



200 BENCH PROCEDURES

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[211 DB] CYLINDER BLOCK

Cylinder Sleeve Counterbore

SPECIAL TOOLS REQUIRED:

- Counterbore Tool PT2210
- Counterbore Cutter Plate PT2210-3A
- Universal Dial Depth Gauge PT5025
- Stylus Extension (3-Inch) PT5052-11
- Hex Key Wrench PT2210-14

INSPECTION AND REPAIR

If the cylinder block deck is resurfaced, the cylinder sleeve counterbore depth must be recut to specification. If the cylinder block deck was not resurfaced but cylinder sleeve counterbore surface shows excessive pitting or erosion, recut the counterbore as required.

Use shims to re-establish the correct liner flange height. Shims are available in the following thicknesses: 0.002, 0.003, 0.004, 0.008, 0.010, 0.012 and 0.014 inch.

To resurface the cylinder sleeve counterbore area of the cylinder block, use counterbore tool PT2210 with counterbore cutter plate PT2210-3A.

NOTE

This procedure can be performed either in or out of the chassis. If performing the procedure in the chassis, be sure to cover the crankshaft and any holes in the block to prevent contamination from machining chips.

CAUTION

Do not cut seats deeper than 4.034 inches (102.464 mm).

1. Make sure that the top of the deck is clean and free of burrs. Use a finish mill file and crocus cloth, if necessary, to create a smooth, flat surface for positioning the tool.
2. Using compressed air, thoroughly remove all debris.

NOTE

Universal dial depth gauge PT5025, with a 3-inch stylus extension PT5052-11, is recommended for measuring the counterbore.

3. Measure and record the counterbore in four places, 90 degrees apart. Using a depth gauge with a 3-inch extension, mark the shallowest point. Subtract the lowest number from the highest number. This is the minimum amount to be machined for cleanup.

SETTING UP COUNTERBORE TOOL PT2210 WITH CUTTER PLATE PT2210-3A

Refer to Figure 5-1.

1. Loosen the two cutter bit hold-down capscrews (9). Install cutter bit (11) into cutter plate PT2210-3A (13) by turning the cutter bit adjuster (10) counterclockwise. Cutter bit face must be facing a clockwise rotation cut.

CAUTION

Do not tighten the cutter bit hold-down cap (12).

The cutter point should not extend beyond the outer edge of the cutter plate. If the cutter bit does stick out, damage to the bit will occur when installing counterbore tool onto cylinder block.

2. Install the cutter plate on the main shaft (15). Use the large end of hex key wrench PT2210-14 (18) to hold the cutter plate and tighten securely. The hole in the side of the cutter plate accepts the large end of the tool.

CAUTION

Do not allow the cutter bit (11) to touch the cylinder sleeve bore wall.



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SERVICE HINT

When the entire block must be counterbored, cut the deepest bores first. This way, the tool can be adjusted to the lowest depth and used for all cylinders, ensuring uniform depth on all cylinder counterbores.

3. Position the tool in the cylinder bore by backing the depth-set collars (5 and 16) off and lowering the cutter plate (13) into the counterbore to center the tool.
4. Secure the cutter plate to the cylinder block with four M16 x 2 x 90 hex-head capscrews (3) and special washers (4) from the counterbore tool kit PT2210.
5. Cross-torque the capscrews to 30 lb-ft (41 N·m) using torque wrench J 24406 or equivalent.

NOTE

Lift T-handle (2) slightly (so cutter plate is not in contact with the counterbore) and rotate the mainshaft (15) counterclockwise to ensure cutter plate turns freely without binding. If necessary, loosen the capscrews and relocate the tool.

6. Using the counterbore tool T-handle (2), raise the cutter plate approximately 1/2 inch (12.7 mm) from the counterbore ledge.
7. Using hex key wrench PT2210-14 (18), turn the cutter bit adjusting screw (10) clockwise until the cutter bit contacts the counterbore ledge. Do not touch the counterbore wall.
8. Back off the lower depth-set collar (16) and lower the cutter plate until the cutter rests on the ledge.
9. Rotate the lower depth-set collar down until the collar contacts the main housing.
10. Rotate the collar an additional five increments: 0.005 inch (0.127 mm). Each graduation of the collar is one-thousandth (0.001) of an inch (0.025 mm). This will lift the cutter bit 0.005 inch (0.127 mm) off the counterbore ledge, allowing an accurate setting of the cutter bit.

NOTE

It may be necessary to use a flashlight to see the cutter bit adjusting screw.

11. Using hex key wrench PT2210-14 (18), turn the cutter bit adjusting screw clockwise until the cutter bit rests on the counterbore ledge.
12. If the cutter bit will not adjust, adjust the lower depth-set collar (16) 0.005 inch (0.127 mm) more and recheck cutter bit hold-down screws for looseness.
13. Zero the depth-set collars:
 - a. Back off the lower depth-set collar (16) and carefully lower the cutter plate (13) into the bore and allow the cutter to rest on the counterbore ledge.
 - b. Rotate both depth-set collars (5 and 16) down until the bottom collar contacts the main housing (8).

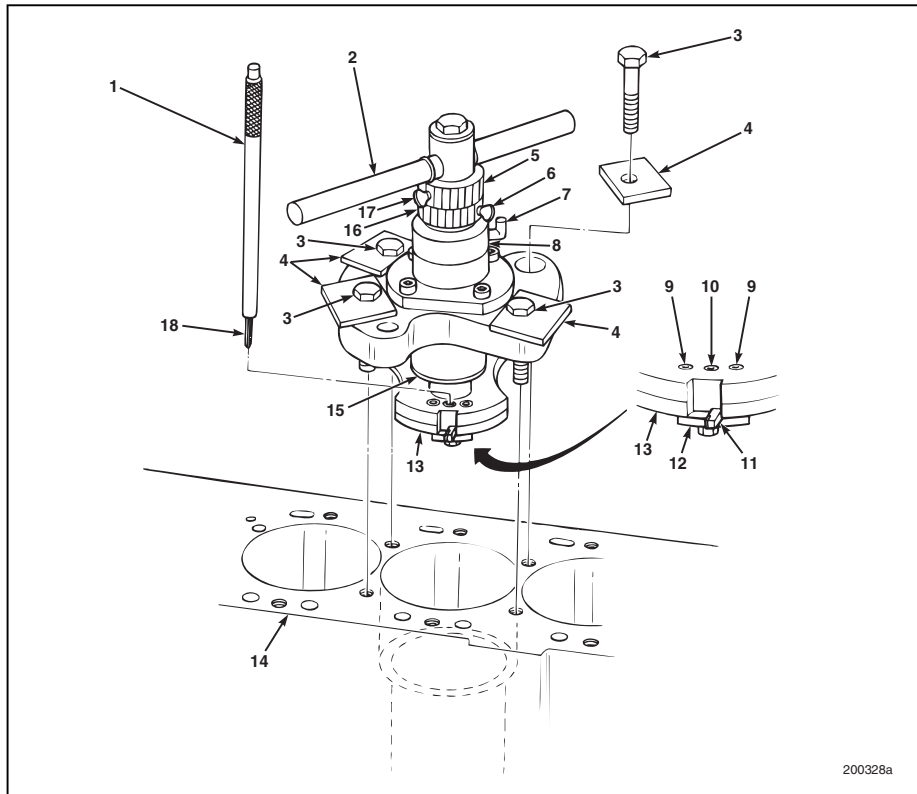
CAUTION

Do not force the collar beyond this point, as it will lift the cutter plate and prevent an accurate zero reading.

14. Set the depth of the cut. Determine the final depth of the cut and back off the top depth-set collar accordingly. Each increment on the depth-set collar increases the depth of the cut by one-thousandth (0.001) of an inch (0.025 mm). Tighten the thumbscrew (17) on the upper collar (5) securely.



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Figure 5-1 — Counterbore Ledge Tool Installation

- | | |
|----------------------------|----------------------------|
| 1. Cutter plate holder | 10. Cutter bit adjuster |
| 2. T-handle | 11. Cutter bit |
| 3. Capscrews, M16 x 2 x 90 | 12. Hold-down cap |
| 4. Special washers | 13. Cutter plate |
| 5. Upper depth-set collar | 14. Cylinder block |
| 6. Lower thumbscrew | 15. Main shaft |
| 7. Oil fill tube | 16. Lower depth-set collar |
| 8. Main housing | 17. Upper thumbscrew |
| 9. Hold-down capscrews | 18. Hex key wrench |



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CUTTING THE COUNTERBORE

Refer back to Figure 5-1.

1. Fill the oil fill tube (7) with 30W nondetergent oil to maintain lubrication during use.
2. Back off the lower depth-set collar (16) two increments or less, and tighten the thumbscrew (6) securely.
3. Cut the counterbore by turning the T-handle clockwise while maintaining constant downward pressure on the tool. Stop the handle in a different position to avoid creating a ridge in the counterbore.
4. Continue backing off the lower depth-set collar, no more than two graduations per cut. Check the depth measurement between each adjustment. Plan to remove 0.001 inch (0.025 mm) on the final cut to meet the final predetermined counterbore depth. This ensures achieving a very fine machined finish.
5. Remove the tool from the cylinder bore.
 - a. Loosen the two cutter bit hold-down capscrews (9) and rotate the cutter bit adjusting screw (10) counterclockwise until the cutter bit is retracted into the cutter plate (13).
 - b. Remove the four machine hold-down bolts (3) and special washers (4).
 - c. Remove the tool from the cylinder bore.
6. Follow steps 1 through 5 for the remaining cylinders.

[212 CV] AUXILIARY DRIVESHAFT

Description

All current production engines (effective February 27, 1992, serial No. 2E1233) are equipped with a "fast ratio" auxiliary driveshaft assembly and oil pump assembly. This arrangement raises oil pump speed to increase operating oil pressure 25%. Refer to Auxiliary Driveshaft Installation instructions in the ENGINE ASSEMBLY section for ratio information.

CAUTION

Do not mix "fast ratio" and "standard ratio" components. Serious damage may occur.

Inspection

1. Thoroughly clean auxiliary driveshaft.
2. Inspect auxiliary driveshaft journals and gear teeth for evidence of cracks, pitting, scoring or severe wear. If any of these conditions exist, replace the auxiliary driveshaft.

[212 LP] CONNECTING RODS

Description

Refer to Figure 5-2.

Early E7 engine connecting rods were machined to give rod cap bottoms a contoured appearance. Since mid-1992, connecting rod caps have had a flat, machined bottom. The rods are the same in strength and configuration, with the only difference being the rod cap bottom surface machining.



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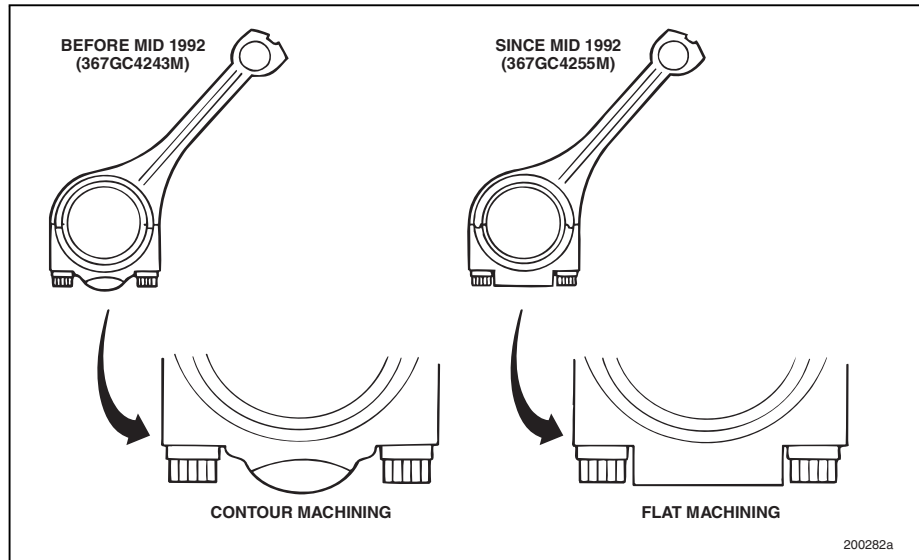


Figure 5-2 — Connecting Rod Identification

Refer to Figure 5-3.

A redesigned connecting rod assembly with an added alignment sleeve feature was introduced into E7 production engines in April 1995. This connecting rod assembly has two alignment sleeves (3), one sleeve in each capscrew hole of the rod cap (1) to locate and align the cap and rod thrust faces. These sleeves provide the best alignment when sleeve gaps are positioned at a location approximately 90 degrees to the tongue or groove (2). The sleeve gaps must not be in line with the tongue or groove.

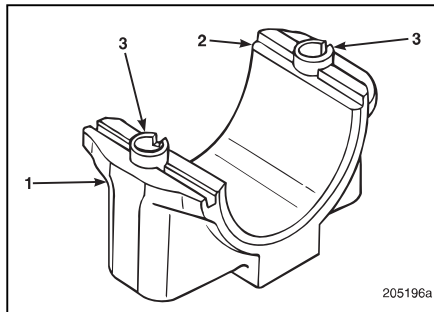


Figure 5-3 — E7 Connecting Rod with Alignment Sleeves

- | | |
|-------------------|---------------------|
| 1. Rod cap | 3. Alignment sleeve |
| 2. Bearing insert | |



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NOTE

During initial production, part numbers were stamped onto the through hole of the connecting rod bearing cap. In later production, the part number was forged into the I-beam of the rod.

NOTE

Old-style connecting rods (without alignment sleeves) and new-style connecting rods (with alignment sleeves) may be intermixed in an engine. However, the capscrews and alignment sleeves are not interchangeable between the two rod assemblies. The alignment sleeves will physically fit into either of the connecting rod assemblies, but the sleeve must be used in the new-style 367GC4267M or M2 connecting rods ONLY. The capscrews cannot be mixed. The difference in the thread size between the two rod assemblies is significant enough that the 14-mm threaded capscrews will not even engage the 16-mm tapped hole in the old-style (367GC4255M or M2) rod assemblies. The 16-mm threaded capscrew cannot be assembled into the 14-mm tapped hole of the new-style (367GC4267M or M2) connecting rod assemblies.

It is essential to closely control the weight of reciprocating parts. MACK E7 connecting rods fall into two weight classes. Prior to mid-1996 production, the weight classes are identified by an "M" number (M1 or M2) stamped onto the connecting rod bearing cap. Effective with mid-1996 production, the M2 connecting rod is no longer stamped with this weight designation. The M1 weight class rod will continue to be stamped on the rod cap. When installing a single rod, or less than a full set, examine removed rod for part number and M number. Installing parts with the same weight class is preferred.

Connecting rods can be weighed to ensure using proper weight class. Connecting rod weights for each engine, within each weight class, should not vary by more than 0.46 ounce (13.04 grams). The maximum weight difference between the heaviest possible M2 rod and the lightest possible M1 rod is 0.83 ounce (23.53 grams).

Special Tools Required

- Piston Pin Bushing Remover/Installer J 37717
- Piston Pin Burnishing Broach J 37718
- Connecting Rod Fixture 945-6041

Inspection

- Inspect connecting rods for nicks, cracks, signs of overheating, bends or twisting that can cause rod failure.
- Inspect bolt holes for elongation or pulled threads.
- Check mating surfaces between rod and cap for correct fit.
- Inspect the crankshaft journal bearing surface and wrist pin bushing.

If any of the above parts are suspected of being faulty, replace the connecting rod.

SERVICE HINT

If it is determined that the condition of any part or component is questionable or is at the limit of tolerance, throw it out; it may fail or become out of tolerance after a short time in operation. It is cost-efficient to replace components when rebuilding.

Always use genuine MACK replacement parts.

Wrist Pin Repair

WRIST PIN BUSHING REMOVAL

If the wrist pin bushing is found to be out of tolerance, it should be replaced.

Refer to Figure 5-4.

To replace bushing:

1. Position rod in a press with piston pin bushing remover/installer J 37717 inserted into wrist pin bushing.
2. Press bushing out of rod.



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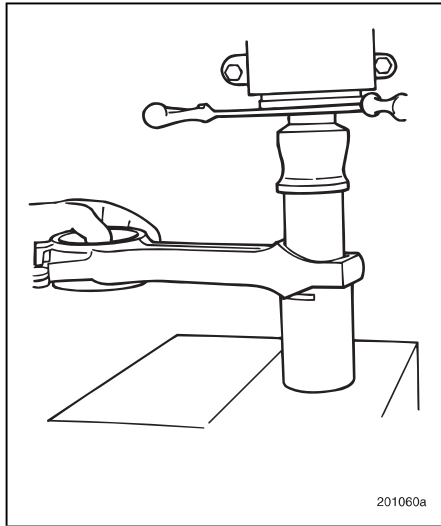


Figure 5-4 — Wrist Pin Bushing Removal

WRIST PIN BUSHING INSTALLATION

CAUTION

*The wrist pin bushing has a lubrication hole through it. This hole **MUST** be aligned with rifle-drilled hole in rod to allow oil flow to wrist pin. If holes are not aligned, wrist pin, piston, and connecting rod failure will result.*

1. Position rod, bushing and piston pin bushing remover/installer J 37717 in press, and press bushing into rod.
2. Align hole in bushing with rifle-drilled hole in rod.

CAUTION

Make certain that bushing is fully expanded in the connecting rod bore or it will loosen in service.

Refer to Figure 5-5.

3. Position rod assembly in press with piston pin burnishing broach J 37718.

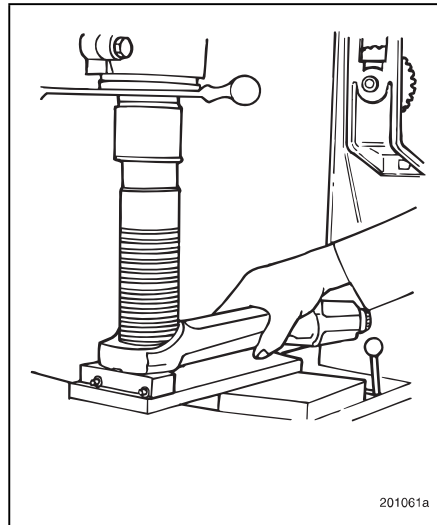


Figure 5-5 — Burnishing Wrist Pin Bushing

4. Using a suitable lubricant, press broach through bushing to expand bushing.

Refer to Figure 5-6.

5. After machining bushing, check connecting rod for twisting or bending. Use Sweeney connecting rod fixture 945-6041. Accessory mandrel and plunger extension assemblies for various engines are required for use with this fixture, and are also available from the Sweeney Company.



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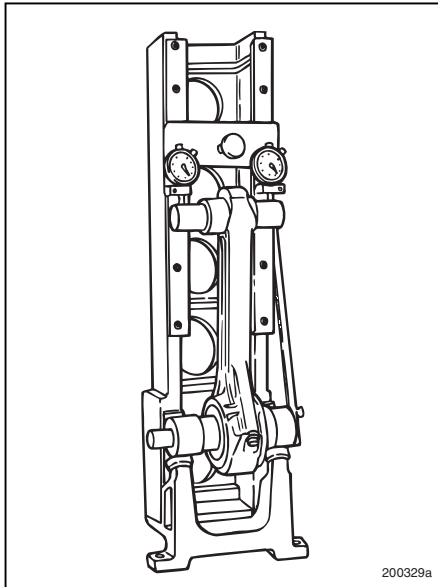


Figure 5-6 — Connecting Rod Fixture

NOTE

Maximum twist of connecting rod within 12 inches (30.5 cm) is 0.010 inch (0.254 mm). The maximum bend of connecting rod within 12 inches (30.5 cm) is 0.004 inch (0.102 mm). Distances are center to center.

[212 HP] CRANKSHAFT

Description

The crankshaft is fully counterbalanced and journals are induction-hardened. There are seven main bearings. Thrust washers located at the center main bearing (position No. 4) absorb fore and aft end thrust. Crankshaft extension at forward end carries the main drive gear, vibration damper and accessory drive pulleys. The main drive gear has a shrink fit and the vibration damper hub has a press fit. The main drive gear is keyed to the crankshaft and proper assembly is

important for engine timing. The flywheel is mounted to a flange at rear of crankshaft. Two seals, one at the front and one at the rear, prevent engine lubricating oil from leaking around ends of the crankshaft.

Bearing caps are furnished with the crankcase and support the crankshaft in true alignment. Webs integral to the crankcase provide upper half of main bearing supports. Removable caps provide lower support. Capscrews hold the caps in position. The bearing caps are not interchangeable and each has a number stamped on it which signifies its correct location and alignment in the crankcase. The caps are numbered 1 through 7, with No. 1 main bearing cap in front of engine. The bearing inserts are precision designed. Bearings are inserted between the crankshaft and crankcase, and between the crankshaft and bearing caps. Thrust flanges to support thrust washers are located at the center main bearing (No. 4).

CAUTION

Extreme care must be taken to guarantee cleanliness of crankcase, crankshaft, and bearings during servicing and after service has been completed. Whenever possible, crankshaft should be removed when bearings are being installed in order to clean crankcase thoroughly.

All bearing surfaces must be free of grit and burrs. Small particles of dust and dirt left between crankshaft and bearings will cause rapid wear and scoring of crankshaft journal and inserts. Any foreign material left between bearings and crankshaft bearing caps will cause distortion of bearing and a reduction in operating clearance at that point. The resulting frictional heat will cause bearing material to melt away from steel backing of bearing at that point. Such melted material will create further hot spots until complete bearing failure occurs. Anything that interferes with operating clearance of any bearing, or proper heat dissipation, affects bearing life. Cleanliness cannot be overstressed.



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Inspection

NOTE

If crankshaft journals are worn, out of round, or tapered, order a new crankshaft or exchange kit through the MACK parts system. New and exchange crankshafts are available through MACK distribution centers. When ordering an E7 crankshaft, be sure to note V-MAC or non V-MAC application, since crankshafts are not the same.

1. Inspect crankshaft journals for straightness, out-of-round, taper, and surface finish.
2. Visually check crankshaft for any apparent cracks, worn journals and damage to threads, dowel or main drive gear.
3. Magnaflux the crankshaft. This process requires special equipment and application methods.
4. Using standard machinist inspection practice, check crankshaft for straightness.
5. Measure crankshaft journals with a micrometer. Measure each journal in two locations, 90 degrees apart, and record measurements.
6. Check measurements against specifications in the FITS AND LIMITS section of this manual.

CAUTION

Crankshaft regrinding by anyone other than Mack Trucks, Inc. is NOT recommended due to the tight control required on maintaining geometrical tolerances, and the hardened characteristics of the crankshaft journals and journal fillets.

If the crankshaft is not serviceable, both new and reground crankshafts are available through the MACK Parts Distribution Centers.

If crankshaft main journals or rod journals are not a standard size, be sure to use properly sized bearing inserts. Bearing inserts are marked with a "P" which follows the part number, and is stamped on the back side of the bearing insert. For example, if a journal is 0.010 inch (0.254 mm) undersize, a 0.010-inch undersize bearing is required and will be stamped "P10".

CAUTION

Some crankshafts may have journals which are 0.002 inch (0.0508 mm) undersize. They are marked by a streak of white paint adjacent to the journal. Always check journals to ensure using proper size bearing inserts.

[212 HA] Crankshaft Dowel Pin Replacement

The "diamond" locating dowel pins used for installing flywheel to crankshaft have been replaced by blade-style locating dowel pins. The diamond pins were dual diameter-type pins. There was a smaller diameter at the round end than at the diamond end. There are no changes in the size of the hole in the flywheel. However, the crankshaft will have larger holes to accept blade-style pins.

The blade-type dowel pin was introduced in May 1992, starting with serial No. 2K. You must use the dowel size that is appropriate for the crankshaft. (Service old with old, and new with new.)

Effective May 1993, all E7 engine crankshafts are equipped with flywheel-to-crankshaft dowel 183GC238 installed in the rear flange. Prior to this date, only V-MAC engine crankshafts had the 183GC238 dowel. Crankshafts in mechanically governed engines did not have a dowel pin hole in the rear flange. However, all E7 engine crankshafts have always had a crankshaft manufacturing locator hole in the rear flange. This hole is approximately 1/2 inch (12.7 mm) in diameter and 3/8 inch (9.52 mm) deep, and is used only in the manufacturing process.

The flywheel locating dowel hole — located directly opposite the manufacturing locator hole — is approximately 9/16 inch (14.29 mm) in diameter by 7/8 inch (22.23 mm) deep in crankshafts made since May 1992 using dowel 183GC238. V-MAC crankshafts made prior to May 1992 have a flywheel locating dowel hole 1/2 inch (12.7 mm) in diameter by 7/8 inch (22.23 mm) deep for dowel 183GC221.



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All new service replacement crankshafts, short blocks or basic engines will have a dowel pin in the crankshaft rear flange. In nearly all cases, the flywheel will already have a hole in it to accept the dowel pin. If, in an earlier version, the flywheel or torque converter drive flange does not have a hole in it for a dowel pin, it must be reworked.

If it is necessary to rework the flywheel or torque converter drive flange, two holes must be added using a 19/32-inch drill bit. One hole is for the dowel pin, and another directly opposite the first hole is to maintain balance of the flywheel/torque converter drive flange.

Refer to Figure 5-7.

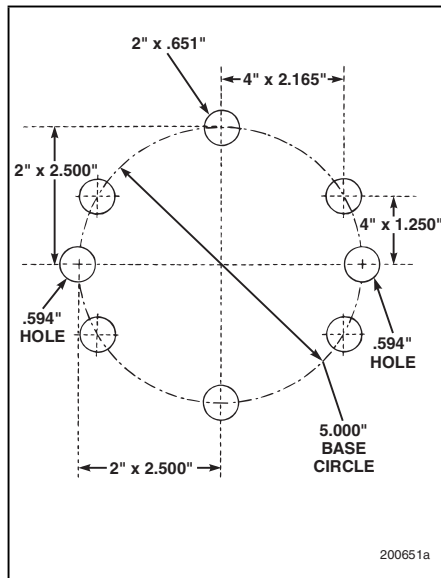


Figure 5-7 — Dowel Pin Hole Dimensions (Flywheel or Torque Converter Drive Flange)

Crankshafts used in early mechanically governed engines, part No. 4566C5127M, did not have a dowel pin or dowel pin hole. It is acceptable to use this early non-pinned crankshaft design in *any* mechanically governed engine, even when the original installation may have had dowel pins.

DOWEL PIN REMOVAL

To remove rear crankshaft dowel pin:

1. Using vise grips, securely grip dowel pin.
2. Rotate dowel pin back and forth while exerting outward pressure until pin is removed.

DOWEL PIN INSTALLATION

Refer to Figure 5-8.

To install a replacement crankshaft dowel pin:

1. Position dowel pin in a 0.5562-inch (14.1275 mm) diameter unthreaded hole in rear of crankshaft. The pin must be installed with the flat surface aligned parallel to the center of crankshaft, as shown in Figure 5-8.
2. Use a suitable tool to drive the pin into the hole. The pin must be firmly seated and protrude 0.77 inch (19.56 mm) from the crankshaft.

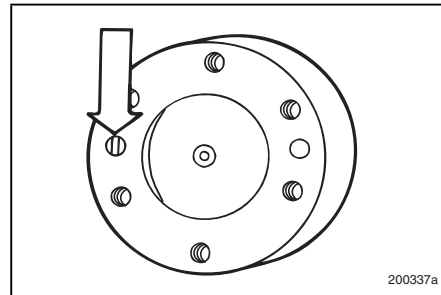


Figure 5-8 — Dowel Pin Alignment



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[212 HV] Crankshaft Gear

INSPECTION

After inspecting the crankshaft and determining that it is serviceable, inspect crankshaft gear for cracks and broken, worn or chipped teeth. If crankshaft gear is defective, it must be replaced.

REPLACEMENT

Refer to Figure 5-9.

1. Using a suitable puller such as J 21834-4A, remove gear and key.

NOTE

The threads in the end of the crankshaft are M8 x 1.25.

2. Clean gear mounting surface. It should be free of grooves, scratches and burrs. Use a file, sandpaper or crocus cloth, as required.

CAUTION

Take care not to damage key slot while installing key.

3. Insert key (4) into key slot (3). Lightly tap key into slot with a soft metal hammer.
4. Heat replacement gear (1) to approximately 250°F (121°C) in a temperature-controlled oven or on a hot plate.

CAUTION

Wear protective gloves when handling heated crankshaft gear to prevent burns or personal injury.

CAUTION

Take care not to damage gear teeth while seating gear.

5. Position the gear over end of shaft (2) with timing mark outward, chamfer (6) toward rear of the shaft, and key slot aligned with key in shaft. In one rapid motion, push heated gear against flange (5). When gear is in place, immediately and carefully tap on gear to help seat it against flange.

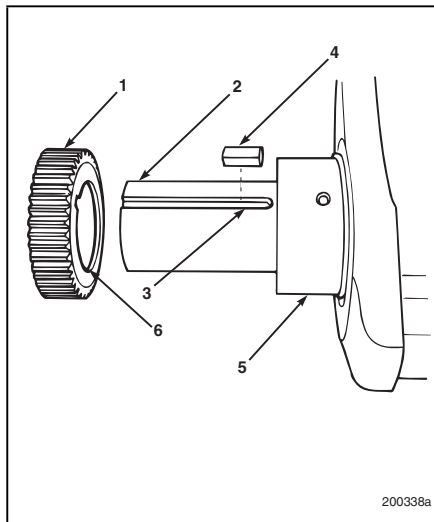


Figure 5-9 — Drive Gear Installation

- | | |
|-------------|------------|
| 1. Gear | 4. Key |
| 2. Shaft | 5. Flange |
| 3. Key slot | 6. Chamfer |



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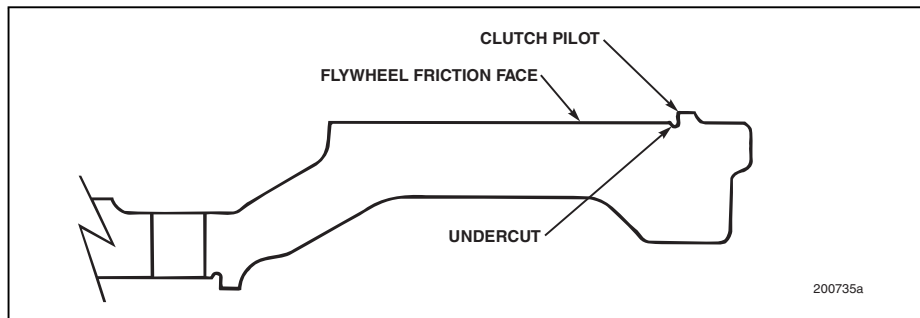


Figure 5-10 — Flywheel Resurfacing

[212 UB] FLYWHEEL

1. Inspect the flywheel to determine if it requires resurfacing. The wear areas should be measured using a straightedge across the friction face and a thickness gauge. If the wear measurement is 0.020 inch (0.508 mm) or less, the flywheel does NOT need to be machined when operated against ceramic clutch facings.
2. Resurface the flywheel as required.

NOTE

To ensure satisfactory life of the flywheel, the maximum amount of material that may be removed from the flywheel surface is 0.070 inch (1.78 mm).

When resurfacing a flat-style flywheel, it is very important that the machine shop NOT leave a step on the friction face outer diameter adjacent to the clutch locating pilot. There is an undercut relief in the corner between the friction face and the clutch locating pilot, and resurfacing must go up to this relief. If resurfacing is done to a depth which would eliminate the relief, a new relief must be recut. Refer back to Figure 5-10.

When resurfacing a flat-style flywheel and attempting to resurface as close to the clutch locating pilot as possible, keep in mind that the pilot must not be altered. The pilot controls location of the clutch; if the locating pilot is altered, imbalance will result.

NOTE

Some machine shop operations can adequately resurface a pot-type flywheel, but may not have the tooling and locating equipment necessary for resurfacing a flat-style flywheel in compliance with the above procedure.

[212 NP] PISTONS

Description

Since 1991, a two-piece piston has been required to aid in particulates control. To ensure a high level of durability, the piston crown is made from forged steel and the piston skirt is made of cast aluminum. The piston pin bore pedestal and piston skirt are stamped FRONT, and must be facing front of engine. One-piece pistons were used from 1989 through year end 1990. The procedures for installation are the same except as noted by "two-piece piston." Current production parts are NOT interchangeable with 1989–1990 production parts.

CAUTION

A radius is cut in lower edge of piston skirt to provide clearance for piston cooling nozzle. The piston must be installed with the word FRONT facing front of engine.



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The two-piece piston design incorporates two compression ring grooves and one oil ring groove. A plasma-faced, keystone-type ring is used in the top ring location. A tapered chrome, rectangular-type ring is used in the second ring groove. The oil control ring is located in the third (or lower) groove, nearest the piston pin bore. New piston rings are designed to further improve oil control, especially relating to particulates control.

NOTE

E7 piston crowns have been modified in the oil control ring groove area. During the second quarter of 1996, the oil drainback holes have been eliminated and replaced by an oil accumulator relief. The relief is machined into the lower half of the third ring land face, 360 degrees around the piston circumference.

CAUTION

Current E7 pistons are NOT interchangeable with 1989/1990 E7 pistons.

Special Tools Required

- Piston Ring Expander PT6587
- Keystone Ring Groove Gauge J 29510

Disassembly

Refer to Figure 5-11.

1. Using piston ring expander PT6587, remove piston rings.

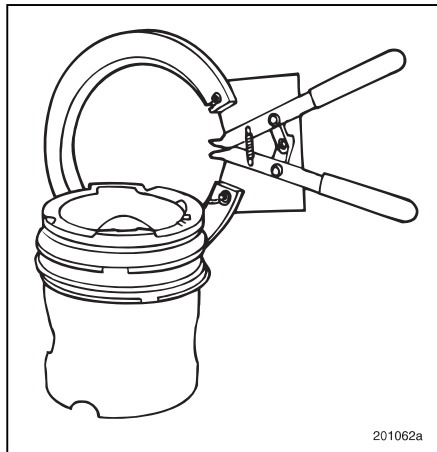


Figure 5-11 — Piston Ring Removal

2. Thoroughly clean ring grooves and combustion bowl area. All carbon must be removed. Carbon left in grooves will reduce ring clearance and prevent replacement rings from seating properly.

CAUTION

Be sure that cleaning solvent is approved for steel/aluminum. Incompatible solvent may cause damage to pistons or skirts.

3. Clean pistons with approved solution and a brass brush. Take care to avoid damaging pistons while cleaning.



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Inspection

Inspect piston ring grooves, lands, piston skirt and combustion bowl for wear, scuffing, cracks or blow-by. Pistons are NOT repairable. Discard piston if it is damaged.

CAUTION

Do not stamp or engrave on TOP of piston. Doing so will reduce piston life.

To ensure that pistons are reinstalled in the same cylinders as removed, tag the piston with the corresponding cylinder number.

[212 NV] PISTON RINGS

NOTE

Before installing piston rings, check keystone ring groove wear and ring end gap.

1. Place a piston ring in the piston sleeve. Push it down into the sleeve with an inverted piston to ensure that it is positioned squarely in sleeve.
2. Using thickness gauges, check ring end gap. Refer to the Fits and Limits chart in the SPECIFICATIONS section for end gap specifications. All rings to be used should be checked in this manner.

CAUTION

Do not file or grind chrome-plated piston rings. This may cause chrome to flake, resulting in ring failure.

Keystone Ring Groove Check

Refer to Figure 5-12.

Keystone piston-ring groove gauge J 29510 consists of two 0.120-inch (3.048 mm) diameter pins (1) connected at ends by two springs (2).

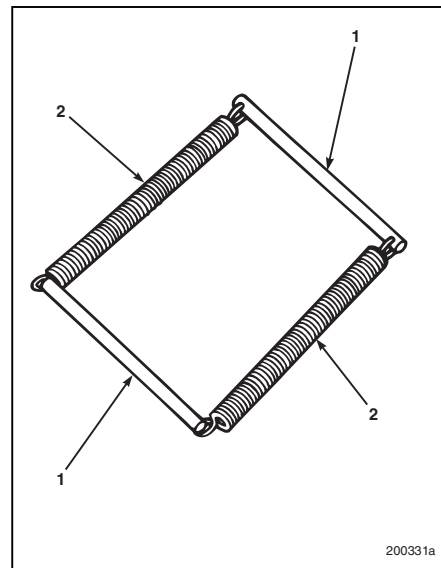


Figure 5-12 — Ring Groove Gauge

- | | |
|---------|------------|
| 1. Pins | 2. Springs |
|---------|------------|

1. Place pins of keystone piston-ring groove gauge J 29510 opposite each other in groove to be measured, so they will be held in position by springs.

Refer to Figure 5-13.

2. Using a four- to five-inch micrometer, measure distance between outer edges of two parallel pins. Check each compression ring groove in two locations: parallel and perpendicular to wrist pin bore. Record both measurements.
3. Compare readings with specifications in Fits and Limits chart in the SPECIFICATIONS section.



200 BENCH PROCEDURES

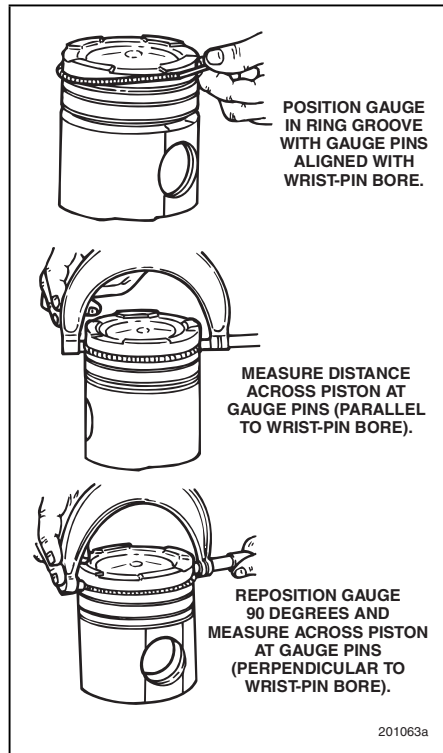


Figure 5-13 — Ring Groove Wear Measurement

4. Perform steps 1, 2 and 3 on each piston.

Refer to Figure 5-14.

5. Check oil control ring.
 - a. Using a thickness gauge, check for excessive wear of oil control ring groove side clearance (1). Position a new oil control ring in groove and insert a thickness gauge between ring and upper land of groove.
 - b. Record measurement and compare reading with Fits and Limits chart to see if it is within tolerance.

NOTE

For a new ring and piston, oil ring side clearance is 0.0016–0.0030 inch (0.0406–0.0762 mm). For an old ring and piston, the clearance should not exceed 0.0045 inch (0.1143 mm).

6. Perform step 5 on each piston.

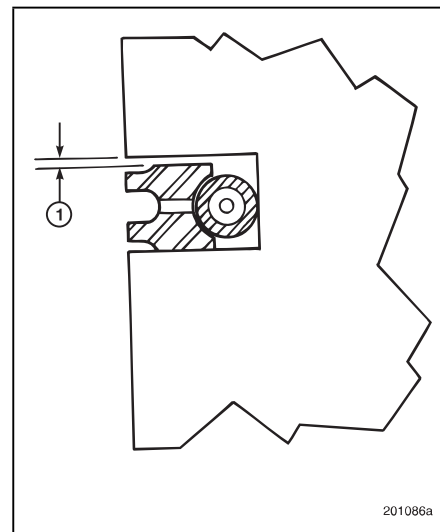


Figure 5-14 — Side Clearance Measurement



200 BENCH PROCEDURES

Ring Installation

NOTE

Identification markings on rings should face top of piston. The keystone ring goes in the top ring groove.

Follow the directions on each piston ring packet.

Refer to Figure 5-15.

1. To prevent distortion, use the proper size piston ring expander (PT6587) to place rings in piston grooves.

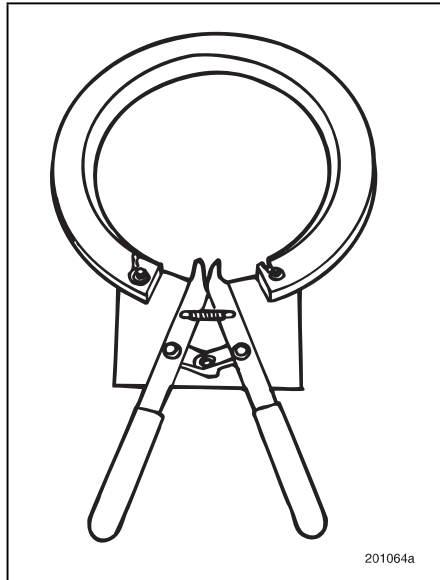


Figure 5-15 — Piston Ring Expander PT6587

Refer to Figure 5-16.

2. Stagger piston rings so that no ring gap is directly over wrist pin bore, and no ring end gaps are aligned over each other.

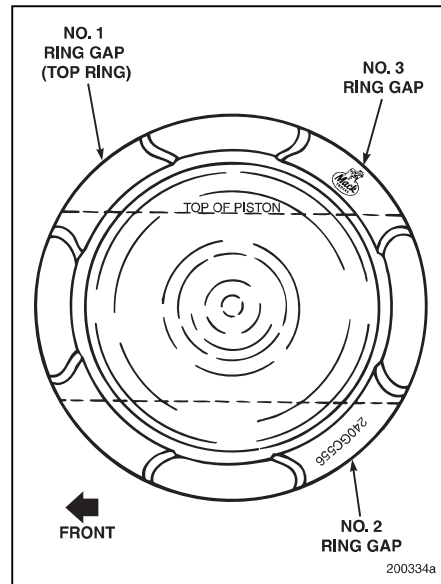


Figure 5-16 — Ring Gap Locations

[212 LP & NP] CONNECTING ROD ASSEMBLY TO PISTON

Refer to Figure 5-17.

1. Install a retaining snap ring in one of the piston pin retaining grooves.
2. Position connecting rod in piston assembly. Make sure that the side of the rod marked FRONT is facing forward. Ensure that two-piece piston identification marks and connecting rod identification marks indicate that piston and rod are matched. They must be returned to same cylinder from which they were removed.



200 BENCH PROCEDURES

CAUTION

The piston crown, skirt and rod are marked **FRONT**. Be sure that rod, piston crown and skirt are properly aligned.

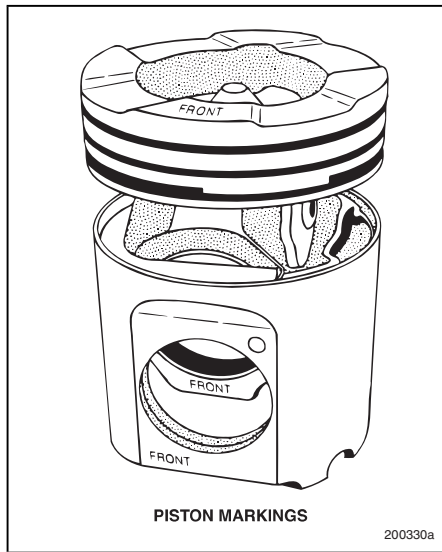


Figure 5-17 — Piston Markings

3. Using a generous amount of clean engine oil, push piston wrist pin into piston wrist pin bore, aligning two piston sections and connecting rod.
4. Secure pin in position by inserting a snap ring in remaining piston snap ring groove.
5. Place the assembled piston in a clean location until it is needed for installation into sleeve.
6. Perform steps 1 through 5 on remaining pistons.

[213 CH] CAMSHAFT

Description

The gear-driven carbon steel E7 camshaft, with its large journal bearing diameter of 2.689 inches (68.301 mm), provides excellent bearing unit loading and allows the use of large, durable camshaft lobes. E7 engine camshaft gears are pressed onto the camshaft.

Disassembly

An extremely tight interference fit holds the cam gears onto the camshaft. Ten tons of force are required to remove the gears. When cam gear installation or removal is required, use the following procedures.

DANGER

A considerable amount of force may be necessary to remove damaged or spun gears. DO NOT apply more than 25 tons (22.7 metric tons) of force to gears. Doing so may shatter the gears and result in severe personal injury.

Refer to Figure 5-18.

1. Position two adequate steel plates on the press to support camshaft gears. The plates should have a 2-1/2 inch (63.5 mm) hole cut out in the center when placed side by side, or similar size V-grooves, to allow clearance for the shaft journals and greater support for the gears.
2. Set camshaft, supported by the gears, into the press.
3. Using a suitable arbor, press camshaft out of camshaft gear and fuel injection pump drive gear.



200 BENCH PROCEDURES

CAUTION

Make sure there is enough clearance between the end of the camshaft and the floor while removing the gears. Do not let camshaft fall or strike the floor when pressed from the gears. The camshaft can be bent easily, and the bend may go unnoticed. Installing a bent camshaft in the engine could result in cam bushing failure.

4. Remove the thrust washer.

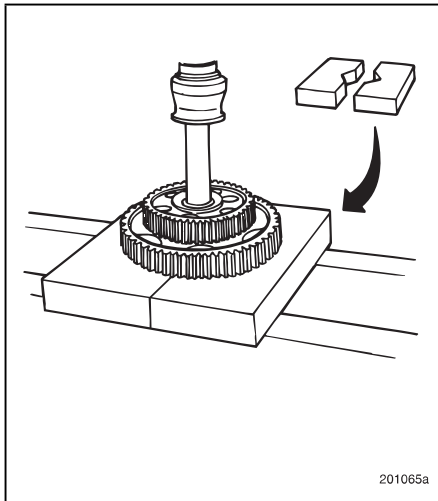


Figure 5-18 — Camshaft Gear and Fuel Injection Pump Gear Removal



200 BENCH PROCEDURES

Inspection

Refer to Figure 5-19.

1. Thoroughly clean camshaft (3).

NOTE

Use magnaflux (PT7190) inspection procedure to detect cracks.

2. Inspect camshaft lobes and journals for evidence of cracks, pitting, scoring or severe wear. If any of these conditions exist, replace camshaft.
3. Inspect camshaft gear (1), injection pump driving gear (5), and camshaft captured thrust washer (2) for cracks, pitting, scoring or adverse wear.
4. Visually inspect key (4) for signs of distortion or breakage.

Assembly

Two methods can be used to assemble camshaft gears on a camshaft.

- Use the heat method to install new gears on a new camshaft.
- Use the press method if reusing any service parts. Do not use heat method on used parts.

HEAT METHOD — CAMSHAFT/INJECTION PUMP DRIVING GEAR INSTALLATION

Refer to Figure 5-19.

1. Thoroughly clean camshaft (3) and gears (1 and 5) using a contact-type cleaner that dries rapidly and leaves no residue.
2. Insert key (4) into camshaft (3). It may be necessary to tap key with a rubber mallet to ensure proper seating of key.
3. Install a new camshaft captured thrust washer (2) on camshaft.

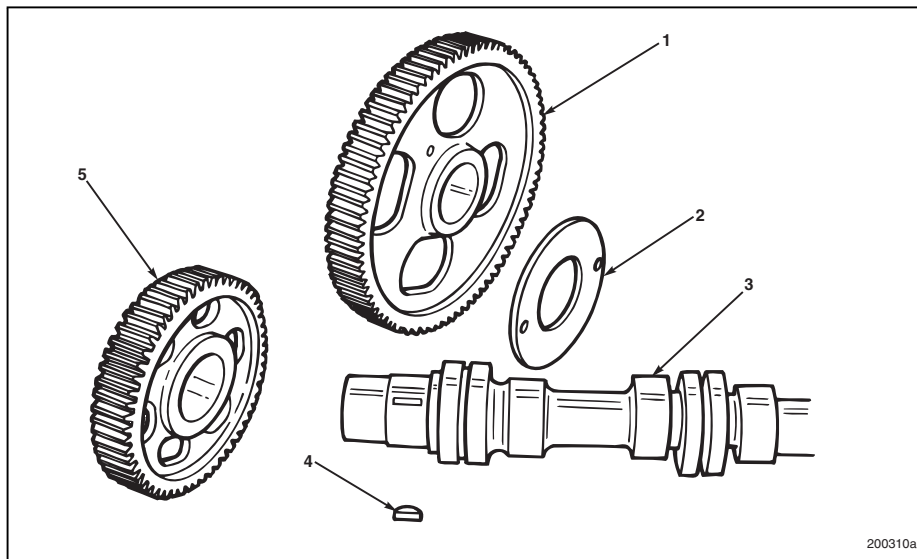


Figure 5-19 — Camshaft Assembly Components

1. Camshaft gear
2. Camshaft captured thrust washer
3. Camshaft

4. Key
5. Injection pump driving gear



200 BENCH PROCEDURES

⚠ DANGER

Wear protective gloves when handling heated gears.

Refer to Figure 5-20.

- Using an oven (not a torch), heat new camshaft gear and new injection pump driving gear to 400°F (205°C). Do not exceed 400°F (205°C) and do not heat for more than one to two hours. Do not exceed two hours. Position camshaft gear with timing marks facing out, and align keyway with key.

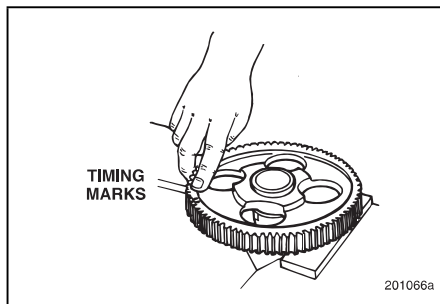


Figure 5-20 — Camshaft Gear Installation, Heat Method

- Push downward with a quick, even pressure to install camshaft gear onto camshaft.

⚠ CAUTION

The heat-expanded gear bore will begin to transfer heat to the camshaft as soon as the gear bore and camshaft contact each other. This makes it absolutely necessary that the gear be installed in one very rapid motion to the fully seated position. If the gear is allowed to stop on the camshaft part way before fully seating, it will become immovable. If this occurs, do not press-install the gear. It should be press removed, allowed to cool, and re-installed using the press method.

- There should be between 0.003–0.012 inch (0.076–0.305 mm) clearance between rear face of gear and thrust washer when measured with thickness gauge.

- Install injection pump driving gear (5) by applying a quick, even pressure until gear bottoms onto camshaft gear. Make sure camshaft thrust washer holes are accessible through injection pump driving gear.

PRESS METHOD — CAMSHAFT/INJECTION PUMP DRIVING GEAR INSTALLATION

Refer to Figure 5-19.

- Thoroughly clean and degrease camshaft (3) and camshaft drive gear (1) with a suitable contact cleaner that dries rapidly and leaves no residue.
- Install a new key (4) in camshaft key slot.
- Place camshaft in a press, making sure camshaft is supported by plates between journal and first lobe.

⚠ CAUTION

Approximately 5 tons (4.54 MT) of force is required to press each gear onto the camshaft. When in the press, use suitable plates to support the camshaft between the journal and first lobe. Do not allow camshaft to rest on the floor.

- Position a new thrust washer (2) on the camshaft.
- Prepare the gear bore with Locquic™ Primer T, or equivalent.
- Apply a bead of Loctite® 609, or equivalent, to the gear bore.
- Using a clean brush, spread Loctite 609 evenly onto the entire surface of the gear bore.

Refer to Figure 5-21.

- Position gear on camshaft with timing marks facing upward and key slot in gear aligned with key in shaft.

⚠ CAUTION

Do not attempt to increase clearance between camshaft and gears by sanding gear bores or camshaft.



200 BENCH PROCEDURES

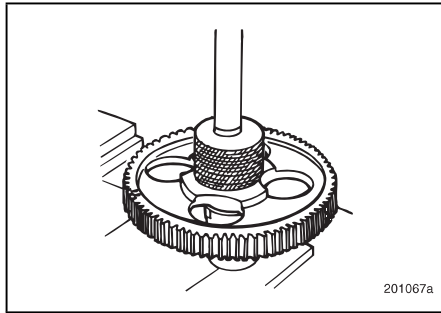


Figure 5-21 — Camshaft Gear Installation

9. Using a suitable press cup, press the gear onto the shaft until it is fully seated. The pressure gauge on the press should read approximately 5 tons (4.54 MT) as the gear is being pressed on. As the gear seats, allow the pressure to climb to, but not exceed, 10 tons (9.1 MT). This will ensure that gear is seated firmly on shaft.
10. When gear is properly seated, clearance between rear face of gear and thrust washer should be between 0.003–0.012 inch (0.076–0.305 mm).
11. Thoroughly clean and degrease injection pump driving gear with a suitable contact cleaner that dries rapidly and leaves no residue.
12. Prepare the gear bore surface with Locquic™ Primer T, or equivalent.
13. Apply a bead of Loctite 609, or equivalent, to the gear bore.
14. Using a clean brush, spread Loctite 609 evenly on the entire surface of the gear bore.
15. Position gear onto camshaft.
16. Using a suitable press cup, press the gear onto the shaft until it is fully seated. The pressure gauge on the press should read approximately 5 tons (4.54 MT) as the gear

is being pressed on. As the gear seats, allow the pressure to climb to, but not exceed, 10 tons (9.1 MT). This will ensure that gear is seated firmly on shaft. The gear should be flush with the end of the shaft when fully seated.

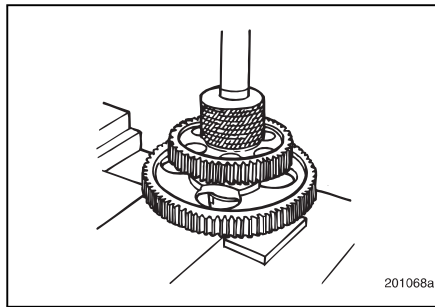


Figure 5-22 — Fuel Injection Pump Driving Gear Installation

[213 EV] CYLINDER HEADS

Description

Refer to Figure 5-23.

The cylinder heads featured on 1991 and later E7 engines incorporate internal design modifications that increase the swirl level of combustion air. To achieve the increase in air motion required, it was necessary to redesign the inlet port. Increased air motion, in conjunction with the eight-hole Valve Covering Orifice (VCO) nozzle tips, provides proper air/fuel atomization in the deeper bowl of the piston crown.

NOTE

1991 and later E7 cylinder heads are NOT interchangeable with 1989/1990 E7 cylinder heads.



200 BENCH PROCEDURES

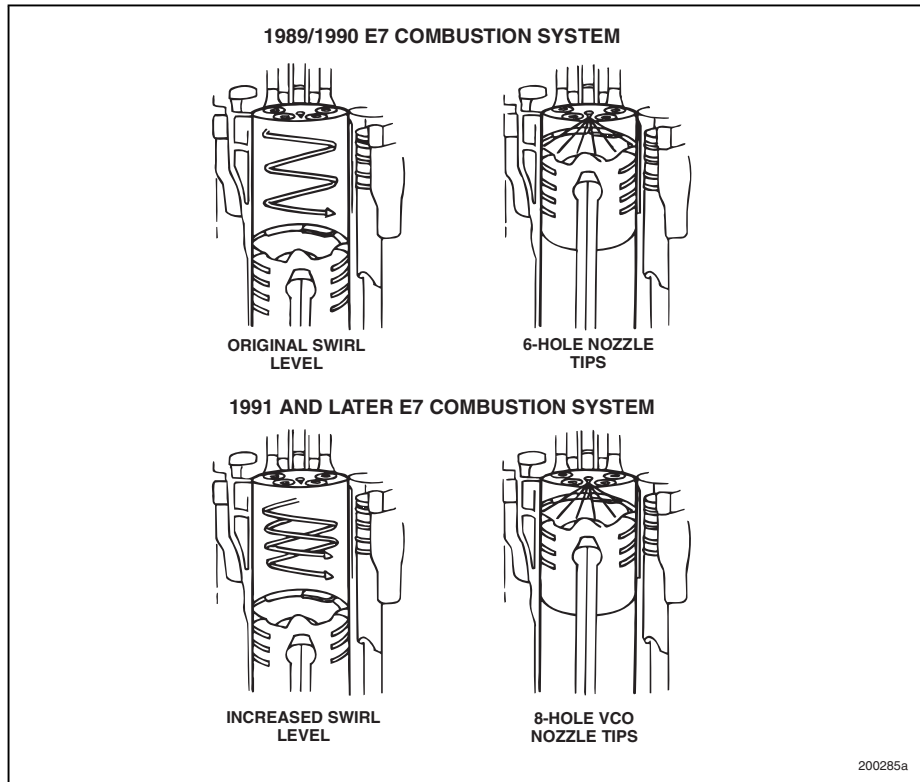


Figure 5-23 — Combustion Chamber Design

Refer to Figure 5-24.

The cast iron cylinder head is constructed using a special iron alloy. The head contains cored inlet, exhaust and coolant passages, drilled oil passages, replaceable inlet and exhaust guides and seats, various drilled passages and tapped holes. Each cylinder head covers three cylinders

and has two inlet and two exhaust valves per cylinder. Circular grooves correspond with the fire ring bead on cylinder sleeves. This design sets the fire ring over the liner, the lip and into groove of the cylinder head while providing a positive combustion pressure seal. Use a rotary brass-wire brush to clean the circular groove.



200 BENCH PROCEDURES

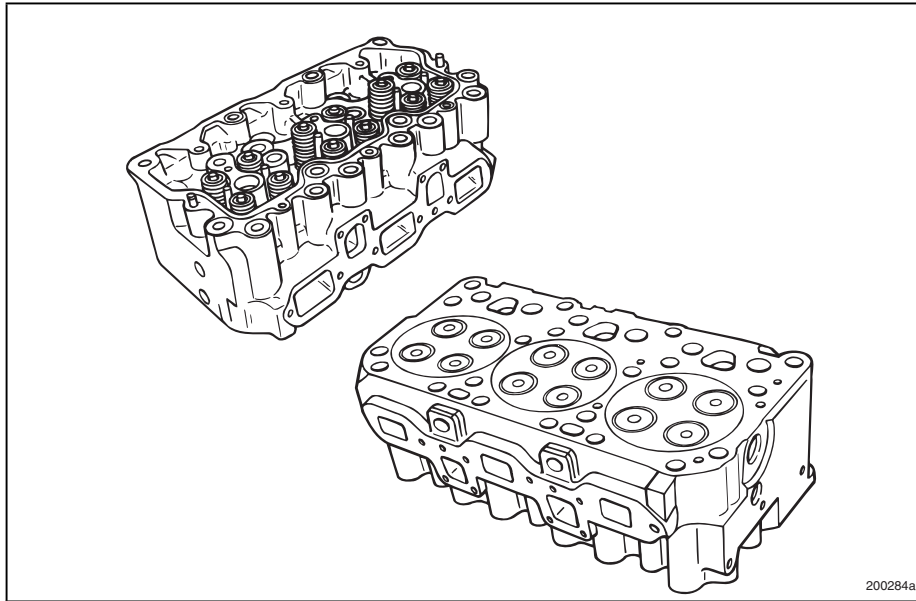


Figure 5-24 — E7 Cylinder Head

Special Tools Required

- Valve Spring Keeper Remover J 29294-B
- Fire Ring Groove Cutter J 29600-C
- E7 Cutter Head J 37719
- Depth Gauge J 26948
- Valve Guide Remover J 37482
- Valve Guide Installer J 37809
- Valve Guide Reamer J 37481
- Valve Seat Extractor Kit PT6391
- Collet PT6390-4
- Valve Seat Insert Counterbore HT77136
- Valve Insert Installer Set J 38586
- Driver Handle J 8092
- Prussian Blue
- Model MST 50 Universal Spring Tester J 22738-02
- Injection Nozzle Sleeve Extractor J 29880
- Basic Heavy-Duty Dowelout Kit PT6575
- Dowelout, Extractor (7/16 inch) PT6570-11
- Torque Wrench J 24407
- Slide Hammer J 2619-01
- Valve Yoke Guide Pin Installer J 29296
- Injection Nozzle Sleeve Installer J 29297
- Cylinder Head Core Plug Installer (13/16-inch cup plugs) J 34684
- Cylinder Head Core Plug Installer (1-1/16 inch cup plugs) J 34687
- Valve Seal Installer J 42453
- Valve Stem Seal Remover J 39460



200 BENCH PROCEDURES

[213 NB] Inlet and Exhaust Valve Removal

Refer to Figure 5-25.

1. Attach valve spring keeper remover J 29294-B to cylinder head.
2. Rest tool compression forks (4) on top of upper washer (3) and center forks above valve.
3. Depress tool handle until valve spring is compressed. Remove valve spring washer keys (2) using a magnet (1).

NOTE

Valve spring keeper remover J 29294-B must be repositioned for each series of valves (two inlet and two exhaust, per cylinder). Drilled and tapped holes are provided for each cylinder.

VALVE STEM SEALS

Refer to Figure 5-26.

A new valve stem seal was introduced into E7 engine production on 11/1/96, beginning with engine serial number 6S2657. The older valve stem seal has a single sealing lip, while the new-style seal incorporates a second lip that significantly reduces crankcase blowby. This new seal can easily be identified by the steel retainer band around the top of the seal lip.

To improve seal-to-guide retention, a change was made to the valve guides. The new-style guides have three sharp ridges machined into the upper outside diameter surface (refer to Figure 5-26). The new valve guides were phased into production during the first quarter of 1997.

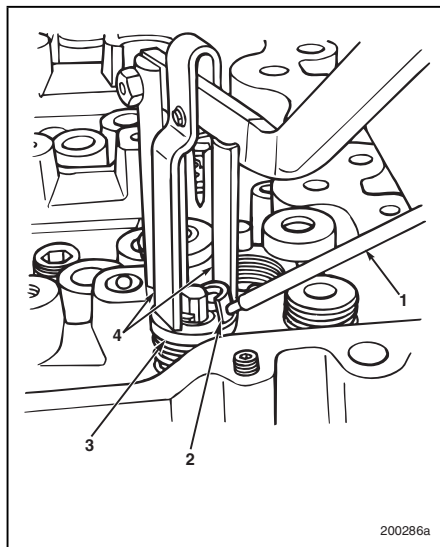


Figure 5-25 — Valve Spring Keeper Removal

- | | |
|-----------------------------|---------------------------------------|
| 1. Magnet | 3. Upper washer |
| 2. Valve spring washer keys | 4. Tool compression forks (J 29294-B) |



200 BENCH PROCEDURES

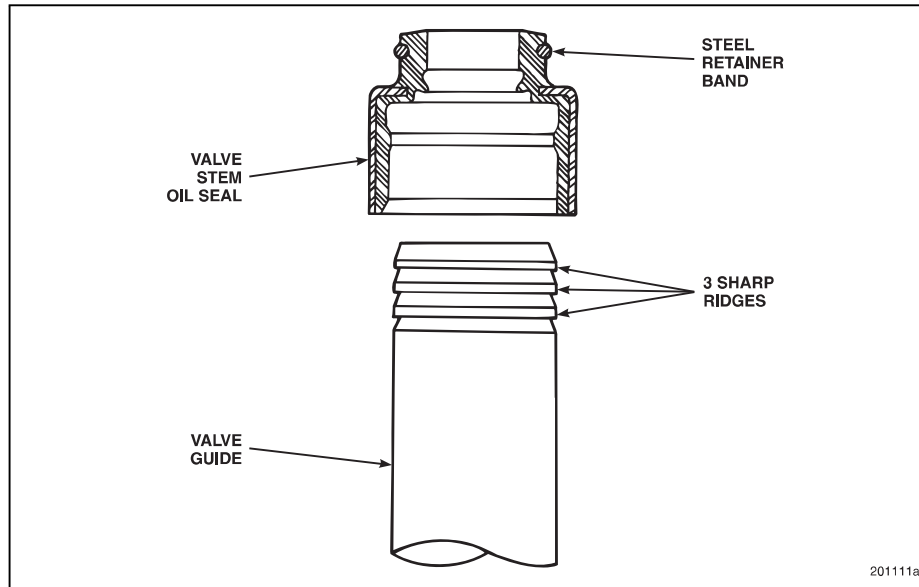


Figure 5-26 — New Valve Stem Seal

This new seal is recommended for all E7 engines. The single lip seal has been terminated, and as service stock is depleted, only the new seal will be available. This new seal can be used on the old-style valve guides.

Part Number	Description	Replaces
446GC328	Valve Stem Seal	446GC296
714GB3103	Valve Guide	714GB222

Refer to Figure 5-27.

4. With valve spring keepers (1) removed, remove upper washer (2), valve spring (3), oil seal (4), lower washer (Roto-Coil) (5) and valve (6).

NOTE

After removing the valve springs, removal of the existing valve stem seals can be accomplished easily and quickly by using the J 39460 Valve Stem Seal Removal tool. Failure to use this tool could make seal removal more difficult, and could result in damaging the outside diameter of the valve guides.



200 BENCH PROCEDURES

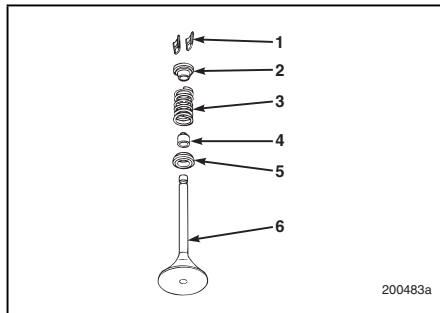


Figure 5-27 — Valve Assembly

- | | |
|-------------------------|-----------------------------|
| 1. Valve spring keepers | 5. Lower washer (Roto-Coil) |
| 2. Upper washer | 6. Valve |
| 3. Valve spring | |
| 4. Oil seal | |

[213 EX] Cylinder Head Inspection

SERVICE HINT

Pressure Test — It is recommended that cylinder heads be pressurized and checked for internal cracks and leaks. Refer to Cylinder Head and Cylinder Block Leak Test procedures in the TROUBLESHOOTING section of this manual.

Check cylinder head deck surface for warping, pitting or other imperfections. Deck surface flatness for a new head must not vary more than 0.0015 inch (0.0381 mm) over 18 inches (45.7 cm) of surface area. Resurface or replace as necessary.

When resurfacing, remove a minimum amount of material from deck to obtain a flat, uniform surface. Standard head height is 6.397–6.391 inches (162.483–162.310 mm). A maximum of 0.010 inch (0.254 mm) of material may be removed, making the minimum height of a resurfaced head 6.381 inches (162.077 mm).

NOTE

When the deck is resurfaced, fire ring groove and valve seat insert dimensions must be reestablished. Correct dimensions are shown in this section.

[213 EH] Fire Ring Groove

DESCRIPTION

Fire ring grooves are located in the machined flat surface of the cylinder head that mates with the engine block. These grooves correspond with the fire ring machined lip on cylinder liner. This design provides a locking groove for the fire ring to seat as well as a positive-combustion pressure seal.

After resurfacing the cylinder head deck, it is necessary to reestablish the fire ring groove depth using fire ring groove cutter J 29600-C.

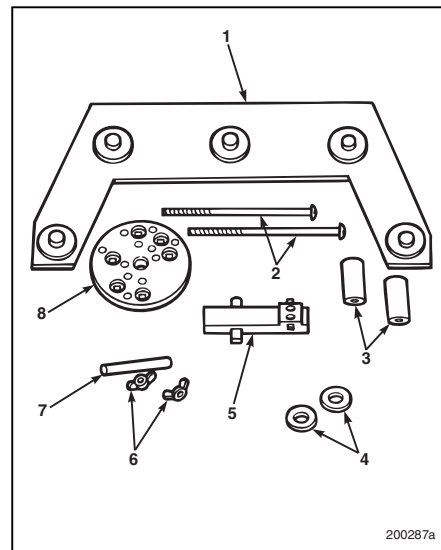


Figure 5-28 — Fire Ring Groove Cutter J 29600-C

- | | |
|------------------------|--------------------------|
| 1. Alignment fixture | 5. Cutter head (J 37719) |
| 2. Hold-down capscrews | 6. Wing nuts |
| 3. Spacers | 7. Thickness gauges |
| 4. Washers | 8. Cutter base |



200 BENCH PROCEDURES

FIRE RING GROOVE CUTTING PROCEDURE

Refer to Figure 5-29.

1. Place cutter base (1) on cylinder head (2). Insert hold-down capscrews into appropriate mounting holes (per application) until hold-down capscrews bottom out in mounting holes.

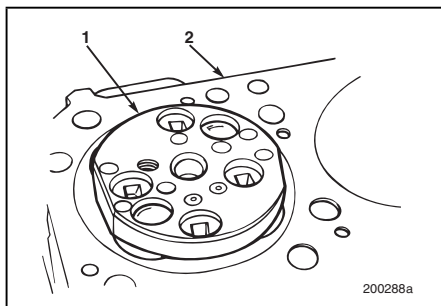


Figure 5-29 — Cutter Base Alignment

- | | |
|----------------|------------------|
| 1. Cutter base | 2. Cylinder head |
|----------------|------------------|

Refer to Figure 5-30.

2. Position cylinder head so threaded section of hold-down capscrews can be reached. Install spacer (3), washer (2) and wing nut (1). Lightly tighten wing nut.

NOTE

The cutter base must be free to move.

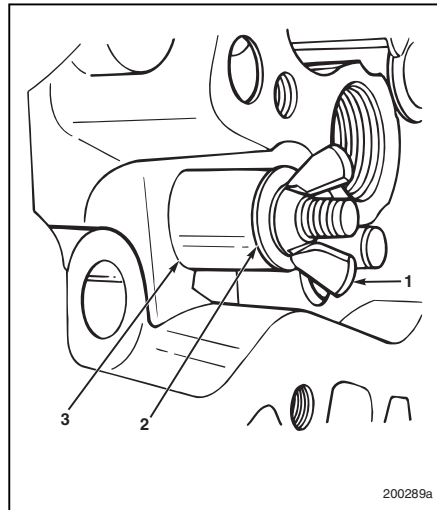


Figure 5-30 — Fastening Cutter Base

- | | |
|-------------|-----------|
| 1. Wing nut | 3. Spacer |
| 2. Washer | |



200 BENCH PROCEDURES

Refer to Figure 5-31.

3. Place alignment fixture (1) over the cutter base (2) to ensure proper positioning. With fixture in place, tighten wing nuts on hold-down capscrews. Remove alignment fixture.

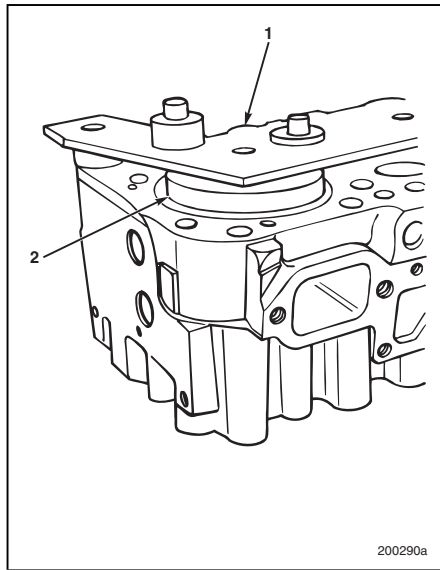


Figure 5-31 — Alignment Fixture Placement

- | | |
|----------------------|----------------|
| 1. Alignment fixture | 2. Cutter base |
|----------------------|----------------|

Refer to Figure 5-32.

NOTE

The desired finished fire ring groove depth is 0.008 inch (0.203 mm).

4. Install cutter head J 37719 (1) on cutter base (4).
 - a. If fire ring groove (3) is visible, check existing fire ring groove depth dimension with depth gauge J 26948. The difference between 0.008 inch and the actual remaining depth of fire ring groove is the amount to cut. Insert two appropriate thickness gauges (2) between cutter head (1) and cutter base (4).
 - b. If fire ring groove (3) is not visible, insert two 0.008-inch thickness gauges (2) between cutter head (1) and cutter base (4).
5. Adjust cutter head J 37719 until it bottoms out on deck surface of existing fire ring groove. Tighten cutter head in this position and remove the two thickness gauges.

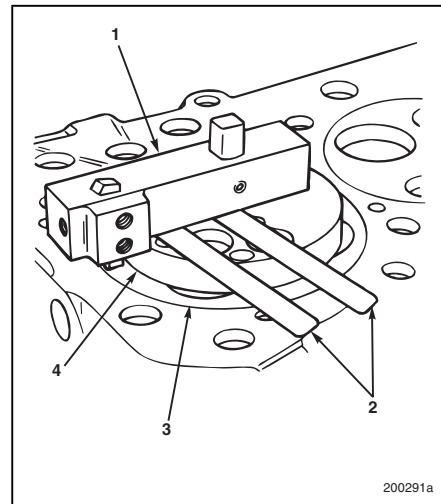


Figure 5-32 — Setting Cutter Depth

- | | |
|--------------------------|---------------------|
| 1. Cutter head (J 37719) | 3. Fire ring groove |
| 2. Thickness gauges | 4. Cutter base |



200 BENCH PROCEDURES

Refer to Figure 5-33.

6. Install a socket (1) and T-handle (2) on cutter head (3). Using T-handle, rotate cutter head in a clockwise direction only, applying an even downward pressure to cut fire ring groove.

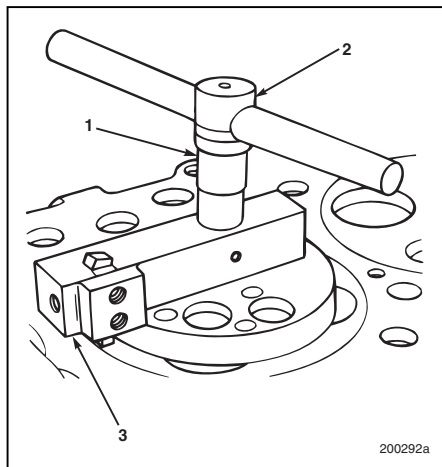


Figure 5-33 — Cutting Ring Groove

- | | |
|-------------|--------------------------|
| 1. Socket | 3. Cutter head (J 37719) |
| 2. T-handle | |

7. After groove is cut, remove cutter head and cutter base from cylinder head.
8. Use a honing stone to remove any burrs around fire ring groove.
9. Check fire ring groove depth with depth gauge J 26948 to verify that groove depth meets specification. If groove depth does not meet specification, recut as necessary.
10. Repeat above procedure with each fire ring groove cut.

NOTE

To ensure proper groove depth, always adjust cutting tool height when cutting next groove.

[213 EP] Valve Guides

INLET AND EXHAUST VALVE GUIDE DIMENSIONS

Refer to Figure 5-34.

- Valve guide ID (3) — 3/8 inch (9.53 mm)
- Top end of guide to valve spring seat (4) — 0.959 ± 0.040 inch (24.36 ± 1.02 mm)
- Valve guide extension, fire deck to top of guide (5) — 5.24 ± 0.03 inch (133.10 ± 0.76 mm)
- Valve guide bore in head (6) — 0.687–0.686 inch (17.450–17.424 mm)
- Valve guide OD (7) — 0.6886–0.6881 inch (17.4904–17.4777 mm)

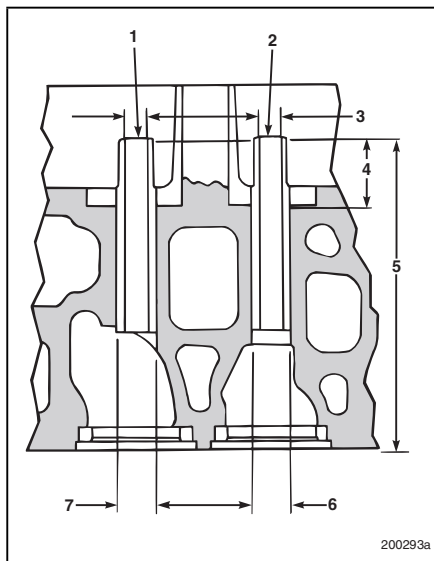


Figure 5-34 — Valve Guide Dimensions

- | | |
|--|---|
| 1. Exhaust valve guide | 5. Valve guide extension, fire deck to top of guide |
| 2. Inlet valve guide | 6. Valve guide bore in head |
| 3. Valve guide ID | 7. Valve guide OD |
| 4. Top end of guide to valve spring seat | |



200 BENCH PROCEDURES

INSPECTION

NOTE

Worn valve guides may result in poor valve-to-seat contact, valve damage or oil consumption.

1. Inspect valve guides for wear, damage, cracks and looseness.

Refer to Figure 5-35.

2. Use a small bore gauge (1) to obtain an accurate valve guide bore (2) measurement.

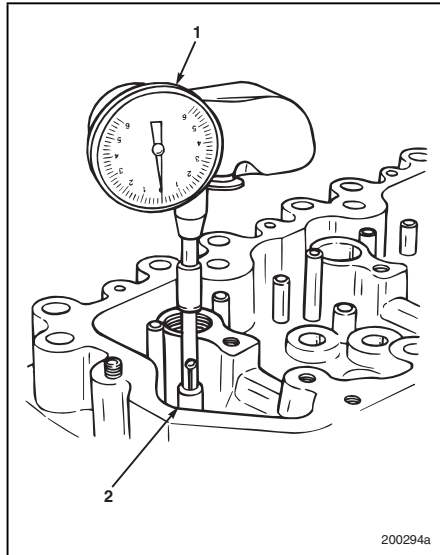


Figure 5-35 — Measuring Valve Guide Bore

- | | |
|---------------|---------------------|
| 1. Bore gauge | 2. Valve guide bore |
|---------------|---------------------|

Refer to Figure 5-36.

3. Use a depth gauge to check valve guide extension.

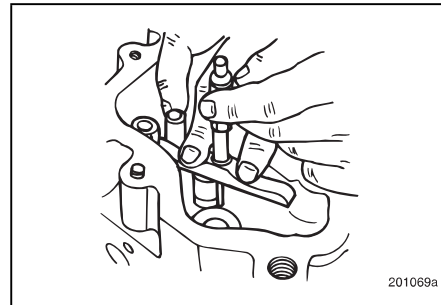


Figure 5-36 — Checking Valve Guide Extension

NOTE

When reconditioning the cylinder head, it is recommended that all valve guides be replaced.

VALVE GUIDE REMOVAL

SERVICE HINT

Clean exhaust valve guide OD (shoulder) before removal. Use a rotary brush to prevent scoring of exhaust valve guide bore.

Refer to Figure 5-37.

1. Insert valve guide remover J 37482 (1) into valve guide from deck side of the cylinder head (2).



200 BENCH PROCEDURES

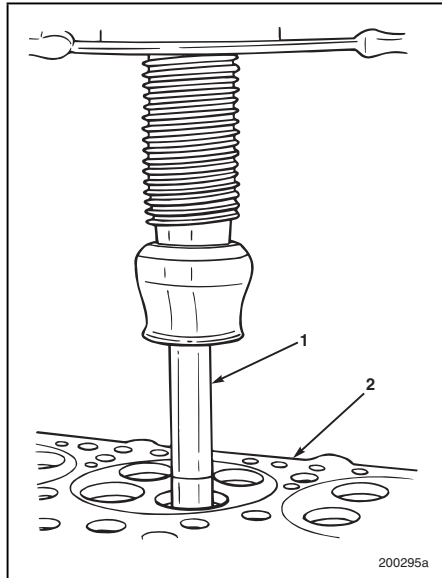


Figure 5-37 — Valve Guide Remover J 37482

- | | |
|--------------------------------|------------------|
| 1. Valve guide remover J 37482 | 2. Cylinder head |
|--------------------------------|------------------|
- Press out old valve guides from cylinder head.
 - Check valve guide bore in the cylinder head for wear, cracks or other damage. Clean surfaces thoroughly and check ID measurement.

VALVE GUIDE INSTALLATION

- Insert new valve guide into valve guide installer J 37809.
- Oil OD of new guide before installation.
- Press new valve guide into top of cylinder head using tool J 37809.

Refer to Figure 5-38.

- Using depth gauge, check extension of valve guide from valve spring seat to top end of the guide.

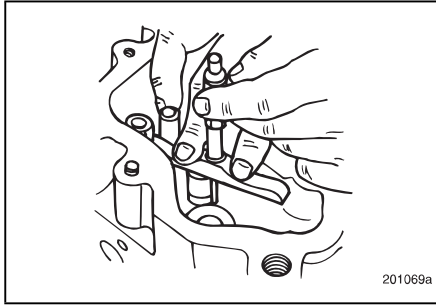


Figure 5-38 — Checking Valve Guide Extension

Refer to Figure 5-39.

- Using valve guide reamer J 37481 (1), ream new valve guide (2) to dimension.

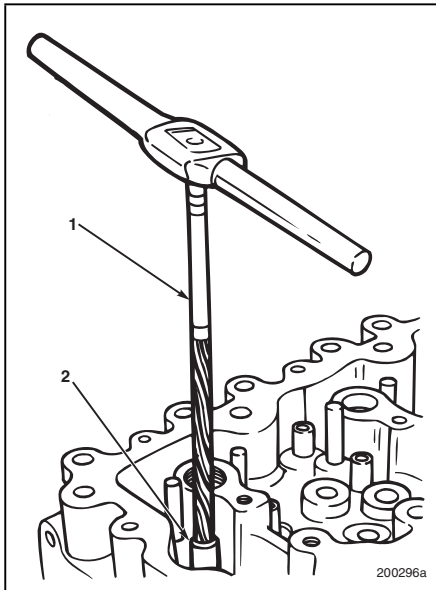


Figure 5-39 — Reaming Valve Guide

- | | |
|-------------------------------|----------------|
| 1. Valve guide reamer J 37481 | 2. Valve guide |
|-------------------------------|----------------|



200 BENCH PROCEDURES

6. Thoroughly clean all metal debris from valve guide and surrounding area.
7. Install valves in cylinder head and check for binding, looseness and other conditions that may result in premature valve or valve guide failure.

[213 FB] Inlet and Exhaust Valve Seat Inserts

INLET AND EXHAUST VALVE SEAT INSERT DIMENSIONS

Refer to Figure 5-40.

- Valve seat (3) insert face angle (1)
 - Inlet: $30^{\circ} - 0' / + 30'$ (before November 1996), $20^{\circ} 30' \pm 15'$ (November 1996 and later)
 - Exhaust: $30^{\circ} \pm 0' / + 30'$
- Valve seat insert diameter (2)
 - Inlet: 1.832–1.831 inches (46.533–46.507 mm)
 - Exhaust: 1.693–1.691 inches (43.002–42.951 mm)
- Valve seat width (4) — 0.066 ± 0.015 inch (1.676 ± 0.381 mm)

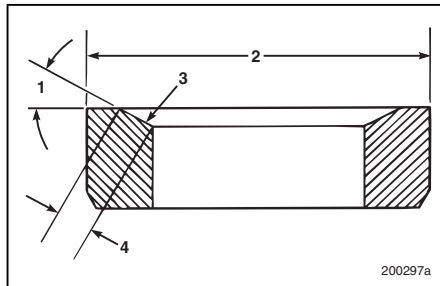


Figure 5-40 — Valve Seat Insert Dimensions

- | | |
|---------------------------------|---------------------|
| 1. Valve seat insert face angle | 3. Valve seat |
| 2. Valve seat insert diameter | 4. Valve seat width |



200 BENCH PROCEDURES

INSPECTION

Visually inspect valve seat inserts for looseness, cracks or other conditions that may result in improper operation. Replace as necessary.

NOTE

Collet PT6390-4 is not included in basic kit PT6391.

VALVE SEAT INSERT REMOVAL

Refer to Figure 5-41.

Valve seat extractor kit PT6391 and collet PT6390-4 are used to remove inlet and exhaust seat inserts.

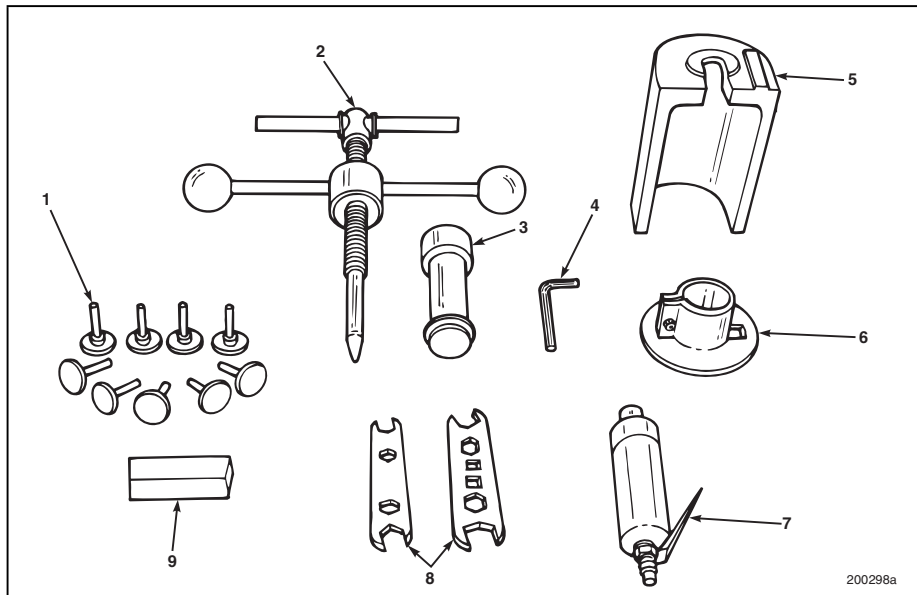


Figure 5-41 — Valve Seat Extractor Kit PT6391

1. Grinding wheels
2. T-handle and shaft assembly
3. Collet
4. Allen wrench
5. Lifting bridge

6. Grinder base
7. Grinder
8. Wrenches
9. Dressing stone



200 BENCH PROCEDURES

Refer to Figure 5-42.

1. Using depth measurement tool (1), measure distance from cylinder head surface (2) to point on insert where groove will be ground.

NOTE

This point should be approximately 0.060 inch (1.524 mm) below any angular face on valve seat insert.

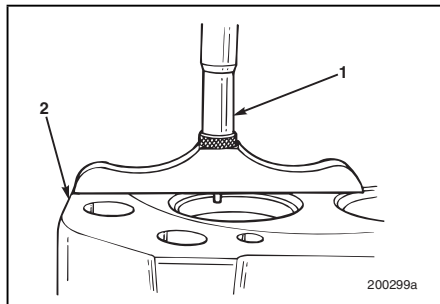


Figure 5-42 — Valve Insert Depth Measurement

- | | |
|---------------------------|--------------------------|
| 1. Depth measurement tool | 2. Cylinder head surface |
|---------------------------|--------------------------|

Refer to Figure 5-43.

2. Install grinding wheel (2) into grinder (4) and set depth of grinder base (1) to dimension found in preceding step.
3. Secure base to grinder by tightening hex-head screw (3).

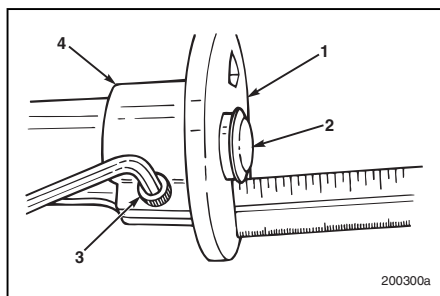


Figure 5-43 — Setting Depth of Grinder

- | | |
|-------------------|-------------------|
| 1. Grinder base | 3. Hex-head screw |
| 2. Grinding wheel | 4. Grinder |

4. Grind a groove around inside circumference of valve seat insert. This groove should be approximately 0.030 inch (0.762 mm) deep.

CAUTION

Use care not to damage any machined surface of the cylinder head.

5. Attach collet to T-handle and shaft assembly.
6. Position collet in valve seat insert so ridge of collet will be inside groove. Turn T-handle to fully expand collet.

Refer to Figure 5-44.

7. Position lifting bridge (3) under crank handle (2). Turn crank handle clockwise to remove insert.
8. Release insert from collet (4) by slightly turning T-handle (1).

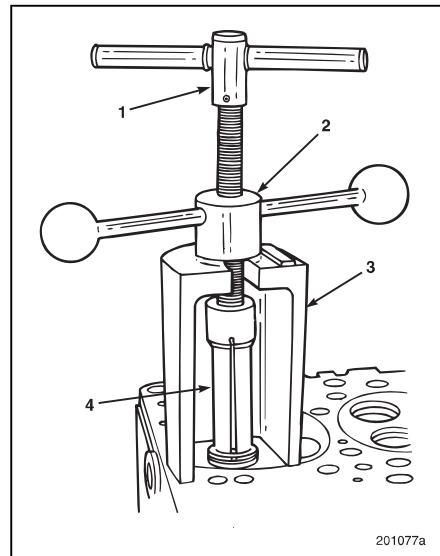


Figure 5-44 — Removing Valve Insert

- | | |
|-----------------|-------------------|
| 1. T-handle | 3. Lifting bridge |
| 2. Crank handle | 4. Collet |



200 BENCH PROCEDURES

VALVE SEAT INSERT COUNTERBORE

Refer to Figure 5-45.

- Valve seat at counterbore depth (3):
 - Exhaust: 0.376–0.372 inch (9.55–9.449 mm)
 - Inlet: 0.364–0.360 inch (9.246–9.144 mm)
- Inlet valve seat insert counterbore diameter (4): 1.8295–1.8285 inches (46.4693–46.4439 mm)
- Exhaust valve seat counterbore diameter (5): 1.6885–1.6875 inches (42.8879–42.8625 mm)

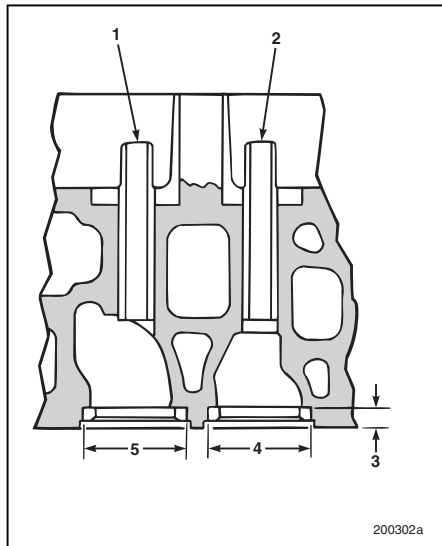


Figure 5-45 — Valve Seat Insert Counterbore Dimensions

- | | |
|------------------------------------|---|
| 1. Exhaust valve guide | 4. Inlet valve seat insert counterbore diameter |
| 2. Inlet valve guide | 5. Exhaust valve seat counterbore diameter |
| 3. Valve seat at counterbore depth | |

INSPECTION

Refer to Figure 5-46.

1. With valve seat insert removed from cylinder head (2), clean surfaces thoroughly with wire brush.

2. Check surface finish for smoothness. Check counterbore diameter with an inside diameter micrometer (1). Refer back to specifications listed in Figure 5-45.

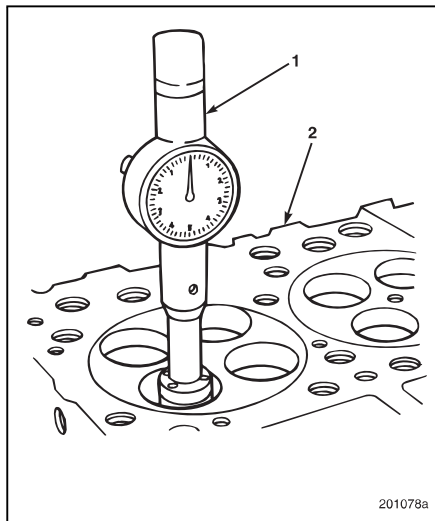


Figure 5-46 — Checking Counterbore Dimensions

- | | |
|-------------------------------|------------------|
| 1. Inside diameter micrometer | 2. Cylinder head |
|-------------------------------|------------------|

VALVE SEAT INSERT INSTALLATION

NOTE

Oversize inlet and exhaust valve seat inserts are available in 0.005, 0.015, 0.031, 0.047 and 0.062 inch sizes if counterbore requires machining.

1. If required, machine the inlet and exhaust valve seat insert counterbores using tool HT77136.

Refer to Figure 5-47.

2. Position valve seat insert (1) over corresponding counterbore. Install inserts using valve seat insert installation set J 38586 (2). Use driver handle J 8092 (3) to drive valve seat insert into counterbore.



200 BENCH PROCEDURES

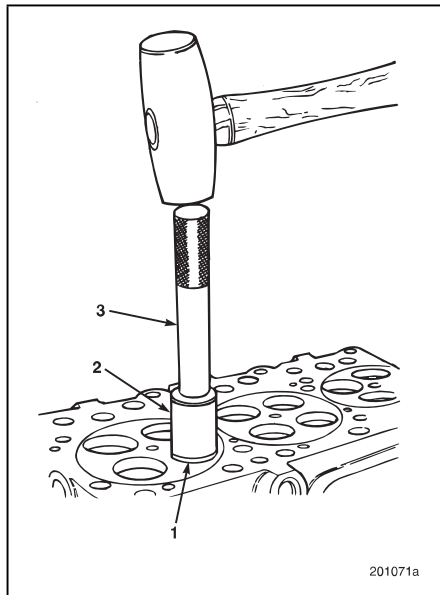


Figure 5-47 — Valve Seat Insert Installation

- | | |
|----------------------|-----------|
| 1. Valve seat insert | 3. J 8092 |
| 2. J 38586 | |

3. Grind inlet/exhaust valve seat inserts to specification.
 - Inlet valve inserts before November 1996: $30^{\circ} - 0' / + 30'$ angle; November 1996 and later: $20^{\circ} 30' \pm 15'$ angle
 - Exhaust valve inserts: $30^{\circ} - 0' / + 30'$

CAUTION

Always use 30-degree valves with 30-degree valve inserts and 20-degree valves with 20-degree valve inserts. Excessive wear and possible failure will result if 30-degree parts are matched with 20-degree parts.

NOTE

If valve seat insert widths exceed specifications when grinding inserts, use a 15-degree angle grinding stone to obtain correct width.

Refer to Figure 5-48.

4. After grinding is completed, thoroughly clean valve seat insert.
5. Determine concentricity of each valve seat insert relative to valve guide. Valve seat runout is to be held within 0.001 (0.025 mm) FIM (Full Indicator Movement), with finished valve guide ID measurements made from snug-fitting arbor (1) and through-mounted into finished valve guides (2).
6. After valve insert has been ground and cleaned, determine position of contact area between valve and valve seat insert. Apply a dab of Prussian Blue to valve face at four points, 90 degrees apart.
7. Lower stem of valve into valve guide and allow valve face to rest on seat insert. Rotate valve 90 degrees on insert. Carefully remove valve without making contact with valve face. Properly ground inserts should have full pattern on insert.

NOTE

Thoroughly clean cylinder head after checking valve seat inserts and before installing valves.



200 BENCH PROCEDURES

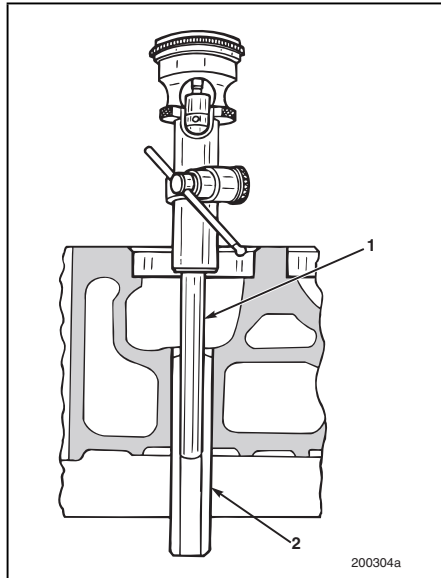


Figure 5-48 — Checking Valve Seat Runout

- | | |
|----------|-----------------|
| 1. Arbor | 2. Valve guides |
|----------|-----------------|

[213 MB] Valve Springs

1. Visually inspect inside surfaces of coils. Also, feel inside surfaces of spring for any indication of roughness or grooving. If any of these conditions exist, replace spring.

Refer to Figure 5-49.

2. Check spring tension on universal spring tester J 22738-02.

Part No. 575GC213 (E7)
142.5–157.5 lb. at 1.435 inches
(64.6–71.4 kg at 36.4 mm)

Part No. 575GC35 (E7 with Extarder)
190–210 lb. at 1.5 inches
(86.2–95.3 kg at 38.1 mm)

NOTE

If spring force does not meet specification, discard and install new spring.

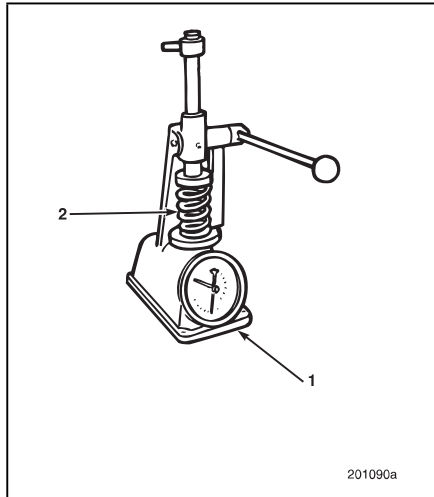


Figure 5-49 — Checking Valve Spring Tension

- | | |
|--------------------------------|-----------------|
| 1. Spring tester
J 22738-02 | 2. Valve spring |
|--------------------------------|-----------------|

[213 GB] Injection Nozzle Holder Insert

The injection nozzle holder insert is machined to provide a press fit in cylinder head.

INJECTION NOZZLE HOLDER INSERT REMOVAL

1. To remove injection nozzle holder insert, tap ID with 3/4-10 tap.

Refer to Figure 5-50.

2. Install nozzle sleeve puller J 29880 (2) to slide hammer J 2619-01 (1) or equivalent.
3. Thread sleeve puller into end of injection nozzle holder insert. Use slide hammer to remove insert.



200 BENCH PROCEDURES

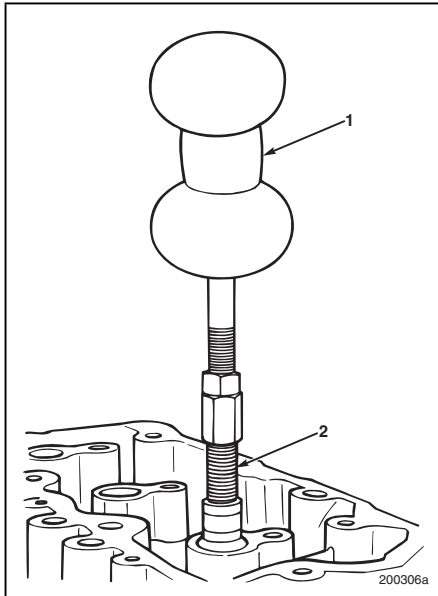


Figure 5-50 — Removing Injection Nozzle Holder Insert

- | | |
|------------------------------|--------------------------|
| 1. Slide hammer
J 2619-01 | 2. Sleeve puller J 29880 |
|------------------------------|--------------------------|

INJECTION NOZZLE HOLDER INSERT INSTALLATION

1. Thoroughly clean insert bore and surrounding area before installing insert.
2. Apply Loctite 620 completely around the center of all three sealing diameters of the new insert.

Refer to Figure 5-51.

3. Using nozzle sleeve installer J 29297 (2), drive insert (1) into cylinder head until it bottoms in lower counterbore face.

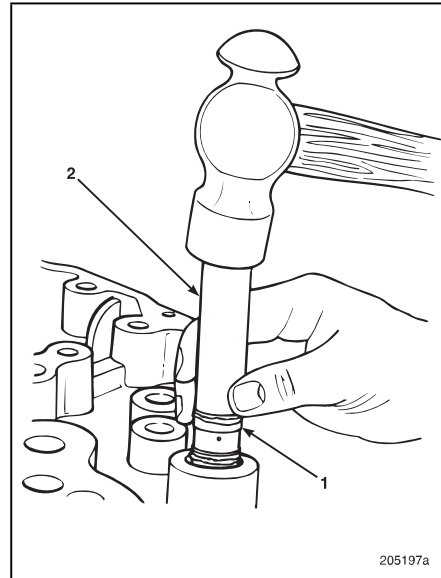


Figure 5-51 — Injection Nozzle Holder Insert Installation

- | | |
|-----------|---------------------------------------|
| 1. Insert | 2. Nozzle sleeve installer
J 29297 |
|-----------|---------------------------------------|

[213 FH] Valve Yoke Guide Pins

The valve yoke guide pins are located between valve guides.

INSPECTION

Inspect valve yoke guide pin surface for cracks or other damage. Also check pin diameter and installed height.



200 BENCH PROCEDURES

VALVE YOKE GUIDE PIN REMOVAL

Refer to Figure 5-52.

1. To remove pin, use valve yoke guide pin puller kit PT6575 and extractor PT6570-11 (7/16 inch).
2. Install extractor over guide pin and position extractor lock over extractor.
3. Using slide hammer, remove pin.

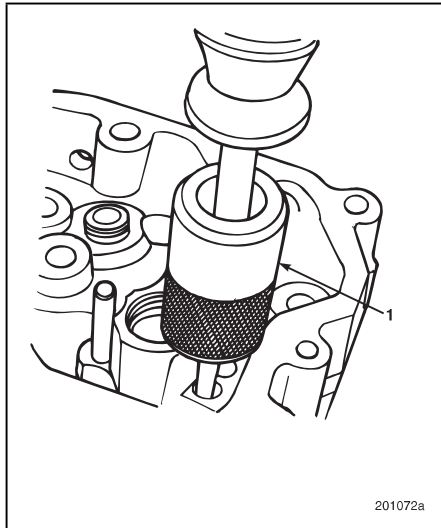


Figure 5-52 — Valve Yoke Guide Pin Removal

- | |
|---------------------------------------|
| 1. Extractor lock (part of PT6570-11) |
|---------------------------------------|

VALVE YOKE GUIDE PIN INSTALLATION

Refer to Figure 5-53.

If new pin is required, use valve guide pin installer J 37809 to drive pin into cylinder head. Guide pin will be at correct height when tool bottoms on cylinder head.

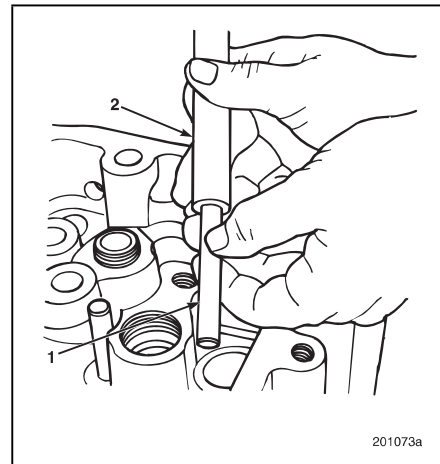


Figure 5-53 — Valve Yoke Guide Pin Installation

- | | |
|-------------------------|------------|
| 1. Valve yoke guide pin | 2. J 37809 |
|-------------------------|------------|



200 BENCH PROCEDURES

[213 FP] Cylinder Head Cup Plugs

DESCRIPTION

The cylinder head has two different-size cup plugs: 13/16 inch (20.64 mm) and 1-1/16 inch (26.99 mm).

CYLINDER HEAD CUP PLUG INSTALLATION

1. Clean cup bore thoroughly.
2. Use Loctite 277 sealer, or equivalent, and apply to cup plug and cup plug bore in head.

Refer to Figure 5-54.

3. Install cup plugs in cylinder head, using cylinder head core plug installer J 34684 for 13/16-inch cup plugs, and cylinder head core plug installer J 34687 for 1-1/16 inch cup plugs.

NOTE

Cup should be installed flush with machined surface to 0.020 inch (0.508 mm) below cylinder head.

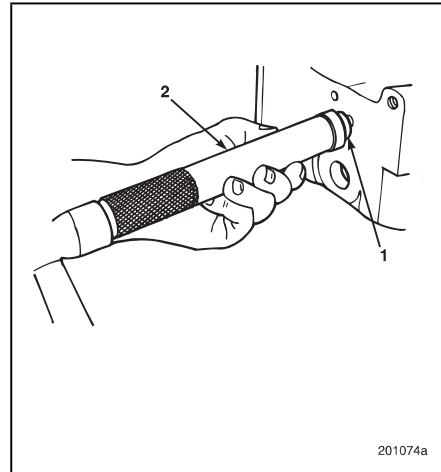


Figure 5-54 — Cylinder Head Cup Plug Installation

1. Cup plug

2. Cup plug installer

201074a



200 BENCH PROCEDURES

Cylinder Head Pipe Plugs

CYLINDER HEAD PIPE PLUG INSTALLATION

1. Apply dry pipe thread sealant to pipe plug and pipe plug bore in head.

Refer to Figure 5-55.

2. Install a 1/8-inch pipe plug in top of rear cylinder head.
3. Install two 3/4-inch core hole pipe plugs in cylinder head. Torque to 28 lb-ft (38 N•m).

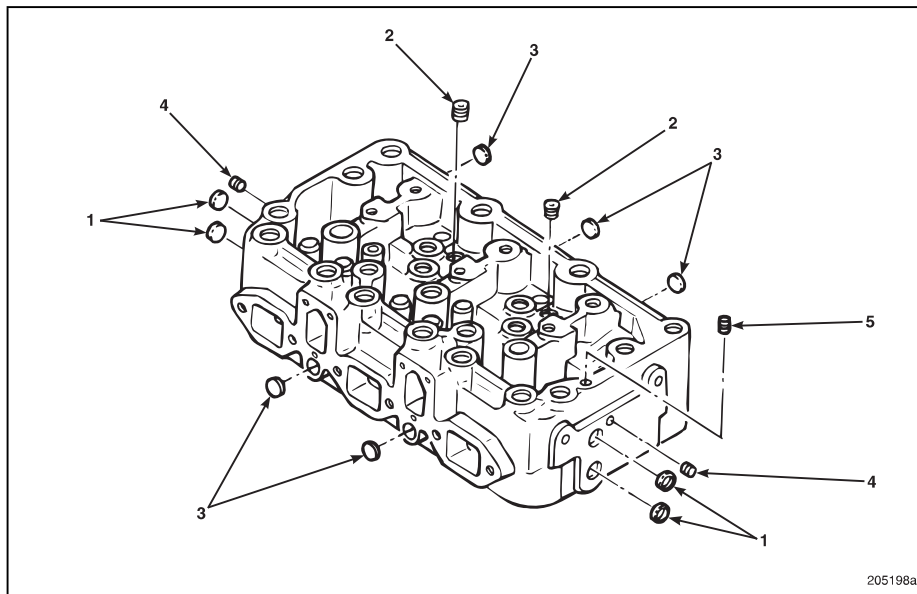


Figure 5-55 — Cylinder Head Pipe Plug Locations

1. 1-1/16 inch cup plug
2. 3/4-inch NPT plug
3. 13/16-inch cup plug

4. 1/16-inch NPT plug
5. 1/8-inch NPT plug



200 BENCH PROCEDURES

[213 NB] INLET AND EXHAUST VALVES

Inspection

Refer to Figure 5-56.

Visually inspect valves for cracks, pits or other conditions that may cause improper operation. Check valve seat angle. Also check stem length, diameter and condition.

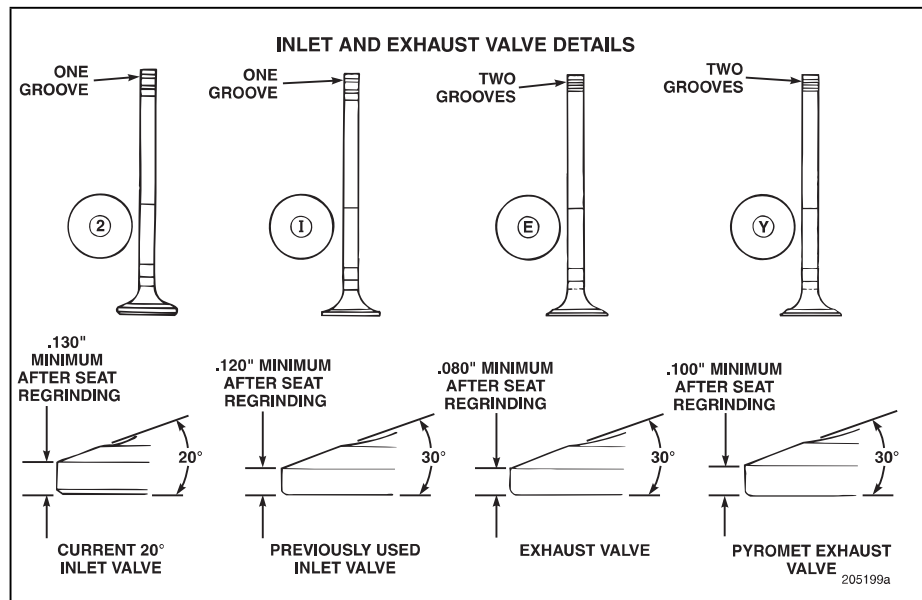


Figure 5-56 — Valve Dimensions (Through September 1996 Production)

Valve Identification

CAUTION

The Pyromet exhaust valve cannot be used on E7 engines equipped with a Dynatard® engine brake. The Pyromet exhaust valve head is 0.020 inch (0.508 mm) thicker than a conventional exhaust valve; therefore, valve-to-piston contact may occur when engine brake is activated.

To permit positive identification, exhaust valve has two stem grooves and inlet valve has one stem groove.

The valves are also identified by letters "1" (30-degree inlet), "2" (20-degree inlet), "E" (exhaust) or "Y" (Pyromet exhaust), which are forged in a slight depression on bottom face of valve head.



200 BENCH PROCEDURES

NOTE

New cylinder heads have been produced in November 1996 which have 20-degree intake valves and seats. These valves and seats replace the 30-degree intake valves and seats in all E7 cylinder heads. The 20-degree valves and seats are 100% interchangeable with the 30-degree valves and seats, provided the seat matches the valve (20-degree seat with 20-degree valve, 30-degree seat with 30-degree valve). Remanufactured assemblies will use either 20-degree or 30-degree valves and seats on certain applications (never mixed in one head). See the following chart and figures to identify your assembly.

Reman Part No.	Angle	Assembly ID	Valve ID	Applications
732GB3424X	20°	72	2	E6 4VH Engines
	30°	24	1	
732GB3452MX	20°	71	2	E7 engines (pre 1991)
	30°	52	1	
732GB3451MX	20°	70	2	E7 engines (1991/92/93)
	30°	51	1	
732GB3466MX	20°	66	2	E7 engines (1994/95/96)
732GB3469MX	20°	69	2	1995/96 E7 engines for Jacob® Stealth™ retarding system applications.



200 BENCH PROCEDURES

Refer to Figures 5-57 and 5-58.

The following (Figures 5-57 and 5-58) show a remanufactured cylinder head assembly ID and 20-degree intake valve ID.

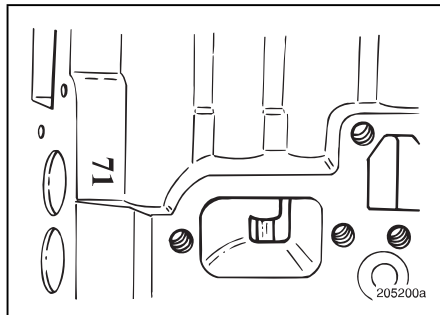


Figure 5-57 — Remanufactured Cylinder Head Assembly ID

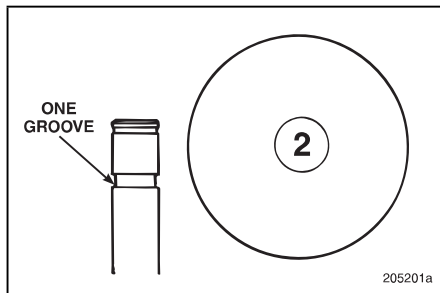


Figure 5-58 — 20-Degree Intake Valve ID

Refer to Figure 5-57.

Any remanufactured cylinder head produced prior to 12/13/96 will not have the assembly ID stamped on it. Heads which do not have assembly ID stamps are 30-degree intake valves and seats.

Inlet and Exhaust Valve Installation

CAUTION

The inlet and exhaust valve head diameters are nearly the same size. It is important, therefore, that extra care be taken when assembling these valves.

NOTE

With the new, more effective valve stem seals (446GC328), pre-lubing the seals and valve stems during installation is extremely important. Perform the following:

- **Valve Stem to Guide** — If valves are removed, lubricate the inside diameter of the valve guides by using a "bottle brush" coated with graphite grease. This is particularly important when both the valves and the valve guides are new. With an on-engine seal replacement, pre-lube the valve stems with engine oil while moving the valve up and down, prior to installation of the valve spring.
- **Valve Stem to Seal Lip** — The inside diameter of the seal lip and outside diameter of the valve stem should be well-lubricated with clean engine oil when installing the seal over the valve stem.

It is essential that the J 42453 Valve Stem Seal Installation tool be used to install the seals. This tool bottoms on the cylinder head rocker arm mounting bracket surface when the seal is installed to the proper depth on the valve guide. Using any non-bottoming type seal driver (such as a socket) may result in distorting the top surface of the seal casing which permanently distorts the seal lip and prevents proper sealing, or in the top rubber portion of the seal being cut off. Also, do not use seal installer J 41150, or seal damage will result. Tool J 41150 should be discarded immediately after receiving tool J 42453.

NOTE

Before installing valve stem seals, be sure the rotator has been installed. The rotator will not fit over the valve stem seal.



200 BENCH PROCEDURES

1. Lubricate the valve guides and valve stems with engine oil prior to installation.
2. Install valve spring lower washer (Roto-Coil), over valve guide.
3. Lubricate valve stem seals with engine oil and install seals using valve seal installer J 42453.
4. Install valve into cylinder head.
5. Check valve stem tip for nicks or burrs that may damage valve seal upon installation.
6. Install valve spring, upper washer and keepers. Use tool J 29294-B to install keepers.

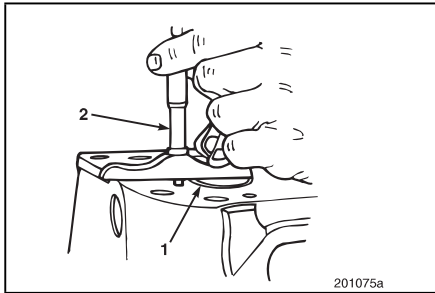


Figure 5-59 — Checking Valve Assembly Height

Refer to Figures 5-59 and 5-60.

7. After valves are assembled, check each inlet valve for head height above cylinder deck. The protrusion dimension for inlet valves should be 0.0425 ± 0.007 inch (1.0795 ± 0.178 mm).

- | 1. Inlet valve | 2. Depth/height measurement tool |
|---|----------------------------------|
| 8. Check each exhaust valve for head depth below cylinder deck. The depth dimension for exhaust valve should be 0.0414 ± 0.007 inch (1.0516 ± 0.178 mm), or 0.021 ± 0.007 inch (0.553 ± 0.178 mm) for Pyromet valves. | |

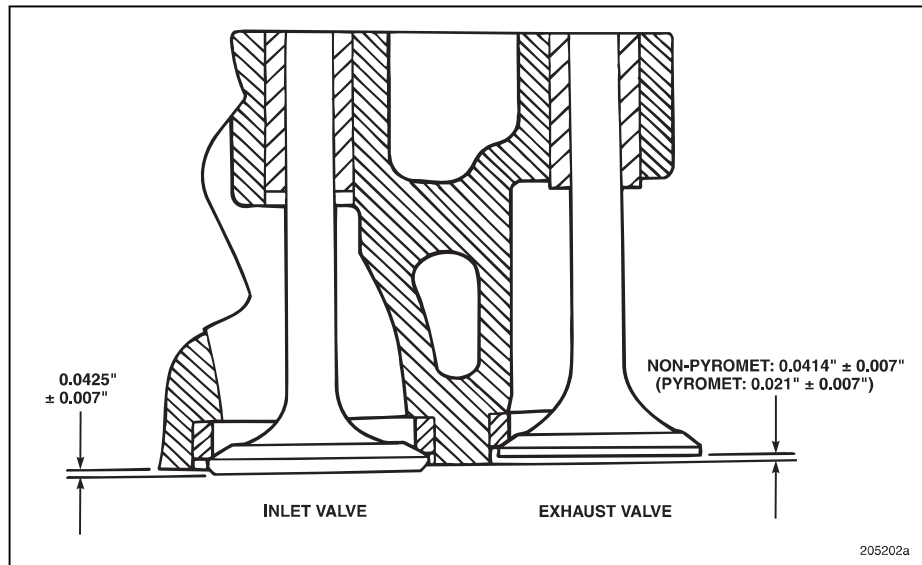


Figure 5-60 — Inlet/Exhaust Valve Head Depth Measurement



200 BENCH PROCEDURES

NOTE

If dimensions are not within specification, machine valve seat insert and/or valve face as necessary. Refer back to Valve Seat Insert Installation (page 36 in this section) for detailed specifications.

[213 LV] VALVE ROCKER ARM SHAFT

NOTE

There is a shouldered rocker arm mounting capscrew at one end of each rocker arm assembly to ensure proper alignment.

Inspection

Inspect all components of rocker arm and bracket assembly for evidence of damage or wear. Replace as necessary.

Rocker Arms

To date, E7 and E7 EUP (E-Tech™) engines use the same rocker arms. Effective second quarter 1997, both models use a newly designed rocker arm, where the slipper end wear surface is a hardened, headed pin, pressed into the rocker arm.

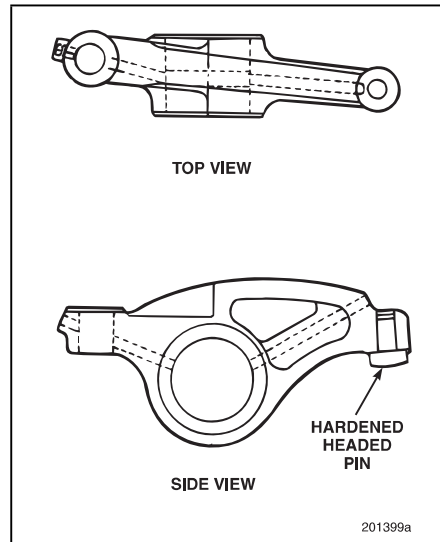


Figure 5-61 — New-Style Rocker Arm

Valve Rocker Arm Shaft Assembly (Except Jacobs Engine Brake)

Refer to Figure 5-62.

The assembly procedure for rocker arm shaft (includes Dynatard) without Jacobs engine brake is described below. The rocker arm bracket mounting dimensions are the same for both non-brake and brake assemblies. The rocker arm arrangement includes valve rocker arms (with lash adjusters) mounted on rocker arm shaft.

1. Position shaft (12) so that screw locating hole is in line with bracket locating screw hole.
2. The offset side of bracket must be positioned toward right side of engine.
3. Assemble bracket (8) on press table. Press shaft into bracket until oil hole in shaft is positioned under hole bracket. Install locating screw and lock washer (8) to secure bracket on shaft.
4. Lubricate inlet rocker arm (3) and install on rocker arm shaft.
5. Lubricate valve rocker arm adjusting screw and nut, and install into inlet rocker arm.



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6. Assemble rocker arm retaining (coil) spring (6) on shaft.
7. Lubricate exhaust rocker arm (5) and install on rocker arm shaft.
8. Lubricate valve rocker arm adjusting screw and nut, and install into exhaust rocker arm.
9. Place center (second) rocker arm shaft bracket (4) and shaft (12) on a flat surface. This bracket does not have a threaded hole on top or an oil hole at bottom surface. Align mounting surface and offset of bracket with bracket already installed.
10. Press shaft into rocker arm bracket until center lines of mounting holes in brackets are spaced 5.750 inches (146 mm) apart.
12. Assemble rocker arm retaining (coil) spring (6) on shaft.
13. Lubricate exhaust rocker arm (5) and install on shaft.
14. Place last (third) rocker arm shaft bracket (4) and shaft on a flat surface. This bracket does not have a threaded hole on top or an oil hole at bottom surface. Align mounting surface and offset of bracket with two brackets already installed.
15. Check for proper bracket alignment. Press bracket onto shaft. Ensure that mounting surfaces of each bracket are parallel.
16. Lubricate and install outermost inlet rocker arm (3).
17. Install flat spring and retaining snap ring on end of shaft to keep inlet rocker arm in place.
18. At opposite end of shaft, lubricate and install outermost exhaust rocker arm (5).

SERVICE HINT

At this point, a used or scrapped cylinder head can be used as a template for proper bracket alignment and to ensure mounting surfaces of each bracket are parallel.

11. Lubricate inlet rocker arm (3) and install on shaft.



200 BENCH PROCEDURES

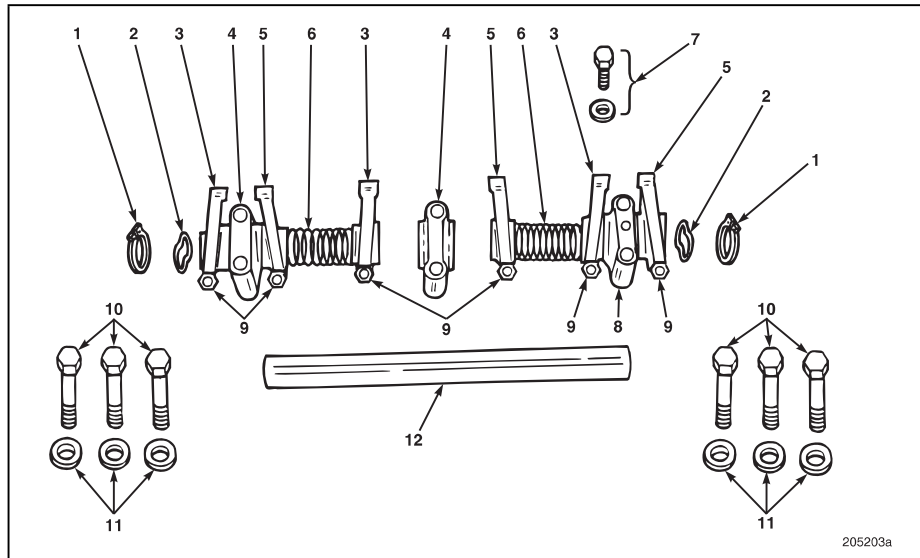


Figure 5-62 — Valve Rocker Arm Shaft Assembly (Without Engine Brake)

1. Snap ring
2. Flat spring
3. Inlet rocker arm
4. Brackets
5. Exhaust rocker arm
6. Spring

7. Locating screw and lock washer
8. Bracket with center threaded hole
9. Standard adjusting screws and jam nuts
10. Capscrews
11. Washers
12. Shaft

19. Install flat spring (2) and snap ring (1) on end of shaft. Some rocker arm shafts are equipped with threaded plugs and aluminum washers instead of flat springs and snap rings.
20. Check all rocker arms to make sure they rotate freely.

NOTE

Valve rocker arm shaft assembly will be installed during engine assembly by inserting capscrews (10) and washers (11) into holes in brackets (4) and (8).

Valve Rocker Arm Shaft Assembly (with Jacobs Engine Brake)

Refer to Figure 5-63.

The assembly procedure for rocker arm shaft with engine brake is described below. The engine brake arrangement includes exhaust valve rocker arms with lash adjusters and a solenoid mounted in the rocker arm shaft.

1. Position shaft (11) so that the oil supply screw locating hole is in line with bracket locating screw hole.
2. The offset side of bracket must be positioned toward the right side of engine.
3. Assemble bracket with center threaded hole (8) on press table. Press shaft into bracket until oil hole in shaft is positioned under threaded hole in bracket.



200 BENCH PROCEDURES

4. Thread oil supply screw and O-ring (7) into bracket and torque to 5 lb-ft (7 N•m) using torque wrench J 24405 or equivalent.
5. Lubricate inlet rocker arm (3) and install on rocker arm shaft.
6. Lubricate valve rocker arm adjusting screw and nut, and install into inlet rocker arm.
7. Assemble rocker arm retaining (coil) spring (6) on shaft.
8. Lubricate exhaust rocker arm (5) and install on rocker arm shaft.
9. Lubricate valve rocker arm adjusting screw and nut, and install into exhaust rocker arm (5).
10. Place center (second) rocker arm shaft bracket (4) and shaft (11) on a flat surface. This bracket does not have a threaded hole on top or an oil hole at bottom surface. Align mounting surface and offset of bracket with bracket that is already installed.
11. Press shaft into rocker arm bracket until center lines of mounting holes in brackets are spaced 5.750 inches (146.050 mm) apart.

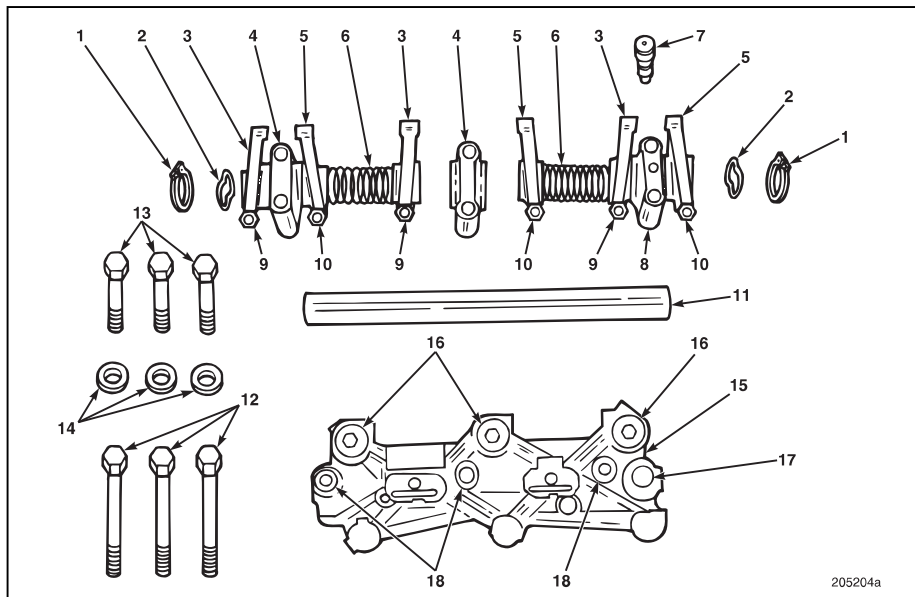


Figure 5-63 — Valve Rocker Arm Shaft Assembly (with Jacobs Engine Brake)

- | | |
|--|--|
| 1. Snap ring | 10. Jacobs adjusting screws and jam nuts |
| 2. Flat spring | 11. Shaft |
| 3. Inlet rocker arm | 12. Capscrews (long) |
| 4. Brackets | 13. Capscrews (short) |
| 5. Exhaust rocker arm | 14. Washers (for short capscrews) |
| 6. Spring | 15. Jacobs brake housing |
| 7. Locating/Jacobs oil supply screw and O-ring | 16. Slave piston adjusters |
| 8. Bracket with center threaded hole | 17. Solenoid |
| 9. Standard adjusting screws and jam nuts | 18. Locations for long capscrews |



200 BENCH PROCEDURES

SERVICE HINT

At this point, a used or scrapped cylinder head can be used as a template for proper bracket alignment and to ensure mounting surfaces of each bracket are parallel.

12. Lubricate inlet rocker arm (3) and install on shaft.
13. Assemble rocker arm retaining (coil) spring (6) on shaft.
14. Lubricate exhaust rocker arm (5) and install on shaft.
15. Place last (third) rocker arm shaft bracket (4) and shaft on a flat surface. This bracket does not have a threaded hole on top or an oil hole at bottom surface. Align mounting surface of bracket and offset with two brackets already installed.
16. Check for proper bracket alignment. Ensure that mounting surfaces of each bracket are parallel. Press shaft into rocker arm bracket.
17. Lubricate and install outermost inlet rocker arm (3).
18. Install flat spring and retaining snap ring on end of shaft to keep inlet rocker arm in place.
19. At opposite end of shaft, lubricate and install outermost exhaust rocker arm (5).
20. Install flat spring (2) and snap ring (1) on end of shaft to keep rocker arm in place. Some rocker arm shafts are equipped with threaded plugs and aluminum washers instead of flat springs and snap rings.
21. Check all rocker arms to make sure they rotate freely.

Dynatard Engine Brake Solenoid

Refer to Figure 5-64.

1. On valve rocker arm shaft assemblies with a Dynatard engine brake, install solenoid mounting adapter seal (O-ring) in counterbore in rocker shaft.
2. Lubricate solenoid mounting threads with clean engine oil.

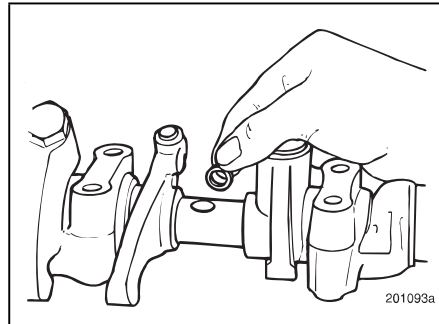


Figure 5-64 — Solenoid Mounting Adapter O-Ring

Refer to Figure 5-65.

3. Assemble solenoid mounting adapter into shaft and torque to 23–25 lb-ft (31–34 N•m) with crows-foot adapter and a calibrated torque wrench (J 24406 or equivalent).

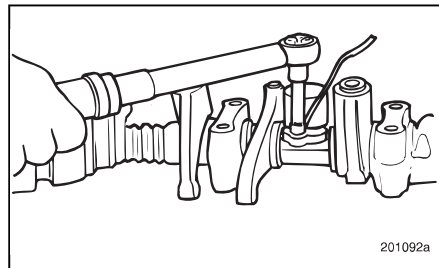


Figure 5-65 — Dynatard Engine Brake Solenoid Installation

[266 KD] DYNATARD ENGINE BRAKE

Dynatard Overload Protection (E7 Engines with Dynatard)

E7 engines built after January 1, 1992 and through mid-year 1993 are equipped with a Dynatard overload protection system. From mid-year 1993 through December 1993, E7 engines were built with either the Dynatard system or a Jake Brake®. Mack Trucks, Inc. recommends installing the Dynatard overload protection system on all E7 engines built prior to January 1, 1992. This system consists of a



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pressure relay switch and related hardware. Its purpose is to protect the Dynatard exhaust push rod from overload and from possibly bending during the transition from power mode to braking mode. An overload condition occurs when the turbocharger boost pressure in the inlet manifold is greater than 25 psi (172.4 kPa). The pressure delay switch momentarily restricts Dynatard engine brake activation if turbocharger boost inlet manifold pressure is above 24 psi (165.5 kPa).

PARTS REQUIRED FOR OVERLOAD PROTECTION

- Dynatard pressure switch assembly 1MR3532*
- Engine brake wiring harness 41MR4381*
- Engine brake switch jumper wire 41MR21252
- Cylinder head capscREW 400GC39M4*
- Pressure switch clamp screw 66AM2*
- Wiring harness strap 48RU2313P1*
- Wiring harness strap 48RU2313P2
- Pressure switch clamp 83AX894*
- Engine brake switch harness bracket 72RU11120
- Engine brake switch harness clamp 83AX922
- Engine brake switch harness screw 64AM1
- Engine brake switch harness washer 271AM5007
- Engine brake switch harness nut 157AM2

*Required parts for V-MAC applications.

NOTE

All parts listed are required for mechanical applications.

Dynatard Overload Protection System

INSTALLATION (E7 MECHANICAL ENGINES)

1. Remove air cleaner ducting.
2. Remove cylinder head covers.
3. Remove existing engine brake harness.
4. Remove No. 16 undrilled cylinder head capscREW.
5. Lubricate and install cylinder head capscREW, with a drilled hole, in No. 16 location.
6. Torque cylinder head capscREW to 205 lb-ft (278 N•m) using torque wrench J 24407 or equivalent.
7. Remove front 1/8 NPT pipe plug from inlet manifold.
8. Install new Dynatard pressure delay switch 1MR3532 into pipe plug opening and tighten with an open-end wrench.
9. Install new Dynatard wiring harness 41MR4381 using the following steps:
 - a. Lubricate connector O-rings and snap connectors into cylinder heads.
 - b. Connect Dynatard wire harness terminals to terminal post screws.
 - c. Connect Dynatard wire harness terminal to Dynatard pressure delay switch connection and route wire through crossover loop connector between heads.
10. Install valve covers.
11. Reuse three clamps, 83AX922, from old engine brake harness and install on new brake harness at appropriate locations.
12. Install clamp to Dynatard pressure delay switch wire and position Dynatard engine harness ground wire on clamp.
13. Install capscREW through clamp to No. 16 drilled cylinder head capscREW to securely hold Dynatard pressure delay switch wire and ground wire.
14. Attach wire tie(s) around Dynatard pressure delay switch wire and fuel return jumper line as needed.
15. Remove diode from existing Dynatard injection pump throttle switch.
16. Install jumper wire No. 41MR21252 to Dynatard injection pump throttle switch.
17. Install fuel injection line L-shaped bracket to stud located on right side of engine block. Secure engine brake lead to this bracket.



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18. Connect jumper wire to Dynatard engine brake harness connection.
19. Attach wire tie around jumper wire and Dynatard switch bracket.
20. Test engine brake and check for leaks.

INSTALLATION (V-MAC APPLICATIONS)

1. Connect engine brake wiring harness to connection located on right-hand side engine harness.
2. Secure connection to air compressor coolant line with wire tie.
3. Secure engine brake wiring to a clamp located on cylinder block near rear of injection pump.
4. Test engine brake and check for leaks.

[266] JACOBS® ENGINE BRAKE

E7 engines built from mid-year 1993 through December 1993 were equipped with either a Dynatard engine brake or a Jake Brake. Since January 1, 1994, the Jake Brake has been used exclusively.

The Model 680B Jake Brake engine retarder is a vehicle-slowng device designed and approved for use on MACK E7 engines. Energizing the Jake Brake effectively converts a power-producing diesel engine into a power-absorbing air compressor. This is accomplished by opening the cylinder exhaust valves near the top of the compression stroke, releasing the compressed air to exhaust.

Releasing compressed air to exhaust prevents the return of energy to the engine piston on the power stroke. The result is a net energy loss used to slow the vehicle. For more detailed information, specifications and repair procedures, refer to the appropriate Jacobs service manual.

[266] ENGINE BRAKE SWITCH AND BRACKET ASSEMBLY

Description

Beginning in 1991, a cylinder block-mounted engine brake switch and mounting bracket assembly was released for E7 mechanically governed (non V-MAC) engines equipped with either a Jake Brake or Dynatard system (pre-1994). The bracket design improves the service life of the switch by significantly reducing the engine vibration levels that the switch is subjected to. This reduction in vibration levels is accomplished by relocating the mounting of the bracket from the rear of the injection pump to the auxiliary housing area of the cylinder block. Refer to Figure 5-65.

In mid 1992, an improved switch (part No. 1MR3529) was incorporated into the assembly. This new switch, along with relocation of the bracket, adds significantly to the service life of the assembly.

CAUTION

Proper adjustment is essential. Over-adjustment of this switch arrangement will cause accelerated switch wear or switch failure.

Adjustment (E7 Mechanically Governed Engine with Engine Brake)

1. Loosen the two screws holding the throttle switch to the switch bracket.
2. Check the continuity by connecting a volt-ohmmeter across the switch terminals.
3. Insert an 0.008-inch (0.203 mm) thickness gauge between the low idle screw and the idle lever.
4. Secure the throttle lever in the low idle position.
5. Slide the switch toward the throttle lever to the point where continuity is obtained.
6. Torque the two screws that hold the throttle switch to the switch bracket to 10 lb-in using torque wrench J 24405 or equivalent.



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7. Remove the 0.008-inch (0.203 mm) thickness gauge and insert a 0.014-inch (0.356 mm) thickness gauge. There must be NO continuity with the 0.014-inch thickness gauge.
8. Apply locking compound to the switch assembly nut after adjustment is correct.

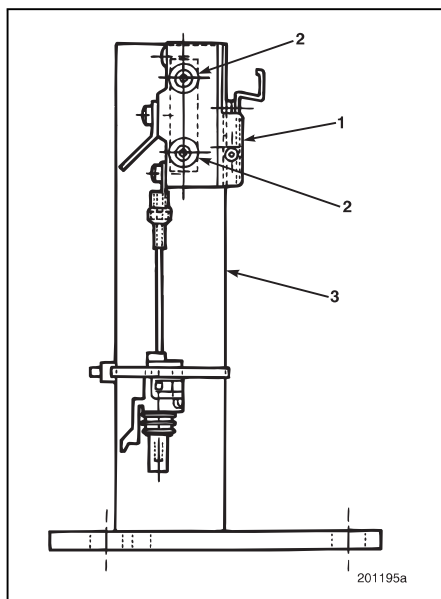


Figure 5-66 — Engine Brake Switch and Bracket
(Non V-MAC Engines)

- | | |
|------------------------|------------|
| 1. Engine brake switch | 3. Bracket |
| 2. Screw | |

[215 DW] OIL COOLER ASSEMBLY

Description

The oil cooler assembly is located near the left front of the engine. Engine coolant from the radiator flows through the lower radiator hose, into a chamber in the oil cooler. The coolant then flows into the water pump.

The oil pump sends engine oil through the inlet port of the oil cooler into the cooling chamber. Heat from the engine oil is transferred through the chamber walls to engine coolant. Cooled oil exits the oil cooler through the oil outlet port, flows through oil filters, and then into the engine.

E7 engines feature a "removable-bundle" type oil cooler. Periodic visual inspection of the oil cooler will indicate condition of gaskets, O-ring and core. If a problem exists, these components can be serviced separately rather than replaced as an assembly.

NOTE

The presence of engine oil in the engine coolant may indicate internal engine problems or worn, loosened or damaged parts within the oil cooler. Continued operation under these conditions may result in severe engine damage.



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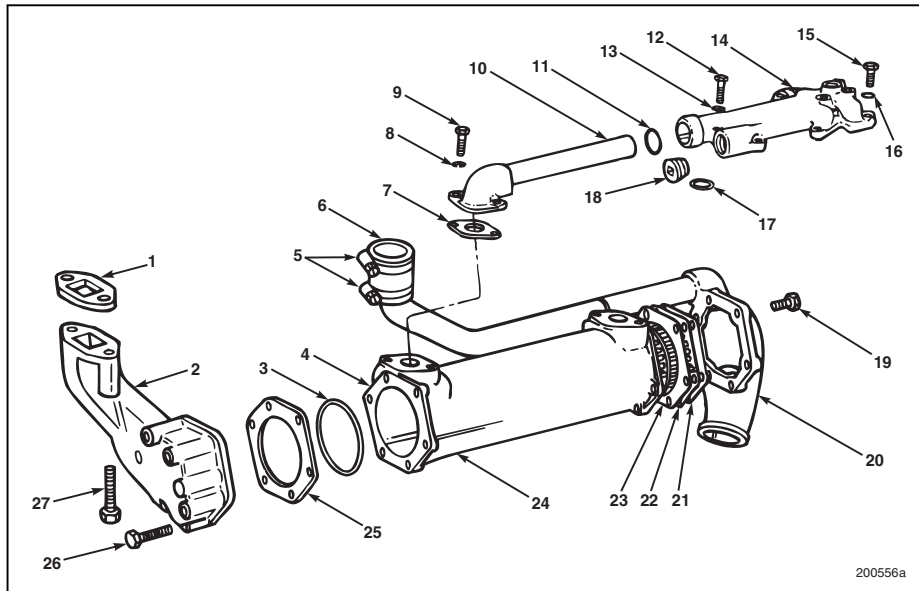


Figure 5-67 — Oil Cooler Assembly

- | | |
|---------------------------|-----------------------|
| 1. Gasket | 15. Capscrew |
| 2. Coolant outlet end cap | 16. Washer |
| 3. O-ring | 17. O-ring |
| 4. Mounting flange | 18. Pipe plug |
| 5. Clamps | 19. Capscrew |
| 6. Coupler | 20. Coolant inlet cap |
| 7. Gasket or O-ring | 21. Gasket |
| 8. Washer | 22. Bundle |
| 9. Capscrew | 23. Gasket |
| 10. Oil outlet tube | 24. Housing |
| 11. O-ring | 25. Gasket |
| 12. Capscrew | 26. Capscrew |
| 13. Washer | 27. Capscrew |
| 14. Oil supply head | |

Disassembly

Refer to Figure 5-67.

1. Remove coolant inlet end cap (20) by removing six capscrews (19).
2. Remove coolant outlet end cap (2) by removing six capscrews (26).
3. Remove bundle (22) from coolant inlet end of housing (24).
4. Remove O-ring (3) from coolant outlet end of housing.
5. Clean gasket material from all surfaces.



200 BENCH PROCEDURES

Inspection

Refer back to Figure 5-67.

1. Visually inspect housing (24) for cracks which may cause a leak. Replace housing if damaged.
2. Check oil cooler bundle (22) for leaks by pressurizing with air to 80 psi (552 kPa) and submerging it in water. If a leak is detected, replace with new bundle.

Assembly

Refer back to Figure 5-67.

Lubricate and install O-ring (3) in groove at coolant outlet end of oil cooler housing (24).

1. Apply Permatex® gasket sealer on coolant inlet flange before installing gasket (23).
2. Install gasket (23) on coolant inlet end of housing (24).
3. Apply Permatex gasket sealer on top of gasket.
4. Install bundle (22). If necessary, tap bundle with soft-faced hammer to seat bundle past O-ring (3).

NOTE

The alignment notch in the bundle end flange must be positioned at the top for proper installation.

5. Apply Permatex gasket sealer on bundle end.
6. Place gasket on bundle end.
7. Apply Permatex gasket sealer on top of gasket (21) before installing inlet cap (20).
8. Install coolant inlet end cap and secure with six capscrews (19).
9. Torque coolant inlet end-cap capscrews to 20 lb-ft (27 N•m) using torque wrench J 24405 or equivalent.
10. Apply Permatex sealant to both sides of gasket (25) and install on mounting flange (4) of housing.
11. Install coolant outlet end cap (2) with six capscrews (26).

12. Torque coolant outlet end-cap capscrews to 20 lb-ft (27 N•m) using torque wrench J 24406 or equivalent.

Refer to Figure 5-68.

13. Pressure-check oil cooler for leaks by installing a test plate (4) with air fitting (3) as follows:
 - a. Position a rubber gasket (5) and test plate (4) on mounting flange (1) and secure with mounting capscrews (2).

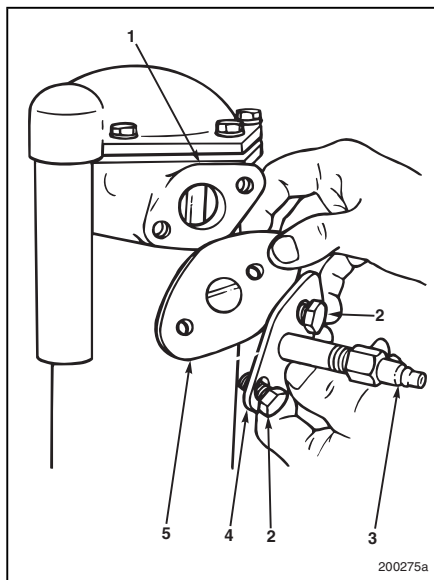


Figure 5-68 — Installing Test Plate

- | | |
|--------------------|------------------|
| 1. Mounting flange | 4. Test plate |
| 2. Capscrews | 5. Rubber gasket |
| 3. Air fitting | |

Refer to Figure 5-69.

- b. Install a steel plate (2) with a rubber gasket on oil outlet opening. Secure to housing (1) with two capscrews (3).
- c. Connect air line and pressurize to 80 psi (552 kPa). Submerge in water to check for leaks.



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NOTE

When pressure-testing complete oil cooler assembly using an in-line pressure regulator, apply pressure at 2–5 psi (14–34 kPa) maximum. Then gradually increase pressure, checking for leaks until 80 psi (552 kPa) is reached.

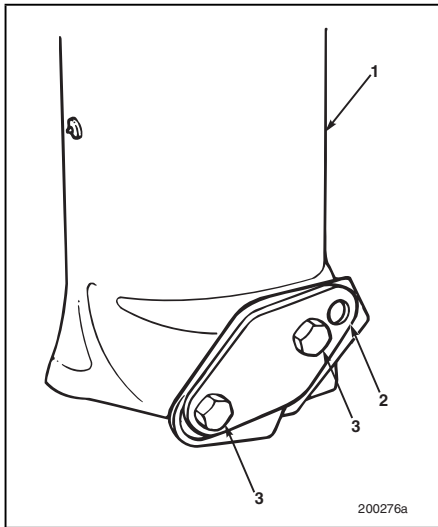


Figure 5-69 — Sealing Oil Outlet

1. Housing	3. Capscrews
2. Plate	

[215 SW] WATER PUMP

The water pump is a belt-driven centrifugal or impeller type, and is located on the front of the engine. The water pump pulley is belt-driven by the crankshaft pulley.

During engine operation, the impeller spins in proportion to engine speed. The spinning impeller blades create a negative pressure (suction) at the water pump inlet port and a positive pressure at the outlet port. Engine coolant is drawn into the water pump from the radiator, through the lower radiator hose. The impeller motion forces coolant to circulate through the engine block, cylinder head, and back to the radiator.

To perform water pump service other than replacement, refer to the COOLING 7.0 manual.

[219 MU] OIL PUMP

The shaft and pumping gear on oil pumps manufactured after February 1996 are a one-piece design. Earlier models have a gear pressed onto a keyed shaft. The shafts are interchangeable and replacement with a new (one-piece) shaft is recommended as oil pump gear-to-housing contact is reduced, resulting in longer pump life.

Disassembly

Refer to Figure 5-70.

1. Remove pick-up tube and screen assembly (not shown).
2. Remove oil pump housing cover (7) from oil pump housing (4).
3. Remove oil pressure relief valve cap (13).
4. Remove oil pressure relief valve spring (12) and plunger (11).
5. Slide oil pump idler gear (14) off shaft.
6. Turn oil pump upside down and remove oil pump shaft nut (1) and washer (2).
7. Using a press, remove drive gear (3) and key (5) from pumping gear and shaft assembly (6).
8. Remove pumping gear and shaft assembly from housing.
9. Remove oil pump inlet flange plate (9) and gasket (8) from housing by removing capscrews (10).



200 BENCH PROCEDURES

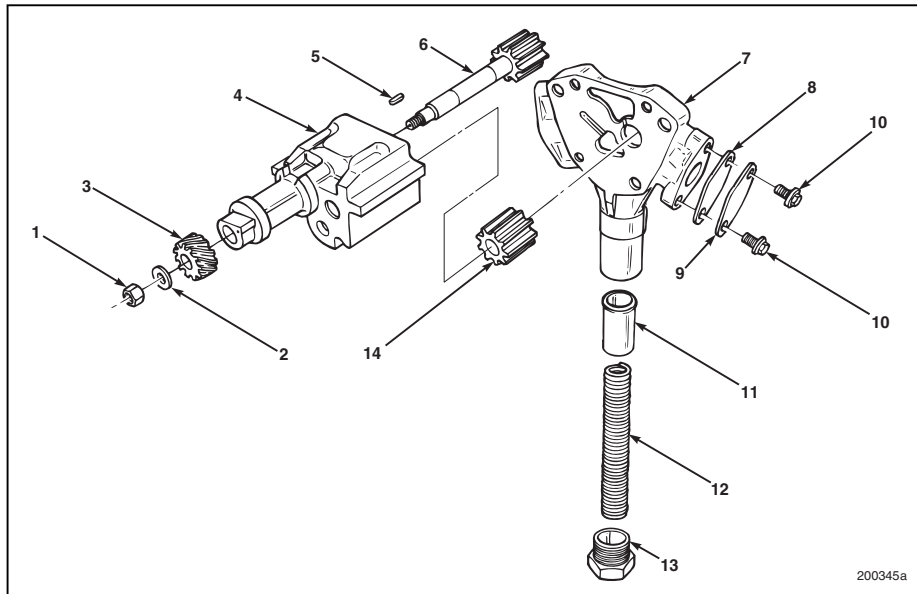


Figure 5-70 — Lubrication Oil Pump

1. Self-locking nut
2. Washer
3. Drive gear
4. Housing
5. Key
6. Pumping gear and shaft assembly
7. Oil pump housing cover

8. Gasket
9. Inlet flange plate
10. Capscrews
11. Plunger
12. Relief valve spring
13. Relief valve cap
14. Idler gear

Inspection

Refer to Figure 5-70.

1. Clean and inspect oil pump housing (4) for scoring, cracks or other damage. If any of these conditions exist, replace oil pump.
2. Check bushings in oil pump housing for burrs, nicks, or cracks.

NOTE

The bushings are an integral part of the oil pump housing. If bushings are damaged, replace oil pump housing.

3. Clean and inspect relief valve spring (12) for breaks. Replace as necessary.
4. Clean and inspect plunger (11) seating surface for burrs or nicks. If seating surface contains burrs or nicks, repair seat as follows:
 - a. Place valve lapping compound on plunger seat.
 - b. Insert plunger in relief valve housing and rotate plunger against seat to smooth seat.
 - c. Remove plunger and clean.
5. Check oil pump idler gear (14) for free play by spinning it on its shaft. If any binding occurs, check housing bore and gear teeth for burrs, nicks, or other damage. Replace as necessary.



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6. Insert pumping gear in housing and check for free play by spinning. If any binding occurs, check housing and gear teeth for burrs, nicks, or other damage. Replace as necessary.

NOTE

Before proceeding with assembly, check end clearance, side clearance, and backlash of drive gears as follows.

END CLEARANCE CHECK

Refer to Figure 5-71.

1. Low Limit — Place a straightedge across face of gears and run a 0.001-inch (0.025 mm) thickness gauge under straightedge. Gauge should move freely without binding. If binding occurs, check gears for nicks or burrs. Replace as necessary.
2. High Limit — With straightedge in place (as in step 1), run a 0.007-inch (0.178 mm) thickness gauge under straightedge. Gauge should be very tight. If gauge moves freely, replace gears.

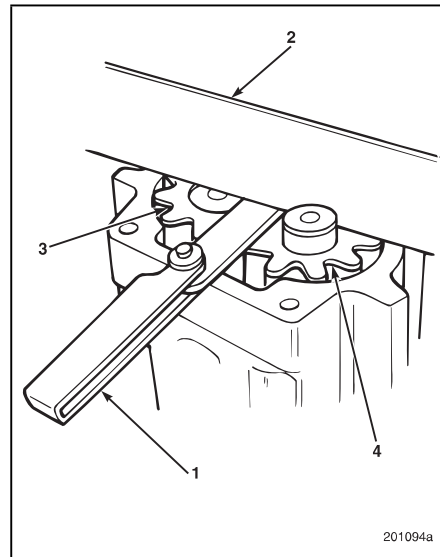


Figure 5-71 — Oil Pump Driving/Idler Gear Assembly End Clearance Check

- | | |
|--------------------|----------------------|
| 1. Thickness gauge | 3. Pump driving gear |
| 2. Straightedge | 4. Pump driven gear |



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SIDE CLEARANCE CHECK

Refer to Figure 5-72.

1. Low Limit — Insert a 0.002-inch (0.051 mm) thickness gauge between side of gears and housing. Gauge should pass between gears and housing without drag. If it drags, check housing and gears for nicks or burrs. Replace as necessary.
2. High Limit — Insert a 0.006-inch (0.152 mm) thickness gauge between gears and housing. Gauge should not pass through. If gauge passes through, replace housing.

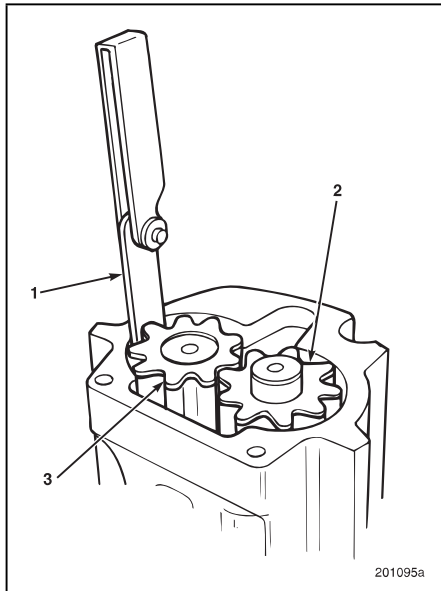


Figure 5-72 — Oil Pump Driving/Idler Gear Assembly Side Clearance Check

- | | |
|---------------------|----------------------|
| 1. Thickness gauge | 3. Pump driving gear |
| 2. Pump driven gear | |

BACKLASH CHECK

Refer to Figure 5-73.

1. Check backlash between driving gear (3) and driven gear (2) with thickness gauge (1).
 - a. Low Limit — Insert a 0.013-inch (0.33 mm) thickness gauge (1) between pump driven gear (2) and pump driving gear (3). Gauge should pass between gears without binding. If binding occurs, check for nicks or burrs. Replace as necessary.
 - b. High Limit — Insert a 0.028-inch (0.711 mm) thickness gauge (1) between pump driven gear (2) and pump driving gear (3). Gauge should not pass through. If gauge passes through, replace gears.

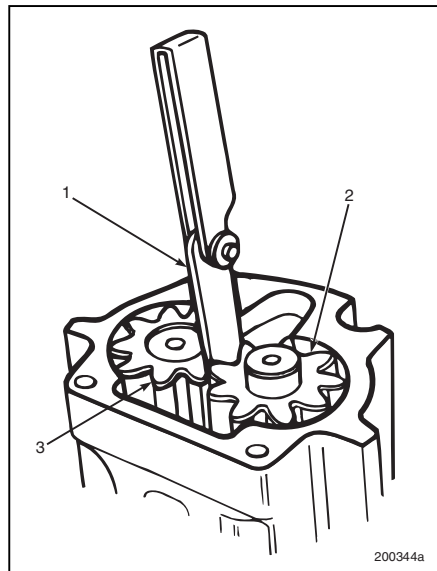


Figure 5-73 — Checking Oil Pump Gear Backlash

- | | |
|---------------------|----------------------|
| 1. Thickness gauge | 3. Pump driving gear |
| 2. Pump driven gear | |



200 BENCH PROCEDURES

Improved "Fast Ratio" Auxiliary Driveshaft

An improved "fast ratio" auxiliary driveshaft assembly and oil pump assembly are in current production engines (effective February 27, 1992, serial No. 2E1233) and are available for service. These arrangements increase operating oil pressure by approximately 25%.

- Current "fast ratio" oil pump:
 - With rear sump, part No. 315GC459AM
 - With front sump, part No. 315GC459AM2
 - Drive gear (12 teeth), part No. 683GB284
- Former "standard ratio" oil pump:
 - With rear sump, part No. 315GC460AM
 - With front sump, part No. 315GCA460AM2
 - Drive gear (13 teeth), part No. 683GB287

CAUTION

Do not mix "fast ratio" and "standard ratio" components. Serious damage may occur.

Short (quarter) blocks are stamped with the date of manufacture on the right rear side pad (for example, "2G": 2G = 1992, March). Short blocks stamped with "2G" or later (2H, 2K, 2L, etc.) are equipped with a 1.5 fast ratio auxiliary driveshaft assembly. It is critical that the matching oil pump also be fitted with a 1.5 fast ratio oil pump driveshaft gear.

A noncurrent 1.3 standard ratio E7 oil pump can be reused in combination with a 1.5 fast ratio auxiliary driveshaft assembly; however, several steps are necessary to modify the pump.

Refer to Figure 5-74.

1. Obtain a 1.5 fast ratio oil pump driving shaft gear (683GB284).
2. Restamp or etch new number on oil pump housing.
 - "459M" on rear sump oil pumps
 - "459M2" on front sump oil pumps

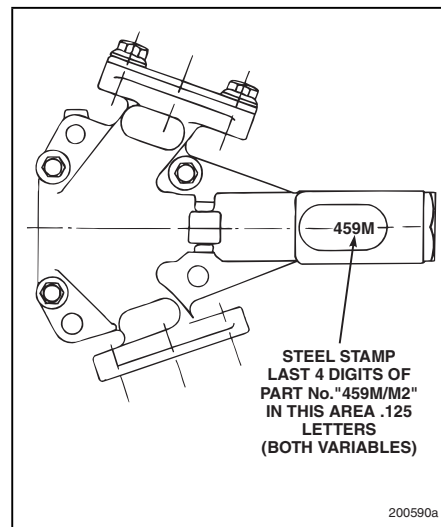


Figure 5-74 — Marking Oil Pump

3. Install a 1.5 fast ratio oil pump driving shaft gear on an old E7 oil pump. Torque retaining nut to 60 lb-ft (81 N•m). Torque cylinder block mounting screws to 40 lb-ft (54 N•m).

CAUTION

It is possible to bolt a current 1.5 fast ratio oil pump driving gear in an engine with a noncurrent 1.3 standard ratio auxiliary driveshaft gear; however, serious damage will occur.

It is not physically possible to bolt a noncurrent 1.3 standard ratio oil pump driving gear in an engine with a current 1.5 fast ratio auxiliary driveshaft gear.



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Assembly

Refer back to Figure 5-70.

1. Install oil pressure relief valve plunger (11) in relief valve housing (4).
2. Install oil pressure relief valve spring (12) in relief valve housing.
3. Clean oil pressure relief cap (13) and install in relief valve housing.

CAUTION

To maintain correct oil pressure for various oil system arrangements, the proper oil pressure relief valve spring and cap combination must be used. Using incorrect components may result in either high or low oil pressure, and contribute to premature engine damage.

4. Install oil pump inlet flange cover (9) and gasket (8) on housing. Secure with capscrews (10).
5. Install driving shaft and gear assembly (6) in housing and check for free spin.
6. Install idler gear (14) on housing shaft.

CAUTION

It is extremely important that pump application be checked prior to drive gear assembly. Several drive gears are available to establish correct oil pump-to-auxiliary drive gear ratio combination. Failure to select proper drive gear for application will result in gear and engine damage. Refer to Improved "Fast Ratio" Auxiliary Driveshaft in this section.

CAUTION

Apply Loctite® 271 to all capscrews used to assemble the oil pump.

7. Install cover (7) on pump and secure with capscrews. Torque to 15 lb-ft (20 N•m).
8. Install key (5) in driving shaft and gear assembly (6).
9. Place gear (3) on shaft aligning slot with key on shaft. Press drive gear on shaft.
10. Install washer (2) and self-locking nut (1) on shaft. Torque to 60 lb-ft (81 N•m) using torque wrench J 24407 or equivalent.
11. Install pickup tube and screen assembly.

[221 CD] ECONOVANCE

Econovance Control Valve Assembly

Refer to Figure 5-74.

The Econovance control valve assembly consists of a valve housing (7) and a solenoid valve assembly (6).

The valve housing (7) contains oil passages to direct engine oil pressure to the Econovance, enabling the Econovance to perform the function of dynamically varying injection pump timing.

The solenoid valve assembly (6) consists of a proportional solenoid controlled by the V-MAC module, which can position the solenoid anywhere within its range of travel; and a hydraulic spool valve, the position of which determines engine oil flow to the Econovance. The spool valve is not affected by the oil pressure it controls. The three O-rings on the spool valve are replaceable.



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Econovance Disassembly

Refer to Figure 5-75.

1. Place scalloped drive hub (5) in a vise equipped with brass jaws. Remove drive-hub retaining capscrew (10) and washer (9) while holding inner shaft assembly (2) at rear of Econovance. This will prevent assembly from dropping out of housing when retaining capscrew is removed.
2. Using snap-ring pliers, remove snap ring (1) from rear of Econovance housing (8).
3. Remove inner shaft assembly from rear of Econovance housing by manually guiding gear assembly outward.
4. Remove inner sleeve (4) from inner shaft assembly.
5. Remove and inspect Econovance spring (3) for cracks or signs of wear.
6. Remove outer shaft drive hub (5) from housing (8).

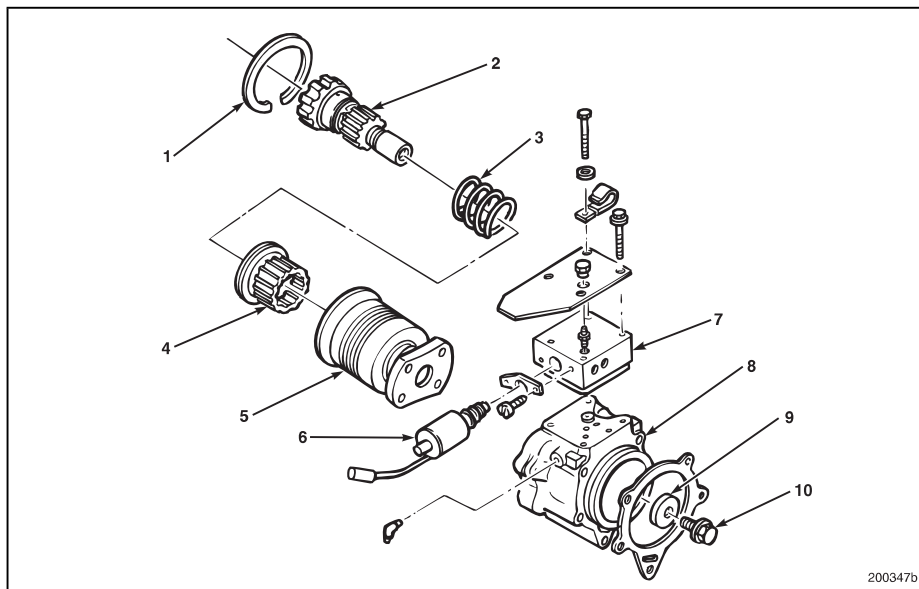


Figure 5-75 — Econovance Assembly

- | | |
|--------------------------|----------------------------------|
| 1. Retainer ring | 6. Solenoid valve |
| 2. Inner shaft assembly | 7. Valve housing |
| 3. Econovance spring | 8. Econovance housing |
| 4. Inner sleeve | 9. Washer |
| 5. Outer shaft drive hub | 10. Drive hub retaining capscrew |



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Cleaning and Inspection

1. Thoroughly clean inner sleeve and inner shaft with solvent and dry with compressed air.
2. Inspect inner sleeve and inner shaft for extreme wear, cracks or other damage. Replace as necessary.
3. Inspect outer shaft drive hub and seals.
4. Inspect Econovance housing.

Econovance Assembly

1. Using clean engine oil, lubricate all gear surfaces.
2. Install Econovance spring (3) on inner shaft assembly (2).

CAUTION

Make sure spring is properly seated. If not, binding will occur, causing damage to Econovance assembly.

3. Reinstall inner sleeve (4) on inner shaft assembly. Push down on inner sleeve until flush with lower seat. To accomplish this, spring must be properly seated. Make sure sleeve does not bind on shaft.
4. Reinstall inner sleeve and inner shaft assembly into outer shaft drive hub. Install outer shaft drive hub into Econovance outer housing (8), using new seal if needed.
5. Reinstall retainer ring (1) in rear of Econovance assembly.
6. Apply Loctite 242 to drive-hub retaining capscREW (10) threads.

NOTE

Grooved side of hub retaining capscREW washer must face outer shaft drive hub (5).

Refer to Figure 5-76.

7. Install outer shaft drive-hub retaining capscREW (10) and washer (9). Torque to 150 lb-ft (203 N•m) using torque wrench J 24407 or equivalent.

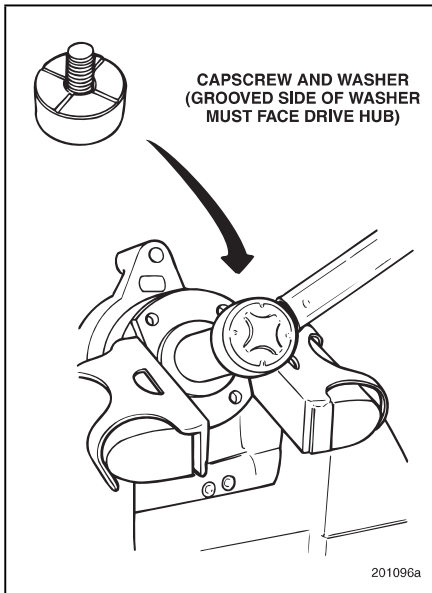


Figure 5-76 — Drive Hub Installation

[221 KU] INJECTION PUMP DRIVE HUB

Description

For mechanically governed engines, a scalloped-type drive hub is installed directly on the fuel injection pump camshaft. For V-MAC engines, the outer shaft drive hub, along with inner sleeve, spring and inner shaft assembly, is part of the Econovance unit. It is linked to the fuel injection pump with a Celeron coupling or a two-piece metal-type coupling, depending on the date of production.

Special Tools Required

- Pump Holding Fixture J 37078
- Injection Pump Drive Coupling Holder J 28452-A



200 BENCH PROCEDURES

Cleaning

Degrease tapered surfaces of injection pump camshaft and drive hub with Stoddard No. 303 or Loctite 75559, or an equivalent degreasing agent.

⚠ CAUTION

Failure to degrease drive components prior to assembly may result in drive hub slippage.

Installation of Drive Hub (Mechanically Governed Engines)

Refer to Figure 5-77.

1. Place injection pump into pump holding fixture J 37078. Turn pump drive hub to allow pump to be slid forward, engaging alignment pins until pump mounting surface is flush with fixture bracket.

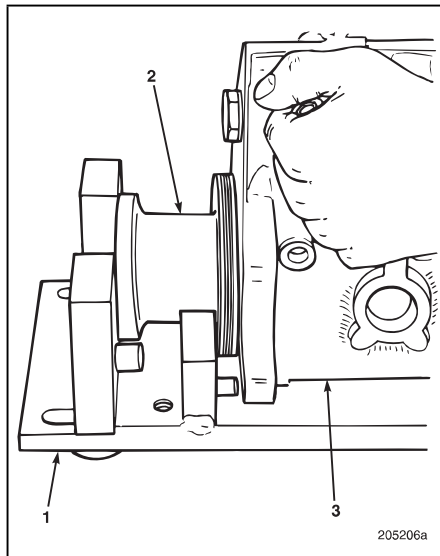


Figure 5-77 — Positioning Drive Hub and Pump in Fixture

- | | |
|----------------------------|------------------------|
| 1. Holding fixture J 37078 | 3. Fuel injection pump |
| 2. Drive hub | |

NOTE

MACK E7 engines equipped with Bosch P7100 Series close-coupled injection pumps require a longer drive pump hub.

CAUTION

Do not install a key in the driveshaft. A key is not required and no keyway is provided in the hub.

Refer to Figure 5-78.

2. Install the flat washer and drive hub nut. Torque to 200 lb-ft (271 N•m) using torque wrench J 24407 or equivalent.
3. Remove injection pump from holding fixture.

NOTE

The recess in the drive hub is now in position to clear the camshaft gear during installation.

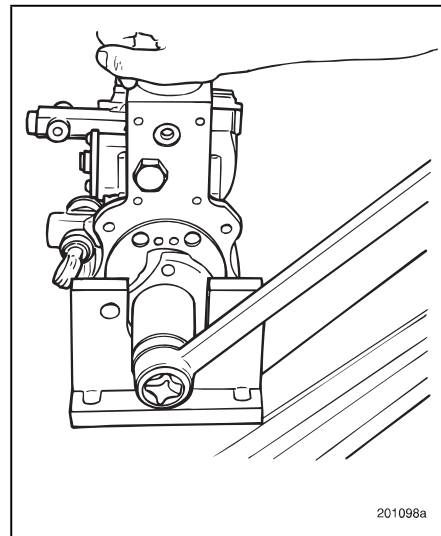


Figure 5-78 — Drive Hub Retaining Capscrew Installation



200 BENCH PROCEDURES

Installation of Drive Hub (V-MAC Engines)

DRIVE COUPLING REMOVAL

A metal two-piece style drive coupling was introduced into production on certified E7 V-MAC engines built after July 1, 1992 — beginning with serial No. 2P and above. When the Celeron drive coupling requires replacement, replace with the two-piece style drive coupling.

Refer to Figure 5-79.

1. Using injection pump drive coupling holder J 28452-A, securely hold injection pump outer coupling from turning while loosening coupling retaining nut. Remove outer coupling.

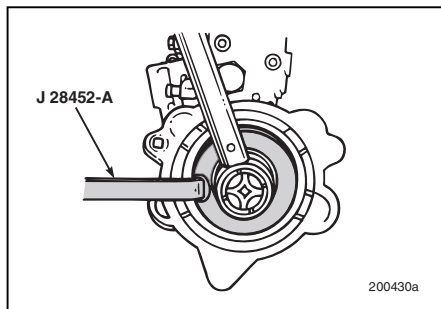


Figure 5-79 — Loosening Coupling Retaining Nut

Refer to Figure 5-80.

2. Remove coupling (inner hub) retaining nut and washer.

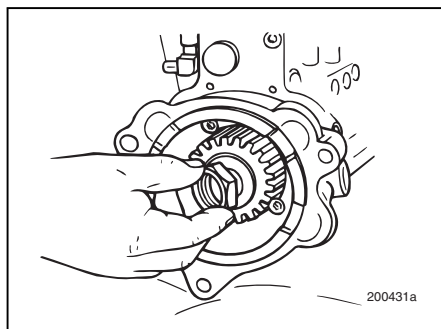


Figure 5-80 — Removing Retaining Nut and Washer

Refer to Figure 5-81.

3. Using a suitable two- or three-jaw puller, remove the inner hub from the injection pump camshaft.

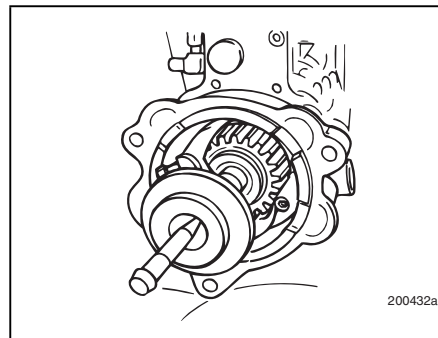


Figure 5-81 — Removing Inner Hub

DRIVE COUPLING INSTALLATION

1. Install inner hub on injection pump camshaft.

CAUTION

Do not install a key in injection pump camshaft. Keying of drive coupling (inner hub) to injection pump camshaft is not required and, if used, may result in damage.

2. Install coupling (inner hub) washer and retaining nut. Hand tighten.
3. Insert outer coupling on inner hub so hub-holding tool can be used to hold inner hub. The coupling may be installed in either direction.

NOTE

A snap ring is installed in the splined bore of the outer coupling. Its function is to keep the outer coupling in proper position between the injection pump inner hub and the Econovance mating gear.

4. Using injection pump drive coupling holder J 28452-A, securely hold outer coupling. Torque coupling (inner hub) retaining nut to 200 lb-ft (271 N•m) using torque wrench J 24407 or equivalent.



200 BENCH PROCEDURES

[222 KG] INJECTOR NOZZLES

1991 and later MACK E7 engines require different fuel injection nozzles, nozzle holders and nozzle holder assemblies than previous E7 engines.

These later nozzles (with eight spray holes) are a Valve Covering Orifice (VCO) configuration and are hydroground for proper fuel flow and atomization.

NOTE

Nozzles used for 1989/1990 MACK E7 production engine models feature six spray holes and are not hydroground.

These parts are not interchangeable with eight-spray-hole nozzles used in 1991 and later engines. Refer to the following engine tune-up publications for pertinent E7 specifications.

5-301	1989
5-302	1990
5-303	1991
5-304	1992
5-305	1993
5-306	1994
5-307	1995
5-308	1996/1997

Nozzle Cleaning

When servicing nozzle holder assemblies, cleaning of nozzle tips may be necessary. Special care must be taken when cleaning nozzle tips to avoid damaging nozzle spray holes.

- Preferred cleaning method: ultrasonic cleaning
- Acceptable cleaning method: brass brush/wire wheel

ULTRASONIC CLEANING METHOD

Ultrasonic cleaning units such as J 29653-A, use sound waves or mechanical vibrations, approximately 55,000 cycles per second above human hearing range. Sound waves are generated by the transducer, which changes high-frequency electrical energy into mechanical energy.

CAUTION

The nozzles will be damaged if a steel-wire wheel is used for cleaning. Damage can also occur if an improper size and/or speed of brass-wire wheel is used.



NOTES
