# Bobcat®

# Service Manual


E10

## Compact Excavator

**S/N A33P11001 & Above**
**S/N B4PD11001 & Above**
**S/N B4K911001 & Above**

6986788enUS (08-20) (E)

Printed in U.S.A.



**EU T2 S5 NA T4-K**

## SAFETY INSTRUCTIONS

**Safety Alert Symbol**

**This symbol with a warning statement means: "Warning, be alert! Your safety is involved!" Carefully read the message that follows.**

**WARNING**

**AVOID INJURY OR DEATH**

**Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual, Operator's Handbook and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments, repairs or service. Untrained operators and failure to follow instructions can cause injury or death.**

W-2003-0807

**IMPORTANT**

**This notice identifies procedures which must be followed to avoid damage to the machine.**

I-2019-0284

**DANGER**

**The signal word DANGER on the machine and in the manuals indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

D-1002-1107

**WARNING**

**The signal word WARNING on the machine and in the manuals indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

W-2044-1107

The following publications provide information on the safe use and maintenance of the Bobcat machine and attachments:

- The Delivery Report is used to assure that complete instructions have been given to the new owner and that the machine is in safe operating condition.
- The Operation & Maintenance Manual delivered with the machine or attachment contains operating information as well as routine maintenance and service procedures. It is a part of the machine and can be stored in a container provided on the machine. Replacement Operation & Maintenance Manuals can be ordered from your Bobcat dealer.
- Machine signs (decals) instruct on the safe operation and care of your Bobcat machine or attachment. The signs and their locations are shown in the Operation & Maintenance Manual. Replacement signs are available from your Bobcat dealer.
- An Operator's Handbook fastened to the operator cab. It's brief instructions are convenient to the operator. The handbook is available from your dealer in an English edition or one of many other languages. See your Bobcat dealer for more information on translated versions.
- The AEM Safety Manual delivered with the machine gives general safety information.
- The Service Manual and Parts Manual are available from your dealer for use by mechanics to do shop-type service and repair work.
- The Compact Excavator Operator Training Course is available through your local dealer or at **Bobcat.com/training** or **Bobcat.com**. This course is intended to provide rules and practices of correct operation of the Bobcat excavator. The course is available in English and Spanish versions.
- Service Safety Training Courses are available from your Bobcat dealer or at **Bobcat.com/training** or **Bobcat.com**. They provide information for safe and correct service procedures.
- The Bobcat compact excavator Safety Video is available from your Bobcat dealer or at **Bobcat.com/training** or **Bobcat.com**.

SI EXC-1016 SM

## LIFTING AND BLOCKING THE EXCAVATOR

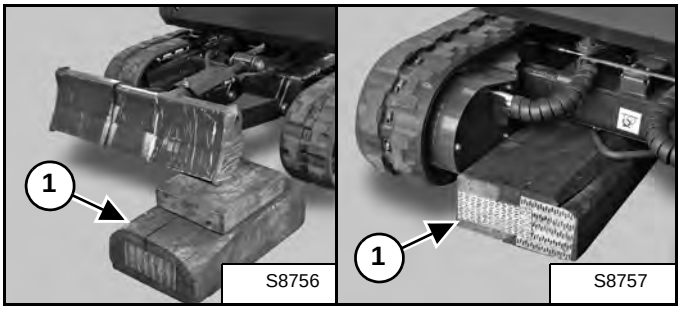
### Procedure

Always park the machine on a level surface.

**Figure 10-10-1**


Raise one side of the machine (approximately 100 mm [4 in]) using the boom and arm as shown in **[Figure 10-10-1]**.

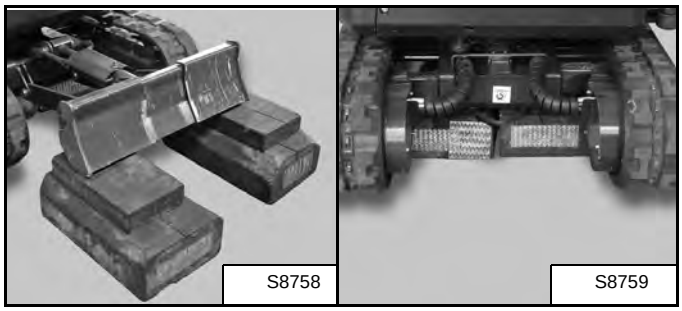
**Figure 10-10-2**




Raise the blade fully and install wooden blocks (Item 1) **[Figure 10-10-2]** or jackstands under the blade and the track frame. Lower the machine until all machine weight is on the wooden blocks or jackstands.

Rotate the upperstructure 180 degrees and repeat procedure for other side.

**Figure 10-10-3**




The machine must be blocked up as shown in **[Figure 10-10-3]**.

Stop the engine.

**⚠ WARNING**

**Put jackstands under the blade and rear corners of the undercarriage before working under the machine. Failure to block up the machine may allow it to move or fall and result in injury or death.**

W-2218-1195

**⚠ WARNING**

**AVOID INJURY OR DEATH**

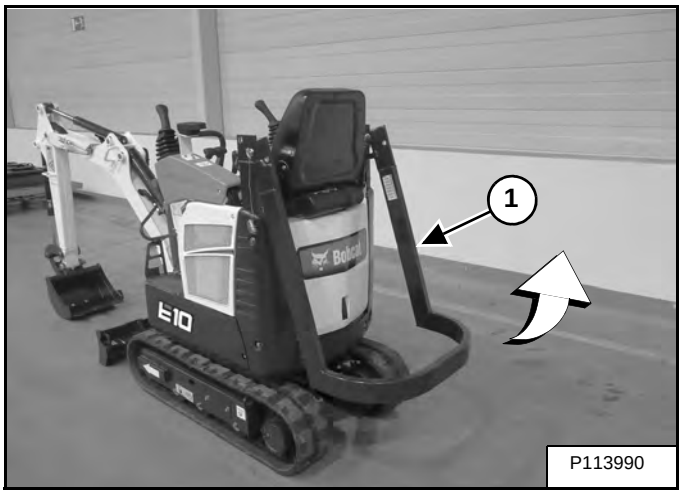
**Do not loosen the grease fitting more than one complete rotation. Also, be careful not to loosen any part other than the grease fitting. If the grease fitting or any part is loosened too much, it can fly off under high pressure. If the grease does not ooze smoothly, try moving the machine back and forth for a short distance.**

W-2143-0189

**FOLD-DOWN TOPS (CONT'D)**

**Raising The Fold Down TOPS**

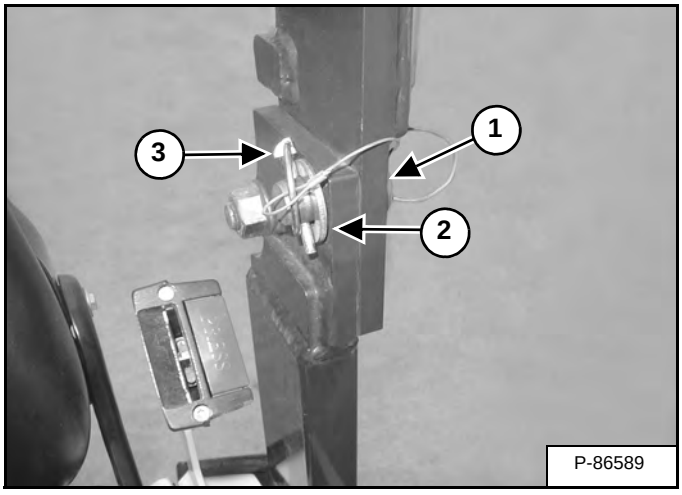
**Figure 10-50-5**




Remove the retainer clip (Item 3) and the washer (Item 2) from the pin (Item 1) **[Figure 10-50-4]** (both sides).

Securely grasp the TOPS (Item 1) **[Figure 10-50-5]** and raise to the upright position and install the pin (Item 1) **[Figure 10-50-6]** (both sides).

**Figure 10-50-6**




Reinstall the pin (Item 1) and the washer (Item 2) on the retainer clip (Item 3) **[Figure 10-50-6]** into the TOPS for storage.

**⚠ WARNING**

**AVOID INJURY OR DEATH**

**The Tip Over Protective Structure (TOPS) must be properly secured in the raised position. Make sure the pins are correctly installed through the mounting frame and the TOPS tube and secured with the retainer pins. Improperly installed fasteners will cause loss of TOPS protection.**

**W-2753-0808**

## ENGINE COOLING SYSTEM

Check the cooling system every day to prevent overheating, loss of performance or engine damage.

### Cleaning

Open the tailgate. (See Opening And Closing The Tailgate on Page 10-60-1.)

Use low air pressure or water pressure to clean the radiator and oil cooler.

### Checking Level

**WARNING**

**AVOID BURNS**

**Do not remove radiator cap when the engine is hot. You can be seriously burned.**

W-2070-1203

**WARNING**

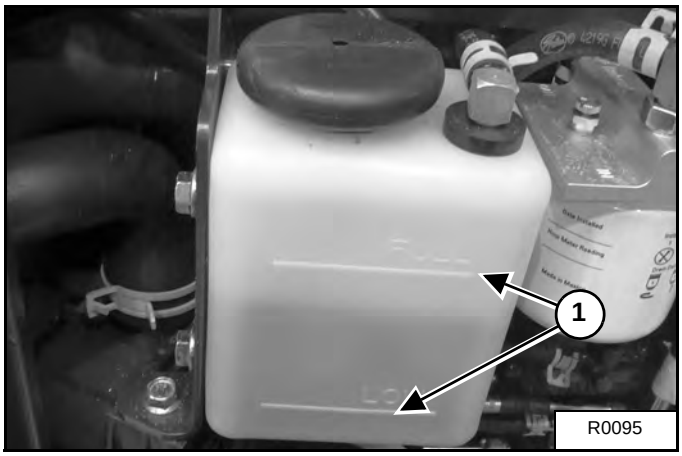
**AVOID INJURY OR DEATH**

**Wear safety glasses to prevent eye injury when any of the following conditions exist:**

- **When fluids are under pressure.**
- **Flying debris or loose material is present.**
- **Engine is running.**
- **Tools are being used.**

W-2019-0907

**Figure 10-90-1**




The coolant level must be between the marks (Item 1) **[Figure 10-90-1]** on the coolant recovery tank.

**IMPORTANT**

**AVOID ENGINE DAMAGE**

**Always use the correct ratio of water to antifreeze.**

**Too much antifreeze reduces cooling system efficiency and may cause serious premature engine damage.**

**Too little antifreeze reduces the additives which protect the internal engine components; reduces the boiling point and freeze protection of the system.**

**Always add a premixed solution. Adding full strength concentrated coolant can cause serious premature engine damage.**

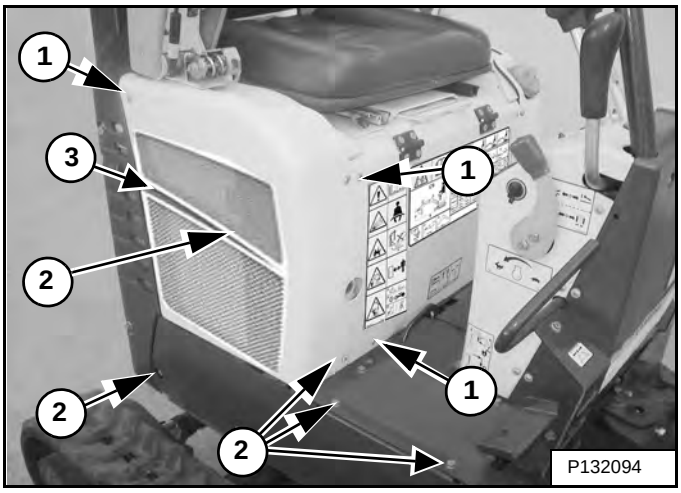
I-2124-0497

**Removing And Replacing Hydraulic Fluid**

See the SERVICE SCHEDULE for the correct service interval. (See SERVICE SCHEDULE on Page 10-70-1.)

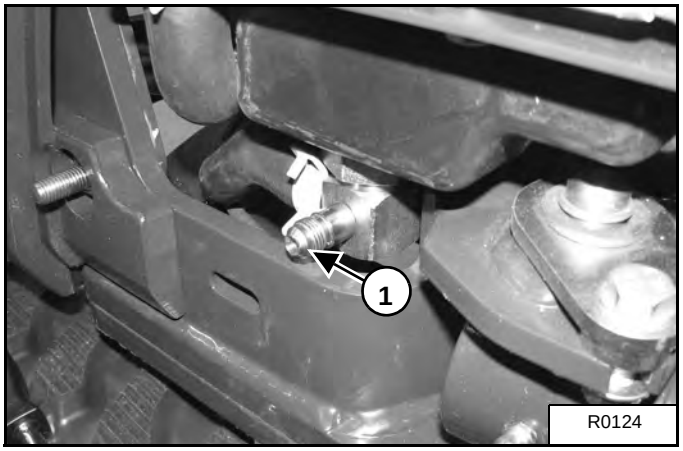
Retract the arm and bucket cylinders, lower the bucket to the ground. Stop the engine.

**Figure 10-120-5**




To gain access to drain the hydraulic fluid, loosen the three bolts (Item 1) from the cover. Pivot the cover downward. Then remove the black protection on the floor by loosening the bolts (Item 2 **[Figure 10-120-5]**.

**Figure 10-120-6**




Before removing the cap, place a container under the drain plug (Item 1) **[Figure 10-120-6]** to collect the oil.

Remove the cap and drain the hydraulic fluid.

# IMPORTANT

**Fluid such as engine oil, hydraulic fluid, coolants, grease, etc. must be disposed of in an environmentally safe manner. Some regulations require that certain spills and leaks on the ground must be cleaned in a specific manner. See local regulations for the correct disposal.**

**I-2067-EN-0711**

# IMPORTANT

**If the fluid is being drained because of a system failure, remove and clean all hydraulic lines.**

**I-2045-0788**

Install the cap again.

Add fluid to the reservoir until it is at the center of the sight gauge (Item 3) **[Figure 10-120-1]**.

Run the excavator through the hydraulic functions. Stop the engine. Check the fluid level and add as needed.

Replace the black protection and the cover.

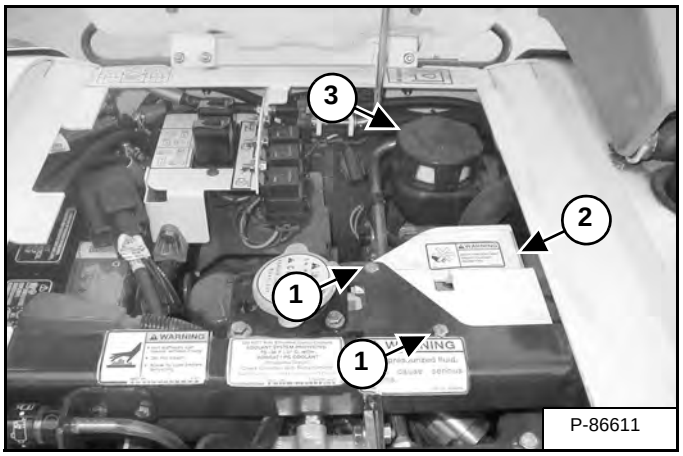
## ALTERNATOR BELT

### Belt Adjustment

Replace the belt if it has stretched or there are cracks in the belt. Replace the pulley if the belt makes contact with the bottom of the groove in the pulley.

Stop the engine.

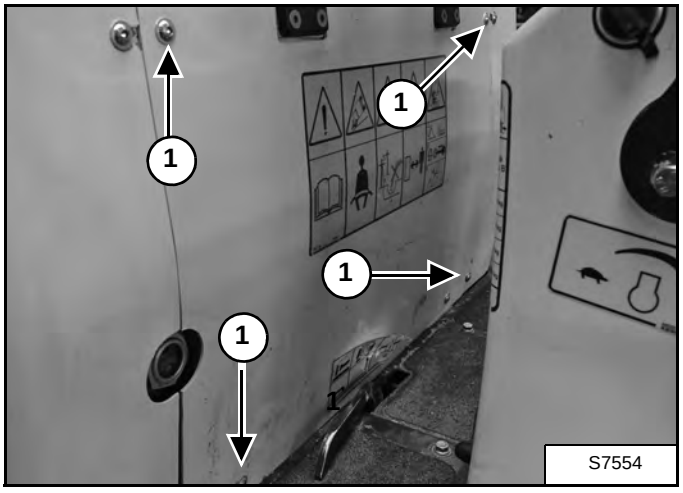
**Figure 10-160-1**




Remove the two bolts (Item 1) and remove the fan guard (Item 2) **[Figure 10-160-1]**.

Remove the fill cap (Item 3) **[Figure 10-160-1]** from the hydraulic reservoir.

**Figure 10-160-2**



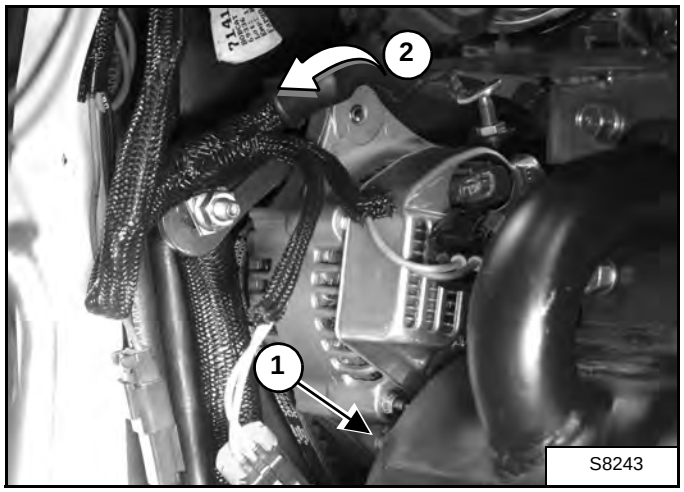

Remove the four bolts (Item 1) **[Figure 10-160-2]**.

Remove the cover.

**Figure 10-160-3**


Loosen the upper alternator bolt **[Figure 10-160-3]**.

**Figure 10-160-4**




Loosen the lower alternator mounting and adjustment bolt (Item 1) **[Figure 10-160-4]**.

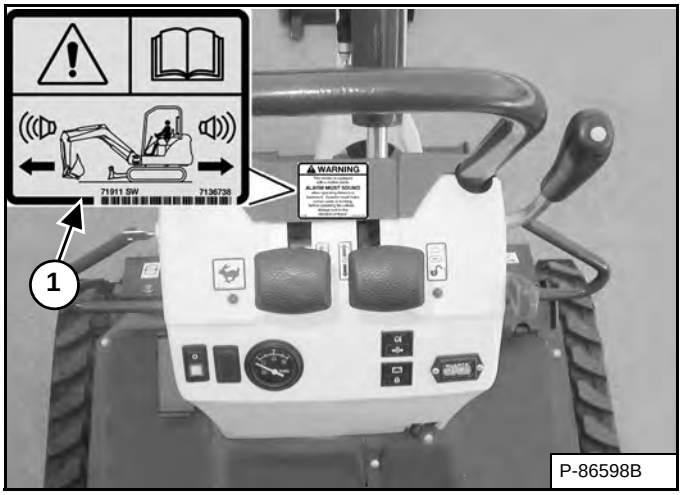
## MOTION ALARM

### Description

This excavator may be equipped with a motion alarm system. The motion alarm will sound when the operator moves the travel control levers in either the forward or reverse direction. Slight movement of the steering levers in either the forward or reverse direction is required with hydraulic components before the motion alarm will sound.

### Inspecting

**Figure 10-210-1**




Inspect for damaged or missing motion alarm decal (Item 1) **[Figure 10-210-1]**. Replace if damaged.

Sit in the operator's seat. Turn Start key to ON position but DO NOT start the engine.

**WARNING**

**AVOID INJURY OR DEATH**

**When an engine is running in an enclosed area, fresh air must be added to avoid concentration of exhaust fumes. If the engine is stationary, vent the exhaust outside. Exhaust fumes contain odorless, invisible gases which can kill without warning.**

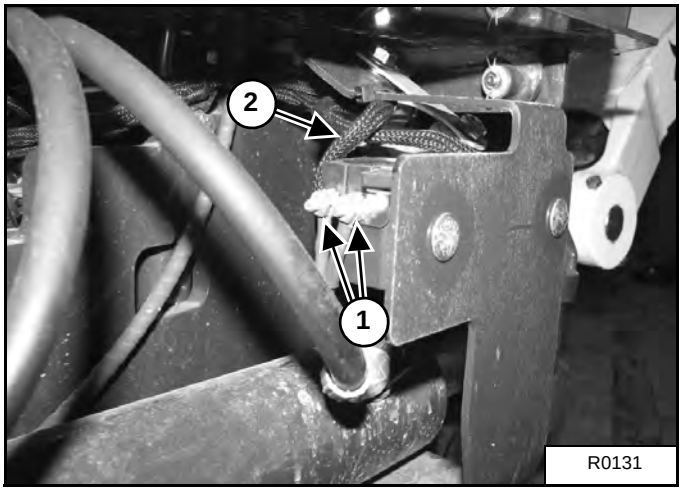
**W-2050-0807**

Move the travel control levers in the forward direction. The motion alarm must sound. Move the travel control levers in the reverse direction. The motion alarm must sound.

Turn the Start key to the OFF position.

The motion alarm is located on the lower part of the frame, on top of the swing cylinder.

**Figure 10-210-2**




Inspect the motion alarm connections (Item 1), wire harness (Item 2) **[Figure 10-210-2]** and motion alarm switch (Item 1) **[Figure 10-210-3]** for tightness and damage. Repair or replace any damaged components.

If the motion alarm switch requires adjustment, see information below.

# HYDRAULIC SYSTEM

# HYDRAULIC/HYDROSTATIC SCHEMATIC
# E10 (S/N A33P17207 AND ABOVE)

**(PRINTED MAY 2019)**
**V-1687legend**

## LEGEND

1. HYDRAULIC RESERVOIR with FILL STRAINER
   Reservoir Capacity: . . . . . 2,6 L (2.75 qt)
   System Capacity to centre of site gauge:
   . . . . . 9,4 L (9.9 qt)
2. BREATHER/FILL CAP with FILTER
3. HYDRAULIC FILTER ELEMENT
   10 Micron
4. FILTER BY-PASS 17200 kPa (1,72 bar) (25 psi)
5. HYDRAULIC PUMP - 2 Section Gear Pump:
   Pump Section 1
   10,0 Lpm (2.6 gpm) at High Engine Idle
   Pump Section 2
   10,0 Lpm (2.6 gpm) at High Engine Idle
6. SOLENOID VALVE - SYSTEM BY-PASS
7. MAIN RELIEF VALVE:
   18400 – 19200 kPa (184 - 192 bar) (2660 - 2770 psi)
8. PRESSURE REDUCING VALVE:
   3000 kPa (30 bar) (435 psi)
9. SOLENOID VALVE - CONSOLE (Joystick)
   LOCK OUT
10. ACCUMULATOR
    Nitrogen . . . . . 1100 kPa (11 bar) (165 psi)
    non-rechargeable
11. TEST PORT - "F" Port - Gauge Test Port
12. TEST PORT - “PS1” Port - Pilot Pressure
    Test Port
13. CHECK VALVE
14. BUILD UP VALVE: 2700 kPa (27 bar) (391 psi)
15. PORT RELIEF / ANTICAVITATION VALVE
    Boom Cylinder (Base End)
    23200 kPa (232 bar) (3365 psi)
16. PORT RELIEF / ANTICAVITATION VALVE
    Arm Cylinder (Base End)
    22500 kPa (225 bar) (3262 psi)
17. SLEW MOTOR - CROSS PORT RELIEF
    VALVE . . . . 8400 kPa (84 bar) (1218 psi)
18. ANTICAVITATION VALVE
    Boom Swing Cylinder (Rod End)
19. PORT RELIEF / ANTICAVITATION VALVE
    Arm Cylinder (Rod End)
    23200 kPa (232 bar) (3365 psi)
20. CHECK VALVE
21. ORIFICE . . . . . 1,2 mm (0.047 in)
22. ORIFICE . . . . . 1,1 mm (0.043 in)
23. ORIFICE . . . . . 1,1 mm (0.043 in)
24. TRAVEL MOTOR SPOOL
25. TWO SPEED VALVE - Travel Motor
26. CHECK VALVE
27. ORIFICE . . . . . 1,2 mm (0.047 in)
28. PORT RELIEF / ANTICAVITATION VALVE
    Bucket Cylinder (Base End):
    23200 kPa (232 bar) (3365 psi)

NOTE: Unless otherwise specified springs have NO significant pressure value.

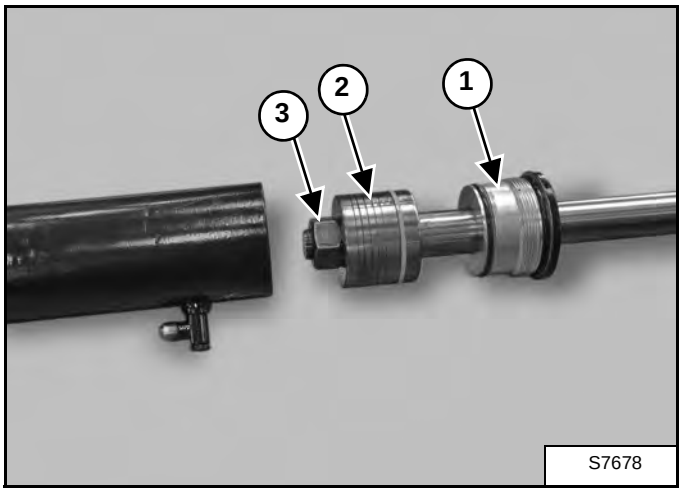
Printed in U.S.A.

**Troubleshooting The Swing (Upperstructure Slew) Circuit**

| TROUBLESHOOTING THE SWING (UPPERSTRUCTURE SLEW) CIRCUIT | | |
|---|---|---|
| **PROBLEM** | **CAUSE** | **CORRECTION** |
| Swing not operating. | Control console(s) raised. | Lower control console(s). |
| | Control console lockout switch defective. | Readjust or replace. |
| | Swing lock pin engaged. | Disengage lock pin. |
| | Control lever (joystick) manifold pressure reducing valve defective. | Repair or replace. |
| | Control lever (joystick) manifold solenoid coil defective. | Replace. |
| | Control lever (joystick) manifold solenoid valve defective. | Repair or replace. |
| | Swing motor gear defective. | Repair or replace. |
| | Control lever (joystick) internal leakage excessive. | Repair or replace |
| | Swing motor defective. | Repair or replace. |
| Swing force. | Main relief valve set too low. | Readjust or replace. |
| | Swing motor cross port relief valve pressure too low. | Readjust or replace. |
| Swing speed too slow. | Pump flow low. | Check, repair or replace. |
| | Blocked or restricted line to swing motor. | Replace. |
| | Control lever (joystick) internal leakage excessive. | Repair or replace. |
| | Control valve internal leakage excessive. | Repair or replace. |
| | Swing motor internal leakage excessive. | Repair or replace. |
| Swing over run excessive. | Control valve spool sticking. | Repair or replace. |
| | Control lever (joystick) spool sticking. | Repair or replace. |
| | Swing motor cross port relief valve set too low. | Repair or replace. |
| | Swing motor internal leakage excessive. | Repair or replace. |

**Assembly (Cont'd)**

**Figure 20-20-23**




Install the head (Item 1) and the piston (Item 2) **[Figure 20-20-23]** on the rod as shown.

Grease the piston where the nut contacts the piston. Do not get grease on the threads.

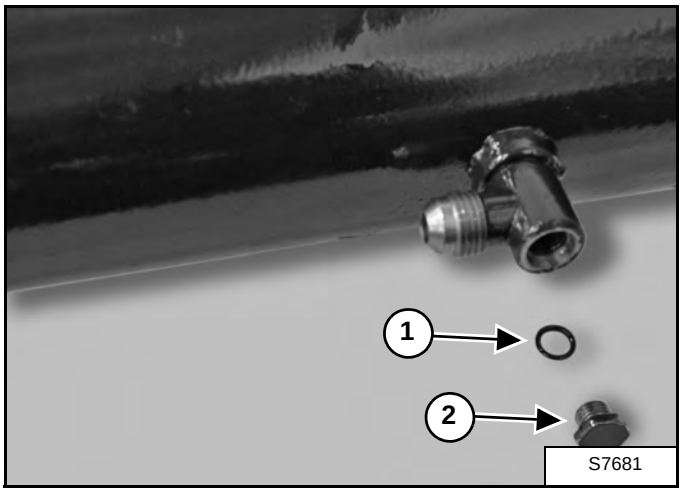
Provide an adequate support for the cylinder before tightening.

Install the nut (Item 3) **[Figure 20-20-23]**.

**NOTE: Clean and dry the rod threads, from the kit install a NEW NUT with preapplied Loctite®.**

Tighten the nut to 406 N•m (300 ft-lb) torque.

**Figure 20-20-24**



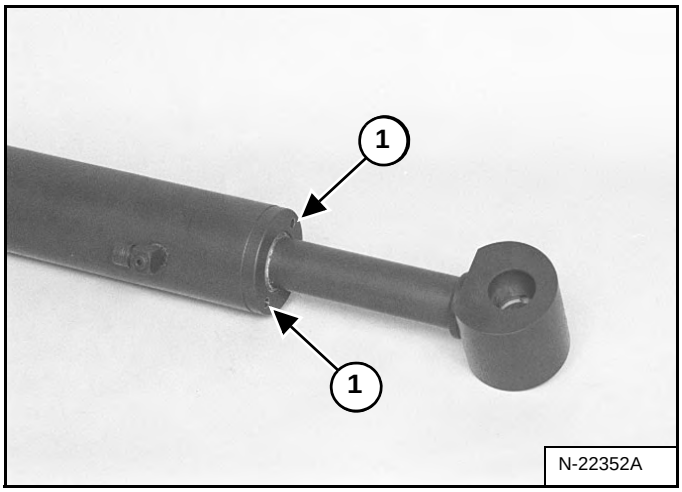

Install the O-ring (Item 1) and plug (Item 2) **[Figure 20-20-24]**.

Tighten the base end fitting plug to 50 N•m (37 ft-lb) torque.

Tighten the rod end fitting plug to 20 N•m (15 ft-lb) torque.

Put the base end of the hydraulic cylinder in a vise.

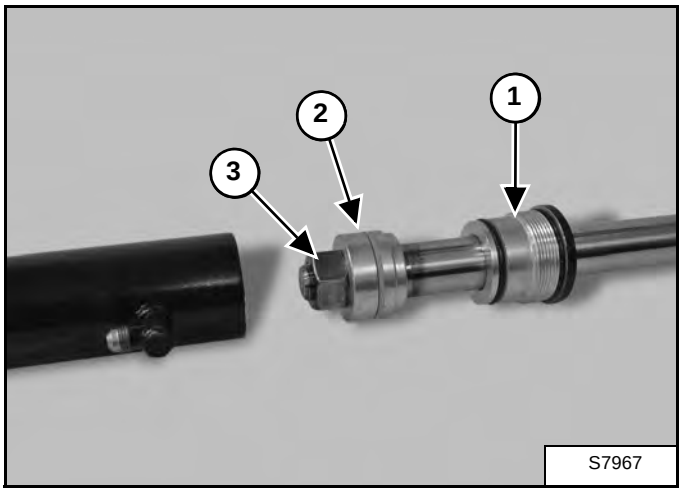
**Figure 20-20-25**




Insert the adjustable gland nut wrench into the two holes (Item 1) **[Figure 20-20-25]** to tighten the head. Head to be torqued until flush with end of the housing.

**Assembly (Cont'd)**

**Figure 20-21-20**




Install the head (Item 1) and the piston (Item 2) **[Figure 20-21-20]** on the rod.

Grease the piston where the nut contacts the piston. Do not get grease on the threads.

Provide an adequate support for the cylinder before tightening.

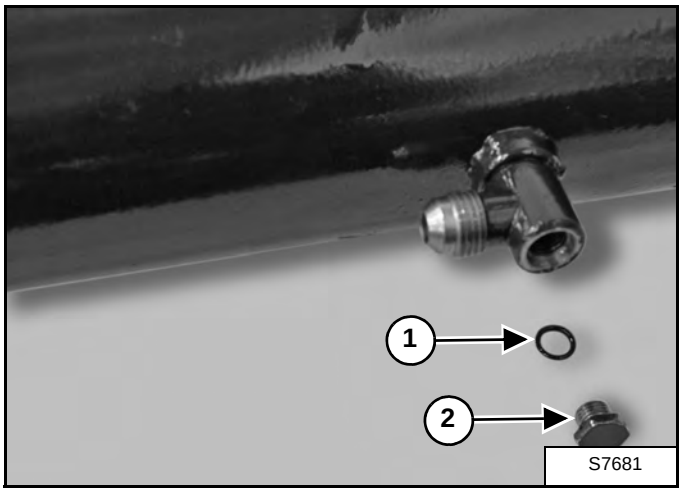
Install the nut (Item 3) **[Figure 20-21-20]**.

**NOTE: Clean and dry the rod threads, from the kit install a NEW NUT with preapplied Loctite®.**

**Reclean thread area for Loctite® residue.**

Tighten the nut to 410 N•m (300 ft-lb) torque.

**Figure 20-21-21**

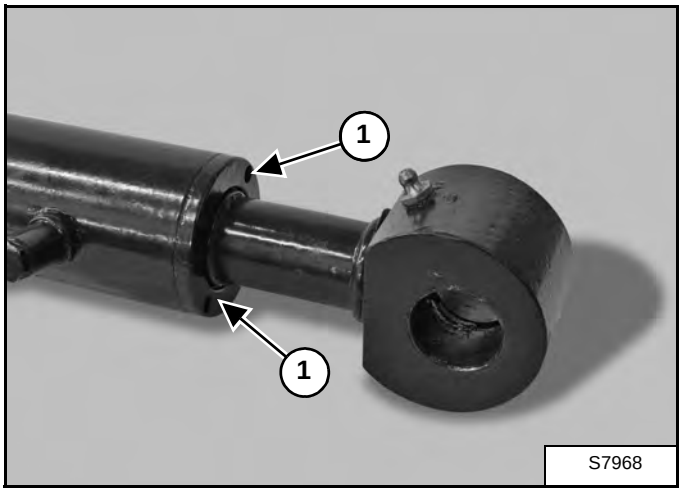



Install the O-ring (Item 1) and plug (Item 2) **[Figure 20-21-21]**.

Tighten the plug to 20 N•m (15 ft-lb) torque.

Put the base end of the hydraulic cylinder in a vise.

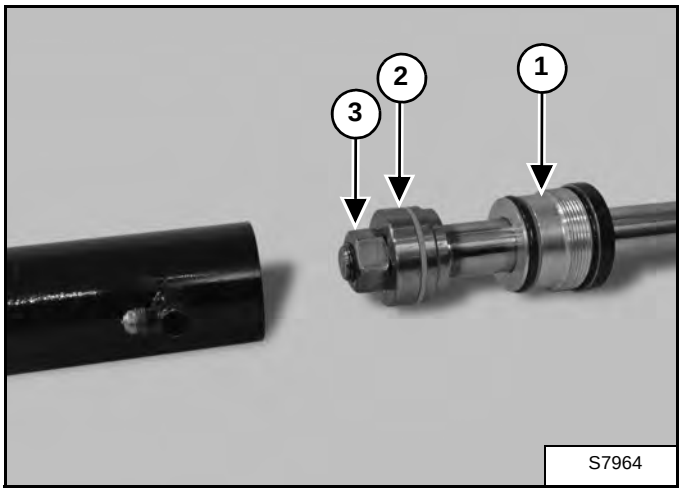
**Figure 20-21-22**




Insert the adjustable gland nut wrench into the two holes (Item 1) **[Figure 20-21-22]** to tighten the head. Head to be torqued until flush with end of the housing.

**Assembly (Earlier Models) (Cont'd)**

**Figure 20-22-24**




Install the head (Item 1) and the piston (Item 2) **[Figure 20-22-24]** on the rod.

Grease the piston where the nut contacts the piston. Do not get grease on the threads.

Provide an adequate support for the cylinder before tightening.

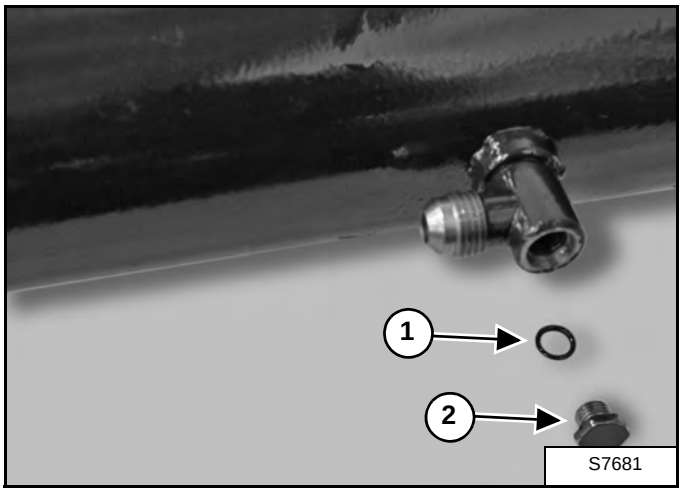
Install the nut (Item 3) **[Figure 20-22-24]**.

**NOTE: Clean and dry the rod threads, from the kit install a NEW NUT with preapplied Loctite®.**

**Reclean thread area for Loctite® residue.**

Tighten the nut to 407 N•m (300 ft-lb) torque.

**Figure 20-22-25**

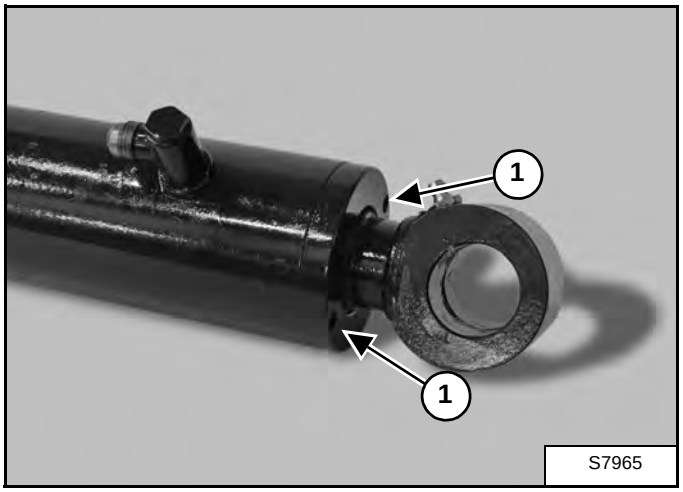



Install O-ring (Item 1) and plug (Item 2) **[Figure 20-22-25]**.

Tighten the plug to 20 N•m (15 ft-lb) torque.

Put the base end of the hydraulic cylinder in a vise.

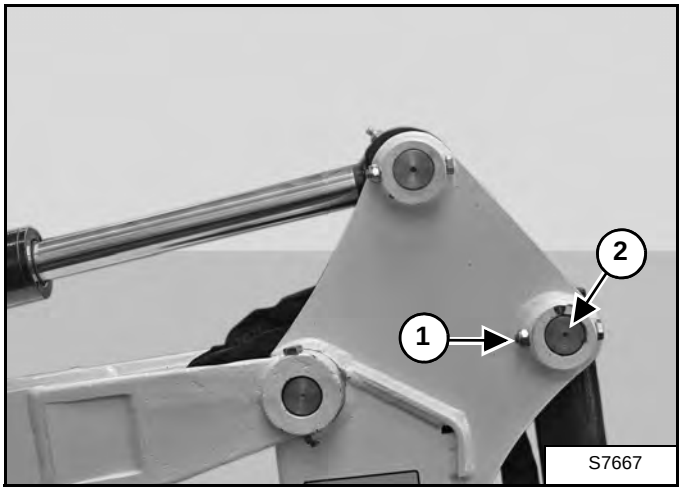
**Figure 20-22-26**




Insert the adjustable gland nut wrench into the two holes (Item 1) **[Figure 20-22-26]** to tighten the head. Head to be torqued until flush with end of the housing.

**Removal And Installation (Cont'd)**

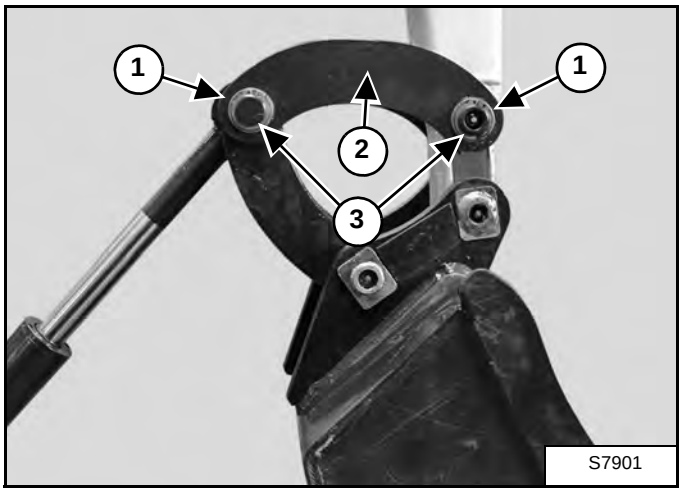
**Figure 20-23-7**




Remove the bolt and nut (Item 1) **[Figure 20-23-7]** from the base end pivot pin.

Remove the base end pivot pin (Item 2) **[Figure 20-23-7]** and lower the base end of the cylinder to the floor.

**Figure 20-23-8**




Remove the two snap rings and washers (Item 1) **[Figure 20-23-8]**.

Remove the bucket link (Item 2) **[Figure 20-23-8]**.

Remove the bucket link pins (Item 3) **[Figure 20-23-8]**.

Remove the bucket cylinder.

# IMPORTANT

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

I-2003-0888

# ⚠ WARNING

**Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin. This can cause serious injury and possible death if proper medical treatment by a physician familiar with this injury is not received immediately.**

W-2145-0290

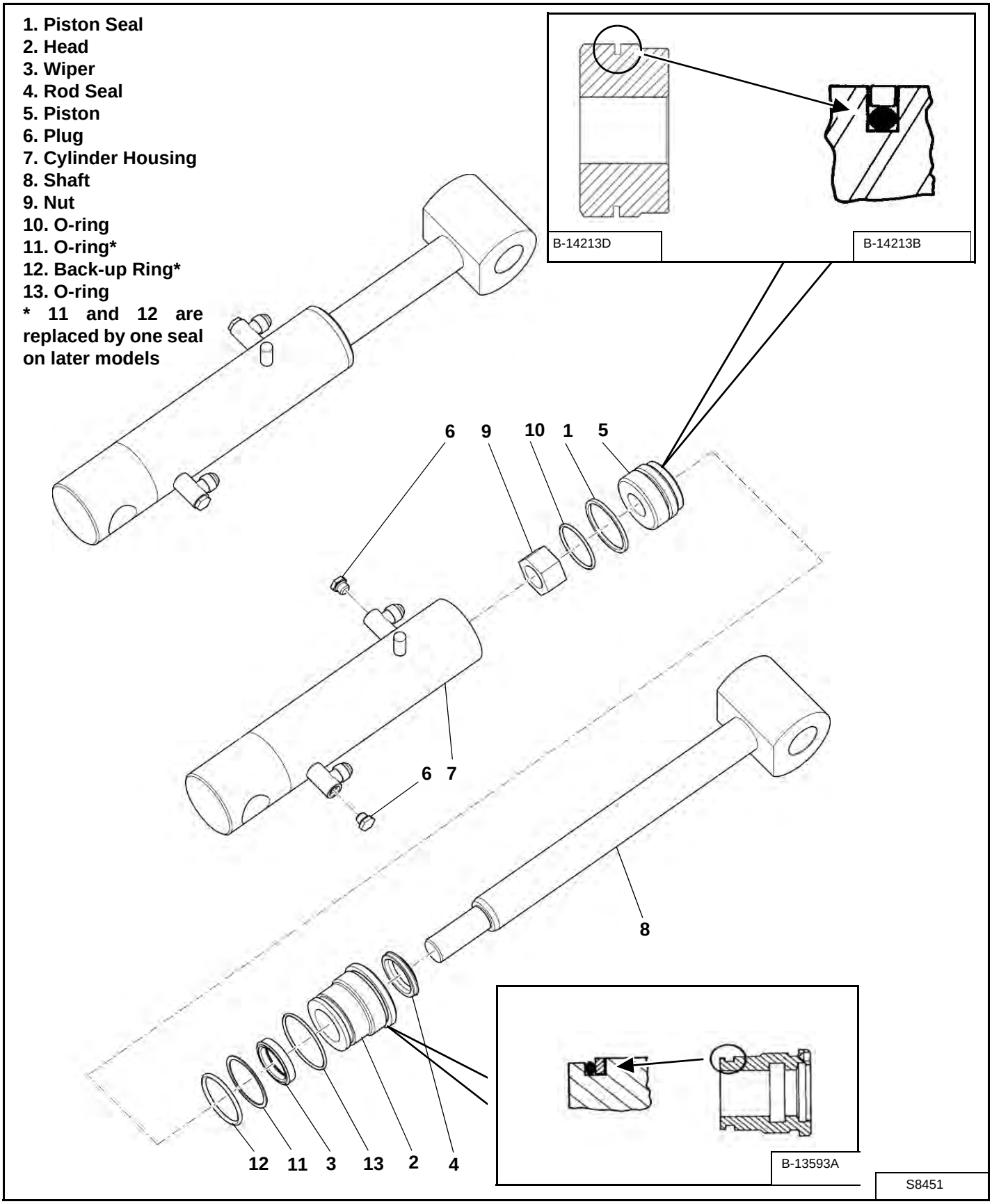
# ⚠ WARNING

**AVOID INJURY OR DEATH**

**Always clean up spilled fuel or oil. Keep heat, flames, sparks or lighted tobacco away from fuel and oil. Failure to use care around combustibles can cause explosion or fire.**

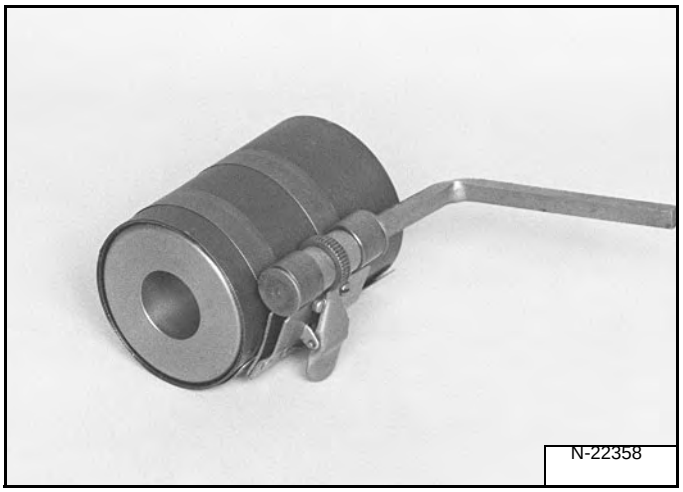
W-2103-0508

**Parts Identification (Earlier Models)**



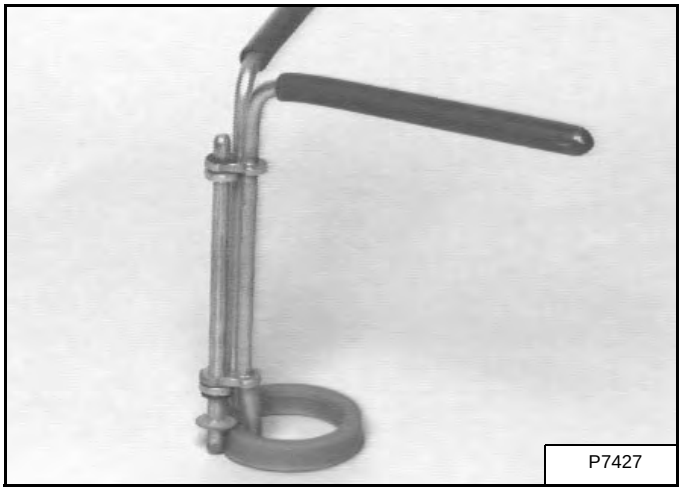
**Assembly (Later Models) (Cont'd)**

**Figure 20-24-34**




Use a ring compressor to compress the seal to the correct size. Leave the piston in the compressor for about three minutes **[Figure 20-24-34]**.

**Figure 20-24-35**

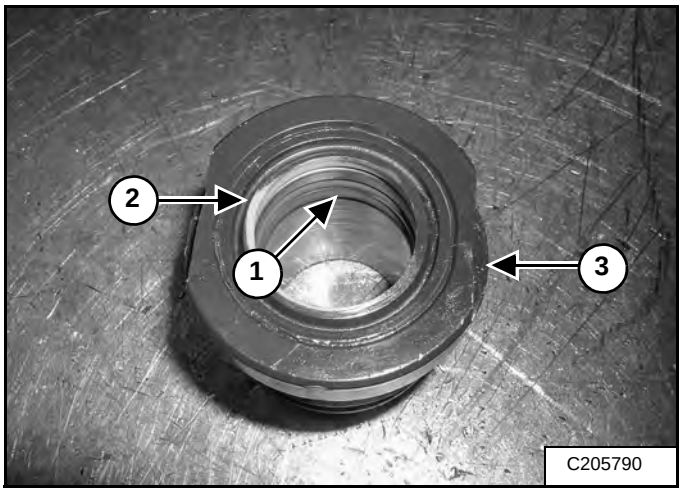



Install the rod seal on the rod seal tool **[Figure 20-24-35]**.

**NOTE: Install the spring side of the seal toward the inside of the cylinder.**

Rotate the handles to collapse the rod seal.

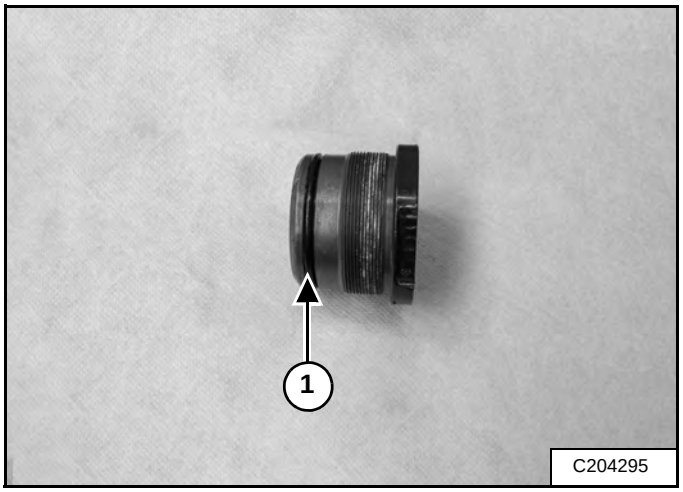
**Figure 20-24-36**




Install the rod seal (Item 1) and wiper seal (Item 2) in the head (Item 3) **[Figure 20-24-36]**.

Install the wiper seal with the wiper (Item 2) **[Figure 20-24-36]** toward the outside of the head.

**Figure 20-24-37**




Install the O-ring (Item 1) **[Figure 20-24-37]** on the head.

**Assembly (Earlier Models)**

Use the following tools to assemble the cylinder:

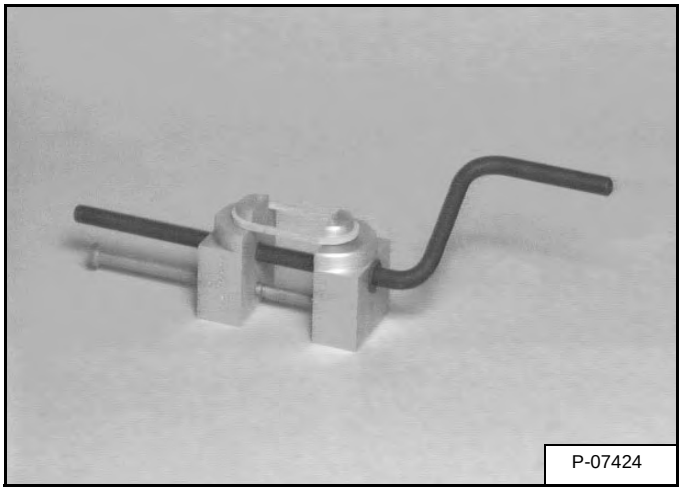
MEL1396 - Universal Seal Expander
MEL1033 - Rod Seal Installation Tool
Piston Ring Compressor
MEL1075 - Adjustable Gland Nut Wrench
MEL1075-1 - Standard Pins

Clean all parts in solvent and dry with compressed air.

Inspect all parts for wear or damage. Replace any worn or damaged parts.

Always install new seals and O-rings. Lubricate all seals and O-rings with clean hydraulic fluid before installation.

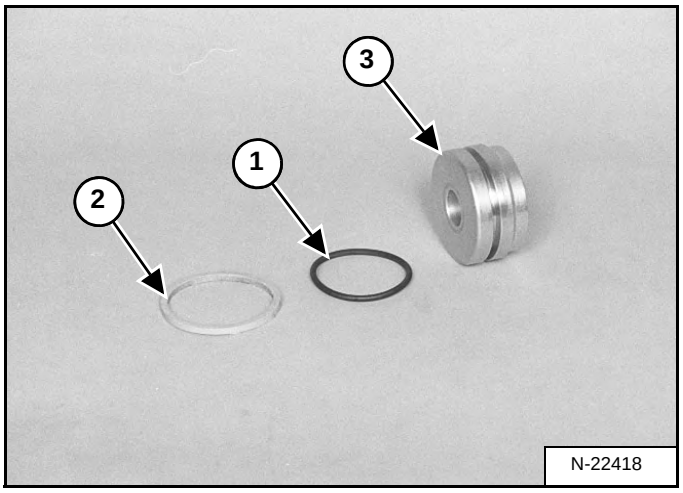
**Figure 20-25-23**




Install the seal on the tool and slowly stretch it until it fits the piston **[Figure 20-25-23]**.

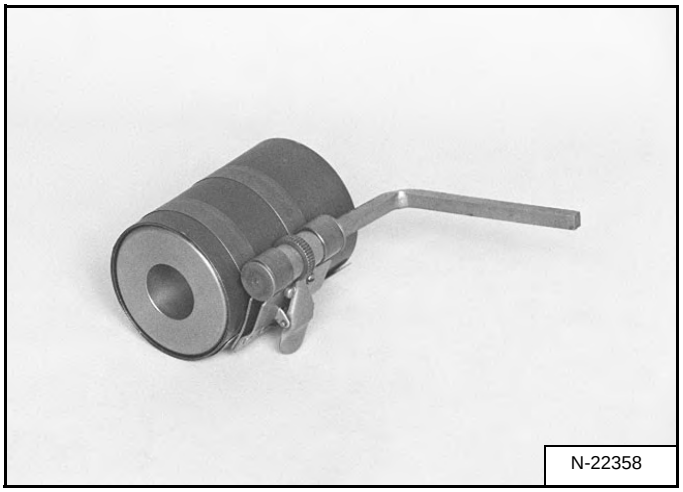
Allow the seal to stretch for 30 seconds before installing it on the piston.

**Figure 20-25-24**




Install the O-ring (Item 1) and seal (Item 2) on the piston (Item 3) **[Figure 20-25-24]**.

**Figure 20-25-25**



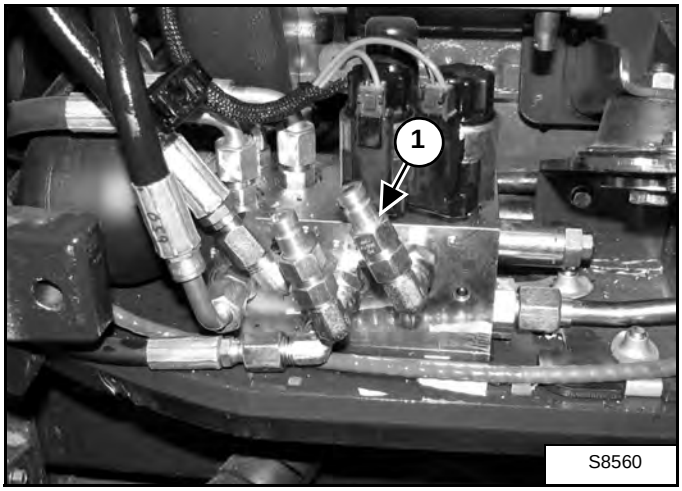

Use a ring compressor to compress the seal to the correct size. Leave the piston in the compressor for about 3 minutes **[Figure 20-25-25]**.

## VALVE (MAIN RELIEF)

### Testing And Adjusting

All testing is done with the hydraulic oil at operating temperature and the engine at high speed setting of 2500 rpm Maximum.

**Figure 20-30-1**




There is one diagnostic coupler (Item 1) **[Figure 20-30-1]** (F port) on the manifold assembly for checking each of the pump section pressure.

The following tools will be needed for the testing at the diagnostic coupler:

MEL1355 - Test Kit includes the following:
MEL1355-3 - 5000 psi Gauge
MEL1355-12 - Coupler
MEL1355-9 - Thermometer

***System Pressures At Gauge Port Specifications***

**TEST CONDITIONS**

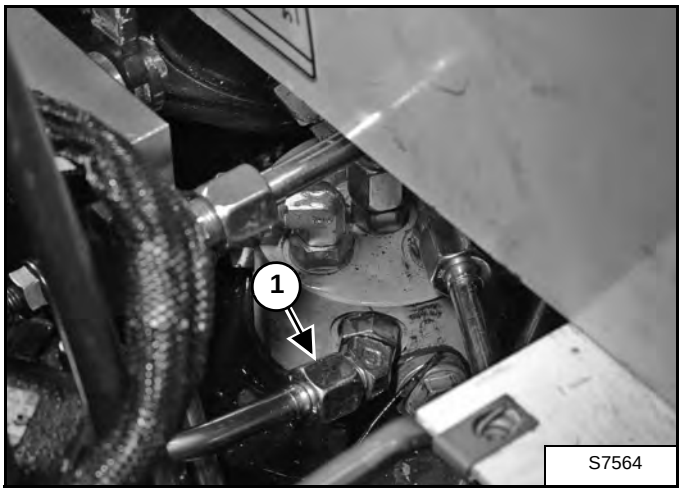
1. Engine High Idle Speed

2. Warm oil over relief function to minimum 66°C (150°F). Cycle all functions during warm up procedure.
   Warm oil until the pressure build-up valve stabilizes near its target pressure.

| SYSTEM CHECK | FUNCTION TO ENGAGE | CIRCUIT PRESSURIZED | TEST PORT | TARGET kPa (bar) (psi) | ACCEPTABLE RANGE kPa (bar) (psi) |
|---|---|---|---|---|---|
| | | | | | |
| JOYSTICK PILOT PRESSURE | ANY JOYSTICK FUNCTION | JOYSTICK PILOT | PS1 | 299,9 (30) (45) | 2799,3 - 3102,6 (28 - 31) (406 - 450) |
| SYSTEM BYPASS | NONE - CONSOLE UP | DUMP TO TANK | F | 284,2 (2,5) (36) | MAXIMUM ALLOWED 448,2 (4,5) (65) |
| MAIN RELIEF ON MANIFOLD BLOCK | BUCKET | P2 | F | 18202,1 (182) (2640) | 17698,7 - 18698,6 (177 - 187) (2567 - 2712) |
| MAIN RELIEF ON MANIFOLD BLOCK | AUXILIARY | P1 and P2 | F | 19002 (190) (2756) | 18498,6 - 19498,8 (185 - 195) (2683 - 2828) |
| MAIN RELIEF ON MANIFOLD BLOCK | ARM | P1 | F | 18202,2 (182) (2640) | 17698,8 - 18698,6 (177 - 187) (2567 - 2712) |
| SWING MOTOR - PORT RELIEF | SLEW RIGHT | P1 | F | 8397,8 (84) (1218) | 7997,9 - 8797,7 (80 - 88) (1160 - 1276) |
| SWING MOTOR - PORT RELIEF | SLEW LEFT | P1 | F | 8397,8 (84) (1218) | 7997,9 - 8797,7 (80 - 88) (1160 - 1276) |

**Removal And Installation (Cont'd)**

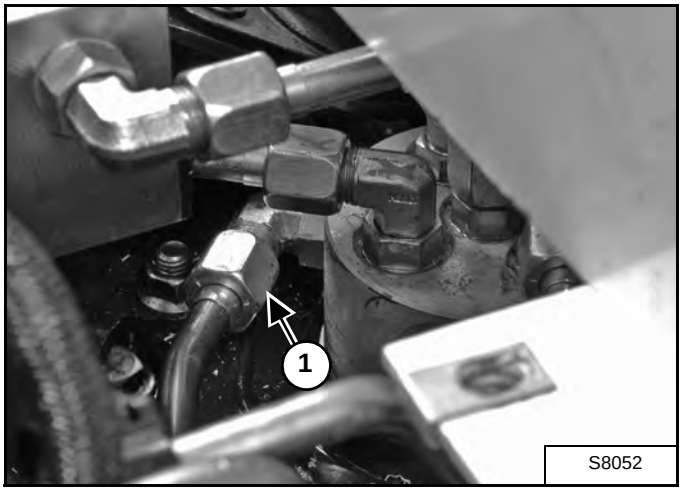
**Figure 20-40-15**




Disconnect the tubeline (Item 1) **[Figure 20-40-15]** from the swivel joint.

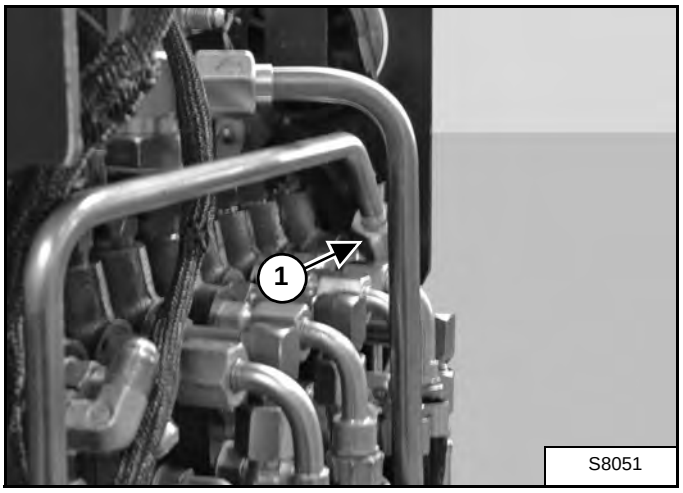
Remove the tubeline from the excavator for easy access to other tubelines and hoses.

**Figure 20-40-16**




Disconnect the tubeline (Item 1) **[Figure 20-40-16]** from the swivel joint.

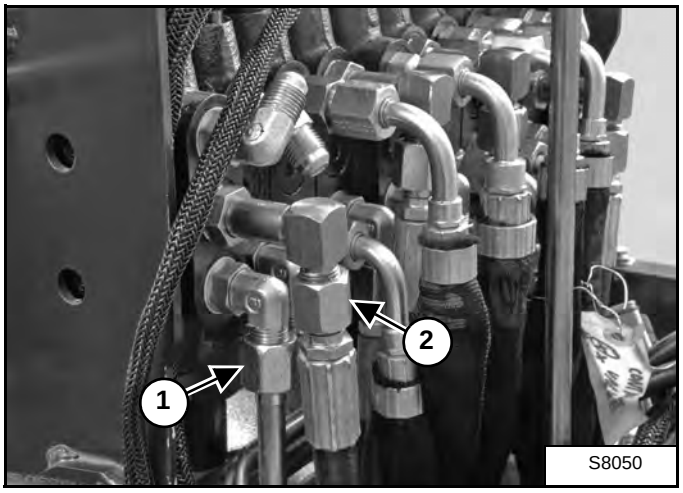
**Figure 20-40-17**




Disconnect the tubeline (Item 1) **[Figure 20-40-17]** from the control valve.

Remove the tubeline from the excavator for easy access to other tubelines and hoses.

**Figure 20-40-18**




Disconnect the tubeline (Item 1) and hose (Item 2) **[Figure 20-40-18]** from the control valve.

**Slew Valve Section Disassembly And Assembly**

# IMPORTANT

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

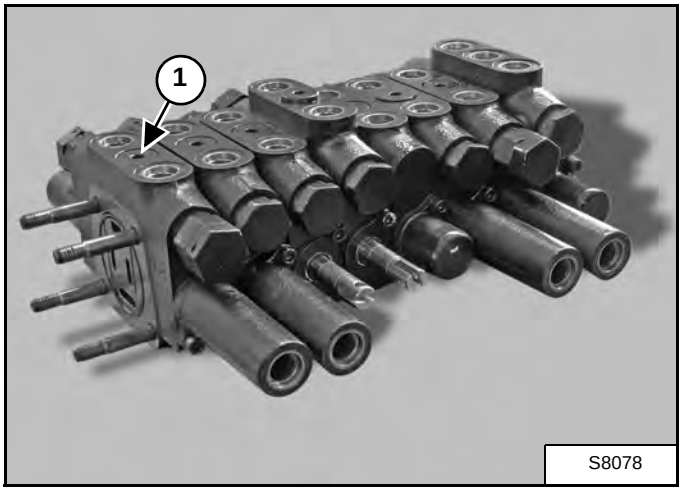
**I-2003-0888**

Clean all parts in solvent and dry with compressed air.

Inspect all parts for wear or damage. Replace any worn or damaged parts.

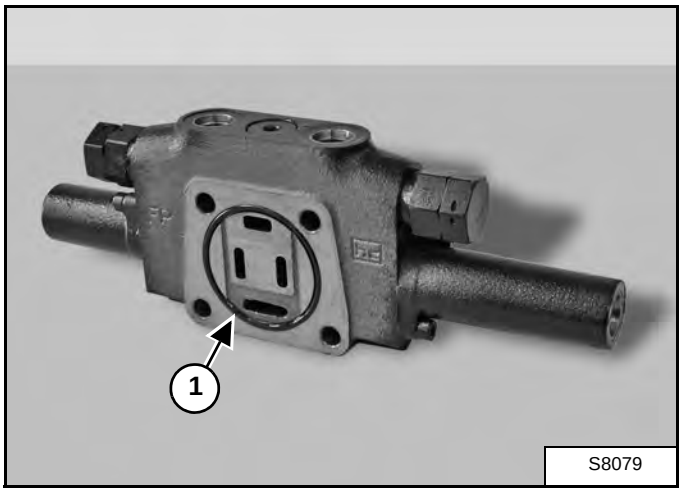
Always install new seals and O-rings. Lubricate all seals and O-rings with clean hydraulic fluid before installation.

**Figure 20-40-44**



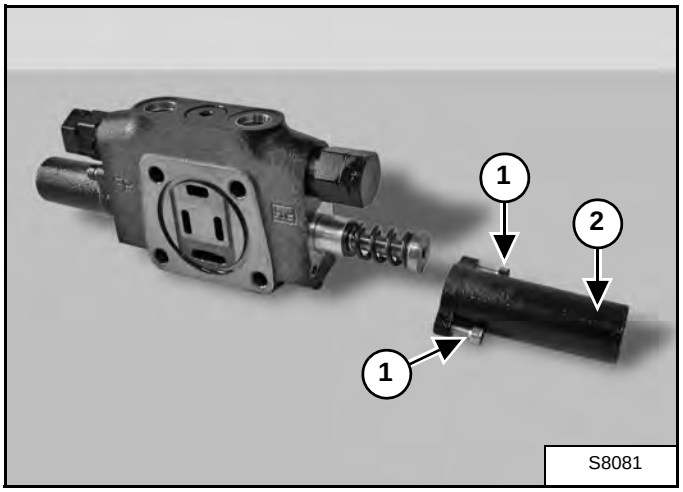

Remove the slew valve section (Item 1) **[Figure 20-40-44]** from the valve assembly.

**Figure 20-40-45**




Remove the O-ring (Item 1) **[Figure 20-40-45]** from the slew valve section.

**Figure 20-40-46**

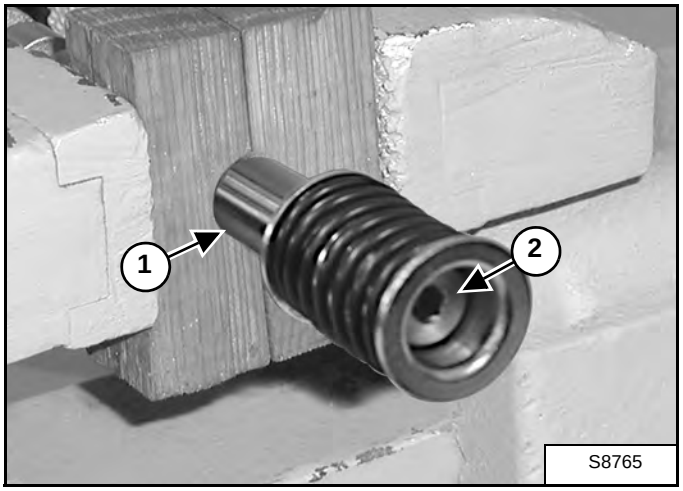



Loosen the bolts (Item 1) and remove cap and screw assembly (Item 2) **[Figure 20-40-46]**.

***Installation:*** Tighten the bolts to 6,5 N•m (58 in-lb) torque.

**Boom Swing Valve Section Disassembly And Assembly (Cont'd)**

**Figure 20-40-82**



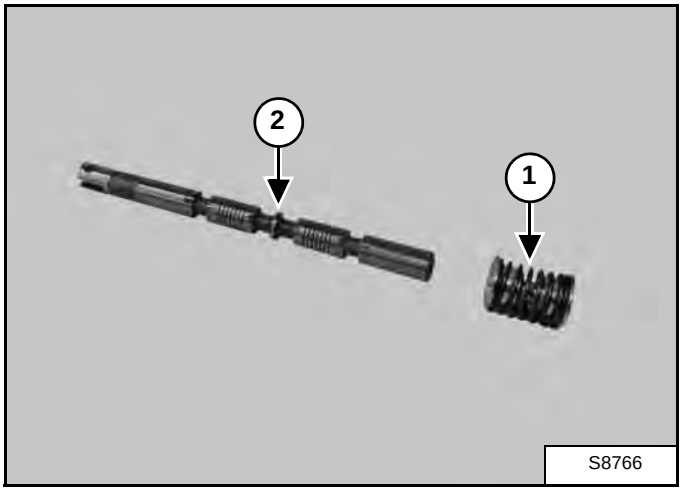

Using the wood blocks clamp the spool and spring assembly (Item 1) **[Figure 20-40-82]** in a vise.

**NOTE: Do not use anything other than hardwood blocks to grip the spool, or the spool will be damaged.**

Loosen the bolt (Item 2) **[Figure 20-40-82]**.

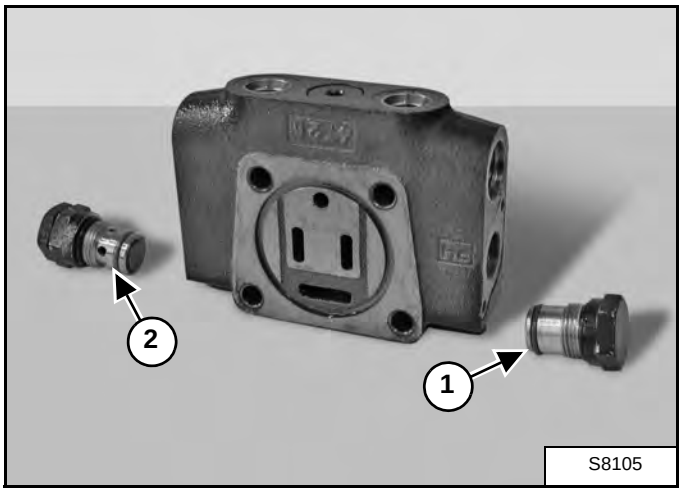
***Installation:*** Apply Loctite® 243 or equivalent and tighten the bolt to 6 N•m (53 in-lb) torque.

**Figure 20-40-83**




Remove the spring assembly (Item 1) from the spool (Item 2) **[Figure 20-40-83]**.

**Figure 20-40-84**

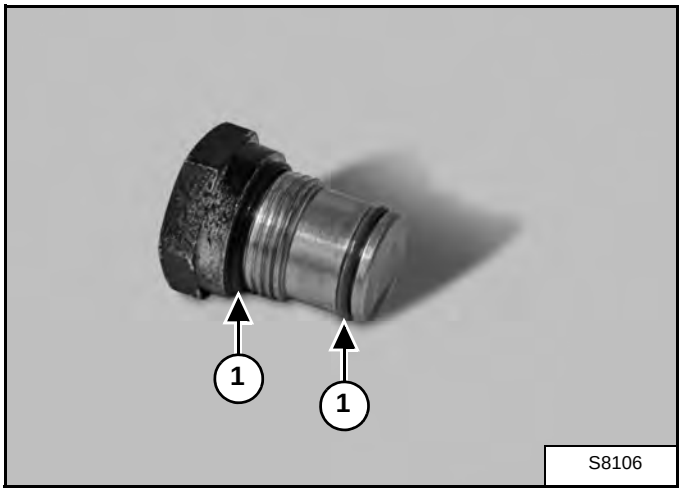



Remove the plug (Item 1) and valve assembly (Item 2) **[Figure 20-40-84]**.

***Installation:*** Tighten the plug to 40 - 45 N•m (29 - 33 ft-lb) torque.

***Installation:*** Tighten the valve assembly to 40 - 45 N•m (29-33 ft-lb) torque.

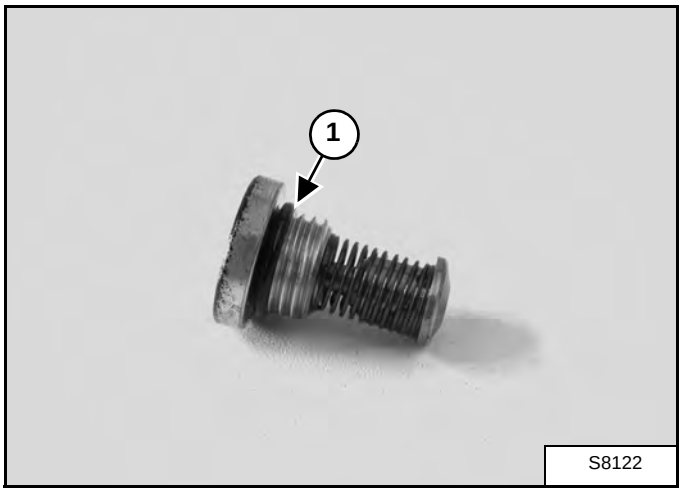
**Figure 20-40-85**




Remove the O-rings (Item 1) **[Figure 20-40-85]**.

**Blade Valve Section Disassembly And Assembly (Cont'd)**

**Figure 20-40-118**




Remove the O-ring (Item 1) **[Figure 20-40-118]** from the check valve.

**Right Travel Valve Section Disassembly And Assembly**

# IMPORTANT

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

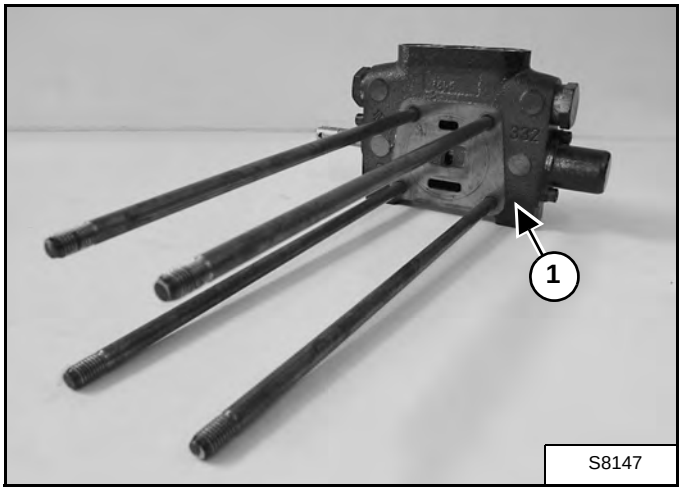
**I-2003-0888**

Clean all parts in solvent and dry with compressed air.

Inspect all parts for wear or damage. Replace any worn or damaged parts.

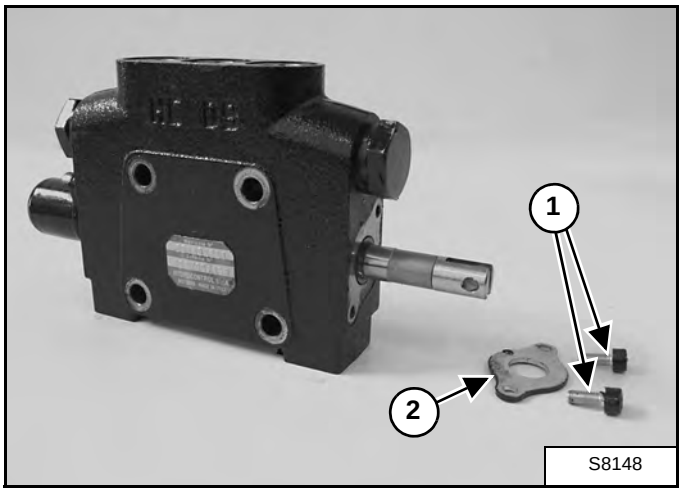
Always install new seals and O-rings. Lubricate all seals and O-rings with clean hydraulic fluid before installation.

**Figure 20-40-149**




Remove the right travel valve section (Item 1) **[Figure 20-40-149]** from the tie rods.

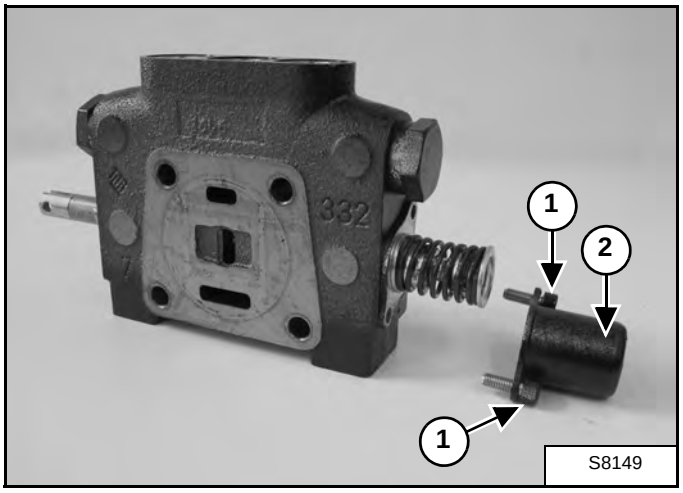
**Figure 20-40-150**




Remove the bolts (Item 1) and retaining plate (Item 2) **[Figure 20-40-150]**.

***Installation:*** Tighten the bolts to 6,5 N•m (58 in-lb) torque.

**Figure 20-40-151**




Loosen the bolts (Item 1) and remove cap and screw assembly (Item 2) **[Figure 20-40-151]**.

***Installation:*** Tighten the bolts to 6,5 N•m (58 in-lb) torque.

**Removal And Installation**

Lower the boom / bucket and blade to the ground.

Relieve hydraulic pressure.

Drain the hydraulic reservoir. (See Removing And Replacing The Hydraulic Filter on Page 10-100-2.)

# IMPORTANT

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

I-2003-0888

# ⚠ WARNING

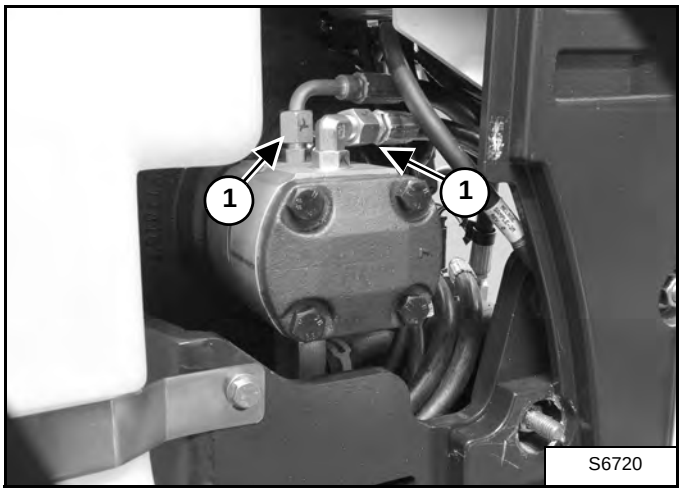
**Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin. This can cause serious injury and possible death if proper medical treatment by a physician familiar with this injury is not received immediately.**

**W-2145-0290**

Remove the upper left hand side cover. (See Upper Left Side Cover Removal And Installation on Page 40-210-1.)

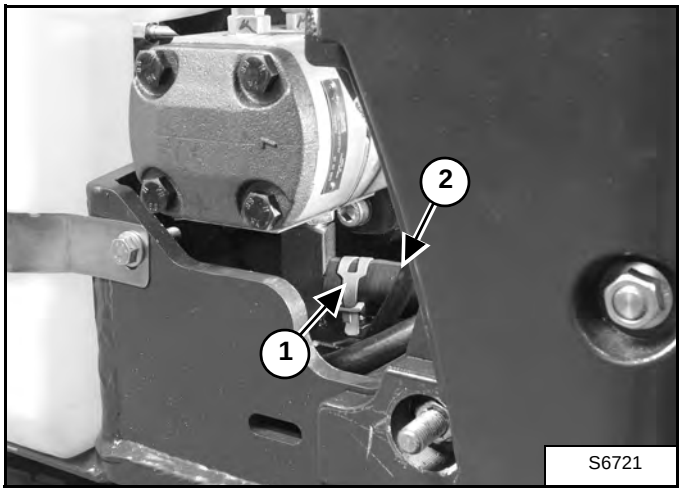
Remove the lower left hand side cover. (See Lower Left Side Cover Removal And Installation on Page 40-210-2.)

**Figure 20-50-4**




Remove the two pressure hoses (Item 1) **[Figure 20-50-4]**. Cap and plug the hoses and fittings.

**Figure 20-50-5**




Remove the hose clamp (Item 1) and inlet hose (Item 2) **[Figure 20-50-5]**.

## MANIFOLD ASSEMBLY / ACCUMULATOR

### Description

The manifold body contains a system bypass solenoid valve, a console (joystick) lockout solenoid valve, a pressure reducing valve and a safety relief valve.

The body is connected to the accumulator.

The manifold supplies 3,0 MPa (30 bar) (435 psi) to the joysticks to activate the control valve spools.

The accumulator provides short term reserve pressure for joystick function with the engine off and the key in the ON position.

### Removal And Installation

Lower the boom / bucket and blade to the ground.

**WARNING**

**Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin. This can cause serious injury and possible death if proper medical treatment by a physician familiar with this injury is not received immediately.**

**W-2145-0290**

**IMPORTANT**

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

**I-2003-0888**

From the operator's seat, drain the residual pressure from the accumulator by stroking a function with the engine off and the key in the run position.

Open the tailgate.

Remove the rear counterweight. (See Rear Counterweight Removal And Installation on Page 40-200-1.)

**NOTE: All counterweights are removed for photo clarity!**

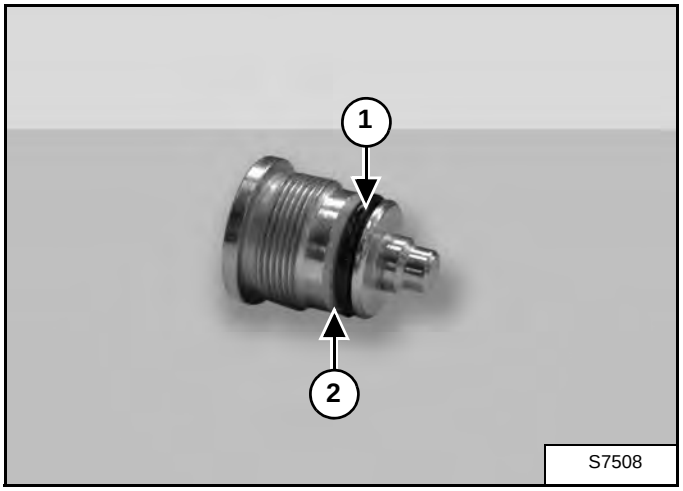
**Assembly**

Clean all parts in solvent and dry with compressed air.

Inspect all parts for wear or damage. Replace any worn or damaged parts.

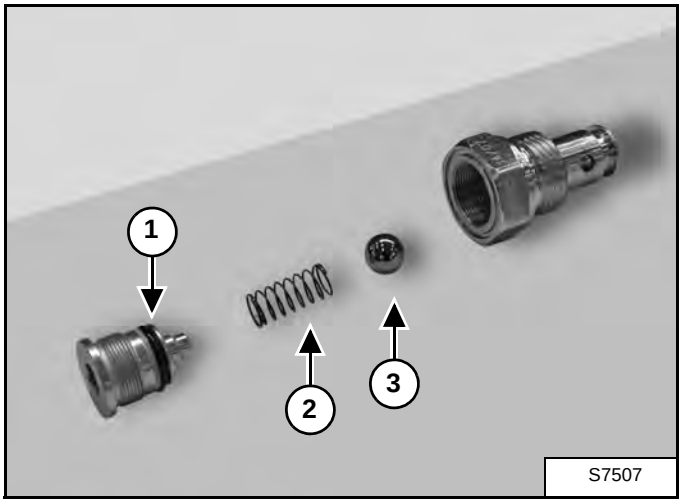
Always install new back-up rings and O-rings. Lubricate all back-up rings and O-rings with clean hydraulic fluid before installation.

**Figure 20-60-34**




Install the O-ring (Item 1) and the back-up ring (Item 2) **[Figure 20-60-34]** on the plugs.

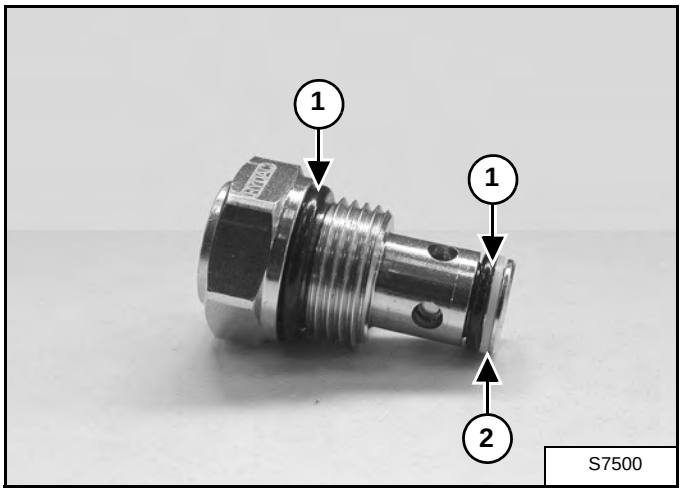
**Figure 20-60-35**




Install the ball (Item 1), spring (Item 2) and plug (Item 3) **[Figure 20-60-35]** in the valves.

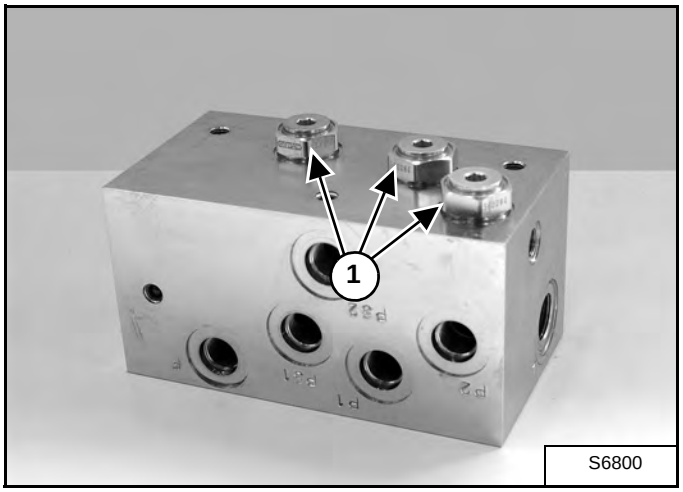
Tighten the plug to 60 N•m (44 ft-lb) torque.

**Figure 20-60-36**




Install the two O-rings (Item 1) and the back-up ring (Item 2) **[Figure 20-60-36]** on the valves.

**Figure 20-60-37**

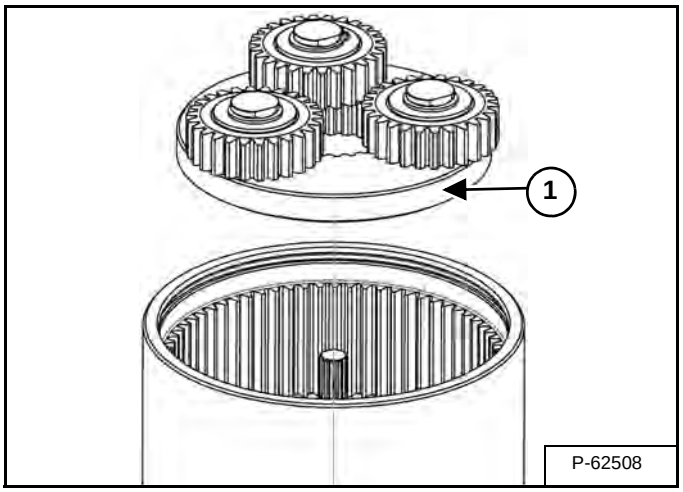



Install the three valves (Item 1) **[Figure 20-60-37]**.

Tighten the valves to 60 N•m (44 ft-lb) torque.

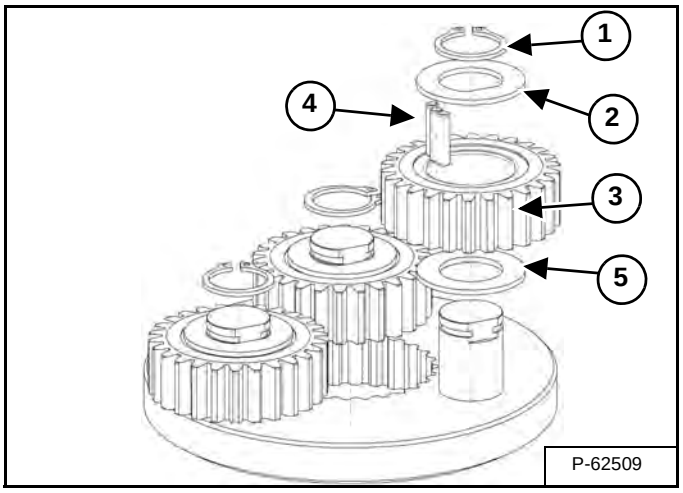
**Disassembly (Cont'd)**

**Figure 20-70-11**



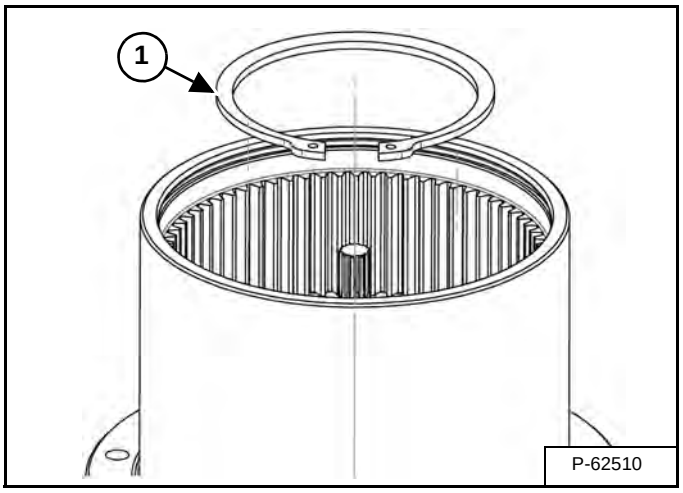

Remove the second stage planetary carrier (Item 1) **[Figure 20-70-11]** using your hands.

**Figure 20-70-12**



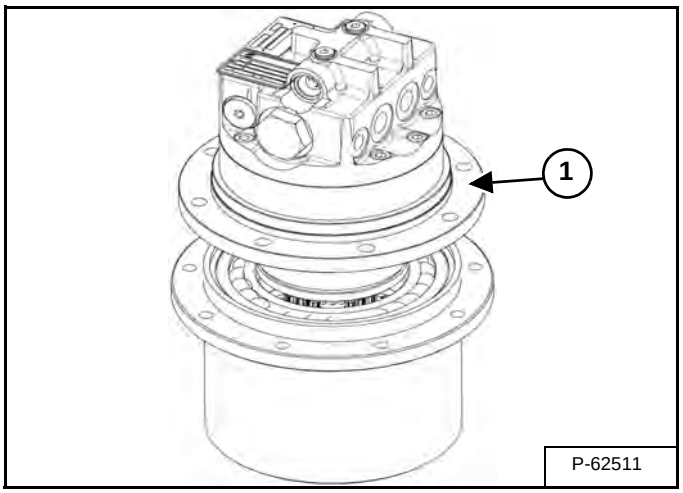

Remove the retaining rings (Item 1), anti-rotation washer (Item 2), planetary gears (Item 3), needle bearings (Item 4) and thrust washer (Item 5) **[Figure 20-70-12]** from the first stage planetary carrier assembly.

**Figure 20-70-13**




Remove the retaining ring (Item 1) **[Figure 20-70-13]** from the hub to free the two bearings, ring gear and motor.

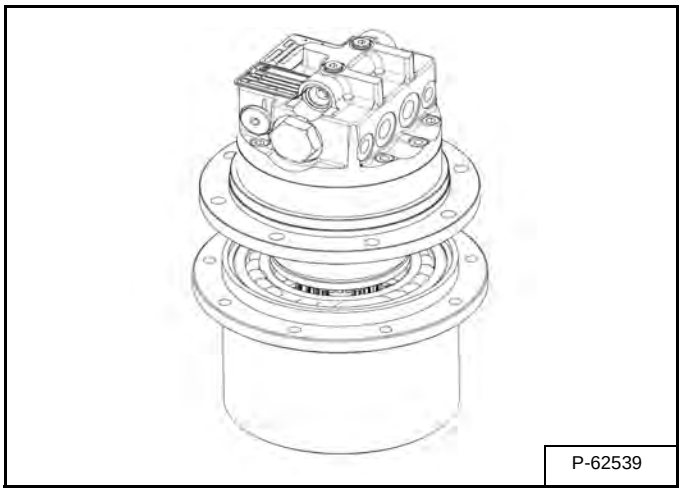
**Figure 20-70-14**




Remove the hub (Item 1) **[Figure 20-70-14]** from the ring gear.

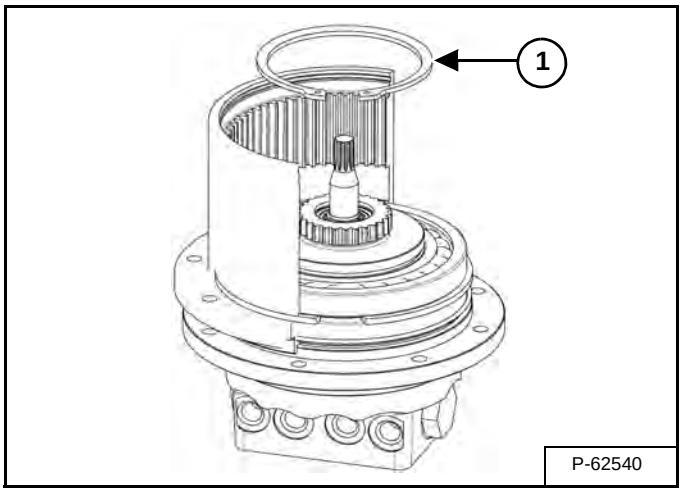
**Assembly (Cont'd)**

**Figure 20-70-49**



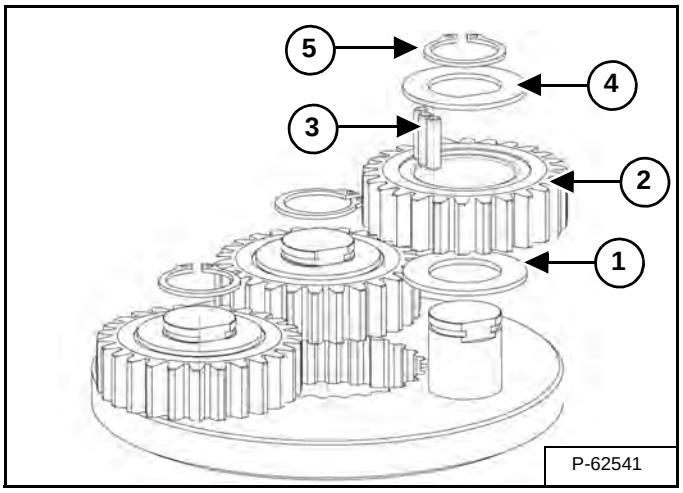

Press the reduction unit and motor assembly into the seat of the bearings **[Figure 20-70-49]**.

**Figure 20-70-50**




Install the external snap ring (Item 1) **[Figure 20-70-50]** in the motor reduction unit.

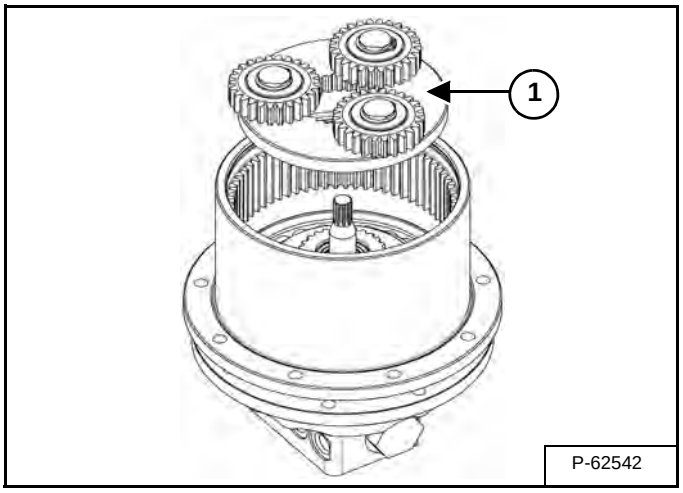
**Figure 20-70-51**




Install the thrust washers (Item 1), planetary gears (Item 2), needle bearing (Item 3) anti-rotation washers (Item 4), and external snap rings (Item 5) **[Figure 20-70-51]**.

**NOTE: Install the snap rings so the opening of the snap ring is towards the outside.**

**Figure 20-70-52**




Install the planetary assembly (Item 1) **[Figure 20-70-52]**.

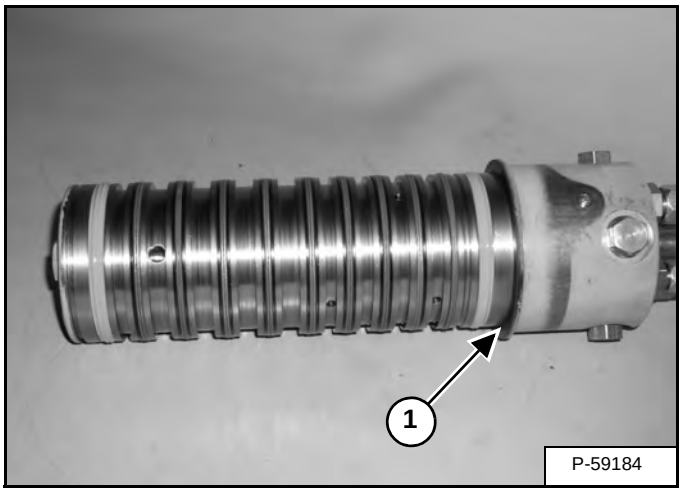
**SWIVEL JOINT (S/N 133P14286 & ABOVE, B4K911001 & ABOVE AND B4PD11001 & ABOVE) (CONT'D)**

**Assembly**

Clean all parts in solvent and dry with compressed air.

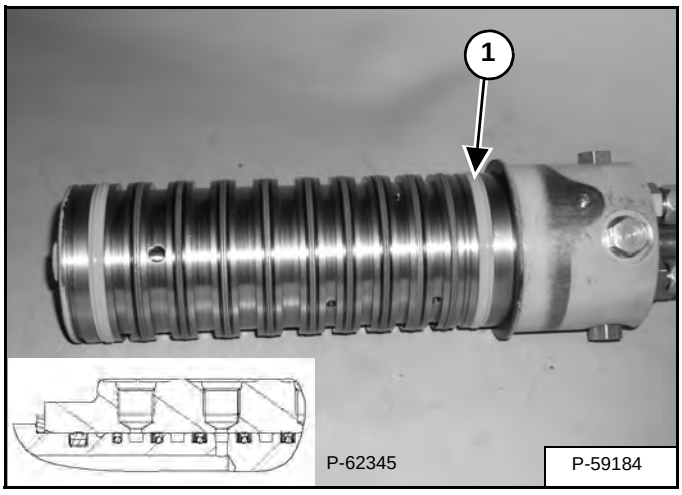
Inspect the rotor and housing for scratches or wear that could cause internal leakage. Always install new seals and back-up seals. Lubricate all seals and back-up seals with clean hydraulic fluid before installation.

**Figure 20-80-15**




Install the nylon washer (Item 1) **[Figure 20-80-15]**.

**Figure 20-80-16**

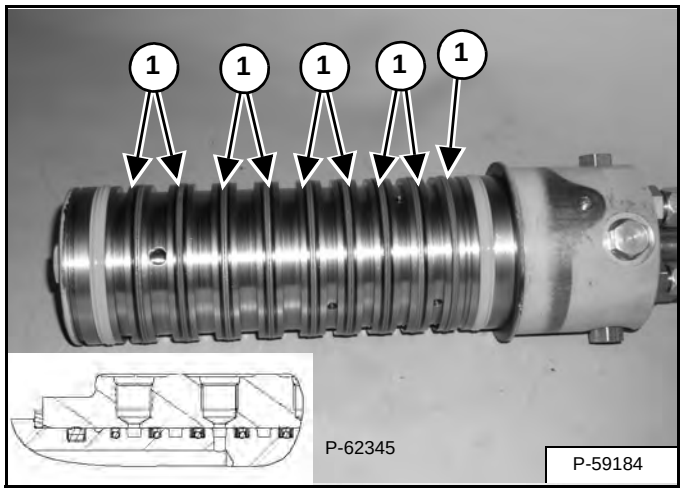



Heat the seals in hydraulic fluid for 3 minutes at 54°C (130°F).

Install the inner and outer seals (Item 1) **[Figure 20-80-16]**.

**NOTE: The inner and outer seal are serviceable as one part number.**

**Figure 20-80-17**



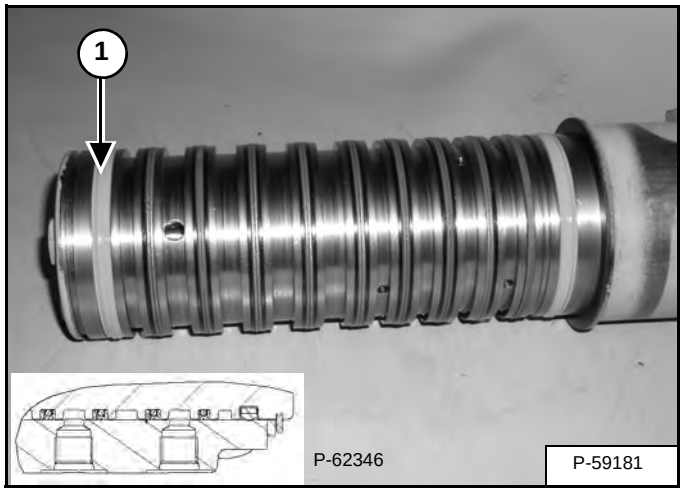

Install the O-rings under the seals (Item 1) **[Figure 20-80-17]**.

Heat the seals in hydraulic fluid for 3 minutes at 54°C (130°F).

Install the seals and back-up seals (Item 1) **[Figure 20-80-17]**.

**NOTE: The seal and O-ring are serviceable as one part number.**

**Figure 20-80-18**




Heat the seals in hydraulic fluid for 3 minutes at 54°C (130°F).

Install the inner and outer seals (Item 1) **[Figure 20-80-18]**.

**NOTE: The inner and outer seal are serviceable as one part number.**

## SWIVEL JOINT (S/N A33P12838 - A33P13633)

### Description

The swivel joint is located under the floor panels and mounted to the upperstructure. The swivel joint directs hydraulic fluid to the undercarriage components while allowing the upperstructure to rotate.

### Removal And Installation

Expand the track frame fully.

**Figure 20-82-1**


Place blocks under the excavator tracks and blade **[Figure 20-82-1]**.

Lower the boom / bucket to the ground.

Relieve hydraulic pressure.

Remove the muffler. (See Removal And Installation on Page 60-20-1.)

Remove the floor panels. (See FLOOR PANELS on Page 40-120-1.)

Drain the hydraulic reservoir. (See Removing And Replacing Hydraulic Fluid on Page 10-120-3.)

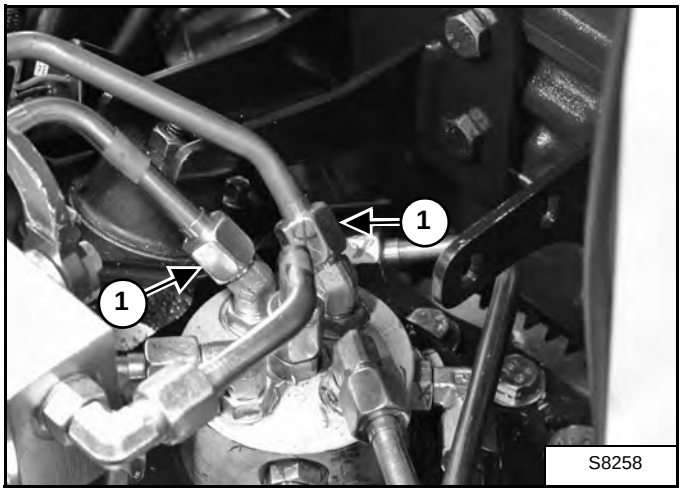
**WARNING**

**Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin. This can cause serious injury and possible death if proper medical treatment by a physician familiar with this injury is not received immediately.**

**W-2145-0290**

Mark all hoses and tubelines for ease of assembly.

**Figure 20-82-2**




Remove the two tubelines (Item 1) **[Figure 20-82-2]** from the top of the swivel joint.

## SWIVEL JOINT (S/N A33P11001 - A33P12837)

### Description

The swivel joint is located under the floor panels and mounted to the upperstructure. The swivel joint directs hydraulic fluid to the undercarriage components while allowing the upperstructure to rotate.

### Removal And Installation

Expand the track frame fully.

**Figure 20-83-1**


Place blocks under the excavator tracks and blade **[Figure 20-83-1]**.

Lower the boom / bucket to the ground.

Relieve hydraulic pressure.

Remove the muffler. (See Removal And Installation on Page 60-20-1.)

Remove the floor panels. (See FLOOR PANELS on Page 40-120-1.)

Drain the hydraulic reservoir. (See Removing And Replacing Hydraulic Fluid on Page 10-120-3.)

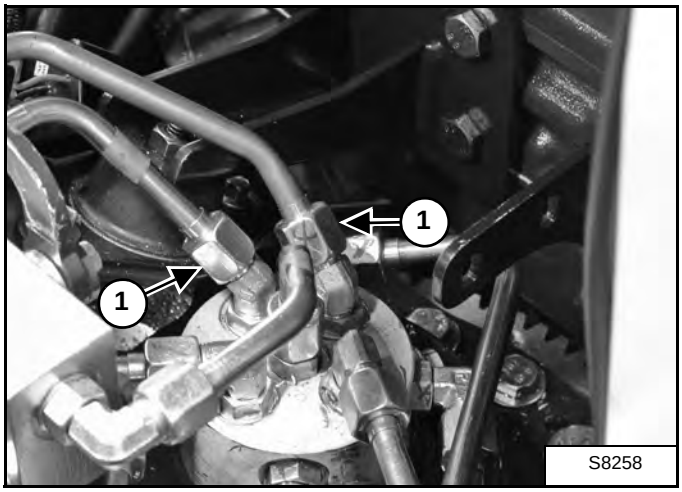
**WARNING**

**Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin. This can cause serious injury and possible death if proper medical treatment by a physician familiar with this injury is not received immediately.**

**W-2145-0290**

Mark all hoses and tubelines for ease of assembly.

**Figure 20-83-2**




Remove the two tubelines (Item 1) **[Figure 20-83-2]** from the top of the swivel joint.

## SWING MOTOR

### Description

The slew motor is a hydraulic motor that receives hydraulic fluid from the gear pump through the control valve to swing the upperstructure left or right. The speed that the slew motor rotates is related to the amount of hydraulic fluid it receives.

### Removal And Installation

# IMPORTANT

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

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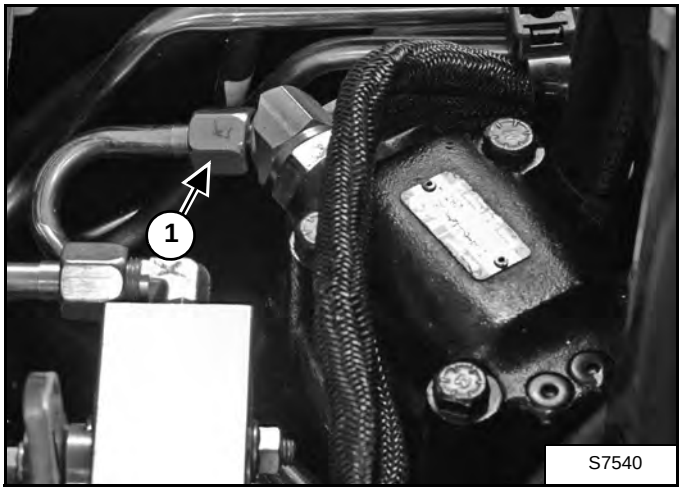
Remove the floor panels. (See FLOOR PANELS on Page 40-120-1.)

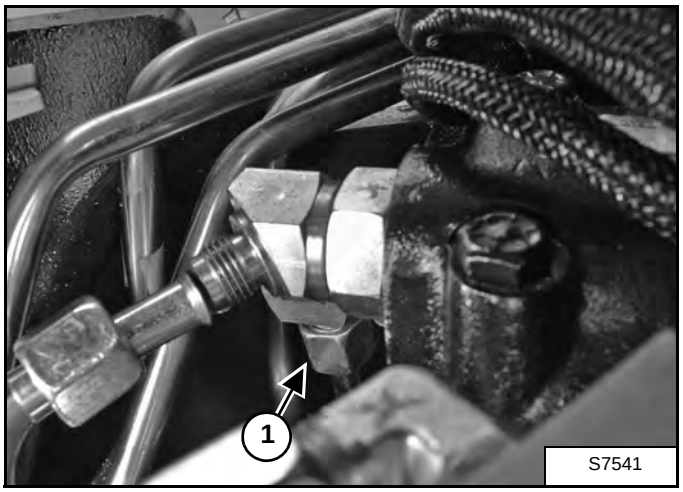
Remove the instrument panel. (See Removal And Installation on Page 40-220-1.)

**Figure 20-90-1**



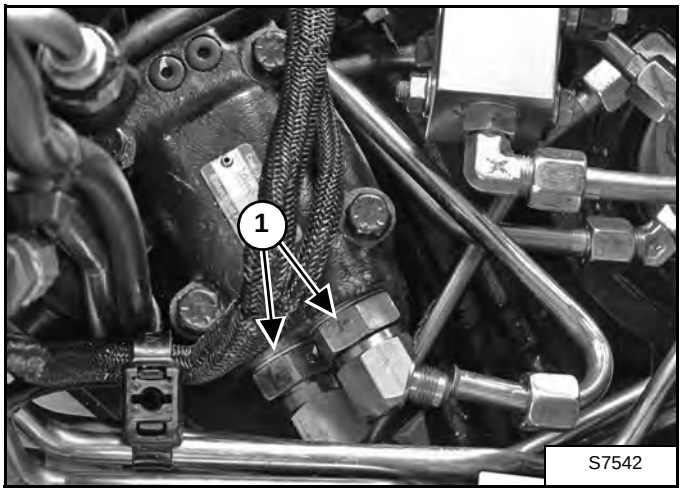

Mark and remove the tubeline (Item 1) **[Figure 20-90-1]**.

**Figure 20-90-2**




Mark and remove the tubeline (Item 1) **[Figure 20-90-2]**.

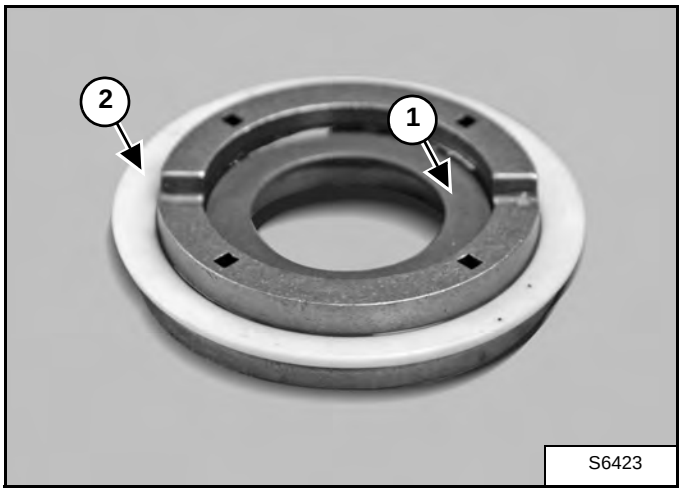
**Figure 20-90-3**




Remove the two fittings (Item 1) **[Figure 20-90-3]** from the slew motor.

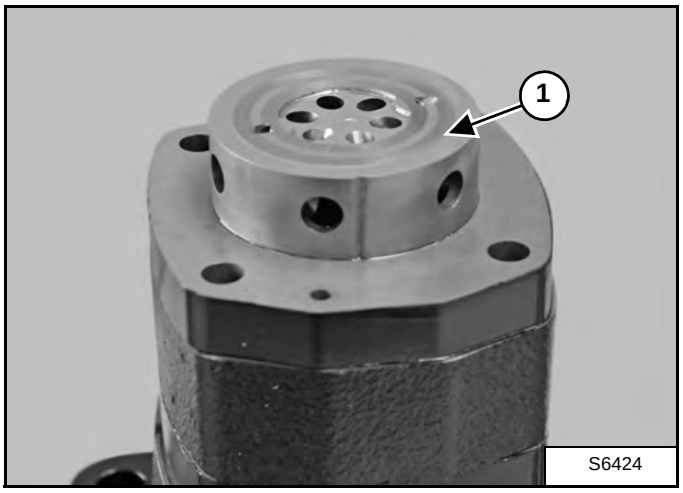
**Disassembly (Cont'd)**

**Figure 20-90-33**



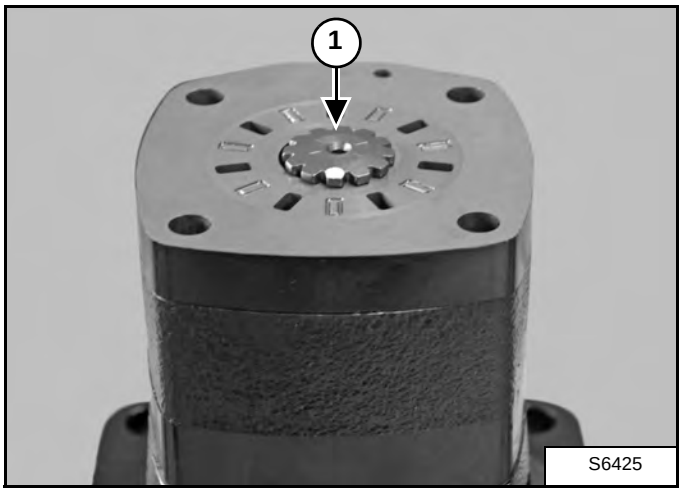

Remove the inner seal (Item 1) and outer seal (Item 2) **[Figure 20-90-33]**.

**Figure 20-90-34**



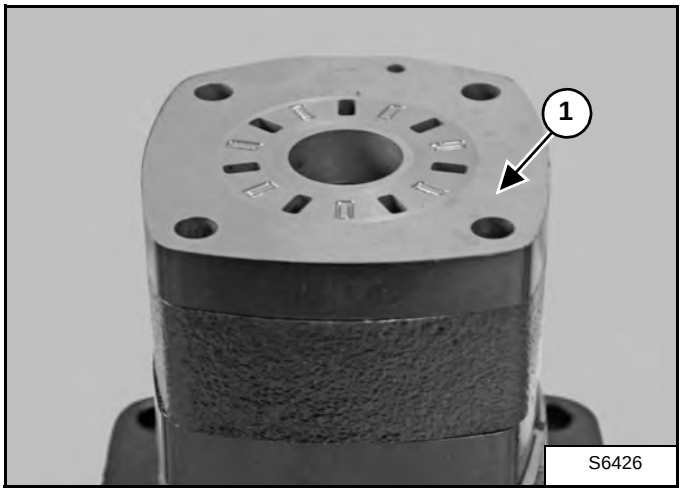

Remove the valve (Item 1) **[Figure 20-90-34]**.

**Figure 20-90-35**




Remove the drive (Item 1) **[Figure 20-90-35]**.

**Figure 20-90-36**




Remove the valve plate (Item 1) **[Figure 20-90-36]**.

## CONTROL PATTERN SELECTOR VALVE

### Description

The control pattern selector valve changes the control patterns from ISO to STD.

The control pattern selector valve is located under the drivers seat, next to the fuel tank on the left side of the excavator.

### Removal And Installation

Lower the boom / bucket and blade to the ground.

With the engine off, turn the start key to the ON position and move blade lever to relieve hydraulic pressure.

**IMPORTANT**

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

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Remove the battery. (See Removal And Installation on Page 50-20-3.)

Remove the fuel tank. (See Removal And Installation on Page 40-130-1.)

**⚠ WARNING**

**Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin. This can cause serious injury and possible death if proper medical treatment by a physician familiar with this injury is not received immediately.**

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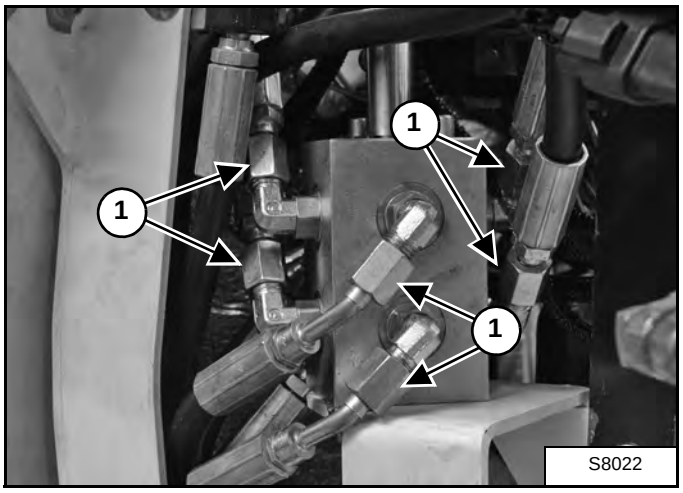
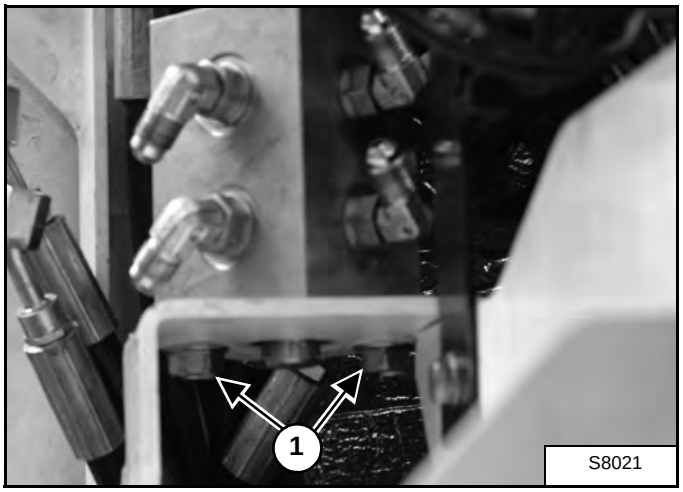
**Figure 20-100-1**




Mark and disconnect the eight hoses (Item 1) **[Figure 20-100-1]**.

**Figure 20-100-2**



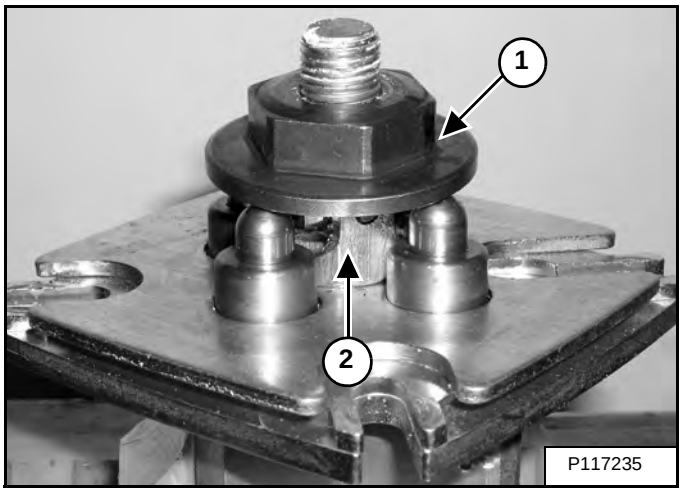

Remove the two bolts (Item 1) **[Figure 20-100-2]**.

Remove the control pattern selector valve from the excavator.

**CONTROL LEVER (JOYSTICK) (RIGHT) (S/N A33S13155 & ABOVE, B4K911001 & ABOVE AND B4PD11001 & ABOVE) (CONT'D)**

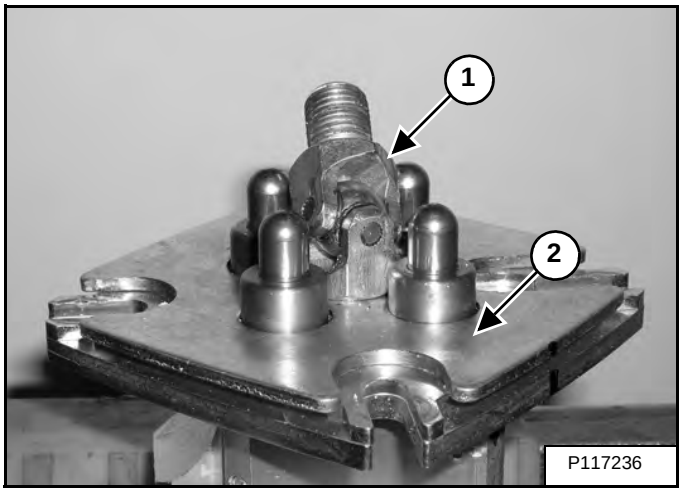
**Disassembly (Cont'd)**

**Figure 20-110-15**




Remove the control plate (Item 1) from the U-joint (Item 2) **[Figure 20-110-15]**.

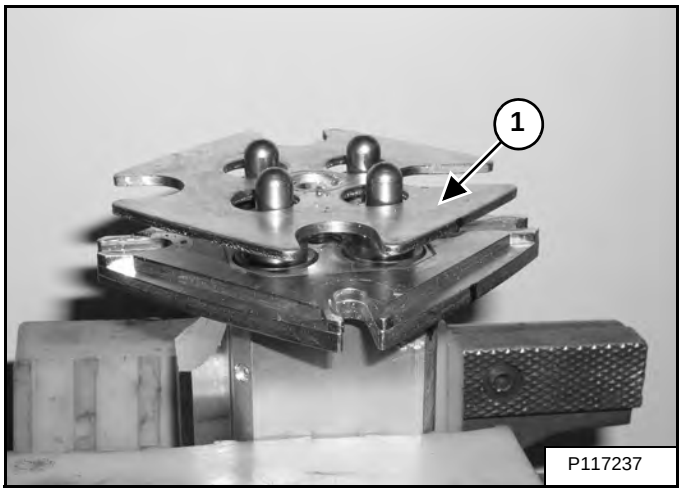
**Figure 20-110-16**




Mark the plate and housing for correct installation. Remove the U-joint (Item 1) **[Figure 20-110-16]**.

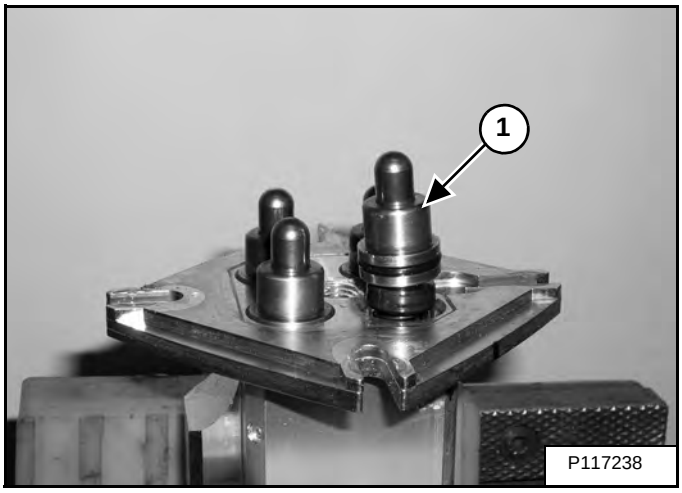
**NOTE: The plate (Item 2) [Figure 20-110-16] is spring loaded and will come up as the U-joint is removed.**

**Figure 20-110-17**




Remove the plate (Item 1) **[Figure 20-110-17]**.

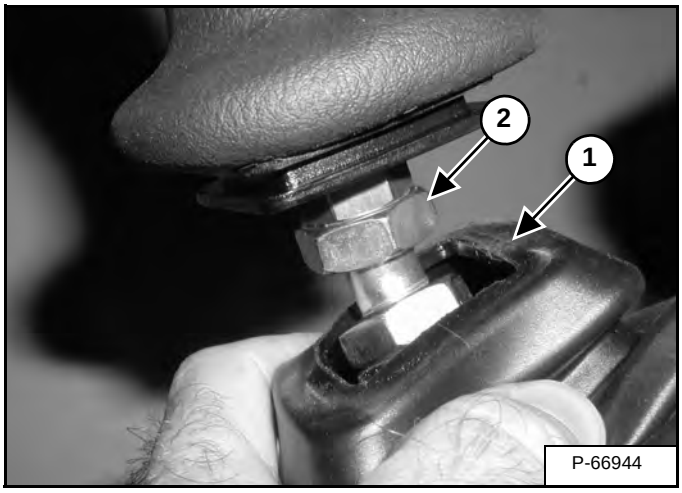
**Figure 20-110-18**




Remove the plunger assemblies (Item 1) **[Figure 20-110-18]**.

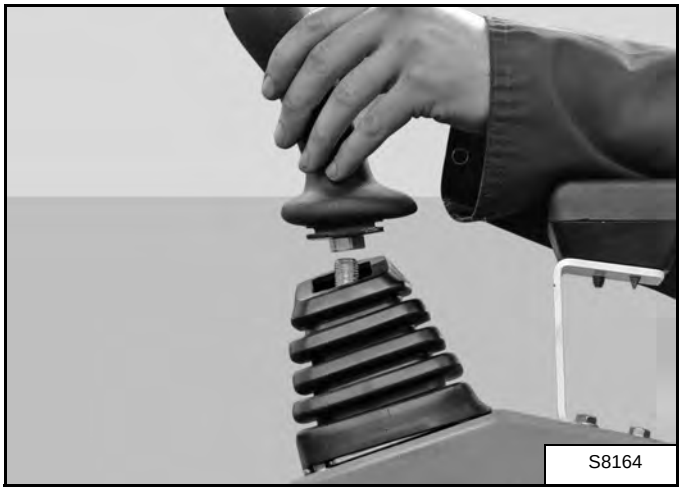
**Handle Removal And Installation (Cont'd)**

**Figure 20-111-6**




Hold the dust boot (Item 1) down and loosen the locknut (Item 2) **[Figure 20-111-6]**.

**Figure 20-111-7**




Remove the handle **[Figure 20-111-7]**.

**Removal And Installation**

Lower the boom / bucket and blade to the ground.

Stop the engine.

Relieve hydraulic pressure.

Remove the console cover. (See Joystick Console Cover Removal And Installation on Page 40-40-1.)

**IMPORTANT**

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

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**⚠ WARNING**

**Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin. This can cause serious injury and possible death if proper medical treatment by a physician familiar with this injury is not received immediately.**

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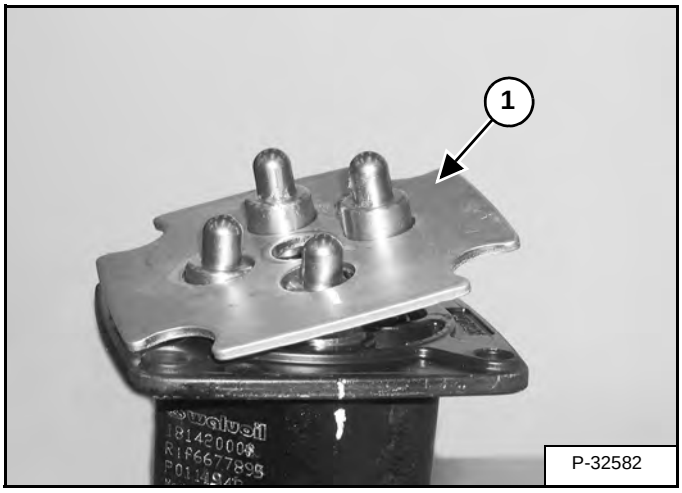
**Assembly (Cont'd)**

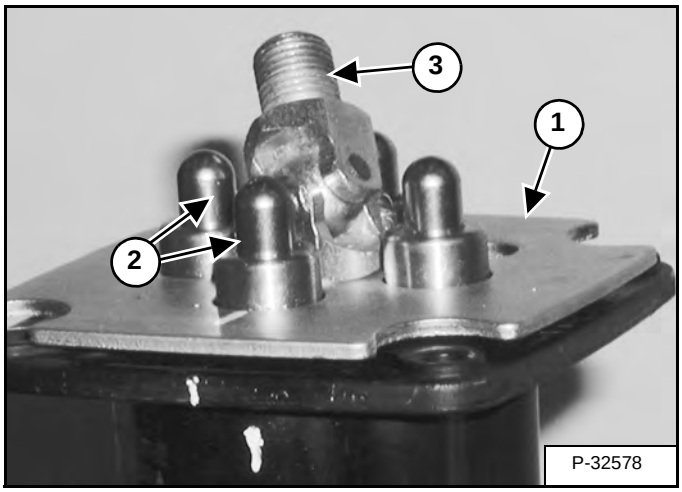
**Figure 20-111-38**




Install the plate (Item 1) **[Figure 20-111-38]**.

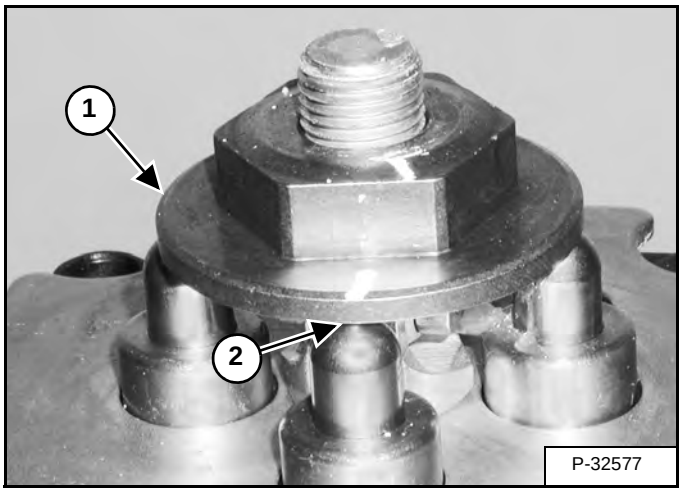
**NOTE: Spring pressure can dislodge the plunger assemblies until the plate (Item 1) [Figure 20-111-38] is secured in place.**

**Figure 20-111-39**



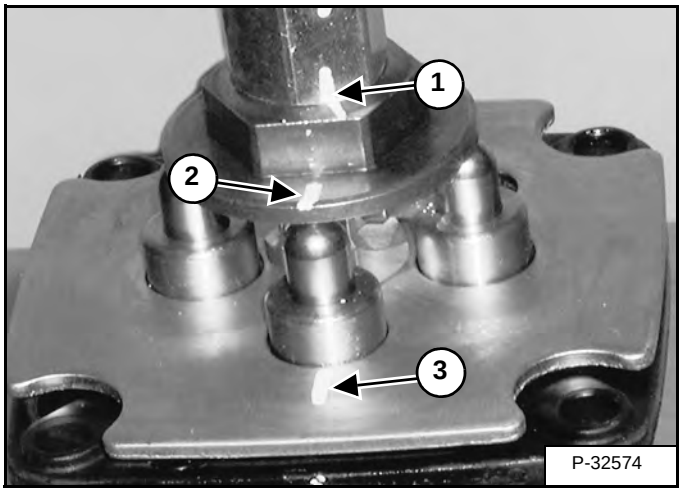

Press down on the plate (Item 1) to seat the plunger assemblies (Item 2). Install the U-joint (Item 3) **[Figure 20-111-39]**.

**Figure 20-111-40**




Install the control plate (Item 1) until the plate makes light contact with all 4 plungers (Item 2) **[Figure 20-111-40]**.

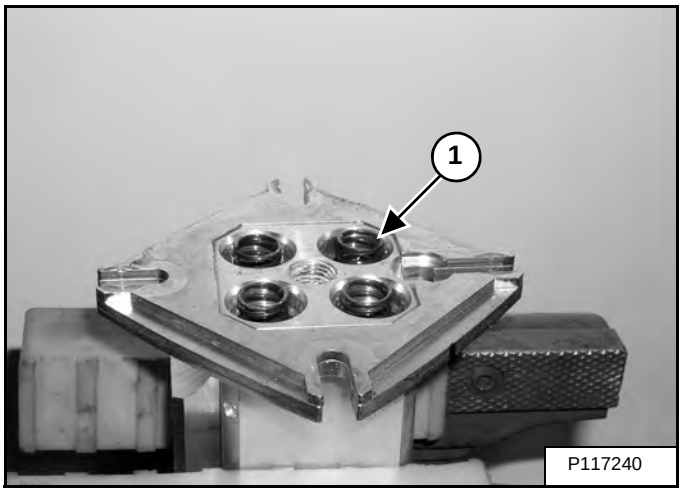
**Figure 20-111-41**




Align the coupler (Item 1) with the control plate (Item 2) and plate (Item 3) **[Figure 20-111-41]**. Tighten the coupler.

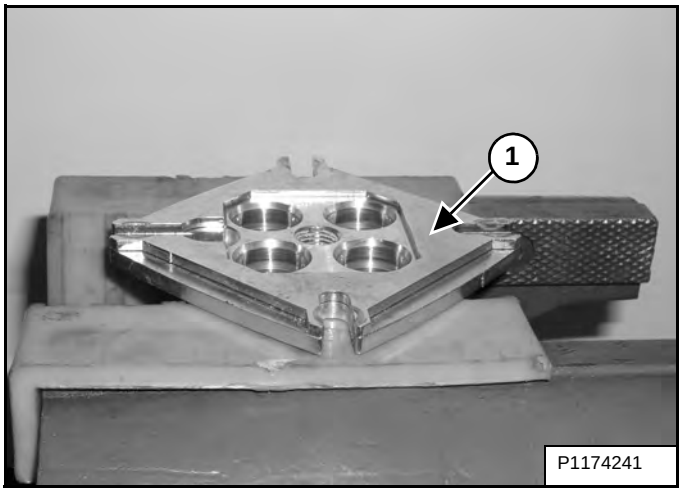
**Disassembly (Cont'd)**

**Figure 20-120-26**




Remove the springs (Item 1) **[Figure 20-120-26]**from the housing.

**Figure 20-120-27**




Remove the plate (Item 1) **[Figure 20-120-27]**.

**CONTROL LEVER (JOYSTICK) (LEFT) (S/N A33P11001 - A33P13154) (CONT'D)**

**Removal And Installation**

Lower the boom / bucket and blade to the ground.

Stop the engine.

Relieve hydraulic pressure.

Remove the left console cover. (See Joystick Console Cover Removal And Installation on Page 40-50-1.)

# IMPORTANT

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

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# ⚠ WARNING

**Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin. This can cause serious injury and possible death if proper medical treatment by a physician familiar with this injury is not received immediately.**

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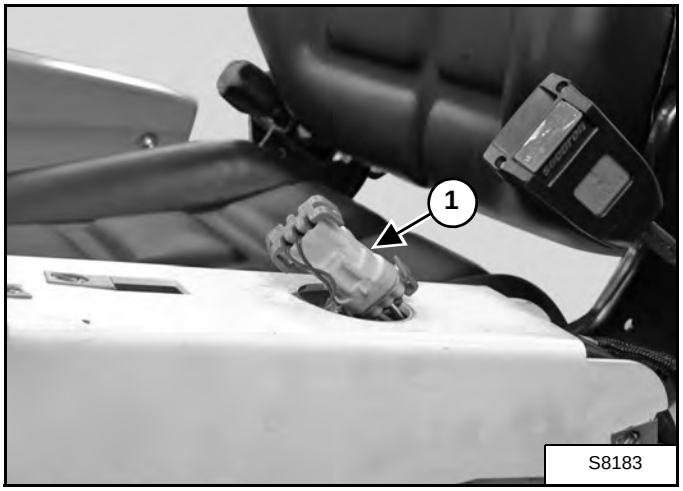
**Figure 20-121-12**



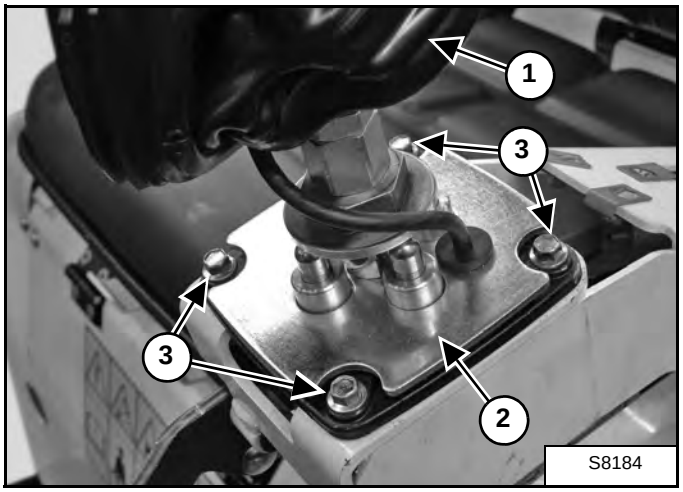

Disconnect the wire harness (Item 1) **[Figure 20-121-12]**.

**Figure 20-121-13**


Mark the hoses for ease of assembly **[Figure 20-121-13]**.

Remove the hoses while the control lever (joystick) is bolted to the console.

**Figure 20-121-14**




Raise the dust boot (Item 1) up from the plate (Item 2) **[Figure 20-121-14]**.

Remove the bolts (Item 3) **[Figure 20-121-14]** from the joystick plate.

Remove the joystick.

## HYDRAULIC RESERVOIR

### Description

The hydraulic reservoir is a storage container for the excavators hydraulic fluid. The reservoir contains a vented fill cap.

The hydraulic reservoir is located behind the radiator on the right side of the excavator.

### Removal And Installation

*With Oil Cooler*

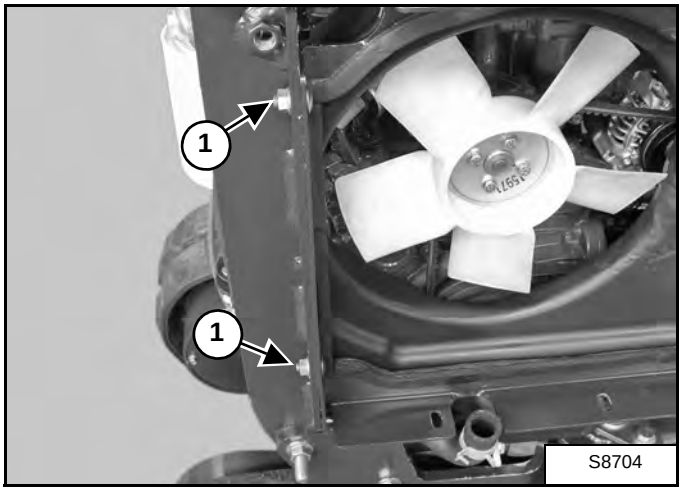
Open the tailgate. (See Opening And Closing The Tailgate on Page 10-60-1.)

Drain the hydraulic reservoir. (See Removing And Replacing Hydraulic Fluid on Page 10-120-3.)

Remove the radiator. (See Radiator Removal And Installation on Page 60-40-1.)

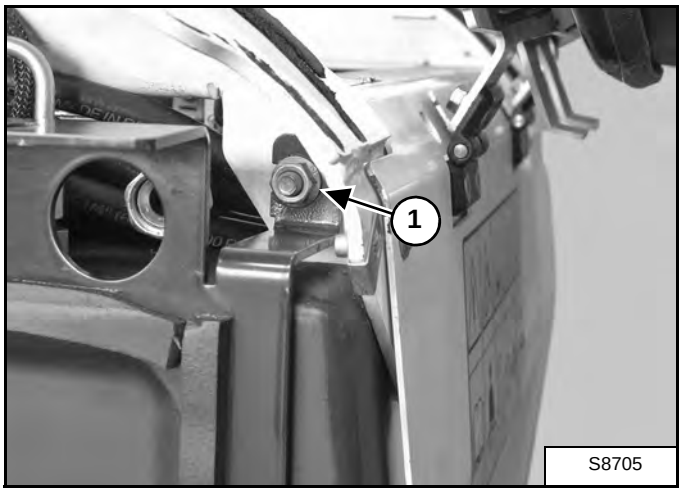
Drain the oil cooler. (See Removal And Installation on Page 20-140-1.)

**Figure 20-130-1**



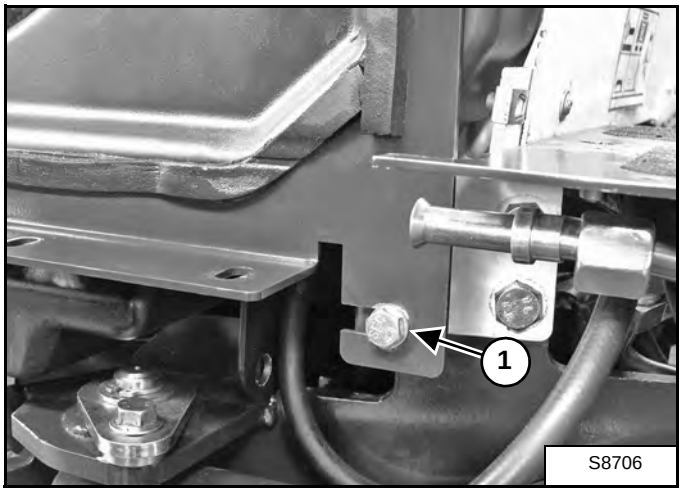

Remove the nuts and bolts (Item 1) **[Figure 20-130-1]**.

**Figure 20-130-2**




Remove the nut and bolt (Item 1) **[Figure 20-130-2]**.

**Figure 20-130-3**



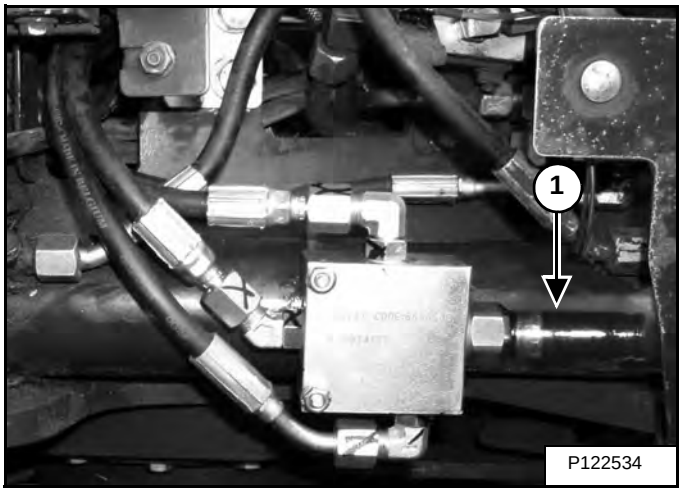

Remove the nut and bolt (Item 1) **[Figure 20-130-3]**.

Remove the bracket.

Proceed with **[Figure 20-130-4]**.

**Solenoid Removal And Installation (Cont'd)**

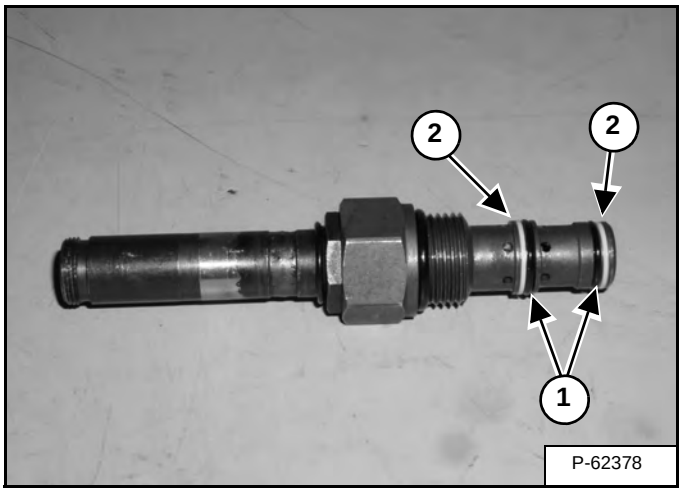
**Figure 20-150-5**




Remove the solenoid stem (Item 1) **[Figure 20-150-5]**.

***Installation:*** Tighten the solenoid stem to 50 N•m (37 ft-lb) torque.

**Figure 20-150-6**




Remove the O-rings (Item 1) and back-up rings (Item 2) **[Figure 20-150-6]**.

**Block Disassembly And Assembly**

# IMPORTANT

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

**I-2003-0888**

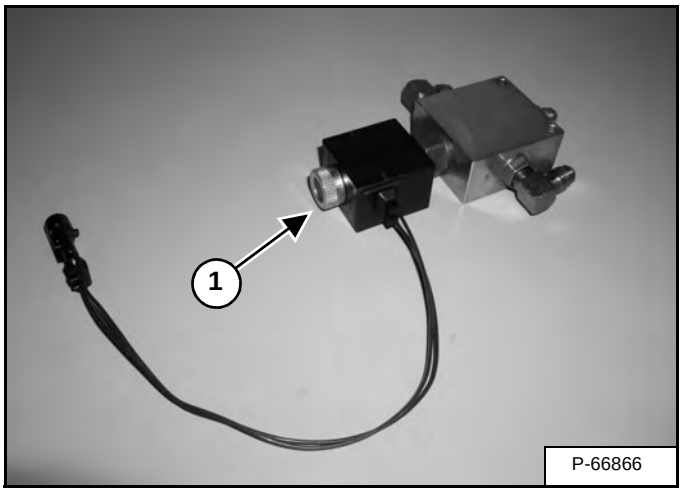
Clean all parts in solvent and dry with compressed air.

Inspectallpartsforwearordamage.

Replace any worn or damaged parts.

Always install new O-rings and back-up rings. Lubricate all O-rings and back-up rings with clean hydraulic fluid before installation.

**Figure 20-150-7**




Remove the nut (Item 1)**[Figure 20-150-7]** from the solenoid.

## TWO SPEED CONTROL VALVE

### Description

The two speed control valve operates at pilot pressure and uses a solenoid to direct flow to the travel motor for shifting between single and two speed. (The pressure is directed to the swash plate to change its angle, which causes a change of flow and displacement).

### Block Removal And Installation

Lower the boom / bucket and blade to the ground.

With the engine off, turn the Start key to the ON position and move blade lever to relieve hydraulic pressure.

# IMPORTANT

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

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Remove the right side floor panel. (See Right Floor Panel Removal And Installation on Page 40-120-1.)

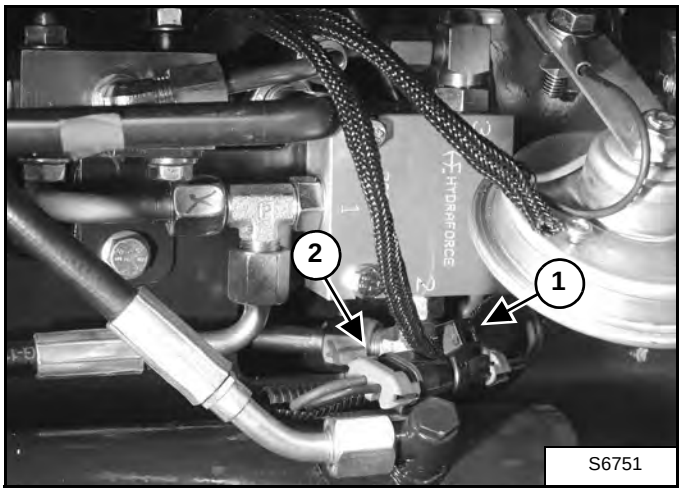
# ⚠ WARNING

**Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin. This can cause serious injury and possible death if proper medical treatment by a physician familiar with this injury is not received immediately.**

**W-2145-0290**

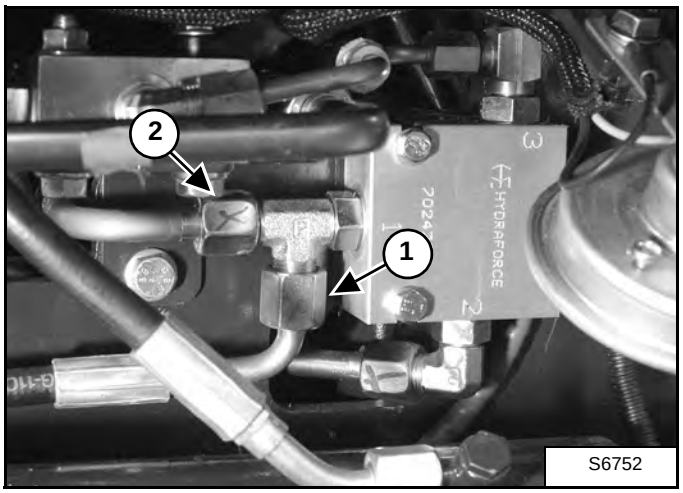
Remove the lower right hand side cover. (See Lower Right Side Cover Removal And Installation on Page 40-210-3.)

**Figure 20-170-1**




Cut the tie-strap (Item 1) and disconnect the wire harness (Item 2) **[Figure 20-170-1]** from the excavator harness.

**Figure 20-170-2**




Remove the hose (Item 1) and tubeline (Item 2) **[Figure 20-170-2]** from the valve.

## TRACK UNDERCARRIAGE COMPONENTS

### Description

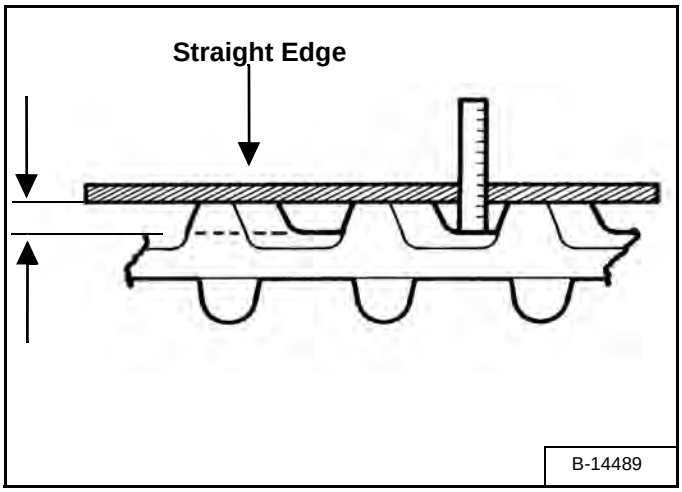
The track undercarriage components consist of the front idler, rollers, drive motor and track frame.

### Track Lug Height

*Rubber Track*

The lug height of a new rubber track is 25,0 mm (0.984 inch).

**Figure 30-20-1**




To find the percentage of wear on an excavator track, measure the height of the lug by placing a straight edge across the top of three lugs and measure the distance from the base of the track to the bottom of the straight edge **[Figure 30-20-1]**.

Divide this measurement by the new track height and multiply by 100. This will give the percentage of track lug left.

Example: lug height 20,0 mm (0.787 in)

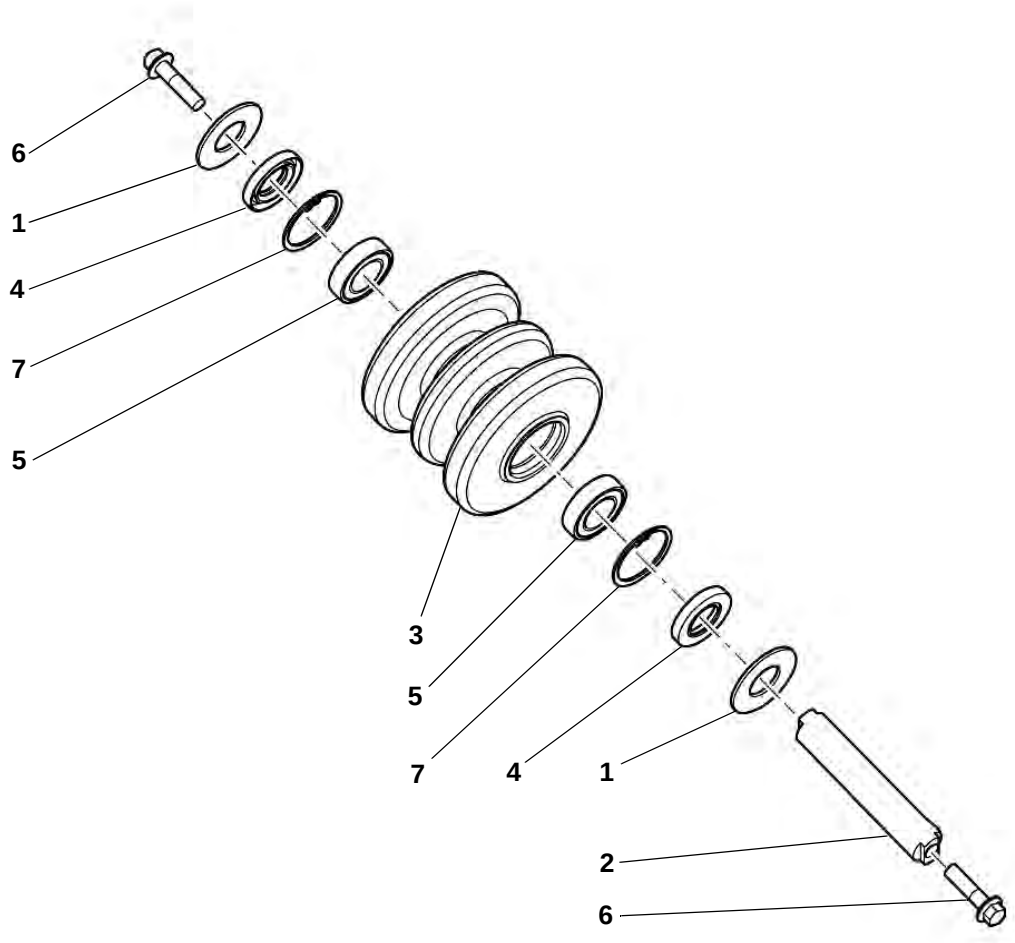
$$\frac{0.787}{0.984} \times 100 = 80$$

80% of the track lug is remaining with 20% wear on the track lugs.

The rubber track should be replaced when lug height measures 6,25 mm (0.246 in) from the base of the track to the top of the lug.

## Roller Parts Identification

1. Washer
2. Shaft
3. Roller
4. Seal
5. Bearing
6. Screw
7. Ring

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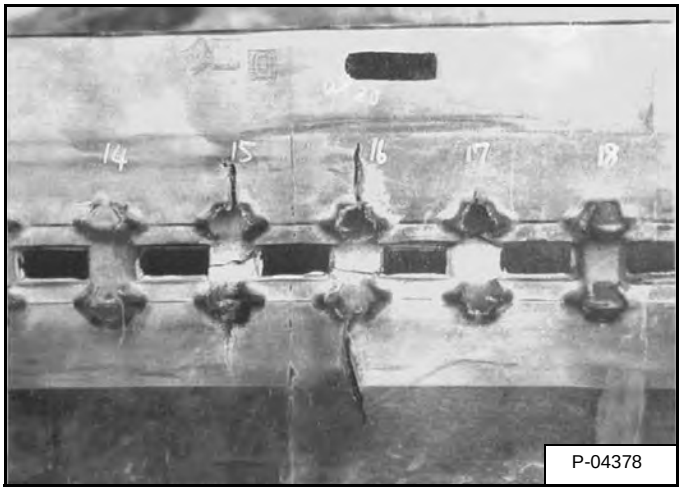
**Track Damage Identification (Cont'd)**

*Separation Of Embedded Metals Due To Corrosion*

**Figure 30-30-10**




**Damage:**

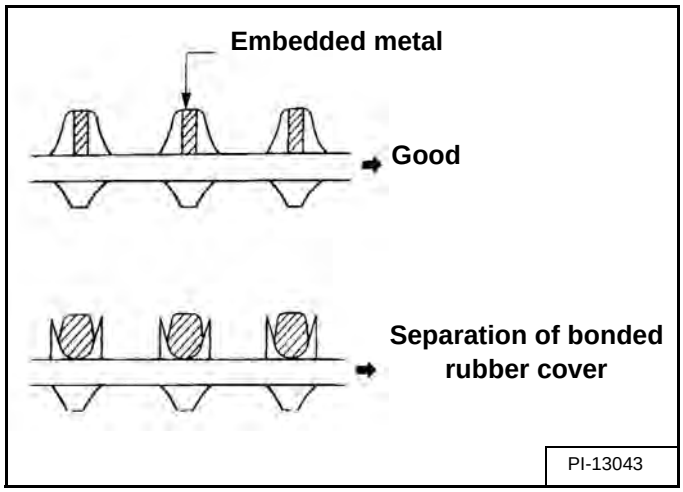
Due to corrosion of embedded metals, the adhesion to the rubber body deteriorates, resulting in complete separation **[Figure 30-30-10]**.

**Replacement:**

Even a partial separation of embedded metals requires a rubber track replacement.

**Causes Of The Damage**

**Figure 30-30-11**




Embedded metals are bonded to the rubber body. The following operating conditions cause embedded metals to corrode, causing deterioration of the bonding, and finally resulting in separation of the embedded metals from the rubber body **[Figure 30-30-11]**.

Excessively salty fields, like the sea shore.

Strong acidic or alkali soil conditions

Compost spread grounds

On tracks that are out of adjustment, the track rollers, idlers and sprockets will gradually wear the rubber surface at track roller side, causing exposure of the embedded metals. Consequently the embedded metals will corrode resulting in their separation from the rubber body.

**Prevention:**

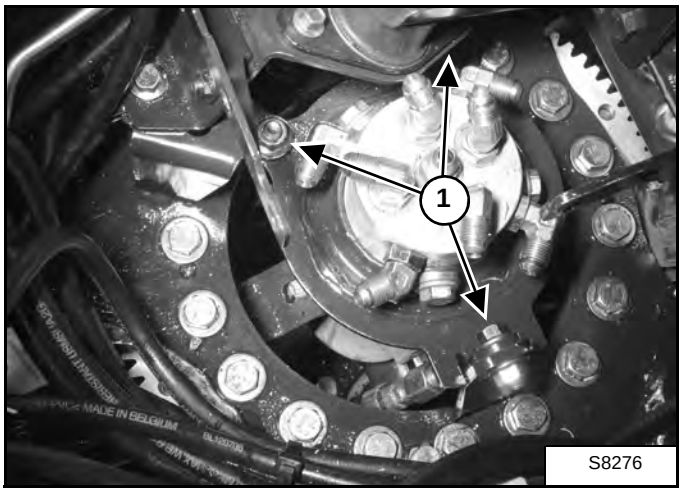
If rubber tracks are used under such field conditions as described under (Causes Of The Damage), they should be washed with plenty of water. After being completely dried, they should be stored correctly.

When the bonded rubber cover is separated from the embedded metal projections and the metals in the rubber body become loose, it is time to consider replacement of the rubber track.

# UPPERSTRUCTURE AND SWING SECTION

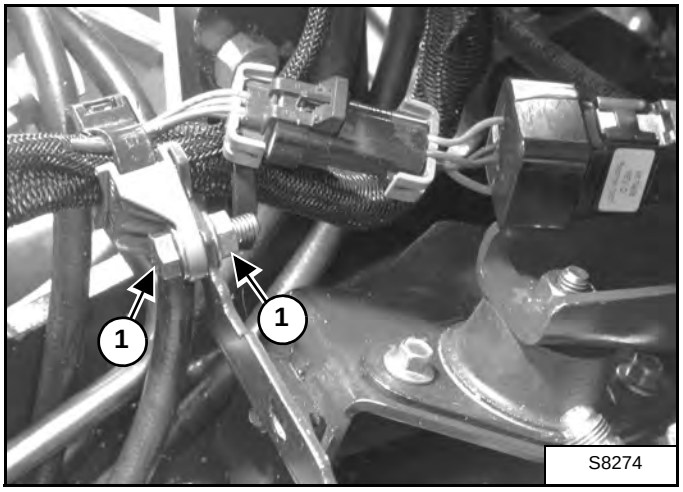
**Installation (Cont'd)**

**Figure 40-10-21**



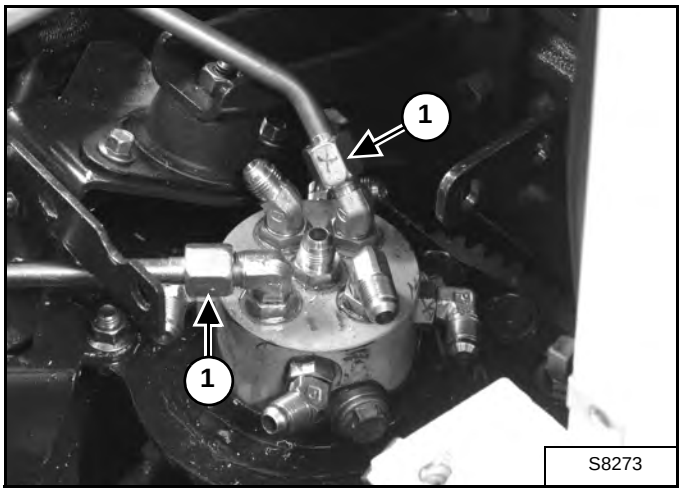

Install the three swivel joint mount nuts (Item 1) **[Figure 40-10-21]**.

**Figure 40-10-22**



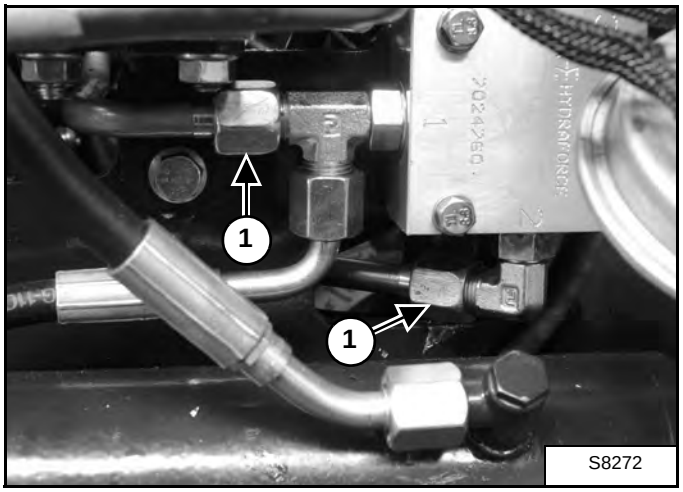

Install the bolt and nut (Item 1) **[Figure 40-10-22]** from the cable bracket.

**Figure 40-10-23**




Connect the two tubelines (Item 1) **[Figure 40-10-23]** on the swivel joint.

**Figure 40-10-24**



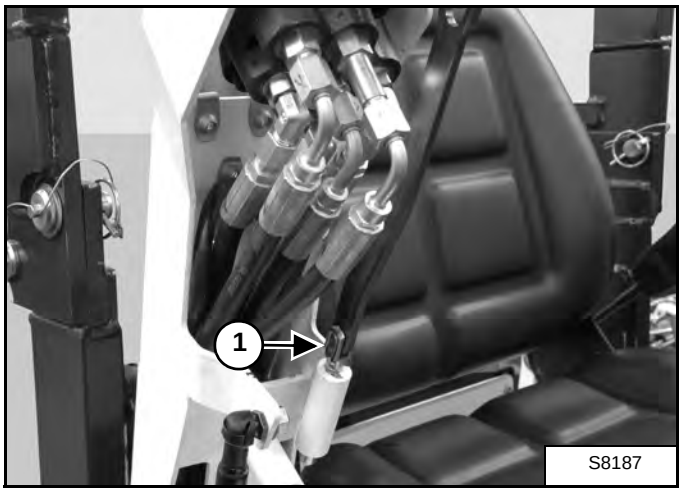

Connect the two tubelines (Item 1) **[Figure 40-10-24]**.

**Lever Removal And Installation**

Remove the joystick console cover. (See Joystick Console Cover Removal And Installation on Page 40-40-1.)

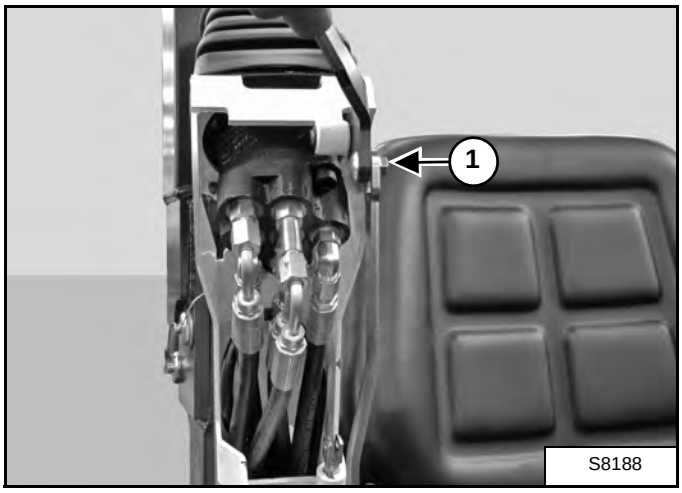
Raise the console.

**Figure 40-40-7**



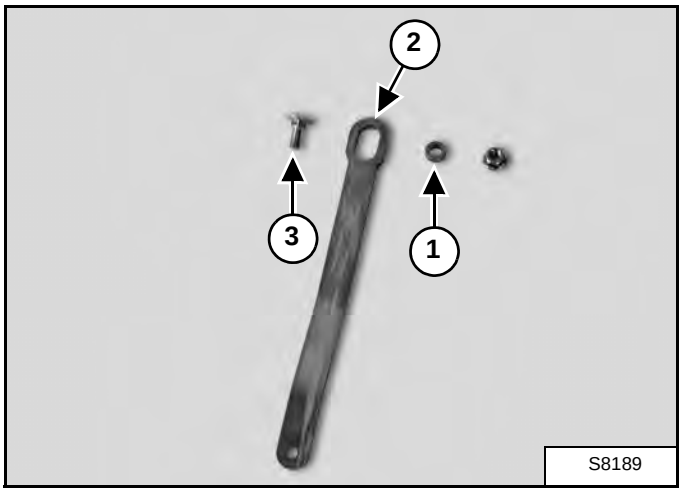

Remove the retaining clip (Item 1) **[Figure 40-40-7]** from the linkage.

**Figure 40-40-8**



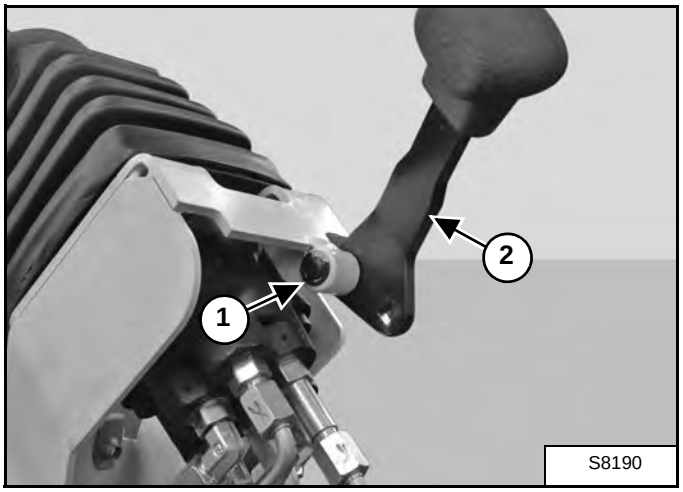

Remove the nut (Item 1) **[Figure 40-40-8]**.

**Figure 40-40-9**




Remove the bushing (Item 1), linkage (Item 2), and bolt (Item 3) **[Figure 40-40-9]**.

**Figure 40-40-10**



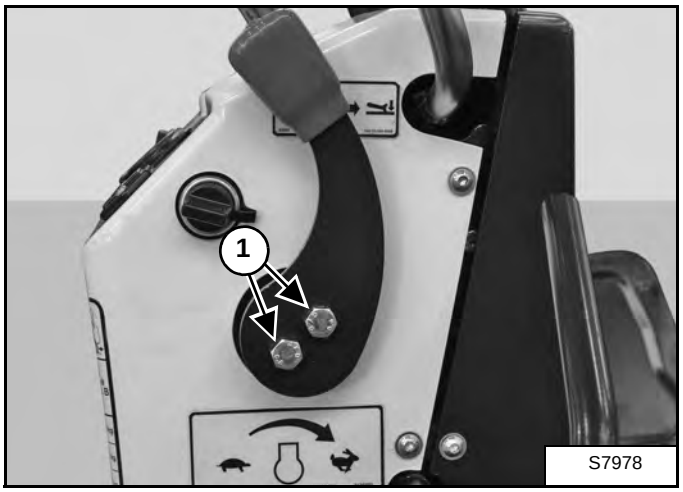

Remove the retaining clip (Item 1) **[Figure 40-40-10]**.

Remove the lever (Item 2) **[Figure 40-40-10]** from the console.

## ENGINE SPEED CONTROL

### Removal And Installation

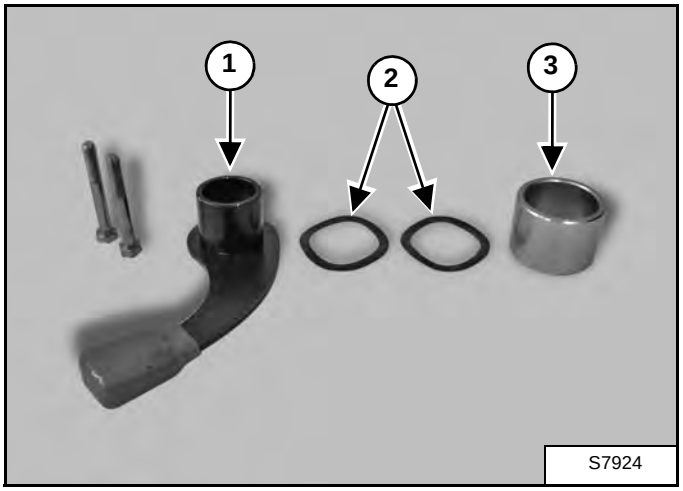
**Figure 40-60-1**




Remove the two bolts (Item 1) **[Figure 40-60-1]** from the throttle lever.

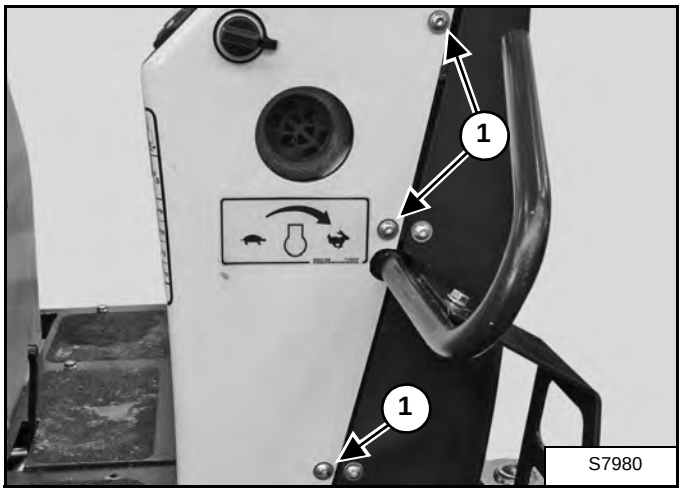
***Installation:*** Tighten the two bolts (Item 1) **[Figure 40-60-1]** evenly until the throttle lever moves back and forth at a comfortable tension.

**Figure 40-60-2**



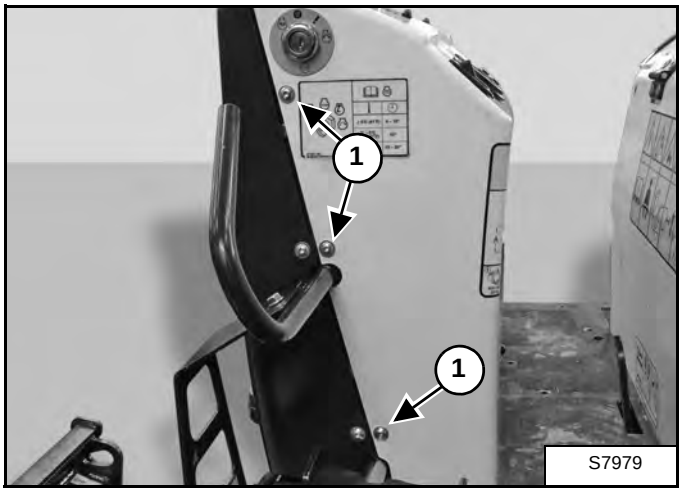

Remove the lever (Item 1), the two wave washers (Item 2), and the spacer (Item 3) **[Figure 40-60-2]**.

**Figure 40-60-3**




Remove the three bolts (Item 1) **[Figure 40-60-3]** from the right hand side of the instrument panel.

**Figure 40-60-4**

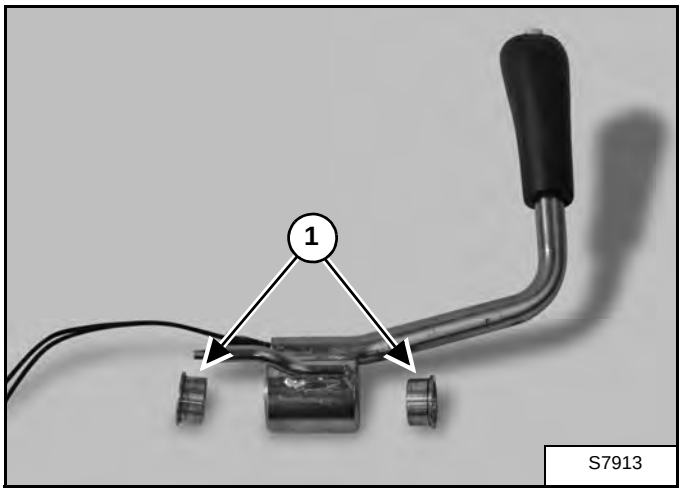



Remove the three bolts (Item 1) **[Figure 40-60-4]** from the left hand side of the instrument panel.

Move the instrument panel to one side to provide extra clearance for easy access to engine speed control.

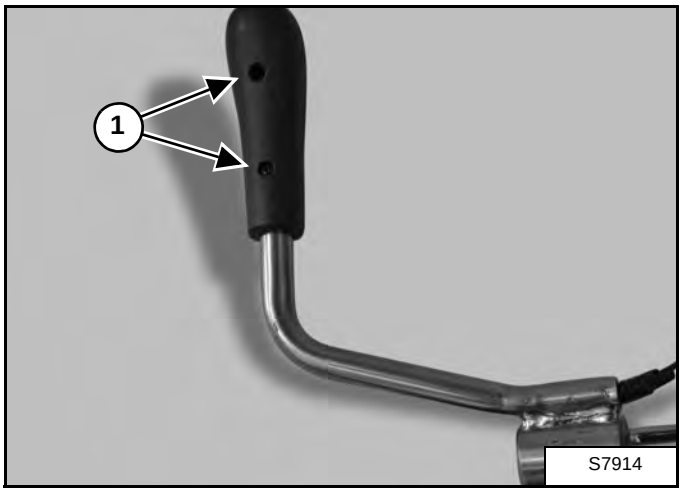
**Disassembly And Assembly**

**Figure 40-70-9**



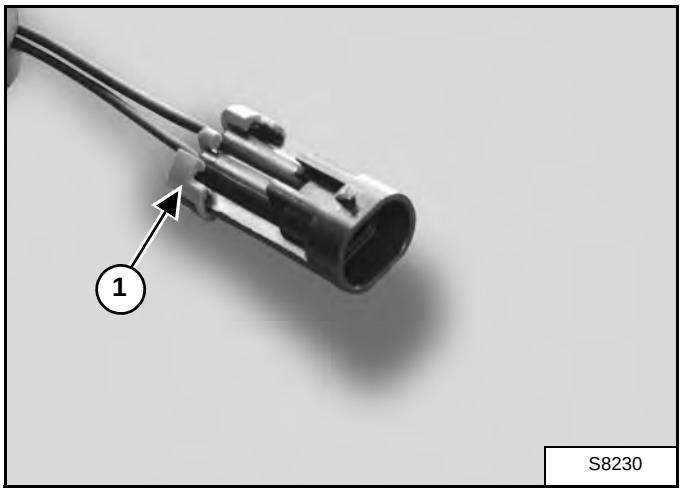

Remove the two bushings (Item 1) **[Figure 40-70-9]** from the blade control handle.

**Figure 40-70-10**



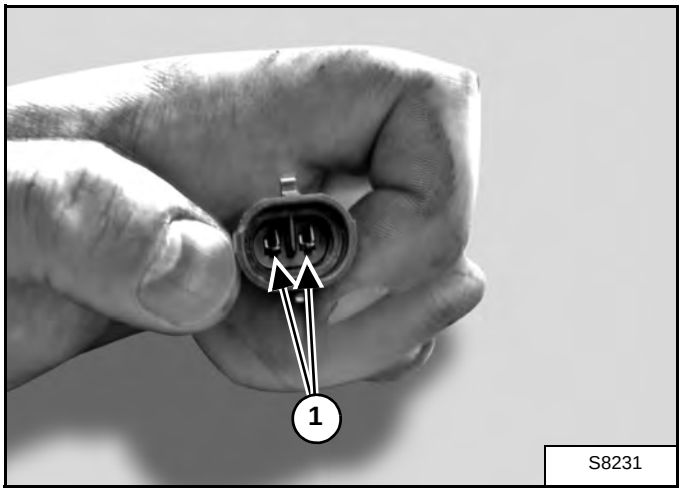

Remove the screws (Item 1) **[Figure 40-70-10]** and plastic handle halves.

**Figure 40-70-11**




Remove the lock (Item 1) **[Figure 40-70-11]** from the electrical connector.

**Figure 40-70-12**




With a small piece of wire, depress the wire terminal tabs (Item 1) **[Figure 40-70-12]**.

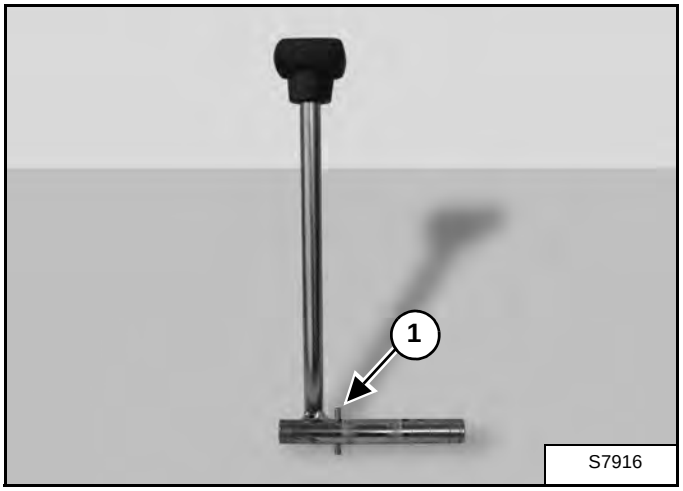
Mark and remove the individual wires from the back of the electrical connector.

## TRAVEL CONTROLS

### Right Hand Travel Control Removal And Installation

Remove the blade control. (See Removal And Installation on Page 40-80-1.)

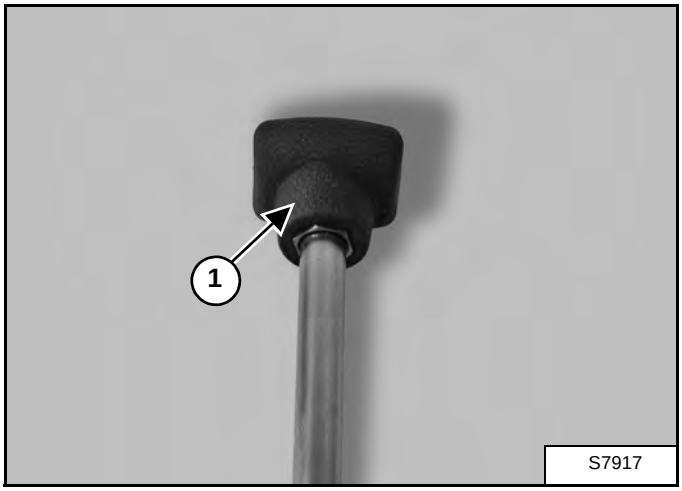
**Figure 40-100-1**




Remove the pin (Item 1) **[Figure 40-100-1]** from the right hand travel control.

### Right Hand Travel Control Disassembly And Assembly

**Figure 40-100-2**




Remove the right hand control knob (Item 1) **[Figure 40-100-2]**.

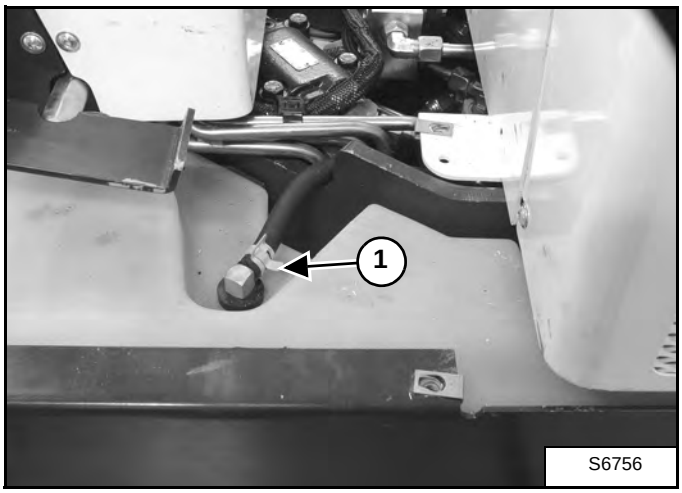
## FUEL TANK

### Removal And Installation

Drain the fuel tank. (See Draining The Fuel Tank on Page 10-100-3.)

Remove the left floor panel. (See Left Floor Panel Removal And Installation on Page 40-120-1.)

**Figure 40-130-1**

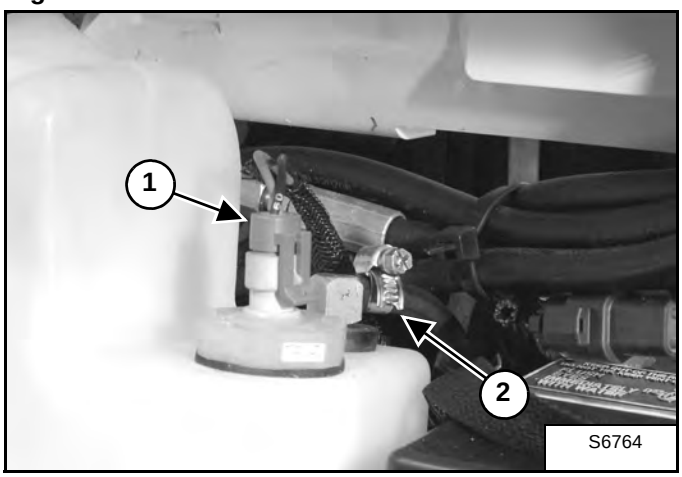



Remove the hose (Item 1) **[Figure 40-130-1]** from the fuel tank.

Remove the upper left hand side cover. (See Upper Left Side Cover Removal And Installation on Page 40-210-1.)

Remove the lower left hand side cover. (See Lower Left Side Cover Removal And Installation on Page 40-210-2.)

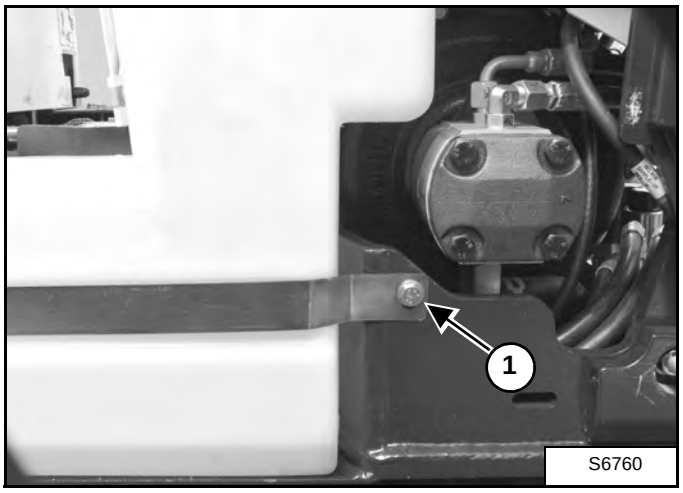
**Figure 40-130-2**




Disconnect the fuel level sender (Item 1) **[Figure 40-130-2]** from the fuel tank.

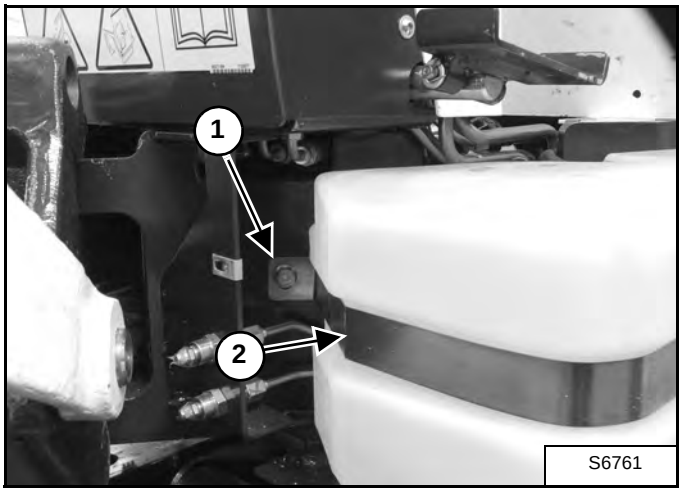
Remove the hose (Item 2) **[Figure 40-130-2]** from the fuel tank.

**Figure 40-130-3**




Remove the bolt (Item 1) **[Figure 40-130-3]** from the mounting bracket.

**Figure 40-130-4**




Remove the bolt (Item 1) and mounting bracket (Item 2) **[Figure 40-130-4]**.

Remove the fuel tank.

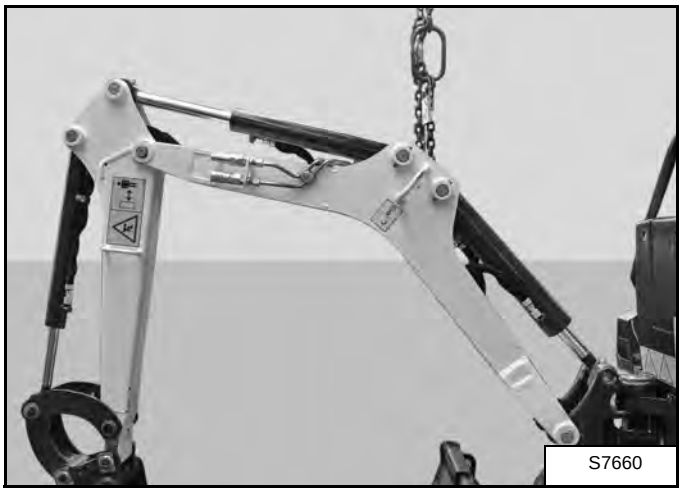
## ARM

### Description

The arm is the section that is connected to the end of the boom section and the bucket / bucket link. The excavator comes with a standard length but has an optional long arm.

### Removal And Installation

**Figure 40-170-1**




Support the boom with a chain hoist **[Figure 40-170-1]**.

Remove the bucket. (See Removal And Installation on Page 40-180-1.)

Remove the bucket cylinder. (See Removal And Installation on Page 20-23-2.)

# IMPORTANT

**When repairing hydrostatic and hydraulic systems, clean the work area before disassembly and keep all parts clean. Always use caps and plugs on hoses, tubelines and ports to keep dirt out. Dirt can quickly damage the system.**

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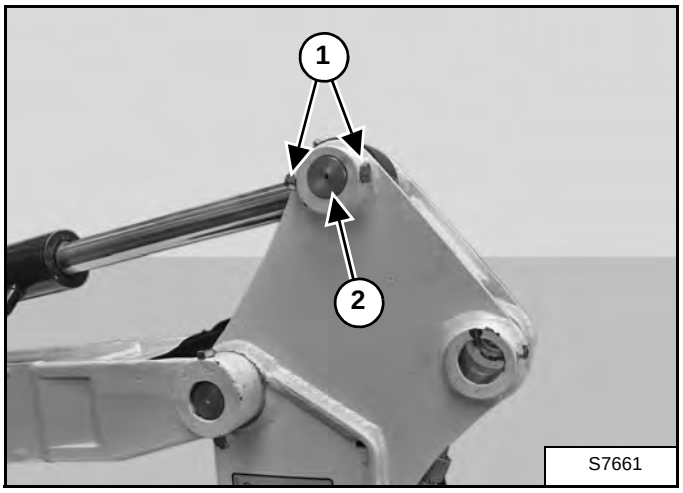
**Figure 40-170-2**

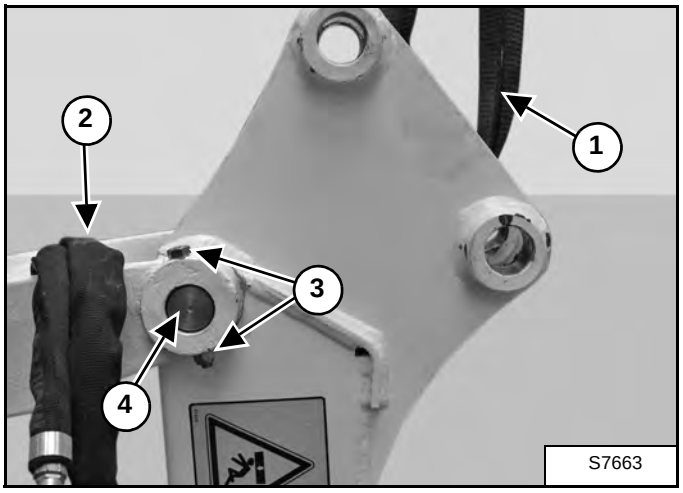



Remove the nut and bolt (Item 1) **[Figure 40-170-2]** from the rod end pivot pin.

Remove the pivot pin (Item 2) **[Figure 40-170-2]**.

Remove the rod end of the cylinder from the arm.

**Figure 40-170-3**




Install a strap (Item 1) **[Figure 40-170-3]** to support the arm.

Move the bucket cylinder hoses (Item 2) **[Figure 40-170-3]** away from the arm.

Remove the nut and bolt (Item 3) **[Figure 40-170-3]** from the arm pivot pin.

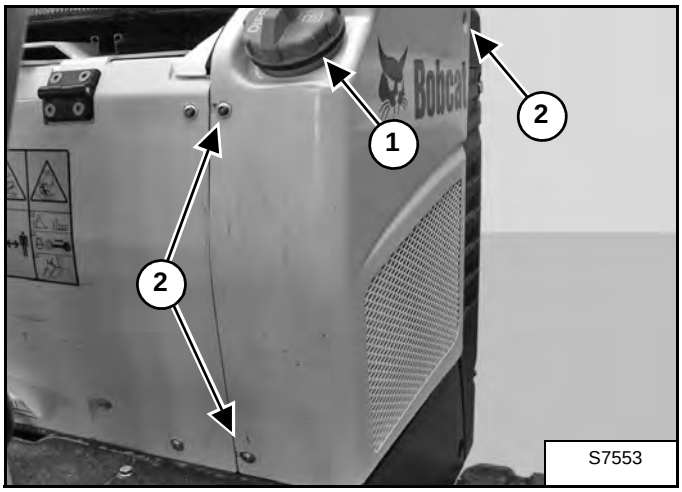
Remove the pivot pin (Item 4) **[Figure 40-170-3]**.

Remove the arm.

## SIDE COVERS

### Upper Left Side Cover Removal And Installation

**Figure 40-210-1**



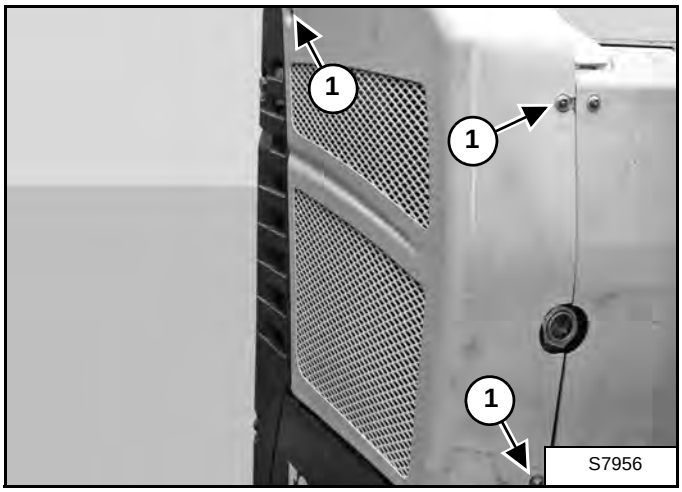

Remove the fuel fill cap (Item 1) **[Figure 40-210-1]** from the fuel tank.

Remove the bolts (Item 2) **[Figure 40-210-1]** from the upper left hand side cover.

Remove the upper left hand side cover.

### Upper Right Side Cover Removal And Installation

**Figure 40-210-2**

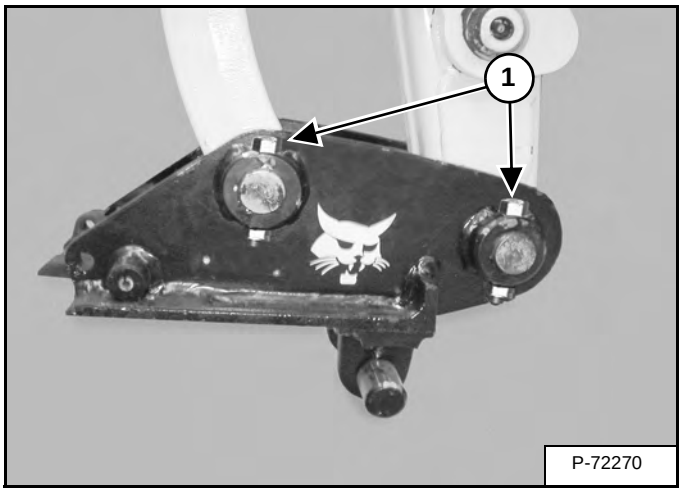



Remove the bolts (Item 1) **[Figure 40-210-2]** from the upper right hand side cover.

Remove the upper right hand side cover.

**Removal And Installation (Cont'd)**

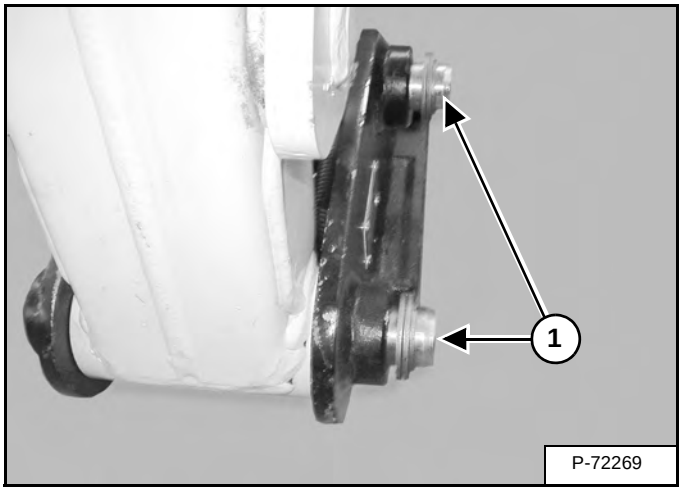
**Figure 40-230-4**




Remove the bolts (Item 1) **[Figure 40-230-4]** and nuts.

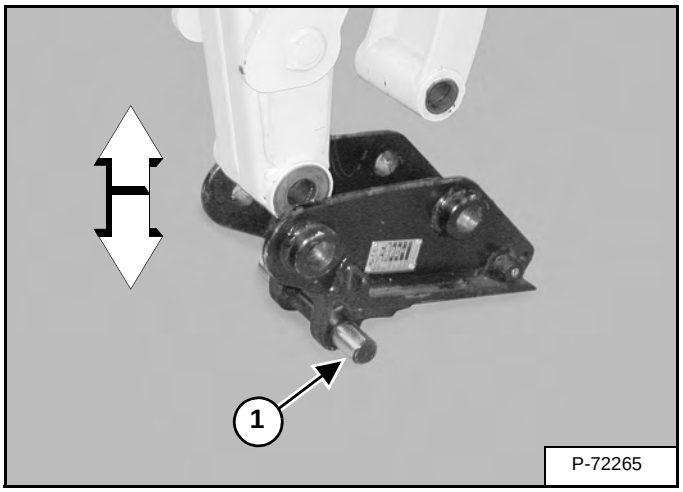
***Installation:*** Align the holes of the connecting pins with the holes in the coupler. Install the two bolts (Item 1) **[Figure 40-230-4]** and nuts. Tighten the nuts securely against the couple.

**Figure 40-230-5**




Remove pins (Item 1) **[Figure 40-230-5]**.

**Figure 40-230-6**



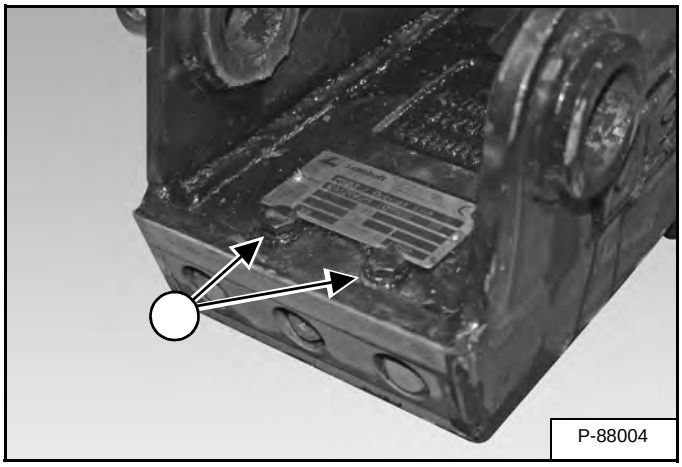

Raise the arm and bucket link until the coupler is free **[Figure 40-230-6]**.

***Installation:*** Align the arm and bucket link with the coupler **[Figure 40-230-6]**. Lower the arm and bucket link into the coupler.

**NOTE: Place the coupler on the ground with the mounting pin (Item 1) [Figure 40-230-6] facing towards the excavator.**

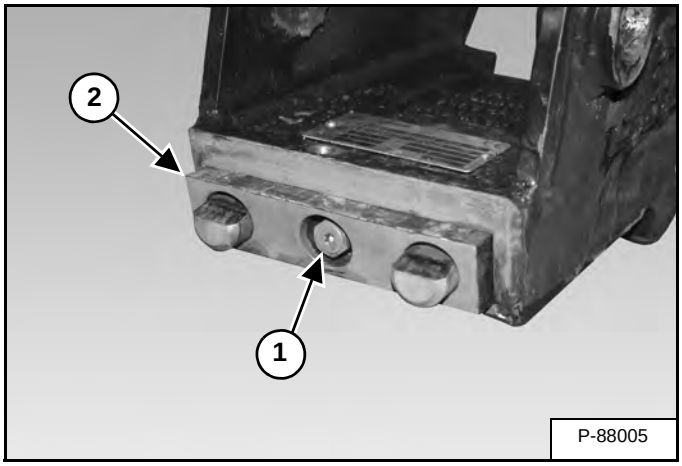
**Disassembly And Assembly (MS03)**

**Figure 40-231-8**




Remove the two bolts (Item 1) **[Figure 40-231-8]** and lockwashers.

**Figure 40-231-9**



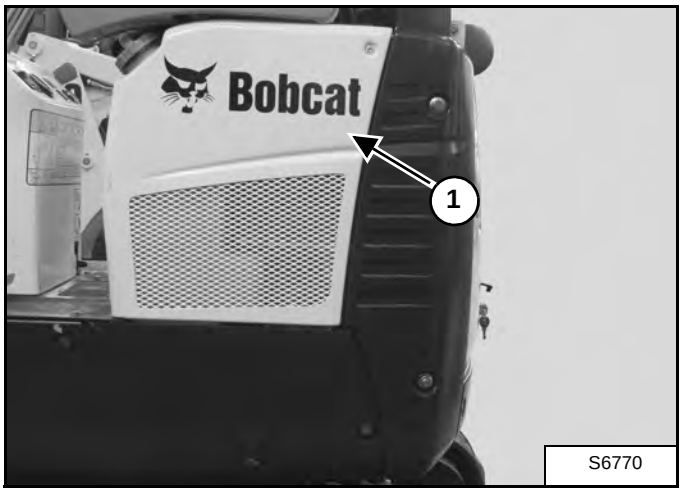

Turn the threaded spindle (Item 1) counterclockwise until the locking mechanism (Item 2) **[Figure 40-231-9]** is free from the housing.

# ELECTRICAL SYSTEM & ANALYSIS

## BATTERY

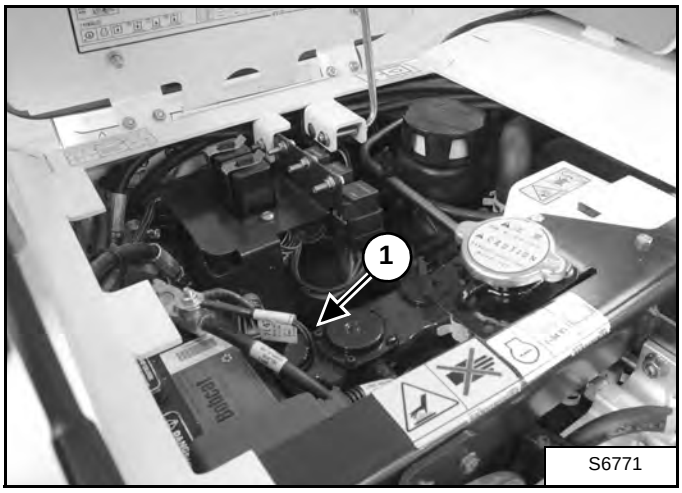
### Location

**Figure 50-20-1**




The battery (Item 1) **[Figure 50-20-1]** is located behind the upper left side cover.

**Figure 50-20-2**



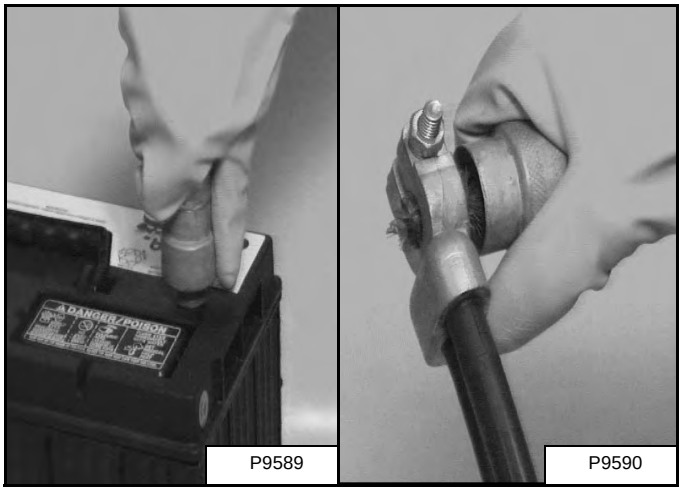

Battery cables (Item 1) **[Figure 50-20-2]** are accessible by opening the tailgate.

### Servicing

See the SERVICE SCHEDULE for the correct service interval. (See Maintenance Intervals on Page 10-70-1.)

The Bobcat brand battery supplied with your machine is sealed and does not require watering. Proper charging and storage are important to maximize the life of all batteries.

**Figure 50-20-3**

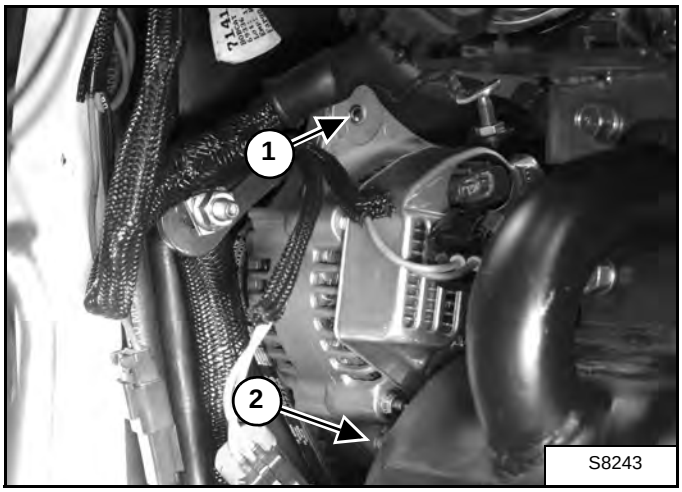



Simple steps for reliability and long battery life:

- Keep battery posts and terminals clean **[Figure 50-20-3]**.
- Keep terminals tight.
- Remove corrosion from battery and terminals with sodium bicarbonate (baking soda) and water solution.
- Put Bobcat Battery Saver or grease on the battery terminals and cable ends to prevent corrosion.
- Operate the machine for at least 15 minutes to recover from the battery drain caused by engine startup whenever practical.
- Maintain the battery charge level. This is a key factor for long battery life.
- Charge a severely discharged battery with a battery charger instead of relying on the machine charging system.

**Removal And Installation (Cont'd)**

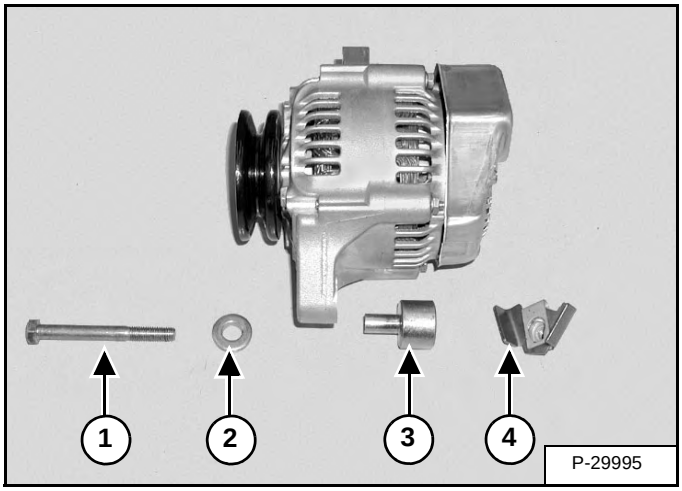
**Figure 50-30-10**




Remove the upper alternator bolt (Item 1) and lower mounting bolt (Item 2) **[Figure 50-30-10]**.

**NOTE: Alternator will fall if not supported while removing bolts.**

**Figure 50-30-11**




**NOTE: The lower alternator mounting bolt (Item 1) is assembled with a washer (Item 2) spacer (Item 3) and retaining bracket with nut (Item 4) [Figure 50-30-11] which will fall during disassembly.**

Remove belt from the alternator pulley.

Remove alternator.

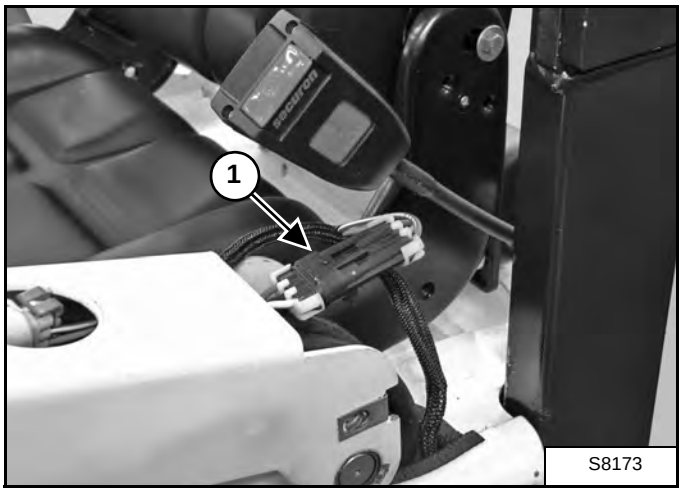
## MICROSWITCH

### Testing Left Console Microswitch

Remove the joystick console cover. (See Joystick Console Cover Removal And Installation on Page 40-50-1.)

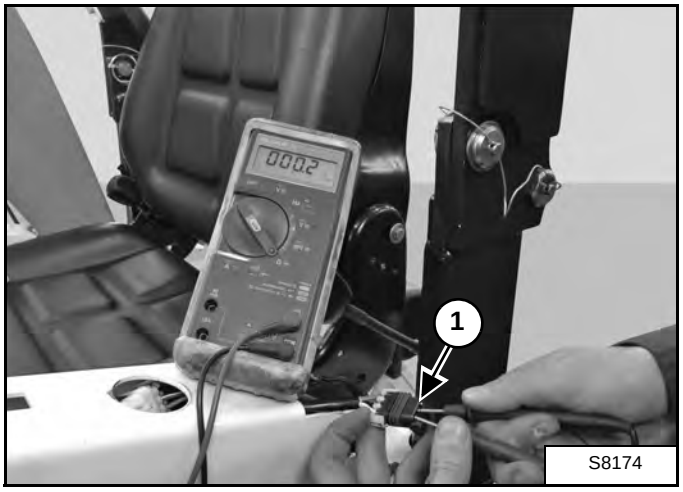
Lower the control console.

**Figure 50-60-1**




Disconnect the microswitch harness (Item 1) **[Figure 50-60-1]** from the control harness.

**Figure 50-60-2**




Use a continuity tester to check the microswitch prior to removal. Test the continuity between the black and white wire pins (Item 1) **[Figure 50-60-2]**.

The microswitch is normally open.

With the console raised the gauge reading should show no current.

By pushing the actuator on the microswitch, the gauge reading should show a completed circuit. If not, the microswitch is faulty and must be replaced.

**Specifications (Cont'd)**

***Rocker Arms***

| | |
|---|---|
| O.D. of Rocker Arm Shaft | 10,473 - 10,484 mm (0.41232 - 0.41276 in) |
| I.D. of Rocker Arm Bushing | 10,5 - 10,518 mm (0.41339 - 0.4141 in) |
| Clearance between Rocker Arm Shaft and Bushing | 0,016 - 0,045 mm (0.00063 - 0.00177 in) |
| Limit Permitted | 0,15 mm (0.0059 in) |

***Camshaft***

| | |
|---|---|
| O.D. of Camshaft Bearing Journal | 32,934 - 32,95 mm (1.29661 - 1.29724 in) |
| I.D. of Camshaft Bearing | 33,00 - 33,025 mm (1.29921 - 1.3002 in) |
| Clearance between Camshaft Bearing and Journal | 0,05 - 0,091 mm (0.00197 - 0.00358 in) |
| Limit Permitted | 0,15 mm (0.0059 in) |
| Alignment of the Camshaft Limit Permitted | 0,01 mm (0.0004 in) |
| Cam Lobe Height | 26,88 mm (1.0583 in) |
| Limit Permitted | 26,83 mm (1.0563 in) |
| Idle Gear to Cam Gear Backlash | 0,047 - 0,123 mm (0.00185 - 0.00484 in) |
| Limit Permitted | 0,15 mm (0.0059 in) |

***Cylinders***

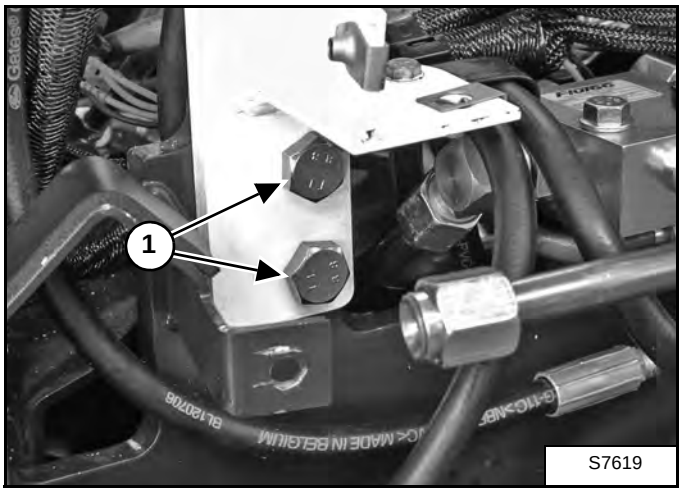
| | |
|---|---|
| I.D. of Cylinder Liner | 67,000 - 67,019 mm (2.63779 - 2.63854 in) |
| Limit Permitted | 67,15 mm (2.6437 in) |
| Rebore Size for Oversize Piston | 67,250 - 67,269 mm (2.64764 - 2.64839 in) |

***Piston Rings***

| | |
|---|---|
| Ring Gap, Top and Oil | 0,15 - 0,30 mm (0.0059 - 0.0118 in) |
| Ring Gap, 2nd | 0,30 - 0,45 mm (0.0118 - 0.0177 in) |
| Limit Permitted | 1,20 mm (0.0472 in) |
| Side Clearance of Ring in Groove; | |
| Top Ring | Because of top ring design, measurement does not apply |
| 2nd Ring | 0,09 - 0,12 mm (0.00354 - 0.00472 in) |
| Oil Ring | 0,04 - 0,08 mm (0.0016 - 0.0031 in) |
| Limit Permitted | 0,15 mm (0.0059 in) |

**Removal And Installation (Cont'd)**

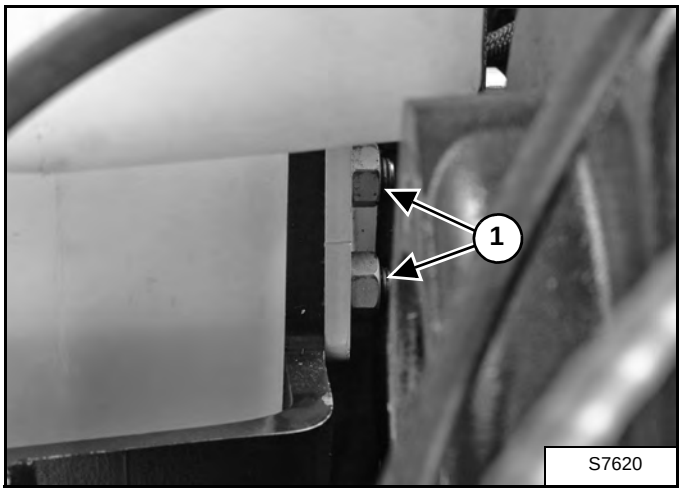
**Figure 60-10-15**




Remove bolts and nuts (Item 1) **[Figure 60-10-15]**.

***Installation:*** Tighten the bolts to 50 N•m (37 ft-lb) torque.

**Figure 60-10-16**



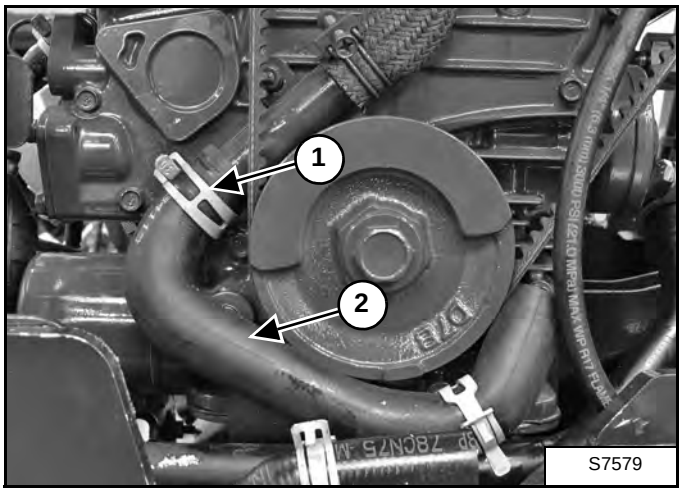

Remove bolts and nuts (Item 1) **[Figure 60-10-16]**.

***Installation:*** Tighten the bolts to 50 N•m (37 ft-lb) torque.

Carefully lift frame upward and tilt forward to clear back frame.

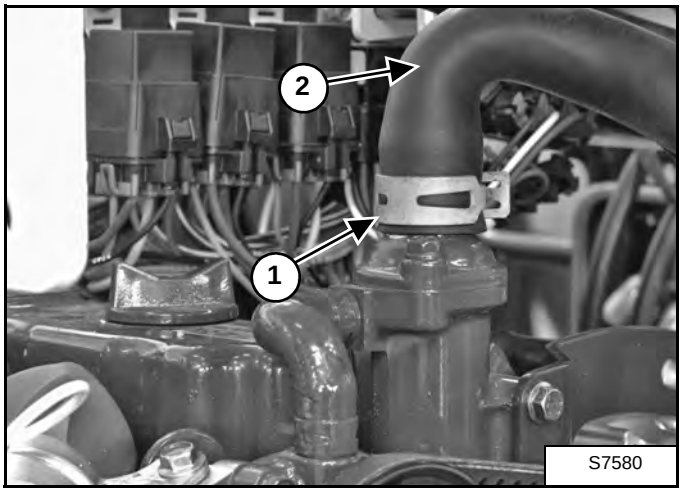
Remove the back frame from the excavator.

**Figure 60-10-17**




Remove the hose clamp (Item 1) and lower radiator hose (Item 2) **[Figure 60-10-17]**.

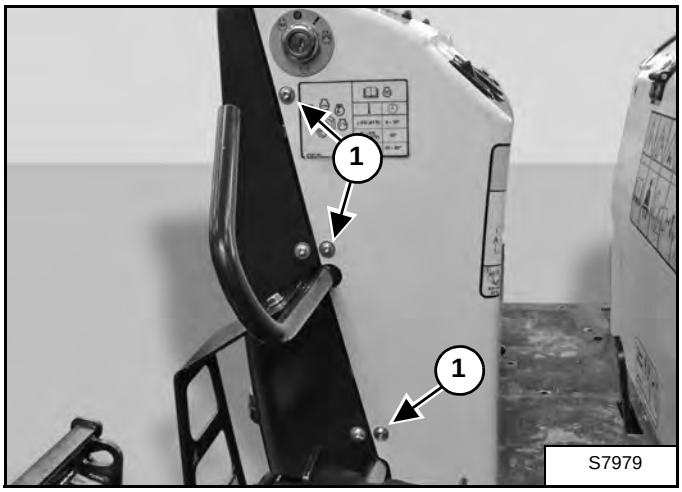
**Figure 60-10-18**




Remove the hose clamp (Item 1) and upper radiator hose (Item 2) **[Figure 60-10-18]**.

**Removal And Installation (Cont'd)**

**Figure 60-20-8**




Remove the three bolts (Item 1) **[Figure 60-20-8]** from the left hand side of the instrument panel.

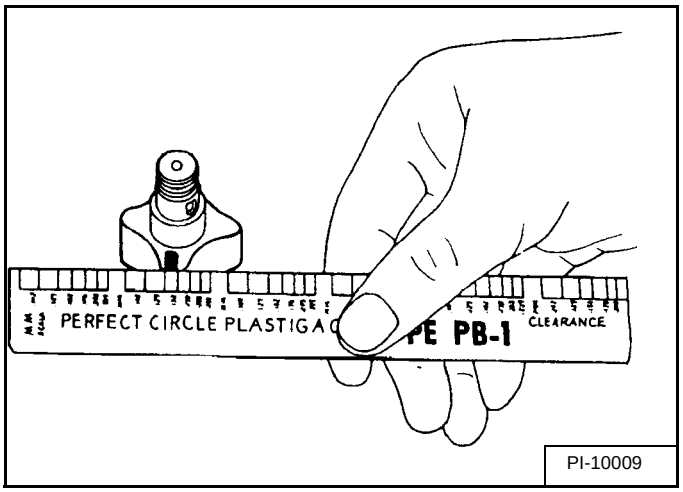
Move the instrument panel to one side to provide extra clearance for muffler removal.

Slide muffler off exhaust extension and remove the muffler from the excavator.

**NOTE: Plug the exhaust manifold hole after muffler removal so no contamination can get into the engine.**

**Oil Pump, Service, (Cont'd)**

**Figure 60-50-8**




Put a piece of press gauge on the rotor face **[Figure 60-50-8]**.

Install the cover and tighten the bolts.

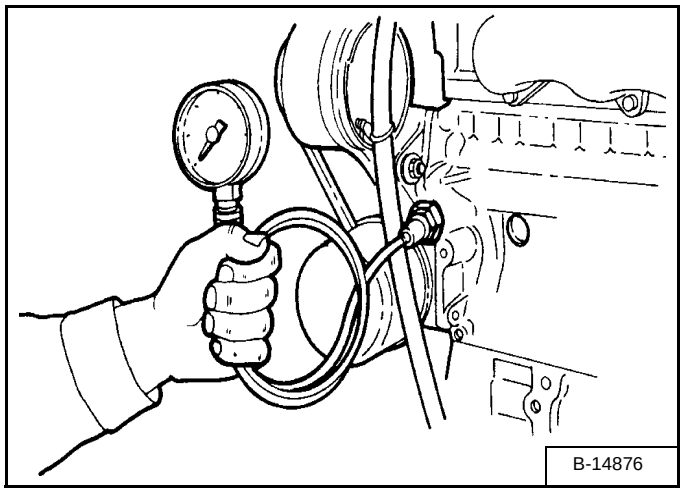
Remove the cover carefully. Measure the width of the press gauge **[Figure 60-50-8]**.

If the clearance exceeds the factory limit replace the oil pump rotor assembly.

| | |
|---|---|
| End Clearance | 0,08 - 0,14 mm<br>(0.003 - 0.005 in) |

**Engine Oil Pressure - Testing**

**Figure 60-50-9**




Remove the oil pressure sensor.

Install a pressure gauge **[Figure 60-50-9]**.

Start the engine and run until it is at operating temperature.

Measure oil pressure at both idling and rated speeds.

If the oil pressure is less than the allowable limit, check the following item:

- Engine Oil Insufficient
- Oil Pump Defective
- Oil Galley Plugged
- Oil Strainer Plugged
- Excessive Oil Clearance
- Foreign Matter in Relief Valve
- Oil Filer Cartridge plugged

| | |
|---|---|
| At Idle Speed Allowable Limit | 48,3 kPa<br>(0,48 bar) (7 psi) |
| At Rated Speed | 193 - 441,3 kPa<br>(2 - 4 bar) (28 - 64 psi) |
| Allowable Limit | 144,8 kPa<br>(1 bar) (21 psi) |

***Installation:*** After checking engine oil pressure, tighten oil pressure sensor to 15 - 20 N•m (11 - 15 ft-lb) torque.

**Relief Valve**

The relief valve prevents damage of the lubricating system due to high pressure. This relief valve is a ball type.

**Fuel Injector Removal And Installation (Cont'd)**

***Installation:*** Tighten the injector nozzle to 49 - 69 N•m (36 - 51 ft-lb) torque.

**NOTE: Be sure to replace the copper washer and nozzle cap anytime new or reconditioned fuel injectors are installed.**

**Fuel Injector Nozzle Pressure - Checking**

# IMPORTANT

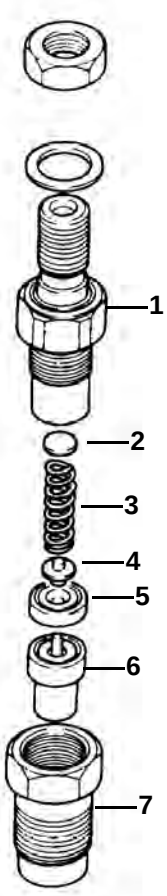
**Do not disassemble or test the fuel injector nozzles unless you have the correct service and testing tools.**

**I-2027-0284**

The tool listed will be needed to do the following procedure:

MEL10018 - Injector Nozzle Tester

**Figure 60-60-23**




**(1) Nozzle Holder**
**(2) Adjusting Washer**
**(3) Nozzle Spring**
**(4) Push Rod**
**(5) Distance Piece**
**(6) Nozzle Piece**
**(7) Nozzle Retaining Nut**

PI-9981

The nozzle release pressure can be adjusted by adding or removing washer(s) (Item 2) from the top of the nozzle spring (Item 3) **[Figure 60-60-23]**.

Each spacer will change the release pressure by about 234,4 kPa (2,3 bar) (34 psi).

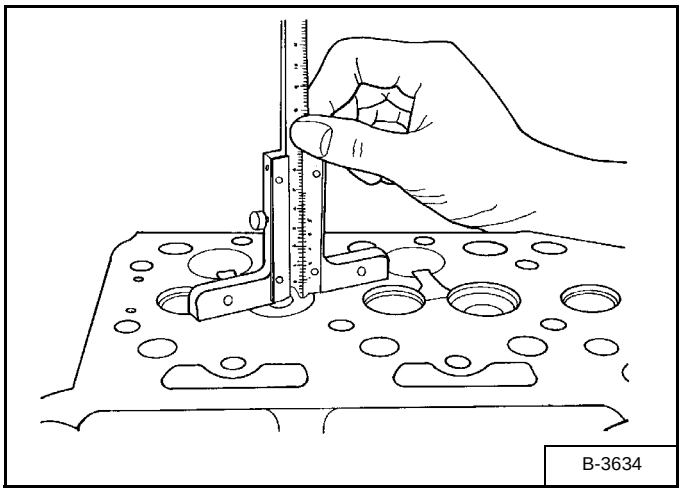
| | |
|---|---|
| Fuel Injection Pressure. | 13,7 - 14,7 MPa (137 - 147 bar) (1991 - 2134 psi) |

### Valve Guide - Checking

Remove the valve and spring from the cylinder head. (See Cylinder Head Removal And Installation on Page 60-70-3.)

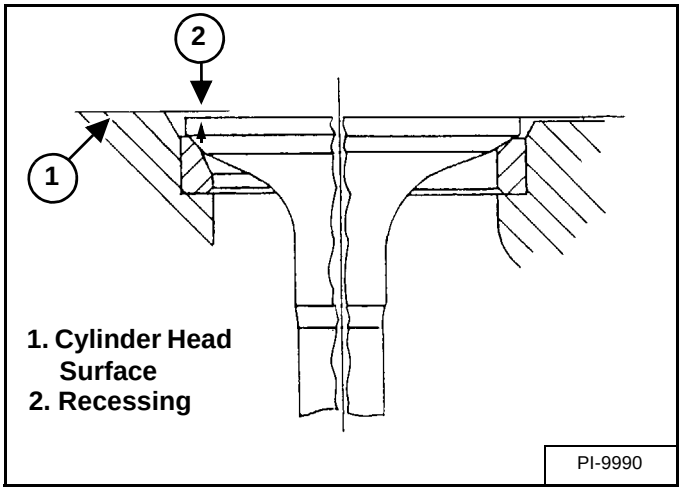
Clean the valve seat and combustion chamber.

**Figure 60-70-19**




Install the valve into the guide. Measure the valve recessing with a depth gauge **[Figure 60-70-19]**.

**Figure 60-70-20**

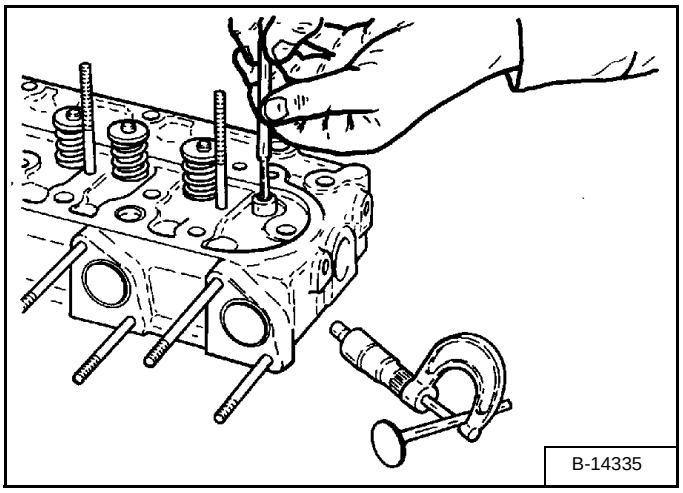



If the measurement exceeds the allowable limit, replace the valve or cylinder head **[Figure 60-70-20]**.

| | |
|---|---|
| Recessing | 0,10 mm (0.004 in) |
| Allowable Limit (Recessing) | 0,30 mm (0.012 in) |

Remove the carbon from the valve guide.

**Figure 60-70-21**



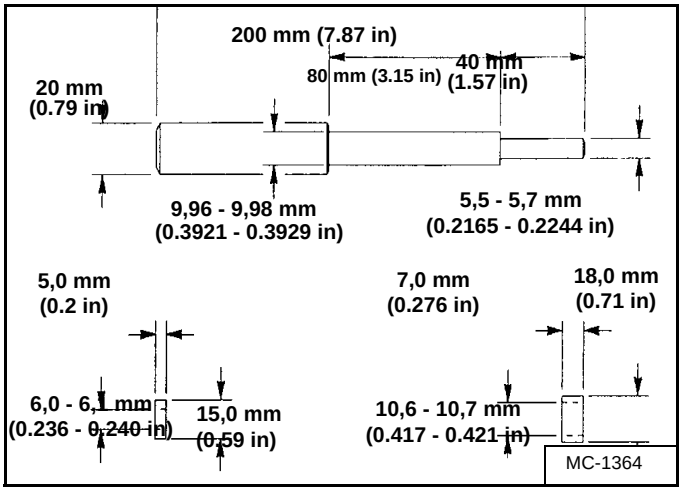

Measure the valve stem O.D. **[Figure 60-70-21]**.

Measure the valve guide I.D. **[Figure 60-70-21]**.

Calculate the clearance. If the clearance exceeds the allowable limit, replace the valve and / or valve guide.

| | |
|---|---|
| Valve Guide I.D | 6,01 - 6,025 mm (0.2366 - 0.2372 in) |
| Valve Stem O.D | 5,968 - 5,980 mm (0.2350 - 0.2354 in) |
| Clearance Between Valve Stem and Guide | |
| | 0,03 - 0,057 mm (0.0012 - 0.0022 in) |
| Allowable Limit | 0,10 mm (0.0039 in) |

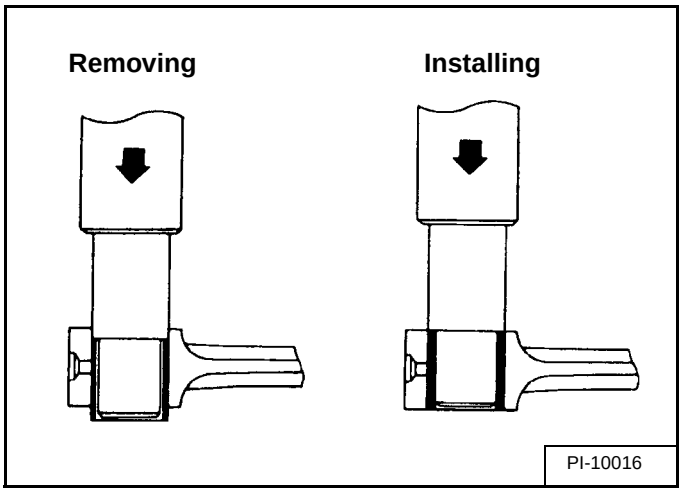
**Figure 60-70-22**




To remove and replace the valve guide, make the driver tools as shown in figure **[Figure 60-70-22]**.

**Piston And Connecting Rod, Servicing (Cont'd)**

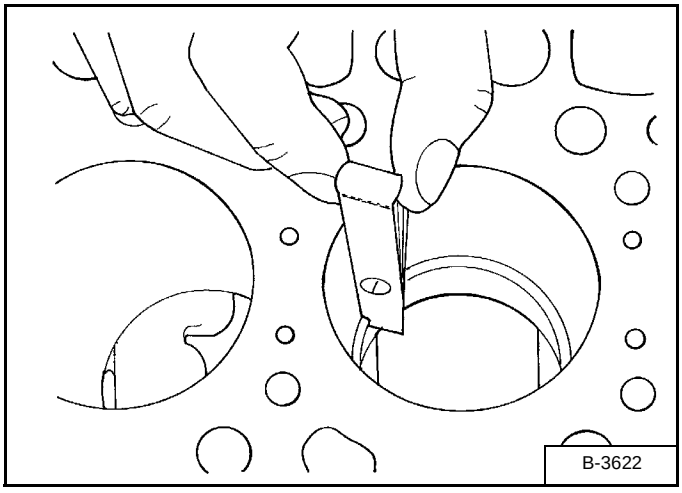
**Figure 60-80-12**




Use a press and special driver tool to remove the small end bushing **[Figure 60-80-12]**.

***Installation:*** Clean the small end bushing and bore. Put oil on the bushing and press into the connecting rod until it is flush **[Figure 60-80-12]**.

**Figure 60-80-13**

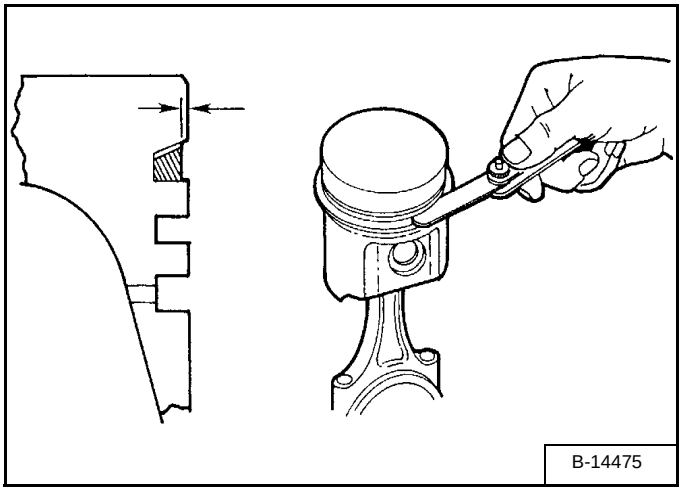



Install a new piston ring into the lower part of the cylinder bore. Measure the ring gap with a feeler gauge **[Figure 60-80-13]**.

If the gap exceeds the allowable limit, replace the piston ring.

| | |
|---|---|
| Top Compression Ring and Oil Ring | |
| | 0,15 - 0,30 mm (0.006 - 0.012 in) |
| Second Compression Ring | |
| | 0,30 - 0,45 mm (0.012 - 0.018 in) |
| Allowable Limit | 1,2 mm (0.047 in) |

**Figure 60-80-14**



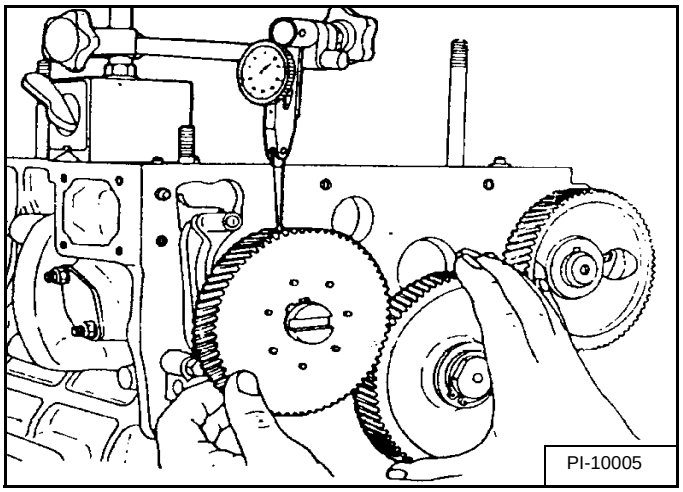

Remove the carbon from the ring grooves. Measure the clearance between the ring and groove with a feeler gauge **[Figure 60-80-14]**.

| | |
|---|---|
| Second ring | 0,09 - 0,12 mm (0.0033 - 0.0045 in) |
| Oil ring | 0,04 - 0,08 mm (0.0016 - 0.0031 in) |
| Allowable limit second ring | |
| | 0,15 mm (0.0059 in) |
| Allowable limit oil ring | |
| | 0,15 mm (0.0059 in) |

If the clearance exceeds the allowable limit, replace the piston.

### Timing Gears Checking Backlash

**Figure 60-90-8**




When the gears are installed, check the backlash of the gears.

Install a dial indicator with its tip on a gear tooth **[Figure 60-90-8]**.

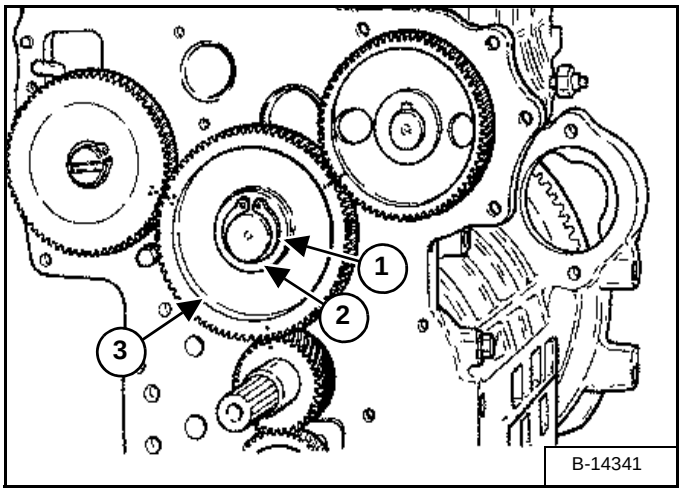
Hold one gear while turning the other gear **[Figure 60-90-8]**.

If the backlash exceeds the allowable limit, check the oil clearance of the shaft and gear. If the oil clearance is correct, replace the gears.

| | |
|---|---|
| Crank Gear and Idler Gear. | |
| | 0,043 - 0,124 mm (0.002 - 0.005 in) |
| Allowable Limit | 0,15 mm (0.006 in) |
| Cam Gear and Idler Gear | |
| | 0,047 - 0,12 mm (0.002 - 0.005 in) |
| Allowable Limit | 0,15 mm (0.006 in) |
| Injection Pump Gear and Idler Gear | |
| | 0,046 - 0,124 mm (0.002 - 0.005 in) |
| Allowable Limit | 0,15 mm (0.006 in) |
| Oil Pump Gear and Crankshaft Cover | |
| | 0,041 - 0,123 mm (0.002 - 0.005 in) |
| Allowable Limit | 0,15 mm (0.006 in) |

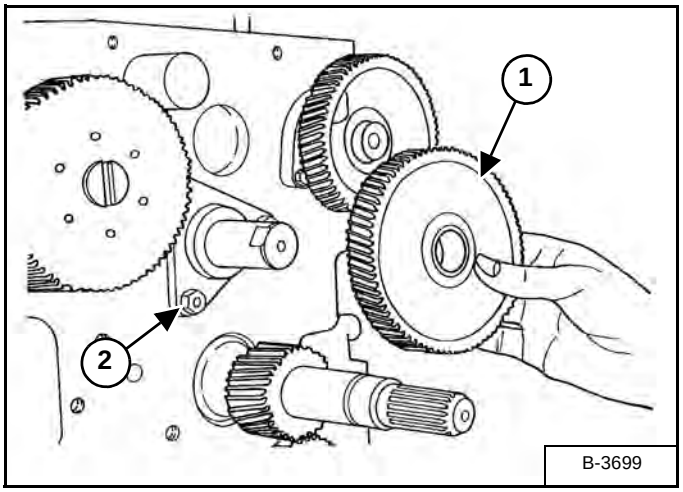
### Idler Gear And Camshaft Removal And Installation

**Figure 60-90-9**




Remove the snap ring (Item 1) and collar (Item 2) from the idler gear shaft (Item 3) **[Figure 60-90-9]**.

**Figure 60-90-10**




Remove the idler gear (Item 1) **[Figure 60-90-10]**.

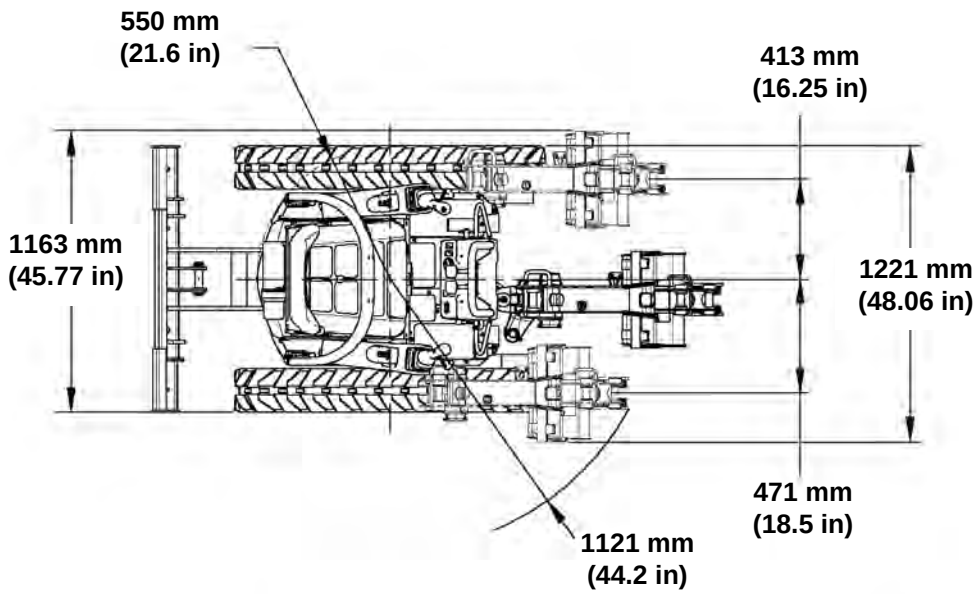
Remove idler gear mounting screws (Item 2) **[Figure 60-90-10]**.

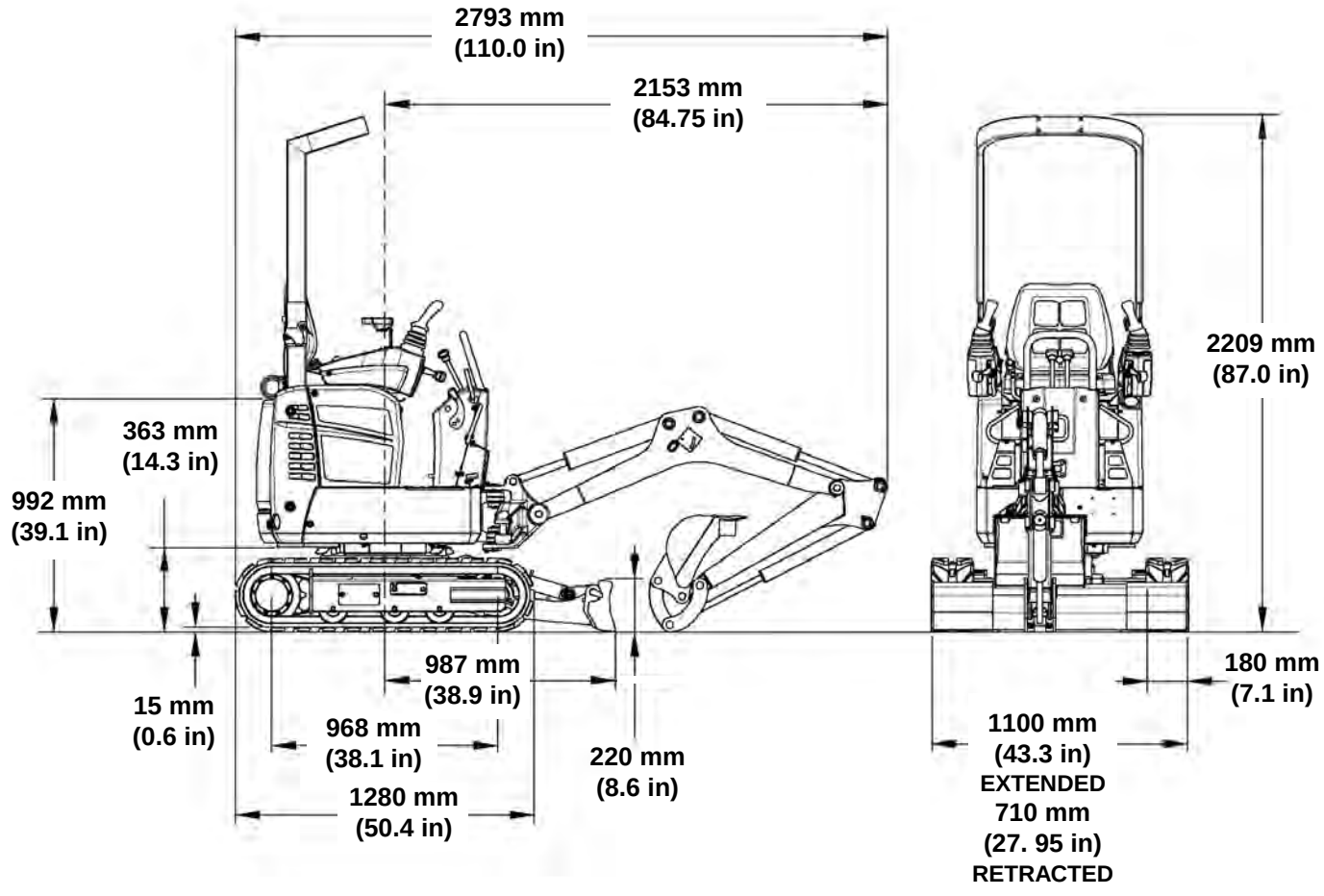
***Installation:*** Tighten screws to 10 - 11 N•m (7 - 8 ft-lb) torque.

## EXCAVATOR SPECIFICATIONS

### Machine Dimensions

- All dimensions are given in mm.
- Where applicable, specification conform to SAE or ISO standards and are subject to change without notice.



## TECHNICAL SERVICE GUIDE SPECIFICATIONS

### Engine

| | |
|---|---|
| Engine Oil Pressure at Low Idle | 48 kPa (0,48 bar) (7 psi) |
| Engine Oil Pressure at High Idle | 193 - 441 kPa (1,9 - 4,4 bar) (28 - 64 psi) |
| Firing Order | 1-2-3 |
| Location of Number 1 Cylinder | Closest to water pump |
| Injection Timing | 19° - 21° BTDC |
| Crankshaft Rotation (Facing Crankshaft Pulley) | Clockwise |
| Compression at Cranking Speed | 10% variance between pistons. 2800 -3200 kPa (28 - 32 bar) (412 - 469 psi) |
| Valve Clearance (Cold) Intake | 0,145 - 0,185 mm (0.0057 - 0.0072 in) |
| Valve Clearance (Cold) Exhaust | 0,145 - 0,185 mm (0.0057 - 0.0072 in) |

**NOTE: For additional engine specifications, (See Specifications on Page 60-10-2.)**

### Engine Torques

| | |
|---|---|
| Engine Oil Drain Cap | 33 - 37 N•m (24 - 27 ft-lb) |
| Fuel Injection Tubeline Nuts | 25 - 34 N•m (18 - 25 ft-lb) |
| Glow Plugs | 8 - 15 N•m (6 - 11 ft-lb) |
| Injection Pump Mounting Bolts/Nuts | 22 - 27 N•m (16 - 20 ft-lb) |
| Valve Cover Bolts | 7 - 11 N•m (5 - 8 ft-lb) |
| Head Bolts | 93,2 - 98,0 N•m (68.8 - 72.3 ft-lb) |

**NOTE: For additional engine torques, (See Torque Values on Page 60-10-6.)**

### Cooling System

| | |
|---|---|
| Coolant Type and Mix | 47% Water and 53% Propylene Glycol |
| Radiator Cap Pressure | 90 kPa (0,90 bar) (13 psi) |
| Thermostat Start Opening | 69,5 - 72,5°C (157.1 - 162.5°F) |
| Thermostat Fully Open | 85°C (185°F) |

**NOTE: For additional cooling system information, (See ENGINE COOLING SYSTEM on Page 60-40-1.)**

## CONVERSIONS

### Decimal And Millimeter Equivalents

| FRACTIONS | DECIMALS | MM |
|---|---|---|
| 1/64 | 0.015625 | 0.397 |
| 1/32 | 0.03125 | 0.794 |
| 3/64 | 0.046875 | 1.191 |
| 1/16 | 0.0625 | 1.588 |
| 5/64 | 0.078125 | 1.984 |
| 3/32 | 0.09375 | 2.381 |
| 7/64 | 0.109375 | 2.778 |
| **1/8** | 0.1250 | 3.175 |
| 9/64 | 0.140625 | 3.572 |
| 5/32 | 0.15625 | 3.969 |
| 11/64 | 0.171875 | 4.366 |
| 3/16 | 0.1876 | 4.762 |
| 13/64 | 0.203125 | 5.159 |
| 7/32 | 0.21875 | 5.556 |
| 15/64 | 0.234375 | 5.953 |
| **1/4** | 0.2500 | 6.350 |
| 17/64 | 0.265625 | 6.747 |
| 9/32 | 0.28125 | 7.144 |
| 19/64 | 0.296875 | 7.541 |
| 5/16 | 0.3125 | 7.938 |
| 21/64 | 0.328125 | 8.334 |
| 11/32 | 0.34375 | 8.731 |
| 23/64 | 0.359375 | 9.128 |
| **3/8** | 0.3750 | 9.525 |
| 25/64 | 0.390625 | 9.922 |
| 13/32 | 0.40625 | 10.319 |
| 27/64 | 0.421875 | 10.716 |
| 7/16 | 0.4375 | 11.112 |
| 29/64 | 0.453125 | 11.509 |
| 15/32 | 0.46875 | 11.906 |
| 31/64 | 0.484375 | 12.303 |
| **1/2** | 0.5000 | 12.700 |

**1 mm = 0.03937”**

| FRACTIONS | DECIMALS | MM |
|---|---|---|
| 33/64 | 0.515625 | 13.097 |
| 17/32 | 0.53125 | 13.494 |
| 35/64 | 0.546875 | 13.891 |
| 9/16 | 0.5625 | 14.288 |
| 37/64 | 0.578125 | 14.684 |
| 19/32 | 0.59375 | 15.081 |
| 39/64 | 0.609375 | 15.478 |
| **5/8** | 0.6250 | 15.875 |
| 41/64 | 0.640625 | 16.272 |
| 21/32 | 0.65625 | 16.669 |
| 43/64 | 0.671875 | 17.066 |
| 11/16 | 0.6875 | 17.462 |
| 45/64 | 0.703125 | 17.859 |
| 23/32 | 0.71875 | 18.256 |
| 47/64 | 0.734375 | 18.653 |
| **3/4** | 0.7500 | 19.050 |
| 49/64 | 0.765625 | 19.447 |
| 25/32 | 0.78125 | 19.844 |
| 51/64 | 0.796875 | 20.241 |
| 13/16 | 0.8125 | 20.638 |
| 53/64 | 0.828125 | 21.034 |
| 27/32 | 0.84375 | 21.431 |
| 55/64 | 0.859375 | 21.828 |
| **7/8** | 0.8750 | 22.225 |
| 57/64 | 0.890625 | 22.622 |
| 29/32 | 0.90625 | 23.019 |
| 59/64 | 0.921875 | 23.416 |
| 15/16 | 0.9375 | 23.812 |
| 61/64 | 0.953125 | 24.209 |
| 31/32 | 0.96875 | 24.606 |
| 63/64 | 0.984375 | 25.003 |
| **1** | 1.000 | 25.400 |

**0.001 = 0.0254 mm**

### U.S. To Metric Conversion Chart

| | TO CONVERT | INTO | MULTIPLY BY |
|---|---|---|---|
| **LINEAR MEASUREMENT** | Miles | Kilometers | 1.609 |
| | Yards | Meters | 0.9144 |
| | Feet | Meters | 0.3048 |
| | Feet | Centimeters | 30.48 |
| | Inches | Meters | 0.0254 |
| | Inches | Centimeters | 2.54 |
| | Inches | Millimeters | 25.4 |
| **AREA** | Square Miles | Square Kilometers | 2.59 |
| | Square Feet | Square Meters | 0.0929 |
| | Square Inches | Square Centimeters | 6.452 |
| | Acre | Hectare | 0.4047 |
| **VOLUME** | Cubic Yards | Cubic Meters | 0.7646 |
| | Cubic Feet | Cubic Meters | 0.02832 |
| | Cubic Inches | Cubic Centimeters | 16.39 |
| **WEIGHT** | Tons (Short) | Metric Tons | 0.9078 |
| | Pounds | Kilograms | 0.4536 |
| | Ounces (Avdp.) | Grams | 28.3495 |
| **PRESSURE** | Pounds/Sq. In. | Kilopascal | 6.895 |
| **WORK** | Foot–Pounds | Newton–Meter | 1.356 |
| **LIQUID VOLUME** | Quarts | Liters | 0.9463 |
| | Gallons | Liters | 3.785 |
| **LIQUID FLOW** | Gallons/Minute | Liters/Minute | 3.785 |
| **TEMPERATURE** | Fahrenheit | Celsius | 1.Subtract 32° 2. Multiply by 5/9 |