ENGINE SERVICE

Continued On Next Page

ENGINE SERVICE (CONT'D)

TROUBLESHOOTING

Chart

The following troubleshooting chart is provided for assistance in locating and correcting problems which are most common. Many of the recommended procedures must be done by authorized Bobcat Service Personnel only.

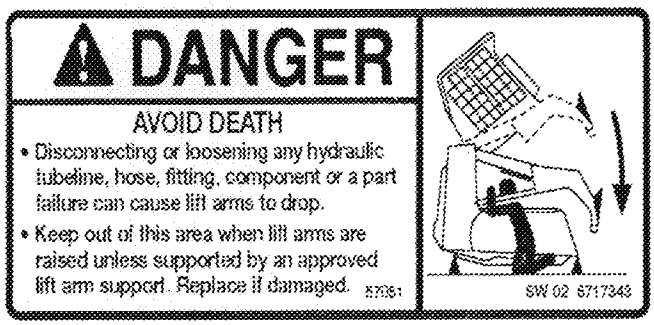
PROBLEM	CAUSE
Slow cranking speed.	1, 2, 3,54
Engine will not start.	2, 5, 6, 7, 8, 9,11, 12, 13, 14, 15, 16, 19, 27, 28, 29
Difficult to start.	1, 2, 5, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 25, 27, 28, 29, 54
No power for engine.	8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 20, 21, 22, 23, 27, 28, 29
Engine is mis-firing.	8, 9, 11, 12, 13, 15, 16, 17, 21, 22, 24, 25, 26, 28
Too much fuel consumption.	10, 12, 13, 15, 16, 17, 19, 20, 21, 23, 24, 25, 27, 28, 29
Black exhaust.	10, 12, 13, 15, 16, 17, 19, 20, 21, 23, 24, 25, 27, 28, 29
Blue/white exhaust.	4, 10, 15, 16, 17, 21, 23, 27, 29, 30, 50
Low oil pressure.	4, 31, 32, 33, 34, 35, 37, 38, 39, 52
Engine knocking.	13, 15, 16, 19, 22, 24, 25, 27, 29, 31, 40, 41, 53
Engine running rough.	7, 8, 9, 10, 11, 12, 13, 17, 18, 22, 24, 25, 26, 29, 40, 53
Vibration.	12, 13, 17, 21, 22, 25, 26, 29, 40, 42, 43
High oil pressure warning.	4, 33, 36
Overheating.	10, 12, 13, 15, 16, 20, 21, 40, 44, 45, 46, 47, 48, 51
Too much crankcase pressure.	22, 27, 29, 30, 40, 49
Poor compression.	10, 16, 21, 24, 25, 27, 28, 29, 30, 41, 53
Start and stop.	9, 10, 11

Chart (Cont'd)

KEY TO CORRECT THE CAUSE	
1. Alternator belt is loose or damaged.	28. Worn valve and seats.
2. Bad electrical connections.	29. Broken or worn piston rings.
3. Faulty starter motor.	30. Worn valve stems or guides.
4. Incorrect grade of oil.	31. Worn or damaged bearings.
5. Low cranking speed.	32. Not enough oil in the crankcase.
6. Fuel tank empty.	33. Switch/sensor is defective.
7. Faulty stop control operation.	34. Oil pump worn.
8. Plugged fuel line.	35. Relief valve is sticking open.
9. Plugged fuel filter.	36. Relief valve is sticking closed.
10. Restriction in the air cleaner.	37. Broken relief valve spring.
11. Air in the fuel system.	38. Faulty suction pipe.
12. Faulty fuel injection pump.	39. Plugged oil filter.
13. Faulty fuel injectors.	40. Piston seizure.
14. Broken injection pump drive.	41. Incorrect piston height.
15. Incorrect injection pump timing.	42. Faulty engine mounting.
16. Incorrect valve timing.	43. Incorrect flywheel alignment.
17. Poor compression.	44. Faulty thermostat.
18. Plugged fuel tank vent.	45. Restriction in water jacket.
19. Incorrect grade of fuel.	46. Loose alternator belt.
20. Exhaust pipe restriction.	47. Plugged radiator.
21. Cylinder head gasket leaking.	48. Faulty water pump.
22. Overheating.	49. Plugged breather pipe.
23. Cold running.	50. Damaged valve stem deflectors.
24. Incorrect tappet adjustment.	51. Coolant level to low.
25. Sticking valves.	52. Plugged oil pump pipe strainer.
26. Incorrect fuel lines.	53. Broken valve spring.
27. Worn cylinder bores.	54. Damaged Battery.

ENGINE SPEED CONTROL

Removal And Installation

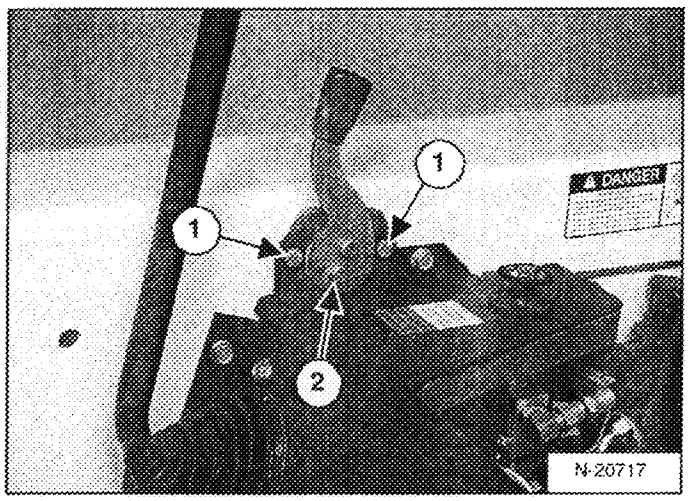


WARNING

Never work on a machine with the lift arms up unless the lift arms are secured by an approved lift arm support device. Failure to use an approved lift arm support device can allow the lift arms or attachment to fall and cause injury or death.

W-2059-0598

Figure 70-20-1



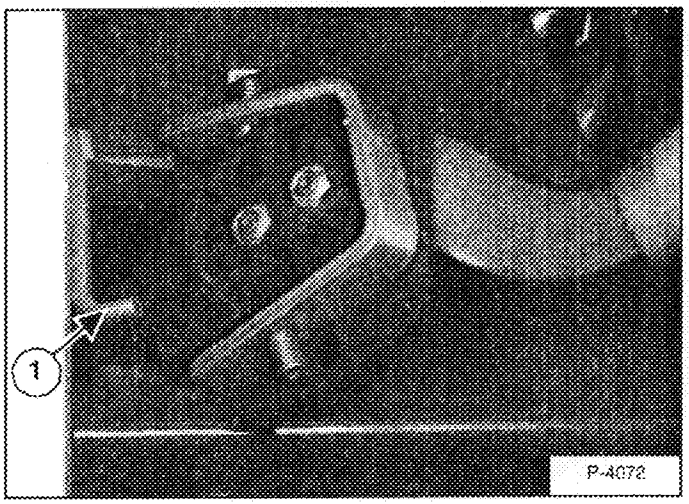
Raise the lift arms and install an approved lift arm device. (See Contents, Page 10-01.)

Raise the operator cab. (See Contents, Page 10-01.)

Remove the two mounting bolts (Item 1) **[Figure 70-20-1]** and nuts from the speed control mounting bracket.

Installation: Tighten the mounting bolts and nuts evenly until the speed control lever moves back and forth at a comfortable tension.

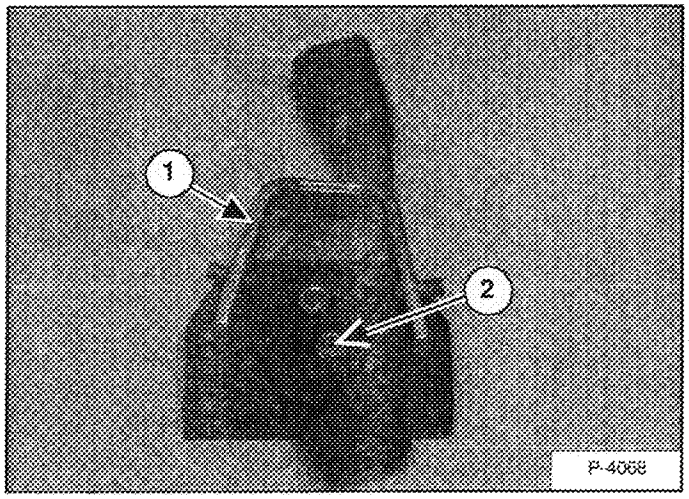
Figure 70-20-2



Pull the speed control away from the loader frame and disconnect the speed control rod (Item 1) **[Figure 70-20-2]** from the control.

Installation: Be sure to install the control rod in the bottom hole of the speed control.

Figure 70-20-3



Installation: Install the stop bracket (Item 1) **[Figure 70-20-3]** in the same location. It is necessary for the front and rear stop on the bracket to be located correctly.

Reverse the removal procedure to install the engine speed control.

Disassembly

Loosen the two control lever mounting bolts (Item 2) **[Figure 70-20-1]** and remove the mounting nuts (Item 2) **[Figure 70-20-3]**.

Assembly: Do not lubricate the engine speed control.

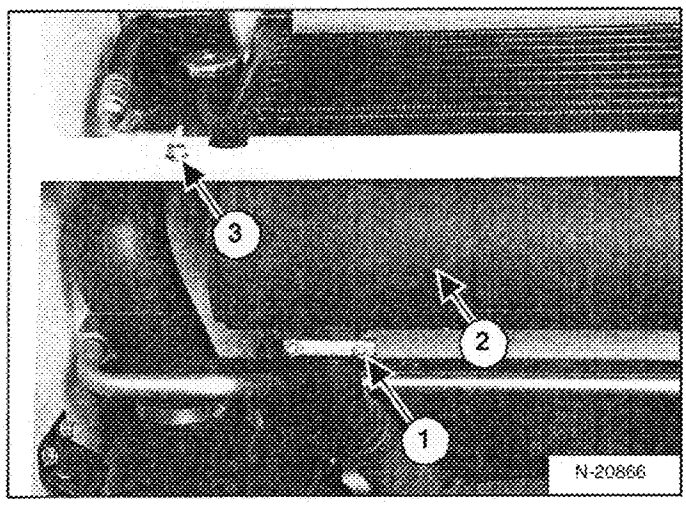
Replace any worn or damaged parts if necessary.

Bobcat®

MUFFLER

Removal And Installation

Figure 70-30-1



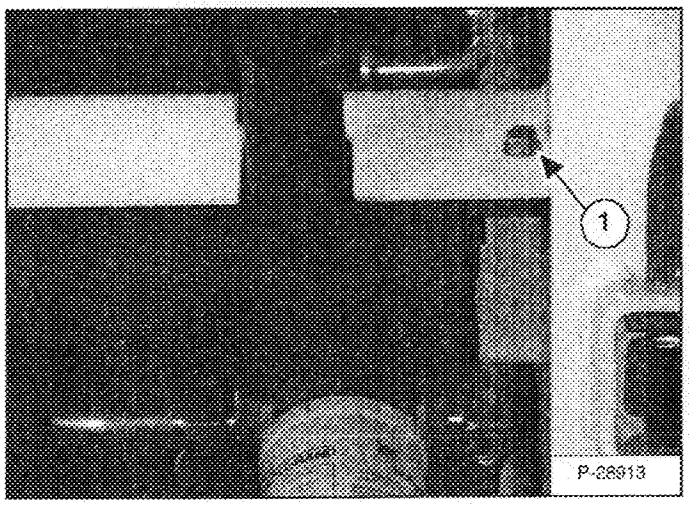
Open the rear door and raise the rear grill.

Remove the exhaust pipe clamp (Item 1) **[Figure 70-30-1]** from the muffler (Item 2) **[Figure 70-30-1]**.

Disconnect the exhaust pipe from the muffler.

Remove the left side mounting bolt (Item 3) **[Figure 70-30-1]** from the muffler.

Figure 70-30-2



Remove the right side mounting bolt (Item 1) **[Figure 70-30-2]** from the muffler.

Installation: Tighten the muffler mounting bolts to 25-28 ft.-lbs. (34-38 Nm) torque.

Remove the muffler from the loader.

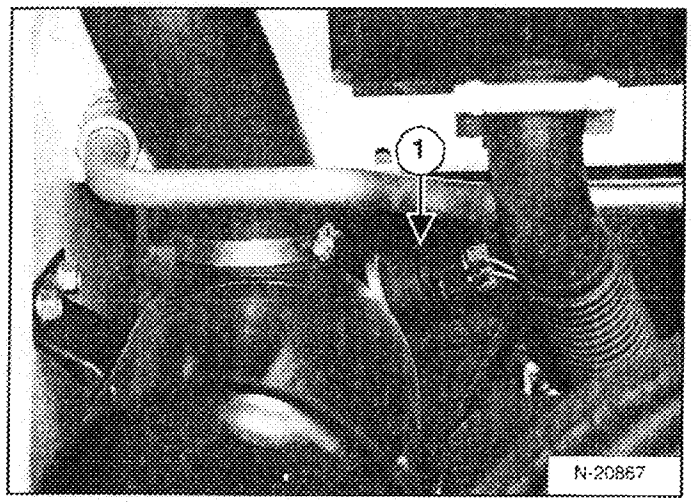
Reverse the removal procedure to install the engine muffler.

Bobcat®

AIR CLEANER

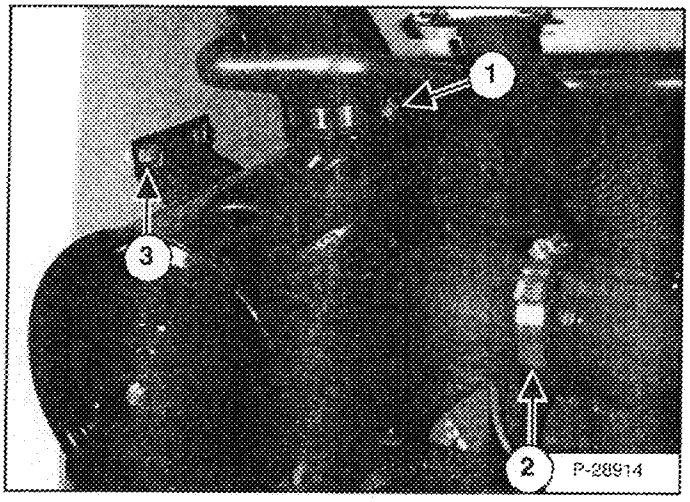
Removal And Installation

Figure 70-40-1



Disconnect the wire harness connector (Item 1) **[Figure 70-40-1]** from the air cleaner sensor on the air cleaner.

Figure 70-40-2

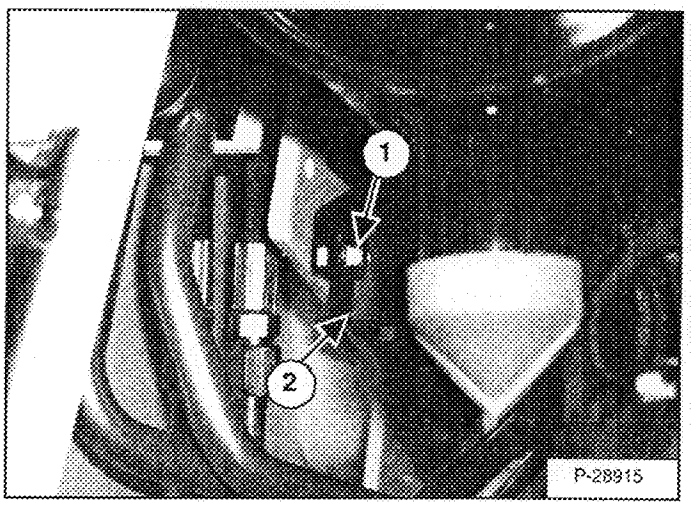


Loosen the hose clamp (Item 1) **[Figure 70-40-2]** on the air cleaner hose.

Loosen the clamp (Item 2) **[Figure 70-40-2]** from the hose on the engine manifold.

Remove the two mounting bolts (Item 3) **[Figure 70-40-2]** from the top mount of the air cleaner.

Figure 70-40-3



Remove the lower mounting bolt (Item 1) **[Figure 70-40-3]** and engine harness mounting bracket (Item 2) **[Figure 70-40-3]** from the air cleaner.

Installation: Tighten the three mounting bolts to 25-28 ft.-lbs. (34-38 Nm) torque.

Remove the air cleaner from the engine compartment.

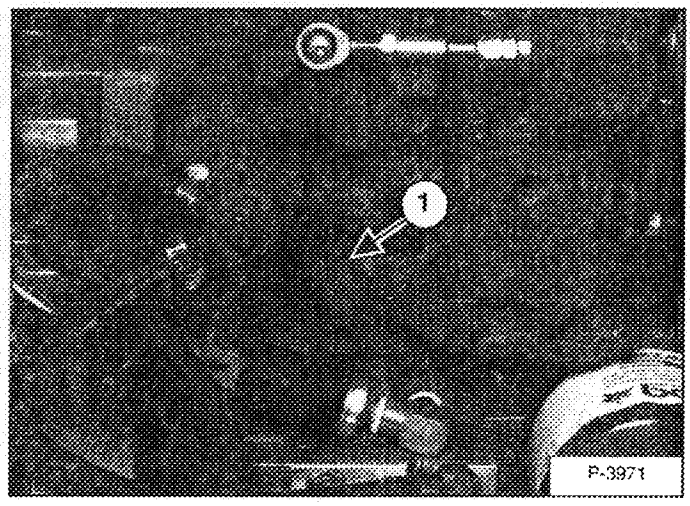
Reverse the removal procedure to install the air cleaner.

Bobcat®

RADIATOR

Removal And Installation

Figure 70-50-1



Stop the engine and open the rear door.

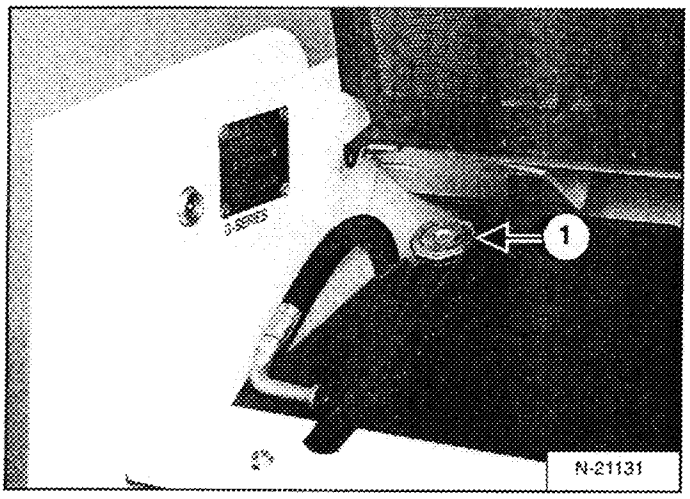
⚠ WARNING

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

W-2070-1285

Open the drain valve (Item 1) **[Figure 70-50-1]** on the engine block and drain the coolant into a container.

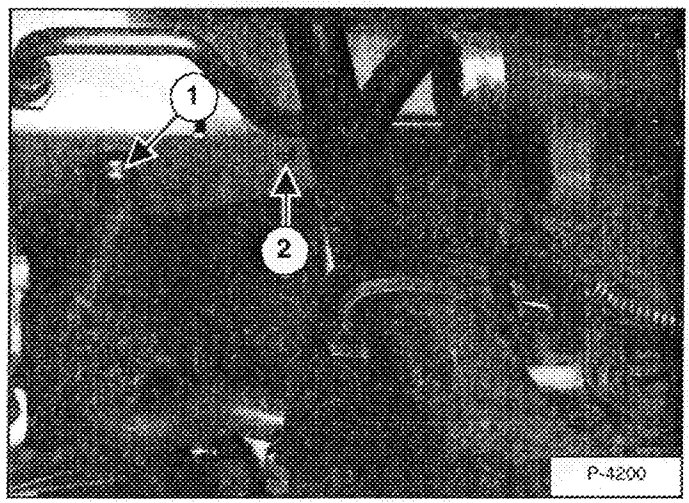
Figure 70-50-2



Loosen the radiator cap (Item 1) **[Figure 70-50-2]** from the radiator fill neck.

Remove the rear grill. (See Contents, Page 50-01.)

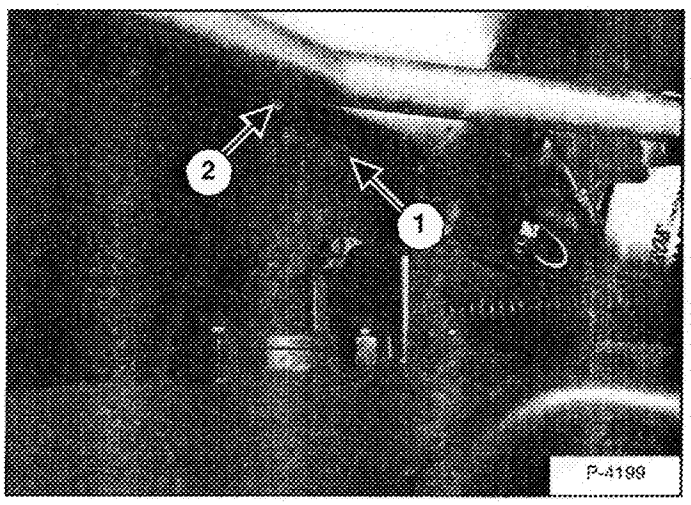
Figure 70-50-3



Loosen the hose clamp (Item 1) **[Figure 70-50-3]** from the left side radiator hose and disconnect the hose from the radiator.

Remove the radiator mounting bolt (Item 2) **[Figure 70-50-3]**.

Figure 70-50-4



Loosen the hose clamp (Item 1) **[Figure 70-50-4]** from the right side radiator hose and disconnect the hose from the radiator.

Remove the radiator mounting bolt (Item 2) **[Figure 70-50-4]**.

Removal And Installation (Cont'd)

Figure 70-50-5

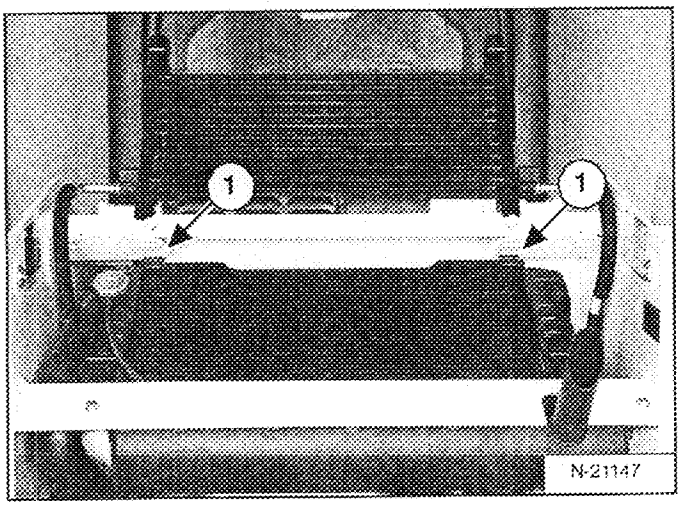
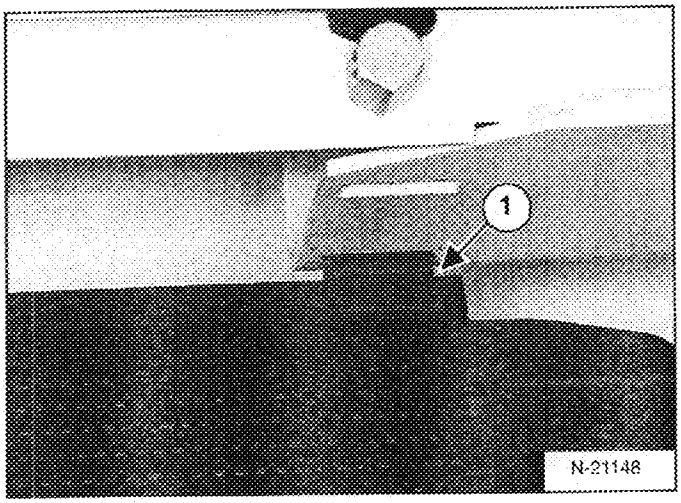
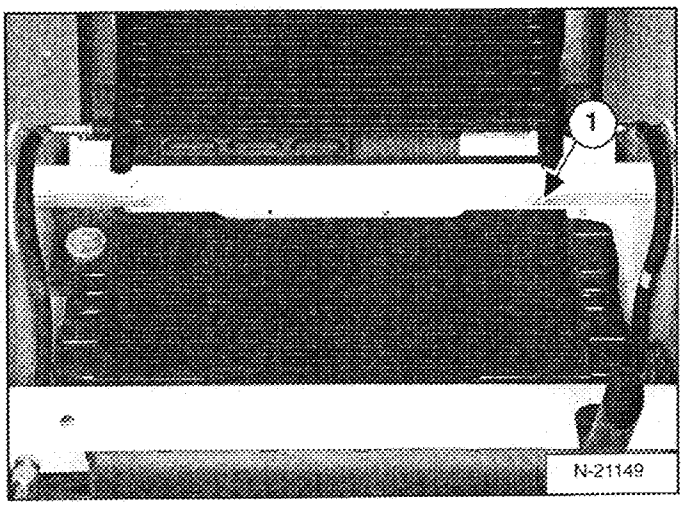


Figure 70-50-6



Remove the two rubber stops (Item 1) **[Figure 70-50-5]** & **[Figure 70-50-6]** from the top of the radiator.

Figure 70-50-7



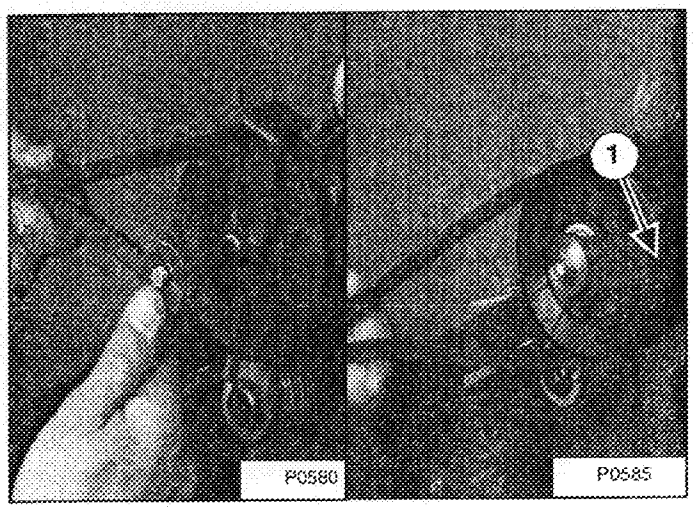
Lift the radiator (Item 1) **[Figure 70-50-7]** up and remove it from the loader.

Reverse the above procedure to install the radiator.

COOLING FAN

Drive Tension Pulley Removal And Installation

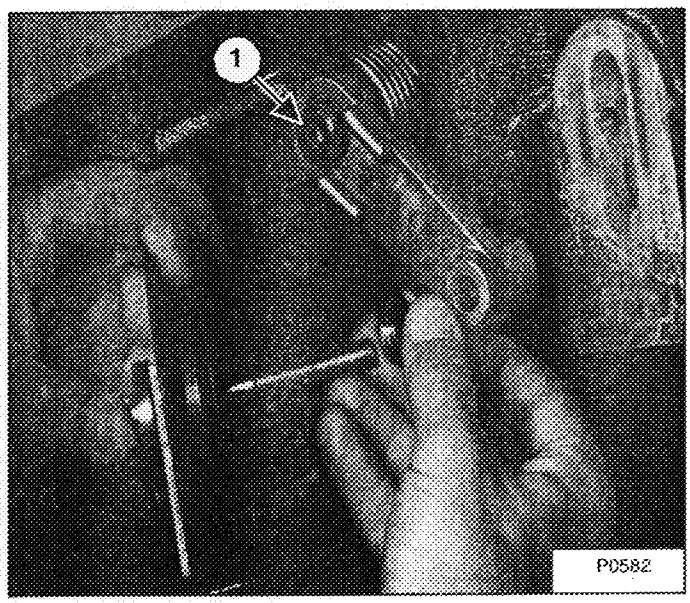
Figure 70-60-1



Loosen the idler pulley bolt **[Figure 70-60-1]**.

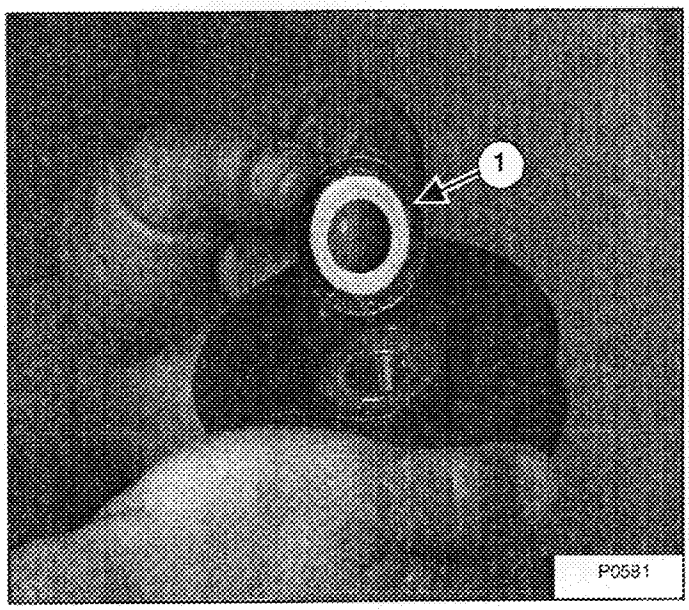
Installation: Install the retainer bracket (Item 1) **[Figure 70-60-1]** for the fan belt at the 3 o'clock position.

Figure 70-60-2



Remove the spacers, bolt and washer from the arm **[Figure 70-60-2]**.

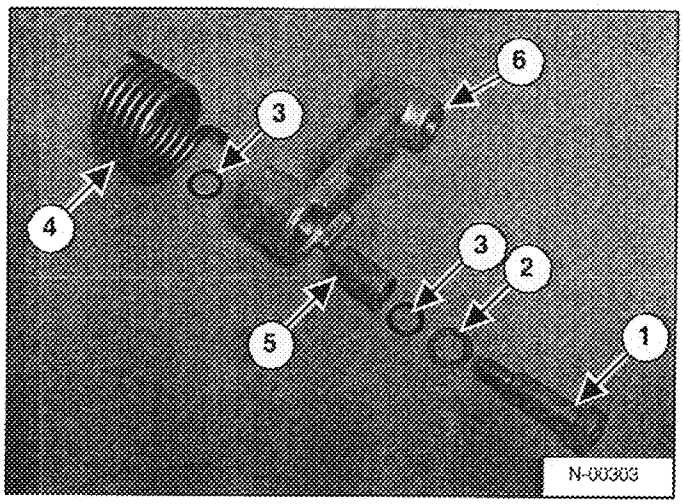
Figure 70-60-3



Installation: Put a small amount of grease around the outside edge (Item 1) **[Figure 70-60-3]** on the grease rings.

Drive Tension Pulley Removal And Installation (Cont'd)

Figure 70-60-4



Remove the bolt (Item 1) **[Figure 70-60-2]** & **[Figure 70-60-4]** from the idler pulley pivot arm (Item 6) **[Figure 70-60-4]]**.

Remove the thrust washer (Item 2) **[Figure 70-60-4]**, O-rings (Item 3) **[Figure 70-60-4]** and spring (Item 4) **[Figure 70-60-4]**.

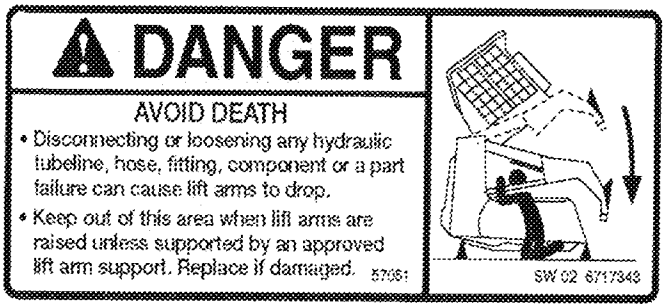
Check all parts for damage or wear and replace them as needed.

NOTE: When making any repairs, replace the bronze bushing (Item 5) [Figure 70-60-4] with a new style nylon bushing. Clean all parts and assemble dry. Do not lubricate. (See Parts Manual for correct part numbers.)

Reverse the removal procedure to install the tension pulley.

Gearbox/Blower Housing Removal And Installation

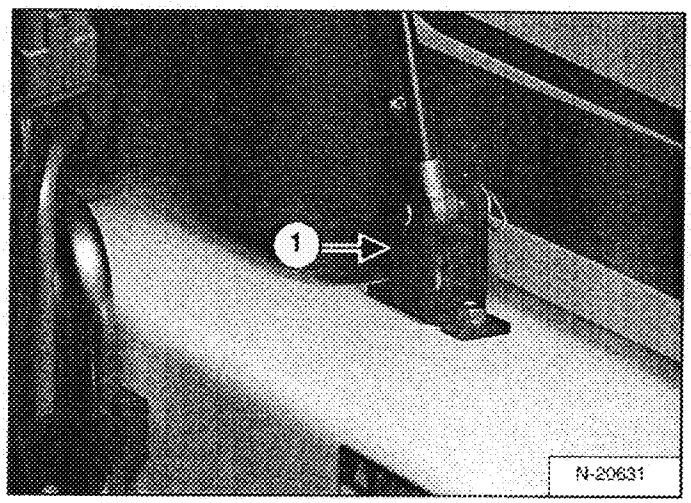
Put jackstands under the rear corners of the loader.



Never work on a machine with the lift arms up unless the lift arms are secured by an approved lift arm support device. Failure to use an approved lift arm support device can allow the lift arms or attachment to fall and cause injury or death.

W-2059-0598

Figure 70-60-5



Raise the lift arms and install an approved lift arm device. (See Contents, Page 10-01.)

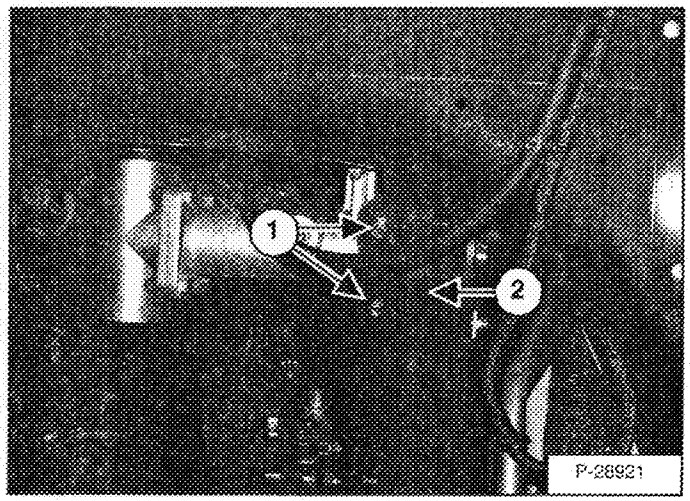
Raise the operator cab. (See Contents, Page 10-01.)

Remove the hydraulic fluid reservoir. (See Contents, Page 20-01.)

Remove the left gas cylinder mounting bracket (Item 1) **[Figure 70-60-5]**. (See Contents, Page 50-01 Operator Cab.)

Gearbox/Blower Housing Removal And Installation (Cont'd)

Figure 70-60-6

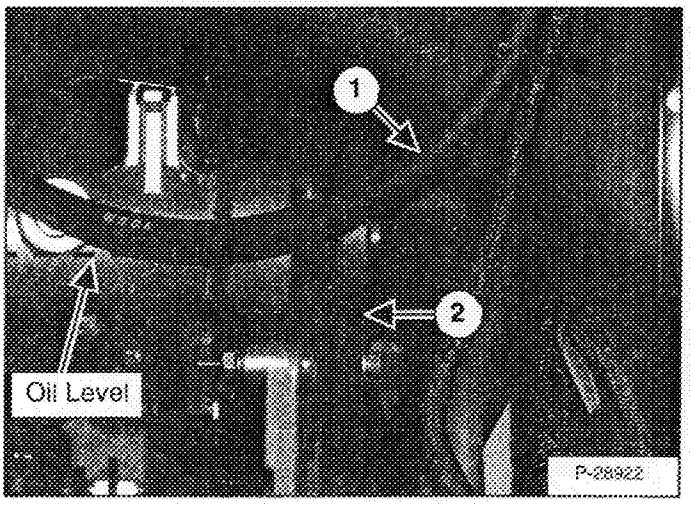


Remove the nuts (Item 1) **[Figure 70-60-6]** from the u-bolt which mounts the fan belt shield (Item 2) **[Figure 70-60-6]** to the blower fan.

Remove the fan belt shield (Item 2) **[Figure 70-60-6]** from the blower fan.

Installation: Be sure to tighten the shield so it does not interfere with the fan belt.

Figure 70-60-7



Disconnect the breather hose (Item 1) **[Figure 70-60-7]** from the electrical harnesses on the loader frame.

Installation: Make sure the breather hose is unrestricted when routing.

Remove the fan drive belt (Item 2) **[Figure 70-60-7]** from the pulley on the blower fan.

NOTE: When checking the fan gearbox oil level, be sure the level does not go above the top of the shaft in the gearbox [Figure 70-60-7]. Use a light colored 90W gear lube if the level is low.

Gearbox/Blower Housing Removal And Installation (Cont'd)

Figure 70-60-8

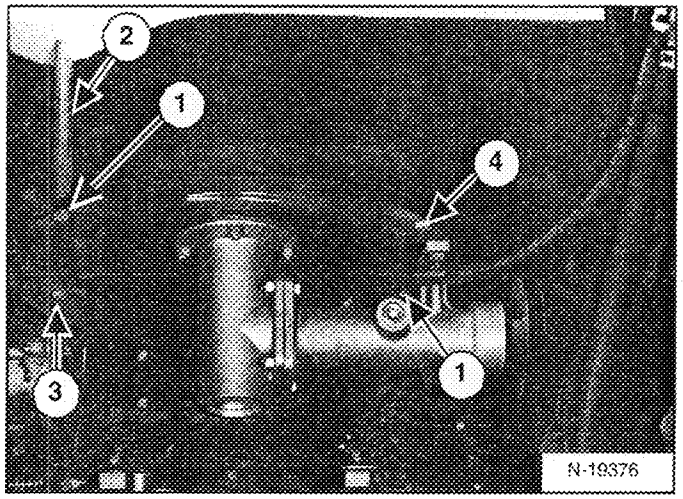
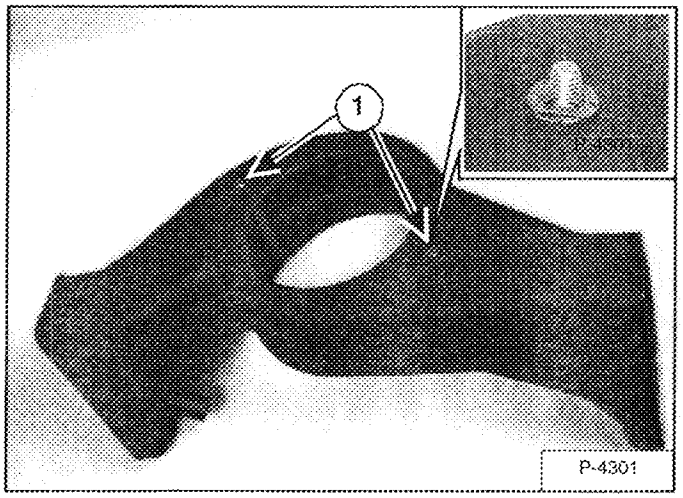


Figure 70-60-9



Remove the two mounting bolts (Item 1) **[Figure 70-60-8]** and the two spacer tubes (Item 2) **[Figure 70-60-8]** from the blower fan.

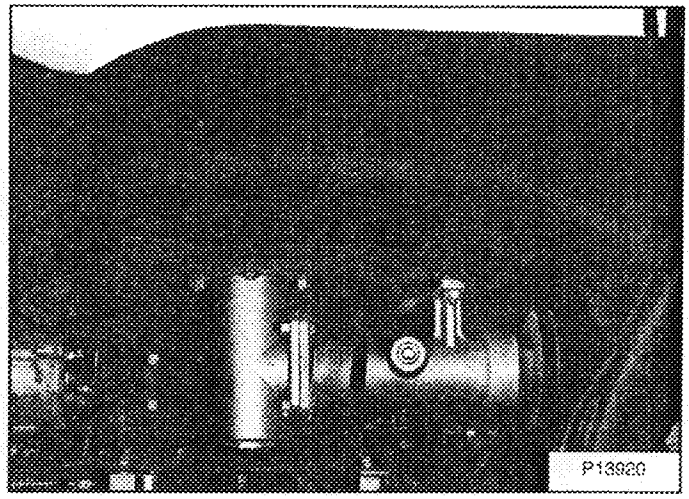
Remove the rear mounting bolt (Item 3) **[Figure 70-60-8]**.

Remove the front mounting bolt (Item 4) **[Figure 70-60-8]**.

NOTE: **Mounting bolts (Item 3 & 4) [Figure 70-60-8] use wave washer (Item 1) [Figure 70-60-9] to prevent tubes and bolts from falling out of the housing during installation.**

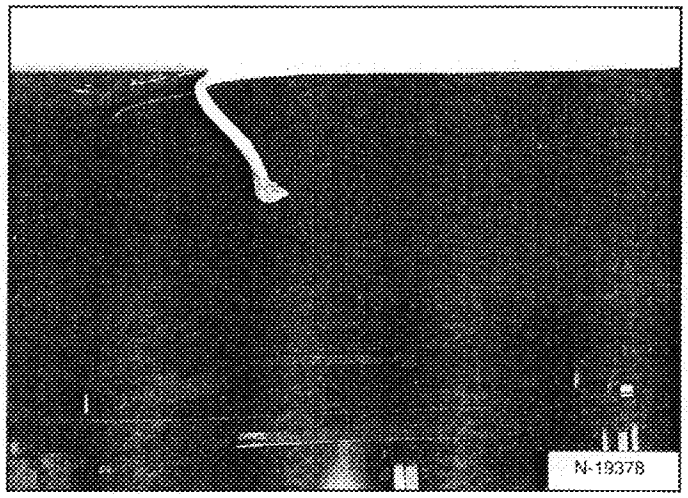
Installation: Tighten the four mounting bolts to 25-28 ft.-lbs. (34-38 Nm) torque.

Figure 70-60-10



Lower the blower fan from the housing until it rests on the steering linkage plate **[Figure 70-60-10]**.

Figure 70-60-11



Remove the strip of sealant along the top of the blower housing **[Figure 70-60-11]**.

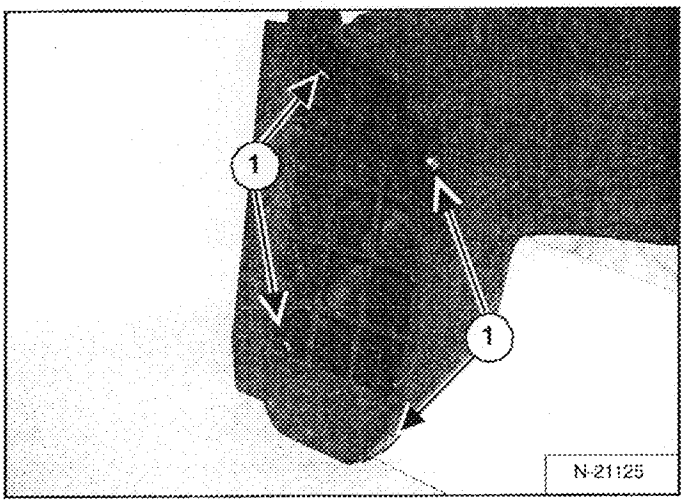
Installation: Use R.T.V. sealant to reseal the blower housing.

Loosen the electrical harnesses from the frame of the loader.

Slide the blower fan and housing forward and remove both from the loader.

Blower Housing Grill Removal And Installation

Figure 70-60-12

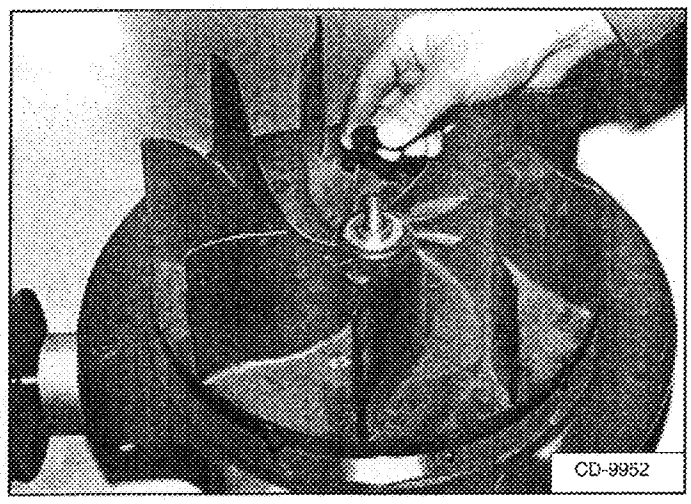


To replace the blower housing grill, remove the four mounting bolts (Item 1) **[Figure 70-60-12]** from the grill.

Install the new grill and replace the mounting bolts.

Blower Disassembly And Assembly

Figure 70-60-13



Remove the lock nut and spacer **[Figure 70-60-13]**.

Installation: Tighten the nut to 45-55 ft.-lbs. (61-75 Nm) torque.

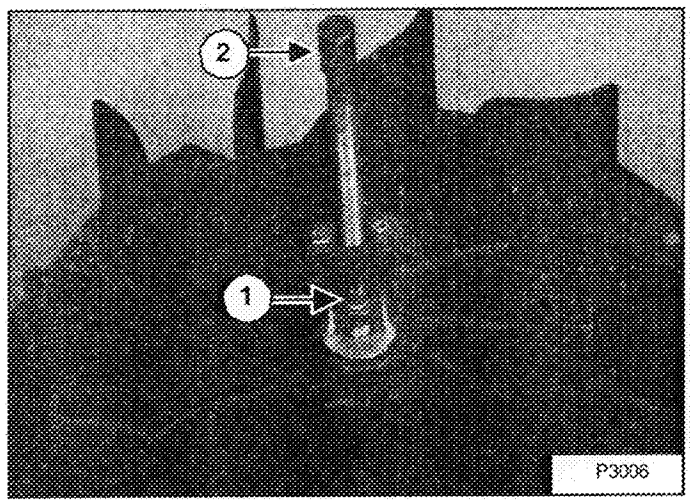
⚠ WARNING

AVOID INJURY OR DEATH

Wear safety goggles to prevent eye injury when drilling or grinding.

W-2108-1186

Figure 70-60-14



Use the following procedure to remove the fan from the shaft.

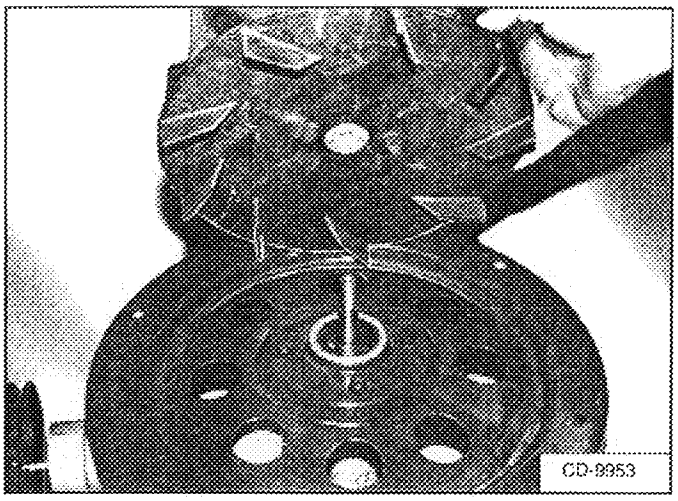
Install the nut (Item 1) **[Figure 70-60-14]** on the tapered shaft to protect the shaft and threads.

Install the puller on the fan as shown **[Figure 70-60-14]**.

As the center bolt (Item 2) **[Figure 70-60-14]** is tightened, periodically strike the bolt head to loosen the fan from the shaft.

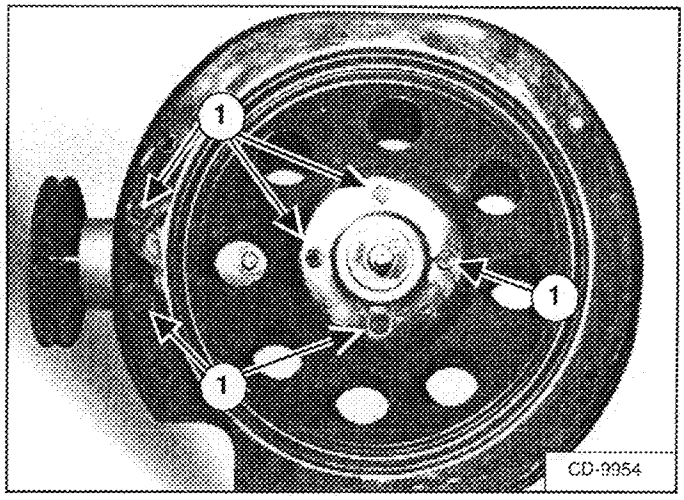
Blower Disassembly And Assembly (Cont'd)

Figure 70-60-15



Remove the fan from the tapered shaft **[Figure 70-60-15]**.

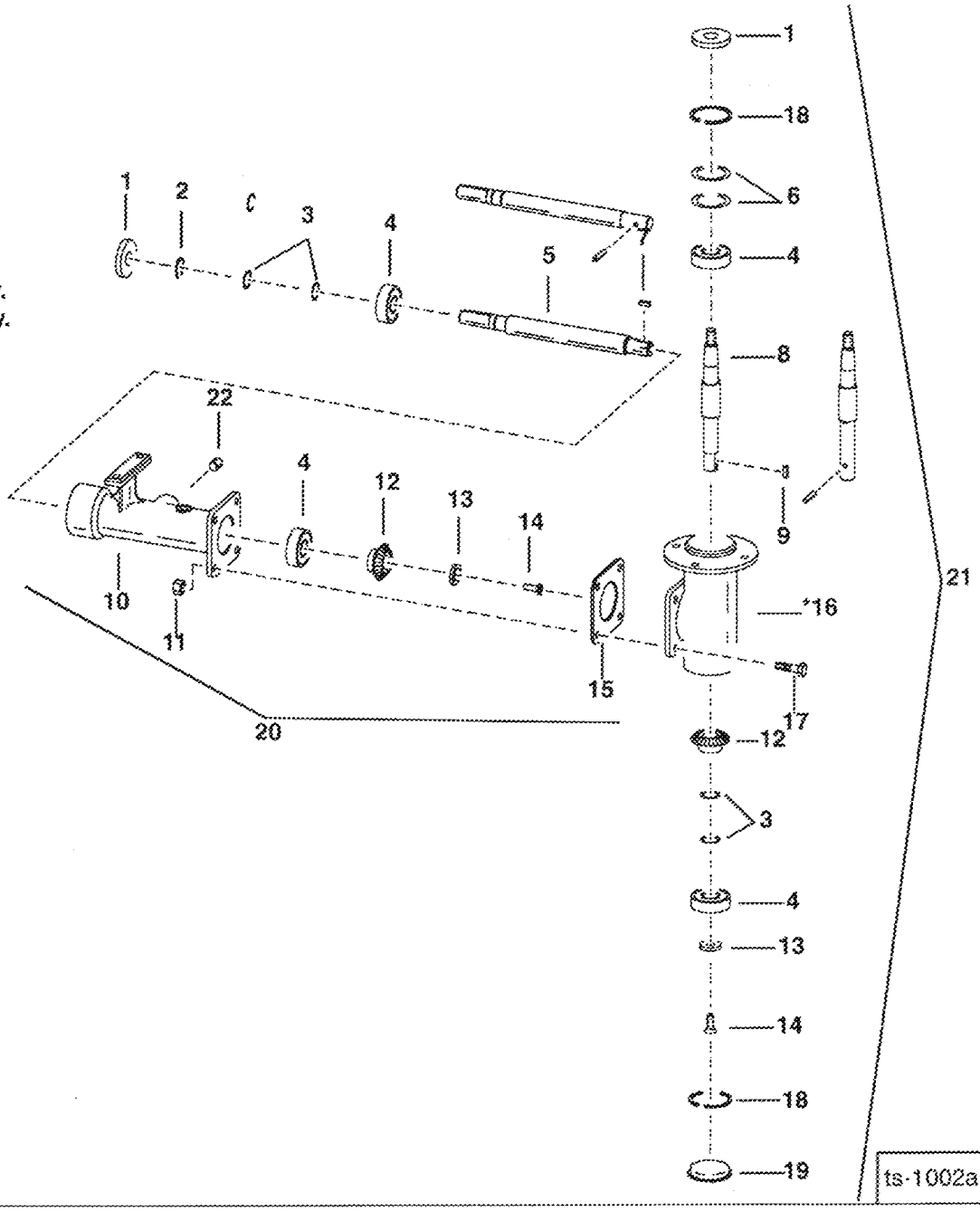
Figure 70-60-16



To remove the blower housing mounting plate, remove the six bolts (Item 1) **[Figure 70-60-16]**.

Gearbox Parts Identification

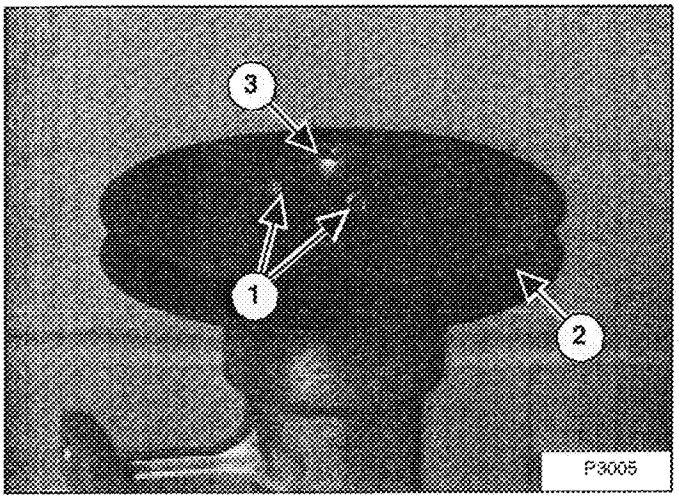
1. Seal
2. Snap Ring (Small)
3. Shims (1.0 inch O.D.)
4. Bearing
5. Shaft (Long)
6. Shims (2.0 inch O.D.)
7. Long Key
8. Shaft (Short)
9. Short Key
10. Long Housing
11. Nut
12. Gear
13. Washer
14. Screw
15. Square Shim
16. Short Housing
17. Bolt
18. Snap Ring (Large)
19. Cap
20. Long Housing Assy.
21. Short Housing Assy.
22. Fill Plug



* Individual Part not available. See Gearbox Disassembly on page 70-60-8

Gearbox Disassembly

Figure 70-60-17



NOTE: When repairing the gearbox order the following as needed.

1. Complete Assembly
2. Long Housing Assembly
3. Long Housing
4. Short Housing Assembly (See Note Below)
5. Internal Parts

NOTE: The short housing is only available as an assembly. (See Gearbox Parts Identification on page 70-60-7) (Order parts from Melroe Parts Sales.)

NOTE: Be sure to count the number and thickness of shims during disassembly. Install the shims in the original location during assembly.

NOTE: Always replace seals during assembly. Replace the parts in the gearbox as needed.

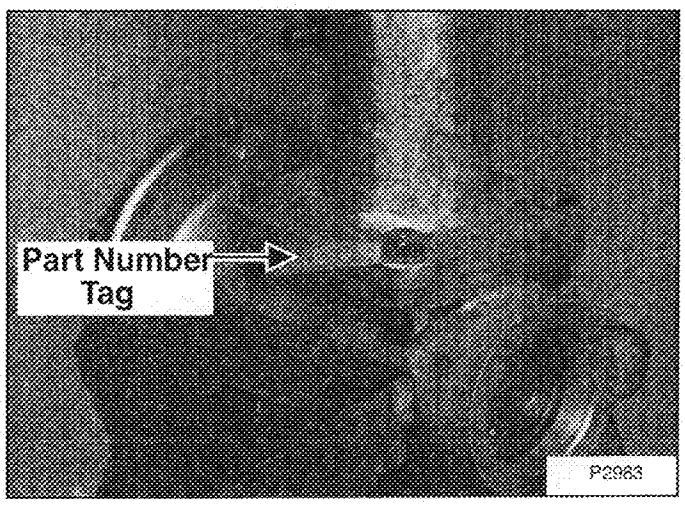
Remove the fan and blower housing mounting plate. (See Blower Disassembly And Assembly on page 70-60-5)

Long Housing

Loosen the set bolts (Item 1) **[Figure 70-60-17]** and remove the pulley (Item 2) **[Figure 70-60-17]**.

Remove the long key (Item 3) **[Figure 70-60-17]**.

Figure 70-60-18



Remove the four mounting bolts and the part number tag **[Figure 70-60-18]**.

Remove the oil from the gearbox.

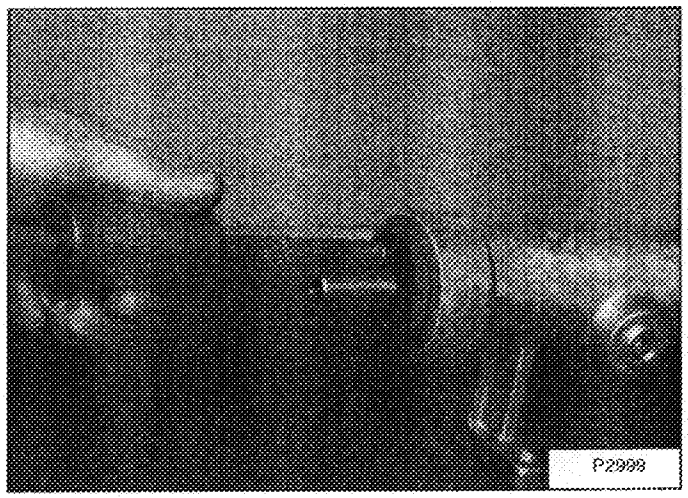
⚠ WARNING

AVOID INJURY OR DEATH

Wear safety goggles to prevent eye injury when drilling or grinding.

W-2108-1186

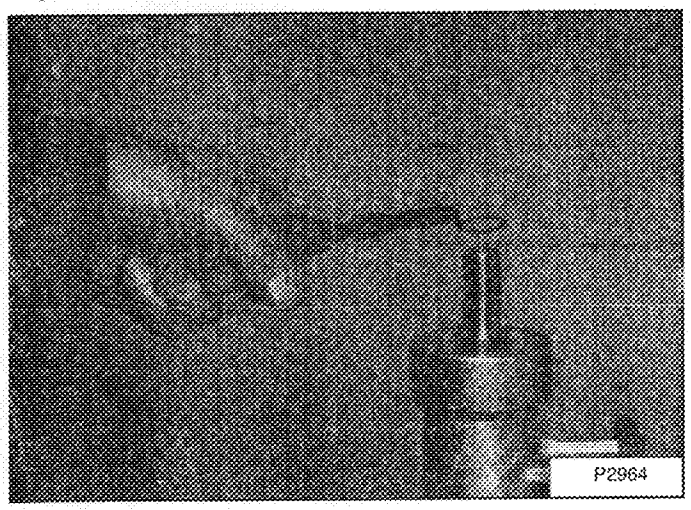
Figure 70-60-19



Drill an 1/8 inch (3 mm) hole in the seal. Use a slide hammer tool to remove the seal **[Figure 70-60-19]**.

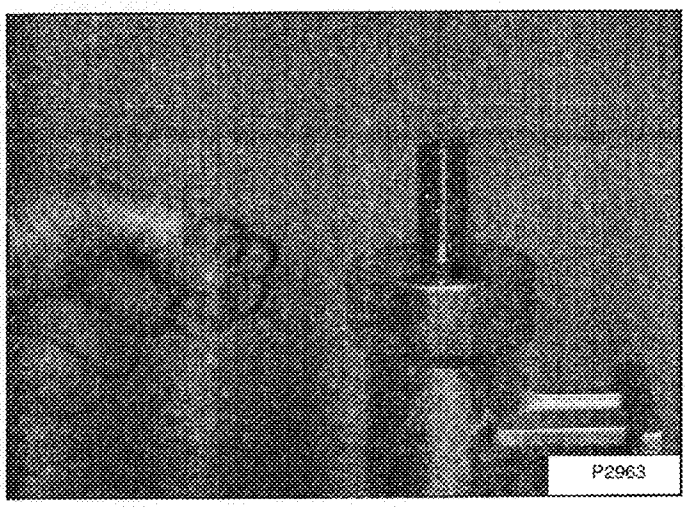
Gearbox Disassembly (Cont'd)

Figure 70-60-20



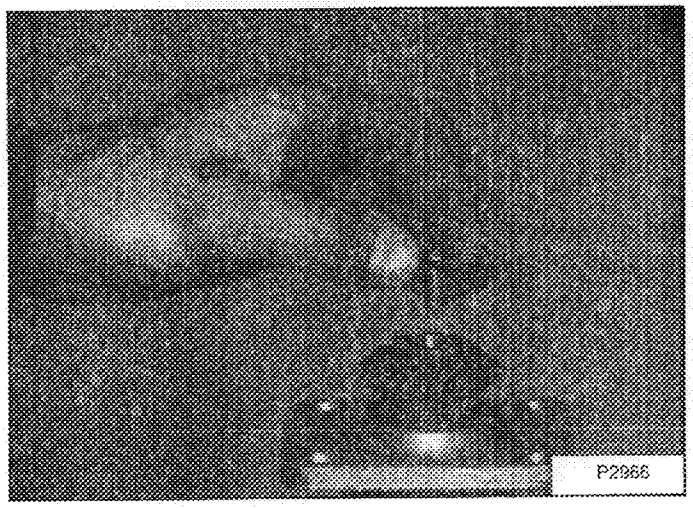
Remove the small snap ring **[Figure 70-60-20]**.

Figure 70-60-21



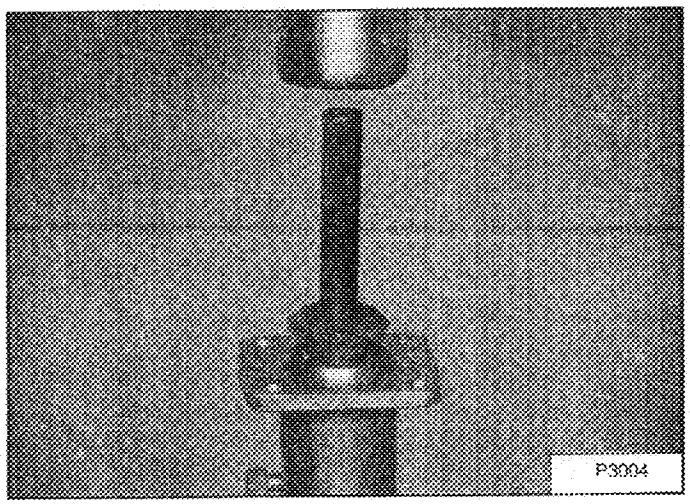
Remove the small shims **[Figure 70-60-21]**.

Figure 70-60-22



Remove the screw and washer from the shaft **[Figure 70-60-22]**.

Figure 70-60-23

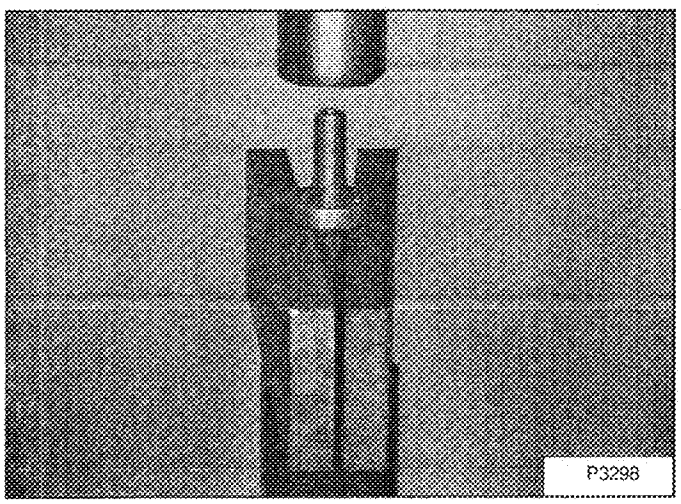


Support the lower flange and press the shaft from the bearing **[Figure 70-60-23]**.

NOTE: The gear and the other bearing (pulley end) will be removed with the shaft.

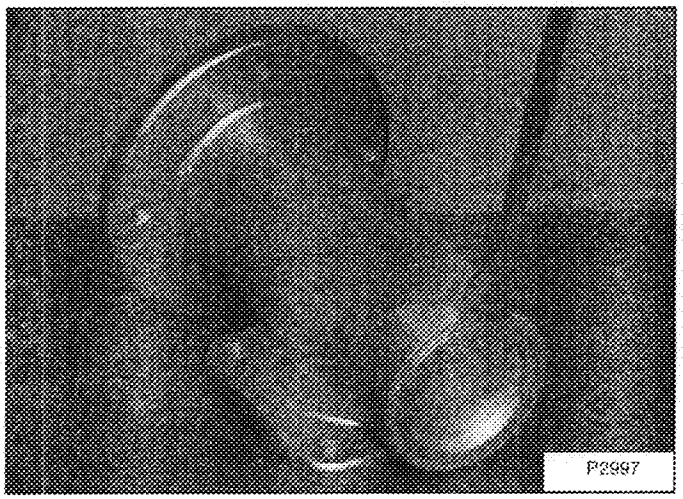
Gearbox Disassembly (Cont'd)

Figure 70-60-24



Support the bearing and press the shaft from the bearing **[Figure 70-60-24]**.

Figure 70-60-25



Short Housing

Remove the end cap **[Figure 70-60-25]**.

Use care not to damage the housing.

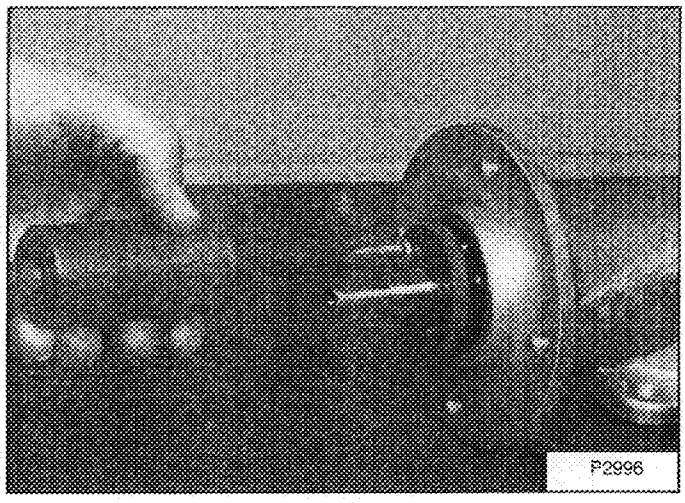
⚠ WARNING

AVOID INJURY OR DEATH

Wear safety goggles to prevent eye injury when drilling or grinding.

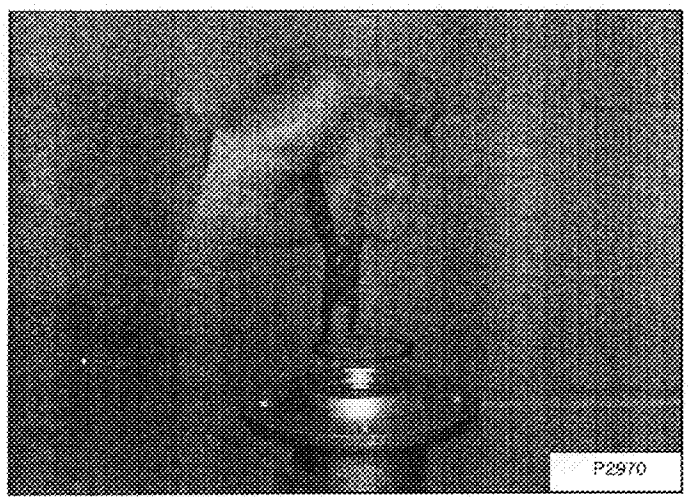
W-2108-1186

Figure 70-60-26



Drill an 1/8 inch (3 mm) hole in the seal. Use a slide hammer tool to remove the seal **[Figure 70-60-26]**.

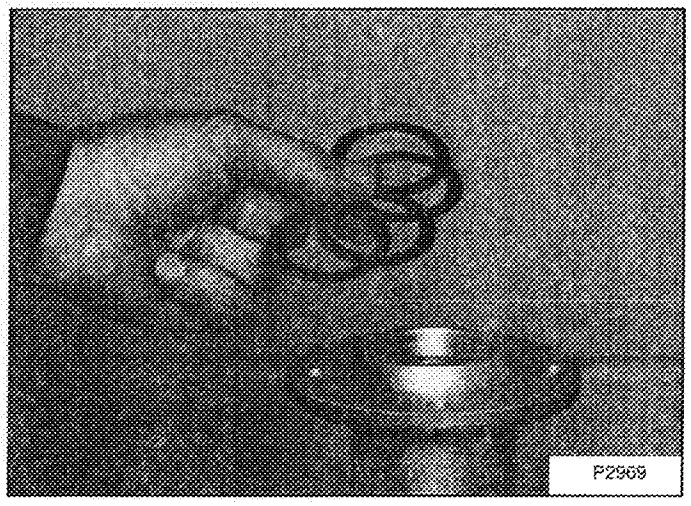
Figure 70-60-27



Remove the large snap ring from the flange end of the housing **[Figure 70-60-27]**.

Gearbox Disassembly (Cont'd)

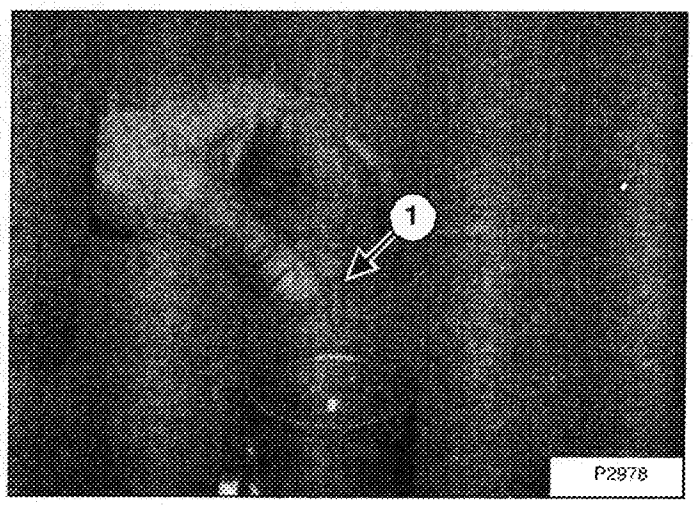
Figure 70-60-28



Remove the large shims from the housing **[Figure 70-60-28]**.

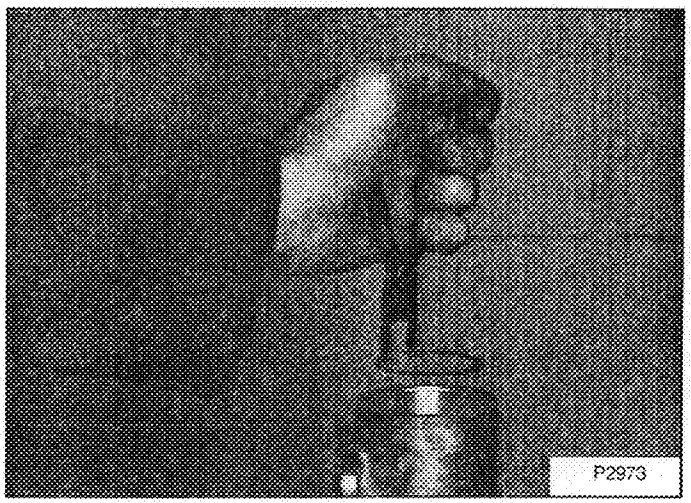
NOTE: Use the same size and thickness of shims during assembly.

Figure 70-60-29



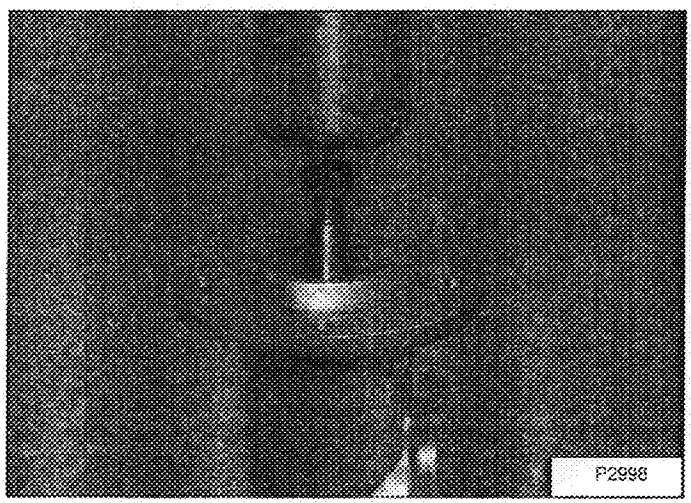
Remove the screw and washer (Item 1) **[Figure 70-60-29]** from the shaft.

Figure 70-60-30



Remove the snap ring from the cap end of the housing **[Figure 70-60-30]**.

Figure 70-60-31

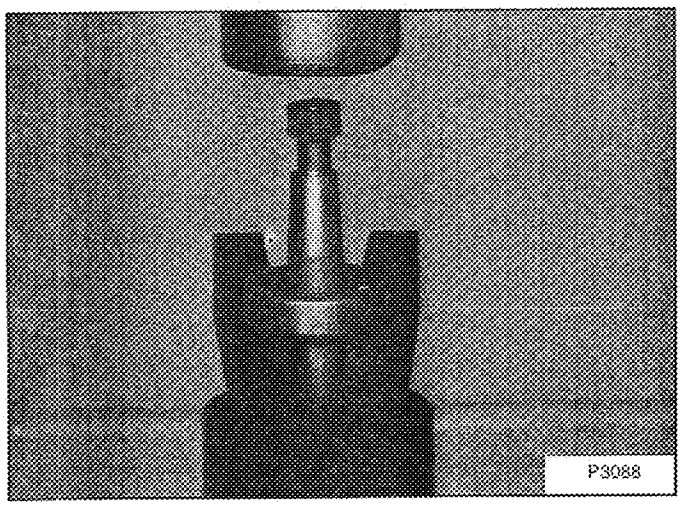


Press the shaft from the housing **[Figure 70-60-31]**.

NOTE: Both bearings may come out of the housing with the shaft. If one bearing remains in the housing use a non metal object to tap the bearing from the housing.

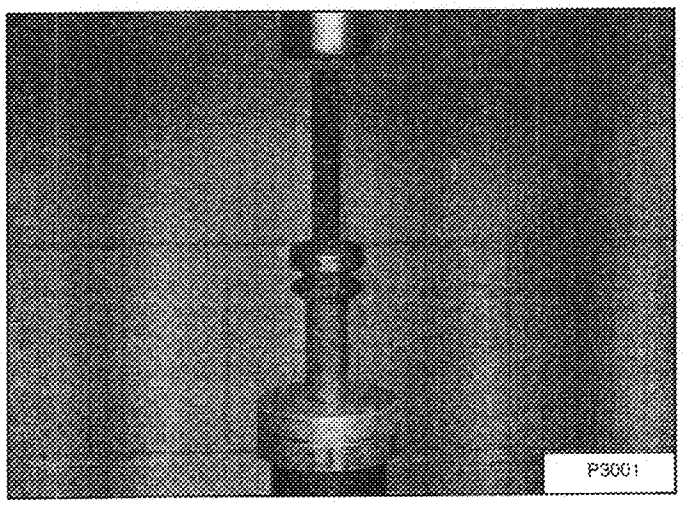
Gearbox Disassembly (Cont'd)

Figure 70-60-32



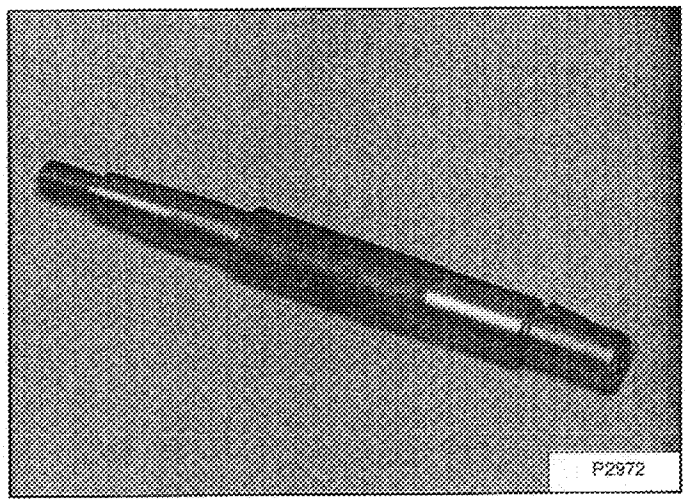
Press the bearing from the tapered end of the shaft **[Figure 70-60-32]**.

Figure 70-60-33



Press the bearing, shims and gear from the shaft **[Figure 70-60-33]**.

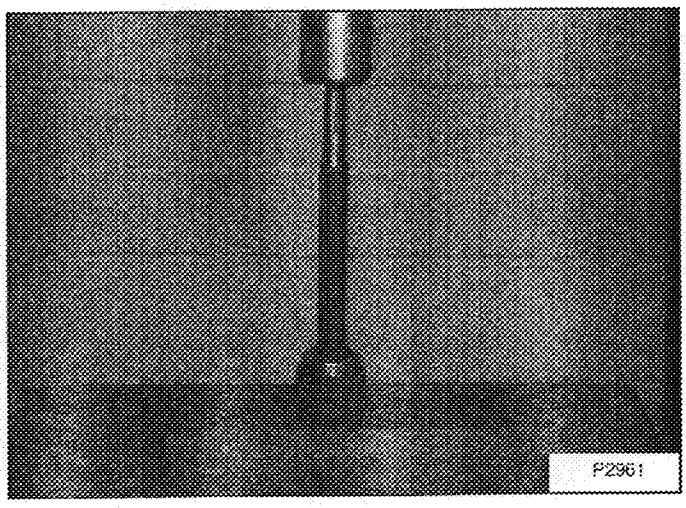
Figure 70-60-34



Remove the key from the shaft **[Figure 70-60-34]**.

Gearbox Assembly

Figure 70-60-35



NOTE: See Gearbox Disassembly on page 70-60-8 when ordering parts for the Fan Gearbox.

NOTE: Do not install the seals and cap in the housing until after the backlash has been checked.

NOTE: Use care when pressing the bearings into the aluminum housing. The housing can be damaged if too much pressure is used.

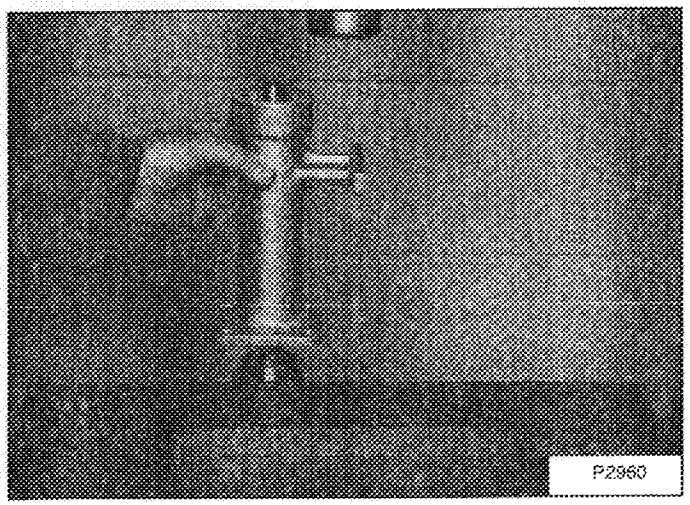
NOTE: For procedures requiring the use of LOCTITE #518 adhesive, thoroughly clean and dry affected parts before the application of LOCTITE #518.

Long Housing

Press a bearing on the short keyed end of the long shaft **[Figure 70-60-35]**.

Gearbox Assembly (Cont'd)

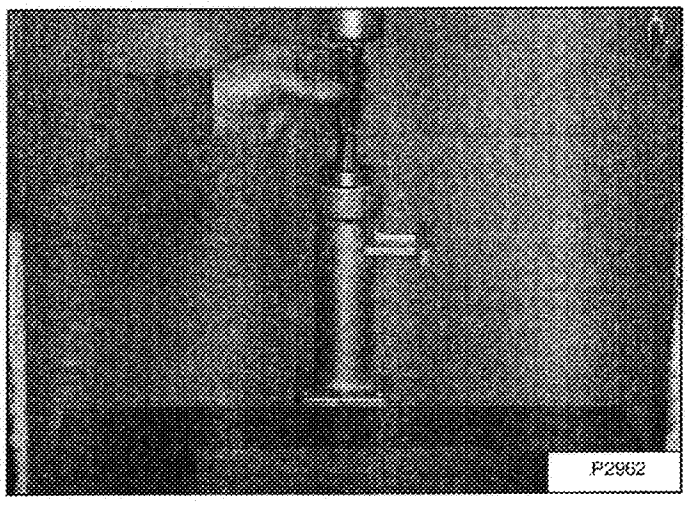
Figure 70-60-36



Install the long housing on the shaft **[Figure 70-60-36]**.

Be sure the bearing is seated in the bore at the lower end of the housing.

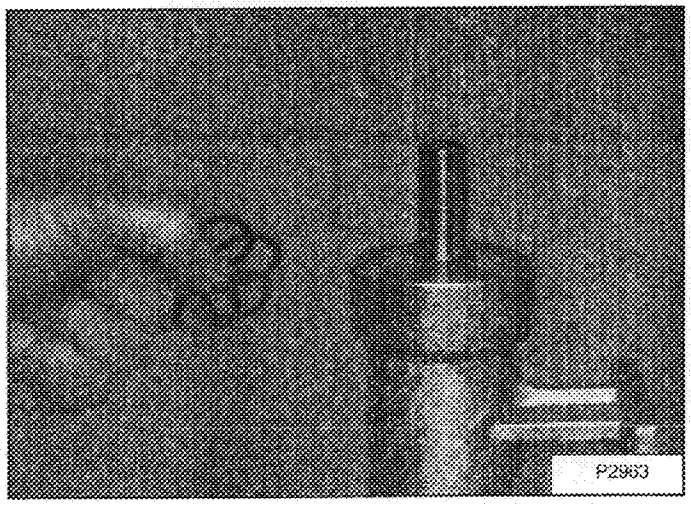
Figure 70-60-37



Install a bearing on the long keyed end of the shaft **[Figure 70-60-37]**.

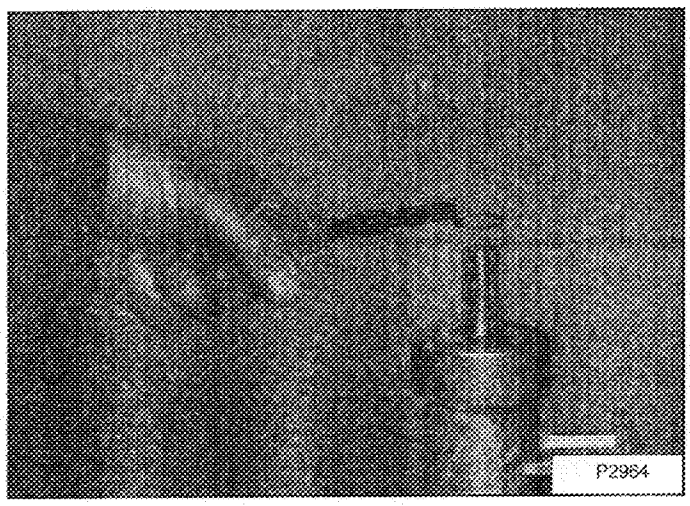
Support the lower bearing and press the other bearing in the housing until the bearings seat in the housing **[Figure 70-60-37]**.

Figure 70-60-38



Install on the bearing, the same number and size shims that were removed during disassembly **[Figure 70-60-38]**.

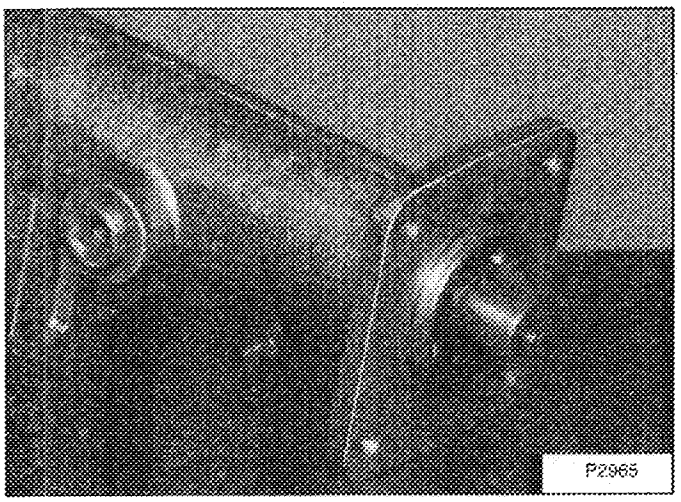
Figure 70-60-39



Install the small snap ring in the groove above the shims **[Figure 70-60-39]**.

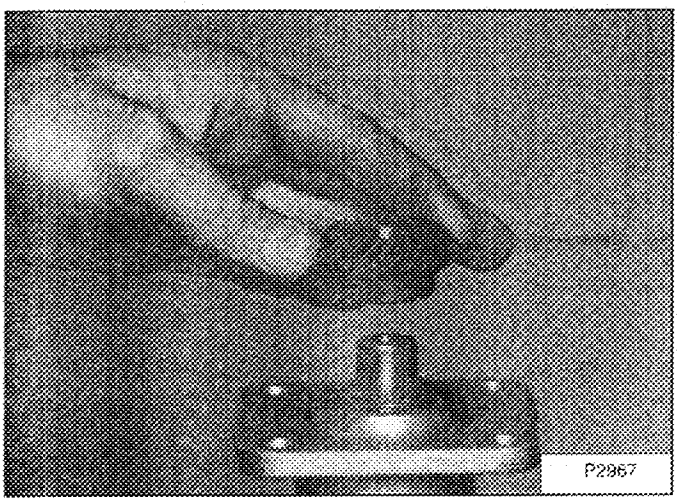
Gearbox Assembly (Cont'd)

Figure 70-60-40



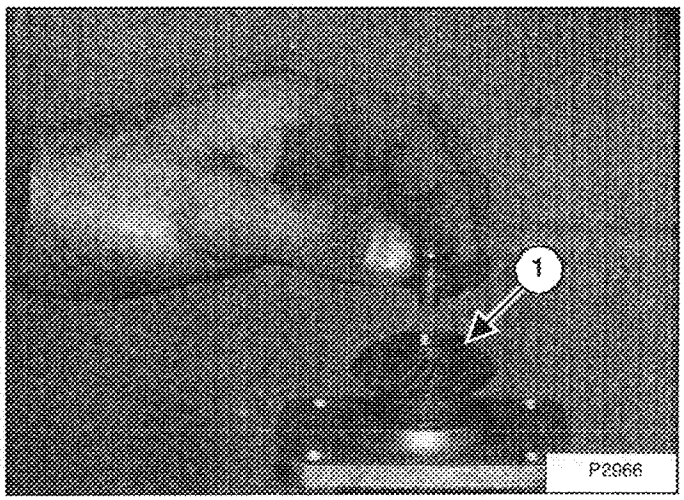
Install the gear key in the flange end of the shaft **[Figure 70-60-40]**.

Figure 70-60-41



Align the key and gear. While supporting the bearing on the other end, press the gear on the shaft until it seats against the bearing **[Figure 70-60-41]**.

Figure 70-60-42

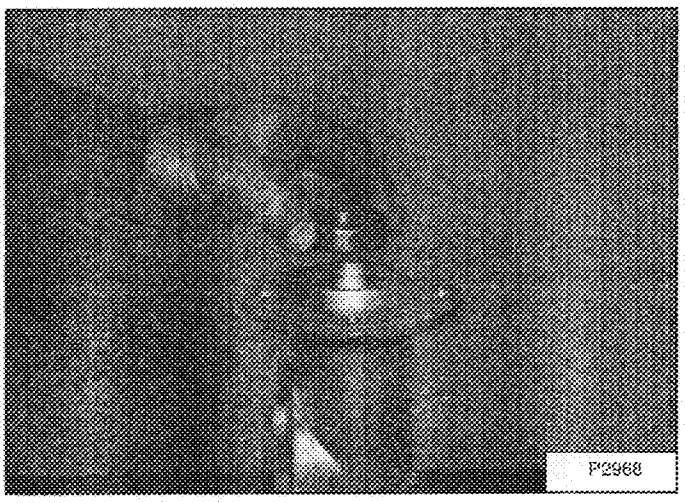


Install the washer (Item 1) **[Figure 70-60-42]**.

Put liquid adhesive (LOCTITE #242) on the screw threads. Install and tighten the screw **[Figure 70-60-42]**.

Short Housing

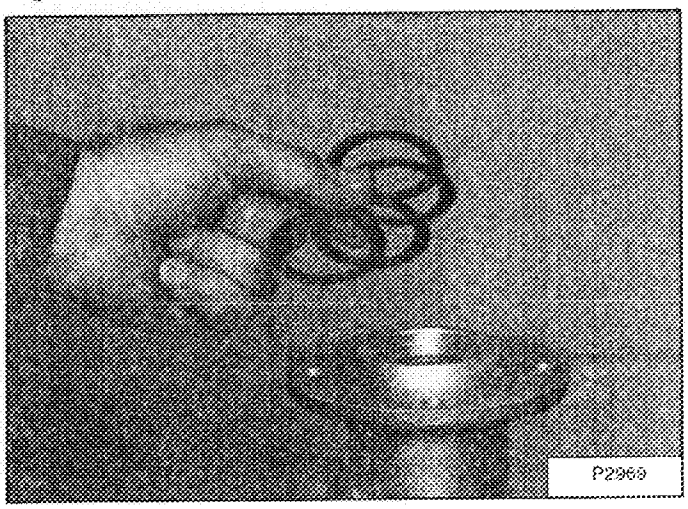
Figure 70-60-43



Install a bearing in the flanged end of the housing **[Figure 70-60-43]**.

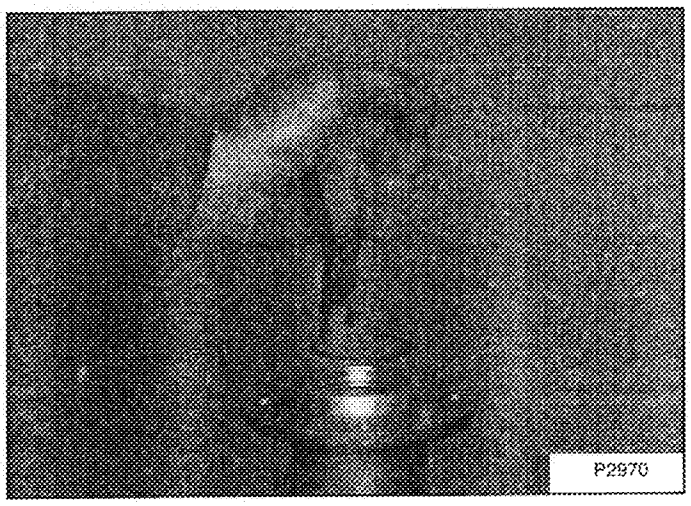
Gearbox Assembly (Cont'd)

Figure 70-60-44



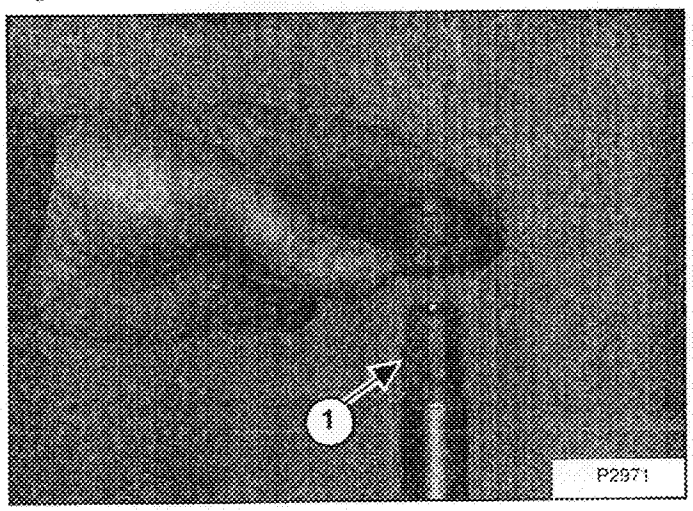
Install the large shims on the bearing (flanged end) **[Figure 70-60-44]**

Figure 70-60-45



Install the large snap ring in the groove above the shims **[Figure 70-60-45]**.

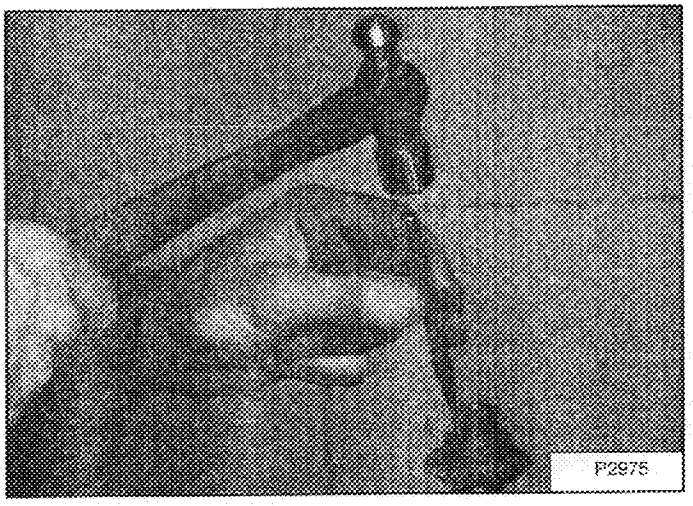
Figure 70-60-46



Install the short key (item 1) **[Figure 70-60-46]**.

Align and press the gear on the shaft (teeth toward the tapered end of the shaft) **[Figure 70-60-46]**.

Figure 70-60-47

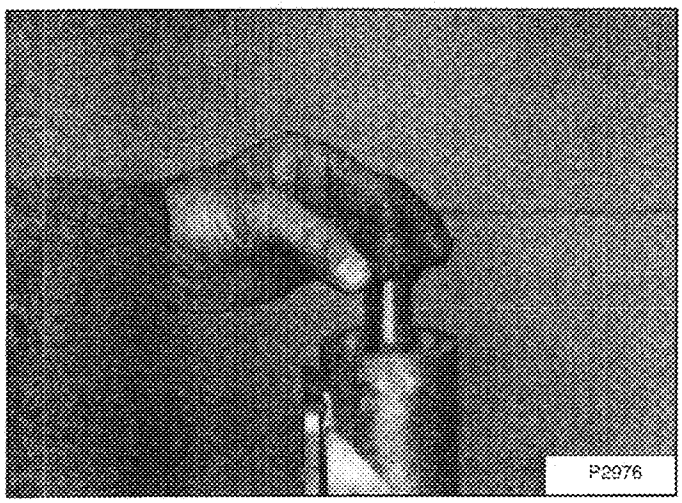


After the gear is seated, drive the key down inside the gear key way **[Figure 70-60-47]**.

NOTE: This will prevent damage to the shims when the bearing is installed later.

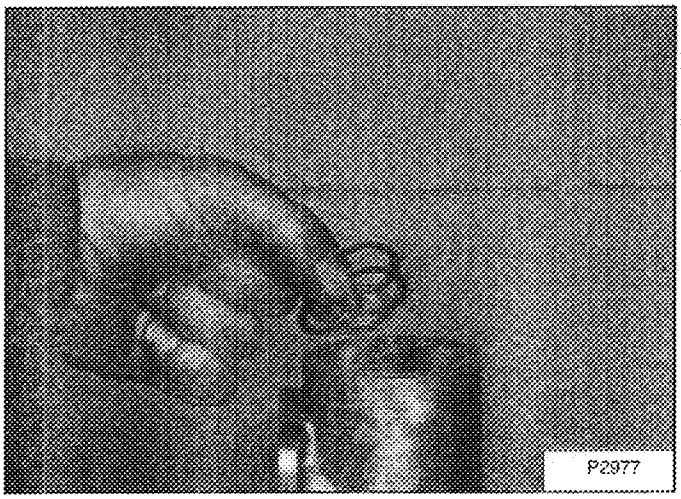
Gearbox Assembly (Cont'd)

Figure 70-60-48



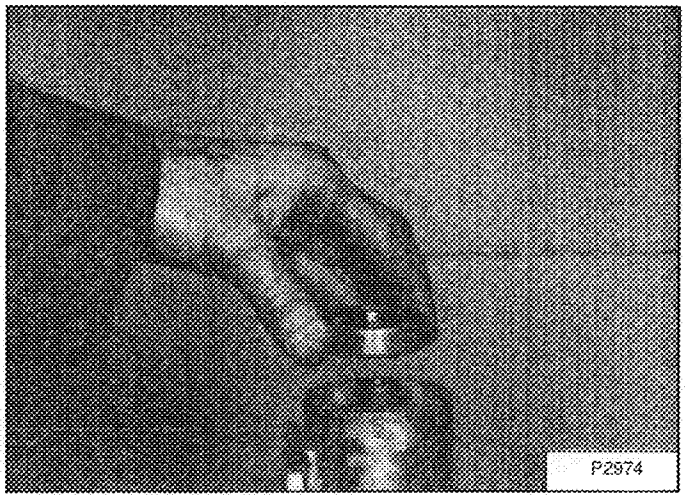
Install the shaft in the housing, tapered end in the bearing at the round flange end of the housing **[Figure 70-60-48]**.

Figure 70-60-49



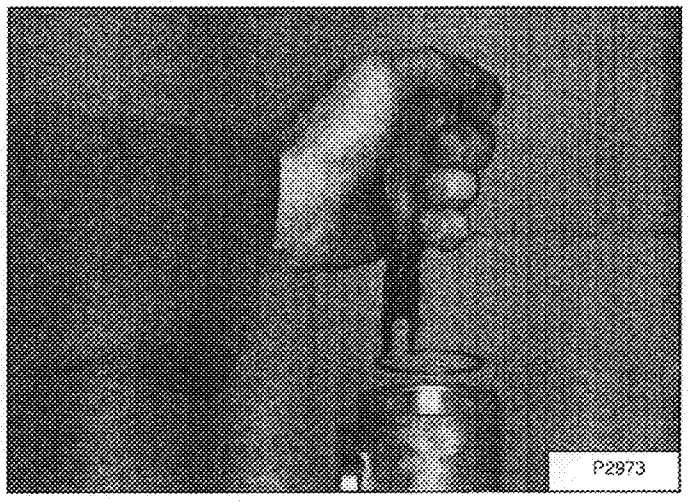
Install on the shaft, the same number and size shims that were removed during disassembly **[Figure 70-60-49]**.

Figure 70-60-50



Install a bearing on the gear end of the shaft **[Figure 70-60-50]**.

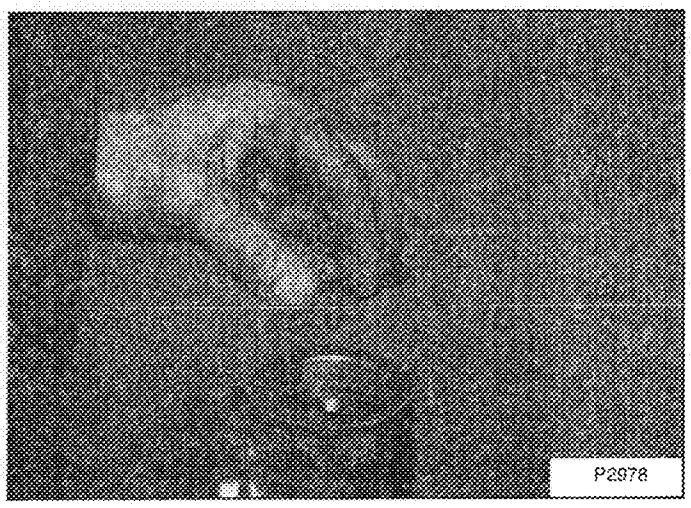
Figure 70-60-51



Install the snap ring in the groove above the bearing **[Figure 70-60-51]**.

Gearbox Assembly (Cont'd)

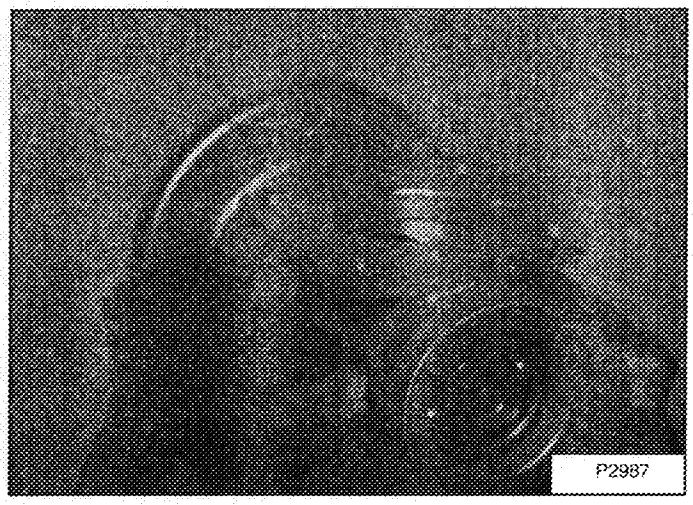
Figure 70-60-52



Install the washer (Item 1) **[Figure 70-60-52]** on the shaft. Put liquid adhesive (LOCTITE #242) on the screw threads and install the screw **[Figure 70-60-52]**.

Gearbox Checking Backlash

Figure 70-60-53



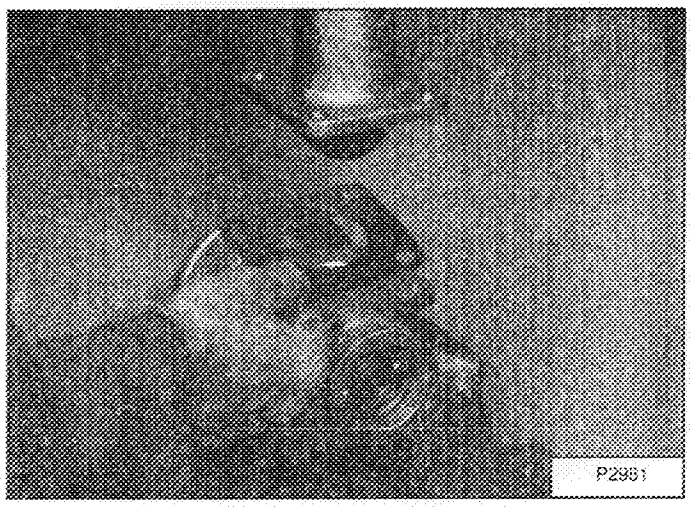
NOTE: For procedures requiring the use of LOCTITE #518 adhesive, thoroughly clean and dry affected parts before the application of LOCTITE #518.

The backlash tolerance between the gears should be 0.005-0.008 inch (0,127-0,203 mm).

To check the gear backlash use the following procedure:

Put the short housing in a vise, square flange facing up as shown **[Figure 70-60-53]**.

Figure 70-60-54

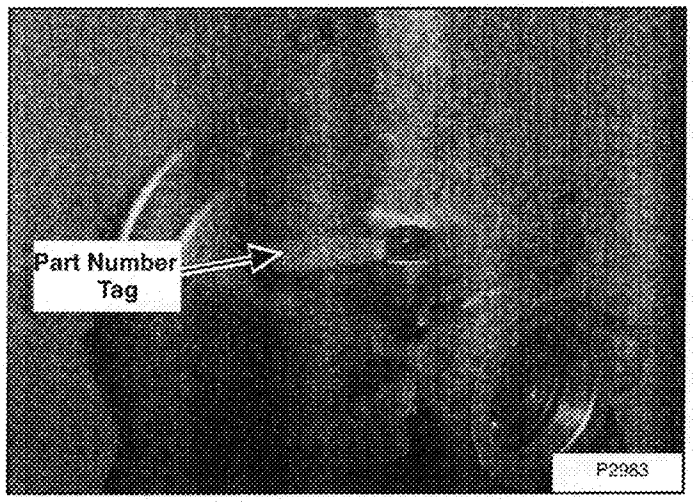


Install the same size and number of square shims (if present during disassembly) between the two housings **[Figure 70-60-54]**.

Set the long housing on the short housing with the sealant (LOCTITE 518) which is a gasket eliminator that cures to flexible seal between the mounting surfaces.

NOTE: If square shims are used, put a small amount of (LOCTITE 518) on both sides of all shims.

Figure 70-60-55



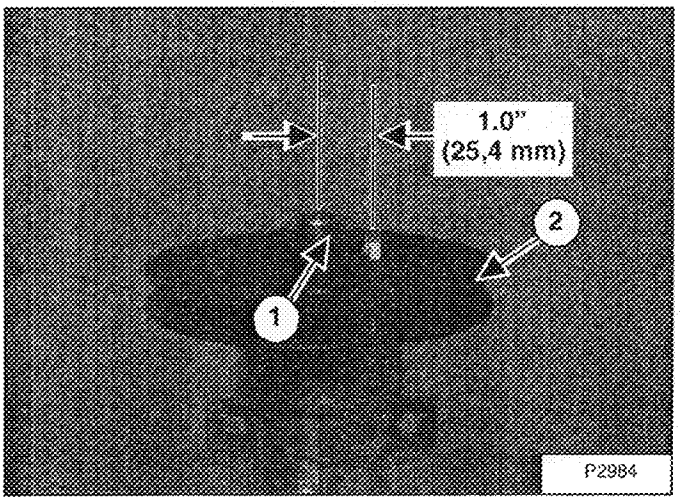
Install the four mounting bolts through the flange holes **[Figure 70-60-55]**.

Install the part number tag **[Figure 70-60-55]**.

Install and tighten the nut to 25-28 ft.-lbs. (34-38 Nm) torque.

Gearbox Checking Backlash (Cont'd)

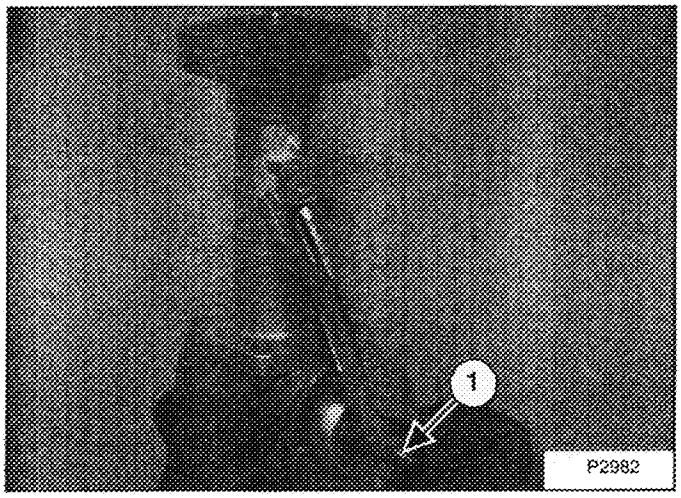
Figure 70-60-56



Install the long key (Item 1) **[Figure 70-60-56]** and the pulley (Item 2) **[Figure 70-60-56]**.

Install a bolt in the set screw hole to maintain a 1.0 inch (25,4 mm) distance from the shaft center to the bolt head (to be used with a dial indicator) **[Figure 70-60-56]**.

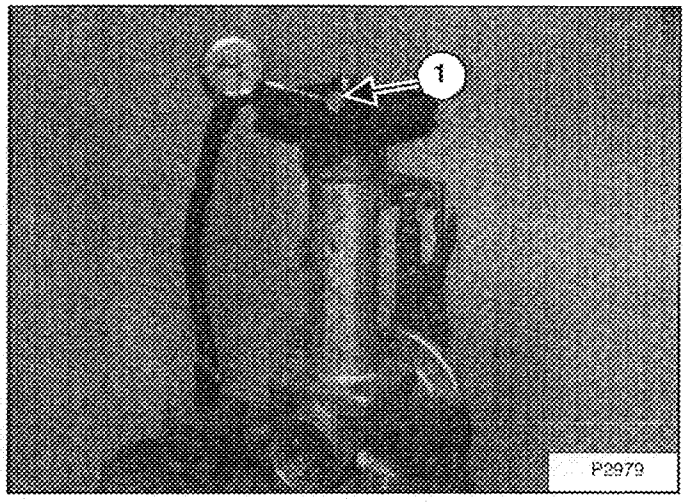
Figure 70-60-57



Put the fan nut (Item 1) **[Figure 70-60-57]** on the shaft and tighten snugly.

Install a locking pliers on the fan nut and support the handle against the long housing **[Figure 70-60-57]**.

Figure 70-60-58



Using a magnetic based dial indicator mounted on a bench vise, touch the dial stem on the bolt (Item 1) **[Figure 70-60-58]**.

Hold the locking pliers against the long housing and rotate the pulley back and forth to read the dial gauge **[Figure 70-60-58]**.

If the backlash is GREATER than 0.008 inch (0,203 mm), do the following:

1. Remove a square shim(s) (if present) between the two housing

2. Remove a large shim(s) from the tapered end of the short shaft and add a small shim (s) of the same thickness between the bearing and the gear on the screw end of the shaft.

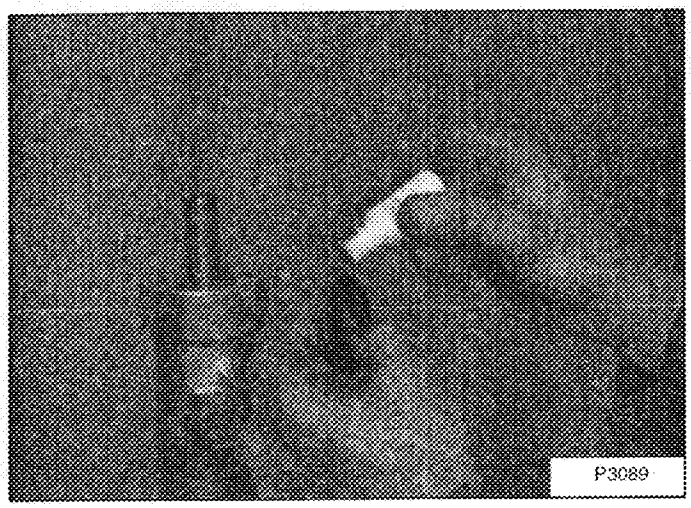
If the backlash is LESS than 0.005 inch (0,127 mm) do the following:

1. Add a square shim(s) between the two housings.

2. Remove a small shim(s) between the bearing and the gear on the screw end of the short shaft and add a large shim(s) of the same thickness between the snap ring and the bearing on the tapered end of the shaft.

Gearbox Checking Backlash (Cont'd)

Figure 70-60-59



When the backlash is correct, install the seals, cap and gear oil as follows:

Remove the bolts from the flanges and separate the two housings.

Put liquid adhesive (LOCTITE #242) on the outside diameter of the seal(s) **[Figure 70-60-59]**.

Figure 70-60-60

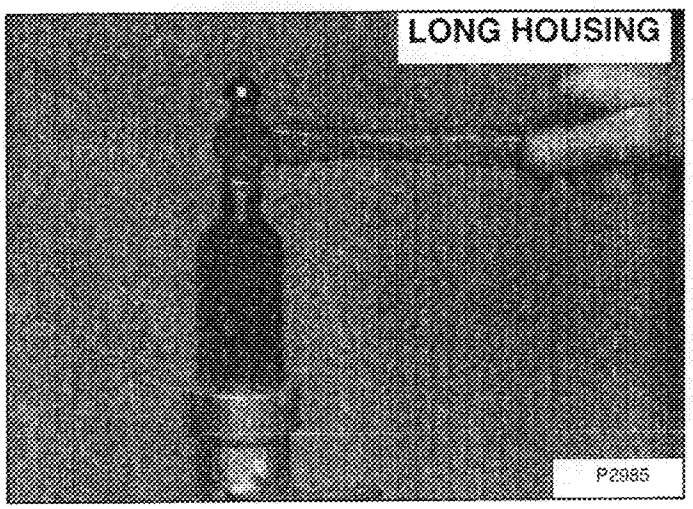
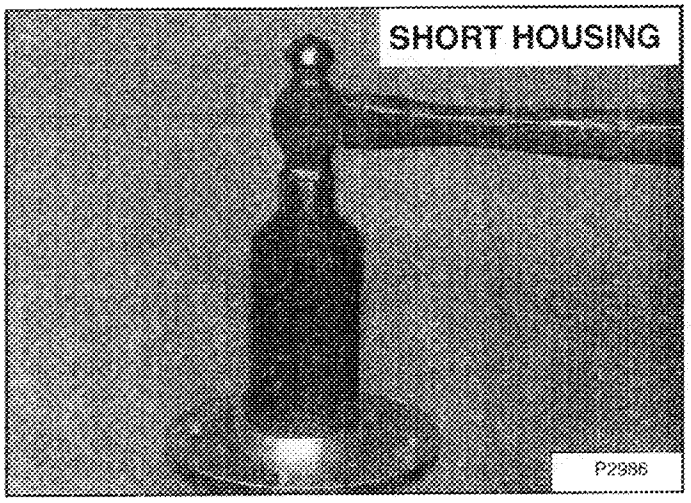


Figure 70-60-61



Install the seal(s) flush with the housing surface **[Figure 70-60-60]** & **[Figure 70-60-61]**.

Clean any oil from the flange surface.

Install the long housing on the short housing flange.

Install the four bolts and part number tag.

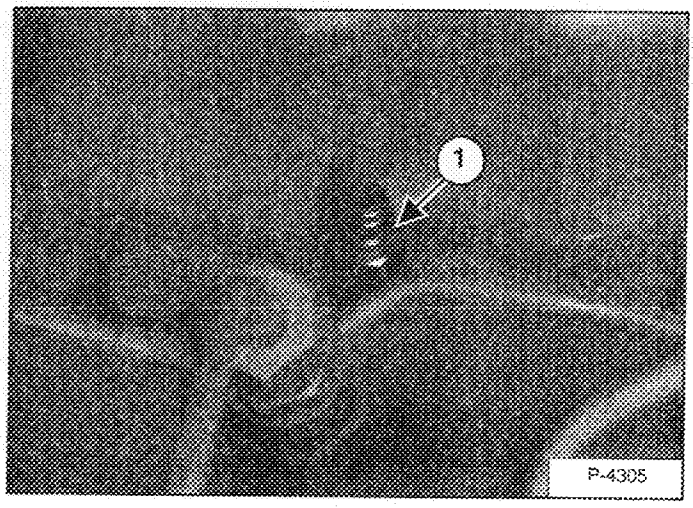
Install and tighten the nuts to 25-28 ft.-lbs. (34-38 Nm) torque.

NOTE: When filling the fan gearbox with oil, be sure the level does not go above the top of the shaft in the gearbox. Use a light colored 90W gear lube.

Bobcat®

Compression Checking

Figure 70-70-1



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

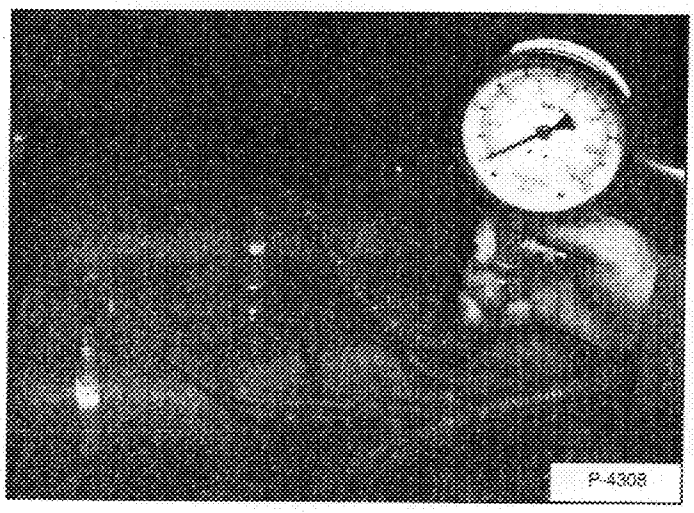
MEL10630 - Engine Compression Kit
MEL1352 - Compression Adapter

The engine must be at operating temperature.

Remove the glow plugs. (See Glow Plugs Removal And Installation on page 70-70-3.)

Install the correct compression adapter (Item 1) **[Figure 70-70-1]** into the cylinder head.

Figure 70-70-2



Connect the compression gauge to the adapter **[Figure 70-70-2]**.

Make sure the engine speed control is fully back (low idle).

Disconnect the fuel stop solenoid.

Crank the engine with the starter at cranking speed.

If the measurement is below the allowable limit, check the cylinder, piston ring, top clearance, valve and cylinder head.

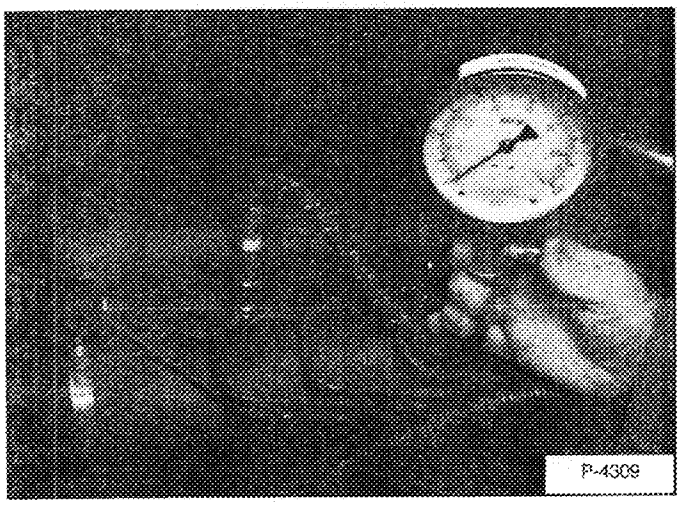
Compression Pressure should be 412-469 PSI (2840-3233 kPa)

Allowable Limit (minimum) is 370 PSI (2255 kPa)

No more than 10% variance among cylinders.

Compression Checking (Cont'd)

Figure 70-70-3

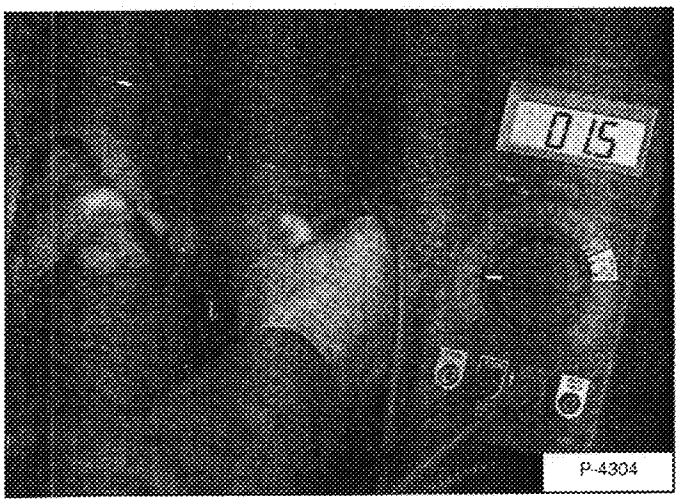


Push the bution on the compression gauge to release pressure **[Figure 70-70-3]**.

Connect the fuel stop solenoid.

Glow Plugs Checking

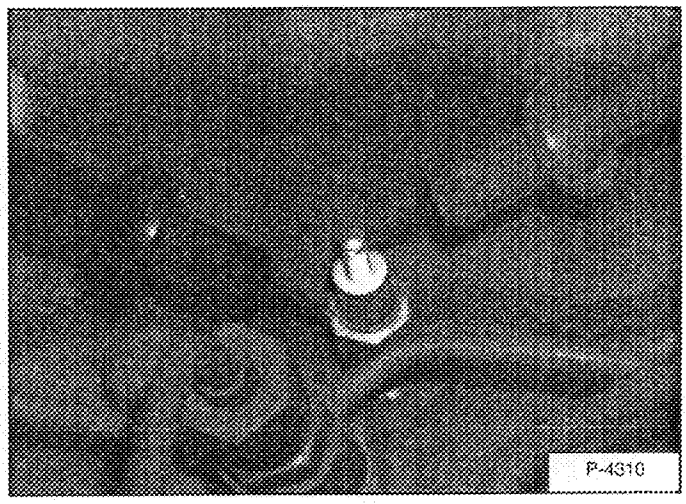
Figure 70-70-4



Disconnect the glow plug cables and leads.

Use an ohmmeter to check the glow plugs **[Figure 70-70-4]**.

Figure 70-70-5



Touch one probe to the end of the glow plug and the other probe to the body of glow plug **[Figure 70-70-5]**.

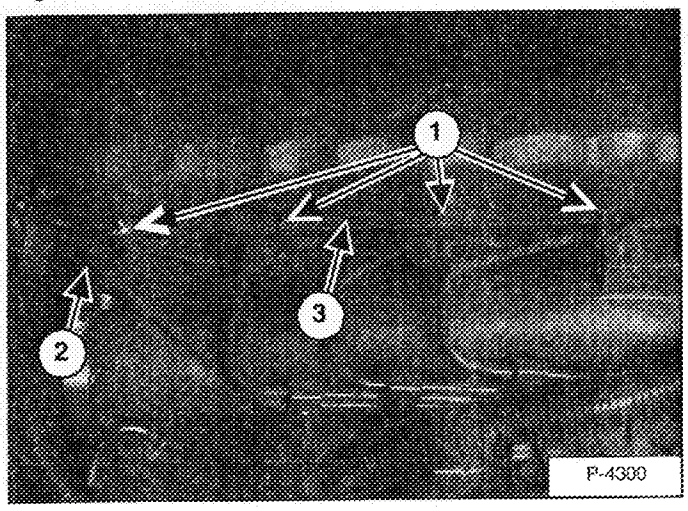
The reading must be between 1 and 2 ohms **[Figure 70-70-4]**. If the resistance is infinite, the coil of the glow plug is broken.

Repeat the procedure for each glow plug.

Reconnect the glow plug cables and leads.

Glow Plugs Removal And Installation

Figure 70-70-6



Disconnect the negative (-) cable from the battery.

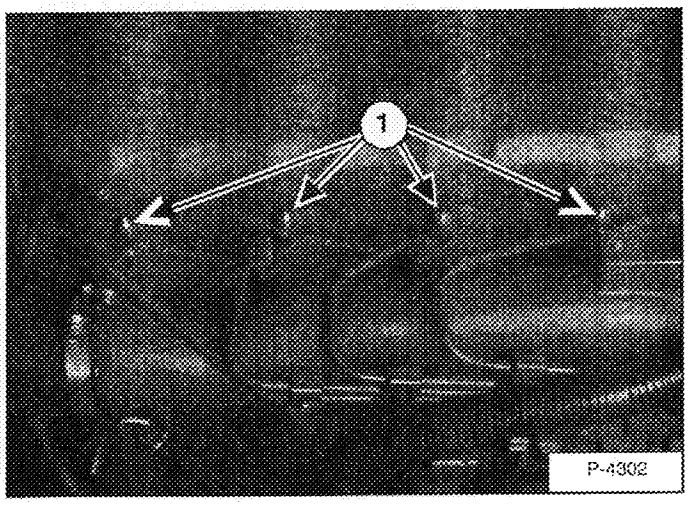
Clean the area around the glow plugs.

Remove the nut (Item 1) **[Figure 70-70-6]** from the top of each glow plug.

Disconnect the engine harness wire (Item 2) **[Figure 70-70-6]** from the glow plug.

Remove the glow plug connecting strap (Item 3) **[Figure 70-70-6]**.

Figure 70-70-7



Loosen and remove the glow plug (Item 1) **[Figure 70-70-7]**.

Installation: Tighten the glow plug to 14.5-18.1 ft.-lbs. (19,6-24,5 Nm) torque.

Figure 70-70-8

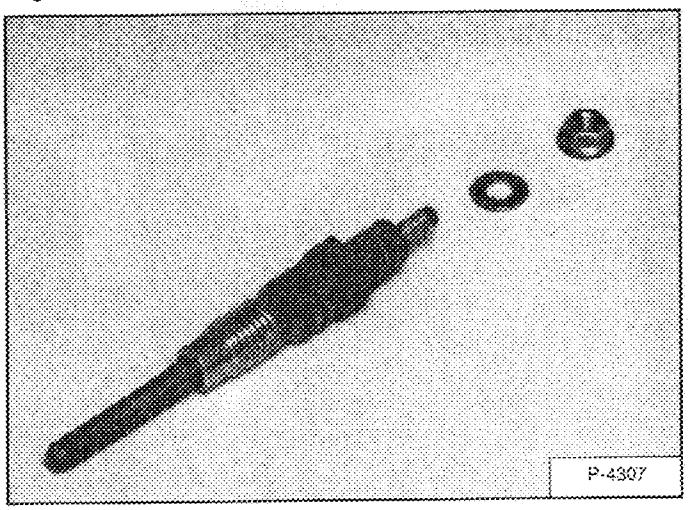
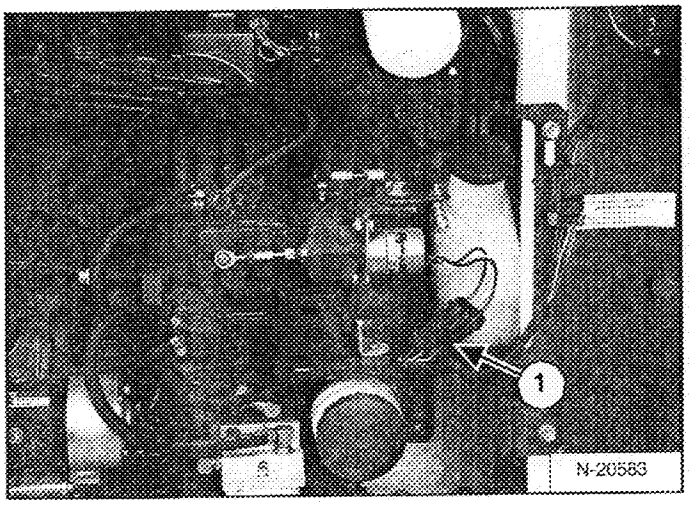


Photo **[Figure 70-70-8]** shows the glow plug assembly removed from the engine. Inspect the glow plugs and replace when necessary.

Fuel Shut-Off Solenoid Checking

Figure 70-70-9



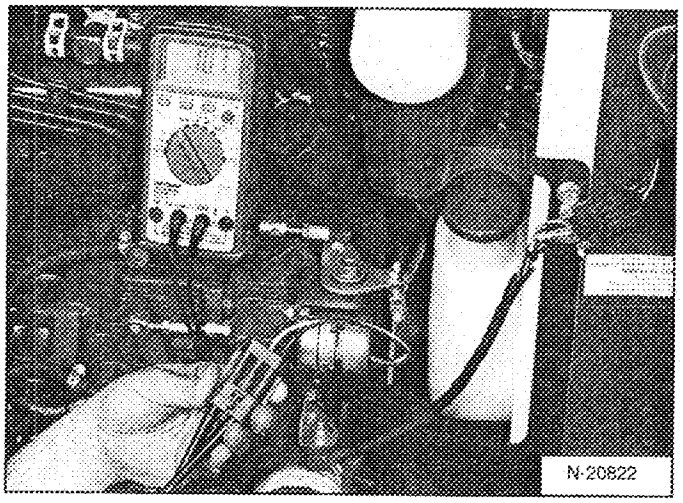
Stop the engine and open the rear door **[Figure 70-70-9]**.

Disconnect the connector (Item 1) **[Figure 70-70-9]** from the fuel shut-off solenoid.

Use an ohmmeter to check the fuel shut-off solenoid.

Fuel Shut-Off Solenoid Checking (Cont'd)

Figure 70-70-10



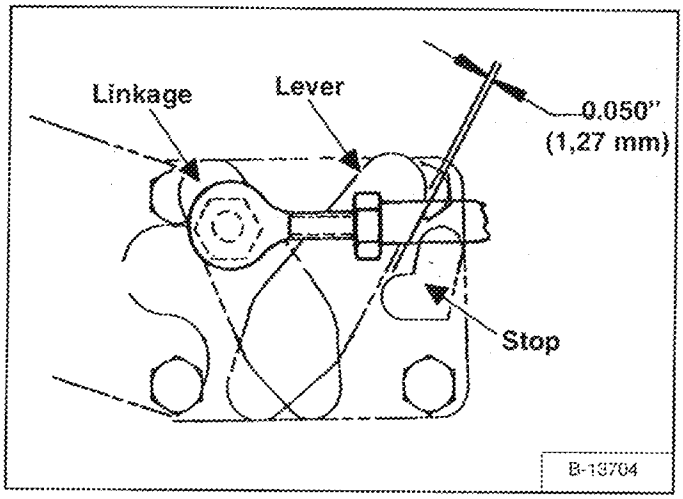
The reading between Red to Black must be between 10.5 and 11 ohms **[Figure 70-70-10]**.

The reading between White to Black must be between.4-.5 ohms.

Reconnect connector (Item 1) **[Figure 70-70-9]**.

Fuel Shut-Off Solenoid Adjusting

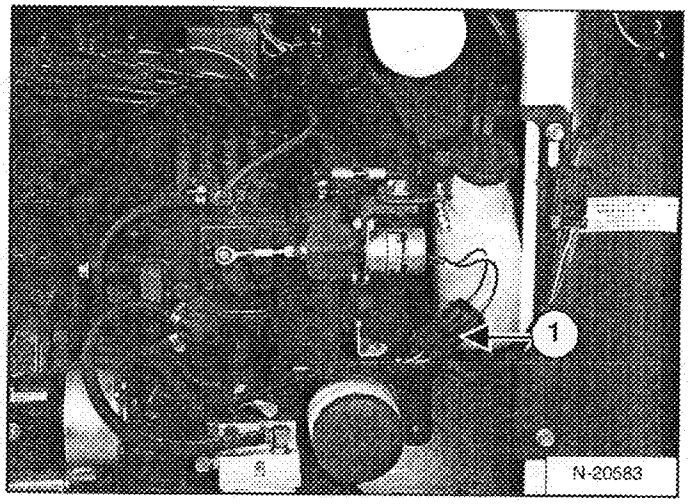
Figure 70-70-11



Adjust shut-off linkage for maximum distance of 0.050 inch (1,27 mm) between the lever and stop when solenoid plunger is seated **[Figure 70-70-11]**.

Fuel Shut-Off Solenoid Removal And Installation

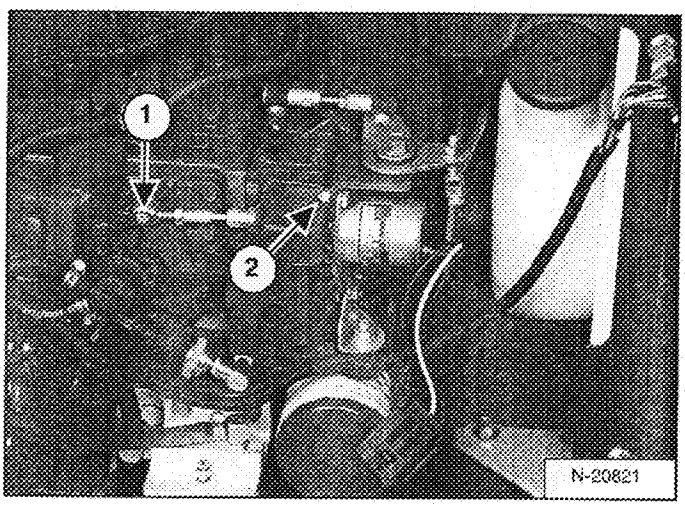
Figure 70-70-12



Stop the engine and open the rear door.

Disconnect the connector (Item 1) **[Figure 70-70-12]**.

Figure 70-70-13



Remove the linkage mounting nut (Item 1) **[Figure 70-70-13]** from the fuel injector pump.

Removing the mounting bolts (Item 2) **[Figure 70-70-13]** of the fuel shut-off solenoid.

Reverse the above procedure to install the fuel shut-off solenoid.

Checking

The injection pump contains parts which have a very close tolerance and its operation has a direct effect on the performance of the engine.

⚠ WARNING

Diesel fuel or hydraulic fluid under pressure can penetrate skin or eyes, causing serious injury or death. Fluid leaks under pressure may not be visible. Use a piece of cardboard or wood to find leaks. Do not use your bare hand. Wear safety goggles. If fluid enters skin or eyes, get immediate medical attention from a physician familiar with this injury.

W-2072-0496

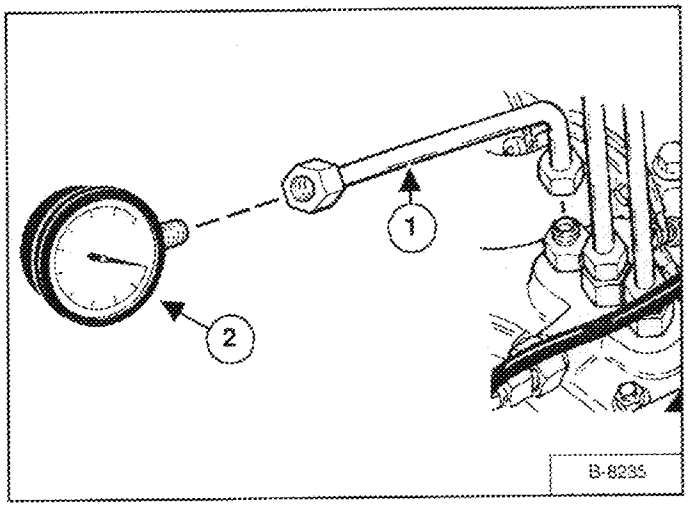
The tools listed will be needed to do the following procedure:

MEL1237 - Adapter Fuel Line
MEL1173A - Pressure Gauge

To check the discharge pressure at the fuel injection pump, use the following procedure:

Disconnect a high pressure fuel line from the injection pump. Loosen the other end of the same fuel line so it can be turned away from the fitting.

Figure 70-70-14



Connect the adapter fuel line (Item 1) **[Figure 70-70-14]** to the fitting and connect the pressure gauge (Item 2) **[Figure 70-70-14]**.

Turn the flywheel to increase the pressure. If the pressure can not reach the allowable limit, replace the injection pump assembly.

Fuel Tightness of Pump Element	
Allowable Limit	2133 PSI (14707 kPa)

Measure the time needed to decrease the pressure from 2133-1990 PSI (14707 -13721 kPa). If the measurement is less than the allowable limit, replace the delivery valve.

Fuel Tightness of Delivery Valve	
Allowable Limit	5 Seconds

Fuel Injection Pump Removal And Installation

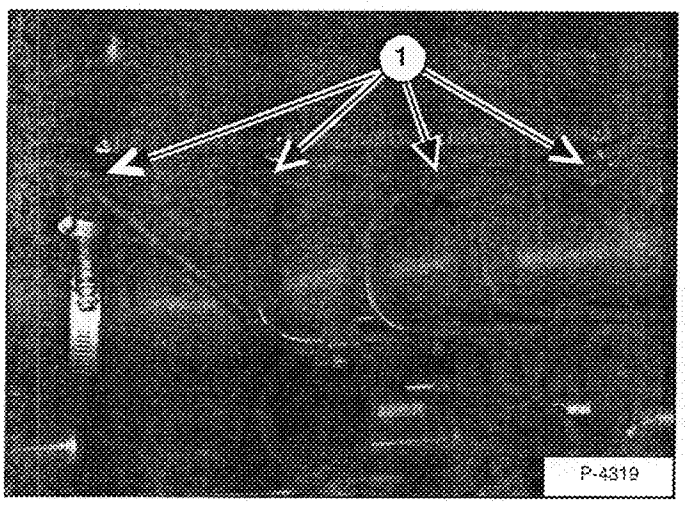
Clean the area around the injection pump thoroughly.

IMPORTANT

Do not bend the high pressure fuel injection tubes when removing or installing them.

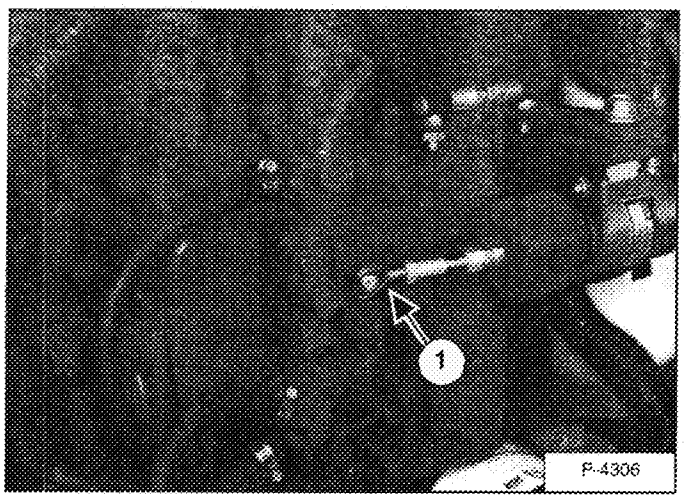
I-2029-0289

Figure 70-70-15



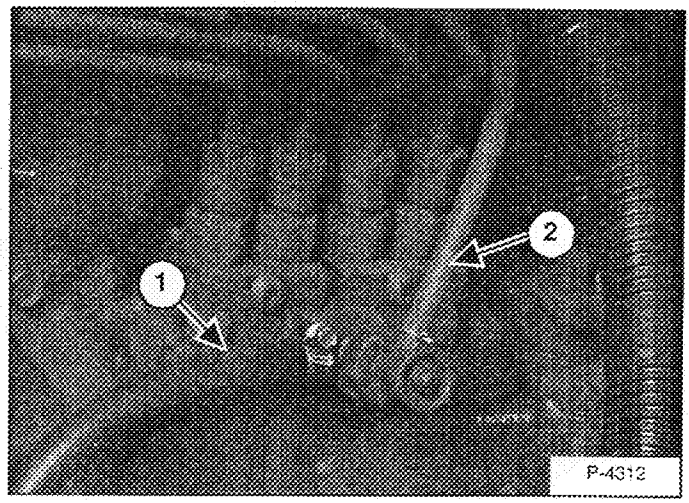
Disconnect the high pressure fuel lines (Item 1) **[Figure 70-70-15]** from the fuel injectors.

Figure 70-70-16



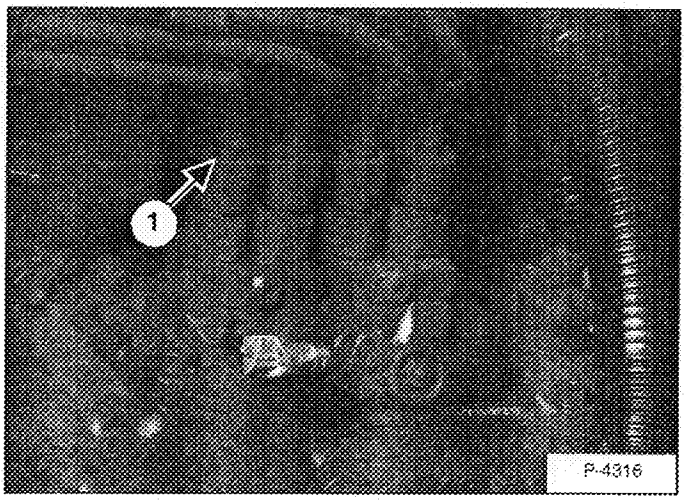
Disconnect the fuel shut-off linkage (Item 1) **[Figure 70-70-16]**.

Figure 70-70-17



Disconnect the fuel inlet hose (Item 1) **[Figure 70-70-17]** and the fuel return hose (Item 2) **[Figure 70-70-17]** from the injection pump vent.

Figure 70-70-18

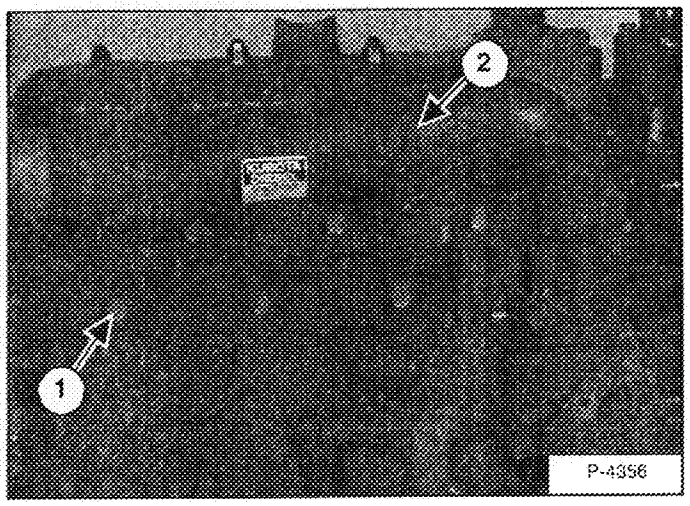


Cap the inlets on the injection pump vent where the hoses were removed **[Figure 70-70-18]**.

Remove the high pressure fuel lines (Item 1) **[Figure 70-70-18]** from the injection pump.

Fuel Injection Pump Removal And Installation (Cont'd)

Figure 70-70-19



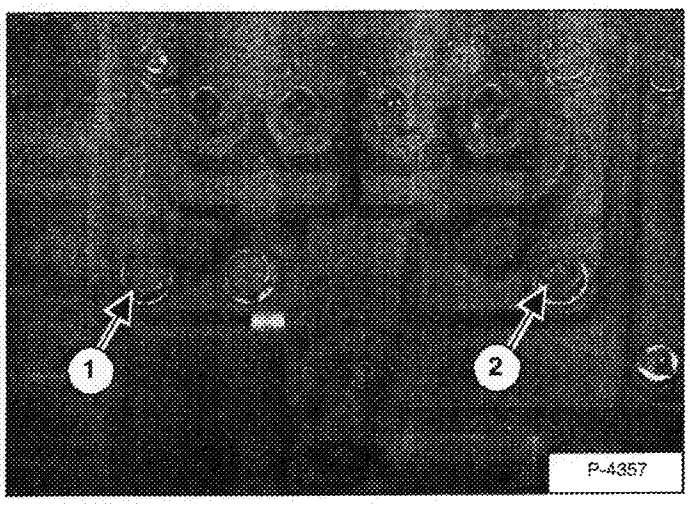
Remove the seven mounting bolts (Item 1) **[Figure 70-70-19]** from the intake manifold (Item 2) **[Figure 70-70-19]**.

Installation: Tighten the mounting bolts to 16-20 ft.-lbs. (22-27 Nm) torque.

Remove the intake manifold from the engine.

Installation: Replace the manifold gasket if it is worn or damaged.

Figure 70-70-20



Remove the four mounting bolts (Item 1) **[Figure 70-70-20]** and two nuts (Item 2) **[Figure 70-70-20]** from the injection pump.

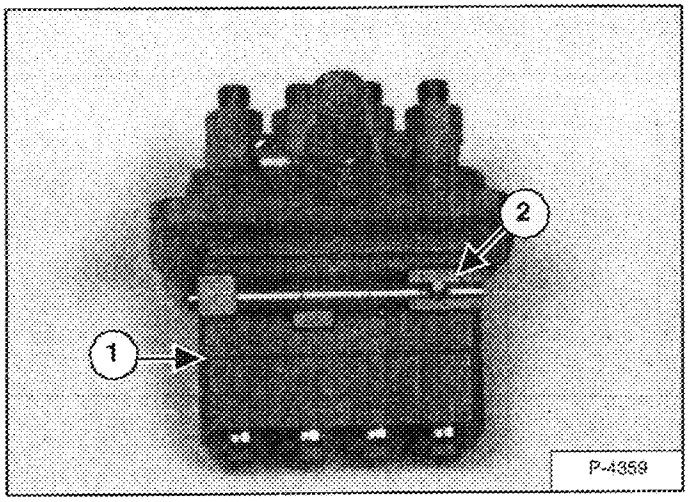
Installation: Tighten the mounting bolts to 16-20 ft.-lbs. (22-27 Nm) torque.

IMPORTANT

Do not attempt to maintain or adjust unless you are trained and have the correct equipment.

I-2028-0289

Figure 70-70-21



Remove the injection pump (Item 1) **[Figure 70-70-21]** and shim(s) from the engine.

NOTE: The pin (Item 2) [Figure 70-70-21] located on the control rack, needs to be installed correctly during installation. See the following procedure for correct installation.

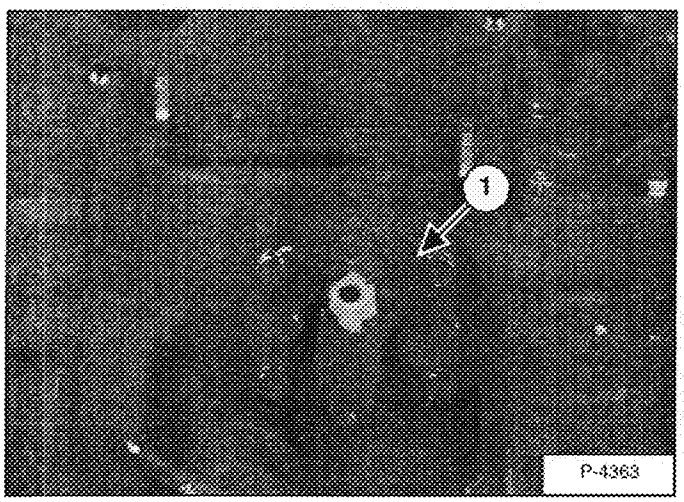
Fuel Injection Pump Removal And Installation (Cont'd)

IMPORTANT

Do not attempt to maintain or adjust unless you are trained and have the correct equipment.

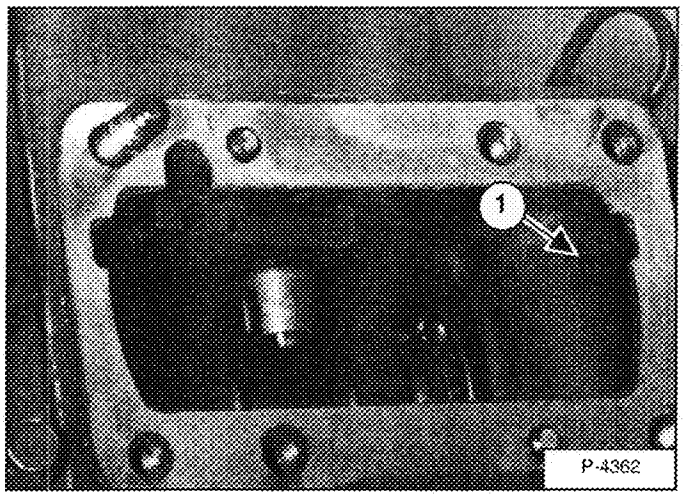
I-2028-0289

Figure 70-70-22



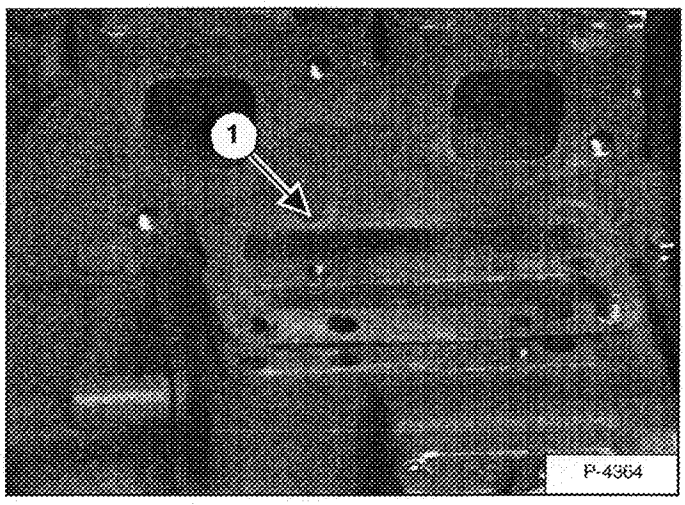
Installation: Remove the side cover (Item 1) **[Figure 70-70-22]** from the injection pump chamber.

Figure 70-70-23



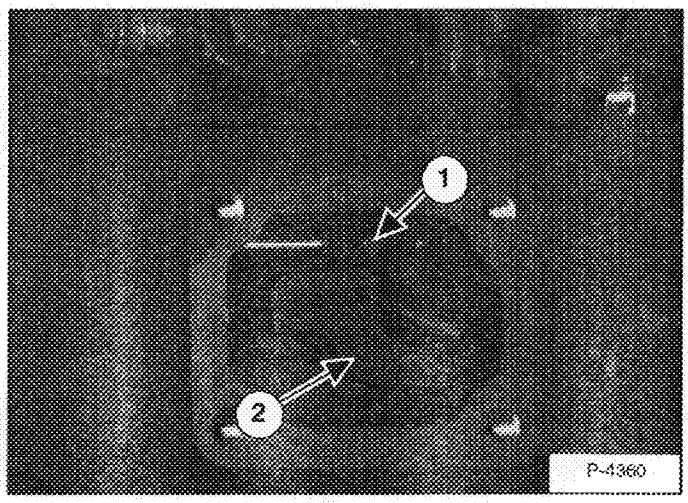
Be sure the spring (Item 1) **[Figure 70-70-23]** is located in the injection pump chamber as shown.

Figure 70-70-24



Install the shim(s) (Item 1) **[Figure 70-70-24]** on the injection pump mounting surface. (See Timing The Injection Pump on page 70-70-9.) for information on number of shims used.

Figure 70-70-25



Install the injection pump in the engine.

Put the pin (Item 1) **[Figure 70-70-25]** on the control rack in the slot of the fork lever (Item 2) **[Figure 70-70-25]** located inside the injection pump chamber.

IMPORTANT

If the pin is not correctly installed in the fork lever, the engine will run over maximum speed, resulting in serious damage to the engine.

I-2086-1195

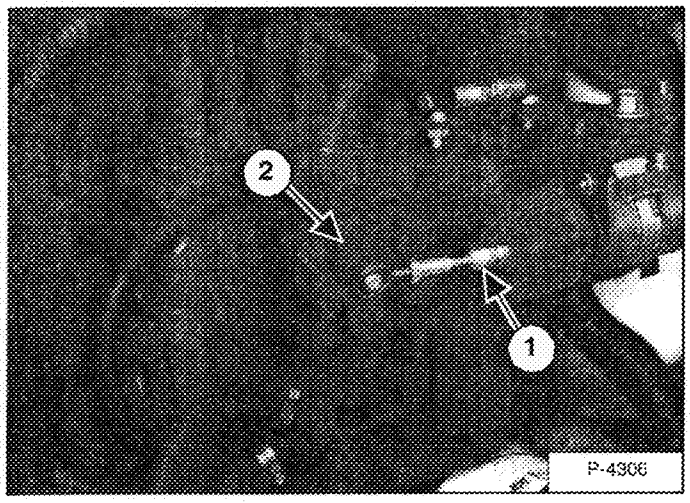
Timing The Injection Pump

IMPORTANT

Do not attempt to maintain or adjust unless you are trained and have the correct equipment.

I-2028-0289

Figure 70-70-26



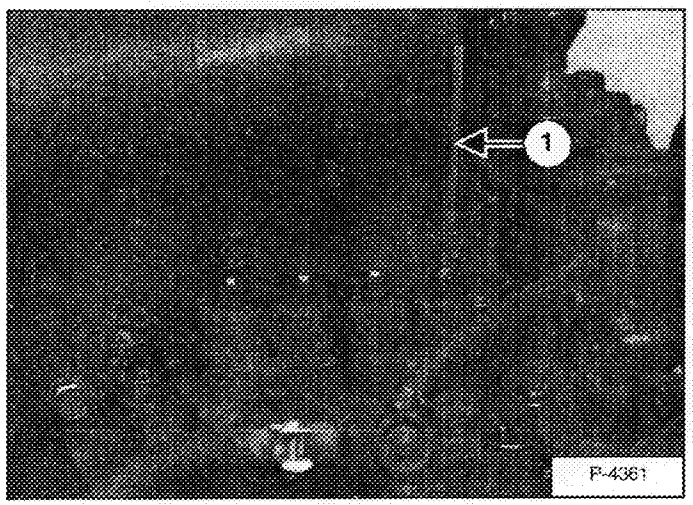
Timing the injection pump is done by changing the number of shims between the injection pump and the injection pump mounting surface.

Disconnect the number one cylinder high pressure line from the injection pump.

Disconnect the fuel shut-off linkage (Item 1) **[Figure 70-70-26]** from the injection pump.

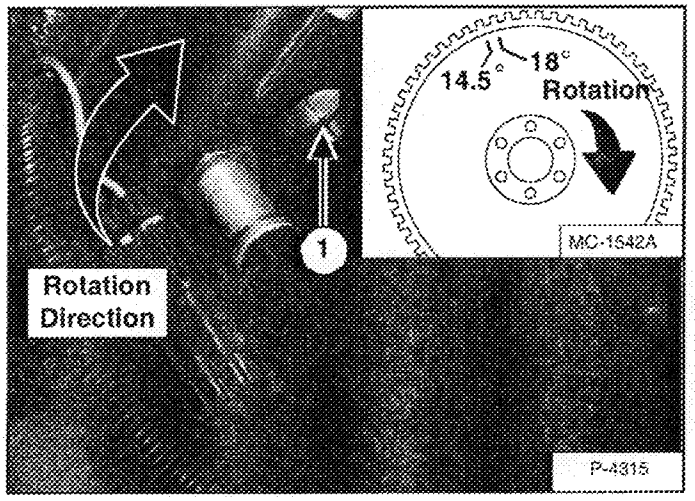
Turn the fuel supply lever (Item 2) **[Figure 70-70-26]** to the ON position (to the right).

Figure 70-70-27



Install a short plastic tube (Item 1) **[Figure 70-70-27]** in the number one cylinder port of the injection pump. The tube should fit securely in the port and point upward.

Figure 70-70-28



Rotate the engine in the direction shown **[Figure 70-70-28]**.

Continue rotation until flywheel timing mark just appears in the window (Item 1) **[Figure 70-70-28]**.

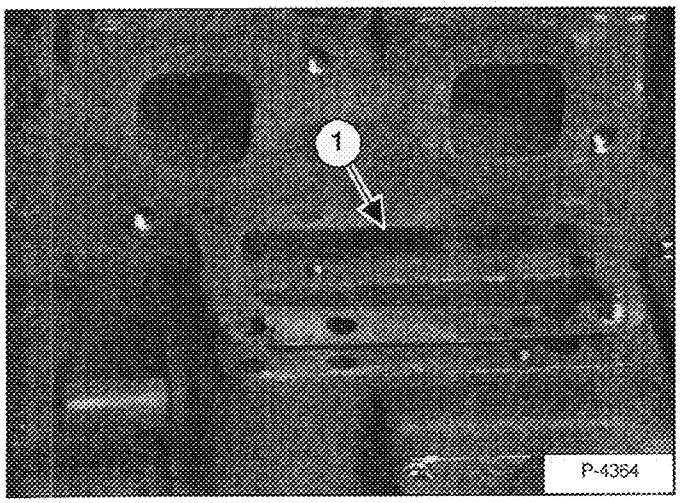
NOTE: The flywheel has two timing marks. The first mark to appear in the window with the rotation shown is 18°. The first mark is used for 753, 763, 773 (Non Turbo) loaders.

Rotate slowly until fuel just starts to flow upward into the plastic tube.

At this instant, the 18° BTDC timing mark on the flywheel should be aligned with the mark in the window (Item 1) **[Figure 70-70-28]**.

Timing The Injection Pump (Cont'd)

Figure 70-70-29



Add or subtract shim(s) (Item 1) **[Figure 70-70-29]** as needed to adjust the fuel delivery timing.

NOTE: Adding or removing one shim will vary the timing by 1.5°. Adding shims retards timing.

Fuel Injector Removal And Installation

⚠ WARNING

Diesel fuel or hydraulic fluid under pressure can penetrate skin or eyes, causing serious injury or death. Fluid leaks under pressure may not be visible. Use a piece of cardboard or wood to find leaks. Do not use your bare hand. Wear safety goggles. If fluid enters skin or eyes, get immediate medical attention from a physician familiar with this injury.

W-2072-0496

The following are some problems caused by faulty injectors:

- Engine is hard to start or will not start
- Rough engine operation and idle
- Engine will not have full power
- Excessive exhaust smoke

IMPORTANT

Do not attempt to maintain or adjust unless you are trained and have the correct equipment.

I-2029-0289

Fuel Injector Removal And Installation (Cont'd)

Figure 70-70-30

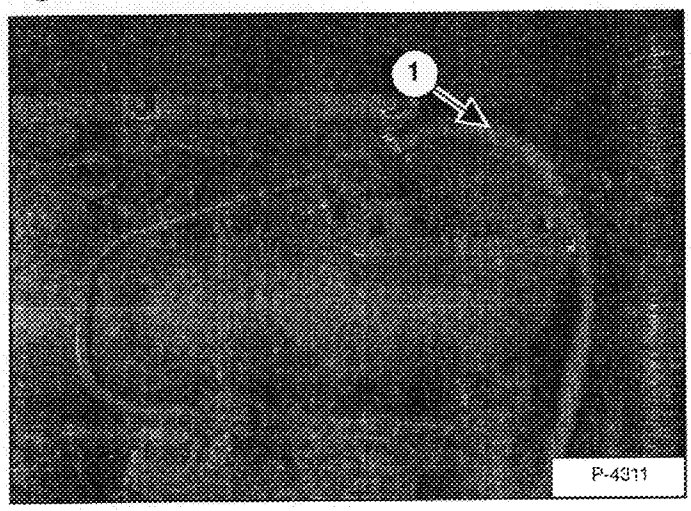
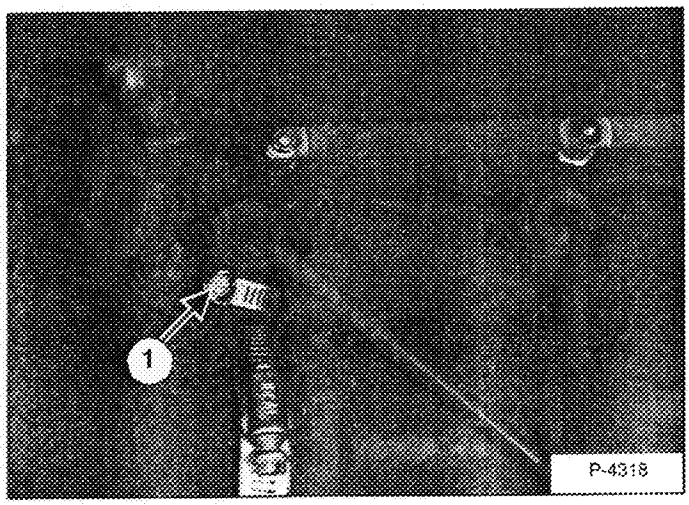


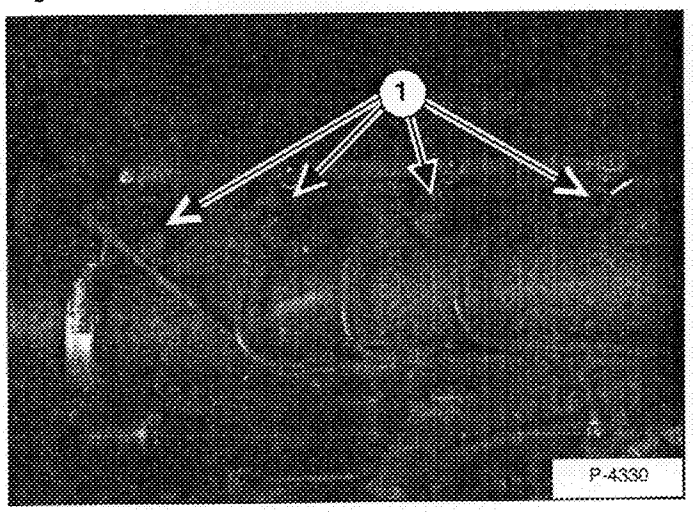
Figure 70-70-31



Clean area around fuel injectors.

Disconnect the fuel return hoses (Item 1) **[Figure 70-70-30]** & **[Figure 70-70-31]** from the injectors.

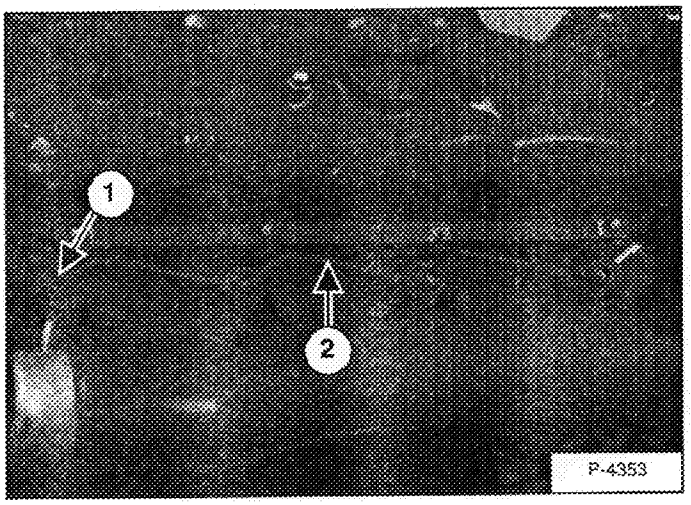
Figure 70-70-32



Disconnect the high pressure fuel lines (Item 1) **[Figure 70-70-32]** from the fuel injectors and from the injection pump.

Remove the high pressure fuel lines from the engine.

Figure 70-70-33

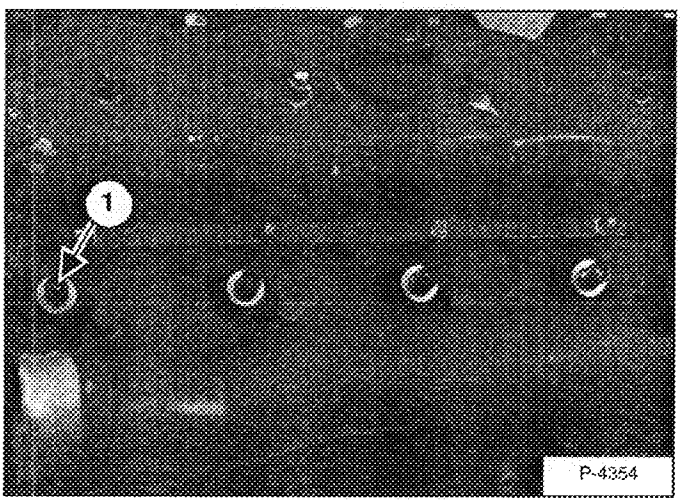


Remove the retainer nut from the top of the fuel injectors (Item 1) **[Figure 70-70-33]**.

Remove the fuel return tube (Item 2) **[Figure 70-70-33]** from the fuel injectors.

Fuel Injector Removal And Installation (Cont'd)

Figure 70-70-34



Remove the injector nozzle (Item 1) **[Figure 70-70-34]** from the cylinder head.

Figure 70-70-35

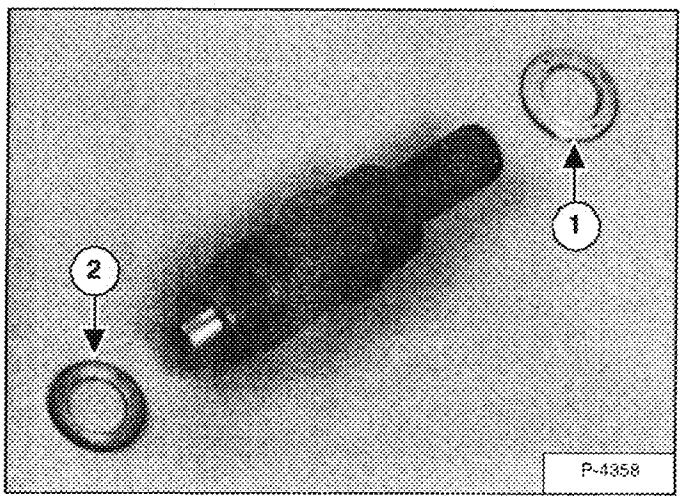


Photo **[Figure 70-70-35]** shows the injector nozzle removed from the cylinder. Inspect the injector and replace if necessary.

Installation: be sure the nozzle cap (Item 1) **[Figure 70-70-35]** and copper washer (Item 2) **[Figure 70-70-35]** are in the correct position. Install new nozzle cap and copper washer when installing new or used injectors.

Fuel Injector Checking

IMPORTANT

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

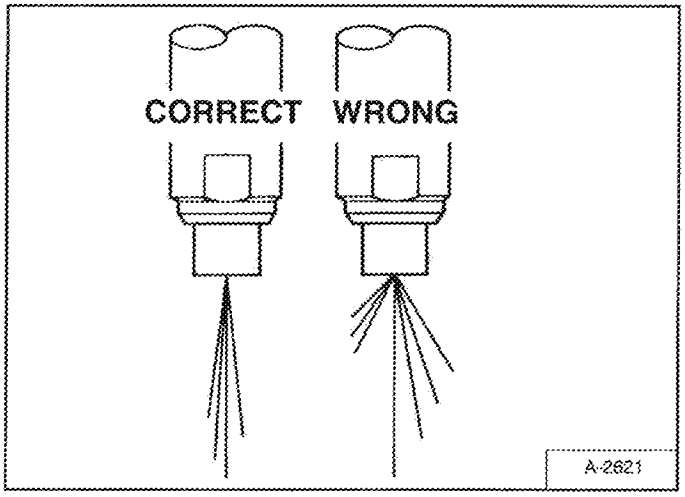
I-2027-0284

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

OEM1064 - Injector Nozzle Tester

Check for inside leakage. Operate the hand lever until the pressure is 1849 PSI (12755 kPa). Keep the nozzle under this pressure for 10 seconds, check to see if fuel leaks from the nozzle. If fuel leaks, replace the nozzle.

Figure 70-70-36

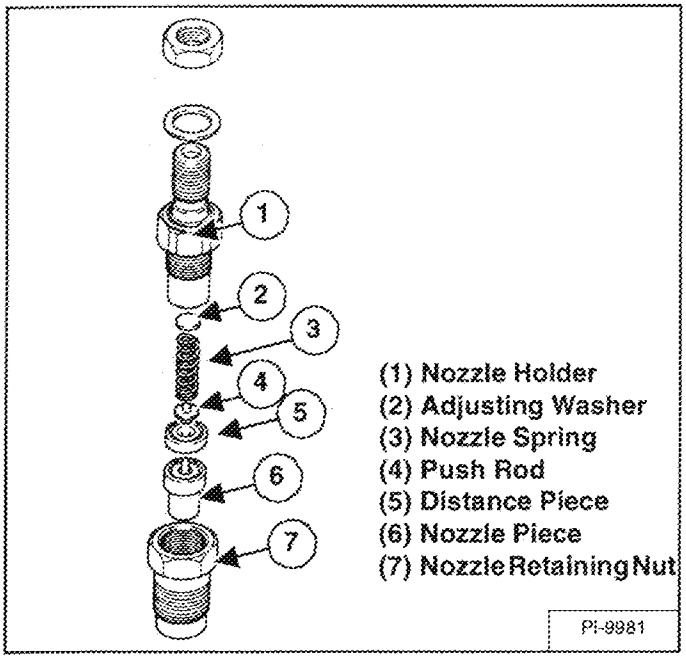


Check that the spray pattern is correct **[Figure 70-70-36]**

1. Fuel does not come out the side of the nozzle.
2. Drops of fuel are not present at the nozzle.
3. The injector has an even flow coming from the nozzle.

Fuel Injector Disassembly

Figure 70-70-37



Disassemble and clean the injector nozzle.

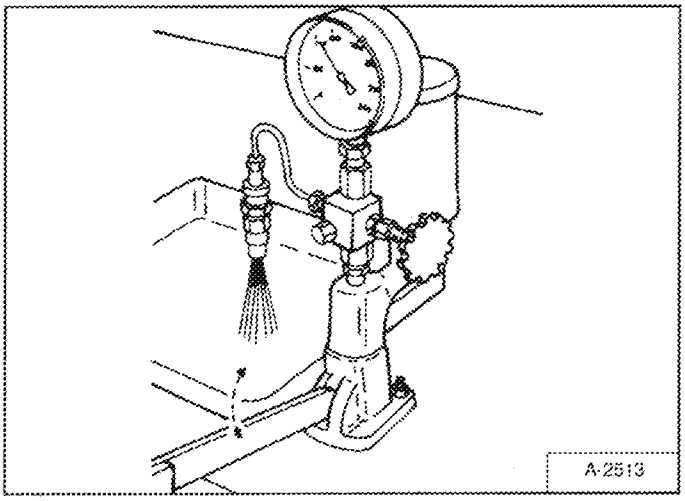
The nozzle release pressure can be adjusted by adding or removing spacer(s) (Item 2) **[Figure 70-70-37]** from the top of the nozzle spring (Item 3) **[Figure 70-70-37]**.

Each spacer will change the release pressure by about 142 PSI (980 kPa).

Fuel Injection Pressure	1991-2133 PSI
	(13728-14707 kPa)

Fuel Injector Assembly

Figure 70-70-38



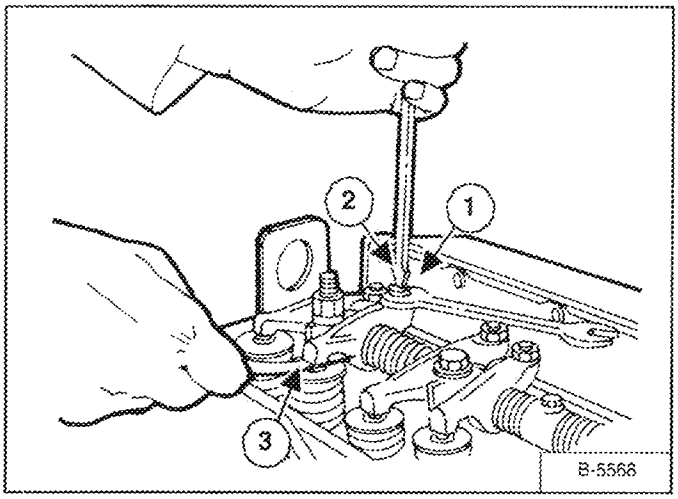
Assemble the injector nozzle. Connect the nozzle to the tester with the nozzle down **[Figure 70-70-38]**.

Operate the hand lever at a slow rate and record the opening pressure. If the pressure is not correct, disassemble the nozzle and add or remove spacers (Item 2) **[Figure 70-70-37]** as needed.

When the injector nozzle is assembled, tighten the nozzle body to 43-58 ft.-lbs. (59-79 Nm) torque.

Valve Clearance Adjustment

Figure 70-70-39



Adjust the valve clearance as follows:

Loosen the lock nut (Item 1) **[Figure 70-70-39]**.

Turn the adjustment screw (Item 2) **[Figure 70-70-39]** until the correct clearance is obtained.

NOTE: The clearance is measured between the rocker arm and valve stem tip (Item 3) [Figure 70-70-39].

Adjust the valve clearance as follows:

.0071-.0087 inch (0,18-0,22 mm) Intake & Exhaust

Figure 70-70-40

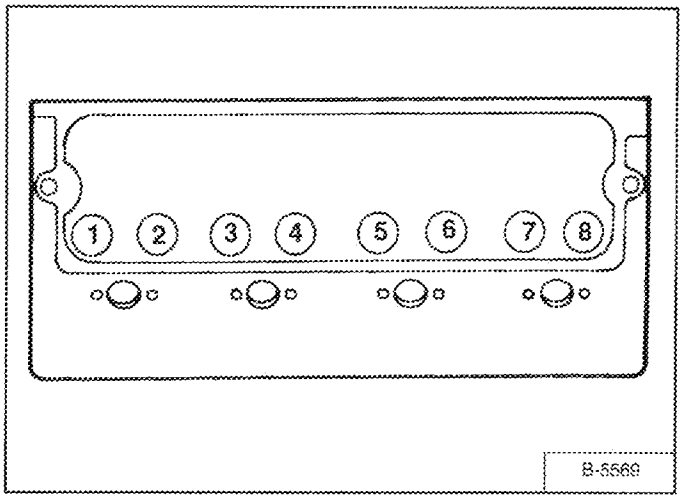


Figure 70-70-41

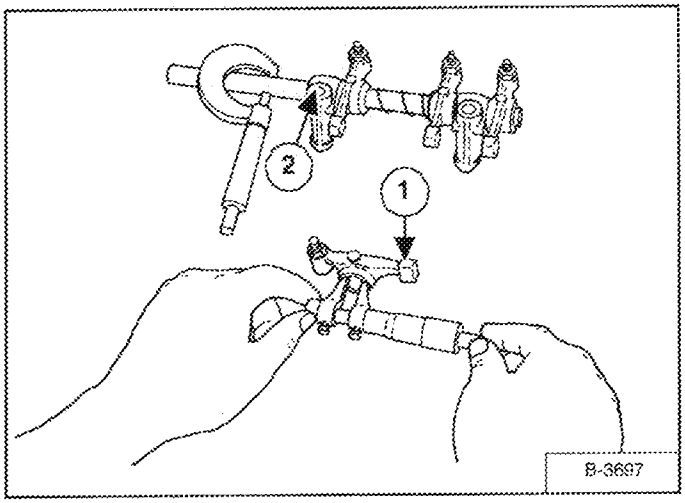
Cylinder Number	1		2		3		4	
Valve Number	1	2	3	4	5	6	7	8
Valve I = Intake E = Exhaust	I	E	I	E	I	E	I	E

Use the following sequence to set the valves **[Figure 70-70-40]** & **[Figure 70-70-41]**:

1. With the rocker arm rocking (valves 7 & 8) on No. 4 cylinder set clearance at No. 1 cylinder (valves 1 & 2).
2. With the rocker arm rocking (valves 3 & 4) on No. 2 cylinder set clearance at No. 3 cylinder (valves 5 & 6).
3. With the rocker arm rocking (valves 1 & 2) on No. 1 cylinder set clearance at No. 4 cylinder (valves 7 & 8).
4. With the rocker arm rocking (valves 5 & 6) on No. 3 cylinder set clearance at No. 2 cylinder (valves 3 & 4).

Rocker Arm And Shaft Checking

Figure 70-70-42



Measure the rocker arm I.D. (Item 1) **[Figure 70-70-42]** with the inside micrometer.

Measure the rocker arm shaft O.D. (Item 2) **[Figure 70-70-42]** with a outside micrometer.

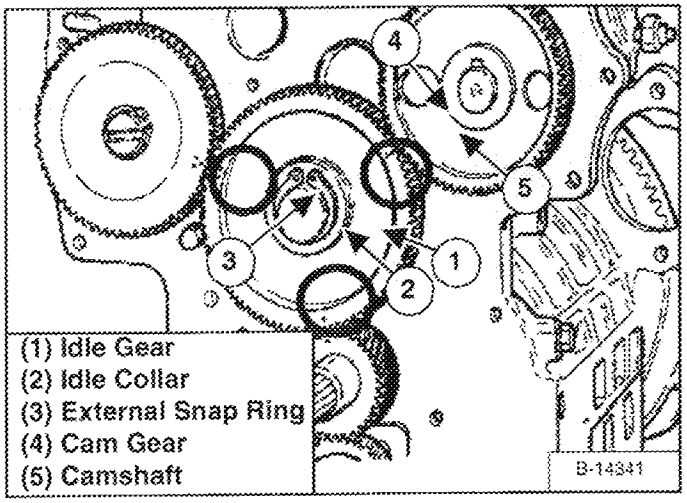
If the clearance exceeds the allowable limit, replace the bushing.

If the clearance still exceeds the allowable limit after the bushing is replaced, replace the rocker arm shaft.

Oil Clearance Between Rocker Arm	
& Shaft	0.006-0.0015 inch (0,016-0,038 mm)
Allowable Limit	0.006 inch (0,15 mm)
Rocker Arm Shaft O.D.	0.5501-0.5506 inch (13,973-13.984 mm)
Rocker Arm I.D.	0.5512-0.5519 inch (14,0-14,018 mm)

Valve Timing Checking

Figure 70-70-43



Stop the engine and open the rear door.

Remove the engine. (See Contents, Page 70-01.)

Remove the timing gearcase cover. (See Contents, Page 70-01.)

Make sure the timing marks are in correct alignment **[Figure 70-70-43]**.

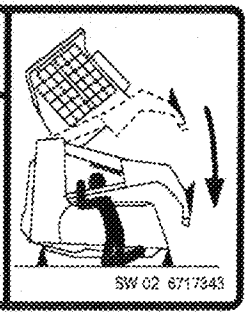
Bobcat®

Removal And Installation

⚠ DANGER

AVOID DEATH

- Disconnecting or loosening any hydraulic tubeline, hose, fitting, component or a part failure can cause lift arms to drop.
- Keep out of this area when lift arms are raised unless supported by an approved lift arm support. Replace if damaged. 57061



⚠ WARNING

Never work on a machine with the lift arms up unless the lift arms are secured by an approved lift arm support device. Failure to use an approved lift arm support device can allow the lift arms or attachment to fall and cause injury or death.

W-2059-0598

Put jackstands under the rear corners of the loader.

Raise the lift arms and install an approved lift arm support device. (See Contents Page 10-01.)

Raise the operator cab. (See Contents Page 10-01.)

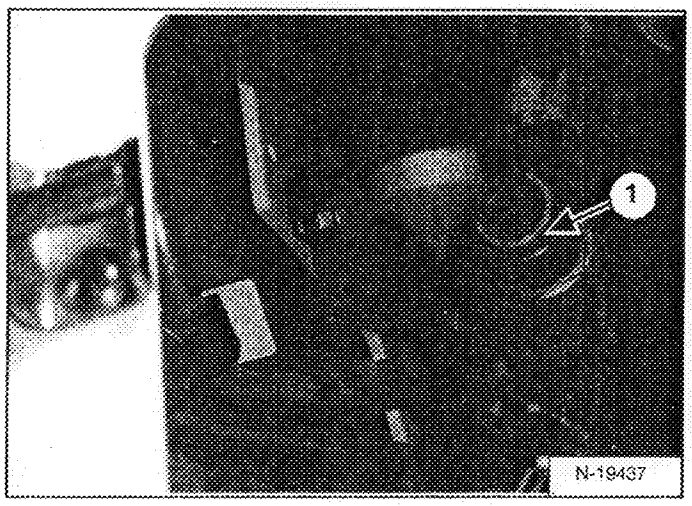
Drain the hydraulic reservoir. (See Contents Page 20-01.)

Disconnect the steering linkage. (See Contents Page 30-01.)

Remove the battery from the loader. (See Contents Page 60-01.)

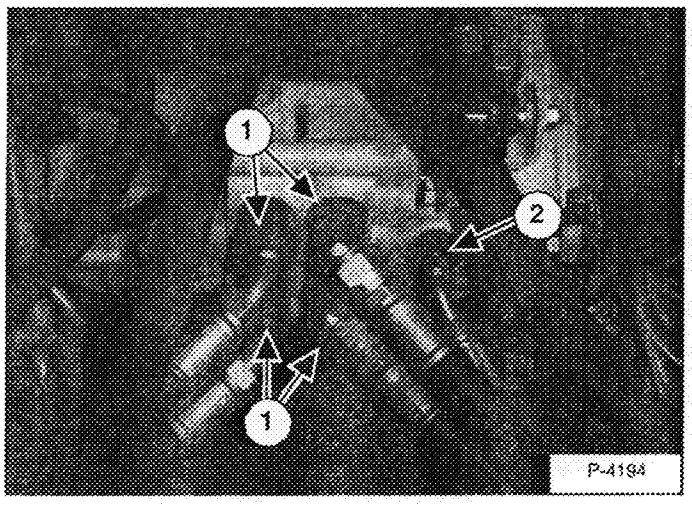
Drain the engine coolant from the cooling system. (See Contents Page 70-01.)

Figure 70-80-1



Disconnect the engine harness connector (Item 1) **[Figure 70-80-1]** from the harness (Earlier models).

Figure 70-80-2



Remove the air cleaner. (See Contents Page 70-01.)

Remove the muffler. (See Contents Page 70-01.)

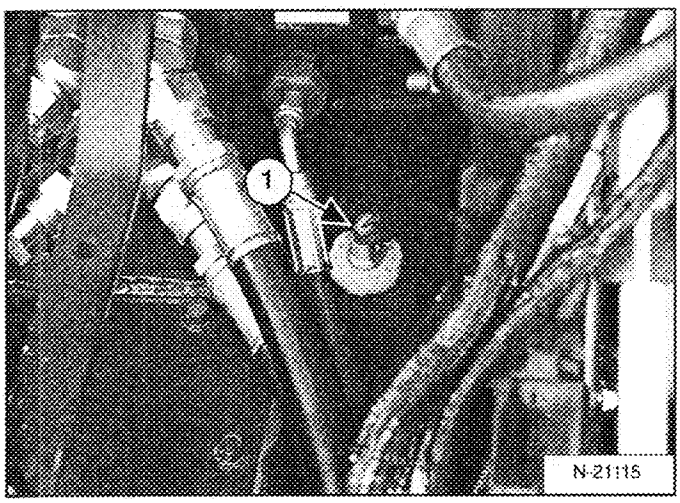
Mark the four drive motor hoses (Item 1) **[Figure 70-80-2]** for correct installation.

Disconnect the four drive motor hoses (Item 1) **[Figure 70-80-2]** from the hydrostatic pump.

Disconnect the motor case drain hose (Item 2) **[Figure 70-80-2]** from the hydrostatic pump.

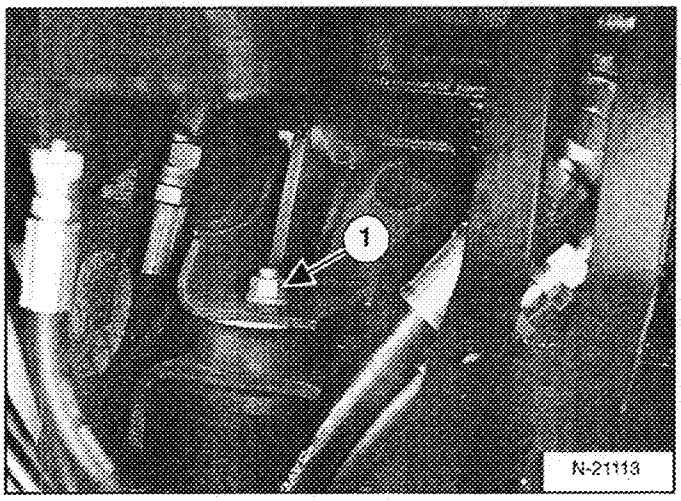
Removal And Installation (Cont'd)

Figure 70-80-3



Disconnect the wire harness connector (Item 1) **[Figure 70-80-3]** from the fuel level sender on the fuel tank.

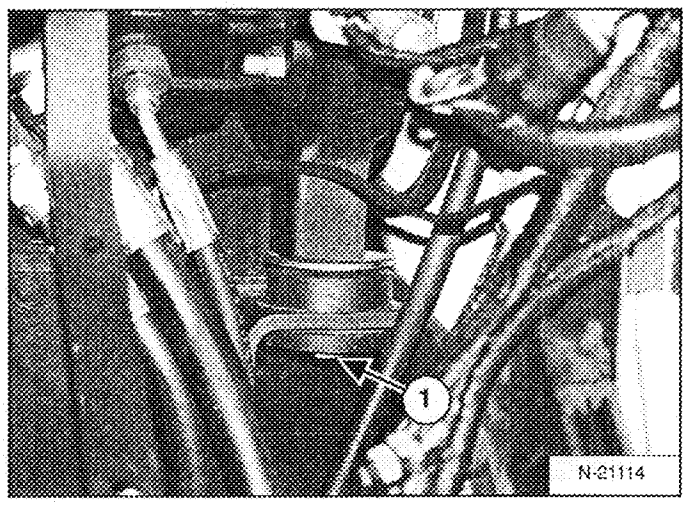
Figure 70-80-4



Disconnect the hoses from the hydraulic pump. (See Contents, Page 20-01.)

Remove the mounting bolt (Item 1) **[Figure 70-80-4]** and nut from the right front engine mount.

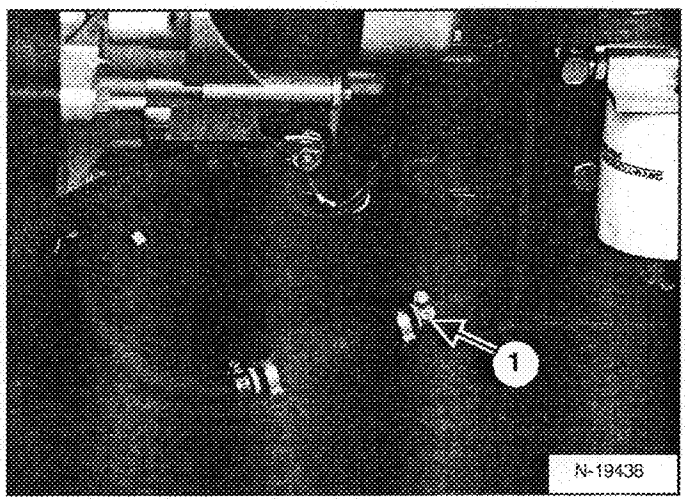
Figure 70-80-5



Remove the mounting bolt (Item 1) **[Figure 70-80-5]** and nut from the left front engine mount.

Installation: Tighten the mounting bolts to 70 ft.-lbs. (95 Nm) torque.

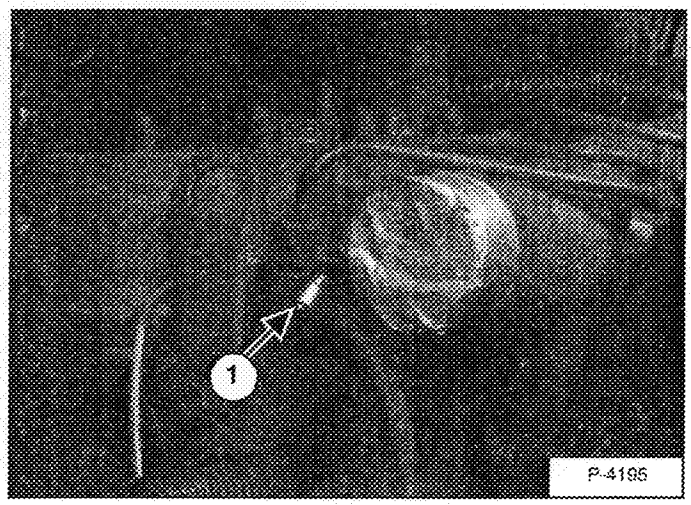
Figure 70-80-6



Disconnect the hand pump (Item 1) **[Figure 70-80-6]** from the fuel line connected to the fuel tank. Cap the fuel lines.

Removal And Installation (Cont'd)

Figure 70-80-7



Disconnect the fuel return hose (item 1) **[Figure 70-80-7]** from the injector.

Figure 70-80-8

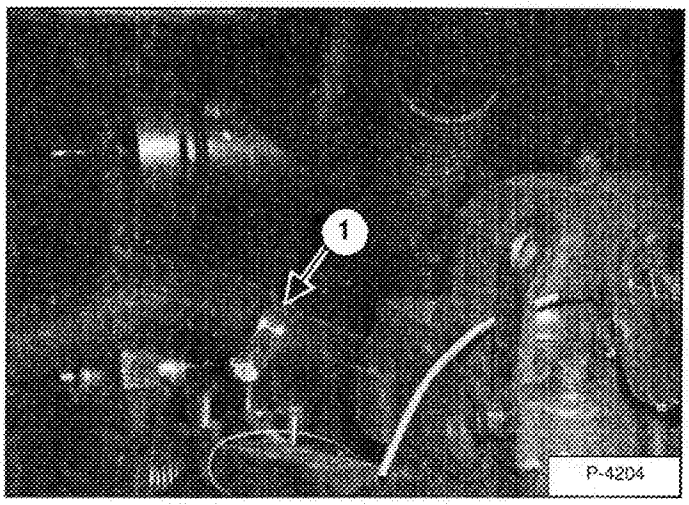
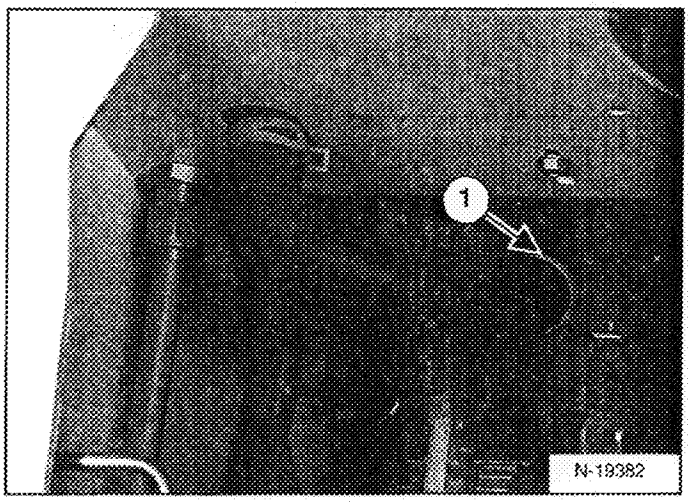


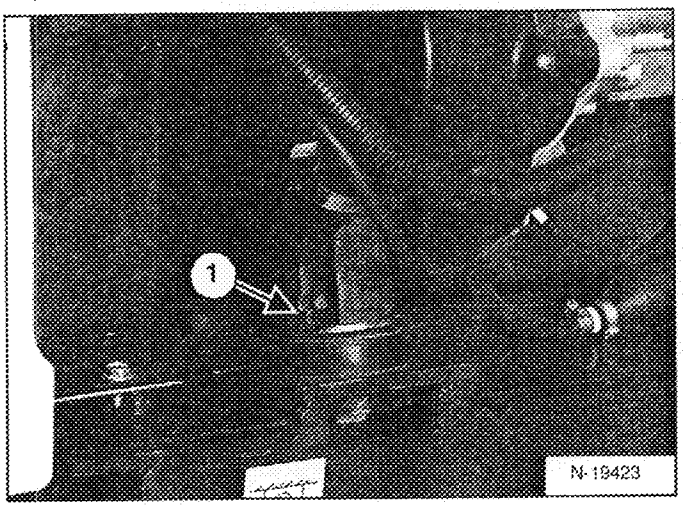
Figure 70-80-9



Disconnect the radiator hoses (Item 1) **[Figure 70-80-8]** & **[Figure 70-80-9]** from the engine.

Removal And Installation (Cont'd)

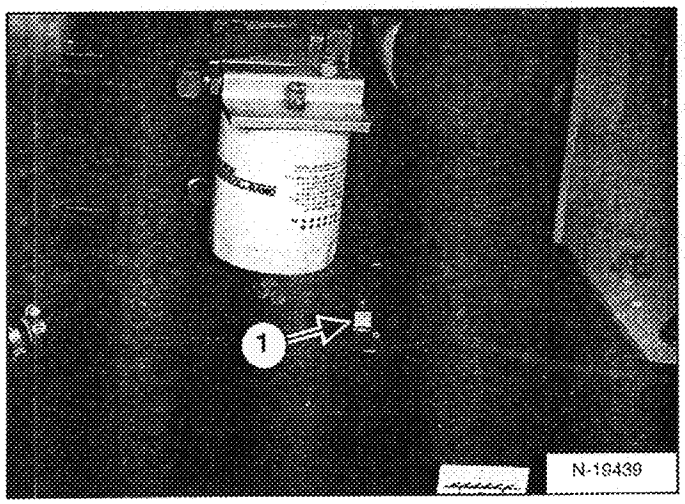
Figure 70-80-10



Remove the mounting bolt and nut (Item 1) **[Figure 70-80-10]** from the left rear engine mount.

Installation: Tighten the mounting bolt to 70 ft.-lbs. (95 Nm) torque.

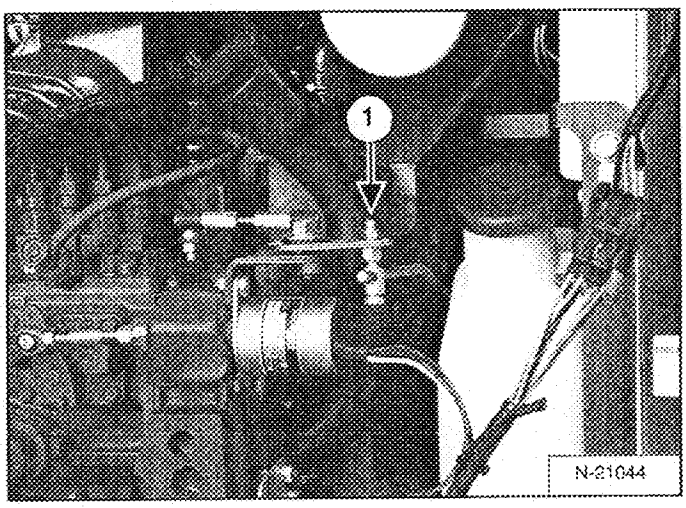
Figure 70-80-11



Remove the mounting bolt and nut (Item 1) **[Figure 70-80-11]** from the right rear engine mount.

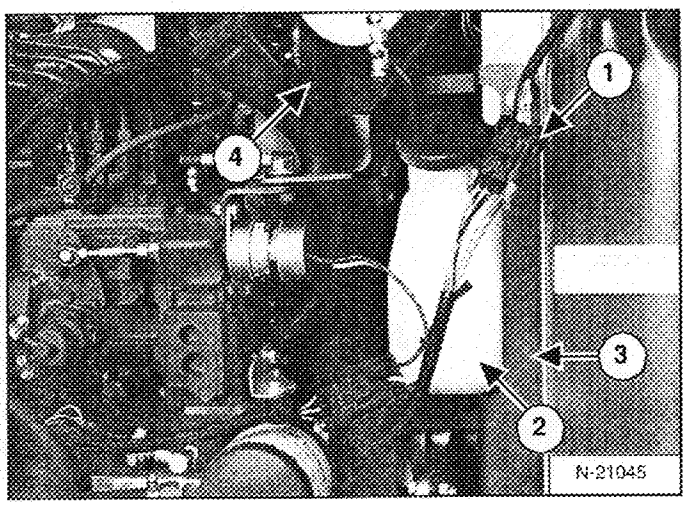
Installation: Tighten the mounting bolt to 70 ft.-lbs. (95 Nm) torque.

Figure 70-80-12



Disconnect the engine speed control rod (Item 1) **[Figure 70-80-12]** from the linkage.

Figure 70-80-13



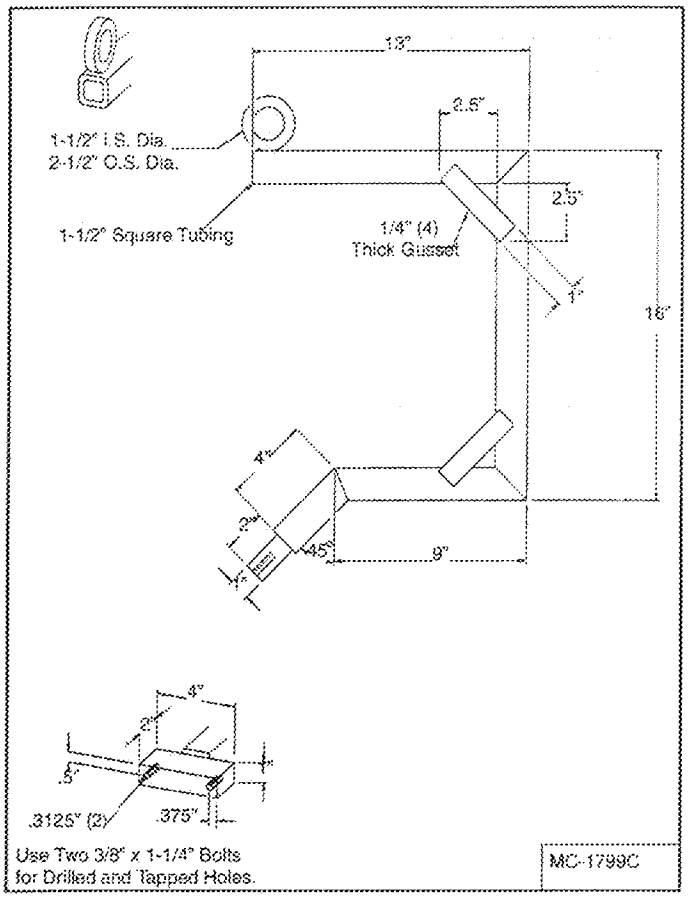
Disconnect the rear light harness connector (Item 1) **[Figure 70-80-13]** from the engine harness.

Remove the coolant recover tank (Item 2) **[Figure 70-80-13]**, mount and belt shield (Item 3) **[Figure 70-80-13]**.

Remove the hydraulic filter housing (Item 4) **[Figure 70-80-13]**. (See Contents, Page 20-01.)

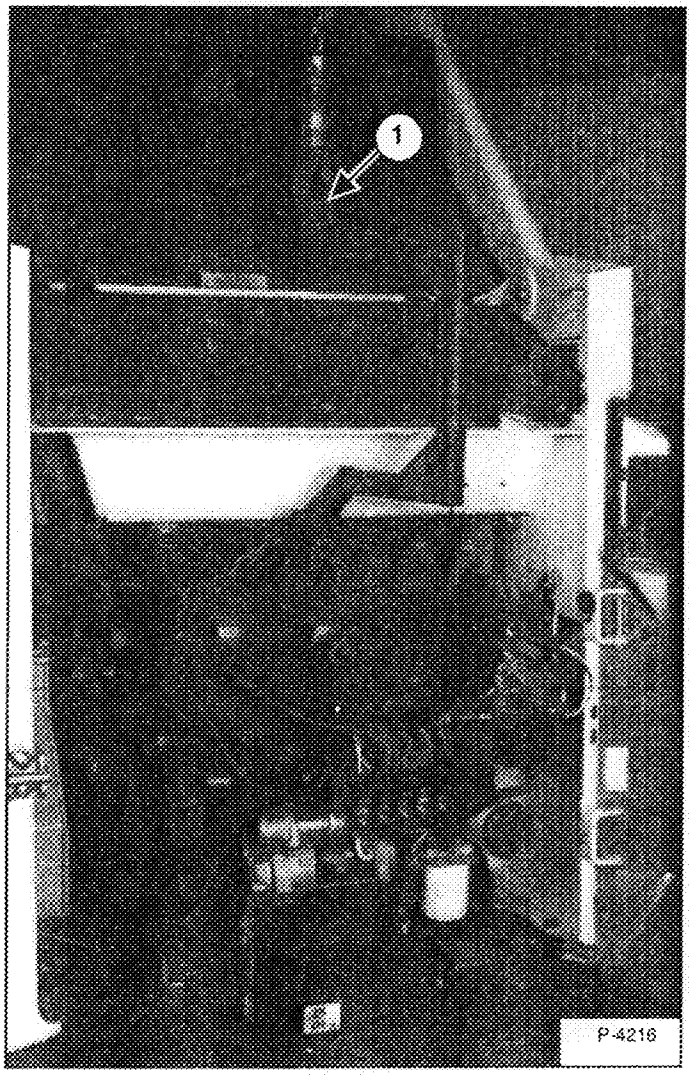
Removal And Installation (Cont'd)

Figure 70-80-14



A tool needs to fabricated to be used in the removal procedure. This tool allows the engine/hydrostatic pump assembly to be lifted evenly for easier removal. Use the dimensions shown in **[Figure 70-80-14]** to make the engine removal tool.

Figure 70-80-15



Install the chain hoist on the eyelet (item 1) **[Figure 70-80-15]** of the removal tool.

Fasten a chain to other end of the removal tool with two bolts as shown in **[Figure 70-80-15]**.

Fasten securely one end of the chain to one of the lifting brackets on the engine **[Figure 70-80-15]**.

Fasten securely the other end of the chain to the other lifting bracket on the engine **[Figure 70-80-15]**.

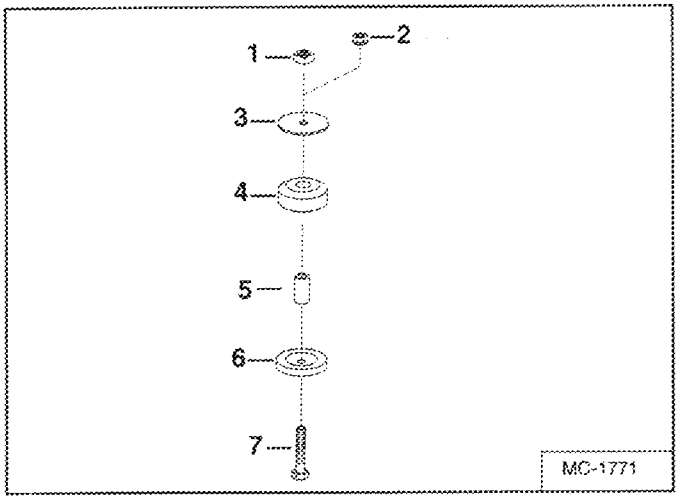
NOTE: You may need to adjust the chain which fastens to the engine a couple of times to reach the correct lifting position.

Remove the engine/hydrostatic pump assembly from the loader.

Reverse the removal procedure to install the engine.

Engine Mount Replacement

Figure 70-80-16



Use the following procedure to install new engine mounts:

Remove the existing mount from the engine. Refer to engine removal and installation for engine mount locations.

Replace all four engine mounts two front and two rear.

Use the parts shown to install the new engine mounts **[Figure 70-80-16]**:

Square Nut - (Item 1) - Used on left side engine mounts

Hex Nut - (Item 2) - Used on right side engine mounts

Mount Washer - (Item 3)

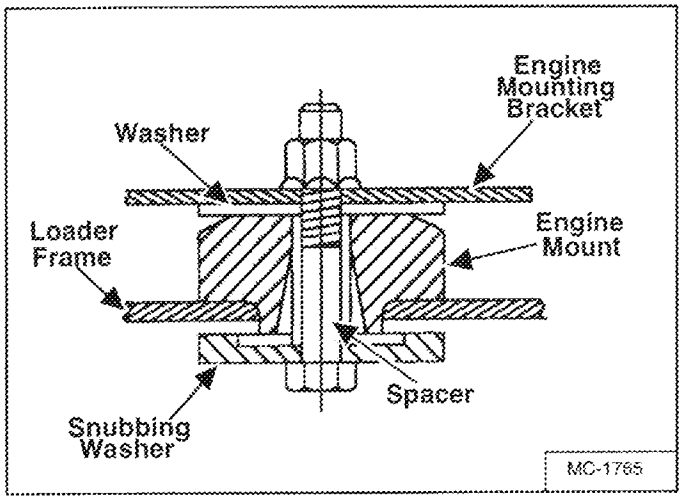
Engine Mount - (Item 4)

Tube Spacer - (Item 5)

Snubbing Washer - (Item 6)

Mounting Bolt - (Item 7)

Figure 70-80-17



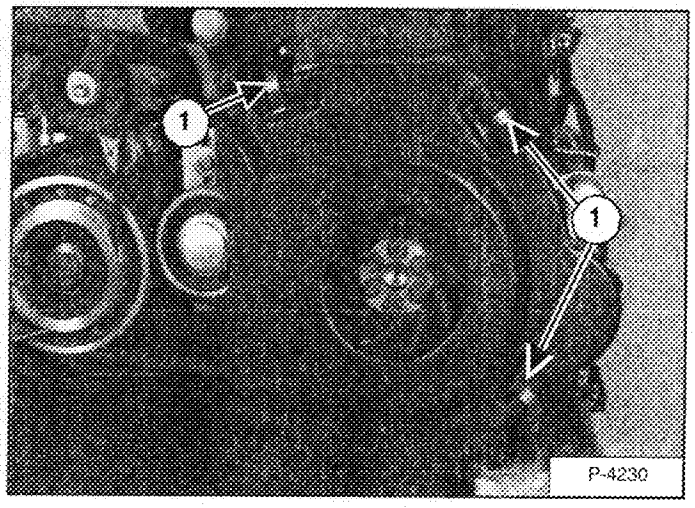
Install the new engine mount as shown in the cut away side view **[Figure 70-80-17]**.

Tighten the mounting bolts to 70 ft.-lbs. (95 Nm) torque.

FLYWHEEL AND HOUSING

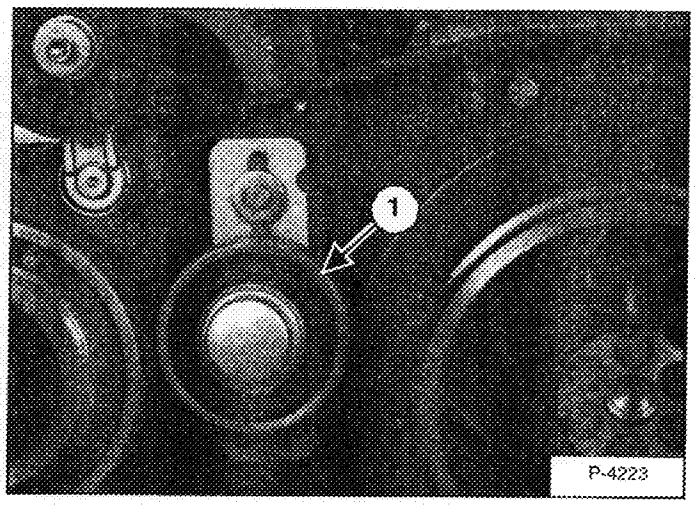
Flywheel Removal And Installation

Figure 70-90-1



Remove the three belt shield clips (Item 1) **[Figure 70-90-1]** and remove the shield from the drive belt housing.

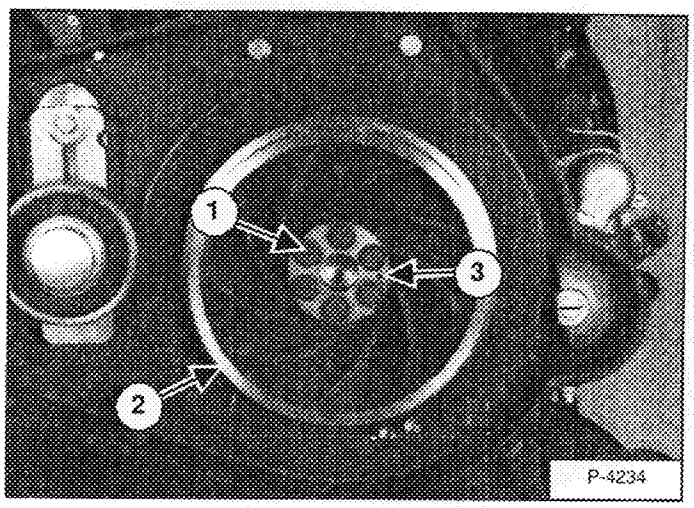
Figure 70-90-2



Loosen and remove the drive belt tension pulley (Item 1) **[Figure 70-90-2]**.

Remove the drive belt. (See Contents, Page 30-01 for drive belt adjustment procedure.)

Figure 70-90-3



Remove the six mounting bolts (Item 1) **[Figure 70-90-3]** from the engine flywheel (Item 2) **[Figure 70-90-3]**.

Installation: Apply engine oil to the threads and seats before tightening. Tighten to 72-80 ft.-lbs. (98-108Nm) torque.

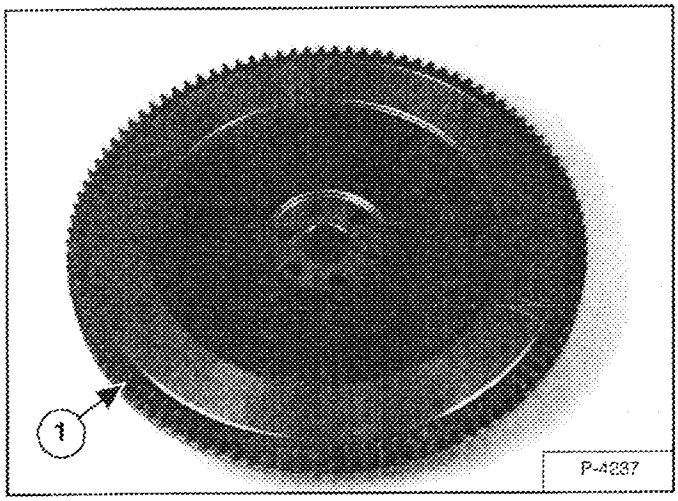
Remove the flywheel from the engine.

Installation: Be sure to align the hole (Item 3) **[Figure 70-90-3]** in the flywheel with the pin located on the crankshaft.

Reverse the removal procedure to install the flywheel.

Ring Gear Removal And Installation

Figure 70-90-4



NOTE: Photo's may be different but the procedure is the same for all models.

The ring gear (Item 1) **[Figure 70-90-4]** on the flywheel is an interference fit. Heat the ring gear enough to expand the gear. Hit the ring gear evenly around the gear to remove it from the flywheel.

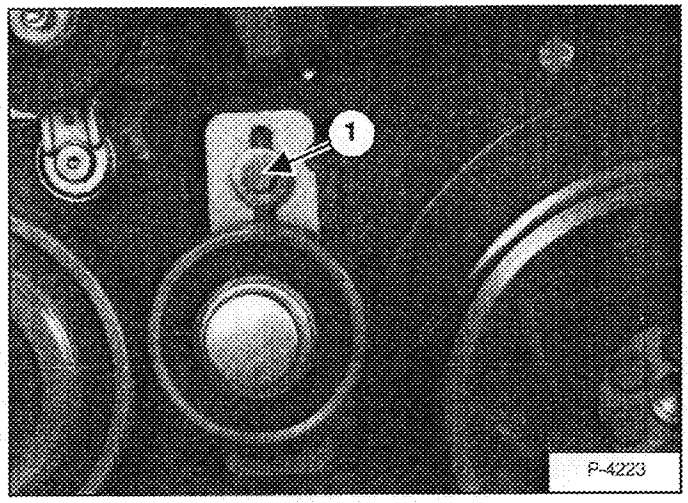
Clean the outer surface of the flywheel thoroughly so the new ring gear will fit smoothly onto the flywheel.

Clean the new ring gear and heat it to a temperature of 450°-500° F. (232°-260° C.)

Fit the ring on the flywheel and be sure the gear is seated correctly.

Housing Removal And Installation

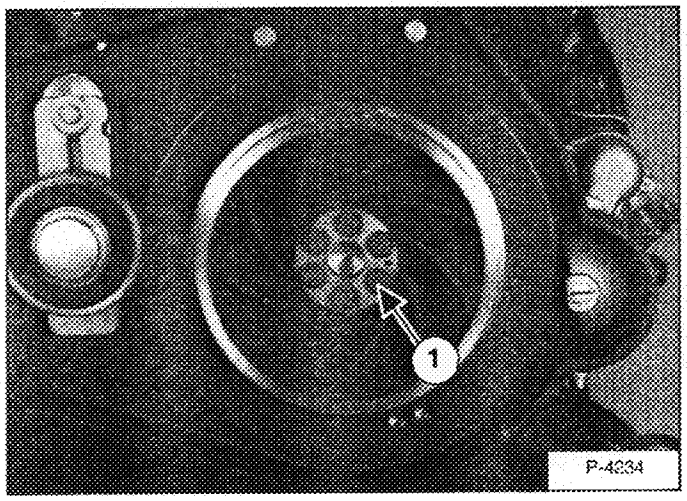
Figure 70-90-5



Loosen the drive belt tensioner bolt (item 1) **[Figure 70-90-5]** from the housing and remove the drive belt.

Installation: Tighten the bolt to 25-28 ft.-lbs. (34-38Nm) torque.
Adjust the drive belt. (See Contents, Page 30-01.)

Figure 70-90-6

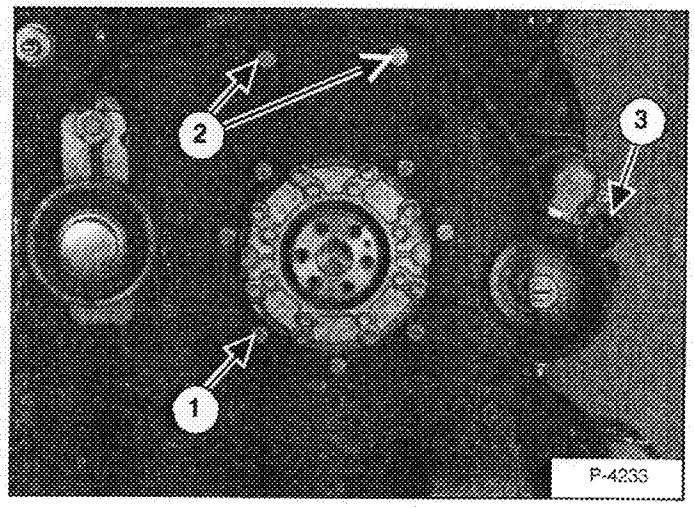


Remove the six flywheel mounting bolts (Item 1) **[Figure 70-90-6]** and remove the engine flywheel.

Installation: Apply engine oil to the threads and seats before tightening. Tighten the mounting bolts to 72-80 ft.lbs. (98-108 Nm) torque.

Housing Removal And Installation (Cont'd)

Figure 70-90-7



Remove the four mounting bolts (Item 1) **[Figure 70-90-7]** which fasten the housing on the engine.

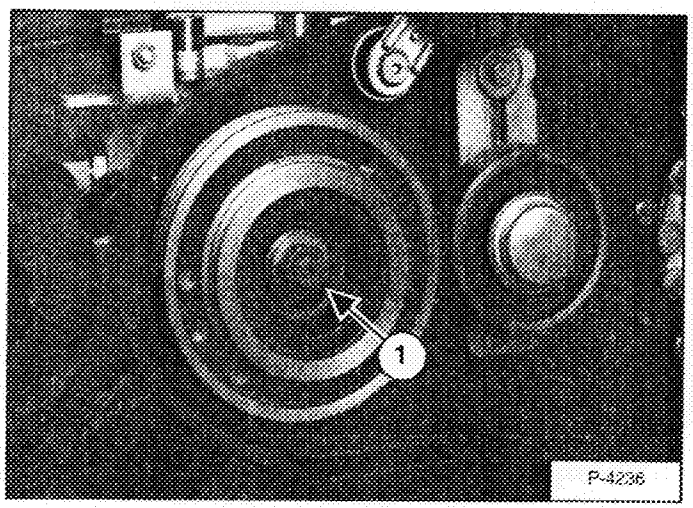
Installation: Tighten the mounting bolts to 35-40 ft.-lbs. (48-54 Nm) torque.

Remove the bolts (Item 2) **[Figure 70-90-7]** which fasten the housing to the engine.

Installation: Tighten the mounting bolts to 60-65 ft.-lbs. (82-88 Nm) torque.

Remove the starter (Item 3) **[Figure 70-90-7]** from the drive belt housing. (See Contents, Page 60-01.)

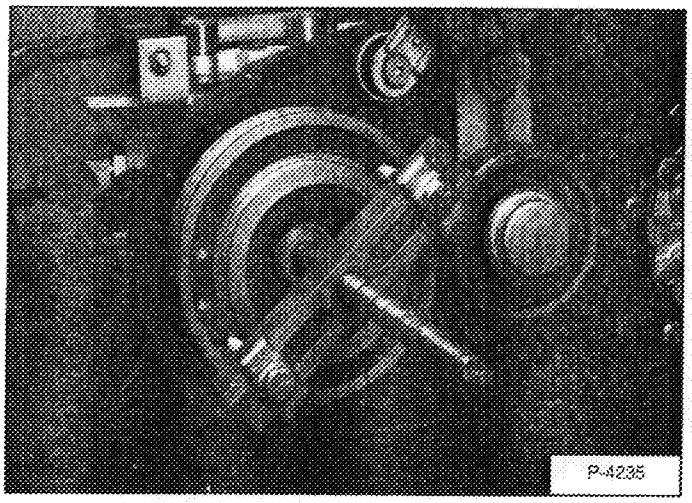
Figure 70-90-8



Remove the hydrostatic pump drive pulley mounting nut (Item 1) **[Figure 70-90-8]** and washer.

Installation: Tighten the mounting nut to 175-200 ft.-lbs. (237-271 Nm) torque.

Figure 70-90-9

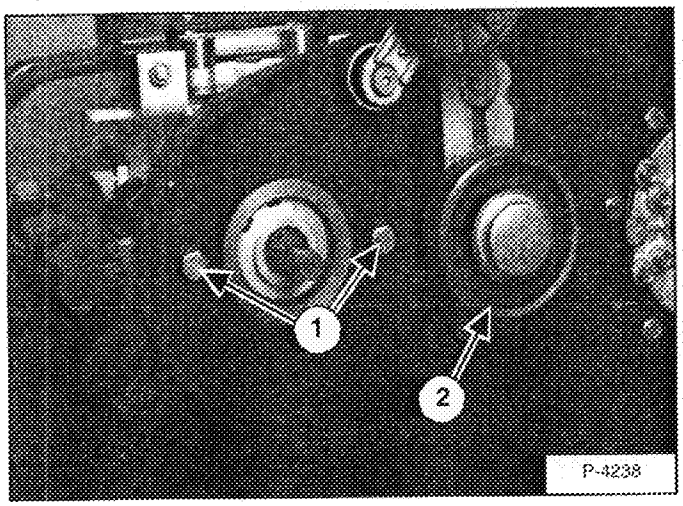


Install a puller in the drive pulley and remove the pulley from the hydrostatic pump shaft **[Figure 70-90-9]**.

Installation: Install the pulley key in the shaft before installing the drive pulley.

Housing Removal And Installation (Cont'd)

Figure 70-90-10

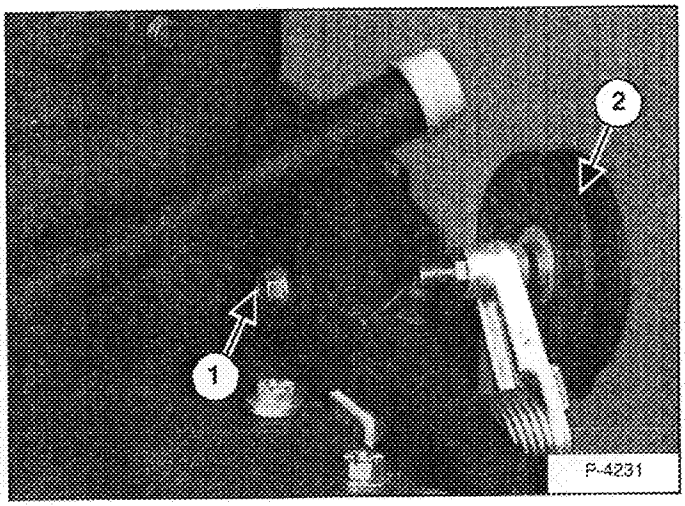


Remove the two mounting bolts (Item 1) **[Figure 70-90-10]** from the drive belt housing which mount the hydrostatic pump to the housing.

Installation: Tighten the mounting bolts to 65-70 ft.-lbs. (88-95 Nm) torque.

Remove the drive belt tensioner (Item 2) **[Figure 70-90-10]** from the drive belt housing. (See Contents, Page 30-01.)

Figure 70-90-11



Remove the mounting bolt (Item 1) **[Figure 70-90-11]** from engine coolant tubeline mounting bracket which is attached to the belt shield housing.

Installation: Tighten the mounting bolt to 25-28 ft.-lbs. (34-38 Nm) torque.

Remove the blower fan drive belt tensioner assembly (Item 2) **[Figure 70-90-11]** from the housing.

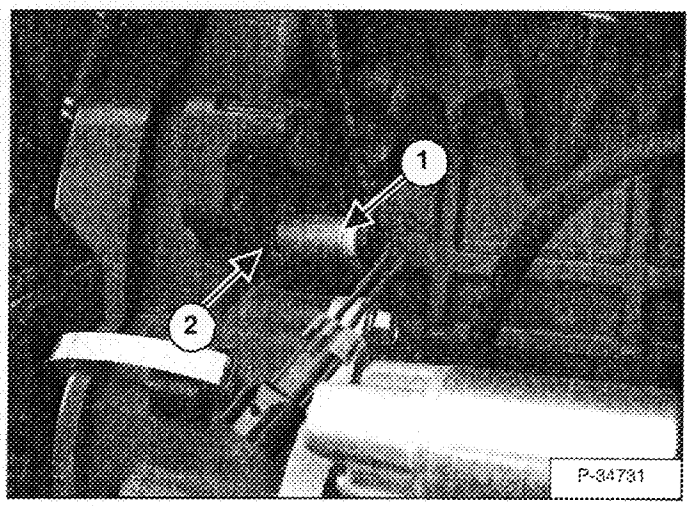
Remove the drive belt housing.

Reverse the removal procedure to install the drive belt housing.

RPM SENSOR

Adjustment

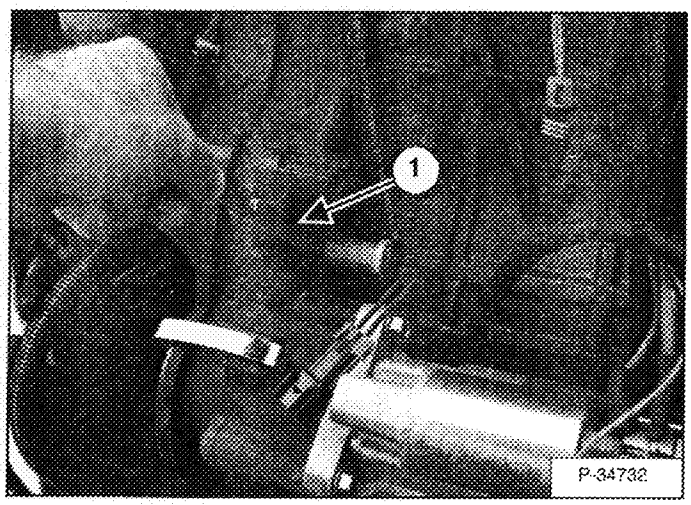
Figure 70-91-1



When reinstalling the RPM sensor, turn the rpm sensor (Item 1) **[Figure 70-91-1]** in until it makes contact with the engine flywheel.

Turn the jam nut (Item 2) **[Figure 70-91-1]** until it contacts the flywheel housing. The jam nut should not be tightened, it needs to turn with the RPM sensor when the sensor is turned back out for adjustment.

Figure 70-91-2



Turn the RPM sensor and the jam nut out from the flywheel. Set a clearance of .050 inch (1,27 mm) between the jam nut and the housing with a feeler gauge (Item 1) **[Figure 70-91-2]**.

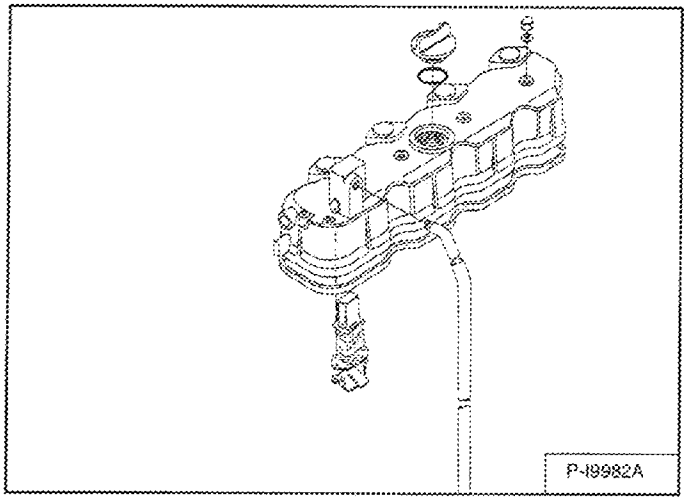
NOTE: New RPM sensors have a plastic tip which is used as a gauge during installation. The plastic tip is designed to come off after the engine is started.

Bobcat®

RECONDITIONING THE ENGINE

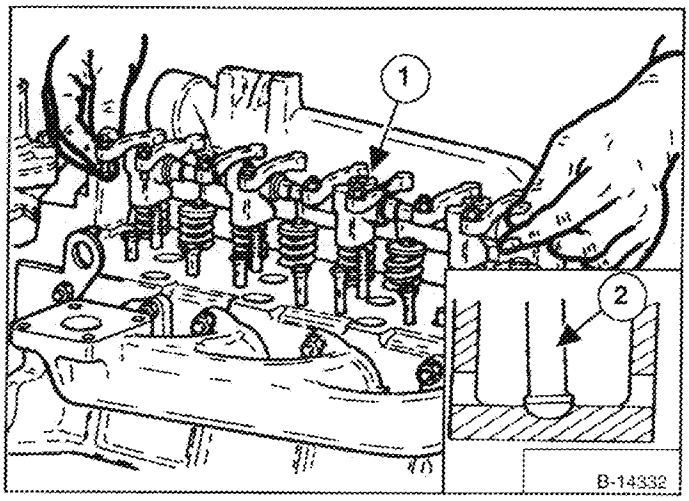
Cylinder Head Removal And Installation

Figure 70-100-1



Remove the nuts from the valve cover, remove the valve cover and gasket **[Figure 70-100-1]**.

Figure 70-100-2



Remove the fuel injector nozzles. (See Contents, Page 70-01.)

Remove the glow plugs. (See Contents, Page 70-01.)

Remove the belt shield. (See Contents, Page 30-01.)

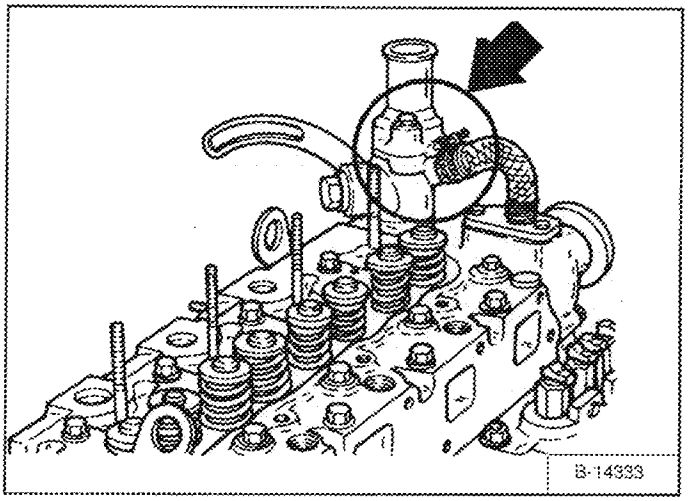
Remove the alternator. (See Contents, Page 60-01.)

Remove the rocker arm and shaft assembly (item 1) **[Figure 70-100-2]**.

Remove the push rods (item 2) **[Figure 70-100-2]**.

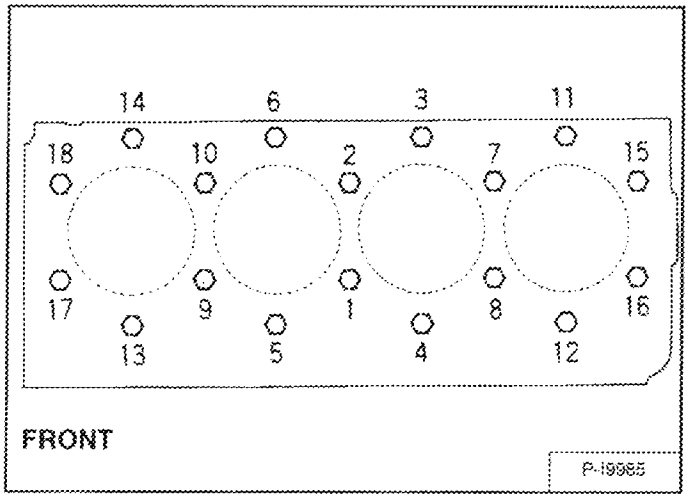
Remove the intake and exhaust manifolds.

Figure 70-100-3



Remove the water return hose **[Figure 70-100-3]**.

Figure 70-100-4



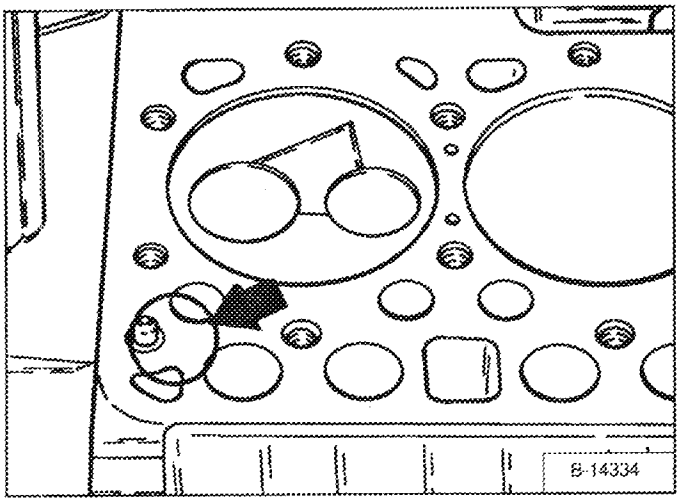
Remove the cylinder head bolts in order of #18 to #1 **[Figure 70-100-4]**.

Installation: Put oil on the bolt threads. Tighten the bolts in the correct sequence to 69-72 ft.-lbs. (93-98 Nm) torque.

NOTE: Retighten the cylinder head bolts in the correct sequence after the engine has been run for 30 minutes.

Cylinder Head Removal And Installation (Cont'd)

Figure 70-100-5

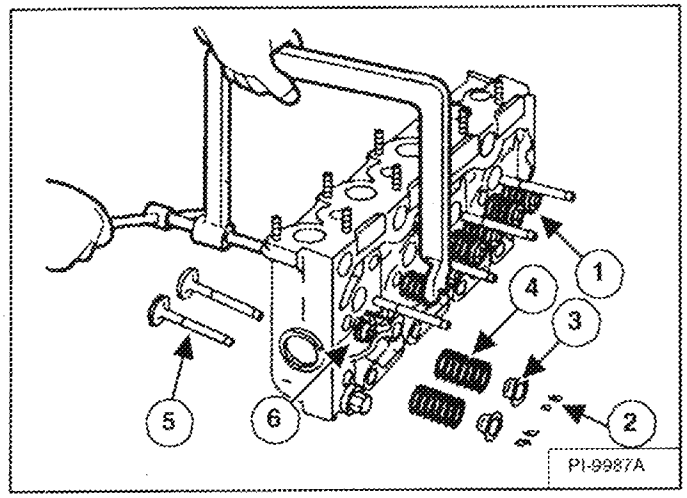


Remove the cylinder head from the engine block.

Installation: Always use new head gasket and new O-ring. Make sure the O-ring is seated over the dowel **[Figure 70-100-5]**.

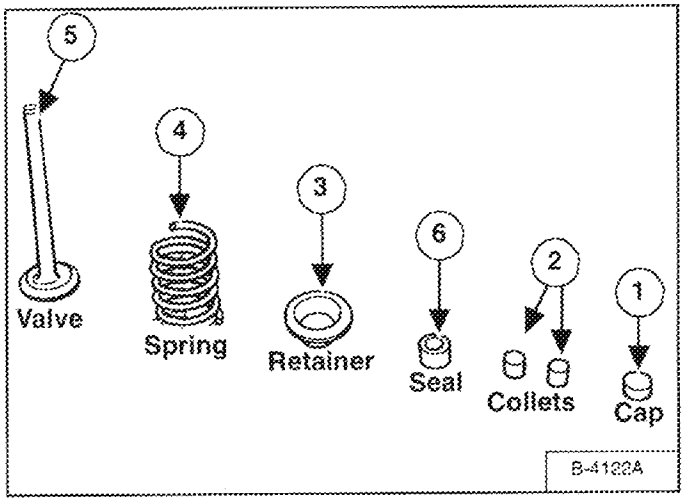
Cylinder Head Disassembly And Assembly

Figure 70-100-6



Use a valve spring compressor to compress the valve spring **[Figure 70-100-6]**.

Figure 70-100-7

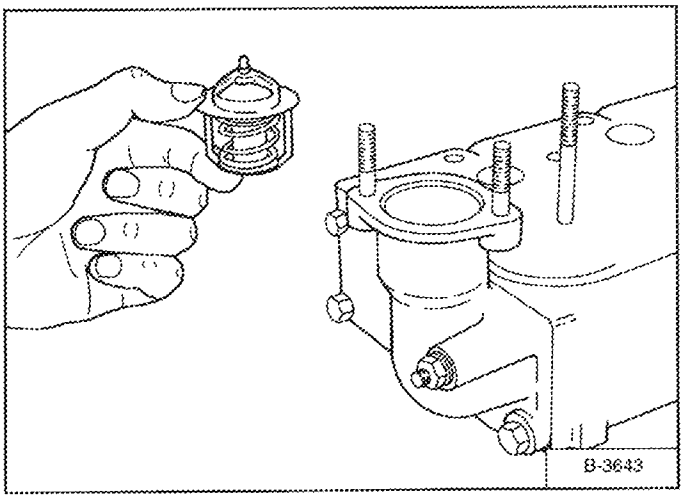


Remove the valve cap (Item 1) **[Figure 70-100-6]** & **[Figure 70-100-7]** and valve spring collet (Item 2) **[Figure 70-100-6]** & **[Figure 70-100-7]**.

Remove the valve spring retainer (Item 3) **[Figure 70-100-6]** & **[Figure 70-100-7]** and the spring (Item 4) **[Figure 70-100-6]** & **[Figure 70-100-7]**.

Remove the seal (Item 6) **[Figure 70-100-6]** & **[Figure 70-100-7]** and the valve (Item 5) **[Figure 70-100-6]** & **[Figure 70-100-7]**.

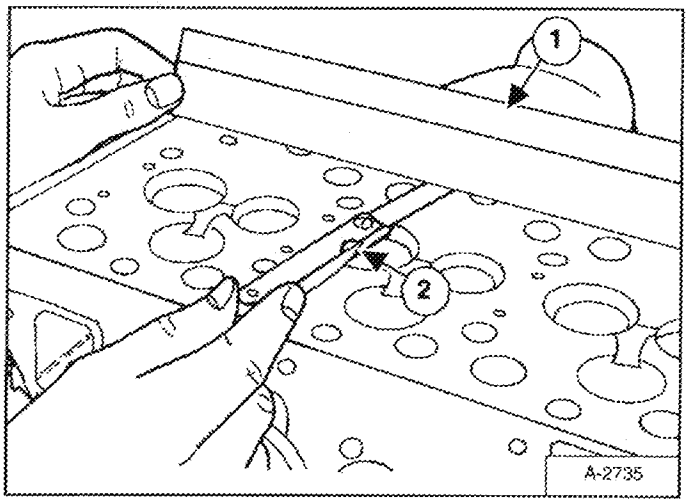
Figure 70-100-8



Remove the thermostat housing. Remove the thermostat from the cylinder head **[Figure 70-100-8]**.

Cylinder Head Servicing

Figure 70-100-9



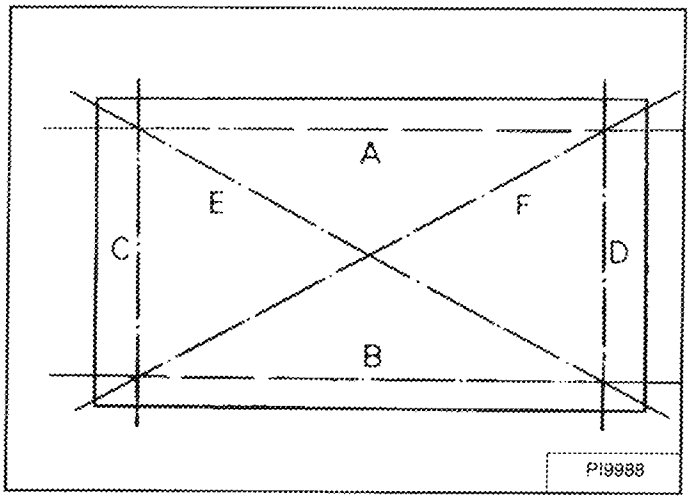
Clean the surface of the cylinder head.

Put a straight edge (Item 1) **[Figure 70-100-9]** on the cylinder head.

NOTE: Do not put the straight edge across the combustion chambers.

Put the feeler gauge (Item 2) **[Figure 70-100-9]** between the straight edge and the surface of the cylinder head.

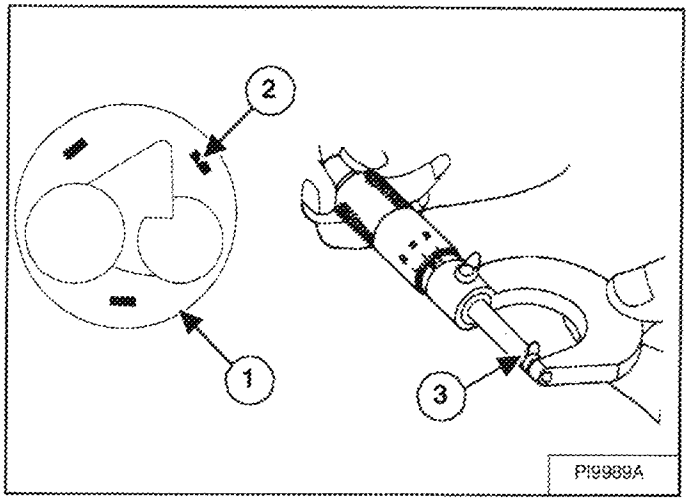
Figure 70-100-10



Put the straight edge on the cylinder head's four sides and two diagonal as shown in figure **[Figure 70-100-10]**.

The maximum distortion of the head surface is ± 0.002 inch (± 0,05 mm). If the measurement exceeds the specification, replace the cylinder head.

Figure 70-100-11



Cylinder Head Top Clearance

Install the cylinder head gasket. Put the piston (Item 1) **[Figure 70-100-11]** being checked at T.D.C.

Put three pieces of 0.060 inch (1,5 mm) diameter solder (Item 2) **[Figure 70-100-11]** on the top of the piston. Use grease to hold them in position.

NOTE: Position the solder so they do not touch the valves.

Turn the piston to bottom dead center.

Install the cylinder head and tighten to the correct torque in the correct sequence. (See Cylinder Head Removal And Installation on page 70-100-1.)

Turn the crankshaft until the piston exceeds T.D.C. Remove the cylinder head.

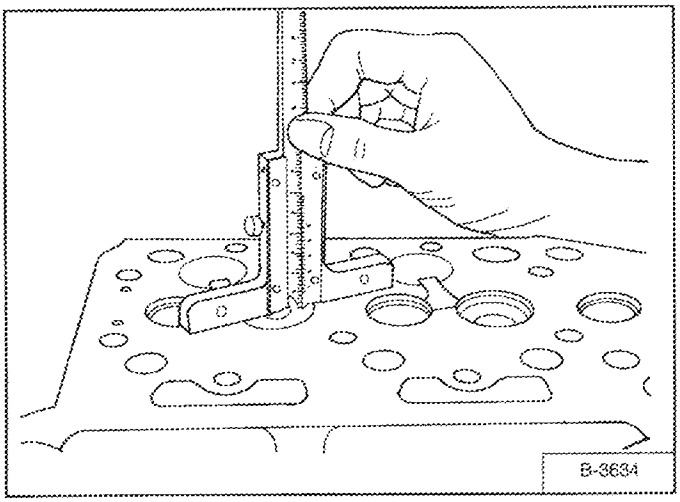
Remove the solder wire (Item 3) **[Figure 70-100-11]** and measure it.

If the measurement exceeds the specifications, check the oil clearance of the crank pin journal or the piston pin.

Top Clearance	0.022-0.028 inch (0,55-0,7 mm)

Checking The Valve Guide

Figure 70-100-12

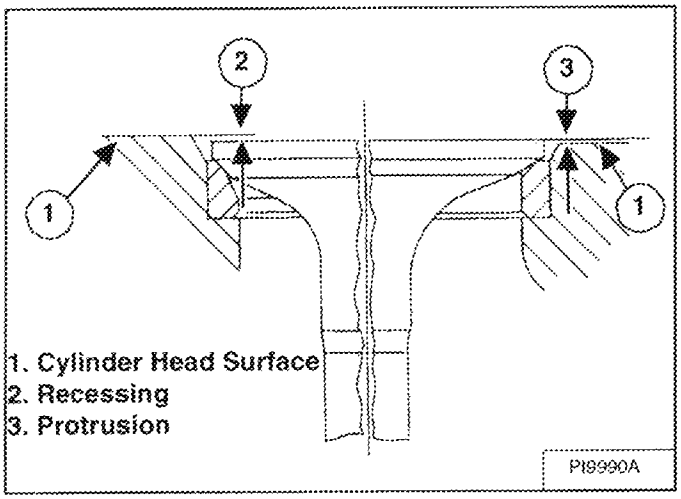


Remove the valve and spring from the cylinder head. (See Cylinder Head Disassembly And Assembly on page 70-100-2.)

Clean the valve seat and combustion chamber.

Install the valve into the guide. Measurement the valve recessing or protrusion with a depth gauge **[Figure 70-100-12]**.

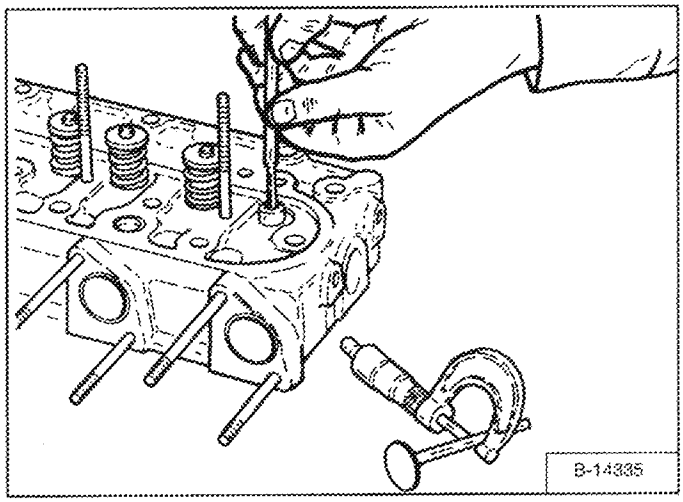
Figure 70-100-13



If the measurement exceeds the allowable limit, replace the valve or cylinder head **[Figure 70-100-13]**.

Protrusion	0.002 inch (0,05 mm)
Recessing	0.006 inch (0,15 mm)
Allowable Limit (Recessing)	0.016 inch (0,4 mm)

Figure 70-100-14



Remove the carbon from the valve guide.

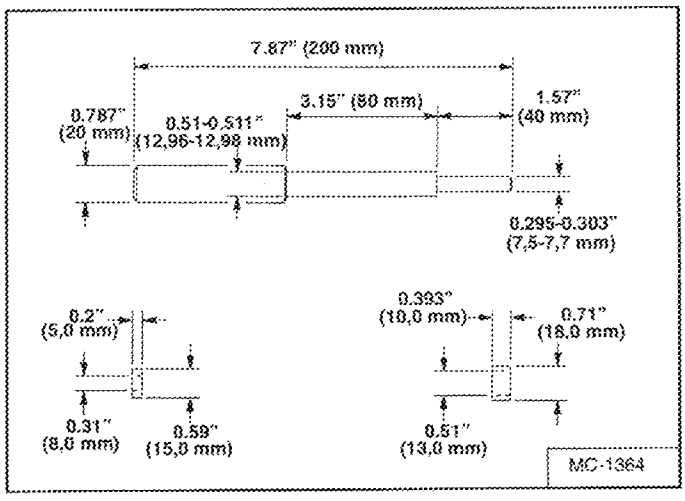
Measure the valve stem O.D. **[Figure 70-100-14]**.

Measure the valve guide I.D. **[Figure 70-100-14]**.

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

Valve Guide I.D.	0.3156-0.3161 inch
	(8,015-8,03 mm)
Valve Stem O.D.	0.3134-0.3142 inch
	(7,96-7,98 mm)
Clearance Between Valve Stem	
and Guide	0.0016-0.0026 inch (0,04-0,07 mm)
Allowable Limit	0.004 inch (0,1 mm)

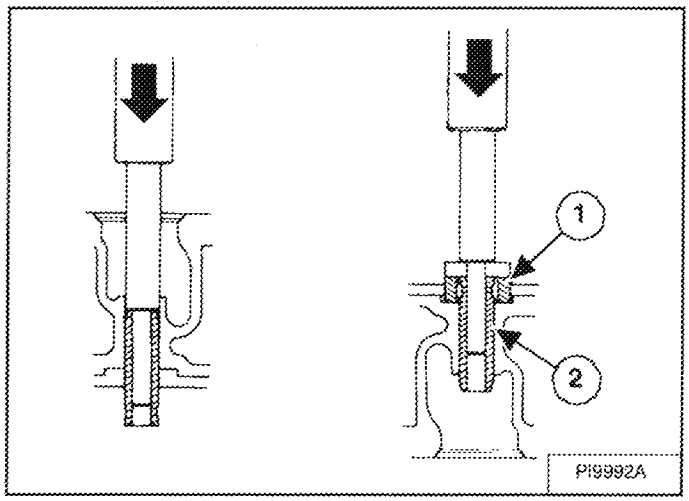
Figure 70-100-15



To remove and replace the valve guide, make the driver tool as shown in figure **[Figure 70-100-15]**.

Checking The Valve Guide (Cont'd)

Figure 70-100-16



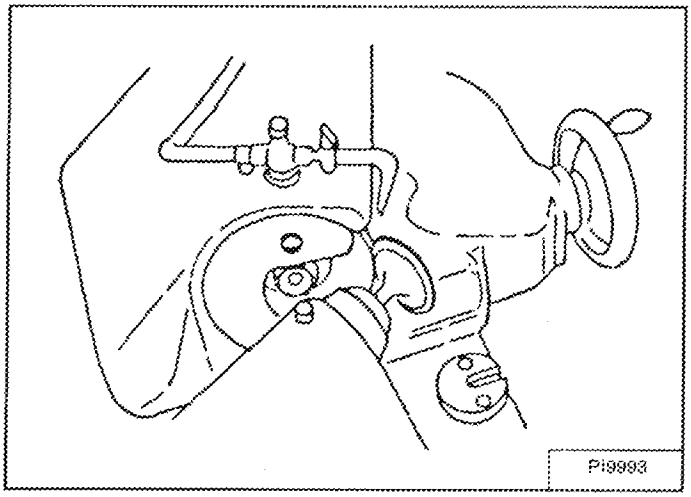
Press the used valve guide out of the cylinder head using the special driver tool **[Figure 70-100-16]**.

Put oil on the outside diameter of the new valve guide. Press the new valve guide into the cylinder head from the top side. Use the special driver tools (Items 1 & 2) **[Figure 70-100-16]**, Press the new guide until the tool contacts the cylinder head.

Ream the valve guide to the correct specifications.

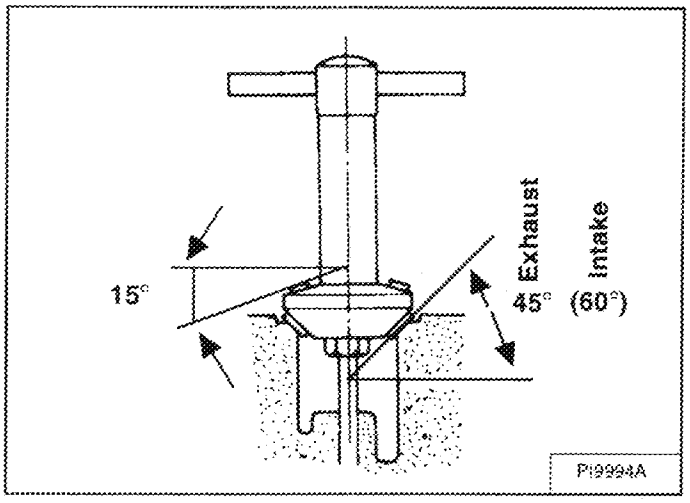
Reconditioning The Valve And Valve Seat

Figure 70-100-17



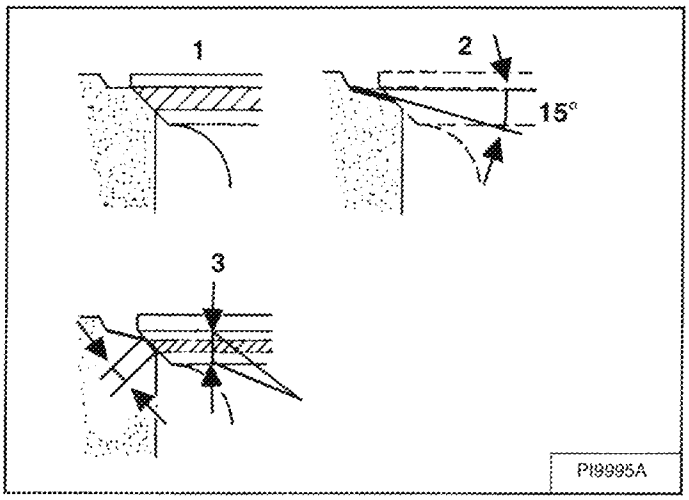
Grind the valve face to the correct angle using a valve refacer **[Figure 70-100-17]**.

Figure 70-100-18



Grind the valve seat surface in the cylinder head to the correct angle **[Figure 70-100-18]**.

Figure 70-100-19



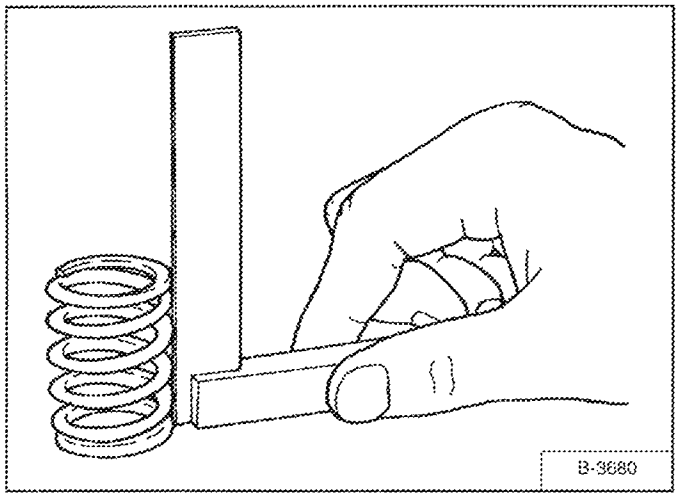
Check the seat surface and valve face (Item 1) **[Figure 70-100-19]**.

If the seat surface is too wide, use a 15 degree cutter (Item 2) **[Figure 70-100-19]** to get the correct width (Item 3) **[Figure 70-100-19]**.

Valve Seat Width	
Intake	0.084 inch (2,12 mm)
Exhaust	0.084 inch (2,12 mm)
Valve Seat & Face Angle	
Intake	60°
Exhaust	45°

Valve Spring

Figure 70-100-20



Measure the length of the valve spring. If the measurement is less than the allowable limit, replace the spring **[Figure 70-100-20]**.

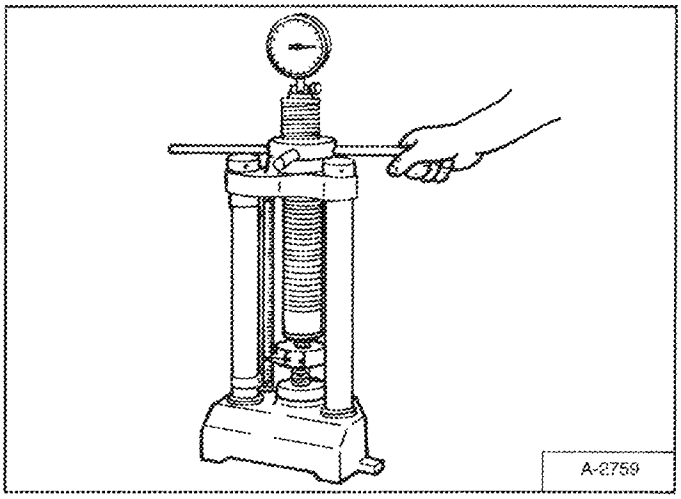
Free Length	1.642-1.661 inch (41,7-42,2 mm)
Allowable Limit	1.622 inch (41,2 mm)

Put the spring on a flat surface, place a square on the side of the spring **[Figure 70-100-20]**.

Rotate the spring and measure the maximum tilt. If the measurement exceeds the allowable limit, replace the spring.

Tilt	0.040 inch (1,0 mm)

Figure 70-100-21



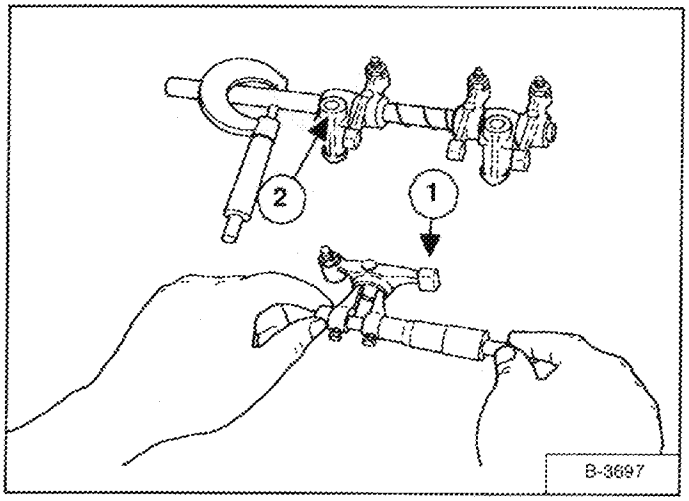
Place the spring on a tester and compress to specified length **[Figure 70-100-21]**.

Read the compressed load on the gauge. If the measurement exceeds allowable limit, replace the spring.

Setting Length	1.378 inch (35,0 mm)
Setting Load	26.4 lbs. (117,6 N)
Allowable Limit	22.5 lbs. (100,0 N)

Rocker Arm And Shaft Checking

Figure 70-100-22



Measure the rocker arm I.D. (Item 1) **[Figure 70-100-22]** with the inside micrometer.

Measure the rocker arm shaft O.D. (Item 2) **[Figure 70-100-22]** with a outside micrometer.

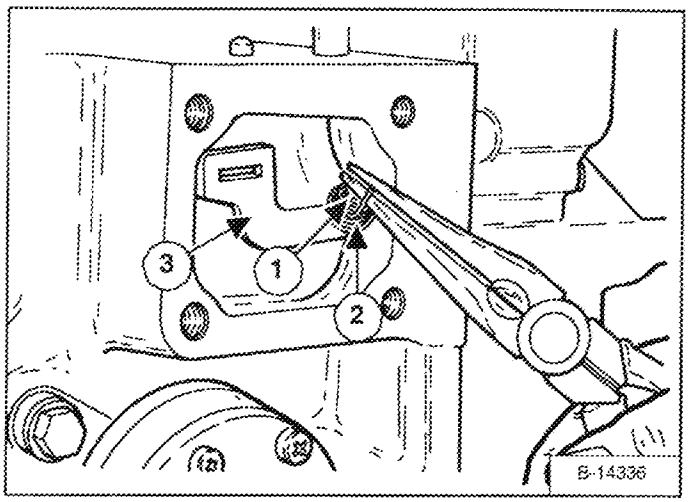
If the clearance exceeds the allowable limit, replace the bushing.

If the clearance still exceeds the allowable limit after the bushing is replaced, replace the rocker arm shaft.

Oil Clearance Between Rocker Arm	
& Shaft	0.0006-0.0015 inch (0,016-0,038 mm)
Allowable Limit	0.006 inch (0,15 mm)
Rocker Arm Shaft	
O.D.	0.5501-0.5506 inch (13,973-13,984 mm)
Rocker Arm I.D.	0.5512-0.5519 inch (14,0-14,01 mm)

Timing Gearcase Cover Removal And Installation

Figure 70-100-23

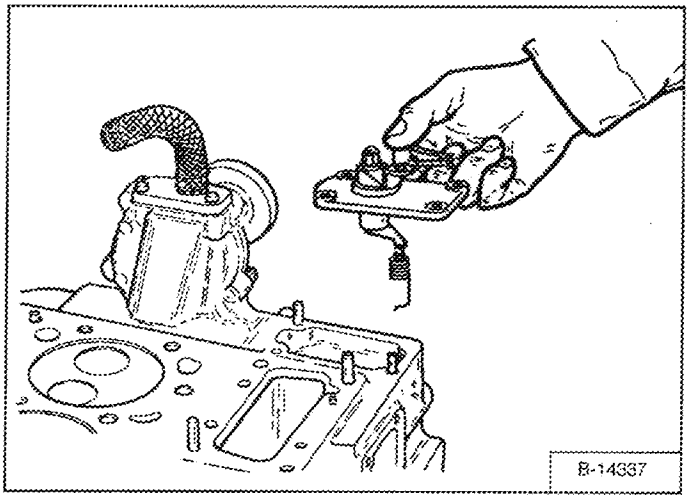


Remove the fuel injection pump. (See Contents, Page 70-01.)

Remove the cylinder head, rocker arms and push rods. (See Contents, Page 70-01.)

Disconnect the two governor springs (Items 1 & 2) **[Figure 70-100-23]** from the fork lever (Item 3) **[Figure 70-100-23]**.

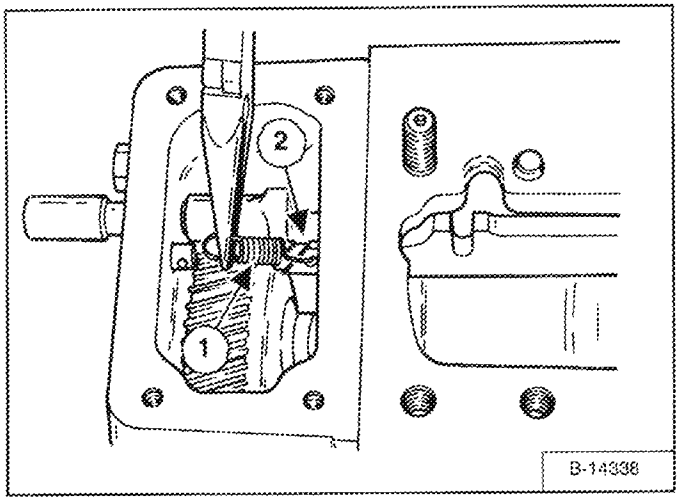
Figure 70-100-24



Remove the speed control plate with the governor springs **[Figure 70-100-24]**.

Timing Gearcase Cover Removal And Installation (Cont'd)

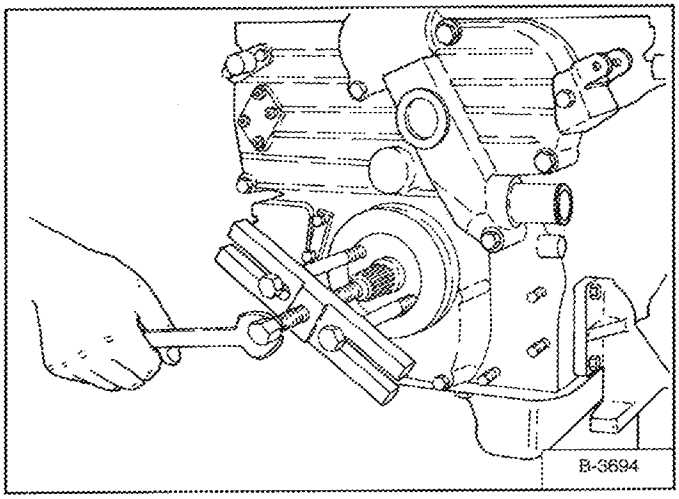
Figure 70-100-25



Remove the start spring (Item 1) **[Figure 70-100-25]** from the fork lever (Item 2) **[Figure 70-100-25]**.

Installation: Be careful; do not drop the spring into the gearcase.

Figure 70-100-26

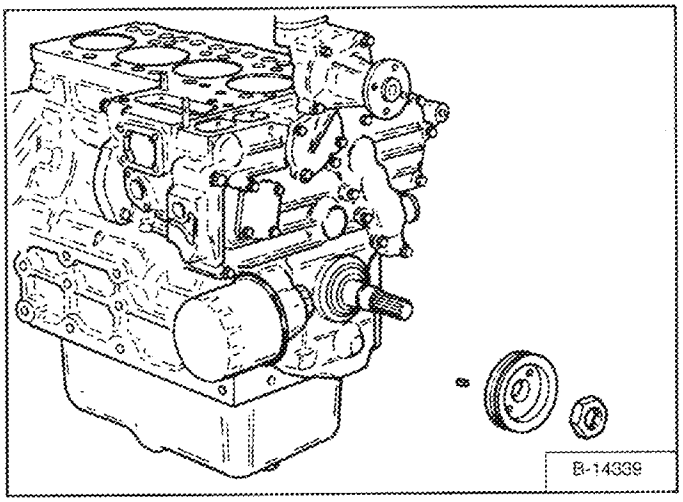


Remove the crankshaft pulley nut.

Installation: Tighten the nut to 101-116 ft.-lbs. (137-157Nm) torque.

Use a puller and remove the crankshaft pulley **[Figure 70-100-26]**.

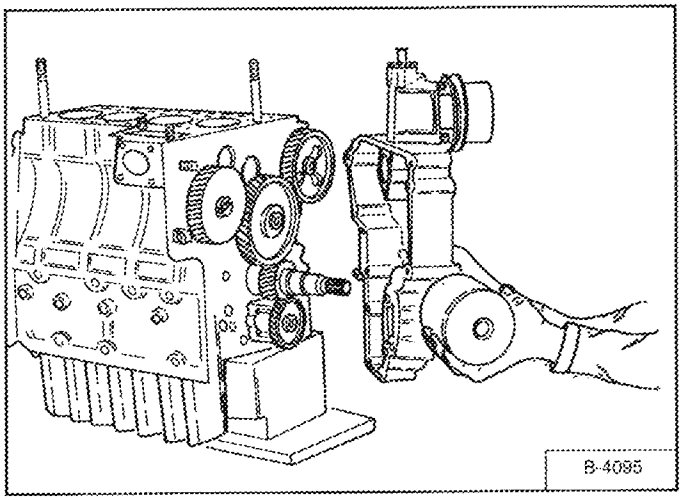
Figure 70-100-27



Remove the bolts from the timing gearcase cover.

Installation: Tighten the bolts to 13-15 ft.-lbs. (18-20 Nm) torque.

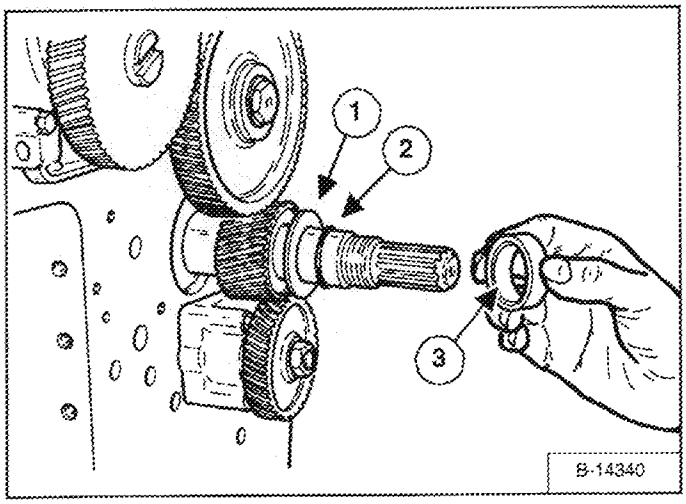
Figure 70-100-28



Remove the timing gearcase cover **[Figure 70-100-28]**.

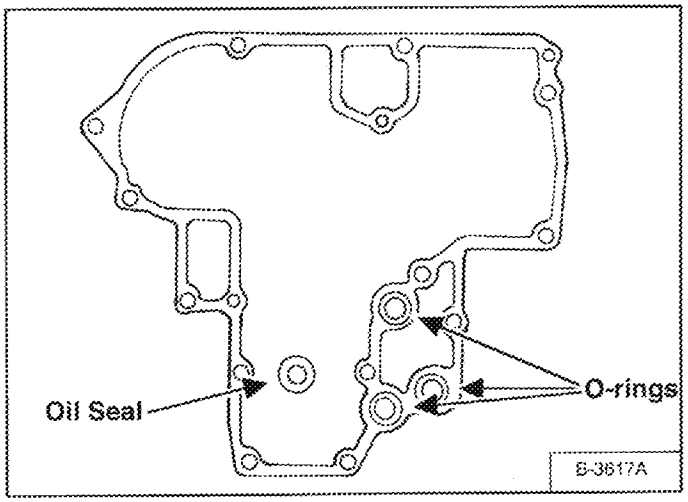
Timing Gearcase Cover Removal And Installation (Cont'd)

Figure 70-100-29



Remove the crankshaft oil slinger (Item 1) **[Figure 70-100-29]**, O-ring (Item 2) **[Figure 70-100-29]** and collar (Item 3) **[Figure 70-100-29]**.

Figure 70-100-30

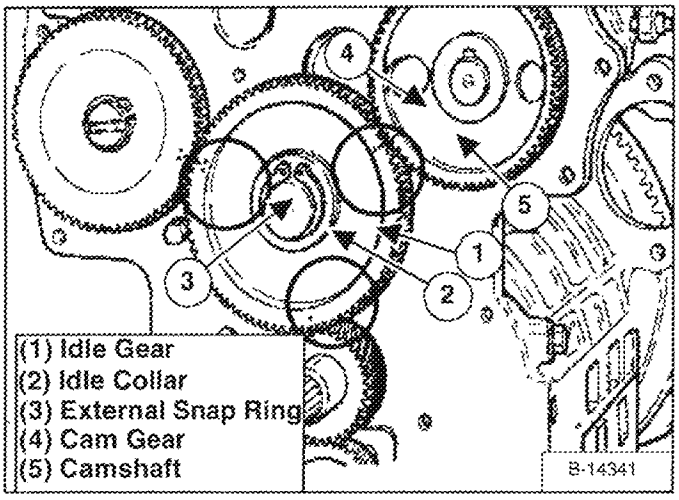


Installation: Install new O-rings and oil seal into the timing gearcase cover **[Figure 70-100-30]**.

NOTE: When a new timing gearcase cover is installed, to establish the *correct position* of the injection pump fuel rack stop before removing it from the old timing gearcase cover, the distance from the machined surface of the gearcase (gasket surface) to the end of the stop should be measured. The stop should then be installed in the new gearcase and set to the same distance that was previously measured. Do not try to test operate the engine to establish if it has enough power. The adjustment must be set by a qualified service personnel for the injection pump.

Idler Gear And Camshaft Removal And Installation

Figure 70-100-31

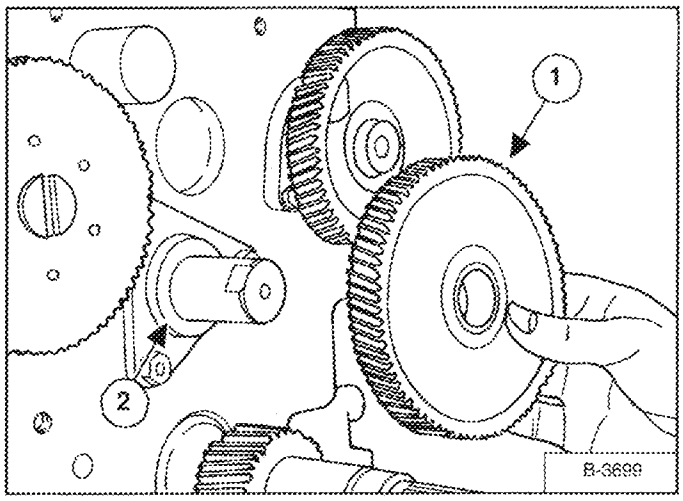


Remove the timing gearcase cover. (See Contents, Page 70-01.)

Remove the snap ring (Item 3) **[Figure 70-100-31]** from the idler gear shaft (Item 1) **[Figure 70-100-31]**.

Installation: Make sure the timing marks are in correct alignment when installing the timing gears **[Figure 70-100-31]**.

Figure 70-100-32



Remove the idler gear (Item 1) **[Figure 70-100-32]**.

Remove the idler gear collar (Item 2) **[Figure 70-100-32]**.

Remove the idler gear shaft mounting bolts.

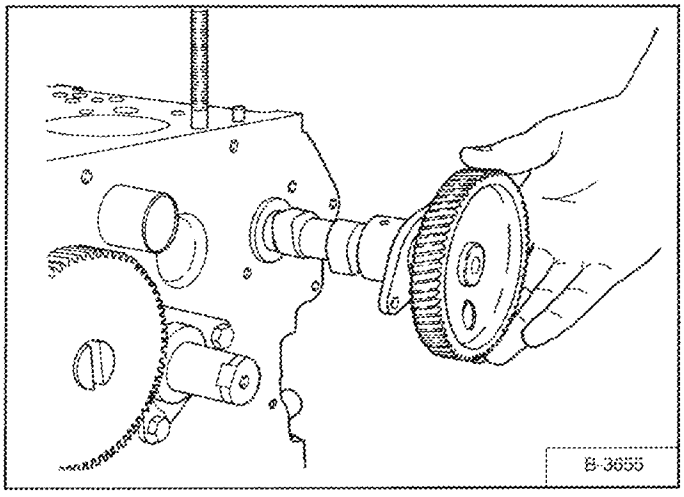
Installation: Tighten the mounting bolts to 17-20-ft.-lbs. (23-27 Nm) torque.

Align the holes on the camshaft gear with the camshaft retainer plate bolts.

Remove the bolts.

Installation: Tighten the camshaft retainer bolts to 17-20 ft.-lbs. (23-27 Nm) torque.

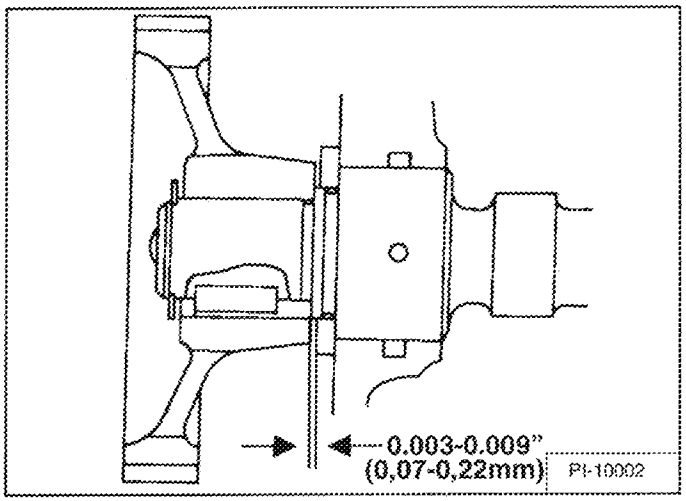
Figure 70-100-33



Remove the camshaft from the engine block **[Figure 70-100-33]**.

Idler Gear And Camshaft Removal And Installation (Cont'd)

Figure 70-100-34

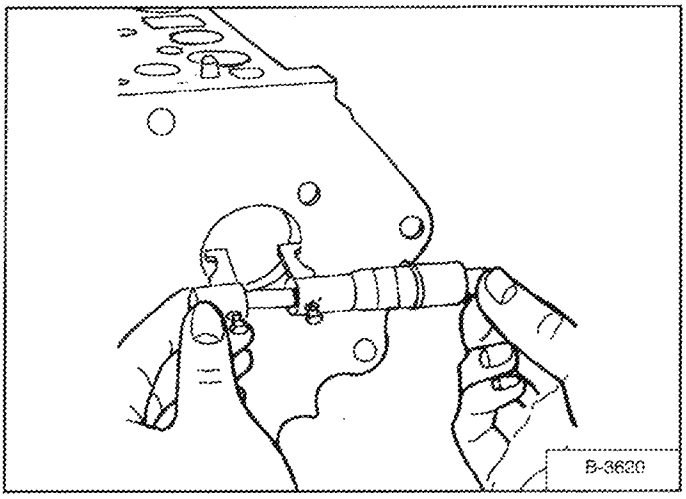


Installation: Check the camshaft end play, if the clearance exceeds the allowable limit, replace the camshaft retainer plate **[Figure 70-100-34]**.

Camshaft End Play	0.003-0.009 inch (0,07-0,22 mm)
Allowable Limit	0.012 inch (0,3 mm)

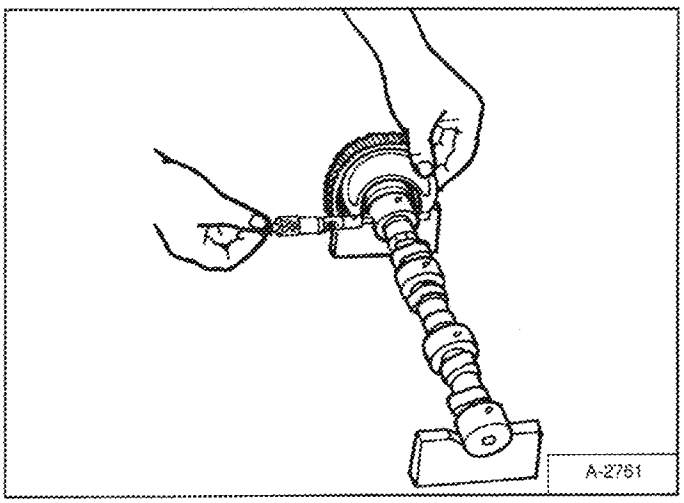
Servicing The Camshaft

Figure 70-100-35



Measure the camshaft bearing in the engine block **[Figure 70-100-35]**.

Figure 70-100-36

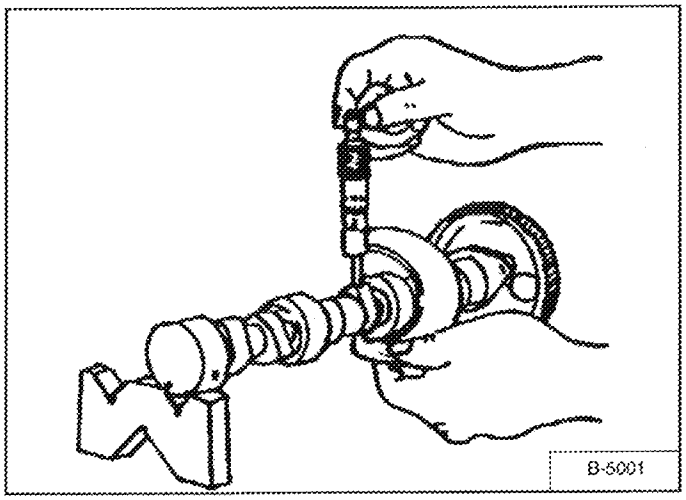


Measure the camshaft journal **[Figure 70-100-36]**.

Calculate the oil clearance. If the clearance exceeds the allowable limit, replace the camshaft.

Bearing I.D.	1.5748-1.5758 inches (40,0-40,03mm)
Journal O.D.	1.5722-1.5728 inches(39,93-39,95 mm)
Oil Clearance of Camshaft	
Journal	0.002-0.0036 inch (0,05-0,09 mm)
Allowable Limit	0.0059 inch (0,15 mm)

Figure 70-100-37



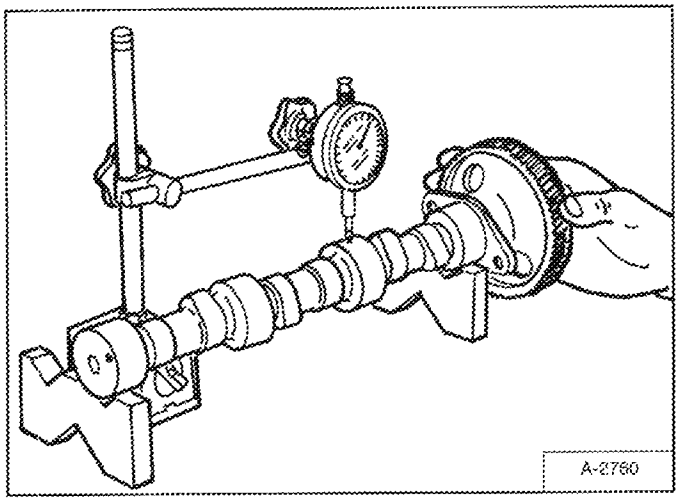
Measure the cam lobes at their highest point **[Figure 70-100-37]**.

If the measurement is less than the allowable limit, replace the camshaft.

Cam Lobe Height	1.3172 inches (33,47 mm)
Allowable Limit	1.3157 inches (33,42 mm)

Servicing The Camshaft (Cont'd)

Figure 70-100-38



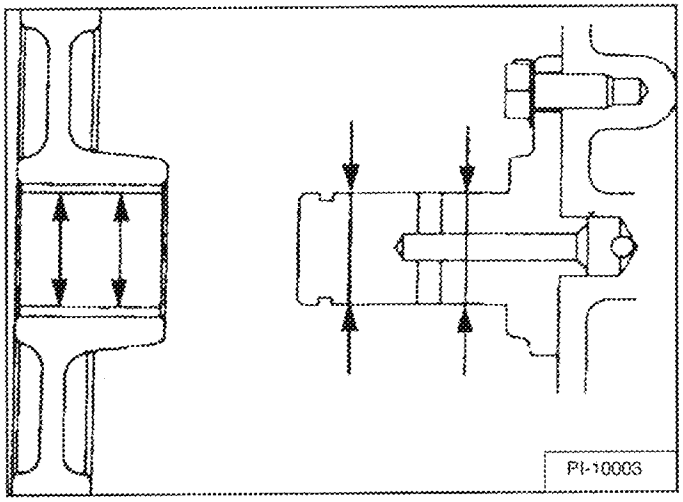
Put the camshaft in V-blocks. Install a dial indicator **[Figure 70-100-38]** on the camshaft bearing surface

Turn the camshaft at a slow rate. If the misalignment exceeds the allowable limit, replace the camshaft.

Camshaft Alignment	
Allowable Limit	0.004 inch (0,01 mm)

Servicing The Idler Gear And Shaft

Figure 70-100-39



Measure the O.D. of the idler gear shaft **[Figure 70-100-39]**.

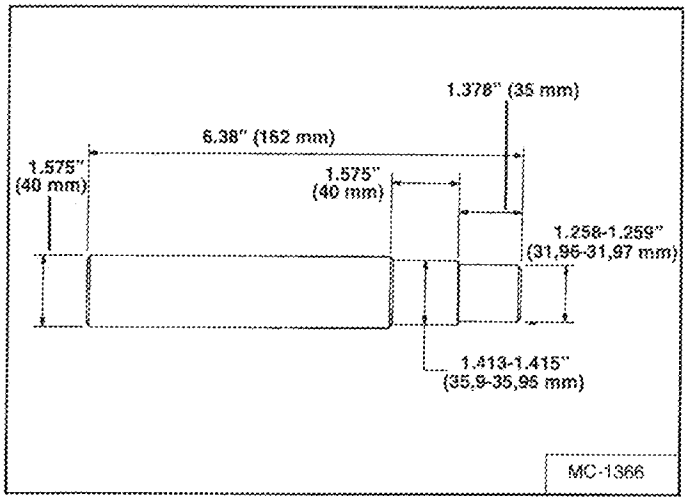
Measure the I.D. of the idler gear bushing **[Figure 70-100-39]**.

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

Idle Gear Shaft O.D.	1.2582-1.2589 inches
	(31,96-31,98 mm)
Idle Gear Bushing I.D.	1.2598-1.2608 inches
	(32,0-32,03 mm)
Clearance Between Idle Shaft & Idler Gear Bushing	0.001-0.0026 inch (0,025-0,07mm)
Allowable Limit	0.004 inch (0,1 mm)

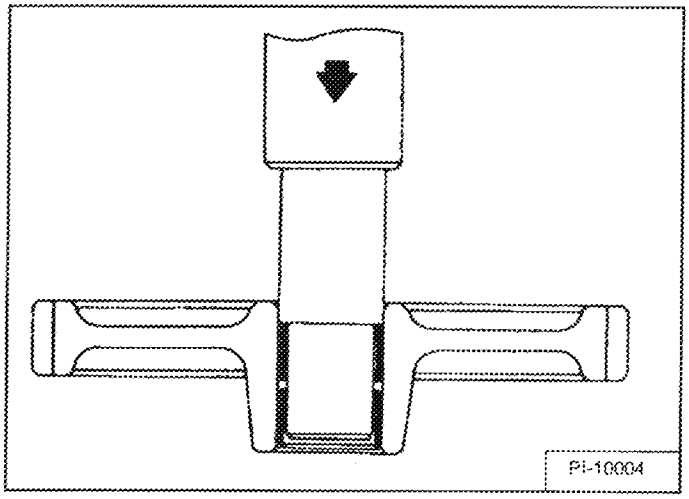
Servicing The Idler Gear And Shaft (Cont'd)

Figure 70-100-40



To replace the idler gear bushing, make a driver tool as shown in figure **[Figure 70-100-40]**.

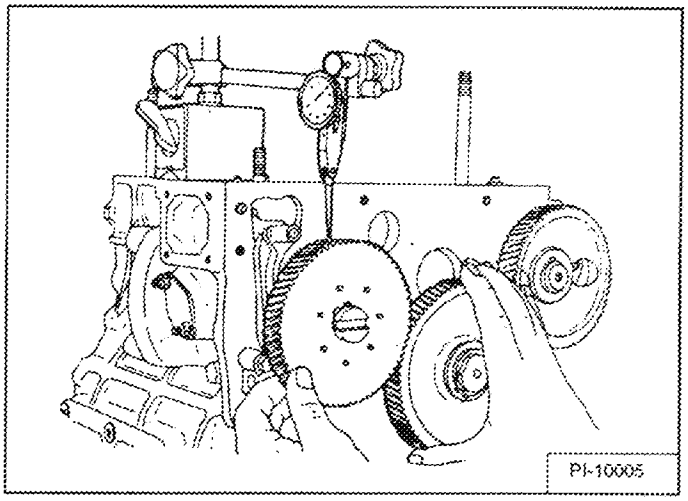
Figure 70-100-41



Use a press and special driver tool, to remove the old bushing and install the new bushing **[Figure 70-100-41]**.

Timing Gears Checking Backlash

Figure 70-100-42



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

Install a dial indicator **[Figure 70-100-42]**.

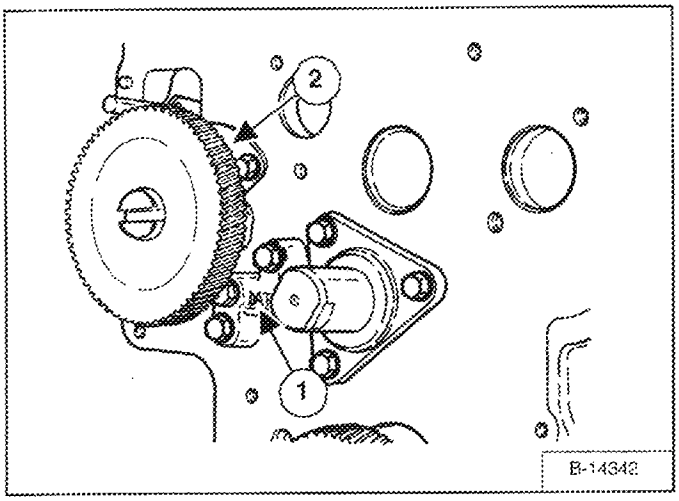
Hold one gear while turning the other gear **[Figure 70-100-42]**.

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

Crank Gear &	
Idle Gear	0.0016-0.0044 inch (0,042-0,112 mm)
Allowable Limit	0.006 inch (0,15 mm)
Cam Gear &	
Idle Gear	0.0016-0.0045 inch (0,042-0,115 mm)
Allowable Limit	0.006 inch (0,15 mm)
Injection Pump Gear &	
Idle Gear	0.0016-0.0045 inch (0,042-0,115 mm)
Allowable Limit	0.006 inch (0,15 mm)
Oil Pump Gear &	
Crank Gear	0.0016-0.0043 inch (0,042-0,109 mm)
Allowable Limit	0.006 inch (0,15 mm)

Fuel Camshaft Removal And Installation

Figure 70-100-43



Remove the timing gearcase cover. (See Contents, Page 70-01.)

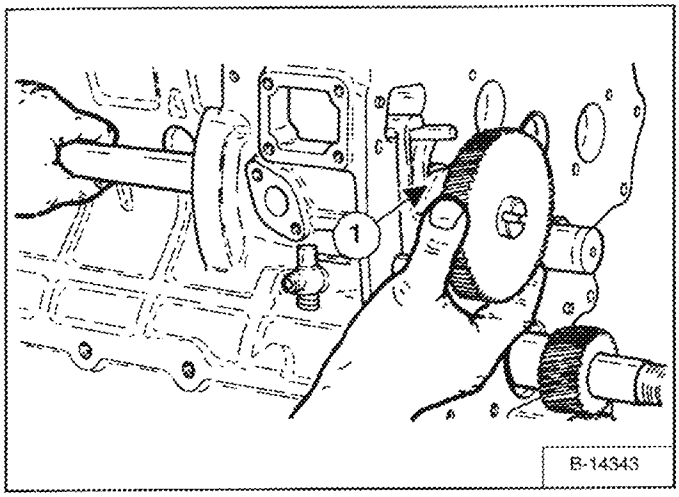
Remove the idler gear. (See Contents, Page 70-01.)

Remove the bolt (Item 1) **[Figure 70-100-43]** from the retainer plate (Item 2) **[Figure 70-100-43]**.

Installation: Tighten the bolt to 60-72 in.-lbs. (6,8-8,1 Nm) torque.

Remove the fuel camshaft retainer plate (Item 2) **[Figure 70-100-43]**.

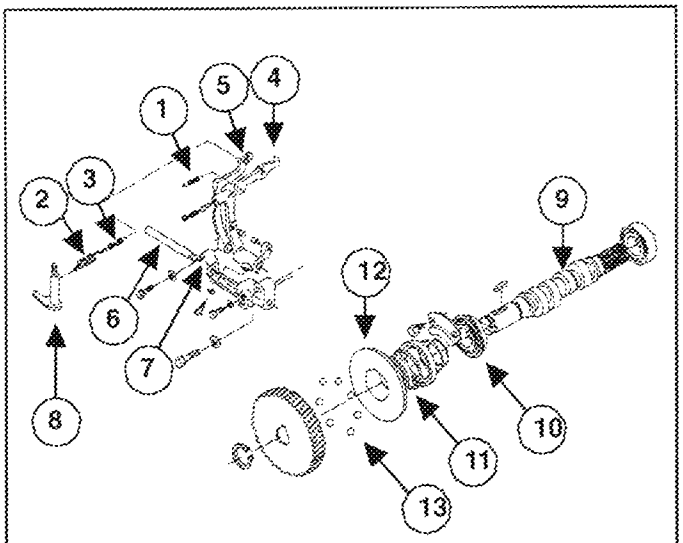
Figure 70-100-44



Remove the fuel camshaft and fork lever assembly (Item 1) **[Figure 70-100-44]** at the same time.

Fuel Camshaft Governor

Figure 70-100-45



1. Start Spring
2. Governor Spring
3. Governor Spring
4. Fork Lever
5. Fork Lever
6. Fork Lever Shaft
7. Fork Lever Holder
8. Governor Lever
9. Fuel Camshaft
10. Governor Ball Case
11. Steel Balls
12. Governor Sleeve
13. Steel Ball

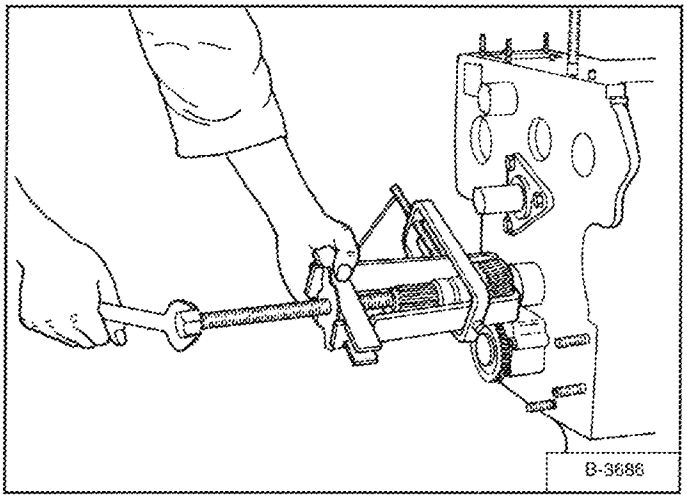
The governor serves to keep the engine speed constant by automatically adjusting the amount of fuel supplied to the engine according to changes in the load.

Disassemble and assemble the governor and fuel camshaft as shown in figure **[Figure 70-100-45]**.

Check all the parts for wear or damage and replace as needed.

Crankshaft Gear Removal And Installation

Figure 70-100-46



Remove the timing gearcase cover. (See Contents, Page 70-01.)

Remove the idler gear. (See Contents, Page 70-01.)

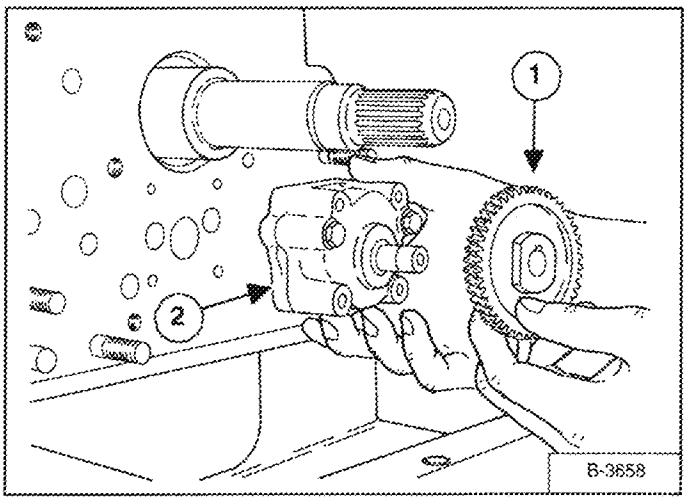
Remove the crankshaft gear with a puller **[Figure 70-100-46]**.

Remove the crankshaft key.

Installation: Install the crankshaft key. Heat the crankshaft gear to 176°F (80°C) and fit it on the crankshaft.

Oil Pump Removal And Installation

Figure 70-100-47



Remove the timing gearcase cover. (See Timing Gearcase Cover Removal And Installation on page 70-100-7.)

Remove the crankshaft gear.

Remove the nut from the oil pump shaft. Use a puller to remove the oil pump gear (Item 1) **[Figure 70-100-47]**.

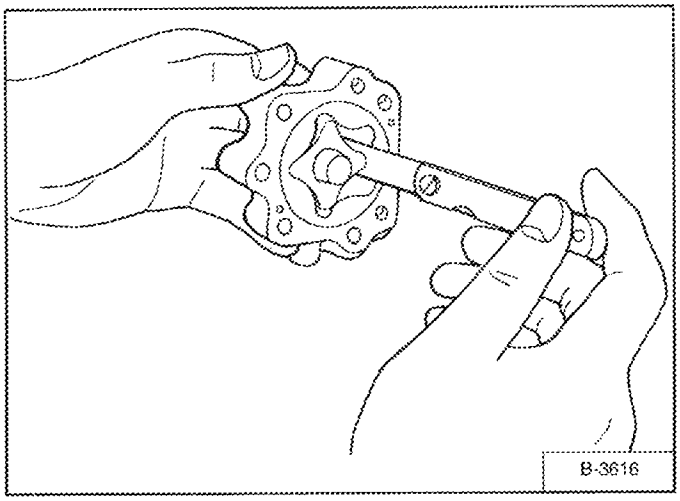
Installation: Tighten the nut on the oil pump shaft to 46-54 ft.-lbs. (62-73 Nm) torque.

Remove the oil pump mounting bolts. Remove the oil pump (Item 2) **[Figure 70-100-47]**.

Installation: Tighten the oil pump mounting bolts to 60-72 in.-lbs. (6,9-8,1 Nm) torque.

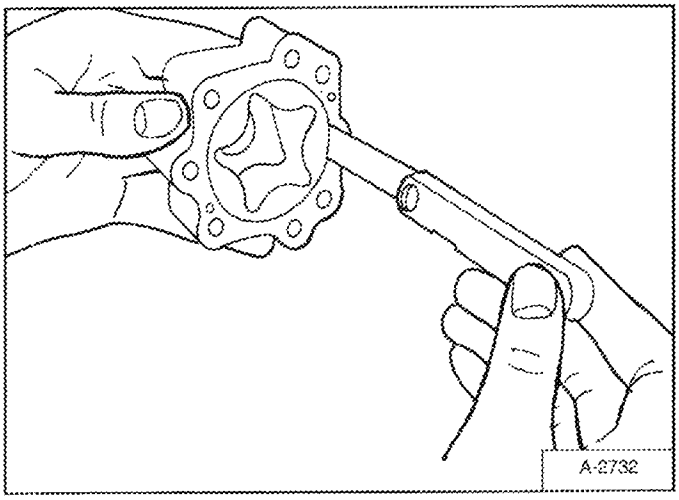
Oil Pump Service

Figure 70-100-48



Measure the clearance between the lobes of the inner rotor and outer rotor **[Figure 70-100-48]**.

Figure 70-100-49

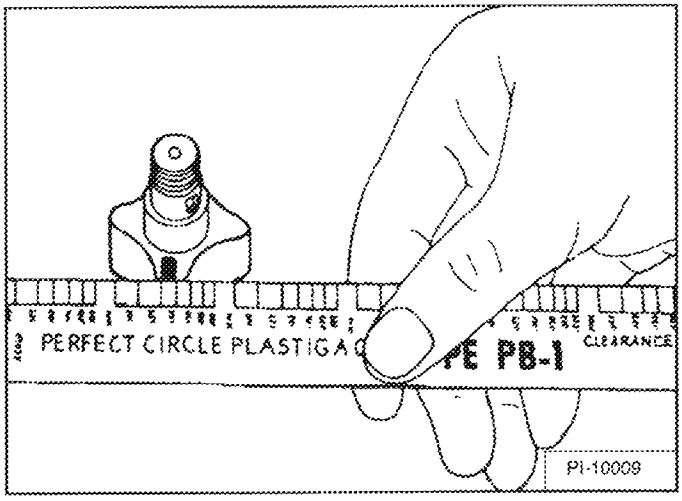


Measure the clearance between the outer roter and pump body **[Figure 70-100-49]**.

If the clearance exceeds the allowable limit, replace the oil pump.

Clearance Between Inner & Outer Rotor	0.0039-0.0063 inch (0,10-0,16 mm)
Clearance Between Outer Rotor & Body	0.0043-0.0075 inch (0, 11-0, 19 mm)

Figure 70-100-50



Put a piece of press gauge on the rotor face **[Figure 70-100-50]**.

Install the cover and tighten the bolts.

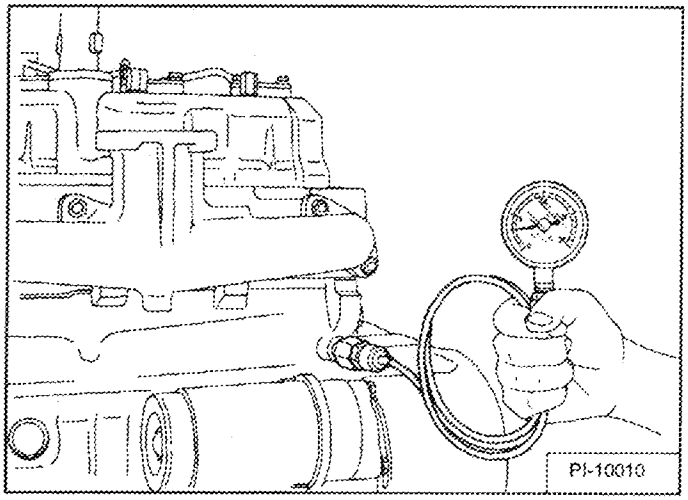
Remove the cover carefully. Measure the width of the press gauge **[Figure 70-100-50]**.

If the clearance exceeds the allowable limit, replace the oil pump.

End Clearance	0.0041-0.0059 inch (0,11-0,15 mm)

Checking Engine Oil Pressure

Figure 70-100-51



Remove the oil pressure sensor.

Install a pressure gauge **[Figure 70-100-51]**.

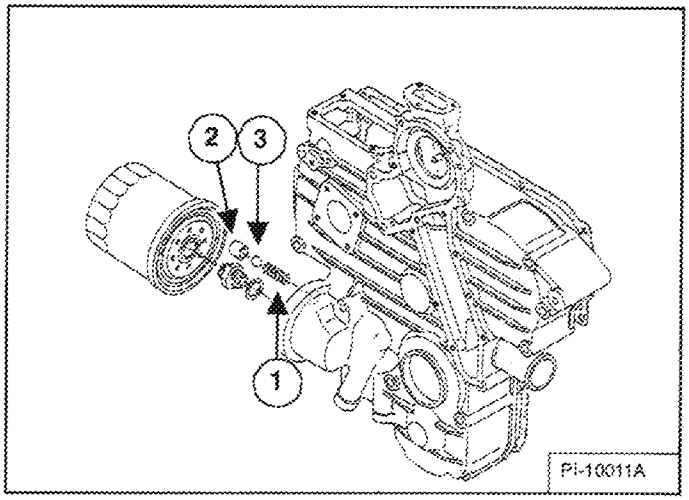
Start the engine and run until it is at operating temperature.

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

* Engine Oil Level Low
* Oil Pump Defective
* Oil Galley Plugged
* Oil Strainer Plugged
* Excessive Clearance at the Rod & Main Bearings
* Relief Valve Stuck

At Idle Speed Allowable Limit	7 PSI (49 kPa)
At IdleSpeed	14 PSI (97 kPa)
At Rated Speed	43-64 PSI (294-441 kPa)
Allowable Limit	36 PSI (245 kPa)

Figure 70-100-52



Relief Valve

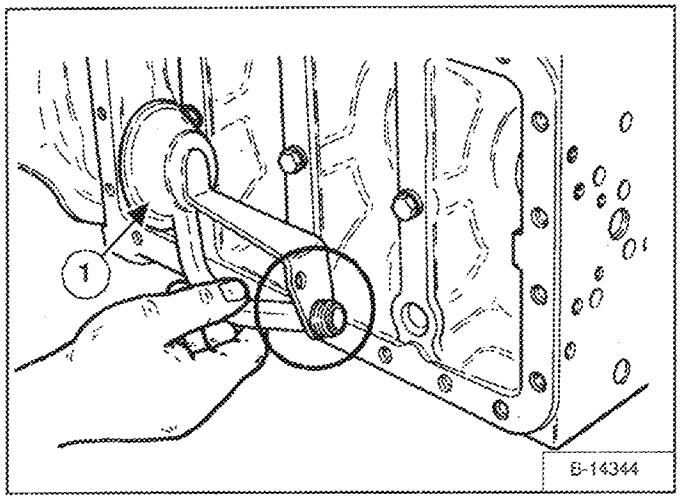
The relief valve prevents damage of the lubricating system due to high pressure. This relief valve is a ball type.

Remove the valve seat (Item 2), **[Figure 70-100-52]** ball (Item 3) **[Figure 70-100-52]** and spring (Item 1) **[Figure 70-100-52]**.

Check the parts for wear or damage and replace as needed.

Piston And Connecting Rod Removal And Installation

Figure 70-100-53



Remove the cylinder head. (See Contents, Page 70-01.)

Remove the top edge from the cylinder bore with a ridge reamer.

Remove the oil pan.

Remove the oil pump strainer (Item 1) **[Figure 70-100-53]**.

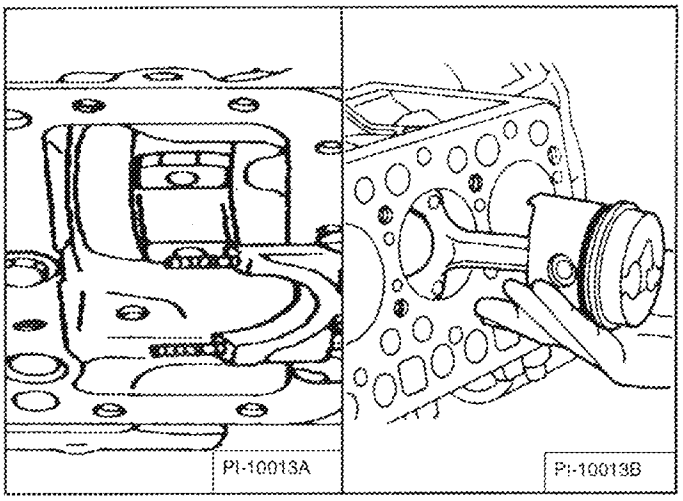
Turn the flywheel and put a pair of connecting rods at bottom dead center.

Remove the connecting rod bolts.

Installation: Tighten the connecting rod bolts to the following torque.

W/O Flange Bolt	27-30 ft.-lbs. (37-41 Nm)
W/Flange Bolt	33-36 ft.-lbs. (45-49 Nm)

Figure 70-100-54

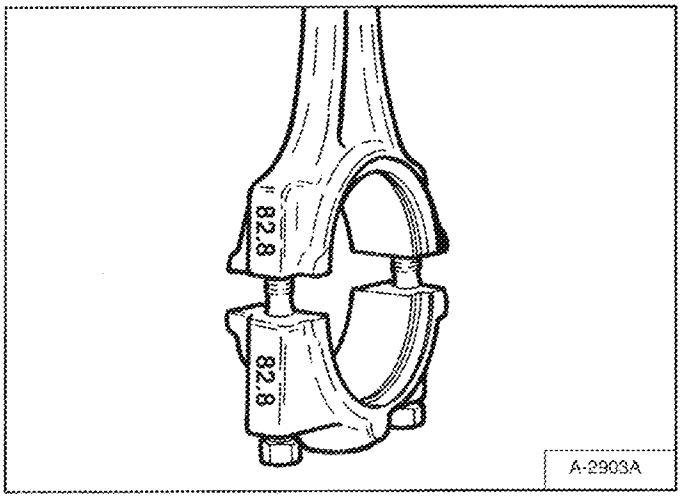


Remove the rod cap and bearing **[Figure 70-100-54]**.

Use a hammer handle and push the piston/connecting rod assembly out of the cylinder bore **[Figure 70-100-54]**.

NOTE: Make sure the pistons are marked so they will be returned to the same cylinder bore.

Figure 70-100-55

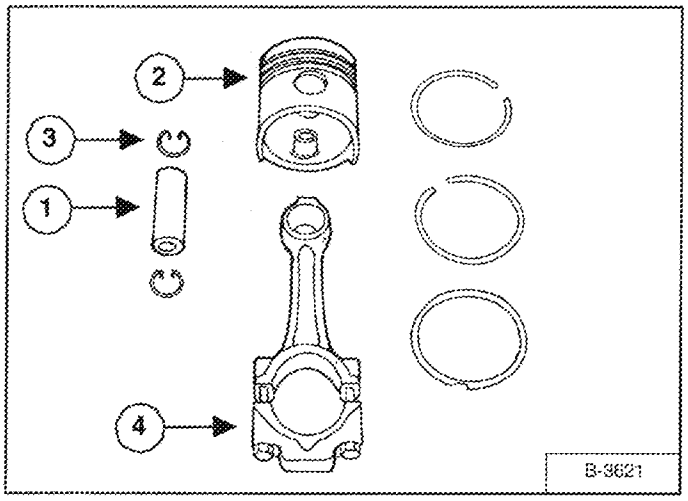


Installation: When inserting the piston into the cylinder, face the mark on the connecting rod to the injection pump **[Figure 70-100-55]**.

Repeat the procedure to remove the other piston/connecting rod assemblies from the engine block.

Piston And Connecting Rod Removal And Installation (Cont'd)

Figure 70-100-56

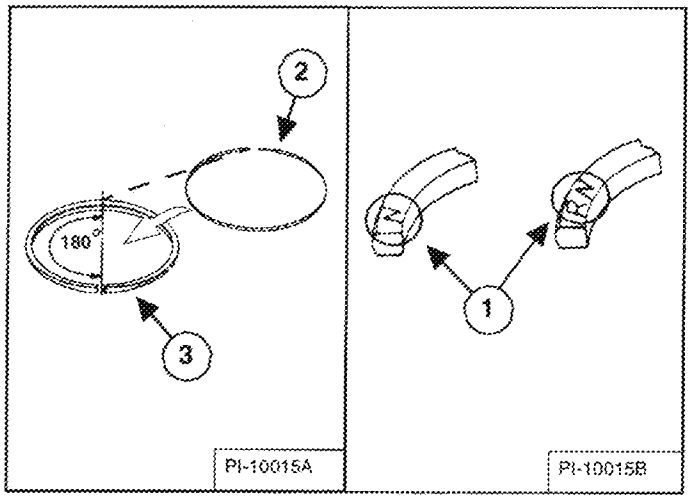


Remove the piston rings **[Figure 70-100-56]**.

Remove the snap ring (Item 3) **[Figure 70-100-56]** and piston pin (Item 1) **[Figure 70-100-56]**.

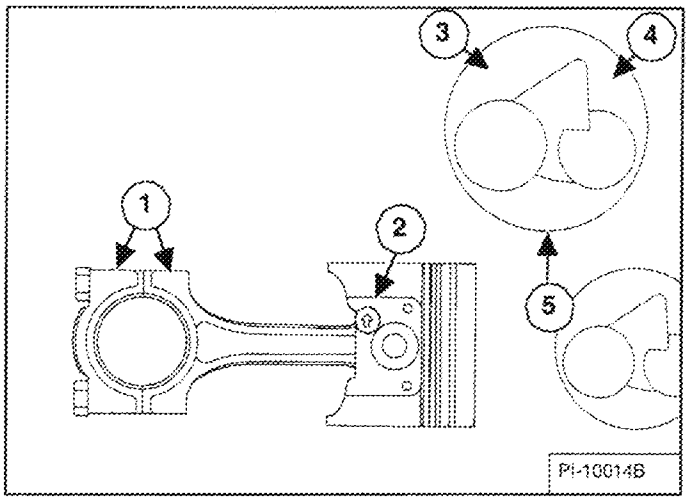
Separate the piston (Item 2) **[Figure 70-100-56]** from the connecting rod (Item 4) **[Figure 70-100-56]**.

Figure 70-100-57



Installation: When installing new rings, assemble the ring so the mark (Item 1) **[Figure 70-100-57]** near the gap faces the top of the piston. When installing the oil ring, place the expander joint (Item 2) **[Figure 70-100-57]** on the opposite side of the oil ring gap (Item 3) **[Figure 70-100-57]**.

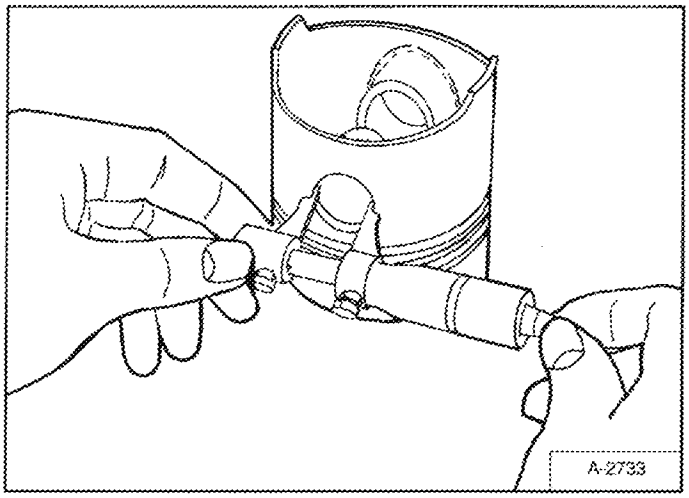
Figure 70-100-58



Installation: When reassembling, align the marks (Item 1) **[Figure 70-100-58]** on the connecting rod and piston (Item 2) **[Figure 70-100-58]**. Heat the piston to 176-212°F. (80-100°C.) and tap the piston pin into position. Place the piston rings so that there are gaps every 120 degrees (Items 3, 4&5) **[Figure 70-100-58]** with no gap facing the piston pin in the cylinder.

Servicing The Piston And Connecting Rod

Figure 70-100-59



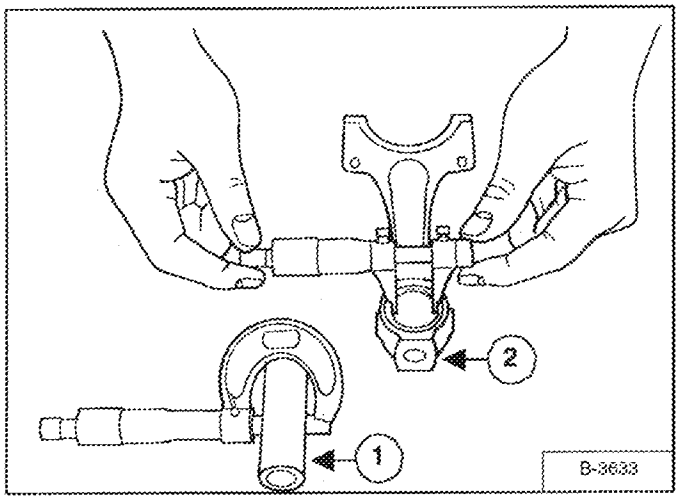
Measure the I.D. of the piston pin bore in both horizontal and vertical directions **[Figure 70-100-59]**.

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

Piston Pin Bore I.D.	0.9843-0.9848 inch
	(25,0-25,014 mm)
Allowable Limit	0.9862 inch (25,05 mm)

Servicing The Piston And Connecting Rod (Cont'd)

Figure 70-100-60



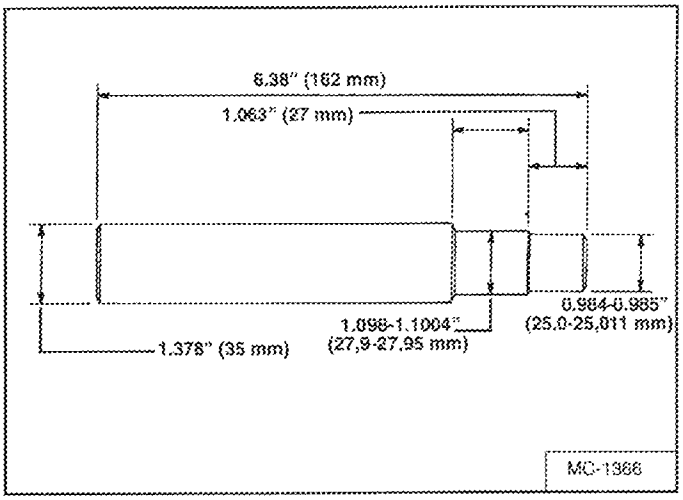
Measure the O.D. of the piston pin (Item 1) **[Figure 70-100-60]**.

Measure the I.D. of the connecting rod small end (Item 2) **[Figure 70-100-60]**.

Calculate the oil clearance. If the clearance exceeds the allowable limit, replace the bushing. If it still exceeds the specifications, replace the piston pin.

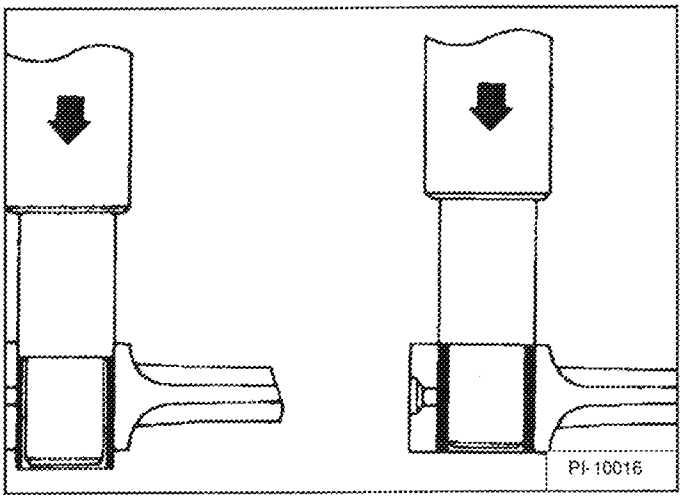
Piston Pin O.D.	0.9843-0.9847 inch (25,0-25,011 mm)
Small End Bushing I.D.	0.9852-0.9858 inch (25,03-25,04 mm)
Clearance Between Piston Pin & Small End	
Bushing	0.0006-0.0015 inch (0,014-0,038 mm)
Allowable Limit	0.0059 inch (0,15 mm)

Figure 70-100-61



To replace the connecting rod small end bushing, make a driver tool as shown in figure **[Figure 70-100-61]**.

Figure 70-100-62

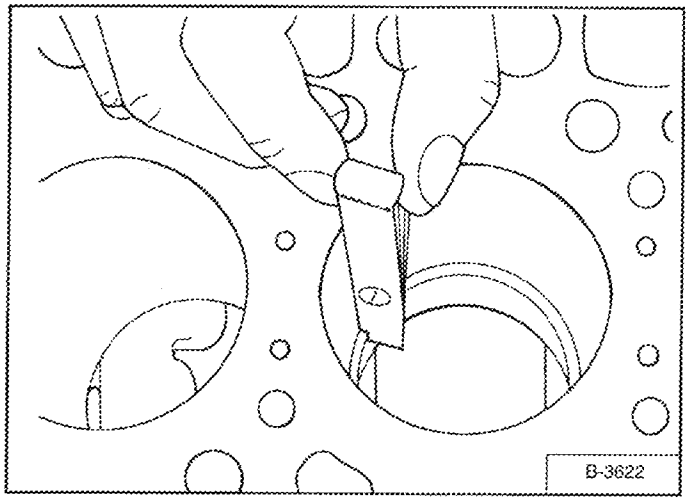


Use a press and special driver tool to remove the small end bushing **[Figure 70-100-62]**.

Installation: Clean the small end bushing and bore. Put oil on the bushing and press into the connecting rod until it is flush **[Figure 70-100-62]**.

Servicing The Piston And Connecting Rod (Cont'd)

Figure 70-100-63

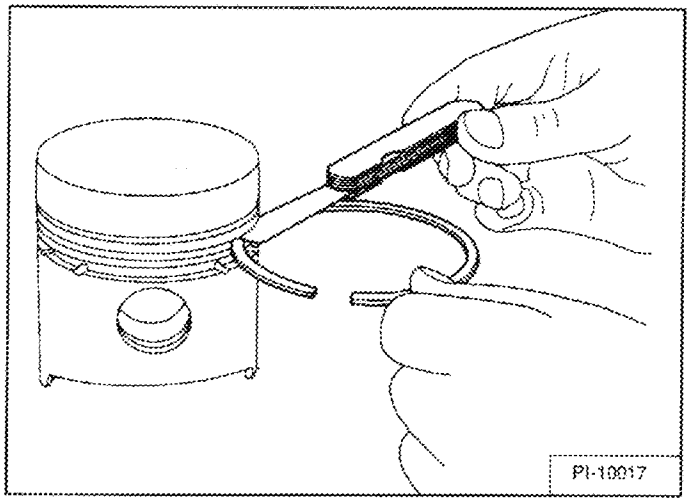


Install new piston ring into the lower part of the cylinder bore. Measure the ring gap with a feeler gauge **[Figure 70-100-63]**.

If the gap exceeds the allowable limit, replace the cylinder liner.

Compression Ring Gap	0.0118-0.0177 inch (0,3-0,45 mm)
Oil Ring Gap	0.010-0.016 inch (0,25-0,4 mm)
Allowable Limit	0.0492 inch (1,25 mm)

Figure 70-100-64



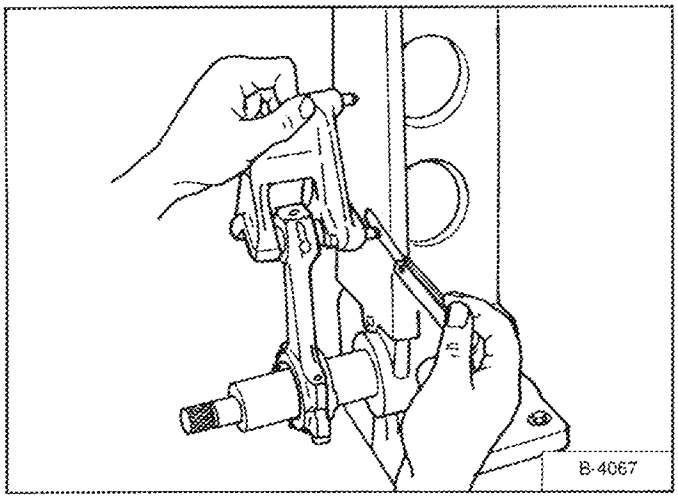
Remove the carbon from the ring grooves. Measure the clearance between the ring and groove with a feeler gauge **[Figure 70-100-64]**.

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

Compression Ring	0.0037-.0047 inch (0,093-,12 mm)
Allowable Limit	.0079 inch (,2 mm)
Oil Ring	0.0008-.002 inch (0,02-,052 mm)
Allowable Limit	.0059 inch (,15 mm)

Connecting Rod Alignment

Figure 70-100-65



NOTE: The small end bushing is the basis of this check, check the bushing for wear before doing this check.

Install the piston pin into the connecting rod.

Install the connecting rod on a alignment tool.

Put the gauge over the piston pin and move it against the face plate.

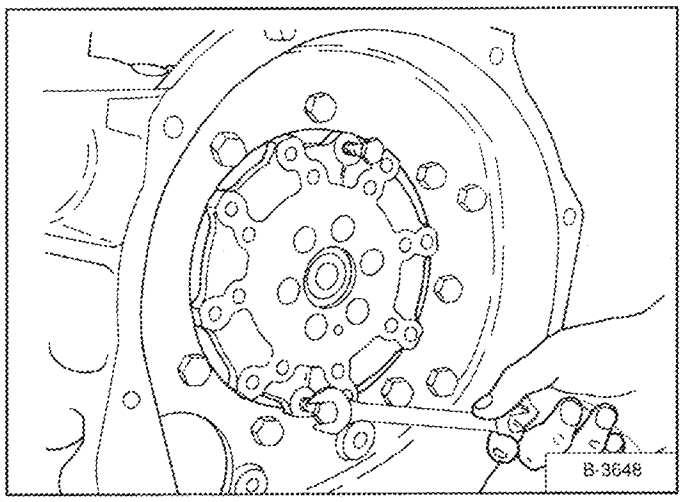
If the gauge does not fit squarely against the face plate, measure the space between the gauge and face plate **[Figure 70-100-65]**.

If the measurement exceeds the allowable limit, replace the connecting rod.

Rod Alignment	0.002 inch (0,05 mm)

Crankshaft And Bearings Removal And Installation

Figure 70-100-66



Remove the piston and connecting rod assemblies. (See Contents, Page 70-01.)

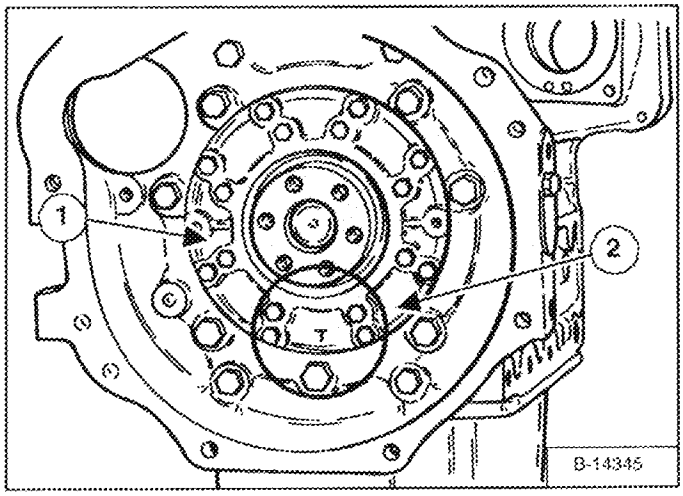
Remove the engine flywheel. (See Contents, Page 70-01.)

Remove the bolts which fasten the bearing case cover to the block.

Installation: Tighten the bearing case cover bolts to 13-15 ft.-lbs. (18-21 Nm) torque.

Install two bolts into the bearing case cover and pull the cover out **[Figure 70-100-66]**.

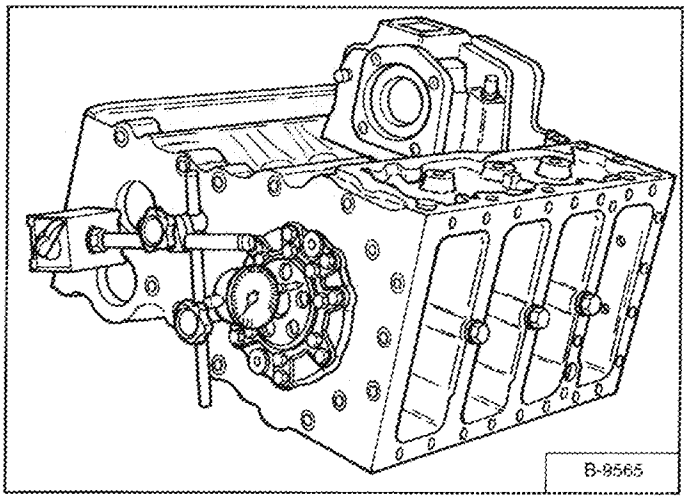
Figure 70-100-67



Installation: When installing the cover (Item 1) **[Figure 70-100-67]**, make sure the casting mark (Item 2) **[Figure 70-100-67]** is in the down position.

Crankshaft And Bearings Removal And Installation (Cont'd)

Figure 70-100-68

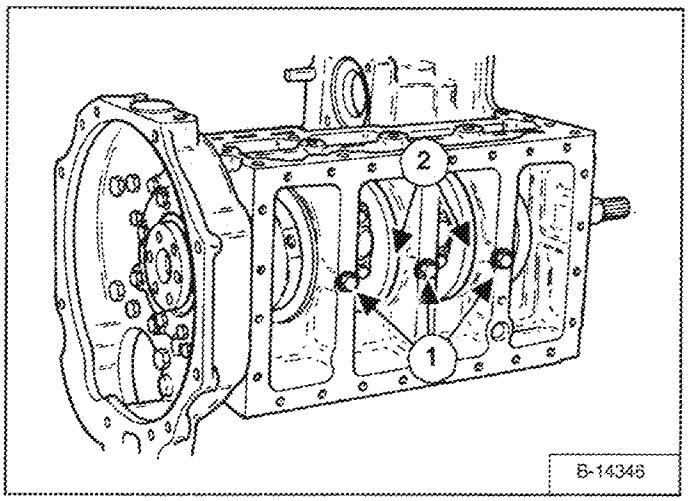


Before removing the crankshaft/main bearings, check the end play. Install a dial indicator. Measure the end play by moving the crankshaft back and forth **[Figure 70-100-68]**.

If the measurement exceeds the allowable limit, replace the thrust washers.

End Play	0.0059-0.0122 inch (0,15-0,31 mm)
Allowable Limit	0.0197 inch (0,5 mm)

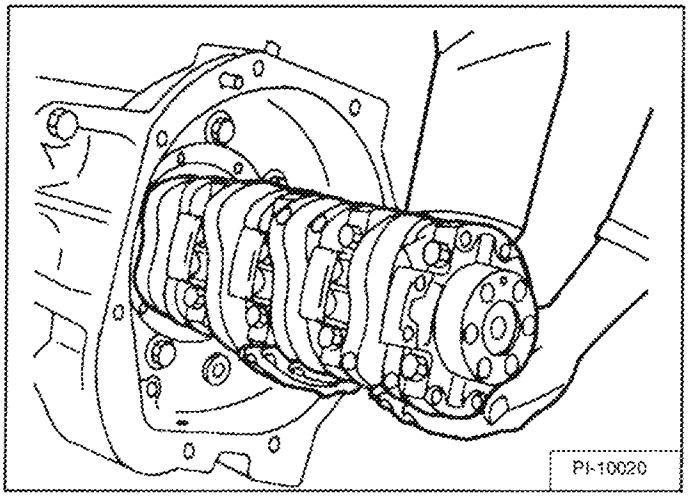
Figure 70-100-69



Remove the main bearing case bolt (Item 1) **[Figure 70-100-69]**.

Installation: Make alignment of the bearing case hole (Item 2) **[Figure 70-100-69]** with the hole in the block. Put oil on the bolt threads and tighten to 51-54-ft.-lbs. (69-73 Nm) torque.

Figure 70-100-70

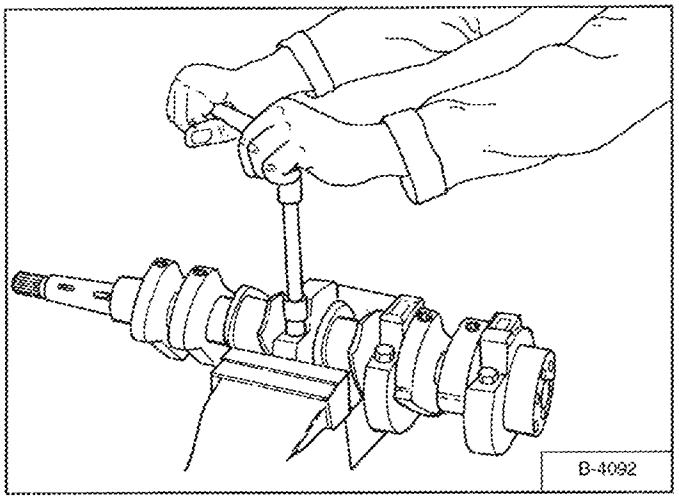


Remove the crankshaft/main bearing assembly from the engine block **[Figure 70-100-70]**.

Mark the bearing case halves for correct installation.

Crankshaft And Bearings Removal And Installation (Cont'd)

Figure 70-100-71

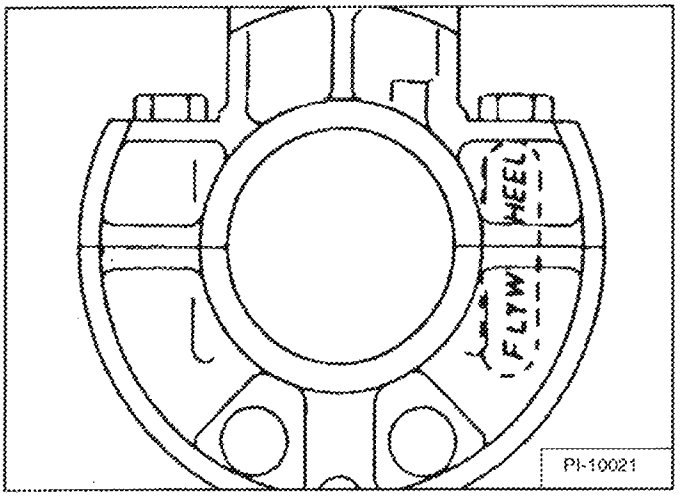


Remove the two bearing case bolts **[Figure 70-100-71]**.

Remove the bearing case and bearing.

Installation: Tighten the bearing case bolts to 34-38 ft.-lbs. (46-52 Nm) torque.

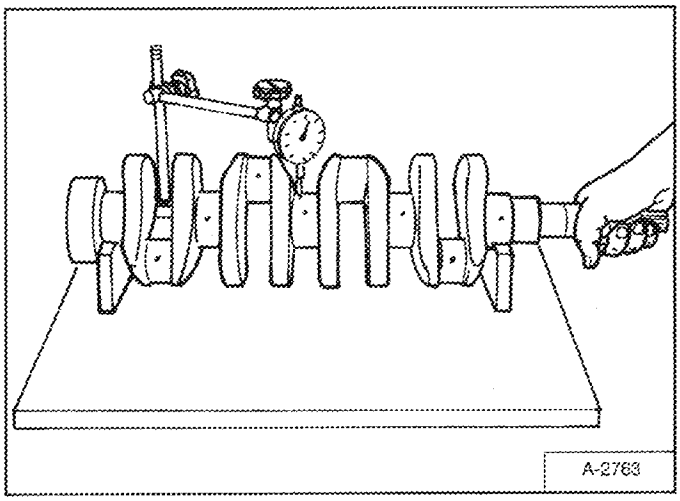
Figure 70-100-72



Installation: When installing the main bearing case assemblies, face the mark FLYWHEEL to the flywheel side of the engine block **[Figure 70-100-72]**. Be sure the thrust washers with its oil grooves face outward.

Servicing The Crankshaft And Bearings

Figure 70-100-73



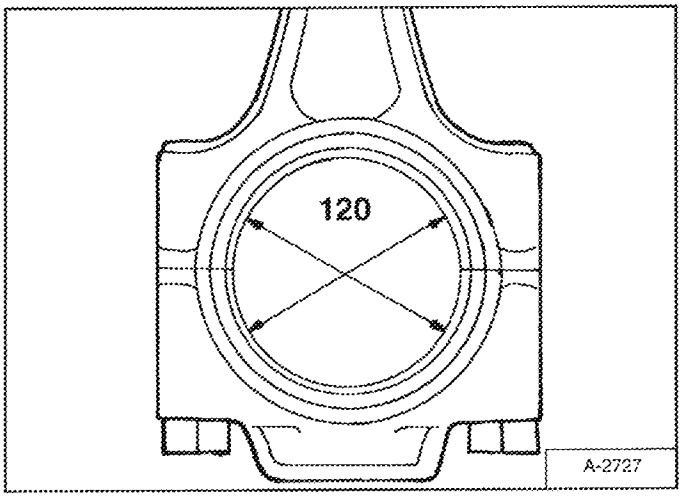
Put the crankshaft on V-blocks. Install a dial indicator on the center journal **[Figure 70-100-73]**.

Turn the crankshaft at a slow rate.

If the misalignment exceeds the allowable limit, replace the crankshaft.

Alignment	0.00079 inch (0,02 mm)

Figure 70-100-74

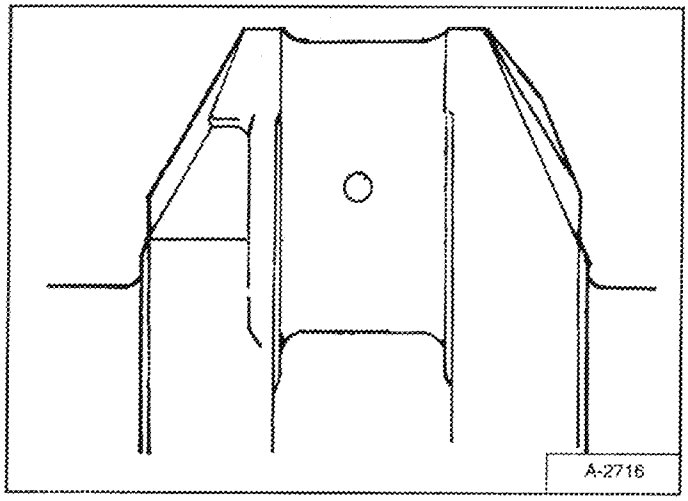


Tighten the connecting rod cap bolts as follows:

W/O Flange Bolt	27-30 ft.-lbs. (37-41 Nm)
W/Flange Bolt	33-36 ft.-lbs. (45-49 Nm)

Servicing The Crankshaft And Bearings (Cont'd)

Figure 70-100-75

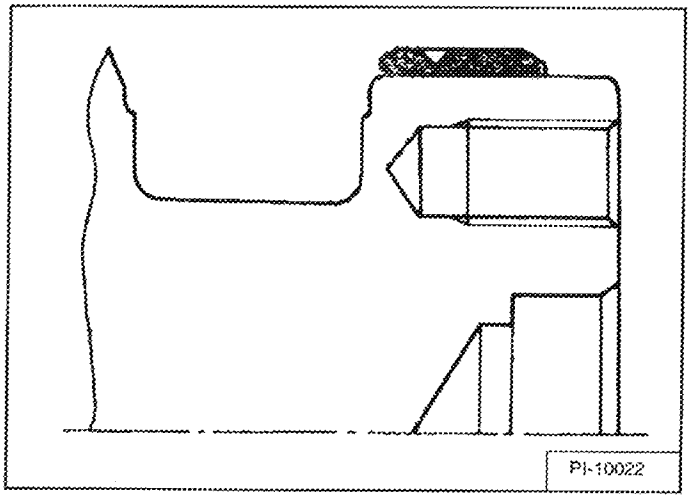


Measure the crankpin O.D. **[Figure 70-100-75]**.

Calculate the oil clearance.

Crankpin Bearing I.D.	1.8504-1.8522 inches (47,0-47,046 mm)
Crankpin O.D.	1.8488-1.8494 inches (46,96-46,98 mm)
Oil Clearance	0.0009-0.0034 inch (0,025-0,087 mm)

Figure 70-100-76

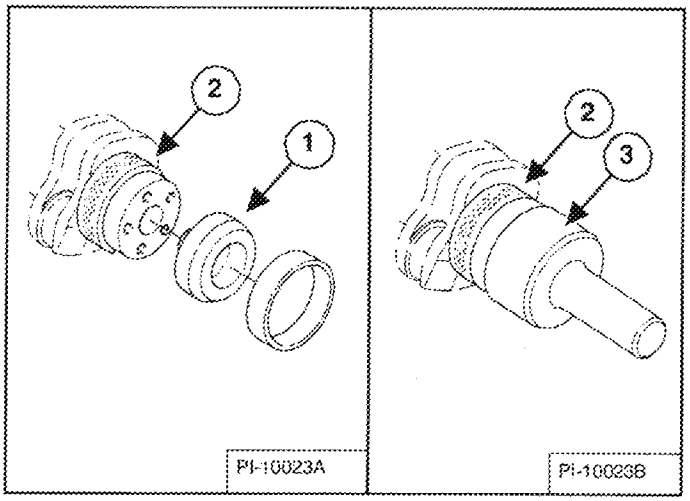


Check the wear on the crankshaft sleeve **[Figure 70-100-76]**.

If the wear exceeds the allowable limit or the seal leaks oil, replace the sleeve,

Wear of Sleeve	0.004 inch (0,1 mm)

Figure 70-100-77



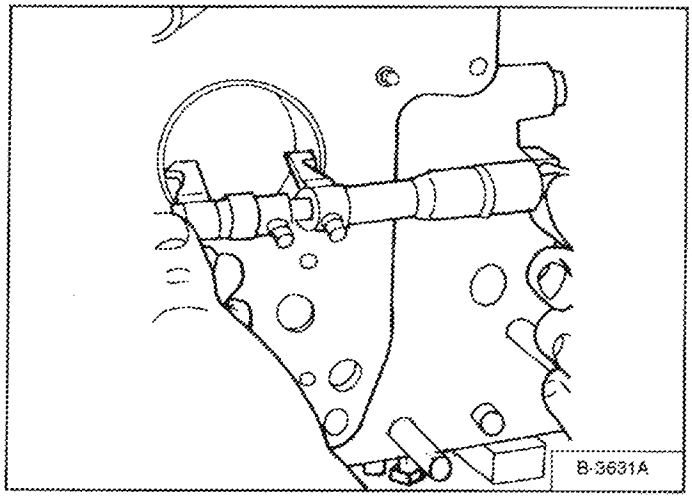
The special tool set (Kubota Code Number: 07916-32091) will be needed to replace the crankshaft sleeve.

Remove the sleeve.

Install the sleeve guide (Item 1) **[Figure 70-100-77]** and stop (Item 2) **[Figure 70-100-77]**.

Heat the sleeve to about 300°F (150°C). Install the sleeve on the crankshaft using the special driver tool (Item 3) **[Figure 70-100-77]**.

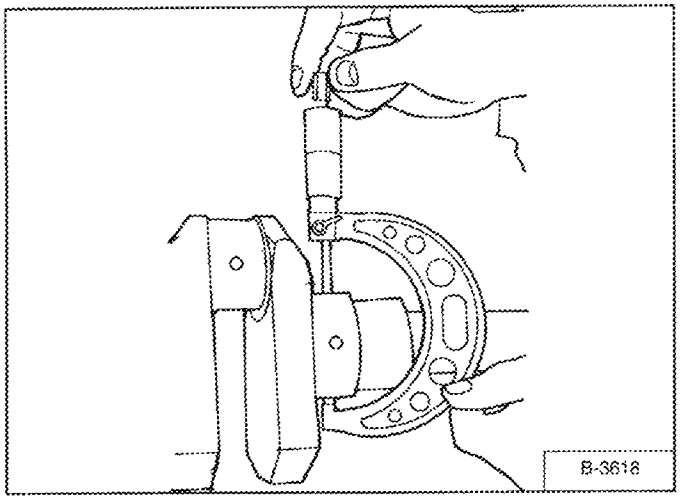
Figure 70-100-78



Measure the I.D. of the No. 1 crankshaft bearing **[Figure 70-100-78]**.

Servicing The Crankshaft And Bearings (Cont'd)

Figure 70-100-79



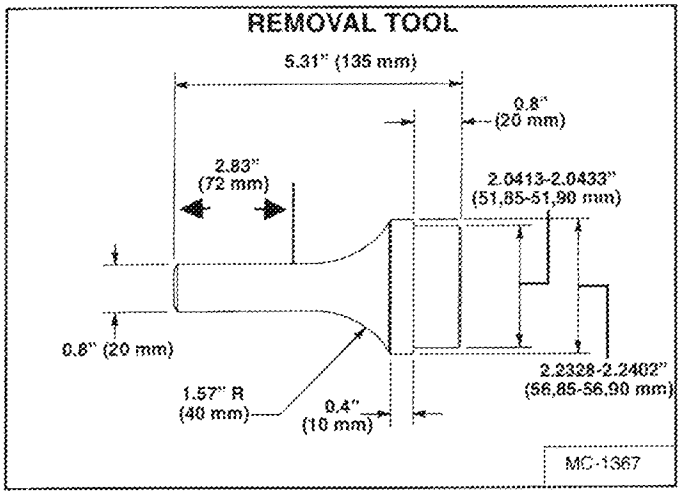
Measure the O.D. of the crankshaft journal **[Figure 70-100-79]**.

Calculate the oil clearance.

If the clearance exceeds the allowable limit, replace the crankshaft bearing.

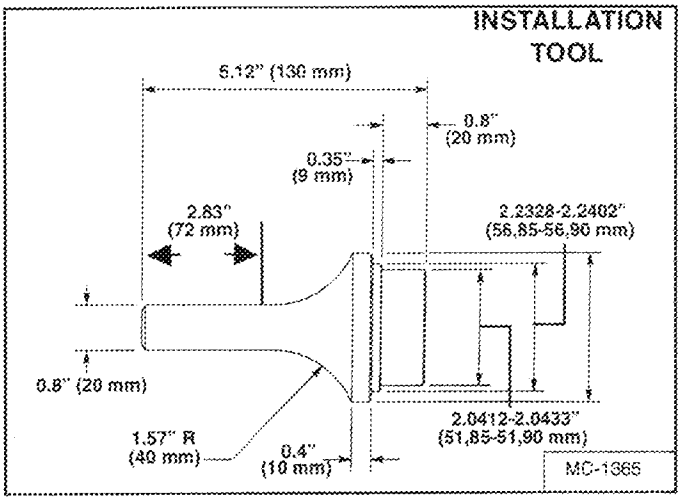
Bearing I.D.	2.0465-2.0488 inches (51,98-52,04 mm)
Journal O.D.	2.0441-2.0449 inches (51,92-51,94 mm)
Oil Clearance	0.0016-0.0046 inch (0,04-0,12 mm)
Allowable Limit	0.0079 inch (0,2 mm)

Figure 70-100-80



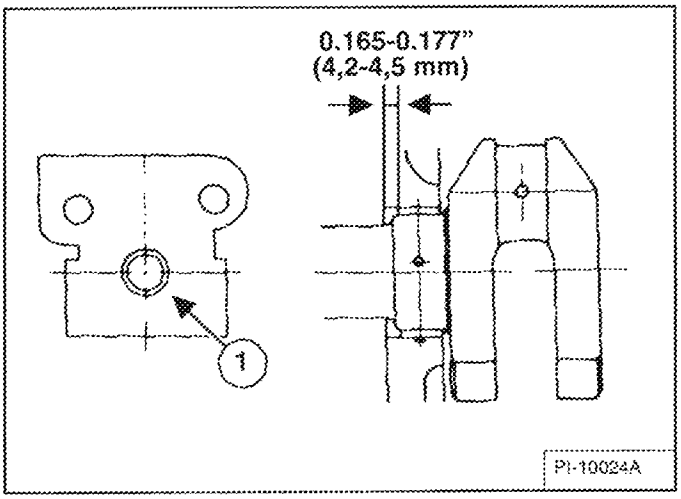
To remove the front bearing make the driver tool as shown in figure **[Figure 70-100-80]**.

Figure 70-100-81



To install the front bearing make the driver tool as shown in figure **[Figure 70-100-81]**.

Figure 70-100-82

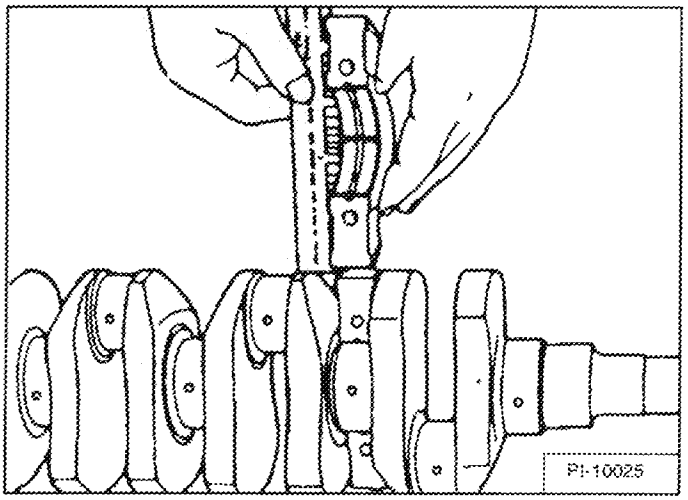


Remove the front bearing (Item 1) **[Figure 70-100-82]** with the special removal tool.

Installation: Clean the new bearing and bore, apply oil on them. Install the new bearing with the installation driver tool **[Figure 70-100-82]**.

Servicing The Crankshaft And Bearings (Cont'd)

Figure 70-100-83



Clean the crankshaft journal and bearing. Put a strip of press gauge on the center journal.

Install the main bearing case halves and tighten the bolts. Remove the bearing case halves.

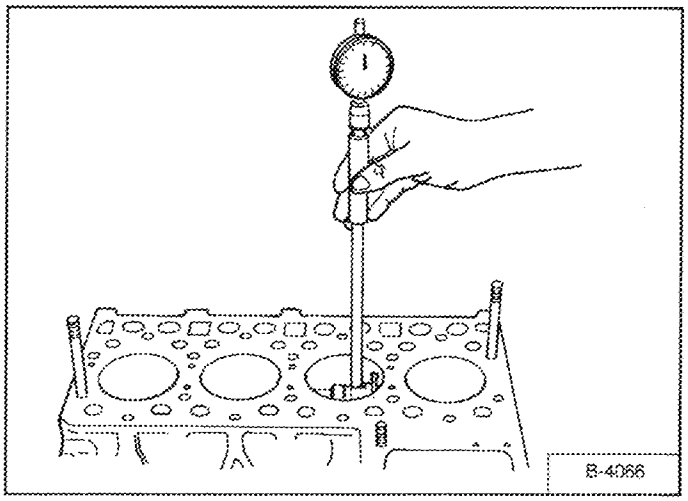
Measure the flattened press gauge **[Figure 70-100-83]**.

If the clearance exceeds the allowable limit, replace the crankshaft bearing.

Crankshaft Journal	
O.D.	2.0441-2.0449 inches (51,92-51,94 mm)
Bearing I.D.	2.0465-2.0482 inches (51,98-52,03 mm)
Oil Clearance	0.0016-0.0041 inch (0,04-0,10 mm)
Allowable Limit	0.0079 inch (0,2 mm)

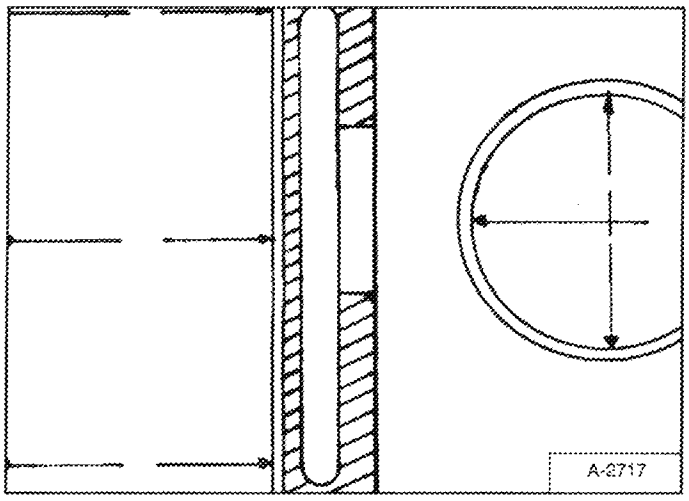
Checking The Cylinder Bore

Figure 70-100-84



Use a gauge to check the inside measurement of the cylinder bore **[Figure 70-100-84]**.

Figure 70-100-85



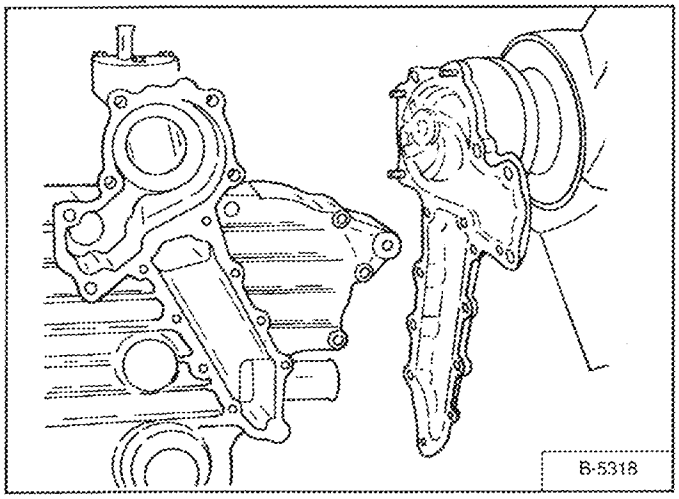
Measure the six points as shown in figure **[Figure 70-100-85]** to find the maximum wear.

The specification is 3.4252-3.4261 inches (87,0-87,022 mm). The wear limit is +0.0059 inch (+0,15 mm).

If the cylinder bore is not within specifications, re-bore the cylinder for oversize piston.

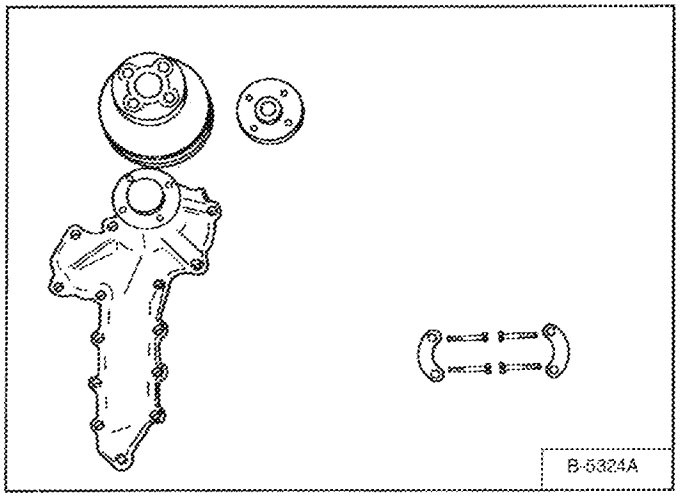
Water Pump Disassembly And Assembly

Figure 70-100-86



Remove the water pump from the timing gearcase cover **[Figure 70-100-86]**.

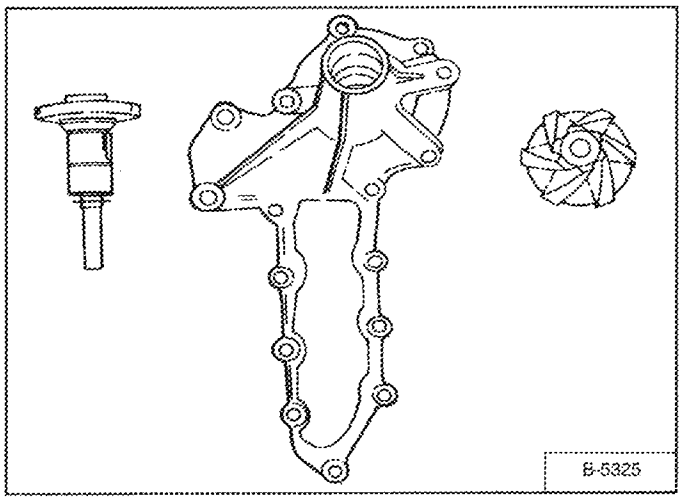
Figure 70-100-87



Put the water pump in a vise and remove the nut **[Figure 70-100-87]**.

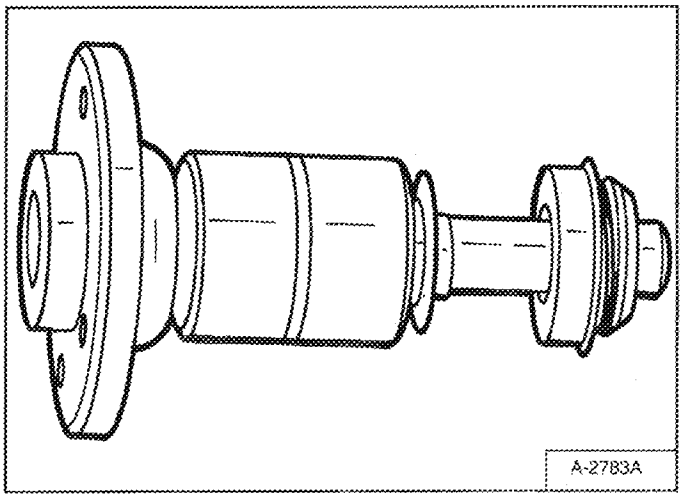
Remove the pulley using a puller. Remove the key and snap ring.

Figure 70-100-88



Drive the shaft out of the impeller side of the water pump housing **[Figure 70-100-88]**.

Figure 70-100-89



Install the new seals **[Figure 70-100-89]**. Install the shaft.

Installation: Put the water pump in a vise and tighten the nut to 50-57 ft.-lbs. (68-77 Nm) torque. Always use a new gasket when installing the water pump on the timing gearcase cover.