HYDRAULICS

DAEWOO
DAEWOO HEAVY INDUSTRIES & MACHINERY LTD.

HYDRAULIC SYSTEM TROUBLESHOOTING, TESTING AND ADJUSTMENT

⚠ CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

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

November 2001

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HYDRAULIC SYSTEM - GENERAL NOTES

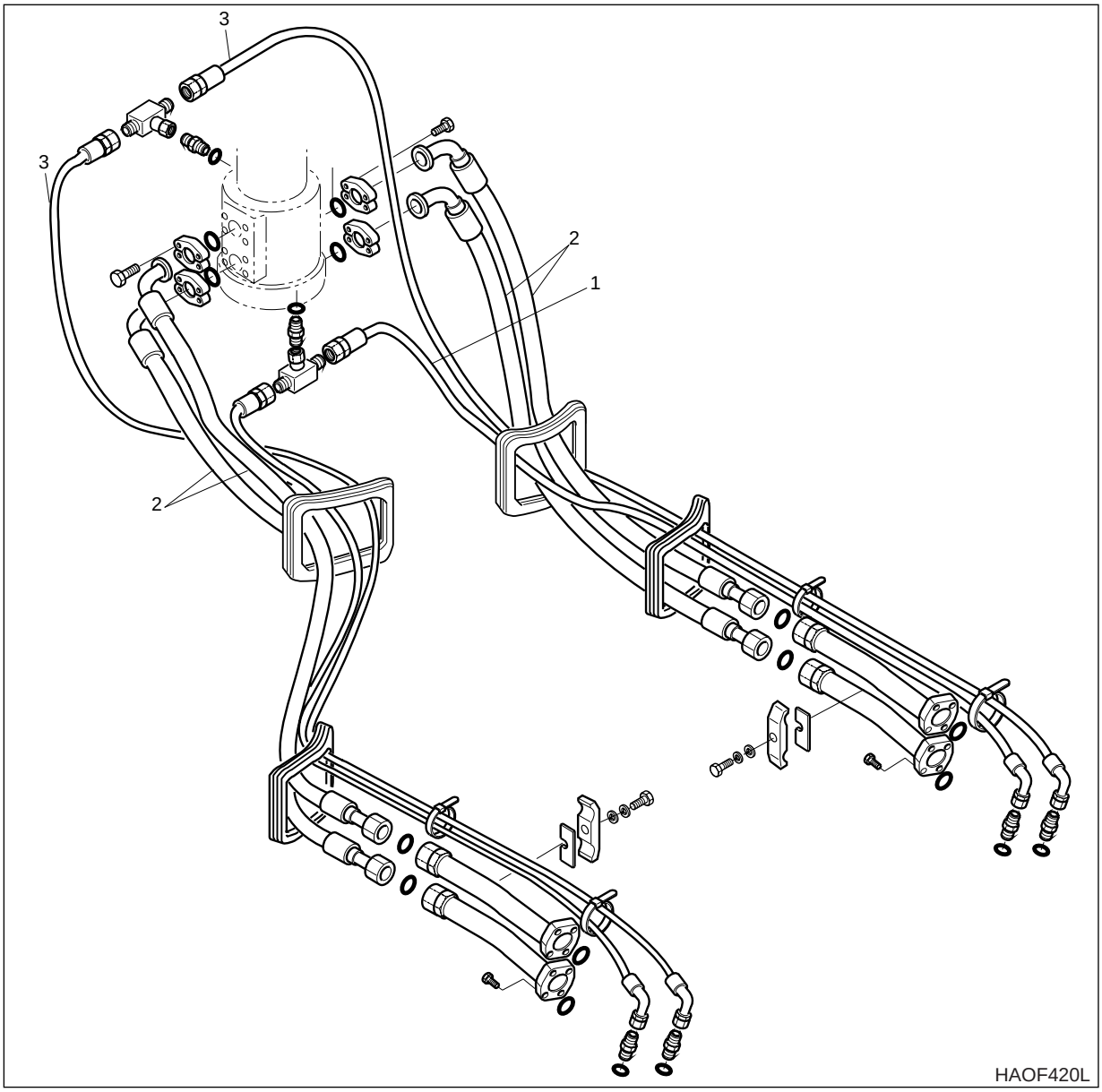

Figure 1 Pattern of Drawing (Solar 470LC-V)

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

The system features an electronically controlled output optimization system, which allows the operator to choose between three, distinctly different power modes: high-output/rapid cycling maximum-speed power mode, low fuel consumption/low-noise light duty power mode, and a standard power mode for most types of general operation offering some of the advantages of each of the other two power modes.

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 Electrcial Schematic Shop Manual." This manual is a collection of diagrams and schematics for a number of models.

GENERAL NOTES

When refering to the schematic, refer to the following items:

- As shown in the schematic, the main pump assembly is driven by the engine. Mechanical energy is converted to hydraulic power, generating the required hydraulic flow which drives the system. Two main pumps (a right side pump and a left side pump) make up the main pump assembly.
- Hydraulic output from the right side pump is transmitted to the right side of the control valve. Output from the left side pump is transmitted to the valve spools on the left side of the control valve. Hydraulic output from the pilot pump is used to control the pump and to operate pilot and solenoid valves.
- The right half of the hydraulic control valve, supplied by the right pump in the pump assembly, operates valve spools for right travel, swing, boom2, and arm1 functions. The amount of oil flow to the actuators at the output end of each of those circuits is regulated through the movement of each individual valve spool.
- The left half of the hydraulic control valve, fed by the left pump in the pump assembly, has control spools for left travel, bucket, boom1 and arm2 operation.
- Two-stage operation is a feature of boom and arm function. All of these circuits can be operated using the output of only one half of the hydraulic pump assembly (one pump or the other), or – since both halves of the control valve have a spool and available circuit for these functions – the output of both pumps can be combined, allowing higher speed operation. Boom up, arm crowd and dumping functions can operate in any one of the two available power modes – the standard or general duty mode, the high speed/rapid cycling mode.
- Whenever the right travel or left travel control spools are shifted, output from the main pump assembly passes through the center joint to one or both of the axial piston motors driving the side frame crawler tracks. A pilot valve connected to the swash plate of each travel motor changes motor capacity (and output) in direct proportion to the position of the travel switch selected by the operator.
- The hydraulic reservoir return line and the pilot circuit both have 10 micron full flow filters. The disposable elements in these two canister-type filters trap and remove impurities from the oil in the system. An 80 mesh, 177 micron reservoir intake strainer also helps maintain system cleanliness and should be cleaned each time hydraulic fluid is drained and replaced. An oil cooler in the hydraulic system helps maintain the operating temperature of the system at approximately 50°C (122°F).
- The arm cylinder operating circuit includes anti-vacuum valves which protect the hydraulic system from vacuum that could result from external shocks or other unusual conditions. Boom, Arm, and Bucket cylinder circuit are also protected by overload relief valves. Whenever high pressure is generated as a result of a shock or overload, excess pressure is dumped to the reservoir return circuit through the relief valve.
- A selection valve in the travel circuit can be used to provide constant high torque/low speed travel, or variable speed/variable torque output for travel. To prevent sliding during simultaneous travel and boom/arm/bucket operation, select the high torque/low speed travel position.

OPERATION OF WORKING COMPONENTS

BOOM OPERATING CIRCUIT

The boom operating circuit includes the right and left main hydraulic pumps (both halves of the main pump assembly), both sides of the control valve and the boom cylinder. The circuit operates in boom down mode through the first shift position and through the second shift position in boom up mode. Overload relief valves set at 360 kg/cm^2. (5,112 psi) protect the hydraulic system from damage as a result of overloads or shocks to the boom. Additional protection - to prevent cavitation of the cylinder - is provided by a make-up valve and reservoir return circuit, which ensures that the volume of oil going to the cylinder will not exceed the volume of oil coming out.

BOOM UP CIRCUIT

When you pull the boom control lever backward, the right side pilot valve generates secondary boom up pilot pressure that is transmitted to the BOOM1 and BOOM2 spools of the control valve simultaneously. When secondary pilot pressure reaches 7 - 10 kg/cm^2 (100 - 142 psi), boom spools open and oil from both pumps goes to the boom cylinder.

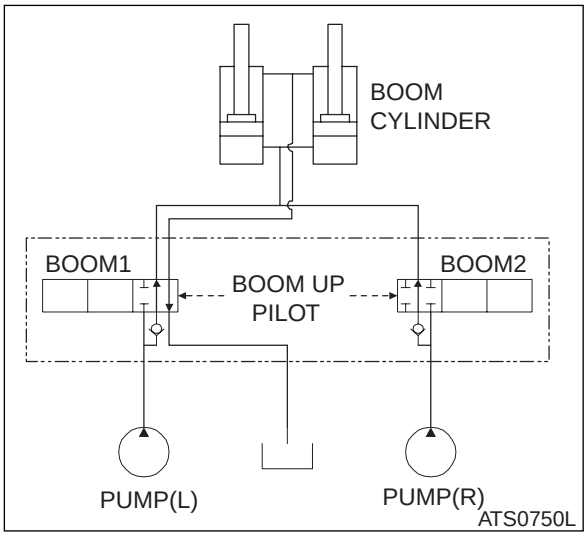

Figure 2

BOOM DOWN CIRCUIT

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

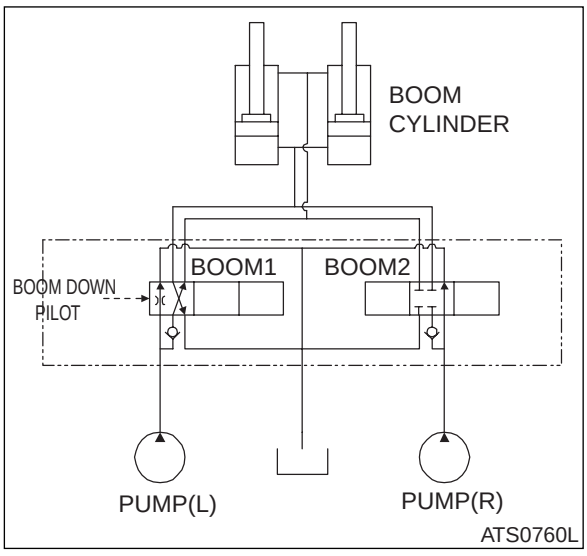

Figure 3

ARM OPERATING CIRCUIT

The arm operating circuit includes both the right and left hydraulic main pumps, the both sides of the control valve, arm regen. valve, and the arm cylinder. The circuit can be operated in the two-stage speed control mode which works through both halves of the control valve and doubles the volume of oil flowing to the cylinder.

Overload relief valves set at 360 kg/cm^2 (5,112 psi) have been installed at the crowd and dump cylinder ports on ARM1 side of the control valve to protect the circuit and system components from possible damage caused by shocks or overload pressure. additional protection - to prevent cavitation of the cylinder - is provided by a make-up valve and reservoir return circuit, which ensures that the volume of oil going to the cylinder will not exceed the volume of oil coming out.

ARM CROWD CIRCUIT

When the arm control lever is put in the crowd mode, the left side pilot valve generates secondary pressure that is transmitted to the ARM1 and ARM2 of the control valve simultaneously.

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

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

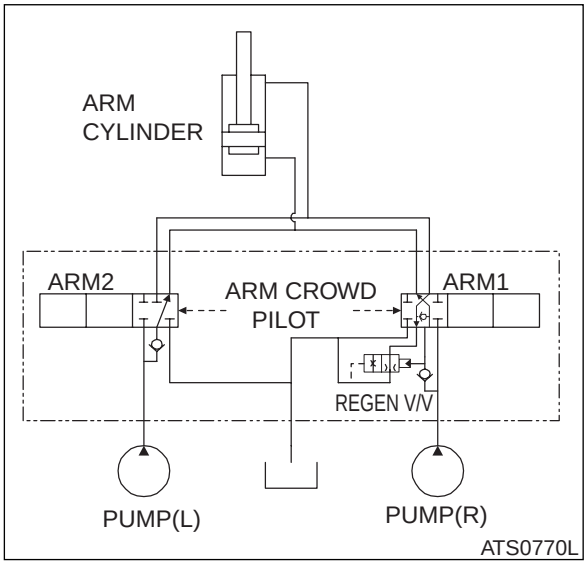

Figure 4

ARM DUMP CIRCUIT

When the arm control lever is put in "dump" mode, the left side pilot valve generates secondary pilot pressure that goes to both ARM1 and ARM2 the control valve simultaneously.

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

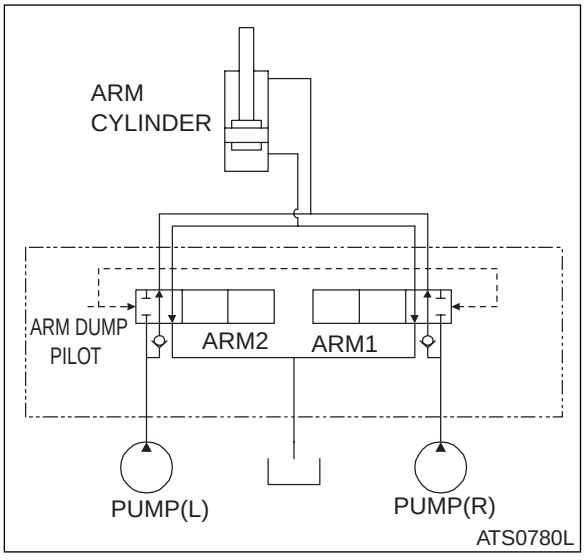

Figure 5

BUCKET OPERATING CIRCUIT

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

BUCKET CROWD CIRCUIT

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

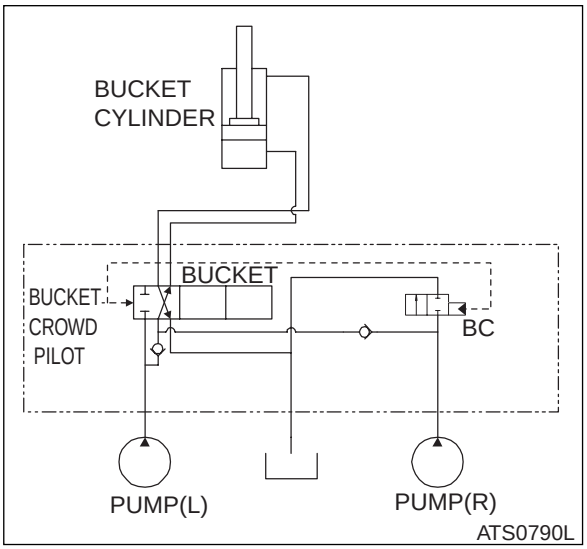

Figure 6

BUCKET DUMP CIRCUIT

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

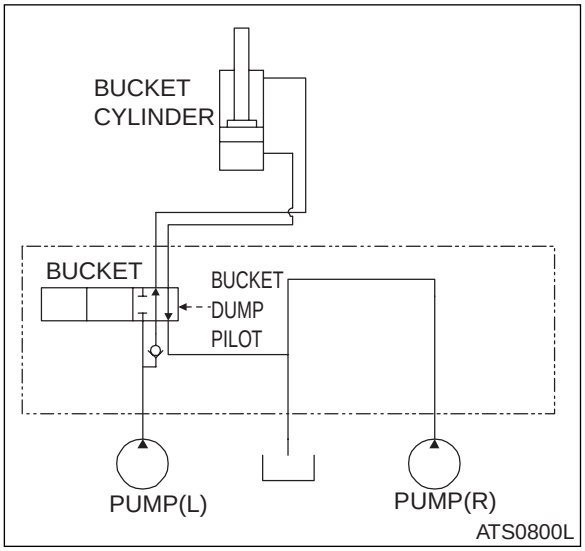

Figure 7

SWING OPERATING CIRCUIT

The swing operating circuit consists of the right main pump in the pump assembly, the right half of the control valve and the swing motor. To keep the upper works from coasting when the swing control is in neutral, an electrical sensor in the control circuit activates a valve to automatically engage a mechanical brake.

RIGHT SWING OPERATING CIRCUIT

When the swing control lever is pushed to the right swing position, pilot pressure from the left side pilot valve is directed to SWING spool of the control valve. Output flow from PUMP(R) is goes to the swing motor.

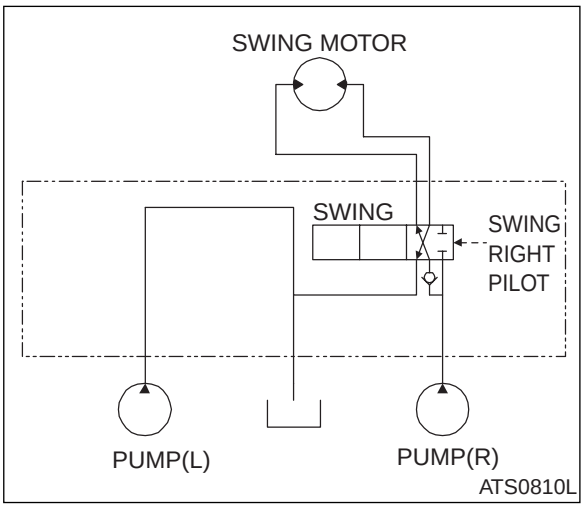

Figure 8

LEFT SWING OPERATING CIRCUIT

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

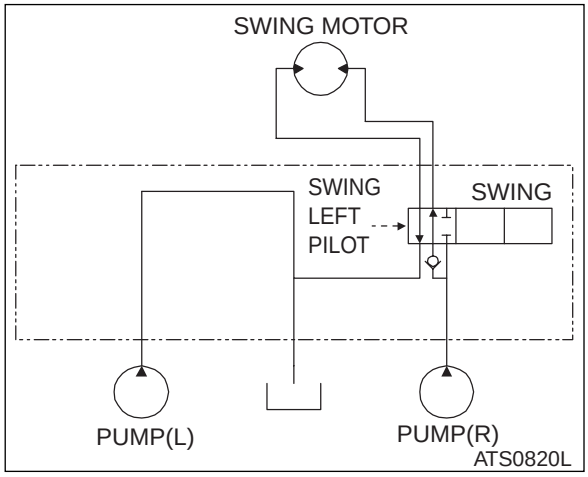

Figure 9

SWING RELIEF VALVE AND MAKE-UP VALVE

Whenever the spool is shifted to the neutral mode during swing operation, the possibility exists that surge pressure in the circuit - caused by inertial momentum of the upper works and correspondingly reduced pressure at the opposite motor port - could produce cavitation in the circuit. To keep that from happening, a relief valve is installed in the swing motor and a large-capacity make-up valve is connected to the entrance port of the hydraulic reservoir, helping maintain acceptable pressures on both sides of the circuit.

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

TRAVEL OPERATING CIRCUIT

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

FORWARD TRAVEL CIRCUIT

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

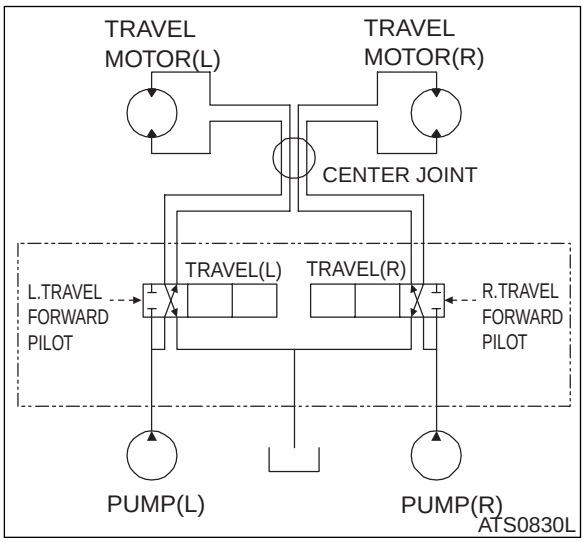

Figure 10

REVERSE TRAVEL CIRCUIT

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

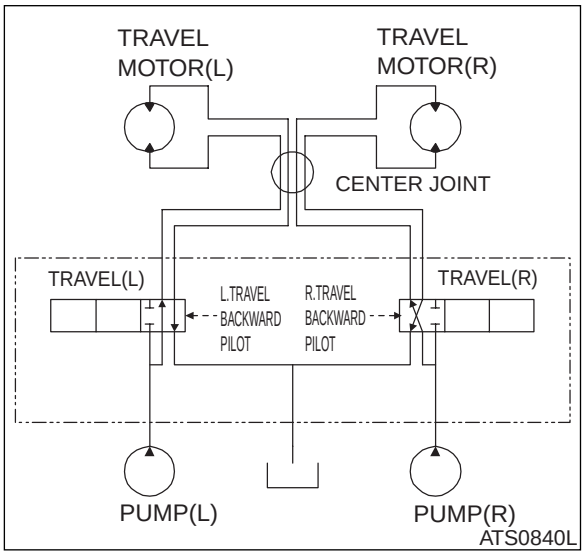

Figure 11

PROCEDURAL TROUBLESHOOTING BASELINE RECOMMENDATIONS

INITIAL CHECKS AND TESTS TO ESTABLISH OPERATING CONDITION OF THE EXCAVATOR

Triage Summary

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

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

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

Check engine operation -

- at 2,150 RPM with no load
- at 2,000 RPM stall load

If engine RPM drops excessively with a load or fails to surpass rated speed (1,900 RPM), performance problems may be due to inadequate hydraulic flow caused by lagging rotational speed.

NOTE: *Verify actual flow on the excavator against rated performance, with a flow meter.*

If engine tests meet specifications and adequate torque and horsepower are available at the pump drive flex coupling, pull out the electrical tray under the operator's seat to inspect the self-diagnostic display.

If the EPOS trouble code display is clear, check hydraulic functions in the following sequence:

- Pilot pressure
- Negacon, negative control pressure
- Main relief pressure (front and rear pump)
- Swing pressure
- Port relief pressure (individual control functions; crowd, bucket, boom, travel)
- Power boost circuit
- Standard performance tests; cylinder speed, hydraulic motor (travel and swing) speed, cylinder oil-tightness "permissible drift" test

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

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

PILOT PRESSURE

ADJUSTMENT AND TESTING

⚠ WARNING!

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

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

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

If gear pump pressure is outside the tolerance specified in the table, adjust gear pump relief pressure by loosening the lock nut and turning the set screw in (clockwise) to increase pressure, or turning it out to decrease it.

NOTE: *Be aware that serial number changes and variation in the joystick assemblies used on different excavators could produce slight change in actual performance characteristics. Comparison of part numbers to serial numbers stamped on your assembly may be required, if questions or doubt exists.*

IMPORTANT

Top off the hydraulic fluid reservoir if there is any measurable loss of hydraulic oil during test gauge and adapter fitting installation.

Engine RPM	Pilot Pressure @ Pump	Pilot Pressure - Joystick
Minimum Speed Setting (full left) on Speed Control Dial	40 ±5 bar (580 ±73 psi)	40 ±5 bar (580 ±73 psi)

POWER MODE VALVE

CURRENT SIGNAL AND HYDRAULIC PRESSURE ADJUSTMENTS

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

The electromagnetic pressure proportioning control (EPPR) "power mode" valve is located on the underside of the pumps (not visible in the harness connections drawing, because it is underneath the assembly), near the engine/pump flexible coupling, adjacent to the pump return line. To test and adjust power shift current and pressure through the power mode valve a multi-lead jumper harness is required. The jumper harness (which is available through Daewoo After Sales Service, or could be spliced together from commonly available, purchased parts) has extra leads so that a VOM meter can be connected to the circuit.

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

Vent the lever on top of the hydraulic tank to relieve pressure and connect an in-line "t-style" adapter to the valve pressure port. Install a 60 bar/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 on the Instrument Panel. Check current readings (in milliamps) on the VOM meter and hydraulic pressure gauge readings and make sure both conform to the values in the table below.

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

Mode	Engine RPM	Current	Pressure
Power Mode	High Idle: 2,150 RPM	600 ±20 mA	1.5 bar (22 psi)
Standard Mode	High Idle 2,150 RPM	0 mA	18 bar (261 psi)

BOOM/FRONT PRIORITY VALVE

CONTROL VALVE PRESSURE AND CURRENT ADJUSTMENTS

⚠ WARNING!

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

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

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

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

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

VALVE FUNCTION	DIGGING MODE		TRENCHING MODE	
	VOLTAGE	PRESSURE	VOLTAGE	PRESSURE
Front Priority	0 V	40 bar (580 psi)	20 - 30 V	0 bar (0 psi)

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

PRESSURE UP VALVE

CHECKS AND ADJUSTMENTS

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

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

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

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

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

If the 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 320 bars (4,641 psi), but less than 325 bars (4,714 psi).

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

Power Mode	Operation	Main Pressure and Tolerance	Pilot Pressure and Tolerance
Mode	Neutral, No Operation	20 - 40 bar (290 - 580 psi)	30 bar + 10 bar (435 psi + 145 psi)
Mode	Cylinder Stall	320 bar + 5 bar (4,641 psi + 75 psi)	30 bar + 10 bar (435 psi + 145 psi)
Mode W/ pressure Up	Cylinder Stall	350 bar + 10 bar 5,075 psi + 145 psi	30 bar + 10 bar (435 psi + 145 psi)

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

PUMP INPUT POWER CONTROL

PUMP REGULATOR ADJUSTMENT

⚠ WARNING!

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

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

IMPORTANT

Before starting this procedure or going on to make any changes of adjustment settings,

- **Verify engine output to the rated speed - 2,150 ±50 RPM.**
- **Permanently mark setscrew positions at the current regulator control setting.**

Use a scribe or other permanent marker to identify a reference point on adjusting screws with a corresponding reference on the body of the valve. The adjustment process affects a complex balance and could require some time to complete. If adjustment has to be interrupted or postponed, reference marks at the adjustment point allow immediate restoration of original performance.

This adjustment procedure is normally performed:

- If the engine is being consistently overloaded (and engine troubleshooting shows engine performance to be at or above rated output);
- If reduced cylinder speed and diminished work performance provide an indication that rated, maximum pump flow may not be available (and all other troubleshooting gives no indication of other flaws or hydraulic system defects);
- If pump output is out of balance and one pump is failing to keep up with the output flow of the other.

To check pump imbalance without a flow meter, travel the excavator forward on flat, level terrain. If the machine veers off despite neutral control input and even, balanced track adjustment, the pump which supplies output to the track frame toward which the excavator is veering is weak.

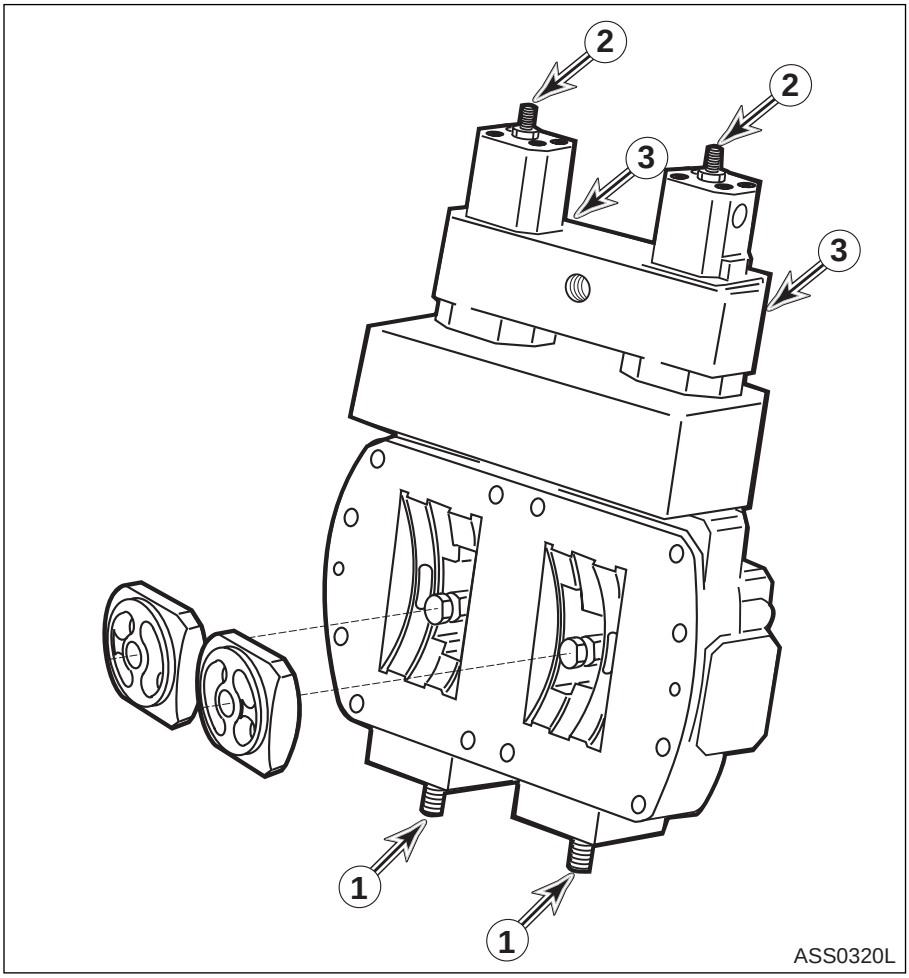

Figure 12

Refer to the illustration of the pump regulator control valve (Figure 12) for the location of adjustment screws (1, 2 and 3). There are three different adjustments, Qmax, Pd-Q, adjustment screws (1, 2 and 3). Each one of the adjustment procedures could affect the setting of the others.

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

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

Start the engine and turn the engine speed dial to maximum. When normal operating temperature is reached, adjust screw 2 clockwise to shft the Pi-Q control valve curve decrease componsating control pressure.

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

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

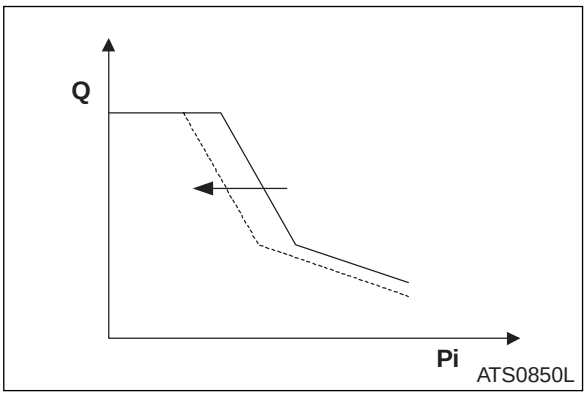

Figure 13

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

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

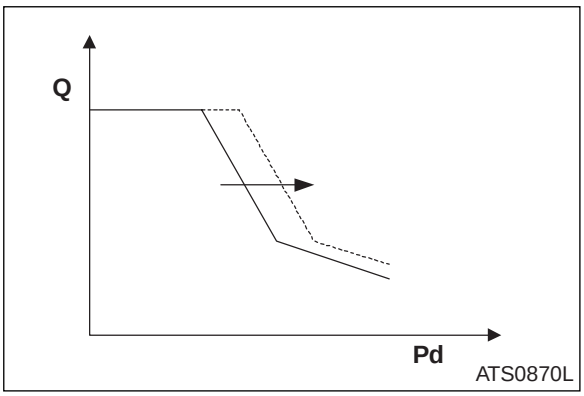

Figure 14

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

Balance both pumps for equal output.

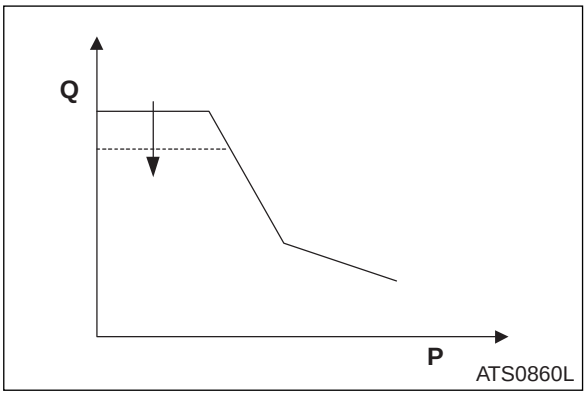

Figure 15

FLOW METER AND FLOW METER KIT INSTALLATION AND TESTING

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

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

Installation and Testing Procedure

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

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

- An assistant - who must remain at the operator's control station at all times - should restart the engine and run it long enough (at minimum RPM) to de-aerate the system and warm up the engine and hydraulic system to operating temperature.

Record the values of all test results in three columns, comparing 1) pump pressure (from the instrument panel display) with 2) measured flow, in gallons or liters per minute, from the installed flow.

meter. The third column of test results should provide a record of engine RPM measured during each of the following tests - with the engine speed control dial set at maximum, the power mode selector at Power Mode III and the work mode selector at digging mode:

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

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

Engine RPM	Pressure	Flow
	100 kg/sq cm (1,422 psi)	
	135 kg/sq cm (1,930 psi)	
	180 kg/sq cm (2,560 psi)	
	240 kg/sq cm (3,413 psi)	
	320 kg/sq cm (4,550 psi)*	
	*See Note, below	

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

If test results do not measure up to specified values, pump output tests can be repeated using different control levers. Recheck front pump operation while stroking the bucket cylinder out lever, and the rear pump by actuating the swing control lever.

NOTE: *When testing bucket and swing functions, read maximum flow tests at 320 kg/cm^2 (4,550 psi), not 350.0 kg/cm^2 (4,978 psi).*

SWING SYSTEM TROUBLESHOOTING

PRECAUTIONS/INITIAL CHECKS

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

⚠ WARNING

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

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

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

- Check oil level.
- Check for overheating, oil leaks, external oil cooler clogging or broken fan belt. Consult service record for prior repair/service work.
- Drain some tank oil to a clean, clear container. Look for metal shavings/grit, cloudiness/water or foam/air bubbles in the oil.
- Check for wobble through the engine/pump flex coupling. Run engine with the pump input hydraulic power control nut turned to the lowest power to check the engine.
- Investigate unusual operating noises or vibration. Check for loose bolts, connections.

SWING RELIEF VALVE CHECKING AND ADJUSTMENT

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

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

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

      Pressure should be between 270 - 280 bar (3,916 - 4,061 psi), with both swing locks engaged. With swing locks released, during full acceleration and deceleration, pressure should approach 250 bar (3,625 psi) in each direction.

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

      Pressure should always stay at or above 4 bar (58 psi) when operating swing, boom or arm.

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

Pressure should stay consistently above 2.5 bar (36 psi). If pressure falls below the recommended minimum level, forceful acceleration of the swing motor could lead to cavitation of the circuit and stalling, slowed rotation, noise and possible damage.

2. If main inlet and outlet pressures were off in the preceding tests in Step 1, adjust swing relief valve pressure.

   Following adjustment, repeat the operating pressure tests (with gauges connected to the inlet and outlet test ports on top of the swing motor) and check pressures with the swing locks engaged and released.

   If pressure adjustment fails to restore adequate performance, proceed to the Troubleshooting - Swing table.

3. If pressure tests were at recommended levels through the main inlet and outlet ports, and through the "SH" port of the swing brake, the causes of poor swing performance could include a faulty swing motor, drive train overloading or gearbox defect, or a problem in the brake assembly or swing control valve. Proceed to the troubleshooting information in the next procedure.

   If pressure through the "SH" port was tested below the minimum 4 bar (58 psi) level, check the shuttle valve in the rear compartment behind cabin. When pressure through the port is at the recommended level, the brake release valve should disengage the swing brake, allowing the swing motor to rotate the excavator. If pressure adjustment to the valve has been restored but the brake still fails to release, the brake piston or friction plate may be frozen, requiring disassembly of the motor and parts repair/ replacement.

4. If pressure tested at the motor makeup valve falls below recommended minimum level, and consequent problems with cavitation, stalling and surging are observed, check the restriction valve. If pressure adjustment to the valve has been restored but if problems with cavitation continues, disassemble the upper swing motor housing and clean or replace assembly components as required.

   NOTE: *If all tested pressures are at or above recommended levels, and there are no mechanical problems in the drive train or in the motor/brake assembly, the problem will require further hydraulic troubleshooting. It's also possible that a defective joystick, an intermittent short in an electrical control circuit or a problem in the e-EPOS circuit is causing diminished swing performance. 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

Problem	Possible Causes	Remedies
Sluggish performance of all hydraulic functions - attachment, swing and travel.	Main pump(s) damaged or worn	Repair or replace
	Main relief valve pressure off	Readjust pressure
	Low oil level in hydraulic system	Refill
	Hydraulic reservoir intake strainer clogged	Clean
	Pump inlet (supply side) piping or hose allowing air into hydraulic system	Tighten connection
Oil temperature abnormally high.	Oil cooler clogged or air circulation to cooler blocked	Clean
	Cooling fan belt tension too loose	Readjust belt tension
	Relief valve set too low	Readjust valve
	Relief valve in constant use	Reduce or slow work load or cycling rate
	Hydraulic oil severely neglected or incorrect for application	Replace oil
One circuit in hydraulic system inoperable.	Overload relief valve malfunction	Readjust or replace
	Oil leak at make-up valve	Clean, repair
	Control valve spool damaged	Repair or replace
	Dirt in control valve spool	Clean or replace
	Actuator (joystick, foot pedal) damaged or worn	Repair or replace
	Internal seal leak in cylinder	Repair or replace
	Cylinder rod damaged	Repair or replace
	Pilot valve or piping malfunction	Repair or replace
	Mechanical linkage frozen, loose or damaged	Repair or replace
Travel motors inoperable.	Center joint damaged.	Repair or replace.
	Parking brake not releasing.	Repair or replace.
	Travel motor worn or damaged.	Repair or replace.
	Travel motor pilot piping damaged.	Repair or replace.
Travel motors operate very slowly.	Track tension poorly adjusted Low oil in idlers or rollers.	Readjust tension Refill.
	Travel brake dragging.	Repair
	Track frame out of alignment, deformed or twisted.	Repair
Swing motor inoperable.	Swing brake not releasing.	Repair or replace
	Relief valve malfunction.	Repair or replace
	Pilot piping damaged.	Repair or replace

Problem	Possible Causes	Remedies
Swing motor operates unevenly.	Swing gear, bearing or mounting loose or worn.	Repair or replace
	Lubricant worn away, inadequate.	Grease
	Swing relief valve may be faulty.	Repair/Replace the swing relief valve.

TROUBLESHOOTING - CONTROL VALVE

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

Problem	Possible Causes	Remedies
Main Relief Valve	Particulate contamination.	Disassemble, clean main poppet.
	Broken or damaged spring.	Replace
	Adjusting screw loose.	Readjust
	Main poppet sticking.	Repair/replace
	Clogged orifice in pilot passage to control valve.	Clean/replace
Cylinder goes down in spool neutral.	Excessive clearance between casing and spool.	Replace spool or casing.
	Spool does not return to neutral/ sticking spool.	Check secondary pilot pressure.
	Spool does not return to neutral because of dirt or other contaminants.	Clean
	Broken or damaged spring.	Replace
	Main relief or port relief not operating properly.	See above
	Impurities in pilot circuit.	Clean
Cylinder drops before start at boom up operation	Rod check valve damaged or clogged.	Clean/replace
	Poppet sticking.	Clean/replace
	Broken or damaged spring	Replace
Slow operation or response	Excessive clearance between spool or casing.	Check pilot pressure and/or replace spool or casing.
	Sticking spool.	Clean/replace
	Broken or damaged spring.	Replace
	Main or port relief valve damaged.	Check pressure/replace

Problem	Possible Causes	Remedies
Swing priority not operating correctly	Sticking spool.	Clean/replace
	Solenoid valve faulty.	Replace
Boom and arm cylinders do not perform normally in combined operation	Priority valve faulty or spool sticking.	Check pilot pressure.
	Broken or deformed spring.	Replace
	Excess clearance between right and left casing and valve spool.	Clean/replace
	Clogged spool passage.	Clean/replace, replace filter.
Relief valve malfunctions:		
Pressure does not increase at all.	Main poppet or pilot poppet stuck open.	Clean/replace
Irregular or uneven pressure.	Poppet seat damaged or pilot piston sticking to main poppet.	Clean/replace
	Loose lock nut and adjusting screw.	Readjust
	Components worn out, past wear limits.	Replace

TROUBLESHOOTING - TRAVEL CONTROL VALVE

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

TROUBLESHOOTING - JOYSTICK CONTROL VALVE

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

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ACCUMULATOR

⚠ CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

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

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GENERAL DESCRIPTION

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

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

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

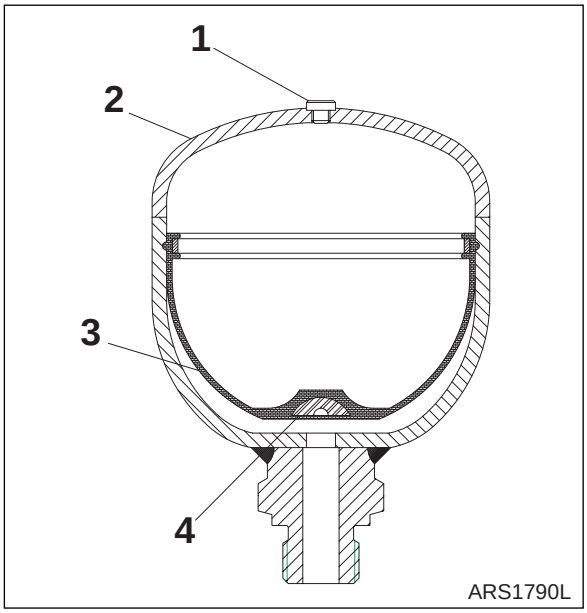

Figure 1

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

There are six possible positions the diaphragm can be in and they are as follows:

1. With no gas charge in the upper chamber 0 bar (0 psi, empty) and no oil in the bottom 0 bar (0 psi, dry) the elastic diaphragm hangs loosely.
2. When the pre-pressure charge of gas (usually nitrogen) is introduced through the port at the top of the accumulator, the diaphragm expands to maximum size. The valve button in the center of the diaphragm pushes into the fluid opening in the bottom chamber, sealing off the lower valve. If the pressure of the gas charge exceeds system oil pressure, no fluid enters the accumulator. The button also keeps the diaphragm from protruding into the lower valve opening.

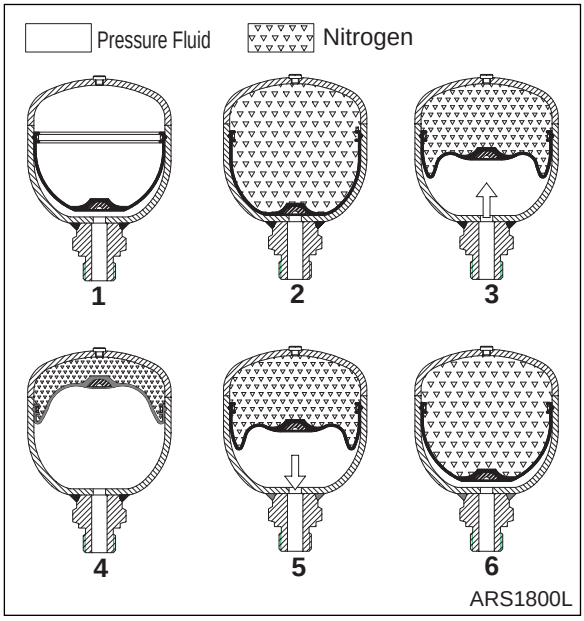

Figure 2

NOTE: *Pre-charge pressure is referred to as the "P1" pressure. The accumulator manufacturer's "P1" rated pressure should be stamped or marked on the accumulator's rating plate. Annual checks of actual pre-charge pressure should be made by tapping a hydraulic pressure gauge (and 3-way adapter coupling) into the valve on the bottom of the accumulator. When hydraulic fluid is pushed out the lower valve opening by the pressure of the gas charge on the other side of the diaphragm - and there is no counter-pressure from system oil - the valve button on the bottom of the diaphragm eventually seals off the lower oil passage. Just after the needle on the gauge reaches its highest point (when there is 0 bar (0 psi) resistance from hydraulic system pressure) pressure on the gauge will drop sharply to zero, as the accumulator is completely emptied of oil and the diaphragm button closes.*

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

3. As hydraulic system pressure overcomes accumulator pre-charge pressure, the flexible diaphragm begins to retract upward.

4. When system oil is at highest working pressure and the accumulator fills to maximum reserve capacity, the flexible diaphragm is pushed up into the top of the upper chamber.

   The highest working pressure is sometimes referred to as the "P3" pressure and can also be referenced on the manufacturer's data label on the exterior of the accumulator.

5. If system oil pressure begins to fall off or is momentarily checked or interrupted, the energy stored on the other side of the diaphragm, in the form of compressed gas, pushes oil back out of the lower chamber, maintaining oil pressure of the circuit.

6. With minimal system pressure, an equilibrium point may be reached in which accumulator pre-charge pressure and hydraulic system oil pressure achieve a rough balance. In this condition a minimal amount of oil is stored in the accumulator.

SPECIFICATIONS

Accumulator		
Model	**Nitrogen Charge**	**Volume**
Solar 300LC-V Solar 300LL Solar 340LC-V Solar 420LC-V Solar 470LC-V	10 kg/cm^2 (142 psi)	320 cc (19.5 in^3)

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CENTER JOINT (SWIVEL)

⚠ CAUTION!

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

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Use lifting and hoisting equipment capable of safely handling load.

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

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GENERAL DESCRIPTION

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

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

PARTS LIST

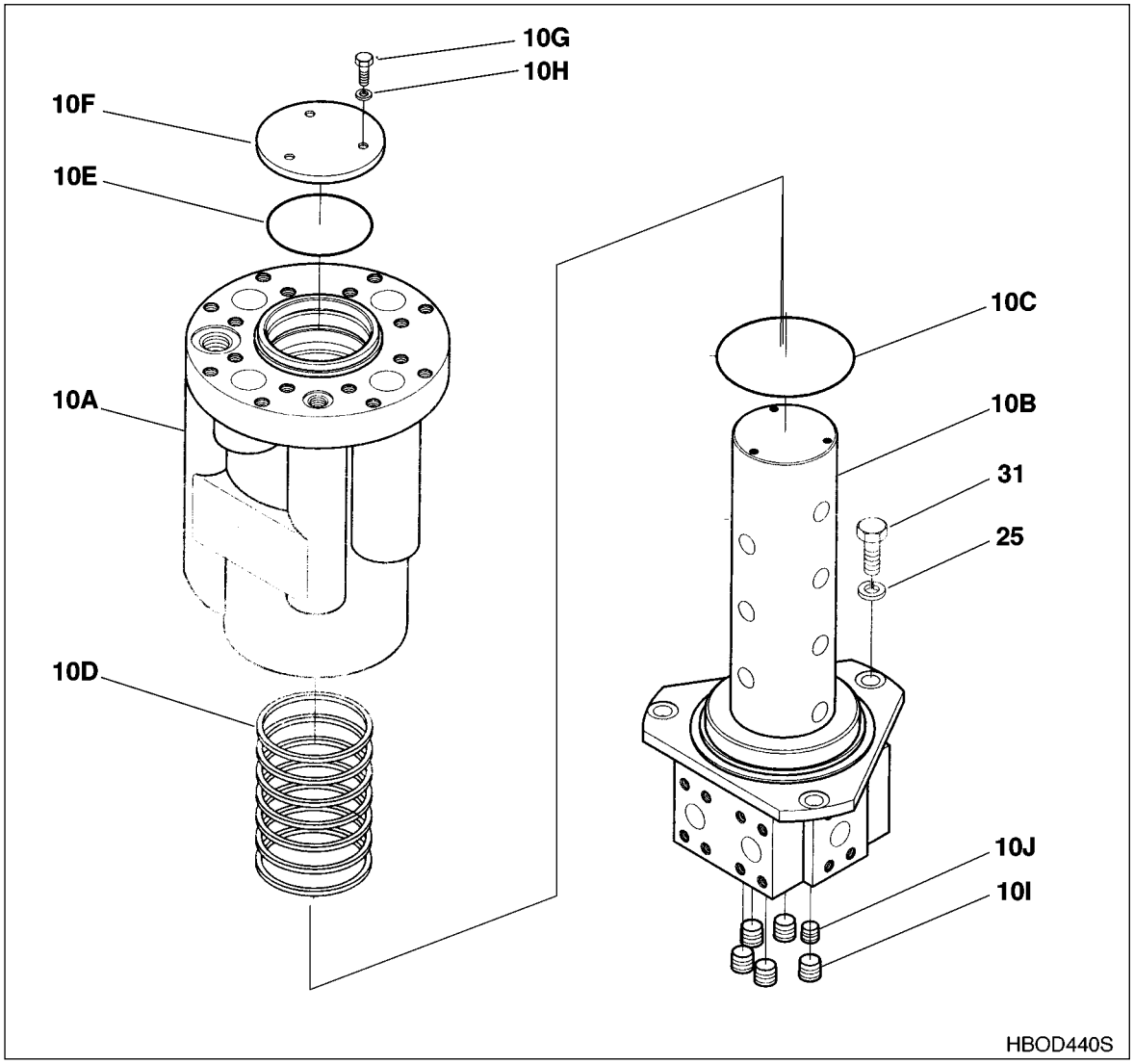

Figure 1

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

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

TROUBLESHOOTING, TESTING AND ADJUSTMENT

INSPECTION

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

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

TESTING

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

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

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

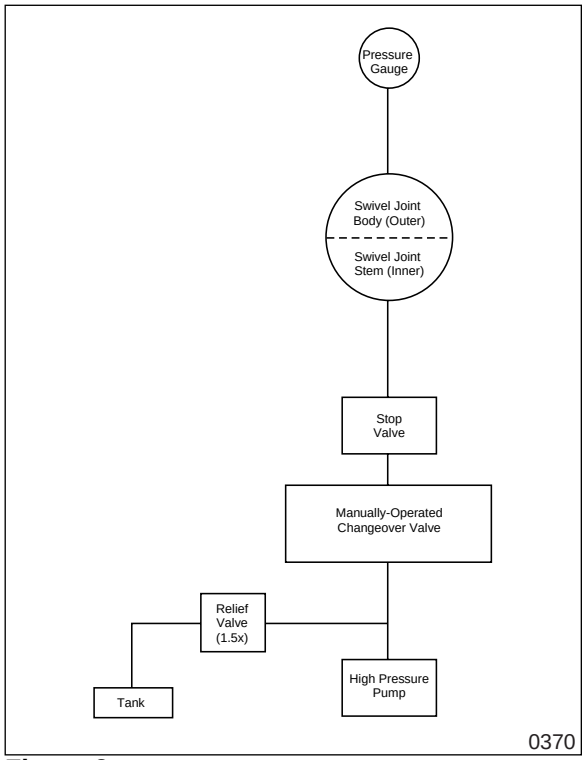

Figure 2

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).*

DISASSEMBLY

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

IMPORTANT

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

1. Clean off the exterior of the swivel joint after it has been removed.
2. Scribe or otherwise mark a line across the cover and the body of the center joint, to allow reassembly in the same configuration.
3. Unbolt the three 8 mm fasteners holding the cover. Use a vise or v-block to hold the assembly in place.
4. Remove the cover, withdraw the spindle.
5. If the spindle doesn't separate easily when cover and fastener bolts are removed, use a wooden block and hammer to drive it out of the housing.
6. O-rings and seals should be replaced whenever the assembly is being overhauled or rebuilt. For repair procedures or emergency teardown, use a thin but rounded-tip, smooth-edge scraper or spatula to remove O-rings or seals, to avoid causing damage to those that must be reused.

   NOTE: *The O-ring (10E) shown in the assembly drawing (above the swivel joint stem lower seals) should not be overlooked. It is tucked behind the top slip ring, doubled up inside the same groove in the body of the Center Joint.*
7. Before reassembling the center swivel, visually inspect ball bearing surfaces for visible signs of wear, damage or discoloration and replace any worn component.

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

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

REASSEMBLY

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

⚠ CAUTION!

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

2. Thoroughly clean all other component surfaces of dirt or grease prior to reassembly.
3. Reverse disassembly steps for reassembly.

4. Clean threads of fasteners before pre-applying Loctite #243 to the threads, and before torquing the cover bolts.
5. Pre-fill the center swivel with clean hydraulic fluid prior to reassembly of high-pressure and drain line piping. Clean and pre-fill piping line ends to reduce the amount of air in the system. Bleed air from the hydraulic system and verify hydraulic tank fluid level before returning the excavator to service.

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CYLINDERS

⚠ CAUTION!

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

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GENERAL DESCRIPTION

Two essentially similar types of hydraulic cylinders are used on the excavator. The cylinder that is used to operate the excavator boom or bucket is equipped with a rod stopper, which acts as a cushion only when the cylinder rod is fully retracted (and the bucket is pulled close to the arm). This type of cylinder is shown in the lower drawing.

Arm cylinders have a cushion or stopper for operation in both directions. This type of cylinder is shown in the upper drawing.

THEORY OF OPERATION

1.	**Piston**
2.	**Oil Path A**
3.	**Oil Path B**

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

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

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

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

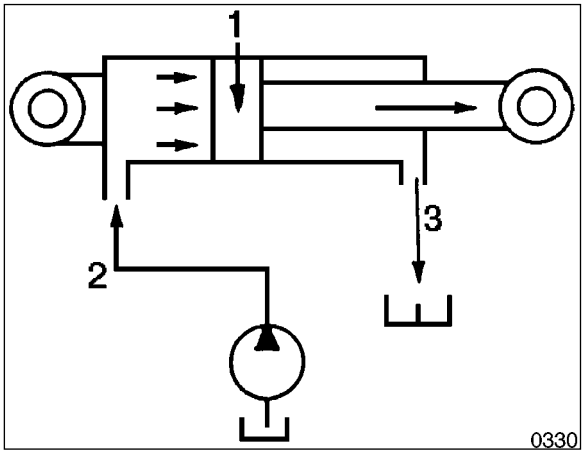

Figure 1

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

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

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

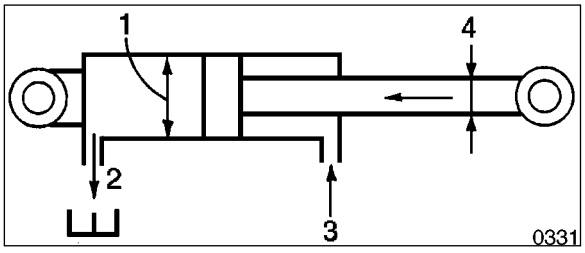

Figure 2

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

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

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

$Q_1 > Q_2$

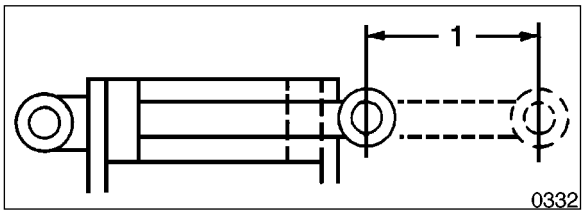

Figure 3

PARTS LIST

The following parts list is a partial listing only; for full and complete parts list information, refer to the Hydraulic Equipment Component Parts List

Cross section in Figure 4 shows an arm cylinder.

Cross section in Figure 5 shows a boom cylinder.

The bucket and boom cylinders are identical and differ only in the attached pipes.

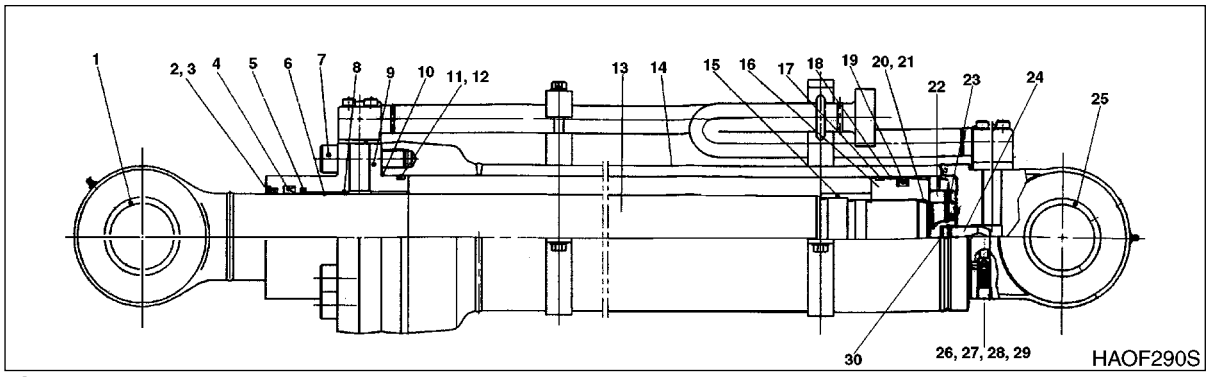

Figure 4

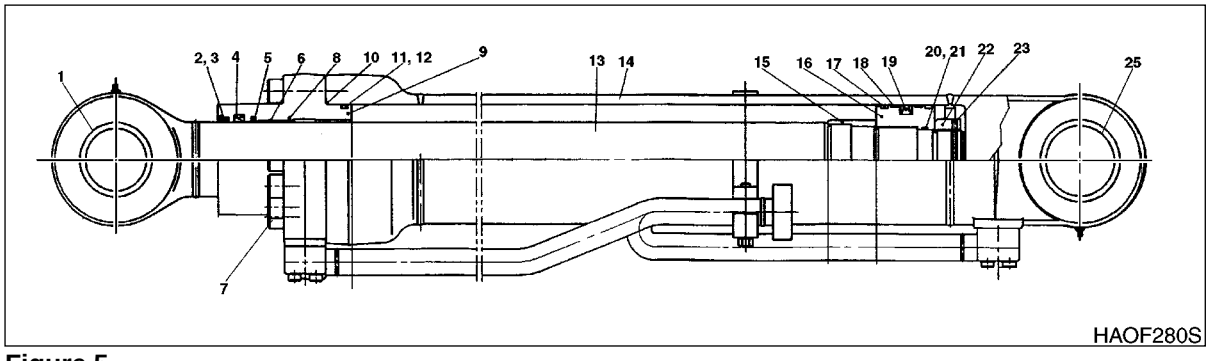

Figure 5

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

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

SPECIAL TOOLS AND MATERIALS

PISTON NUT

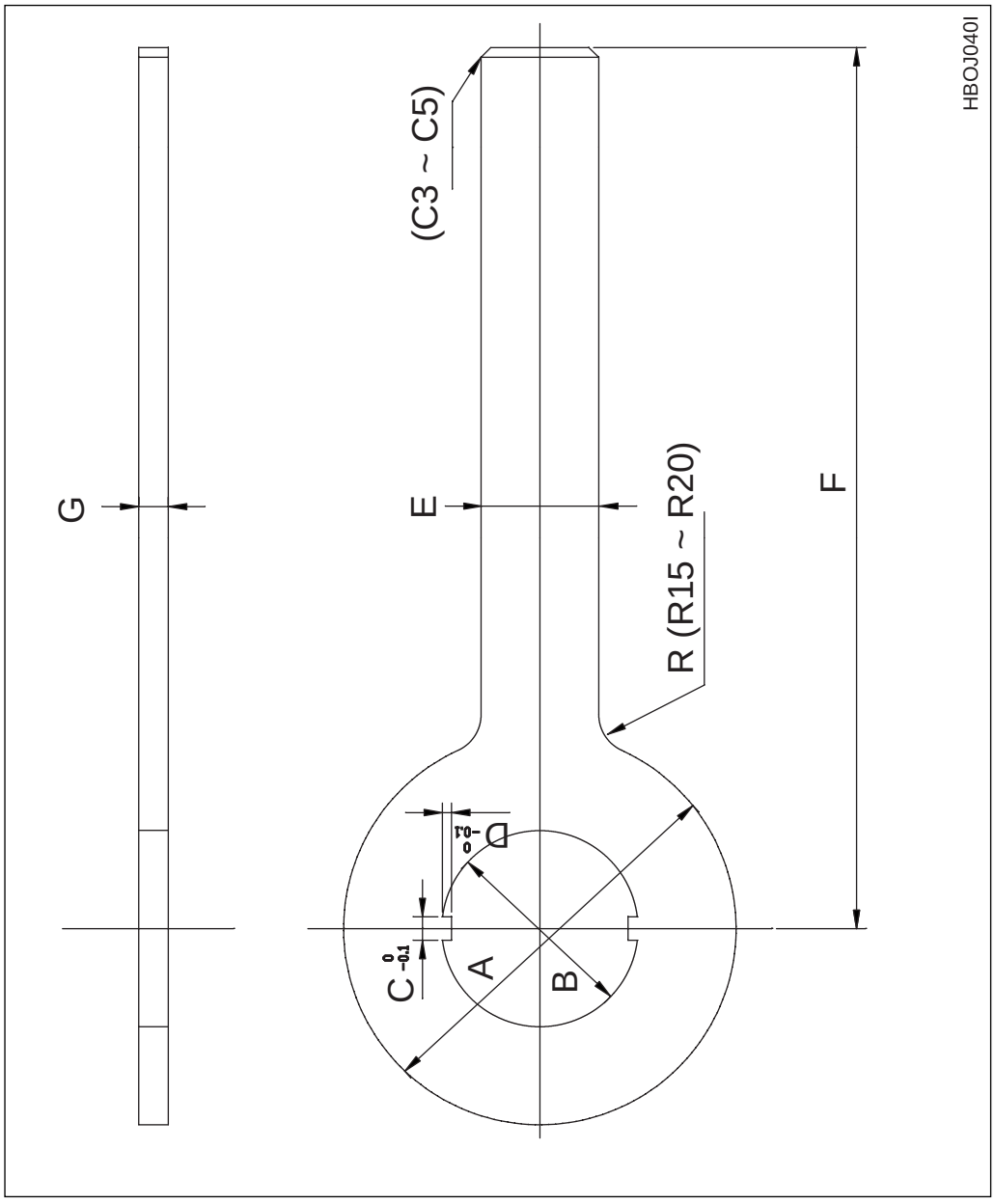

Figure 6

Material SM45C (AISI 1045)

Rockwell Harden from 22 - 27

Oil Quence

MODEL	CYLINDER	A	B	C	D	E	F	G	MODEL (CYLINDER)
S55-V	ARM	110.0 mm (4.33 in)	69.0 mm (2.72 in)	9.0 mm (0.35 in)	4.5 mm (0.18 in)	30.0 mm (1.18 in)	300.0 mm (11.81 in)	15.0 mm (0.59 in)	S55-V (BOOM, BUCKET)
S130-V	ARM	130.0 mm (5.12 in)	90.0 mm (3.54 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	35.0 mm (1.38 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	S130W-V (ARM) S170LC-V (BUCKET) S170W-V (BOOM) S200W-V (BOOM) S200LC-V (BOOM)
	BOOM	120.0 mm (4.72 in)	85.0 mm (3.35 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	30.0 mm (1.18 in)	300.0 mm (11.81 in)	15.0 mm (0.59 in)	S130W-V (BOOM) S170W-V (BUCKET)
	BUCKET	115.0 mm (4.53 in)	75.0 mm (2.95 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	30.0 mm (1.18 in)	300.0 mm (11.81 in)	15.0 mm (0.59 in)	S130W-V (BUCKET)
S220LC-V	ARM	140.0 mm (5.51 in)	102.0 mm (4.02 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	35.0 mm (1.38 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	S170LC-V (ARM) S200W-V (ARM) S250LC-V (BOOM, ARM, BUCKET) S290LC-V (BOOM)
	BUCKET	125.0 mm (4.92 in)	102.0 mm (4.02 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	35.0 mm (1.38 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	S170LC-V (BOOM) S200W-V (BUCKET)
S330-V	ARM	140.0 mm (5.51 in)	107.0 mm (4.21 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	35.0 mm (1.38 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	S290LC-V (ARM) S360-V (ARM) S400LC-V (BOOM, BUCKET) S450LC-V (BOOM, BUCKET)
	BOOM	140.0 mm (5.51 in)	105.0 mm (4.13 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	35.0 mm (1.38 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	S360-V (BUCKET) S400LC-V (BUCKET)
S400LC-V	ARM	140.0 mm (5.51 in)	115.0 mm (4.53 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	35.0 mm (1.38 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	
S200W-V	DOZER	130.0 mm (5.12 in)	92.0 mm (3.62 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	35.0 mm (1.38 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	S170W-V (DOZER, OUTRIGGER) S200W-V (OUTRIGGER)
S170W-V	ARM	130.0 mm (5.12 in)	98.0 mm (3.86 in)	11.0 mm (0.43 in)	4.5 mm (0.18 in)	35.0 mm (1.38 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	

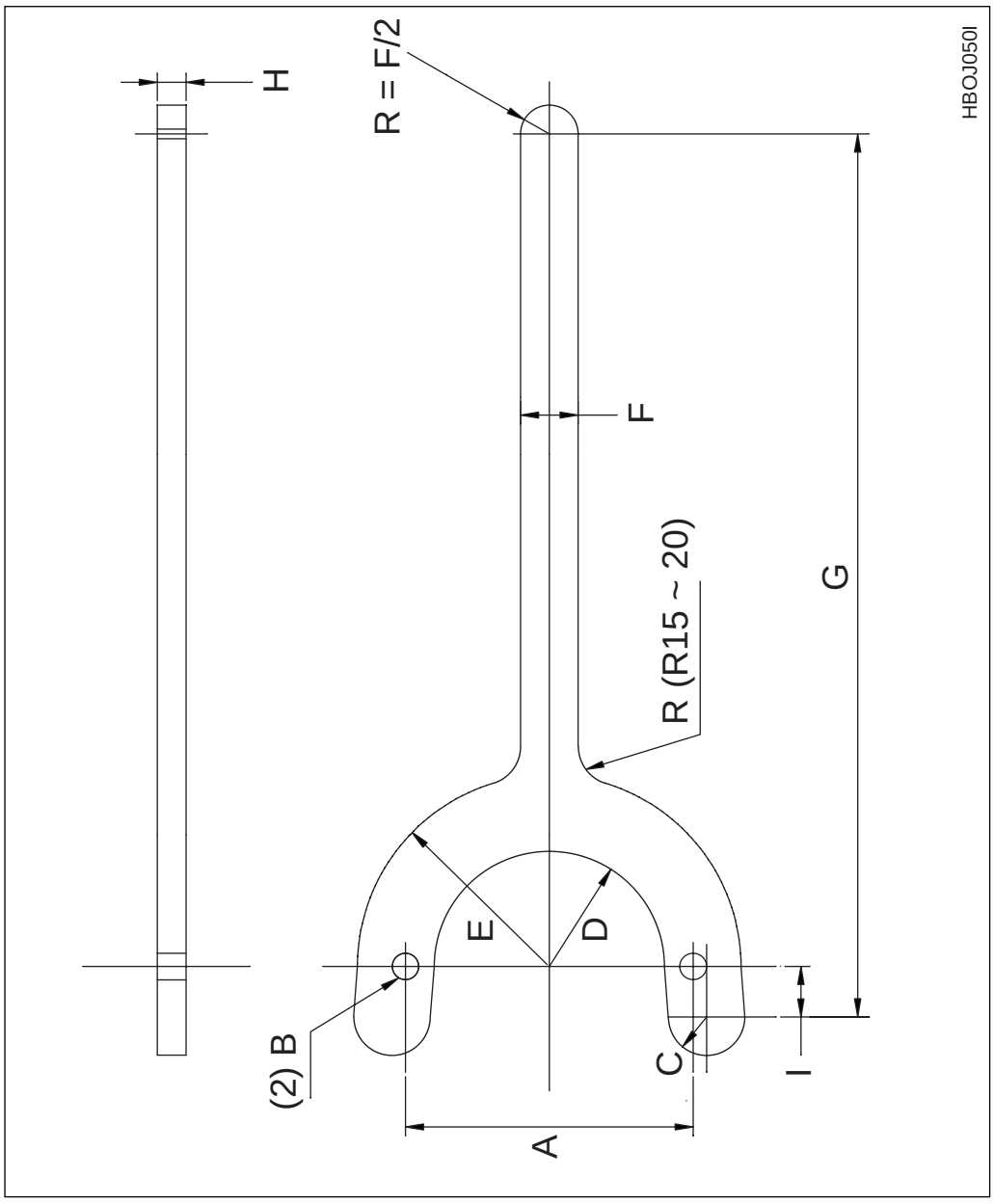

Figure 7

Material SM45C (AISI 1045)

Rockwell Harden from 22 - 27

Oil Quence

MODEL	CYLINDER	A	B	C	D	E	F	G	H	I	MODEL (CYLINDER)
S55-V	ARM	63.0 mm (2.48 in)	12.0 mm (0.47 in)	15.0 mm (0.59 in)	22.0 mm (0.87 in)	50.0 mm (1.97 in)	30.0 mm (1.18 in)	320.0 mm (12.60 in)	15.0 mm (0.59 in)	12.0 mm (0.47 in)	S55-V (BUCKET)
	BOOM	80.0 mm (3.15 in)	12.0 mm (0.47 in)	16.0 mm (0.63 in)	25.0 mm (0.98 in)	55.0 mm (2.17 in)	30.0 mm (1.18 in)	320.0 mm (12.60 in)	15.0 mm (0.59 in)	15.0 mm (0.59 in)	
S130-V	ARM	80.0 mm (3.15 in)	12.0 mm (0.47 in)	15.0 mm (0.59 in)	29.0 mm (1.14 in)	55.0 mm (2.17 in)	30.0 mm (1.18 in)	320.0 mm (12.60 in)	15.0 mm (0.59 in)	15.0 mm (0.59 in)	S130W-V (ARM) S170LC-V (BUCKET)
	BOOM	75.0 mm (2.95 in)	12.0 mm (0.47 in)	15.0 mm (0.59 in)	27.0 mm (1.06 in)	55.0 mm (2.17 in)	30.0 mm (1.18 in)	320.0 mm (12.60 in)	15.0 mm (0.59 in)	14.0 mm (0.55 in)	S130W-V (BOOM)
	BUCKET	70.0 mm (2.76 in)	12.0 mm (0.47 in)	16.0 mm (0.63 in)	25.0 mm (0.98 in)	65.0 mm (2.56 in)	30.0 mm (1.18 in)	300.0 mm (11.81 in)	15.0 mm (0.59 in)	12.0 mm (0.47 in)	S130W-V (BUCKET)
S220LC-V	ARM	110.0 mm (4.33 in)	14.0 mm (0.55 in)	17.0 mm (0.67 in)	40.0 mm (1.57 in)	75.0 mm (2.95 in)	32.0 mm (1.26 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	15.0 mm (0.59 in)	S170LC-V (ARM) S200W-V (ARM) S250LC-V (BOOM, ARM, BUCKET) S290LC-V (BOOM, BUCKET)
	BUCKET	50.0 mm (1.97 in)	14.0 mm (0.55 in)	16.0 mm (0.63 in)	33.0 mm (1.30 in)	65.0 mm (2.56 in)	32.0 mm (1.26 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	15.0 mm (0.59 in)	S170LC-V (BOOM) S200W-V (BUCKET) S200LC-V (BUCKET)
S200W-V	OUTRIGGER	96.0 mm (3.78 in)	14.0 mm (0.55 in)	17.0 mm (0.67 in)	35.0 mm (1.38 in)	65.0 mm (2.56 in)	30.0 mm (1.18 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	15.0 mm (0.59 in)	S170W-V (DOZER, OUTRIGGER) S200W-V (DOZER)
S290LC-V	ARM	120.0 mm (4.72 in)	14.0 mm (0.55 in)	18.0 mm (0.71 in)	46.0 mm (1.81 in)	80.0 mm (3.15 in)	35.0 mm (1.38 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	15.0 mm (0.59 in)	S330-V (BOOM, BUCKET) S360-V (BOOM, BUCKET)
S330LC-V	ARM	130.0 mm (5.12 in)	14.0 mm (0.55 in)	20.0 mm (0.79 in)	50.0 mm (1.97 in)	90.0 mm (3.54 in)	35.0 mm (1.38 in)	350.0 mm (13.78 in)	15.0 mm (0.59 in)	20.0 mm (0.79 in)	S360-V (ARM) S400LC-V (ARM) S400LC-V (BOOM) S400LC-V (BUCKET) S450LC-V (BOOM, BUCKET)

DISASSEMBLY

⚠ CAUTION!

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

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

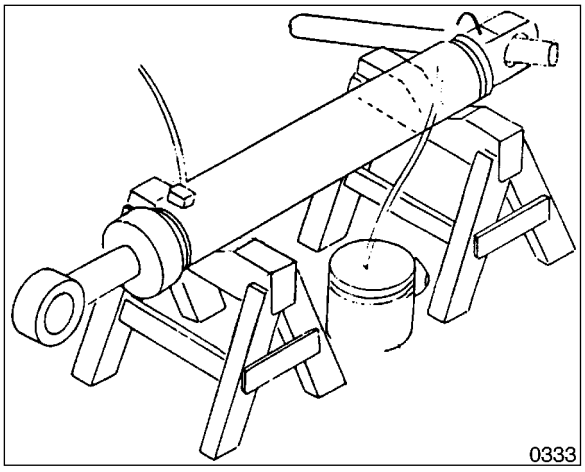

Figure 8

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

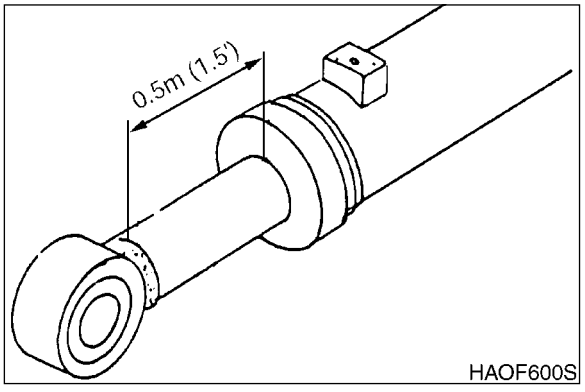

Figure 9

3. Loosen 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.*

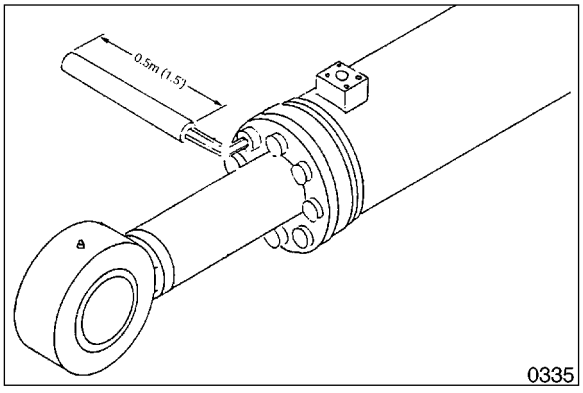

Figure 10

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.

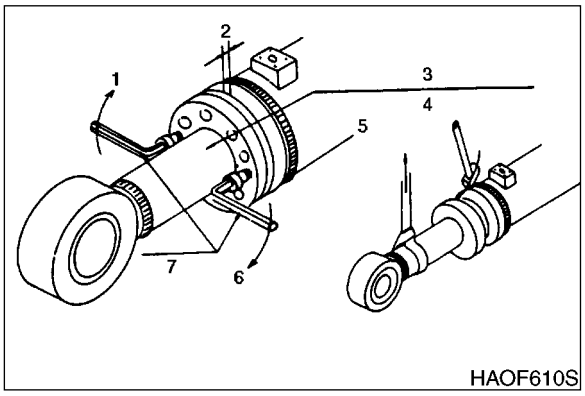

Figure 11

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.

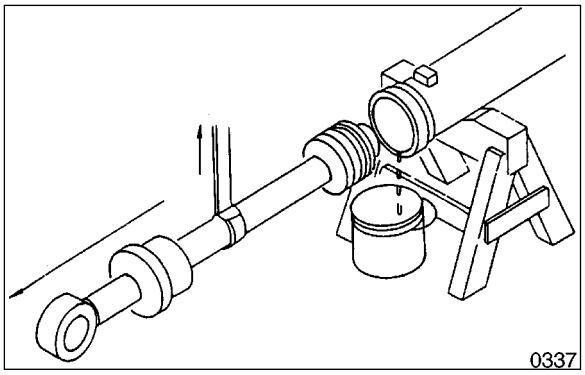

Figure 12

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

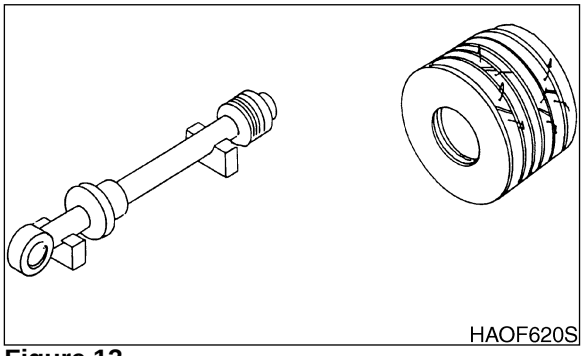

Figure 13

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

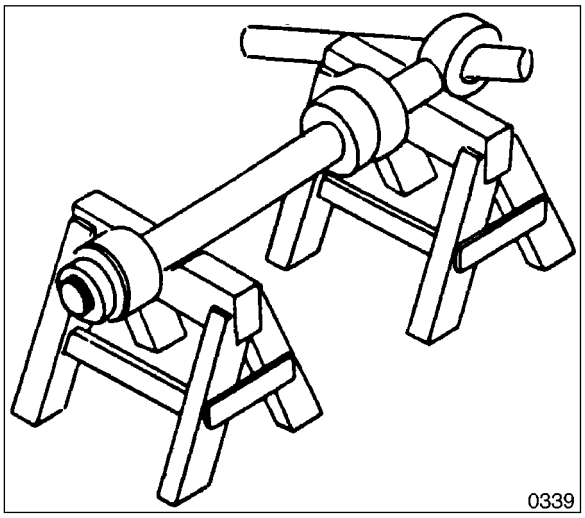

Figure 14

8. Loosen set screw by using a socket wrench.

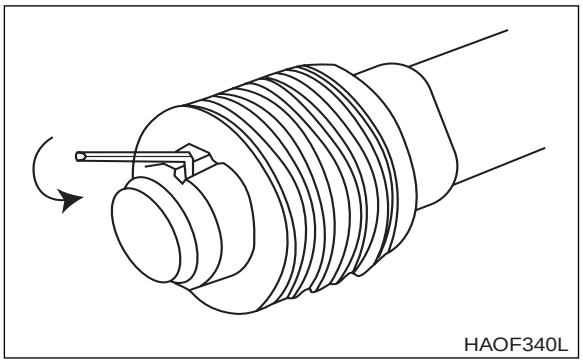

Figure 15

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.

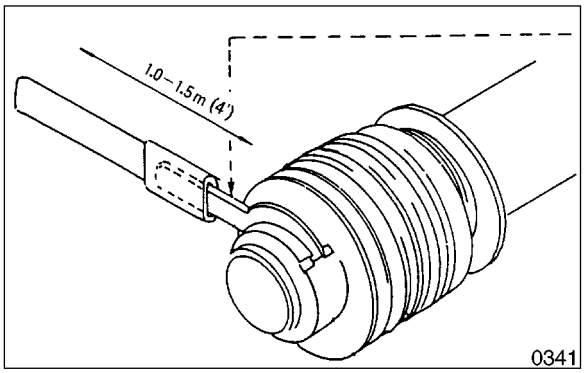

Figure 16

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.

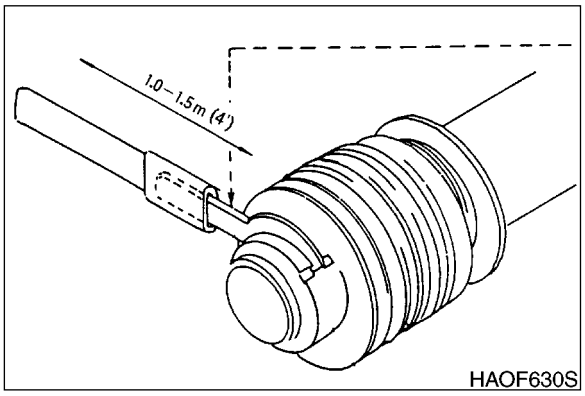

Figure 17

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.

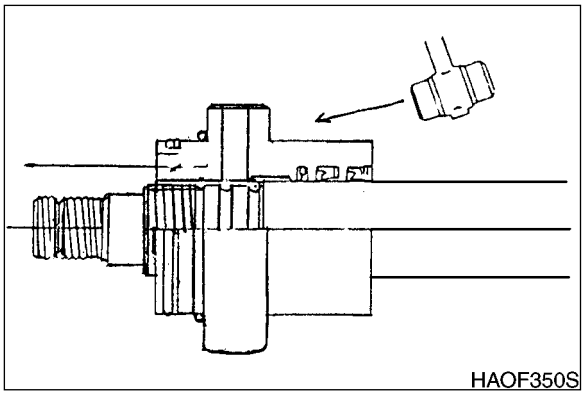

Figure 18

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

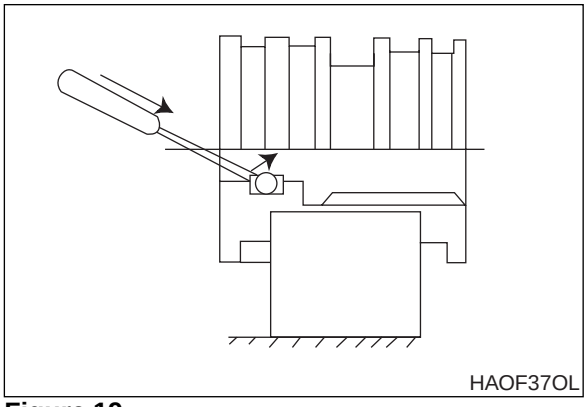

Figure 19

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).

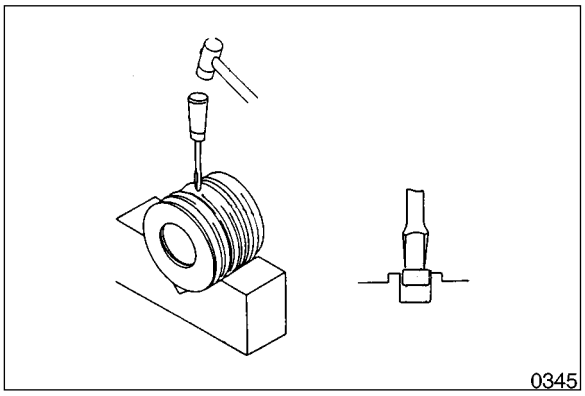

Figure 20

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

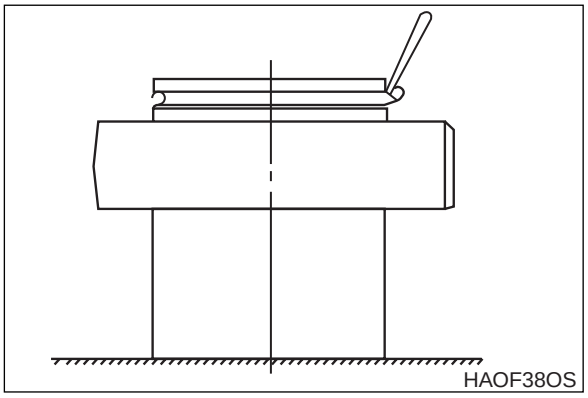

Figure 21

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

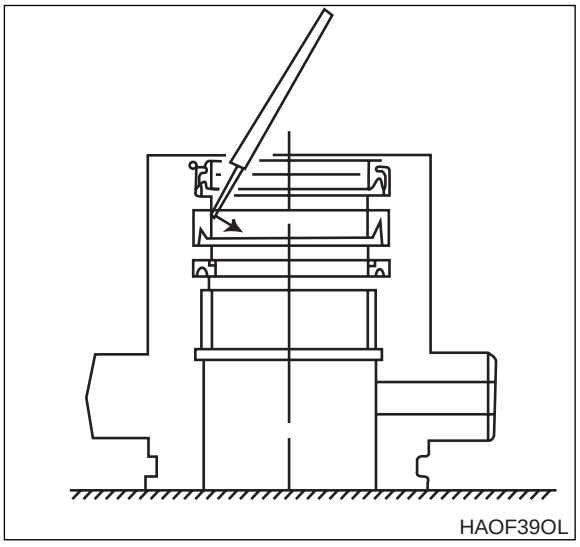

Figure 22

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

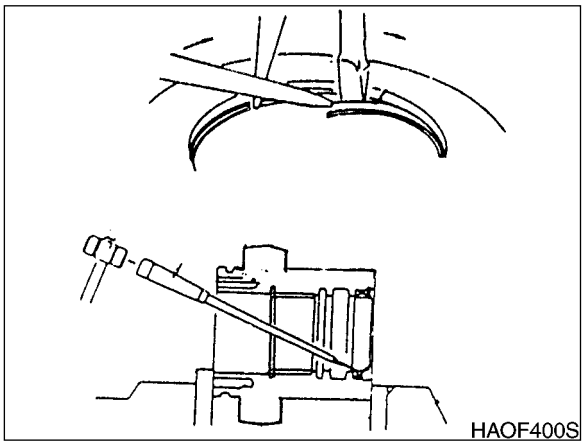

Figure 23

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

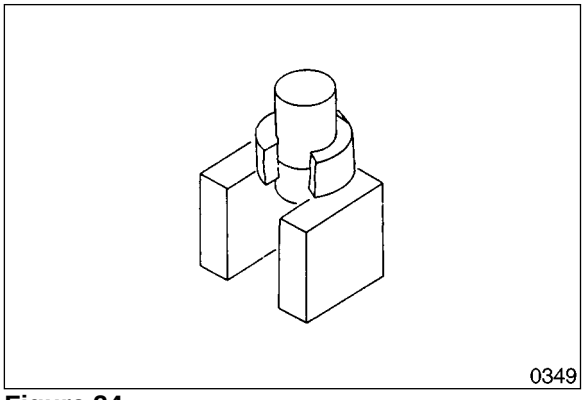

Figure 24

REASSEMBLY

IMPORTANT

Replace any part that shows evidence of damage or excessive wear. Replacement of all O-rings and flexible seals is strongly recommended. Before starting the cylinder reassembly procedure, all parts should be thoroughly cleaned and dried, and/or prelubricated with clean hydraulic fluid. Prepare the work area beforehand to maintain cleanliness during the reassembly procedure.

NOTE: *Reassemble the subassemblies of the cylinder in the following order:*

1. *Body of the cylinder*
2. *Piston rod*
3. *Piston assembly*
4. *Cylinder head assembly*

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

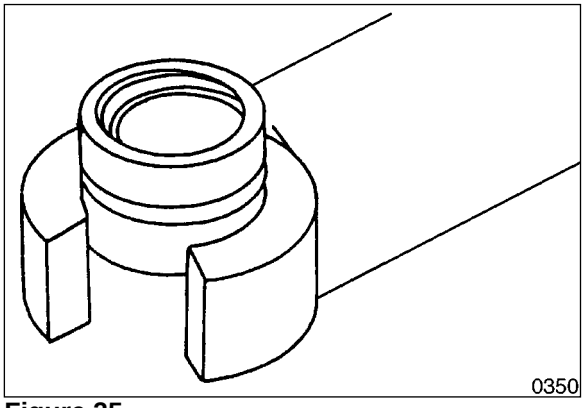

Figure 25

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

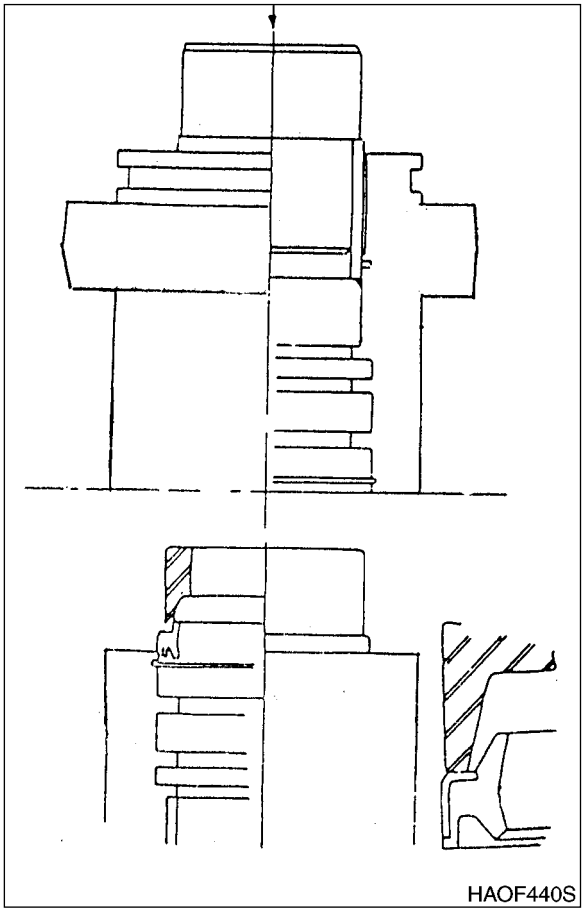

Figure 26

3. Pre-lubricate O-rings and seals before reassembly (Figure 27).

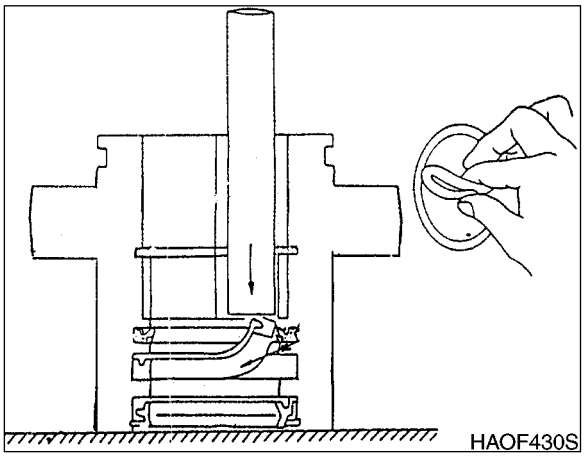

Figure 27

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.

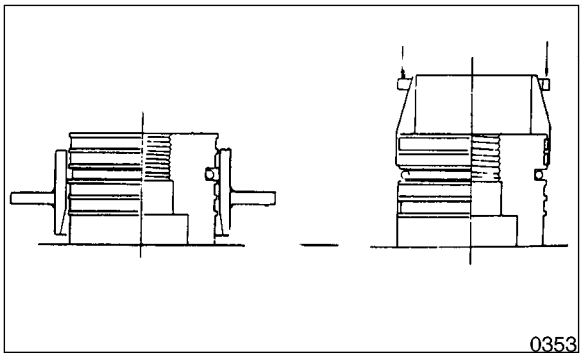

Figure 28

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).

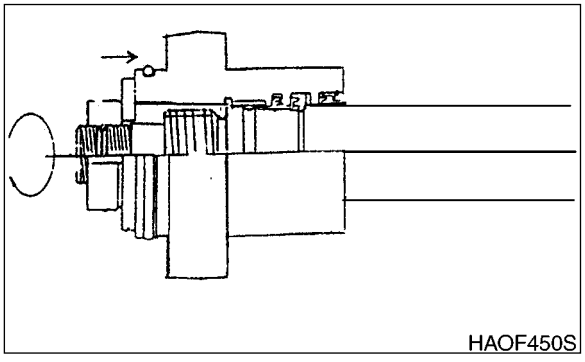

Figure 29

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

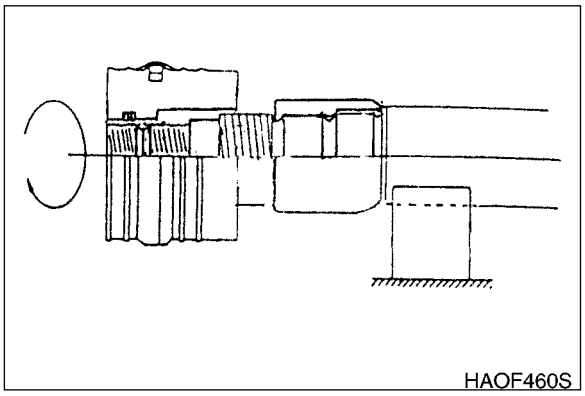

Figure 30

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

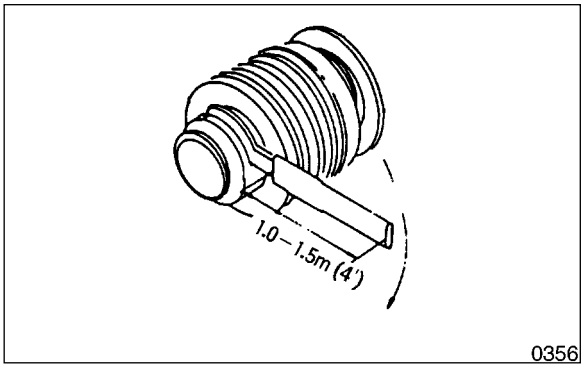

Figure 31

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

Reference Number	Description
1	Set Screw

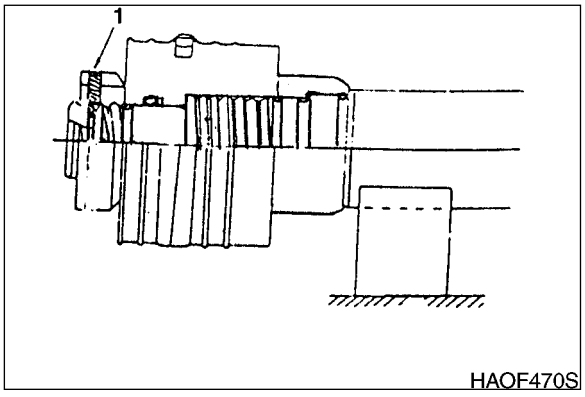

Figure 32

9. Immobilize body of cylinder before reassembly.

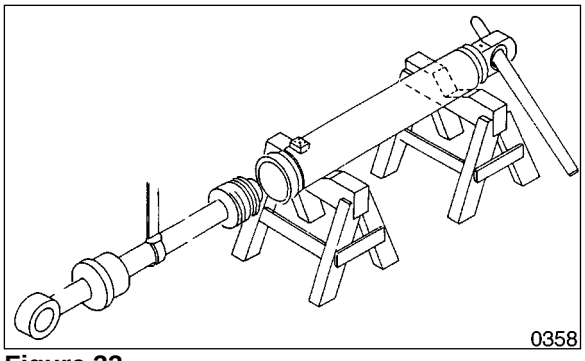

Figure 33

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.

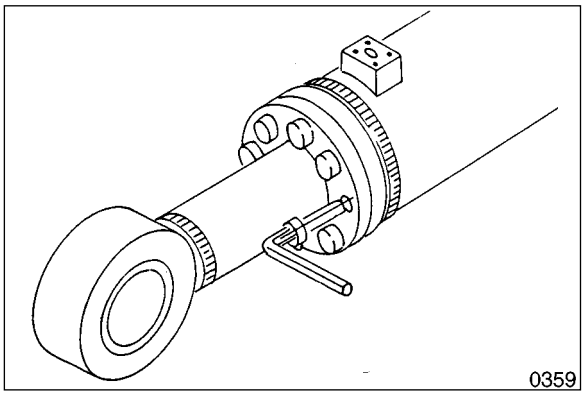

Figure 34

SWING MOTOR

⚠ CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

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

January 2002

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GENERAL DESCRIPTION

THEORY OF OPERATION

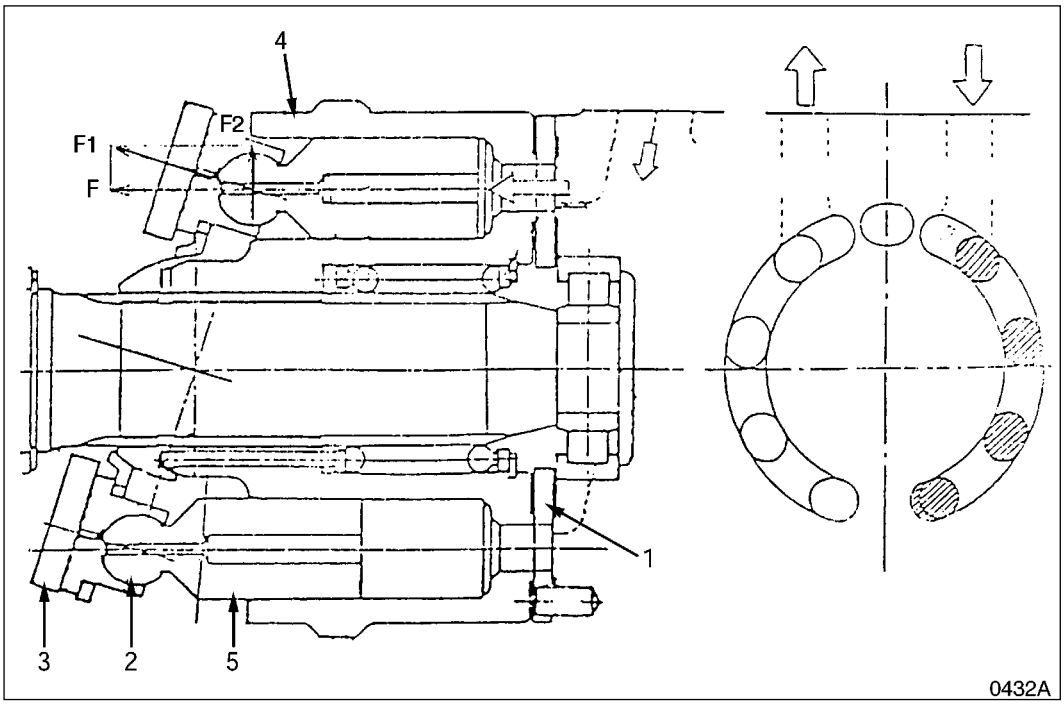


Figure 1

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 (Item 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 EPOS-V 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").

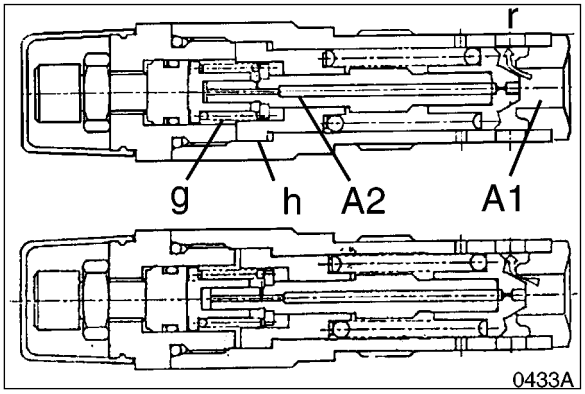


Figure 2

$$= \frac{}{1 - 2}$$

Where Fsp: Spring Force

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.

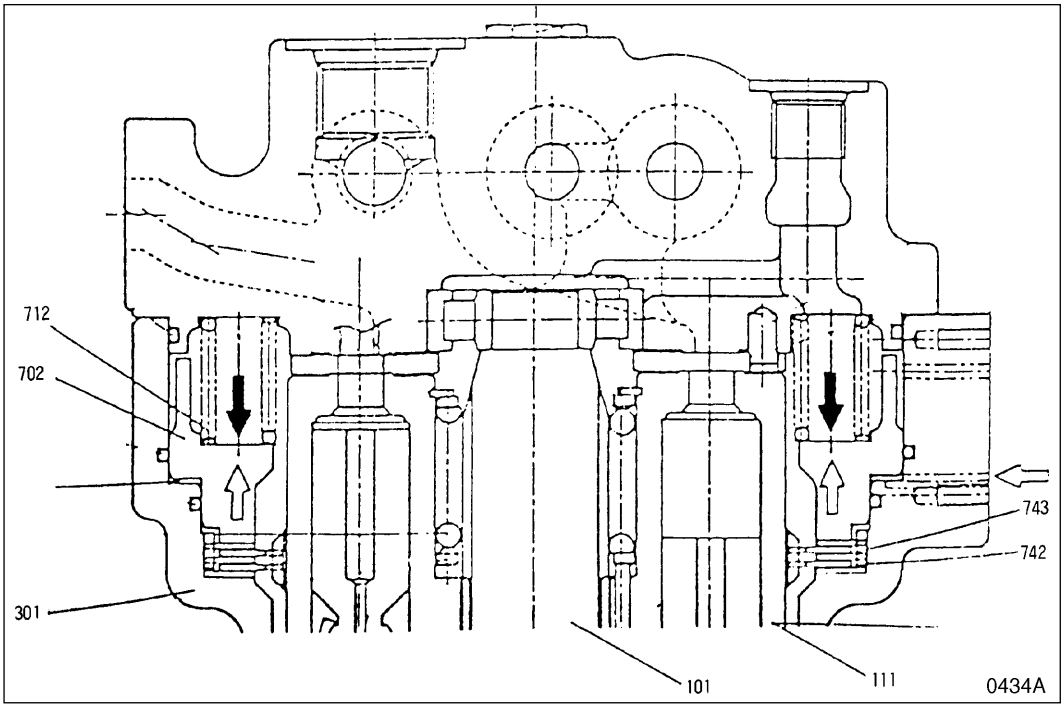
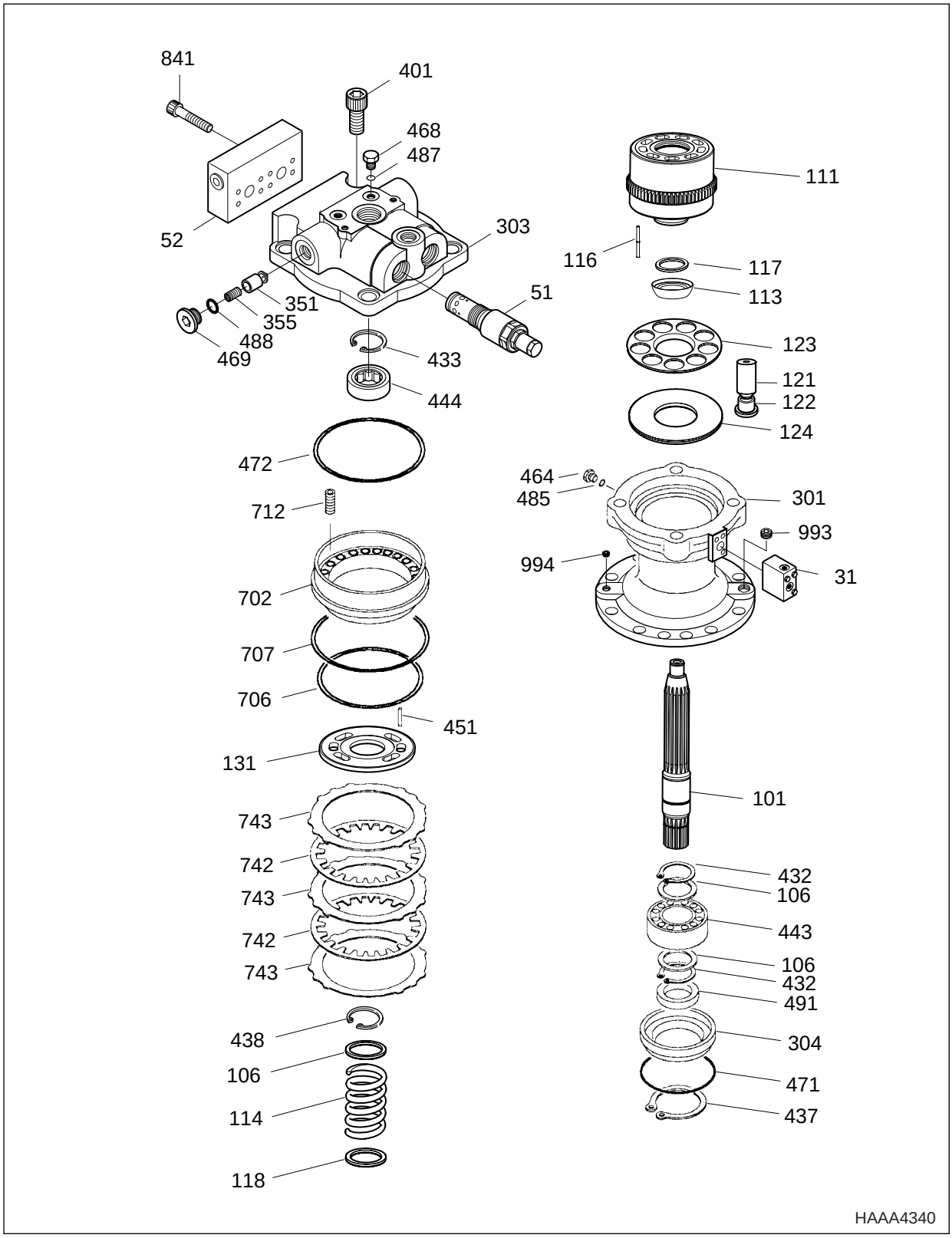


Figure 3

The swing brake is applied when the brake spring (Item 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 2-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.


841
401
468
487
52
303
111
116
117
113
51
351
355
488
469
433
123
121
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124
444
472
464
485
301
712
993
994
31
702
707
706
451
131
101
743
742
743
742
743
432
106
443
106
432
491
304
438
106
114
471
437
118
HAAA4340

Figure 4

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

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

SPECIFICATIONS

Item	Specification	
	Solar 170W-V Solar 220LC-V Solar 220LL	**Solar 170LC-V**
Type	Axial Piston	Axial Piston
Displacement	121.6 cc/rev (18.85 in^3/rev.)	128.0 cc/rev (7.81 in^3/rev.)
Crossover Relief Valve Setting	280 kg/cm^2 (3,980 psi)	280 kg/cm^2 (3,980 psi)
Maximum Supply Flow Rate @ 2000 rpm	227 lpm (60 gpm)	210 lpm (55 gpm)
Max. Motor Shaft Speed	1,867 rpm	1640 rpm
Rated Motor Shaft Torque	54.2 kg•m (392 ft lb)	57 kg•m (412 ft lb)
Weight	56.5 kg (125 lb)	62 kg (137 lb)

SPECIAL TOOLS

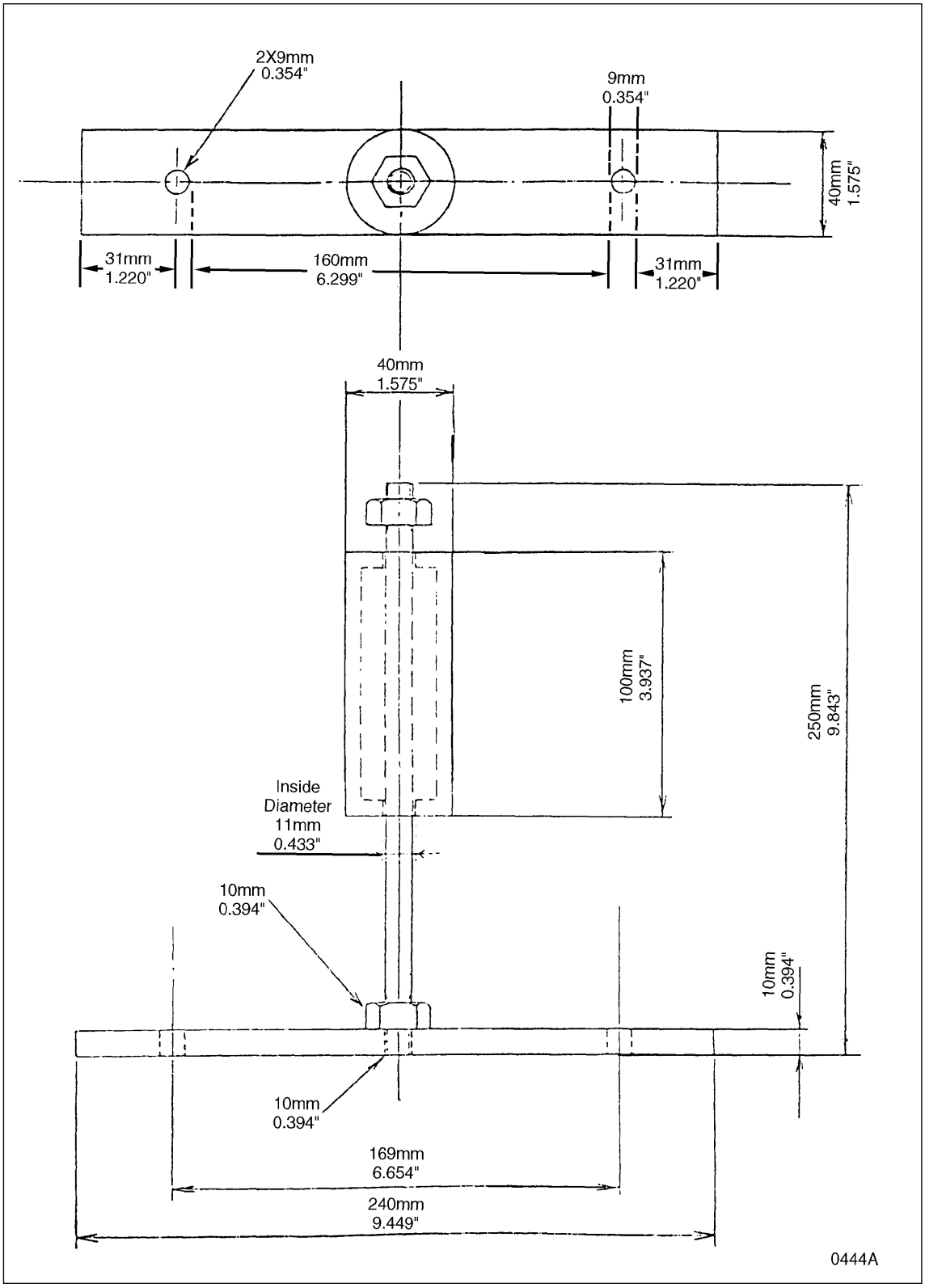


Figure 5

DISASSEMBLY

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

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

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

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

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

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

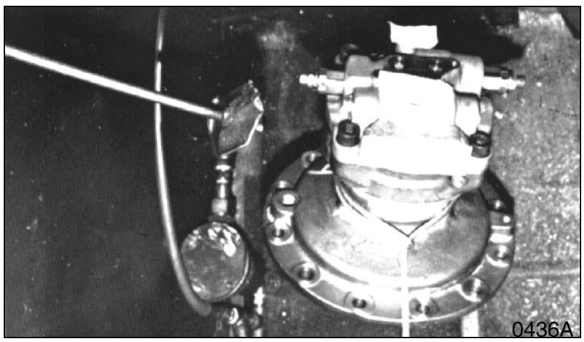


Figure 6

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

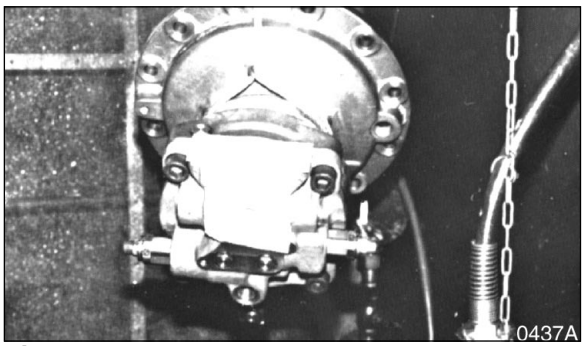


Figure 7

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

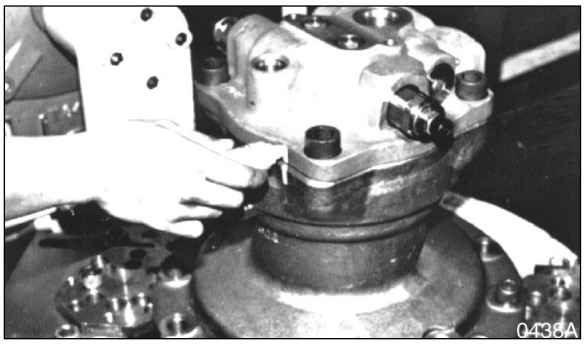


Figure 8

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

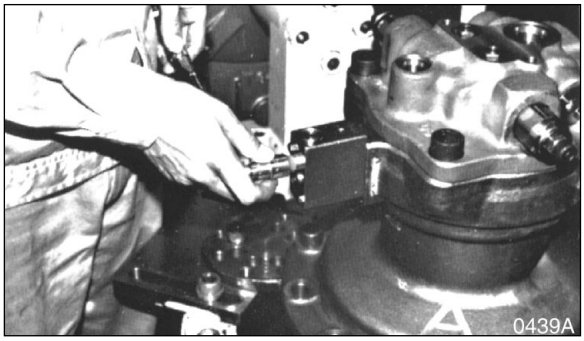


Figure 9

6. Loosen and remove relief valve assemblies (51) from upper valve casing (303).

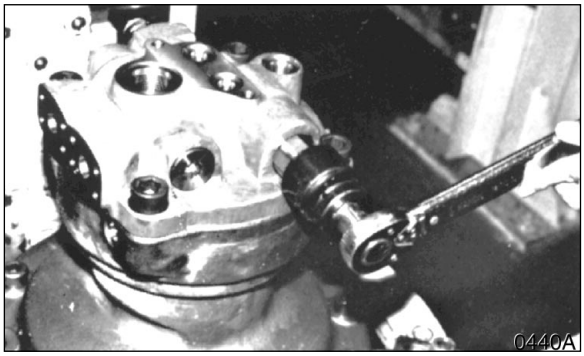


Figure 10

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

IMPORTANT
Use extra care to avoid damaging the plunger seat.

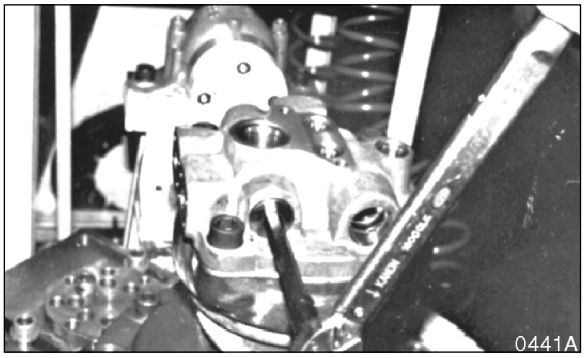


Figure 11

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

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

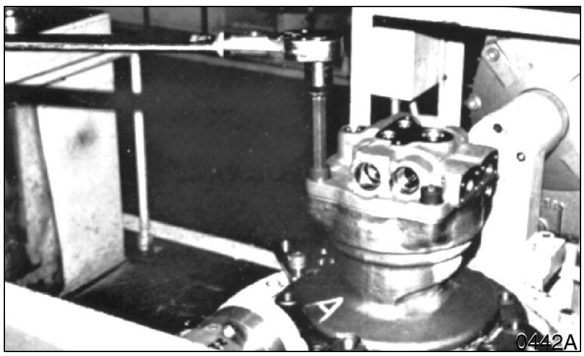


Figure 12

9. Remove all twenty brake springs.

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

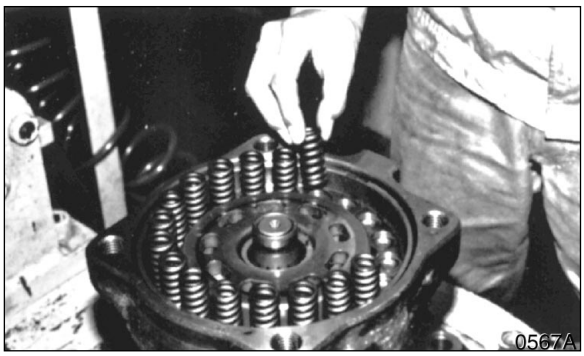


Figure 13

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

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

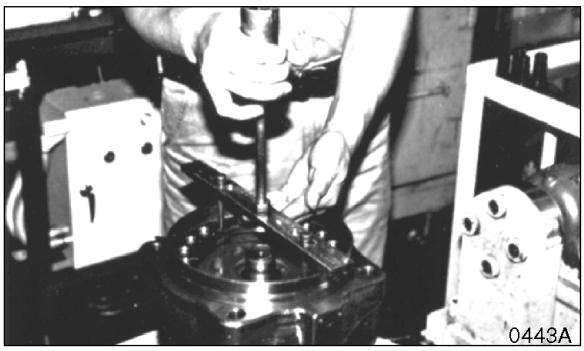


Figure 14

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

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

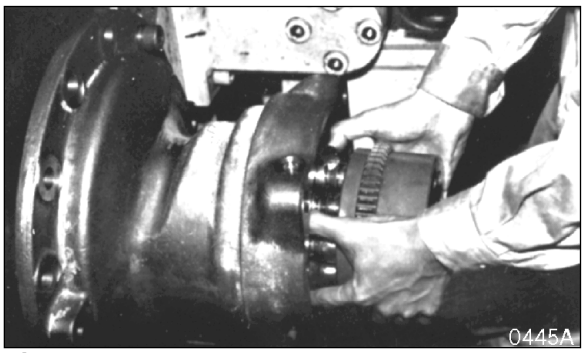


Figure 15

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

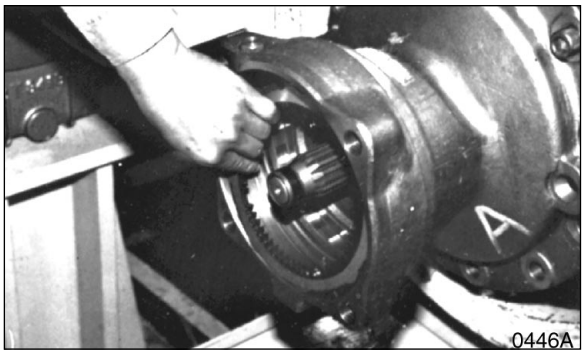


Figure 16

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

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

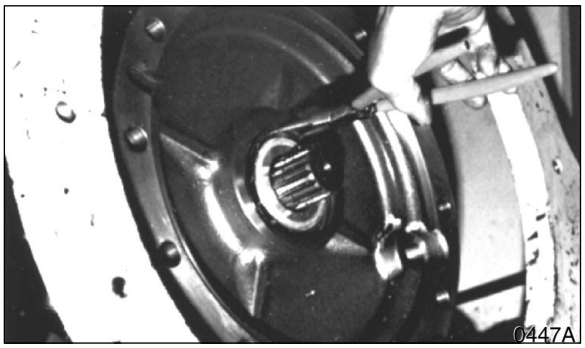


Figure 17

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

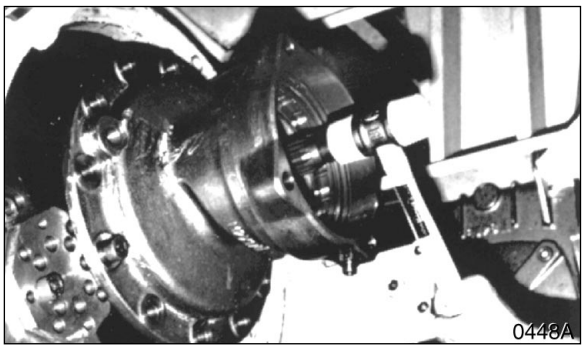


Figure 18

15. Tap bearing race out of casing.

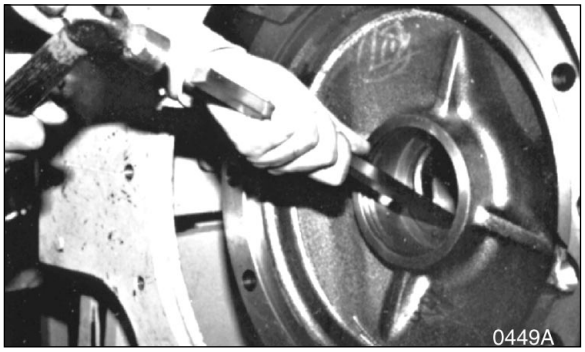


Figure 19

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

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

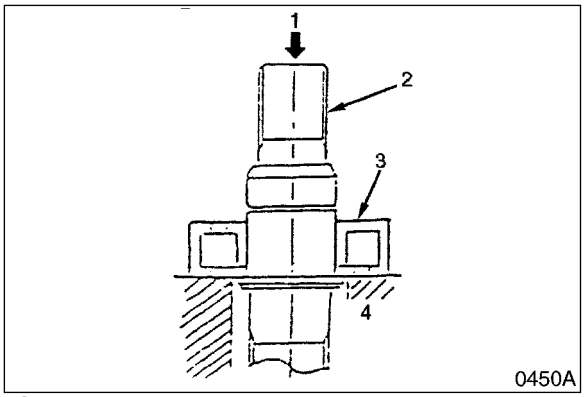


Figure 20

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

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

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

Reference Number	Description
1	Plug
2	Applied Force

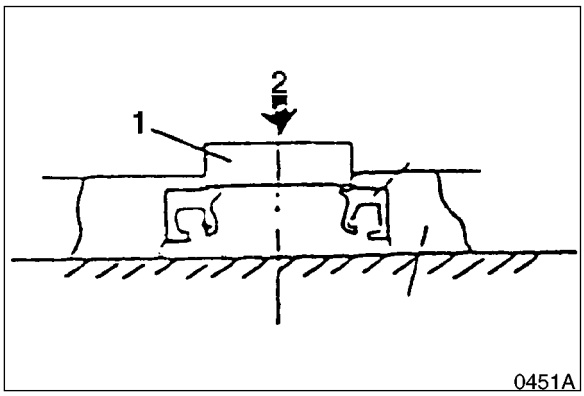


Figure 21

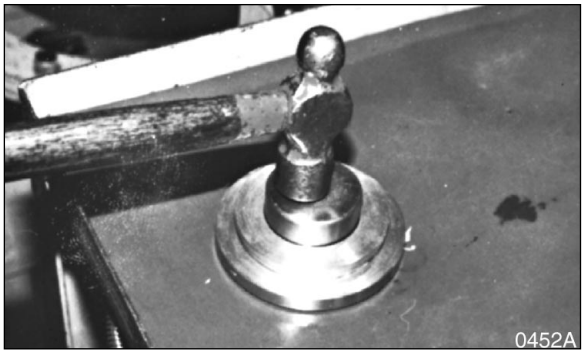


Figure 22

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

Figure 23

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

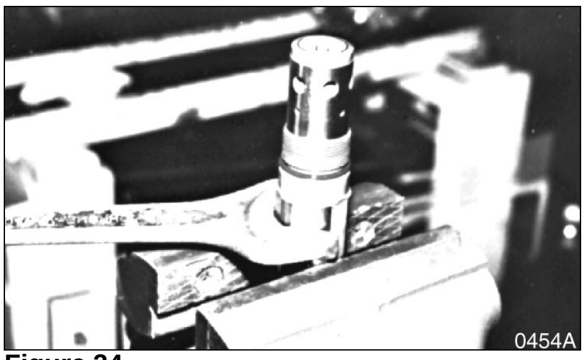


Figure 24

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

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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

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

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

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

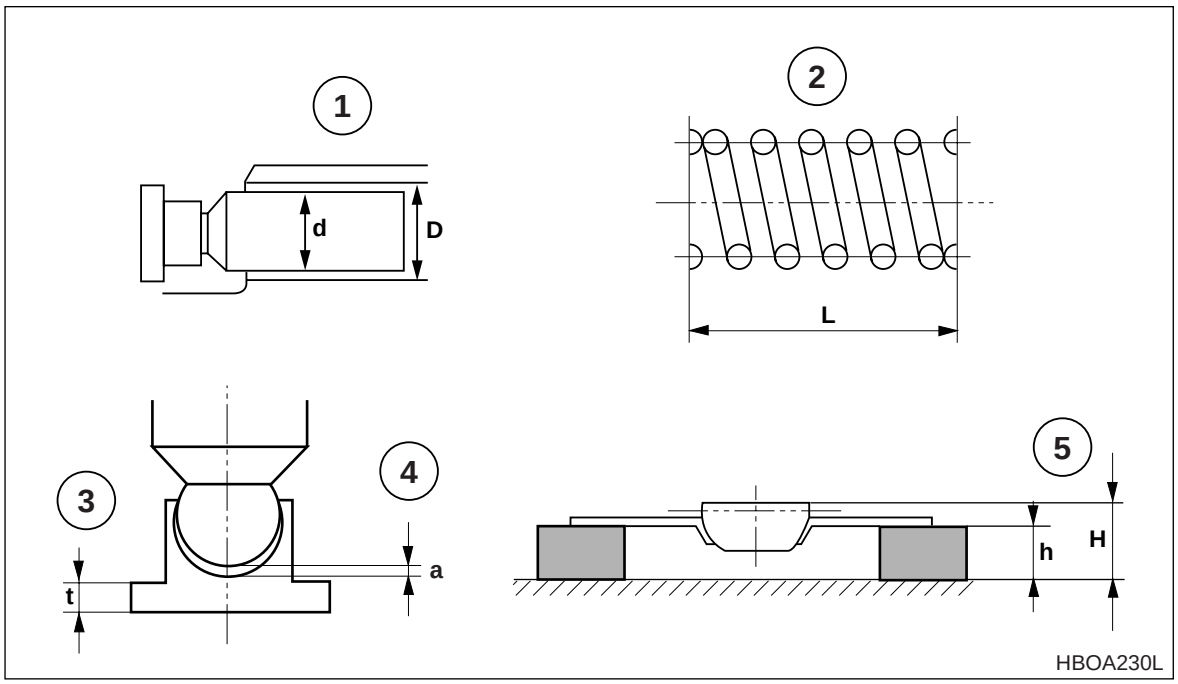


Figure 25

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

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

Service Standards for Replacing Worn Parts

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

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

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

REASSEMBLY

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

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

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

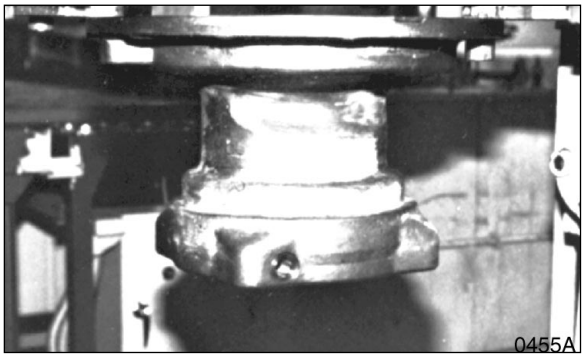


Figure 26

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

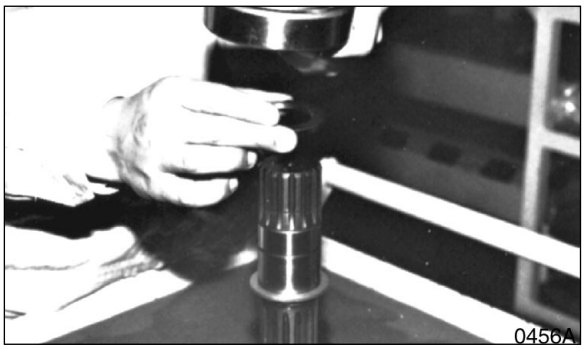


Figure 27

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

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

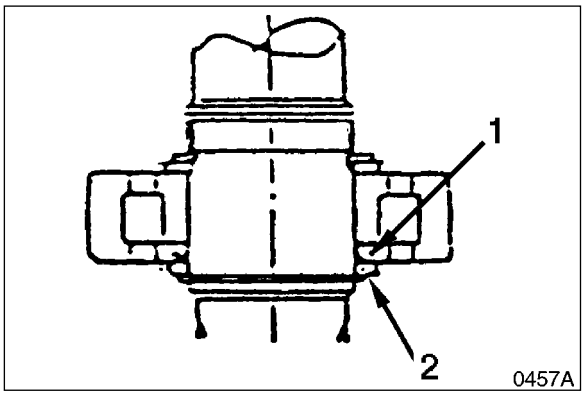


Figure 28

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

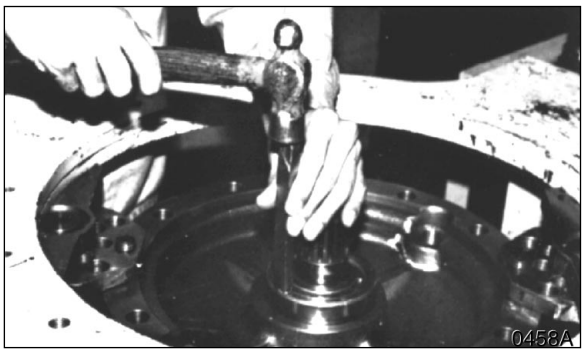


Figure 29

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

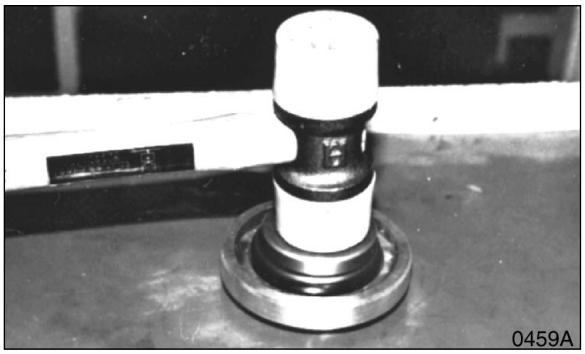


Figure 30

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

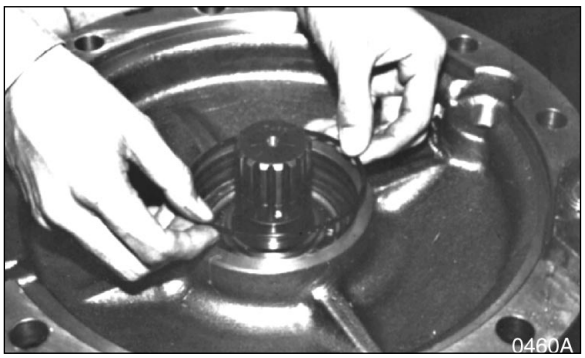


Figure 31

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

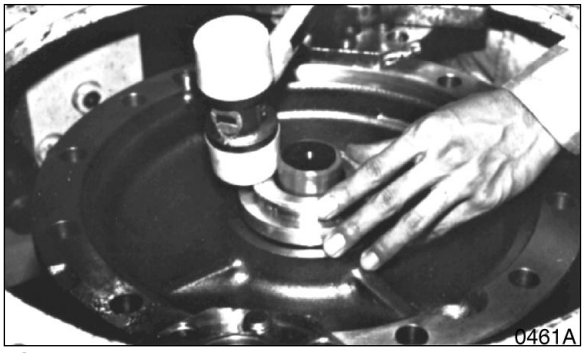


Figure 32

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

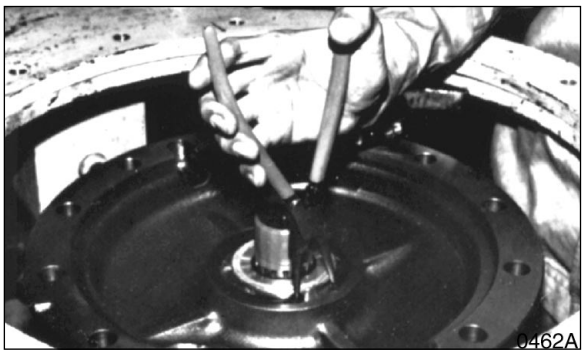


Figure 33

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

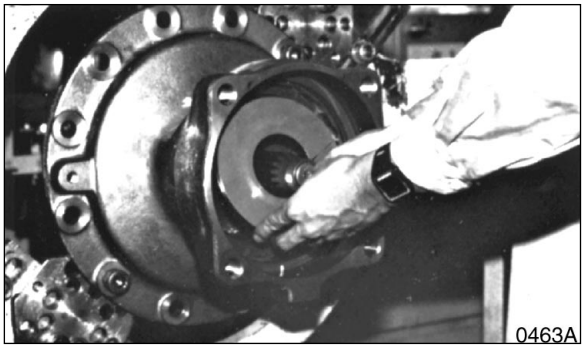


Figure 34

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

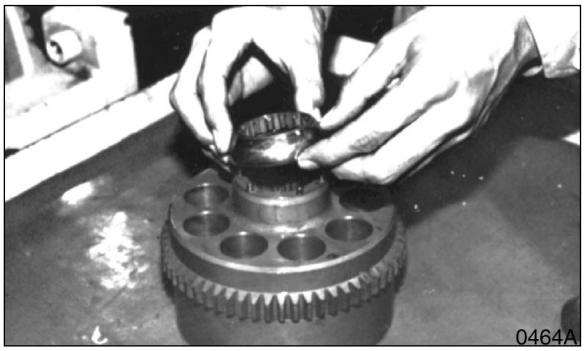


Figure 35

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

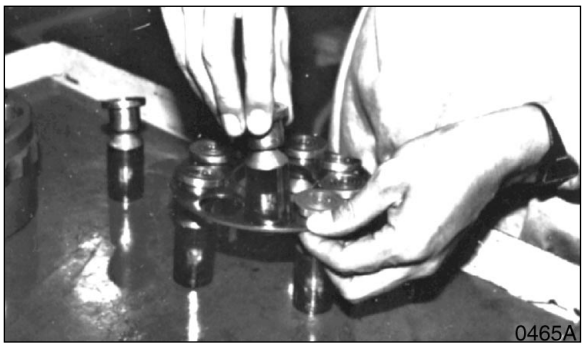


Figure 36

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

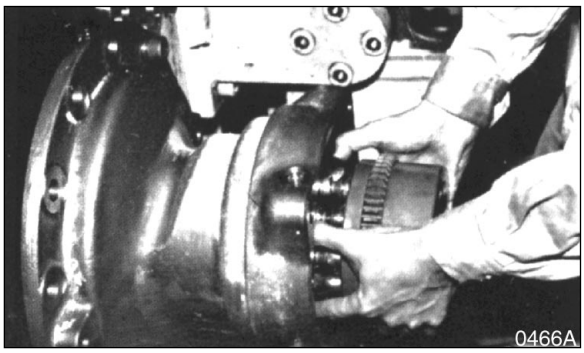


Figure 37

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

Reference Number	Description
1	Brake Valve

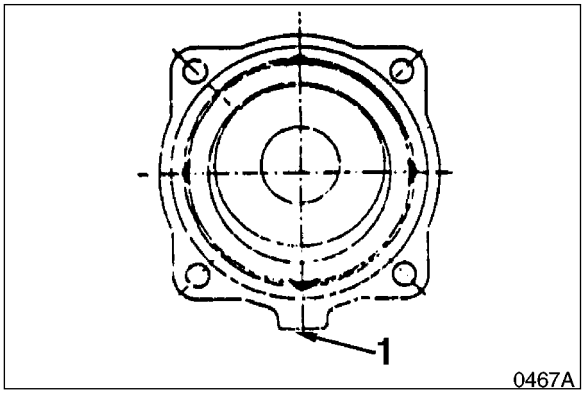


Figure 38 \

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

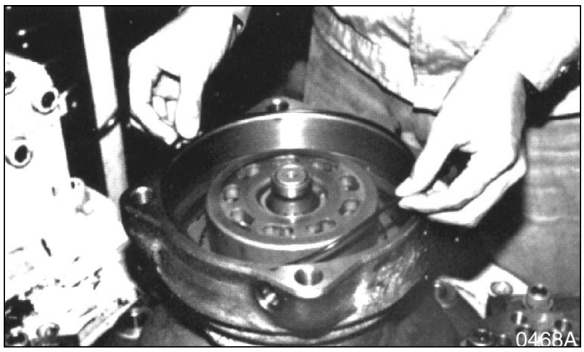


Figure 39

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

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

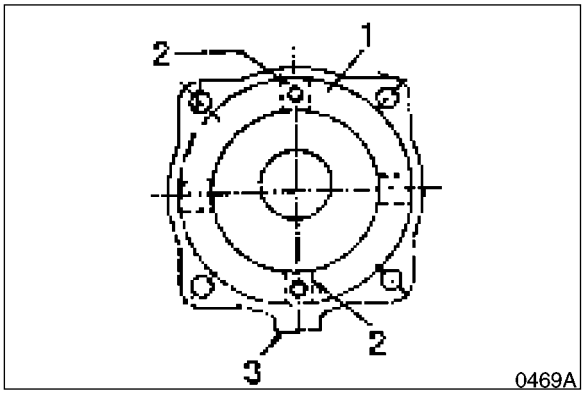


Figure 40

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

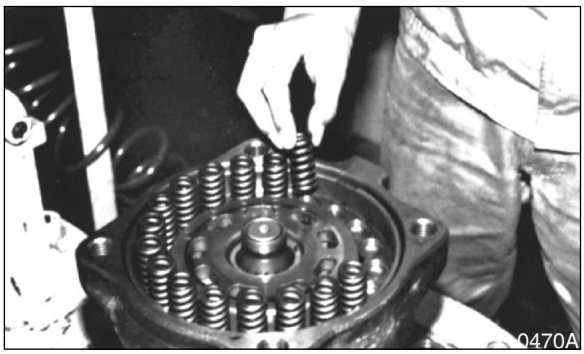


Figure 41

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

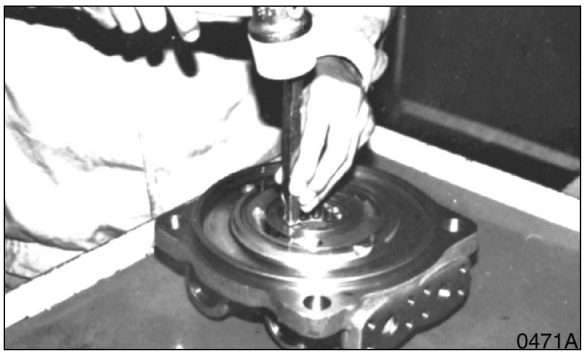


Figure 42

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

Reference Number	Description
1	Flange Side
2	R Port

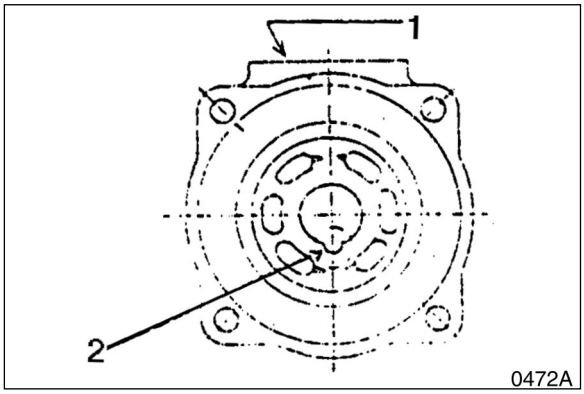


Figure 43

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

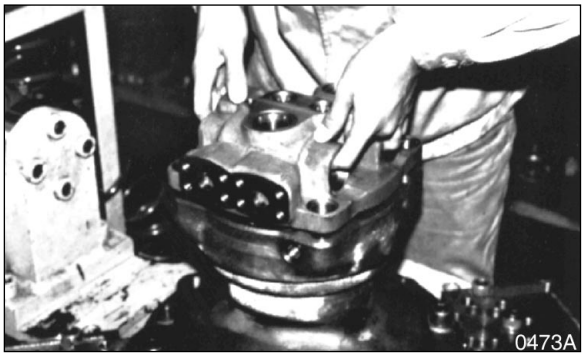


Figure 44

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

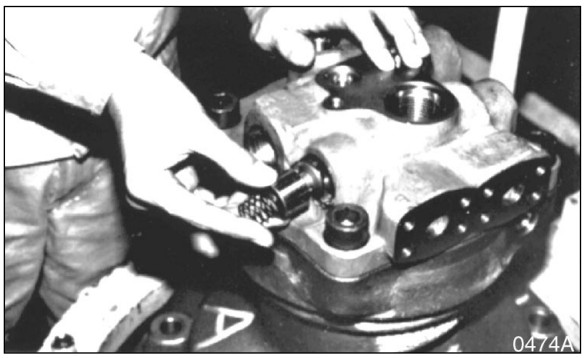


Figure 45

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

Figure 46

IMPORTANT
Be careful not to damage the plunger and spring seat.

Figure 47

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

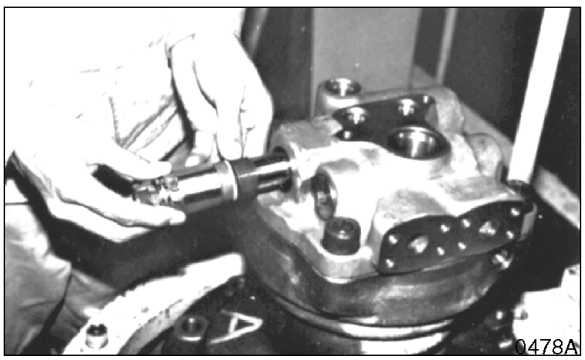


Figure 48

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

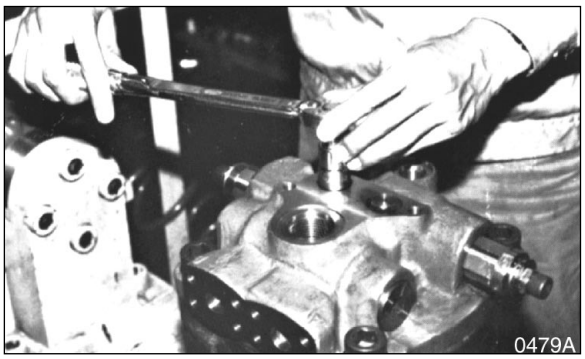


Figure 49

TRAVEL MOTOR (WITH GEARBOX) (A6V160HD)

⚠ CAUTION!

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

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

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

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

January 2002

TABLE OF CONTENTS

GENERAL DESCRIPTION

THEORY OF OPERATION

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

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

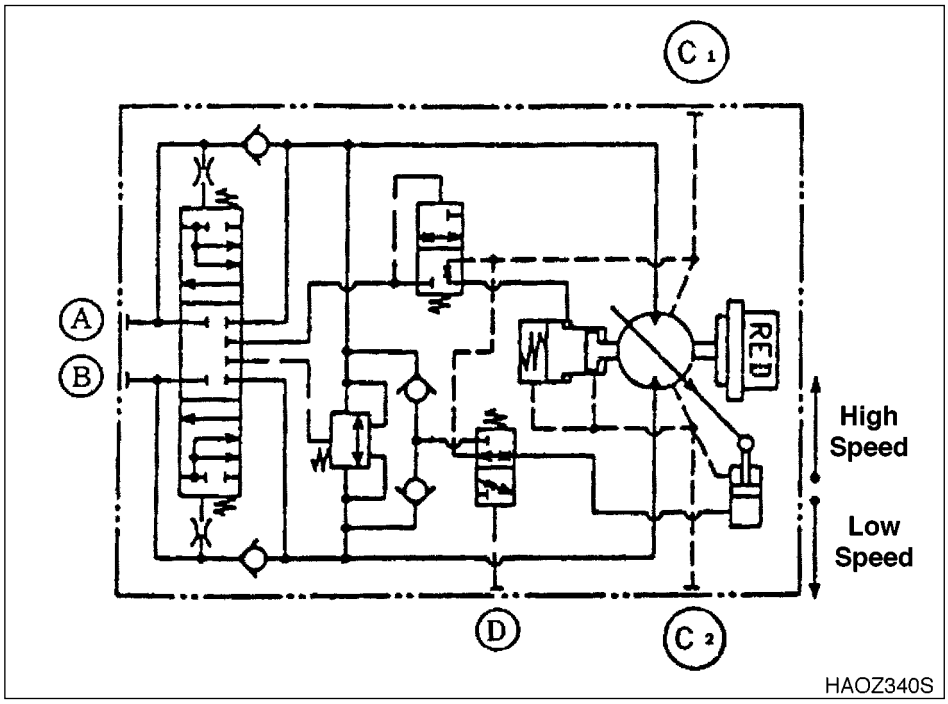


Figure 1

HYDRAULIC MOTOR OPERATION

1. Hydraulic Motor operation.

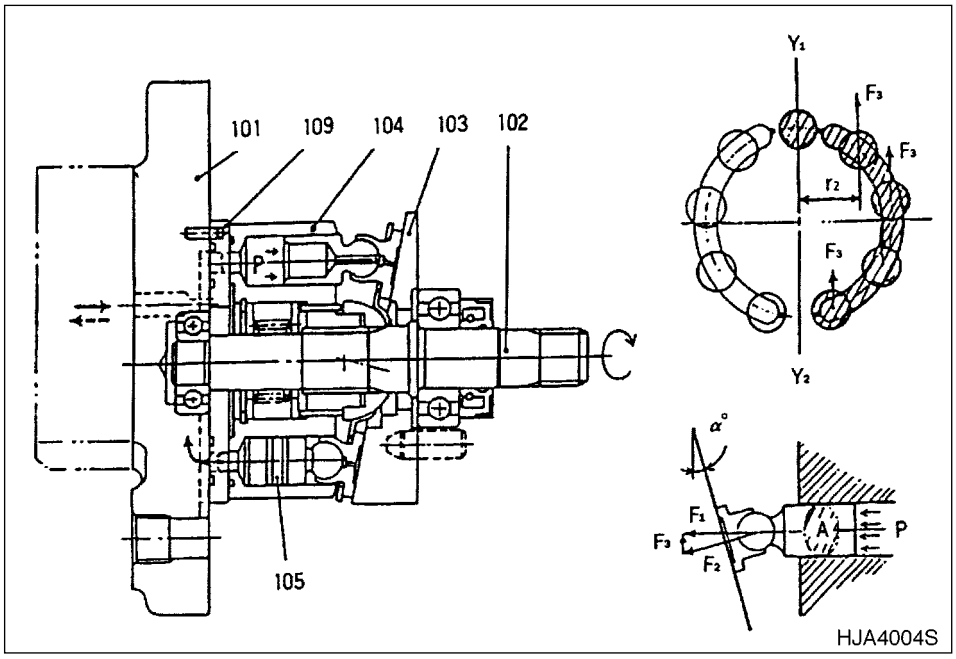


Figure 2

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

2. Brake Valve

A. During Travel.

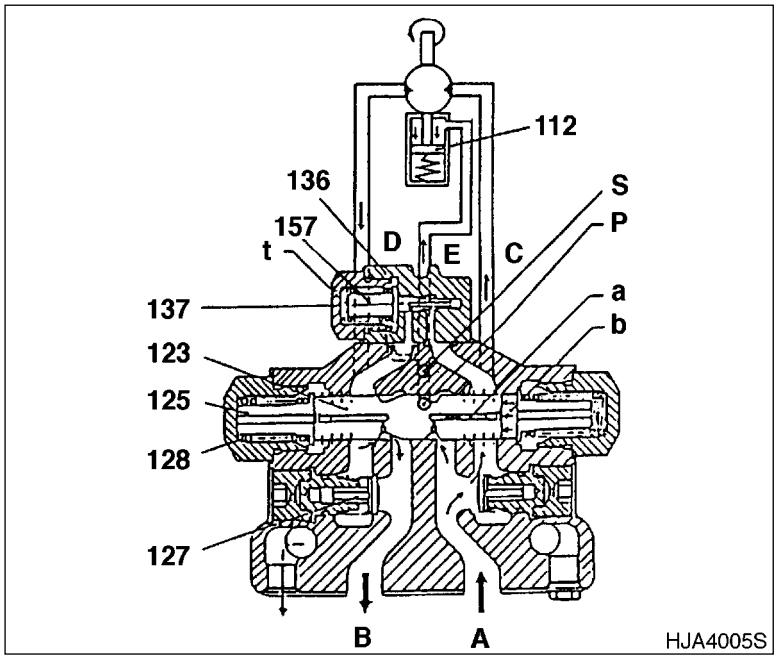


Figure 3

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

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

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

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

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

B. When Stopping by Deceleration.

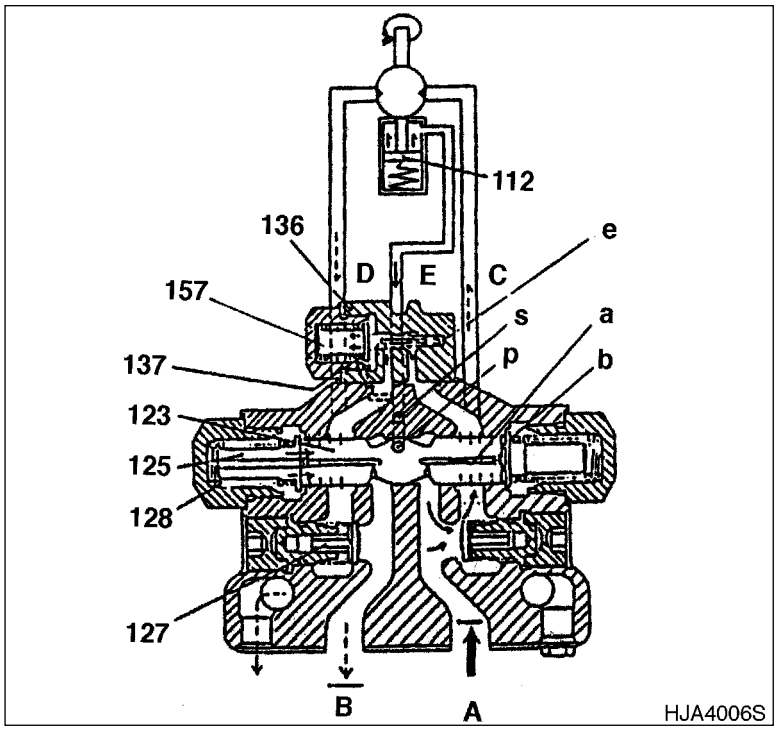


Figure 4

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

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

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

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

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

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

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

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

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

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

3. Parking Brake

C. During Travel.

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

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

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

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

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

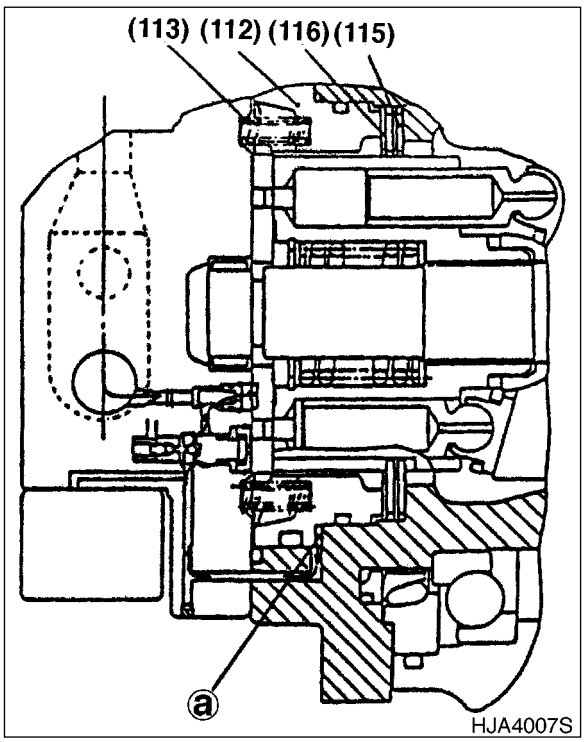


Figure 5

D. During Braking.

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

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

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

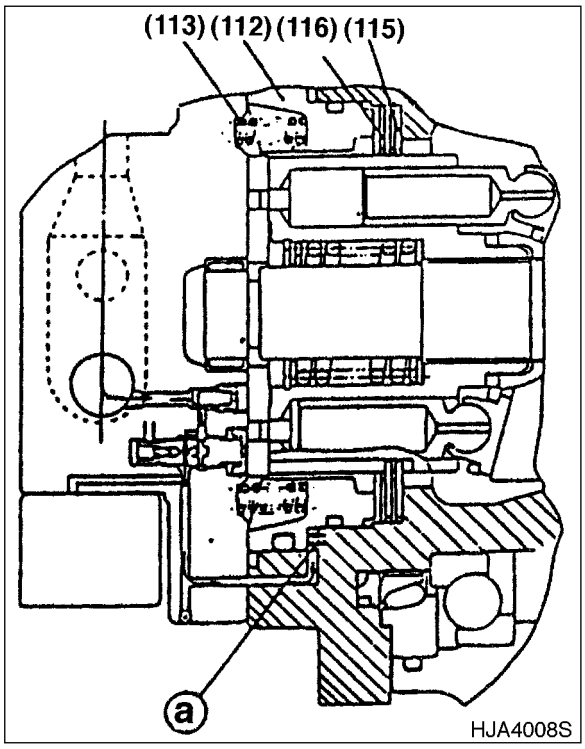


Figure 6

4. High and Low Speed Switching Device

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

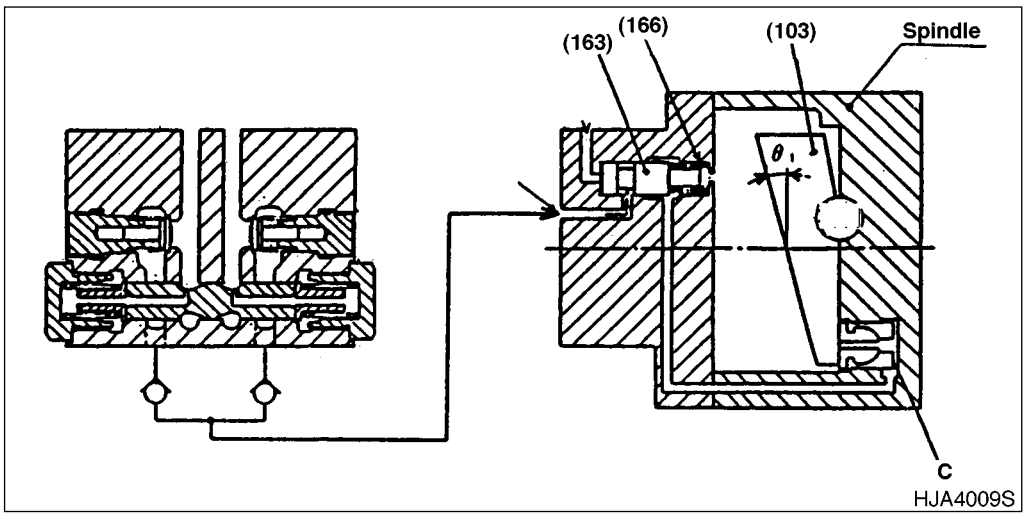


Figure 7

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

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

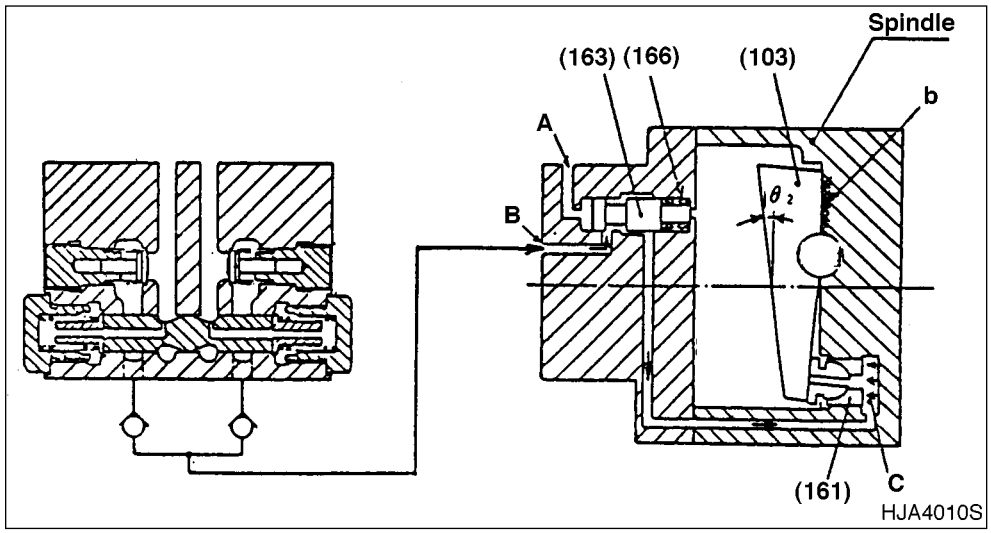


Figure 8

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

REDUCTION GEARBOX OPERATION

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

1. Planetary gear

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

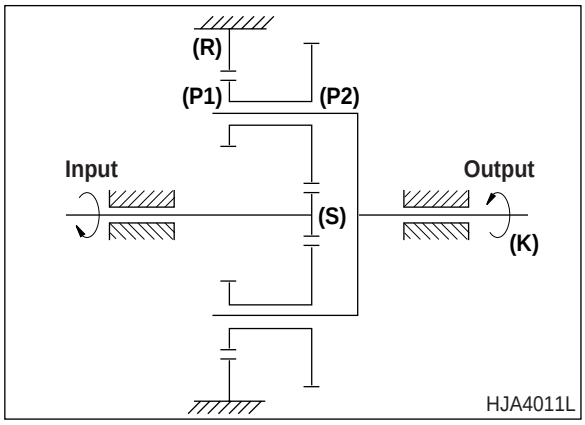


Figure 9

2. Differential gear

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

$$_2 = \frac{}{- \frac{\cdot \ _2}{\cdot \ _1}}$$

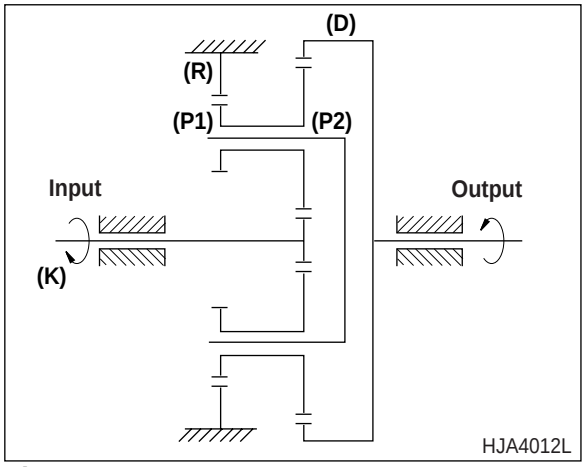


Figure 10

3. Combined device of planetary and differential dvice.

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

$$= {}_1 \times {}_2$$

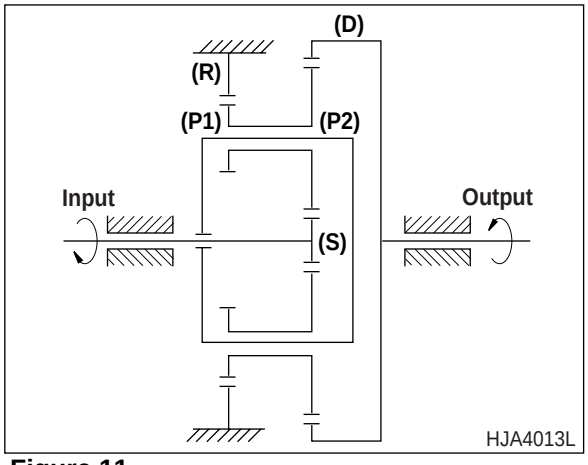


Figure 11

PARTS LIST

Travel Motor

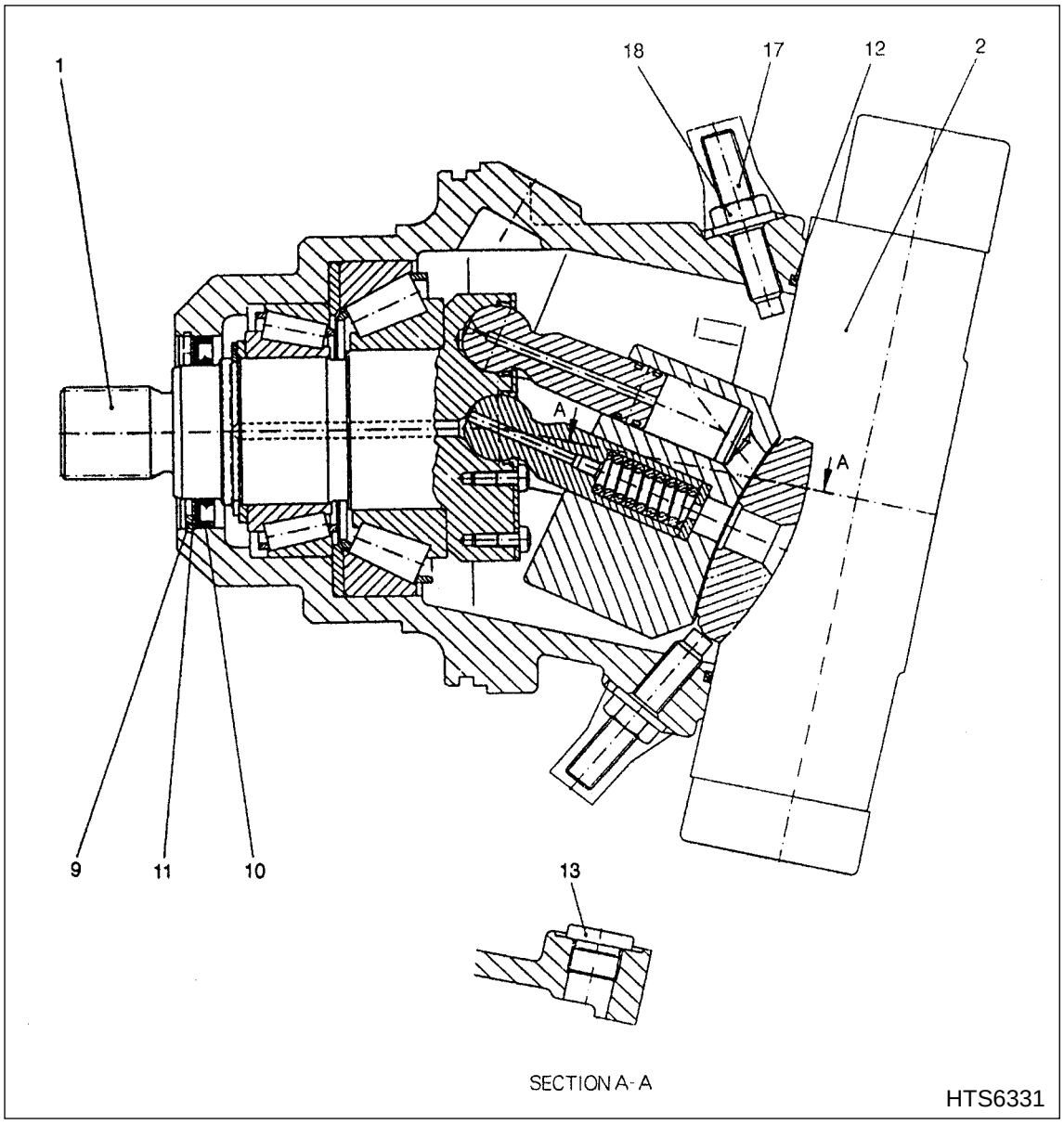


Figure 12

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

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

Travel Motor - Rotary Group

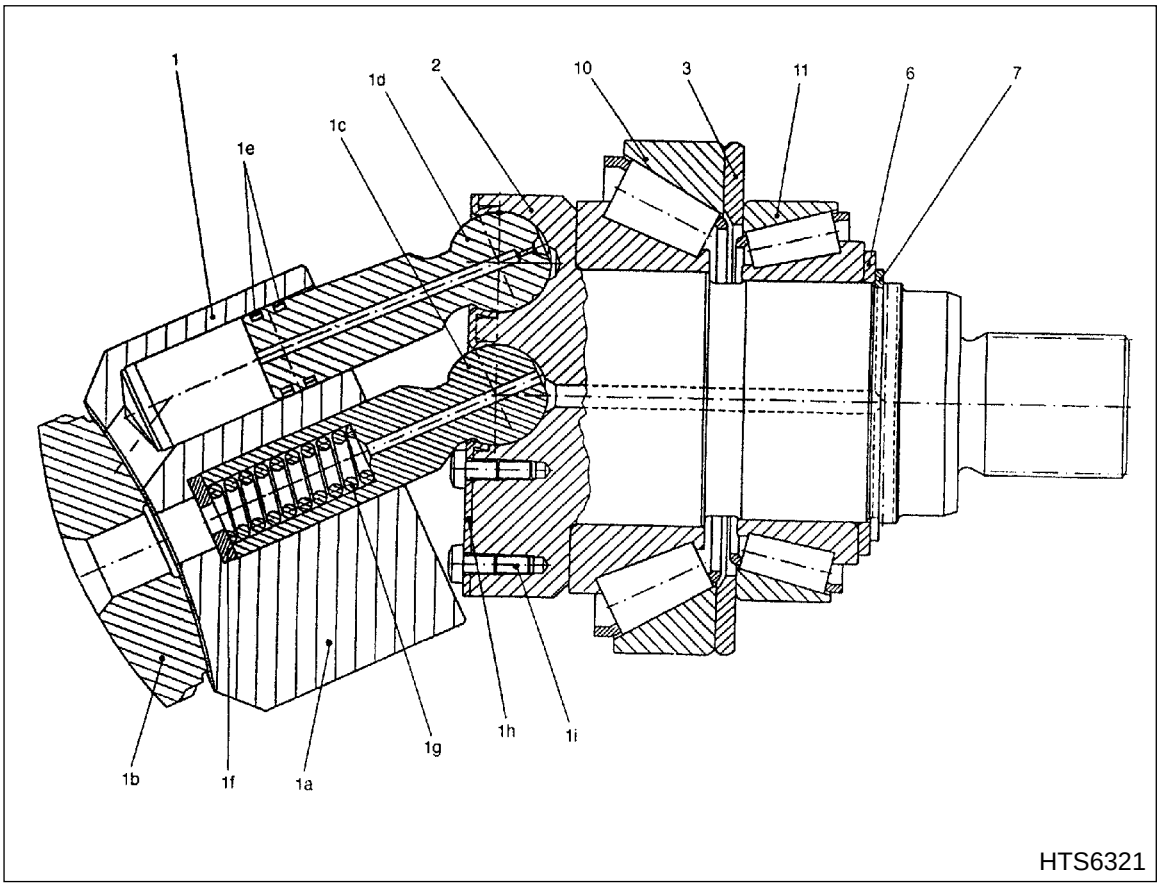
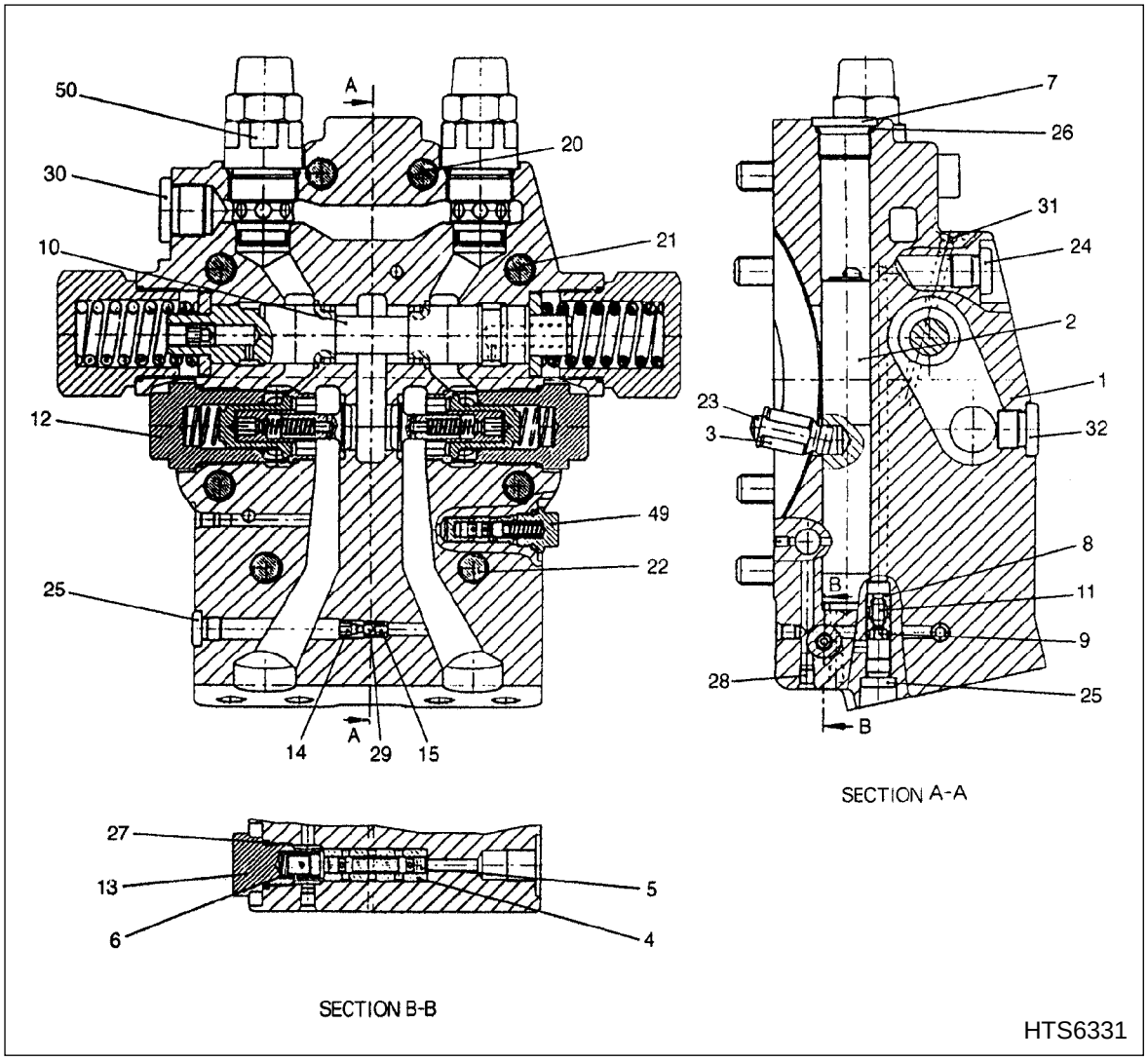


Figure 13

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

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


50
30
10
12
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A
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SECTION B-B
7
26
31
24
2
1
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32
8
11
9
28
25
B
SECTION A-A
HTS6331

Figure 14

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

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

Travel Motor Speed Reduction Gearbox Assembly

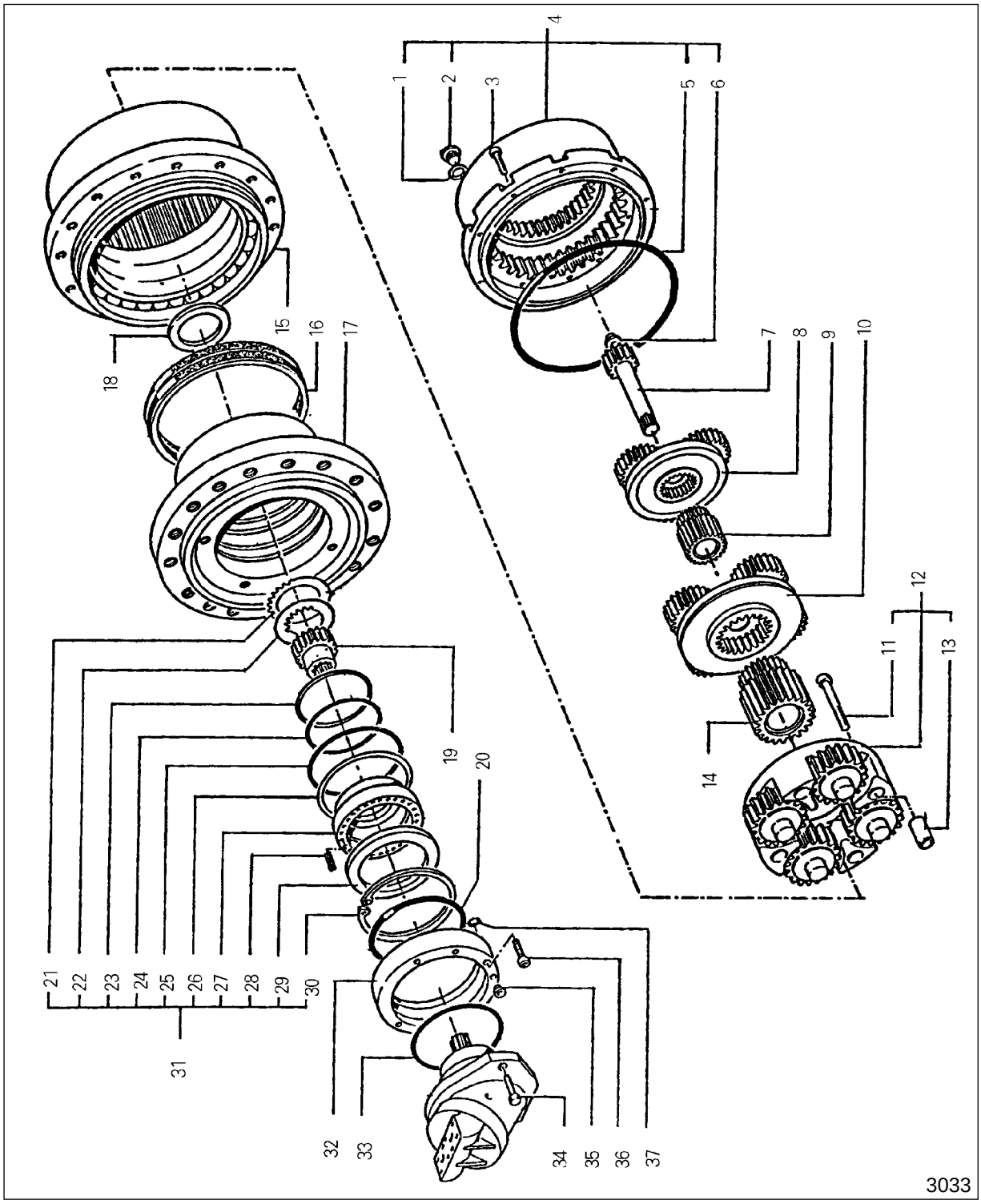


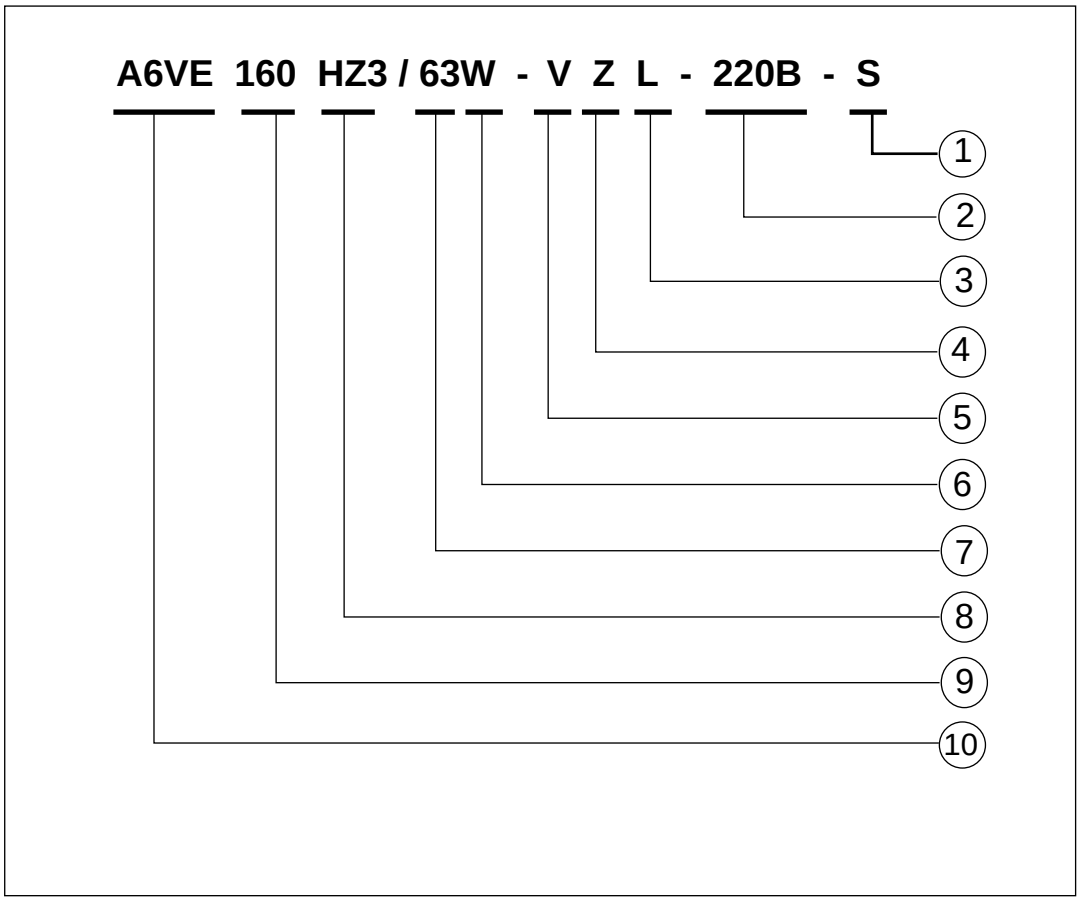
Figure 15

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

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

SPECIFICATIONS

Name Plate Identification



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

Component specifications are shown in following table.

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

TIGHTENING TORQUES

Tightening Torques For Shat Bolts (Metric ISO Standard Thread)							
The valve for tightening torques shown in the table are valid only for shaft bolts with metric ISO-standard threads and head support surface dimensions in accordance with DIN 912, DIN 931 and DIN 933. These values are also valid only for light or unoiled, untreated surface and for use only with torque-indicating wrenches and force limiting tools.	**Thread Size**	**Strength Classes**					
		8.8	**10.9**	**12.9**	**8.8**	**10.9**	**12.9**
		Tightening Torques (lb.ft)			**Tightening Torques (Nm)**		
	M3	0.8	1.2	1.4	1.1	1.6	1.9
	M4	2.1	3.0	3.6	2.9	4.1	4.9
	M5	4.4	6.3	7.4	6	8.5	10
	M6	7.4	10.3	12.5	10	14	17
	M8	18.4	25.8	30.2	25	96	41
	M10	36.1	50.9	61.2	49	69	83
	M12	63.4	88.4	106.9	86	120	145
	M14	99.5	140.0	169.5	135	190	230
	M16	154.8	217.4	261.6	210	295	355
	M18	213.7	298.5	357.4	290	405	485
	M20	302.2	427.5	508.5	410	580	690
	M22	405.4	574.9	685.4	550	780	930
	M24	523.5	737.0	884.4	710	1000	1200
	M27	773.9	1105.5	1326.6	1050	1500	1800
	M30	1068.7	1474.0	1768.8	1450	2000	2400

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

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

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

TRAVEL MOTOR DISASSEMBLY

SECTIONAL VIEW

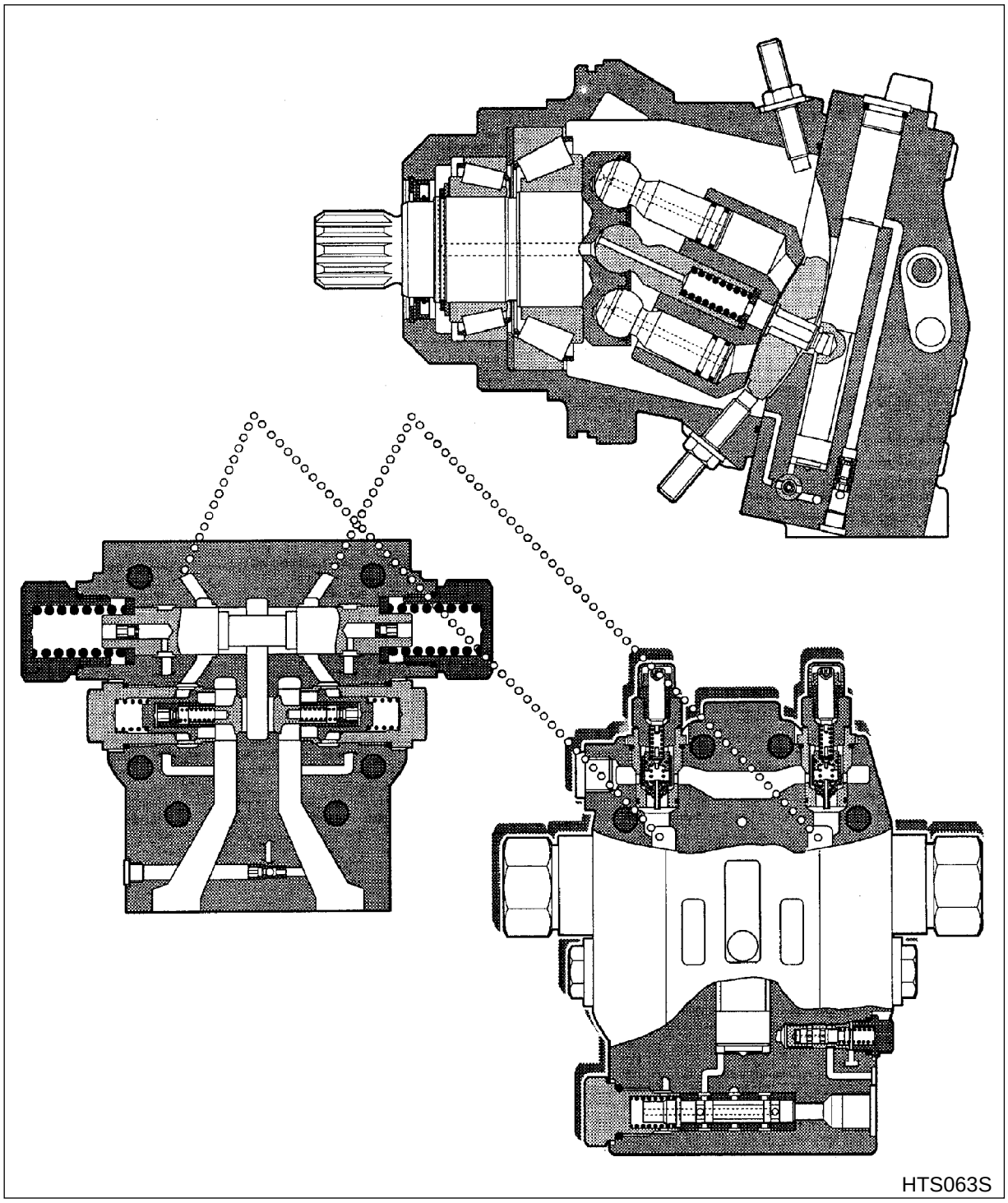


Figure 16

SEAL KITS AND COMPONENT GROUPS

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

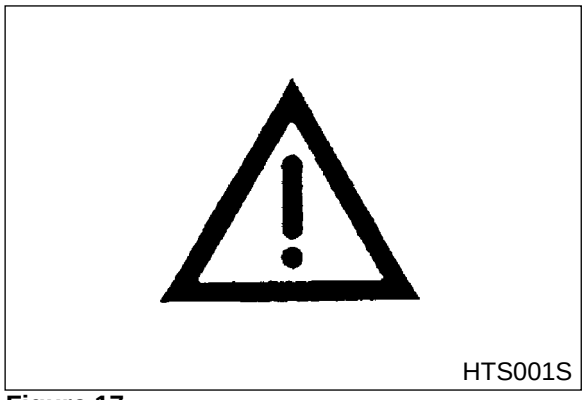


Figure 17

1. Close all points of the hydaulic aggregates.

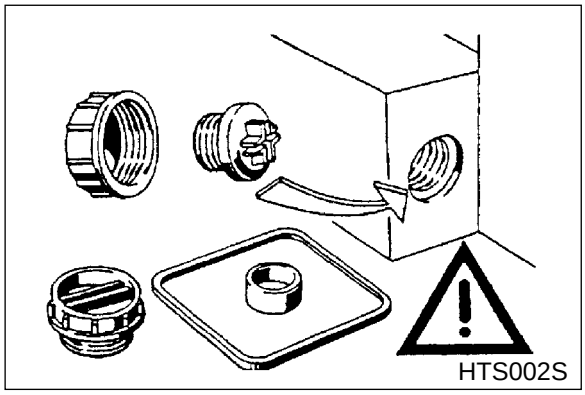


Figure 18

2. Replace all seals.

   NOTE: *Use only original Hydromatik spare parts.*

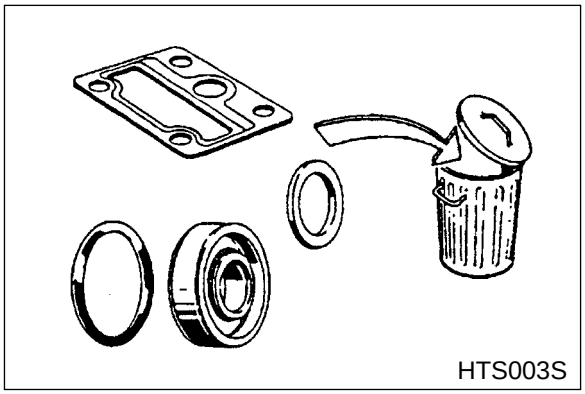


Figure 19

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

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

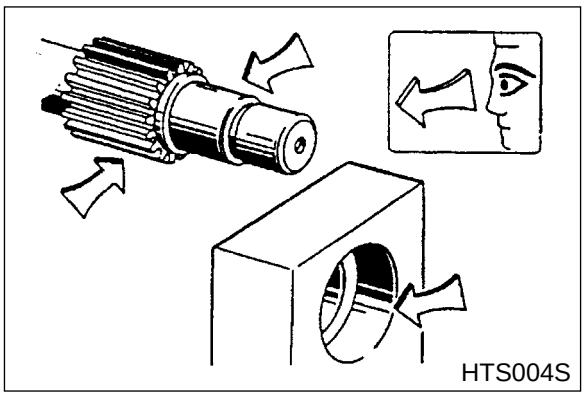


Figure 20

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

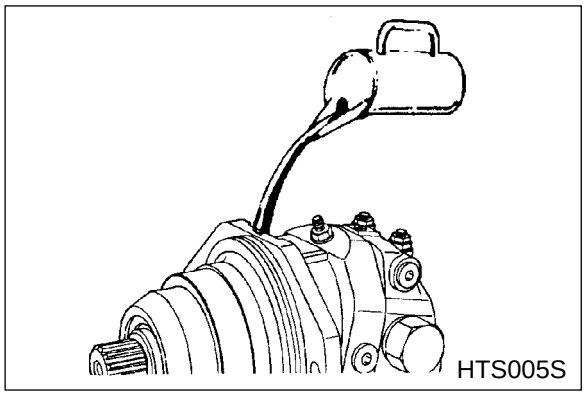


Figure 21

5. Seal kit for drive shaft.

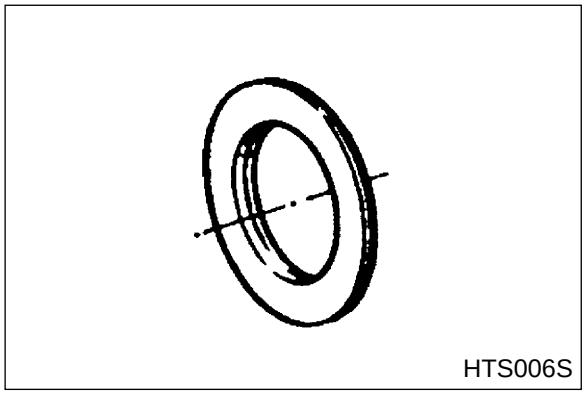


Figure 22

6. External seal kit.

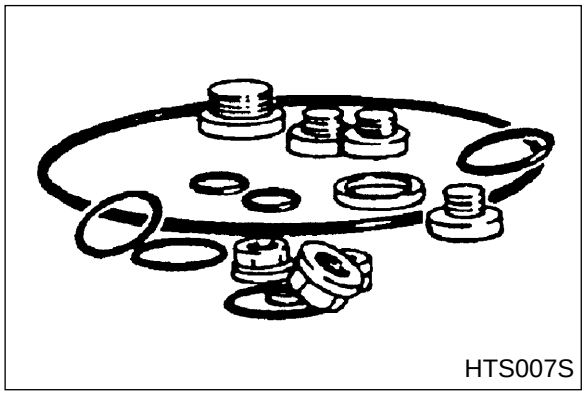


Figure 23

7. Housing.

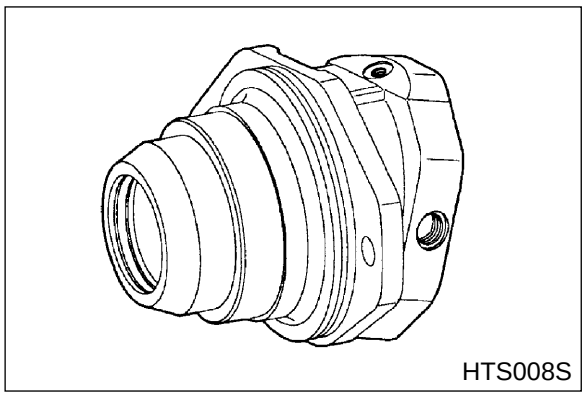


Figure 24

8. Complete rotary group.

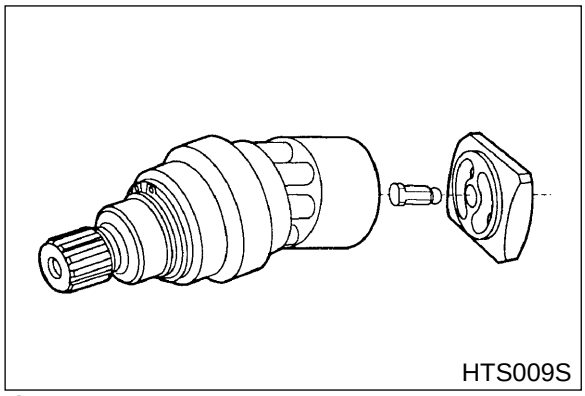


Figure 25

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

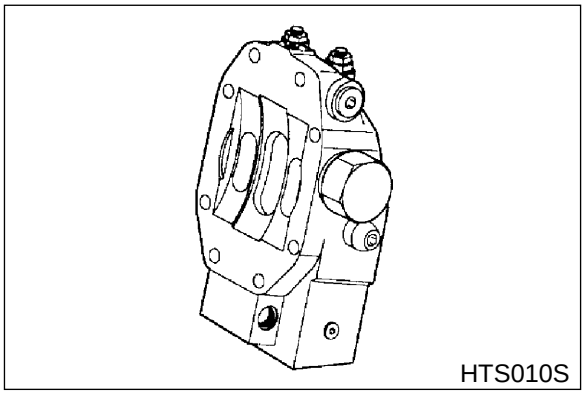


Figure 26

10. Relief valve / Make up check valve.

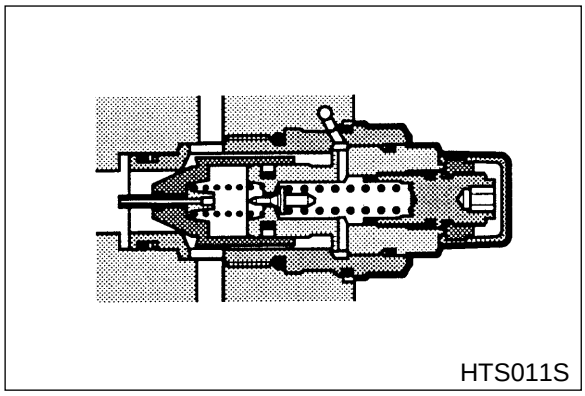


Figure 27

11. Replace seal nut.

    NOTE: *First measure and record setting height.*

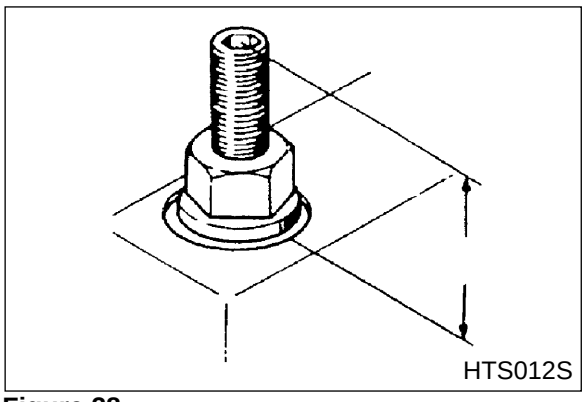


Figure 28

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

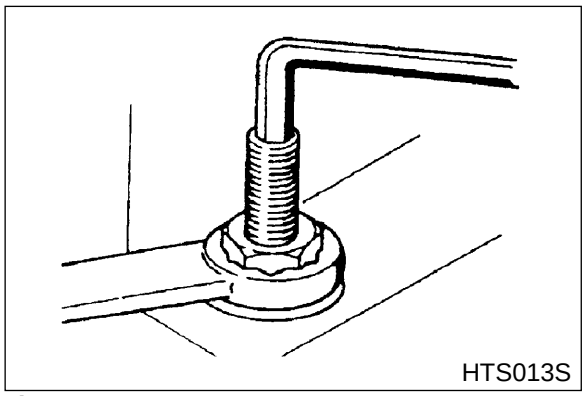


Figure 29

SEALING DRIVE SHAFT

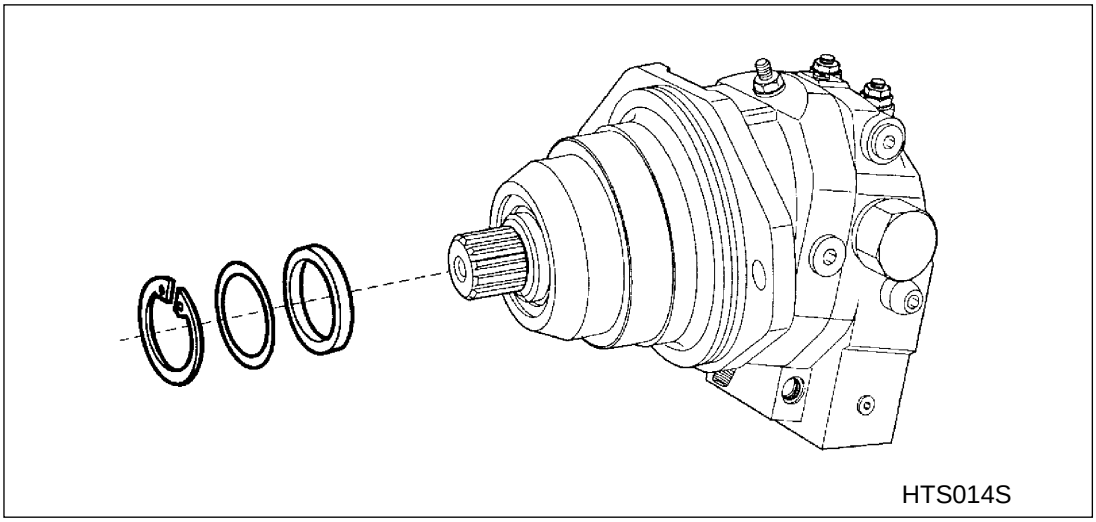


Figure 30

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

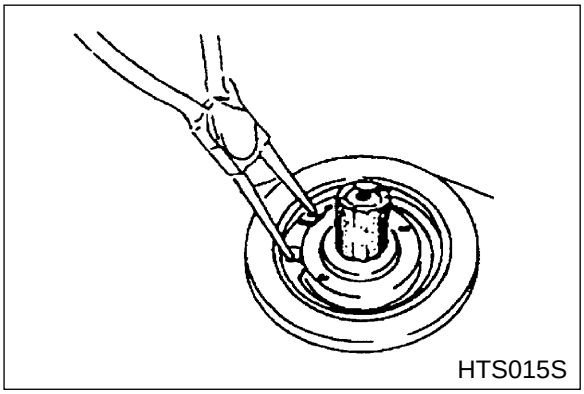


Figure 31

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

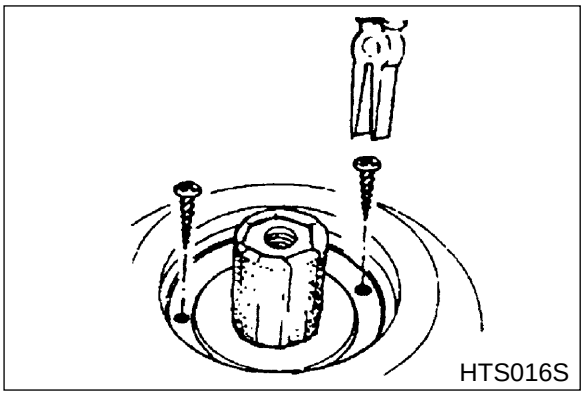


Figure 32

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

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

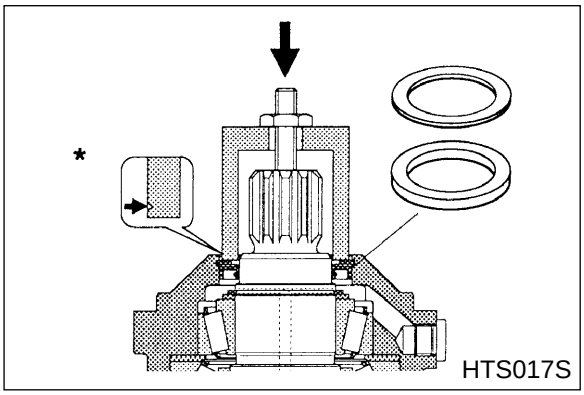


Figure 33

SEALING CONTROL PARTS

1. H-Z- Controler.

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

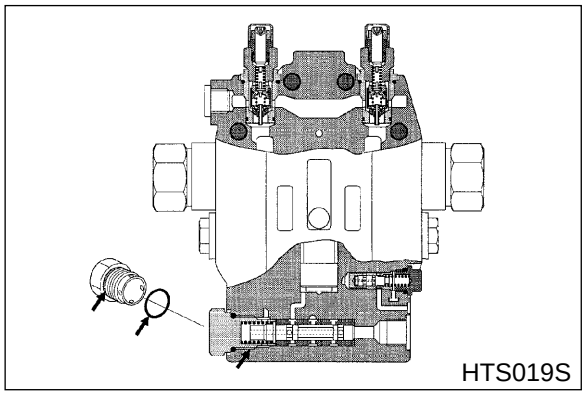


Figure 34

SEALING RELIEF VALVE

1. Remove relief valve.

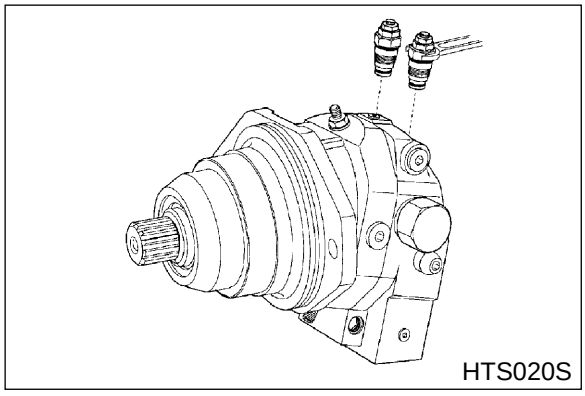


Figure 35

2. Inspect O-ring.

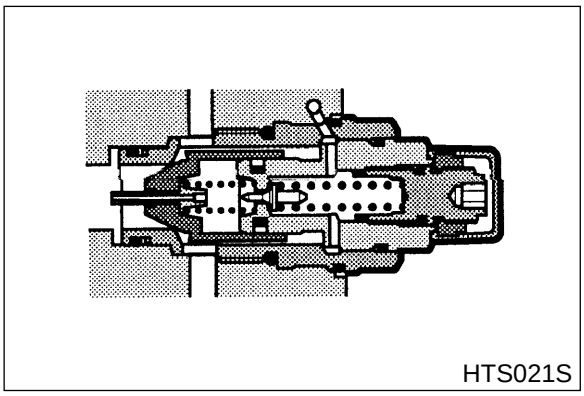


Figure 36

DISASSEMBLY PORT PLATE

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

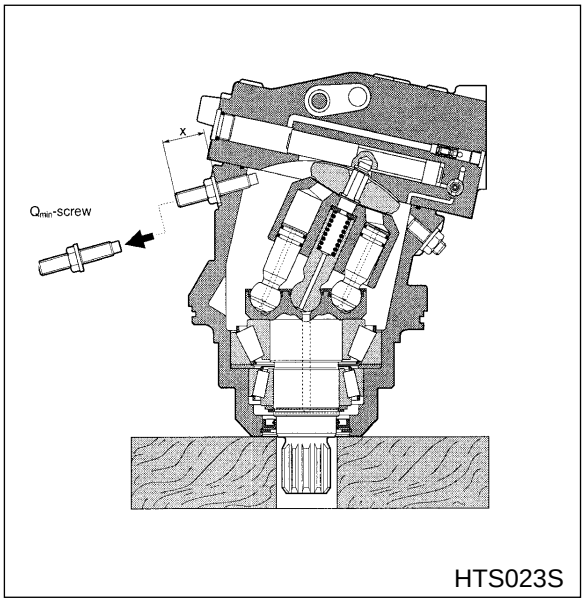


Figure 37

3. For disassembly of the port plate, swivel always rotary group to zero position.
4. Piston rings to hang out the cylinder boring. Swivel rotary group to zero position with screw Q max.

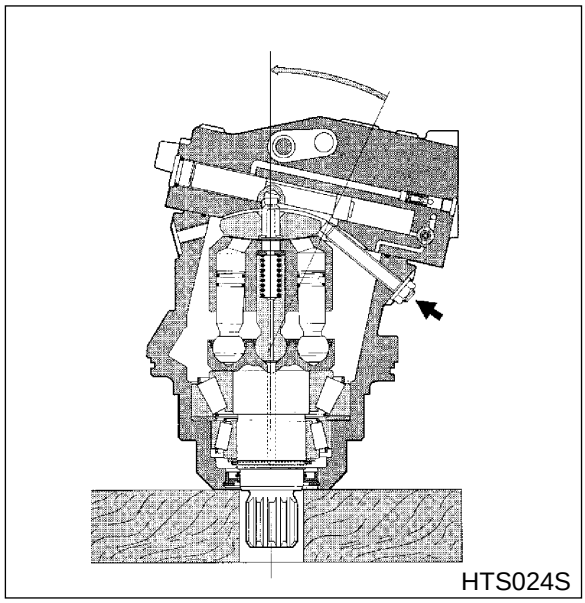


Figure 38

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

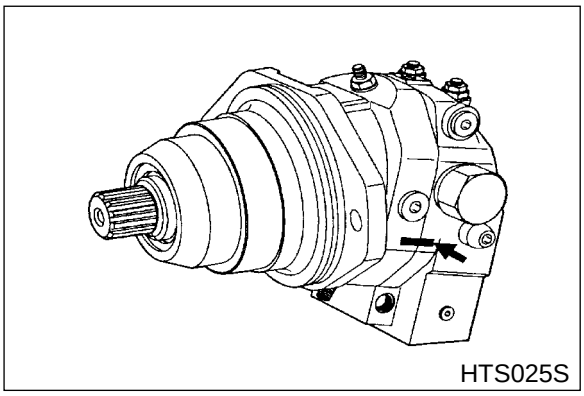


Figure 39

6. Ceck O-ring.

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

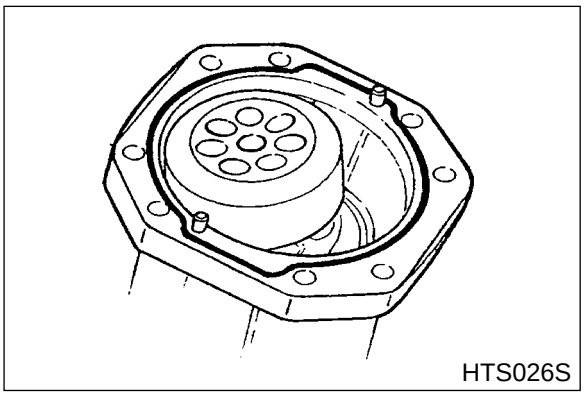


Figure 40

7. Braking valve.

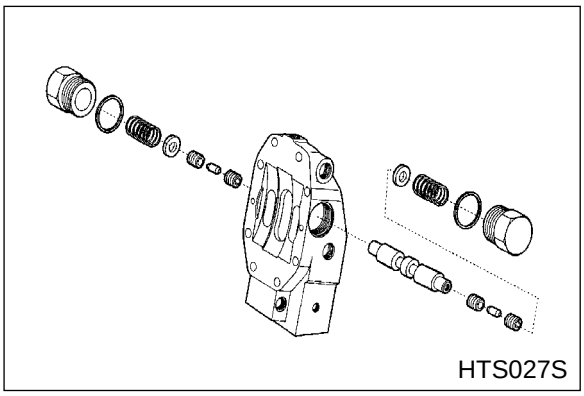


Figure 41

8. Throttle pin.

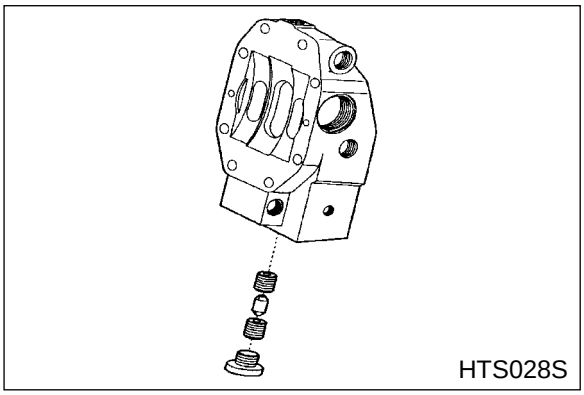


Figure 42

9. Valve.

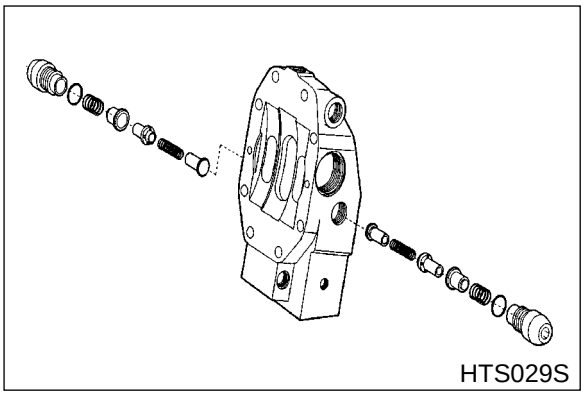


Figure 43

10. Pressure control valve.

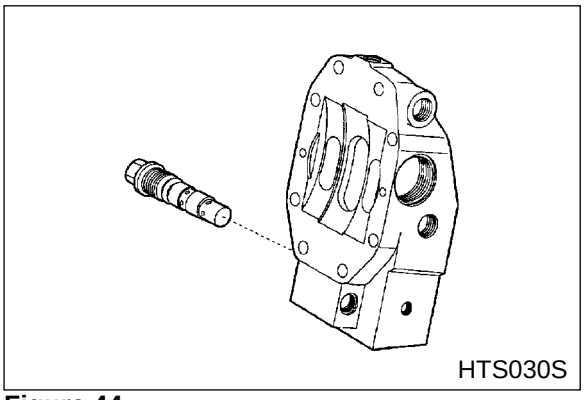


Figure 44

11. Pressure relief valve.

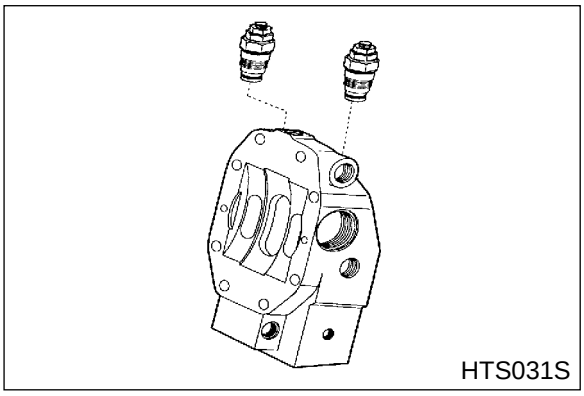


Figure 45

12. Positioning piston.

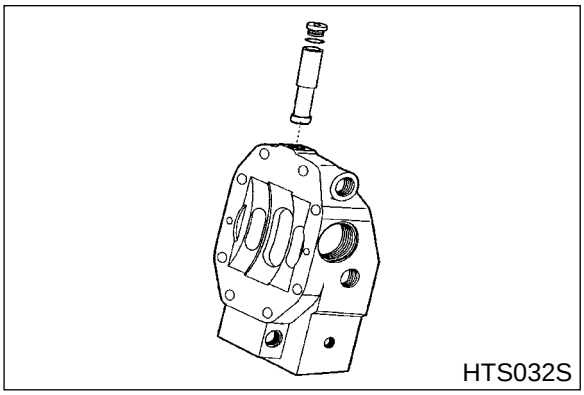


Figure 46

13. H-Z- control.

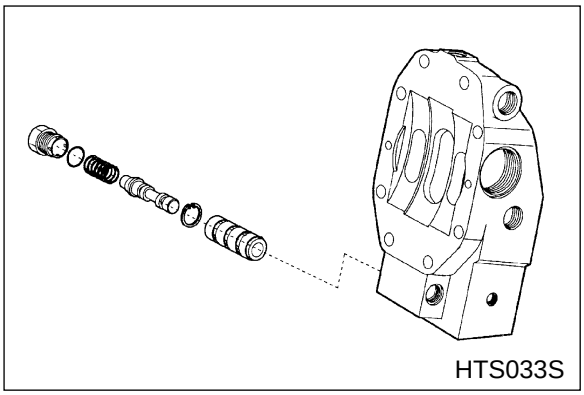


Figure 47

14. Check valve.

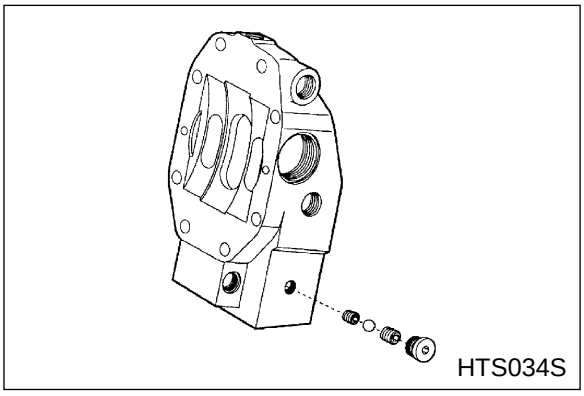


Figure 48

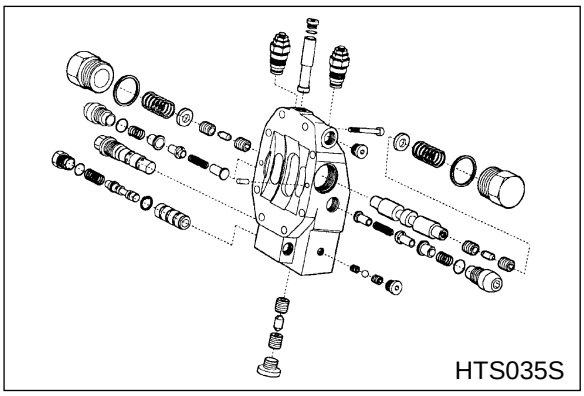


Figure 49

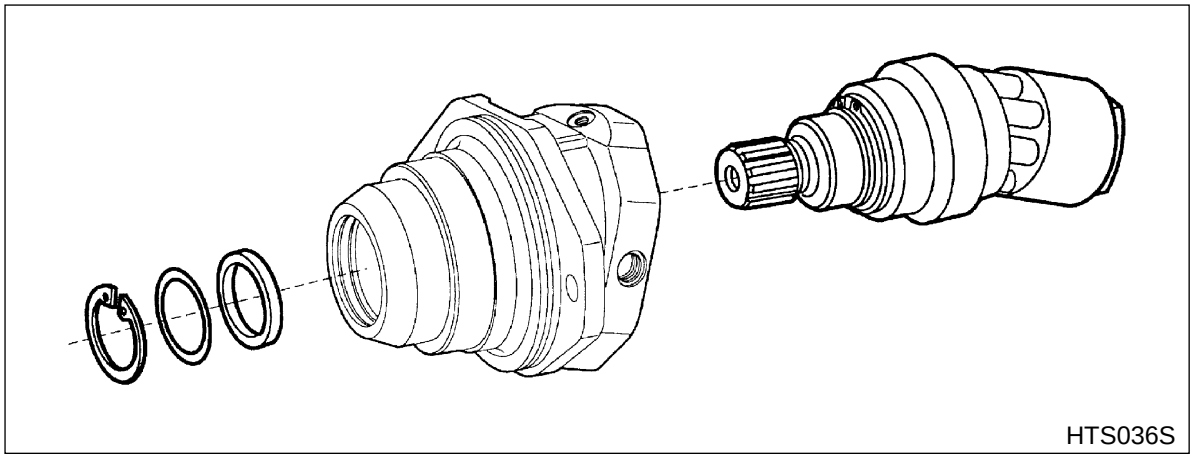


Figure 50

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

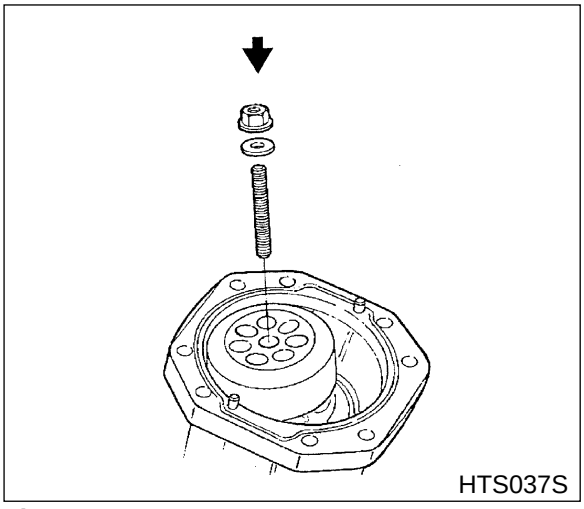


Figure 51

17. Press out rotary group.

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

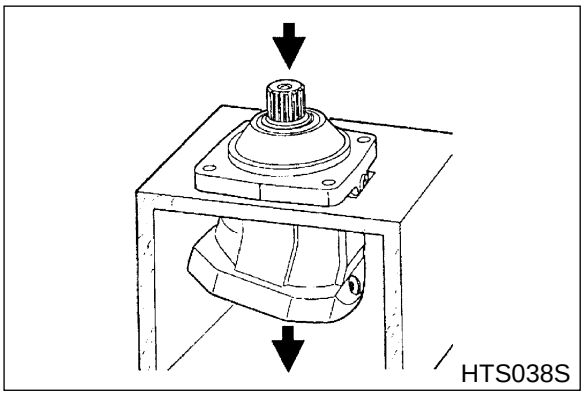


Figure 52

EXCHANGING ROTARY GROUP

1. Complete rotary group.

    NOTE: *Setting of hydraulic part necessary.*

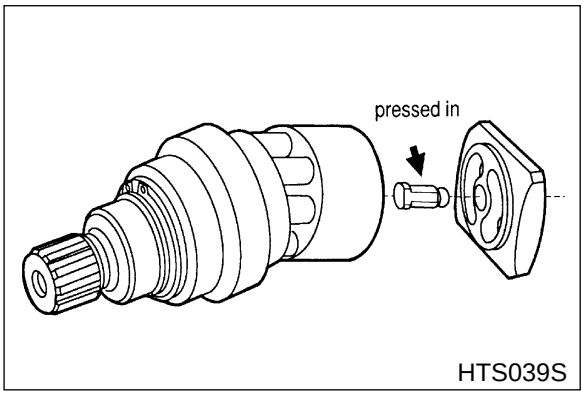


Figure 53

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

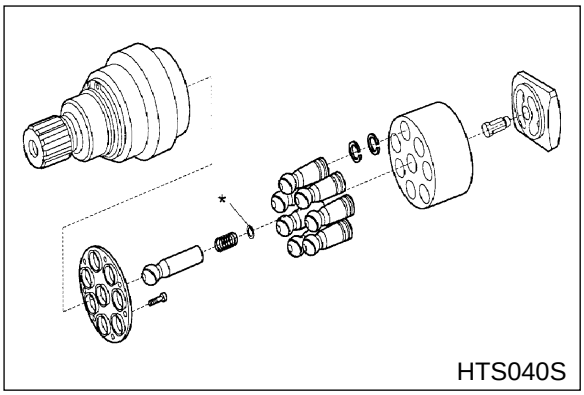


Figure 54

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

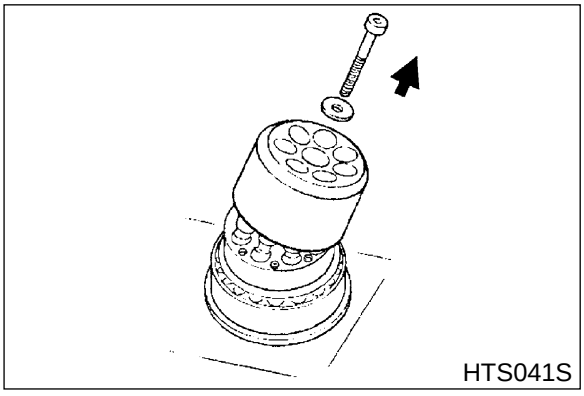


Figure 55

5. Disassemble retaining plate.

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

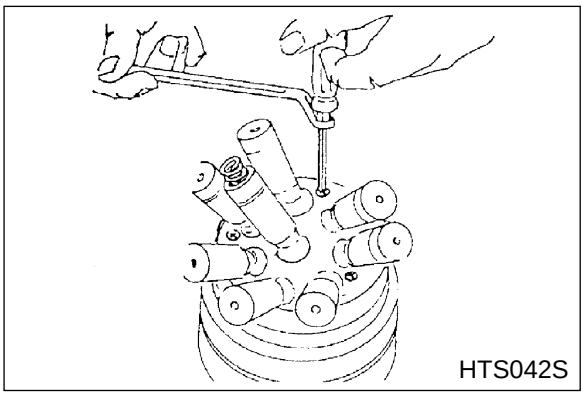


Figure 56

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

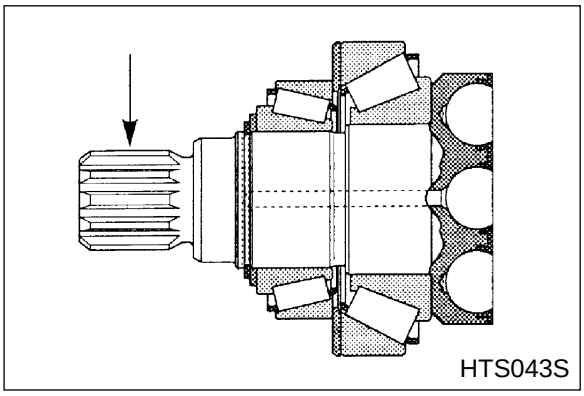


Figure 57

7. Pistons; No scoring and no pittings.

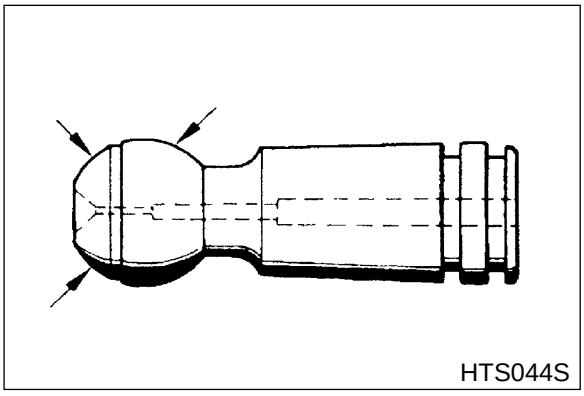


Figure 58

8. Center pin; No scoring and no pittings.

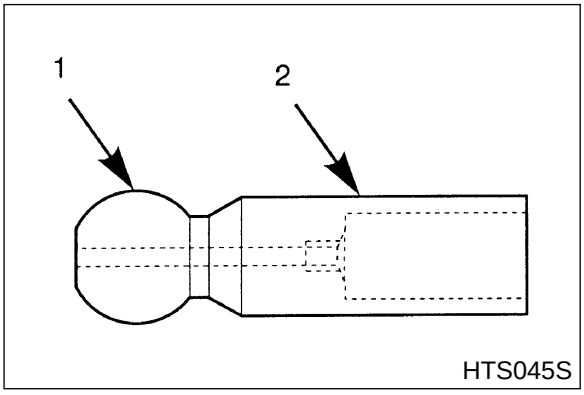


Figure 59

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

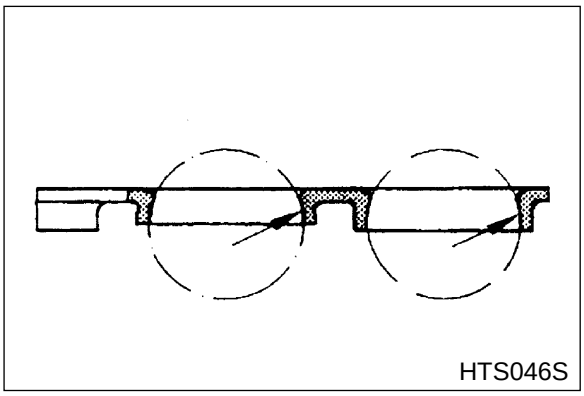


Figure 60

10. Cylinder block / control lens;

    Bores free of scoring, no evidence of wear.

    Faces smooth and even, free of cracks and scoring.

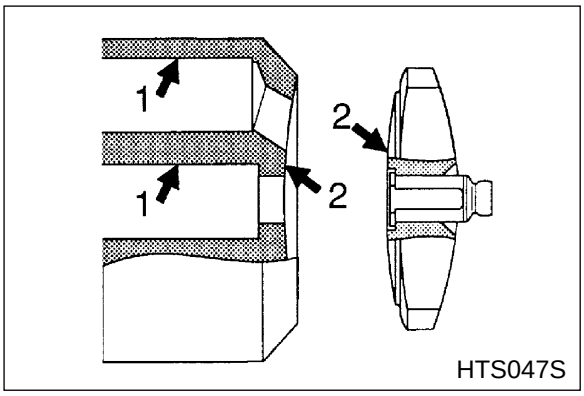


Figure 61

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

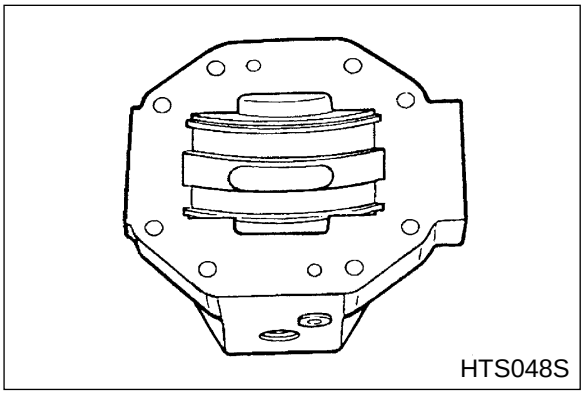


Figure 62

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

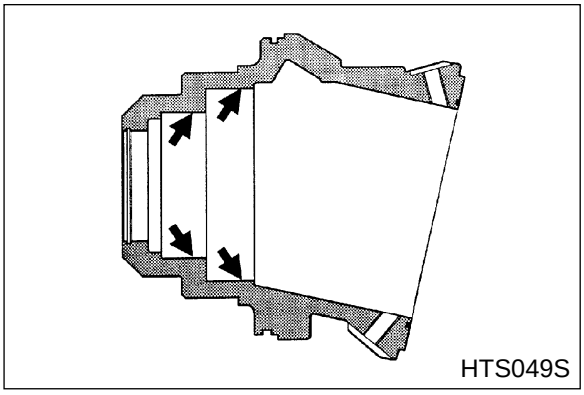


Figure 63

TRAVEL MOTOR SPEED REDUCTION GEARBOX DISASSEMBLY

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

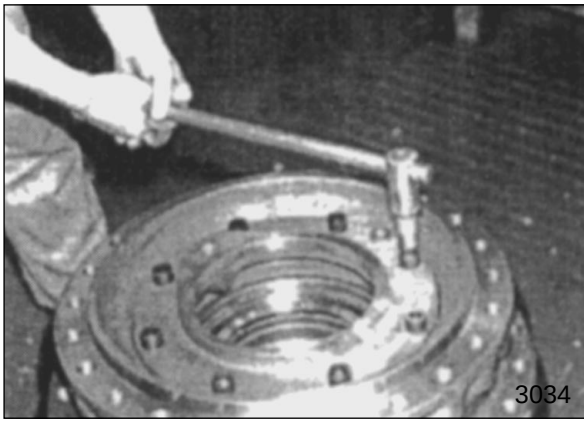


Figure 64

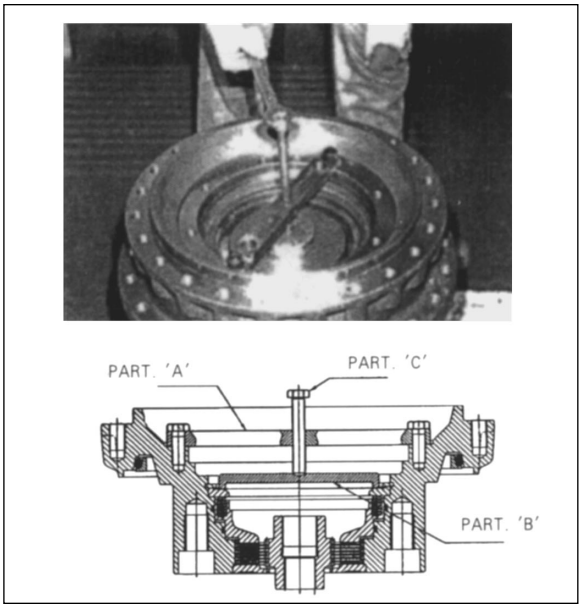
3. Remove O-ring from motor flange. Figure 65.

Figure 65

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

Figure 66

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



3037

Figure 67

6. Remove circlip from hub groove using pliers. Figure 68.

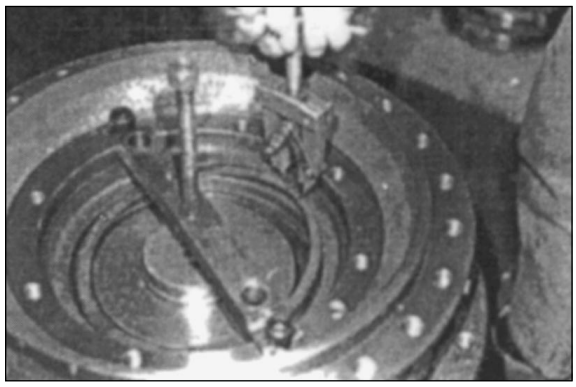


Figure 68

7. Remove jig and circlip. Figure 69.

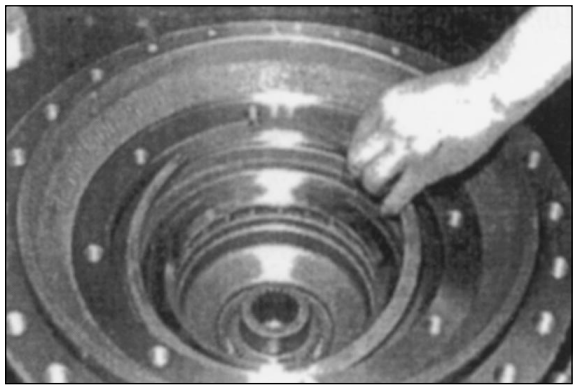


Figure 69

8. Remove spring retainer. Figure 70.

Figure 70

9. Pull spring from groove. Figure 71.

Figure 71

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

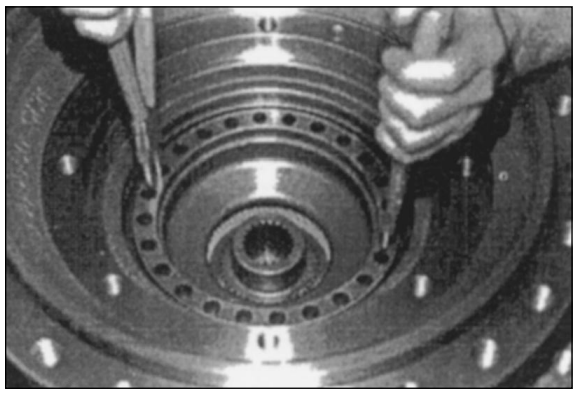


Figure 72

11. Remove brake shaft. Figure 73.

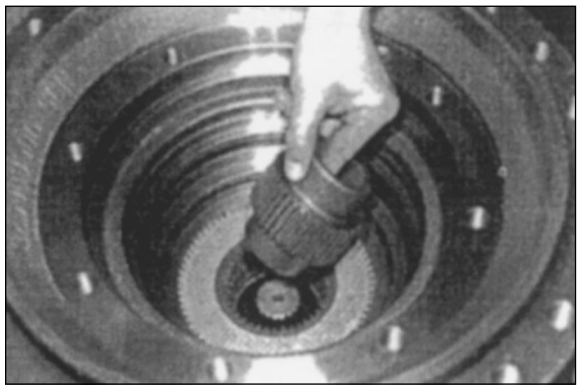


Figure 73

12. Remove disc. Figure 74.

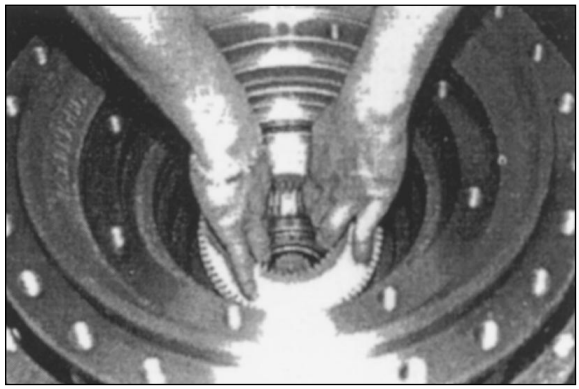


Figure 74

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

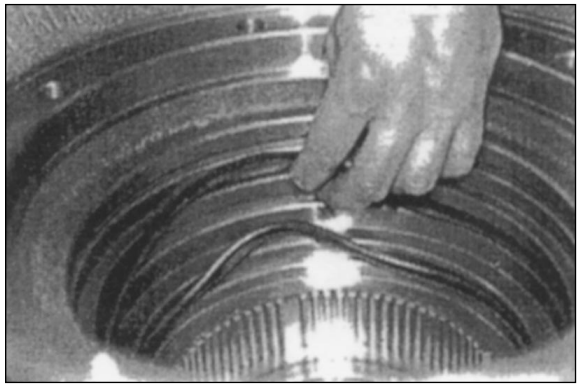


Figure 75

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

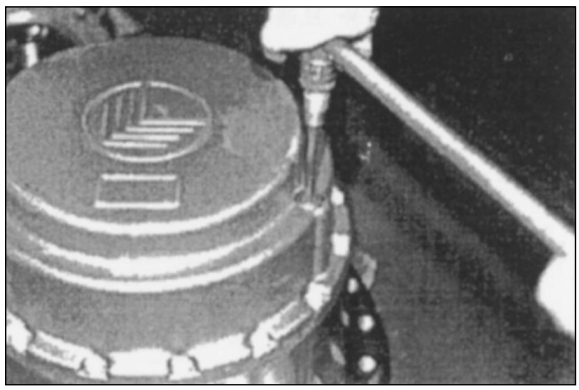


Figure 76

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

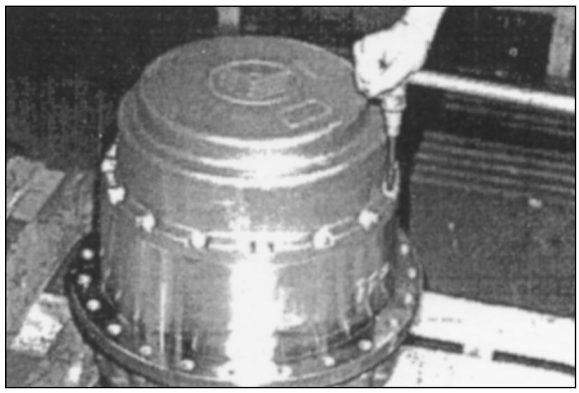


Figure 77

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

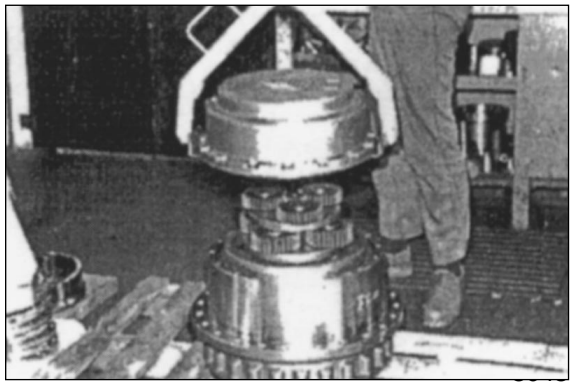


Figure 78

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

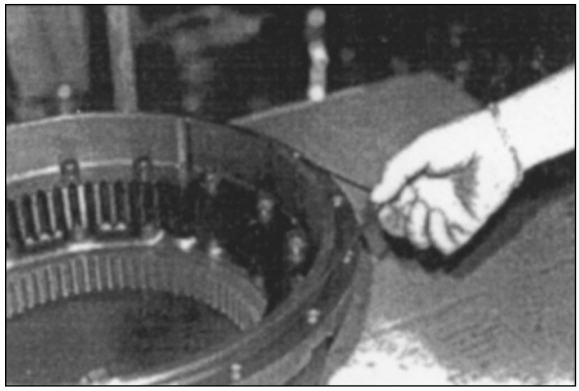


Figure 79

18. Remove first sun gear. Figure 80.

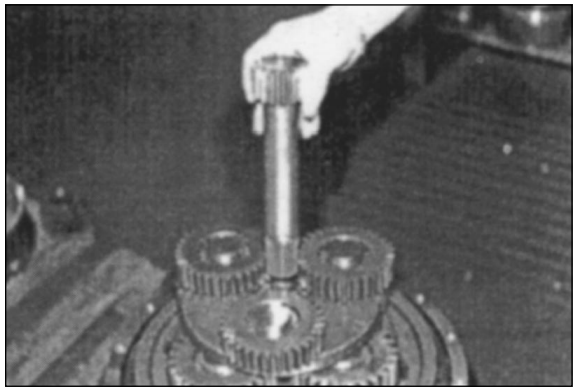


Figure 80

19. Remove first planetary gear assembly. Figure 81.

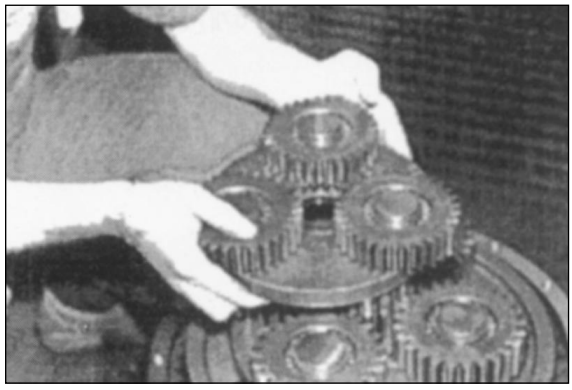


Figure 81

20. Remove second sun gear. Figure 82.

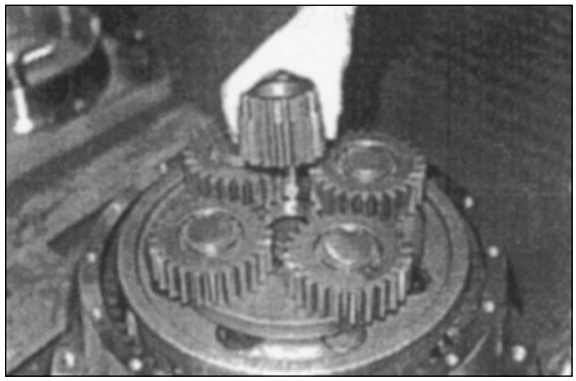


Figure 82

21. Remove second planetary gear assembly. Figure 83.

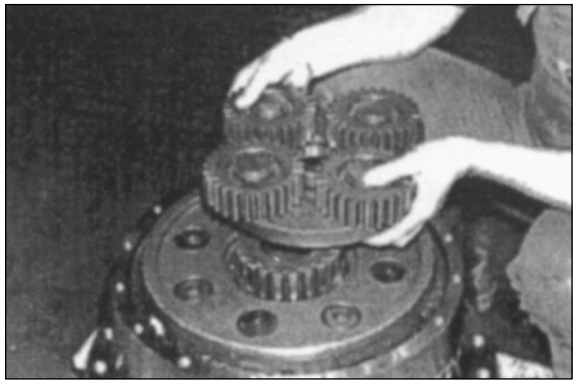


Figure 83

22. Remove third sun gear. Figure 84.

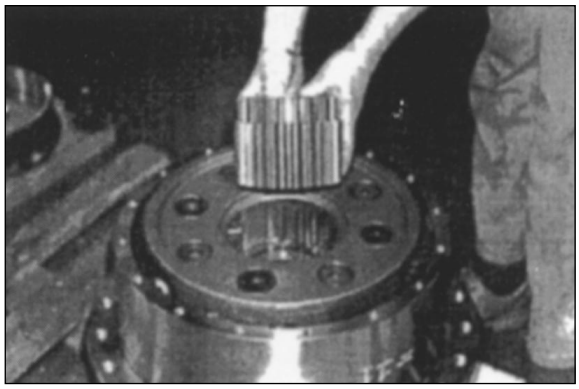


Figure 84

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

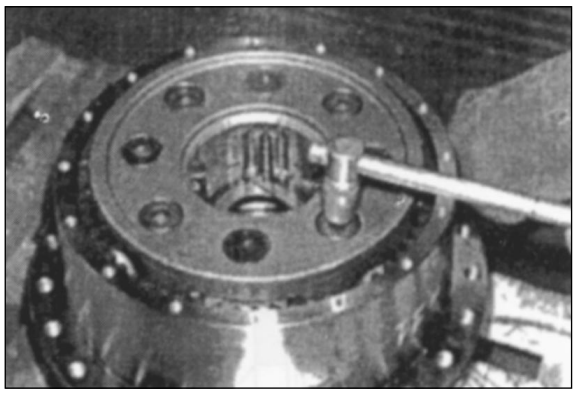


Figure 85

24. Remove bolts. Figure 86.

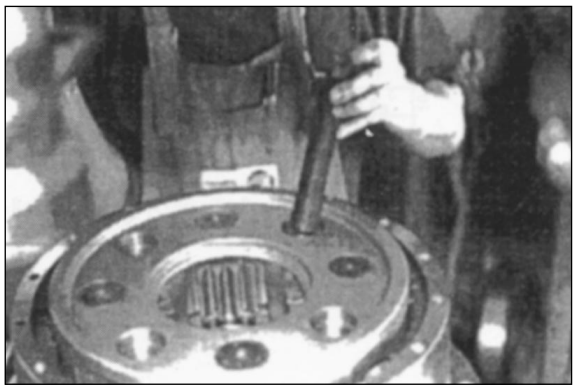


Figure 86

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

    NOTE: *Do not remove main ball bearing.*

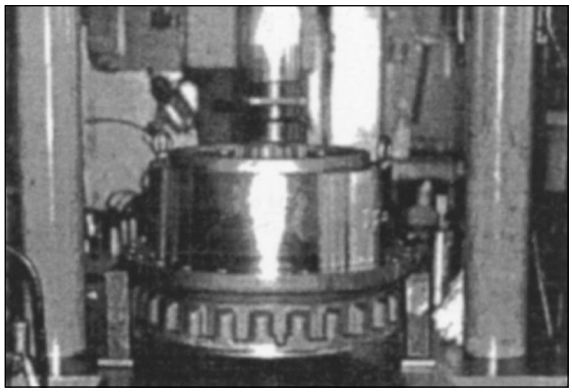


Figure 87

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

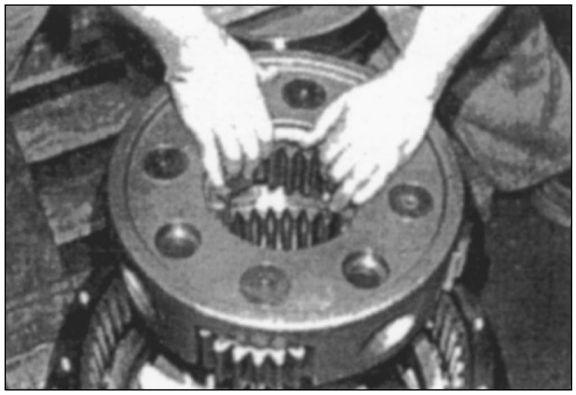


Figure 88

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

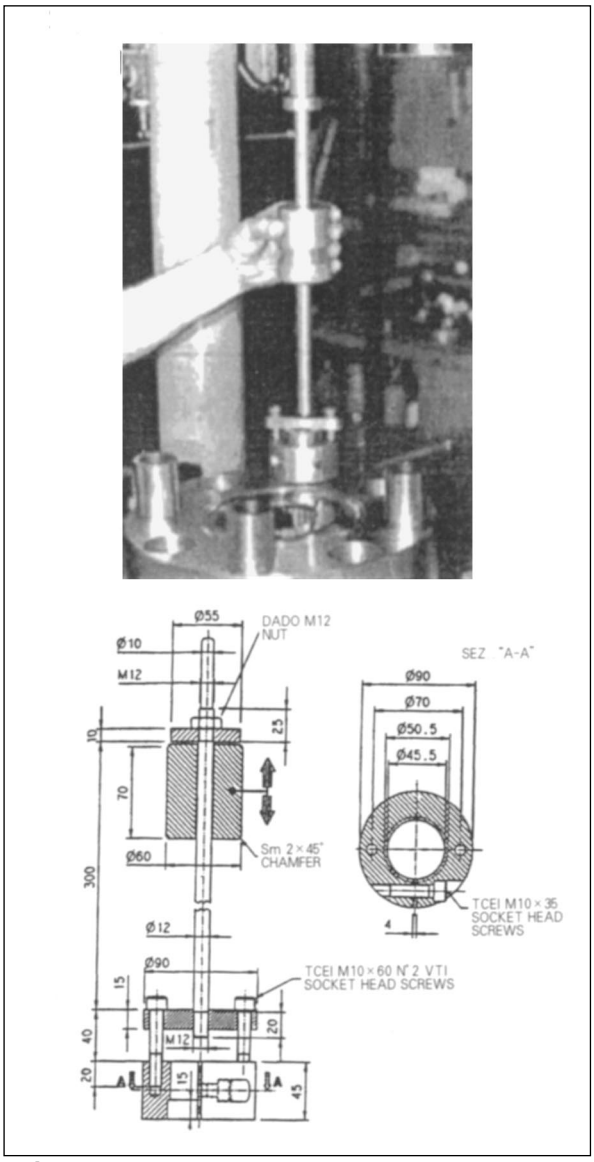


Figure 89

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

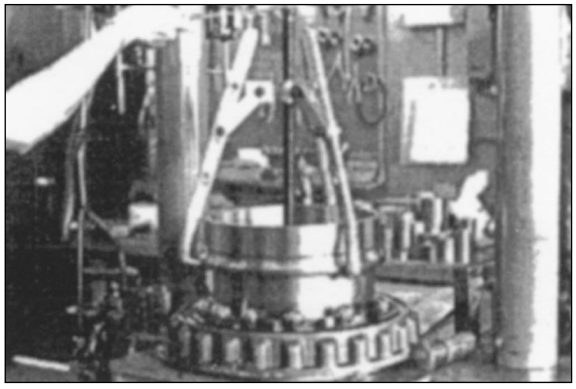


Figure 90

29. Remove gasket. Figure 91.

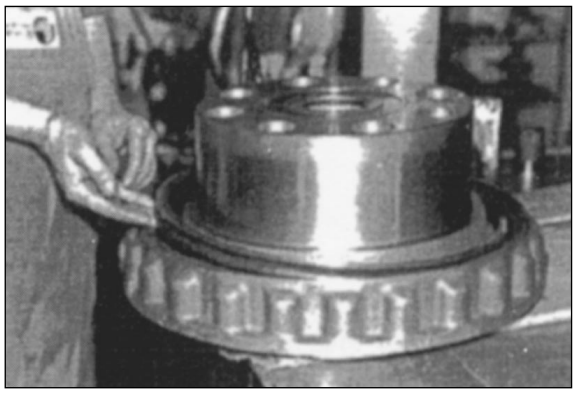


Figure 91

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

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

Gearbox Inspection

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

TRAVEL MOTOR SPEED REDUCTION GEARBOX REASSEMBLY

1. Install seal to jig. Figure 92.

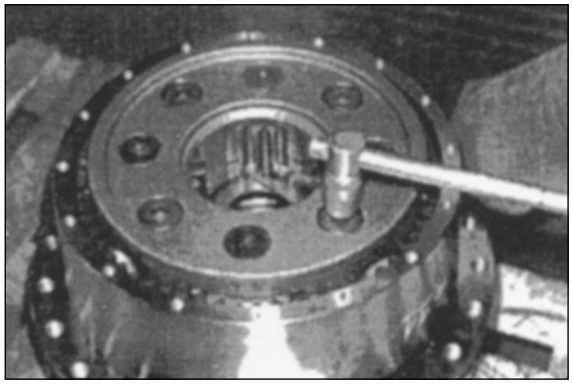


Figure 92

2. Install jig to housing. Figure 93.

Figure 93

3. Clean seal surface. Figure 94.

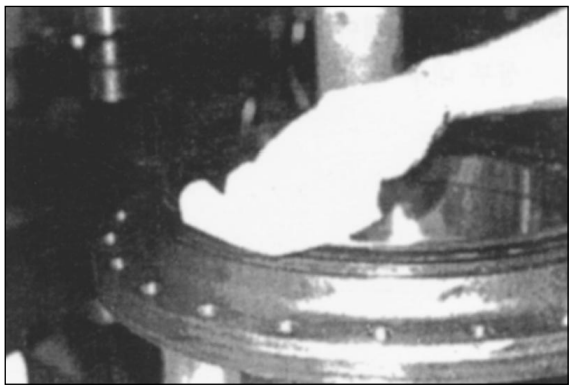


Figure 94

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

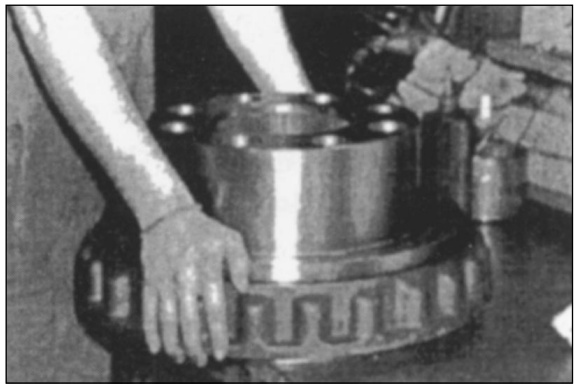


Figure 95

5. Apply lubricant to seal surface. Figure 96.

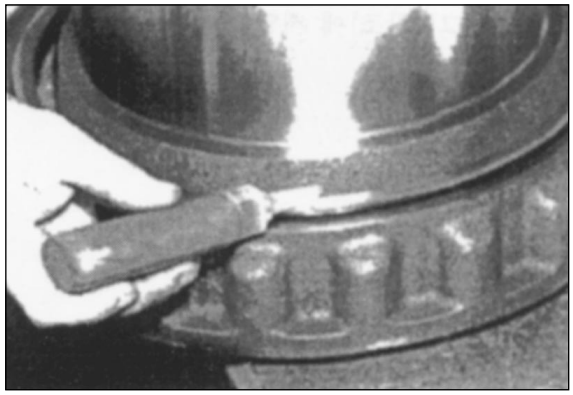


Figure 96

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

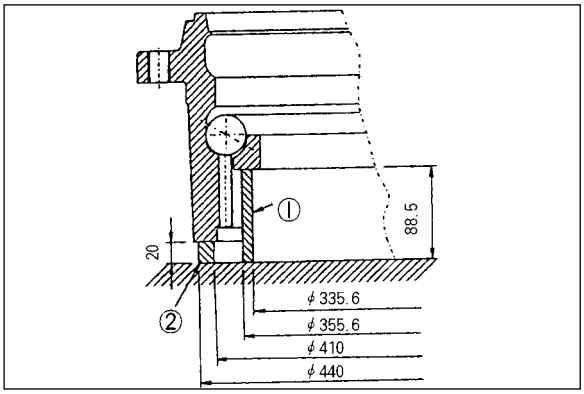


Figure 97

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

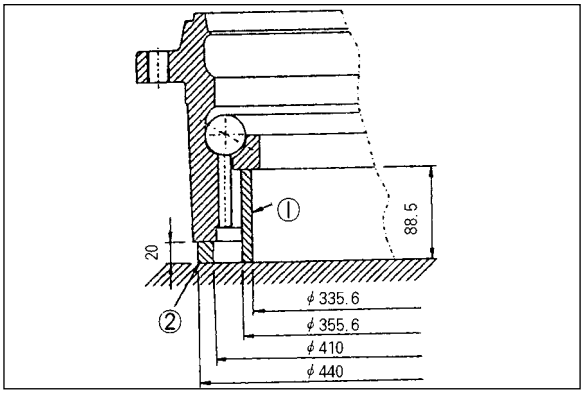


Figure 98

8. Install hub to housing. Figure 99.

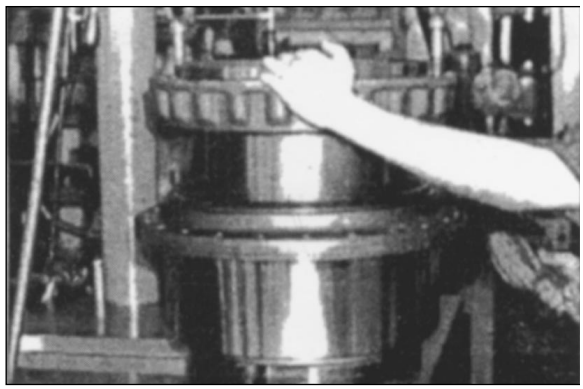


Figure 99

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

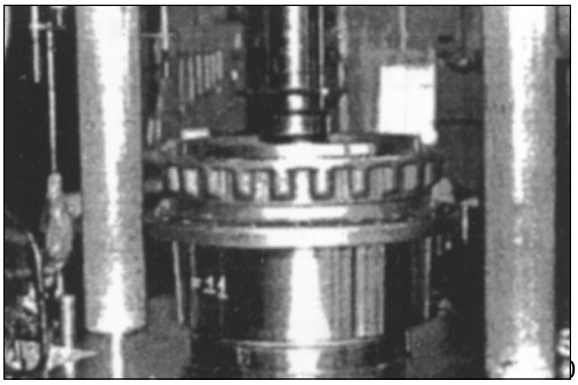


Figure 100

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

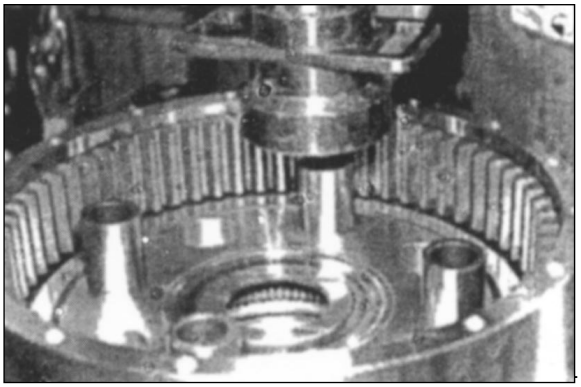


Figure 101

11. Assemble planetary gear assembly. Figure 102.

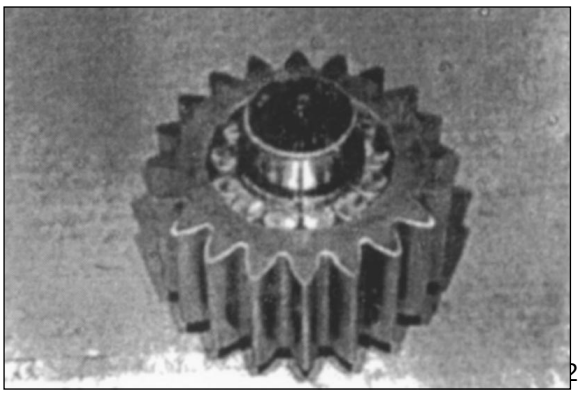


Figure 102

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

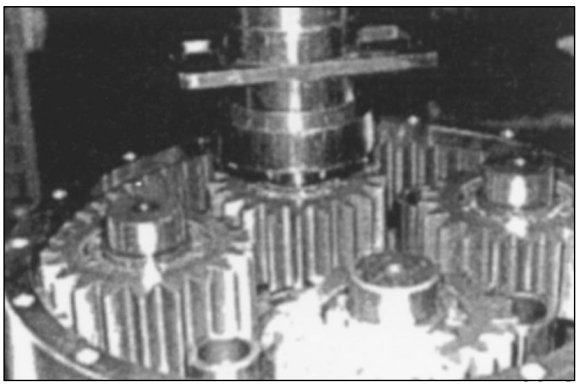


Figure 103

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

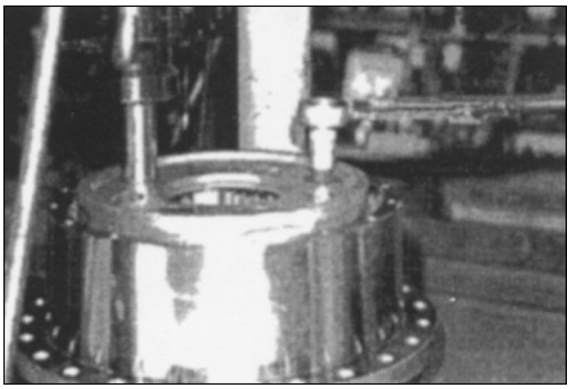


Figure 104

14. Assemble third shift sun gear. Figure 105.

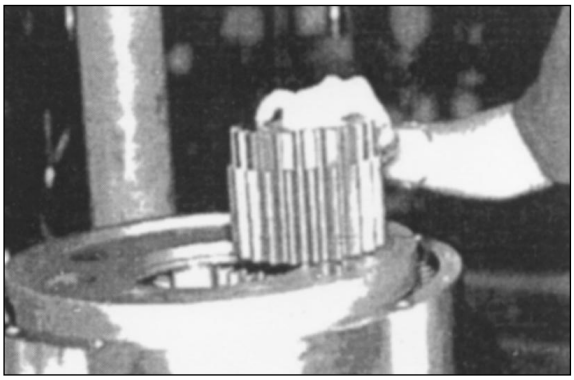


Figure 105

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

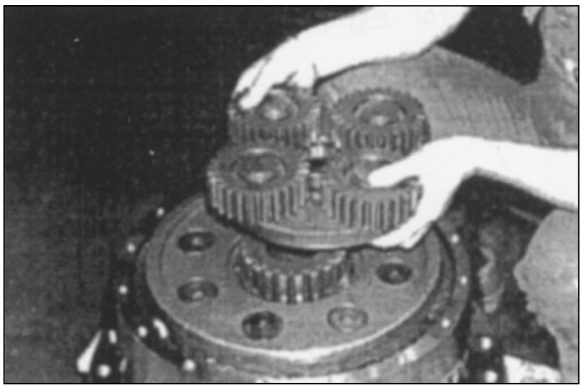


Figure 106

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

Figure 107

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

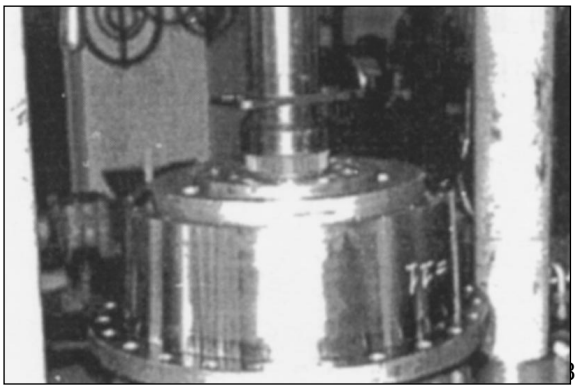


Figure 108

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

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

Figure 109

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

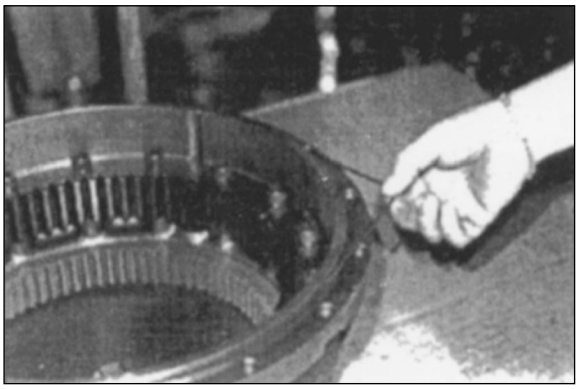


Figure 110

21. Install end cover to housing.

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

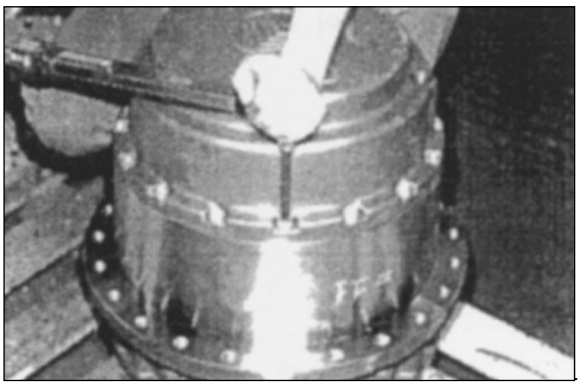


Figure 111

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

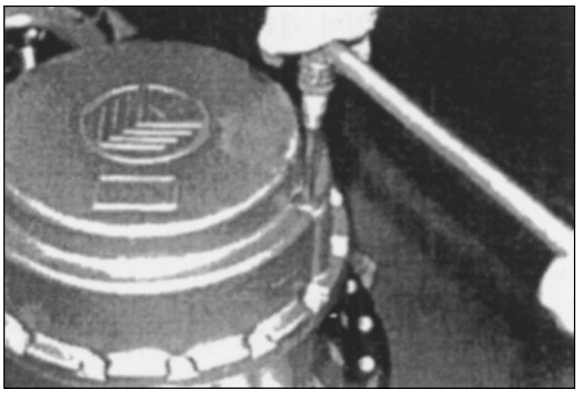


Figure 112

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

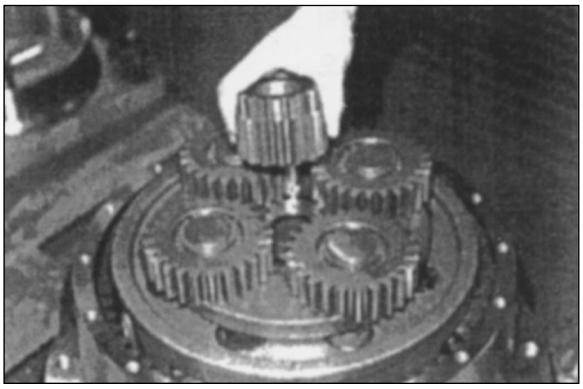


Figure 113

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

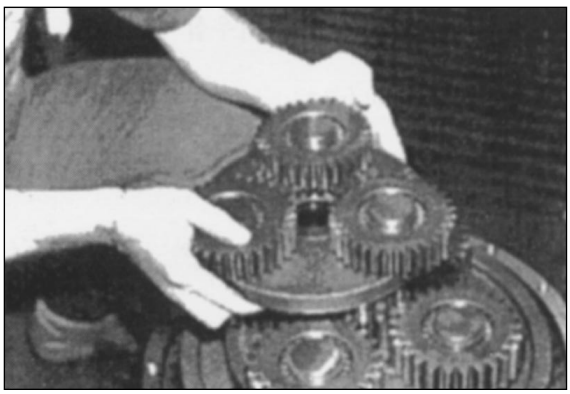


Figure 114

25. Install first shift sun gear. Figure 115.

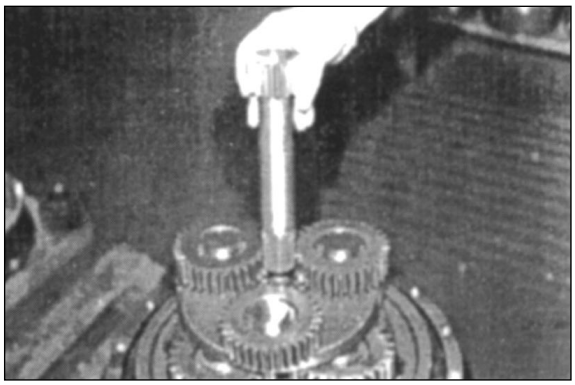
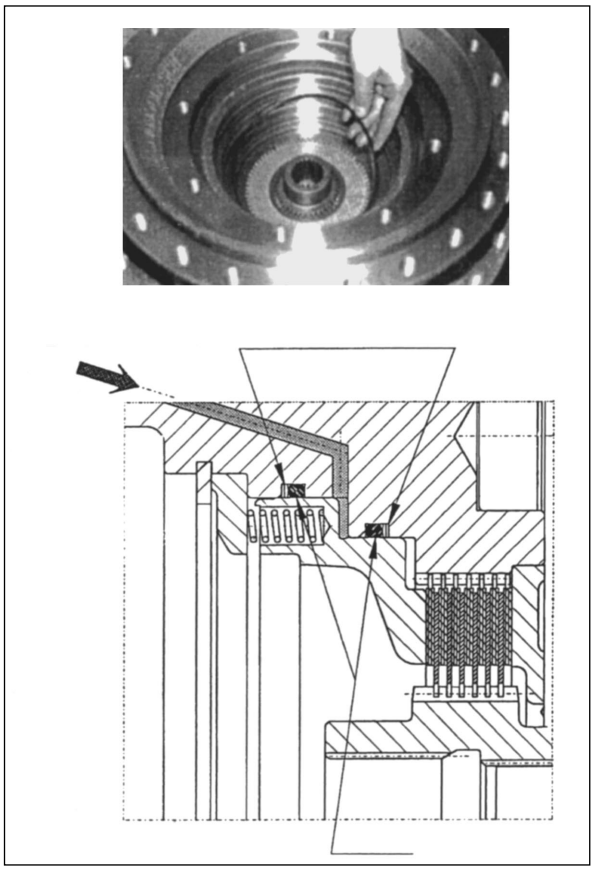


Figure 115

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

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



3086

Figure 116

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

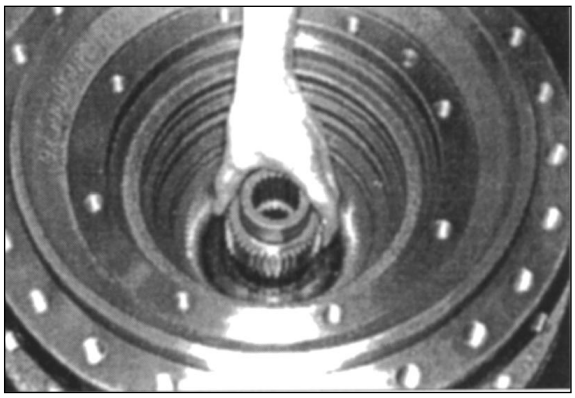


Figure 117

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

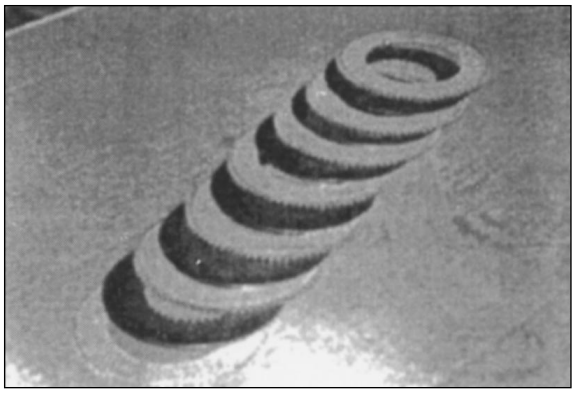


Figure 118

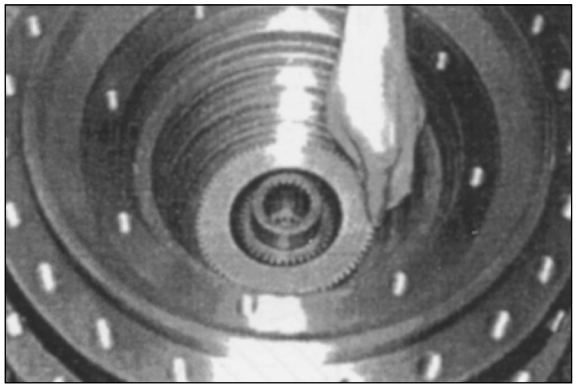


Figure 119

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

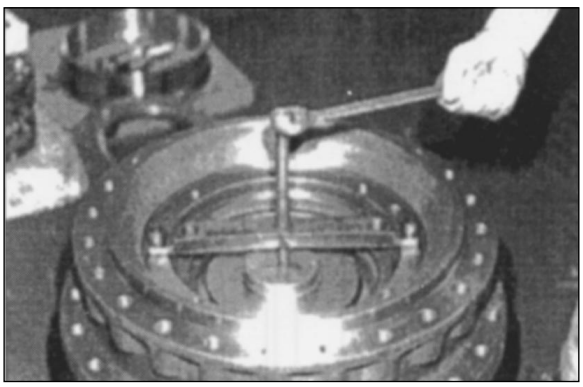


Figure 120

30. Install circlip using circlip pliers. Figure 121.

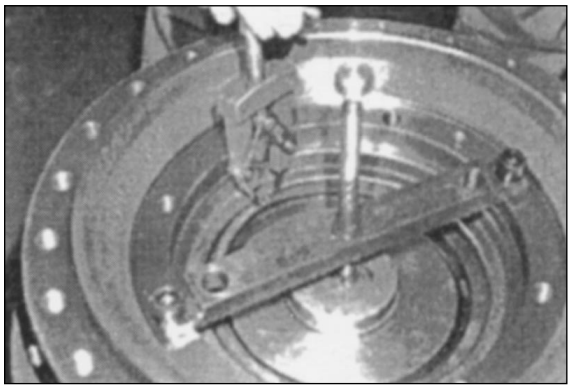


Figure 121

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

Figure 122

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

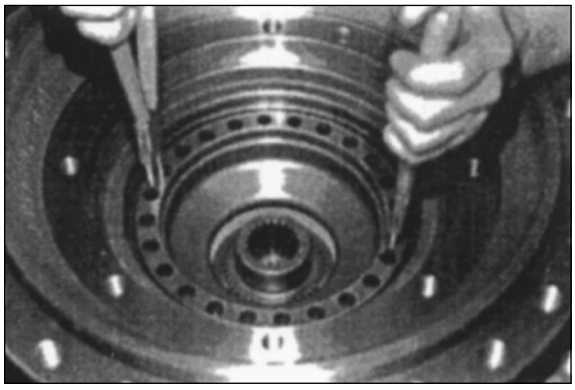


Figure 123

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

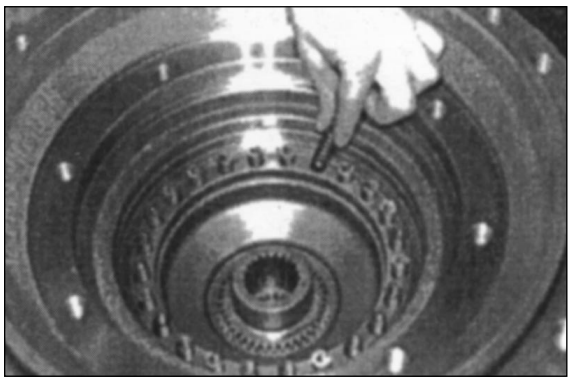


Figure 124

34. Install retainer disc. Figure 125.

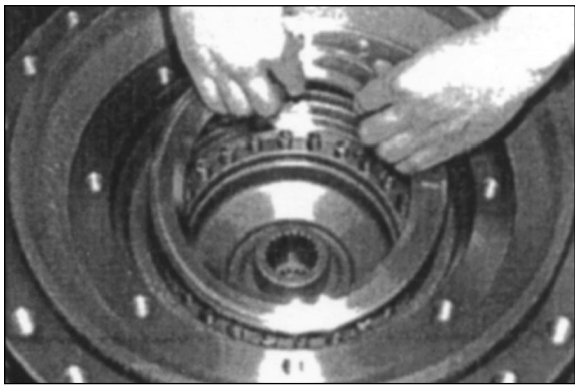


Figure 125

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

Figure 126

36. Tighten motor flange to hub. Figure 127.

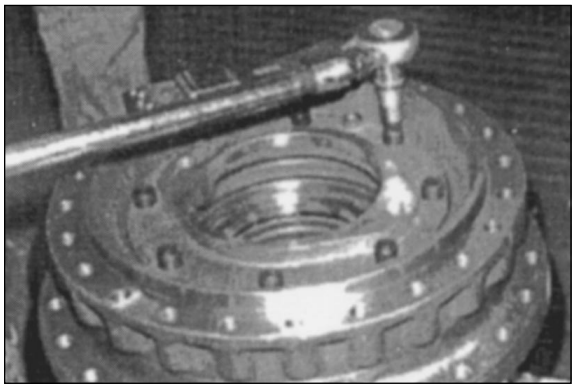


Figure 127

TRAVEL MOTOR REASSEMBLY

ROTARY GROUP ASSEMBLY

1. Rotary group completely assembled ready for assembly.

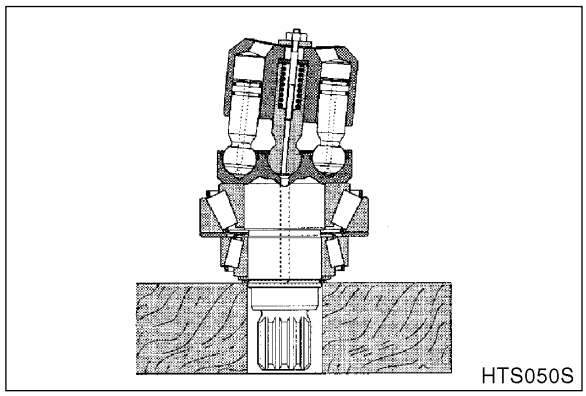


Figure 128

2. Place assembly sleeve.

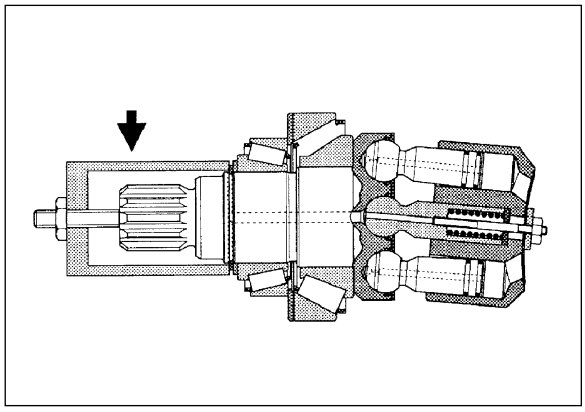


Figure 129

3. Warm up housing to 80˚C (176˚F).

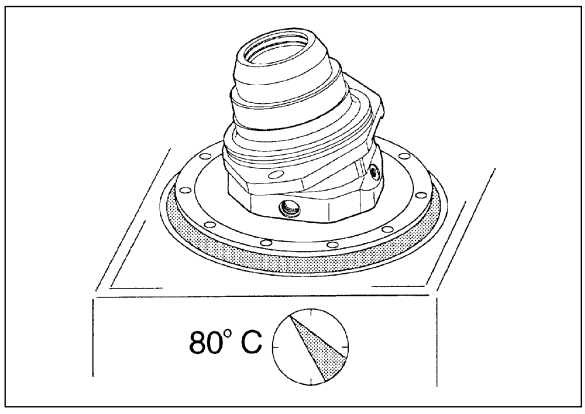


Figure 130

4. Insert rotary group into housing to seat position.

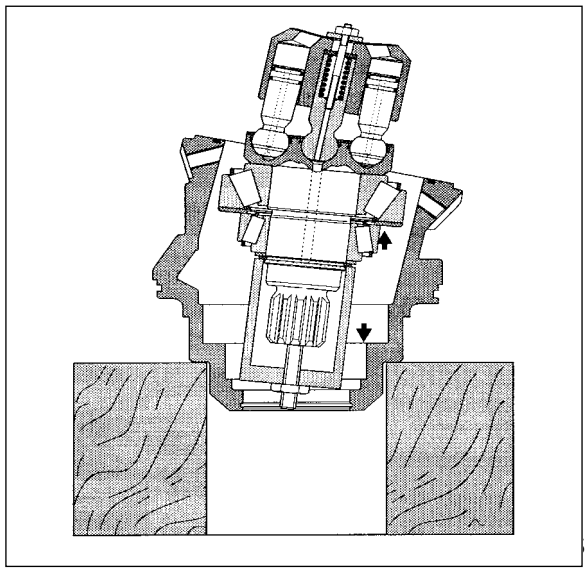


Figure 131

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

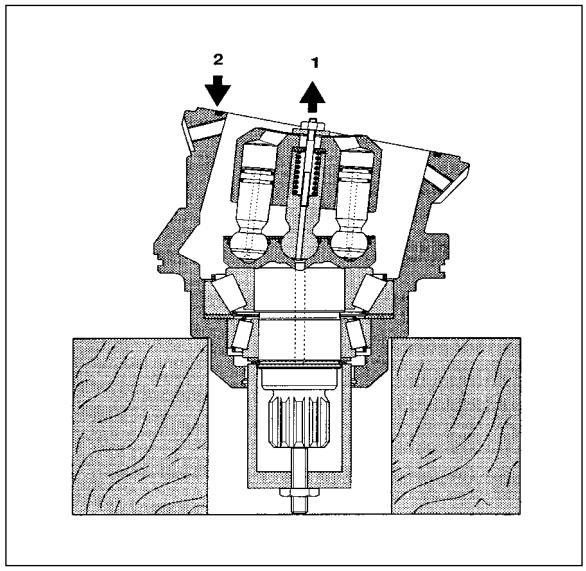


Figure 132

ROTARY GROUP ADJUSTMENT (SEE SERVE INFORMATION)

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

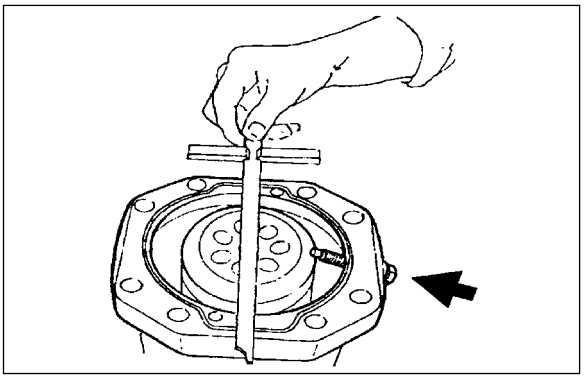


Figure 133

2. Disc.

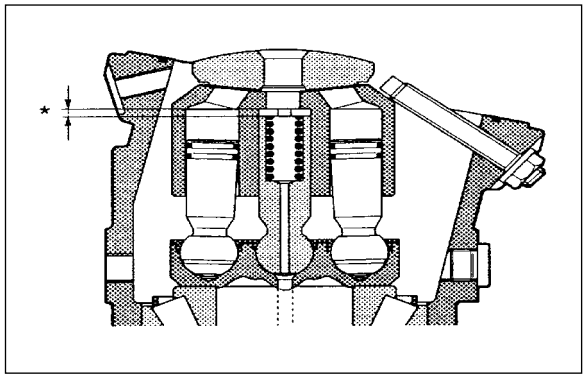


Figure 134

3. Place centering disc.

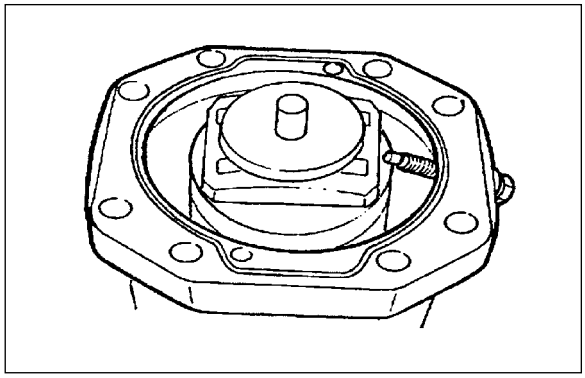


Figure 135

4. Mount measuring device.

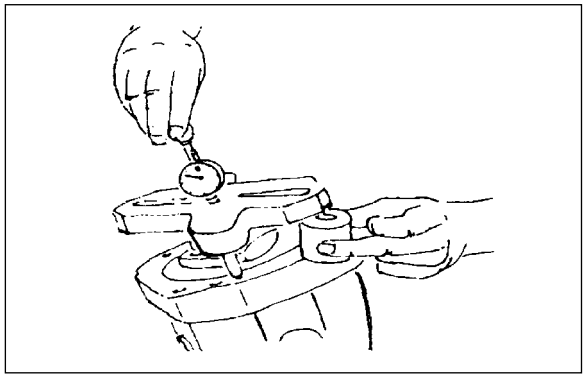


Figure 136

5. Check dimention X.

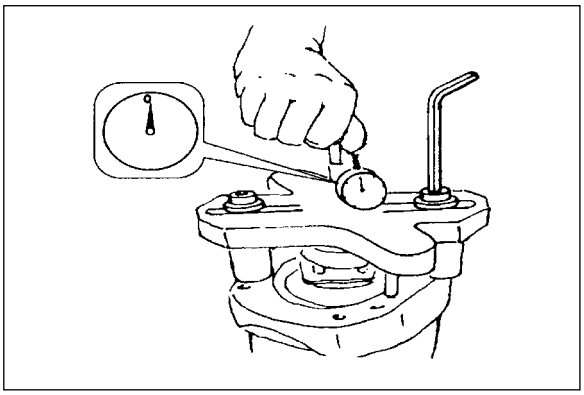


Figure 137

ASSEMBLY OF PORT PLATE

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

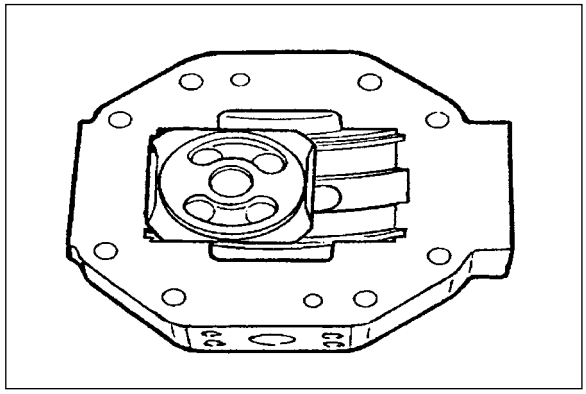


Figure 138

4. Assemble port plate.

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

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

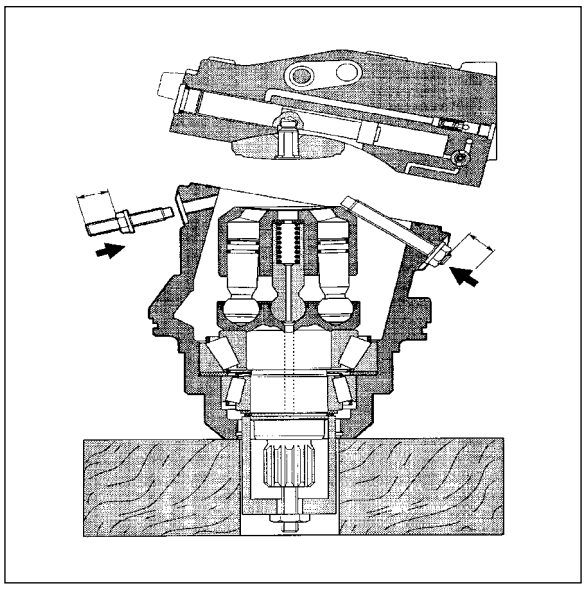


Figure 139

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

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

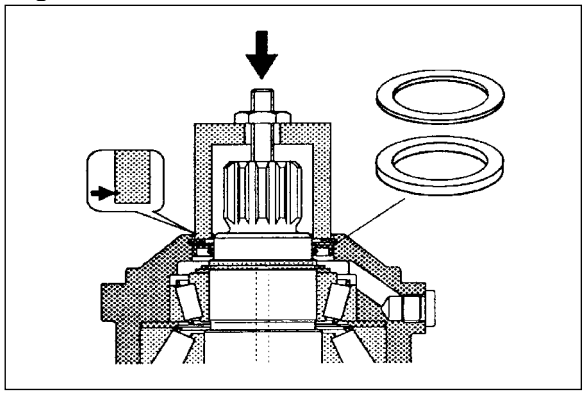


Figure 140