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General Safety Instructions

Important Safety Notice

Read and understand all safety precautions and warnings before performing repairs.

 This symbol appears in the manual when a potential safety hazard exists that can cause personal injury or death. These hazards are not always apparent to a trained mechanic.

It is not possible for Cummins Engine Co., Inc. to anticipate every possible circumstance that can involve a potential hazard.

 **Warning:** Cummins Engine Company, Inc. does not recommend or authorize any modifications or repairs to engines or components except for those detailed in **CUMMINS SERVICE INFORMATION**.

In particular, unauthorized repair to safety-related components can cause personal injury. Components classified as safety-related include the following:

- Air Compressor
- Air Controls
- Air Shutoff Assemblies
- Balance Weights
- Cooling Fan
- Fan Hub Assembly
- Fan Mounting Bracket(s)
- Fan Mounting Capscrews
- Fan Hub Spindle
- Flywheel
- Flywheel Crankshaft Adapter
- Flywheel Mounting Capscrews
- Fuel Shutoff Assemblies
- Fuel Supply Tubes
- Lifting Brackets
- Throttle Controls
- Turbocharger Compressor Casing
- Turbocharger Oil Drain Line(s)
- Turbocharger Oil Supply Line(s)
- Turbocharger Turbine Casing
- Vibration Damper Mounting Capscrews

Read and understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that **must** be followed to provide personal safety. Special safety precautions are included in the procedures when they apply.

 Be sure the work area surrounding the product is safe. Be aware of hazardous conditions that can exist.

 Always wear protective glasses and protective shoes when working.

 Do not wear loose-fitting or torn clothing. Remove all jewelry such as rings, watches, etc., when working.

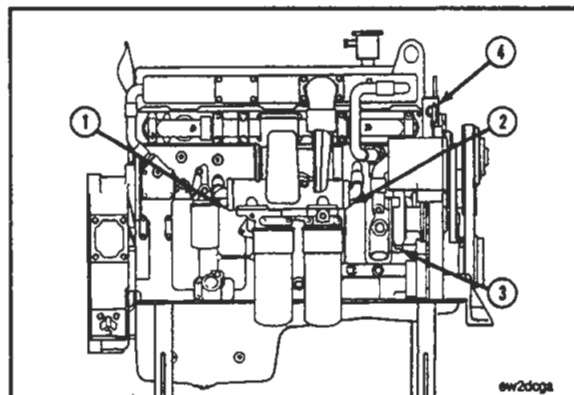
 Disconnect the battery and discharge any capacitors before beginning any repair work. Disconnect the air starter if equipped to prevent accidental engine starting. Put a "Do Not Operate" tag in the operator's compartment or on the controls.

Coolant - Drain

Remove the plugs from the following points:

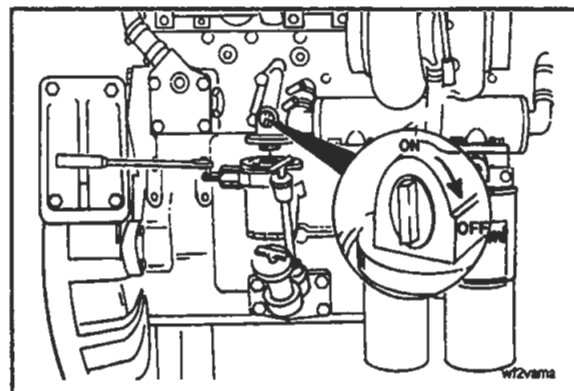
- Lubricating oil cooler (1) and (2)
- Water pump (3)
- Thermostat housing (4)

Use a suitable container to catch the coolant as it is drained.



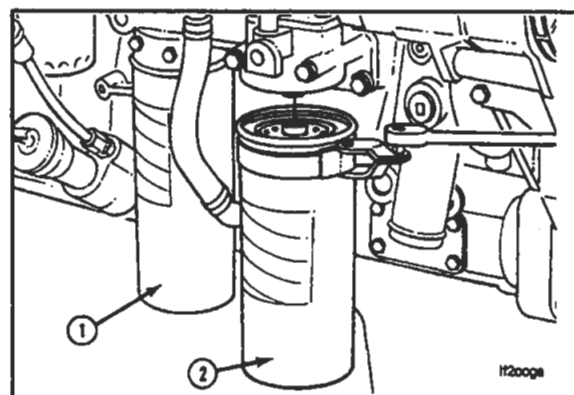
Coolant Filter - Remove

Use a Part No. 3376807 Water and Fuel Filter Wrench to remove the coolant filter.



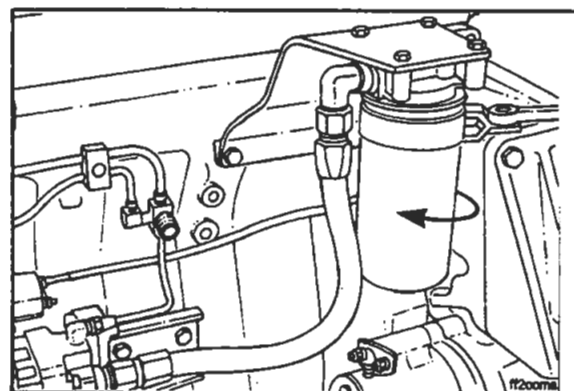
Lubricating Oil Filters - Remove

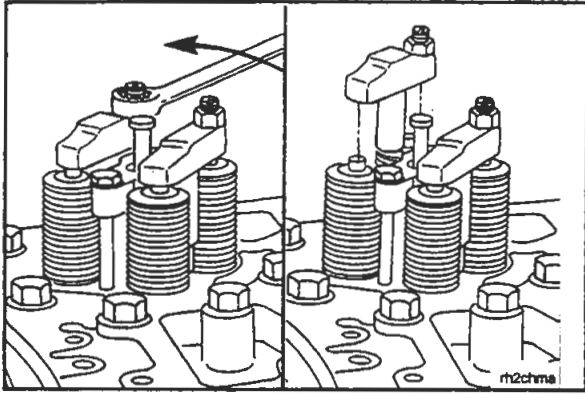
Use a Part No. 3375049 Oil Filter Wrench to remove the bypass filter (1) and the full flow filter (2).



Fuel Filter - Remove

Use a Part No. 3376807 Water and Fuel Filter Wrench to remove the fuel filter.



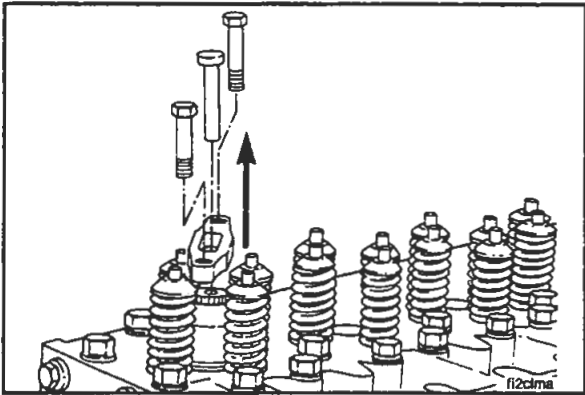


Crossheads - Remove



Loosen the crosshead adjusting screw locknuts and remove the crossheads.

Number each crosshead with the cylinder number and position as it is removed.



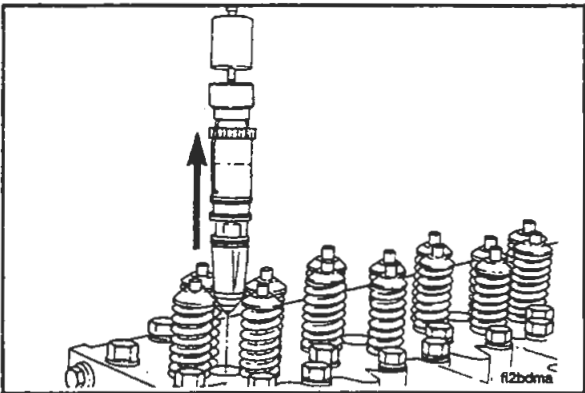
Injectors - Remove



Remove the injector plunger links.

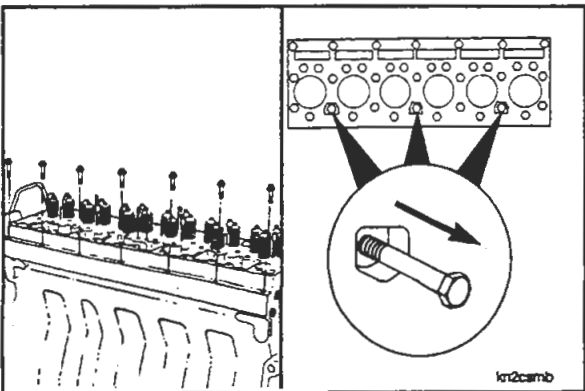
Number each link with the cylinder number as it is removed.

Remove the injector clamp capscrews and clamps.



Use the Part No. 3376872 Universal Injector Puller to remove the injectors.

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



Cylinder Head - Remove

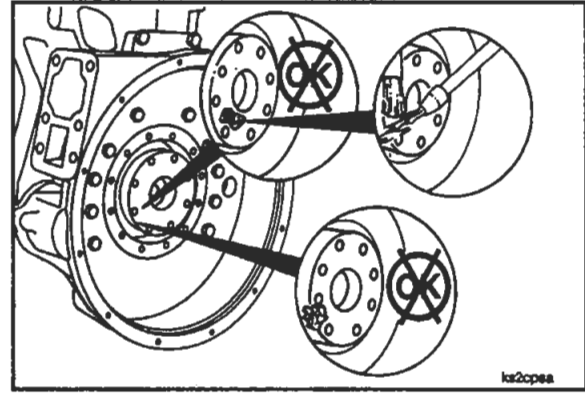


Remove the seven 12 point capscrews.

Note: Do not allow the washers from the three capscrews inside the intake ports to fall into the engine.

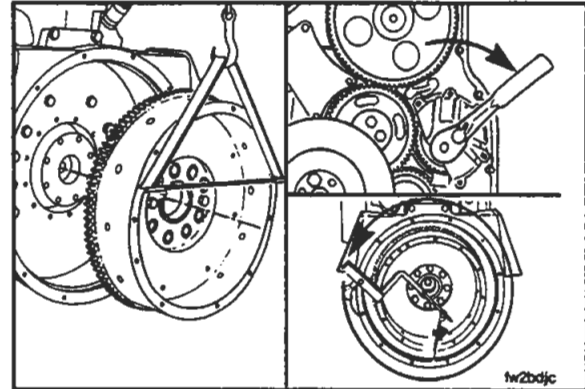
Remove the three capscrews inside the intake ports.

Inspect the crankshaft flange for burrs, dirt or damage.
If burrs cannot be removed with fine crocus cloth or the crankshaft is damaged, it **must** be replaced.

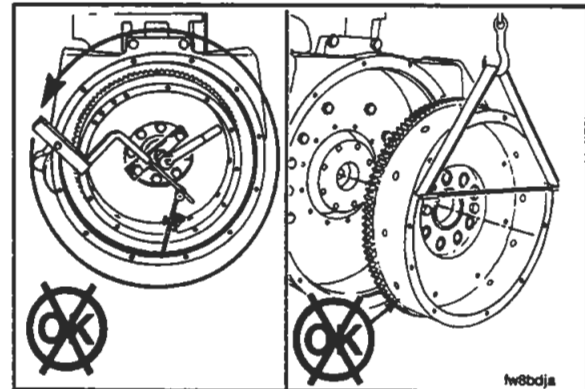


Install the flywheel and tighten the capscrews to the correct torque value.

Measure the bore runout again.



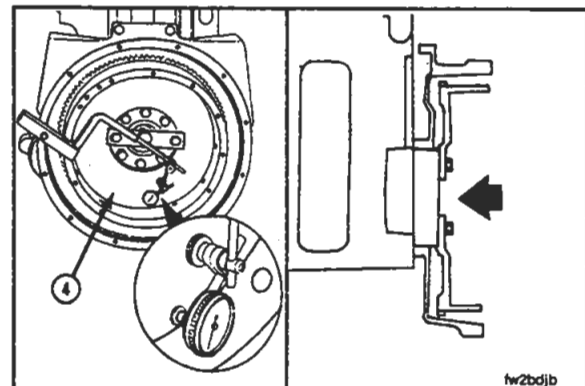
Note: If the TIR still exceeds the specification, the flywheel **must** be replaced.



Measure the Flywheel Face Runout

Install the contact tip of the indicator against the flywheel face as close as possible to the outside diameter to measure the face (4) runout.

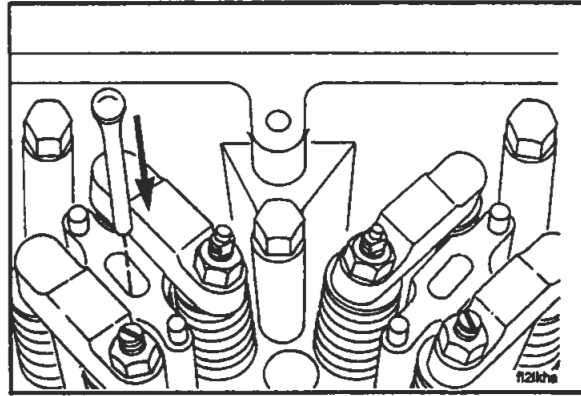
Push the flywheel forward to remove the crankshaft end thrust.



Install the injector plunger link into each injector.

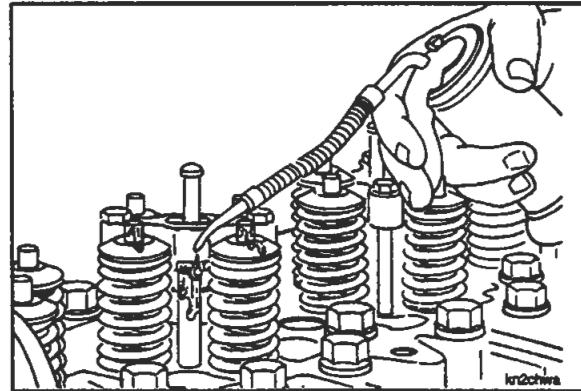
Inspect the injector plunger links for free movement. Raise the link approximately 1/3 of its length. Let the link fall into the injector.

Note: If the link does not move freely, loosen the clamp capscrews. Then, tighten the capscrews and check the free movement of the link again.



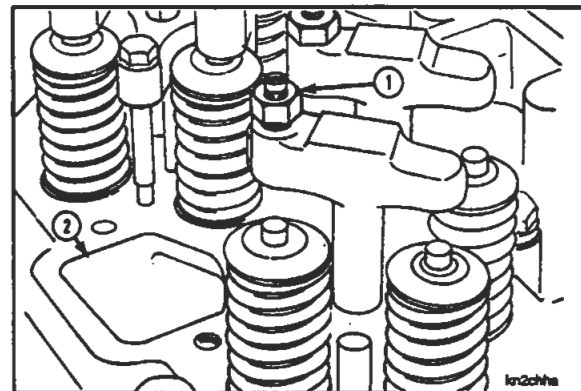
Crossheads - Install

Use clean 15W-40 oil to lubricate the end of the valve stems and crosshead guides.



Note: The adjusting screw (1) must be toward the intake ports (2) of the cylinder head to avoid contacting the rocker levers.

Install the crossheads on the crosshead guides.



Crossheads - Adjust

Note: Use the following procedure to adjust both intake and exhaust valve crossheads.

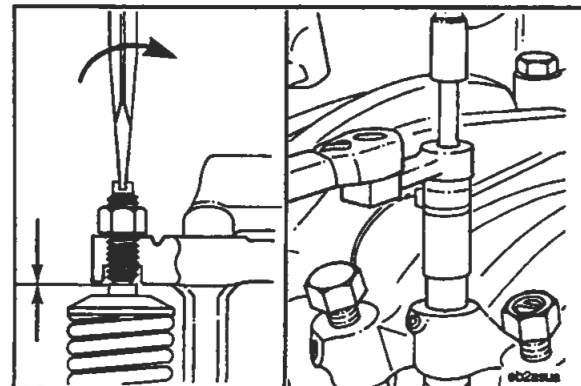
Hold the crosshead in position and turn the adjusting screw down until it touches the top of the valve stem.

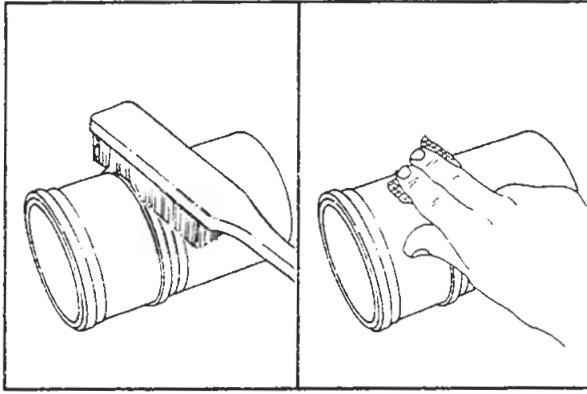
Hold the adjusting screw in position and tighten the locknut.

Torque Value: 40 N•m [30 ft-lb]

Note: When the Part No. ST-669 Torque Wrench Adapter is used to tighten the locknut, reduce the torque.

Torque Value: 30 N•m [25 ft-lb]





Cylinder Liners - Clean and Inspect for Reuse (01-04)

Cylinder Liners - Clean

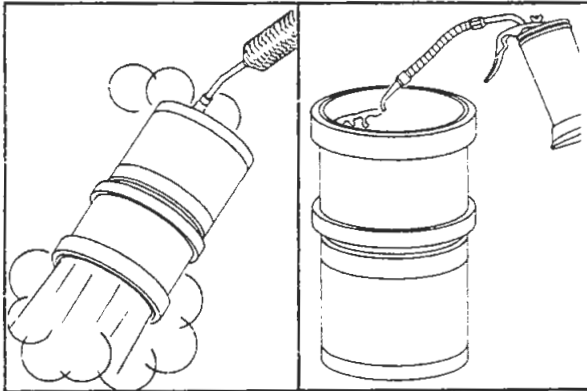


Caution: Do not use any abrasives in the ring travel area of the liner. The liner can be damaged.



Use a soft wire brush to clean the flange seating area.

Use a fine fibrous abrasive pad such as; Scotch-Brite® 7448 or equivalent to remove the remaining carbon.



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

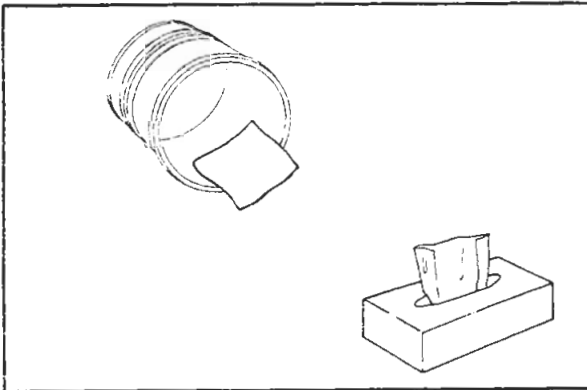


Use solvent or steam clean the liners and dry with compressed air.



Use clean 15W-40 oil to lubricate the inside diameter of the liners.

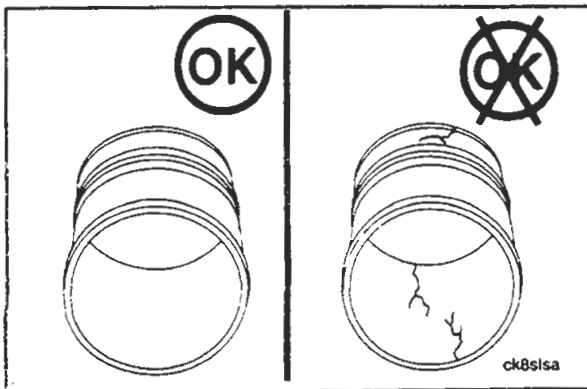
Allow the oil to soak in the liner for five to ten minutes.



Note: Use "lint-free" paper towels to wipe the oil from the inside of the liners.



Continue to lubricate the inside of the liners and wipe clean until the paper towel shows no gray or black residue.



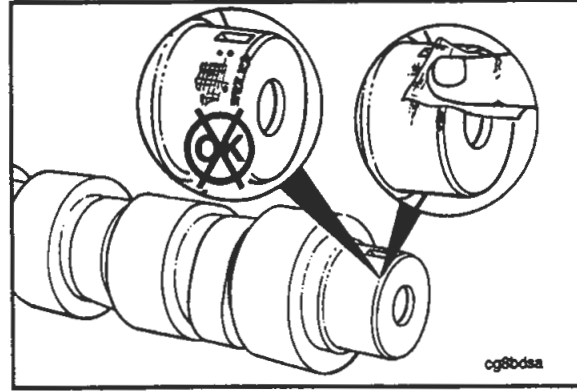
Cylinder Liners - Inspect

Visually inspect for cracks on the inside and the outside of the liner.

Camshaft Gear - Inspect

Visually inspect the camshaft nose for fretting or burrs.

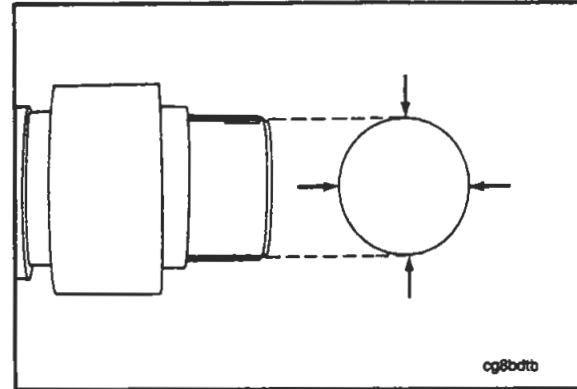
Note: The camshaft must be replaced if the fretting damage is more than 3 mm [1/8 inch] wide.



Measure the camshaft nose (gear mounting surface) outside diameter.



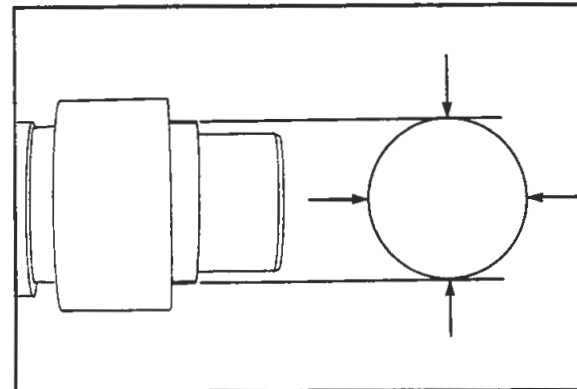
Camshaft Gear Mounting Surface O.D.		
mm		in
46.987	MIN	1.8499
47.013	MAX	1.8509



Measure the camshaft thrust bearing journal outside diameter.



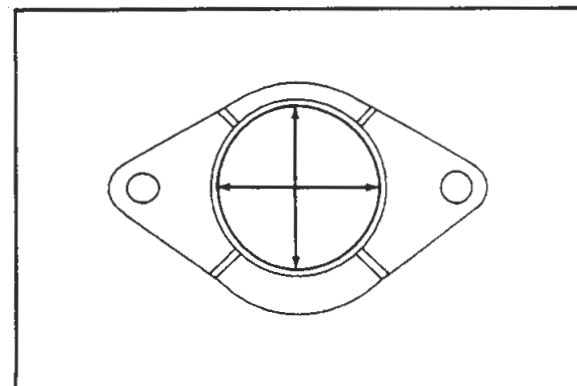
Camshaft Thrust Bearing Journal O.D.		
mm		in
54.80	MIN	2.157
55.20	MAX	2.173

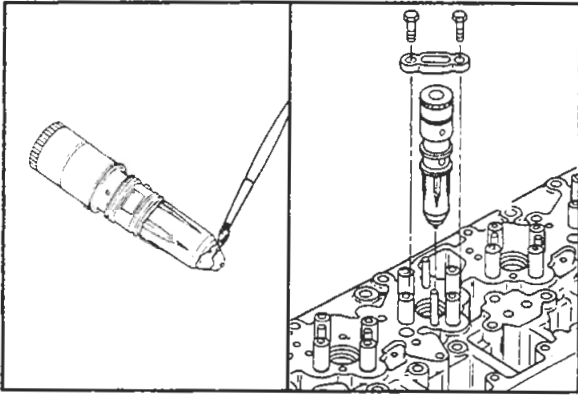


Measure the camshaft thrust plate inside diameter.



Camshaft Thrust Plate I.D.		
mm		in
55.60	MIN	2.189
56.61	MAX	2.229





Caution: Support the cylinder head in the Part No. ST-583 Head Holding Fixture to prevent damage to the injector tip that protrudes from the combustion face.

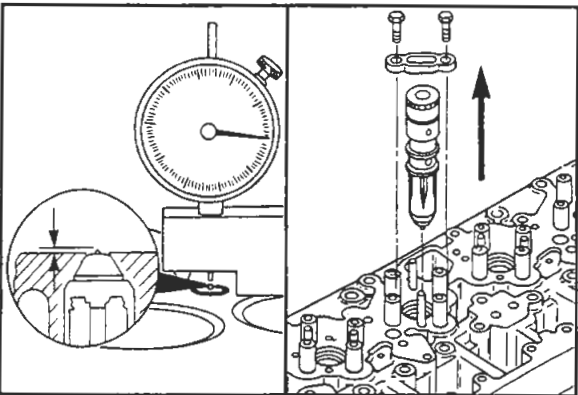


Apply a bluing compound to the outside diameter of the injector at the injector sleeve seat area.



Install the injectors into the cylinder head without o-rings.

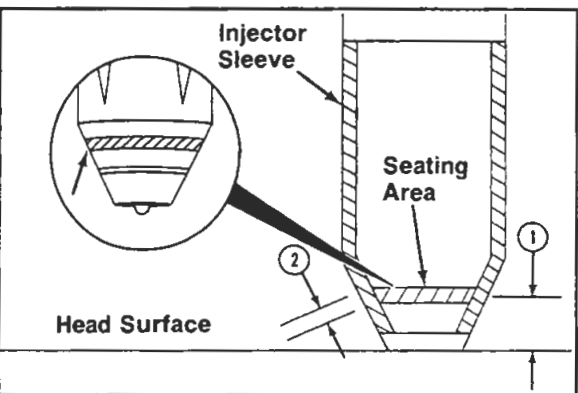
Torque Value: Step one - 5 N•m [45 in-lb]
Step two - 10 N•m [90 in-lb]
Step three - 15 N•m [130 in-lb]



Turn the cylinder head over and use the Part No. 3376220 Gauge Block and Part No. ST-547-3 Indicator to measure the injector tip protrusion.

Injector Tip Protrusion		
mm		in.
2.28	MIN	0.090
2.65	MAX	0.104

Remove the injectors from the cylinder head.



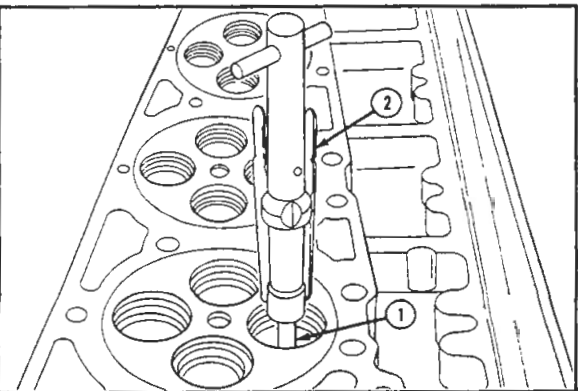
The bluing pattern of the injector seating area (1) **must** be approximately 13 mm [0.50 inch] from the cylinder head surface.



The injector bore seating width (2) **must** be a minimum of 1.52mm [0.060 inch].



Note: If the injector protrusion is **more** than the maximum specified or the injector sleeve bluing pattern does **not** meet the specifications given, the injector sleeve(s) **must** be replaced. Refer to Cylinder Head - Replace Injector Sleeves (02-08).



Grind the Valve Seats

Use the Part No. ST-685 Valve Seat Grinding Machine and the Part No. ST-804 Valve Guide Arbor Set when grinding the valve seat inserts.



Install the valve guide arbor (1) in the valve guide with the arbor puller (2).

Note: Rotate the arbor to be sure that it is installed correctly.

Acceptance Criteria (Exhaust and Intake Valves)

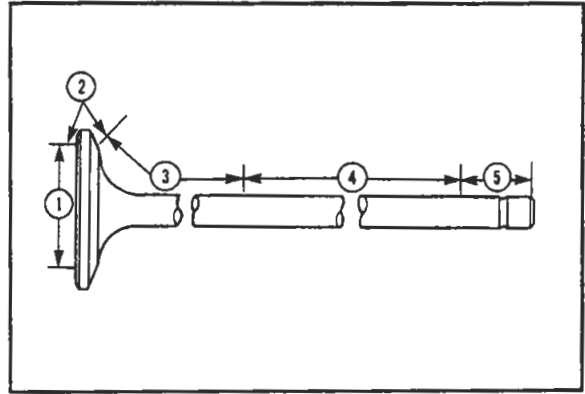
Area (1), no indication longer than 12.70mm [0.500 inch].

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.

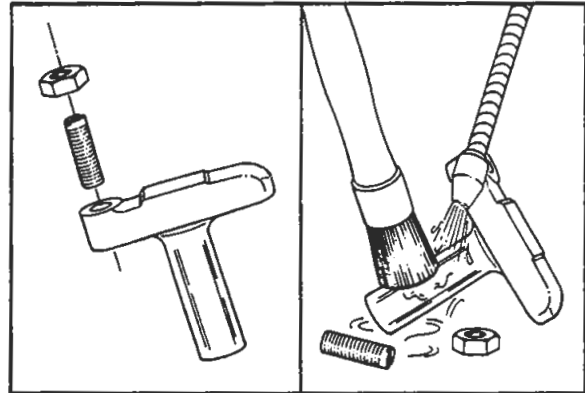


Valve Crosshead - Clean and Inspect for Reuse (02-12)

Disassembly

Remove the adjusting screw and lock nut.

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



Inspection

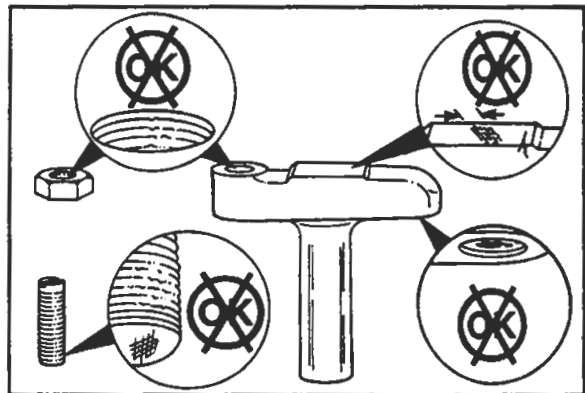
Visually inspect the rocker lever contact pad for wear, cracks or damage.

NOTE: Wear in the pad contact area must not exceed 7mm [1/4 inch] in width.

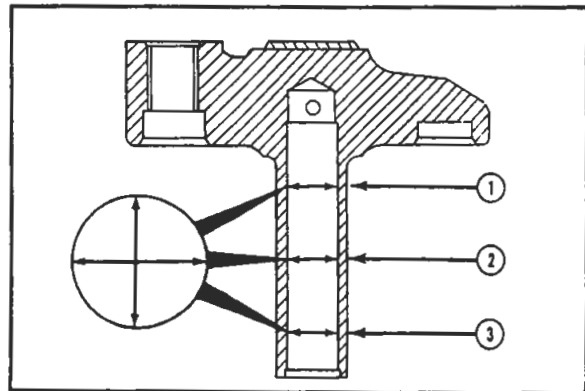
Visually inspect the valve stem contact area for damage.

Visually inspect the nut, adjusting screw and crosshead for damaged or distorted threads.

Visually inspect the contact area of the adjusting screw for excessive wear.



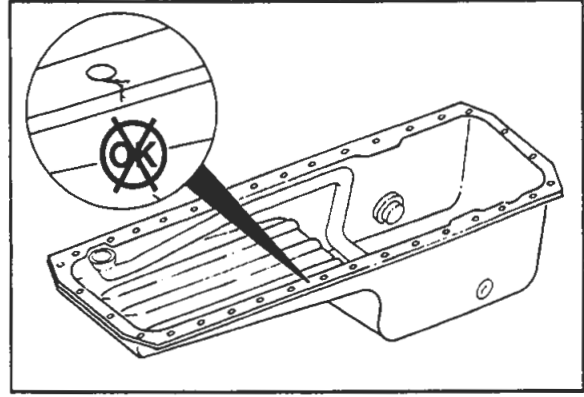
Measure the inside diameter of the crosshead stem bore in locations (1, 2 and 3).



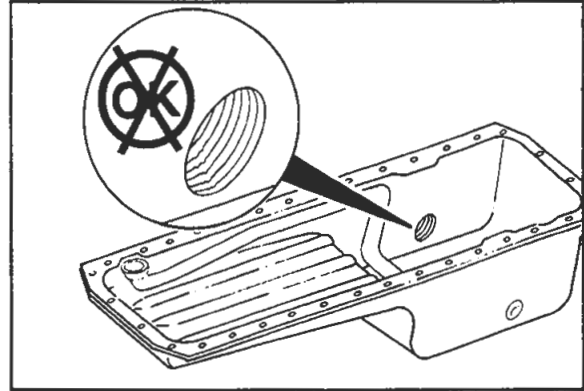
Stem Bore I.D.		
mm		In.
11.037	MIN	0.4345
11.175	MAX	0.4400

Inspection

Visually inspect the oil pan for cracks or damage.



Visually inspect the threaded holes for damage. Damaged threads may be chased with the following taps.



Oil Pan Threaded Holes

Thread Location	Tap Size
Temperature Gauge	3/8 in. NPTF
Oil Sump Heater	1-18 NS-3B
Oil Drain	1 in. NPTF

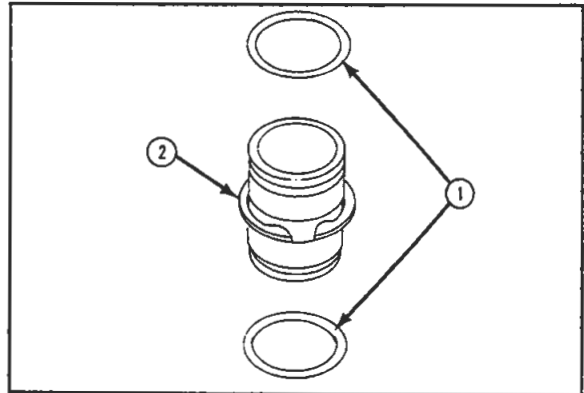
Note: If the oil pan is cracked or damaged or if the threaded holes cannot be repaired with the taps listed above, the oil pan must be replaced.

Lubricating Oil Pan Transfer Tube - Clean and Inspect for Reuse (07-02)

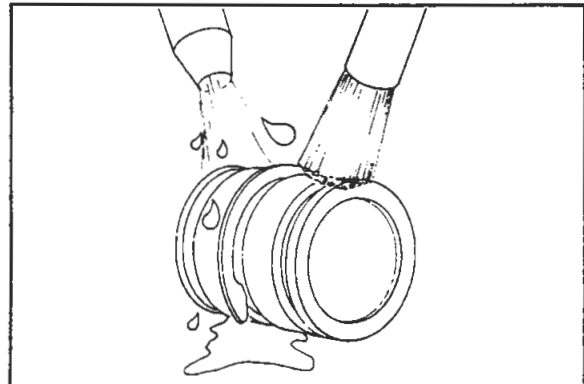
Remove the o-rings (1) from the oil transfer tube.



Note: The snap ring (2) is used to locate the oil transfer tube correctly between the oil pan and the cylinder block during assembly.



Use solvent to clean the oil transfer tube. Dry with compressed air.



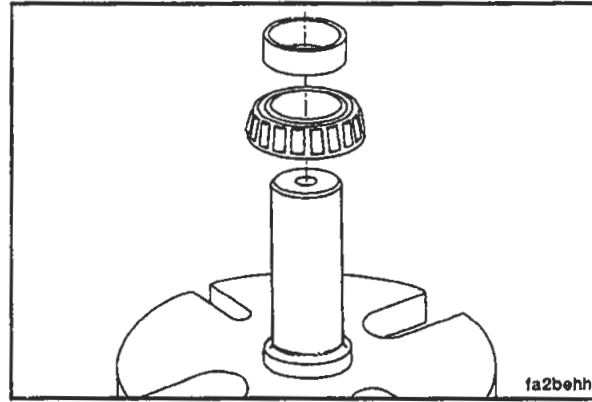
**Group 08 - Cooling System
L10**

**Fan Hub (Belt Driven) - Rebuild (8-04)
Page 8-35**

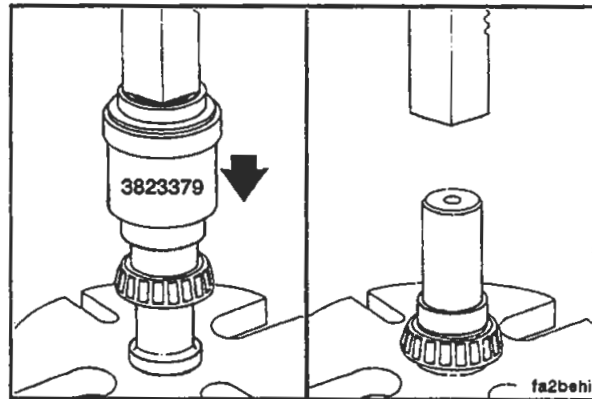
Place the shaft on the arbor press table with the small end pointed up.

Install the rear bearing on the shaft with the small diameter of the bearing on top.

Install the small bearing spacer on top of the bearing.

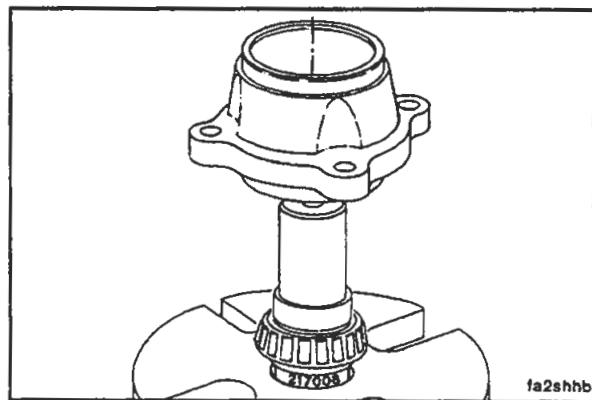


Use the small end of the bearing driver, Part No. 3823379, to press the spacer and bearing onto the shaft until it touches the shaft shoulder.

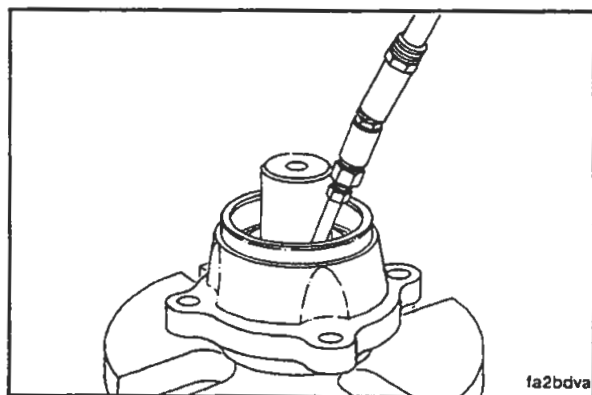


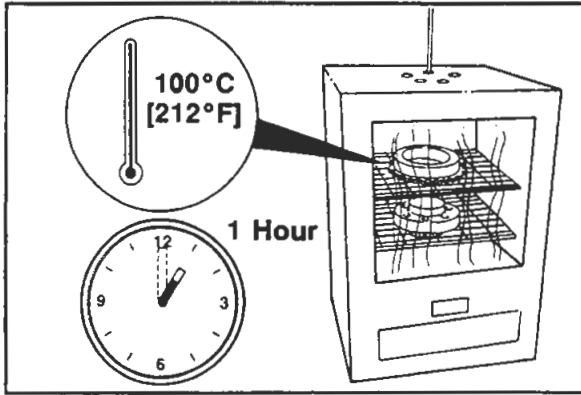
If the shaft is shorter than 95.2 mm [3.75 inch], support the shaft with spacer, Part No. 217008 or equivalent.

With the tapered (fan mounting) end of the fan hub facing up, place the hub over the shaft and bearing assembly.



Use Chevron SRI grease, or equivalent, to fill the hub to the top of the bearing spacer.





Assembly

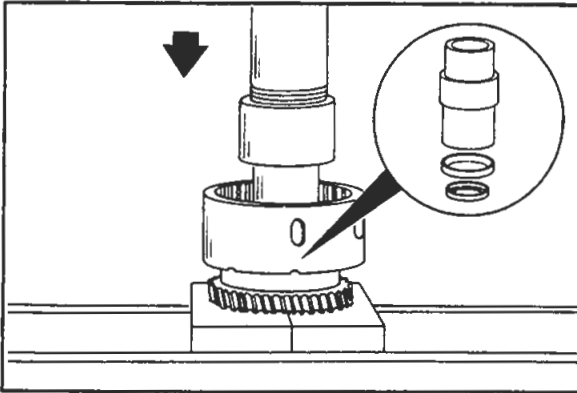


Warning: When heating parts in an oven, wear protective clothing to prevent personal injury from the extreme heat.



Put the fan clutch housing, cover and shaft in an oven for one hour.

Temperature: 100°C [212°F]

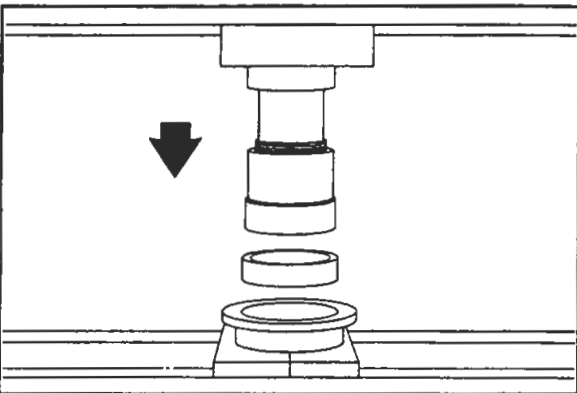


Remove the fan clutch housing from the oven and install the housing in an arbor press.

Use the Part No. 3377073 Small Bearing Mandrel to push the oil baffle plate and bearing race into the housing.

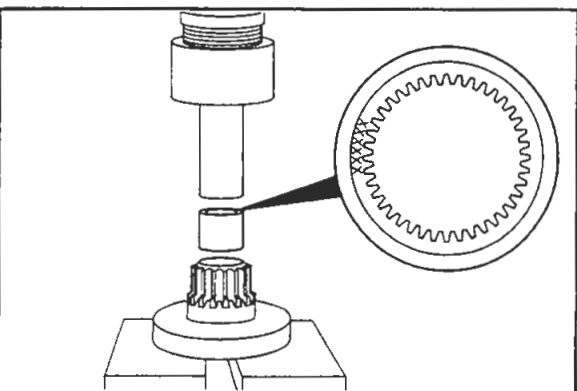


NOTE: The oil baffle plate must be seated against the bearing race.



Remove the fan clutch cover from the oven and install the cover in an arbor press.

Use the Part No. 3377074 Large Bearing Mandrel to push the bearing race into the cover.



Remove the fan clutch shaft from the oven and install the shaft in an arbor press.

NOTE: Install the needle bearing with the part number facing out.



Use clean 15W-40 oil to lubricate the needle bearing.



Use the Part No. 3377075 Needle Bearing Mandrel to push the needle bearing into the shaft.

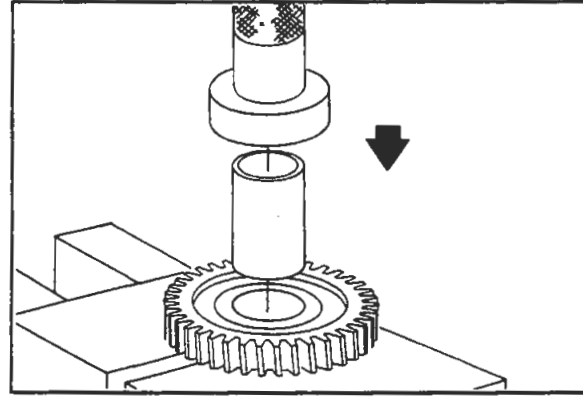
Assembly

Install the drive gear in an arbor press with the part number side of the gear facing down.

Install the shaft into the gear.

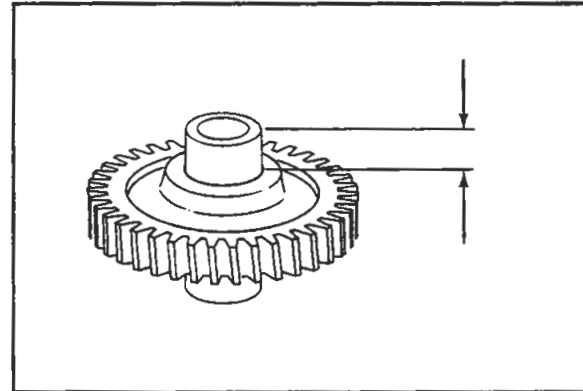
Note: The splined end of the shaft must be toward the non-part number side of the gear.

Use the Part No. 3376820 Hydraulic Drive Gear Driver to push the shaft into the gear until the gear driver touches the gear.



Measure the installed height of the shaft.

Note: Measure the installed height of the shaft in the drive gear from the front. Make sure the part number side of the gear is facing up. If the shaft **does not** meet the specifications, remove the shaft from the gear and install the shaft to the specified height.

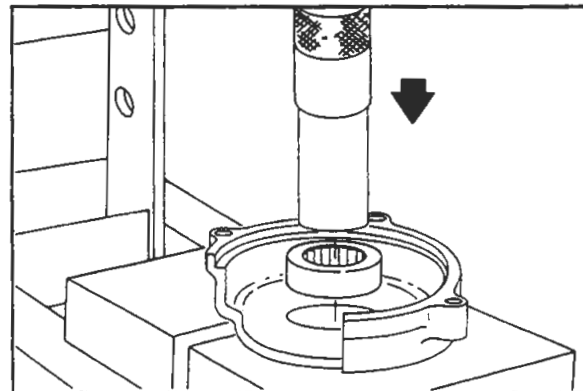


Drive Shaft Installed Height

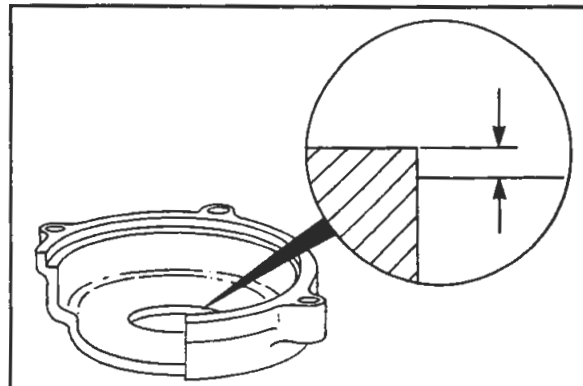
mm		in.
18.50	MIN	0.728
19.50	MAX	0.768

Caution: The numbered side of the bearing must face the drive gear. Push against the outer race or numbered side of the bearing to prevent personal injury or damage to the bearing.

Install the front support in an arbor press with the mounting flange facing up.



Use the Part No. 3376821 Hydraulic Support Bearing Driver to Push the bearing into the support to the specified depth.

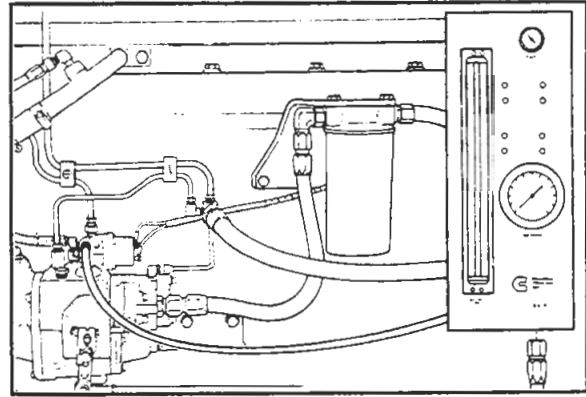


Bearing Depth in Housing Bore

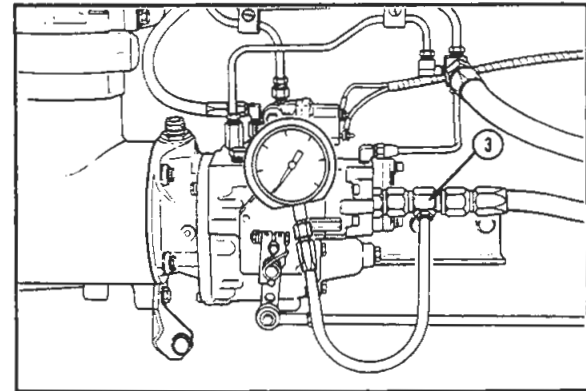
mm		in.
0.00	MIN	0.000
-0.25	MAX	-0.010

The Part No. 3376375 Fuel Measuring Instrument is used during the performance check to measure fuel consumption.

Note: Follow the tool manufacturer's instructions for installing and using the instrument.



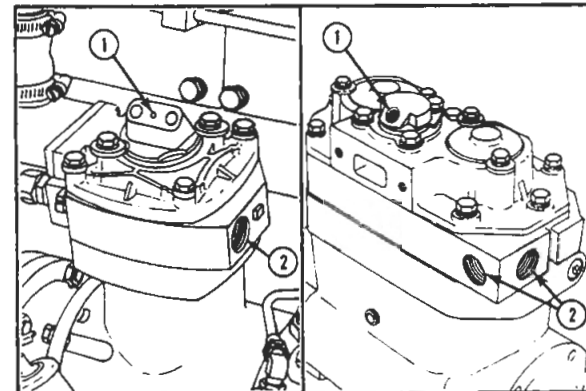
Install the Part No. ST-434 Vacuum Gauge in the gear pump inlet line (3).



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 unloaded or non-operating mode.

Connect a source of compressed air capable of producing 665 kPa [95 psi] to the air compressor unloader (1). This airline **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 520 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.

