

Solar 140/160W-V

Shop Manual

023-00065E

Serial Number 1001 and Up

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

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

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

Product Label



Instructions

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

Solar 140/160W-V
Serial Number 1001 and Up
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Publication Request for Proposed Revision

SAFETY



WHEEL EXCAVATOR SAFETY



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 210W-V	1001 and Up

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TO THE OPERATOR OF A DAEWOO EXCAVATOR



DANGER!

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

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

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

1. "General Safety Essentials" on page 6
2. "Location of Safety Labels" on page 6
3. "Summary of Safety Precautions for Lifting in Digging Mode" on page 7
4. "Unauthorized Modifications" on page 8
5. "General Hazard Information" on page 8
6. "Before Starting Engine" on page 17
7. "Machine Operation" on page 20
8. "Maintenance" on page 25
9. "Battery" on page 33
10. "Towing" on page 35
11. "Shipping and Transportation" on page 36
12. "Lifting With Sling" on page 36



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.

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



SAFETY ALERT SYMBOL



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

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

LEARN THE SIGNAL WORDS USED WITH THE SAFETY ALERT SYMBOL

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



CAUTION!

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



WARNING!

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



DANGER!

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

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

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

GENERAL SAFETY ESSENTIALS

ACCESSORY APPLICATIONS

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

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

LIFTING CAPACITY RATING CONFIGURATION

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

LOCATION OF SAFETY LABELS

IMPORTANT

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

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

Always replace damaged or faded decals.

SUMMARY OF SAFETY PRECAUTIONS FOR LIFTING IN DIGGING MODE



DANGER!

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

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

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

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



WARNING!

NEVER wrap a tagline around your hands or body.

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

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



WARNING!

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

UNAUTHORIZED MODIFICATIONS

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

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

GENERAL HAZARD INFORMATION

SAFETY RULES

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

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

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

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

Always observe strictly any other rules related to safety.

SAFETY FEATURES

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

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

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

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

INSIDE OPERATOR'S COMPARTMENT

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

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

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

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

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

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

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

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

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

CLOTHING AND PERSONAL PROTECTIVE ITEMS

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

Do not wear oily clothes. They are highly flammable.

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

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



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.

MOUNTING AND DISMOUNTING

Before getting on or off the machine, if there is any oil, grease, or mud on the handrails or 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, steps, and track shoes to ensure that you support yourself securely.

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

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

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

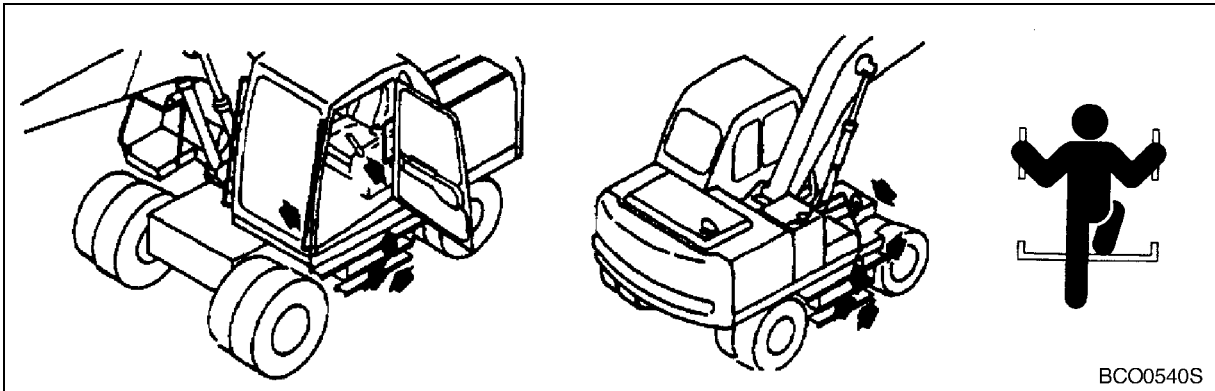


Figure 2

FUEL, OIL AND HYDRAULIC FLUID FIRE HAZARDS

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

Always strictly observe the following.

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

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

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



Figure 3

PRECAUTIONS WHEN HANDLING FLUIDS AT HIGH TEMPERATURE

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

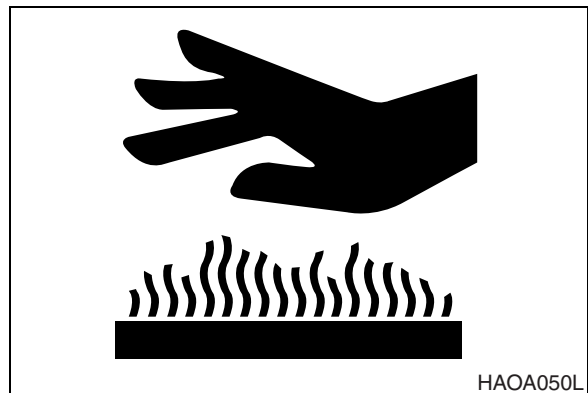


Figure 4

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.

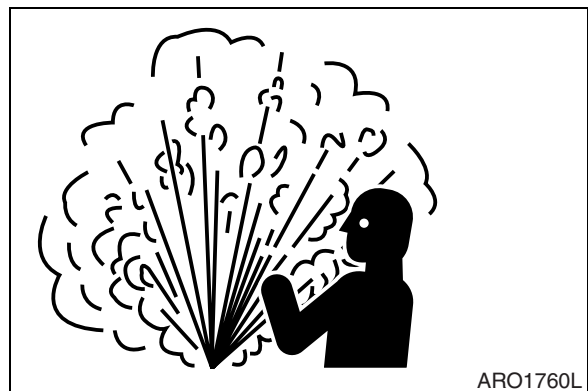


Figure 5

ASBESTOS DUST HAZARD PREVENTION

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

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

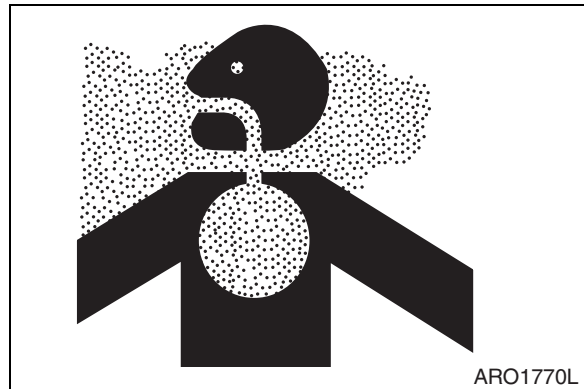


Figure 6

INJURY FROM WORK EQUIPMENT

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

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

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

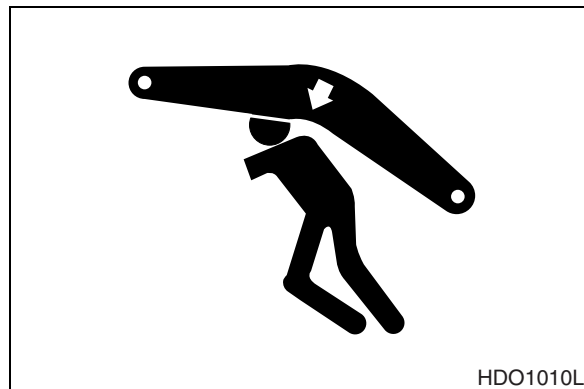


Figure 7

FIRE EXTINGUISHER AND FIRST AID KIT

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

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

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

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

PROTECTION FROM FALLING OR FLYING OBJECTS

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

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

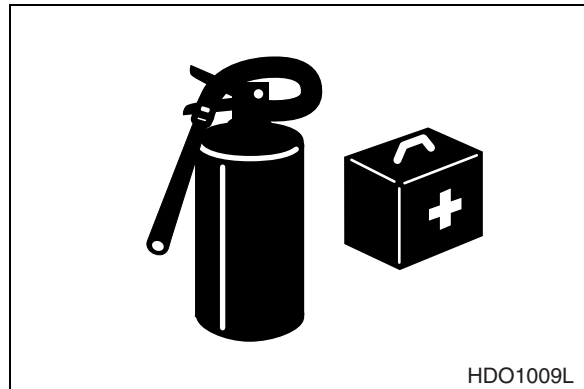


Figure 8

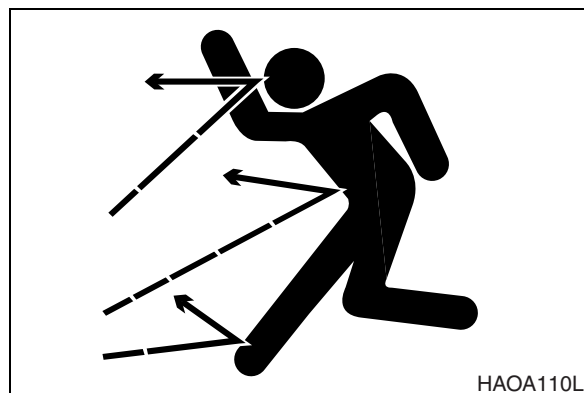


Figure 9

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

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



Figure 10

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

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

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

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

ATTACHMENT PRECAUTIONS

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

ACCUMULATOR

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

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

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

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

INDOOR VENTILATION

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

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

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

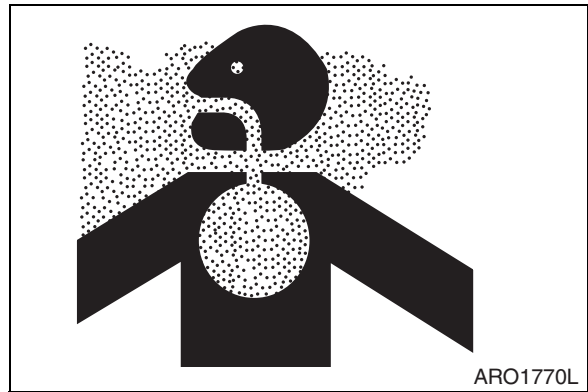


Figure 11

EMERGENCY EXIT

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

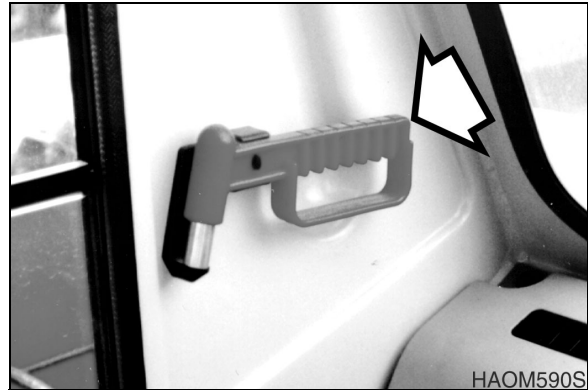


Figure 12

BEFORE STARTING ENGINE

WORK SITE PRECAUTIONS

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

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

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

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

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

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

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

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

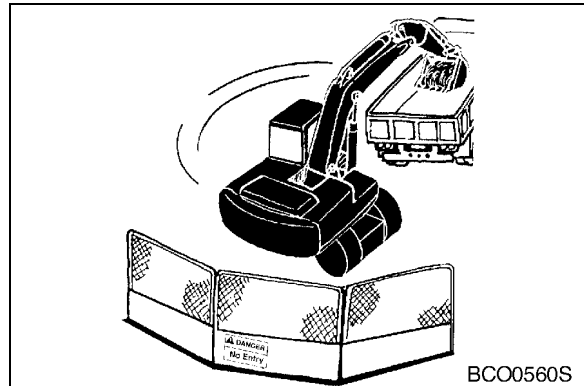


Figure 13

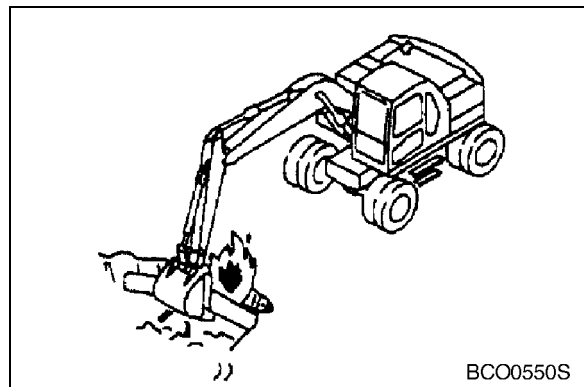


Figure 14

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

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

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 should collapse, the machine could fall or tip over and this could result in serious injury or death.

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

Earth laid on the ground and the soil near ditches is loose. It can collapse under the weight of vibration of your machine and cause your machine to tip over.

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

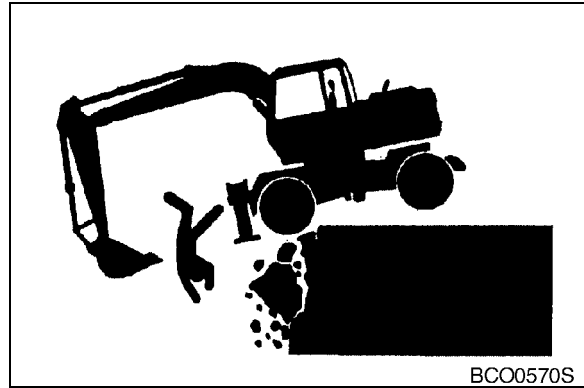


Figure 15

CHECKS BEFORE STARTING ENGINE

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

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

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

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

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

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

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

ENGINE STARTING

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

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

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

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

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

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

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

Start and operate the machine only while seated.

BEFORE OPERATING MACHINE

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

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

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

MACHINE OPERATION

WHEN SWINGING OR CHANGING DIRECTION OF TRAVEL

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

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

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

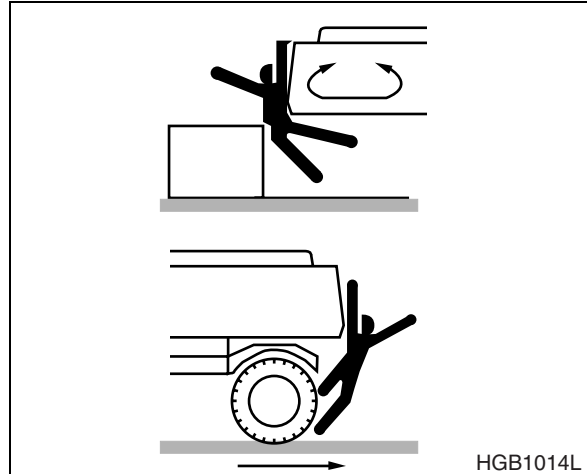


Figure 16

TRAVEL PRECAUTIONS

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

Attachment control levers should not be operated while traveling.

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

Fold in work equipment so that the outer end of the boom is as close to the machine as possible.

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

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

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

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

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

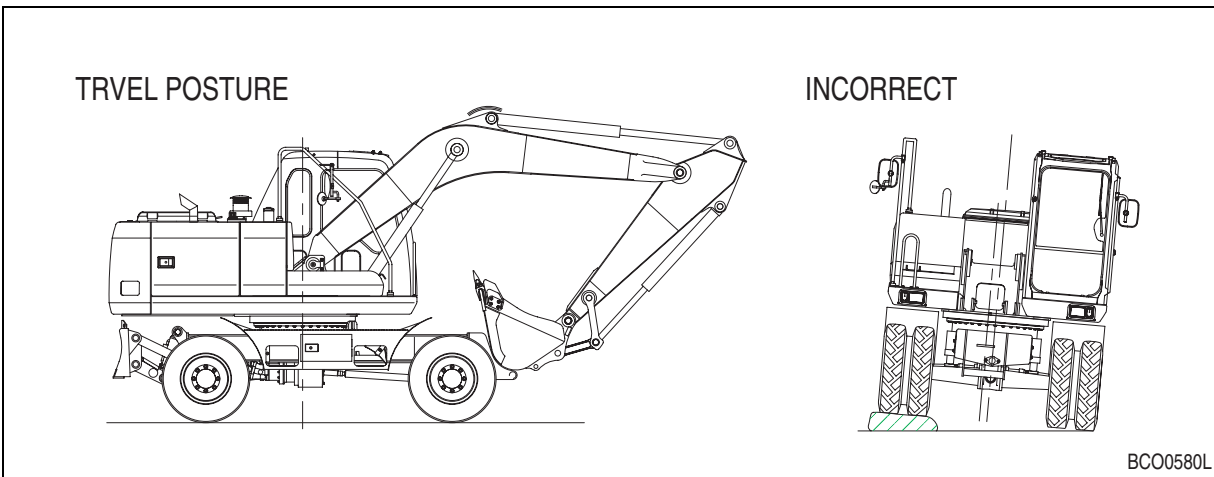


Figure 17

TRAVELING ON SLOPES

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

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

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

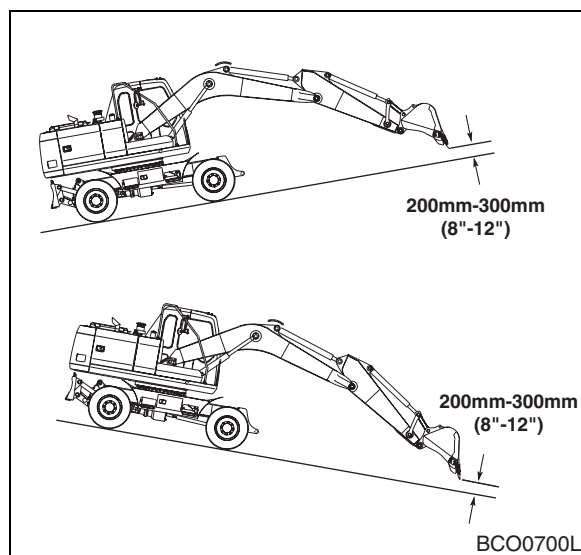


Figure 18

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

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

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

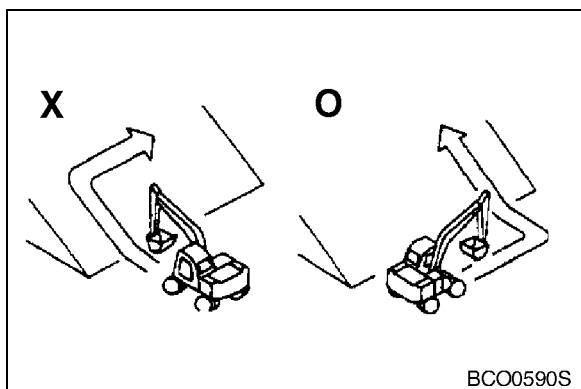


Figure 19

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.

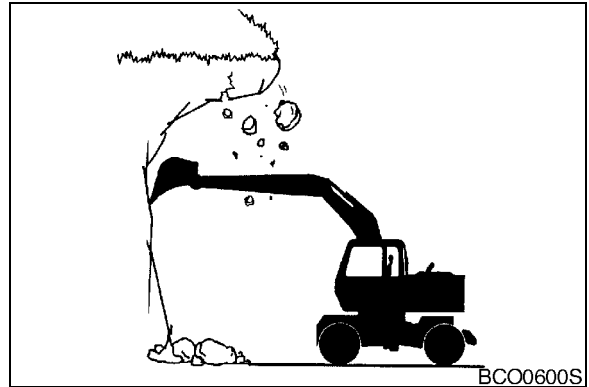


Figure 20

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 tracks fore and aft to prevent any movement.

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

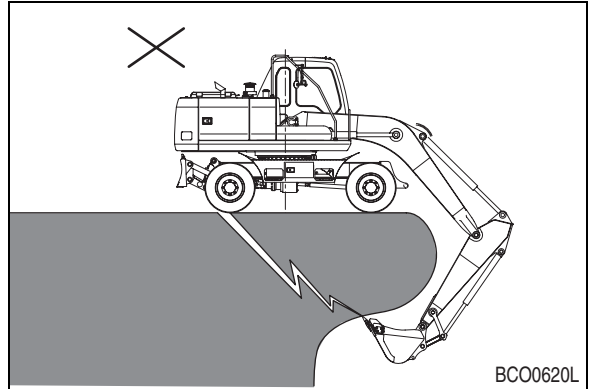


Figure 21

PRECAUTIONS FOR OPERATION

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

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

To ensure an ample view, do as follows:

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

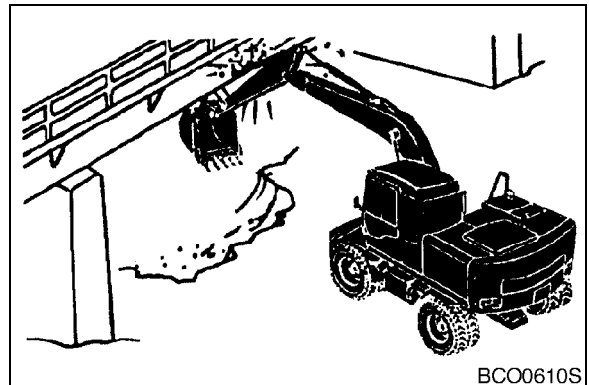


Figure 22

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

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

AVOID HIGH-VOLTAGE CABLES

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

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

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

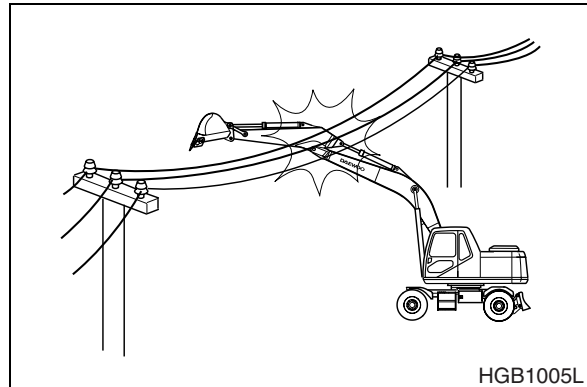


Figure 23

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

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

OPERATE CAREFULLY ON SNOW, ICE AND IN VERY COLD TEMPERATURES

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

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

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

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

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

OPERATIONS ON SLOPES

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

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

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

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

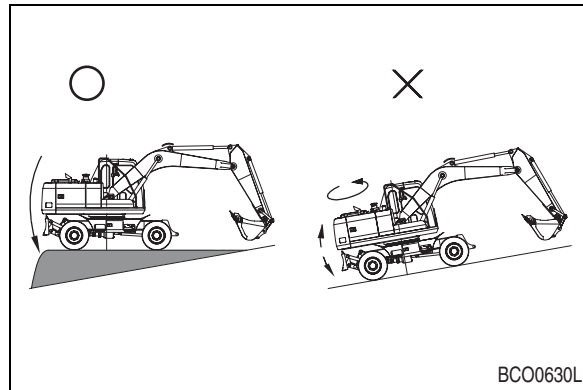


Figure 24

PARKING MACHINE

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

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

Always close the door of the operator's compartment.

NEVER LET ANYONE RIDE ON ATTACHMENT

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

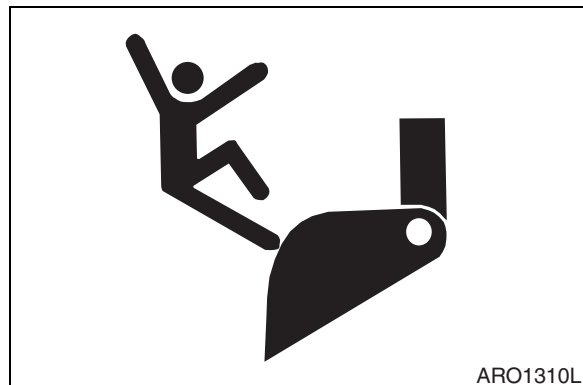


Figure 25

MAINTENANCE

WARNING TAG

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

Warning tags, for controls are available from Daewoo distributors.



Figure 26

CLEAN BEFORE INSPECTION OR MAINTENANCE

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

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

When washing the machine, do the following;

- Wear shoes with nonslip soles to prevent yourself from slipping and falling on wet places.
- Wear safety glasses and protective clothing when washing the machine with high-pressure steam.
- Take action to prevent touching high-pressure water and cutting your skin or having mud fly into your eyes.
- Do not spray water directly on electrical components (sensors, connector) (1, Figure 27). If water gets into the electrical system, there is danger that it will cause defective operation and malfunction.

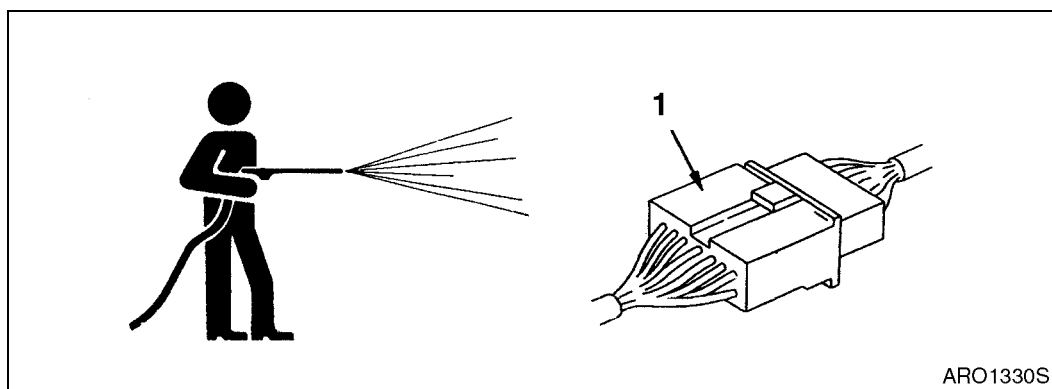


Figure 27

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

PROPER TOOLS

Use only tools suited to the task. Using damaged, low 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.

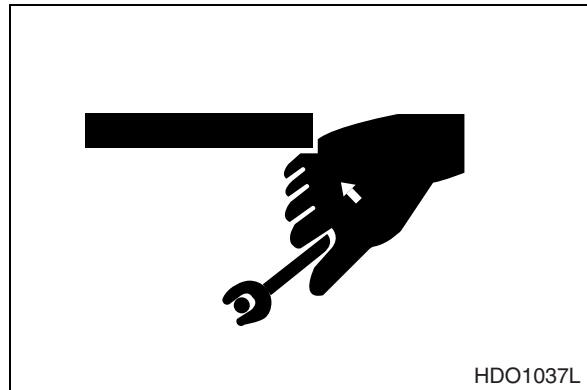


Figure 28

USE OF LIGHTING

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

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

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

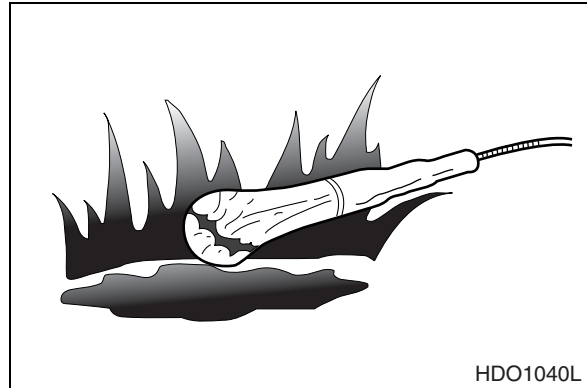


Figure 29

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 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.

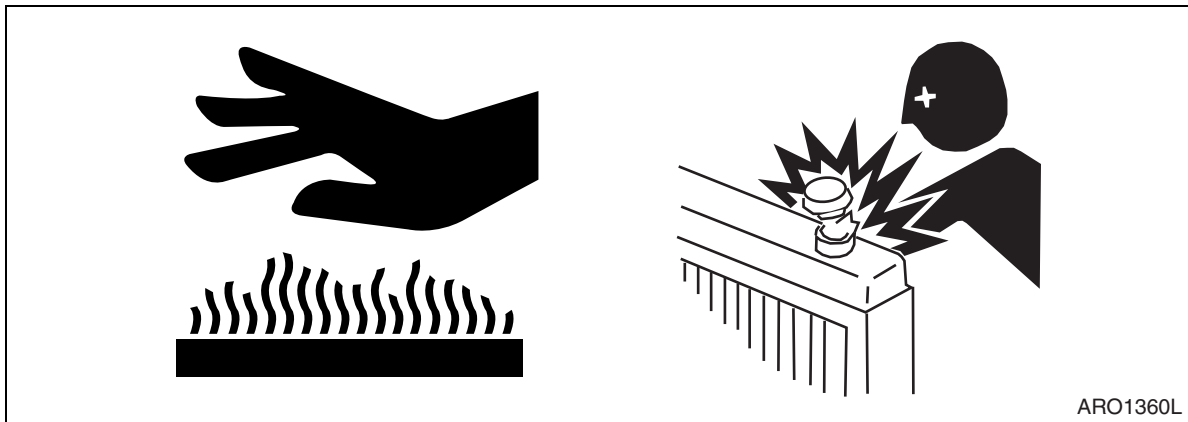


Figure 30

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

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

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

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

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

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

Batteries give off flammable fumes that can explode.

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

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

Always wear protective glasses when you work on batteries.

WELDING REPAIRS

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

The qualified welder must do the following;

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

WARNING FOR COUNTERWEIGHT AND FRONT ATTACHMENT REMOVAL



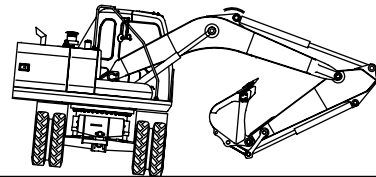
DANGER!

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

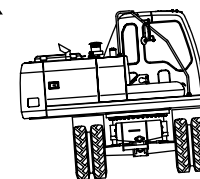
Never remove the counterweight or front attachment unless the upper structure is in-line with the lower structure.

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

X



X



BCO0890L

Figure 31

PRECAUTIONS FOR REMOVAL, INSTALLATION, AND STORAGE OF ATTACHMENTS

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

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

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

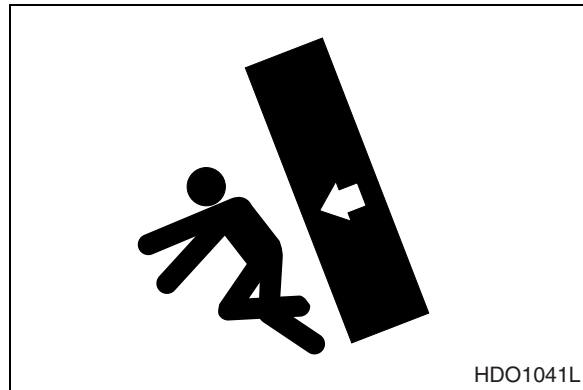


Figure 32

PRECAUTIONS WHEN WORKING ON MACHINE

When carrying out maintenance operations on the machine, keep the area around your feet clean and tidy to prevent you from falling. Always do the following;

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

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

If the job requires it, wear protective clothing.

To prevent injury from slipping or falling, when working on the hood or covers, never use any part except the inspection passage fitted with nonslip pads.



Figure 33

LOCK INSPECTION COVERS

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

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

CRUSHING PREVENTION AND CUTTING PREVENTION

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

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

Stay clear of all rotating parts and moving parts.

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

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

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

SUPPORTS AND BLOCKING FOR WORK EQUIPMENT

Do not allow weight or equipment loads to remain suspended. Lower everything to the ground before leaving the operator's seat. Do not use hollow, cracked or unsteady, wobbling weight supports. Do not work under any equipment supported solely by a lift jack.



Figure 34

ACTION WHEN ABNORMALLY IS FOUND DURING INSPECTION

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

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

PRECAUTIONS WITH HIGH PRESSURE LINE, TUBES AND HOSES

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

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

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

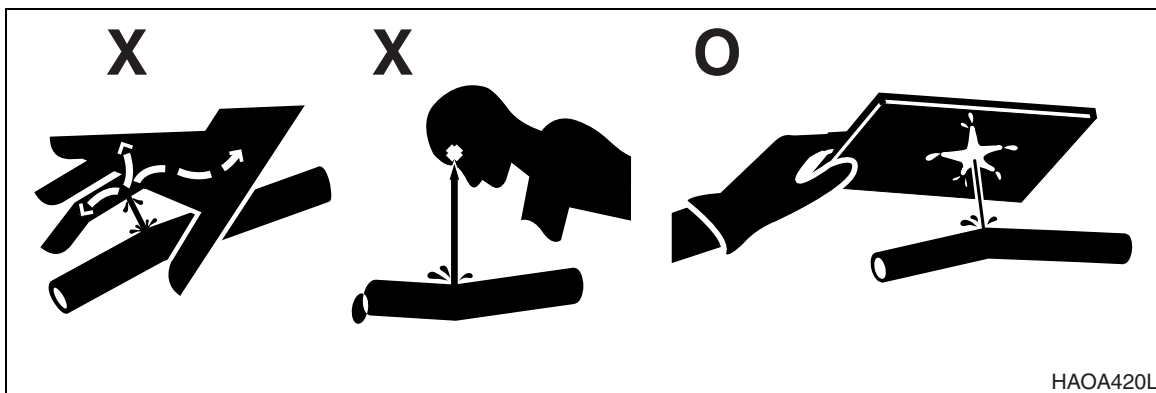


Figure 35

WASTE MATERIALS

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

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

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

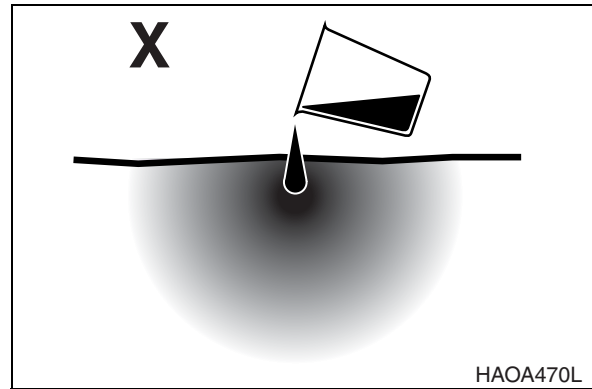


Figure 36

BATTERY

BATTERY HAZARD PREVENTION

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

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

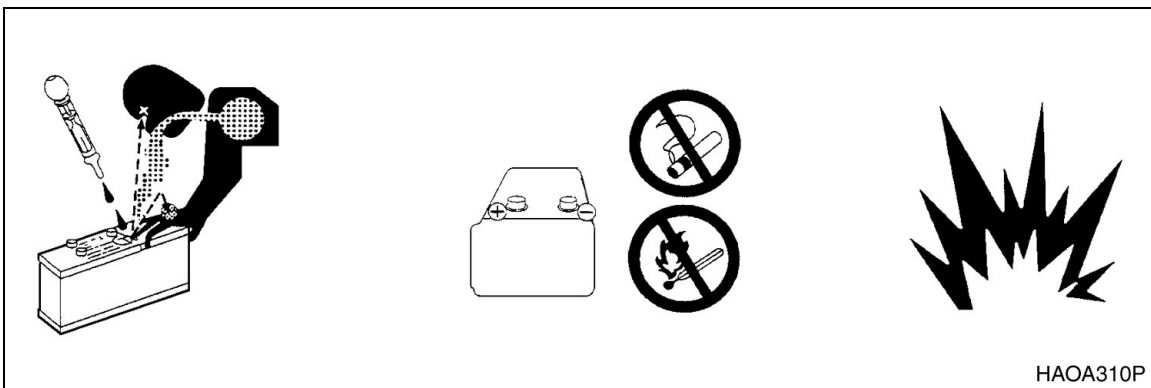


Figure 37

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 non series-connected positive terminals and between the negative terminal of the booster battery and the metal frame of the machine being boosted or charged. Refer to the procedure and illustration in "Starting Engine With a Booster Cable" in the Operation and Maintenance Manual.
- Connect positive cable first when installing cables and disconnect the negative cable first when removing them. The final cable connection, at the metal frame of the machine being charged or boost-started, should be as far away from the batteries as possible.

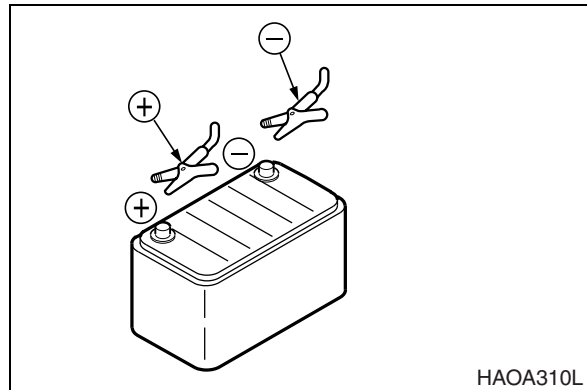


Figure 38

TOWING

PRECAUTIONS WHEN TOWING

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

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

SHIPPING AND TRANSPORTATION

OBEY STATE AND LOCAL OVER-THE-ROAD REGULATIONS

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

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

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

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

LIFTING WITH SLING



WARNING!

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

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

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

SPECIFICATIONS



SPECIFICATIONS FOR S140W-V / 160W-V



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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GENERAL DESCRIPTION

The excavator has three main component sections:

- The Upper Turntable
- The Lower Undercarriage and Power Train
- The Excavator Front-end Attachment

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

COMPONENT LOCATION

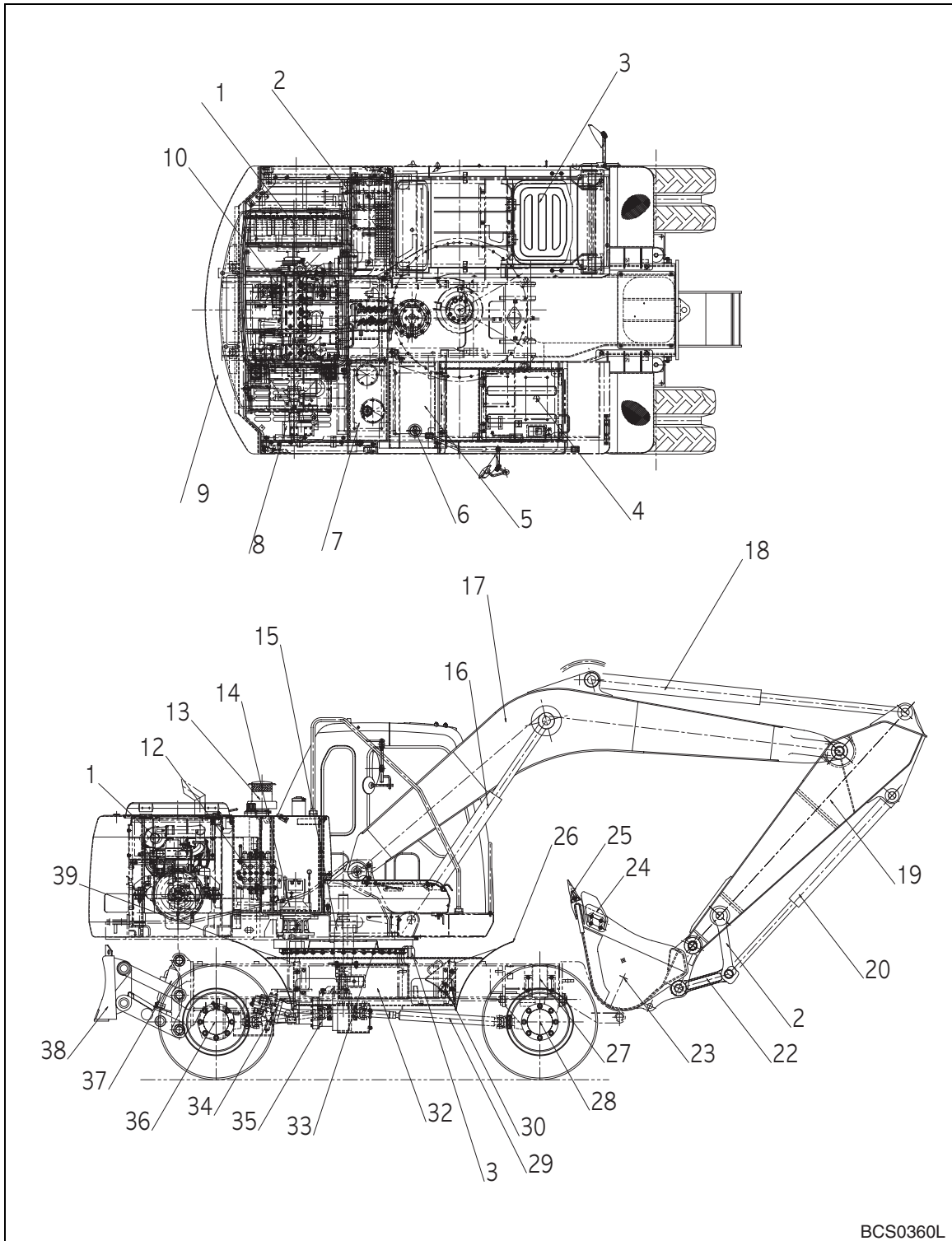


Figure 1

Reference Number	Description
1	Radiator and Oil Cooler
2	Air Cleaner
3	Cab
4	Battery
5	Fuel Tank
6	Fuel Tank Fill Cap
7	Hydraulic Oil Tank
8	Pumps
9	Counterweight
10	Engine
11	Muffler
12	Control Valve
13	Precleaner
14	Swing Motor
15	Center Joint
16	Boom Cylinder
17	Boom
18	Arm Cylinder
19	Arm
20	Bucket Cylinder

Reference Number	Description
21	Guide Link
22	Link
23	Bucket
24	Side Cutter
25	Bucket Tooth
26	Fender
27	Ram Cylinder
28	Front Axle
29	Drive Shaft
30	Wheel Chocks
31	Swing Lock
32	Step
33	Swing Bearing
34	Travel Motor
35	Transmission
36	Rear Axle
37	Blade Cylinder
38	Dozer Blade
39	Fender

SOLAR 140W-V

GENERAL DIMENSIONS

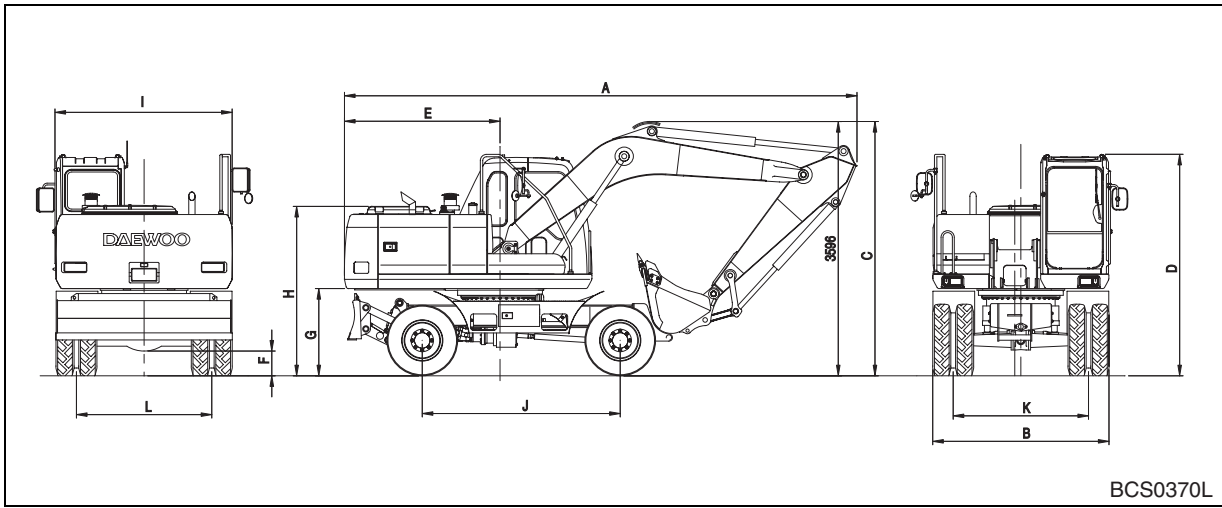


Figure 2

General Dimensions		
Reference	Description	Dimension
A	Shipping Length	7,250 mm (285.4 in)
B	Shipping Width	2,493 mm (98.1 in)
C	Shipping Height (Boom)	3,640 mm (143.3 in)
D	Height Over Cab	3,116 mm (122.7 in)
E	Counter Weight Swing Clearance	2,210 mm (87 in)
F	Ground Clearance	350 mm (13.8 in)
G	Frame Clearance	1,241 mm (48.9 in)
H	Engine Cover Height	2,445 mm (96.3 in)
I	Upper Housing Width	2,494 mm (98.2 in)
J	Wheel Base	2,800 mm (110.2 in)
K, L	Tread Width	1,914 mm (75.4 in)

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.

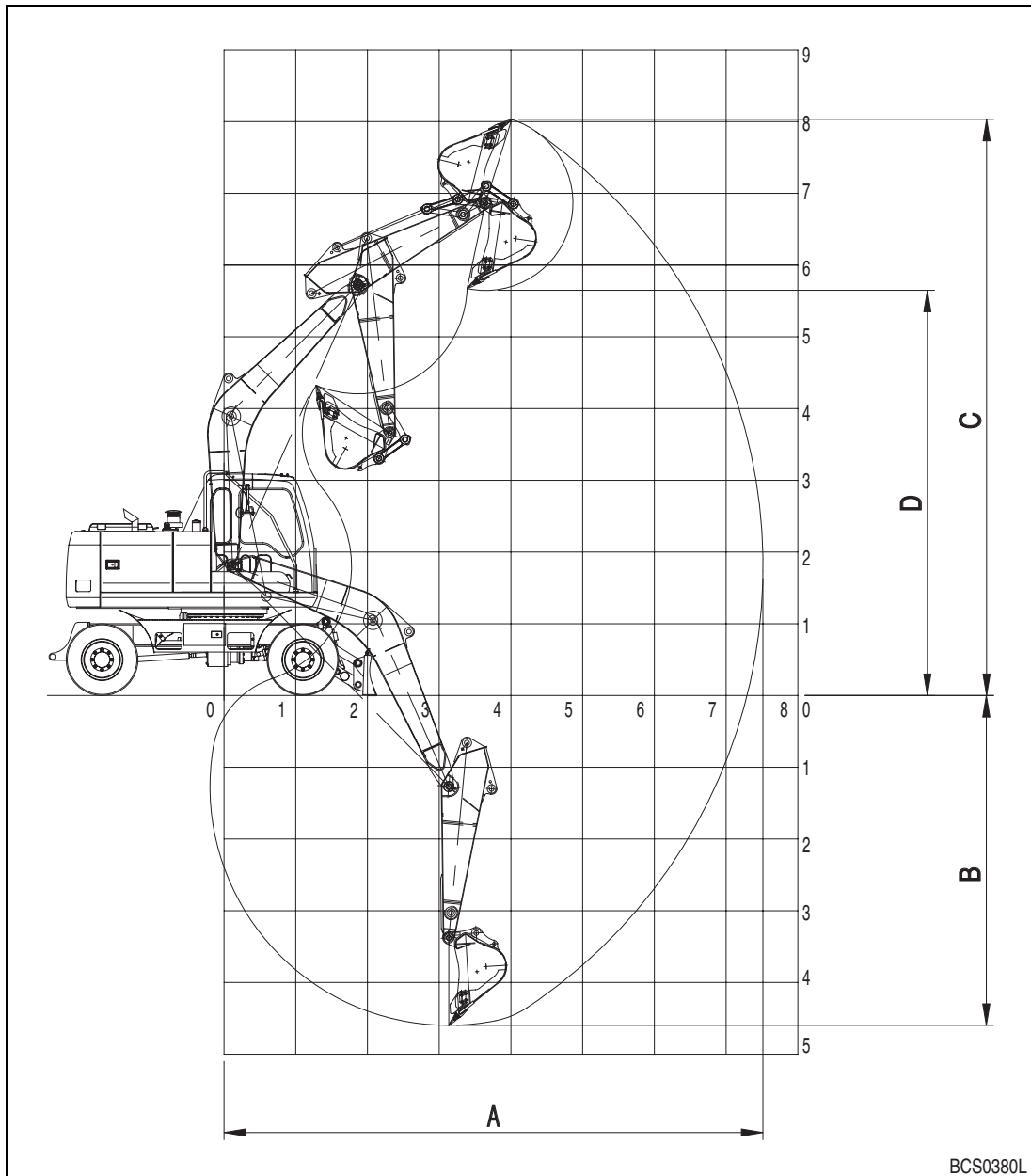


Figure 3

Reference	Description	Dimension
A	Maximum Digging Radius	7,510 mm (24' 8")
B	Maximum Digging Depth	4,610 mm (15' 1")
C	Maximum Digging Height	8,020 mm (26' 4")
D	Maximum Dump Height	5,630 mm (18' 6")

SOLAR 160W-V

GENERAL DIMENSIONS

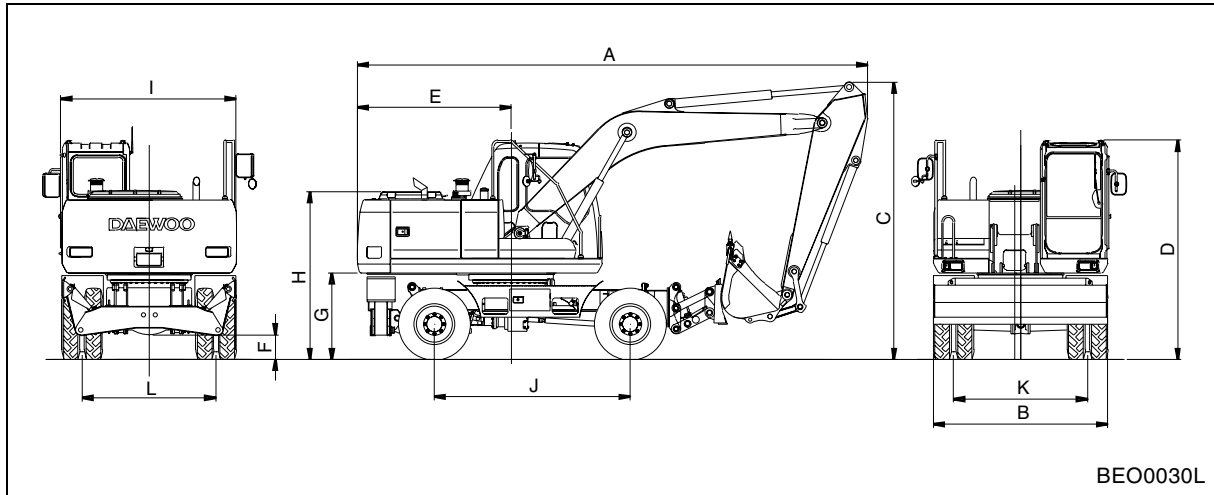


Figure 4

General Dimensions				
Reference	Description	Dimension		
		Standard	Option 1	Option 2
A	Shipping Length	7,290 mm (23' 9")	7,232 mm (23' 7")	7,239 mm (23' 8")
B	Shipping Width	2,496 mm (8' 2")		
C	Shipping Height	3,962 mm (12' 10")	4,124 mm (13' 5")	3,824 mm (12' 6")
D	Height Over Cab	3,116 mm (10' 2")		
E	Counter Weight Swing Clearance	2,210 mm (7' 3")		
F	Ground Clearance	350 mm (1' 2")		
G	Frame Clearance	1,241 mm (4' 1")		
H	Engine Cover Height	2,403 mm (7' 9")		
I	Upper Housing Width	2,494 mm (8' 2")		
J	Wheel Base	2,800 mm (9' 2")		
K, L	Tread Width	1,914 mm (6' 3")		

* Standard: 4.6 m mono boom, 2.5 m arm and SAE 0.58 m³ (CECE 0.5 m³) bucket.

Option 1: 4.6 m mono boom, 3.0 m arm and SAE 0.51 m³ (CECE 0.45 m³) bucket.

Option 2: 4.952 m articulated boom, 2.5 m arm and SAE 0.51 m³ (CECE 0.45 m³) bucket.

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.

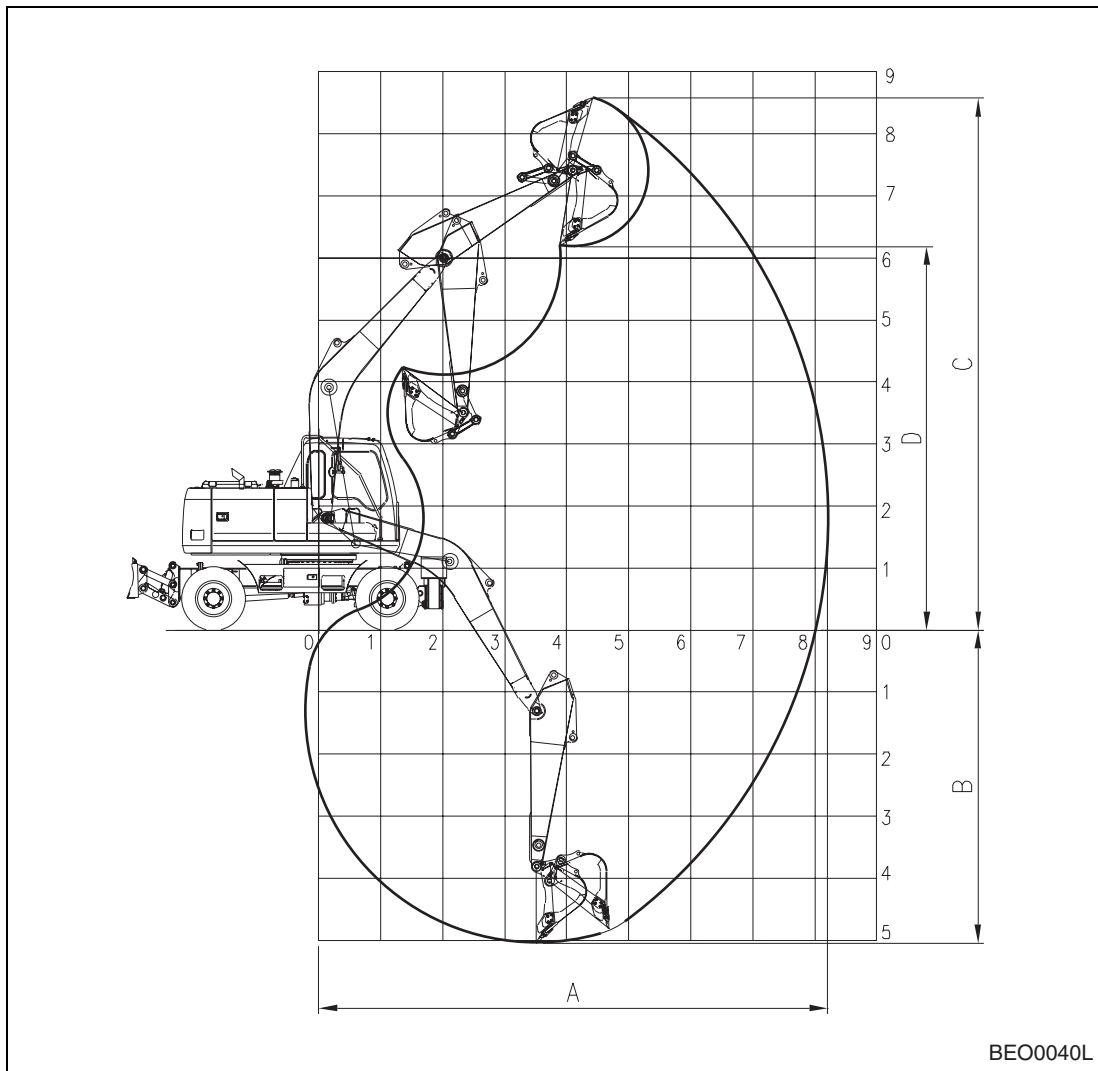


Figure 5

Reference	Description	Dimension		
		Standard	Option 1	Option 2
A	Maximum Digging Radius	8,208 mm (26' 9")	8,720 mm (28' 6")	8,708 mm (8' 5")
B	Maximum Digging Depth	5,056 mm (16' 6")	5,513 mm (18' 1")	5,483 mm (17' 10")
C	Maximum Digging Height	8,565 mm (28' 1")	9,009 mm (29' 6")	9,481 mm (31' 1")
D	Maximum Dump Height	6,170 mm (20' 2")	6,596 mm (21' 6")	7,044 mm (23' 1")

* Standard: 4.6 m mono boom, 2.5 m arm and SAE 0.58 m³ (CECE 0.5 m³) bucket.

Option 1: 4.6 m mono boom, 3.0 m arm and SAE 0.51 m³ (CECE 0.45 m³) bucket.

Option 2: 4.952 m articulated boom, 2.5 m arm and SAE 0.51 m³ (CECE 0.45 m³) bucket.

FRONT LINKAGE PIN SIZE

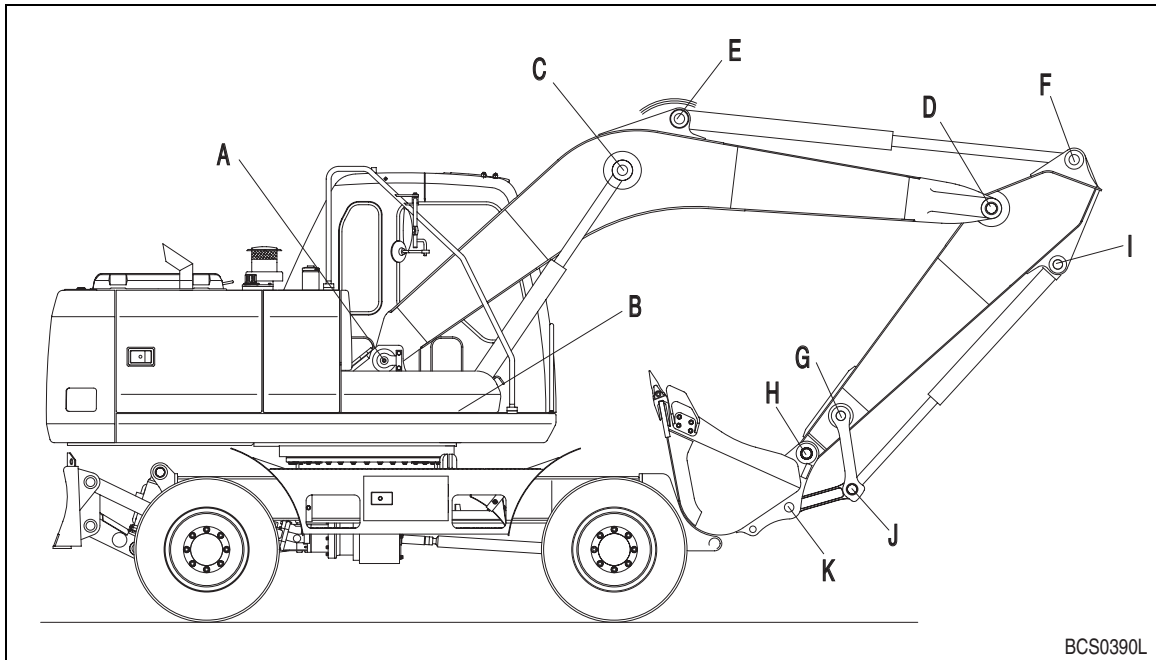


Figure 6

Point	Diameter	Length
A	71.0 mm (2.80 in)	651.0 mm (25.63 in)
B	71.0 mm (2.80 in)	176.0 mm (6.93 in)
C	71.0 mm (2.80 in)	670.0 mm (26.38 in)
D	71.0 mm (2.80 in)	413.0 mm (16.26 in)
E	71.0 mm (2.80 in)	201.0 mm (7.91 in)
F	71.0 mm (2.80 in)	201.0 mm (7.91 in)
G	65.0 mm (2.56 in)	380.0 mm (14.96 in)
H	65.0 mm (2.56 in)	431.0 mm (16.97 in)
I	71.0 mm (2.80 in)	187.0 mm (7.36 in)
J	71.0 mm (2.80 in)	380.0 mm (14.96 in)
K	65.0 mm (2.56 in)	431.0 mm (16.97 in)

HYDRAULIC CYLINDERS

	Boom	Arm	Bucket	Blade	Stabilizer	Chocking
Quantity	2	1	1	2	2	2
Bore	110 mm (4.33 in)	110 mm (4.33 in)	95 mm (3.74 in)	100 mm (3.94 in)	110 mm (4.33 in)	80 mm (3.15 in)
Stroke	1030 mm (40.55 in)	1085 mm (42.72 in)	885 mm (34.84 in)	197 mm (7.75 in)	310 mm (12.20 in)	140 mm (5.51 in)
Rod Dia.	75 mm (2.95 in)	75 mm (2.95 in)	65 mm (2.56 in)	60 mm (2.36 in)	70 mm (2.76 in)	80 mm (3.15 in)
Closed Length	1525 mm (60.04 in)	1660 mm (65.35 in)	1365 mm (53.74 in)	546 mm (21.50 in)	800 mm (31.50 in)	331 mm (13.03 in)
Retract. Cushion	X	O	X	X	X	X
Extend. Cushion	O	O	O	X	X	X
Maker	Dongyang	Dongyang	Dongyang	Dongyang	Dongyang	Dongyang

ENGINE SPECIFICATIONS

Model	Daewoo DB58TIS
Type	4 Cycle In-line 6 Cylinder Diesel, Turbo Charged
Engine Block	
Combustion Chamber	Reentrant
Combustion System	Direct Injection
Cylinder Bore and Stroke	102 mm x 118 mm (4.00 in x 4.60 in)
Engine Displacement	5,785 cm ³ (353 in ³)
Direction of Rotation	Counterclockwise (viewed facing flywheel)
Compression Ratio	19.5: 1
Compression Pressure (Engine Cylinder No-Load Test Pressure)	31 kg/cm ² (440 psi) @ 200 rpm
Cylinder Firing Order	1-5-3-6-2-4
Engine Valve Cold Lash Adjustment	0.4 mm (0.0157 in), intake and exhaust
Valve Timing	Intake Open @ 10° BTDC
	Intake Close @ 42° ABDC
	Exhaust Open @ 50° BTDC
	Exhaust Close @ 10° ABDC
Rated Flywheel Horsepower	135 PS @ 2,200 rpm, per DIN 6270;
Minimum No-Load rpm	1100 ±25 rpm
Torque Output	500 N•m, or 51 kg•m @ 1,600 rpm (369 ft lb @ 1,600 rpm)
Mass (Dry)	460 kg (1014 lb)
Fuel System	
Fuel Injection Pump	in-line T Type
Fuel Injection Opening Pressure	190 kg/cm ² (2,702 psi)
Fuel Injection Timing	9° BTDC
Cooling System	
Injector Nozzle Type	Multihole (6 hole-ø0.235)
Lubrication System	
Fuel Filter	Paper, Element Center Bolt
Governor	Mechanical (RSV)
Fuel Consumption	175 g per Hp/hr, @ 2,200 rpm, per DIN 6271
Engine Oil Capacity	19 l (20 qt)
Engine Oil Pressure	4 kg/cm ² (56.9 psi)
Engine Oil	American Petroleum Institute/SAE Class CC/CD or better (Class CD-II, CE, CF-4, CG-4)
Coolant Capacity (Engine only)	12 l (12.7 qt)
Engine Coolant Thermostat	Wax-Pellet Type
Coolant, Thermostat Opening	71°C (160°F)

Model	Daewoo DB58TIS
Electrical System	
Batteries	2 x 12 V, 100 AH
Charging System Regulator	IC Type (Integrated Circuit)
Alternator	60 amp, 24 V (IC Type)
Starter	4.5 Kw, 24 V, Magnet Type

ENGINE PERFORMANCE CURVES (PER DIN 6270 STANDARD)

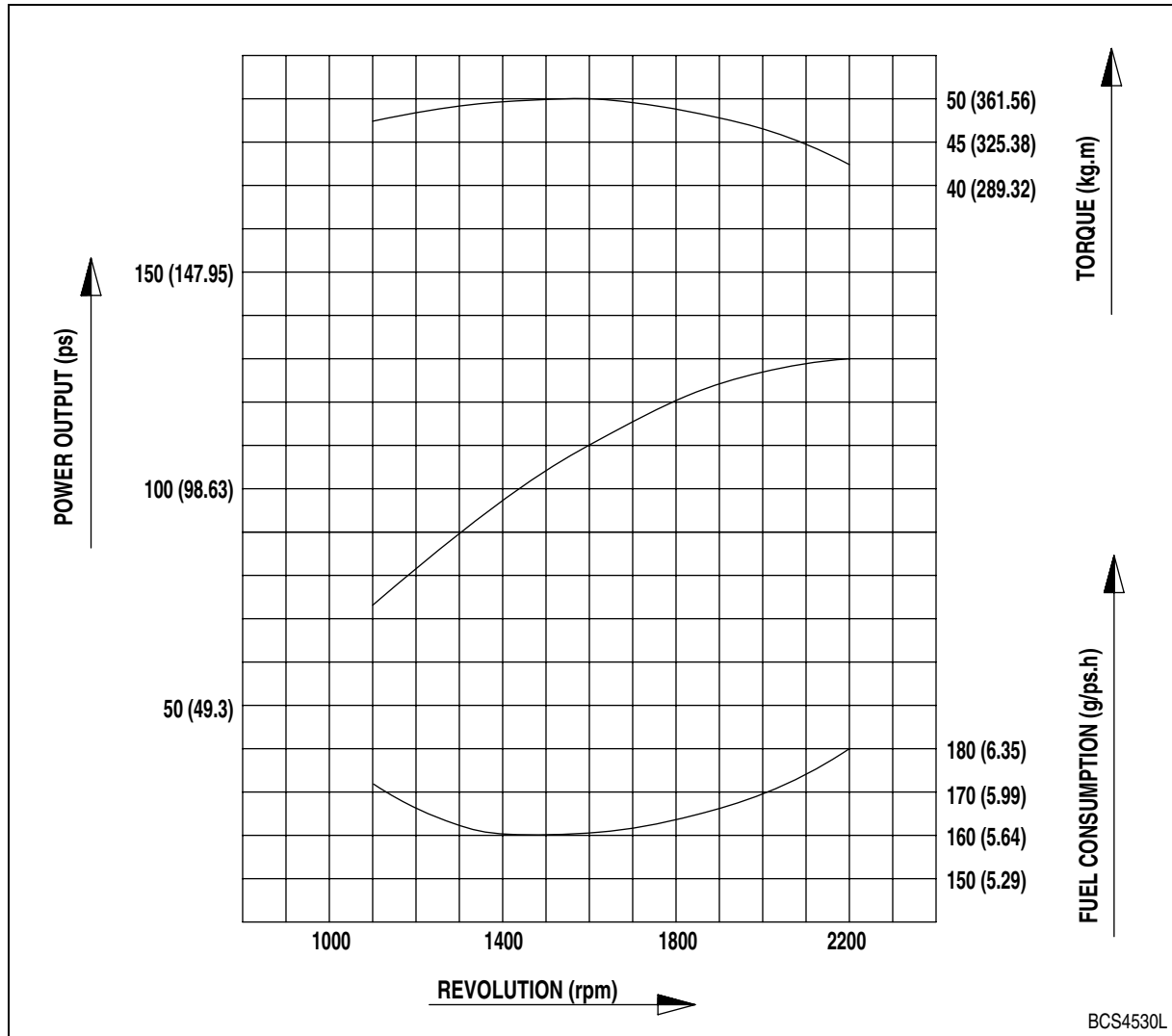


Figure 7

Condition	Specification
Barometric Pressure	760 mm Hg [20°C (68°F)]
Cooling Fan	Not Installed
Alternator	24V x 50A
Air Cleaner	Installed
Muffler	Installed

Performance Standard	DIN 6270
Power (Max, Rated)	135.0 ps (133.15 hp) / 2200 rpm
Max. Torque	51 kg•m (369 ft lb) / 1400 rpm
Fuel Consumption (Min. Rated)	175.0 g/ps•h (6.17 oz/hp•h)

APPROXIMATE WEIGHT OF WORKLOAD MATERIALS

IMPORTANT

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

MATERIAL	LOW WEIGHT OR DENSITY 1,100 KG/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
Charcoal	401 kg/m ³ (695 lb/yd ³)	-----	-----
Coke, blast furnace size	433 kg/m ³ (729 lb/yd ³)	-----	-----
Coke, foundry size	449 kg/m ³ (756 lb/yd ³)	-----	-----
Coal, bituminous slack, piled	801 kg/m ³ (1,350 lb/yd ³)	-----	-----
Coal, bituminous r. of m., piled	881 kg/m ³ (1,485 lb/yd ³)	-----	-----
Coal, anthracite	897 kg/m ³ (1,512 lb/yd ³)	-----	-----
Clay, DRY, in broken lumps	1,009 kg/m ³ (1,701 lb/yd ³)	-----	-----
Clay, DAMP, natural bed	-----	1,746 kg/m ³ (2,943 lb/yd ³)	-----
Cement, Portland, DRY granular	-----	1,506 kg/m ³ (2,583 lb/yd ³)	-----
Cement, Portland, DRY clinkers	-----	1,362 kg/m ³ (2,295 lb/yd ³)	-----
Dolomite, crushed	-----	1,522 kg/m ³ (2,565 lb/yd ³)	-----
Earth, loamy, DRY, loose	-----	1,202 kg/m ³ (2,025 lb/yd ³)	-----

MATERIAL	LOW WEIGHT OR DENSITY 1,100 KG/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, DRY, packed	-----	1,522 kg/m ³ (2,565 lb/yd ³)	-----
Earth, WET, muddy	-----	-----	1,762 kg/m ³ (2,970 lb/yd ³)
Gypsum, calcined, (heated, powder)	961 kg/m ³ (1,620 lb/yd ³)	-----	-----
Gypsum, crushed to 3 inch size	-----	1,522 kg/m ³ (2,565 lb/yd ³)	-----
Gravel, DRY, packed fragments	-----	-----	1,810 kg/m ³ (3,051 lb/yd ³)
Gravel, WET, packed fragments	-----	-----	1,922 kg/m ³ (3,240 lb/yd ³)
Limestone, graded above 2	-----	1,282 kg/m ³ (2,160 lb/yd ³)	-----
Limestone, graded 1-1/2 or 2	-----	1,362 kg/m ³ (2,295 lb/yd ³)	-----
Limestone, crushed	-----	1,522 kg/m ³ (2,565 lb/yd ³)	-----
Limestone, fine	-----	-----	1,602 kg/m ³ (2,705 lb/yd ³)
Phosphate, rock	-----	1,282 kg/m ³ (2,160 lb/yd ³)	-----
Salt	929 kg/m ³ (1,566 lb/yd ³)	-----	-----
Snow, light density	529 kg/m ³ (891 lb/yd ³)	-----	-----
Sand, DRY, loose	-----	1,522 kg/m ³ (2,565 lb/yd ³)	-----
Sand, WET, packed	-----	-----	1,922 kg/m ³ (3,240 lb/yd ³)

MATERIAL	LOW WEIGHT OR DENSITY 1,100 KG/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
Shale, broken	-----	1,362 kg/m ³ (2,295 lb/yd ³)	-----
Sulphur, broken	529 kg/m ³ (1,620 lb/yd ³)	-----	-----

GENERAL SPECIFICATIONS

Shipping Weight	12,700.0 kg (27,999 lb), includes 10% fuel, 4,300 mm (14' 1") mono boom, 2,100 mm (6' 11") arm, 1,050 mm (3' 5") backhoe bucket and dozer
Counterweight	1,600 kg (3,527 lb)
Upper Turntable	4,200 kg (9,259 lb)
Lower Turntable (Including Swing Bearing)	4,750 kg (10,472 lb)
Operating Weight	12,900 kg (28,440 lb) with full fuel tank and operator
Mono Boom	740 kg (1,631 lb)
Long Mono Boom (Opt), 4,600 mm	780 kg (1,720 lb)
Articulated Boom (Lower)	360 kg (794 lb)
Articulated Boom (Upper)	681 kg (1,501 lb)
Boom Cylinders	110 kg (243 lb) each
Arm (Std.), 2,100 mm (6' 11")	350 kg (772 lb)
Long Arm (Opt), 2,250 mm (7' 5")	380 kg (838 lb)
Long Arm (Opt), 2,500 mm (7' 5")	410 kg (904 lb)
Long Arm (Opt), 3,000 mm (7' 5")	460 kg (1,014 lb)
Short Arm (Opt), 1,900 mm (6' 3")	320 kg (705 lb)
Arm Cylinder	146 kg (322 lb)
Bucket (Standard) 0.50 m ³ (0.65 yd ³)	450 kg (992 lb)
Bucket Cylinder	88 kg (194 lb)
Dozer (Standard)	370 kg (816 lb)
Dozer Cylinder	40 kg (88 lb) each
Stabilizer (Option)	560 kg (1,235 lb)
Stabilizer Cylinder (Option)	50 kg (110 lb) each
Digging Forces:	
Bucket Cylinder	81.7 KN or 8,336 kg (18,378 lb) (with 2,100 mm [6' 11"] or 1,900 mm [6' 3"] arm)
Arm Cylinder	65.2 KN or 6,652 kg (14,665 lb) with 2,100 mm (6' 11") standard arm, 69.3 KN or 7,073 kg (15,593 lb) with 1,900 mm (6' 3") optional short arm, or 62.7 KN or 6,400 kg (14,110 lb) with 2,250 mm (7' 5") optional long arm, 60.9 KN or 6,210 kg (13,691 lb) with 2,500 mm (8' 2") optional long arm, or 54.6 KN or 5,570 kg (12,280 lb) with 3,000 mm (8' 10") optional arm.
Fuel Tank Capacity	280.0 liters (74 U.S. gal.)
Hydraulic Reservoir Capacity	168.0 liters (44.35 U.S. gal.)
Bucket Heaped Capacity Range	PCSA 0.3 - 0.76 m ³ (2/5 - 1 yd ³)
	IMPORTANT: Refer to the Load Weight, Bucket and Arm Length Compatibility Table for information on which bucket sizes may be used safely with which arm length, for load material weights.

Undercarriage:	
Ground Clearance	350 mm (13.8")
Wheel Base	2,800 mm (9' 2")
Overall Width	2,494 mm (8' 2")
Dozer Blade Width	2,495 mm (8' 2")
Tire Size (Std. Double)	8 x 9.00 - 20 - 14PR (OTR)
Tire Size (Opt. Double)	8 x 10.00 - 20 - 14PR (OTR)
Tire Size (Opt. Single)	4 x 18.00 - 19.5 - 14PR (OTR)
Transport Dimensions:	
Overall Shipping Length (standard boom and arm)	7,250 mm (23' 9")
Overall Shipping Width	2,495 mm (8' 2")
Overall Shipping Height (to top of cylinder hose)	3,640 mm (11' 11")
Transport Loading Ramp	15° angle.
Allowable Slope	CAUTION: Refer to Transport Procedure for Safe Shipping Instructions

HYDRAULIC SYSTEM COMPONENT SPECIFICATIONS

Pilot Pump Type: Displacement: Max Flow Rate: Relief Valve:	Gear Pump 10.0 cm ³ /rev (0.61 in ³ /rev) 22 lpm (5.8 gpm) @ 2,200 rpm 40 kg/cm ² (569 psi)
Control Valve Relief Valves (Main): Left Side Spools: (22 mm [0.87"] diameter) Right Side Spools: (22 mm [0.87"] diameter) Overload Relief Pressure:	350 kg/cm ² (4,978 psi) - travel 330 kg/cm ² (4,692 psi) - all other Dozer/Outrigger Swing Boom 2 Arm 1 Travel Option Bucket Boom 1 Arm 2 360 kg/cm ² (5,119 psi) Boom, Arm, Bucket, Dozer
Remote Travel Control Valve Type: Pressure/Stroke:	Pilot Control 30 kg/cm ² (427 psi) at 30° pedal angle
Remote Implement Control Valve Type: Pressure/Stroke:	Pilot Control 28 kg/cm ² (398 psi) at 6.5 mm (0.256") stroke
Pilot Accumulator Pilot Nitrogen Charge: Volume:	15 kg/kg/cm ² (213 psi) kg/cm ³ (19.5 in ³)
Transmission Accumulator Nitrogen Charge: Volume:	8 kg/cm ² (114 psi) 750 kg/cm ³ (45.8 in ³)
Brake Accumulator Nitrogen Charge: Volume:	30 kg/cm ² (426 psi) 750 kg/cm ³ (45.8 in ³)

SYSTEM COMPONENT SPECIFICATIONS

DRIVE SYSTEM	
Propeller Shaft (Front and Rear)	
Max. Allowable Torque	447.5 kg•m (3,237 ft lb)
Max. Joint Angle	22.5°
Max. Rotating Speed	5,000 rpm
Tire and Wheel; Standard	
Type	Double
Tire	9.00 - 20 - 14PR, OTR, Tube
Rim	7.00T x 20
Disc Offset	162 mm (6.38")
Tire and Wheel; Option	
Type	Double
Tire	10.00 - 20 - 14PR, OTR, Tube
Rim	7.00T x 20
Disc Offset	162 mm (6.38")
Tire and Wheel; Option	
Type	Wide Single
Tire	18 - 19.5 - 14PR, OTR, Tubeless
Rim	14.00 x 19.5
Disc Offset	67 mm (2.64")
SWING MECHANISM	
Swing Reduction Gear	
Drive Type	2-Stage Planetary Gear
Reduction Ratio	19.00
Max. Output Speed	102.8 rpm
Max. Output Torque	522.5 kg•m (3,779 ft lb)
Weight	74 kg (163 lb)
Pinion Gear (Built in Reduction Gear)	
Type	Spur Gear
Gear P.C.D	Dia 120 mm (4.72")
No. of Teeth	10
Module	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 960 mm (37.79") 80 Dia 28.575 mm (1.125") Dia 1,200 mm (47.24") 81 mm (3.19") 364,500 kg (803,584 lb) 210 kg (463 lb)
Swing Performance Max Swing Speed Max Swing Torque	12.5 rpm 4,224 kg•m (30,552 ft lb)
Brake Control Type Brake Torque Brake Release Pressure	Pilot Pressure, Wet Disc 22 kg•m (159 ft lb) 22 kg/cm ² (313 psi)
Swing Safety Lock Type	Manual Pin Locking
Motor Accessory Brake Time Delayer Make Up Valve Characteristic	5 (+3) 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 l (0.79 qt)
Service Brake Valve Max Output Pressure	60 kg/cm ² (853 psi)
Brake Filter Filtration Rating Bypass Valve Pressure	20 micron 3.5 kg/cm ² (50 psi)
System and Pressure System Service Brake Pressure Digging Brake Pressure Brake Distance	Full Hydraulic, Dual Line 60 kg/cm ² (853 psi) 60 kg/cm ² (853 psi) 5.8 m (19' 0") at 24 km/h (15 mi/h)

STEERING SYSTEM	
Steering Cylinder (Built-in Front Axle)	
Bore Size	80 mm (3.15")
Rod Size	40 mm (1.57")
Stroke	92 mm (3.62")
Maximum Pressure	180 kg/cm ² (2,560 psi)
CHOCKING SYSTEM	
Chocking Valve	
Maker and Model	HANIL, HIH1246
Maximum Working Pressure	400 kg/cm ² (5,689 psi)
Check Valve Cracking Pressure	2 kg/cm ² (28 psi)
Make-up Pressure	4.5 kg/cm ² (64 psi)
Oscillating Angle	± 7°

PERFORMANCE TESTS AND STANDARDS

STANDARDS

1. Main Relief Pressure;
 normal operation: 330 bar (4,786 psi);
 with high travel "Pressure Up": 350 bar (5,076 psi).
2. Actuator Speeds

Operation		Unit	Power Mode	Standard Mode
Boom	Up	Seconds	3.0 ±0.4	3.2 ±0.4
	Down	Seconds	3.0 ±0.4	3.2 ±0.4
Articulated Boom (Lower)	Up	Seconds	2.9 ±0.4	3.3 ±0.4
	Down	Seconds	3.3 ±0.4	3.3 ±0.4
Articulated Boom (Upper)	Up	Seconds	6.4 ±0.4	
	Down	Seconds	8.2 ±0.4	
Arm	Dump	Seconds	2.7 ±0.4	3.0 ±0.4
	Crowd	Seconds	2.1 ±0.4	2.3 ±0.4
Bucket	Dump	Seconds	2.0 ±0.4	2.2 ±0.4
	Crowd	Seconds	3.5 ±0.4	3.7 ±0.4
Dozer	Up	Seconds	3.0 ±0.4	
	Down	Seconds	2.5 ±0.4	
Swing (3 Revolutions)		Seconds	13.5 ±1.0	14.8 ±1.0
Stabilizer	Up	Seconds	2.5 ±0.4	
	Down	Seconds	3.0 ±0.4	
Propeller Shaft	High	rpm (Min.)	2,760 ±50	
	Low	rpm (Min.)	740 ±30	
Breaking Distance		M	5.8 @ 24 km/h (14.9 MPH)	

TESTS

Evaluation of equipment performance and operating condition can be made by running the excavator through a series of different tests, and recording results with a stop watch and tape measure. Compare results of performance tests against the specifications and standards, which are for equipment in new or renewed condition.

TEST CONDITIONS

1. All tests should be performed on a flat, level, firmly supporting ground surface.

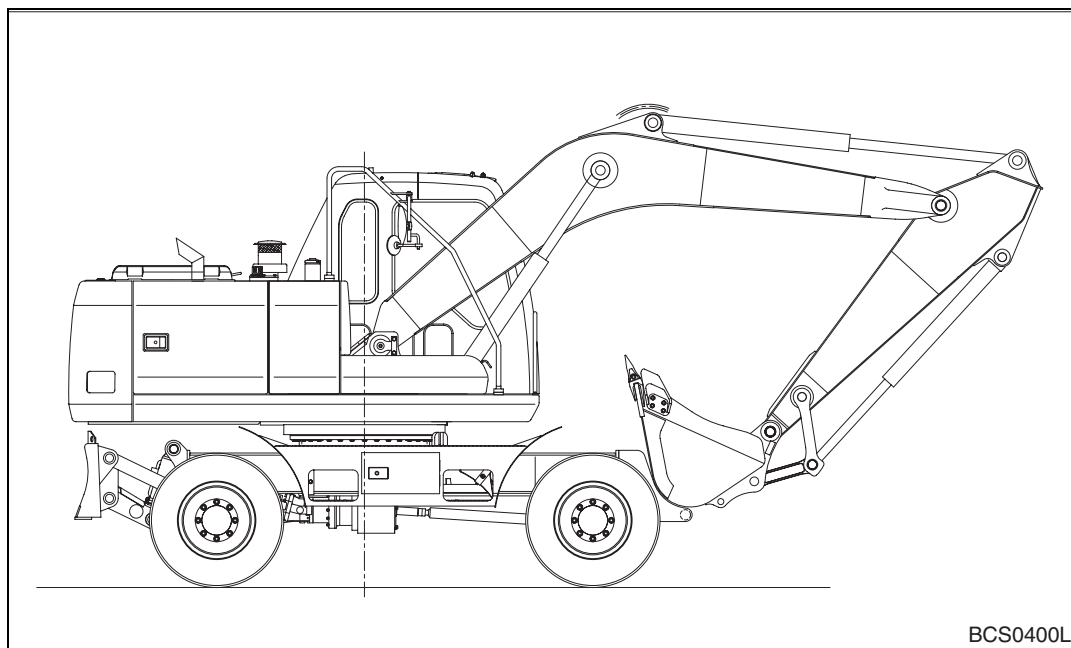


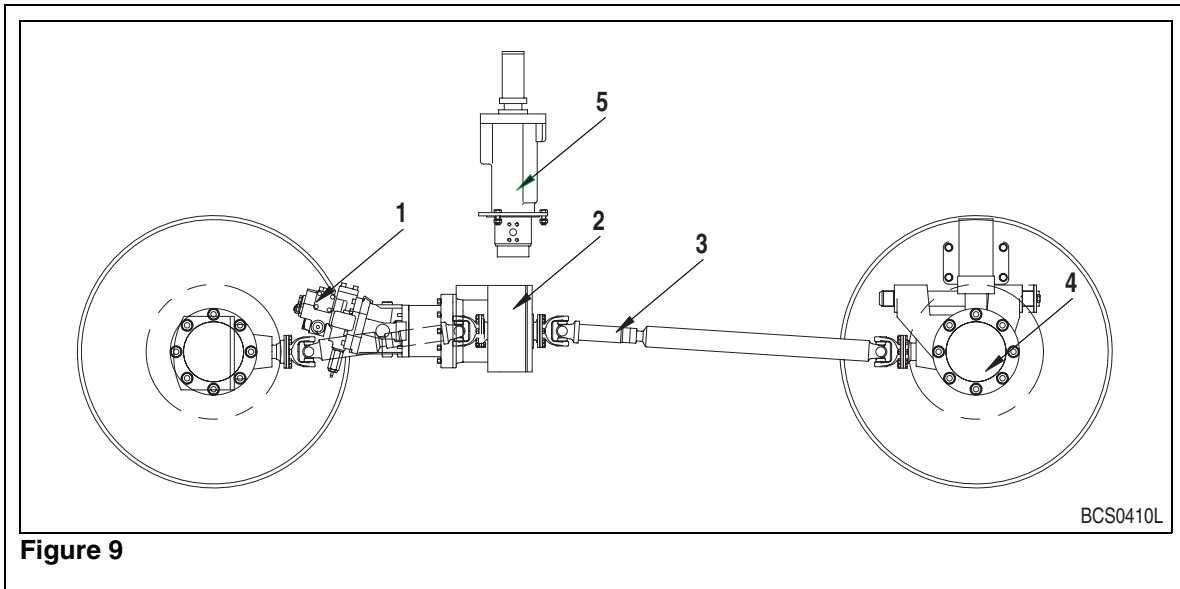
Figure 8

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

TRAVEL SPEED TESTS

Travel Mode	Speed
High Speed	37 km/h (23 MPH)
Low Speed	10 km/h (6.21 MPH)

1. Block up all wheels securely.
2. Check that rpm at drive shaft is above;
2,760 rpm at high speed and above;
740 $\pm$ 50 rpm at low speed.



1. Travel Motor
2. Transmission
3. Propeller Shaft
4. Front Axle
5. Center Joint

SWING SPEED TEST

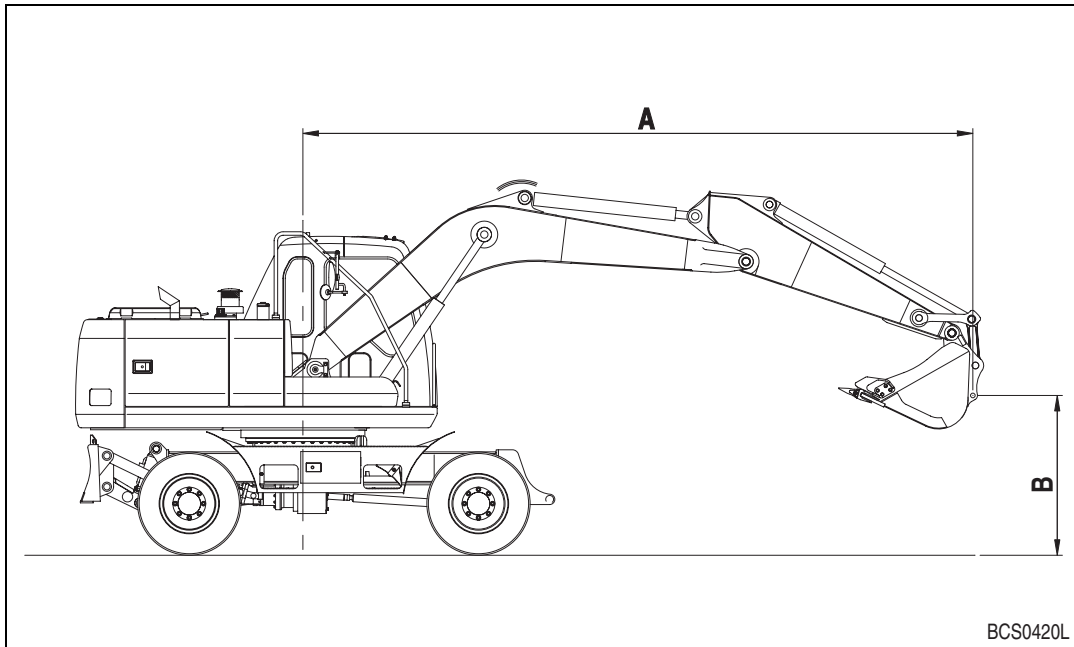


Figure 10

SWING SPEED TEST

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

Use paint marks at the same point on the turntable and undercarriage, or select alternate measuring locations and use a stopwatch to time 3 full 360° rotations. The time required for 3 revolutions is 13.5 seconds in Power Mode and 14.8 seconds in Standard Mode.

SWING DECELERATION FORCE TEST

With the boom, arm and bucket in the same position as for the swing speed test, rotate the turntable so that the boom is evenly centered, 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, at "swing stop" (4).

Record how far the turntable drifts past the stop point, measuring the distance between paint marks. Maximum distance should be less than 700 mm (27 1/2") or less, in both Power Mode H and Standard Mode.

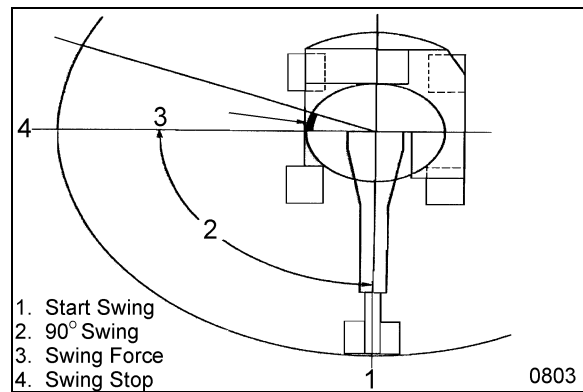


Figure 11

CYLINDER PERFORMANCE TESTS

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

BOOM CYLINDERS TEST

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

ARM CYLINDER TEST

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

BUCKET CYLINDER TEST

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

Operation	Power Mode	Standard Mode
Boom up	3.0 ±0.4 Seconds	3.2 ±0.4 Seconds
Boom down	3.0 ±0.4 Seconds	3.2 ±0.4 Seconds
Arm dump	2.7 ±0.4 Seconds	3.0 ±0.4 Seconds
Arm crowd	2.1 ±0.4 Seconds	2.3 ±0.4 Seconds
Bucket dump	2.0 ±0.4 Seconds	2.2 ±0.4 Seconds
Bucket crowd	3.5 ±0.4 Seconds	3.7 ±0.4 Seconds

HYDRAULIC CYLINDER NATURAL DROP TEST

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

Turn off the engine and measure cylinder drop after 5 minutes. 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



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
ALL MODELS	ALL RANGES

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Welding Precautions and Guidelines	3
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WELDING PRECAUTIONS AND GUIDELINES

IMPORTANT

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

WARNING!

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

CAUTION!

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



CAUTION!

Observe the following safety precautions:

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

HYDRAULIC SYSTEM - GENERAL PRECAUTIONS

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

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

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

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

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

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

IMPORTANT

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

MAINTENANCE SERVICE AND REPAIR PROCEDURE

GENERAL PRECAUTIONS

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

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

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

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

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

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

HYDRAULIC SYSTEM CLEANLINESS AND OIL LEAKS

MAINTENANCE PRECAUTIONS FOR HYDRAULIC SYSTEM SERVICE

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

Dust and other foreign contaminants are major contributors to premature wear in hydraulic circuits. The narrow tolerances, rapidly moving parts and high operating pressures of the system require that fluid be kept as clean as possible. The performance and dependability of the machine (and the service 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 up or disassembled.

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

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

IMPORTANT

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

OIL LEAKAGE PRECAUTIONS

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

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

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

NOTE: Grease lip seals before assembly.

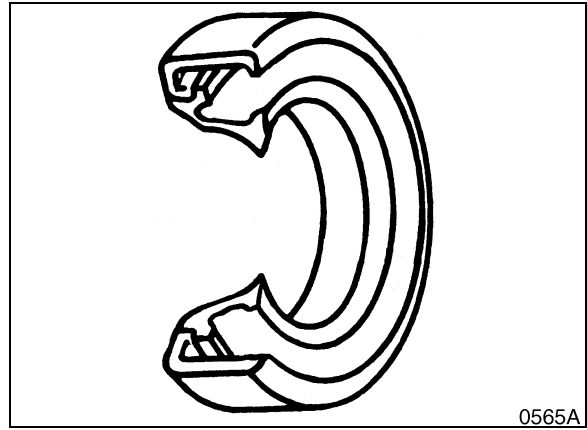


Figure 1

CLEANING AND INSPECTION

GENERAL GUIDELINES

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



WARNING!

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

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

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

4. It is more economical to replace oil seals, O-rings, sealing rings, gaskets and snap rings when unit is disassembled than waiting for premature failures; refer to latest Micro Fiche and/or Parts Book for replacement items. Be extremely careful when installing sealing members, to avoid cutting or

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

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

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

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

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

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

BEARING INSPECTION

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

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

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

After the bearings have been cleaned and dried, carefully inspect all bearing rollers, cages and cups for wear, chipping or nicks. If the bearing cannot be removed and is to be inspected in place, check 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 that the bearing has been turning in its housing or on its shaft.

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

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

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

Normal Bearing

Smooth even surfaces with no discoloration or marks.

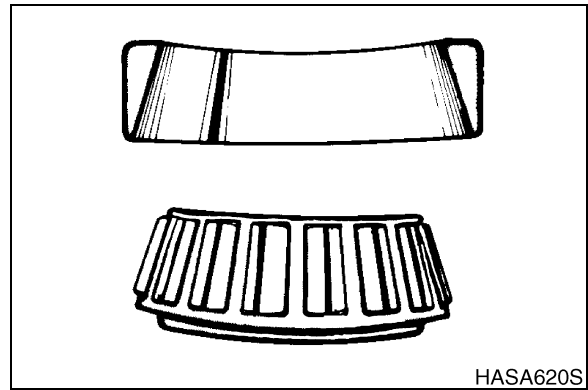


Figure 2

Bent Cage

Cage damage due to improper handling or tool usage.

Replace bearing.

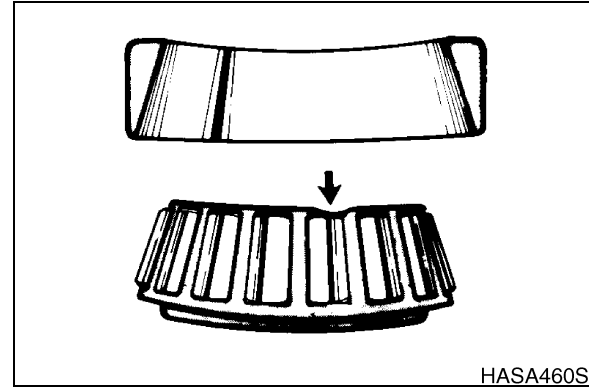


Figure 3

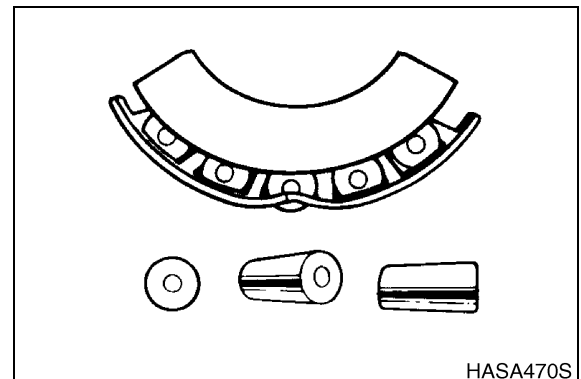


Figure 4

Galling

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

Replace bearing - check seals and check for proper lubrication.

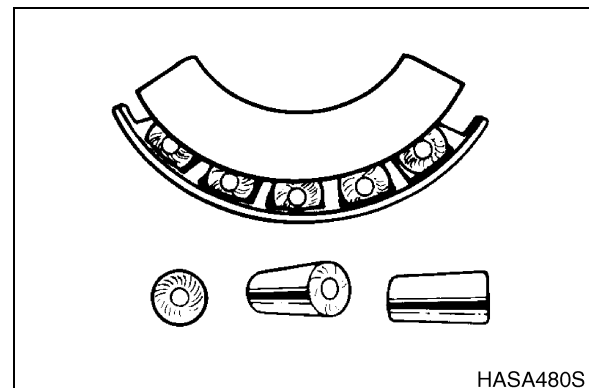


Figure 5

Abrasive Step Wear

Pattern on roller ends caused by fine abrasives.

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

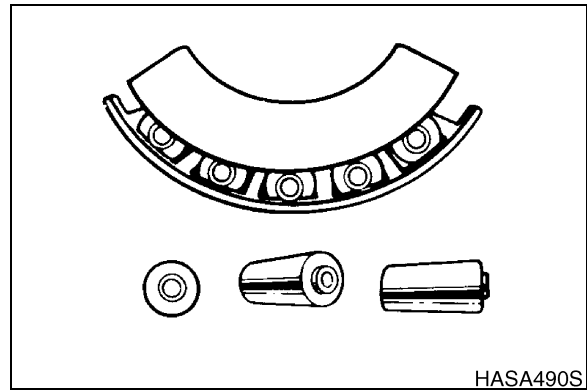


Figure 6

Etching

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

Replace bearings - check seals and check for proper lubrication.

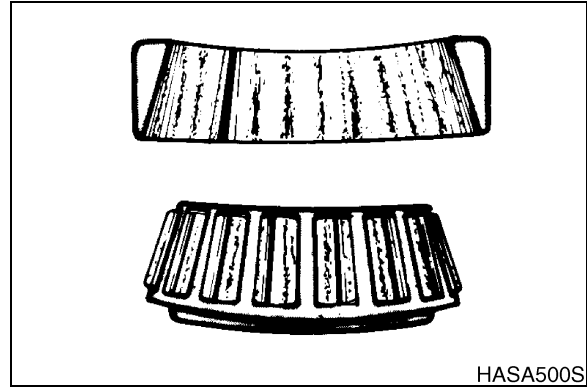


Figure 7

Misalignment

Outer race misalignment due to foreign object.

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

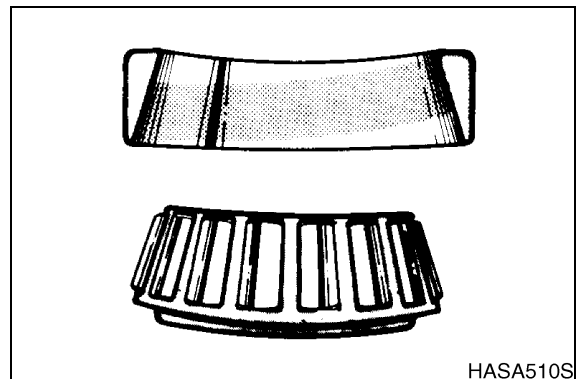


Figure 8

Indentations

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

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

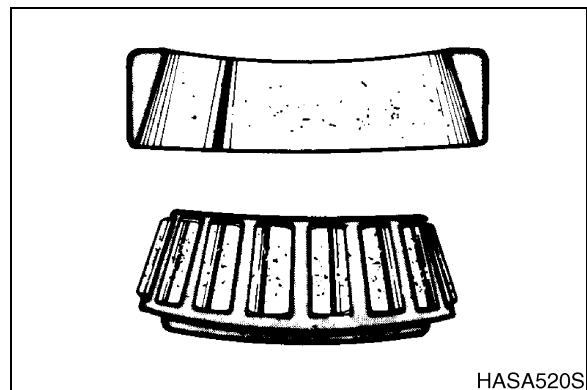


Figure 9

Fatigue Spalling

Flaking of surface metal resulting from fatigue.

Replace bearing - clean all related parts.

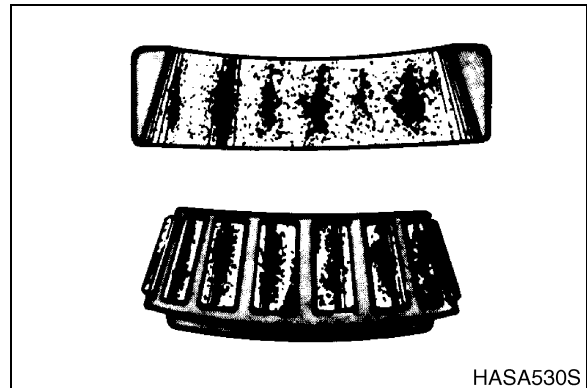


Figure 10

Brinelling

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

Replace bearing if rough or noisy.

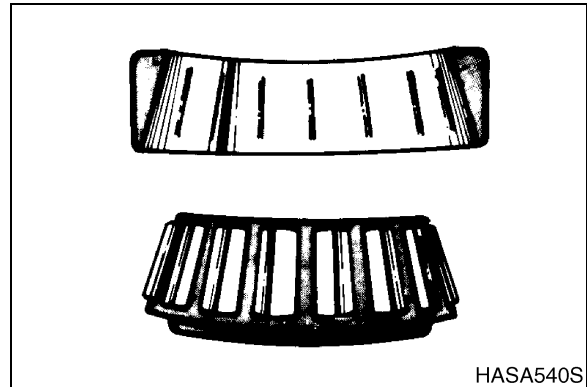


Figure 11

Cage Wear

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

Replace bearings - check seals.

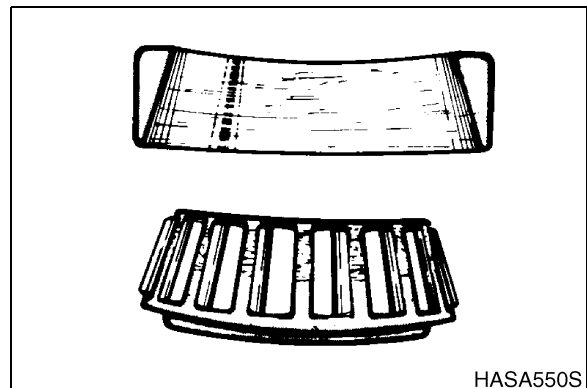


Figure 12

Abrasive Roller Wear

Pattern on races and rollers caused by fine abrasives.

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

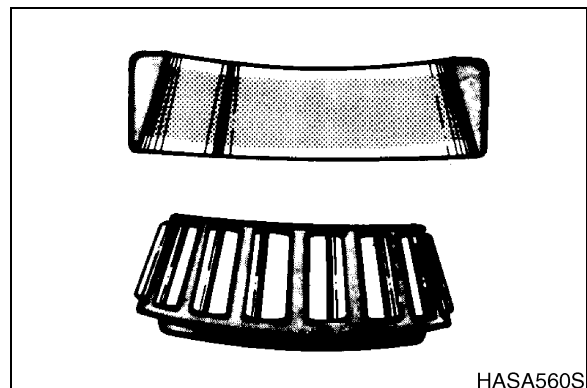


Figure 13

Cracked Inner Race

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

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

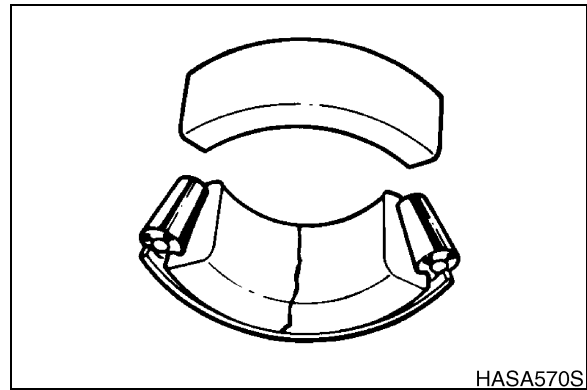


Figure 14

Smears

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

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

Replace shaft if damaged.

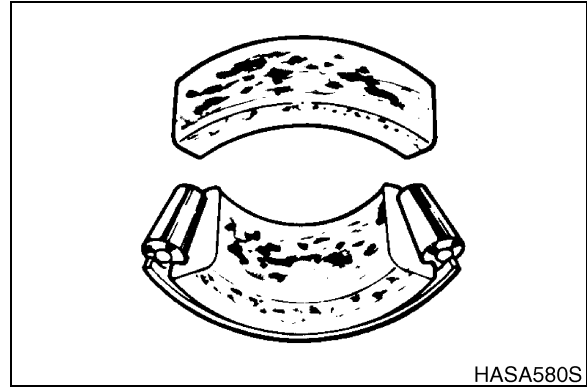


Figure 15

Fretting

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

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

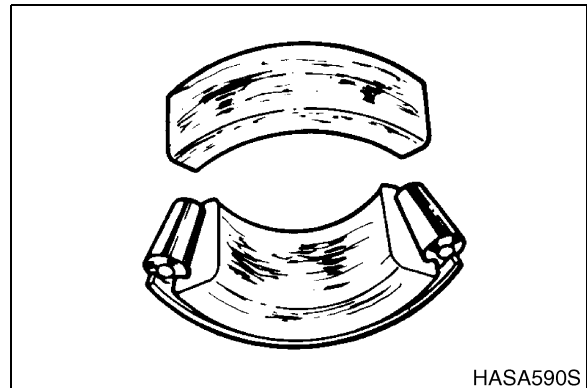


Figure 16

Heat Discoloration

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

Excessive heat can cause softening of races or rollers.

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

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

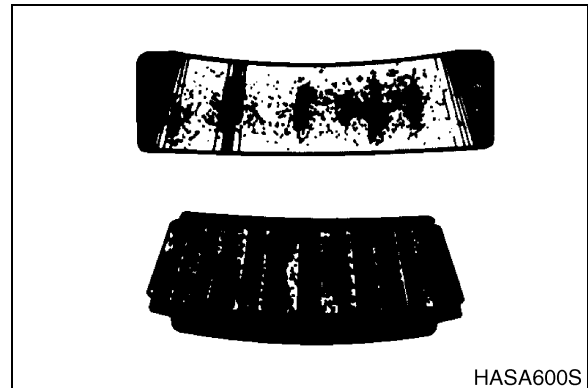


Figure 17

Stain Discoloration

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

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

Check seals and other related parts for damage.

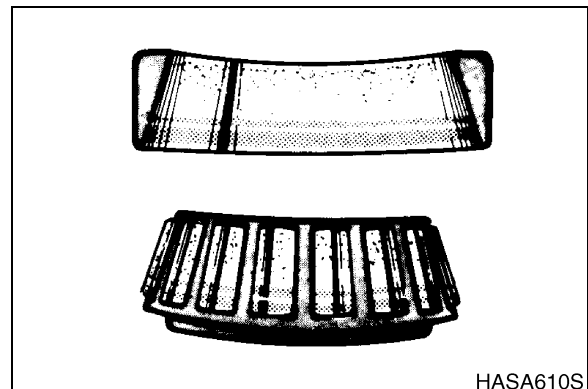


Figure 18



STANDARD TORQUES



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
ALL MODELS	ALL RANGES

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TORQUE VALUES FOR STANDARD METRIC FASTENERS

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

Dia. x Pitch (mm)	Grade										
	3.6 (4A)	4.6 (4D)	4.8 (4S)	5.6 (5D)	5.8 (5S)	6.6 (6D)	6.8 (6S)	6.9 (6G)	8.8 (8G)	10.9 (10K)	12.9 (12K)
M5 x Std.	0.15 (1.08)	0.16 (1.15)	0.25 (1.80)	0.22 (1.59)	0.31 (2.24)	0.28 (2.02)	0.43 (3.11)	0.48 (3.47)	0.50 (3.61)	0.75 (5.42)	0.90 (6.50)
M6 x Std.	0.28 (2.02)	0.30 (2.16)	0.45 (3.25)	0.40 (2.89)	0.55 (3.97)	0.47 (3.39)	0.77 (5.56)	0.85 (6.14)	0.90 (6.50)	1.25 (9.04)	1.50 (10.84)
M7 x Std.	0.43 (3.11)	0.46 (3.32)	0.70 (5.06)	0.63 (4.55)	0.83 (6.00)	0.78 (5.64)	1.20 (8.67)	1.30 (9.40)	1.40 (10.12)	1.95 (14.10)	2.35 (16.99)
M8 x Std.	0.70 (5.06)	0.75 (5.42)	1.10 (7.95)	1.00 (7.23)	1.40 (10.12)	1.25 (9.04)	1.90 (13.74)	2.10 (15.18)	2.20 (15.91)	3.10 (22.42)	3.80 (27.48)
M8 x 1	0.73 (5.28)	0.80 (5.78)	1.20 (8.67)	1.00 (7.23)	1.50 (10.84)	1.35 (9.76)	2.10 (15.18)	2.30 (16.63)	2.40 (17.35)	3.35 (24.23)	4.10 (29.65)
M10 x Std.	1.35 (9.76)	1.40 (10.12)	2.20 (15.91)	1.90 (13.74)	2.70 (19.52)	2.35 (19.99)	3.70 (26.76)	4.20 (30.37)	4.40 (31.18)	6.20 (44.84)	7.20 (52.07)
M10 x 1	1.50 (10.84)	1.60 (11.57)	2.50 (18.08)	2.10 (15.18)	3.10 (22.42)	2.80 (20.25)	4.30 (31.10)	4.90 (35.44)	5.00 (36.16)	7.00 (50.63)	8.40 (60.75)
M12 x Std.	2.40 (17.35)	2.50 (18.08)	3.70 (26.76)	3.30 (23.86)	4.70 (33.99)	4.20 (30.37)	6.30 (45.56)	7.20 (52.07)	7.50 (54.24)	10.50 (75.94)	12.50 (90.41)
M12 x 1.5	2.55 (18.44)	2.70 (19.52)	4.00 (28.93)	3.50 (25.31)	5.00 (36.16)	4.50 (32.54)	6.80 (49.18)	7.70 (55.69)	8.00 (57.86)	11.20 (81.00)	13.40 (96.92)
M14 x Std.	3.70 (26.76)	3.90 (28.20)	6.00 (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 (132.26)	22.00 (158.12)
M16 x Std.	5.60 (40.50)	6.00 (43.39)	9.00 (65.09)	8.00 (57.86)	11.50 (83.17)	10.50 (75.94)	15.50 (112.11)	17.90 (129.47)	18.50 (133.81)	26.00 (188.05)	31.00 (224.22)
M16 x 1.5	6.20 (44.84)	6.50 (47.01)	9.70 (70.16)	8.60 (62.20)	12.50 (90.41)	11.30 (81.73)	17.00 (122.96)	19.50 (141.04)	20.00 (144.66)	28.00 (202.52)	35.50 (256.77)
M18 x Std.	7.80 (56.41)	8.30 (60.03)	12.50 (90.41)	11.00 (79.56)	16.00 (115.72)	14.50 (104.87)	21.00 (151.89)	27.50 (198.90)	28.50 (206.14)	41.00 (296.55)	43.00 (311.01)
M18 x 1.5	9.10 (65.82)	9.50 (68.71)	14.40 (104.15)	12.50 (90.41)	18.50 (133.81)	16.70 (120.79)	24.50 (177.20)	27.50 (198.90)	28.50 (206.14)	41.00 (296.55)	49.00 (354.41)
M20 x Std.	11.50 (83.17)	12.00 (86.79)	18.00 (130.19)	16.00 (115.72)	22.00 (159.12)	19.00 (137.42)	31.50 (227.83)	35.00 (253.15)	36.00 (260.38)	51.00 (368.88)	60.00 (433.98)
M20 x 1.5	12.80 (92.58)	13.50 (97.64)	20.50 (148.27)	18.00 (130.19)	25.00 (180.82)	22.50 (162.74)	35.00 (253.15)	39.50 (285.70)	41.00 (296.55)	58.00 (419.51)	68.00 (491.84)
M22 x Std.	15.50 (112.11)	16.00 (115.72)	24.50 (177.20)	21.00 (151.89)	30.00 (216.99)	26.00 (188.05)	42.00 (303.78)	46.00 (332.71)	49.00 (354.41)	67.00 (484.61)	75.00 (542.47)
M22 x 1.5	17.00 (122.96)	18.50 (133.81)	28.00 (202.52)	24.00 (173.59)	34.00 (245.92)	29.00 (209.75)	47.00 (339.95)	52.00 (44.76)	56.00 (405.04)	75.00 (542.47)	85.00 (614.80)
M24 x Std.	20.50 (148.27)	21.50 (155.50)	33.00 (238.68)	27.00 (195.29)	40.00 (289.32)	34.00 (245.92)	55.00 (397.81)	58.00 (419.51)	63.00 (455.67)	82.00 (593.10)	92.00 (655.43)
M24 x 1.5	23.00 (166.35)	35.00 (253.15)	37.00 (267.62)	31.00 (224.22)	45.00 (325.48)	38.00 (202.52)	61.00 (441.21)	67.00 (484.61)	74.00 (535.24)	93.00 (672.66)	103.00 (744.99)

TORQUE VALUES FOR STANDARD U.S. FASTENERS

TYPE	S.A.E. GRADE	DESCRIPTION	BOLT HEAD MARKING
1	1 OR 2	WILL HAVE NO MARKINGS IN THE CENTER OF THE HEAD. Low or Medium Carbon Steel Not Heat Treated.	
5	5	WILL HAVE THREE RADIAL LINES. Quenched and Tempered Medium Carbon Steel.	
8	8	WILL HAVE 6 RADIAL LINES. Quenched and Tempered Special Carbon or Alloy Steel.	

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

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

NOTE: *Multiply the standard torque by:*

0.65 when finished jam nuts are used.

0.70 when Molykote, white lead or similar mixtures are used as lubricants.

0.75 when parkerized bolts or nuts are used.

0.85 when cadmium plated bolts or nuts and zinc bolts w/waxed zinc nuts are used.

0.90 when hardened surfaces are used under the nut or bolt head.

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

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

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

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

TYPE 8 PHOSPHATE COATED HARDWARE

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

The torques shown below also apply to the following:

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

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

NOMINAL THREAD DIAMETER	STANDARD TORQUE $\pm 10\%$	
	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:

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

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

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

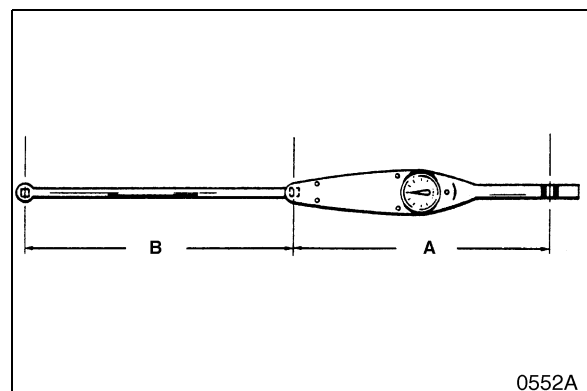


Figure 1

OTHER USES FOR TORQUE WRENCH EXTENSION TOOLS

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

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

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

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

TIGHTENING TORQUE SPECIFICATIONS (METRIC)

(For coated threads, prelubricated assemblies.)



CAUTION!

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

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

IMPORTANT

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

I. "Loctite" Fastener Adhesives

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

II. "Loctite" Pipe Thread Sealant

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

III. "Loctite" gasket/flange sealer

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



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 210W-V	1001 and Up
Solar 225LC-V	1001 and Up
Solar 225NLC-V	1001 and Up
Solar 255LC-V	1001 and Up
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 340LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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REMOVAL

CAUTION!

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

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

WARNING!

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

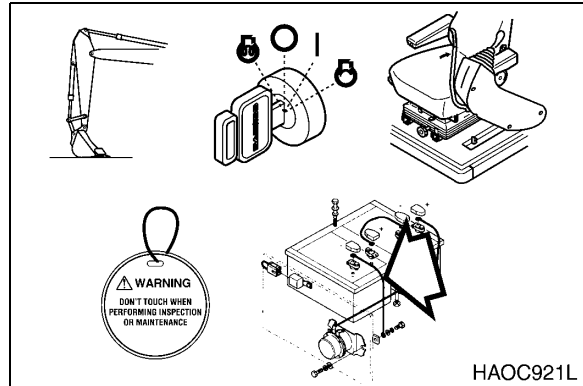


Figure 1

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

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

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

12. Remove floor mat.
13. Remove operator's seat (1, Figure 2).
NOTE: *Be careful not to damage seat covering.*
14. Remove duct covers (2, 3 and 4, Figure 2). When removing cover (2) disconnect hour meter connector and cigar lighter connector. Disconnect main harness connector before removing cover (4).
15. Remove pocket (5, Figure 2) before removing side panel (6, Figure 2).

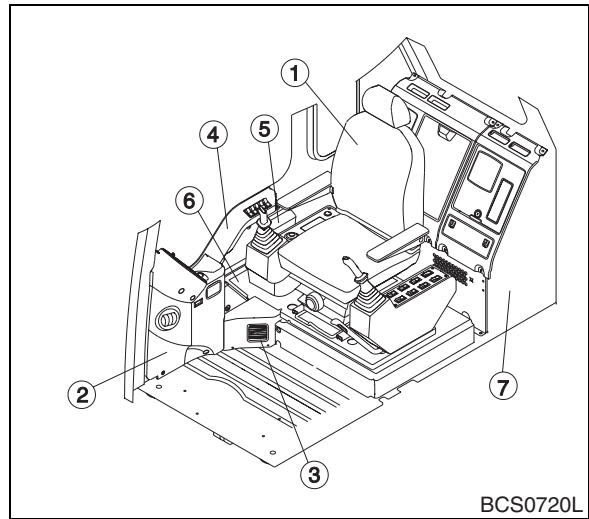


Figure 2

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

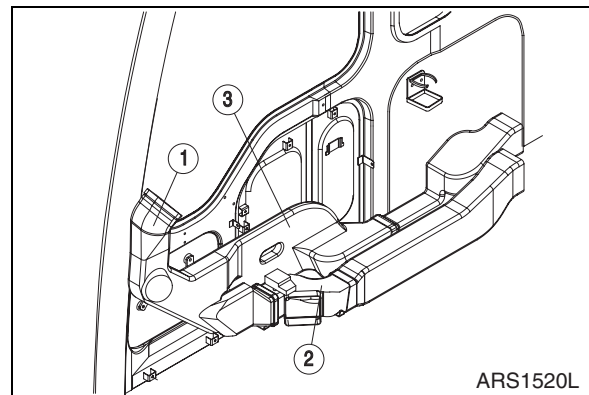


Figure 3

18. Remove cover (5, Figure 4) on left side dash cover (3) and bolts (1, Figure 5).
NOTE: *When removing cover disconnect speaker wire.*
19. Remove two rubber stops (2, Figure 4) used in storing the front lower glass. Remove bolts (1) from the rear left and right dash covers. Remove left side cover (3).
20. Lift right side dash cover (4, Figure 4) and disconnect speaker wire. Remove cover.

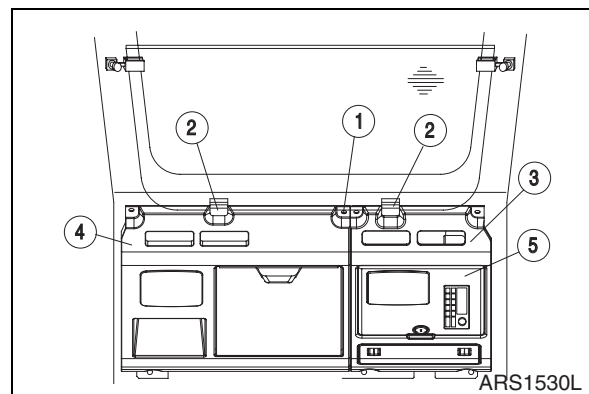


Figure 4

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

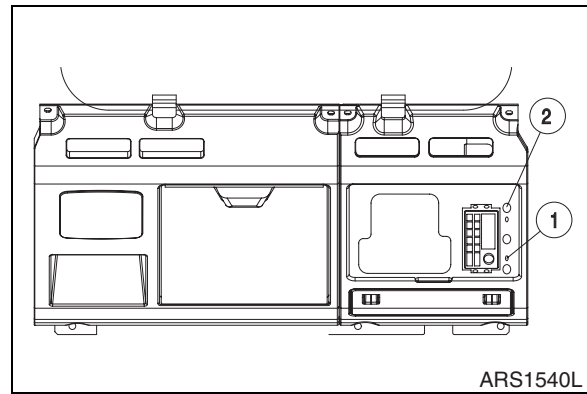


Figure 5

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

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

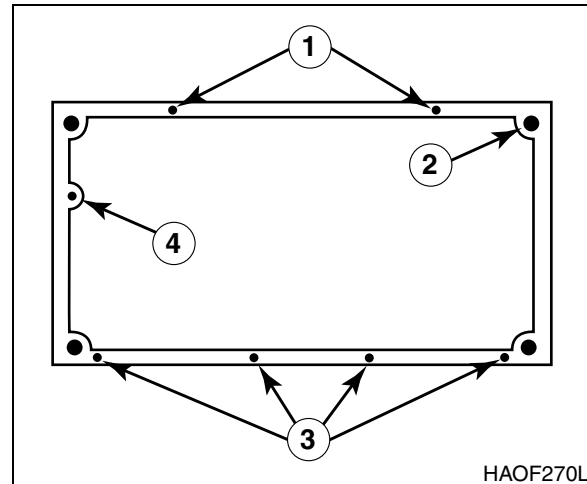


Figure 6

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

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

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

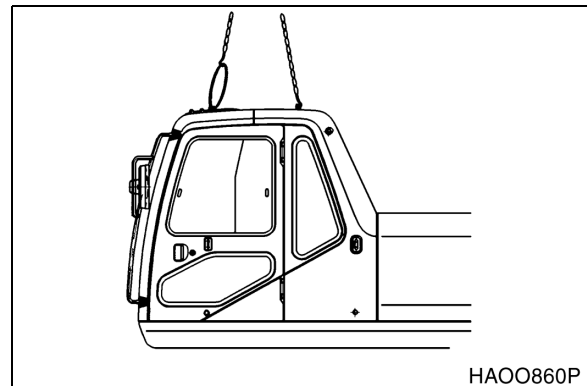


Figure 7

INSTALLATION

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

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

2. Lower cab into position on cab floor

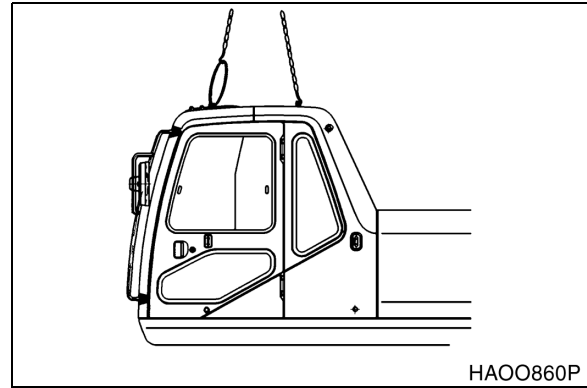


Figure 8

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

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

4. Install four hex bolts (3, Figure 9) in door side of cabin floor.
5. Install two hex bolts (1, Figure 9) in right side of cabin floor and one bolt (4) in front of cab floor.

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

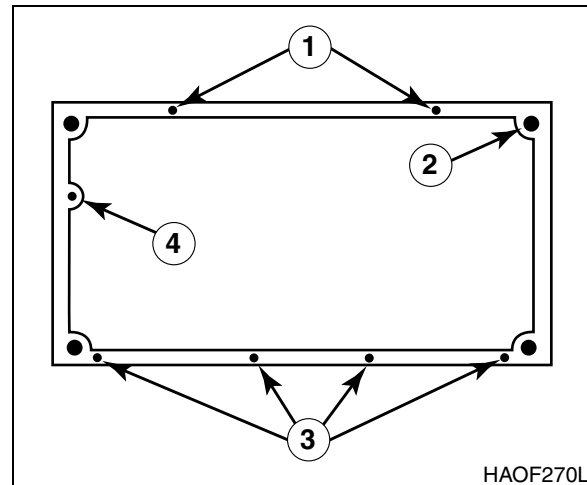


Figure 9

6. Once cab is mounted to floor, unhook lifting device
7. Connect cabin ground cable (7, Figure 2).
8. Connect cab light wiring connector.

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

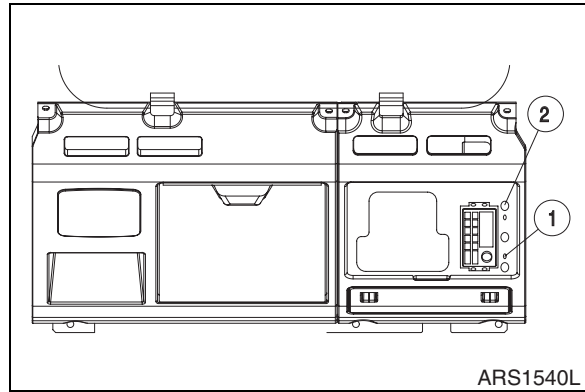


Figure 10

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

NOTE: *Connect speaker wire before installing cover.*

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

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

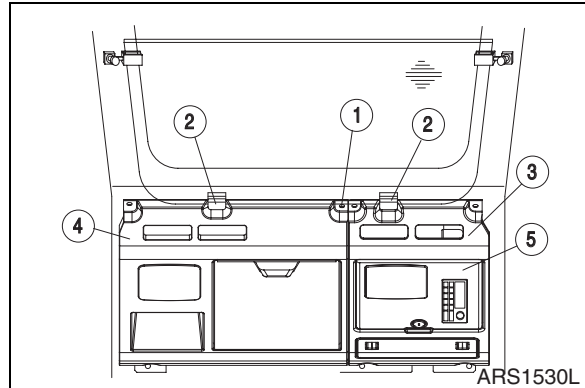


Figure 11

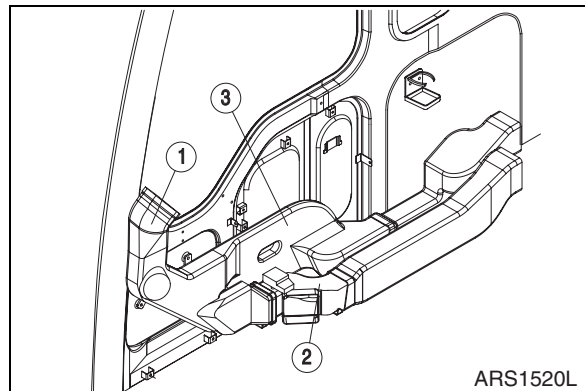


Figure 12

15. Install side panel (6, Figure 13) and pocket (5).
16. Install cover (4, Figure 13) and connect main harness. Install cover (3). Connect hour meter connector and cigar lighter connect of cover (2).
17. Install cover (2, Figure 13).
18. Install operator's seat (1, Figure 13).
NOTE: *Be careful not to damage seat covering.*
19. Install floor mat.
20. Connect negative (-) battery cable leading to frame from battery.

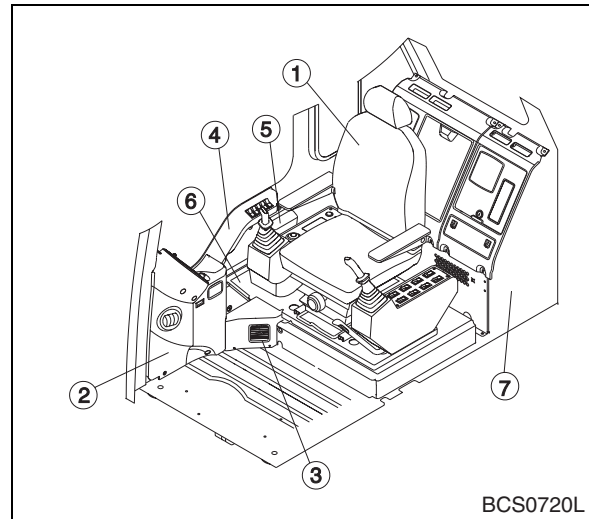


Figure 13



COUNTERWEIGHT



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 210W-V	1001 and Up

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GENERAL



DANGER!

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

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

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

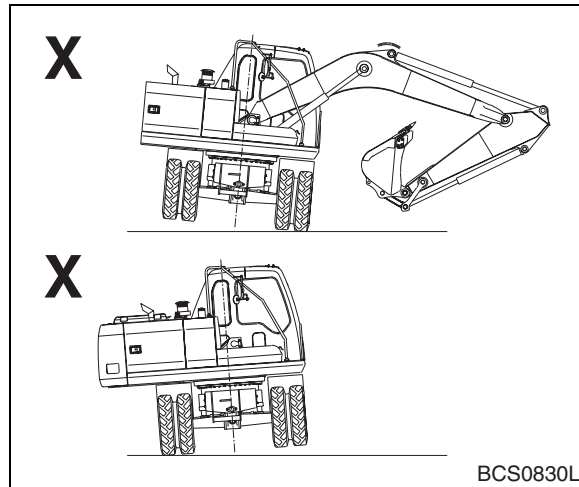


Figure 1

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



WARNING!

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

Model	Weight of Counterweight
Solar 140W-V	1,600 kg (3,530 lb)
Solar 160W-V	2,200 kg (4,850 lb)
Solar 180W-V	2,700 kg (5,950 lb)
Solar 210W-V	3,500 kg (7,720 lb)

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

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



WARNING!

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

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

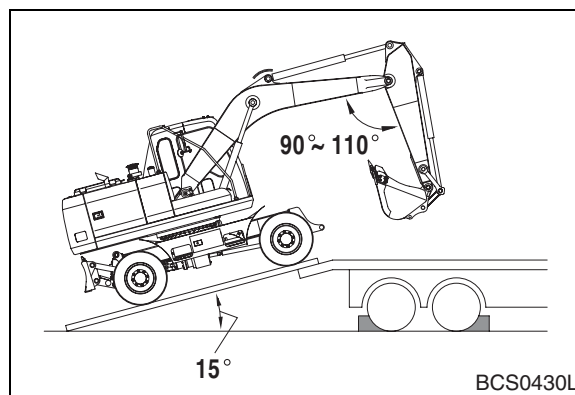


Figure 1

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

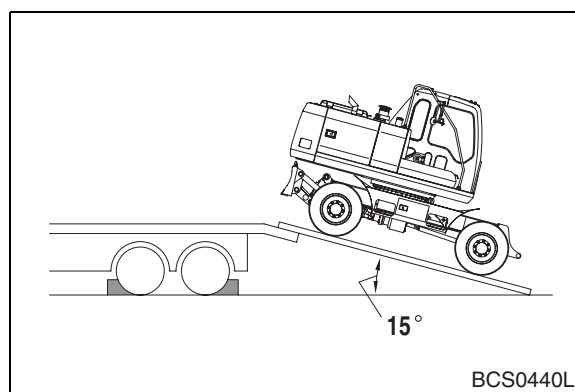


Figure 2

REMOVAL

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



WARNING!

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

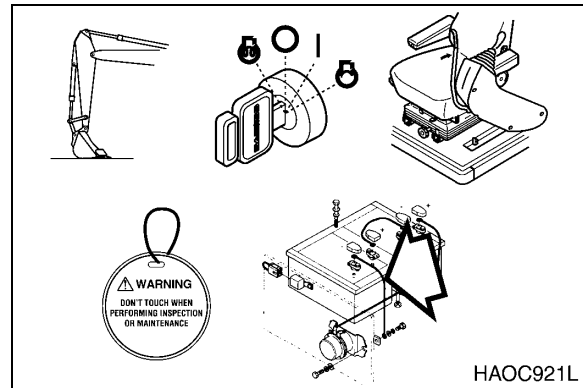


Figure 3

6. Fully stroke work levers (joysticks) in all directions to relieve pressure from accumulators.
7. Set safety lever on "LOCK" position.
8. Turn key to "OFF" position and remove from starter switch.
9. Hang maintenance warning tag on controls.
10. Disconnect negative (-) battery cable leading to frame from battery.
11. Raise engine compartment cover.
12. Remove two caps (A, B, Figure 4) from counter weight (1).
13. Install two lifting eyes in lifting holes (A, B, Figure 4).

Model	Lifting Eye Size
Solar 140W-V Solar 160W-V Solar 180W-V Solar 210W-V	M36x4.0

14. Using a suitable lifting device capable of handling load partially support counterweight (1) before beginning to loosen four bolts (2). Stop lifting with assist crane as soon as lifting slings are taut.
15. Remove four bolts (2, Figure 4) and washers (3) from counterweight (1).

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

16. When bolts (2, Figure 4) and washers (3) have been removed, lift counterweight (1) a very short distance above support frame (4) and stop. Check slings and make sure counterweight is being supported evenly. Once checked, continue to remove counterweight.
17. Remove shims (5) from frame (4) if they exist.

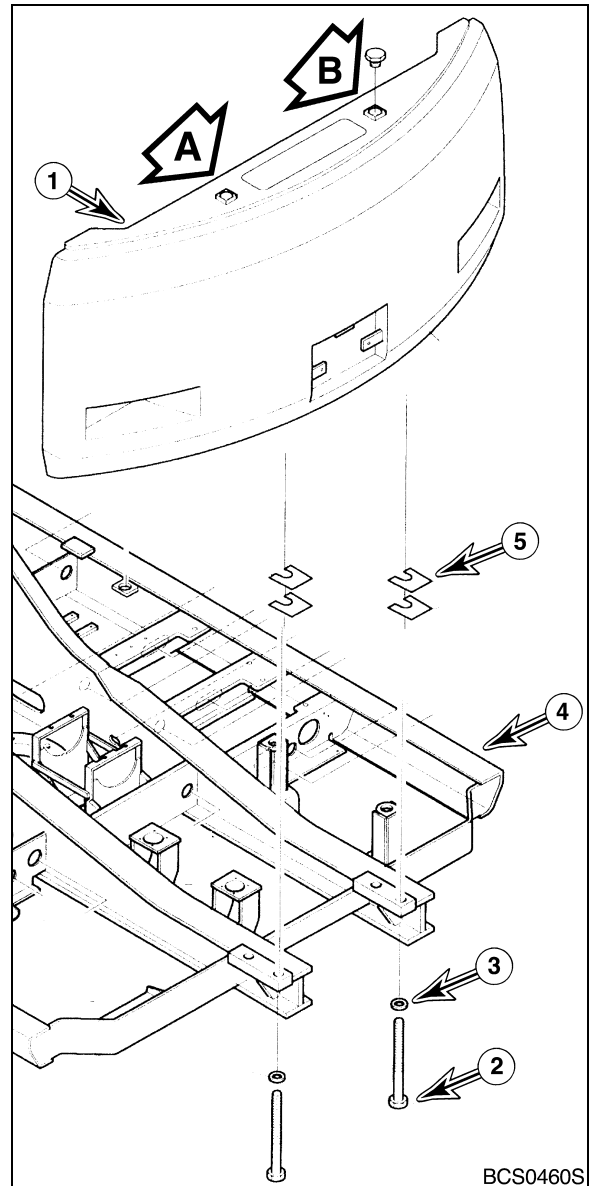


Figure 4

INSTALLATION

1. Raise engine compartment cover.
2. Using suitable lifting device capable of handling load raise counterweight (1, Figure 5) into position just above support frame (4) leaving counterweight suspended. Verify that counterweight is level and even.

NOTE: Leave counterweight (1, Figure 5) suspended 3 mm (0.125") above support frame (4) until all four mounting bolts (2) are started in counterweight mounting holes.

3. Install four bolts (2, Figure 5) with washers (3) into counterweight until washers contact support frame. Fully lower counterweight onto plates and support frame.
4. Using a feeler gauge, check for a gap between counterweight (1, Figure 5) and frame (4). Use an appropriate amount of shims (5) for each bolt location.
5. Remove four bolts (2, Figure 5) and washers (3).
6. Raise counterweight (1, Figure 5) so that shims (5) can be set into position on frame (4).
7. Lower counterweight (1, Figure 5) until it is 3 mm (0.125") above the shims (5) and install four bolts and washers. Apply Loctite #242 to mounting bolt threads.
8. Fully lower counterweight (1, Figure 5) onto shims (5), frame (4) and support frame (4) and finish tightening bolts (2).

NOTE: Tighten bolts (2, Figure 5) to values shown in following table.

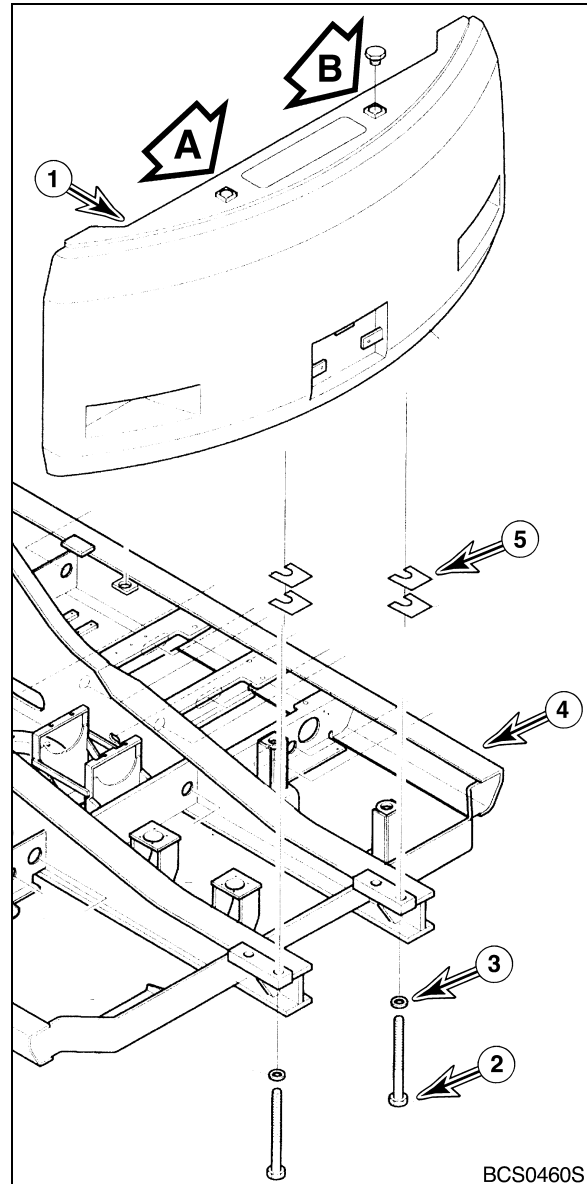


Figure 5

Model	Bolt Torque
Solar 140W-V Solar 160W-V	115 kg•m (830 ft lb)
Solar 180W-V Solar 210W-V	150 kg•m (1,080 ft lb)

9. Remove lifting device and lifting hooks from counterweight (1, Figure 5).
10. Install two caps in lifting holes (A, 13, Figure 5).
11. Connect negative (-) battery cable to battery.



S0405045K

FUEL TANK



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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GENERAL DESCRIPTION



WARNING!

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

PARTS LIST

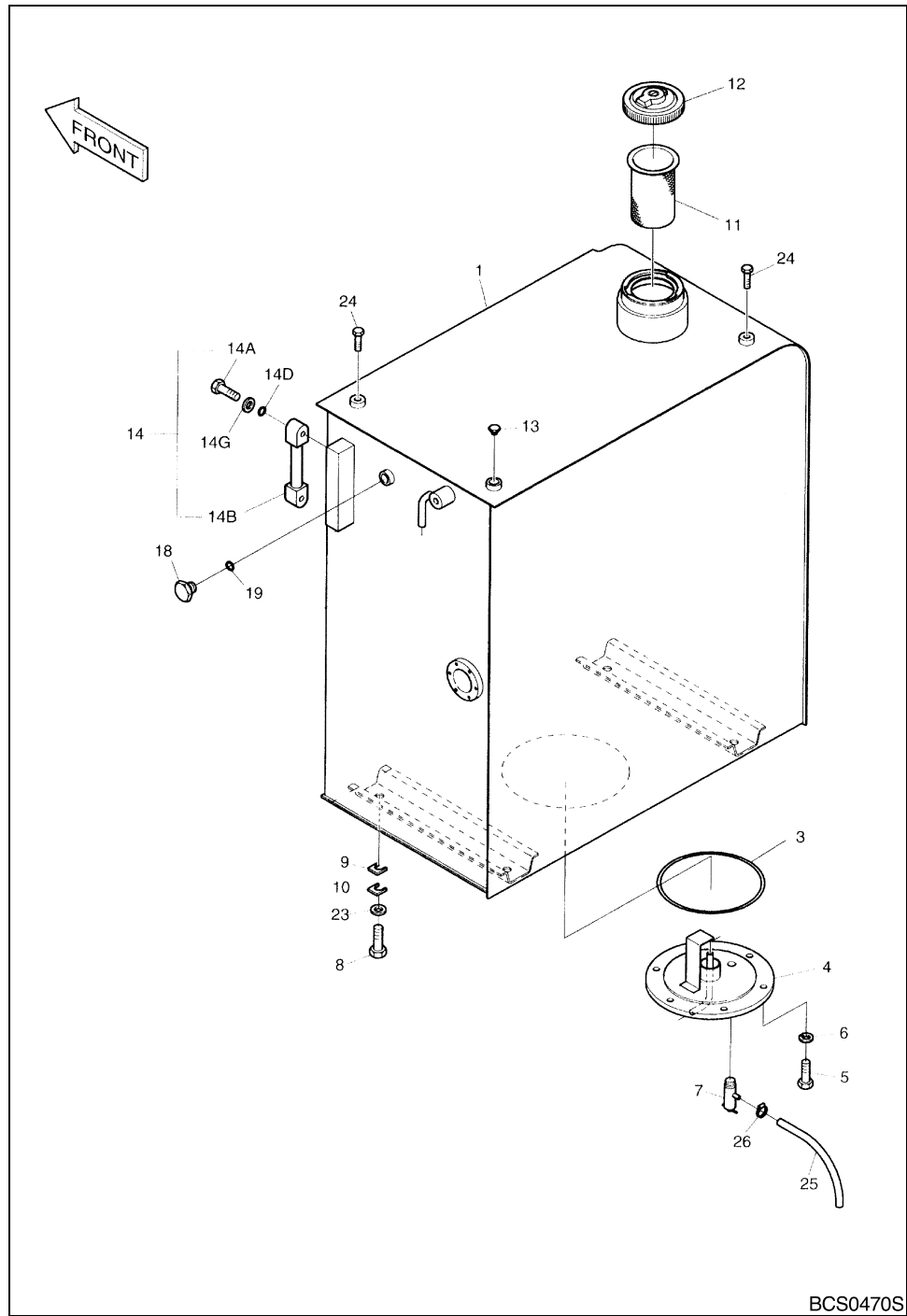


Figure 1

Reference Number	Description
1	Fuel Tank
3	O-ring
4	Cover
5	Bolt
6	Spring Washer
7	Cock
8	Bolt
9	Shim
10	Shim
11	Fuel Filter
12	Cap
13	Plug

Reference Number	Description
14	Level Gauge
14a	Bolt
14b	Block
14d	O-ring
14g	Washer
18	Plug
19	O-ring
23	Hard Washer
24	Bolt
25	Vinyl Hose
26	Hose Clamp

SPECIFICATIONS

Model	Fuel Tank Capacity
140W-V 160W-V	280 liters (74 gal)

REMOVAL

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

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

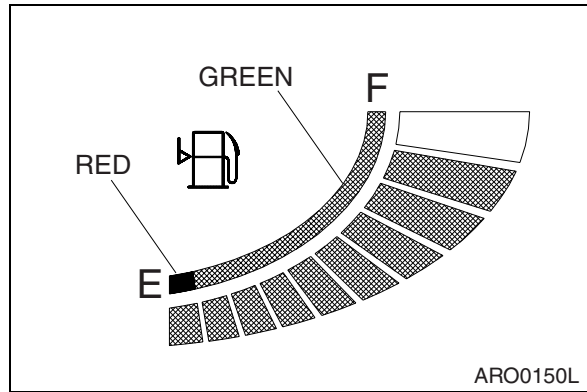


Figure 2

2. Park on firm and level ground and swing turntable to approximately a 180° with respect to wheels. See Figure 3.

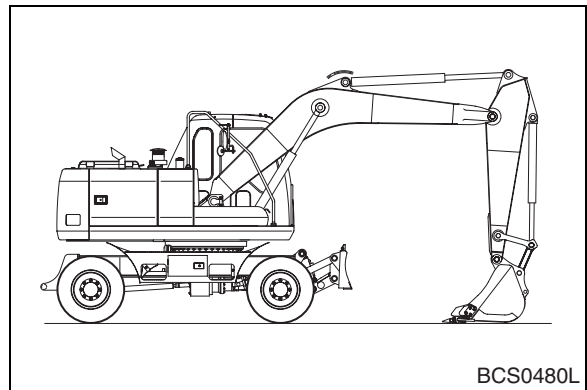


Figure 3

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

**WARNING!**

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

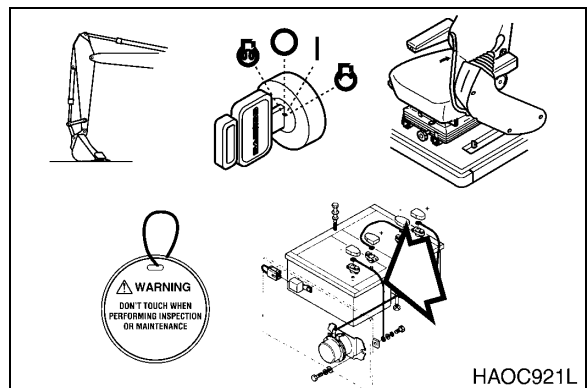


Figure 4

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

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

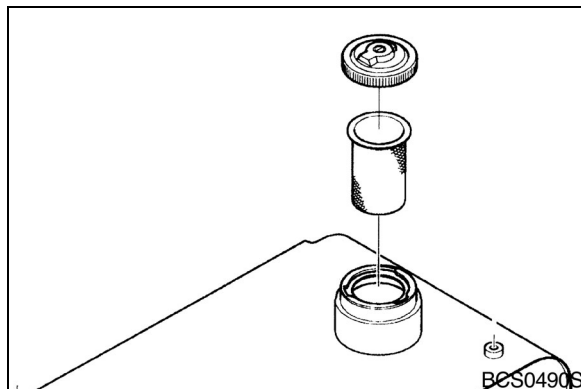


Figure 5

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

NOTE: Refer to "Specifications" on page 5, for fuel tank capacity.

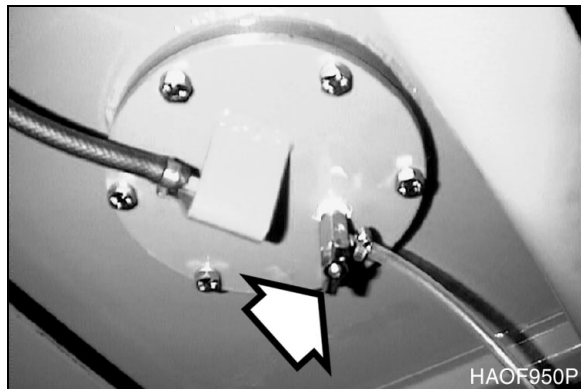


Figure 6

14. Tag and disconnect fuel supply line (1, Figure 7) and fuel return line (2) from the tank (3) and carefully drain remaining fuel from the lines.
15. Remove clamp (4, Figure 7) holding fuel return line (2) to tank (3).

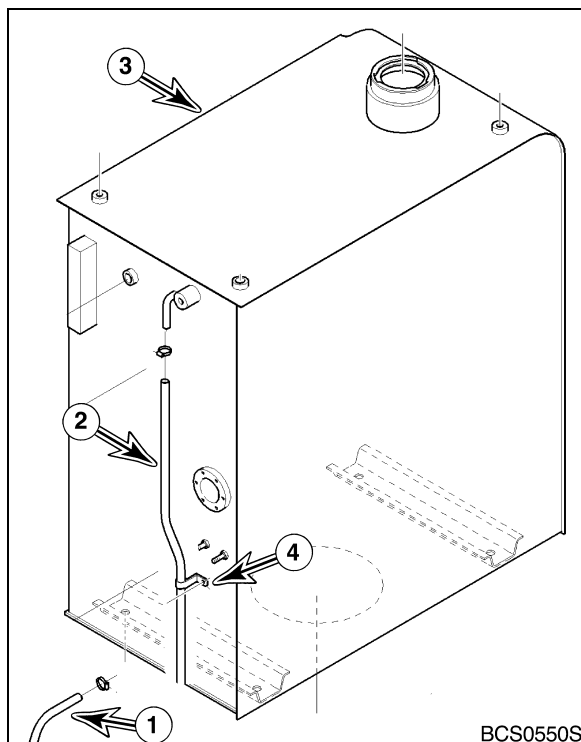


Figure 7

16. Tag and disconnect wires leading to fuel sensor (1, Figure 8) on side of fuel tank (2).
17. If equipped, remove components from the fuel filler pump port (3, Figure 8) on side of fuel tank (2).

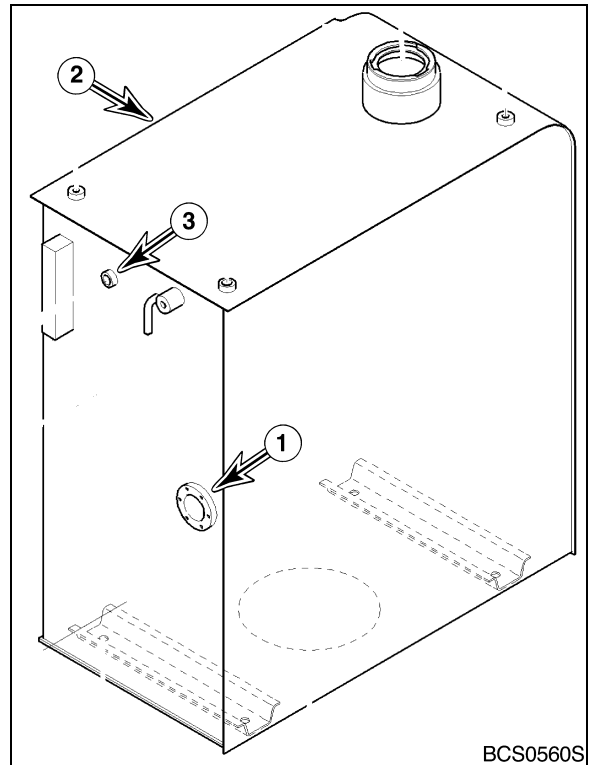


Figure 8

18. Remove eight bolts and washers (1, Figure 9), and handrail (2) from fuel tank (3) and frame (4).
19. Remove four bolts, washers and cover (5, Figure 9) from fuel tank (3).

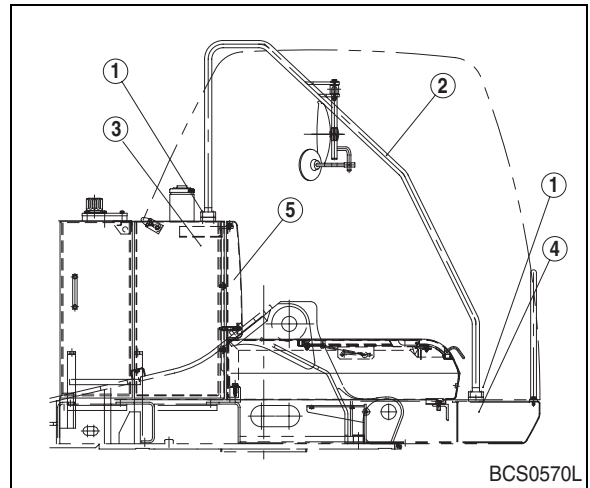


Figure 9

20. Remove four bolts and washers (1, Figure 10) and cover (2) from fuel tank (3) and support (4).

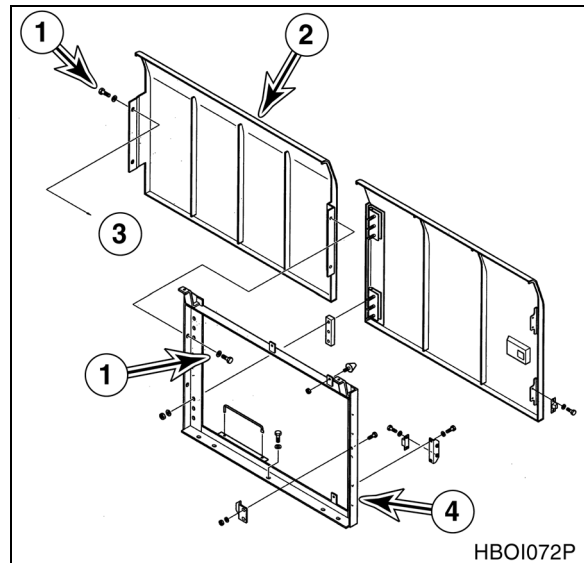


Figure 10

21. Install two 12 mm eye bolts in threaded holes at top surface of tank (1 and 2, Figure 11). Using a suitable lifting device, sling eye bolts.

22. Remove four bolts and washers (4, Figure 11) holding tank (3) to frame. Lift tank 25 mm (1") and make sure it is balanced. Make sure that there are no other electrical wires or hoses connected to tank. Completely remove tank after inspection.

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

23. Remove shims (5, Figure 11).

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

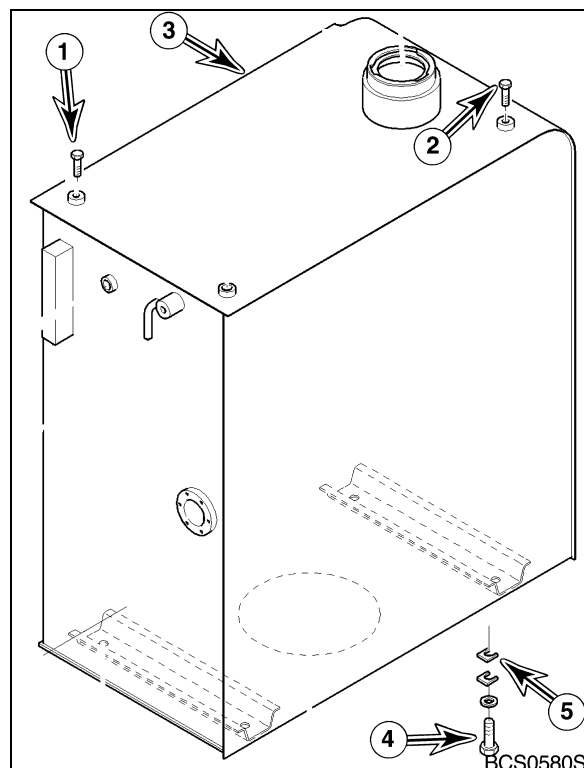


Figure 11

INSTALLATION

1. Install two 12 mm eye bolts in threaded holes at top surface of tank (1 and 2, Figure 12). Using a suitable lifting device, sling eye bolts.

2. Set fuel tank (3, Figure 12) into position. Install four bolts and washers (4) finger tight, to secure tank (3) to frame.

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

3. Install shims (5, Figure 12) as needed to prevent tank (3) from rocking or stress from mounting bolts (4).
4. Tighten mounting bolts (4, Figure 12) after shims are installed.

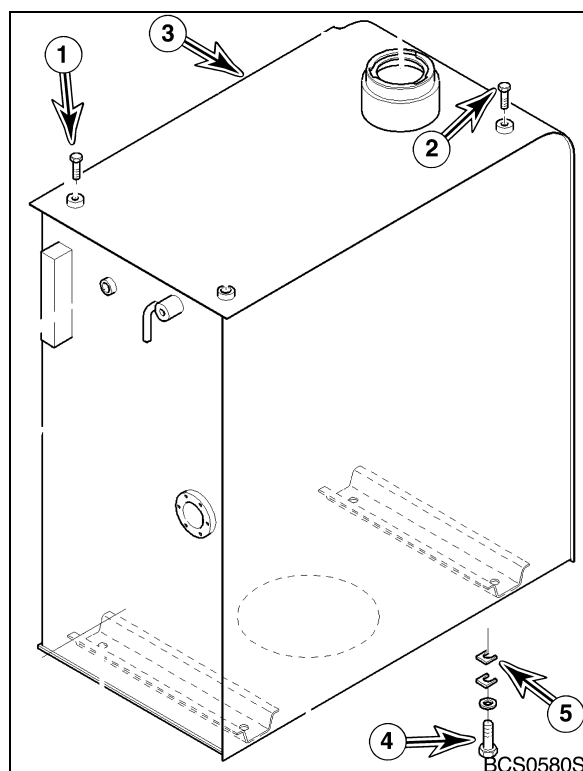


Figure 12

5. Install cover (2, Figure 13) on fuel tank (3) and support (4) with four bolts and washers (1).

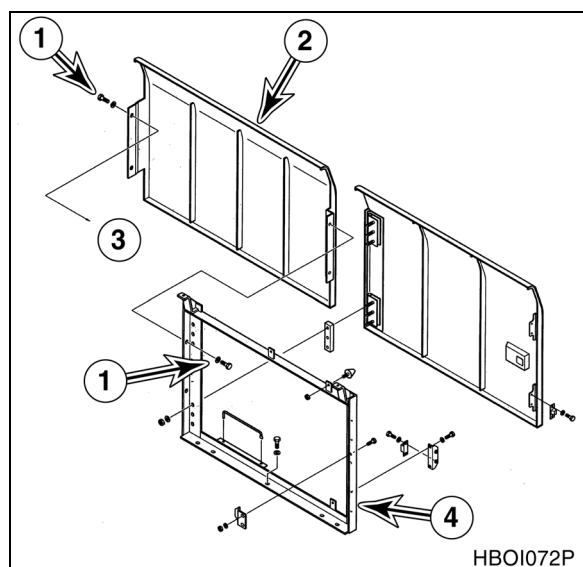


Figure 13

6. Install eight bolts and washers (1, Figure 14), and handrail (2) on fuel tank (3) and frame (4).
7. Install four bolts, washers and cover (5, Figure 14) on fuel tank (3).

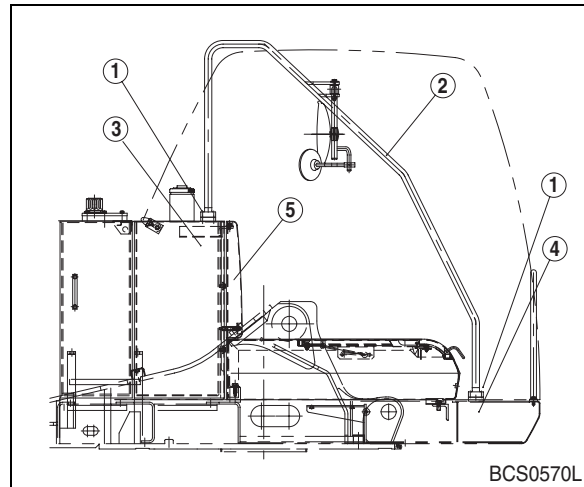


Figure 14

8. Connect wires as tagged to fuel sensor (1, Figure 15) on side of fuel tank (2).
9. If equipped, connect components to the fuel filler pump port (3, Figure 15) on side of fuel tank (2).

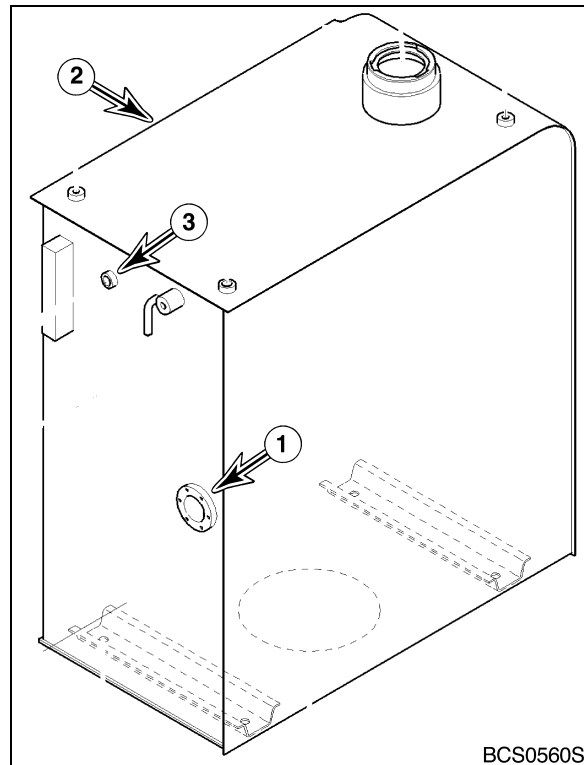


Figure 15

10. Connect as tagged, fuel supply line (1, Figure 16) and fuel return line (2) to fuel tank (3).
11. Install clamp (4, Figure 16) to hold fuel return line (2) to tank (3).

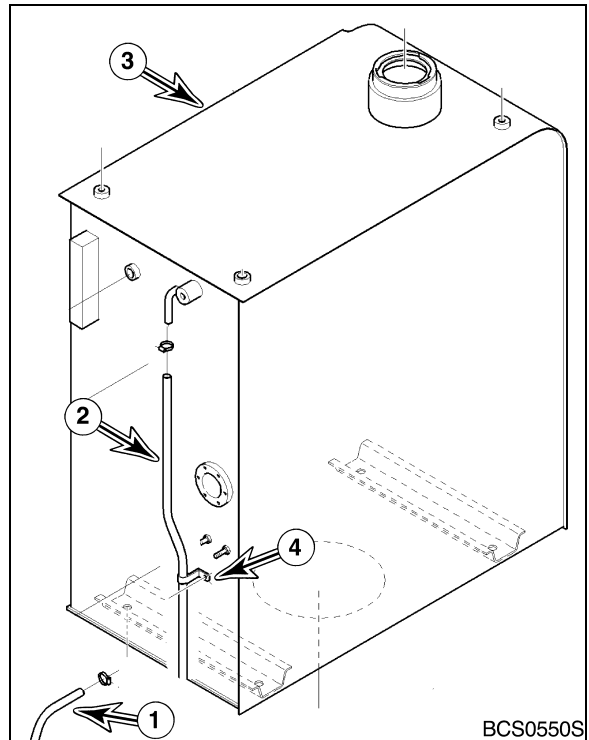


Figure 16

12. Make sure fuel tank drain valve (Figure 17) on bottom of tank is closed.
13. Fill fuel tank and check for signs of leaks. Correct any problems found.
14. Connect negative (-) battery cable to battery.

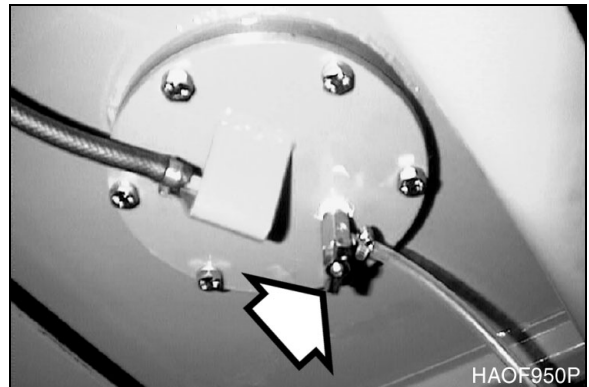


Figure 17

START-UP PROCEDURES

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



FUEL TRANSFER PUMP



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Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Mega 130	0001 and Up
Mega 160	0001 and Up
Mega 200-III	1001 and Up
Mega 200-V (Tier I & II)	1001 and Up
Mega 250-III	1001 and Up
Mega 250-V (Tier I)	1001 thru 2000
Mega 250-V (Tier II)	2001 and Up
Mega 300-V (Tier I)	1001 thru 2000
Mega 300-V (Tier II)	2001 and Up
Mega 400-III PLUS	1001 and Up
Mega 400-V	1001 and Up
Mega 500-V	1001 thru 2000
Mega 500-V (Tier II)	2001 and Up
Solar 75-V	1001 and Up
Solar 130LC-V	0001 and Up
Solar 130W-V	0001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170LC-V	1001 and Up

Models continued on back of cover.

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MODEL	SERIAL NUMBER RANGE
Solar 170W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 210W-V	1001 and Up
Solar 220LC-V	0001 and Up
Solar 220LL	1001 and Up
Solar 220N-V	1001 and Up
Solar 225LC-V	1001 and Up
Solar 225NLC-V	1001 and Up
Solar 250LC-V	1001 and Up
Solar 255LC-V	1001 and Up
Solar 290LC-V	0001 and Up
Solar 290LL	1001 and Up
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 330LC-V	1001 and Up
Solar 340LC-V	1001 and Up
Solar 400LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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GENERAL DESCRIPTION

THEORY OF OPERATION

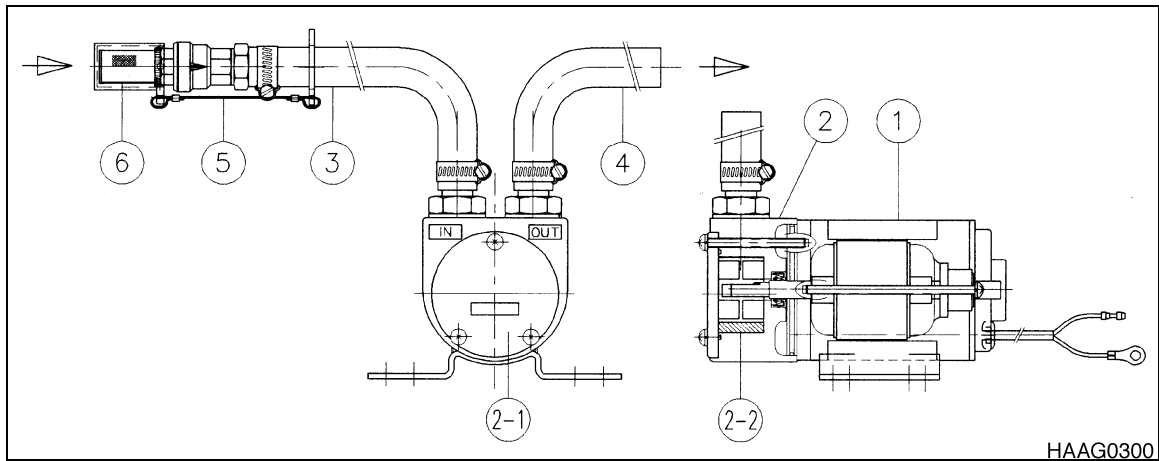


Figure 1

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

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

Fuel pump consists of motor, pump, switch and hose assembly.

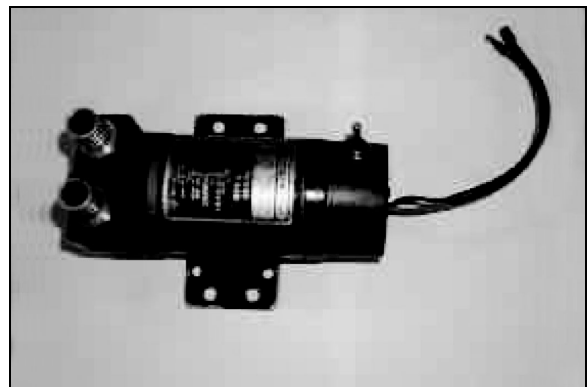


Figure 2

TROUBLESHOOTING

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

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

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

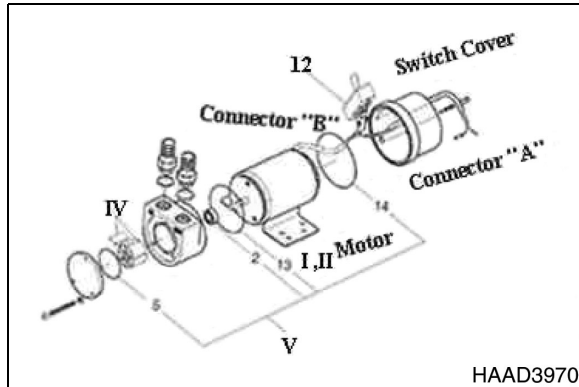


Figure 3 WITH TOGGLE SWITCH

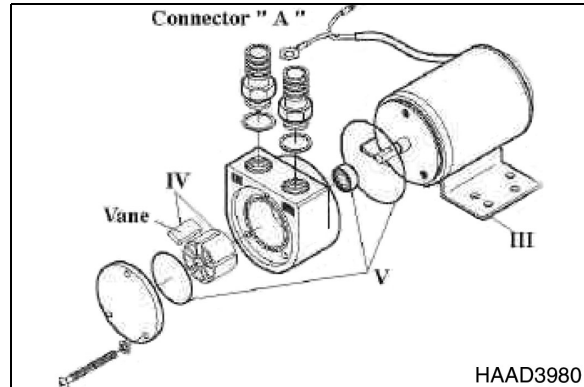


Figure 4 WITHOUT TOGGLE SWITCH

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

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

REPLACEMENT OF ROTOR AND VANE

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

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



Figure 5 WITHOUT TOGGLE SWITCH

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

Insert O-ring again at reassembly of pump cover.

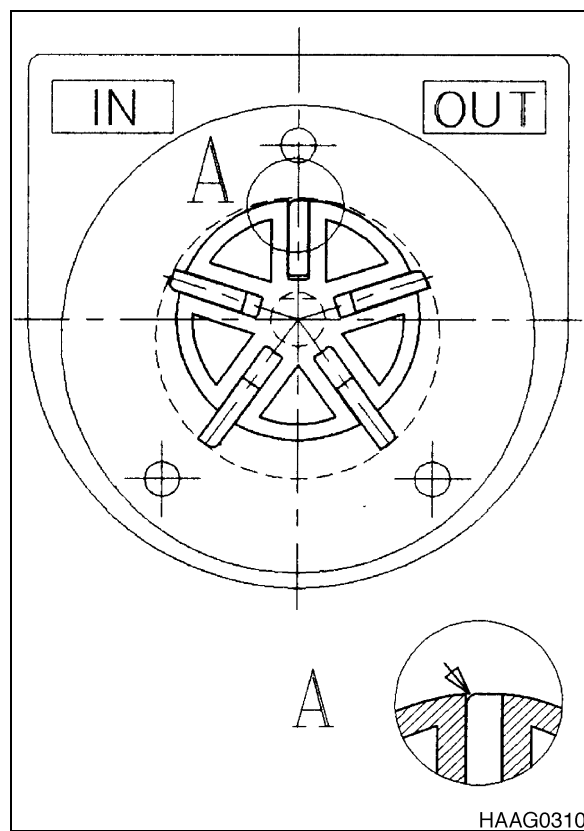


Figure 6

REPLACEMENT OF REAR COVER

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

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

Remove cover.

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

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

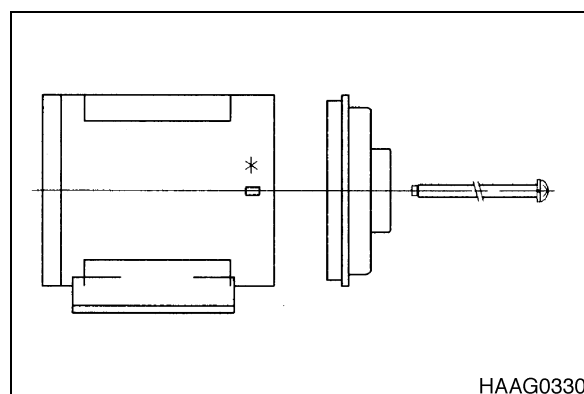


Figure 7

REPLACEMENT OF ARMATURE

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

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

Remove the pump cover and remove the rotor and vane.

Insert a new armature into the housing.

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

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

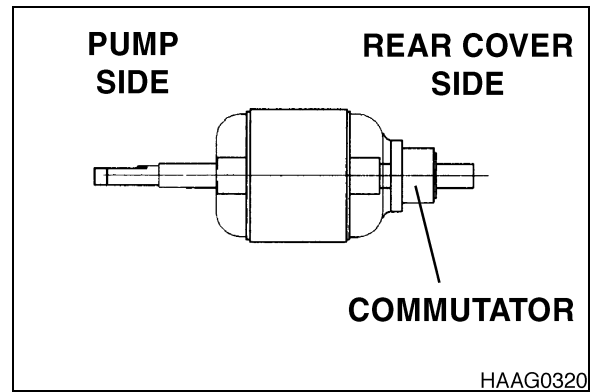


Figure 8



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R1

SWING BEARING



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 130W-V	0001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 210W-V	1001 and Up

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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 of the lateral clearance in the bearing. (Less than 100 lb of force should be required to move the bucket over all the way.) Check lateral play in both directions and record the values. When the bearing is beginning to approach the end of its service life, measured lateral clearance should start to show larger and larger increases.

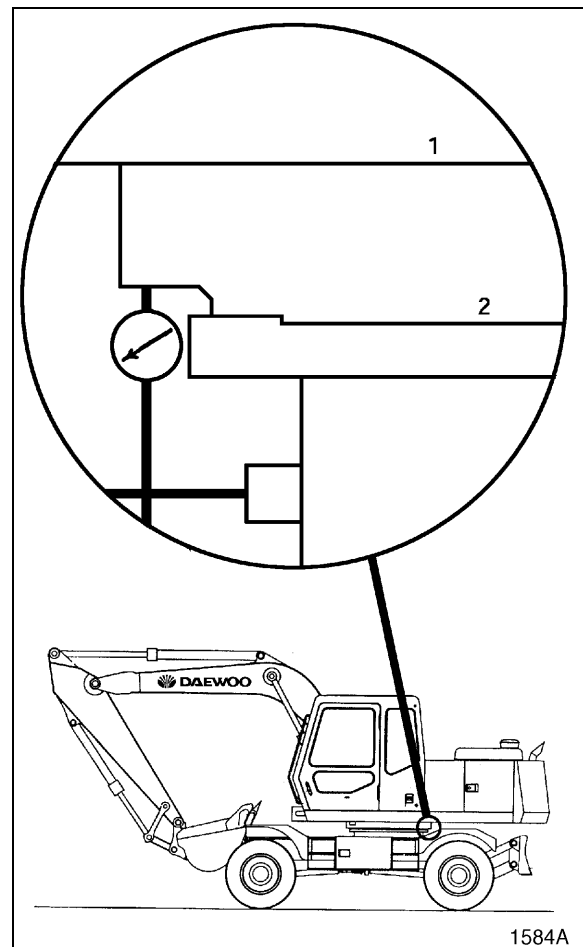


Figure 1

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

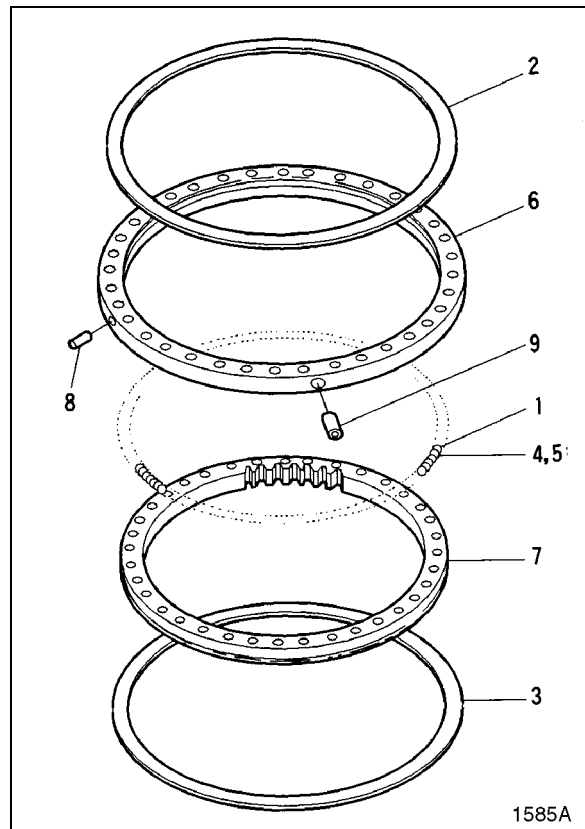


Figure 2

REBUILDING SWING BEARING

1. Remove tip of tapered pin (1, Figure 3) using grinder and tap lightly to remove debris.
2. Remove plug (1, Figure 4) using a M10 x 1.25 bolt (2).

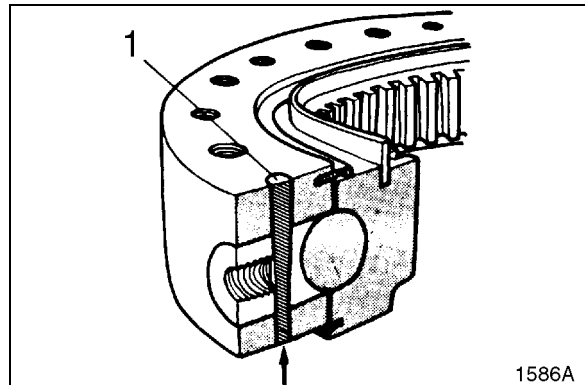


Figure 3

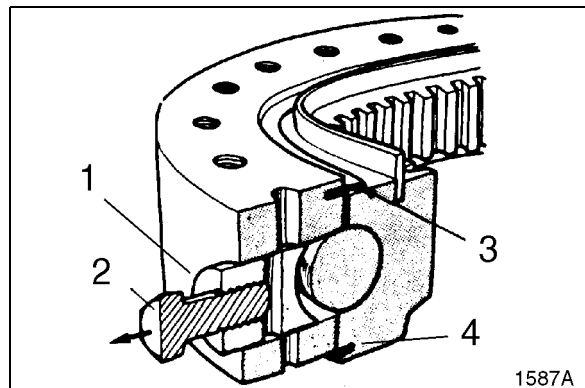


Figure 4

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

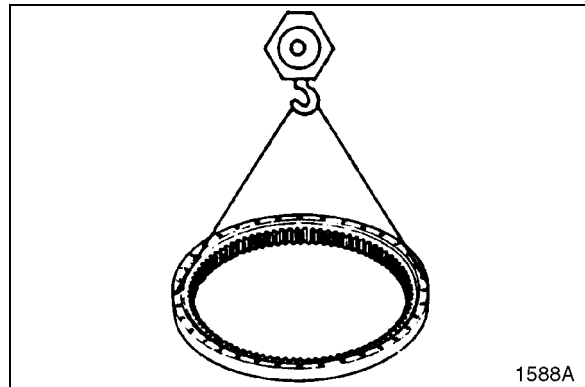


Figure 5

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

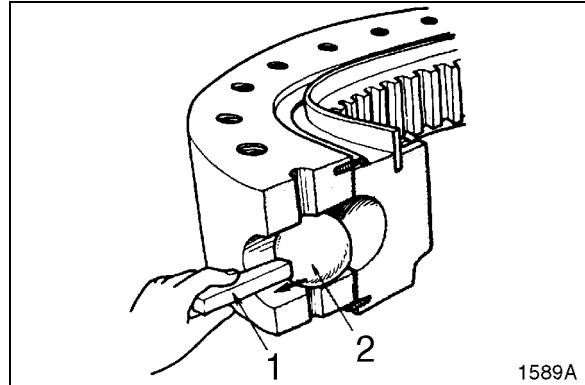


Figure 6

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

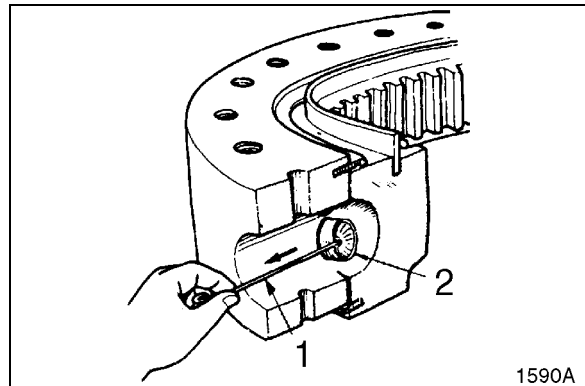


Figure 7

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

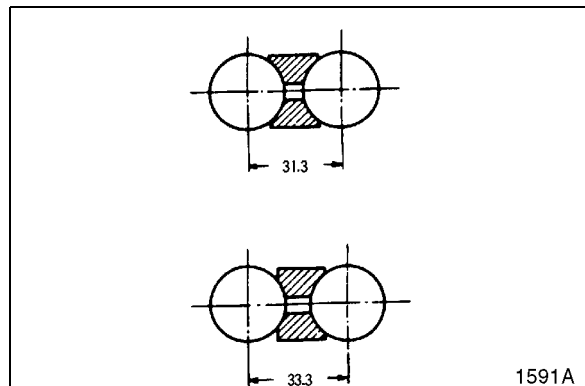


Figure 8



SWING REDUCTION GEARBOX



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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GENERAL DESCRIPTION

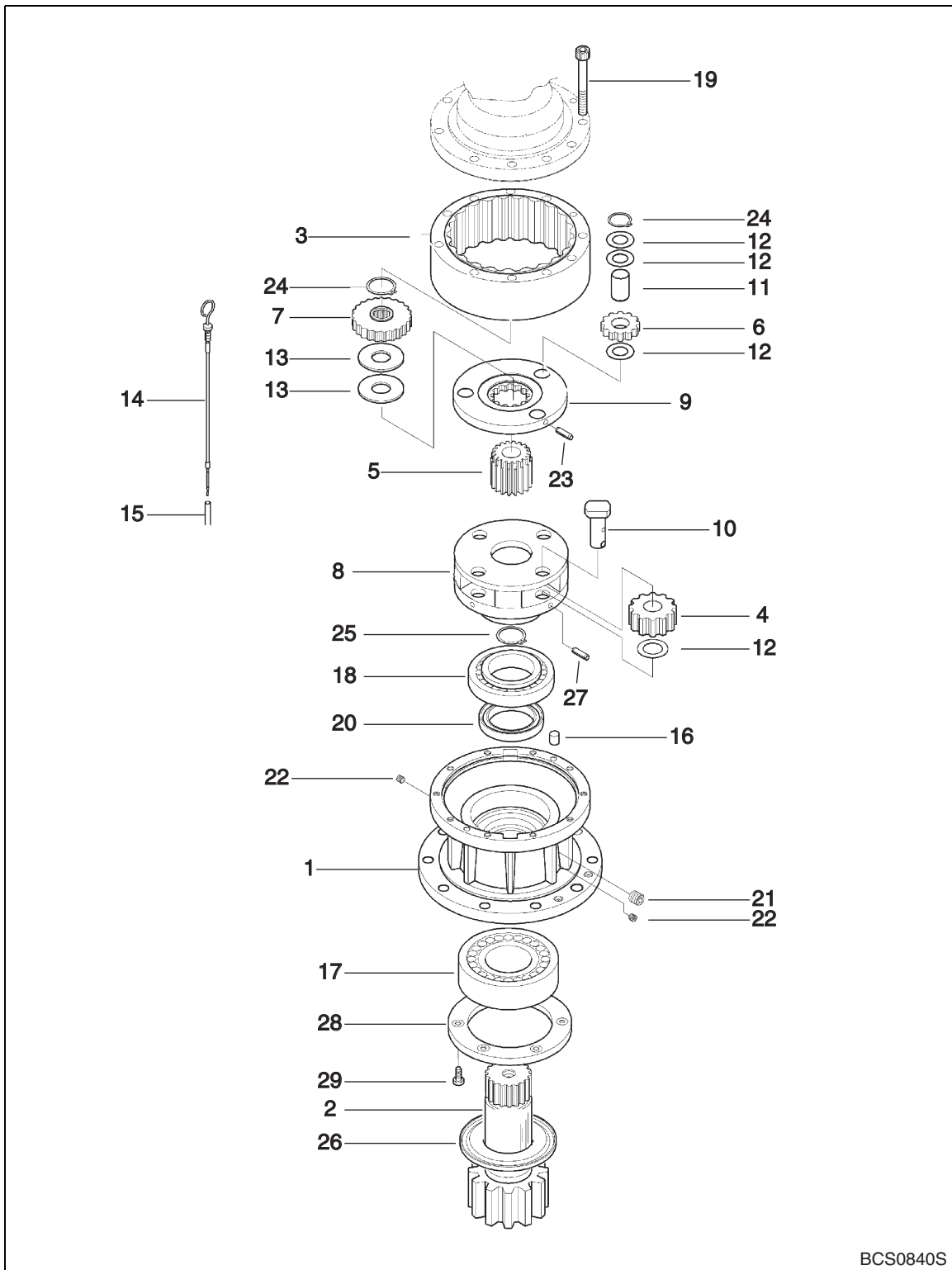
THEORY OF OPERATION

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

The final drive reduces swing motor rpm to increase swing motor output torque. The available maximum swing speed (12.5 rpm) provides a fast turning rate for efficient, rapid work cycling with more than adequate power for good acceleration.

	Sun Gear	Planetary Gear	Ring Gear	Reduction Ratio
1 st Stage	22	25	74	$i_1 = 4.36$
2 nd Stage	25	25	74	$i_2 = 4.36$
Total				$i_1 X i_2 = 19.0$

PARTS LIST



BCS0840S

Figure 1

Reference Number	Description
1	Casing
2	Shaft; Drive
3	Gear; Ring
4	Gear; Planet
5	Gear; Sun
6	Gear; Planet
7	Gear; Sun
8	Carrier
9	Carrier
10	Pin Assembly
11	Pin Assembly
12	Washer; Thrust
13	Washer; Thrust
14	Level Bar
15	Pipe; Level Gauge

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

NOTE: *The inner and outer cylinder roller bearing must be changed at the same time.*

SPECIAL TOOLS AND MATERIALS

SPECIAL TOOLS

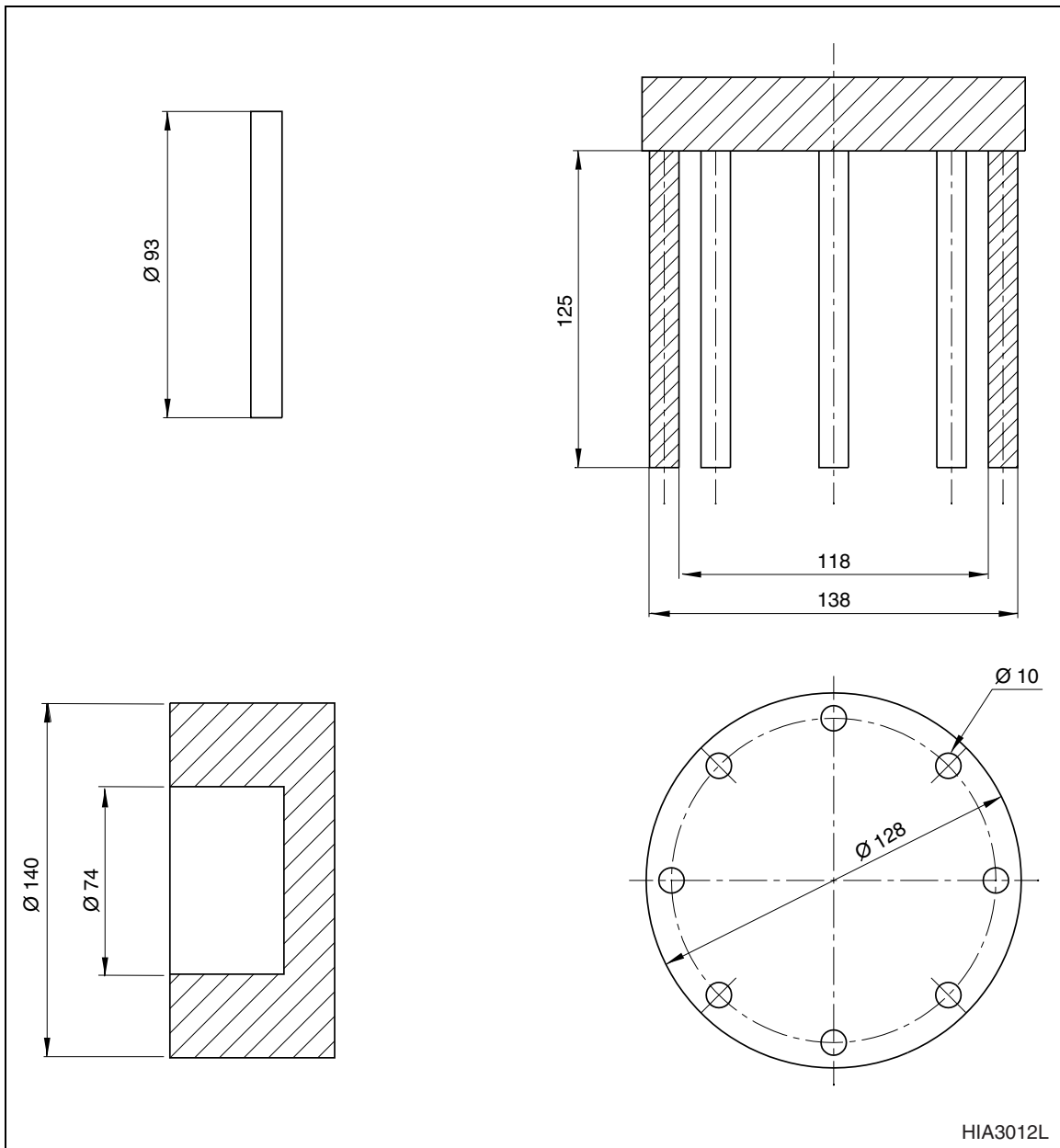


Figure 2

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



WARNING!

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

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

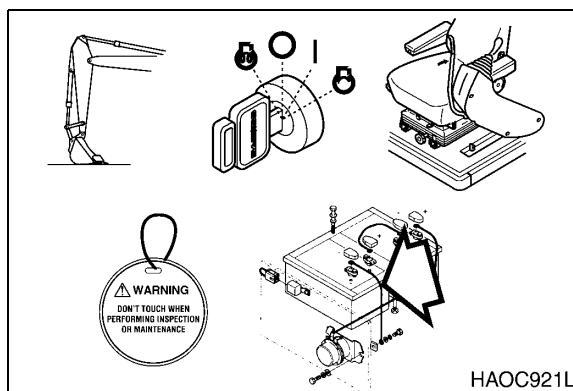


Figure 3

11. Tag and disconnect hoses from swing motor (1, Figure 4). Plug and cap hoses and port to prevent contamination from entering hydraulic system or component.
12. Disconnect tube (2) from drain valve (3)
13. Remove eleven bolts and washers (4, Figure 4) holding swing reduction gearbox (5) to frame.
14. Using a suitable lifting device, sling swing motor (1, Figure 4) and remove swing motor and reduction gearbox (5) as an assembly from unit.

NOTE: A drain valve (3, Figure 4) and tube are on side of gearbox. Be careful not to damage valve or tube.

NOTE: There is one alignment pin (6, Figure 4), on side of reduction gearbox flange.

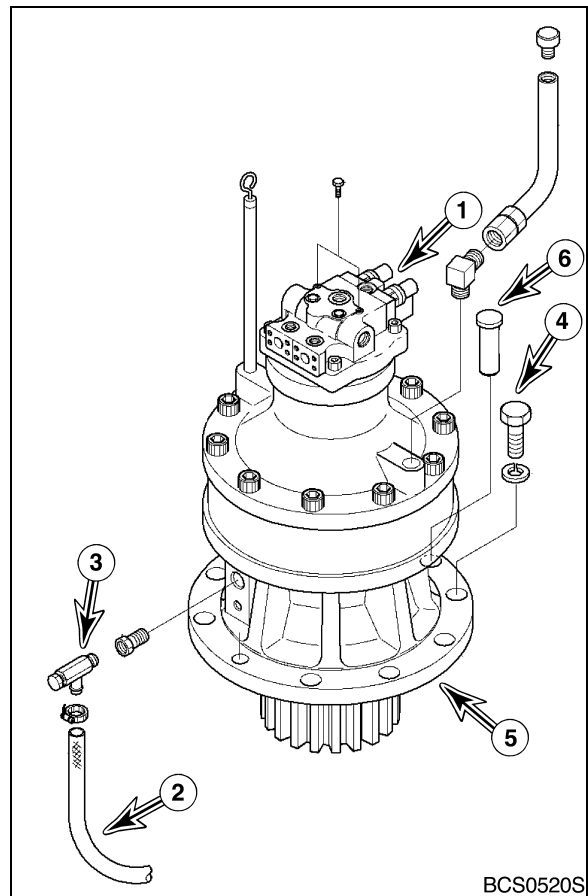


Figure 4

DISASSEMBLY



CAUTION!

1. Place the disassembled parts in a safe location so they do not get damaged.
2. Prior to reassembly, inspect each part for any damages.
3. Clean and dry each part before reassembly.
4. Clean all surface of sealing compound.
5. Torque all bolts according to specifications.

1. Remove swing motor assembly from the equipment and drain gear oil from housing by opening drain plug.



CAUTION!

Please take out gear oil with clean container and check for wearing out part.

2. Remove mounting bolts (19) and separate motor from reduction gear.
3. Remove No. 1 sun gear (7)
4. Remove No. 1 carrier assembly with No. 1 planetary gear (6).
5. Disassembling No. 1 carrier assembly.
 - A. Remove stopper ring (24) and separate thrust washers on the upper part.



CAUTION!

Mark on each planetary gear and pin so that they can be replaced to their proper location during reassembly.

- B. Remove planetary gear (6).
 - C. Remove thrust washers from lower section of planetary gear (6).

If the No. 1 pin (11) is not defective, do not remove it from the No. 1 carrier (9). If it must be replaced, tap on the inner side of the pin to remove.
6. Remove No. 2 sun gear (5).
7. Remove No. 2 carrier assembly.
8. Disassembling No. 2 carrier assemble.

If there are no visible defects after inspection, do not disassemble the No. 2 carrier assembly.

 - A. Place a dowel at the opposite end of No. 2 pin (10) and tap it with a hammer to cut off the spring pin (27) and remove No. 2 pin (10).
 - B. Remove No. 2 planetary gear (4) and thrust washer (12).



CAUTION!

Do not reuse No. 2 pin (10) once it is removed.

9. Remove ring gear (3).

NOTE: *Install two M12 bolts in the threaded holes and lift out.*

10. Remove lock pin (16).



CAUTION!

Do not remove lock pin if it is not necessary.

11. Remove stop ring (25) from shaft (2).
12. Place the reduction gear so that axle is facing the ground. Tap the axle shaft using a hammer to remove from housing.
13. To remove ring (26), support plate (28) and roller bearing (17), secure axle shaft into a vise and press out using appropriate equipment.
14. Remove oil seal (20) from casing (1).



CAUTION!

Do not reuse oil seal and bearing once it is removed.

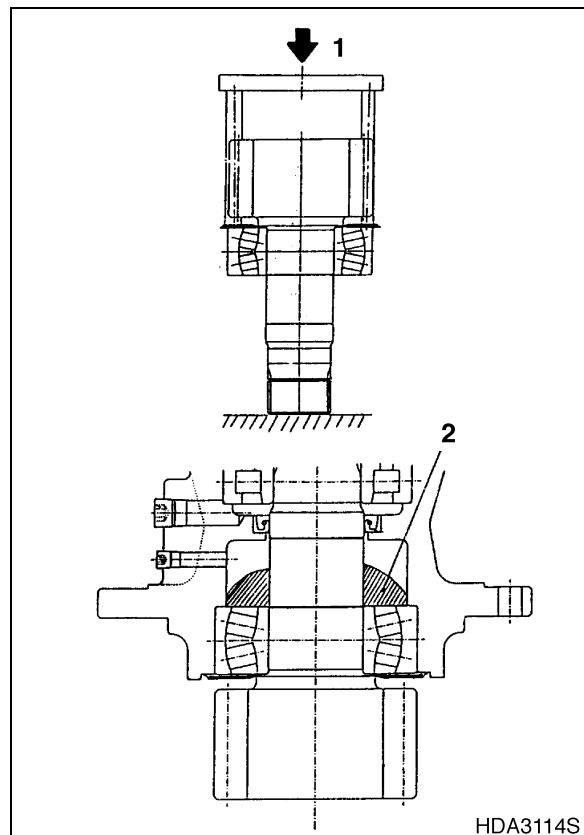


Figure 5

REASSEMBLY

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

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

1. Assembling shaft.
 - A. Insert ring (26) and support plate (28) into shaft.
 - B. Spread grease on inner side of roller bearing (17) then install completely using a press. Apply grease to the bearing (2, Figure 5).



CAUTION!

The bearing must be installed completely perpendicular to the shaft. Do not force bearing onto shaft.

2. Place the housing on a flat working area.
3. Assemble roller bearing into housing by placing it vertically using a screw at the bottom of the axle. Insert it by lightly tapping until it is completely horizontal to the housing.

NOTE: Use roller bearing installing tool listed in the section "Special Tools and Materials" on page 6.
4. Position the housing so that the axle shaft is facing down.
5. Insert oil seal into housing (1).
6. Use bearing installing tool listed in the section "Special Tools and Materials" on page 6 and a press.
7. Install stop ring (25).
8. Insert grease into bearing and seal area. Wrap sealing tape on plug and tighten into hole.
9. Assembling No. 2 carrier assembly.
 - A. Place thrust washer (12) into the location of pin hole.
 - B. Insert the No. 2 planetary carrier (8) into place.
 - C. Check the location of hole and insert No. 2 pin (10) with tapping which from direction which is same as No. 1 carrier hole to spring pin fixed at a hole direction as seen at the top.
 - D. Insert spring pin (27) using jig and use a punch and hammer to secure the spring from moving.
10. Drive in locking pin (16) into two holes of the casing (1).
11. Spread sealing compound on the mating surface between casing (1) and ring gear (3).
12. Locate the marks that were made during disassembly and assemble ring gear (3) into casing (1). Install 4 bolts temporarily to hold it in place. Install all bolts with flat washers and tighten to 8 kg•m.
13. Assemble No. 2 carrier assembler into ring gear.
14. Install No. 2 sun gear (5).
15. Assembling No. 1 carrier assembly.
 - A. Place No. 1 carrier (9) on flat working area.

- B. Align the spring pin (23) hole of the No. 1 pin (11) and the No. 1 carrier (9) and insert pin by lightly tapping.
 - C. Use the spring pin installing jig to install the spring pin (910) and punch 2 areas with a hammer and punch to secure into place.
 - D. Install the thrust washer (12).
 - E. Install thrust washer (13) in the center.
 - F. Install planetary gear (6).
 - G. Install two thrust washer (12) on the upper section and install stop ring (24).
16. Assemble No. 1 carrier assembly. Check that the thrust washer (286) in the center is properly aligned with No. 2 sun gear.
 17. Assemble No. 1 sun gear (7).
 18. Remove the temporarily bolts and apply sealant on motor mating surface area on ring gear (3).
 19. Lower the motor shaft vertically placing stop ring (24) into it then assemble motor comparing with the location of thrust washer then tighten it with hex. socket bolt (19).
 20. Wrap seal tape onto the plug and place it into the casing.
 21. Fill with gear oil.

INSTALLATION

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

NOTE: Apply Loctite #262 to bolt threads.

5. Connect tube (2) to drain valve (3)
6. Connect hoses as tagged during removal to swing motor (1, Figure 6).
7. Fill swing reduction gearbox with oil. Refer to operation manual for specifications.

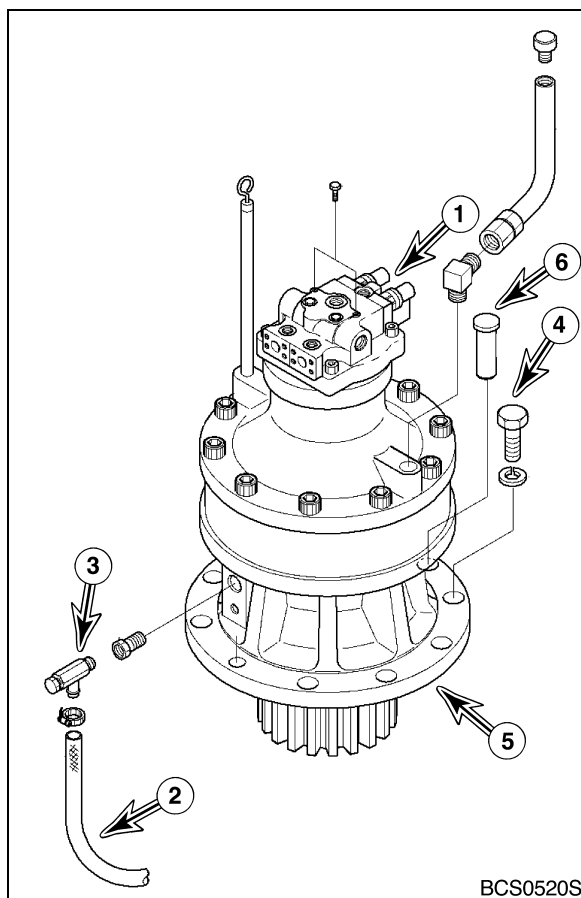


Figure 6

LOWER STRUCTURE AND CHASSIS



S0503000
R1

RAM LOCK VALVE OPERATION



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 130W-V	0001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 210W-V	1001 and Up

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THEORY OF OPERATION

The ram lock valve absorbs vibration of the front axle and helps adjust the front axle, according to the type of work being done. When the ram lock solenoid valve is off, port P's pressure is the same as the tank pressure and spring pressure moves the check valve to the left and blocks passage between the ram cylinders. When the ram lock solenoid valve is on, pressurized oil flows into port P, pushes the spool, moves the check valve to the right and opens the passage between the ram cylinders. The stroke is adjusted according to the load applied to the ram cylinder.

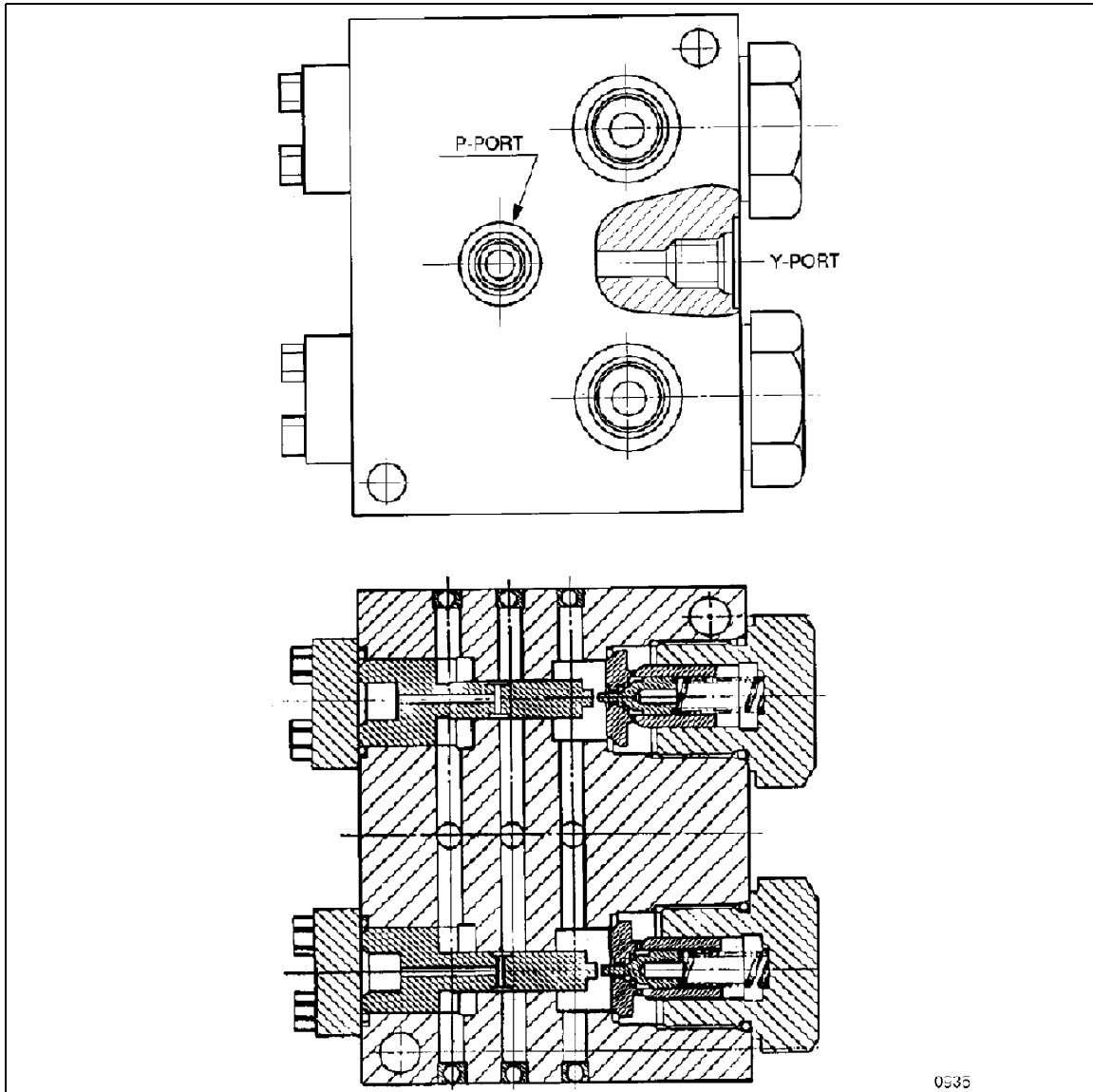


Figure 1

ENGINE AND DRIVE TRAIN



FRONT AXLE (DANA)



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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INTRODUCTION

The efficiency and continued operation of mechanical units depend on constant, correct maintenance and also on efficient repair work, should there be a break-down or malfunction. The instructions contained in this manual have been based on a complete overhaul of the unit.

However, it is up to the mechanic to decide whether or not it is necessary to assemble only individual components, when partial repair work is needed. The manual provides a quick and sure guide which, with the use of photographs and diagrams illustrating the various phases of the operations, allows accurate work to be performed.

All the information needed for correct disassembly, checks and assembly of each individual component is set out below. In order to remove the differential unit from the vehicle, the manuals provided by the vehicle manufacturer should be consulted. In describing the following operations it is presumed that the unit has already been removed from the vehicle.

IMPORTANT

In order to facilitate work and protect both working surfaces and operators, it is advisable to use proper equipment such as: trestles or supporting benches, plastic or copper hammers, appropriate levers, pullers and specific spanners or wrenches.

Before going on to disassemble the parts and drain the oil, it is best to thoroughly clean the unit, removing any encrusted or accumulated grease.

INTRODUCTORY REMARKS

All the disassembled mechanical units should be thoroughly cleaned with appropriate products and restored or replaced if damage, wear, cracking or seizing have occurred.

In particular, thoroughly check the condition of all moving parts (bearings, gears, crown wheel and pinion, shafts) and sealing parts (O-rings, oil shields) which are subject to major stress and wear. In any case, it is advisable to replace the seals every time a component is overhauled or repaired. During assembly, the sealing rings must be lubricated on the sealing edge. In the case of the crown wheel and pinion, replacement of one component requires the replacement of the other one. During assembly, the prescribed pre-loading, backlash and torque of parts must be maintained.

MAINTENANCE AND LUBRICANT

DEFINITION OF VIEWPOINTS

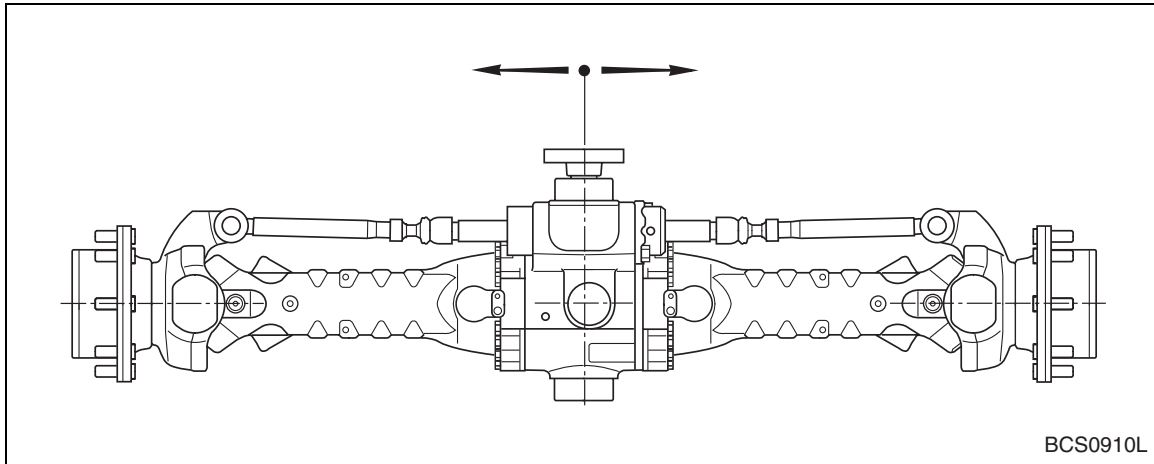


Figure 1

DATA PLATE

Reference Number	Description
1	Type and model unit
2	Serial number
3	Lubricant

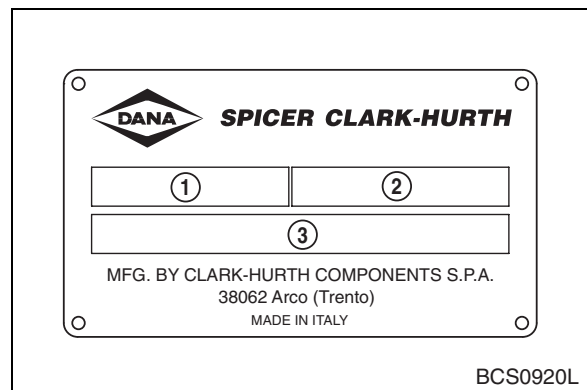


Figure 2

MAINTENANCE POINTS

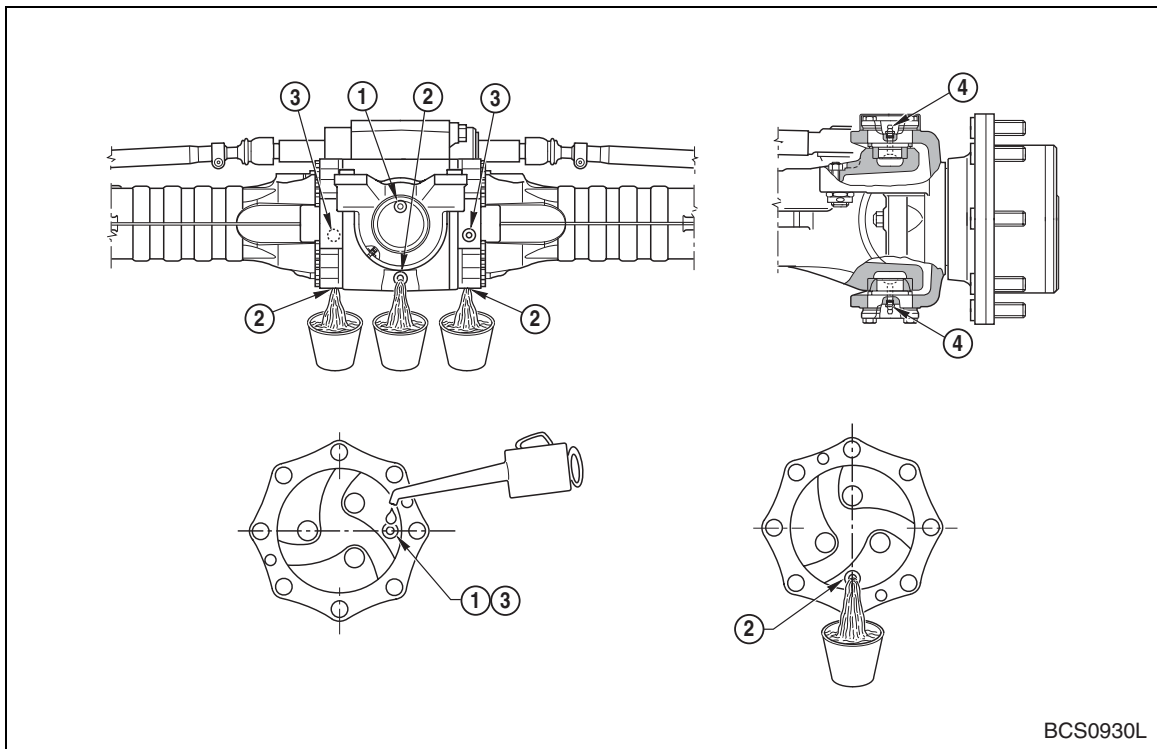


Figure 3

Reference Number	Description
1	Oil Filling Plug
2	Oil Draining Plug

Reference Number	Description
3	Check Level Plug
4	Grease Nipples

MAINTENANCE INTERVALS

Operation		Frequency	Lubricants
• Check levels:	Differential	Monthly	• SAE85W90 (API GL4 - MIL L-2105) With additives for oil-bath brakes • SAE85W90 (API GL5 - MIL 2105-B) With additives for oil-bath brakes, for units presenting hypoid crown wheel and pinion and /or self-locking differential gear.
	Planetary reduction	Every 200 hours	
• Oil change:	Differential	Every 800 hours *	
	Planetary reduction	Every 1000 hours *	
	Self-locking differential gear	Every 700 hours *°.	

* Initially after 100 working hours

°. When it starts sounding noisy

Operation	Member	Conditions	Frequency	Lubricants
Greasing	Articulations	Normal work	Monthly	MOLIKOTE
		Awkward work	Weekly	

ADJUSTMENT AND CHECKS

Unit	Operation	Frequency	Service Brake Circuit
Negative brake	Adjustment	Every 1000 hours *	Only for mineral oil use e.g. ATF Dexron II. Make sure that master cylinder seals are suitable for mineral oil.
Service brake	Adjustment	Every 500 hours	
Wheel nuts	Tightening	Every 200 hours	

* Initially after 100 working hours

TIGHTENING TORQUES

Unit: Nm (ft lb)

Size of Bolt		Type of Bolt					
		8.8		10.9		12.9	
		Loctite 242	Loctite 242	Loctite 242	Loctite 242	Loctite 242	Loctite 242
Coarse Pitch	M6 x 1	9,5-10,5 (7-8)	10,5-11,5 (8-9)	14,3-15,7 (11-12)	15,2-16,8 (11-12)	16,2-17,8 (12-13)	18,1-20,0 (13-15)
	M8 x 1,25	23,8-26,2 (18-19)	25,6-28,4 (19-21)	34,2-37,8 (25-28)	36,7-40,5 (27-30)	39,0-43,0 (29-32)	43,7-48,3 (32-36)
	M10 x 1,5	48-58 (35-43)	52-58 (38-43)	68-75 (50-55)	73-81 (54-59)	80-88 (59-64)	88-97 (64-71)
	M12 x 1,75	82-91 (61-67)	90-100 (66-74)	116-128 (86-94)	126-139 (93-102)	139-153 (103-112)	152-168 (112-123)
	M14 x 2	129-143 (95-105)	143-158 (106-116)	182-202 (134-148)	200-221 (148-163)	221-244 (163-179)	238-263 (176-193)
	M16 x 2	200-221 (148-163)	219-242 (162-178)	283-312 (209-230)	309-341 (228-251)	337-373 (249-275)	371-410 (274-302)
	M18x 2,5	276-305 (204-225)	299-331 (221-244)	390-431 (288-317)	428-473 (316-348)	466-515 (344-379)	509-562 (376-414)
	M20 x 2,5	390-431 (228-318)	428-473 (316-348)	553-611 (408-450)	603-667 (445-491)	660-730 (487-538)	722-798 (533-588)
	M22 x 2,5	523-578 (386-426)	575-635 (424-468)	746-824 (550-607)	817-903 (603-666)	893-987 (659-727)	974-1076 (718-793)
	M24 x 3	675-746 (498-550)	732-809 (540-596)	950-1050 (701-774)	1040-1150 (767-848)	1140-1260 (841-929)	1240-1370 (915-1010)
	M27 x 3	998-1103 (736-813)	1088-1202 (803-886)	1411-1559 (1041-1149)	1539-1701 (1135-1254)	1710-1890 (1261-1393)	1838-2032 (1356-1498)
	M30 x 3,5	1378-1523 (1016-1123)	1473-1628 (1086-1200)	1914-2115 (1412-1559)	2085-2305 (1538-1700)	2280-2520 (1682-1859)	2494-2757 (1840-2033)

Size of Bolt		Type of Bolt					
		8.8		10.9		12.9	
		Loctite 242	Loctite 242	Loctite 242	Loctite 242	Loctite 242	Loctite 242
Coarse Pitch	M8 x 1	25,7-28,3 (19-21)	27,5-30,5 (20-22)	36,2-39,8 (27-29)	40,0-44,0 (30-32)	42,8-47,2 (32-34)	47,5-52,5 (35-38)
	M10 x 1,25	49,4-54,6 (36-40)	55,2-61,0 (41-45)	71,5-78,5 (53-57)	78,0-86,0 (58-63)	86,0-94,0 (63-69)	93,0-103,0 (69-75)
	M12 x 1,25	90-100 (66-74)	98-109 (72-80)	128-142 (95-104)	139-154 (103-113)	152-168 (112-123)	166-184 (123-135)
	M12 x 1,5	86-95 (63-70)	94-104 (69-76)	120-132 (89-97)	133-147 (98-108)	143-158 (106-116)	159-175 (117-129)
	M14 x 1,5	143-158 (106-116)	157-173 (116-127)	200-222 (148-163)	219-242 (162-178)	238-263 (176-193)	261-289 (193-213)
	M16 x 1,5	214-236 (158-174)	233-257 (172-189)	302-334 (223-246)	333-368 (246-271)	361-399 (266-294)	394-436 (291-321)
	M18 x 1,5	312-345 (230-254)	342-378 (252-278)	442-489 (326-360)	485-536 (358-395)	527-583 (389-430)	580-641 (428-472)
	M20 x 1,5	437-483 (322-356)	475-525 (350-387)	613-677 (452-499)	674-745 (497-549)	736-814 (543-600)	808-893 (596-658)
	M22 x 1,5	581-642 (429-473)	637-704 (470-519)	822-908 (606-669)	903-998 (666-736)	998-1103 (736-813)	1078-1191 (795-878)
	M24 x 2	741-819 (547-604)	808-893 (596-658)	1045-1155 (771-851)	1140-1260 (841-929)	1235-1365 (911-1006)	1363-1507 (1005-1111)
	M27 x 2	1083-1197 (799-883)	1178-1302 (869-960)	1520-1680 (1121-1239)	1672-1848 (1233-1363)	1834-2027 (1353-1495)	2000-2210 (1475-1630)
	M30 x 2	1511-1670 (1115-1231)	1648-1822 (1216-1343)	2138-2363 (1577-1742)	2332-2577 (1720-1900)	2565-2835 (1892-2090)	2788-3082 (2056-2273)

SCREW-LOCKING, SEALING AND LUBRICATING MATERIALS

IMPORTANT	
1.	Locking, sealing and lubricating materials referred to in this manual are the same used in the shop-floor.
2.	The table below gives an account of the typical applications of each single material, in order to facilitate replacement with similar products marketed by different brand names with different trade marks.

Denomination	Application
Loctite 242	Anaerobic product apt to prevent the loosening of screws, nuts and plugs. Used for medium-strength locking. Before using it, completely remove any lubricant by using the specific activator.
Loctite 243	The oleocompatible alternative to 242. Does not require the activation of lubricated surfaces.
Loctite 270	Anaerobic product for very-high strength locking of screws and nuts. Before using it, completely remove any lubricant by using the specific activator. To remove parts, it may be necessary to heat them at 80° C (176° F) approx.
Loctite 275	Anaerobic product suitable for high-strength locking and sealing of large threaded parts, bolts and stud bolts, for pipe sealing and for protecting parts against tampering; suitable for sealing coupling surfaces with a max. diametrical clearance of 0.25 mm.
Loctite 510	Anaerobic product for the hermetic sealing of flanged units and screw holes communicating with fluids. Can seal clearances between flanges up to 0.2 mm.
Loctite 577	Quick anaerobic sealant for sealing threaded portions of conical or cylindrical unions up to M80. Before using it, remove any lubricant with the specific activator. After polymerisation, disassembly may result rather difficult, so heating may be necessary for larger diameters.
Loctite 638	Anaerobic adhesive for fast and high-strength gluing of cylindrical metal joints (hub on shaft). Can glue together parts with clearance ranging between 0.1 and 0.25 mm.
Loctite 648	Anaerobic adhesive for fast and medium-strength gluing of cylindrical metal joints (hub on shaft). Can glue together parts with radial clearance below 0.1 mm.
(AREXONS) Repositionable jointing compound for seals	Solvent-based sealing compound for elastic seals, drying through evaporation. Used for sealing the outer diameter of sealing rings for rotating shafts with outer metal reinforcement.
Silicone	Semi-fluid adhesive material used for sealing and filling and to protect components from environmental and physical elements. Polymerises with non-corrosive dampness.
(TECNO LUPE/101) Silicone-based grease	Highly adhesive synthetic grease, with silicone compounds added. Applied to adjustment screws with hole communicating with oil-type fluids. Used when frequent adjusting is required.
Molikote (DOW CORNING)	Lubricating compound containing molybdenum disulphide, used to lubricate articulation pins and to prevent sticking and oxidation of parts that are not lubricated on a regular basis.
(Lithium-based) Grease	Applied to bearings, sliding parts and used to lubricate seals or parts during assembly.

NOTES ON SAFETY PRECAUTIONS

1. During all operations described in this manual, the axle should be fastened onto a trestle, while the other parts mentioned should rest on supporting benches.
2. When removing one of the arms, an anti-tilting safety trestle should be placed under the other arm.
3. When working on an arm that is fitted on the machine, make sure that the supporting trestles are correctly positioned and that the machine is locked lengthways.
4. Do not admit any other person inside the work area; mark off the area, hang warning signs and remove the ignition key from the machine.
5. Use only clean, quality tools; discard all worn, damaged, low-quality or improvised wrenches and tools. Ensure that all dynamometric wrenches have been checked and calibrated.
6. Always wear gloves and non-slip rubber shoes when performing repair work.
7. Should you stain a surface with oil, remove marks straight away.
8. Dispose of all lubricants, seals, rags and solvents once work has been completed. Treat them as special waste and dispose of them according to the relative law provisions obtaining in the country where the axles are being overhauled.
9. Make sure that only weak solvents are used for cleaning purposes; avoid using turpentine, dilutants and toluol-, xylol-based or similar solvents; use light solvents such as Kerosene, mineral spirits or water-based, environment friendly solvents.
10. For the sake of clarity, the parts that do not normally need to be removed have not been reproduced in some of the diagrams.
11. The terms RIGHT and LEFT in this manual refer to the position of the operator facing the axle from the side opposite the drive.
12. After repair work has been completed, accurately touch up any coated part that may have been damaged.

CHECKING WEAR AND REPLACING BRAKE DISKS

DISASSEMBLY OF BRAKE UNITS

NOTE: Perform all operations on both arms.

1. Remove the oil-level plug (1).

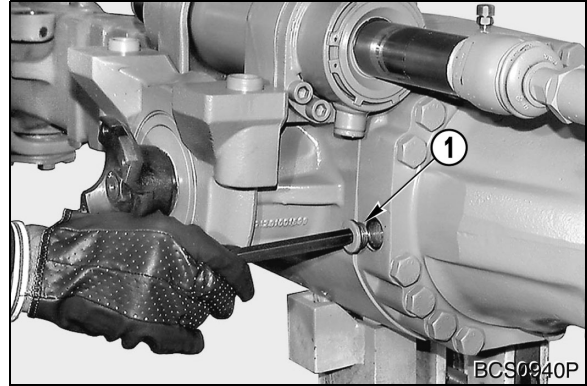


Figure 4

2. Apply the brakes and, keeping them under pressure, check the linings "S" between the disks using tool T1. Minimum "S": 4.5 mm (0.18 in)

NOTE: Replace the braking disks and the intermediate disks on both sides if necessary.

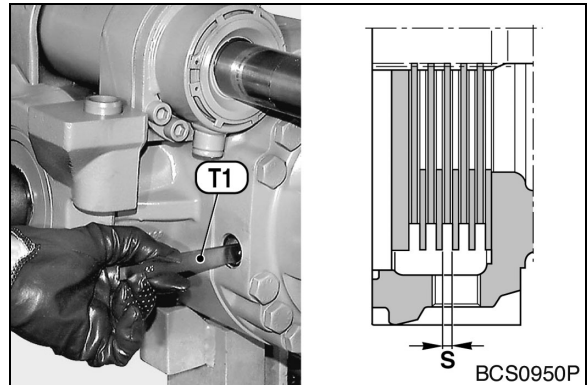


Figure 5

3. Remove the swinging support (2) on the side opposite the drive.

NOTE: If the bushing (17) is worn and needs replacing, note down the assembly side of the connection notch "A".

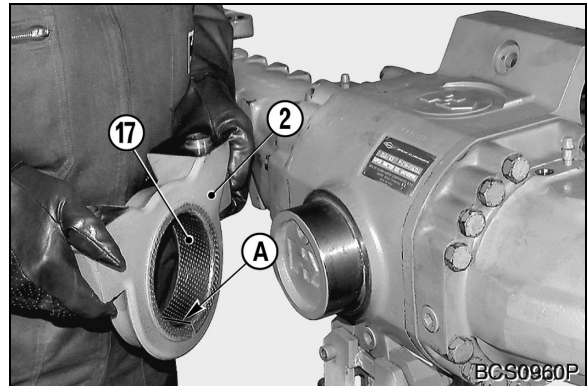


Figure 6

4. Disconnect the pins of the steering bars from the steering case (See “Steering Cylinder” on page 45).
5. Sling the arm (3) to be removed and put the rod under slight tension.

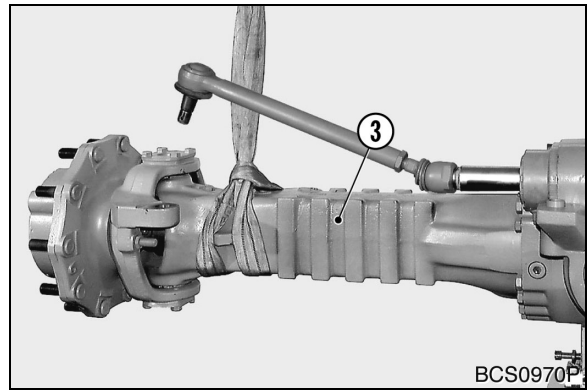


Figure 7

6. Unloose and remove the screws (4) and the washers (5) that fix the arm (3) to the central body (6).

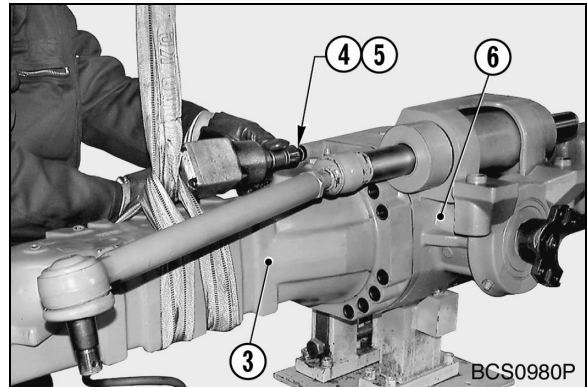


Figure 8

7. Remove the arm (3) together with the pack of the braking disks (7).
8. Place the arm on a bench.

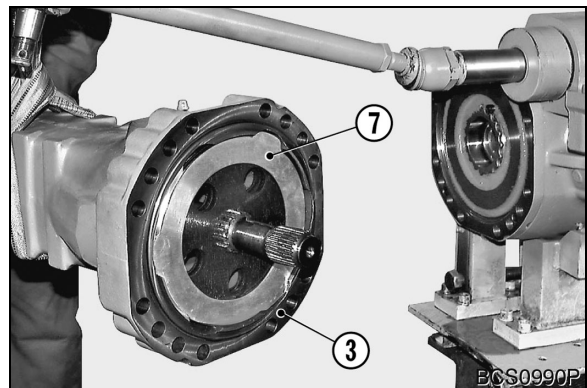


Figure 9

9. Remove the braking disks (7) and note down their order of assembly.

NOTE: 1) If the disks do not need replacing, avoid switching their position.

2) Extract the u-joint (18).

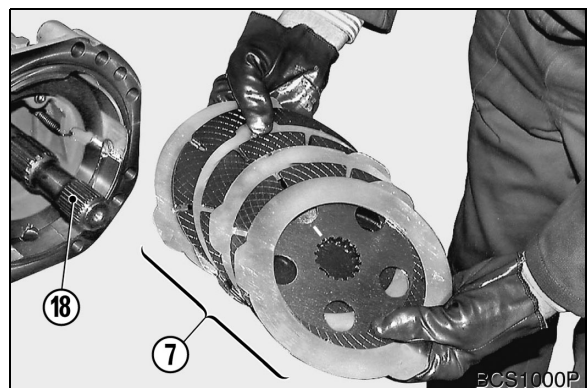


Figure 10

10. Remove the reversal springs (8) from the piston (9).

NOTE: *If the springs (8) are weak or deformed they must be replaced.*

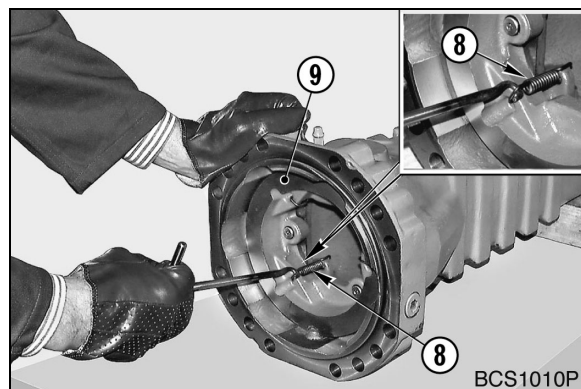


Figure 11

11. Remove the pin screws (10) guiding the piston (9).

NOTE: *If the screws are to be replaced, note down the different colors for the different brake gap. (See "Assembly of Brake Units" on page 16.)*

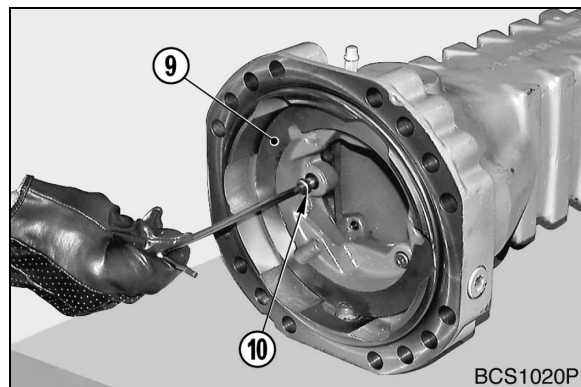


Figure 12

12. Slowly introduce compressed air through the connection of the braking circuit in order to extract the entire piston.

NOTE: *Hold on to the piston as it may be suddenly ejected and damaged.*

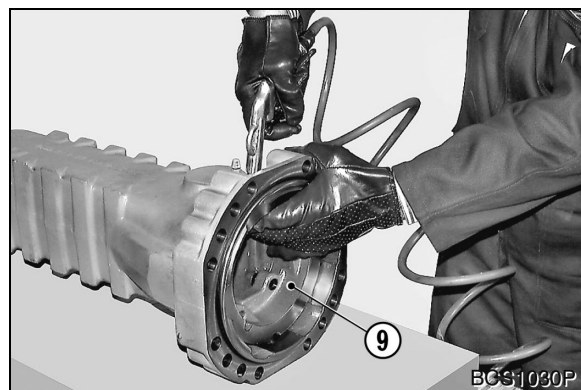


Figure 13

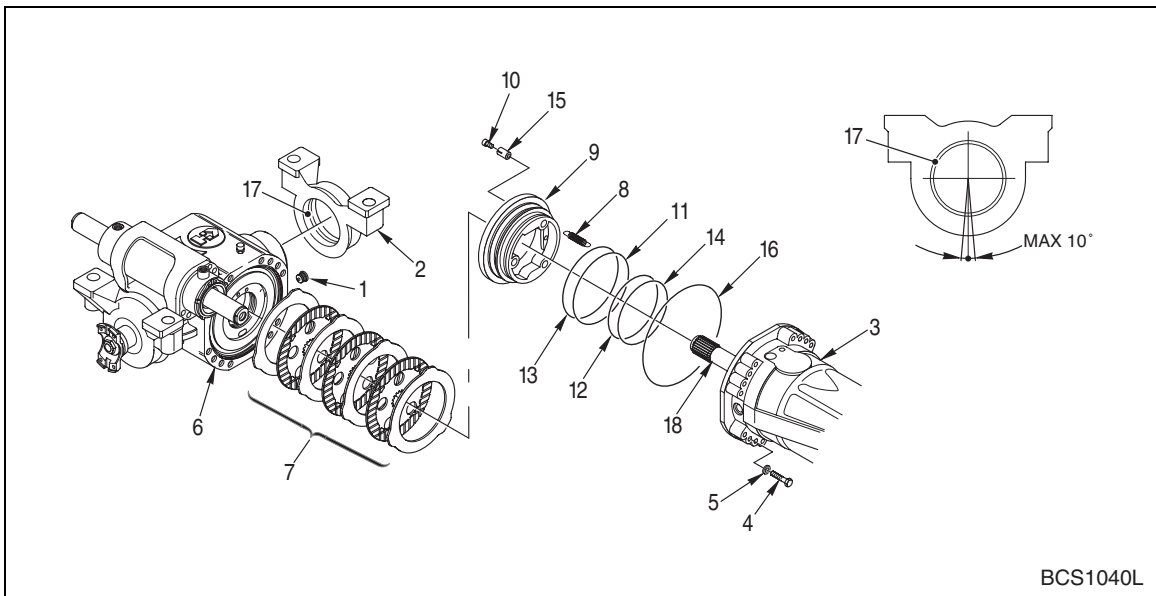


Figure 14

ASSEMBLY OF BRAKE UNITS

1. Accurately clean the piston (9) and the seats of slide and seal.
2. Replace the O-rings (11) and (12) and the anti-extrusion rings (13) and (14); make sure that the assembly side is correct.

NOTE: *Accurately check the positioning of the anti-extrusion rings (13) and (14).*

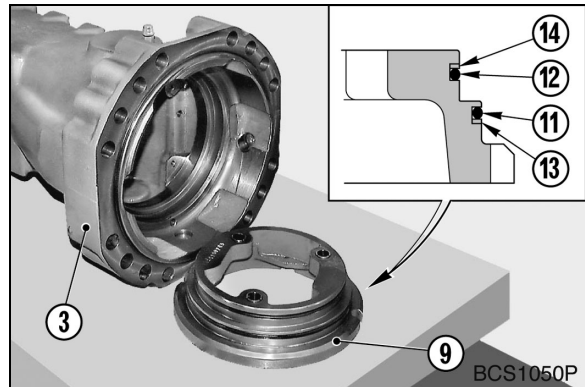


Figure 15

3. Insert the stroke automatic regulation springs (15); place them in line with the piston (9).

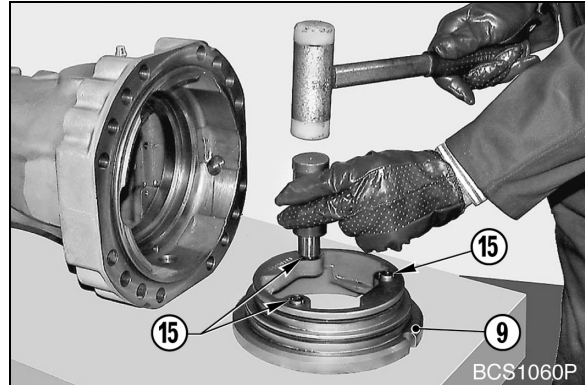


Figure 16

4. Lubricate the seals (11) and (12) and fit the piston (9) into the arm (3).

NOTE: *Make sure that the piston seat fits into the stop pin (A) inside the arm.*

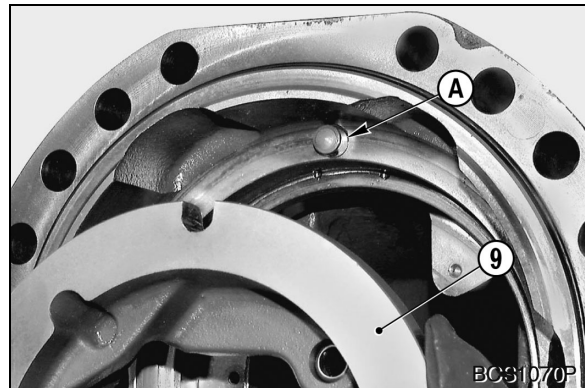


Figure 17

5. Assist the insertion of the piston (9) by lightly hammering around the edge with a plastic hammer.

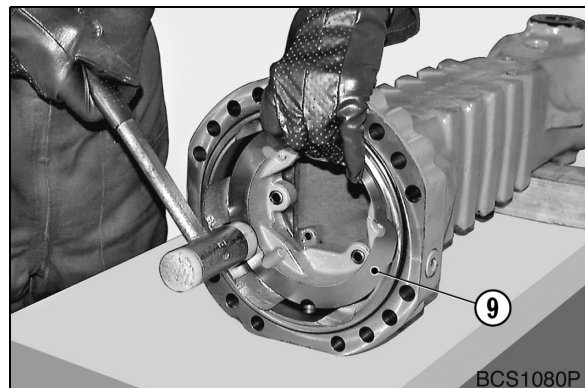


Figure 18

6. Fit the pin screws (10) making sure that they are all of the same color.

White: 1 mm (0.04 in) gap
Yellow: 0.75 mm (0.03 in) gap
Blue: 0.50 mm (0.02 in) gap

7. Torque wrench setting: 5-7 Nm (4-5 ft lb).

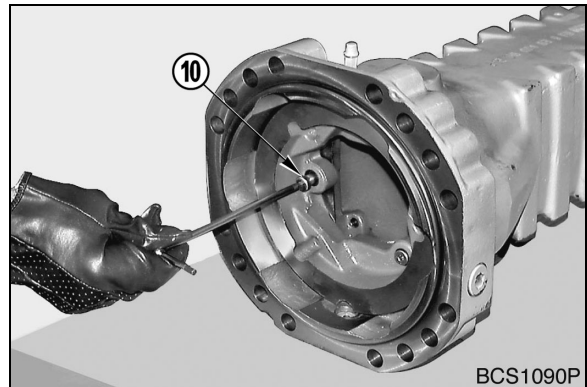


Figure 19

8. Fit the reversal springs (8) on the piston (9).

NOTE: Pay due attention not to deform the connections of the springs.

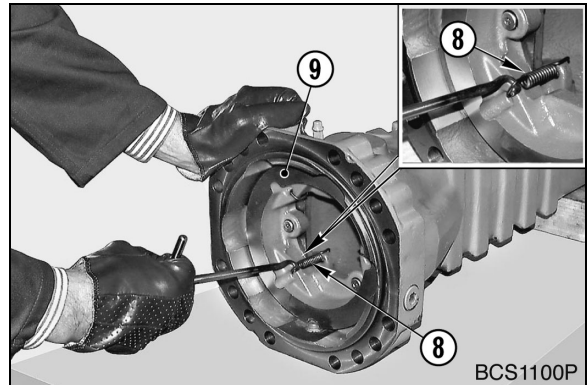


Figure 20

9. Slightly lubricate the braking disks (7) and fit them in the arm following the correct sequence; orient them so that the oil circulation holes and the marks "B" are perfectly lined up.

NOTE: When installing the steel discs, the slot corresponding to the oil level cap should always be kept free.

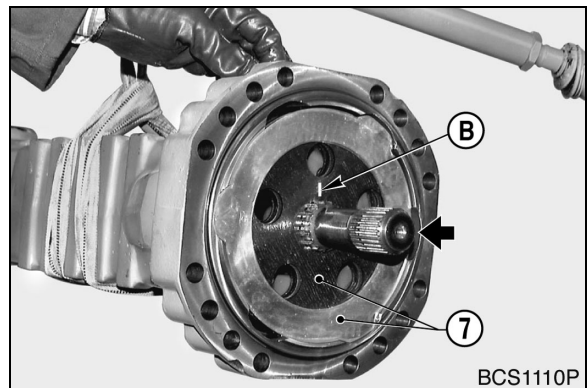


Figure 21

10. Check that the positioning of the sealing ring (16) on the arm is intact; install the complete arm. Lock it into position using two facing screws (4) and washers (5).

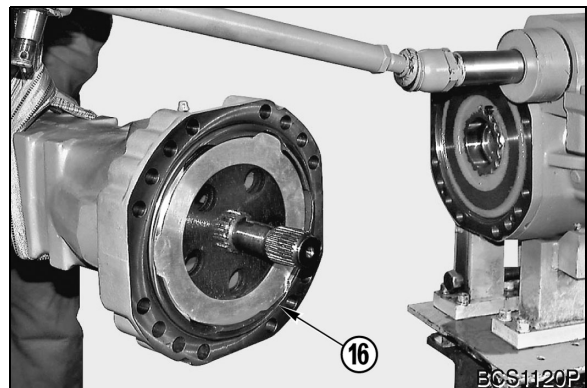


Figure 22

11. Check the flatness of the arms using tool **T2** and finally lock the arms with the screws (4) and the washer (5) using the cross-tightening method.

Torque wrench setting: 298 Nm (220 ft lb).

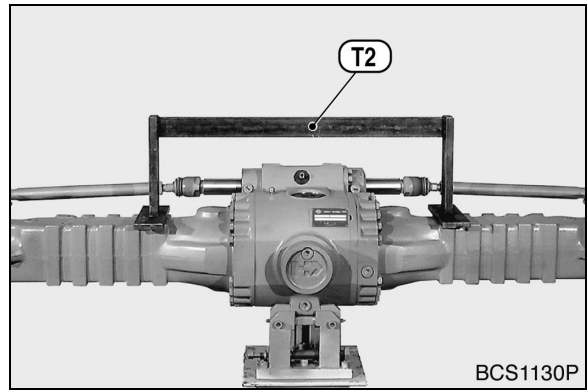


Figure 23

STEERING CASE

REMOVAL AND DISASSEMBLY

1. Remove the guard (1) and disconnect the articulation pin (2).

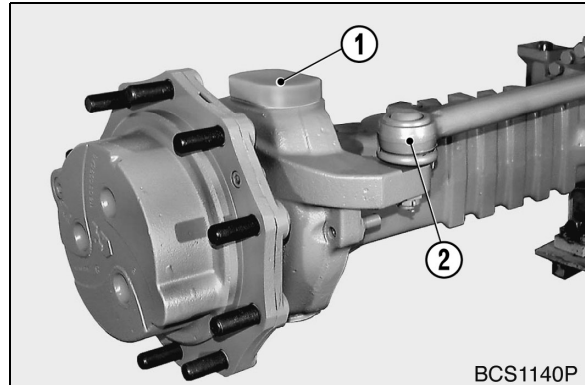


Figure 24

2. Sling the entire unit (7) and connect it to the hoist, putting the rod under light tension.

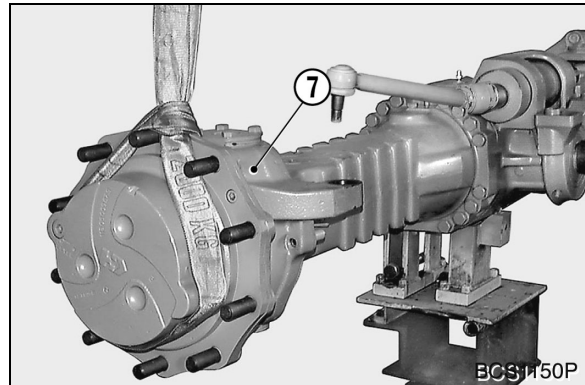


Figure 25

3. Unloose and remove the fitting screws (3) from the bottom articulation pin (4).

NOTE: *Screws cannot be re-used.*

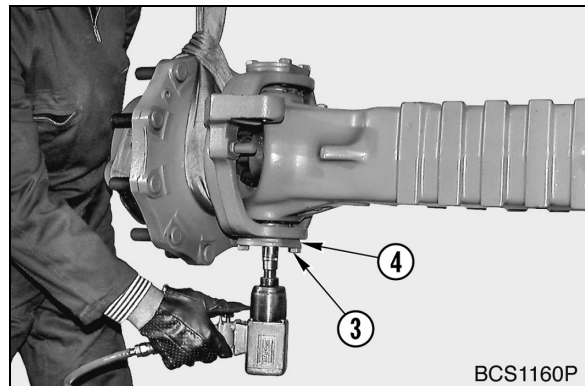
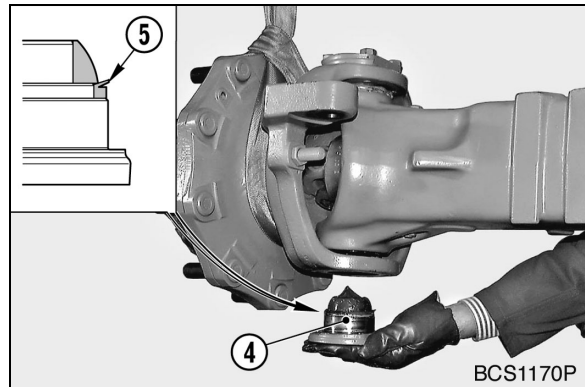
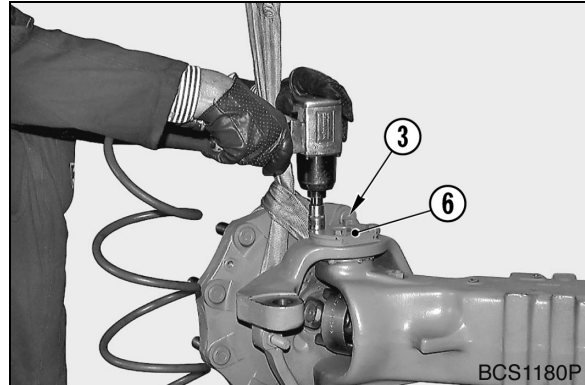


Figure 26

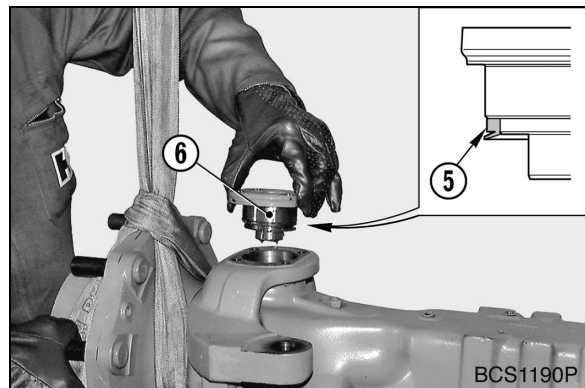
4. Remove the bottom articulation pin (4) complete with front sealing ring (5).



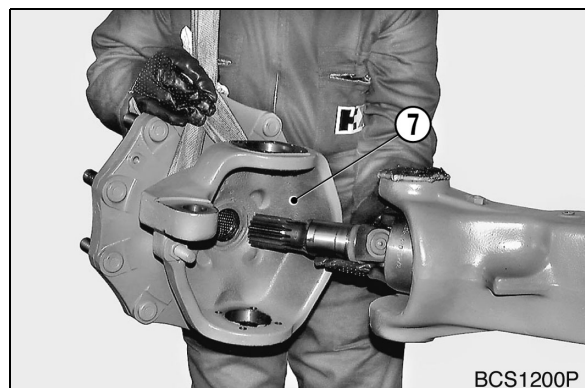
5. Unloose and remove the fitting screws (3) from the top articulation pin (6).



6. Using two levers, remove the top articulation pin (6) complete with front seal (5).
7. Pay attention not to damage the surfaces.



8. Remove the complete steering case (7).



9. Using a puller for inner parts, remove the top bush (8) and the bottom ball-bush (9).

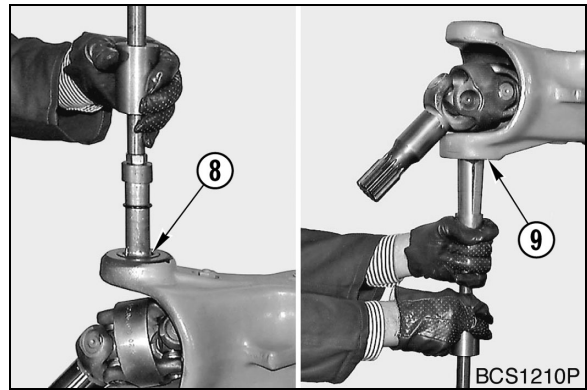


Figure 31

10. Remove the articulation pins (4) and (6) and the front sealing rings (5).

NOTE: *Note down the side for assembly.*

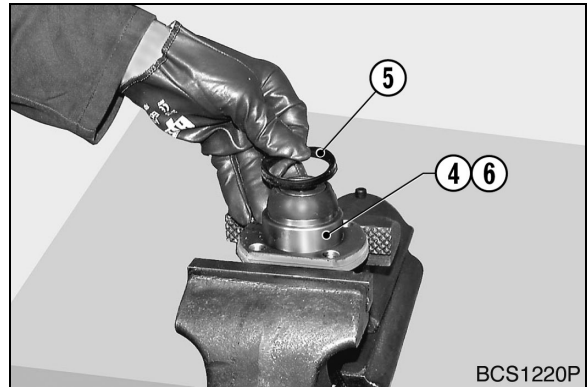


Figure 32

11. If the ball cover (11) needs replacing, remove it from the bottom articulation pin (4).

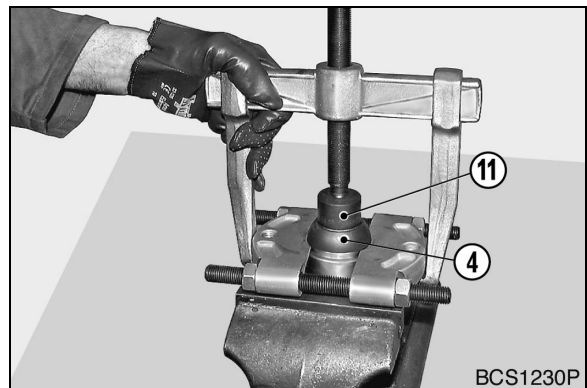


Figure 33

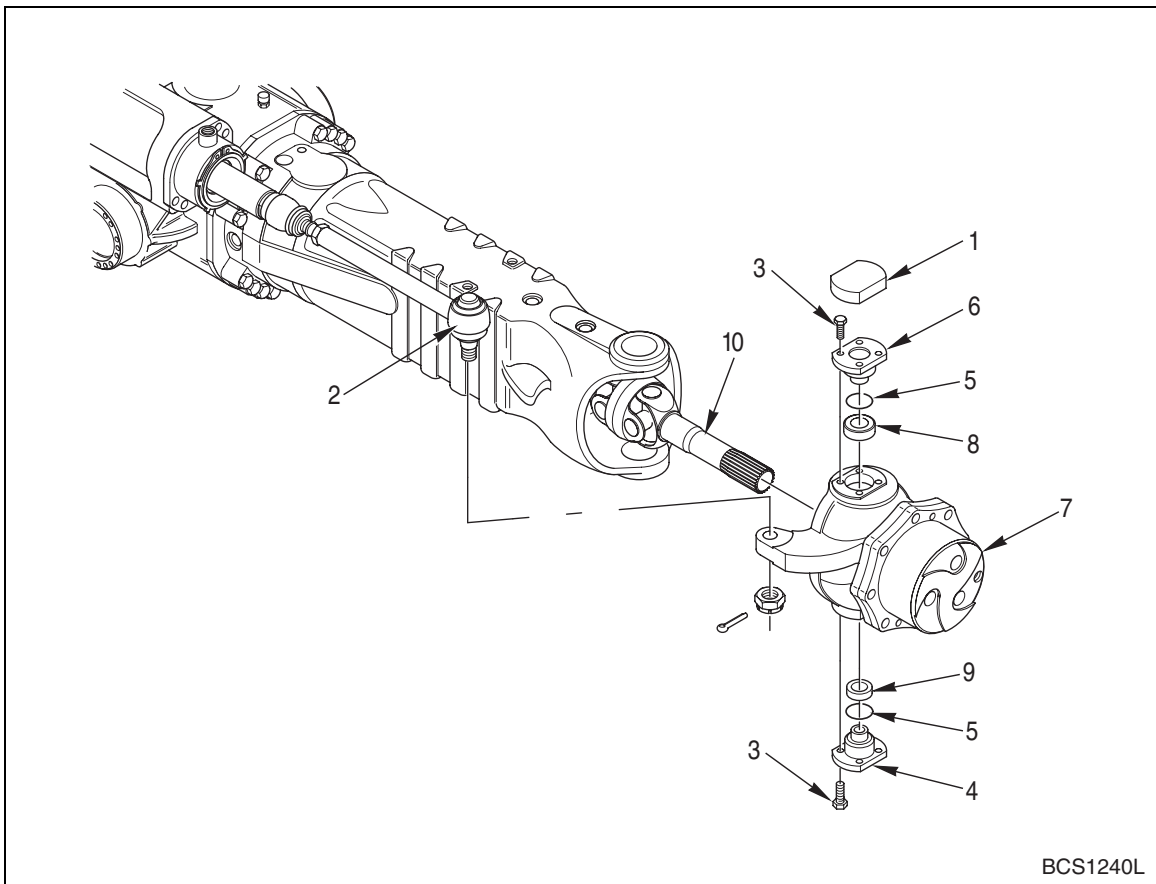


Figure 34

ASSEMBLY AND INSTALLATION

1. If the bottom articulation pin (4) has been extracted, position the pin under a press and fit the ball cover (11).

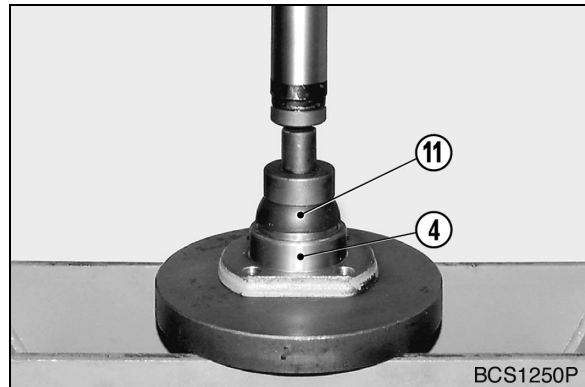


Figure 35

2. Fit the front sealing rings (5) onto the articulation pins (4) and (6).

NOTE: Carefully check that the rings are properly oriented (5).

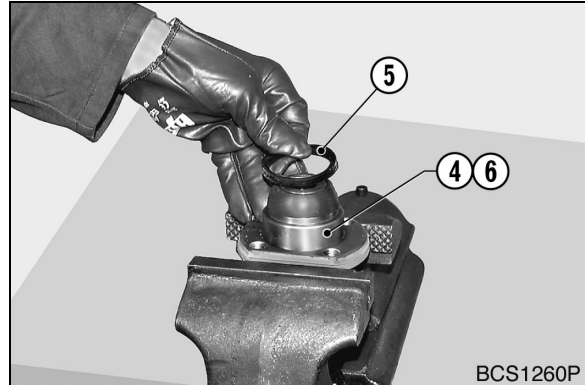


Figure 36

3. Lubricate the top bush (8) or the bottom ball bush (9) and fit them into the fulcrum holes of the arm.
4. Use tools T3 and T4.

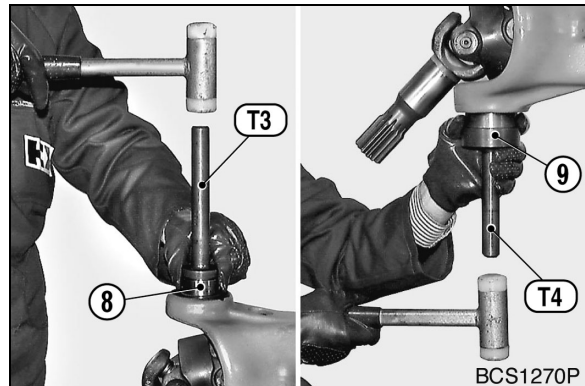


Figure 37

5. Lubricate the terminal of the u-joint (10) and install the steering case (7).
6. Pay due attention not to damage the dust cover rings and the sealing rings.

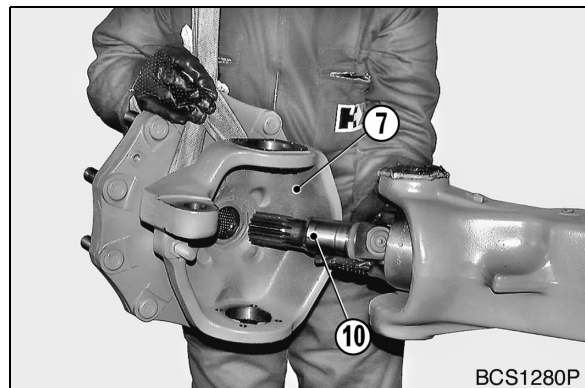


Figure 38

7. Fit a new seal (5) onto the top articulation pin (6). Lubricate and install the unit in the steering case. Position the screws (3) and lightly tighten.
8. Check the correct assembly side of the seal (5).

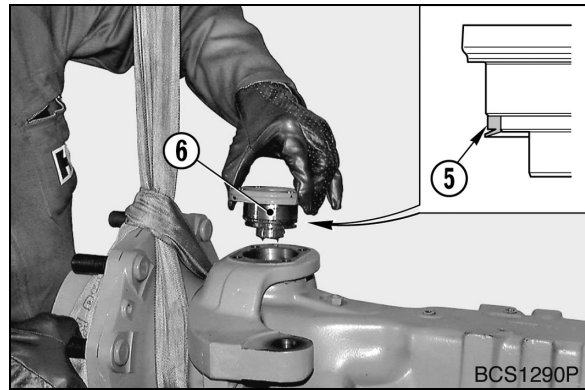


Figure 39

9. Fit a new seal (5) onto the bottom articulation pin (4). Lubricate and fit the unit in the steering case. Position the screws (3) and lightly tighten.
10. Check for the correct assembly side of the seal (5).

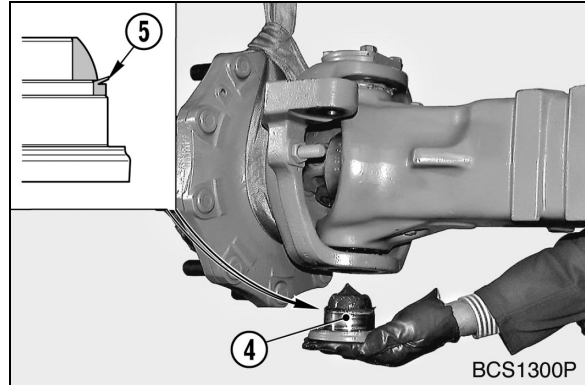


Figure 40

11. Tighten the new fitting screws (3) of top and bottom articulation pins in sequence using the cross tightening method.
- Torque wrench setting: 128-142 Nm (95-104 ft lb).

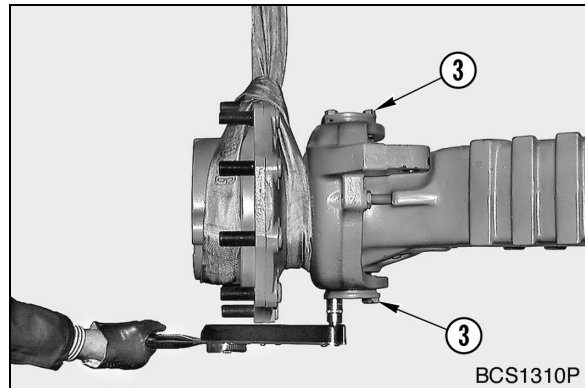


Figure 41

12. Connect the articulation pin (2).
13. Lubricate articulations with Molikote and fit the dust cover (1).

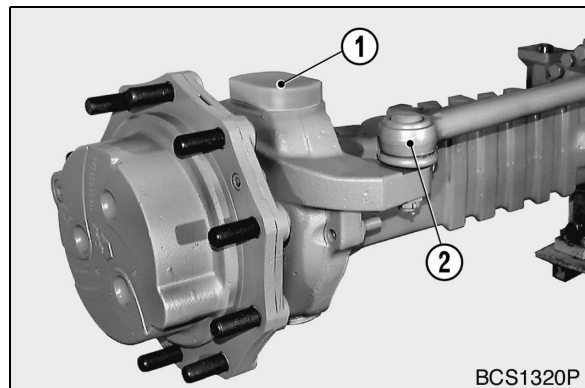


Figure 42

U-JOINT

NOTES ON SAFETY PRECAUTIONS

The u-joint can only be removed after extraction of the steering case has been performed (See: "Steering Case" on page 19). Different procedures need to be followed depending on the kind of repair operation needed and the type of axle:

1. Axle without parking brakes: compressed air (7 bar approx.) should be introduced in the braking circuit in order to hold the braking disks in position.
2. Axle with negative brake: does not require any preparation as the disks are mechanically locked in position.
3. Axle with mechanical brake: requires that the external control levers are put under tension in relation to each other.
4. Disassembly to be carried out with the arm resting on the bench.

The explanations reported herewith refer to removal operations carried out on the bench; the different stages of u-joint removal also apply to all other solutions or versions.

REMOVAL AND DISASSEMBLY

1. Unloose and remove the top and bottom check nuts (2) from the dowels (3).

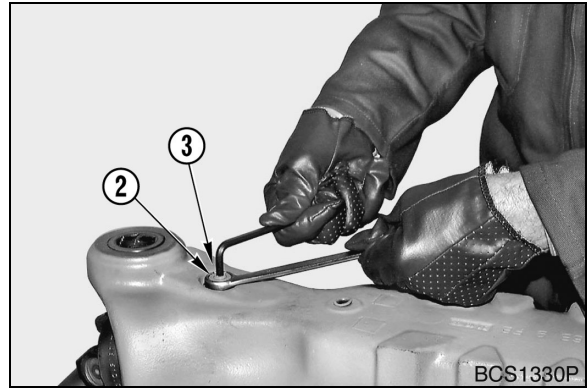


Figure 43

2. Remove top and bottom check dowels (3) from the flange (5) or bush (13).

NOTE: *The u-joint can only be removed after extraction of the steering case has been performed (See: "Steering Case" on page 19). Different procedures need to be followed depending on the kind of repair operation needed and the type of axle:*

1) Axle without parking brakes: compressed air (7 bar approx.) should be introduced in the braking circuit in order to hold the braking disks in position.

2) Axle with negative brake: does not require any preparation as the disks are mechanically locked in position.

3) Axle with mechanical brake: requires that the external control levers are put under tension in relation to each other.

4) Disassembly to be carried out with the arm resting on the bench.

The explanations reported herewith refer to removal operations carried out on the bench; the different stages of u-joint removal also apply to all other solutions or versions.

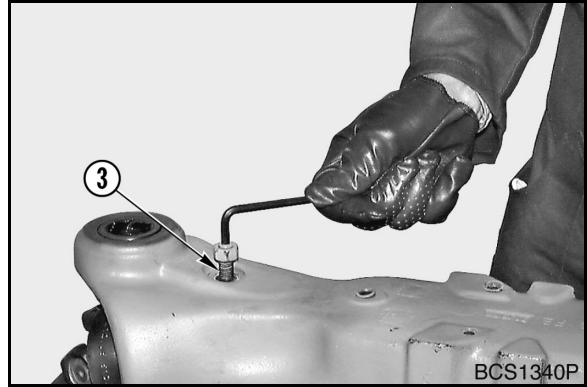


Figure 44

Flanged Version

1. Remove the u-joint (4).

NOTE: *To remove the u-joint use, if necessary, a plastic hammer or a lever.*

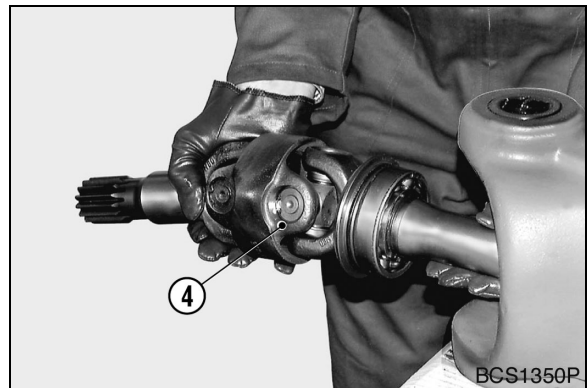


Figure 45

2. Remove the snap ring (9) from the bearing as well as the packing ring (5).

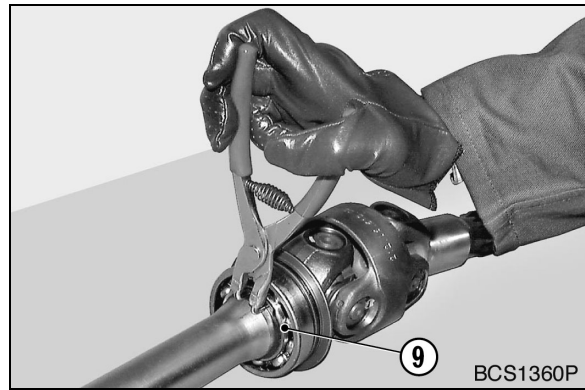


Figure 46

3. Position the entire u-joint (4) under a press and remove the bearing (8) and the ring (5) simultaneously.

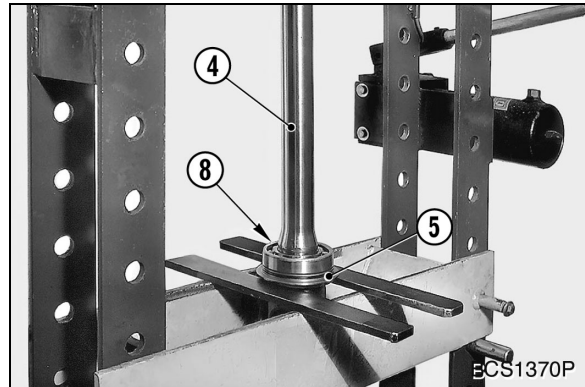


Figure 47

4. Extract the sealing ring of the shaft from the flange (5).

NOTE: *Note down the assembly side of the ring.*

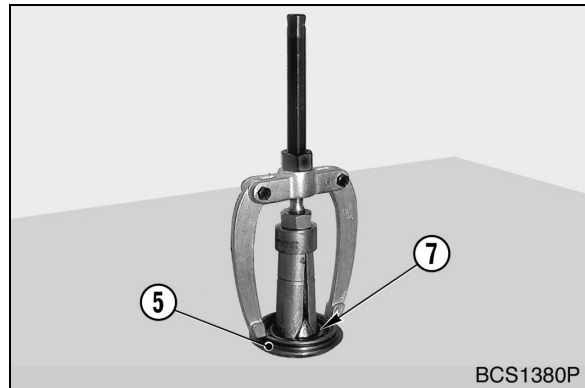


Figure 48

Coupling Version

1. Remove the entire u-joint (4).

NOTE: *To remove the u-joint use, if necessary, a plastic hammer or a lever.*

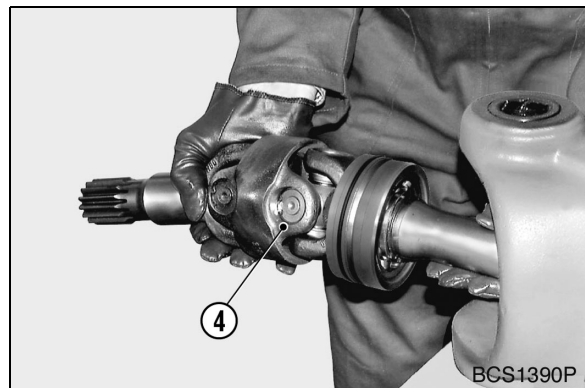


Figure 49

2. Remove the snap ring (9) from the bushing unit (13).

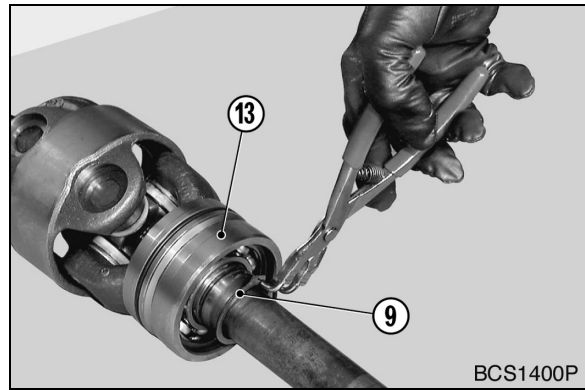


Figure 50

3. Position the entire u-joint (4) under a press and remove the complete bush (13).

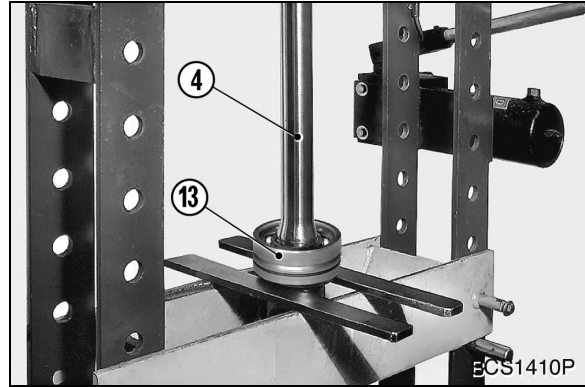


Figure 51

4. Remove the snap ring (10) from the bearing (11). Use a puller to remove the bearing (11), the sealing ring (12) and the O-ring (14).

NOTE: Note down the assembly side of the ring (12).

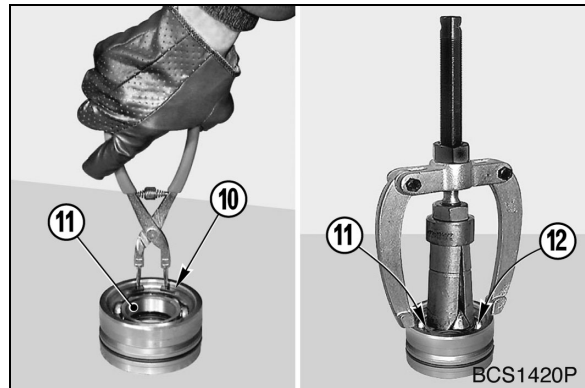


Figure 52

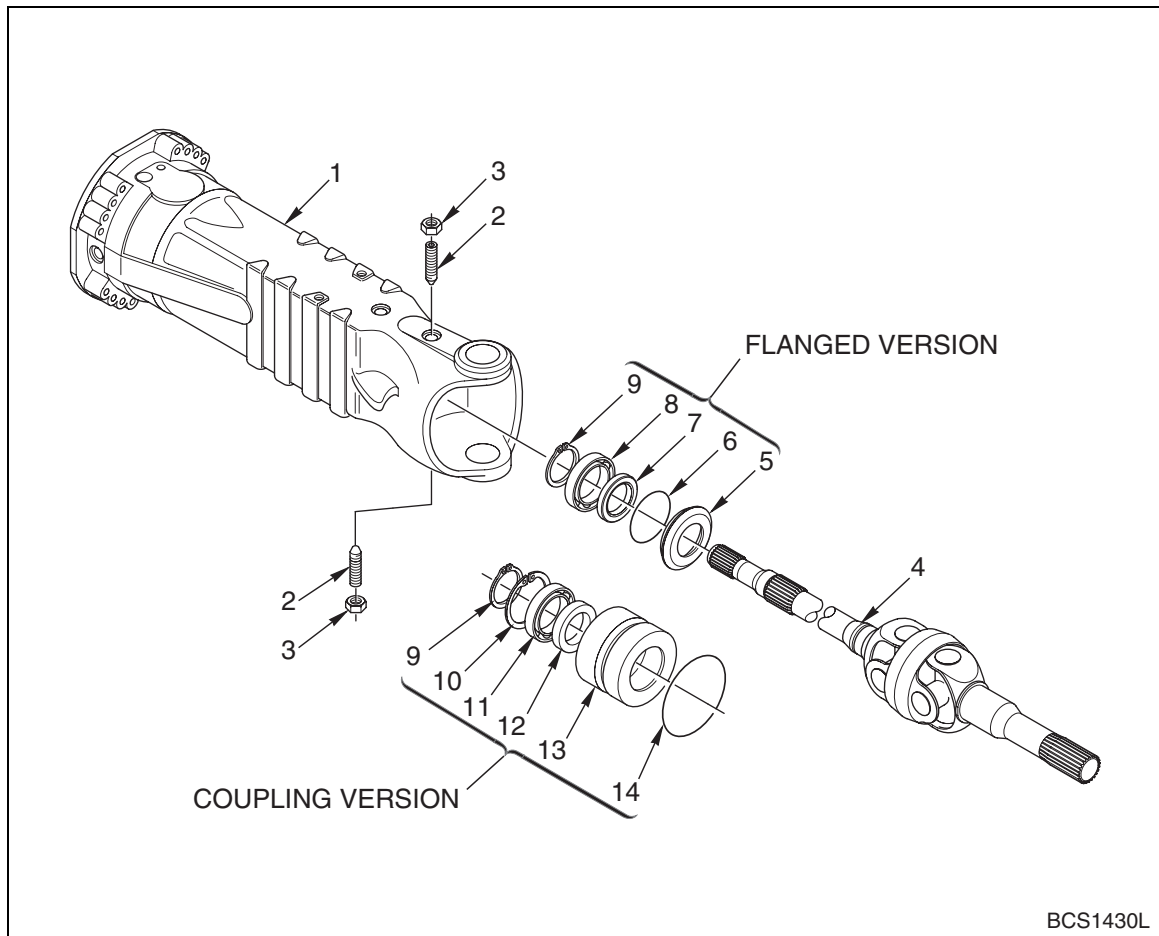


Figure 53

ASSEMBLY AND INSTALLATION

Flanged Version

1. Insert the sealing ring (7) of the shaft in the flange (5), using tool **T5**.

NOTE: Carefully check the assembly side. Also replace the outer O-ring (6).

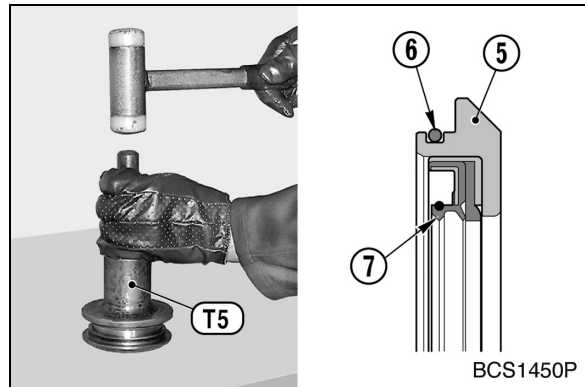


Figure 54

2. Fit the flange (5) onto the u-joint (4).
3. Heat the bearing (8) at an approx. temperature of 100° C (212° F), fit it on the u-joint and fasten.

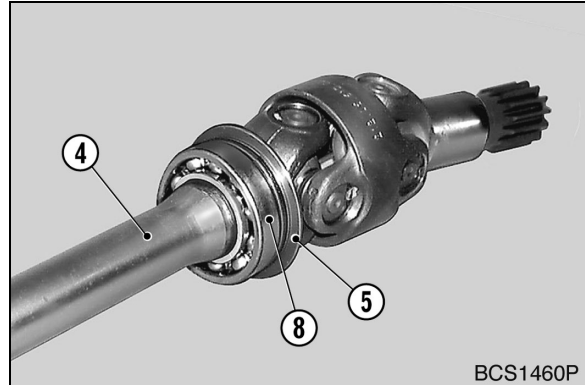


Figure 55

4. Fit the snap ring (9) on the bearing (8).

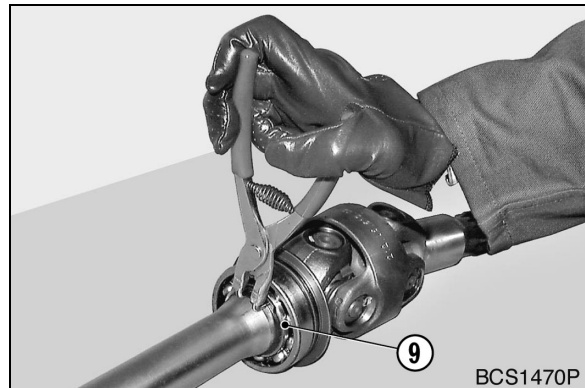


Figure 56

Coupling Version

1. Using tools **T5** and **T6**, insert the sealing ring (12) and the bearing (11) in the bush (13).

NOTE: Carefully check the assembly side of the seal (12).

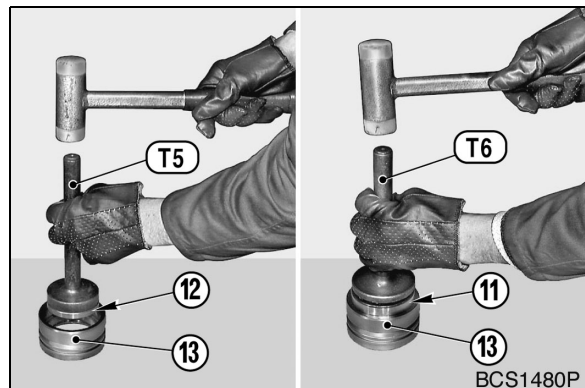


Figure 57

2. Fit the snap ring (10) on the bearing (11).

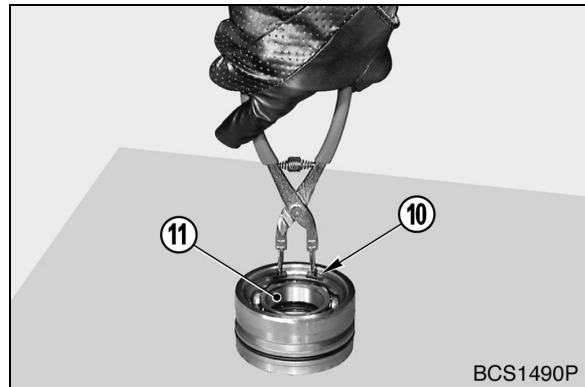


Figure 58

3. Heat the bearing in oil at an approx. temperature of 100° C (212° F) and fit the entire bush (13) on the u-joint (4).

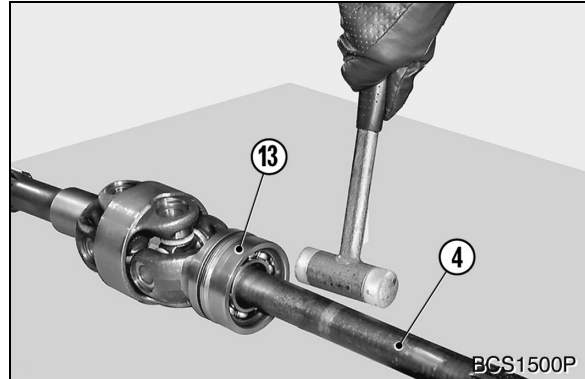


Figure 59

4. Fit the check ring (9) on the bushing unit (13); also put the O-ring (14) into position.

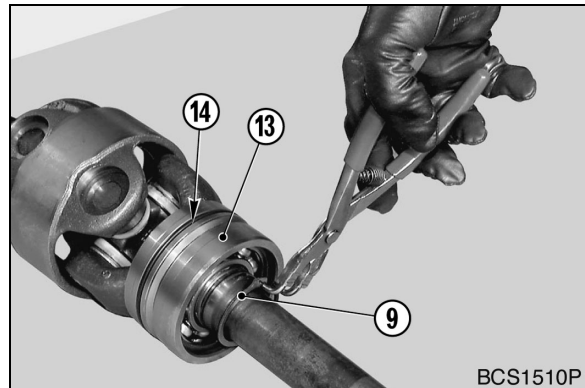


Figure 60

5. Insert the u-joint and tighten the top and bottom dowels (2).

Torque wrench setting: Max. 15 Nm.

NOTE: For u-joint coming with a bush, centre the point of the check dowels in the slot.

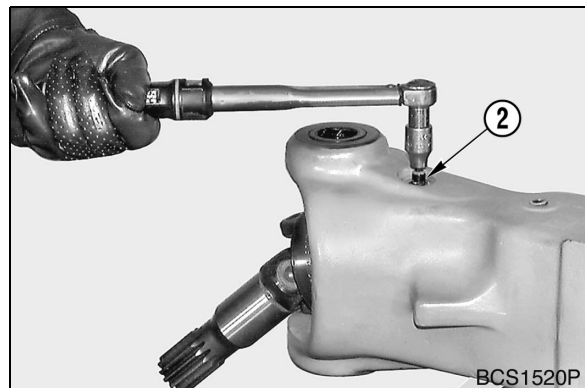


Figure 61

6. Apply Loctite 242 to the jutting parts of the dowels (2).

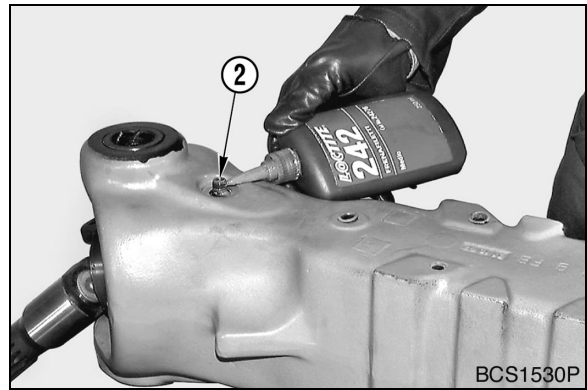


Figure 62

7. Screw the check nuts (3) of the dowels (2) and lock them using a dynamometric wrench.

Torque wrench setting: 122 Nm (90 ft lb)

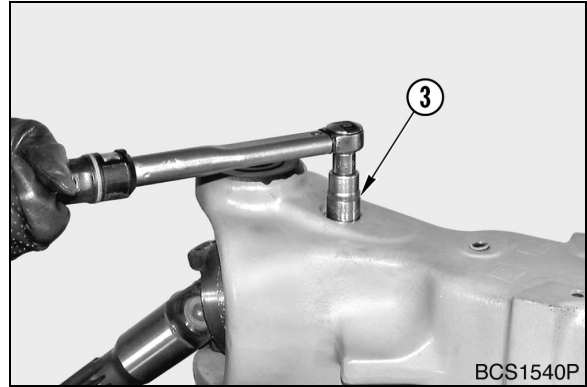


Figure 63

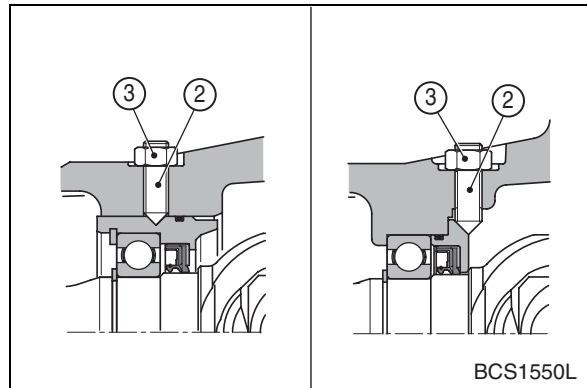


Figure 64

PLANETARY REDUCTION

DISASSEMBLY

1. Disconnect the steering bars from the steering case (3).

NOTE: For details, see "Steering Case" on page 19.

2. Remove the securing screws (1) from the planetary carrier cover (2).
3. Disjoint the planetary carrier cover (2) from the steering case (3) by alternatively forcing a screwdriver into the appropriate slots.
4. Remove the complete planetary carrier cover (2).

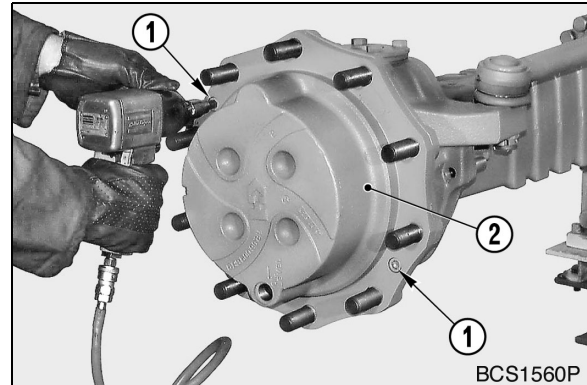


Figure 65

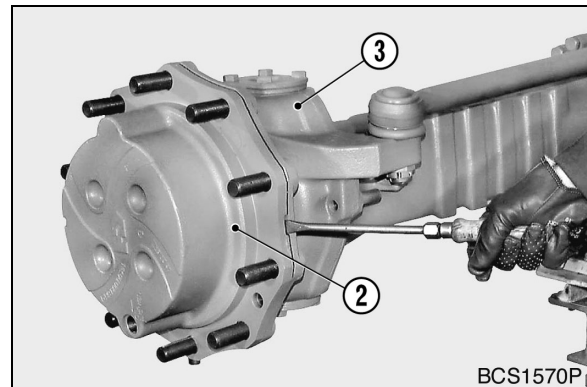


Figure 66

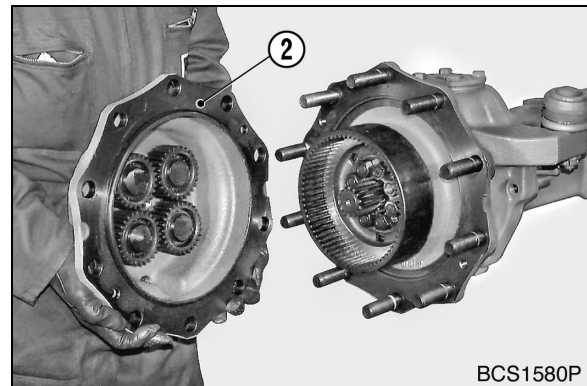


Figure 67

5. Unloose and remove the tightening nuts (4) from the crown flange (5).

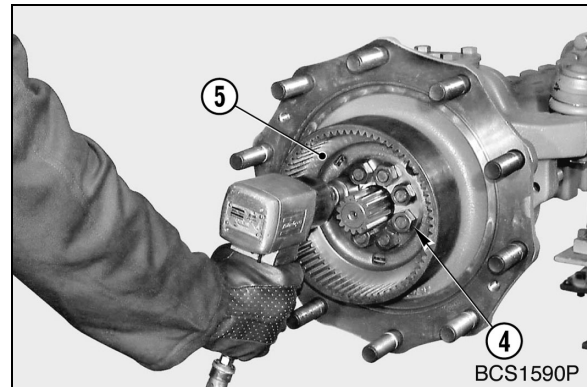


Figure 68

6. Remove the safety flange (6).

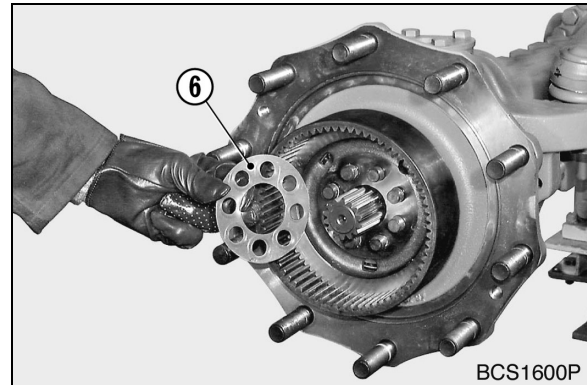


Figure 69

7. Using a puller, remove the complete crown flange (5) by acting on the stud bolts.

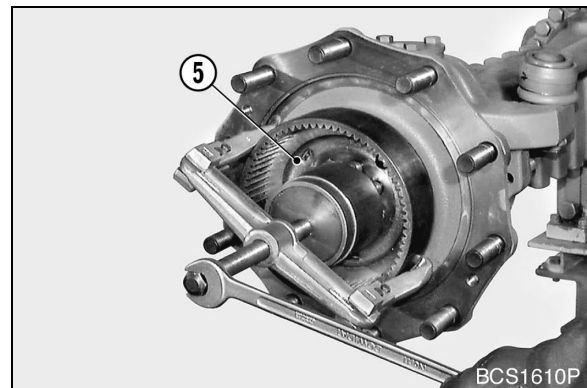


Figure 70

8. Partially extract the hub (7) using a plastic hammer.

NOTE: *Alternately hammer on several equidistant points.*

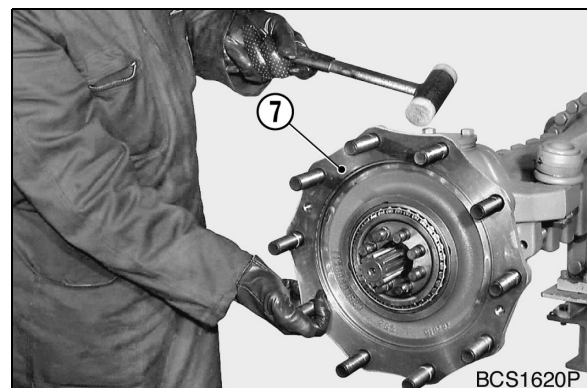


Figure 71

9. Remove the external bearing (8).

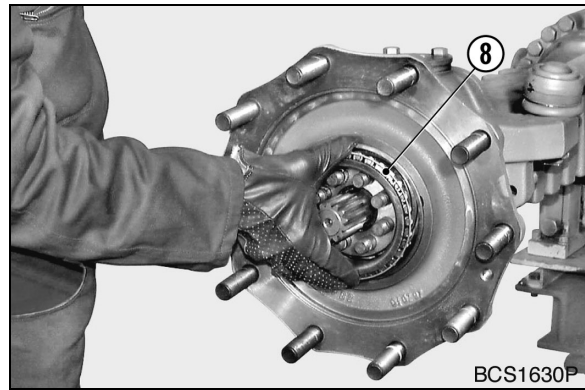


Figure 72

10. By hand remove the complete hub (7).

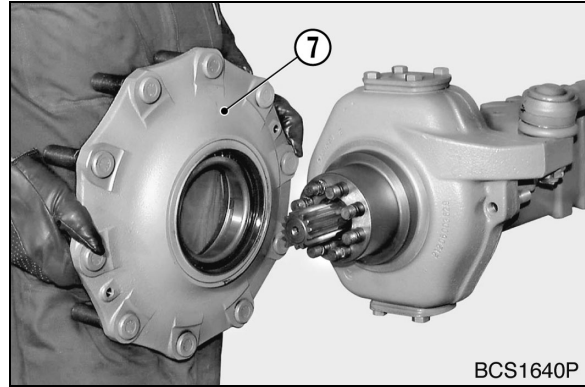


Figure 73

- 1) Remove the pins and remove the steering case (3).

NOTE: For details, see "Steering Case" on page 19.

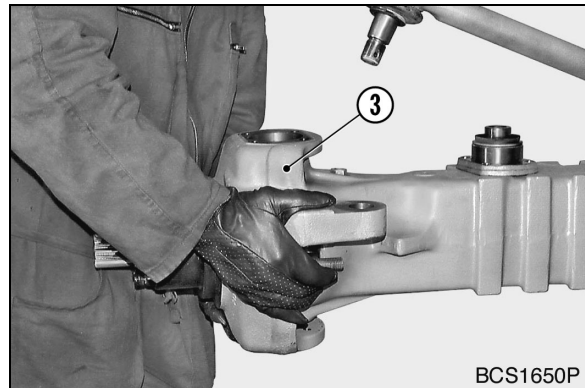


Figure 74

11. Remove the snap rings (9).

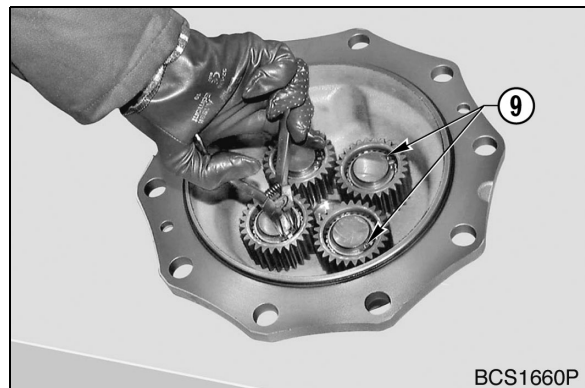


Figure 75

12. With the help of a puller, remove the planet wheel gears (10).

NOTE: *Note down the assembly side of planet wheels.*

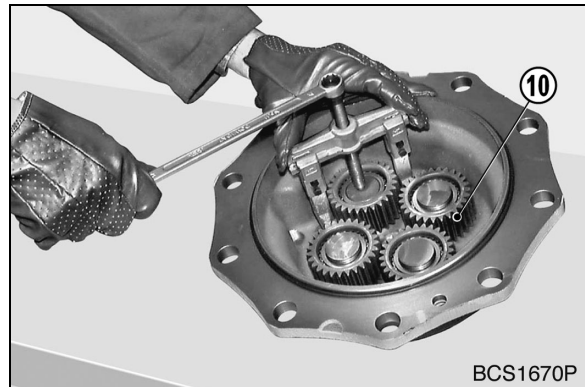


Figure 76

13. Remove the snap ring (12) from the crown (13).

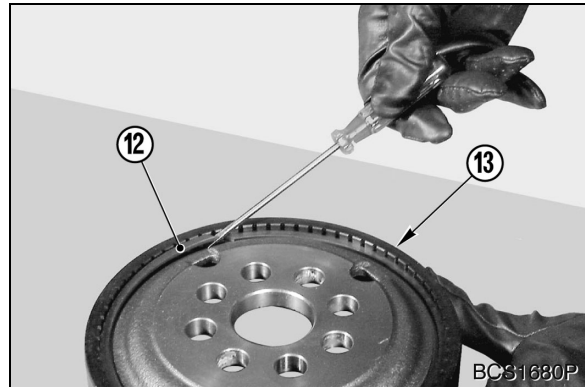


Figure 77

14. Remove the crown flange (5).

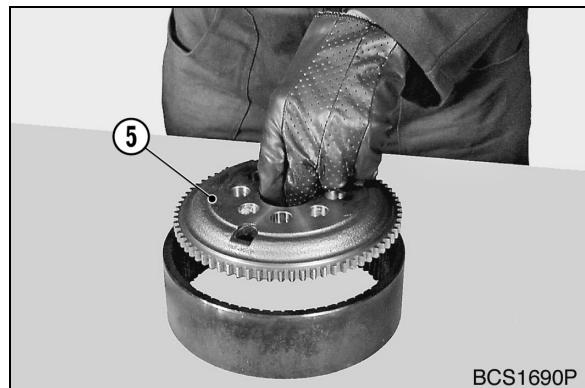


Figure 78

15. Remove the sealing ring from the hub (14).



Figure 79

16. Remove the internal bearing (15).

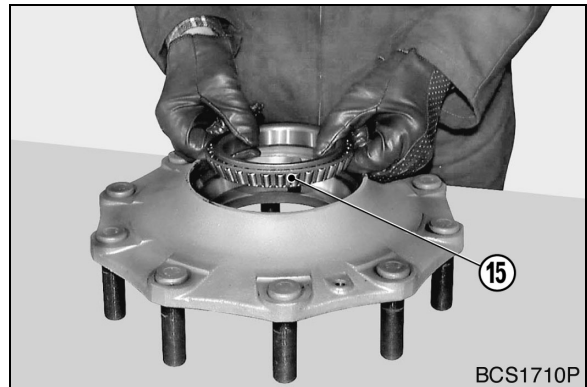


Figure 80

17. Remove the external thrust blocks from the bearings (8) and (15) forcing a pin-driver into the appropriate slots on the hub (7).

NOTE: *Hammer in an alternate way so as to avoid crawling or deformation of the thrust blocks.*



Figure 81

18. Use a puller to remove the centring ring (16), the sealing ring (17) and the bearing (18) from the steering case (3).

NOTE: *Note down the orientation of both centring ring (16) and sealing ring (17).*

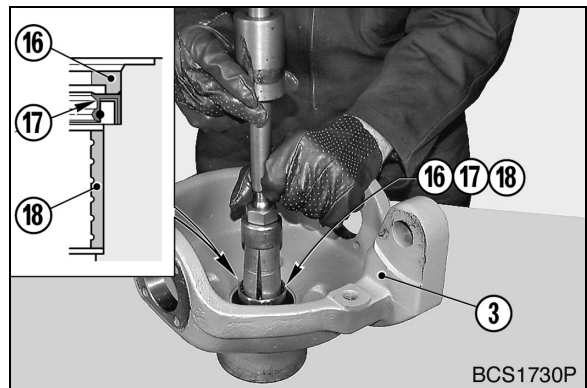


Figure 82

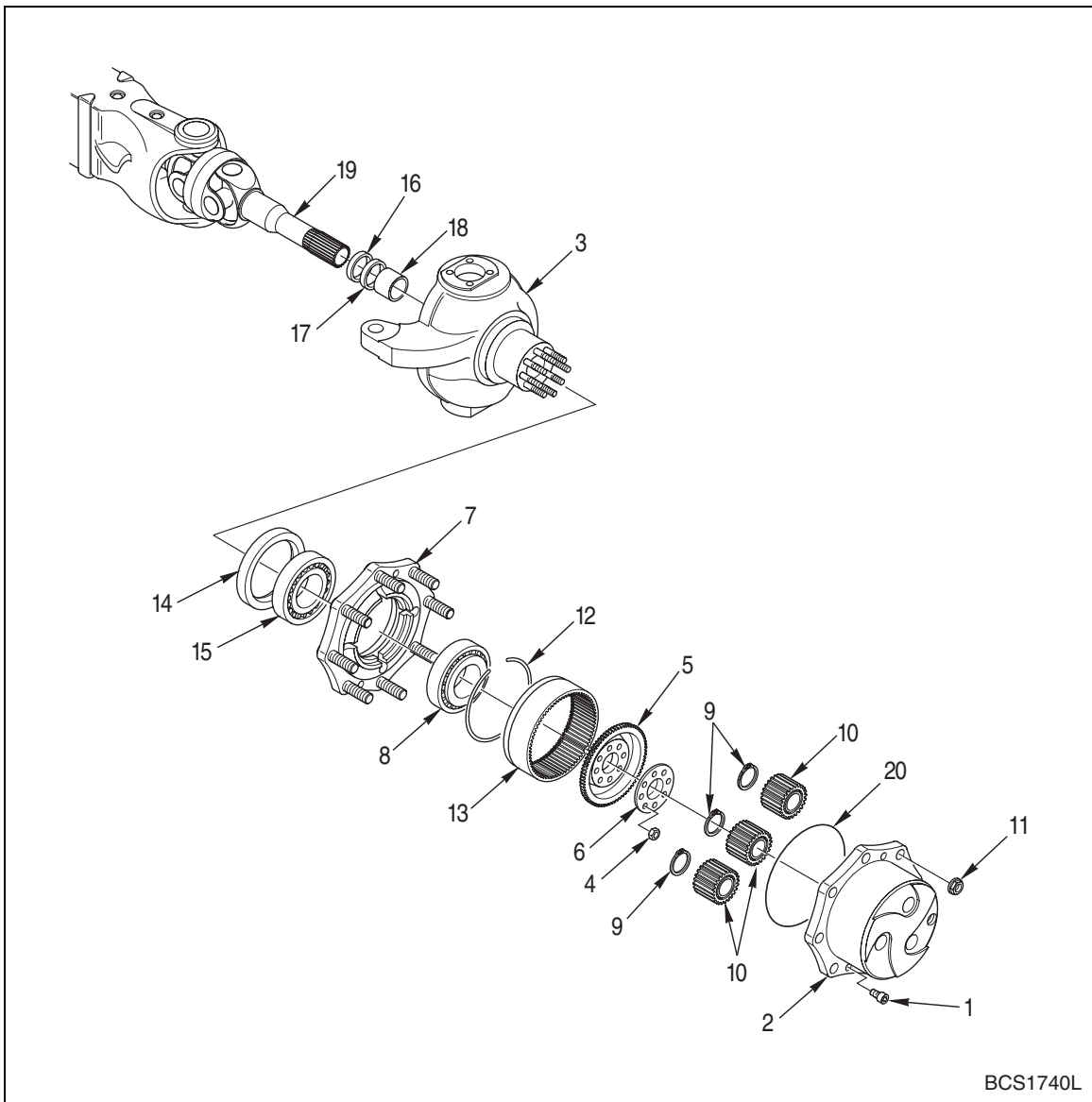


Figure 83

ASSEMBLY

1. Lubricate the bushing (18) and the seat of the steering case (3).
2. Install the bushing (18), using tool **T7**.

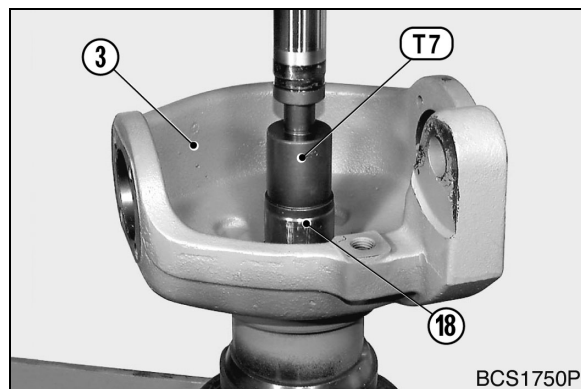


Figure 84

3. Lubricate the outer surface of the sealing ring (17) and centring ring (16); fit them into their seat using tool **T8**.

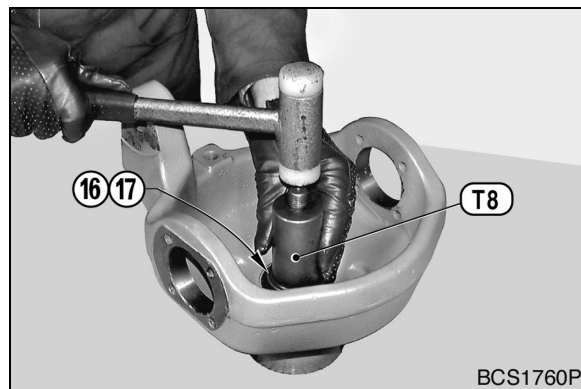


Figure 85

4. Position the lower part of tool **T9A** and the thrust block of the external bearing (8) under the press.

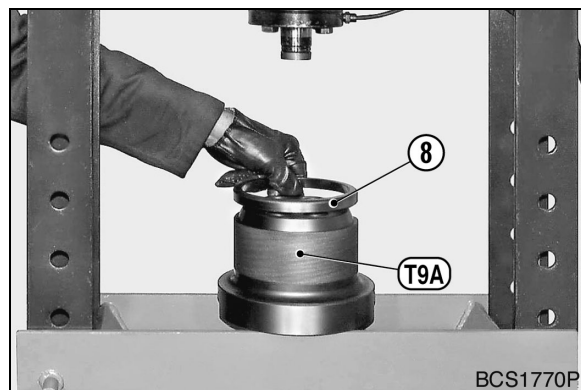


Figure 86

5. Lubricate the seats of the bearings and position the hub (7) on tool **T9A**; position the thrust block of the internal bearing (15).

NOTE: Check that the thrust block is correctly oriented.

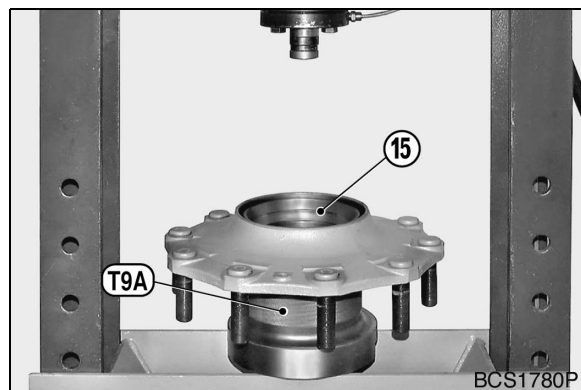


Figure 87

6. Position the upper part of tool T9B and press the thrust blocks into the hub (7) all the way down.

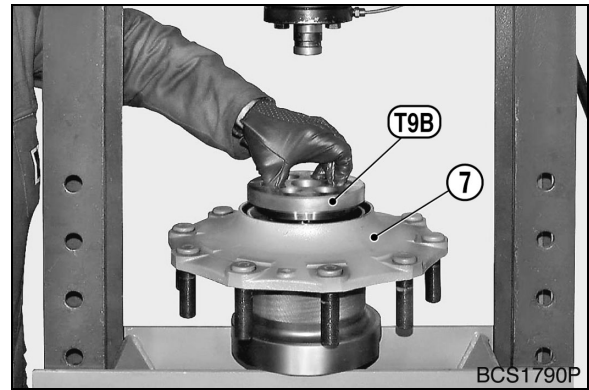


Figure 88

7. Fit the bearing (15) into the internal thrust block.

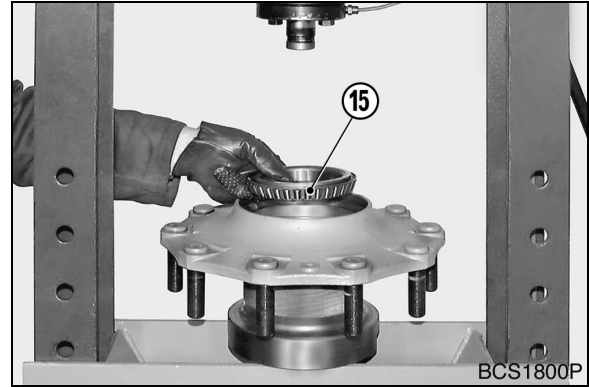


Figure 89

8. Apply a repositionable jointing compound for seals to the outer surface of the sealing ring (14). Position the sealing ring (14) in the hub (7).

NOTE: Check that the ring (14) is correctly oriented.

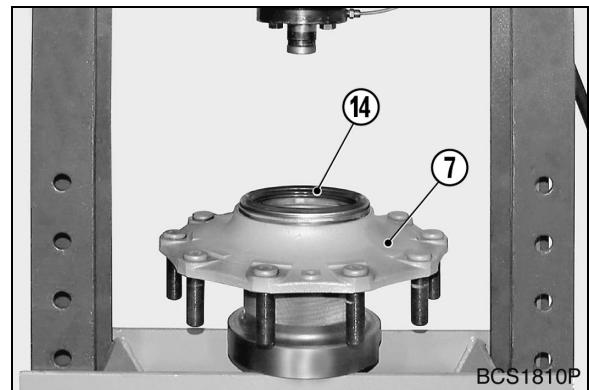


Figure 90

9. Position tool T10 and press the sealing ring (14) into its seat.

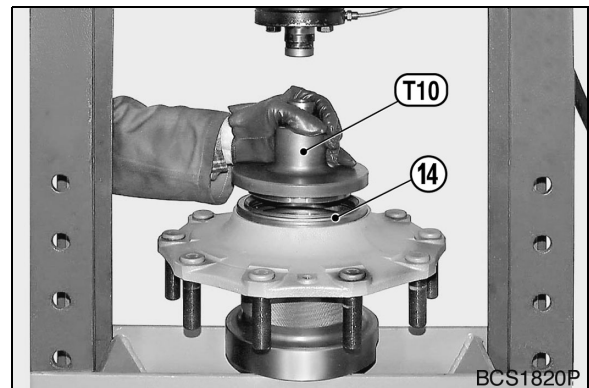


Figure 91

10. Insert the flange (5) in the crown (13).

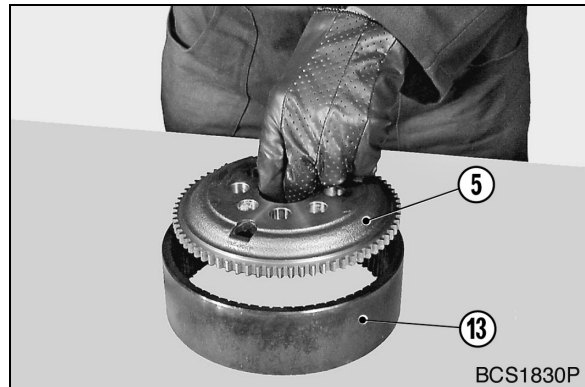


Figure 92

11. Insert the snap ring (12) in order to fix the flange (5) in the crown (13).

NOTE: Carefully check that ring (12) is properly inserted in the slot of the crown (13)

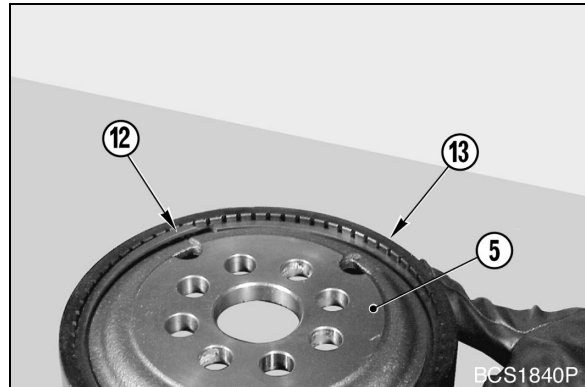


Figure 93

12. With the help of tool T11, insert the planet wheel gears (10) into the cover (2).
13. Accurately check the orientation.

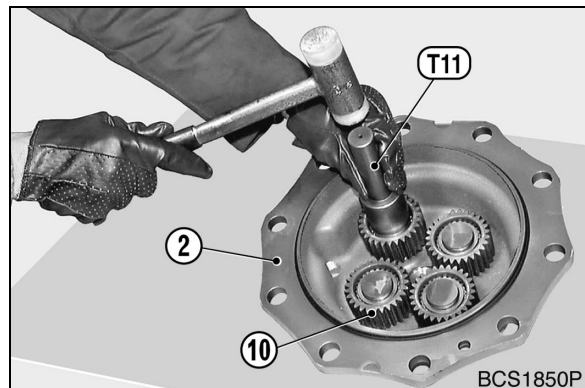


Figure 94

14. Lock the gears (10) into position by fitting the snap rings (9).

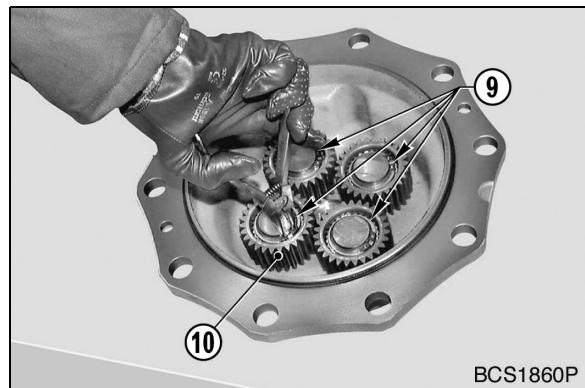


Figure 95

15. Fit the steering case (3) onto the U-joint (19) and install the articulation pins.

NOTE: For pin assembly details, see "Steering Case" on page 19.

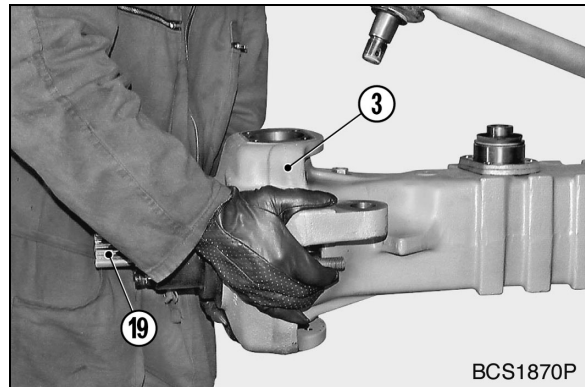


Figure 96

16. Connect the steering bars.

NOTE: For details, see "Steering Case" on page 19.

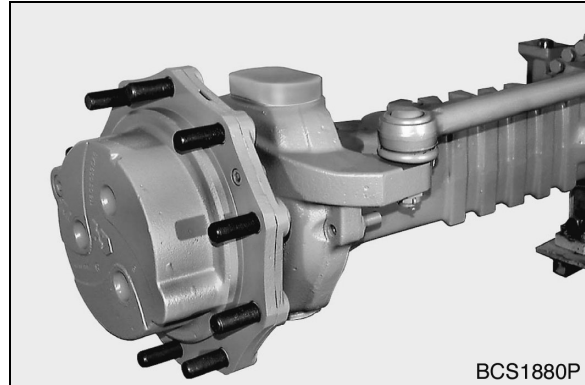


Figure 97

17. Install the hub (7).

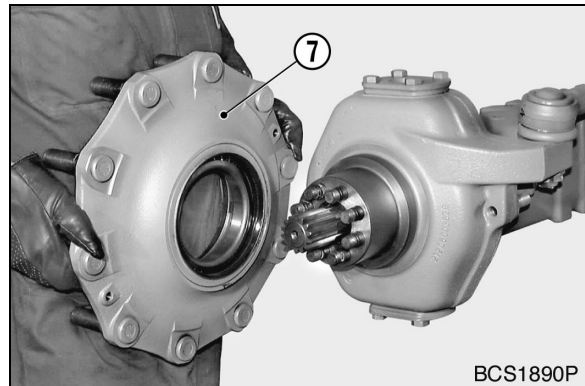


Figure 98

18. Install the external bearing (8).

NOTE: Using a plastic hammer, drive the bearing to the limit stop by lightly hammering around the edge.

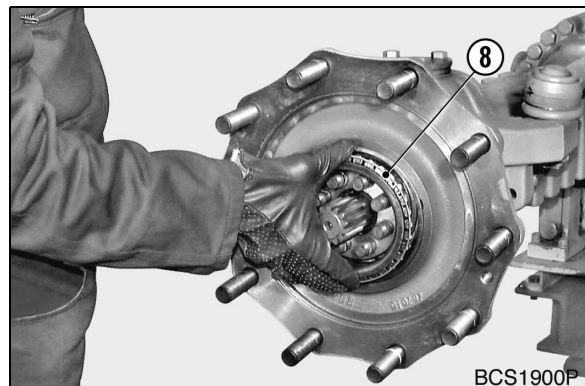


Figure 99

19. Fit the complete crown flange (5).

NOTE: *In order to fasten the flange (5), use a plastic hammer and alternately hammer on several equidistant points.*

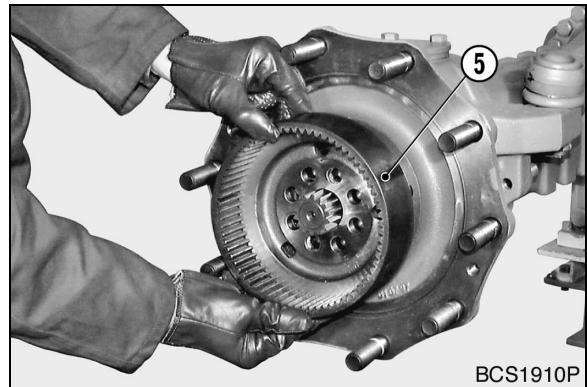


Figure 100

20. Apply Tecnolube Seal 101 grease to the surface of the safety flange (6) which touches the crown flange (5).
21. Fit the safety flange (6).

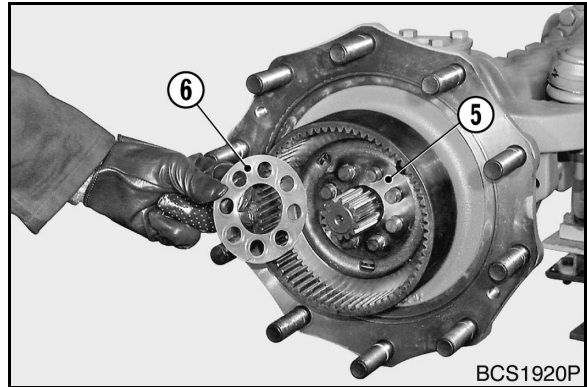


Figure 101

22. Apply Loctite 242 to the studs and fit in the nuts (4).



Figure 102

23. Cross tighten the nuts (4) in two stages.
- Initial torque wrench setting: 120 Nm (89 ft lb).
- Final torque wrench setting: 255-285 Nm (188-210 ft lb)

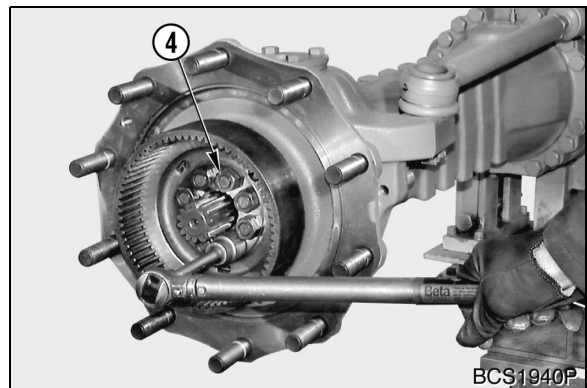


Figure 103

24. Fit the planetary carrier cover (2) onto the hub (3).

NOTE: Check that the O-ring (20) is in good condition and in position.

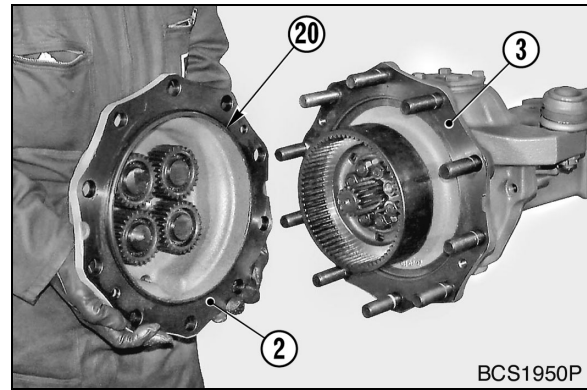


Figure 104

25. Lock the planetary carrier cover (2) by tightening the screws (1).

Torque wrench setting for screws: 40-50 Nm (29-36 ft lb).

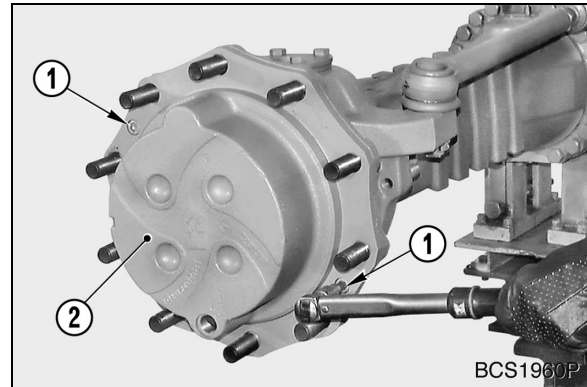


Figure 105

STEERING CYLINDER

REMOVAL

1. Remove the centring sensor (1) of the steering piston (2), if supplied.

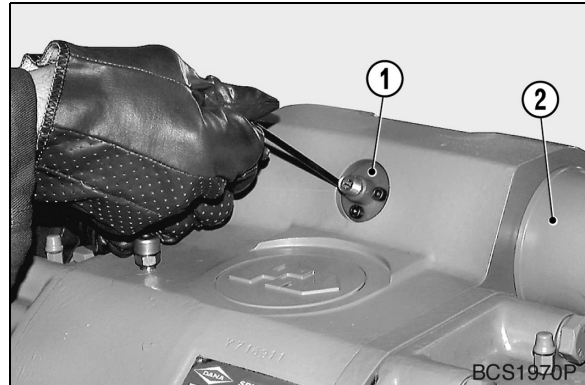


Figure 106

2. Remove the safety cotter pins (3) from the articulation pins (4) of the steering bars (5).

NOTE: *Dispose of used cotter pins.*

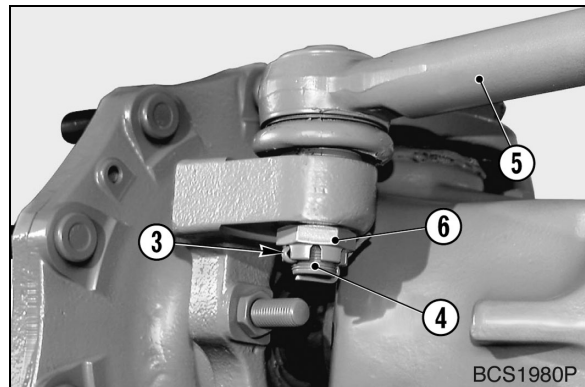


Figure 107

3. Remove the castellated nuts (6) that lock the articulation pins (4).

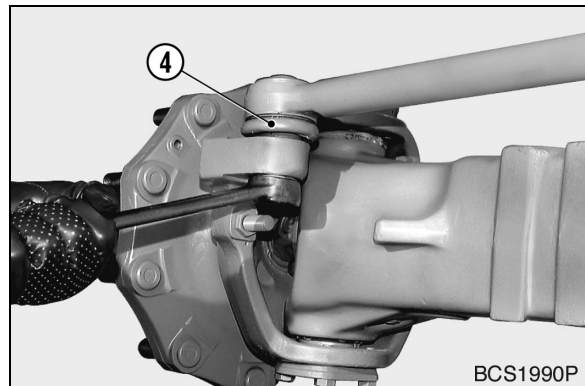


Figure 108

4. Disconnect the tapered pins of the articulation (4) from the steering case (7) by means of a puller.

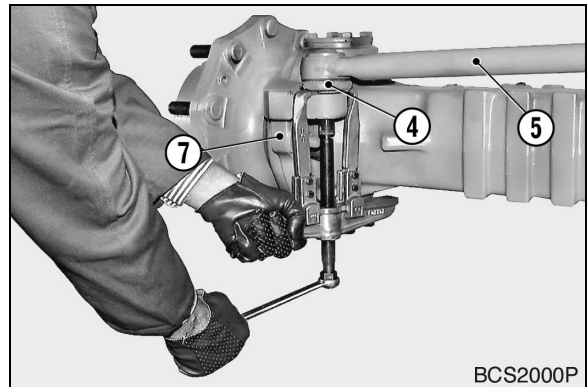


Figure 109

5. If the connection of the steering bars includes a safety collar (13), raise the border.

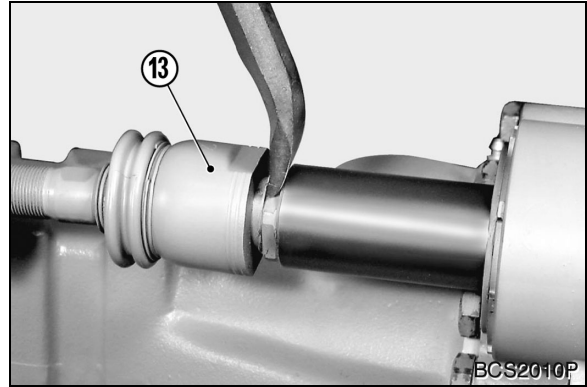


Figure 110

6. Disconnect left and right steering bars (5) from the piston (2).

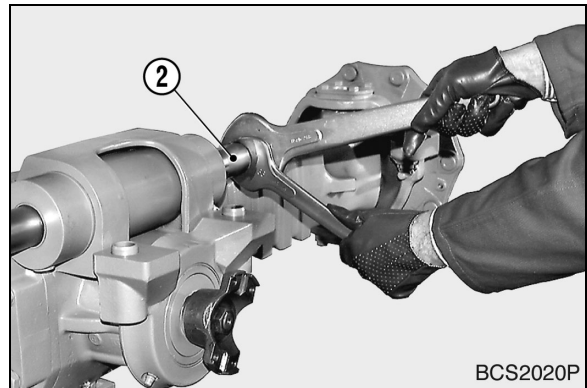


Figure 111

7. Remove the securing screws (8) from the steering cylinder (9).

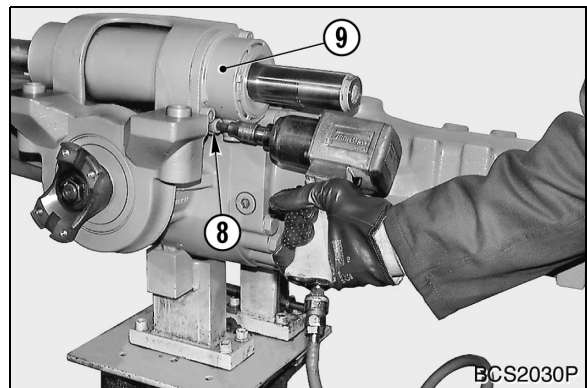


Figure 112

8. Extract the cylinder (9) using a plastic hammer.

NOTE: For cylinder disassembly, refer to "Steering Cylinder" on page 45.

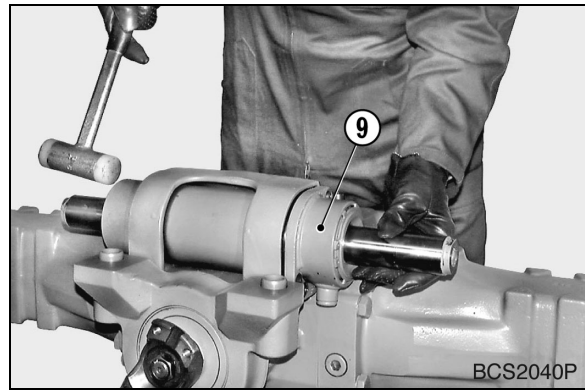


Figure 113

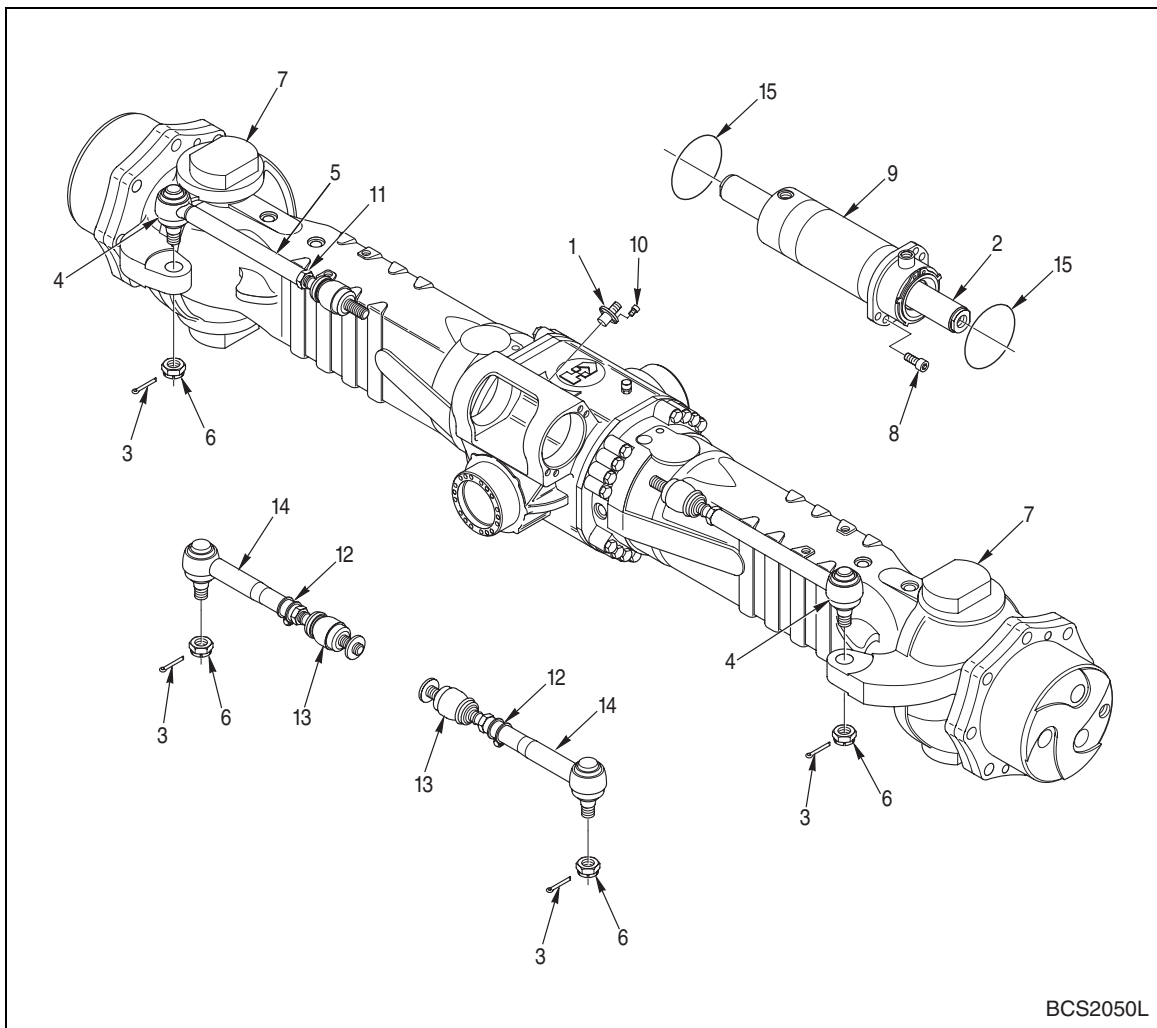


Figure 114

INSTALLATION

1. Check that the O-rings (15) of the axle unit are in good condition; lubricate the seats of the seals (15) and fit the steering cylinder (9) into its seat.

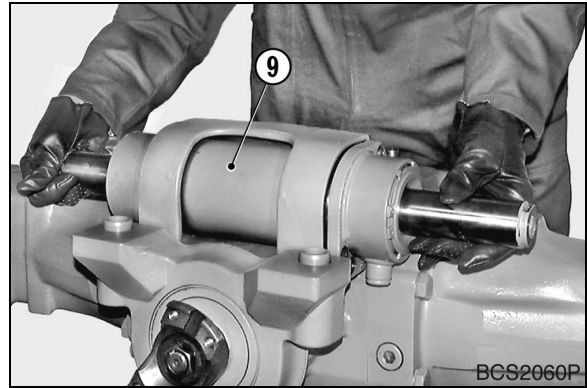


Figure 115

2. Lock the cylinder by cross-tightening the screws (8).

Torque wrench setting: 116-128 Nm (86-94 ft lb).

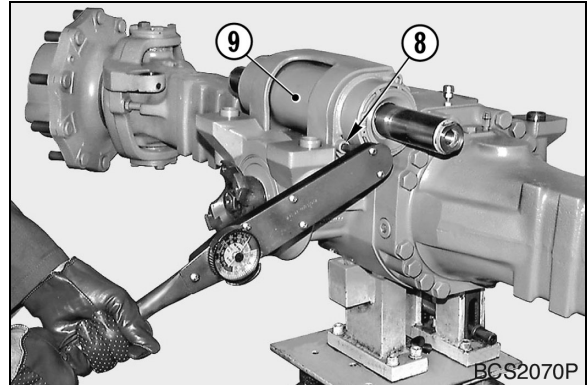


Figure 116

3. Apply Loctite 242 to the thread and connect the steering bars by screwing the terminals onto the piston stem.

Torque wrench setting: 240-270 Nm (177-199 ft lb).

NOTE: Versions with coupling require that the rim of the articulation (13) is riveted onto the surfaces of the piston stem.

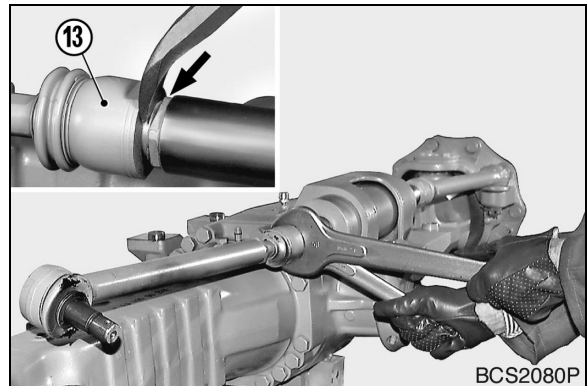


Figure 117

4. Insert the pins (4) in the steering case (7) and lock into position using a torque wrench setting of 260-290 Nm (192-213 ft lb).
5. Find the position of the notching in relation to the hole of the cotter pins and tighten the nut (6) further.

NOTE: Check that rubber guards (A) are intact.

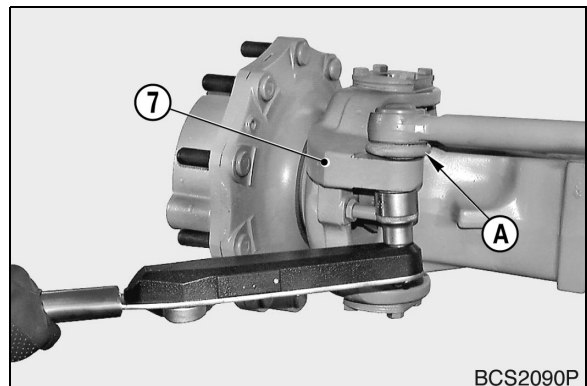


Figure 118

6. Insert the cotter pins (3) and bend the safety stems.

NOTE: Use new cotter pins.

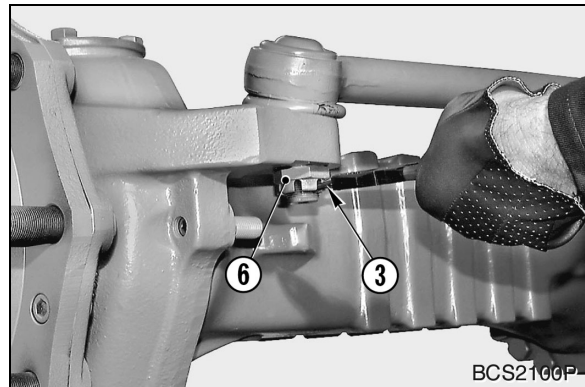


Figure 119

7. Install the proximity (1) for checking piston centring - if applicable - and tighten the screws (10).

Torque wrench setting: 5-6 Nm (4 ft lb).

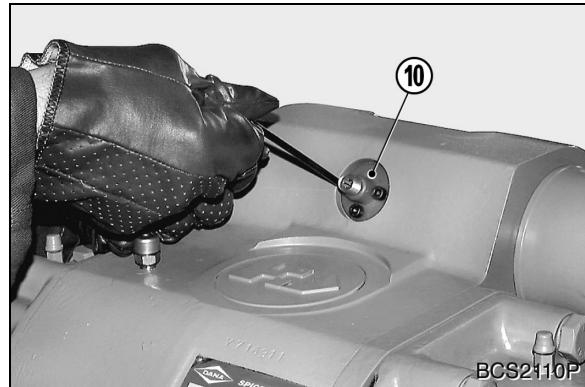


Figure 120

NOTE: Eliminate the action of the negative brake, if fitted.

8. Apply tools **T12** to the hubs and lock them.
9. Using a level **"B"**, check that tools are perfectly flat and parallel to each other.

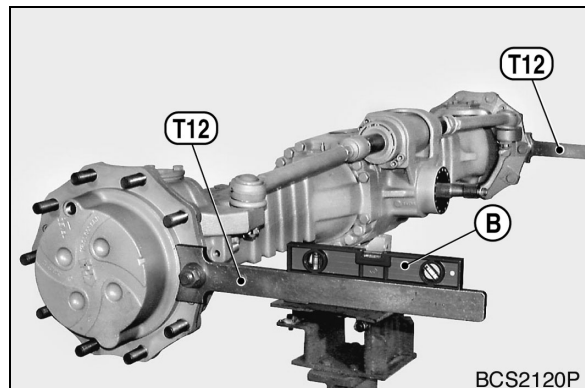


Figure 121

10. Connect the sensor (1) to the inspection device according to either diagram.

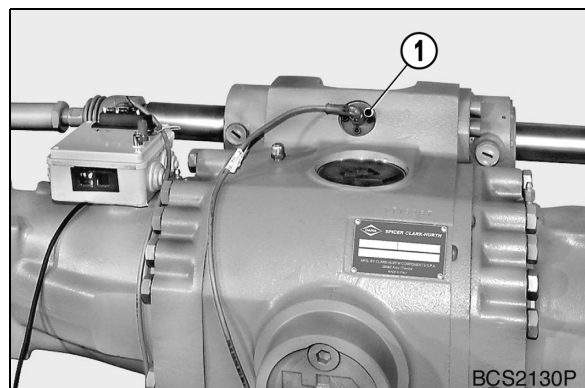


Figure 122

11. Sensor connection card, STANDARD version.

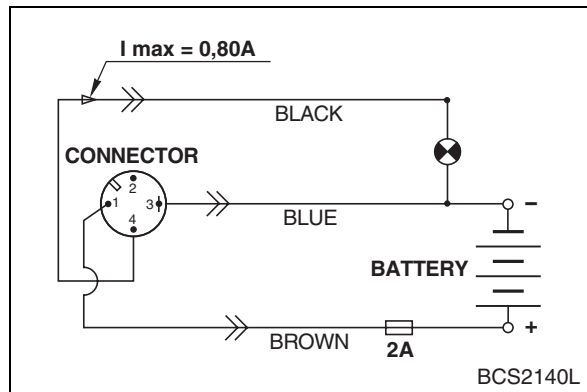


Figure 123

12. Sensor connection card, OPTIONAL version.

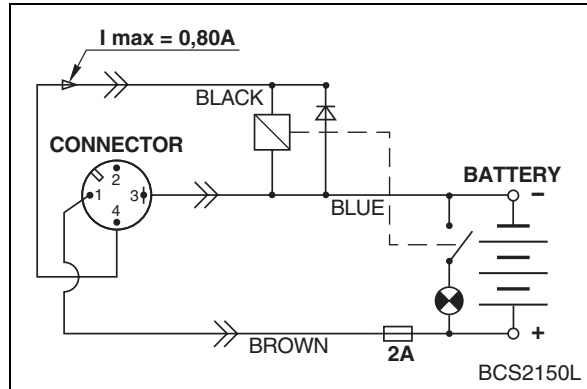


Figure 124

13. Centre the piston by slowly moving it first in one direction then in the other and position it half way on the stroke, which is determined by the switching on and off of the signal lamp of the inspection device in the reversal stage.

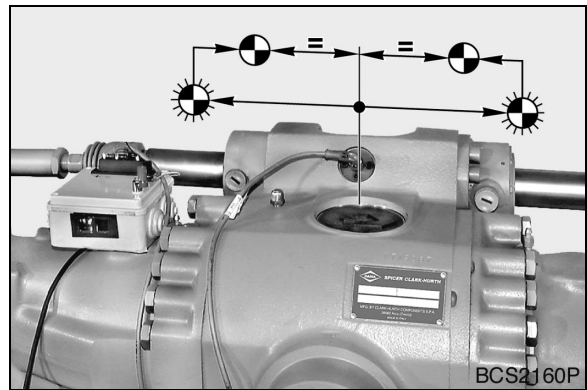


Figure 125

14. Inspect nut "C" on one side of the piston and note down the size for checking later adjustments.

NOTE: *If cylinders come without a sensor, the centring of the piston must be carried out on the basis of the maximum stroke.*

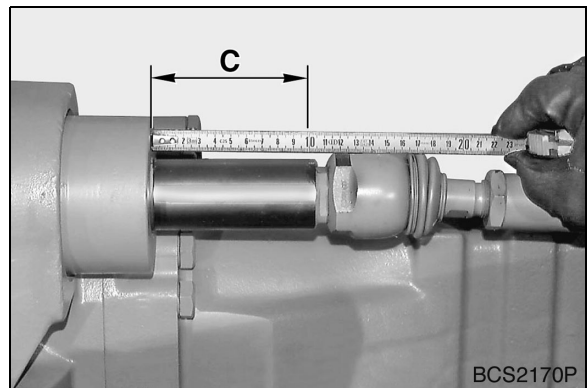


Figure 126

15. Without moving the piston, check front and rear size at the edge of tools **T12**.

Max. difference: 0.6-0.7 mm (0.02-0.03 in).

NOTE: *In order to check the rear size, rotate the bevel pinion and check that tools **T12** are flat.*

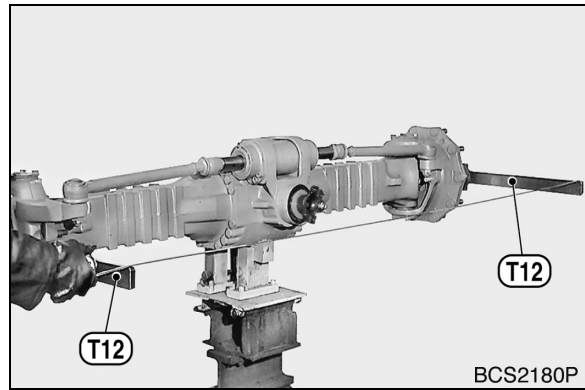


Figure 127

16. If necessary, adjust convergency without moving the centring of the piston and adjust the length of the steering bars (5) or (14).

NOTE: *With a half turn of screw, the front size is reduced by about 3 mm, whereas the rear one is increased by about 3 mm.*

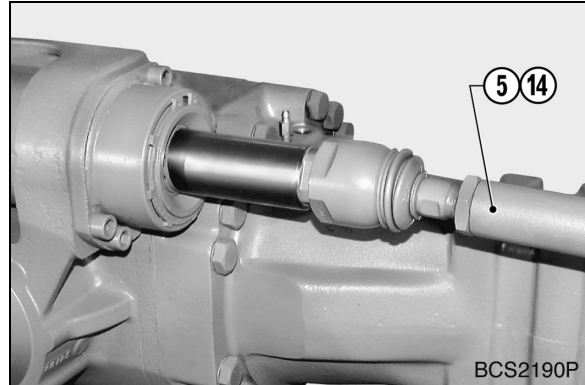


Figure 128

17. Unloose the nuts on the collars (12).

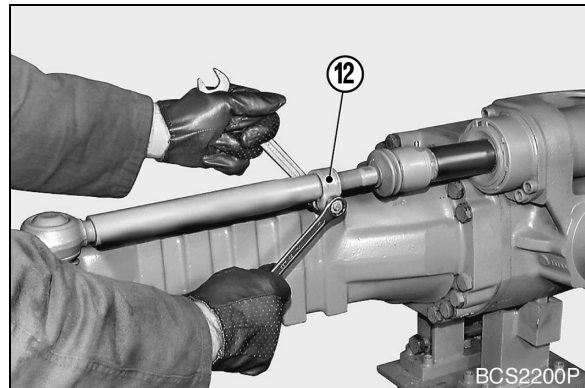


Figure 129 CONVERGENCY ADJUSTMENT ON UNITS WITH COLLAR

18. Rotate the ball-and-socket joints (16) until convergency has been obtained.
19. Check that articulations move easily and lock the collars (12).

Torque wrench setting for nuts: 42-52 Nm (31-38 ft lb).

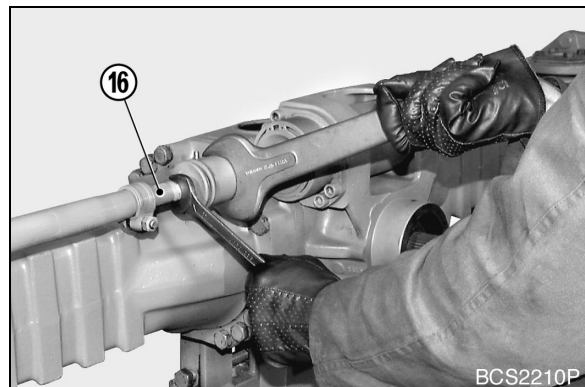


Figure 130

20. Unloose the nuts (11) and screw them onto the ball-and-socket joints (15).

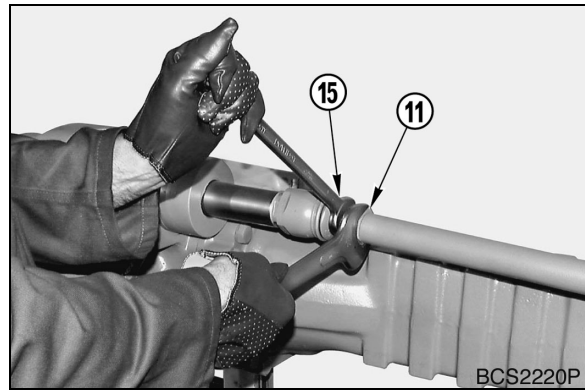


Figure 131 CONVERGENCY ADJUSTMENT
ON ALTERNATIVE VERSIONS

21. Hold the articulations still and rotate the ball-and-socket joints (15).
22. Once the convergency has been adjusted, lock the nuts (11).

Torque wrench setting for nuts: 298-328 Nm (219-241 ft lb).

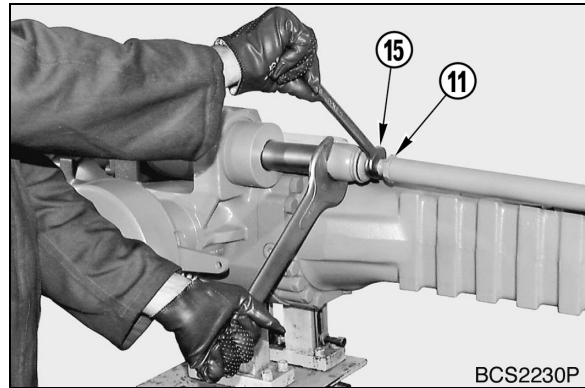


Figure 132

DISASSEMBLY

1. Remove the snap ring (1) from the cylinder head (2).

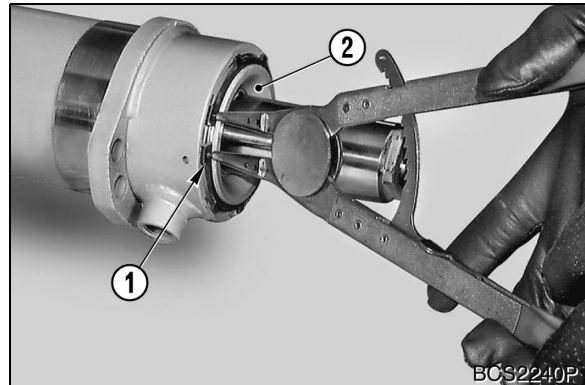


Figure 133

2. With the help of a plastic hammer, push the head (2) inside the cylinder (3).

NOTE: *The head should line up with the edge of the cylinder.*

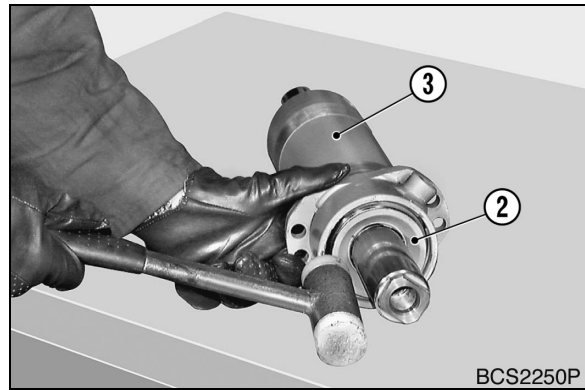


Figure 134

3. With the help of a drift, apply pressure to the stop ring (4) that is placed inside the cylinder (3) and extract the ring using a screwdriver.

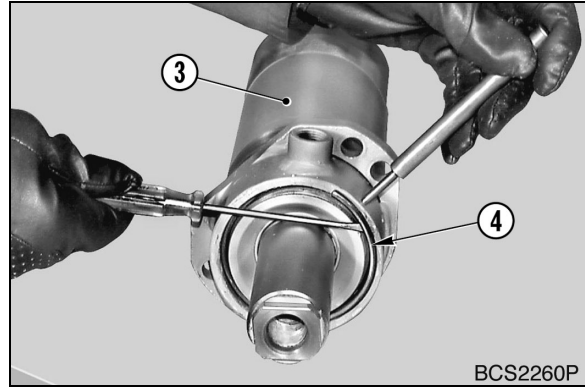


Figure 135

4. Hammer the piston (5) on the rear of the head (2) using a plastic hammer.
5. Continue hammering until the head (2) is ejected from the cylinder (3).

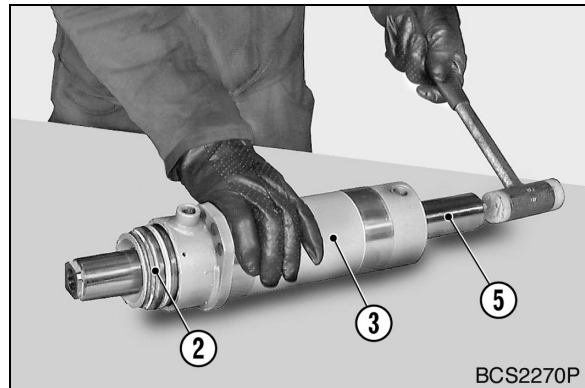


Figure 136

6. Disassemble the cylinder unit (3) by extracting first the head (2), then the piston (5).

NOTE: *Note down the assembly side of the piston (5). The bevelled part "A" of the piston is oriented towards the head (2).*

7. Remove all seals, anti-extrusion rings and scraper rings from head (2), cylinder (3) and piston (5).

NOTE: *1) All seals must be replaced every time the unit is disassembled.*

2) Particular attention must be paid not to damage the seats of both seals and piston slide.

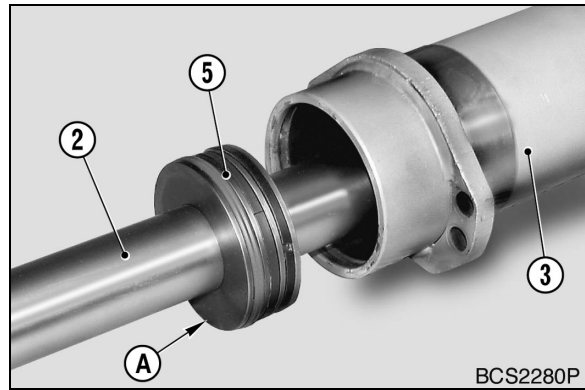


Figure 137

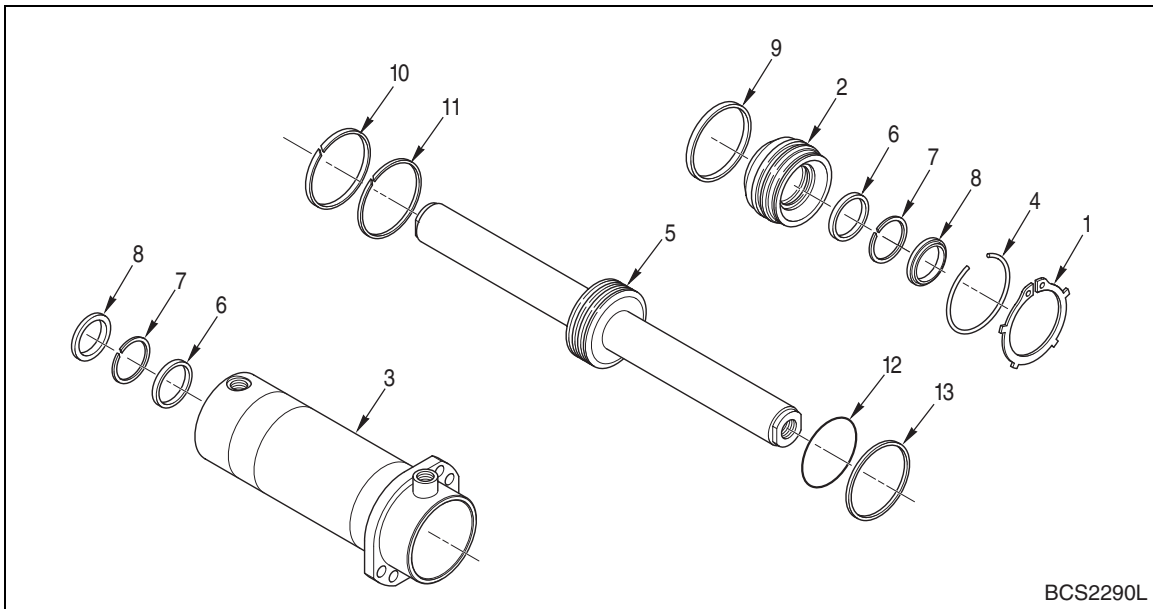


Figure 138

ASSEMBLY

1. After applying grease, install the sealing ring (6) of the shaft, the anti-extrusion ring (7) and the scraper ring (8) inside the cylinder (3).

NOTE: *Thoroughly check that positioning of the anti-extrusion ring (7) is correct.*

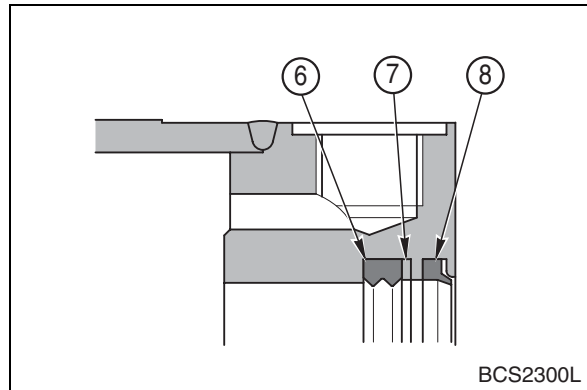


Figure 139

2. After applying grease, install the sealing ring (6) of the shaft, the anti-extrusion ring (7) and the scraper ring (8) in the head (2).

NOTE: *Thoroughly check that positioning of the anti-extrusion (7) ring is correct.*

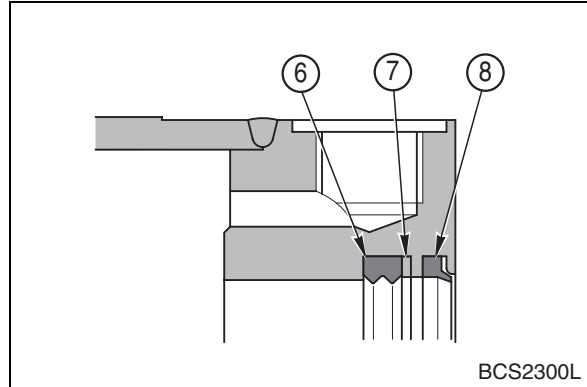


Figure 140

3. After applying grease, install the sealing ring (6) of the shaft, the anti-extrusion ring (7) and the scraper ring (8) in the head (2).

NOTE: *Thoroughly check that positioning of the anti-extrusion (7) ring is correct.*

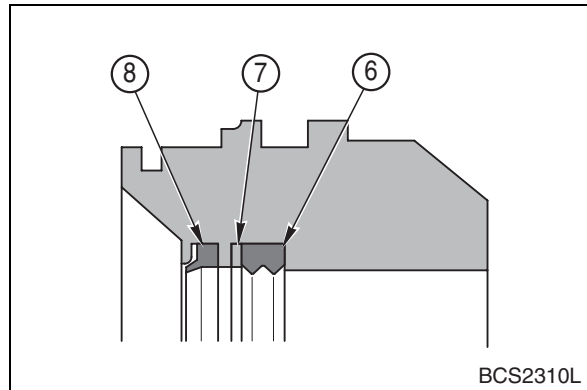


Figure 141

4. Fit the seal (9) onto the outside of the head (2).

NOTE: *1) In order to facilitate assembly, apply grease to the outer surface of the piston.
2) Do not roll the seal (9) up.*

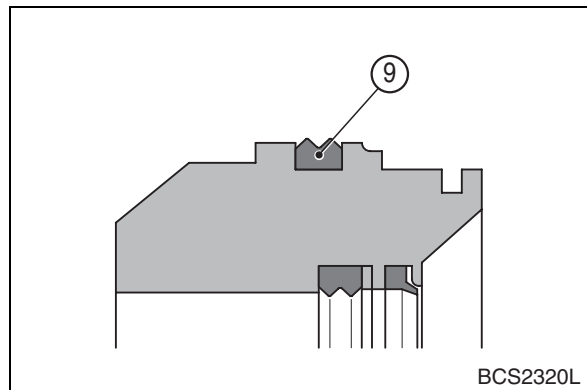


Figure 142

5. Prepare the piston (5) by fitting it with the guide ring (10), the magnetic ring (11), the O-ring (12) and the seal (13).

NOTE: 1) In order to facilitate assembly, apply grease.

2) If a centring sensor is not fitted, then the magnetic ring (11)

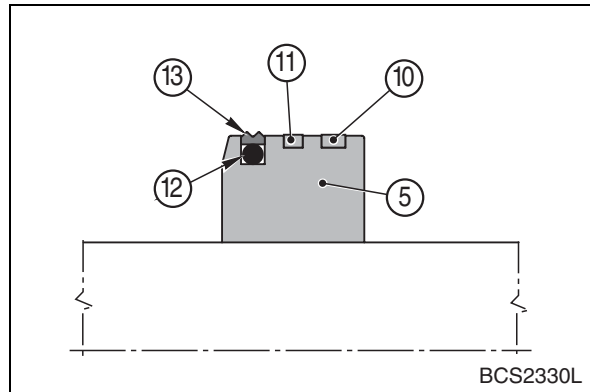


Figure 143

6. Apply tool **T18** to the shaft on the opposite side of the head (2) and centre it on the cylinder (3) so that it fits into the piston (5).

NOTE: Apply a little grease to seals and cylinder.

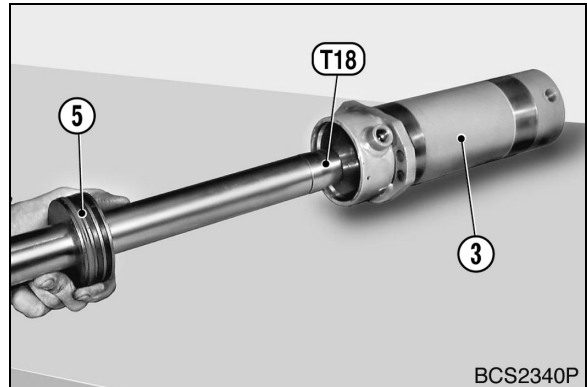


Figure 144

7. Push the piston (5) into the cylinder for 100 mm using a plastic hammer.

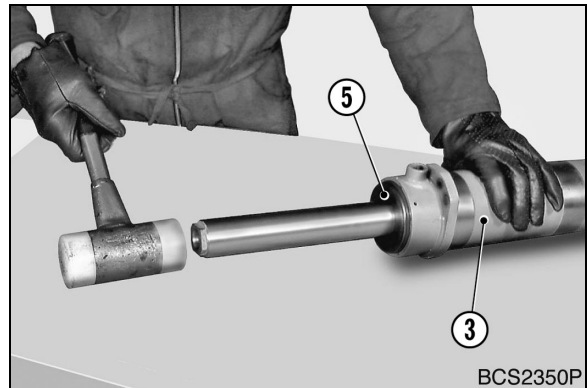


Figure 145

8. Remove tool T18 and apply it to the opposite side of the piston (5).

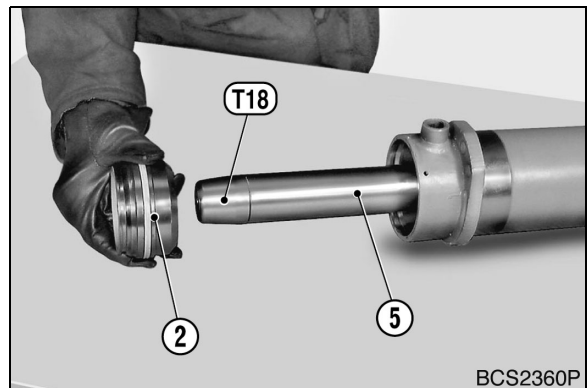


Figure 146

9. Apply grease to head (2) seals, fit the head onto the piston and push it into the cylinder (3) using a plastic hammer.

NOTE: *Insert the head as to line it up with the edge of the cylinder.*

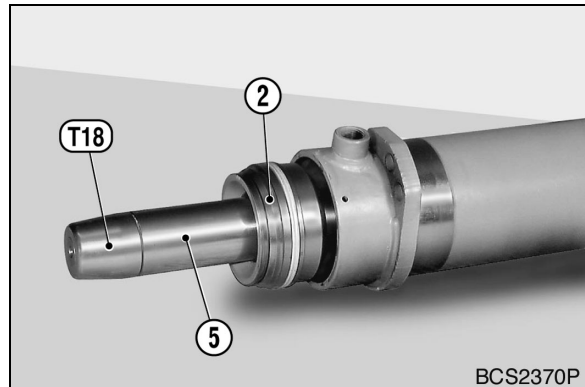


Figure 147

10. Insert the stop ring (4) ensuring that it fits into the seat of the cylinder (3).

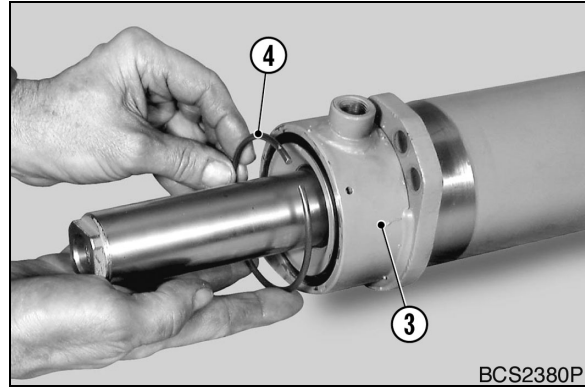


Figure 148

11. Apply pressure to the head using two screwdrivers or levers until the head is fastened onto the stop ring (4).

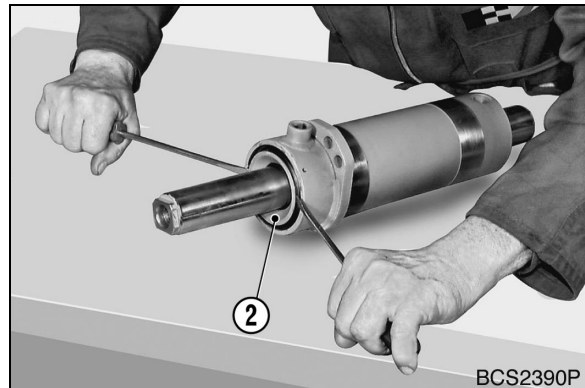


Figure 149

12. Fit the snap ring (1) on the head (2).

NOTE: *Make sure that the snap ring (1) is securely fastened in its seat.*

13. If necessary, force it into its seat using a drift and a hammer.

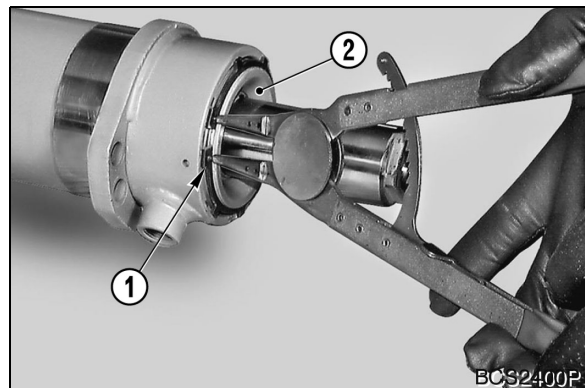


Figure 150

DIFFERENTIAL UNIT

REMOVAL AND DISASSEMBLY

Removing

1. Remove the complete arms.

NOTE: For details, see "Checking Wear and Replacing Brake Disks" on page 12.

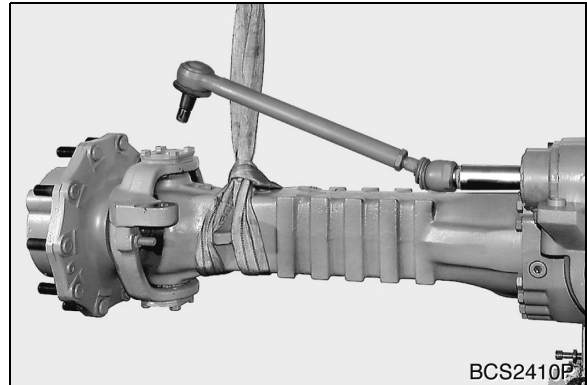


Figure 151

2. Mark the position of the ring nuts (1). Remove the fitting screws (3) from the ring nuts (1).

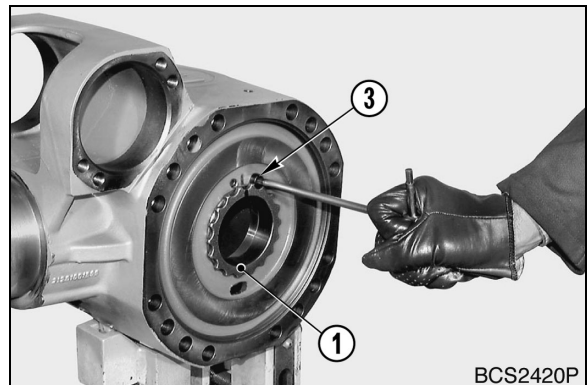


Figure 152

3. Uniformly heat the ring nuts (1) up to a temperature of 80° C (176° F).

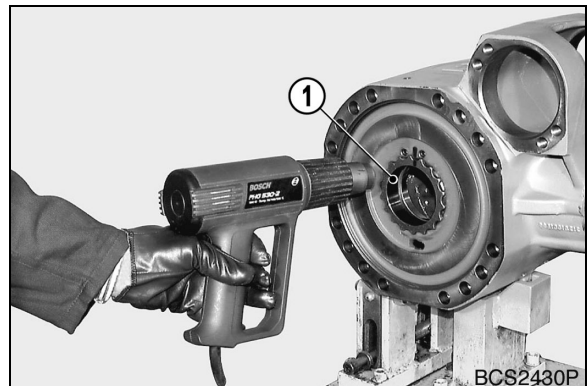


Figure 153

4. Apply tool **T13** and remove the ring nuts.

NOTE: *Accurately clean the threaded portions on ring nuts of body and cover.*

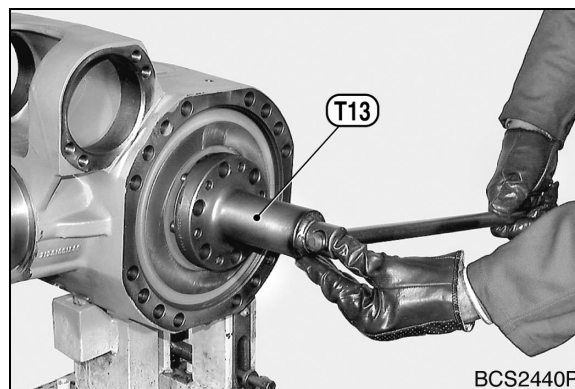


Figure 154

5. Remove the fitting screws (4) from the middle cover (5).

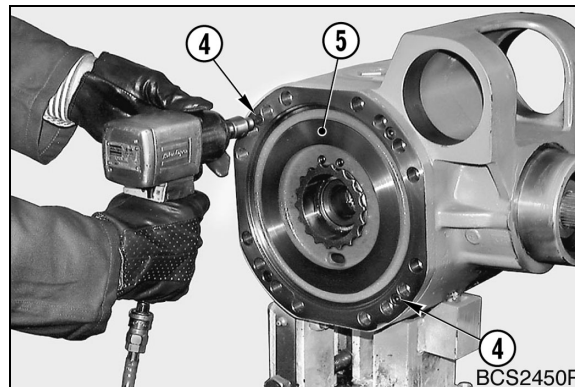


Figure 155

6. Insert a screw-driver in the opposing slots then force and remove the middle cover (5) and the complete differential unit (6).

NOTE: *Support the pieces using a rod.*

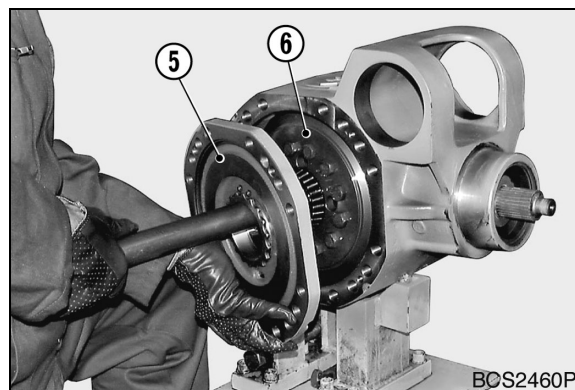


Figure 156

7. If the bearings need replacing, extract the external thrust blocks of the bearings (7) and (8) from middle cover (5) and central body (2).

NOTE: *Accurately check the O-ring (9).*

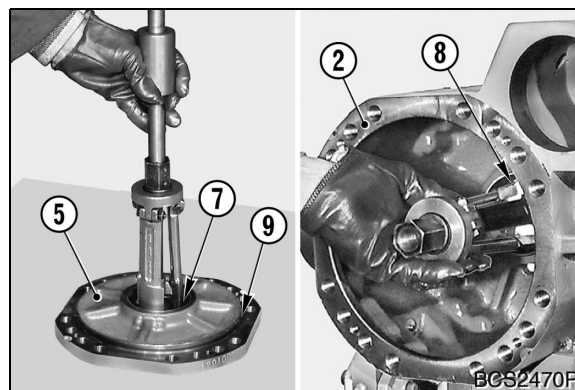


Figure 157

8. Remove the top plug (10).

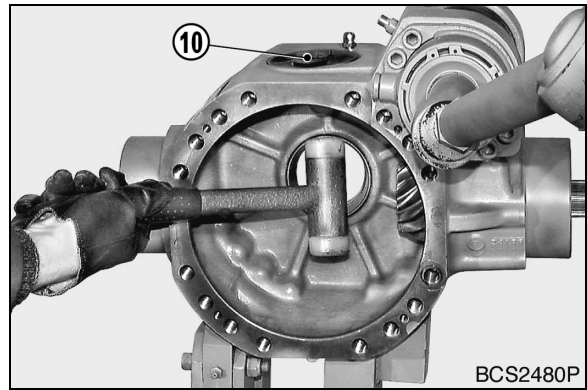


Figure 158

Disassembling

1. Remove the fitting screws (11) from the crown (12).
2. If the bearing need replacing, extract the bearing (7) and remove the crown (12).

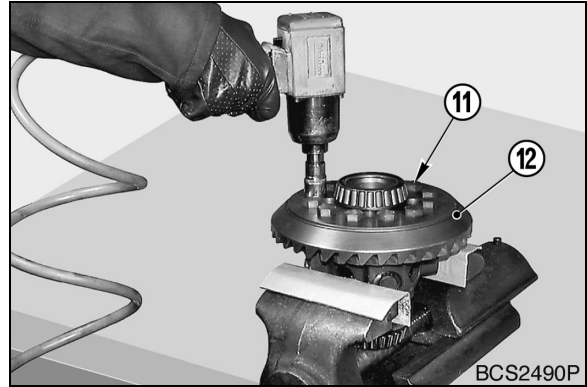


Figure 159

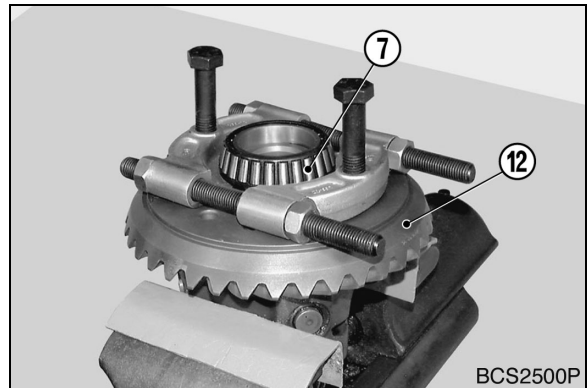


Figure 160

3. Remove the shim washer (13) and the planetary gear (14).

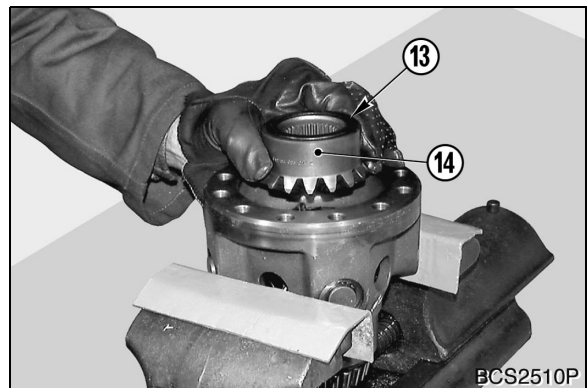


Figure 161

4. If the bearing need replacing, extract the bearing (8) from the differential carrier (15).

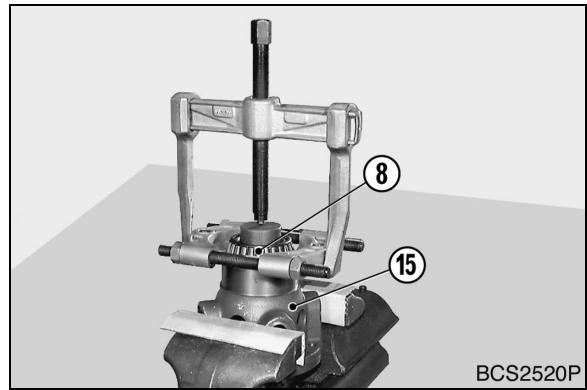


Figure 162

5. Remove the snap rings (16) from the two pins (17) of the planet wheel gears (18).

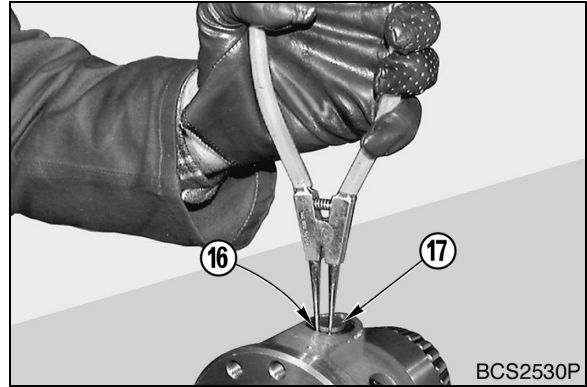


Figure 163

6. Insert tool **T14** between the planet wheel gears (18).

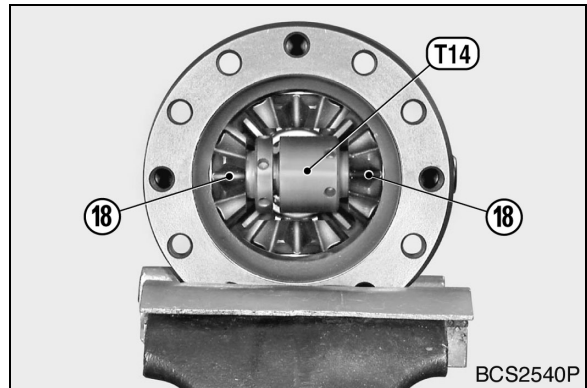


Figure 164

7. Force tool **T14** in-between the planet wheel gears (18) using two pin-drivers.

NOTE: Make sure that tool **T14** is perfectly lined up with the pins (17) when locked.

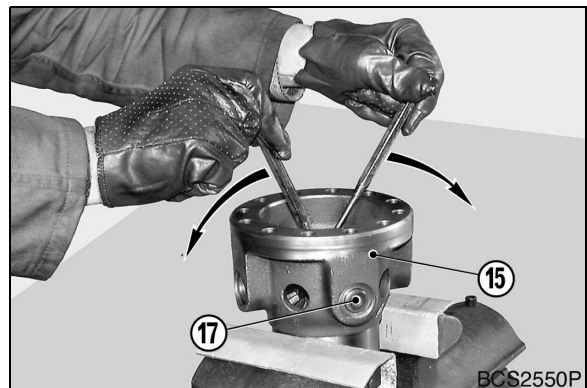


Figure 165

8. Place the differential carrier (15) under a press, position bush **T15** and insert gudgeon **T16A**. Press **T16A** pin to limit position.

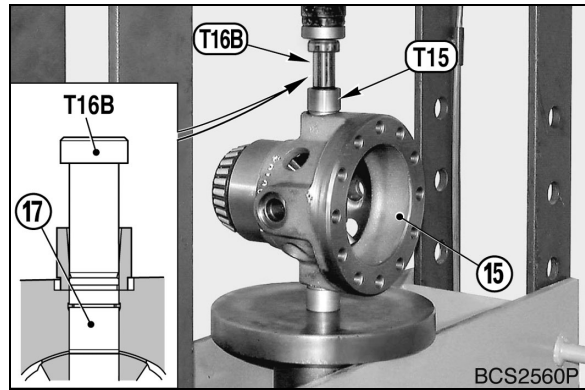


Figure 166

9. Remove gudgeon **T16A** and bush **T15**.
NOTE: In this condition the tool **T14** contains pin (17).

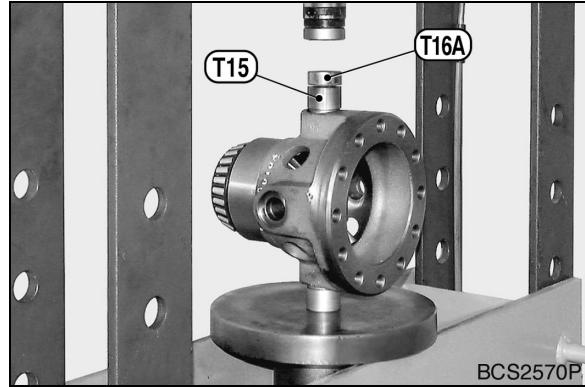


Figure 167

10. Remove tool **T14** together with the pin (17) of the planet wheel.



Figure 168

11. Leave the released planetary gear in position and again lock tool **T14**.
12. Repeat the operations for the extraction of the pin of the 2 nd planet wheel (17).
13. Repeat the operations for all other pins.

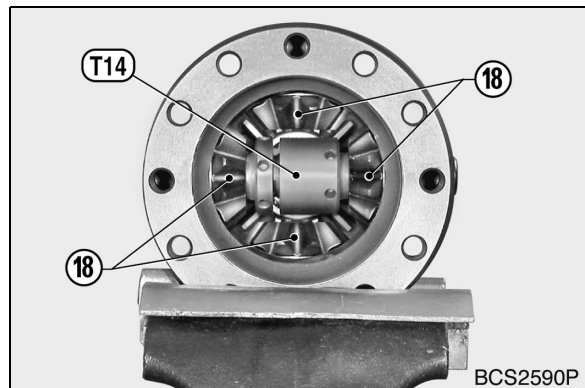


Figure 169

14. Remove tool **T14** and remove the last two planet wheel gears (18), the 2 nd differential unit gear (14) and the relative shim washer (13) from the differential carrier.

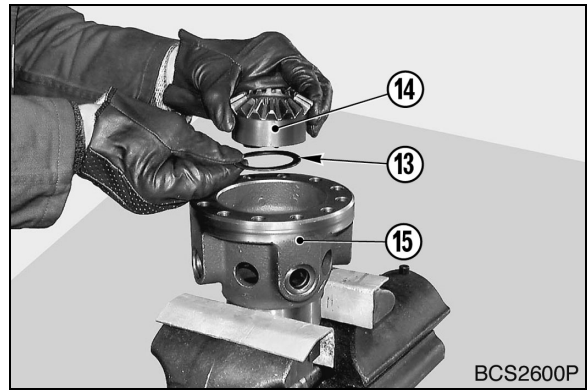


Figure 170

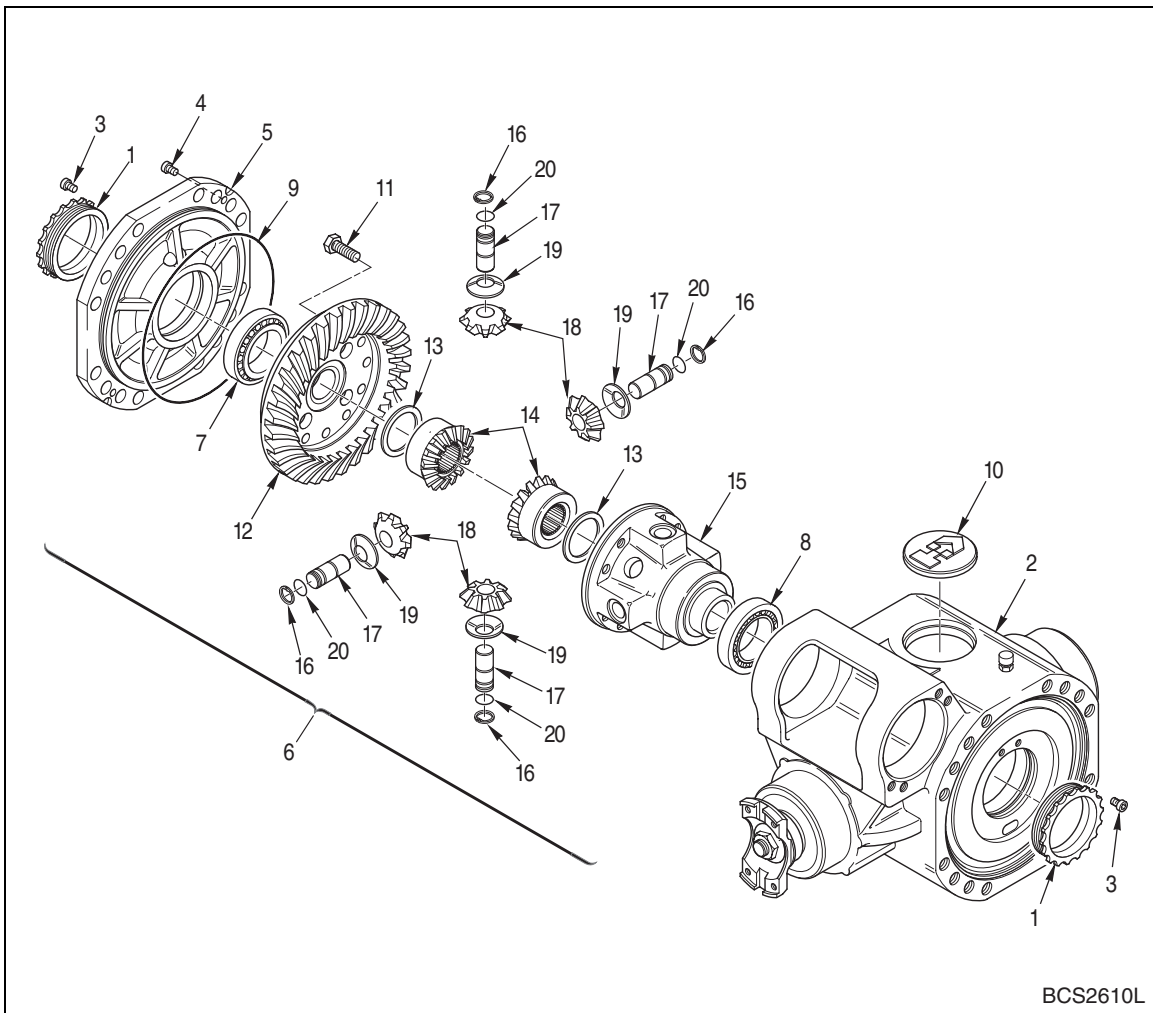


Figure 171

ASSEMBLY, ADJUSTING AND INSTALLATION

Assembling

1. Insert the shim washer (13) and the planetary gear (14) in the differential carrier (15).
2. Position the shim washer (19) and the first planet wheel gear (18).
3. Hold them in position using bar **T16C**.
4. With the help of gudgeon **T16A**, position the second planet wheel gear (18) and the relative shim washer (19).
5. Insert tool **T14** between the two planetary gears (18). Line up the entire unit by pushing bar **T16C** all the way down until gudgeon **T16A** is ejected.

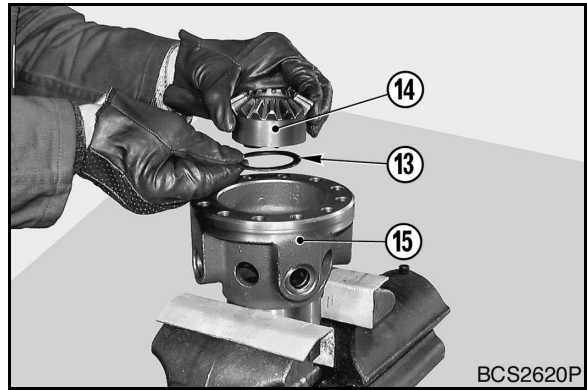


Figure 172

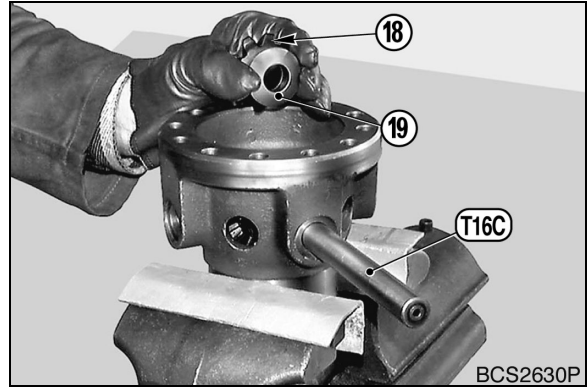


Figure 173

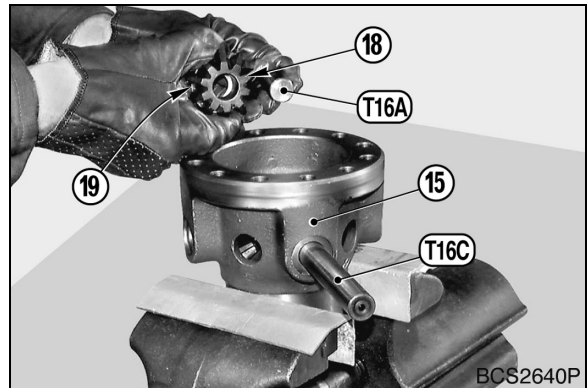


Figure 174

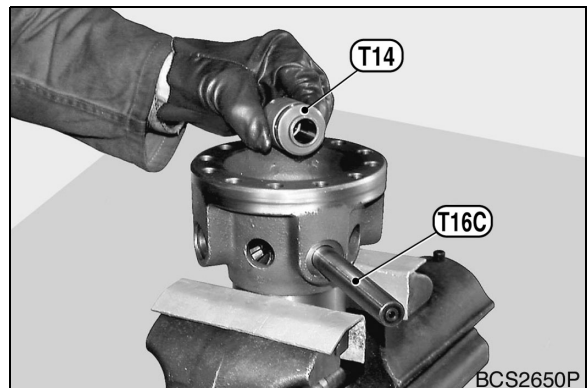


Figure 175

6. Lock tool **T14** behind the planet wheel gears (18).
7. After locking, remove bar **T16C**.

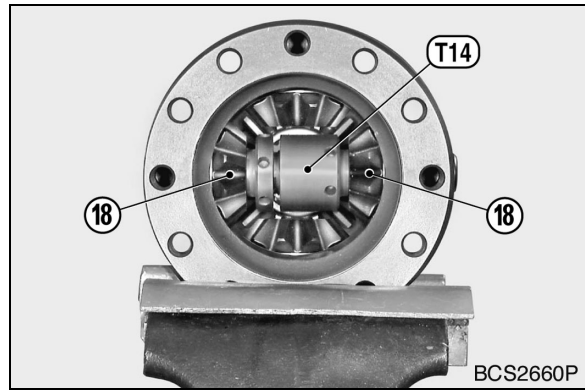


Figure 176

8. Fit the snap rings (20) onto the pins (17).

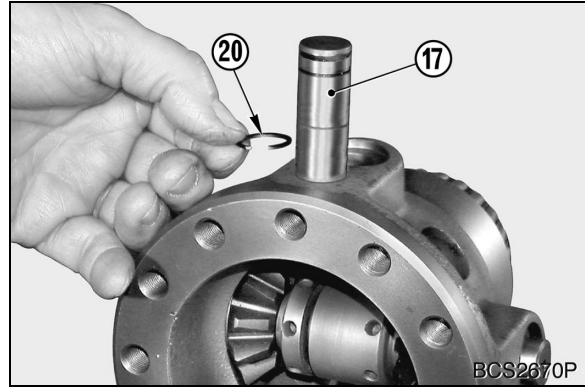


Figure 177

9. Place the differential carrier (15) under the press, position bush **T15** and insert the planet wheel pin (17).

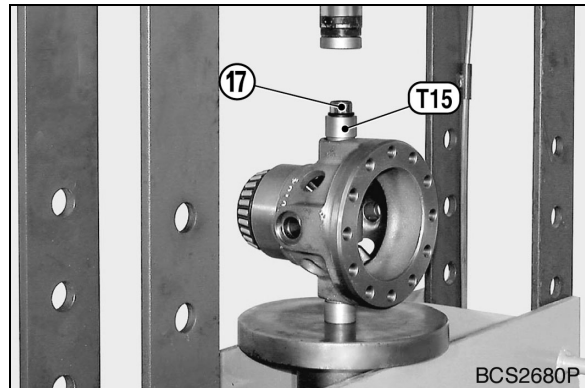


Figure 178

10. Put gudgeon **T16B** on top of the planet wheel pin (17).

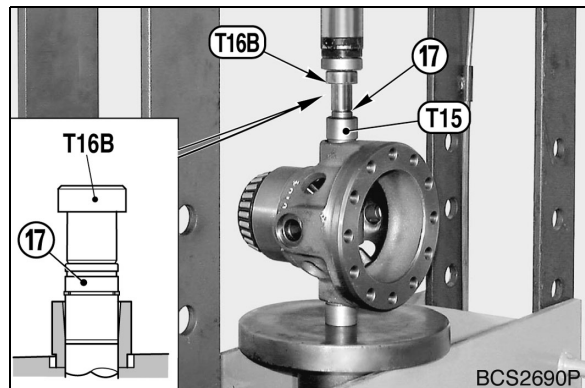


Figure 179

11. Press **T16B** pin all the way down.

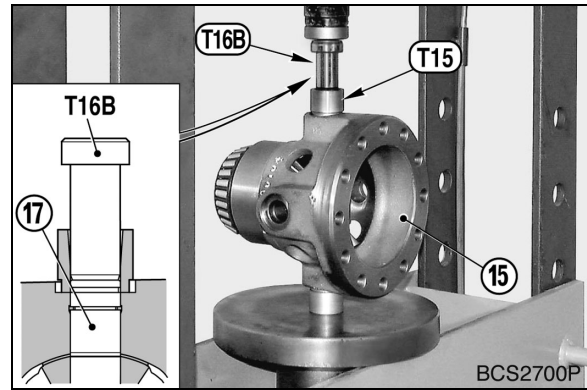


Figure 180

12. Remove gudgeon **T16B**, bush **T15** and fit the snap ring (16) on the pin (17).

NOTE: *Make sure that the snap ring centres the seat and that it rests on the surface of the differential carrier.*

13. Repeat the operations on the other planet wheel pin or planet wheel axle.

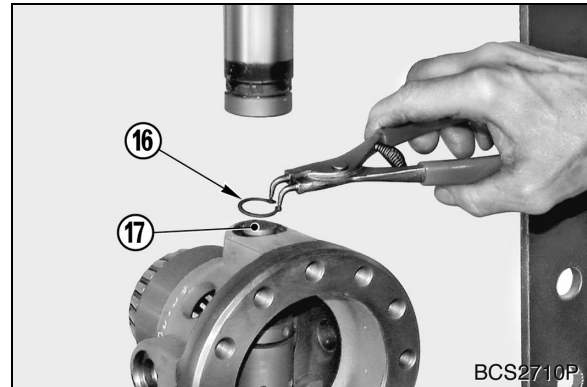


Figure 181

14. Position the second planetary gear (14) in the differential carrier (15).

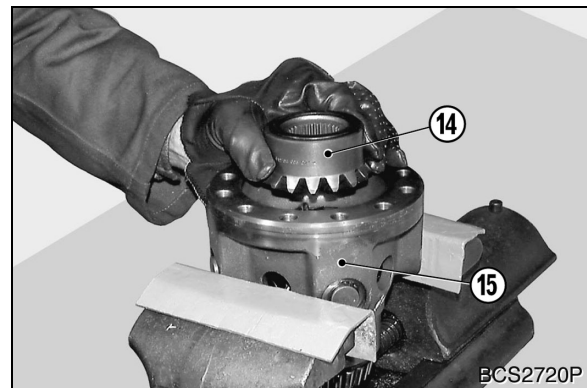


Figure 182

15. Position the shim washer (13) on the crown (12).

NOTE: *In order to hold the shim washer (13) in position, apply grease to it.*

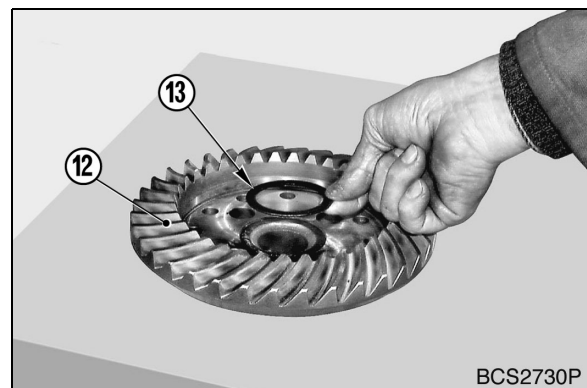


Figure 183

16. Position the crown (12) on the differential carrier (15) and lock it with screws (11) applied with Loctite 242.

Torque wrench setting for screws: 128-142 Nm (95-104 ft lb).

NOTE: *Secure the screws using the cross-tightening method.*

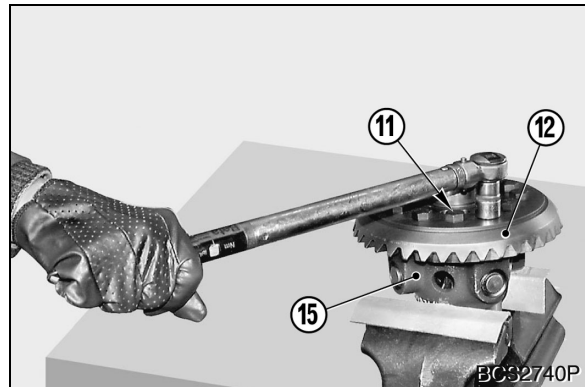


Figure 184

17. Install the bearings (7) and (8) using tool T17.

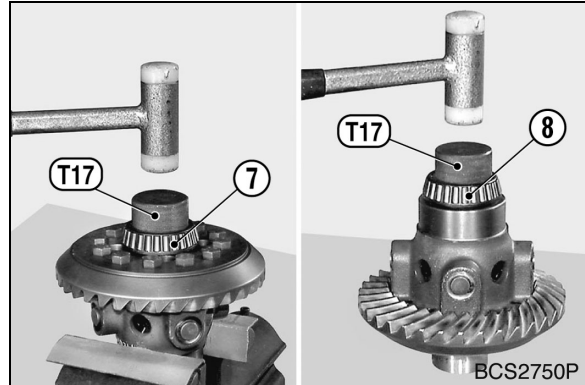


Figure 185

18. If the bearings are replaced, insert the external thrust blocks in the middle cover (5) and in the central body (2).

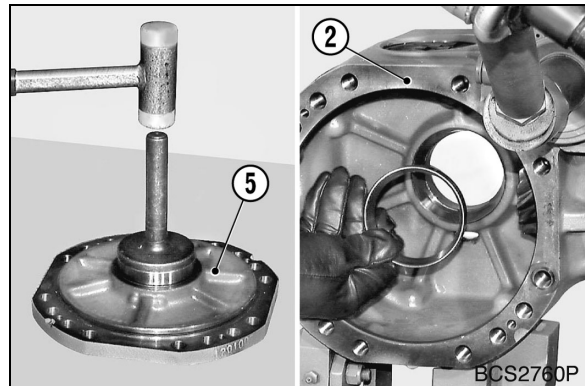


Figure 186

Installing

1. Position the differential unit (6) in the central body (2) with the help of a bar and fit the middle cover (5).

NOTE: *Thoroughly check the state of the O-ring (9) and make sure that the cover is fitted with the oil discharge in the lower position.*

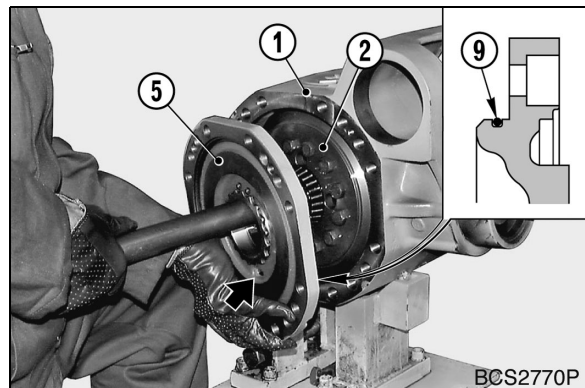


Figure 187

2. Lock the middle cover (5) with screws (4).

Torque wrench setting for screw: 23.8-26.2 Nm (18-19 ft lb).

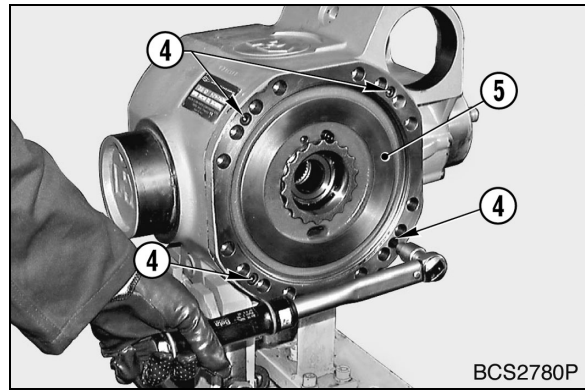


Figure 188

NOTE: If the ring nuts (1) are removed, spread them with Loctite 242.

3. Tighten ring nuts on the crown side until clearance between pinion and crown is zero, then lock the crown; go back 1/4 - 1/2 turn.

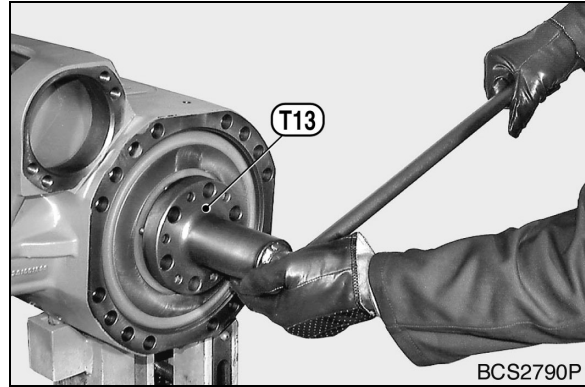


Figure 189

4. Pre-set the bearings by means of the ring nut situated on the opposite side of the crown, so as to increase pinion torque up to 140 - 210 Ncm.

NOTE: If bearings are not new, check the static torque; if bearings are new, check the continuous torque.

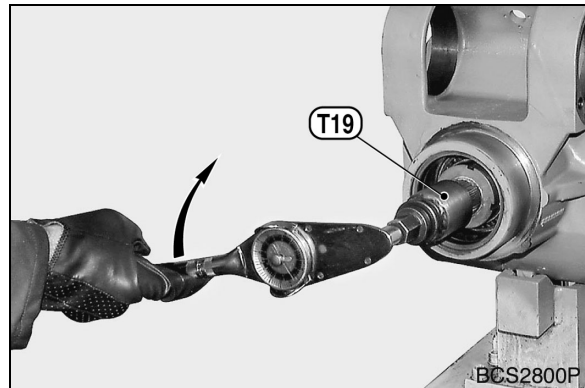


Figure 190

5. Introduce a comparator with rotary key "A" through the top plug hole (10). Position the comparator on the centre of one of the teeth of the crown (12), pre-set it to 1mm and reset it.

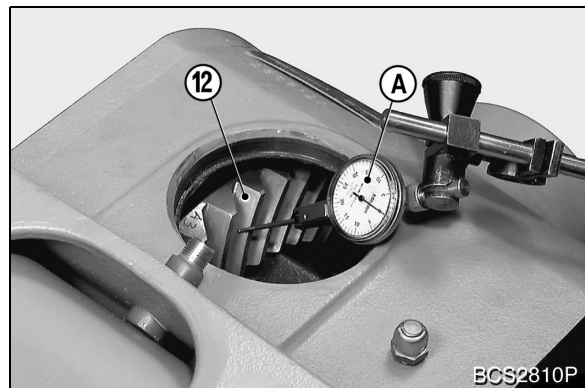


Figure 191

6. Manually move the crown (12) in both directions in order to check the existing backlash between the pinion and the crown.

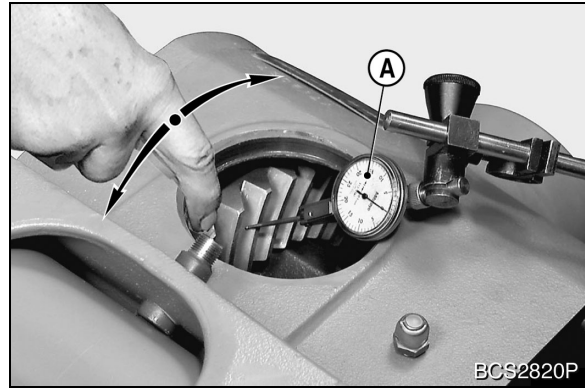


Figure 192

7. Adjust the backlash between the pinion and the crown by unloosening one of the ring nuts (1) and tightening the opposite to compensate.
8. Normal backlash: see table.

Ratio	Clearance	
	Min.	Max.
9 : 34	0.18	0.23
9 : 35	0.13	0.18
11 : 31	0.20	0.28
11 : 35	0.13	0.18
12 : 35	0.13	0.18
12 : 41	0.15	0.20
14 : 32	0.18	0.23
14 : 36	0.15	0.20
14 : 41	0.15	0.20
15 : 32	0.18	0.23
15 : 47	0.13	0.18

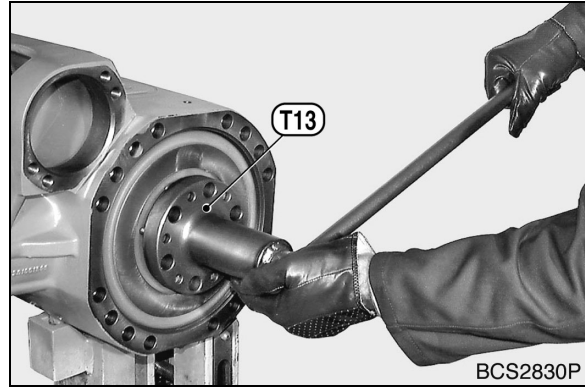


Figure 193

9. Apply Loctite 242 to the screws (3), fit them into one of the two holes and tighten.
Torque wrench setting: 23.8-26.2 Nm (18-19 ft lb)
10. Fit the top plug (10) after applying repositionable jointing compound for seals to the rims.

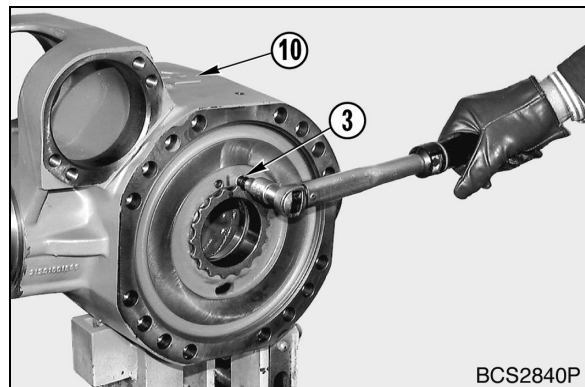


Figure 194

11. Re-install the complete arms.

NOTE: For details, see “Checking Wear and Replacing Brake Disks” on page 12.

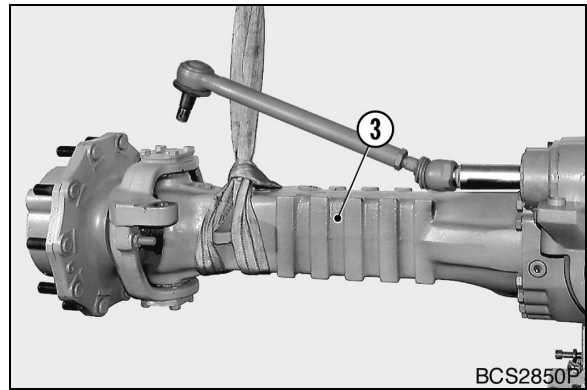


Figure 195

BEVEL PINION

REMOVAL

1. Remove the complete arms and the differential unit.

NOTE: For details, see “Checking Wear and Replacing Brake Disks” on page 12 and “Differential Unit” on page 58.

2. If disassembly is awkward, heat the check nut (1) of the flange (2) at 80° C (176° F).

NOTE: Heating is meant to unloose the setting of Loctite on the nut (1).

3. Position tool **T20A** (or **T20B**), so as to avoid pinion rotation.
4. Unloose and remove the nut (1); also remove the O-ring (3).

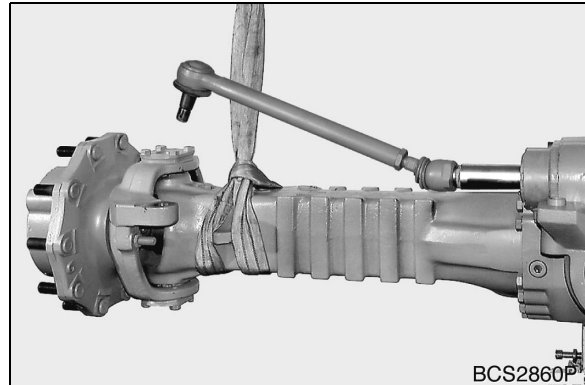


Figure 196

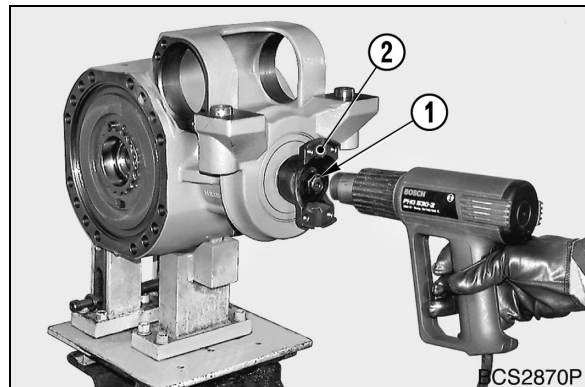


Figure 197

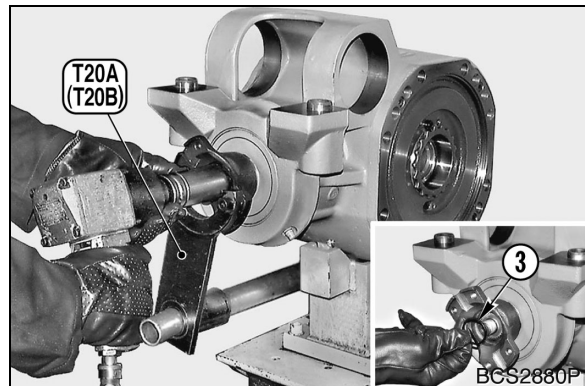


Figure 198

5. Remove the flange (2) complete with guard (4) by means of a puller.

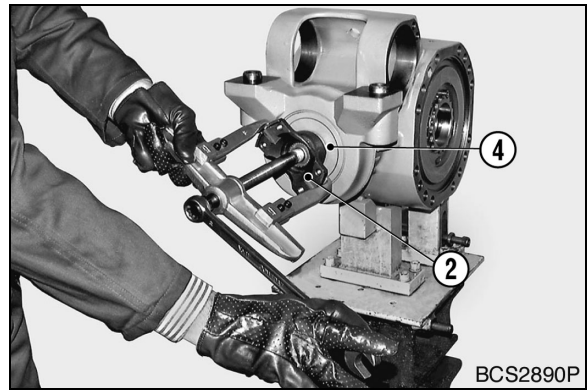


Figure 199

6. Remove the swinging support (5).

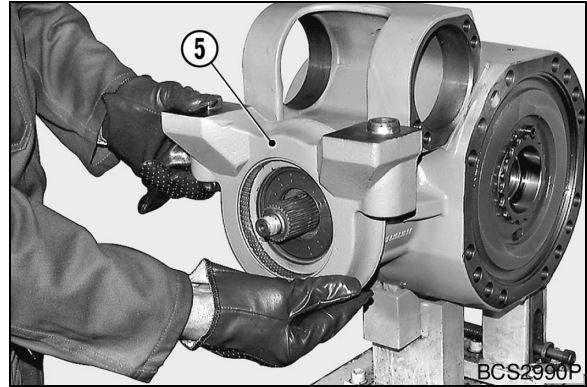


Figure 200

7. Remove the sealing ring (6).



Figure 201

8. Position wrench **T22** onto the ring nut (7) and apply bar hold **T21** to the pinion (8).
9. Stop wrench **T22** and rotate the pinion so as to release and remove the ring nut (7).

NOTE: *If disassembly proves awkward, weld the ring nut at approx. 80° C (176° F).*

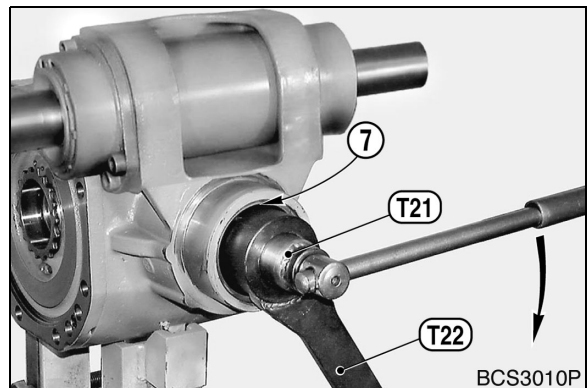


Figure 202

10. Apply blocks **T23** and, with the help of a puller, extract the pinion (8) complete with the internal bearing (9), the distance piece (10) and shims (11).

NOTE: *The thrust blocks of the bearings remain in the central body (12).*

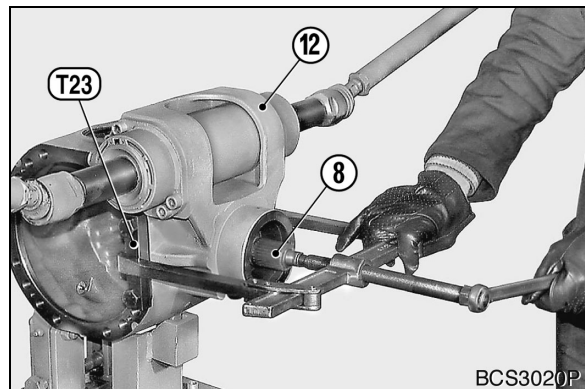


Figure 203

11. Remove the pinion (8), shims (11) and distance piece (10).

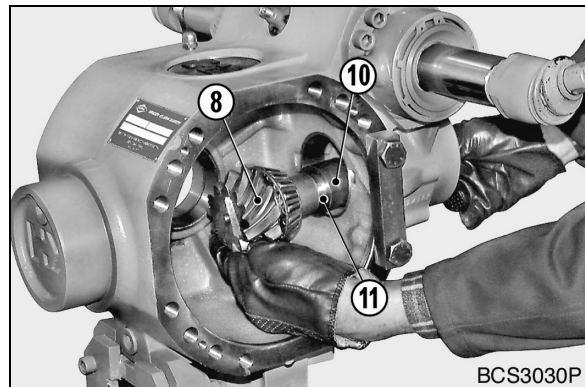


Figure 204

12. Using a puller and a press, remove the inner bearing (9) from the pinion (8).

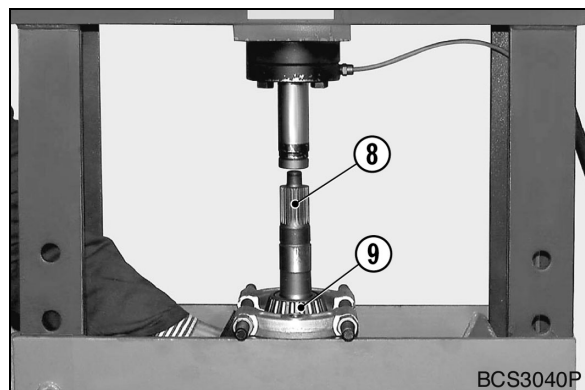


Figure 205

13. Remove the thrust block of the external bearing (13).

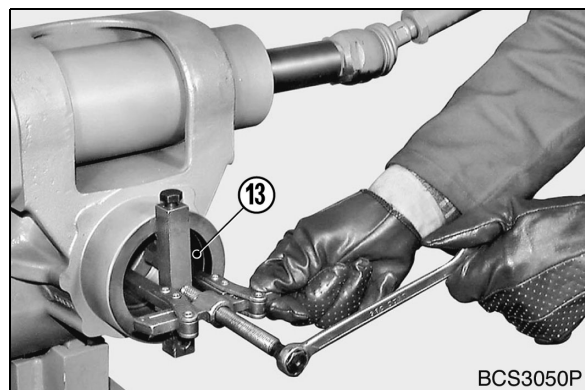


Figure 206

14. Insert a drift in the appropriate holes and remove the thrust block of the internal bearing (9) as well as the shim washers (14).

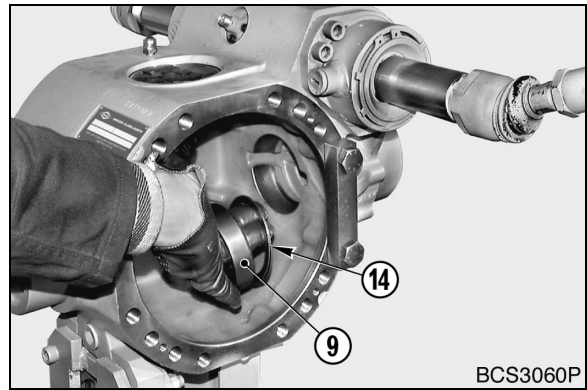


Figure 207

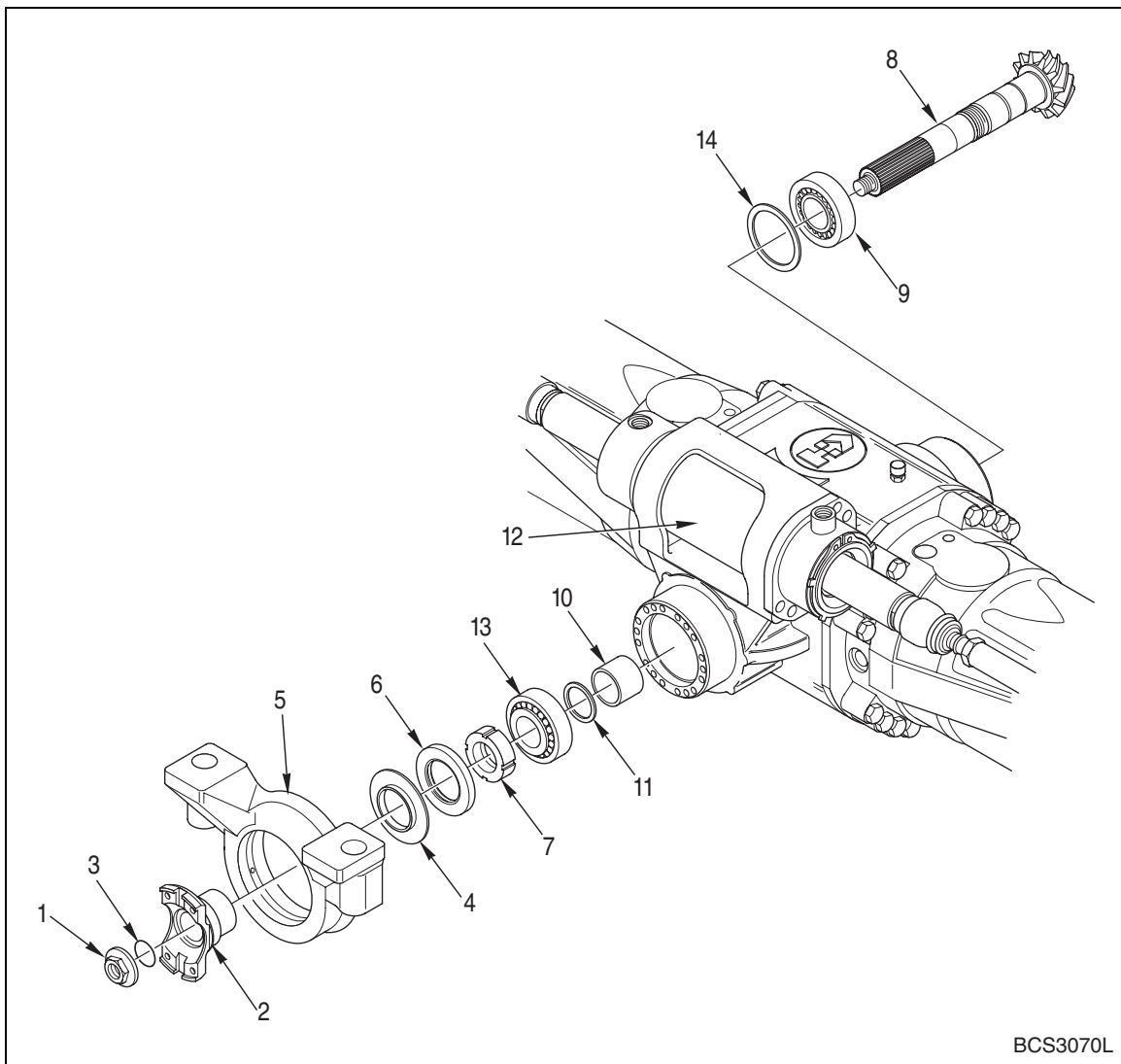


Figure 208

ADJUSTING AND INSTALLATION

1. Using a surface plate, reset a centesimal comparator "DG" and place it on the measurement ring **T24** (with a thickness of 30.2 mm).
2. Preset the comparator to approx. 2 mm (0.08 in).

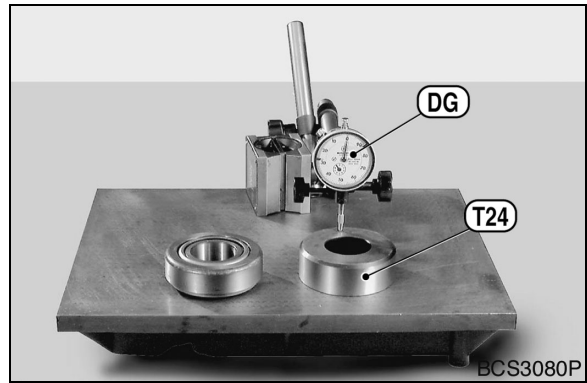


Figure 209

3. Bring the internal bearing (9), complete with its thrust block, under the comparator "DG".
4. Determine overall thickness "D" of the bearing checking the discrepancy between this size and the size of the measurement ring.

NOTE: Press the thrust block in the centre and take several measurements while rotating the thrust block.

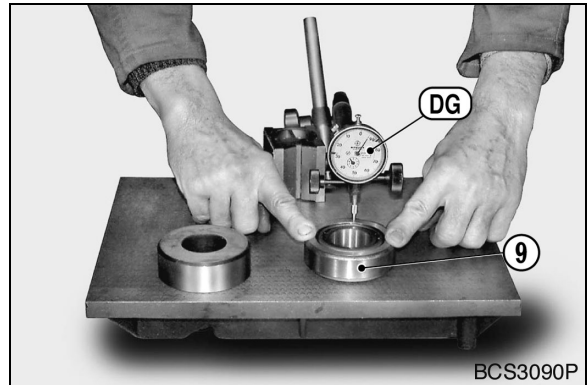


Figure 210

5. Partially insert the thrust block of the external bearing (13).

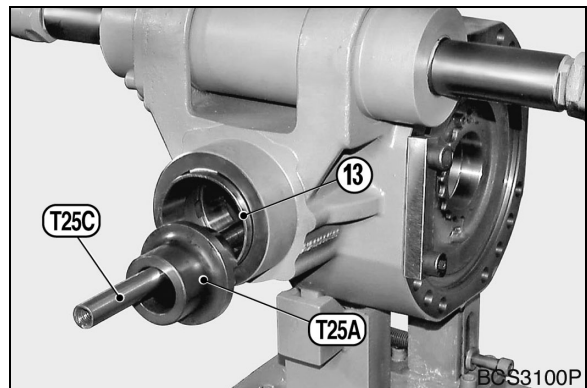


Figure 211

6. Install tension rod **T25C**, measurement ring **T24** and front guide tool **T25A** on the thrust block of the external bearing (13).

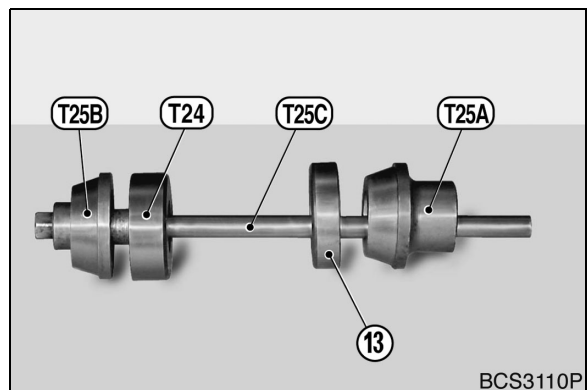


Figure 212

7. Connect the tension rod to the press and move the thrust block of the external bearing (13) into its seat.
8. Disconnect the press and remove the tension rod.

NOTE: *Before starting the next stage, make sure that the thrust block has been completely inserted into its seat.*

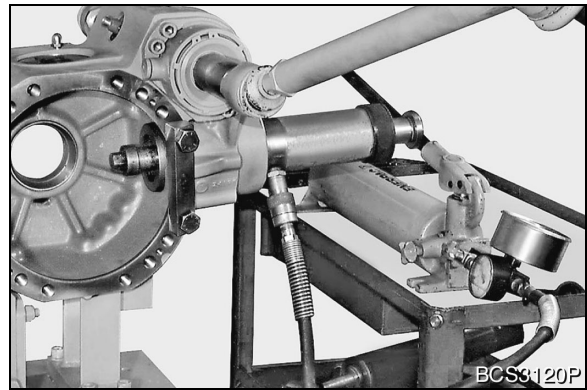


Figure 213

9. Insert tool **T26B** complete with external bearing (13), measurement ring **T24** and gauged ring nut **T26C**.
10. Manually tighten.

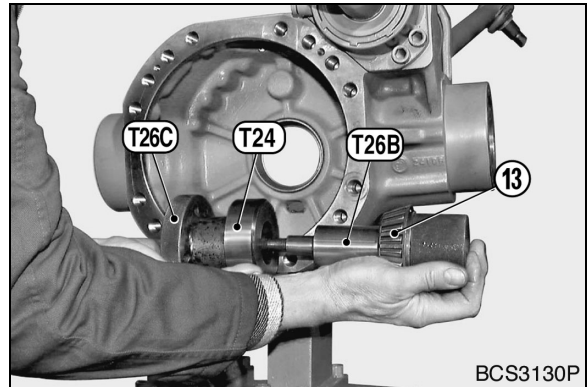


Figure 214

11. Fit a centesimal comparator "**DG1**" with long stem into bar **T26A**; when the bar rests on two size- blocks "**GB**" of 57 mm (2.24 in), reset the comparator.
12. Preset the comparator to approx. 2 mm (0.08 in) and reset.

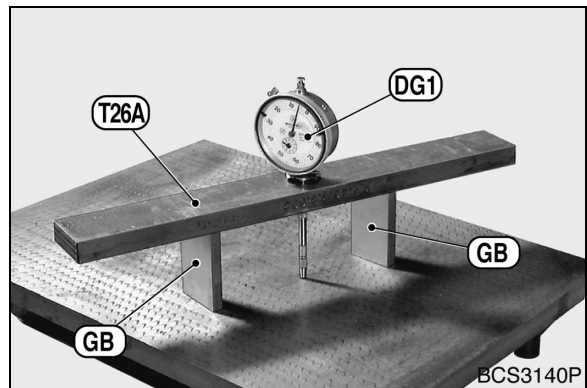


Figure 215

13. Lay bar T26A on gauged nut T26C and take the size "**A**" at about 57 mm (2.24 in) corresponding to the maximum diameter of arms centring.

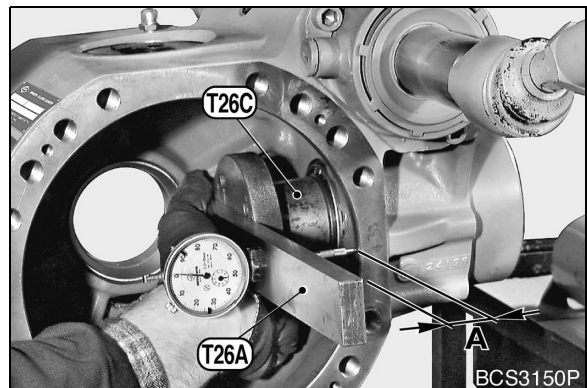


Figure 216

14. Calculate size "**B**" which will be the first useful value for calculating the size of the shims (14) that are to be inserted under the thrust block of the internal bearing (9).

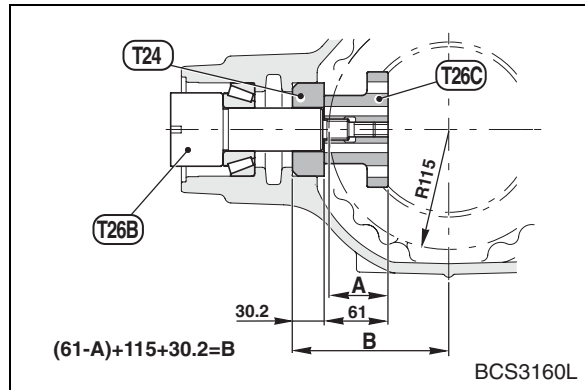


Figure 217

15. Check the nominal size (X) marked on the pinion and add or subtract the indicated variation (Y) so as to obtain size "Z".

e.g.: $Z = 118 + 0.1 = 118.1$

$Z = 118 - 0.2 = 117.8$

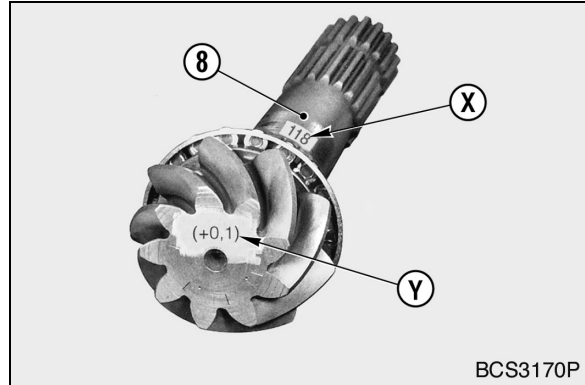


Figure 218

16. Calculate size "**C**" which represents the second value for calculating the size of the shims "**S**" that are to be placed under the thrust block of the internal bearing (9).

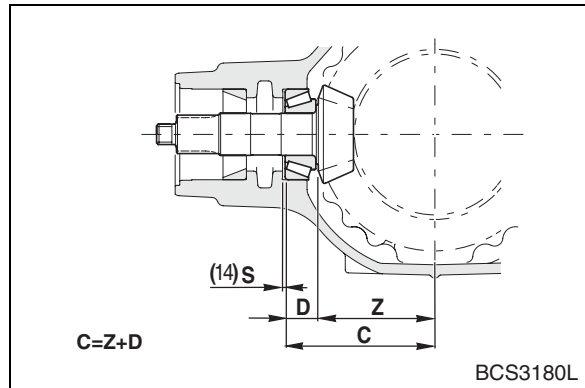


Figure 219

17. Calculate the difference between sizes "**B**" and "**C**" so as to obtain the size "**S**" of the shim (14) that will go under the thrust block of the internal bearing (9).

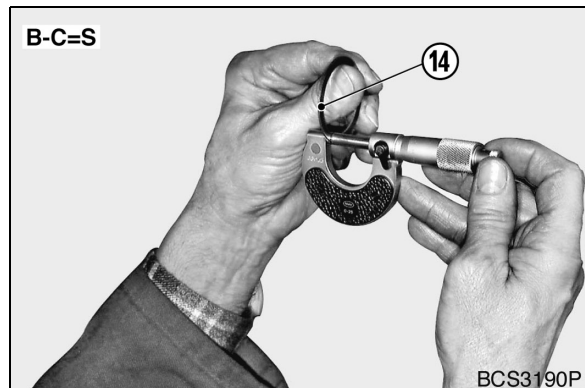


Figure 220

18. Insert shim "S" (14) and the thrust block of the internal bearing (9) in the central body.

NOTE: To hold shim "S" (14) in position, apply grease.

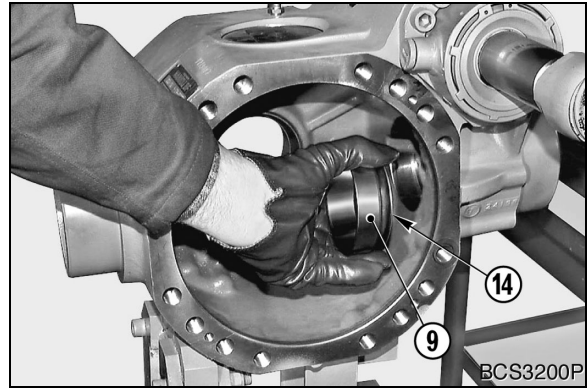


Figure 221

19. Position tool **T25A** and tension rod **T25C**.
20. Connect the tension rod to the press, fasten the thrust block and then remove the tools.

NOTE: Before going on to the next stage, make sure that the thrust block has been completely inserted.

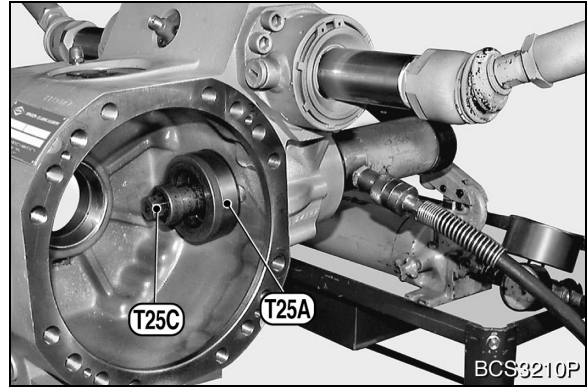


Figure 222

21. Position tools **T26C** and **T26B** complete with tapered bearings (9) and (13); manually tighten until a rolling torque has been obtained.

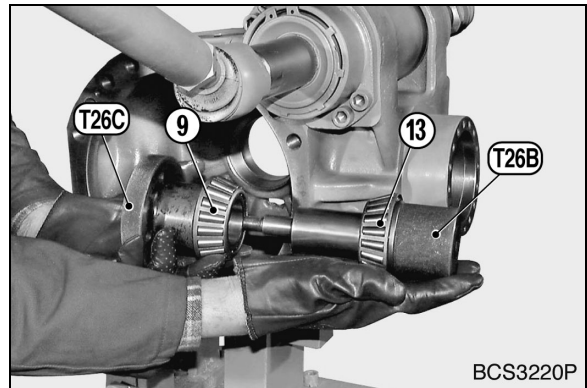


Figure 223

22. Insert the stem of a depth comparator "DDG" in either side hole of tool **T26C**; reset the comparator with a presetting of approx. 3 mm (0.12 in).

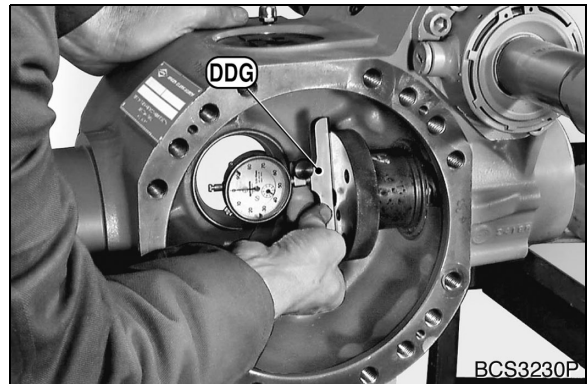


Figure 224

23. Remove the comparator and release tools and bearings from the central body.
24. Re-install all and insert the distance piece (10) between bearings (9) and (13); manually tighten the whole pack.

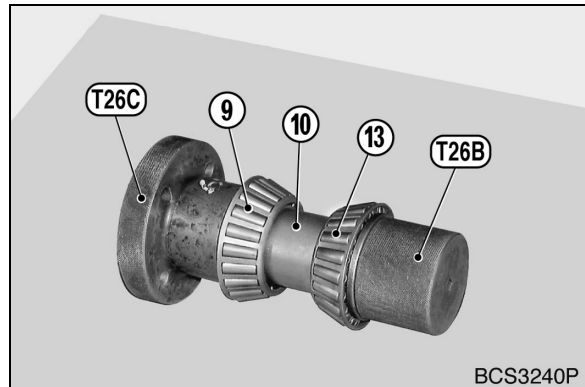


Figure 225

25. Insert depth comparator "DDG" into tool **T26B-T26C** and measure variation "H" in relation to the zero setting performed back at point d.

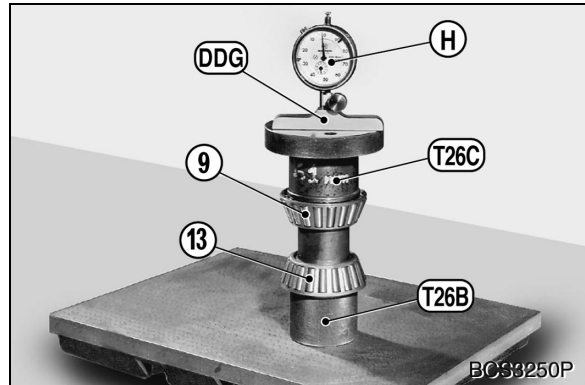


Figure 226

26. The variation is to be added to a set value of 0.12-0.13 mm (0.01 in), so as to obtain the size of shim "S1" (11) which will be inserted between the external bearing (13) and the distance piece (10) and subsequently, to determine the preload for the bearings.

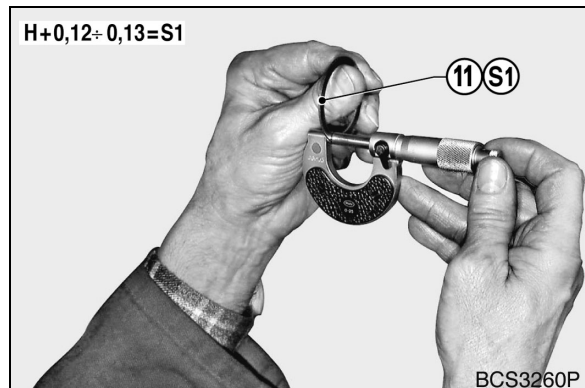


Figure 227

27. Position the internal bearing (9) and the pinion (8) under a press; force the bearing onto the pinion.

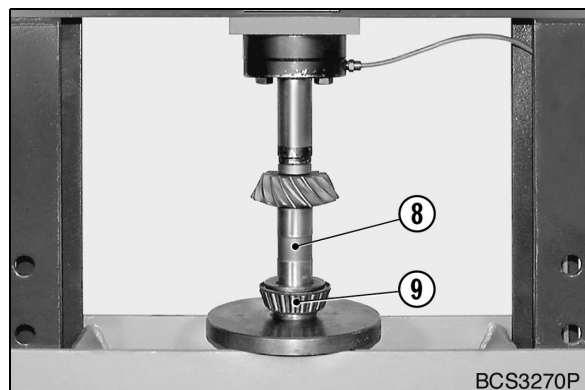


Figure 228

28. Fit the pinion (8), shim "S1" (11) and distance piece (10) in the main body (12).

NOTE: *The finer shims must be placed in- between the thicker ones*

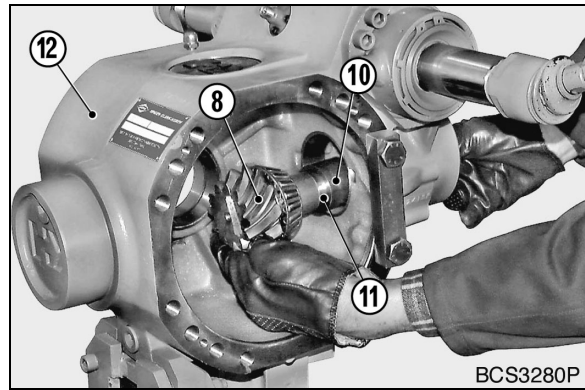


Figure 229

29. Insert the external bearing (13) in the central body in order to complete the pack arranged as in the figure.

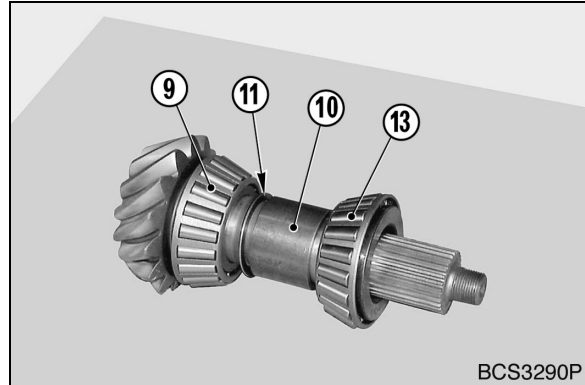


Figure 230

30. Connect the pinion (8) to the tie rod **T28A** and **T28B**; connect the tie rod **T28C** (see special tools) to the press and block.

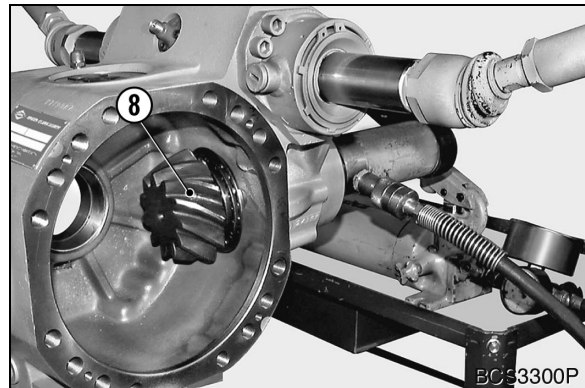


Figure 231

31. Apply Loctite 242 to the thread of the ring nut (7) and screw the nut onto the pinion (8).

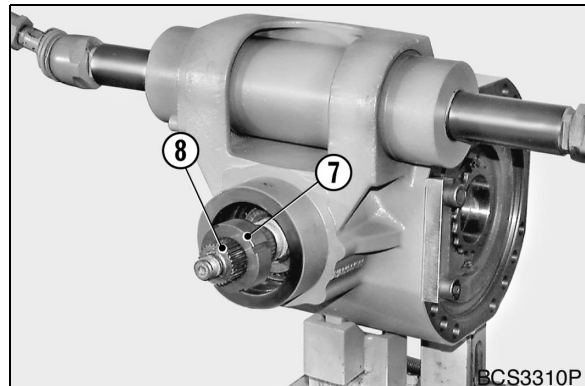


Figure 232

32. Apply special wrench **T22** to the ring nut (7) and bar-hold **T21** to the pinion (8).
33. Lock the wrench **T22** and rotate the pinion using a dynamometric wrench, up to a minimum required torque setting of 500 Nm (369 ft lb).

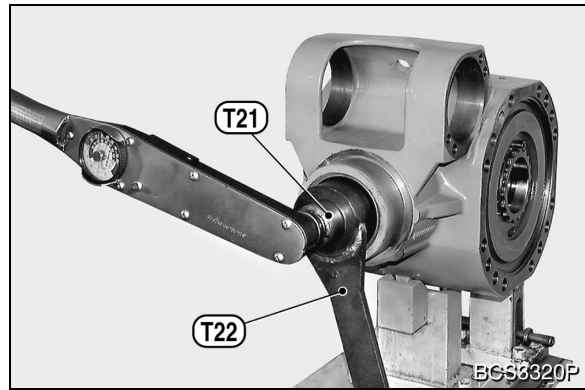


Figure 233

34. Apply onto the pinion (8) the bar-hold and with the help of a torque metre, check the torque of the pinion (8).

Torque: 120-170 Nm (89-125 ft lb)

NOTE: If torque exceeds the maximum value, then size of shim "S1" (11) between bearing (13) and distance piece (10) needs to be increased. If torque does not reach the set value, increase the torque setting of ring nut (7) in different stages to obtain a maximum value of 570 Nm (420 ft lb).

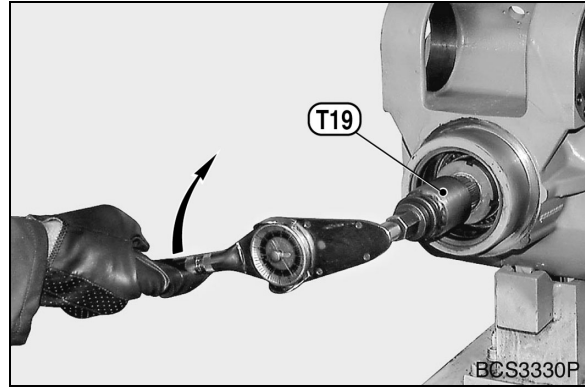


Figure 234

NOTE: If torque does not reach the minimum value, then size of shim "S1" (11) needs to be reduced.

NOTE: When calculating the increase or decrease in size of shim "S1", bear in mind that a variation of shim (11) of 0.01 mm corresponds to a variation of 60 Nm (44 ft lb) in the torque of pinion (8).

35. Lubricate the outer surface of the new sealing ring (6) and fit it onto the central body (12) using tool **T27**.

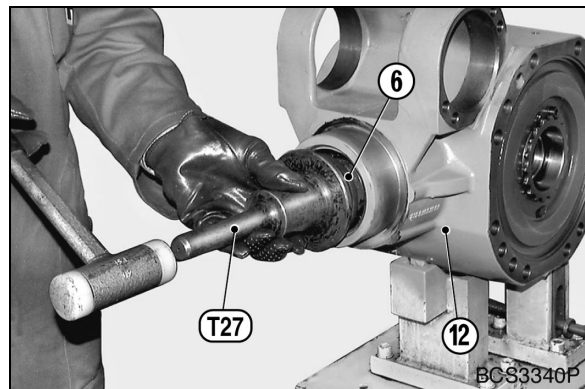


Figure 235

36. Install the swinging support (5).

NOTE: *Make sure it is properly oriented.*

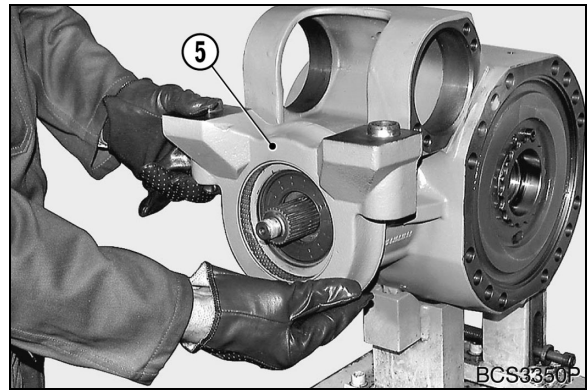


Figure 236

37. Fit flange (2) complete with guard (4) and fasten it.

38. For keying flange (2), use a plastic hammer if necessary.

NOTE: *Make sure that guard (4) is securely fastened onto the flange and that it is not deformed.*

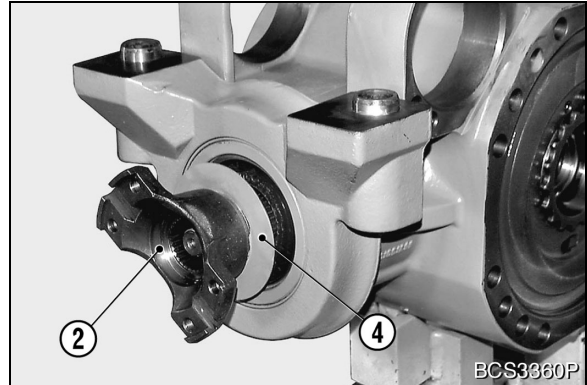


Figure 237

39. Apply Loctite 242 to the threaded part of pinion (8).

40. Position tool **T20A** (or **T20B**) and fasten it in order to avoid rotation.

41. Insert O-ring (3), nut (1) and tighten it using a dynamometric wrench.

Torque wrench setting: 280-310 Nm (207-228 ft lb).

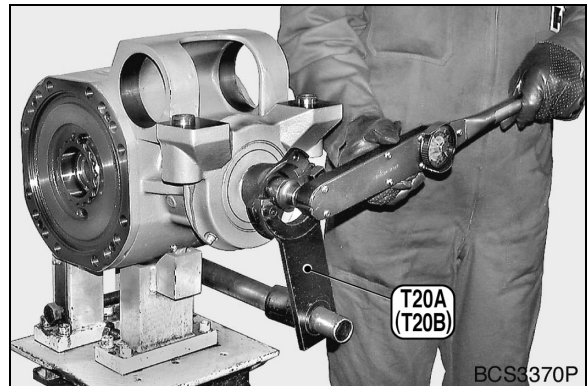


Figure 238

42. Remove blocks **T23** (used for extracting the pinion) and re-install the arms.

NOTE: *For details, see "Checking Wear and Replacing Brake Disks" on page 12.*

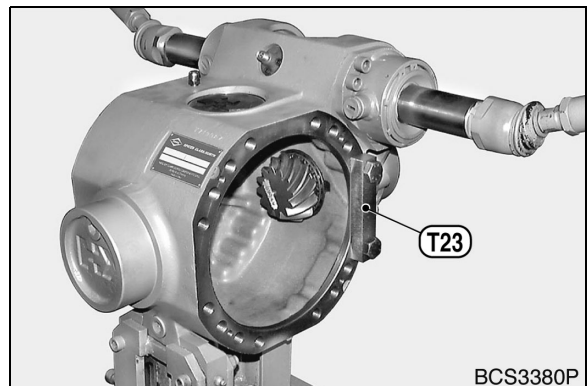


Figure 239

SPECIAL TOOLS

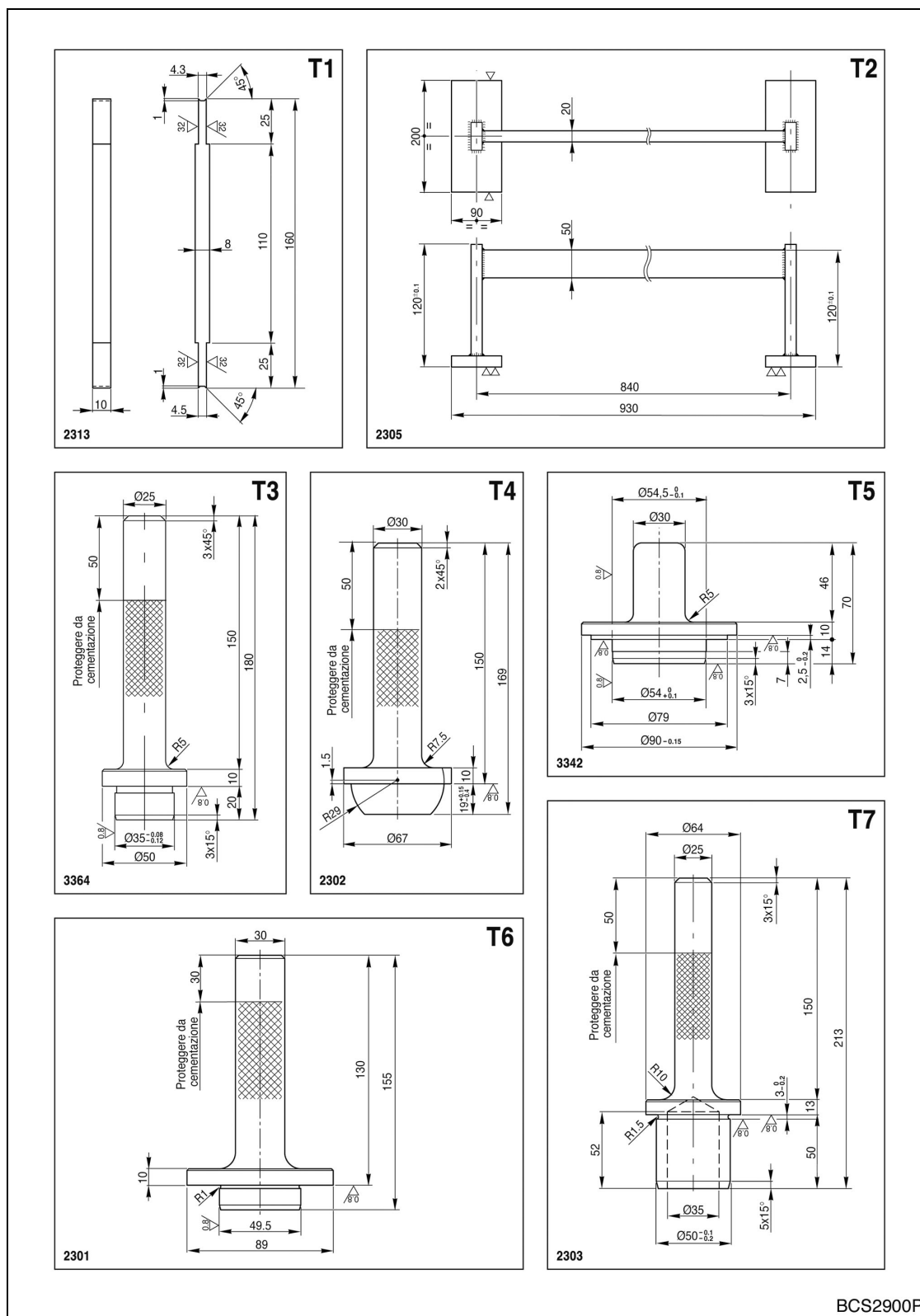


Figure 240

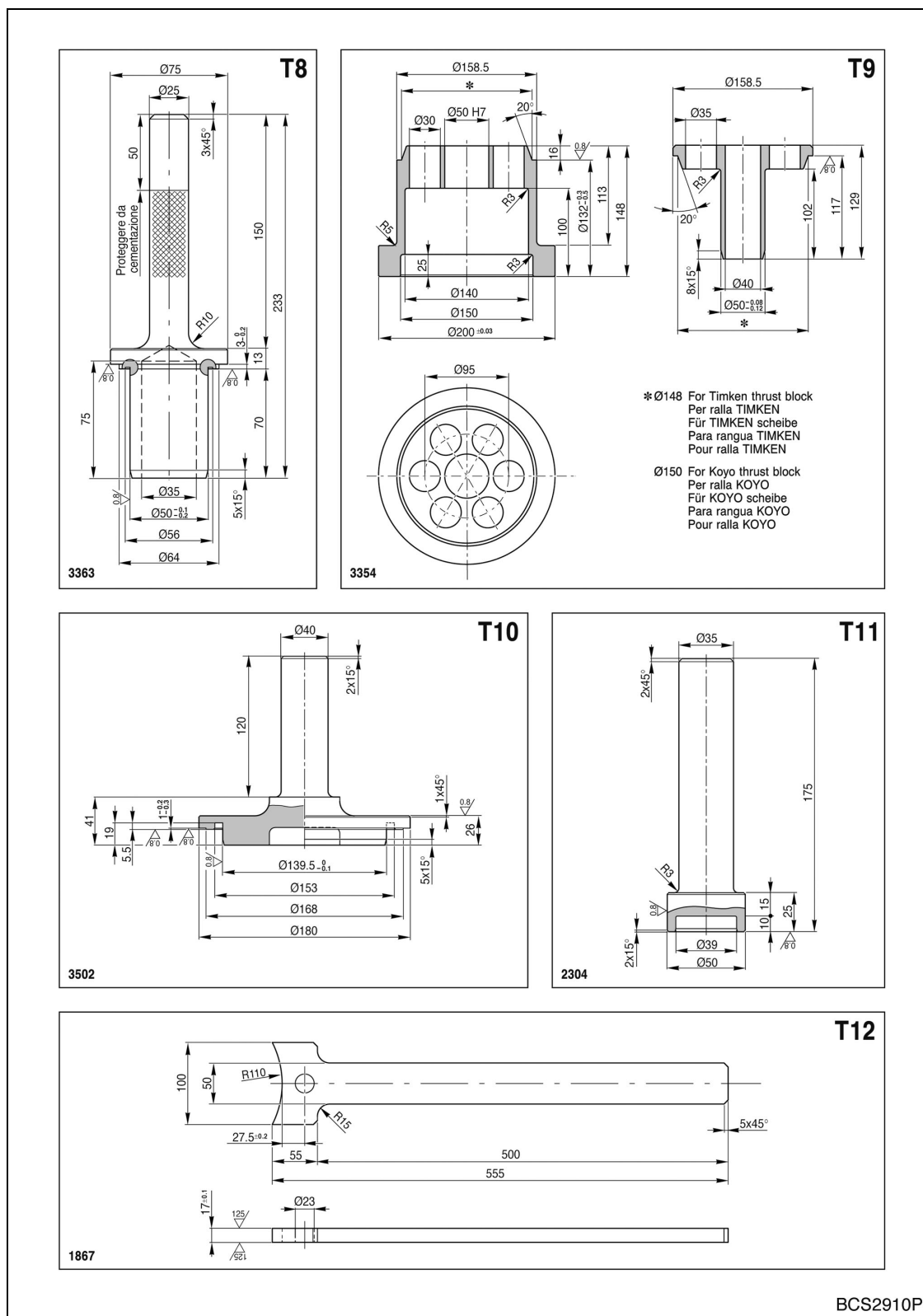


Figure 241

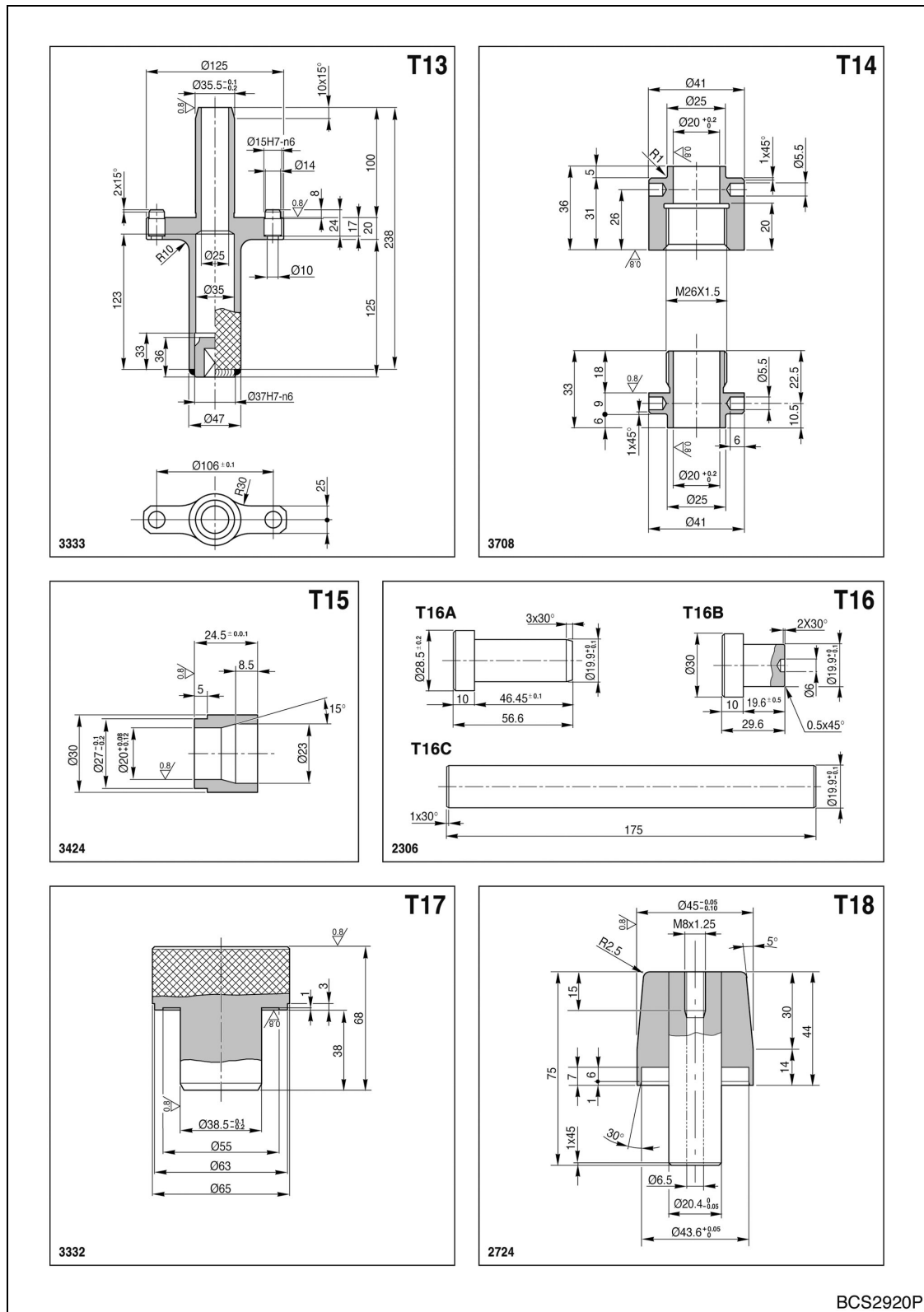
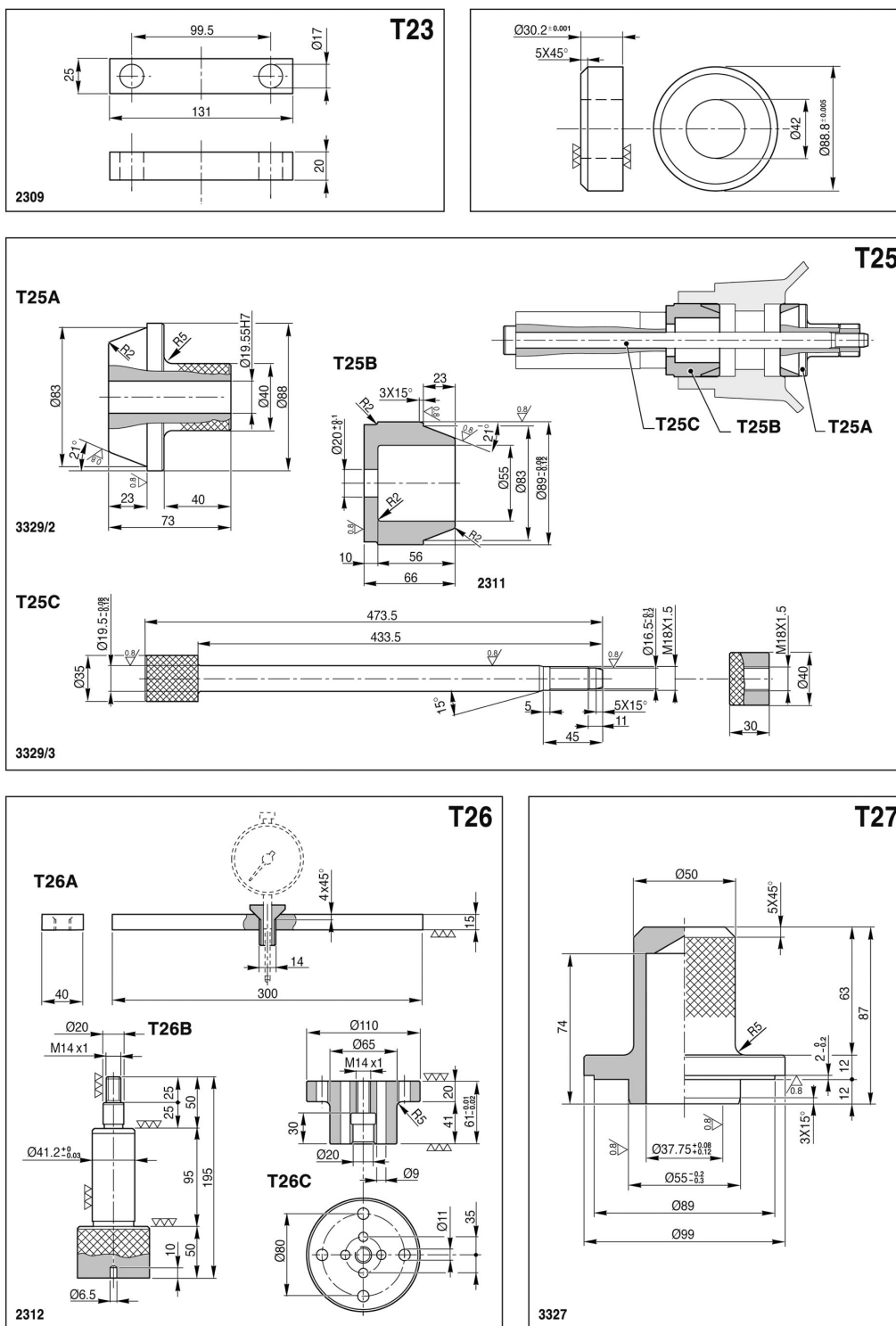


Figure 242

Front Axle (Dana)



BCS2940P

Figure 244

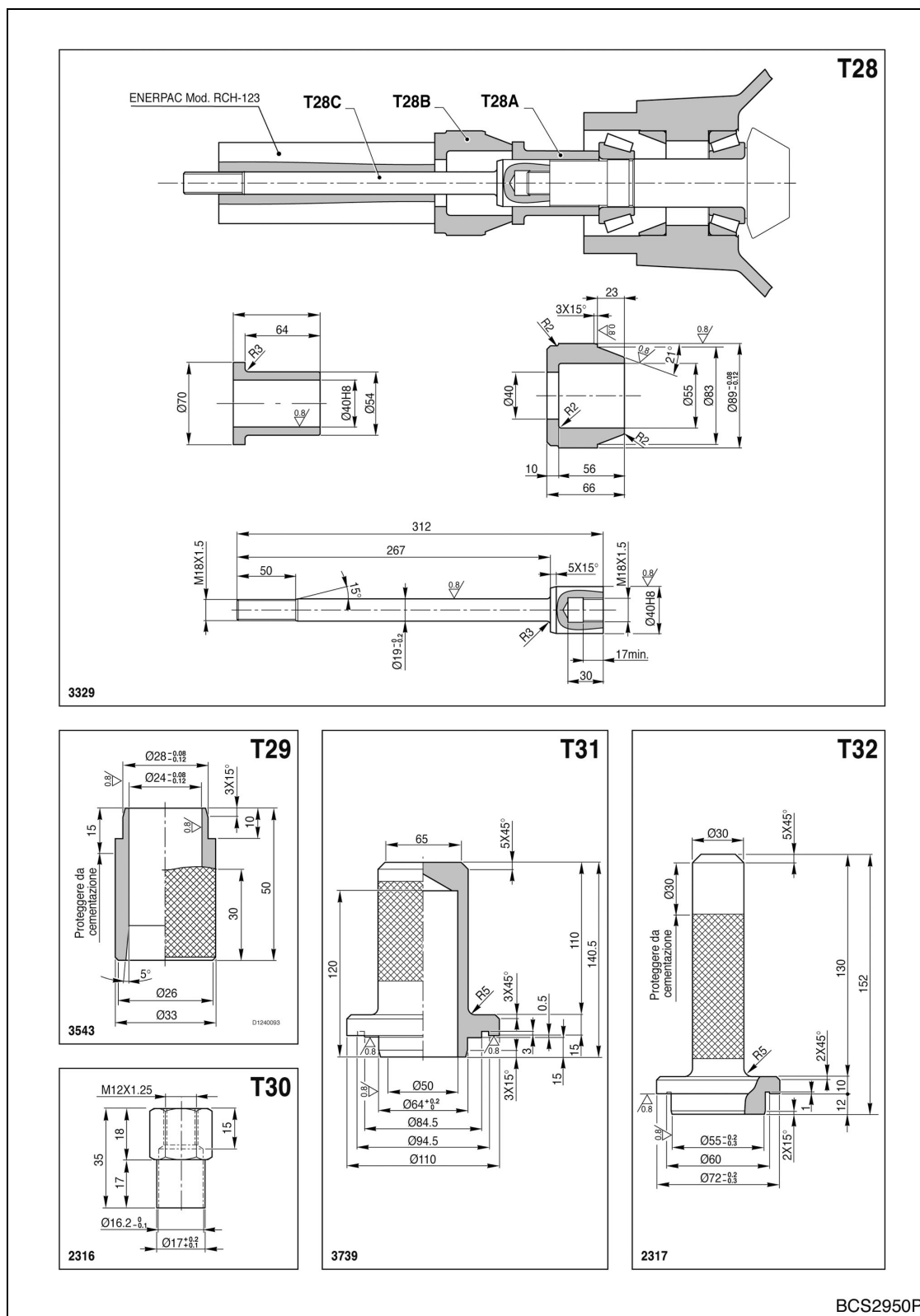


Figure 245

TROUBLESHOOTING

Problem	Cause	Correction
Insufficient braking	1. Incorrect adjustment	Inspect disc thickness and if discs are usable read just brakes to the specifications in the vehicle's manual.
	2. Brake discs worn out	Inspect disc thickness and replace if necessary.
	3. Incorrect brake fluid	Replace all seals in axle and master cylinder that have made contact with the incorrect fluid and all brake hoses. If incorrect fluid leaked into axle oil, seals and o-rings in axle must be replaced.
	4. Loss of brake fluid	Inspect for and repair any leaks in outside circuit or master cylinder. If caused by incorrect brake fluid see correction N. 3. If leak is to the outside replace the o-rings between the center and intermediate housings. If leak is to the inside replace above o-rings and brake piston o-rings.
	5. Overheated axle causing brake fluid to vaporize. (Brake return when axle cools)	See «overheating» problem.
Soft brake pedal	6. Air in brake circuit	Bleed brakes as described in the vehicle's service manual.
Ineffective safety brake	7. Incorrect adjustment	See correction N. 1.
	8. Brake disc worn out	See correction N. 2.
Overheating	9. Oil level wrong	Drain, flush and refill oil to proper level.
	10. Too small of a brake gap	Readjust brakes to the specifications in the vehicle's service manual.
	11. Park brake dragging	Unlock the brake and adjust the correct gap.
	12. Incorrect brake fluid in system	See correction N. 3.
	13. No free-pedal at master cylinder	Readjust brake pedal as described in the vehicle's service manual.
	14. Restriction in brake lines	Inspect for and replace damage lines.
	15. Restriction in return line of brake Servo system	Inspect for and replace damaged return line. Inspect for and remove any filter, tee'd in line or any other source of back pressure from the return line.
	16. Incorrect lubricant	Change the retaining rings of the brake circuit and brake pump.

Problem	Cause	Correction
Diff-lock inoperative	17. If manual control, loose or misadjusted linkage	Inspect and correct linkage and readjust as indicated in vehicle's service manual.
	18. If hydraulic control, problems in the hydraulic or electrical circuits of the vehicle	Refer to the service manual for the vehicle.
	19. If hydraulic control: problems in actuating cylinder (noteable through loss of hydraulic oil or increase of the oil level in axle)	Rebuilt cylinder.
	20. If with lim. slip differential, worn discs	Replace discs.
Oil coming out of breather	21. Leak in internal brake system	See correction N. 2 and 3.
	22. Leak in diff-lock actuating cylinder	See correction N. 19.
NoSpin indexing noise when driving straight NOTE: <i>With NoSpin, fatigue damage can occur on the side with the larger tire.</i>	23. Unequal tire pressure left and right	Inflate tires to the recommended pressure in the service manual, or until the rolling radius is equal.
	24. Different style, size or brand of tires between left and right hand side	Change tires to make the rolling radius equal. Vary the tire pressure within the specifications until the rolling radius is equal.
Noise during coast and under power the same	25. Wheel bearings damaged	Replace and adjust.
Noise under power greater than during coast	26. Low oil level	Refill oil to proper level.
	27. Incorrect lubricant	See correction N. 16.
	28. Ring and pinion worn	Inspect through top cover. Replace and adjust.
	29. Worn ring and pinion bearings	Replace and adjust.
	30. Worn planetary gears or bearings	Replace.
Noise during coast greater than under power	31. Loose pinion nut	Inspect ring, pinion and pinion bearings. If undamaged, retighten nut.
	32. Only pinion bearing damaged	See correction N. 29.
Noise during turn (without NoSpin)	33. Worn spider and/or side gears	Replace.

Problem	Cause	Correction
A «Stick slip» noise when going from forward to reverse	34. Worn or damaged cardanshaft	Inspect and replace as described in vehicle's service manual.
	35. Loose wheel	Inspect for wheel and wheel stud damage. Replace if needed and retorque lug nuts.
	36. Articulation box joint and achsel shaft damaged	Inspect and replace.
	37. Spider pins loose in diff-carrier	Inspect through top cover. Replace.
	38. Damaged or missing spider and/or side gear washers	See correction N. 33.



REAR AXLE (DANA)



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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INTRODUCTION

The efficiency and continued operation of mechanical units depend on constant, correct maintenance and also on efficient repair work, should there be a break-down or malfunction. The instructions contained in this manual have been based on a complete overhaul of the unit.

However, it is up to the mechanic to decide whether or not it is necessary to assemble only individual components, when partial repair work is needed. The manual provides a quick and sure guide which, with the use of photographs and diagrams illustrating the various phases of the operations, allows accurate work to be performed.

All the information needed for correct disassembly, checks and assembly of each individual component is set out below. In order to remove the differential unit from the vehicle, the manuals provided by the vehicle manufacturer should be consulted. In describing the following operations it is presumed that the unit has already been removed from the vehicle.

IMPORTANT

In order to facilitate work and protect both working surfaces and operators, it is advisable to use proper equipment such as: trestles or supporting benches, plastic or copper hammers, appropriate levers, pullers and specific spanners or wrenches.

Before going on to disassemble the parts and drain the oil, it is best to thoroughly clean the unit, removing any encrusted or accumulated grease.

INTRODUCTORY REMARKS

All the disassembled mechanical units should be thoroughly cleaned with appropriate products and restored or replaced if damage, wear, cracking or seizing have occurred.

In particular, thoroughly check the condition of all moving parts (bearings, gears, crown wheel and pinion, shafts) and sealing parts (O-rings, oil shields) which are subject to major stress and wear. In any case, it is advisable to replace the seals every time a component is overhauled or repaired. During assembly, the sealing rings must be lubricated on the sealing edge. In the case of the crown wheel and pinion, replacement of one component requires the replacement of the other one. During assembly, the prescribed pre-loading, backlash and torque of parts must be maintained.

MAINTENANCE AND LUBRICANT

DEFINITION OF VIEWPOINTS

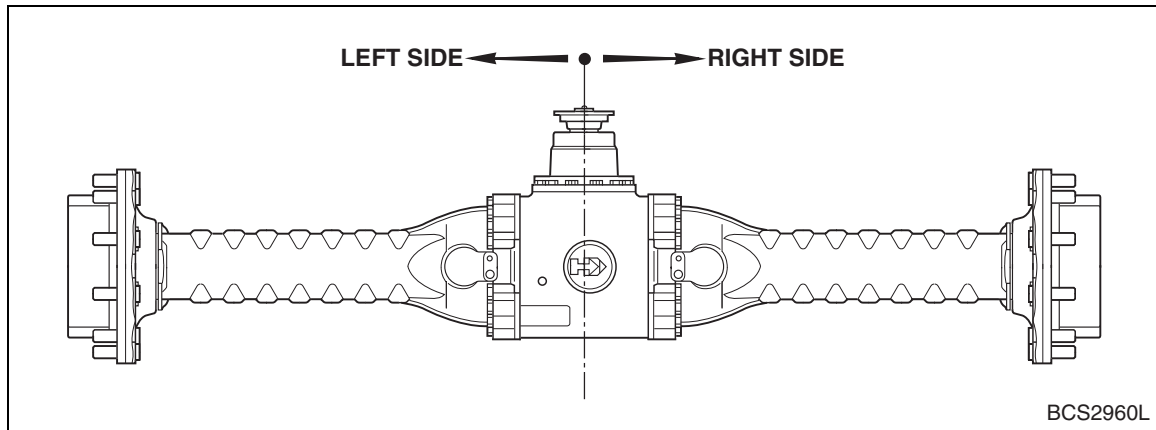


Figure 1

DATA PLATE

Reference Number	Description
1	Type and model unit - modification index
2	Serial number
3	Lubricant

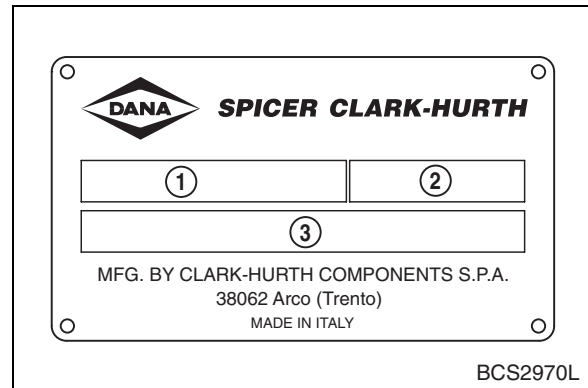


Figure 2

MAINTENANCE POINTS

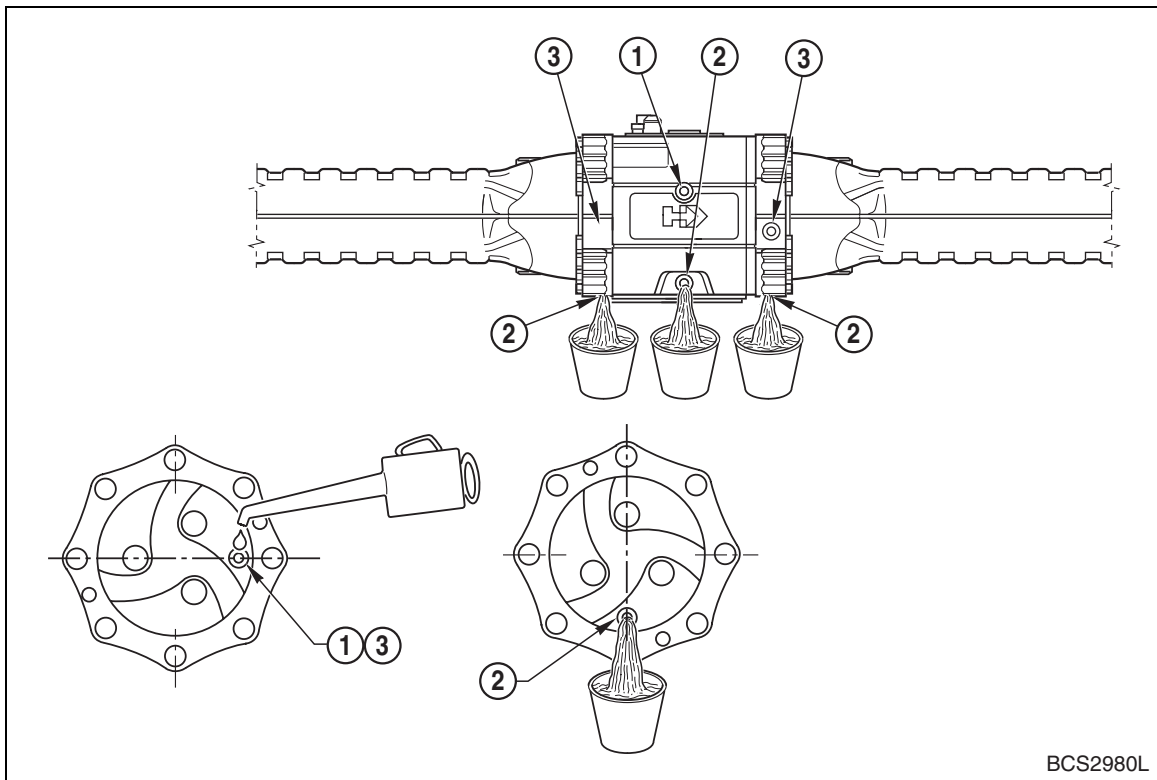


Figure 3

Reference Number	Description
1	Oil Filling Plug
2	Oil Draining Plug

Reference Number	Description
3	Check Level Plug

MAINTENANCE INTERVALS

Operation		Frequency	Lubricants
• Check levels:	Differential	Monthly	• SAE85W90 (API GL4 - MIL L-2105) With additives for oil-bath brakes • SAE85W90 (API GL5 - MIL 2105-B) With additives for oil-bath brakes, for units presenting hypoid crown wheel and pinion and /or self-locking differential gear.
	Planetary reduction	Every 200 hours	
• Oil change:	Differential	Every 800 hours *	
	Planetary reduction	Every 1000 hours *	
	Self-locking differential gear	Every 700 hours *°.	

* Initially after 100 working hours

°. When it starts sounding noisy

Operation	Member	Conditions	Frequency	Lubricants
Greasing	Articulations	Normal work	Monthly	MOLIKOTE
		Awkward work	Weekly	

ADJUSTMENT AND CHECKS

Unit	Operation	Frequency	Service Brake Circuit
Negative brake	Adjustment	Every 1000 hours *	Only for mineral oil use e.g. ATF Dexron II. Make sure that master cylinder seals are suitable for mineral oil.
Service brake	Adjustment	Every 500 hours	
Wheel nuts	Tightening	Every 200 hours	

* Initially after 100 working hours

TIGHTENING TORQUES

Unit: Nm (ft lb)

Size of Bolt		Type of Bolt					
		8.8		10.9		12.9	
		Loctite 242	Loctite 242	Loctite 242	Loctite 242	Loctite 242	Loctite 242
Coarse Pitch	M6 x 1	9,5-10,5 (7-8)	10,5-11,5 (8-9)	14,3-15,7 (11-12)	15,2-16,8 (11-12)	16,2-17,8 (12-13)	18,1-20,0 (13-15)
	M8 x 1,25	23,8-26,2 (18-19)	25,6-28,4 (19-21)	34,2-37,8 (25-28)	36,7-40,5 (27-30)	39,0-43,0 (29-32)	43,7-48,3 (32-36)
	M10 x 1,5	48-58 (35-43)	52-58 (38-43)	68-75 (50-55)	73-81 (54-59)	80-88 (59-64)	88-97 (64-71)
	M12 x 1,75	82-91 (61-67)	90-100 (66-74)	116-128 (86-94)	126-139 (93-102)	139-153 (103-112)	152-168 (112-123)
	M14 x 2	129-143 (95-105)	143-158 (106-116)	182-202 (134-148)	200-221 (148-163)	221-244 (163-179)	238-263 (176-193)
	M16 x 2	200-221 (148-163)	219-242 (162-178)	283-312 (209-230)	309-341 (228-251)	337-373 (249-275)	371-410 (274-302)
	M18x 2,5	276-305 (204-225)	299-331 (221-244)	390-431 (288-317)	428-473 (316-348)	466-515 (344-379)	509-562 (376-414)
	M20 x 2,5	390-431 (228-318)	428-473 (316-348)	553-611 (408-450)	603-667 (445-491)	660-730 (487-538)	722-798 (533-588)
	M22 x 2,5	523-578 (386-426)	575-635 (424-468)	746-824 (550-607)	817-903 (603-666)	893-987 (659-727)	974-1076 (718-793)
	M24 x 3	675-746 (498-550)	732-809 (540-596)	950-1050 (701-774)	1040-1150 (767-848)	1140-1260 (841-929)	1240-1370 (915-1010)
	M27 x 3	998-1103 (736-813)	1088-1202 (803-886)	1411-1559 (1041-1149)	1539-1701 (1135-1254)	1710-1890 (1261-1393)	1838-2032 (1356-1498)
	M30 x 3,5	1378-1523 (1016-1123)	1473-1628 (1086-1200)	1914-2115 (1412-1559)	2085-2305 (1538-1700)	2280-2520 (1682-1859)	2494-2757 (1840-2033)

Size of Bolt		Type of Bolt					
		8.8		10.9		12.9	
		Loctite 242	Loctite 242	Loctite 242	Loctite 242	Loctite 242	Loctite 242
Coarse Pitch	M8 x 1	25,7-28,3 (19-21)	27,5-30,5 (20-22)	36,2-39,8 (27-29)	40,0-44,0 (30-32)	42,8-47,2 (32-34)	47,5-52,5 (35-38)
	M10 x 1,25	49,4-54,6 (36-40)	55,2-61,0 (41-45)	71,5-78,5 (53-57)	78,0-86,0 (58-63)	86,0-94,0 (63-69)	93,0-103,0 (69-75)
	M12 x 1,25	90-100 (66-74)	98-109 (72-80)	128-142 (95-104)	139-154 (103-113)	152-168 (112-123)	166-184 (123-135)
	M12 x 1,5	86-95 (63-70)	94-104 (69-76)	120-132 (89-97)	133-147 (98-108)	143-158 (106-116)	159-175 (117-129)
	M14 x 1,5	143-158 (106-116)	157-173 (116-127)	200-222 (148-163)	219-242 (162-178)	238-263 (176-193)	261-289 (193-213)
	M16 x 1,5	214-236 (158-174)	233-257 (172-189)	302-334 (223-246)	333-368 (246-271)	361-399 (266-294)	394-436 (291-321)
	M18 x 1,5	312-345 (230-254)	342-378 (252-278)	442-489 (326-360)	485-536 (358-395)	527-583 (389-430)	580-641 (428-472)
	M20 x 1,5	437-483 (322-356)	475-525 (350-387)	613-677 (452-499)	674-745 (497-549)	736-814 (543-600)	808-893 (596-658)
	M22 x 1,5	581-642 (429-473)	637-704 (470-519)	822-908 (606-669)	903-998 (666-736)	998-1103 (736-813)	1078-1191 (795-878)
	M24 x 2	741-819 (547-604)	808-893 (596-658)	1045-1155 (771-851)	1140-1260 (841-929)	1235-1365 (911-1006)	1363-1507 (1005-1111)
	M27 x 2	1083-1197 (799-883)	1178-1302 (869-960)	1520-1680 (1121-1239)	1672-1848 (1233-1363)	1834-2027 (1353-1495)	2000-2210 (1475-1630)
	M30 x 2	1511-1670 (1115-1231)	1648-1822 (1216-1343)	2138-2363 (1577-1742)	2332-2577 (1720-1900)	2565-2835 (1892-2090)	2788-3082 (2056-2273)

SCREW-LOCKING, SEALING AND LUBRICATING MATERIALS

IMPORTANT	
1.	Locking, sealing and lubricating materials referred to in this manual are the same used in the shop-floor.
2.	The table below gives an account of the typical applications of each single material, in order to facilitate replacement with similar products marketed by different brand names with different trade marks.

Denomination	Application
Loctite 242	Anaerobic product apt to prevent the loosening of screws, nuts and plugs. Used for medium-strength locking. Before using it, completely remove any lubricant by using the specific activator.
Loctite 243	The oleocompatible alternative to 242. Does not require the activation of lubricated surfaces.
Loctite 270	Anaerobic product for very-high strength locking of screws and nuts. Before using it, completely remove any lubricant by using the specific activator. To remove parts, it may be necessary to heat them at 80° C (176° F) approx.
Loctite 275	Anaerobic product suitable for high-strength locking and sealing of large threaded parts, bolts and stud bolts, for pipe sealing and for protecting parts against tampering; suitable for sealing coupling surfaces with a max. diametrical clearance of 0.25 mm.
Loctite 510	Anaerobic product for the hermetic sealing of flanged units and screw holes communicating with fluids. Can seal clearances between flanges up to 0.2 mm.
Loctite 577	Quick anaerobic sealant for sealing threaded portions of conical or cylindrical unions up to M80. Before using it, remove any lubricant with the specific activator. After polymerisation, disassembly may result rather difficult, so heating may be necessary for larger diameters.
Loctite 638	Anaerobic adhesive for fast and high-strength gluing of cylindrical metal joints (hub on shaft). Can glue together parts with clearance ranging between 0.1 and 0.25 mm.
Loctite 648	Anaerobic adhesive for fast and medium-strength gluing of cylindrical metal joints (hub on shaft). Can glue together parts with radial clearance below 0.1 mm.
(AREXONS) Repositionable jointing compound for seals	Solvent-based sealing compound for elastic seals, drying through evaporation. Used for sealing the outer diameter of sealing rings for rotating shafts with outer metal reinforcement.
Silicone	Semi-fluid adhesive material used for sealing and filling and to protect components from environmental and physical elements. Polymerises with non-corrosive dampness.
(TECNO LUPE/101) Silicone-based grease	Highly adhesive synthetic grease, with silicone compounds added. Applied to adjustment screws with hole communicating with oil-type fluids. Used when frequent adjusting is required.
Molikote (DOW CORNING)	Lubricating compound containing molybdenum disulphide, used to lubricate articulation pins and to prevent sticking and oxidation of parts that are not lubricated on a regular basis.
(Lithium-based) Grease	Applied to bearings, sliding parts and used to lubricate seals or parts during assembly.

NOTES ON SAFETY PRECAUTIONS

1. During all operations described in this manual, the axle should be fastened onto a trestle, while the other parts mentioned should rest on supporting benches.
2. When removing one of the arms, an anti-tilting safety trestle should be placed under the other arm.
3. When working on an arm that is fitted on the machine, make sure that the supporting trestles are correctly positioned and that the machine is locked lengthways.
4. Do not admit any other person inside the work area; mark off the area, hang warning signs and remove the ignition key from the machine.
5. Use only clean, quality tools; discard all worn, damaged, low-quality or improvised wrenches and tools. Ensure that all dynamometric wrenches have been checked and calibrated.
6. Always wear gloves and non-slip rubber shoes when performing repair work.
7. Should you stain a surface with oil, remove marks straight away.
8. Dispose of all lubricants, seals, rags and solvents once work has been completed. Treat them as special waste and dispose of them according to the relative law provisions obtaining in the country where the axles are being overhauled.
9. Make sure that only weak solvents are used for cleaning purposes; avoid using turpentine, dilutants and toluol-, xylol-based or similar solvents; use light solvents such as Kerosene, mineral spirits or water-based, environment friendly solvents.
10. For the sake of clarity, the parts that do not normally need to be removed have not been reproduced in some of the diagrams.
11. The terms RIGHT and LEFT in this manual refer to the position of the operator facing the axle from the side opposite the drive.
12. After repair work has been completed, accurately touch up any coated part that may have been damaged.

CHECKING WEAR AND REPLACING BRAKE DISKS

DISASSEMBLY OF BRAKE UNITS

NOTE: *Perform all operations on both arms.*

1. Remove the oil-level plug (1).

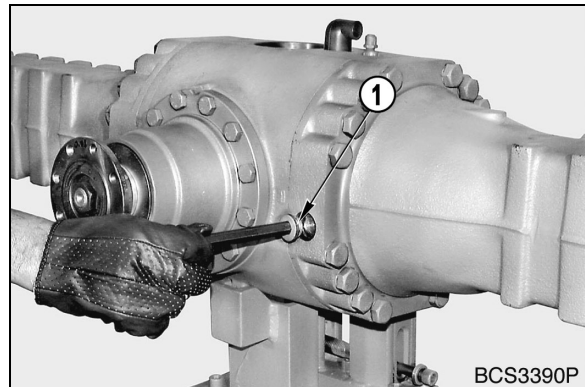


Figure 4

2. Apply the brakes and, keeping them under pressure, check the linings "S" between the disks using tool T1.

Minimum "S": 4.5 mm (0.18 in)

NOTE: *Replace the braking disks and the intermediate disks on both sides if necessary.*

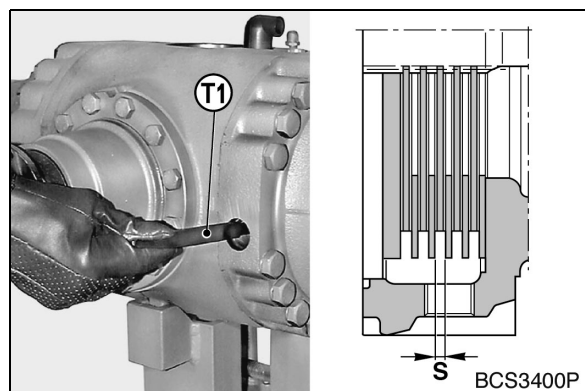


Figure 5

3. Unloose and remove the screws (3) and the washers (4) that fix the arm (2) to the central body (5).

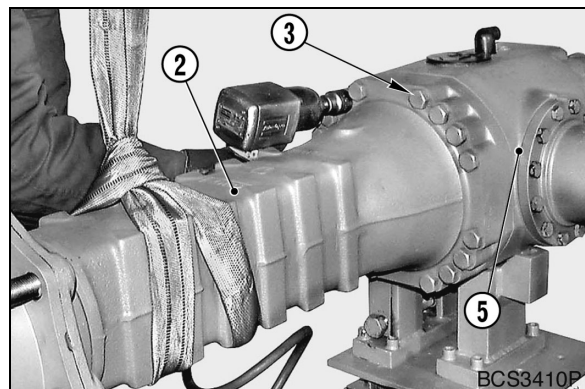


Figure 6

4. Remove the arm (2) together with the pack of the braking disks (6).
5. Place the arm on a bench.

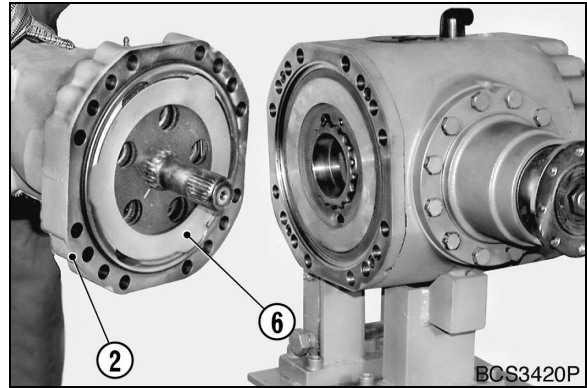


Figure 7

6. Remove the braking disks (6) and note down their order of assembly.

NOTE: 1) If the disks do not need replacing, avoid switching their position.
2) Extract the axle shaft (9).

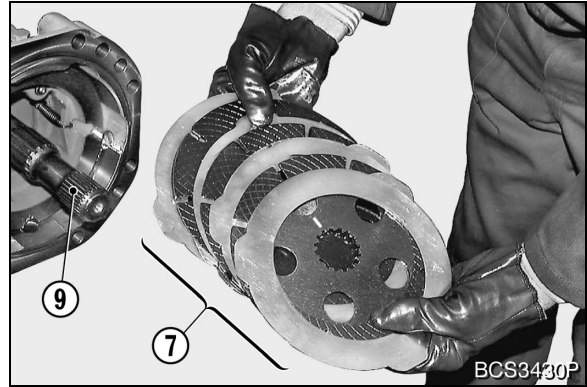


Figure 8

7. Remove the reversal springs (7) from the piston (8).

NOTE: If the springs (7) are weak or deformed they must be replaced.

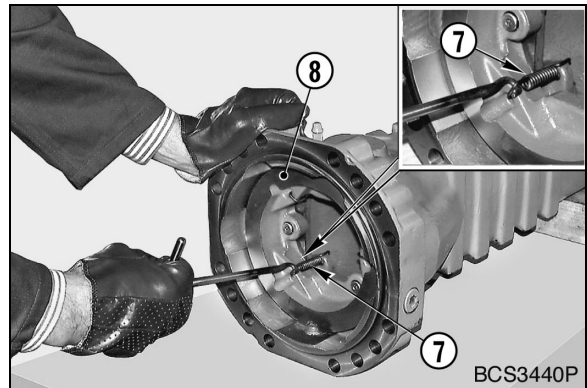


Figure 9

8. Remove the pin screws (10) guiding the piston (8).

NOTE: If the screws are to be replaced, note down the different colors for the different brake gaps. (See "Assembly of Brake Units" on page 15.)

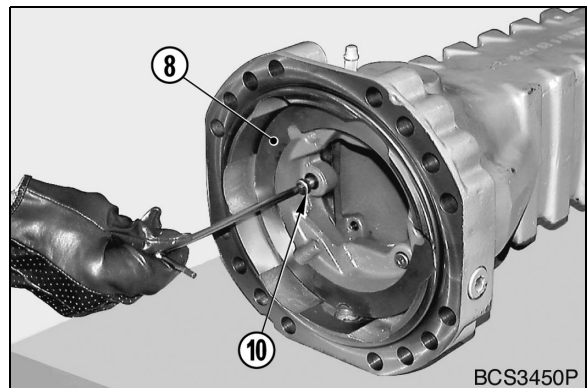


Figure 10

9. Slowly introduce compressed air through the connection of the braking circuit in order to extract the entire piston.

NOTE: *Hold on to the piston as it may be suddenly ejected and damaged.*

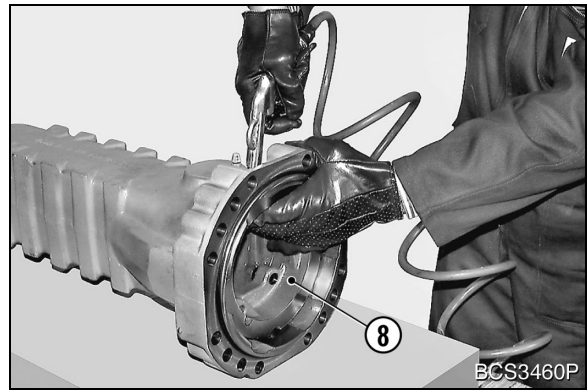


Figure 11

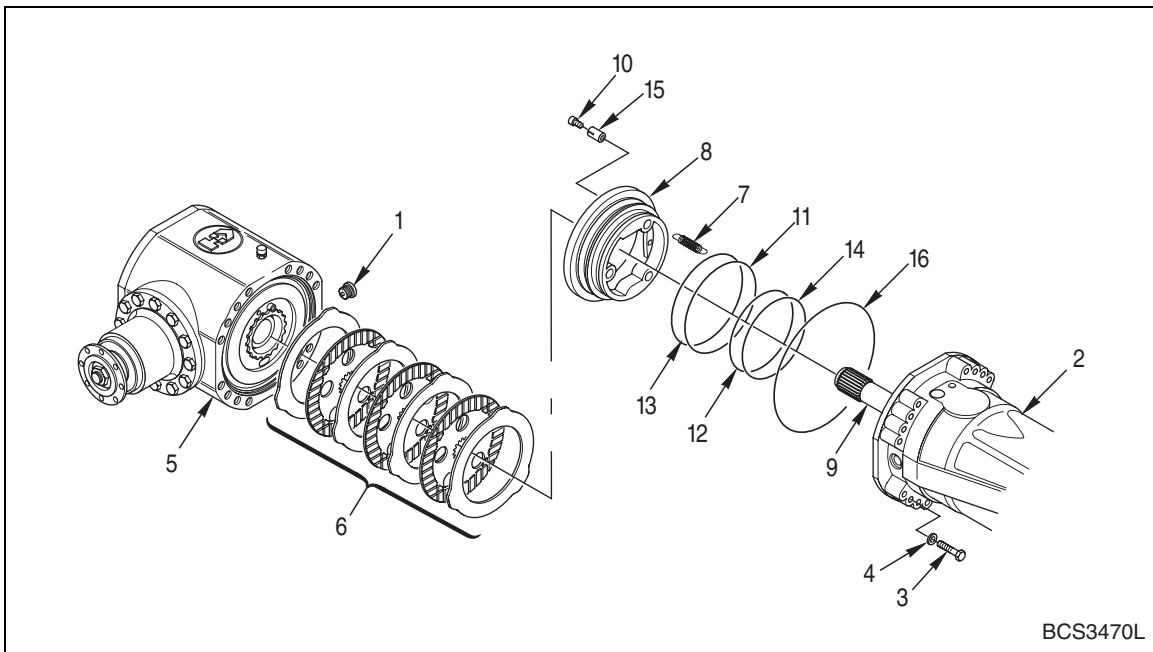


Figure 12

ASSEMBLY OF BRAKE UNITS

1. Accurately clean the piston (8) and the seats of slide and seal.
2. Replace the O-rings (11) and (12) and the anti-extrusion rings (13) and (14); make sure that the assembly side is correct.

NOTE: *Accurately check the positioning of the anti-extrusion rings (13) and (14).*

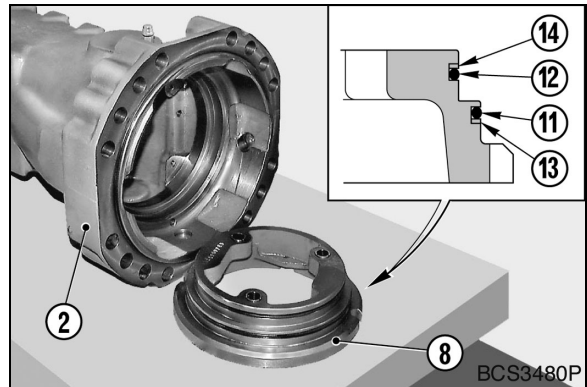


Figure 13

3. Insert the stroke automatic regulation springs (15); place them in line with the piston (8).

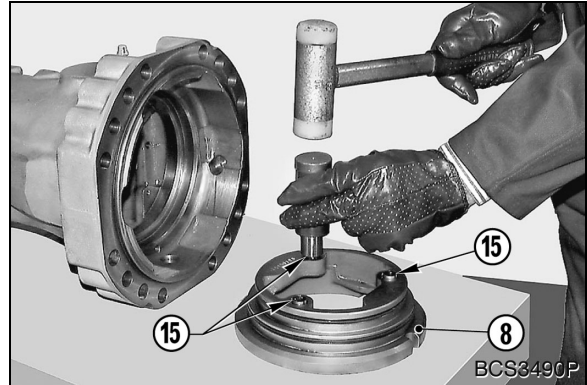


Figure 14

4. Lubricate the seals (11) and (12) and fit the piston (8) into the arm (2).

NOTE: *Make sure that the piston seat fits into the stop pin "A" inside the arm.*

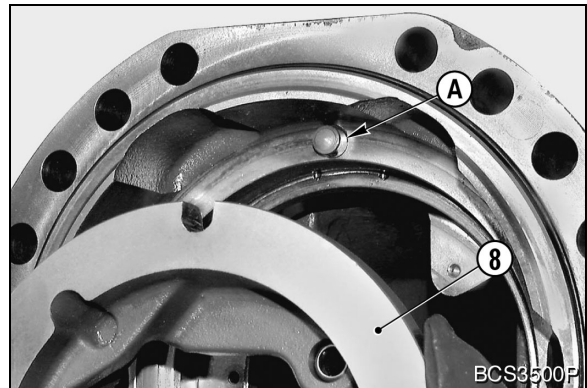


Figure 15

5. Assist the insertion of the piston (8) by lightly hammering around the edge with a plastic hammer.

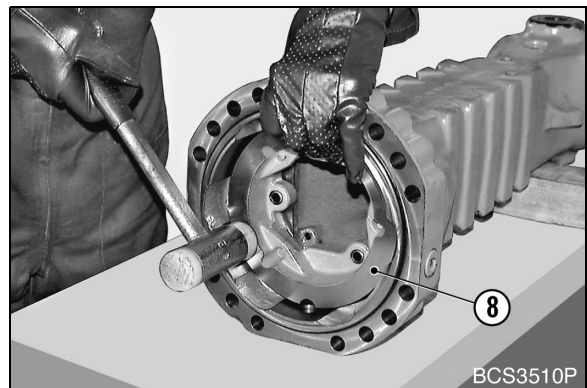


Figure 16

6. Fit the pin screws (10) making sure that they are all of the same color.

White: 1 mm (0.04 in) gap

Yellow: 0.75 mm (0.03 in) gap

Blue: 0.50 mm (0.02 in) gap

Apply Loctite 270 to the thread.

Torque wrench setting: 5-7 Nm (4-5 ft lb).

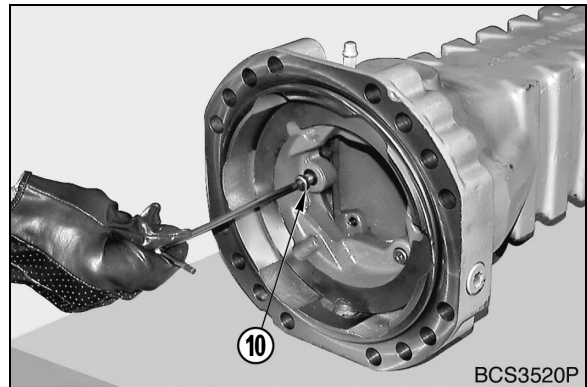


Figure 17

7. Fit the reversal springs (7) on the piston (8).

NOTE: Pay due attention not to deform the connections of the springs.

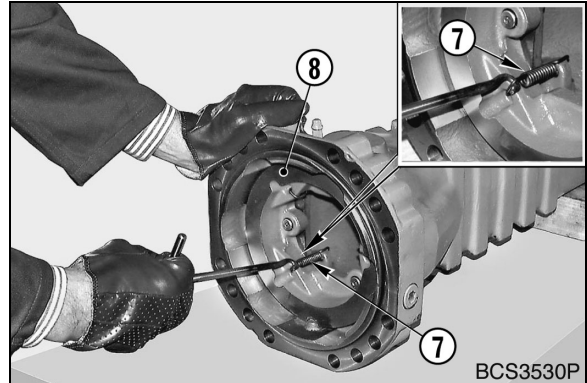


Figure 18

8. Slightly lubricate the braking disks (6) and fit them in the arm following the correct sequence; orient them so that the oil circulation holes and the marks "B" are perfectly lined up.

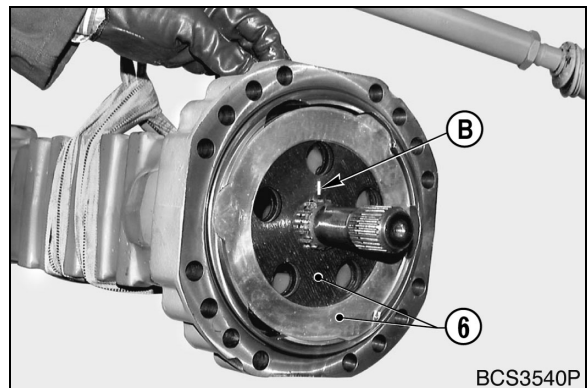


Figure 19

9. Check that the positioning of the sealing ring (16) on the arm is intact; install the complete arm (2). Lock it into position using two facing screws (3) and washers (4).

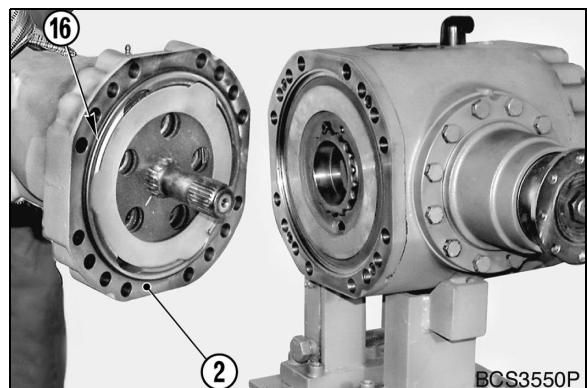


Figure 20

10. Check the flatness of the arms using tool T2 and finally lock the arms with the screws (3) and the washer (4) using the cross-tightening method.

Torque wrench setting: 298 Nm (220 ft lb).

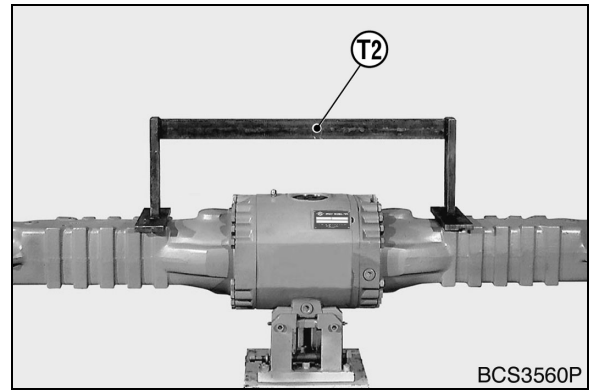


Figure 21

PLANETARY REDUCTION AND AXLE SHAFT

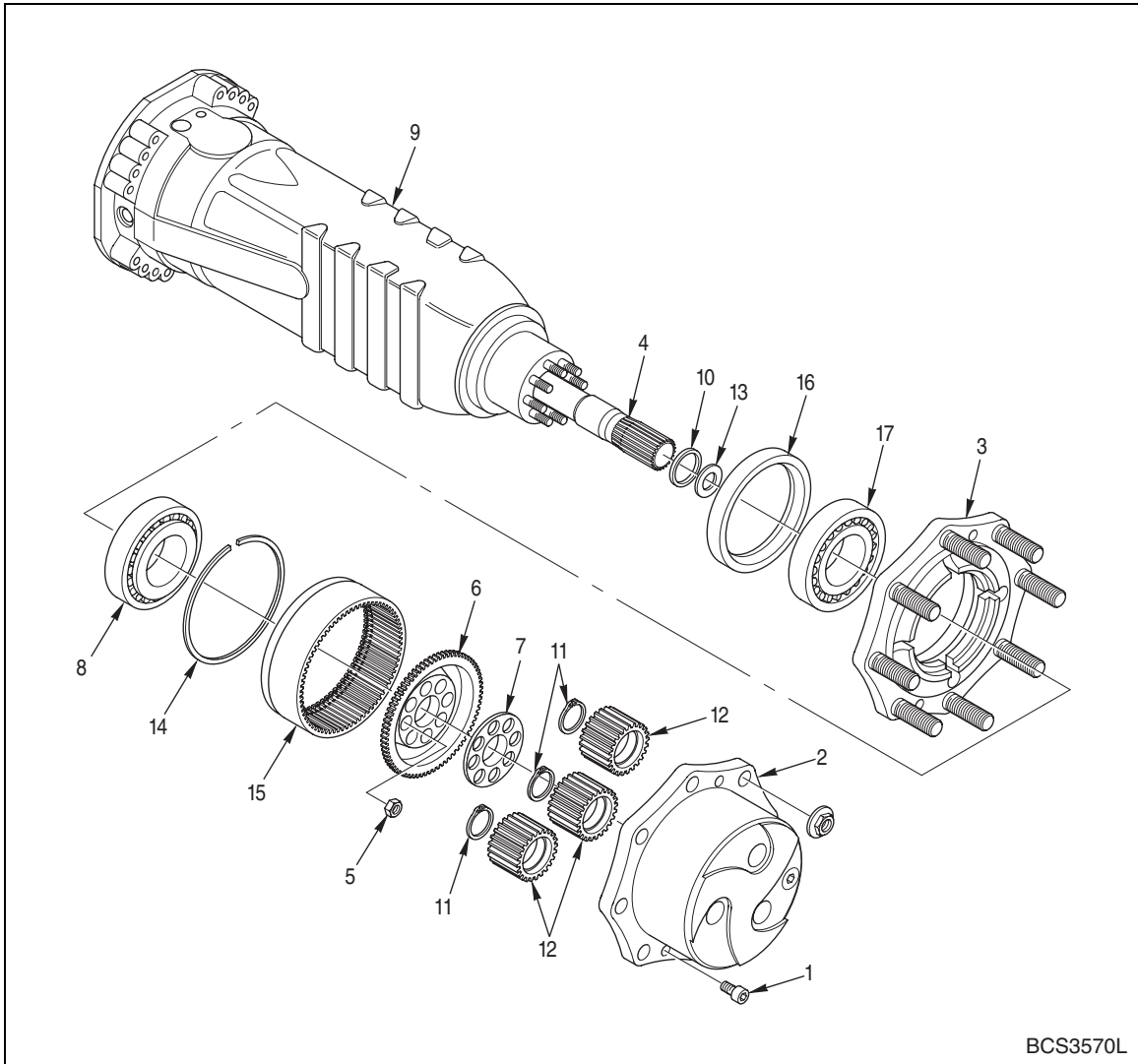
NOTES ON SAFETY PRECAUTIONS

The axle shafts can only be removed after extraction has been performed. Different procedures need to be followed depending on the kind of repair operation needed and the type of axle:

1. Axle without parking brakes: compressed air (7 bar approx.) should be introduced in the braking circuit in order to hold the braking disks in position.
2. Axle with negative brake: does not require any preparation as the disks are mechanically locked in position.
3. Axle with mechanical brake: requires that the external control levers are put under tension in relation to each other.
4. Disassembly to be carried out with the arm resting on the bench.

The explanations reported herewith refer to removal operations carried out on the bench; the different stages of axle shaft removal also apply to all other solutions or versions.

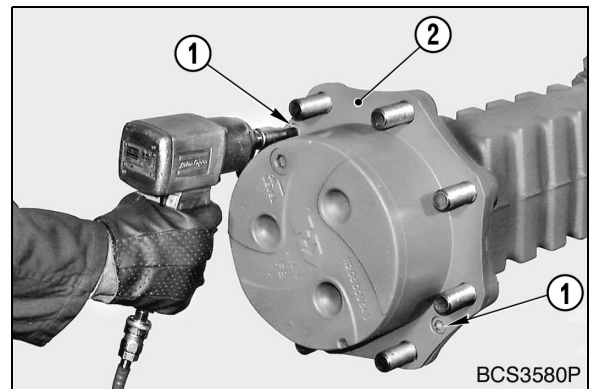
DISASSEMBLY



BCS3570L

Figure 22

1. Remove the securing screws (1) from the spider cover (2).



BCS3580P

Figure 23

2. Disjoin the spider cover (2) from the hub (3) by alternatively forcing a screwdriver into the appropriate slots.

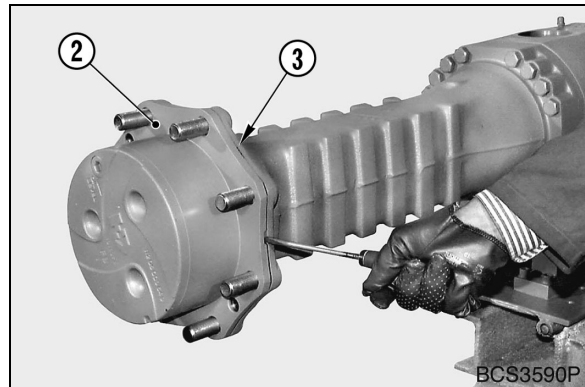


Figure 24

3. Remove the complete planetary carrier cover (2).

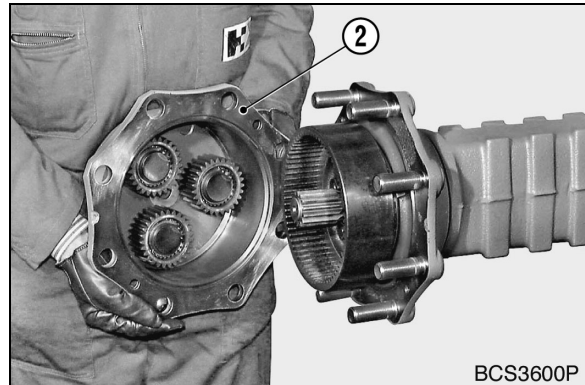


Figure 25

4. Remove the complete axle-shaft (4).

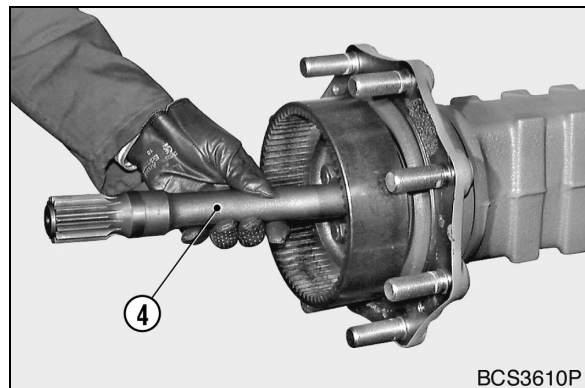


Figure 26

5. Unloose and remove the tightening nuts (5) from the crown flange (6).

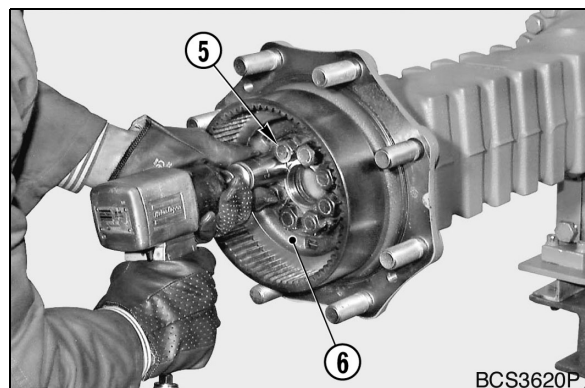


Figure 27

6. Remove the safety flange (7).

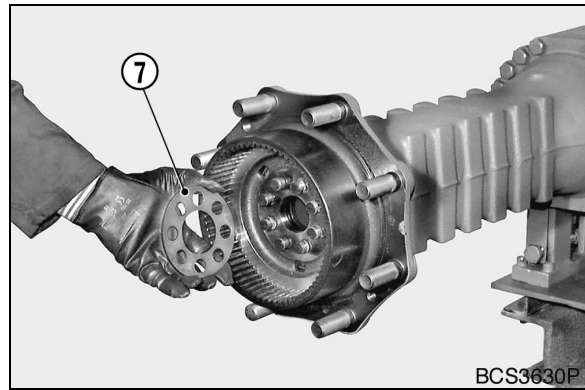


Figure 28

7. Using a puller, remove the complete crown flange (6) by acting on the stud bolts.

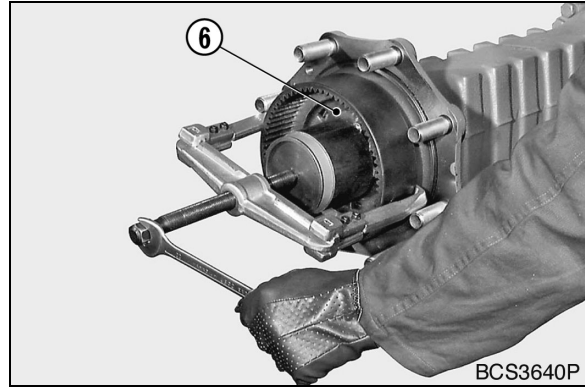


Figure 29

8. Partially extract the hub (3) using a plastic hammer.

NOTE: *Alternately hammer on several equidistant points.*

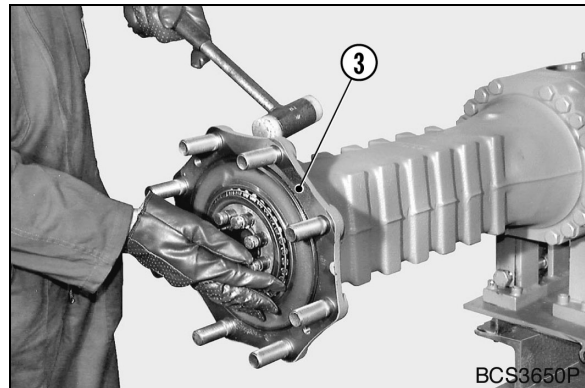


Figure 30

9. Remove the external bearing (8).

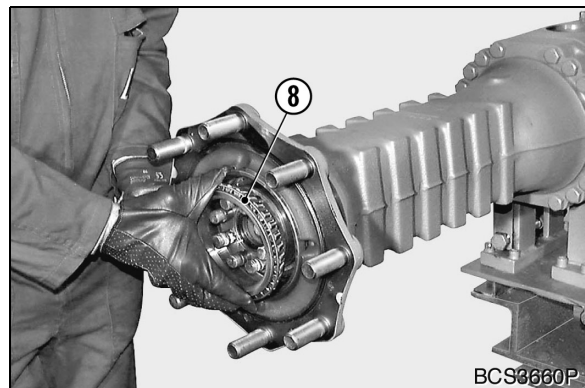


Figure 31

10. Extract the hub (3).

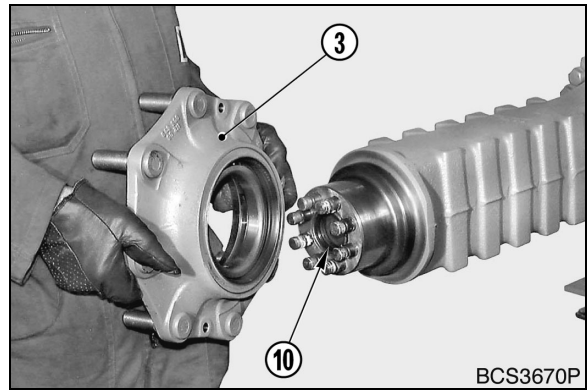


Figure 32

11. Remove snap ring (10) from the arm (9).

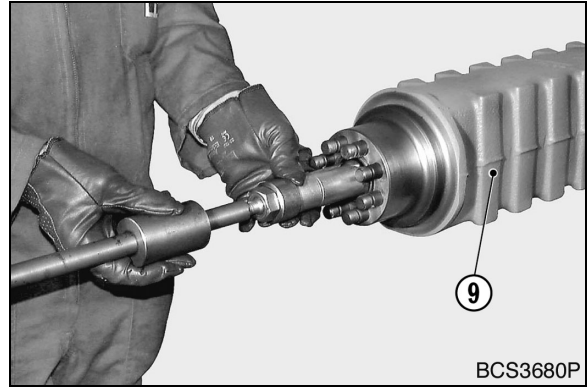


Figure 33

12. Remove the snap rings (11).

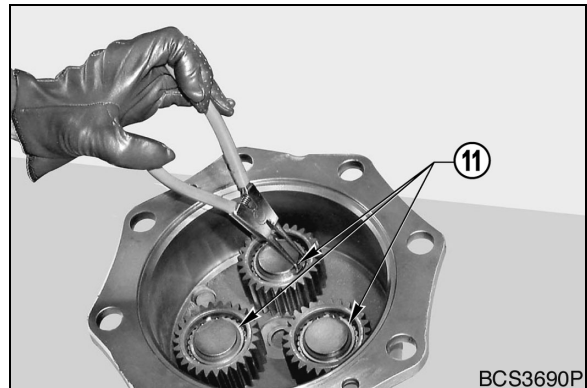


Figure 34

13. With the help of a puller, remove the planet wheel gears (12).

NOTE: *Note down the assembly side of planet wheels.*

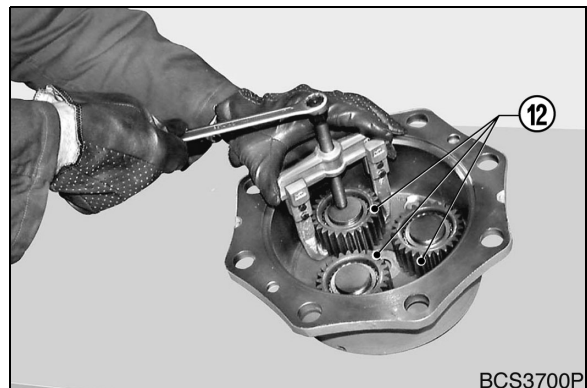


Figure 35

14. Using a puller for inner parts, remove shim washer (13) from planetary cover (2).

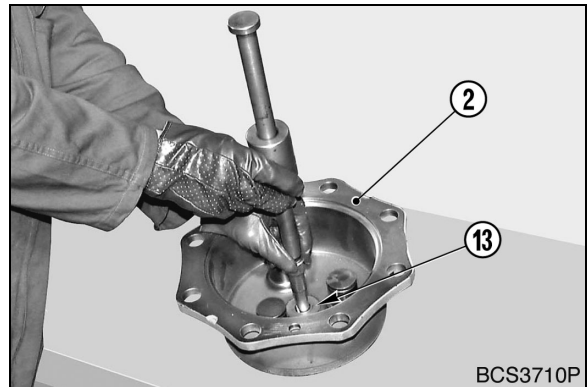


Figure 36

15. Remove the snap ring (14) from the crown (15).

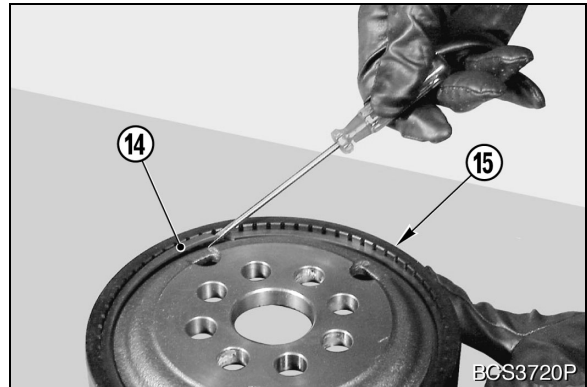


Figure 37

16. Remove the crown flange (6).

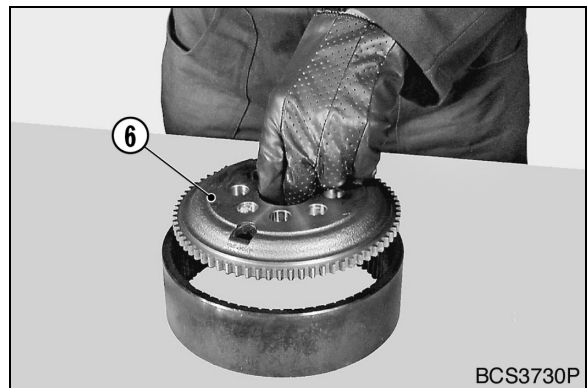


Figure 38

17. Remove the sealing ring (16) from the hub (3).



Figure 39

18. Remove the internal bearing (15).

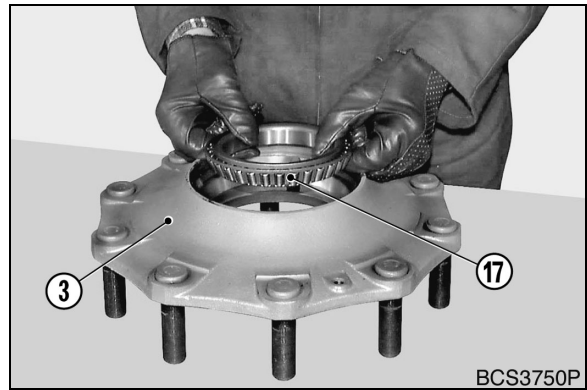


Figure 40

19. Remove the external thrust blocks from the bearings (8) and (17) forcing a pin-driver into the appropriate slots on the hub (3).

NOTE: *Hammer in an alternate way so as to avoid crawling or deformation of the thrust blocks.*

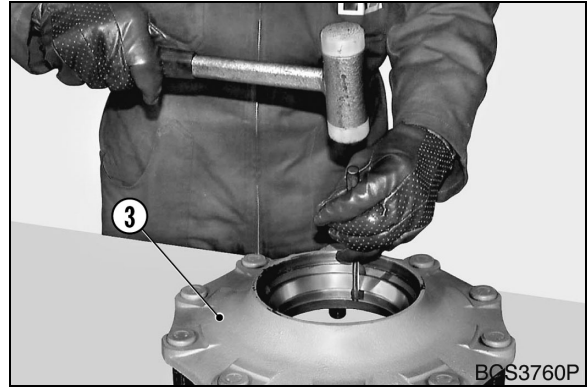


Figure 41

ASSEMBLY

1. Position the lower part of tool **T9A** and the thrust block of the external bearing (8) under the press.



Figure 42

2. Lubricate the seats of the bearings and position the hub (3) on tool **T9A**; position the thrust block of the internal bearing (17).

NOTE: *Check that the thrust block is correctly oriented.*

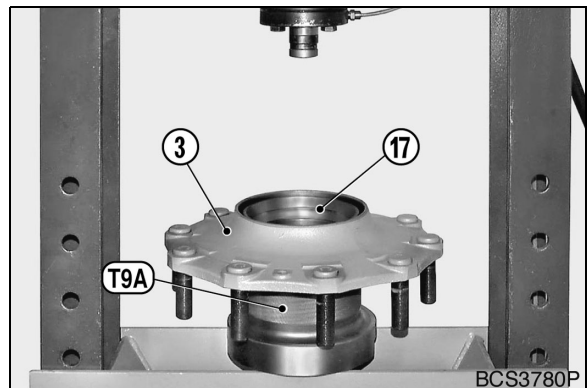


Figure 43

3. Position the upper part of tool **T9B** and press the thrust blocks into the hub (3) all the way down.

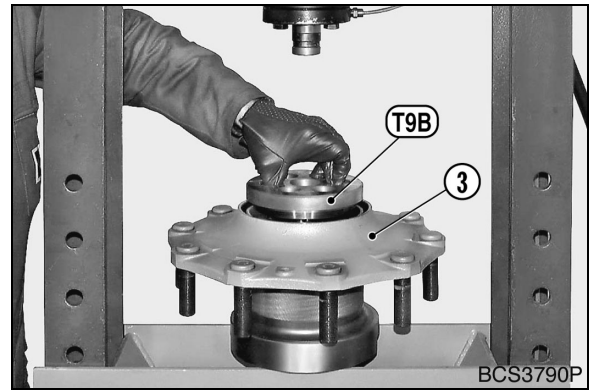


Figure 44

4. Fit the bearing (15) into the internal thrust block.

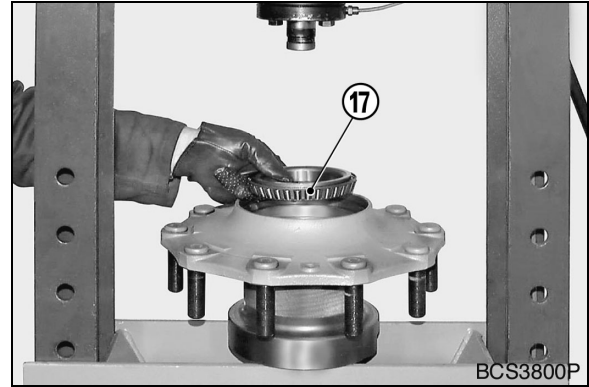


Figure 45

5. Apply a sealant for removable seals to the outer surface of the sealing ring (16). Position the sealing ring (16) in the hub (3).

NOTE: Check that the ring (16) is correctly oriented.

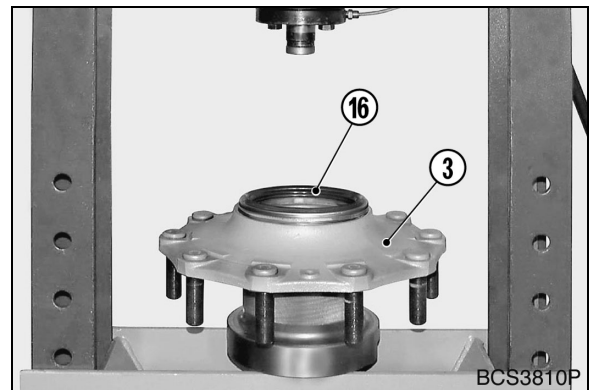


Figure 46

6. Position tool **T10** and press the sealing ring (16) into its seat.

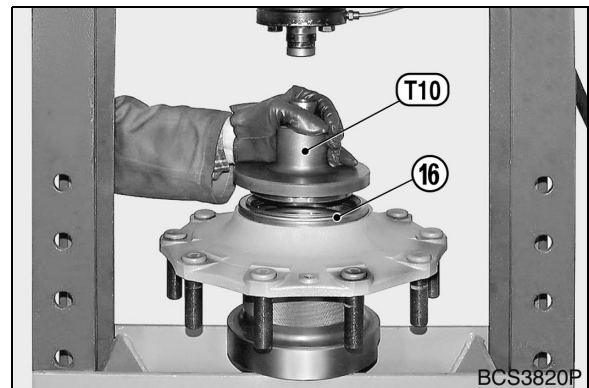


Figure 47

7. Insert the flange (6) in the crown (15).

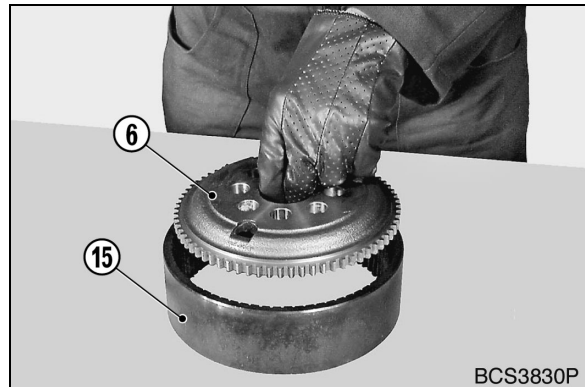


Figure 48

8. Insert the snap ring (14) in order to fix the flange (6) in the crown (15).

NOTE: Carefully check that ring (14) is properly inserted in the slot of the crown (15).

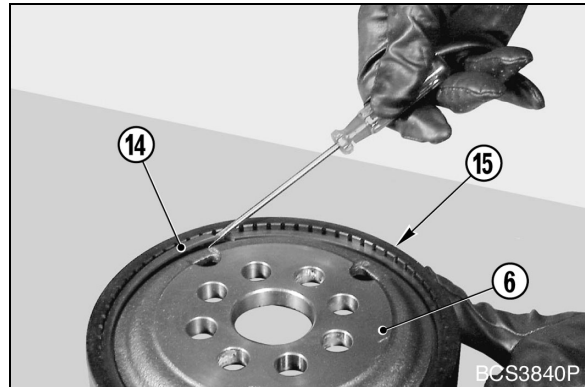


Figure 49

9. Using tool **T33**, fit shim washer (13) into planetary cover (2).

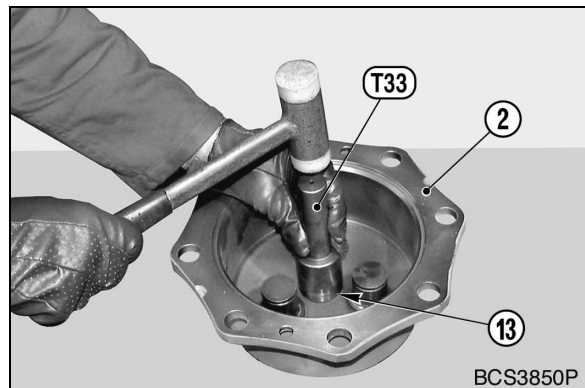


Figure 50

10. With the help of tool **T11**, insert the planet wheel gears (12) into the cover (2).
11. Accurately check the orientation.

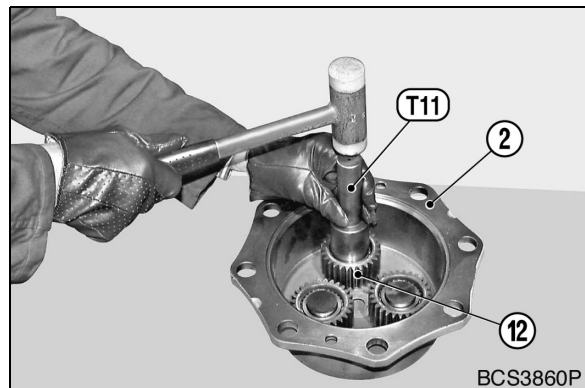


Figure 51

12. Lock the gears (12) into position by fitting the snap rings (11).

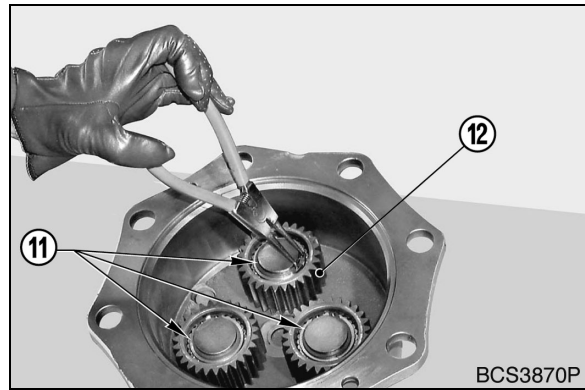


Figure 52

13. Lubricate the outer face of the sealing ring (10) and, with the help of tool **T34**, fit it in the arm.

NOTE: *Accurately check direction of assembly.*

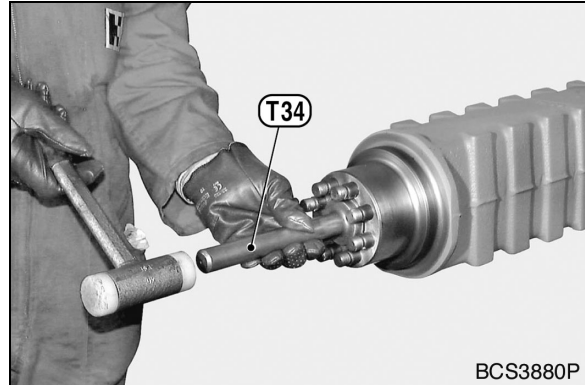


Figure 53

14. Lubricate with grease the sealing ring (16) and the hub of the arm (9).
15. Install the hub (3).

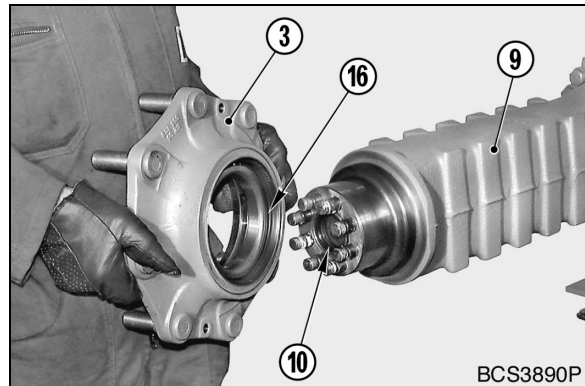


Figure 54

16. Install the external bearing (8).

NOTE: *Using a plastic hammer, drive the bearing to the limit stop by lightly hammering around the edge.*

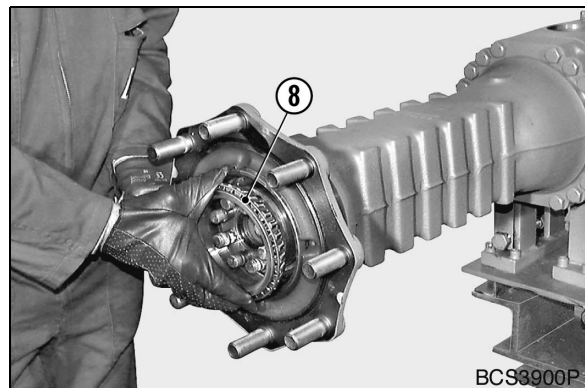


Figure 55

17. Fit the complete crown flange (6).

NOTE: *In order to fasten the flange (6), use a plastic hammer and alternately hammer on several equidistant points.*

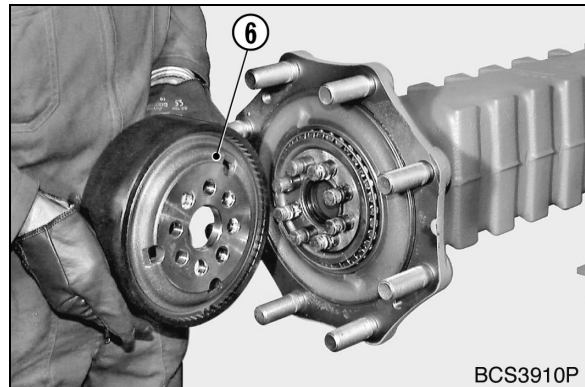


Figure 56

18. Apply Tecnolube Seal 101 grease to the surface of the safety flange (7) which touches the crown flange (6).
19. Fit the safety flange (7).

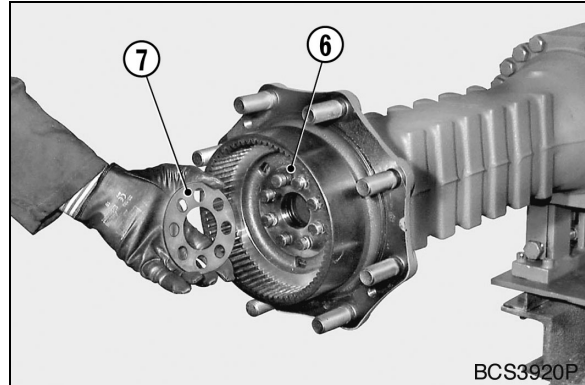


Figure 57

20. Apply Loctite 242 to the studs and fit in the nuts (5).

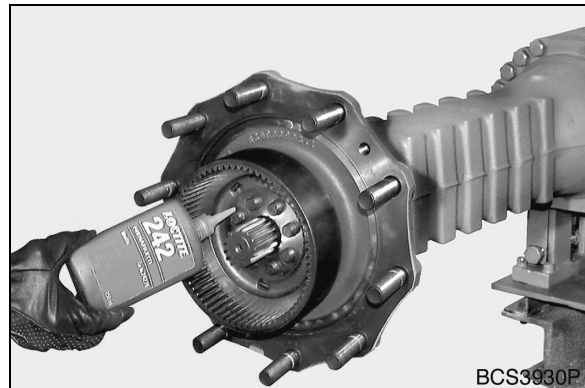


Figure 58

21. Cross tighten the nuts (5) in two stages.

Initial torque wrench setting: 130 Nm (96 ft lb)

Final torque wrench setting: 255-285 Nm (188-210 ft lb)

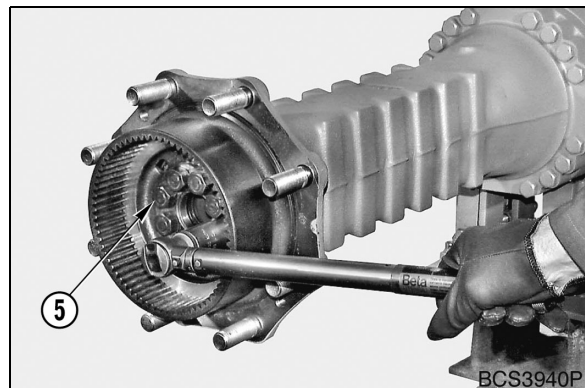


Figure 59

22. Grease snap ring (10) and sealing face of axle-shaft (4).
23. Install the axle shaft (4) making sure it is properly engaged in the braking disks and in the differential unit.

NOTE: *Be very careful not to damage the snap ring (10).*

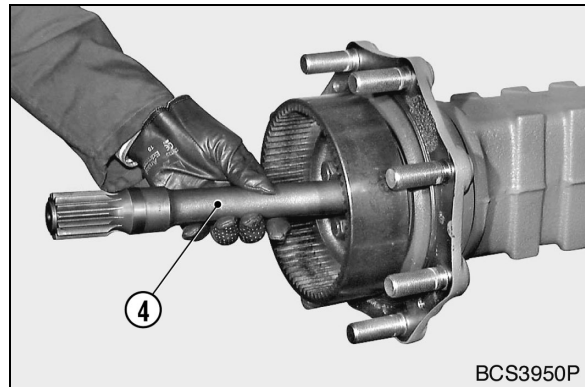


Figure 60

24. Fit the planetary carrier cover (2) onto the hub (3).

NOTE: *Check that the O-ring (18) is in good condition and in position.*

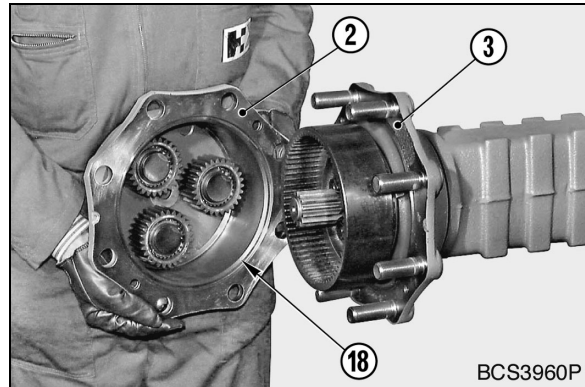


Figure 61

25. Lock the planetary carrier cover (2) by tightening the screws (1).

Torque wrench setting for screws: 40-50 Nm (30-37 ft lb)

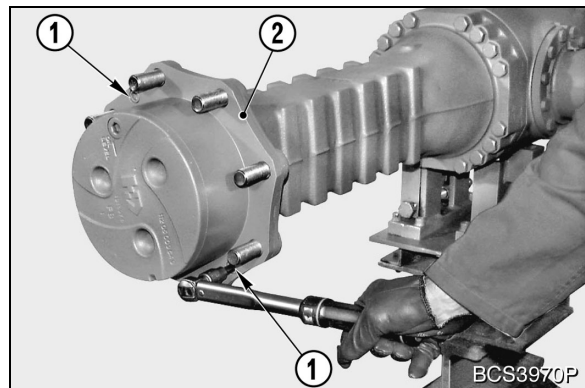


Figure 62

BEVEL PINION

REMOVAL

NOTE: Though the photos in this manual refer to a steering and oscillating axle, the operations described apply anyway.

1. Remove the complete arms and the differential unit.

NOTE: For details, see "Checking Wear and Replacing Brake Disks" on page 12.

2. If disassembly is awkward, heat the check nut (1) of the flange (2) at 80° C (176° F).

NOTE: Heating is meant to unloose the setting of Loctite on the nut (1).

3. Position tool **T20A** (or **T20B**), so as to avoid pinion rotation.
4. Unloose and remove the nut (1); also remove the O-ring (3).

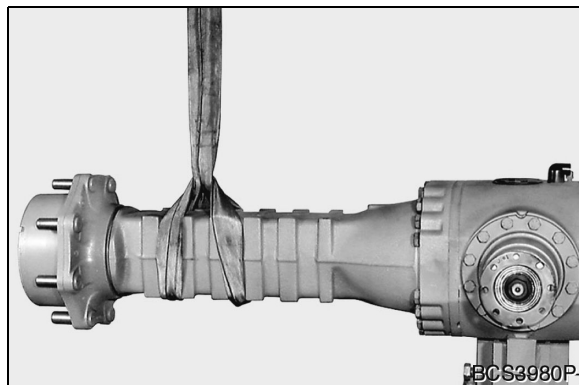


Figure 63

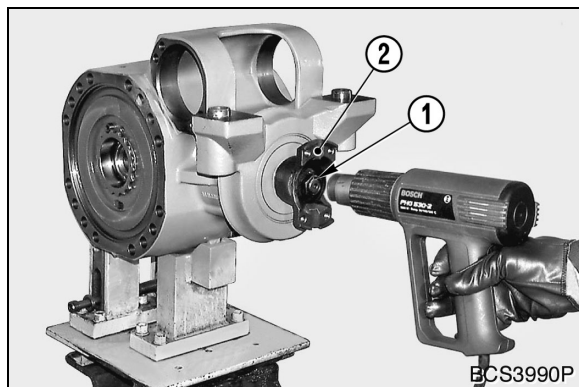


Figure 64

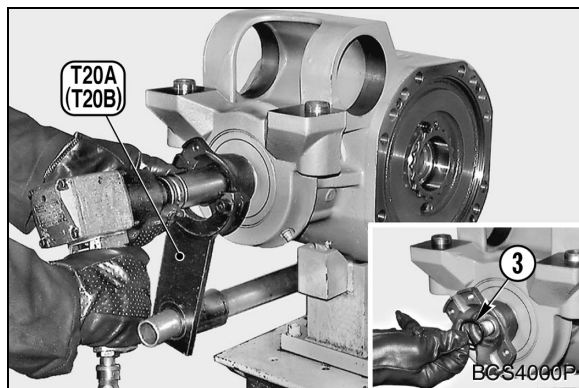


Figure 65

5. Remove the flange (2) complete with guard (4) by means of a puller.

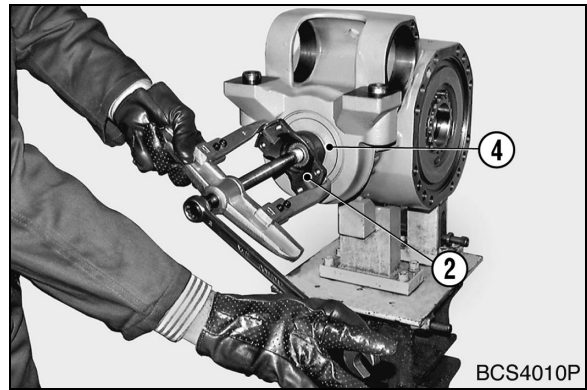


Figure 66

NOTE: *This operation does not apply to the fixed axle.*

6. Remove the swinging support (5).

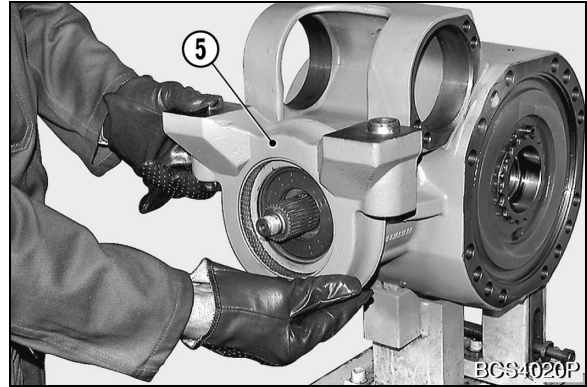


Figure 67

7. Remove the sealing ring (6).



Figure 68

8. Position wrench **T22** onto the ring nut (7) and apply bar hold T21 to the pinion (8).
9. Stop wrench **T22** and rotate the pinion so as to release and remove the ring nut (7).

NOTE: *If disassembly proves awkward, weld the ring nut at approx. 80° C (176° F).*

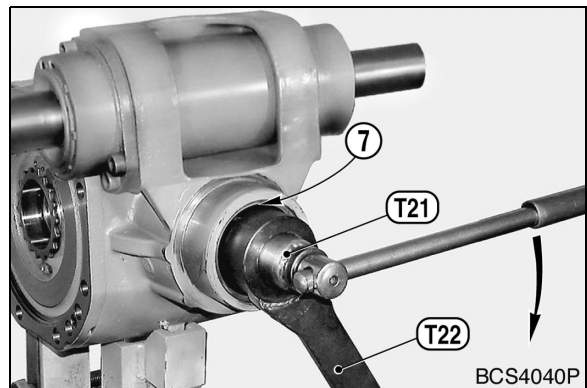


Figure 69

10. Apply blocks **T23** and, with the help of a puller, extract the pinion (8) complete with the internal bearing (9), the distance piece (10) and shims (11).

NOTE: *The thrust blocks of the bearings remain in the central body (12).*

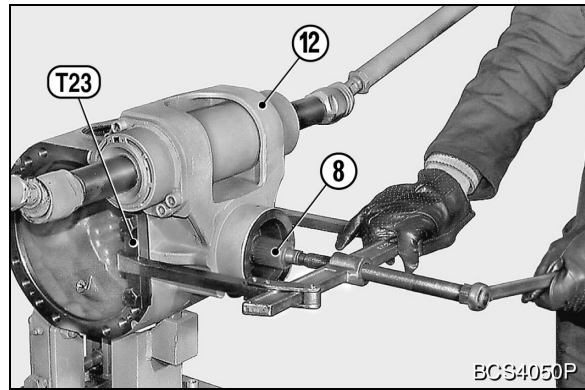


Figure 70

11. Remove the pinion (8), shims (11) and distance piece (10).

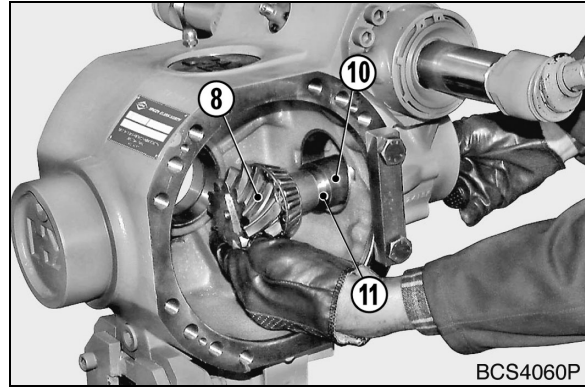


Figure 71

12. Using a puller and a press, remove the inner bearing (9) from the pinion (8).

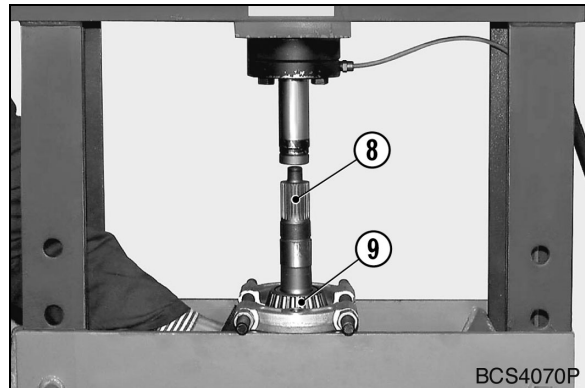


Figure 72

13. Remove the thrust block of the external bearing (13).

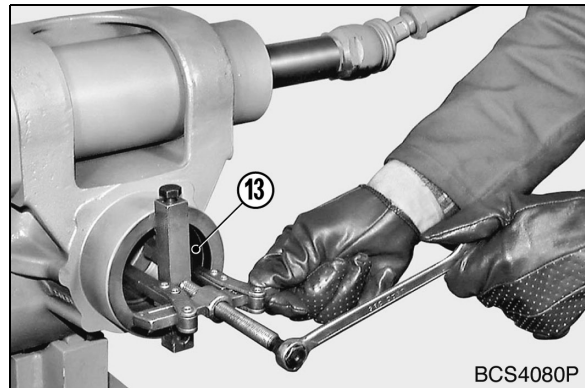


Figure 73

14. Insert a drift in the appropriate holes and remove the thrust block of the internal bearing (9) as well as the shim washers (14).

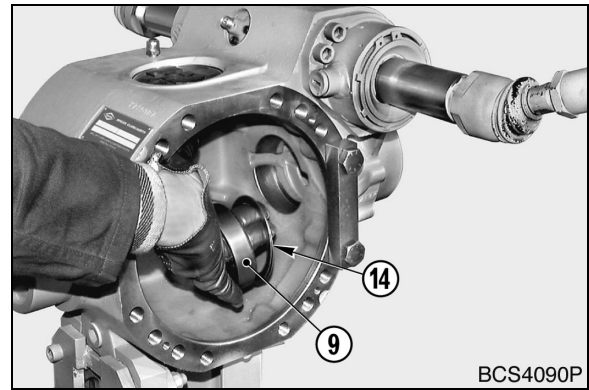


Figure 74

15. Unloose and remove the screws (15) locking the support (16); remove the whole support.

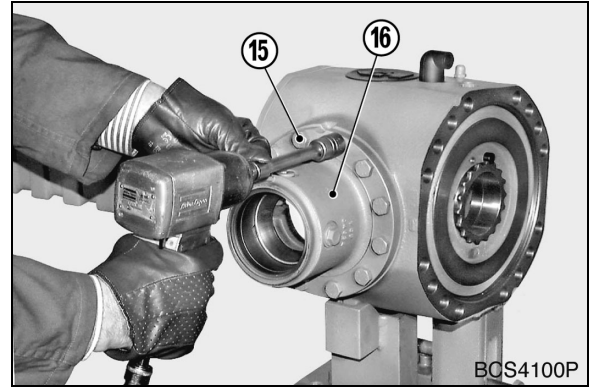


Figure 75

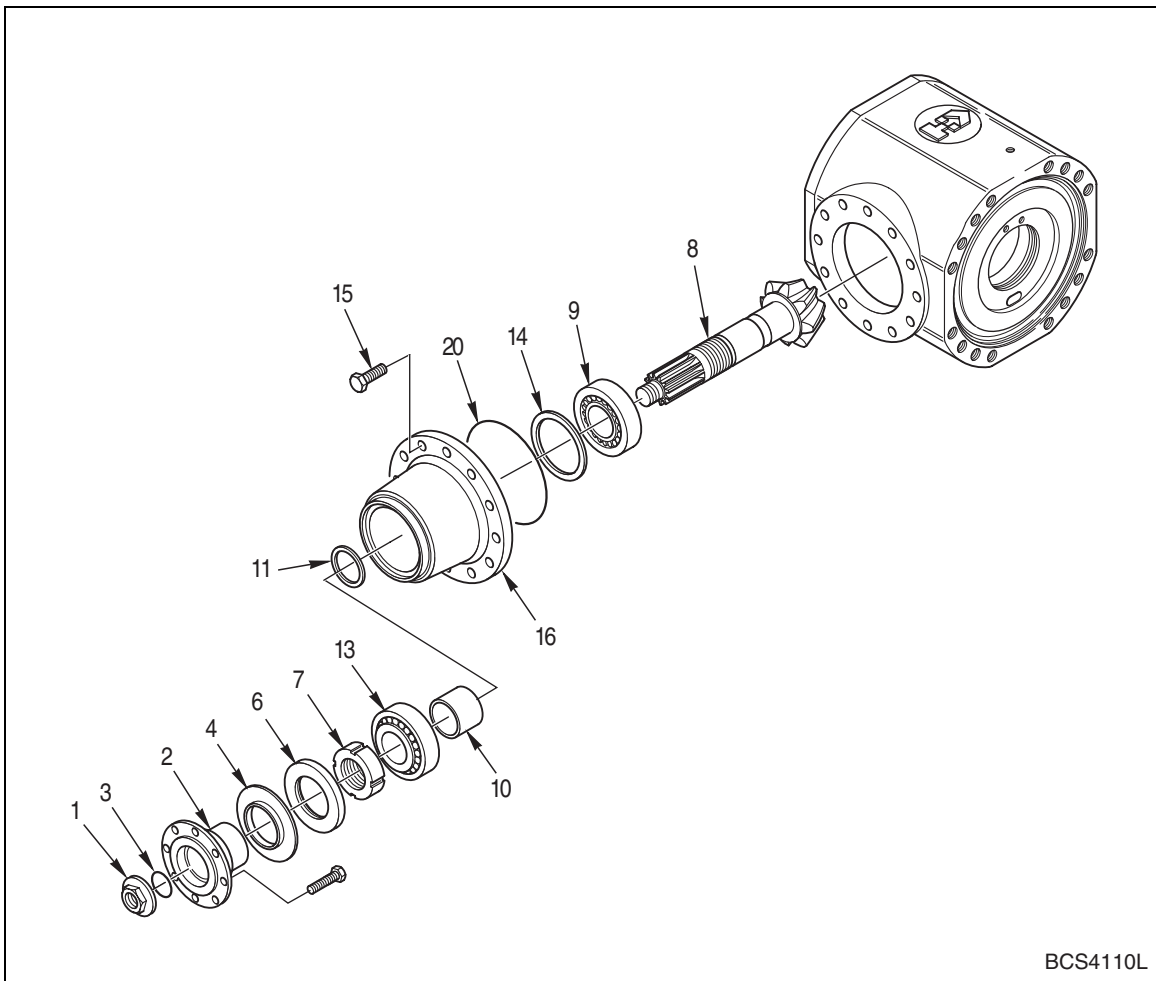


Figure 76

ADJUSTING AND INSTALLATION

1. Fit support (16), including O-ring (20), onto the intermediate body.

NOTE: 1) *The cavity located on the outer diameter must face upwards.*

2) *Check and lubricate the O-ring (20).*

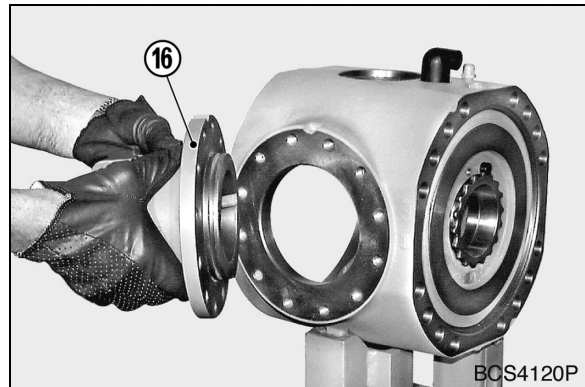


Figure 77 ONLY IF HAS BEEN REMOVED

2. Fasten support with screws (15) previously coated with Loctite 270.
3. Tighten using the criss-cross method to a tightening torque of 90-100 Nm (66-74 ft lb)

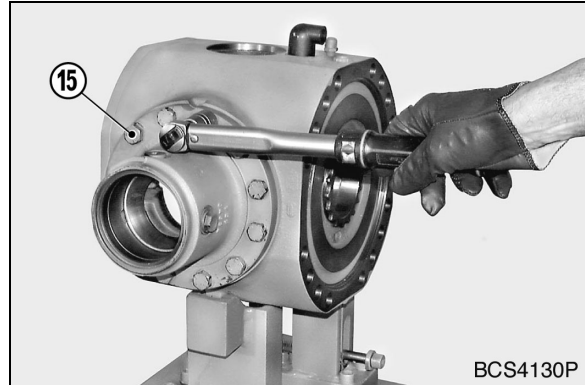


Figure 78

4. Using a surface plate, reset a centesimal comparator "DG" and place it on the measurement ring T24 (with a thickness of 30.2 mm).
5. Preset the comparator to approx. 2 mm (0.08 in).

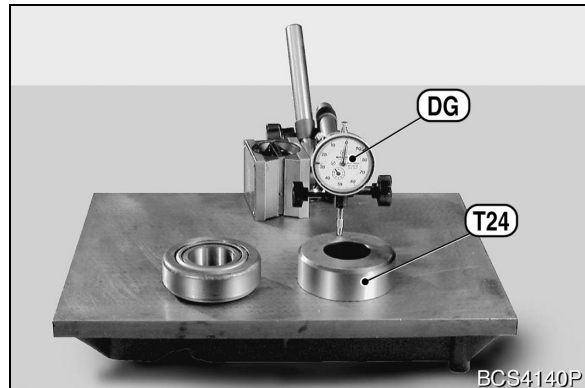


Figure 79

6. Bring the internal bearing (9), complete with its thrust block, under the comparator "DG".
7. Determine overall thickness "D" of the bearing checking the discrepancy between this size and the size of the measurement ring.

NOTE: *Press the thrust block in the centre and take several measurements while rotating the thrust block.*

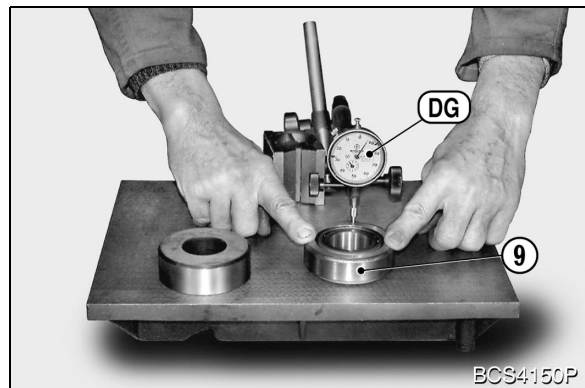


Figure 80

8. Partially insert the thrust block of the external bearing (13).

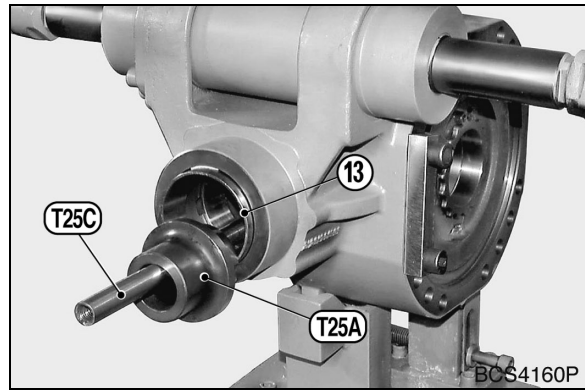


Figure 81

9. Install tension rod **T25C**, measurement ring **T24** and front guide tool **T25A** on the thrust block of the external bearing (13).

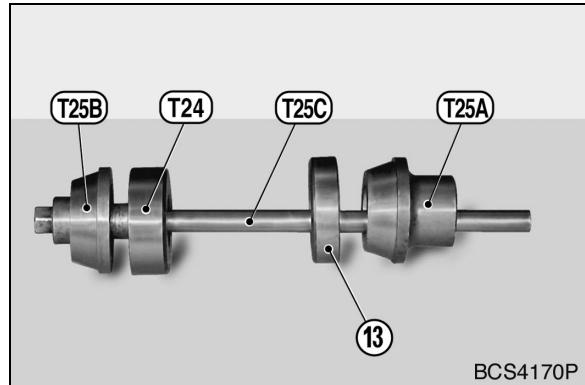


Figure 82

10. Connect the tension rod to the press and move the thrust block of the external bearing (13) into its seat.
11. Disconnect the press and remove the tension rod.

NOTE: *Before starting the next stage, make sure that the thrust block has been completely inserted into its seat.*

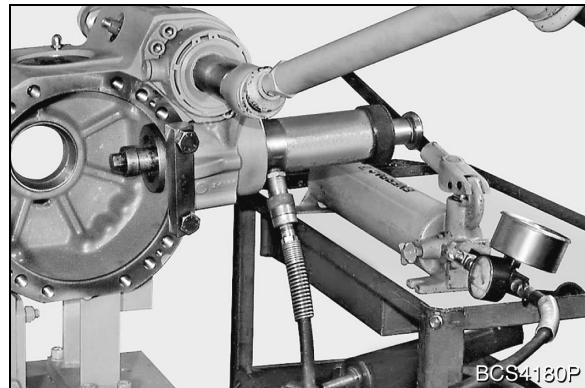


Figure 83

12. Insert tool **T26B** complete with external bearing (13), measurement ring **T24** and gauged ring nut **T26C**.
13. Manually tighten.

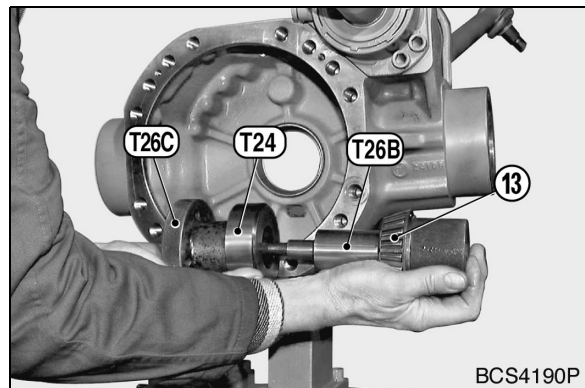


Figure 84

14. Fit a centesimal comparator "DG1" with long stem into bar **T26A**; when the bar rests on two size- blocks "GB" of 57 mm (2.24 in).
15. Reset the comparator.
16. Preset the comparator to approx. 2 mm (0.08 in) and reset.

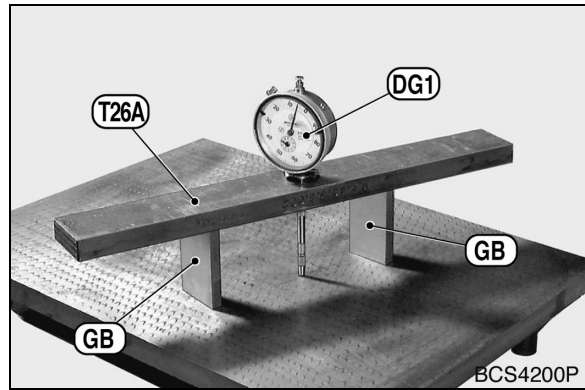


Figure 85

17. Lay bar **T26A** on gauged nut **T26C** and take the size "A" at about 57 mm (2.24 in) corresponding to the maximum diameter of arms centring.

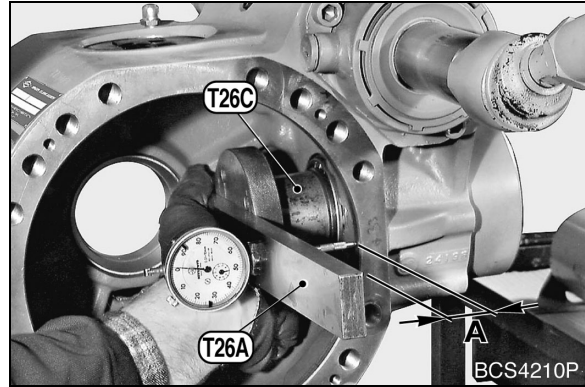


Figure 86

18. Calculate size "B" which will be the first useful value for calculating the size of the shims (14) that are to be inserted under the thrust block of the internal bearing (9).

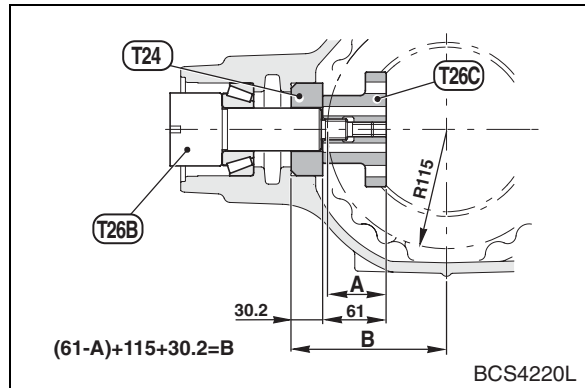


Figure 87

19. Check the nominal size (X) marked on the pinion and add or subtract the indicated variation (Y) so as to obtain size "Z".

e.g.: $Z = 118 + 0.1 = 118.1$
 $Z = 118 - 0.2 = 117.8$

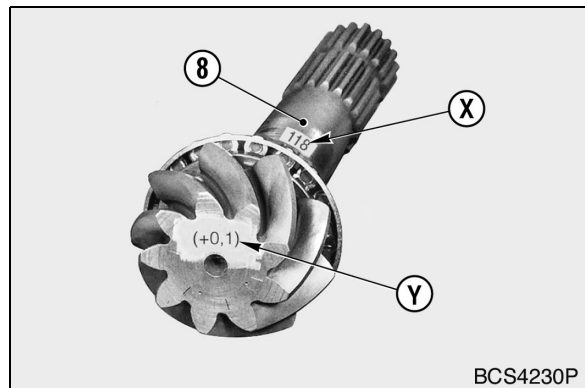


Figure 88

20. Calculate size "**C**" which represents the second value for calculating the size of the shims "**S**" that are to be placed under the thrust block of the internal bearing (9).

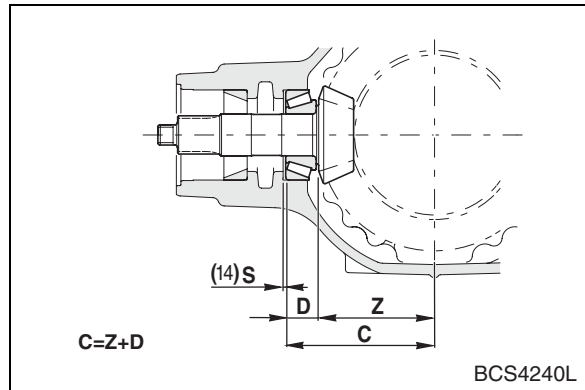


Figure 89

21. Calculate the difference between sizes "**B**" and "**C**" so as to obtain the size "**S**" of the shim (14) that will go under the thrust block of the internal bearing (9).

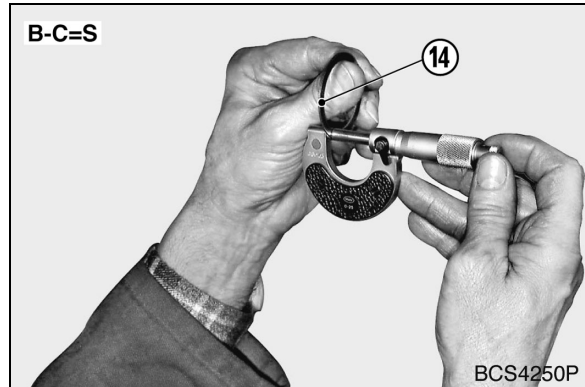


Figure 90

22. Insert shim "**S**" (14) and the thrust block of the internal bearing (9) in the central body.

NOTE: To hold shim "**S**" (14) in position, apply grease.

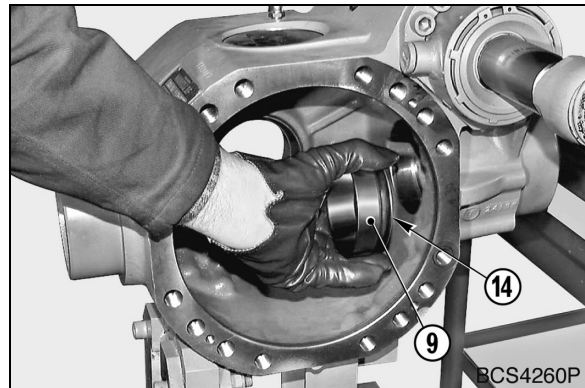


Figure 91

23. Position tool **T25A** and tension rod **T25C**.
24. Connect the tension rod to the press, fasten the thrust block and then remove the tools.

NOTE: Before going on to the next stage, make sure that the thrust block has been completely inserted.

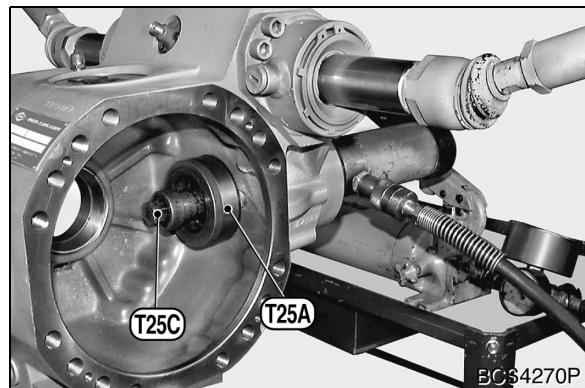


Figure 92

25. Position tools **T26C** and **T26B** complete with tapered bearings (9) and (13); manually tighten until a rolling torque has been obtained.

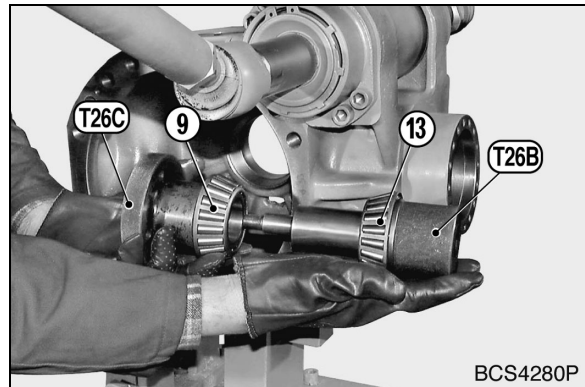


Figure 93

26. Insert the stem of a depth comparator "DDG" in either side hole of tool **T26C**; reset the comparator with a presetting of approx. 3 mm (0.12 in).

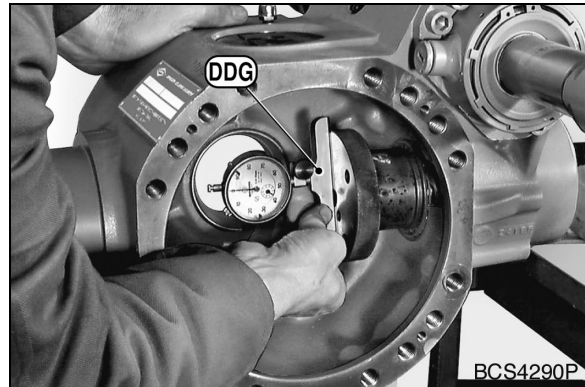


Figure 94

27. Remove the comparator and release tools and bearings from the central body.
28. Re-install all and insert the distance piece (10) between bearings (9) and (13); manually tighten the whole pack.

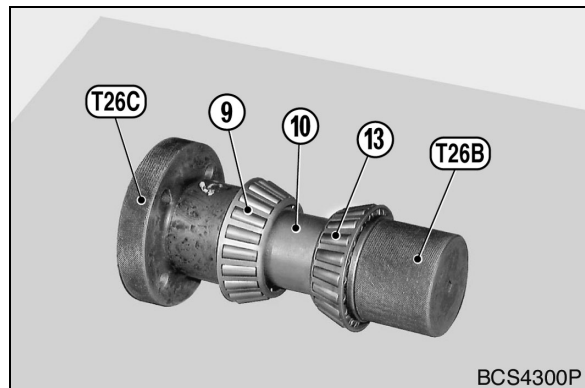


Figure 95

29. Insert depth comparator "DDG" into tool **T26B-T26C** and measure variation "H" in relation to the zero setting performed back at point d.

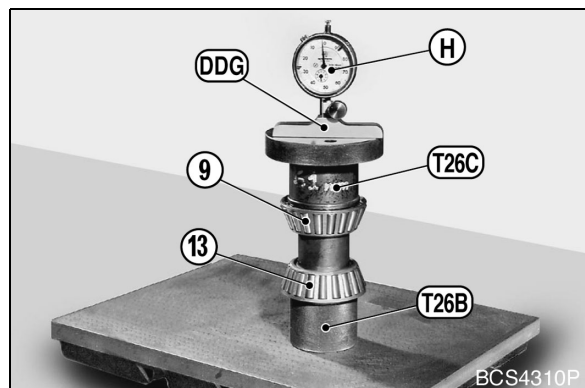


Figure 96

30. The variation is to be added to a set value of 0.12-0.13 mm (0.01 in), so as to obtain the size of shim "S1" (11) which will be inserted between the external bearing (13) and the distance piece (10) and subsequently, to determine the preload for the bearings.

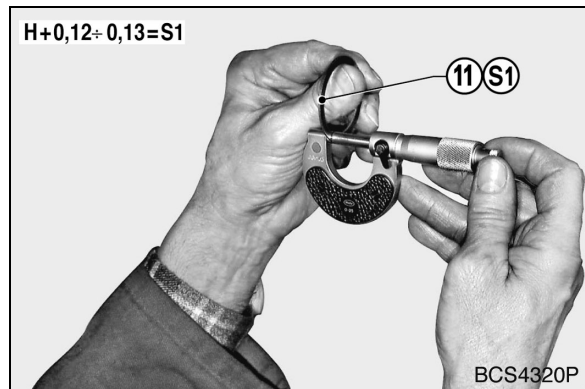


Figure 97

31. Position the internal bearing (9) and the pinion (8) under a press; force the bearing onto the pinion.

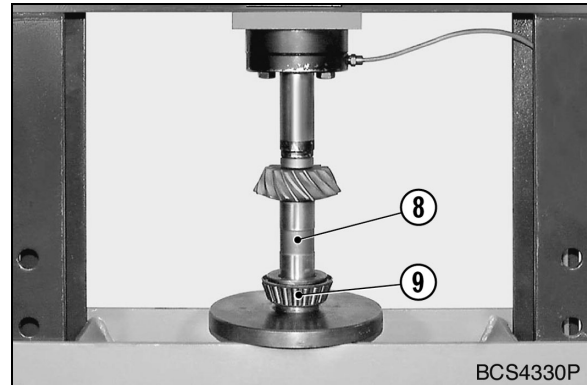


Figure 98

32. Fit the pinion (8), shim "S1" (11) and distance piece (10) in the main body (12).

NOTE: *The finer shims must be placed in-between the thicker ones*

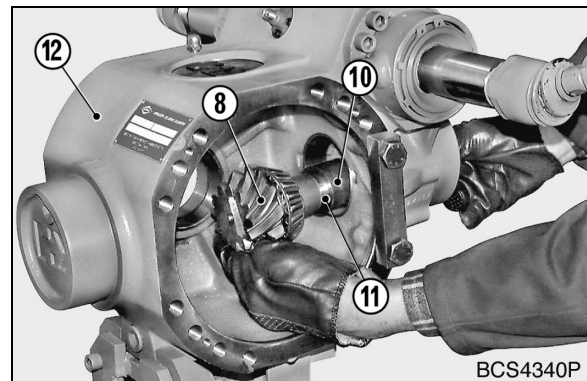


Figure 99

33. Insert the external bearing (13) in the central body in order to complete the pack arranged as in the figure.

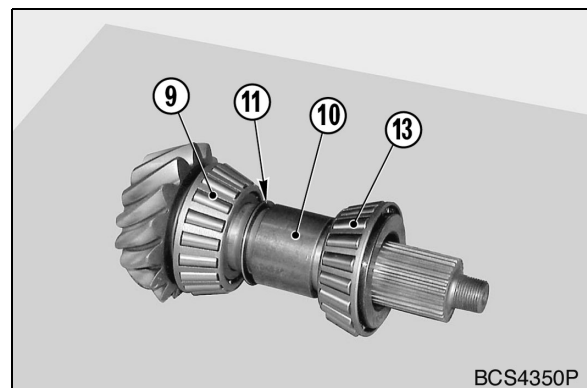


Figure 100

34. Connect the pinion (8) to the tie rod **T28A** and **T28B**; connect the tie rod **T28C** (see special tools) to the press and block.

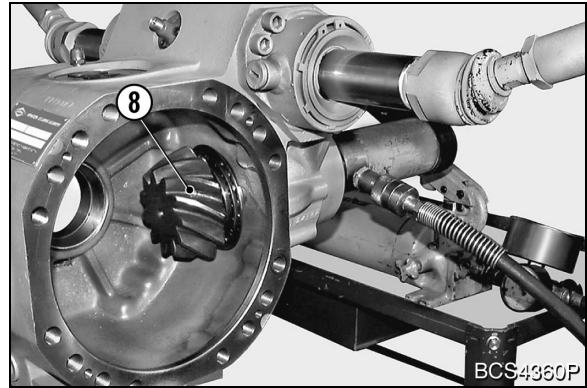


Figure 101

35. Apply Loctite 242 to the thread of the ring nut (7) and screw the nut onto the pinion (8).

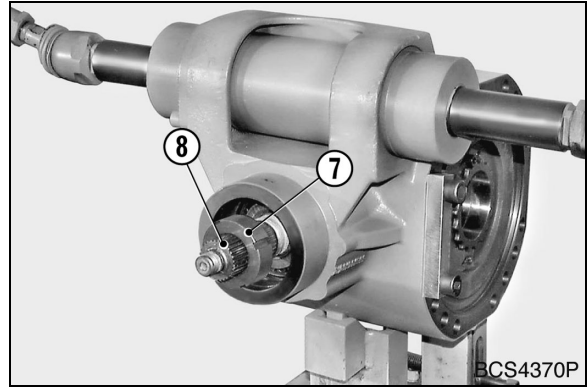


Figure 102

36. Apply special wrench **T22** to the ring nut (7) and bar-hold **T21** to the pinion (8).
37. Lock the wrench **T22** and rotate the pinion using a dynamometric wrench, up to a minimum required torque setting of 500 Nm (369 ft lb).

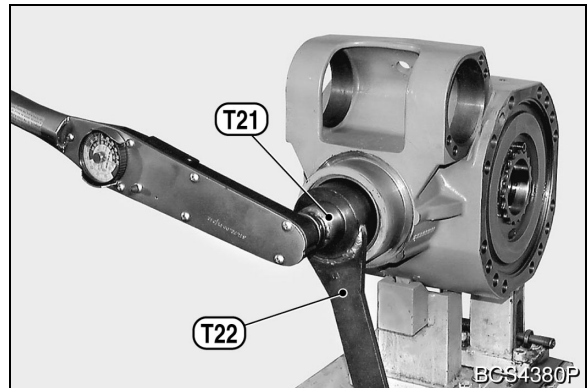


Figure 103

38. Apply onto the pinion (8) the bar-hold and with the help of a torque metre, check the torque of the pinion (8).

Torque: 120-170 Nm (89-125 ft lb)

NOTE: If torque exceeds the maximum value, then the size of shim "S1" (11) between the bearing (13) and the distance piece (10) needs to be increased. If torque does not reach the set value, increase the torque setting of the ring nut (7) in different stages to obtain a maximum value of 570 Nm (420 ft lb).

NOTE: If torque does not reach the minimum value, then the size of shim "S1" (11) needs to be reduced.

NOTE: When calculating the increase or decrease in size of shim "S1", bear in mind that a variation of shim (11) of 0.01 mm corresponds to a variation of 60 Nm (44 ft lb) in the torque of the pinion (8).

39. Lubricate the outer surface of the new sealing ring (6) and fit it onto the central body (12) using tool T27.

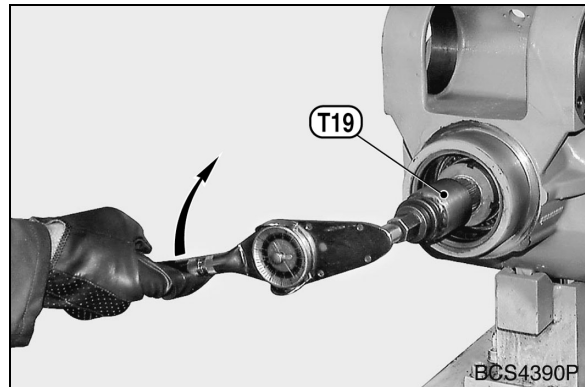


Figure 104

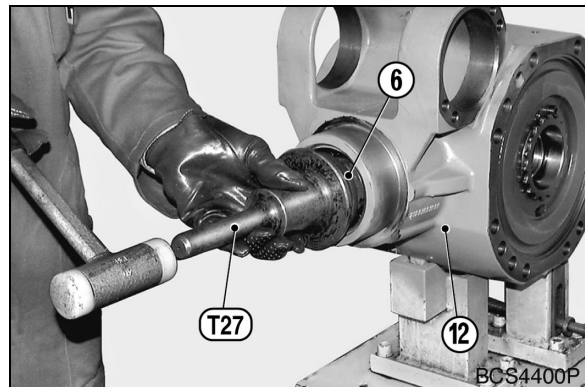


Figure 105

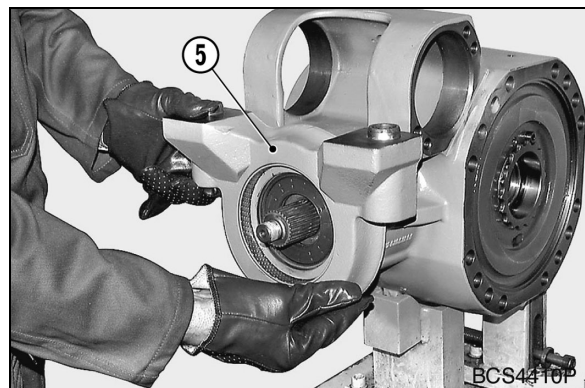


Figure 106

NOTE: This operation does not apply to the fixed axle.

NOTE: Check that it is properly oriented.

40. Fit the flange (2) complete with the guard (4) and fasten it.
41. For keying the flange (2), use a plastic hammer if necessary.

NOTE: *Make sure that the guard (4) is securely fastened onto the flange and that it is not deformed.*

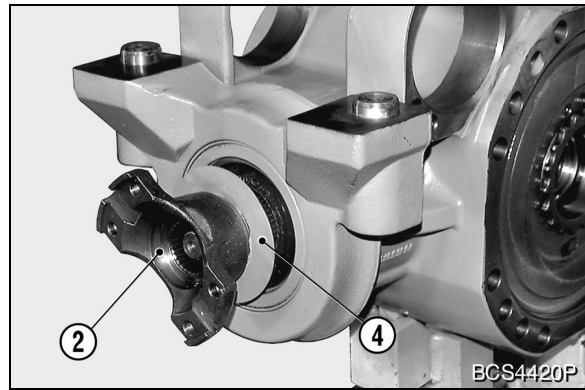


Figure 107

42. Apply Loctite 242 to the threaded part of the pinion (8).
43. Position tool **T20A** (or **T20B**) and fasten it in order to avoid rotation.
44. Insert O-ring (3) the nut (1) and tighten it using a dynamometric wrench.

Torque wrench setting: 280-310 Nm (207-228 ft lb).

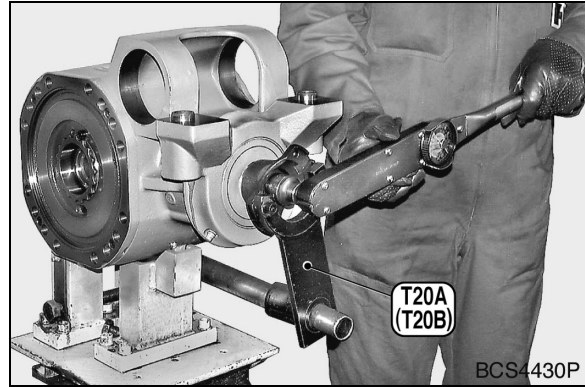


Figure 108

45. Remove blocks **T23** (used for extracting the pinion) and re-install the arms.

NOTE: *For details, see "Checking Wear and Replacing Brake Disks" on page 12.*

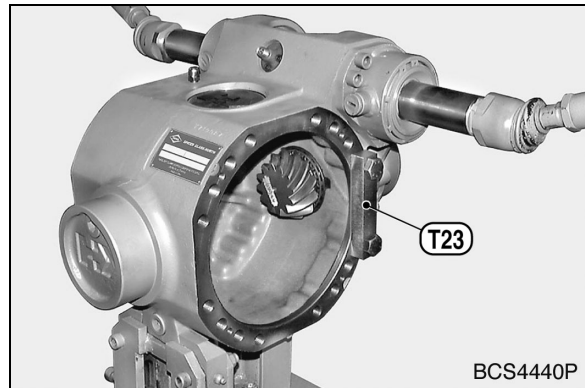


Figure 109

SPECIAL TOOLS

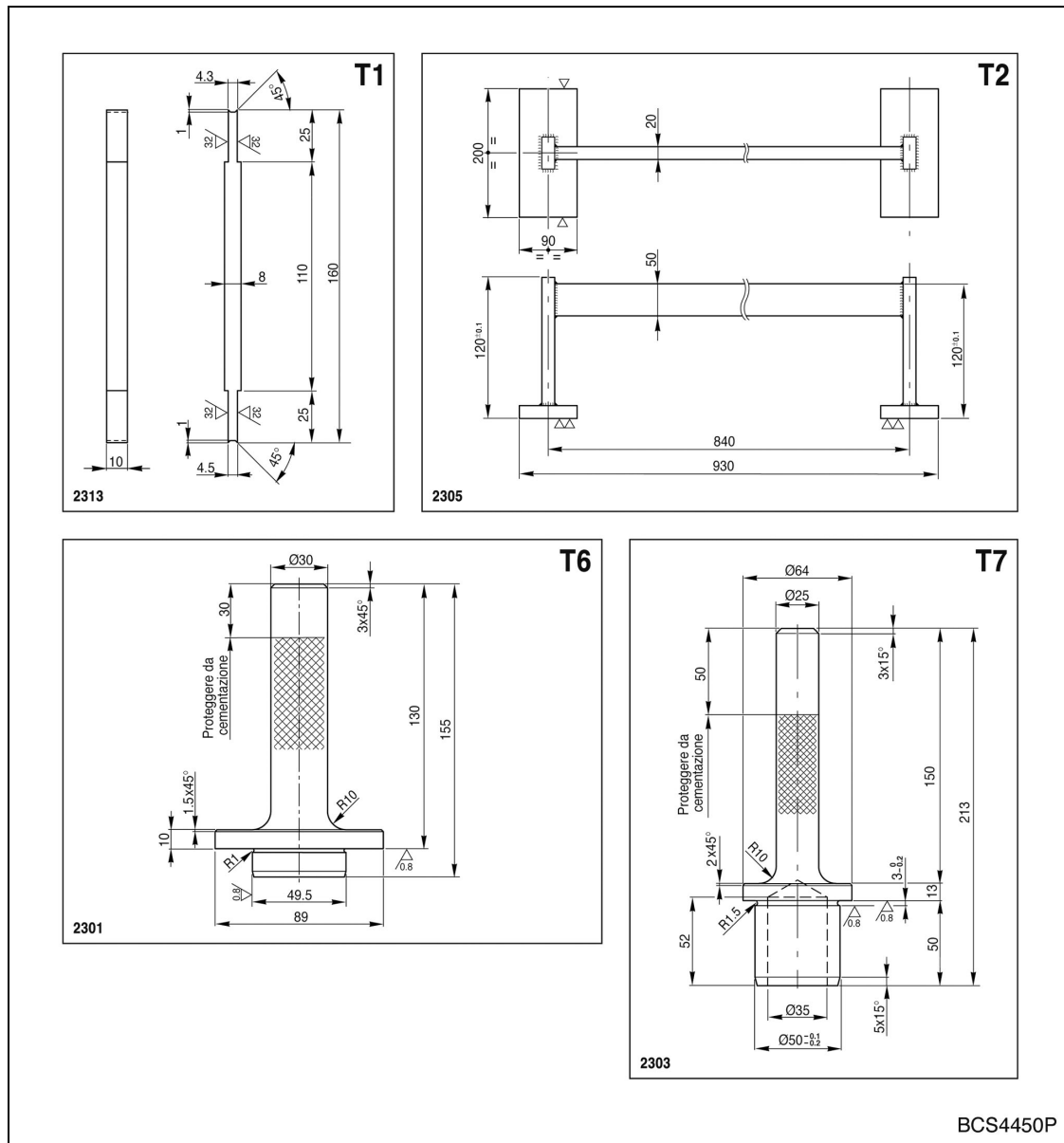


Figure 110

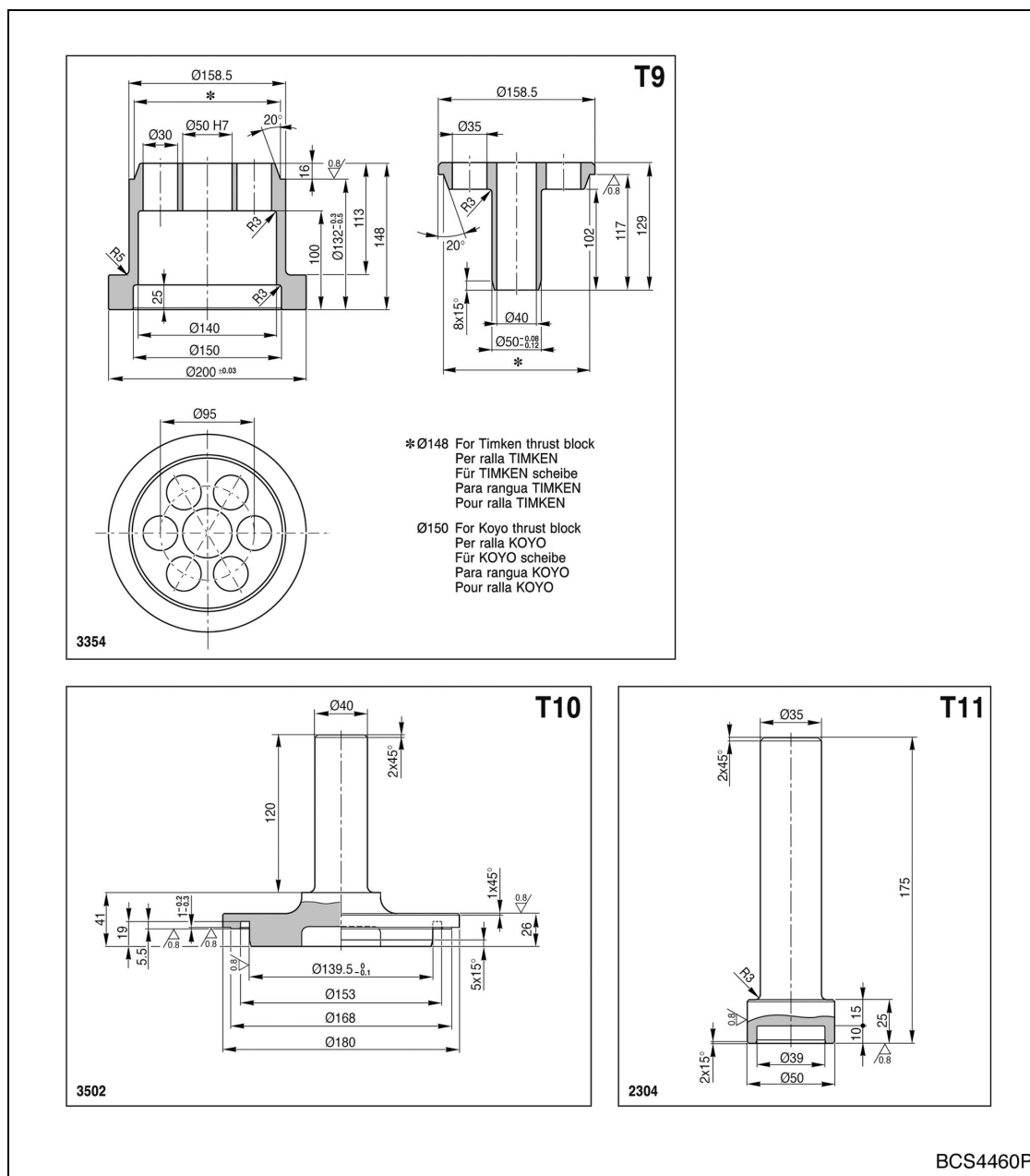


Figure 111

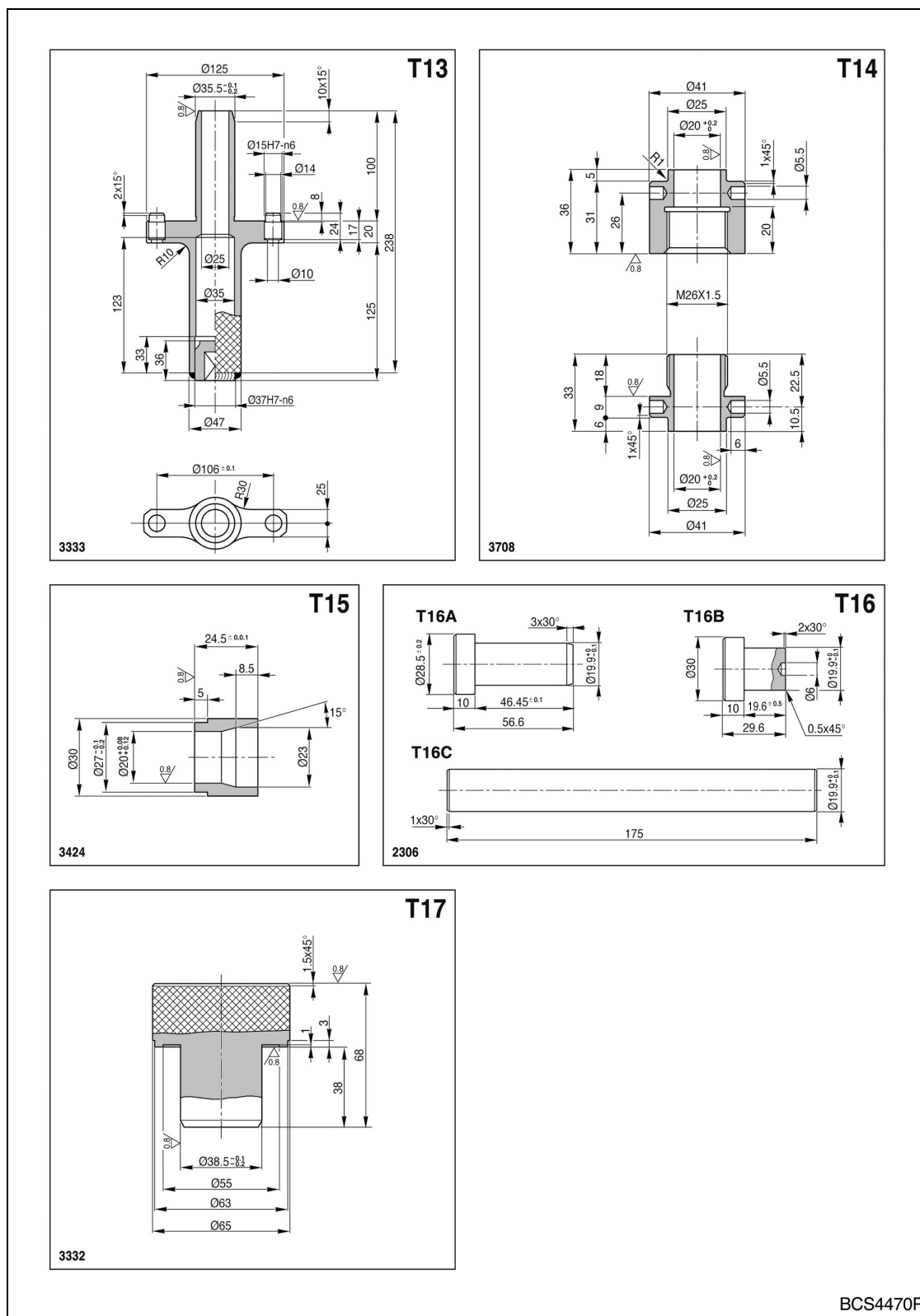
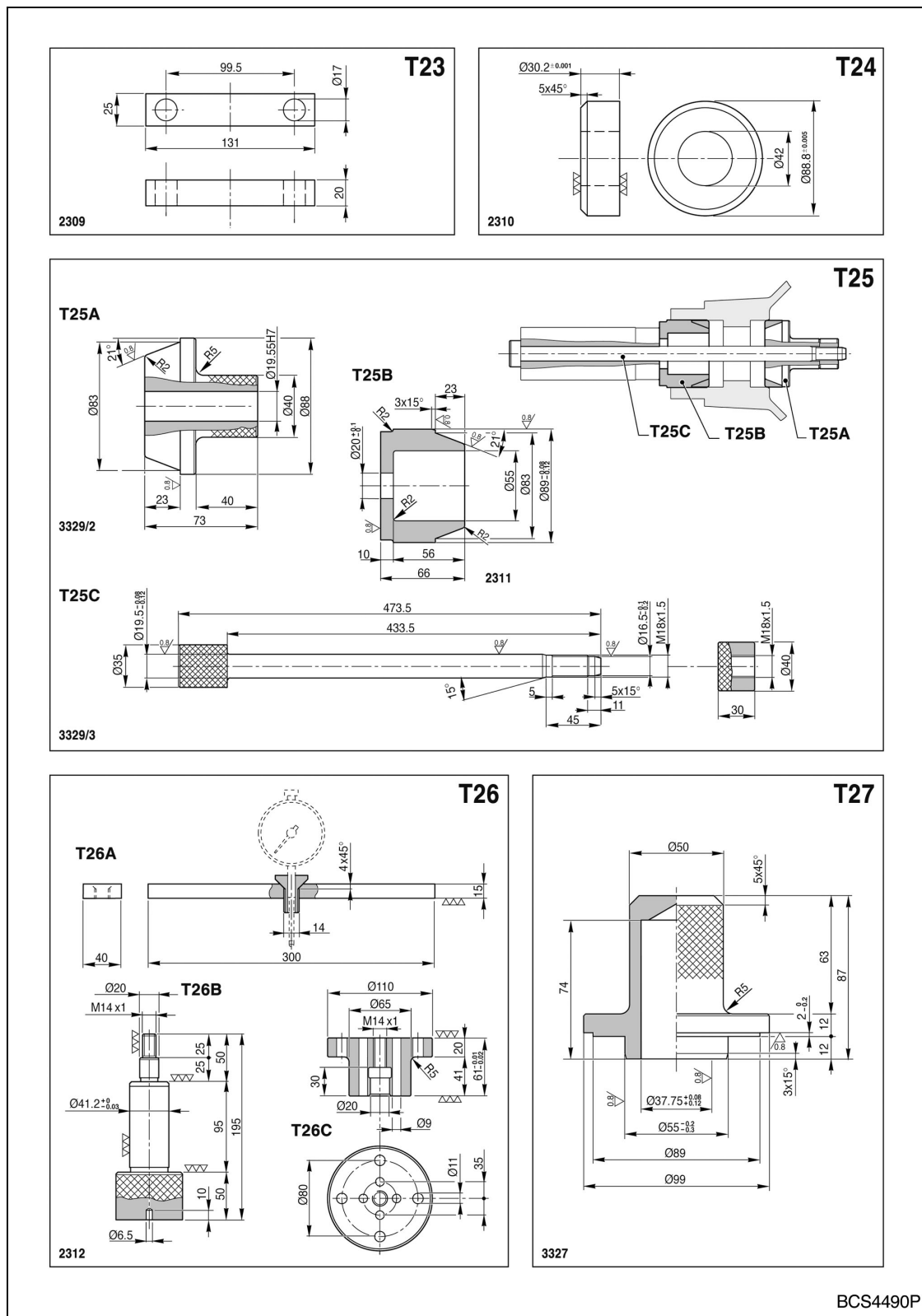


Figure 112

Rear Axle (Dana)



BCS4490P

Figure 114

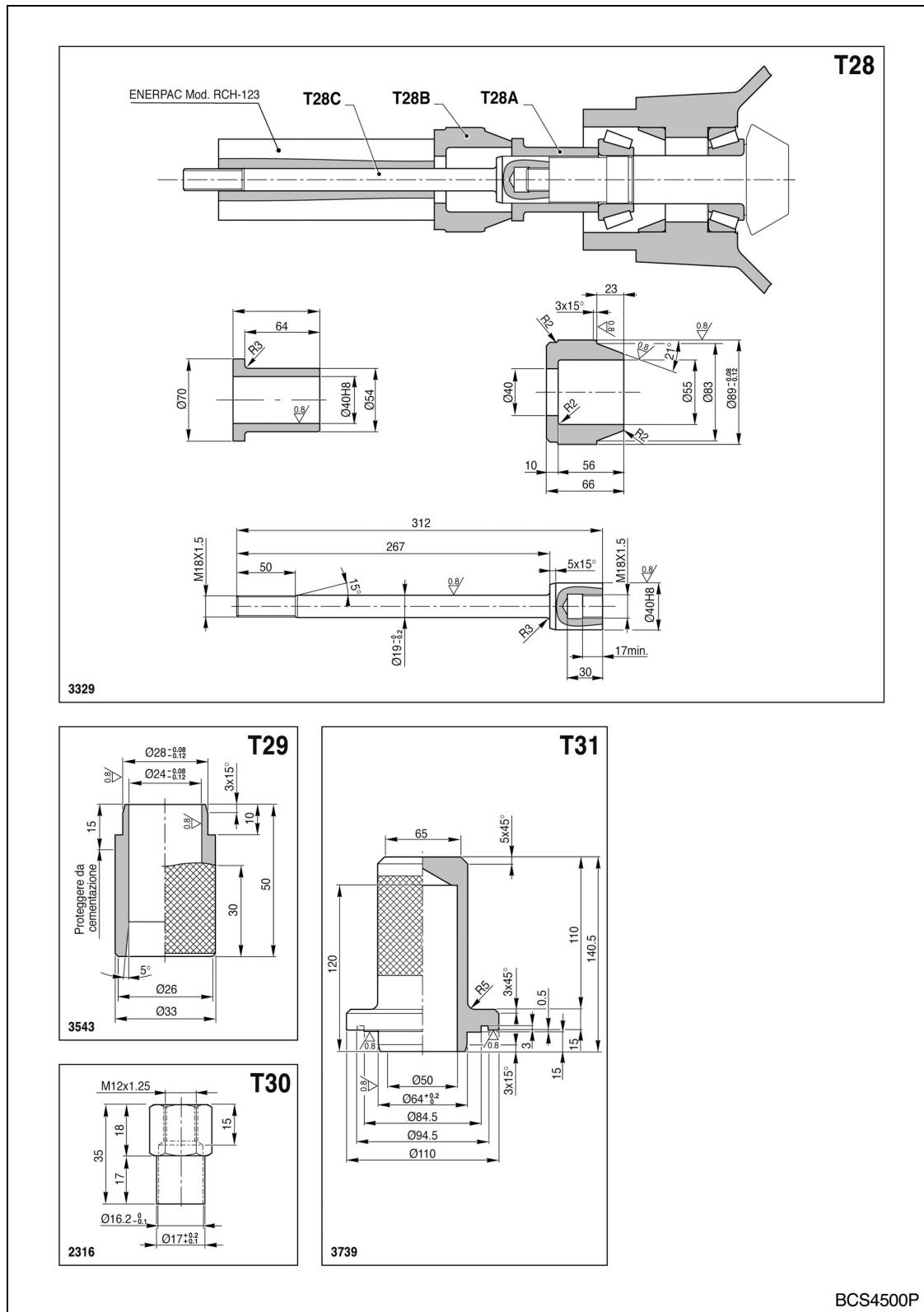


Figure 115

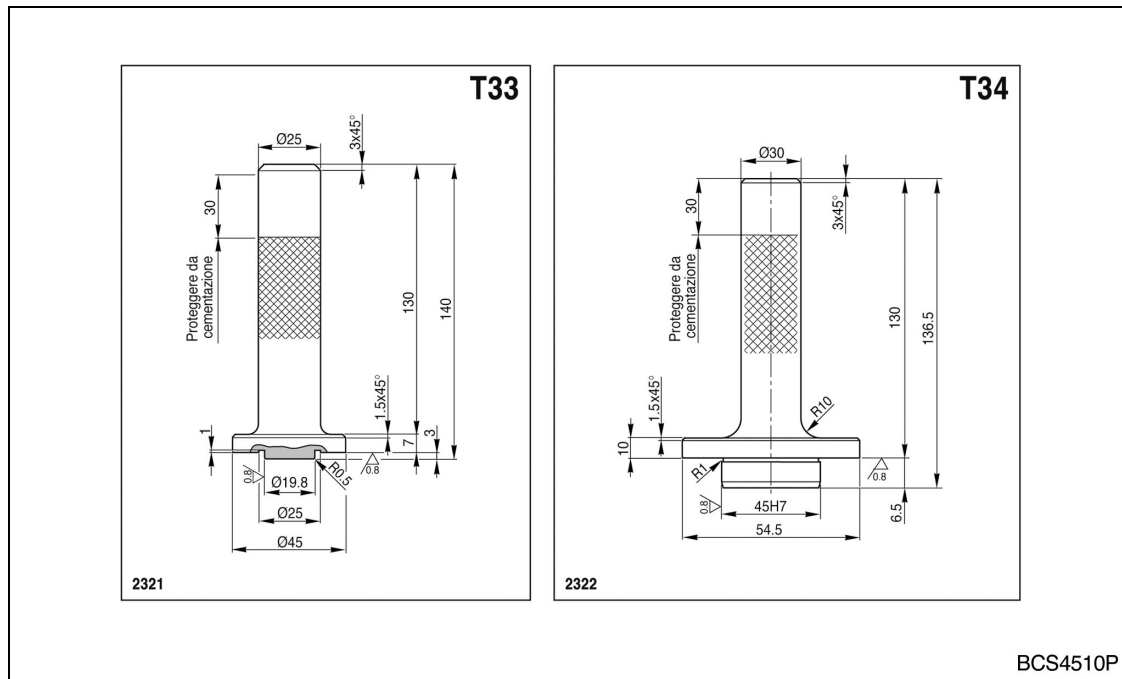


Figure 116

TROUBLESHOOTING

Problem	Cause	Correction
Insufficient braking	1. Incorrect adjustment	Inspect disc thickness and if discs are usable read just brakes to the specifications in the vehicle's manual.
	2. Brake discs worn out	Inspect disc thickness and replace if necessary.
	3. Incorrect brake fluid	Replace all seals in axle and master cylinder that have made contact with the incorrect fluid and all brake hoses. If incorrect fluid leaked into axle oil, seals and o-rings in axle must be replaced.
	4. Loss of brake fluid	Inspect for and repair any leaks in outside circuit or master cylinder. If caused by incorrect brake fluid see correction N. 3. If leak is to the outside replace the o-rings between the center and intermediate housings. If leak is to the inside replace above o-rings and brake piston o-rings.
	5. Overheated axle causing brake fluid to vaporize. (Brake return when axle cools)	See «overheating» problem.

Problem	Cause	Correction
Soft brake pedal	6. Air in brake circuit	Bleed brakes as described in the vehicle's service manual.
Ineffective safety brake	7. Incorrect adjustment	See correction N. 1.
	8. Brake disc worn out	See correction N. 2.
Overheating	9. Oil level wrong	Drain, flush and refill oil to proper level.
	10. Too small of a brake gap	Readjust brakes to the specifications in the vehicle's service manual.
	11. Park brake dragging	Unlock the brake and adjust the correct gap.
	12. Incorrect brake fluid in system	See correction N. 3.
	13. No free-pedal at master cylinder	Readjust brake pedal as described in the vehicle's service manual.
	14. Restriction in brake lines	Inspect for and replace damage lines.
	15. Restriction in return line of brake Servo system	Inspect for and replace damaged return line. Inspect for and remove any filter, tee'd in line or any other source of back pressure from the return line.
	16. Incorrect lubricant	Change the retaining rings of the brake circuit and brake pump.
Diff-lock inoperative	17. If manual control, loose or misadjusted linkage	Inspect and correct linkage and readjust as indicated in vehicle's service manual.
	18. If hydraulic control, problems in the hydraulic or electrical circuits of the vehicle	Refer to the service manual for the vehicle.
	19. If hydraulic control: problems in actuating cylinder (noteable through loss of hydraulic oil or increase of the oil level in axle)	Rebuilt cylinder.
	20. If with lim. slip differential, worn discs	Replace discs.
Oil coming out of breather	21. Leak in internal brake system	See correction N. 2 and 3.
	22. Leak in diff-lock actuating cylinder	See correction N. 19.
NoSpin indexing noise when driving straight NOTE: <i>With NoSpin, fatigue damage can occur on the side with the larger tire.</i>	23. Unequal tire pressure left and right	Inflate tires to the recommended pressure in the service manual, or until the rolling radius is equal.
	24. Different style, size or brand of tires between left and right hand side	Change tires to make the rolling radius equal. Vary the tire pressure within the specifications until the rolling radius is equal.

Problem	Cause	Correction
Noise during coast and under power the same	25. Wheel bearings damaged	Replace and adjust.
Noise under power greater than during coast	26. Low oil level	Refill oil to proper level.
	27. Incorrect lubricant	See correction N. 16.
	28. Ring and pinion worn	Inspect through top cover. Replace and adjust.
	29. Worn ring and pinion bearings	Replace and adjust.
	30. Worn planetary gears or bearings	Replace.
Noise during coast greater than under power	31. Loose pinion nut	Inspect ring, pinion and pinion bearings. If undamaged, retighten nut.
	32. Only pinion bearing damaged	See correction N. 29.
Noise during turn (without NoSpin)	33. Worn spider and/or side gears	Replace.
A «Stick slip» noise when going from forward to reverse	34. Worn or damaged cardanshaft	Inspect and replace as described in vehicle's service manual.
	35. Loose wheel	Inspect for wheel and wheel stud damage. Replace if needed and retorque lug nuts.
	36. Articulation box joint and achsel shaft damaged	Inspect and replace.
	37. Spider pins loose in diff-carrier	Inspect through top cover. Replace.
	38. Damaged or missing spider and/or side gear washers	See correction N. 33.



AIR-CONDITIONER



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 210W-V	1001 and Up
Solar 225LC-V	1001 and Up
Solar 225NLC-V	1001 and Up
Solar 255LC-V	1001 and Up
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 340LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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GENERAL DESCRIPTION

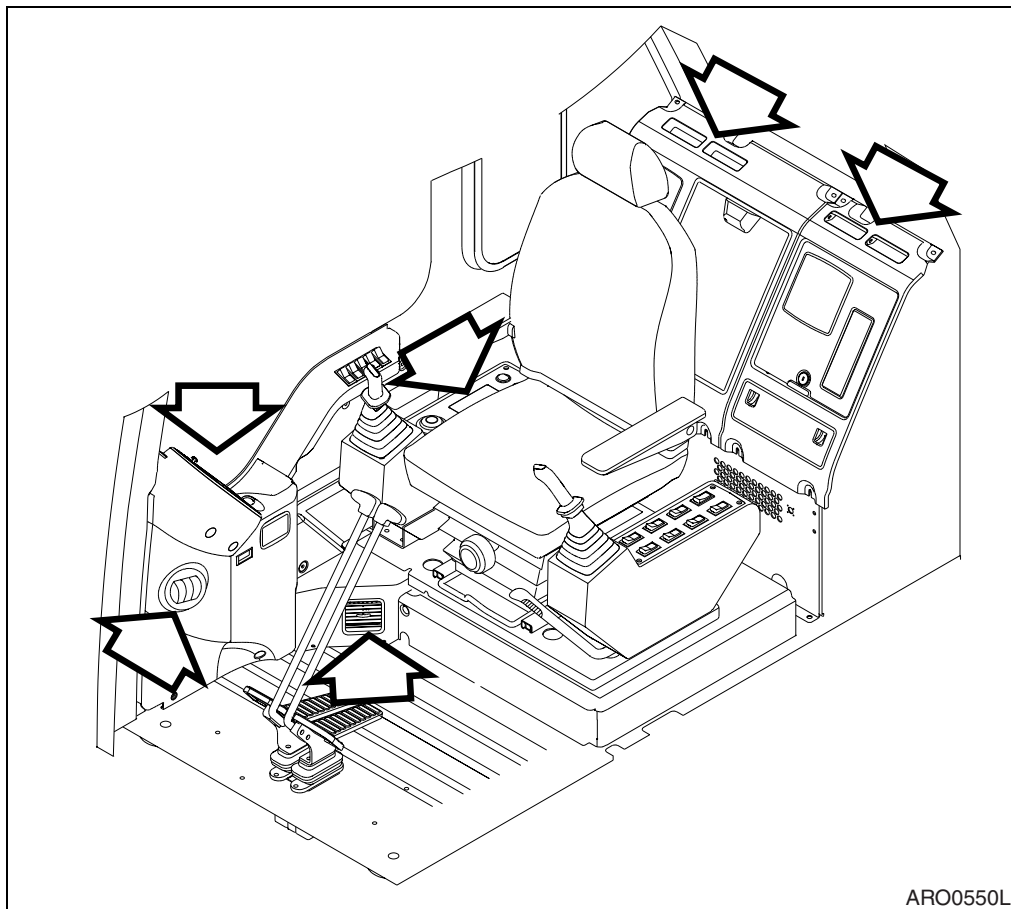


Figure 1

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

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

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



WARNING!

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



WARNING!

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

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

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

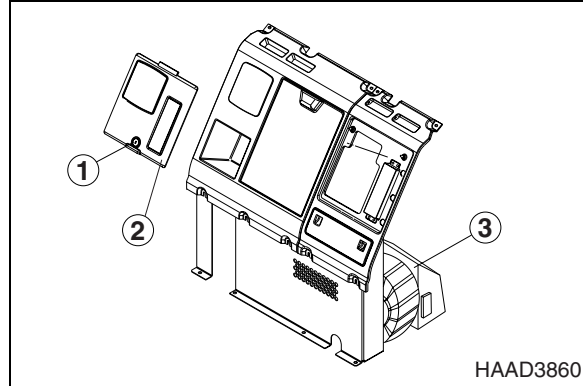


Figure 2

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

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

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

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

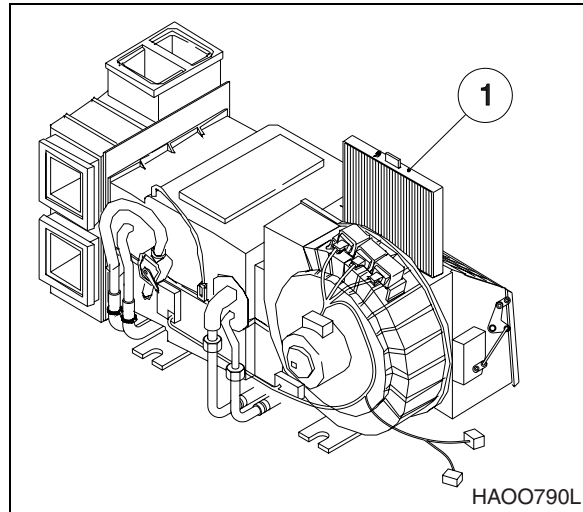


Figure 3

REFRIGERANT CIRCULATION

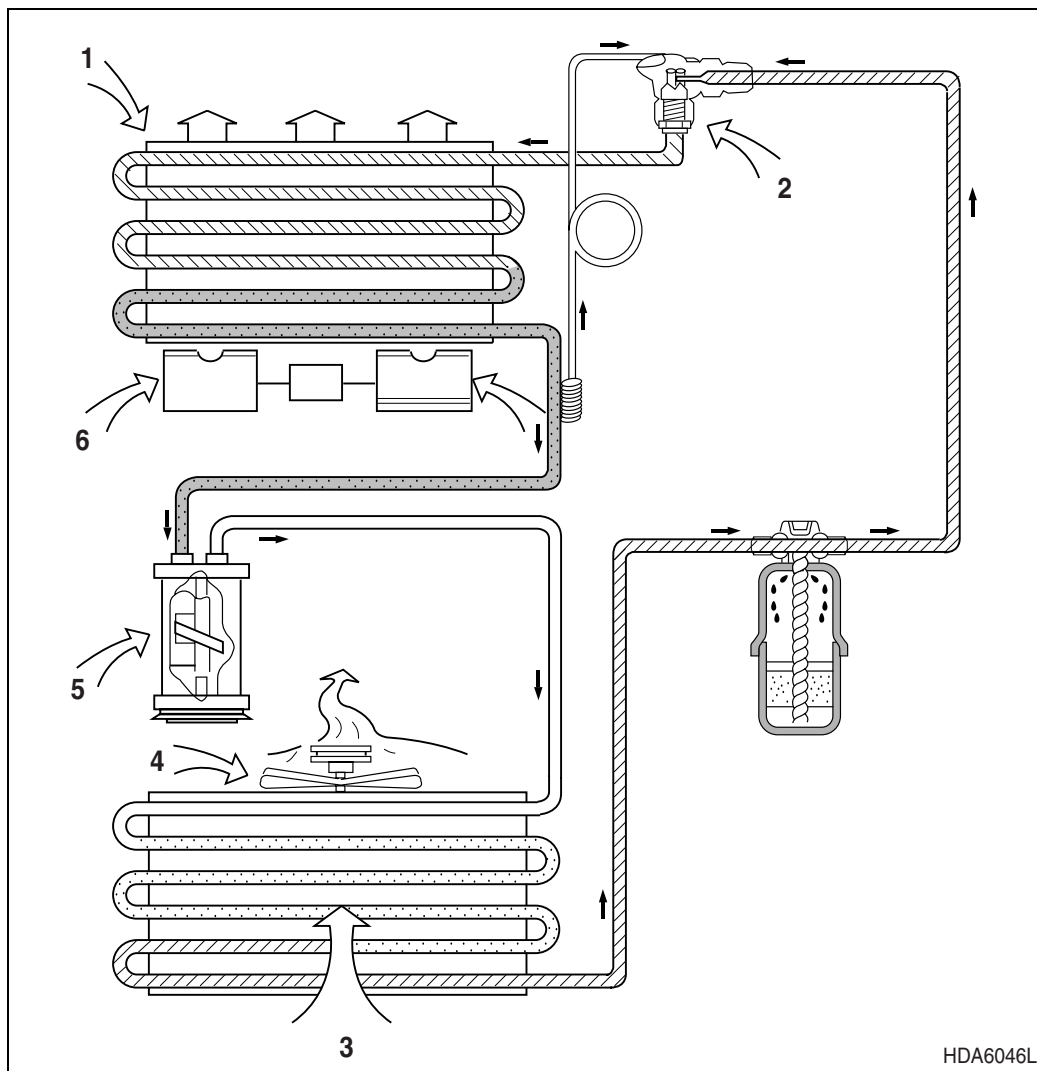


Figure 4

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

Reference Number	Description
5	Compressor
6	Blower Fan
7	Receiver Dryer

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

- Refrigerant (R134a) is compressed to approximately 15.0 kg/cm² (213 psi) within the compressor.
- The compressed refrigerant flows into the condenser at high temperature (approximately 80°C (176°F)).
- The refrigerant in the condenser is cooled to approximately 60° by the condenser fan. At this time the refrigerant changes from the gas to the liquid state, even though the temperature has only been reduced 20°C (68°F). (From 80° - 60°C (176° - 140°F)).
- The refrigerant in its liquid form is injected into the evaporator through the expansion valve. At this time the pressure is reduced by approximately 2.0 kg/cm² (28 psi) and the temperature is also reduced. As a result, the refrigerant absorbs the heat from the air surrounding the evaporator creating a cooling effect and changes from the gas to the liquid state.
- The refrigerant once again flows into the compressor in the gaseous state and the process is repeated.



WARNING!

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

CONTROL PANEL

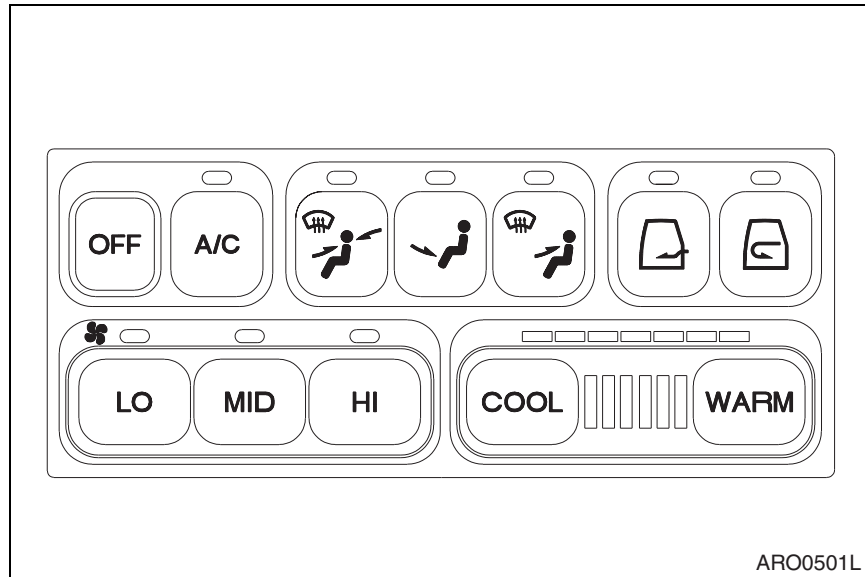


Figure 5

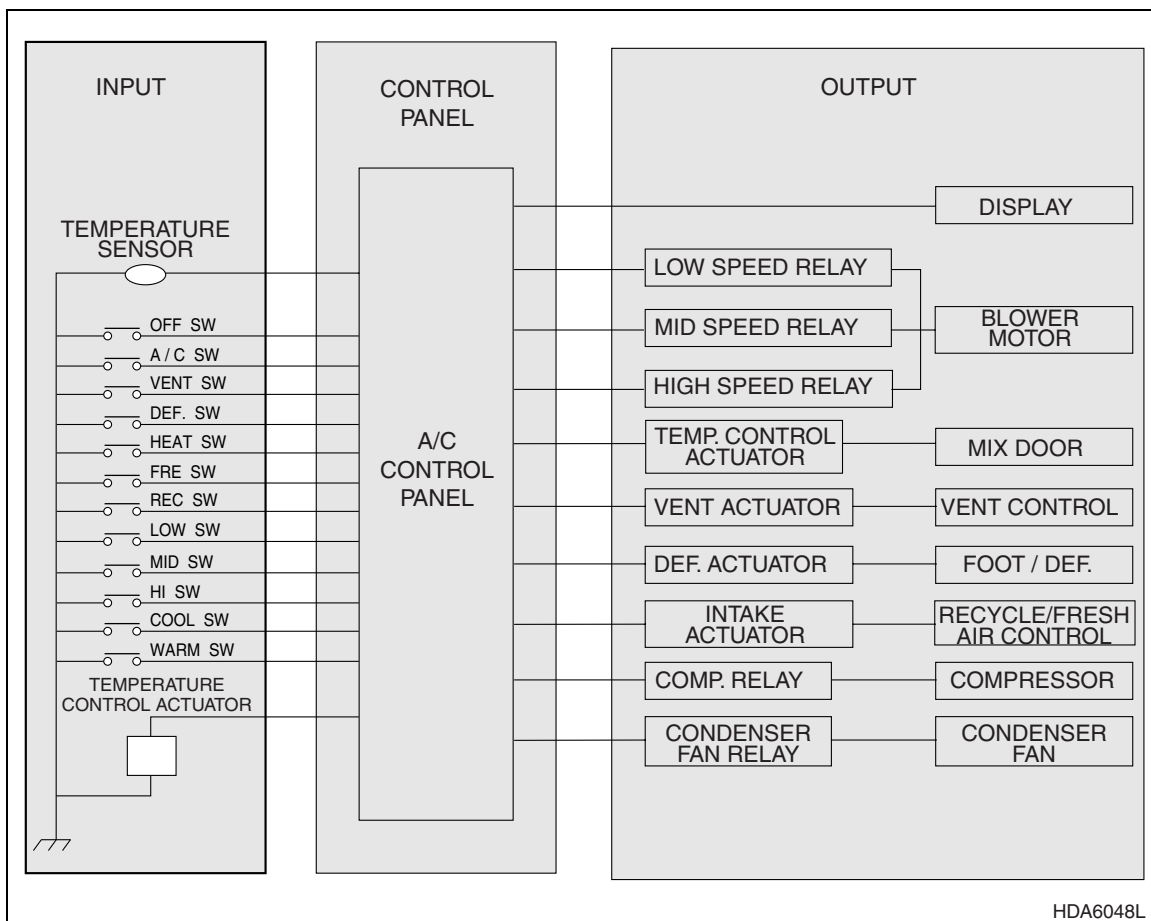
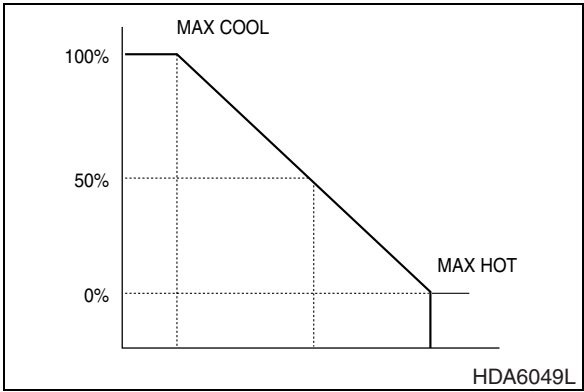
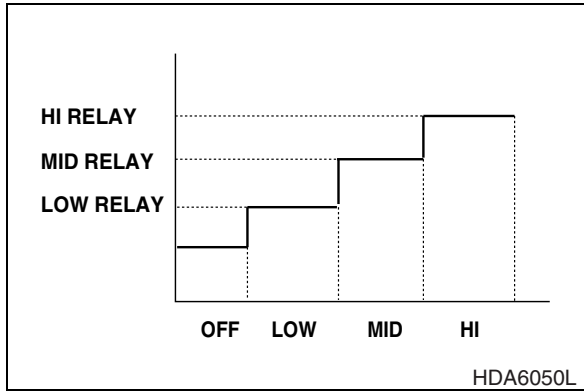
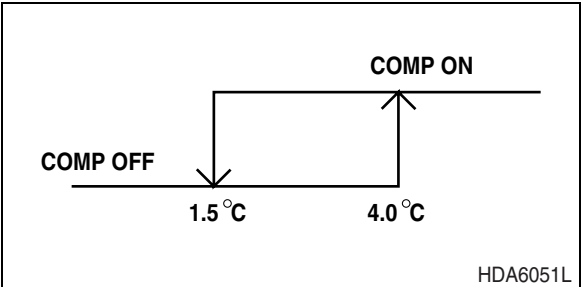


Figure 6

CONTROL SPECIFICATIONS

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

TEMPERATURE LEVEL CONTROL AND DISPLAY

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

AIR DISCHARGE ACCORDING TO PATH SELECTION

Face, Rear, and Defroster

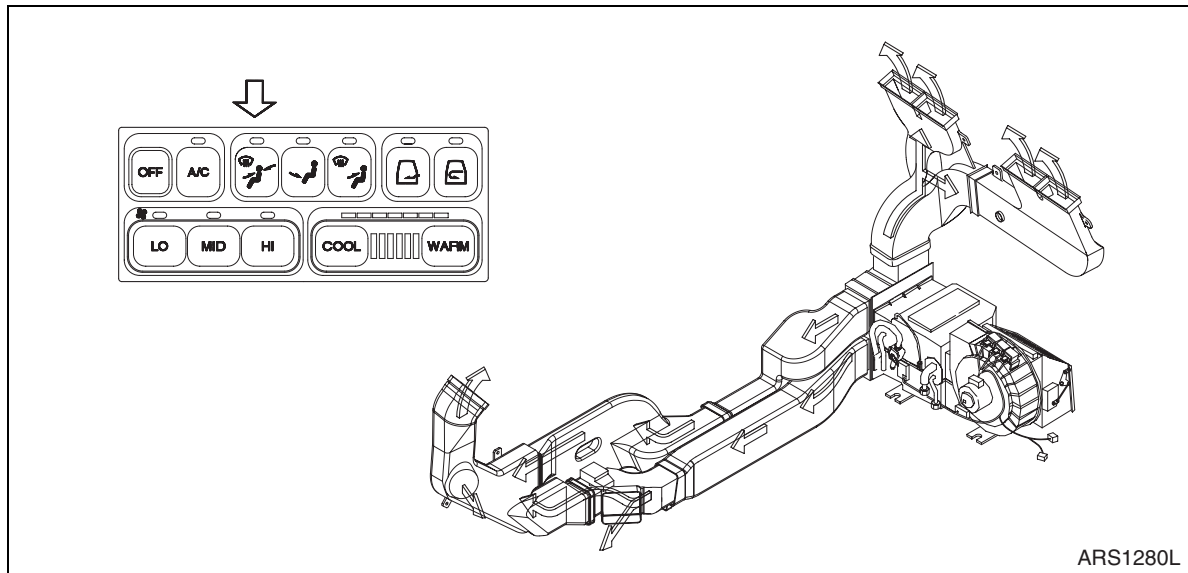


Figure 10

Foot

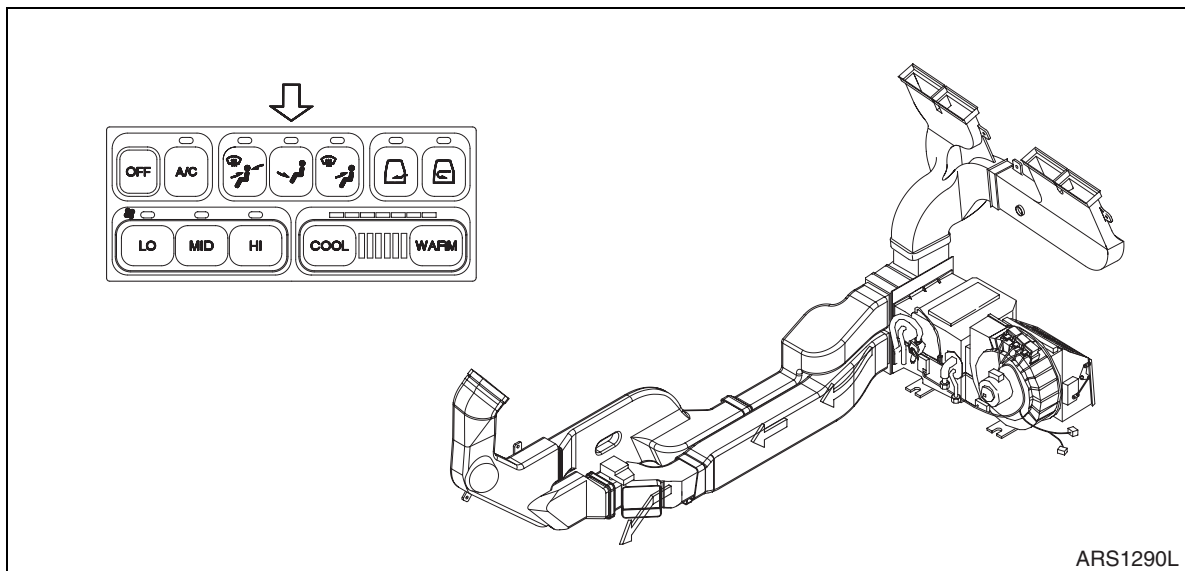


Figure 11

Face and Defroster

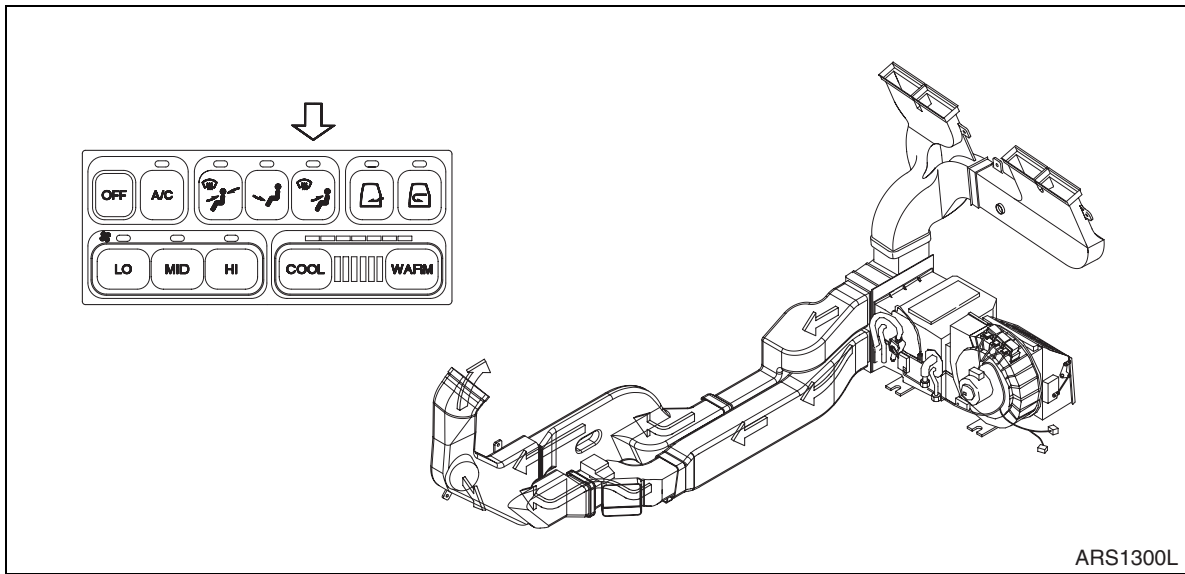


Figure 12

AIR-CONDITIONING SYSTEM CIRCUIT DIAGRAM

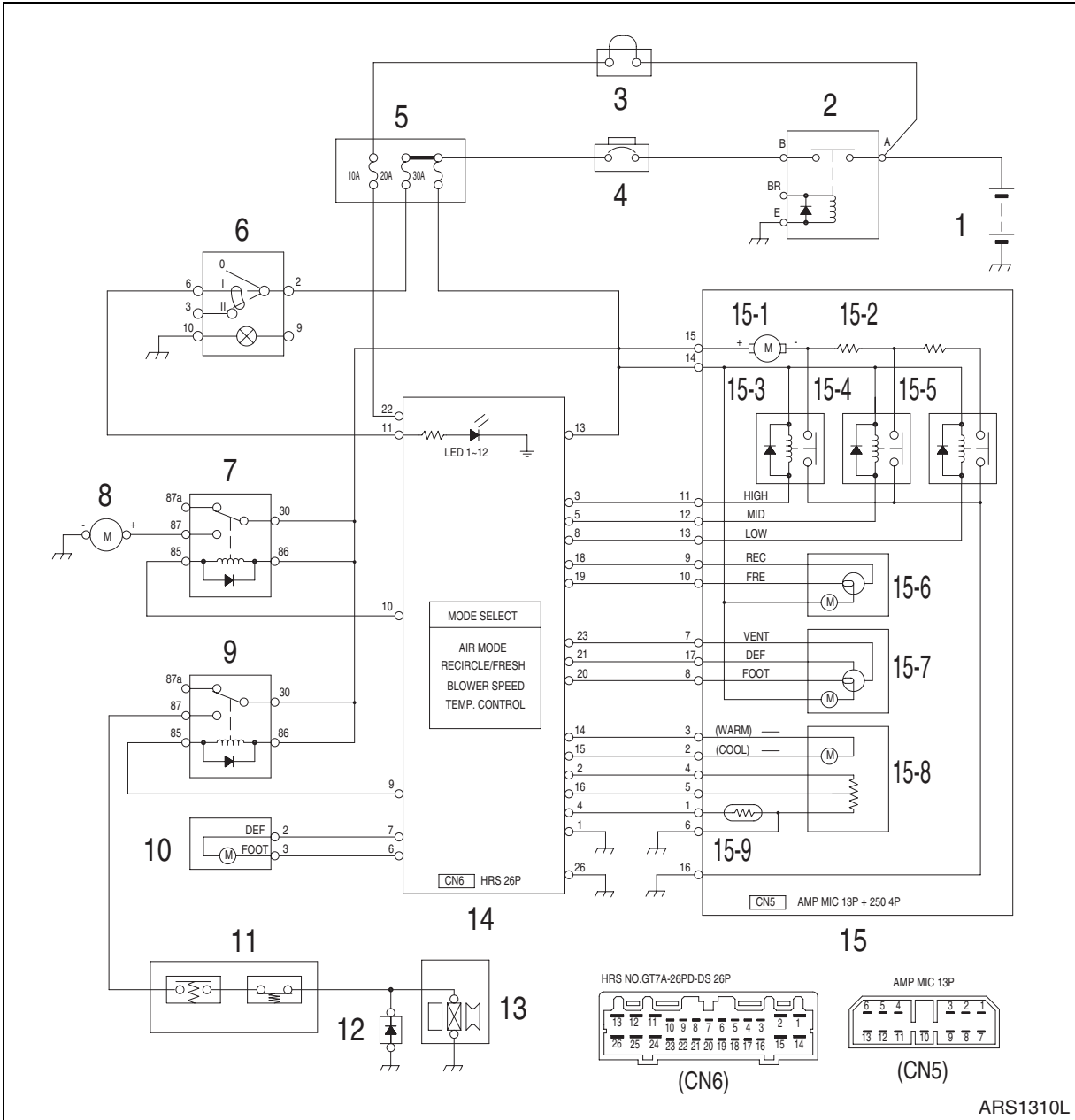


Figure 13

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

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

TROUBLESHOOTING

Refrigerant Pressure Check

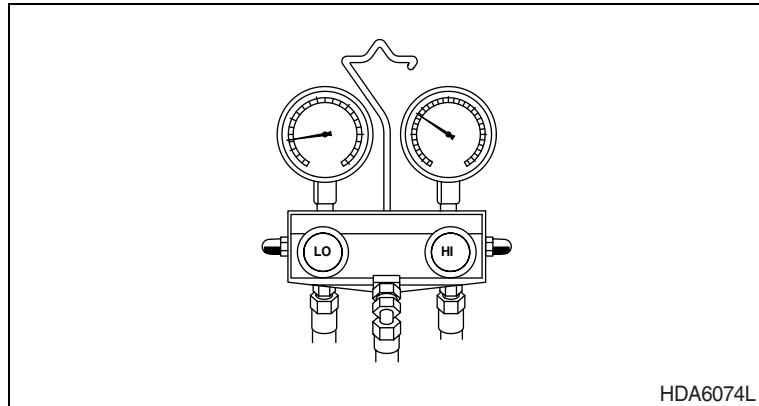


Figure 14

1. Open all doors and windows.
2. Install manifold gauge set.
3. Start engine and maintain engine speed at 1,800 - 2,000 rpm.
4. Check high / low pressure of refrigerant.

1	High Pressure: 8.0 - 10.0 kg/cm² (114 - 142 psi)		
	Low Pressure: Approximately 1.0 kg/cm² (14 psi)		
Possible Cause: Low Refrigerant Level			
Step	Inspection Item		Remedy
1	Check for traces of refrigerant oil.	Yes	Reassemble using correct tightening torque.
		No	Go to next step.
2	Using a leak detection device or soapy water check for refrigerant leakage at all major components and joints.	Yes	Repair leaking component.
		No	Recharge system to correct pressure.

2	High Pressure: Over 23 kg/cm² (327 psi)		
	Low Pressure: Approximately 2.5 - 3.0 kg/cm² (36 - 43 psi)		
Possible Cause: Overcharge, Frost on condenser			
Step	Inspection Item		Remedy
1	Check for condenser pin damage or contamination.	Yes	Clean, repair or replace condenser.
		No	Refrigerant overcharge.

3	High Pressure: Approximately 20 - 25 kg/cm² (285 - 356 psi) Low Pressure: Approximately 2.5 - 3.5 kg/cm² (36 - 50 psi)
Possible Cause: Air in system.	
1. Recover any remaining refrigerant. 2. Vacuum out system. 3. Recharge system.	
NOTE: <i>If the system has been exposed to the air for a long period of time, replace the receiver dryer.</i>	

4	High Pressure: Over 6 kg/cm² (85 psi) Low Pressure: Approximately 760 mmHg (Negative Pressure)		
Possible Cause: Refrigerant does not circulate			
Step	Inspection Item		Remedy
1	1. Connect manifold gauge and start engine. 2. Turn on air-conditioner. 3. Set blower switch to HIGH position. 4. Turn air-conditioner OFF and wait 10 minutes.	Yes	Moisture in system, replace receiver dryer.
	5. Recheck high / low pressure readings. High Pressure: 13.0 - 19.0 kg/cm ² (185 - 270 psi) Low Pressure: 1.5 - 3.3 kg/cm ² (21.3 - 46.9 psi)	No	Contaminated system, replace expansion valve. (Replace evaporator core assembly.)

5	High Pressure: Over 6 - 18 kg/cm² (85 - 256 psi) Low Pressure: 500 mmHg (Negative Pressure) - Dial indicator needle unstable.
Possible Cause: Moisture in system has iced up the expansion valve.	
NOTE: <i>When the absorbed moisture freezes the pressure readings may look normal. Careful readings should be made to determine whether pressure is in normal range.</i>	
1. Recover any remaining refrigerant. 2. Vacuum out system. 3. Recharge system.	
NOTE: <i>If the system has been exposed to the air for a long period of time, replace the receiver dryer.</i>	

6	High Pressure: Over 22.0 - 23 kg/cm ² (313 - 327 psi)		
	Low Pressure: 2.5 kg/cm ² (36 psi)		
Possible Cause: Refrigerant pressure problem due to defective expansion valve or temperature sensor.			
Step	Inspection Item		Remedy
1	Inspect whether the temperature sensor is installed properly.	Yes	Replace expansion valve.
		No	Exchange duct sensor.

7	High Pressure: Over 7.0 - 11.0 kg/cm² (100 - 156 psi) Low Pressure: 4.0 - 6.0 kg/cm² (57 - 85 psi)
Possible Cause: Low refrigerant pressure due to poor compressor compression	
Inspect and replace compressor if necessary.	

WEIGHT OF R134A GAS USED IN MACHINES

Model	Weight of Gas
Mega 130	850 ±20 grams (30 ±0.7 oz.)
Mega 160	850 ±20 grams (30 ±0.7 oz.)
Mega 200-III	850 ±20 grams (30 ±0.7 oz.)
Mega 200-V	850 ±20 grams (30 ±0.7 oz.)
Mega 250-III	850 ±20 grams (30 ±0.7 oz.)
Mega 250-V (Tier I)	850 ±20 grams (30 ±0.7 oz.)
Mega 250-V (Tier II)	850 ±20 grams (30 ±0.7 oz.)
Mega 300-III	950 ±20 grams (33 ±0.7 oz.)
Mega 300-V (Tier I)	850 ±20 grams (30 ±0.7 oz.)
Mega 300-V (Tier II)	850 ±20 grams (30 ±0.7 oz.)
Mega 400-III	950 ±20 grams (33 ±0.7 oz.)
Mega 400-III PLUS	850 ±20 grams (30 ±0.7 oz.)
Mega 400-V	850 ±20 grams (30 ±0.7 oz.)
Mega 500-V	850 ±20 grams (30 ±0.7 oz.)
Solar 55	750 ±20 grams (26 ±0.7 oz.)
Solar 55-V PLUS	750 ±20 grams (26 ±0.7 oz.)
Solar 70-III	800 ±20 grams (28 ±0.7 oz.)
Solar 75-V	750 ±20 grams (26 ±0.7 oz.)
Solar 130-III	950 ±20 grams (33 ±0.7 oz.)
Solar 130LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 130W-III	950 ±20 grams (33 ±0.7 oz.)
Solar 130W-V	850 ±20 grams (30 ±0.7 oz.)
Solar 140W-V	850 ±20 grams (30 ±0.7 oz.)
Solar 160W-V	850 ±20 grams (30 ±0.7 oz.)
Solar 170LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 170W-III	1100 ±20 grams (38 ±0.7 oz.)
Solar 180W-V	850 ±20 grams (30 ±0.7 oz.)
Solar 200W-III	1100 ±20 grams (38 ±0.7 oz.)
Solar 200W-V	850 ±20 grams (30 ±0.7 oz.)
Solar 210W-V	850 ±20 grams (30 ±0.7 oz.)
Solar 220LC-III	950 ±20 grams (33 ±0.7 oz.)
Solar 220LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 220LL	850 ±20 grams (30 ±0.7 oz.)
Solar 225LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 225NLC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 250LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 255LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 280LC-III	1250 ±20 grams (44 ±0.7 oz.)
Solar 290LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 290LL	850 ±20 grams (30 ±0.7 oz.)

Model	Weight of Gas
Solar 300LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 300LL	850 ±20 grams (30 ±0.7 oz.)
Solar 330-III	1250 ±20 grams (44 ±0.7 oz.)
Solar 330LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 340LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 400LC-III	1250 ±20 grams (44 ±0.7 oz.)
Solar 400LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 420LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 450LC-III	1250 ±20 grams (44 ±0.7 oz.)
Solar 450LC-V	850 ±20 grams (30 ±0.7 oz.)
Solar 470LC-V	850 ±20 grams (30 ±0.7 oz.)

REFRIGERANT SYSTEM REPAIRS



WARNING!

Always wear protective glasses and gloves when handling refrigerant. If refrigerant comes in contact with the skin or eyes, immediately flush with clean, running water and consult a physician.

Select a clean and well ventilated area to work.

The refrigerant container is under high pressure and should be stored below 40°C (104°F). Be careful not to drop the container from a high location

The contents are under high pressure and should not be used with compressed air or near an open flame.

REFRIGERANT SAFE HANDLING PROCEDURES

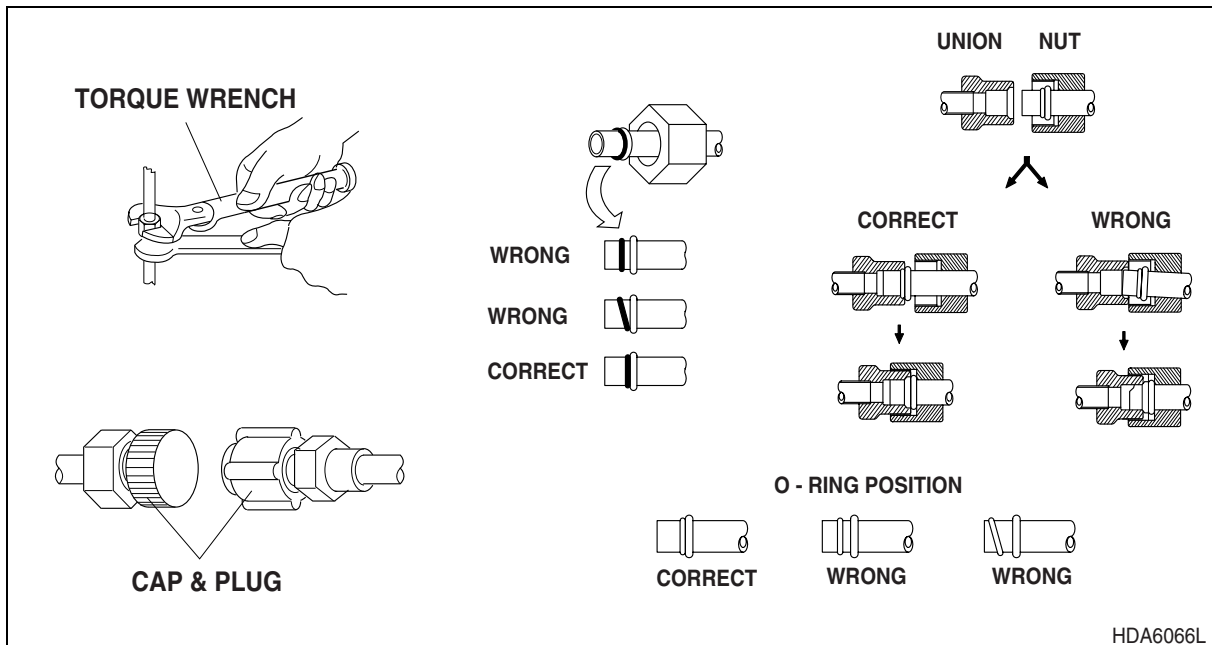


Figure 15

The following procedures should be observed for safe handling of refrigerant during vacuum and charging process.

1. Use an approved recovery / charging device which can safely perform vacuum and charge work simultaneously.
2. The new refrigerant has improved cooling characteristics than the old type and care should be used not to overcharge the system.
3. Do not over tighten connections when working on refrigerant system.
4. The new refrigerant system standards require new tools, equipment and parts. DO NOT attempt to use equipment use in servicing the old refrigerant system.

5. The new refrigerant oil (PAG type) has a high moisture absorption characteristic. When the refrigerant system vacuum seal has been broken, immediately plug up all openings to prevent moisture from entering into the system.
6. When joining unions which use O-ring seals, lightly coat O-rings with refrigerant oil. Be careful not to drip oil on the threads of the nut.
7. Be certain the O-rings are seated properly on the refrigerant line lip. Always use new O-rings when reassembling parts. Do not reuse old O-rings.
8. Use a vacuum pump to evacuate refrigerant system of air.
9. When charging the refrigerant system with the engine running, do not open the high pressure valve on the manifold gauge as the reverse flow of high pressure refrigerant will rupture the hose.
10. When releasing the high pressure hose after completing the charging process, quickly disconnect the hose to minimize refrigerant released to the air.

REPAIR AND REPLACEMENT PROCEDURE

1. Work Procedure
 - A. Before repairing or replacing any refrigerant components first, return all refrigerant oil to the compressor and perform recovery procedures.
2. Operating Condition
 - A. Run engine at maximum engine speed.
 - B. Select "HI" blower fan speed and select A/C switch to "ON".
 - C. Set the temperature control switch for maximum cooling and leave running for approximately 20 minutes.

NOTE: *The manifold gauge dial pointer can vary depending on the outdoor temperatures.*

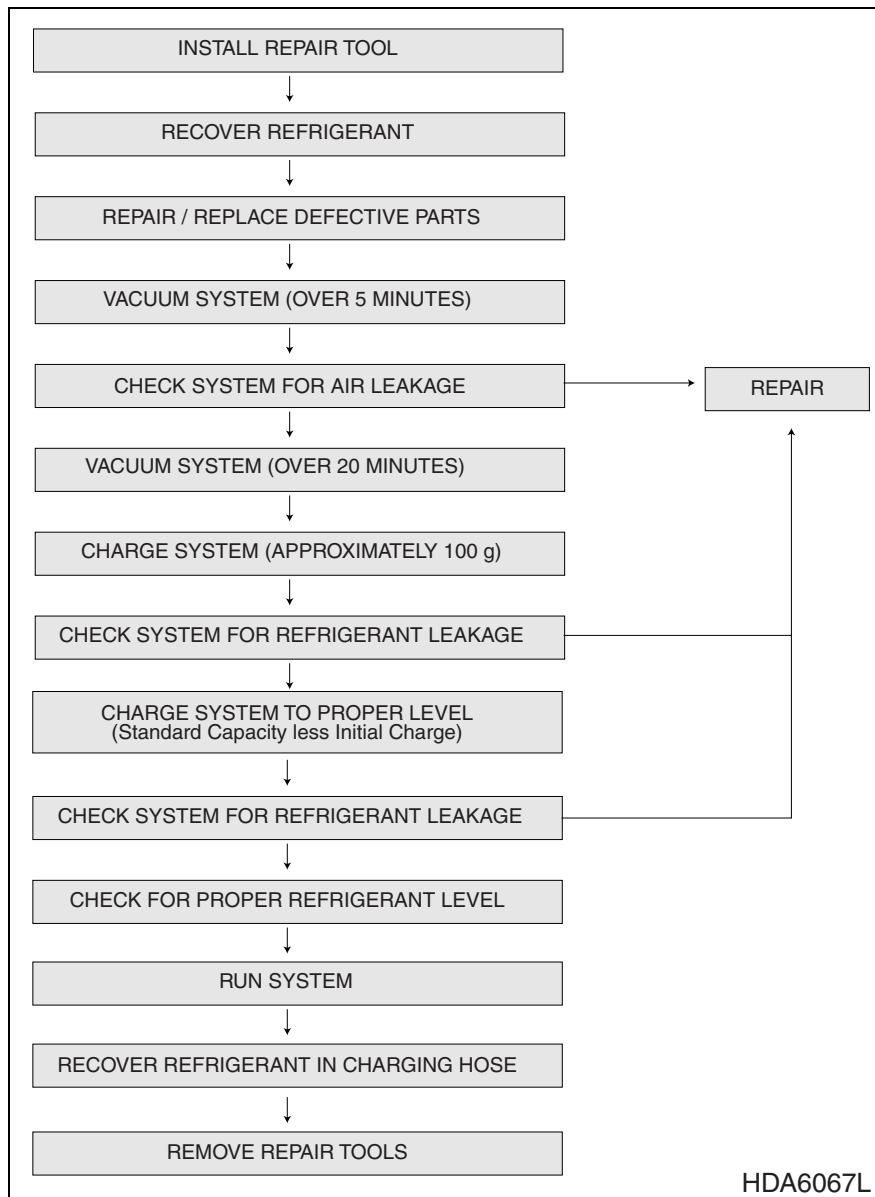


Figure 16

REFRIGERANT RECOVERY

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

1. Attach the manifold gauges and the refrigerant recovery unit to the refrigerant lines as shown.

NOTE: Be careful not to switch the connections for the low and high pressure valves.

2. Open the high pressure valve slowly to release the refrigerant to the recovery unit.

NOTE: Open the valve slowly, while checking to see that refrigerant is not leaking out.

3. When the manifold gauge dial falls below 3.5 kg/cm² (50 psi), slowly open the low pressure valve.

4. Open both the high and low pressure valves slowly until the manifold gauge dials indicates 0 kg/cm² (0 psi).

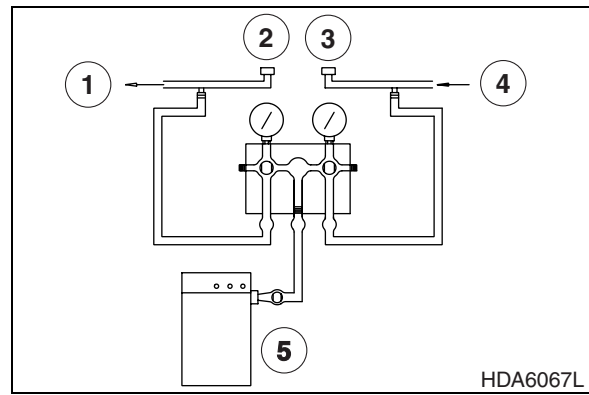


Figure 17

VACUUMING REFRIGERANT SYSTEM

Reference Number	Description
1	To Compressor
2	Low Pressure Side
3	High Pressure Side
4	From Receiver
5	Vacuum Pump

1. Vacuuming Procedure

NOTE: When the A/C system has been exposed to the air, it must be vacuumed out. Perform vacuum process for 30 minutes for complete moisture and air evacuation.

- A. Attach the manifold gauges and vacuum pump to the refrigerant system as shown.
- B. Turn on the vacuum pump and open both valves.
- C. When the low pressure gauge shows approximately 710 mmHg, close both valves and turn off vacuum pump.

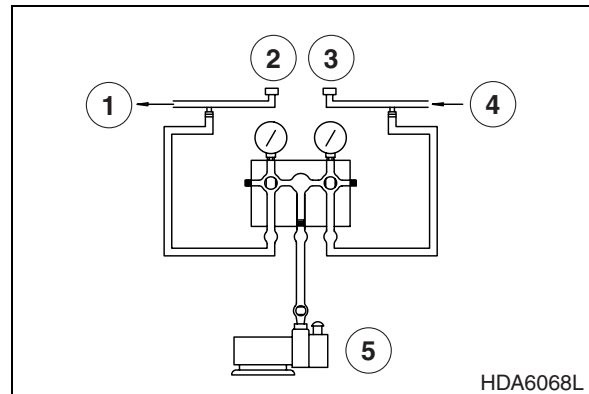


Figure 18

2. Check system for vacuum leak.

Allow system to sit for 10 minutes and check whether the system is holding the pressure. If the pressure has dropped, it must be repaired before proceeding to the next step.

3. Vacuuming Procedure

If the system is holding the pressure and it has not changed for 10 minutes, vacuum out the system for an additional 20 minutes.

- A. Turn on the vacuum pump and slowly open both valves.
- B. Allow vacuum pump to run for additional 20 minutes until the low pressure gauge dial reads approximately 750 mmHg.
- C. Close both valves and stop the vacuum pump.

4. Installation of Refrigerant Container

Reference Number	Description
1	Handle
2	Hose Connection
3	Mounting Disk

- A. Before mounting valve on the container, make sure the handle is in the counter clockwise most position, with the puncture pin retracted and the mounting disk is in the raised position.
- B. Attach the manifold gauge center hose to the valve assembly.
- C. Turn the disc in the clockwise direction and securely mount valve onto refrigerant container.
- D. Turn the valve handle in the clockwise direction and puncture the container seal with the pin.
- E. Once the can has been punctured, turn the handle in the counter clockwise direction so the refrigerant can flow into the manifold gauge center hose. At this time, do not open the low and high pressure valves of the manifold gauge.
- F. Press the manifold gauge low side valve to eliminate the trapped air in the hose.

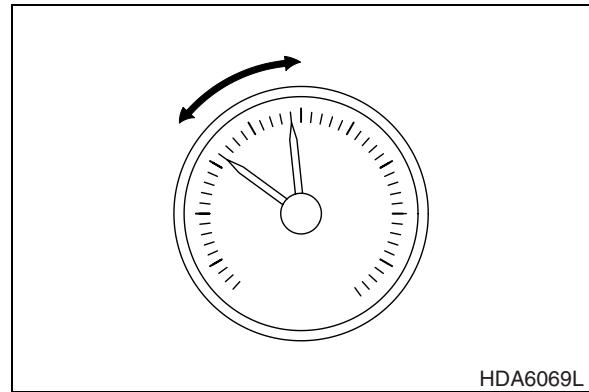


Figure 19

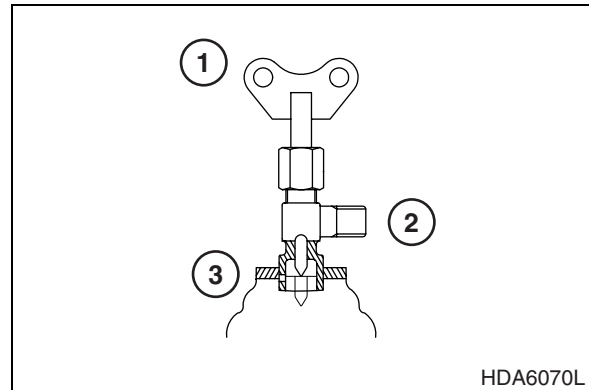


Figure 20

LEAKAGE CHECK

NOTE: Perform the leakage check after completing vacuuming process.

1. After attaching the manifold gauge, open the high side valve.

2. Charge system until the low side gauge dial indicates a pressure of 1 kg/cm² (14 psi) and close the high side valve.
3. Using a refrigerant leak detector or soapy water check each joint for leakage.

Reference Number	Description
1	Refrigerant Leak Detection Device

4. If a leak is detected, check for O-ring damage or correct tightening torque and replace or repair as necessary.
5. If no leaks are detected, proceed with the charging process.

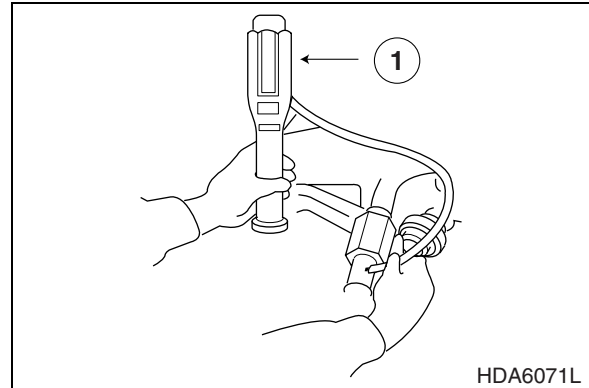


Figure 21



WARNING!

For accurate refrigerant leak detection, perform leak detection procedure in a well ventilated area.

REFRIGERANT CHARGING

1. Perform the vacuuming procedure, vacuum holding and leaking tests as described in the proceeding headings.

NOTE: *First charge the refrigerant system with 100g (3.5 ounces) of refrigerant with the engine off. Then using the manifold gauges as a guide fully charge the system with the engine running.*

When exchanging refrigerant containers, press the manifold gauge low side valve to eliminate air from the charging hose.

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

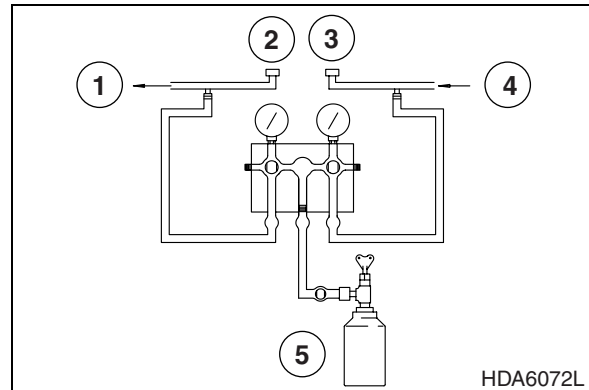


Figure 22

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

Initial charge amount: 100 g (3.5 ounces).

- If refrigerant does not flow freely into system, try starting engine first before operating air-conditioner.

- Temperature control switch setting: Maximum Cooling

Blower Speed Setting: Hi (3 step)

Engine Speed: 1,300 - 1,500 rpm



WARNING!

When charging refrigerant system with the engine running;

- Always keep refrigerant supply container in the upright position.**
- Never open the high side pressure valve.**

- Open the manifold gauge low side valve and charge system to standard capacity.

Gauge Dial	Standard Reading
High Side Gauge	13 - 20 kg/cm ² (185 - 285 psi)
Low Side Gauge	1.5 - 3.5 kg/cm ² (22 - 50 psi)

NOTE: These standards are for outside temperatures between 30° - 35°C (86° - 95°F). The gauge readings may vary for extreme temperature conditions.



WARNING!

- When outside temperature is low, warm the refrigerant supply container with warm water not exceeding 40°C (104°F). Do not allow water to come in contact with the charging adapter valve handle.**
- When outside temperature is high, cool off refrigerant supply container and condenser to aid the refrigerant charging process.**

- Close low pressure side valve.

6. Shut off engine and close refrigerant supply container adapter valve. Disconnect manifold gauge hoses from vehicle.

INSPECTING SYSTEM FOR LEAKAGE

After completing charging procedures, clean all joints and connections with a clean dry cloth. Using a refrigerant leak detecting device or soapy water, inspect system for leaks starting from the high pressure side.

NOTE: When the refrigerant circulation has been stopped the high pressure will start to decrease and the low pressure will start to increase until they are equalized. Starting the inspection from the high side will result in a accurate test.

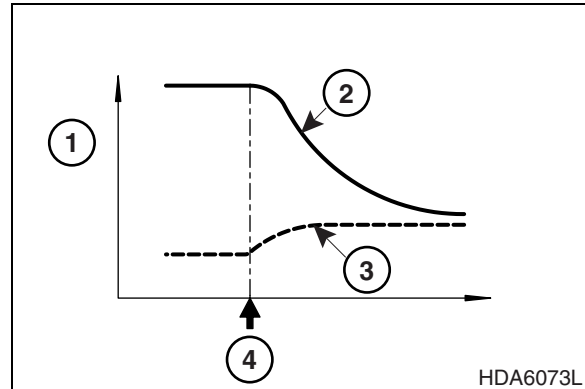


Figure 23

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

Inspection Procedure

1. High Pressure Side
Compressor outlet → condenser inlet → receiver dryer inlet → air-conditioner unit inlet
2. Low pressure side
Compressor inlet → air-conditioner unit outlet
3. Compressor
Compressor shaft area, bolt hole area and magnetic clutch area.
4. Receiver dryer
Pressure switch and plug area.
5. Connection valve area
Inspect all valve areas.
Verify all valves are capped to prevent leaking.
Check for foreign material inside of valve cap.
6. Interior of air-conditioning unit.
After stopping engine, insert detector probe into drain hose. (Leave inserted for 10 seconds minimum.)

NOTE: When inspecting leakage from the air-conditioning unit, perform the inspection in a well ventilated area.



TRANSMISSION (ZF 2HL-100)



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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SPECIFICATIONS

Transmission	
Type	2 Speed, Power-Shift
Reduction Ratio	5.35 / 1.39
Power Shift Control Pressure	30 - 35 kg/cm ² (427 - 498 psi)
Max. Input Torque	78 kg•m (564 ft lb)
Max. Rotating Speed	4,500 rpm

TRANSMISSION OPERATION

The transmission is a two-speed, powershift transmission of planetary design with helically cut spur gear and dual countershaft construction. The powershift stage includes an integrated multidisc brake and a rotating multidisc clutch. Both are actuated by plate springs and hydraulically released. A mechanically operated dog clutch, between the planetary and spur gears, allows interruption of power and towing of the unit.

The shift control is hydraulic for open hydraulic circuitry and electro-hydraulic for closed loop circuitry. Both types of control provide overspeed protection by preventing downshifting until speed is reduced to a point where damage to the hydraulic motor will not occur.

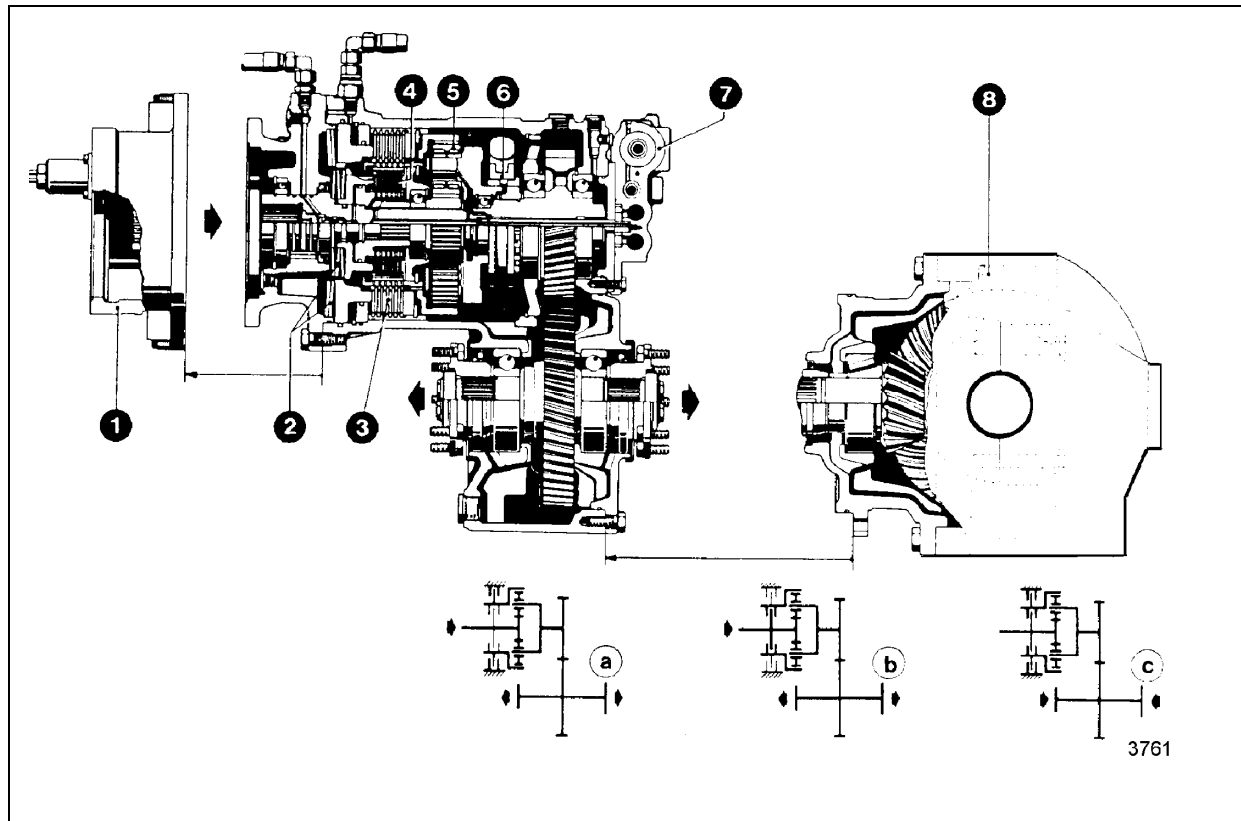


Figure 1

Power Flow	5. Planetary Stage
a = 1st Gear	6. Manual Disconnect Clutch
b = 2nd Gear	7. Inductive Speed Sensor for Electro-hydraulic Overspeed Protection
c = Braking	8. Hydraulic Overspeed Protection
1. Drive Housing with Integrated Shifting Valves	9. Emergency Steering Pump
2. Hydraulically Released Plate Springs	10. Direct Axle Mounting
3. Multidisc Brake	
4. Multidisc Clutch	

TRANSMISSION DISASSEMBLY

DETACHING DRIVE (INPUT) HOUSING

1. Secure gear box; then loosen plug and drain oil.

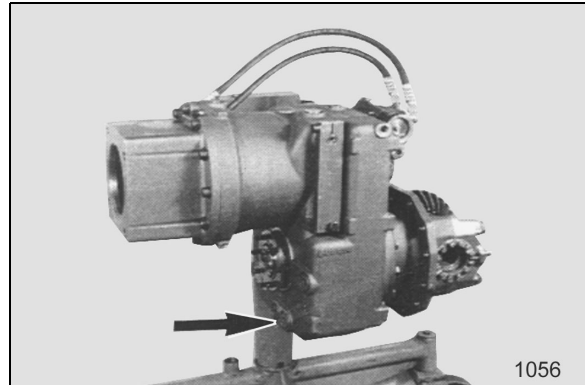


Figure 2

2. Remove two oil lines.

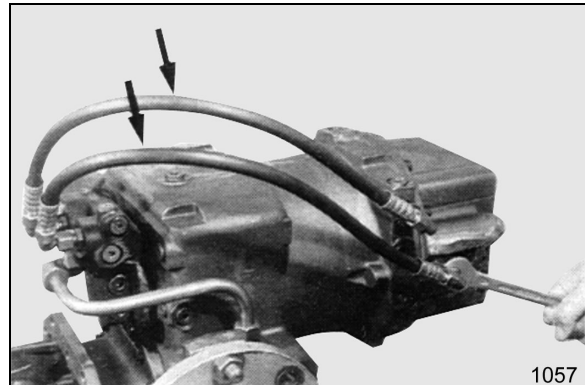


Figure 3

3. Remove screw.

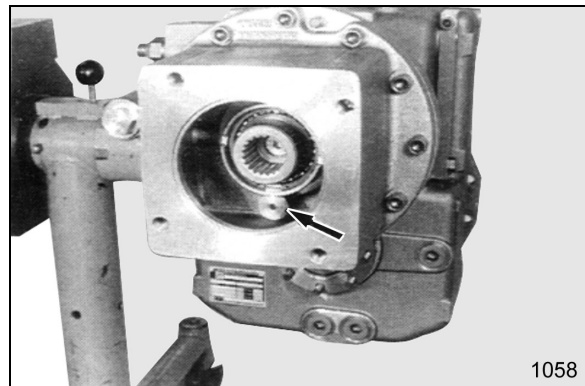


Figure 4

4. Remove snap ring.

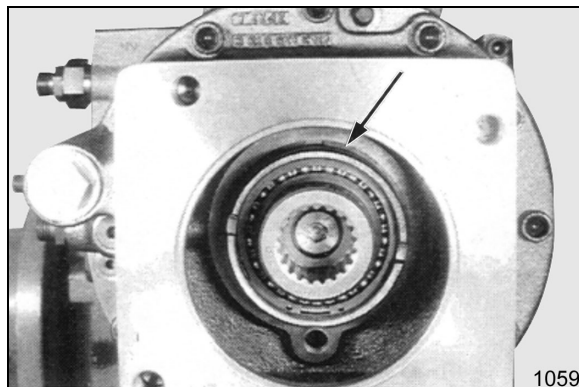


Figure 5



CAUTION!

**Drive housing is spring loaded -
Work carefully in next step.**

5. Loosen hex socket bolts and detach drive housing from gearbox using two adjusting bolts.

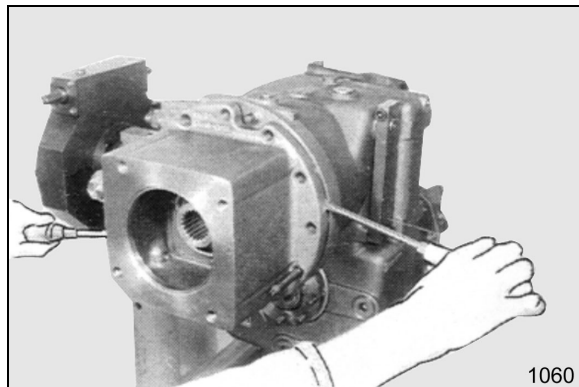


Figure 6

DISASSEMBLING INPUT SHAFT ASSEMBLY

1. Remove two cup springs.
2. Block supply line and use compressed air or press piston out of bore in housing.

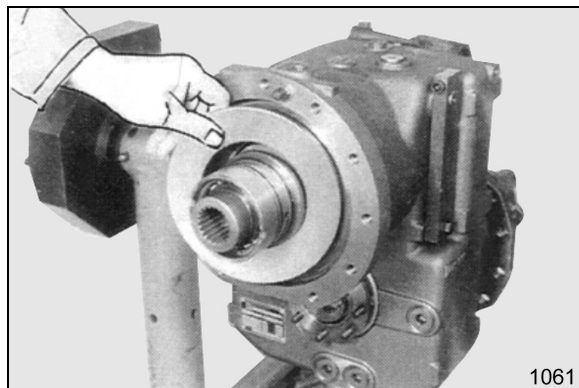


Figure 7

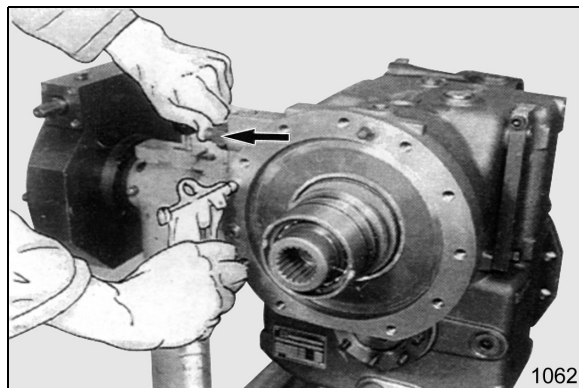


Figure 8

3. Remove plug and breather.

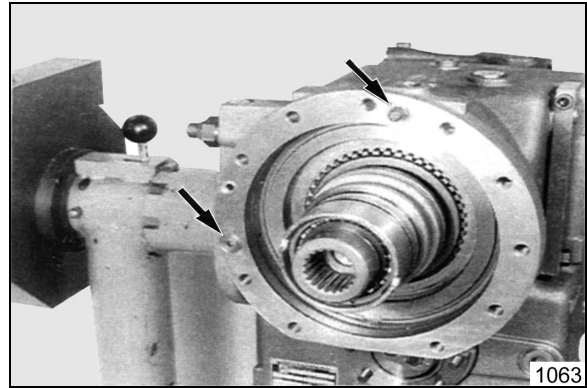


Figure 9

4. Remove seal ring and backup ring from ring groove in housing.

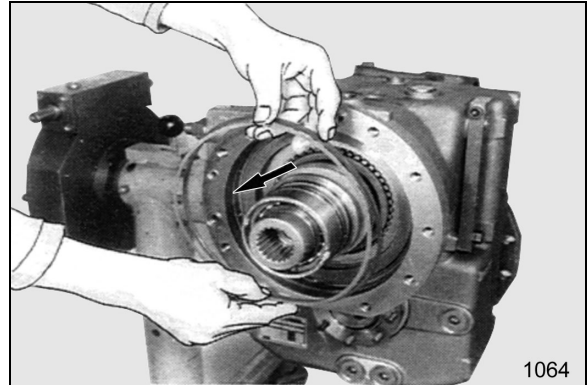


Figure 10

5. Remove snap ring.

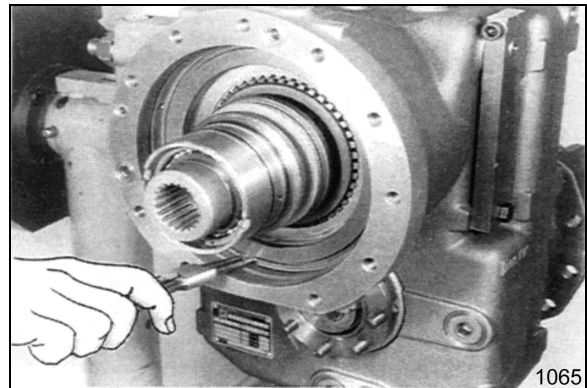


Figure 11

6. Pull gasket from housing, using an L-type driver or offset screwdriver.

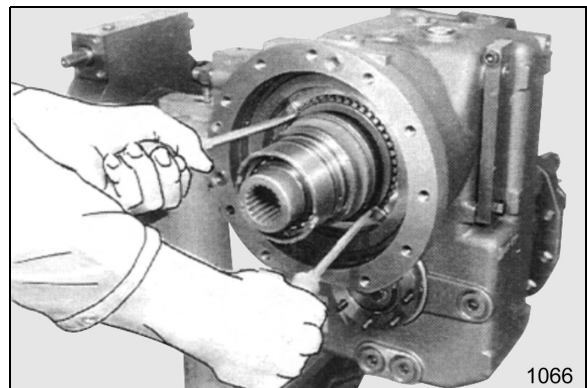


Figure 12

7. Remove O-ring.

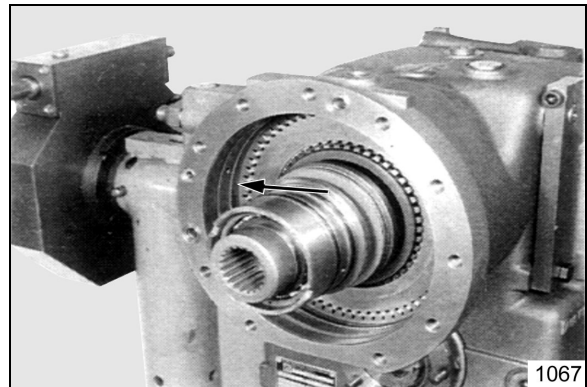


Figure 13

8. Remove clutch plate pack and backing plate.

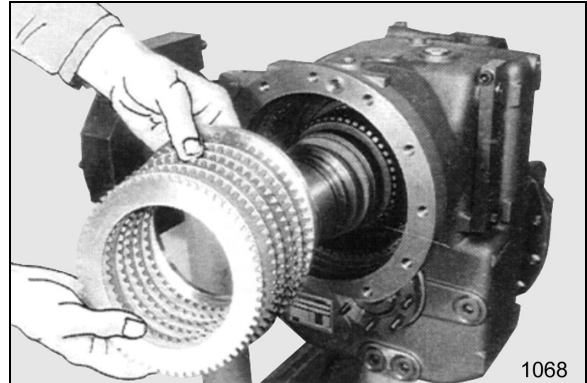


Figure 14

9. Remove snap ring.

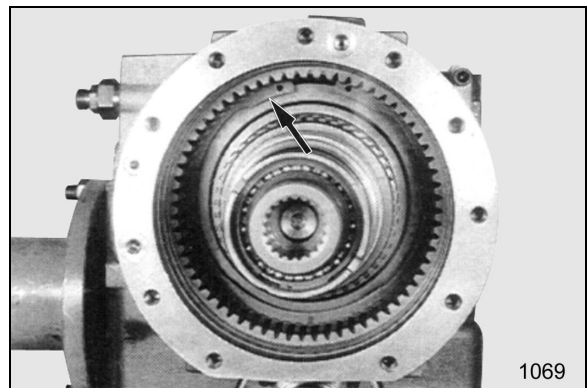


Figure 15

10. Remove clutch.

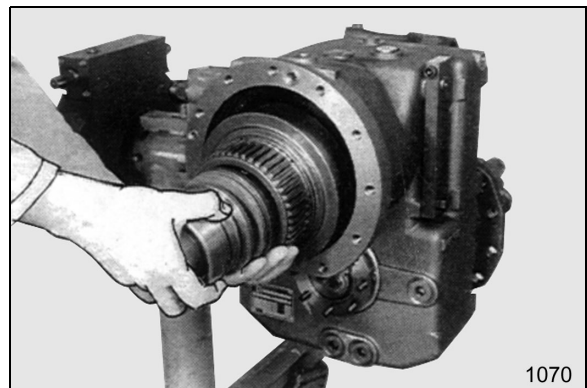


Figure 16

11. Secure sun gear shaft so that it will not turn. Remove snap ring and cup spring pack.

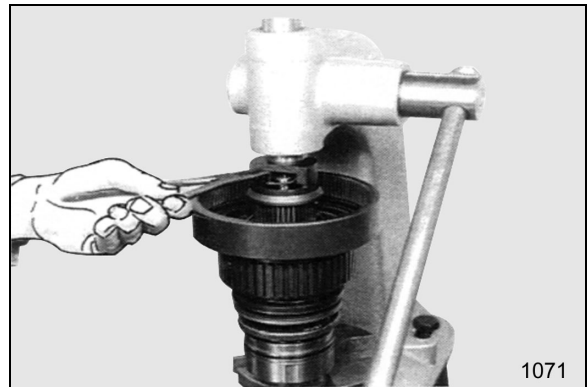


Figure 17

12. Remove disc and sun gear.



Figure 18

13. Remove ring gear from drive shaft.

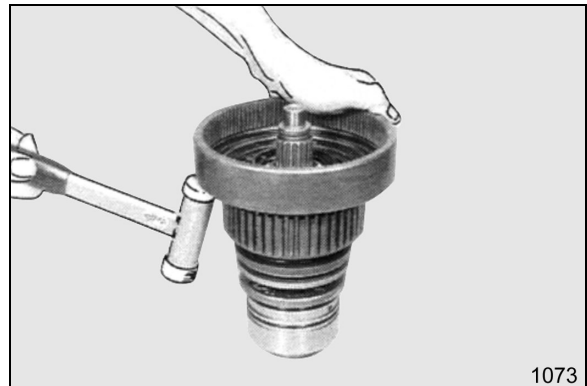


Figure 19

14. Remove snap ring and centering disc.



Figure 20

15. Remove plate pack.



Figure 21

16. Remove plate.



Figure 22

17. Pry inner plate carrier out of piston.

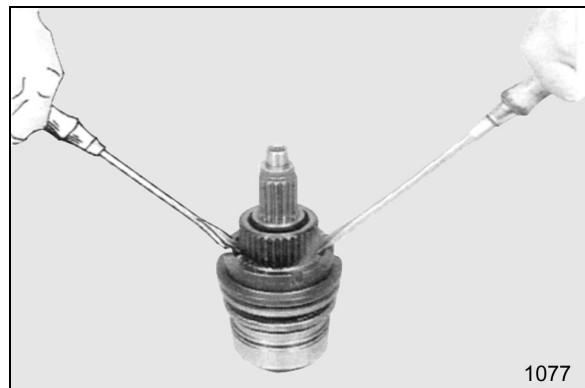


Figure 23

18. Remove piston from drive shaft.

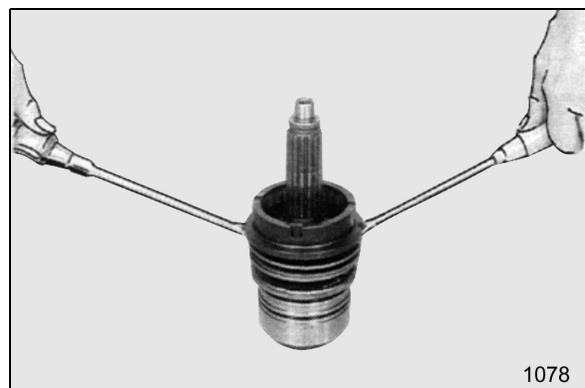


Figure 24

19. Remove cup spring pack.

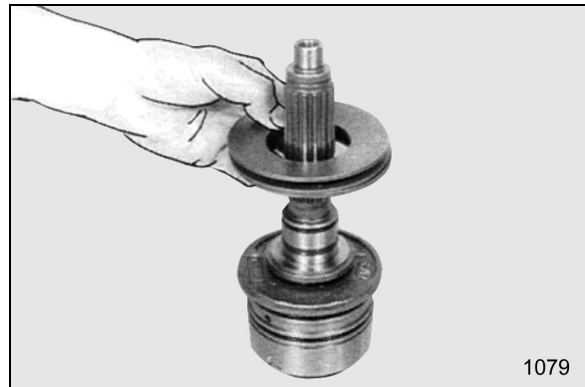


Figure 25

20. Remove seal ring and O-ring. Remove disc.

NOTE: *Seal rings have to be replaced.*



Figure 26

21. Remove snap ring.



Figure 27

22. Remove snap ring from 85 mm (3.35 in) ring groove of guide bushing.



Figure 28

23. Separate guide bushing from drive shaft.

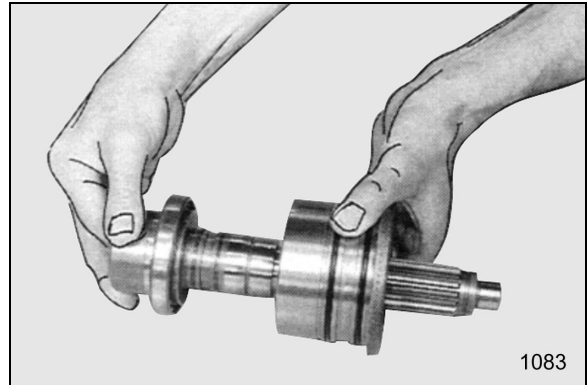


Figure 29

24. Remove snap ring and shaft seal.



Figure 30

25. Remove snap ring and press bearing off shaft.

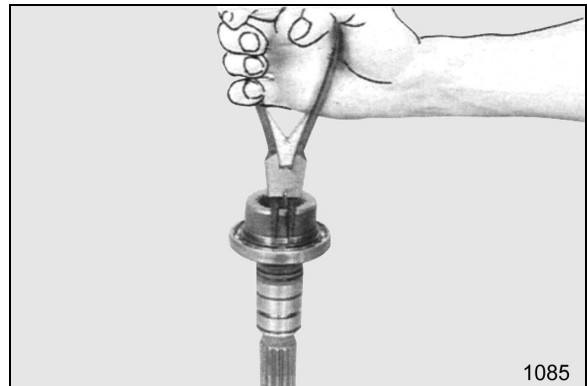


Figure 31

26. Remove throttle valve.



Figure 32

DISASSEMBLING PLANETARY DRIVE

1. Remove snap ring.

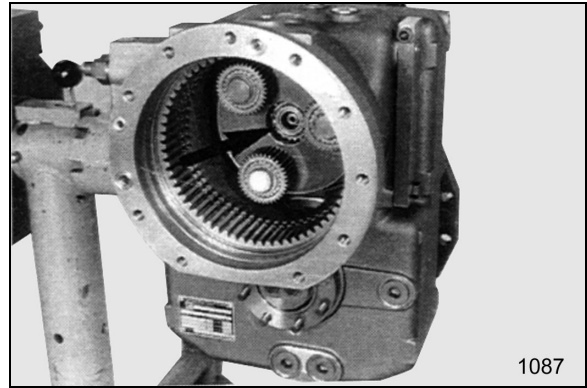


Figure 33

2. Turn housing so that it faces up, and remove the planetary gear carrier from the helical gear using an internal puller.

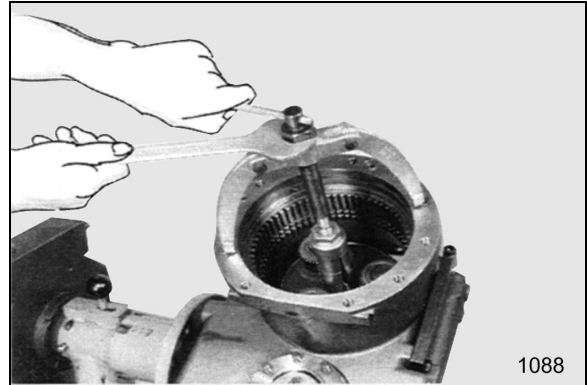


Figure 34

3. Remove snap ring.

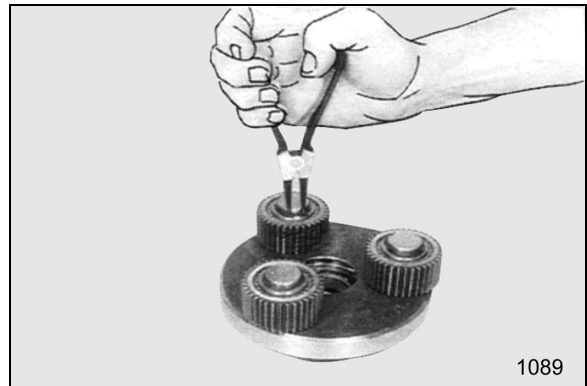


Figure 35

4. Remove planetary gear from gear shaft using an L-type driver.



Figure 36

5. Remove inner race of bearing using puller.

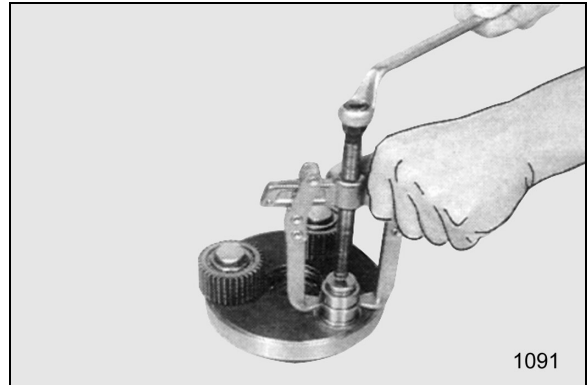


Figure 37

6. Remove snap ring and ball bearing.



Figure 38

DISASSEMBLING CLUTCH AND SPUR GEAR

1. Loosen hex bolts and remove sliding collar and block.

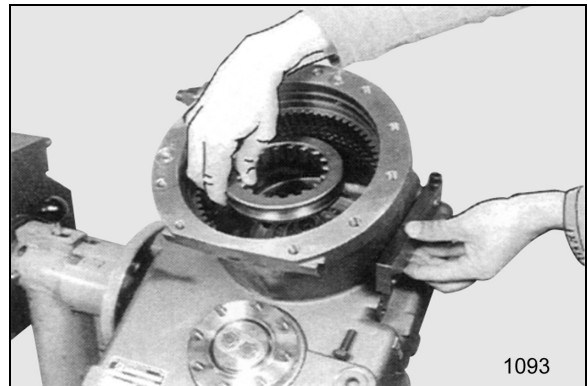


Figure 39

2. Loosen plug.

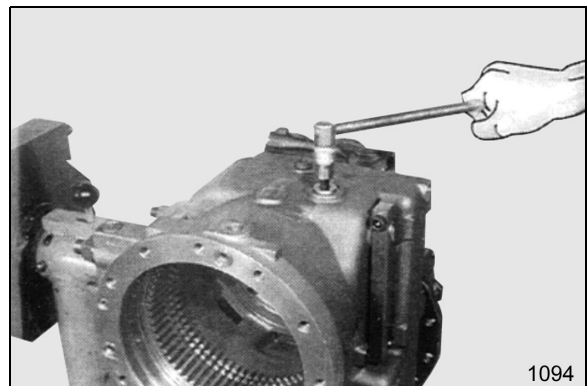


Figure 40

3. Drive out roll pin.

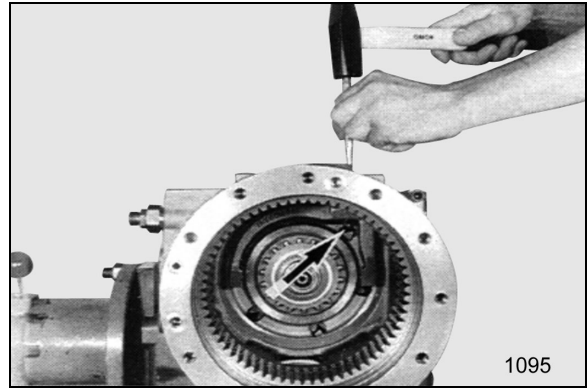


Figure 41

4. Pry shift lever out of bore in housing and detach shift fork.

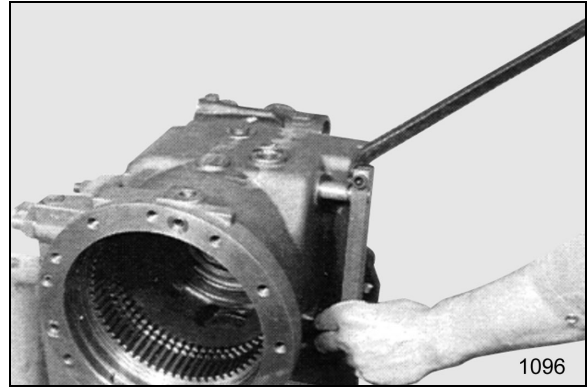


Figure 42

5. Remove suction line.

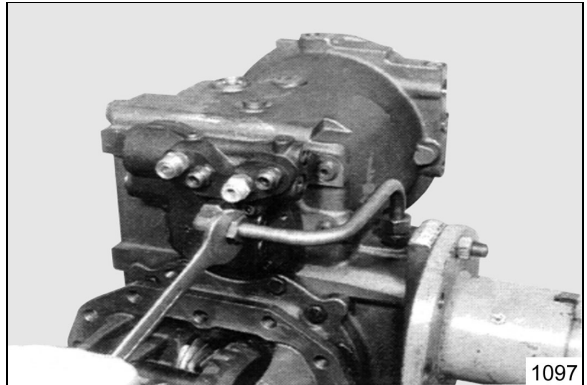


Figure 43

6. Loosen four hex socket bolts and remove shift lock from housing.

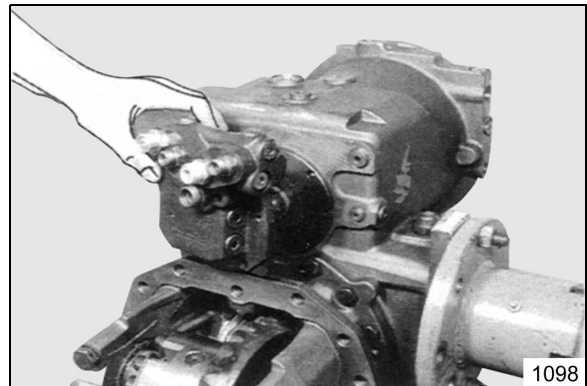


Figure 44

7. Pull rotor set from shaft and remove drive ball.

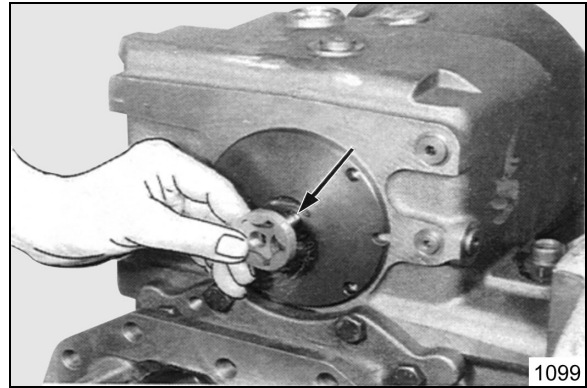


Figure 45

8. Pry pump cover out of housing.

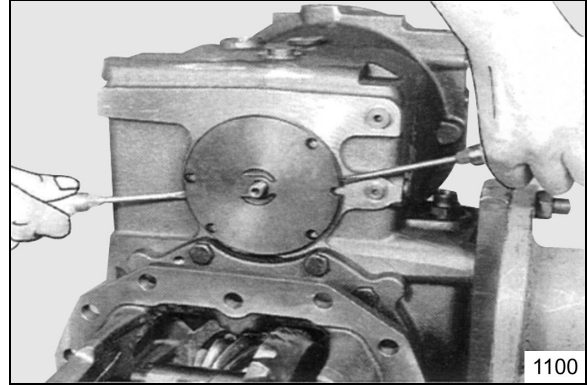


Figure 46

9. Remove snap ring.

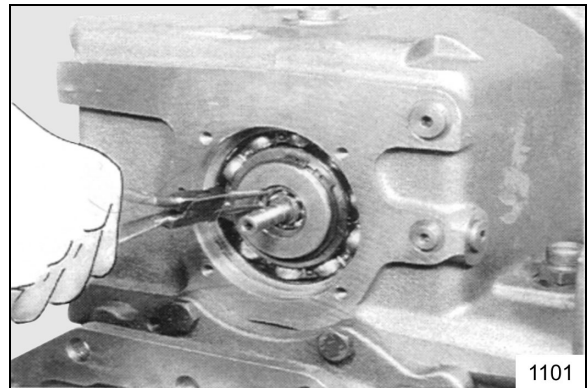


Figure 47

10. Remove pump shaft.

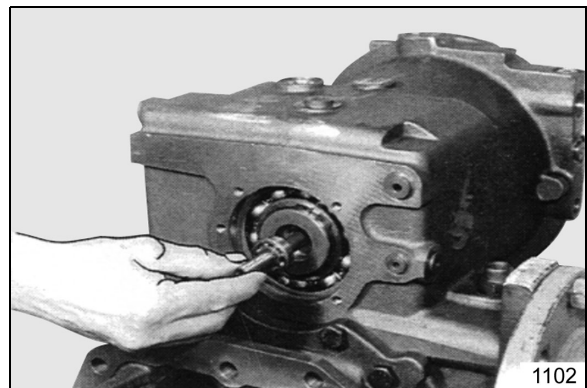


Figure 48

11. Remove snap ring.

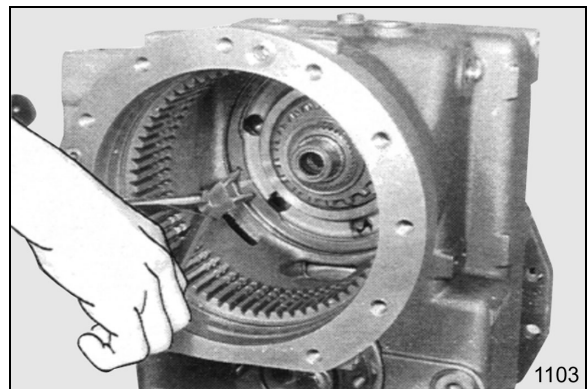


Figure 49

12. Pry off helical gear and lift from housing.

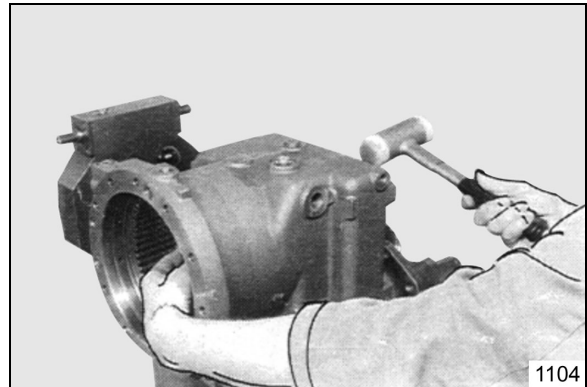


Figure 50

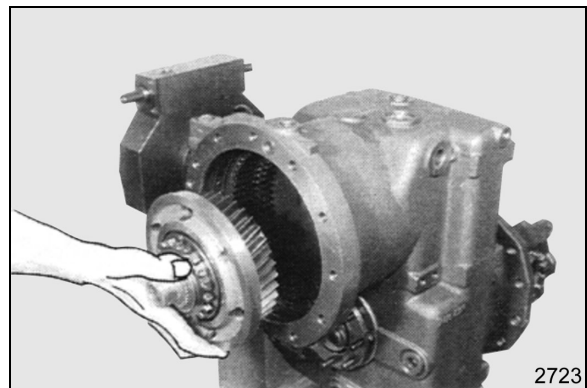


Figure 51

13. Remove snap ring and shim.



Figure 52

14. Remove shift dog and, on some models, remove spacer.

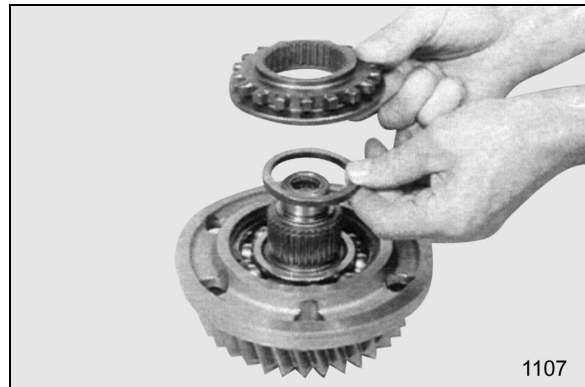


Figure 53

15. Pull needle bearing from bore of housing using an internal puller.



Figure 54

16. Press helical gear from bearing cup.

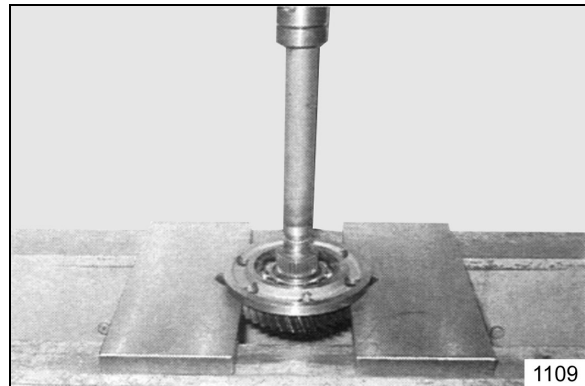


Figure 55

17. Remove snap ring and press ball bearing out of bearing cup.



Figure 56

18. Remove snap ring.

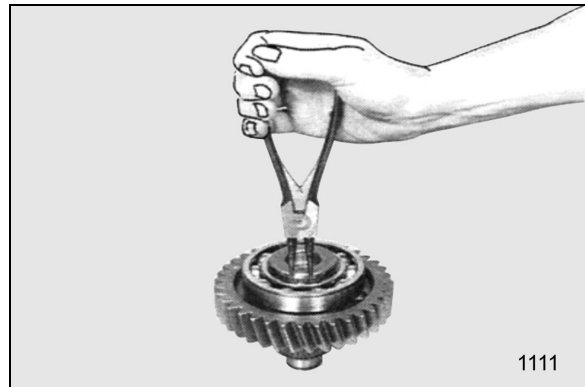


Figure 57

19. Pry ball bearing off collar of helical gear.



Figure 58

DISASSEMBLING SHIFT LOCK

NOTE: *If oil pump rotor or valve body is damaged, replace entire shift lock.*

1. Remove control spool.



Figure 59

2. Heat and remove set screw; disassemble control spool.

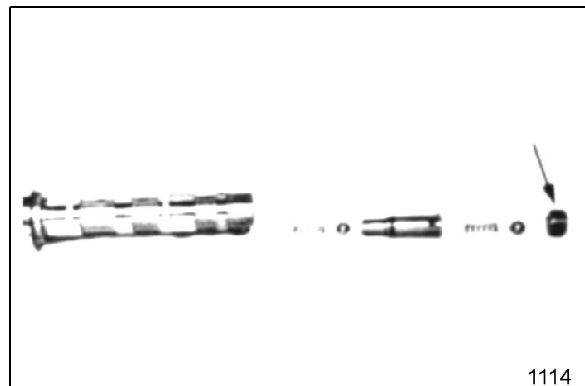


Figure 60

3. Remove pilot spool.

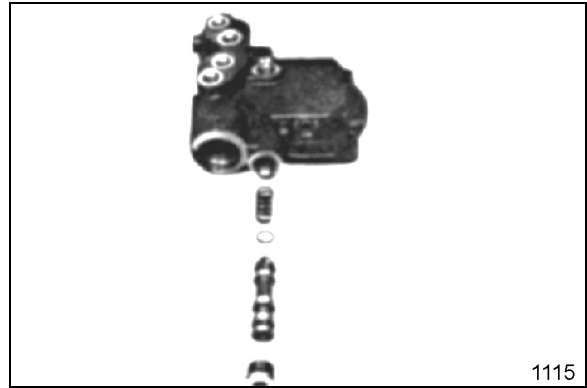


Figure 61

4. Remove shuttle valve.

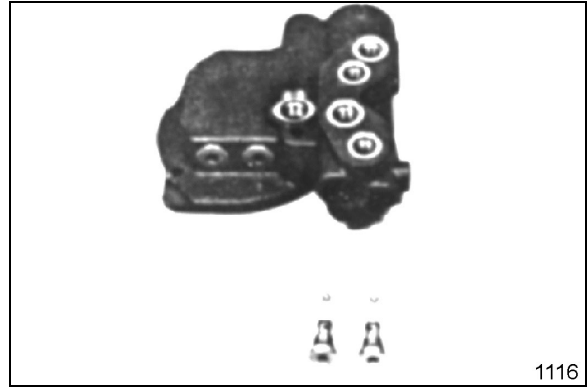


Figure 62

5. Disassemble shuttle valve using special tool to remove bushing.



Figure 63

6. Remove diaphragm, which is secured in place with Loctite.

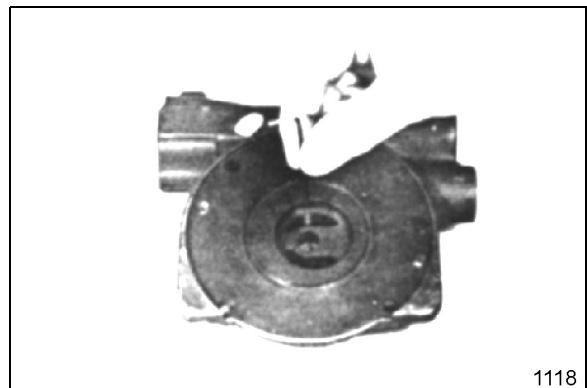


Figure 64

FINAL DRIVE, DRIVE SHAFT AND DIFFERENTIAL DISASSEMBLY

1. Loosen hex bolts and remove flange.



Figure 65

2. Pry out shaft seal.



Figure 66

3. Turn housing so that it faces up, loosen hex bolts and remove drive shaft, (using adjusting screws), and taking care not to damage inner bearing race or shim.

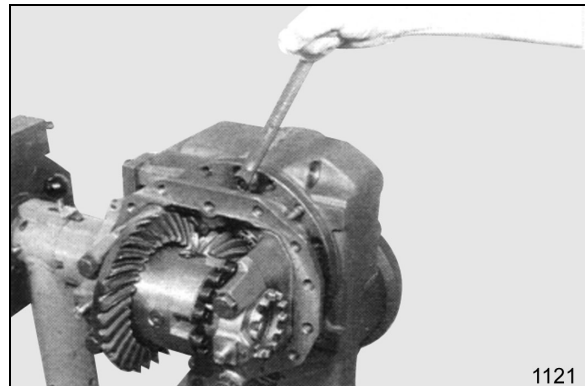


Figure 67

4. Remove output gear from drive pinion.



Figure 68

5. Remove baffle plate.

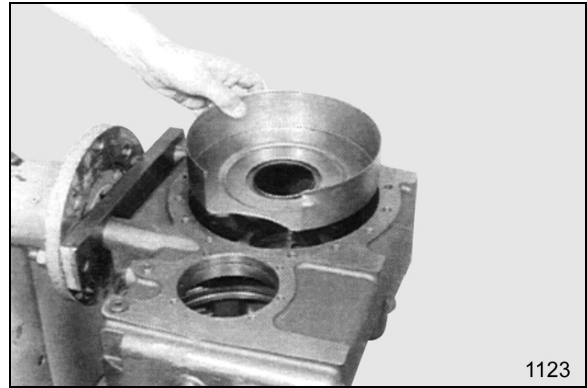


Figure 69

6. Drive bearing outer race out of housing.

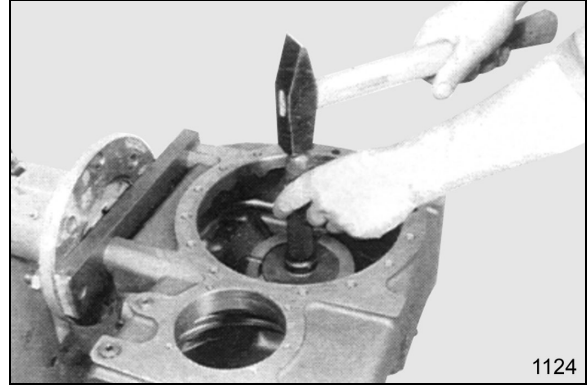


Figure 70

7. Remove shaft seal from housing.

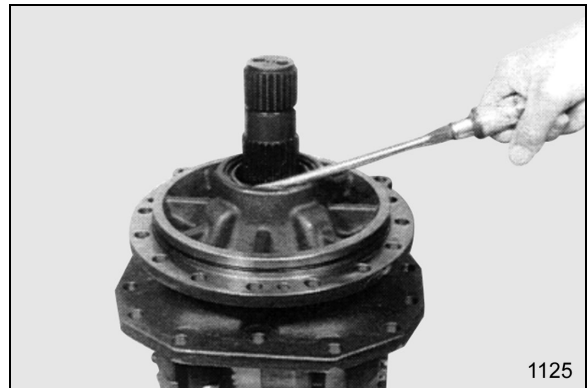


Figure 71

8. Secure axle carrier, using an assembly type fixture. Drive out roll pins.

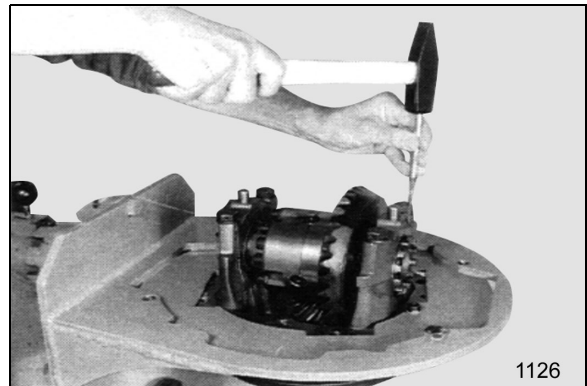


Figure 72

9. Remove differential bearing preload by loosening adjusting nut.

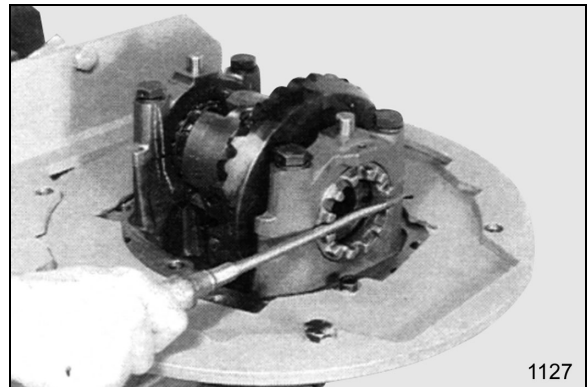


Figure 73

10. Loosen hex head screws and remove bearing caps and adjusting nuts.

NOTE: *Mark position of bearing caps and position of crown wheel.*

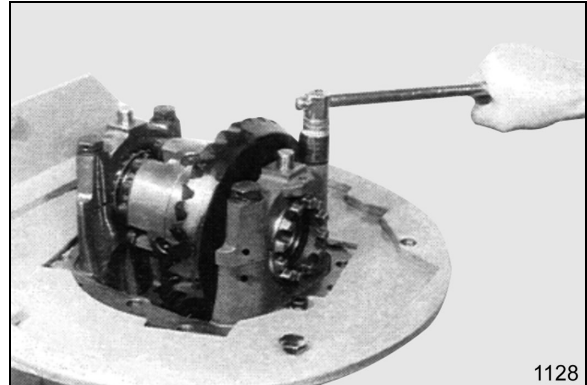


Figure 74

11. Lift differential assembly out of axle carrier.

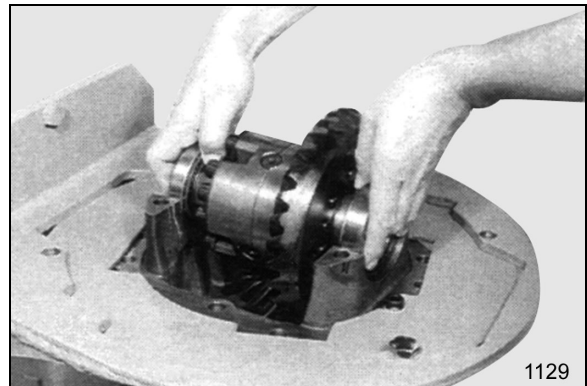


Figure 76

12. Remove inner bearing races, using puller.



Figure 77

13. Loosen socket head screws.



Figure 78

14. Separate halves of differential case and remove loose components.

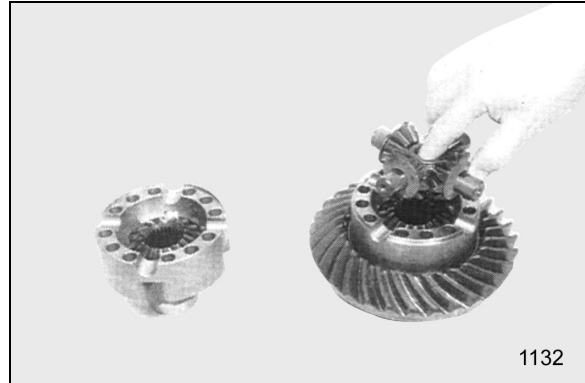


Figure 79

15. Press crown wheel from differential case.

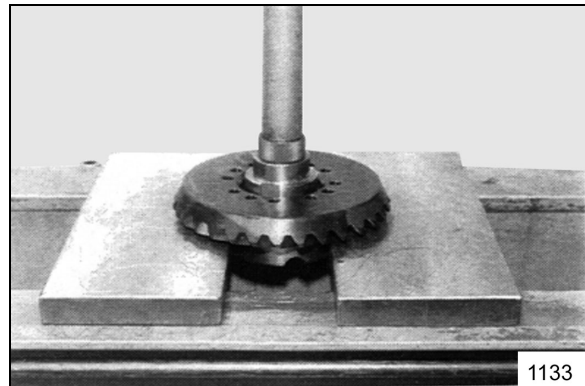


Figure 80

16. Remove drive pinion.

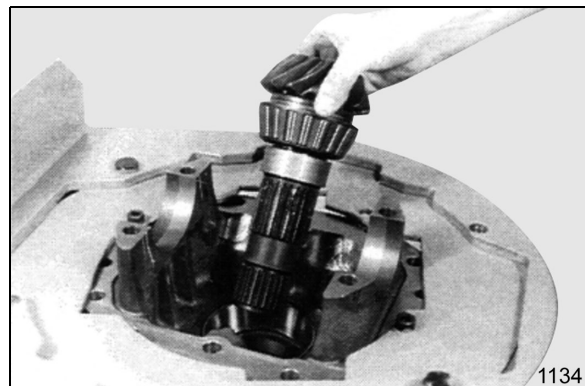


Figure 81

17. Remove O-ring and bushing.



Figure 82

18. Pull tapered roller bearing from drive pinion.



Figure 83

19. Pull bearing outer race from housing bore, using internal puller.

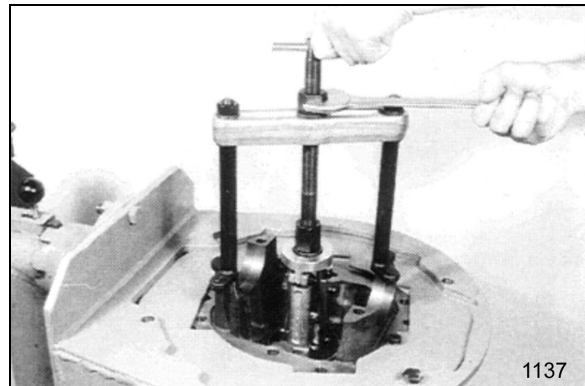


Figure 84

20. Remove shim.

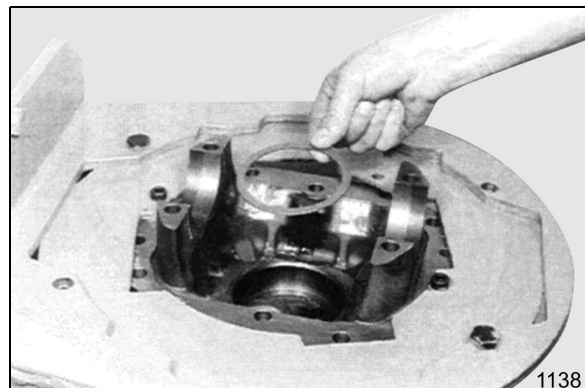


Figure 85

TRANSMISSION REASSEMBLY

NOTE: Replace all seals and damaged components.

NOTE: Crown wheel and drive must be replaced as a matched assembly.

NOTE: Use oil to protect seal lips and other compounds such as Loctite and silicon as directed in reassembly.

SHIMMING DRIVE PINION

1. Install shims, two bearing caps, pin, and measuring shaft.

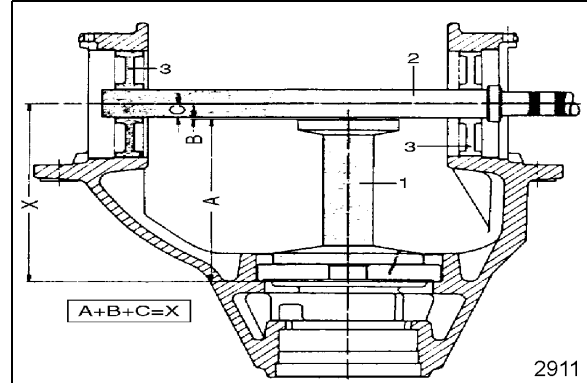


Figure 86

2. Measure gap between pin and shaft using feeler gauge.

Example:

Dimension A (pin) 134 mm (5.275 in)

Dimension B (gap) +0.85 mm (0.33 in)

Dimension C +15.00 mm (0.590 in)

(1/2 dia of shaft) _____

Dimension X = 149.85 mm (5.899 in)

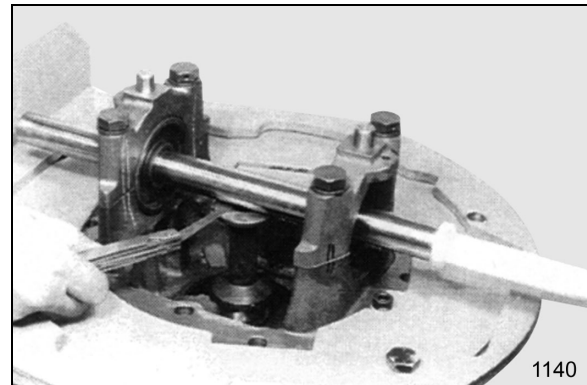


Figure 87

3. Measure bearing width.

Example:

Bearing Width: 36.5 mm (1.437 in)

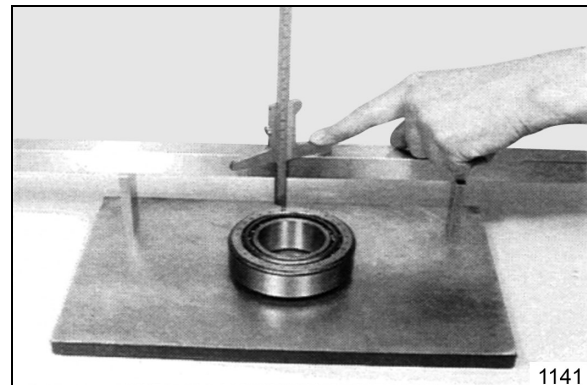


Figure 88

4. Measure pinion.

Example:	
Bearing width	36.5 mm (1.437 in)
Pinion dimension (112 - 0.15 mm)	+111.85 mm (4.404 in)
gives Dimension X ¹	= 148.35 mm (5.840 in)

5. Subtract X¹ from X to find shim thickness.

Example:	
Dimension X	149.85 mm (5.899 in)
Dimension X ¹	- 148.35 mm (5.840 in)
Gives Shim Thickness	= 1.5 mm (0.059 in)

REASSEMBLING DRIVE PINION

1. Remove bearing caps, shims and measuring shaft.
2. Insert shim, determined according to Steps 2 through 4 above, in housing bore.
3. Chill bearing outer race and seat firmly against shoulder.

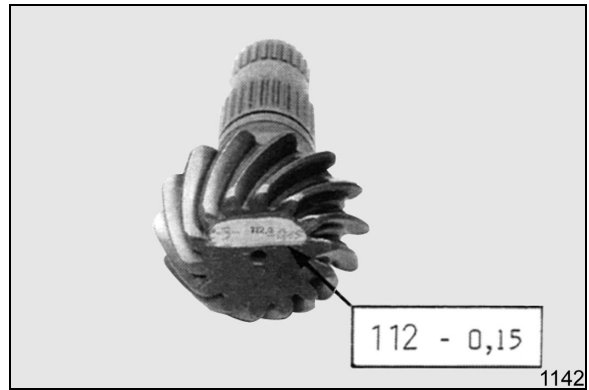


Figure 89

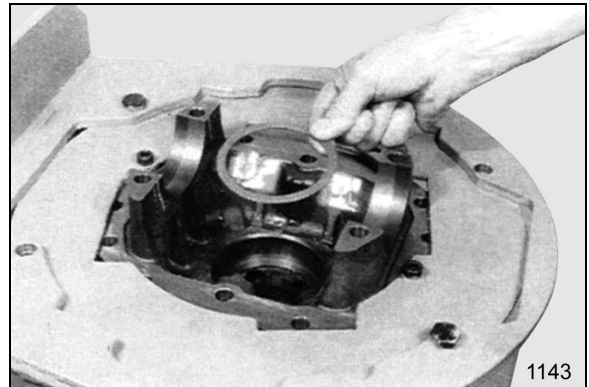


Figure 90

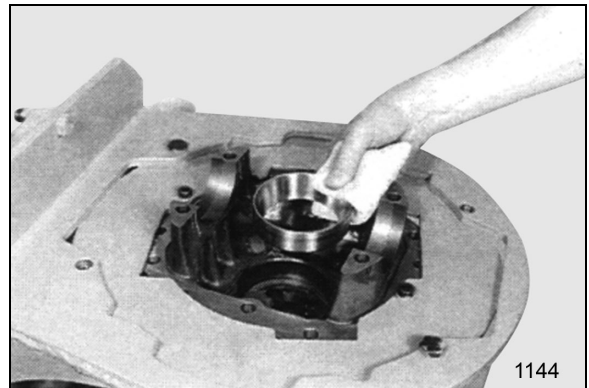


Figure 91

4. Insert second outer race in housing bore.

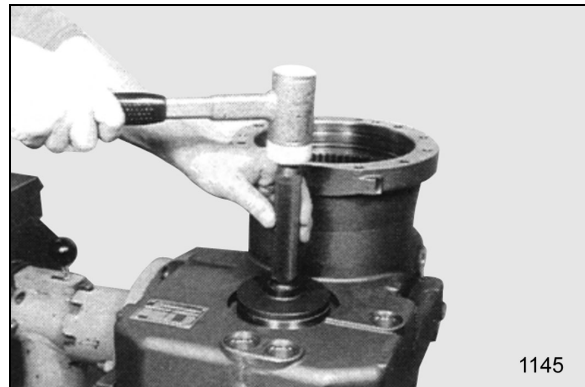


Figure 92

5. Install new seal using Loctite #586 and install adapter.

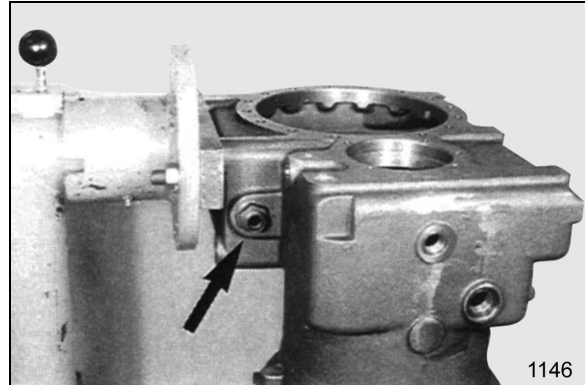


Figure 93

6. Install oil pipe, using hex head screws secured with Loctite #586. Torque to maximum of 23 N•m (5 ft lb).

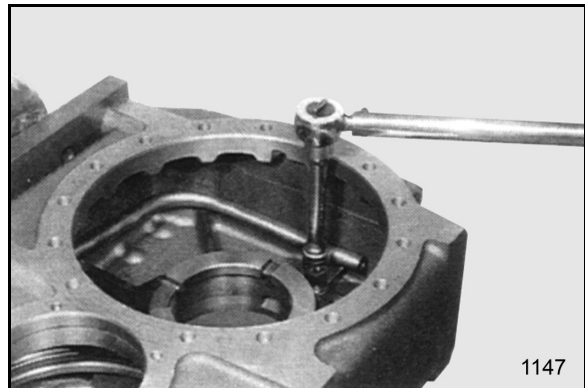


Figure 94

7. Note installation position (Figure 95) and install baffle plate firmly against shoulder.

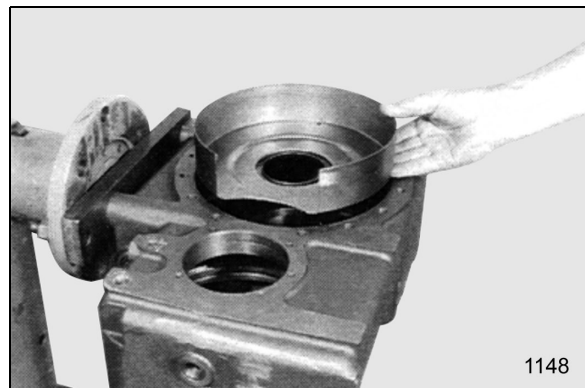


Figure 95

8. Lubricate outer diameter and grease sealing lip of shaft seal. Install shaft seal, open side up, firmly against shoulder. Install O-ring.



Figure 96

9. Install output gear as shown.

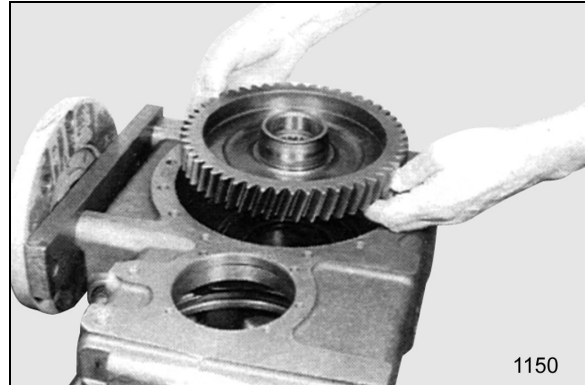


Figure 97

10. Install two adjusting screws, assemble housing as shown. Secure housing with two hex head screws and torque to 79 N•m (18 ft lb).

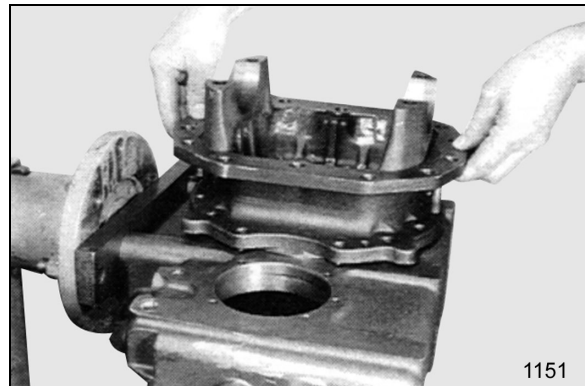


Figure 98

11. Heat and install tapered roller bearing.



Figure 99

12. Install bushing. Grease O-ring and install in ring groove.



Figure 100

13. Install drive pinion.

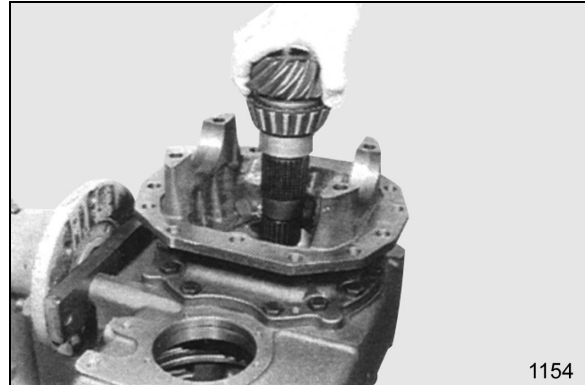


Figure 101

14. Secure drive pinion so that it will not turn, using puller.

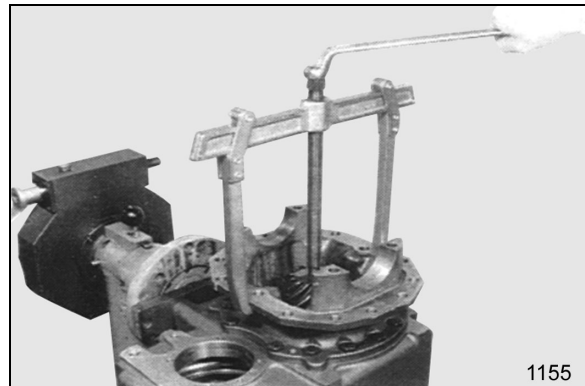


Figure 102

15. Turn housing 180°, place output gear firmly over O-ring, and install shim and bearing inner race.

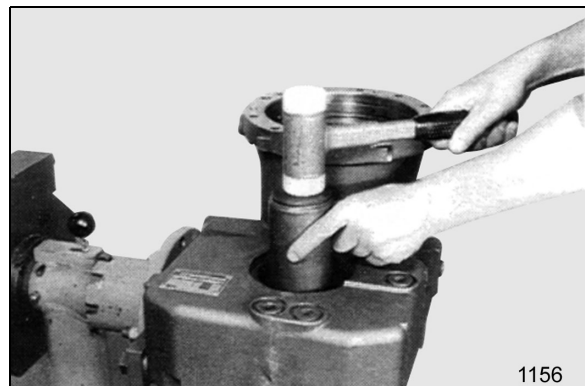


Figure 103

ADJUSTING ROLLING RESISTANCE OF DRIVE PINION BEARING

1. Install 2.60 mm (0.10 in) shim.

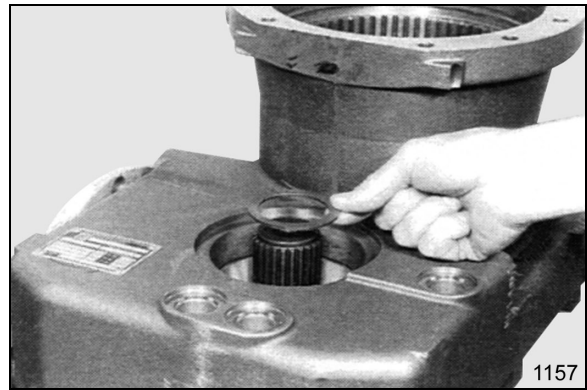


Figure 104

2. Heat and install bearing inner race.



Figure 105

3. Place output flange in position.



Figure 106

4. Secure output flange with disk and hex head screws, turning drive pinion several times while tightening. Torque to 46 N•m (10 ft lb).

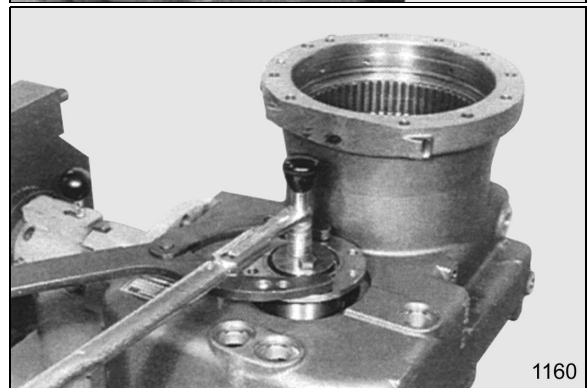


Figure 107

5. Check movement of drive pinion bearing. If rolling resistance does not fall between 2.5 N•m (0.56 ft lb) to 3.5 N•m (0.78 ft lb), adjust thickness of shim(s).

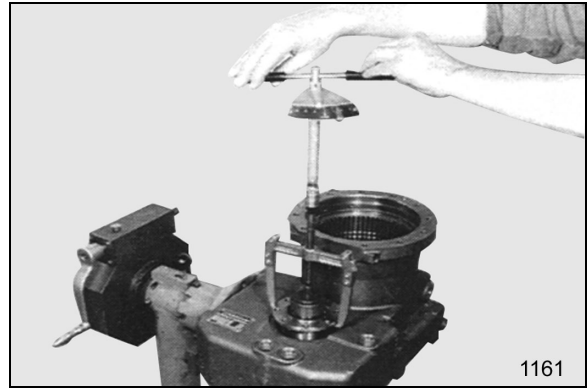


Figure 108

6. Lubricate outer diameter and grease sealing lip of shaft seal. Install shaft seal to a depth of exactly 2.1 mm (0.0827") using driver.



Figure 109

7. Install output flange, tightening hex head screws evenly to allow mounting of dust shield.



Figure 110

8. Press plate against collar of output flange.

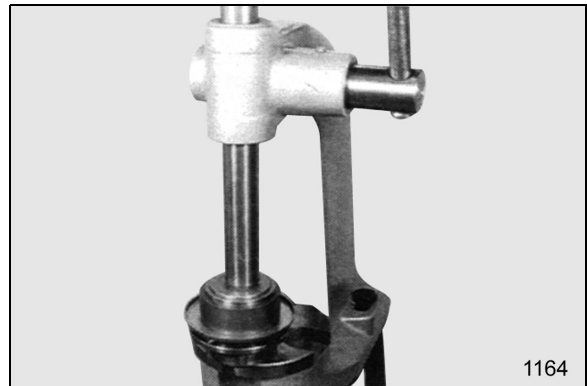


Figure 111

9. Install output flange. Grease and install O-ring.

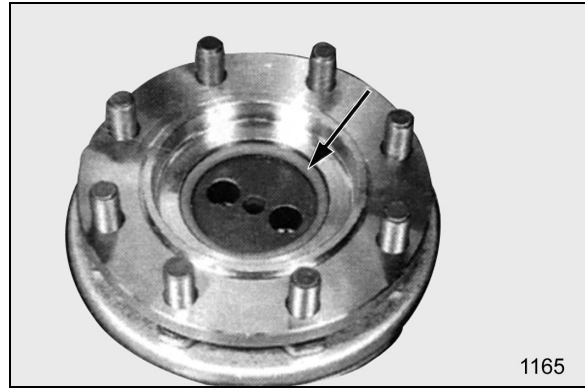


Figure 112

10. Secure output flange using washers and hex head screws. Torque to 46 N•m (10 ft lb).

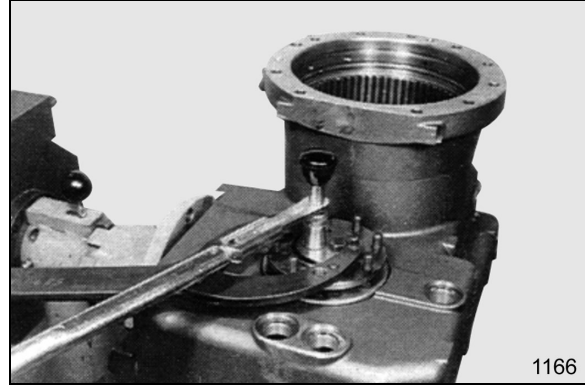


Figure 113

11. Secure output flange screws with lock plate.

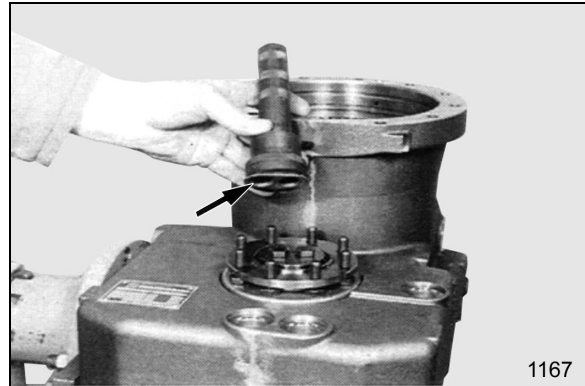


Figure 114

INSTALLING DIFFERENTIAL

NOTE: *Oil all differential components using DA 85W/90 before reassembly.*

1. Drive in two roll pins per bore, spaced 180° apart, in differential case half.

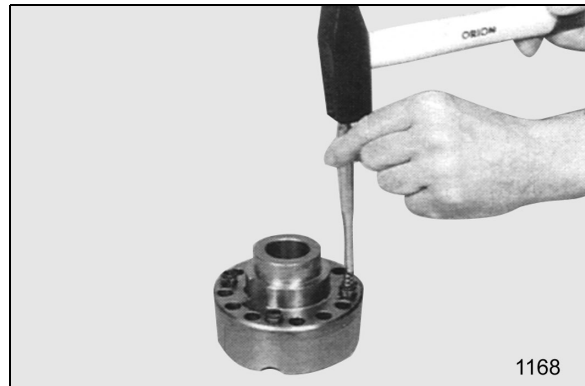


Figure 115

2. Press crown wheel onto roll pins.

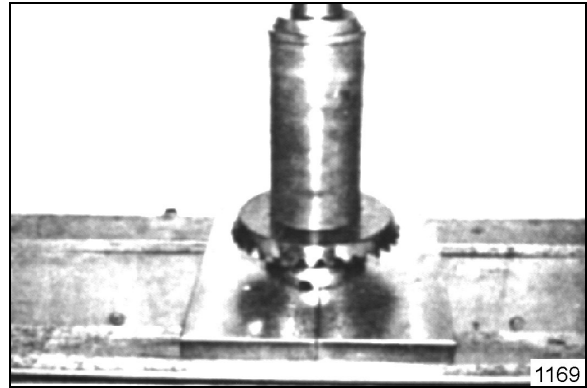


Figure 116

3. Install thrust washer.



Figure 117

4. Install side gear.



Figure 118

5. Install spider assembly and second side gear, making sure thrust washer lobes face up.



Figure 119

6. Use grease so that thrust washers will adhere to differential, and install differential.

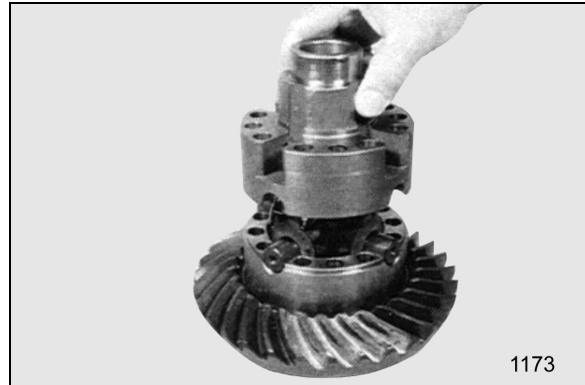


Figure 120

7. Secure differential in a fixture. Install segments and torque socket head screws to 145 N•m (33 ft lb).

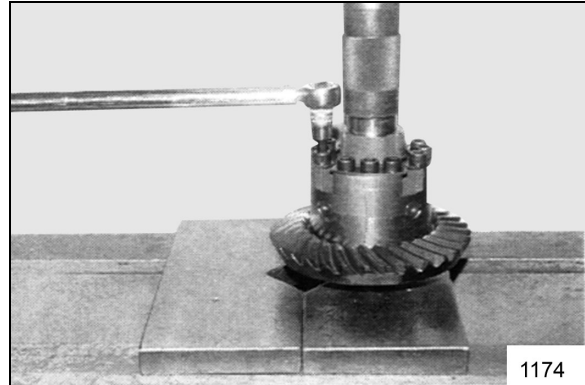


Figure 121

8. Press both inner races of differential bearing firmly against shoulder.

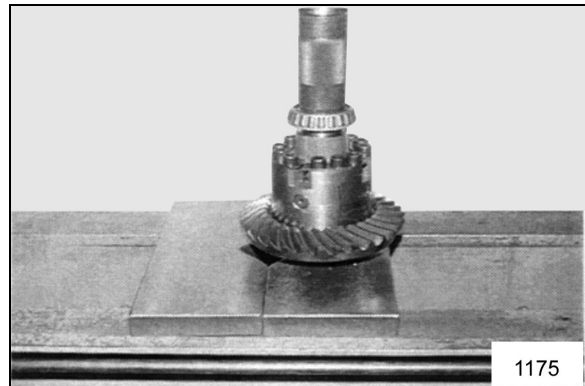


Figure 122

9. Install bearing outer races and insert differential into axle carrier, noting position of crown wheel in next step.

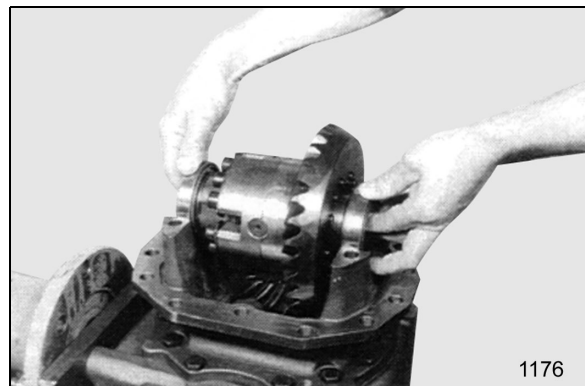


Figure 123

10. Note crown wheel position: arrow shows direction of Forward Drive.

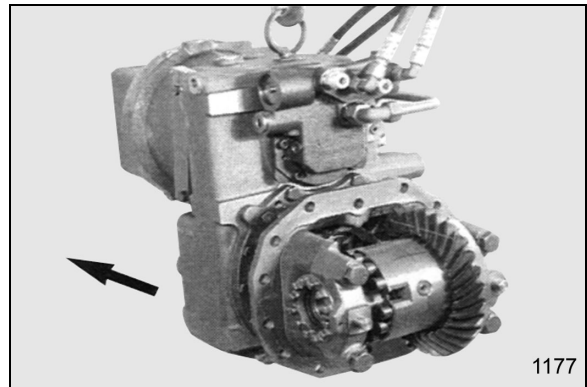


Figure 124

11. Screw two adjusting nuts into bearing bores.

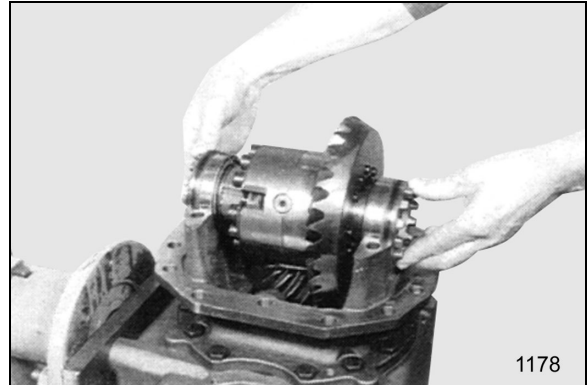


Figure 125

12. Using Loctite #242, drive straight pins fully into bores of bearing caps.

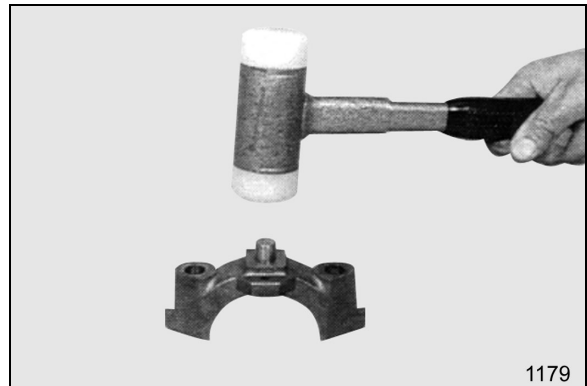


Figure 126

13. Note correct installation position and install two bearing caps with hex head screws. Torque to 195 N•m (44 ft lb).

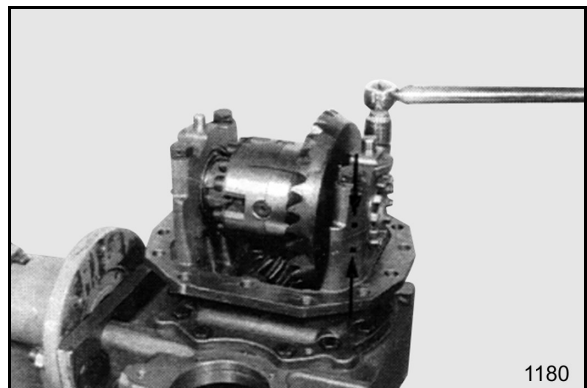


Figure 127

ADJUSTING BACKLASH AND BEARING PRELOAD

NOTE: *Note backlash value marked on crown wheel. Bearing pre-load is 1 - 4 N•m (0.22 - 0.89 ft lb).*

1. Install dial indicator at right angle to side of tooth.
2. Adjust adjusting nut on crown wheel side until backlash is correct.
3. Screw in second adjusting nut, on side opposite to crown wheel, until there is no play in differential bearing.
4. Tighten adjusting nut two more notches to obtain differential bearing preload.
5. Check backlash again while rotating differential several times, correct if necessary.
6. Check that dimension is 216 ± 0.05 mm (8.5 ± 0.002 "); correct if necessary by repeating last step of differential installation and Steps 1 - 5 in this adjustment procedure.
7. Install dial indicator on back side of crown wheel and make one full rotation to determine run out. Maximum run-out is 0.08 mm (0.003 in).

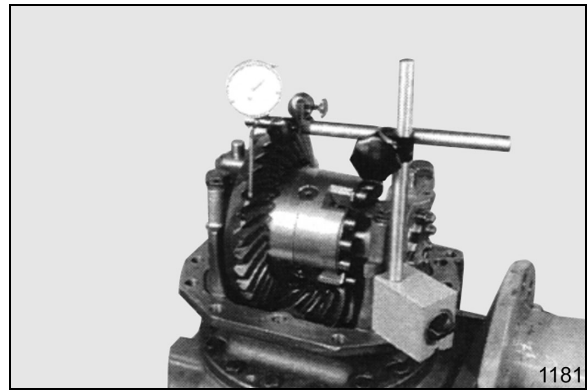


Figure 128

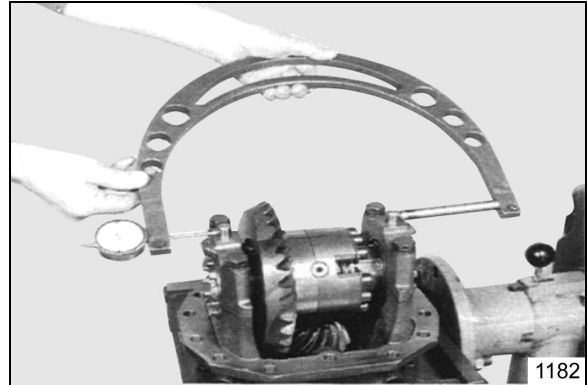


Figure 129

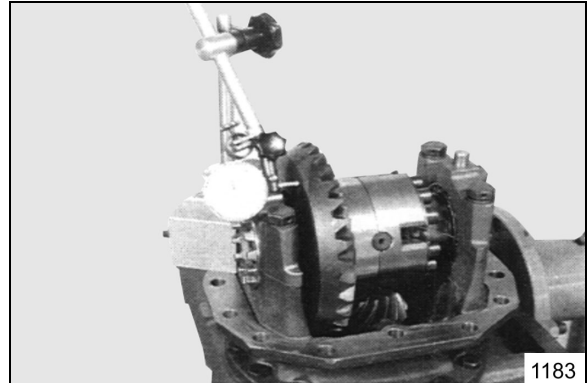


Figure 130

8. Cover several crown wheel teeth with gear marking compound, roll crown wheel back and forth over drive pinion, and compare contact pattern with samples in Figure 217 thru Figure 222 at the end of this section.

NOTE: *If contact pattern is incorrect, unit must be reshimmed.*

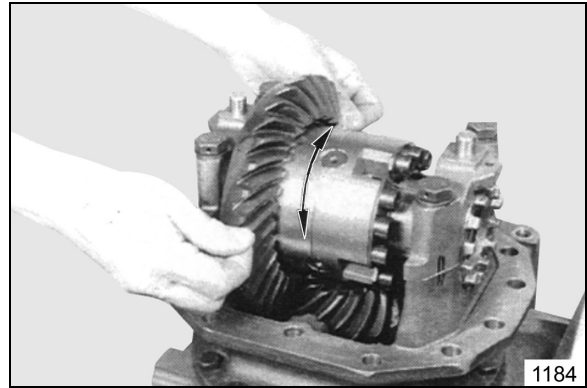


Figure 131

9. When adjustment is correct, secure position of adjusting nuts using straight pins.

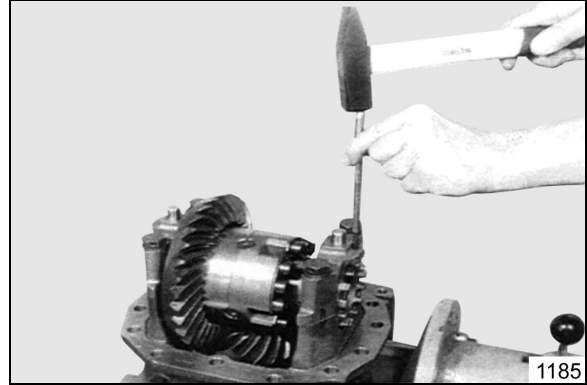


Figure 132

INSTALLING HELICAL GEAR AND CLUTCH

1. Install ball bearing in bearing cover and secure with retaining ring.
2. Press ball bearing over collar of helical gear and secure with retaining ring.



Figure 133

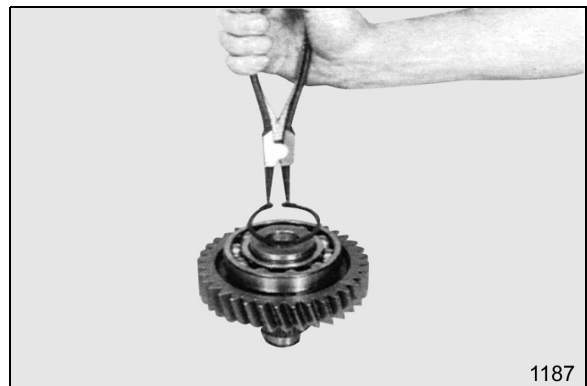


Figure 134

3. Press bearing cover, retaining ring up, firmly onto shoulder.

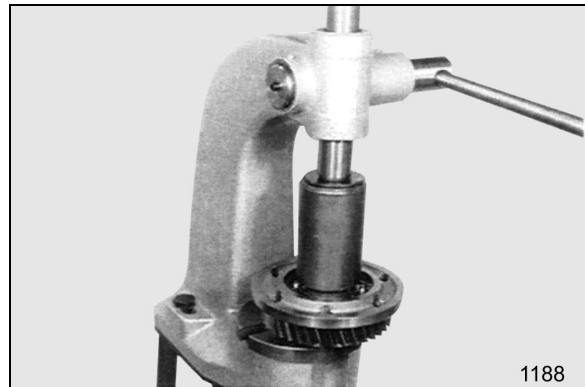


Figure 135

4. Install spacer, on some models, and shift dog.



Figure 136

5. Secure shift dog with shim and retaining ring; maximum end play is 0.1 mm (0.0039 in).



Figure 137

6. Check installation position in illustration and press needle bearing firmly against shoulder.

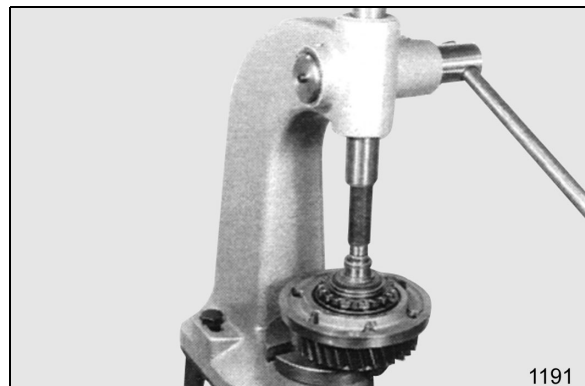


Figure 138

7. Insert preassembled helical gear into housing bore.

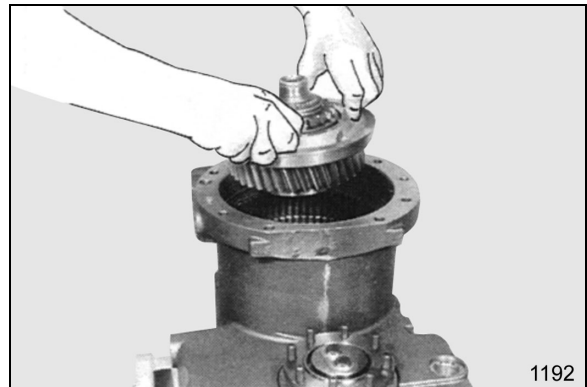


Figure 139

8. Secure bearing cover with retaining ring.

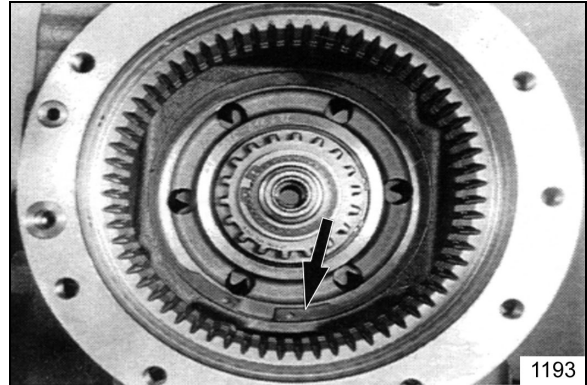


Figure 140

NOTE: *Shift Dog Assembly is shown.*

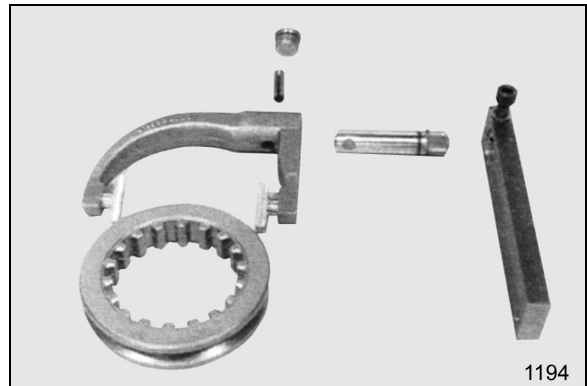


Figure 141

9. Install retaining ring (1) and O-ring (2).



Figure 142

10. Insert shift fork and sliding collar.

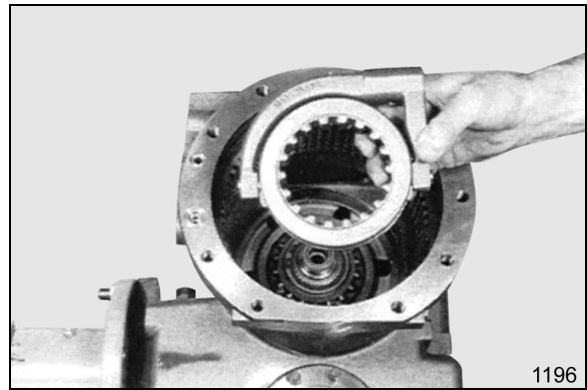


Figure 143

11. Install shift shaft so that it is tight.

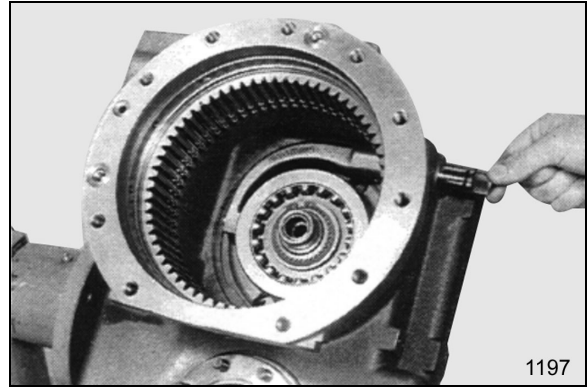


Figure 144

12. Align shift shaft radially and secure by driving in roll pin until it is flush.

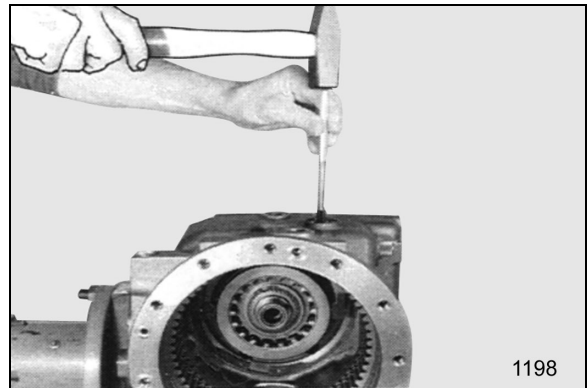


Figure 145

13. Install new O-ring and install screw plug, torque to 60 N•m (13.5 ft lb).

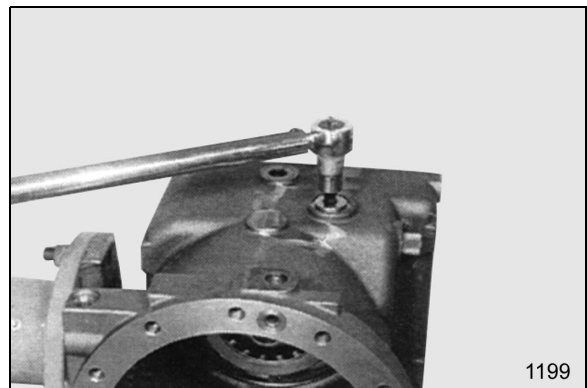


Figure 146

INSTALLING PLANETARY CARRIER

1. Grease cylindrical rollers and preassemble planetary gear.

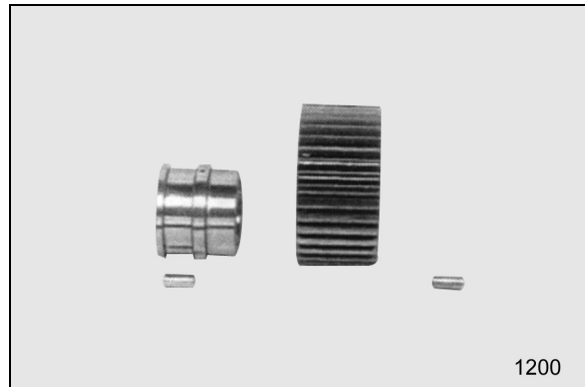


Figure 147

2. Press planetary gear firmly against shoulder.

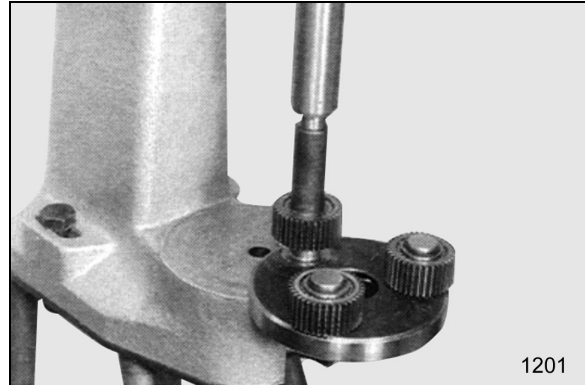


Figure 148

3. Install collar shim and retaining ring.

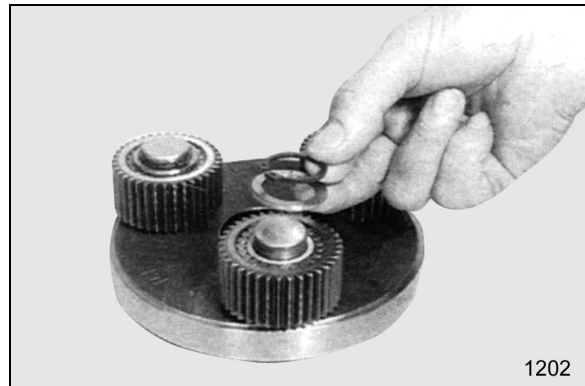


Figure 149

4. Install ball bearing firmly on shoulder and secure with retaining ring.



Figure 150

5. Heat ball bearing and install planetary carrier.

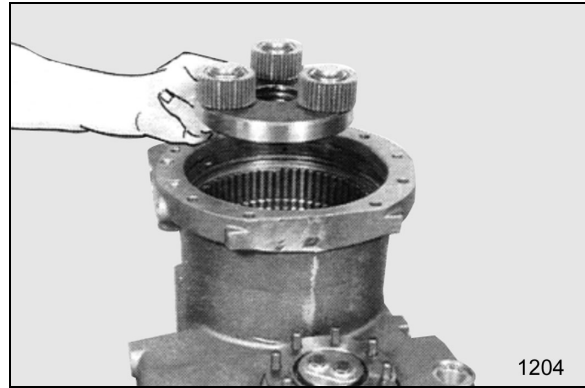


Figure 151

6. Secure planetary carrier with retaining ring.

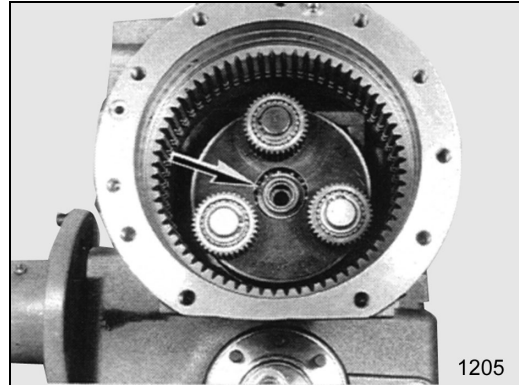


Figure 152

ADJUSTING SHIFT LEVER

1. Install shift lever and secure temporarily in "OFF" Position with hex screw.
2. Turn shift shaft clockwise to stop, using (temporary) screw, and secure shift lever using socket head screw and flat washer. Torque to 46 N•m (10 ft lb).

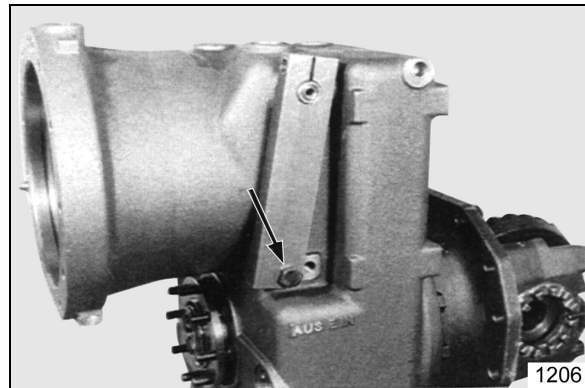


Figure 153

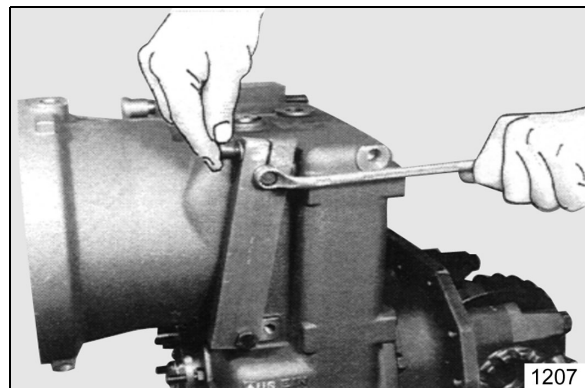


Figure 154

3. Turn shift lever to "ON" position and fasten with hex head screw. Torque to 46 N•m (10 ft lb).

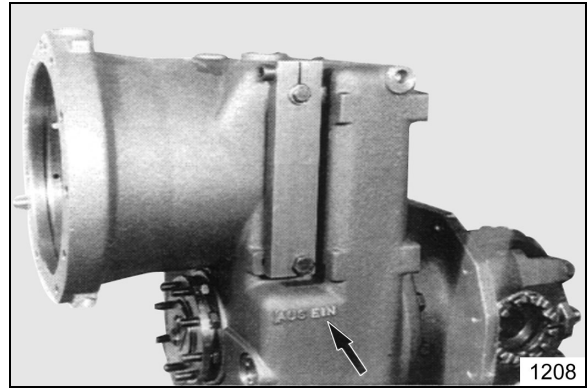


Figure 155

PREASSEMBLING AND INSTALLING CLUTCH

1. Press ball bearing firmly against shoulder and secure with retaining ring.
2. Install two rings (rectangular cross section).
3. Wet outer diameter of shaft seal and grease sealing lip. Install to correct depth by using special driver.

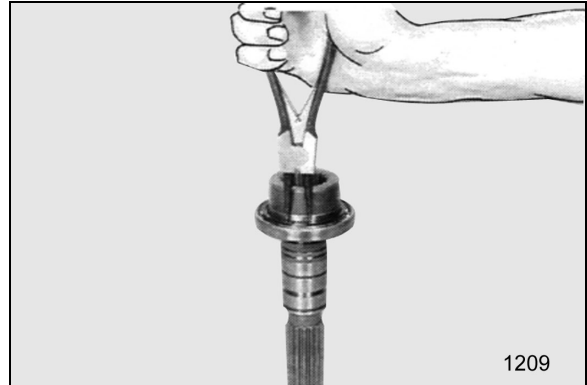


Figure 156



Figure 157

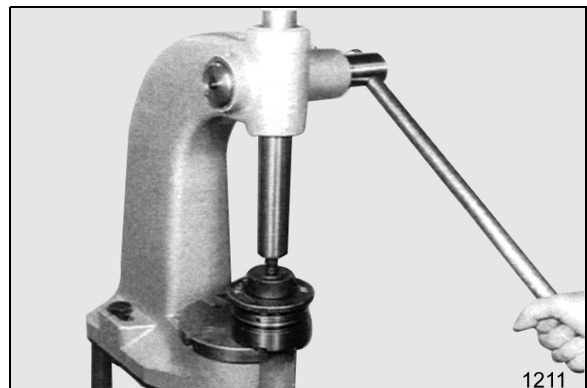


Figure 158

4. Secure shaft seal with retaining ring.



Figure 159

5. Grease two rings (with rectangular cross section), align vertically and press drive shaft into guide sleeve until seated.

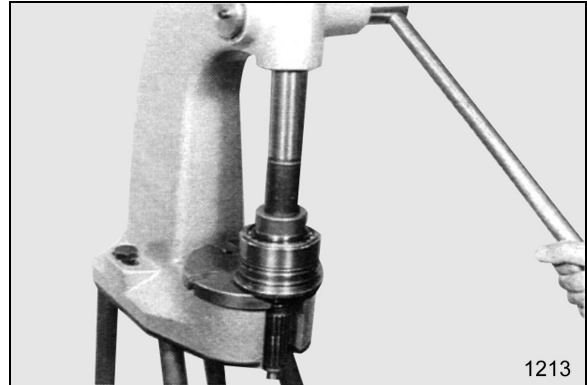


Figure 160

6. Secure drive sleeve with retaining ring.



Figure 161

7. Install retaining ring (one only). Install back plate with bevel facing up.



Figure 162

8. Determine value B from table and adjust if necessary, following Steps 9 - 13.

Number of Plate Pairs	Value B
10	$10.6 + 0.2 \text{ mm}$ ($0.417 \pm 0.0079"$)
11	$7.8 + 0.2 \text{ mm}$ ($0.307 \pm 0.0079"$)

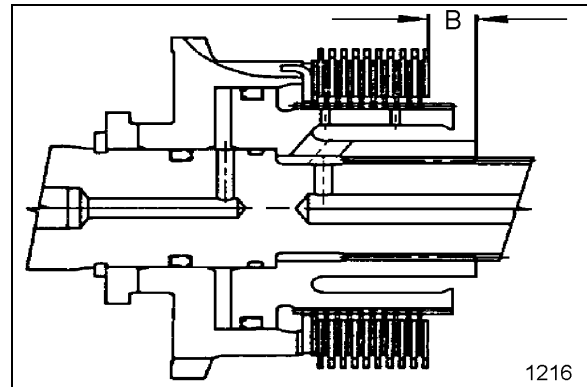


Figure 163

9. Install piston.



Figure 164

10. Install plate carrier and tap against shoulder until seated. See Figure 165 and Figure 166.



Figure 165



Figure 166

11. Install plate.

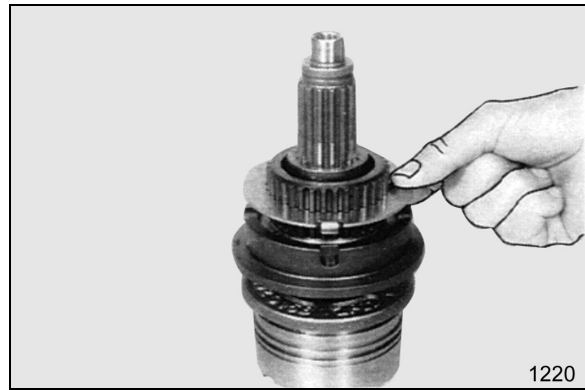


Figure 167

12. Determine number of plate pairs, using Parts List, and assemble the plate pack starting with an inner plate and using no oil.



Figure 168

13. Determine dimension B, the distance from face of inner plate carrier to outer plate and correct distance to 10.6 ± 0.2 mm (0.417 ± 0.0079 in) or 7.8 ± 0.2 mm (0.3071 ± 0.0079 in) using shims of 1.0, 1.2, 1.4, or 1.8 mm.



Figure 169

14. Determine end play of plate carrier, ball bearing and sun gear. Adjust to maximum end play of 0.1 mm (0.0039 in), using shim(s) in next Step. Install ball bearing and sun gear.



Figure 170

15. Assemble shim(s) of 3.0 - 3.9 mm (0.1181 - 0.1535 in), secure with retaining ring and check end play again. Remove all components including the piston assembled in Steps 9 - 15.



Figure 171

16. Grease lip of sealing ring and install, lip up, using driver.

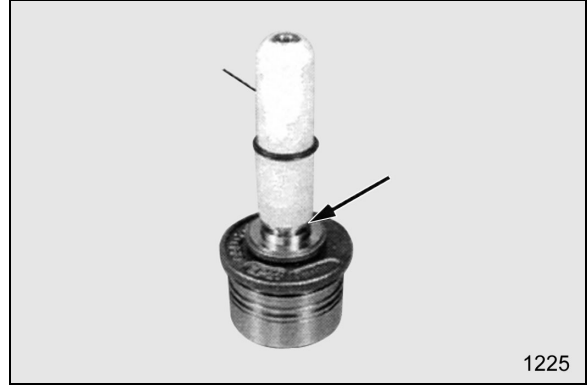


Figure 172

17. Grease and install O-ring.



Figure 173

18. Install cup springs according to illustration.



Figure 174

19. Install piston.



Figure 175

20. Grease seal ring and install lip down.
Install inner plate carrier against shoulder.



Figure 176

21. Install plate.



Figure 177

22. Oil and assemble plate pack.



Figure 178

23. Install ball bearing into centering disc and secure with snap ring.



Figure 179

24. Install centering disc in internal gear bore and secure with retaining ring.



Figure 180

25. Align outer plates radially and install internal gear.



Figure 181

26. Install sun gear.



Figure 182

27. Install end play shims determined in Steps 14 and 15.



Figure 183

28. Preload plate pack using an assembly type fixture and secure with retaining ring (one only).

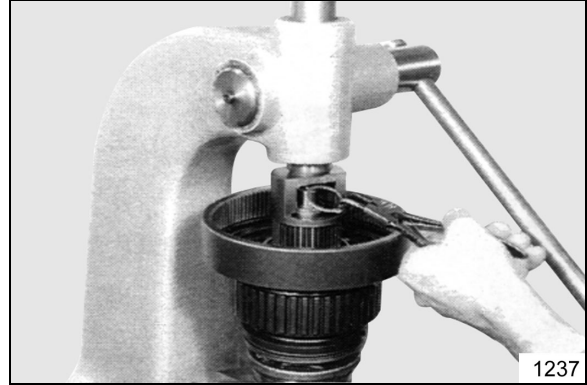


Figure 184

CHECKING CLUTCH

1. Install hydraulic connection.



Figure 185

NOTE: Test medium in following test should be TE-M107 or TEMPL2

2. Clean piston by blowing compressed air into it several times. Set test pressure to 35 bar (507 psi); use shut off valve to shut off pump, and check that pressure holds for 3 minutes.

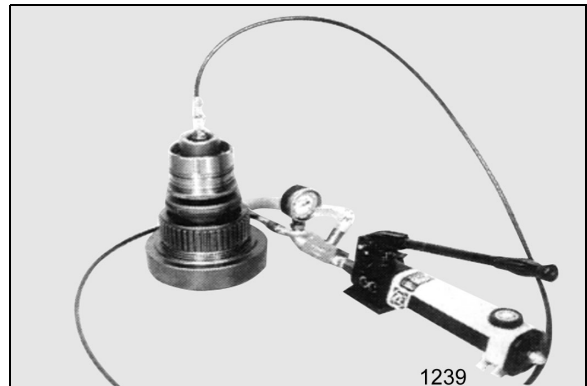


Figure 186

3. Remove pressure connection, install throttle valve and new O-rings.

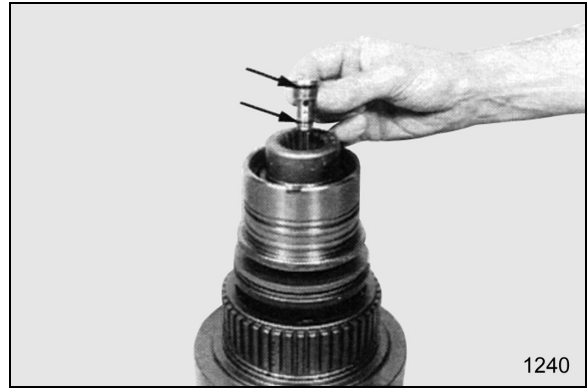


Figure 187

4. Install preassembled clutch.

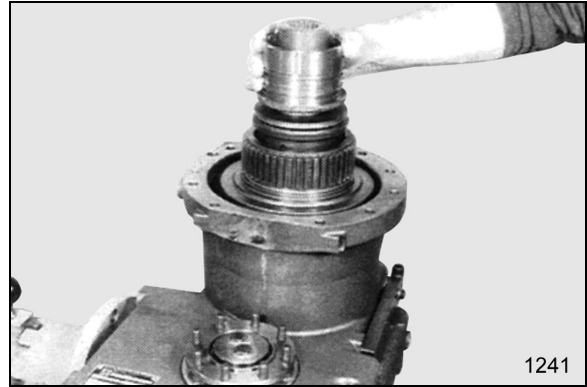


Figure 188

5. Install 190 x 4 retaining ring.

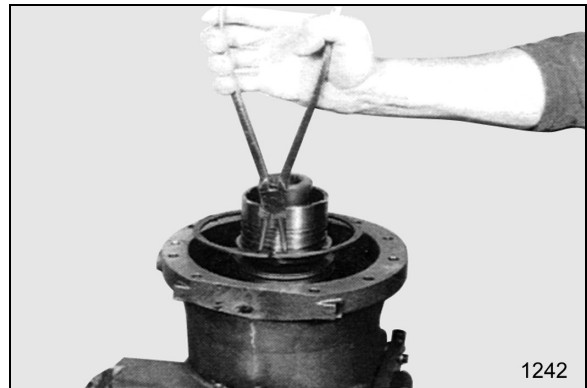


Figure 189

INSTALLING BRAKE

1. Install backing plate.

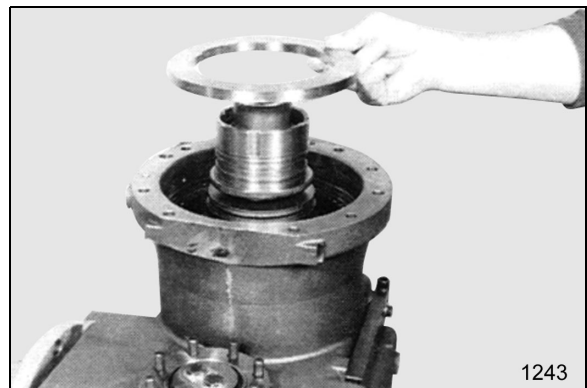


Figure 190

2. Determine number of plate pairs, using Parts List; oil and assemble the plate pack starting with an inner plate.

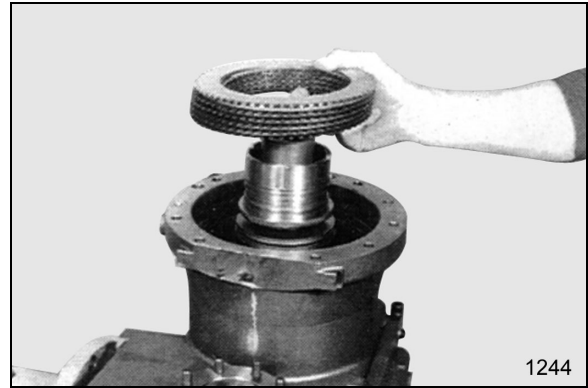


Figure 191

3. Seat piston firmly on shoulder.

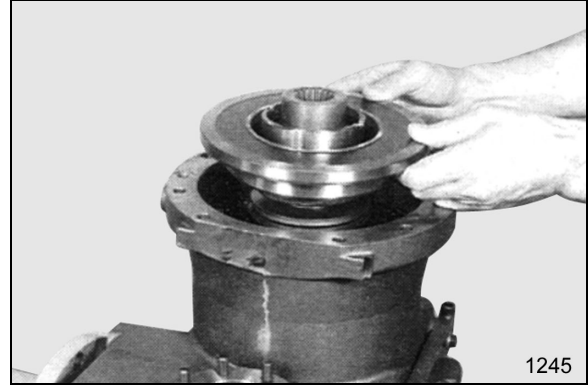


Figure 192

4. Install two cup springs, centering them carefully.

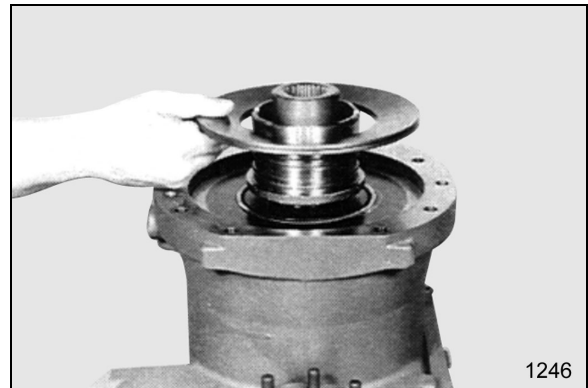


Figure 193

5. Install measuring cover and draw it down evenly against shoulder using socket head screws. Torque to 79 N•m (17.8 ft lb).

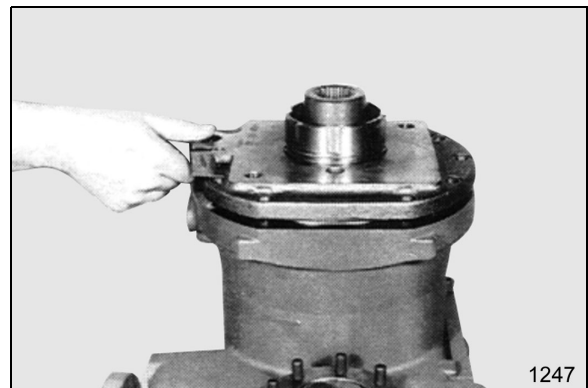


Figure 194

6. Measure distance from cover to piston (Dimension 1). Subtract manufacturing dimension engraved on cover (20 mm) from Dimension 1 to get Dimension X.

Dimension 1	32.60 mm (1.28 in)
Manufacturing Dimension	- 20.00 mm (0.787 in)
Dimension X	= 12.60 mm (0.499 in)

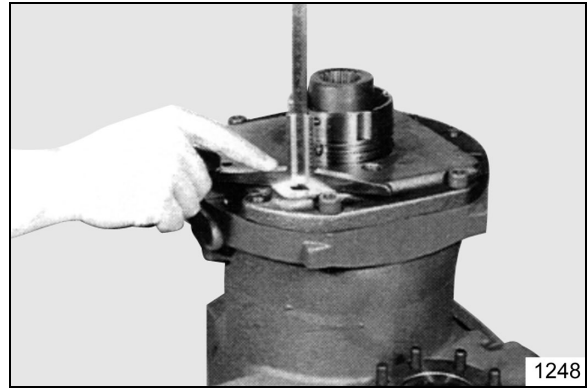


Figure 195

7. Measure distance from drive casing to flange (Dimension "Y"). Subtract Y from X to get Adjustment Value (A).

Dimension X	12.60 mm (0.496 in)
Dimension Y	-11.10 mm (0.437 in)
Adjustment Value (A)	= 1.50 mm (0.059 in)



Figure 196

8. Correct adjustment, using 3.0, 3.2 and 3.5 mm shims. Remove measuring cover and piston.
9. Install O-ring in ring groove, making sure O-ring makes good contact.

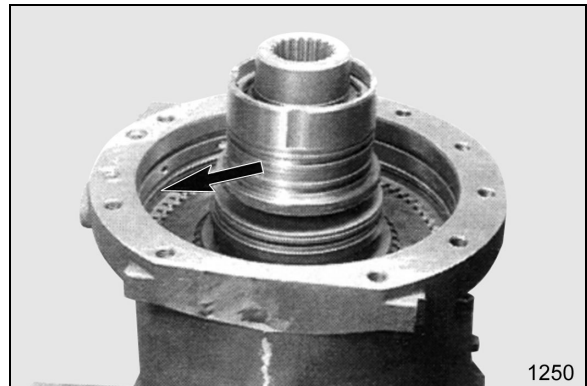


Figure 197

10. Note position of disc, piston, and seals.

Reference Number	Description
1	Drive Casing
2	Clutch Disc Housing
3	Gasket, Backup
4	Gasket, U-section
5	Retaining Ring
6	O-ring
7	Disc
8	Gasket, Backup
9	Gasket, U-section
10	Piston
11	Cup Springs
12	O-ring

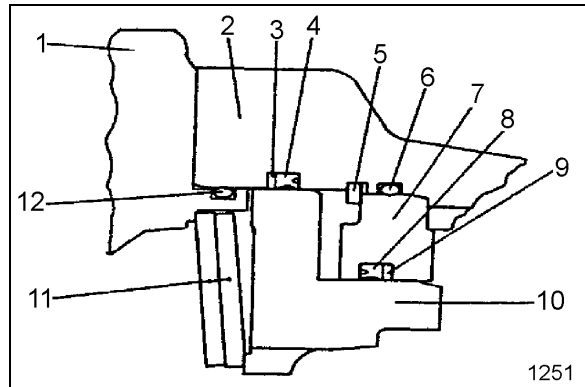


Figure 198

11. Install Backup and U-section rings in ring groove. Oil rings. Check installation position and install disc.

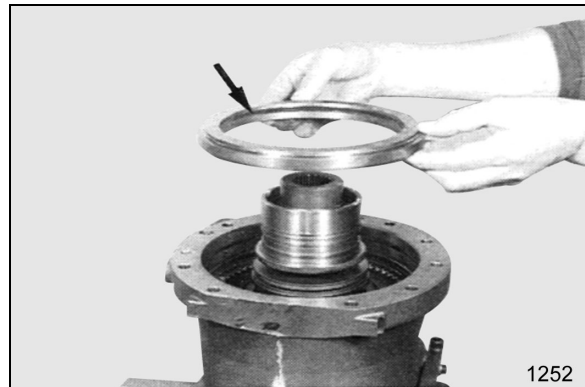


Figure 199

12. Secure disc with snap ring.

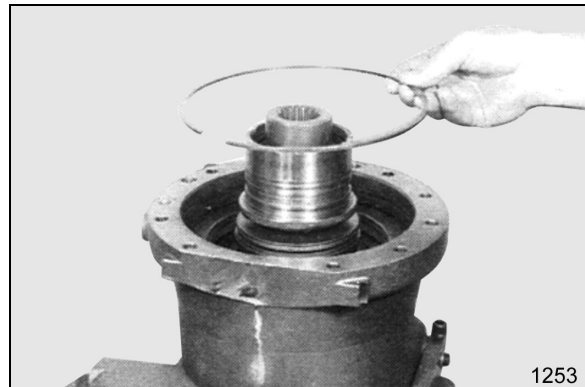


Figure 200

13. Install backup ring and seal ring in ring groove of housing; oil the rings. Install piston evenly against shoulder using measuring cover and socket head screws, then remove measuring cover. See Figure 201 and Figure 202.

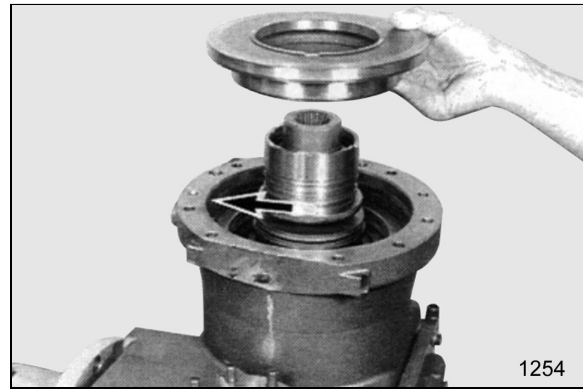


Figure 201

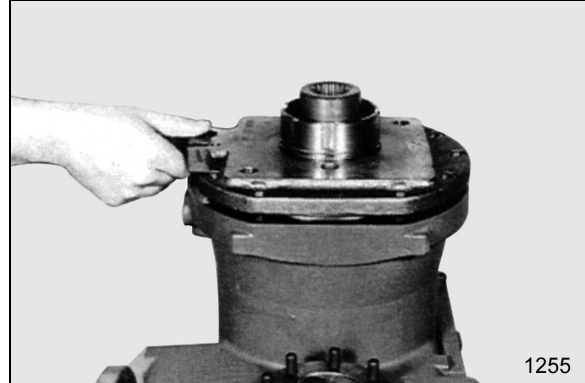


Figure 202

14. Install two cup springs and center them (noting installation position in Figure 198).

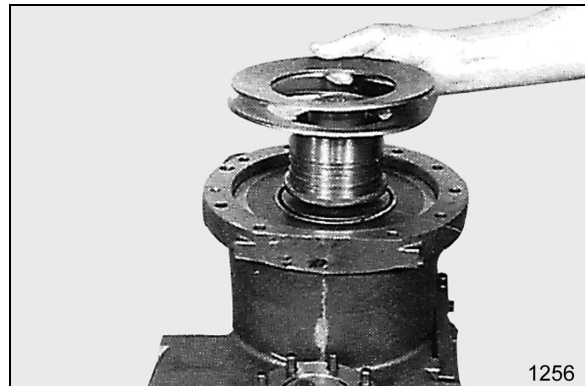


Figure 203

INSTALLING DRIVE CASING

1. Insert O-ring (1) in bore and insert O-rings in ring grooves of guide sleeve. Grease O-rings.

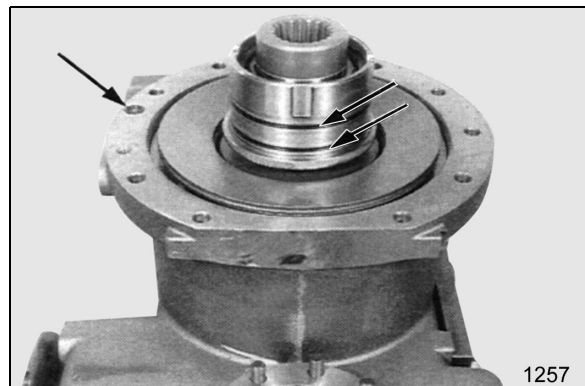


Figure 204

2. Insert O-ring into groove of drive casing.
Grease O-ring.

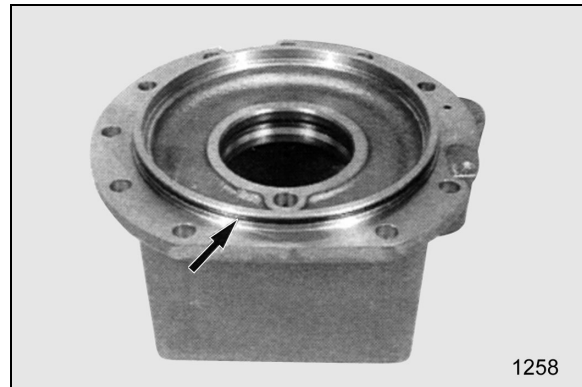


Figure 205

3. Align guide bushing radially.

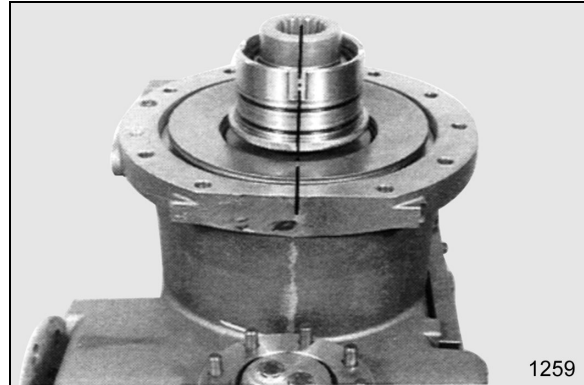


Figure 206

4. Install drive casing, being careful to align it radially.

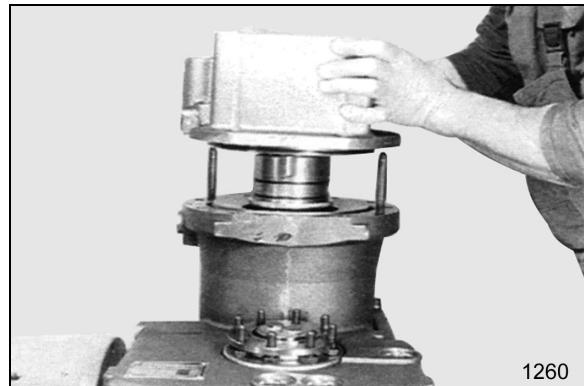


Figure 207

5. Pull drive casing evenly against shoulder using socket head screws. Torque to 79 N•m (18 ft lb).

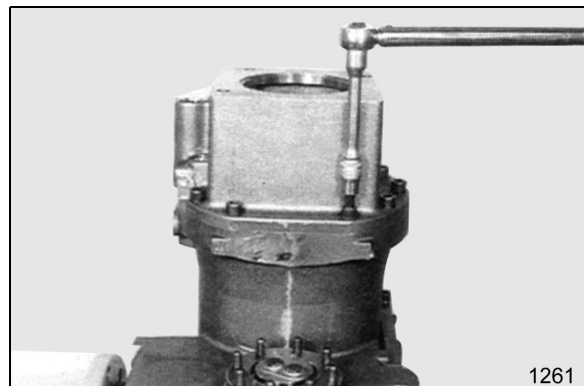


Figure 208

6. Pull guide bushing out of housing using internal puller until snap ring (95 mm) can be installed.

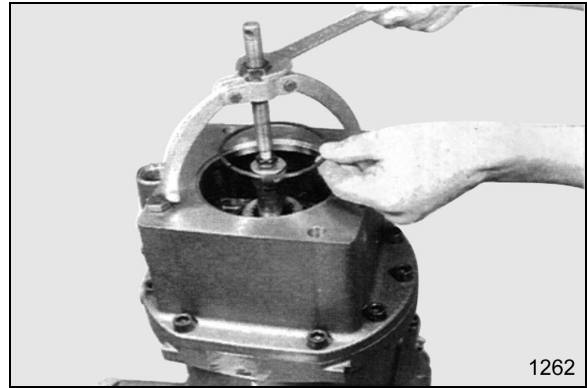


Figure 209

7. Secure guide bushing radially, using screw plug. Install new U-ring.

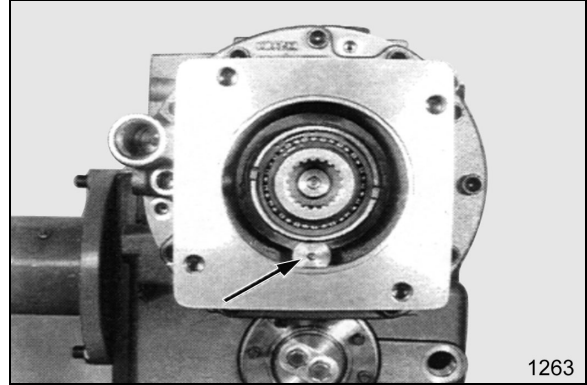


Figure 210

8. Heat turcon ring in oil bath. Insert gasket (O-ring and turcon ring) into ring groove of piston, using installer. Grease gasket.

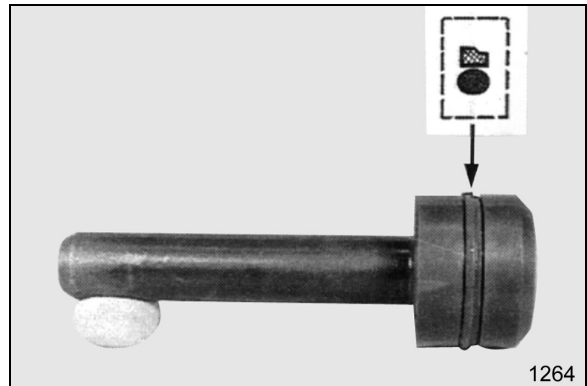


Figure 211

9. Install new O-ring on screw plug. Insert pre-assembled piston and spring into housing bore and secure with screw plug.

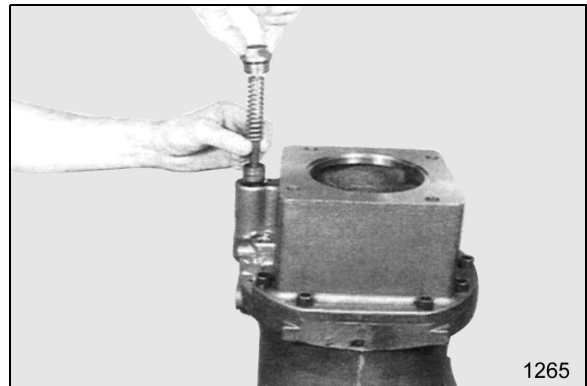


Figure 212

10. Install new O-ring on screw plug. Install breather (1) and screw plug (2).

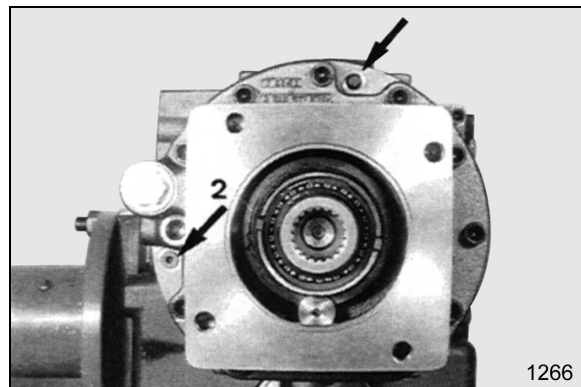


Figure 213

11. Install two screw plugs (1) and shear plug (S). Install hydraulic connection (2).

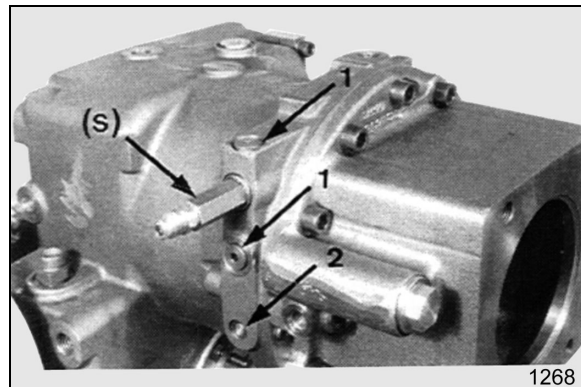


Figure 214

12. Ventilate piston chamber by filling it several times with air. Build up test pressure of 35 bar (507 psi), close off HP-pump using shut-off valve and check that there is no pressure drop during a period of three minutes.

NOTE: Use ZF lubricants TE ML 07 or TE ML 12 for testing.

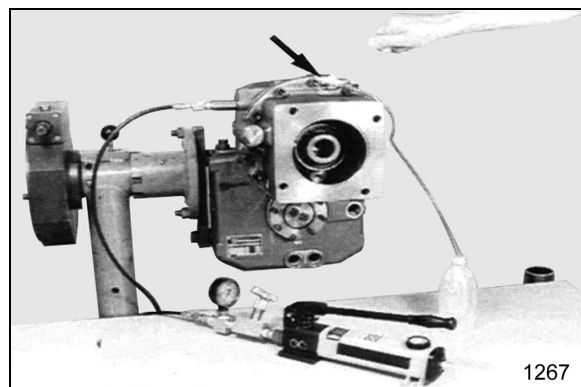


Figure 215

13. Remove hydraulic connection. Install throttle valve and install new O-ring.

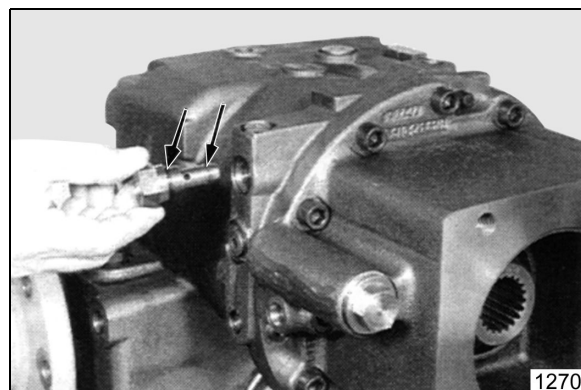


Figure 216

DRIVE PINION / CROWN WHEEL CONTACT PATTERN

CORRECT PATTERN

Drive Side.

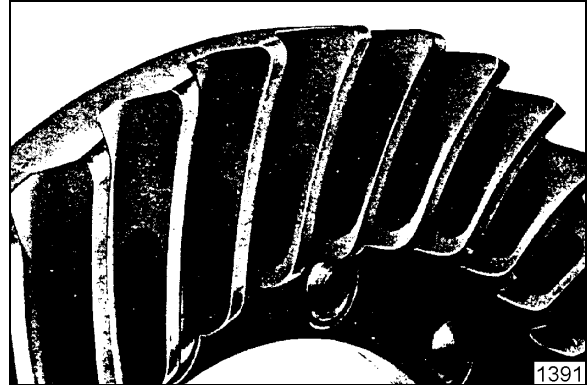


Figure 217

Neutral Side.

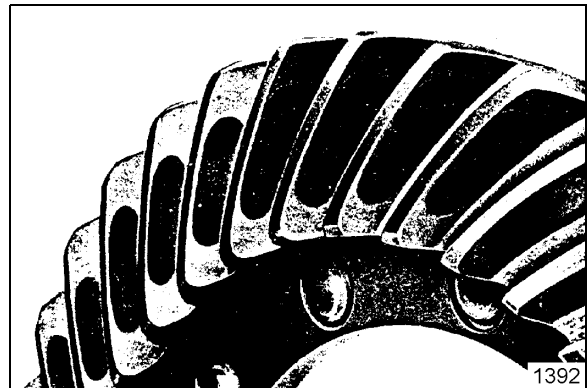


Figure 218

INCREASE PINION DISTANCE

Drive Side.

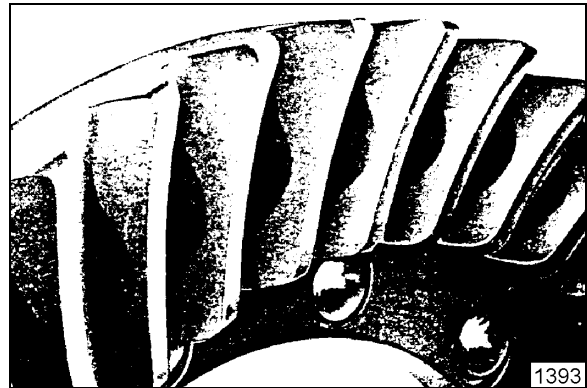


Figure 219

Neutral Side.



Figure 220

DECREASE PINION DISTANCE

Drive Side.

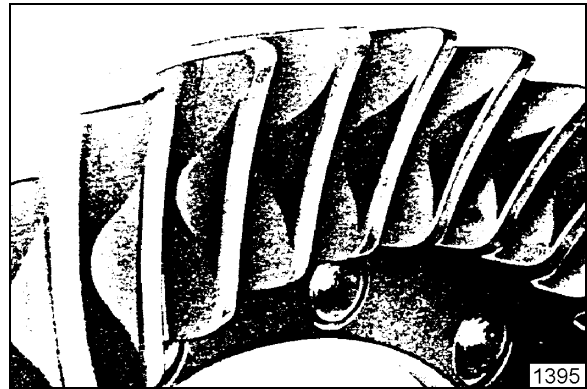


Figure 221

Neutral Side.



Figure 222

TRANSMISSION GOVERNOR

PARTS LIST

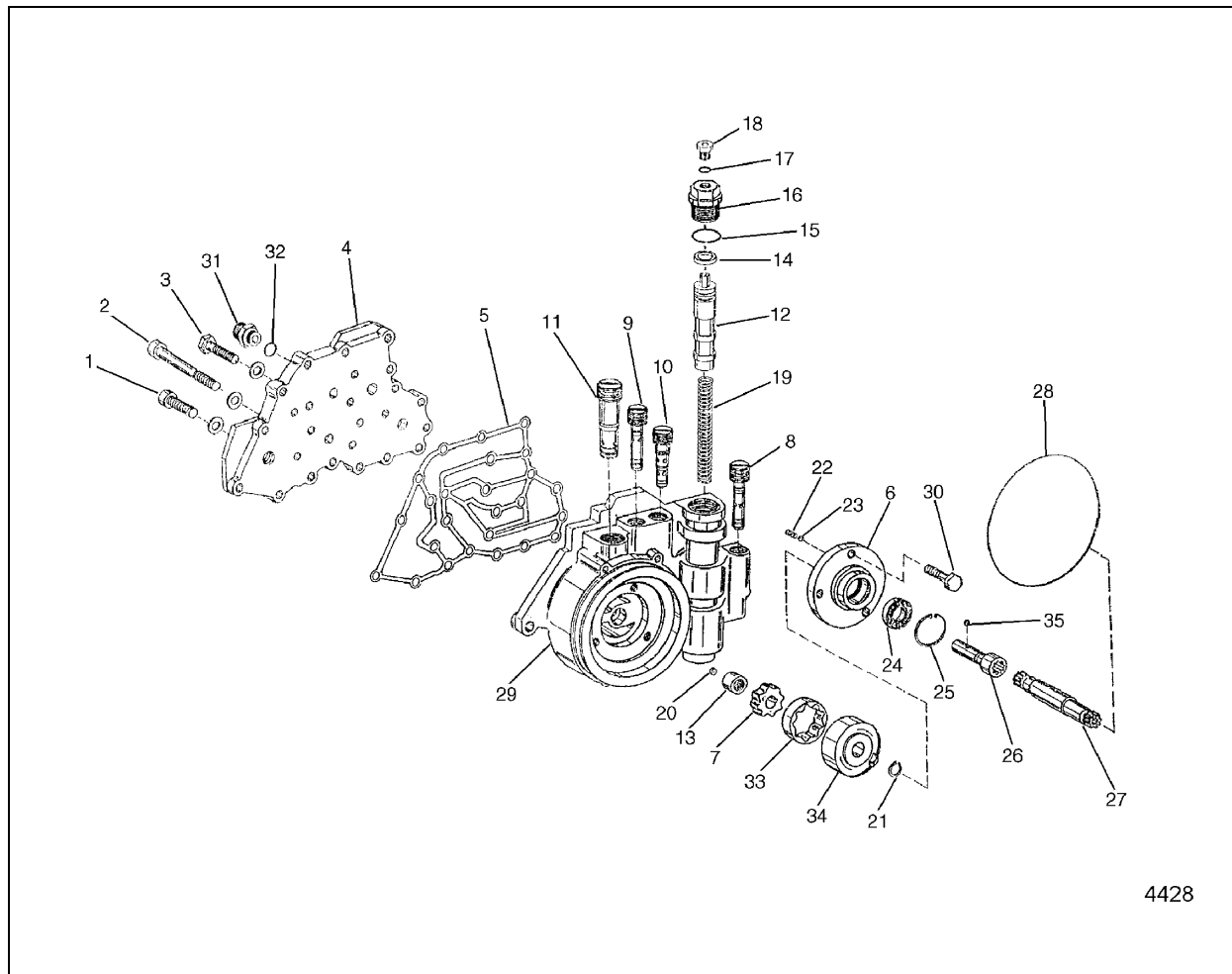


Figure 223

Reference Number	Description
1	Screw, Socket Head
2	Screw, Socket Head
3	Screw, Hex Head
4	Cover, Valve
5	Gasket, Cover
6	Cover, Pump
7	Rotor Assembly
8	Valve, Check
9	Valve, Check
10	Valve, Check
11	Valve, Pressure Limiting
12	Spool, Control
13	Bearing, Needle
14	Ring, Plastic
15	O-ring
16	Reducer
17	Ring, Sealing
18	Plug, Threaded

Reference Number	Description
19	Spring, Compression
20	Orifice
21	Ring, Retaining
22	Spring
23	Ball
24	Bearing, Ball
25	Ring, Retaining
26	Shaft, Drive
27	Shaft, Extension
28	O-ring, Cover
29	Housing, Valve
30	Screw, Hex Head
31	Adapter, Hose
32	O-ring
33	Ring, Rotor
34	Housing, Rotor
35	Ball, Drive Shaft

DISASSEMBLY OF GOVERNOR

(Refer to Figure 223)

1. Remove any oil lines and hoses connected to governor housing (29).
2. Remove four socket head bolts (1) and (2), and remove governor assembly from transmission.
3. Remove hex bolts (3) that hold cover (4) to housing (29). Remove cover (4) and gasket (5).

NOTE: *In the following steps, be prepared to catch four balls and three springs that will be released when cover (4) is removed.*

4. Remove three hex bolts (30) that hold pump cover (6) to housing (29). Remove cover (6) using caution to catch three springs (22) and four balls (23).
5. Remove rotor gear (7), rotor ring (33), and ball (35) from end of drive shaft (26).
6. Remove retaining ring (21) from groove in drive shaft (26).
7. Remove rotor housing (34) from drive shaft (26).
8. Slide drive shaft (26) and shaft extension (27) out of pump cover (6).
9. Use an internal puller to remove needle bearing (13) from housing (29).
10. Remove retaining ring (25) and bearing (24) from pump cover (6).
11. Match mark the position and remove check valves (8), (9), and (10) from housing (29).
12. Match mark position and remove pressure limiting valve (11) from housing (29).
13. Unthread reducer (16) and remove control spool (12) and spring (19) from housing (29).

REASSEMBLY OF GOVERNOR

(Refer to Figure 223)

NOTE: *It is recommended that new O-rings and sealing rings are used when reassembling the governor.*

1. Coat a new orifice (20) with Loctite #242. Install orifice with a flat tipped punch until the orifice bottoms in its bore. Use compressed air to clean orifice passage and remove any excess Loctite.
2. Use a press to install needle bearing (13) into its bore. Install the bearing to a depth of 0.2 - 0.5 mm (0.0078 - 0.0196 in).
3. Slide new O-ring (15) into its groove on control spool (12). Use a installing sleeve to slide plastic ring (14) into position on O-ring (15).

NOTE: *To properly size plastic ring (14), slide a calibrating ring over plastic ring.*

4. Lubricate check valves (8), (9), (10), and pressure limiting valve (11) with transmission fluid, and install. Torque these valves to 10 N•m (7 ft lb). Use a center punch to stake each valve in 2 places.
5. Lubricate the control spool components (12) and (19) with transmission fluid and install them into housing (29). Torque reducer (16) to 50 N•m (36.8 ft lb). Torque threaded plug (18) to 20 N•m (15 ft lb).
6. Install bearing (24) into cover (6). Install retaining (25) to hold bearing in place.
7. Slide drive shaft (26) through bearing (24). Install retaining ring (21) onto drive shaft (26) to hold shaft in place.
8. Install springs (22) into bores in pump cover (6). Coat balls (23) with grease and place them into bores, on top of springs.
9. Slide rotor housing (34) over drive shaft (26). Install ball (35) into drive shaft (26). Slide rotor gear (7) onto drive shaft (26). Be certain that ball (35) properly engages inside of rotor gear (7). Slide rotor ring (33) over rotor gear (7). Lubricate rotor components before installing cover (6) onto housing (29).
10. Insert assembled pump cover (6) into bore of housing (29). Install bolts (30) and torque to 9.5 N•m (7 ft lb).
11. Place gasket (5) on cover (4). Place cover (4) on housing (29). Install bolts (3) through cover (4) and torque to 20 N•m (15 ft lb).
12. Grease O-ring (28) and place around bore on housing (29).
13. Slide shaft extension (27) into transmission. Engage splines on shaft extension (27) with splines in transmission.
14. Thread two aligning studs into transmission, slide governor assembly over studs until flush against transmission. Be certain that splines on drive shaft (26) are fully engaged with splines on shaft extension (27).
15. Install bolts (1) and (2) and torque to 23 N•m (17 ft lb).
16. Attach all oil lines and hoses that were originally attached to the governor. Before operating check and fill transmission with the recommended fluid.



DRIVE COUPLING (MAIN PUMP)



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
DD80L	0001 and Up
Solar 130LC-III	0001 and Up
Solar 130LC-V	0001 and Up
Solar 130W-III	0001 and Up
Solar 130W-V	0001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170LC-III	0001 and Up
Solar 170W-III	0001 and Up
Solar 170W-V	1001 and Up
Solar 200W-III	0001 and Up
Solar 200W-V	0001 and Up
Solar 210W-V	1001 and Up
Solar 220LC-III	0001 and Up
Solar 220LC-V	0001 and Up
Solar 220LL	1001 and Up
Solar 220N-V	1001 and Up
Solar 225LC-V	1001 and Up
Solar 225NLC-V	1001 and Up

Models continued on back of cover.

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MODEL	SERIAL NUMBER RANGE
Solar 250LC-V	1001 and Up
Solar 255LC-V	1001 and Up
Solar 280LC-III	0001 and Up
Solar 290LC-V	0001 and Up
Solar 290LL	1001 and Up
Solar 330LC-III	0001 and Up
Solar 330LC-V	1001 and Up
Solar 400LC-III	0001 and Up
Solar 400LC-V	1001 and Up
Solar 450-III	0001 and Up
Solar 450LC-V	0001 and Up

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DRIVE COUPLING

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

Figure 1 thru Figure 3, show typical drive coupling installations.

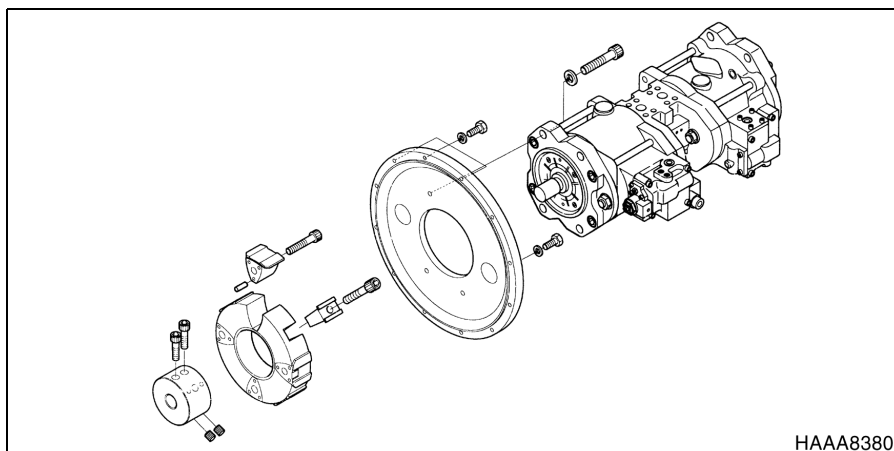


Figure 1 KAWASAKI (OR TONG MYUNG)

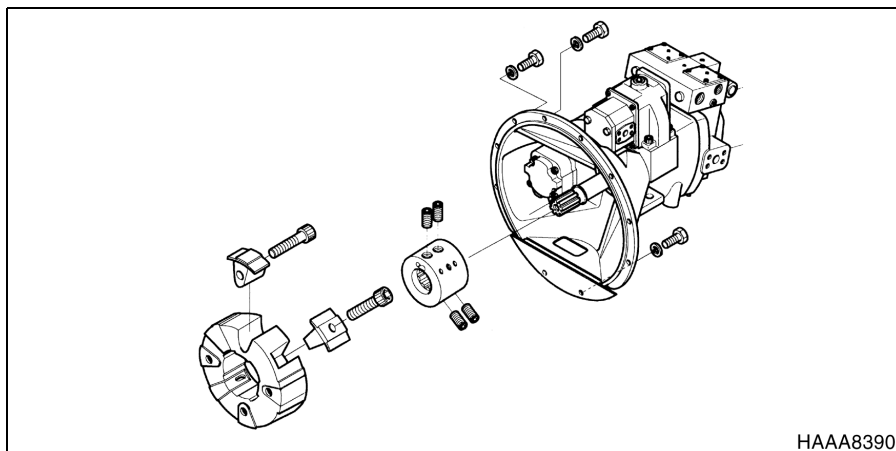


Figure 2 UCHIDA

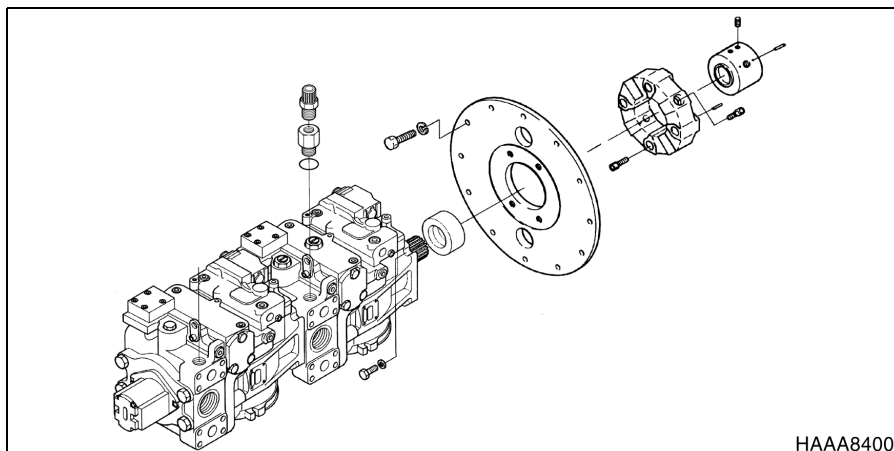


Figure 3 SAUER SUNDSTRAND

SPECIAL TOOLS

KAWASAKI / TONG MYUNG PUMP TOOL

NOTE: *This tool is also used for the Sauer Sundstrand Pump for the DD80L.*

This tool is used to control the distance between the end of the pump drive shaft and the front face of the drive coupling hub (Figure 4 and Figure 9). This distance will be referred to as "Measurement H" in the installation instructions that follow.

NOTE: *In manufacturing drawings (Figure 5 and Figure 6), 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.*

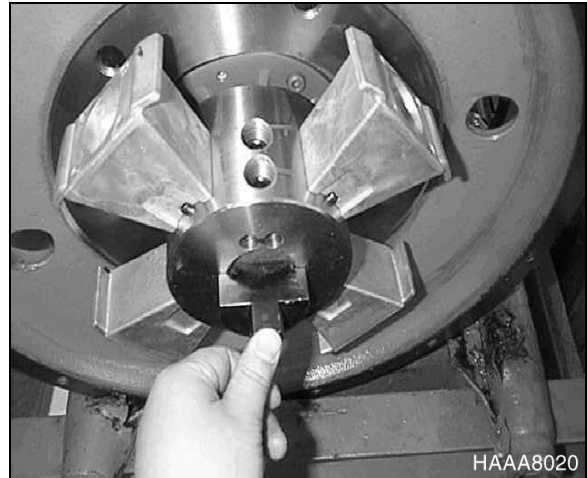


Figure 4

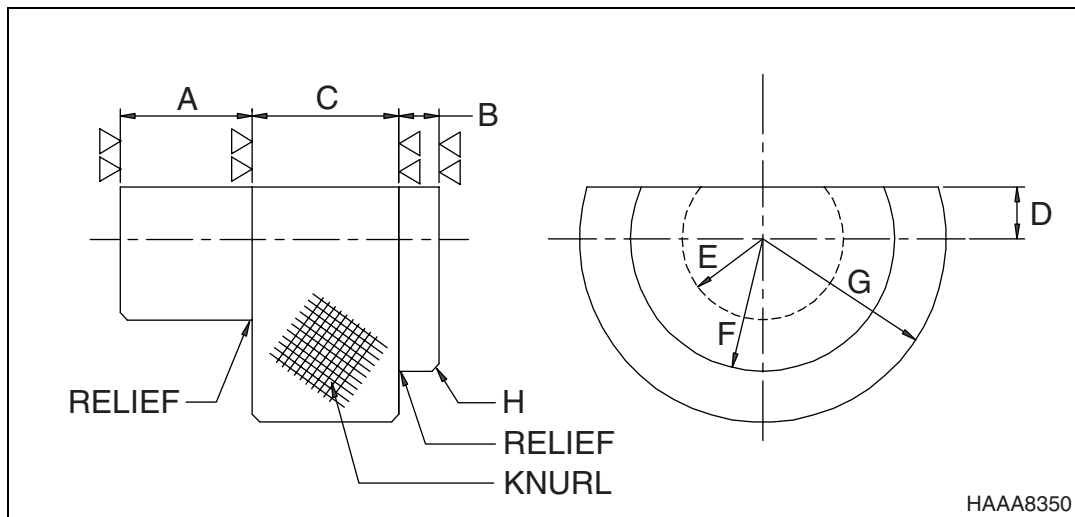


Figure 5

Dimensional Details for Figure 5		
Dimension	Measurement	Models
A	18 ±0.1 mm (0.7087 ±0.0039 in)	DD80L
B	5.5 ±0.1 mm (0.2165 ±0.0039 in)	S330LC-III, S330LC-V, S400LC-III, S400LC-V, S450LC-V
C	20.0 mm (0.787 in)	
D	7.0 mm (0.275 in)	
E	11.0 mm (0.433 in) Radius	
F	18.0 mm (0.708 in) Radius	
G	30.0 mm (1.181 in) Radius	
H	1.0 mm (0.039 in) x 45° Chamfer	

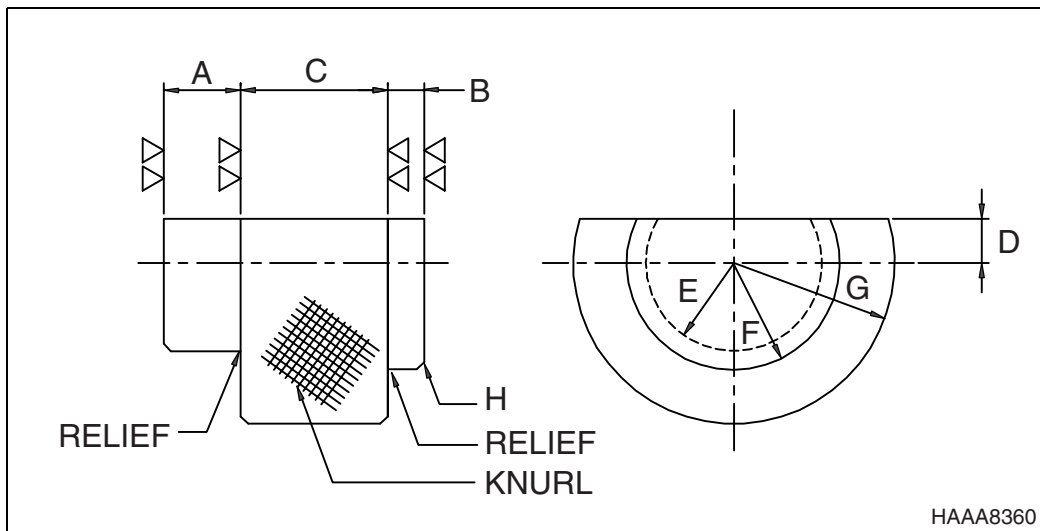


Figure 6

Dimensional Details for Figure 6		
Dimension	Measurement	Models
A	10.5 ±0.1 mm (0.4134 ±0.0039 in)	S170LC-III, S200W-V, S220LC-III, S220LC-V, S220LL, S220N-V, S225LC-V, S225NLC-V, S250LC-V, S255LC-V
	2.0 ±0.1 mm (0.0787 ±0.0039 in)	S170LC-V, S170W-V
	1.0 ±0.1 mm (0.0394 ±0.0039 in)	S140W-V, S160W-V
B	5.0 ±0.1 mm (0.1969 ±0.0039 in)	S280LC-III, S290LC-V, S290LL
C	20.0 mm (0.787 in)	
D	7.0 mm (0.275 in)	
E	12.0 mm (0.472 in) Radius	
F	14.50 mm (0.570 in) Radius	
G	25.0 mm (0.984 in) Radius	
H	1.0 mm (0.039 in) x 45° Chamfer	

UCHIDA PUMP TOOL

This tool is used to control the distance between the shoulder on the pump drive shaft and the rear face of the drive coupling hub (Figure 7 and Figure 10). This distance will be referred to as "Measurement H" in the installation instructions that follow.

NOTE: *In manufacturing drawing (Figure 8), dimension "A" equals "Measurement H."*

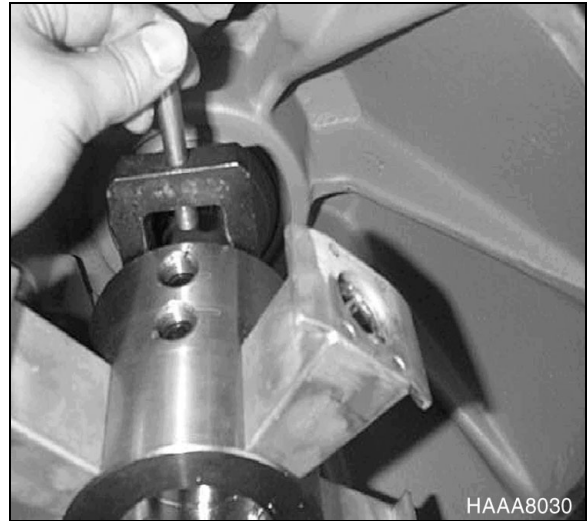


Figure 7

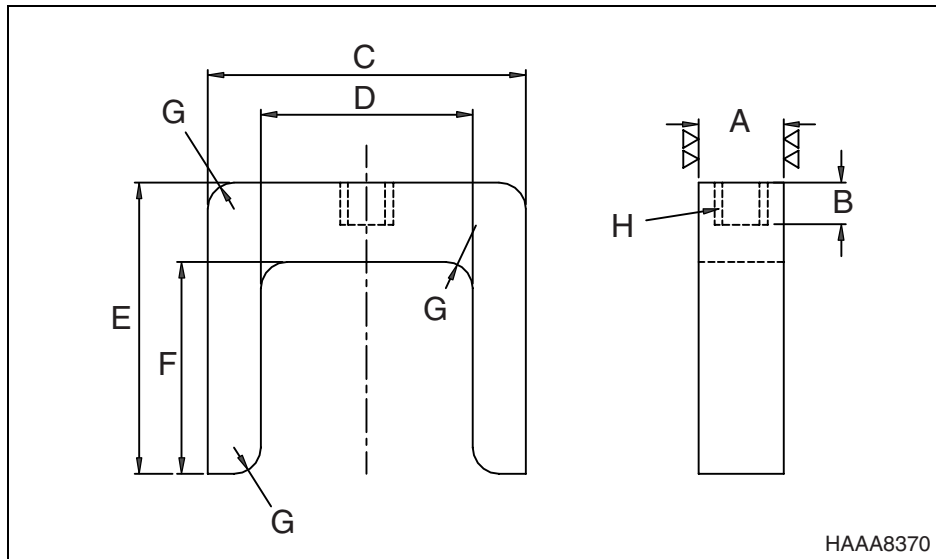


Figure 8

Dimensional Details for Figure 8		
Dimension	Measurement	Models
A	16 ±0.1 mm (0.6299 ±0.0039 in)	S130W-III, S130W-V
B	8 mm (0.315 in)	
C	60 mm (2.362 in)	
D	40 mm (1.575 in)	
E	55 mm (2.165 in)	
F	40 mm (1.575 in)	
G	5.0 mm (0.196 in) Radius	
H	TAP M10X1.5	

DRIVE COUPLING INSTALLATION

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

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

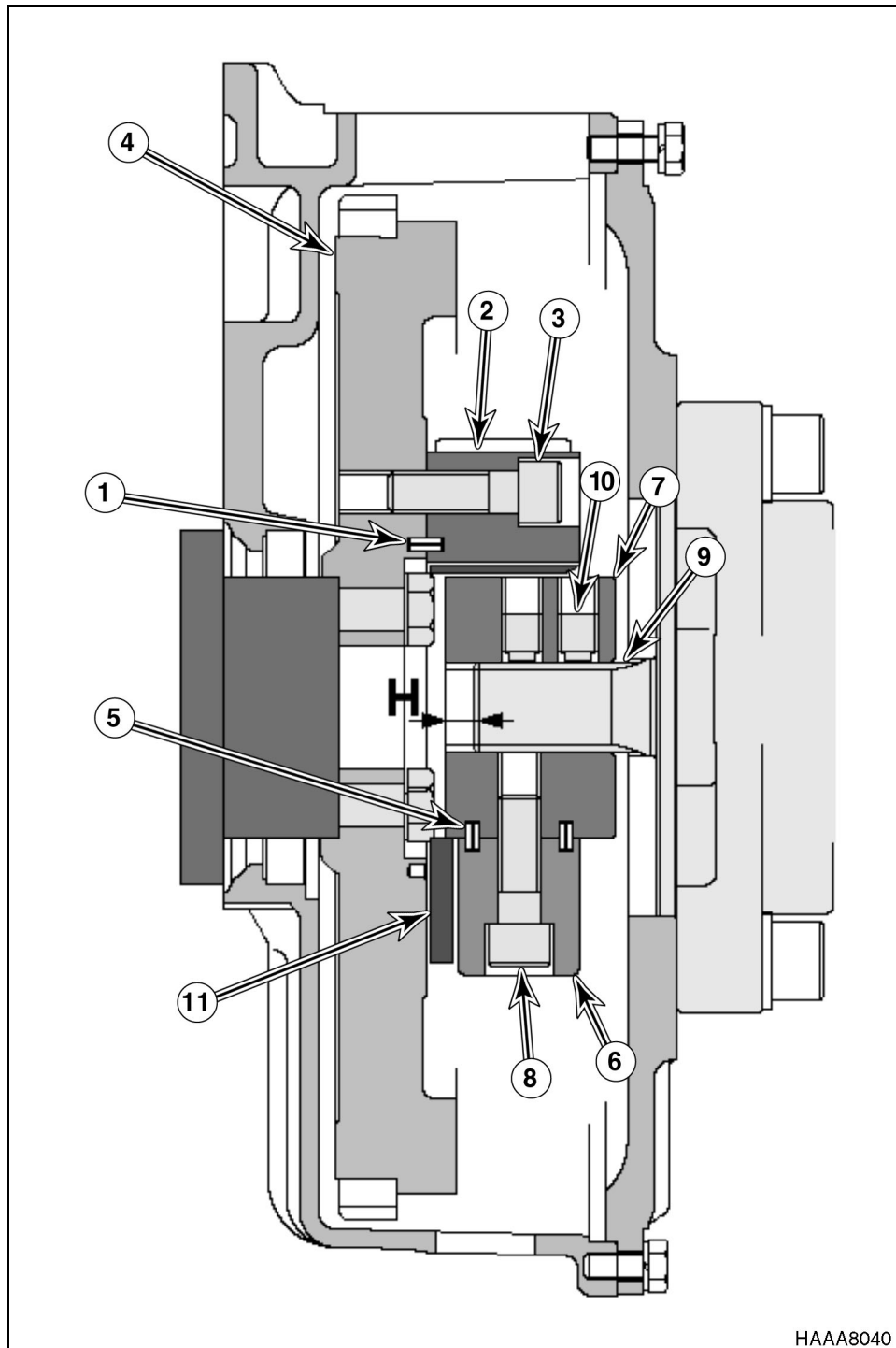


Figure 9 DRIVE COUPLING INSTALLATION (KAWASAKI / TONG MYUNG PUMP)

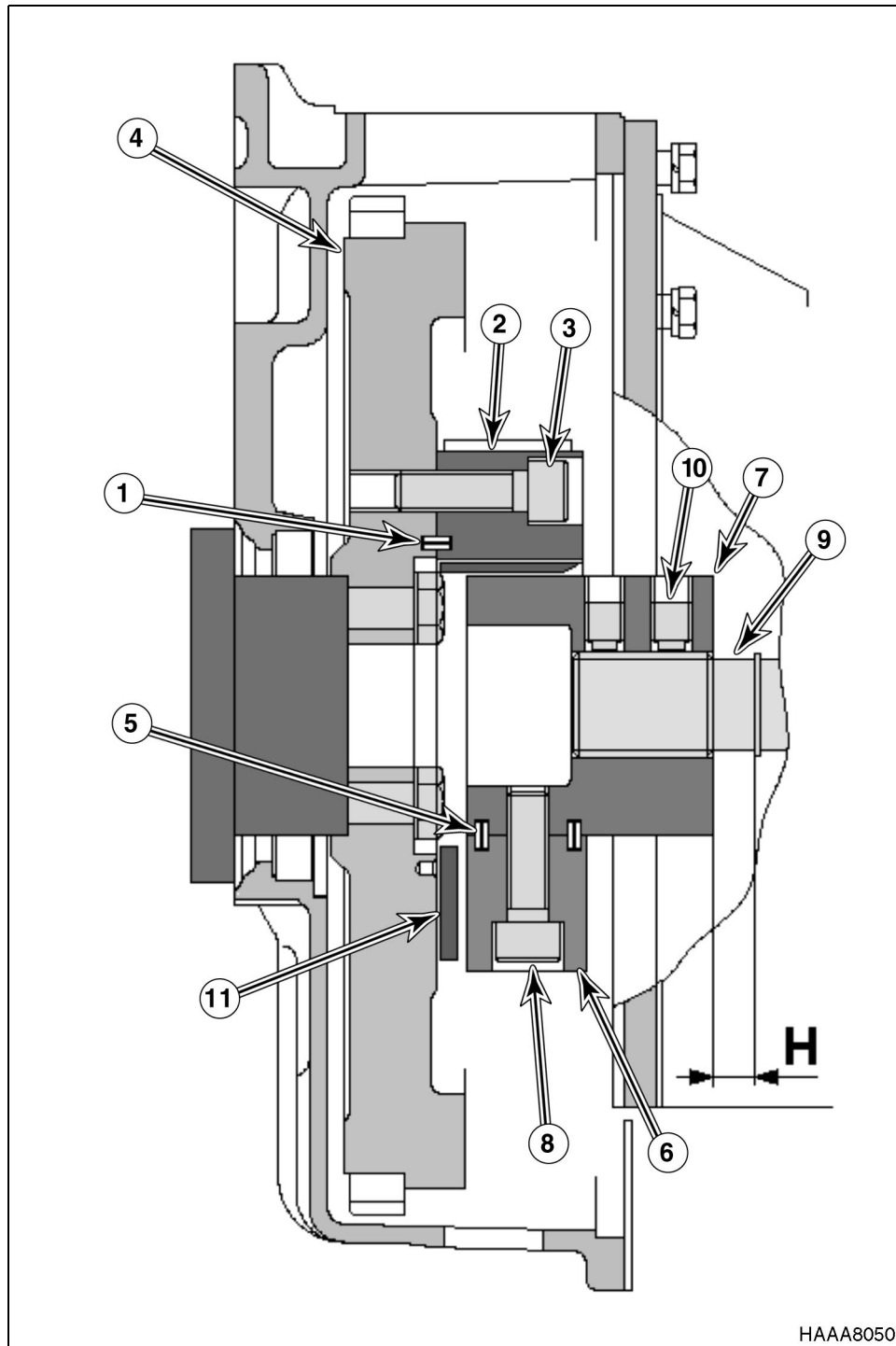


Figure 10 DRIVE COUPLING INSTALLATION (UCHIDA PUMP)

Table 1 Parts Information and Torque for Figure 9 and Figure 10			
Reference Number	Description	Qty.	Torque (See Table 2 and 3)
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 9)							
Model	Coupling Part Number	"Measurement H"	Torque Value for "Ta"	Torque Value for "Tb"			
DD80L	2414-9009A	17.5 - 18.5 mm (0.689 - 0.728 in)	21 - 23 kg•m (152 - 166 ft lb)	10 - 12 kg•m (72 - 87 ft lb)			
S130LC-III	2414-9009A	Note 1	21 - 23 kg•m (152 - 166 ft lb)	10 - 12 kg•m (72 - 87 ft lb)			
S130LC-V							
S130W-III	See Table 3.						
S130W-V							
S140W-V	2414-9042	0.5 - 1.5 mm (0.020 - 0.059 in)	21 - 23 kg•m (152 - 166 ft lb)	12 kg•m (87 ft lb)			
S160W-V							
S170LC-III	2414-9008A	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)			
S170LC-V	2414-9042	2.5 - 3.5 mm (0.098 - 0.138 in)	21 - 23 kg•m (152 - 166 ft lb)	10 - 12 kg•m (72 - 87 ft lb)			
S170W-III	2414-9025	Note 2	21 - 23 kg•m (152 - 166 ft lb)	10 - 12 kg•m (72 - 87 ft lb)			
S200W-III							
S220LC-III	2414-9008A	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)			
S220LC-V							
S220N-V							
S220LL							
S225LC-V							
S225NLC-V							
S200W-V	2414-9041	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)			
S210W-V							
S250LC-V							
S255LC-V							
S280LC-III	2414-9034	4.5 - 5.5 mm (0.177 - 0.216 in)	44 - 49 kg•m (318 - 354 ft lb)	20 - 22 kg•m (145 - 159 ft lb)			
S290LC-V							
S290LL							
S330LC-III	2414-9040	5.0 - 6.0 mm (0.196 - 0.236 in)	44 - 49 kg•m (318 - 354 ft lb)	20 - 22 kg•m (145 - 159 ft lb)			
S330LC-V							
S400LC-III							
S400LC-V							
S450-III S450LC-V	2414-9040	Note 2	44 - 49 kg•m (318 - 354 ft lb)	20 - 22 kg•m (145 - 159 ft lb)			
NOTE:	1) S130LC-III and S130LC-V has reverse dimension, that is, pump shaft must protrude outwards by 5.5 - 6.5 mm (0.216 - 0.255 in)						
NOTE:	2) Push the hub toward the pump until it stops on S170W-III, S200W-III and S450-III.						

Table 3 Specification for "Measurement H" for Wheel Excavator (Refer to Figure 10)				
Model	Coupling part number	Height (H) (mm)	Ta (kg•m)	Tb (kg•m)
S130W-III	2414-9021	15.5 - 16.5 (0.610 - 0.650 in)	21 - 23 kg•m (152 - 166 ft lb)	10 - 12 kg•m (72 - 87 ft lb)
S130W-V				

INSTALLATION PROCEDURE

NOTE: Refer to Figure 9 and Figure 10 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. (Kawasaki pump only.)

4. Slide hub (7) into place on pump shaft (9) as specified in the "Table 2" or "Table 3" 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.



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).

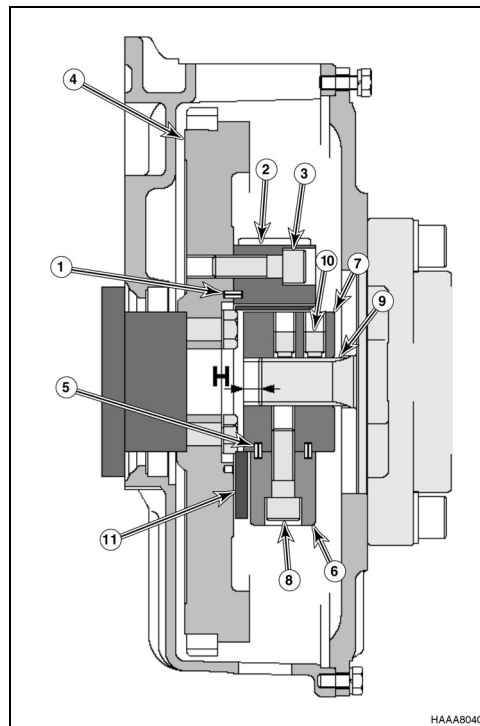


Figure 11 DRIVE COUPLING INSTALLATION (KAWASAKI / TONG MYUNG PUMP)

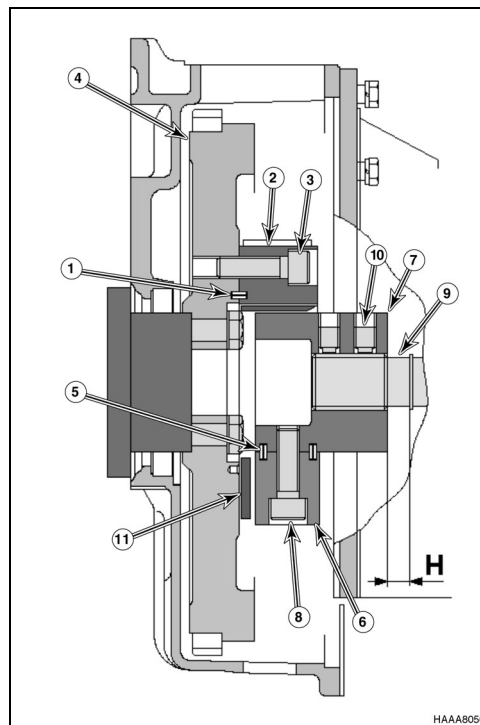


Figure 12 DRIVE COUPLING INSTALLATION (UCHIDA PUMP)

HYDRAULICS



HYDRAULIC SYSTEM TROUBLESHOOTING, TESTING AND ADJUSTMENT



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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HYDRAULIC SYSTEM - GENERAL NOTES

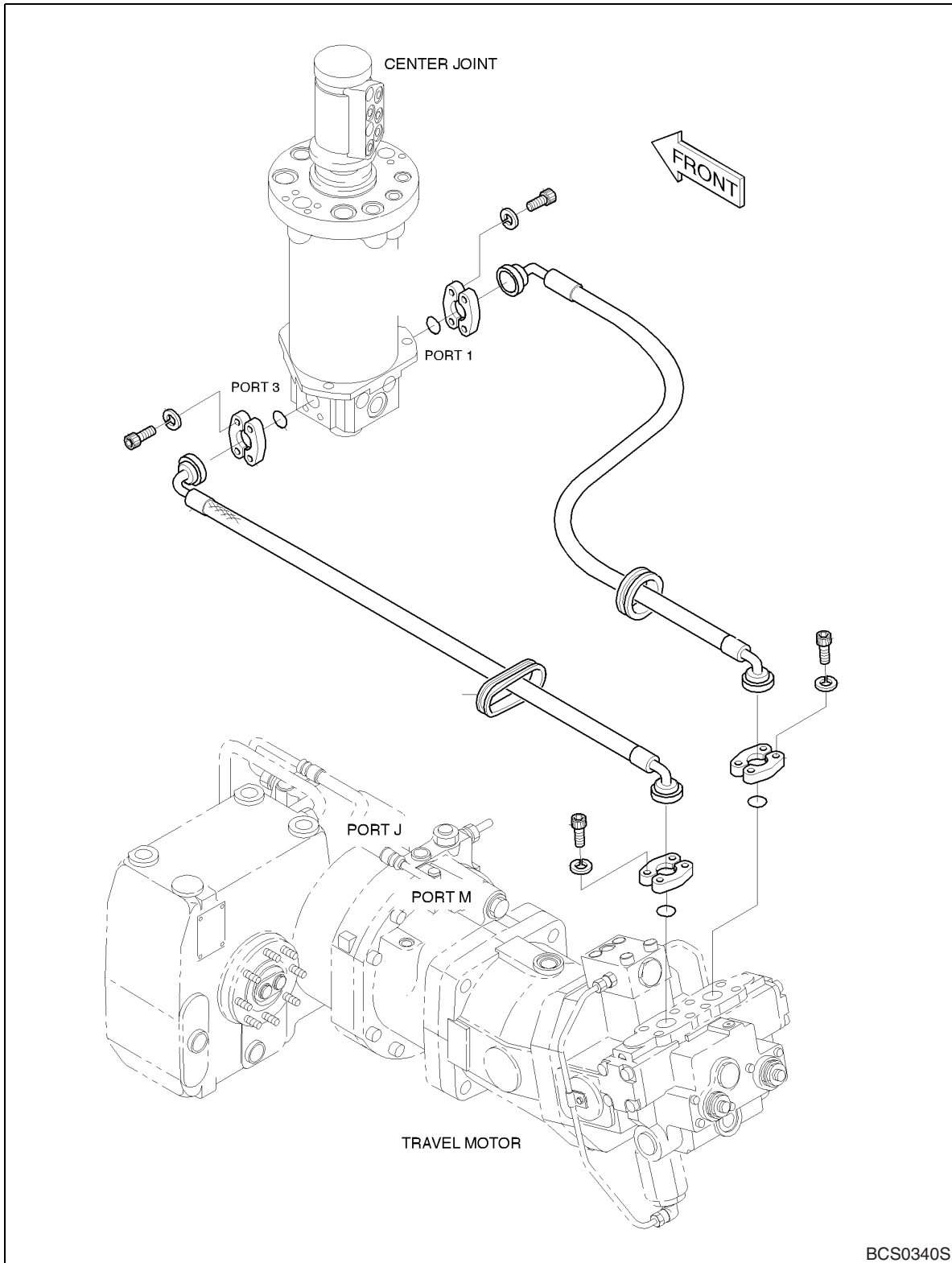


Figure 1

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

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

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

HYDRAULIC SCHEMATIC

The hydraulic schematic(s) is available in the "Hydraulic and Electrical Schematic Shop Manual." This Manual is a collection of diagrams and schematics for a number of models.

GENERAL NOTES

When referring to the schematic, refer to the following items:

- As shown in the schematic, the main pump assembly is driven by the engine. Mechanical energy is converted to hydraulic power, generating the required hydraulic flow which drives the system. Two main pumps (a right side pump and a left side pump) make up the main pump assembly.
- Hydraulic output from the right side pump is transmitted to the left side of the control valve. Output from the left side pump is transmitted to the valve spools on the right 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 left pump in the pump assembly, operates valve spools for right travel, boom, bucket 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 right pump in the pump assembly, has control spools for dozer, swing, boom up and arm operation.
- Two-stage operation is a feature of boom, arm and bucket function. All three 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 of 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 three 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 anti-vacuum valves which protect the hydraulic system from vacuum that could result from external shocks or other unusual conditions. The arm cylinder circuit is also protected by overload relief valves. Whenever high pressure is generated as a result of a shock or overload, excess pressure is dumped to the reservoir return circuit through the relief valve.

OPERATION OF WORKING COMPONENTS

BOOM OPERATING CIRCUIT

The boom operating circuit includes the right and left main hydraulic pumps (both halves of the main pump assembly), both sides of the control valve and the boom cylinder. The circuit operates in boom down mode through the first shift position and through the second shift position in boom up mode. Overload relief valves set at 360 kg/cm^2 (5,112 psi) protect the hydraulic system from damage as a result of overloads or shocks to the boom.

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 $7 - 9 \text{ kg/cm}^2$ (100 - 128 psi), boom control valve spools open and oil from both pumps goes to the boom cylinder.

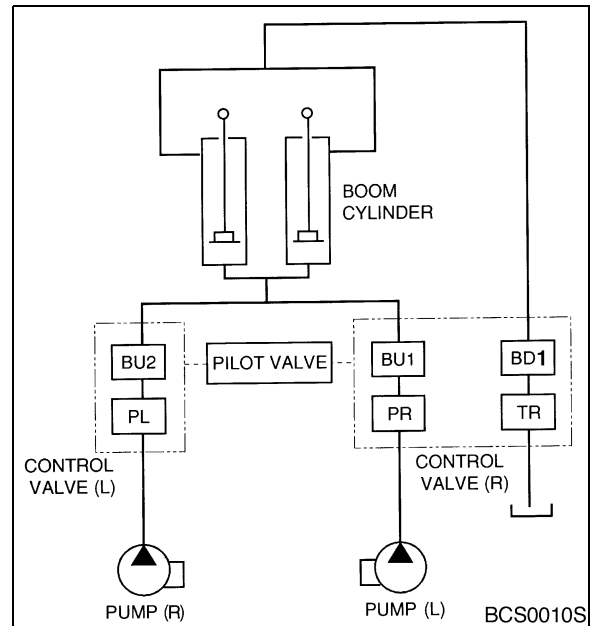


Figure 2

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 $7 - 9 \text{ kg/cm}^2$ (100 - 128 psi), the valve spool on the right side of the control valve opens so that oil from only one half of the pump assembly goes to the boom cylinder for boom lowering.

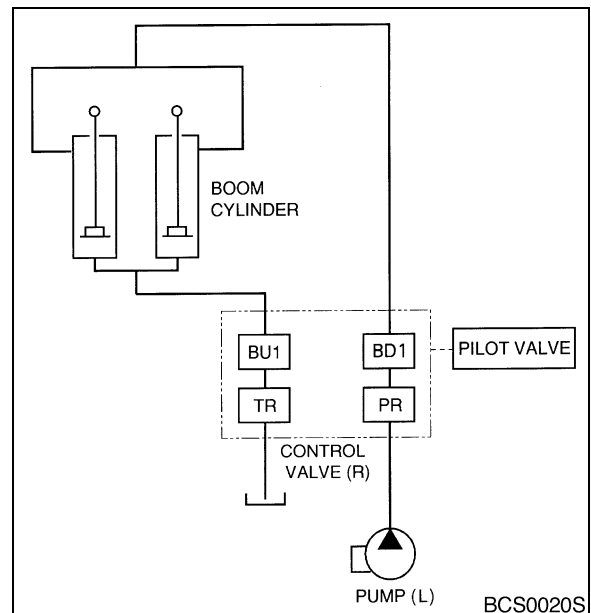


Figure 3

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/cm^2 (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 make-up valve and reservoir return circuit, which ensures that the volume of oil going to the cylinder will not exceed the volume of oil coming out.

ARM CROWD CIRCUIT

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

When secondary pilot pressure reaches 7 - 9 kg/cm^2 (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.

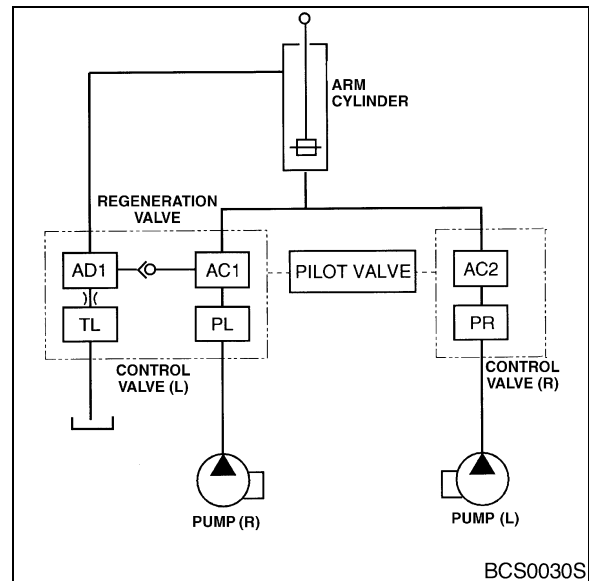


Figure 4

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.

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.

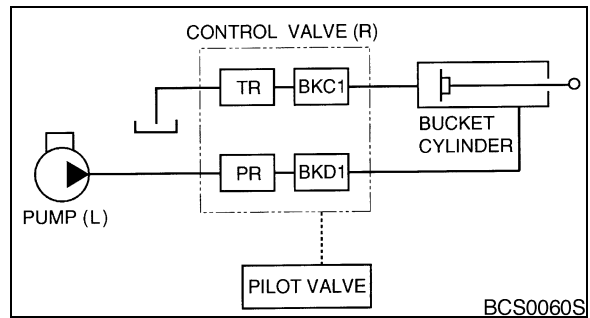


Figure 7

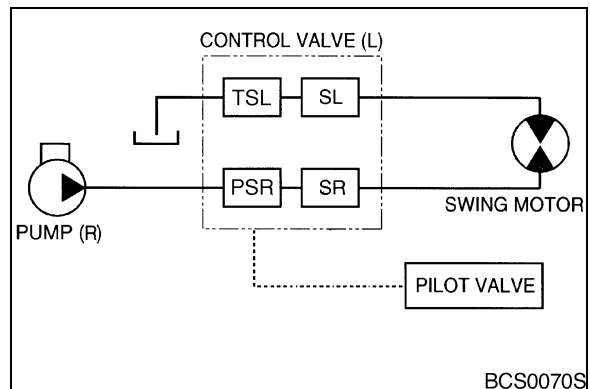


Figure 8

LEFT SWING OPERATING CIRCUIT

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

SWING RELIEF VALVE AND MAKE-UP VALVE

Whenever the spool is shifted to the neutral mode during swing operation, the possibility exists that surge pressure in the circuit - caused by inertial momentum of the upper works and correspondingly reduced pressure at the opposite motor port - could produce cavitation in the circuit. To keep that from happening, a 270 kg/cm² (3,840 psi) relief valve is installed in the swing motor and a large-capacity make-up valve is connected to the entrance port of the hydraulic reservoir, helping maintain acceptable pressures on both sides of the circuit.

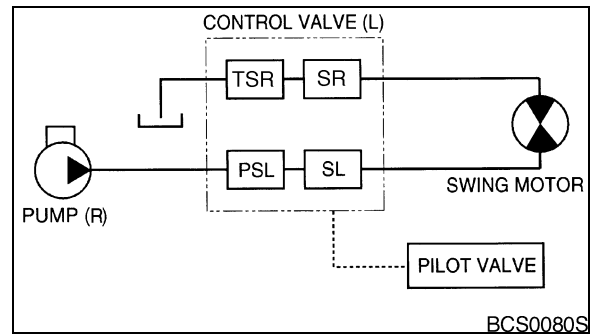


Figure 9

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 -

- at 2,250 rpm with no load.
- at 2,250 rpm stall load.

If engine rpm drops excessively with a load or fails to surpass rated speed (2,200 rpm), performance problems may be due to inadequate hydraulic flow caused by lagging rotational speed.

NOTE: *Verify actual flow on the excavator against rated performance, with a flow meter.*

If engine tests meet specifications and adequate torque and horsepower are available at the pump drive flex coupling, pull out the electrical tray under the operator's seat to inspect the self-diagnostic display.

If the EPOS trouble code display is clear, check hydraulic functions in the following sequence:

- Pilot pressure.
- Negacon, negative control pressure.
- Main relief pressure (front and rear pump).
- Swing pressure.
- Port relief pressure (individual control functions; boom, arm, bucket, swing, and travel).
- Power boost circuit.
- Standard performance tests; cylinder speed, hydraulic motor (travel and swing) speed, cylinder oil-tightness "permissible drift" test.

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

IMPORTANT

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

PILOT PRESSURE

ADJUSTMENT AND TESTING



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

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

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

If gear pump pressure is outside the tolerance specified in the table, adjust gear pump relief pressure by loosening the lock nut and turning the set screw in (clockwise) to increase pressure, or turning it out to decrease it.

NOTE: *Be aware that serial number changes and variation in the joystick assemblies used on different excavators could produce slight change in actual performance characteristics. Comparison of part numbers to serial numbers stamped on your assembly may be required, if questions or doubt exists.*

IMPORTANT

Top off the hydraulic fluid reservoir if there is any measurable loss of hydraulic oil during test gauge and adapter fitting installation.

Engine RPM	Pilot Pressure @ Pump	Pilot Pressure - Joystick
Minimum Speed Setting (full left) on Speed Control Dial	40 $\pm$ 5 bar (580 $\pm$ 73 psi)	23.5 $\pm$ 1.5 bar (341 $\pm$ 22 psi)

POWER MODE VALVE

CURRENT SIGNAL AND HYDRAULIC PRESSURE 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.

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 Daewoo After Sales Service, or could be spliced together from commonly available, purchased parts) has extra leads so that a VOM meter can be connected to the circuit.

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

Vent the lever on top of the hydraulic tank to relieve pressure and connect an in-line "t-style" adapter to the valve pressure port. Install a 60 bar/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 lock nut on the end of the valve, turn the adjusting screw 1/4 turn and re-check current and pressure. Repeat adjustment as required to obtain specified performance and retighten the valve lock nut.*

Mode	Engine RPM	Current	Pressure
Power Mode	High Idle: 1,900 rpm	600 ±20 mA Mid-range value corresponding to engine rpm for both current and hydraulic pressure readings.	4 ±2 bar (58 ±29 psi)
Standard Mode "S"	1,750 rpm	0 mA	36 ±6 bar (522 ±87 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. Turn off the engine, disconnect either of the electrical leads and connect the test equipment to that side of the valve. An in-line "t-style" gauge adapter can be used to connect a 60 bar/870 psi (1,000 psi) test gauge to the outlet (pressure) side of the valve. Set the engine control speed dial to maximum and warm up the engine to at least 45°C (113°F) before making any tests.

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

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" lamp) 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 counter clockwise several times. Reset the work mode control to "trenching" mode and repeat the same tests.

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

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

PRESSURE UP VALVE

CHECKS AND ADJUSTMENTS



WARNING!

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

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

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

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

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

If the 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) lock nut on the relief valve. Turn the adjusting screw clockwise to increase pressure, or counterclockwise to decrease it. Pressure must be 350 bars (5075 psi), or up to 10 bars (145 psi) higher.

Because one adjustment can affect the other, check low-stage main relief pressure by repeating the cylinder stall test without "pressure up." Readjust standard relief pressure by turning the inner-most (smallest diameter) screw clockwise to increase the setting, or counterclockwise to decrease it. Pressure should be at least 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 cab, 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.

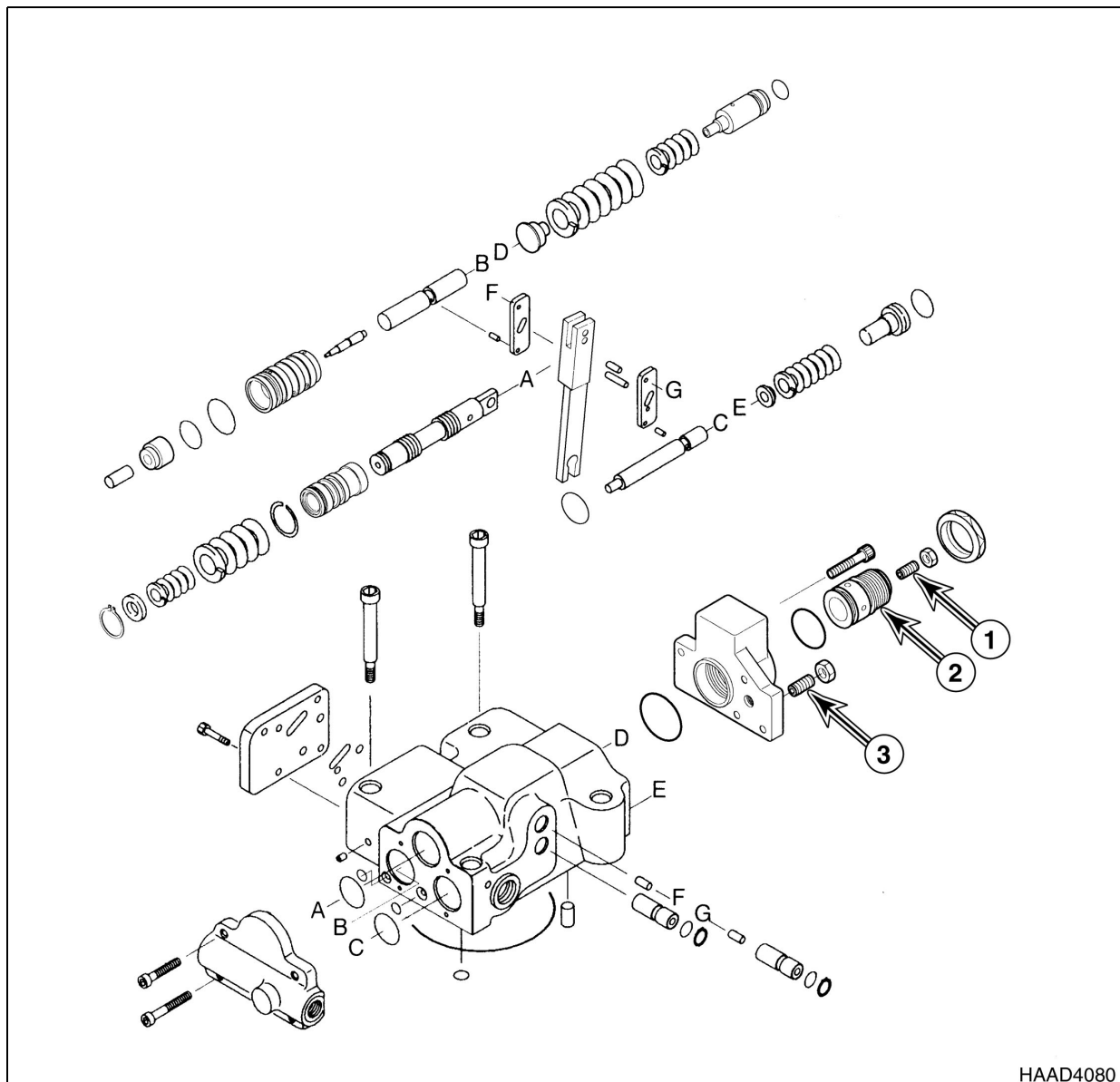
- **Verify engine output to the rated speed - 2,200 $\pm$ 50 rpm.**
- **Permanently mark setscrew positions at the current regulator control setting.**

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.



HAAD4080

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 lock nut around the adjustment screw (2) for the outer regulator spring. Tightening the screw shifts the P/Q (Pressure/Flow) control curve to the right, and increases compensating control pressure.

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

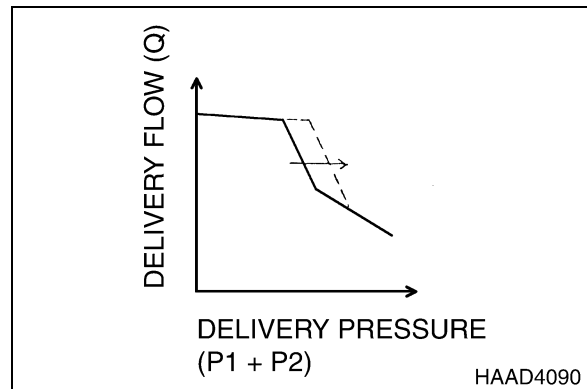


Figure 11

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.

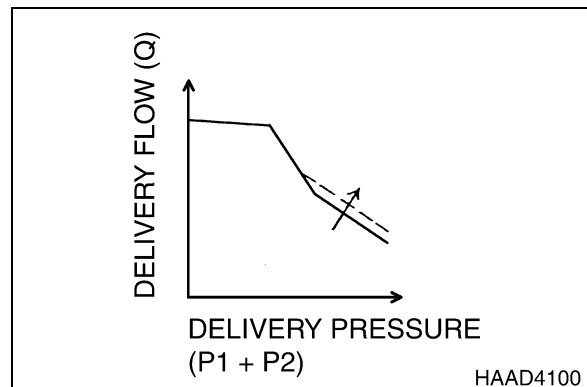


Figure 12

The adjusting screw (1, Figure 14) 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.

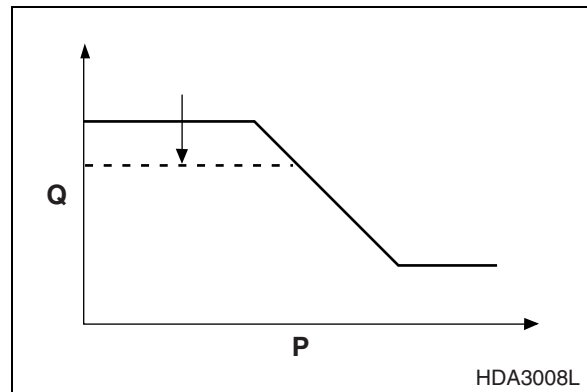


Figure 13

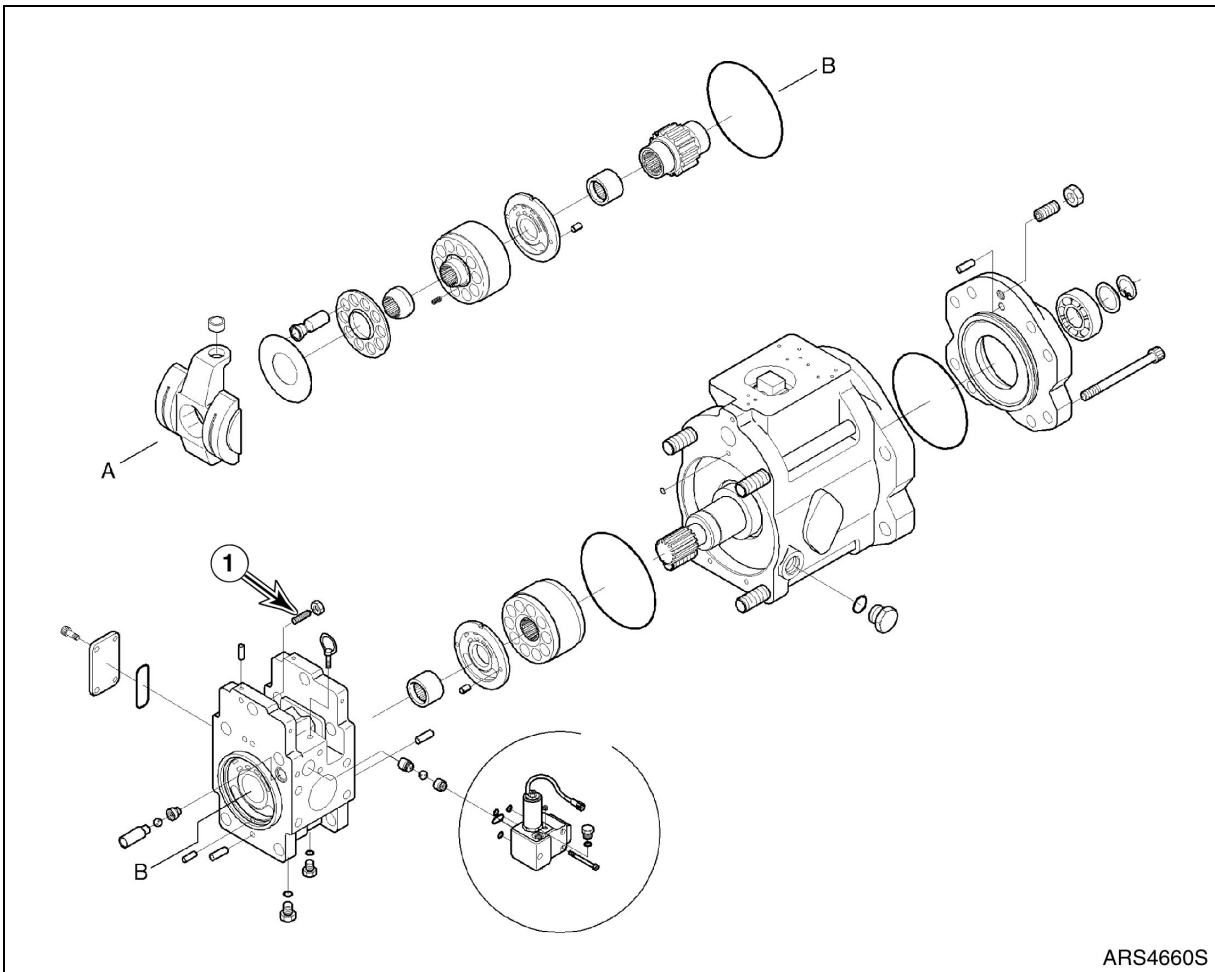


Figure 14

FLOW METER AND FLOW METER KIT INSTALLATION AND TESTING

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

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

Installation and Testing Procedure

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

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

- An assistant - who must remain at the operator's control station at all times - should restart the engine and run it long enough (at minimum rpm) to de-aerate the system and warm up the engine and hydraulic system to operating temperature.

Record the values of all test results in three columns, comparing 1) pump pressure (from the instrument panel display) with 2) measured flow, in gallons or liters per minute, from the installed flow.

meter. The third column of test results should provide a record of engine rpm measured during each of the following tests - with the engine speed control dial set at maximum, the power mode selector at Power Mode III and the work mode selector at digging mode:

- Unloaded maximum engine speed baseline test (all controls in neutral).
- Front pump test - operate "bucket cylinder out" lever. Record values at all specified pressures.
- Rear pump test - operate "swing" 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)	
	330 kg/cm ² (4,785 psi)*	
	*See Note, below	

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

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 type of load safely before proceeding. Avoid risking injury or adding to damage.
2. Turn off engine and disengage control functions until initial tests are ready to be made.



WARNING

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

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

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

- Check oil level.
- Check for overheating, oil leaks, external oil cooler clogging or broken fan belt. Consult service record for prior repair/service work.
- Drain some tank oil to a clean, clear container. Look for metal shavings/grit, cloudiness/water or foam/air bubbles in the oil.
- Check for wobble through the engine/pump flex coupling. Run engine with the pump input hydraulic power control nut turned to the lowest power to check the engine.
- Investigate unusual operating noises or vibration. Check for loose bolts, connections.

SWING RELIEF VALVE CHECKING AND ADJUSTMENT

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

- The swing motor fails to turn.
 - Swings in one direction only.
 - Swings but continues to coast.
 - There is drifting on a slope.
1. Check operation by connecting:
 - A. Two 600 bar (8,700 psi) pressure gauges to the inlet and outlet measuring ports on top of the swing motor.

Pressure should be between 265 and 285 bar (3,843.56 psi and 4,133.64 psi), with both swing locks engaged. With swing locks released, during full acceleration and deceleration, pressure should approach 275 bar (3,988.60 psi) in each direction.
 - B. Connect a 60 bar (870 psi) pressure gauge at the "SH" port of the hydraulic brake.

Pressure should always stay at or above 4 bar (58 psi) when operating swing, boom or arm.
 - C. Connect a 10 bar (145 psi) gauge at the motor makeup valve.

Pressure should stay consistently above 2.5 bar (36 psi). If pressure falls below the recommended minimum level, forceful acceleration of the swing motor could lead to cavitation of the circuit and stalling, slowed rotation, noise and possible damage.

2. If main inlet and outlet pressures were off in the preceding tests in Step 1, adjust swing relief valve pressure.

Following adjustment, repeat the operating pressure tests (with gauges connected to the inlet and outlet test ports on top of the swing motor) and check pressures with the swing locks engaged and released.

If pressure adjustment fails to restore adequate performance, proceed to the Troubleshooting - Swing table.

3. If pressure tests were at recommended levels through the main inlet and outlet ports, and through the "SH" port of the swing brake, the causes of poor swing performance could include a faulty swing motor, drive train overloading or gearbox defect, or a problem in the brake assembly or swing control valve. Proceed to the troubleshooting information in the next procedure.

If pressure through the "SH" port was tested below the minimum 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 falls below recommended minimum level, and consequent problems with cavitation, stalling and surging are observed, check the restriction valve. If pressure adjustment to the valve has been restored but if problems with cavitation continues, disassemble the upper swing motor housing and clean or replace assembly components as required.

NOTE: *If all tested pressures are at or above recommended levels, and there are no mechanical problems in the drive train or in the motor/brake assembly, the problem will require further hydraulic troubleshooting. It's also possible that a defective joystick, an intermittent short in an electrical control circuit or a problem in the e-EPOS circuit is causing diminished swing performance. Pull out the e-EPOS indicator panel from underneath the operator's seat and perform the self-diagnosis test. If the display panel reads code "0.2," it is reporting that the swing priority proportional valve is not functioning, except in the minimum "fail-safe" mode. Refer to the Electrical section of this book for more information.*

TROUBLESHOOTING - SWING GEARBOX

Problem	Possible Causes	Remedies
Swing motor fails to operate and:		
Three pressure tests at motor, brake or makeup valve show low reading(s).	Swing relief valve defective Brake release valve defective Motor makeup valve defective.	Adjust pressure to recommended range in affected valve. OR Disassemble and clean valve assembly. Replace all valve components that show damage.
All three pressure checks are OK but left travel also fails to run.	Exchange front and rear pump inlet and outlet hoses to test pump function.	If swing and left travel are restored but right travel stops working, replace or repair P1 pump.
All three pressure tests are OK, but machine fails to swing at all.	Brake assembly or motor friction plate failing to release.	Check for binding. Disassemble and repair.
	Pilot (control) pressure low or swing control valve stuck.	Disassemble / Repair pilot pressure swing spool (305) and / or swing control valve.
	Swing motor defective.	Test motor drain rate. Replace / Repair motor.
	Gear train defective.	Refer to "Swing Gear Troubleshooting" procedure.
Swing functions but only at reduced rpm.	Causes listed above could also produce dragging swing, OR hot or wrong oil OR worn-out parts.	Check above list; then replace oil, test motor drain rate and check for "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.

Problem	Possible Causes	Remedies
Swing movement is in one direction only.	Check to see that pilot pressure is the same right and left.	If pilot pressure is unequal, clean or repair piping or repair/replace valve.
	Swing control valve spool may be stuck.	Repair/Replace the swing control valve.
	Swing relief valve may be faulty.	Repair/Replace the swing relief valve.
No rotation and:		
Pressure at swing motor inlet increases.	Swing brake not releasing.	Check brake engagement and disengagement; check release pressure.
	Internal damage to gearbox drive train.	Replace broken gears and drive train assemblies.
	Overload.	Reduce load weight.
Pressure at swing motor inlet shows no increase, and the swing motor is making irregular noises.	Swing motor drive shaft damage.	Replace swing motor.
	Internal damage to gearbox drive train.	Repair/Replace broken or faulty assemblies.
Pressure at swing motor inlet shown no increase, but without irregular noises from the swing motor.	Hydraulic pump or valve problem.	Troubleshoot hydraulic system.
Oil Leakage:		
From drive shaft From bolted connections or other assembled surfaces.	Oil seal damaged Assembly compound (joint sealer) old and not sealing, bolt not tight or flange warped.	Replace oil seal Disassemble and check mating surfaces. Reapply Loctite; torque bolts to specifications.
Excess heat:		
Gearbox casing becomes excessively hot, with or without irregular noises, during operation.	Low oil level.	Replace oil; refill to specified level.
	Bearings or gears worn but not completely inoperative.	Repair or replace gearbox.

TROUBLESHOOTING - HYDRAULIC PROBLEMS

Problem	Possible Causes	Remedies
Attachment cylinders, swing and travel motors are all inoperable. Loud noises are heard from main pump assembly.	Main pump(s) malfunction	Repair or replace
	Low oil level in hydraulic system	Refill
	Main pump inlet (oil supply) piping or hose damaged	Repair or replace
Attachment cylinders, swing and travel motors are all inoperable. No usual or loud noises can be heard.	Pilot pump malfunction	Repair or replace
	Pilot cutoff solenoid stuck	Repair or replace
	Pilot cutoff switch faulty	Repair or replace
	Engine/pump flex coupling damaged	Replace flex coupling
Sluggish performance of all hydraulic functions - attachment, swing and travel.	Main pump(s) damaged or worn	Repair or replace
	Main relief valve pressure off	Readjust pressure
	Low oil level in hydraulic system	Refill
	Hydraulic reservoir intake strainer clogged	Clean
	Pump inlet (supply side) piping or hose allowing air into hydraulic system	Tighten connection
Oil temperature abnormally high.	Oil cooler clogged or air circulation to cooler blocked	Clean
	Cooling fan belt tension too loose	Readjust belt tension
	Relief valve set too low	Readjust valve
	Relief valve in constant use	Reduce or slow work load or cycling rate
	Hydraulic oil severely neglected or incorrect for application	Replace oil
One circuit in hydraulic system inoperable.	Overload relief valve malfunction	Readjust or replace
	Oil leak at make-up valve	Clean, repair
	Control valve spool damaged	Repair or replace
	Dirt in control valve spool	Clean or replace
	Actuator (joystick, foot pedal) damaged or worn	Repair or replace
	Internal seal leak in cylinder	Repair or replace
	Cylinder rod damaged	Repair or replace
	Pilot valve or piping malfunction	Repair or replace
	Mechanical linkage frozen, loose or damaged	Repair or replace
Travel motors inoperable.	Center joint damaged.	Repair or replace.
	Parking brake not releasing.	Repair or replace.
	Travel motor worn or damaged.	Repair or replace.

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

Problem	Possible Causes	Remedies
Irregular or uneven pressure.	Poppet seat damaged or pilot piston sticking to main poppet.	Clean/replace
	Loose lock nut and adjusting screw.	Readjust
	Components worn out, past wear limits.	Replace

TROUBLESHOOTING - TRAVEL PEDAL VALVE

Problem	Possible Causes	Remedies
Secondary pressure does not increase	Low primary pressure	Check primary pressure
	Broken spring	Replace spring
	Spool sticking	Clean, repair or replace
	Excess spool to casing clearance	Replace spool casing
	Worn or loose universal joint (handle) subassembly	Repair or replace 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
	Interference, restriction or 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.		

TROUBLESHOOTING - JOYSTICK CONTROL VALVE

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



ACCUMULATOR



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Mega 200-V (Tier I & II)	1001 and Up
Mega 250-V (Tier II)	2001 and Up
Solar 55	0001 and Up
Solar 55-V Plus	1001 and Up
Solar 75-V	1001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 210W-V	1001 and Up
Solar 225LC-V	1001 and Up
Solar 225NLC-V	1001 and Up
Solar 255LC-V	1001 and Up
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up
Solar 340LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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GENERAL DESCRIPTION

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

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

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

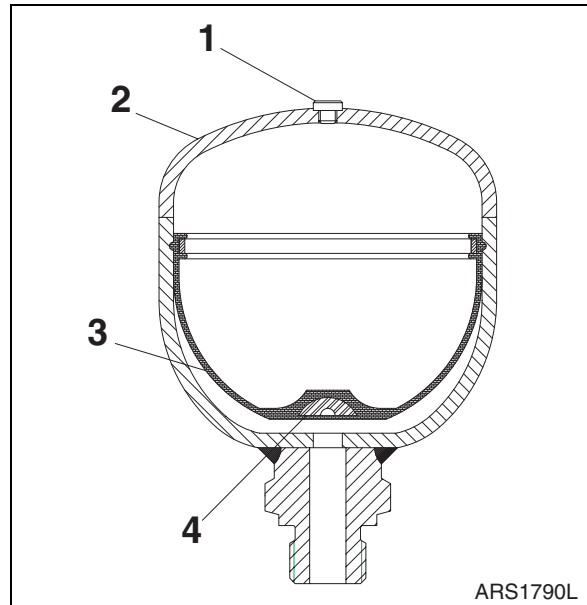


Figure 1

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

There are six possible positions the diaphragm can be in and they are as follows:

1. With no gas charge in the upper chamber 0 bar (0 psi, empty) and no oil in the bottom 0 bar (0 psi, dry) the elastic diaphragm hangs loosely.
2. When the pre-pressure charge of gas (usually nitrogen) is introduced through the port at the top of the accumulator, the diaphragm expands to maximum size. The valve button in the center of the diaphragm pushes into the fluid opening in the bottom chamber, sealing off the lower valve. If the pressure of the gas charge exceeds system oil pressure, no fluid enters the accumulator. The button also keeps the diaphragm from protruding into the lower valve opening.

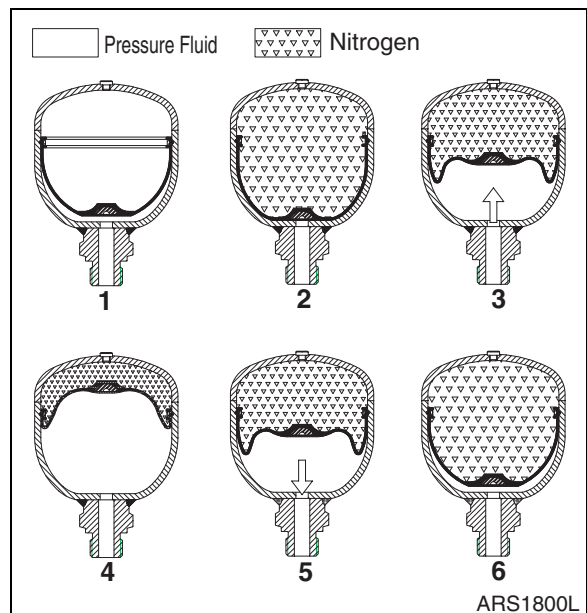


Figure 2

NOTE: *Pre-charge pressure is referred to as the "P1" pressure. The accumulator manufacturer's "P1" rated pressure should be stamped or marked on the accumulator's rating plate. Annual checks of actual pre-charge pressure should be made by tapping a hydraulic pressure gauge (and 3-way adapter coupling) into the valve on the bottom of the accumulator. When hydraulic fluid is pushed out the lower valve opening by the pressure of the gas charge on the other side of the diaphragm - and there is no counter-pressure from system oil - the valve button on the bottom of the diaphragm eventually seals off the lower oil passage. Just after the needle on the gauge reaches its highest point (when there is 0 bar (0 psi) resistance from hydraulic system pressure) pressure on the gauge will drop sharply to zero, as the accumulator is completely emptied of oil and the diaphragm button closes.*

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

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

The highest working pressure is sometimes referred to as the "P3" pressure and can also be referenced on the manufacturer's data label on the exterior of the accumulator.

5. If system oil pressure begins to fall off or is momentarily checked or interrupted, the energy stored on the other side of the diaphragm, in the form of compressed gas, pushes oil back out of the lower chamber, maintaining oil pressure of the circuit.
6. With minimal system pressure, an equilibrium point may be reached in which accumulator pre-charge pressure and hydraulic system oil pressure achieve a rough balance. In this condition a minimal amount of oil is stored in the accumulator.

SPECIFICATIONS

Model	Serial Number	System	Charge Pressure	Volume
Mega 200-V (Tier I & II)	S/N 1001 and Up	Brake System	30 kg/cm ² (427 psi)	750 cc (45.77 in ³)
Mega 200-V (Tier I & II)	S/N 1001 and Up	Pilot	15 kg/cm ² (213 psi)	320 cc (19.53 in ³)
Mega 250-V (Tier I)	S/N 1001 thru 2000	Brake System	30 kg/cm ² (427 psi)	750 cc (45.77 in ³)
Mega 250-V (Tier I)	S/N 1001 thru 2000	Pilot	15 kg/cm ² (213 psi)	320 cc (19.53 in ³)
Mega 250-V (Tier II)	S/N 2001 and Up	Brake System	30 kg/cm ² (427 psi)	750 cc (45.77 in ³)
Mega 250-V (Tier II)	S/N 2001 and Up	Pilot	15 kg/cm ² (213 psi)	320 cc (19.53 in ³)
Solar 55-V	S/N 0001 and Up	Pilot	10 kg/cm ² (140 psi)	320 cc (19.53 in ³)
Solar 55-V Plus	S/N 1001 and Up	Pilot	10 kg/cm ² (140 psi)	320 cc (19.53 in ³)

Model	Serial Number	System	Charge Pressure	Volume
Solar 75-V	S/N 1001 and Up	Pilot	10 kg/cm ² (140 psi)	320 cc (19.53 in ³)
Solar 140W-V /160W-V	S/N 1000 and Up	Brake System	30 kg/cm ² (427 psi)	750 cc (45.77 in ³)
Solar 140W-V /160W-V	S/N 1000 and Up	Pilot	15 kg/cm ² (213 psi)	320 cc (19.53 in ³)
Solar 140W-V /160W-V	S/N 1000 and Up	Transmission	8 kg/cm ² (114 psi)	750 cc (45.77 in ³)
Solar 180W-V	S/N 1001 and Up	Brake System	30 kg/cm ² (427 psi)	750 cc (45.77 in ³)
Solar 180W-V	S/N 1001 and Up	Pilot	15 kg/cm ² (213 psi)	320 cc (19.53 in ³)
Solar 180W-V	S/N 1001 and Up	Transmission	8 kg/cm ² (114 psi)	750 cc (45.77 in ³)
Solar 210W-V	S/N 0001 and Up	Brake System	30 kg/cm ² (427 psi)	750 cc (45.77 in ³)
Solar 210W-V	S/N 0001 and Up	Pilot	15 kg/cm ² (213 psi)	320 cc (19.53 in ³)
Solar 210W-V	S/N 0001 and Up	Transmission	8 kg/cm ² (114 psi)	750 cc (45.77 in ³)
Solar 225LC-V	S/N 1001 and Up	Pilot / Travel	10 kg/cm ² (142 psi)	750 cc (45.77 in ³)
Solar 225NLC-V	S/N 1001 and Up	Pilot / Travel	10 kg/cm ² (142 psi)	750 cc (45.77 in ³)
Solar 255LC-V	S/N 1001 thru 1002	Pilot / Travel	10 kg/cm ² (142 psi))	320 cc (19.53 in ³)
Solar 255LC-V	S/N 1003 and Up	Pilot / Travel	10 kg/cm ² (142 psi)	750 cc (45.77 in ³)
Solar 300LC-V	S/N 1001 thru 1099	Pilot / Travel	10 kg/cm ² (142 psi)	320 cc (19.53 in ³)
Solar 300LC-V	S/N 1100 and Up	Pilot / Travel	10 kg/cm ² (142 psi)	750 cc (45.77 in ³)
Solar 300LL	S/N 1100 and Up	Pilot / Travel	10 kg/cm ² (142 psi))	750 cc (45.77 in ³)
Solar 340LC-V	S/N 1001 thru 1059	Pilot / Travel	10 kg/cm ² (142 psi)	320 cc (19.53 in ³)
Solar 340LC-V	S/N 1060 and Up	Pilot / Travel	10 kg/cm ² (142 psi))	750 cc (45.77 in ³)
Solar 420LC-V	S/N 1001 thru 1029	Pilot / Travel	10 kg/cm ² (142 psi)	320 cc (19.53 in ³)
Solar 420LC-V	S/N 1030 and Up	Pilot / Travel	10 kg/cm ² (142 psi))	750 cc (45.77 in ³)

Model	Serial Number	System	Charge Pressure	Volume
Solar 470LC-V	S/N 1001 thru 1049	Pilot / Travel	10 kg/cm ² (142 psi)	320 cc (19.53 in ³)
Solar 470LC-V	S/N 1050 and Up	Pilot / Travel	10 kg/cm ² (142 psi))	750 cc (45.77 in ³)



CENTER JOINT (SWIVEL)



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 210W-V	1001 and Up

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GENERAL DESCRIPTION

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

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

PARTS LIST

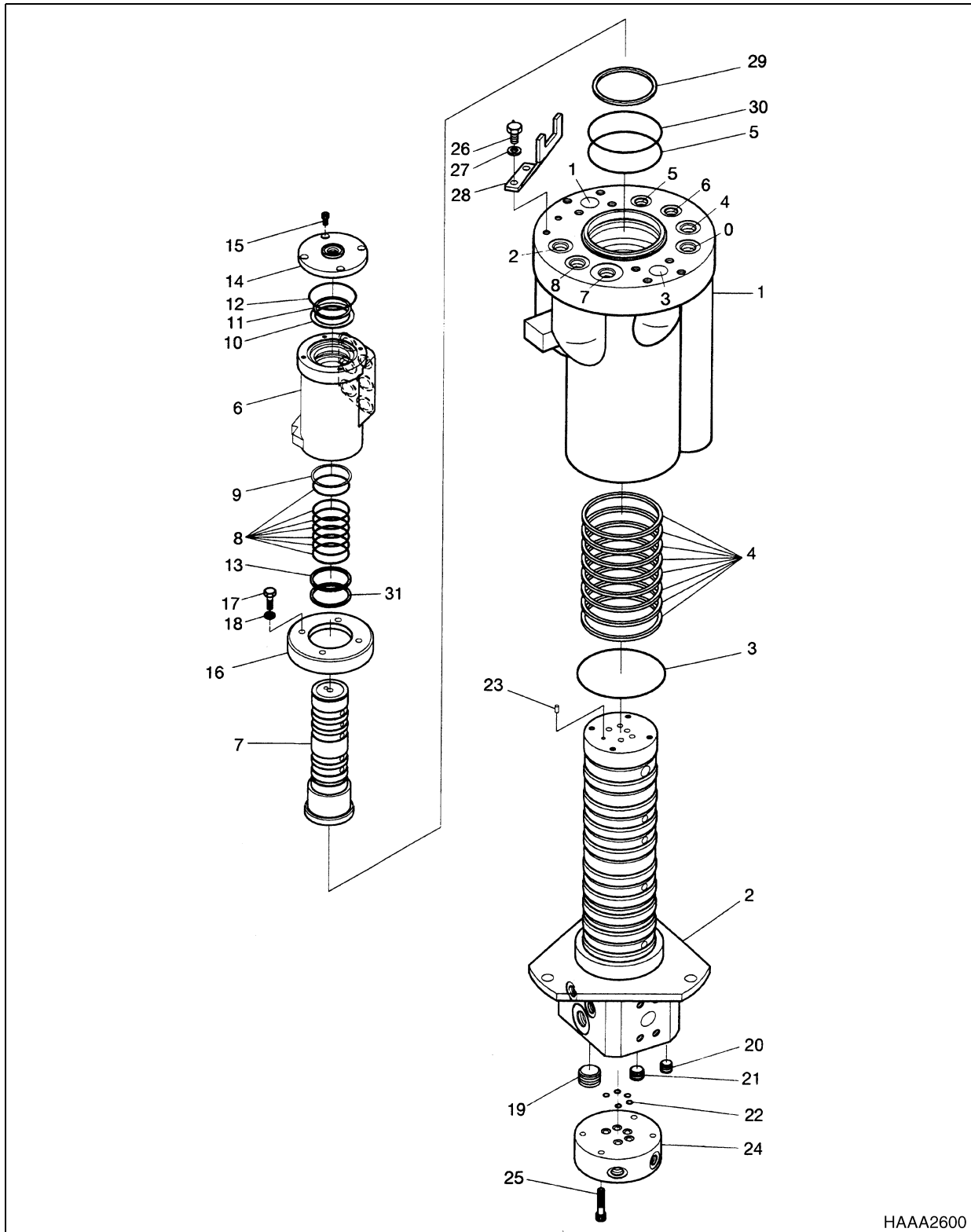


Figure 1

Reference Number	Description
1	Main Hub
2	Shaft Assembly
3	O-ring
4	Slipper Seal
5	O-ring
6	Top Hub
7	Top Shaft
8	O-ring
9	Backup Ring
10	Spacer
11	Retaining Ring
12	O-ring
13	Dust Seal
14	Top Cover
15	Bolt
16	Main Cover

Reference Number	Description
17	Hex Bolt
18	Spring Washer
19	Plug
20	Plug
21	Plug
22	O-ring
23	Pin
24	Adapter
25	Bolt
26	Hex Bolt
27	Spring Washer
28	Plate
29	Shim
30	O-ring
31	Wear Ring

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 change-over valve.

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

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

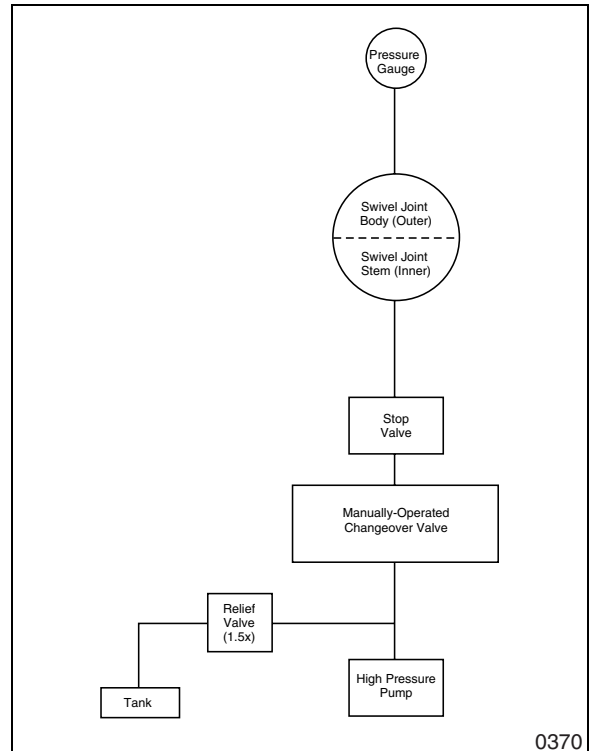


Figure 2

DISASSEMBLY

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

IMPORTANT

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

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

NOTE: *The "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.*

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

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

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

REASSEMBLY

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



CAUTION!

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

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



CYLINDERS



CAUTION!

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

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Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 55	0001 and Up
Solar 55-V Plus	1001 and Up
Solar 75-V	1001 and Up
Solar 130LC-V	0001 and Up
Solar 130W-V	0001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170LC-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 210W-V	1001 and Up
Solar 220LC-V	0001 and Up
Solar 225LC-V	1001 and Up
Solar 225NLC-V	1001 and Up
Solar 250LC-V	1001 and Up
Solar 255LC-V	1001 and Up
Solar 290LC-V	0001 and Up
Solar 300LC-V	1001 and Up
Solar 300LL	1001 and Up

MODEL	SERIAL NUMBER RANGE
Solar 330LC-V	1001 and Up
Solar 340LC-V	1001 and Up
Solar 400LC-V	1001 and Up
Solar 420LC-V	1001 and Up
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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GENERAL DESCRIPTION

Two essentially similar types of hydraulic cylinders are used on the excavator. The cylinder that is used to operate the excavator boom or bucket is equipped with a rod stopper, which acts as a cushion only when the cylinder rod is fully retracted (and the bucket is pulled close to the arm). This type of cylinder is shown in the lower drawing.

Arm cylinders have a cushion or stopper for operation in both directions. This type of cylinder is shown in the upper drawing.

THEORY OF OPERATION

1.	Piston
2.	Oil Path A
3.	Oil Path B

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

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

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

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

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

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

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

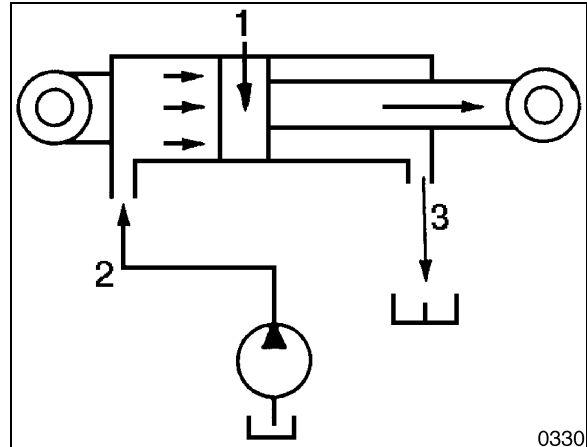


Figure 1

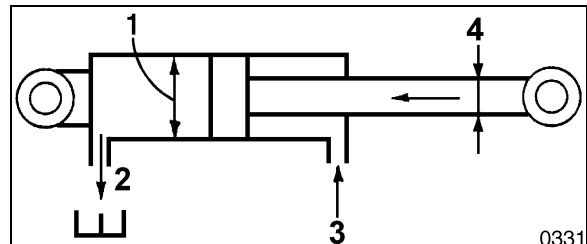


Figure 2

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

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

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

$$Q_1 > Q_2$$

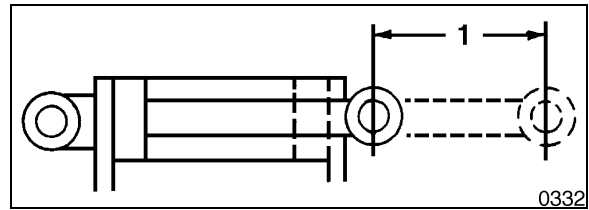


Figure 3

PARTS LIST

The following parts list is a partial listing only; for full and complete parts list information, refer to the Hydraulic Equipment Component Parts List

Cross section in Figure 4 shows an arm cylinder.

Cross section in Figure 5 shows a boom cylinder.

The bucket and boom cylinders are identical and differ only in the attached pipes.

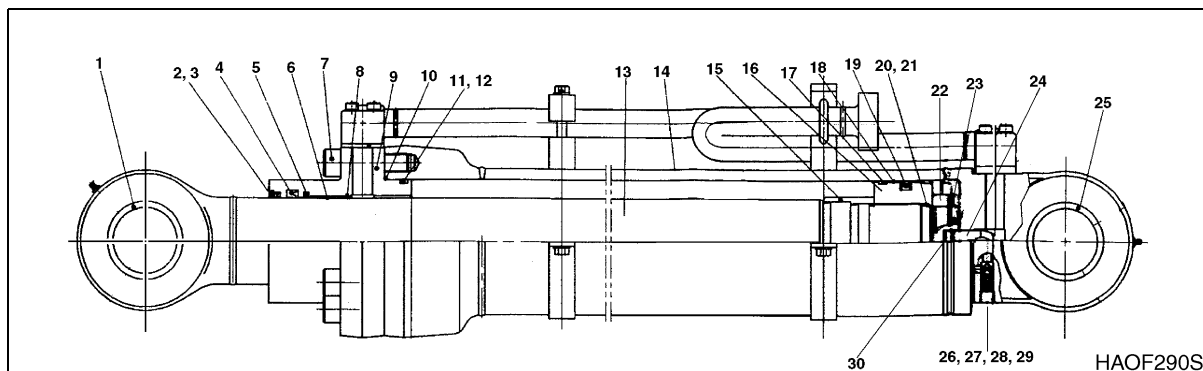


Figure 4

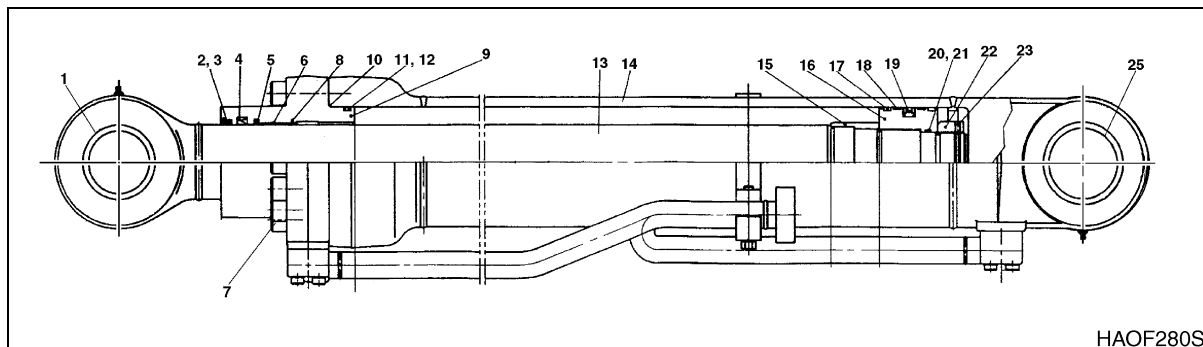


Figure 5

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

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

SPECIAL TOOLS AND MATERIALS

PISTON NUT

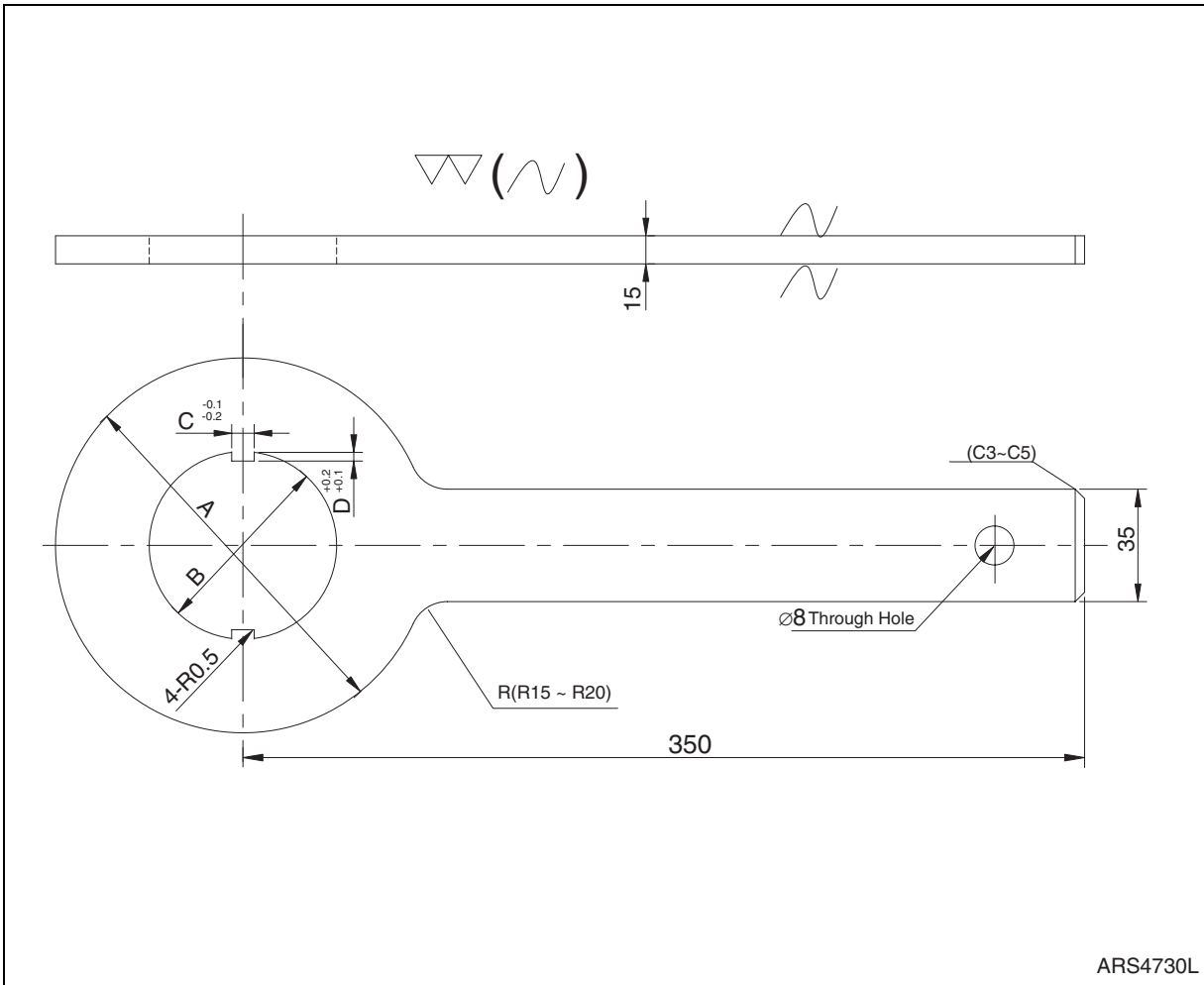


Figure 6

Material SM45C (AISI 1045)

Rockwell Harden from 22 - 27

Oil Quench

MODEL	CYLINDER	øA	øB	C	D	MODEL (CYLINDER)
S55-V	ARM	110 mm (4.33 in)	69 mm (2.72 in)	12 mm (0.47 in)	5 mm (0.20 in)	S55-V (BOOM, BOOM {OPT}) S55-V PLUS (SWING) S75-V (BUCKET)
	SWING	100 mm (3.94 in)	58 mm (2.23 in)	12 mm (0.47 in)	5 mm (0.20 in)	
	BUCKET	110 mm (4.33 in)	69 mm (2.72 in)	10 mm (0.39 in)	5 mm (0.20 in)	S55-V PLUS (BUCKET) S80W-II (DOZER) MEGA 400 (P/S)
S130LC-V	ARM	130 mm (5.12 in)	90 mm (3.54 in)	12 mm (0.47 in)	5 mm (0.20 in)	S130W-V (ARM (EURO)) S140W-V (ARM (EURO)) S160W-V (ARM) S170LC-V (BOOM) S170W-V (BOOM) S180W-V (BOOM) S200W-V (BOOM) S200LC-V (BOOM) S200N-V (BUCKET) (OPTION) S210W-V (BOOM) S220LC-V (BOOM) S225LC-V (BOOM) S225NLC-V (BOOM) S225NLC-V (BUCKET) (OPTION)
	BOOM (OP)	125 mm (4.92 in)	85 mm (3.35 in)	12 mm (0.47 in)	5 mm (0.20 in)	S130W-V (ARM) S130W-V (NEW BOOM) S130LC-V (SHORT ARM) S140W-V (ARM) S140W-V (BOOM) S140W-V (OUTRIGGER) S160W-V (BOOM) S160W-V (OUTRIGGER) S170W-V (BUCKET) S220LC-V (BUCKET) S220LL (BUCKET) S225LC-V (BUCKET) S225NLC-V (BUCKET)
	BUCKET	115 mm (4.53 in)	75 mm (2.95 in)	12 mm (0.47 in)	5 mm (0.20 in)	S140W-V (BUCKET) S160W-V (BUCKET)
S220LL	ARM	147 mm (5.79 in)	107 mm (4.21 in)	12 mm (0.47 in)	5 mm (0.20 in)	S330LC-V (ARM) S340LC-V (ARM) S370LC-V (ARM) S400LC-V (BOOM, BUCKET) S420LC-V (BOOM, BUCKET) S450LC-V (BOOM, BUCKET) S470LC-V (BOOM, BUCKET)
	BOOM	142 mm (5.59 in)	102 mm (4.02 in)	12 mm (0.47 in)	5 mm (0.20 in)	S200N-V (ARM (OP)) S225NLC-V (ARM (OP)) S210W-V (ARM) S220LC-V (ARM) S225LC-V (ARM) S225NLC-V (ARM) S290LC-V (BOOM) S300LC-V (BOOM)
	BUCKET	125 mm (4.92 in)	102 mm (4.02 in)	11 mm (0.43 in)	4.5 mm (0.18 in)	S170LC-V (BOOM) S200W-V (BUCKET) S210W-V (BUCKET)

MODEL	CYLINDER	øA	øB	C	D	MODEL (CYLINDER)
S250LC-V	ARM	145 mm (5.71 in)	105 mm (4.13 in)	12 mm (0.47 in)	5 mm (0.20 in)	S255LC-V (ARM) S290LL (BOOM, BUCKET) S330LC-V (BUCKET (OP), BOOM, BUCKET) S340LC-V (BUCKET (OP), BOOM, BUCKET) S370LC-V (BUCKET (OP), BUCKET) S390LL (BOOM, BUCKET)
S290LC-V	S/ARM	147 mm (5.79 in)	107 mm (4.21 in)	12 mm (0.47 in)	5 mm (0.20 in)	S290LC-V (ARM) S300LC-V (ARM, S/ARM) S370LC-V (BOOM)
S290LL	ARM	155 mm (6.10 in)	115 mm (4.53 in)	12 mm (0.47 in)	5 mm (0.20 in)	S140W-V (ARTI.) S160W-V (ARTI.) S400LC-V (ARM) S420LC-V (ARM)
S450LC-V	ARM	170 mm (6.69 in)	129 mm (5.08 in)	12 mm (0.47 in)	5 mm (0.20 in)	S470LC-V (ARM)
S55W-V	ARM	106 mm (4.17 in)	66 mm (2.60 in)	12 mm (0.47 in)	5 mm (0.20 in)	
	BOOM	112 mm (4.41 in)	72 mm (2.84 in)	12 mm (0.46 in)	5 mm (0.20 in)	S55-V PLUS (ARM, BOOM) S75-V (ARM, SWIVNG)
S80W-II	ARM	120 mm (4.72 in)	79 mm (3.11 in)	10 mm (0.39 in)	5 mm (0.20 in)	S70-III (ARM) S80W-II (BOOM) MEGA 130-III (LIFT) S140W-V (DOZER) S160W-V (DOZER)
	BOOM	120 mm (4.72 in)	79 mm (3.11 in)	10 mm (0.39 in)	5 mm (0.20 in)	S70-III (BOOM, DOZER) S75-V (DOZER) S130LC-V (DOZER) MEGA 200-III TC (BUCKET) MEGA 130-III (BUCKET)
	BUCKET	110 mm (4.33 in)	69 mm (2.72 in)	10 mm (0.39 in)	5 mm (0.20 in)	S70-III (BUCKET)
S130W-V	BOOM	120 mm (4.72 in)	80 mm (3.15 in)	12 mm (0.47 in)	5 mm (0.20 in)	S75-V (BOOM)
S170W-V	ARM	140 mm (5.52 in)	98 mm (3.86 in)	12 mm (0.47 in)	5 mm (0.20 in)	S170LC-V (ARM) S180W-V (ARM) S250LC-V (BOOM, BUCKET) S255LC-V (BOOM, BUCKET) S290LC-V (S/BUCKET, BUCKET) S300LC-V (S/ BUCKET, BUCKET)
S210W-V	DOZER	132 mm (5.20 in)	92 mm (3.62 in)	12 mm (0.47 in)	5 mm (0.20 in)	S180W-V (DOZER) S180W-V (OUTRIGGER) S210W-V (OUTRIGGER)
P/S: Power Steering						

PISTON JIG

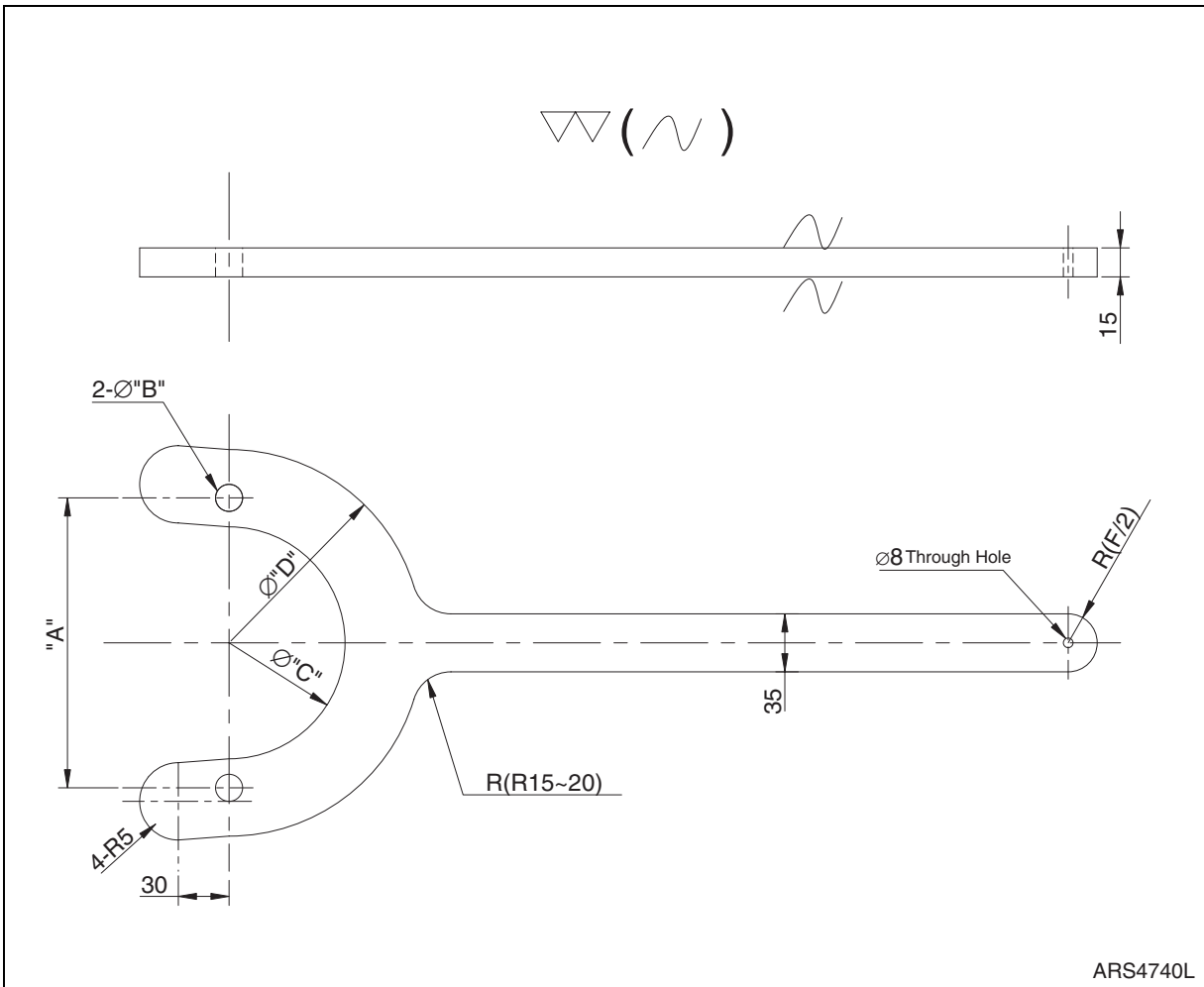


Figure 7

Material SM45C (AISI 1045)

Rockwell Harden from 22 - 27

Oil Quench

MODEL	CYLINDER	A (±0.1)	øB	øC	øD	MODEL (CYLINDER)
S55	BOOM	80.0 mm (3.15 in)	11.0 mm (0.43 in)	45.0 mm (1.77 in)	110.0 mm (4.33 in)	S55 (BOOM (OP)) S55W-V (BOOM)
	SWING	58.0 mm (2.28 in)	11.0 mm (0.43 in)	38.0 mm (1.50 in)	80.0 mm (3.15 in)	MEGA 300 (P/S)
S55-V PLUS	ARM	65.0 mm (2.56 in)	11.0 mm (0.43 in)	49.0 mm (1.93 in)	90.0 mm (3.54 in)	MEGA 130-III (LIFT) MEGA 160TC (BUCKET) MEGA 400 (P/S)
S70-III	ARM	70 mm (2.76 in)	11 mm (0.43 in)	51 mm (2.01 in)	95 mm (3.74 in)	S80W-II (ARM)
	BUCKET	60 mm (2.36 in)	11 mm (0.43 in)	43 mm (1.69 in)	85 mm (3.35 in)	S80W-II (BUCKET, DOZER) S75-V (BUCKET)
	DOZER	70 mm (2.76 in)	11 mm (0.43 in)	53 mm (2.09 in)	95 mm (3.74 in)	S75-V (ARM, DOZER) S130LC-V (DOZER) S140W-V (DOZER) S160W-V (DOZER)
S220LC-V	ARM	110 mm (4.33 in)	13 mm (0.51 in)	76 mm (2.99 in)	140 mm (5.51 in)	S210W-V (ARM) S220LC-V (BOOM) S220N-V (ARM (OP)) S225NLC-V (BOOM) S225NLC-V (ARM (OP)) S250LC-V (ARM) S255LC-V (ARM) S290LC-V (BOOM, BUCKET) S300LC-V (BOOM, BUCKET)
	BUCKET	90 mm (3.54 in)	11 mm (0.43 in)	63 mm (2.48 in)	115 mm (4.53 in)	S70-III (BOOM) S75-V (SWING) S80W-II (BOOM) S130W-V (ARM (EURO)) S130LC-V (S/ARM, BOOM (OP), ARM) S160W-V (ARM) S170LC-V (BOOM) S170W-V (BUCKET, BOOM) S180W-V (BOOM) S210W-V (BUCKET) S220LC-V (BUCKET) S225LC-V (BUCKET) S225NLC-V (BUCKET) MEGA 200-III (LIFT)
S290LC-V	ARM S/ARM	120 mm (4.72 in)	13 mm (0.51 in)	85 mm (3.35 in)	150 mm (5.91 in)	S290LL (BUCKET, BOOM) S300LC-V (ARM, S/ARM) S330LC-V (BOOM, BUCKET) S340LC-V (BUCKET, BOOM, BUCKET (OP)) S370LC-V (BUCKET, BUCKET (OP))
S330LC-V	ARM	130 mm (5.12 in)	13 mm (0.51 in)	93 mm (3.66 in)	165 mm (6.50 in)	S140W-V (ARTI) S160W-V (ARTI) S340LC-V (ARM) S400LC-V (ARM, BOOM) S420LC-V (ARM, BOOM, BUCKET) S450LC-V (BOOM, BUCKET) S470LC-V (BOOM, BUCKET)

MODEL	CYLINDER	A (±0.1)	øB	øC	øD	MODEL (CYLINDER)
S450LC-V	ARM	150 mm (5.91 in)	13 mm (0.51 in)	103 mm (4.06 in)	180 mm (7.09 in)	S470LC-V (ARM)
S55W-V	ARM	63 mm (2.48 in)	11 mm (0.43 in)	43 mm (1.69 in)	90 mm (3.54 in)	S55-V (ARM, BUCEKT) S55W-V (BUCKET) S55-V PLUS (BUCKET)
S130W-V	BOOM	75 mm (2.95 in)	11 mm (0.43 in)	53 mm (2.09 in)	100 mm (3.94 in)	S75-V (BOOM) S130LC-V (BOOM)
S140W-V	BUCKET	70 mm (2.76 in)	11 mm (0.43 in)	46 mm (1.81 in)	95 mm (3.74 in)	S160W-V (BUCKET)
S170W-V	ARM	96 mm (3.78 in)	13 mm (0.51 in)	69 mm (2.72 in)	130 mm (5.12 in)	S170LC-V (ARM) S180W-V (ARM) S180W-V (O/R, DOZER) S200W-V (O/R, DOZER) S210W-V (O/R, DOZER) S250LC-V (BUCKET, BOOM) S255LC-V (BUCKET, BOOM)
	BUCKET	80 mm (3.15 in)	11 mm (0.43 in)	58 mm (2.28 in)	110 mm (4.33 in)	S55-V PLUS (BOOM, SWING) S70-III (BOOM) S80W-II (BOOM) S130W-V (ARM) S130LC-V (S/ARM, BOOM {OP}) S140W-V (ARM) S140W-V (BOOM) S140W-V (O/R) S160W-V (ARM) S160W-V (O/R) S180W-V (BUCKET)
S200W-V	BOOM	90 mm (3.54 in)	13 mm (0.51 in)	63 mm (2.48 in)	115 mm (4.53 in)	S220LC-V (BOOM) S220N-V (BUCKET) (OP) S225LC-V (BOOM) S225NLC-V (BOOM) S225NLC-V (BOOM) (OP)
P/S: Power Steering O/R: Out Rigger						

STEEL BUSH JIG

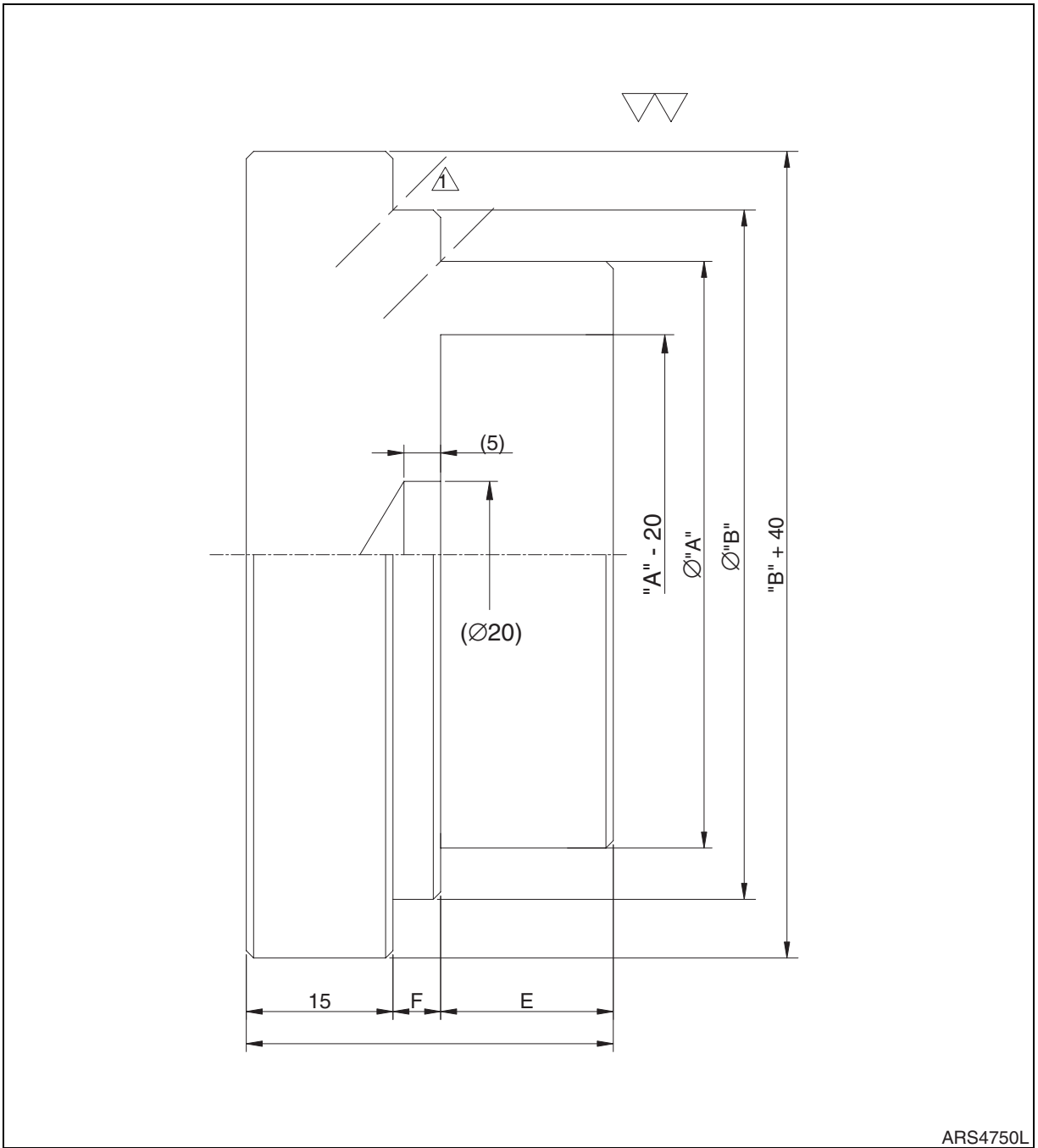


Figure 8

Material: SM45C which is done thermal refining <QT> Hrc 22 - 28

Undefined Chamfer C/R = 0.5 Max.

1 Place: Finally work to used DNMG Tip <Nose R0.4>

MODEL	CYLINDER	ϕA ^{-0.05} _{-0.15}	$\phi B (\pm 0.1)$	E	F ^{+0.05} ₀	Part	MODEL (CYLINDER)
S55-V	BOOM	50 mm (1.97 in)	65 mm (2.56 in)	30 mm (1.18 in)	-		S55W-V (BOOM) S55-V PLUS (SWING)
	SWING	40 mm (1.58 in)	50 mm (1.97 in)	20 mm (0.79 in)	-		
	DOZER	65 mm (2.56 in)	70 mm (2.76 in)	30 mm (1.18 in)	-		
S70-III	DOZER	50 mm (1.97 in)	60 mm (2.36 in)	40 mm (1.58 in)	0		S75-V (DOZER)
	BUCKET	50 mm (1.97 in)	60 mm (2.36 in)	25 mm (0.98 in)	5 mm (0.20 in)	H/C	S55-V (ARM) S55- V PLUS (ARM, BOOM, BUCKET) S75-V (BUCKET)
	BUCKET	55 mm (2.17 in)	68 mm (2.68 in)	30 mm (1.18 in)	5.5 mm (0.22 in)	K/C	S80W-II BUCKET (K/C)
S130LC-V	DOZER	60 mm (2.36 in)	70 mm (2.76 in)	30 mm (1.18 in)	-		S140W-V (DOZER) S160W-V (DOZER)
	BUCKET	65 mm (2.56 in)	80 mm (3.15 in)	30 mm (1.18 in)	6 mm (0.24 in)		S70-III (ARM, BOOM) S75-V (ARM, BOOM, SWING) S140W-V (BUCKET) S160W-V (BUCKET) MEGA 200-III (LIFT) MEGA 200-III TC (H/C)

MODEL	CYLINDER	ϕA ^{-0.05} _{-0.15}	ϕB (± 0.1)	E	F ^{+0.05} ₀	Part	MODEL (CYLINDER)
S220LL	ARM	90 mm (3.54 in)	105 mm (4.13 in)	40 mm (1.58 in)	6.5 mm (0.26 in)		S210W-V (ARM) S290LC-V (S/ARM, ARM) S290LL (BOOM, BUCKET) S300LC-V (S/ARM, ARM) MEGA 250-III (BUCKET) MEGA 400 (LIFT (H/C), BUCKET) MEGA 400-V (LIFT (H/C)) MEGA 500-III
	BOOM	80 mm (3.15 in)	95 mm (3.74 in)	35 mm (1.38 in)	6.5 mm (0.26 in)		S180W-V (DOZER, O/R) S200W-V (BOOM, DOZER, O/R) S210W-V (BOOM, DOZER, O/R) S220N-V (ARM (OP), BUCKET (OP)) S220LC-V (ARM, BOOM, BUCKET) S225LC-V (ARM, BOOM, BUCKET) S225NLC-V (ARM (OP), BUCKET (OP)) S225NLC-V (ARM, BOOM, BUCKET) S250LC-V (ARM, BUCKET) S255LC-V (ARM, BUCKET) MEGA 160 (BUCKET) MEGA 200-III (BUCKET) MEGA 200 (BUCKET) MEGA 300 (BUCKET) MEGA 300-V (LIFT)
	BUCKET	65 mm (2.56 in)	80 mm (3.15 in)	35 mm (1.38 in)	6.5 mm (0.26 in)		S210W-V (BUCKET)
S250LC-V	BOOM	90 mm (3.54 in)	105 mm (4.13 in)	40 mm (1.58 in)	7 mm (0.28 in)		S255LC-V (BOOM) S290LC-V (S/BUCKET, BOOM, BUCKET) S300LC-V (S/BUCKET, BOOM, BUCKET)
S290LL	ARM (STICK)	100 mm (3.94 in)	115 mm (4.53 in)	70 mm (2.76 in)	6.5 mm (0.26 in)		
S330LC-V	BUCKET (OP)	100 mm (3.94 in)	115 mm (4.53 in)	45 mm (1.77 in)	7.5 mm (0.30 in)		S330LC-V (ARM, BOOM, BUCKET) S340LC-V (ARM, BOOM, BUCKET) S370LC-V (ARM, BOOM, BUCKET) MEGA 300-V (BUCKET) MEGA 400-V (BUCKET) MEGA 500-III (LIFT (H/C))

MODEL	CYLINDER	ϕA ^{-0.05} _{-0.15}	$\phi B (\pm 0.1)$	E	F ^{+0.05} ₀	Part	MODEL (CYLINDER)
S450LC-V	ARM	120 mm (4.72 in)	140 mm (5.51 in)	75 mm (2.95 in)	11 mm (0.43 in)		S470LC-V (ARM)
	BOOM	110 mm (4.33 in)	130 mm (5.12 in)	70 mm (2.76 in)	11 mm (0.43 in)	H/C	S400LC-V (ARM, BOOM (H/C), BUCKET) S420LC-V (ARM, BOOM (H/C), BUCKET) S450LC-V (BUCKET) S470LC-V (BOOM, BUCKET)
	BOOM	120 mm (4.72 in)	140 mm (5.51 in)	70 mm (2.76 in)	11 mm (0.43 in)	K/C	S420LC-V (BOOM (K/C)) S400LC-V (BOOM (K/C))
S55W-V	BUCKET	50 mm (1.97 in)	60 mm (2.36 in)	30 mm (1.18 in)	-		S55-V (ARM, BOOM (OP), BUCKET)
	DOZER	65 mm (2.56 in)	75 mm (2.95 in)	30 mm (1.18 in)	-		S55-V PLUS (DOZER)
S80W-II	BUCKET	50 mm (1.97 in)	60 mm (2.36 in)	25 mm (0.98 in)	5.5 mm (0.22 in)	H/C	
S130W-V	BOOM	71 mm (2.80 in)	86 mm (3.39 in)	40 mm (1.58 in)	6.5 mm (0.26 in)		S130LC-V (BOOM, BOOM (OP)) S140W-V (BOOM) S160W-V (BOOM)
	ARM (EURO)	71 mm (2.80 in)	86 mm (3.39 in)	40 mm (1.58 in)	7 mm (0.28 in)		S130W-V (ARM) S130LC-V (S/ARM, ARM) S140W-V (ARM) S160W-V (ARM) S180W-V (ARM, BOOM, BUCKET)
S140W-V	O/R	60 mm (2.36 in)	75 mm (2.95 in)	30 mm (1.18 in)	6.5 mm (0.26 in)		S160W-V (O/R)
S140W-V	ARTI.	90 mm (3.54 in)	105 mm (4.13 in)	40 mm (1.58 in)	6 mm (0.24 in)		S160W-V (ARTI.)
S170W-V	ARM	71 mm (2.80 in)	86 mm (3.39 in)	50 mm (1.97 in)	6 mm (0.24 in)		S170W-V (BOOM, BUCKET) S170LC-V (ARM, BOOM)
H/C: Head Cover K/C: Knuckle Cover							

DUST WIPER JIG

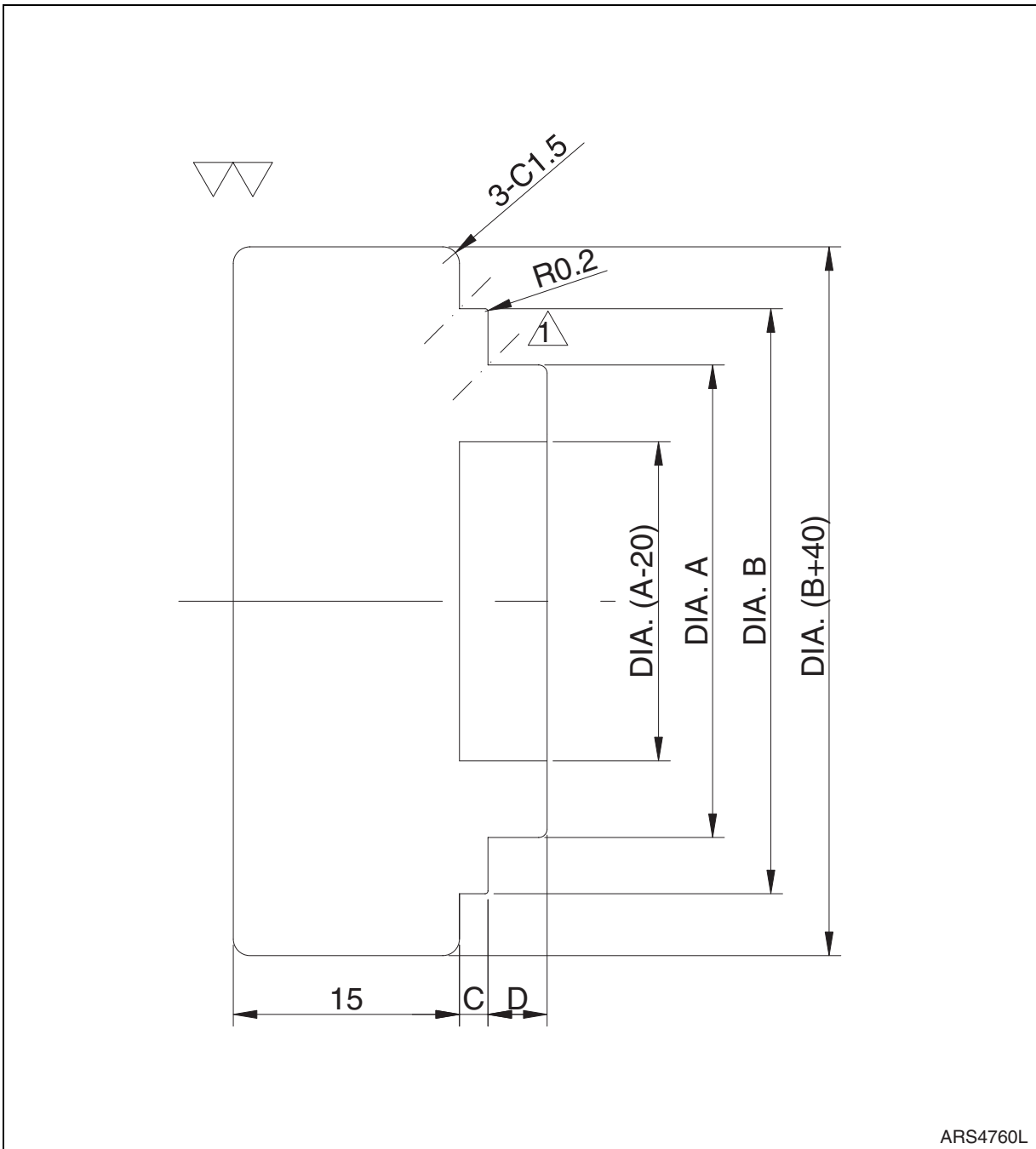


Figure 9

Material: SM45C which is done thermal refining <QT> Hrc 22 - 28

Undefined Chamfer C/R = 0.5 Max.

1 Place: Finally work to used DNMG Tip <Nose R0.4>

MODEL	CYLINDER	ϕA -0.2 -0.3	ϕB -0.2 -0.3	C 0 -0.1	D	MODEL (CYLINDER)
DD80L	TILT	35 mm (1.38 in)	47 mm (1.85 in)	0	6 mm (0.24 in)	
	DOZER	45 mm (1.77 in)	57 mm (2.24 in)	0.5 mm (0.02 in)	6 mm (0.24 in)	DD80L (ANGLE)
	ANGLE	45 mm (1.77 in)	57 mm (2.24 in)	0.5 mm (0.02 in)	6 mm (0.24 in)	
S55-V	ARM	55 mm (2.17 in)	69 mm (2.72 in)	5 mm (0.20 in)	6 mm (0.24 in)	
	BOOM	55 mm (2.17 in)	69 mm (2.72 in)	5 mm (0.20 in)	6 mm (0.24 in)	
	BOOM (OP)	55 mm (2.17 in)	69 mm (2.72 in)	5 mm (0.20 in)	6 mm (0.24 in)	
	BUCKET	55 mm (2.17 in)	69 mm (2.72 in)	5 mm (0.20 in)	6 mm (0.24 in)	
	SWING	40 mm (1.58 in)	52 mm (2.05 in)	3.5 mm (0.14 in)	6 mm (0.24 in)	S55W-V (SWING)
	DOZER	60 mm (2.36 in)	74 mm (2.91 in)	7 mm (0.28 in)	6 mm (0.24 in)	
S70-III	ARM	65 mm (2.56 in)	79 mm (3.11 in)	5.5 mm (0.22 in)	6 mm (0.24 in)	S80W-III (ARM)
	BOOM	70 mm (2.76 in)	84 mm (3.31 in)	5.5 mm (0.22 in)	6 mm (0.24 in)	S80W-III (BOOM) S130W-V (BOOM) S130LC-V (BOOM) MEGA 160-III (BUCKET)
	BUCKET	55 mm (2.17 in)	69 mm (2.72 in)	5 mm (0.20 in)	6 mm (0.24 in)	S55-V (ARM, BOOM, BOOM (OP), BUCKET) S55-V PLUS (BUCKET, SWING) S55W-V (ARM) S75-V (BUCKET) S80W-III (BUCKET) MEGA 130-III (LIFT)
	DOZER	60 mm (2.36 in)	74 mm (2.91 in)	5 mm (0.20 in)	6 mm (0.24 in)	S55W-V (BOOM) S55-V PLUS (ARM, BOOM) S75-V (ARM, SWING DOZER) S140W-V (DOZER) S160W-V (DOZER) MEGA 130-III (BUCKET) MEGA 160-III (LIFT) MEGA 200-III TC (BUCKET)
S75-V	BOOM	70 mm (2.76 in)	84 mm (3.31 in)	5 mm (0.20 in)	6 mm (0.24 in)	
S80-III	DOZER	60 mm (2.36 in)	74 mm (2.91 in)	7 mm (2.28 in)	6 mm (0.24 in)	S55-V (DOZER) S55-V PLUS (DOZER) S55W-V (DOZER)
S130LC-V	ARM	80 mm (3.15 in)	94 mm (3.70 in)	6 mm (0.24 in)	7 mm (2.28 in)	S160W-V (ARM) S170W-V (BOOM) S220N-V (BOOM (OP)) S225NLC-V (BOOM (OP))
	BOOM	70 mm (2.76 in)	84 mm (3.31 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BOOM (OP)	75 mm (2.95 in)	89 mm (3.50 in)	6 mm (0.24 in)	7 mm (2.28 in)	

MODEL	CYLINDER	ϕA -0.2 -0.3	ϕB -0.2 -0.3	C 0 -0.1	D	MODEL (CYLINDER)
S220LC-V	ARM	95 mm (3.74 in)	109 mm (4.29 in)	6 mm (0.24 in)	7 mm (2.28 in)	S210W-V (ARM) S220N-V (ARM (OP)) S225LC-V (ARM) S225NLC-V (ARM) S290LC-V (BOOM) S300LC-V (BOOM)
	BOOM	85 mm (3.35 in)	99 mm (3.90 in)	6 mm (0.24 in)	7 mm (2.28 in)	S225LC-V (BOOM) S225NLC-V (BOOM)
	BUCKET	75 mm (2.95 in)	89 mm (3.50 in)	6 mm (0.24 in)	7 mm (2.28 in)	S210W-V (BUCKET) S225LC-V (BUCKET) S225NLC-V (BUCKET)
S220LL	ARM (STICK)	115 mm (4.53 in)	131 mm (5.16 in)	6 mm (0.24 in)	7 mm (2.28 in)	S340LC-V (ARM) S420LC-V (BOOM) S470LC-V (BOOM, BUCKET) S370LC-V (ARM) S360LC-V (ARM) S400LC-V (BOOM) S450LC-V (BOOM, BUCKET)
	BOOM (HOIST)	90 mm (3.54 in)	104 mm (4.10 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BUCKET (HEEL)	75 mm (2.95 in)	89 mm (3.50 in)	6 mm (0.24 in)	7 mm (2.28 in)	
S220N-V	ARM (OP)	95 mm (3.74 in)	109 mm (4.29 in)	6 mm (0.24 in)	7 mm (2.28 in)	S225NLC-V (ARM (OP))
	BOOM (OP)	80 mm (3.15 in)	94 mm (3.70 in)	6 mm (0.24 in)	7 mm (2.28 in)	S225NLC-V (BOOM (OP))
S250LC-V	ARM	100 mm (3.94 in)	114 mm (4.49 in)	6 mm (0.24 in)	7 mm (2.28 in)	S255LC-V (ARM) S360LC-V (BOOM, BUCKET, BUCKET (OP)) S340LC-V (BOOM, BUCKET, BUCKET (OP)) S370LC-V (BUCKET, BUCKET (OP)) S290LL (BOOM (HOIST), BUCKET (HEEL))
	BOOM	90 mm (3.54 in)	104 mm (4.10 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BUCKET	90 mm (3.54 in)	104 mm (4.10 in)	6 mm (0.24 in)	7 mm (2.28 in)	
S290LC-V	ARM	105 mm (4.13 in)	121 mm (4.76 in)	6 mm (0.24 in)	7 mm (2.28 in)	S290LC-V (S/ARM) S300LC-V (ARM, S/ARM) S370LC-V (BOOM)
	S/ARM	105 mm (4.13 in)	121 mm (4.76 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BOOM	95 mm (3.74 in)	109 mm (4.29 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BUCKET	90 mm (3.54 in)	104 mm (4.10 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	S/BUCKET	90 mm (3.54 in)	104 mm (4.10 in)	6 mm (0.24 in)	7 mm (2.28 in)	

MODEL	CYLINDER	ϕA -0.2 -0.3	ϕB -0.2 -0.3	C 0 -0.1	D	MODEL (CYLINDER)
S290LL	ARM (STICK)	120 mm (4.72 in)	136 mm (5.35 in)	9 mm (0.35 in)	7 mm (2.28 in)	
	BOOM (HOIST)	100 mm (3.94 in)	114 mm (4.49 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BUCKET (HEEL)	100 mm (3.94 in)	114 mm (4.49 in)	6 mm (0.24 in)	7 mm (2.28 in)	
S360LC-V	ARM	115 mm (4.53 in)	131 mm (5.16 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BOOM	100 mm (3.94 in)	114 mm (4.49 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BUCKET	100 mm (3.94 in)	114 mm (4.49 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BUCKET (OP)	100 mm (3.94 in)	114 mm (4.49 in)	6 mm (0.24 in)	7 mm (2.28 in)	
S400LC-V	ARM	120 mm (4.72 in)	136 mm (5.35 in)	9 mm (0.35 in)	7 mm (2.28 in)	S420LC-V (ARM) S290LL (ARM (STICK))
	BOOM	115 mm (4.53 in)	131 mm (5.16 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BUCKET	110 mm (4.33 in)	126 mm (4.96 in)	6 mm (0.24 in)	7 mm (2.28 in)	S420LC-V (BUCKET)
S450LC-V	ARM	130 mm (5.12 in)	146 mm (5.75 in)	6.5 mm (0.26 in)	7 mm (2.28 in)	S470LC-V (ARM)
	BOOM	115 mm (4.53 in)	131 mm (5.16 in)	6 mm (0.24 in)	7 mm (2.28 in)	S140W-V (ARTI.) S160W-V (ARTI.)
	BUCKET	115 mm (4.53 in)	131 mm (5.16 in)	6 mm (0.24 in)	7 mm (2.28 in)	
S55W-V	ARMS	55 mm (2.17 in)	69 mm (2.72 in)	5 mm (0.20 in)	6 mm (0.24 in)	
	SWING	40 mm (1.58 in)	52 mm (2.05 in)	3.5 mm (0.14 in)	6 mm (0.24 in)	
	BOOM	60 mm (2.36 in)	74 mm (2.91 in)	5 mm (0.20 in)	6 mm (0.24 in)	
	BUCKET	50 mm (1.97 in)	62 mm (2.44 in)	4.5 mm (0.18 in)	6 mm (0.24 in)	
	DOZER	60 mm (2.36 in)	74 mm (2.91 in)	5 mm (0.20 in)	6 mm (0.24 in)	
S80W-III	ARM	65 mm (2.56 in)	79 mm (3.11 in)	5.5 mm (0.22 in)	6 mm (0.24 in)	
	BOOM	70 mm (2.76 in)	84 mm (3.31 in)	5.5 mm (0.22 in)	6 mm (0.24 in)	
	BUCKET	55 mm (2.17 in)	69 mm (2.72 in)	5 mm (0.20 in)	6 mm (0.24 in)	

MODEL	CYLINDER	ϕA -0.2 -0.3	ϕB -0.2 -0.3	C 0 -0.1	D	MODEL (CYLINDER)
S130W-V	ARM	75 mm (2.95 in)	89 mm (3.50 in)	6 mm (0.24 in)	7 mm (2.28 in)	S130W-V (S/ARM) S130LC-V (BOOM (OP)) S140W-V (ARM) S140W-V (BOOM) S160W-V (BOOM) S170W-V (BUCKET) S220LC-V (BUCKET) S220LL (BUCKET (HEEL))
	S/ARM	75 mm (2.95 in)	89 mm (3.50 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BOOM	70 mm (2.76 in)	84 mm (3.31 in)	6 mm (0.24 in)	7 mm (2.28 in)	
	BUCKET	65 mm (2.56 in)	79 mm (3.11 in)	6 mm (0.24 in)	7 mm (2.28 in)	S140W-V (BUCKET) S160W-V (BUCKET)
S140W-V	OR	70 mm (2.76 in)	84 mm (3.31 in)	0.5 mm (0.02 in)	6 mm (0.24 in)	S160W-V (O/R)
S170W-V	ARM	90 mm (3.54 in)	104 mm (4.10 in)	6 mm (0.24 in)	7 mm (2.28 in)	S180W-V (ARM) S220LL (BOOM (HOIST)) S250LC-V (BOOM, BUCKET) S255LC-V (BOOM, BUCKET) S290LC-V (BUCKET, S/BUCKET) S300LC-V (BUCKET, S/BUCKET)
	BOOM	80 mm (3.15 in)	94 mm (3.70 in)	6 mm (0.24 in)	7 mm (2.28 in)	S180W-V (BOOM)
	BUCKET	75 mm (2.95 in)	89 mm (3.50 in)	6 mm (0.24 in)	7 mm (2.28 in)	S180W-V (BUCKET)
S200W-V	BOOM	85 mm (3.35 in)	99 mm (3.90 in)	6 mm (0.24 in)	7 mm (2.28 in)	S210W-V (BOOM) S220LC-V (BOOM)

SLIPPER SEAL JIG

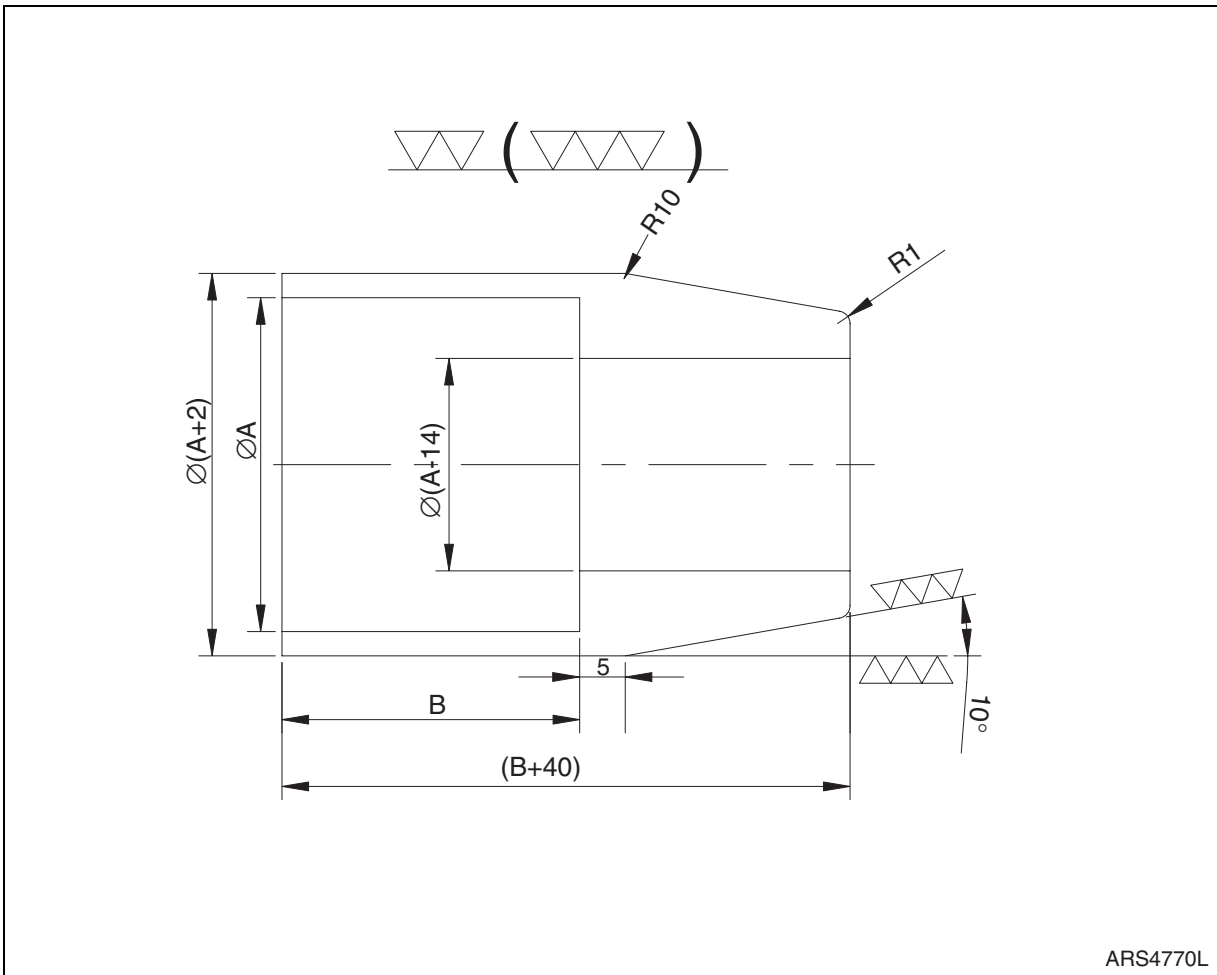


Figure 10

MODEL	CYLINDER	øA ^{+0.2} _{+0.1}	B ^{+0.2} _{+0.1}	MODEL (CYLINDER)
S55-V	ARM	85 mm (3.35 in)	32 mm (1.26 in)	S55W-V (ARM)
	BOOM	110 mm (4.33 in)	21.5 mm (0.85 in)	S55-V (BOOM (OP)) S55W-V (BOOM)
	SWING	80 mm (3.15 in)	30 mm (1.18 in)	S55W-V (BUCKET, SWING) S55-V PLUS (BUCKET) MEGA 300-III (P/S)
	DOZER	100 mm (3.94 in)	18 mm (0.71 in)	S55W-V (DOZER)
S55-V PLUS	ARM	90 mm (3.54 in)	27 mm (1.06 in)	
	BOOM	115 mm (4.53 in)	20 mm (0.79 in)	
S70-III	BUCKET	85 mm (3.35 in)	28.5 mm (1.12 in)	S55-V (ARM) S80W-II (BUCKET, DOZER)
S75-V	BOOM	115 mm (4.53 in)	25 mm (0.90 in)	
	ARM	95 mm (3.74 in)	23.5 mm (0.92 in)	
	BUCKET	85 mm (3.35 in)	23 mm (0.90 in)	
	SWING	110 mm (4.33 in)	31.5 mm (1.24 in)	
S130LC-V	ARM	115 mm (4.53 in)	28.5 mm (1.12 in)	S170W-V (BOOM) S180W-V (BOOM) S210W-V (BUCKET) S220LC-V (BUCKET) S220LL (BUCKET (HEEL)) S225LC-V (BUCKET) S225NLC-V (BUCKET)
S220LC-V	BOOM	120 mm (4.72 in)	28.5 mm (1.12 in)	S220N-V (BUCKET (OP)) S225LC-V (BOOM) S225NLC-V (BUCKET (OP)) S225NLC-V (BOOM)
S220LL	ARM (STICK)	165 mm (6.50 in)	34.5 mm (1.36 in)	S400LC-V (BOOM) S420LC-V (BOOM)
S250LC-V	ARM	140 mm (5.51 in)	28.5 mm (1.12 in)	S220LL (BOOM (HOIST)) S255LC-V (ARM) S290-V (BOOM, BUCKET, S/BUCKET) S300LC-V (BOOM, BUCKET, S/BUCKET)
	BOOM	130 mm (5.12 in)	28.5 mm (1.12 in)	S250LC-V (BUCKET) S255LC-V (BOOM, BUCKET)
S290LC-V	ARM	150 mm (5.91 in)	28.5 mm (1.12 in)	S290LL (BOOM (HOIST), BUCKET (HEEL)) S290LC-V (S/ARM) S300LC-V (ARM, S/ARM) S340LC-V (BOOM, BUCKET, BUCKET (OP)) S360LC-V (BOOM, BUCKET, BUCKET (OP)) S370LC-V (BOOM, BUCKET, BUCKET (OP))
S360LC-V	ARM	170 mm (6.69 in)	34.5 mm (1.36 in)	S340LC-V (ARM) S370LC-V (ARM) S450LC-V (BOOM, BUCKET) S470LC-V (BOOM, BUCKET)

MODEL	CYLINDER	ϕA ^{+0.2} / _{+0.1}	B ^{+0.2} / _{+0.1}	MODEL (CYLINDER)
S400LC-V	ARM	180 mm (7.09 in)	41.5 mm (1.63 in)	S140W-V (ARTI.) S160W-V (ARTI.) S290LL (ARM (STICK)) S420LC-V (ARM)
	BUCKET	160 mm (6.30 in)	34.5 mm (1.36 in)	S420LC-V (BUCKET)
S450-V	ARM	190 mm (7.48 in)	41.5 mm (1.63 in)	S470LC-V (ARM)
S130W-V	ARM	110 mm (4.33 in)	28.5 mm (1.12 in)	S55-V PLUS (SWING) S70-III (BOOM) S80W-III (BOOM) S130W-V (S/ARM) S130LC-V (BOOM (OP)) S140W-V (ARM) S140W-V (BOOM) S140W-V (O/R) S160W-V (ARM) S160W-V (BOOM) S160W-V (O/R) S170W-V (BUCKET) S180W-V (BUCKET)
	BOOM	100 mm (3.94 in)	28.5 mm (1.12 in)	S70-III (ARM, DOZER) S75-V (DOZER) S80W-III (ARM) S130W-V (BOOM) S130LC-V (BOOM (OP)) S140W-V (DOZER) S160W-V (DOZER)
	BUCKET	95 mm (3.74 in)	28.5 mm (1.12 in)	S140W-V (BUCKET) S160W-V (BUCKET)
S170W-V	ARM	125 mm (4.92 in)	28.5 mm (1.12 in)	S1480W-V (ARM)
S200W-V	BOOM	135 mm (5.32 in)	28.5 mm (1.12 in)	S210W-V (ARM) S210W-V (BOOM) S220LC-V (ARM) S220N-V (ARM (OP)) S225LC-V (ARM) S225NLC-V (ARM) S225NLC-V (ARM (OP))
P/S: Power Steering				

SLIPPER SEAL STRAIGHTENING JIG

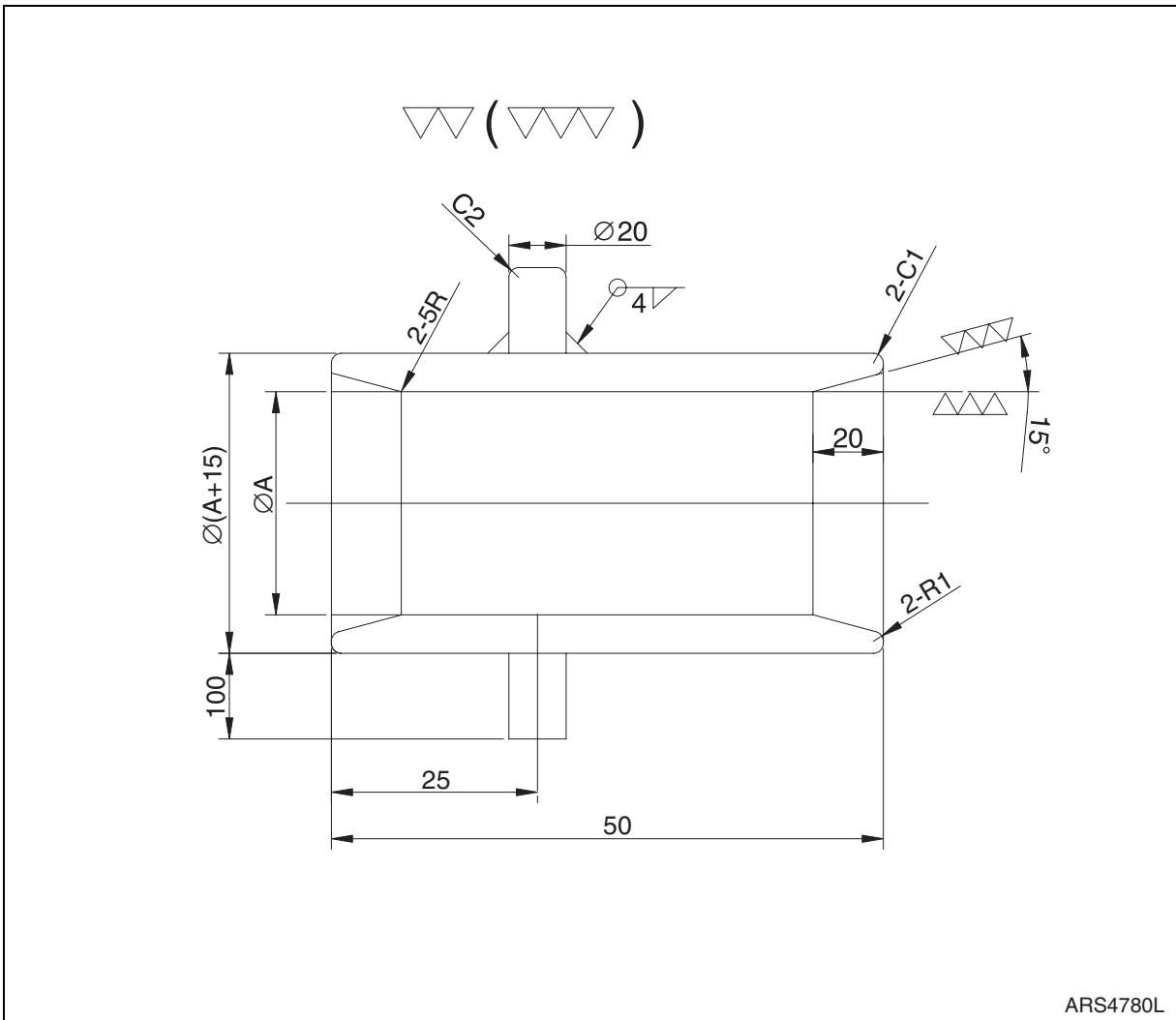


Figure 11

MODEL	CYLINDER	$\varnothing A^{+0.2}_{+0.1}$	MODEL (CYLINDER)
S55-V	ARM	85 mm (3.35 in)	S55W-V (ARM)
	BOOM	110 mm (4.33 in)	S55-V (BOOM (OP)) S55W-V (BOOM)
	SWING	80 mm (3.15 in)	S55W-V (BUCKET, SWING) S55-V PLUS (BUCKET) MEGA 300-III P/S
	DOZER	100 mm (3.94 in)	S55W-V (DOZER) S55-V PLUS (DOZER)
S55-V PLUS	ARM	90 mm (3.54 in)	
	BOOM	115 mm (4.53 in)	
S75-V	BOOM	115 mm (4.53 in)	
	ARM	95 mm (3.74 in)	
	BUCKET	85 mm (3.35 in)	
	SWING	110 mm (4.33 in)	
S70-III	BUCKET	85 mm (3.35 in)	S55-V (ARM) S80W-III (BUCKET) S80-III (DOZER)
S130LC-V	ARM	115 mm (4.53 in)	S170W-V (BOOM) S180W-V (BOOM) S210W-V (BUCKET) S220LC-V (BUCKET) S220LL (BUCKET (HEEL)) S225LC-V (BUCKET) S225NLC-V (BUCKET)
S220LC-V	BOOM	120 mm (4.72 in)	S220N-V (BUCKET (OP)) S225LC-V (BUCKET (OP)) S225NLC-V (BUCKET (OP)) S225NLC-V (BOOM)
S220LL	ARM (STICK)	165 mm (6.50 in)	S400LC-V (BOOM) S420LC-V (BOOM)
S250LC-V	ARM	140 mm (5.51 in)	S220LL (BOOM (HOIST)) S255LC-V (ARM) S290-V (BOOM, BUCKET, S/BUCKET) S300LC-V (BOOM, BUCKET, S/BUCKET)
	BOOM	130 mm (5.12 in)	S250LC-V (BUCKET) S255LC-V (BOOM, BUCKET)
S290LC-V	ARM	150 mm (5.91 in)	S300LC-V (ARM, S/ARM) S340LC-V (BOOM, BUCKET, BUCKET (OP)) S370LC-V (BOOM, BUCKET, BUCKET (OP)) S290-V (S/ARM) S360-V (BOOM, BUCKET, BUCKET (OP)) S290LL (BOOM (HOIST), BUCKET (HEEL))
S360-V	ARM	170 mm (6.69 in)	S340LC-V (ARM) S370LC-V (ARM) S470LC-V (BOOM, BUCKET) S450-V (BOOM, BUCKET)

MODEL	CYLINDER	$\varnothing A^{+0.2}_{+0.1}$	MODEL (CYLINDER)
S400LC-V	ARM	180 mm (7.09 in)	S140W-V (ARTI.) S160W-V (ARTI.) S420LC-V (ARM) S290LL (ARM (STICK))
	BUCKET	160 mm (6.30 in)	S420LC-V (BUCKET)
S450LC-V	ARM	190 mm (7.48 in)	S470LC-V (ARM)
S130W-V	ARM	110 mm (4.33 in)	S55-V PLUS (SWING) S70-III (BOOM) S80W-III (BOOM) S130W-V (S/ARM) S130-V (BOOM (OP)) S140W-V (ARM) S140W-V (BOOM) S140W-V (O/R) S160W-V (ARM) S160W-V (BOOM) S160W-V (O/R) S170W-V (BUCKET) S180W-V (BUCKET)
	BOOM	100 mm (3.94 in)	S70-III (ARM, DOZER) S75-V (DOZER) S80W-III (ARM) S130W-V (BOOM) S130-V (BOOM) S140W-V (DOZER) S160W-V (DOZER)
	BUCKET	95 mm (3.74 in)	S140W-V (BUCKET) S160W-V (BUCKET)
S170W-V	ARM	125 mm (4.92 in)	S180W-V (ARM)
S200W-V	BOOM	135 mm (5.32 in)	S210W-V (ARM) S210W-V (BOOM) S220LC-V (ARM) S220N-V (ARM (OP)) S225LC-V (ARM) S225NLC-V (ARM) S225NLC-V (ARM (OP))
P/S: Power Steering			

DISASSEMBLY



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

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

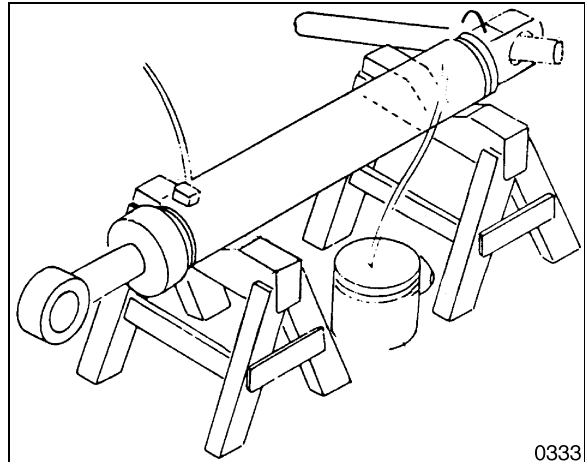


Figure 12

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

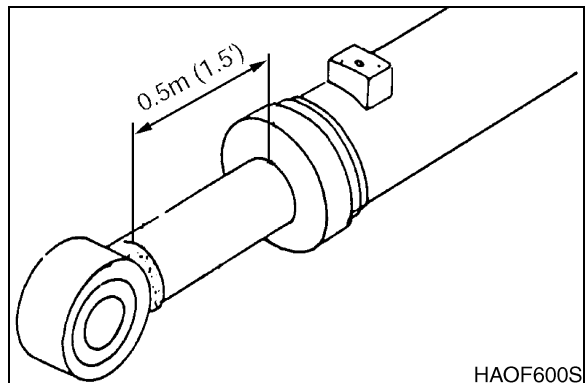


Figure 13

3. Remove bolts (7) on the end of cylinder.

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

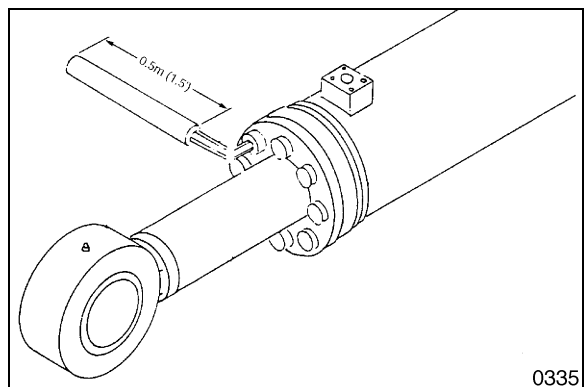


Figure 14

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

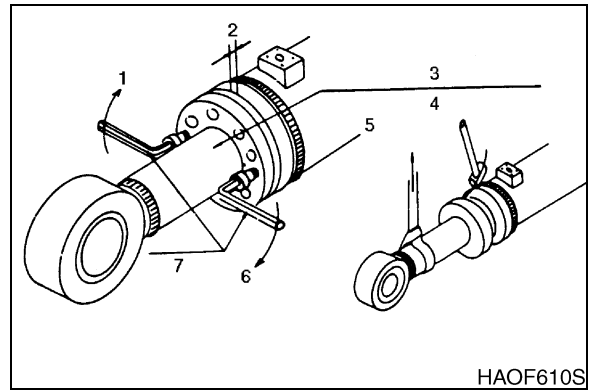


Figure 15

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

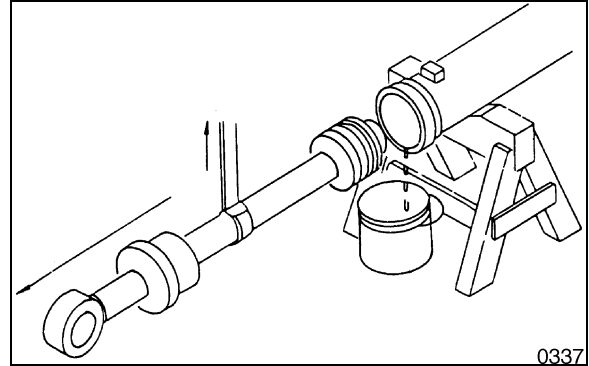


Figure 16

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

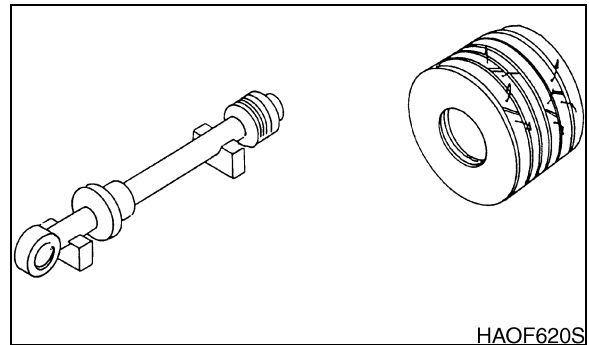


Figure 17

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

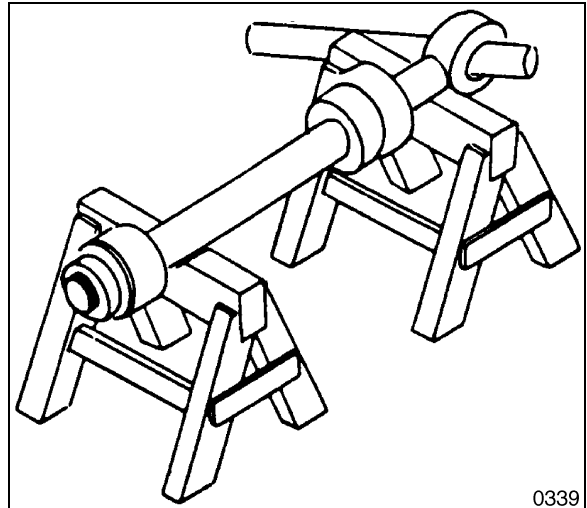


Figure 18

8. Remove set screw by using a socket wrench.

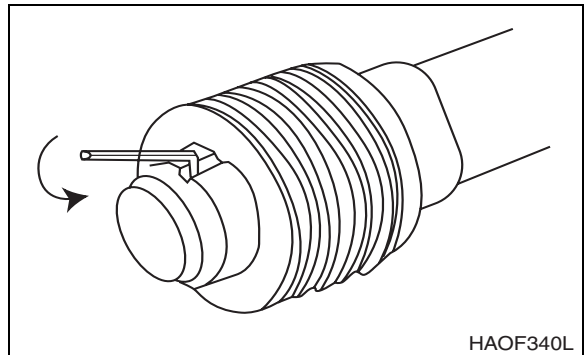


Figure 19

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

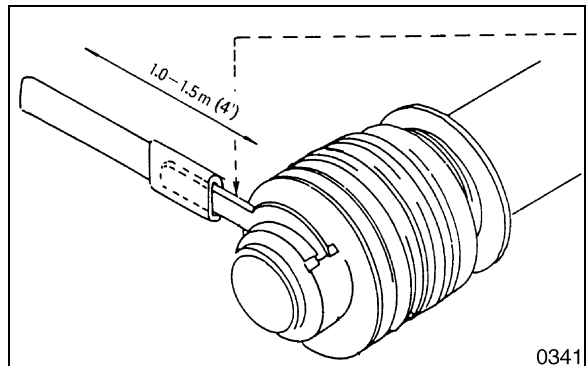


Figure 20

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

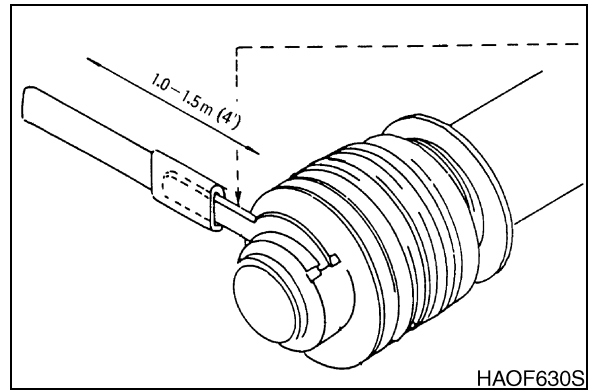


Figure 21

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

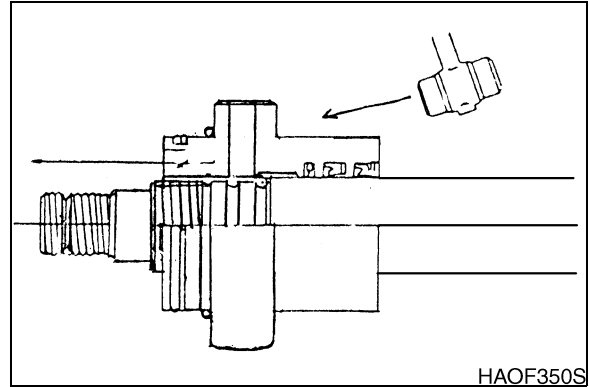


Figure 22

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

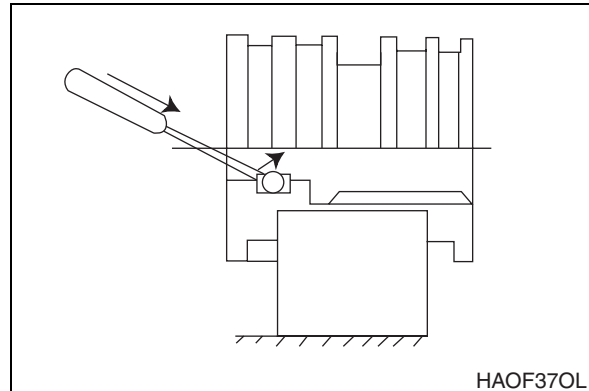


Figure 23

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

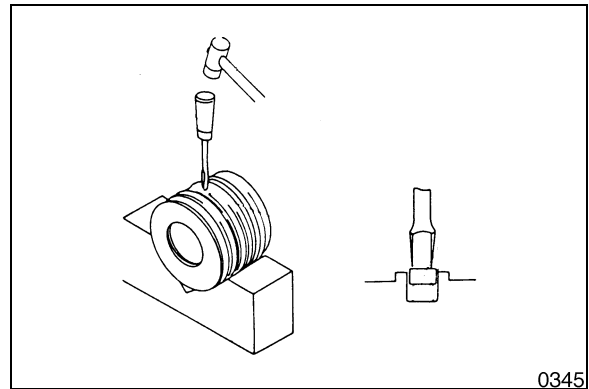


Figure 24

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

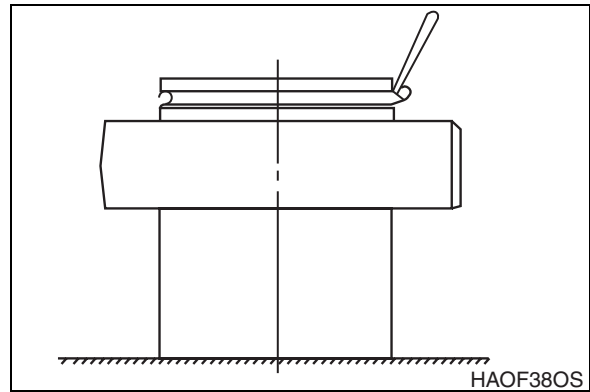


Figure 25

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

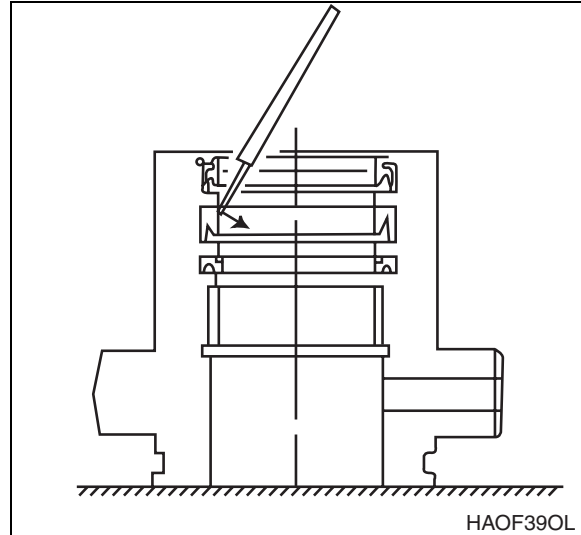


Figure 26

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

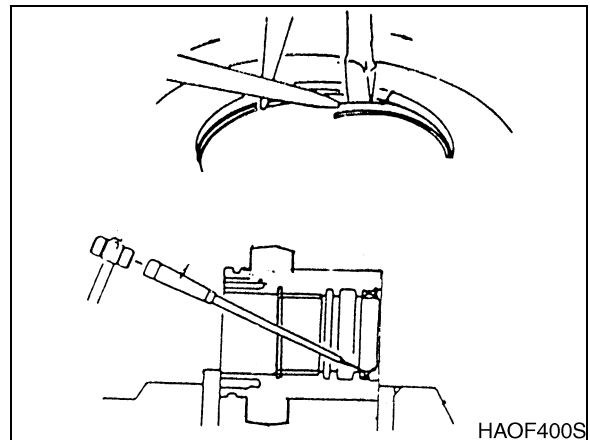


Figure 27

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

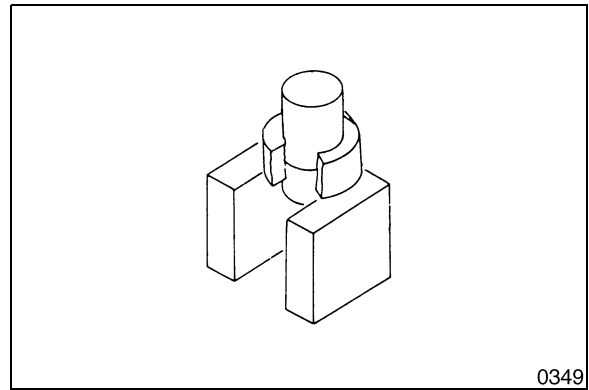


Figure 28

0349

ASSEMBLY

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 assembly 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 assembly procedure.

NOTE: Assemble subassemblies of cylinder in the following order:

1. Cylinder body
2. Piston rod
3. Piston assembly
4. Cylinder head assembly

1. Assemble pin bushing (1) to piston rod (13) and body of cylinder (14).
2. Following the assembly of rod cover components, install dust wiper (2) and rod bushing (6) to rod cover (9). Insert retaining rings (3 and 8).

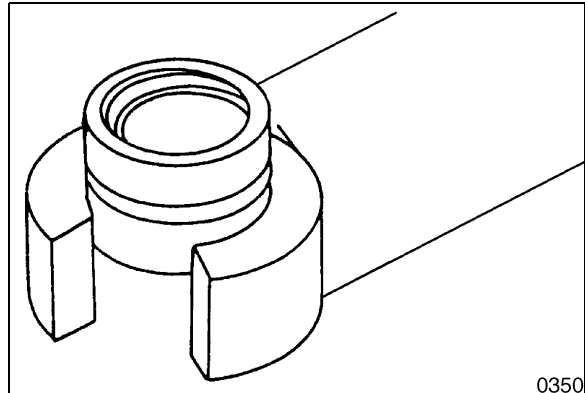


Figure 29

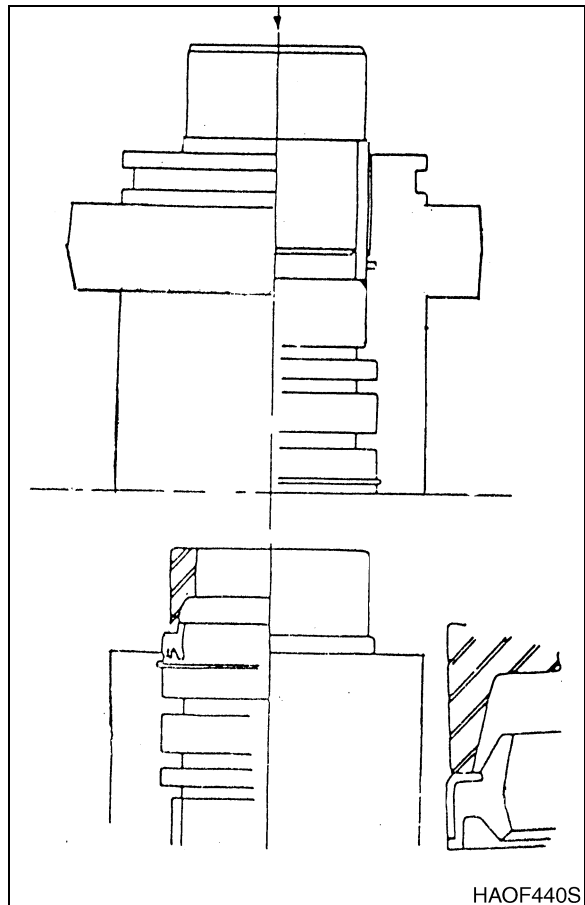


Figure 30

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

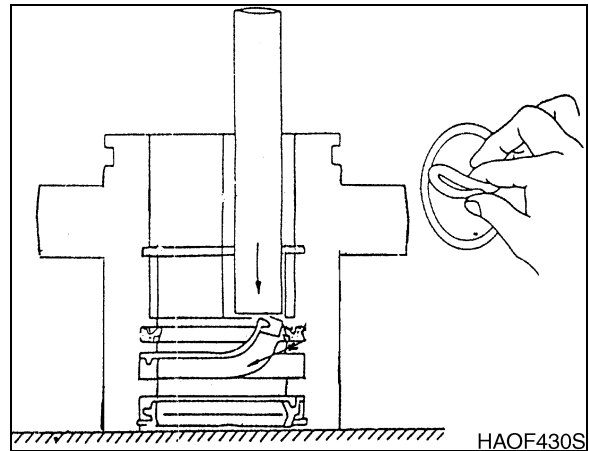


Figure 31

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

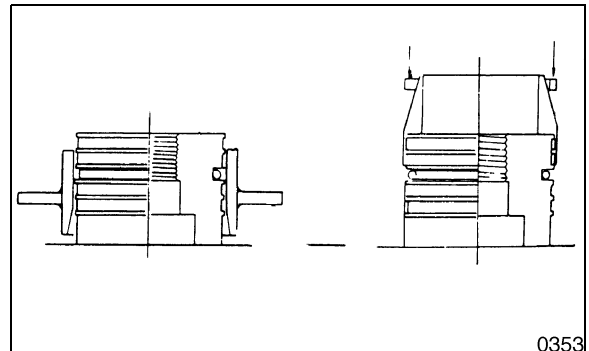


Figure 32

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

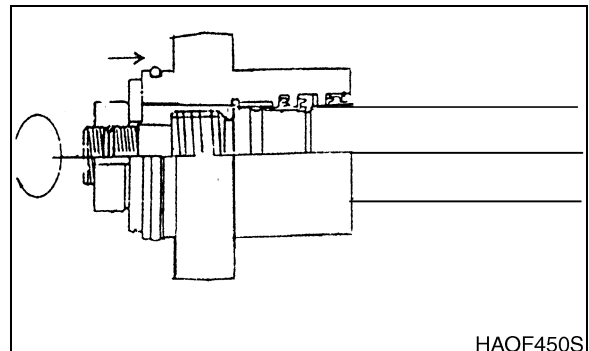


Figure 33

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

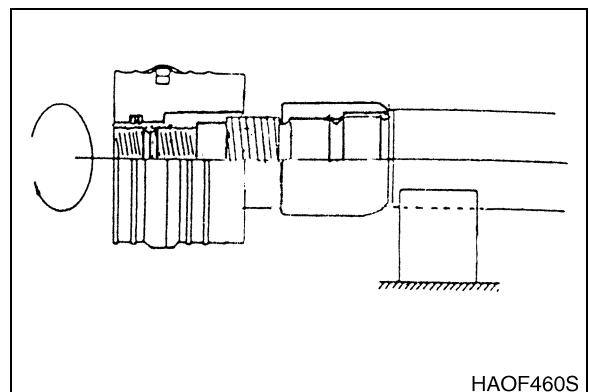


Figure 34

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

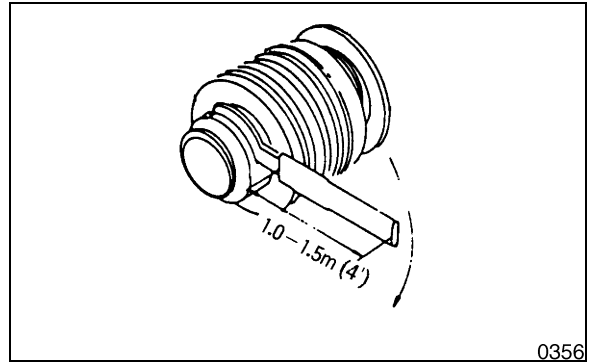


Figure 35

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

Reference Number	Description
1	Set Screw

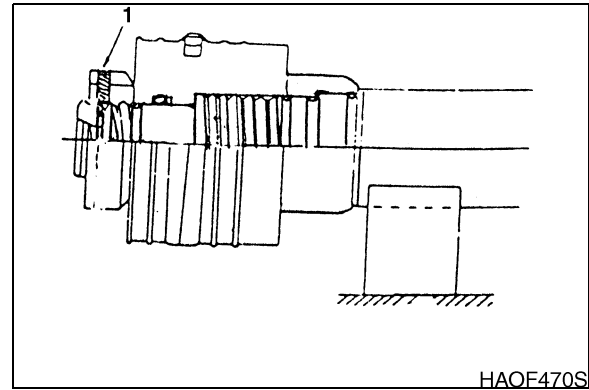


Figure 36

9. Immobilize body of cylinder before assembly.

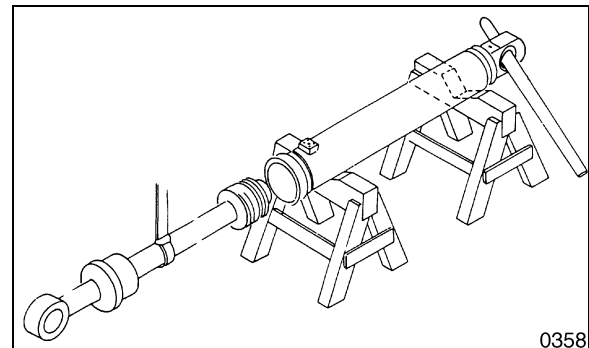


Figure 37

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

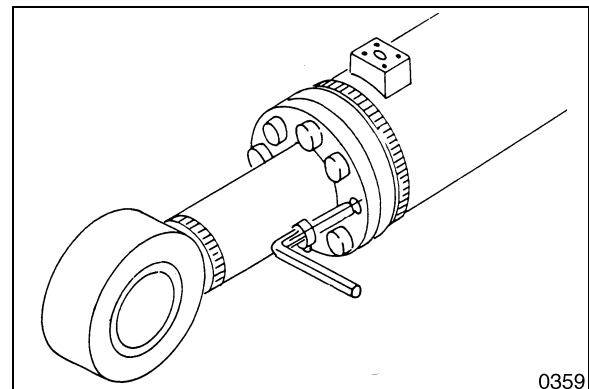


Figure 38



SWING MOTOR



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170LC-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 450LC-V	1001 and Up
Solar 470LC-V	1001 and Up

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GENERAL DESCRIPTION

THEORY OF OPERATION

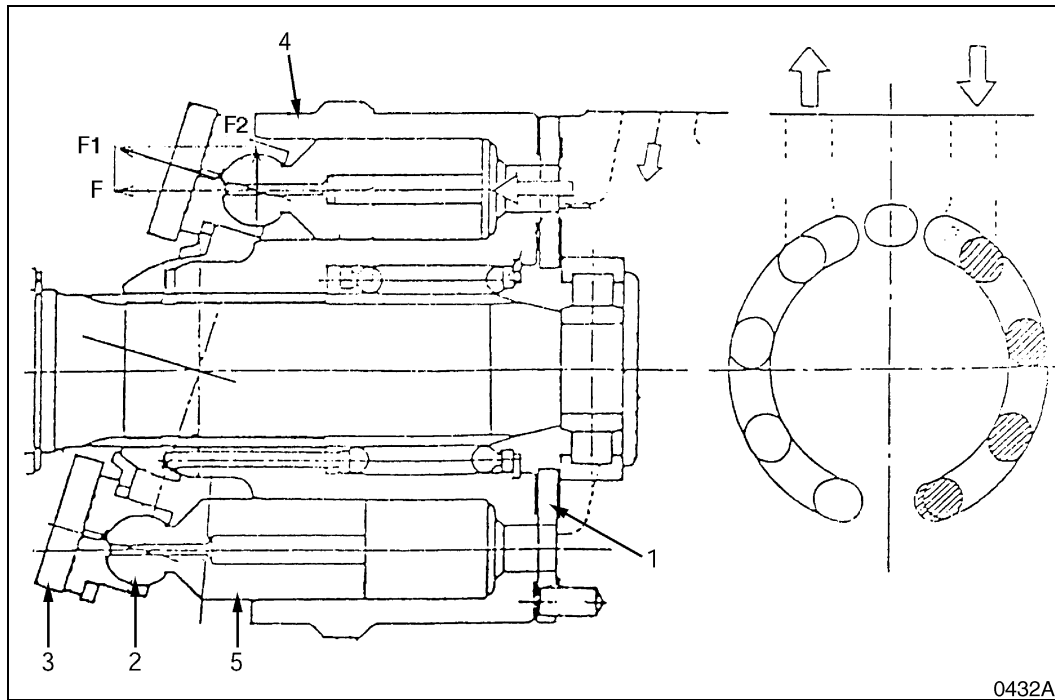


Figure 1

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

Reference Number	Description
4.	Cylinder Block
5.	Piston

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

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

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

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

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

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

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

IMPORTANT

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

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

SWING MOTOR ANTI-CAVITATION MAKE-UP VALVE

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

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

RELIEF VALVE

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

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

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

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

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

$$P_s = \frac{F_{sp}}{A_1 - A_2}$$

Where Fsp: Spring Force

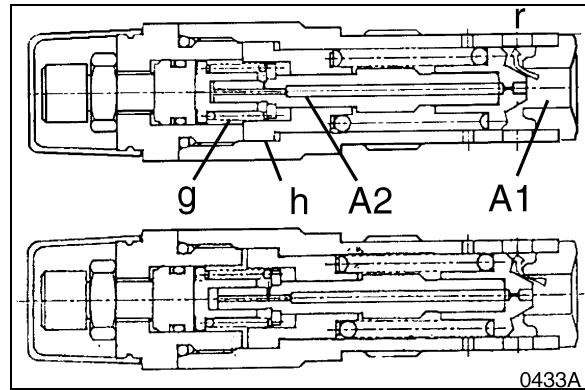


Figure 2

SWING BRAKE OPERATION

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

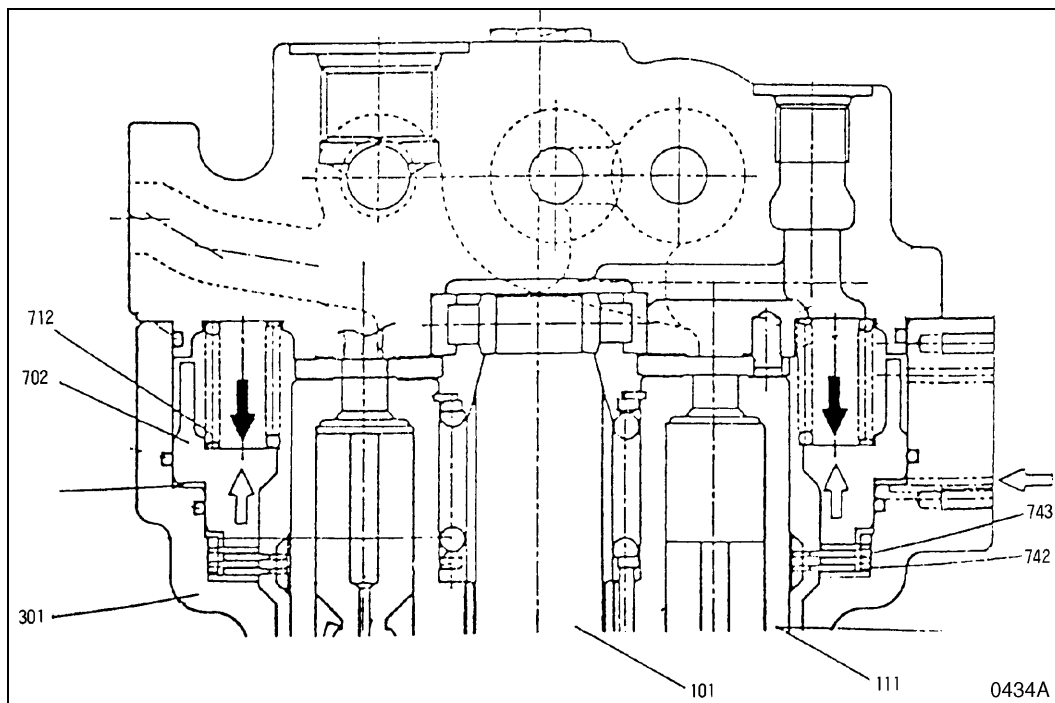


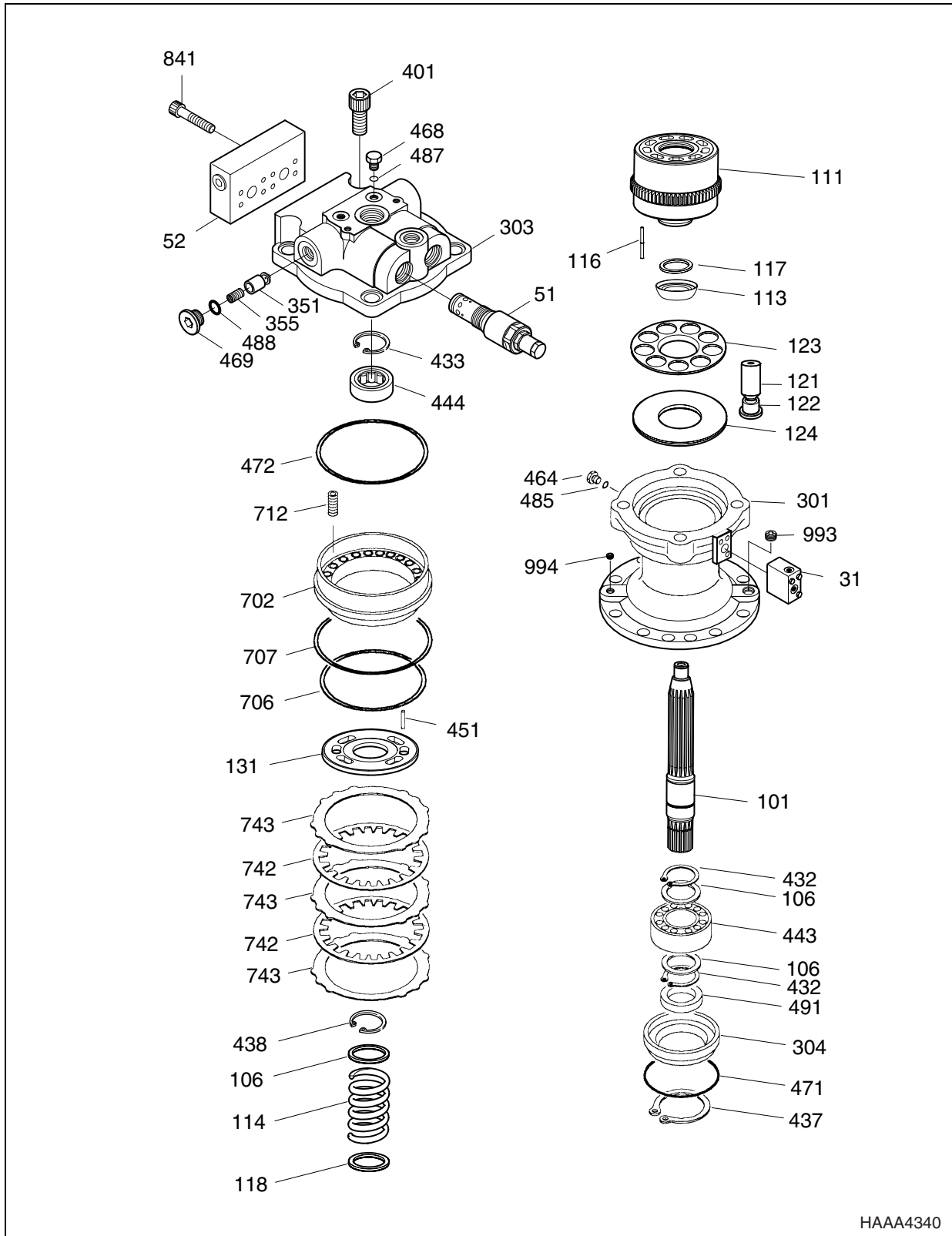
Figure 3

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

IMPORTANT

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

PARTS LIST (SOLAR 140W-V, 160W-V)



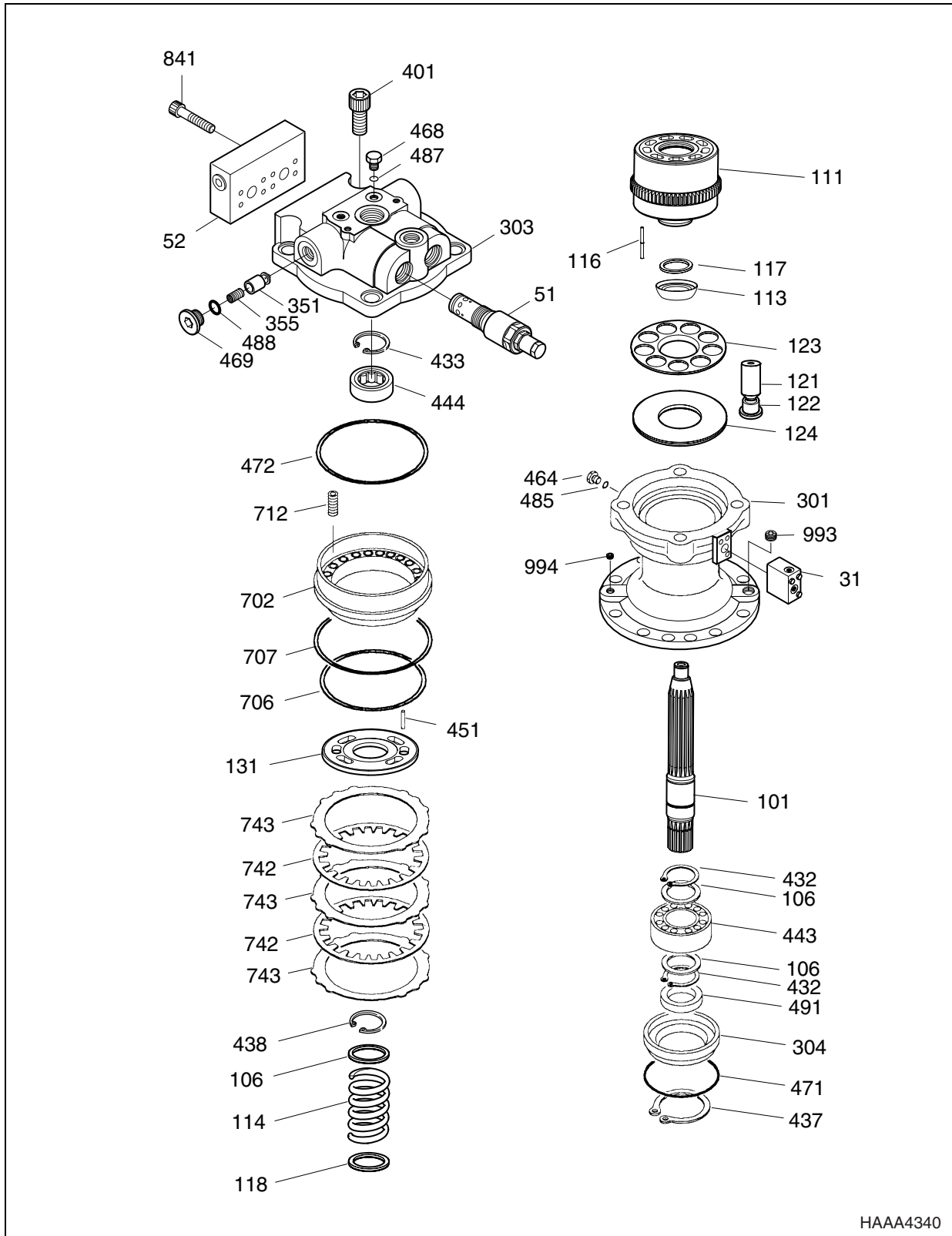
HAAA4340

Figure 4

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

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

PARTS LIST (SOLAR 170LC-V, 170W-V, 450LC-V, 470LC-V)



HAAA4340

Figure 5

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

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

SPECIFICATIONS

Item	Specification			
	Solar 140W-V Solar 160W-V	Solar 170W-V Solar 220LC-V Solar 220LL	Solar 170LC-V	Solar 450LC-V Solar 470LC-V
Type	Axial Piston			
Displacement	64 cc/rev (3.91 in ³ /rev.)	121.6 cc/rev (18.85 in ³ /rev.)	128.0 cc/rev (7.81 in ³ /rev.)	2 x 128.0 cc/rev (2 x 7.81 in ³ /rev.)
Crossover Relief Valve Setting	270 kg/cm ² (3,840 psi)	280 kg/cm ² (3,980 psi)	280 kg/cm ² (3,980 psi)	280 kg/cm ² (3,980 psi)
Maximum Supply Flow Rate @ 2000 rpm	125 liter/pm (33 gpm)	227 liter/pm (60 gpm)	210 liter/pm (55 gpm)	2 x 210 liter/pm (2 x 55 gpm)
Max. Motor Shaft Speed	1,953 rpm	1,867 rpm	1,640 rpm	1,640 rpm
Rated Motor Shaft Torque	27.5 kg•m (199 ft lb)	54.2 kg•m (392 ft lb)	57 kg•m (412 ft lb)	114 kg•m (825 ft lb)
Weight	29 kg (64 lb)	56.5 kg (125 lb)	62 kg (137 lb)	2 x 62 kg (2 x 137 lb)

SPECIAL TOOLS (SOLAR 140W-V, 160W-V)

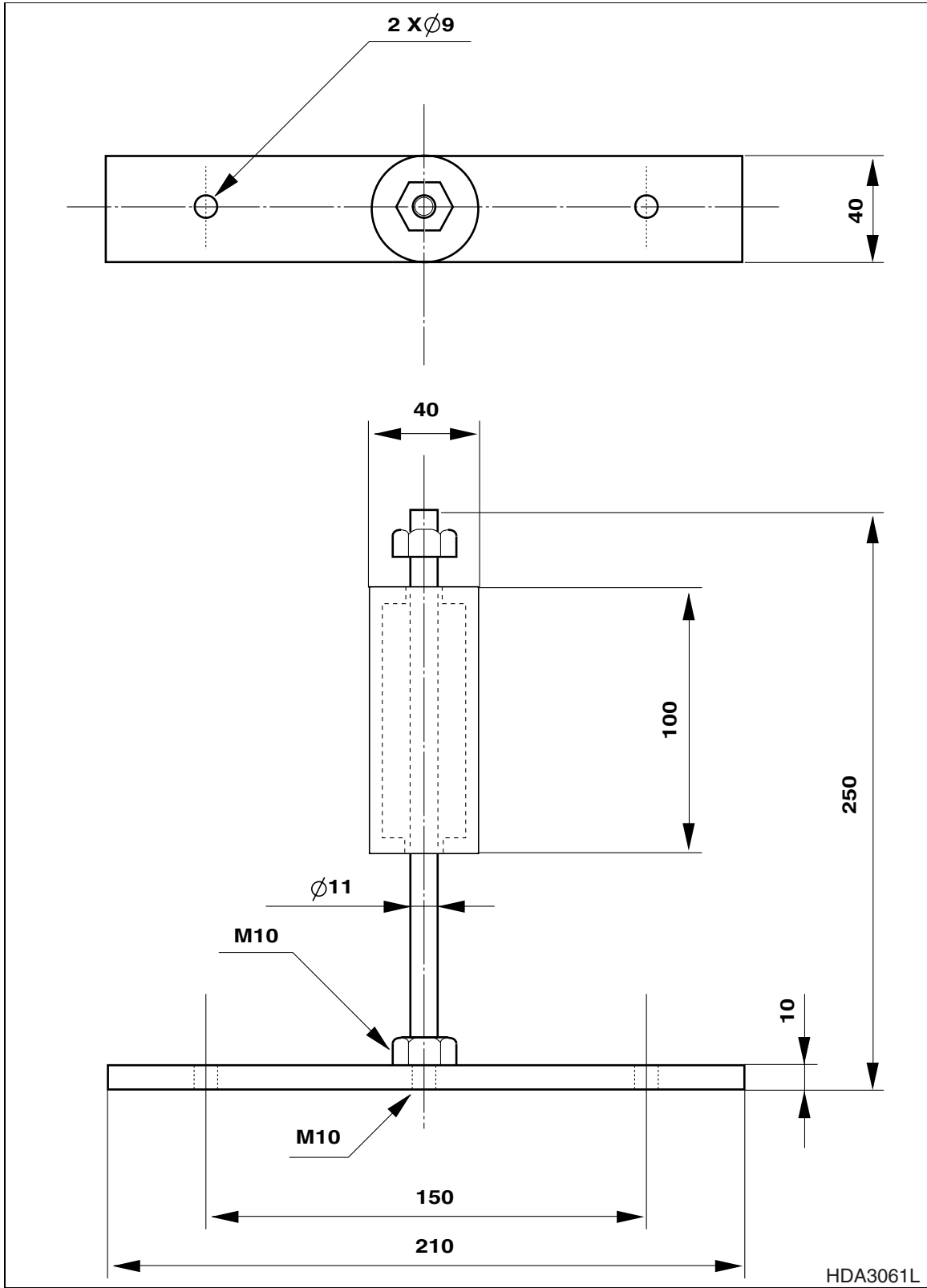


Figure 6

SPECIAL TOOLS (SOLAR 170LC-V, 170W-V)

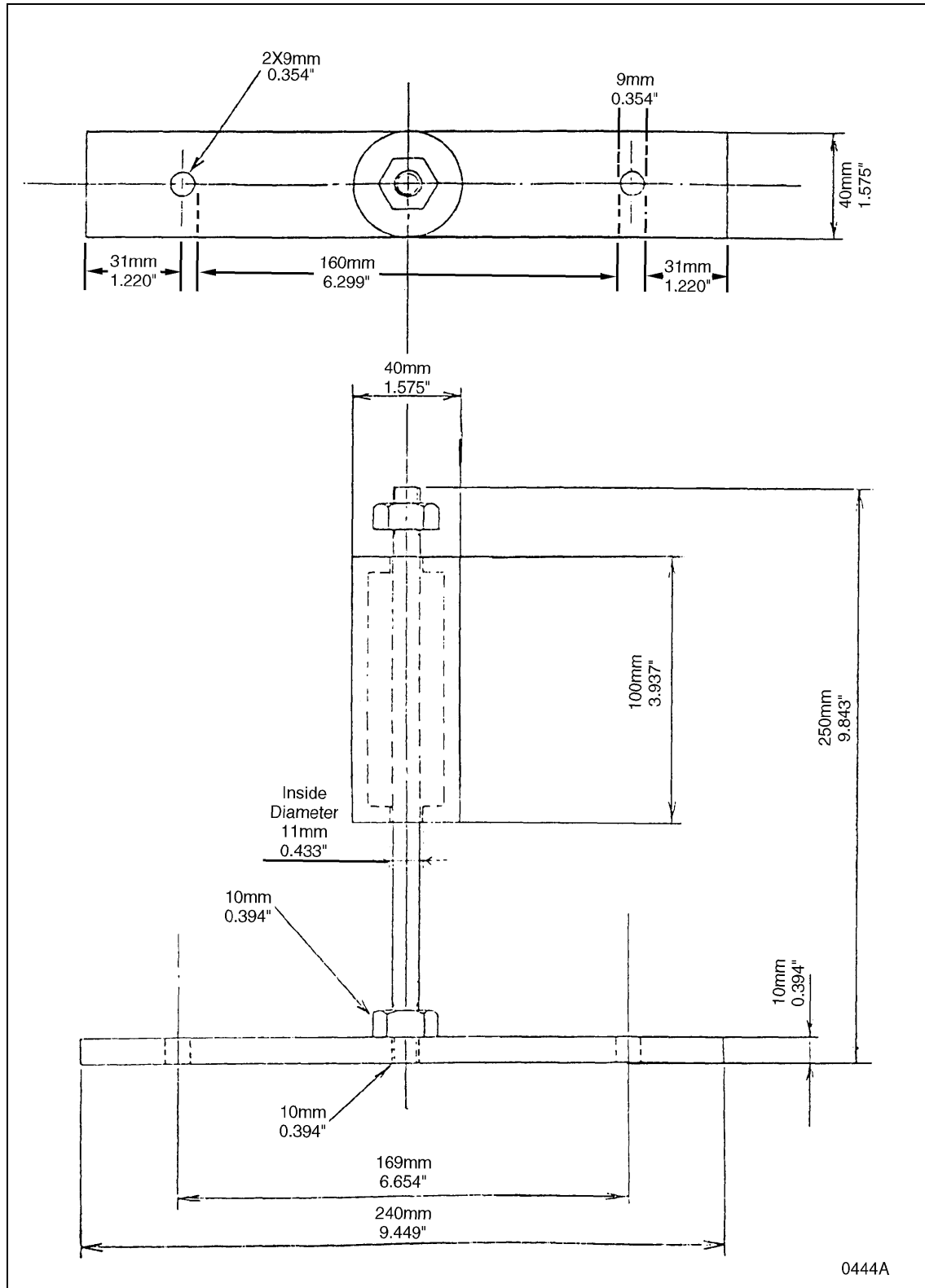


Figure 7

SPECIAL TOOLS (SOLAR 450LC-V, 470LC-V)

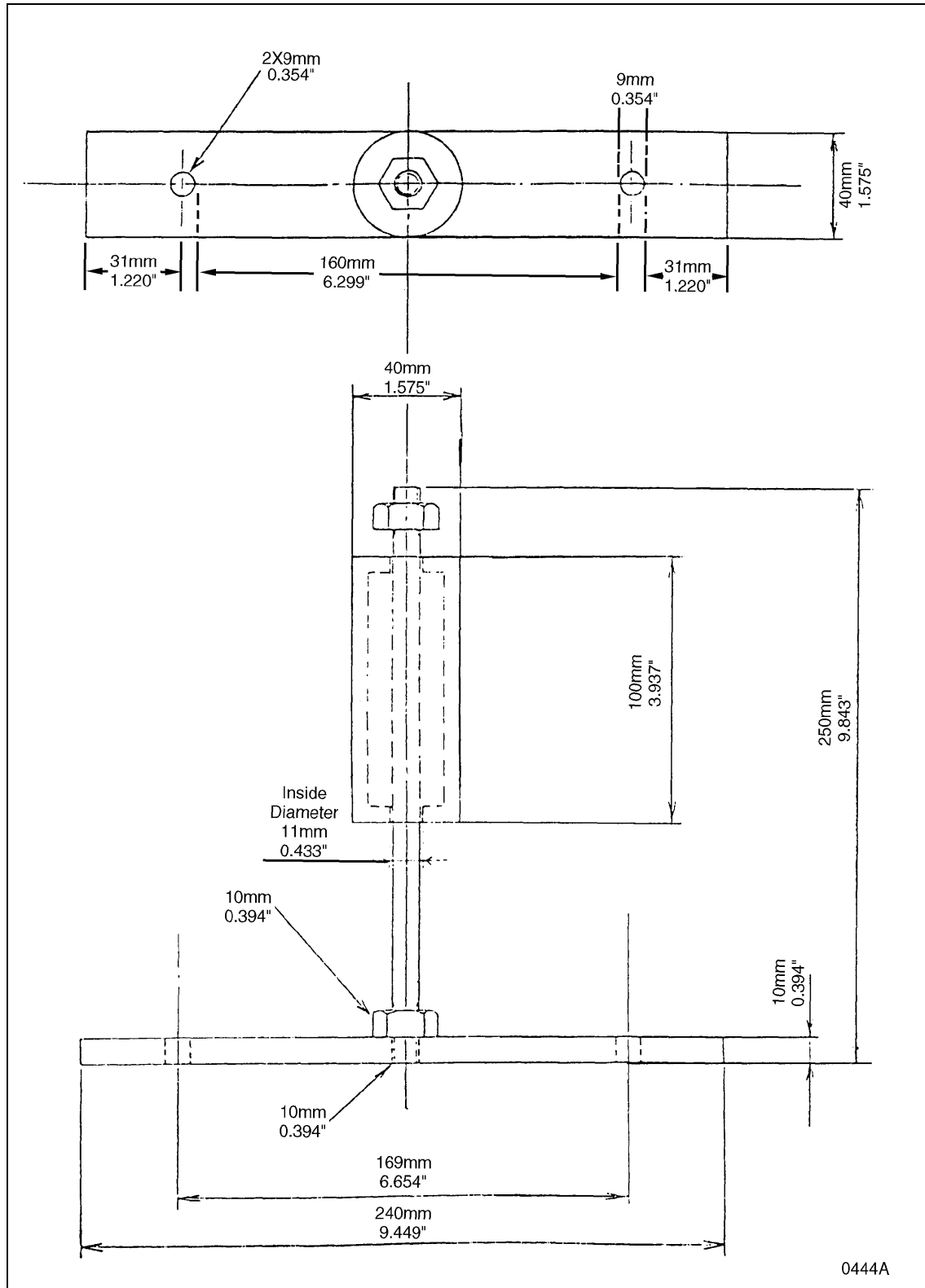


Figure 8

DISASSEMBLY

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

IMPORTANT

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

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

NOTE: *Swing Motor component parts (numbered in parentheses) are keyed to Figure 5.*

IMPORTANT

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

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

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

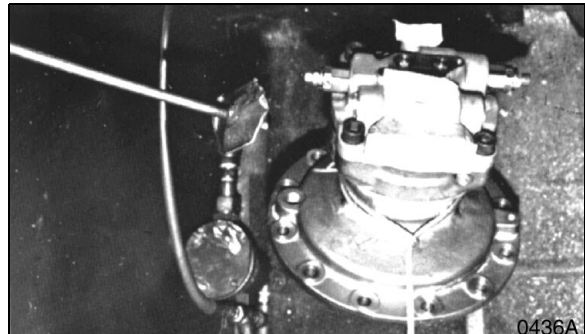


Figure 9

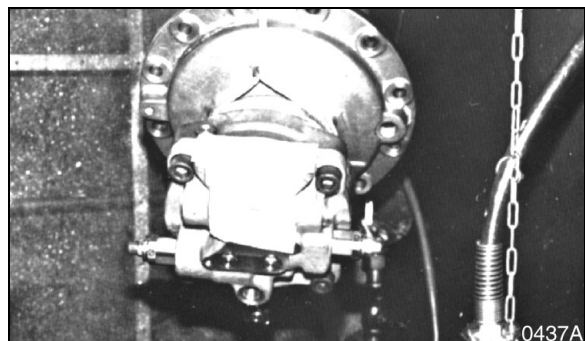


Figure 10

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

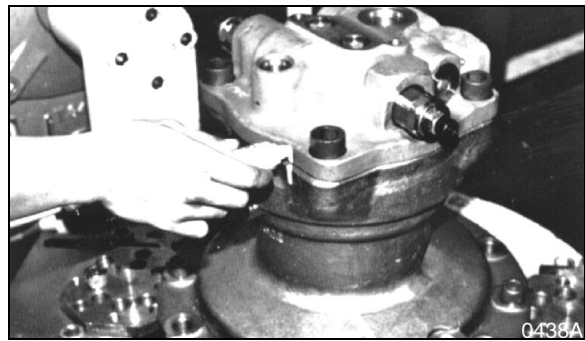


Figure 11

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

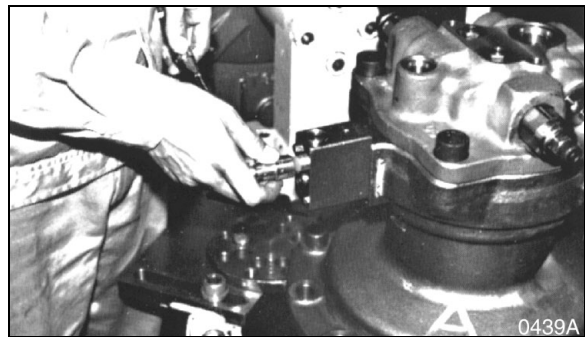


Figure 12

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

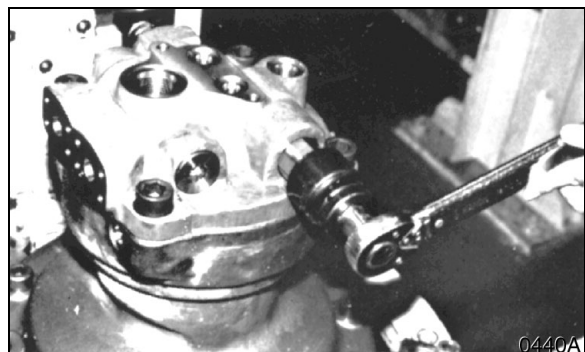


Figure 13

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

IMPORTANT
Use extra care to avoid damaging the plunger seat.

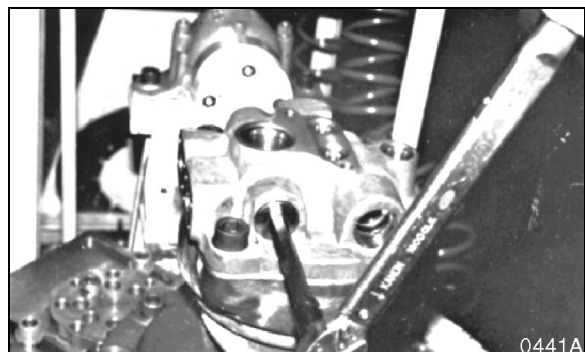


Figure 14

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

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

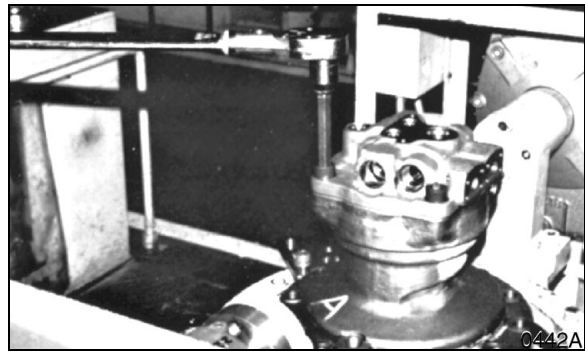


Figure 15

9. Remove all twenty brake springs.

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

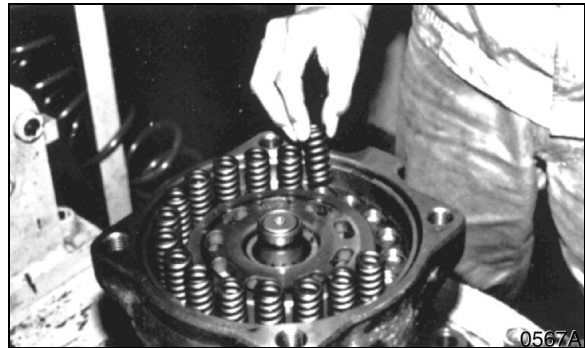


Figure 16

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

NOTE: *See "Special Tools (Solar 140W-V, 160W-V)" portion of this section for manufacturing details of special tool.*

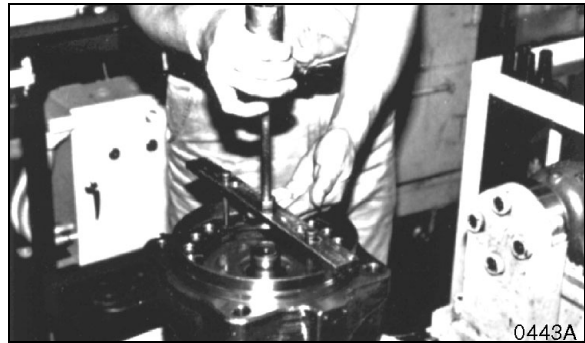


Figure 17

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

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

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

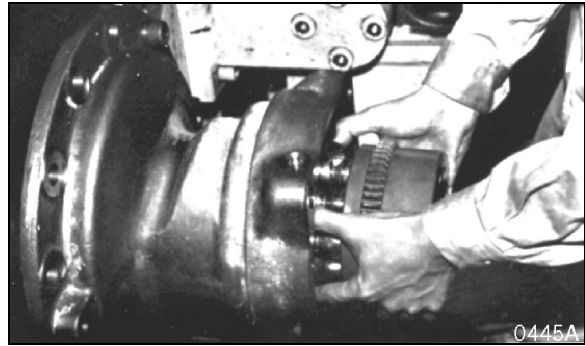


Figure 18

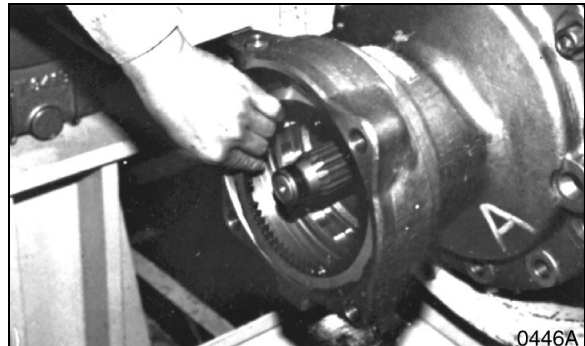


Figure 19

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

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

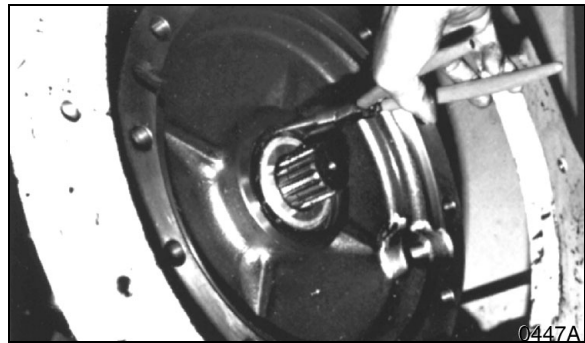


Figure 20

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

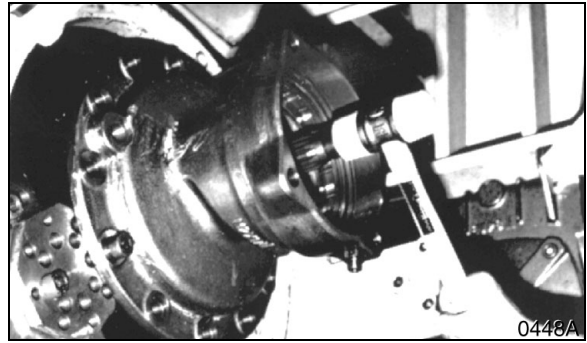


Figure 21

15. Tap bearing race out of casing.

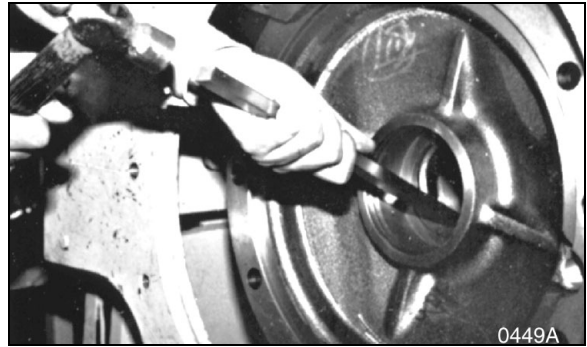


Figure 22

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

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

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

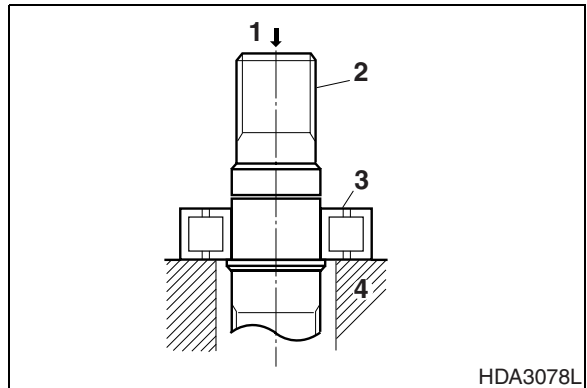


Figure 23

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

- A. Disassemble oil seal from the front cover if they were not separated during removal. Apply force (2, Figure 24) and use a plug (1) to hammer through drive shaft opening in cover.

Reference Number	Description
1	Plug
2	Applied Force

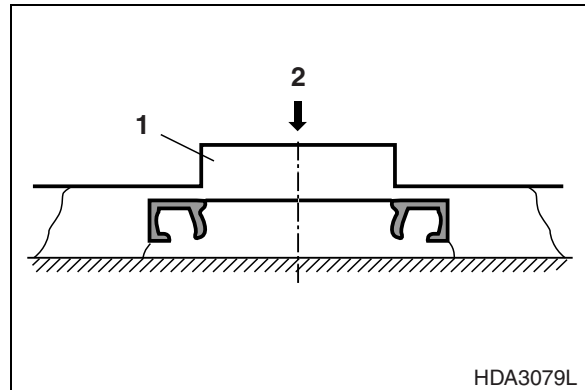


Figure 24

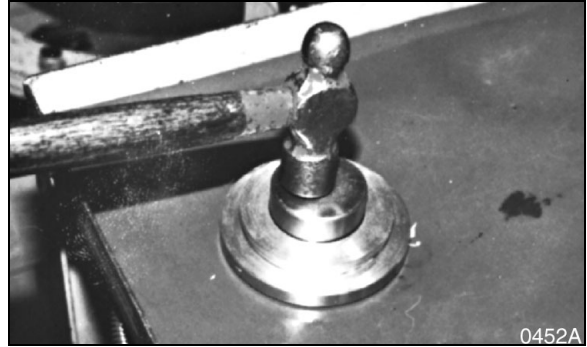


Figure 25

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



Figure 26

- C. Relief valves can be replaced in sets by ordering one part number through your authorized Daewoo dealer/parts distributor. To disassemble relief valves, pull out plug (201, Figure 5), disassemble bushing (343), spring (322) and spring seat (331) from rod (303). Position valve housing facing down and separate piston (302), rod (303), spring (321), spring seat (331) and plunger (301).

IMPORTANT

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

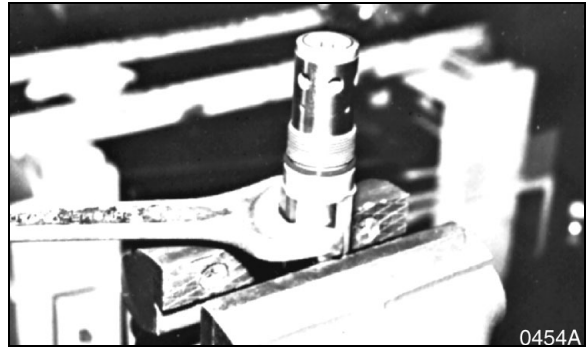


Figure 27

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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

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

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

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

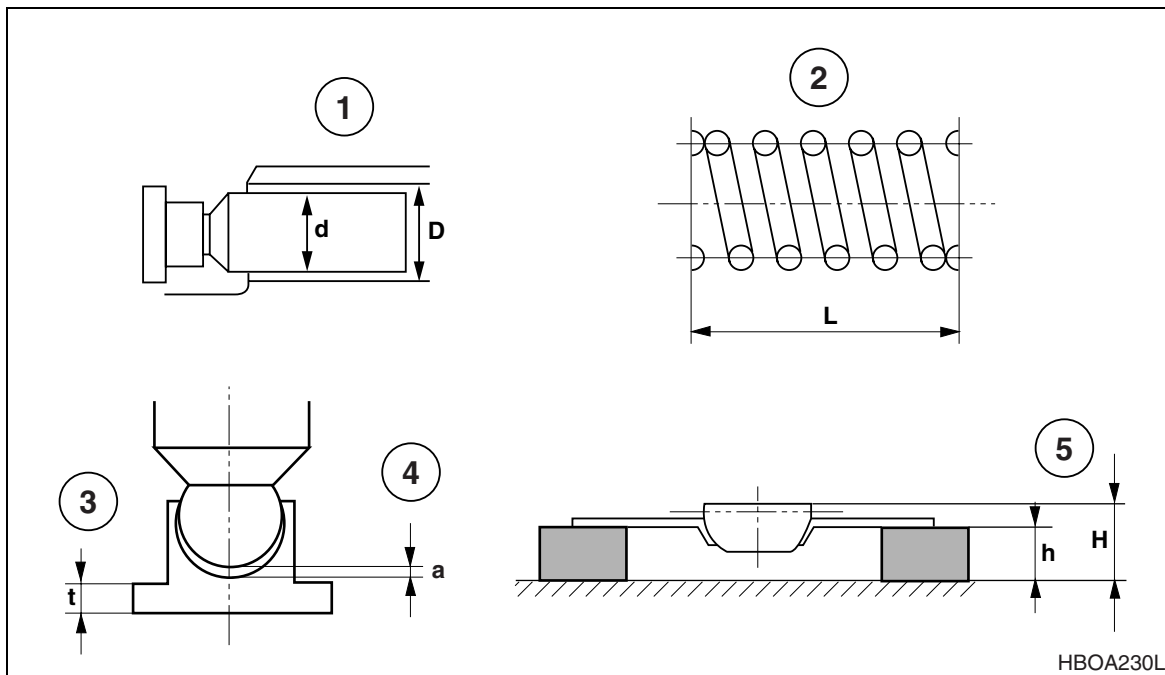


Figure 28

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

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

Service Standards for Replacing Worn Parts

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

Solar 140W-V, 160W-V

Item	Standard Value mm (In)	Replacement Limit mm (In)	Remedy
Clearance between cylinder bore and piston (D-d)	0.016 mm (0.006 in)	0.046 mm (0.018 in)	Replace piston or cylinder
Clearance between piston and shoe socket	0 mm (0 in)	0.30 mm (0.0118 in)	Replace piston, shoe assembly parts
Thickness of shoe (t)	4.0 mm (0.16 in)	3.80 mm (0.15 in)	Replace piston, shoe assembly parts
Height of push plate, round bushing assembly (H-h)	5.50 mm (0.22 in)	5.0 mm (0.20 in)	Replace set; spherical bushing and retainer
Thickness of friction plate	3.50 mm (0.14 in)	3.10 mm (0.12 in)	Replace

Solar 170LC-V, 170W-V, 450LC-V, 470LC-V

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

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

REASSEMBLY

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

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

1. Position motor casing face down (Figure 29).

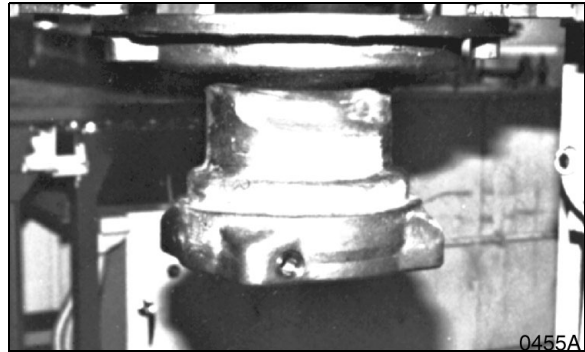


Figure 29

2. If drive shaft roller bearings were not disassembled, go onto next phase of assembly. Bearing reassembly begins with replacement of stop ring (432) (Figure 5 and its accompanying Parts List) and spacer (106) on drive shaft (101).

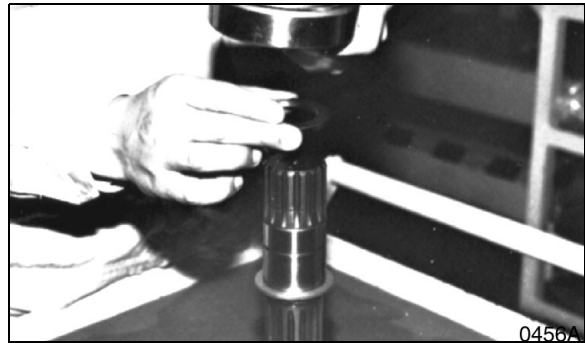


Figure 30

Make sure that bearing raceways (collars) are facing right direction. The drawing shows one side of the bearing collar (1, Figure 31), marked "R," which should be assembled next to spacer (2) on lower end of drive shaft.

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

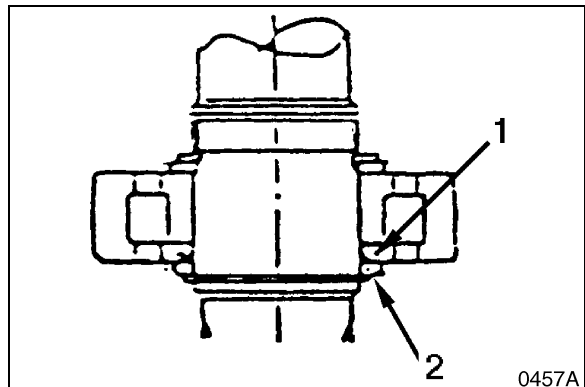


Figure 31

3. Reassemble drive shaft (101, Figure 5), roller bearing (443) and lower casing (301). Pay attention to bearing alignment inside bore of case. Make sure it is fully seated.



Figure 32

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

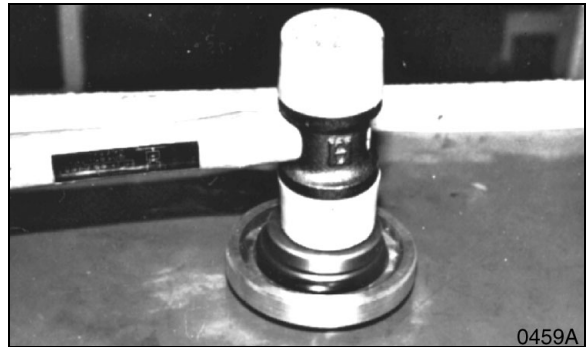


Figure 33

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

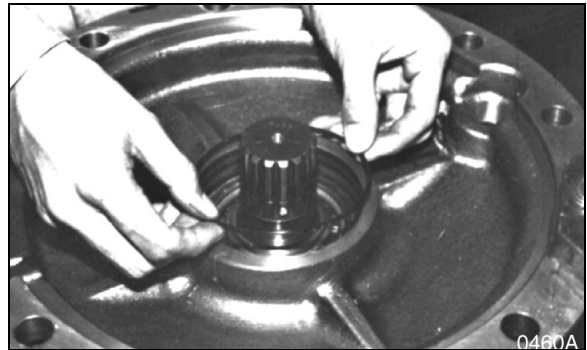


Figure 34

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

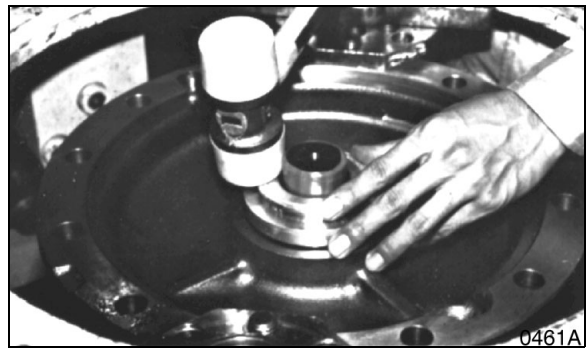


Figure 35

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

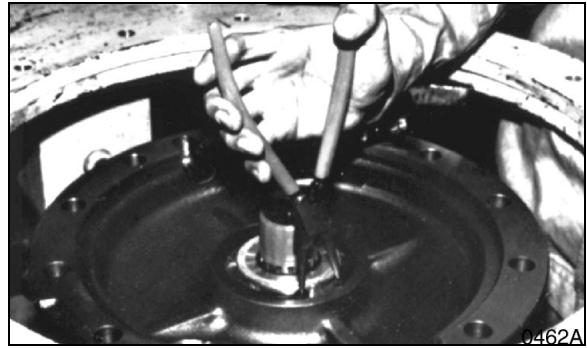


Figure 36

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

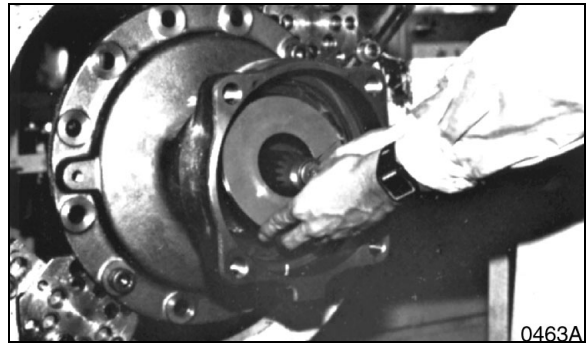


Figure 37

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

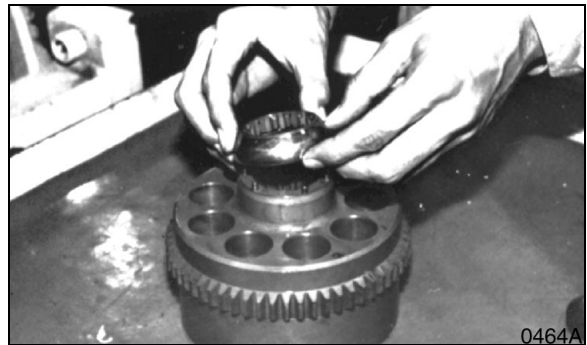


Figure 38

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



Figure 39

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

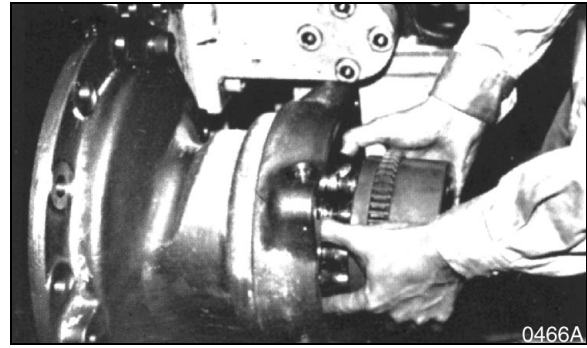
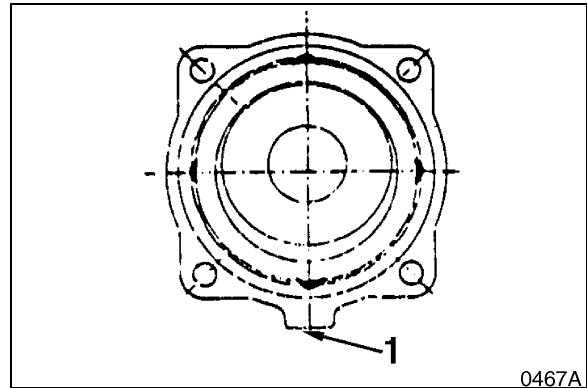


Figure 40

12. Turn motor so that front cover side (304) is down. Put separator plates (743) and friction plates (742) back in same order in which they were removed. There are three separator plates (743) and two friction plates (742), which should be positioned as shown in drawing below, with clearance towards side of casing with brake valve (1, Figure 41).

Reference Number	Description
1	Brake Valve



**Figure 41 **

13. Very lightly grease larger O-rings (706 and 707, Figure 5) before replacing them in casing (301).

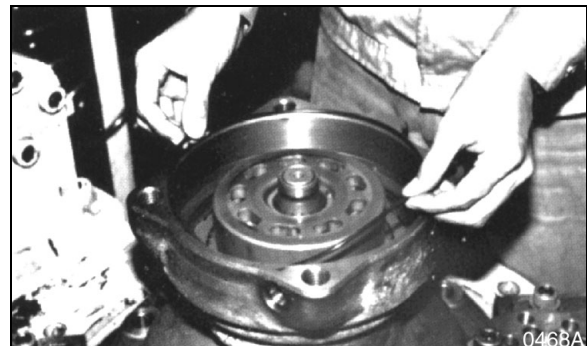


Figure 42

14. Position brake piston (1, Figure 43) in casing. The diagram shows position of four piston grooves (2) in relation to valve-connected side (3), and two 8 mm bolts which should be tightened in an even, progressive rotation.

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

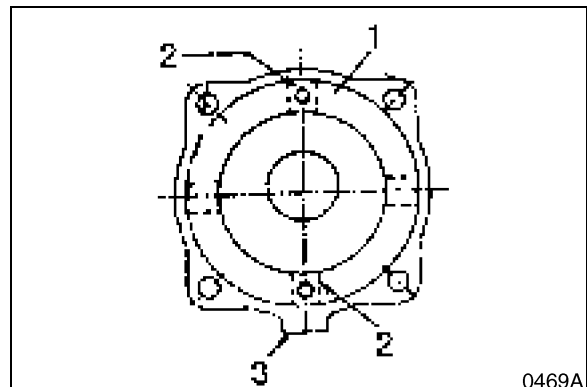


Figure 43

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

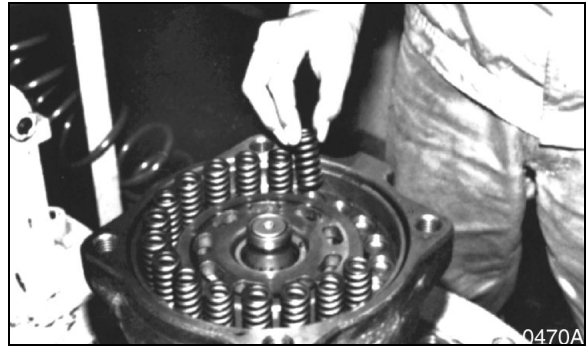


Figure 44

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

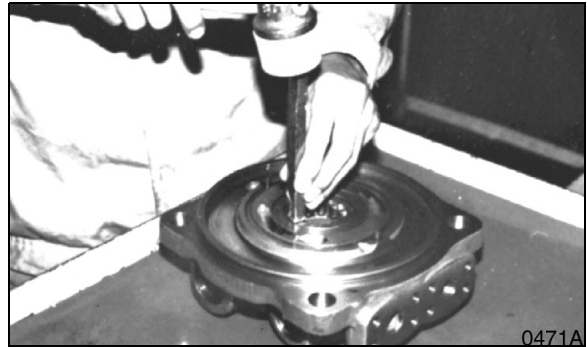


Figure 45

17. Assemble valve plate (131), O-ring and upper valve casing (303). Refer to assembly that shows "R" part (2, Figure 46) of the valve plate turned away from mounting flanges (1) on side of valve plate. Lightly grease O-ring to help keep it in place during assembly.

Reference Number	Description
1	Flange Side
2	R Port

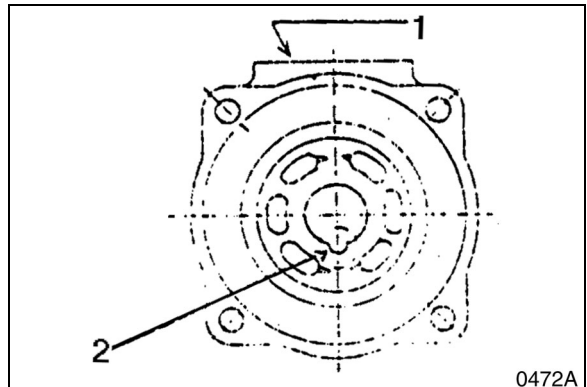


Figure 46

18. Bolt up two halves of motor casing (301 and 303, Figure 5). Be careful not to lose or damage O-ring. Tighten four 20 mm socket head bolts using a progressive, even rotation. Make sure that all brake springs are fully seated and that valve casing inlet and output ports are correctly matched.

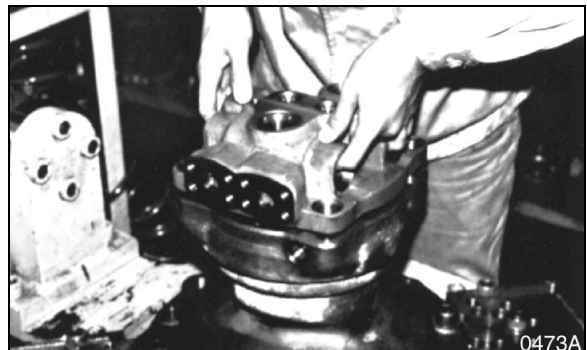


Figure 47

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

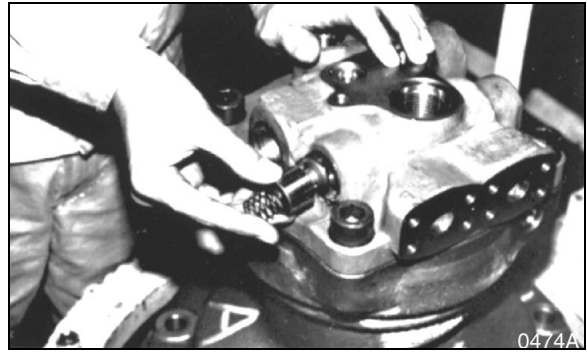


Figure 48

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



Figure 49

IMPORTANT

Be careful not to damage the plunger and spring seat.

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



Figure 50

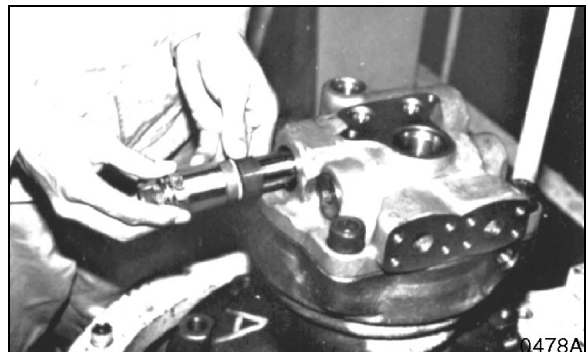


Figure 51

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

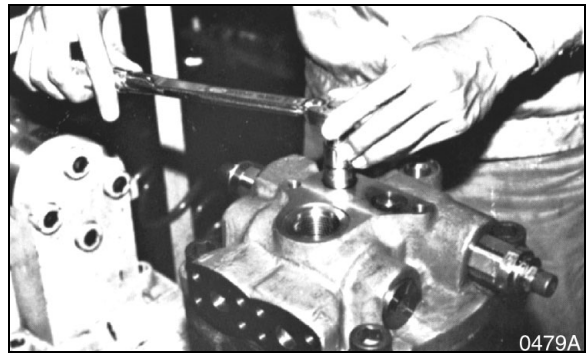


Figure 52



**S0707350
R2**

TRAVEL MOTOR



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 130W-V	0001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 210W-V	1001 and Up

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GENERAL DESCRIPTION

THEORY OF OPERATION

The drive train consists of a travel motor, rear axle/transmission, propeller shaft, and front axle. Drive force from the travel motor is transmitted through the transmission to the rear axle and through a propeller shaft to the front axle. Speed is reduced through differential and hub reduction gears.

Models Solar 130W-V

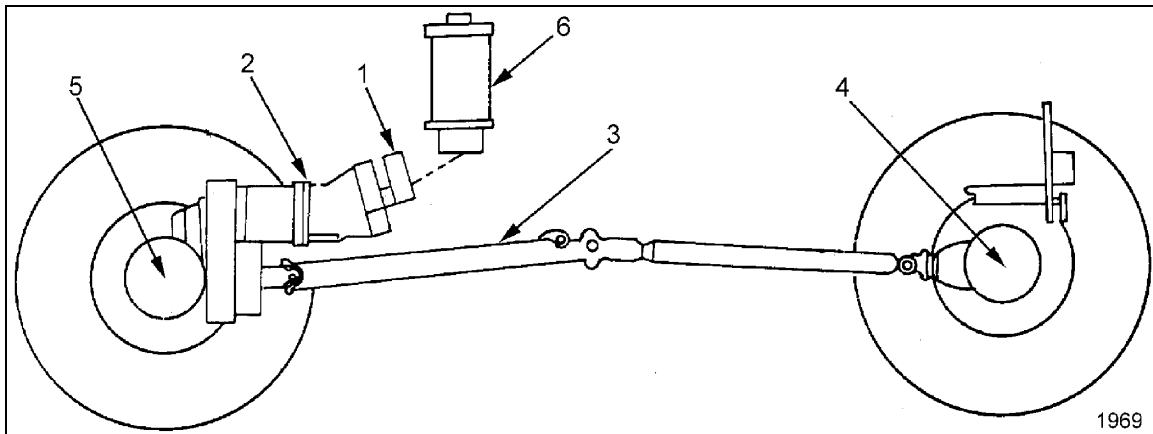


Figure 1

Reference Number	Description
1	Travel Motor
2	Transmission
3	Propeller Shaft

Reference Number	Description
4	Front Axle
5	Rear Axle
6	Center Joint

Models Solar 140W-V, 160W-V, 170W-V, 200W-V, 210W-V

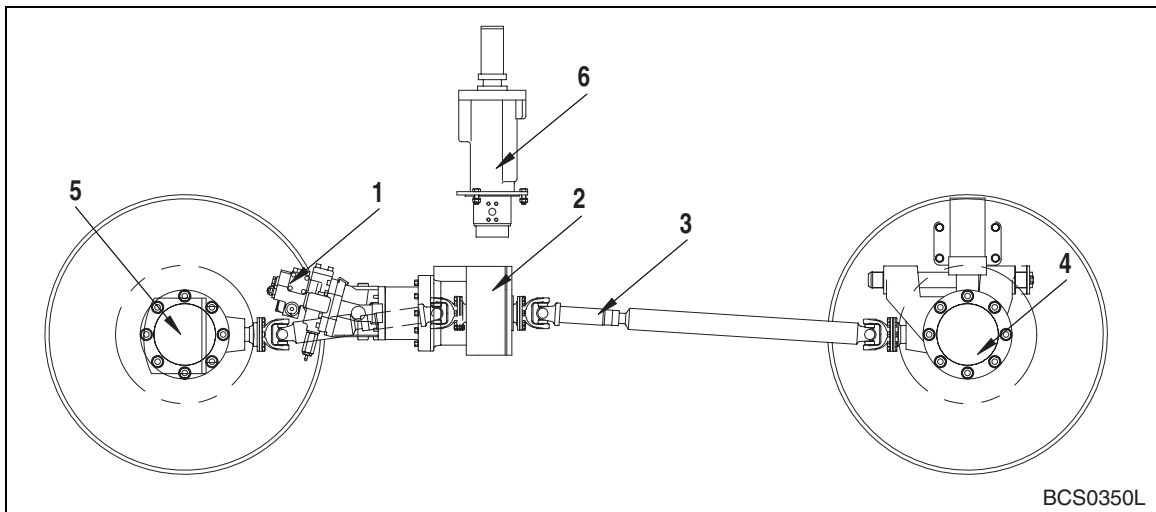


Figure 2

Reference Number	Description
1	Travel Motor
2	Transmission
3	Propeller Shaft

Reference Number	Description
4	Front Axle
5	Rear Axle
6	Center Joint

PARTS LIST

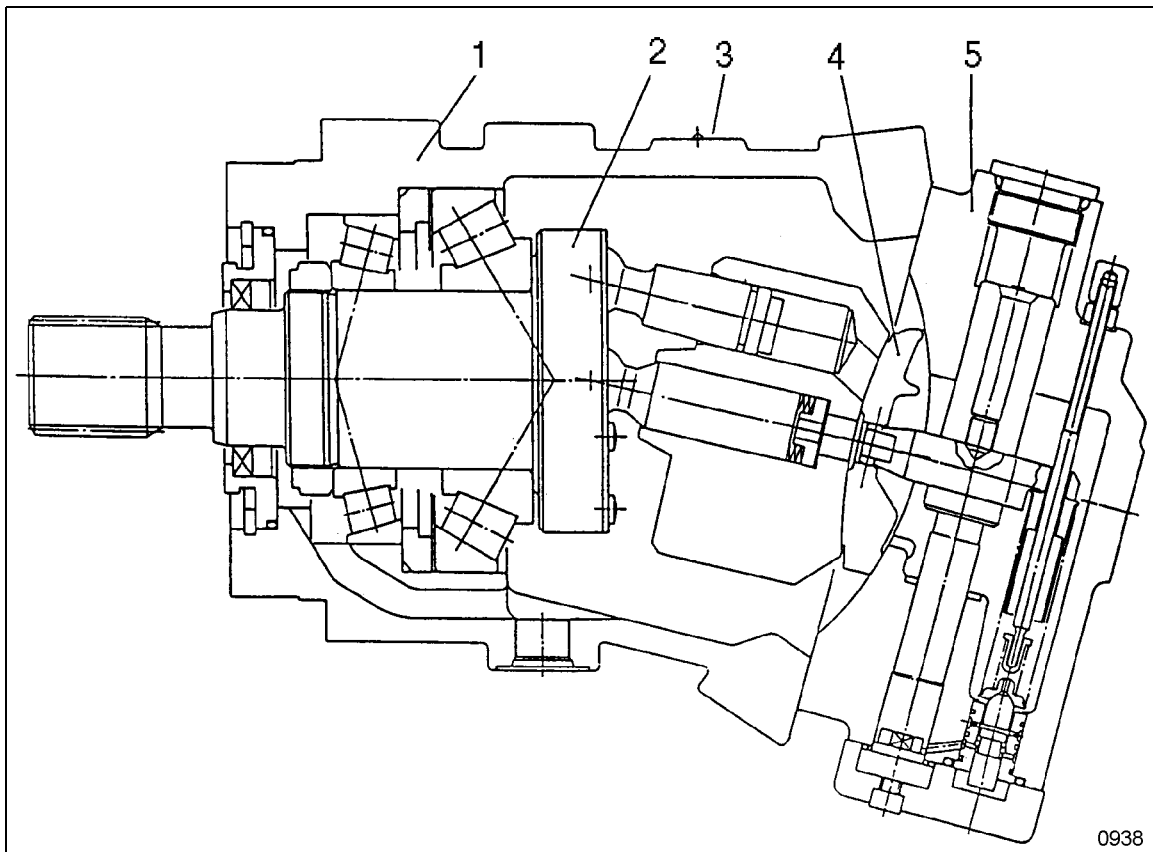


Figure 3

Reference Number	Description
1	Housing
2	Rotary Group
3	Main Valve

Reference Number	Description
4	Control Plate
5	Regulator

SPECIFICATIONS

Travel Motor	Solar 130W-V	Solar 140W-V / 160W-V
Type	Bent Axis Piston	Bent Axis Piston
Displacement	45 - 114.7 cc/rev. (2.75 - 7.0 in ³ /rev.)	42 - 114.7 cc/rev. (2.56 - 7.0 in ³ /rev.)
Crossover Relief Valve Setting	360 kg/cm ² (5,120 psi)	360 kg/cm ² (5,120 psi)
Max. Supply Flow Rate	160 lpm (42 gpm)	166 lpm (44 gpm)
Maximum Operating Speed	3,555 rpm	3,952 rpm
Maximum Output Torque	60.7 kg•m (439 ft lb)	67 kg•m (484.5 ft lb)

Travel Motor	Solar 170W-V	Solar 200W-V / 210W-V
Type	Bent Axis Piston	Bent Axis Piston
Displacement	50 - 172 cc/rev. (3.05 - 10.5 in ³ /rev.)	66 - 172 cc/rev. (4.03 - 10.5 in ³ /rev.)
Crossover Relief Valve Setting	350 kg/cm ² (4,980 psi)	350 kg/cm ² (4,980 psi)
Max. Supply Flow Rate	226 lpm (59.7 gpm)	226 lpm (59.7 gpm)
Maximum Operating Speed	4,000 rpm	3,343 rpm
Maximum Output Torque	77 kg•m (557 ft lb)	77 kg•m (557 ft lb)

TRAVEL MOTOR GENERAL DISASSEMBLY AND REASSEMBLY INSTRUCTIONS

RECOMMENDED TOOLS

Hexagon Wrench	4, 6, 8, 10, 17 mm
Spanner Wrench	17, 19, 26, 41, 51 mm
Long Nose Pliers	Nominal Size About 125
Plastic hammer	Medium Size
Snap Ring Pliers	50 - 130 for outer side
Driver	Medium Size
Grease	Spray Type Preferred
Cleaning Oil	Spray Type Preferred
Rubber Disk Assembly (See Figure 4)	To Prevent Cylinder Block from Releasing
Liquid Packing	Three Bond 1215

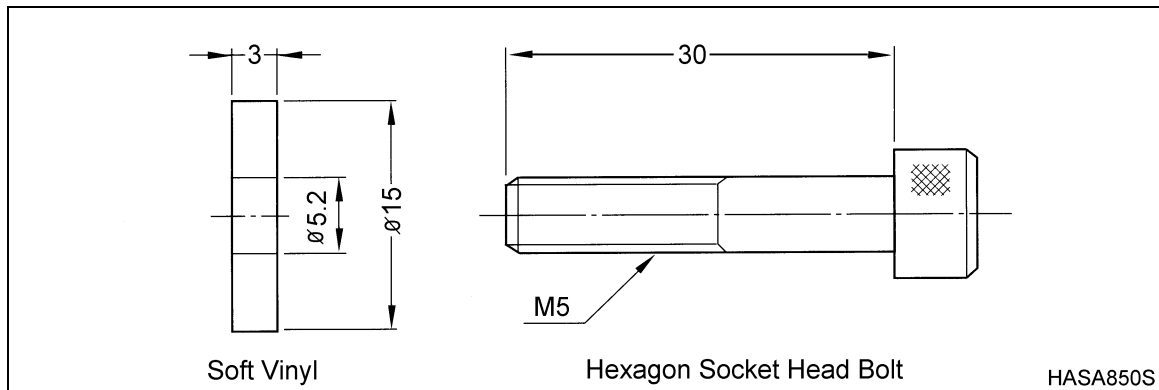


Figure 4

PRECAUTIONS FOR DISASSEMBLY AND ASSEMBLY

1. Replace rotary group with a new one as a complete assembly.
2. Make sure not to damage any adjustment screws, replace any damaged adjustment screw with new. Variance of set value may result with damaged equipment.
3. Drain oil from inside motor, clean outside and place clean paper, cloth, or gum mat on workbench before disassembly and assembly. Be careful not to damage any components, and prevent foreign objects from entering motor assembly.
4. Clean, lubricate (with operating oil), and inspect disassembled parts. Replace damaged parts before reassembling.

DISASSEMBLY OF TRAVEL MOTOR

APPEARANCE OF MOTOR

1. Appearance of motor side view.

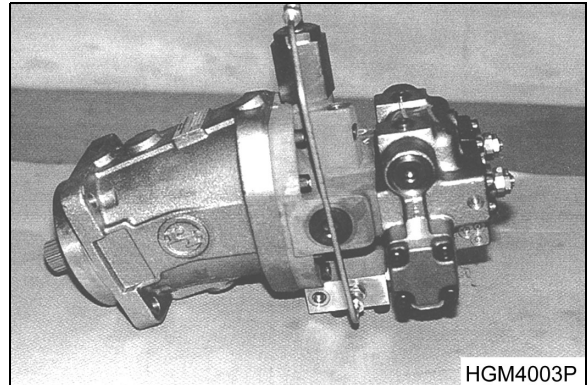


Figure 5

2. Appearance of motor rear view.

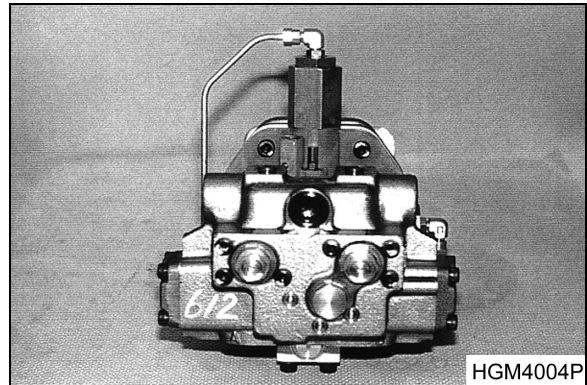


Figure 6

REMOVAL OF COUNTERBALANCE VALVE

1. Remove counterbalance valve by removing six, hex socket bolts.

NOTE: *The counterbalance valve is covered in this section after the travel motor.*

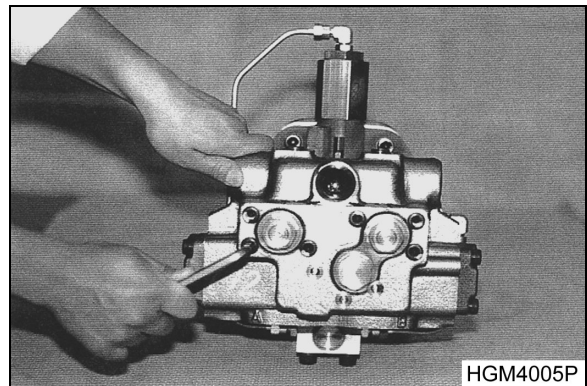


Figure 7

2. Do not adjust pressure adjusting screw at this time.

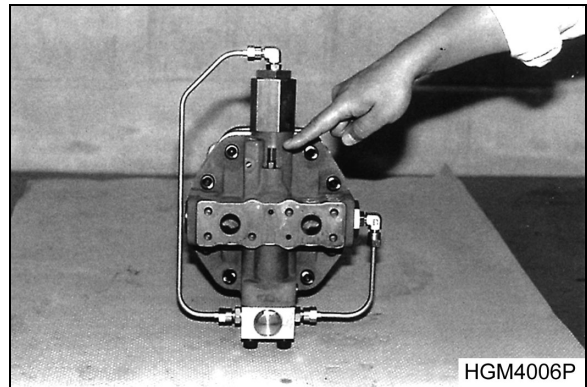


Figure 8

REMOVAL OF OUTER PIPING

1. Remove control valve to stroke limiter lubrication tube.

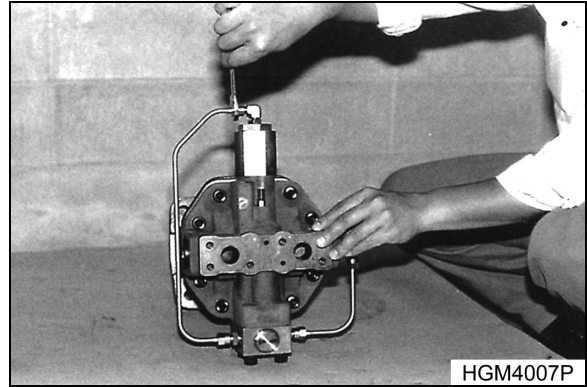


Figure 9

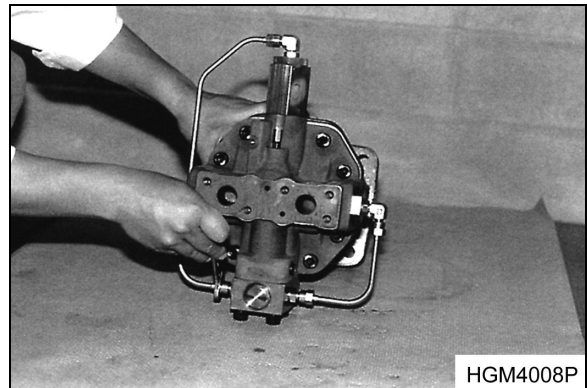


Figure 10

2. Remove control valve to regulator body lubrication tube.

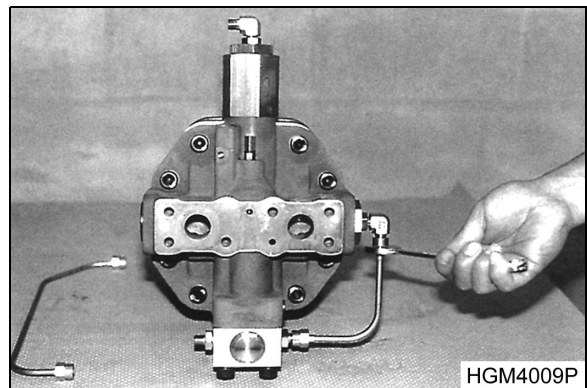


Figure 11

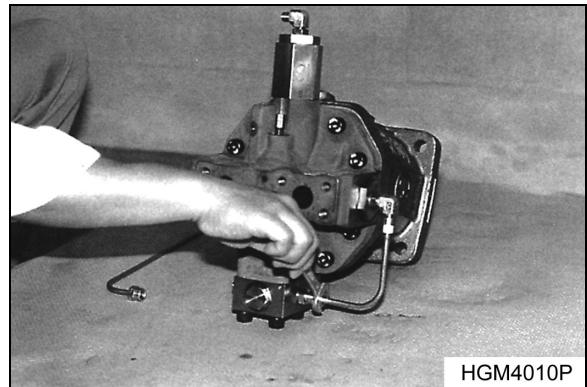


Figure 12

3. Remove 90° elbows from stroke limiter and regulator body.

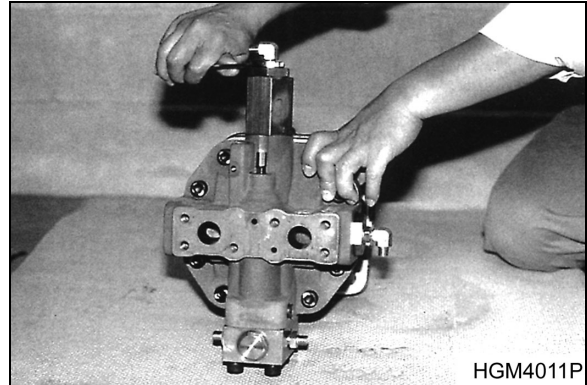


Figure 13

4. Remove nipples from control valve.

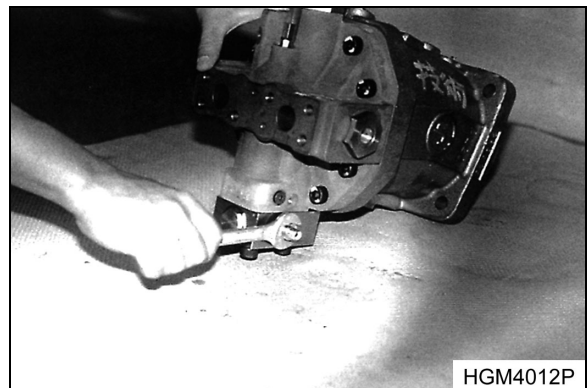


Figure 14

REMOVAL OF STROKE LIMITER

1. Remove stroke limiter assembly.

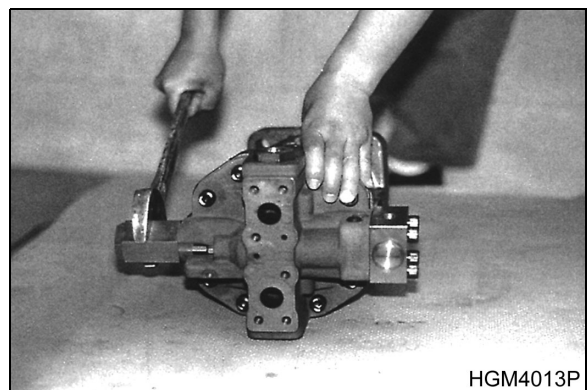


Figure 15

REMOVAL OF OIL SEAL

1. Remove C-type stop ring using snap ring pliers.
2. Remove seal case using 2 screw drivers inserted into groove.
3. Remove case and pull out O-ring.

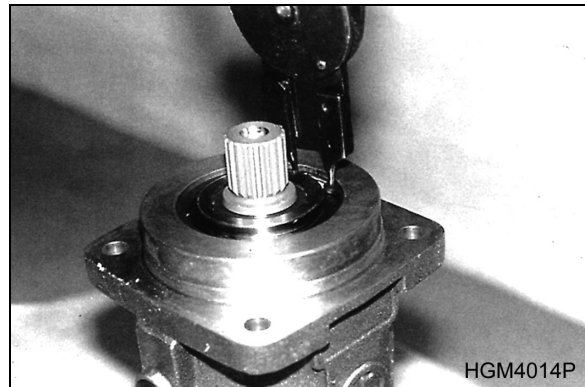


Figure 16

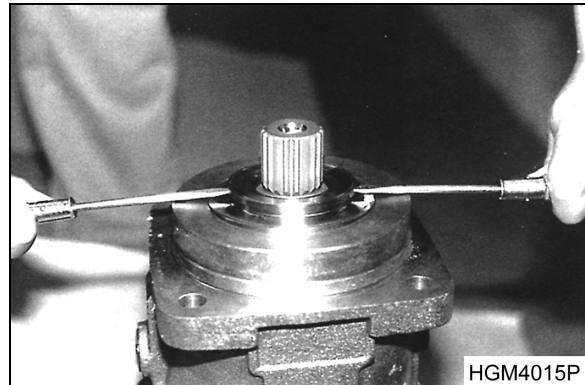


Figure 17

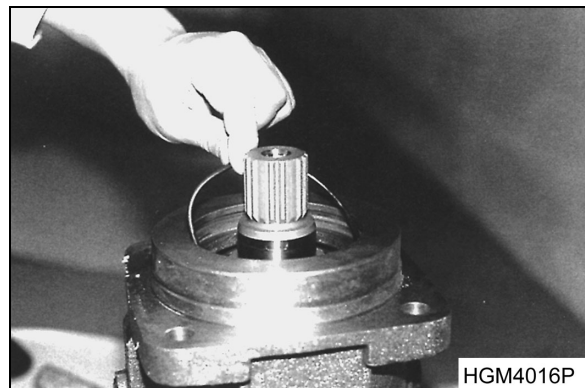


Figure 18

REMOVAL OF CONTROL UNIT

1. Remove eight hex socket bolts.

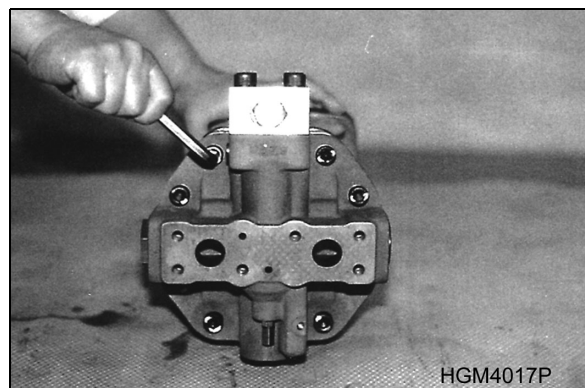


Figure 19

2. Turn motor so that shaft faces down and lift main control body up and out.

NOTE: During this step, control plate may come out with main control body, be careful not to drop the control plate and damage cylinder block.

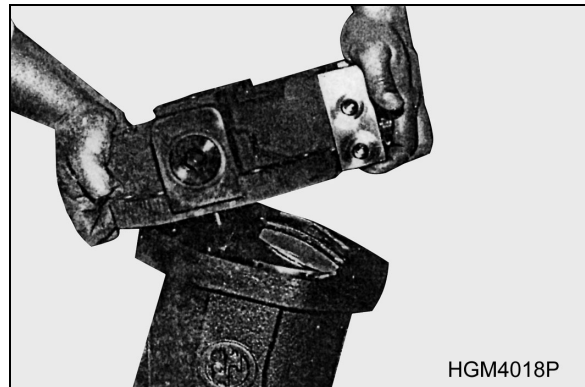


Figure 20

3. Remove control plate.



Figure 21

4. Install rubber disc assembly, which is used to fix cylinder block to prevent separation.

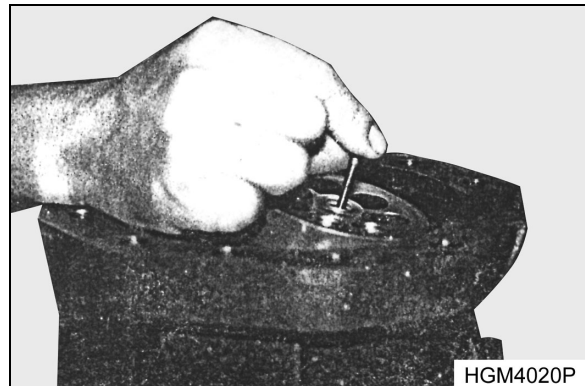


Figure 22

5. Remove parallel pins with pliers.

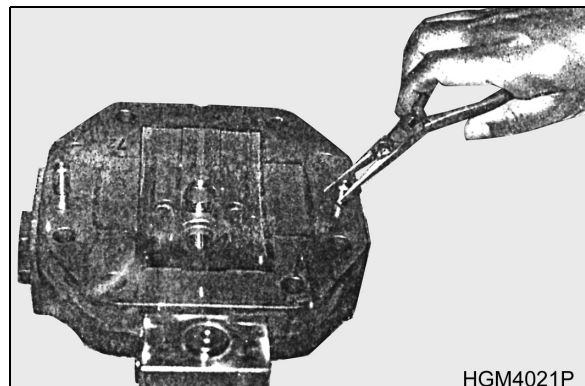


Figure 23

6. Remove plug.

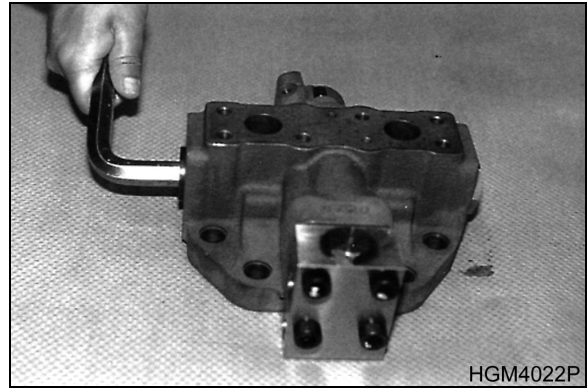


Figure 24

7. Remove bushing.

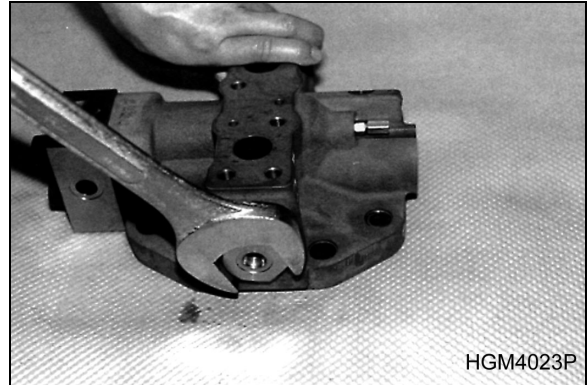


Figure 25

REMOVAL OF CONTROL VALVE

1. Loosen four hex socket bolts and remove cover.

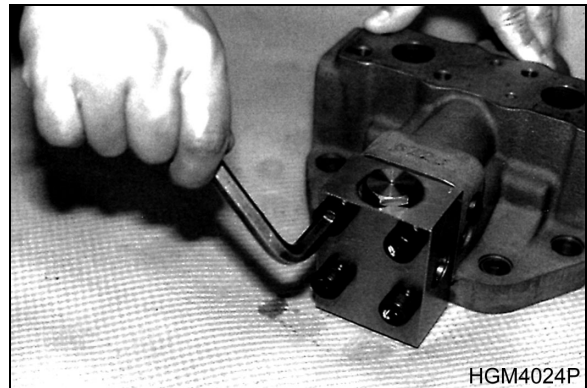


Figure 26

2. Remove O-ring.

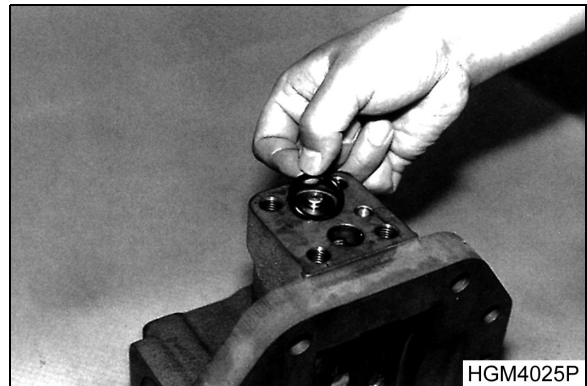


Figure 27

3. Remove spool and barrel, being careful not to cut piston ring on outside of barrel.

NOTE: *If spool and barrel are not pulled out smoothly, hold the groove part of spool slightly, using a long nose pliers. Remove spool being careful not to scratch it.*

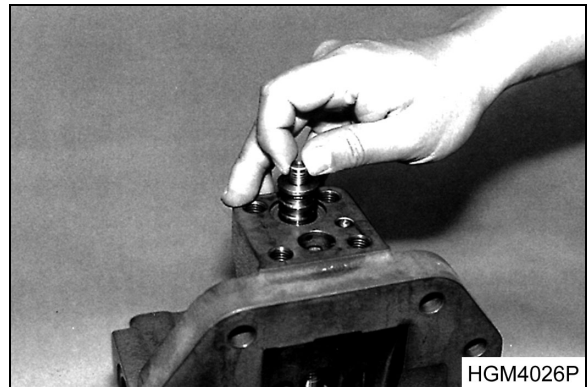


Figure 28

4. Remove spring seats.

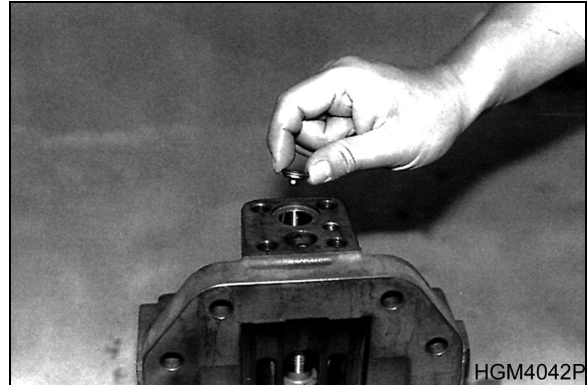


Figure 29

5. Remove large spring.

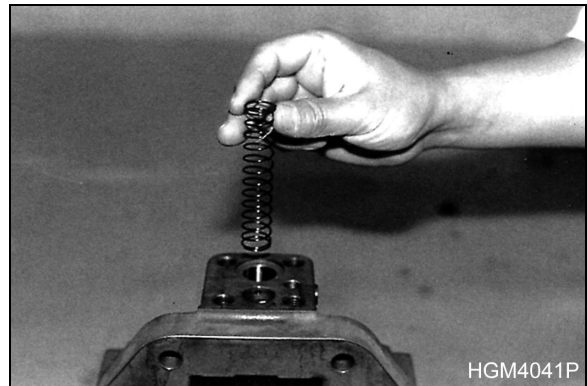


Figure 30

6. Remove small spring.

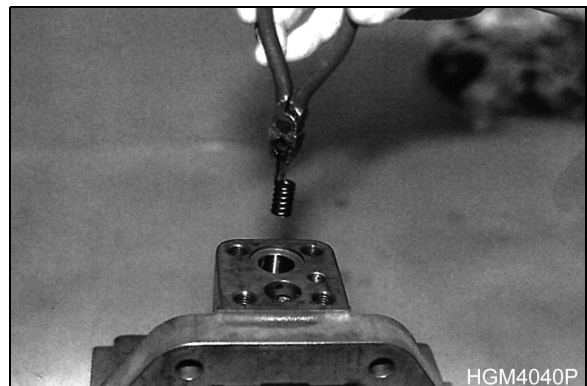


Figure 31

7. Remove spring seats.

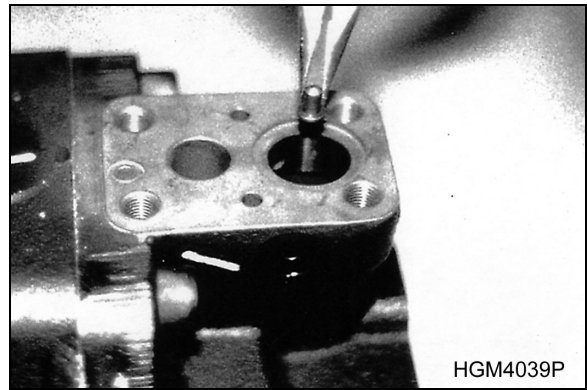


Figure 32

8. Arrange removed components, as shown.

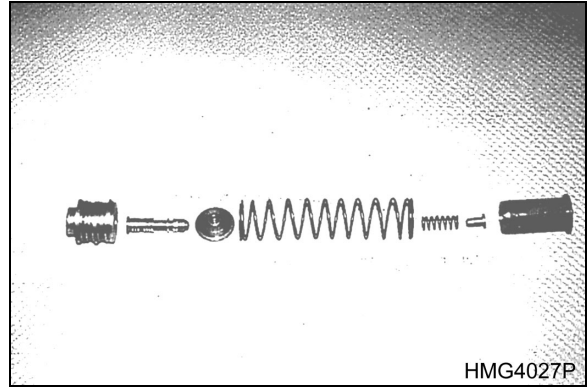


Figure 33

DISASSEMBLE CONTROL VALVE

1. Remove hex head plug.

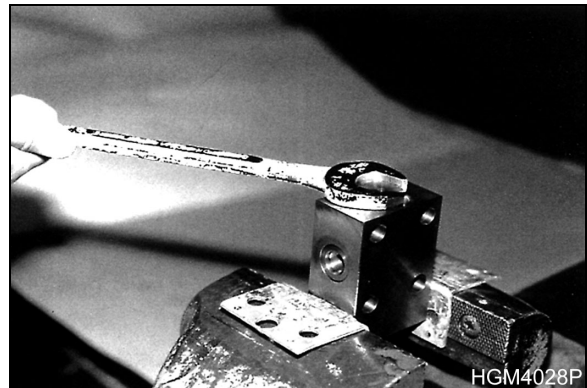


Figure 34

2. Remove spring.

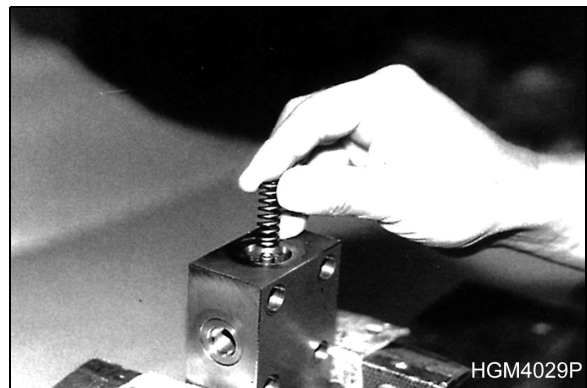


Figure 35

3. Remove spool.

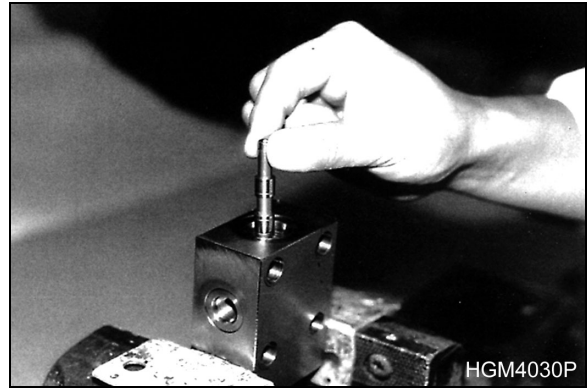


Figure 36

4. Remove socket head plug.

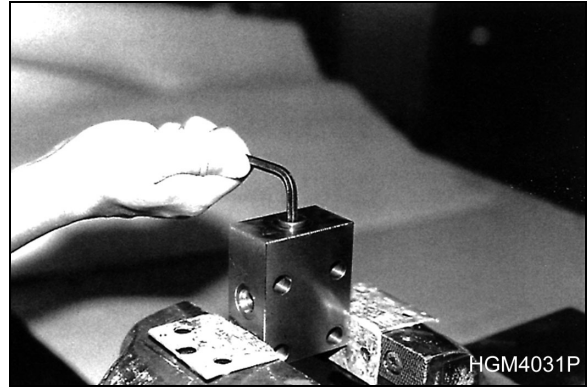


Figure 37

5. Arrange removed components as shown.

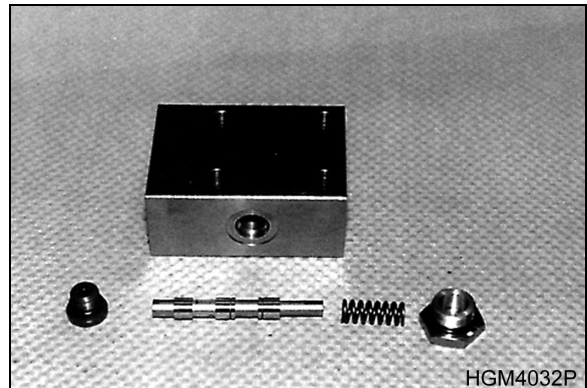


Figure 38

DISASSEMBLE STROKE LIMITER

1. Remove bushing.

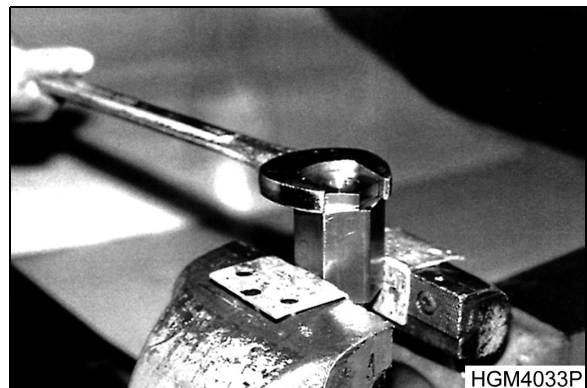


Figure 39

2. Remove piston.

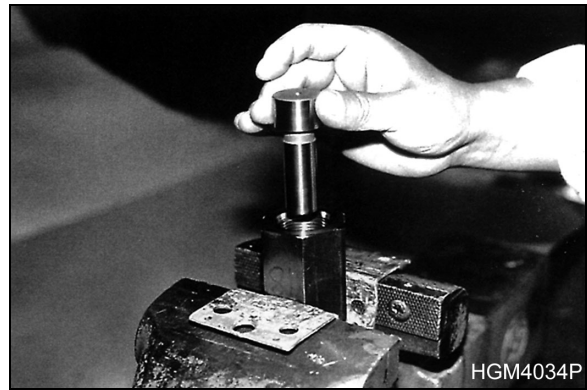


Figure 40

REASSEMBLE STROKE LIMITER

1. Install piston.

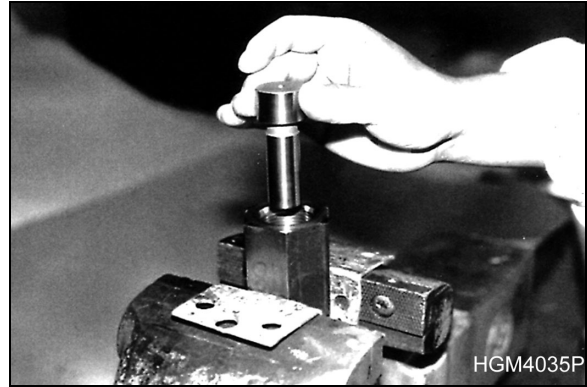


Figure 41

2. Install bushing.



Figure 42

REASSEMBLE CONTROL VALVE

1. Install socket head plug.

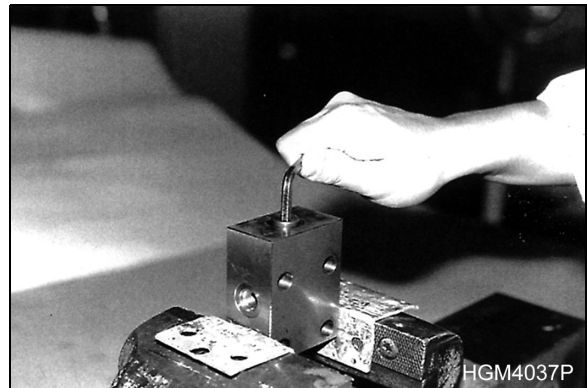


Figure 43

2. Install spool.

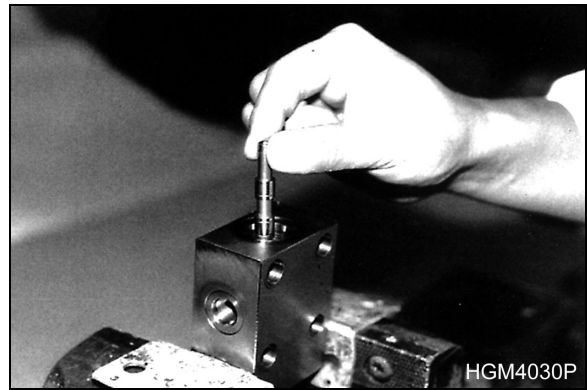


Figure 44

3. Install spring.

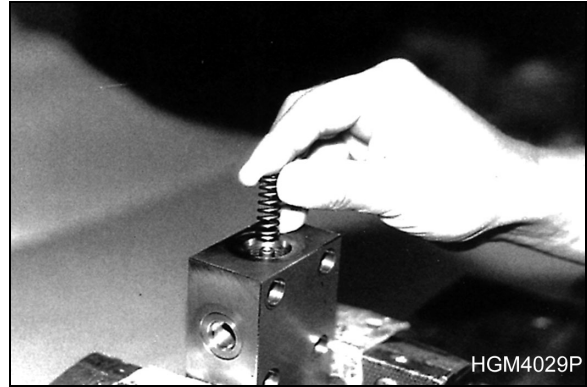


Figure 45

4. Install hex head plug.

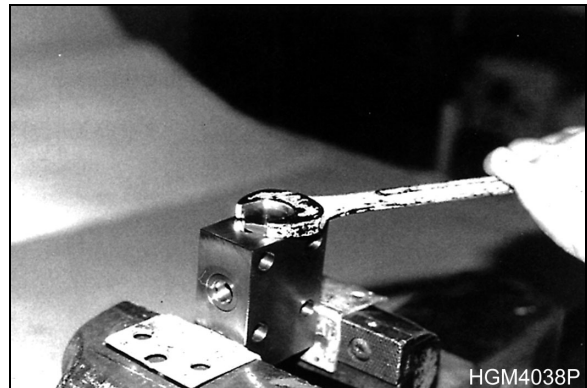


Figure 46

INSTALLATION OF CONTROL VALVE

1. Attach spring seats.

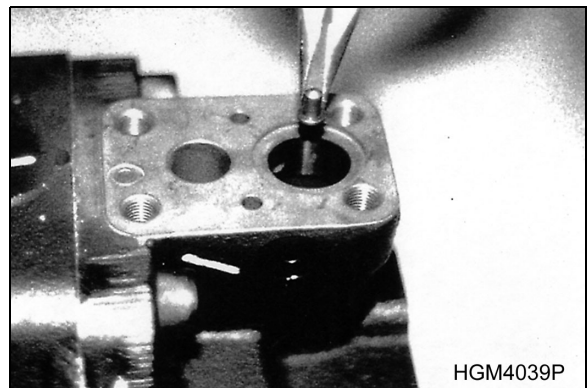


Figure 47

2. Attach small spring.

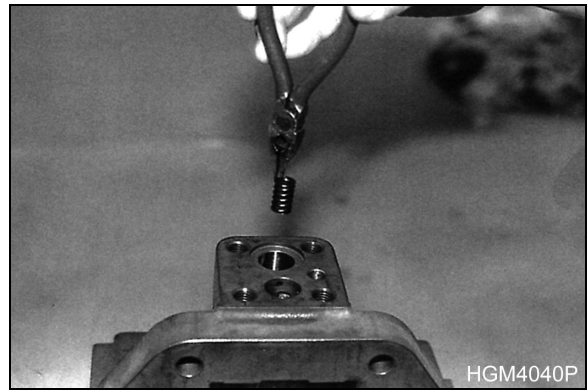


Figure 48

3. Attach large spring.

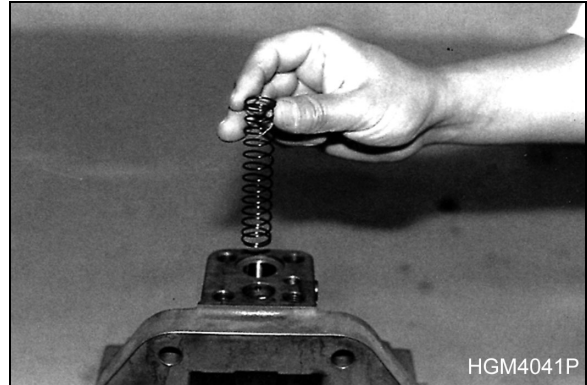


Figure 49

4. Attach spring seat.

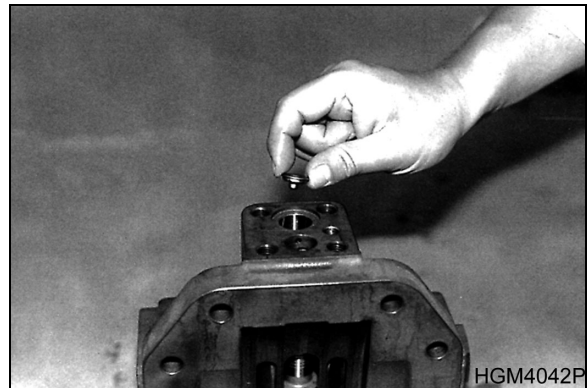


Figure 50

5. Insert spool in middle of barrel.



Figure 51

6. Install barrel into main control body, while pushing piston ring into groove with flat screw driver, being careful not to cut piston ring.



Figure 52

7. Install O-ring.

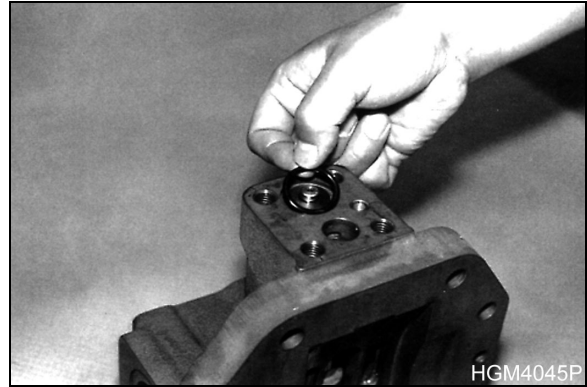


Figure 53

8. Secure control valve with four socket bolts.
NOTE: Torque to 12.5 kg•m (90 ft lb).

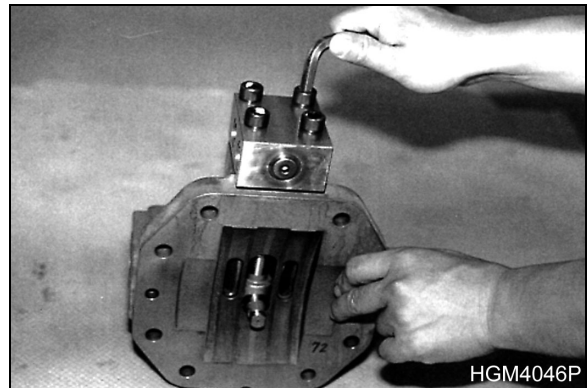


Figure 54

REASSEMBLY OF TRAVEL MOTOR

ASSEMBLY OF CONTROL UNIT

1. Install plug.

NOTE: Torque to 12.5 kg•m (90 ft lb).

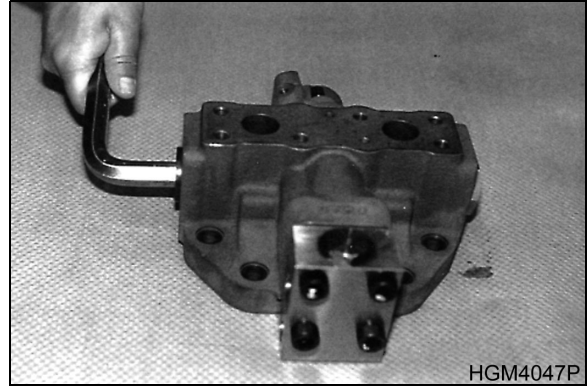


Figure 55

2. Install bushing.

NOTE: Torque from 22 - 27 kg•m (159 - 195 ft lb).

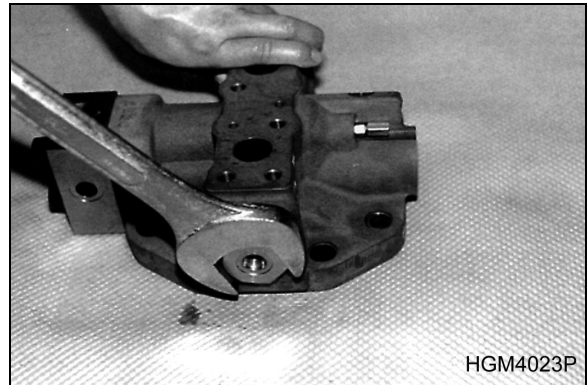


Figure 56

3. Remove rubber disc assembly, which is used to fix cylinder block.

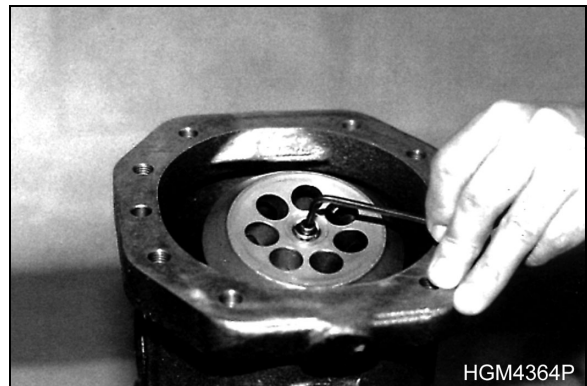


Figure 57

4. Check that control plate is installed in the correct position. Grease control plate and install in main control body.

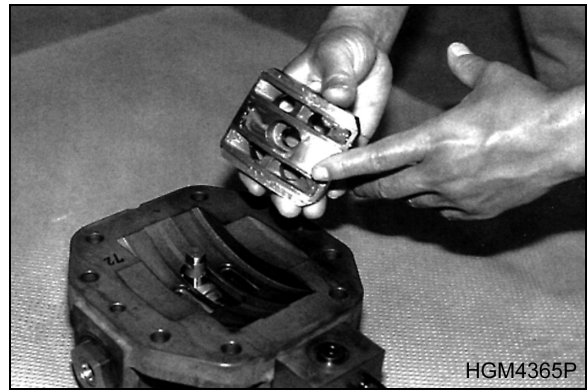


Figure 58

5. Grease top surface of control plate and recheck that it is installed in the right position.

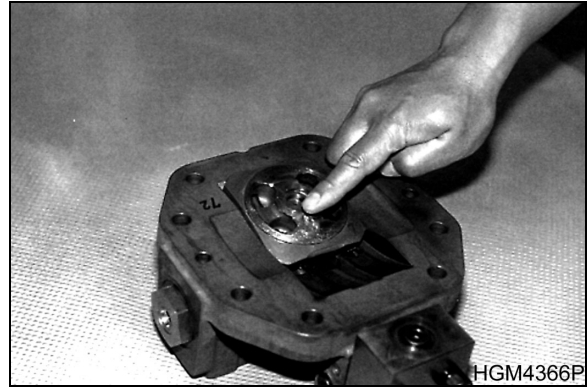


Figure 59

6. Install main control body and parallel pins. Clean surface that contacts housing.

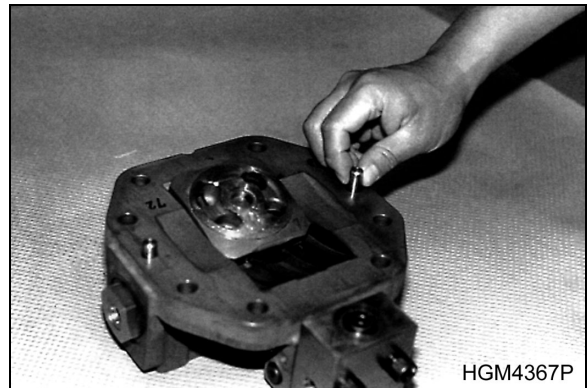


Figure 60

7. Clean surface that contacts main control body and apply Three Bond 1215 (allow sufficient time to dry).

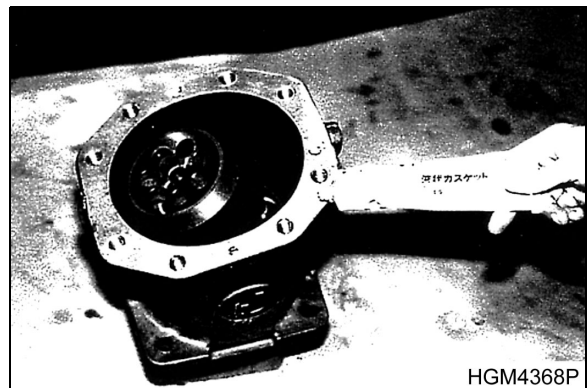


Figure 61

8. Attach main control body to housing, being careful not to drop control plate.

NOTE: *Though Figure 62 does not show parallel pin on connecting side, assemble after engaging it.*

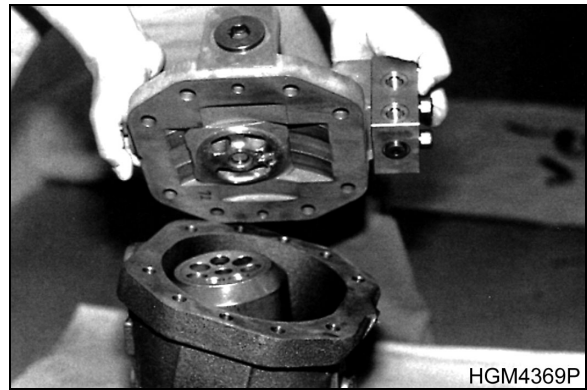


Figure 62

9. Tighten eight, hex socket bolts.

NOTE: *Torque to 12.5 kg•m (90 ft lb).*



Figure 63

INSTALLATION OF OIL SEAL

1. Install O-ring.

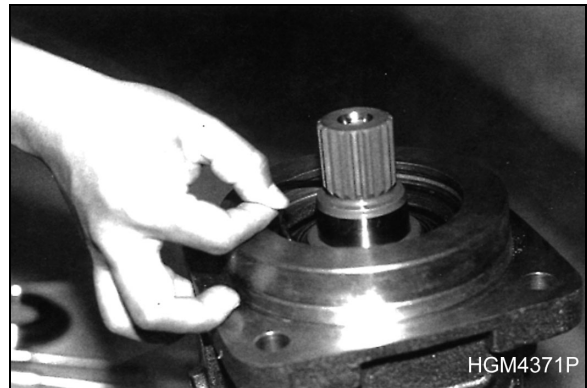


Figure 64

2. Install seal case.

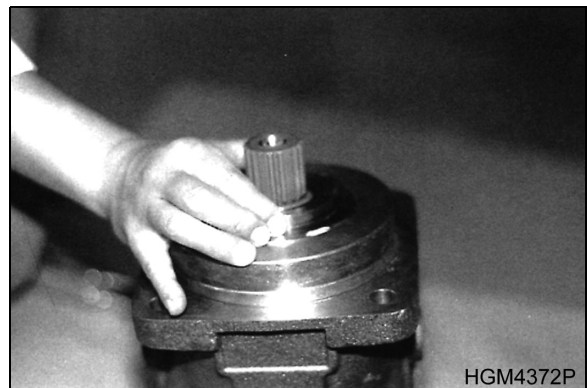


Figure 65

3. Secure seal case with snap ring.

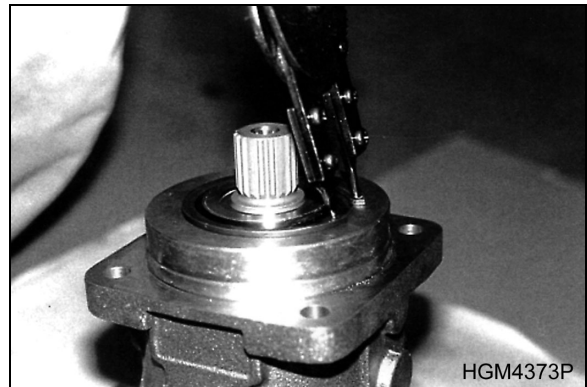


Figure 66

4. Secure C-type snap ring by tapping with plastic hammer and driver.

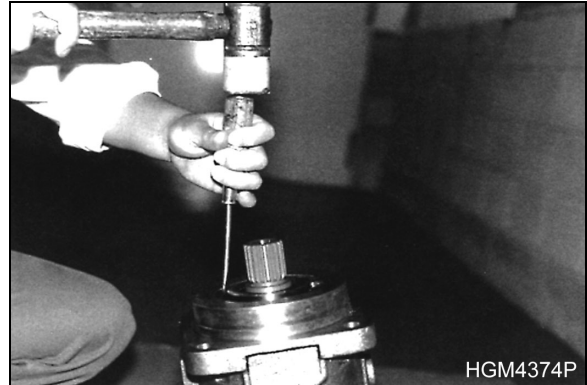


Figure 67

INSTALLATION OF STROKE LIMITER

1. Install stroke limiter assembly.

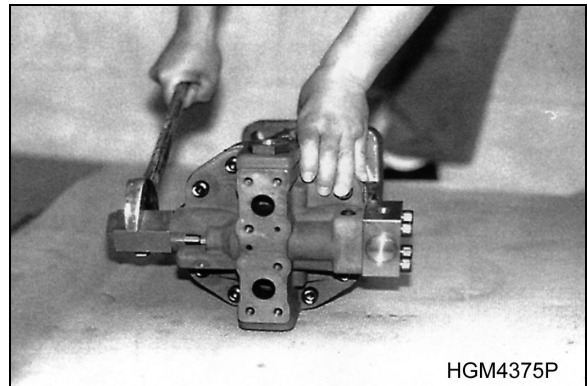


Figure 68

INSTALLATION OF OUTER PIPING

1. Install connectors to control valve.

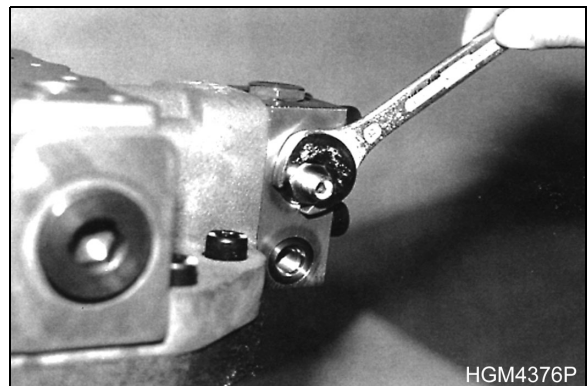


Figure 69

2. Install 90° elbows to stroke limiter and control unit body.

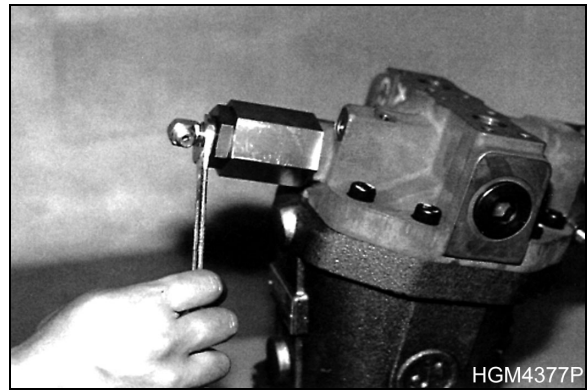


Figure 70

3. Install lubrication lines from control valve to control unit and stroke limiter.

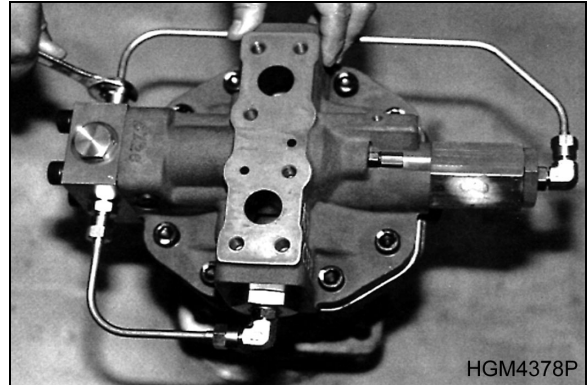


Figure 71

INSTALLATION OF COUNTERBALANCE VALVE

1. Install counterbalance valve with six hex socket bolts.

NOTE: Torque to 7 kg•m (51 ft lb).

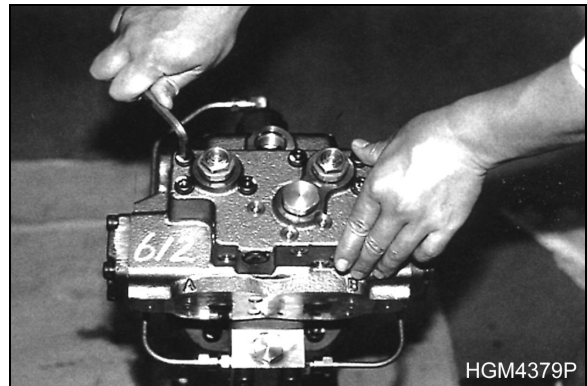


Figure 72



MAIN PUMP (TONGMYUNG)



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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SWASH PLATE TYPE K5V SERIES AXIAL PISTON PUMP

TYPE DESIGNATION

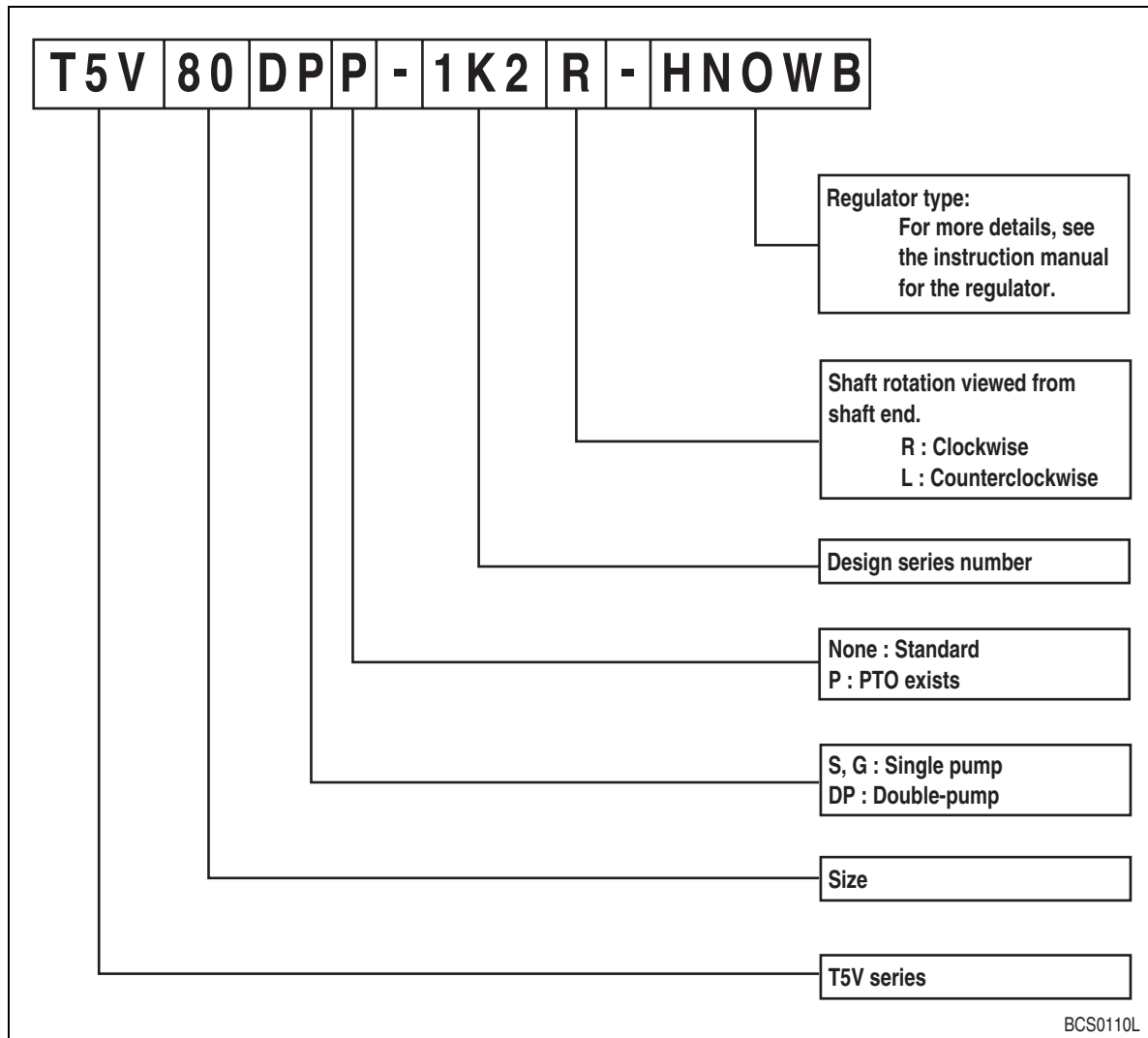


Figure 1

SPECIFICATIONS

Item		Specification
Size		80
Displacement		73.7 cm ³ / rev
Pressure	Rated	31.4 MPa (320 kg/cm ²)
	Max.	34.3 MPa (350 kg/cm ²)
Speed	Max. *1	3,000 min ⁻¹
	Max. for self-priming *2	2,400 min ⁻¹
Weight	Single	
	Double	91 kg
Working Oil	Type	Mineral working oil
	Oil temp range	-20 ~ +95 °C
	Oil viscosity range	10~1,000 cSt (mm ² /s)
	Recommended filter	10μm

*1 These are the maximum speeds for the closed-circuit specifications. For the closed-circuit specifications, consult us in advance.

*2 These are the speeds when the suction pressure is 0 kg/cm² (0 psi).

CONSTRUCTION AND FUNCTION

Construction

This pump assembly consists of two pumps connected by a splined coupling (114). The two pumps can be driven simultaneously as the rotation of the prime mover (engine) is transferred by the drive shaft (F) (111) on the front side. The suction and discharge ports are integrated at the connecting part of the two pumps, i.e. in valve block (312): The suction port serves both the front pump and the rear pump.

Function

The pumps may be classified roughly into the rotary group performing a rotary motion and working as the major part of the whole pump function: the swash plate group that varies the delivery rates: and the valve cover group that changes over oil suction and discharge.

1. Rotary Group

The rotary group consists of a drive shaft (F) (111), cylinder block (141), piston shoes (151, 152), set plate (153), spherical bushing (156) and cylinder spring (157). The drive shaft is supported by bearings (123 and 124) at both ends. The shoe is caulked to the piston to form a spherical coupling. It has a pocket to relieve thrust force generated by loading pressure and to take hydraulic balance so that it slides lightly over the shoe plate (211). The sub-group is composed of a piston and shoe pressed against the shoe plate by the action of the cylinder spring via a retainer and a spherical bush.

Similarly, the cylinder block is pressed against valve plate (313) by the action of the cylinder spring.

2. Swash Plate Group

The swash plate group consists of swash plate (212), shoe plate (211), swash plate support (251), tilting bushing (214), tilting pin (531) and servo piston (532).

The swash plate is a cylindrical part formed on the opposite side of the sliding surface of the shoe and is supported by the swash support.

The servo piston moves to the right and left as hydraulic oil, controlled by the regulator is transmitted to each hydraulic chamber located on both ends of the servo piston. The swash plate slides over the swash plate support via the spherical part of the tilting pin to change the tilting angle (α).

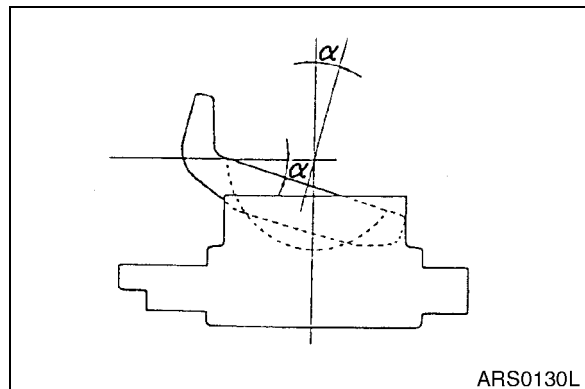


Figure 2 Swash Plate Group

3. Valve Block Group

The valve block group consists of valve block (312), valve plate (313) and valve plate pin (885). The valve plate has two melon-shaped ports, that are mated to the valve block. These feed and collect oil to and from the cylinder block.

The oil changed over by the valve plate is connected to an external pipeline by way of valve block.

When the drive shaft is driven by the prime mover (engine), it rotates the cylinder block via a splined coupling. If the swash plate is tilted as in Figure 2, the pistons arranged in the cylinder block make a reciprocating motion with respect to the cylinder block, while they revolve with the cylinder block. If you pay attention to a single piston, it performs a motion away from the valve plate (oil sucking process) within 180 degrees, and makes a motion towards the valve plate (or oil discharging process) in the rest of 180 degrees. When the swash plate has no tilt angle (zero degrees), the piston does not stroke and neither discharges or draws oil.

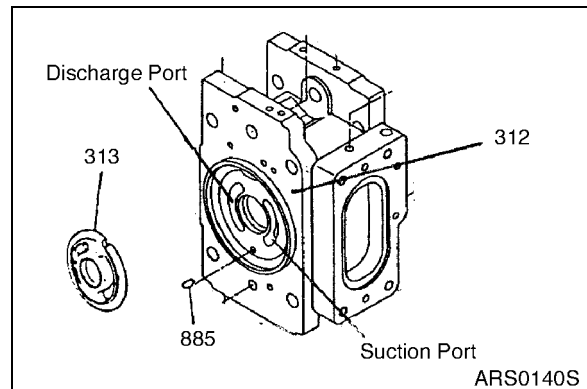


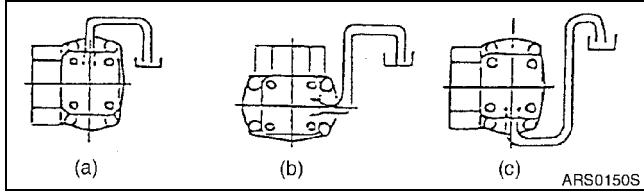
Figure 3 Valve Block Group

CAUTIONS FOR OPERATION

Installation

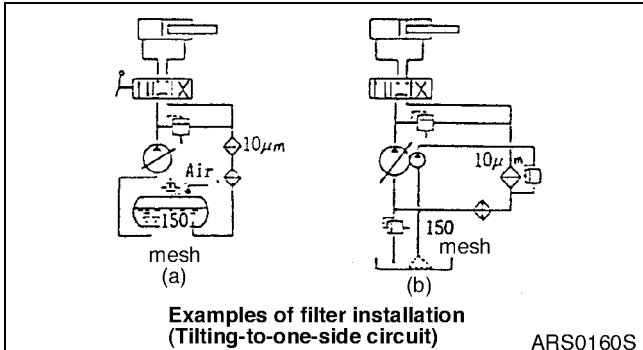
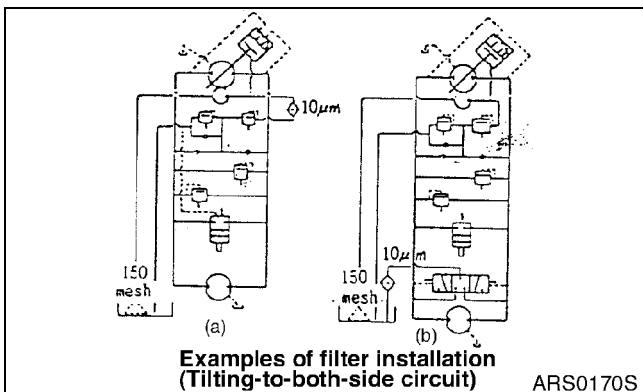
Item	Caution	Applied Type
Installed direction.	Install pump with drive shaft horizontal in general.	All types.
External load to shaft end.	Apply neither radial nor thrust load externally to the pump shaft end.	All types.
Removal of rust preventing paint.	Since the shaft end splined section has been coated with rust preventing paint, remove it with cleaning liquid before using the pump. Apply lubricant, such as molybdenum disulfide, before installing this section on the coupling. When cleaning liquid is used, be careful not to get liquid on oil seal sections.	All types.
Coupling and centering of pump.	Couple the pump drive shaft with the prime mover shaft with a flexible coupling in general. For centering between the coupling and drive shaft, keep the alignment within $\pm 0.03\text{mm}$.	All types.
Tightening of pump mounting bolts.	For the tightening torques of the pump mounting bolts, refer to the values of their respective sizes shown in "Tightening Torques" on page 26.	All types.

Cautions for Piping

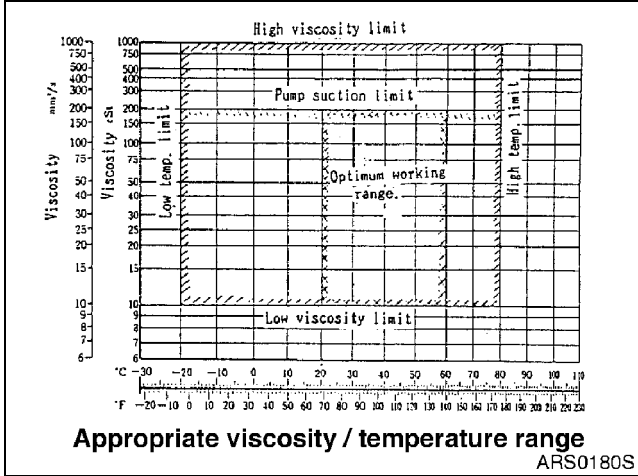
Item	Caution	Applied Type
Rotating direction and delivery direction.	For the variable pump, these indications depend on the command method of the regulator. For each application of the pump, refer to the indications shown in the outside dimension drawing.	All types.
Sanitation of pipings.	Carry out acid pickling and flushing of the suction / delivery pipings and tank. Especially, thoroughly clean the suction piping.	All types.
Installation of suction / delivery pipings.	When installing pipings, prevent the suction and delivery ports of the pump from being forcedly-stressed. Also avoid sudden bending as much as possible. Refer to attached list 1 tightening torque list in tightening the mounting bolts.	All types.
Drain piping.	Raise the drain pipe of the pump higher than the pump and route it to the tank, as shown in the following figures.  For a tandem type double-pump, install the drain pipe on the front pump first as far as possible. It is desirable to provide a filter in the drain line.	All types. Tandem type pumps.
Drain pressure.	Allowable internal case pressure for this pump is normally less than 1 kg/cm^2 (14 psi).	All types.

Cautions for Filters

The most important factor to prevent the pumps and other components from being damaged and to lengthen their life-spans is control of contamination in the hydraulic oil. A filter of 10 μ m must be provided in the circuit.

Item	Caution	Applied Type
Tilting-to-one side circuit.	In the circuit, do not forget to provide a filter of 10μm in the actuator return pipe. The following figure shows examples. In addition, provide a filter of 80 to 150 mesh at the suction side.  Examples of filter installation (Tilting-to-one-side circuit) ARS0160S	All types of tilting-to-one side pumps.
Tilting-to-both side circuit.	It is ideal to provide a filter of 10μm in the booster line as shown in (a) of the following figure, but there are also a number of experiences to provide filters of 10μm in the flushing circuits. Always, provide a filter of 80-150 mesh in the suction side of the booster pump.  Examples of filter installation (Tilting-to-both-side circuit) ARS0170S	All types of tilting-to-both side pumps.
Contamination.	The relationship between contamination and the pump's life-span is very understandable and the latter depends largely on the kind and nature of dust. Mixing of dust in the oil will cause any pump to have a shorter life-span. On the premise that dust is not mixed the recommended range is class 9 or better in NAS class, and 2 to 4 mmg/100cc or less in millipoise pollution grade.	All types.

Working Oil and Temperature Range

Item	Caution	Applied Type
Kind of oil.	Use general-use working oil that has an antifoaming additive, antioxidant, anticorrosive, sec. and has a high viscosity index.	All types.
Optimum viscosity and temperature of working oil.	For the open circuit, the recommended working viscosity range is 10 to 200 cSt. For the close circuit or when used as a motor, the range of 10 to 1000 cSt can be available, but the range of 10 to 200 cSt is desirable, considering the optimum efficiency. The temperature range is limited approximately to -20°C to 80°C by oil seals, O-rings, etc. It is desirable to use oil at a temperature lower than 65°C as low as possible, considering deterioration of working oil, seals and so on.  Appropriate viscosity / temperature range ARS0180S	All types.
Working oil other than mineral oil.	When any working oil of phosphate, water-glycol, fatty acid ester is to be used, do not fail to consult us in advance.	All types.

Operational Cautions

Item	Caution	Applied Type
Out of service for a long period.	It is not recommendable that the pump/motor is stored for a long period (one year or more) without being operated. During such period, rotate it even for a short time. When it is stored independently, it is effective even to turn its shaft manually. If the storage period is longer it is necessary to overhaul it.	All types.
Change of rotating direction.	The rotating direction is as indicated by the arrow plate. If it must be changed during its life-span, consult us.	All types.

Oil filling and Air Venting

Item	Caution	Applied Type
Oil filling.	Fill the pump casing with oil. Inside the pump there are high-speed sliding and moving parts, such as bearings, pistons/shoes, retainer, etc. If not filled with oil, these parts may suffer some serious problems, such as seizures damage.	All types.
Air venting.	When air is left in the circuit or pump, it may cause a malfunction or damage. Completely vent air.	All types.

Cautions During Starting Operation

1. Check pipings for proper installation.
2. Check that the rotating and suction / delivery directions are correct.
3. Before starting the prime mover, make sure the pump free of any load.
4. After starting, continue the idling for a while to vent air completely from the circuit.
5. Check the pump and pipings for oil leaks and abnormal vibrations.
6. When the pump is attached to a gear box, check that the box is full of oil to its proper level.

TROUBLESHOOTING

General Cautions

This section describes the countermeasures to be taken if any abnormality is detected during the operation of the Tongmyung swash plate type axial piston pump.

The general cautions are as follows:

1. Consider the condition before starting work.
2. Judge the nature of the abnormality, before starting work. Especially, judge if it is a problem in the circuit or caused by the regulator or attached valves and determine that something is truly wrong with the pump or not.
3. Read and understand the maintenance manual before disassembling and follow the right disassembling procedures.
4. Even when any section is to be disassembled, not to make dust or let it enter into the pump.
5. Since the parts are finely finished, handle them carefully to prevent damage.

Check Pump Proper for Abnormalities

The pump is often fitted with a regulator, accessory valves and associated pump. It is very difficult to find the cause of the failure. Investigate the following items, and the abnormal point will be revealed.

1. Check filter and drain oil
Check filter elements for excessive amount of abnormal impurities. Since the shoes and cylinder may give off worn metal particles, a small quantity may be detected there. However if a excessive amount of metal particles is found in the filters, it should be considered that shoes may be damaged. Similarly, check drain oil in the pump casing.
2. Existence of abnormal noises or vibrations

Check the pump for abnormal noises and vibrations. If any, investigate if it is a noise in the regular frequency, such as hunting of the regulator or the relief valve of an accessory valve, or not. If it is an abnormal vibration or noise, it may be the result of cavitation or damage inside the pump.

3. Case where two pumps are used

For the circuit with two single pumps or motors or for the duplex pump, exchange the piping of one pump with that of the other one. With the results of this exchange, it will be determined if the trouble is the problem of the circuit downstream the pump or not.

4. Pressure Measurement at Various Points

If the failure is a problem in control, do not unnecessarily overhaul the pump, but measure pressures at various areas to investigate the abnormal position.

Overload of Prime Mover

Cause	Countermeasure	Remark
Is not the speed-pressure higher than their specified values?	Set them as specified.	
Is not the torque setting of the regulator higher?	Reinvestigate the regulator.	See the instruction manual of the regulator.
Seizure or damage of a part inside the pump.	Replace the damaged part.	Check the filter and drain oil for abnormal worn metal particles.
Wrong installation of the regulator piping.	Correct the regulator piping.	

**Extreme Decrease of Pump Delivery Flow and
Non-increase of Delivery Pressure**

Cause	Countermeasure	Remark
Failure of the regulator.	Repair the regulator.	See the instruction manual of the regulator.
Seizure or damage of a part inside the pump.	Replace the damaged part.	Check the filters and drain oil.
Failure of the associated pump.	Replace the damaged part.	Remove the associated pump and check the shaft coupling.
Failure of the accessory valve.	Check the accessory valves. (Especially check the poppets, seats and springs).	See the instruction manual of the accessory valves.
Wrong installation of the regulator piping.	Correct the regulator piping.	

Abnormal Noises and Abnormal Vibrations

Cause	Countermeasure	Remark
Cavitation	Prevention from cavitation. Check working oil for emulsion.	Low boost press. Failure of the associated pump. Air leakage at the suction pipe. Increased suction resistance.
Damage in the caulking suction of the shoe.	Replace the piston shoe, plate, etc.	
Cranking of the cylinder.	Replace the cylinder.	
Wrong installation of the pump.	Correct installation.	
Hunting of the regulator.	Repair the regulator.	See the instruction manual for the regulator.
Hunting of the relief valve of the accessory valve.	Repair the accessory valve.	See the instruction manual for the accessory valve.

CONSTRUCTION OF TANDEM TYPE DUPLEX PUMP

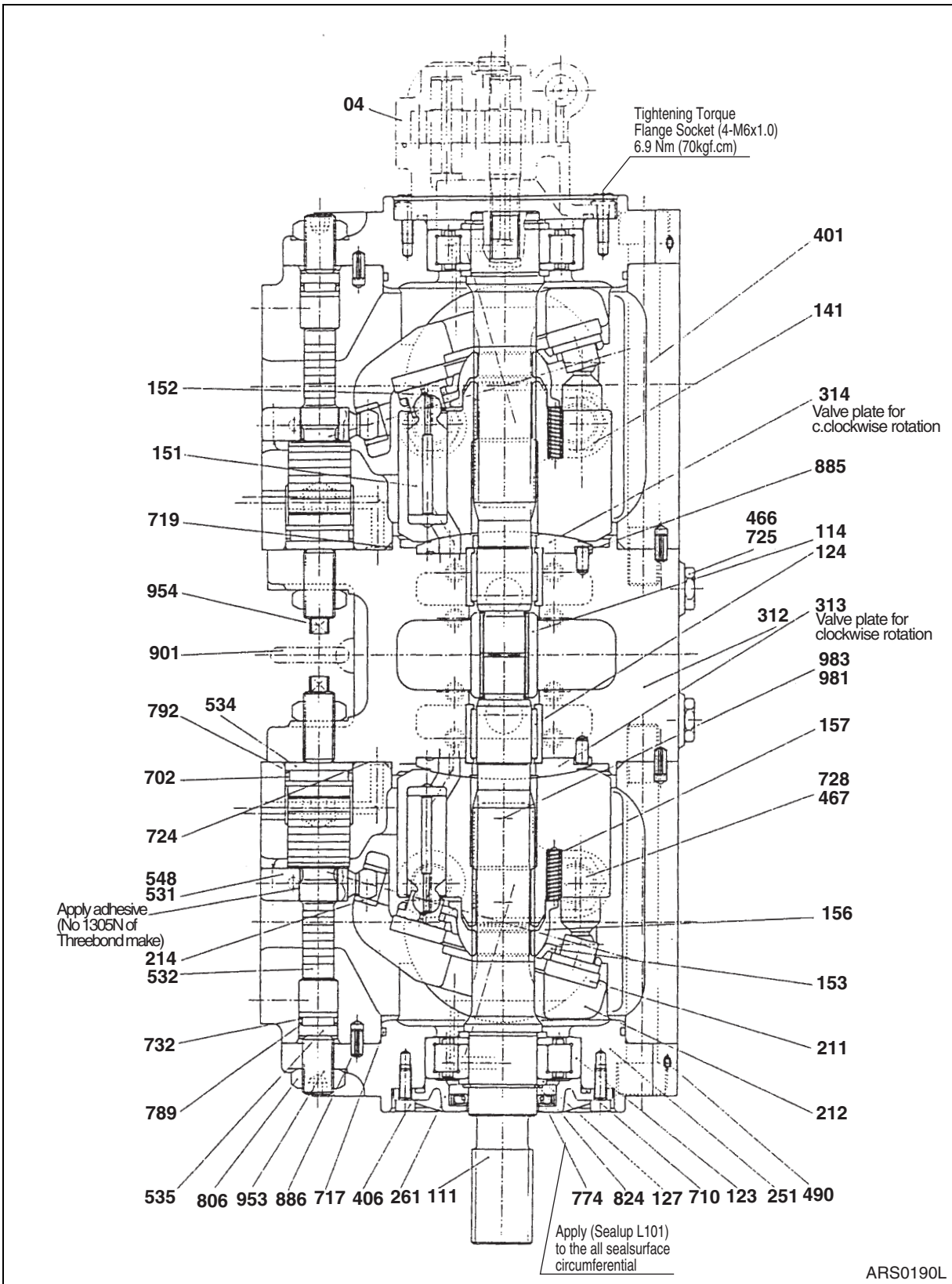


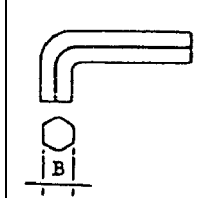
Figure 4

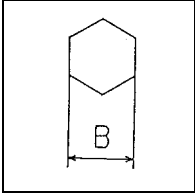
Reference Number	Description
04	Gear Pump
111	Drive Shaft (F)
113	Drive Shaft (R)
114	Spline Coupling
116	1st Gear (for DTP)
123	Roller Bearing
124	Needle Bearing
127	Bearing Spacer
141	Cylinder Block
151	Piston
152	Shoe
153	Set Plate
156	Spherical Bush
157	Cylinder Spring
211	Shoe Plate
212	Swash Plate
214	Tilting Bush
251	Swash Plate Support
261	Seal Cover (F)
262	Seal Cover (R)
271	Pump Casing
312	Valve Block
313	Valve Plate (R)
314	Valve Plate (L)
325	Valve Casing
401	Hexagon Socket Head Bolt
406	Hexagon Socket Head Bolt

Reference Number	Description
466	VP Plug
468	VP Plug
531	Tilting Pin
532	Servo Piston
534	Stopper (L)
535	Stopper (S)
548	Feed Back Pin
702	O-ring
710	O-ring
717	O-ring
719	O-ring
724	O-ring
725	O-ring
728	O-ring
732	O-ring
774	Oil Seal
789	Backup Ring
792	Backup Ring
808	Nut
824	Snap Ring
885	Valve Plate Pin
886	Spring Pin
901	Eye Bolt
953	Set Screw
954	Set Screw
981	Name Plate
983	Pin

TOOLS

The tools necessary to disassemble / reassemble the T3V pump are shown in the following list. The size of the bolts and plugs depend on the type of pump.

Tool Name And Size		Necessary Tool (Marked with O)		Part Name			
		Pump Type					
Name	B	T5V80	T5V112	Hexagon socket head bolt	PT plug (PT thread)	PO plug (PF thread)	Hexagon socket head setscrew
	2						M4
	2.5						M5
	3						M6
	4	O	O	M5	BP-1/16		M8
	5	O	O	M6	BP-1/8		M10
	6	O	O	M8	BP-1/4	PO-1/4	M12,M14
	8	O	O	M10	BP-3/8	PO-3/8	M16,M18
	10			M12	BP-1/2	PO-1/2	M20
	12			M14			
	14	O		M16, M18	BP-3/4	PO-3/4	
	17		O	M20, M22	BP-1	PO-1, 1 ¹ / ₄ , 1 ¹ / ₂	
	19			M24, M27			
	21						
	22			M30		PO-2	

Tool Name and Size		Necessary Tool (Marked with O)		Part Name		
Name	B	T5V80	T5V112	Hexagon headed bolt	Hexagon nut	VP plug (PF thread)
Double ring spanner, Socket wrench, Double (single) open end spanner. 	19	O	O	M12	M12	VP-1/4
	22	O				VP-3/8
	24	O	O	M16	M16	
	27	O		M18	M18	VP-1/2
	30		O	M20	M20	
	36		O			VP-3/4
	41					VP-1
	50					VP-1 ¹ / ₄
	55					VP-1 ¹ / ₂
Adjustable angle wrench		O	O	Medium size, 1 set		
Screwdriver		O	O	Minus type screwdriver, medium size, 2 sets		
Hammer		O	O	Plastic hammer, 1 set		
Pliers		O	O	For snap ring, TSR-160		
Steel bar		O	O	Steel bar of key material approximately 10x8x200		
Torque wrench		O	O	Capable of tightening with the specified torques		

AXIAL PISTON PUMP DISASSEMBLING

For disassembling the pump, read this section thoroughly and disassemble it in the following sequence. The figures in parentheses after part names show the items in “Construction of Tandem Type Duplex Pump” on page 14.

This maintenance manual describes the disassembling procedures for both a single pump and tandem type double-pump. Disassemble the pump, referring to the contents for its appropriate type.

In addition, for the double-pump, do not exchange parts of one pump with the same ones of the other pump.

1. Select place suitable to disassembling.

IMPORTANT

Select clean place.

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

2. Remove dust, rust, etc., from pump surfaces with cleaning oil.
3. Remove drain port plug (468) and let oil out of pump casing.

IMPORTANT

For tandem type pump, remove plugs from both front and rear pumps.

4. Remove hexagon socket head bolts (412 and 413) and regulator.

IMPORTANT

Refer to “Regulator for T5V Series of Tongmyung Swash Plate Type Axial Piston Pump” on page 27 for disassembling instructions.

5. Remove hexagon socket head bolts (401), swash plate support (251), pump casing (271) and valve block (312).

IMPORTANT

If a gear pump is attached to rear face of pump, remove it before proceeding.

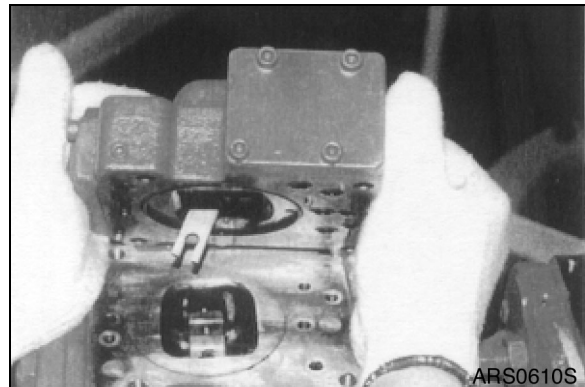


Figure 5

6. Place pump horizontally on workbench with its regulator mounting surface facing down. Separate pump casing (271) from valve block (312).

IMPORTANT

Before laying this surface down, spread rubber mat on workbench to prevent this surface from being damaged.

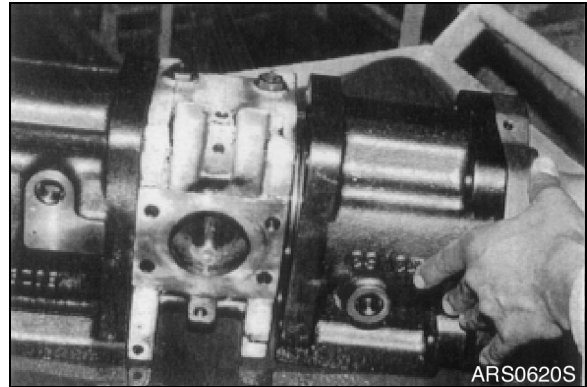


Figure 6

7. Pull cylinder (141) straight out of pump casing (271) over drive shaft (111). Pull out pistons (151), set plate (153), spherical bushing (156) and cylinder springs (157) simultaneously.

IMPORTANT

Do not damage sliding surfaces of cylinder, spherical bushing, shoes, swash plate, etc.

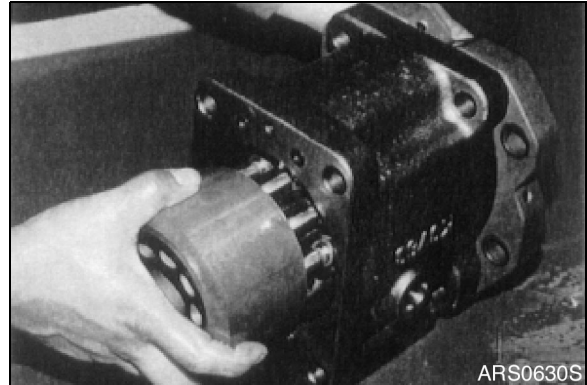


Figure 7

8. Remove hexagon socket head bolts (406) and seal cover (F) (261).

IMPORTANT

Install bolt into pulling-out tapped hole of seal cover (F), and cover can be removed easily.

Since oil seal is attached on seal cover (F), do not damage it when removing cover.

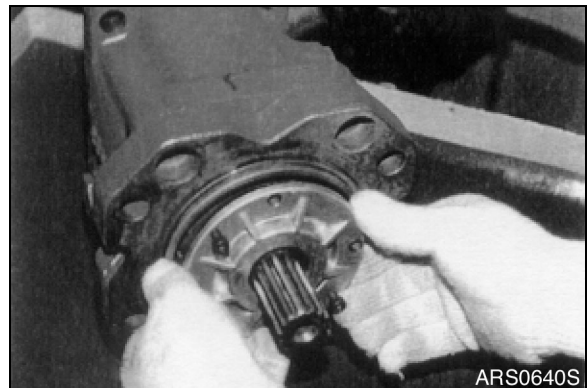


Figure 8

9. Remove hexagon socket head bolts (408) and seal cover (R) (262).

NOTE: *In case there is a gear pump, remove it first.*

10. Lightly tap flange section of swash plate support (251) on the pump casing side. This will separate swash plate support from pump casing.

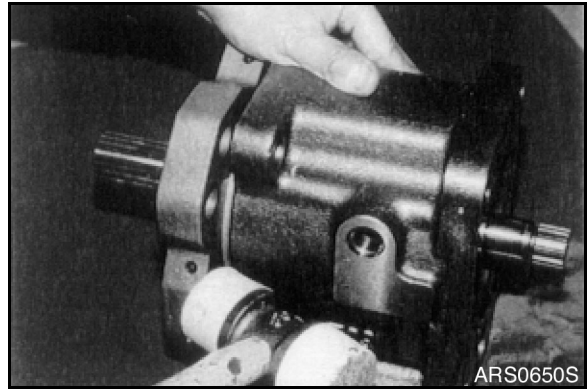


Figure 9

11. Remove shoe plate (211) and swash plate (212) from pump casing (271).



Figure 10

12. Lightly tap ends of drive shafts (111 and 113) with plastic hammer, to remove shafts from swash plate supports.

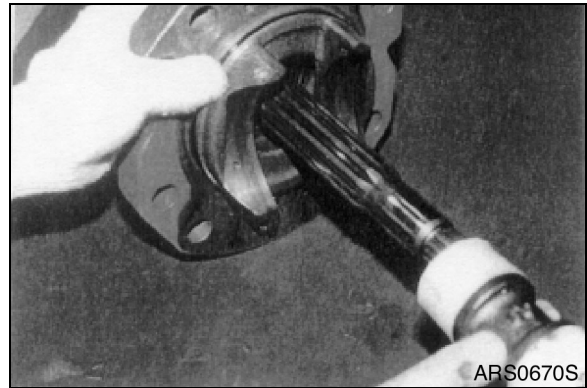


Figure 11

13. Remove valve plates (314 and 314) from valve block (312).

IMPORTANT
These may be removed in work 6.

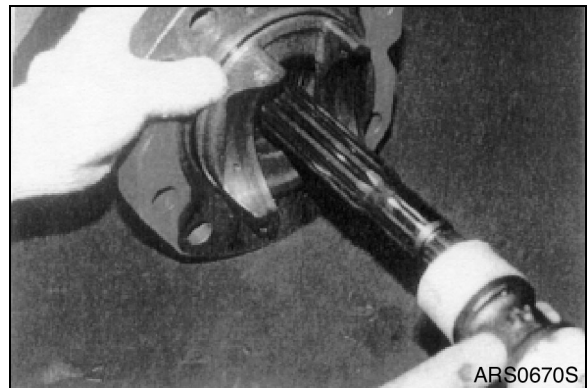


Figure 12

14. If necessary, remove stopper (L) (534), stopper (S) (535), servo piston (532) and tilting pin (531) from pump casing (271). Remove needle bearing (124) and splined coupling (114) from valve block (312).

IMPORTANT

When removing tilting pin, use a protector to prevent pin head from being damaged.

Since Loctite is applied to mounting areas of tilting pin and servo piston, do not damage servo piston.

Do not remove needle bearing if possible, except when it is considered to be worn out.

Do not loosen hexagon nuts of valve block and swash plate support. If loosened, flow setting will be changed.

AXIAL PISTON PUMP REASSEMBLING

For reassembling reverse the disassembling procedures, paying attention to the following items.

- Do not fail to repair the parts damaged during disassembling, and prepare replacement parts in advance.
- Clean each part with cleaning oil and dry it with compressed air.
- Do not fail to apply clean working oil to sliding sections, bearings, etc. before assembling them.
- Always replace seal parts, such as O-rings, oil seals, etc.
- For mounting bolts, plug, etc., use a torque wrench, and tighten them with torques shown in "Tightening Torques" on page 26.
- For the double-pump, do not exchange parts of the front pump with those of the rear pump.

1. Install swash plate support (251) on pump casing (271), by lightly tapping it with a hammer.

IMPORTANT

After servo piston, tilting pin, stopper (L) and stopper (S) are removed, Install them on pump casing in advance for reassembling.

When tightening servo piston and tilting pin, use a protector to prevent tilting pin head and feedback pin from being damaged. In addition, apply Loctite (medium strength) to their threaded sections.

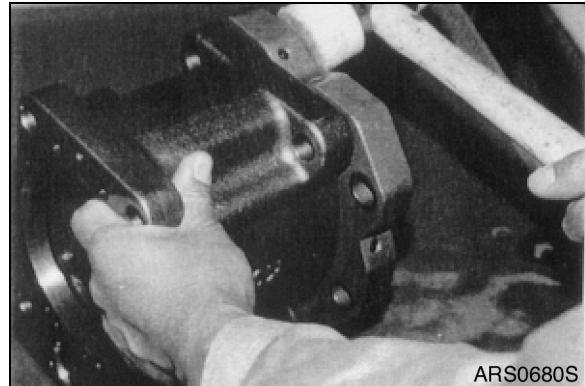


Figure 13

2. Place pump casing with its regulator mounting surface down, Install tilting bushing of swash plate on tilting pin (531). Install swash plate (212) on swash plate support (251) correctly.

IMPORTANT

Confirm with fingers of both hands that swash plate can be moved smoothly.

Apply grease to sliding sections of swash plate and swash plate support, so drive shaft can be easily installed.



Figure 14

3. On swash plate support (251), install drive shaft (111) with bearing (123), bearing spacer (127) and snap ring (824).

IMPORTANT

Do not tap drive shaft with hammer.

Assemble them into support, lightly tapping outer race of bearing with plastic hammer. Fully seat them, using steel bar.

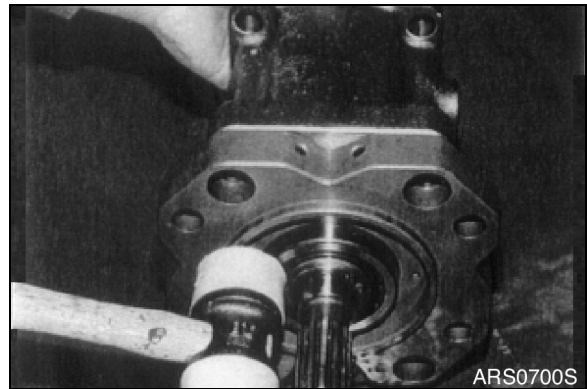


Figure 15

4. Assemble seal cover (F) (261) to pump casing (271) and attach it with hexagon socket head bolts (406).

IMPORTANT

Lightly apply grease to oil seal in seal cover (F).

Assemble oil seal, taking full care not to damage it.

For tandem type pump, install rear cover (263) and seal cover (262) in the same manner.

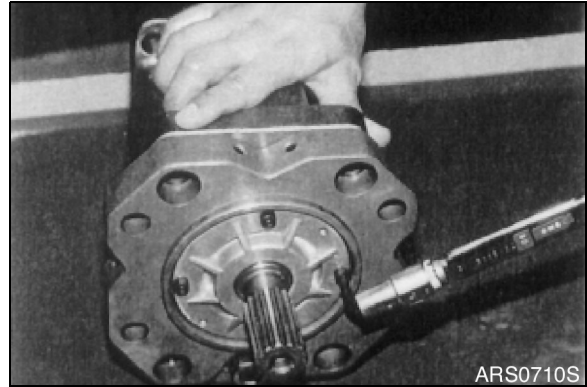


Figure 16

5. Assemble piston cylinder subassembly (cylinder (141), piston subassembly (151, 152), set plate (153), spherical bushing (156) and cylinder spring (157).
6. Fit spline phases of retainer and cylinder.
7. Then insert piston cylinder subassembly into pump casing.

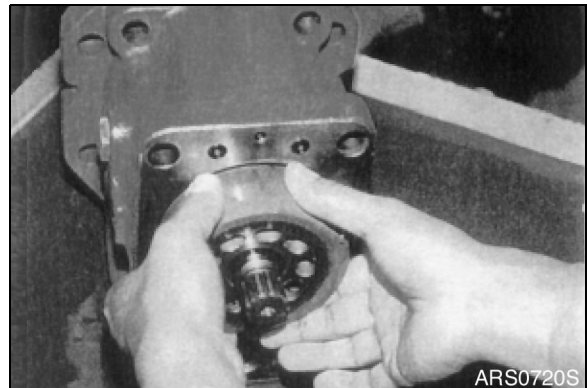


Figure 17

8. Install valve plate (313) on valve block (312), entering pin in to pin hole.

IMPORTANT

Do not mistake suction / delivery directions of valve plate.

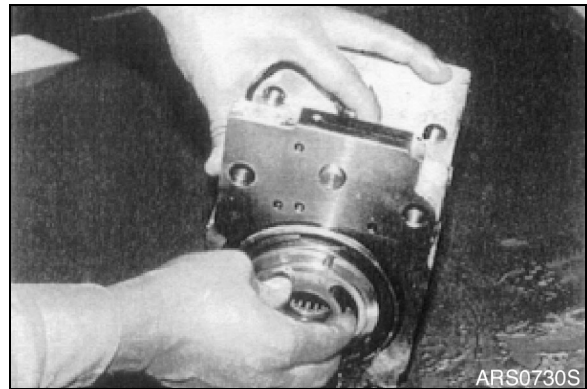


Figure 18

9. Install valve block (312) on pump casing (271) and tighten hexagon socket head bolts (401).

IMPORTANT

Assemble the rear pump side first, to make the procedure easier.

Do not mistake direction of valve block.

Clockwise rotation (viewed from input shaft side) - Install block with regulator up and with delivery flange left, viewed from front side.

Counterclockwise rotation (viewed from input shaft side) - Install block with regulator up and with delivery flange right, viewed from front side.

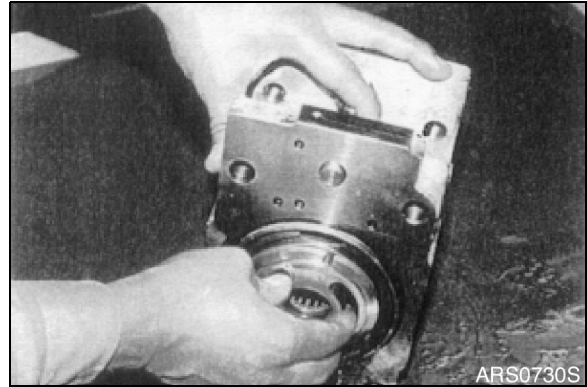


Figure 19

10. Place feedback pin of tilting pin into feedback lever of regulator. Install regulator and tighten hexagon socket head bolts (412 and 413).

IMPORTANT

Do not mistake regulator of front pump for that of rear pump.

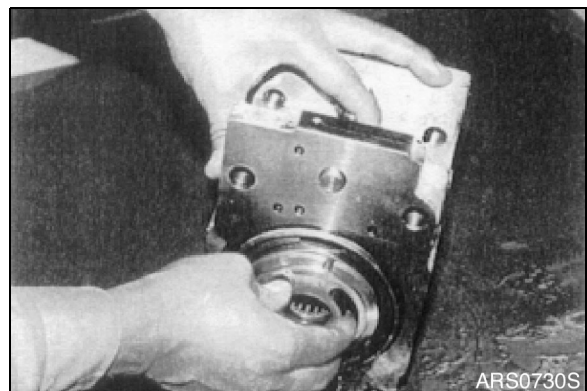


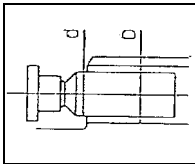
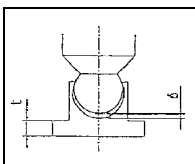
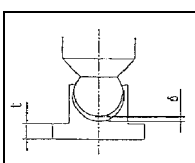
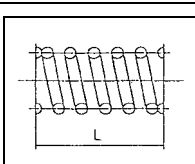
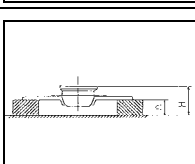
Figure 20

11. Install drain port plug (468).

AXIAL PUMP MAINTENANCE CRITERIA

Worn Part Replacement Criteria

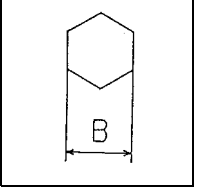
When a part exceeds any of the following criteria, replace or readjust it. However, when a part is seriously damaged in appearance, replace it.

Part Name and Inspection Item		Pump Type		Countermeasures
		T3V63/T5V80	T5V140	
		Standard Dimension / Recommended Replacement Value		
Clearance between piston and cylinder bore (D-d)		0.028 / 0.056	0.043 / 0.070	Replace piston or cylinder
Play between piston and shoe-caulking section (δ)		0-0.1 / 0.3	0-0.1 / 0.3	Replace assembly of piston and shoe
Thickness of shoe (t)		3.9 / 3.7	4.9 / 4.7	Replace assembly of piston and shoe
Free height of cylinder spring (L)		31.3 / 30.5	41.1 / 40.3	Replace cylinder spring
Combined height of set plate and spherical bushing (H-h)		19.0 / 18.3	23.0 / 22.0	Replace retainer or set plate

Correction Criteria for Cylinder, Valve Plate and Swash Plate (Shoe Plate)

Surface roughness for valve plate (sliding face), swash plate (shoe plate area) and cylinder (sliding face)	Surface roughness necessary to be corrected	3-Z
	Standard surface roughness (Corrected value)	0.4-Z or lower (Lapping)

TIGHTENING TORQUES

Part Name	Size	Tightening Torque	Tool Name	
Hexagon socket head bolt (Material: SCM 435)	M 5	70 kg•cm	B=4	 Allen wrench
	M 6	120 kg•cm	B=5	
	M 8	300 kg•cm	B=6	
	M 10	580 kg•cm	B=8	
	M 12	1,000 kg•cm	B=10	
	M 14	1,600 kg•cm	B=12	
	M 16	2,400 kg•cm	B=14	
	M 18	3,400 kg•cm	B=14	
	M 20	4,400 kg•cm	B=17	
PT plug (Material:S45C) Wind a seal tape 1 1/2 to 2 turns round the plug.	PT 1/16	70 kg•cm	B=4	Do.
	PT 1/8	105 kg•cm	B=5	
	PT 1/4	175 kg•cm	B=6	
	PT 3/8	350 kg•cm	B=8	
	PT 1/2	500 kg•cm	B=10	
	PF 1/4	300 kg•cm	B=6	Do.
	PF 1/2	1,000 kg•cm	B=10	
	PF 3/4	1,500 kg•cm	B=14	
	PF 1	1,900 kg•cm	B=17	
	PF 1 1/4	2,700 kg•cm	B=17	
	PF 1 1/2	2,800 kg•cm	B=17	

REGULATOR FOR T5V SERIES OF TONGMYUNG SWASH PLATE TYPE AXIAL PISTON PUMP

TYPE DESCRIPTION

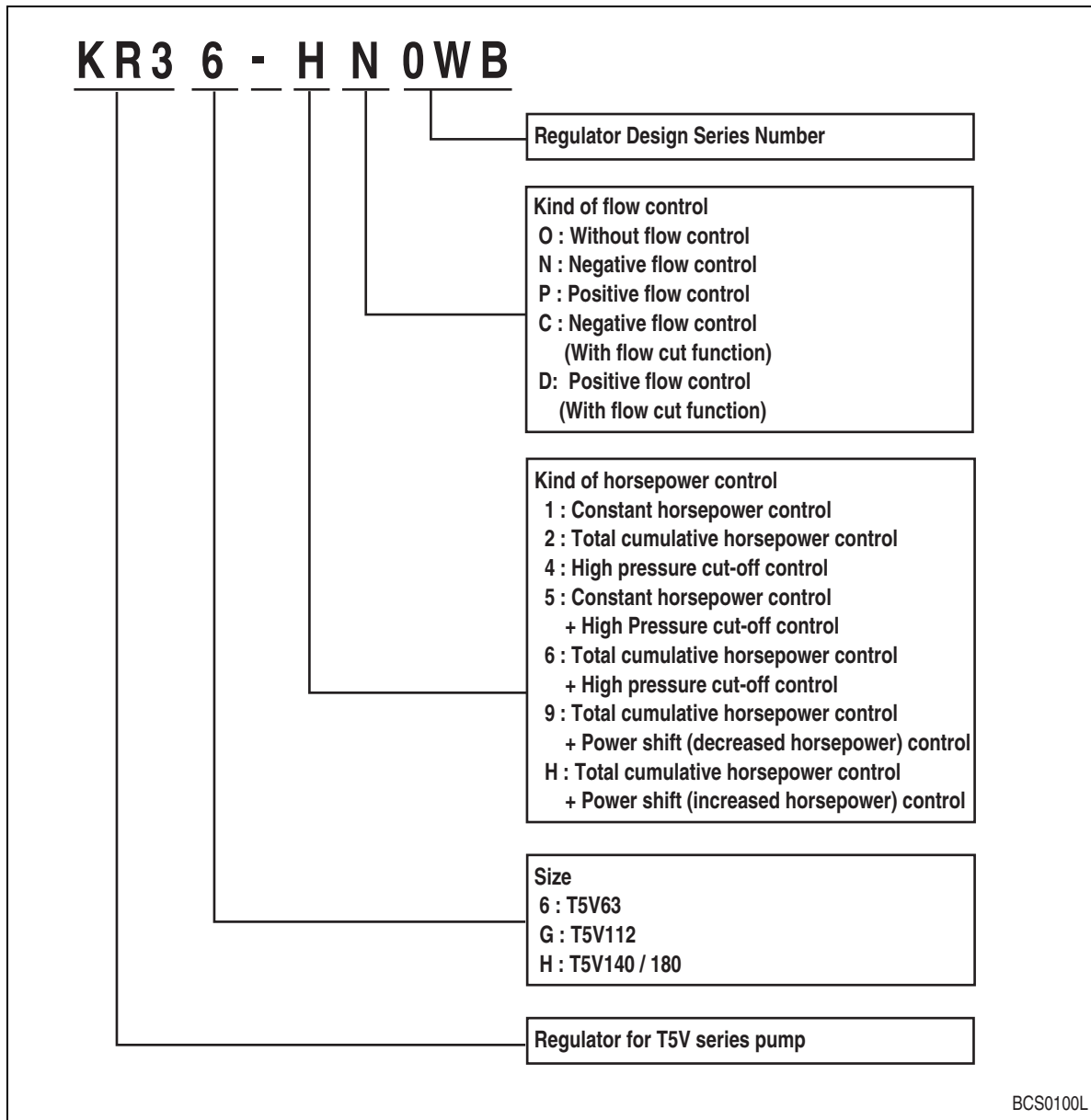


Figure 21

CONSTRUCTION OF REGULATOR

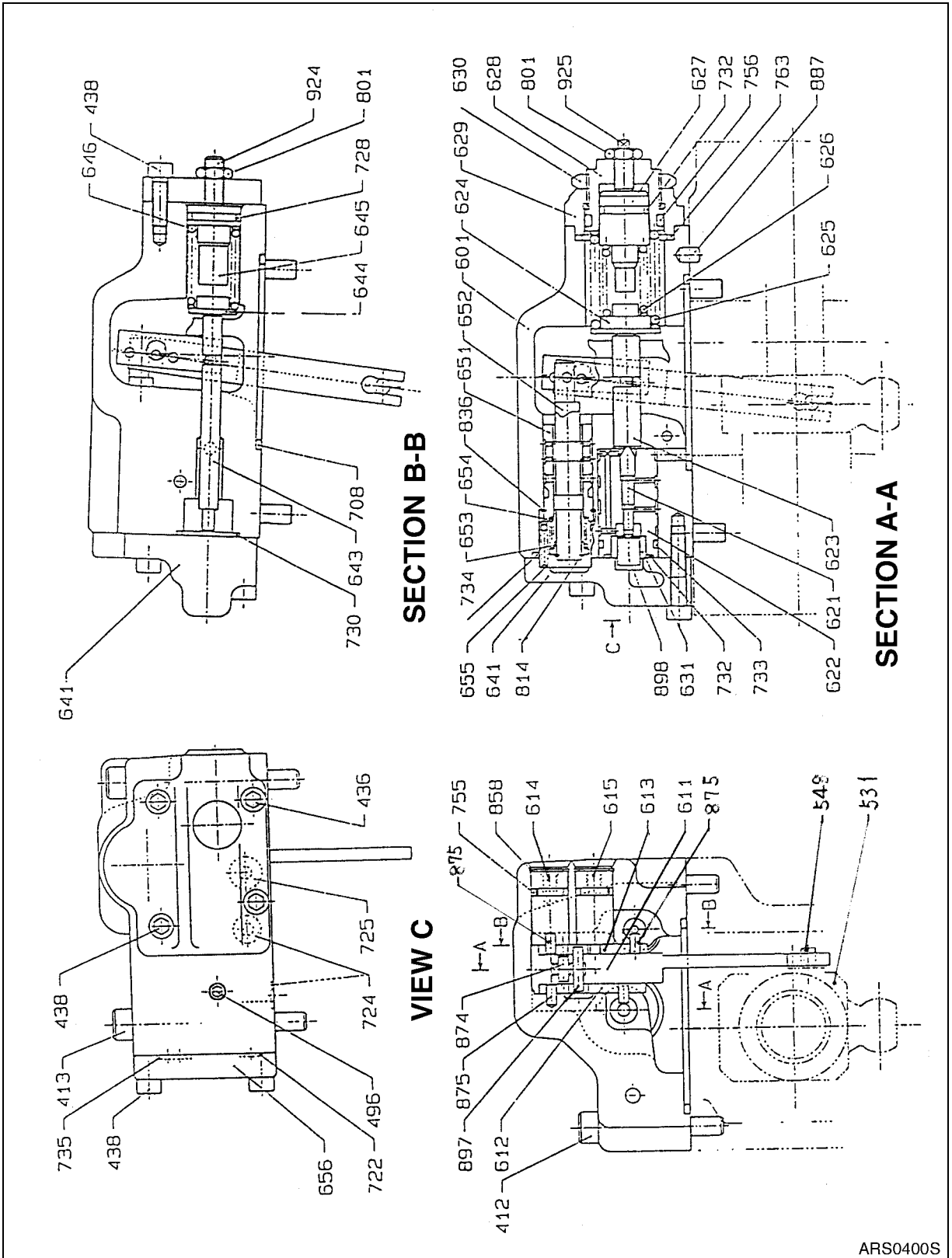


Figure 22

Reference Number	Description
412	Hexagon Socket Head Screw
413	Hexagon Socket Head Screw
436	Hexagon Socket Head Screw
438	Hexagon Socket Head Screw
496	Plug
531	Tilting Pin
548	Feedback Pin
601	Casing
611	Feedback Lever
612	Lever (1)
613	Lever (2)
614	Fulcrum Plug
615	Adjusting Plug
621	Compensating Piston
622	Piston Case
623	Compensating Rod
624	Spring Seat (C)
625	Outer Spring
626	Inner Spring
627	Adjusting Ring (C)
628	Adjusting Screw (C)
629	Cover (C)
630	Lock Nut
631	PF Sleeve
641	Pilot Cover
643	Pilot Piston
644	Spring Seat
645	Adjusting Ring (Q)
646	Pilot Spring
651	Sleeve

Reference Number	Description
652	Spool
653	Spring Seat
654	Return Spring
655	Set Spring
656	Block Cover
708	O-ring
722	O-ring
724	O-ring
725	O-ring
728	O-ring
730	O-ring
732	O-ring
733	O-ring
734	O-ring
735	O-ring
755	O-ring
756	O-ring
763	O-ring
801	Nut
814	Snap Ring
836	Snap Ring
858	Locking Ring
874	Pin
875	Pin
887	Pin
897	Pin
898	Pin
924	Adjusting Screw
925	Adjusting Screw (QI)

FUNCTIONAL EXPLANATIONS

The regulator for Tongmyung in-line axial piston pump T5V Series consists of the following control functions.

1. Negative flow control
2. Total cumulative horsepower control
3. Power shift control

Regulator Function Diagram

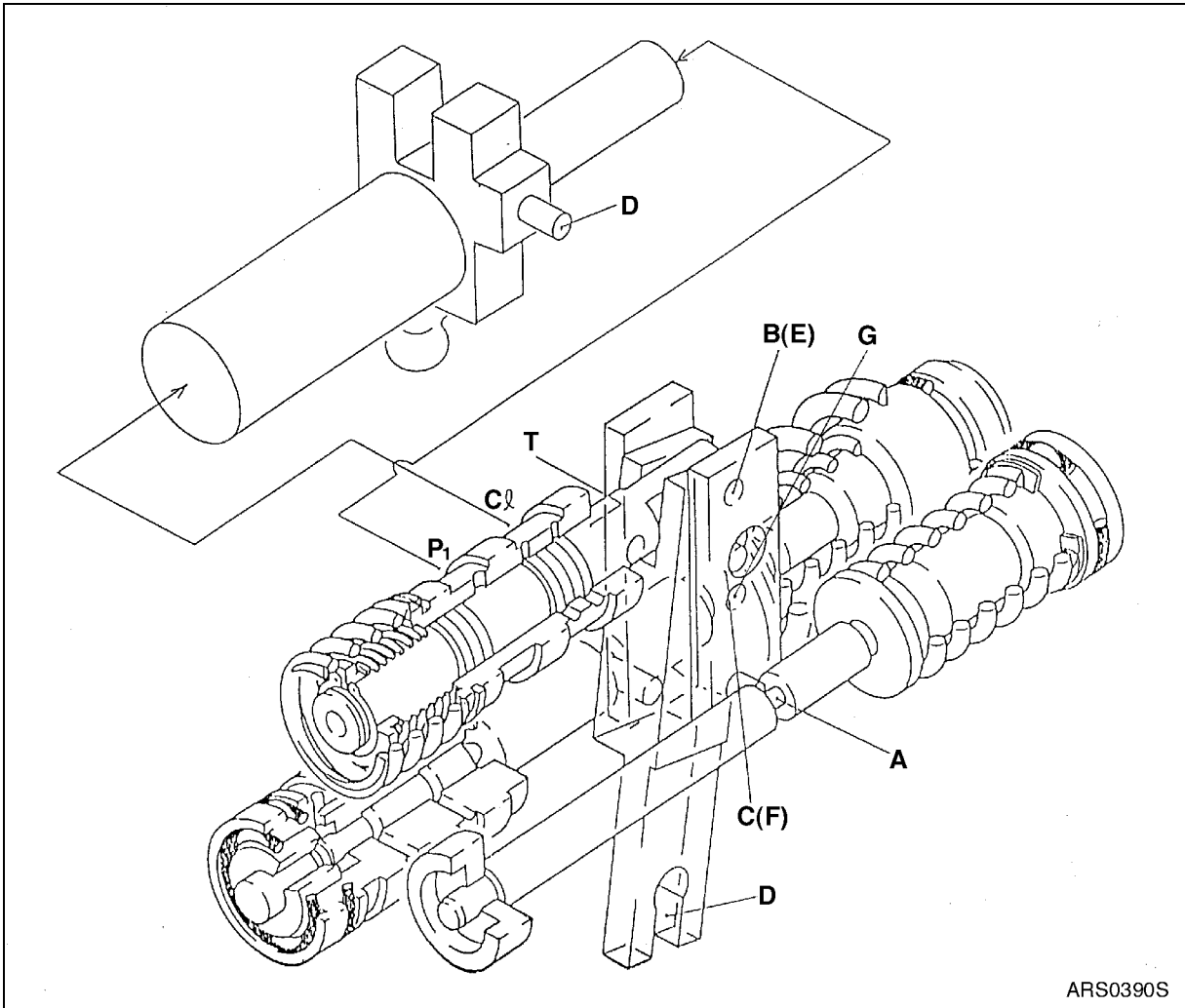


Figure 23

Negative Flow Control

By changing the pilot pressure P_i , the pump tilting angle (delivery flow) is regulated arbitrarily, as shown in Figure 24.

This regulator is a negative flow control in which the delivery flow Q decreases as the pilot pressure P_i rises. With this mechanism, when the pilot pressure corresponding to the flow required for the work is commanded, the pump discharges the required flow only, so it does not consume unnecessary power.

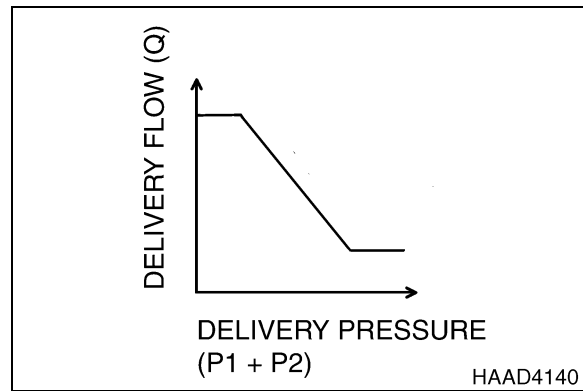


Figure 24

1. Functional Explanation

A. Flow reducing Function

As the pilot pressure P_i rises, the pilot piston (643) moves to the right to a position where the force of the pilot spring (646) balances with the hydraulic force.

The groove (A) in the pilot piston is attached with pin (875) that is fixed to lever 2 (613). Therefore, when the pilot piston moves, lever 2 rotates around the fulcrum of point B (fixed by the fulcrum plug (614) and pin (875)). Since the large-hole section (C, Figure 23) of lever 2 contains a protruding pin (897) fixed to the feedback lever (611), the pin (897) moves to the right as lever 2 rotates. Since the opposing-flat section (D) of the feedback lever is attached with the pin (548) fixed by the tilting pin (531) that swings the swash plate, the feedback lever rotates around the fulcrum of point D, as the pin (897) moves. Since the feedback lever is connected with the spool (652) via the pin (874), the spool moves to the right.

The movement of the spool causes the delivery pressure P_1 to connect to port C liter through the spool and to be admitted to the large-diameter section of the servo position. The delivery pressure P_1 that is constantly admitted to the small-diameter section of the servo piston moves the servo piston to the right due to the area difference, resulting in decrease of the tilting angle.

When the servo piston moves to the right, point D also moves to the right. The spool is fitted with the return spring (654) and is tensioned to the left at all times, and so the pin (897) is pressed against the large-hole section (C) of lever2. Therefore, as point D moves, the feedback lever rotates around the fulcrum of point C, and the spool is shifted to the left. This causes the opening between the sleeve (651) and spool (652) to close slowly, and the servo piston comes to a complete stop when it closes completely.

B. Flow Increasing Function

As the pilot pressure P_i decreases, the pilot piston (643) moves to the left by the action of the pilot spring (646) and causes lever 2 (613) to rotate around the fulcrum of point B. Since the pin (897) is pressed against the large-hole section (C) of lever 2 by the action of the return spring (654) via the spool (652), pin (874), and feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 2 rotates, and shifts the spool to the left. Port C liter opens a way to the tank port as the spool moves. This deprives the large-diameter section of the servo piston of pressure, and shifts the servo piston to the left by the discharge pressure P_1 in the small-diameter section, resulting in an increase in the flow rate.

As the servo piston moves, point D also moves to the left, the feedback lever rotates around the fulcrum of point C, and the spool moves to the right till the opening between the spool and sleeve is closed.

2. Adjustment of flow control characteristic

The flow control characteristic can be adjusted with the adjusting screw.

Adjust it by loosening the hexagon nut (801) and by tightening (or loosening) the hexagonal socket head screw (924).

Tightening the screw shifts the control chart to the right as shown in the Figure 25.

NOTE: *Adjusting values are shown in the attached Table. See "Summary of Regulator Adjustment Values" on page -36.*

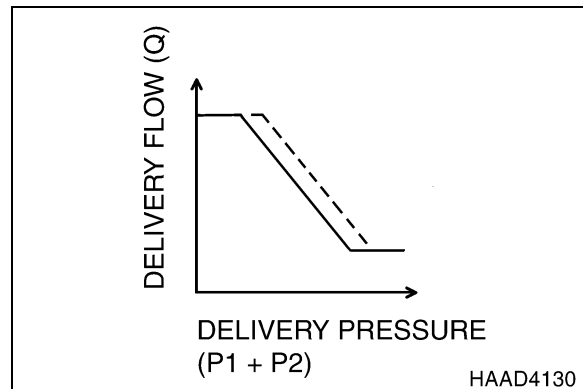


Figure 25

Total Horsepower Control

The regulator decreases the pump tilting angle (delivery flow) automatically to limit the input torque within a certain value with a rise in the delivery pressure P1 of the self pump and the delivery pressure P2 of the companion pump. (The input horsepower is constant when the speed is constant.)

Since the regulator is of the simultaneous total horsepower type that operates by the sum of load pressures of the two pumps in the tandem double-pump system, the prime mover is automatically prevented from being overloaded, irrespective of the load condition of the two pumps, when horsepower control is under way.

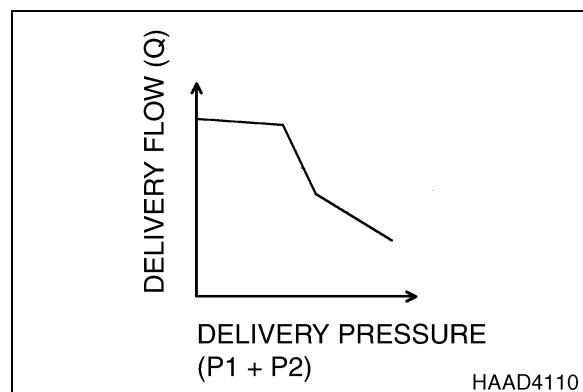


Figure 26

1. Functional explanation

Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles (displacement volumes) of the two pumps to the same values as represented by the following equation:

$$\bullet \quad T_{in} = P1 \times q/2\pi + P2 \times q/2\pi = (P1 + P2) \times q/2\pi$$

The horsepower control function is the same as the flow control function and is summarized in the following. (For detailed behaviors of respective parts, refer to the section of flow control).

A. Overload Preventive Function

When the self pump delivery pressure P1 or the companion pump delivery pressure P2 rises, it acts on the stepped part of the compensating piston (621). It presses the compensating rod (623) to the right till the force of the outer spring (625) and inner spring (626) balances with the hydraulic force. The movement of the compensating rod is transmitted to Lever 1 via pin (875). Lever 1 rotates around the pin (875) (E) attached to the casing (601).

Since the large-hole section (F) of Lever 1 contains a protruding pin (897) attached to the feedback lever (611), the feedback lever rotates around the fulcrum of Point D as Lever 1 rotates, and then the spool (652) is shifted to the right. As the spool moves, the delivery pressure P1 is admitted to the large-diameter section of the servo piston via Port C liter, causes

the servo piston move to the right, reduces the pump delivery flow rate, and prevents the prime mover from being overloaded.

The movement of the servo piston is transmitted to the feedback lever via point D. Then the feedback lever rotates around the fulcrum of point F and the spool is shifted to the left. The spool moves till the opening between the spool and sleeve (651) is closed.

B. Flow Reset Function

As the self pump delivery pressure P1 or the companion pump delivery pressure P2 decreases, the compensating rod (623) is pushed back by the action of the springs (625 and 626) to rotate Lever 1 around point E. Rotating of Lever 1 causes the feedback lever to rotate around the fulcrum of point D and then the spool to move to the left. As a result, Port C liter opens a way to the tank port. This causes the servo piston to move to the left and the pump's delivery rate to increase.

The movement of the servo piston is transmitted to the spool by the action of the feedback mechanism to move it till the opening between the spool and sleeve is closed.

2. Low tilting angle (low flow) command preferential function

As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections (C and F) of levers 1 and 2. However, since sections C and F have the pins ($\varnothing 4$) protruding from the large hole ($\varnothing 8$), only the lever lessening the tilting angle contacts the pin (897); the hole ($\varnothing 8$) in the lever of a larger tilting angle command is freed without contacting the pin (897). Such a mechanical selection method permits preference of the lower tilting angle command of the flow control and horsepower control.

3. Adjustment of Input horsepower

Since the regulator is of total cumulative horsepower type, adjust the adjusting screws of both the front and rear pumps, when changing the horsepower set values. The pressure change values by adjustment are based on two pumps pressurized at the same time, and the values will be doubled when only one pump is loaded.

A. Adjustment of outer springs

Adjust it by loosening the hexagon nut (630) and by tightening (or loosening) the adjusting screw C (628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the Figure 27. Since turning the adjusting screw C by N turns changes the setting of the inner spring, return the adjusting screw C1 (925) by NxA turns at first.

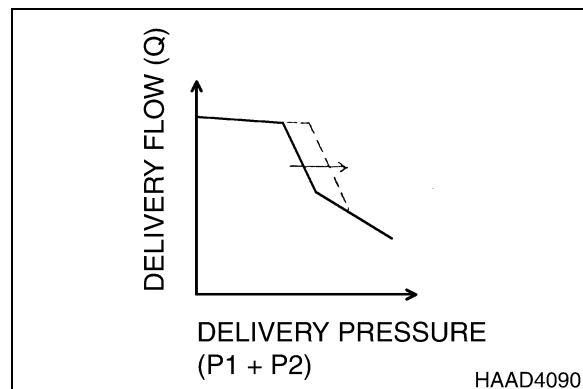


Figure 27

B. Adjustment of inner spring

Adjust it by loosening the hexagon nut (801) and by tightening (or loosening) the adjusting screw CI (925). Tightening the screw increases the flow and then the input horsepower as shown in the Figure 28.

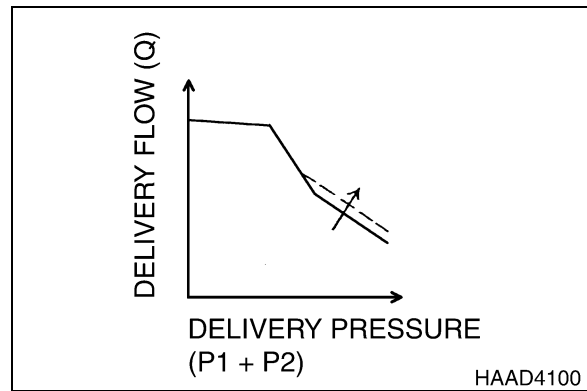


Figure 28

Power shift Control

The set horsepower valve is shifted by varying the command current level of the proportional pressure reducing valve attached to the pump.

Only one proportional pressure reducing valve is provided. However, the secondary pressure P_f (power shift pressure) is admitted to the horsepower control section of each pump regulator through the pump's internal path to shift it to the same set horsepower level. This function permits arbitrary setting of the Pump output power, thereby providing the optimum power level according to the operating condition.

1. Functional explanation

The power shift pressure P_f controls the set horsepower of the pump to a desired level, as shown in the Figure 29.

As the power shift pressure P_f rises, the compensating rod (623) moves to the right via the pin (898) and compensating piston (621). This decreases the pump tilting angle and then the set horsepower in the same way as explained in the overload preventive function of the horsepower control. On the contrary, the set horsepower rises as the power shift pressure P_f falls.

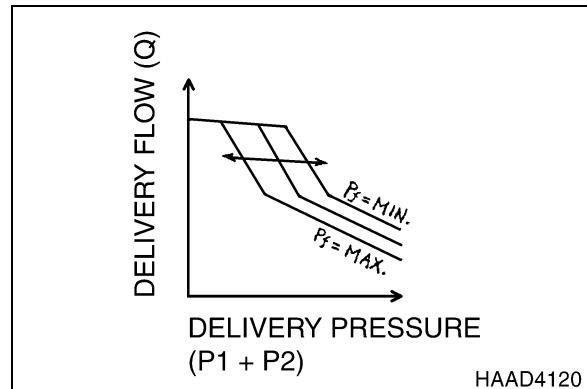


Figure 29

ADJUSTMENT OF MAXIMUM AND MINIMUM FLOWS

The regulator can adjust the maximum and minimum flows with the adjusting screws.

NOTE: Their respective adjustment values are shown in the attached Table. See "Summary of Regulator Adjustment Values" on page -36.

Adjustment of Maximum Flow

Adjust it by loosening the hexagon nut (809) and by tightening (or loosening) the set screw (954). The maximum flow only is adjusted without changing other control characteristics.

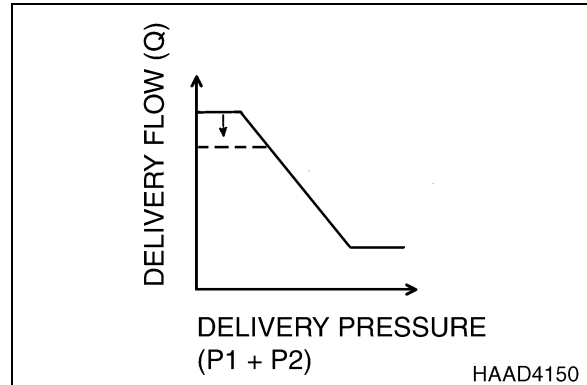


Figure 30

Adjustment of Minimum Flow

Adjust it by loosening the hexagon nut (909) and by tightening (or loosening) the hexagonal socket head set screw (953). Similarly to the adjustment of the maximum flow, other characteristics are not changed. However, remember that, if tightened too much, the required horsepower during the maximum delivery pressure (or during relieving) may increase.

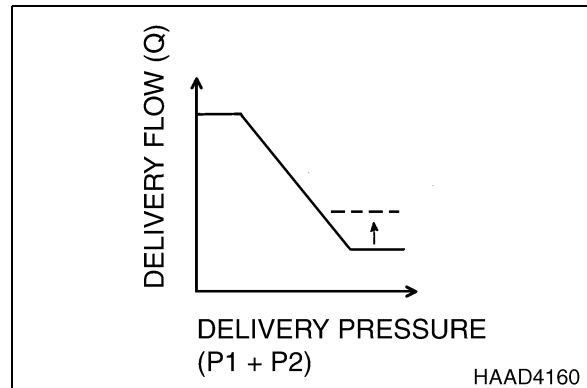


Figure 31

Summary of Regulator Adjustment Values

Item			Specification
Speed			2200 min ⁻¹
Adjustment of Maximum Flow		Tightening amount of adjusting screw (954)	+1/4 Turn
		Flow change amount	-3.5 L/min
Adjustment of Minimum Flow		Tightening amount of adjusting screw (953)	+1/4 Turn
		Flow change amount	+3.5 L/min
Adjustment of Input Horsepower	Adjustment of outer spring	Tightening amount of adjusting screw (C) (628)	+1/4 Turn
		Compensating control starting pressure change amount	+19 kg/cm ²
		Input torque change amount	+3 kg•m
		A	1.9
	Adjustment of inner spring	Tightening amount of adjusting screw (QI) (925)	+1/4 Turn
		Compensating control starting pressure change amount	+27 kg/cm ²
		Input torque change amount	+2.5 kg•m
Adjustment of flow control characteristic		Tightening amount of adjusting screw (924)	+1/4 Turn
		Flow control starting pressure change amount	+1.5 kg/cm ²
		Flow change amount	+8 L/min

FAULT FINDING AND REMEDIES ON REGULATOR

In case a functional fault probably resulting from the regulator occurs, disassemble and inspect it, referring to the maintenance manual.

Prime Mover is Overloaded

Determine which is faulty, the front pump or rear pump, by loading each pump independently. When both pumps are found faulty, investigate the following (1) and (2). Begin investigation with (3), when only one pump is found faulty. (1) and (2) are only for cases of the variable horsepower control.

1. Check that the power shift command current I is normal.
2. The power shift pressure is low:
 - Check the amplifier dither.
 - Replace the proportional pressure reducing valve.
3. The compensating piston (621) and compensating rod (623) are stuck with each other:
 - Disassemble and clean the regulator.
4. The Pin (898) is stuck:
 - Disassemble and clean the regulator.

Maximum Flow Is Not Available

1. Check that the pilot pressure P_i is normal.
2. The pilot piston (643) is stuck:
 - Disassemble and clean the regulator.
3. The spool (652) is stuck:
 - Disassemble and clean the regulator.
4. The piston QMC stopper (647) and piston (648) are stuck with each other:
 - Disassemble and clean the regulator.
5. The spool (COV) (637) is stuck:
 - Disassemble and clean the regulator.

NOTE: *Replace faulty parts that are deeply scored.*

(1) and (2) are only for cases of the pilot control.

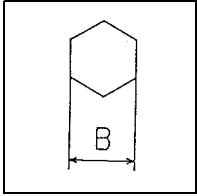
(4) is only for cases of the 2-stage max. flow control.

(5) is only for cases of the cut-off control.

PREPARATION FOR DISASSEMBLY

1. Since the regulator consists of small precision-finished parts, disassembly and assembly are rather complicated. For this reason, replacement of a regulator assembly is recommended, unless there is a special reason, but in case disassembly is necessary for an unavoidable reason, read through this manual to the end before starting disassembly.
2. The numbers in parentheses after part names represent those in the “Construction of Regulator” on page 28.

TOOLS

Name	Description
Allen wrench	4,5,6 (Dimension B mm) 
Socket wrench, double-ended (single-ended) wrench	
Adjustable wrench	Small size (max. 36 mm)
Screw driver	
Plastic hammer	
Torque wrench	
Pliers	2 sets for stop ring
Steel bar	4 mm or less in dia., L=100mm
Pincers	
Bolt	M4, L = about 50 mm

REGULATOR DISASSEMBLY

1. Choose a place for disassembly.



CAUTION!

1. Choose a clean place.
2. Spread rubber mat or cloth, on top of work-bench to prevent parts from being damaged.

2. Remove dust, rust, etc. from surfaces of regulator with cleaning oil.
3. Remove hexagon socket head screws (412,413) and regulator main body from pump main body.

IMPORTANT

Do not lose O-ring.

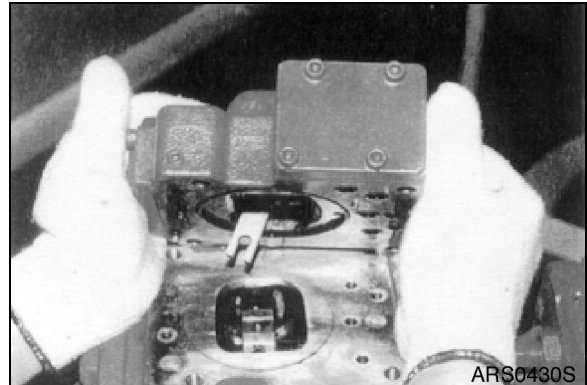


Figure 32

4. Remove hexagon socket head screws (488) and cover (C) (629).

IMPORTANT

Cover (C) is attached with adjusting screw (C), (QI) (628, 925), adjusting ring (C) (627), lock nut (630), hexagon ring nut (801) and adjusting screw (924). Do not loosen these screws and nuts. If they are loosened, adjusted pressure-flow setting will vary.

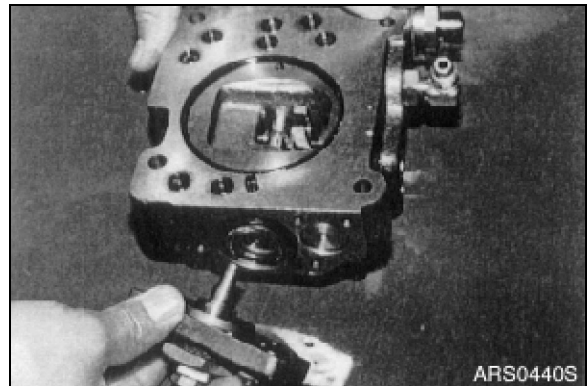


Figure 33

5. After removing cover (C) (629) subassembly, remove outer spring (625), inner spring (626) and spring seat (C) (624) from compensating section. Then draw out adjusting ring (Q) (645), pilot spring (646) and spring seat (644) from pilot section.

IMPORTANT

Adjusting ring (Q) (645) can easily be drawn out with M4 bolt.

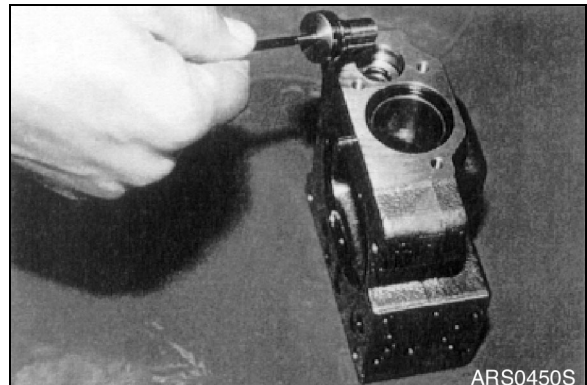


Figure 34

6. Remove hexagon socket head screws (436, 438) and pilot cover (641). After removing pilot cover, remove set spring (655) from pilot section.

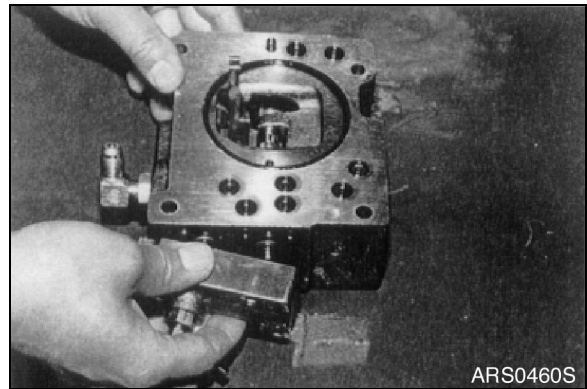


Figure 35

7. Remove snap ring (814), spring seat (653), return spring (654) and sleeve (651).

IMPORTANT

Sleeve (651) is attached with snap ring (836).

When removing snap ring (814), return spring (654) may pop out. Take care not to lose it.

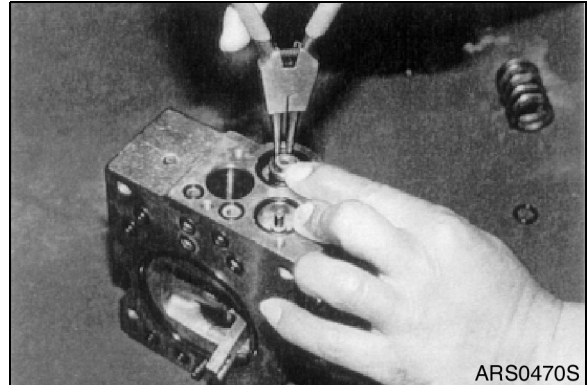


Figure 36

8. Remove locking ring (858), fulcrum plug (614) and adjusting plug (615).



Figure 37

IMPORTANT

Fulcrum plug (614) and adjusting plug (615) can be easily taken out with M6 bolt.

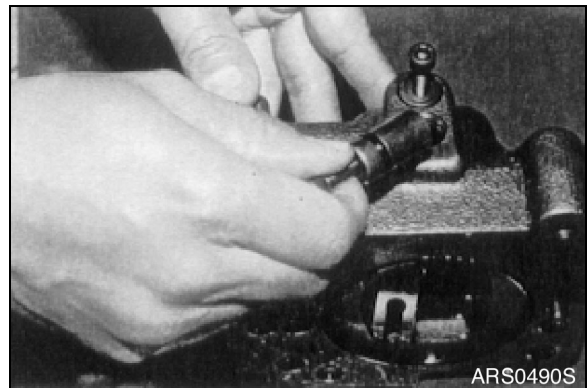


Figure 38

9. Remove lever (2) (613). Do not draw out pin (875).

IMPORTANT

Work will be promoted by using pincers.

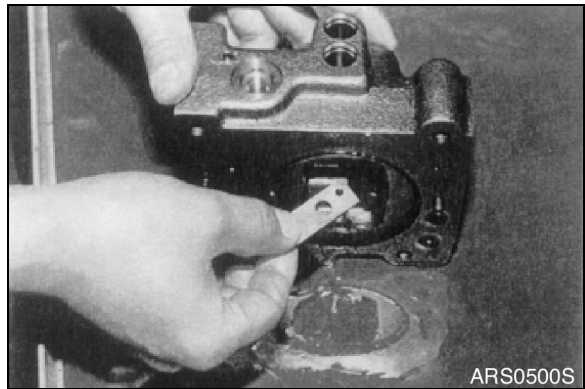


Figure 39

10. Draw out pin (874) and remove feedback lever (611).

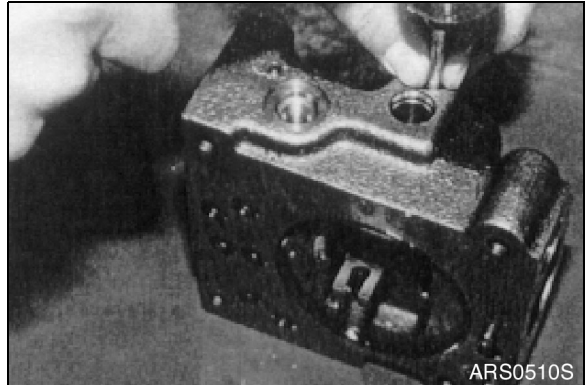


Figure 40

IMPORTANT

Push out pin (874) (4 mm in dia.) from above with slender steel bar so that it may not interfere with lever (1) (612).

11. Remove lever (1) (612). Do not draw out pin (875).
12. Draw out pilot piston (643) and spool (652).
13. Draw out piston case (622), compensating piston (621) and compensating rod (623).

NOTE: Since component parts are small, do not lose them.

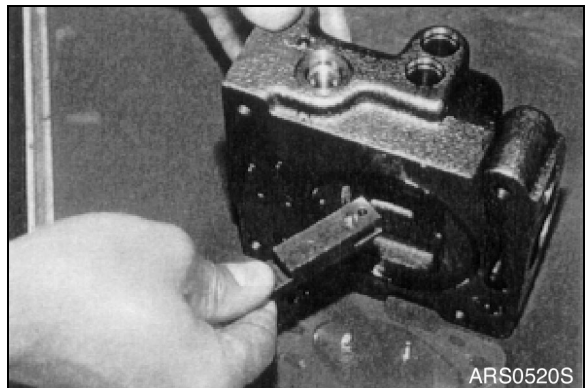


Figure 41

REGULATOR REASSEMBLY

For assembly, reverse disassembly procedures, but pay attention to the following.

- Always repair parts that were scored at disassembly. Get replacement parts ready beforehand.
 - Mixing of foreign material will cause malfunction. Therefore, wash parts well with cleaning oil, let them dry with jet air and handle them in clean place.
 - Always tighten bolts, plugs, etc. to their specified torques.
 - Do not fail to coat sliding surfaces with clean hydraulic oil before assembly.
 - Replace seals such as O-rings with new ones as a rule.
1. Put compensating rod (623) into compensating hole of casing (601).
 2. Press fit pin in lever (1) (612) into groove of compensating rod and fit lever (1) to pin press fitted in casing.
 3. Install spool (652) and sleeve (651) into hole in spool of casing.

IMPORTANT

Confirm that spool and sleeve slide smoothly in casing without binding.

Pay attention to orientation of spool.

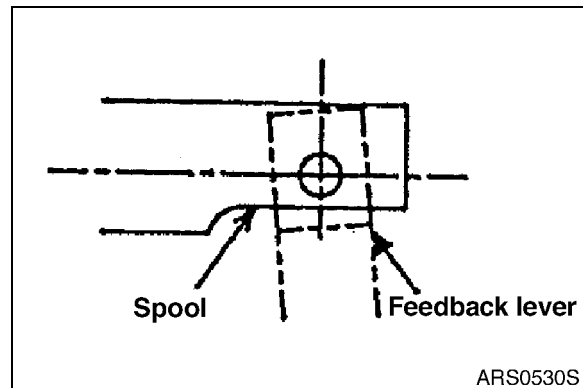


Figure 42

4. Install feedback lever (611), matching its pin hole with pin hole in spool. Then insert pin (874).

IMPORTANT

Insert pin in feedback lever a little to ease operation.

Do not mistake direction of feedback lever.

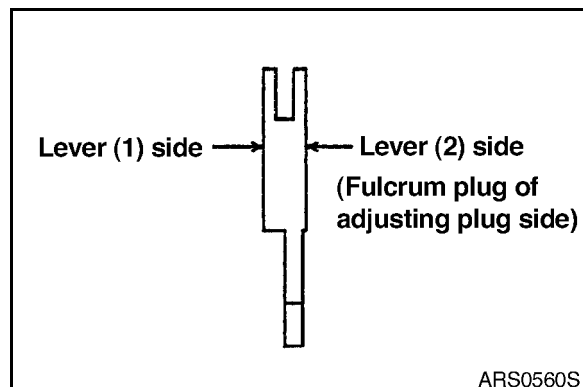


Figure 43

5. Insert pilot piston (643) into pilot hole of casing.

IMPORTANT

Confirm that pilot piston slides smoothly without binding.

6. Press fit pin in lever (2) (613) into groove of pilot piston. Then attach lever (2).

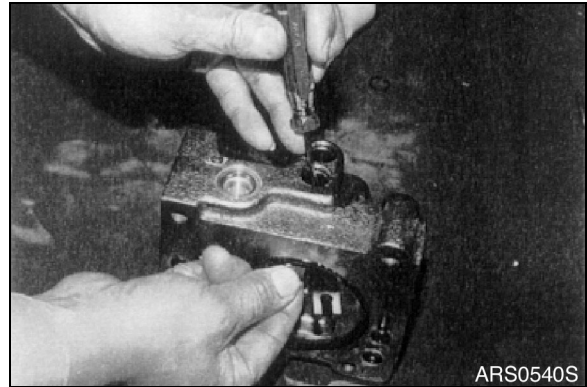


Figure 44

7. Install fulcrum plug (614) so that pin pressed into fulcrum plug (614) can be inserted into pin hole of lever (2). Then attach locking ring (858).
8. Insert adjusting plug (615) and install locking ring.

IMPORTANT

Do not mistake inserting holes for fulcrum plug and adjusting plug.

Now move feedback lever to confirm that it has no large play and is free from binding.

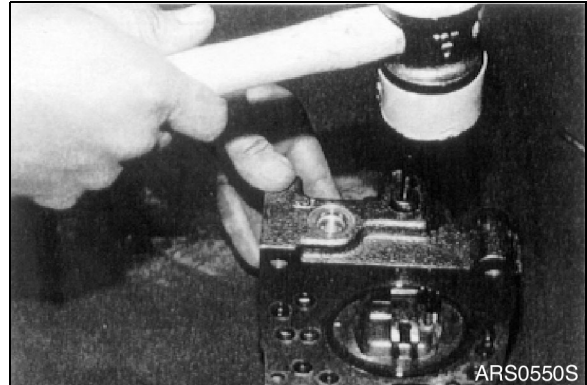


Figure 45

9. Install return spring (654) and spring seat (653) into spool hole. Install snap ring (814).

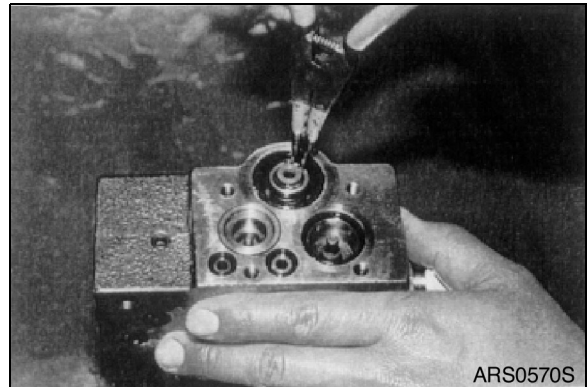


Figure 46

10. Install set spring (655) in spool hole. Slide compensating piston (621) and piston case (622) into compensating hole.
11. Install pilot cover (641) and secure it in place with hexagonal socket head screws (436 and 438).

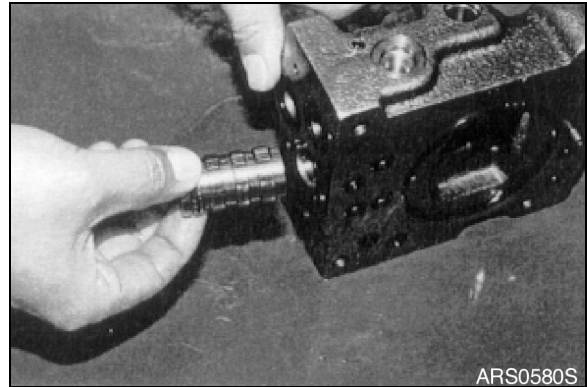


Figure 47

12. Insert spring seat (644), pilot spring (646) and adjusting ring (Q) (645) into pilot hole.
13. Install spring seat (624), inner spring (626) and outer spring (625) into compensating hole.

IMPORTANT

When fitting spring seat, do not mistake direction of spring seat.

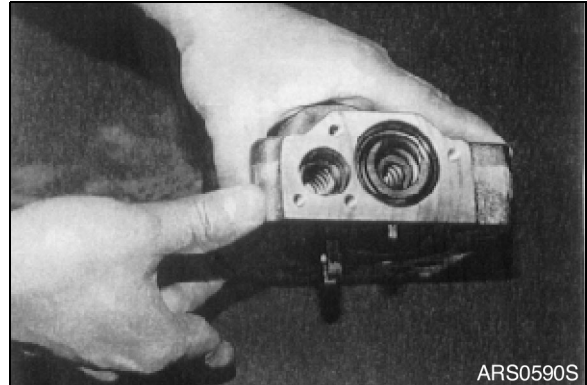


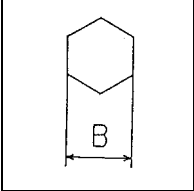
Figure 48

14. Install cover (C) (629) with adjusting screws (628 and 925), adjusting ring (C) (627), lock nut (630), hexagon nut (801) and adjusting screw (924). Secure them with hexagonal socket head screws (438).



Figure 49

TIGHTENING TORQUE

Part Name	Size	Tightening Torque	Tool Name	
Hexagon socket head bolt (Material: SCM 435)	M 5	70 kg•cm (5 ft lb)	B = 4	 Allen wrench
	M 6	120 kg•cm (9 ft lb)	5	
	M 8	300 kg•cm (22 ft lb)	6	
	M 10	580 kg•cm (42 ft lb)	7	
	M 12	1,000 kg•cm (72 ft lb)	8	
	M 14	1,600 kg•cm (116 ft lb)	10	
	M 16	2,400 kg•cm (174 ft lb)	12	
	M 18	3,400 kg•cm (246 ft lb)	14	
	M 20	4,400 kg•cm (318 ft lb)	17	
PT filling plug (Material: S45C) Wind a seal tape 1 1/2 to 2 turns round the plug.	PT 1/16	70 kg•cm (5 ft lb)	4	Do.
	PT 1/8	105 kg•cm (8 ft lb)	5	
	PT 1/4	175 kg•cm (13 ft lb)	6	
	PT 3/8	350 kg•cm (25 ft lb)	8	
	PT 1/2	500 kg•cm (36 ft lb)	10	
PO plug (Material: S35C)	PF 1/4	300 kg•cm (22 ft lb)	6	Do.
	PF 1/2	1,000 kg•cm (72 ft lb)	10	
	PF 3/4	1,500 kg•cm (109 ft lb)	14	
	PF 1	1,900 kg•cm (137 ft lb)	17	
	PF 1 1/4	2,700 kg•cm (195 ft lb)	17	
	PF 1 1/2	2,800 kg•cm (203 ft lb)	17	



GEAR PUMP (STEERING PUMP & BRAKE PUMP)



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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GENERAL DESCRIPTION

THEORY OF OPERATION

The steering pump is a gear pump that directs hydraulic oil to the steering valve.

The brake pump is a gear pump that directs hydraulic oil to the brake supply valve.

PARTS LIST

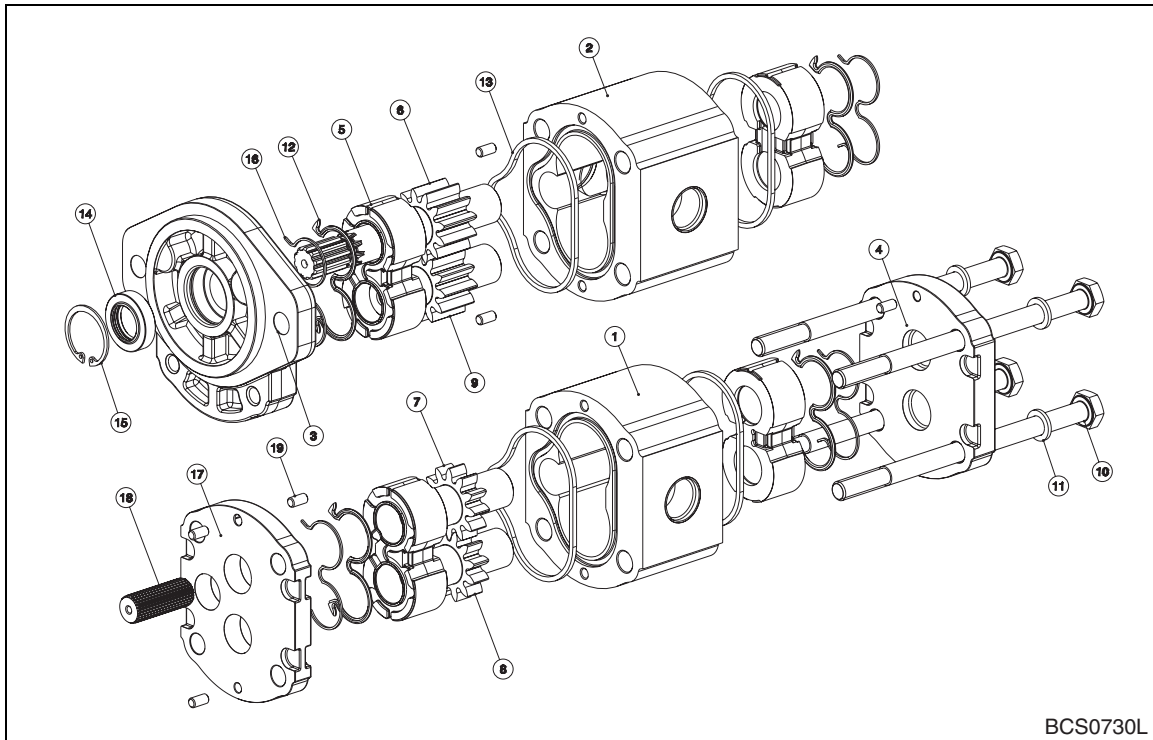


Figure 1

Reference Number	Description
1	Body
2	Body
3	Front Cover
4	Rear Cover
5	Thrust Plate
6	Drive Shaft
7	Drive Gear
8	Driven Gear
9	Driven Gear
10	Screw

Reference Number	Description
11	Washer
12	Seal
13	Seal
14	Shaft Seal
15	Ring
16	Backup Ring
17	Flange
18	Splined Connecting Shaft
19	Dowel Pin

SPECIFICATIONS

Steering Pump Type: Displacement: Max Flow Rate:	Gear Pump 14.53 cm ³ /rev (0.89 in ³ /rev) 32 lpm (8.5 gal/m) @ 2,200 rpm
Brake Pump Type: Displacement: Max Flow Rate:	Gear Pump 6.61 cm ³ /rev (0.4 in ³ /rev) 14.5 lpm (3.8 gal/m) @ 2,200 rpm



BRAKE SUPPLY VALVE



CAUTION!

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

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

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Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 130W-V	0001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 210W-V	1001 and Up

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PARTS LIST

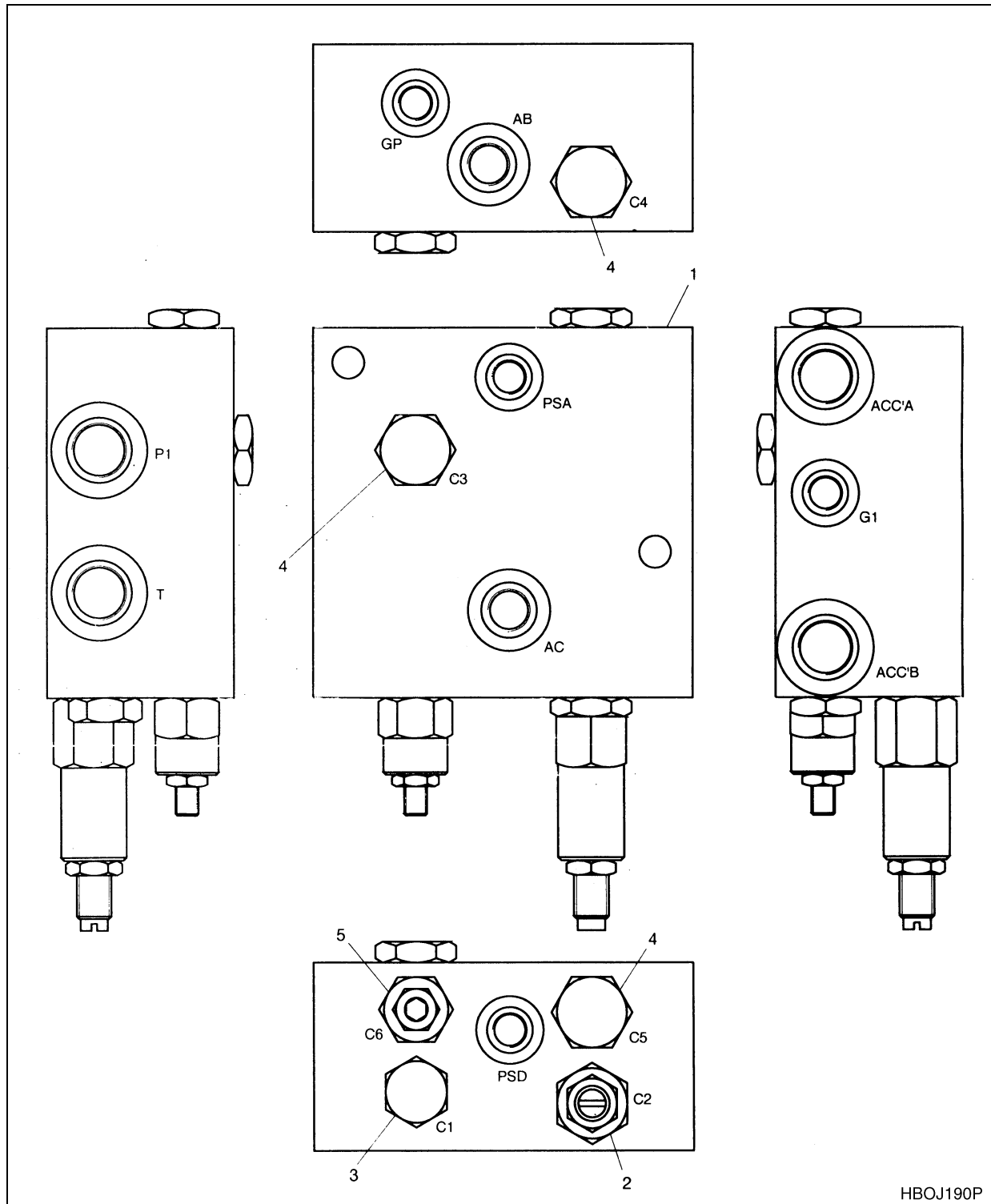


Figure 1

Reference Number	Description
1	Block
2	Relief Valve
3	Logic Valve

Reference Number	Description
4	Check Valve
5	Unloading Valve

SPECIFICATIONS

Brake Supply Valve	
Loading-Unloading Pressure	103 - 125 kg/cm ² (1,465 - 1,778 psi)
Low Pressure Warning	65 kg/cm ² (925 psi)
Pressure Relief Valve	160 kg/cm ² (2,276 psi)



S0709300
R1

COUNTERBALANCE VALVE



CAUTION!

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

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Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 130W-V	0001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 210W-V	1001 and Up

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Adjustment of Relief Valve	4
Troubleshooting	5
Counterbalance Valve	6
Recommended Tools	6
Disassembly	6
Order of Disassembly and Torque Values	7
Reassembly	8

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 by means of 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 due to 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. At this time, 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.

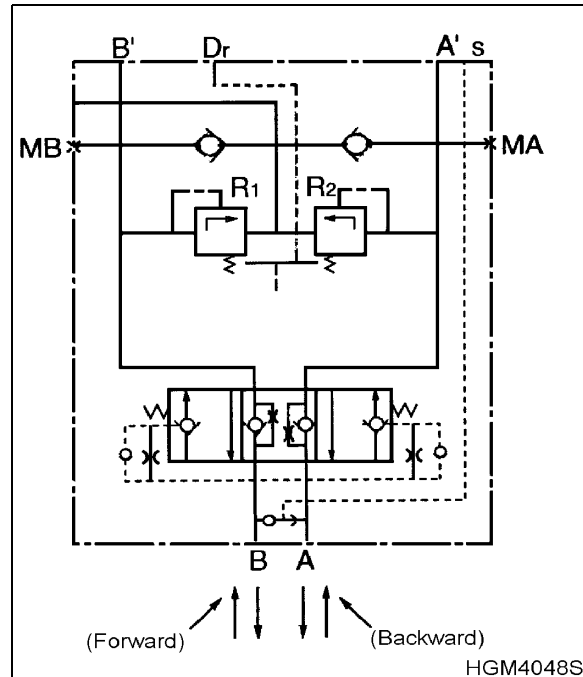


Figure 1

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 anti-cavitation 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 kg/cm² (1,140 psi).

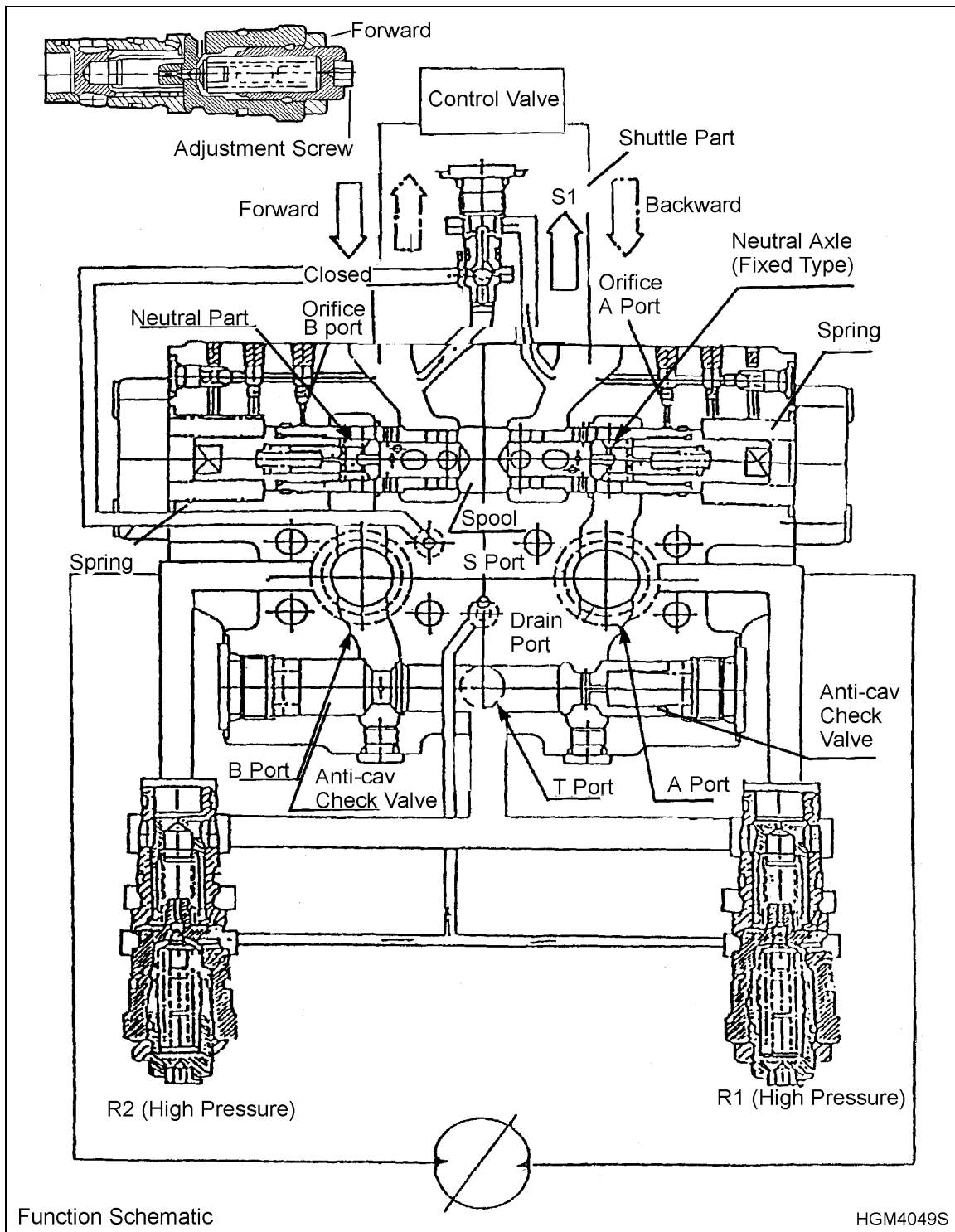


Figure 2

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 anti-cavitation (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. Neutral part of spool defective	Disassemble and clean.
	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.*

REASSEMBLY

1. Install plug (3) and spring (20) to spool (2).

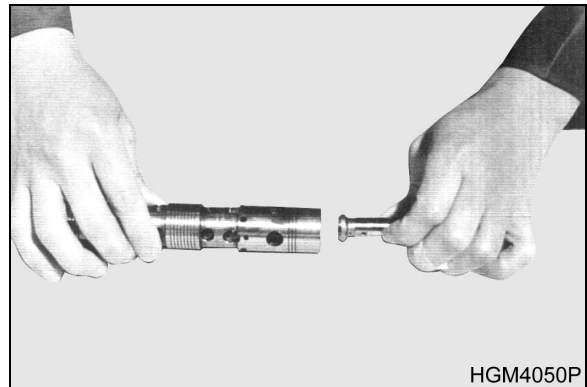


Figure 4

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.

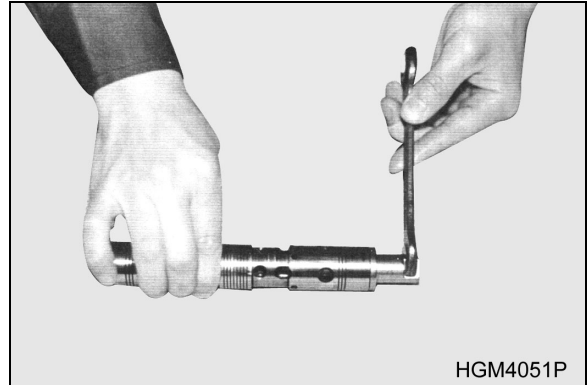


Figure 5

3. Install small ball bearings (12) into body (1).

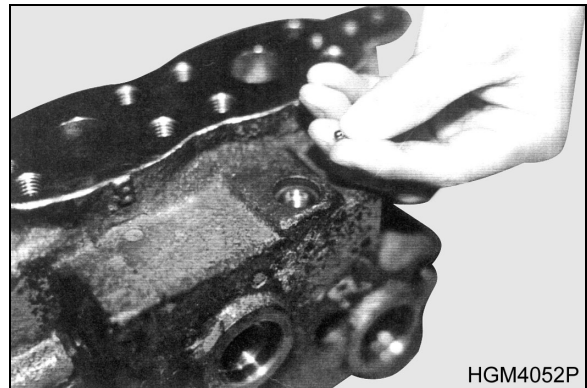


Figure 6

4. Install guide (7) into body (1).

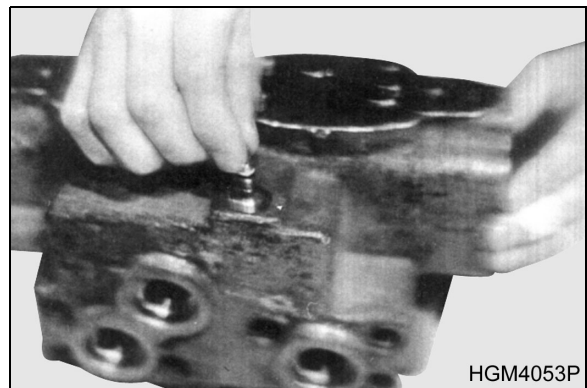


Figure 7

5. Install plug (33) into body and torque to $71.9 \pm 2.3 \text{ kg}\cdot\text{m}$ ($520 \pm 16 \text{ ft lb}$).

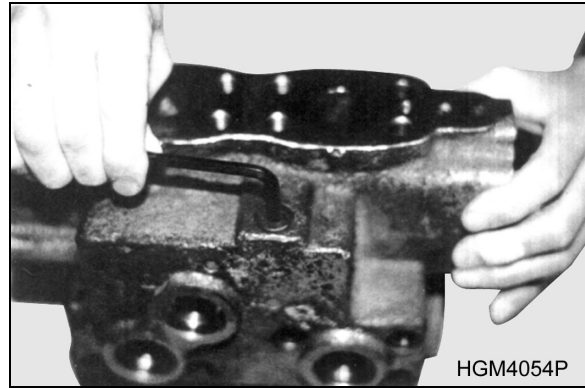


Figure 8

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 $70.25 \pm 0.3 \text{ kg}\cdot\text{m}$ ($508 \pm 2 \text{ ft lb}$).

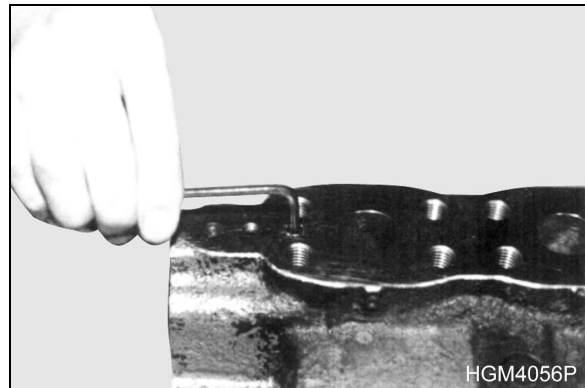


Figure 10

8. Install small ball bearings (11) and spring (21) into body (1) (both sides).

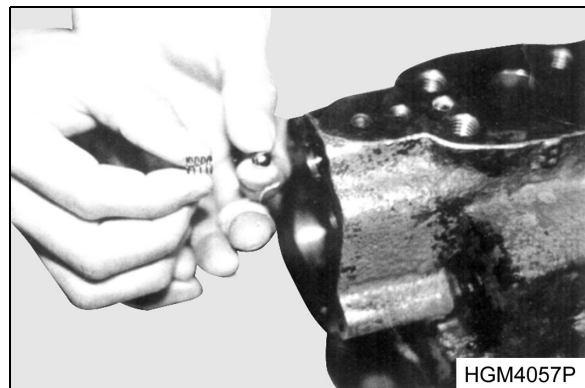


Figure 11

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.*

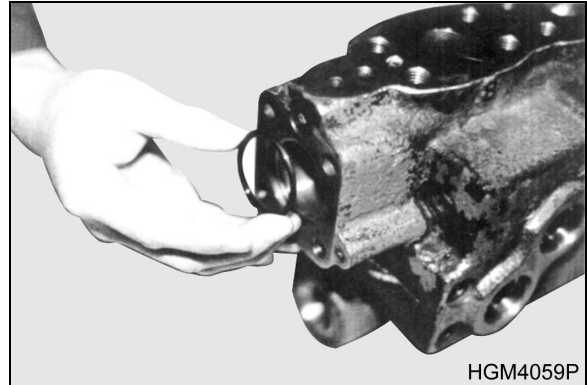


Figure 13

11. Install spool (2) into body (1).

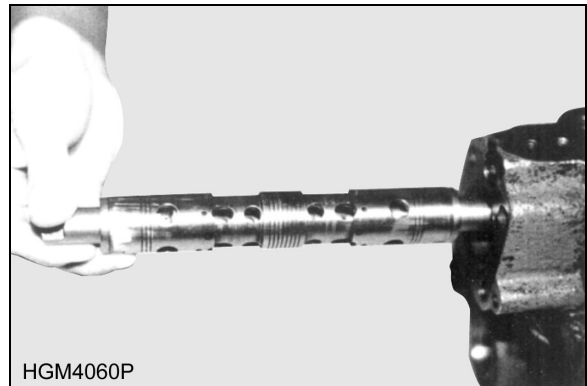


Figure 14

12. Install spring (19) into body (1), then install cover (6).

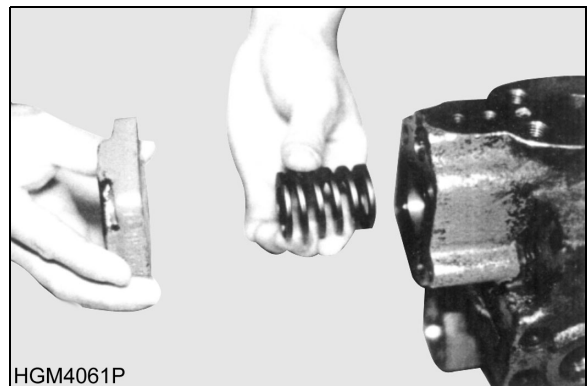


Figure 15

13. Tighten cover (6) (both sides) and torque to $75.6 \pm 7 \text{ kg}\cdot\text{m}$ ($548 \pm 50 \text{ ft lb}$).

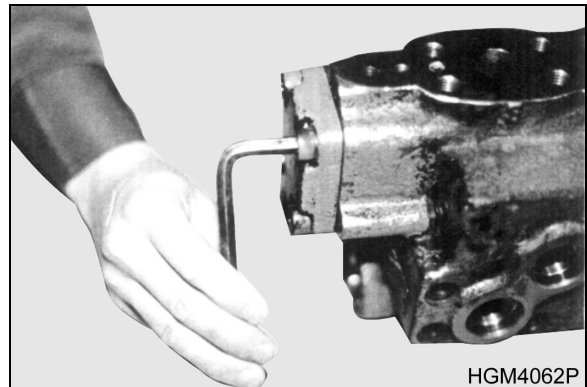


Figure 16

14. Install plunger (8) and spring (18), in that order, into body (1).

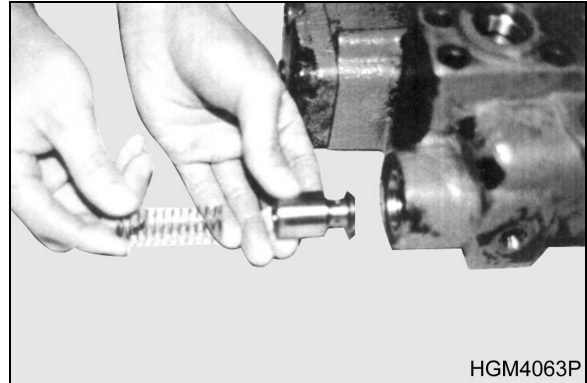


Figure 17

15. Install plug (14) into body (1) (both sides) and torque to $71.2 \pm 1.5 \text{ kg}\cdot\text{m}$ ($505 \pm 10 \text{ ft lb}$).

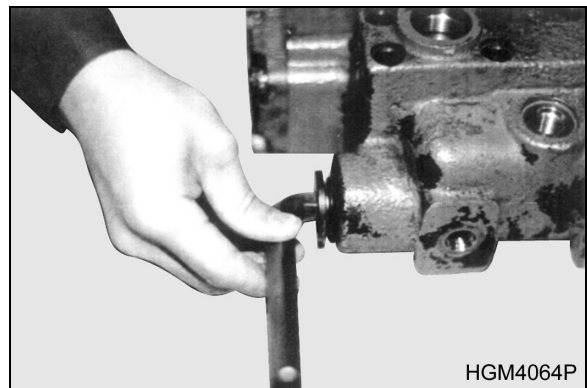


Figure 18

16. Install plug (33) into body (1) (both sides) and torque to $71.9 \pm 2.3 \text{ kg}\cdot\text{m}$ ($520 \pm 16 \text{ ft lb}$).

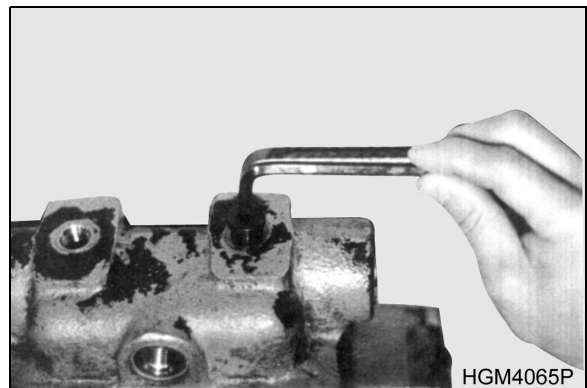


Figure 19

17. Install relief valve (9) into body (1) (both sides).

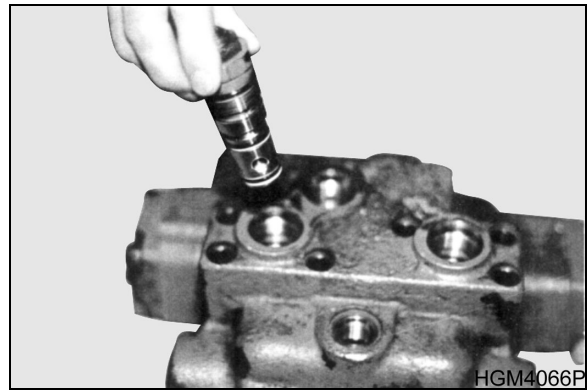


Figure 20

18. Torque to $78 \pm 9 \text{ kg}\cdot\text{m}$ ($564 \pm 65 \text{ ft lb}$).

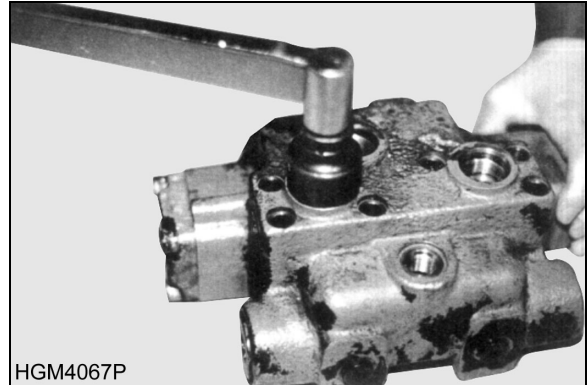


Figure 21

19. Install O-rings (22) and (23) into body (1).

NOTE: *It is recommended to replace O-rings with new.*

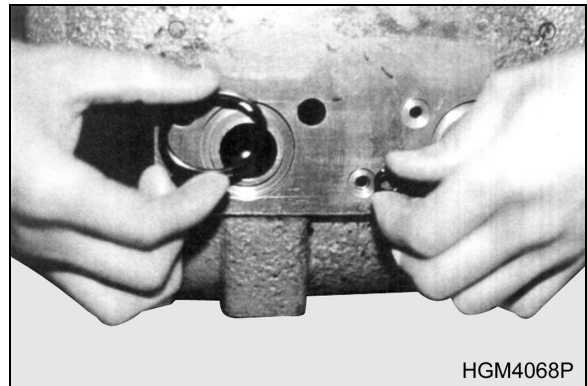


Figure 22

NOTE: *Reassembled counterbalance valve is shown.*

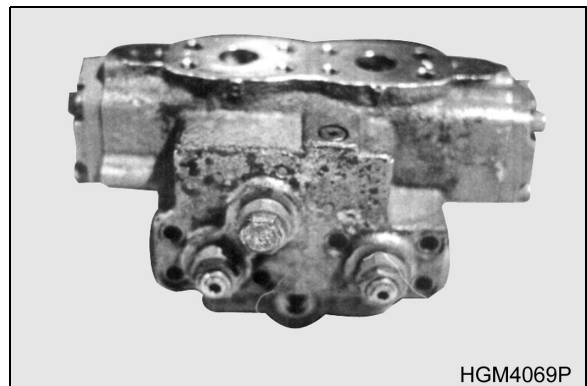


Figure 23



MAIN CONTROL VALVE



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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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 Circuitry" on Page 6
2. "Bucket (Junction) Circuitry" on Page 8
3. "Straight Traveling Circuit" on Page 10
4. "Plunger Replacement" on Page 14
5. "Main Relief Valve" on Page 15
6. "Overload Relief Valve" on Page 16
7. "Arm Load Holding Valve" on Page 18
8. "Boom Load Holding Valve" on Page 21
9. "Arm Regeneration" on Page 23
10. "Foot Relief Valve" on Page 25

ARM PRIORITY CIRCUITRY

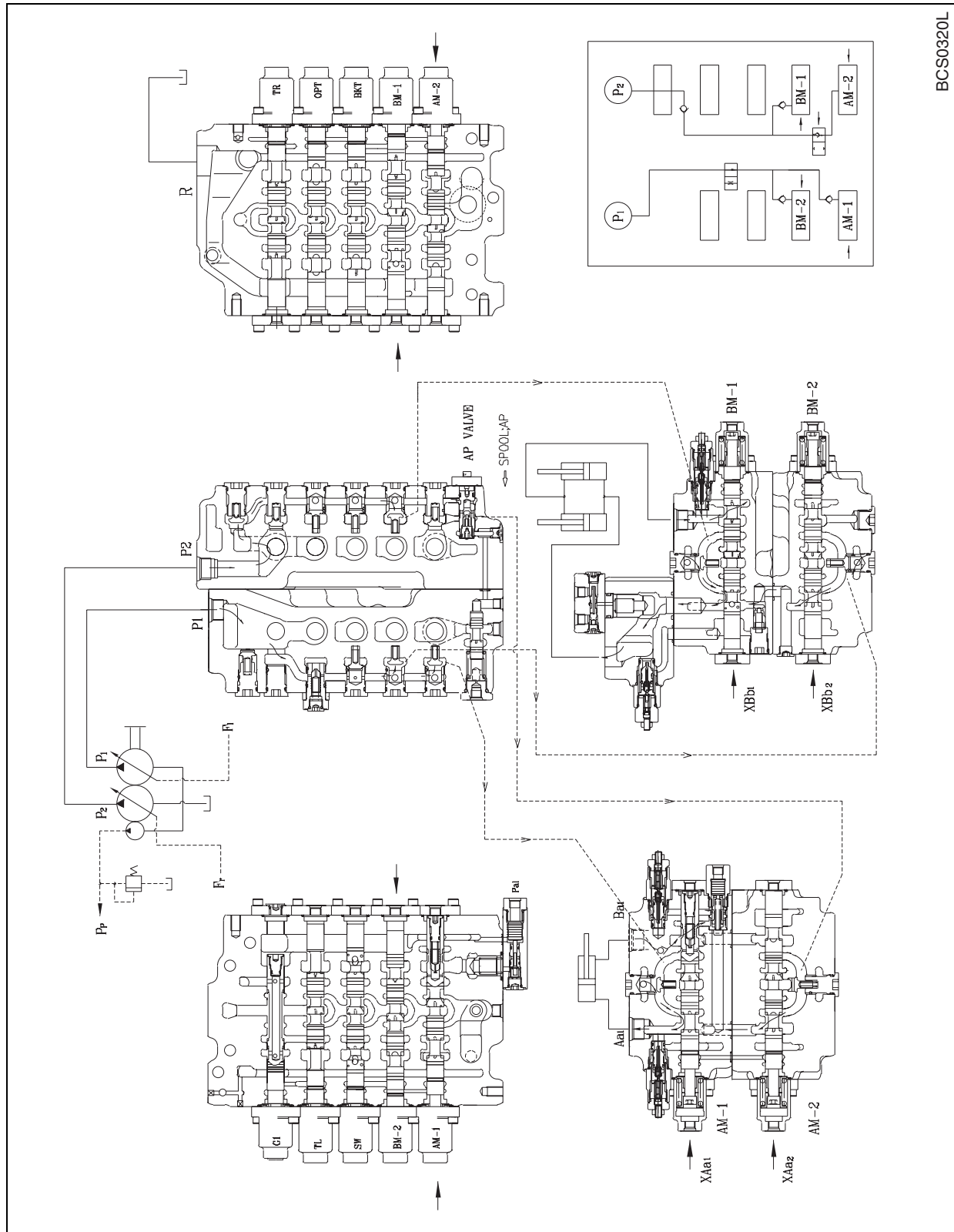


Figure 1

1. When the AP valve is energized, the spool is shifted to the upper position allowing pilot pressure to pass through it. Thus hydraulic oil from the P2 pump passes through the AP valve to the low (load) arm.
2. Hydraulic oil from the P2 pump does not trigger the AP valve. Oil, therefore, passes through a parallel passage supplying oil to the high (load) arm and to the boom.
3. When the AP valve is de-energized, the spool is shifted to the lower position, preventing pilot pressure from passing through it. Thus hydraulic oil from pump P2 triggers the AP valve's spool AP and stops the flow of oil, so that oil is supplied only to the boom.

BUCKET (JUNCTION) CIRCUITRY

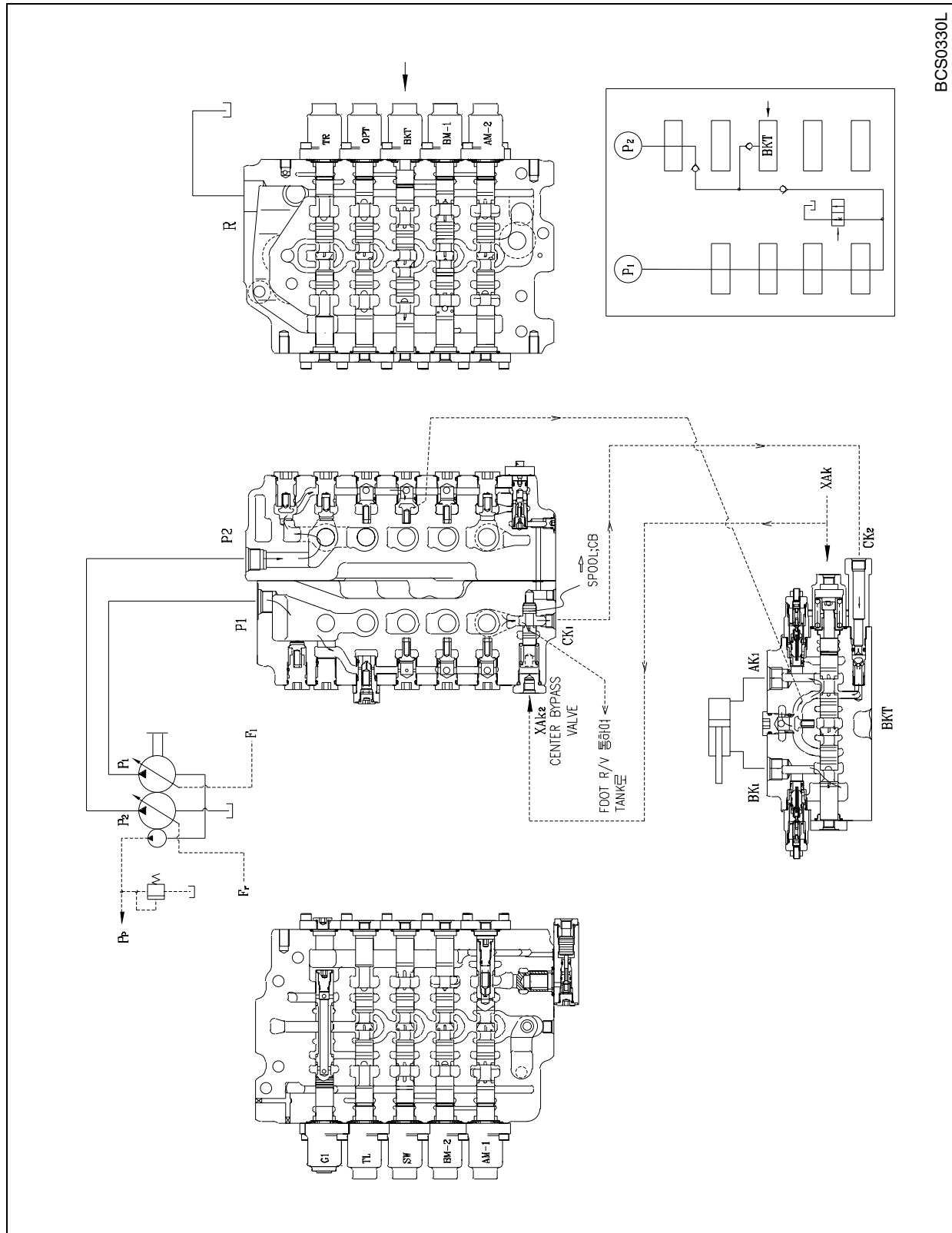


Figure 2

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.

Straight traveling circuit maintains straight travel of the excavator even if other actuators (SW, AM, BKT, BM) are operated in combination.

1. Straight Travel Circuit (Travel Only)

- A. As the plunger is switched on the pilot signal line (Py) is blocked off, but since the signal line (Px) is connected to the tank by the orifice, the hydraulic fluid flow from P1 pump is supplied to the left travel motor without activating the travel straight (TS) switching valve.
- B. The hydraulic fluid flow from P2 pump is supplied to the right travel motor in the same manner. As a result P1 pump powers the left travel motor and P2 pump powers the right travel motor and straight travel is achieved.

2. Travel Straight Circuit (Combined operation with swing)

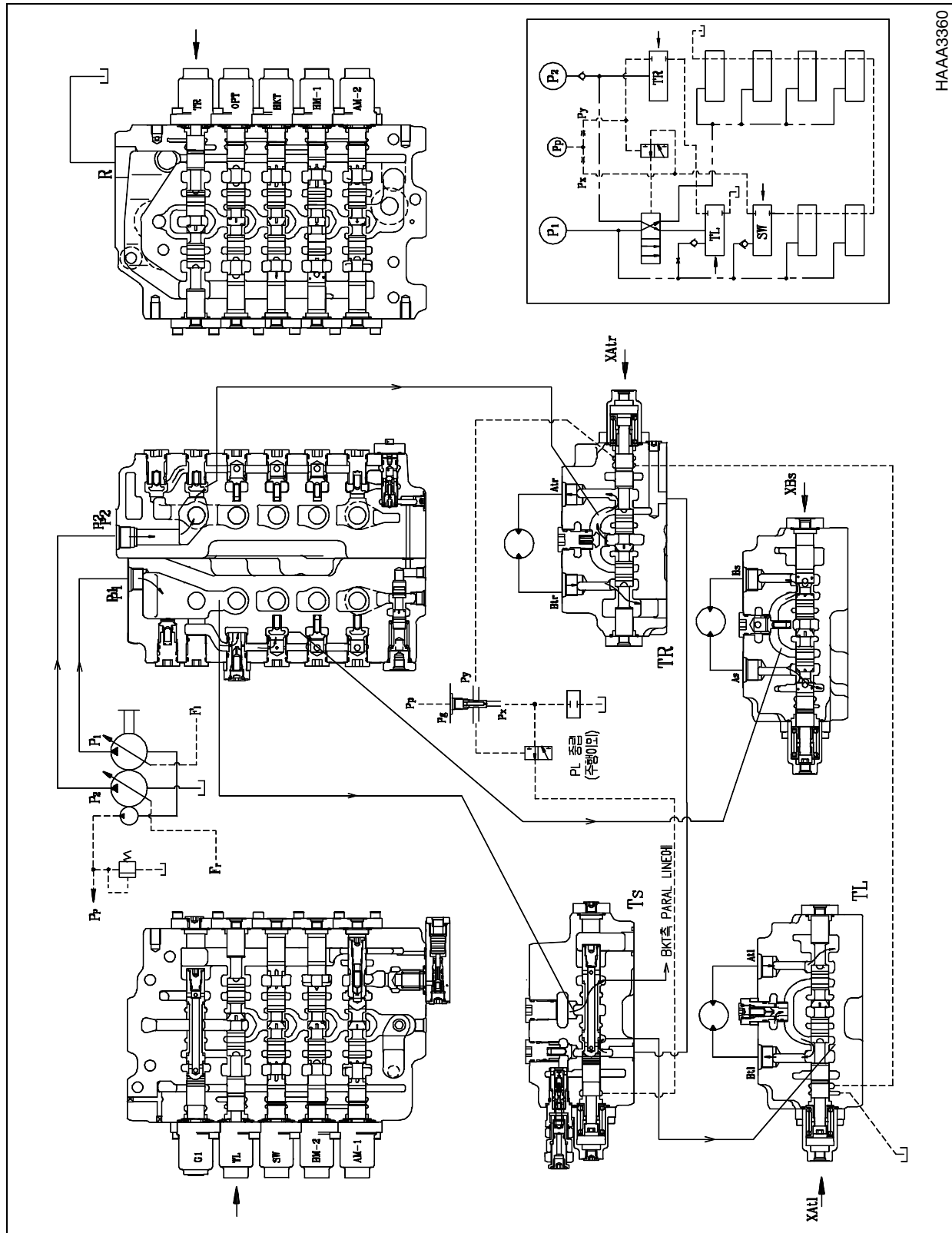


Figure 4

- A. First, when the swing plunger is switched on, the pilot signal (Px) within the control valve is blocked, as a result of that signal pressure travel straight (TS) switch valve will be switched on and a provide a supply path to the left and right travel plunger. When the swing plunger is completely switched on the oil flow from the P1 pump is first supplied to the swing and the oil flow from the P2 pump is supplied to the right travel and left travel motors for straight travel and as a result combined operation is made possible.
- B. In addition, orifice C which follows a parallel path to the travel side of the valve, allows flow of surplus hydraulic fluid to the left, right travel motors and acts to minimize sudden changes in travel speeds.

PLUNGER REPLACEMENT

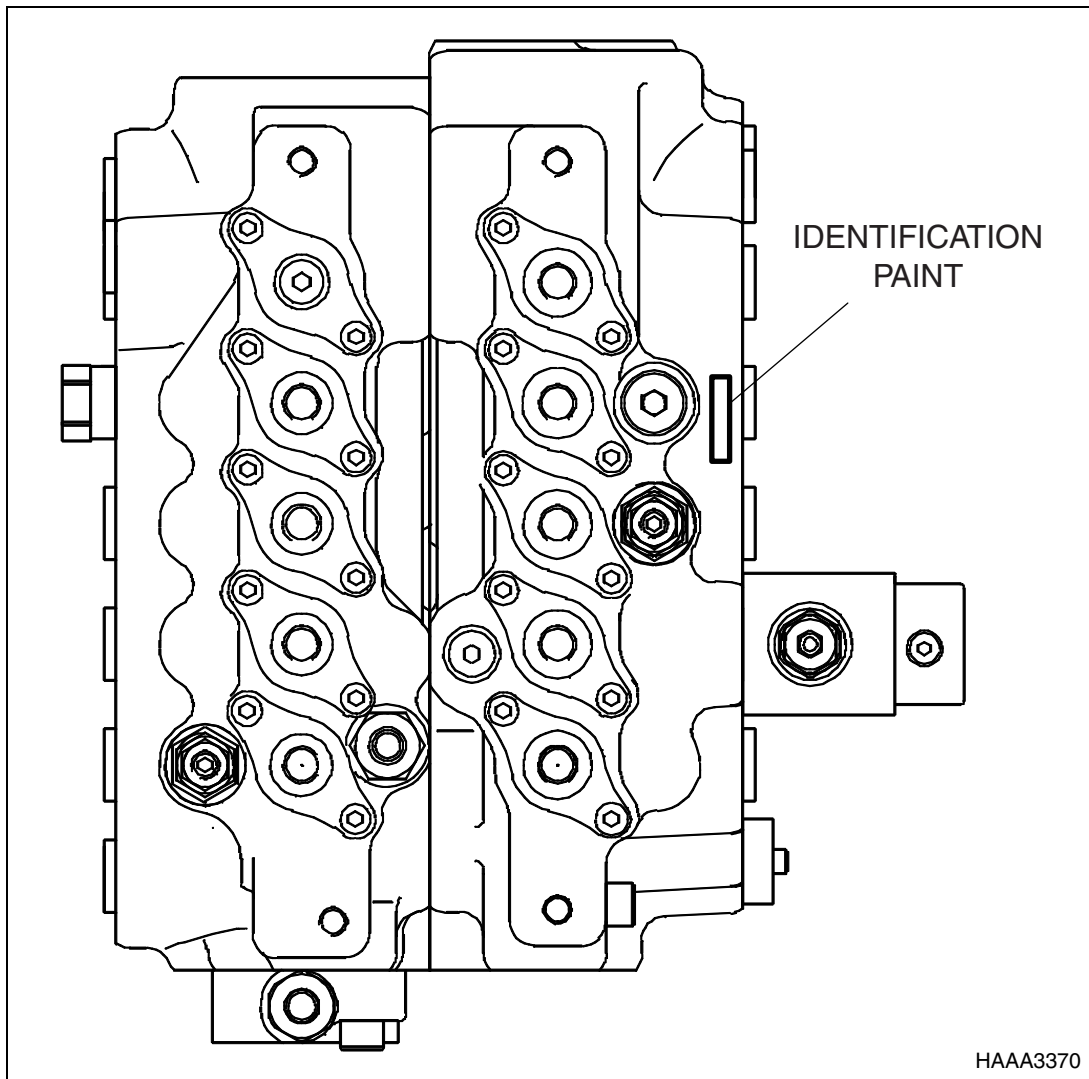


Figure 5

1. The plunger is selected and toothed into the housing; as a result it is a non serviceable part and can not 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 name plate.
 - 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.

MAIN RELIEF VALVE

1. Normal (low pressure) Operation (Pz pilot signal: OFF)

- Piston (d) is pushed to the right most position by spring (c).
- A. The pressurized oil from the main pump flows into chamber 3 through the orifice (2) of the main poppet A. Main poppet A is completely closed because $d1 > d2$.
- B. When the oil pressure reaches the set pressure of spring C, the pilot poppet B is opened and oil flows to the tank through paths (4) and (5).

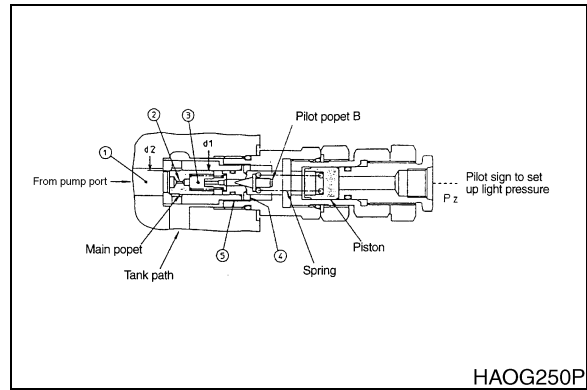


Figure 6

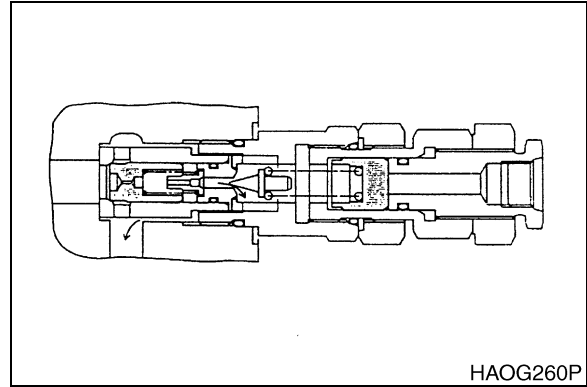


Figure 7

- C. During oil flow when pressure drops in front and back of orifice (2) and pressure of chamber (1) $d2 >$ pressure of chamber (1) $d1$, main poppet A will open and pressurized oil flows to the tank.

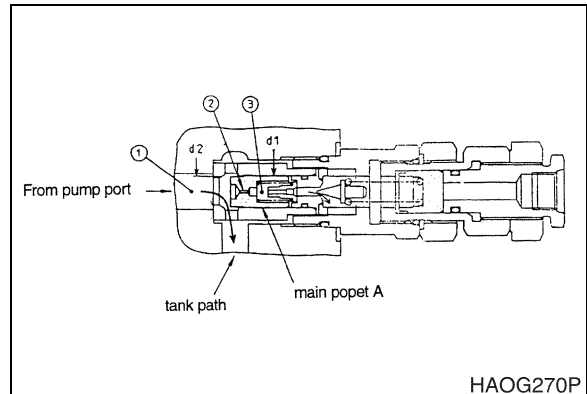


Figure 8

2. High pressure operation (Pz pilot signal: ON)

When piston D is in the left most position and the pressure has increased above the set pressure of spring C, high pressure condition is achieved.

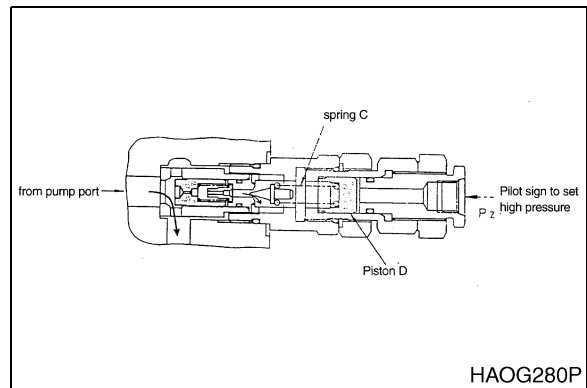


Figure 9

OVERLOAD RELIEF VALVE

1. Operation of overload relief valve

A. The pressurized oil from the cylinder port enter into chamber (2) through orifice (3) of piston A. Main poppet B is closed shut due to $d1 > d2$.

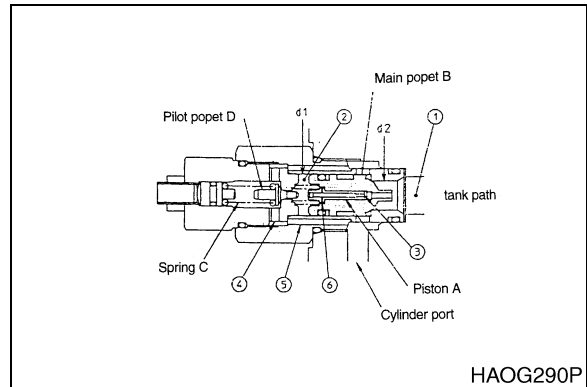


Figure 10

B. When the pressurized oil overcomes the set pressure of spring C, pilot poppet D opens and oil flows to the tank through the transverse hole (4) and path (5).

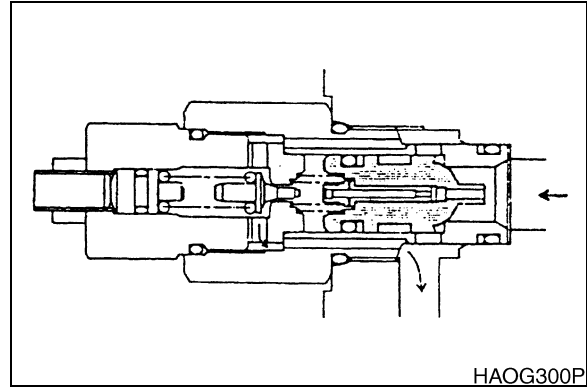


Figure 11

C. Oil flows and pressure decreases in orifice (3) 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, transverse hole (4) and passage (5).

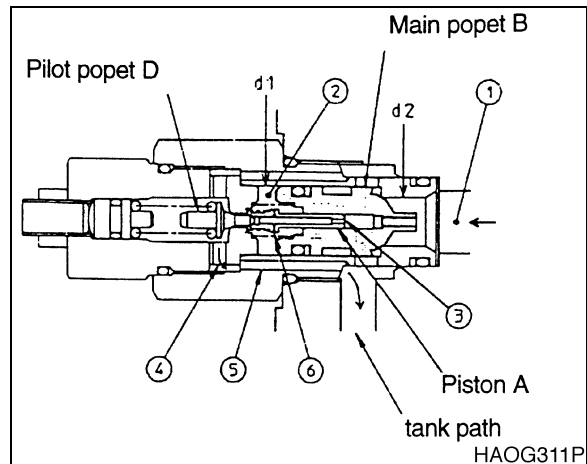


Figure 12

- D. Pressure decreases behind orifice of piston A and if chamber (1) pressure $p_1 > p_2$ the main poppet B opens and the pressurized oil of cylinder port flows to the tank to protect the actuator.

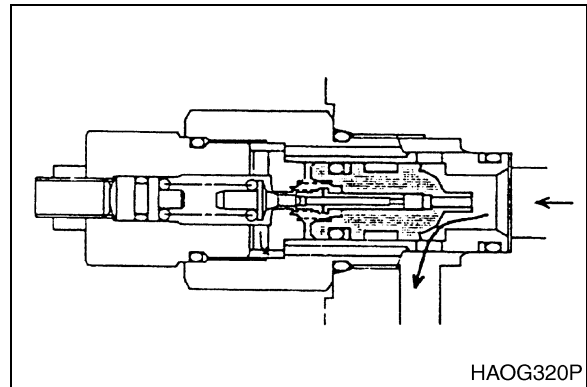


Figure 13

2. Operation of make-up valve

- A. The main poppet area $d_1 > d_2$ 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 due to the area difference d_1 & d_2 and the tank pressure and oil flows from the tank to the cylinder port preventing cavitation.

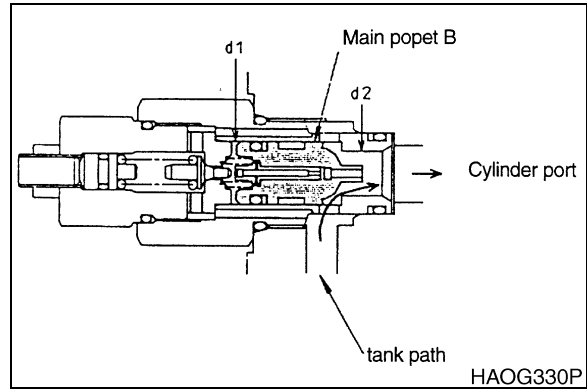


Figure 14

ARM LOAD HOLDING VALVE

1. When plunger is in neutral position (Pal pilot signal: OFF)

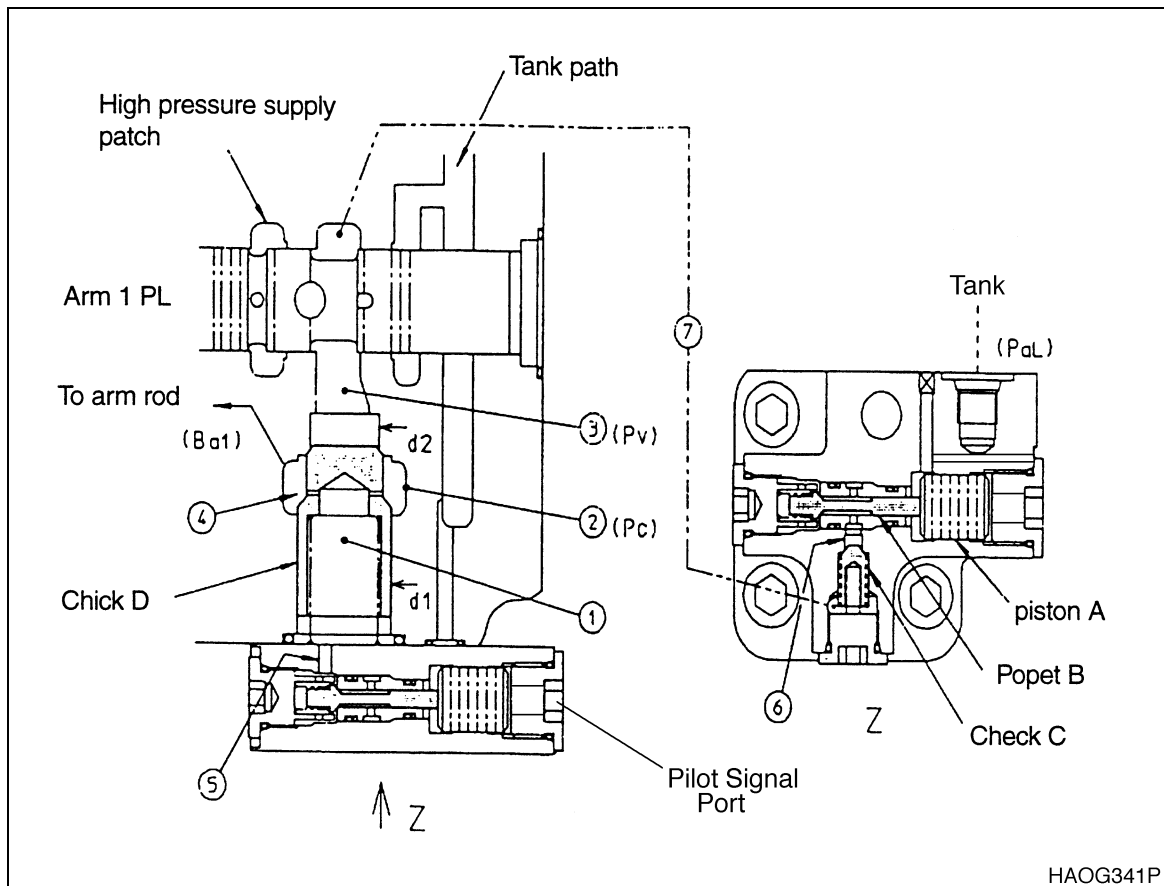


Figure 15

- Piston A and poppet B are in position blocking path 5 & 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) & (3).

2. When plunger is operated

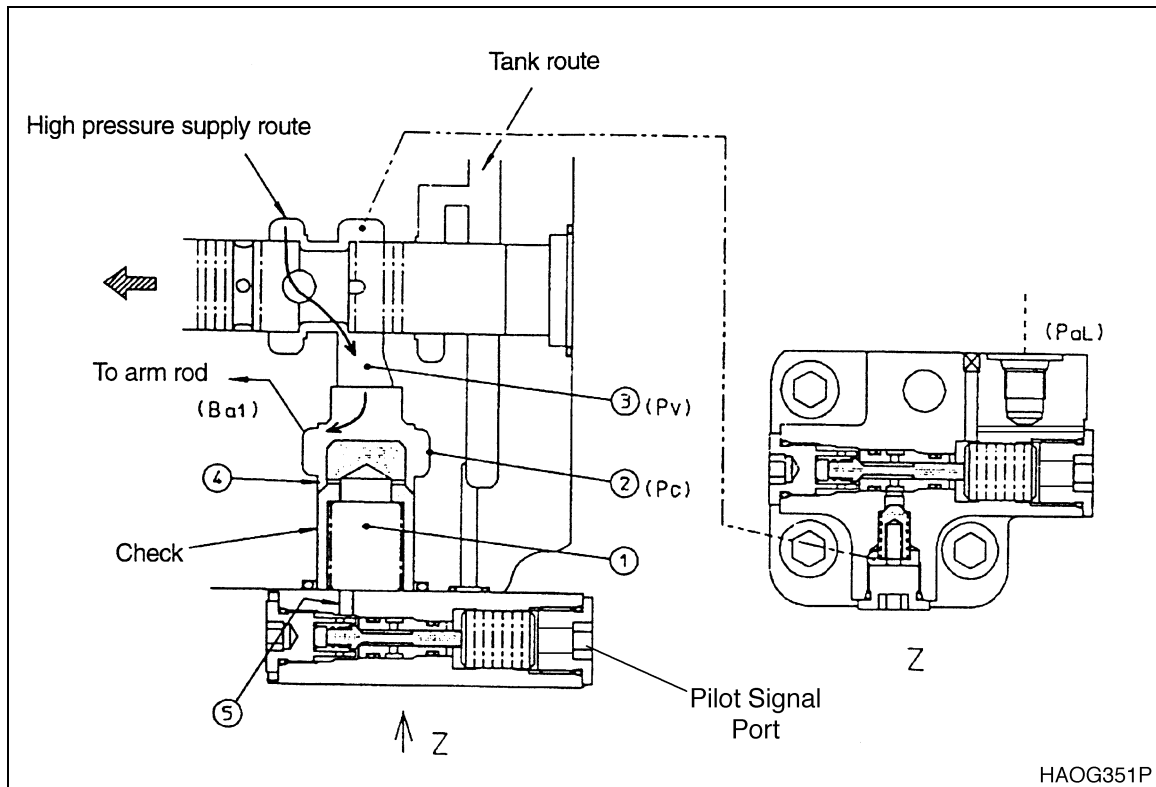


Figure 16

A. Arm Dump Operation ($p_1 > p_c$) (P_{aL} pilot signal: OFF)

Oil passes through path (4) 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.

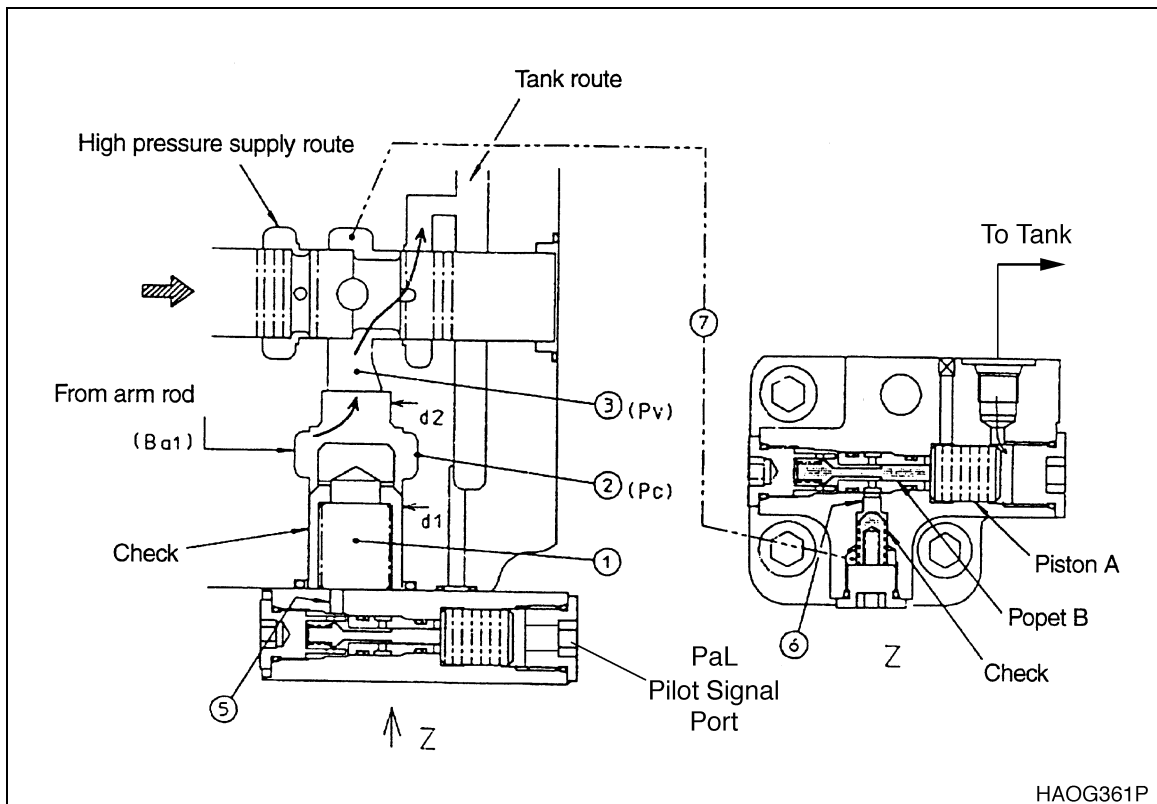


Figure 17

B. Arm Crowd ($P_c > P_v$) (PaL pilot signal: ON)

Pilot signal pressure enters signal port, piston A moves to the left and poppet B is opened and paths (5) & (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)
 - A. Spool A 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 Pc. $d_1 > d_2$, poppet B is seated closing off chamber (2) & chamber (3).

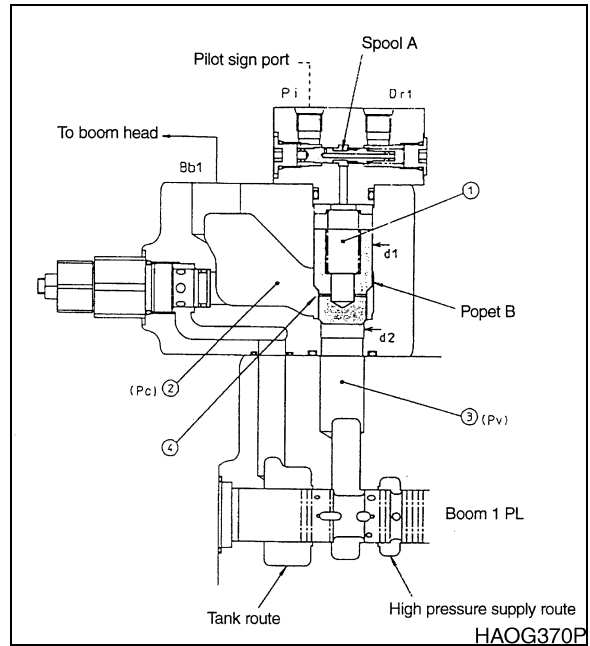


Figure 18

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). Chamber (1) and chamber (2) pressures are Pc and equalized through squeeze (4). Pv overcomes set spring pressure and high pressure oil is supplied to the cylinder head.

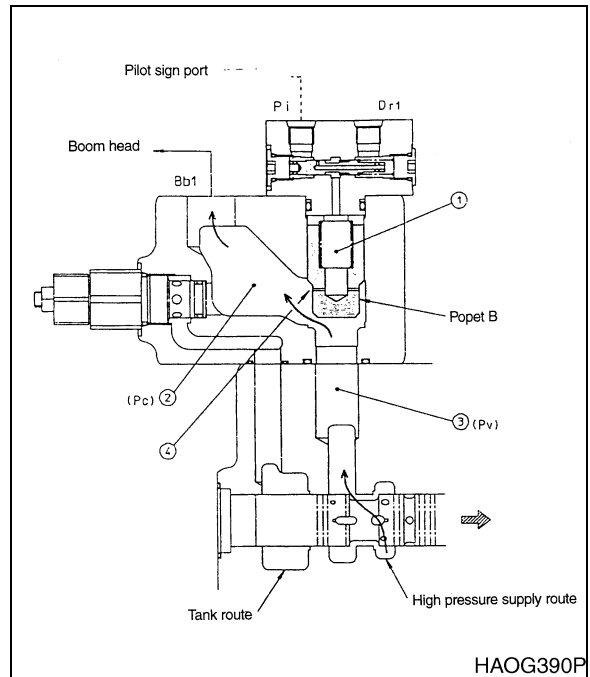


Figure 19

B. Boom-down ($P_c > P_v$) (P_i pilot signal: ON).

Pilot signal pressure enters signal port, spool A 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.

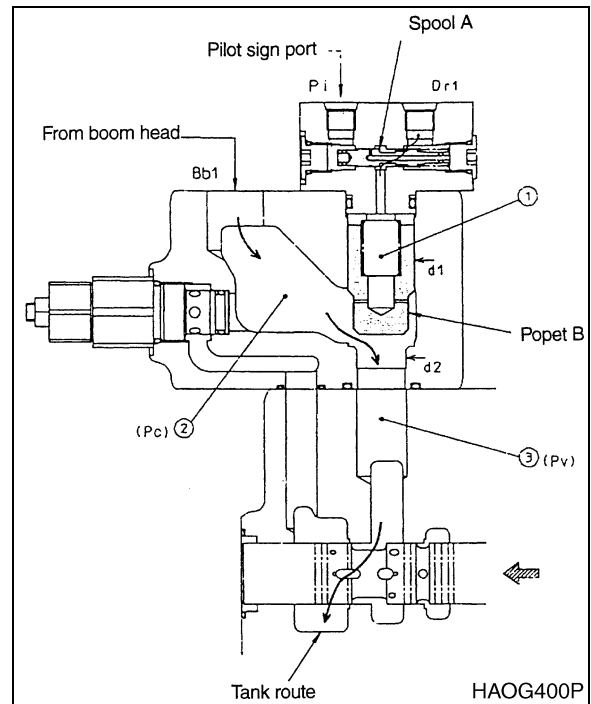


Figure 20

ARM REGENERATION

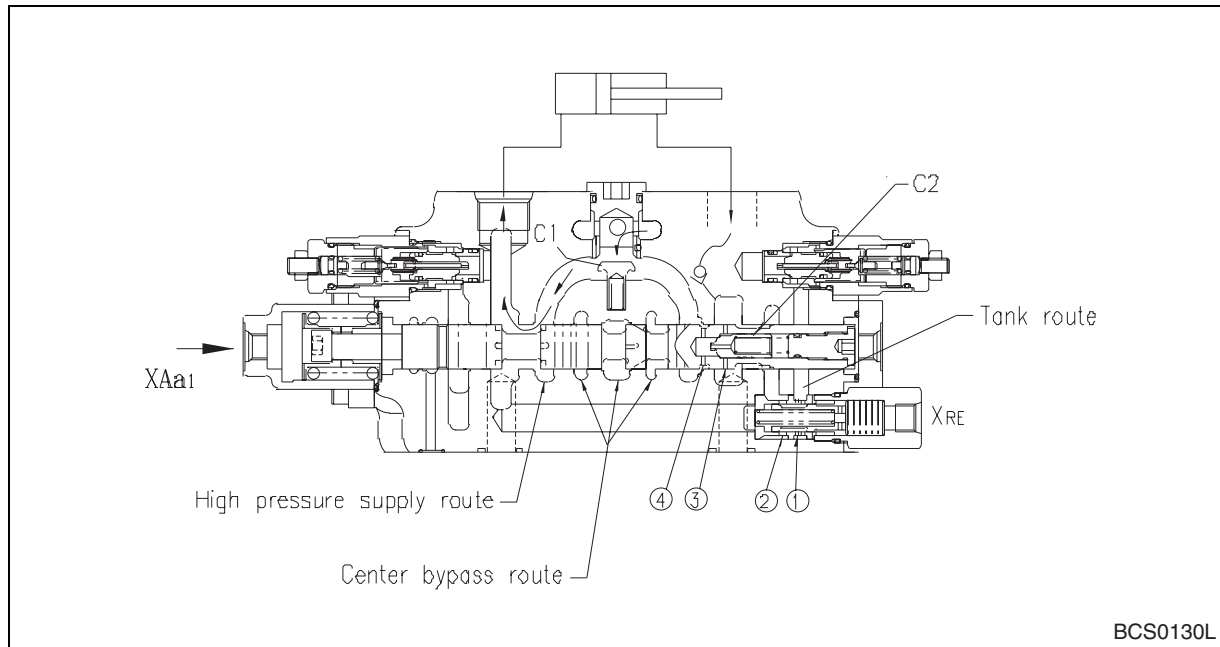


Figure 21

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.

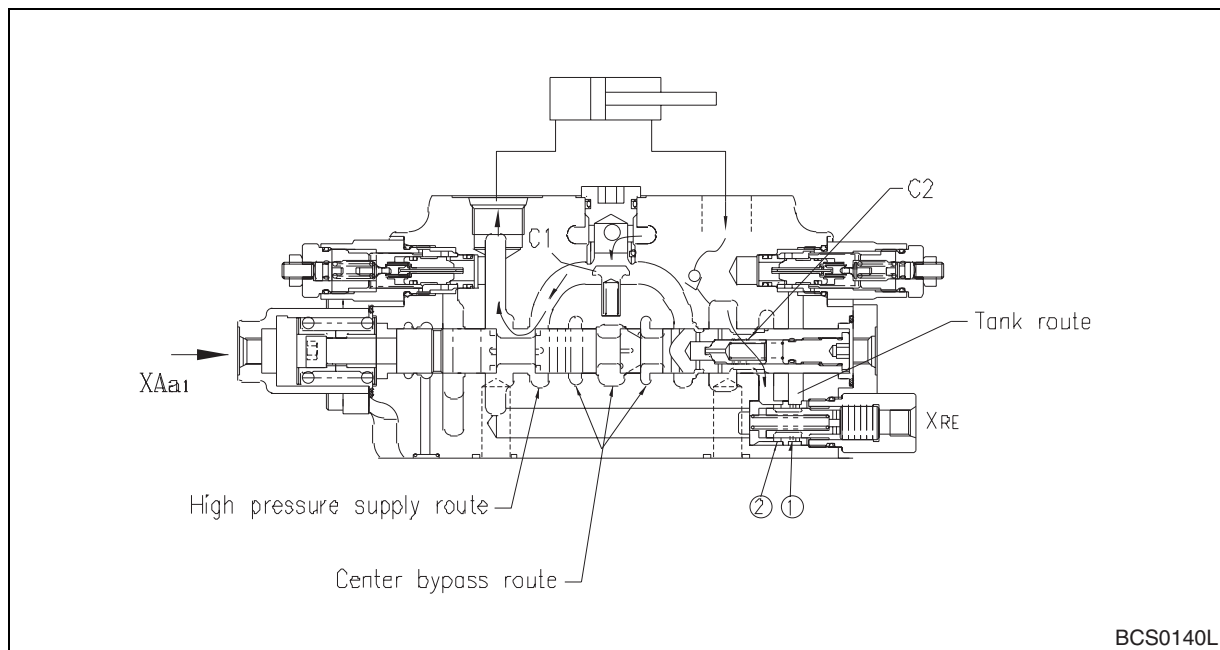


Figure 22

2. Oil returning from the rod side flows back to the tank through regeneration valve route (2) to route (1).

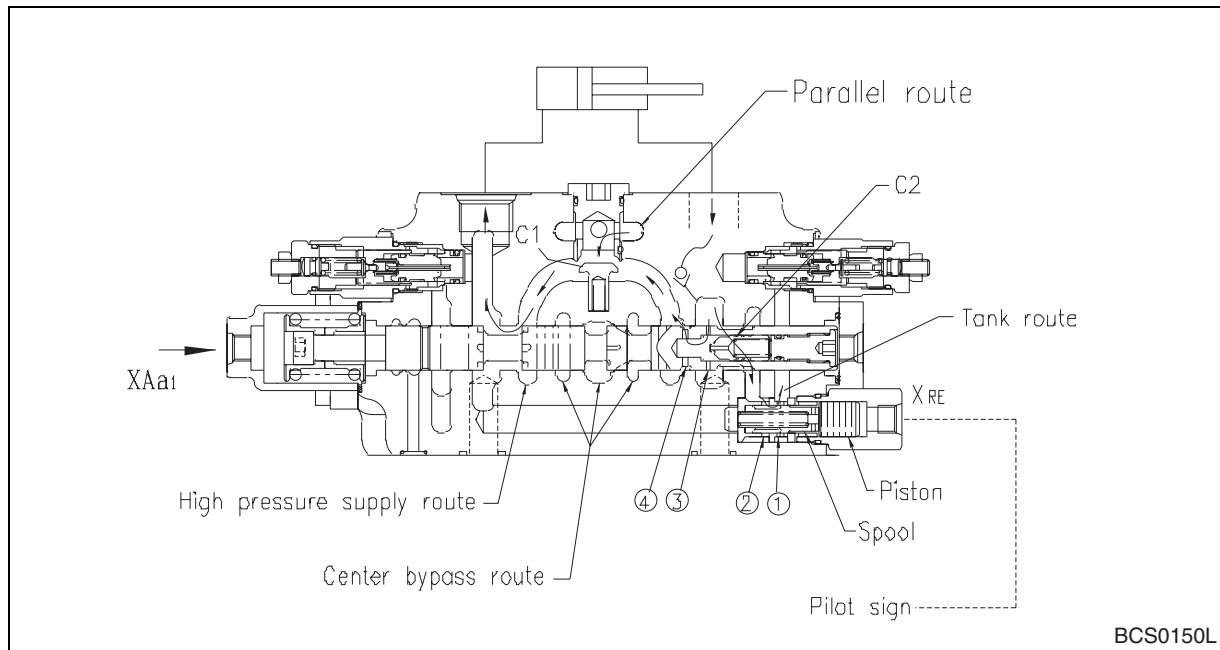


Figure 23

3. When the pilot signal is supplied to port XRE, piston A is moved to the left. Rod side pressure is raised up due to 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.

FOOT RELIEF VALVE

1. Oil from center bypass route flows to tank route through orifice A of poppet. The pressure (f_p) generated by flow passed through orifice is fed back to the pump to control the discharge volume by the pump.
2. A large amount of fluid flow from delayed pump response causes pressure (f_p) to overcome set spring pressure and the poppet is opened, allowing oil to flow to the tank operating as a relief valve.

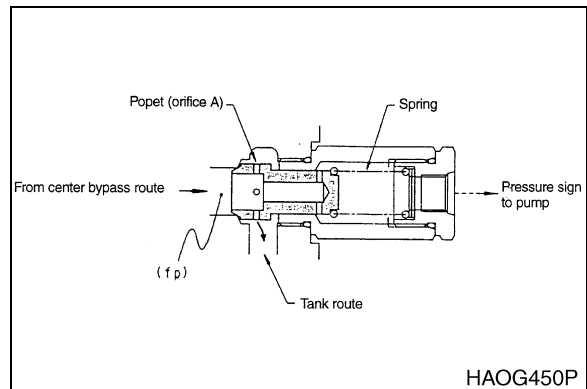


Figure 24

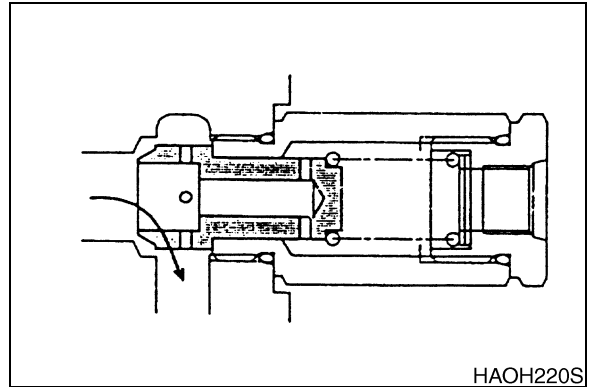


Figure 25

PARTS LIST

Main Plunger Element

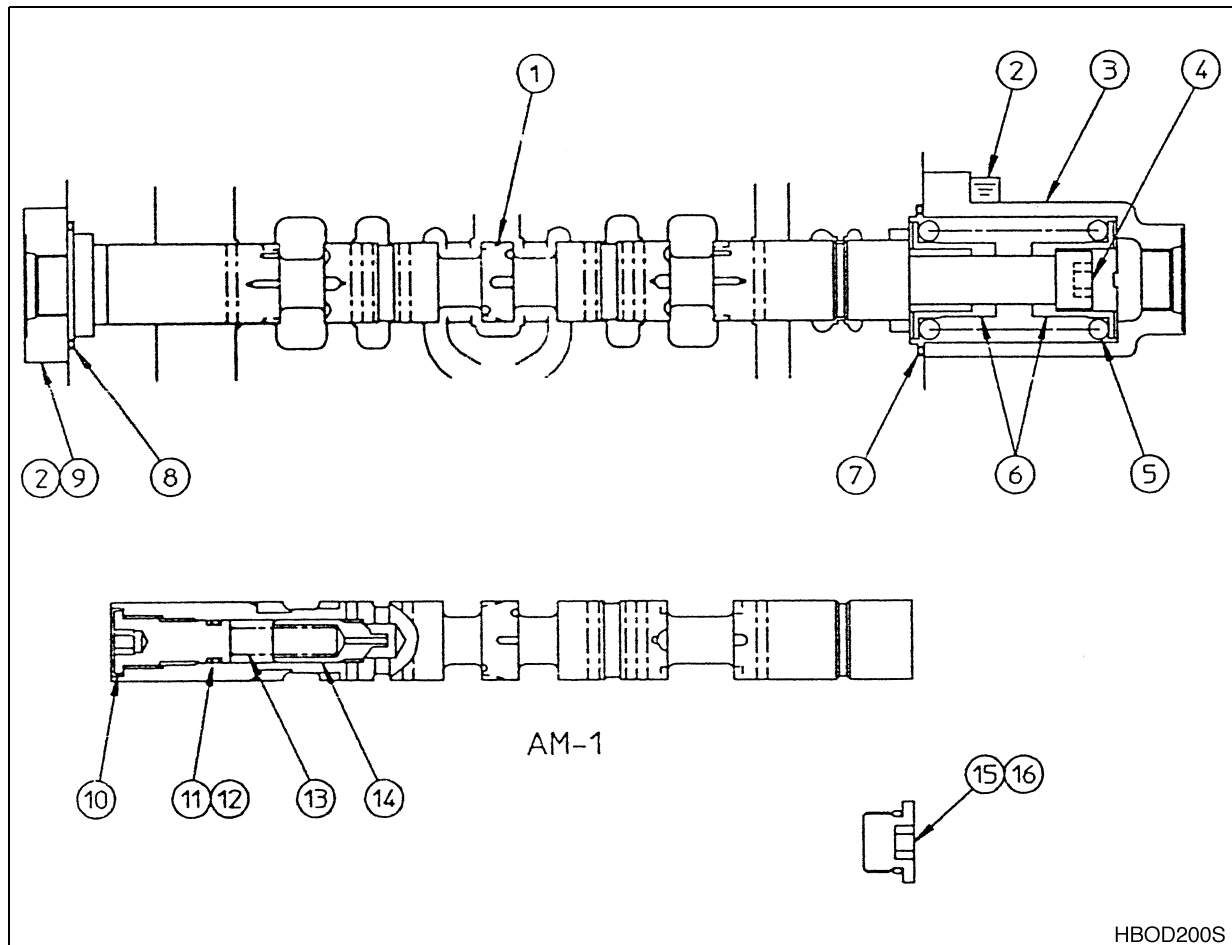


Figure 26

Reference Number	Description
1	Plunger
2	Bolt With Hole
3	Cover
4	Plunger Cap
5	Spring
6	Spring Guide
7	O-ring
8	O-ring

Reference Number	Description
9	Retainer
10	Cap
11	Backup, Ring
12	O-ring
13	Spring
14	Check Valve
15	Cap (Option Only)
16	O-ring (Option Only)

Main Relief Valve

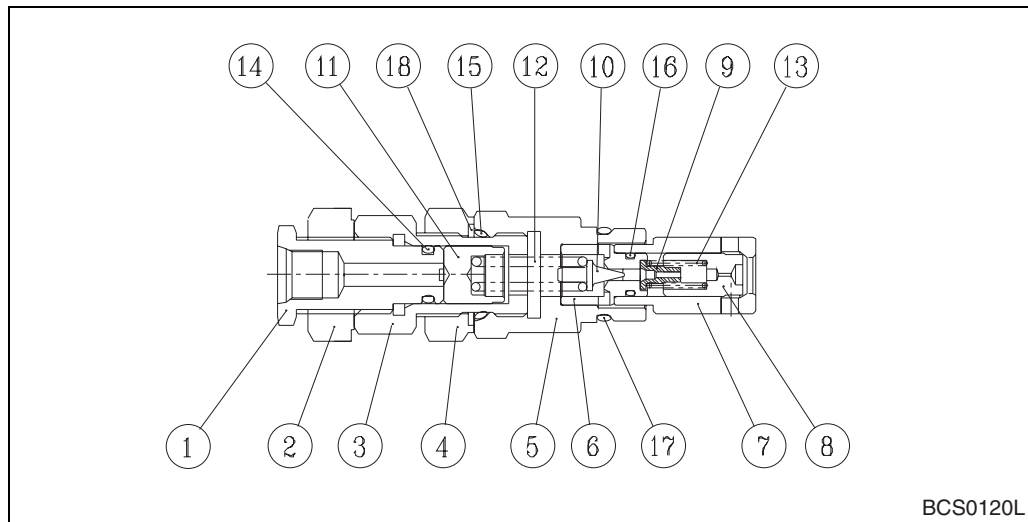


Figure 27

Reference Number	Description
1	Adjust Screw
2	Nut; Lock
3	Sleeve
4	Lock Nut
5	Cap
6	Pilot Seat
7	Sleeve
8	Poppet
9	Orifice

Reference Number	Description
10	Relief Poppet
11	Piston
12	Spring
13	Spring
14	Spring
15	O-ring
16	O-ring
17	O-ring
18	Backup Ring

Overload Relief Valve

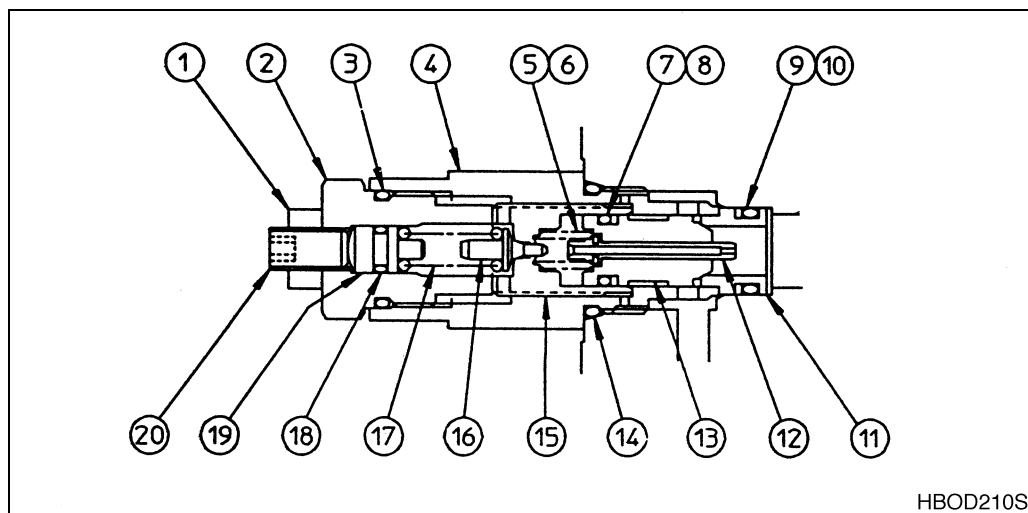


Figure 28

Reference Number	Description
1	Hexagonal 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 Seat
12	Piston
13	Main Poppet
14	O-ring
15	Pilot Seat
16	Pilot Poppet
17	Spring
18	O-ring
19	Spring Seat
20	Adjusting Screw

Boom Load Holding Valve

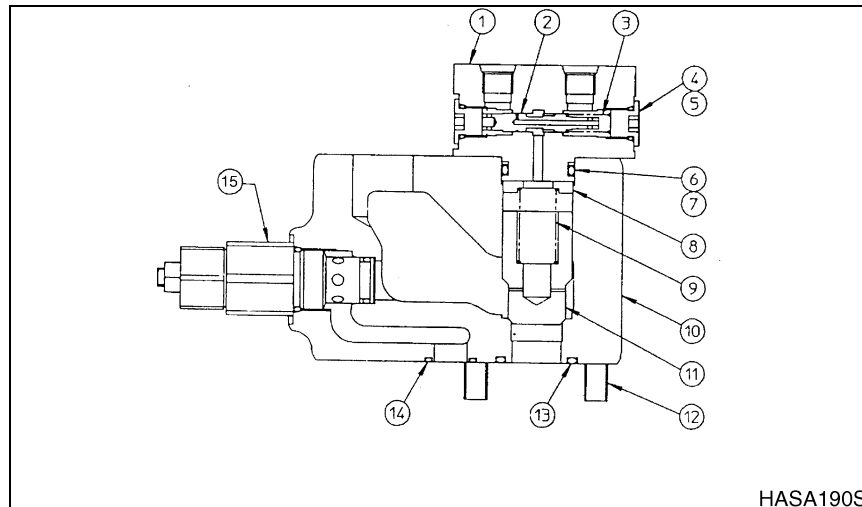


Figure 29

Reference Number	Description
1	Cover
2	Spool
3	Spring
4	Cap
5	O-ring
6	Backup Spring
7	O-ring
8	Spring Seat

Reference Number	Description
9	Spring
10	Manifold
11	Poppet
12	Bolt With Hole
13	O-ring
14	O-ring
15	Relief Valve

Boom Unity Check

Reference Number	Description
1	Cap
2	O-ring
3	Spring
4	Check

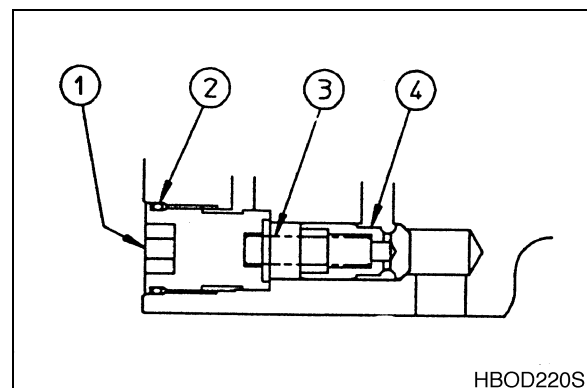
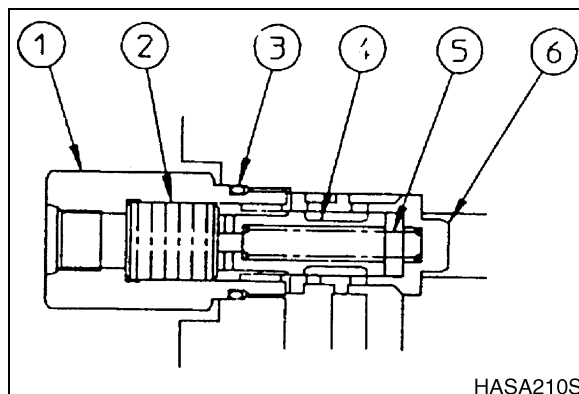


Figure 30

Arm Regeneration Valve

Reference Number	Description
1	Cap
2	Piston
3	O-ring
4	Spool
5	Spring
6	Sleeve

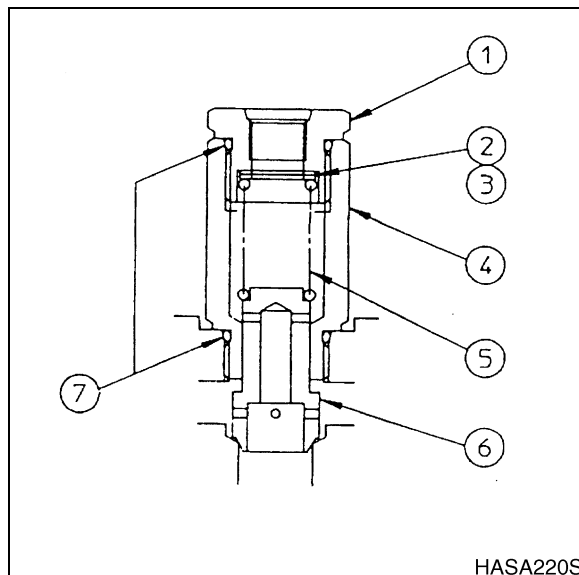


HASA210S

Figure 31

Foot Relief Valve

Reference Number	Description
1	Cap
2	Seam
3	Seam
4	Cap
5	Spring
6	Poppet
7	O-ring

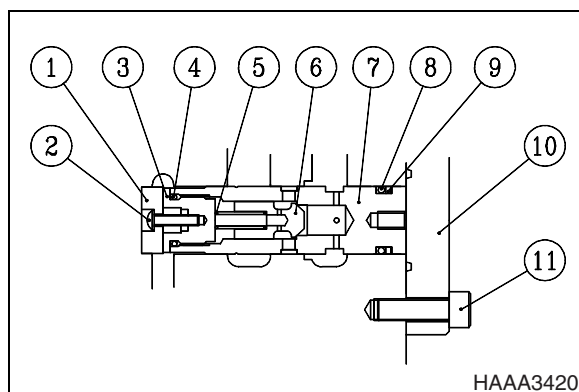


HASA220S

Figure 32

Arm Priority Valve (AP Valve)

Reference Number	Description
1	Spacer
2	Screw
3	Cap
4	O-ring
5	Spring
6	Check
7	Spool Ap
8	O-ring
9	Backup Ring
10	Retainer
11	Bolt With Hole



HAAA3420

Figure 33

Check Valve (Tr, Am-2)

Reference Number	Description
1	Cap
2	Backup Ring
3	O-ring
4	Spring
5	Nylon Chip
6	Check

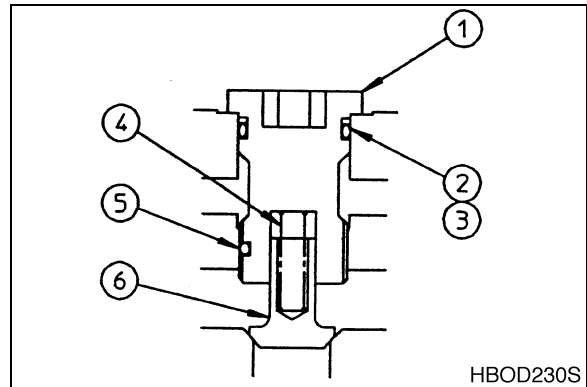


Figure 34

Check Valve (Opt, Bkt, Bm-1, Bm-2, Am-1)

Reference Number	Description
1	Cap
2	Backup Ring
3	O-ring
4	Spring
5	Nylon Chip
6	Check

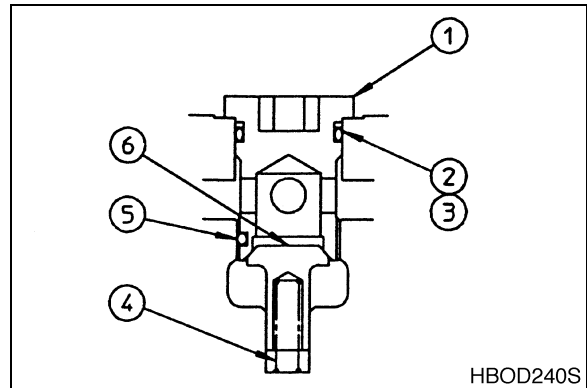


Figure 35

Check Valve

Reference Number	Description
1	Cap
2	Backup Ring
3	O-ring
4	Nylon Chip
5	Spring
6	Check

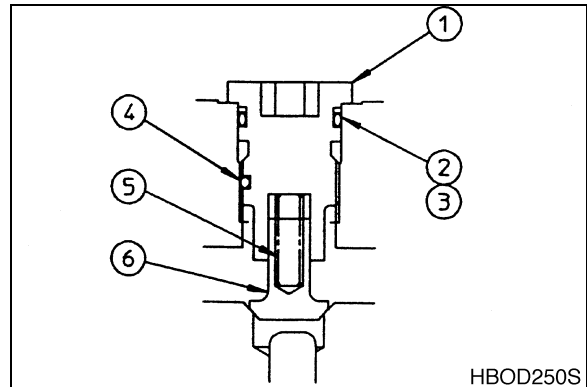


Figure 36

Cap

Reference Number	Description
1	Cap
2	Backup Ring
3	O-ring
4	Nylon Chip

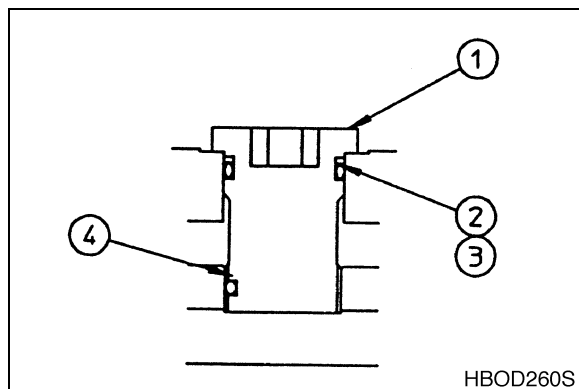


Figure 38

Check Valve (TI)

Reference Number	Description
1	Cap
2	O-ring
3	Cap
4	Spacer
5	Backup Ring
6	O-ring
7	Spring
8	Check
9	Nylon Chip

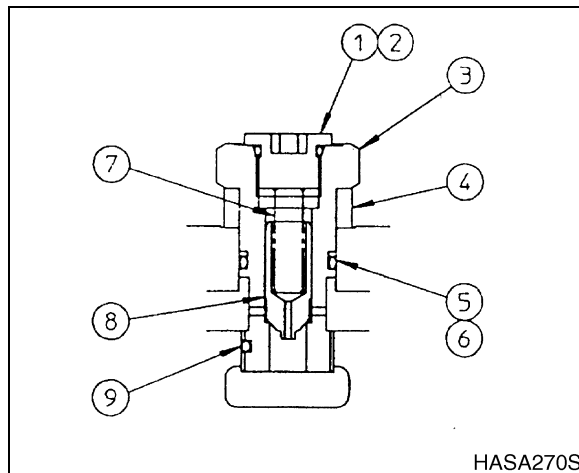


Figure 39

Check Valve (Sw)

Reference Number	Description
1	Cap
2	Backup Ring
3	O-ring
4	Spring
5	Nylon Clip
6	Check

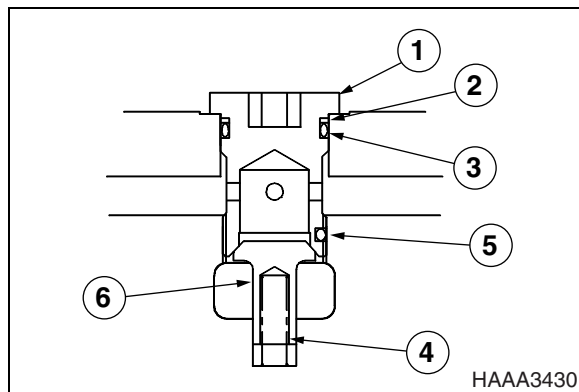


Figure 40

Straight Travel Selector Valve

Reference Number	Description
1	Check
2	O-ring
3	Spring
4	Spool TS

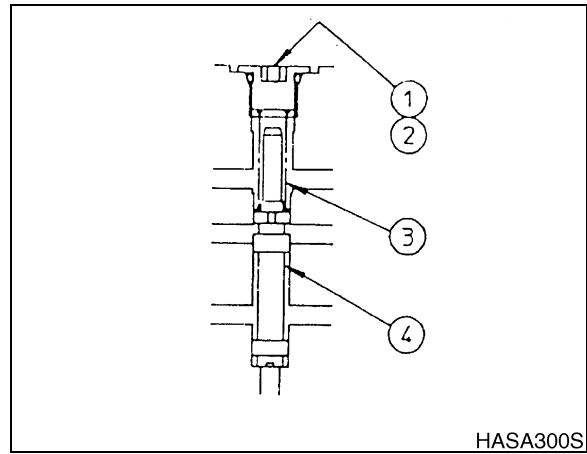


Figure 41

Center Bypass Valve (Cb Valve)

Reference Number	Description
1	Check
2	O-ring
3	Spring
4	Spool

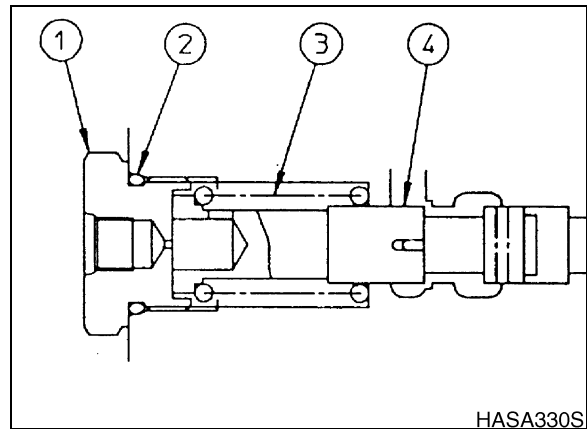


Figure 42

Arm Load Holding Valve

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
12	O-ring
13	Poppet
14	Spring
15	O-ring
16	Cap
17	Bolt With Hole
18	Cover
19	Cap
20	Spring
21	Check

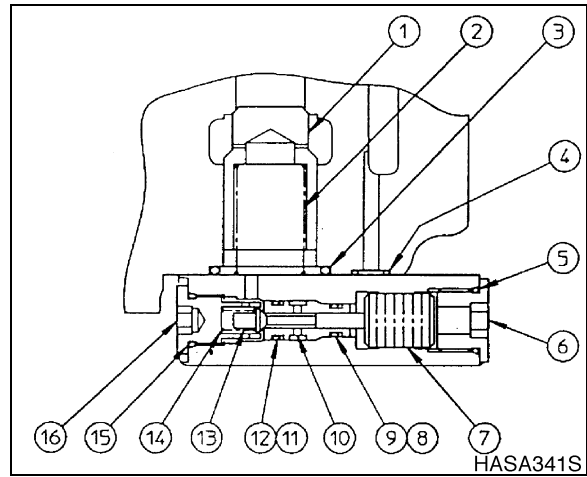


Figure 43

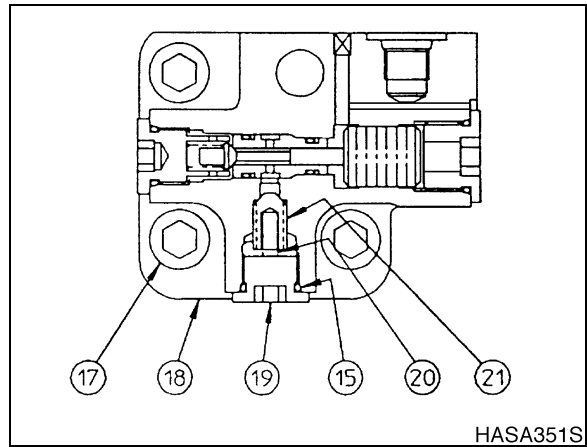


Figure 44

SPECIFICATIONS

Control Valve	Relief Valves (Main):	330 kg/cm ² (4686 psi) – normal, travel 350 kg/cm ² (4970 psi) – pressure up.
	Left Side Spools: (and spool diameter)	Travel: left 22 mm (0.866") diameter Swing: 22 mm (0.866") diameter Boom-2: 22 mm (0.866") diameter Arm-1: 22 mm (0.866") diameter
	Right Side Spools: (and spool diameter)	Travel: right 22 mm (0.866") diameter Option: open 22 mm (0.866") diameter Boom-1: 22 mm (0.866") diameter Bucket: 22 mm (0.866") diameter Arm-2: 22 mm (0.866") diameter
	Overload Relief Pressure:	360 kg/cm ² (5112 psi)

CONTROL VALVE DRAWING AND HYDRAULIC CIRCUIT

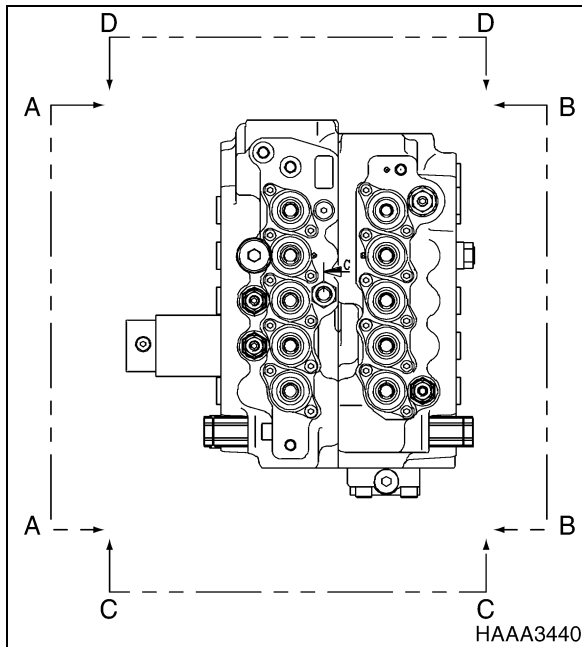


Figure 45 CONTROL VALVE TOP VIEW

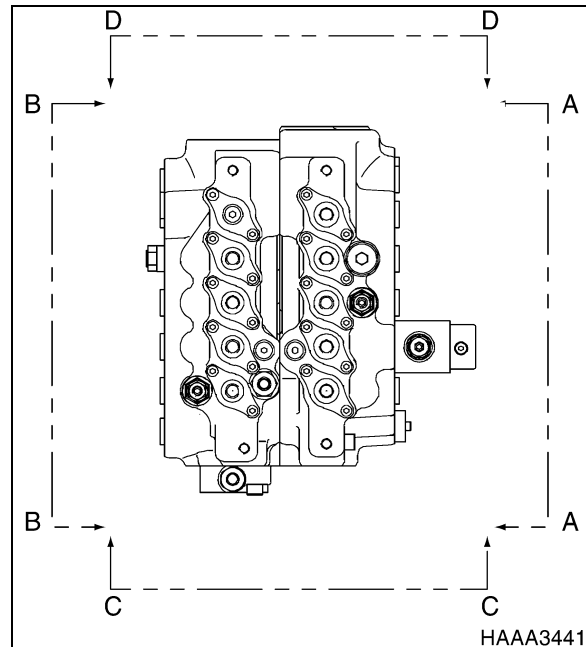


Figure 46 CONTROL VALVE BOTTOM VIEW

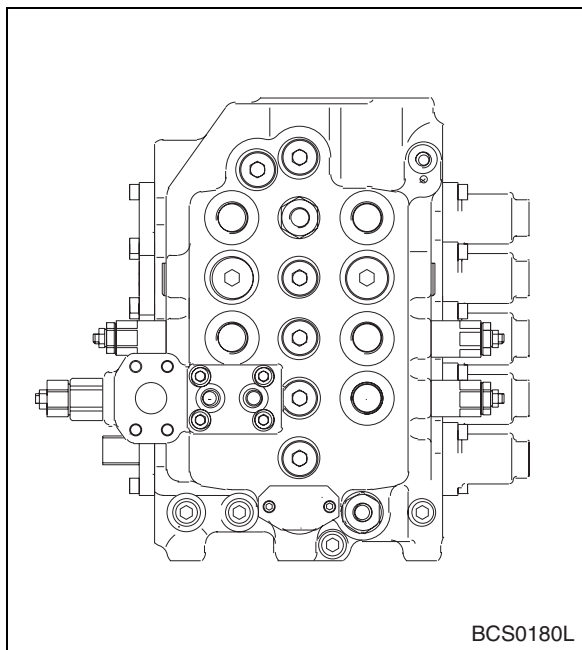


Figure 47 CONTROL VALVE LEFT VIEW A-A

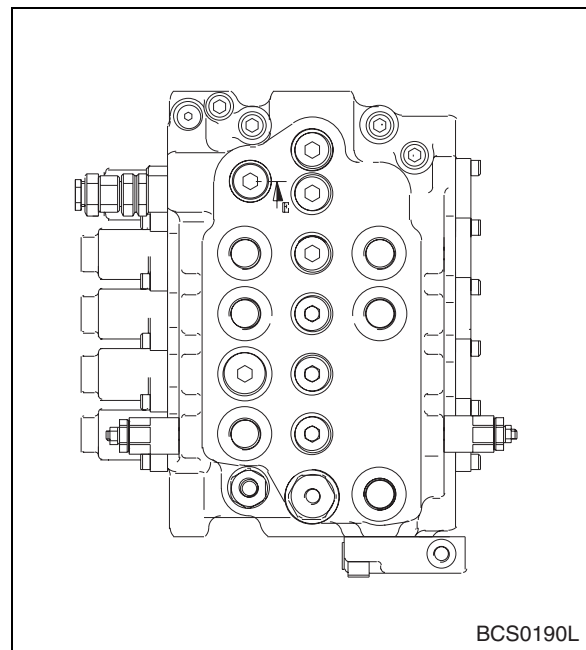


Figure 48 CONTROL VALVE RIGHT VIEW B-B

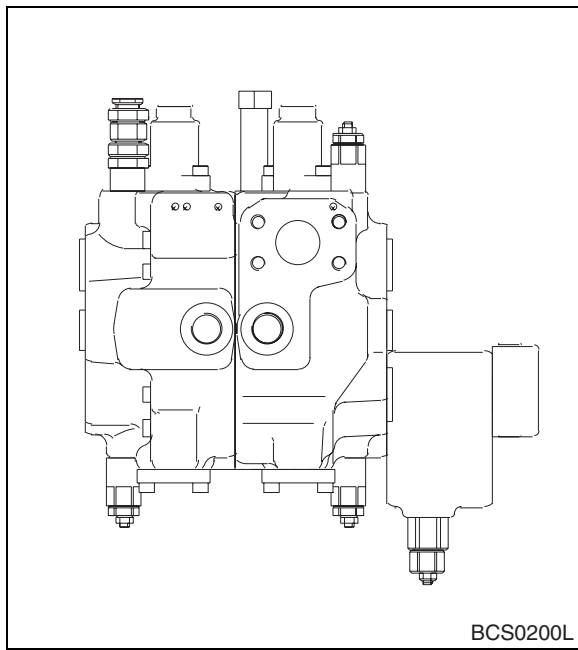


Figure 49 CONTROL VALVE FRONT VIEW C-C

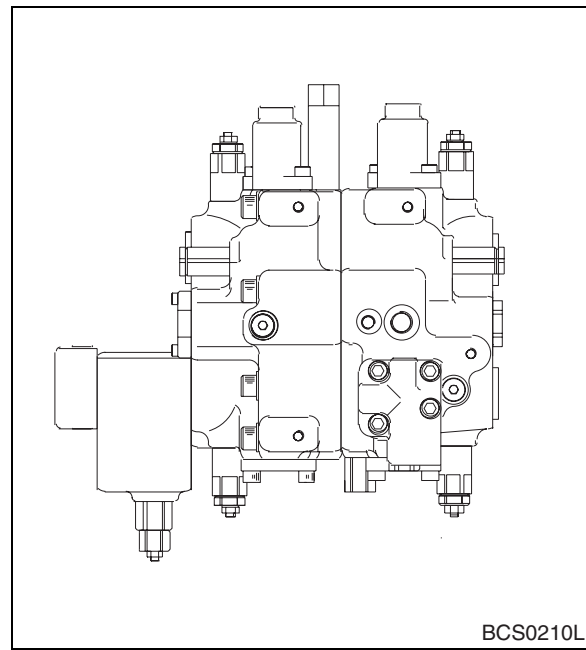


Figure 50 CONTROL VALVE REAR VIEW D-D

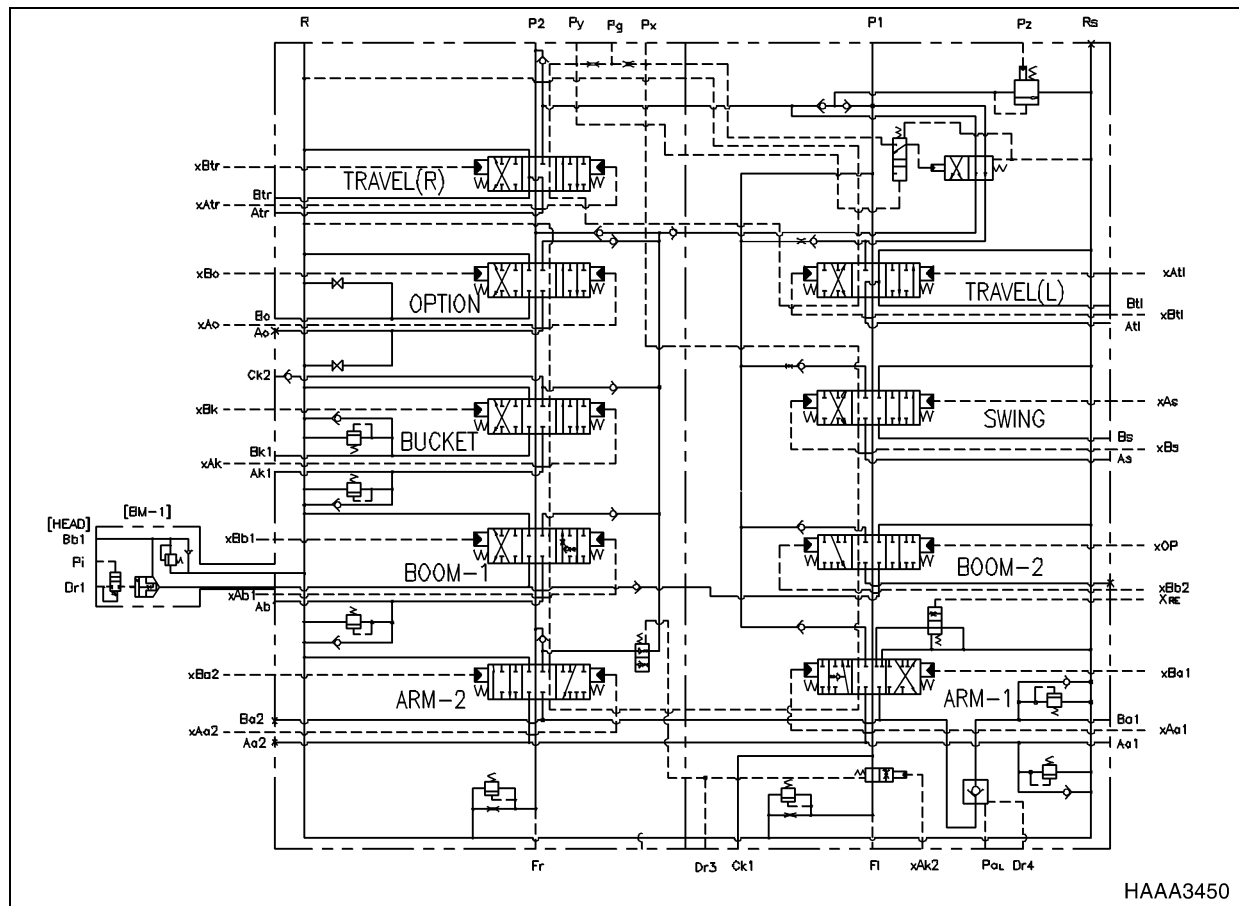


Figure 51 CONTROL VALVE HYDRAULIC CIRCUIT

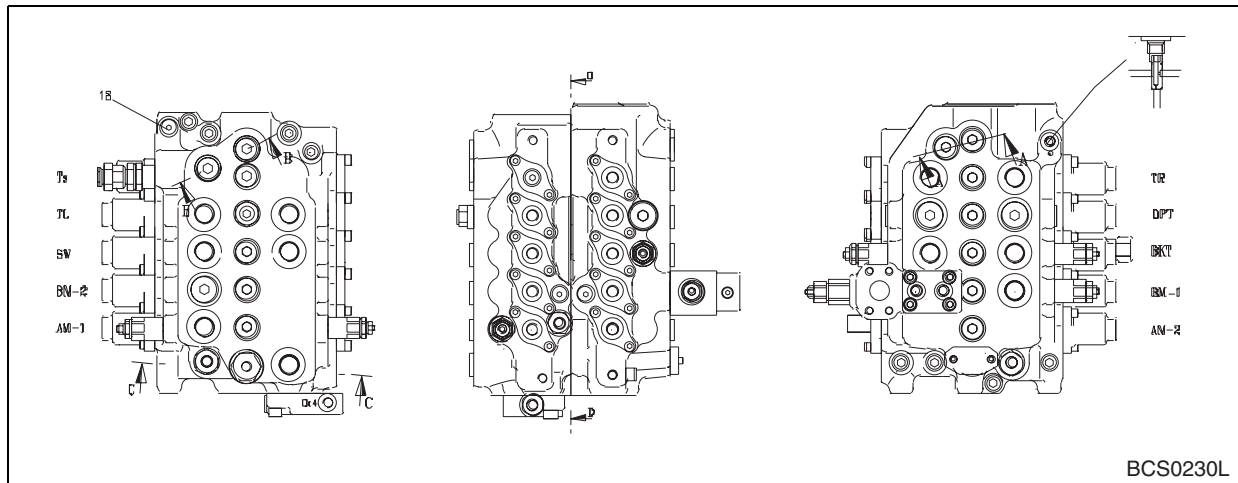


Figure 52

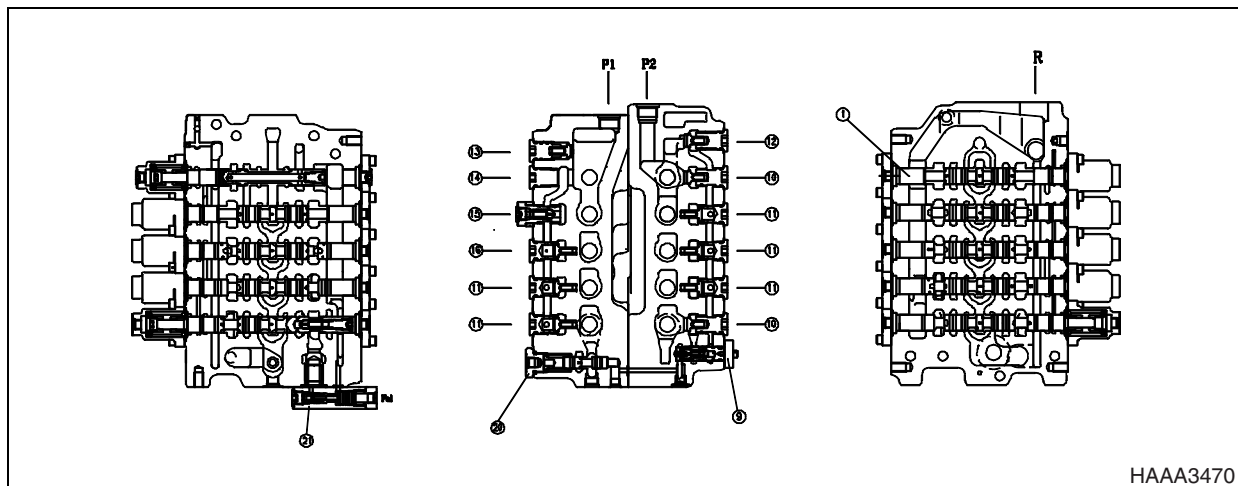


Figure 53

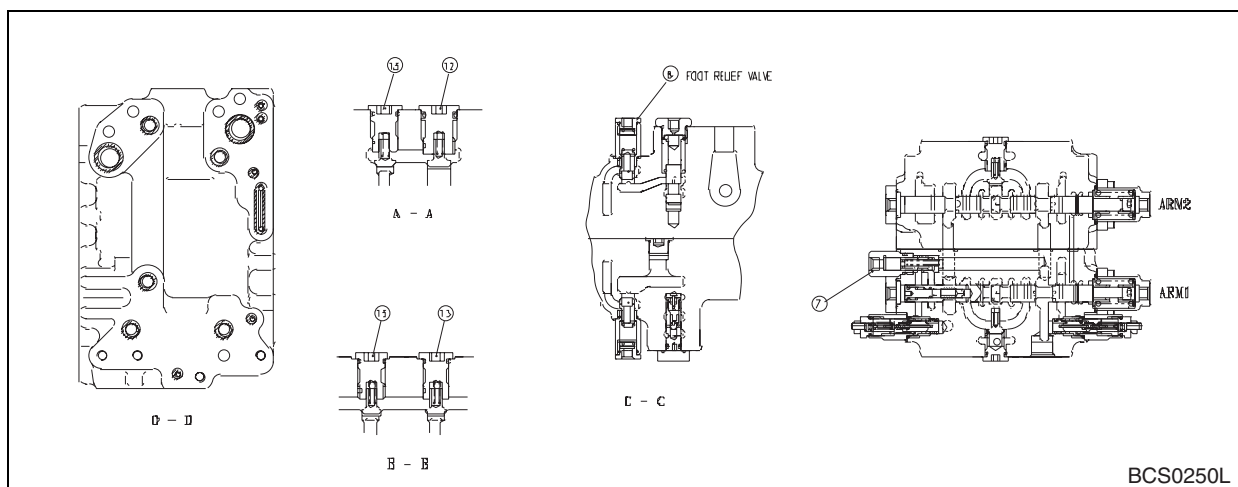


Figure 54

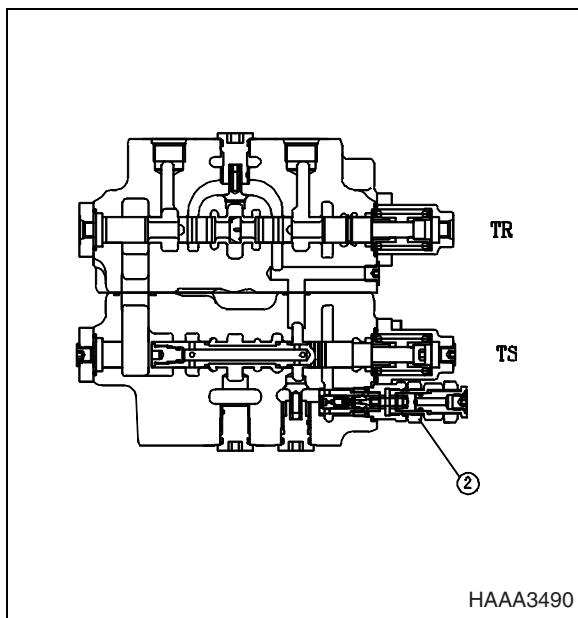


Figure 55

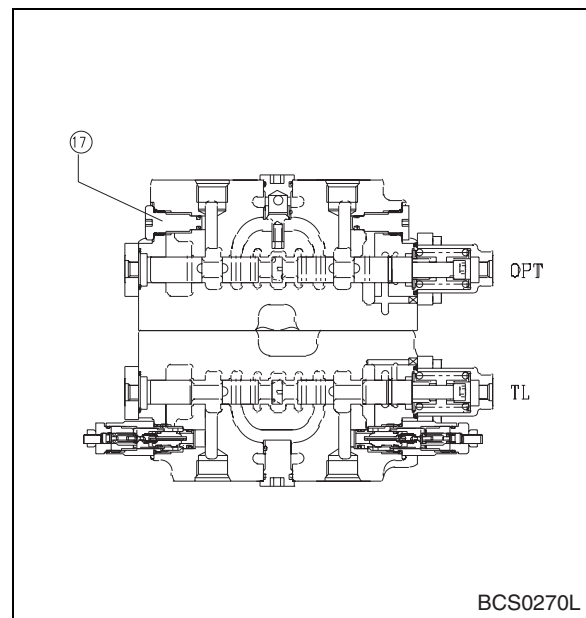


Figure 56

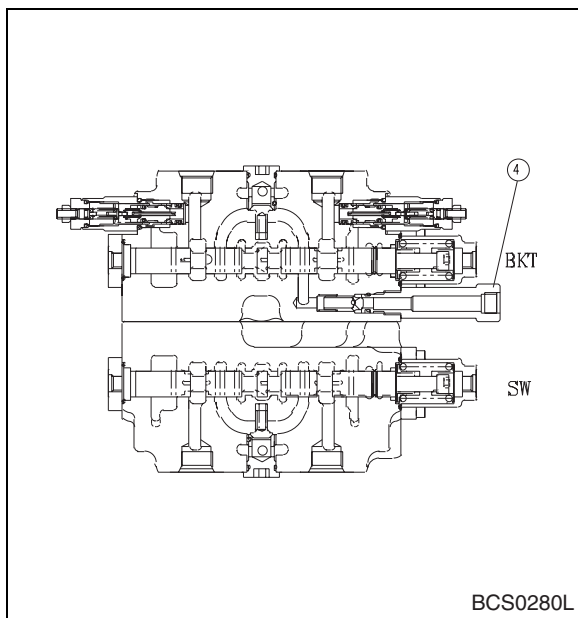


Figure 57

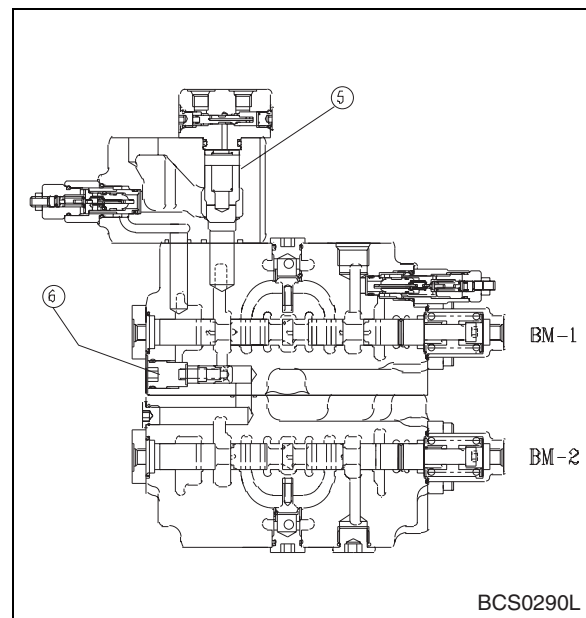


Figure 58

Reference Number	Description	Quantity
1	Main Plunger	10
2	Main Relief Valve	1
3	Overload Relief Valve (AM, BM Down, BKT, OPT)	7
4	Overload Relief Valve (BM Up)	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 (TR, AM-2)	4
11	Check Valve (OPT, BKT, BM-1, BM-2, AM-1)	5
13	Check Valve	2
14	Cap	1
15	Check Valve (TL)	1
16	Check Valve (SW)	1
17	Overload Relief Valve Plug	1
18	Bucket Conflow (Junction) Check Cap	1
20	Center Bypass Valve (CB Valve)	1
21	Arm Holding Valve	1
22	Orifice (Px, Py)	1

DISASSEMBLY AND REASSEMBLY

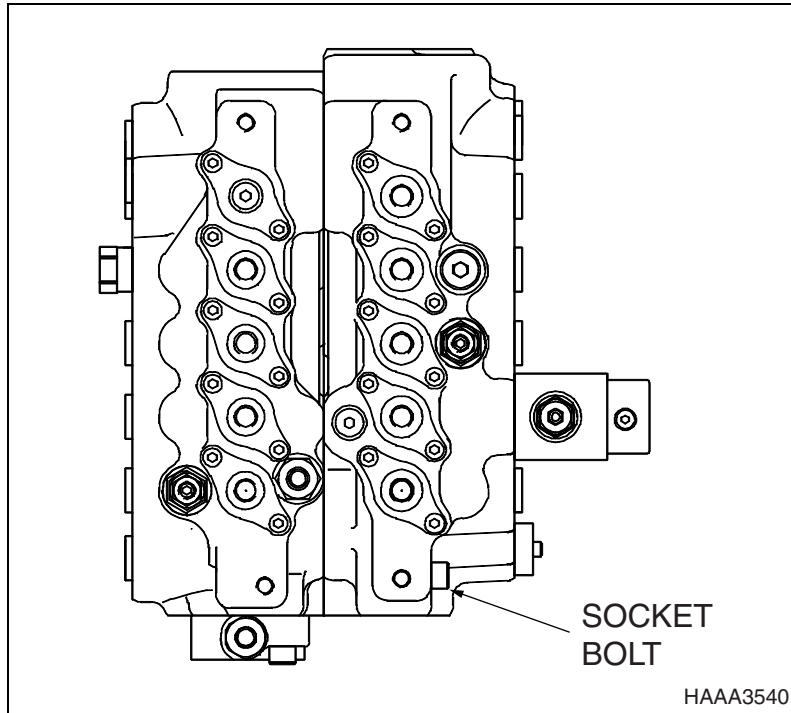


Figure 59

GENERAL DISASSEMBLY

To disassemble control valve, remove bolts from left and right side of the control valve.

Allen Key Size	10 mm
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GENERAL REASSEMBLY

Stand control valve on flat surface and tighten bolts with correct torque.

Socket Bolt Tightening Torque	10 kg•m (72 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.

MAIN PLUNGER ELEMENT

IMPORTANT

When disassembling Main Plunger element tag and label each component so that all parts can be reassembled in the proper order.

IMPORTANT

The hydraulic control valve used in the S130LC-V uses 3 different plungers. Care should be taken when disassembling and reassembling plunger assemblies.

Special 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 Across Flat Surface	Application
21.8 mm (0.86 in)	35 mm (1.38 in)	Main Plunger

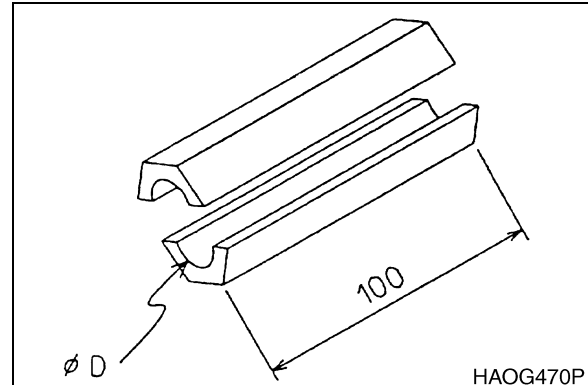


Figure 60

Length	100 mm (3.94 in)
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Service

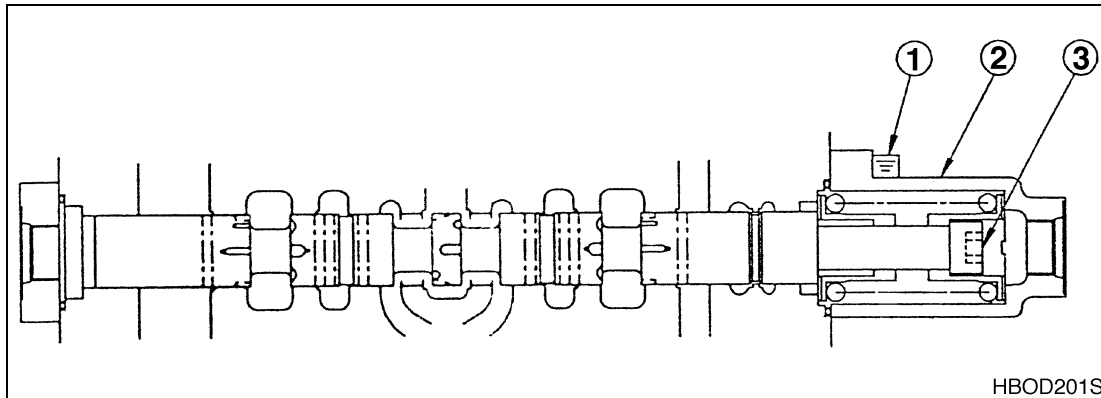


Figure 61

Reference Number	Description
1	6 mm Allen head Style Bolts
2	Plunger Cover
3	Plunger cap bolt

1. Remove two bolts (1) from cover and remove cover (2) from valve housing.

Allen head style bolt	6 mm
Tightening torque	3 kg•m (22 ft lb)

2. Pull out plunger sub-assembly from housing.

IMPORTANT

Do not force out plunger. Pull out plunger slowly, to avoid damage.

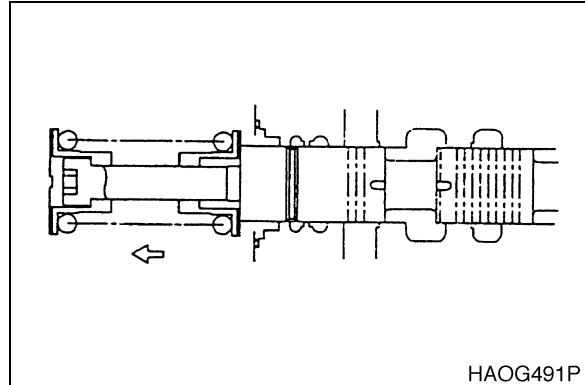


Figure 62

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)

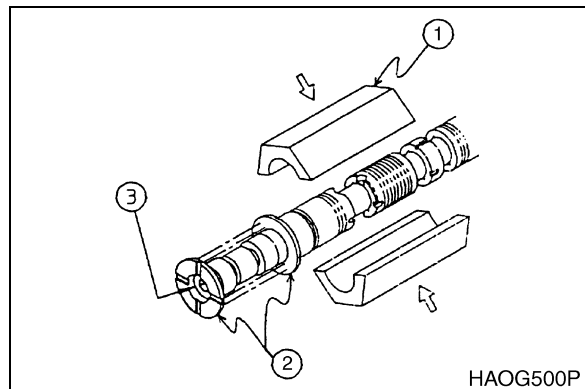


Figure 63

4. Remove plunger cap bolt (3), upper spring guide (4), spring (5) and lower spring guide (4).

IMPORTANT

Use caution when disassembling and assembling plungers. The travel straight spring and plunger cap bolts are different from the others.

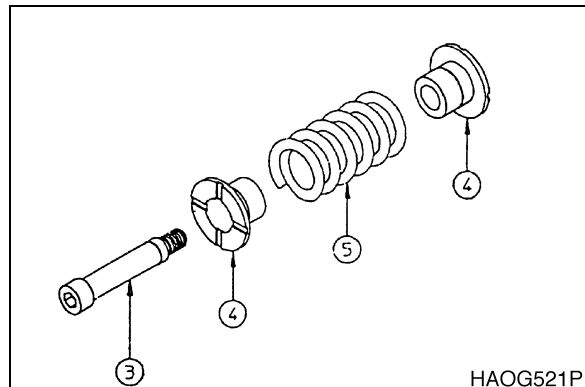


Figure 64

5. Plunger (Lower side)

AM-1: Remove cap (7), O-rings, backup spring, spring (8) and check valve (9).

Lower cap hex hole	6 mm
Tightening torque	3 kg•m (22 ft lb)

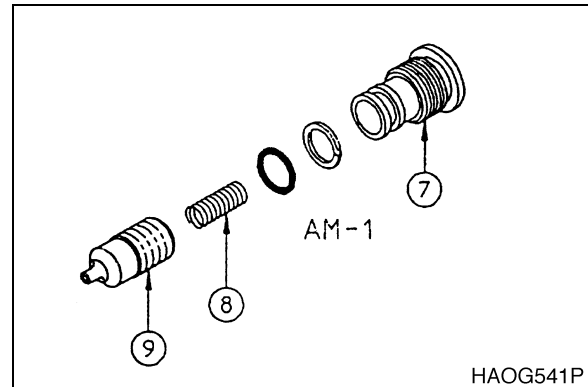


Figure 65

TS: Remove cap (7), O-ring and backup spring.

Lower cap hex hole	6 mm
Tightening torque	3 kg•m (22 ft lb)

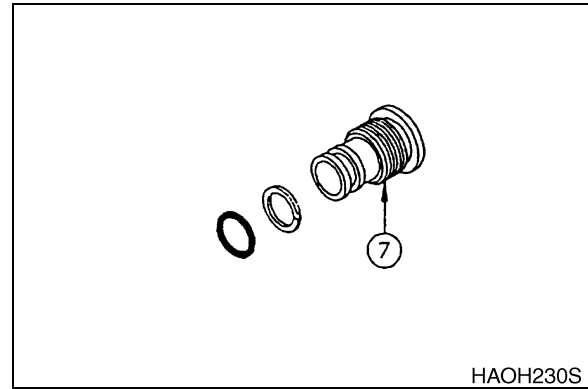


Figure 66

MAIN RELIEF VALVE

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 seat	
6	Lower sleeve	
7	Sleeve	27 mm

1. Hold adjusting screw (1) and loosen hexagonal nut (2).
2. Hold cap (4) and loosen hexagonal nut (3).
3. Loosen cap (4) and remove valve assembly by unscrewing cap (4).

Reference number	Description
6	Lower sleeve
8	Piston
9	Spring
10	Orifice

4. Remove lower sleeve (6) from cap (4) by gently pulling sleeve out of cap. Remove piston (8), spring (9) and orifice (10) from lower sleeve.

IMPORTANT

Further disassembly of pilot sheet from the cap is not recommended, as it is pressed in at the factory.

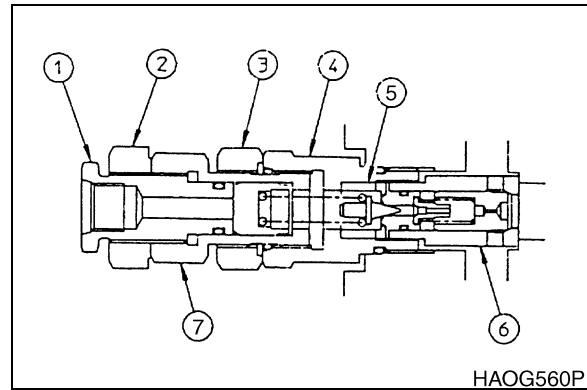


Figure 67

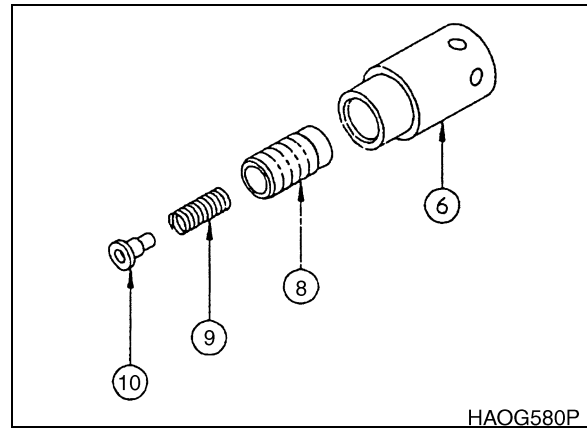


Figure 68

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.

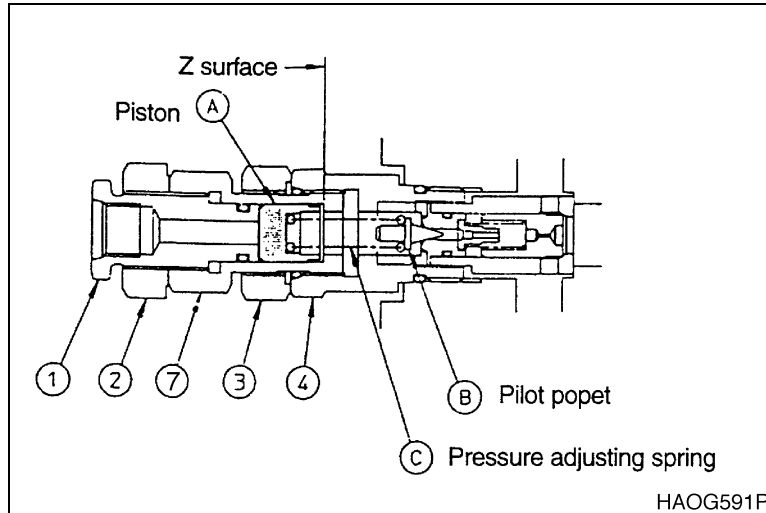


Figure 69

IMPORTANT

Inspect all O-ring gaskets for damage and replace as necessary. Never reuse damaged or questionable O-rings.

Main Relief Valve - Reassembly

1. Insert piston (A) into sleeve (7). Assemble hex nut (2) onto adjustment screw (1). Assemble adjustment screw (1) to sleeve (7), until piston (A) is seated.
2. Insert pilot poppet (B) into pressure adjustment 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)
--------------------------	--------------------

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 adjustment screw (1).
2. After the desired pressure has been adjusted, tighten hexagonal nut (2) while adjustment 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 that all parts can be reassembled in the proper order.

IMPORTANT

Do not disassemble the pressure adjustment element. The pressure is factory set and can not 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	27 mm
Tightening torque	6 kg•m (43 ft lb)

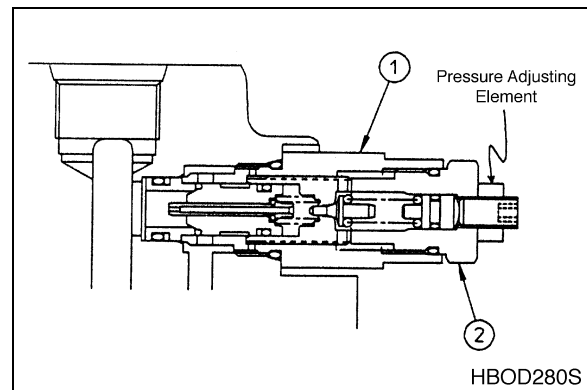


Figure 70

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	24 mm
Tightening torque	6 kg•m (43 ft lb)

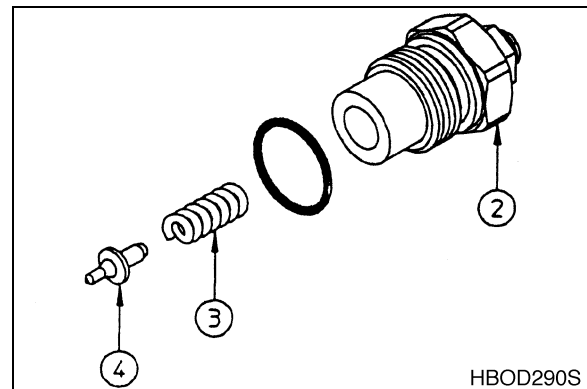


Figure 71

3. Remove pilot seat (5), outer spring (6), inner spring (7), piston (8), O-ring, backup spring and main poppet (9).

Reference Number	Description
5	Pilot seat
6	Outer spring
7	Inner spring
8	Piston
9	Main Poppet

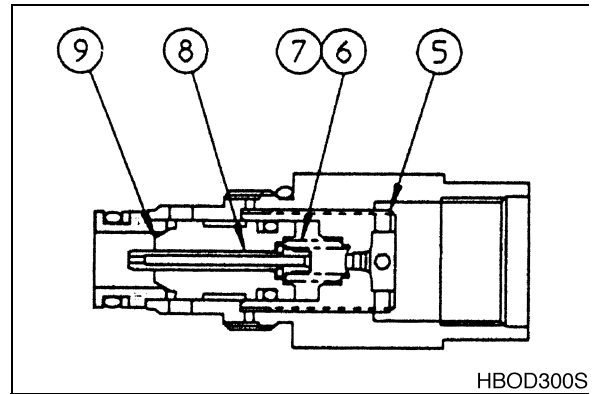


Figure 72

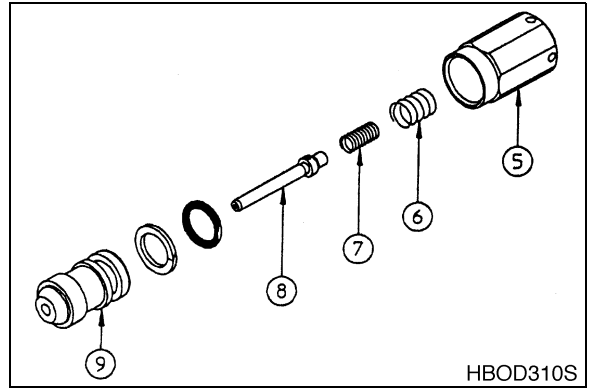


Figure 73

OVERLOAD RELIEF VALVE (BM UP)

IMPORTANT

When disassembling Overload Relief Valve, tag and label each component so that all parts can be reassembled in the proper order.

IMPORTANT

Do not disassemble the pressure adjustment element. The pressure is factory set and can not 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	27 mm
Tightening torque	6 kg•m (43 ft lb)

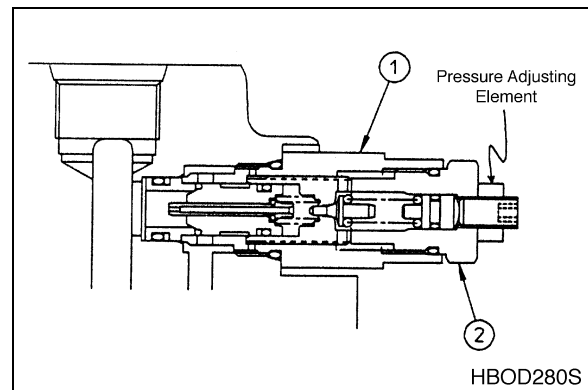


Figure 74

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	24 mm
Tightening torque	6 kg•m (43 ft lb)

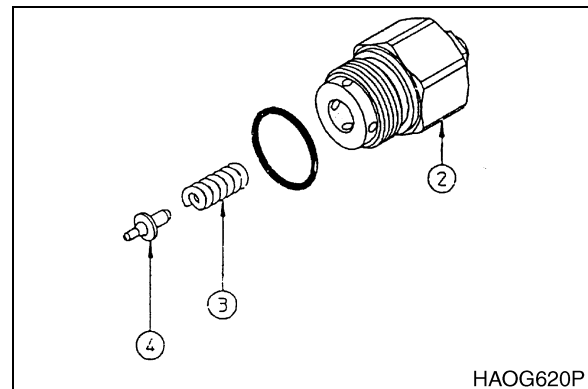


Figure 75

3. Remove pilot seat (5), outer spring (6), inner spring (7), piston (8), O-ring, backup spring and main poppet (9).

Reference Number	Description
5	Pilot seat
6	Outer spring
7	Inner spring
8	Piston
9	Main Poppet

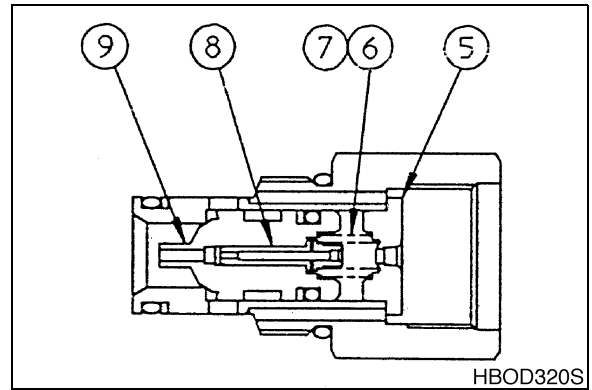


Figure 76

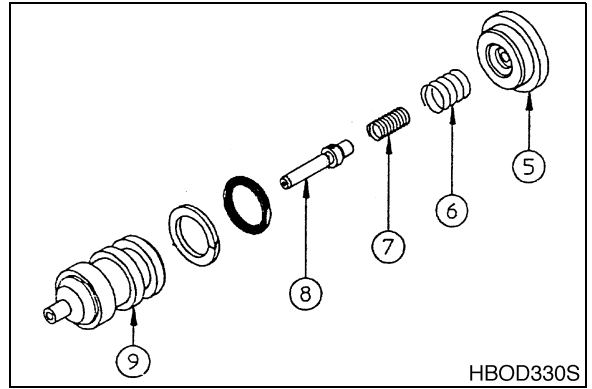


Figure 77

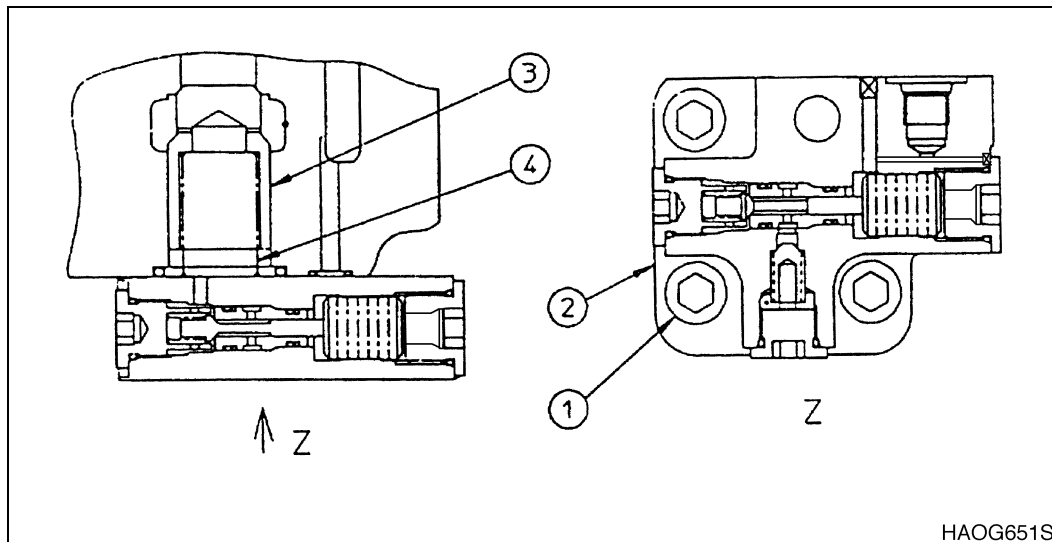
ARM LOAD HOLDING VALVE

IMPORTANT

When disassembling Arm Load Holding Valve, tag and label each component so that all parts can be reassembled in the proper order.

Check Valve Main Body

1. Remove allen-style bolts (1) and cover (2).

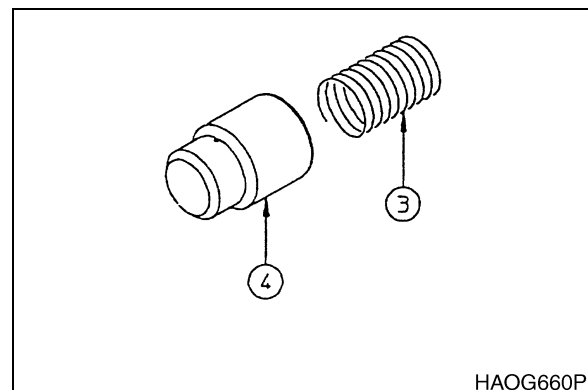


Mounting Bolt Allen Socket	10 mm
Tightening Torque	10 kg•m (72 ft lb)

IMPORTANT

When assembling cover, inspect O-rings for any damage and replace as necessary.

2. Remove spring (3) and poppet (4).



Cover Assembly

Reference Number	Description
1	Cap
2	Spring
3	Check
4	Cap
5	Piston
6	Sleeve
7	Poppet
8	Spring
9	Cap

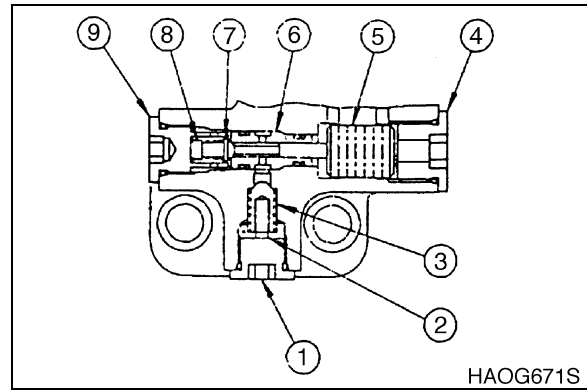


Figure 80

1. Loosen cap (1) and remove spring (2) and check (3).

Cap hex hole size	8 mm
Tightening torque	5 kg•m (36 ft lb)

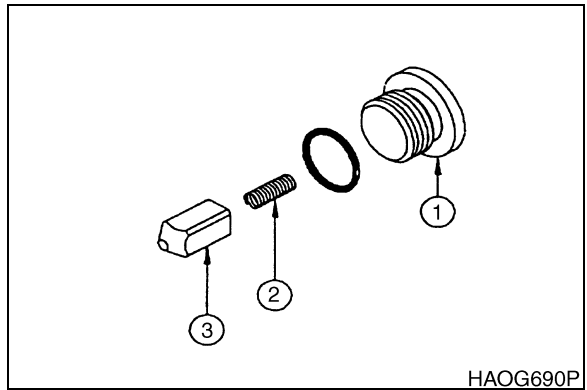


Figure 81

2. Loosen cap (4) and remove piston (5).

Cap hex hole size	10 mm
Tightening torque	6 kg•m (43 ft lb)

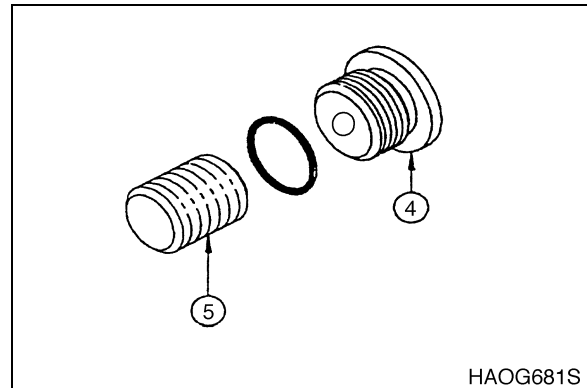


Figure 82

3. Loosen cap (9) and remove spring (8) and poppet (7).

Cap hex hole size	8 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.

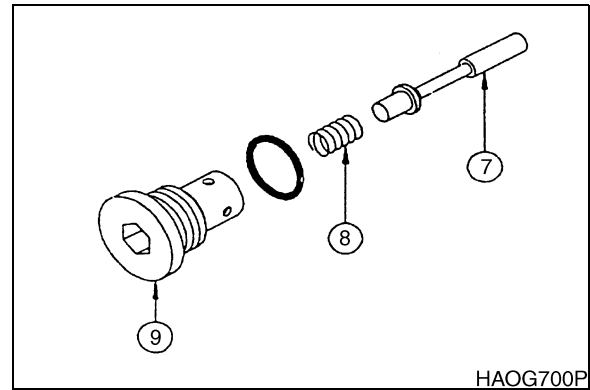


Figure 83

BOOM LOAD HOLDING VALVE

IMPORTANT

When disassembling Boom Load Holding Valve, tag and label each component so that all parts can be reassembled in the proper order.

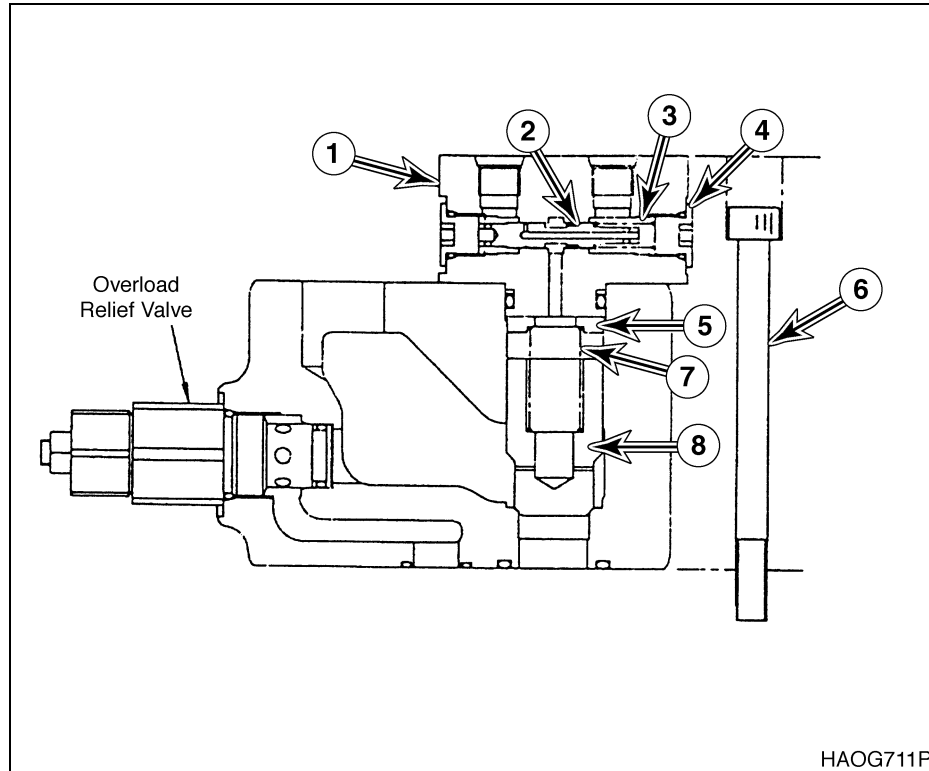


Figure 84

Reference Number	Description
1	Cover
2	Spool
3	Spring
4	cap

Reference Number	Description
5	Spring Seat
6	Allen Head Bolt
7	Spring
8	Poppet

1. Remove allen head bolts (6) and remove cover (1).

Allen head bolt size	8 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 Seat (5), Spring (7) and Poppet (8) from manifold bore.

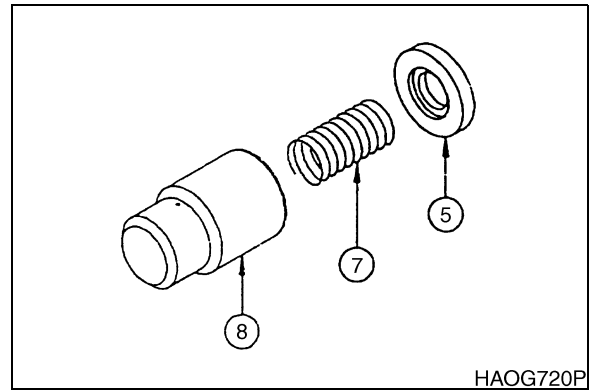


Figure 85

3. Loosen cap (4) and remove spring (3) and spool (2).

Cap allen hole size	6 mm
Tightening torque	3 kg•m (22 ft lb)

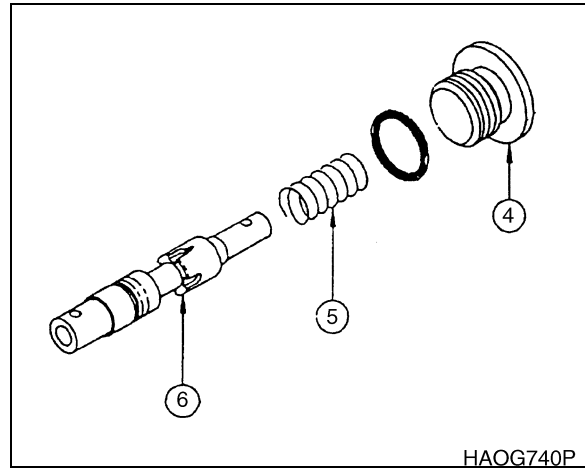


Figure 86

ARM REGENERATION VALVE

IMPORTANT

When disassembling Arm Regeneration Valve, tag and label each component so that all parts can be reassembled in the proper order.

Reference Number	Description
1	Cap
2	Piston
3	Spool
4	Spring
5	Sleeve

1. Loosen cap (1) and remove piston (2).

Cap wrench size	27 mm
Tightening torque	10 kg•m (72 ft lb)

2. Remove spool (3), spring (4) and sleeve (5) from housing.

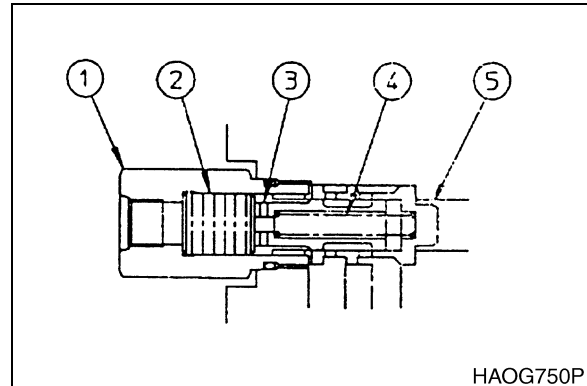


Figure 87

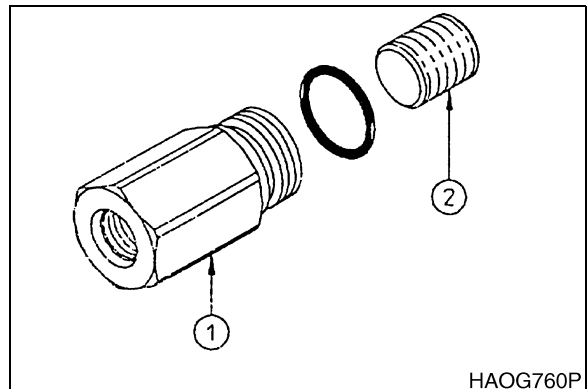


Figure 88

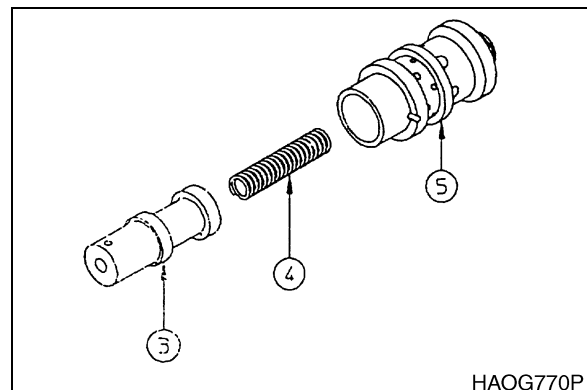


Figure 89

FOOT RELIEF VALVE

IMPORTANT

When disassembling Foot Relief Valve, tag and label each component so that all parts can be reassembled in the proper order.

Reference Number	Description
1	Cap
2	Poppet
3	Cap
4	Shim
5	Spring

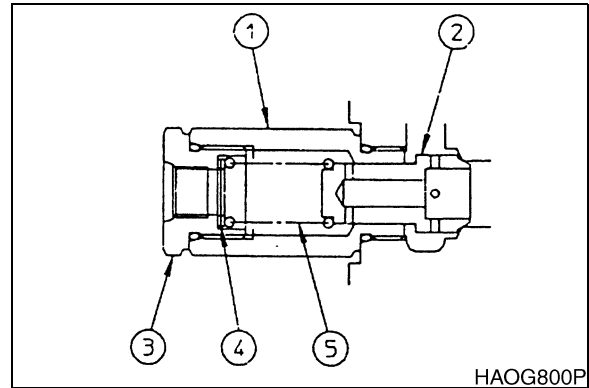


Figure 90

- Loosen cap (1) and remove poppet (2).

Cap wrench size	30 mm
Tightening torque	6 kg•m (43 ft lb)

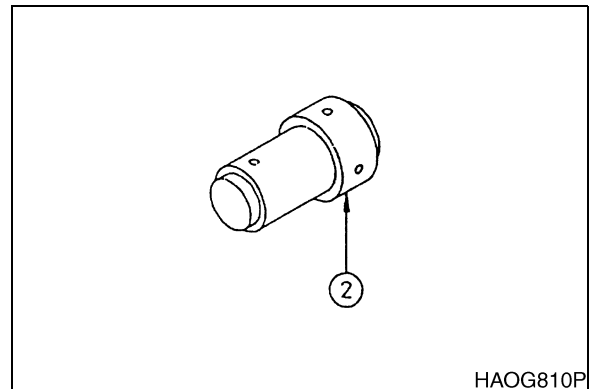


Figure 91

- Loosen cap (3) and remove shim (4) and spring (5).

Cap wrench size	30 mm
Tightening torque	6 kg•m (43 ft lb)

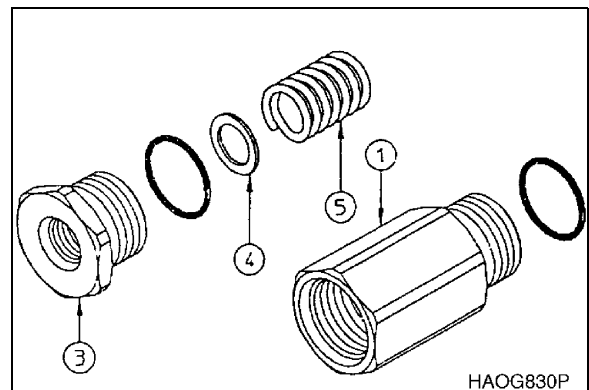


Figure 92

IMPORTANT

Shim is necessary for correct pressure adjustment and must not be left out.

CENTER BYPASS VALVE (CB VALVE)

IMPORTANT

When disassembling Center Bypass Valve, tag and label each component so that all parts can be reassembled in the proper order.

Reference Number	Description
1	Cap
2	Spring
3	Spool

1. Loosen cap (1) and remove spring (2) and spool (3).

Cap wrench size	36 mm
Tightening torque	8 kg•m (58 ft lb)

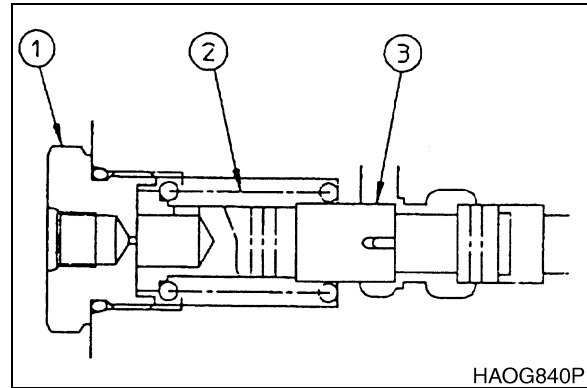


Figure 93

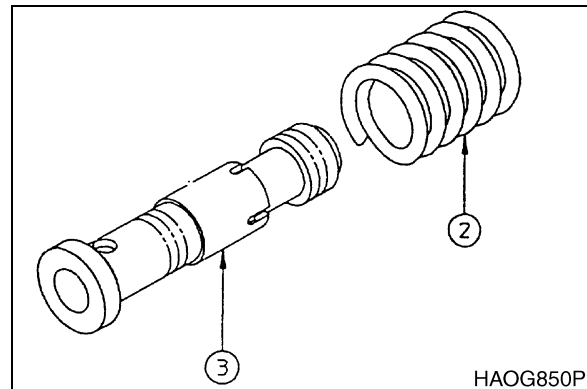


Figure 94

ARM PARALLEL SWITCH VALVE

IMPORTANT

When disassembling Arm Parallel Switch Valve, tag and label each component so that all parts can be reassembled in the proper order.

Special Tool

This holding tool is used to clamp and hold BP 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 mm (0.75 in)	32 mm (1.26 in)	BP Spool

Length	100 mm (3.94 in)
--------	---------------------

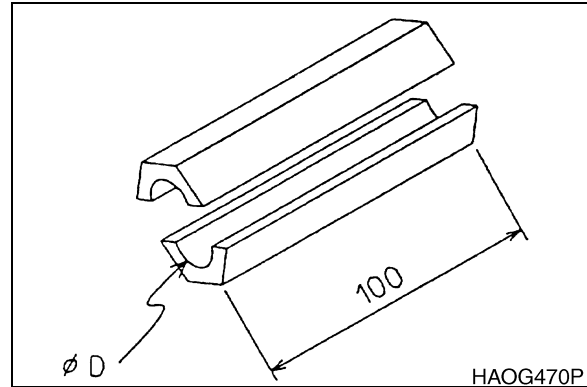


Figure 95

Service

Reference Number	Description
1	Spacer
2	Screw
3	Cap
4	O-ring
5	Spring
6	Check
7	Spool Ap
8	O-ring
9	Backup Ring
10	Retainer
11	Bolt With Hole

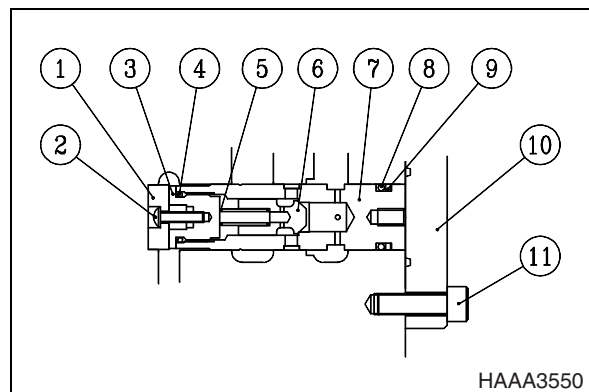


Figure 96

1. Remove allen head bolts (1) and cover (2).

Allen hole size	5 mm
Tightening torque	1.2 kg•m (9 ft lb)

IMPORTANT

When assembling cover, inspect O-rings for any damage and replace as necessary.

2. Slide out spool assembly and remove spring (3).

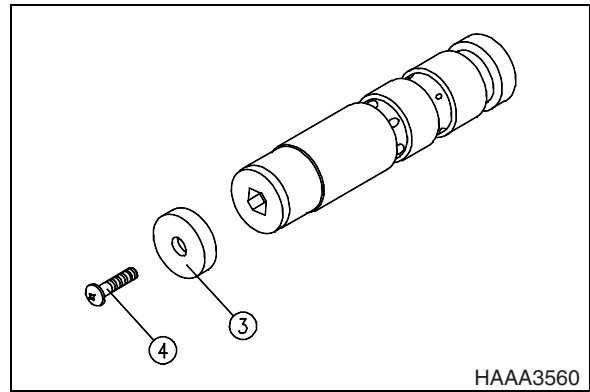


Figure 97

3. Using the tool described above, clamp and hold the spool in place. Remove cap (4), Spring (5) and check (6).

Allen hole size	6 mm
Tightening torque	3.5 kg•m (25 ft lb)

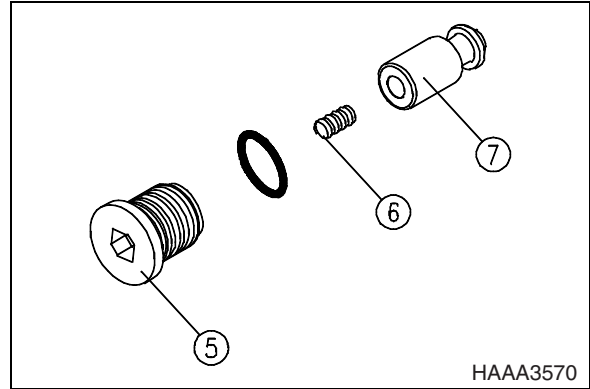


Figure 98

BOOM UNITY CHECK VALVE

IMPORTANT

When disassembling Boom Unity Check Valve, tag and label each component so that 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	Spring
3	Check

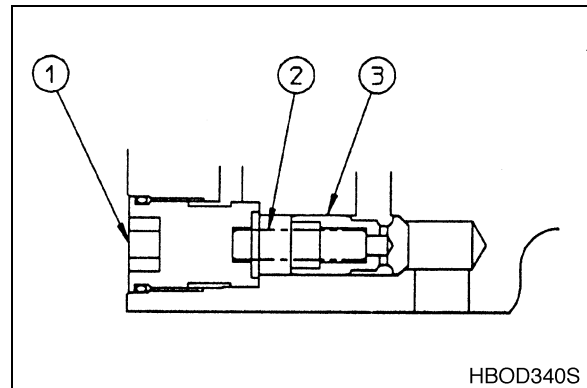


Figure 99

1. Loosen cap (1), remove stopper (2), spring (3) and check (4).

Cap hole size	12 mm
Tightening torque	10 kg•m (72 ft lb)

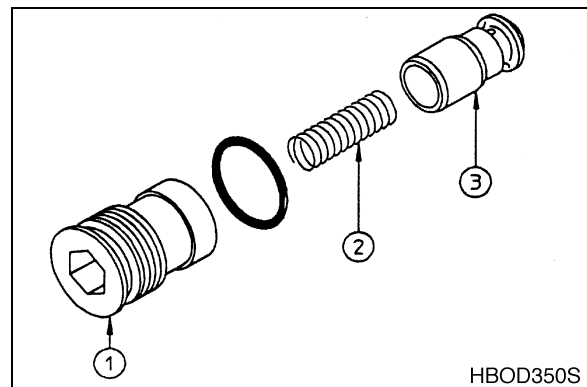


Figure 100

STRAIGHT TRAVEL SELECTOR VALVE

IMPORTANT

When disassembling Swing Straight Travel Valve, tag and label each component so that 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

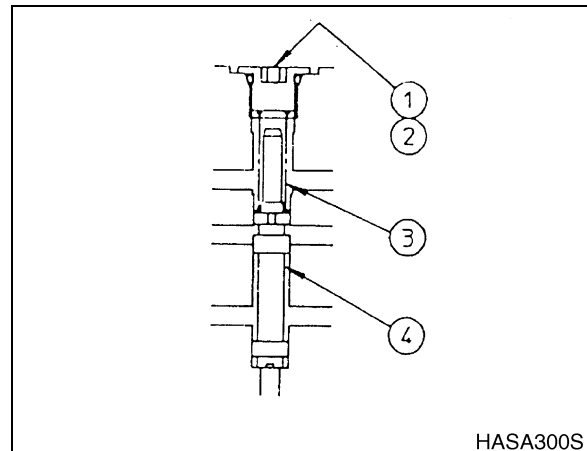


Figure 101

1. Loosen cap (1), remove stopper (2), spring (3) and check (4).

Cap hole size	8 mm
Tightening torque	4 kg•m (29 ft lb)

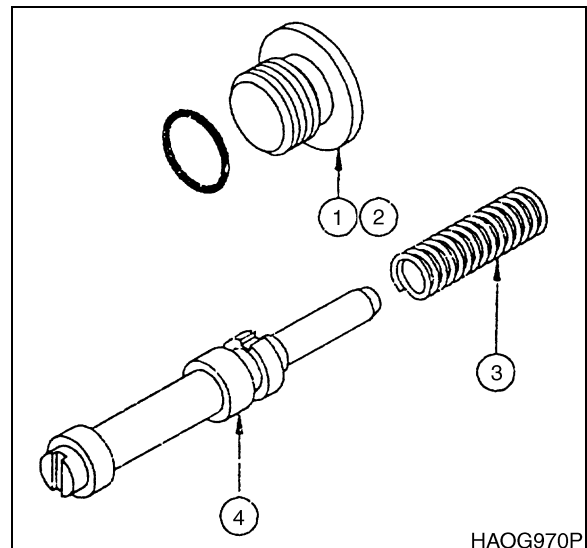


Figure 102

CHECK VALVE - LOCATIONS

Valve Location Reference	Description
A	TR, AM2
B	BKT, OPT, BM1, BM2, AM1
C	Main Relief Valve
D	SW
E	TL
F	Cap Only

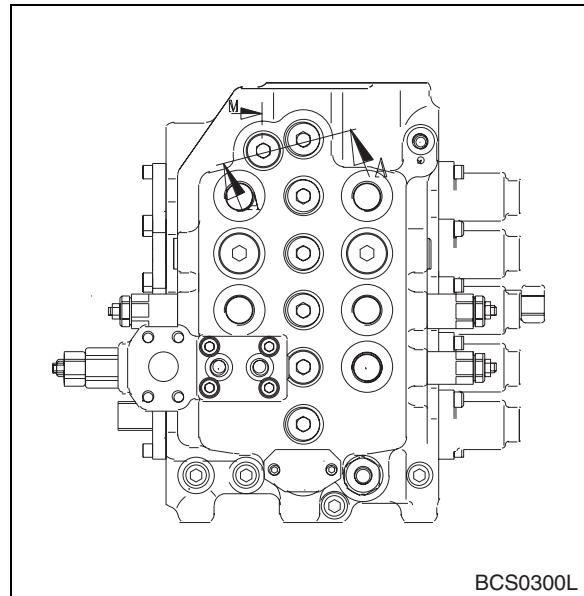


Figure 103

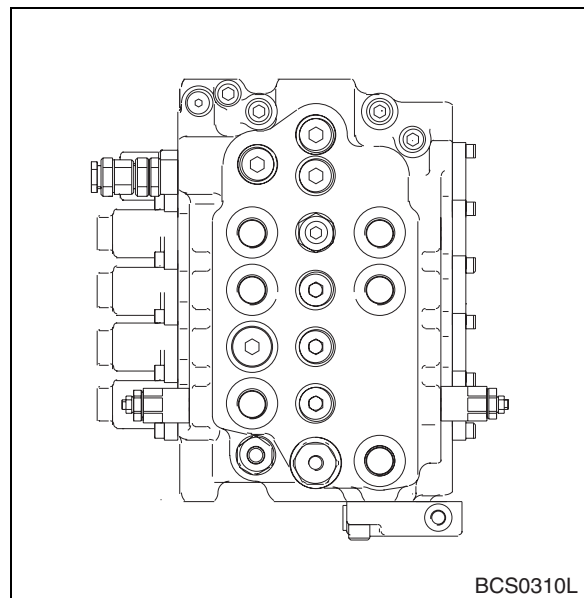


Figure 104

CHECK VALVE

IMPORTANT

When disassembling Check Valves, tag and label each component so that all parts can be reassembled in the proper order.

A: Check Valve (TR, AM2)

Reference Number	Description
1	Cap
2	Spring
3	Check

Cap hole size	12 mm
Tightening torque	15 kg•m (108 ft lb)

1. Loosen cap (1), remove spring (2) and check (3).

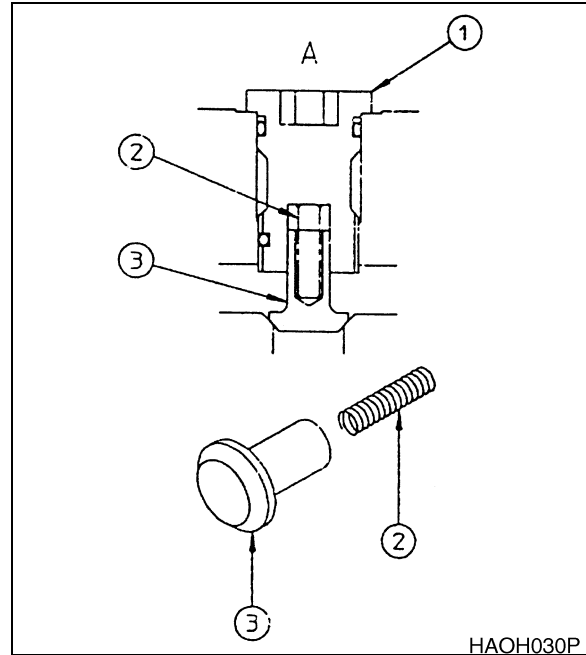


Figure 105

B: Check Valve (OPT, BKT, BM1, BM2, AM1)

Reference Number	Description
1	Cap
2	Spring
3	Check

Cap hole size	12 mm
Tightening torque	15 kg•m (108 ft lb)

1. Loosen cap (1), remove spring (2) and check (3).

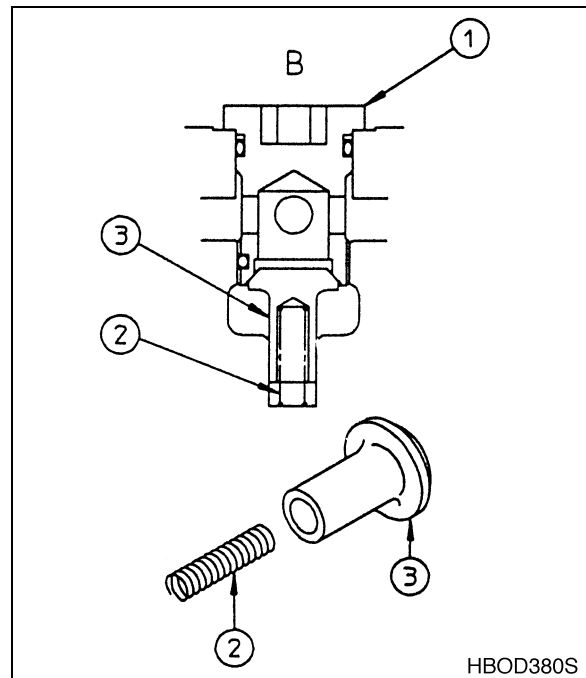


Figure 106

C: Check Valve (Main Relief Valve)

Reference Number	Description
1	Cap
2	Spring
3	Check

Cap hole size	12 mm
Tightening torque	15 kg•m (108 ft lb)

1. Loosen cap (1), remove spring (2) and check (3).

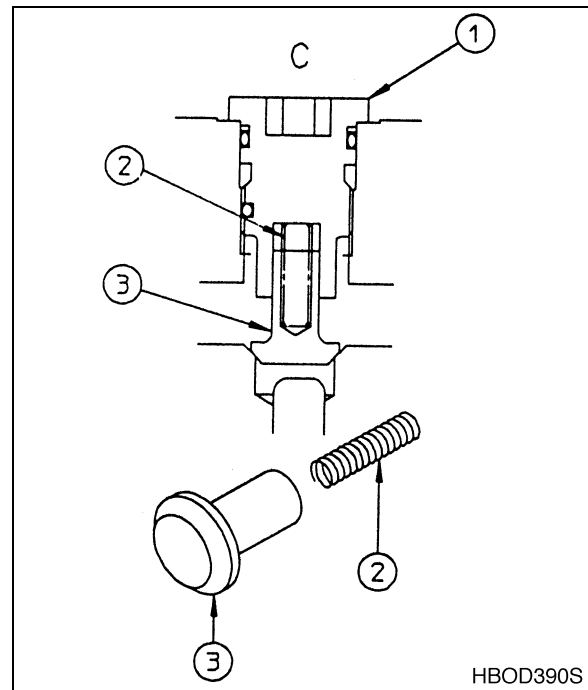


Figure 107

D: Check Valve (SW)

IMPORTANT

SP valve must be removed first, before removing SW valve.

IMPORTANT

The SW & AM-1 sleeves may look similar but are different and can not be interchanged.

Reference Number	Description
1	Cap
2	Backup Ring
3	O-ring
4	Spring
5	Nylon Clip
6	Check

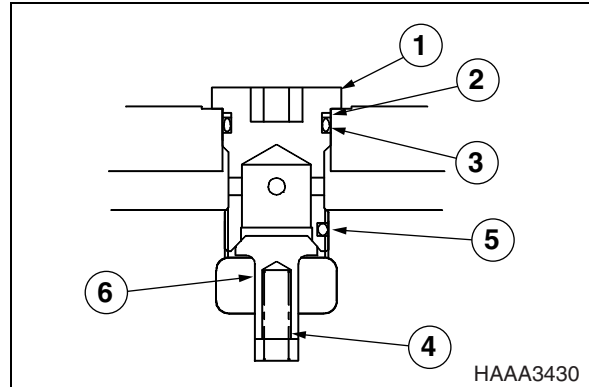


Figure 108

E: Check Valve (TL)

Reference Number	Description
1	Cap
2	Cap
3	Spring
4	Check

Cap 1 hole size	32 mm
Tightening torque	10 kg•m (72 ft lb)

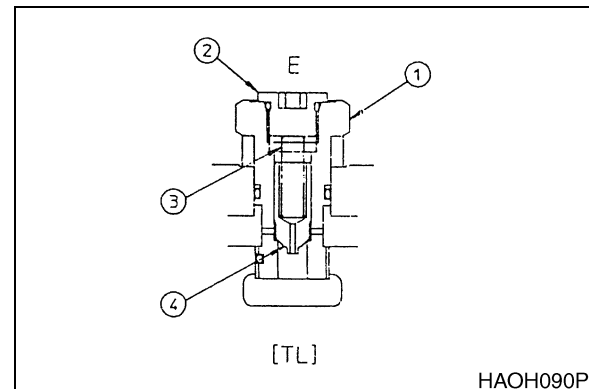


Figure 109

1. Loosen cap (1), remove spring (2) and check (3).

Cap 2 hole size	8 mm
Tightening torque	4 kg•m (29 ft lb)

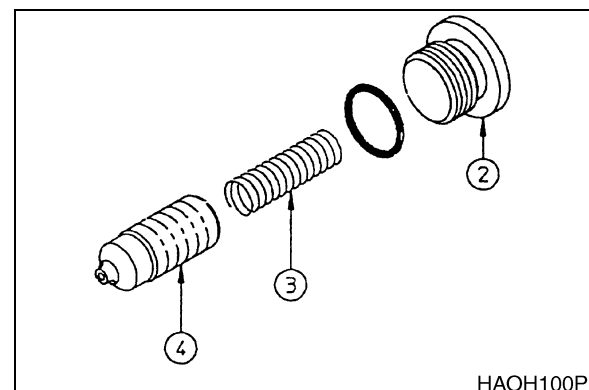


Figure 110



PILOT CONTROL VALVE (WORK LEVER / JOYSTICK)



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 75-V	1001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 210W-V	1001 and Up
Solar 225LC-V	1001 and Up
Solar 225NLC-V	1001 and Up
Solar 255LC-V	1001 and Up
Solar 300LC-V	1001 and Up
Solar 340LC-V	1001 and Up

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GENERAL DESCRIPTION

THEORY OF OPERATION

Structure

The remote control valve contains four push rods, spring holders, spools and return springs, which are located in the valve casing. The valve works as a pressure reduction valve.

The housing has six ports, which include input port P, tank port T, and four secondary pressure ports.

The electric horn switch is installed in the valve handle. Gear pump pressure is used for operating control spools.

Function

1. Neutral Mode

When the lever is in neutral mode, the spool is thrust upward by return spring, and the force of balancing spring, which determines the secondary discharge pressure, is not transmitted to the spool. The input port is closed and the pressure of the output port is the same as the pressure of the tank port T.

2. Control Mode

When push rod is pushed, the balance spring begins to compress, and spring force is conveyed to the spool. Ports P and T are then connected together and the pilot pressure is conveyed to the area. Output pressure works on the bottom of the spool, thrusting the spool upward until it is balanced with the power of the balance spring. The secondary pressure (output pressure), therefore, changes in proportion to the compression force of the balance spring.

PARTS LIST

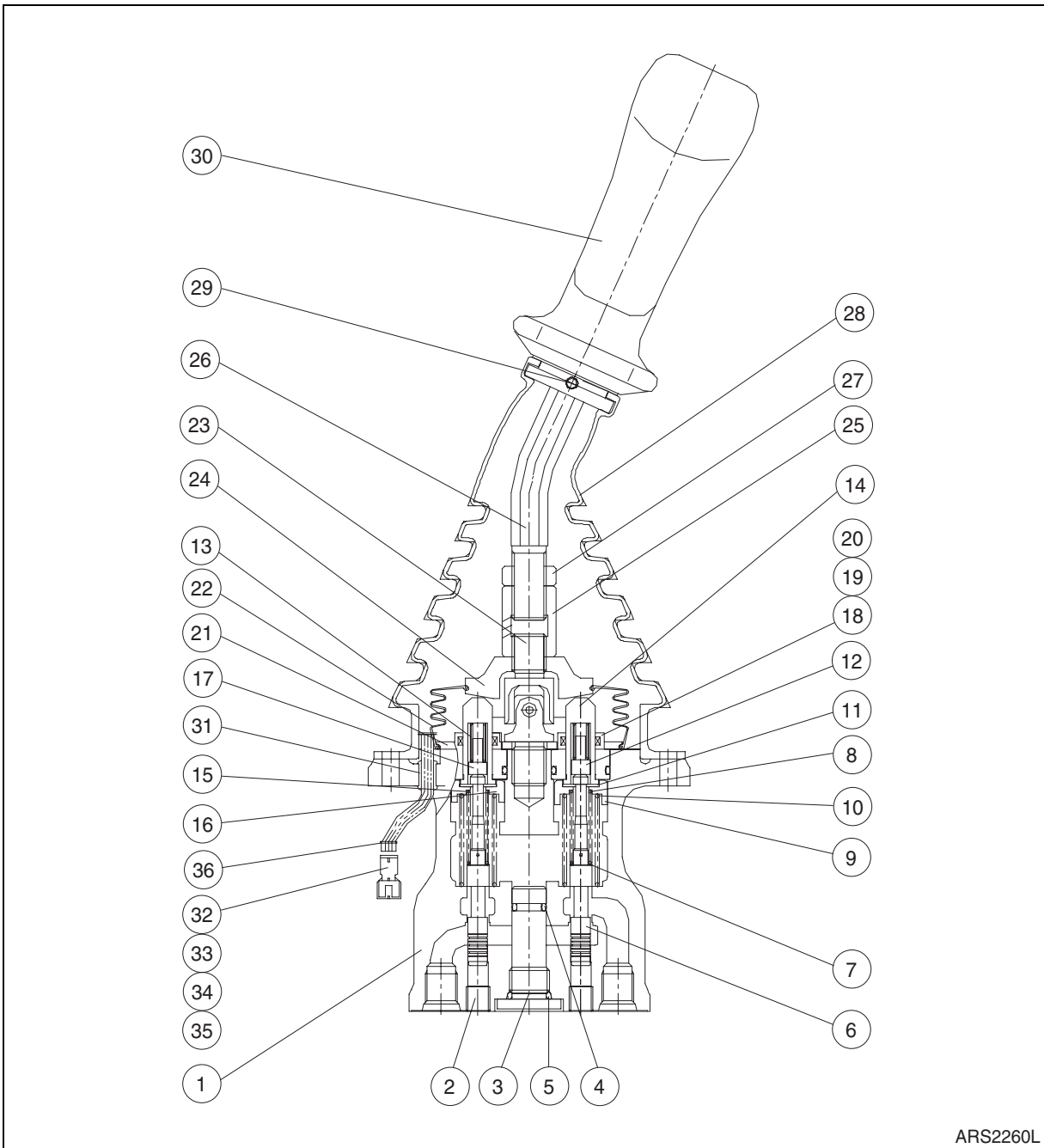


Figure 1

Reference Number	Description
1	Case
2	Plug
3	Plug
4	O-ring
5	O-ring
6	Spool
7	Shim
8	Spring
9	Spring Seat
10	Spring
11	Stopper
12	Stopper
13	Spring
14	Push Rod
15	Spring
16	Spring Seat
17	Stopper
18	Plug

Reference Number	Description
19	O-ring
20	Rod Seal
21	Plate
22	Boot
23	Joint Assembly
24	Swash Plate
25	Hex Nut
26	Handle Bar
27	Nut
28	Boot
29	Spring Pin
30	Handle Assembly
31	Bushing
32	Terminal
33	Seal Wire
34	Housing
35	Holder Rear
36	Clip Band

SPECIFICATIONS

Pilot Control Valve	Specification
Type	Pilot Control (2-Stage Joystick)
Pressure / Stroke	(1,3) 28 kg/cm ² @ 6.5 mm Stroke (398 psi @ 0.256 in. Stroke) (2,4) 28 kg/cm ² @ 7.5 mm Stroke (398 psi @ 0.295 in. Stroke)
Weight	4.8 kg (11 lb)

Torques

Reference Number	Bolt Size	Tool	Torque
2	PT 1/8	5 mm L-Wrench	150 kg•cm (11 ft lb)
3	PF 3/8	8 mm L-Wrench	500 kg•cm (36 ft lb)
24	M14	24 mm Spanner	1,240 kg•cm (90 ft lb)
25	M14	22 mm Spanner	1,240 kg•cm (90 ft lb)
27	M14	22 mm Spanner	1,240 kg•cm (90 ft lb)

Performance

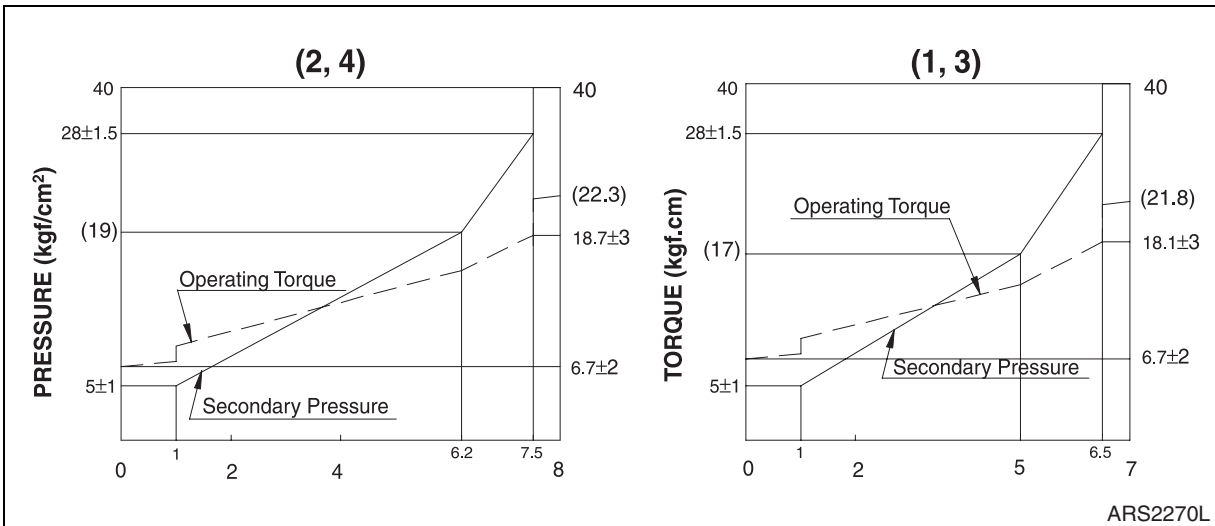


Figure 2

REMOVAL

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



WARNING!

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

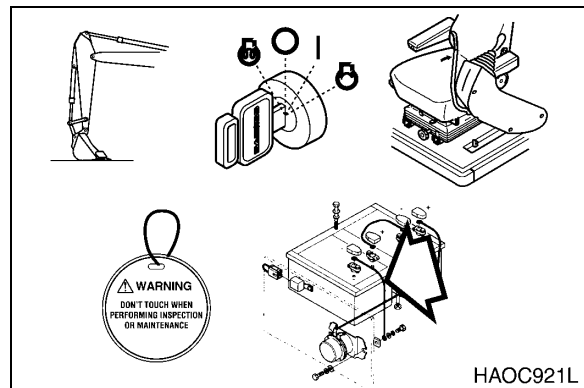


Figure 3

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

11. Remove four bolts and washers (2, Figure 4) and cover (1).
12. Pull cap (5, Figure 4) out and remove two screws, two bolts and washers (6) and cover (3).
13. Remove three screws, one bolt and washers (7, Figure 4) and cover (4).

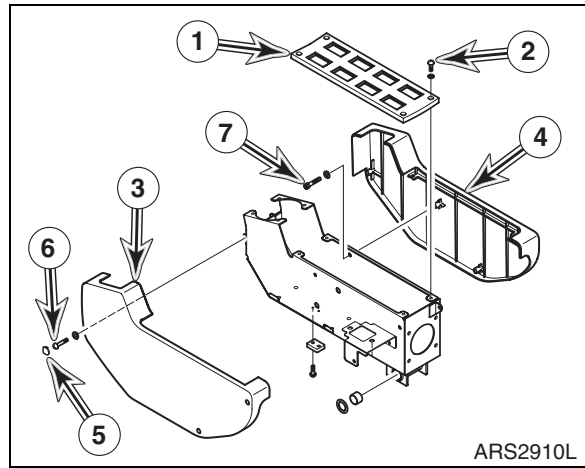


Figure 4

14. Remove four bolts (3, Figure 5) and cover (2), and pull remote control valve L.H. (1) out.
15. Tag and disconnect hoses from remote control valve L.H. (1, Figure 5). Plug and cap hoses and ports to prevent contamination from entering hydraulic system or component.

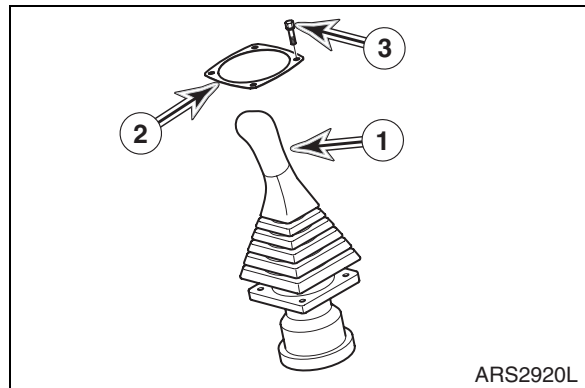


Figure 5

16. Remove four bolts and washer (2, Figure 6), and cover (2).
17. Pull cap (5, Figure 6) out and remove screw, three bolts and washers (6) and cover (3).
18. Remove two screws, two bolts and washers (7 and 8, Figure 6) and cover (4).

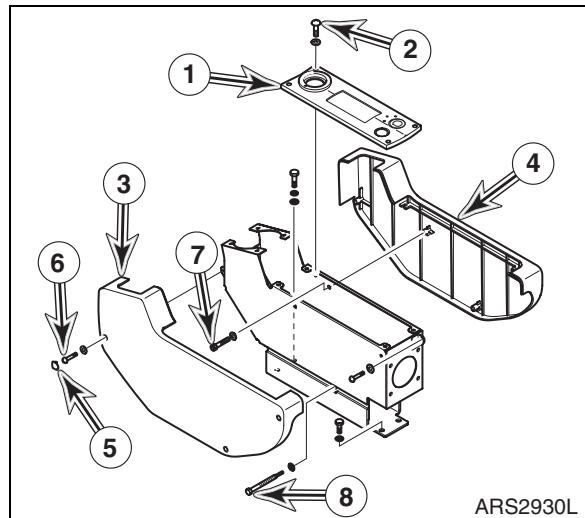


Figure 6

19. Remove four bolts (3, Figure 7) and cover (2), and pull remote control valve R.H. (1) out.
20. Tag and disconnect hoses from remote control valve R.H. (1, Figure 7). Plug and cap hoses and ports to prevent contamination from entering hydraulic system or component.

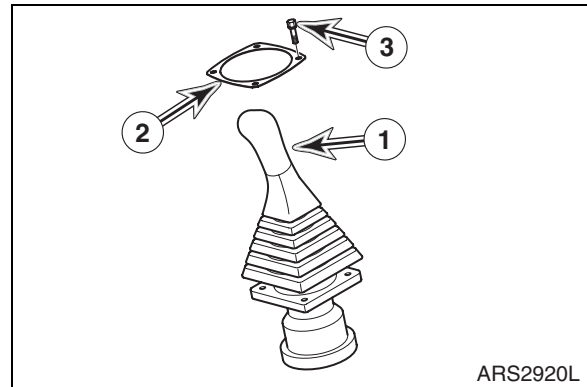


Figure 7

DISASSEMBLY

1. Lift up the boot (28) and pull the switch cord through the hole in the case (1).



Figure 8



Figure 9

2. Loosen nut (27) from hex nut (25) and remove handle assembly (30).



Figure 10

3. Remove hex nut (25) and swash plate (24).

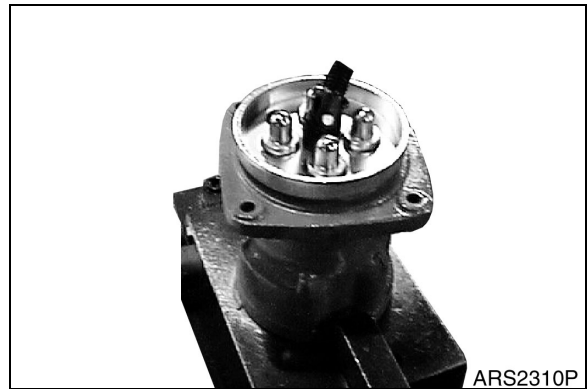


Figure 11

4. Remove joint (23) from case (1).

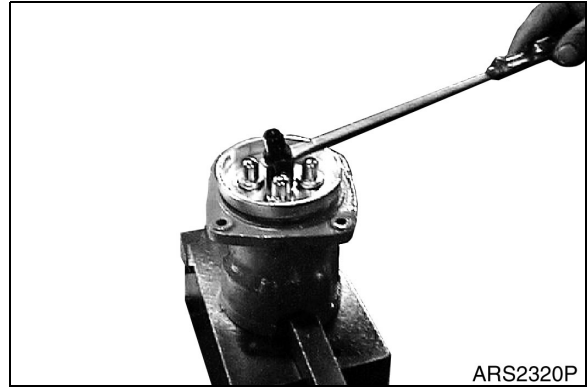


Figure 12

5. Remove plate (21).

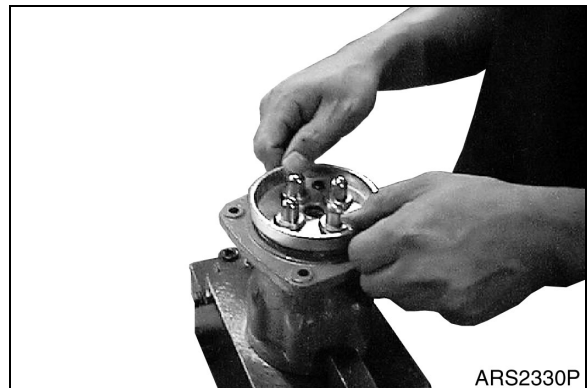


Figure 13

6. Press spring (10) and remove plug (18).

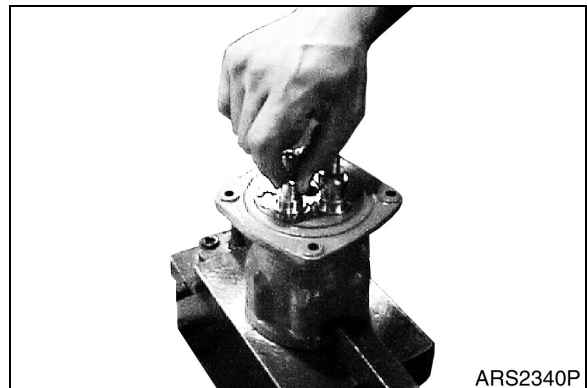


Figure 14

7. Remove pressure reduction valve (6, 7, 8, 9, 11) and spring (10).

IMPORTANT

Mark valve disassembling position (port).

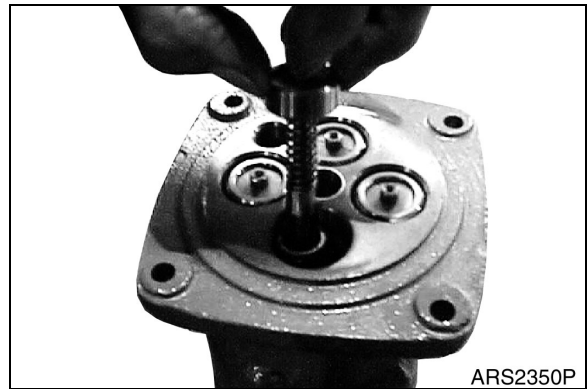


Figure 15

8. Remove plug (3) and four plugs (2).



Figure 16

9. Remove stopper (11) from pressure reduction valve (6, 7, 8, 9, 11).

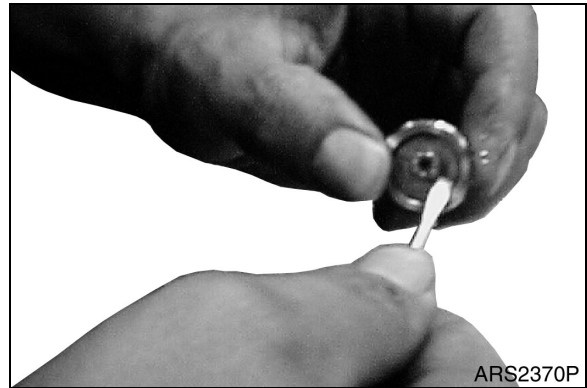


Figure 17

10. Remove spool (6), spring seat (9), spring (8) and shim (7).

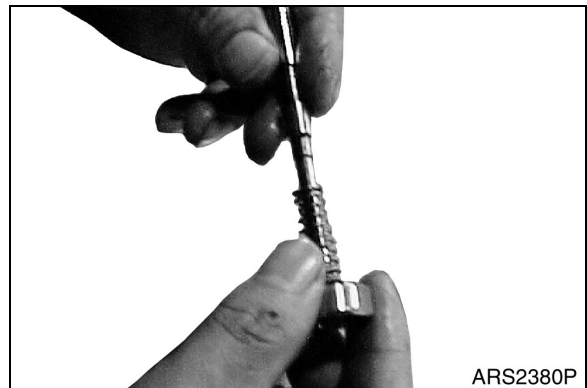


Figure 18

11. Remove push rod (14) and plug (18).

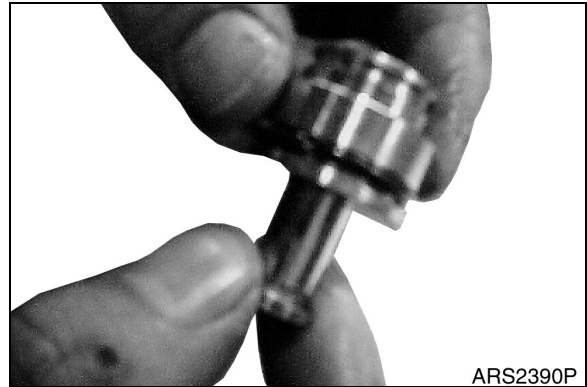


Figure 19

12. Remove O-ring (19) from plug (18).

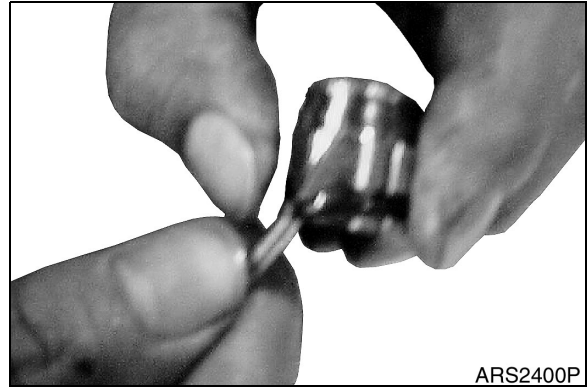


Figure 20

13. Remove seal (20) from plug (18).

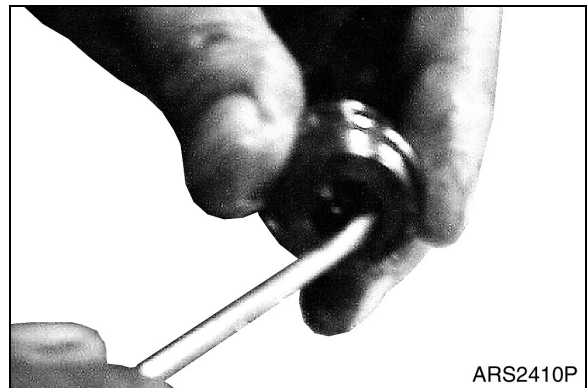


Figure 21

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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

Clean all parts and dry them with compressed air. Keep all parts free from dust. Lubricate all moving parts.

REASSEMBLY

1. Tighten plug (3) slowly.

NOTE: Tightening torque: 350 kg•cm
(25 ft lb).

Tighten four plugs (2).

NOTE: Use Loctite #592 pipe sealant
on plugs.

NOTE: Tightening torque 150 kg•cm
(11 ft lb).

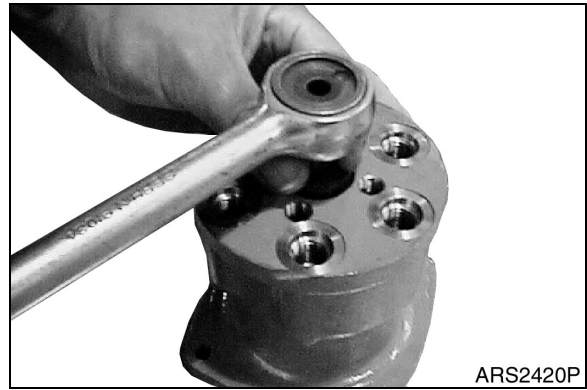


Figure 22

2. Install shim (7), spring (8), spring seat (9),
and spool (6).

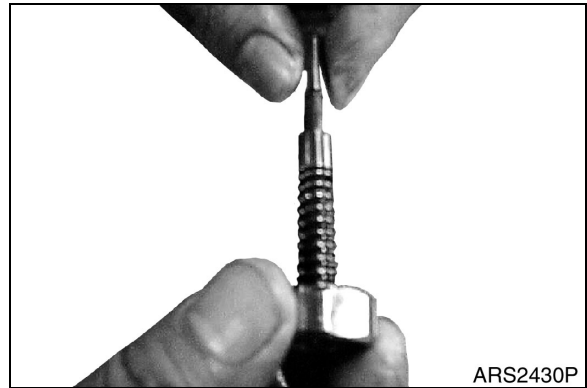


Figure 23

3. Press spring (9) and install stopper (11).

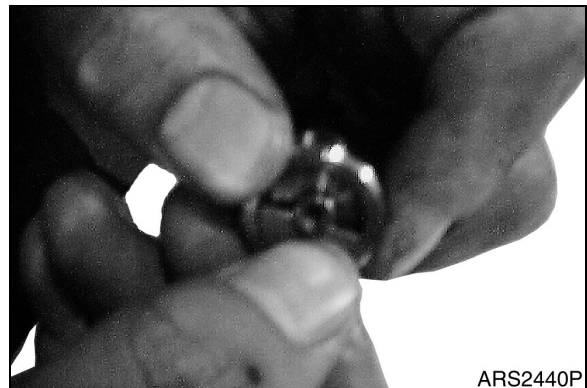


Figure 24

4. Install spring (10) in case (1) and pressure reducing valve assembly (6, 7, 8, 9, 11).

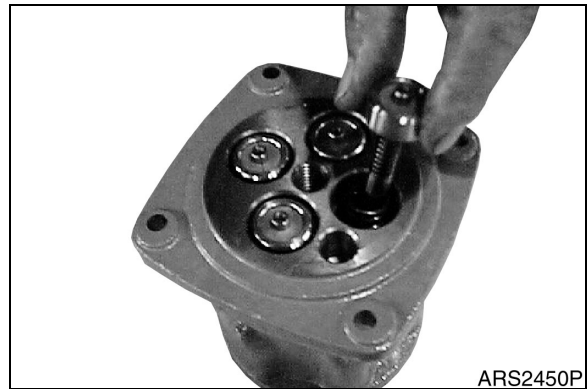


Figure 25

5. Install seal (20) on plug (18).



Figure 26

6. Install O-ring (19) on plug (18).



Figure 27

7. Install push rod (14) on plug (18).

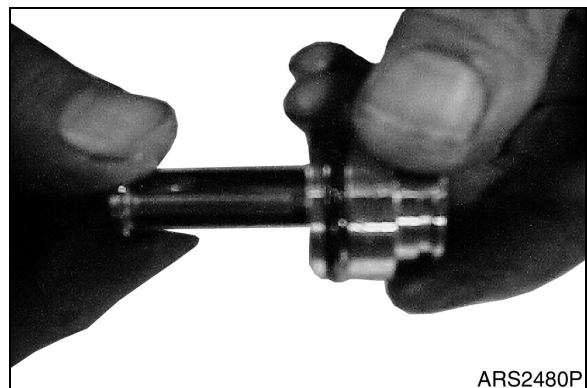


Figure 28

8. Install spring (13) on stopper (12).



Figure 29

9. Position stopper (12) and spring (13) on pressure reducing valve.

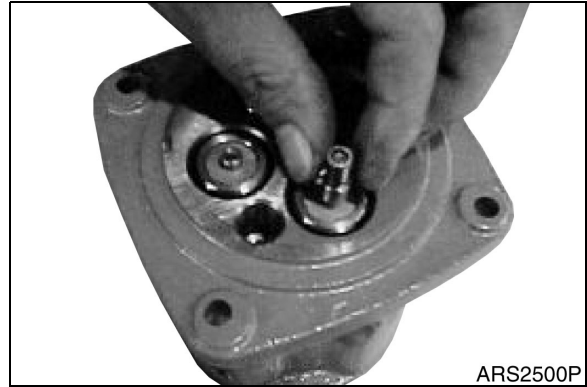


Figure 30

10. Install plug (18) in case (1).

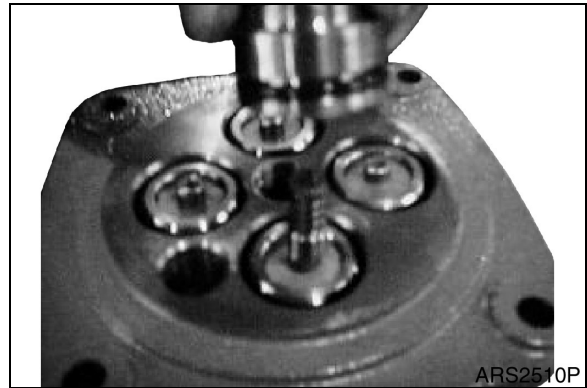


Figure 31

11. Install plate (21) and tighten joint (23).

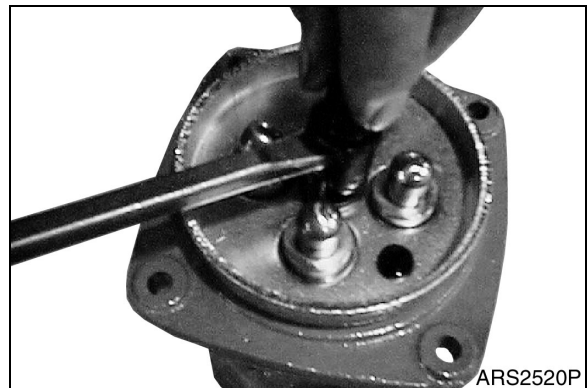


Figure 32

12. Install swash plate (24) on joint (23).

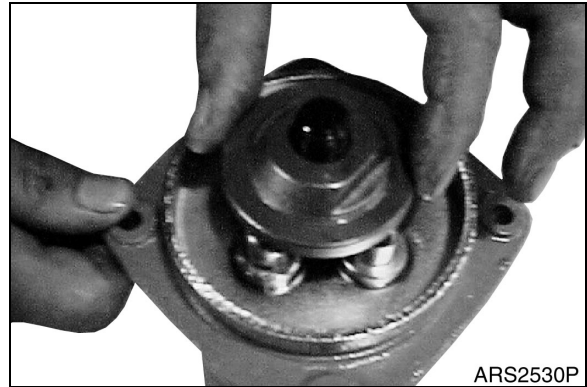


Figure 33

13. Install hex nut (25) and tighten swash plate (24).

NOTE: *Tightening torque 1,240 kg•cm (90 ft lb).*

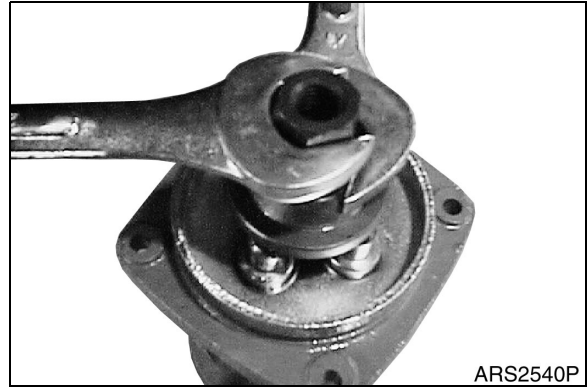


Figure 34

14. Pull cord and tube out through hole of hex nut (25).

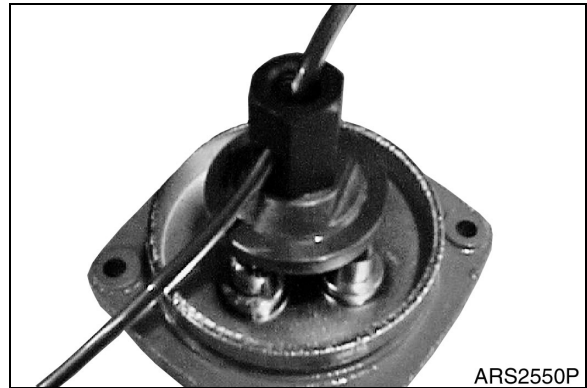


Figure 35

15. Align the direction of handle (30) and tighten hex nut (25) and nut (27).

NOTE: *Tightening torque 1,240 kg•cm (90 ft lb).*

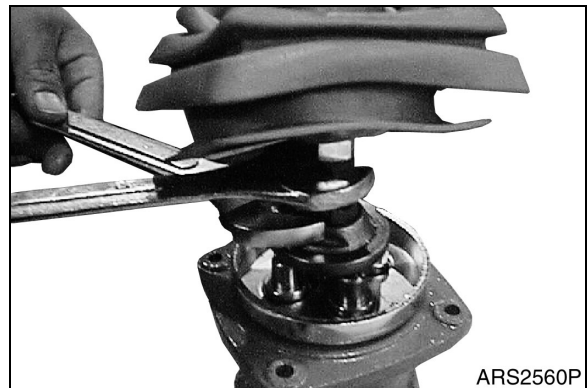


Figure 36

16. Grease joint (23), swash plate (24) and push rod (14).

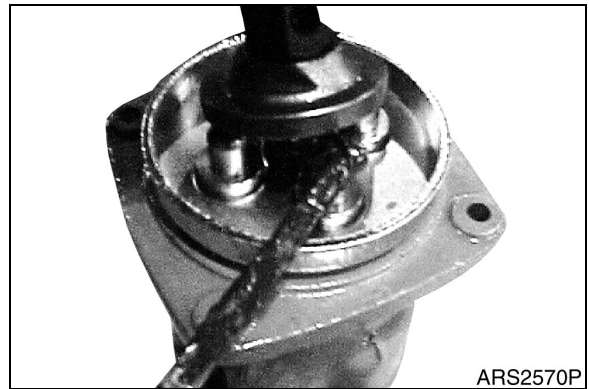


Figure 37

17. Install boot (28).

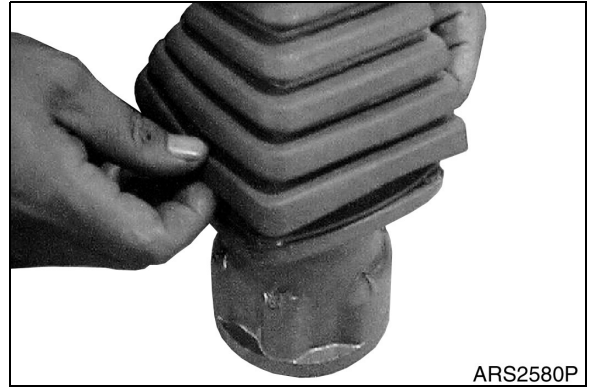


Figure 38

INSTALLATION

1. Connect hoses as tagged during removal to remote control valve R.H. (1, Figure 39).
2. Position remote control valve R.H. (1, Figure 39) on control stand and install four bolts and washers (3) and cover (2).

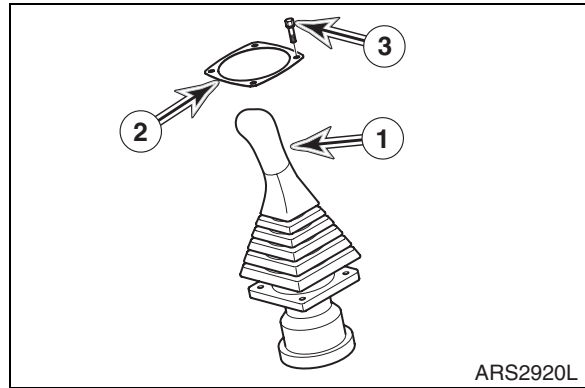


Figure 39

3. Install two screws, two bolts and washers (7 and 8, Figure 40) and cover (4).
4. Install a screw, three bolts and washers (6, Figure 40) and cover (3). Push cap (5) into cover (3).
5. Install four bolts and washers (2, Figure 40) and cover (1).

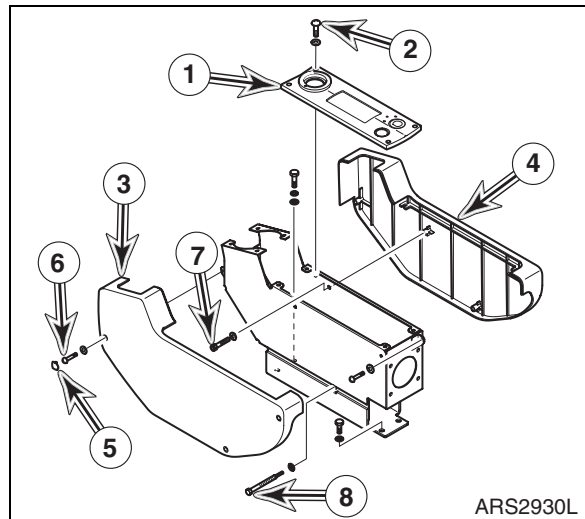


Figure 40

6. Connect hoses as tagged during removal to remote control valve L.H. (1, Figure 41).
7. Position remote control valve L.H. (1, Figure 41) on control stand and install four bolts and washers (3), and cover (2).

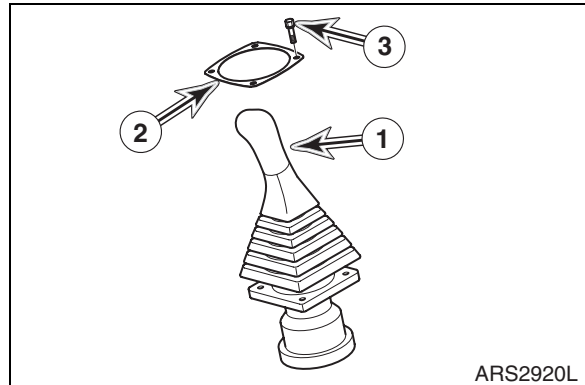


Figure 41

8. Install three screws, one bolts and washers (7, Figure 42), and cover (4).
9. Install two screws, two bolts and washers (6, Figure 42), and cover (3). Push cap (5) into cover (3).
10. Install four bolts and washers (2, Figure 42), and cover (1).

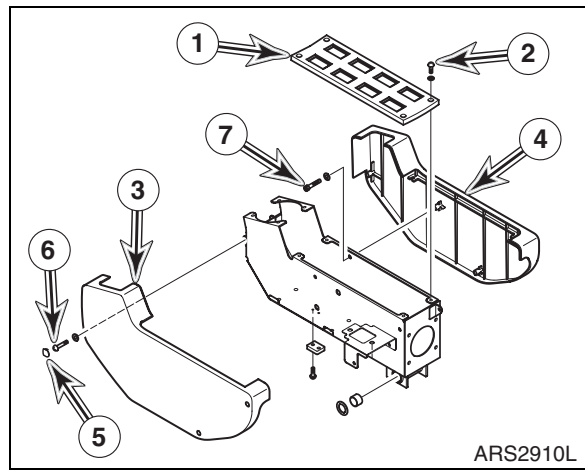


Figure 42

START-UP PROCEDURES

1. Start engine and set throttle at "LOW IDLE."
2. Set safety lever on "UNLOCK" position.
3. Slowly cycle boom, arm, bucket cylinders and swing motor about five times without a load to vent air from pilot lines. Do this for 5 minutes.

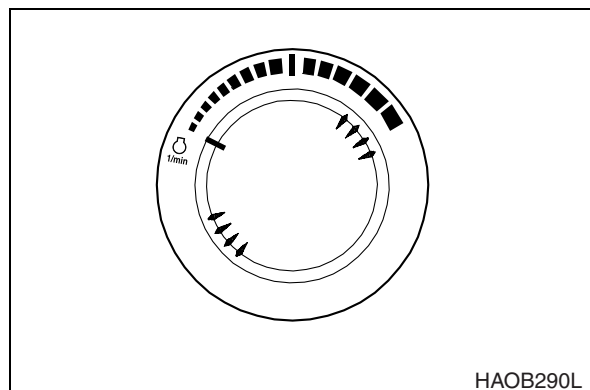


Figure 43

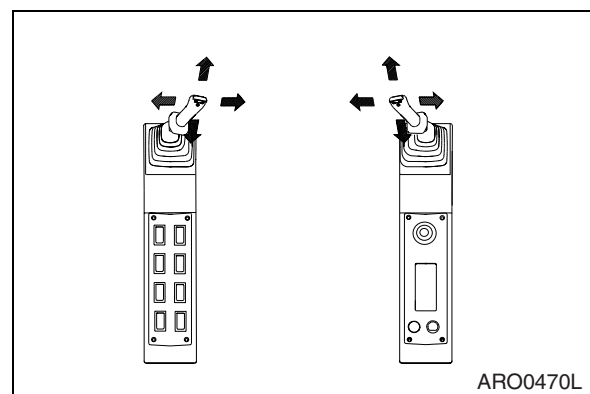


Figure 44



**S0709710
R3**

STEERING VALVE



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 130W-V	0001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 210W-V	1001 and Up

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Special Tools	8
Disassembly	10
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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.

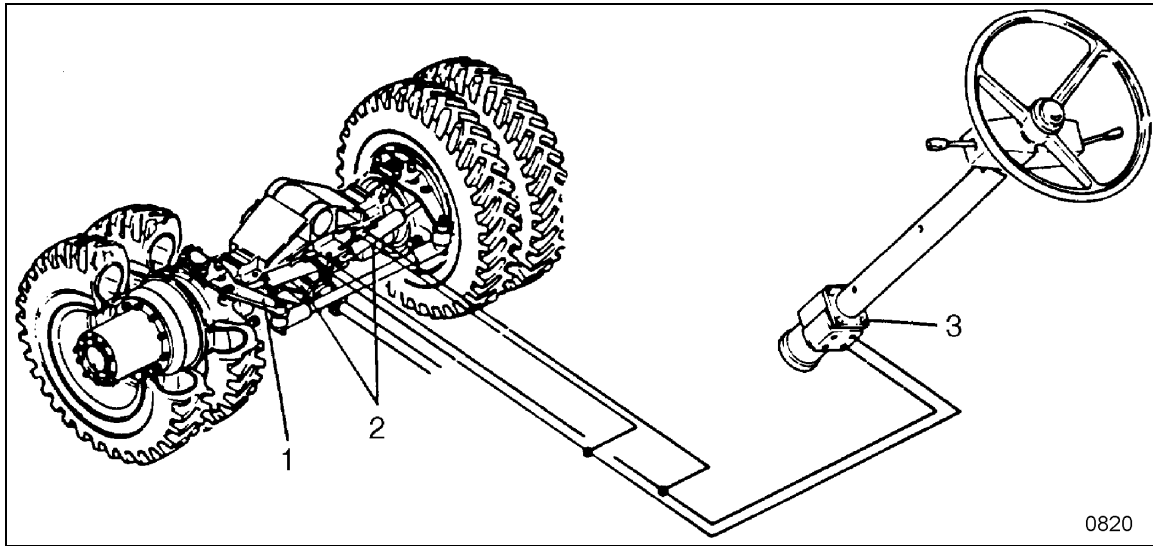


Figure 1

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.

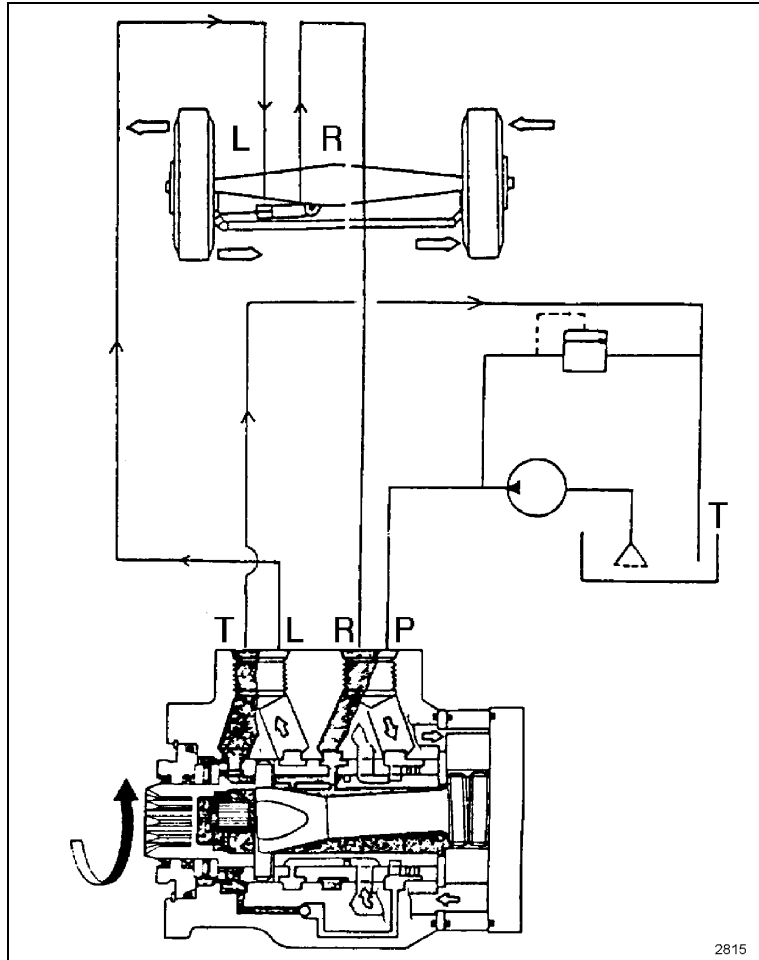


Figure 2

PARTS LIST

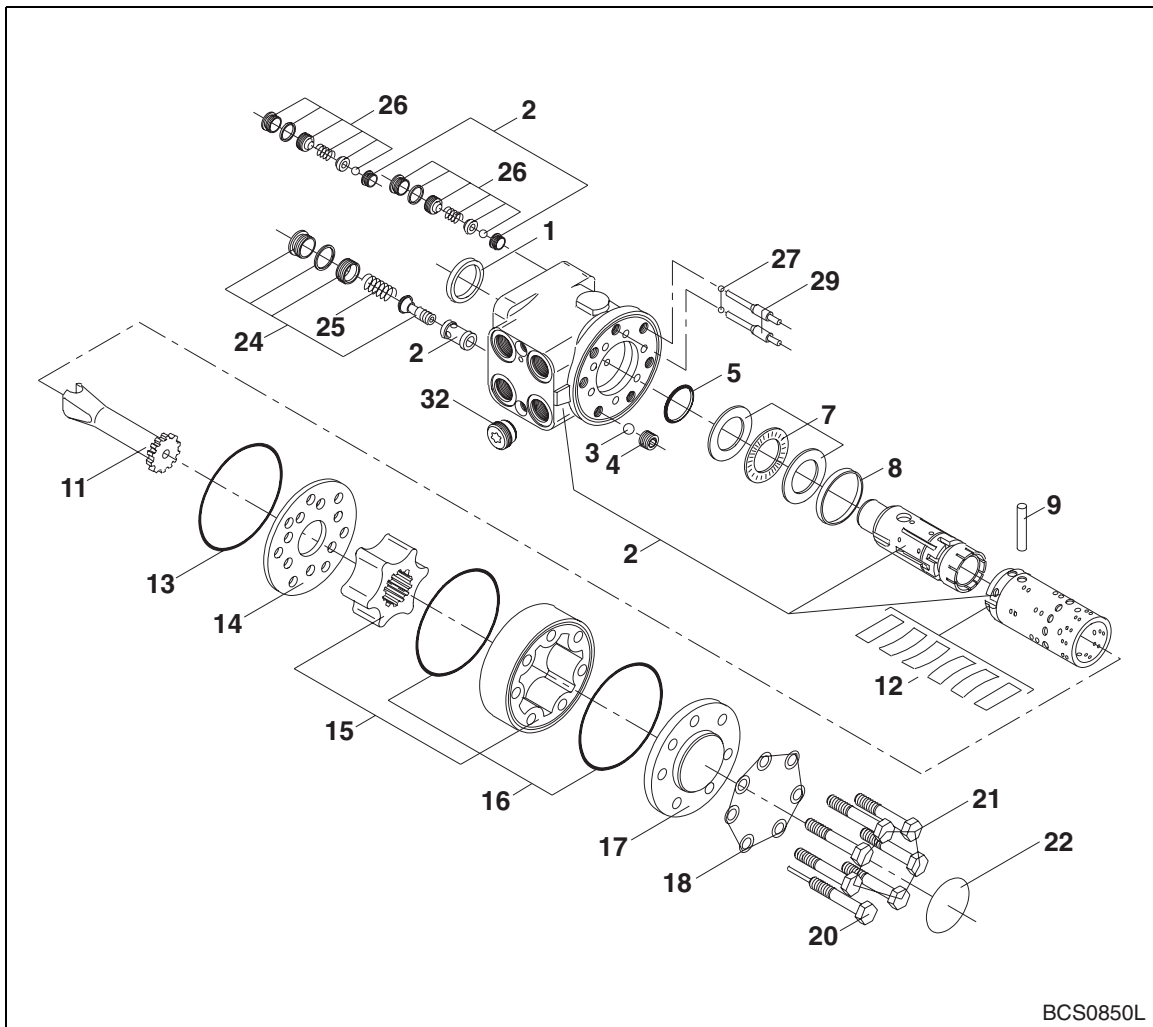


Figure 3

Reference Number	Description
1	Dust Seal Ring
2	Spool Housing Assembly
3	Ball
4	Threaded Bushing
5	O-ring
7	Bearing Assembly
8	Ring
9	Cross Pin
11	Cardan Shaft
12	Spring Set
13	O-ring
14	Distributor Plate
15	Gear Wheel Set

Reference Number	Description
16	O-ring
17	End Cover
18	Washer
20	Screw
21	Screw with Pin
22	Name Plate
24	Relief Valve Assembly
25	Wire Spring
26	Shock Valve Assembly
27	Ball
29	Bushing with Pin
30	Check Valve
*	Seal Kit (1, 5, 13, 16, and 18)

SPECIFICATIONS

Steering Unit	Solar 130W-V	Solar 140W-V / Solar 160W-V	Solar 170W-V / Solar 180W-V	Solar 200W-V / Solar 210W-V
Type	Open Center, Non reaction	Open Center, Non reaction	Open Center, Non reaction	Open Center, Non reaction
Displacement	200 cc/rev (12.2 in ³ /rev.)	200 cc/rev (12.2 in ³ /rev.)	315 cc/rev (19.22 in ³ /rev)	315 cc/rev (19.22 in ³ /rev)
Relief Valve Set Pressure	140 kg/cm ² (1,990 psi)	170 kg/cm ² (2,418 psi)	195 - 200 kg/cm ² (2,770 - 2,840 psi)	150 kg/cm ² (2,130 psi)
Overload Relief Valve Set Pressure	200 kg/cm ² (2,840 psi)	225 kg/cm ² (3,200 psi)	240 - 250 kg/cm ² (3,400 - 3,600 psi)	200 kg/cm ² (2,840 psi)

SPECIAL TOOLS AND MATERIALS

SPECIAL TOOLS

NOTE: *Part numbers listed here for special tools are Danfoss. Contact Danfoss for purchasing tools.*

A. Holding tool. Code no.: SJ 150-9000-2.

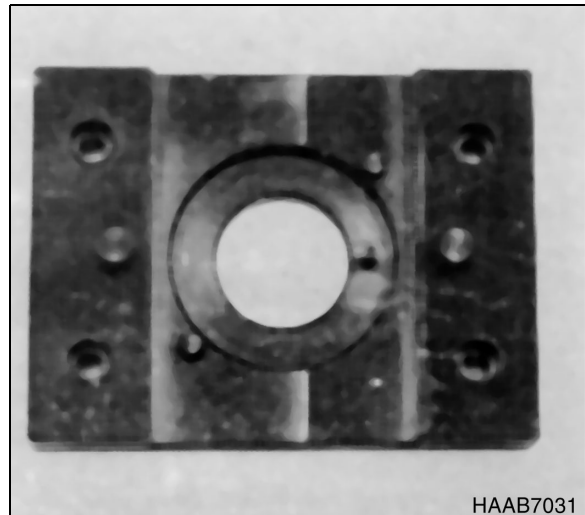


Figure 4

B. Assembly tool for O-ring and kin-ring. Code no. SJ 150-9000-11.

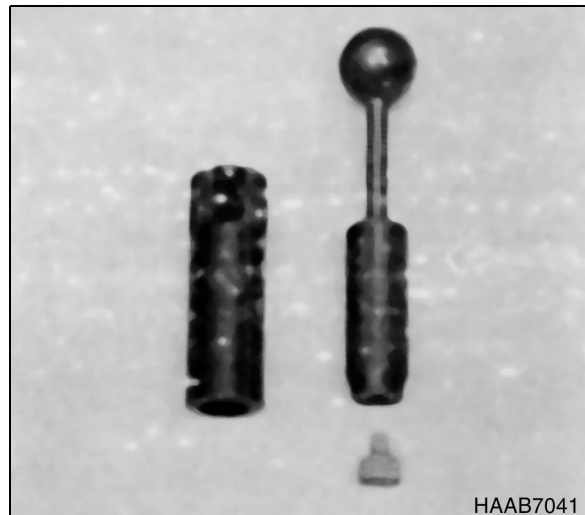


Figure 5

C. Assembly tool for lip seal. Code no. SJ 150-9000-17.



Figure 6

D. Assembly tool for cardin shaft. Code no. 150-9000-3.



Figure 7

E. Assembly tool for dust seal. Code no. SJ 150-9000-22.

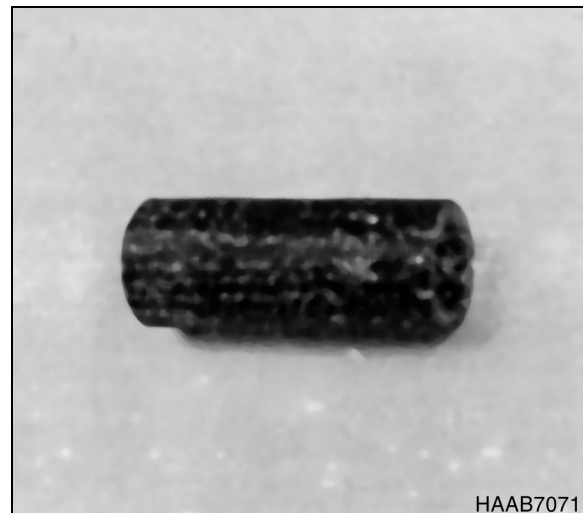


Figure 8

DISASSEMBLY

1. Remove steering column and secure steering valve in a vise. Remove screws from end cover (six screws plus one special screw, used as a special tool).



Figure 9

2. Slide end cover to one side.



Figure 10

3. Lift gear wheel set, with spacer on some models, off unit. Remove two O-rings.



Figure 11

4. Remove cardan shaft.

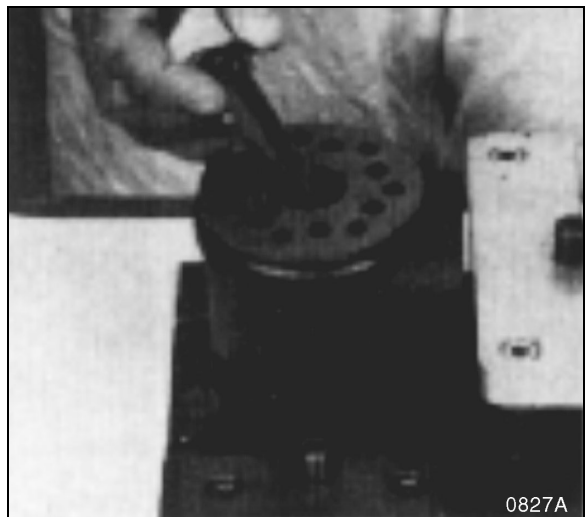


Figure 12

5. Remove distributor plate.

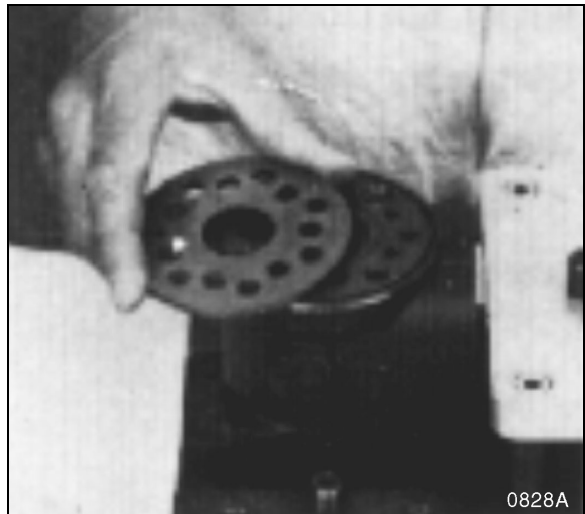


Figure 13

6. Screw out threaded bushing over check valve.

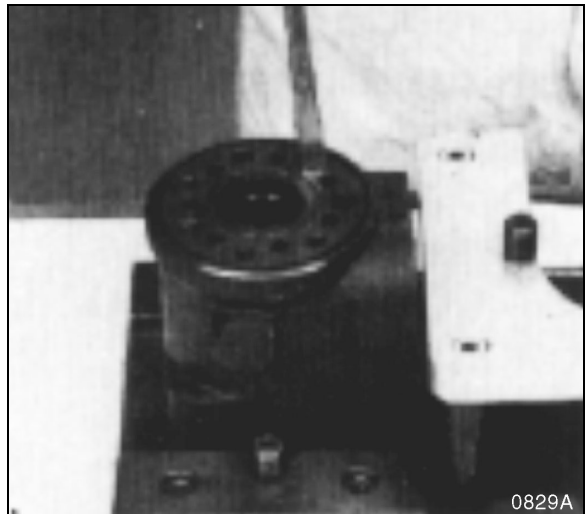


Figure 14

7. Remove O-ring.



Figure 15

8. Shake out check valve ball, and suction valve pins and balls.



Figure 16

9. Taking care to keep cross pin in sleeve and spool horizontal, press spool in and push sleeve, ring, bearing races and needle bearing out of housing together.



Figure 17

10. Remove ring, bearing races and needle bearing from sleeve and spool. Check that outer, thin bearing race is not stuck in housing.



Figure 18

11. Press out cross pin, using special screw from end cover.



Figure 19

NOTE: *If there are no alignment marks on spool and sleeve, close to one of the slots for neutral position springs, mark with pumice stone before removing springs.*

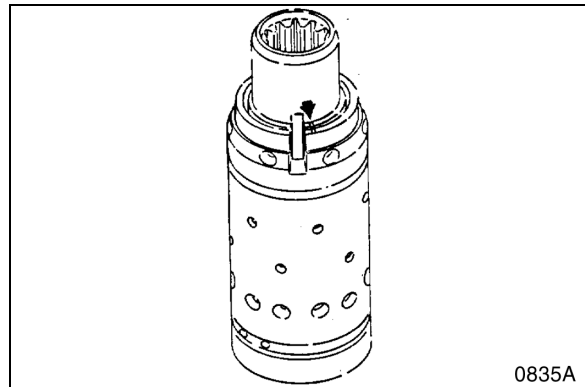


Figure 20

12. Carefully press spool out of sleeve.

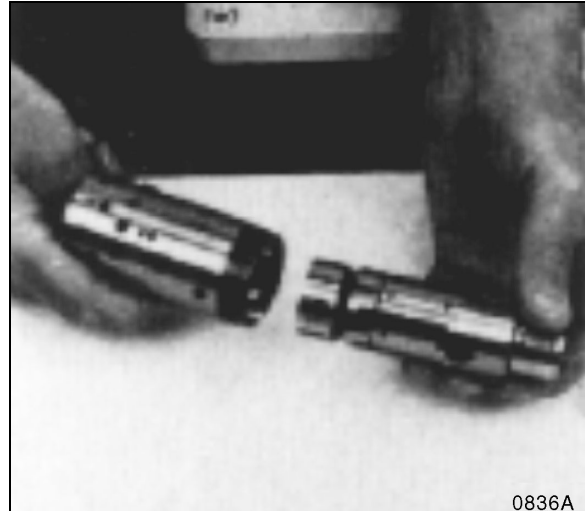


Figure 21

13. Press neutral springs out of their slots in spool.



Figure 22

14. Remove dust seal and O-ring.

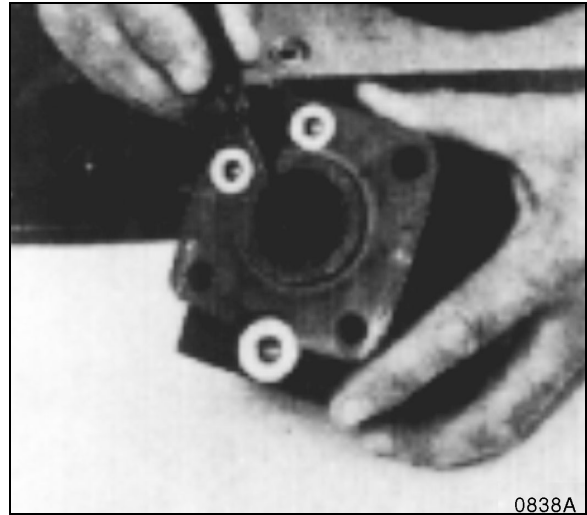


Figure 23

15. Remove plugs from shock valves using a 6 mm hex socket spanner.

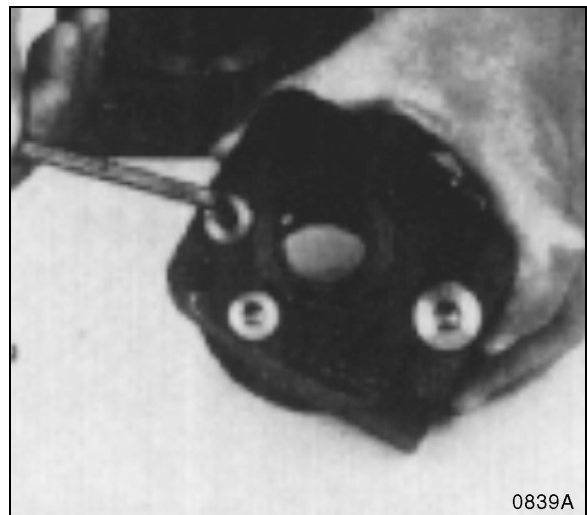


Figure 24

16. Remove two seal washers.

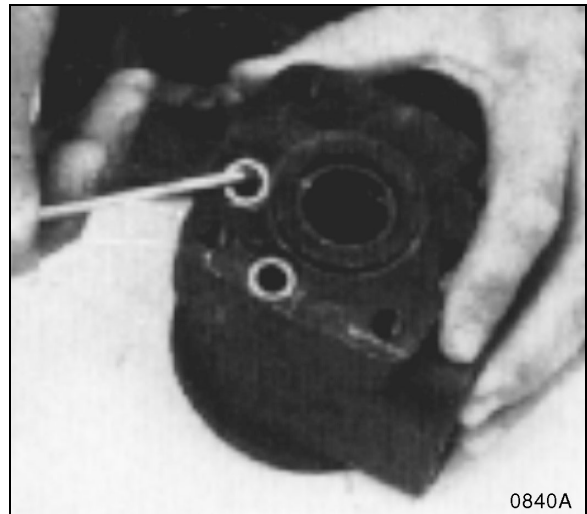


Figure 25

17. Unscrew set screws using 6 mm hex socket spanner.



Figure 26

18. Shake two springs and valve balls out of housing.

NOTE: *Valve seats are bonded into housing and cannot be removed.*



Figure 27

19. Dual Shock Valves are shown disassembled.

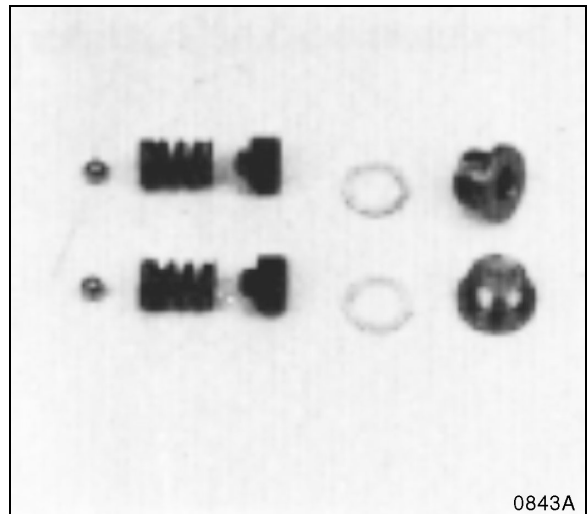
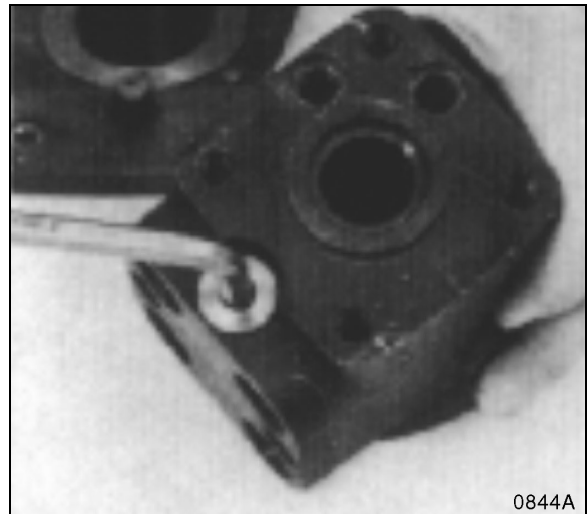


Figure 28

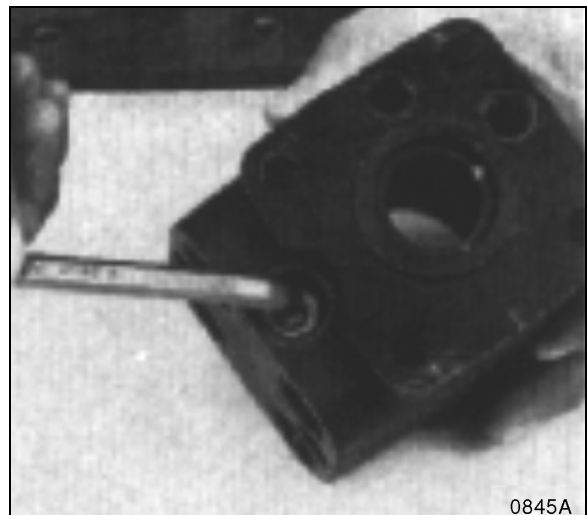
20. Screw out plug using 8 mm hex socket spanner. Remove seal washers.



0844A

Figure 29

21. Unscrew set screw using 8 mm hex socket spanner.



0845A

Figure 30

22. Shake out spring and piston. (Note: valve seat is bonded into housing and cannot be removed).



0846A

Figure 31

23. Pressure relief valve is shown disassembled.



Figure 32

REASSEMBLY

1. Assemble spool/sleeve, making sure marks on spool and sleeve are lined up.



Figure 33

2. Place two, flat, neutral position springs in slot. Place curved springs between flat springs and press into place.



Figure 34

3. Line up spring set.



Figure 35

4. Guide spool into sleeve.



0851A

Figure 36

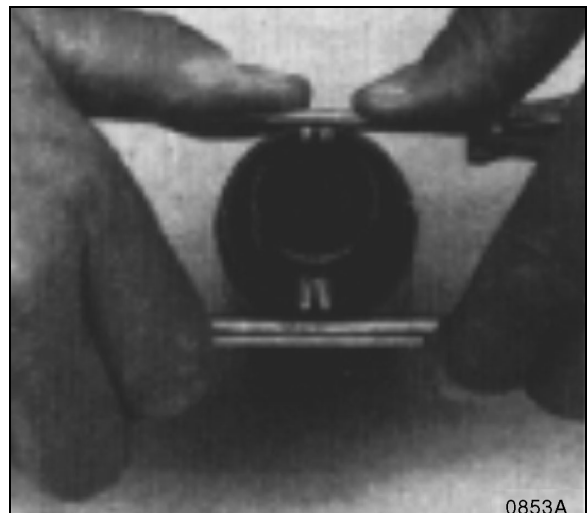
5. Press springs together and push neutral position springs into place in sleeve.



0852A

Figure 37

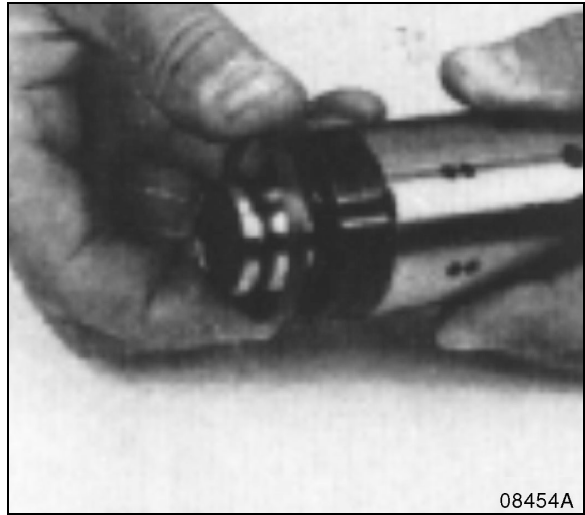
6. Line up springs and center them.



0853A

Figure 38

7. Guide ring down over sleeve so that ring can turn free of the springs.



08454A

Figure 39

8. Fit cross pin into spool/sleeve.



0855A

Figure 40

9. Assemble bearing races and needle bearing as shown in Figure 41 and Figure 42.



0856A

Figure 41

Reference Number	Description
1	Outer Bearing Race
2	Needle Bearing
3	Inner Bearing Race
4	Spool
5	Sleeve

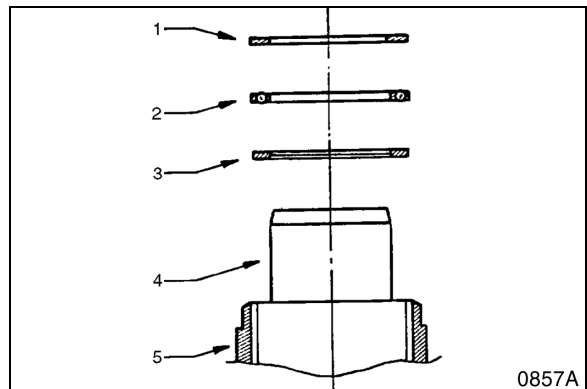


Figure 42

10. Turn unit until bore is horizontal. Guide outer part of assembly tool into bore of spool/ sleeve.



Figure 43

11. Grease O-ring and ring with oil and place on tool.

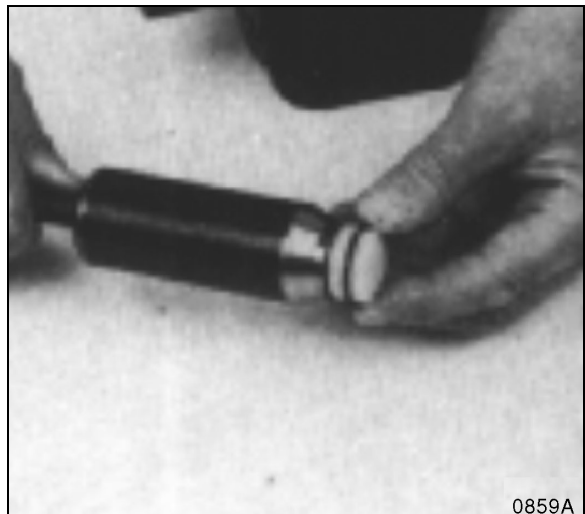


Figure 44

12. Hold outer part of assembly tool in bottom of housing and guide inner part of tool to bottom.

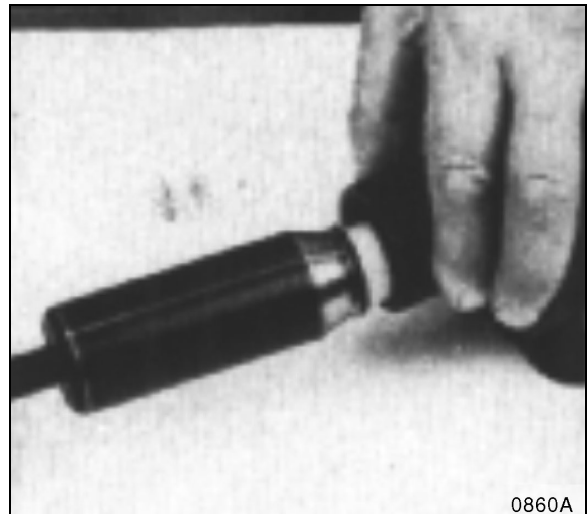


Figure 45

13. Press and turn O-ring and ring into position in housing.



Figure 46

14. Draw inner and outer parts of assembly tool out of housing bore, leaving guide from inner part inside.

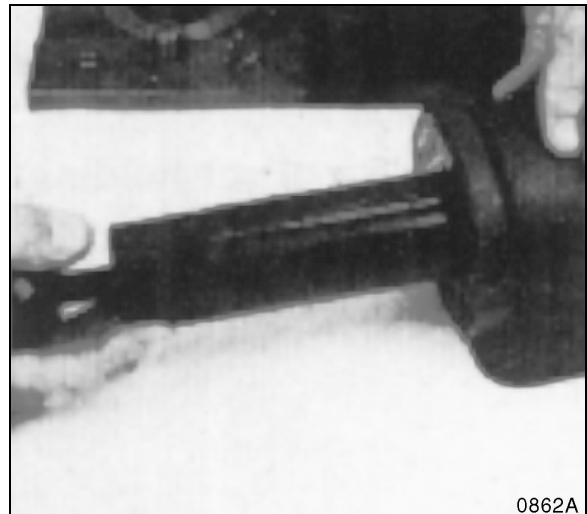


Figure 47

15. Lubricate lip seal and place on assembly tool.



Figure 48

16. Guide assembly tool to bottom of housing.

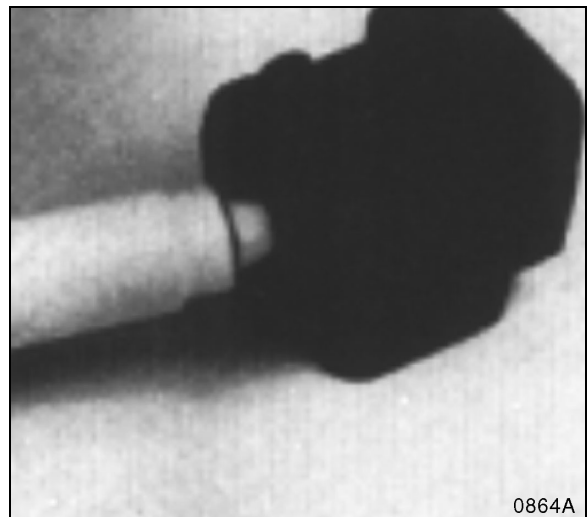


Figure 49

17. Press and turn lip seal into place in housing.



Figure 50

18. Holding cross pin horizontal, guide spool and sleeve into bore with light turning movement.



Figure 51

NOTE: *O-ring and ring are now in position; spool set will push out assembly tool guide.*



Figure 52

19. Turn steering until bore is vertical. Place check valve ball into hole shown in illustration.

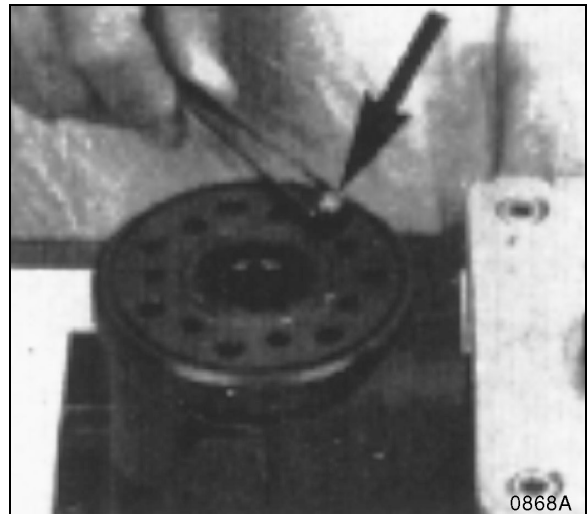


Figure 53

20. Screw threaded bushing lightly into check valve bore so that top of bushing lies just below housing surface.

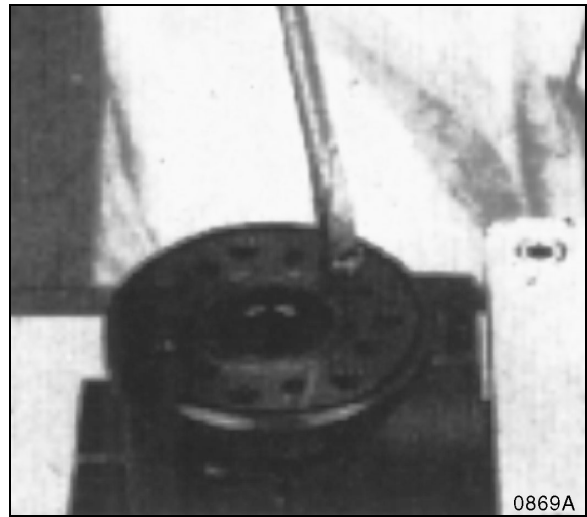


Figure 54

21. Place ball in two holes shown in illustration.



Figure 55

22. Place pin in holes.

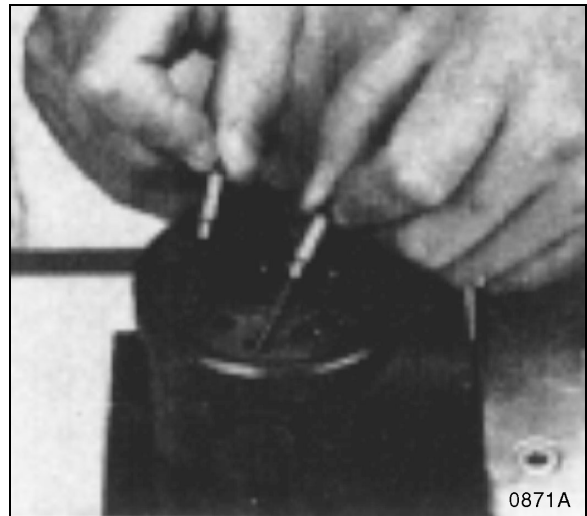


Figure 56

23. Install pin, with spring on some models, into housing.



Figure 57

24. Grease O-ring with mineral oil (500 cst viscosity at 20°C [68°F]).



Figure 58

25. Install distributor plate so that channel holes match holes in housing.



Figure 59

26. Guide cardan shaft into bore so that slot is parallel with connection flange.



Figure 60

27. Place cardan shaft so that it is held in position by mounting fork.

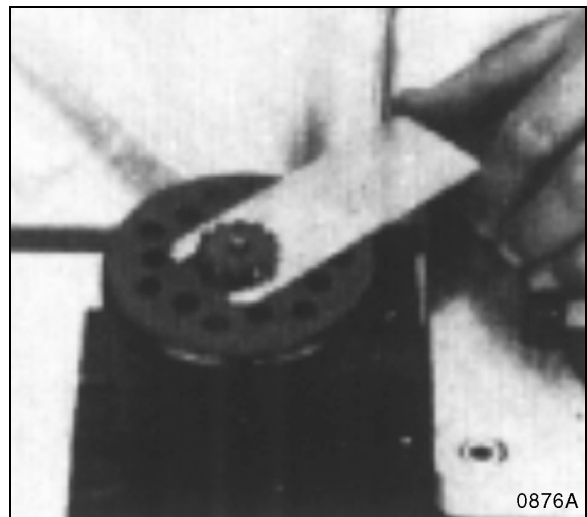


Figure 61

28. Grease two O-rings with mineral oil (500 cst viscosity at 20°C [68°F]) and place in grooves in rear rim. Fit gearwheel and rim on cardan shaft.

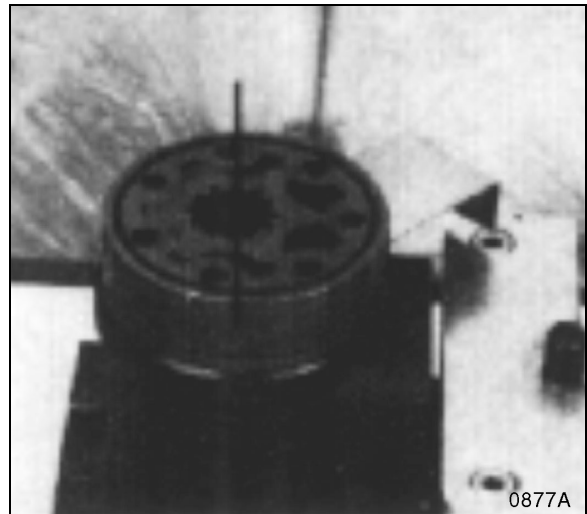


Figure 62

29. Fit gearwheel (rotor) and cardan shaft so that a tooth base in the rotor is positioned in relation to shaft slot as shown. Turn gear rim so that seven holes match holes in housing.

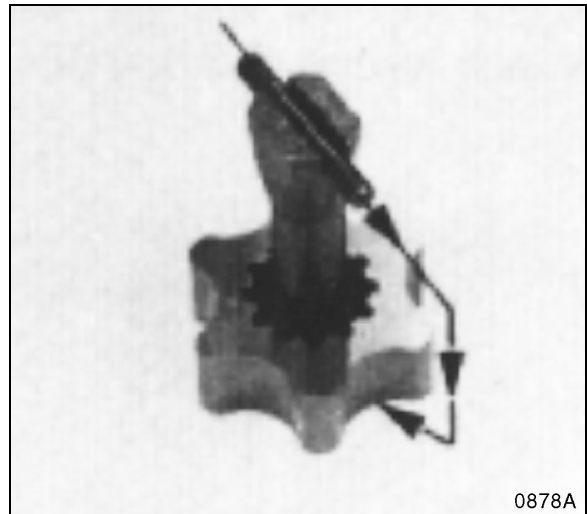


Figure 63

30. Install spacer, if used.



Figure 64

31. Place end cover in position.



Figure 65

32. Fit special screw with washer and place in hole shown.



Figure 66

33. Fit six screws with washers and install. Cross-tighten screws and roll pin to 30 N•m (22 ft lb)

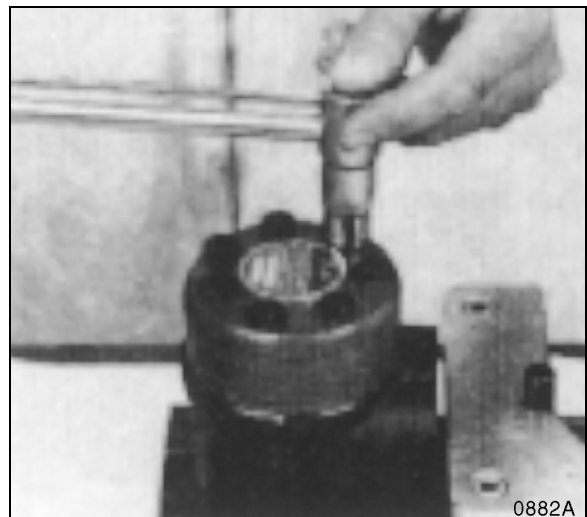


Figure 67

34. Place dust seal ring in housing after pressure relief valve and shock valves are installed.

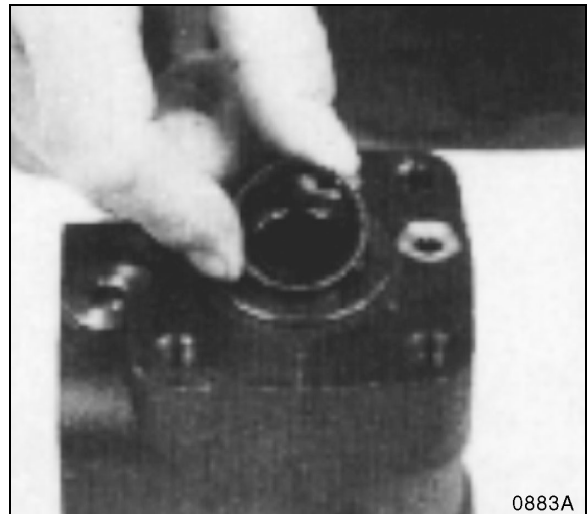


Figure 68

35. Install dust seal ring to housing using special tool and plastic hammer.

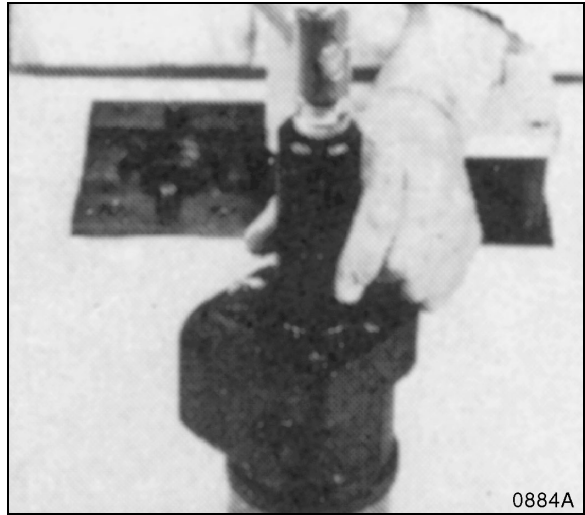


Figure 69

36. Press plastic plugs into connection ports, by hand, **DO NOT** use hammer.

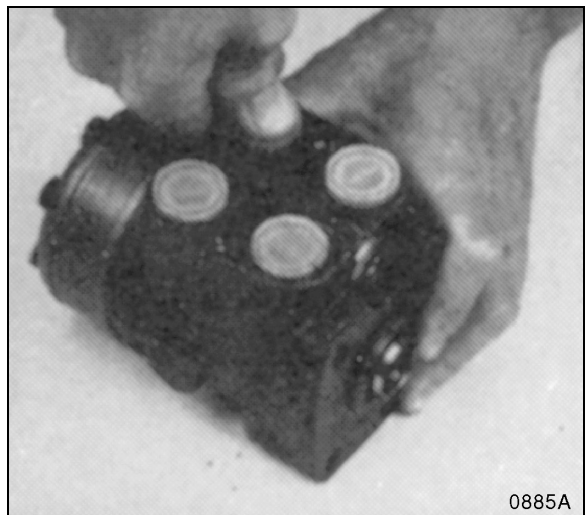


Figure 70

37. Install piston.

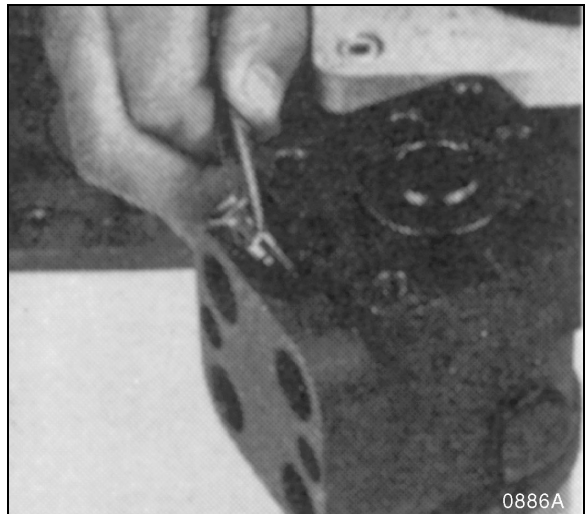


Figure 71

38. Install spring.

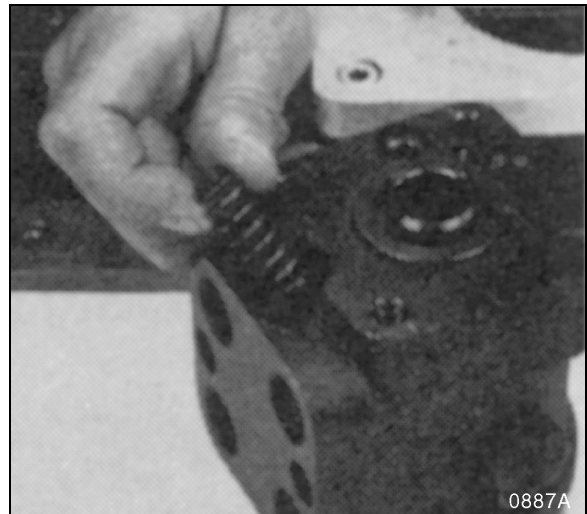


Figure 72

39. Screw in set screw using 8 mm hex socket spanner and set pressure setting as follows.

Spring Dia.	Pressure
1.7 mm (0.066")	50 - 70 bar (725 - 1,015 psi)
1.9 mm (0.075")	70 - 105 bar (1,015 - 1,522 psi)
2.1 mm (0.083")	110 - 155 bar (1,595 - 2,248 psi)

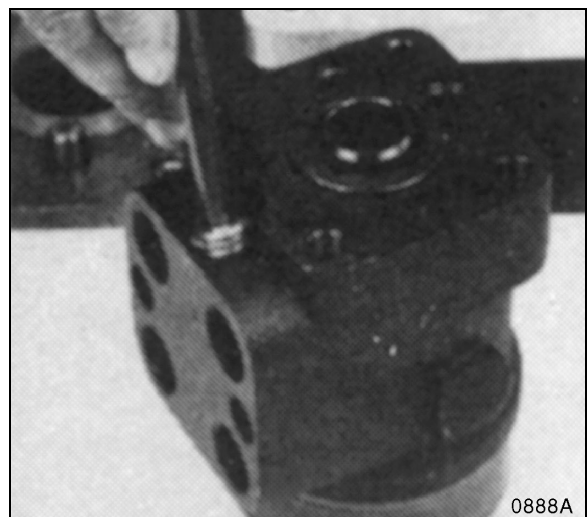


Figure 73

40. Screw plug with dust seal into housing using 8 mm hex socket spanner. Tighten to $5 \pm 1 \text{ N}\cdot\text{m}$ ($1.12 \pm 0.22 \text{ ft lb}$).

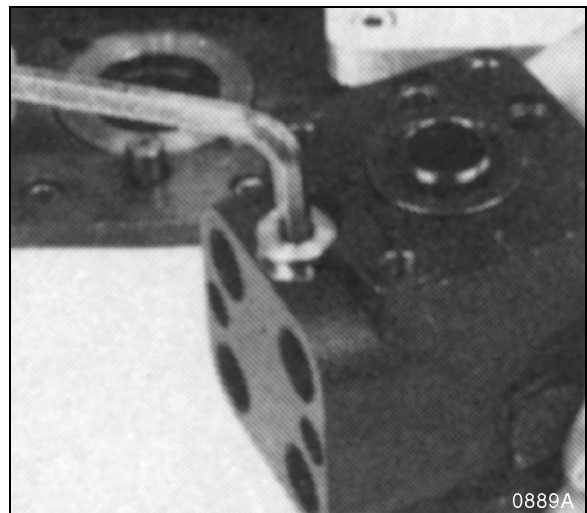


Figure 74



S0709905K

DOZER CONTROL VALVE



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 210W-V	1001 and Up

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PARTS LIST

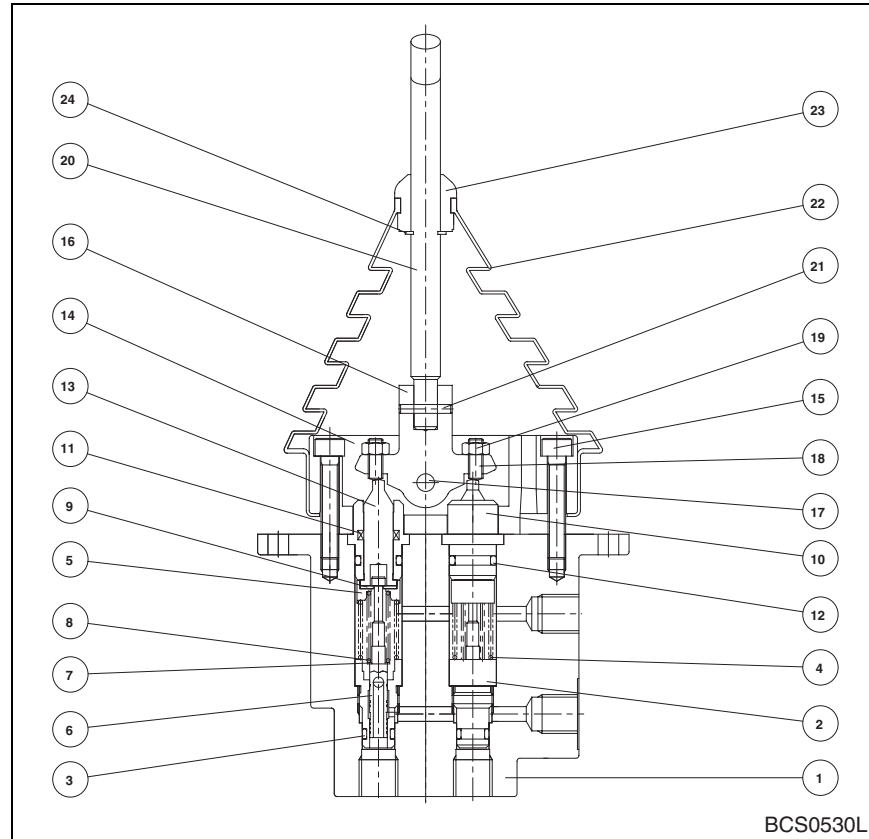


Figure 1

Reference Number	Description
1	Body
2	Plug
3	O-ring
4	Spring
5	Spring Seat
6	Spool
7	Spring Seat
8	Spring
9	Stopper
10	Plug
11	Rod Seal
12	O-ring

Reference Number	Description
13	Push Rod
14	Cover
15	Wrench Bolt
16	Guide
17	Pin
18	Socket Bolt
19	Nut
20	Lever
21	Spring Pin
22	Boot
23	Bushing
24	Snap Ring

SPECIFICATIONS

Remote Blade (Dozer) Control Valve Type: Pressure/Stroke:	Pilot Control 28 kg/cm ² (398 psi) at 6.5 mm (0.256") stroke
--	---



HYDRAULIC SCHEMATIC (S140W-V / 160W-V)



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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General Description.....	3
Solar 140W-V / 160W-V	4

GENERAL DESCRIPTION

Schematic(s) presented in this section are laid out on facing pages.

An overlapping edge has been taken into consideration so that a photocopy can be made and pasted together to make a complete schematic.

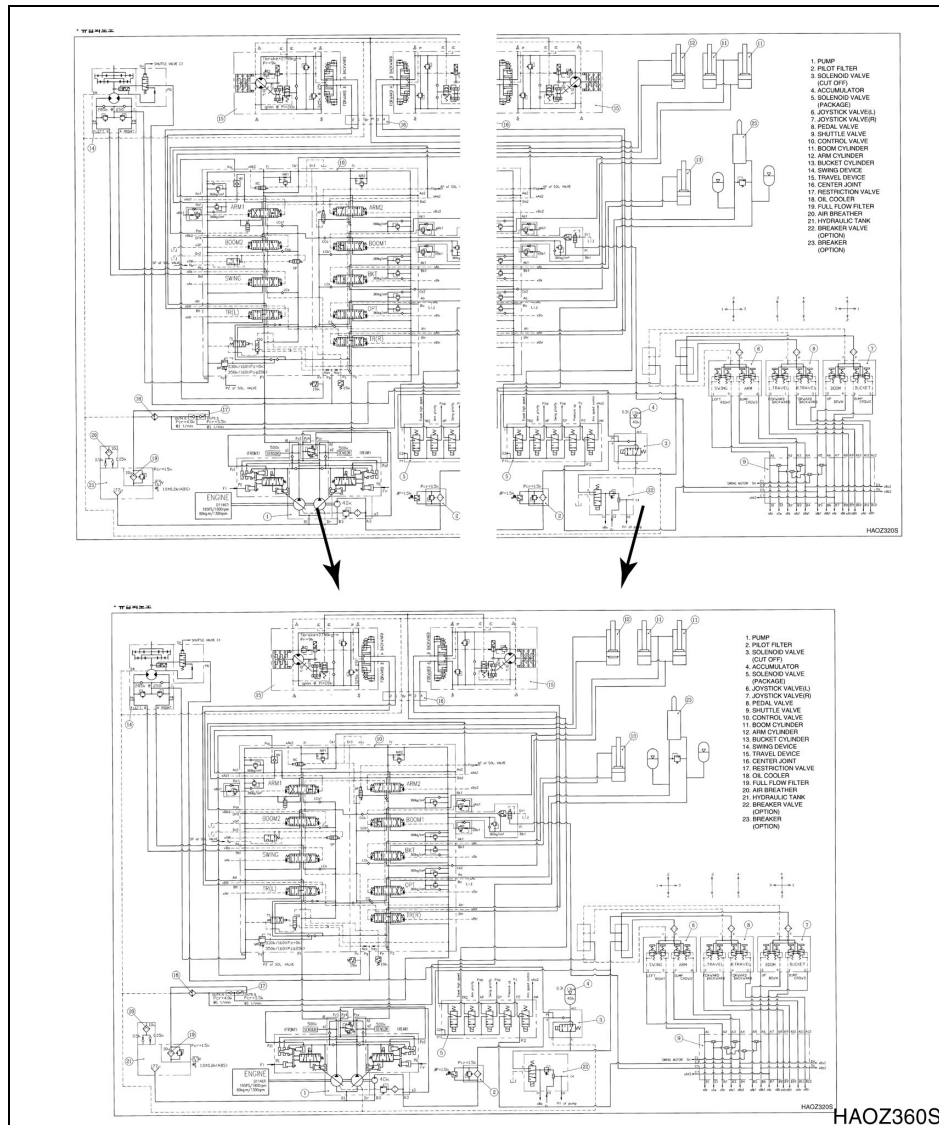


Figure 1

SOLAR 140W-V / 160W-V

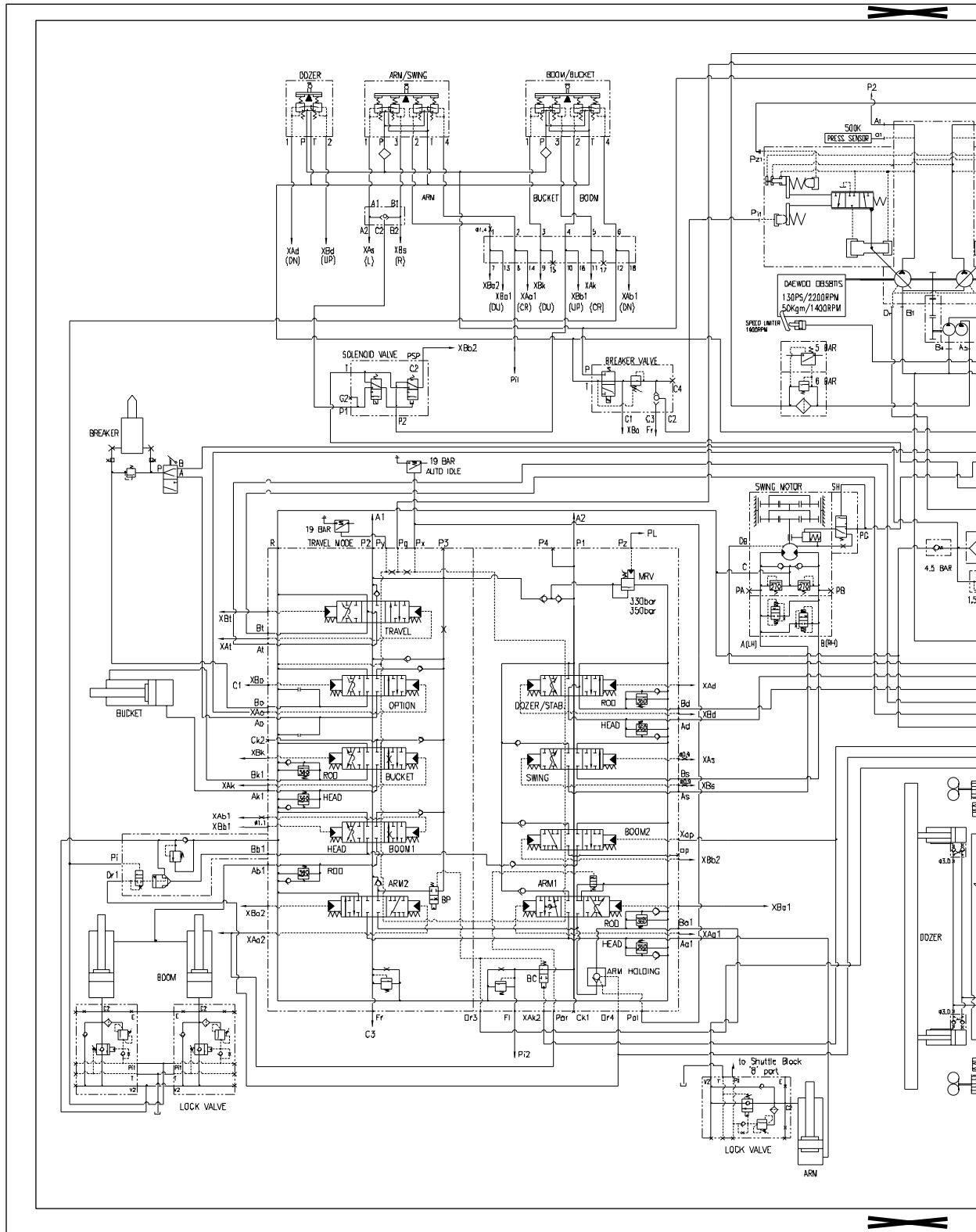


Figure 2

S0792145K
Page 5

ELECTRICAL SYSTEM



ELECTRICAL SYSTEM



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 210W-V	1001 and Up

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TROUBLESHOOTING - ELECTRICAL SYSTEM

Problem	Possible Causes	Remedies
Battery will not stay charged.	Internal battery short.	Replace battery.
	Short in other part of circuit.	Repair wiring or replace component.
Battery does not charge.	Battery worn out or defective.	Replace battery.
	Defective alternator or belt.	Repair or replace.
	Cable connection loose or severely corroded. Circuit ground corroded or weak.	Repair or replace.
Engine rpm not controllable.	Engine speed potentiometer or dial defective.	Repair or replace.
	Engine control cable broken or loose.	Repair or replace.
	Engine control motor defective or not connected.	Repair connection or replace component.
	Engine throttle controller defective or not connected.	Repair connection or replace component.
	Blown fuse.	Replace fuse. Check connections and circuit components for shorts or other damage.
	Wiring harness or connector defective or damaged.	Repair or replace.
Power mode selection does not change.	Blown fuse.	Replace fuse. Check connections and circuit components for shorts or other damage.
	Instrument Panel switch broken.	Repair or replace.
	Wiring harness or connector defective or damaged.	Repair or replace.
	e-EPOS controller defective.	Replace.
	Speed sensor defective.	Replace.
Work mode selection does not change.	Blown fuse.	Replace fuse. Check connections and circuit components for shorts or other damage.
	Instrument Panel switch broken.	Repair or replace.
	Wiring harness or connector defective or damaged.	Repair or replace.
	e-EPOS controller defective.	Replace.
	Solenoid valve defective.	Replace.

OVERVIEW

The electrical system for this equipment is DC 24 volts. The rated voltage for all electric components is 24 volts with the exception of the car stereo and the air-conditioning control actuator. The system contains two 12 volt batteries connected in series and a three phase AC generator with a rectifier. The electric wiring used in the system is easily identifiable by the insulator color. The color symbols used in the electrical system are listed in the following chart.

Electric Wire Color

Symbol	Color
W	White
G	Green
Or	Orange
B	Black
L	Blue
Lg	Light green

Symbol	Color
R	Red
Gr	Gray
P	Pink
Y	Yellow
Br	Brown
V	Violet

NOTE: *RW: Red wire with White stripe*
R - Base Color, W - Stripe Color

NOTE: *0.85G: Nominal sectional area of wire core less insulator = 0.85 mm²*

ELECTRIC SUPPLY SYSTEM

The electric power circuit supplies electric current to each electric component. It consists of a battery, battery relay, starter switch, circuit breaker, fusible link and fuse box.

The negative terminal of the battery is grounded to the vehicle body.

Even when the starter switch (5) is in the "OFF" position, electric current is supplied to the following components through battery (1) →fusible link (3) →fuse (6).

1. Cabin light, fuel pump switch, No. 1 terminal of DC-DC converter (backup for car stereo memory)
2. "B" terminal of starter switch and No. 22 terminal of air conditioner control panel.
3. No. 17 terminal of instrument panel (backup for instrument panel).
4. Power terminal "B" of engine stop motor.

When the starter switch (5) is in the preheat, on and start positions, the current flows from the battery (1) →fusible link (3) →fuse (6) →starter switch (5) "B" terminal/starter switch (5) "BR" terminal →battery relay (2) "BR" terminal which activates the coil of the battery relay and the electric supply system is energized.

When the battery relay's contacts are connected, all electric devices can be operated.

While the engine is not running, the electric power for all electric devices are supplied by the battery. Once the engine is started the power is supplied from the alternator (7).

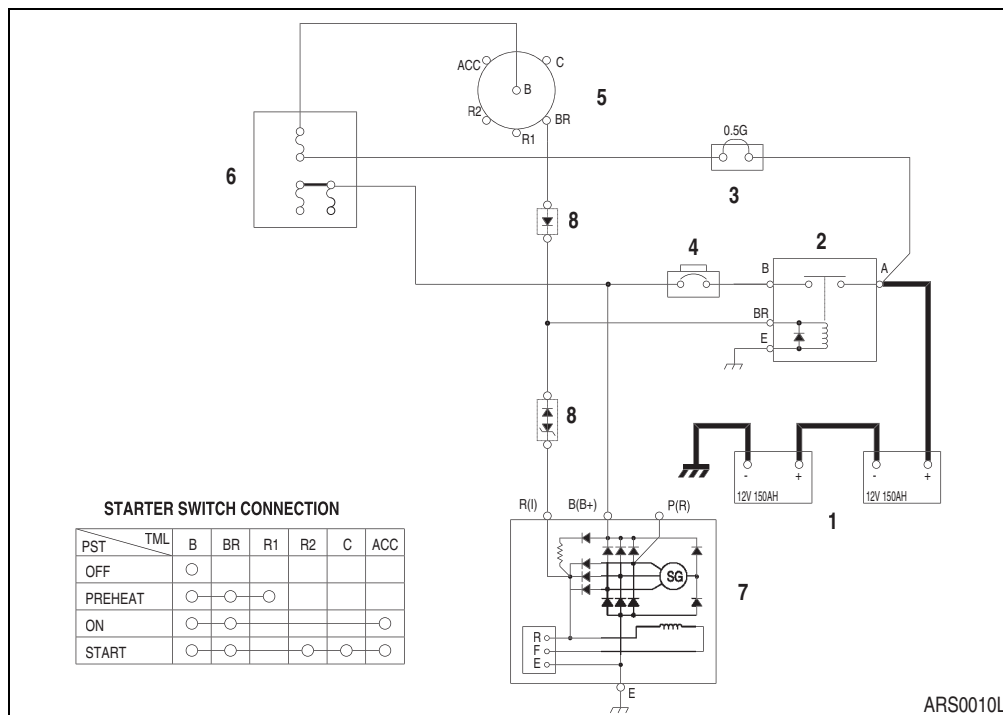


Figure 1 ELECTRIC POWER CIRCUIT DIAGRAM

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker

Reference Number	Description
5	Starter Switch
6	Fuse Box
7	Alternator
8	Diode

ENGINE STARTING CIRCUIT

OPERATION DURING START PROCESS

When the starter switch is turned to the start position, the "E" terminals of the starter controller (7) are connected. At this time the contacts in the starter relay (8) are closed by the current flow from the battery (1, Figure 2) → fusible link (3) → "B" terminal of the starter switch (5) → "C" terminal of the starter switch (5) → "C" terminal of the starter relay (8) → "D" terminal of starter relay (8) → "S" terminal of starter controller (7) → "E" terminal of the starter controller (7) → ground.

The contact point "B" and "PP" of starter relay (8) are connected, the pinion gear of the starter (9) is pushed forward and makes contact with the ring gear of the flywheel and the internal contacts of the starter are connected.

The current flows from the battery (1) → "A" terminal of the battery relay (2) → "B" terminal of the battery relay (2, Figure 2) → "B" terminal of the starter (9). The starter motor is rotated and the engine is started.

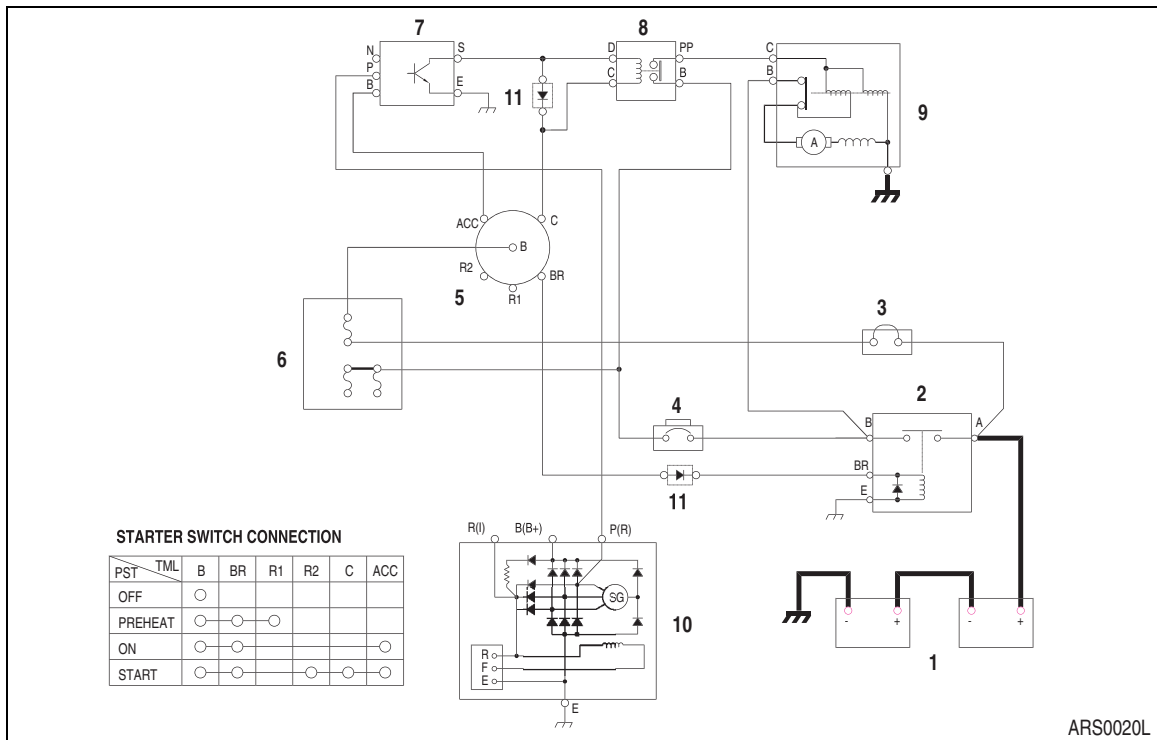


Figure 2 STARTER CIRCUIT (1) - WHILE STARTING

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch
6	Fuse Box

Reference Number	Description
7	Starter Controller
8	Starter Relay
9	Starter
10	Alternator
11	Diode

ENGINE PREHEATING SYSTEM

An air heater (8) device is installed in the intake manifold of the engine.

When the starter switch (5) is turned to the "Preheat" position, the current flows from the battery (1) → fusible link (3) → "B" terminal of starter switch (5) → "R1" terminal of starter switch (5) → "C" terminal of preheat relay (7) → ground and the contact points of the preheat relay are closed.

When the contact points of the preheat relay (7) are closed, the heating coils of the air heating device are heated by current flowing from the battery (1) → battery relay (2) → preheat relay (7) → air heater (8) → ground.

The preheat time is approximately 19 seconds. A built-in timer in the instrument panel will activate an indicator light approximately 19 seconds after the preheat process has been selected.

Even after the starter switch (5) has been moved to the start position the current will continue to flow through the "R2" terminal of the starter switch (5) to the coil of the preheat relay (7) without disruption of the preheat process.

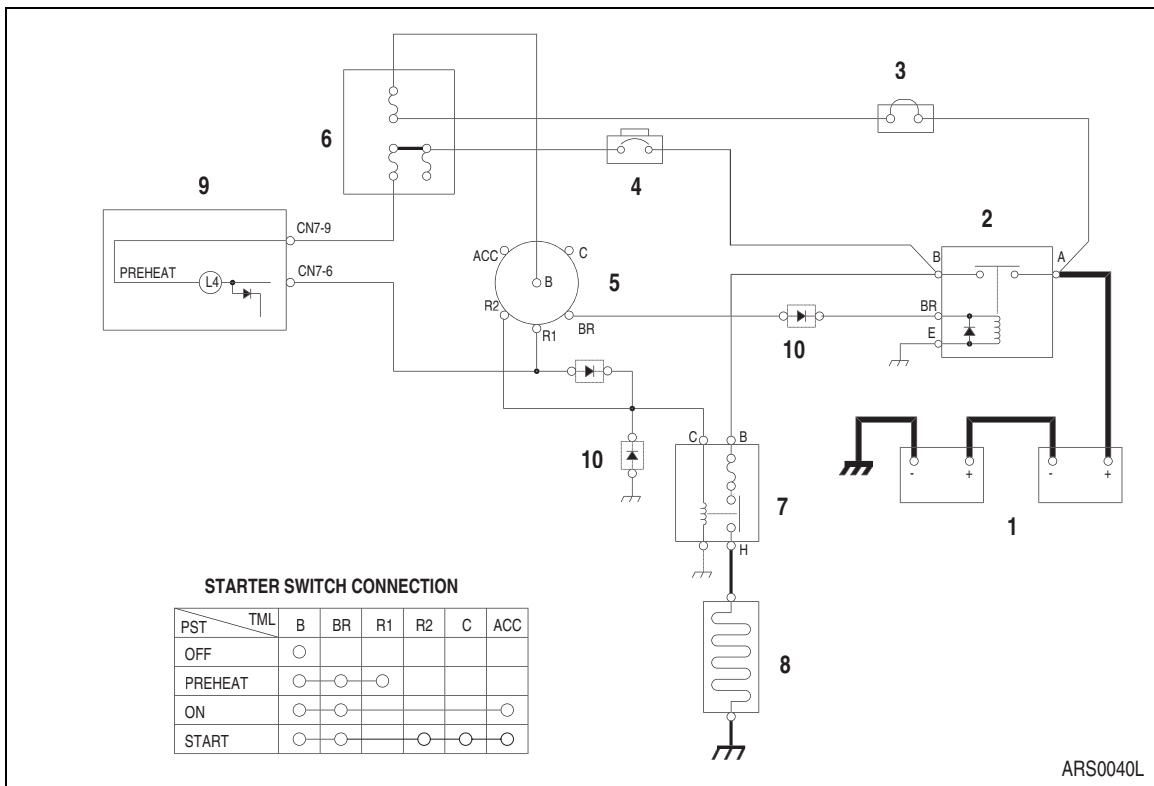


Figure 4 ENGINE PREHEAT CIRCUIT

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch

Reference Number	Description
6	Fuse Box
7	Preheat Relay
8	Air Heater
9	Indicator Lamp
10	Diode

ENGINE STOP SYSTEM

The engine stop circuit consists of a starter switch (5), engine stop motor (9) and engine stop relay (8). There are two modes of operation - engine running and engine stop.

The worm gear built into the motor reduces the engine stop motor's speed and changes motor's revolution to reciprocation. The fuel shut off lever is pushed or pulled by this change.

When the start switch is in the "ON" position, the engine stop motor rotates 180° and comes to a stop due to the cam switch. When the start switch is in the "OFF" position, the engine stop motor moves 180° from the running mode position and is stopped by the cam switch.

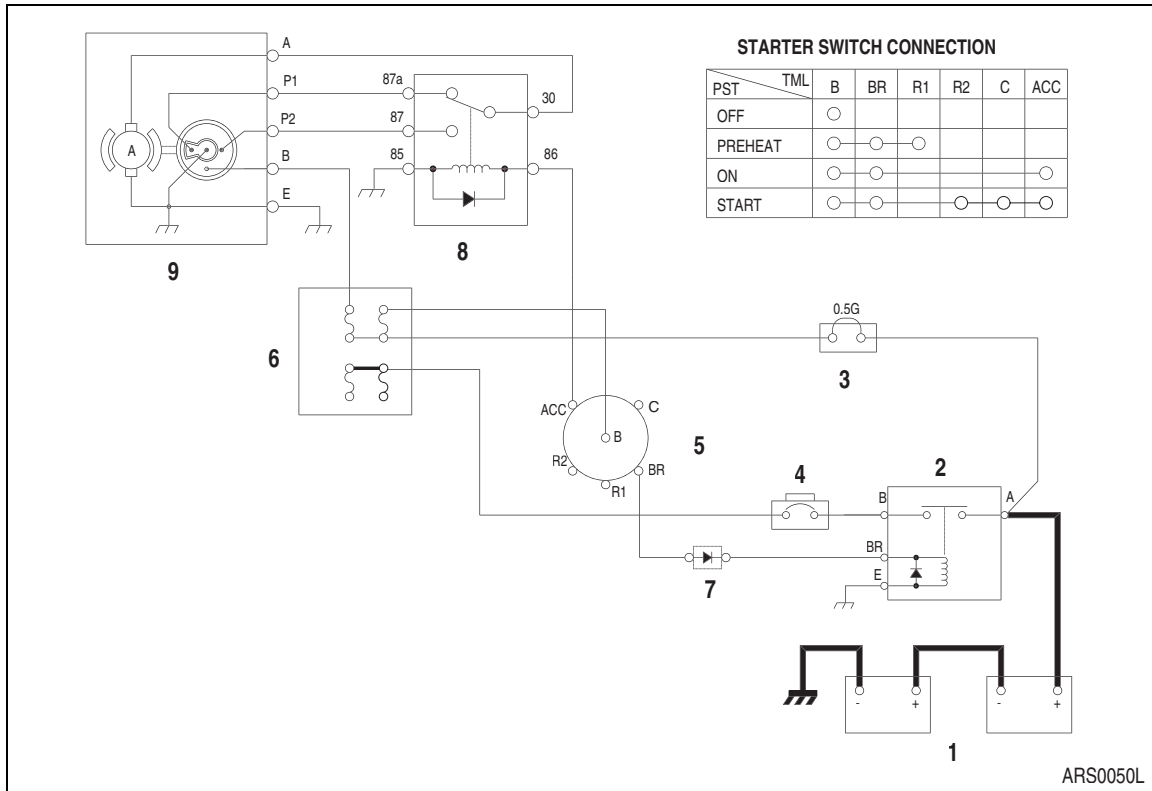


Figure 5 ENGINE STOP CIRCUIT

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch

Reference Number	Description
6	Fuse Box
7	Diode
8	Engine Stop Relay
9	Engine Stop Motor

Operation In Engine Running Mode

When the starter switch (3) is turned to the "ON" position, the contact points "30" and "87" of the engine stop relay (5) are closed due to current flowing from the battery (1) → fusible link (2) → "B" terminal of starter switch (3) → "ACC" terminal of starter switch (3) → "86" terminal of engine stop relay (5) → "85" terminal of engine stop relay (5) → ground.

As a result, the engine stop motor (6) is rotated by the current flow from the battery (1) → fusible link (2) → "B" terminal of the engine stop motor (6) → "P2" terminal of engine stop motor (6) → "87" terminal of engine stop relay (5) → "30" terminal of the engine stop relay (5) → "A" terminal of engine stop motor (6) → "E" terminal of engine stop motor (6) → ground. The engine stop motor opens (pushes) the fuel shut off lever of the fuel injection pump and the system is in the running mode. The engine stop motor rotates 180° and comes to a stop due to the cam switch which shuts off the current to the motor.

When the starter switch is in the "ON" position, the internal components of the engine stop motor's cam switch is in running mode position.

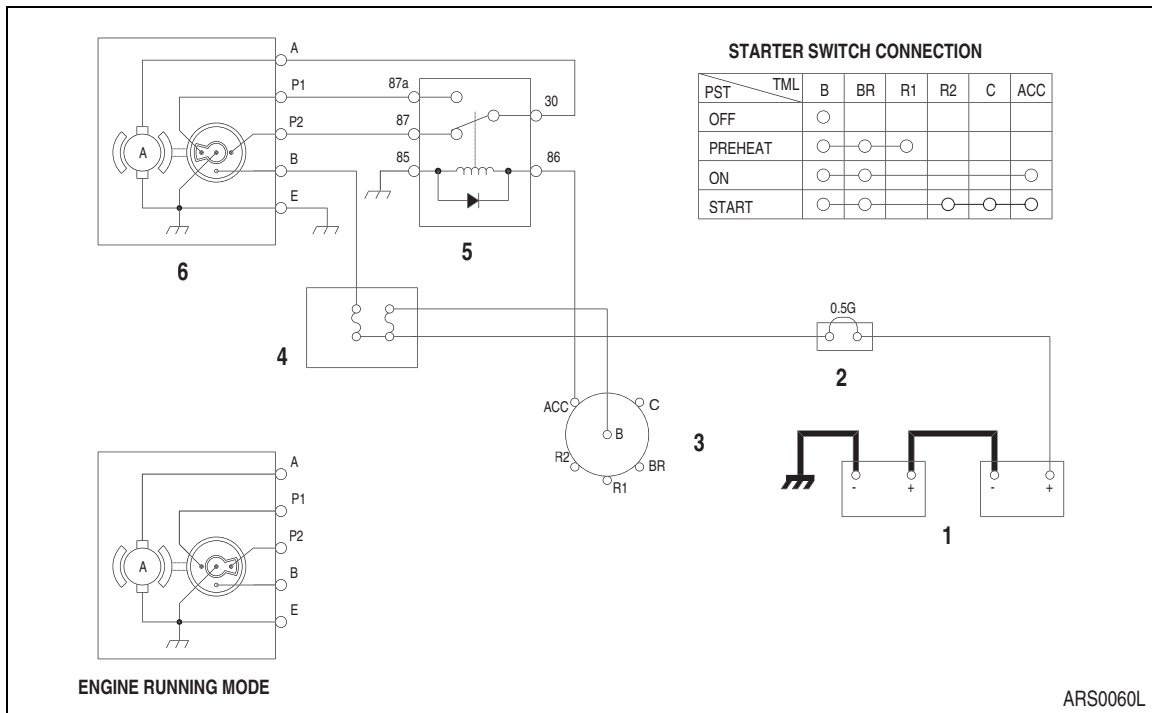


Figure 6 ENGINE STOP CIRCUIT - RUNNING MODE

Reference Number	Description
1	Battery
2	Fusible Link
3	Starter Switch

Reference Number	Description
4	Fuse Box
5	Engine Stop Relay
6	Engine Stop Motor

Operation In Engine Stop Mode

When the starter switch (3) is in the "OFF" position, the electric current flow to the coil of the engine stop relay (5) is shut off.

As a result, the "30" and "87a" contact point of the engine stop relay are connected and current is supplied to the engine stop motor from the battery (1) → fusible link (2) → "B" terminal of engine stop motor (6) → "P1" terminal of engine stop motor (6) → "87a" terminal of engine stop relay (5) → "30" terminal of engine stop relay (5) → "A" terminal of engine stop motor (6) → "E" terminal of engine stop motor (6) → ground and the motor is rotated.

The shut off lever of the fuel injection pump, linked to the engine stop motor by a cable, is moved to the close (pull) position and the engine is stopped. The engine stop motor moves 180° from the running mode position and is stopped by the internal cam switch which cuts off the current to the motor.

When the starter switch is in the "OFF" position, the internal components of the engine stop motor's cam switch is in the stop mode position.

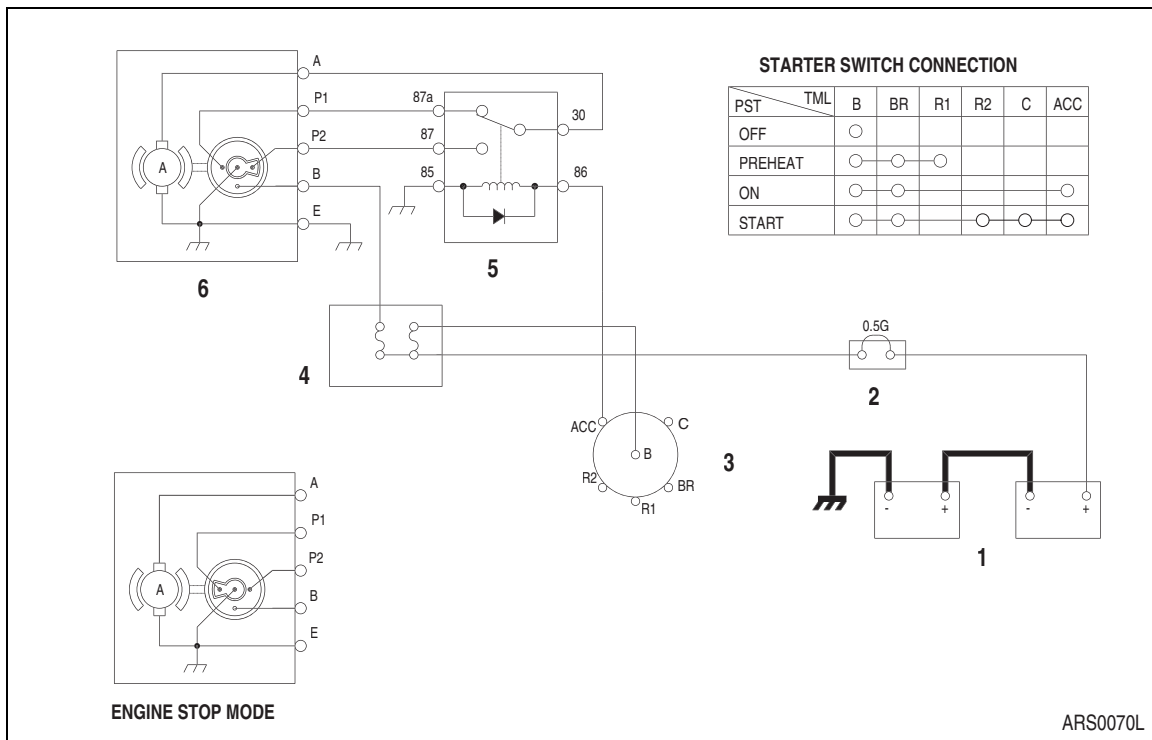


Figure 7 ENGINE STOP CIRCUIT - STOP MODE

Reference Number	Description
1	Battery
2	Fusible Link
3	Starter Switch

Reference Number	Description
4	Fuse Box
5	Engine Stop Relay
6	Engine Stop Motor

CHARGING SYSTEM

When the starter switch (5) is turned to the "ON" position, an initial excited current flows to the field coil of the alternator (7) through the battery relay (2) and circuit breaker (4). When the engine is started from this condition the alternator (7) starts charging. The current flows from the "B" terminal of alternator (7) → circuit breaker (4) → battery relay (2) → battery (1).

The alternator also supplies electric current to other electrical components. When the alternator (7) starts to operate, a current flows from the "R(I)" terminal of alternator → diode (8) → battery relay (2) coil securing a path for the charging current to the battery (1). Thus preventing the possibility of a high voltage build up and possible damage to the electric system.

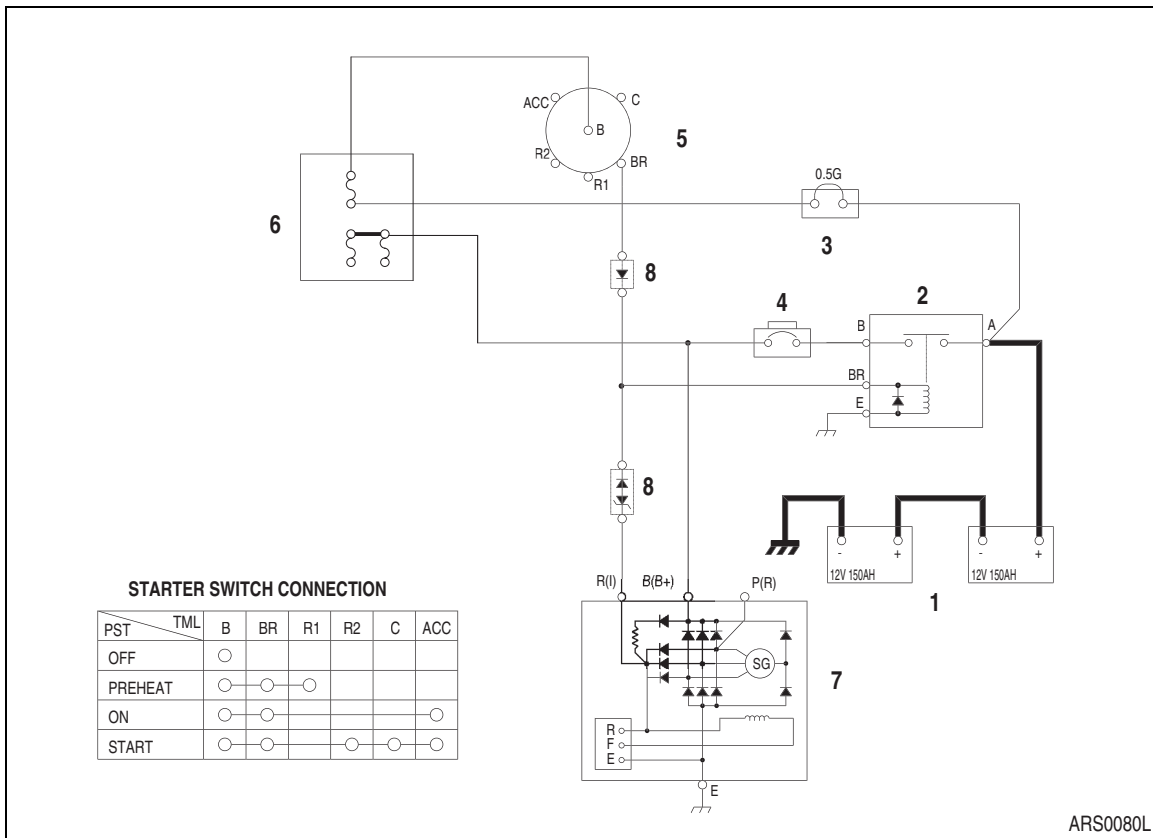


Figure 8 CHARGING CIRCUIT

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker

Reference Number	Description
5	Starter Switch
6	Fuse Box
7	Alternator
8	Diode

MONITORING SYSTEM

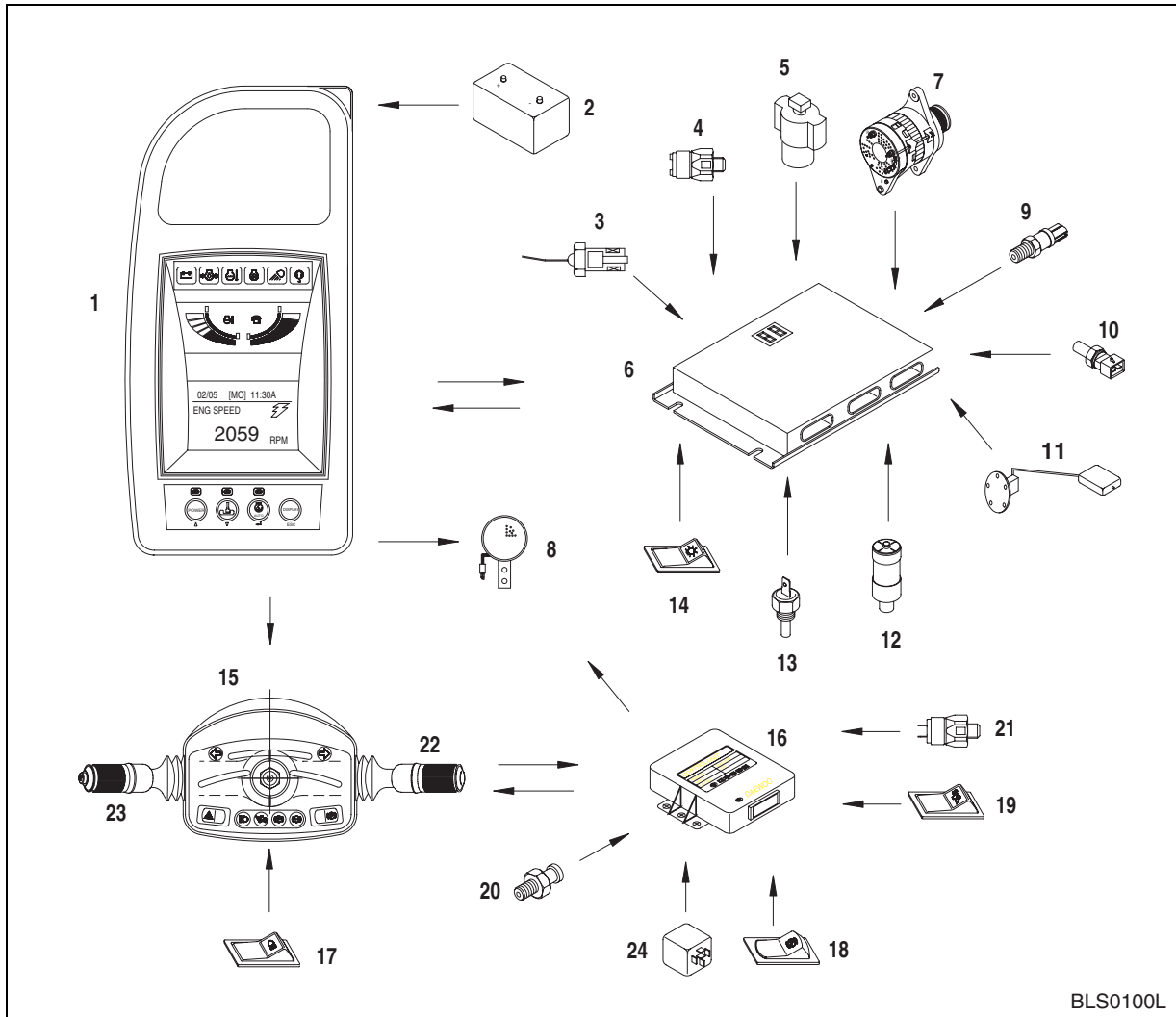


Figure 9

Reference Number	Description
1	Instrument Panel
2	Battery
3	Engine Speed Sensor
4	Return Filter Switch
5	Pilot Filter Switch
6	e-EPOS Controller
7	Alternator
8	Warning Buzzer
9	Pump Discharge Pressure Sensor
10	Engine Coolant Temperature Sensor
11	Fuel Sensor
12	Air Cleaner Indicator
13	Engine Oil Pressure Switch

Reference Number	Description
14	Light Switch
15	Steering Console
16	Control Unit
17	High Beam Switch
18	Parking Switch
19	Travel, Work, Park Select Switch
20	Transmission Pressure Sensor
21	Brake Pressure Sensor
22	Right Side Combination Switch
23	Left side Combination Switch
24	Pilot Relay

The monitoring system displays the various data and warning signals onto the instrument panel by processing the information gathered from the e-EPOS controller. It displays information selected by the operator.

INSTRUMENT PANEL

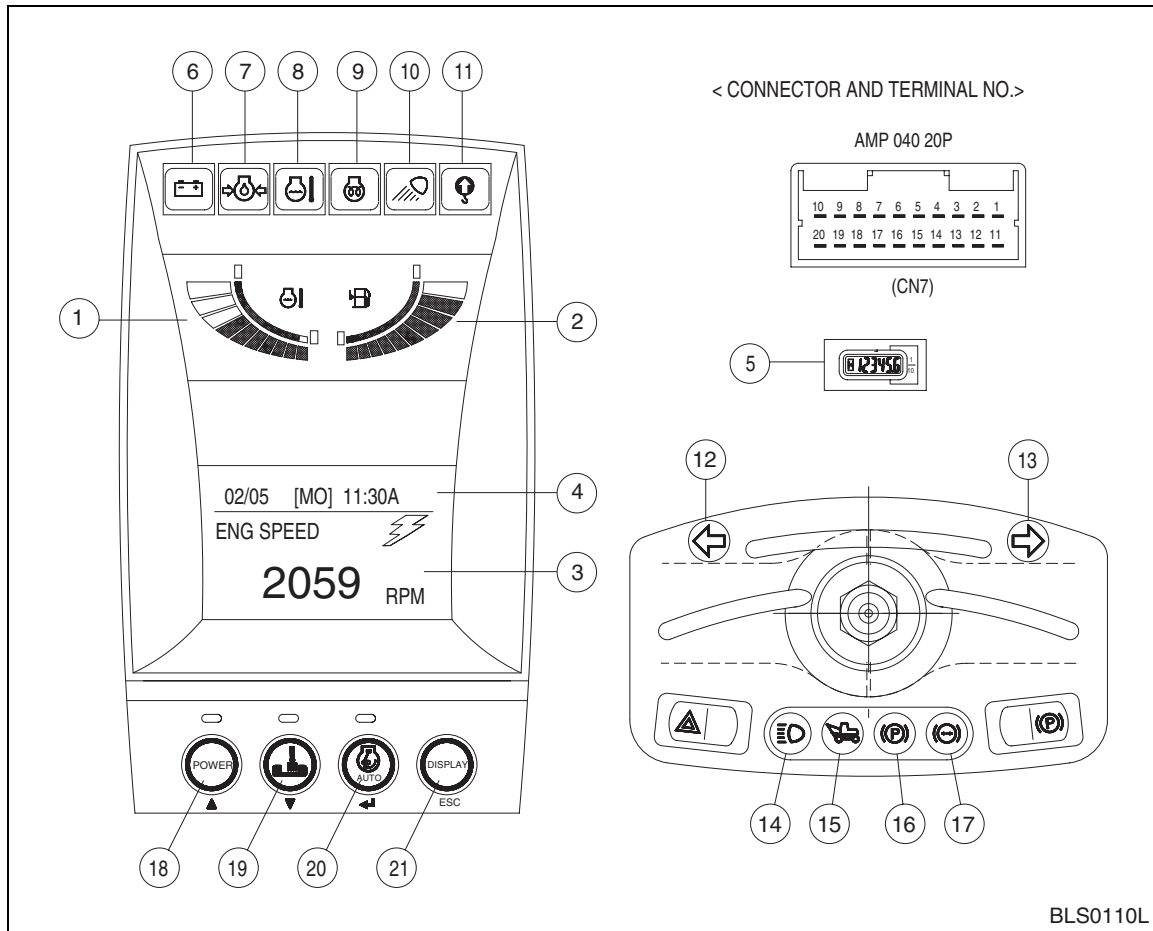


Figure 10

Gauges	Warning Lights	Mode Select Switches
1. Engine Coolant Temp. Gauge	6. Charge Warning Light	18. Power Mode Select Switch (Up Arrow Button)
2. Fuel Gauge	7. Engine Oil Pressure Warning Light	19. Trenching Mode Select Switch (Down Arrow Button)
3. Multifunction Gauge and Graphic Information Area	8. Coolant Temp. Warning Light	20. Auto Idle Switch (Enter Button)
4. Digital Clock	9. Preheat Completion Light	21. Display Select Switch (Escape Button)
5. Service Hour Meter	10. Work Lamp Indicator Light	
	11. Overload Warning Light	
	12. Left Directional / Hazard Indicator Light	
	13. Right Directional / Hazard Indicator Light	
	14. High Beam Indicator Light	
	15. Travel Indicator Light	
	16. Parking Brake Indicator Light	
	17. Brake Fluid Pressure Warning Light	

When the engine starter switch is turned to the "I" (ON) position, all bands of gauges, indicator lights of switches/buttons and indicator/warning lights will turn "ON" and the alarm buzzer will sound for about 2 seconds.

During this time, a moving excavator will appear on the digital clock and graphic information area (3 and 4, Figure 10).

MONITORING SYSTEM SCHEMATIC

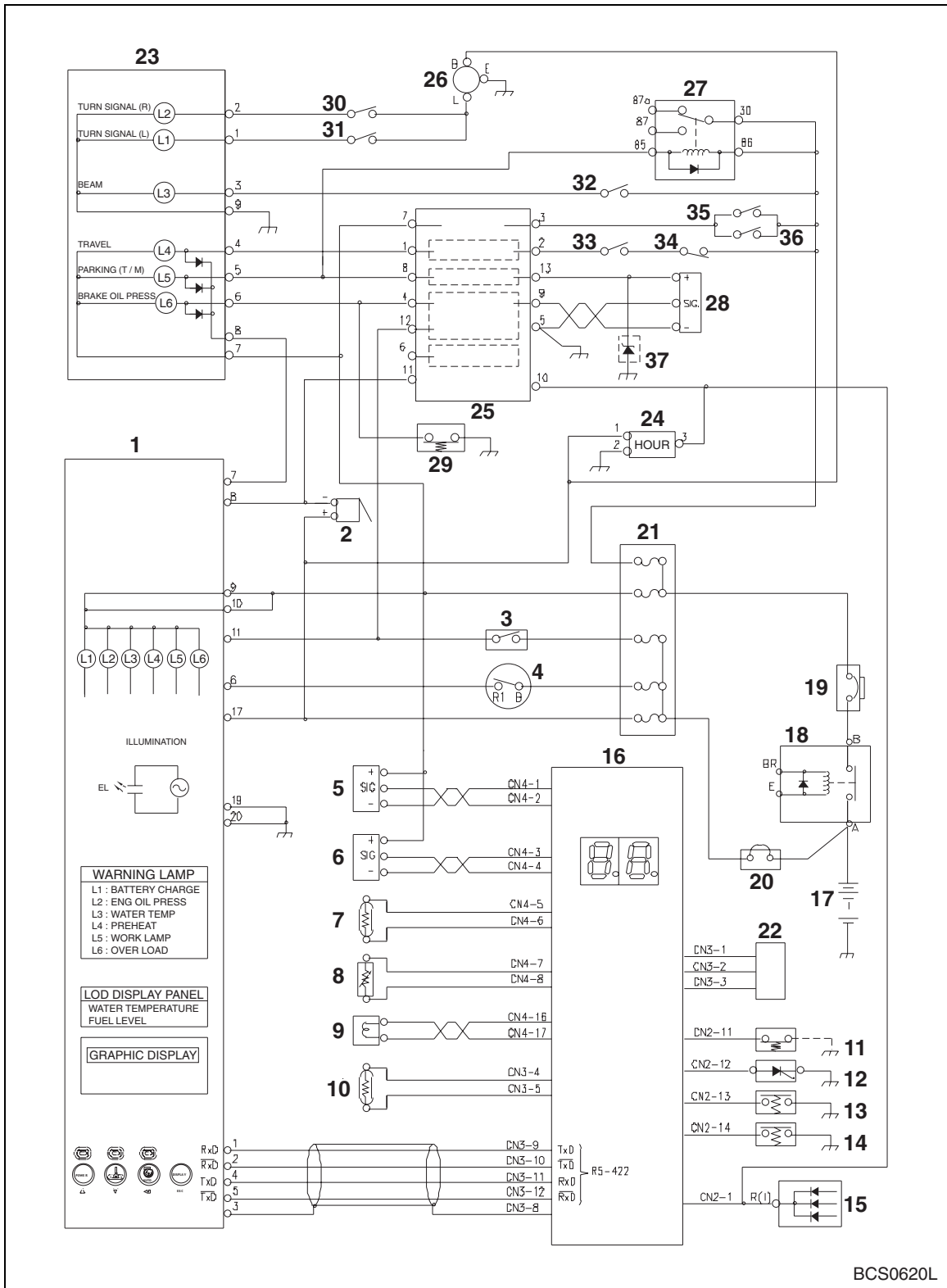


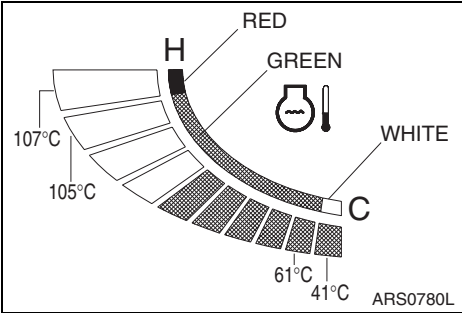
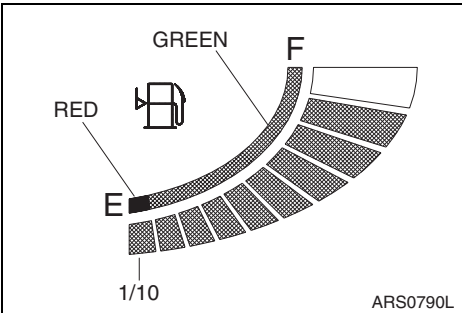
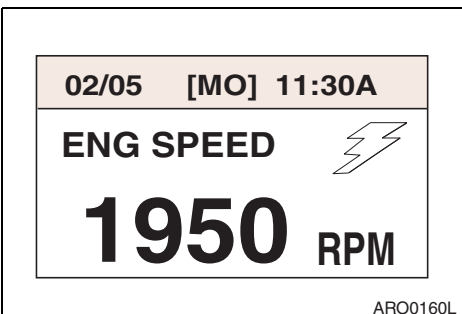
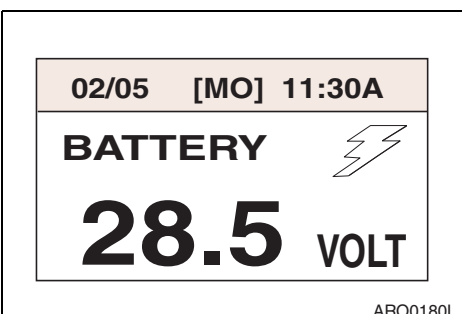
Figure 11

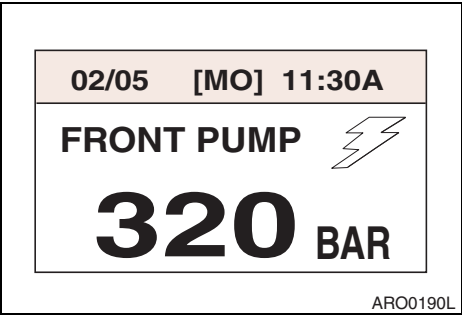
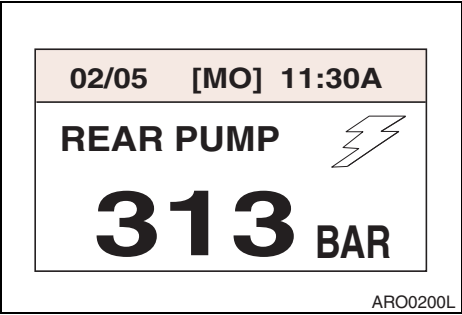
Reference Number	Description
1	Instrument Panel
2	Warning Buzzer
3	Light Switch
4	Starter Switch
5	Pump Discharge Pressure Sensor (Front Pump)
6	Pump Discharge Pressure Sensor (Rear Pump)
7	Coolant Temperature Sensor
8	Fuel Level Sensor
9	Engine Speed Sensor
10	Hydraulic Oil Temp. Sensor
11	Engine Oil Pressure Switch
12	Air Cleaner Indicator
13	Return Filter Switch
14	Pilot Filter Switch
15	Alternator
16	e-EPOS Controller
17	Battery
18	Battery Relay
19	Circuit Breaker

Reference Number	Description
20	Fusible Link
21	Fuse Box
22	Check Connector
23	Steering Console
24	Hour Meter
25	Control Unit
26	Blinker Unit
27	Pilot Relay
28	Transmission Pressure Sensor
29	Brake Oil Pressure Sensor
30	Left Directional Indicator Light Switch
31	Right Directional Indicator Light Switch
32	High Beam Switch
33	Travel Select Switch
34	Parking Brake Switch
35	Forward Run Select Switch
36	Backward Run Select Switch
37	Zener Diode

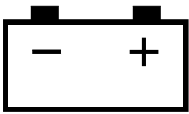
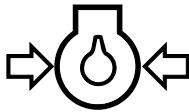
OPERATION

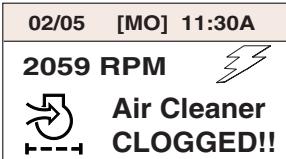
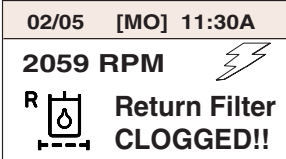
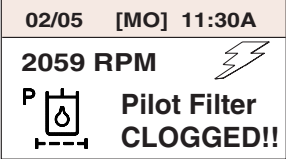
INSTRUMENTS

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Engine Coolant Temperature		CN4-5 CN4-6	41°C (106°F) →1,372 ohms 61°C (142°F) →855 ohms 102°C (216°F)→160 ohms 105°C (221°F) →147 ohms 107°C (225°F) →128 ohms
Fuel Level		CN4-7 CN4-8	1/10 LCD Blinking →over 5K ohms FULL →under 525 ohms
Tachometer		CN4-16 CN4-17	N = 129 f / 60 (S140W-V) N = 129 f / 60 (S160W-V) N = 129 f / 60 (S180W-V) N = 129 f / 60 (S210W-V)
Voltmeter		CN7-9 CN7-19	0 - 32 VDC

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Main pump discharge pressure (front pump)		CN4-1 CN4-2	$V = 0.00816 \times P + 1.0$ V: Sensor output voltage (V) P: Displayed pressure (Bar)
Main pump discharge pressure (rear pump)		CN4-3 CN4-4	

WARNING AND INDICATOR LIGHTS

Description	Symbol	Input Terminal	Operation	Remarks
Charge	 HAOA610L	CN2 - 1	Lights up when not charging [R(I) terminal output drops below 12±1V] and over charging [R(I) terminal output increase over 33 V].	Lights up before engine start up and shut off once engine is running.
Engine Oil Pressure	 HAOA620L	CN2 - 11	Lights up when engine oil pressure switch is turned "ON" (Oil pressure drops below 0.7 kg/cm ² (10 psi).	After starting engine, if engine oil pressure is insufficient after 8 seconds, a warning buzzer will sound.
Engine Coolant Temperature	 HAOD350L	CN4 - 5 CN 4 - 6	Lights up when the resistance of engine coolant temperature sensor drops below 128 ohms.	
Preheat	 HAOA639L	CN7 - 6	Lights up when preheat process is completed. (Approximately 19 seconds from start)	
Work Light	 2658A	CN2 - 7	Lights up when work light switch is turned "ON."	

Description	Symbol	Input Terminal	Operation	Remarks
Overload (Optional)	 ARO0220L	CN1 - 3 CN1 - 4	Lights up when lifting load exceeds limit. (When the over load warning switch is turned "ON," output voltage increases over reading in remarks.)	Warning buzzer will sound. 2.39 V (S140W-V) 2.39 V (S160W-V) 2.39 V (S210W-V) 2.31 V (S180W-V)
Graphic Information Area				
Air Cleaner	 ARO0210L	CN2 - 12	Lights up when air cleaner is clogged	Symbol is blinking.
Return Filter	 ARO0230L	CN2 - 13	Lights up when return filter pressure increases over 1.5 kg/cm ² (21 psi).	Symbol is blinking.
Pilot Filter	 ARO0240L	CN2 - 14	Lights up when pilot filter pressure increases over 1.0 kg/cm ² (14 psi).	Symbol is blinking.

CONTROL UNIT

OPERATION SCHEMATIC

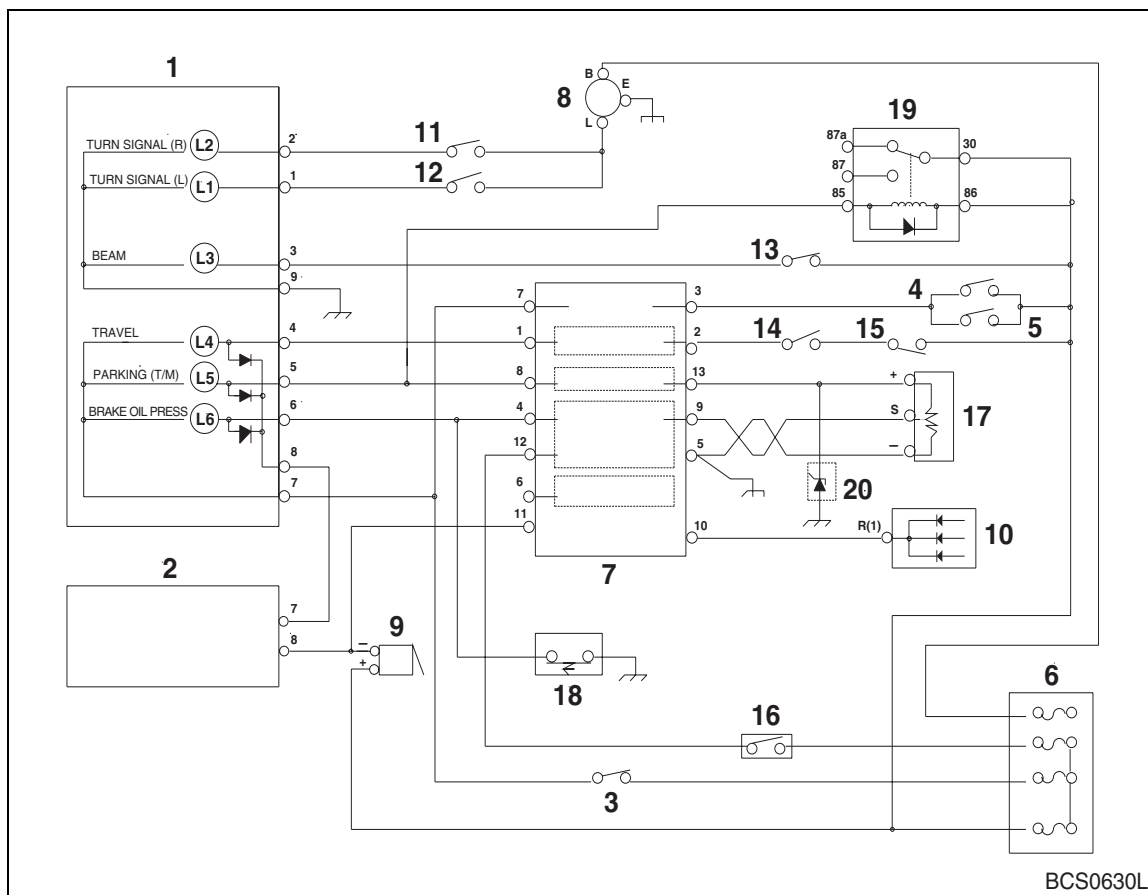


Figure 12

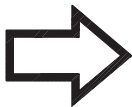
Reference Number	Description
1	Steering Console
2	Instrument Panel
3	Starter Switch
4	Forward Run Select Switch
5	Backward Run Select Switch
6	Fuse Box
7	Control Unit
8	Blinker Unit
9	Warning Buzzer
10	Alternator

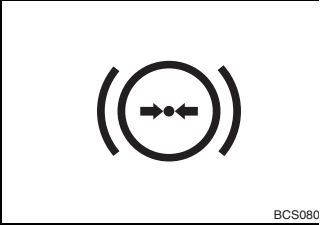
Reference Number	Description
11	Right Directional Indicator Light Switch
12	Left Directional Indicator Light Switch
13	High Beam Switch
14	Travel Select Switch
15	Parking Brake Switch
16	Lamp Switch
17	Transmission Pressure Sensor
18	Brake Oil Pressure Switch
19	Pilot Relay
20	Zener Diode

OPERATION SPECIFICATION

No	Input		Output	Remark
1	Starter switch turns "OFF"/Lamp switch turns "ON."		Warning buzzer sounds (Immediately).	
2	When the output of alternator's "I" terminal is over 14.5V $\pm$ 1V.	Brake pressure switch turns "ON."	Warning buzzer sounds (Immediately).	
		Forward run and backward run select switches turn "ON" and parking brake indicator light turns "ON."	Warning buzzer sounds (Immediately).	
3	The voltage of transmission pressure sensor (Between 5 and 9).	Over 2.60V $\pm$ 0.1V	Parking brake indicator light turns "OFF."	
		Below 2.51V $\pm$ 0.1V	Parking brake indicator light turns "ON."	
4	When the parking brake switch turns "OFF."	Travel, work select switch is placed in "TRAVEL."	Travel indicator light turns "ON."	
		Travel, work select switch is placed in "WORK."	Travel indicator light turns "OFF."	

CONSOLE WARNING LIGHT

Description	Symbol	Input Terminal	Operation	Remarks
Directional Indicator (Left)	 BCS0760L	CN11-1	Turns on and flashes when the left turn signal switch is selected and the hazard switch is turned "ON"	
Directional Indicator (Right)	 BCS0761L	CN11-2	Turns on and flashes when the right turn signal switch is selected and the hazard switch is turned "ON"	
High Beam	 BCS0770L	CN11-3	Lights up when the high beams are turned "ON"	
Travel	 BCS0780L	CN11-4	Lights up when the "travel, work" select switch is placed in the travel position and the parking brake switch turns "OFF"	
Parking	 BCS0790L	CN11-5	Lights up when the "park" select switch is turned "ON"	

Brake		CN11-6	Lights up when the brake oil pressure switch is turned "ON" (Oil pressure drops below 65 kg/cm ²)	A warning buzzer will simultaneously sound
-------	---	--------	---	--

INITIAL OPERATION

Item	Input (Terminal)	Output (Operation and initial setting mode)
Initial Operation	When battery voltage is input to CN7 - 9 (starter switch is turned from "OFF" to "ON" position).	• All LCD, LED and warning lights are turned on and turned off after about 2 seconds. • Warning buzzer is activated and turned off after about 2 seconds. • Power mode: Standard mode. • Work Mode: Digging mode. • Auto Idle: High Output (Activation). • Numerical display: Engine speed. • Clock: Current time display.

NOTE: Refer to the clock setting method of operation manual for time setting.

MODE SELECT SWITCH

Power Mode / Trenching Mode Switch

Operation Mode		Output Check (Operation mode display LED)	e-EPOS Output		
			Pump Discharge Volume Control Valve Current (mA)	Swing Priority Solenoid Valve	7-Segment Display
Power Mode	Power Mode	ON	Variable Output	-	9 x
	Standard Mode	OFF	0	-	7 x
Work Mode	Trenching Mode	ON	-	ON	x 2
	Digging Mode	OFF	-	OFF	x 0

Auto Idle Switch

Operation Mode		Output Check (Operation mode display LED)	e-EPOS Output (CN1 - 7 Terminal)
Auto Idle	Activation	ON	H (11 ±1.5V)
	Cancellation	OFF	L (0 - 1V)

GRAPHIC INFORMATION AREA DISPLAY

OVERVIEW

Many kinds of condition of machine are displayed on the letter information display department. The information display department is divided into two menus. One is main menu for user and the other is special menu for specialist. These menus can be moved from normal display mode by the combination of select buttons.

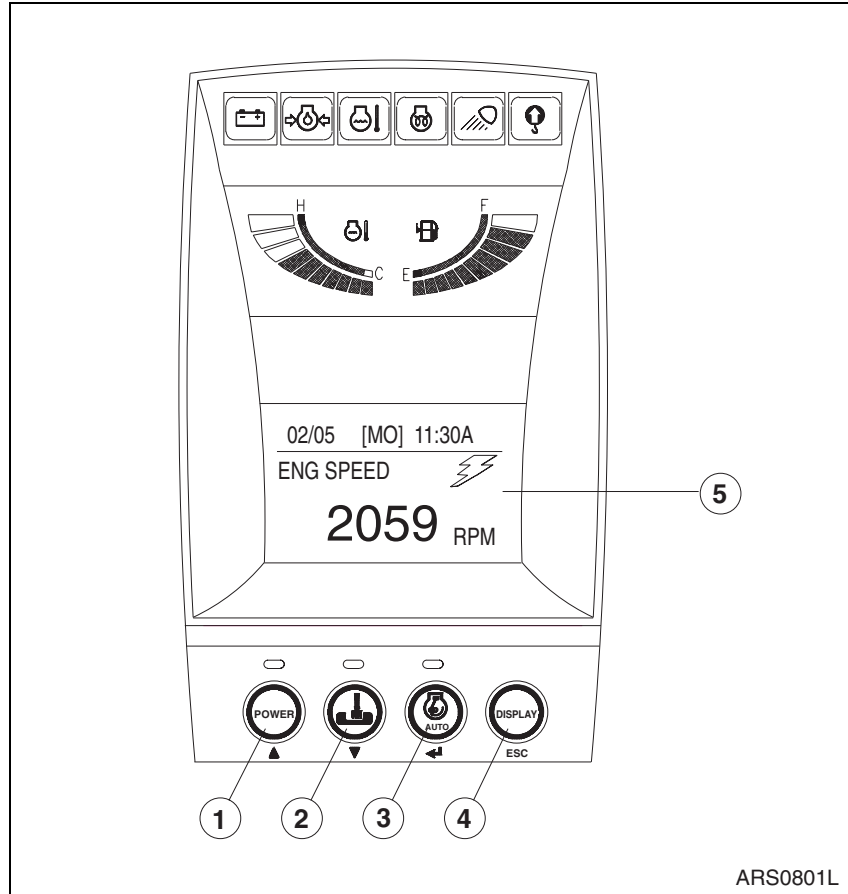


Figure 13

Selection Buttons	Graphic Display Area
1. Up Arrow Button	5. Letter Information Display Department
2. Down Arrow Button	
3. Enter Button	
4. Escape Button	

MAIN MENUS FOR THE GRAPHIC DISPLAY AREA

1. Main menu: Language setting, Time setting, Filter/Oil information
2. Special menu: Information of machine status, failure information, Information of machine operation.

MENU SELECTION BUTTONS

1. Up Arrow Button (▲, 1 on Figure 13): Move the cursor to up, left and previous screen.
2. Down Arrow Button (▼, 2 on Figure 13): Move the cursor to down, right and next screen.
3. Enter Button (↵, 3 on Figure 13): Move the menu to selected mode. When setting the menu, this button is used to function as the select button.
4. Escape Button (ESC, 4 on Figure 13): Move a screen to previous menu or main menu.

MAIN MENU

When the "ESC" button is pressed for more than 3 seconds, the main menu screen is displayed.

Main menu offers three sub-menus (language setting, time setting, or filter/oil information) to the operator.

Refer to the "Operation and Maintenance Manual" for details.

LANGUAGE SETTING

This mode is used for setting desired language.

TIME SETTING

This mode is used for setting time on the digital clock.

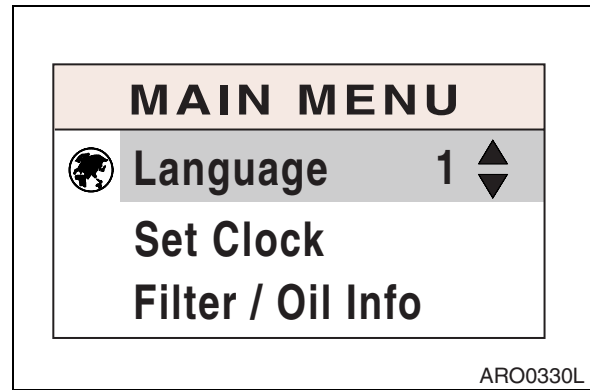


Figure 14

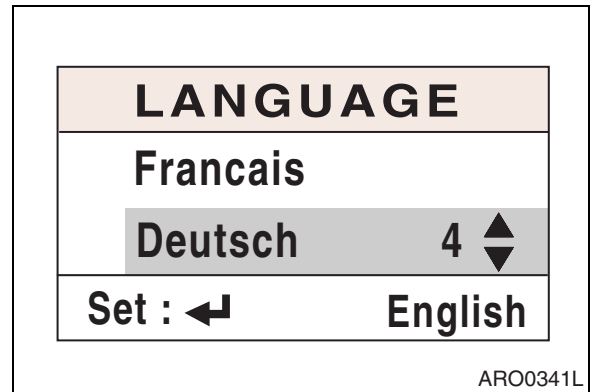


Figure 15

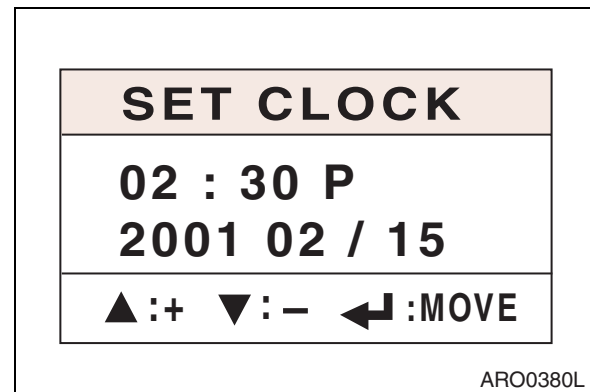


Figure 16

FILTER/OIL INFORMATION

This mode displays total operating hours of filters and oils.

After changing the filter and oil, reset the operating hour and then the operating hours until the next service interval can be easily checked.

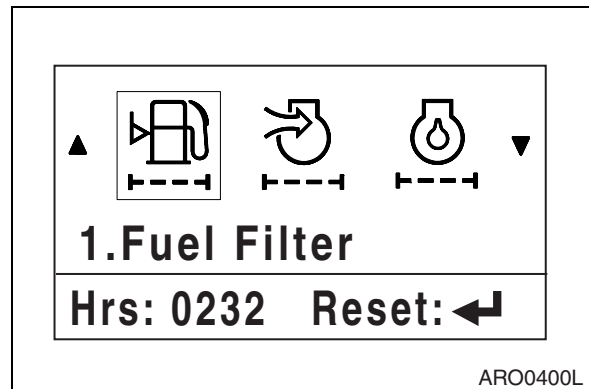


Figure 17

Menu Display Order and Icon Explanation

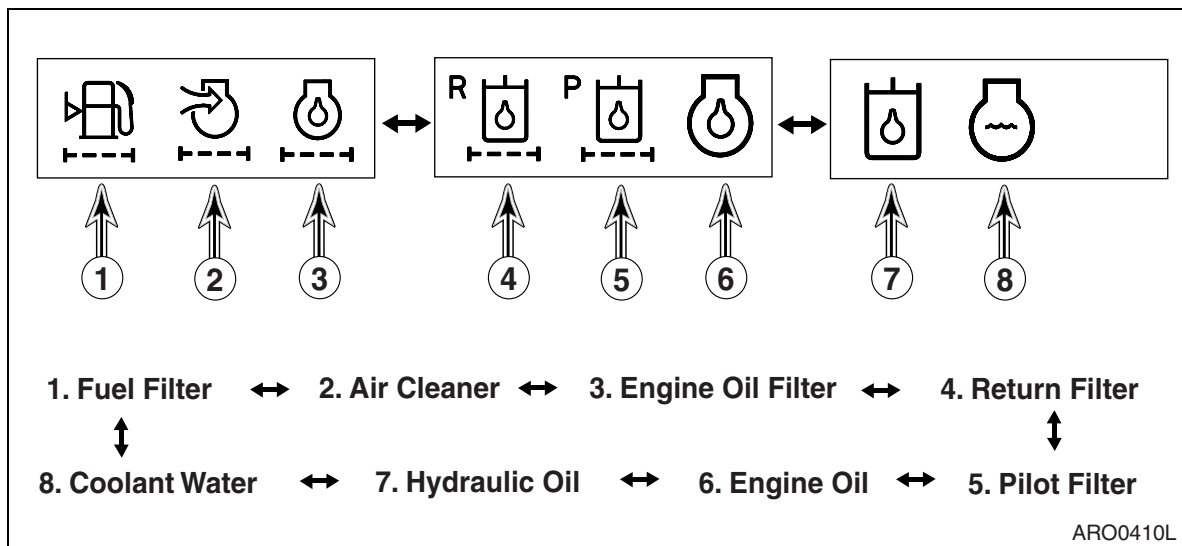


Figure 18

SPECIAL MENU

In this menu, many types of operating conditions and functions can be accessed and displayed, including the e-EPOS controller. This menu is mainly used for machine testing and failure diagnostics.

The special menu offers three sub-menus;

1. Machine status.
2. Failure information.
3. Information on machine operation

ENTERING/ACCESSING AND EXITING/ESCAPING MENUS

Entering/Accessing Menus

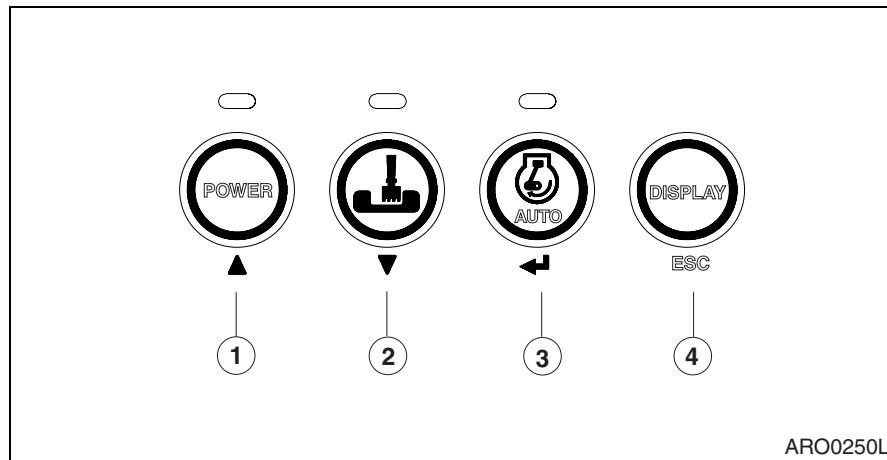


Figure 19

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 20) will be changed to special menu screen (Figure 21).

Normal Mode Screen

NOTE: Normal mode screen can display many kinds of display mode by selecting, for example, engine revolution (RPM), battery voltage (V), front pump pressure (BAR), rear pump pressure (BAR) and so on by selecting.

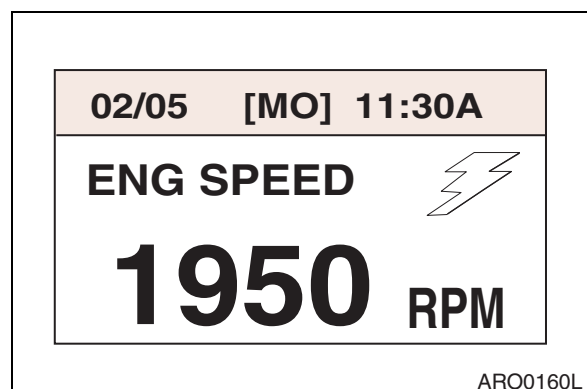


Figure 20

Special Menu Screen

NOTE: *Displayed language on the special menu screen consists of Korean and English.*

If any language except for Korean is selected during language selection mode of main menu, only English will be displayed on special menu screen.

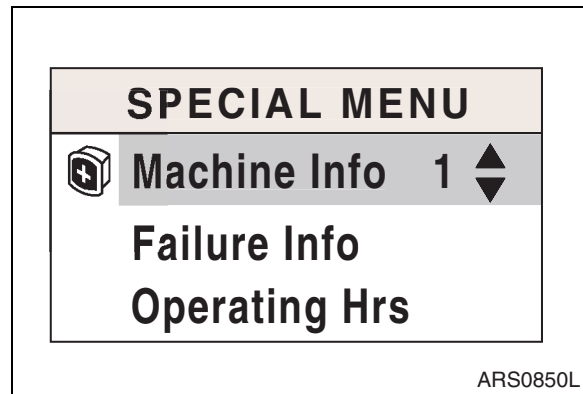


Figure 21

Exiting/Escaping Menus

1. If escape button (ESC, 4 on Figure 19) is pressed for more than 1 second, the special menu screen will be returned to the normal mode screen.
2. If this special menu is "ON" without any activity, for more than 20 seconds, it will turn to the normal mode screen.
3. After the turning starter switch to the "OFF" position, turn it back to the "ON" position, and the normal mode screen displayed once again.

SPECIAL MENU SELECTIONS

Sub-menu Selection Method

Various sub-menus can be selected by pressing "Up (▲, 1 on Figure 19)" and "Down (▼, 2 on Figure 19)" 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 19)" button for menu selection.

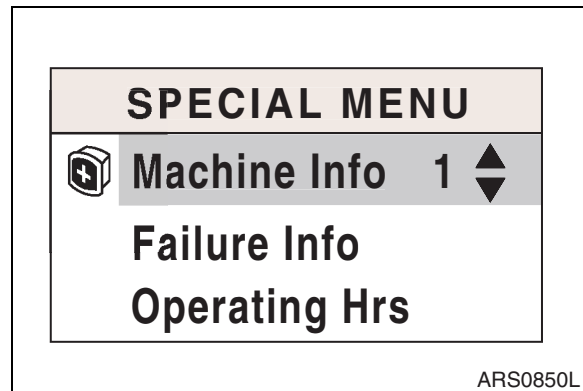


Figure 22

Information of Machine Status

1. Entering Sub-menus: When cursor is located on "Machine Info" of special menu screen, press "Enter (↵, 3 on Figure 19)" button and the "Machine Info Sub-menu" will be displayed.
2. Exiting Sub-menus: If escape button (ESC, 4 on Figure 19) is pressed for more than 1 second, display will be turned to previous sub-menu.

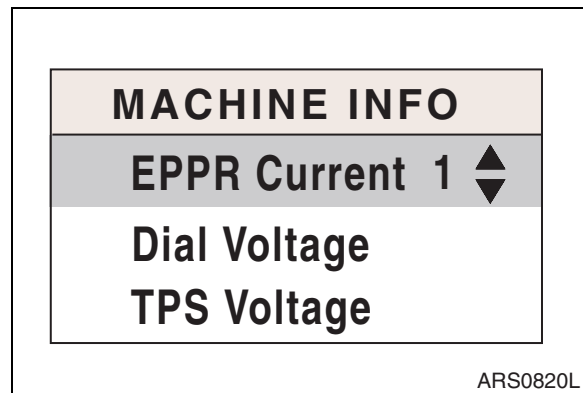


Figure 23

Contents of Machine Status

Display Item of Machine State Information			Display	Remarks
1. EPPR Current			"mA"	EPPR valve current
2. Dial Voltage			"mV"	Dial voltage
3. TPS Voltage			"mV"	TPS voltage
4. Input State	1. Alternator	8. Pressure (Px)	On or Off	Input status delivered from switches and sensors to e-EPOS controller is displayed as on or off. * Number 3 (Work/Travel Solenoid) is used only wheel type machine. * Number 13 (OWD Select) is optional part.
	2. Power Max	9. E/G Oil Press.		
	3. Work/Travel Solenoid	10. Air Cleaner		
	4. Hi Speed Solenoid	11. Return Filter		
	5. Auto Travel	12. Pilot Filter		
	6. Work Lamp	13. OWD Select		
	7. Pressure (Py)			
5. Output State	1. Relief Press Up	4. Spare Out 1	On or Off	Output status delivered from e-EPOS controller to solenoid valves is displayed as on or off.
	2. High Speed	5. Spare Out 2		
	3. Swing Priority			
6. Hydraulic Oil Temp			°C (°F)	Hydraulic oil temperature.
7. Boom Pressure (Opt)			BAR	On machine with overload warning device, it displays cylinder pressure.
8. T/M Pressure (Wheel Type)			BAR	Gear pump pressure.

Sub-menu Selections

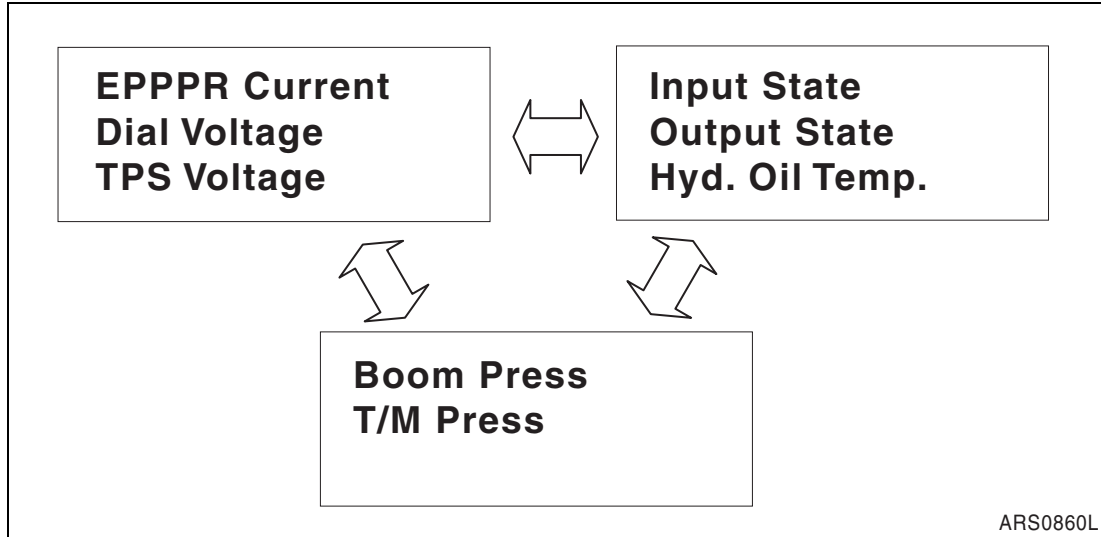


Figure 24

Display Example: Machine Status Information

1. EPPR Valve Current

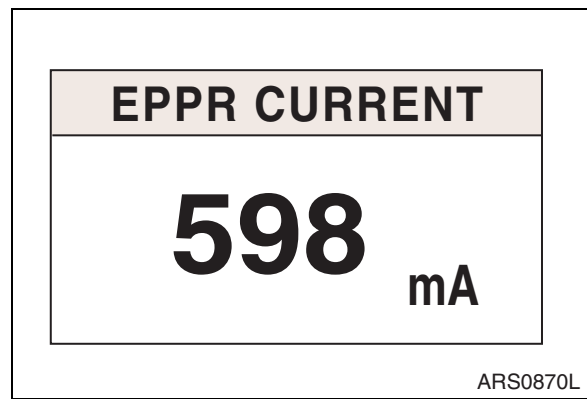


Figure 25

2. Dial Voltage

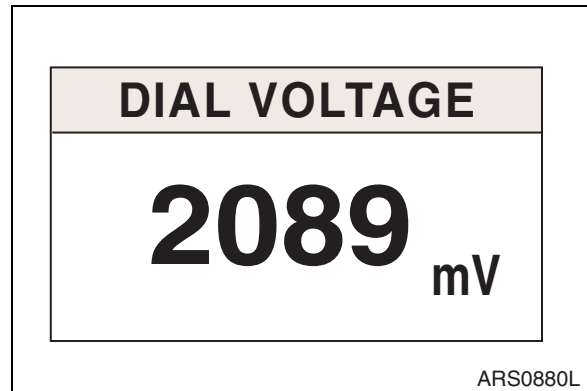


Figure 26

3. TPS Voltage
Output voltage of throttle position sensor.

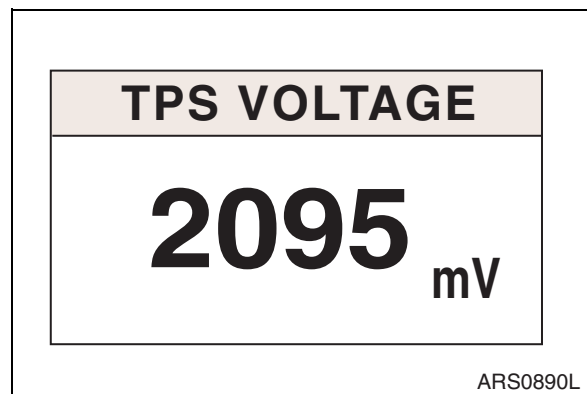


Figure 27

4. Input Status

"YES" or "NO" for alternator's generation (Generation: "ON"/ Non generation: "OFF"), selection status of select switch (Selection: "ON"/ Non selection: "OFF") and the other statuses of on/off type sensors.

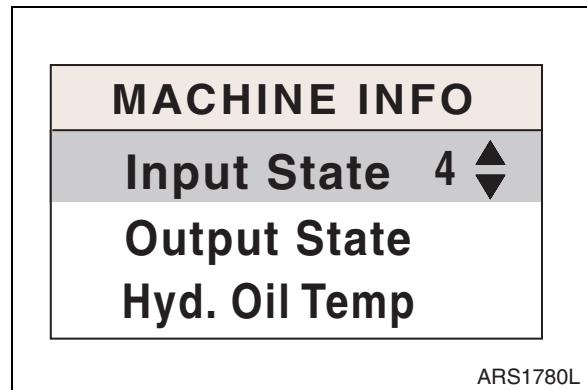


Figure 28

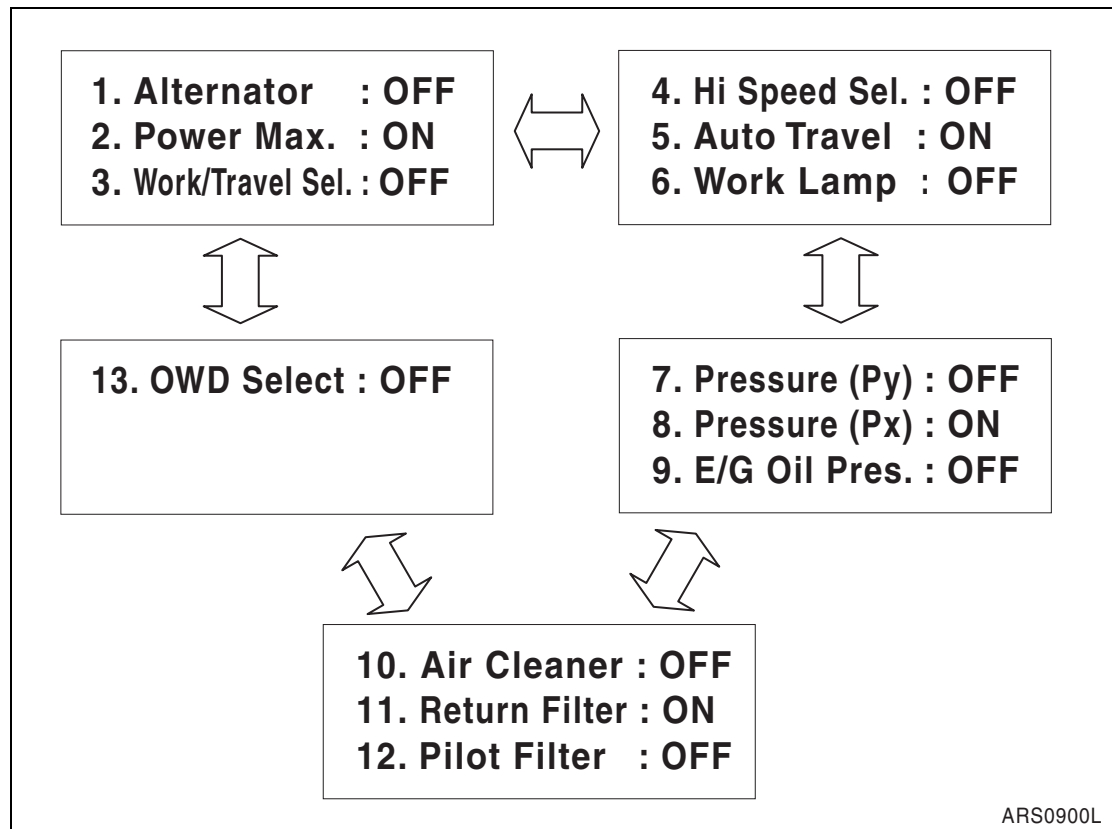


Figure 29

5. Output Status: Output status of solenoid valves and spare valves are displayed. (Output: "ON"/ Non output: "OFF")

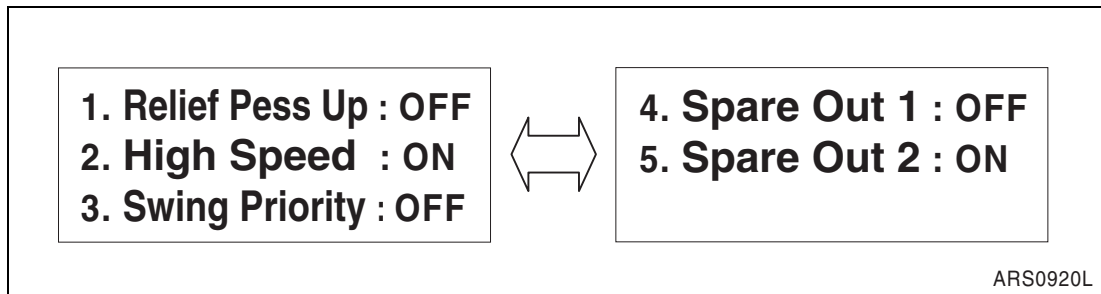


Figure 30

6. Hydraulic Oil Temperature

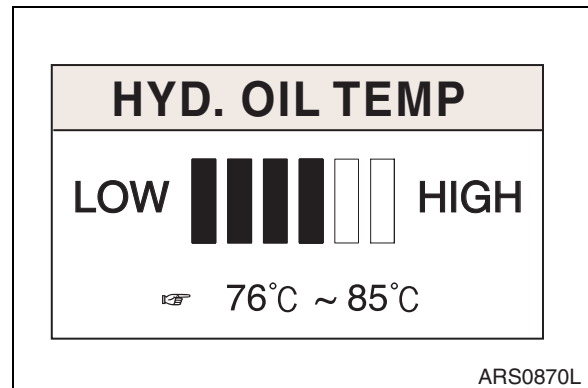


Figure 31

- Display Specification

BAR Graph Display	Input Terminal	Sensor Input Specification	Remarks
1/6 BAR Lit	CN 3 - 4 CN 3 - 5	Over 1,510 Ω	Below 30°C (Below 86°F)
1/6 - 2/6 BAR Lit		745 - 1,510 Ω	31 - 50°C (87 - 122°F)
1/6 - 3/6 BAR Lit		332 - 745 Ω	51 - 75°C (123 - 167°F)
1/6 - 4/6 BAR Lit		244 - 332 Ω	76 - 85°C (168 - 185°F)
1/6 - 5/6 BAR Lit		181 - 244 Ω	86 - 95°C (186 - 203°F)
1/6 - 6/6 BAR Lit		Under 181 Ω	Over 96°C (Over 204°F)

7. Boom Pressure (Optional)

On machine with OWD (Overload Warning Device), detected pressure from boom cylinder is displayed with numeric values (Unit: Bar).

The relative equation between the, output voltage of pressure sensor, and the pressure of boom cylinder, is as follows.

- $V = 0.00816P + 1$

V: Output voltage of pressure sensor (V).

P: Displayed pressure (Bar).

NOTE: At standard machine, "0 BAR" is always displayed.

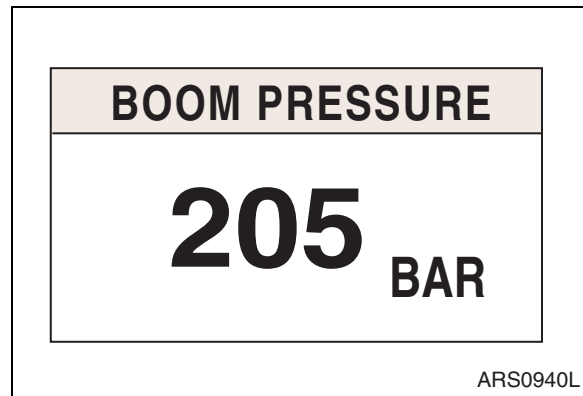


Figure 32

Failure Information

1. Entering Sub-menus: When a cursor is located in "Failure Info" of special menu screen press enter button (↵, 3 on Figure 19) and "Failure Info" screen is displayed.
2. Exiting Sub-menus: If escape button (ESC, 4 on Figure 19) is pressed for more than 1 second, this information screen will be returned to previous screen.

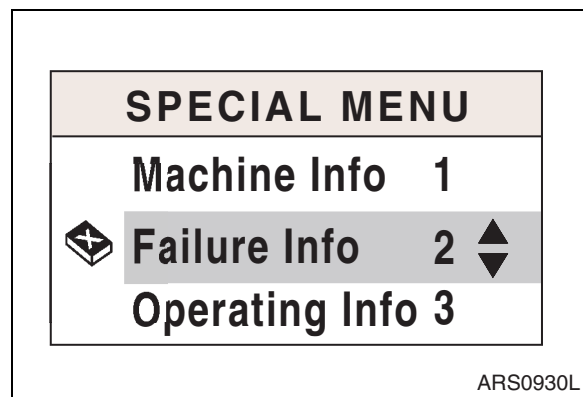


Figure 33

- * Real-time Failure:
Current status of failure is displayed.
- * Failure Log:
Memorized record of past failure is displayed.
- * Delete Fail Log:
This mode is used to delete all of the memorized record of past failure.

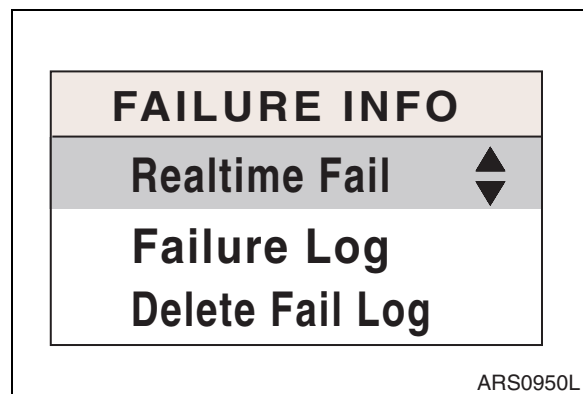


Figure 34

A. Current failure information

Current status of failure is displayed (Failure code, failure contents).

When a number of failures are produced, failure information can be checked by using "PRV" (▲, 1 on Figure 19) or "NXT" (▼, 2 on Figure 19) button.

* CODE: 12: Unique code of failure information.

* 01/02: A serial number of current failure/ total quantity of failure.

This example shows one of two failures.

B. Past failure information

Memorized record of past failure is displayed (Failure code, failure contents).

When a number of failures are produced, failure information can be checked by using "PRV" (▲, 1 on Figure 19) or "NXT" (▼, 2 on Figure 19) button.

NOTE: " N: xxx ": "xxx" means that the totally counted number of the same failure.

" xxxx Hr ": It will display the operation hour until the failure is generated. (Above example screen shows that breaking of a wire of pressure solenoid valve is generated at 75Hr.)

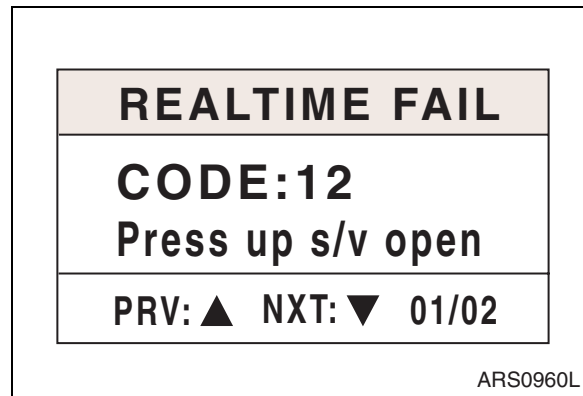


Figure 35

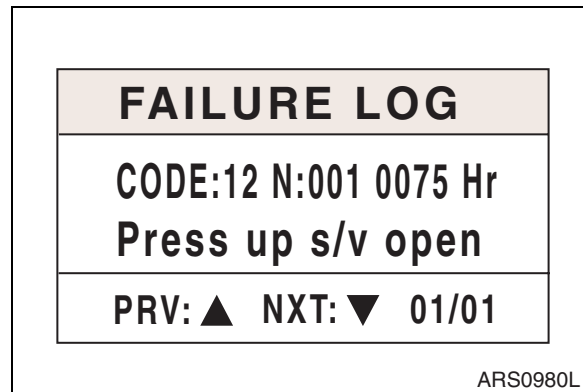


Figure 36

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 19) button is pressed, the memorized record will be deleted.

At this time, deletion signal will be displayed and the screen will move to previous menu after deletion.

This screen will be displayed during 3 seconds.

When "NO" (ESC, 4 on Figure 19) button is pressed, the screen will recover to previous menu without deletion.

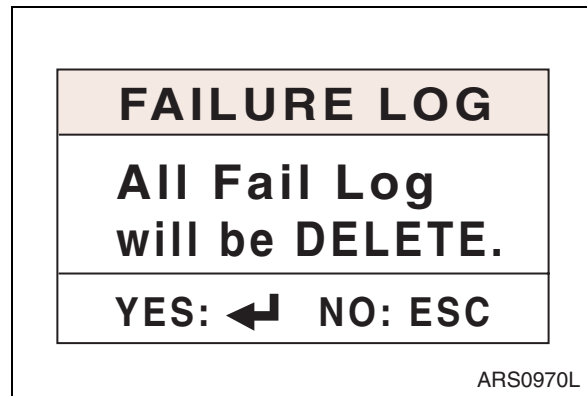


Figure 37

Code Description of Failure Information

Code	State
0 x	Short Circuit
1 x	Open circuit
2 x	Output error
3 x	Output error
8 x	Communication

Display Contents of Failure Information Code

Code	Contents	Cause	Operation	Reset Procedure
82	Communication Error	Communication error between e-EPOS controller and instrument panel	* Note	Automatic reset when problem is corrected
01	EPPR v/v short	Short Circuit	Cut off output current (0 mA)	After correcting problem, turn start switch from "OFF" to "ON."
02	Press Up s/v short	Short Circuit		
03	Swing pri. s/v short	Short Circuit		

Code	Contents	Cause	Operation	Reset Procedure
11	EPPR v/v open	Open Circuit	-	Automatic reset when problem is corrected
12	Press Up s/v open	Open Circuit	-	
13	Swing pri. s/v open	Open Circuit	-	
21	Dial Voltage Err (H)	Output voltage Over 4.6 ± 0.2 V	-	
22	Dial Voltage Err (L)	Output voltage Over 0.4 ± 0.2 V	-	
23	TPS Voltage Err (H)	Output voltage Over 4.6 ± 0.2 V	Cut off EPPR v/v current (0 mA)	
24	TPS Voltage Err (L)	Output voltage Over 0.4 ± 0.2 V	Cut off EPPR v/v current (0 mA)	
25	Fpump Sensor Err (H)	Output voltage Over 4.6 ± 0.2 V	-	
26	Fpump Sensor Err (L)	Output voltage Over 0.4 ± 0.2 V	-	
27	Rpump Sensor Err (H)	Output voltage Over 4.6 ± 0.2 V	-	
28	Rpump Sensor Err (L)	Output voltage Over 0.4 ± 0.2 V	-	
29	Speed Sensor Err	Under 1067 ± 20 Hz (On condition that alternator output exceeds over 12 ± 1 V)	-	
31	Fuel shot to GND	Sensor's resistance between two terminals is under $150 \pm 100 \Omega$	-	
32	Fuel Sensor open	Sensor's resistance between two terminals is under 6.5 ± 0.5 k Ω	-	
33	Alternator too high	Output voltage of alternator exceeds 33 V for more than 3 seconds	-	
34	Alternator too low	When the output voltage is maintained under 18 ± 1 for more than 3 seconds (On condition that speed sensor output exceeds over 1,067Hz)	-	

NOTE:

1. If a communication error is generated during operation, the power mode, work mode and auto idle mode will be maintained at the last mode setting before the failure took place until the unit is shut down.
2. When start switch is turned to the "ON" position during a period of a communication error, the e-EPOS controller will operate in the following modes.
 - Power mode: Standard mode

- *Work mode: Digging mode*
 - *Auto idle: "ON" (Selection state)*
3. *The above mentioned two statuses are applicable to normal condition of an e-EPOS controller.*
 4. *Under the abnormal condition of an e-EPOS controller, communication cable or instrument panel failure, "Failure code: 82" can be generated.*

Information of Machine Operation

Accumulated operation hour of each mode and status is displayed.

1. Operating Hour Information

- A. Entering Sub-menus: When a cursor is located in "Operating Info" of special menu screen (Figure 38) press enter button (↵, 3 on Figure 19) and "Operating Info" screen will be displayed (Figure 39).

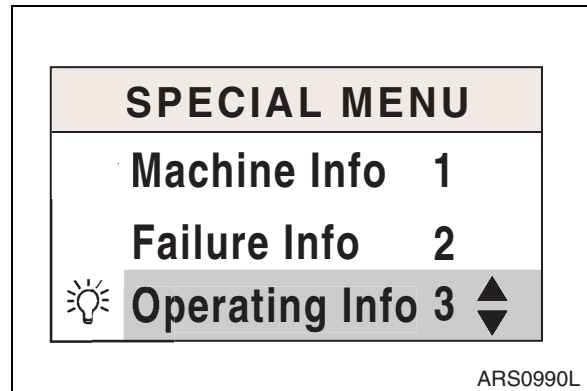


Figure 38

- B. Information screen of machine operation (Figure 39).

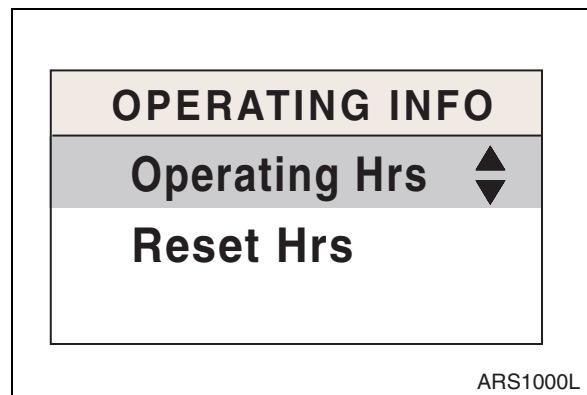


Figure 39

- C. Operation Hour Screen
- D. Exiting Sub-menus: If escape button (ESC, 4 on Figure 19) is pressed for more than 1 second, this information screen will be returned to previous screen.

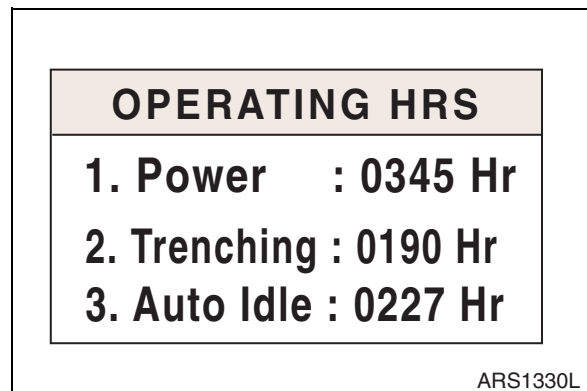


Figure 40

Information contents of operation hour

Item	Information Contents	Detection Method
Power Mode	Operation hours used power mode are displayed.	Power mode switch (Instrument panel) - "ON" status and Alternator signal (CN2-1)
Trenching Mode	Operation hours used trenching mode are displayed.	Trenching mode switch (Instrument panel) - "ON" status and Alternator signal (CN2-1)
Auto Idle	Operation hours used auto idle status are displayed.	Auto idle switch (Instrument panel) - "ON" status and Alternator signal (CN2-1)
Travel Speed: - Low speed - High speed	Operation hours used low speed and high speed are displayed	Low speed: High speed s/v "OFF" status and travel pressure switch "Py" (control valve) - "ON" status High speed: High speed s/v and travel pressure switch "Py" (control valve) - "ON" status
Hydraulic Oil Temperature Distribution (°C (°F))	Temperature of hydraulic oil is classified 6 steps. And operation hours of each step are displayed Under 30°C (87°F) 31 - 50°C (88 - 123°F) 51 - 75°C (124 - 168°F) 76 - 85°C (169 - 186°F) 86 - 95°C (187 - 203°F) Over 96°C (204°F)	The resistance delivered from temperature sensor of hydraulic oil is classified 6 steps. And operation hours of each step are displayed. (Alternator output)
Coolant Temperature Distribution (°C (°F))	Temperature of coolant is classified 6 steps. And operation hours of each step are displayed Under 40°C (105°F) 41 - 60°C (106 - 141°F) 61 - 85°C (142 - 186°F) 86 - 95°C (187 - 204°F) 96 - 105°C (205 - 222°F) Over 106°C (223°F)	The resistance delivered from coolant sensor is classified 6 steps. And operation hours of each step are displayed. (Alternator output)

Menu Selection of Operation Hour Information

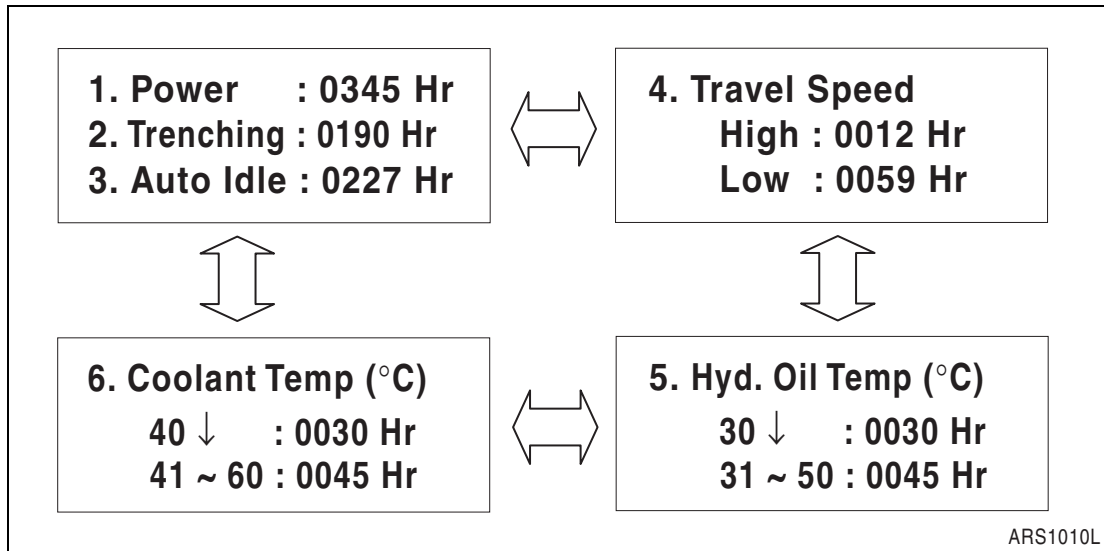


Figure 41

2. Operation hour reset

- A. Entering Sub-menus: When cursor is located in "Reset Hrs" of information screen of operation hour press enter button (↵, 3 on Figure 19) and "Reset Hrs" screen will be displayed.

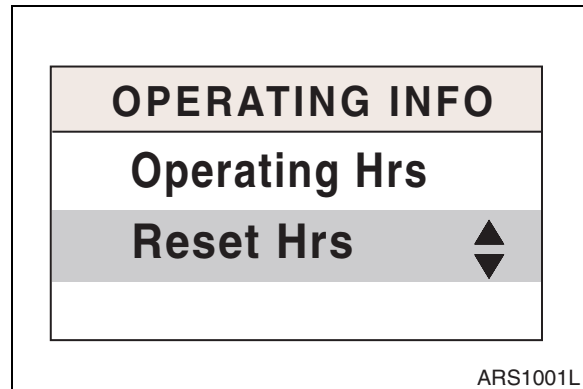


Figure 42

- B. Reset screen of operation hour
- C. Exiting Sub-menus: If escape button (ESC, 4 on Figure 19) is pressed for more than 1 second, this information screen will be returned to previous screen.

NOTE: When "YES" (↵, 3 on Figure 19) button is pressed, operation hours will reset. At this time, resetting signal will be displayed and the screen will move to previous menu after resetting.

NOTE: When "NO" (ESC, 4) button is pressed, the screen will recover to previous menu without resetting.



Figure 43

ELECTRONIC HYDRAULIC CONTROL SYSTEM (e-EPOS)

Control System Schematic

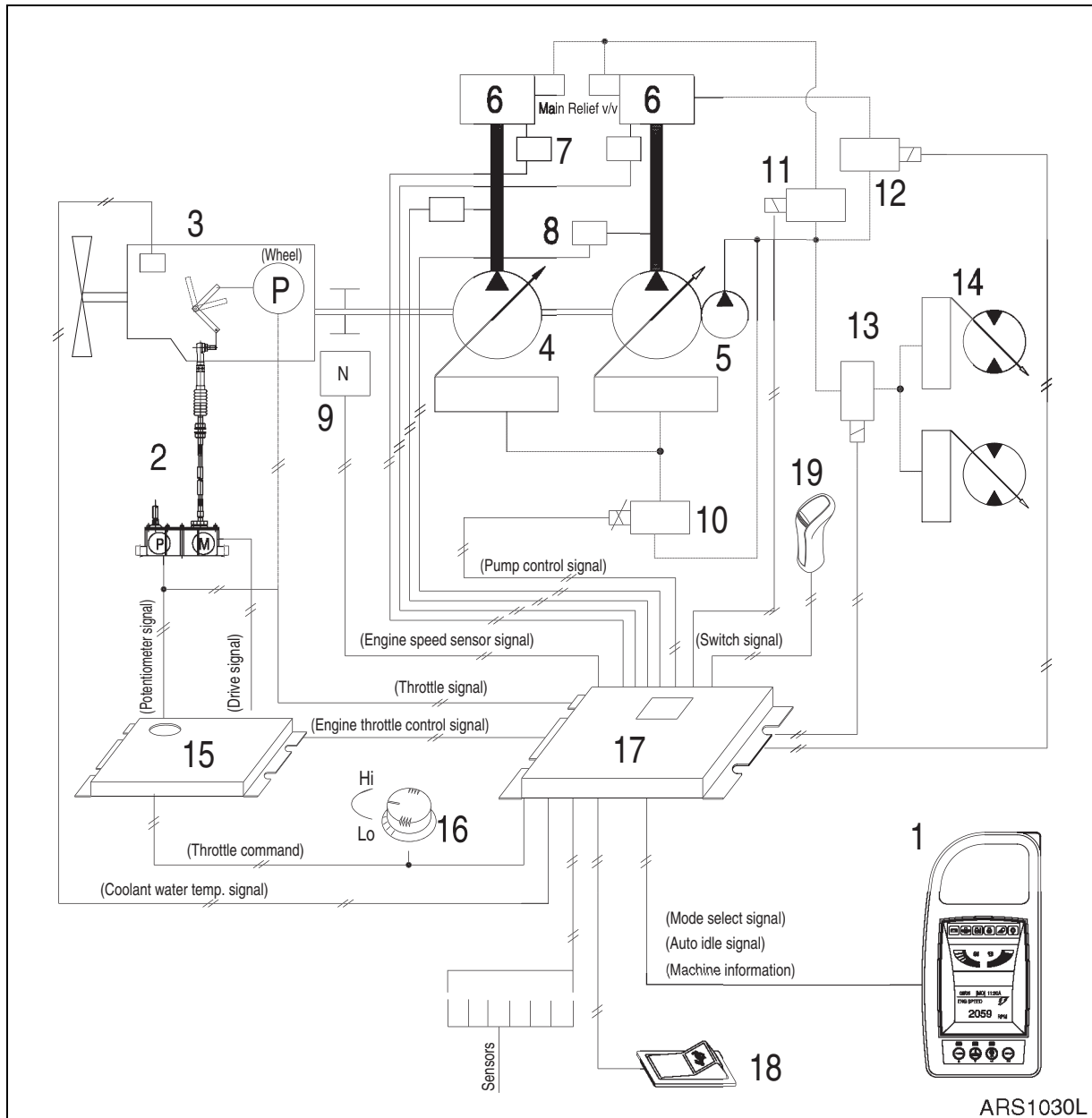


Figure 44

Reference Number	Description
1	Instrument Panel
2	Engine Control Motor
3	Engine
4	Main Hydraulic Pump
5	Control Pump
6	Control Valve
7	Pressure Switch
8	Pump Pressure Sensor
9	Engine Speed Sensor
10	Electro-magnetic Proportional Pressure Reducing Valve (E.P.P.R. Valve)

Reference Number	Description
11	Solenoid Valve (Pressure Up)
12	Solenoid Valve (Swing Priority)
13	Solenoid Valve (High Speed)
14	Travel Motor
15	Engine Throttle Control
16	Engine Control Dial
17	e-EPOS Controller
18	Auto Travel Select Switch
19	Boost Switch (Right Work Lever)

POWER MODE CONTROL

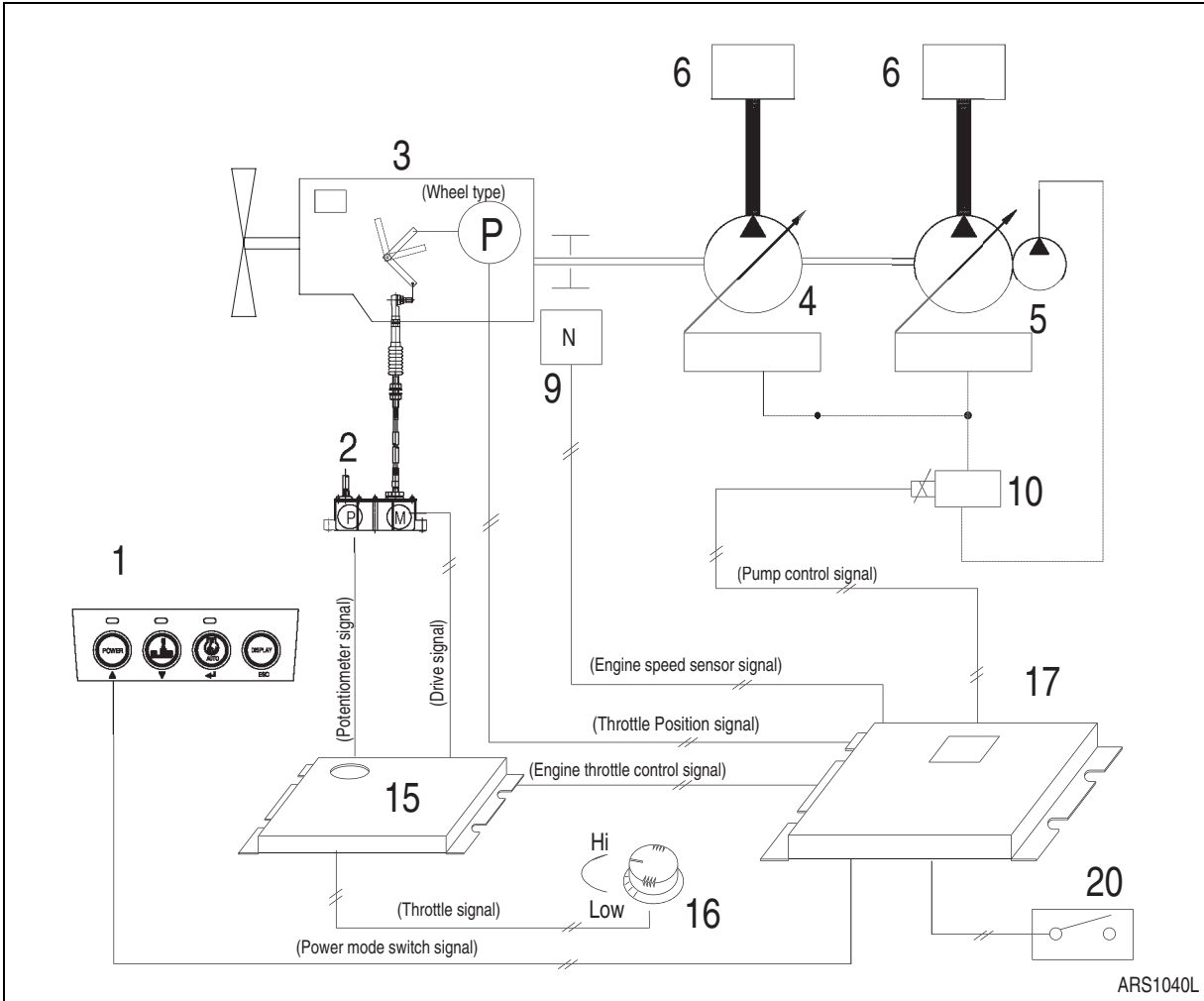


Figure 45

Reference Number	Description
1	Instrument Panel (Power Mode Selection Switch)
2	Engine Control Motor
3	Engine
4	Main Hydraulic Pump
5	Control Pump
6	Control Valve

Reference Number	Description
9	Engine Speed Sensor
10	E.P.R. Valve
15	Engine Throttle Controller
16	Engine Control Dial
17	e-EPOS Controller
20	Work / Travel Selection Switch (Wheel Type)

The power mode switch permits the selection of the appropriate engine power depending on the working condition. One of the two, Power Mode or Standard Mode, setting can be selected. When the engine start switch is turned "ON," the power mode is automatically defaulted to standard mode. The desired mode can be selected by pressing the select button on the instrument panel. When the power mode is selected, the indicator lamp will turn "ON" to display the selected mode.

The quantity of oil discharged by the pump and the engine speed are determined by the mode selected by the operator. The pump output in each mode is determined by the mode selection and is listed in the following table

Mode	Standard Mode	Power Mode
Output (%)	Approximately 85%	100%

OPERATION

1. Power Mode

This mode should be selected for high speed work. In this mode the engine output is most efficiently utilized due to the discharged oil volume being controlled based on the equivalent horsepower curve at various loaded pressures. The e-EPOS controller compares the target engine speed with the actual engine speed and controls the signal to the E.P.P.R. (Electric Proportional Pressure Reducing) valve which in turn varies the pump output quantity.

If the load increases, the engine speed will fall below the rated speed. When this occurs, the controller senses this decrease and immediately reduces the pump discharge volume to maintain the engine speed at the rated level.

On the other hand, if the load is decreased the controller increases the discharge volume of the pump to maintain the engine speed at the rated level.

By repeating these control operations, the engine speed is maintained at the rated speed so that maximum power can be generated.

In Power Mode, the controller receives engine speed signals from the engine speed sensor and the throttle position sensor (sensor is built into engine control motor) and converts it to an operating signal current and is then transferred to the pump's E.P.P.R valve. At this time the E.P.P.R. valve converts the electric signal to the corresponding control pressure and sends it to the two pumps, adjusting the pump discharge volume to the desired level.

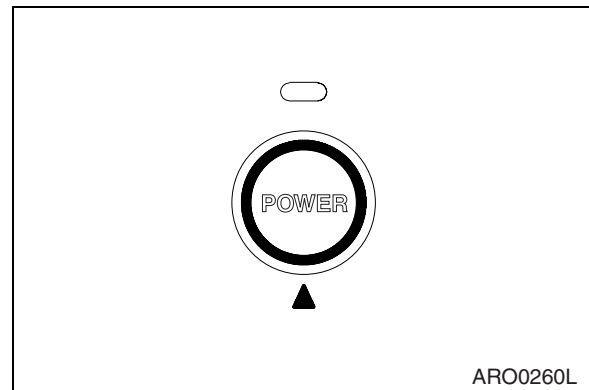


Figure 46

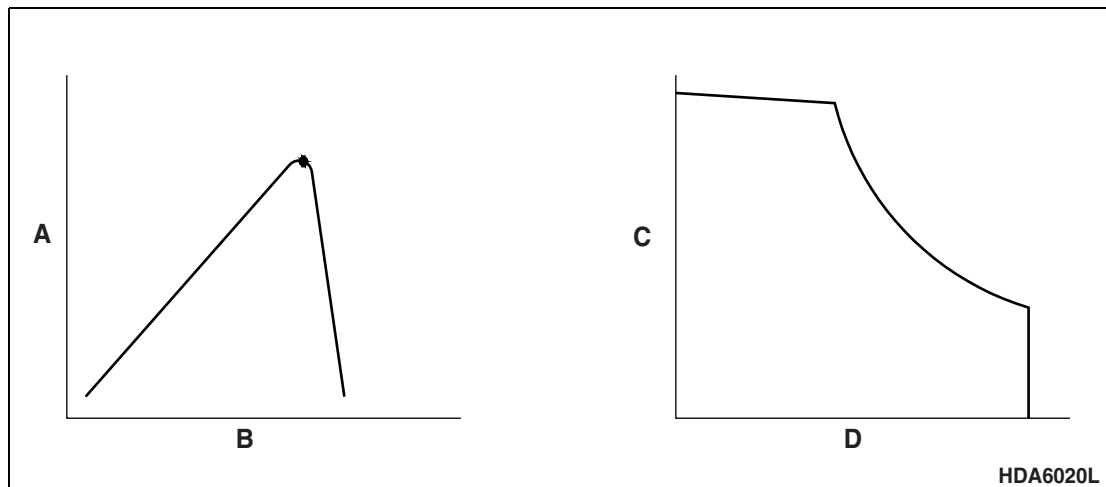


Figure 47

Reference Number	Description
A	Engine Horsepower (hp)
B	Engine Speed (rpm)
C	Pump Discharge Volume (liter/min)

Reference Number	Description
D	Pump Discharge Pressure (kg/cm ²)

2. Standard Mode

Standard Mode is used for general work. When this mode is selected it will reduce noise and fuel consumption in comparison with Power Mode. The current to the E.P.P.R. valve is shut off and pump discharge volume is controlled by pump regulator.

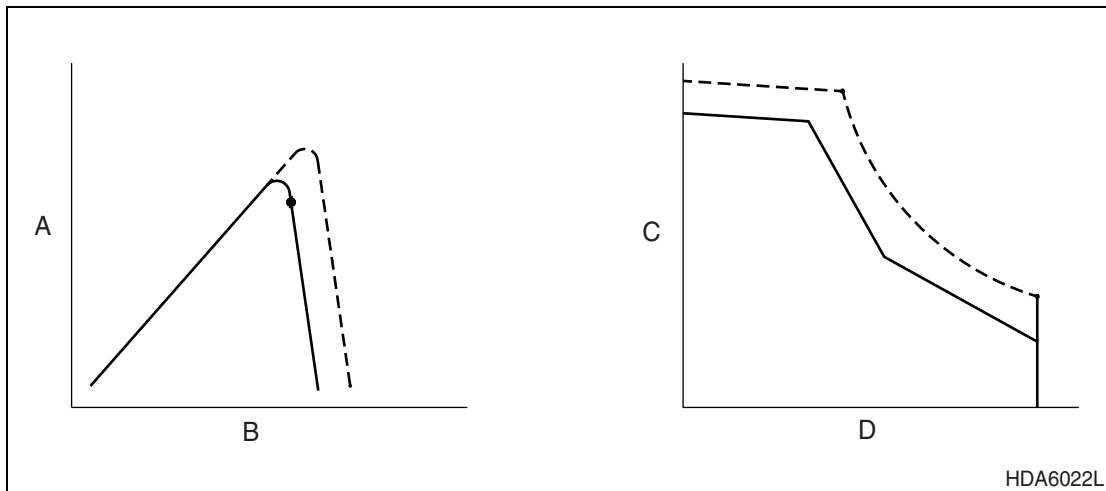


Figure 48

Reference Number	Description
A	Engine Horsepower (hp)
B	Engine Speed (rpm)
C	Pump Discharge Volume (liter/min)

Reference Number	Description
D	Pump Discharge Pressure (kg/cm ²)

THROTTLE POSITION SENSOR

As sensor that senses the engine fuel levers position (angle), in case of selecting III speed mode, by informing the position of fuel lever to EPOS-V controller. It will act a role to determine the rated engine rpm in the sensing control of rotation.

As shown in the graph below, in case that the fuel changes from low to high speed, the output voltage between No.2 terminal and No.3 terminal will change from 3.75V to 1.0V.

NOTE: *If the throttle position sensor is not adjusted properly, since the performance of the equipment may not be displayed or overloaded at the work, the accurate adjustment is required.*

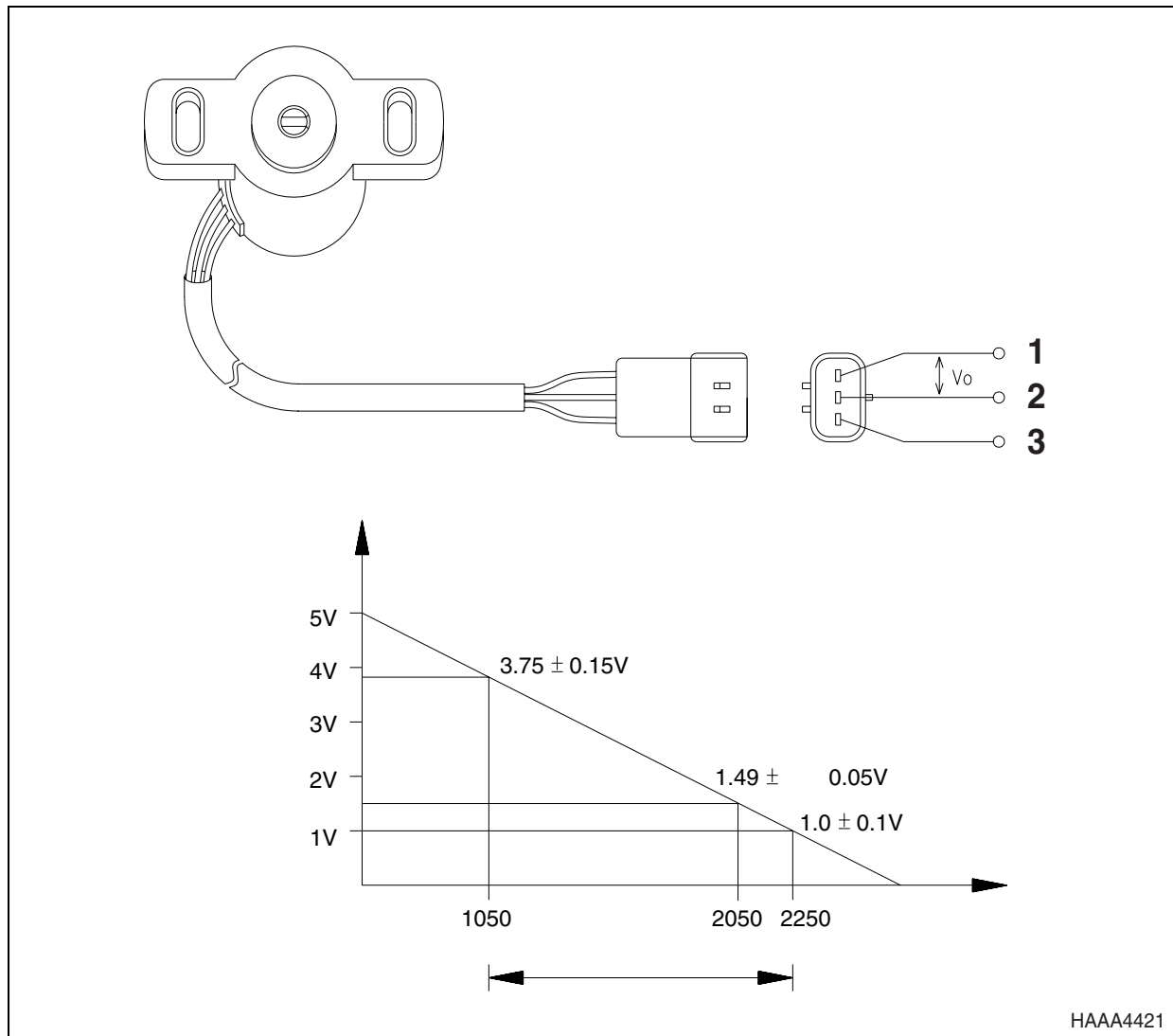
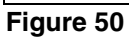


Figure 49

Reference Number	Description
1	Ground (-)
2	Output

Reference Number	Description
3	5V INput (+)



Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse
4	e-EPOS Controller
5	Instrument Panel
6	Engine Speed Sensor

Reference Number	Description
7	Engine Throttle Controller
8	Engine Control Motor
9	Engine Control Dial
10	Throttle Position Sensor
11	Travel Select Switch
12	E.P.P.R Valve

WORK MODE CONTROL

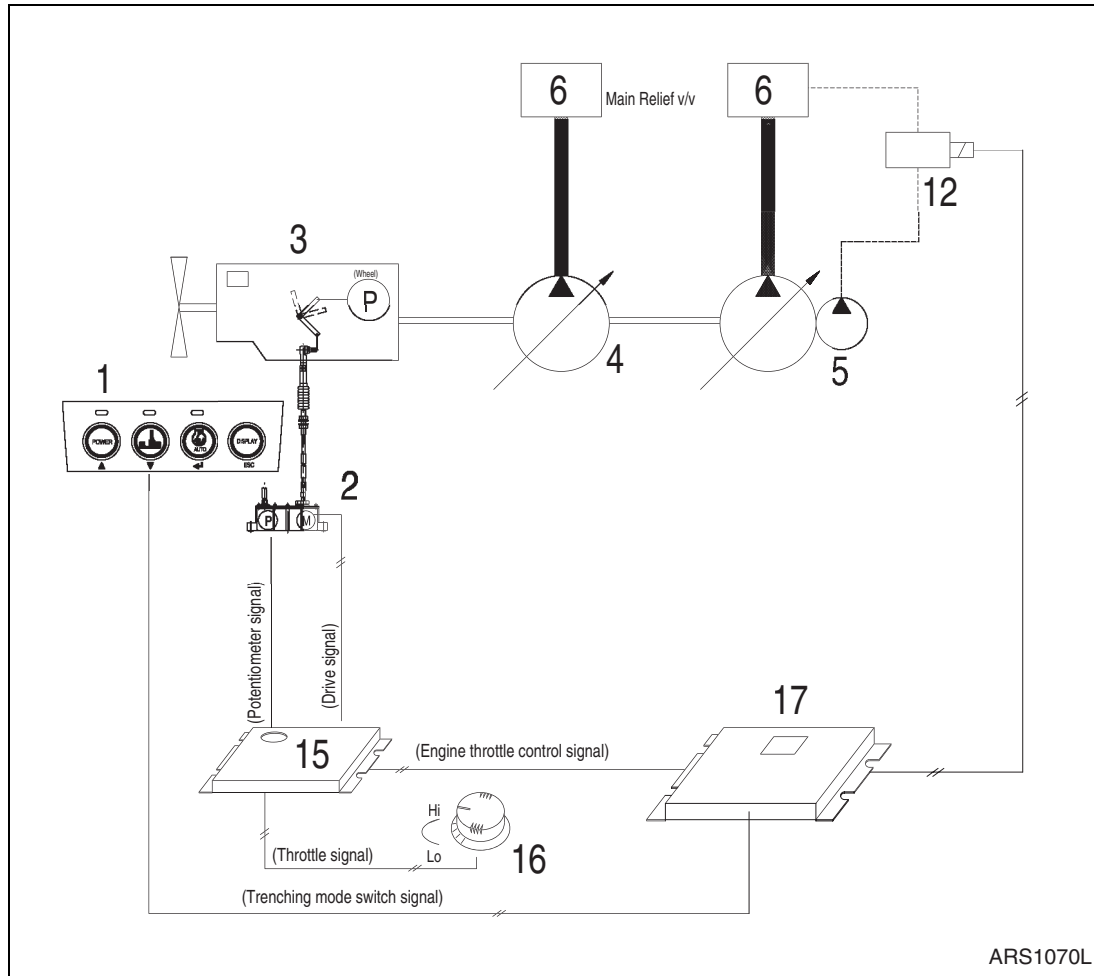


Figure 51

Reference Number	Description
1	Instrument Panel (Trenching Mode Select Switch)
2	Engine Control Motor
3	Engine
4	Main Hydraulic Pump
5	Control Pump

Reference Number	Description
6	Control Valve
12	Solenoid Valve
15	Engine Throttle Control
16	Engine Control Dial
17	e-EPOS Controller

Depending on the working condition, one of two work modes, "DIGGING" or "TRENCHING" can be selected from the instrument panel.

When the engine start switch is turned "ON," the work mode is automatically defaulted to digging mode.

Depending on the trenching mode selected, the control valve solenoid adjusts the assignment of hydraulic oil flow to each device on the equipment.

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.

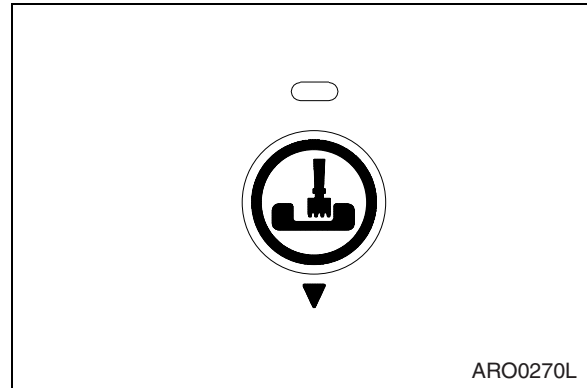


Figure 52

WORK MODE CONTROL - CIRCUIT DIAGRAM

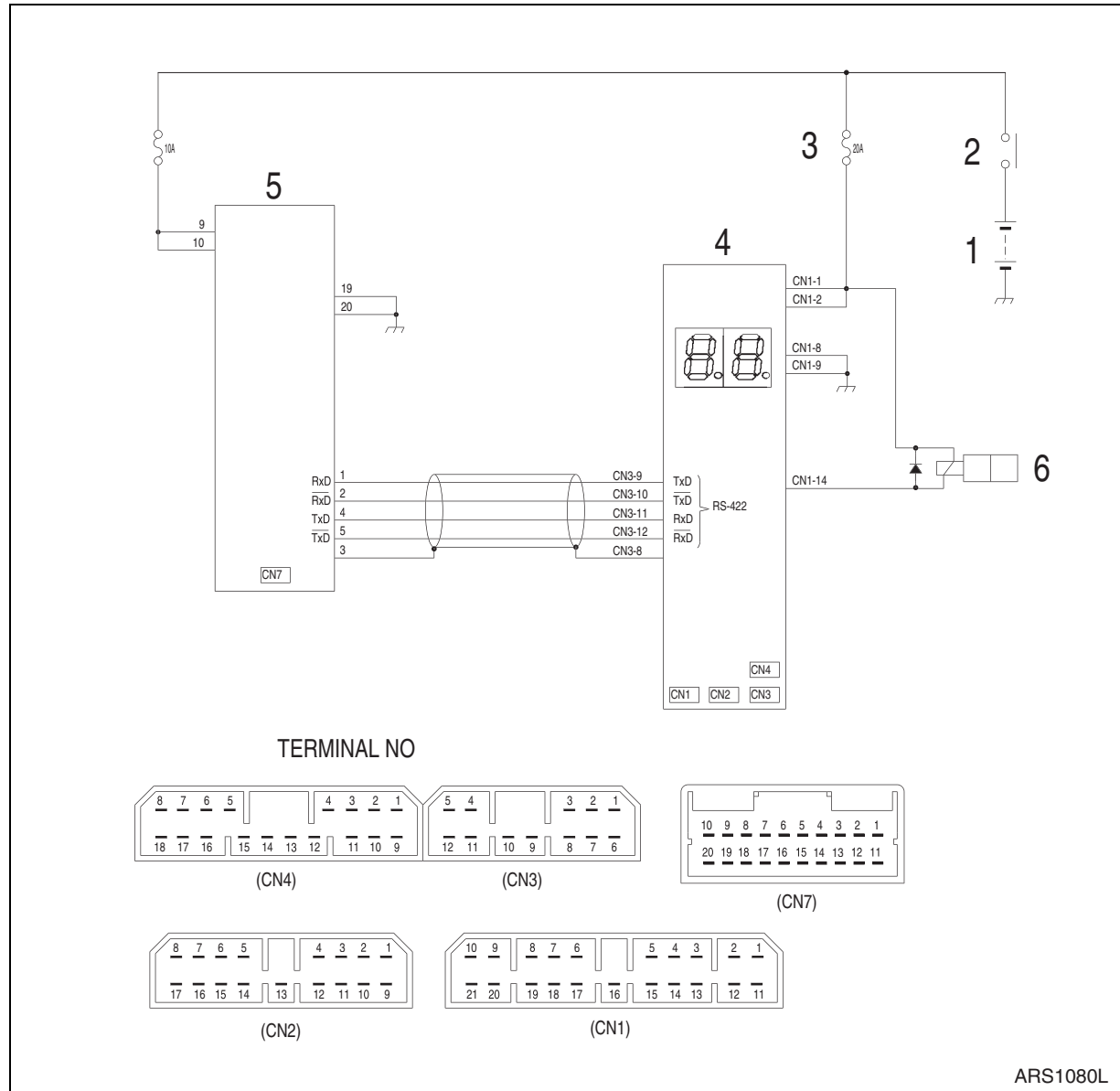


Figure 53

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse

Reference Number	Description
4	e-EPOS Controller
5	Instrument Panel
6	Solenoid Valve (Swing Priority)

ENGINE CONTROL SYSTEM

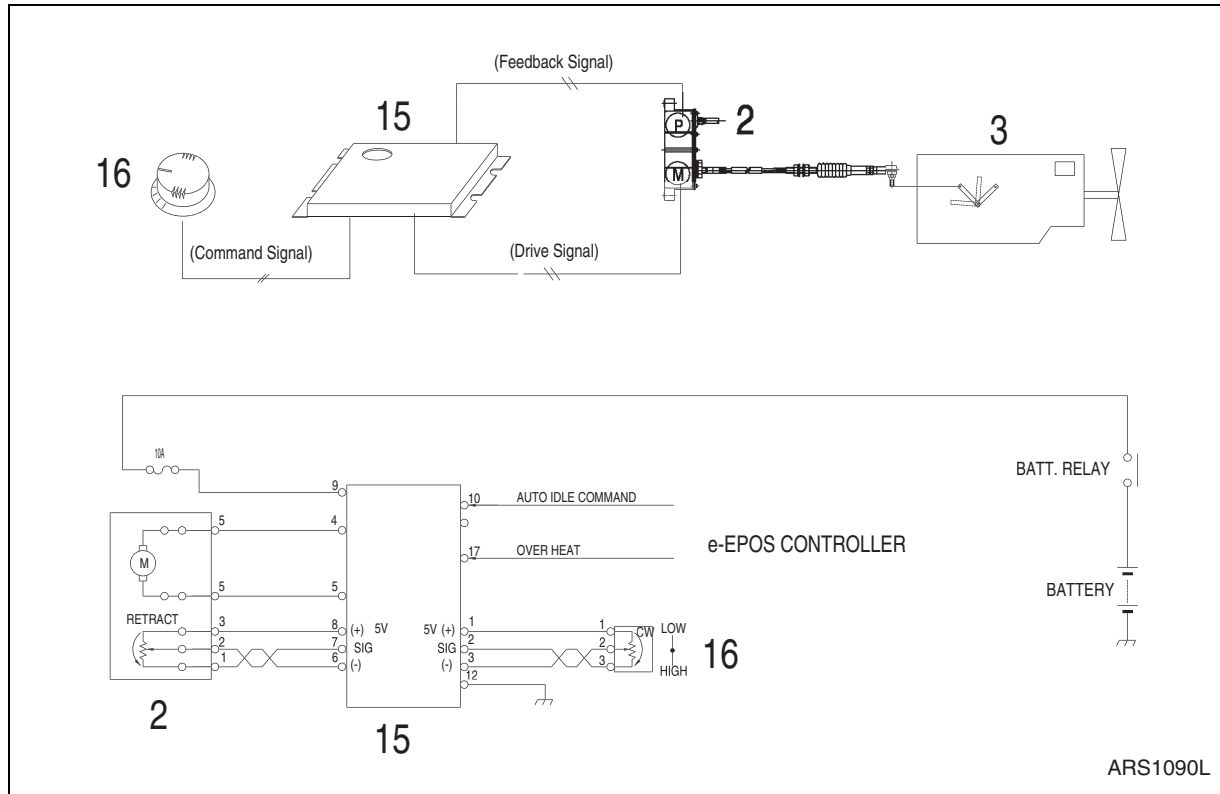


Figure 54

Reference Number	Description
2	Engine Control Motor
3	Engine

Reference Number	Description
15	Engine Throttle Controller
16	Engine Control Dial

When the engine control dial is moved the output voltage changes according to the dial position. This signal is input to the engine throttle controller. The engine throttle controller then compares the input voltage from the engine speed dial with the feedback signal from the throttle position sensor built into the engine control motor and drives the motor to the position set by the control dial. When the command signal and the potentiometer feed back signals are the same the engine controller shuts off the current to the control motor. The engine control motor cable is a solid type and is connected to the engine fuel injection control lever. The engine speed is controlled by the movement of the fuel injection lever which is directly linked with the rotation of the control motor.

ENGINE CONTROL MOTOR

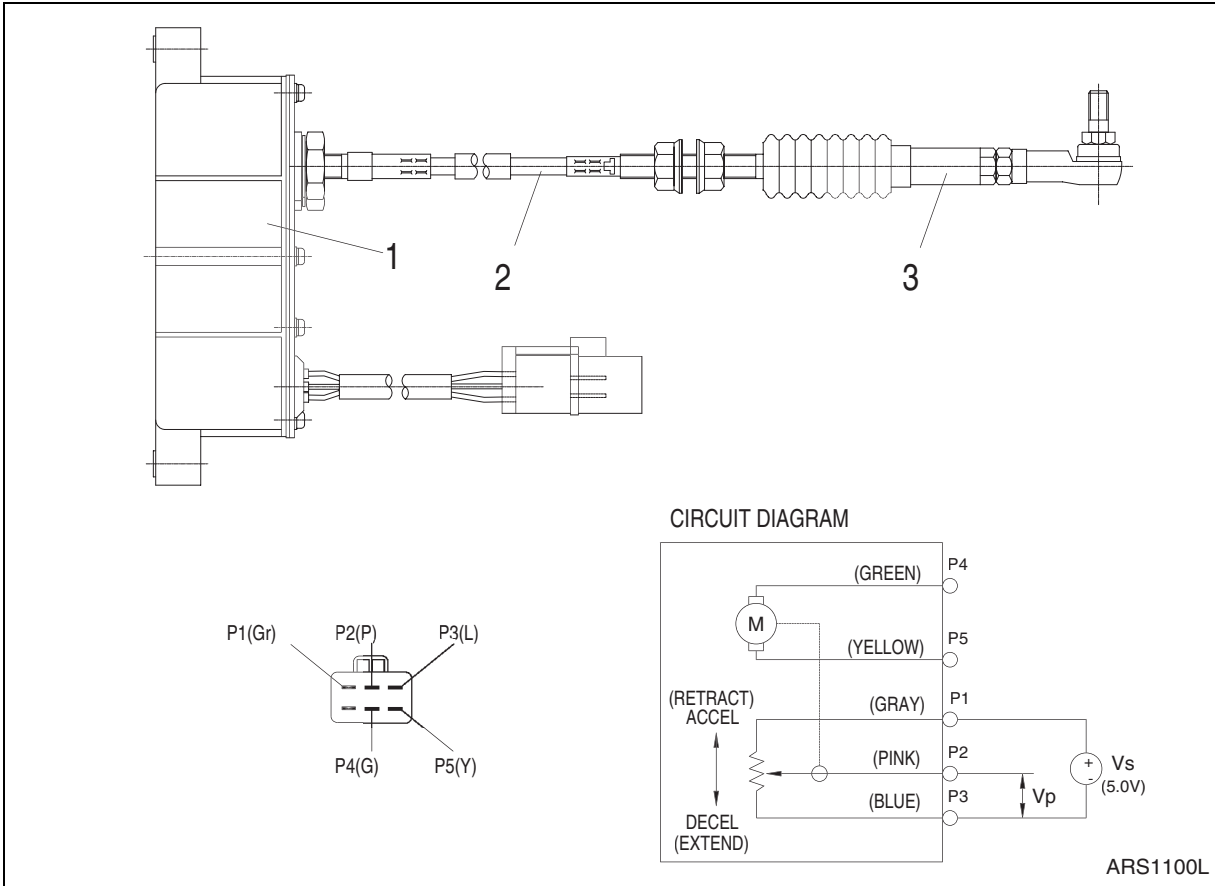


Figure 55

Reference Number	Description
1	Motor Assembly
2	Cable
3	Spring Assembly

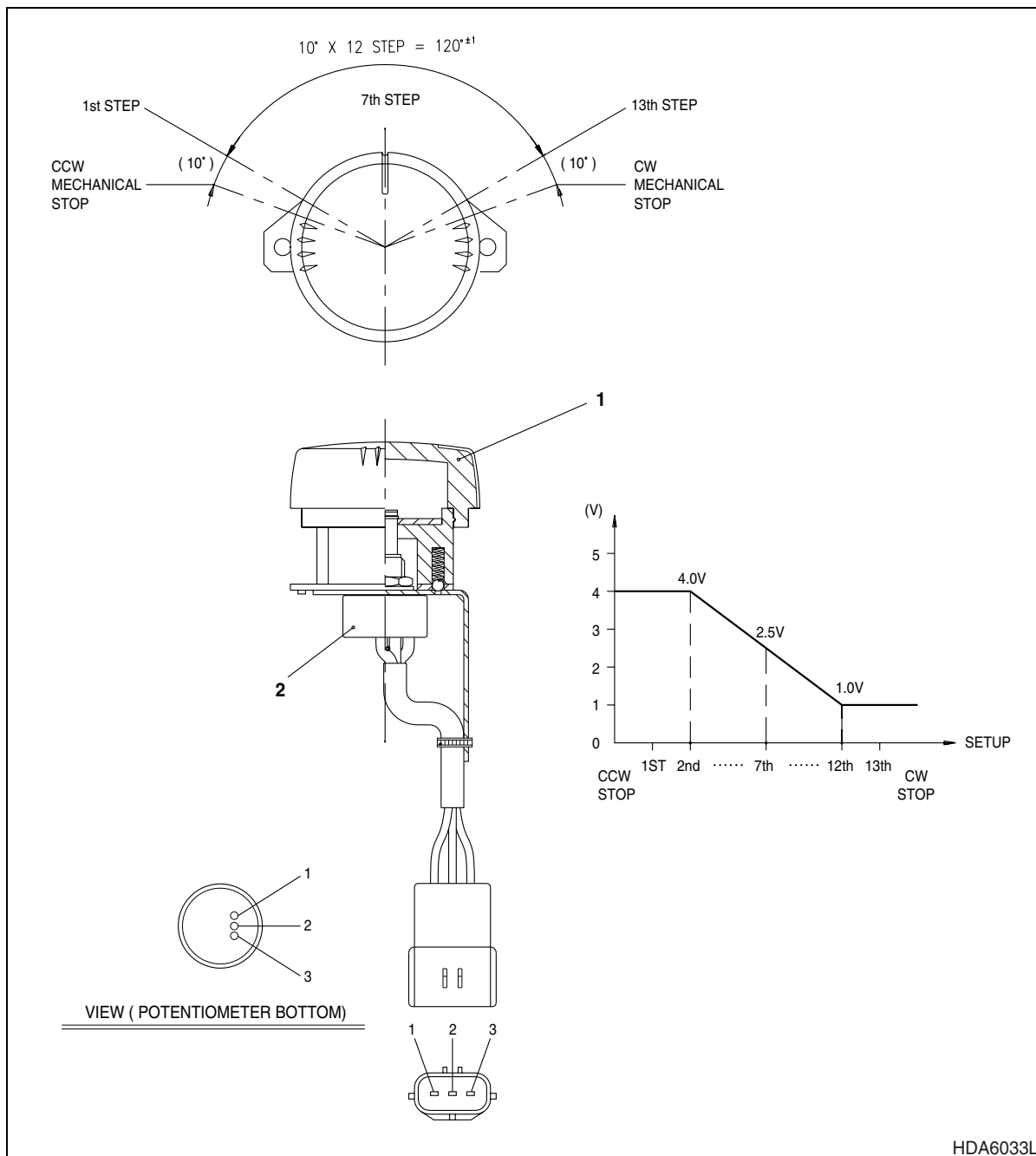
The engine control motor uses a D.C. motor with a built in potentiometer to sense the position of the control cable. If an abnormal load (worn or kinked control cable) is sensed in the control motor, the engine controller cuts off the electric current flowing to the engine control motor to protect the system. In such a case, the engine control motor will not operate even though the engine control dial is moved.

The starter switch should be turned off and the cause of abnormal load should be repaired and the starter switch can be turned on again. The engine control dial can once again be used to control the engine speed.

IMPORTANT

When the engine control motor has been replaced or repaired refer to Adjusting the Engine Control Device for correct adjustment of the engine control system. The engine will not perform to its maximum efficiency if it is not adjusted properly.

ENGINE CONTROL DIAL



Reference Number	Description
1	Knob
2	Potentiometer (Variable Resistor)

The engine control dial has a built in potentiometer. When the control knob is moved the output voltage (through terminals 2 and 3) will vary from the 5 V supplied from the throttle controller as shown in the graph.

ENGINE CONTROL CIRCUIT DIAGRAM

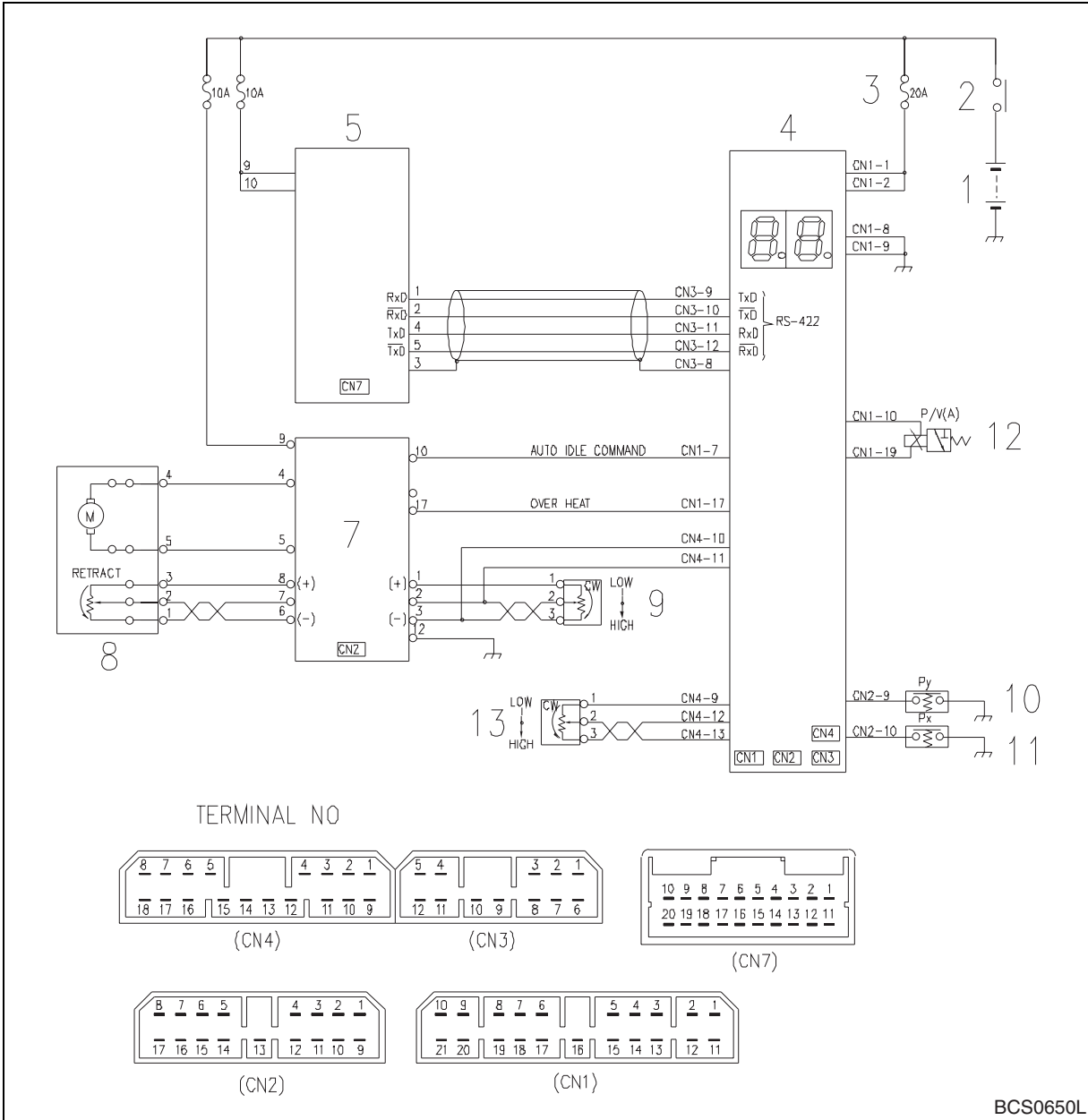


Figure 57

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse
4	e-EPOS Controller
5	Instrument Panel
7	Engine Throttle Controller

Reference Number	Description
8	Engine Control Motor
9	Engine Control Dial
10	Pressure Switch (Py Port)
11	Pressure Switch (Px Port)
12	E.P.R Valve
13	Throttle Position Sensor

AUTOMATIC DECELERATION CONTROL (AUTO IDLE CONTROL)

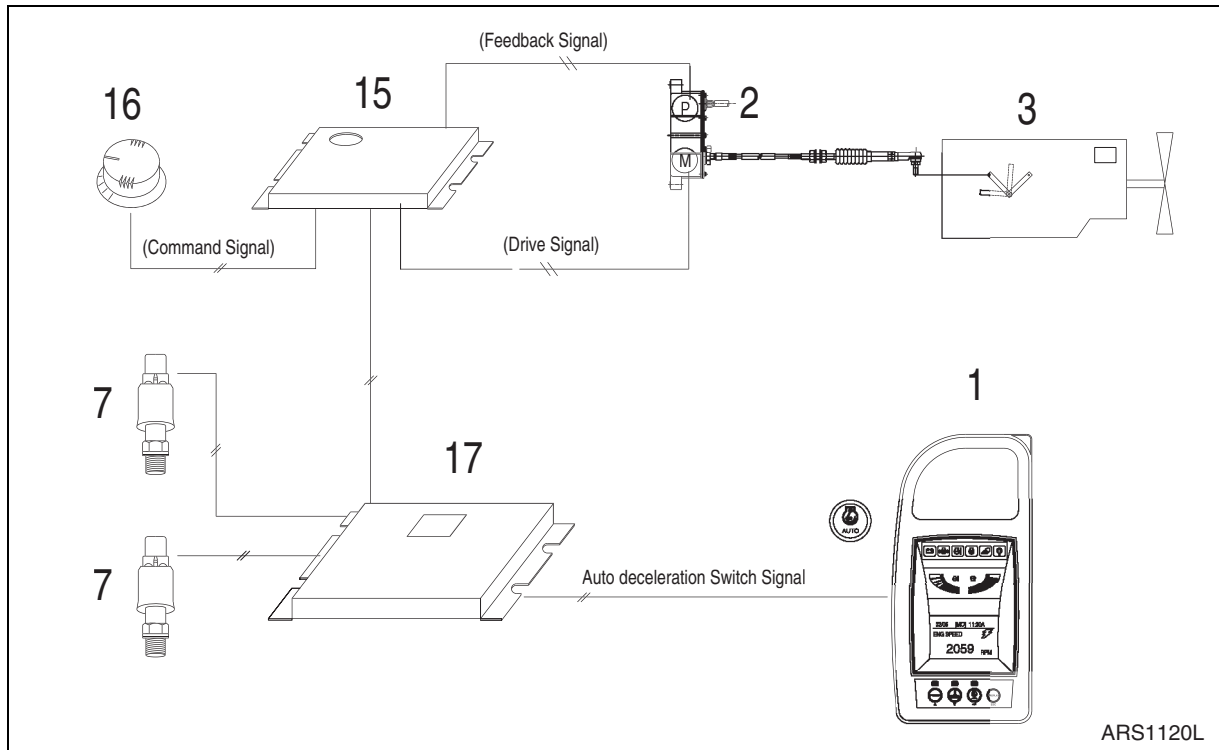


Figure 58

Reference Number	Description
1	Instrument Panel
2	Engine Control Motor
3	Engine
7	Pressure Switch

Reference Number	Description
15	Engine Throttle Controller
16	Engine Control Dial
17	e-EPOS Controller

If the machine is idling without the controls being operated or is waiting for a dump truck the engine speed is automatically lowered. Once the controls are operated and work is being started the machine will be restored to the previous settings. As a result, noise and fuel consumption will be reduced. This function can be selected or cancelled through the Auto Idle Select Switch on the instrument panel.

The initial setting at start-up is with this switch in the select position. Approximately 4 seconds after this function is selected, if all work levers are in the neutral position, the e-EPOS controller sends an automatic reduction signal to the throttle controller. When the engine throttle controller receives this signal, it is compared with the signal set by the engine control dial. The lower of the two signals is selected and the engine control motor is adjusted to this engine speed.

The neutral status of the machine is detected by the two pressure switches in the control valve. When the work levers are in the neutral position, the switch is in the off position.



Reference Number	Description
7	Engine Throttle Controller
8	Engine Control Motor
9	Engine Control Dial
10	Pressure Switch (Py port)
11	Pressure Switch (Px port)

OPERATION

Division	Auto Idle Operation	Auto Idle Cancel
Control condition	Auto idle switch: OFF and Travel/Work levers: Neutral	Auto idle switch: OFF and Travel/Work levers: Operation
Pressure switch	Open	Close
Control signal of Engine speed	High (DC10-12V), Approximately 4seconds after the pressure switch is opened.)	Low (Immediately after the pressure switch is closed.)
Engine speed	Preset rpmrpm	Return to the position of engine control dial or selected rpm of power mode

NOTE: *The auto idle function will be only operated when the pressure switch and the control conditions are corresponded with each other.*



Reference Number	Description
10	E.P.P.R. Valve
15	Engine Throttle Controller
17	e-EPOS Controller
21	Warning Buzzer

When the coolant temperature falls below 95°C (203°F), normal operation will resume.

POWER BOOST MODE

OPERATION

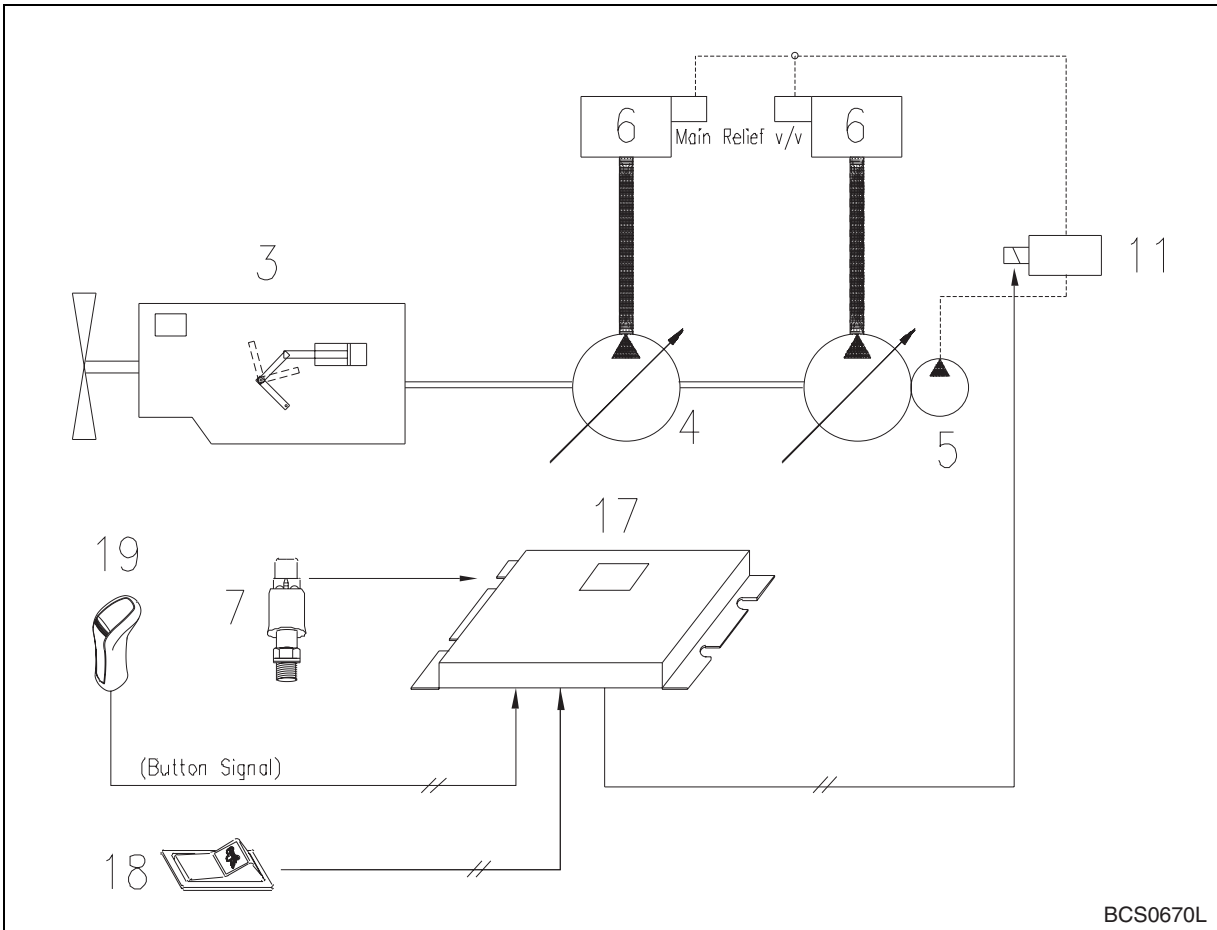


Figure 61

Reference Number	Description
3	Engine
4	Main Pump
5	Control Pump
6	Control Valve
7	Pressure Switch

Reference Number	Description
11	Solenoid Valve
17	e-EPOS Controller
18	Travel Select Switch
19	Power Boost Switch (Top of Right Work Lever)

The Power Boost function is used to temporarily increase the main relief pressure to enhance excavation ability. When the switch button on top of the right work lever is pressed during work, the e-EPOS controller will activate the power boost solenoid valve and increase the relief valve pressure from 330 - 350 kg/cm² (4,700 - 5,000 psi). The excavation ability is increased by approximately 6%.

The excavation ability is increased by approximately 6%.

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse
4	e-EPOS Controller
5	Instrument Panel

Reference Number	Description
6	Solenoid Valve (Pressure Up)
7	Power Boost Switch (Top of Right Work Lever)
8	Travel Select Switch
9	Pressure Switch

CRUISE CONTROL

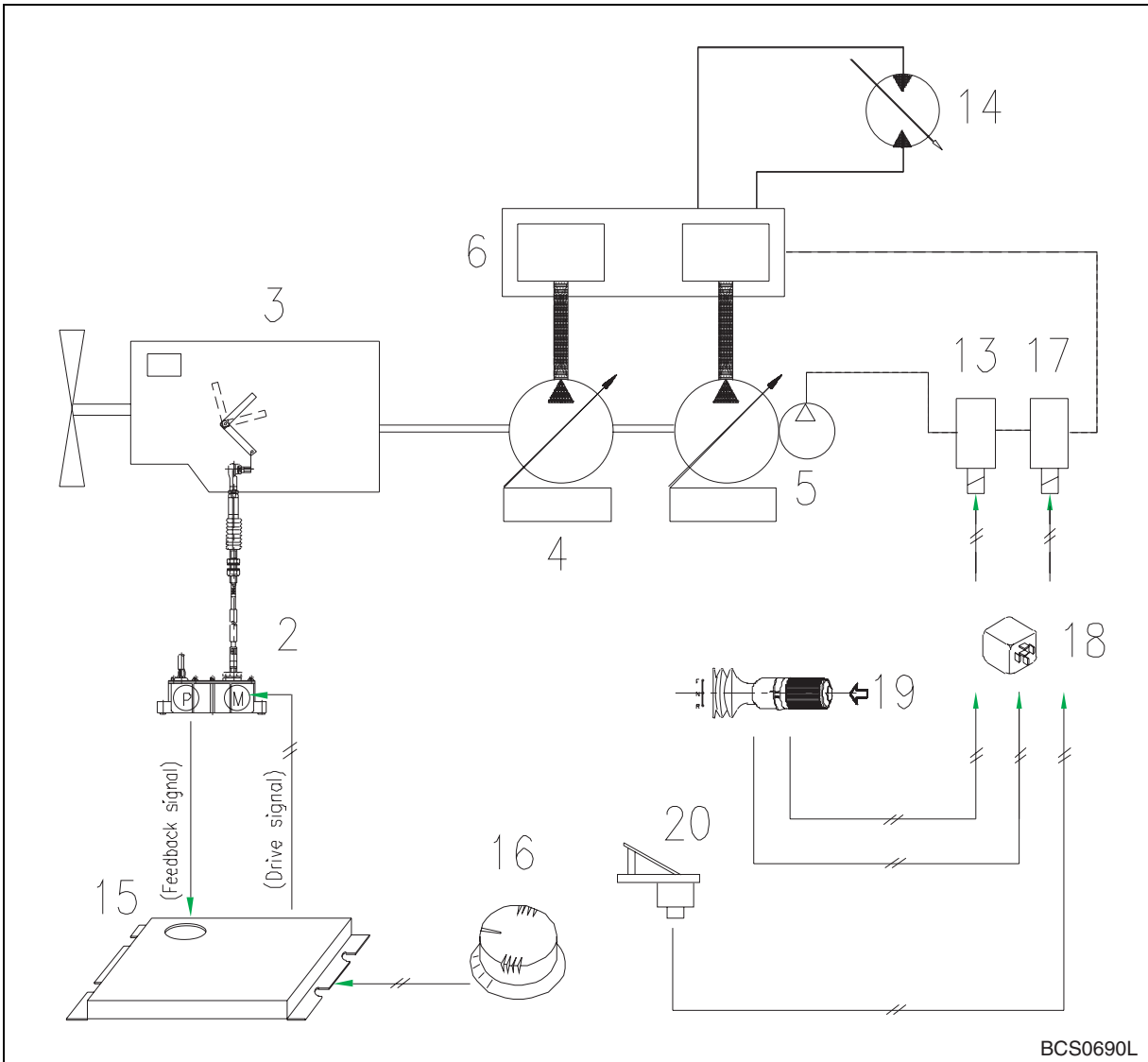


Figure 63

Reference Number	Description
2	Engine Control Motor
3	Engine
4	Main Pump
5	Control Pump
6	Control Valve
13	Cruise Solenoid Valve
14	Travel Motor

Reference Number	Description
15	e-EPOS Controller
16	Engine Speed Control Dial
17	Forward Run Solenoid Valve
18	Relay
19	Cruise Switch
20	Brake Pedal

Cruise control is used for the purpose of 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. At this time, 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.

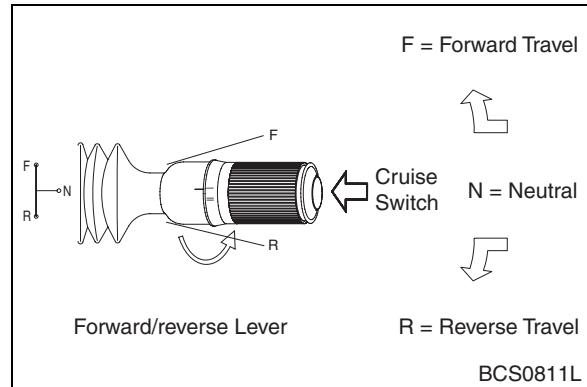


Figure 64

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.

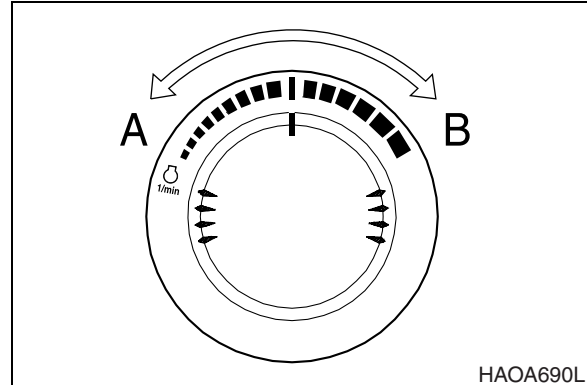


Figure 65

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

CRUISE CONTROL CIRCUIT

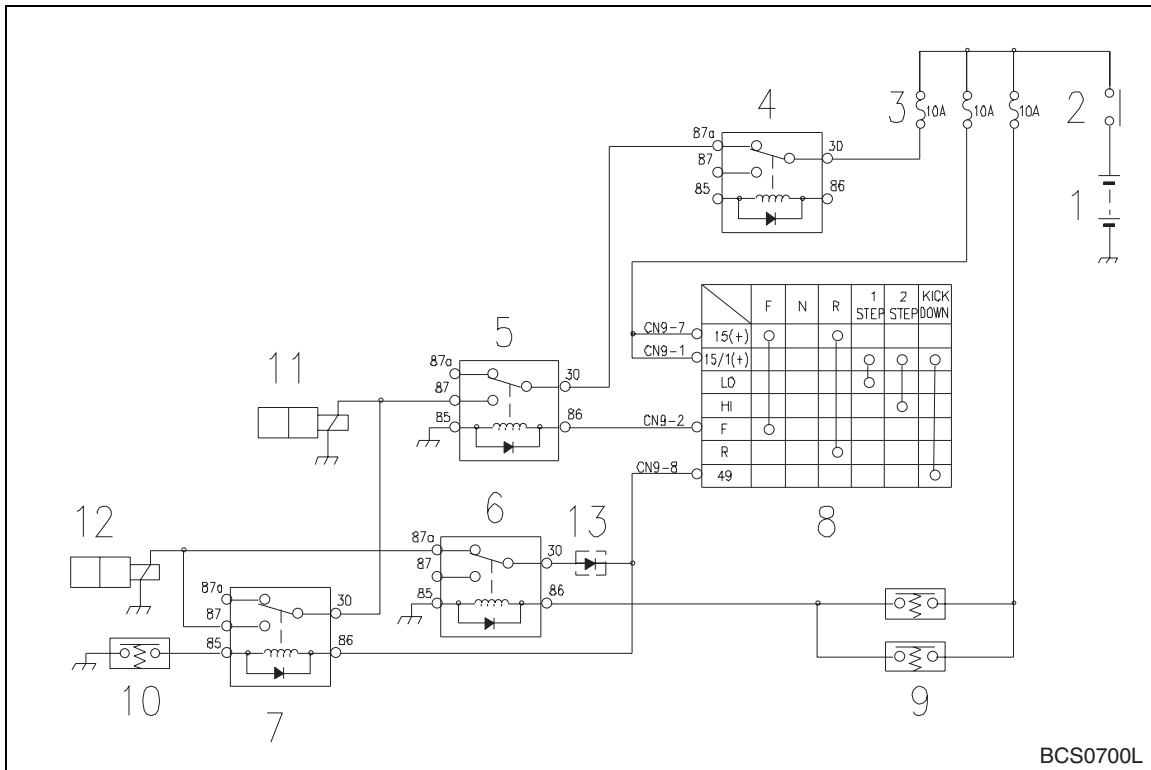


Figure 66

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse
4	Pilot Relay
5	Forward Run Relay
6	Cruise Relay (2)
7	Cruise Relay (1)

Reference Number	Description
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. At this time 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 placed in neutral or reverse position during the cruise, the forward run relay will be deactivated and cruise function will be cancelled.

Also If the brake pedal is pressed, the brake light switch (9) will be turned "ON". At this time, the cruise relay2(6) will be activated and the cruise relay1(7) will be deactivated. So cruise function will be cancelled.

ADJUSTING METHOD OF ENGINE CONTROL UNIT

NOTE: *If the adjustment of engine control unit is improper, it may cause overloading of the engine, and lowering speed of Work/Run. This will affect the performance of equipment During repair and adjustment of engine control system, use the following directions.*

ADJUSTING METHOD OF ENGINE CONTROL SYSTEM

Accelerator Pedal (Refer to Figure 68)

1. Assembled length of rod (B, Figure 68) must be adjusted to 250 mm.
2. With rod (B, Figure 68) adjusted to 250 mm, adjust stop bolt (C) so that pedal (A) touches plunger (K) of run modulation valve.

NOTE: *Make sure that plunger (K, Figure 68) is not being depressed.*

3. After the rod (H, Figure 68) is temporarily assembled to bracket, install spring (G) between lever (D) and rod (H). Adjust the rod (H) to an initial installation length of 67 mm. Spring (G) should be adjusted to a length of 140 mm.
4. Extend cable (J, Figure 68) out of cable sheath 150 mm, attach end of cable to clevis (F, Figure 68). Attach the cable to bracket.

At this time, adjust the insertion depth of cable (J, Figure 68) end into clevis (F). Then adjust cable in bracket so that it is again adjusted to 150 mm.

NOTE: *Clevis pin should be 207.5 mm from bracket.*

NOTE: *During assembling, if the cable is pulled on either end, the assembly length will change, take care not to apply any force.*

5. Inject grease into grease fitting (E, Figure 68) to ensure proper lubrication.

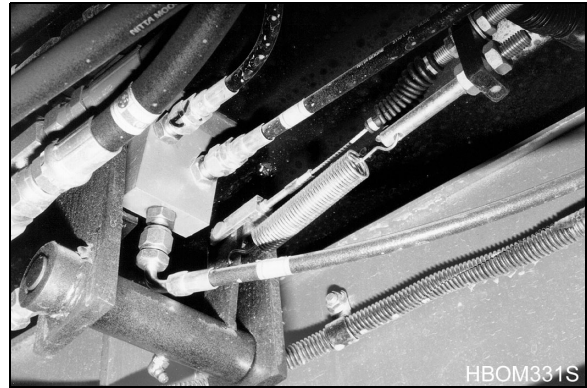


Figure 67 ACCELERATOR PEDAL LINKAGE

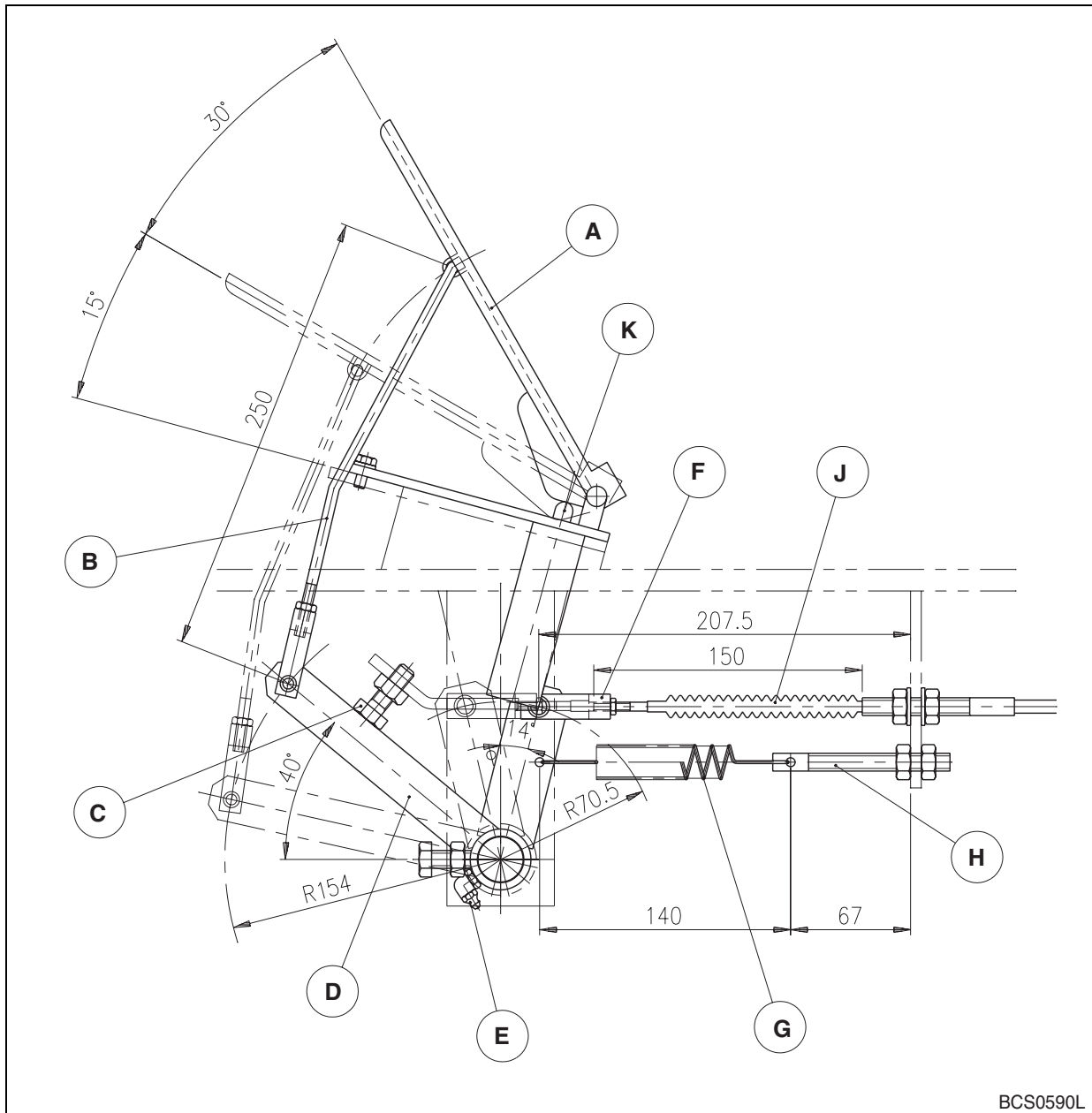


Figure 68

Engine Control Motor (Refer to Figure 69 and Figure 70)

1. The engine control motor (Figure 69) holds the cable length that was set pulled at maximum when responding to a "HIGH IDLE" position.
2. When installing the motor on frame, be careful not to bend cable, connect it to bracket (B, Figure 70) temporarily with nuts.

ADJUSTING METHOD OF ENGINE RPM

Inspection Before Adjustment (Refer to Figure 70)

1. Adjust bolt (E, Figure 70), so that its head is at the minimum height "Lb."
2. Turn starter switch "ON" and position engine speed control dial to "LOW IDLE."
3. Adjust accelerator pedal cable (J, Figure 70) and engine control motor cable (K, Figure 70) using the following method.
 - A. Attach cables (J and K, Figure 70) to levers (C) and (C), in the hole positions shown in Figure 70.
 - B. Cable (J, Figure 70) has a tendency to hang-up once in a while on the accelerator pedal end. Before attaching cable (J) to bracket (B), pull cable (J) to ensure it is extended all the way. (Do not apply excessive force.)
 - C. Attach cables (J and K) to bracket (B) so that levers (C) and (C) touch the stop plate on lever (N). Adjust cables so they do not hang down.

NOTE: *Lever (N) is between the two (C) levers. There are a total of three levers.*

Travel Mode RPM adjustment (Refer to Figure 70)

Engine rpm adjustment is performed at no load state.

Start engine, set work/travel select switch to "TRAVEL" and check if forward/reverse lever is in "NEUTRAL."

NOTE: *Work/travel select switch is at right side end on the console below steering wheel.*

Adjust according to following steps.

1. Adjustment of High Idle RPM - Engine Control Motor
 - A. Turn starter switch "ON," select "POWER MODE," turn auto idle switch "OFF," and set work/travel select switch to "TRAVEL."
 - B. Set engine speed control dial to "HIGH IDLE" position. This will make engine control motor cable (K) be pulled to maximum.
 - C. Adjust the screw part of cable (K) in bracket (B) so that lever (A) touches the high idle stop.
2. Adjustment of Low Idle RPM - Engine Control Motor.
 - A. Set engine speed control dial to "LOW IDLE." This will make engine control motor cable (K) be extended to its maximum position.
 - B. Check that lever (A) touches engine low idle stop and that cable installation is correct.
 - C. If lever (A) does not touch the low idle engine stop, move cable (K) one stage down in holes on lever (C). If cable is extending to far (with excessive bending) move cable one stage up on holes in lever (C). When cable is moved either up or down on lever (C), adjust the cable position in bracket (B) up or down so that the end of cable (K) is not pointing up or down.

NOTE: *Lightly pull levers (C) and (C) toward high idle position. Levers should not come out of contact with stop on lever (N), When released, lever (A) should not come out of contact from engine low idle stop.*

3. Repeat preceding steps and try to satisfy both high idle and low idle adjustments.

4. When above procedure is completed, set engine speed control dial to "HIGH IDLE." Loosen the left side attachment nut of cable (K) and tighten the right side nut 2/3 - 1 turn more so the cable is pulled 1 - 1.25 mm (0.04 - 0.05 in) more.

NOTE: *Securely hold the right side nut and cable (K) in position, while tightening left side nut.*

5. Adjustment of High Idle RPM - Accelerator Pedal.

- A. Set engine speed control dial to "LOW IDLE." Fully depress accelerator pedal.
- B. Adjust the screw part of cable (J, Figure 70) installed on bracket (B, Figure 70) so that lever (A) just touches engine high idle stop.

NOTE: *By adjusting cable (J, Figure 70) at bracket (B, Figure 70) this will ensure that the accelerator pedal is properly depressing plunger (K, Figure 68).*

6. Adjustment of Low Idle RPM - Accelerator Pedal.

- A. Release accelerator pedal.
- B. Check that lever (A, Figure 70) touches the engine low idle stop and the cable's installation position is proper.
- C. If lever (A, Figure 70) does not touch the engine low idle stop this means that there is not enough cable stroke.
 - 1) Move the screw part of cable (J, Figure 70) to the left till lever (A, Figure 70) touches the engine low idle stop.
 - 2) When fully depressing accelerator pedal, adjust length of rod (B, Figure 68) longer (more than 250 mm) so that lever (A, Figure 70) touches the high idle stop.

NOTE: *If length of rod (B, Figure 68) is made excessively long, lever (A, Figure 70) will touch the engine high idle stop before the accelerator pedal (A, Figure 68) fully depresses plunger (K, Figure 68). Check whether the plunger is fully depressed or not.*

- D. In case that cable (J) hanging is excessive. (Pedal stroke excessive.)
 - 1) If cable is hanging, it should still function properly. The excessive play will not effect the normal operation of plunger (K).

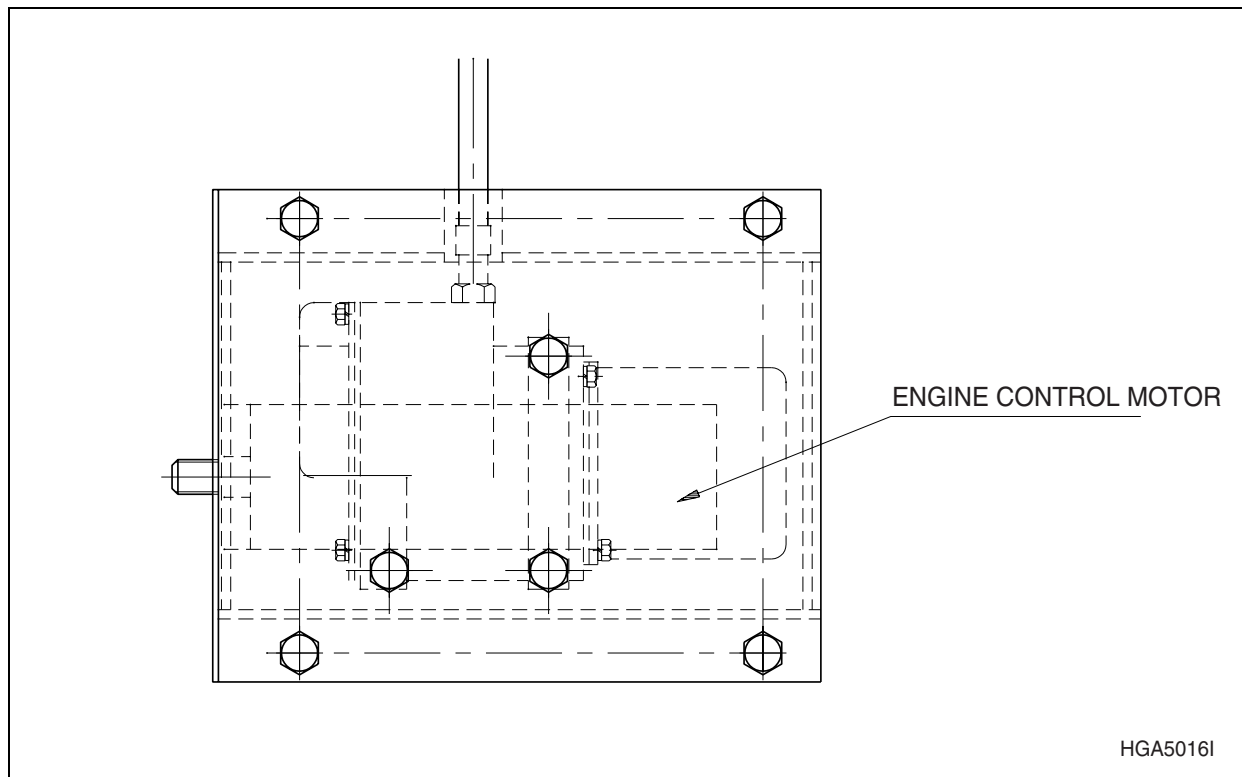


Figure 69

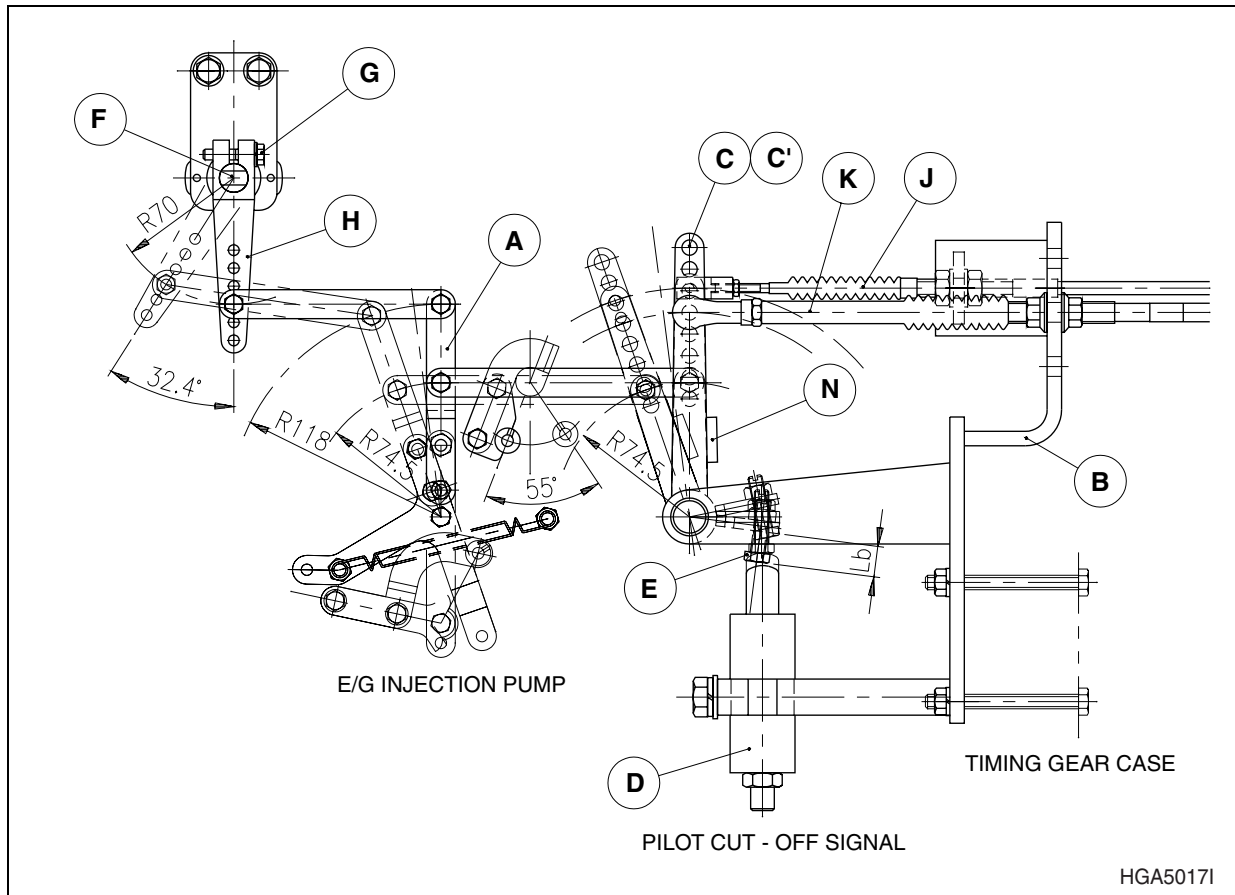


Figure 70

Adjustment of Work Mode RPM (Refer to Figure 72)

1. Engine Control Motor Adjustment

- A. Start engine, set to "POWER" for power mode, "OFF" for auto idle switch.
- B. Set work/travel select switch to "WORK," and check that forward/reverse lever is in "NEUTRAL."
- C. Set engine speed control dial to "HIGH IDLE."
- D. With a small screw driver adjust the variable resistor "VR4" shown in Figure 72. Adjust it until the engine is at "A (Table 1)" rpm.
- E. Check the "A" rpm setting by turning the engine speed control dial from "LOW IDLE" to "HIGH IDLE," and work/travel select switch to "TRAVEL"/"WORK."

NOTE: The values of the engine rpm may vary as the engine speed is changed from high to low and low to high. This deviation is normal.

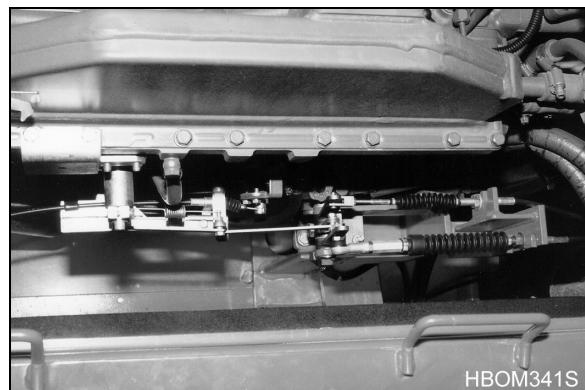


Figure 71 ENGINE THROTTLE LINKAGE

2. Accelerator Pedal Adjustment

- A. Lower left side control stand. (Pilot Cutoff Switch "ON")
- B. Check that plunger (D, Figure 70) of engine speed limiter (pilot cutoff signal) works as work/travel select switch is set to "WORK" or "TRAVEL."

NOTE: When in "WORK" mode the plunger should be extended. When in "TRAVEL" mode the plunger should be retracted to about 6 mm.

NOTE: In case of operating in "WORK" mode, for in order for plunger to be shrunken, adequate external force is required, confirm by pressing plunger.

- C. When operational check is over, set work/travel select switch to "WORK" position.
- D. Step on accelerator pedal slowly to maintain the engine speed at "A" rpm. Adjust length of stop bolt (E) till its head contacts plunger (D). Tighten jam nut.
- E. Step on the accelerator pedal two to three times to check if engine is running at "A" rpm.

Adjustment of Auto Idle and Other RPM (Refer to Figure 72)

1. Adjustment of Auto Idle.

- A. Start engine, set engine speed control dial to "HIGH IDLE" position.
- B. Set work/travel select switch to "WORK," select "POWER MODE," and auto idle switch to "ON."
- C. With a small screw driver adjust the variable resistor "VR1" shown in Figure 72. Adjust it until the engine is at "B" rpm.

2. Standard Mode

- A. Set engine speed control dial at "HIGH IDLE."
- B. Set work/travel select switch to "WORK," and auto idle switch to "ON."
- C. With a small screw driver adjust the variable resistor "VR2" shown in Figure 72. Adjust it until the engine is at "C" rpm.

Table 1			
Model	"A" RPM	"B" RPM	"C" RPM
S140W-V	1,900 ±50	1,250 ±50	1,750 ±50
S160W-V	1,900 ±50	1,250 ±50	1,750 ±50
S180W-V	2,050 ±50	1,400 ±50	1,950 ±50
S210W-V	2,150 ±50	1,400 ±50	2,050 ±50

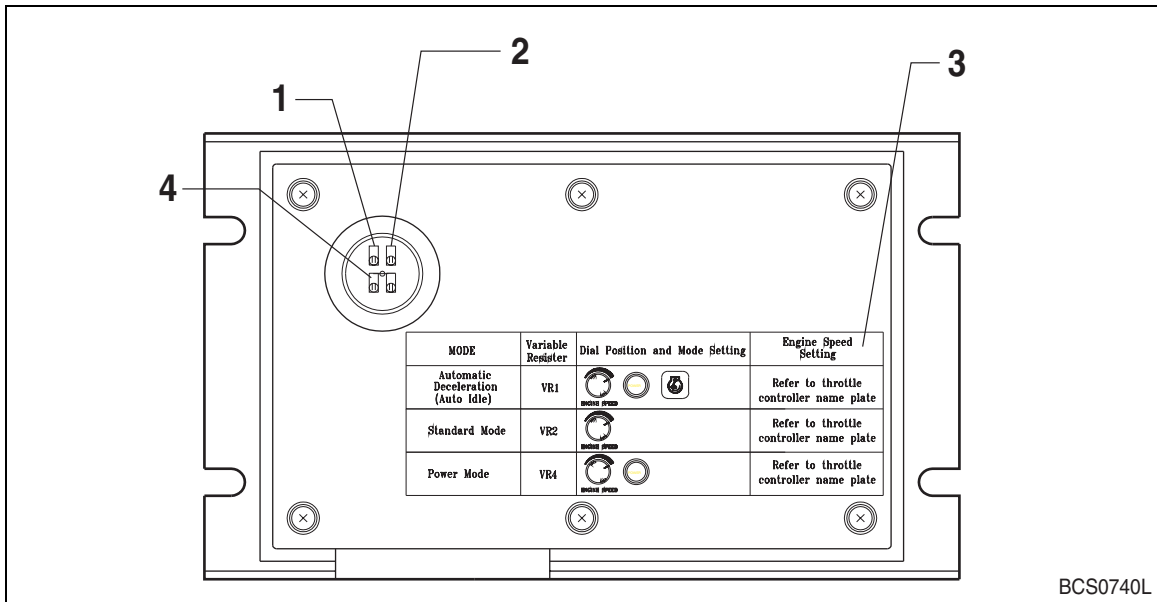


Figure 72

Reference Number	Description
1	VR1 (Automatic Deceleration Adjusting Variable Resister)
2	VR2 (Standard Mode Adjusting Variable Resister)
3	Name Plate
4	VR4 (Power Mode Adjusting Variable Resister)

ADJUSTMENT OF TPS (THROTTLE POSITION SENSOR)

NOTE: Refer to Figure 72 thru Figure 74.

NOTE: If TPS adjustment is not correct, the performance of equipment will not be exerted and may become the cause of overloading and so correct adjustment is necessitated.

- After connecting the harness for test to TPS, install multi tester, and select DC voltage (DCV) (Refer to "Figure 73").
- Set work/travel select switch at "WORK."
- Set engine speed control dial at "HIGH IDLE" position.
- After reading the engine rpm at gauge panel, look for the corresponding TPS voltage value.
- Rotate shaft (F, Figure 70) so that the TPS voltage value matches the value found on the table and tighten bolt (G).
- Set work/travel select switch to "TRAVEL," select "POWER MODE" and turn the engine speed control dial to "HIGH IDLE."
- Read the engine speed displayed on the gauge panel and find the corresponding TPS voltage on table "Figure 74."
- Check to see if the TPS voltage matches the voltage found on the table.

9. Turn the engine speed control dial to "LOW IDLE" position and check to see if the TPS voltage matches the voltage found on the table "9-7."
10. If the measured voltage is greater than the listed voltage on the table, move the H lever one hole lower than the present position; if it is less than the voltage listed on the table move the lever one hole higher than the present position.
11. By repeating steps 2 - 10 the maximum engine rpm voltage for work mode and the maximum rpm voltage for travel mode can be simultaneously set.

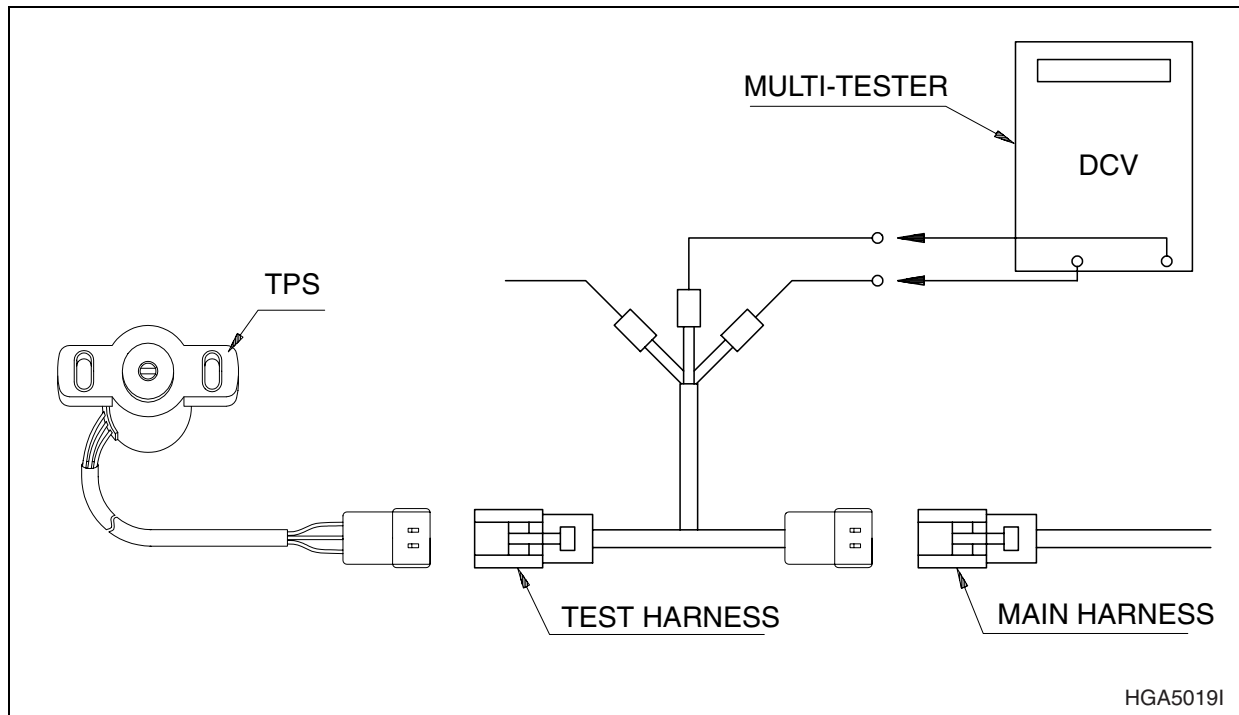


Figure 73

S140W-V / S160W-V

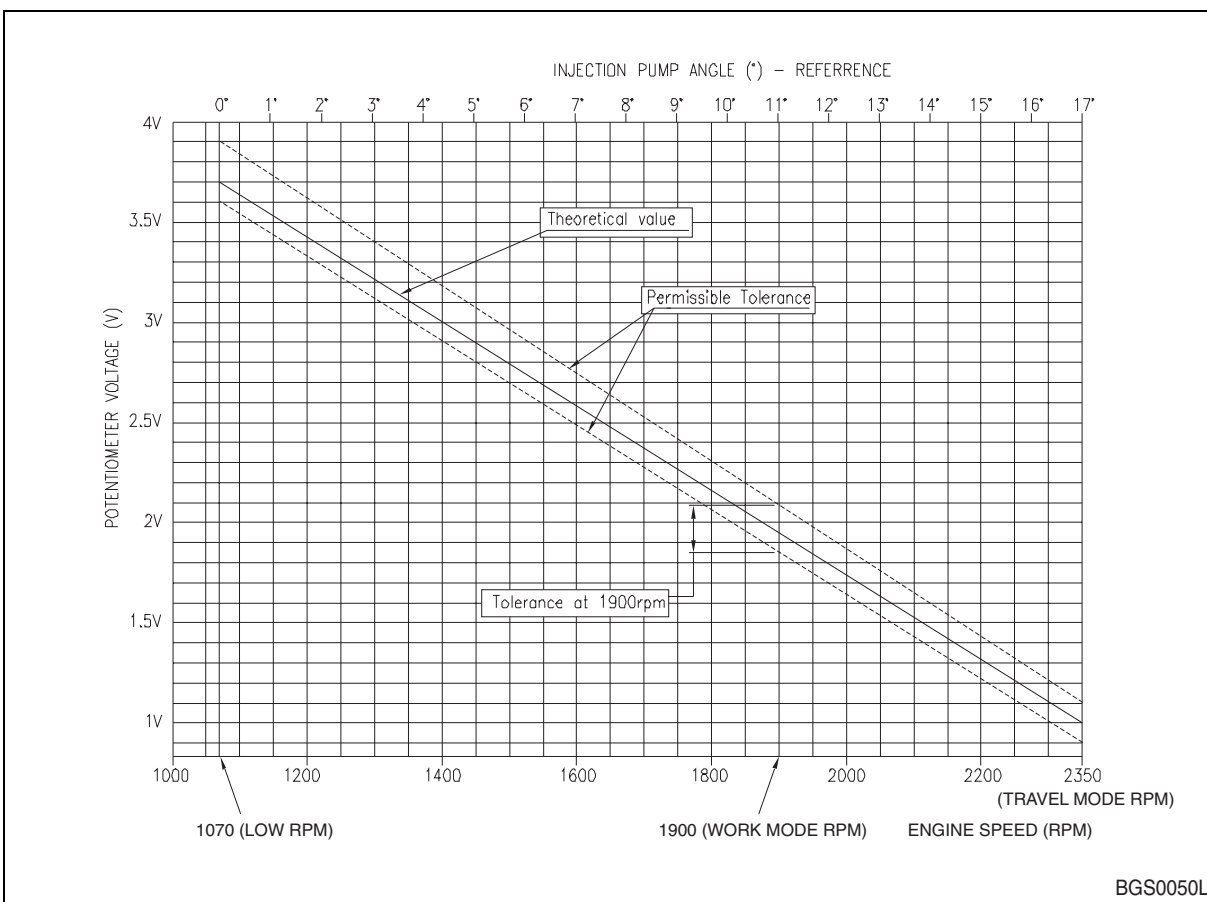


Figure 74

Engine Speed @ Approx. 1070 rpm		Engine Speed @ Approx. 1900 rpm		Engine Speed @ Approx. 2350 rpm	
Speed	Tolerance	Speed	Tolerance	Speed	Tolerance
1070 rpm and under	3.60 - 3.90V	1850 rpm	2.05 ±0.05V	2350 rpm and over	0.90 - 1.10V
1080 rpm	3.58 - 3.88V	1860 rpm	2.03 ±0.05V	2340 rpm	0.92 - 1.12V
1090 rpm	3.56 - 3.86V	1870 rpm	2.01 ±0.05V	2330 rpm	0.94 - 1.14V
1100 rpm	3.54 - 3.84V	1880 rpm	1.99 ±0.05V	2320 rpm	0.96 - 1.16V
1110 rpm	3.52 - 3.81V	1890 rpm	1.97 ±0.05V	2310 rpm	0.98 - 1.19V
1120 rpm	3.50 - 3.79V	1900 rpm	1.95 ±0.05V	2300 rpm	1.00 - 1.21V
		1910 rpm	1.93 ±0.05V		
		1920 rpm	1.91 ±0.05V		
		1930 rpm	1.89 ±0.05V		
		1940 rpm	1.87 ±0.05V		
		1950 rpm	1.85 ±0.05V		

S180W-V

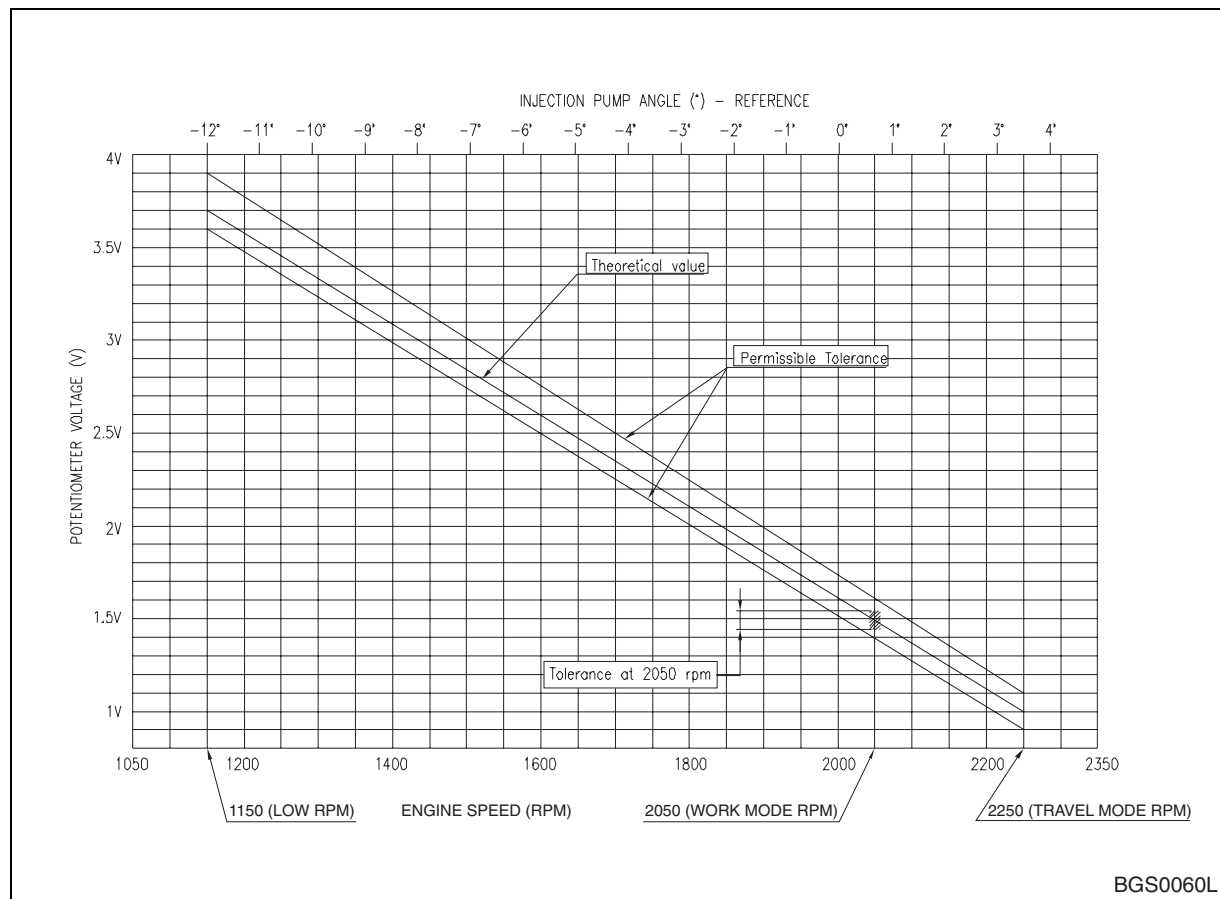


Figure 75

Engine Speed @ Approx. 1150 rpm		Engine Speed @ Approx. 2050 rpm		Engine Speed @ Approx. 2250 rpm	
Speed	Tolerance	Speed	Tolerance	Speed	Tolerance
1150 rpm and under	3.60 - 3.90V	2000 rpm	1.61 ±0.05V	2250 rpm and over	0.90 - 1.10V
1160 rpm	3.58 - 3.88V	2010 rpm	1.59 ±0.05V	2240 rpm	0.92 - 1.13V
1170 rpm	3.55 - 3.85V	2020 rpm	1.56 ±0.05V	2230 rpm	0.95 - 1.15V
1180 rpm	3.53 - 3.83V	2030 rpm	1.54 ±0.05V	2220 rpm	0.97 - 1.18V
1190 rpm	3.50 - 3.80V	2040 rpm	1.52 ±0.05V	2210 rpm	1.00 - 1.20V
1200 rpm	3.48 - 3.77V	2050 rpm	1.49 ±0.05V	2200 rpm	1.02 - 1.23V
		2060 rpm	1.47 ±0.05V		
		2070 rpm	1.44 ±0.05V		
		2080 rpm	1.42 ±0.05V		
		2090 rpm	1.39 ±0.05V		
		2100 rpm	1.37 ±0.05V		

S210W-V

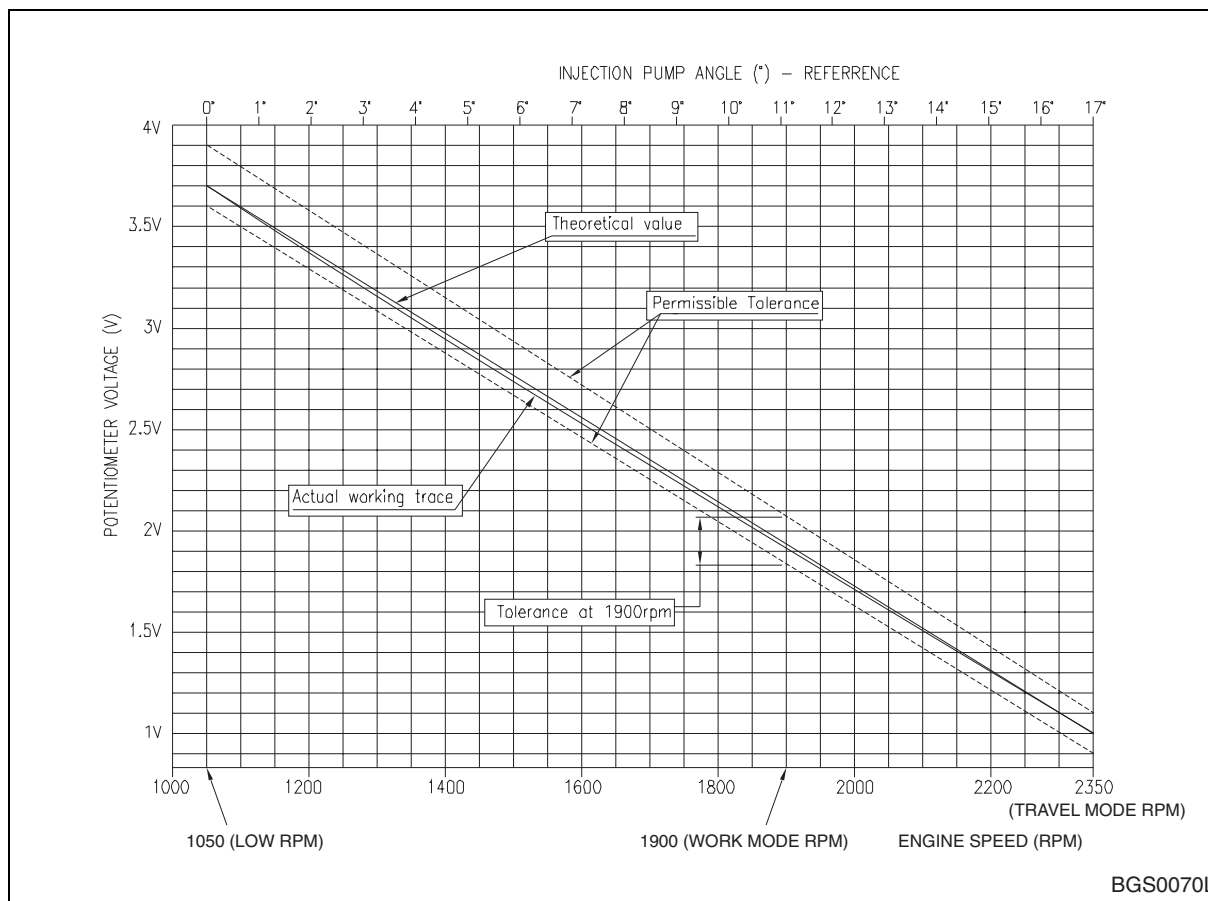


Figure 76

Engine Speed @ Approx. 1100 rpm		Engine Speed @ Approx. 2150 rpm		Engine Speed @ Approx. 2350 rpm	
Speed	Tolerance	Speed	Tolerance	Speed	Tolerance
1100 rpm and under	3.60 - 3.90V	2100rpm	1.54 ±0.05V	2350 rpm and over	0.90 - 1.10V
1110 rpm	3.58 - 3.88V	2110rpm	1.52 ±0.05V	2340 rpm	0.92 - 1.12V
1120 rpm	3.56 - 3.86V	2120rpm	1.49 ±0.05V	2330 rpm	0.94 - 1.14V
1130 rpm	3.54 - 3.84V	2130rpm	1.47 ±0.05V	2320 rpm	0.96 - 1.16V
1140 rpm	3.52 - 3.81V	2140rpm	1.45 ±0.05V	2310 rpm	0.98 - 1.19V
1150 rpm	3.50 - 3.79V	2150rpm	1.43 ±0.05V	2300 rpm	1.00 - 1.21V
		2160rpm	1.41 ±0.05V		
		2170rpm	1.39 ±0.05V		
		2180rpm	1.37 ±0.05V		
		2190rpm	1.34 ±0.05V		
		2200rpm	1.32 ±0.05V		

SELF-DIAGNOSTIC FUNCTION

E-EPOS CONTROLLER

The system operation status and malfunction codes can be checked through the display on top of the e-EPOS controller box in the drawer under the operator's seat.

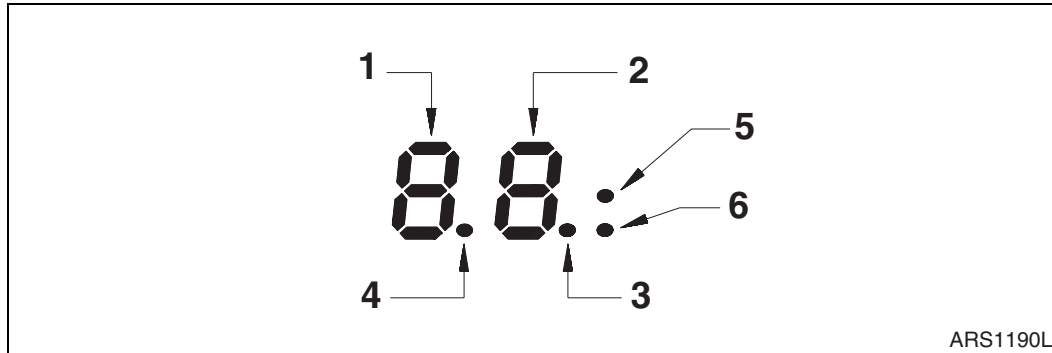


Figure 77

Reference Number	Description
1	Upper Digit
2	Lower Digit
3	Engine Speed Monitor LED (Flash Interval Increases With Engine Speed.)

Reference Number	Description
4	Power Monitor (Stays On While Power Is In Normal Range,)
5	Communication Monitor LED (Flash when normal condition)
6	

1. Power Monitor

This LED is turned off when the input voltage to the e-EPOS controller is below 18.5 ± 1 V or above 32.5 ± 1 V. Stays on while in normal range.

2. Engine Speed Monitor

This LED light flashes according to the engine speed. The flashing interval is proportional to the engine speed.

3. Communication Monitor

These LED lamps flash when normal state of communication between main controller and instrument panel.

4. Normal Operation Display Readout

Mode Selection		Display Readout		Operation Status
		Upper Digit	Lower Digit	
Power Mode	Power Mode	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

5. Malfunction Display and Reset Procedure

The malfunction codes displayed on the top of the e-EPOS controller and reset procedure are the same with failure information codes a part of failure information.

Refer to the failure information part of letter information display for details.

No.	Fault Area	Cause	Display Readout	Action	Reset Procedure
1	Pump Discharge Volume Control Valve (E.P.P.R. Valve)	Short Circuit	01 HAOH400L	Cut Off Output Current (0 mA)	After correcting problem, turn starter switch from "OFF" to "ON."
2	Relief Pressure Up Solenoid Valve	Short Circuit	02 HAOH410L	Cut Off Output Current (0 mA)	After correcting problem, turn starter switch from "OFF" to "ON."
3	Travel Speed - II Solenoid Valve	Short Circuit	03 HAOH420L	Cut Off Output Current (0 mA)	After correcting problem, turn starter switch from "OFF" to "ON."
4	Swing Priority Control Solenoid Valve	Short Circuit	04 HAOH430L	Cut Off Output Current (0 mA)	After correcting problem, turn starter switch from "OFF" to "ON."

No.	Fault Area	Cause	Display Readout	Action	Reset Procedure
5	Arm Regeneration Control Solenoid Valve	Short Circuit	05 HAOH440L	Cut Off Output Current (0 mA)	After correcting problem, turn starter switch from "OFF" to "ON."
6	Arm Priority Control Solenoid Valve	Short Circuit	06 HAOH450L	Cut Off Output Current (0 mA)	After correcting problem, turn starter switch from "OFF" to "ON."
7	Relief Pressure Up Solenoid Valve	Open Circuit	12 HAOH460L		Automatic reset when problem is corrected.
8	Travel Speed - II Solenoid Valve	Open Circuit	13 HAOH470L		Automatic reset when problem is corrected.
9	Swing Priority Control Solenoid Valve	Open Circuit	14 HAOH480L		Automatic reset when problem is corrected.
10	Arm Regeneration Control Solenoid Valve	Open Circuit	15 HAOH490L		Automatic reset when problem is corrected.
11	Arm Priority Control Solenoid Valve	Open Circuit	16 HAOH500L		Automatic reset when problem is corrected.
12	Engine Speed Control Dial	Output Voltage: over 4.6 ± 0.2 V Abnormal: under 0.4 ± 0.2 V	21 HAOH510L		Automatic reset when problem is corrected.
13	Engine Control Motor (Potentiometer)	Output Voltage: over 4.6 ± 0.2 V Abnormal: under 0.4 ± 0.2 V	23 HAOH520L		Automatic reset when problem is corrected.
14	Front Pump Pressure	Output Voltage: over 4.6 ± 0.2 V Abnormal: under 0.4 ± 0.2 V	24 HAOH530L		Automatic reset when problem is corrected.

No.	Fault Area	Cause	Display Readout	Action	Reset Procedure
15	Rear Pump Pressure	Output Voltage: over 4.6 ± 0.2 V Abnormal: under 0.4 ± 0.2 V	 HAOH540L		Automatic reset when problem is corrected.
16	Mode Select Signal Input	CN1 - 12 and CN1 - 13 Terminals At High Level (12 V)	 HAOH550L		Automatic reset when problem is corrected.

ENGINE THROTTLE CONTROLLER

Under the rubber cap on the surface of the engine controller, there are three LEDs. Based on the equipment status the following LEDs will turn "ON."

Throttle Controller Input Signal	Status	LED Status			Voltage At Control Motor Terminal
		Red	Green	Yellow	
Dial Voltage < Motor Potentiometer Voltage	While Control Motor Is Operating (Increasing rpm)	X	Δ	O	Approximately +24 V
Dial Voltage > Motor Potentiometer Voltage	While Control Motor Is Operating (Decreasing rpm)	Δ	X	O	Approximately - 24 V
Dial Voltage = Motor Potentiometer Voltage	Control Motor Stopped	O	O	O	0 V
	Motor Overload (Cut Off Motor Current)	X	X	O	0 V
	Abnormal Controller Power Voltage (Low Or No Input)	X	X	X	0 V

Δ	O	X
Brightly Lit	ON	OFF

- NOTE:**
1. Control Motor Voltage is Measured at throttle controller 4 (+) and 5 (-) terminals.
 2. Yellow LED indicates power status (ON, OFF).
 3. To protect the control motor from overloads, the control motor automatically cuts off supply voltage to the motor when there is a heavy load on the motor and the possibility of motor damage or burn out exists.
 4. After the malfunction is corrected, turn the starter switch from "OFF" to the "ON" position and normal operation will resume.

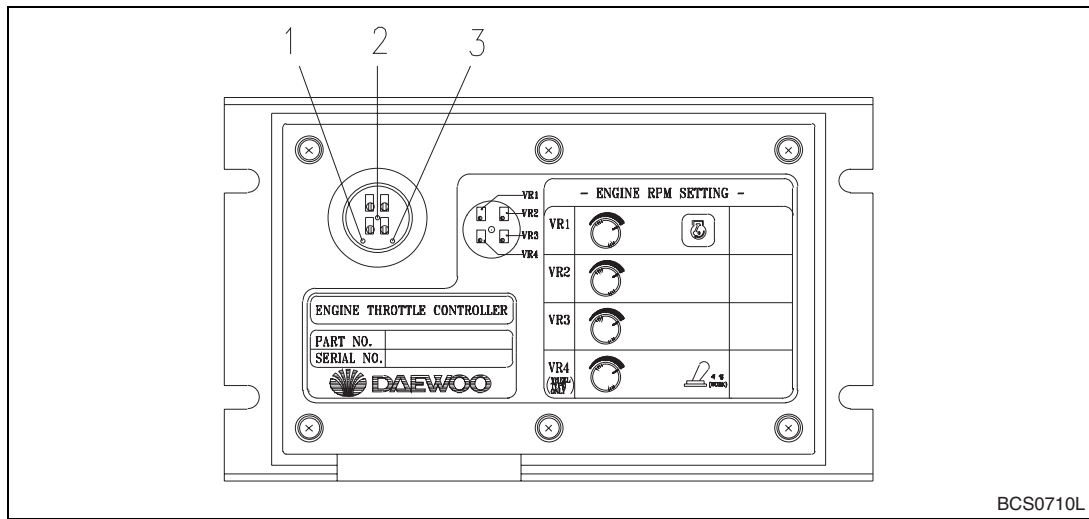


Figure 78

Reference Number	Description
1	Red LED
2	Yellow LED
3	Green LED

WIPER SYSTEM

WIPER CIRCUIT

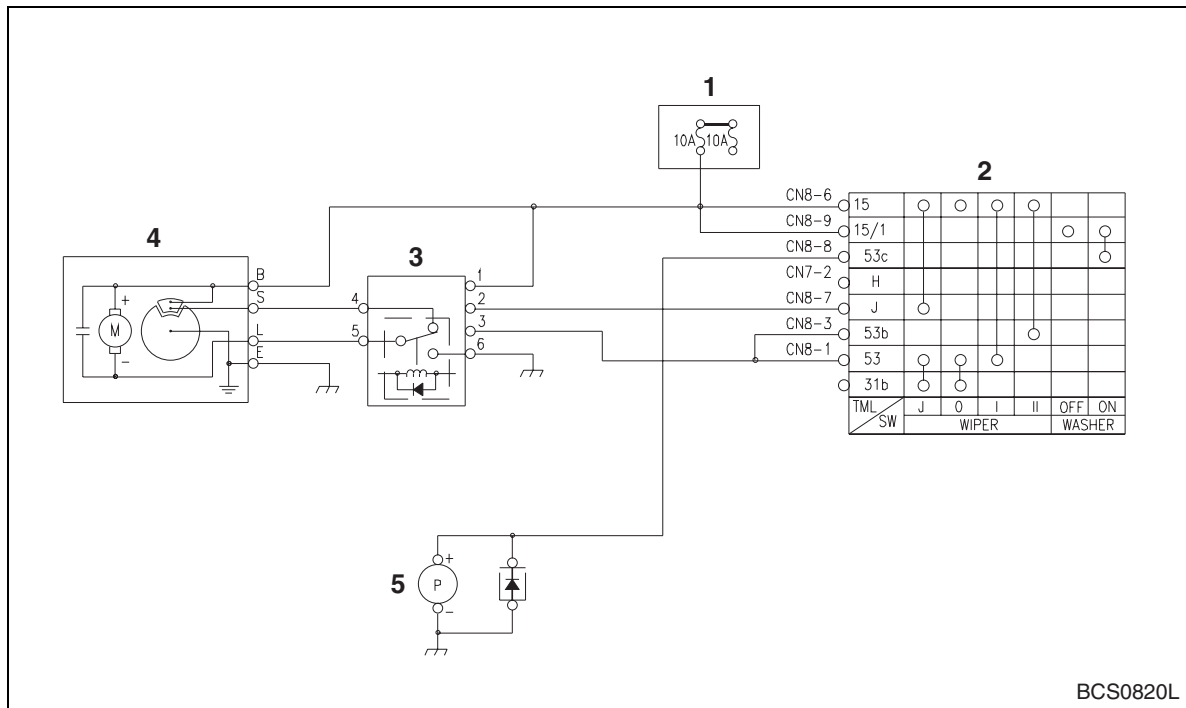


Figure 79

Reference Number	Description
1	Fuse Box
2	Combination Switch (Left)
3	Washer Timer

Reference Number	Description
4	Wiper Motor
5	Window Washer

WIPER OPERATION

Intermittent Operation (I - position)

When the wiper switch (4) is turned "I" position, the current flows from the fuse (3) → "B" terminal of wiper motor (7) → "L" terminal of wiper motor (7) → "5" terminal of wiper timer (6) → "6" terminal of wiper timer (6) → ground and the wiper motor operates intermittently by the timer built in wiper timer. (On: approximately 1 second, Off: approximately 5 seconds)

Continuous Operation (II - Position)

When the wiper switch (4) is turned "I" position, the current flows from the fuse (3) → "B" terminal of wiper motor (7) → "L" terminal of wiper motor (7) → No. 5 terminal of wiper timer (6) → No. 6 terminal of wiper timer (6) → ground and the contact points No. 5 and No. 6 of wiper timer (6) are connected continuously, the wiper motor operates continuously.

When the wiper switch (4) is turned "OFF," the current flows from the fuse (3) → "B" terminal of wiper motor (7) → "L" terminal of wiper motor (7) → No. 5 terminal of wiper timer (6) → No. 4 terminal of wiper timer (6) → "S" terminal of wiper motor (7) → "B" terminal of wiper motor (7) and the wiper motor is stopped at the auto stop position.

WINDOW WASHER OPERATION

When the window washer switch is turned "ON," the current flows from the fuse (3) → No. 1 terminal of washer switch (5) → No. 5 terminal of washer switch (5) → "+" terminal of window washer (8) → ground and windshield washer fluid is sprayed.

OVERLOAD WARNING DEVICE

OVERLOAD WARNING DEVICE CIRCUIT DIAGRAM

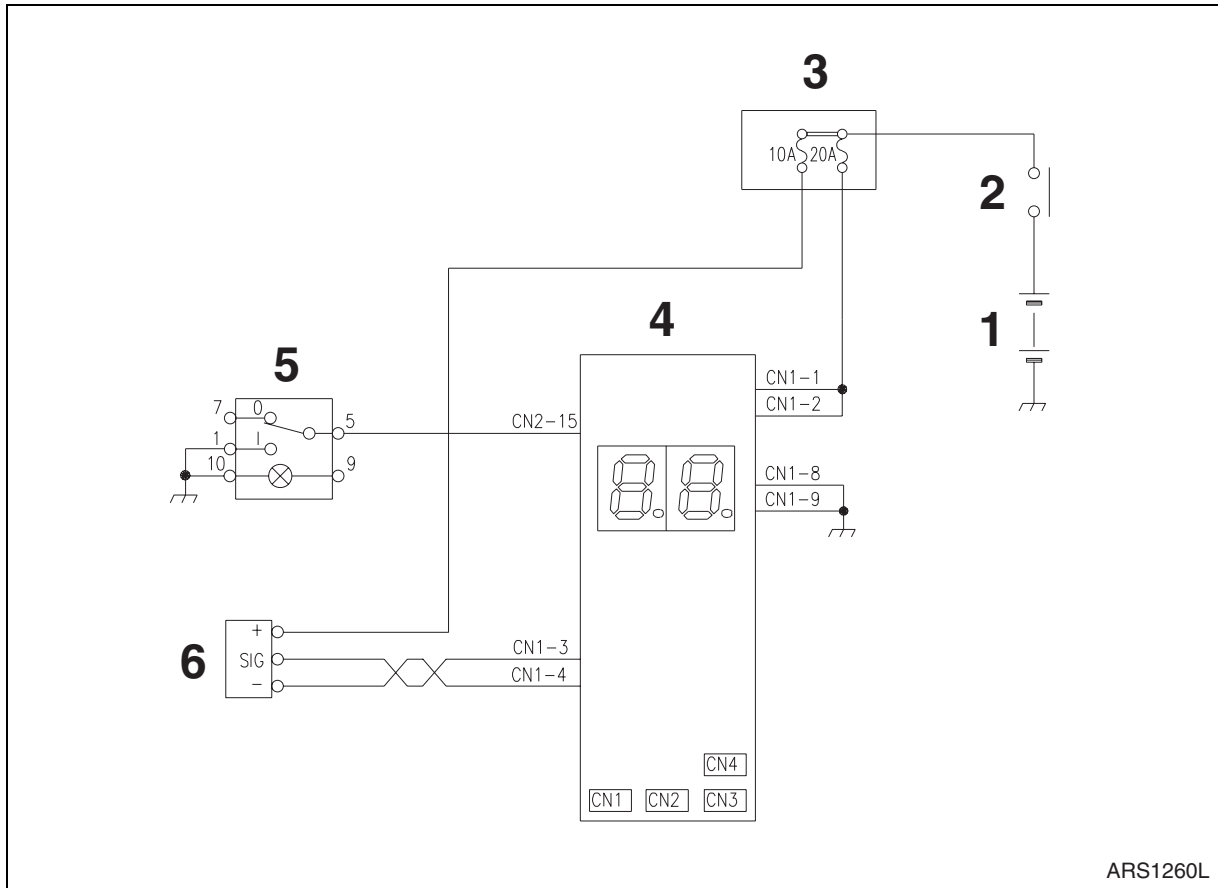


Figure 80

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse Box

Reference Number	Description
4	e-EPOS Controller
5	OWD Select Switch
6	Pressure Sensor



ELECTRICAL SCHEMATIC (S140W-V / 160W-V)



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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General Description.....	3
Solar 140W-V / 160W-V	4

GENERAL DESCRIPTION

Schematic(s) presented in this section are laid out on facing pages.

An overlapping edge has been taken into consideration so that a photocopy can be made and pasted together to make a complete schematic.

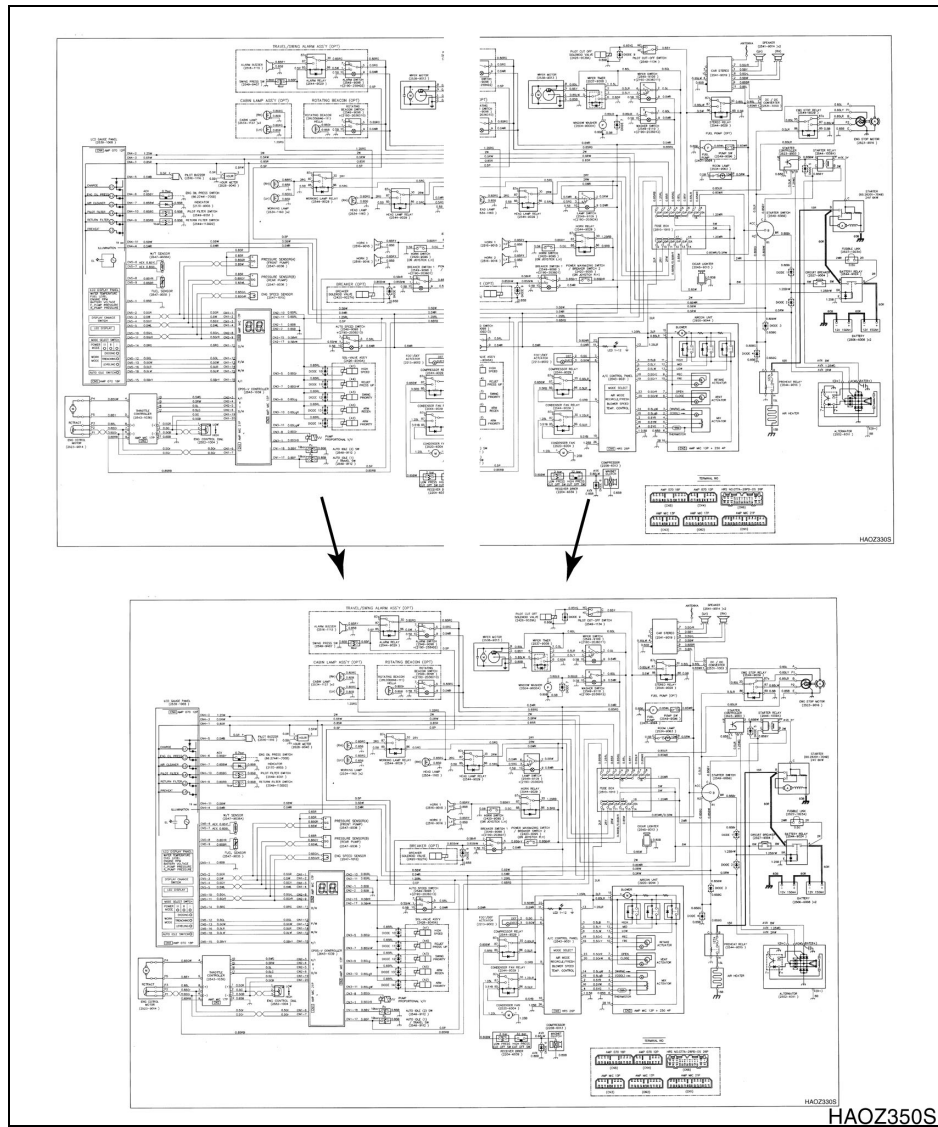


Figure 1

SOLAR 140W-V / 160W-V

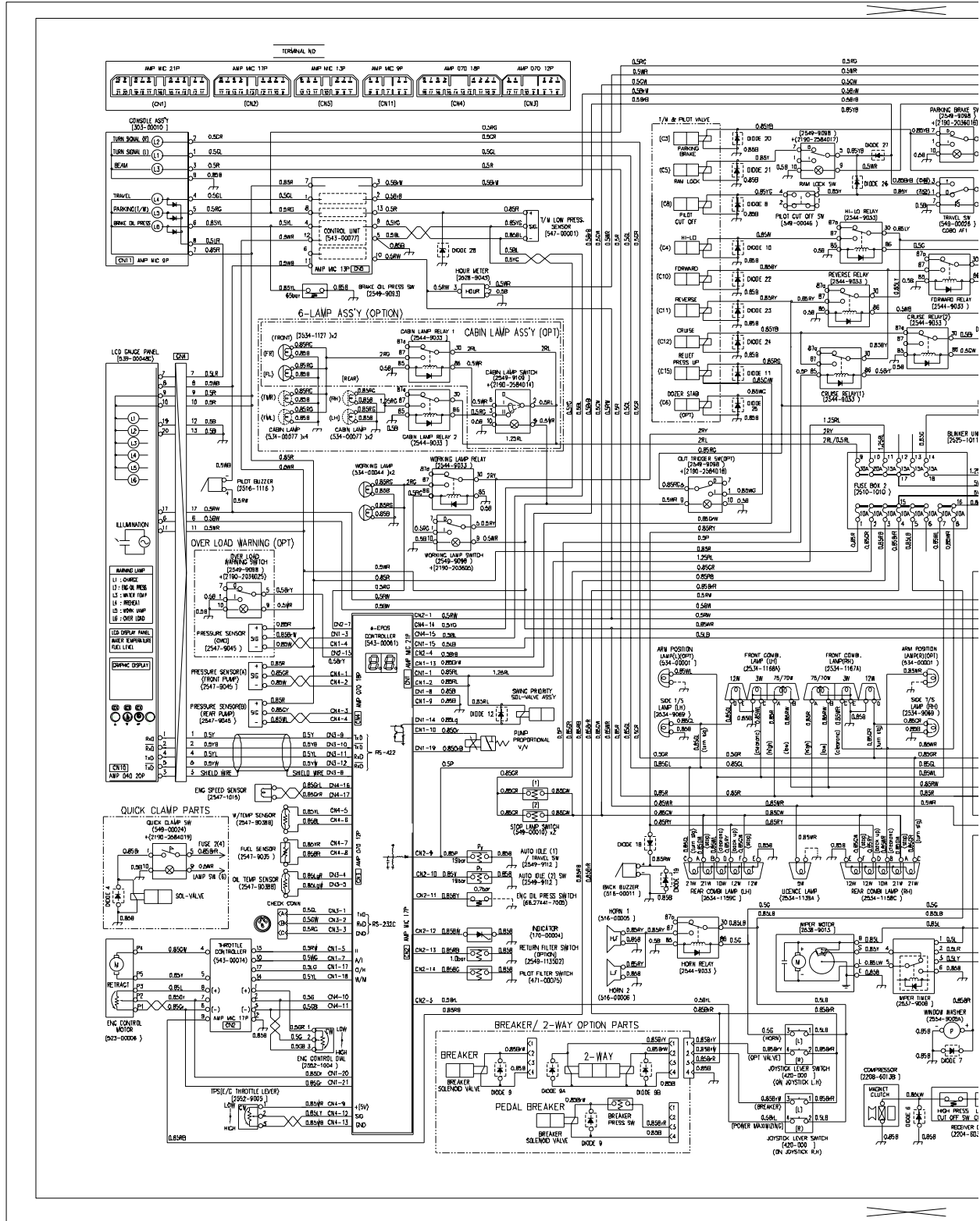


Figure 2

ATTACHMENTS



BOOM AND ARM



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 130W-V	0001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up

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Front Attachment - Removal and Installation	4
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Boom Removal Procedure	6
Front Attachment - Installation	7
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Boom Installation Procedure	7
Start-up Procedures	8

FRONT ATTACHMENT PIN SPECIFICATIONS

The table below has a complete listing of dimensional specifications for all mounting pins used on the front attachment.

NOTE: *Some mounting pins must be drilled and tapped for lubrication fittings and piping, or may have other required specifications. Consult Daewoo After Sales Service for information on wear tolerances and replacement limits for mounting pins.*

Mounting Pin	Diameter, mm (Inches)	Length, mm (Inches)
A	71.0 mm (2.80 in)	651.0 mm (25.63 in)
B	71.0 mm (2.80 in)	176.0 mm (6.93 in)
C	71.0 mm (2.80 in)	670.0 mm (26.38 in)
D	71.0 mm (2.80 in)	413.0 mm (16.26 in)
E	71.0 mm (2.80 in)	201.0 mm (7.91 in)
F	71.0 mm (2.80 in)	201.0 mm (7.91 in)
G	65.0 mm (2.56 in)	380.0 mm (14.96 in)
H	65.0 mm (2.56 in)	431.0 mm (16.97 in)
I	65.0 mm (2.56 in)	187.0 mm (7.36 in)
J	65.0 mm (2.56 in)	380.0 mm (14.96 in)
K	65.0 mm (2.56 in)	431.0 mm (16.97 in)

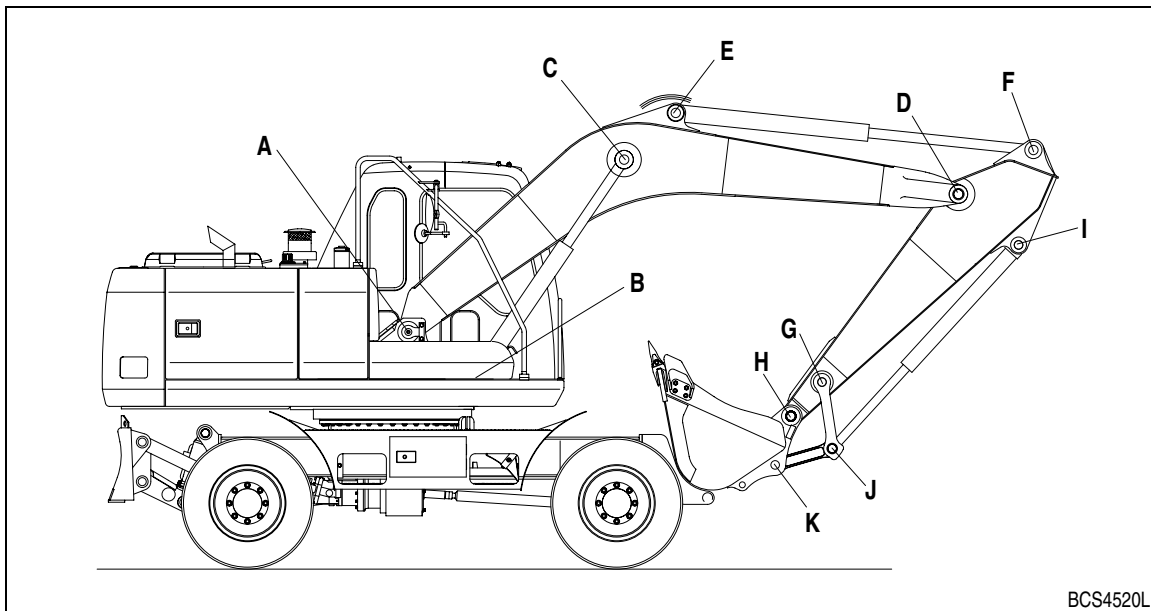


Figure 1

FRONT ATTACHMENT - REMOVAL AND INSTALLATION



DANGER!

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

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

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

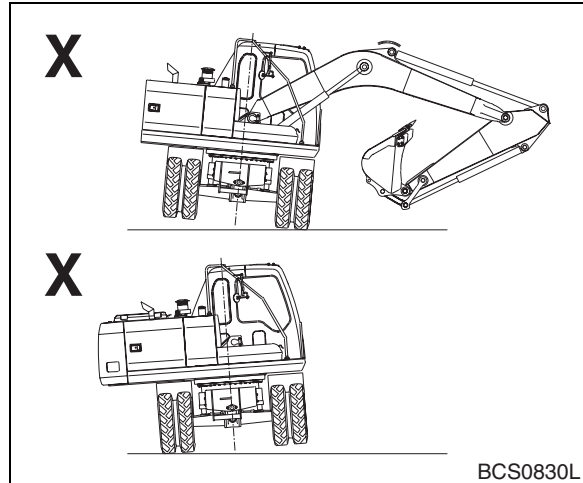


Figure 2

IMPORTANT

Always break down the front attachment by removing outermost sections first - the bucket before the arm, the arm before the boom. Reinstallation of the attachment should begin with the boom and end with the bucket.

Refer to the appropriate Bucket section for its removal and installation procedure before going onto the initial step of the front attachment removal or installation procedure.

ARM REMOVAL PROCEDURE



WARNING!

This procedure is only intended for routine removal or replacement of the attachment, while working under normal, safe operating conditions. In the event of a major structural collapse of some part of the attachment, an accident or complete loss of attachment hydraulic function, **DO NOT** proceed with attachment disassembly unless you are completely sure of what you are doing. Please call your local Daewoo distributor or Daewoo After Sales Service for assistance. **DO NOT** allow personnel to stand underneath a weakened or only partially supported attachment section. Keep clear of hydraulic lines that may have fluid escaping at high pressure - it can cause severe or even fatal injuries.

Complete the bucket end removal procedure by pulling out the two bucket linkage pins and the bucket cylinder mounting pin, on the arm. Use an assist crane or hoist to lift the cylinder and relieve weight on mounting pins.

Park the excavator away from obstructions and all traffic on clear, flat, level ground. Extend the arm cylinder and crowd the arm into the boom. Partially retract the boom cylinder so that the boom is stretched out in front of the excavator, as low to the ground as possible, with the arm crowded under the boom.

The tip of the arm point should be lowered to secure blocking that will safely support the weight of the arm. Place the blocking directly in front of the excavator and make sure that it will not be unbalanced with an initial weight load that is all to one end, under the arm point.

Shut off the engine and release hydraulic system pressure - move any of the control levers with the engine off to release pressure built up in the accumulator. Manually vent residual hydraulic pressure in the tank by moving the lever near the cap, on top of the reservoir.



WARNING!

Secure the swing lock and tag and lock out controls in the operator's cab to keep anyone from moving or inadvertently starting the engine. Restrict access to the work site while sections of the attachment are in the air, or while they are being supported by the assist crane. The safe lifting capacity of the assist crane or hoist that is used must exceed the weight of the heaviest section of the attachment, the boom (approximately 2,000 kg [4,400 lb], not including the weight of accessories or fixtures).

Before beginning the disassembly of attachment mounting pins, disconnect the arm cylinder hydraulic hose couplings and put a clean plug in the end of each one. Use any and all reasonable precautions necessary to avoid introducing dirt or other contaminants into the hydraulic system. Wipe down coupling points before disconnecting hydraulic lines and use evaporative-type solvent spray cleaner. Tag and mark hoses for reassembly, if necessary.

Place a sling under the arm cylinder (the cylinder used to extend and retract the attachment arm, pinned to the top of the boom). Lift the sling so that the weight load on the rod end of the arm cylinder (pinned to the ears on the inner end of the arm) is released. Prepare blocking under the arm that will securely support the weight of the arm and arm cylinder.



CAUTION!

To make sure that the polished surfaces of cylinder rod ends will not suffer accidental damage during disassembly or removal procedures, wrap exposed rod surfaces (especially those of boom cylinders) with a protective covering material. Immediately following disassembly and removal, cylinder rods should always be fully retracted. This eases handling problems and also avoids possible damage.

Remove retainers on the end of the mounting pin for the arm cylinder rod end. Use the assist crane to relieve the weight load and withdraw the pin. Lower the arm down to the blocking support for any continued disassembly procedures.

BOOM REMOVAL PROCEDURE

NOTE: *Boom removal may be simplified if the shell of the operator's cab is taken off the turntable deck first. Refer to the Operator's Cab Removal procedure before continuing, if both components are to be removed from the excavator.*

After the bucket, arm and arm cylinder have been removed, lower the end of the boom to a stable, secure blocking support.

Attach the assist crane sling to the body of either boom cylinder, break the mounting pin connection to the boom by tapping through the pin from the same side of the boom and repeat for the opposite cylinder.

Release hydraulic pressure and disconnect line couplings as previously outlined in the Arm Removal Procedure, observing the same precautions.

Disconnect wiring for work light assemblies and any other accessory lines or connections. Locate the sling of the assist crane near the center of gravity, optimum lift point for the boom, and use the crane to take pressure off the boom foot pin. Drive out the pin after disassembling retainers and carefully lift away the boom.



WARNING!

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

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

FRONT ATTACHMENT - INSTALLATION

ARM INSTALLATION PROCEDURE

Re-attach the base of the arm cylinder to the mounting point on top of the boom.



WARNING!

Before assembling the front attachment, make sure that the individual boom, arm and bucket sections are all compatible and can be used safely for work intended. Refer to the General Safety Pages, Lift Ratings, Working Range Diagrams and Weights of Materials sections in the Operation and Maintenance Manual. Consult your dealer or Daewoo After Sales Service for more information if you have any questions or require more information.

Begin with the arm securely supported on blocking in front of the excavator. Pre-grease the mounting pin for the rod end of the arm cylinder and push it through the ears on the end of the arm. Attach a sling around that mounting pin and lift the arm with an assist crane until it is in position for the boom-arm pin connection to be made.

Relieve hydraulic pressure from all points of the system before any hydraulic lines are opened, then carefully assemble hydraulic connections to the arm cylinder.

Remove the sling from around the rod end arm cylinder pin, withdraw the pin and lift the body of the arm cylinder to re-pin the mounting connection.

BOOM INSTALLATION PROCEDURE

Before reassembling the attachment, make sure to inspect all bushings and pivot points of each section. To avoid damaging the seats, bushings should never be hammered or chiseled out of their seats.

Installation is otherwise a reversal of the removal procedures.

START-UP PROCEDURES

Once the boom has been serviced, it should be lubricated as outlined in the initial start-up procedures of the operation manual. Refer to the appropriate operation and maintenance manual for unit.



**S0904000
R4**

BUCKET



CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

MODEL	SERIAL NUMBER RANGE
Solar 015	0001 and Up
Solar 015 PLUS	1001 and Up
Solar 55	0001 and Up
Solar 55-V Plus	1001 and Up
Solar 75-V	1001 and Up
Solar 130LC-V	0001 and Up
Solar 130W-V	0001 and Up
Solar 140W-V	1001 and Up
Solar 160W-V	1001 and Up
Solar 170LC-V	1001 and Up
Solar 170W-V	1001 and Up
Solar 180W-V	1001 and Up
Solar 200W-V	0001 and Up
Solar 210W-V	1001 and Up
Solar 220LC-V	0001 and Up
Solar 225NLC-V	1001 and Up
Solar 250LC-V	1001 and Up
Solar 255LC-V	1001 and Up
Solar 290LC-V	0001 and Up
Solar 330LC-V	1001 and Up
Solar 400LC-V	1001 and Up
Solar 450LC-V	1001 and Up

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BUCKET TOOTH INSPECTION AND REPLACEMENT

There are several different types of attachment methods for replaceable bucket teeth. Some of the most common types are shown in the following drawings.

Bucket teeth are usually replaced in sets but it may sometimes be necessary to replace individual teeth.

TYPE 1

Look for the following indications of wear or damage:

- Lock pins protrude unevenly on one side.
- Lock pins have been worn down so far that they no longer make full contact through the length of the pin hole.
- Lock washers or pins show obvious damage or weakness.
- Wear points on the working surfaces of tooth points - pits, cracks, chips or craters - are larger than 8 - 10 mm (1/3" - 1/2") across.

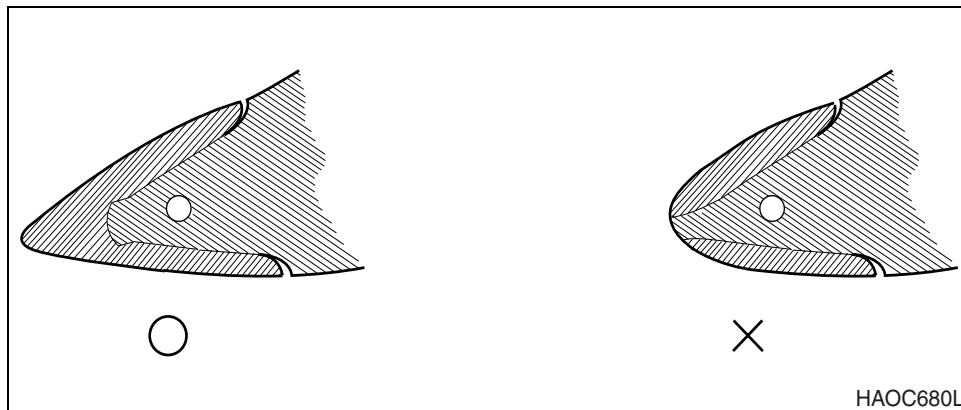


Figure 1

1. On a routine basis, inspect the bucket teeth to make sure that tooth wear or breakage has not developed. Do not allow the replaceable bucket teeth to wear down to the point that the bucket adapter is exposed. See Figure 7.
2. To replace a tooth (1, Figure 4), use a hammer and punch to drive the locking pin (2) and lock washer (3) out of the tooth adapter (4).
3. Once the worn tooth has been removed, use a putty knife to scrape the adapter as clean as possible.
4. Slide the new tooth into position and insert the lock washer.
5. Insert the locking pin into the tooth and with a hammer, drive the pin in until the lock washer seats in the locking groove.

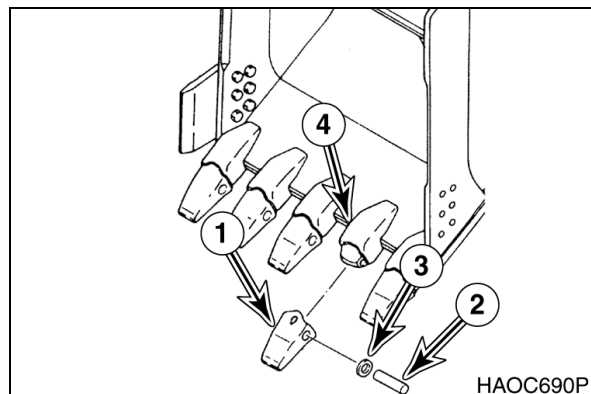


Figure 2

TYPE 2



WARNING!

Due to the possibility of flying metal objects, always wear safety helmet, protective gloves and eye protection when changing bucket teeth.

Curl the bucket upwards and place the round rear surface of the bucket firmly on the ground. Shut the engine off and lock out the hydraulic controls before working on the bucket.

NOTE: These instructions are only for Daewoo OEM buckets. If you are using other manufacturers buckets, refer to their specific instructions.

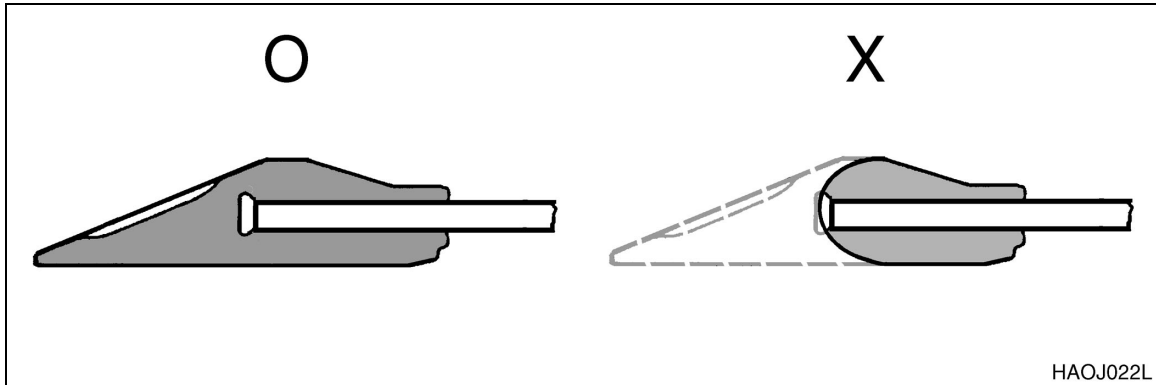


Figure 3

1. On a routine basis, inspect the bucket teeth to make sure that tooth wear or breakage has not developed. Do not allow the replaceable bucket teeth to wear down to the point that the bucket is exposed. See Figure 3.
2. To replace a tooth, remove bolts, lock washers and plain washers from seat. Remove tooth and shim(s) from bucket. See Figure 4.
3. Once the worn tooth has been removed, use a putty knife to scrape bucket as clean as possible.

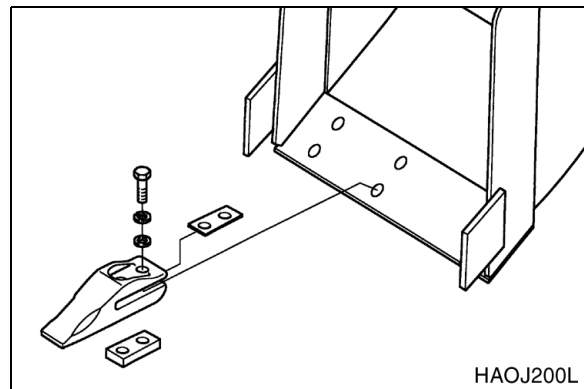


Figure 4

4. Slide the new tooth into position and insert shims. Shim tooth until gap is less than "X" [0.5 mm (0.020 in)]. See Figure 5.
5. Secure tooth and shim into position with seat, plain washers, lock washers and bolts.

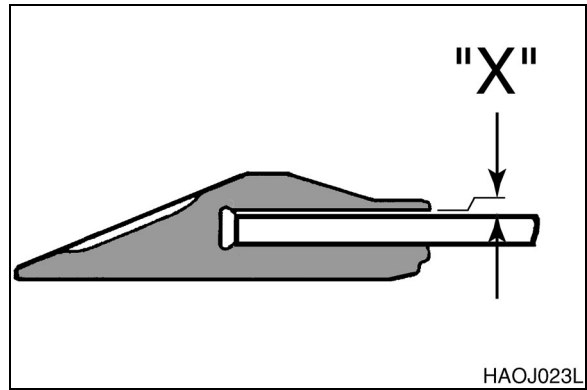


Figure 5

TYPE 3



WARNING!

Due to the possibility of flying metal objects, always wear safety helmet, protective gloves and eye protection when changing bucket teeth.

Curl the bucket upwards and place the round rear surface of the bucket firmly on the ground. Place wooden blocks under front of bucket. Shut the engine off and lock out the hydraulic controls before working on the bucket.

Inspect locking pin assembly and replace it if the following conditions exist;

1. The locking pin is too short when both surfaces are aligned.
2. The rubber has been torn and bosses of the steel balls are liable to slip off.
3. Pressing steel ball causes the boss to go inside.

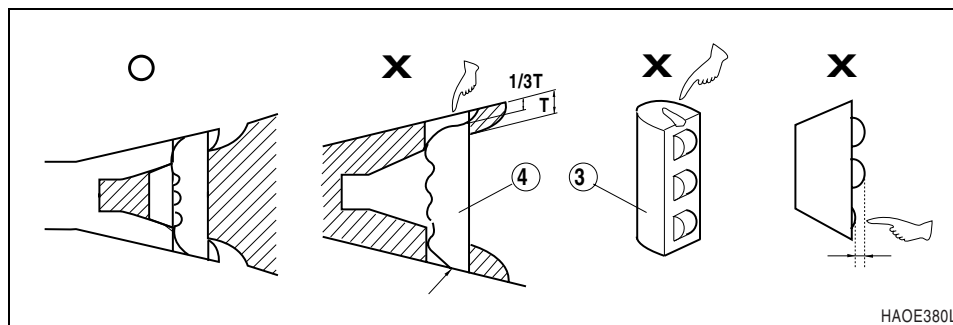


Figure 6

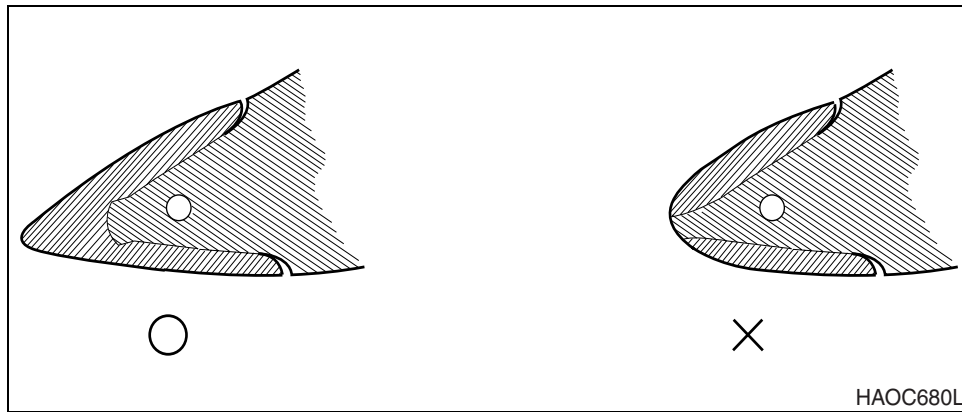


Figure 7

1. On a routine basis, inspect bucket teeth to make sure that tooth wear or breakage has not developed. Do not allow replaceable bucket teeth to wear down to a point that bucket adapter is exposed. See Figure 7.
2. To replace a tooth, use a hammer (1, Figure 8) and punch (2) to drive locking pin assembly out of tooth and tooth adapter.
3. Once the worn tooth has been removed, use a putty knife to scrape adapter as clean as possible.
4. Slide new tooth into position and insert locking pin assembly.

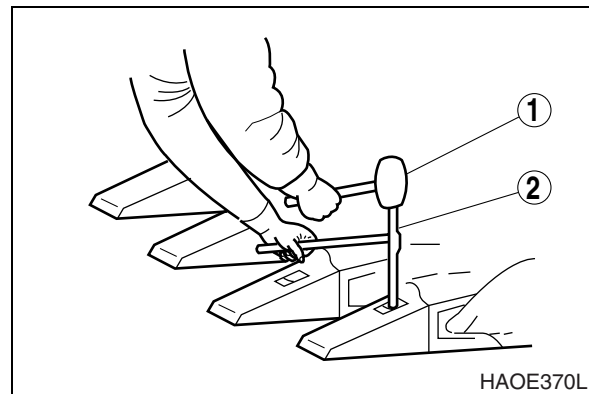


Figure 8

BUCKET O-RING REPLACEMENT

TYPE 1



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.

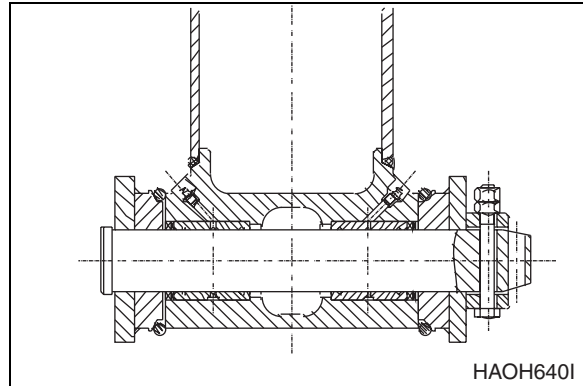


Figure 9

2. Roll the old O-ring (1, Figure 10) onto the boss (2) around the bucket pin (3). Remove the bucket pin and move the arm or bucket link (4) out of the way.

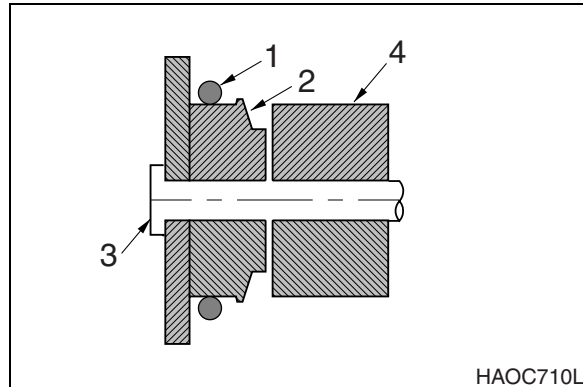


Figure 10

3. Remove the old O-ring and temporarily install the new O-ring (1, Figure 11) onto the bucket boss (2). Make sure that the O-ring groove on both the bucket link (4) and boss have been cleaned.
4. Realign the arm or link with the bucket pin hole and insert the bucket pin (3, Figure 10).

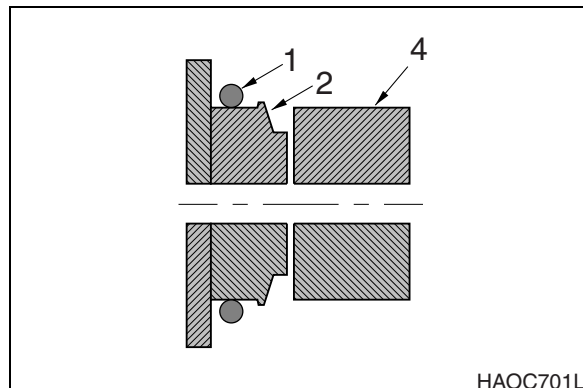


Figure 11

5. Roll the new O-ring (1, Figure 12) into the O-ring groove.

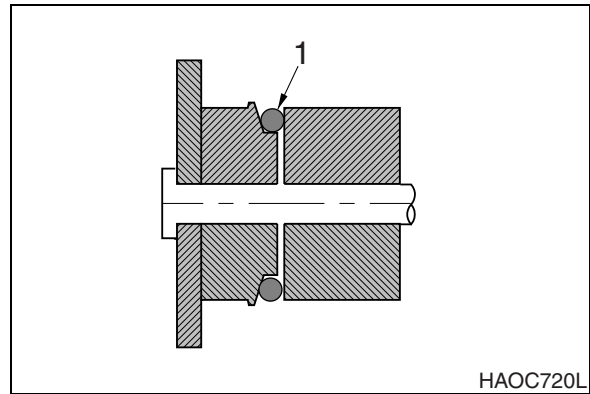


Figure 12

TYPE 2



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.

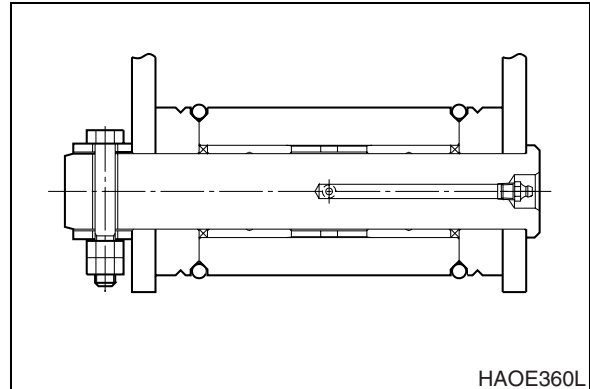


Figure 13

2. Roll the old O-ring (1, Figure 10) onto the bushing (2) around the bucket pin (3). Remove the bucket pin and move the arm or bucket link (4) out of the way.

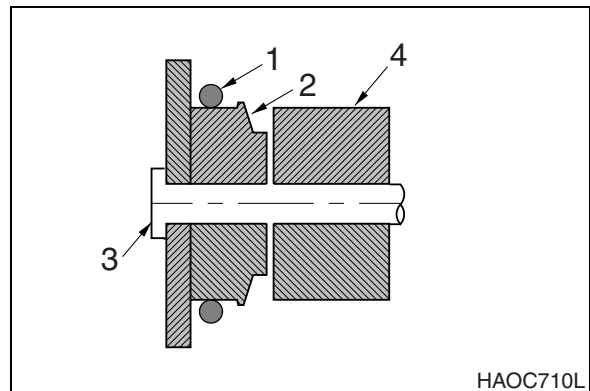


Figure 14

3. Remove the old O-ring and temporarily install the new O-ring (1, Figure 11) onto the bucket bushing (2). Make sure that the O-ring groove on both the bucket link (3) and bushing have been cleaned.
4. Realign the arm or link with the bucket pin hole and insert the bucket pin (3, Figure 10).

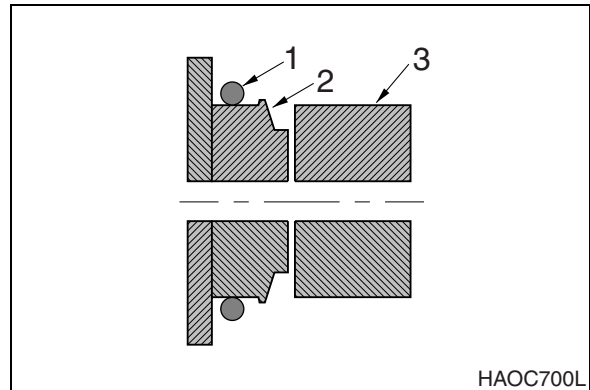


Figure 15

5. Roll the new O-ring (1, Figure 12) into the O-ring groove.

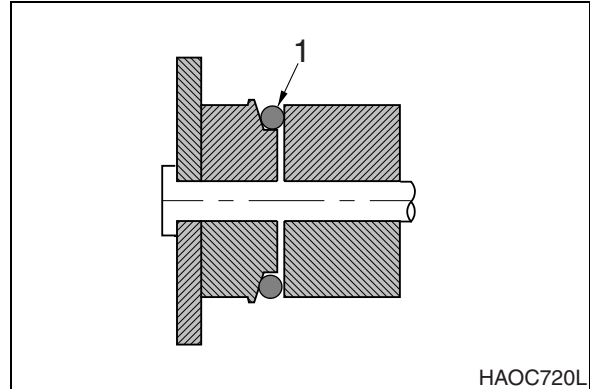


Figure 16

BUCKET SHIMMING PROCEDURES

NEW BUCKET INSTALLATION

1. If a new bucket is being installed on the excavator, measure the inside dimension between the bucket ears and the outside dimension across the arm mounting boss.
2. Subtract the clearance on both sides from the difference of the two and shim accordingly, prior to assembly.



WARNING!

To check end play (side-to-side) clearance at bucket attachment point, the bucket must be free to move but at all other times lower it to the ground or use support blocks to immobilize this assembly. Shut off engine and tag and lock out controls to prevent movement during this procedure.

TYPE 1

Shimming Procedures for Installed Bucket

1. With bucket attached, curl bucket and arm outward and lower boom so that bucket teeth are pointing away from excavator, just a few inches off ground. This position provides easy accessibility for dimensional measurements.
2. Force bucket to one side and check for end play (side-to-side) clearance under O-rings at attachment point. Total clearance should be 1 mm (0.04 in) between side face of boss and inside edge of ear bushing (Y, Figure 17). Too tight a fit (less than 1 mm (0.04 in)) can cause excessive wear while too much clearance may produce excessive noise and potentially hazardous slack control.
3. Recheck end play by forcing bucket towards opposite side and repeating clearance measurements.
4. If an adjustment is required, remove two jam nuts (1, Figure 17) and bolt (2) from pin (3). Add or remove shims (4) as required. Use equal amount of shims on each side. Install bolt (2) and two jam nuts (1). Jam nuts must clear boss by 1 - 2 mm (0.04 - 0.08 in) at point (X).

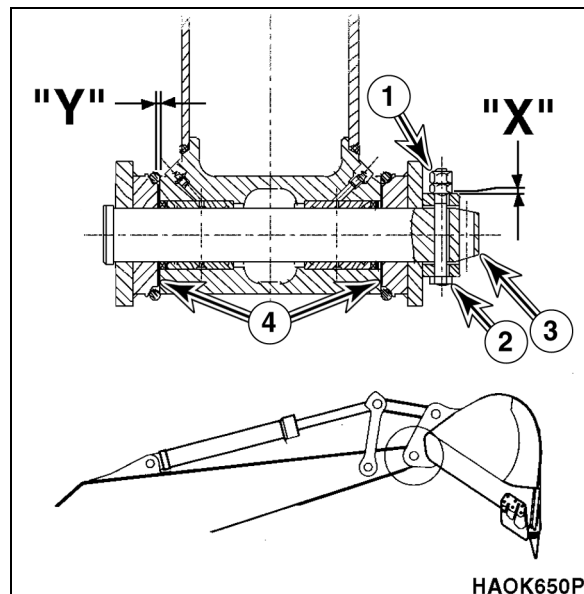


Figure 17

TYPE 2

Shimming Procedures for Installed Bucket

1. With bucket attached, curl bucket and arm outward and lower boom so that bucket teeth are pointing away from excavator, just a few inches off ground. This position provides easy accessibility for dimensional measurements.
2. Force bucket to one side and check for end play (side-to-side) clearance under O-rings at attachment point. Clearance should be between 0.2 - 0.7 mm (0.0078 - 0.0275 in) on each end of arm boss, between side face of boss and inside edge of ear bushing. Too tight a fit can cause excessive wear while too much clearance may produce excessive noise and potentially hazardous slack control.
3. Recheck end play by forcing bucket towards opposite side and repeating clearance measurements.
4. If an adjustment is required, remove bolt (Figure 17) and pin. Add or remove shims as required. Install pin and bolt. Torque bolts to 42 N•m / 4.3 kg•m (31 ft lb).

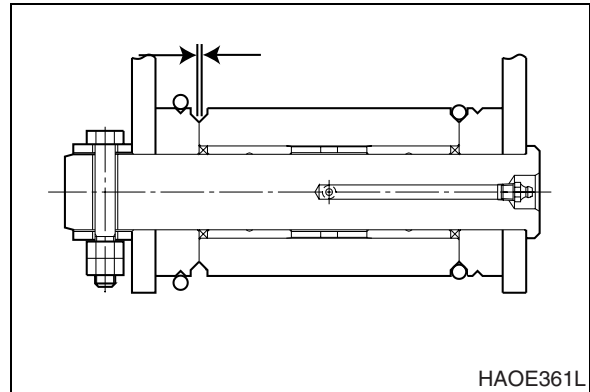


Figure 18

BUCKET ATTACHMENT, REMOVAL AND REVERSAL

DETACHING THE BUCKET

Park the excavator away from obstructions on clear, flat, level ground. Lower the bucket carefully to pre-assembled blocking on the ground. Brace the bucket so that there is no load weight on the pin connecting the bucket and arm. Disassemble the fasteners on the end of the bucket pin and pull out the pin.

If the pin sticks and resists normal withdrawal, there may be a load on it. Raise and lower the arm slightly until the unstressed pin position is located.



CAUTION!

Use care pulling out the pin to avoid damaging the dust seals on either end of the arm.

When the pin has been withdrawn, move the operating joystick slightly to take weight off the remaining link pin. Disassemble the link pin end retainers and pull out the pin.

Lift the arm away from the bucket so that the bucket can be carried away or another end attachment can be put on the excavator.

ATTACHING THE BUCKET

Carefully inspect all parts before reassembling the bucket linkage. Look for cracks or any other evidence of physical damage and replace any seal or O-ring that is not in like-new condition. Pre-lube linkage pins before assembly.

Use an old cylinder rod, a long breaker bar or a similar, relatively thin diameter support bar for making the first (temporary) pin connection, between the bucket and arm. If the support bar is straight, the arm can be raised and the bucket will hang level, allowing direct insertion of the bucket ear-attachment linkage pin.

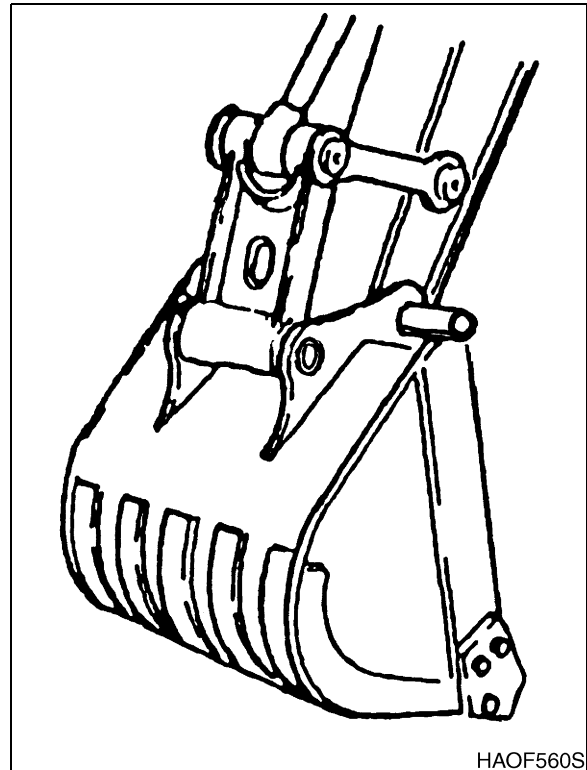


Figure 19

When the link pin has been installed, withdraw the temporary support rod from the bucket pin holes, lower and raise the arm and boom and install the bucket pin.



WARNING!

When making linkage alignments, never insert fingers into pin holes. The attachment or bucket could shift position and cause a severe injury. Match holes by visually lining them up. Use the sharp tipped, soft point of a pencil or a similar tool to check for high spots or irregularities.

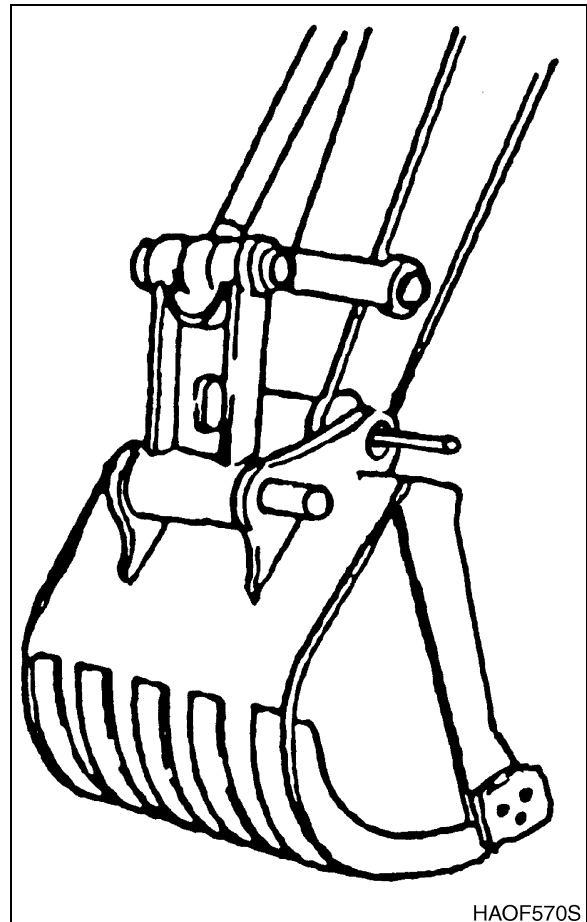
REVERSING THE BUCKET

Follow instructions for "Detaching the Bucket" and remove both the bucket and link pins. Rotate the bucket 180° to change bucket configuration. This procedure is greatly simplified if some type of rotating or swiveling support can be used, on the ground underneath the bucket. Follow instructions for "Bucket Attachment" to replace pins.



WARNING!

Bucket curl and dump levers must be used in opposite directions, after the bucket has been reversed.



HAOF570S

Figure 20

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 DAEWOO SERVICE REPRESENTATIVE: YES NO	
IF YES - WHO:	
(It is advised to discuss this with a Daewoo service representative to ensure that the above correction is appropriate and valid.)	

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