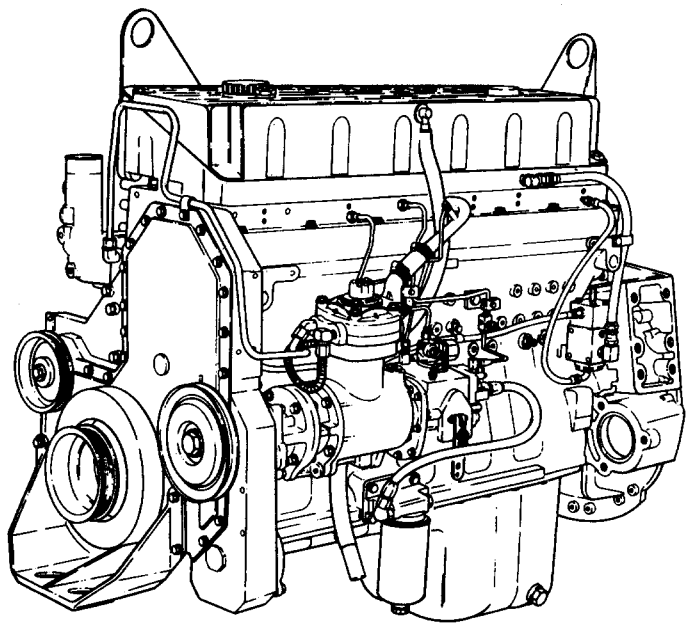
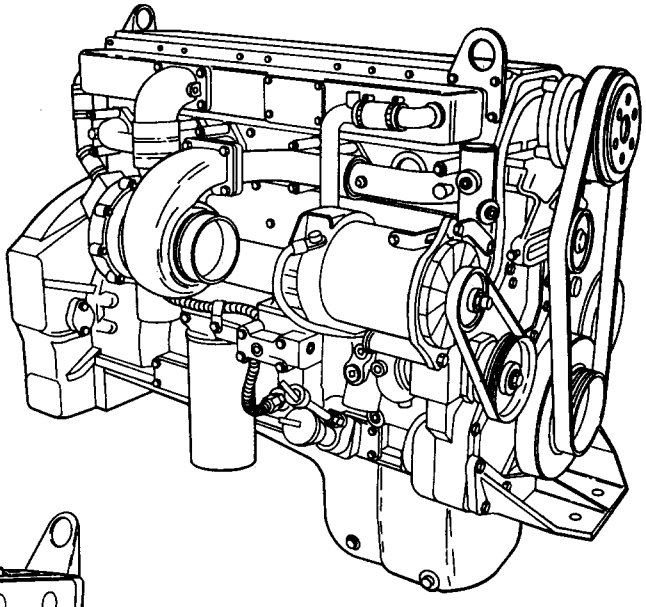
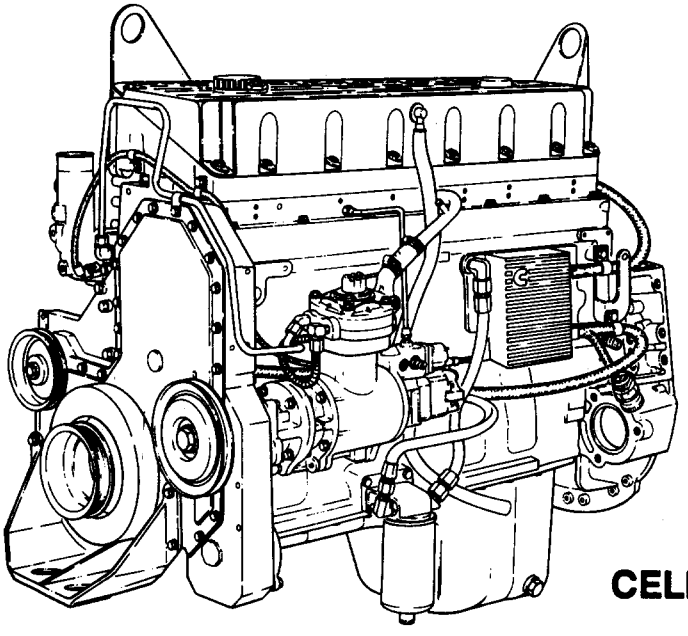
Shop Manual
L10 Series Engines
External Damper Models



STC



Fixed Time



CELECT

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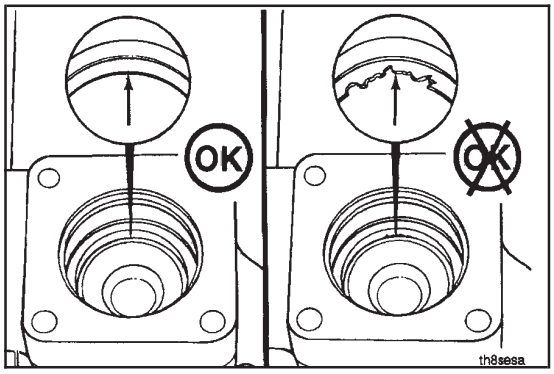
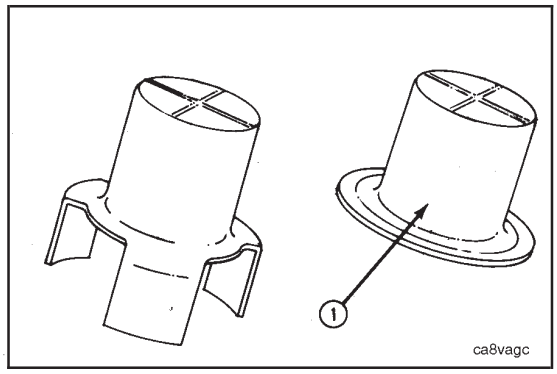
Printed 3/93

Illustrations

The illustrations used in the ″Repair Sections″ of this manual are intended to give an example of a problem, and to show what to look for and where the problem can be found. Some of the illustrations are ‘‘generic’’ and might **not** look exactly like the engine or parts used in your application. The illustrations can contain symbols to indicate an action required, and an acceptable or **not** acceptable condition.



The illustrations are intended to show repair or replacement procedures. The illustration can differ from your application, but the procedure given will be the same.



Section E - Engine Identification

Section Contents

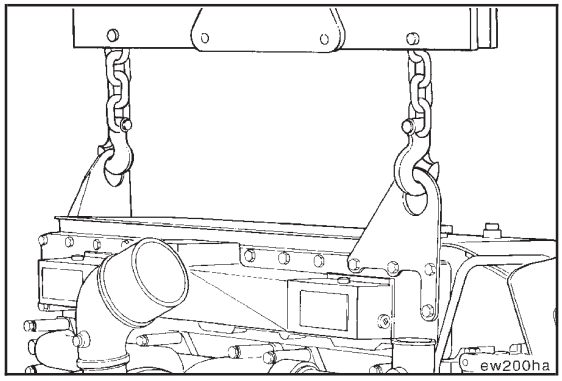
Page

Engine Lifting Brackets

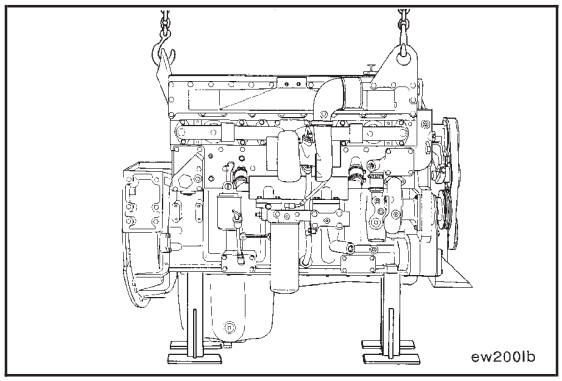
Warning: The engine lifting equipment must be designed to safely lift the engine as an assembly.

Use a properly rated hoist and engine lifting fixture, Part No. 3822512, attached to the engine mounted lifting brackets to lift the engine.

Refer to Section E for the weight of the engine you are working on.



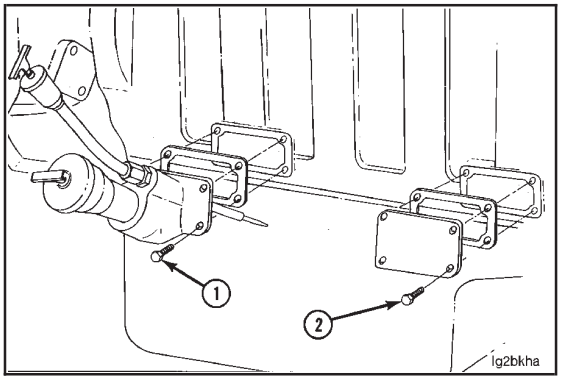
Install the engine on two engine support stands, Part No. 3376057.



Hand Hole Cover and Dipstick Tube Bracket - Removal

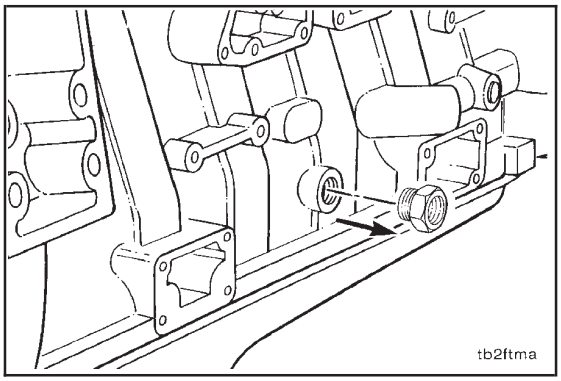
Remove the four capscrews (1), the dipstick tube bracket and gasket.

Remove the four capscrews (2), the hand hole cover and gasket.



Turbocharger Oil Drain Connection - Removal

Remove the turbocharger oil drain tube connection fitting from the side of the cylinder block.

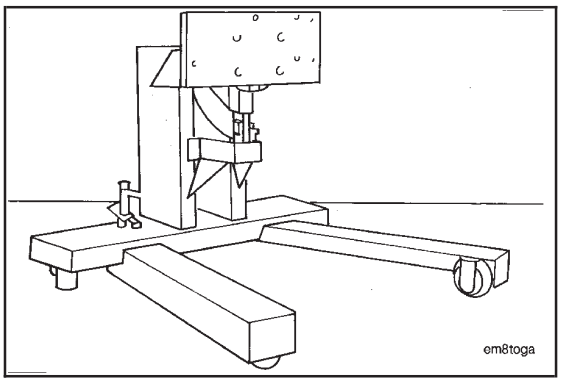


Engine - Installation On Rebuild Stand

Use the engine rebuild stand, Part No. 3375194, and adapter plate, Part No. 3376432.

Use five capscrews (5/8—11 X 2 inch) grade 5 capscrews to install the adapter plate to the rebuild stand.

Torque Value: 180 N•m [135 ft-lb]

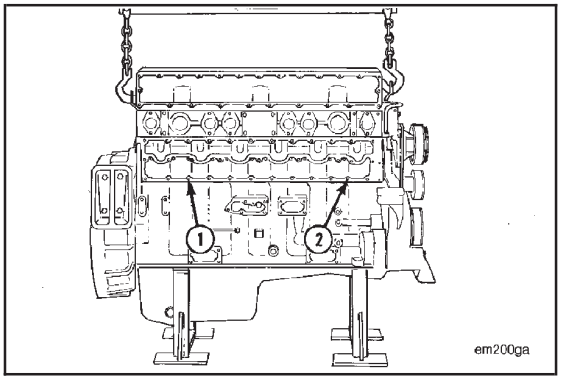


Install two guide pins, Part No. 3376488, in the water header plate mounting capscrew holes at points (1) and (2).

Warning: To avoid personal injury, use a properly rated hoist to lift the engine. The engine weighs approximately 902 kg [1990 lb].

Use the engine lifting fixture, Part No. 3822512, to lift the engine.

Install the exhaust side of the engine to the adapter plate of the rebuild stand.

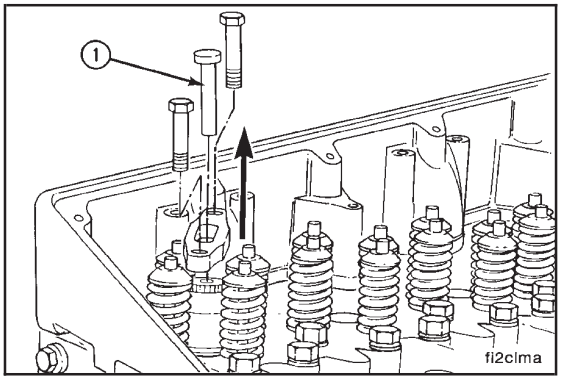


Injectors (Fixed Time Engines) - Removal

Remove the injector plunger links (1).

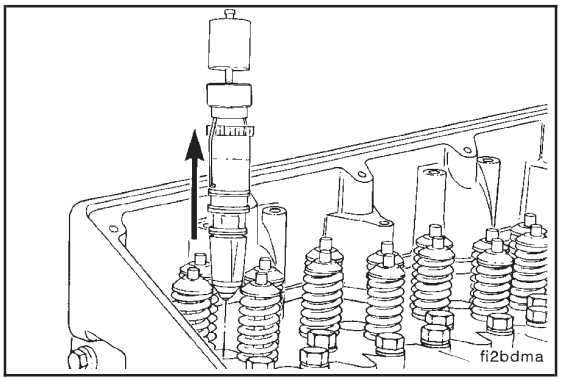
Number each link with the cylinder number as it is removed.

Remove the injector clamp capscrews and clamps.



Use injector puller, Part No. 3823024, to remove the injectors.

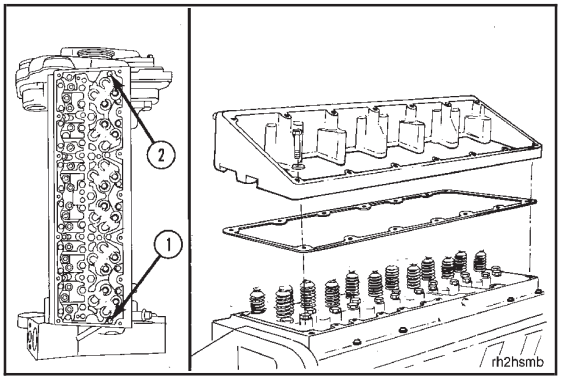
Number each injector with the cylinder number as it is removed.



Rocker Lever Housing - Removal

NOTE: Do not drop the capscrew washers into the engine.

Remove the capscrews, washers and rocker lever housing.



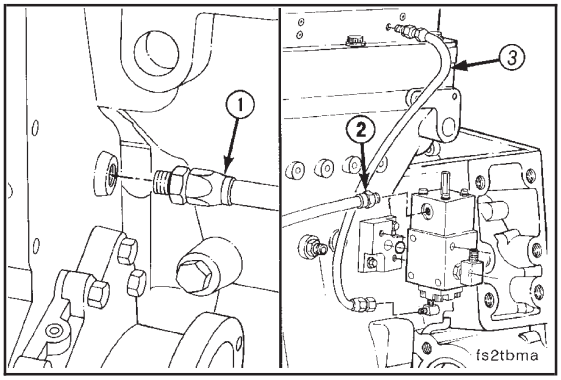
STC Oil Control Valve - Removal

Remove the oil vent line from the gear housing (1) and STC valve (2).

Remove the STC fuel pressure sensing line (3) from the cylinder head and the STC control valve.

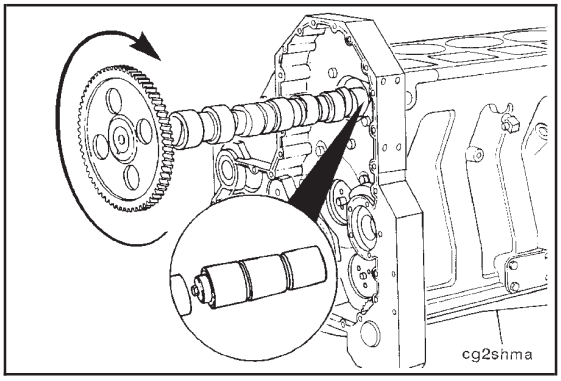
Remove the two STC control valve mounting capscrews, oil control valve and o-ring seal.

Remove the two adapter block capscrews, adapter block and seal.



Use one hand to slowly rotate and pull the camshaft from the cylinder block and the other hand to balance the camshaft as it is removed.

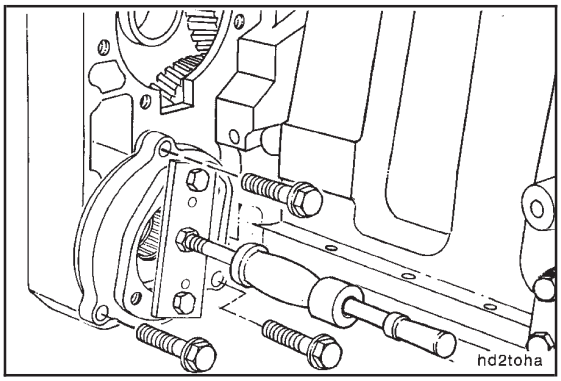
Remove the camshaft pilot tool.



Hydraulic Pump Drive - Removal

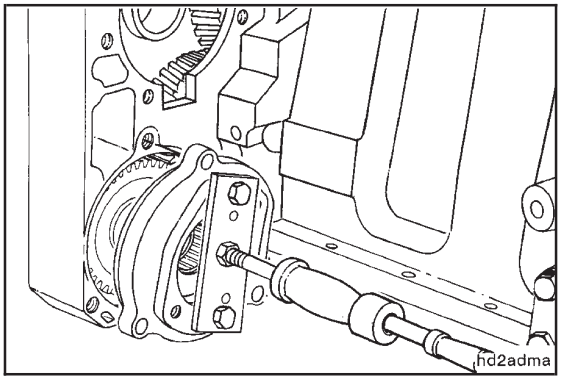
Remove the three drive adapter mounting capscrews.

Install engine barring tool, Part No. 3824270, and dowel pin extractor, Part No. ST-1134, to the hydraulic drive adapter. Use two (M10-1.50 x 30) capscrews, Part No. 3335003, for SAE ''A'' drives. Use two (M12-1.75 x 40) capscrews, Part No. 3018671, for SAE ''B'' drives.



Caution: Do not allow the hydraulic drive gear to slide out of the adapter or the gear housing during removal. Damage to the gear will result.

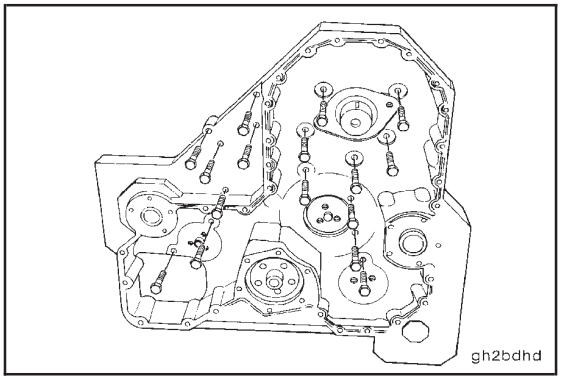
Remove the hydraulic drive adapter, o-ring and hydraulic drive gear.



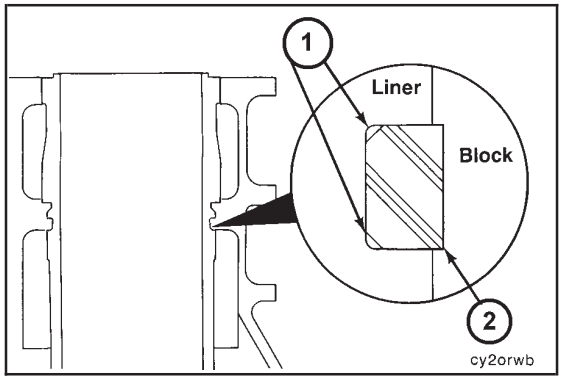
Gear Housing - Removal

Remove the gear housing mounting capscrews and the housing.

Remove the rectangular seal from the back side of the housing.



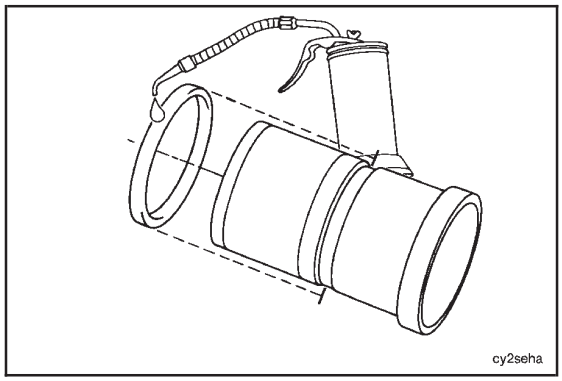
- A lathe cut o-ring which has a straight outside with sharp corners and the inside which has two 45 degree chamfers, so there are no sharp corners next to the liner. This o-ring **must** be installed with the straight side facing the block, and the chamfered side next to the liner. If the o-ring is **not** installed this way, liner bore distortion can occur.



Caution: Do not let the oil remain on the liner o-rings for more than 12 hours before the liners are installed. The o-ring can be damaged when installing the liner.

Make sure the cylinder block and all parts are clean.

Install the liner o-ring on the liner then use clean 15W-40 oil to coat the o-ring.

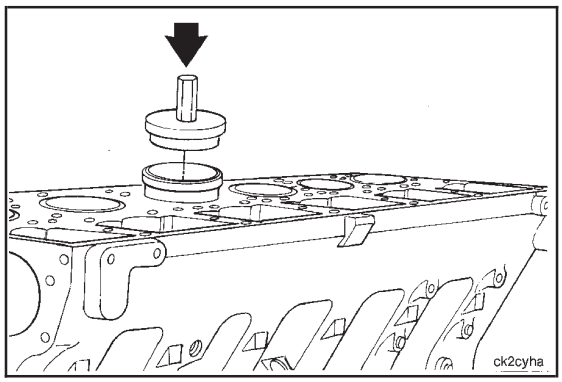


Install the liner into the cylinder block.

NOTE: When acceptable reused liners are installed, rotate the liner 90 degrees from their original position in the engine. The thrust and anti-thrust surfaces **must** face the front and back of the cylinder block.

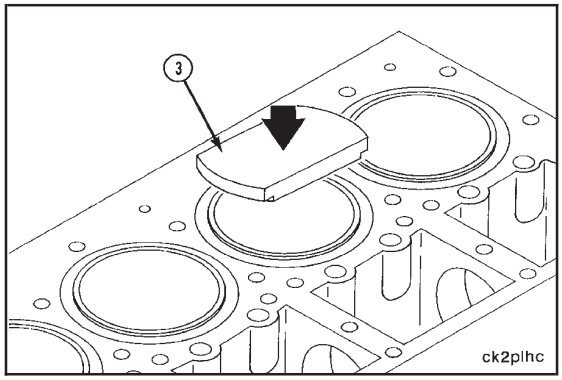
Use the cylinder liner driver, Part No. 3376056, and a leather mallet to drive the liner into the cylinder block bore.

If the liner does **not** seat properly, remove the liner. Inspect the counterbore seat and liner for nicks, burrs, or dirt. Install the liner again.



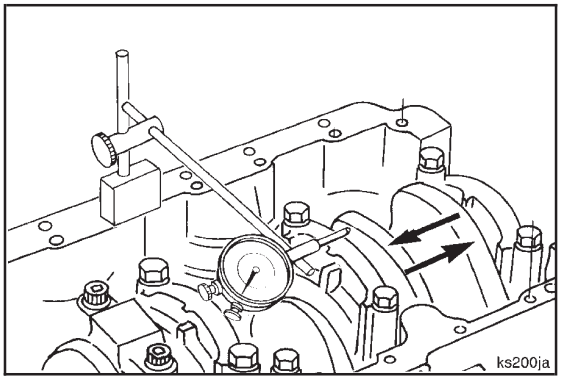
Use cylinder liner clamping tool, Part No. 3824272, to seat the liner into the cylinder block.

Place the force plate (3) across the top of the liner with the step inside the liner bore.



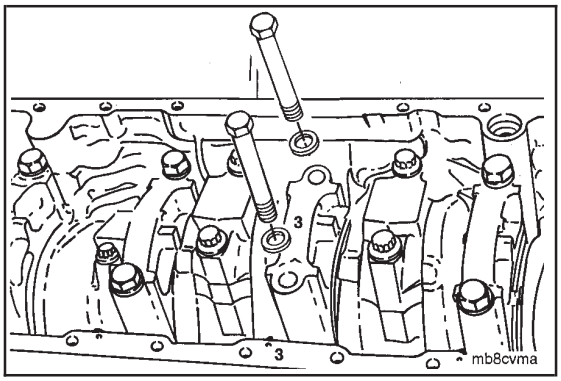
Use dial indicator, Part No. 3376050, to measure the crankshaft end clearance.

Crankshaft End Clearance		
mm		in
0.10	MIN	0.004
0.56	MAX	0.022



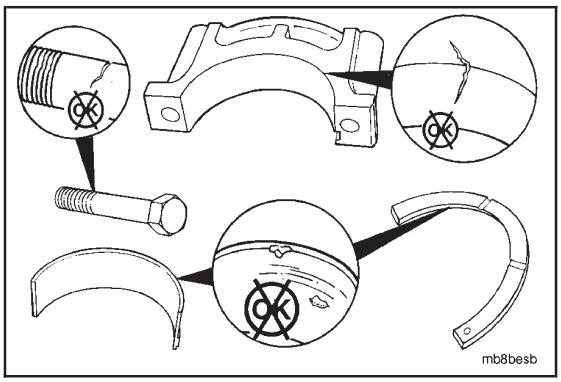
If the end clearance is **not** within specifications, complete the following steps:

- Remove the number ''4'' main bearing cap and thrust bearings.



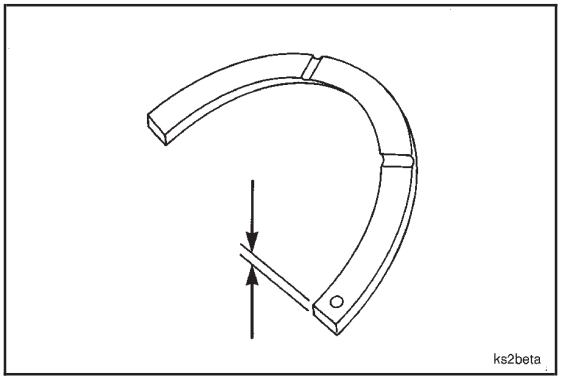
- Inspect for burrs, dirt or damage.

If nicks or burrs **cannot** be removed with fine crocus cloth, the cap and bearings **must** be replaced.



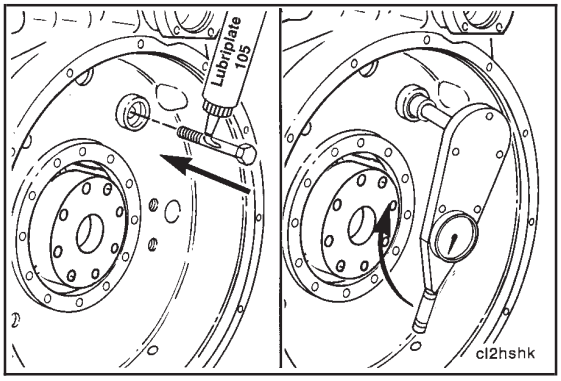
Measure the thrust bearing thickness and replace the bearings if they are **not** within specifications.

Crankshaft Thrust Bearing Thickness		
mm		in
4.83	MIN	0.1902
4.89	MAX	0.1925



Apply Lubriplate® 105 under the head of the idler shaft capscrew. Insert the capscrew through the idler shaft. Tighten the installation capscrew with a torque wrench.

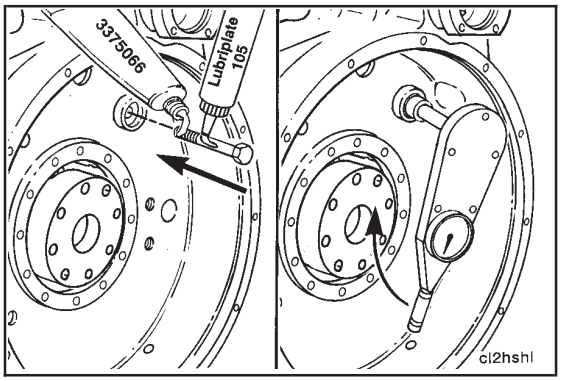
NOTE: The torque needed to draw the idler shaft in place **must not** exceed 88 N•m [65 ft-lb]. If installation torque exceeds this amount, it indicates misalignment between the bore and the shaft. Remove the idler shaft and install it again.



After the idler shaft has been seated, remove the capscrew.

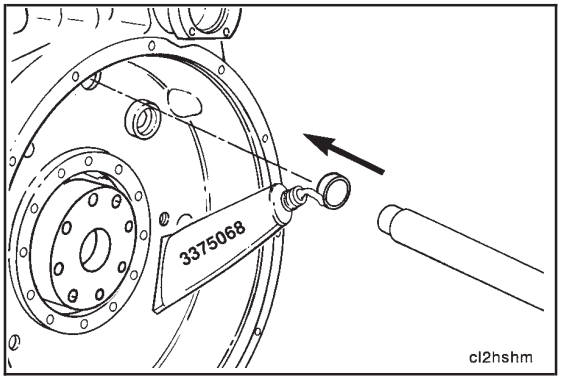
Apply pipe sealant, Part No. 3375066, to the threads of the idler shaft capscrew. Apply Lubriplate® 105 under the head of the capscrew. Install the capscrew and tighten to its final torque value.

Torque Value: 102 N•m [75 ft-lb]



Apply a film of cup plug sealant, Part No. 3375068, to the outside diameter of the cup plug.

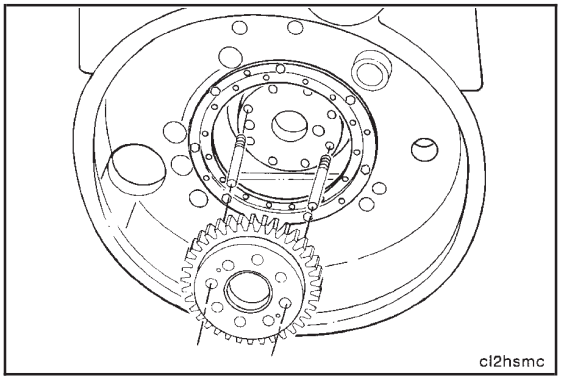
Use driver, Part No. 3823710, to install the cup plug into the housing as shown.



Install two guide pins, Part No. 3822784, into the crankshaft flywheel mounting flange 180 degrees apart.

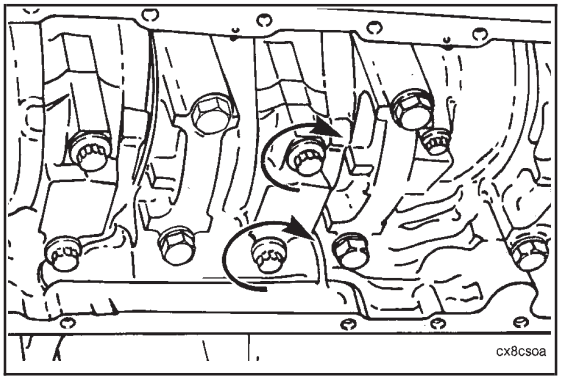
Make sure the crankshaft and crankshaft gear are clean.

Install the crankshaft gear on the guide pins.



Complete the following steps to tighten the capscrews in alternating sequence:

Torque Value: Step 1 - 68 N•m [50 ft-lb]
2 - 142 N•m [105 ft-lb]
3 - 210 N•m [155 ft-lb]
4 - Loosen Completely
5 - 68 N•m [50 ft-lb]
6 - 142 N•m [105 ft-lb]
7 - 210 N•m [155 ft-lb]

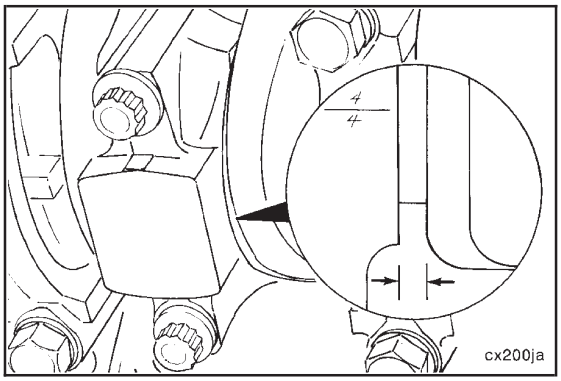


Connecting Rod Side Clearance Measurement

Use a feeler gauge to measure the connecting rod side clearance.

Connecting Rod Side Clearance		
mm		in.
0.10	MIN	0.004
0.30	MAX	0.012

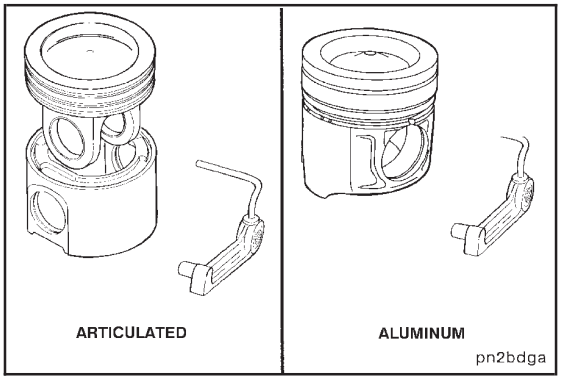
The rod **must** move freely from side-to-side.



Piston Cooling Nozzles - Installation

Two kinds of piston cooling nozzles are used. Engines with articulated pistons use a longer spray nozzle than engines with aluminum pistons. Make sure the correct nozzles are used.

Piston Cooling Nozzle Length		
	mm	in
Articulated Pistons	44.5	1.752
Aluminum Pistons	15.9	0.626

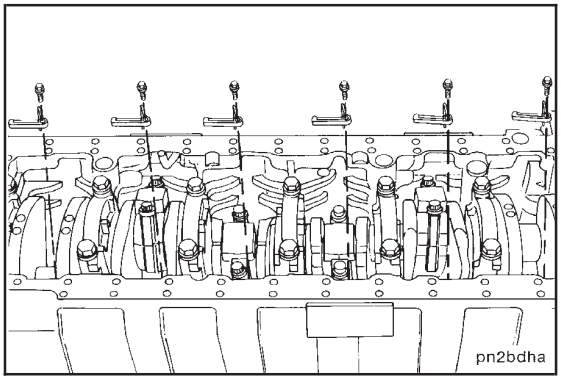


The piston and connecting rod assemblies **must** be installed before the piston cooling nozzles are installed.

Rotate the crankshaft to position the connecting rod journal toward the exhaust side of the engine.

Install the nozzles and the special capscrews.

Torque Value: 27 N•m [18 ft-lb]

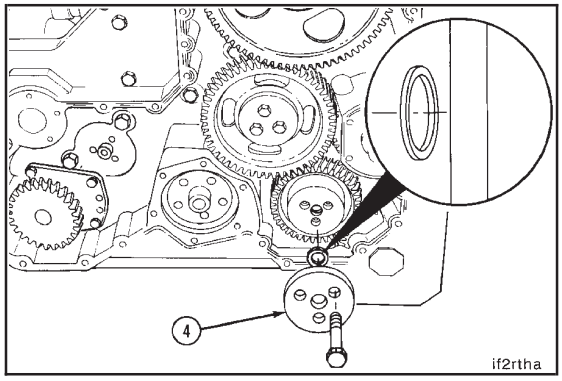


NOTE: On SAE ''B'' drives, install a new rectangular seal on the rear surface of the gear retainer (4) before installation.

Install the gear retainer (4).

Install the three capscrews (M10-1.50x60) and tighten.

Torque Value: 61 N•m [45 ft-lb] plus 60 degrees



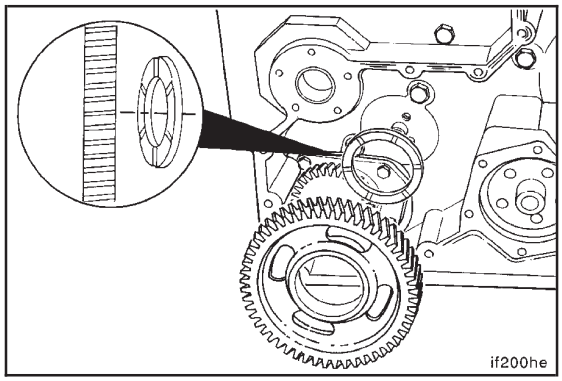
Water Pump/Lube Pump Idler - Installation

Caution: The grooved side of the rear thrust bearing must be facing toward the gear to prevent damage to the gear and engine during engine operation.

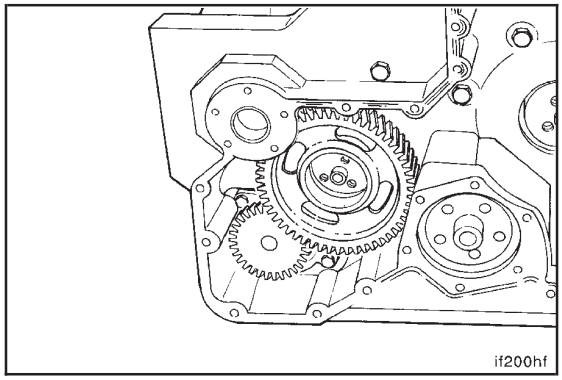
Use Lubriplate® 105, or equivalent, to lubricate the thrust bearings and idler gear shaft.

Install the rear thrust bearing.

Install the idler gear without the shaft.

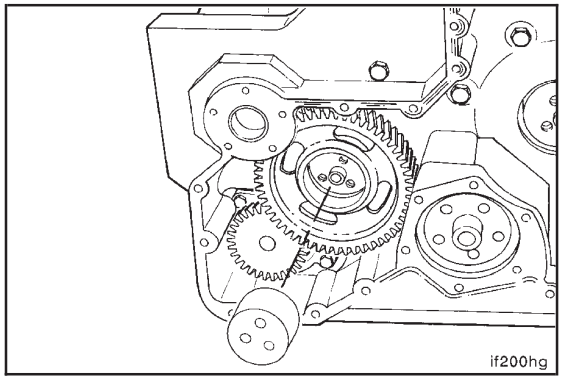


Align the inside diameter of the rear thrust bearing with the inside diameter of the idler gear.



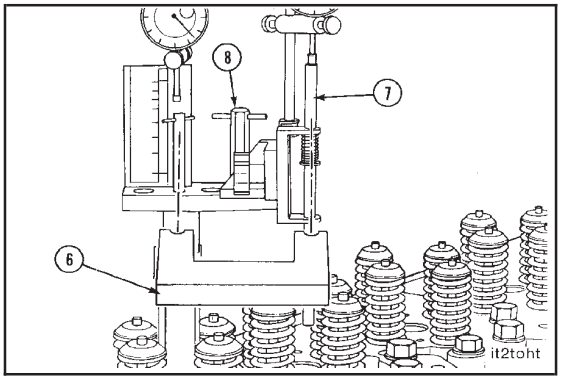
The shaft **must** pass through the gear and pilot into the rear thrust bearing. After installation, the shaft **must** protrude only slightly less than the thickness of the front thrust bearing. Shaft protrusion beyond the thickness of the front thrust bearing indicates that the shaft is **not** properly piloted into the rear thrust bearing.

Install the shaft into the gear bore.



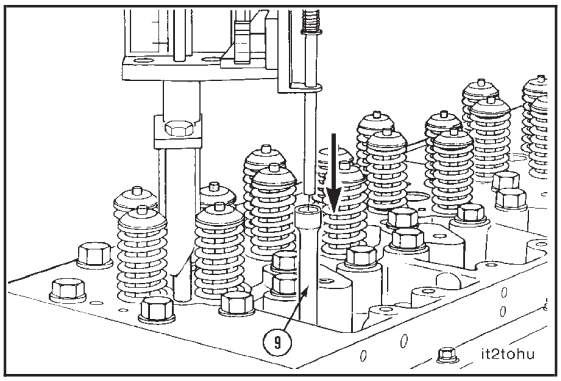
Use the alignment tool (6) to align the push rod plunger rod (7).

Tighten the clamp handle (8) after the plunger rod is aligned, and remove the alignment tool.



Install the injector push rod (9) between the injector camshaft follower and the plunger rod.

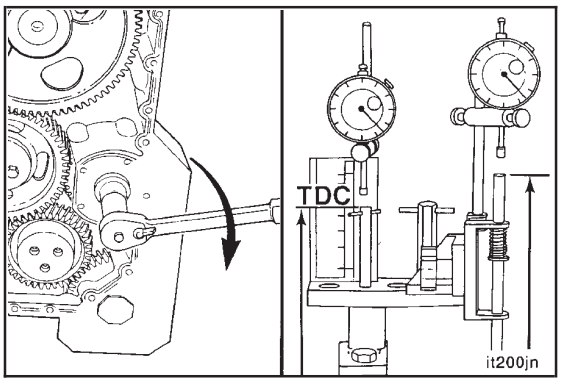
NOTE: The push tube **must** be aligned properly to attain a correct reading.



Caution: Always use the accessory drive shaft to rotate (bar) the crankshaft for injection timing. Using any other method will cause an error in the injection timing or can damage the engine.

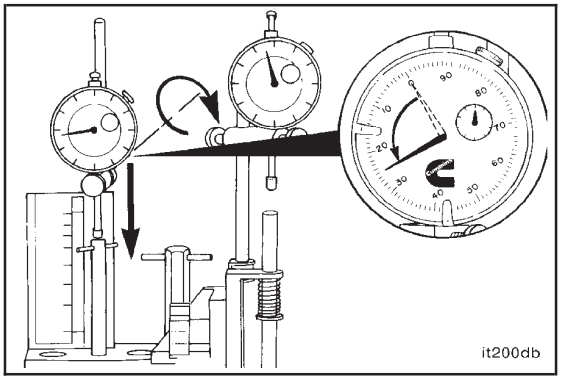
Determine the piston top dead center (TDC) on the compression stroke by rotating the accessory drive shaft in the direction of engine rotation **clockwise**. The accessory drive pulley capscrew will need to be installed to rotate the crankshaft.

The piston is on the compression stroke when both plungers move in an upward direction at the same time. TDC is indicated by the maximum **clockwise** indicator position of the piston travel indicator pointer.



Caution: Both indicators must have a travel range of at least 6.35 mm [0.250 inch] or the indicators will be damaged.

Position the gauge contact tip in the center of the plunger rod and lower the gauge to within 0.63 mm [0.025 inch] of the fully compressed position.



Vibration Damper Face Alignment (''Wobble'') - Measurement

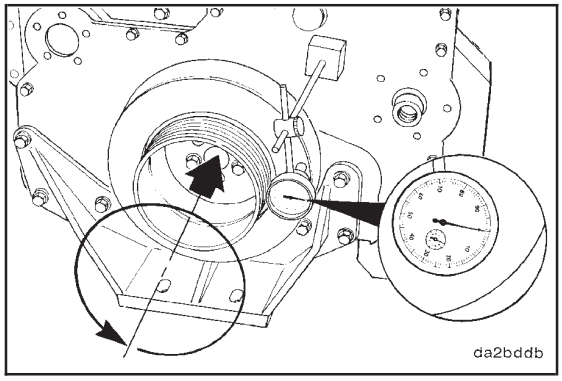
Install the dial indicator gauge against the face of the vibration damper to measure the ''wobble''.

Push the crankshaft toward the front or the rear of the engine.

Rotate the crankshaft with the accessory drive shaft one complete revolution (360 degrees) while maintaining the position of the crankshaft either toward the front or the rear of the engine.

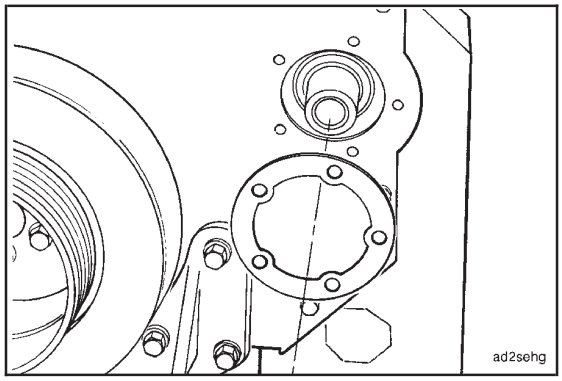
Record the total indicator movement.

Replace the damper if wobble exceeds 0.28 mm [0.011 inch].



Accessory Drive Oil Seal - Installation

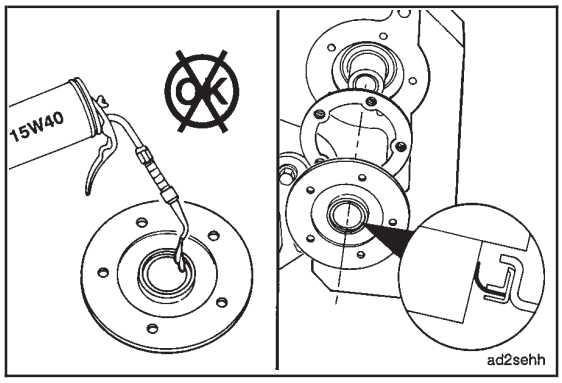
Install a new gasket on the gear cover.



Do not use lubricant to install the seal. The oil seal **must** be installed with the lip of the seal and the shaft clean and dry to provide a proper oil sealing surface and provide maximum engine life.

The dust lip of the seal **must** be facing out to prevent an oil leak.

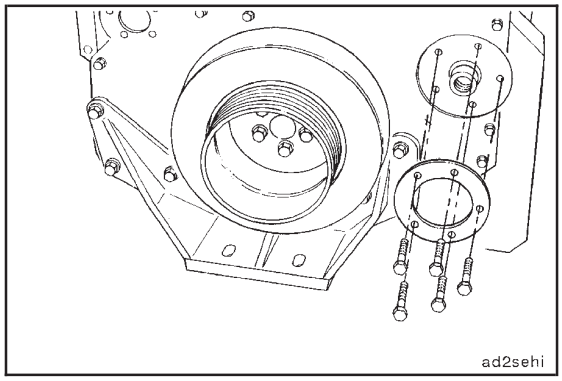
Use the installation sleeve provided with the new seal or oil seal guide, Part No. 3376099, to install the seal.



Install the clamping ring and five capscrews (M8-1.25 X 20) and washers.

Tighten the capscrews in a star pattern in two steps.

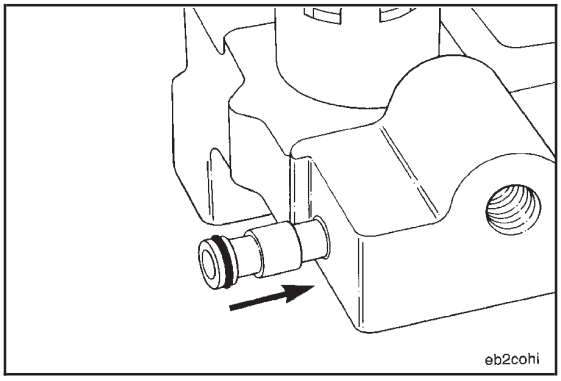
Torque Value: Step 1 - 7 N•m [60 in-lb]
2 - 19 N•m [170 in-lb]



Use clean 15W-40 oil to lubricate the oil connector o-rings.

Press the oil connector all the way into the front housing by hand.

NOTE: When installing the front housing, be sure the oil connector and o-ring is in position to be pushed into the rear housing.

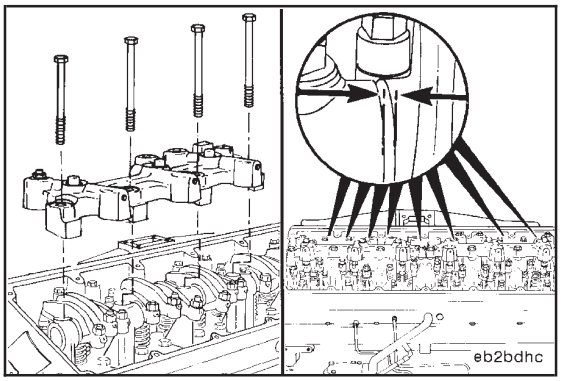


Install the front Jacobs® Brake housing on the front rocker lever supports.

Center the oil connector between the front and rear housings before tightening the capscrews. Snug the capscrews.

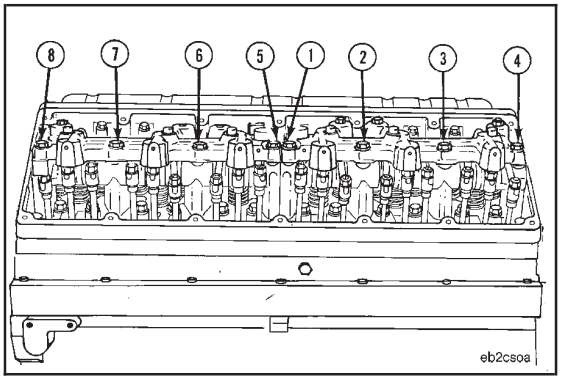
Torque Value: 5 N•m [45 in-lb]

Adjust the rocker lever side clearance. Refer to the preceding procedure (''Rocker Lever Side Clearance - Adjustment'').



After adjusting the side clearance for each rocker lever assembly, torque the support capscrews in the sequence shown as the rocker lever side clearance is adjusted.

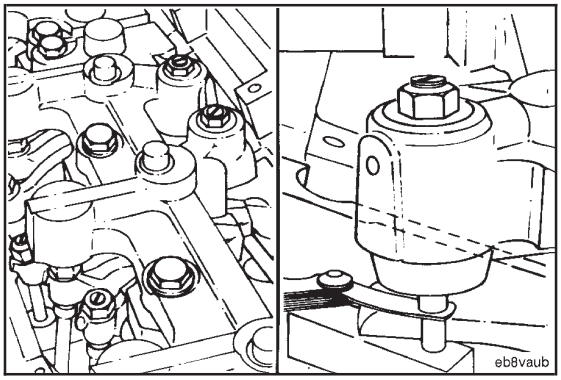
Torque Value: 122 N•m [90 ft-lb]



Slave Piston Clearance Adjustment

To achieve maximum brake operating efficiency and prevent engine damage by piston-to-valve contact, complete the following instructions carefully.

Install an 0.38 mm [0.015 inch] feeler gauge between the slave piston and the actuating pin in the crosshead.



Adjust the appropriate injector and valves following the Injector and Valve Adjustment Sequence Chart.

Repeat the process to adjust all injectors and valves.

STC
Injector and Valve Adjustment Sequence

Bar Engine in Direction of Rotation	Pulley Position	Set Cylinder Injector	Valve
Start	A	3	5
Advance to	B	6	3
Advance to	C	2	6
Advance to	A	4	2
Advance to	B	1	4
Advance to	C	5	1

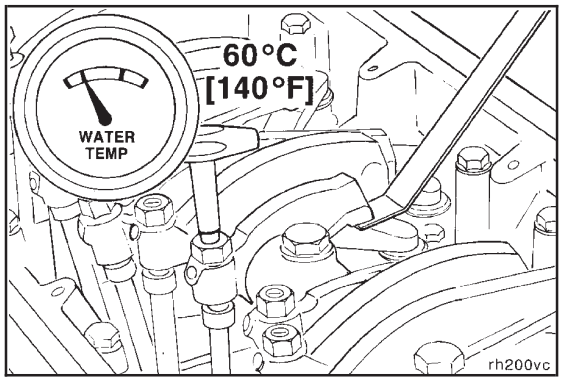
Firing Order: 1-5-3-6-2-4

oi200vi

Injector Adjustment - CELECT™ Engines

This procedure describes the valve and injector adjustment procedures for CELECT™ engines.

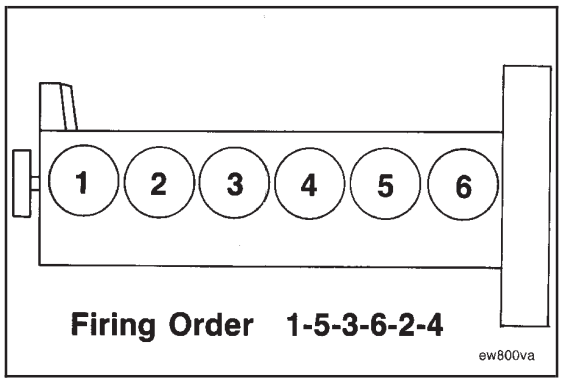
All valve and injector adjustments **must** be made when the engine is cold, any stabilized coolant temperature at 60°C [140°F] or below.



The crankshaft rotation is **clockwise** when viewed from the front of the engine.

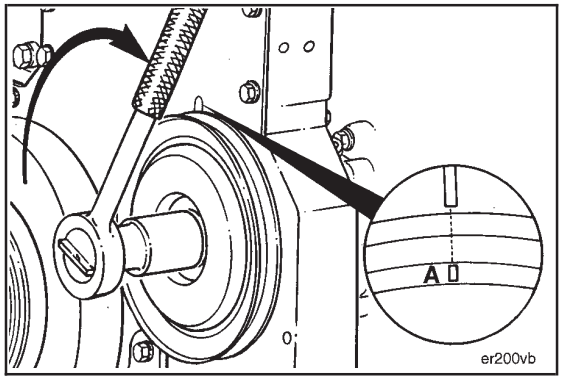
The cylinders are numbered from the front gear housing end of the engine.

The engine firing order is 1-5-3-6-2-4.



The valve set marks are located on the accessory drive pulley. The marks align with a pointer on the gear cover.

Use the accessory drive shaft to rotate the crankshaft.



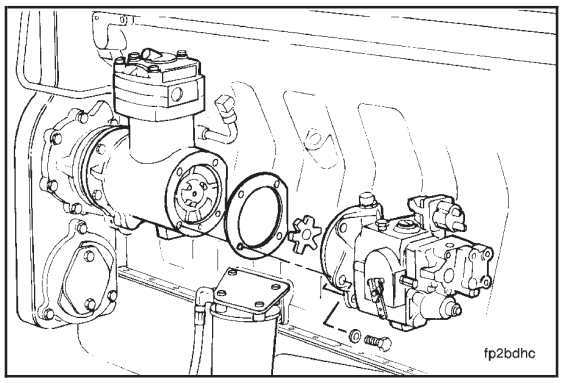
Fuel Pump (With Air Compressor) - Installation

Install the spider coupling to the end of the air compressor crankshaft.

Use a new gasket to install the fuel pump.

Install the four 12 point capscrews (7/16-14 x 1-1/4) and tighten.

Torque Value: 47 N•m [35 ft-lb]



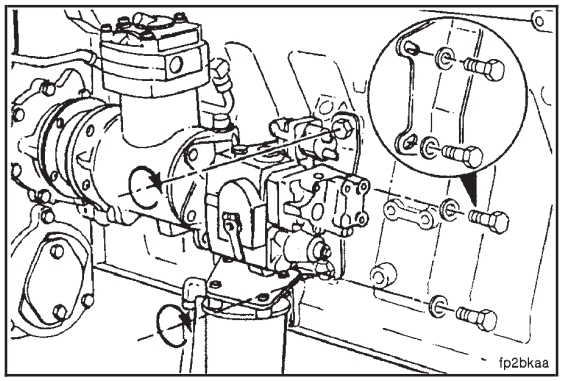
Install the support bracket to the cylinder block with two capscrews (M10-1.50 x 25) and washers. Do **not** tighten the capscrews.

Install two support capscrews (1/4-20 x 7/8) with washers into the fuel pump housing.

Torque Value: 11 N•m [95 in-lb]

Tighten the two capscrews (M10-1.50 x 25) into the cylinder block.

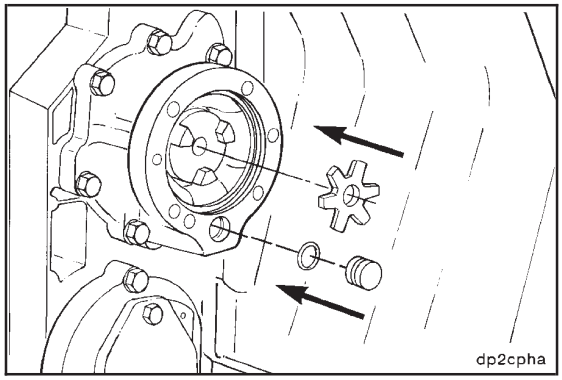
Torque Value: 47 N•m [35 ft-lb]



Fuel Pump (Without Air Compressor) - Installation

Install the spider coupling to the end of the accessory drive shaft.

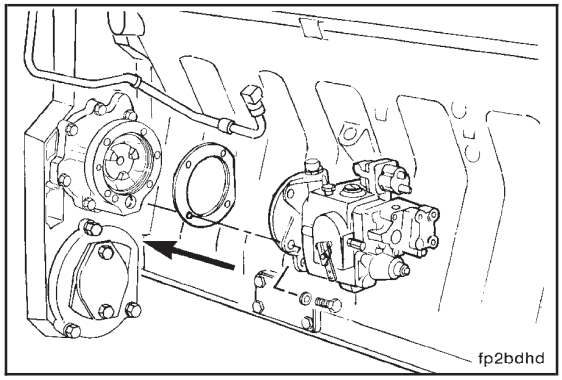
Install the new o-ring on the accessory drive oil drain plug and install the plug into the accessory drive.



Use a new gasket and install the fuel pump on the accessory drive.

Install four capscrews (M10-1.50 x 45) and four nuts (M10-1.50).

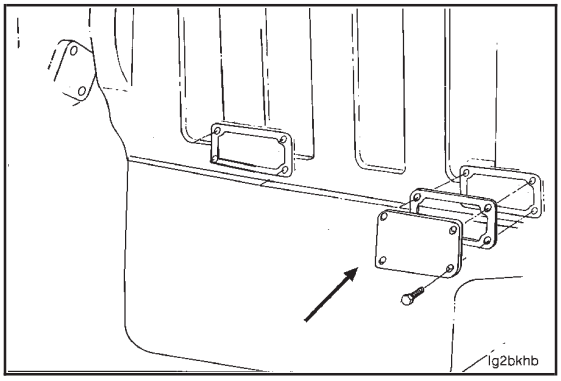
Torque Value: 47 N•m [35 ft-lb]



Hand Hole Cover (Exhaust Side of Engine) - Installation

Use a new gasket and install the cover with four capscrews (M10-1.50 X 20).

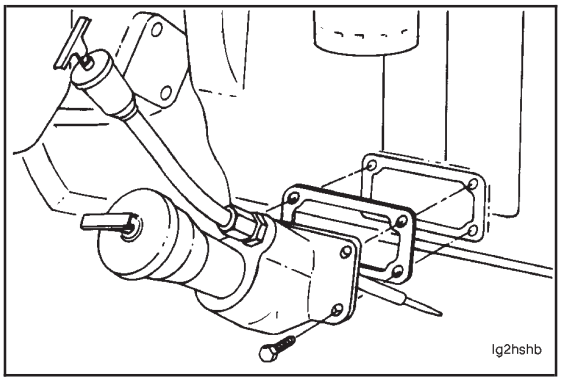
Torque Value: 47 N•m [35 ft-lb]



Dipstick Tube Bracket - Installation

Use a new gasket and install the tube bracket with four capscrews (M10-1.50 X 20).

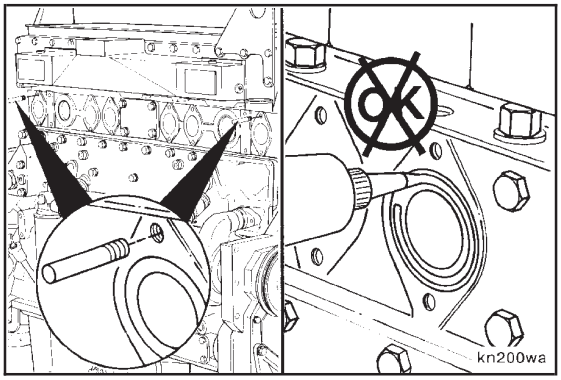
Torque Value: 47 N•m [35 ft-lb]



Exhaust Manifold - Installation

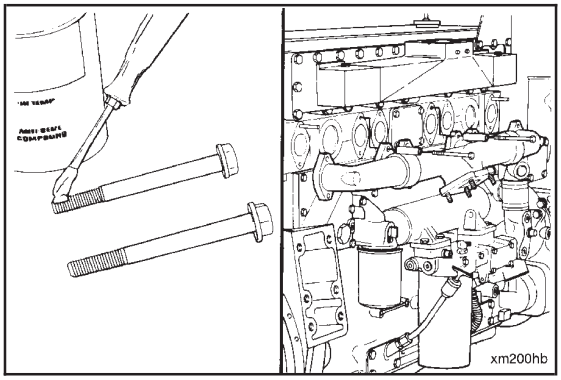
Install two guide pins, Part No. 3376488, into the cylinder head.

The gaskets can be installed with either side facing out. **Do not** use an adhesive to hold the gaskets in place on the cylinder head.



Use high temperature anti-seize compound, Part No. 3823097 or equivalent, to coat the capscrew threads, this will aid future capscrew removal.

Install the exhaust manifold with twelve capscrews (M10-1.50 X 100) and tubular spacers.

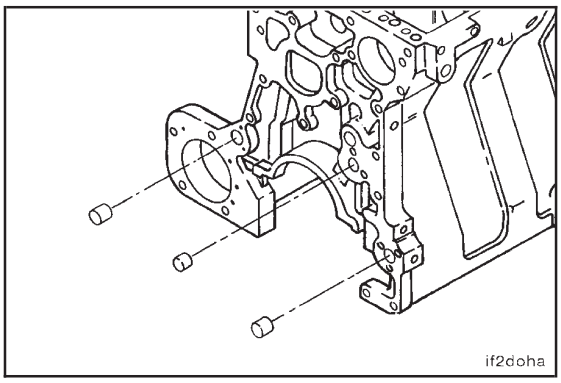


Section 1 - Cylinder Block - Group 01

Section Contents

Idler Shaft Ring Dowels - Removal

Use the puller kit, Part No. 3375784, to remove the three ring dowels.

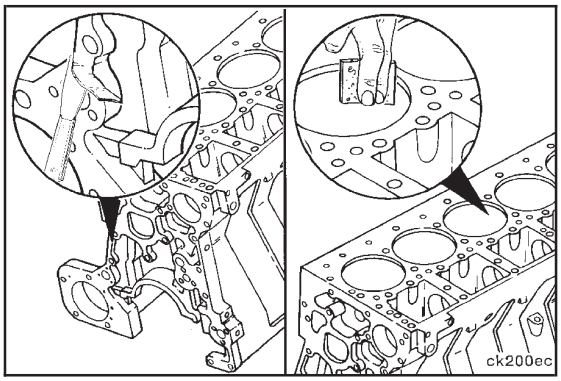


Cylinder Block - Cleaning

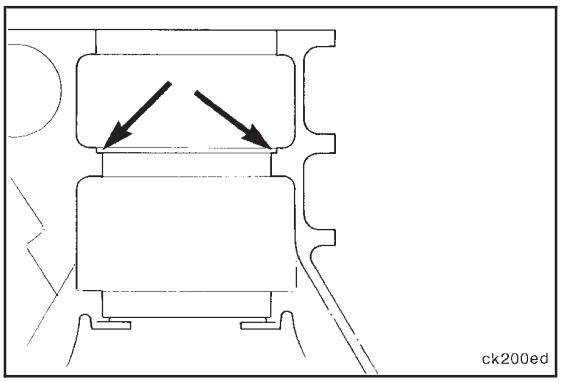
Caution: Do not damage the machined surfaces when using a wire brush or gasket scraper.

Use a Scotch-Brite® pad, emery cloth, or gasket scraper to clean the following cylinder block areas:

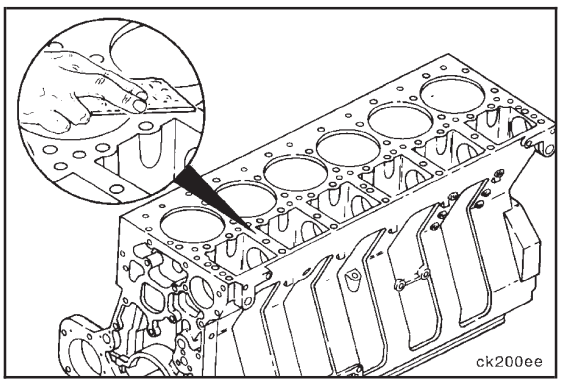
- Gasket surfaces
- Cylinder Liner counter bores



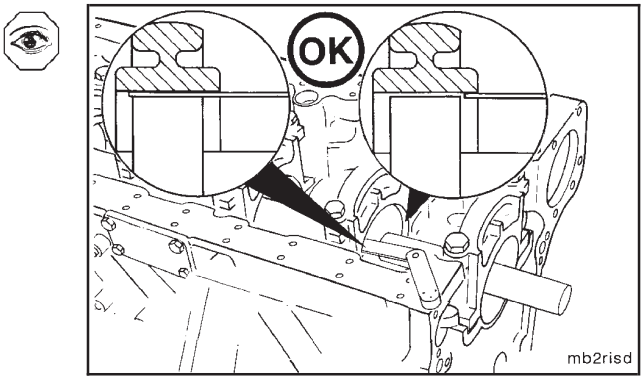
- Cylinder liner sealing ring bores



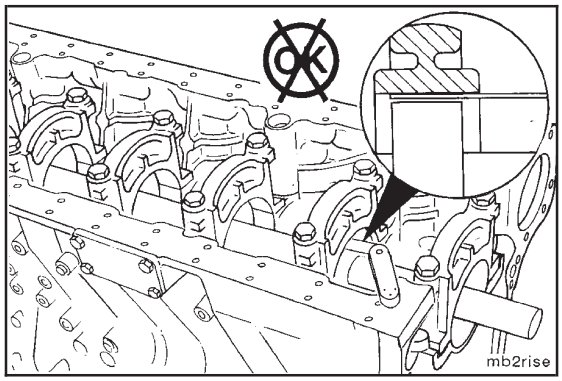
- Cylinder head deck surface



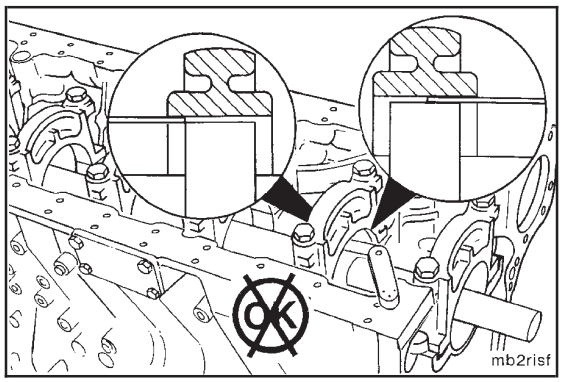
- If the feeler gauge will enter the bore at one point on one side of the checking ring, but will **not** enter the bore 180 degrees from that point on the same side and the checking bar rotates freely, there is a slight misalignment but the main bearing bore is acceptable.



- If the feeler gauge is loose in the bore, the bore is oversize and **not** acceptable. Mark the main bearing bore to be repaired.



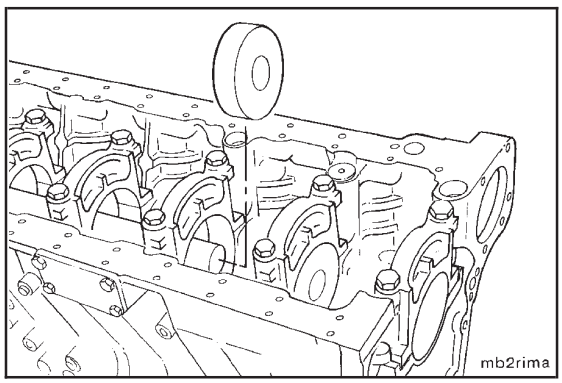
- If the feeler gauge will enter the bore all the way around on one side of the checking ring, but will **not** enter the bore on the other side, the bore is tapered and **not** acceptable. Mark the main bearing bore to be repaired.



Remove the checking ring.

NOTE: Leave the centering rings and checking bar in place if any bores are to be repaired.

Refer to the Alternative Repair Manual, Bulletin No. 3810310, for salvage procedures.

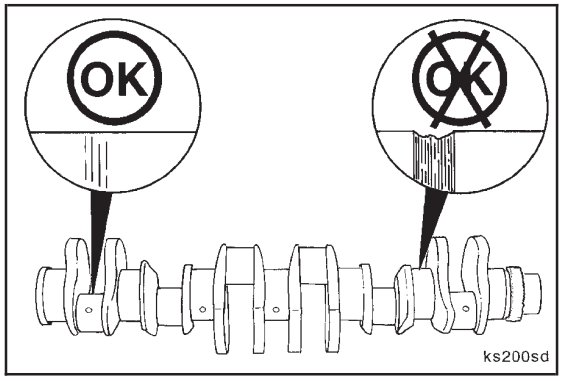


Crankshaft - Inspection

Visually inspect the machined surfaces for scratches or nicks.

Use fine crocus cloth to remove the nicks and scratches.

If scratches or nicks can be felt with a fingernail after the crankshaft has been polished with crocus cloth, the crankshaft **must be** replaced or reconditioned. Refer to the Alternative Repair Manual, Bulletin No. 3810310.

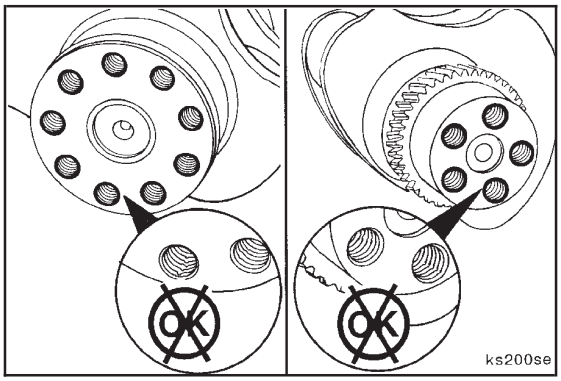


Visually inspect the threaded capscrew holes for damage.

Use one of the following methods to repair any threaded holes:

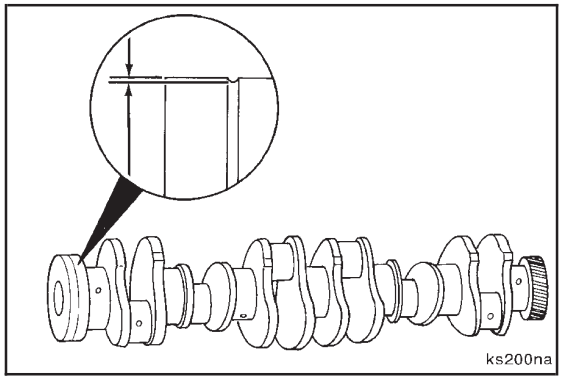
- Chase the threads
- Use threaded insert kit, Part No. 3375021

NOTE: If more than three threaded holes are damaged in one end, the crankshaft **must be** replaced.



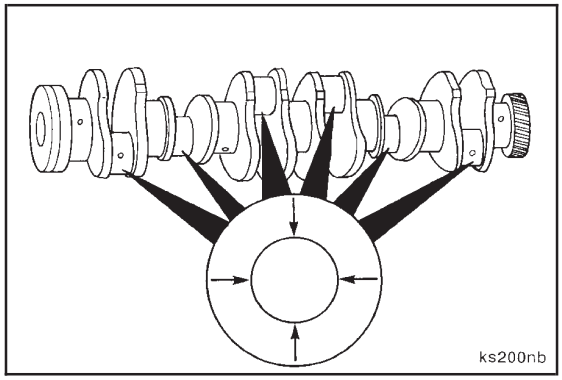
Measure the rear oil seal wear groove.

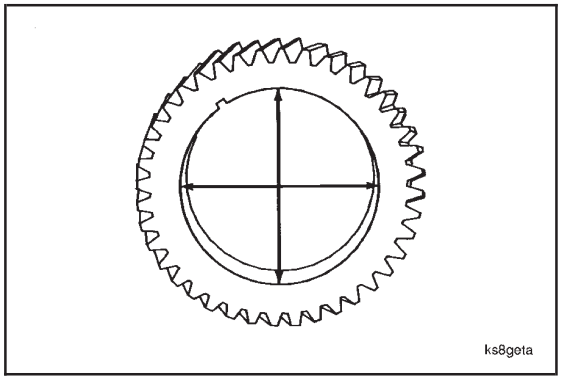
Crankshaft Rear Oil Seal Wear Groove		
mm		in
0.25	MAX	0.0098



Measure the connecting rod journals outside diameters.

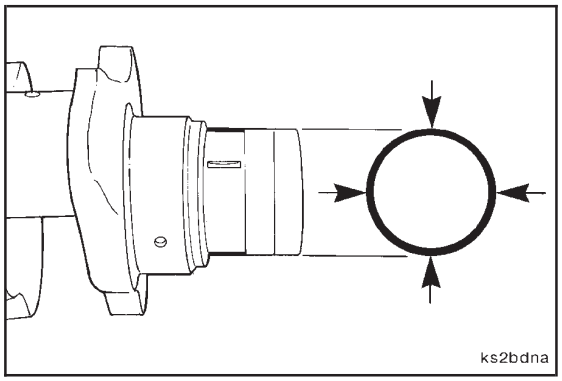
Crankshaft Connecting Rod Journal O.D.		
mm		in
78.950	MIN	3.1083
79.013	MAX	3.1107





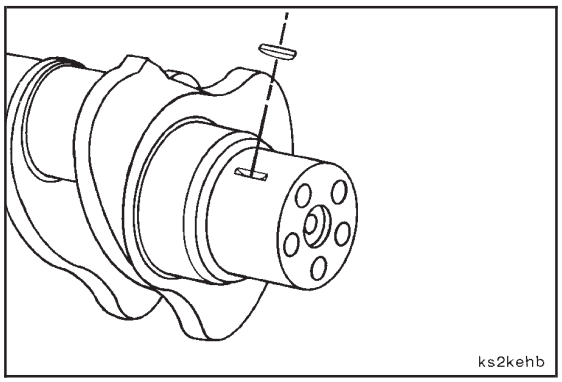
Measure the crankshaft gear inside diameter.

Crankshaft Gear Bore I.D.		
mm		in
85.910	MIN	3.3823
85.935	MAX	3.3833



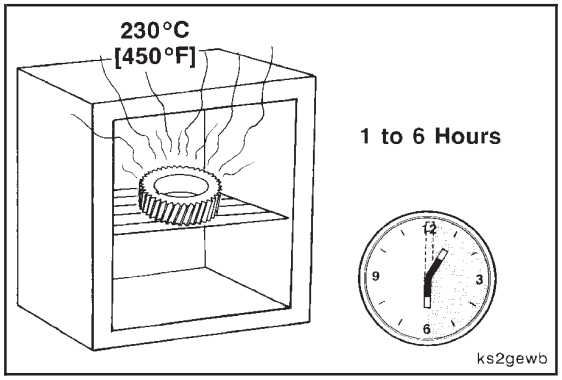
Measure the crankshaft gear journal outside diameter.

Crankshaft Gear Journal O.D.		
mm		in
85.975	MIN	3.3848
86.000	MAX	3.3858



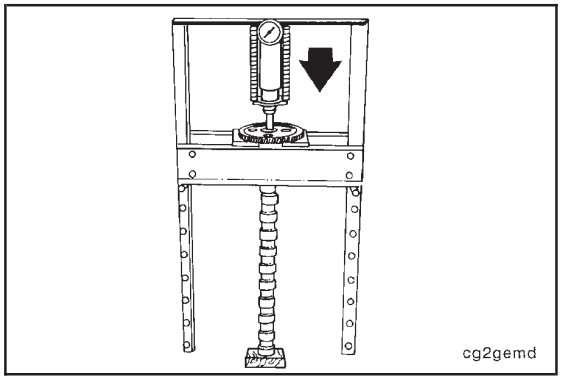
Crankshaft Gear - Installation

Use a soft hammer to install the key in the crankshaft keyway.



Caution: Do not exceed the specified heating time or temperature. The crankshaft gear and teeth can be damaged.

Place the gear in an oven heated to 230°C [450°F] for a minimum of one hour, but **not** more than six hours.

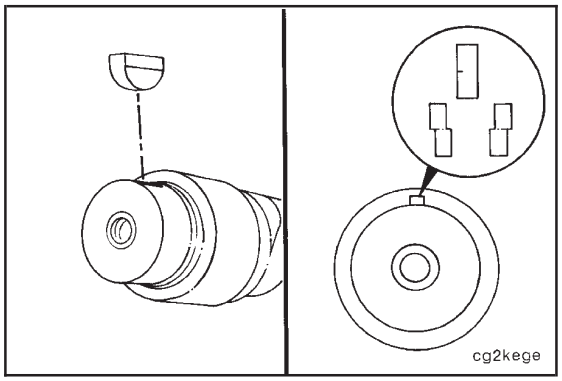


Camshaft Gear - Replacement (1-17)

Caution: Place a wooden block under the camshaft to avoid damage to the camshaft as it drops free from the gear.

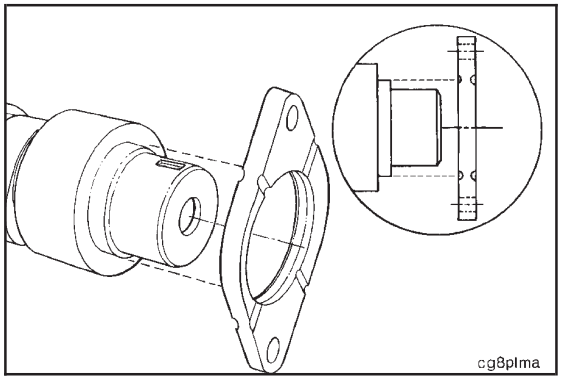
Install the camshaft assembly into a hydraulic press.

Press the shaft from the gear.



Camshaft keys are available in different sizes (amount of offset). Injection timing is controlled by the following:

- Amount of key offset.
- Key offset direction compared to camshaft gear rotation.

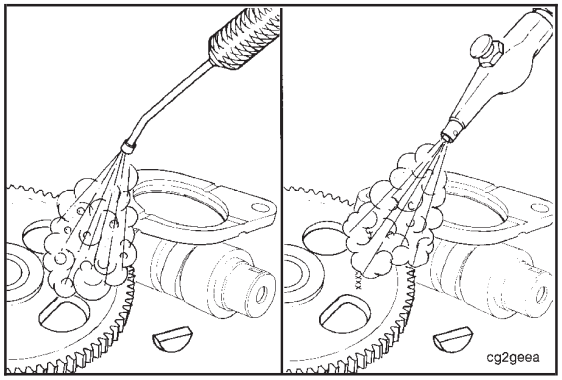


Record the size (amount of offset) and part number of the key.

Record the direction the arrow on the key is pointed (toward or away from the camshaft) for future reference.

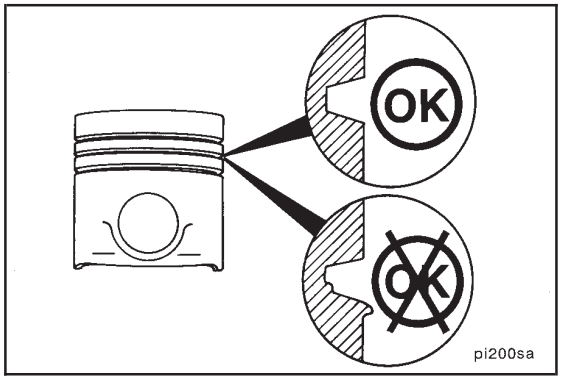
Use a flat chisel and hammer to remove the camshaft key.

Remove the thrust plate.



Camshaft Gear - Cleaning

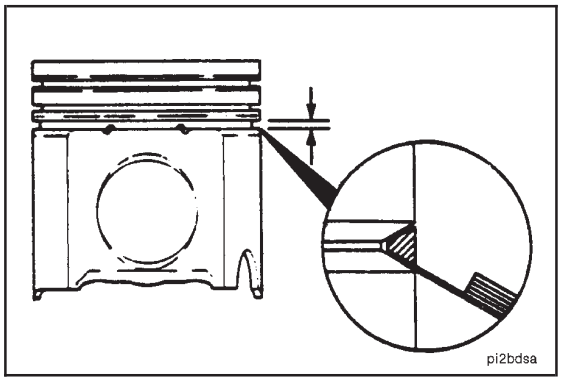
Use solvent to clean the parts and dry with compressed air.



Piston - Inspection

Visually inspect the piston ring grooves for damage.

Replace the piston if there is a visible ridge in the back of the groove, or a lip has formed on the outside diameter of the groove.

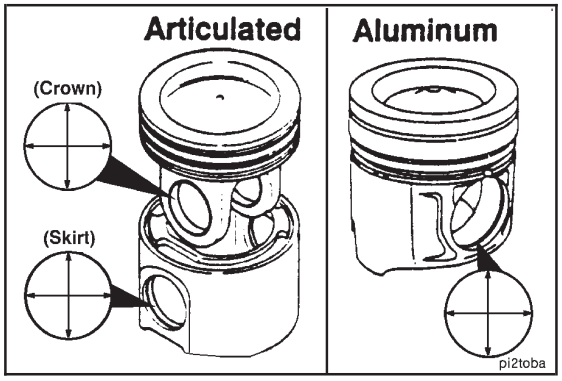


Measure the oil ring groove.

NOTE: The ring groove can be inspected with a new ring and a feeler gauge.

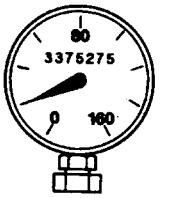
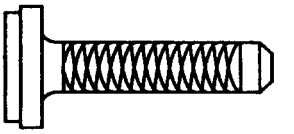
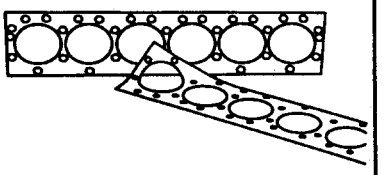
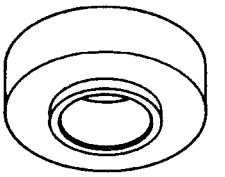
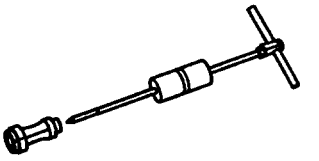
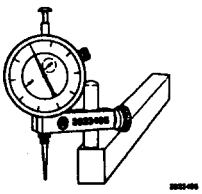
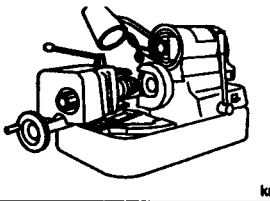
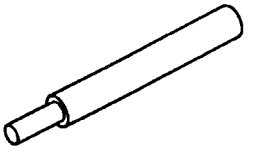
Hold a new ring in the groove and insert a 0.152 mm [0.0060 inch] feeler gauge.

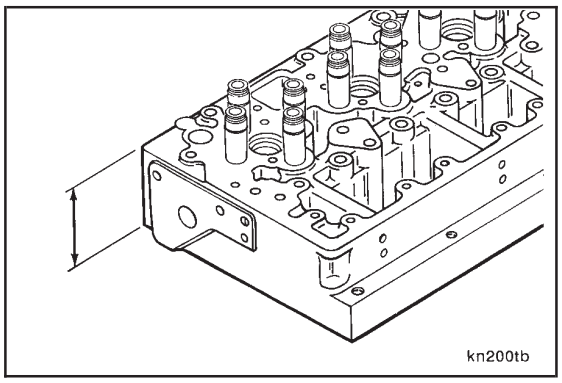
If the feeler gauge enters the the groove without resistance, there is too much wear. The piston **must** be replaced.



Measure the piston pin bore at a room temperature of approximately 21°C [70°F] in the directions shown.

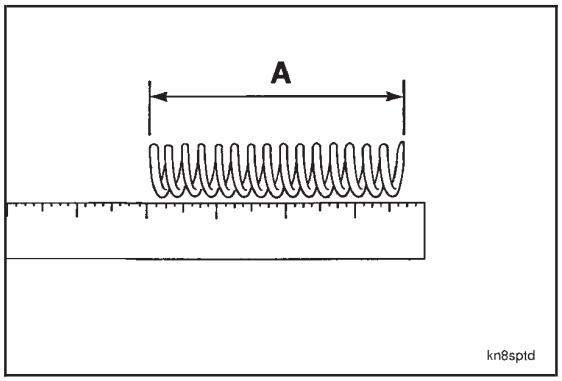
Piston Pin Bore I.D. (Articulated Crown)		
mm		in
54.040	MIN	2.1276
54.055	MAX	2.1281
Piston Pin Bore I.D. (Articulated Skirt)		
mm		in
54.007	MIN	2.1263
54.015	MAX	2.1266
Piston Pin Bore I.D. (Aluminum)		
mm		in
54.007	MIN	2.1263
54.015	MAX	2.1266

Tool No.	Tool Description	Tool Illustration
3375275	**Pressure Gauge [0-160 psi]** Used to measure air pressure.	 3375275
3376058	**Expansion Plug Driver** Install the 2.263 inch diameter expansion plugs in the cylinder head.	 bp8togc
3376082	**Cylinder Head Water Test Fixture** The test fixture contains the nuts, Part No. 3376083, the gasket, Part No. 3376084, and the test plate, Part No. 3376658, used to perform a leak check to the cylinder head.	 kn2togv
3376105	**Valve Seat Driver Mandrel** Used with the adapter sleeve and seat driver in the valve seat insert tool, Part No. ST-257.	 3376105
3376146	**Valve Seat Extractor** Used with slide hammer assembly, Part No. 3376617 to remove the valve seat inserts from the cylinder head.	 kn8togx
3823495	**Gauge Block** Used to measure the injector protrusion and valve recess in the cylinder head.	
3376256	**Valve Facing Machine** Grind cylinder head valves and resurface valve stems.	 kn8togz
3376398	**Valve Guide Driver** Remove the valve guides from the cylinder head.	 3376398



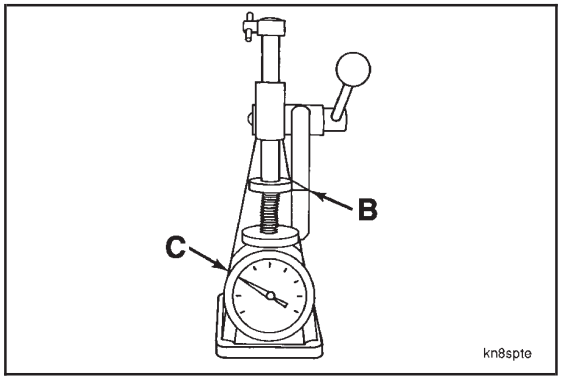
Measure the thickness of the cylinder head.

Cylinder Head Thickness		
mm		in
99.24	MIN	3.907
100.25	MAX	3.947



Measure the valve spring free height.

Valve Spring Free Height (A)		
mm		in
103.30	Nominal	4.0669

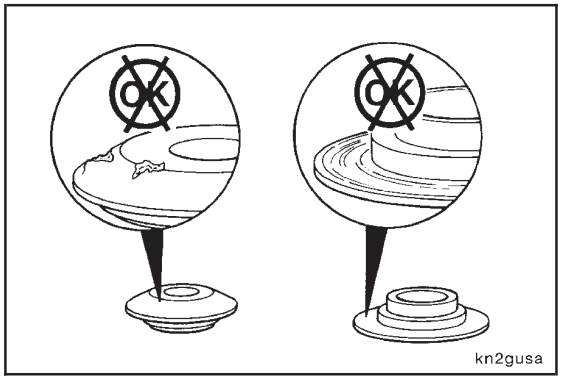


Use valve spring tester, Part No. 3375182, to measure the valve spring load at the valve spring working height.

Valve Spring Working Height (B)		
mm		in
71.48	Nominal	2.8142

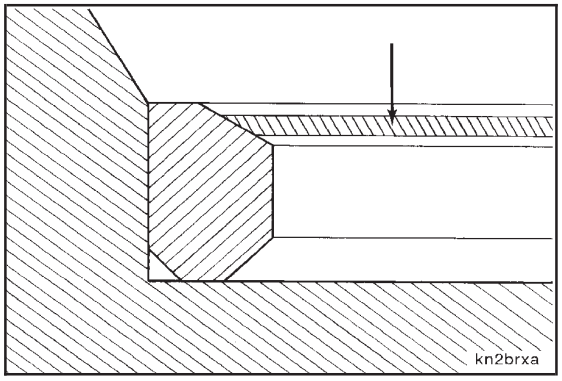
Valve Spring Load for Working Height (C)		
N		lbf
1252	MIN	281
1584	MAX	356

If the valve spring load for the working height is less than the minimum specified, the valve spring **must** be replaced.

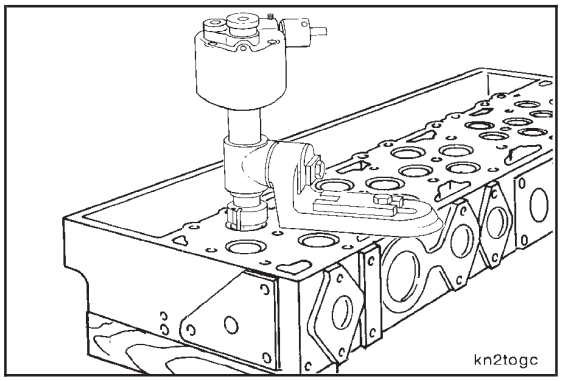


Visually inspect the valve spring retainers and valve spring guides for damage or worn areas.

Discard damaged and worn parts.



Use valve seat grinding machine, Part No. ST-685, and valve guide arbor set, Part No. 804, to grind the new valve seat inserts. Refer to Cylinder Head - Rebuild - Grind the Valve Seats (2-02).

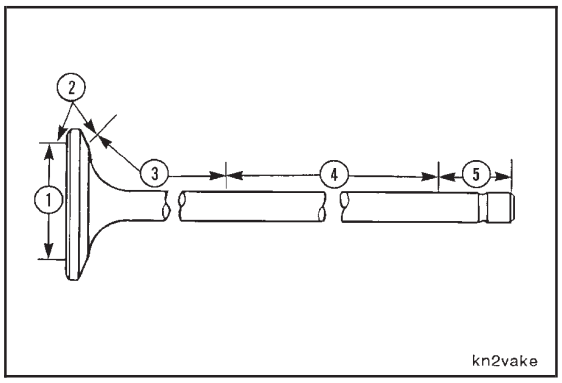


Cylinder Head - Oversize Valve Seat Insert Installation (2-05)

Valve seat inserts that are oversize on both the outside diameter and thickness are available to repair cylinder heads that are worn or damaged in the valve seat insert counterbore. The insert bore depth and inside diameter of the standard and oversize valve seat inserts are listed below. For complete instructions for machining the counterbore for oversize inserts, refer to the Alternative Repair Manual, Bulletin No. 3810310.

The valve seat insert cutter set, Part No. 3376595, consists of the oversize cutters listed below.

Valve Seat Inserts					
Valve Insert Part No.	Valve Seat Insert Cutter Part No.	Cylinder Head Valve Insert Bore Depth Nominal	Cylinder Head Valve Insert Bore Diameter Nominal	Valve Insert O.D. Oversize	Valve Insert Thickness Oversize
3027060 STD		9.45 mm	45.920 mm	STD mm	STD mm
		0.344 in	1.8079 in	STD in	STD in
3028071	3376596	8.75 mm	460170 mm	0.25 mm	STD mm
		0.344 in	1.8177 in	0.010 in	STD in
3028072	3376597	8.88 mm	46.420 mm	0.50 mm	0.13 mm
		0.349 in	1.8276 in	0.020 in	0.005 in
3028073	3376598	9.00 mm	46.670 mm	0.75 mm	0.25 mm
		0.354 in	1.8374 in	0.030 in	0.010 in
3028074	3376599	9013 mm	46.920 mm	1.00 mm	0.38 mm
		0.359 in	1.8472 in	0.040 in	0.015 in



Acceptance Criteria (Exhaust and Intake Valves)

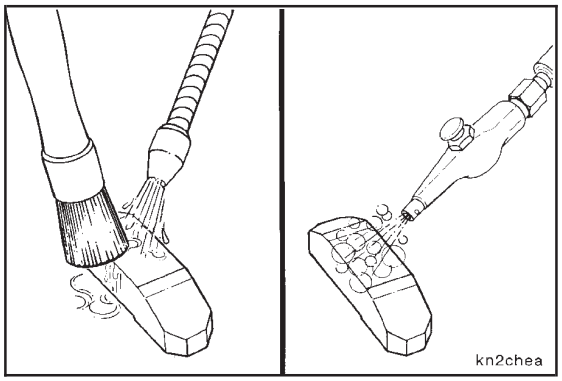
Area (1), **no** indication longer than 12.70mm [0.500 inch].

NOTE: There **must** be no more than five indications or no indications closer together than 3.18mm [0.125 inch].

Areas (2, 3, 4 and 5) **must not** have any magnetic indications or visible indications.

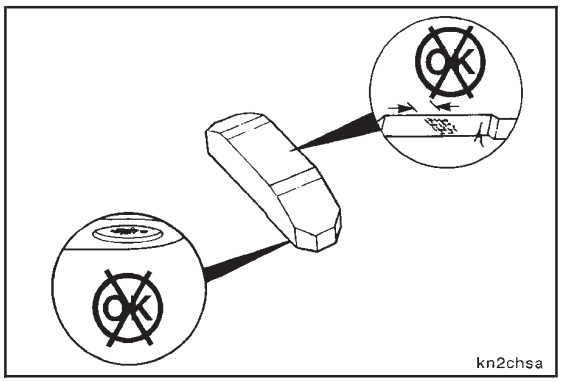
NOTE: ''Visible'' means an indication of a crack can be seen through a three power magnifying glass after the magnetic particle suspension is removed.

Remove all magnetism and clean the acceptable valves.



Valve Crosshead - Cleaning and Inspection for Reuse (2-11)

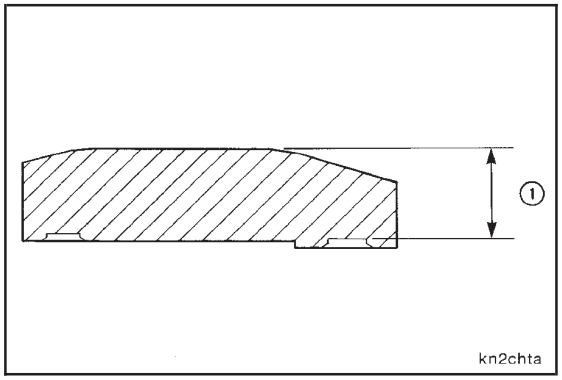
Use solvent to clean the parts. Dry with compressed air.



Inspection

Visually inspect the rocker lever contact pad for wear, cracks or damage.

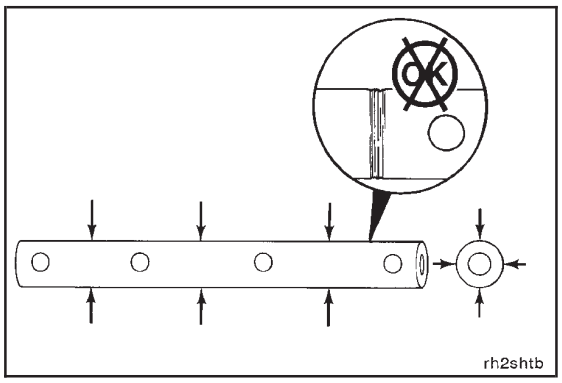
Wear in the pad contact area **must not** exceed 7mm [0.250 inch] in width.



Measure the valve stem pocket depth from the valve stem pocket to the rocker pad face (1).

Stem Pocket to Pad Face		
mm		in
12.05	MIN	0.474
12.55	MAX	0.494

If damaged parts are found or the pocket depth is **not** within the limits specified, the parts **must** be replaced. If cracks are suspected, refer to Valve Crosshead - Magnetic Crack Inspection (2-13).



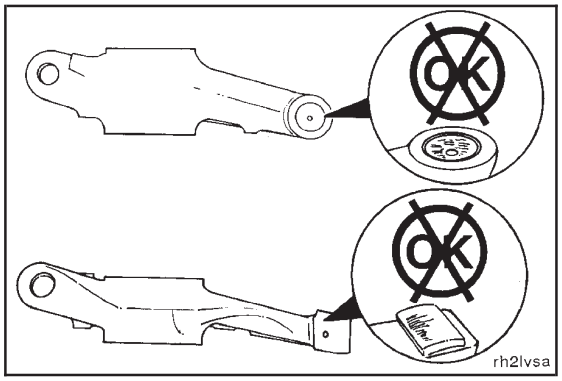
Visually inspect the rocker lever shafts for pitting, scoring or other damage.

Measure the outside diameter of the rocker lever shafts.

Rocker Lever Shaft O.D.		
mm		in
34.837	MIN	1.3715
34.863	MAX	1.3726

Refer to Overhead Reuse Guidelines, Bulletin No. 3810388, to identify wear patterns and excessive wear.

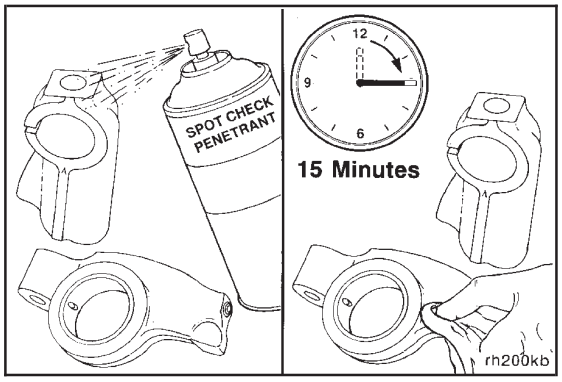
If worn or damaged parts are found, or the rocker lever bushings or shafts are **not** within the specifications given, the rocker lever assemblies **must** be rebuilt. Refer to Rocker Lever Assembly - Rebuild (3-02).



Visually inspect the sockets in the injector rocker levers for wear or damage.

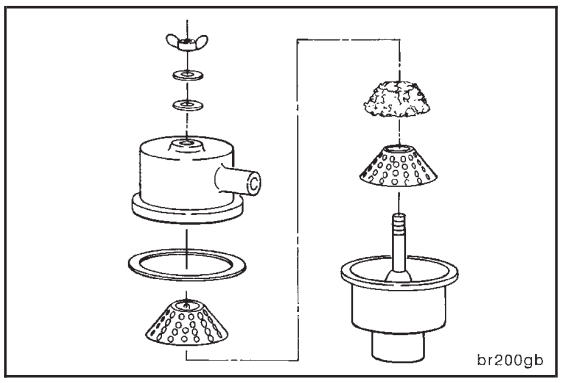
Visually inspect the valve rocker lever pads for wear, cracks or other damage.

If wear, cracks or other damage is found, the rocker lever **must** be replaced.



Use crack detection kit, Part No. 3375432, to inspect the rocker lever shaft supports for cracks or damage.

If cracks or damage is found, the rocker lever shaft support **must** be replaced.

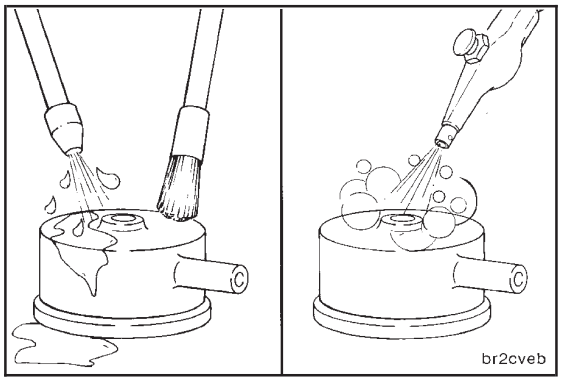


Crankcase Breather (External) - Replacement (3-08)

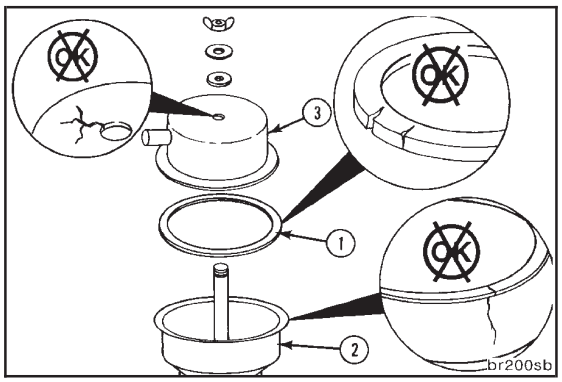
Do **not** remove the crankcase breather from the rocker lever cover if the breather is **not** damaged.

Disassembly

Disassemble the breather as shown.



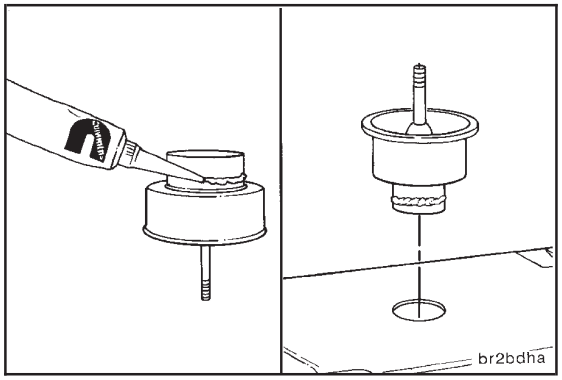
Use solvent to clean the breather parts. Dry with compressed air.



Inspection

Visually inspect the rubber gasket (1), body (2) and cover (3) for cracks or damage.

If damage to the rubber gasket (1) or the cover (3) is found, the parts **must** be replaced. If damage to the body (2) is found, the breather **must** be replaced.



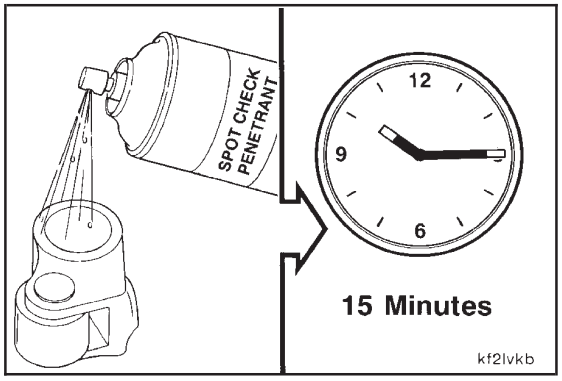
Assembly

Support the rocker lever cover in an arbor press.

Use silicone sealant, Part No. 3823494 or equivalent, to seal the outside diameter of the breather body.

Use a mandrel to push the breather body into the cover.

Assemble the remaining parts.

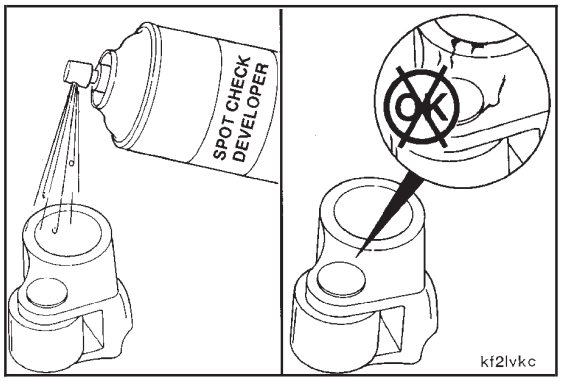


Use the crack detection penetrant, Part No. 3375435, to spray the levers and supports.

NOTE: Do **not** dry the penetrant with compressed air.

Allow the penetrant to dry for 15 minutes.

Remove the excess penetrant with a dry cloth.



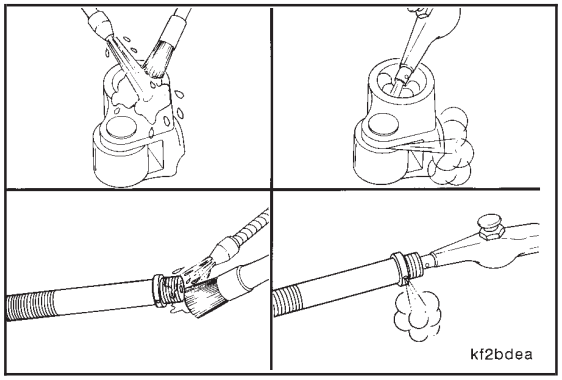
Use the crack detection developer, Part No. 3375434, to spray the levers and supports.

Visually inspect the levers and supports.

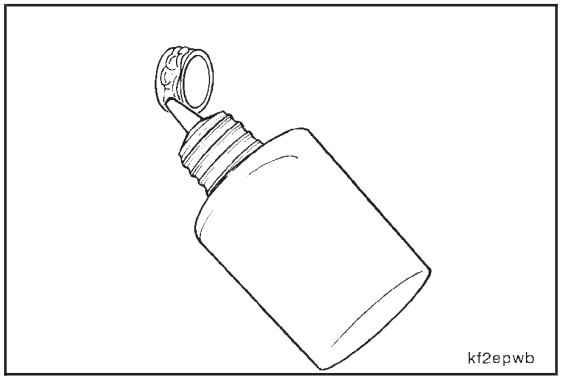
Cracks will appear as a solid bright line.

Cavitation in the casting will appear as a small round mark.

If cracks or cavitation are found the part **must** be replaced.



Use solvent to clean the acceptable levers and supports. Dry with compressed air.



Assembly

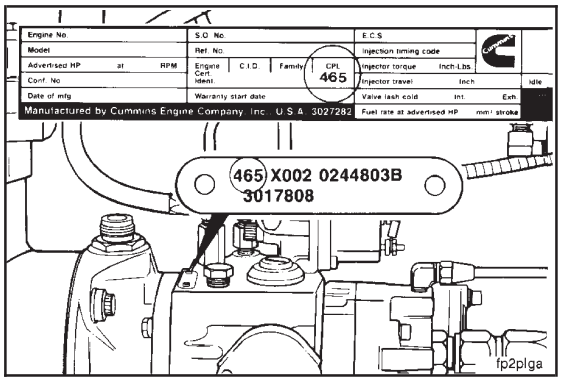
Apply a coat of cup plug sealant, Part No. 3375068, to the outside diameter of the shaft plugs.

Fuel Pump - General Information

NOTE: Warranty repairs are **not** to be made to the fuel pump unless the work is performed in a shop meeting all requirements established by Cummins Engine Company, Inc. to accurately calibrate, test and repair the fuel systems on Cummins engines.

The fuel pump is calibrated for a specified performance and will vary between engine application and model. The performance of the engine is defined by the Control Parts List (CPL) and the fuel pump code.

The fuel pump calibration **must** be within the published specifications. Fuel pump calibration is certified by several emission agencies. Tampering with the fuel pump can be a violation of the law. Tampering with the fuel pump can also void the engine warranty and lower the performance of the engine.

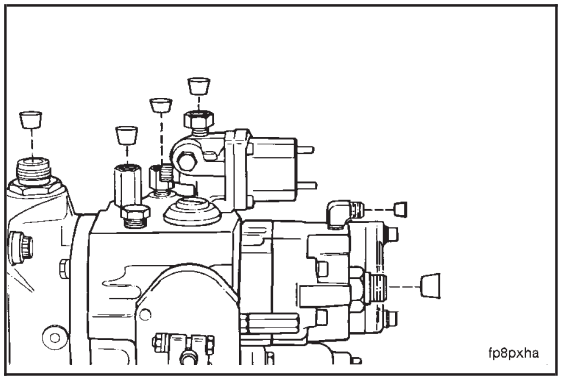


Fuel Pump - Cleaning and Inspection for Reuse (5-01)

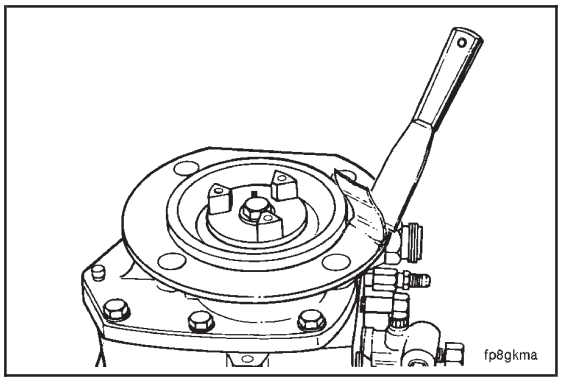
Cleaning - STC and Fixed Time Engines

When removing the fuel pump from a STC or fixed time engine, compare the CPL number on both the fuel pump dataplate and the engine dataplate.

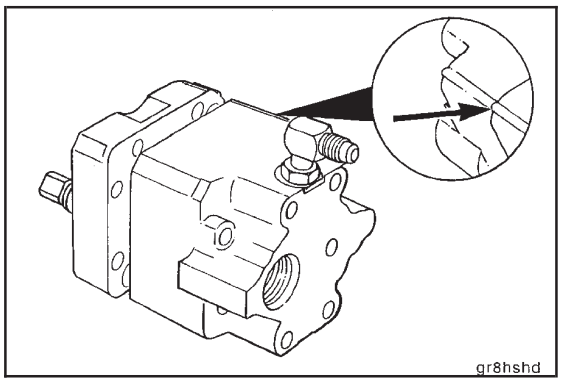
The numbers **must** be the same on both dataplates.



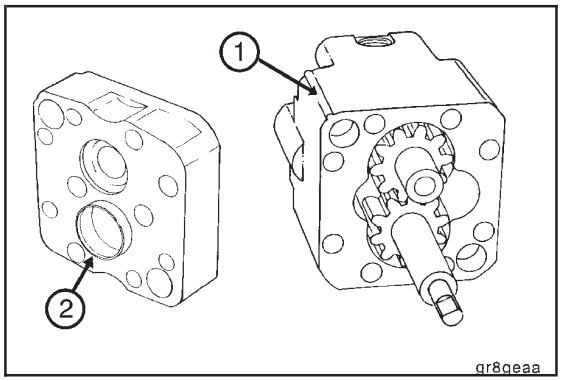
Install plastic cup plugs or tape on all openings of the fuel pump to prevent dirt or cleaning solvent from entering the pump.



Remove the gasket material from the front cover gasket sealing surface.

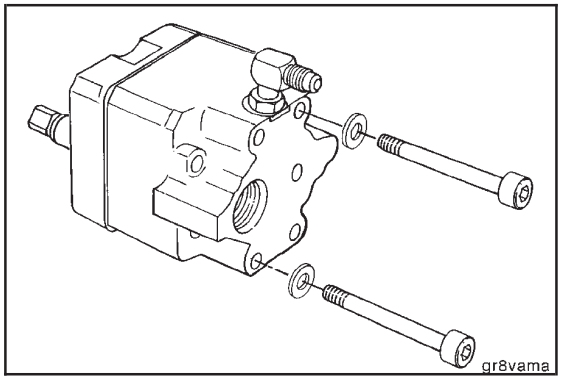


NOTE: The location of the notches and the drive gear shaft determines the rotation of the pump.



Assemble a right hand rotation pump as follows:

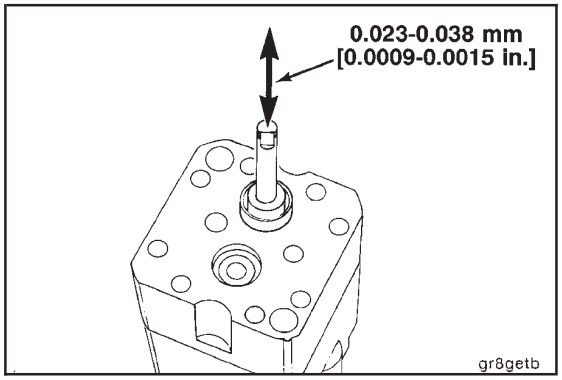
- Place the driven gear shaft of the pump in the body nearest the **location notches** (1).
- Place the driving gear shaft in the opposite hole.
- The ring dowel (2) **must** be around the drive shaft.



Align the cover and body with the dowels. Tighten the four cover to body capscrews evenly.

Check that the pump rotates freely with finger pressure.

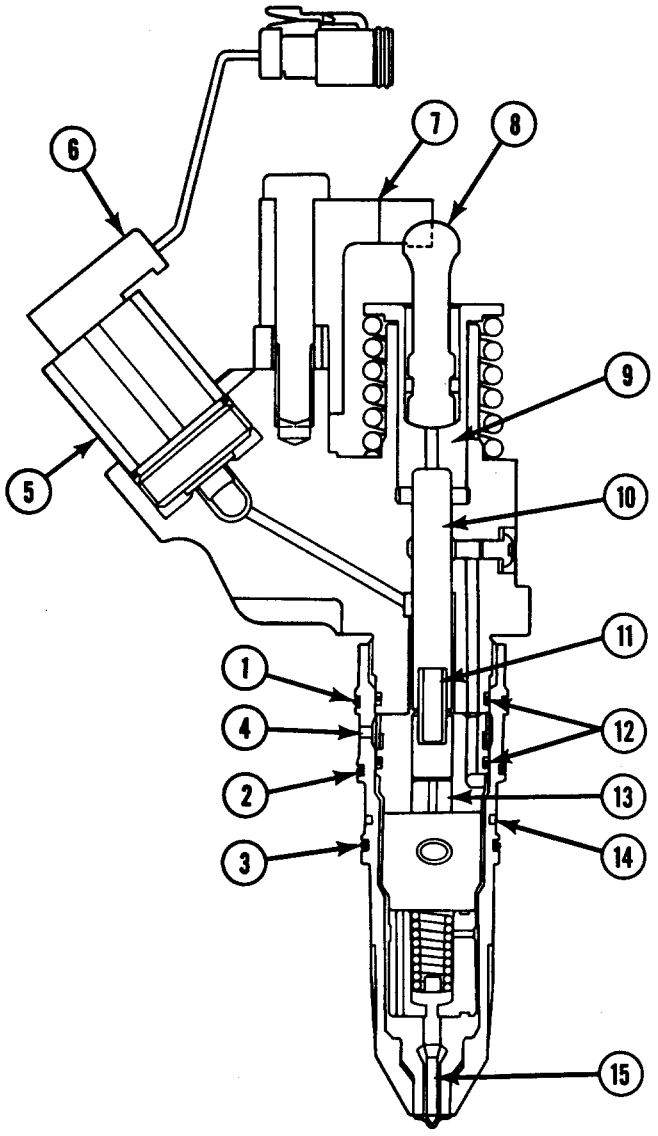
Torque Value: 18 N•m [13 ft-lb]



Shaft End Clearance		
mm		**in**
0.023	MIN	0.0009
0.038	MAX	0.0015

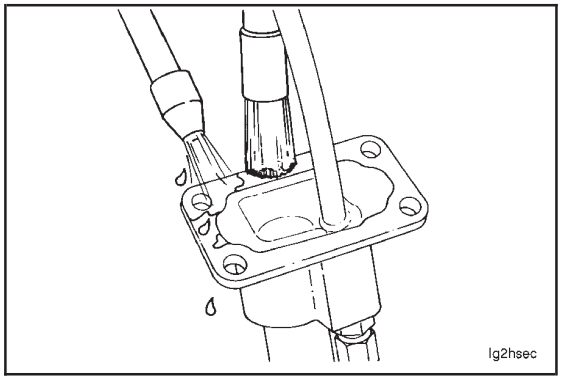
NOTE: Gaskets are available in 0.51 mm [0.0020 inch] (red) and 0.038 mm [0.0015 inch] (purple). If the end clearance is **not** correct or the pump does **not** rotate freely, check for an error in the assembly procedure.

Injector - CELECT™ - Exploded View



Ref. No.	Description	Qty.
1.	Seal, O-ring Top (Black)	1
2.	Seal, Oring Middle (Brown)	1
3.	Seal, Oring Bottom (Black with White dot)	1
4.	Drain, Fuel	1
5.	Solenoid	1
6.	Connection, Wire Harness	1
7.	Cap, Top Stop Retainer	1

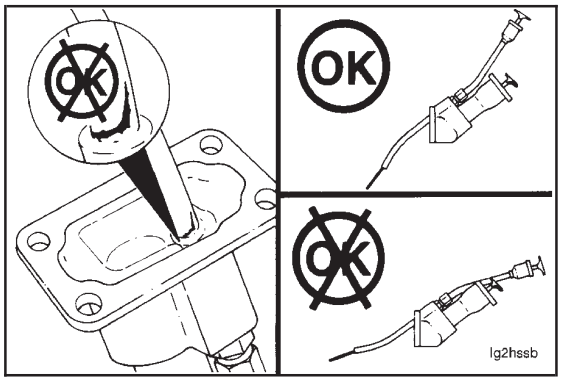
Ref. No.	Description	Qty.
8.	Link, Injector	1
9.	Coupling	1
10.	Plunger, Timing	1
11.	Spring, Bias	1
12.	Seal, O-ring	2
13.	Plunger, Metering	1
14.	Port, Fuel Inlet	8
15.	Tip	1



Lubricating Oil Dipstick and Dipstick Tube - Cleaning and Inspection for Reuse (7-03)

Remove all gasket material from the gasket sealing surface.

Use solvent to clean the dipstick and filler tube assembly. Dry with compressed air.

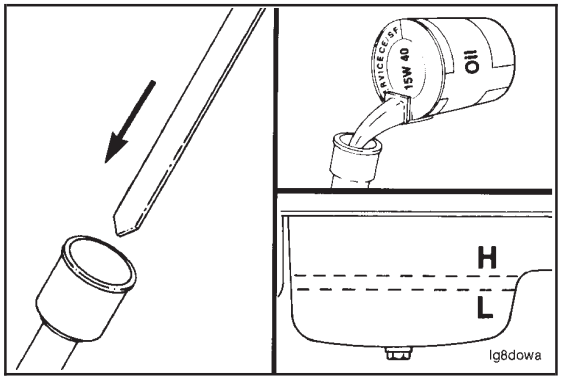


Inspection

Visually inspect the dipstick tube, filler tube and hand hole cover for cracks or damage.

Visually inspect the dipstick tube angle.

If cracks or damage is found or the dipstick tube does **not** angle downward into the oil pan, the damaged parts or dipstick tube **must** be replaced.



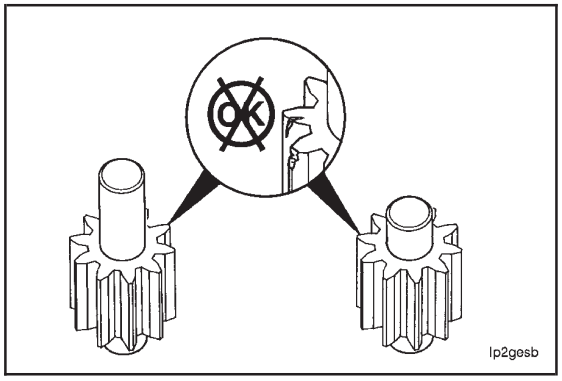
Lubricating Oil Dipstick - Calibration (7-04)

Install the dipstick in the dipstick tube.

NOTE: Be sure the engine is level. Begin this procedure with the oil pan empty.

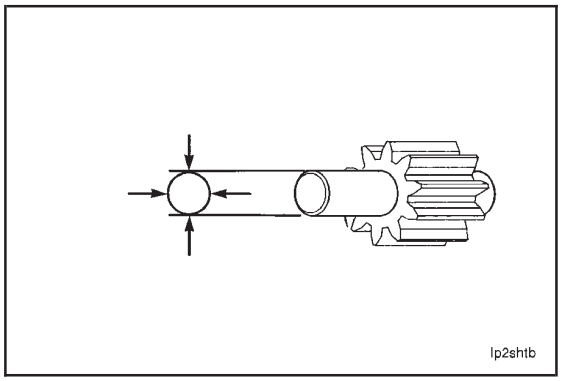
Use clean 15W-40 oil to fill the oil pan to the specified ''Low'' oil pan capacity level.

Oil Pan Capacity		
Litres		**U.S. Gallons**
	Automotive	
26.5	Low	7.0
34.0	High	9.0
	Industrial	
30.3	Low	8.0
34.0	High	9.0



Visually inspect the internal oil pump gears for cracked or broken teeth and excessive wear.

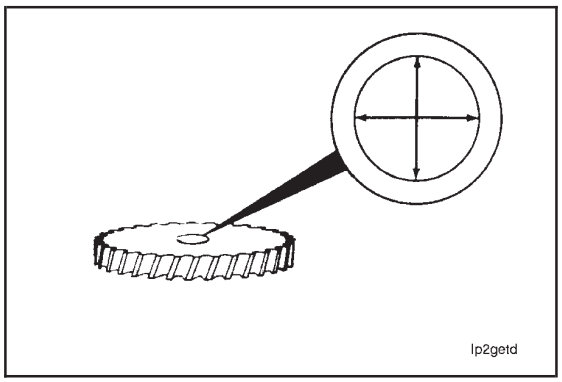
If cracked or broken teeth or excessive wear is found, the gear(s) **must** be replaced.



Measure the outside diameter of the oil pump gear shafts.

Gear Shafts O.D.		
mm		**in**
18.669	MIN	0.7350
18.681	MAX	0.7355

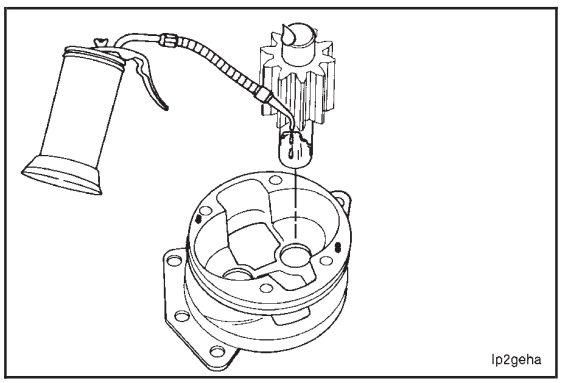
If the gear shafts are worn beyond the minimum limit specified, the shaft(s) **must** be replaced.



Measure the inside diameter of the drive gear bore.

Drive Gear Bore I.D.		
mm		**in**
18.600	MIN	0.7323
18.625	MAX	0.7333

If the drive gear bore is worn beyond the maximum limit, the drive gear **must** be replaced.



Assembly

Use clean 15W-40 oil to lubricate the internal drive gear and shaft.

Install the drive gear and shaft in the oil pump body.

Water Pump Assembly - General Information

The L10 engine water pump is a centrifugal type pump with a phenolic impeller. The water pump is gear driven from an idler gear in the front gear train. The water pump contains an oil seal and a unitized water seal. The water pump bearing, gear and shaft receive lubrication from engine oil in the front gear train.

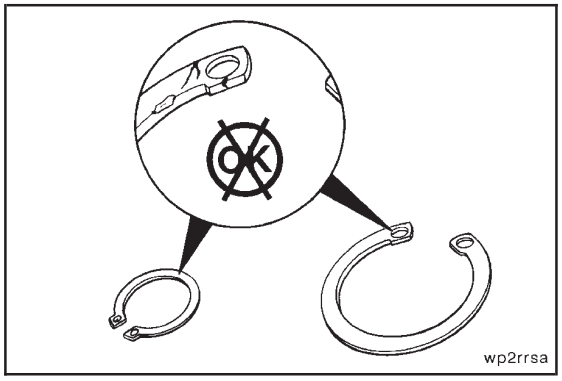
The L10 engine uses both metric and U.S. Customary capscrews. In some cases, capscrews in metric and U.S. Customary threads are almost identical in appearance. Be sure to install the capscrews in the same location they were removed from.

Pipe plugs used in the cooling system are U.S. Customary dimensions.

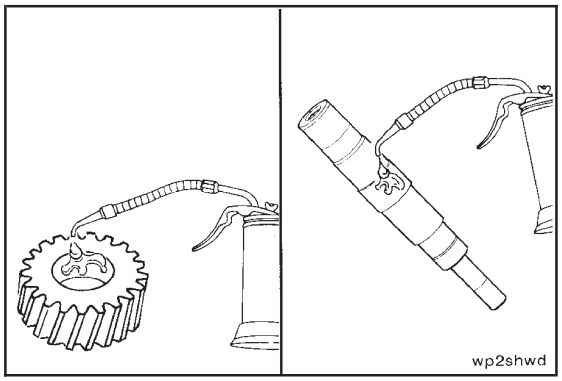
Fan Hub and Fan Idler Pulley - General Information

The fan belt tension is adjusted by an adjusting screw and idler pulley in the fan hub support.

The fan idler pulley contains two anti-friction tapered roller type bearings. The idler pulley end clearance is set properly by two bearing race spacers. **Always** replace the complete bearing set if any one piece requires replacement.

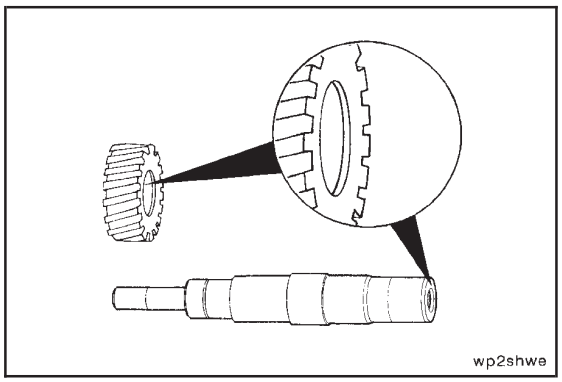


Visually inspect the bearing retainer rings for nicks or cracks.

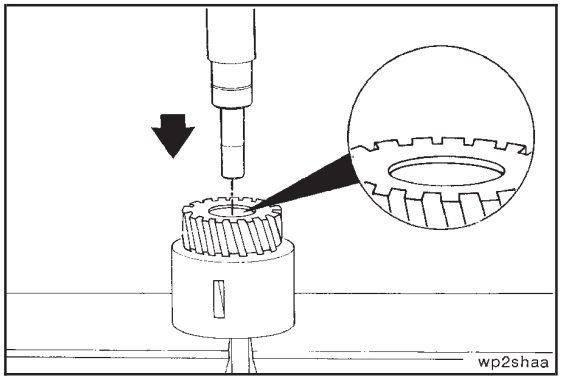


Assembly

Use clean 15W-40 oil to lubricate the drive gear bore and the shaft.

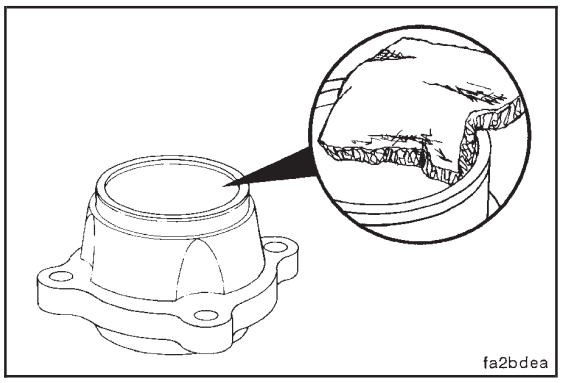


Caution: The chamfered side of the drive gear bore must be installed toward the large diameter end of the shaft to prevent damage to the gear when the water pump is installed on the engine.



Install the gear in an arbor press with the chamfered side of the gear bore facing up.

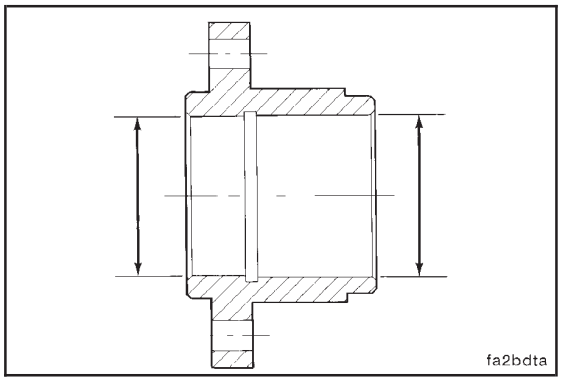
Insert the impeller end (smallest diameter) of the shaft through the top of the gear bore.



Use Scotch-Brite® 7448, Part No. 3823258 or equivalent, to remove any minor damage from the hub bore.

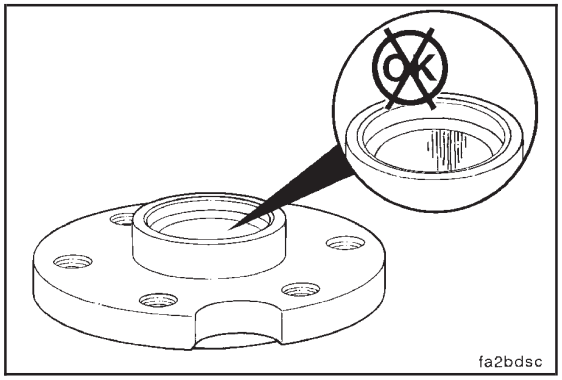
NOTE: When removing nicks or scratches from the hub, the inside diameter **must** be maintained, or the hub **must** be replaced.

Use solvent to clean the hub and dry with compressed air.

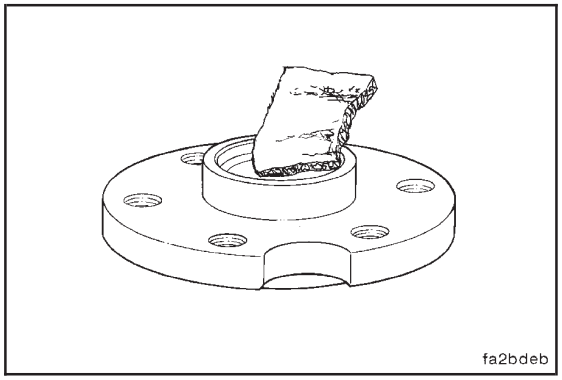


Measure the inside diameter of the hub bearing bores.

Hub Bearing Bore I.D.		
mm		**in**
65.038	MIN	2.5605
65.076	MAX	2.5620



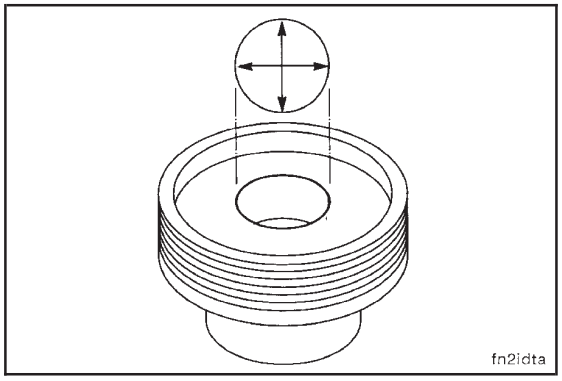
Visually check the flange bore for grooves, scratches or any type of damage.



Use Scotch-Brite® 7448, Part No. 3823258 or equivalent to remove any minor damage from the flange bore.

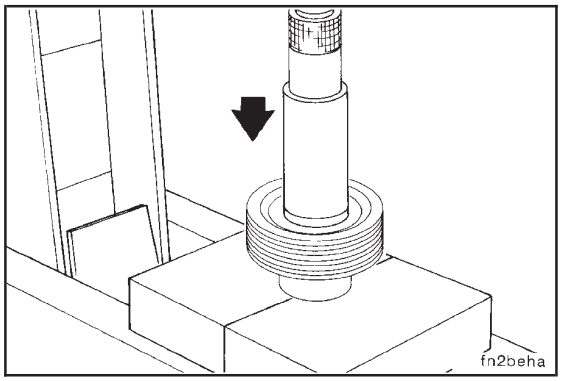
NOTE: When removing nicks or scratches from the flange, the inside diameter **must** be maintained, or the flange **must** be replaced.

Use solvent to clean the flange and dry with compressed air.



Measure the inside diameter of the idler pulley bearing bores.

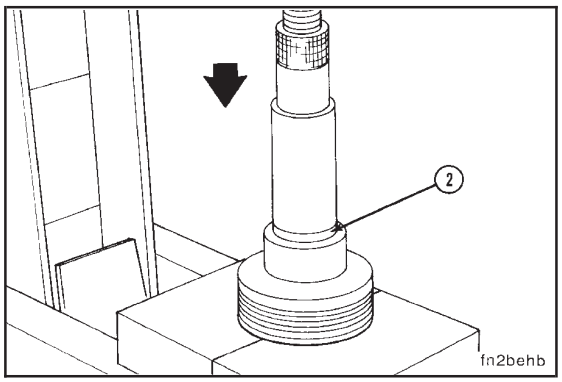
Front and Rear Bearing Bores I.D.		
mm		in
45.199	MIN	1.7795
45.224	MAX	1.7805



Assembly

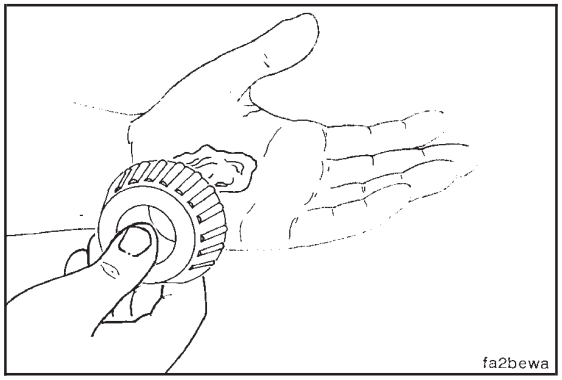
Install the idler pulley in an arbor press with the mounting flange facing down.

Use the bearing driver, Part No. 3375696, to press the front bearing race (1) into the pulley until it touches the spacer ring.



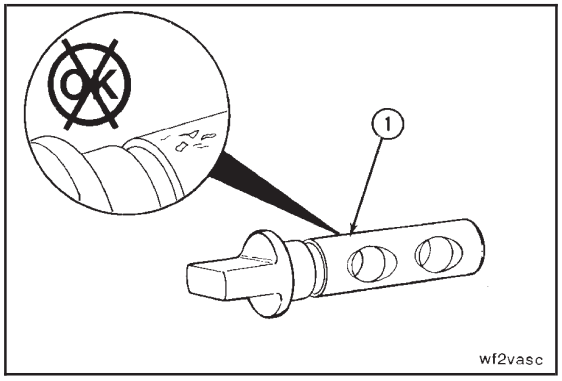
Turn the pulley over with the mounting flange facing up in the arbor press.

Use the bearing driver, Part No. 3375696, to press the rear bearing race (2) into the pulley until it touches the spacer ring.



Use clean Chevron SRI, or equivalent to lubricate the front and rear bearings.

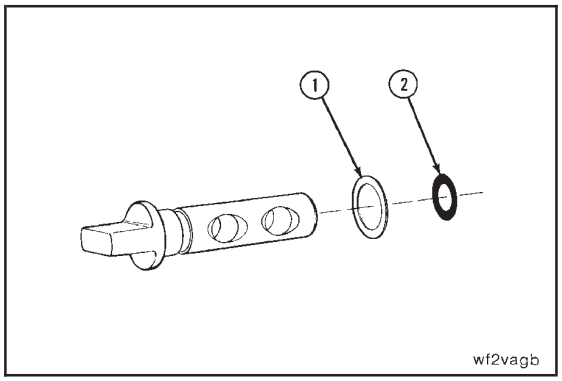
NOTE: Fill the space between the two bearings with grease when assembling the idler pulley.



Visually inspect the water passages in the shutoff valve shaft (1).

Visually inspect the shaft for corrosion or pitting. Use 240 grit aluminum oxide paper to remove the corrosion.

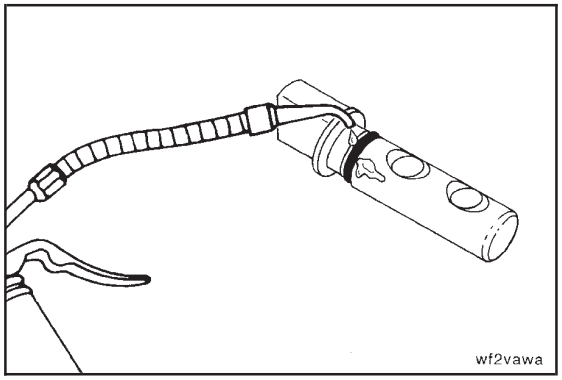
If the parts are cracked or damaged, the filter head assembly **must** be replaced.



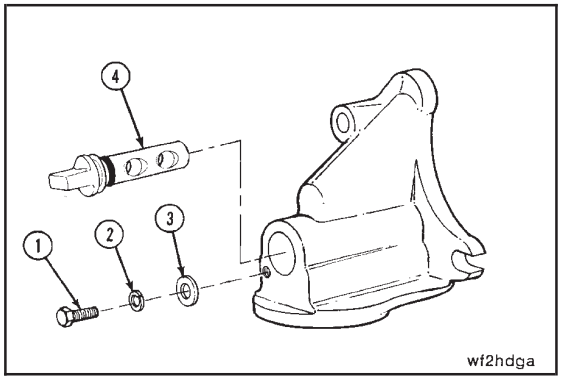
Assembly

Install the spring washer (1) on the shutoff valve shaft.

Install a new o-ring (2) in the groove of the shaft.



Use anti-seize to lubricate the shaft and o-ring.

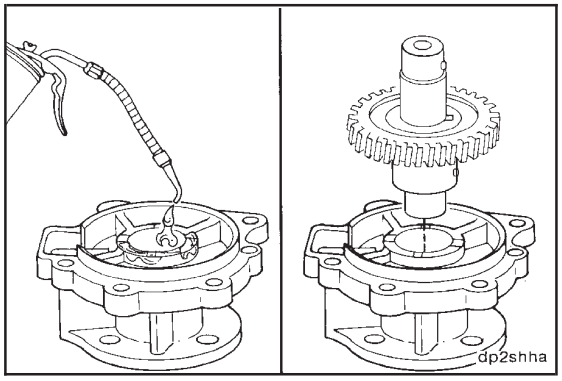


Install the shutoff valve shaft (4) in the filter head.

Install the hardened flat washer (3), lockwasher (2) and clamping capscrew (1) in the filter head.

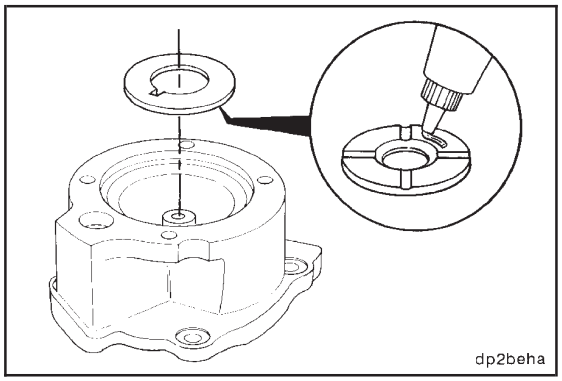
NOTE: Make sure the flat washer (3) is a hardened steel washer.

Torque Value: 10 N•m [60 in-lb]



Use clean 15W-40 oil to lubricate the shaft bore and thrust bearing surface of the housing.

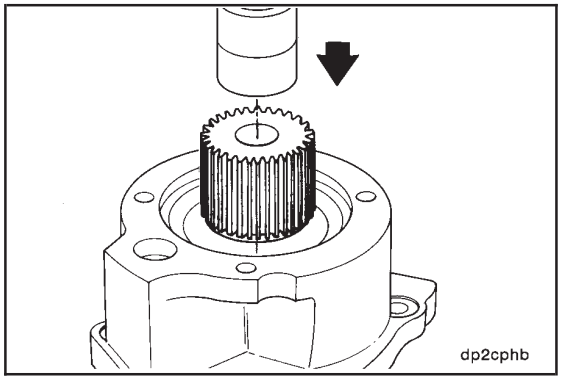
Install the shaft and gear assembly into the housing.



Caution: The grooved surface of the thrust bearing must be facing the thrust surface of the housing to provide proper lubrication and prevent damage to the drive assembly.

Use Lubriplate® No. 105, or equivalent to lubricate the grooved surface of the thrust bearing.

Install the thrust bearing over the shaft.



Install the Spline Coupling Gear

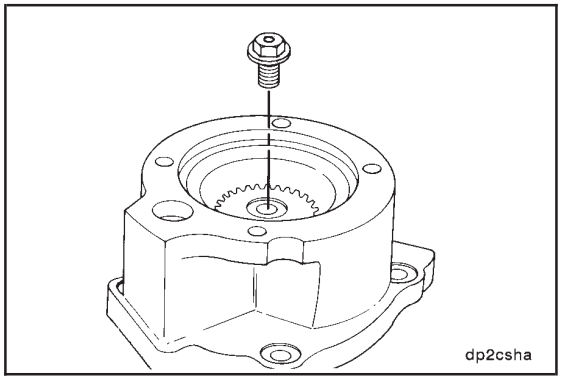
Use clean 15W-40 oil to lubricate the bore of the splined coupling gear.

Install the drive assembly in an arbor press with the drive gear facing down.

NOTE: Make sure the end of the drive shaft is supported.

The splined teeth are recessed from one end of the gear to aid in removal of the gear. Install this end of the gear on the shaft.

Press the gear onto the shaft.



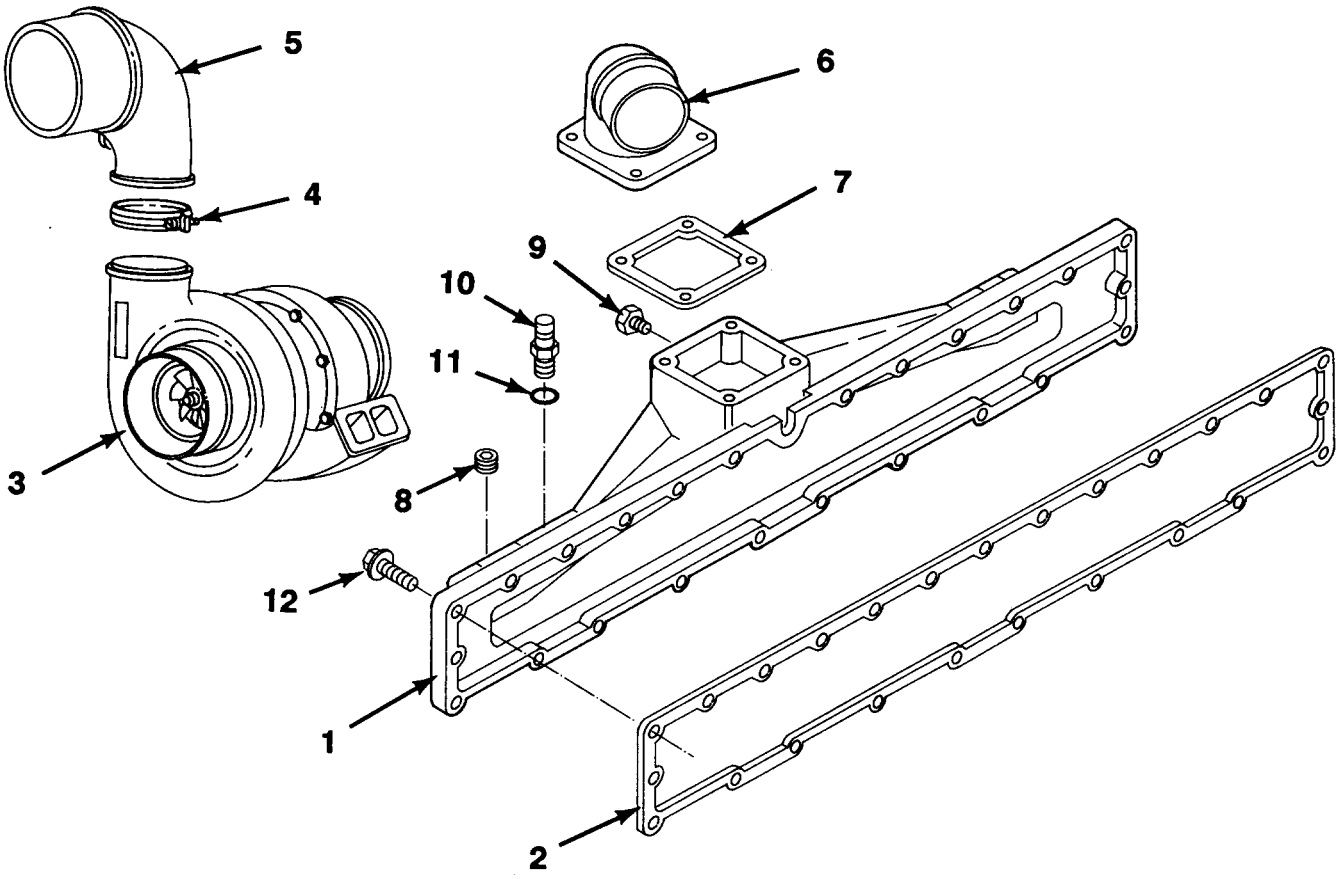
Install the splined coupling gear retainer washer and capscrew.

Caution: The retainer capscrew must have an oil drilling if an air compressor is to be used. The oil drilling will lubricate and prevent damage to the coupling.

Tighten the capscrew.

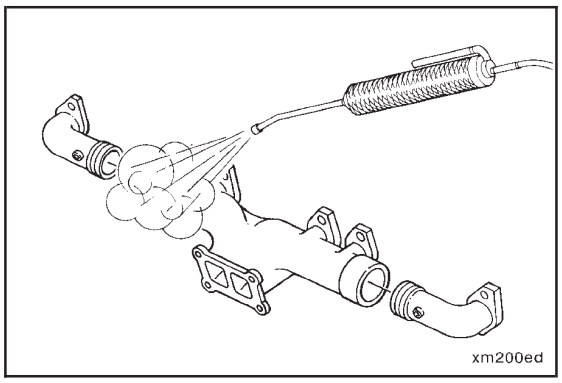
Torque Value: 47 N•m [35 ft-lb]

CAC Air Intake System - Exploded View



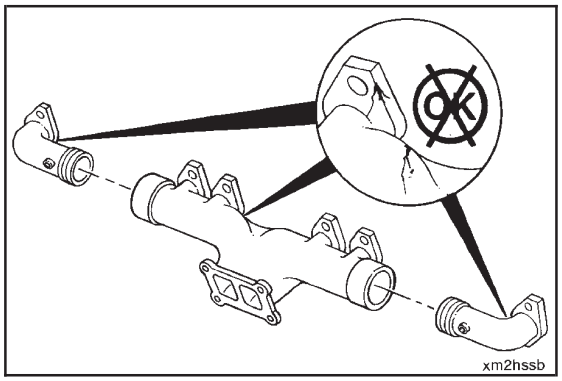
Ref. No.	Description	Qty.
1.	Manifold, Intake	1
2.	Gasket, Intake Manifold	1
3.	Turbocharger	1
4.	Clamp, V-Band	1
5.	Connection, Turbo Discharge Air	1
6.	Connection, Air Intake	1

Ref. No.	Description	Qty.
7.	Gasket, Connection	1
8.	Plug, Pipe	2
9.	Plug, Pipe	2
10.	Compuchek® Fitting	1
11.	Seal, O-ring	1
12.	Capscrews	21



Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Use steam to clean the manifold sections. Dry with compressed air.



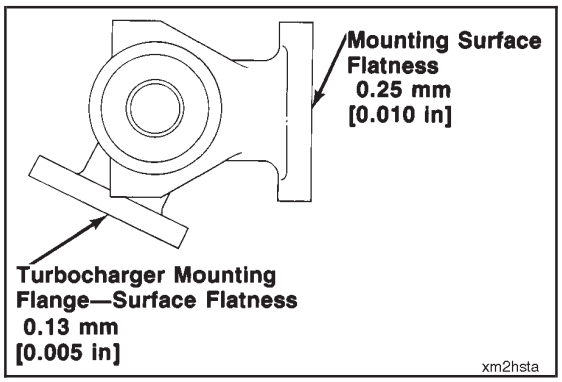
Inspection

Visually inspect the manifold sections for cracks or damage.

Visually inspect the sealing connection surfaces for damage.

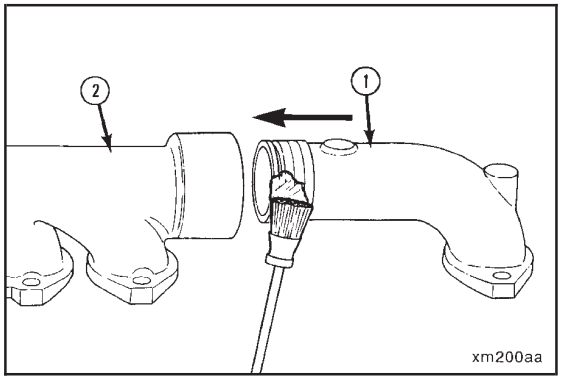
Visually inspect the center section for damaged threads in the turbocharger mounting stud holes.

Replace damaged parts.



Inspect the mounting surfaces for flatness. The exhaust manifold mounting surface **must** be flat to within 0.25 mm [0.010 in]. The turbocharger mounting flange **must** have a surface flatness of 0.13 mm [0.005 in].

If these surfaces are not within the flatness specifications, refer to the Alternative Repair Manual, L10 Series Engines, Bulletin No. 3810310.



Apply a coat of anti-seize compound to the outside diameter of both end sections in the area that enters the center section.

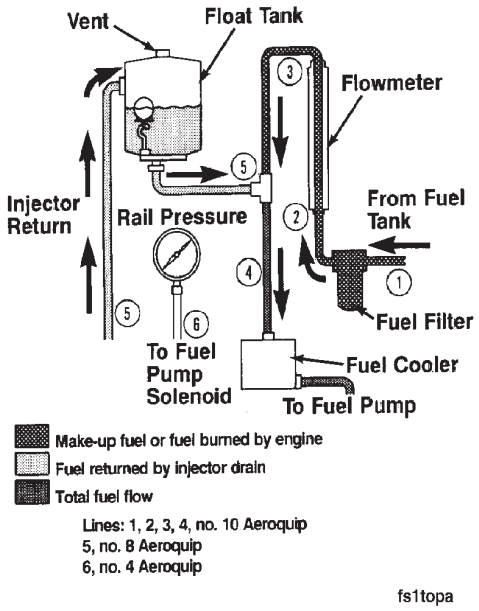
Install the end sections (1) in the center section (2).

NOTES

Operation

This is a schematic of the fuel measuring device, Part No. 3376375. The device consists of the following components:

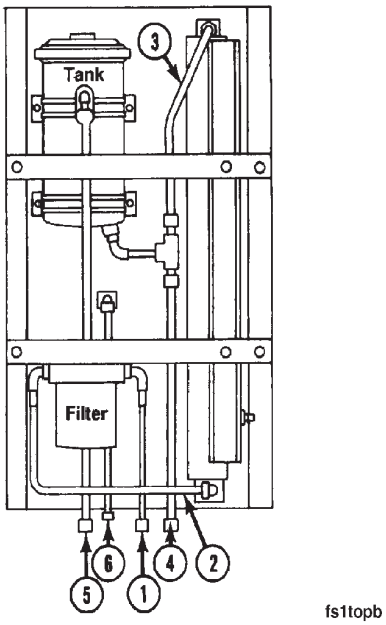
- Fuel Filter
- Flowmeter
- Float Tank
- Fuel Rail Pressure Gauge
- Fuel Cooler is not a part of fuel measuring device, Part No. 3376375; however, **must** be used when conducting test with the flow meter.



The fuel measuring device recirculates return fuel to the engine fuel inlet by routing the return fuel to the top side of the float tank. The fuel is deaerated as it passes through the baffling in the float tank. A ball float valve at the bottom of the float tank maintains an adequate volume in the tank for deaeration. The fuel is then returned to the engine fuel inlet. Refer to the sketch for fuel line connection points on the fuel measuring device.

1. Fuel Supply From Tank
2. Fuel Flow to Fuel Meter
3. Fuel Flow From Fuel Meter
4. Fuel Flow to Fuel Cooler
5. Injector Return Fuel
6. Fuel Rail Pressure

Note: The fuel supply tank **must** be below the level of the fuel measuring device to prevent overflow of the float tank. If an overhead fuel supply tank is used, a float controlled reservoir **must** be installed between the fuel supply tank and the fuel measuring device, and below the level of the device.



Dynamometer Worksheet

Date _____ Repair Order No. _____ Operator_____

ESN _____ CPL _____ Fuel Pump Code_____

Complaint_____ SC Code_____

PARAMETER	CODE SPECIFICATIONS	ACTUAL READING
Fuel Pressure (psi @ RPM)		
Fuel Rate (lb/hr)		
Check Point 1 (psi @ RPM)	(Reference Only)	
Intake Mfd. Pressure (in.Hg)		
Intake Mfd. Temperature	77°C [170°F] 66°C [150°F] or below-Target	
Governor Break RPM		
No-Air Setting (psi @ RPM)		
*Intake Air Restriction	25 in. H_20, Maximum	
*Exhaust Air Restriction	3 in. Hg, Maximum	
*Fuel Inlet Restriction	8 in. Hg (Dirty Filter), Maximum	
CELECT™ Fuel Inlet Restriction	9 in Hg (Dirty Filter), Maximum	
*Fuel Drain Line Restriction	2.5 in. Hg with Check Valves, Max. 6.5 in. Hg without Check Valves, Max.	
Engine Blowby	12 in. H_20 New Engines, Max. 18 in. H_20 Used Engines, Max.	

*Recorded at Maximum Horsepower Speed and Full Load

Road Speed Limit _____ **Engine High Speed Limit**_____

Check Oil Level ____ Low ____ High ____ OK **Fuel Quality** ____ **OK** ____ **Not OK**

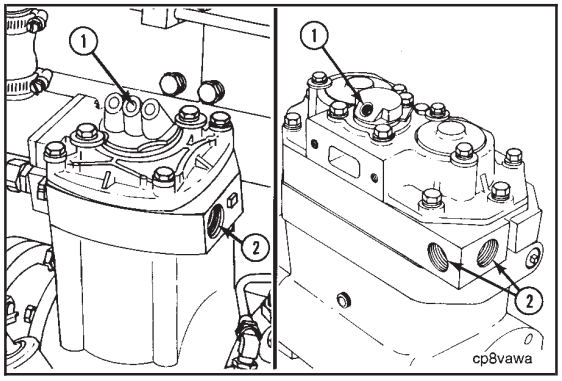
Engine Speed	Fuel *Rate/Press		Fuel Temp	Turbo Inlet Air Temp	Intake Manifold Temp/Press		Coolant Temp/Press		Engine Blowby	Lube Oil Press	Horse power or Torque

* Be sure that the fuel rate is corrected for temperature.

Fuel Temperature	Correction for Flow Rate
Less than 7°C[45°F]	Flow meter **not** accurate
7 to 13°C[45 to 55°F]	Subtract 2% from flow rate reading
13.0 to 20.0°C[55 to 68°F]	Subtract 1% from flow rate reading
20.0 to 29°C[68 to 85°F]	No Correction
29 to 42°C[85 to 108°F]	Add 1% to flow rate reading
42 to 56°C[108 to 132°F]	Add 2% to flow rate reading
56°C above [132°F]	Flow meter **not** accurate.

Pressure Conversions
1 in. H_20 = 0.074 in. Hg = 0.036 psi 1 in. Hg = 13.514 in. H_20 = 0.491 psi 1 psi = 2.036 in. Hg = 27.7 in. H_20

This Page Can Be Copied For Your Convenience.

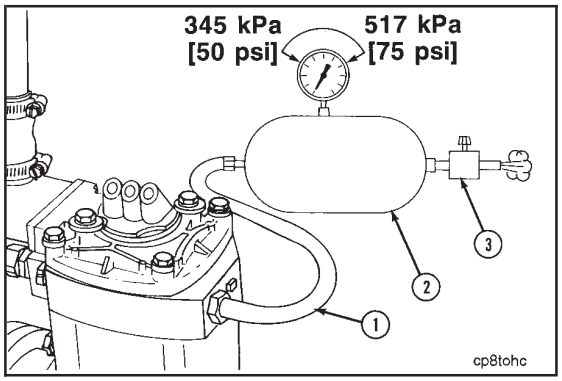


Air Compressor

NOTE: All air compressors manufactured by Cummins Engine Company, Inc. **must** be operating during the engine run-in. During the performance check, all air compressors **must** be in the unload or non-operating mode.

Connect a source of compressed air capable of producing 665 kPa [95 psi] to the air compressor unloader (1). This air line **must** contain a valve between the source and the unloader.

NOTE: The compressed air load in the accompanying illustration **must** be attached to the air compressor outlet (2).

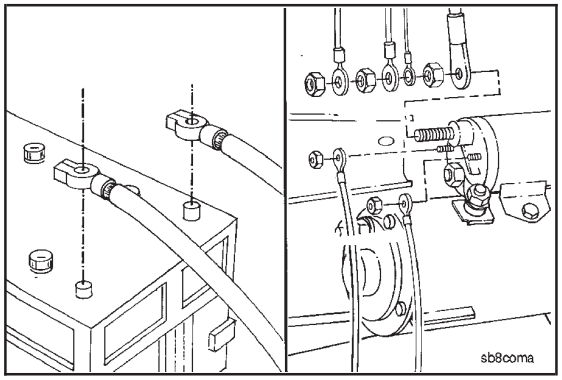


Use an air tank (2). Install an air regulator (3) capable of maintaining 345 to 517 kPa [50 to 75 psi] air pressure at both minimum and maximum engine RPM.

Install a steel tube or high temperature hose (1).

Hose Temperature (Minimum): 235°C [500°F].

Connect the tube or hose (1) to the air compressor outlet.

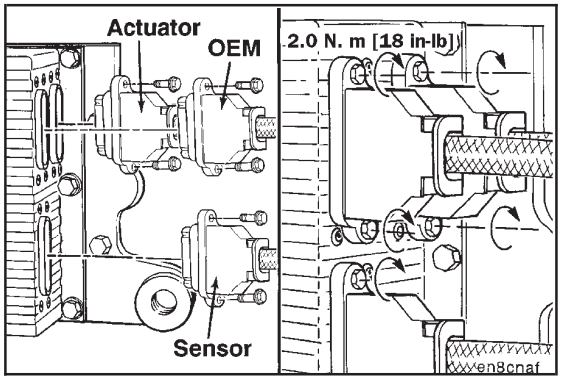


Starting Motor

Inspect the voltage rating on the starting motor before installing the electrical wiring.

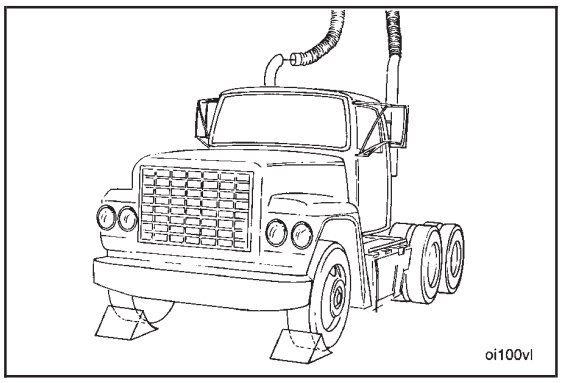
Install the electrical wiring to the starting motor and batteries, if used.

NOTE: If another method of starting the engine is used, follow the manufacturer's instructions to make the necessary connections.

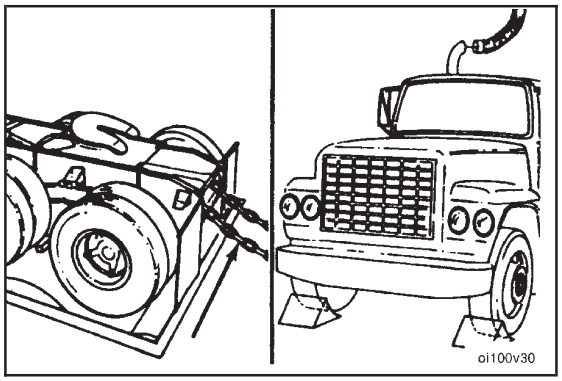


CELECT™ Engine Throttle Control

CELECT™ engines run on an engine dynamometer require that the sensor and actuator harness be installed, and connected to the engine. Additionally, a special engine dynamometer version of the OEM wiring harness and throttle control **must** be installed.

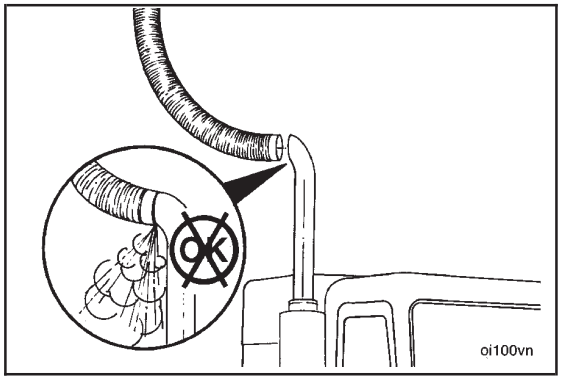


- Make sure there is correct overhead clearance for exhaust stacks, air deflectors, or other attachments above the cab.

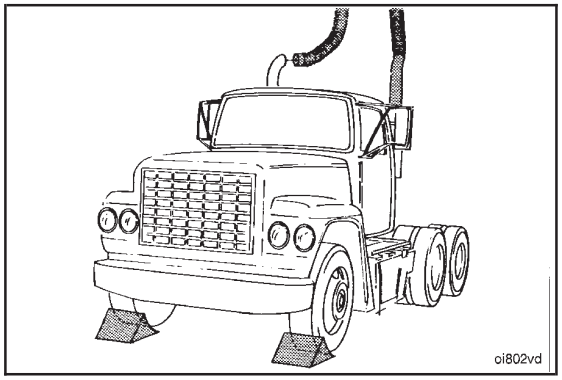


Caution: The ''tie down'' chains must have slack to prevent damage to the chassis dynamometer.

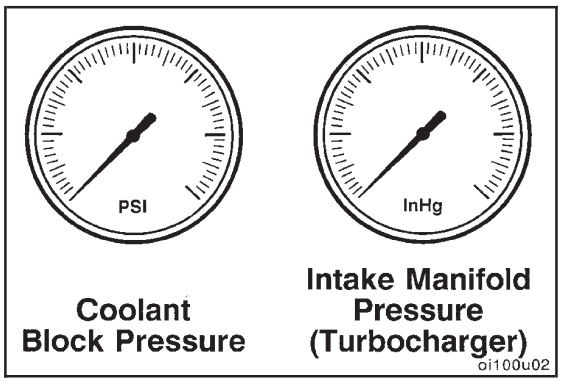
- Carefully position the vehicle on the rollers.
- Attach the ''tie down'' chains to the rear of the vehicle, and put wheel chocks in front of the front wheels.



- Adjust the vehicle and dynamometer room exhaust system to make sure all exhaust gases are removed from the room.
- Refer to the chassis dynamometer and vehicle manufacturer's recommendations and specifications for testing procedures.



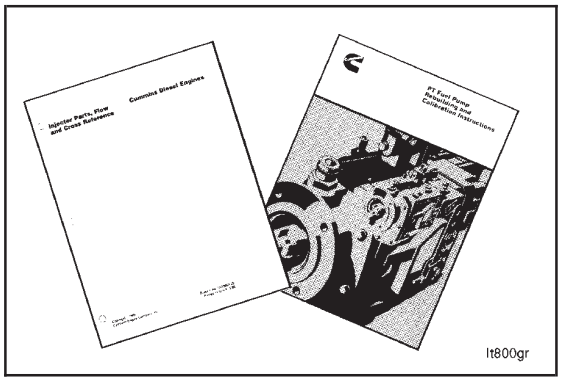
- Make sure there is proper overhead clearance for exhaust stacks, air deflectors, or other attachments above the cab.



Refer to the Engine Dynamometer Worksheet on page 8-16.

Intake manifold pressure (turbo boost) **must** be corrected for variances due to intake air temperature. Use the 'Boost Pressure Correction Factors' explained in ''Engine Testing - General Information''.

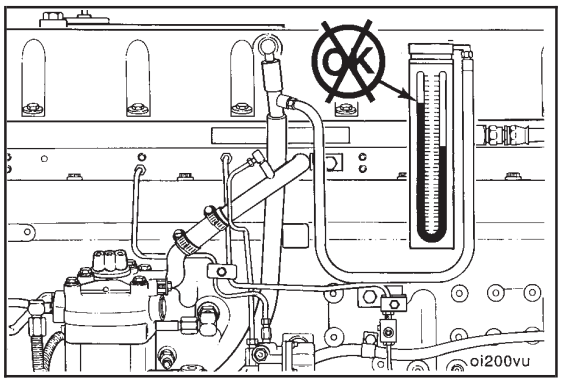
It is recommended to monitor block coolant pressure during run-in to aid in early indication of a cooling system problem.



Obtain CPL number from the engine data plate and the fuel pump code from the fuel pump data plate.

Engine performance specifications and fuel system calibration values are listed for specific engine CPL and fuel pump codes in the following publications:

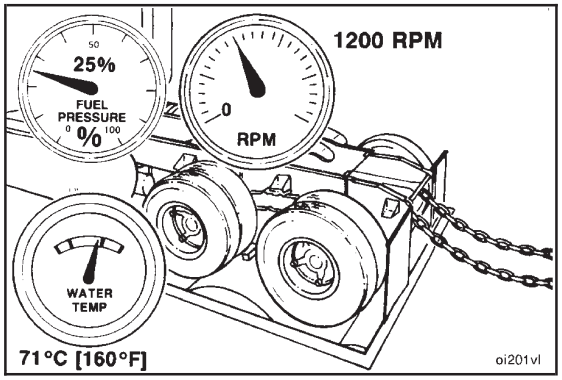
1. Fuel Pump Calibration Values, Bulletin No. 3379352.
2. Injector Parts Flow and Cross Reference, Bulletin No. 3379664.
3. Engine Data Sheets
4. L10 Engine Shop Manual, Bulletin No. 3810476.
5. L10 Specifications Manual, Bulletin No. 3810498.



If a sudden increase in blowby occurs, or if blowby exceeds the maximum allowable limit during any run-in, return to the previous step and continue the run-in. If blowby does **not** reach an acceptable level during the next step, discontinue the run-in and determine the cause.

Do **not** proceed to the next step until a steady, acceptable blowby reading is obtained.

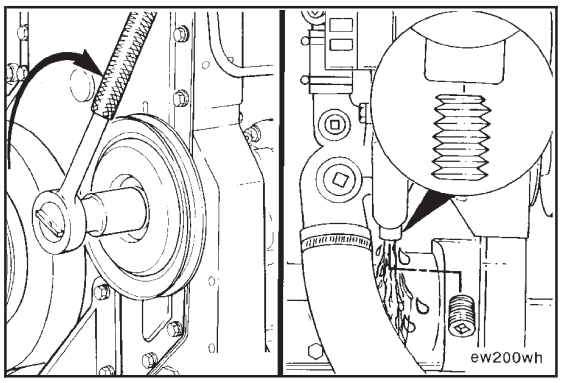
NOTE: Blowby **must** be measured by using Service Tool, Part No. 3375150 or 3822566 with manometer, Part No. ST-1111-3, or equivalent. Service Tool, Part No. 3375150, as shown, utilizes a chamfered 7.67 mm [0.302 in] orifice.



Move the throttle to obtain 1200 RPM engine speed, and apply a test load sufficient to develop 25 percent rated fuel pressure or 25 percent fuel rate on CELECT™ engines.

Operate the engine at this speed and load level until the coolant temperature reaches 71°C [160°F].

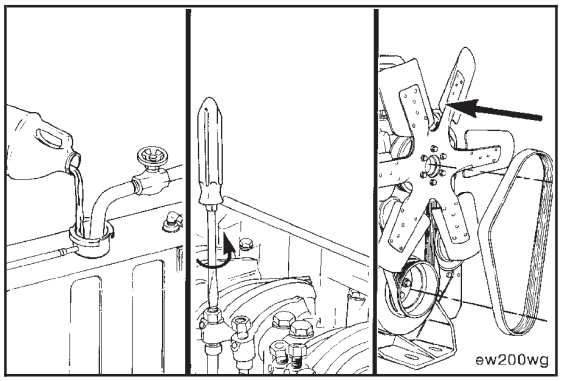
Check all gauges and record the data.



Remove a plug from the main oil rifle drilling. Use a light mineral oil to flush the preservative oil from the engine.

Use the accessory drive shaft to rotate the crankshaft three to four revolutions during the flushing procedure.

Drain and flush the cooling system.



Replace the oil, water and fuel filters.

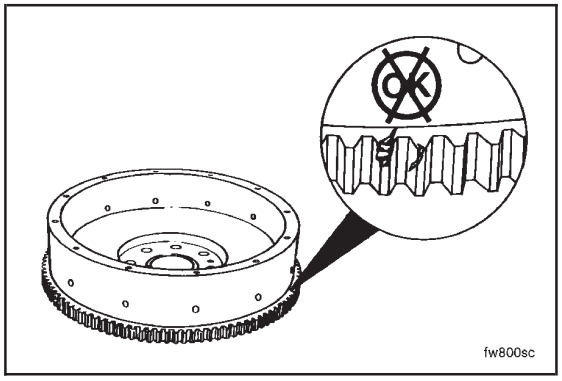
Fill the cooling system with coolant.

Prime the lubricating oil system. Refer to Engine Testing (14-02).

Adjust the injector and valve clearance. Refer to Engine Assembly (0-02).

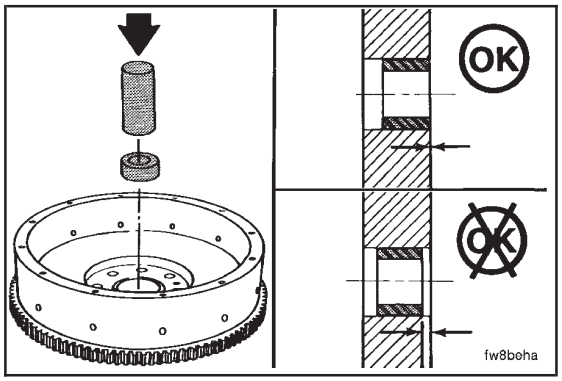
Adjust the belt tension. Refer to Engine Assembly (0-02).

Tighten the aftercooler assembly or intake manifold cover capscrews. Tighten the exhaust manifold capscrews. Refer to Engine Assembly (0-02).



Visually inspect the flywheel ring gear for chipped, cracked or broken teeth.

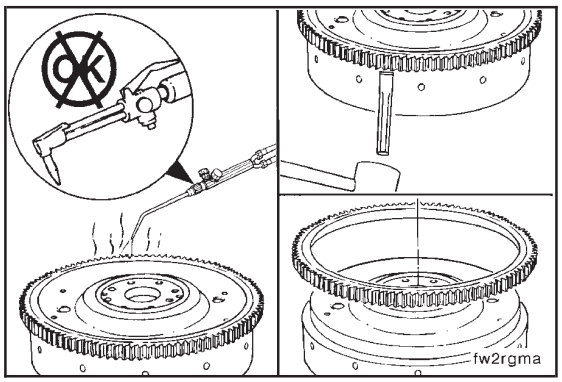
If the ring gear teeth are damaged, the ring gear **must** be replaced. Refer to Flywheel Ring Gear - Replacement (16-02).



Assembly

Use a new pilot bearing when installing a new or rebuilt clutch. The pilot bearing **must** be installed flush with the pilot bore surface.

Use a mandrel and hammer to install the pilot bearing.



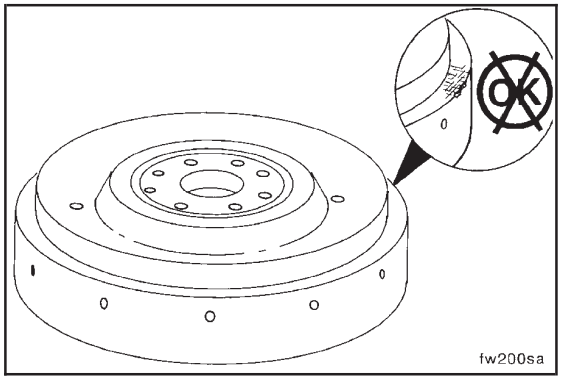
Flywheel Ring Gear - Replacement (16-02)

Disassembly

Caution: Do not use a cutting torch to heat the ring gear, the flywheel can be damaged.

Use a heating torch to heat the outside diameter of the ring gear.

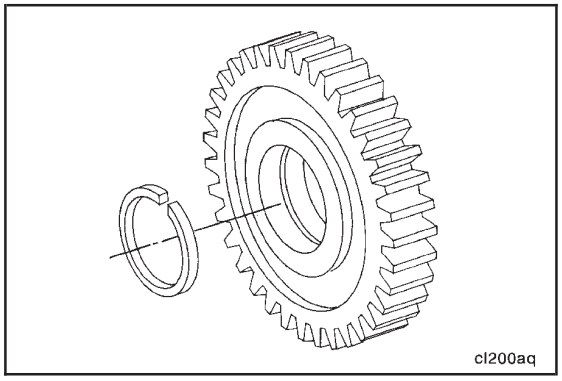
Use a blunt chisel and hammer to remove the ring gear from the flywheel.



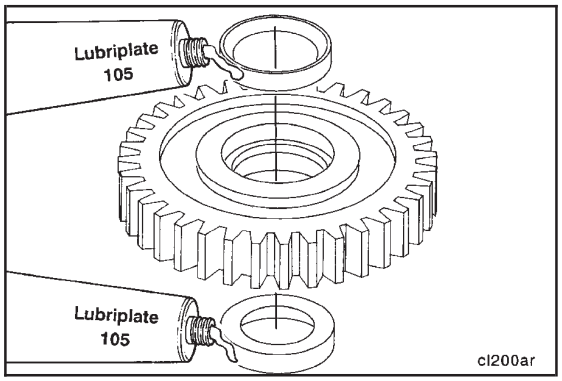
Inspection

Visually inspect the flywheel outside diameter for damage at the ring gear location.

Use 240 grit emery cloth to remove small nicks and burrs.

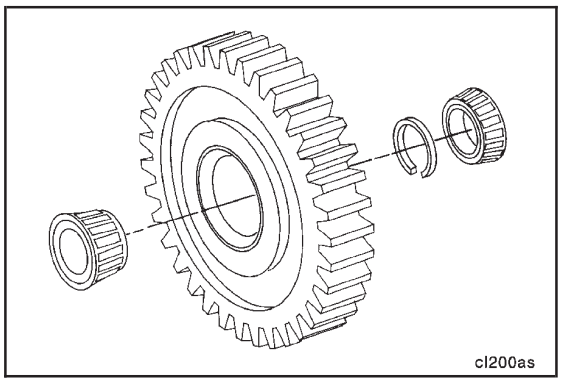


Insert a new spacer ring into the bore of the idler gear. Push it in until it snaps into place in the center groove.



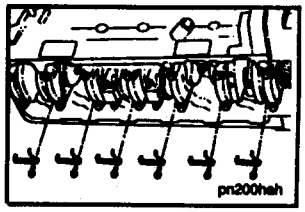
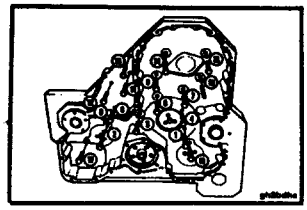
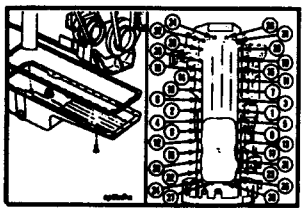
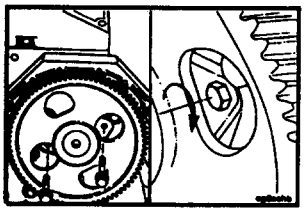
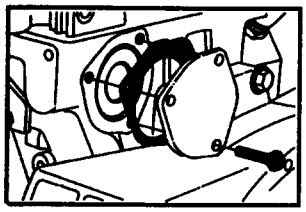
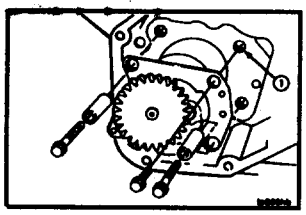
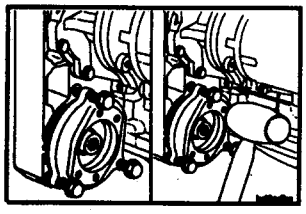
Use Lubriplate 105 to lubricate the bearing outer races.

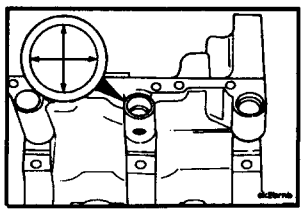
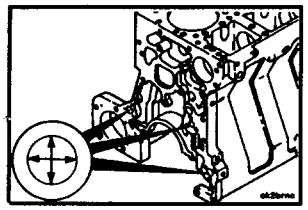
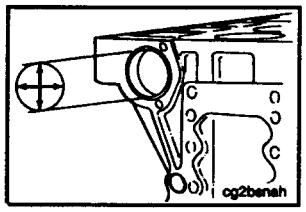
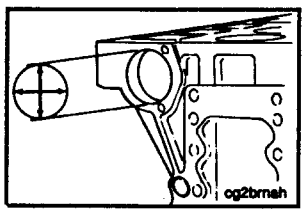
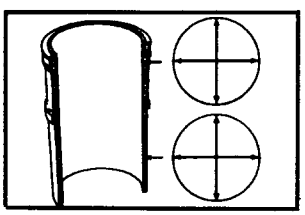
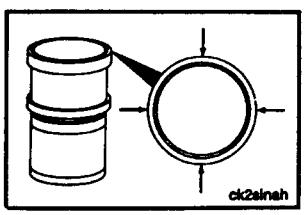
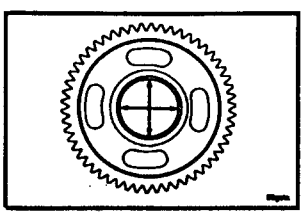
Press the two new bearing outer races into the bore of the idler gear. The larger side of the taper **must** face toward the outside of the gear.

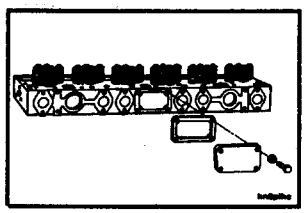
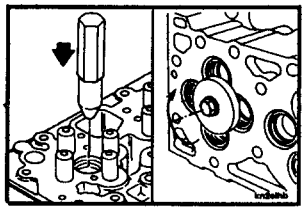
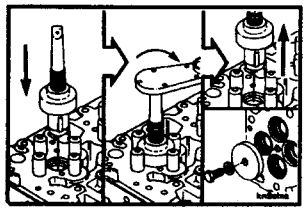
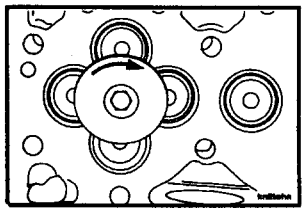
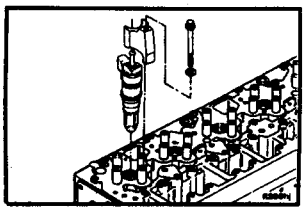
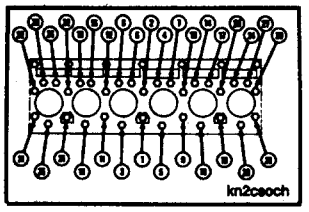


NOTE: Do **not** interchange individual parts that make up the idler gear bearing assembly. Rebuild the idler gear with bearings that are packaged together.

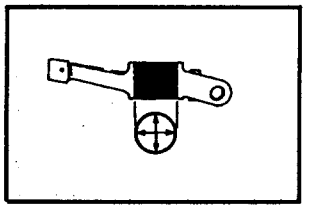
Keep the two roller bearing assemblies and the spacer ring with the idler gear.

	Component or Assembly (Procedure)	Ref.No./Steps	Metric	U.S.
	**Piston Cooling Nozzle**		27 N•m	18 ft-lb
	**Gear Housing** **Note:** Tighten the capscrews in sequence shown	1 2	20 N•m 68 N•m	15 ft-lb 50 ft-lb
	**Lubricating Oil Pan** **Note:** Tighten the capscrews in the sequence shown.		47 N•m	35 ft-lb
	**Camshaft Thrust Plate**		47 N•m	35 ft-lb
	**Camshaft Rear Cover Plate**		47 N•m	35 ft-lb
	**Lubricating Oil Pump (Grade 10.9 Capscrews)** Spot Faced Pump Casting As Cast Pump Casting **Note:** Use sealant, Part No. 3824038 or 3375068, or equivalent to coat the threads of the capscrews.		41 N•m 34 N•m	30 ft-lb 25 ft-lb
	**Hydraulic Drive Adapter** **Hydraulic Drive Cover Plate**		47 N•m 27 N•m	35 ft-lb 20 ft-lb

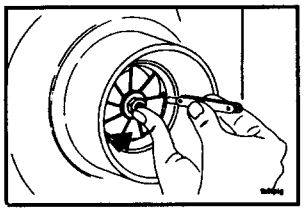
	Component or Assembly (Procedure)	Ref.No./Steps	Metric		U.S.
	**Main Oil Pressure Regulator Valve Bore I.D.**		22.226 mm 22.301 mm	MIN MAX	0.8750 in 0.8780 in
	**Idler Gear Ring Dowel Bore I.D.**		19.175 mm 19.215 mm	MIN MAX	0.7549 in 0.7565 in
	**Camshaft Bushing I.D. (Installed)** **Note:** If one of the bushings exceeds the specifications, all of the bushings must be replaced.		72.078 mm 72.142 mm	MIN MAX	2.8377 in 2.8402 in
	**Cylinder Block Camshaft Bore I.D.**		76.987 mm 77.040 mm	MIN MAX	3.0310 in 3.0331 in
	**Cylinder Liner I.D.**		125.000 mm 125.095 mm	MIN MAX	4.9213 in 4.9250 in
	**Cylinder Liner Top Press Fit O.D.**		145.938 mm 145.976 mm	MIN Max	5.7456 in 5.7471 in
	**Idler Gear Bushing Bore I.D.**		60.045 mm 60.100 mm	MIN MAX	2.3640 in 2.3661 in

	Component or Assembly (Procedure)	Ref.No./Steps	Metric		U.S.
	**Water Cover Plate**		68 N•m		50 ft-lb
	**Injector Sleeve Holding Tool Capscrew** **Note:** This torque value is for installing new injector sleeves. Refer to Cylinder Head - Replace Injector Sleeves (2-08).		50 N•m		38 ft-lb
	**Injector Sleeve Expander Mandrel**		8.9 N•m		75 in-lb
	**Injector Sleeve Holding Tool Capscrew** **Note:** This torque value is for pressure testing the cylinder head. Refer to Cylinder Head-Pressure Test for Reuse (2-08).	1 2 3	5 N•m 10 N•m 15 N•m		45 in-lb 90 in-lb 130 in-lb
	**Injector Hold-Down Clamp Capscrews (Fixed Time Engines)** **(STC and CELECT™)**	1 2 3	6 N•m 12 N•m 19 N•m 75 N•m		55 in-lb 110 in-lb 165 in-lb 55 ft-lb
	**Cylinder Head Capscrew Torque** Refer to Engine Assembly Torque Values.				

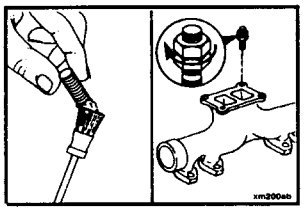
Rocker Lever Assembly - Rebuild Specifications



Rocker Lever Bushing Bore I.D.	34.900 mm	MIN	1.3740 in
	34.976 mm	MAX	1.3770 in

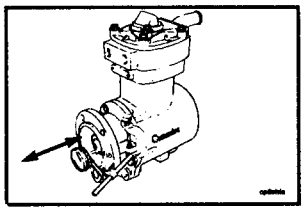
Component or Assembly (Procedure)	Ref.No./Steps	Metric		U.S.
 **Turbocharger Turbine Wheel Radial Clearance** **Note:** Specifications and instructions for rebuilding the turbocharger are provided in the Turbocharger Component Shop Manual, Bulletin No. 3379461.		0.15 mm 0.64 mm	MIN MAX	0.006 in 0.025 in

Exhaust Manifold - Torque Values

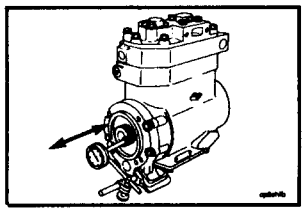


Exhaust Manifold Flange To Turbocharger Mounting Stud Torque **Note:** Apply a coat of anti-seize compound to the threads. Use two mounting nuts locked together to tighten the studs.	65 N•m		50 ft-lb

Air Compressor - Inspection Specifications

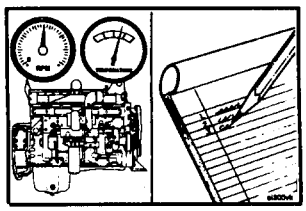


Single Cylinder Air Compressor Crankshaft End Clearance **Note:** Specifications and instructions for rebuilding the single cylinder air compressor are provided in the Air Equipment Rebuild Manual, Bulletin No. 3810457.	0.05 mm 0.15 mm	MIN MAX	0.002 in 0.006 in



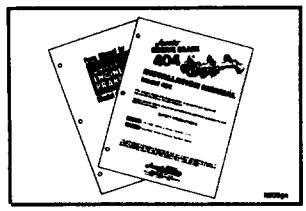
Two Cylinder Air Compressor Crankshaft End Clearance **Note:** Specifications and instructions for rebuilding the two cylinder air compressor are provided in the Air Equipment Rebuild Manual, Bulletin No. 3810347.	0.05 mm 0.19 mm	MIN MAX	0.002 in 0.008 in

Engine Testing - Test Specifications



Note: The specifications and instructions for testing the engine are provided in this manual. Refer to Engine Testing - Group 14, Page 14-1.

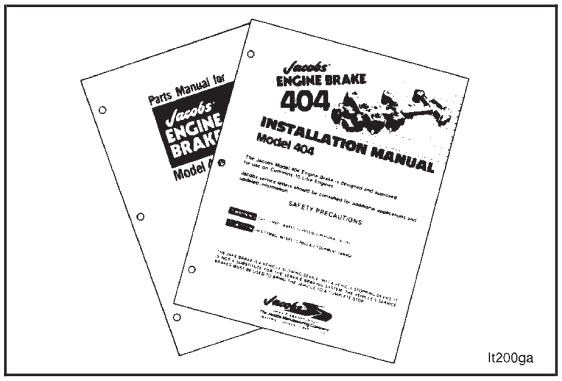
Vehicle Braking - Rebuild Specifications



Note: The specifications and instructions for rebuilding the Jacobs® Brake are provided in the Jacobs® Brake Installation Manual. Refer to Vehicle Braking - Group 20, Page 20-1.

Vehicle Braking - General Information

For installation and adjustment of the Jacobs® Engine Brake, Model 404, refer to the installation and parts manuals. The Installation Manual, Form No. 011948, and the Parts Manual, Form No. 3000, can be purchased from a Jacobs® Engine Brake dealer, or refer to the manufacturer at the following address:



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