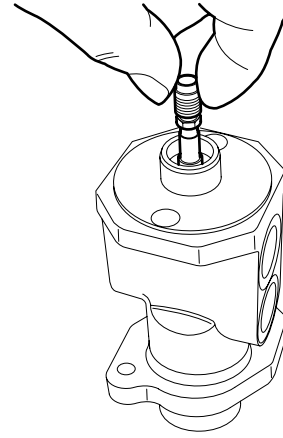


Figure 12

FG003658

3. Assemble the upper and lower parts.



Do not forget to install O-ring.

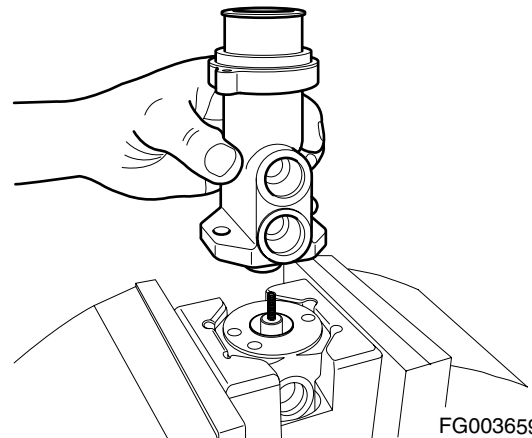


Figure 13

FG003659

4. Connection of the upper and lower parts
6 mm torque wrench (Tightening torque: 250 - 300 kg•m)

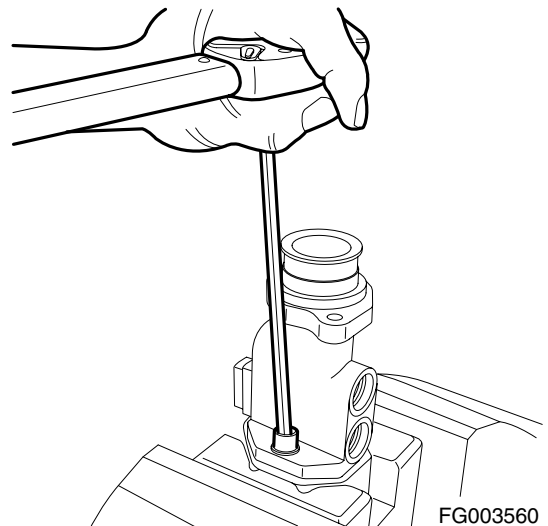


Figure 14

FG003560

5. Assemble spring retainer (7) and main spring (8).

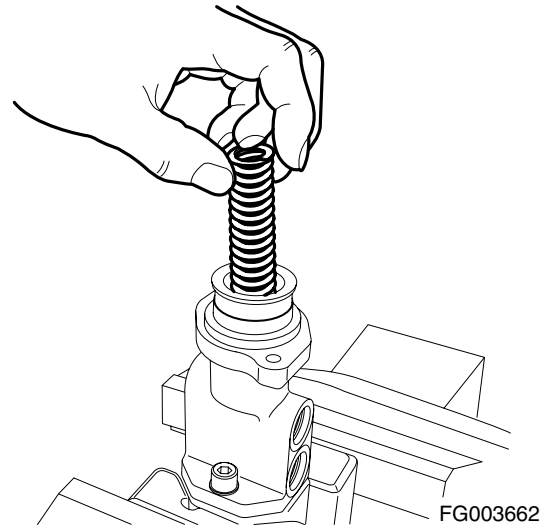


Figure 15

6. Install holder (9).

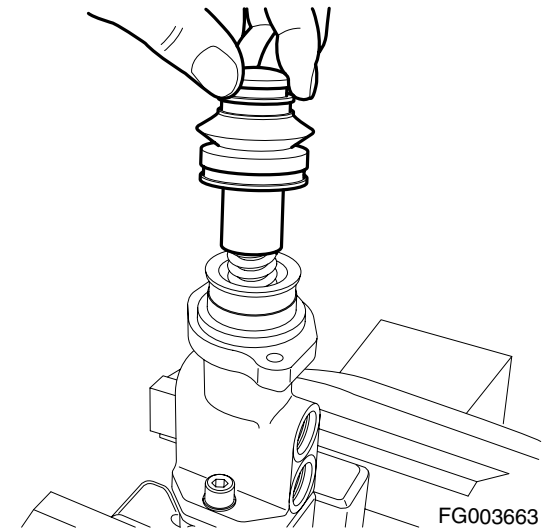


Figure 16

7. Install rubber cover (10).

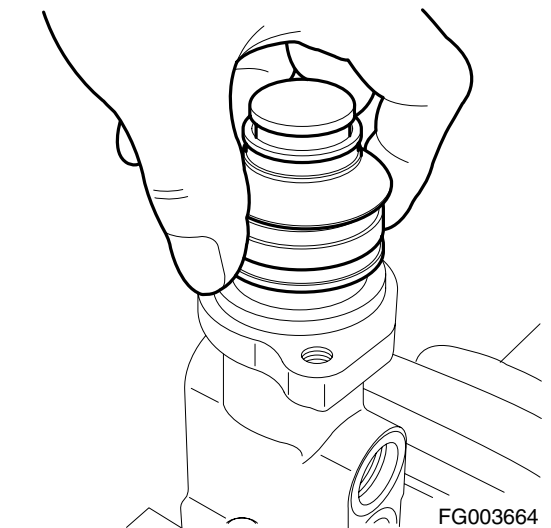


Figure 17

Assembly of Pedal Plate

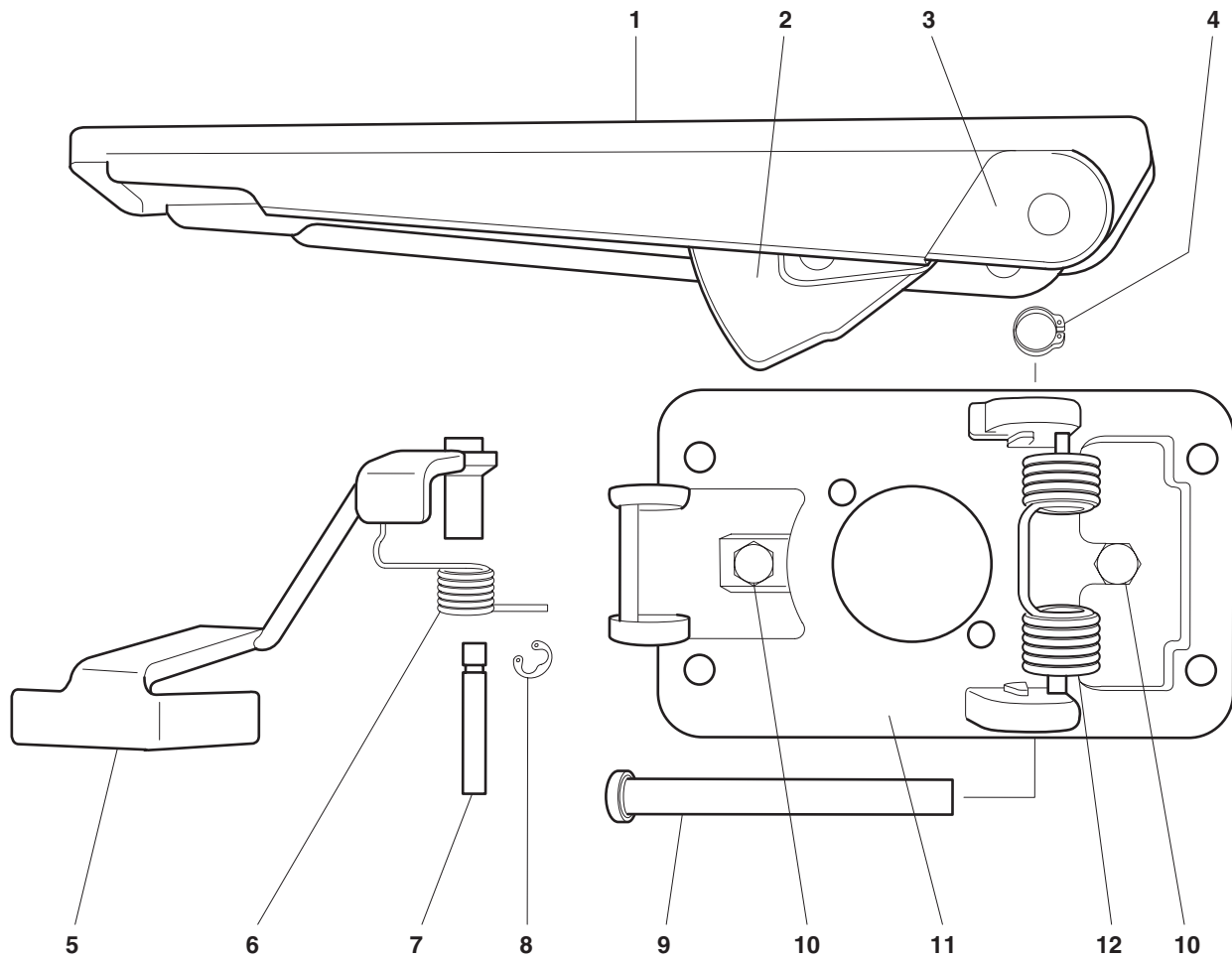


Figure 18

FG003665

Reference Number	Description
1	Rubber Pedal
2	Lock Plate
3	Pedal
4	Retaining Ring
5	Latch
6	Latch Spring

Reference Number	Description
7	Latch Lock Pin
8	Retaining Ring
9	Pedal Lock Pin
10	Hexagon Bolt
11	Pedal Plate
12	Double Torsion Spring

1. Install pedal plate.

Tools: 6 mm torque wrench (Tightening torque: 250 - 300 kg•m)

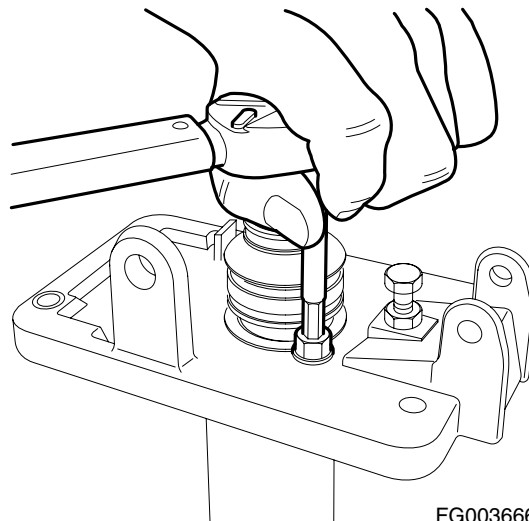


Figure 19

FG003666

2. Use a $\varnothing 12$ round rod to place pedal elements (2, 3) and double torsion spring (11) on pedal plate (12) and use a hammer to push the round rod into lock pin (9).

Tools: $\varnothing 12$ round rod and plastic hammer

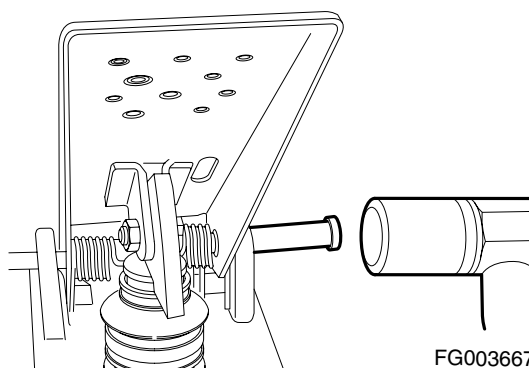


Figure 20

FG003667

3. Install the lock pin retaining ring at the end of lock pin (9).

Tools: Shaft retaining ring flyer



CAUTION!

When removing lock pin, remove retaining ring first.

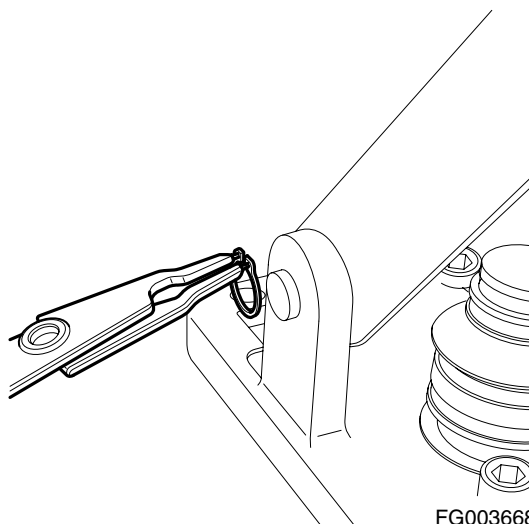


Figure 21

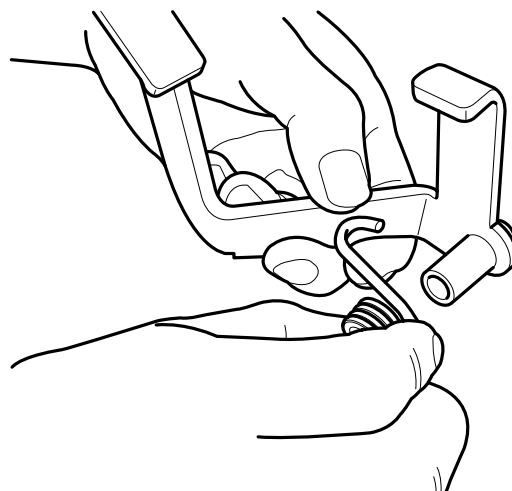
FG003668

4. Install latch spring (6) on latch (5).



CAUTION!

Apply grease to the inside of latch spring.



FG003669

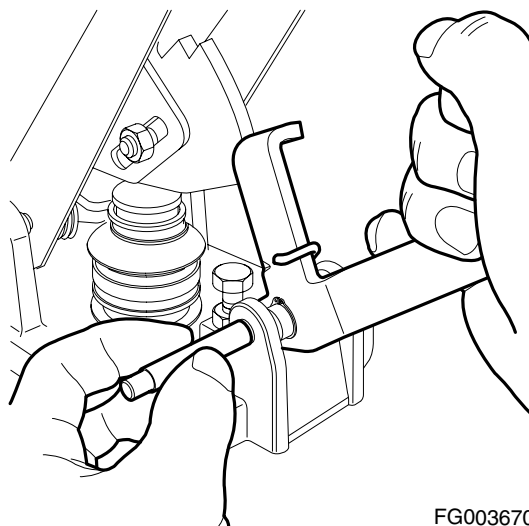
Figure 22

5. Use latch lock pin (7) to install the latch assembly in pedal plate (11).



CAUTION!

**When removing lock pin, remove retaining ring first.
(Damage to pedal plate)**

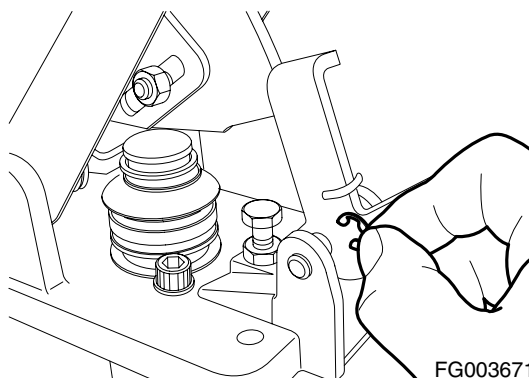


FG003670

Figure 23

6. Install retaining ring.

Tool: Driver



FG003671

Figure 24

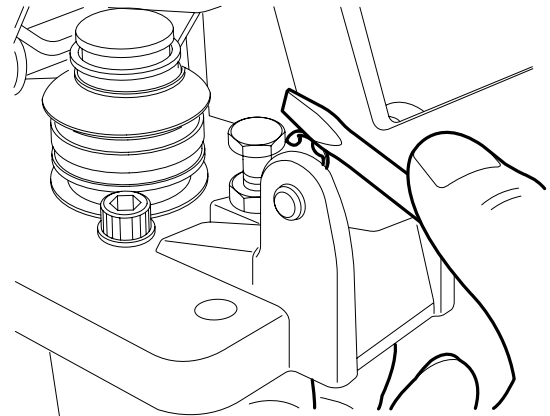


Figure 25

FG003672

7. Apply grease to the area of lock plate (2) which latch contacts.

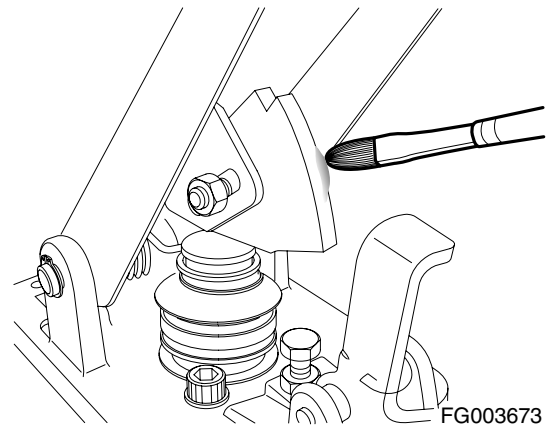


Figure 26

FG003673

8. Use a driver to install rubber pedal (1) on the pedal assembly.

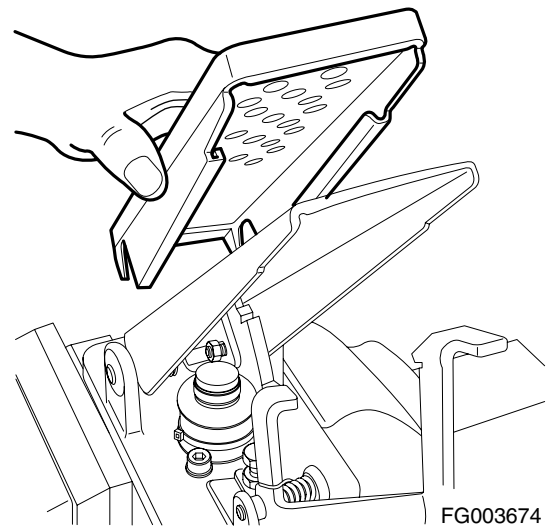


Figure 27

FG003674

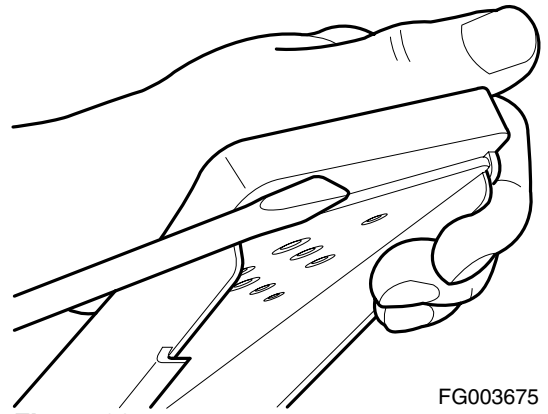


Figure 28

FG003675

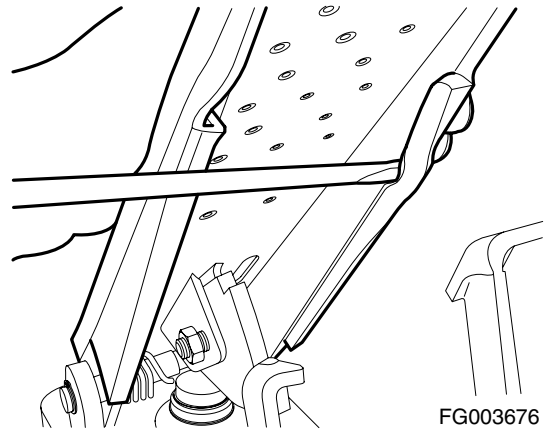


Figure 29

FG003676

9. Install pedal angle adjustment bolt (10).
Tool: 13 mm wrench (tightening torque: 200 kg•m)

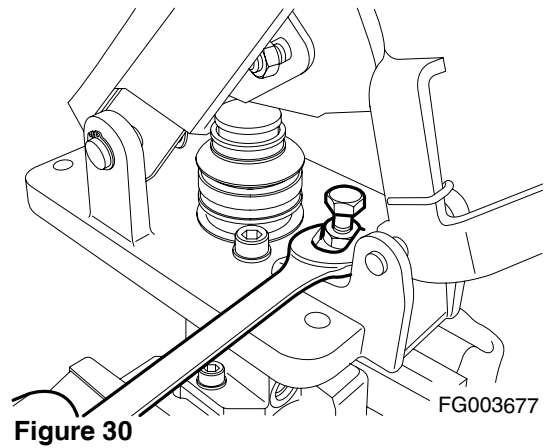


Figure 30

FG003677

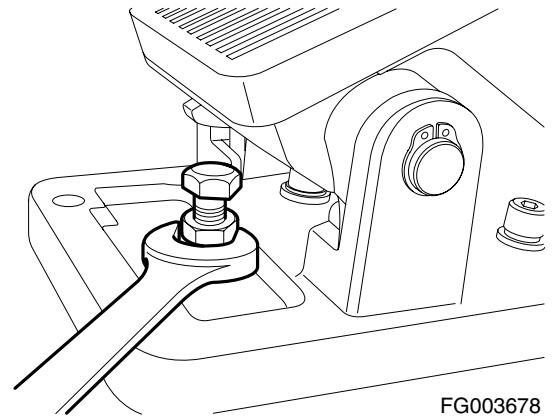


Figure 31

FG003678

Solenoid Valve Assembly

Edition 1

MEMO

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

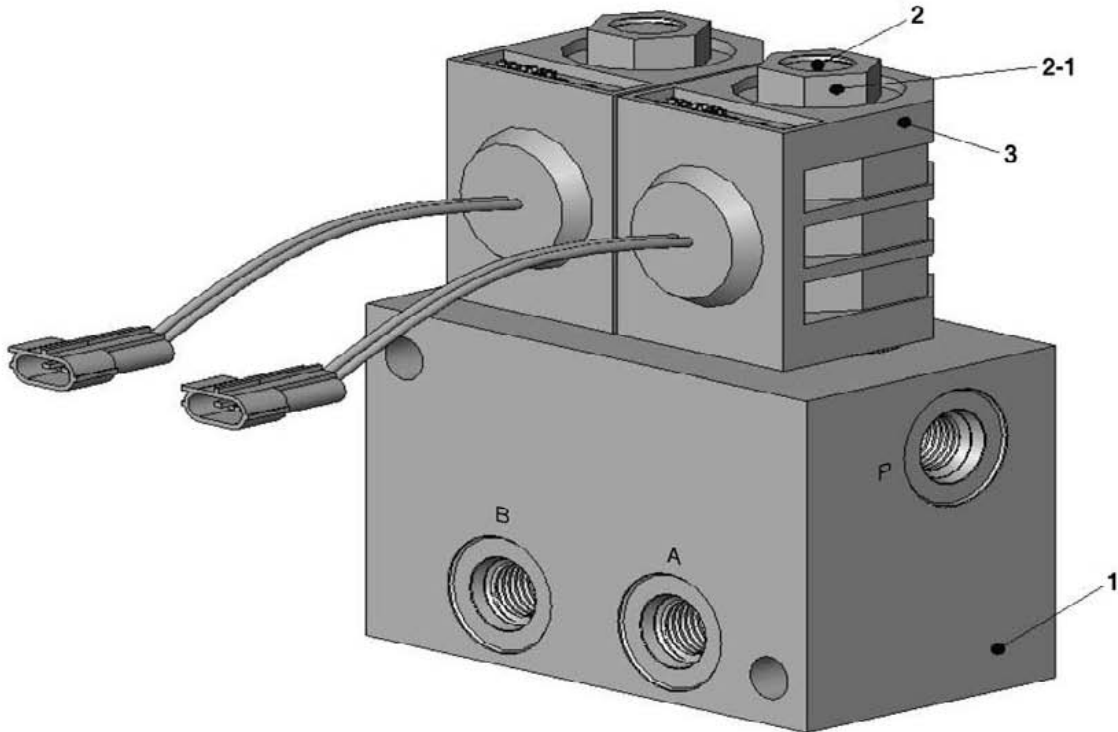
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	5001 and Up

2-SOLENOID VALVE

Diagram of 2-Solenoid Valve Assembly Package

2- Solenoid valve package includes parts described in the table below.



FG007533

Figure 1

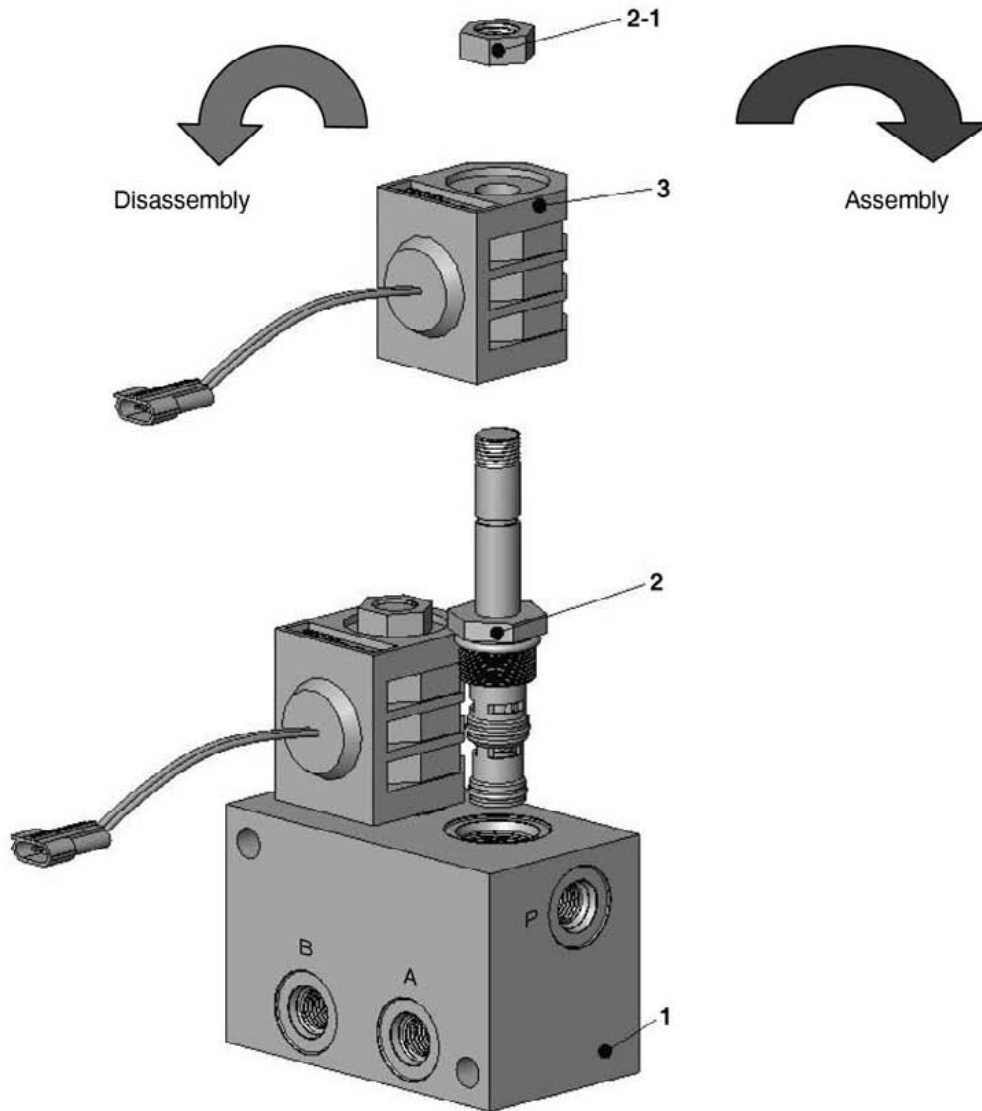
No.	Part Name	Part Specification	Quantity	Remark
1	Block Body	60*71*106	1	1-A2006-03-0
2	Solenoid Valve	TF-S3A-00-VDL24VDC	2	

Exploded View and Tools

The assembly torque of each part in the solenoid valve package is described in the table below.

Observe the specified torque values using the right tool.

Assembly, Reassembly of Solenoid Valve Package, and Necessary Tools



FG007534

Figure 2

No.	Part Name	Screw Spec	Assembly Torque (kg•cm)	Assembling Tools
2	Solenoid Valve	UNF7/8-14"	200 ± 25	Torque wrench/1" hex. socket
2-1	Coil Locknut	UNF1/2-20"	200 ± 25	Torque wrench/ 19 mm hex. socket

Cautions for Disassembly and Reassembly

1. Clean up the surrounding area to remove any foreign substances before disassembly and reassembly.
2. Make sure to observe the assembly torques and tools specified in table of page8 when disassembling and reassembling parts.
3. Follow the directions described in the above drawing for disassembly and reassembly.
4. Disassembly and reassembly of solenoid valve
 - A. Disassemble the valve by turning 2-1 coil locknut in the disassembly direction.



CAUTION!

Do not damage the tube and retainer of Solenoid Valve when disassembling the coil locknut.

In case the tube and retainer gets damaged (dented, deformed), solenoid valve will not work.

- B. After disassembling coil locknut, remove 3 coil using your hand.
- C. Then, disassemble 3 Solenoid valve by turning it in the disassembly direction.
- D. Identify problems and reassembling solenoid valve and coil.
- E. Avoid using excessive torque in reassembling solenoid valve and coil.

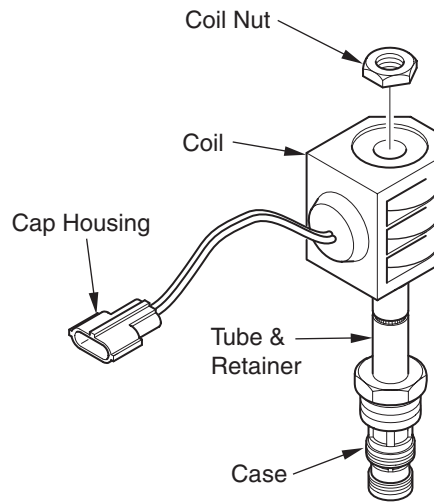


CAUTION!

Excessive use of torque will result in defects on solenoid valve.

5. Be careful not to let any contaminants go into the package when reassembling.
6. Make sure to clean parts before reassembly after disassembly.

Solenoid Valve Diagram



FG007535

Figure 3

Troubleshooting Guide

Symptom	Checkpoints	Descriptions	Remedy
Solenoid valve will not function properly	1. Foreign materials, contaminants in valve	1. Disassemble valve and check if any foreign materials or contaminants such as sludge lodged between case and spool.	Remove foreign materials and clean the contaminated area.
	2. Damages in tube and retainer	2. Disassemble valve and check if the tube and retainer area is deformed (dented, contracted).	Replace valve.
	3. Breaking of wire, short-circuiting, thermal reactions in coil	A. Disassemble valve and check resistance of coil. Condition: 26.7Ω @ 20°C Breaking of wire: The resistance of coil is ∞ (infinite). Short circuiting: The resistance is low or excessive.	Replace coil.
		B. Disassemble valve and check if the molded area of coil is melted by thermal reactions.	
	4. Connection to terminal in connector	4. Check if the terminals of the cap housing (with a lead coil) and the housing (facing housing) are connected properly.	Replace faulty housing and terminal.

Functions of 6-Solenoid Valve Assembly Package

Functions

This solenoid valve package has functions as below:

1. Supplies pressure to breaker.
2. Boosts main pressure.
3. Controls the operation mode, - swing priority
4. Drives forward and backward.
5. Controls cruise driving.

Application by Function of Each Solenoid Valve

Valve No.	Valve Function	Application	Remark
C1	Operation of breaker	Used to supply pilot pressure to the breaker valve assembly and the main control valve that supplies pressure to the breaker.	
C2	Main pressure boost	Used to increase set pressure of the main relief valve to boost excavation power temporarily.	Travel mode
C3	Control of operation mode	"C3" solenoid valve and "C4" pilot shift valve form an associated circuit. When solenoid valve operates, pilot shift valve operates to improve turning performance by making priority valve operate.	Swing priority
C5 and C6	Driving forward or backward	Used to drive vehicles forward or backward by operating the travel valve of the main control valve.	
C7	Cruise control	Used to reduce driver fatigue in long haul operations.	

Detailed Functions and Application of Each Solenoid Valve

1. Operation of Breaker

The C2 solenoid valve starts to operate when the breaker of the joy stick is switched on and supplies pilot pressure to option valve of the main control valve. The spool in option valve, converted by the pilot pressure, supplies the pressure and oil flows discharged by the pump into the breaker to enable the vehicle to perform an excavation operation.

2. Main Pressure Boost

This is a function that increases the pressure of the main relief valve to boost excavation power temporarily. When the pressure boost switch on the lever is turned on by the signals of the e-EPOS controller, this solenoid valve for pressure boost is turned "ON" for operation increasing the set pressure of the main relief valve from 330 kg•cm² approx. to 350 kg•cm² approx., to boost excavation power. In addition, this solenoid valve can be operated by selecting a mode on the switch (operation/ parking/

driving). The default pressure in the relief valve is 350 kg•cm² in the driving mode.

3. Operation Mode Control

The Operation mode offers selections of Excavation mode, Drilling mode, and Stop mode. Once the engine is started, the Operation mode is automatically set to excavation mode and C3 is turned "OFF." This excavation mode is used for normal excavation, loading and quick stop (leveling). If Drilling mode is selected on the panel, the priority valve that controls the control valves is turned "ON" and activates to tighten the low path coming into boom and arm resulting in improving the performance of the swing valve.

This Drilling mode is used to drill the sides of bucket or load with a big swing angle.

4. Control of Driving Forward or Backward

The incoming pressure and oil flows from the pilot pump is supplied by way of C7 to the solenoid valve (C5 and C6) that controls driving directions- forward and backward driving. The position of the lever - Forward driving, Backward driving, Gear shift - directs this pressure and oil flows to activate C5 and C6 and then the travel valve of the main control valve.

This incoming pressure and oil flows from the main pump make the travel motor rotate in the right or reverse direction changing driving directions of the vehicle.

When the vehicle runs forward, forward driving solenoid valve (C6) operates, while backward solenoid valve (C5) operates when the car runs backward.

5. Cruise Control

This cruise control function is used to reduce driver fatigue in long haul operations. Pushing the cruise switch will run the vehicle with the lever on "F" without pushing the accelerator pedal. The driving speed can be controlled with the engine control dial.

Also, the vehicle can be set to run at a constant speed by adjusting the engine control dial.

When the vehicle runs uphill or downhill, its speed may change. However, this is not a malfunction but this happens because of changes in load. Pushing the brake pedal will automatically stop cruise driving at a traffic signal or roadblock. Cruise driving can also be released by moving the lever to "N." If the engine noise is too loud, adjust the engine control dial to low speed.

With Automatic Low Speed switched "ON," the engine slows down to the set speed in 4 minutes or so after the cruise driving function is released (after the pedal is pressed).

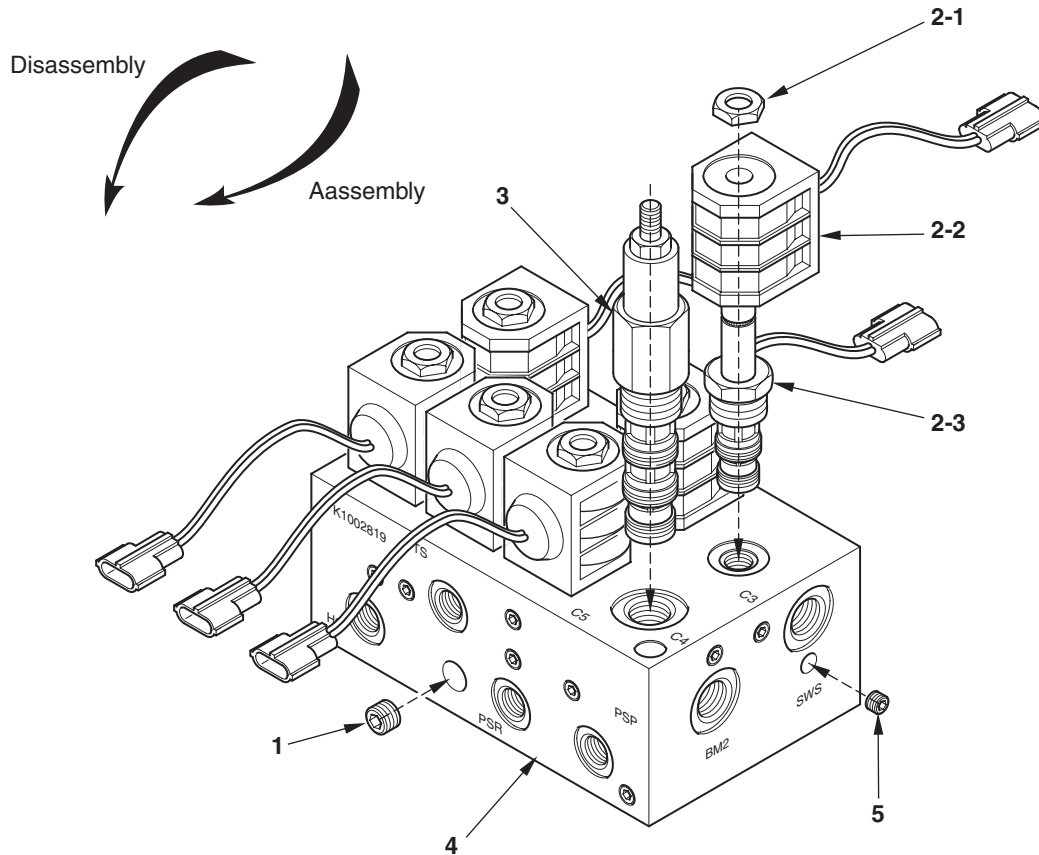
If the cruise driving function operates again, the engine speed goes up to the original speed right away.

Exploded View and Tools

The assembly torque of each part in the solenoid valve package is described in the table below.

Observe the specified torque values using the right tool.

Disassembly, Reassembly of Solenoid Valve Package, and Necessary Tools



FG007536

Figure 5

No.	Part Name	Screw Spec	Assembly Torque (kg•cm)	Assembling Tools
2-1	Coil Locknut	UNF1/2-20"	60 ± 2	Torque wrench/19 mm hex. socket
2-3	Solenoid Valve	UNF7/8-14"	200 ± 25	Torque wrench/1" hex. socket
3	Pilot Shift Valve	UNF7/8-14"	200 ± 25	Torque wrench/1" hex. socket
4	PT 1/4" Plug Bolt	PT 1/4-19"	500	Torque wrench/6 mm wrench socket
5	PT 1/8" Plug Bolt	PT 1/8-28"	280	Torque wrench/5 mm wrench socket

Cautions for Disassembly and Reassembly

1. Clean up the surrounding area to remove any foreign substances before disassembly and reassembly.
2. Make sure to observe the assembly torques and tools specified in table of page16 when disassembling and reassembling parts.
3. Follow the directions described in the above drawing for disassembly and reassembly.
4. Disassembly and reassembly of solenoid valve
 - A. Disassemble the valve by turning 2-1 coil locknut in the disassembly direction.



CAUTION!

Do not damage the tube and retainer of Solenoid Valve when disassembling the coil locknut.

In case the tube and retainer gets damaged (dented, deformed), solenoid valve will not work.

- B. After disassembling coil locknut, remove 3 coil using your hand.
- C. Then, disassemble 3 Solenoid valve by turning it in the disassembly direction.
- D. Identify problems and reassembling solenoid valve and coil.
- E. Avoid using excessive torque in reassembling solenoid valve and coil.

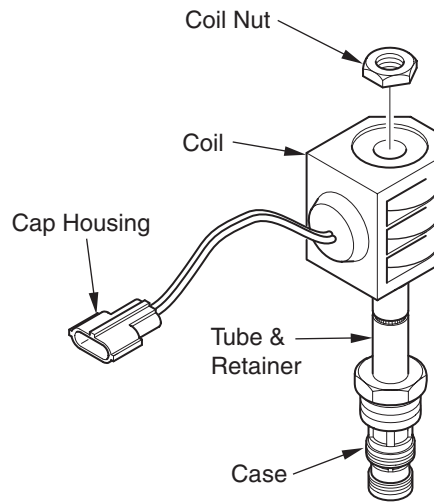


CAUTION!

Excessive use of torque will result in defects on solenoid valve.

5. Be careful not to let any contaminants go into the package when reassembling.
6. Make sure to clean parts before reassembly after disassembly.

Solenoid Valve Diagram



FG007535

Figure 6

Troubleshooting Guide

Parts

Symptom	Checkpoints	Descriptions	Remedy
Solenoid valve will not function properly	1. Foreign materials, contaminants in valve	1. Disassemble valve and check if any foreign materials or contaminants such as sludge lodged between case and spool.	Remove foreign materials and clean the contaminated area.
	2. Damages in tube and retainer	2. Disassemble valve and check if the tube and retainer area is deformed (dented, contracted).	Replace valve.
	3. Breaking of wire, short-circuiting, thermal reactions in coil	A. Disassemble valve and check resistance of coil. Condition: $26.7\Omega @ 20^{\circ}\text{C}$ Breaking of wire: The resistance of coil is ∞ (infinite). Short circuiting: The resistance is low or excessive. B. Disassemble valve and check if the molded area of coil is melted by thermal reactions.	Replace coil.
	4. Connection to terminal in connector	4. Check if the terminals of the cap housing (with a lead coil) and the housing (facing housing) are connected properly.	Replace faulty housing and terminal.

Symptom	Checkpoints	Descriptions	Remedy
No pilot pressure	1. Pilot pressure	1. Remove adapter and hydraulic hoses at the PL port and install a pressure gauge to check discharge pressure value at the pilot pump with C2 operated.	Refer to the above checkpoints and descriptions for "Solenoid valve"
	2. Pilot relief valve	2. Check operation of the relief valve installed on the pilot line. A. Check if pressure is bypassed by foreign materials.	Remove foreign materials and replace relief valve.
	3. Pilot pump	3. Check pilot pump operation.	Replace pilot pump
	4. Pilot filter	4. Check if the mesh screen of pilot filter is contaminated by foreign materials.	Clean affected parts and replace filter.
Actuator will not function properly	1. Pilot system	1. Check pilot system according to the above checkpoints and descriptions for "No" pilot pressure.	Locate cause of problems in pilot system and correct.
	2. Solenoid valve	2. Install a pressure gauge at each valve outlet (Ports HO, PL, BM2, PBR, PAR, TS) and operate solenoid valve to check discharge pressure value.	Refer to the above checkpoints and descriptions for "Solenoid valve"
	3. Main control valve	3. Check if the main control valve for each device is working properly.	Follow descriptions to correct.
	4. Devices	4. Check if the device is working properly.	Follow descriptions to correct.

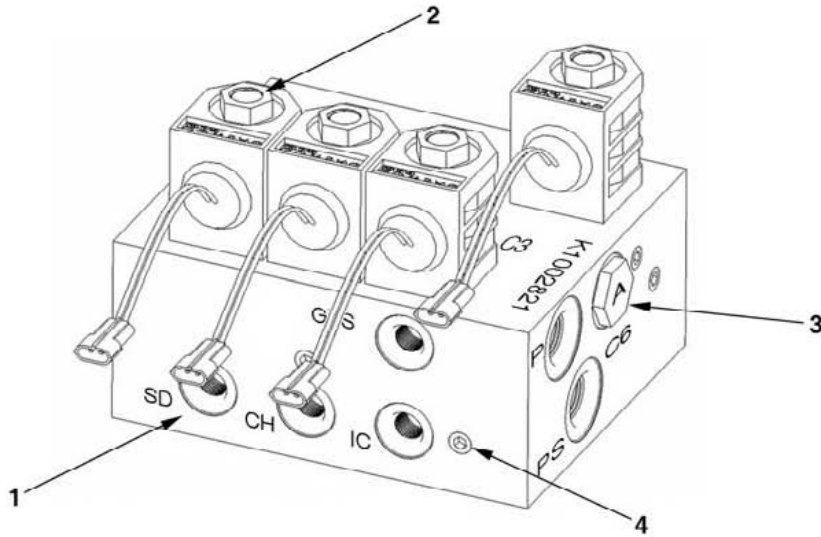
How to Check Pilot Pressure

Where to Install Pressure Gauges	Screw Specification	Remark
HO, PL, PBR, PAR, TS	PF1/4" O-ring boss	Solenoid valve "ON"
BM2	PF3/8" O-ring boss	Solenoid valve "ON"

4-SOLENOID VALVE

Diagram of 4-Solenoid Valve Assembly Package

4-Solenoid valve assembly package includes parts described in the table below.



FG007537

Figure 7

No.	Part Name	Part Specification	Quantity	Remark
1	Manifold Block	80*149*178	1	1-A2083-03-1
2	Solenoid Valve	TF-S3A-00-VDL24VDC	6	C1,C2,C3,C4
3	Check Valve	FD-CDP-O-A	2	C5,C6
4	Plug	PT1/8	11	

Functions of 4 Solenoid Valve Assembly Package

Functions

This solenoid valve package has functions as below:

1. Operates devices. (Selects the outrigger for operation/ options.)
2. Performs a ram lock function.
3. Controls driving speed.
4. Cuts off pilot pressure.

Application by Function of Each Solenoid Valve

Valve No.	Valve Function	Application	Remark
C1	Valve operates devices. - Valve selects the outrigger	Solenoid selector valve (C1) that operates the outrigger increases the stability of excavation for the vehicle.	
C2	Performs a ram lock function.	Ram lock absorbs vibration from the front axle depending on road conditions when the vehicle is moving while it keeps the front axle stable to increase operation convenience when the vehicle is working.	Ram lock
C3	Controls driving speed.	Converts to low-speed driving (below 5km/h).	
C4	Cuts off pilot pressure.	Supplies the pressure and oil flows discharged by the pilot pump to the solenoid valve that supplies pilot pressure and the remote control valve, to drive each device.	

Detailed Function and Application Descriptions by Solenoid Valve

1. Selects devices for operation.

The solenoid selector valve (C1) selects subdevices such as dozer and outrigger. Dozer blade operates when C1 is turned ""OFF"" while outrigger operates when C1 is turned "OFF." This means that if C1 is operated, pilot pressure is sent to pilot directional valve changing the opening area of the spool. Then, C1 sends the pressure and oil to the outrigger stopping the pressure and oil from flowing into dozer blade. If C1 doesn't operate, the pilot pressure cannot be sent to the pilot directional valve. In this case, the pilot directional valve is initialized and block the pressure and oil flows from the outrigger, supplying them to the dozer blade. This pilot directional valve spool determines the selection of devices- a dozer or an outrigger.

2. Performs a ram lock function.

Ram lock is a function to absorb vibration from the front axle depending on road conditions when the vehicle is

moving while it keeps the front axle stable to increase operation convenience when the vehicle is working.

A. How the ram lock function "ON" works

When C2 goes "OFF," it blocks the flow path between both ram cylinders enabling the oil flow in the cylinders to remain steady, and this activates ram lock.

B. How ram lock "OFF" works

If C2 is turned "ON," it connects the flow path between both ram cylinders allowing load on them and the strokes of the cylinders are adjusted based on their loads.

3. Cuts off pilot pressure.

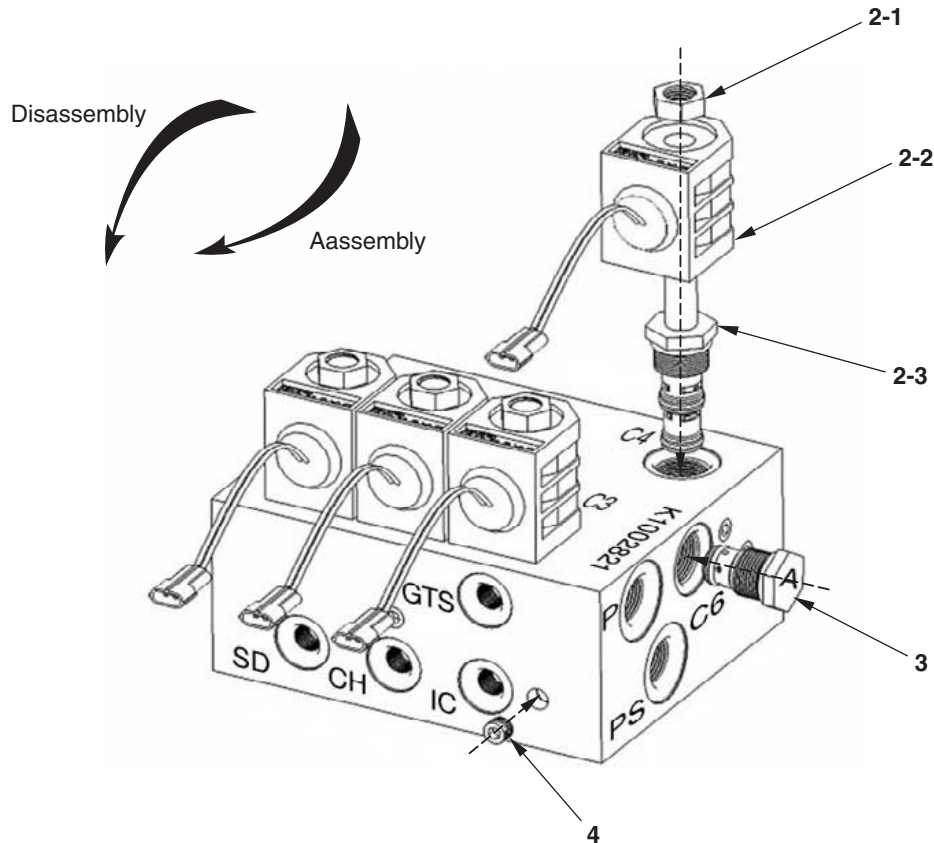
C4 transmits the pressure and oil supplied by the pilot pump to the solenoid valve that supplies pilot pressure, the breaker valve package, and remote control valves (dozer, arm/swing, boom/bucket). With the cut-off lever pulled down on the left-hand side of the driver's seat, the limit switch emits electric signals enabling C4 to supply pressure into the system.

Exploded View and Tools

The assembly torque of each part in the Solenoid Valve Package is described in the table below.

Observe the specified torque values using the right tool.

Disassembly, Reassembly of Solenoid Valve Package, and Necessary Tools



FG007550

Figure 8

No.	Part Name	Screw Spec	Assembly Torque (kg•cm)	Assembling Tools
2-1	Coil Locknut	UNF1/2-20"	60 ± 2	Torque wrench/ 19 mm hex. socket
2-3	Solenoid Valve	UNF7/8-14"	200 ± 25	Torque wrench/1" hex. socket
3	Check Valve	UNF7/8-14"	200 ± 25	Torque wrench/1" hex. socket
4	PT 1/8" Plug Bolt	PT 1/8-28"	280	Torque wrench/5 mm wrench socket

Cautions for Disassembly and Reassembly

1. Clean up the surrounding area to remove any foreign substances before disassembly and reassembly.
2. Make sure to observe the assembly torques and tools specified in table of page24 when disassembling and reassembling parts.
3. Follow the directions described in the above drawing for disassembly and reassembly.
4. Disassembly and reassembly of solenoid valve
 - A. Disassemble the valve by turning 2-1 coil locknut in the disassembly direction.



CAUTION!

Do not damage the tube and retainer of Solenoid Valve when disassembling the coil locknut.

In case the tube and retainer gets damaged (dented, deformed), solenoid valve will not work.

- B. After disassembling coil locknut, remove 3 coil using your hand.
- C. Then, disassemble 3 Solenoid valve by turning it in the disassembly direction.
- D. Identify problems and reassembling solenoid valve and coil.
- E. Avoid using excessive torque in reassembling solenoid valve and coil.



CAUTION!

Excessive use of torque will result in defects on solenoid valve.

5. Be careful not to let any contaminants go into the package when reassembling.
6. Make sure to clean parts before reassembly after disassembly.

Solenoid Valve Diagram

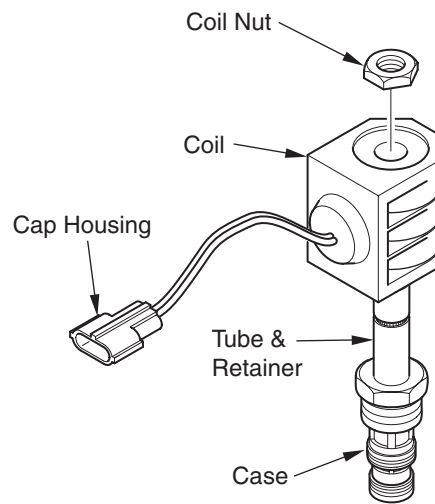


Figure 9

FG007535

Troubleshooting Guide

Parts

Symptom	Checkpoints	Descriptions	Remedy
Solenoid valve will not function properly	1. Foreign materials, contaminants in valve	1. Disassemble valve and check if any foreign materials or contaminants such as sludge lodged between case and spool.	Remove foreign materials and clean the contaminated area.
	2. Damages in tube and retainer	2. Disassemble valve and check if the tube and retainer area is deformed (dented, contracted).	Replace valve.
	3. Breaking of wire, short-circuiting, thermal reactions in coil	A. Disassemble valve and check resistance of coil. Condition: 26.7Ω @ 20°C Breaking of wire: The resistance of coil is ∞ (infinite). Short circuiting: The resistance is low or excessive.	Replace coil.
		B. Disassemble valve and check if the molded area of coil is melted by thermal reactions.	
	4. Connection to terminal in connector	4. Check if the terminals of the cap housing (with a lead coil) and the housing (facing housing) are connected properly.	Replace faulty housing and terminal.
No pilot pressure	1. Pilot pressure	1. Remove adapter and hydraulic hoses at the PL port and install a pressure gauge to check discharge pressure value at the pilot pump with C2 operated.	Refer to the above checkpoints and descriptions for "Solenoid valve"
	2. Pilot relief valve	2. Check operation of the relief valve installed on the pilot line. A. Check if pressure is bypassed by foreign materials.	Remove foreign materials and replace relief valve.
	3. Pilot pump	3. Check pilot pump operation.	Replace pilot pump
	4. Pilot filter	4. Check if the mesh screen of pilot filter is contaminated by foreign materials.	Clean affected parts and replace filter.
Actuator will not function properly	1. Pilot system	1. Check pilot system according to the above checkpoints and descriptions for "No" pilot pressure.	Locate cause of problems in pilot system and correct.
	2. Solenoid valve	2. Install a pressure gauge at each valve outlet (Ports HO, PL, BM2, PBR, PAR, TS) and operate solenoid valve to check discharge pressure value.	Refer to the above checkpoints and descriptions for "Solenoid valve"
	3. Main control valve	3. Check if the main control valve for each device is working properly.	Follow descriptions to correct.
	4. Devices	4. Check if the device is working properly.	Follow descriptions to correct.

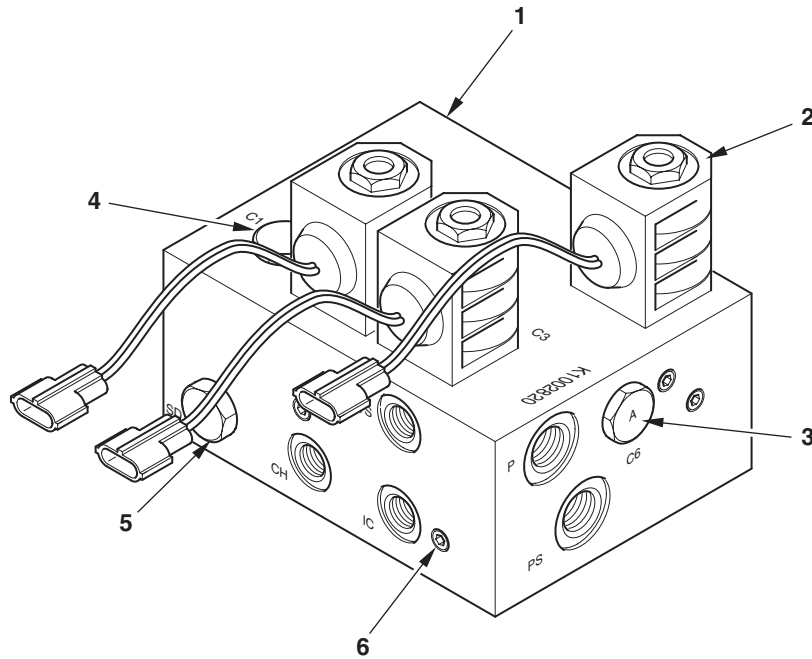
How to Check Pilot Pressure

Where to Install Pressure Gauges	Screw Specification	Remark
SD, CH, IC, PS	PF1/4" O-ring boss	Solenoid valve "ON"

3-SOLENOID

Diagram of 3-Solenoid Valve Assembly Package

3-Solenoid valve assembly package includes parts described in the table below.



FG000008

Figure 10

No.	Part Name	Part Specification	Quantity	Remark
1	Manifold Block	80*149*178	1	1-A2130-03-1
2	Solenoid Valve	TF-S3A-00-VDL24VDC	6	C2, C3, C4
3	Check Valve	FD-CDP-O-A	2	C5, C6
4	Dummy Plug	-	1	C1
5	Plug	PF1/4-19"	1	SD
6	Plug	PT1/8"	11	

Functions of 3 Solenoid Valve Assembly Package

Functions

This solenoid valve package has functions as below:

1. Selects devices for operation (dozer blade/ STD).
2. Performs a ram lock function.
3. Controls driving speed.
4. Cuts off pilot pressure.

Application by Function of Each Solenoid Valve

Valve No.	Valve Function	Application	Remark
C1	Selects devices. - Dozer blade	Dummy plug (C1) shut off the circuit against selection system. Only dozer blade is available for selection.	
C2	Performs a ram lock function.	Used to absorb vibration from the front axle depending on road conditions when the vehicle is moving while it keeps the front axle stable to increase operation convenience when the vehicle is working.	Ram lock
C3	Controls driving speed.	Converts to low-speed driving (below 5km/h).	
C4	Cuts off pilot pressure.	Supplies the pressure and oil flows discharged by the pilot pump to the solenoid valve that supplies pilot pressure and the remote control valve, to drive each device.	

Detailed Function and Application Descriptions by Solenoid Valve

1. Selects devices for operation.

This Dummy plug (C1) selects subdevices such as a dozer blade and forms a closed circuit for selection system. So, pilot directional valve will not operate and the opening position of spool will remain the same at all times as pilot pressure will not be transmitted to pilot directional valve. However, the pressure and oil that are going into the devices (dozer blade and outrigger) will be transmitted to dozer blade with the directional valve in its normal opening position (no operation).

2. Performs ram lock functions.

Ram lock is a function to absorb vibration from the front axle depending on road conditions when the vehicle is moving while it keeps the front axle stable to increase operation convenience when the vehicle is working.

- A. How the ram lock function "ON" works

When C2 goes "OFF," it blocks the flow path between both ram cylinders enabling the oil flow in the

cylinders to remain steady, and this activates ram lock.

B. How ram lock "OFF" works

If C2 is turned "ON," it connects the flow path between both ram cylinders allowing load on them and the strokes of the cylinders are adjusted based on their loads.

3. Cuts off pilot pressure.

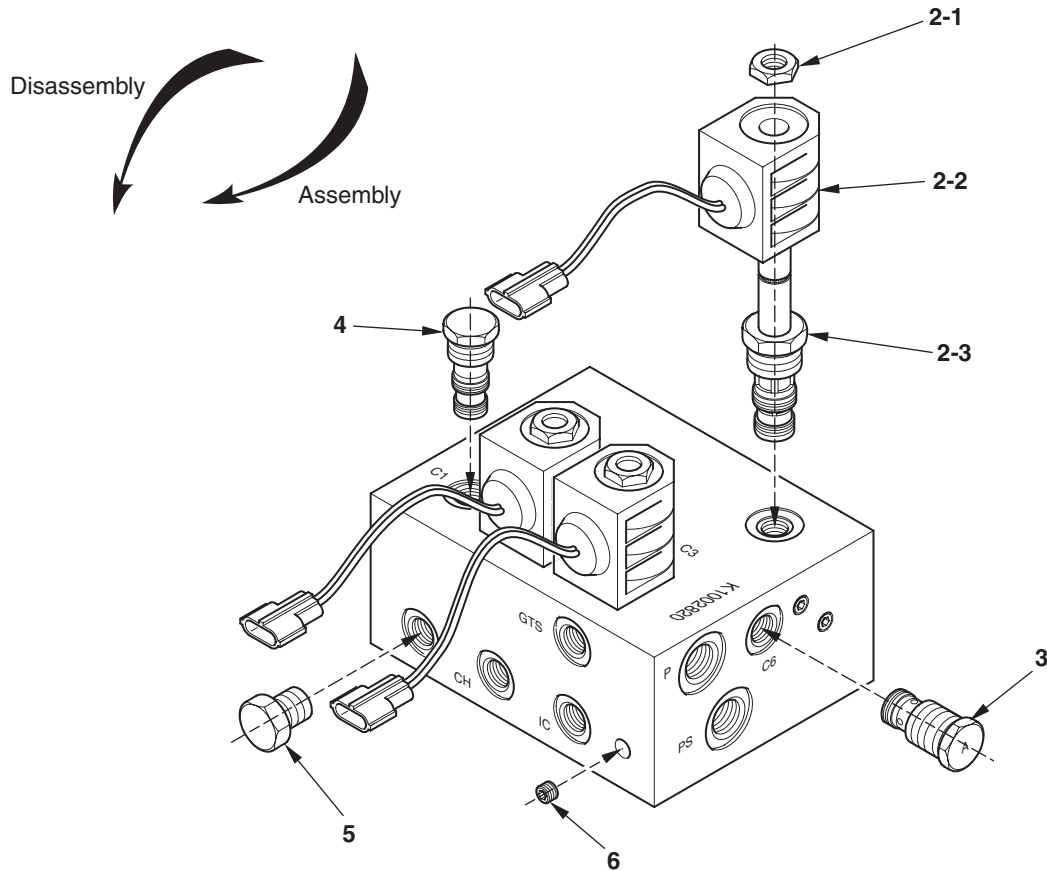
C4 transmits the pressure and oil supplied from the pilot pump to solenoid valve that supplies pilot pressure, the breaker valve package, and remote control valve (dozer, arm/swing, boom/bucket). Pull down the cut-off lever on the left-hand side of the driver's seat to give electric signals of the limit switch enabling the valve to supply pilot pressure into the system.

Exploded View and Tools

The assembly torque of each part in the Solenoid Valve Package is described in the table below.

Observe the specified torque values using the right tool.

Disassembly, Reassembly of Solenoid Valve Package, and Necessary Tools



FG007551

Figure 11

No.	Part Name	Screw Spec	Assembly Torque (kg•cm)	Assembling Tools
2-1	Coil Locknut	UNF1/2-20"	60 ± 2	Torque wrench/19 mm hex. socket
2-3	Solenoid Valve	UNF7/8-14"	200 ± 25	Torque wrench/1" hex. socket
3	Check Valve	UNF7/8-14"	200 ± 25	Torque wrench/1" hex. socket
4	Dummy Plug	UNF7/8-14"	200 ± 25	Torque wrench/1" hex. socket
5	PF 1/4" Plug	PF 1/4-19"	250 ± 25	Torque wrench/19 mm hex. socket
6	PT 1/8" Plug Bolt	PT 1/8-28"	280	Torque wrench/5 mm wrench socket

Cautions for Disassembly and reassembly

1. Clean up the surrounding area to remove any foreign substances before disassembly and reassembly.
2. Make sure to observe the assembly torques and tools specified in table of page29 when disassembling and reassembling parts.
3. Follow the directions described in the above drawing for disassembly and reassembly.
4. Disassembly and reassembly of solenoid valve
 - A. Disassemble the valve by turning 2-1 coil locknut in the disassembly direction.



CAUTION!

Do not damage the tube and retainer of Solenoid Valve when disassembling the coil locknut.

In case the tube and retainer gets damaged (dented, deformed), solenoid valve will not work.

- B. After disassembling coil locknut, remove 3 coil using your hand.
- C. Then, disassemble 3 Solenoid valve by turning it in the disassembly direction.
- D. Identify problems and reassembling solenoid valve and coil.
- E. Avoid using excessive torque in reassembling solenoid valve and coil.

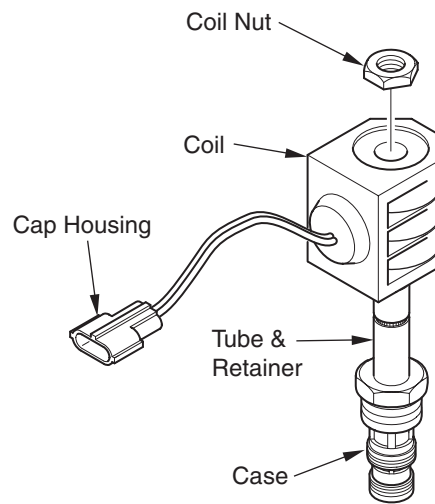


CAUTION!

Excessive use of torque will result in defects on solenoid valve.

5. Be careful not to let any contaminants go into the package when reassembling.
6. Make sure to clean parts before reassembly after disassembly.

Solenoid Valve Diagram



FG007535

Figure 12

Troubleshooting Guide

Parts

Symptom	Checkpoints	Descriptions	Remedy
Solenoid valve will not function properly	1. Foreign materials, contaminants in valve	1. Disassemble valve and check if any foreign materials or contaminants such as sludge lodged between case and spool.	Remove foreign materials and clean the contaminated area.
	2. Damages in tube and retainer	2. Disassemble valve and check if the tube and retainer area is deformed (dented, contracted).	Replace valve.
	3. Breaking of wire, short-circuiting, thermal reactions in coil	A. Disassemble valve and check resistance of coil. Condition: 26.7Ω @ 20°C Breaking of wire: The resistance of coil is ∞ (infinite). Short circuiting: The resistance is low or excessive.	Replace coil.
		B. Disassemble valve and check if the molded area of coil is melted by thermal reactions.	
	4. Connection to terminal in connector	4. Check if the terminals of the cap housing (with a lead coil) and the housing (facing housing) are connected properly.	Replace faulty housing and terminal.
No pilot pressure	1. Pilot pressure	1. Remove adapter and hydraulic hoses at the PL port and install a pressure gauge to check discharge pressure value at the pilot pump with C2 operated.	Refer to the above checkpoints and descriptions for "Solenoid valve"
	2. Pilot relief valve	2. Check operation of the relief valve installed on the pilot line. A. Check if pressure is bypassed by foreign materials.	Remove foreign materials and replace relief valve.
	3. Pilot pump	3. Check pilot pump operation.	Replace pilot pump
	4. Pilot filter	4. Check if the mesh screen of pilot filter is contaminated by foreign materials.	Clean affected parts and replace filter.
Actuator will not function properly	1. Pilot system	1. Check pilot system according to the above checkpoints and descriptions for "No" pilot pressure.	Locate cause of problems in pilot system and correct.
	2. Solenoid valve	2. Install a pressure gauge at each valve outlet (Ports HO, PL, BM2, PBR, PAR, TS) and operate solenoid valve to check discharge pressure value.	Refer to the above checkpoints and descriptions for "Solenoid valve"
	3. Main control valve	3. Check if the main control valve for each device is working properly.	Follow descriptions to correct.
	4. Devices	4. Check if the device is working properly.	Follow descriptions to correct.

How to Check Pilot Pressure

Where to Install Pressure Gauges	Screw Specification	Remark
CH, IC, PS	PF1/4" O-ring boss	Solenoid valve "ON"

Hydraulic Schematic

Edition 1

MEMO

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Hydraulic Schematic

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DX210W (MONO).....	9

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
DX210W	5001 and Up

GENERAL DESCRIPTION

Schematic(s) presented in this section are laid out on facing pages.

An overlapping edge has been taken into consideration so a photocopy can be made and pasted together to make a complete schematic.

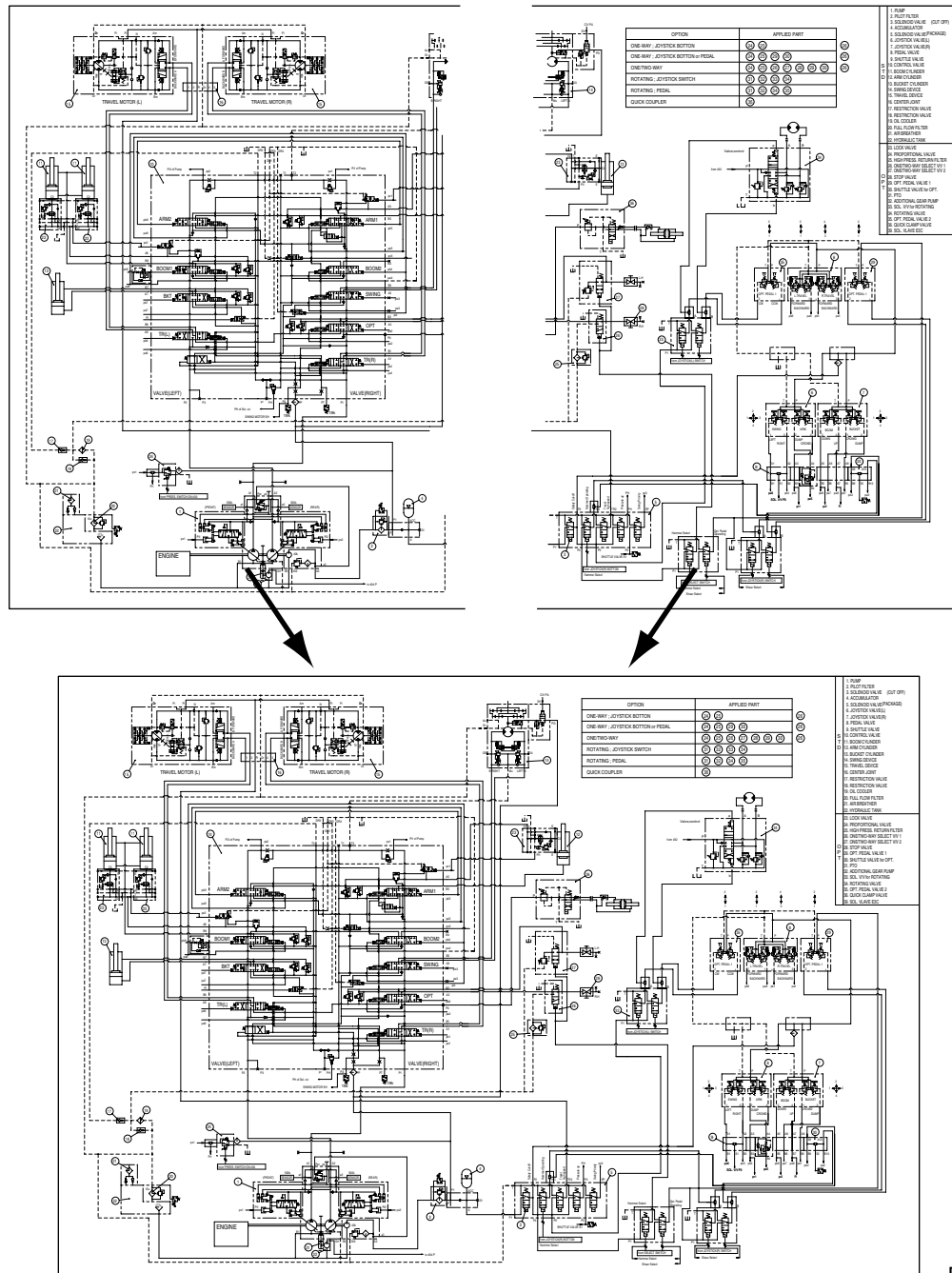


Figure 1

DX210W (4-INDI)

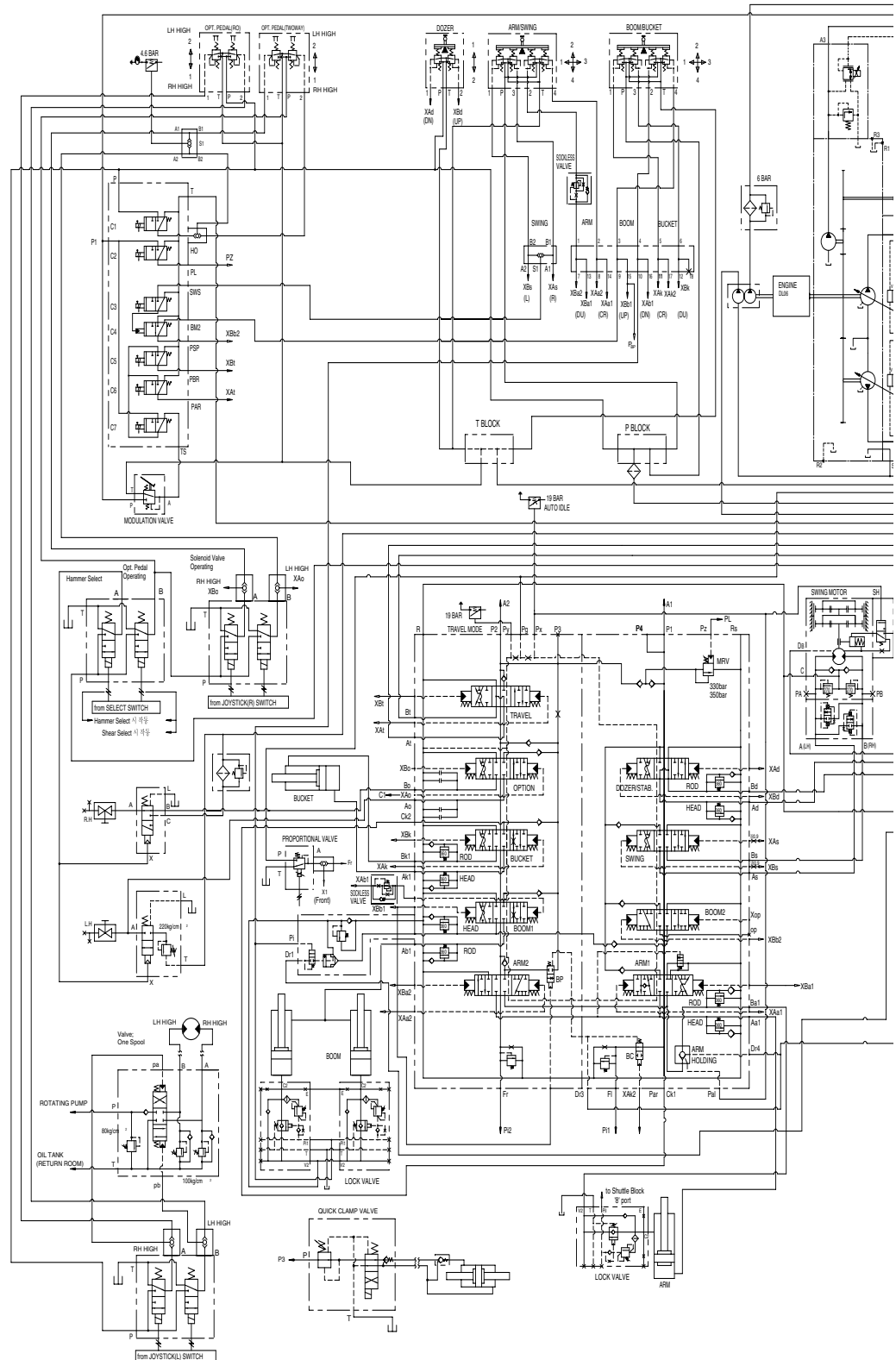


Figure 2

SP001107
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DX210W (ARTICULATED)

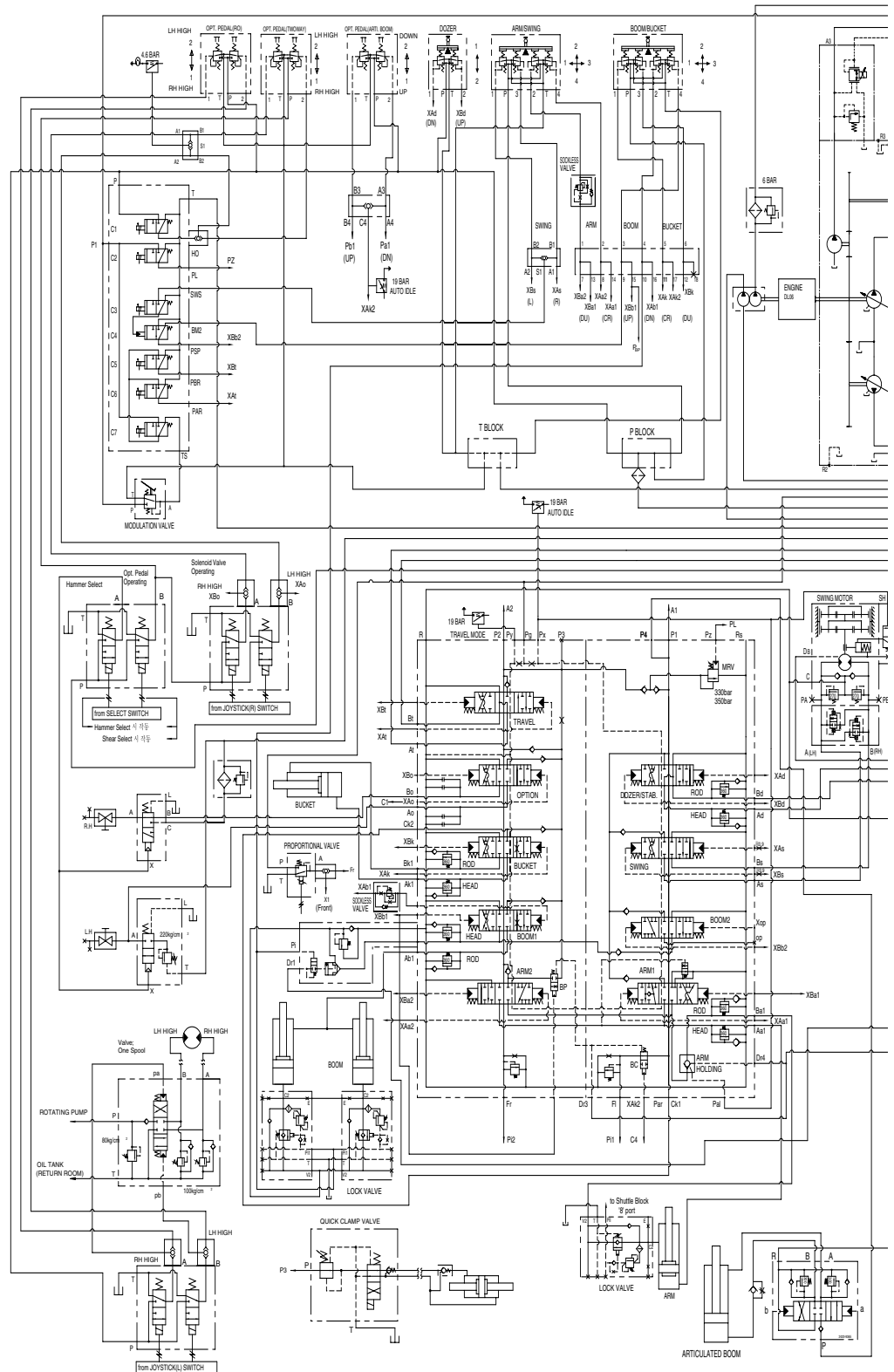


Figure 3

SP001107
Page 11

DX210W (MONO)

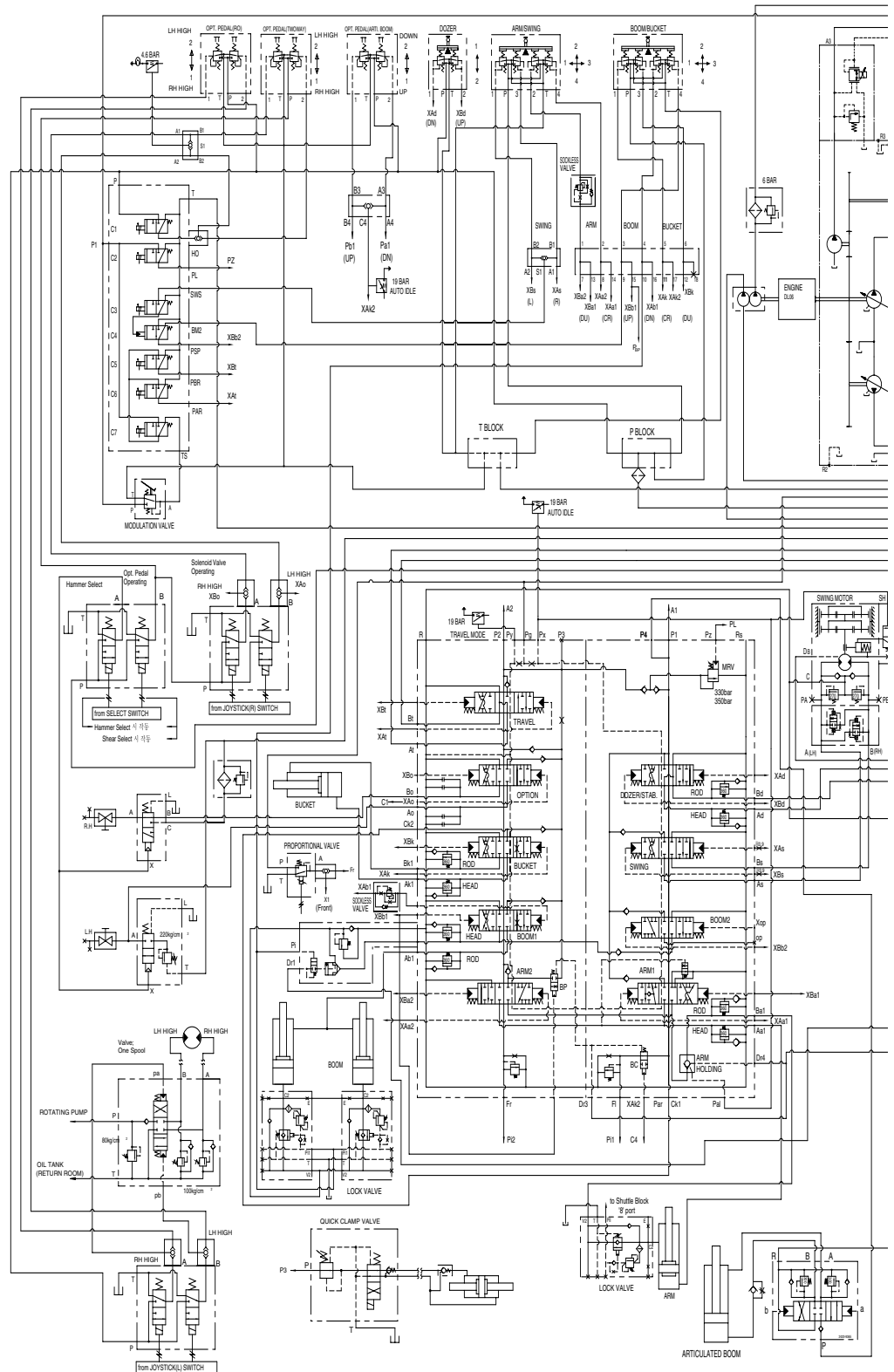


Figure 4

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Electrical System

Electrical System

Edition 1

MEMO

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SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX210W	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 electrical wiring used in the system is easily identifiable by the insulator color. The color symbols used in the electrical system are listed in the following chart.

Electrical Wire Color

Symbol	Color
W	White
G	Green
Or	Orange
B	Black
L	Blue
Lg	Light green
R	Red
Gr	Gray
P	Pink
Y	Yellow
Br	Brown
V	Violet

NOTE: *RW: Red wire with White stripe*

R - Base Color, W - Stripe Color

NOTE: *0.85G: Nominal sectional area of wire core less insulator = 0.85 mm²*

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.

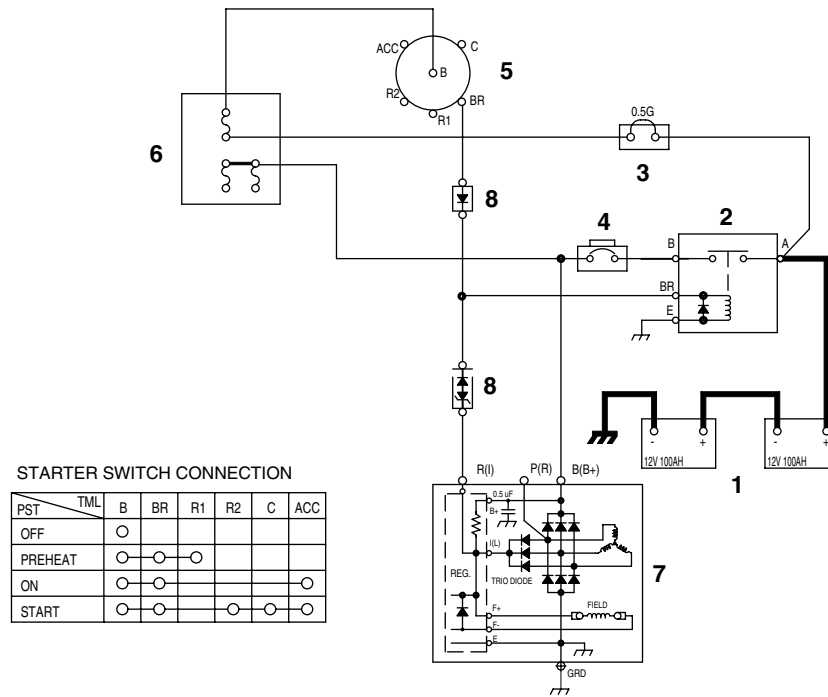
Even when the starter switch (5) is in the "OFF" position, electric current is supplied to the following components through battery (1) → fusible link (3) → fuse box (6).

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. Pilot buzzer
11. Light switch

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).



FG004584

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

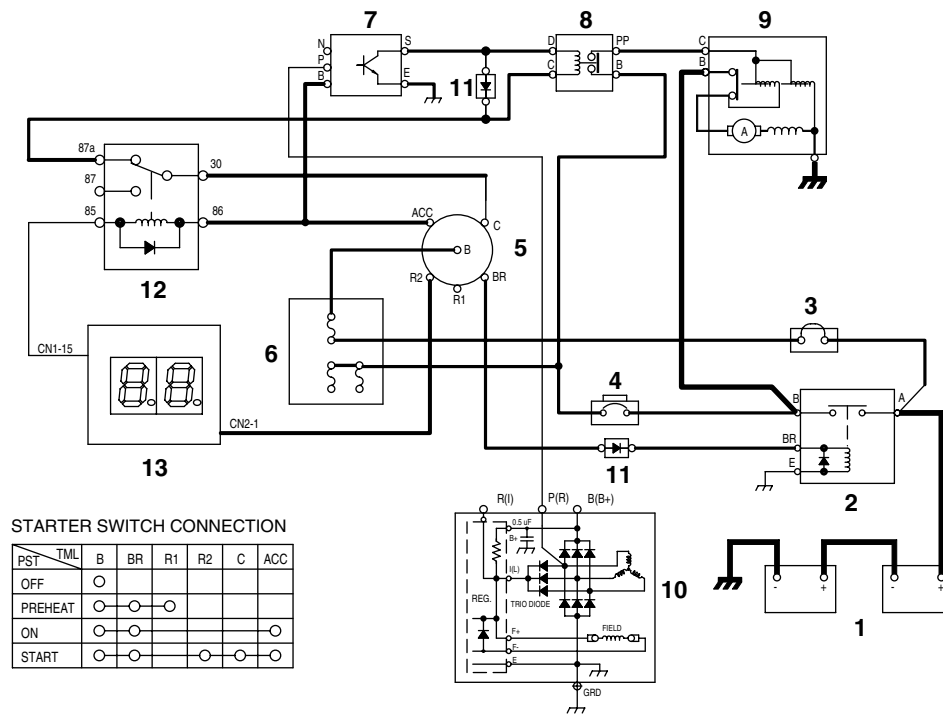
ENGINE STARTING CIRCUIT

Start Operation

When the starter switch is turned to the "START" position, the "S" and "E" terminals of the starter controller (7) are connected. Now 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 2) → "30" 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.



FG004587

Figure 2 STARTER CIRCUIT (1) - WHILE STARTING

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch
6	Fuse Box
7	Starter Controller

Reference Number	Description
8	Starter Relay
9	Starter
10	Alternator
11	Diode
12	Starter Relay 2
13	e-EPOS Controller

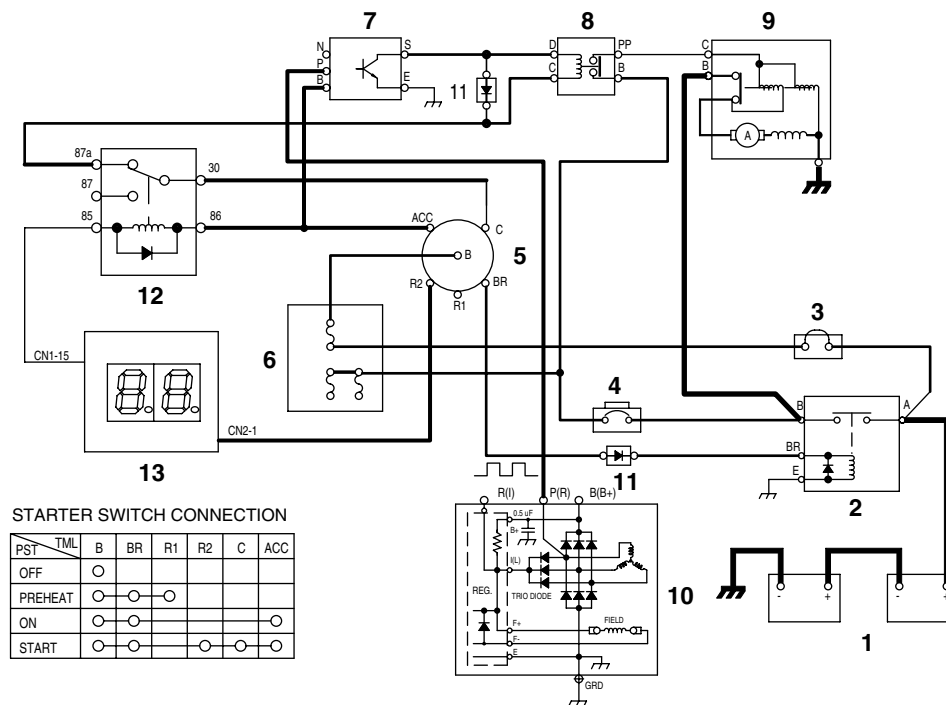
After Start

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 "R" 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



FG004588

Figure 3 OPERATION OF START CIRCUIT (2) - IMMEDIATELY AFTER START

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch
6	Fuse Box
7	Starter Controller

Reference Number	Description
8	Starter Relay
9	Starter
10	Alternator
11	Diode
12	Starter Relay 2
13	e-EPOS Controller

ENGINE PREHEATING SYSTEM

An air heater (8) is installed in the intake manifold of the engine. When the starter switch (5) is turned "ON," the current flows from the battery (1) → fusible link (3) → fuse box (6) → "B" terminal of starter switch (5) → "BR" terminal of starter switch (5) → "1-39" terminal of engine controller (12), causing current to flow through "1-16" terminal of engine controller (12) → "C and D" terminals of preheat relay (7) → "1-04" terminals of engine controller (12) → ground.

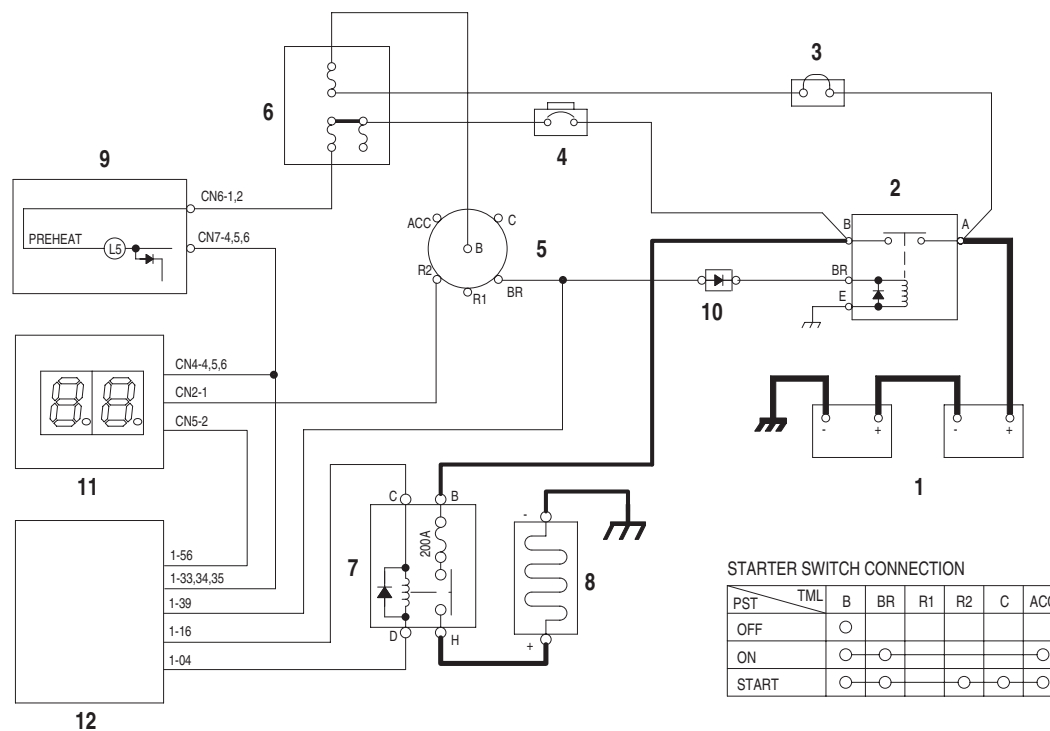
This current flow causes the coil in preheat relay (7) to be activated, closing contacts.

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.



FG007757

Figure 4 ENGINE PREHEAT CIRCUIT

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch
6	Fuse Box

Reference Number	Description
7	Preheat Relay
8	Air Heater
9	Preheat Indicator Light
10	Diode
11	e-EPOS Controller
12	Engine Controller

ENGINE STOP

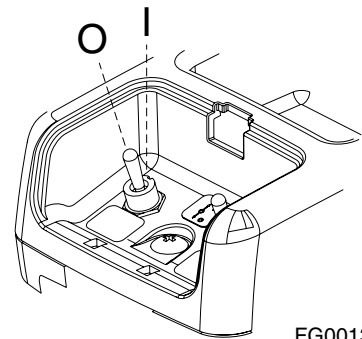
When starter switch (5) is turned "ON" the engine controller (8) is activated. The engine controller monitors and controls the engine including the injector solenoid (9). It controls the fuel deliver rate and the injection timing for each cylinder.

NOTE: *There is an individual injector solenoid (9) for each of the six cylinders. Only one solenoid is shown in Figure 6.*

When starter switch (5) is turned "OFF," the engine controller stops supplying power to the injector solenoid (9). This stops fuel from being injected into the engine cylinder, thus stopping the engine.

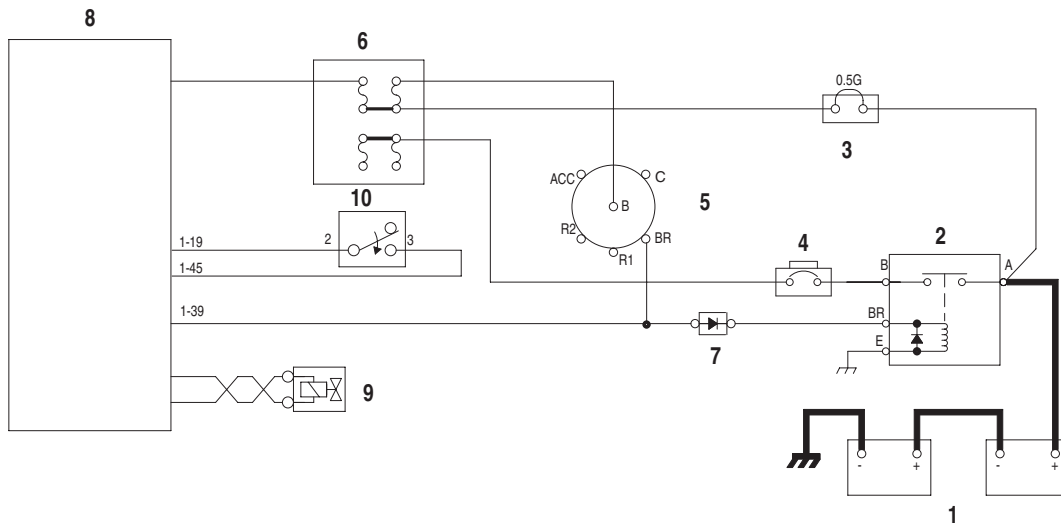
If the engine can be shut down using the starter switch (5), an emergency stop switch (10) is provided to shut down engine. To activate the emergency stop switch, move it to the "I" (EMERGENCY STOP) position.

The emergency stop switch (10) is in its "O" (OFF) position during normal operation. The switch must be moved and held in the "I" (EMERGENCY STOP) position until the engine stops. When released it will automatically move back to the "O" (OFF) position.



FG001344

Figure 5 ENGINE EMERGENCY STOP SWITCH



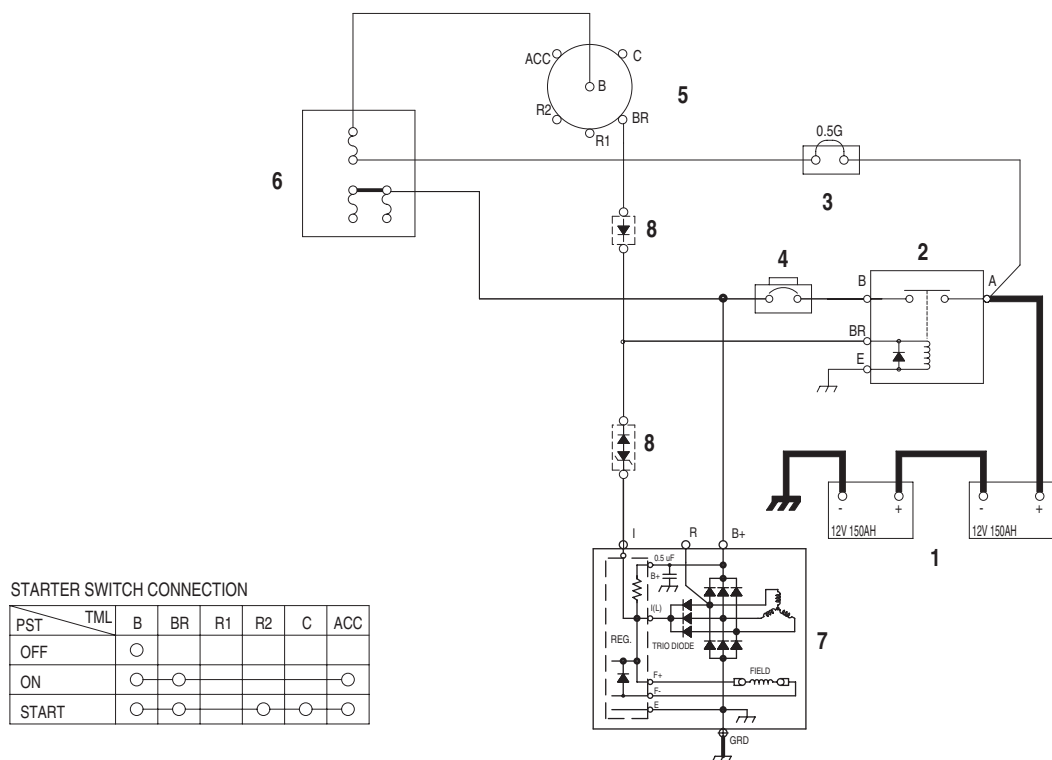
FG001473

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 "I (R)" terminal of alternator → diode (8) → battery relay (2) coil securing a path for the charging current to the battery (1). Thus preventing the possibility of a high voltage build up and possible damage to the electrical system.



FG007765

Figure 7 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

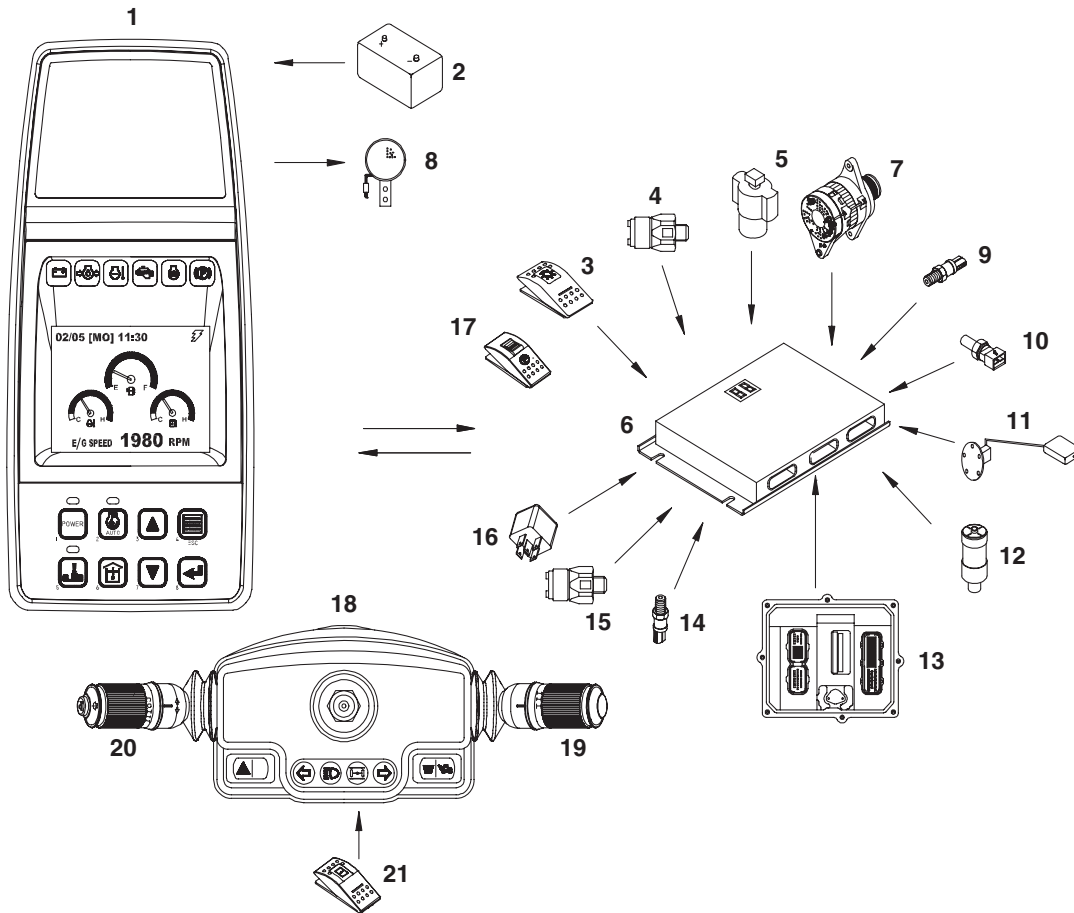


Figure 8

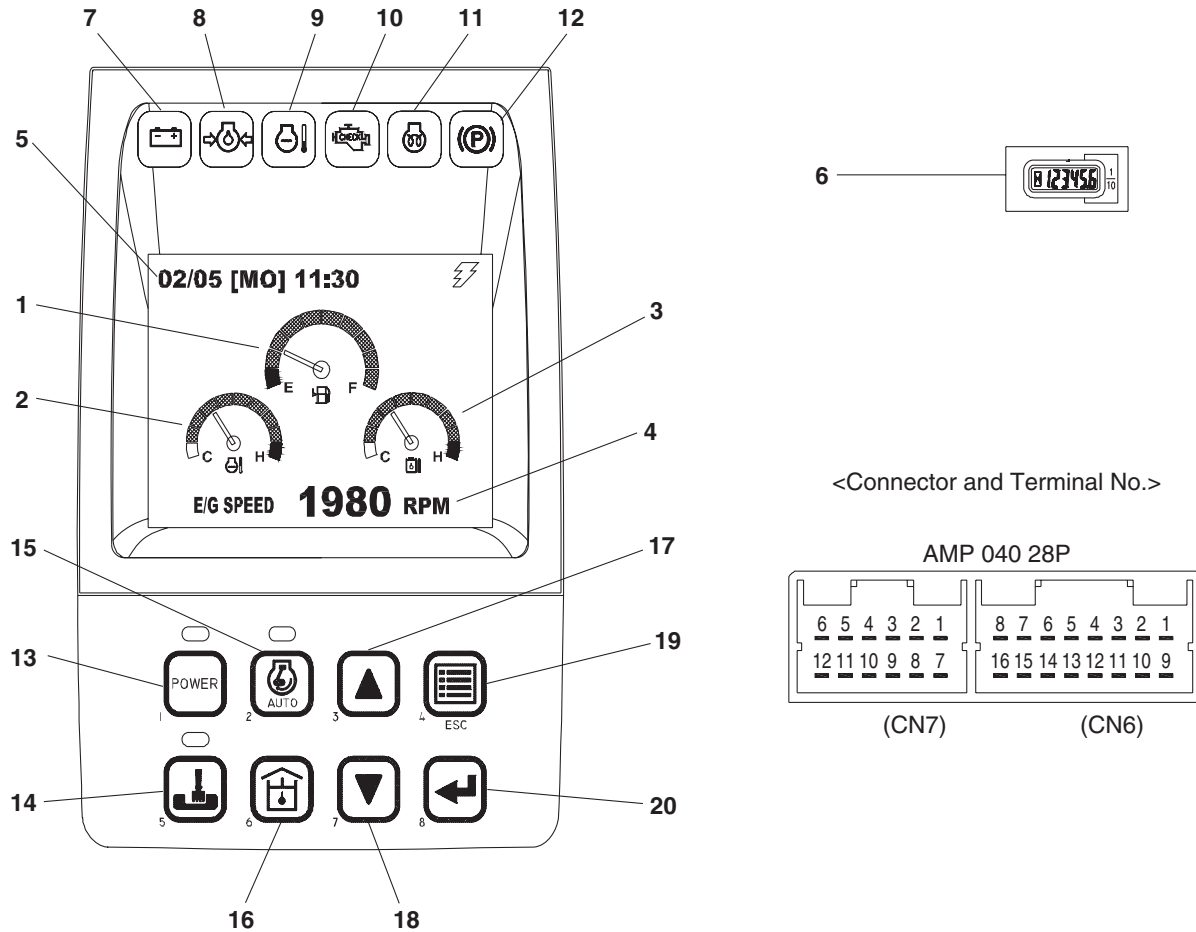
FG007778

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
8	Warning Buzzer
9	Pump Discharge Pressure Sensor
10	Oil Temperature Sensor
11	Fuel Sensor

Reference Number	Description
12	Air Cleaner Indicator
13	Engine Control Unit
14	Parking Brake Sensor
15	Brake Oil Pressure Switch
16	Pilot Relay
17	Parking Brake Switch
18	Steering Console
19	Right Side Combination Switch
20	Left Side Combination Switch
21	Ram Lock Switch

The monitoring system displays the various data and warning signals onto the instrument panel by processing the information gathered from the e-EPOS controller. It displays information selected by the operator.

Instrument Panel



FG007779

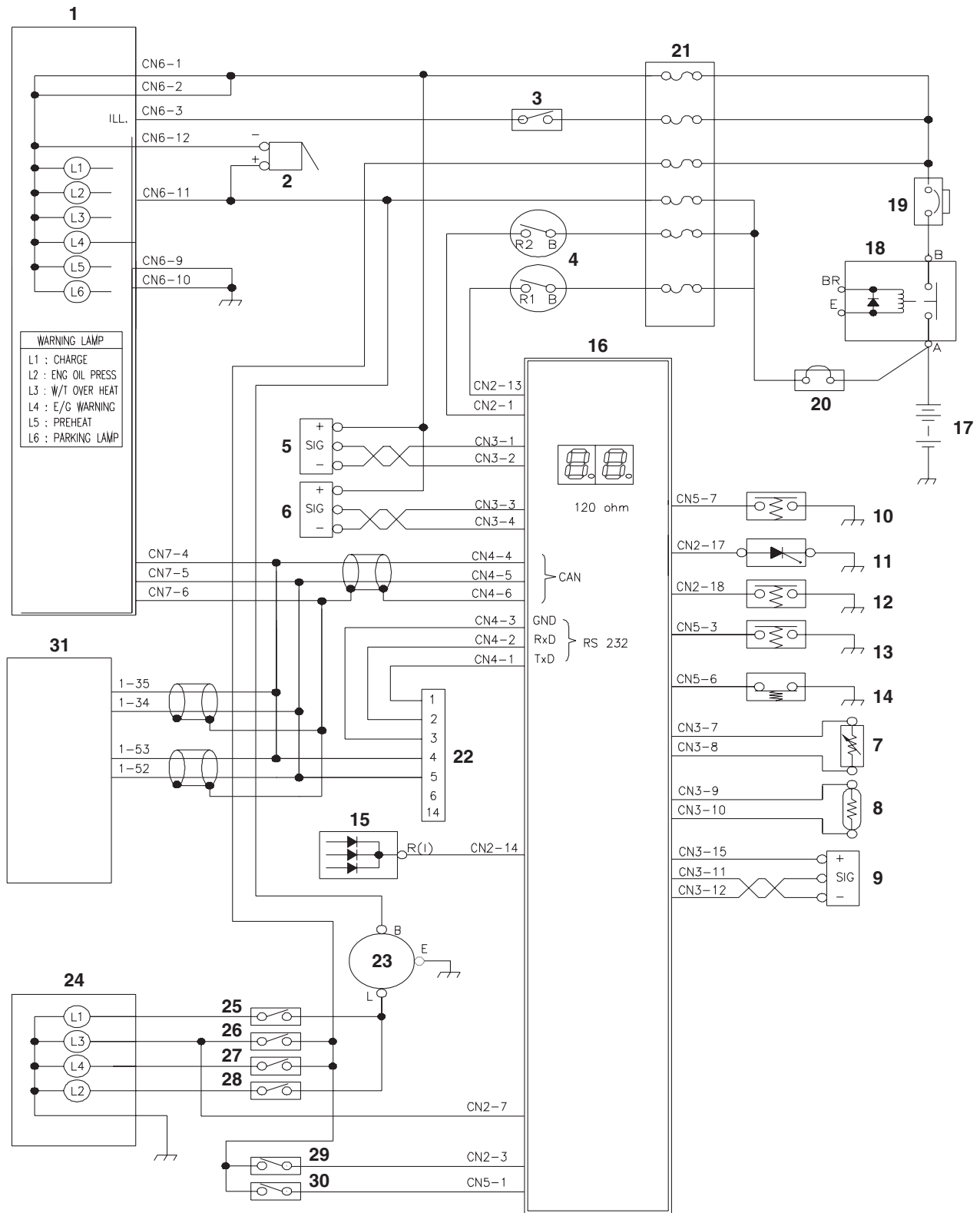
Figure 9

Gauges	Warning Lights	Mode Selector Switches
1. Fuel Gauge	7. Charge Warning Light	13. Power Mode Selector Switch
2. Engine Coolant Temperature Gauge	8. Engine Oil Pressure Warning Light	14. Work Mode Selector Switch
3. Hydraulic Oil Temperature Gauge	9. Coolant Temperature Warning Light	15. Auto Idle Switch
4. Multifunction Gauge and Graphic Information Area	10. Engine Check Light	16. Flow Control Switch
5. Digital Clock	11. Preheat Indicator Light	17. Up Button Switch
6. Hour Meter	12. Parking Brake Indicator Light	18. Down Button Switch
		19. Display Switch
		20. Enter Switch

When the engine starter switch is turned to the "I" (ON) position, all gauge bands, switch/button indicator lights and indicator/warning lights will turn "ON" and the alarm buzzer will sound about two seconds.

During this functional check, a LOGO will appear on the multifunction gauge in the graphic information area.

Monitoring System Schematic



FG007781

Figure 10

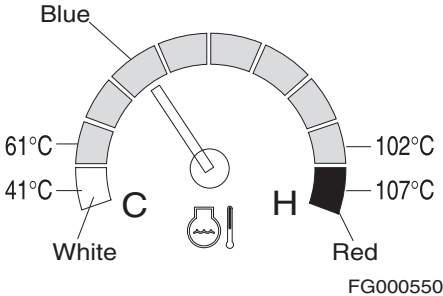
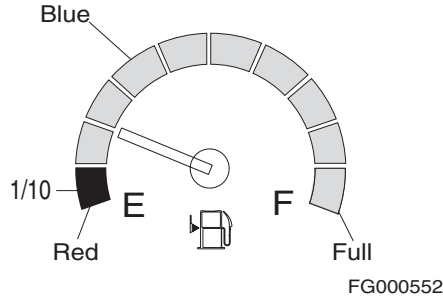
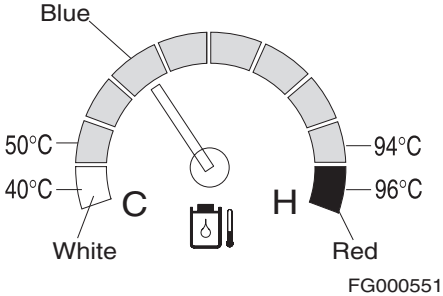
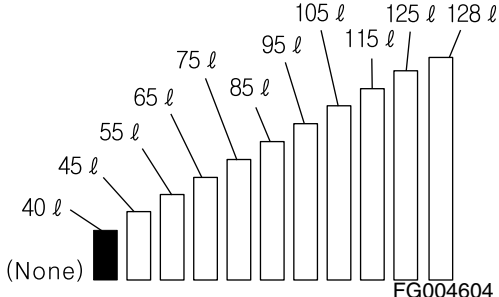
Reference Number	Description
1	Instrument Panel
2	Pilot Buzzer
3	Light Switch
4	Starter Switch
5	Front Pump Pressure Sensor
6	Rear Pump Pressure Sensor
7	Fuel Sensor
8	Hydraulic Oil Temp. Sensor
9	Parking Brake Sensor
10	Pedal Breaker Pressure Sensor
11	Air Cleaner Indicator
12	Pilot Filter Switch
13	Return Filter Switch
14	Brake Oil Pressure Switch
15	Alternator

Reference Number	Description
16	e-EPOS Controller
17	Battery
18	Battery Relay
19	Circuit Breaker
20	Fusible Link
21	Fuse Box
22	Check Connector
23	Blink Unit
24	Steering Console
25, 26	Turn Signal Switch
27	High Beam
28	Ram Lock Switch
29	Travel Switch
30	Parking Switch
31	Engine Controller

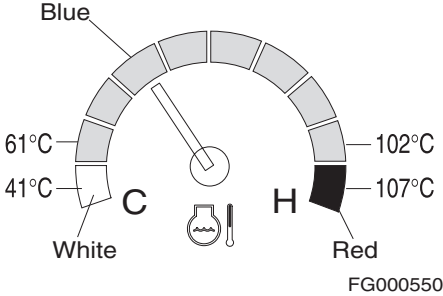
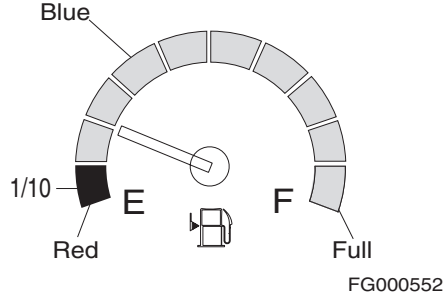
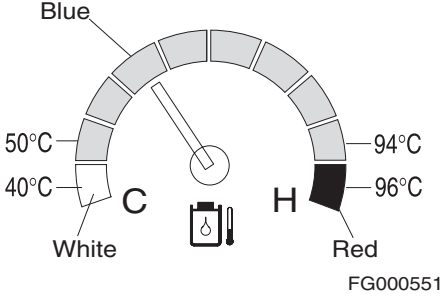
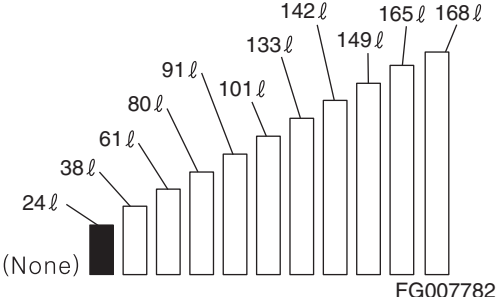
OPERATION

Instruments

DX210W

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Coolant Temperature		ECU-CAN Communication	
Fuel Level		CN3-7 CN3-8	1/10 LCD (Red Zone) Blinking → over 5K ohms FULL → under 525 ohms
Hydraulic Oil Temperature		CN3-9 CN3-10	40°C (104°F) → 1,397 ohms 50°C (122°F) → 1,139 ohms 60°C (140°F) → 881 ohms 94°C (201°F) → 190 ohms 96°C (205°F) → 177 ohms (When reading increase)
Flow Adjusting		(Output Terminal) CN1-19 CN1-20	40 lpm → 605 mA 45 lpm → 538 mA 55 lpm → 487 mA 75 lpm → 413 mA (Default Set) 115 lpm → 341 mA 128 lpm → 290 mA

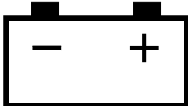
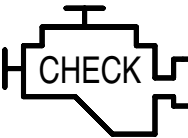
DX190W

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Coolant Temperature		ECU-CAN Communication	
Fuel Level		CN3-7 CN3-8	1/10 LCD (Red Zone) Blinking → over 5K ohms FULL → under 525 ohms
Hydraulic Oil Temperature		CN3-9 CN3-10	40°C (104°F) → 1,397 ohms 50°C (122°F) → 1,139 ohms 60°C (140°F) → 881 ohms 94°C (201°F) → 190 ohms 96°C (205°F) → 177 ohms (When reading increase)
Flow Adjusting		(Output Terminal) CN1-19 CN1-20	24 lpm → 605 mA 38 lpm → 538 mA 61 lpm → 487 mA 91 lpm → 413 mA (Default Set) 149 lpm → 341 mA 188 lpm → 290 mA

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Tachometer	E/G SPEED 1700 RPM FG000049	ECU-CAN Communication	$N = 162 f / 60$ N = Engine speed (rpm) f = Frequency of engine speed sensor (Hz)
Voltmeter	BATTERY 28.0 VOLT FG000050	CN2-14	0 - 32 VDC
Main pump discharge pressure (front pump)	FRONT PUMP 320 BAR FG000051	CN3-1 CN3-2	$V = 0.00816 \times P + 1.0$ V: Sensor output voltage (V) P: Displayed pressure (Bar)
Main pump discharge pressure (rear pump)	REAR PUMP 313 BAR FG000052	CN3-3 CN3-4	

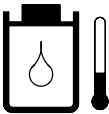
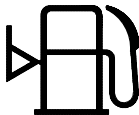
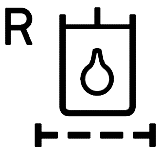
WARNING AND INDICATOR LIGHTS

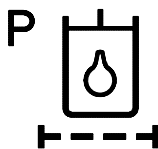
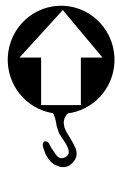
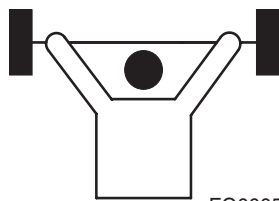
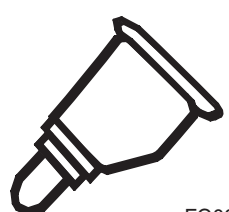
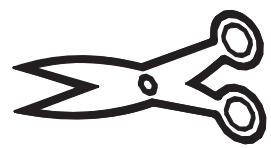
Indication of Warning Lights

Description	Symbol	Input Terminal	Operation	Remarks
Charge	 HAOA610L	CN2 - 14	It lights in case of no charge [voltage of "R (I)" terminal is below $12 \pm 1V$] or overcharge [voltage of "R (I)" terminal is above 33 (V)].	Normally, it lights when starting engine and is out after engine starts.
Engine Oil Pressure	 HAOA620L	ECU-CAN Communication	It lights when engine oil pressure is below the reference.	After starting engine, if engine oil pressure is insufficient after 8 seconds, a warning buzzer will sound.
Engine Check	 FG000045	ECU-CAN Communication	It lights in case of failure in engine system.	
Coolant Temperature	 HAOD350L	ECU-CAN Communication	It lights when engine coolant temperature sensor resistant is below about 128 ohms.	
Preheating	 HAOA639L	CN5-2	It lights during preheating ("CN5-2" terminal voltage is below 2V) and turns "OFF" after completion of preheating.	Preheating period depends on coolant temperature. No preheating at above $10^{\circ}C$ 10 sec preheating at $5^{\circ}C$ 20 sec preheating at below $0^{\circ}C$

Description	Symbol	Input Terminal	Operation	Remarks
Parking Brake Indicator Light	 BCS0790L	CN5-1 CN3-11 CN3-12	- Lights up when the parking brake switch is placed in the park position. - Lights up when parking brake pressure decrease below 26.0 kg•cm ² (377 psi)	

Indication of Multifunction Gauge and Letter Information Area

Description	Symbol	Input Terminal	Operation	Remarks
Hydraulic Oil Temperature	 FG000056	CN3-9 CN3-10	When hydraulic oil temperature is above about 96°C.	
Fuel Exhausted	 FG000057	CN3-7 CN3-8	When fuel is almost exhausted.	
Air Cleaner	 FG000053	CN2-17	When air cleaner is clogged.	
Return Filter	 FG000054	CN5-3	When return filter pressure is above about 1.50 kg•cm ² (21 psi)	

Pilot Filter	 FG000055	CN2-18	When pilot filter pressure is above about 1 kg•cm ² (14 psi)	
Overload Warning	 FG000253	CN3-5 CN3-6	Warning buzzer also starts when boom pressure sensor output voltage is about 2.7V while overload warning switch is "ON."	It flickers in case of 2.71V and above and lights continuously in case of 2.8V and above (and warning buzzer also starts).
Boost	 FG000554	CN2-2	It lights when boost is selected.	
Breaker	 FG001470	CN2-10	It lights when breaker is selected.	
Shear	 FG001471	CN2-9	It lights when shear is selected.	
Quick Clamp	 FG002195	CN2-11	Lights up when quick clamp was release.	

Travel	 FG004605	CN2-3	Lights up when travel was selected.	
Working Light	 HB4O2003	CN2-6	It lights when work light turns "ON."	

INITIAL OPERATION

Item	Input (Terminal)	Output (Operation and initial setting mode)
Initial Operation	When "CN6-1,2" is applied battery voltage (starter switch shifts from "OFF" to "ON")	- LCD, all of LED and warning lights are turned "ON" and turned "OFF" after about 2 seconds. - Warning buzzer is activated and turned "OFF" after about 2 seconds. - Power mode: Standard mode. - Work Mode: Digging mode. - Auto Idle: High Output (Activation). - Display: Indicating coolant temperature, Fuel level, Hydraulic oil temperature, Engine speed. - Clock: Current time display.

NOTE: Refer to method for setting clock in operation manual for setting time.

MODE SELECTOR SWITCH

Power Mode

Operation Mode		Output Check (Operation mode display LED)	Work/Travel Selector Switch	e-EPOS Output	
				Pump Discharge Volume Control Valve Current (mA)	7-Segment Display
Power Mode	Power	ON	Travel Mode	No load: 240 ± 20 mA Load: Variable output (Max. current: 650 ± 50 mA)	9 x
			Work Mode	No load: 270 ± 20 mA Load: Variable output (Max. current: 650 ± 500 mA)	
	Standard	OFF	Travel Mode	No load: 240 ± 20 mA Load: Variable output (Max. current: 650 ± 50 mA)	7 x
			Work Mode	No load: 320 ± 20 mA Load: Variable output (Max. current: 650 ± 50 mA)	

Trenching Mode Switch

Operation Mode		Output Check (Operation mode display LED)	e-EPOS Output		
			Swing Valve	Priority Solenoid	7-Segment Display
Work Mode	Digging	ON	OFF		x 0
	Trenching	OFF	ON		x 2

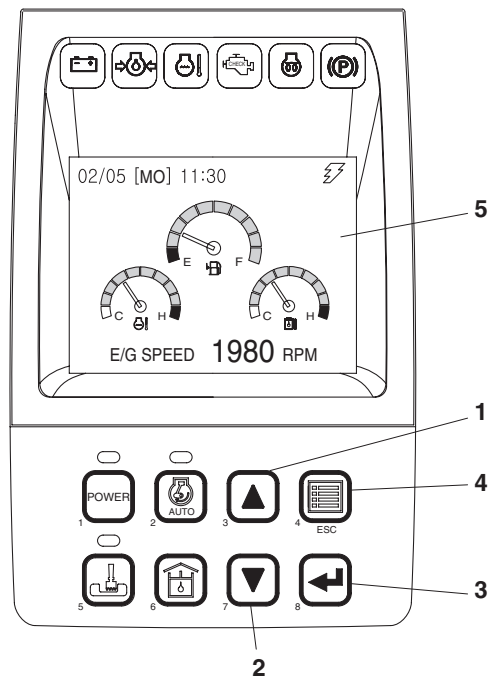
Auto Idle Switch

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.



FG007783

Figure 11

Selector Buttons	Graphic Display Area
1. Up Arrow Button 2. Down Arrow Button 3. Enter Button 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 11): Move the cursor to up, left and previous screen.
 2. Down Arrow Button (▼, 2 on Figure 11): Move the cursor to down, right and next screen.
 3. Enter Button (↵, 3 on Figure 11): 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 11): Move a screen to previous menu or main menu.
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

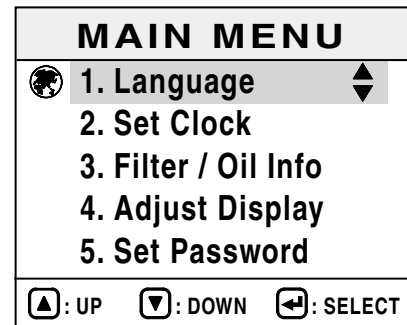
1. Up Arrow Button (▲, 1 on Figure 11): Move the cursor to up, left and previous screen.
2. Down Arrow Button (▼, 2 on Figure 11): Move the cursor to down, right and next screen.
3. Enter Button (↵, 3 on Figure 11): Move the menu to selected mode. When setting the menu, this button is used to function as the selector button.
4. Escape Button (ESC, 4 on Figure 11): Move a screen to previous menu or main menu.

MAIN MENU

When the "ESC" button is pressed for more than 3 seconds, the main menu screen is displayed.

Main menu offers submenus (language setting, time setting, or filter/oil information, brightness adjustment, password) to the operator.

Refer to the "Operation and Maintenance Manual" for details.



FG000072

Figure 12

Language

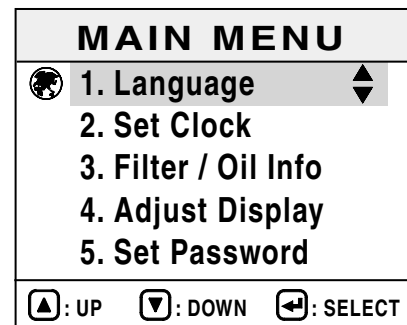
Put the cursor on Language in the main menu and put the Enter Button (↵, 3 on Figure 11) and the language select view appears.

The default language is Korean, but it will memorize and use the newly set language.

Use the Up Arrow Button (▲, 1 on Figure 11) or Down Arrow Button (▼, 2 on Figure 11) to move cursor to a language to be selected on the Language Select display and press the Enter Button (↵, 3 on Figure 11) and the selected language is indicated in the right bottom of the screen.

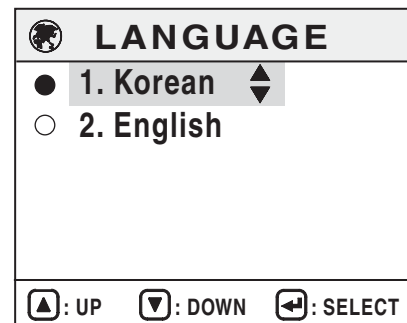
At this point pressing the Enter Button (↵, 3 on Figure 11) or the Escape Button (ESC, 4 on Figure 11) more than 1 second brings the main menu with changed language and then pressing the ESC button again shows the default view.

Without pressing a button more than 20 seconds, the default view appears.



FG000072

Figure 13



FG000783

Figure 14

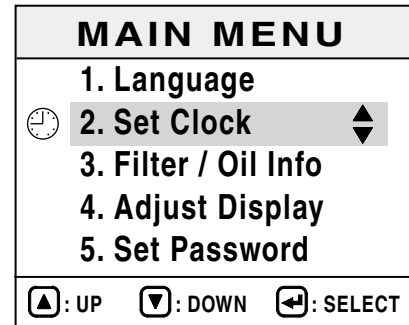
Set Clock

It is used to adjust time of the digital clock.

Pressing the Enter Button (↵, 3 on Figure 11) in the Main Menu after putting cursor on Set Clock brings Set Clock display.

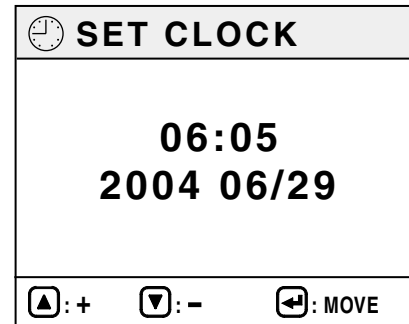
Without pressing a button more than 20 seconds, the default view appears.

Please refer to the Operation Manual for details on Time Setting.



FG000075

Figure 15



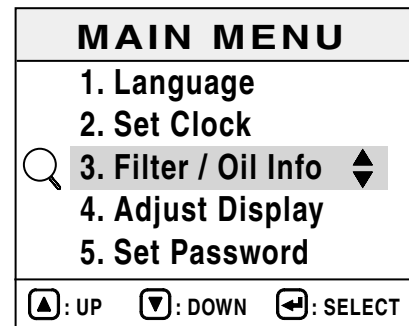
FG000076

Figure 16

Filter/Oil Info

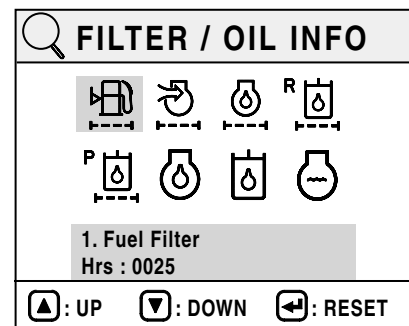
This mode displays total operating hours of filters and oils.

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

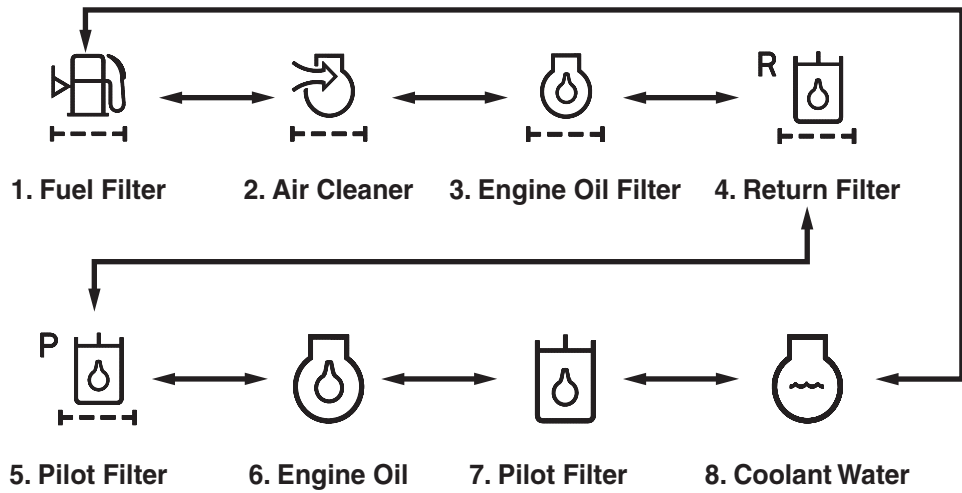
Figure 17



FG000078

Figure 18

Menu Display Order and Icon Explanation



FG004977

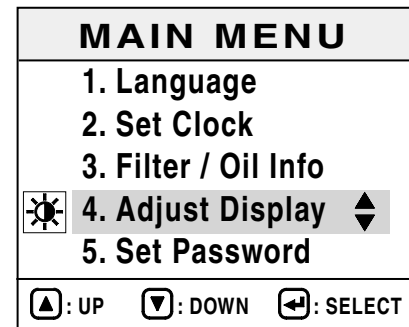
Figure 19

Adjust Display

Pressing the Enter Button (↵, 3 on Figure 11) in the main menu after putting cursor on Adjust Display brings Adjust Display.

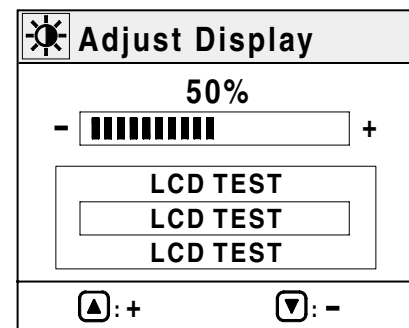
Screen brightness can be adjusted using the Up Arrow Button (▲, 1 on Figure 11) or the Down Arrow Button (▼, 2 on Figure 11).

The default brightness is set to 50%.



FG000080

Figure 20



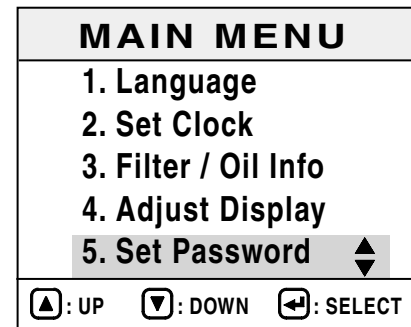
FG000081

Figure 21

Set Password

This menu is used to apply (lock), release, or change password.

Please refer to the Operation Manual for details on Password Setting.



FG000227

Figure 22

SPECIAL MENU

In this menu, many types of operating conditions and functions can be accessed and displayed, including the e-EPOS controller. This menu is mainly used for machine testing and failure diagnostics.

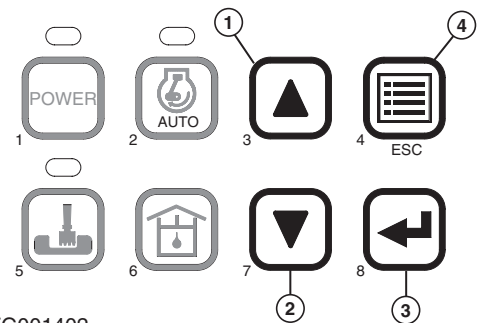
The special menu offers three submenus:

1. Machine status.
2. Failure information.
3. Information on machine operation.

Entering/Accessing and Exiting/Escaping Menus

Entering/Accessing Menus

When normal mode screen is displayed, if the enter button (↵, 3) and escape button (ESC, 4) are pressed simultaneously for more than 3 seconds, normal mode screen (Figure 24) will be changed to special menu screen (Figure 25).

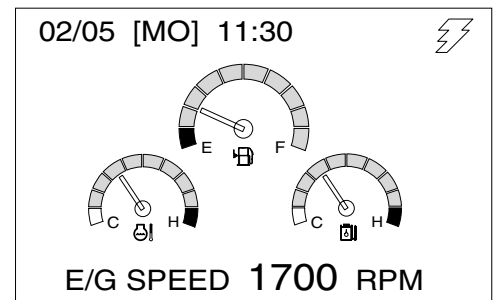


FG001402

Figure 23

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.



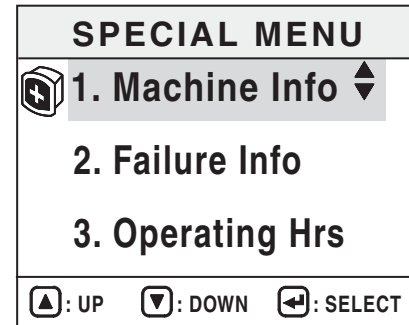
FG000043

Figure 24

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 25

Exiting/Escaping Menus

1. If escape button (ESC, 4 on Figure 23) is pressed for more than 1 second, the special menu screen will be returned to the normal mode screen.
2. If this special menu is "ON" without any activity, for more than 20 seconds, it will turn to the normal mode screen.
3. After the turning starter switch to the "OFF" position, turn it back to the "ON" position, and the normal mode screen displayed once again.

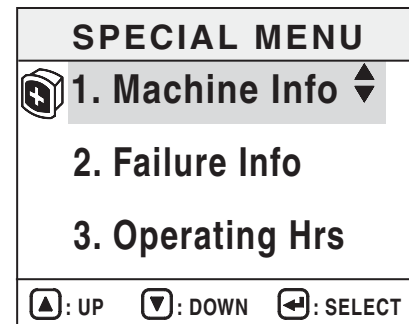
Special Menu Selections

Submenu Selection Method

Various submenus can be selected by pressing "Up (▲, 1 on Figure 23)" and "Down (▼, 2 on Figure 23)" 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 23)" button for menu selection.

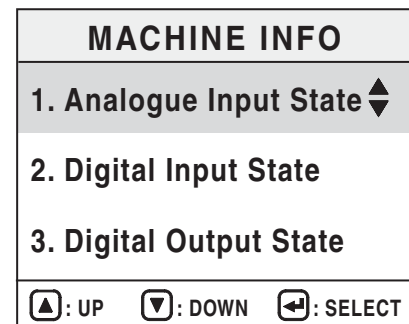


FG000558

Figure 26

Information of Machine Status

1. Entering Submenus: When cursor is located on "Machine Info" of special menu screen, press "Enter (↵, 3 on Figure 23)" button and the "Machine Info" will be displayed.
2. Exiting Submenus: If escape button (ESC, 4 on Figure 23) is pressed for more than 1 second, display will be turned to previous screen.



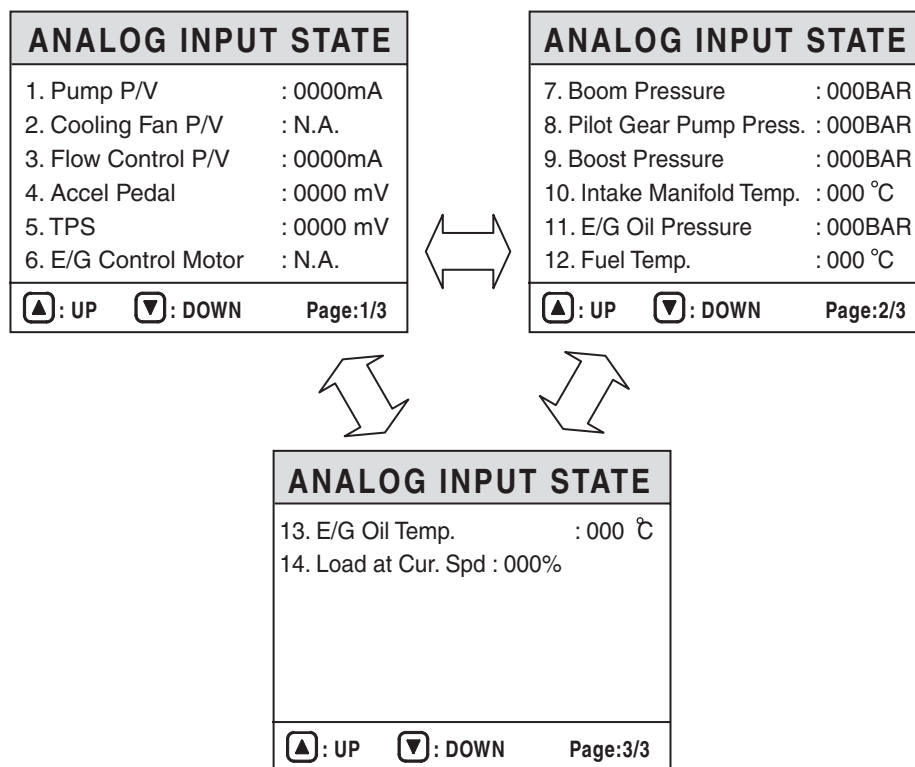
FG000559

Figure 27

Analog Inputs Description

Analog Input Items	Display	Remark
1. Pump P/V	mA	Current in pump proportional valve.
2. Cooling Fan P/V	mA	N.A.
3. Flow Control P/V	mA	Current in flow control proportional valve.
4. Dial	mV	Indicating dial voltage.
5. Accelerator Pedal	mV	Indicating accelerator pedal voltage.
6. E/G Control Motor	mV	N.A.
7. Boom Pressure	BAR	Boom cylinder head pressure.
8. Pilot Gear Pump Press	BAR	Pilot gear pump pressure.
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 Current Speed	%	Current load ratio of equipment.

Submenu Selections



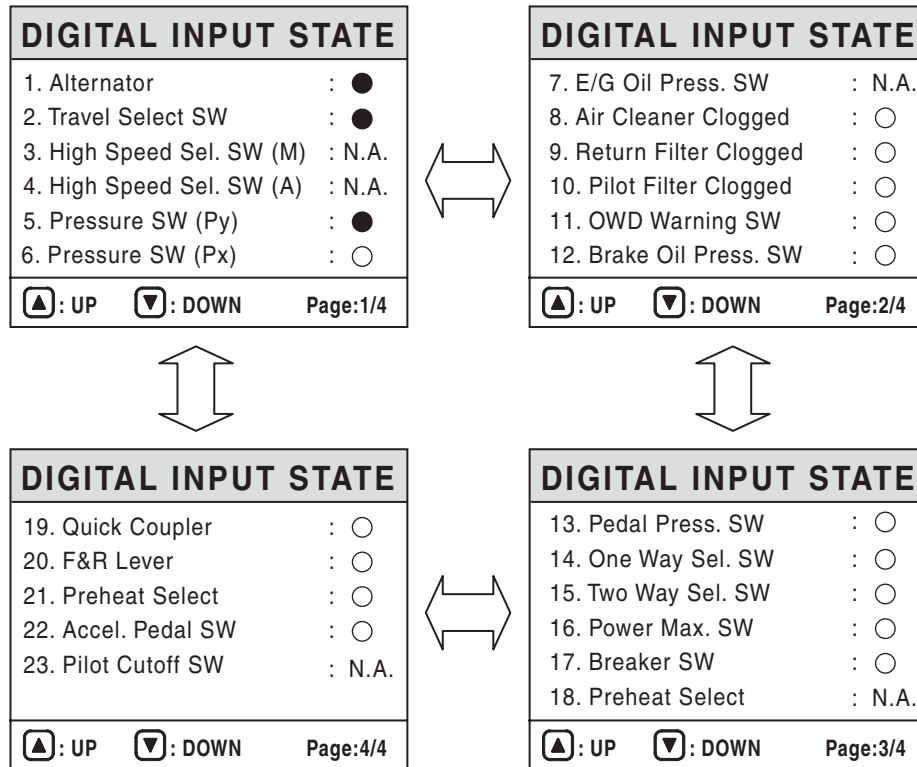
FG007784

Figure 28

Digital Inputs Descriptions

Digital Inputs Items	Mark	Remark
1. Alternator	ON / OFF	Lights up when output at alternator "R (I)" terminal is above $12 \pm 1V$.
2. Travel Select SW		Lights up when work/travel selector switch is placed in the travel position.
3. High-speed Sel. SW (M)		N.A. (only for crawler type equipment)
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.
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		Lights up when brake oil pressure droops below $65 \text{ kg} \cdot \text{cm}^2$
13. Pedal Press. SW		Lights up when 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 while the air heater is heated.
22. Pedal Press. SW		Lights up when accelerator pedal switch is "ON."
23. Pilot Cutoff SW		N.A. (only for wheel type equipment)

Menu Select



FG007785

Figure 29

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. Pilot Relay S/V		Lights up when the Pilot relay 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

DIGITAL OUTPUT STATE	
1. Relief Press. Up S/V	: ●
2. High Speed S/V	: ○
3. Swing Priority S/V	: ●
4. Reverse Fan S/V	: N.A.
5. Starter Relay	: ●
6. Afterheat Relay	: N.A.
▲: UP ▼: DOWN Page:1/1	

FG007786

Figure 30**Failure Information**

- Entering Submenus: When a cursor is located in "Failure Info" of special menu screen press enter button (↵, 3 on Figure 23) and "Failure Info" screen is displayed.
- Exiting Submenus: If escape button (ESC, 4 on Figure 23) is pressed for more than 1 second, this information screen will be returned to previous screen.

SPECIAL MENU	
1. Machine Info	
2. Failure Info	▲▼
3. Operating Hrs	
▲: UP ▼: DOWN ↵: SELECT	

FG000563

Figure 31

- * Real-time Failure:
Current status of failure is displayed.
- * Failure Log:
Memorized record of past failure is displayed.
- * Delete Fail Log:
This mode is used to delete all the memorized record of past failure.

FAILURE INFO	
1. Realtime Fail	▲▼
2. Failure Log	
3. Delete Fail Log	
▲: UP ▼: DOWN ↵: SELECT	

FG000564

Figure 32

A. Current failure information

Current status of failure is displayed (Failure code, failure contents).

When several failures are produced, failure information can be checked using "UP" (▲, 1 on Figure 23) or "DOWN" (▼, 2 on Figure 23) 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.

B. Past failure information

Memorized record of past failure is displayed (Failure code, failure contents).

When several failures are produced, failure information can be checked using "UP" (▲, 1 on Figure 23) or "DOWN" (▼, 2 on Figure 23) button.

NOTE: " Number: xxx ": "xxx" means that 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.)

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 23) button is pressed, the memorized record will be deleted.

Now, deletion signal will be displayed and the screen will move to previous menu after deletion.

This screen will be displayed during 3 seconds.

NOTE: Failure record deletion can be performed only approved person. If you want to delete past failure record, contact distributor.

REALTIME FAIL	
1/2	CODE : V204-05
2/2	CODE : E011-04
Relief Pressure Up S/V	
Current below normal (CURRENT BELOW NORMAL or open circuit)	
▲: UP	▼: DOWN

FG000565

Figure 33

FAILURE LOG	
1/2	CODE : V204-05
2/2	CODE : E011-04
Period:00254Hr 29m Number:08	
Relief Pressure Up S/V	
Current below normal (CURRENT BELOW NORMAL or open circuit)	
▲: UP	▼: DOWN

FG000566

Figure 34

DELETE FAIL LOG	
 All Fail Log will be DELETED.	
↵: Yes	ESC: No

FG000567

Figure 35

Input your password with one of No. 1 - 8 switches.

When "NO" (ESC, 4 on Figure 23) button is pressed, the screen will recover to previous menu without deletion.

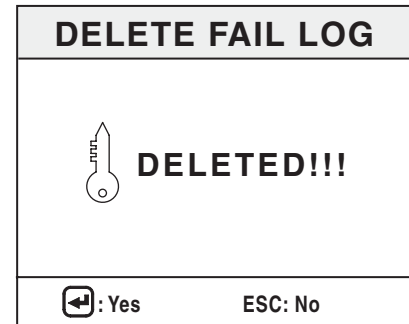


FG000568

Figure 36

Delete Completed screen will appear 3 seconds and the screen will move to Failure Info screen.

It has been shown 3 seconds upon deleting Fail Log.

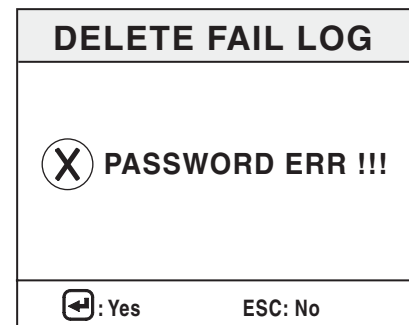


FG000569

Figure 37

The screen shown on the left will appear 3 seconds in case of wrong password input and then Enter Password screen appears again.

It has been shown 3 seconds in case of password failure.



FG000570

Figure 38

Failure Information Code at Machine Side

Code	Failure Component	Measuring Points	Correct Value		Remarks
			Active	Passive	
V201	Gauge Panel Communication Error	CN7-4 CN7-5	-	$R = 60 \pm 5 \text{ W}$	It is a composite resistance of CAN line. This value has to be measured by connected condition of CAN line.
V202	Ecu Communication Error	CN4-4 CN4-5	-	$R = 60 \pm 5 \text{ W}$	
V210	Pump P/V	CN1-10 CN1-21	-	$R = 18 \pm 2 \text{ W}$ (25°C (77°F))	Pump proportional pressure reducing valve.
V211	Cooling Fan P/V		-	-	N.A.
V212	Flow Control P/V	CN1-19 CN1-20	-	$R = 14 \pm 2 \text{ W}$ (25°C (77°F))	Flow control proportional pressure reducing valve.
V213	Relief Pressure Up S/V	CN1-1 CN1-11	$V = V_{\text{volt}}$ (Note 4.)	$R = 26.2 \pm 2 \text{ W}$ (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	Pilot Relay S/V	CN1-1 CN1-12	$V = V_{\text{volt}}$	$R = 330 \pm 10 \text{ W}$ (25°C (77°F))	Voltage is only measured when the pilot relay is turned "ON."
V215	Swing Priority S/V	CN1-1 CN1-13	$V = V_{\text{volt}}$	$R = 26.2 \pm 2 \text{ W}$ (25°C (77°F))	Work mode has to be selected as a trenching mode.
V216	Reverse Fan Speed S/V		-	-	N.A.
V217	Starter Relay	CN1-1 CN1-15	$V = V_{\text{volt}}$	-	It has to be measured in engine start up state.
V218	After Heat Relay	1-16 1-04	-	-	N.A.

Code	Failure Component	Measuring Points	Correct Value		Remarks
			Active	Passive	
V220	Front Pump Press. Sensor	CN3-1 CN3-2	V = 1V	-	It has to be measured in engine stop state.
V221	Rear Pump Press. Sensor	CN3-3 CN3-4	V = 1V	-	
V222	Hydraulic Oil Temperature Sensor	CN3-9 CN3-10	-	R = 2.45 ± 0.25 kW (25°C (77°F)) R = 320 ± 32 W (80°C (176°F))	
V223	Water Temperature Sensor		-	-	N.A.
V224	Engine Speed Sensor		-	-	N.A.
V225	Fuel Level Sensor	CN3-7 CN3-8	-	Empty: 5 ± 0.25 kW Full: 320 ± 32 W	
V226	Alternator Potential	CN2-14 CN1-8	V = 2 ± 1V	-	It has to be measured in engine stop state.
V227	Dial	CN3-16 CN3-7	-	R = 1.0 ± 0.3 kW R = 4.0 ± 1.5 kW	
V228	Accelerator Pedal	CN3-13 CN3-14	V = 0.66 ± 0.1V (at min position) V = 3.85 ± 0.1V (at max position)	-	
V229	Parking Brake Press. Sensor	CN3-11 CN3-12	V = 0.5V	-	It has to be measured in engine stop state.
V230	E/g Control Motor Sensor	-	-	-	N.A.
V231	Accelerator Pedal SW	CN5-8	V = 4 ± 1V	-	Voltage is only measured when the accelerator pedal sw is turned "ON."

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	2-36 2-18	-	R=186 ± 5 W (100°C (212°F))	
E012	Fuel Temperature Sensor	2-34 2-17	-	R=186 ± 5 W (100°C (212°F))	
E013	Boost Air Temperature Sensor	2-29 2-21	-	R=186 ± 5 W (100°C (212°F))	
E014	Boost Air Pressure Sensor	2-28 2-10	V = 1,071 ±58mV (at 23°C (73°F) and absolute pressure 1 bar)	-	It has to be measured in engine running state.
E017	E/G Oil Temperature Sensor	2-35 2-19	-	R=186 ± 5 W (100°C (212°F))	
E018	E/G Oil Pressure Sensor	2-33 2-09	V = 2,318 ±80mV (at 23°C (73°F) and absolute pressure 3 bar)	-	It has to be measured in engine running state.
E021	Battery Voltage	1-13 1-15	V = V_volt (Note 4.)	-	
E022	Fuel Pressure Sensor	2-27 2-20	V = 1,833 ±28mV (at 23°C (73°F) and absolute pressure 300 bar)	-	It has to be measured in engine running state.
E032	Fuel Pressure Monitoring MPROP	2-7 2-5	-	R=2.60 ± 3.15 W (20°C (68°F))	
E037	CAN-B Line	1-53 and 1-52 1-35 and 1-34	-	R=60 ± 5 W (20°C (68°F))	It is a composite resistance of CAN line. This value has to be measured by connected condition of CAN line.
E038	Engine Overspeed		-	-	
E039	Main Relay (SCG)		-	-	
E041	Redundant Shutoff Path		-	-	Abnormal engine stop.
E042	E/G Speed (Crankshaft)	2-25 2-24	-	R=860 ± 6 W (20°C (68°F))	

Code	Failure Component	Measuring Points	Current Valve		Remarks
			Active	Passive	
E043	E/G Speed (Camshaft)	2-23 2-30	-	-	
E044	Engine Speed Sensor		-	-	Synchronizing error between crankshaft speed sensor and camshaft speed sensor.
E045	EEPROM		-	-	Data storing error when engine stop.
E046	Recovery		-	-	
E047	Monitoring of PRV		-	-	When the pressure sensor of common rail or high-pressure pump has a defect.
E048	Power Supply	1-13 1-15	$V = V_{\text{volt}}$	-	
E049	Main Relay SCB		-	-	
E051	Main Relay ECU		-	-	
E058	Solenoid Power Stage 1	3-13 3-09	-	$R=0.31 \pm 0.42$ W (20°C (68°F))	
E059	Solenoid Power Stage 2	3-03 3-06	-	-	
E061	Solenoid Power Stage 3	3-04 3-12	-	-	
E062	Solenoid Power Stage 4	3-05 3-14	-	-	
E063	Solenoid Power Stage 5	3-11 3-16	-	-	
E064	Solenoid Power Stage 6	3-10 3-15	-	-	
E066	Preheat Light (E/G: Low Side Power Stage 2)	1-29 1-30	-	-	
E068	Preheat Relay (E/G: High Side Power Stage 1)	1-16 1-04	$V = V_{\text{volt}}$	$R=40 \pm 5$ W (25°C (77°F))	Voltage is only measured when afterheat function is operating status.

Code	Failure Component	Measuring Points	Current Valve		Remarks
			Active	Passive	
E065	Fuel HI pressure pump (E/G: Current controlled high side power stage 1)	-	-	-	Fuel metering unit error of high-pressure pump.
E091	CAN-A Line	-	-	R=60 ± 5 W (20°C (68°F))	It is a composite resistance of CAN line. This value has to be measured by connected condition of CAN line.
E077	Monitoring of misfire cylinder 1	-	-	-	Injector error Speed signal error of camshaft speed sensor or crankshaft speed sensor.
E098	Monitoring of misfire cylinder 2	-	-	-	
E099	Monitoring of misfire cylinder 3	-	-	-	
E101	Monitoring of misfire cylinder 4	-	-	-	
E102	Monitoring of misfire cylinder 5	-	-	-	
E103	Monitoring of misfire cylinder 6	-	-	-	
E104	Monitoring of misfire multiple cylinder	-	-	-	
E105	Monitoring of overrun	-	-	-	
E106	Engine speed redundant	-	-	-	

NOTE: 1. Active value: Starter switch has to be turned "ON"

Measuring points between component and wire harness have to be connected.

2. Passive value: Starter switch has to be turned "OFF"

Measuring points between component and wire harness have to be disconnected.

3. Measuring points are engine controller's points and passive value is each component's value.

4. V_{batt}: Source power of equipment.

FMI (Failure Mode Identifier)

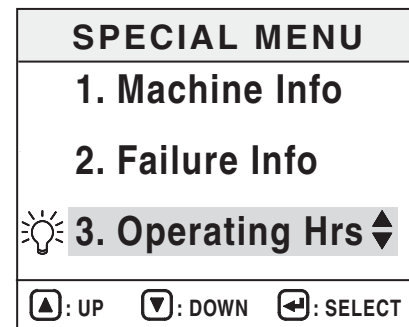
FMI 0	Above normal range (DATA VALID but ABOVE NORMAL OPERATIONAL RANGE)
FMI 1	Below normal range (DATA VALID but BELOW NORMAL OPERATIONAL RANGE)
FMI 2	Incorrect signal (DATA ERRATIC, INTERMITTENT OR INCORRECT)
FMI 3	Voltage above normal (VOLTAGE ABOVE NORMAL OR SHORTED TO HIGH SOURCE)
FMI 4	Voltage below normal (VOLTAGE BELOW NORMAL OR SHORTED TO LOW SOURCE)
FMI 5	Current below normal (CURRENT BELOW NORMAL OR OPEN CIRCUIT)
FMI 6	Current above normal (CURRENT ABOVE NORMAL OR GROUNDED CIRCUIT)
FMI 8	Abnormal signal (ABNORMAL FREQUENCY OR PULSE WIDTH OR PERIOD)
FMI 11	Failure mode not identifiable (ROOT CAUSE NOT KNOWN - Malfunction)
FMI 31	NOT AVAILABLE OR CONDITION EXISTS

Information of Machine Operation

Accumulated operation hour of each mode and status is displayed.

1. Operating Hour Information

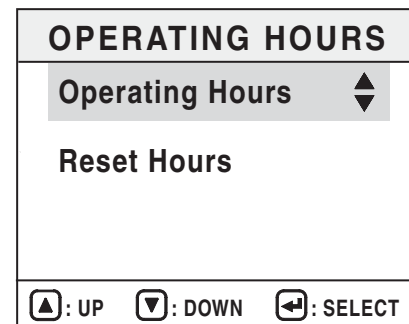
- A. Entering Submenus: When a cursor is located in "Operating Hrs" of special menu screen (Figure 39) press enter button (↵, 3 on Figure 23) and "Operating Hrs" screen will be displayed (Figure 40).



FG000571

Figure 39

- B. Information screen of machine operation (Figure 40).



FG000572

Figure 40

- C. Operating Hours Screen
- D. Exiting Submenus: If escape button (ESC, 4 on Figure 23) is pressed for more than 1 second, this information screen will be returned to previous screen.

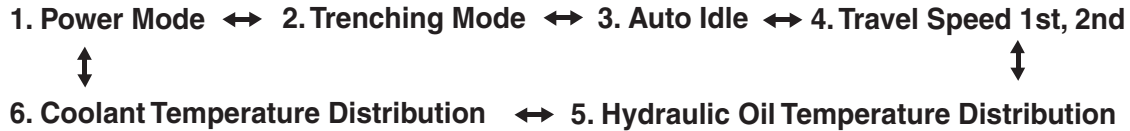
OPERATING HOURS	
1. Power	: 00042 Hr
2. Trenching	: 00003 Hr
3. Auto idle	: 00005 Hr
4. Travel speed	
I speed	: N.A.
II speed	: N.A.
: UP : DOWN : SELECT	

FG007787

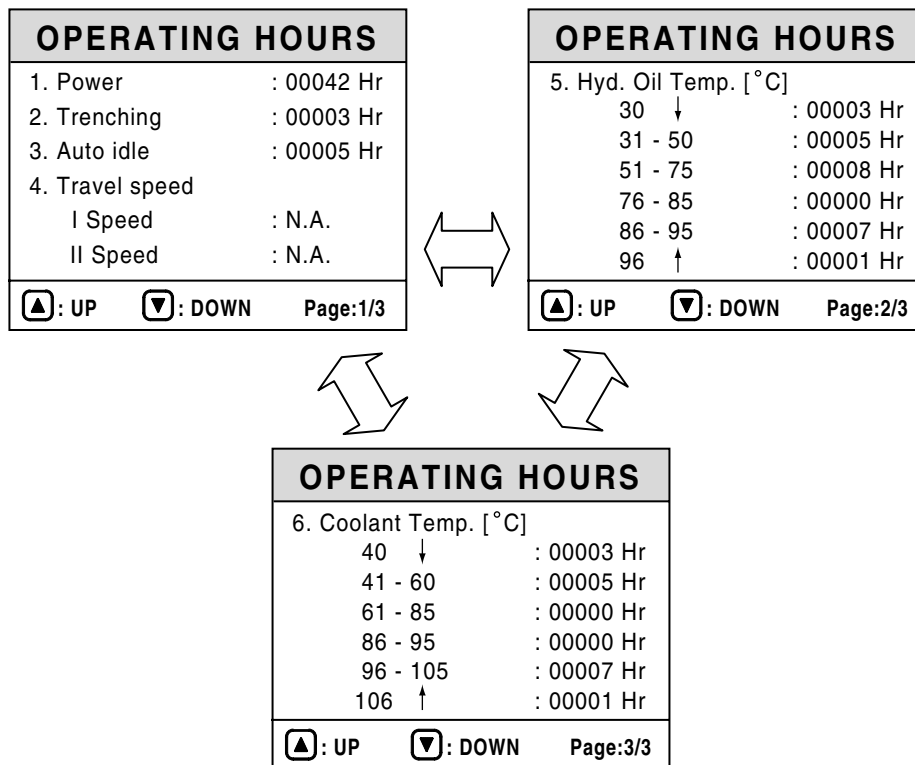
Figure 41

Information contents of operation hour

Item	Information Contents	Detection Method
Power Mode	Operation hours used power mode are displayed.	Power mode switch (Instrument panel) - "ON" status and Alternator signal (CN2-14) is "HI"
Trenching Mode	Operation hours used trenching mode are displayed.	Trenching mode switch (Instrument panel) - "ON" status and Alternator signal (CN2-14) is "HI"
Auto Idle	Operation hours used auto idle status are displayed.	Auto idle switch (Instrument panel) - "ON" status and Alternator signal (CN2-14) is "HI"
Travel Speed: - 1st - 2nd	N.A.	
Hydraulic Oil Temperature Distribution (°C (°F))	Temperature of hydraulic oil is classified 6 steps, and operation hours of each step are displayed Under 30°C (87°F) 31 - 50°C (88 - 123°F) 51 - 75°C (124 - 168°F) 76 - 85°C (169 - 186°F) 86 - 95°C (187 - 203°F) Over 96°C (204°F)	The resistance delivered from temperature sensor of hydraulic oil is classified 6 steps, and operation hours of each step are displayed. (Alternator output HI status)
Coolant Temperature Distribution (°C (°F))	Temperature of coolant is classified 6 steps, and operation hours of each step are displayed. Under 40°C (105°F) 41 - 60°C (106 - 141°F) 61 - 85°C (142 - 186°F) 86 - 95°C (187 - 204°F) 96 - 105°C (205 - 222°F) Over 106°C (223°F)	The resistance delivered from coolant sensor is classified 6 steps, and operation hours of each step are displayed. (Alternator output HI status)

Menu Selection of Operation Hour Information

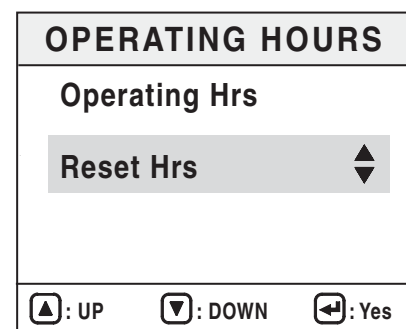
FG000574

Figure 42**Example of Machine Operation Info Screen**

FG007788

Figure 43**2. Operation hour reset**

- A. Entering Submenus: When cursor is located in "Reset Hrs" of information screen of operating hours press enter button (↵, 3 on Figure 23) and "Machine Operation Info" screen will be displayed.



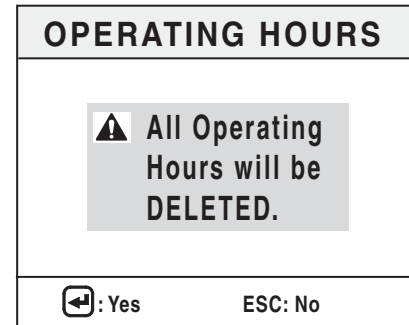
FG000578

Figure 44

- B. Reset screen of operation hour
- C. Exiting Submenus: If escape button (ESC, 4 on Figure 23) is pressed for more than 1 second, this information screen will be returned to previous screen.

NOTE: When "YES" (←, 3 on Figure 23) button is pressed, operation hours will reset. Now, 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.

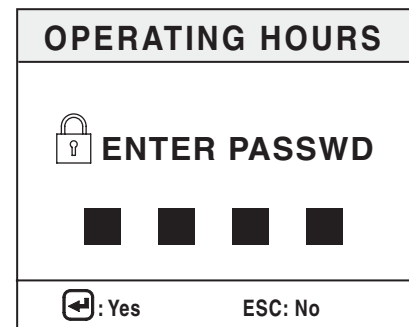


FG000579

Figure 45

Machine Operation Info Screen

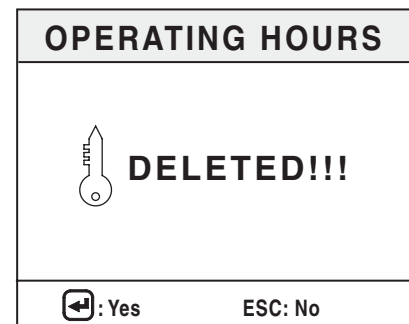
1. If you press the "YES" (←, 3 on Figure 23) button, password entrance screen appears.



FG000576

Figure 46

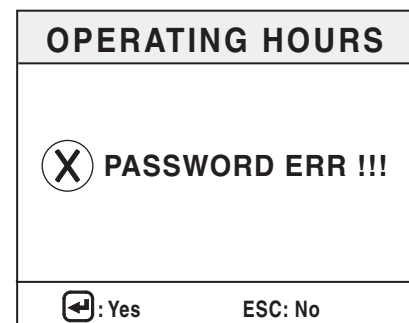
2. When right password is input, machine operation periods will be deleted and Reset Completed screen will appear 3 seconds.



FG000577

Figure 47

3. If you press the "NO" (ESC, 4) button, the previous screen appears without resetting operation periods.

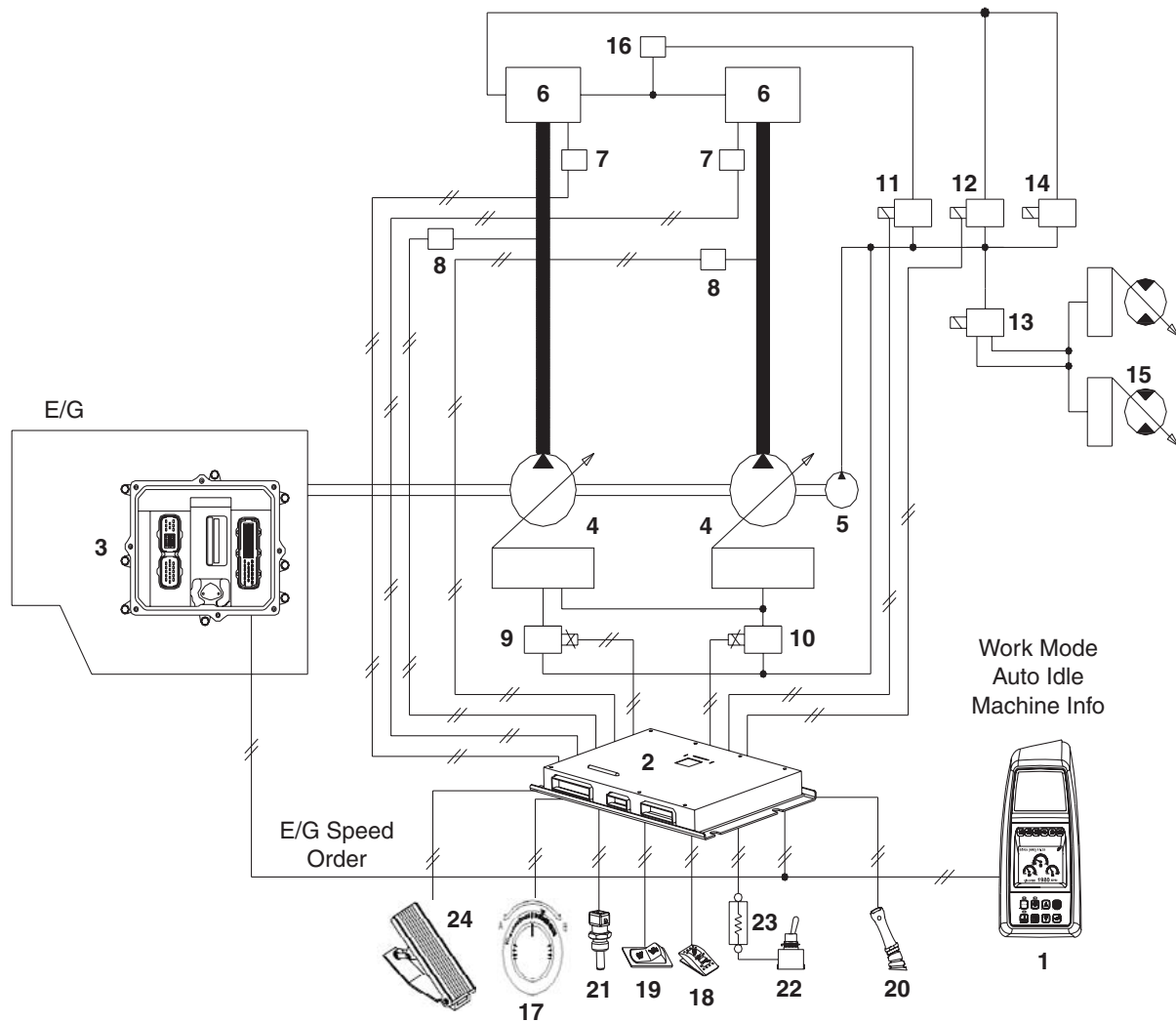


FG001086

Figure 48

ELECTRONIC HYDRAULIC CONTROL SYSTEM (e-EPOS)

Control System Schematic



FG007789

Figure 49

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
10	Electromagnetic Proportional Pressure Reducing Valve (Mode Control)
11	Solenoid Valve (Boost)
12	Solenoid Valve (Swing Priority)

Reference Number	Description
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	Work/Travel Selector Switch
20	Boost Switch (Right Work Lever)
21	Sensors
22	Aux Mode Switch
23	Aux Mode Resistance
24	Acceleration Pedal



Figure 50

Reference Number	Description
17	Engine Control Dial
19	Work/Travel Selector Switch
22	Aux Mode S/W
23	Aux Mode Resistance
24	Acceleration Pedal

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 because of the discharged oil volume being controlled based on the equivalent horsepower curve at various loaded pressures. The e-EPOS controller compares the target engine speed with the actual engine speed and controls the signal to the E.P.P.R. (Electromagnetic Proportional Pressure Reducing) valve which in turn varies the pump output quantity.

If the load increases, the engine speed will fall below the rated speed. When this occurs, the controller senses this decrease and immediately reduces the pump discharge volume to maintain the engine speed at the rated level.

On the other hand, if the load is decreased the controller increases the discharge volume of the pump to maintain the engine speed at the rated level.

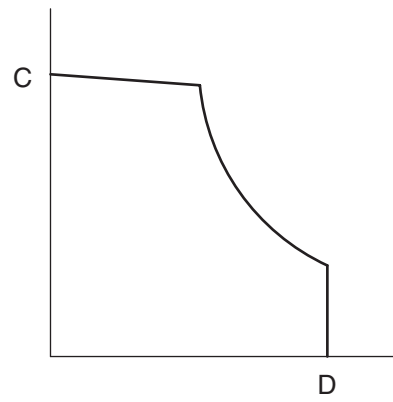
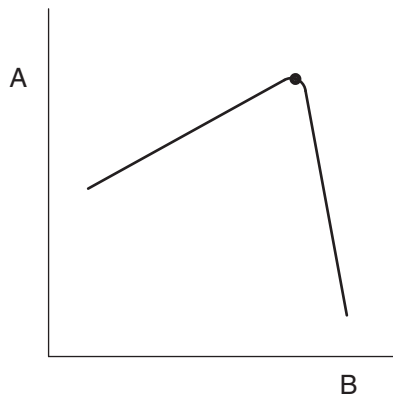
By repeating these control operations, the engine speed is maintained at the rated speed so maximum power can be generated.

In Power Mode, the e-EPOS controller receives engine speed signals from the engine control dial and the engine controller (ECU) and converts it to an operating signal current and is then transferred to the pump's E.P.P.R valve. Now the E.P.P.R. valve converts the electric signal to the corresponding control pressure and sends it to the two pumps, adjusting the pump discharge volume to the desired level.



Figure 51

ARO0260L



FG000580

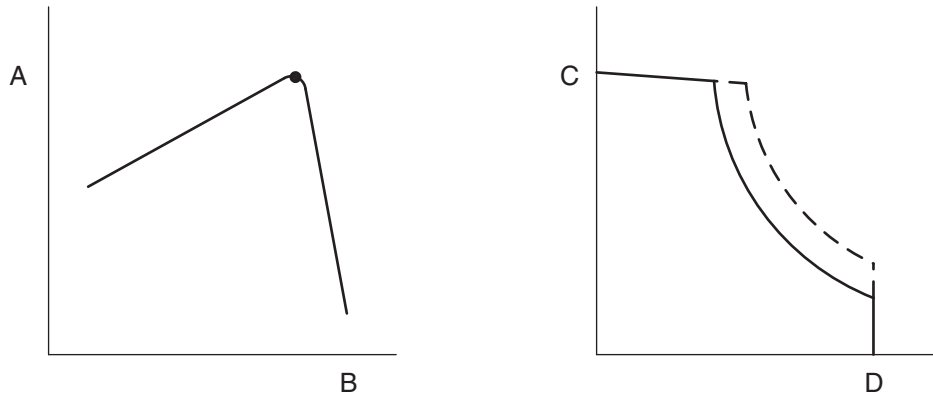
Figure 52

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.



FG000581

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)

3) Operation in case of failure in the control system (Aux mode operation)

Though it is impossible to control current of the E.P.P.R (Electromagnetic Proportional Pressure Reducing) Valve controlling the discharge volume of pump because of fault in control system, the machine can be operated in the aux mode.

Upon turning "ON" the aux mode switch, the E.P.P.R Valve controlling the discharge volume of pump comes into contact with the aux mode resistor to let current of a certain value flow. Now, the discharge volume of pump follow the control by the pump regulator, nearly at quantity roughly similar to that in the standard mode.

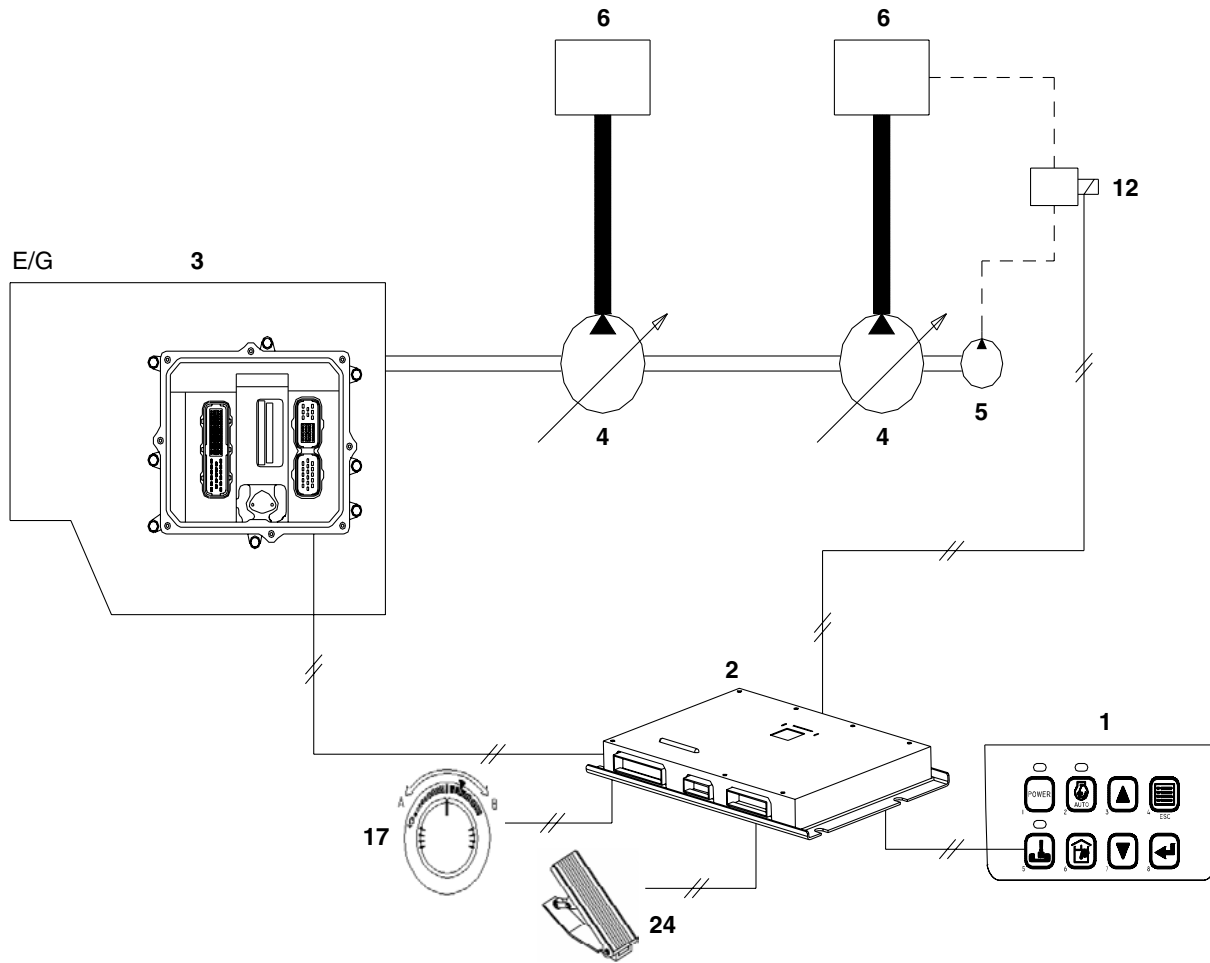


Figure 54

Reference Number	Description
1	Instrument Panel
2	e-EPOS Controller
3	Engine Controller
10	E.P.P.R. Valve (Electromagnetic Proportional Pressure Reducing) Valve
17	Engine Control Dial
19	Work/Travel Selector Switch

Reference Number	Description
22	Aux Mode S/W
23	Aux Mode Resistance
24	Acceleration Pedal
25	Battery
26	Battery Relay
27	Fuse
28	Fusible Link
29	Start S/W

WORK MODE CONTROL



FG007792

Figure 55

Reference Number	Description
1	Instrumental Panel (Trenching Mode S/W)
2	e-EPOS Controller
3	E/G Controller
4	Main Pump

Reference Number	Description
5	Aux Pump
6	Control Valve
12	Solenoid V/V (swing priority)
17	Engine Control Dial
24	Acceleration Pedal

Depending on the working condition, one of two work modes, "DIGGING" or "TRENCHING" can be selected from the instrumental 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.

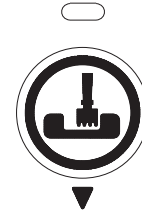
Operation

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 56

WORK MODE CONTROL - CIRCUIT DIAGRAM

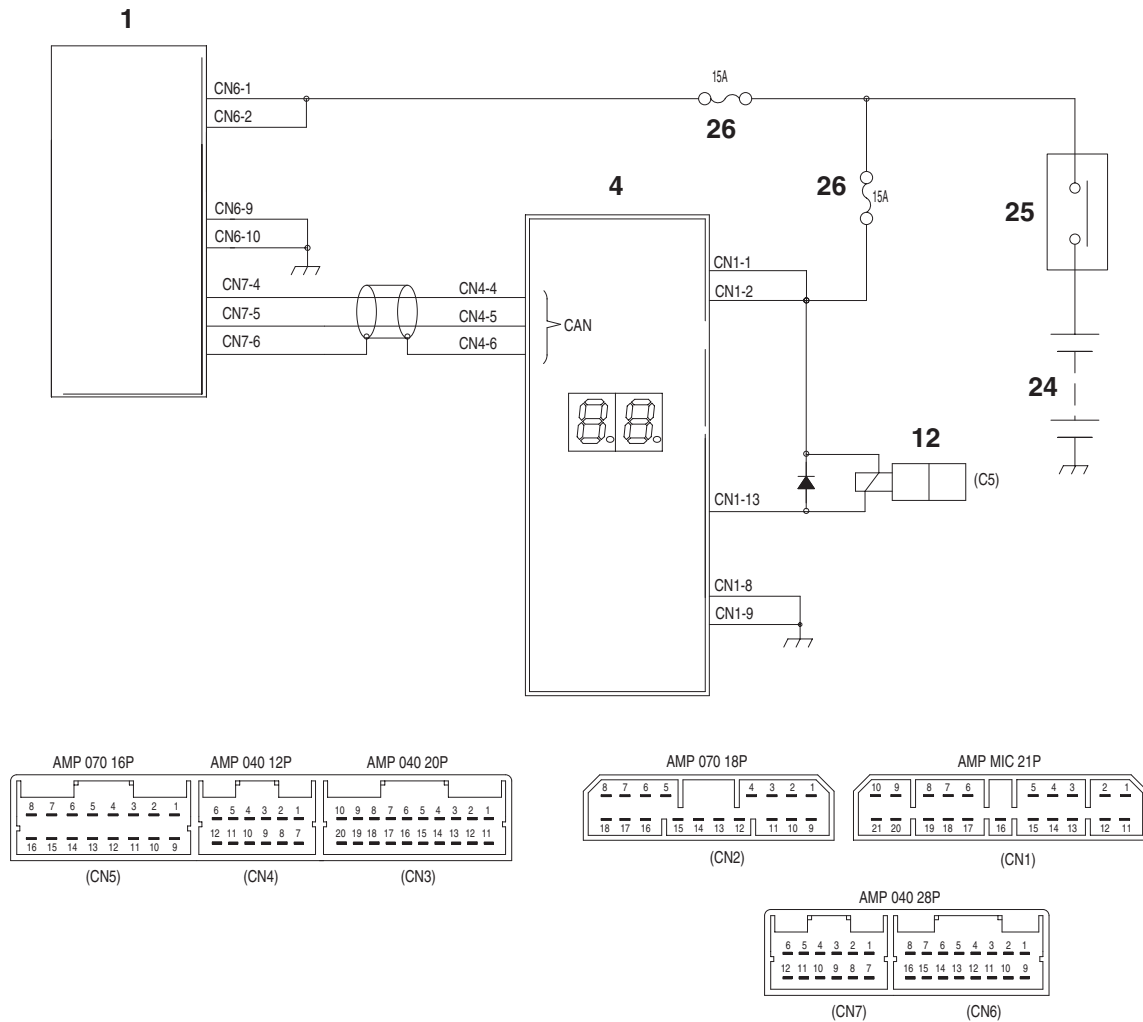


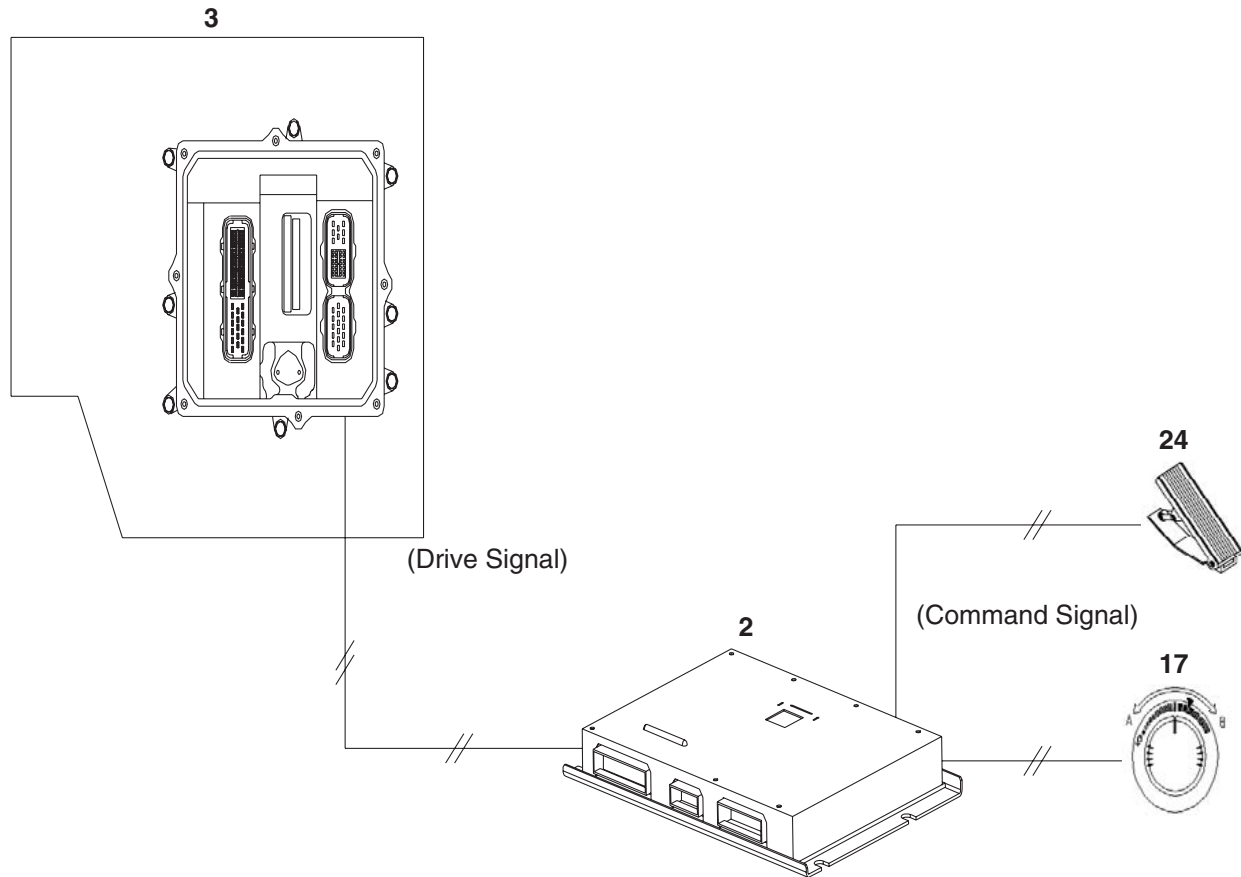
Figure 57

FG000583

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



FG007793

Figure 58

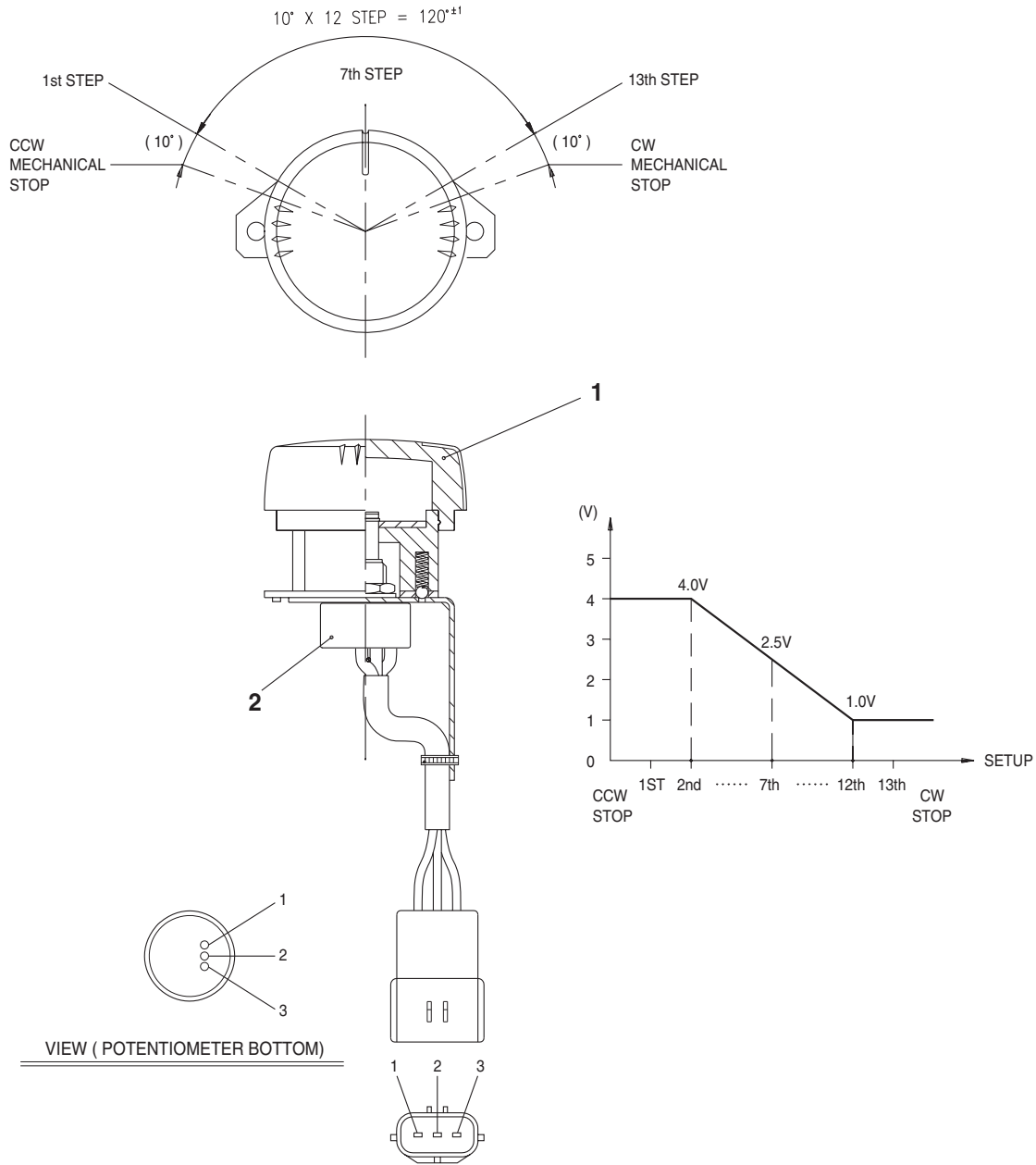
Reference Number	Description
2	e-EPOS Controller
3	Engine Controller

Reference Number	Description
17	Engine Control Dial
24	Acceleration Pedal

When the engine control dial is moved the output voltage changes according to the dial position.

The e-EPOS controller converts this output voltage of dial to digital signal and sends it to the engine controller by CAN line. According to the dial command, the quantity of fuel injection is adjusted.

ENGINE CONTROL DIAL



FG000866

Figure 59

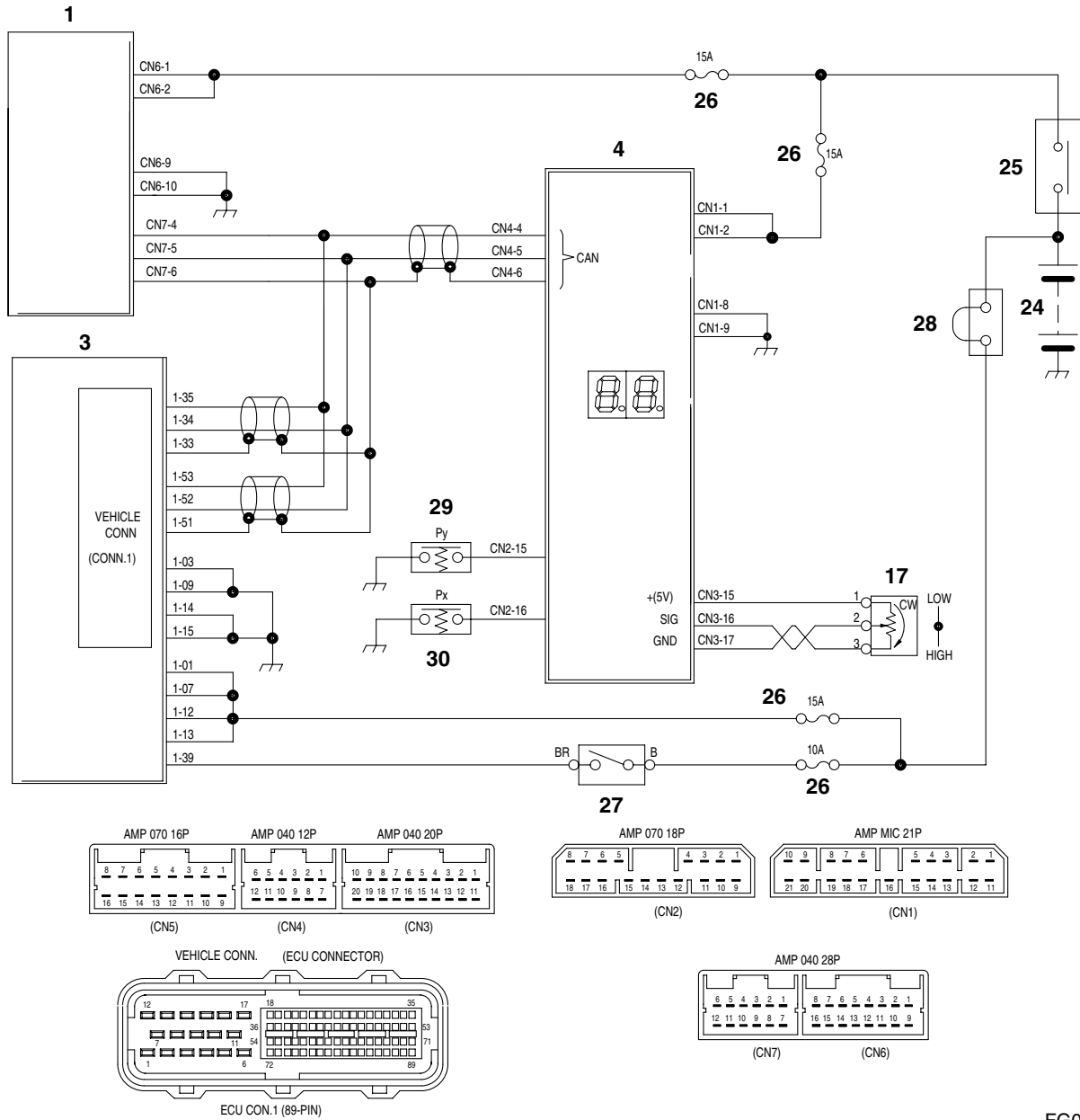
Reference Number	Description
1	Knob
2	Potentiometer (Variable Resistor)

The engine control dial has a built in potentiometer. When the control knob is moved the output voltage (through "2 and 3" terminals) will vary from the 5 V supplied from the e-EPOS controller as shown in the graph.



The acceleration pedal has a built in potentiometer. When the acceleration pedal is pressed output voltage (through "2 and 1" terminals) will vary from the 5V supplied from the e-EPOS controller as shown in the graph.

ENGINE CONTROL CIRCUIT DIAGRAM



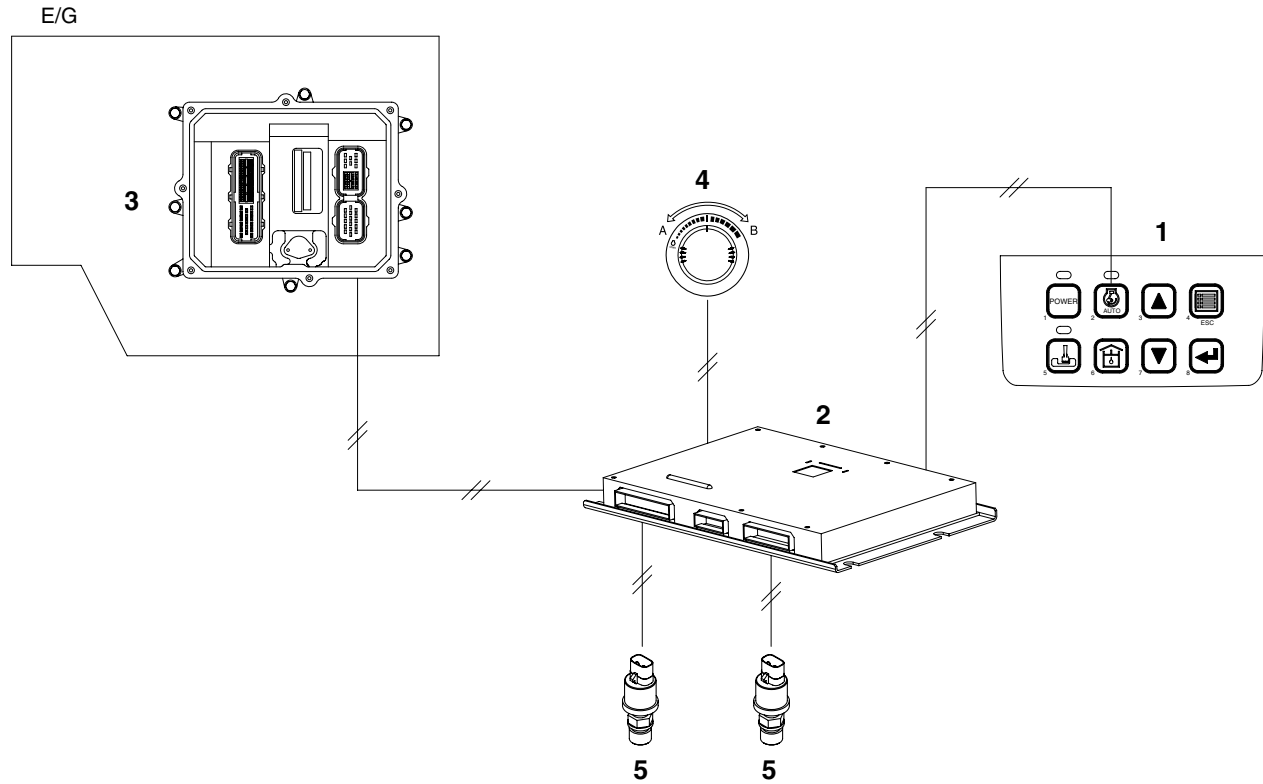
FG009234

Figure 61

Reference Number	Description
1	Instrumental Panel
3	Engine Controller
4	e-EPOS Controller
17	Engine Control Dial
24	Acceleration Pedal
25	Battery

Reference Number	Description
26	Battery Relay
27	Fuse
28	Start S/W
29	Fusible Link
30	Pressure S/W (Py)
31	Pressure S/W (Px)

AUTOMATIC DECELERATION CONTROL (AUTO IDLE CONTROL)



FG000798

Figure 62

Reference Number	Description
1	Instrument Panel (Auto Idle Switch)
2	e-EPOS Controller
3	Engine Controller

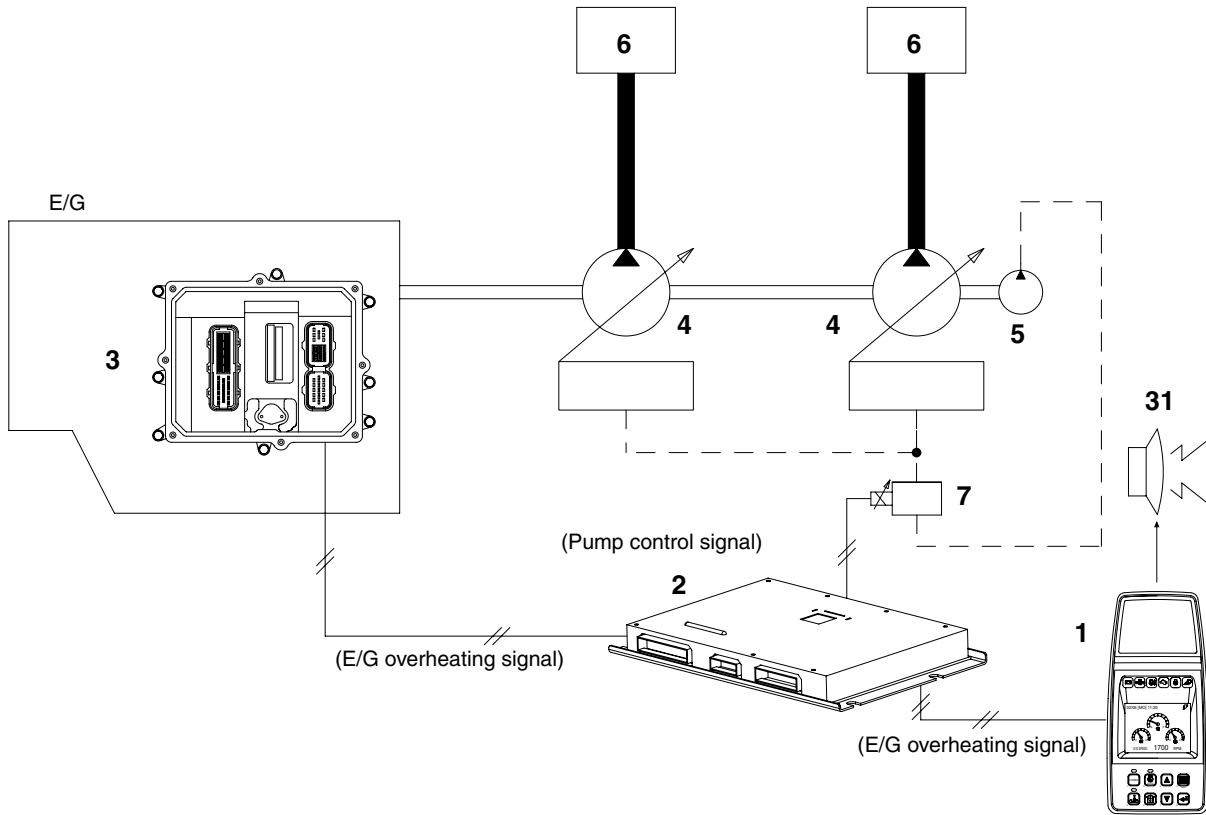
Reference Number	Description
4	Engine Control Dial
5	Pressure Switch

If the machine is idling without the controls being operated or is waiting for a dump truck the engine speed is automatically lowered. Once the controls are operated and work is being started the machine will be restored to the previous settings. As a result, noise and fuel consumption will be reduced. This function can be selected or canceled through the Auto Idle Selector Switch on the instrument panel.

The initial setting at start-up is with this switch in the select position. Approximately 4 seconds after this function is selected, if all work levers are in the neutral position, the e-EPOS controller compares the automatic reduction signal with the signal set by engine control dial. The lower of the two signals is selected, the e-EPOS controller sends a signal to the engine controller to control the engine speed.

The neutral status of the machine is detected by the two pressure switches in the control valve. When the work levers are in the neutral position, the switch is in the "OFF" position.

ENGINE OVERHEAT PROTECTION SYSTEM



FG000802

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
7	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

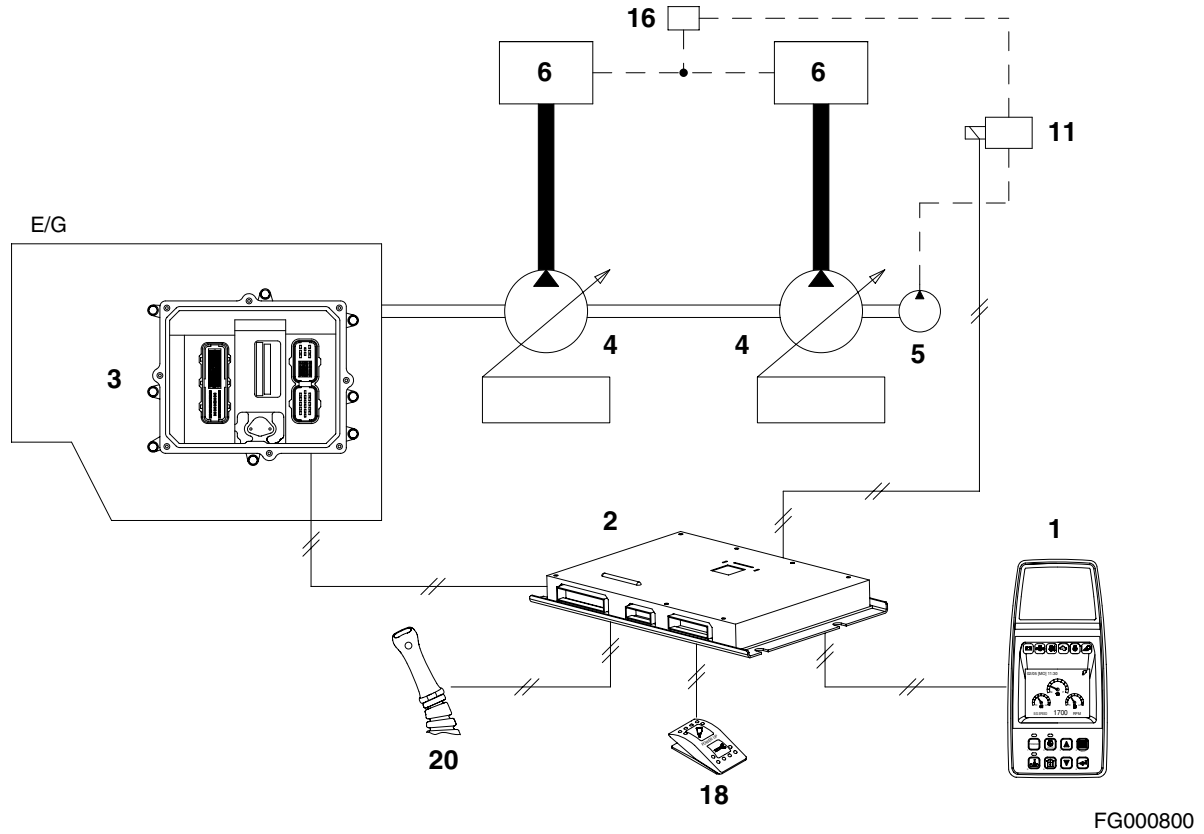


Figure 64

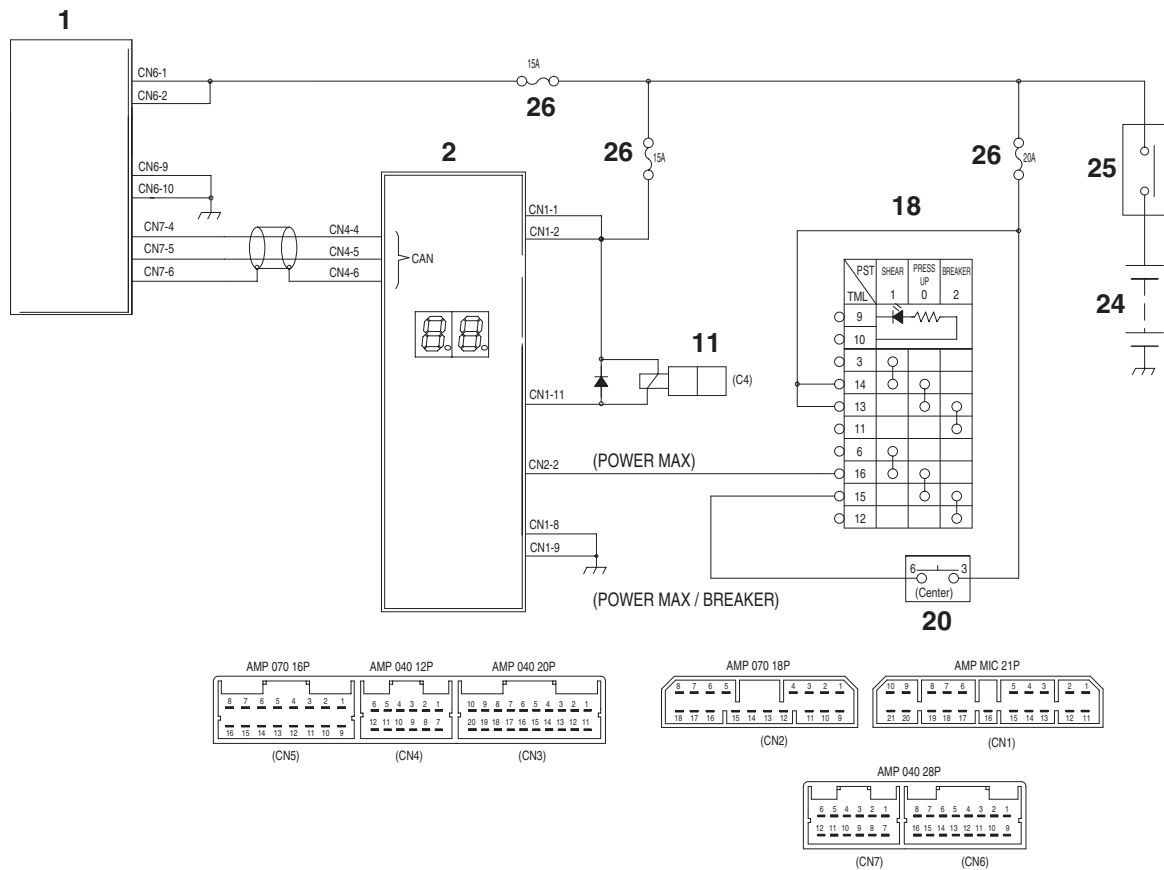
Reference Number	Description
1	Instrument Panel
2	e-EPOS Controller
3	Engine Controller
4	Main Pump
5	Aux Pump
6	Control Valve

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•cm² (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.

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

CRUISE CONTROL

Operation

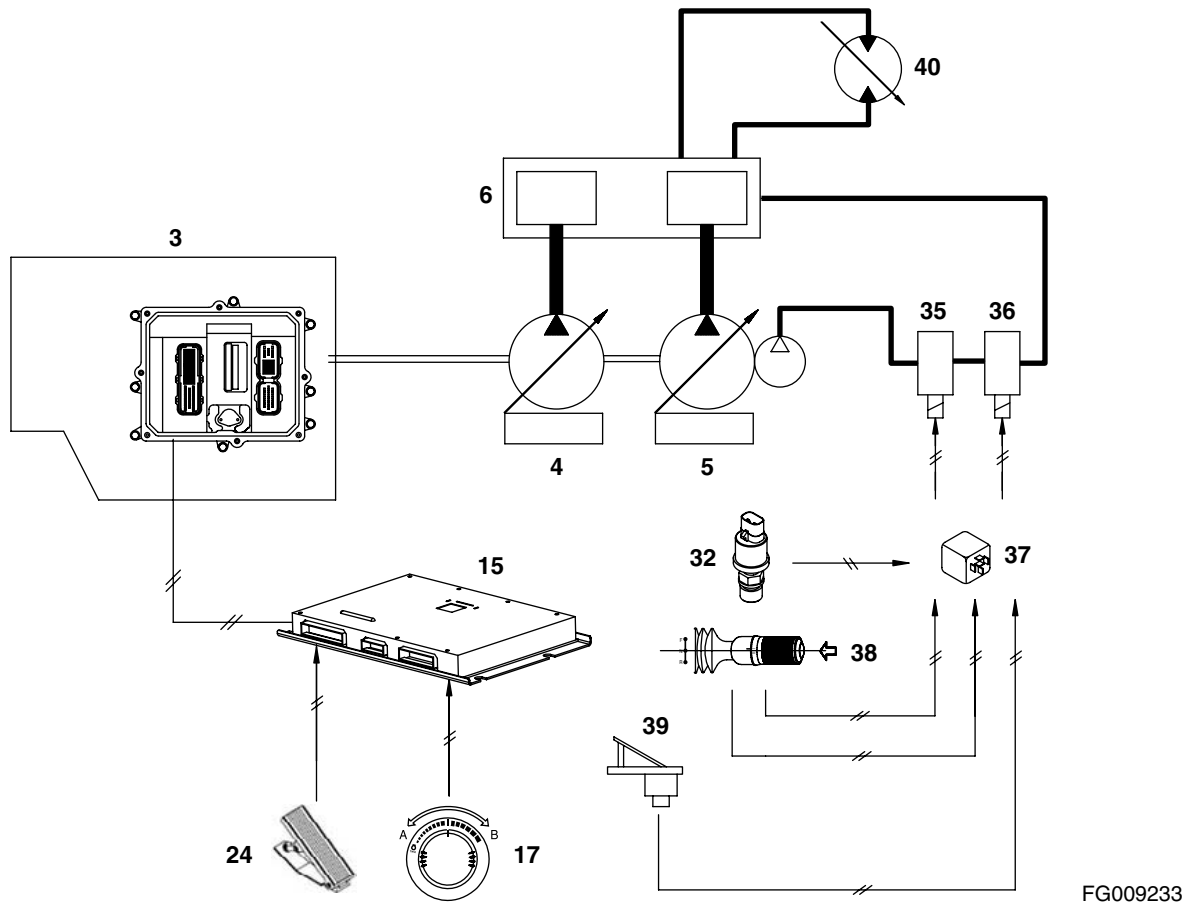


Figure 66

Cruise control is used for reducing operator's fatigue during long travel distances.

1. Run Method

Forward/reverse lever is placed at forward position (F), although accelerator pedal is not stepped on, the unit can travel. Now, faster or slower travel speed can be obtained by adjusting the engine speed control dial. When engine speed control dial is adjusted to desired speed, the unit will travel at a constant speed. If there is a change in the load, a change of travel speed can occur. When the forward/reverse lever is placed in reverse position, this function will be not operated.

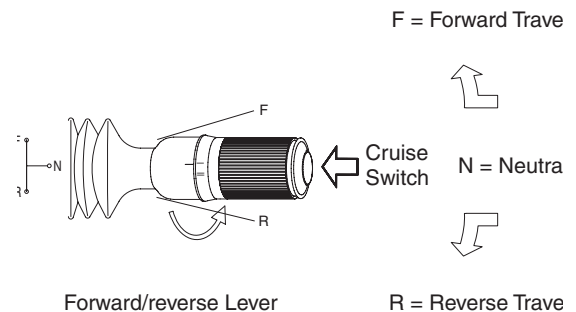


Figure 67

BCS08111

2. Cancel

When the brake is applied the cruise control will be canceled.

Bring the forward/reverse lever back to neutral (N), will also cancel the cruise control.

If the engine is running at an excessive rpm when the cruise control is canceled, reduce the engine rpm setting.

NOTE: *If the auto idle is "ON" when the cruise control is canceled, the engine will return to idle in approximately four seconds. When the cruise control is turned back "ON" the engine will return to the rpm setting control by the engine speed control dial.*

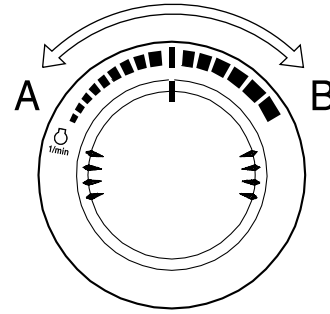


Figure 68

HAOA690L

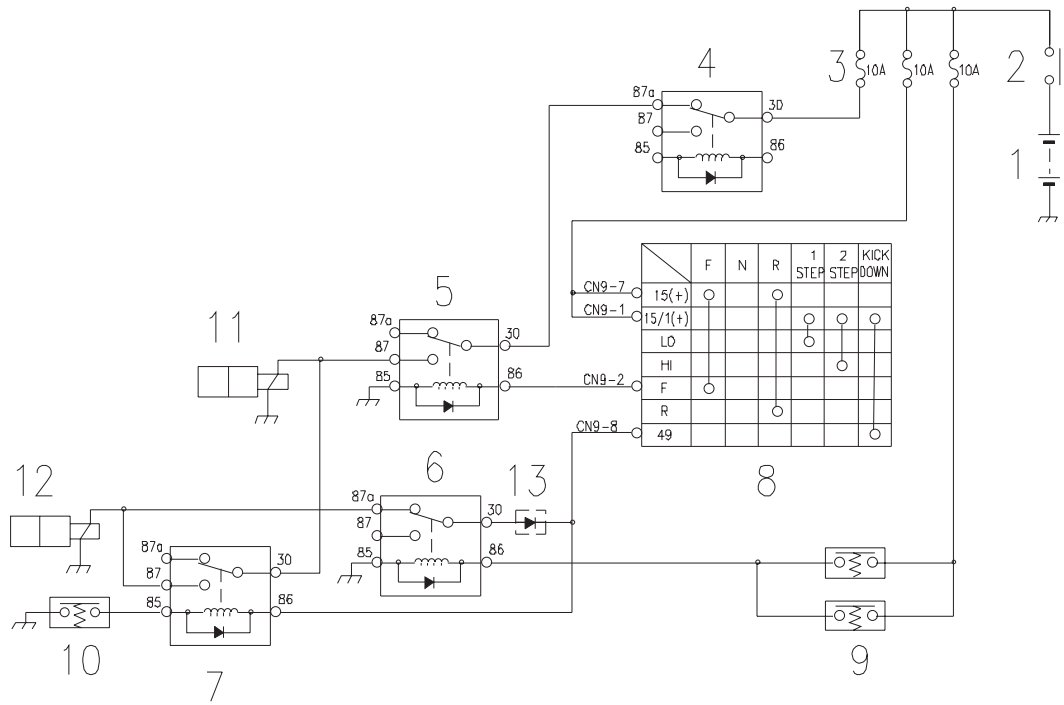
3. Cruise Operation

Division	Run	Cancel
Condition	1. Forward/reverse lever is placed in FORWARD. 2. Accelerator pedal is stepped ON. 3. Cruise switch turns "ON."	1. When the brake is applied. 2. Forward/reverse lever is placed in NEUTRAL or REVERSE.
Forward Relay	Operation	Cancel
Forward Solenoid Valve	Operation	Cancel
Cruise Relay (1)	Operation	Cancel
Cruise Relay (2)	Cancel	Operation
Cruise Solenoid Valve	Operation	Cancel
Speed Control	Engine Speed Control Dial	Accelerator Pedal

Reference Number	Description
3	Engine Controller (ECU)
4	Main Pump
5	Aux Pump
6	Control Valve
15	e-EPOS Controller
17	Engine Control Dial
24	Acceleration Pedal

Reference Number	Description
32	Pressure Switch (Py)
35	Cruise Solenoid Valve
36	Forward Solenoid Valve
37	Pilot Relay
38	Cruise Switch
39	Brake Pedal
40	Travel Motor

Cruise Control Circuit



BCS0700L

Figure 69

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse
4	Pilot Relay
5	Forward Run Relay
6	Cruise Relay (2)

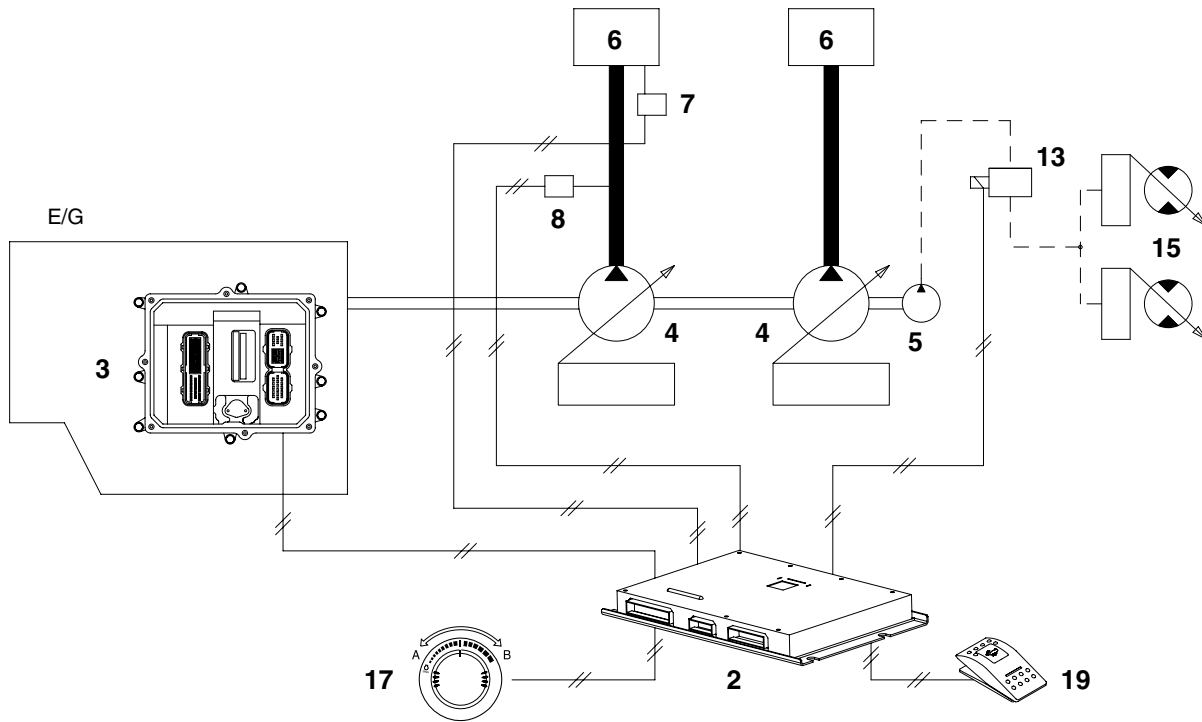
Reference Number	Description
7	Cruise Relay (1)
8	Forward/Reverse Lever Switch
9	Brake Light Switch
10	Pressure Switch
11	Forward Run Solenoid Valve
12	Cruise Solenoid Valve

If the cruise switch is turned on during the forward run, the "15/1 (+)" and "49" terminals of the travel speed control switch are connected. Now the current flows from the battery (1) → battery relay (2) → fuse box (3) → "15/1" (+) and "49" terminals of the travel speed control switch (8) → "86" and "85" terminals of cruise relay 1 (7) → pressure switch (10) → ground. The other side, the current flows from the fuse box (3) → "30" and "87a" terminals of pilot relay (4) → "30" and "87" terminals of forward run relay (5) → "30" and "87" of cruise relay 1 (7) → cruise solenoid valve (12) and the machine runs as a cruise state. Also the cruise relay 1 (7) is activated by the current flows from the "87a" and "30" terminals of cruise relay 2 (6) → diode (13) and it makes self - activated circuit.

If the forward/reverse lever (8) is place in neutral or reverse position during the cruise, the forward run relay will be deactivated and cruise function will be canceled.

Also if the brake pedal is pressed, the brake light switch (9) will be turned "ON." Now, the cruise relay (6) will be activated and the cruise relay 1 (7) will be deactivated. So cruise function will be canceled.

AUTOMATIC TRAVEL SPEED CONTROL



FG000799

Figure 70

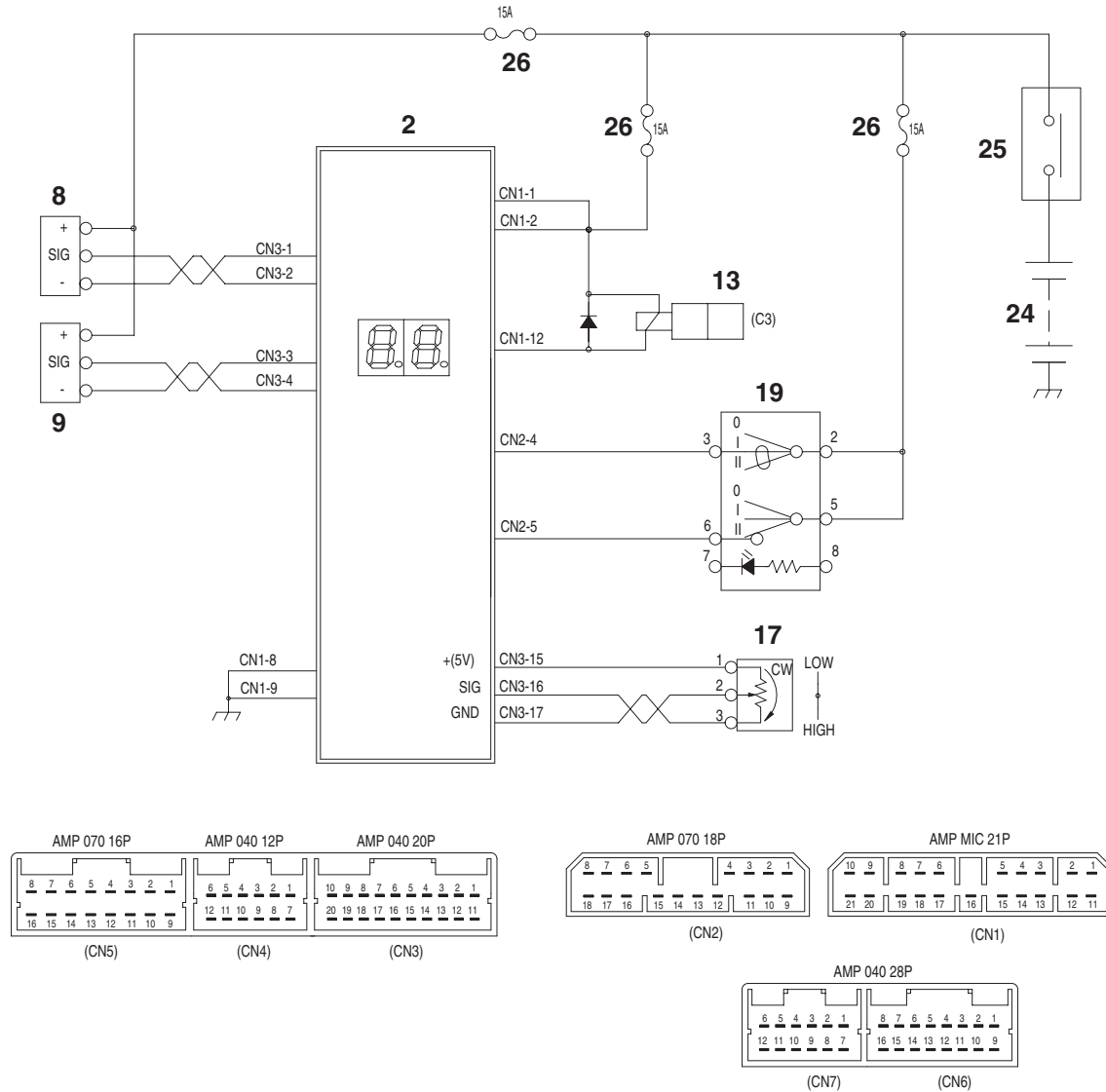
Reference Number	Description
2	e-EPOS Controller
3	Engine Controller
4	Main Pump
5	Aux Pump
6	Control Valve
7	Pressure Switch (Py Port)

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 $300 \text{ kg}\cdot\text{cm}^2$ (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 $160 \text{ kg}\cdot\text{cm}^2$ (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 71

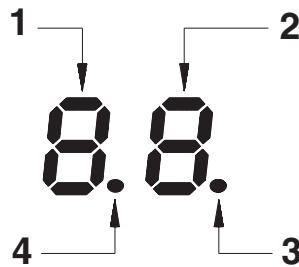
Reference Number	Description
2	e-EPOS Controller
8	Pressure Sensor (Front Pump)
9	Pressure Sensor (Rear Pump)
13	Solenoid Valve (High-speed)
17	Engine Control Dial

Reference Number	Description
19	Selector Switch For Automatic Travel
24	Battery
25	Battery Relay
26	Fuse

SELF-DIAGNOSTIC FUNCTION

e-EPOS Controller

The system operation status and malfunction codes can be checked through the display on top of the e-EPOS controller box the rear cover behind the operator's seat.



FG000588

Figure 72

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	9 HAOH340L		Normal Operation Power Mode
	Standard Mode	7 HAOH350L		Normal Operation Standard Mode
Work Mode	Digging		0 HAOH370L	Normal Operation Digging Mode
	Trenching		2 HAOH380L	Normal Operation Trenching Mode

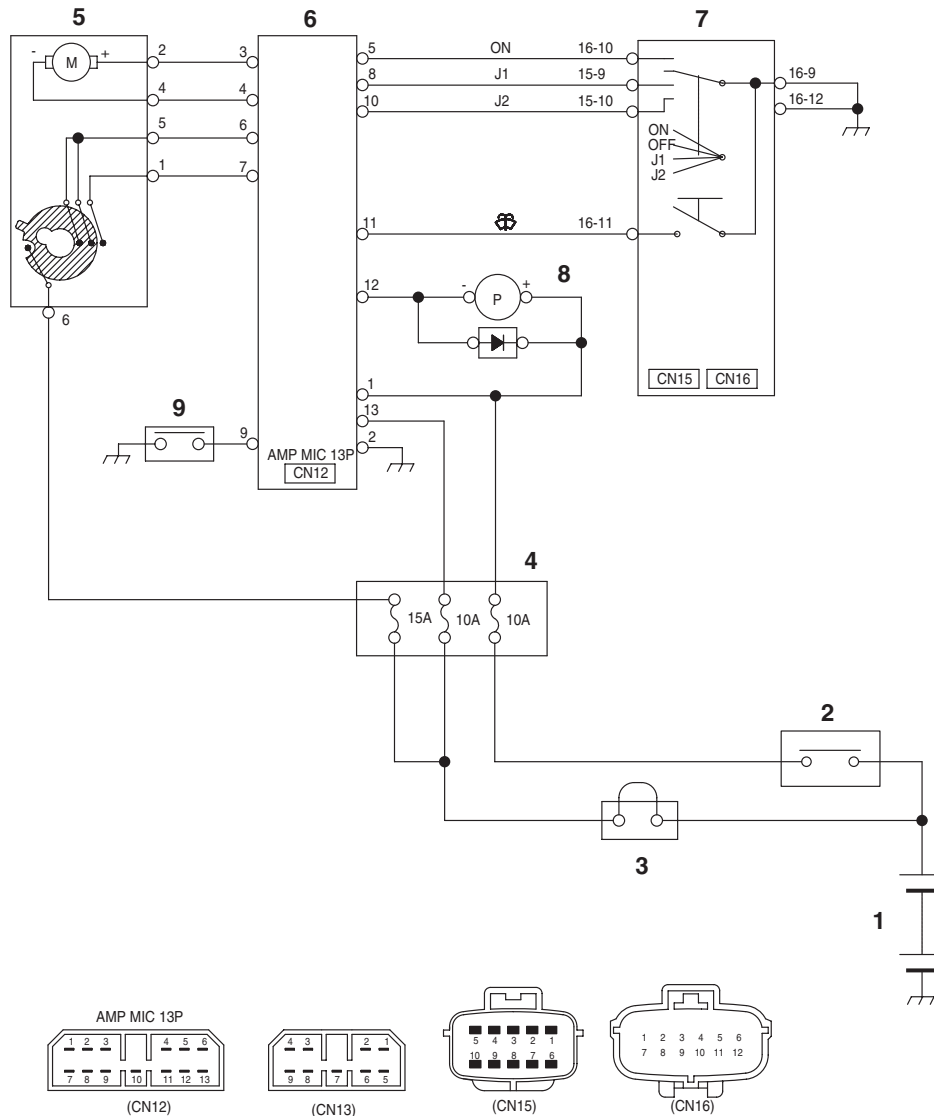
4. Communication Monitor

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.

WIPER SYSTEM

Wiper Circuit



FG004677

Figure 73

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Fuse Box
5	Wiper Motor

Reference Number	Description
6	Wiper Controller
7	Combination Switch (Wiper and Washer)
8	Window Washer
9	Wiper Cutoff 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 $5.5 \pm 0.5V$) to LOW ($0+0.5V$) and current flows by way of the "3" terminal of the wiper controller (6) → the "2" and "4" terminals of the wiper motor (5) → the "4" terminal of the wiper controller (6) to run the wiper motor (5) continuously.

- Stop of wiper motor

Pressing again the successive operation switch on the wiper switch panel (7) changes the voltage of the "5" terminal of the wiper controller (6) from LOW ($0+0.5V$) to HIGH (about $5.5 \pm 0.5V$). As the "5" and "6" terminals of the wiper motor are connected still that power is supplied to the "6" terminal of the wiper controller (6),

However, the controller (6) runs the wiper motor continuously and then rotates the motor reversely by "letting current flow by way of the "4" terminal of the wiper controller (6) → the "2" and "4" terminals of the wiper motor (5) → the "3" terminal of the wiper controller (6) when the "1" and "6" terminals of the 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 $5.5 \pm 0.5V$) 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 $5.5 \pm 0.5V$) 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.

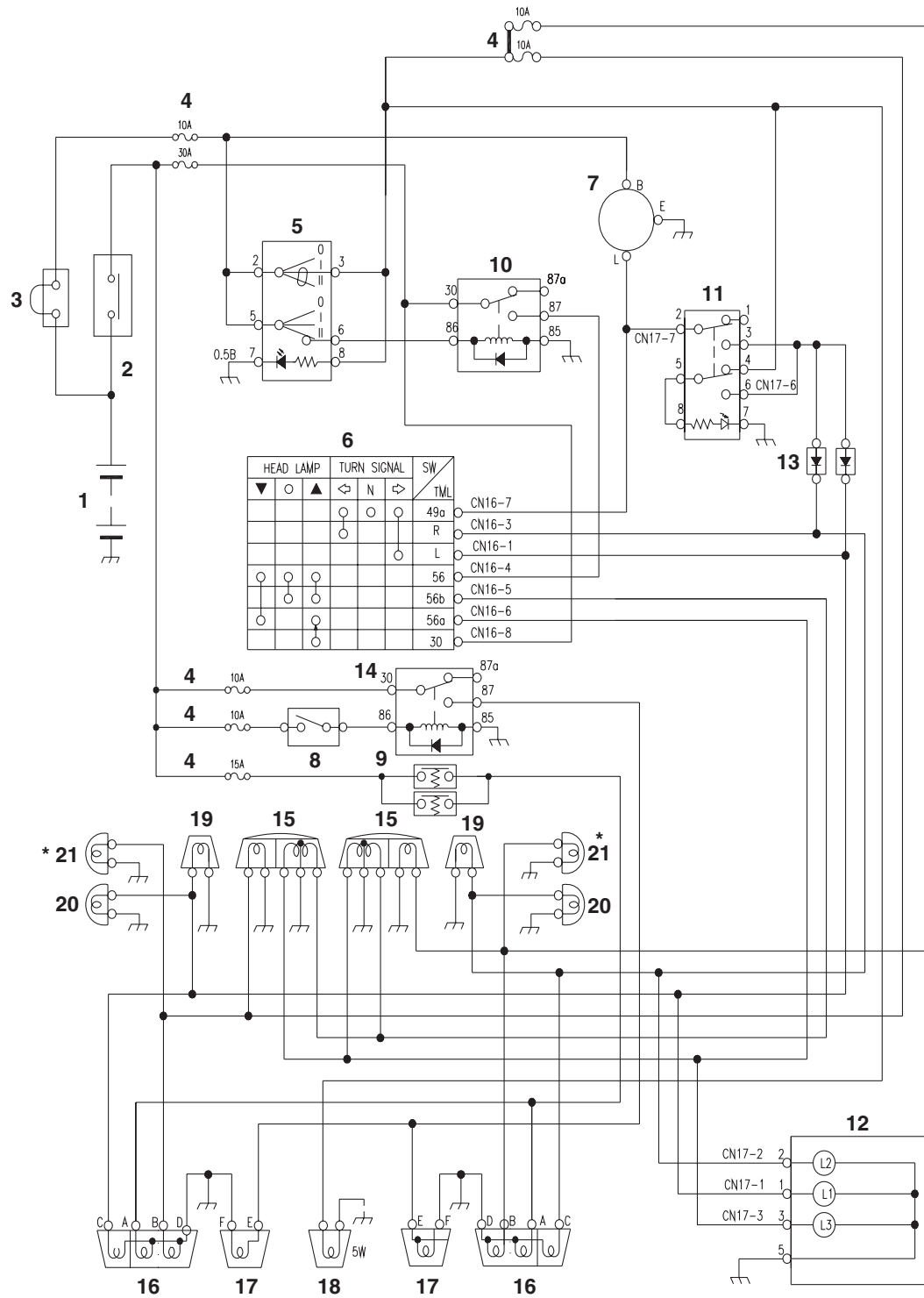
- Stopping the intermittent action

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



FG007795

Figure 74

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Fuse
5	Light Switch
6	Combination Switch
7	Flasher Unit
8	Reverse Switch
9	Stoplight Pressure SW
10	Headlight Relay
11	Hazard Switch

Reference Number	Description
12	Console
13	Diode
14	Reverse Relay
15	Headlight
16	Rear Combination Light
17	Backup Light
18	Registration Plate Light
19	Front Turn Signal Light
20	Side Turn Signal Light
21	Arm Position Light

NOTE: * indicates optional items.

Type

Lighting system consists of headlight, work lights, cabin light (optional), and S/W devices and relays to control them.

Operation

Switch	Position	Connected Terminal of Switch	Activated Relay/ Operated Switch	Lit Light
Light Switch (5)	1st	"2-3" Terminals	-	Illumination Light of Switch/ Position Light of Headlight/ Position Light of Rear Combination Light Position Light of Arm
	2nd	"2-3" Terminals	-	"
		"5-6" Terminals	Headlight Relay (10)	Low Beam of Headlight (2 Ea.)
Combination Switch (6)	▼	"56-56b" Terminals	Operated Light Switch (2nd)	Low Beam of Headlight (2 Ea.)
	▲	"56-56a" Terminals	Operated Light Switch (2nd)	High Beam of Headlight (2 Ea.)
	▲	"30-56a" Terminals	-	High Beam of Headlight (2 Ea.)
	◀	"49a-L" Terminals	-	Front Turn Signal Light (LH) Side Turn Signal Light (LH) Rear Combination Light (LH)
	▶	"49a-R" Terminals	-	Front Turn Signal Light (RH) Side Turn Signal Light (RH) Rear Combination Light (RH)

Switch	Position	Connected Terminal of Switch	Activated Relay/ Operated Switch	Lit Light
Transmission Switch (Reverse Position) (8)	ON	(+) - R Terminals	Reverse Relay	Back up Light (2 Ea.)
Stoplight Switch (9)	ON	ON	-	Stoplight of Rear Combination Light (2 Ea.)

OVERLOAD WARNING DEVICE

Overload Warning Device Circuit Diagram

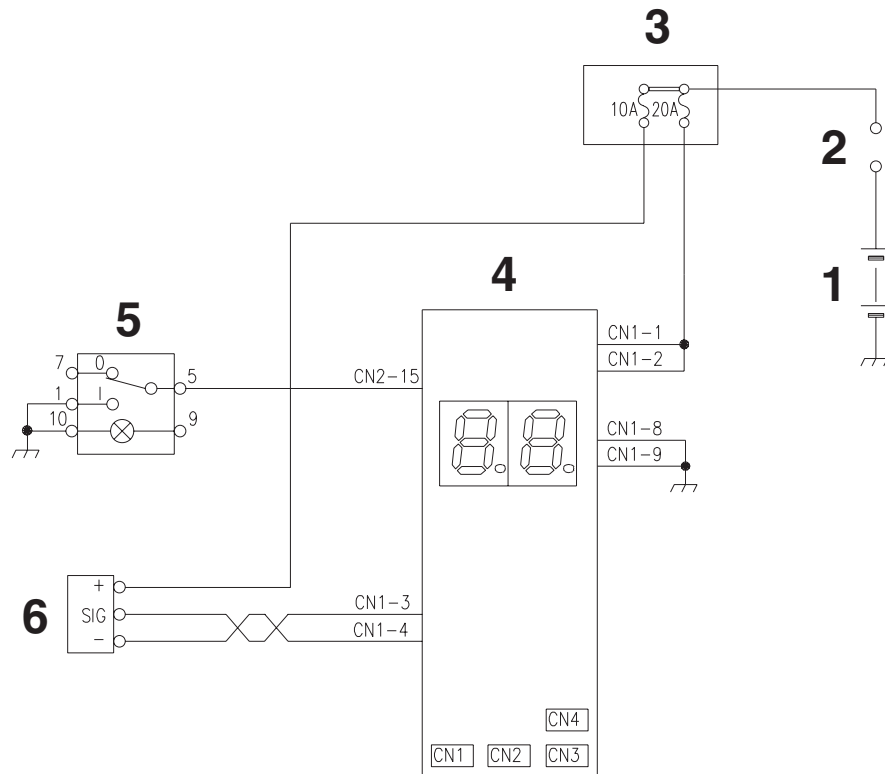


Figure 75

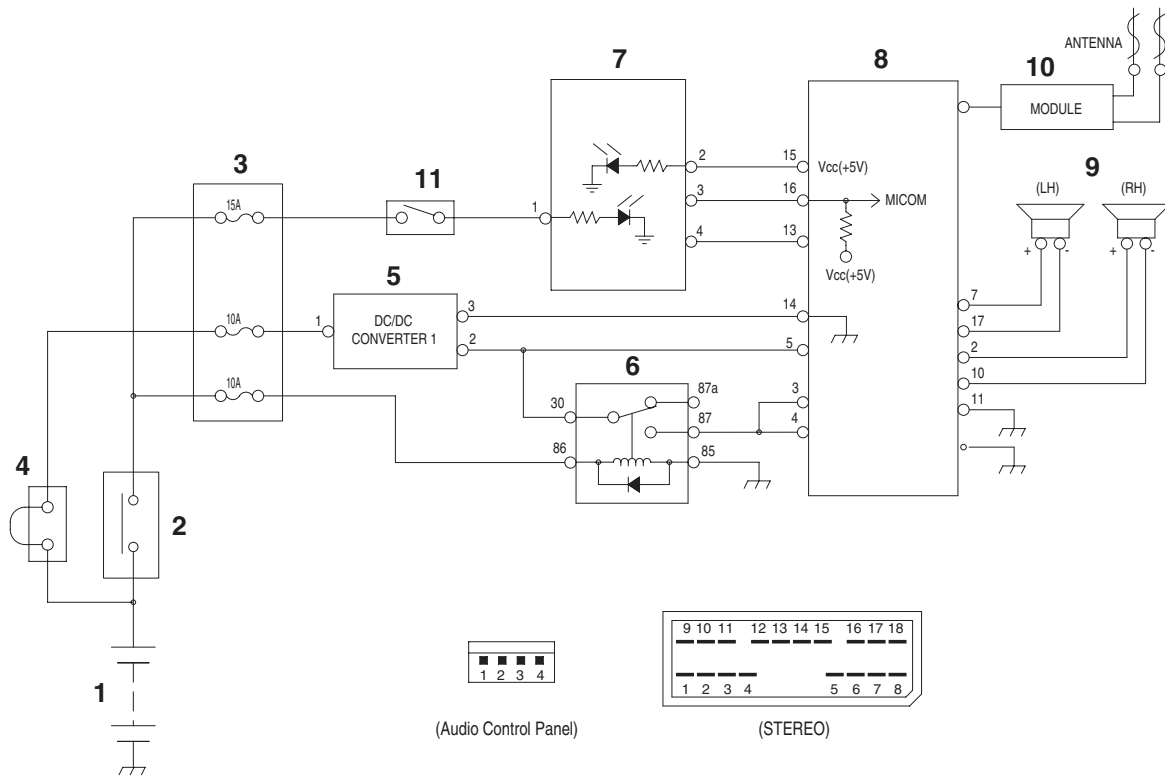
Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse Box

Reference Number	Description
4	e-EPOS Controller
5	OWD Selector Switch
6	Pressure Sensor

ARS1260L

AUDIO CONTROLLER

Audio Controller Circuit Diagram



FG000591

Figure 76

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 $\pm$ 0.2V	Stereo ON, OFF
▲		1.24 $\pm$ 0.2V	Volume up
▼		0+0.2V	Volume down
SCAN		2.49 $\pm$ 0.2V	Frequency selection

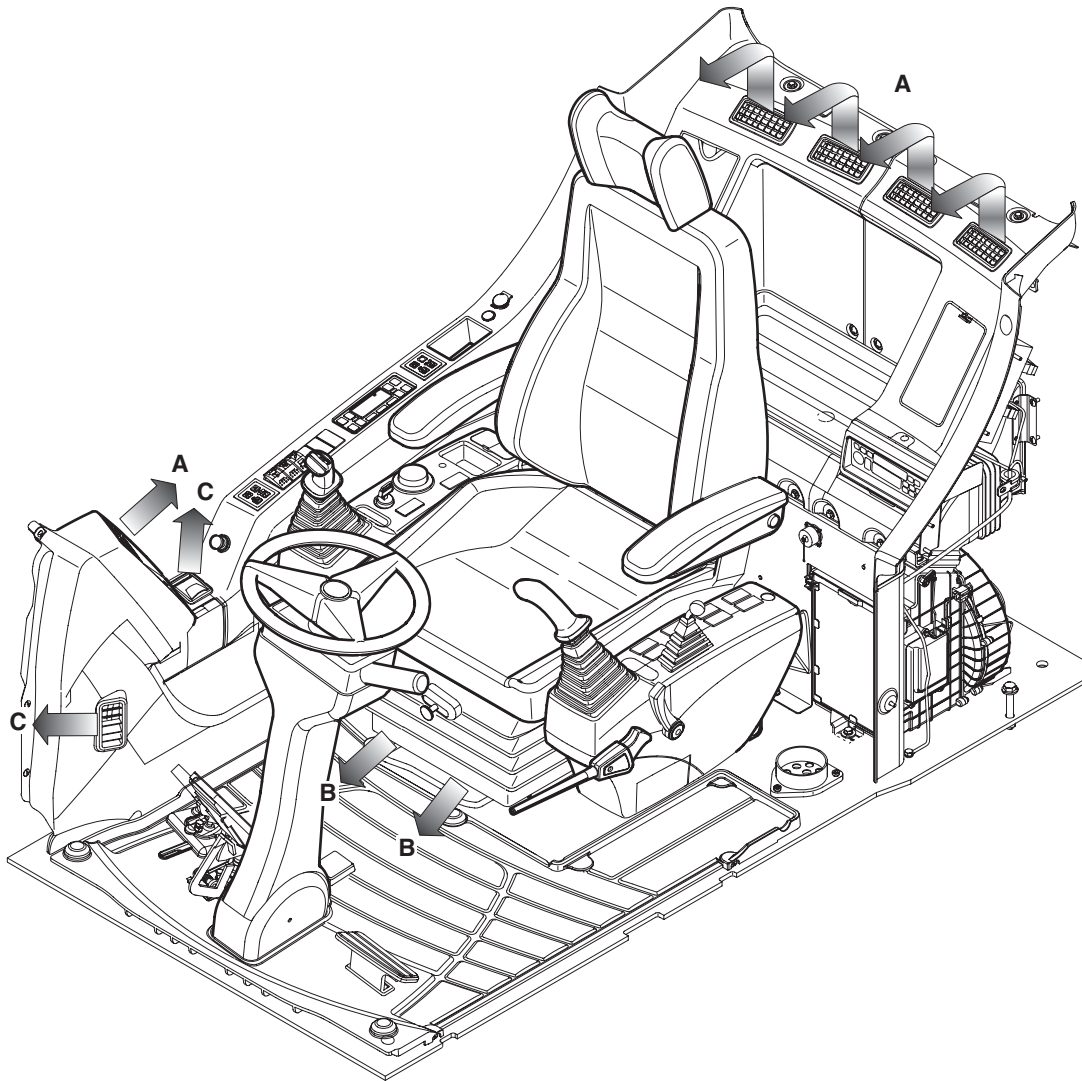
Operation

Input					Output		Remark
Parking Brake Switch (4)	Work/Travel Switch (7)	Ram Lock Switch (13)	Ram Lock Pressure Switch (10)	Combination Switch (F/R) (6)	Ram Lock Solenoid Valve (11)	Console (Ram Lock Light) (12)	
"2-3" Terminals (Parking)	-				Lock (OFF)	ON	
	"2-1" Terminals (Travel)	"2-1" Terminals (Lock)	-	-	Lock (OFF)	ON	
		"2-3" Terminals (Release)	-	-	Release (ON)	OFF	
	"2-3" Terminals (Work)	"2-1" Terminals (Lock)	OFF (below 47 bar)	-	Lock (OFF)	ON	
		"2-3" Terminals (Release)		-	Release (ON)	OFF	
		-	ON (above 47 bar)	OFF	Lock (OFF)	ON	
		"2-1" Terminals (Lock)		ON	Lock (OFF)	ON	
		"2-3" Terminals (Release)		ON	Release (ON)	OFF	

NOTE: "-" is don't-care condition.

AIR CONDITIONER SYSTEM

Outline



FG004504

Figure 78

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

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

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

Vent mode selects the direction of discharged air.

Outlets by vent modes

Modes					
Outlets	A	A+B	B	B+C	C

Internal and External Filters

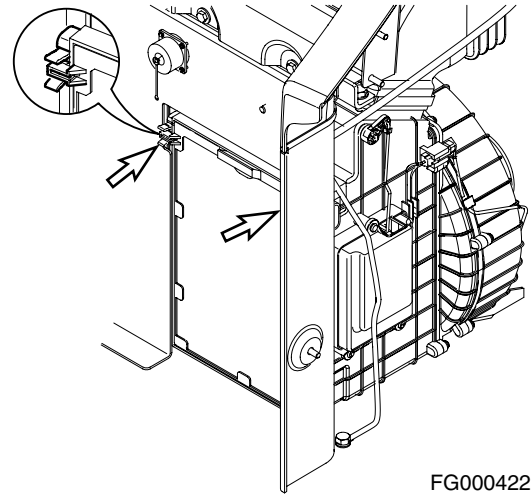
Internal and external air purification filters are installed for the driver's room.

Filters 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 Indoor air filter

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

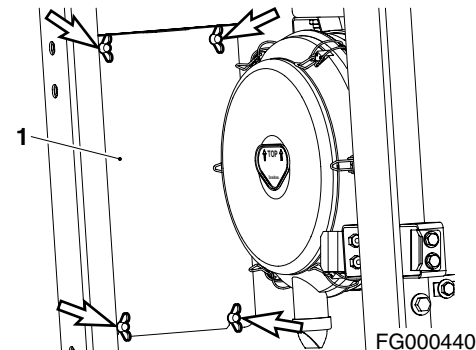


FG000422

Figure 79

How to check outdoor air filter

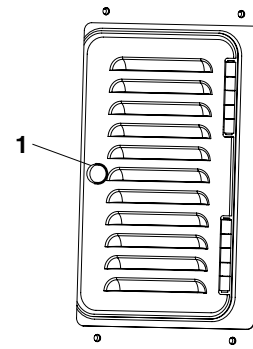
1. Open the front door at the left side of machine and loosen four marked bolts to remove cover (1, Figure 80).



FG000440

Figure 80

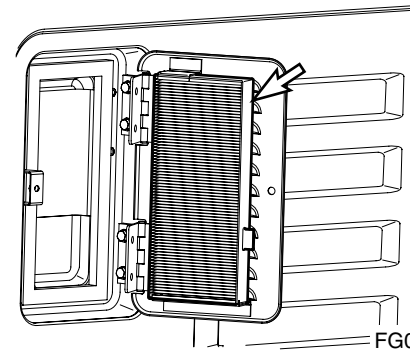
2. Turn marked knobs (1, Figure 81) at the rear side of the cabin to open the cover.



FG000441

Figure 81

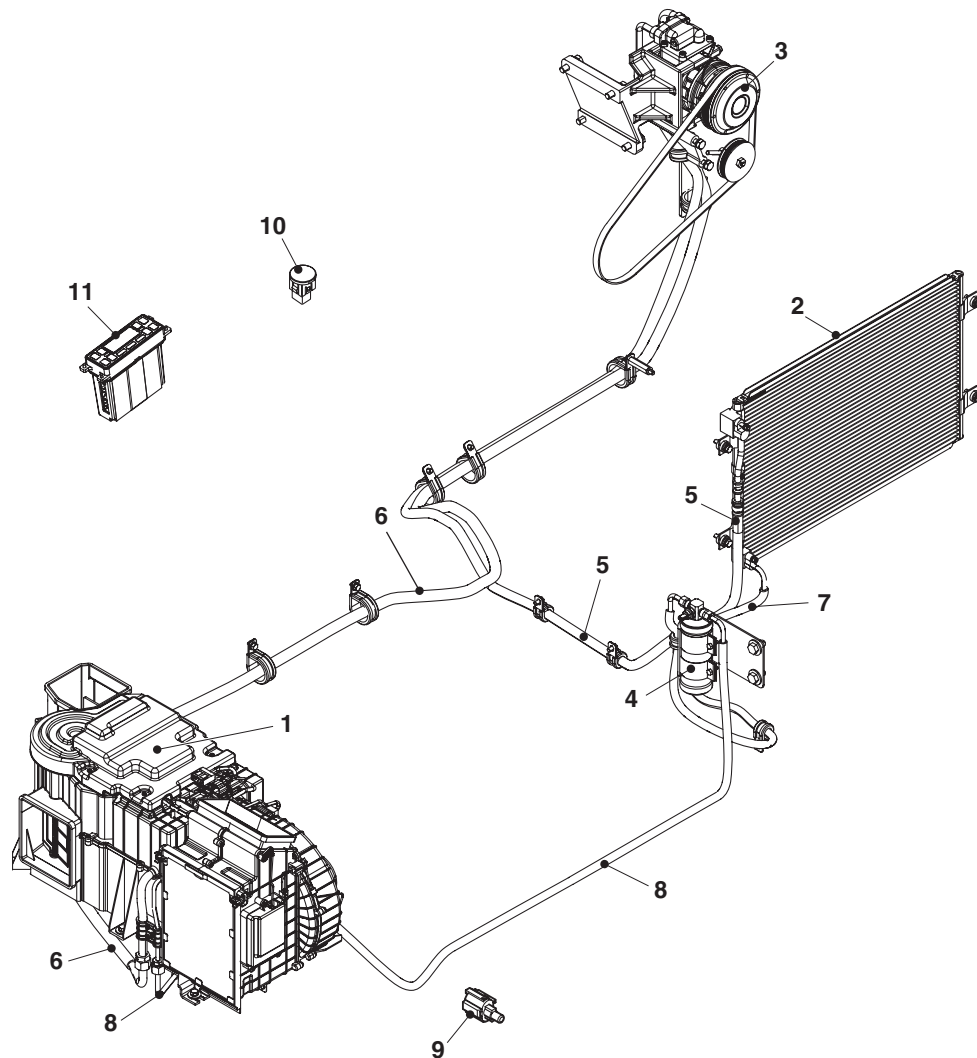
3. Remove filter attached to the cover and clean the contaminated filter using compressed air.
4. Close the cover, replace the knobs, and secure the cover to the support with butterfly bolts.



FG000342

Figure 82

Air-Conditioning System Layout



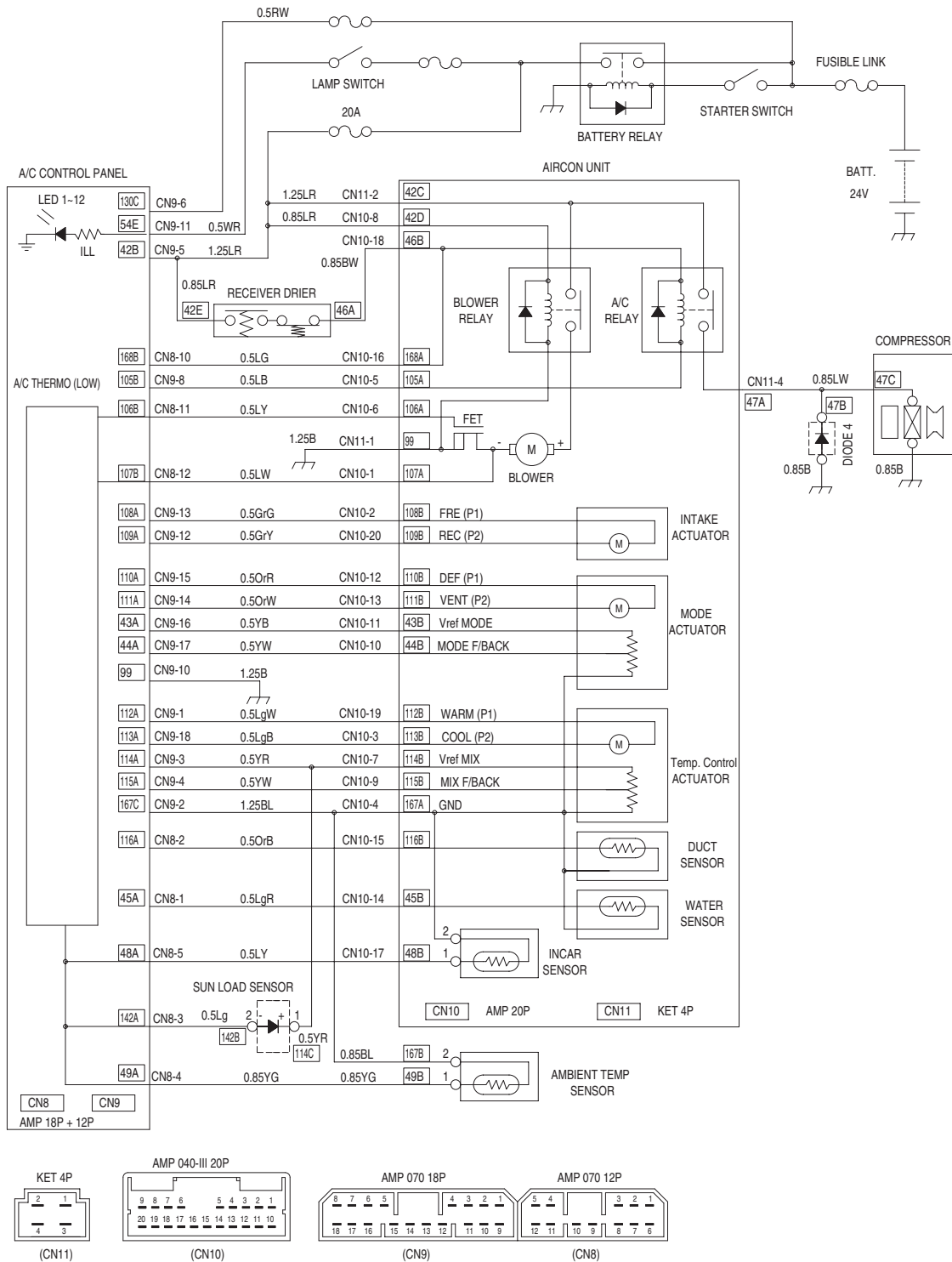
FG003919

Figure 83

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

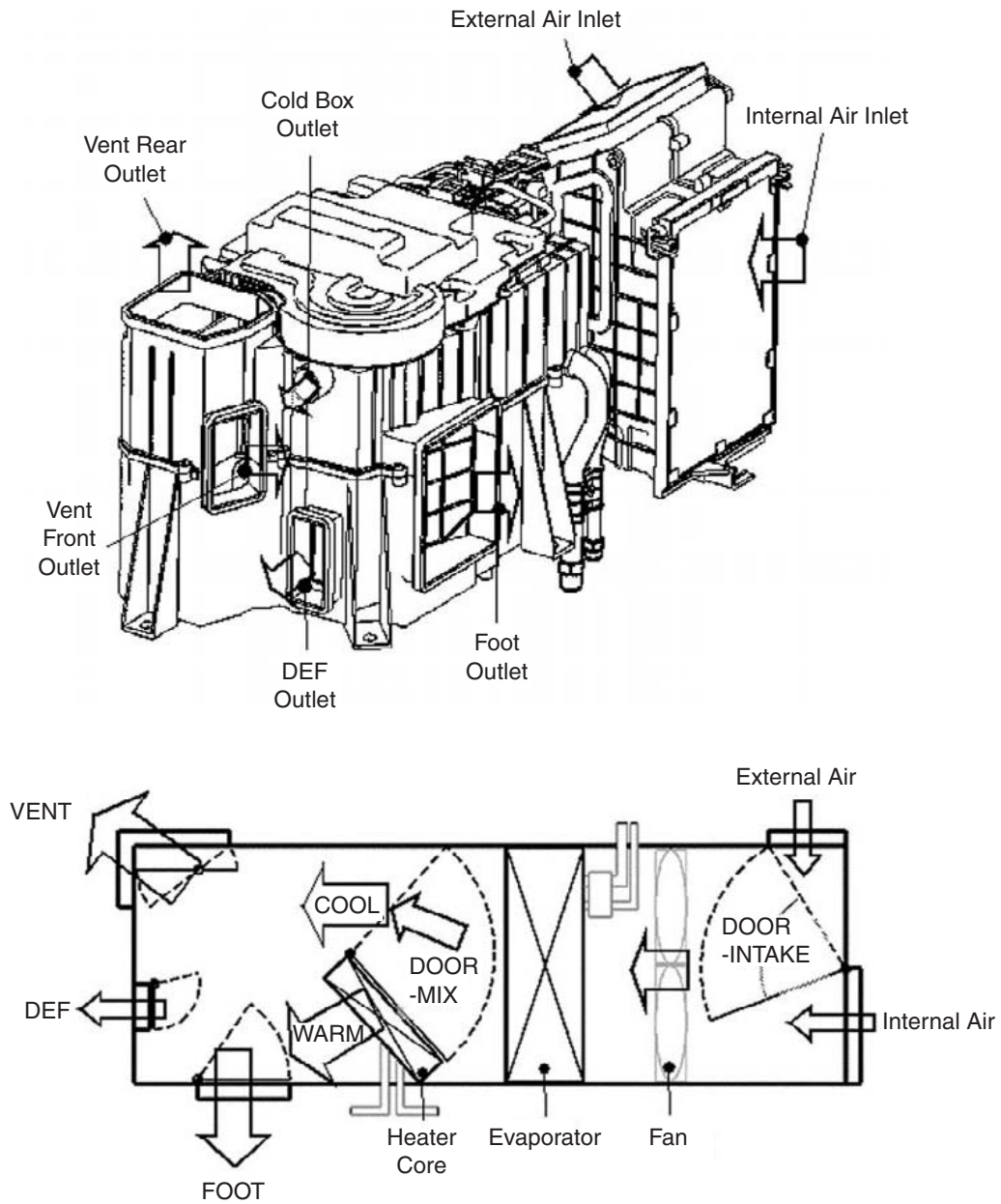


FG000781

Figure 84

Air Conditioner/Heater Unit

Airflow Diagram



FG001359

Figure 85

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

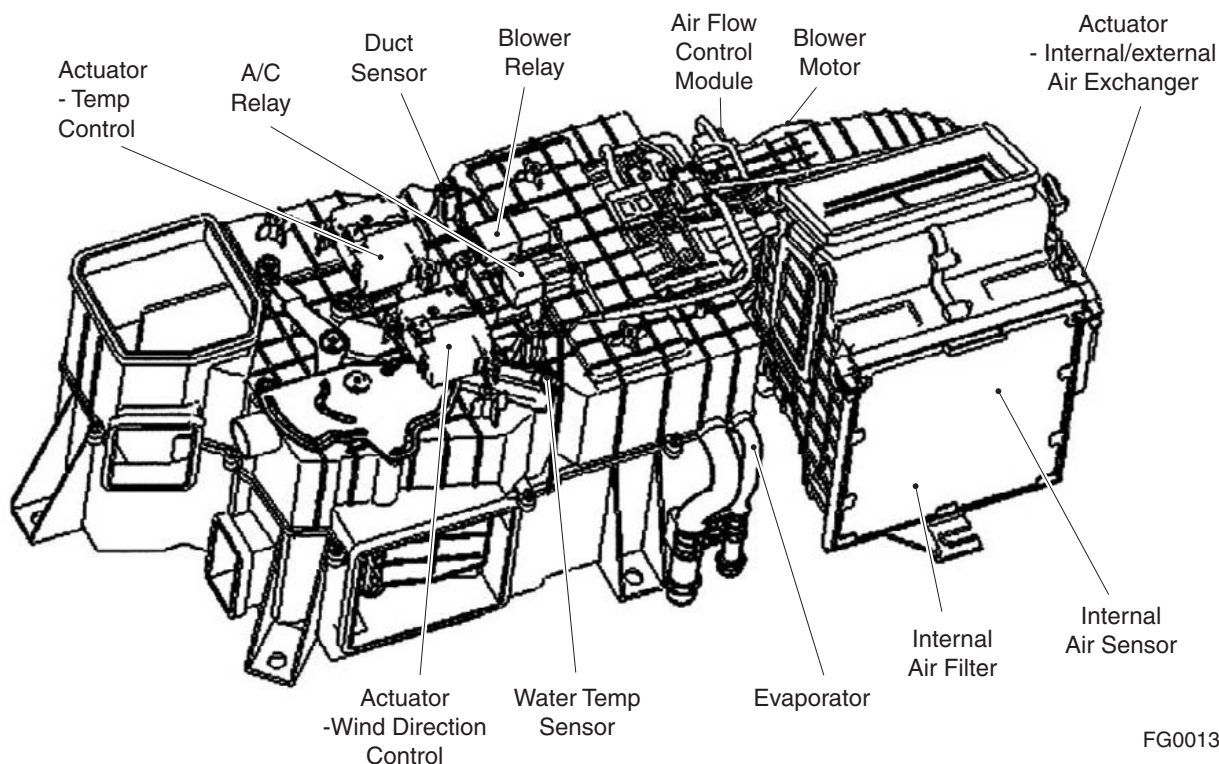
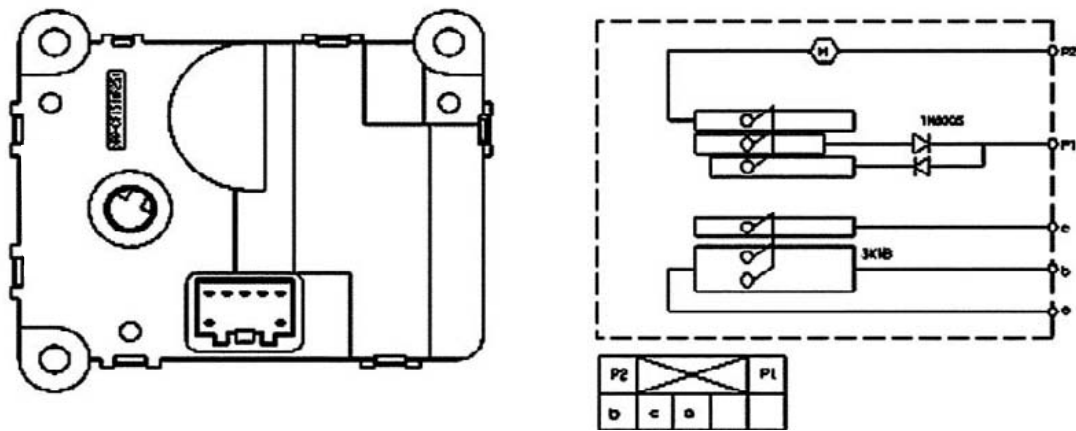


Figure 86

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

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



FG001361

Figure 87

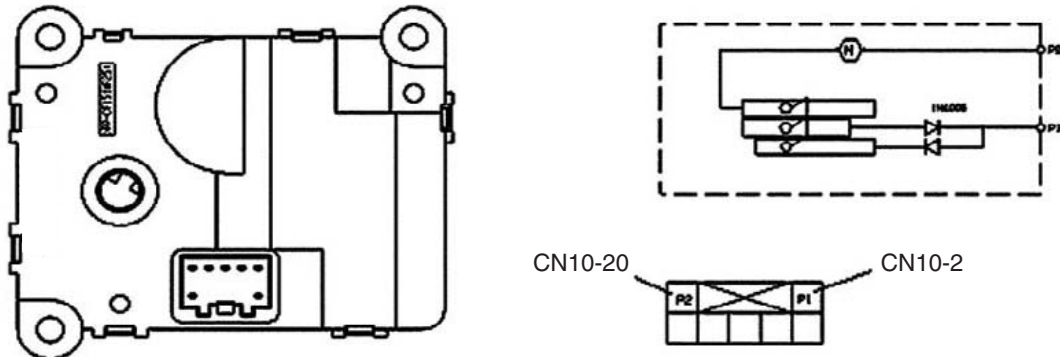
Actuator - Wind direction control

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

Actuator - Temp control

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

Actuator - Internal/external air exchange



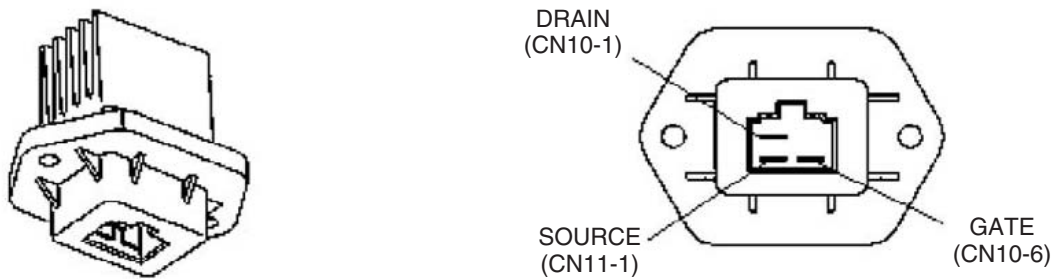
FG001055

Figure 88

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

Airflow Control Module

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



FG001056

Figure 89

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

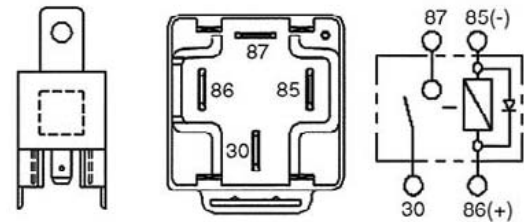
Applied voltage: Standard voltage is 27.5V.

Basically, airflow is set manually.

Relay - Blower

Power is supplied to the blower motor when the system is turned on.

Specifications	
Rated voltage	24V
Rated current	20A



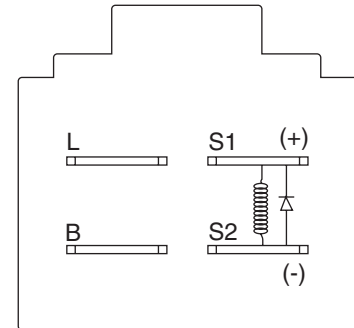
FG001057

Figure 90

Relay - A/C

Power is supplied to the magnetic clutch of the compressor.

Specifications	
Rated voltage	24V
Rated current	10A



FG001058

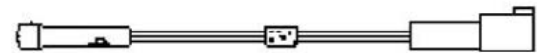
Figure 91

Duct Sensor

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

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

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



FG001059

Figure 92

Water Temp Sensor

It senses the temperature of coolant water in the heater core.

Temp (°C)	Resistance (KW)
-10	55.8 ± 1.7
0	32.9 ± 0.9
15	15.76 ± 0.5
25	10.0 ± 0.3
35	6.5 ± 0.2



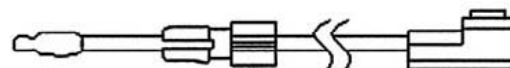
FG001060

Figure 93

Internal Air Temp Sensor

Built in the internal air filter, it senses the internal temperature.

Temp (°C)	Resistance (KW)
-15	218.2 ± 7.5
0	97.83 ± 0.9
15	47.12 ± 0.7
25	30.0 ± 0.36
35	19.60 ± 0.3



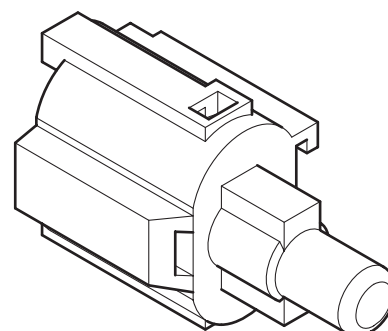
FG001061

Figure 94

Ambient Air Temperature Sensor

Built at the bottom of the cockpit, it senses the temperature of external air.

Temp (°C)	Resistance (KW)
-10	163 ± 4.9
0	96.9 ± 2.9
10	59.4 ± 1.8
20	37.4 ± 1.1
25	30 ± 0.9
30	24.2 ± 0.7

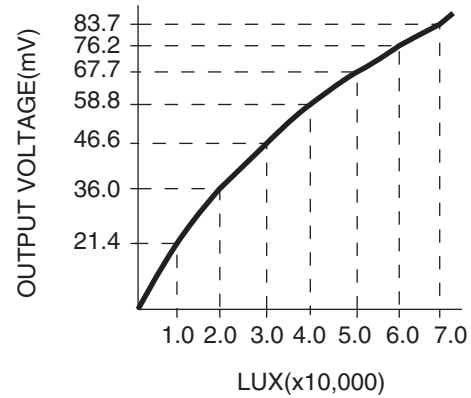
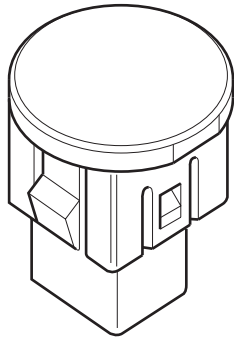


FG001064

Figure 95

Sun Sensor

Built beside the socket of spare power, it senses the quantity of the sun radiation to regulate discharge temperature and airflow as set by driver.

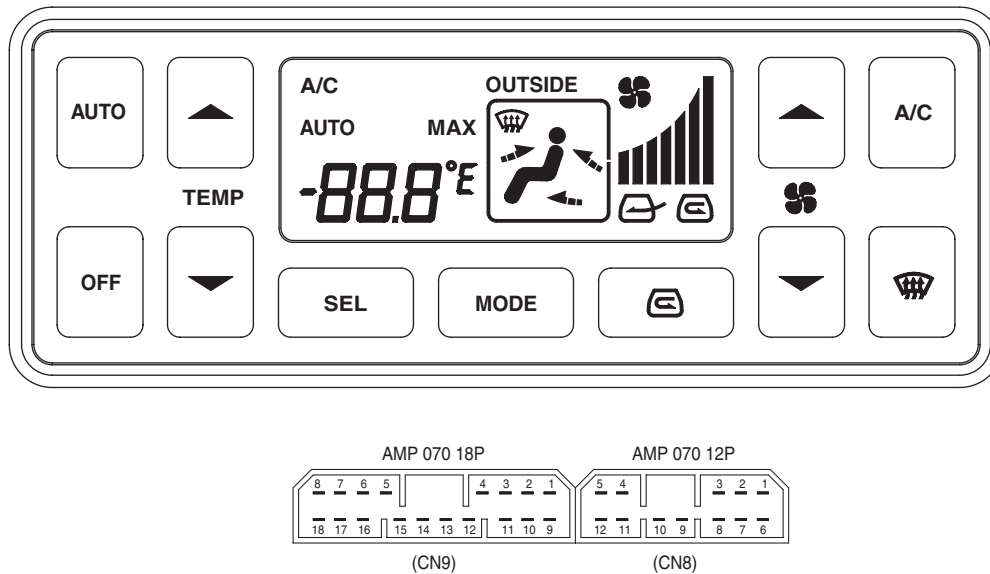


FG001062

Figure 96

Control Panel

Appearance and Terminal Arrangement



FG001063

Figure 97

Refer to "Air Conditioner and Heater" of operation manual.

Terminal Terms

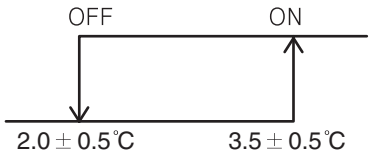
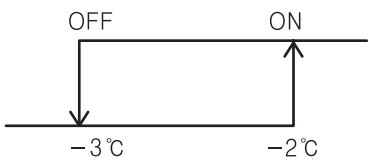
CN	Term No.	Terms	CN	Term No.	Terms
CN9	1	Temperature control (warm)	CN8	1	Water temperature sensor
	2	Sensor ground		2	Duct sensor
	3	Temperature control Power (5V)		3	Sun sensor
	4	Mix feedback		4	Ambient air temperature sensor
	5	Power (KEY "ON")		5	Internal air temperature sensor
	6	Backup		6	-
	7	-		7	-
	8	A/C output (LOW)		8	-
	9	-		9	-
	10	Ground		10	D.P.S CHECK
	11	Illumination		11	Airflow module (gate)
	12	Intake/Recirculate (Recirculate)		12	Blower motor (feedback)
	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)			

Control Logic

Categories	Inputs	System Operation
AUTO	Set temperature Internal air temperature sensor Ambient air temperature sensor Water temperature sensor Sun sensor	1. Automatically adjust room temperature as set and then next items. Temperature, Wind direction, Recirculate/Intake, Airflow, Compressor 2. Auto mode is released when manually setting any switch except, Temperature Control switch in Auto mode. 3. Upon the releasing of Auto mode, all of functions except selected switch are controlled automatically.

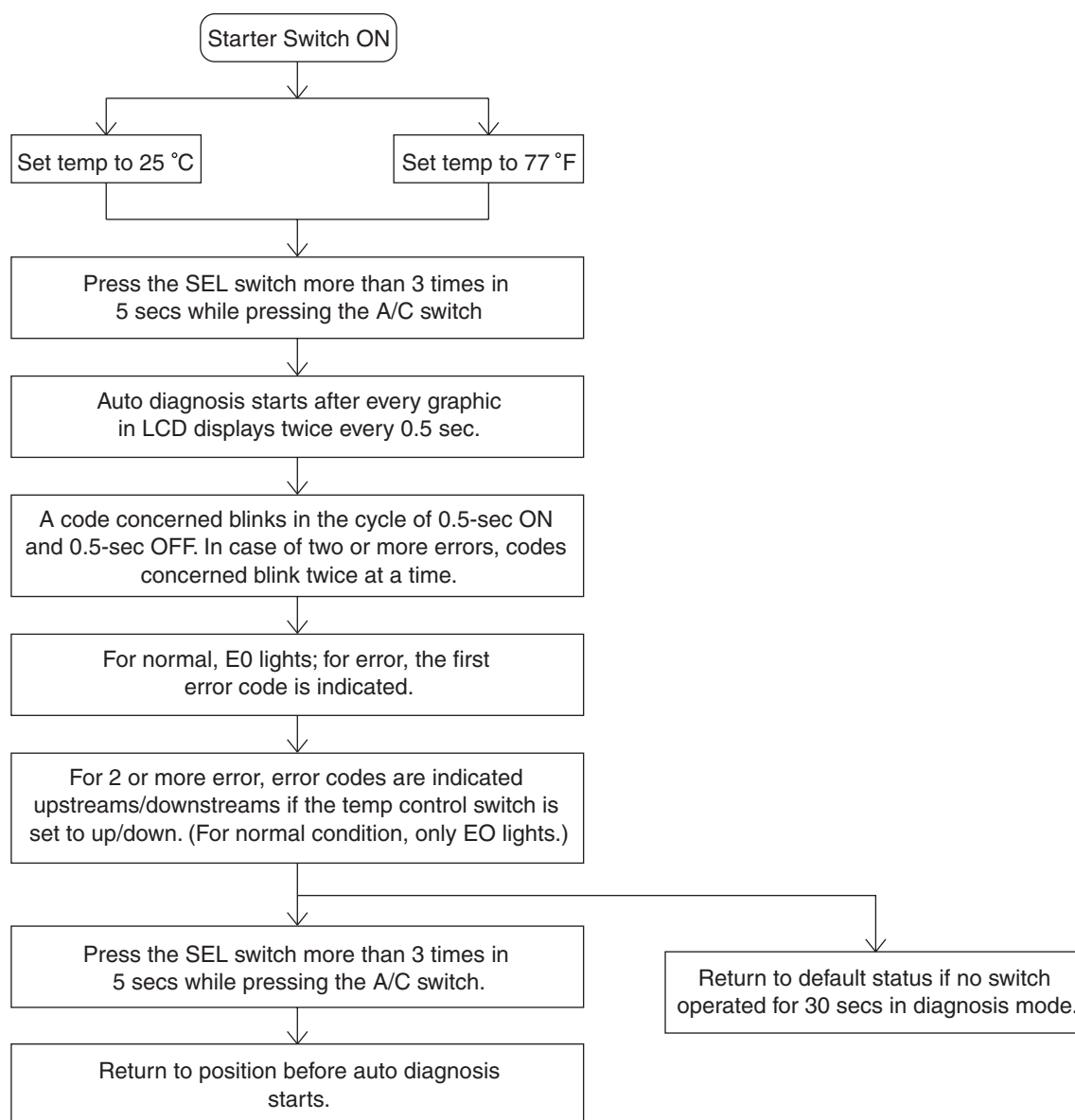
Categories	Inputs	System Operation																		
Sensor compensation	Set temperature Internal air temperature sensor Ambient air temperature sensor Water temperature sensor	In case of sensor failure, following defaults are applied: Internal air temperature sensor: 25°C, Ambient air temperature sensor: 25°C, Duct sensor: -2°C Temperature control actuator: - Set Temperature 17 - 24.5°C: Max cooling, Set Temperature 25 - 32°C: Max heating Wind direction mode actuator - VENT: VENT fix, modes other than VENT: Fixed to DEF * Sun sensor is not compensated.																		
Max cooling/heating control	Auto Setting	- Set Temperature 32°C: Max heating - Set Temperature 17°C: Max cooling <table border="1"> <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.		Max Cooling (17 °C)	Max Heating (32 °C)	Temp Control Actuator	FULL COOL	FULL HOT	Air Flow	MAX HI	AUTO HI	Compressor	Forced ON	OFF	Intake/Recircle	Recircle	Intake	Wind Direction Mode	VENT	FOOT
	Max Cooling (17 °C)	Max Heating (32 °C)																		
Temp Control Actuator	FULL COOL	FULL HOT																		
Air Flow	MAX HI	AUTO HI																		
Compressor	Forced ON	OFF																		
Intake/Recircle	Recircle	Intake																		
Wind Direction Mode	VENT	FOOT																		
Starting Control of Cooling	Auto mode Duct sensor	- Prevention of discharge of hot air before discharge temperature drops enough in hot summer weather - Start conditions (AND condition) - A/C on (AUTO or manual) - Temperature sensed by the duct sensor is above 30°C - Airflow: Auto mode - One time control in the cycle of engine OFF → engine run - Initial cooling control is executed when the Auto switch is "ON" in the manual status (A/C "OFF" and manual control of airflow) in 5 seconds after engine run. - Initial cooling control should be before max cooling. - Release condition (OR condition) - A/C "OFF" - Airflow: Manual control - Release is possible with the "OFF" switch but not allowed within 12 seconds (after Start "ON") while the system is off using the "OFF" switch and during the time of initial cooling control.																		

Categories	Inputs	System Operation
Starting control of heating (1)	Water temperature sensor Internal air temperature sensor Auto mode Set Temperature	- Start condition (AND condition) (1) When wind direction mode is one of the following modes in the Auto or manual control mode - BI-LEVEL, FOOT or FOOT/DEF (2) The Water temperature sensor is stable and the water temperature < 73°C (3) Airflow: Auto mode (4) Set temperature > Internal air temperature + 3°C * Airflow falls gradually up to 12 seconds when operation released.
		- One time control in the cycle of engine OFF → engine run - Initial heating control should be before max heating. - Airflow is controlled only when the wind direction is in the manual mode and BI-LEVEL, FOOT, or FOOT/DEF is set. - Control through the water temperature sensor for start. - Starting control of heating (2) starts in case of fault of the water temperature sensor during controlling. - Operation release (OR condition) (1) Only airflow is released if it is selected manually. (2) When handling the wind direction mode switch, only wind direction is released but the airflow control is performed only for the remaining period of the starting control of heater. (3) When Max Cooling (17°C) is selected. (4) Water temperature sensor > 73°C.

Categories	Inputs	System Operation
Starting control of heating (2)	Water temperature sensor Ambient air temperature sensor Internal air temperature sensor Auto mode	- Entry condition (AND condition) (1) Auto Mode (2) Ambient air temperature $< 5^{\circ}\text{C}$ and difference between ambient and internal air temperature $> 5^{\circ}\text{C}$ (3) Failure of water temperature sensor - Only one time of engine OFF $\rightarrow$ engine run - Starting control of heating is before max heating. - Operation release (OR condition) (1) Airflow: Manual selection (2) When handling the wind direction mode switch, only wind direction is released but the airflow control is performed only for the remaining period of the starting control of heater. (3) Difference between internal and ambient air temperature $> 15^{\circ}\text{C}$ (4) When Max Cooling (17°C) is selected. - Exceptional case Starting control of heating is performed only once during the remaining period if the entry condition is satisfied within the starting control period that is the accumulation of initial start times. (Inclusive of Auto mode "ON" case within the period of starting control of heater.) * Airflow should be reduced slowly for up to 12 seconds in case of exceptional entry case.
Compressor control	Duct sensor	- 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." - Control pattern. 
	External temperature sensor	- Function: Prevention of compressor in winter. - Control pattern.  *Only for Auto mode.

Self-diagnosis

How to start self-diagnosis



FG001367

Figure 98

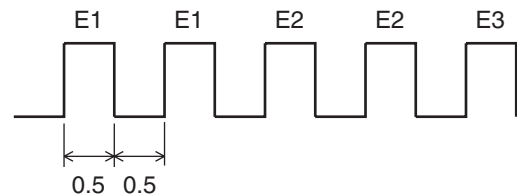
Error codes

Code	Description
E0	Normal
E1	Internal Air Temp Sensor Short
E2	Internal Air Temp Sensor Open
E3	Ambient Air Temp Sensor Short
E4	Ambient Air Temp Sensor Open
E5	Duct Sensor Short
E6	Duct Sensor Open
E7	Sun Sensor Short
E8	Sun Sensor Open
E9	Water Temp Sensor Short
E10	Water Temp Sensor Open
E11	D.P.S OPEN
E12	Position Error of Wind Direction Actuator.
E13	Position Error of Temp Control Actuator.

NOTE: *Position error means that it fails to move to designated place in 40 seconds.*

Sun sensor displays E8 in case of no sunlight.

2 and more fails: Codes concerned blinks twice at a time.



FG001067

Figure 99

Ambient Temp Display

Selection of both the SEL and MODE switch for more than 3 seconds indicates the ambient temp in the set temp display department.

- Range of temp display: -40 - +60°C

NOTE: *Display of ambient temp may be released in the same way for its entry way.*

It returns automatically to default mode 5 seconds after entering the ambient air temp display mode.

Compressor

Categories	Specifications
Output	155.3 cc/rev (9.48 in ³)
Oil Level	120 cc (ND-OIL8) (7.32 in ³ (ND-OIL8))
Refrigerant	R134a
Rated Voltage	24V
Relief Valve	Open: 35 - 42.2 kg•cm ² G (500 - 600 psi) Close: 28.1 kg•cm ² G (400 psi)

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 temperatures and high-pressured gas to freeze it in the condenser.

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.

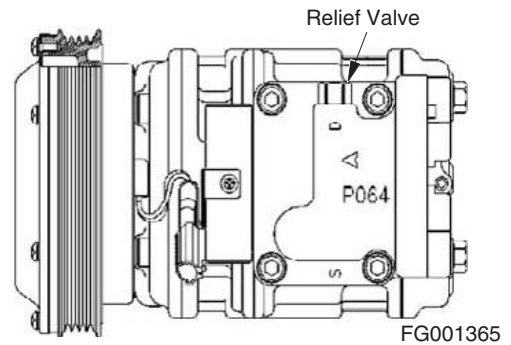


Figure 100

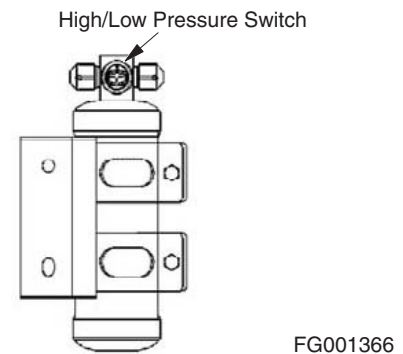


Figure 101

Volume of refrigerant by model

Model	Volume of refrigerant (g)
DX300LC	800 ±20
DX340LC	800 ±20
DX420LC	800 ±20
DX480LC	800 ±20
DX520LC	800 ±20

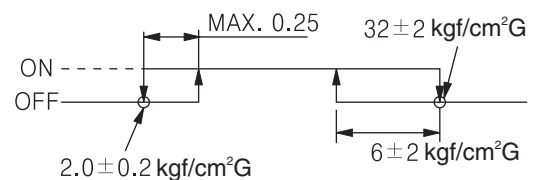


Figure 102

FG003921

Electrical Schematic

Edition 1

MEMO

Table of Contents

Electrical Schematic

Safety Precautions	5
Applicable Models	5
General Description	7
DX210W	8

MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

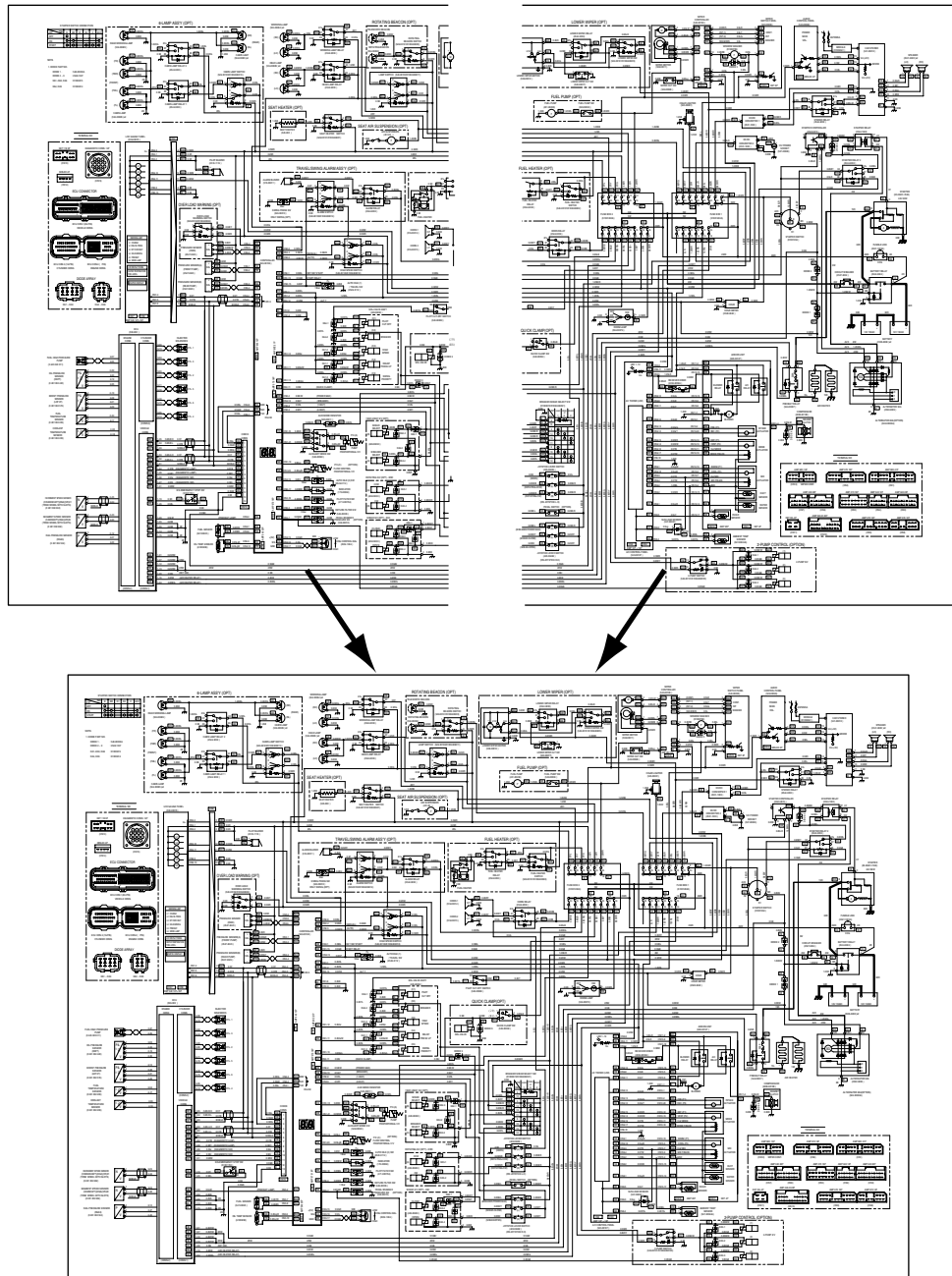
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX190W	5001 and Up

GENERAL DESCRIPTION

Schematic(s) presented in this section are laid out on facing pages.

An overlapping edge has been taken into consideration so a photocopy can be made and pasted together to make a complete schematic.



FG001435

Figure 1

DX210W

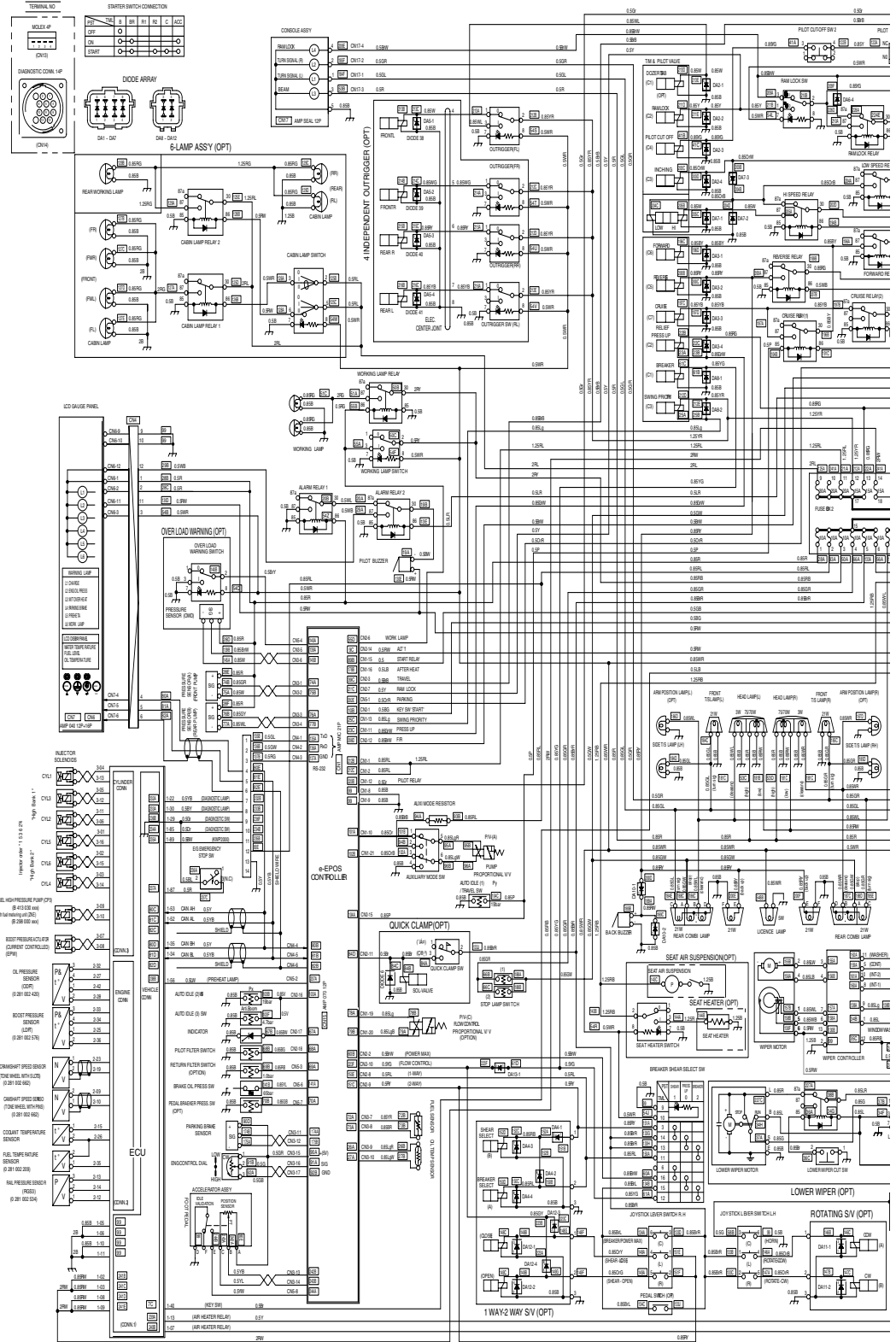
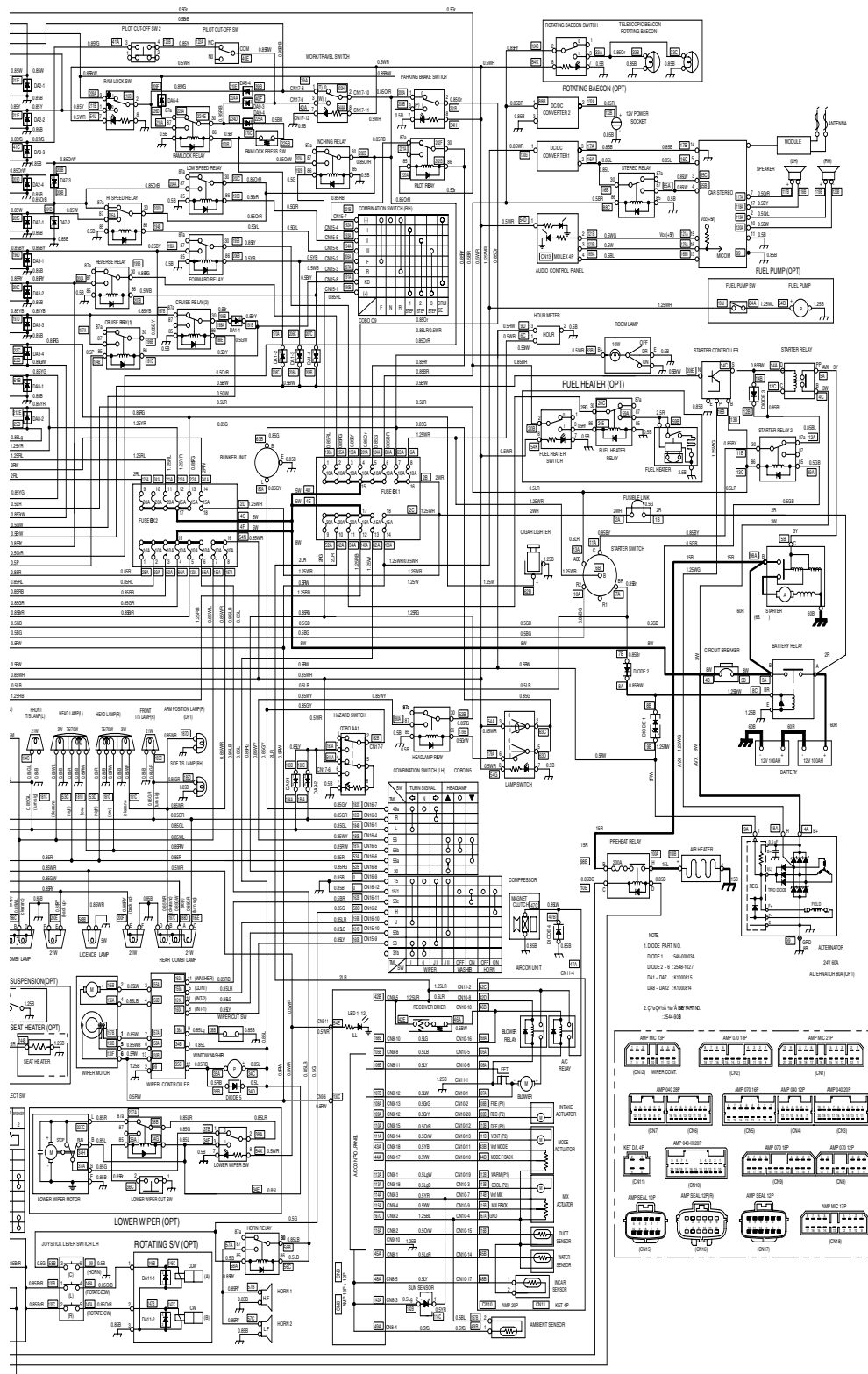


Figure 2



FG009241

Attachments

Boom and Arm

Edition 1

MEMO

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Boom and Arm

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MEMO

SAFETY PRECAUTIONS



CAUTION!

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

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

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

Remember, that ultimately safety is your own responsibility.

APPLICABLE MODELS

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

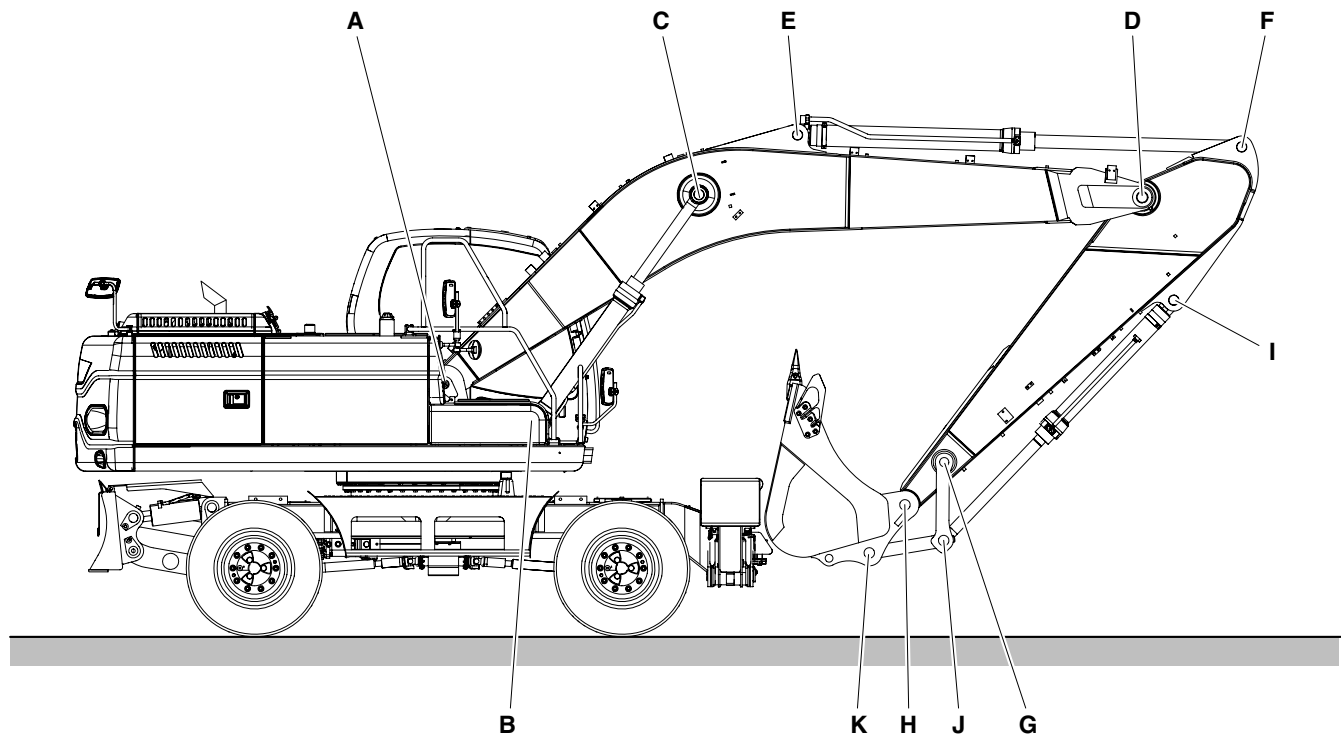
MODEL	SERIAL NUMBER RANGE
DX210W	5001 and Up

FRONT ATTACHMENT PIN SPECIFICATIONS

The table below has a complete listing of dimensional specifications for all mounting pins used on the front attachment.

NOTE: Some mounting pins must be drilled and tapped for lubrication fittings and piping, or may have other required specifications. Consult DOOSAN After Sales Service for information on wear tolerances and replacement limits for mounting pins.

One-piece Boom

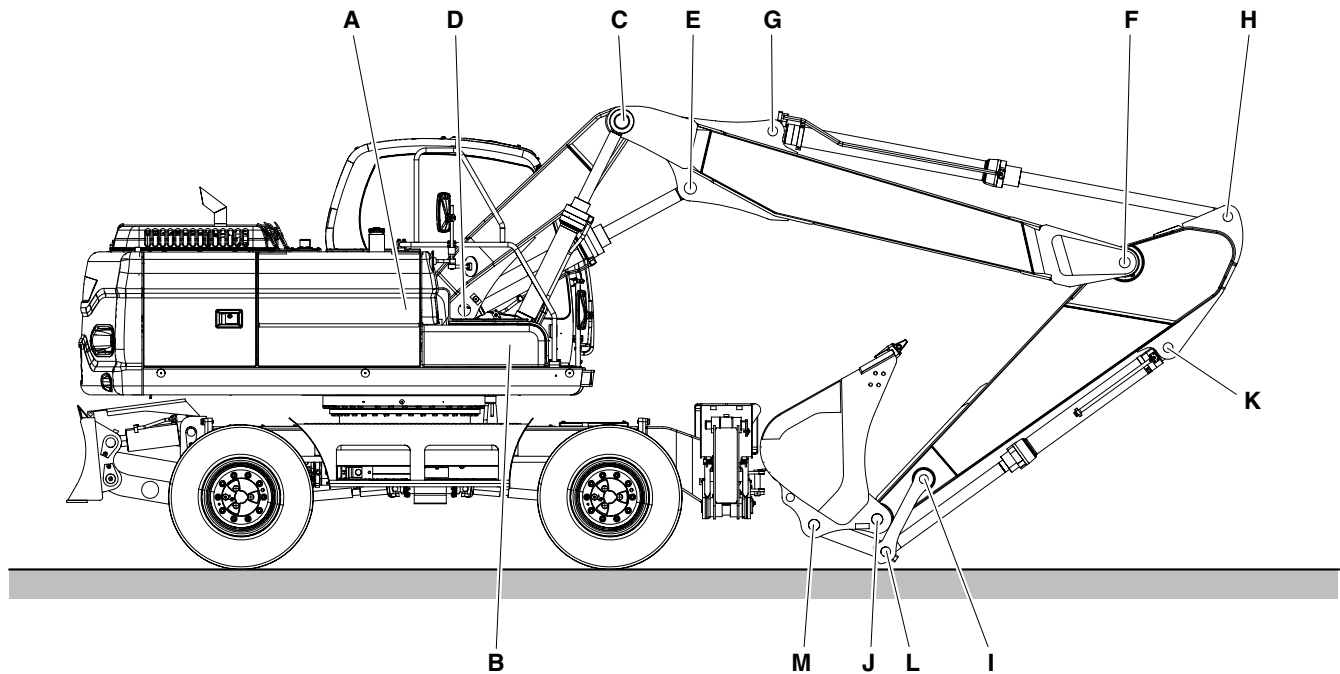


FG009222

Figure 1

Mounting Pin	Diameter, mm (Inches)	Length, mm (Inches)
A	90 mm (3.54 in)	811 mm (31.93 in)
B	80 mm (3.15 in)	221 mm (8.7 in)
C	80 mm (3.15 in)	792 mm (31.18 in)
D	90 mm (3.54 in)	548 mm (21.57 in)
E	80 mm (3.15 in)	241 mm (9.49 in)
F	80 mm (3.15 in)	274 mm (10.79 in)
G	75 mm (2.95 in)	460 mm (18.11 in)
H	80 mm (3.15 in)	519 mm (20.43 in)
I	80 mm (3.15 in)	236 mm (9.29 in)
J	80 mm (3.15 in)	460 mm (18.11 in)
K	80 mm (3.15 in)	519 mm (20.43 in)

Two-piece Boom



FG009246

Figure 2

Mounting Pin	Diameter, mm (Inches)	Length, mm (Inches)
A	90 mm (3.54 in)	811 mm (31.93 in)
B	80 mm (3.15 in)	221 mm (8.70 in)
C	100 mm (3.94 in)	791 mm (31.14 in)
D	90 mm (3.54 in)	306 mm (12.05 in)
E	90 mm (3.54 in)	306 mm (12.05 in)
F	90 mm (3.54 in)	548 mm (21.57 in)
G	80 mm (3.15 in)	246 mm (9.69 in)
H	80 mm (3.15 in)	274 mm (10.79 in)
I	71 mm (2.80 in)	460 mm (18.11 in)
J	80 mm (3.15 in)	519 mm (20.43 in)
K	80 mm (3.15 in)	227 mm (8.94 in)
L	80 mm (3.15 in)	460 mm (18.11 in)
M	80 mm (3.15 in)	519 mm (20.43 in)

FRONT ATTACHMENT - REMOVAL AND INSTALLATION

DANGER!

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

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

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

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.

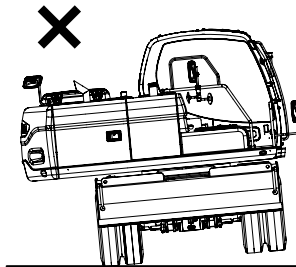
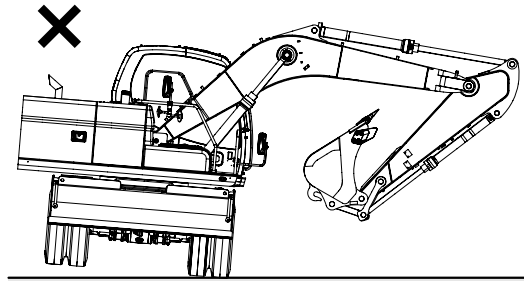


Figure 3

FG007095

Park the excavator away from obstructions and all traffic on clear, flat, level ground. Extend the arm cylinder and crowd the arm into the boom. Partially retract the boom cylinder so the boom is stretched out in front of the excavator, as low to the ground as possible, with the arm crowded under the boom.

The tip of the arm point should be lowered to secure blocking that will safely support the weight of the arm. Place the blocking directly in front of the excavator and make sure that it will not be unbalanced with an initial weight load that is all to one end, under the arm point.

Shut off the engine and release hydraulic system pressure - move any of the control levers with the engine off to release pressure built up in the accumulator. Manually vent residual hydraulic pressure in the tank by moving the lever near the cap, on top of the reservoir.

 WARNING!

Secure the swing lock and tag and lock out controls in the operator's cabin to keep anyone from moving or inadvertently starting the engine. Restrict access to the work site while sections of the attachment are in the air, or while they are being supported by the assist crane. The safe lifting capacity of the assist crane or hoist that is used must exceed the weight of the heaviest section of the attachment, the boom (approximately 1,130 kg [2,491 lb], not including the weight of accessories or fixtures).

Before beginning the disassembly of attachment mounting pins, disconnect the arm cylinder hydraulic hose couplings and put a clean plug in the end of each one. Use any reasonable precautions necessary to avoid introducing dirt or other contaminants into the hydraulic system. Wipe down coupling points before disconnecting hydraulic lines and use evaporative type solvent spray cleaner. Tag and mark hoses for reassembly, if necessary.

Place a sling under the arm cylinder (the cylinder used to extend and retract the attachment arm, pinned to the top of the boom). Lift the sling so the weight load on the rod end of the arm cylinder (pinned to the ears on the inner end of the arm) is released. Prepare blocking under the arm that will securely support the weight of the arm and arm cylinder.

 CAUTION!

To make sure that polished surfaces of cylinder rod ends will not suffer accidental damage during disassembly or removal procedures, wrap exposed rod surfaces (especially those of boom cylinders) with a protective covering material. Immediately following disassembly and removal, cylinder rods should always be fully retracted. This eases handling problems and avoids possible damage.

Remove retainers on the end of the mounting pin for the arm cylinder rod end. Use the assist crane to relieve the weight load and withdraw the pin. Lower the arm down to the blocking support for any continued disassembly procedures.

Boom Removal Procedure

NOTE: *Boom removal may be simplified if the shell of the operator's cabin is taken off the turntable deck first. Refer to the Operator's Cabin Removal procedure before continuing, if both components are to be removed from the excavator.*

After the bucket, arm and arm cylinder have been removed, lower the end of the boom to a stable, secure blocking support.

Attach the assist crane sling to the body of either boom cylinder, break the mounting pin connection to the boom by tapping through the pin from the same side of the boom and repeat for the opposite cylinder.

Release hydraulic pressure and disconnect line couplings as previously outlined in the Arm Removal Procedure, observing the same precautions.

Disconnect wiring for work light assemblies and any other accessory lines or connections. Locate the sling of the assist crane near the center of gravity, optimum lift point for the boom, and use the crane to take pressure off the boom foot pin. Drive out the pin after disassembling retainers and carefully lift away the boom.

 WARNING!

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

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

INSTALLATION

Arm Installation Procedure

Reattach the base of the arm cylinder to the mounting point on top of the boom.



WARNING!

Before assembling the front attachment, make sure that individual boom, arm and bucket sections are all compatible and can be used safely for work intended. Refer to the General Safety Pages, Lift Ratings, Working Range Diagrams and Weights of Materials sections in the Operation and Maintenance Manual. Consult your dealer or DOOSAN After Sales Service for more information if you have any questions or require more information.

Begin with the arm securely supported on blocking in front of the excavator. Pregrease the mounting pin for the rod end of the arm cylinder and push it through the ears on the end of the arm. Attach a sling around that mounting pin and lift the arm with an assist crane until it is in position for the boom-arm pin connection to be made.

Relieve hydraulic pressure from all points of the system before any hydraulic lines are opened, then carefully assemble hydraulic connections to the arm cylinder.

Remove sling from around the rod end arm cylinder pin, withdraw the pin and lift the body of the arm cylinder to repin the mounting connection.

Boom Installation Procedure

Before reassembling the attachment, make sure to inspect all bushings and pivot points of each section. To avoid damaging the seats, bushings should never be hammered or chiseled out of their seats.

Installation is otherwise a reversal of the removal procedures.

START-UP PROCEDURES

Once the boom has been serviced, it should be lubricated as outlined in the initial start-up procedures of the operation manual. Refer to the appropriate operation and maintenance manual for unit.

Bucket

Edition 1

MEMO

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MEMO

SAFETY PRECAUTIONS



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APPLICABLE MODELS

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

MODEL	SERIAL NUMBER RANGE
DX140W	5001 and Up
DX160W	5001 and Up
DX190W	5001 and Up
DX210W	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 pinhole.
- Lock washers or pins show obvious damage or weakness.
- Wear points on the working surfaces of tooth points - pits, cracks, chips or craters - are larger than 8 mm to 10 mm (1/3" to 1/2") across.

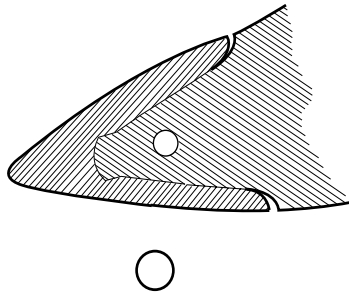
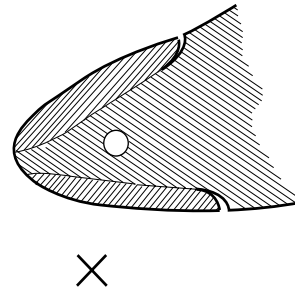


Figure 1



HAOC680L

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 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.

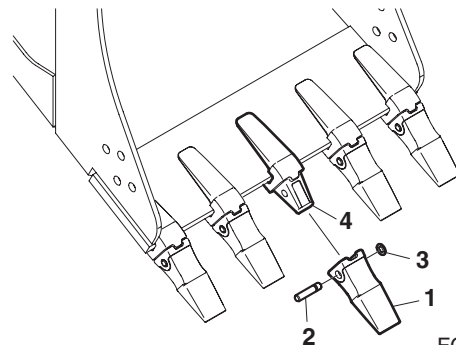


Figure 2

FG004542

BUCKET O-RING REPLACEMENT



WARNING!

Due to possibility of flying metal objects, always wear safety helmet, protective gloves and eye protection when changing pins.

1. Inspect the bucket O-rings on a routine basis. If worn or damaged, replacement is necessary.

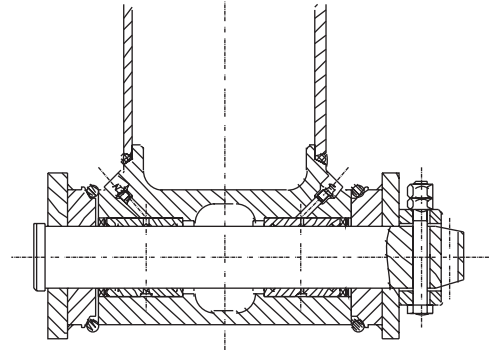


Figure 3

HAOH640

2. Roll the old O-ring (1, Figure 4) onto the boss (2) around the bucket pin (3). Remove bucket pin and move the arm or bucket link (4) out of the way.

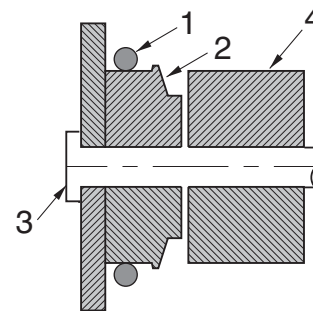


Figure 4

HAOC710

3. Remove old O-ring and temporarily install the new O-ring (1, Figure 5) onto the bucket boss (2). Make sure that O-ring groove on both the bucket link (4) and boss have been cleaned.
4. Realign the arm or link with the bucket pinhole and insert the bucket pin (3, Figure 4).

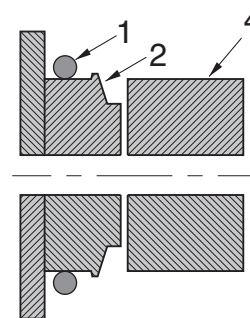


Figure 5

HAOC701

5. Roll the new O-ring (1, Figure 6) into the O-ring groove.

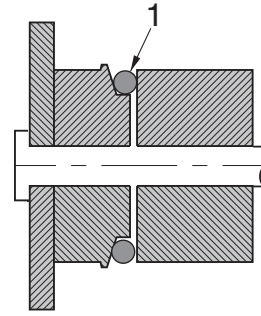


Figure 6

HAOC720

BUCKET ATTACHMENT, REMOVAL AND REVERSAL

Detaching the Bucket

Park the excavator away from obstructions on clear, flat, level ground. Lower the bucket carefully to preassembled blocking on the ground. Brace the bucket so there is no load weight on the pin connecting the bucket and arm. Disassemble the fasteners on the end of the bucket pin and pull out the pin.

If the pin sticks and resists normal withdrawal, there may be a load on it. Raise and lower the arm slightly until an unstressed pin position is located.



CAUTION!

Use care pulling out the pin to avoid damaging the dust seals on either end of the arm.

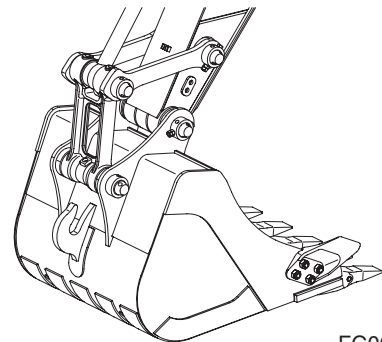
When the pin has been withdrawn, move the operating joystick slightly to take weight off the remaining link pin. Disassemble the link pin end retainers and pull out the pin.

Lift the arm away from the bucket so the bucket can be carried away or another end attachment can be put on the excavator.

Attaching the Bucket

Carefully inspect all parts before reassembling the bucket linkage. Look for cracks or any other evidence of physical damage and replace any seal or O-ring that is not in like new condition. Prelube linkage pins before reassembly.

Use an old cylinder rod, a long breaker bar or a similar, relatively thin diameter support bar for making the first (temporary) pin connection, between the bucket and arm. If the support bar is straight, the arm can be raised and the bucket will hang level, allowing direct insertion of the bucket ear attachment linkage pin.



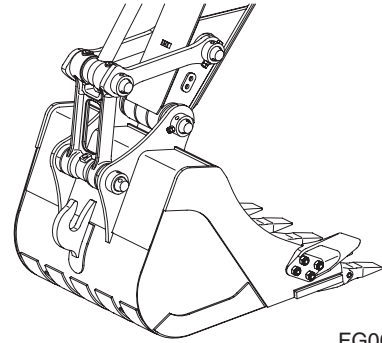
FG004543

Figure 7

When the link pin has been installed, withdraw the temporary support rod from the bucket pinholes, lower and raise the arm and boom and install the bucket pin.

WARNING!

When making linkage alignments, never insert fingers into pinholes. The attachment or bucket could shift position and cause a severe injury. Match holes by visually lining them up. Use the sharp tipped, soft point of a pencil or a similar tool to check for high spots or irregularities.



FG004543

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 point 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.
