

E7 ENGINE SETUP AND ADJUSTMENTS

[213 NB] VALVE YOKE AND VALVE LASH ADJUSTMENTS (NON-JAKE BRAKE ENGINE AND DYNATARD EQUIPPED)

DESCRIPTION

Yoke and valve adjustments are done in two stages on E7 engines. Adjust the yoke clearance first, then adjust the valve lash. Make sure both adjustments are done in firing order sequence. Manually rotate the engine in normal rotation direction until pointer in flywheel housing aligns with valves 1 and 6 mark on the flywheel and the No. 1 piston on the compression stroke.

The flywheel has a stamped timing scale consisting of TC through 45 degrees of engine travel for setting and checking pump-to-engine timing. Also, the flywheel has three stamped locations at 120-degree intervals for valve settings.

Some E7 engines are equipped with a pointer on the timing gear cover and marks on the vibration damper. To adjust the yoke and valves on these engines, bar engine in normal rotation direction until the TC mark on the damper (with the No. 1 piston on the compression stroke) aligns with pointer marked VALVE. This provides the 30-degrees-after-TDC relationship for valve lash adjustment necessary with the E7 camshaft design.

NOTE

Yoke and valve adjustments must be made under static conditions with coolant temperature below 100 ° F (37 ° C).

NOTE

E7 engine firing order is 1-5-3-6-2-4.

SPECIAL TOOL REQUIRED

- Engine Barring Socket J 38587-A

LOCATING AND MARKING FLYWHEEL VALVE ADJUSTMENT MARKINGS

NOTE

Some E7 engines built in early 1995 may be equipped with flywheels that have missing or illegible valve adjustment markings. If this problem is encountered, a typical flywheel can be marked while the engine is in the chassis.

TYPICAL FLYWHEELS

On a typical flywheel, the TC markings, and the valve adjustment markings, are directly in line with the clutch mounting bolt/bolt holes. To determine if the engine is equipped with a typical flywheel, view the flywheel through the timing access hole in the flywheel housing. Align the TC markings with the timing pointer. If the flywheel is typical, there should be a clutch mounting bolt/bolt hole directly in line with the TC marking. In this case, the valve adjustment markings should be in line with a clutch mounting bolt at three locations. (Refer to [Figure 2 -- Flywheel Marks](#) .)

There are 12 clutch mounting bolt holes in the flywheel, but only 8 of these holes are used to mount the clutch. Every third bolt hole, for a total of four, is not used. These holes are in an open area between the clutch mounting flanges. The unused holes are easy to see through the timing access hole in the flywheel housing. The bolt holes where there is a clutch mounting bolt are more difficult to see because the clutch mounting bolt head is somewhat rearward of the timing access opening. To aid in counting the clutch mounting bolt/bolt holes, keep in mind that there is slightly over four inches between one bolt hole and the next. Locating the clutch mounting bolts may be made easier by removing the bell housing inspection cover and viewing or feeling for the bolts through the bell housing.

After verifying that there is a clutch mounting bolt/bolt hole in line with the TC mark, the next step is to locate the three locations where the valve adjustment marks should be. Put a temporary (chalk, grease pencil, paint, etc.) mark at each of the three locations. Proceed as follows:

1. Beginning with the TC mark aligned with the timing pointer, rotate the engine in the direction of normal rotation (counterclockwise, viewed from rear) to the next clutch mounting bolt/bolt hole. Temporarily mark this location for cylinders 1 and 6.
2. Continue rotating the engine in the normal direction and count the clutch mounting bolt/bolt holes as they pass the timing access opening. At the fourth mounting bolt/bolt hole, make a temporary mark on the flywheel for cylinders 2 and 5.
3. Rotate the engine another four mounting bolt/bolt holes and make a temporary mark on the flywheel for cylinders 3 and 4.
4. Rotate the engine another three clutch mounting bolt/bolt holes and verify that the flywheel is at the TC mark. Then, rotate the engine one more bolt/bolt hole and verify that the flywheel is at the temporary mark made for cylinders 1 and 6.
5. Permanently mark the flywheel at this location for cylinders 1 and 6. To gain access, rotate the engine slightly so that the area to be marked is either to the right or left side of the timing pointer. Place a chisel mark directly in line with the clutch mounting bolt/bolt hole. Then, stamp or electric-etch the cylinder numbers on either side of the chisel mark.
6. Rotate the engine to the remaining locations and make sure to count the clutch mounting bolt/bolt holes to verify the locations of the temporary markings. Once verified, permanently mark each location as described.

NON-TYPICAL FLYWHEELS

If the engine is equipped with a non-typical flywheel, the TC markings will be halfway between two clutch mounting bolts. If this type of flywheel has no valve adjustment markings, it should be replaced. Also, any flywheel which has no markings for injection pump timing should be replaced, even though piston travel method of injection pump timing could be used.

VALVE YOKE ADJUSTMENT

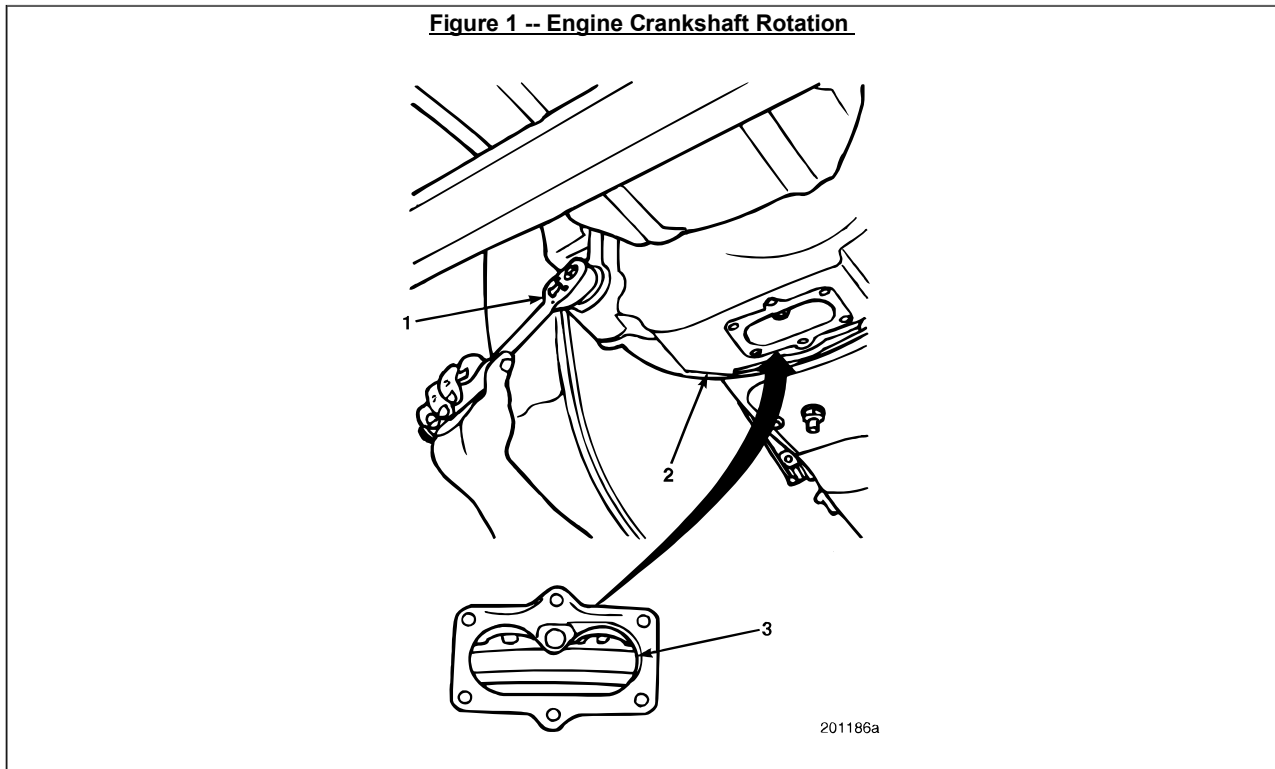


On mechanically governed engines, before barring engine for any reason, secure injection pump stop lever in stop position.

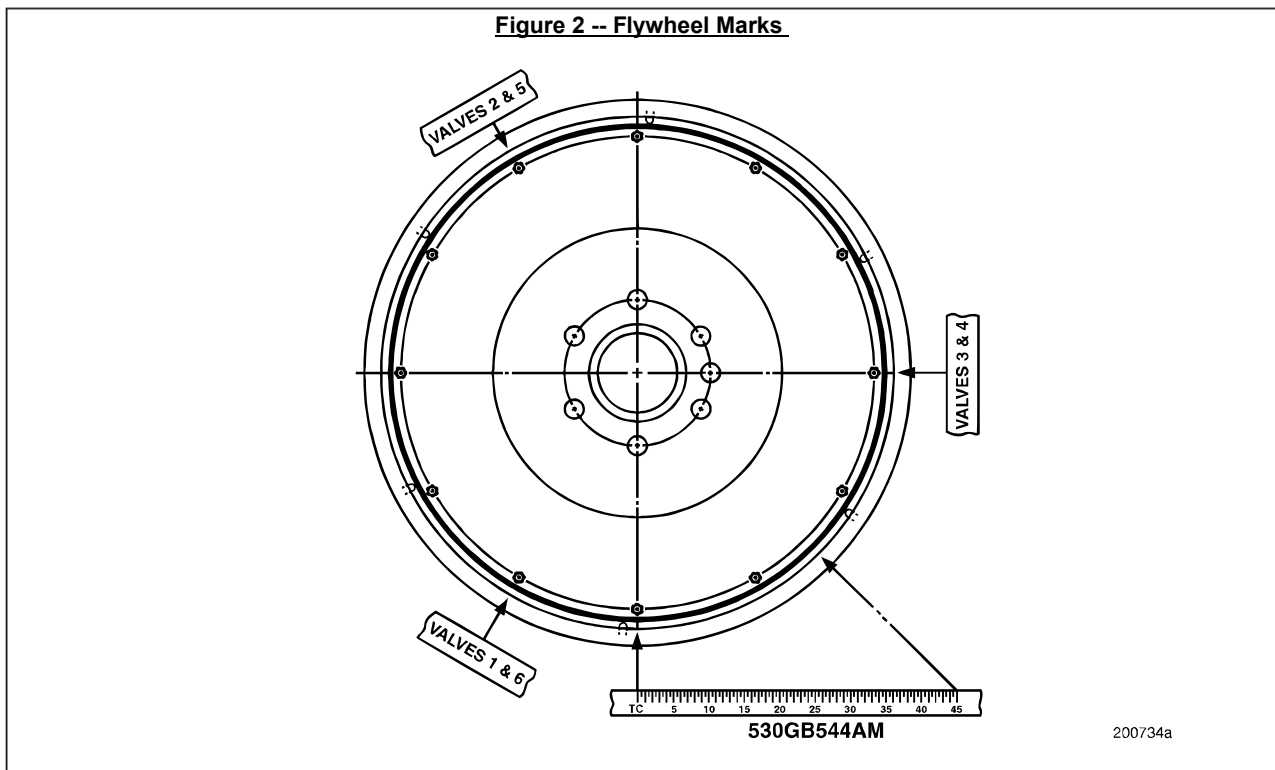
Make sure that adjusting screws are retracted upward in the rocker arms. If they extend too far below the rocker arm, the push rods can be bent when tightening the rocker arm assembly brackets.

Refer to **Figure 1 -- Engine Crankshaft Rotation** , **Figure 2 -- Flywheel Marks** and **Figure 3 -- Yoke Adjusting Screw and Locknut** .

- Using engine barring socket J 38587-A, manually rotate engine in normal rotation direction until pointer in flywheel housing aligns with valves 1 and 6 mark on the flywheel and the No. 1 piston is on the compression stroke (or until the pointer marked VALVE aligns with the TC mark on the vibration damper, if equipped).



1. Barring socket J 38587-A	2. Flywheel housing 3. Flywheel
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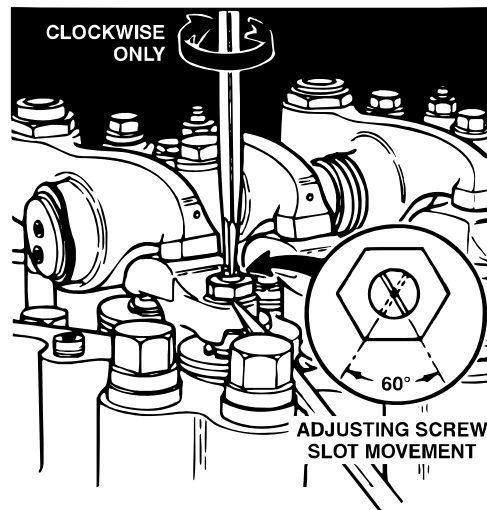
2. Back off the valve rocker adjusting screws.
3. Loosen the No. 1 cylinder yoke adjusting screw locknuts.
4. Exert moderate force on the yoke by pressing on the rocker arm slipper end. Turn down the yoke adjusting screw until it makes solid contact with the outboard valve stem tip, as sensed by a light drag on the adjusting screw.
5. Turn adjusting screw an additional 1/6 turn (60 degrees) clockwise.

SERVICE HINT

A 1/6 turn is equal to one flat on the adjusting screw locknut.

6. Hold the yoke adjusting screw in this position while tightening the adjusting screw locknut. Torque locknut to 33 lb-ft (45 N • m) using torque wrench J 24407 or equivalent.

Figure 3 -- Yoke Adjusting Screw and Locknut



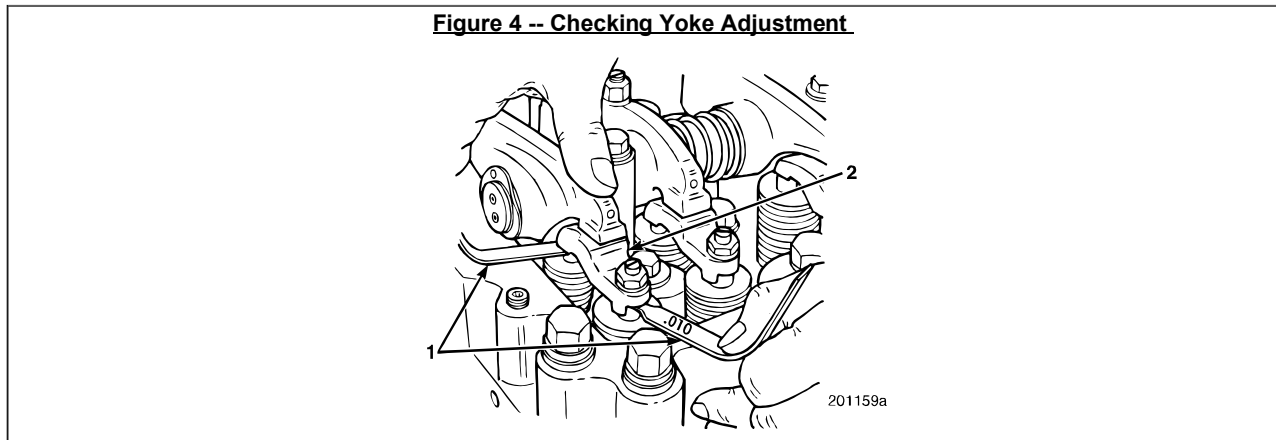
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CHECKING YOKE ADJUSTMENT

Refer to **Figure 4 -- Checking Yoke Adjustment** .

7. Insert a 0.010-inch (0.254 mm) thickness gauge between the yoke and valve stem, at both the inboard and outboard locations.

8. Exert moderate force on the yoke by pressing on the rocker arm slipper end. An equal drag should be felt on both thickness gauges. If drag is unequal, readjust the yoke adjusting screw, as required.



1. Thickness gauge

2. Yoke

INLET VALVE ADJUSTMENT

Refer to **Figure 5 -- Inlet Valve Adjustment** .

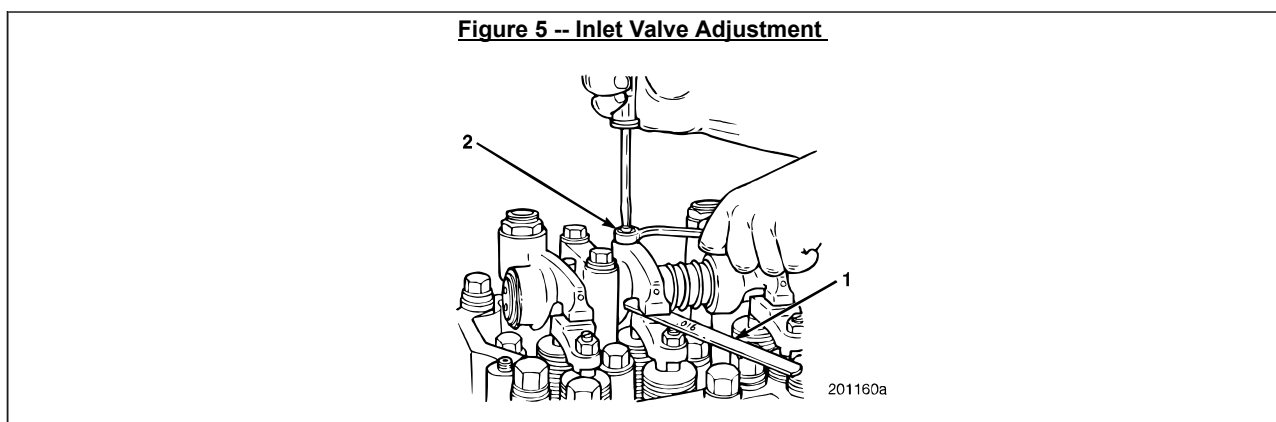
Inlet valve lash clearance is 0.016 inch (0.406 mm).

1. Place a 0.016-inch (0.406 mm) thickness gauge between the rocker arm and yoke on the No. 1 cylinder.
2. Turn the adjusting screw until a light drag is felt on the thickness gauge.
3. After setting adjustment screw, tighten locknut. Torque locknut to 40 lb-ft (54 N • m) using torque wrench J 24407 or equivalent.

NOTE

Do not allow the adjustment screw to turn.

4. After tightening locknut, recheck valve lash clearance. Readjust as necessary.



1. Thickness gauge

2. Adjusting screw and locknut

EXHAUST VALVE ADJUSTMENT

Refer to **Figure 6 -- Exhaust Valve Adjustment** .

Exhaust valve clearance is 0.024 inch (0.610 mm) for engines produced through engine serial No. 6F in April 1996 and 0.028 inch (0.711 mm) for engines produced after engine serial No. 6F in April 1996.

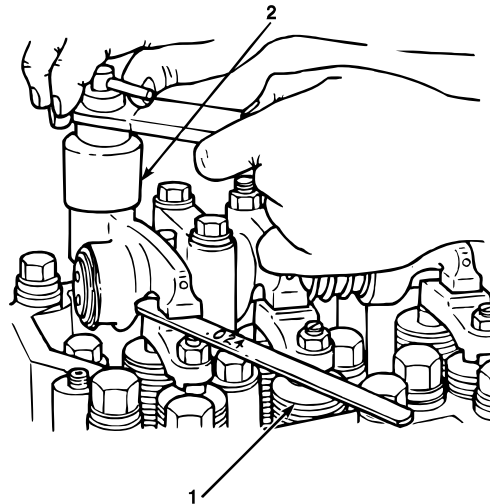
1. Place the proper thickness gauge between the rocker arm and yoke on the No. 1 cylinder.
2. Turn the adjusting screw until a light drag is felt on the thickness gauge.
 - If equipped with a Dynatard engine brake, use Dynatard valve-lash adjusting wrench J 37092 to rotate adjusting screw. Press downward with hand on the hydraulic lash adjuster while gauging valve lash. Adjust the lash until a light drag is felt on the thickness gauge.
3. After adjustment is complete, tighten locknut. Torque locknut to 40 lb-ft (54 N • m) using torque wrench J 24407 or equivalent.

NOTE

Do not allow the adjustment screw to turn.

4. Recheck valve lash clearance after tightening locknut. Readjust as necessary.

Figure 6 -- Exhaust Valve Adjustment



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1. Thickness gauge

2. Adjusting wrench J 37092

Refer to **Figure 1 -- Engine Crankshaft Rotation** .

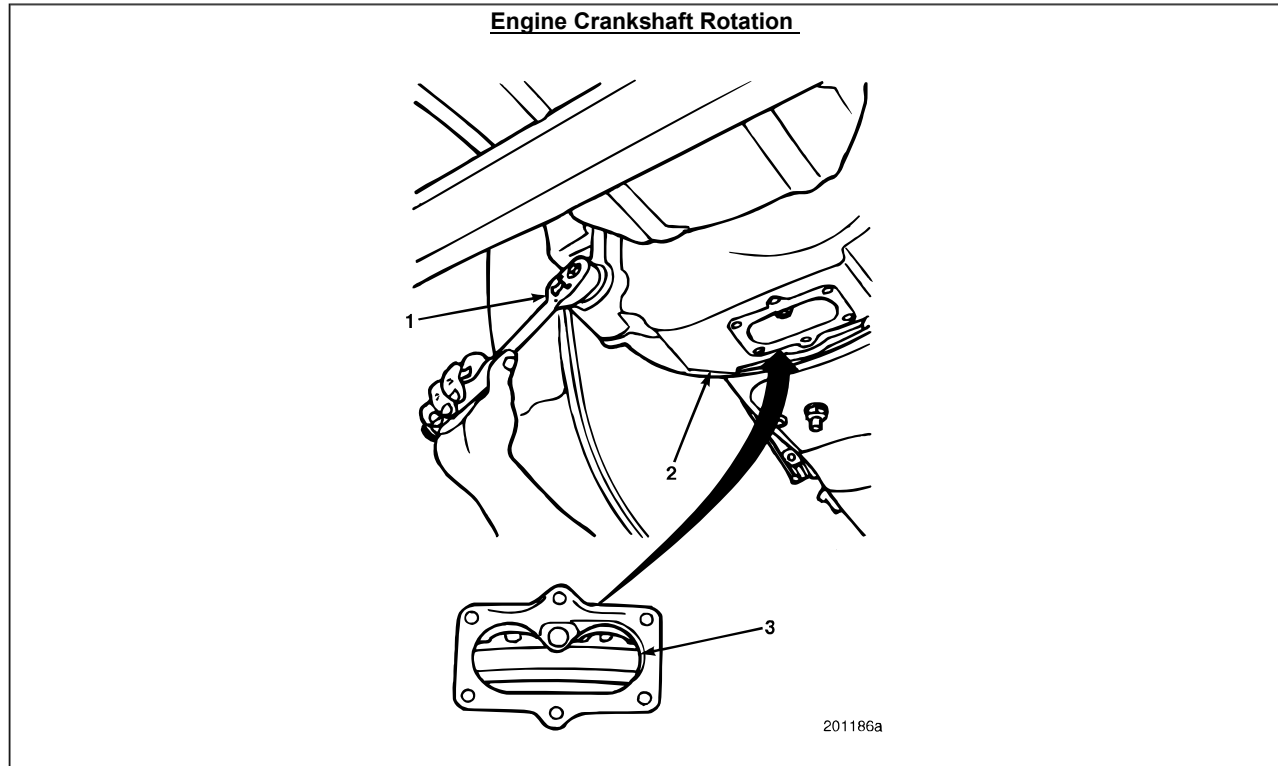
5. Using engine barring socket J 38587-A, manually rotate engine in normal rotation direction 120 degrees until pointer in flywheel housing aligns with the "5" mark on the flywheel. The No. 5 piston will be on the compression stroke. If engine is equipped with a pointer mounted on the timing gear cover and marks on the vibration damper, rotate the engine until the pointer marked VALVE aligns with the "5" mark on the vibration damper.

6. Adjust the yoke and valve lash as previously outlined for the No. 1 cylinder.

NOTE

E7 engine firing order is 1 - 5 - 3 - 6 - 2 - 4.

7. Continue adjusting yoke and valve lash for the remaining cylinders, in firing order. Rotate crankshaft to place each piston 30 degrees past TDC.



1. Barring Socket J 38587-A	2. Flywheel Housing
	3. Flywheel

[213 NB] VALVE YOKE, VALVE LASH AND SLAVE PISTON ADJUSTMENTS (JACOBS BRAKE ENGINE)

DESCRIPTION

Make yoke and valve lash adjustments for each cylinder in the proper order. Adjust the yoke clearance first, then adjust the valve lash. Adjust the Jake Brake slave piston last. The flywheel has a stamped timing scale TC through 45 degrees of crankshaft rotation for setting and checking pump-to-engine timing. Also, the flywheel has three stamped valve setting locations.

Some E7 engines are equipped with a pointer marked VALVE on the timing gear cover. When aligned with the TC mark on the vibration damper, it provides the 30 degrees after Top Dead Center (TDC) damper relationship for valve lash adjustment. Make all adjustments in firing order sequence.

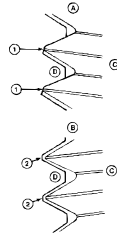
NOTE

E7 engine firing order is 1 - 5 - 3 - 6 - 2 - 4.

The Jacobs exhaust valve yoke originally used a valve yoke screw with SAE threads. MACK yokes had metric threads. SAE and metric threads are different enough so that mixing threads should not be possible. An incorrect screw can be started into the threads but will lock up after a quarter of a turn to two full turns.

Effective January 1994, on engine serial No. 401269, the E7 Jacobs yoke has metric threads utilizing the Spirallock(tm)™ thread form. This special thread form has a wedge ramp at the root of each thread to provide a locking effect. The yoke adjusting screw is free-spinning in the yoke threads until the locknut is tightened. When the locknut is tightened, the crests of yoke adjusting screw threads are pulled tightly against the wedge ramp of screw threads. Because of this feature, when the locknut is loosened, the adjusting screw usually remains locked to the yoke threads and can be difficult to turn with a screwdriver. A light tap squarely on top of the yoke adjusting screw may be required to loosen the locking effect and allow screw to be turned. Refer to **Figure 7 -- Spirallock™ Thread Ramp**.

Figure 7 -- Spirallock™ Thread Ramp



1. Wedge ramp	B. Free spinning yoke threads
2. Radial clearance	C. Yoke adjusting screw
A. Spirallock™ yoke threads	D. Yoke

NOTE

Yoke and valve lash adjustment must be made under static conditions with coolant temperature below 100 ° F (38 ° C).

HOUSING IDENTIFICATION

Each engine brake housing assembly has an identification tag showing the model number and is marked FRONT or REAR to show installation location. Make sure to install front to front or rear to rear. Engine brake housing serial numbers are stamped on top of the castings. E7 engines use the Jacobs Model 680B engine brake assembly.

SPECIAL TOOLS REQUIRED

Jacobs feeler gauges:

- 0.060 inch (1.52 mm) No. 022001
- 0.080 inch (2.03 mm) No. 018781
- 0.085 inch (2.16 mm) No. 014177
- 0.100 inch (2.54 mm) No. 021327

VALVE YOKE

Jacobs yokes must be installed on the exhaust yoke guide pins. Lubricate the guide pin and the pallet of the yoke with engine oil. Install yoke with the adjustment screw outboard (toward the intake manifold side of the engine).

1. Loosen the yoke adjusting screw locknut and back the screw out several turns.
2. Exert a moderate force on the yoke by pressing on the rocker arm slipper end. Turn down yoke adjusting screw until it makes solid contact with outboard valve stem tip as sensed by a light drag on the adjusting screw.

- Turn adjusting screw an additional 1/6 turn (60 degrees) clockwise.

SERVICE HINT

A 1/6 turn is equal to one flat on the adjusting screw locknut.

- Hold the yoke adjusting screw in this position while tightening the adjusting screw locknut. Torque locknut to 33 lb-ft (45 N • m) using torque wrench J 24407 or equivalent.

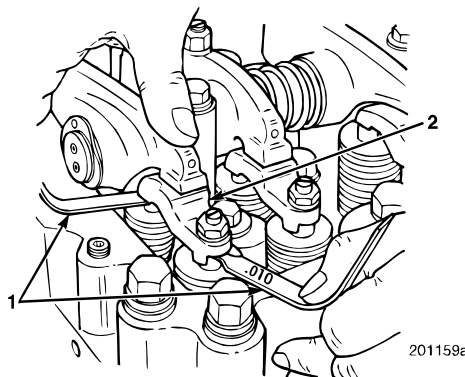
CHECKING YOKE ADJUSTMENT

- To check the yoke adjustment, insert a 0.010-inch (0.254 mm) thickness gauge between the yoke and valve stem, at both the inboard and outboard locations.

Refer to **Figure 8 -- Checking Yoke Adjustment** .

- Exert moderate force on the yoke by pressing on the rocker arm slipper end. An equal drag should be felt on both thickness gauges. If drag is unequal, readjust yoke adjusting screw.

Figure 8 -- Checking Yoke Adjustment



1. Thickness gauge

2. Yoke

SLAVE PISTON, INLET VALVE AND EXHAUST VALVE LASH ADJUSTMENTS

Make the following adjustments with the engine shut down. Coolant temperature must be below 100 ° F (38 ° C) to ensure proper adjustment.

⚠ CAUTION

On mechanically governed engines, before barring engine for any reason, secure injection pump stop lever in STOP position.

NOTE

Do not rotate the engine crankshaft backward when using the hub damper bolt. This might change the torque.

- Using engine barring socket J 38587, manually rotate engine in normal rotation direction.
- Rotate until pointer in flywheel housing aligns with the mark for valves 1 and 6 on the flywheel and the No. 1 piston on the compression stroke (or until the pointer marked VALVE aligns with the TC mark on the vibration damper, if equipped). This provides the 30 degrees after TDC relationship for valve lash adjustment necessary with the E7 valve design.

Inlet Valve Adjustment

Inlet valve lash clearance is 0.016 inch (0.406 mm).

3. Place a 0.016-inch (0.406 mm) thickness gauge between the rocker arm and yoke.
4. Turn adjusting screw until a light drag is felt on the thickness gauge.
5. After adjustment is complete, hold screw (to keep from turning) and tighten locknut. Torque locknut to 40 lb-ft (54 N • m) using torque wrench J 24407 or equivalent.
6. After tightening locknut, recheck valve lash clearance. Readjust as necessary.

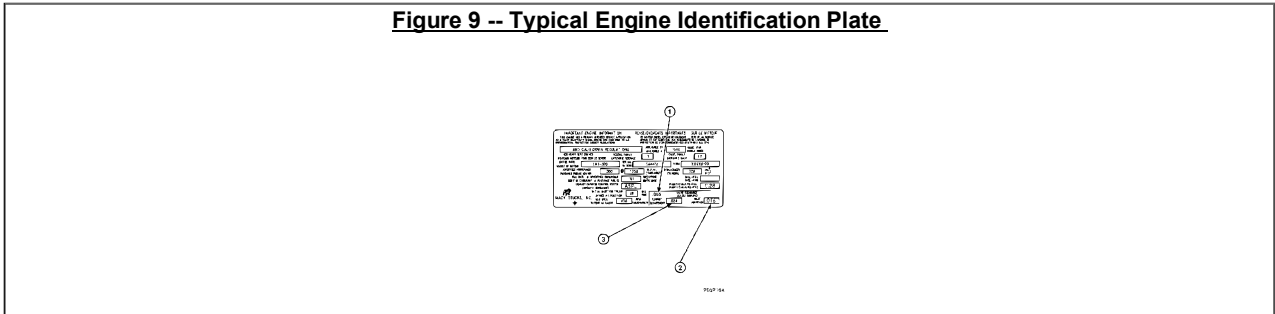
Exhaust Valve Adjustment

Exhaust valve lash clearance is 0.024 inch (0.610 mm) or 0.028 inch (0.711 mm) for V-MAC II or mechanically governed engines equipped with camshafts effective April 1996.

7. Place the appropriate thickness gauge between the rocker arm and yoke.

NOTE

Exhaust valve lash clearance is 0.028 inch (0.711 mm) for V-MAC II or mechanically governed engines equipped with the new cam effective April 1996. Check the engine identification plate for the proper setting. Refer to **Figure 9 -- Typical Engine Identification Plate** .



1. Jake brake slave piston setting	3. Exhaust valve setting
2. Inlet valve setting	

8. Turn adjusting screw until a light drag is felt on the thickness gauge.
9. After adjustment is complete, hold screw (to keep from turning) and tighten locknut. Torque locknut to 40 lb-ft (54 N • m) using torque wrench J 24407 or equivalent.
10. After tightening locknut, recheck valve lash clearance. Readjust as necessary.

Slave Piston Adjustment

Table 1

Engine and Turbocharger Model, and Camshaft Part No.	Engine Brake	Slave Lash	Adjusting Tool Part No.
454GC —			
1996/1997 E7 with 5205 camshaft and S300 or S400 Turbocharger	Jake Brake plus Extarder	0.085"	014177
1996/1997 E7 with 5205 camshaft and S300 or S400 Turbocharger	Jake Brake Only	0.060"	022001

Engine and Turbocharger Model, and Camshaft Part No.	Engine Brake	Slave Lash	Adjusting Tool Part No.
454GC —			
1996 E7 with 583(A), 5142 camshaft and S3B or S4D Turbocharger	Jake Brake Only	0.080"	018781/020521
1991 – 1996 E7 with 583(A), 5142 camshaft and S3B or S4D Turbocharger	Jake Brake plus Extarder	0.100"	021327
1991 – 1995 E7 with 583(A), 5142 camshaft	Jake Brake Only	0.080"	018781/020521
Pre-1991 E7 with 583(A) and 5142 camshaft	Jake Brake Only	0.085"	014177

* Refer to 200 APPENDIX (at the back of this manual) for list of selected 1990 E7 engine serial numbers requiring 0.080-inch (2.05 mm) thickness gauge No. 017099 for slave piston adjustment.

NOTE

To determine the proper Jake brake slave piston lash setting for a particular engine, first determine if the engine has the Jake brake only or Jake brake plus Extarder, then refer to the appropriate chart. The production change from the 5142 camshaft to the 5205 camshaft occurred mid-year 1996. To determine which camshaft a 1996 engine has, determine the turbocharger model from the turbocharger identification plate. A turbocharger model S3B or S4D means the engine was built with a 5142 camshaft. A turbocharger model S300 or S400 means the engine was built with a 5205 camshaft.

NOTE

If an S3B or S4D turbocharger is mistakenly replaced with an S300 or S400 turbocharger on a Jake Brake-equipped engine, slave lash adjustment does not change. Slave lash adjustment is determined by the original engine camshaft, not the turbocharger.

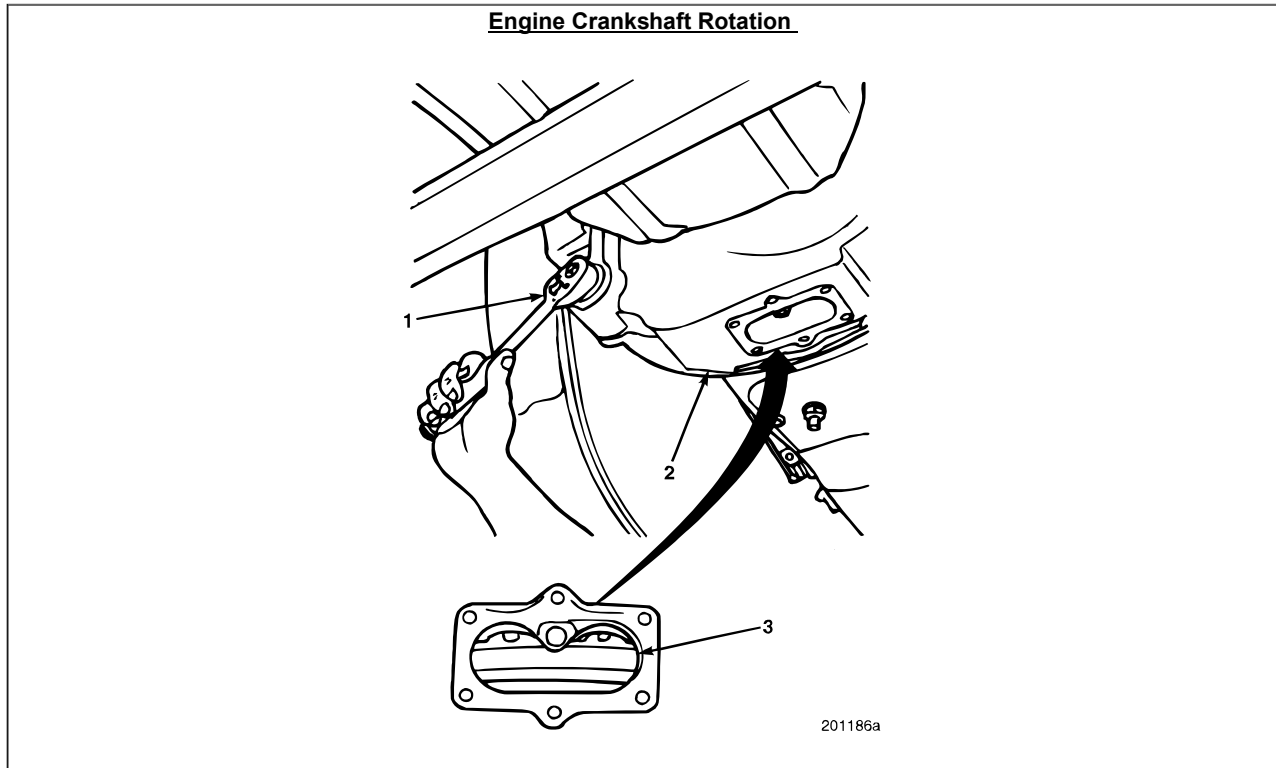
CAUTION

Make this adjustment carefully. After slave piston adjusting screw locknut is properly torqued to 40 lb-ft (54 N • m), recheck the clearance with the Jacobs feeler gauge. Readjust as necessary.

11. Loosen the No. 1 cylinder slave piston adjusting screw until the slave piston is fully retracted in its bore (no drag on screw).
12. Insert the proper Jacobs feeler gauge between slave piston feet and Jacobs yoke. Turn the adjusting screw in until a slight drag is felt on the feeler gauge.
13. Hold adjusting screw (to keep from turning) and tighten locknut. Torque locknut to 40 lb-ft (54 N • m) using torque wrench J 24407 or equivalent. Refer to the Lash Adjustment chart under Slave Piston Adjustment for correct thickness gauge.

Continuation of Adjustments

14. Using engine barring socket J 38587-A, manually rotate engine in normal rotation direction 120 degrees until pointer in flywheel housing aligns with the "5" mark on the flywheel. The No. 5 piston will be on the compression stroke. If engine is equipped with a pointer on the timing gear cover and marks on the vibration damper, rotate the engine until the pointer marked VALVE aligns with the "5" mark on the vibration damper. Refer to **Figure 1 -- Engine Crankshaft Rotation** .



1. Barring socket J 38587-A)

2. Flywheel housing

3. Flywheel

15. Adjust the yoke, valves and slave piston lash as previously outlined for the No. 1 cylinder.

NOTE

E7 engine firing order is 1 - 5 - 3 - 6 - 2 - 4.

16. Continue adjusting yokes, valves and slave cylinder lash for the remaining cylinders, in firing order, placing each piston 30 degrees past TDC by rotating the crankshaft and aligning marks on the flywheel with pointer marked VALVE and appropriate mark on vibration damper, if equipped.

[221 GP] INJECTION PUMP FIXED-TIMING PROCEDURES

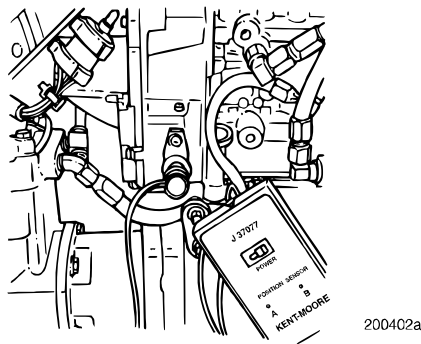
NOTE

Whenever the injection pump is removed from a MACK E7 engine, it is necessary to set injection pump-to-engine timing using the fixed-timing method. This method uses a portable fixed-timing light which electronically determines port closure to verify precise injection pump-to-engine timing.

DESCRIPTION

The fixed-timing method is a simple, accurate procedure which uses a timing light to set injection-to-engine timing. Using the fixed-timing method ensures optimum fuel economy and engine durability, and maintains engine exhaust within established EPA limits.

Figure 10 -- Fixed Timing Method



⚠ CAUTION

Make sure key is off.

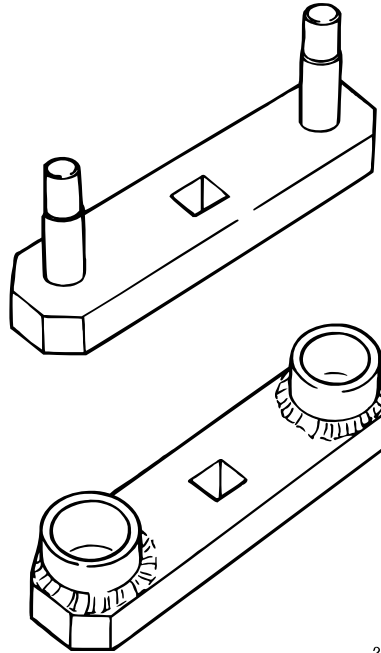
- On all P7100 non V-MAC mechanically controlled fuel-injection systems, injection timing is referenced to the No. 1 cylinder. The engine must be timed during the compression stroke of cylinder No. 1.
- On all P7100 V-MAC electronically controlled fuel-injection systems, injection timing is referenced to the No. 6 cylinder. The engine must be timed during the compression stroke of cylinder No. 6.
- On all P8500 V-MAC electronically controlled fuel-injection systems, injection timing is referenced to the No. 1 cylinder. The engine must be timed during the compression stroke of cylinder No. 1.

NOTE

The injection pump driven gear capscrews on factory-assembled E7 engines come in three different head sizes (15 mm, 16 mm or 17 mm). All four capscrews on a given engine will be the same and the torque is the same for all three head sizes: 40 lb-ft (54 N • m).

On mechanically governed engines, different head sizes pose no problem. On V-MAC engines, however, different capscrew head sizes can affect the use of V-MAC hub rotation tool J 38740, used to rotate the injection pump when setting injection pump-to-engine timing. J 38740 actually consists of two tools:

- An adapter with two posts that fit into tapped holes in drive hub.
- An adapter with two tubes, one on each end, fit over the heads of two of the timing adjustment capscrews. (This adapter will not fit over the heads of some of the timing adjustment capscrews. If this problem occurs, simply remove two of the adjustment capscrews and washers, and use the tool with posts in the openings.)

Figure 11 -- V-MAC Hub Rotation Tool J 38740**CAUTION**

When removing capscrews and washers, be extremely careful not to drop a washer into the engine. Removing the washer is difficult and may require some engine disassembly.

Following are procedures for:

- Setting Static Fuel Injection Pump Timing
- Fuel Injection Pump Driven Gear Installation
- Checking Pump-to-Engine Timing
- Fuel Injection Pump Access Cover Installation
- Fuel Injection Pump Pre-Lubrication
- Timing Event Marker (TEM) Installation

SERVICE HINT

Accurately setting the injection pump timing is the best way to ensure optimum fuel economy, engine durability, and maintain engine exhaust within established EPA limits.

SPECIAL TOOLS REQUIRED

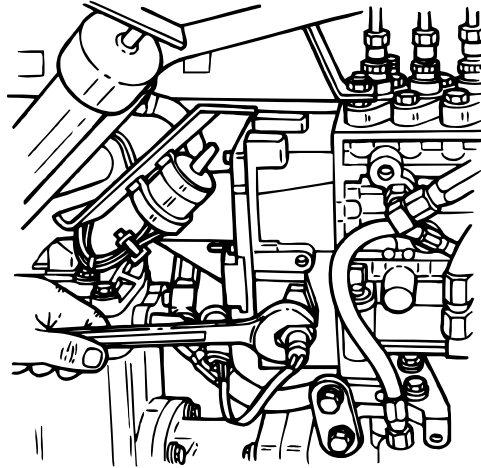
- Fixed Timing Position Sensor (Light) J 37077
- Alignment Fixture J 37078
- Pump Drive Gear Alignment Dowels J 37085
- Hub Rotation Tool J 38740

SETTING STATIC FUEL INJECTION PUMP TIMING

To set the static fuel injection pump timing, prior to pump removal, proceed as follows:

1. Remove the TEM sensor (on mechanically governed engines, remove plug) from the fixed timing port.

Figure 12 -- Removing TEM Sensor



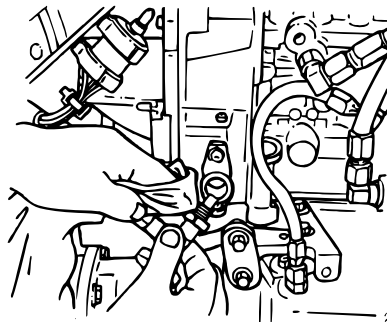
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CAUTION

Thoroughly clean all residue from the fixed timing port threads (timing access window) before installing tool sensor. This will prevent the possibility of a false reading.

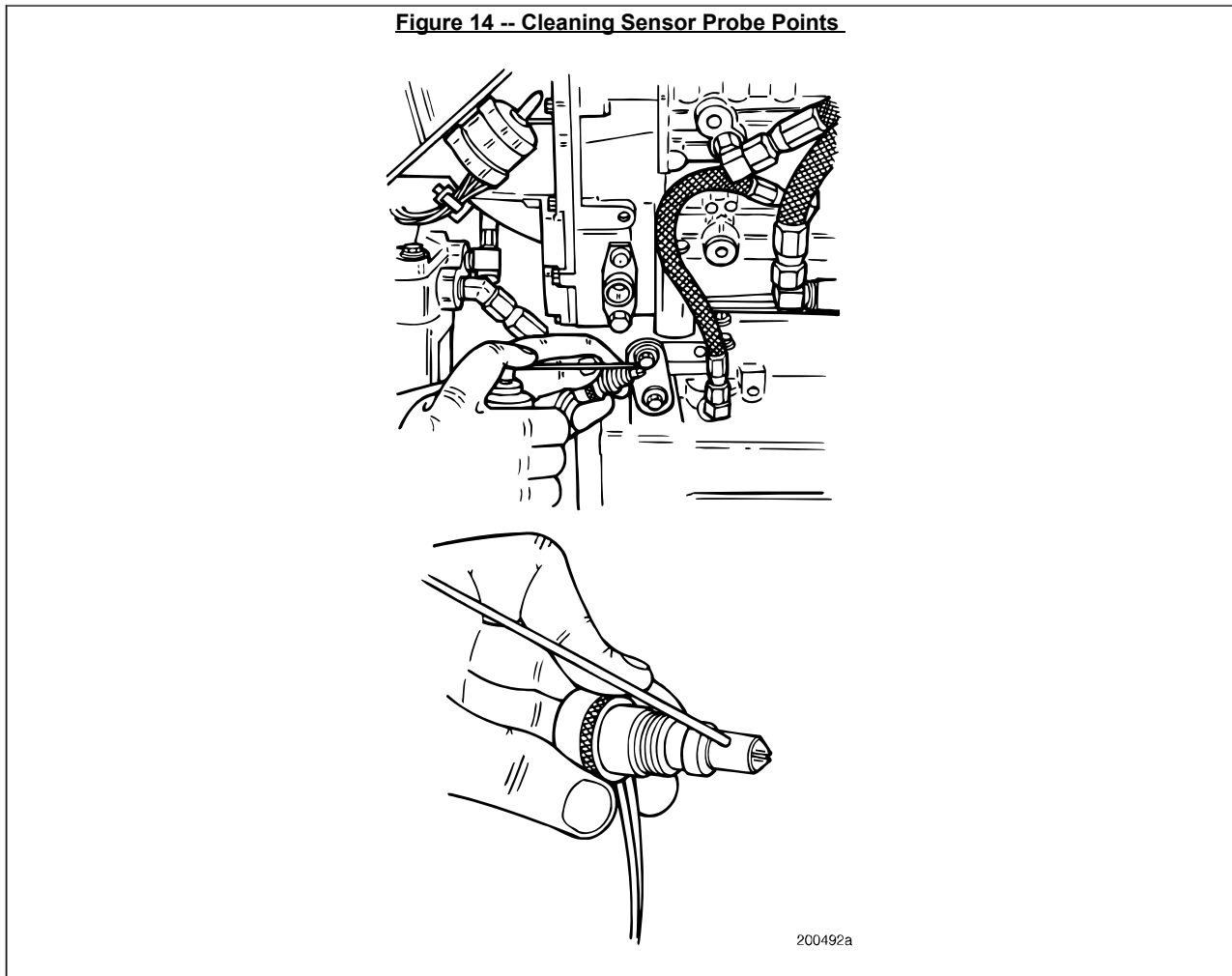
2. Clean all residue from the TEM sensor or plug threads.

Figure 13 -- Cleaning TEM Sensor Threads

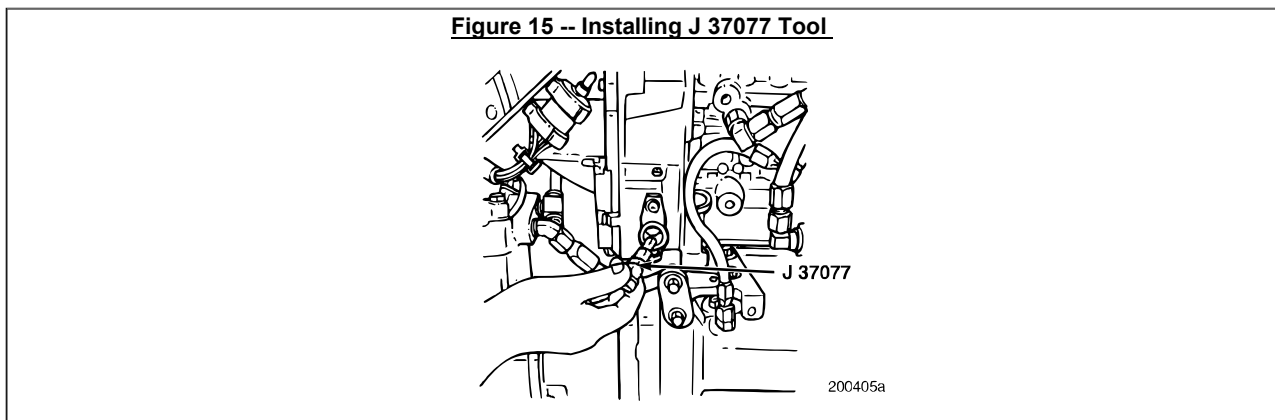


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- Clean the J 37077 tool sensor probe points with compressed air before using. This helps prevent metallic contamination between the sensor probe points.

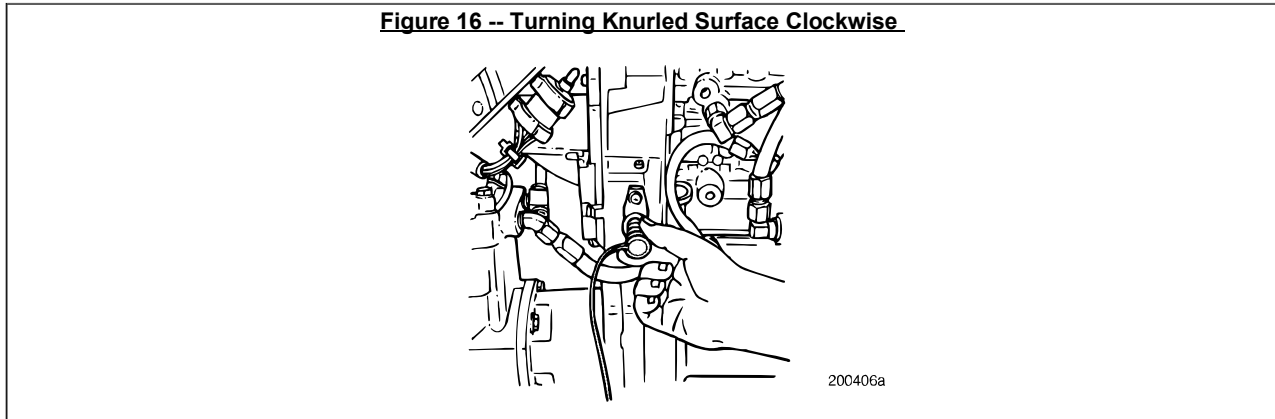


- Install fixed timing position sensor tool J 37077. Make sure that tool is correctly aligned with the locating groove in the fixed timing port.



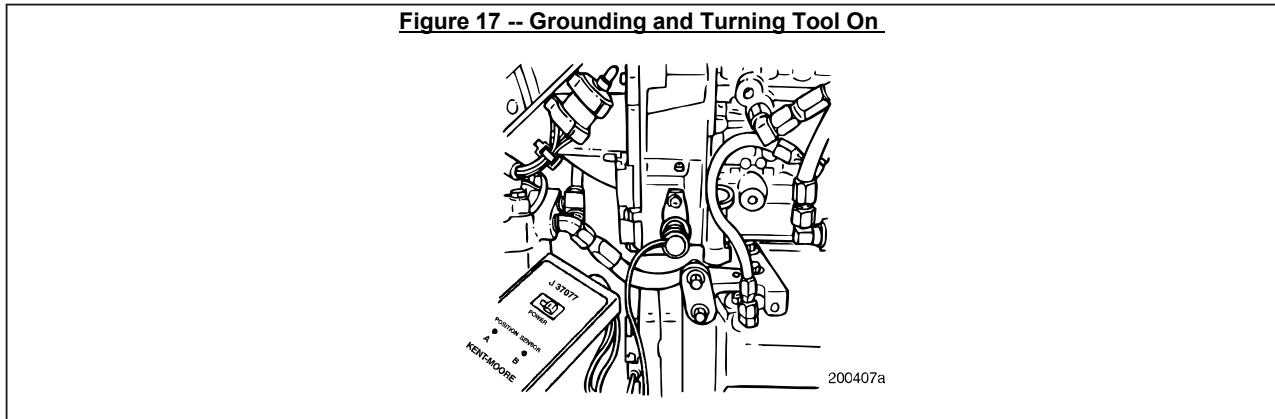
- Slowly turn the knurled surface clockwise to lock the tool into place. Check to make sure tool is seated by applying pressure to the end of the tool and checking for any movement. If movement is detected, remove and reinstall the tool.

Figure 16 -- Turning Knurled Surface Clockwise



- Connect the fixed timing tool ground to the engine and press power switch on.

Figure 17 -- Grounding and Turning Tool On



- To continue the procedures for setting the timing, refer to the following applications for an engine with front timing indicator or with rear timing indicator.

ENGINE WITH FRONT TIMING INDICATOR

E7 mechanically governed engines with automatic transmissions use the Center Web Vibration Damper with timing marks. The vibration damper timing indicator and engine front turnover bracket are used in this application.

- Rotate the engine crankshaft counterclockwise (as viewed from the front of the engine) to a minimum of 45 degrees before Top Dead Center (TDC).
- Rotate the engine crankshaft clockwise until lamps A and B are both lit. Fuel injection pump-to-engine timing is now set and the injection pump can be removed from the engine.

ENGINE WITH REAR TIMING INDICATOR

E7 mechanically governed engines with manual transmissions and all V-MAC engines with manual and automatic transmissions use the flatback vibration damper with no timing marks. They are also equipped with flywheel and flywheel housings that incorporate engine timing and turnover features. With rear timing, the front timing indicator and engine front turnover bracket are not utilized.

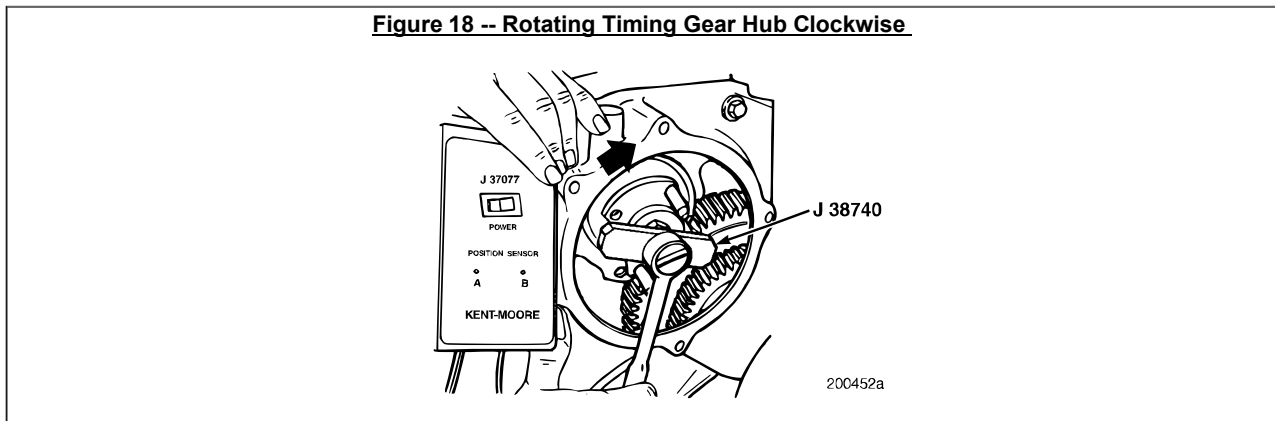
- Remove all six 8-mm capscrews to access the flywheel housing timing window.
- Remove the plastic plug in the cast-machined opening in the forward face of the housing.
- Insert engine barring socket tool J 38587 into the opening.
- Install a 1/2-inch drive ratchet into tool J 38587 to rotate the flywheel.

14. Rotate the flywheel counterclockwise to a minimum of 45 degrees before TDC.
15. Rotate the flywheel clockwise in normal direction (as viewed from the front of the engine), until lamps A and B are both lit. Fuel injection pump-to-engine timing is now set and the injection pump can be removed from the engine. Remove tool J 38587 from the flywheel housing.

FUEL INJECTION PUMP DRIVEN GEAR INSTALLATION

To install the fuel injection pump gear:

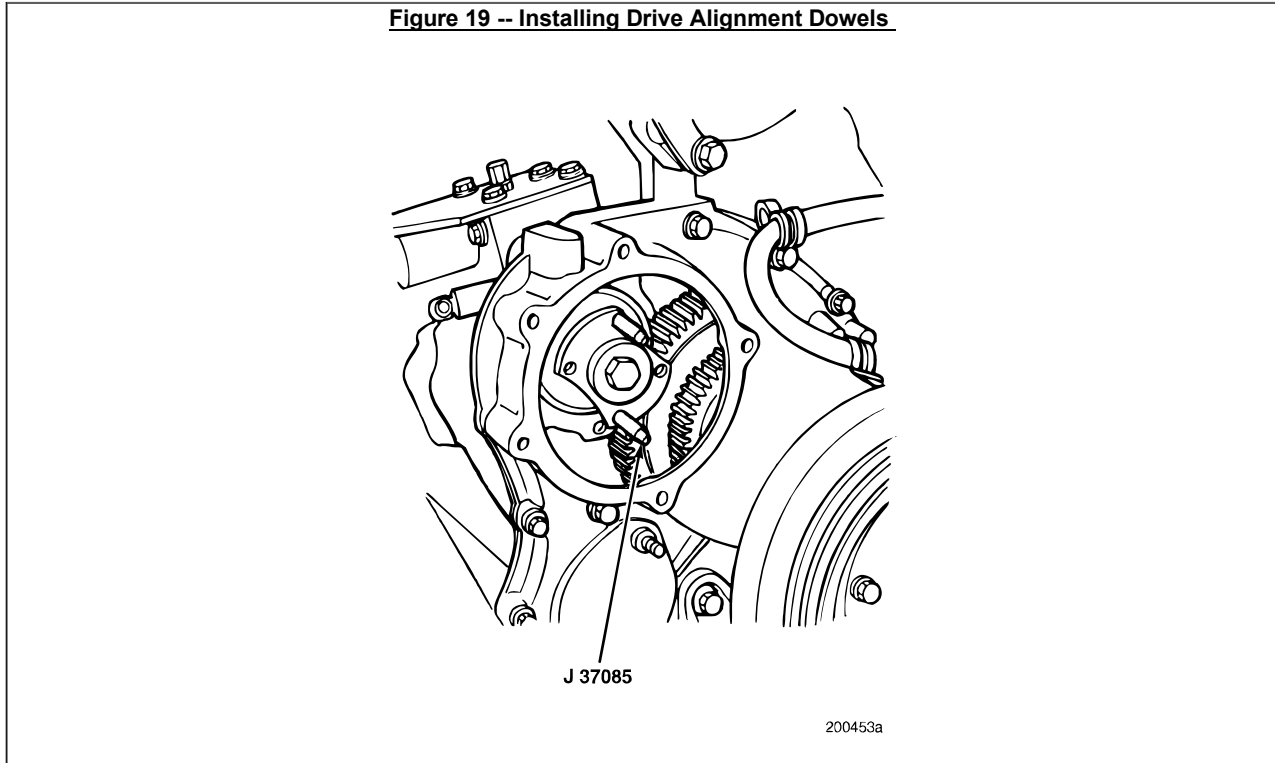
1. Verify crankshaft is set to correct BTDC position for pump timing.
2. Connect timing-light tool J 37077 (refer to beginning of the section, Setting Static Fuel Injection Pump Timing). Using hub rotation tool J 38740, rotate the timing gear hub clockwise until both lights A and B are lit.



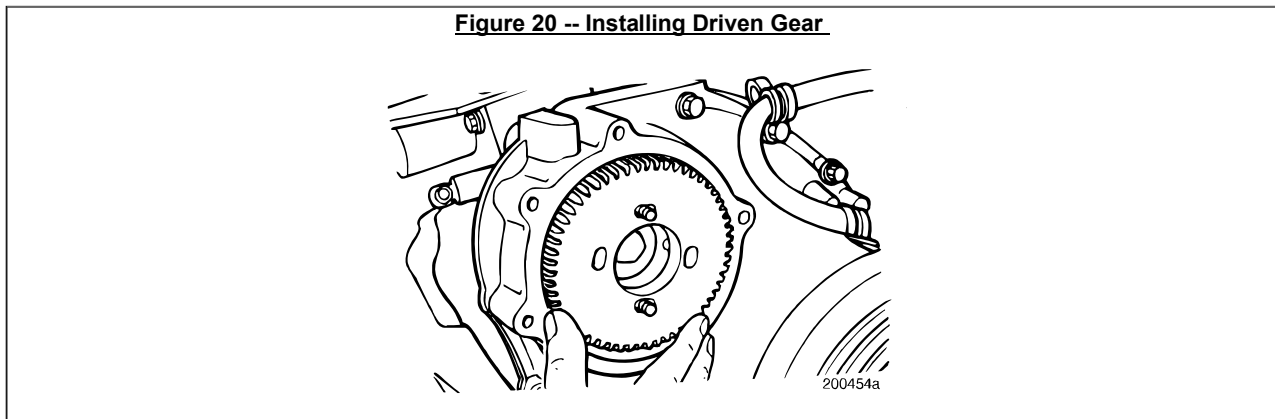
CAUTION

- Use the proper hub rotation tool J 38740 which allows rotation of the hub only.
- Do not use the inner shaft nut (25 mm) to rotate the timing gear hub.
- If the inner shaft nut is used to rotate the hub, the nut may loosen, resulting in subsequent failure.

3. Install two pump drive gear alignment dowels, J 37085, to ease alignment of drive gear to timing gear hub.

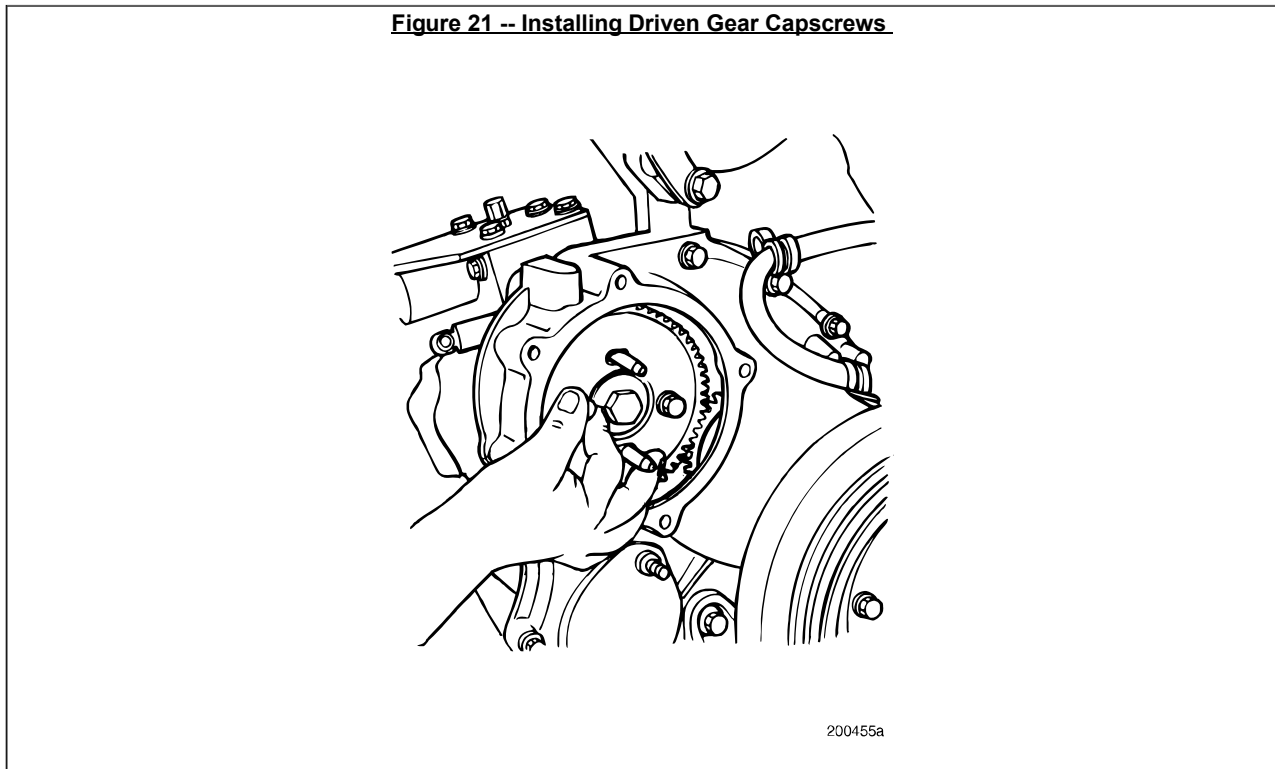


4. Install the fuel injection pump driven gear on the timing gear hub so the screw holes in the hub are centered in the gear slots/alignment dowels.



5. Install two driven gear capscrews in the open holes. Install capscrews snugly to remove clearance but allow relative motion between hub and gear.

Figure 21 -- Installing Driven Gear Capscrews

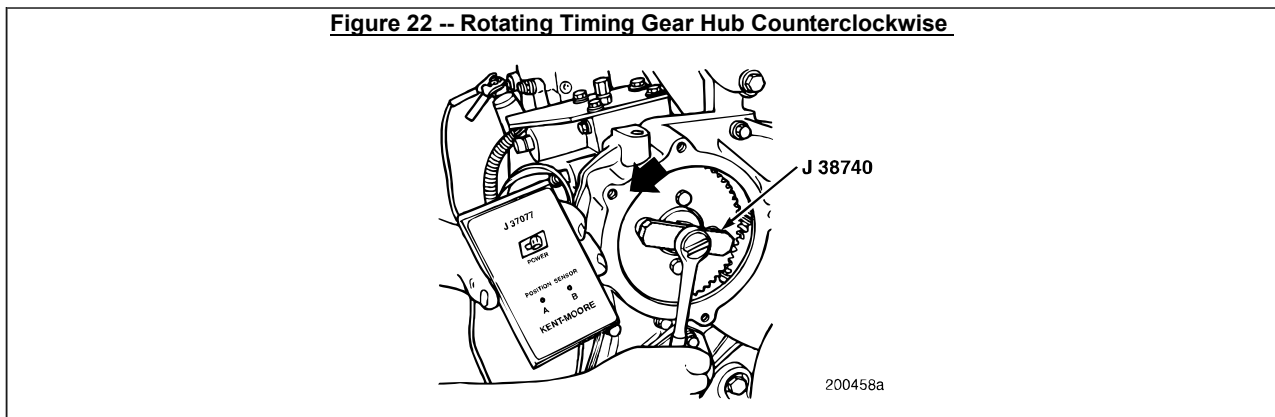


6. Remove the alignment dowels and install remaining capscrews in the same manner.
7. Using hub rotation tool J 38740, rotate the timing gear hub counterclockwise until screws bottom in the ends of the gear slots in the fuel injection pump driven gear. When this happens, both lamps will go out.

NOTE

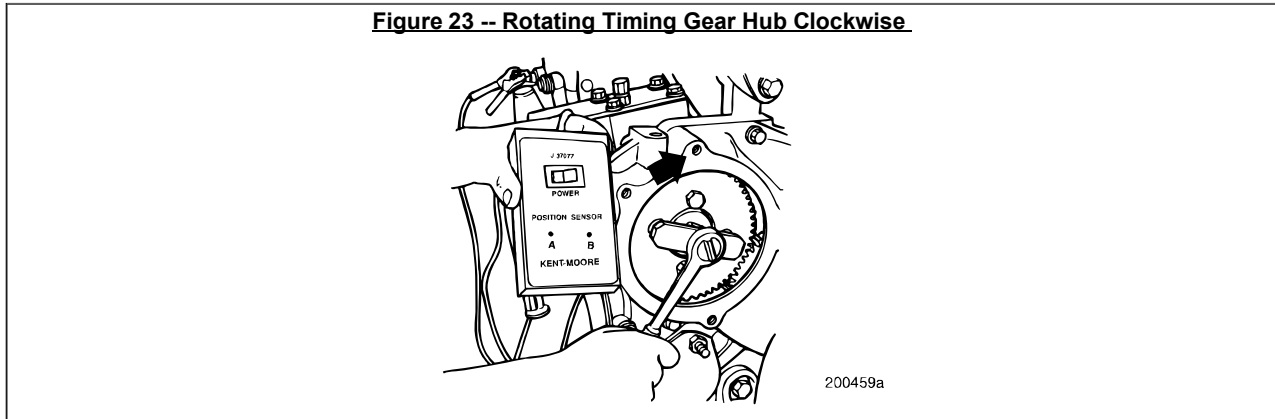
Three different head sizes have been used for the injection pump timing adjustment capscrews. Refer to Description at the beginning of this procedure for additional information.

Figure 22 -- Rotating Timing Gear Hub Counterclockwise



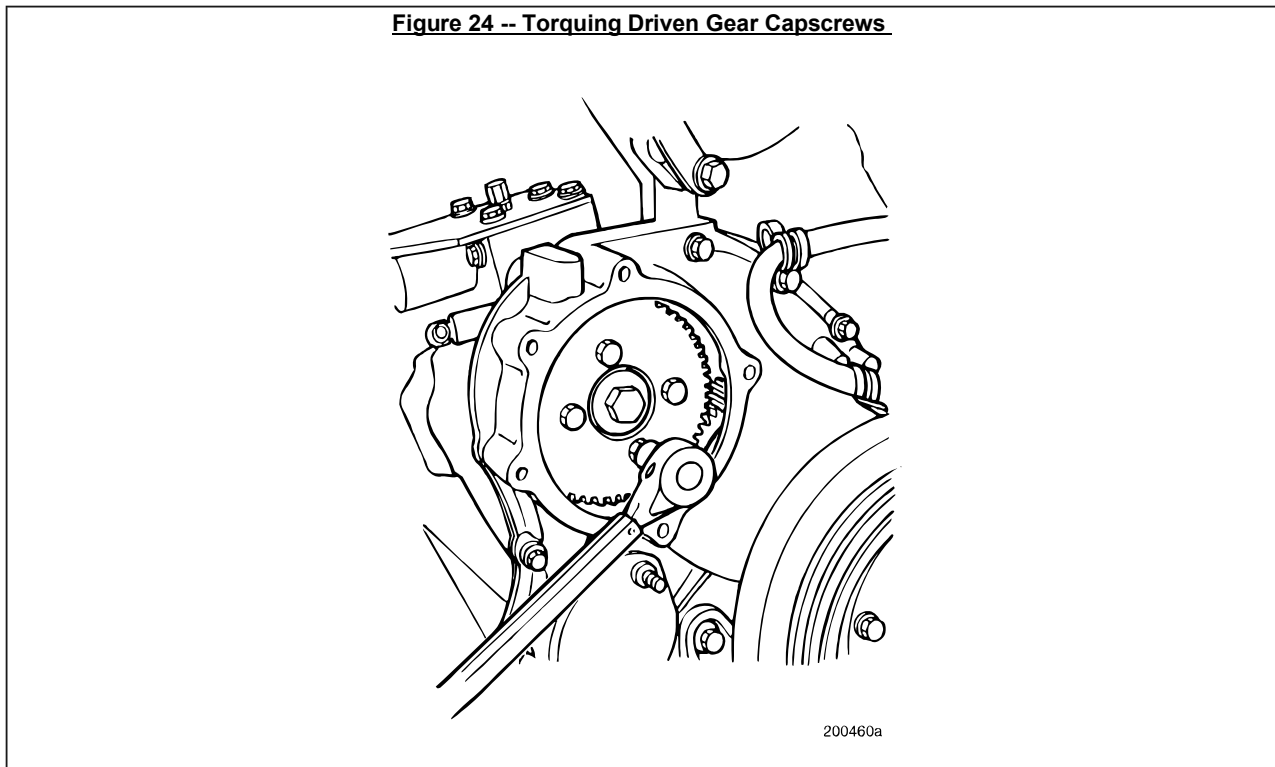
8. Rotate timing gear hub clockwise until both A and B lamps are lit. There is only a very small band of rotation for which both lamps are lit.

Figure 23 -- Rotating Timing Gear Hub Clockwise



9. Torque all fuel injection pump driven gear capscrews to 40 lb-ft (54 N • m) using torque wrench J 24407 or equivalent.

Figure 24 -- Torquing Driven Gear Capscrews



⚠ CAUTION

Lamp A or B may go out during torquing procedure. This is acceptable. Do not attempt to keep lamps lit. Doing so may cause improper pump-to-engine timing.

CHECKING PUMP-TO-ENGINE TIMING

⚠ CAUTION

Using hub bolt to rotate engine backward may change bolt torque. Check torque of hub bolt after completing timing procedure.

1. Rotate engine crankshaft counterclockwise to a minimum of 45 degrees before TDC. Both A and B lamps will go out.
2. Rotate engine crankshaft clockwise until both A and B lamps are lit. If timing pointer does not cover a value within ± 0.5 (1/2) degree of desired timing, the engine is not timed correctly. Before continuing, check and verify piston is at TDC. Refer to **[212 NP] LOCATING PISTON TOP DEAD CENTER (TDC)**.

NOTE

If timing is not within specification, reset and recheck timing.

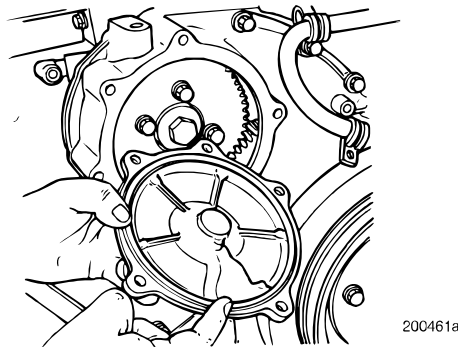
3. After achieving correct timing, remove timing tools.
 - a. Turn tester power off.
 - b. Disconnect tester ground.
 - c. Remove fixed timing probe.
4. Install fixed timing port plug or TEM sensor.
5. Check torque of hub bolt. The correct torque is 360 lb-ft (488 N • m).

FUEL INJECTION PUMP ACCESS COVER INSTALLATION

To install the fuel injection pump access cover:

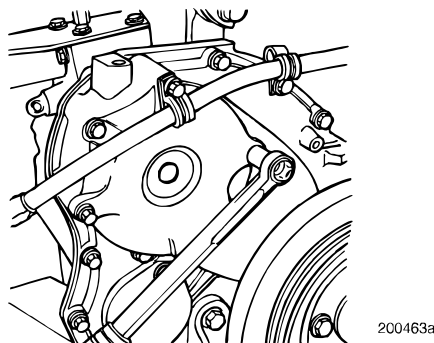
1. Lubricate the access cover O-ring with Lubrizol ® OS-50044 or equivalent.

Figure 25 -- Lubricating Access Cover O-Ring

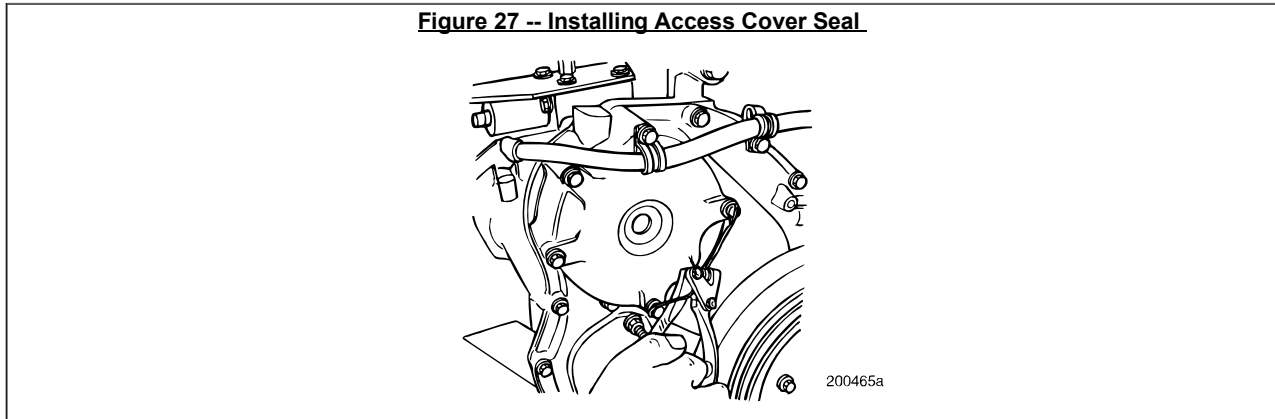


2. Install clamp and access cover capscrews.
3. Torque access cover capscrews to 30 lb-ft (41 N • m) using torque wrench J 24407 or equivalent.

Figure 26 -- Installing and Torquing Access Cover Capscrews



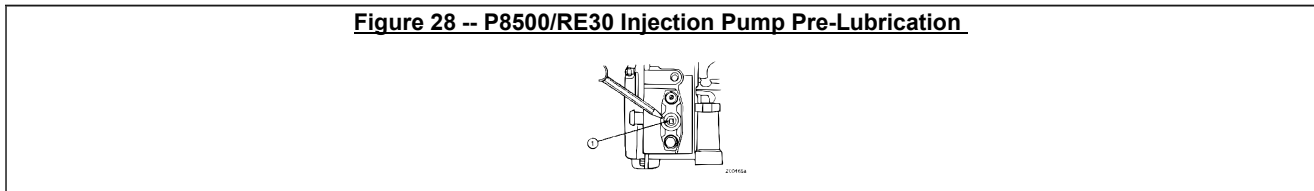
- Run wire through both the drilled access cover capscrews and through the center of the lead seal and loop it. Then bring it through again.



- Using Midget sealing tool 814 or equivalent, compress the lead seal.
- Reconnect fuel injection pump oil supply line.

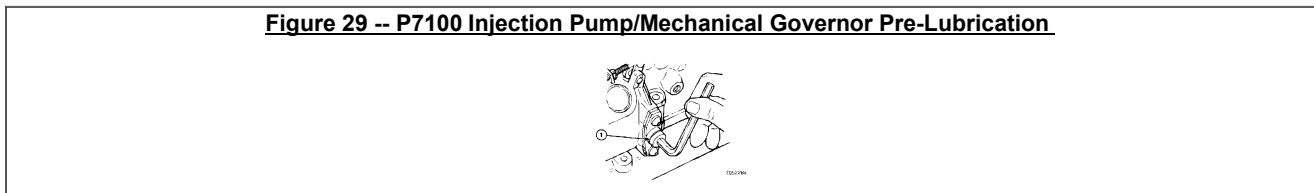
FUEL INJECTION PUMP PRE-LUBRICATION

To pre-lubricate the P8500/RE30 fuel injection pump and governor, add 12 ounces (0.4 liter) of clean engine oil through the Timing Event Marker (TEM) port located in the RE30 governor housing. Oil will run through the governor into the pump.



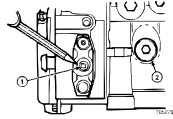
- TEM Port

To pre-lubricate the P7100 fuel injection pump with mechanical governor, remove the timing sensor (fixing plate) plug in the governor housing. Add 12 ounces (355 ml) of clean engine oil. This will fill both the governor and fuel injection pump. Reinstall the timing sensor (fixing plate) plug.



- Fixing Plate Plug

To pre-lubricate the P7100 V-MAC fuel injection pump and governor, remove the timing event marker located on the governor and add 3.5 ounces (104 ml) of clean engine oil. Reinstall the timing event marker. To pre-lubricate the V-MAC injection pump, remove the plug in the side of the pump housing and add 11 ounces of clean engine oil. Reinstall the plug.

Figure 30 -- P7100 V-MAC Injection Pump/Governor Pre-Lubrication

1. TEM Port

2. Injection Pump Plug

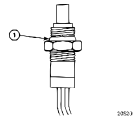
NOTE

Pre-lubrication is required anytime a new or used fuel injection pump is removed and then installed on the engine.

TIMING EVENT MARKER (TEM) INSTALLATION

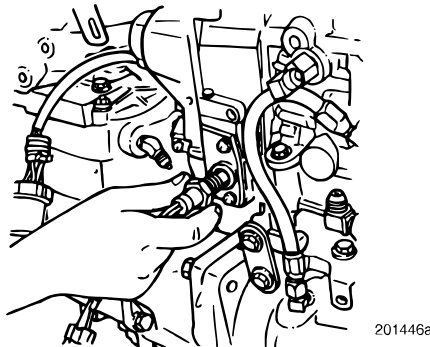
To install the TEM:

1. Thoroughly clean all oil residue from the TEM and timing access window.
2. Completely back off the TEM jam nut (toward the sensor pigtail).
3. Apply a 1/8- to 1/4-inch bead of Silastic (MACK part No. 342SX32 or equivalent) around the sensor threads at the jam nut.

Figure 31 -- Silastic Application

1. Apply 1/8-1/4 inch bead of silastic

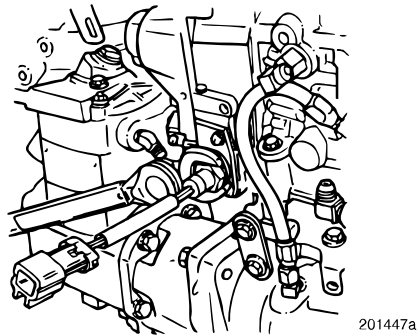
4. Install the TEM sensor into the timing access window and hand tighten until seated in the timing window.

Figure 32 -- Installing TEM Sensor

5. Tighten the jam nut, running it over the Silastic.

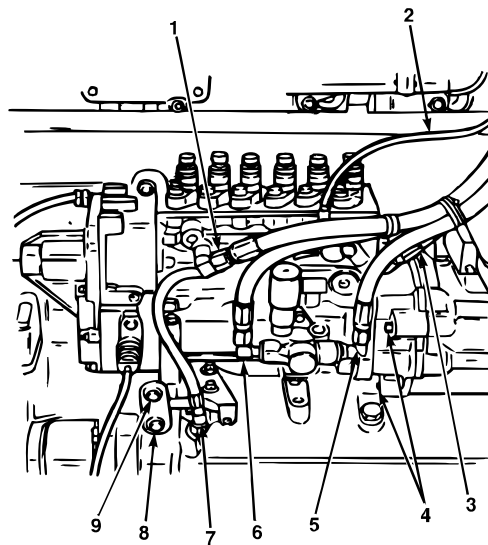
6. Torque the jam nut to 22 lb-ft (30 N • m) using torque wrench J 24406 or equivalent.

Figure 33 -- Torquing TEM Sensor Jam Nut



7. Wipe the excess Silastic with a dry cloth.
8. Reconnect all brackets, connections and fuel lines.

Figure 34 -- Pump Line Connections



1. Return from secondary filter
2. Cylinder head overflow line
3. Return to tank line
4. Capscrew

5. Return to secondary filter
6. Return from primary filter
7. Lubrication supply line
8. Capscrew
9. Capscrew

9. Check all connections and clamps for tightness. Check for leaks.

[212 NP] LOCATING PISTON TOP DEAD CENTER (TDC)

E7 SERIES ENGINES WITH TIMING INDICATORS

During timing inspection, if timing is found to be incorrect, check piston TDC and retime engine. The following instructions are provided to aid in locating piston TDC in the event the engine front timing pointer is bent or misaligned.

NOTE

On engines with front timing indicators, vibration damper is marked to show TDC location relative to No. 1 piston on compression stroke. After locating piston TDC, front timing indicator may be adjusted slightly until it aligns with the TC or "0" mark stamped on vibration damper.

SPECIAL TOOL REQUIRED

- Top Dead Center Indicator Tool J 29539-A

LOCATING PISTON TDC

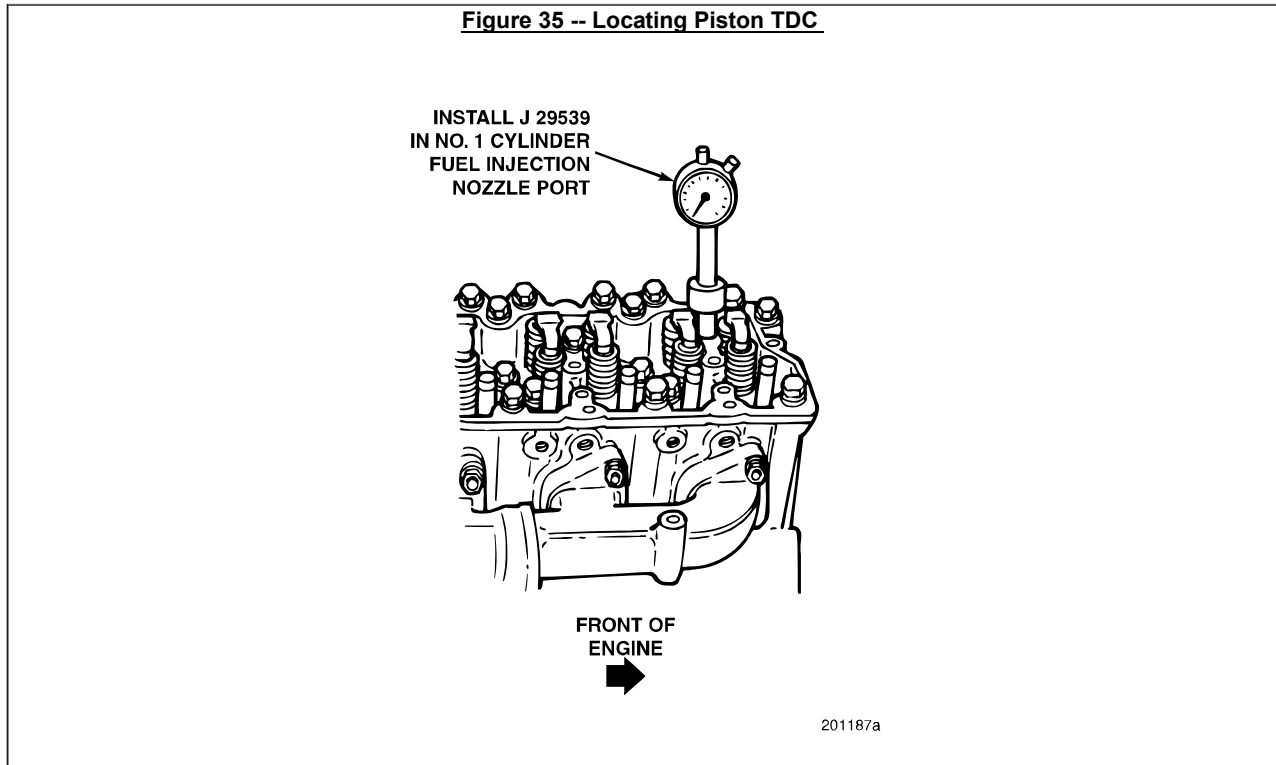
CAUTION

If chassis is equipped with an engine stop control, pull control out to prevent accidental starting.

Refer to **Figure 35 -- Locating Piston TDC**.

1. Rotate engine in normal rotation direction until No. 1 piston is approximately at TDC on compression stroke.
2. Remove injection nozzle holder assembly from the No. 1 cylinder (front cylinder on E6 and E7 engines).
3. Install TDC indicator tool J 29539-A in nozzle holder opening.
4. Rotate engine in normal rotation direction until the highest reading is obtained on the dial indicator. At this point, zero dial indicator.
5. Center a 5-inch (127 mm) length of masking tape below the pump timing pointer and on the vibration damper.
6. Rotate engine in direction opposite to normal rotation until a reading of 0.060 inch (1.524 mm) is obtained on the dial indicator.
7. Rotate engine in normal rotation direction until dial indicator reads exactly 0.035 inch (0.889 mm).
8. Place a mark on the masking tape on the vibration damper to align with pump timing indicator pointer.

9. Rotate engine in normal rotation direction past zero on dial indicator until a reading of 0.060 inch (1.524 mm) is obtained.



10. Rotate engine in direction opposite to normal rotation until a reading of exactly 0.035 inch (0.889 mm) is indicated on dial indicator.
11. Place a mark on the masking tape on the vibration damper to align with pump timing pointer.
12. Measure distance between the two marks just made on the masking tape and place a third mark exactly at the midpoint between the first two marks.
13. Rotate engine in direction opposite to normal rotation until engine timing pointer aligns with the middle mark just made on vibration damper. Remove masking tape.
14. If necessary, without rotating the engine, realign pump timing pointer until it aligns with the TC or "0" mark stamped on the vibration damper.

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