

## **1.18 PISTON AND CONNECTING ROD ASSEMBLY**

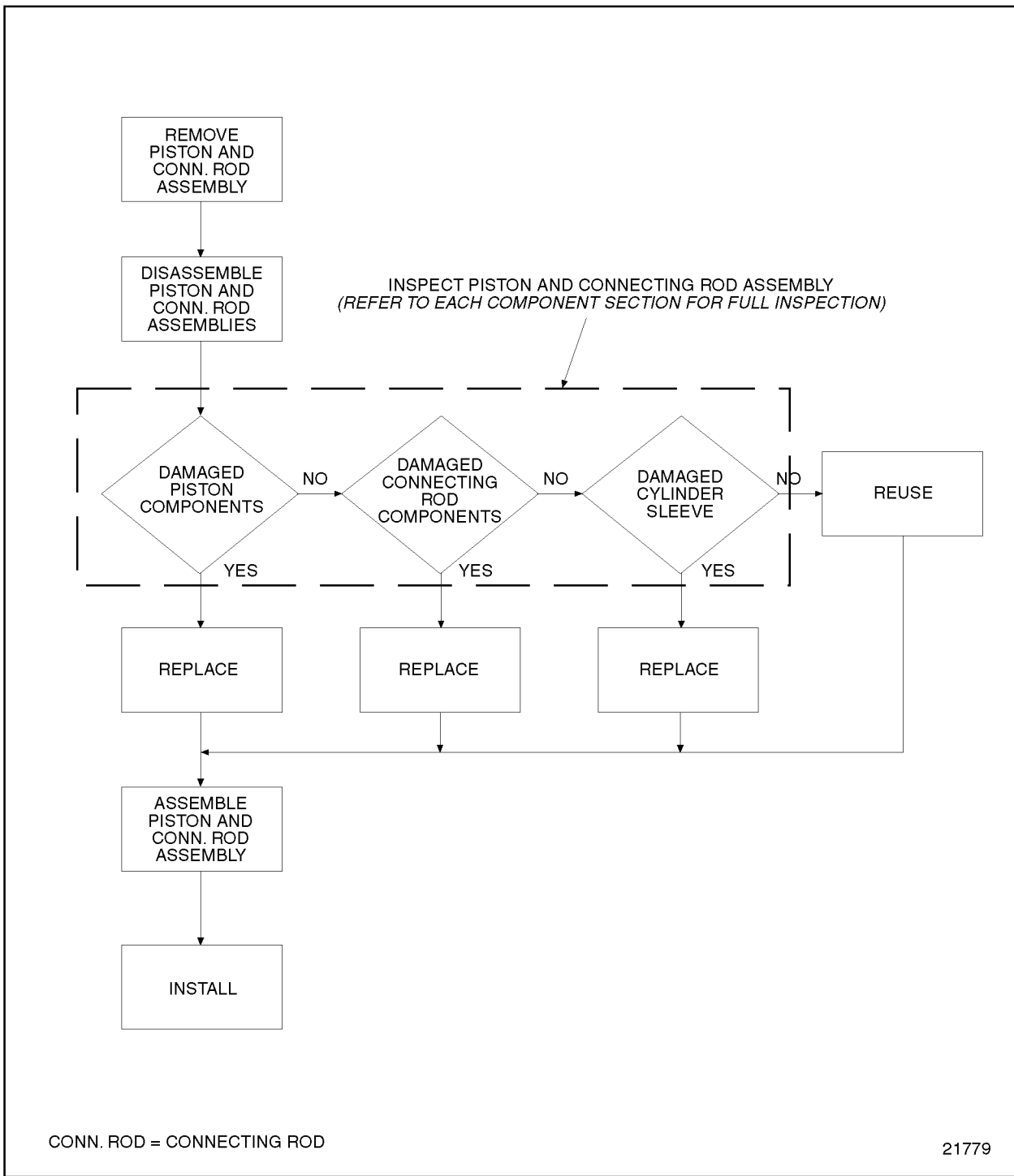
The piston and connecting rod assembly is one unit made of two separate components.

For general information, refer to Section 1.17.

For connecting rod assembly information, refer to Section 1.19.

### **1.18.1 Repair or Replacement of Piston and Connecting Rod**

To determine if repair is possible or replacement is necessary, perform the following procedure. See Figure 1-239.



**Figure 1-239** Flowchart for Repair or Replacement of Piston and Connecting Rod

### 1.18.2 Cleaning and Removal of Piston and Connecting Rod

Precleaning is not necessary.

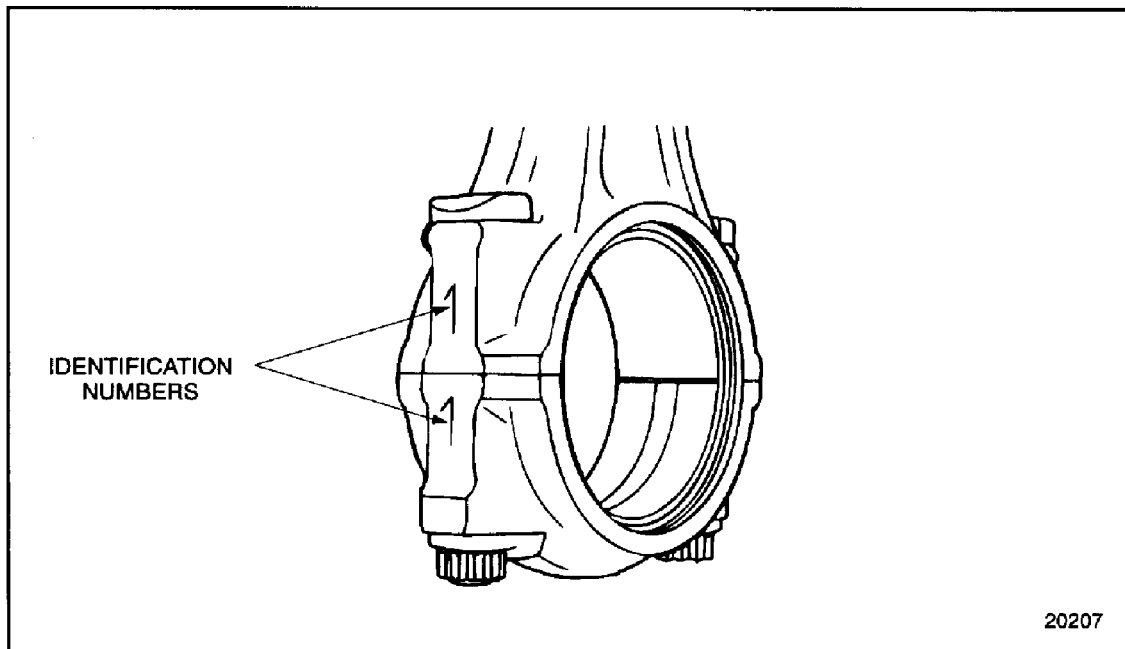
Remove the piston and connecting rod assembly as follows:

1. Drain the engine cooling system. Refer to Section 13.5.4.
2. Drain the engine oil and remove the oil pan. Refer to Section 3.9.2.
3. Remove the cylinder head. Refer to Section 1.2.2.
4. Use an emery cloth to remove any carbon deposits from the upper surface of the cylinder liner.
5. Remove the bearing cap and lower bearing shell from the connecting rod.
6. Install connecting rod guides, J 35945 (or equivalent), to protect the crankshaft journals.
7. Push the piston and rod assembly out through the top of the cylinder block.

**NOTE:**

The piston cannot be removed from the bottom of the cylinder block.

8. Assemble the bearing cap and lower bearing shell to the connecting rod after removal. If not already marked, match-mark the rod and cap (on the tang side) with the cylinder No. where they were removed. See Figure 1-240.



**Figure 1-240 Connecting Rod and Cap Identification**

**NOTE:**

When removed, the bearing cap and the bearing shell must be reinstalled on the original connecting rod before another connecting rod bearing cap is removed.

**NOTE:**

If removing the piston and connecting rod assembly to work on the cylinder liner, stop here. Refer to Section 1.20.2 for cylinder liner removal procedure.

### 1.18.3 Disassembly of Piston and Connecting Rod Assembly

Piston assembly components should be segregated by cylinder and match-marked during disassembly to ensure they are assembled in the same position and orientation.

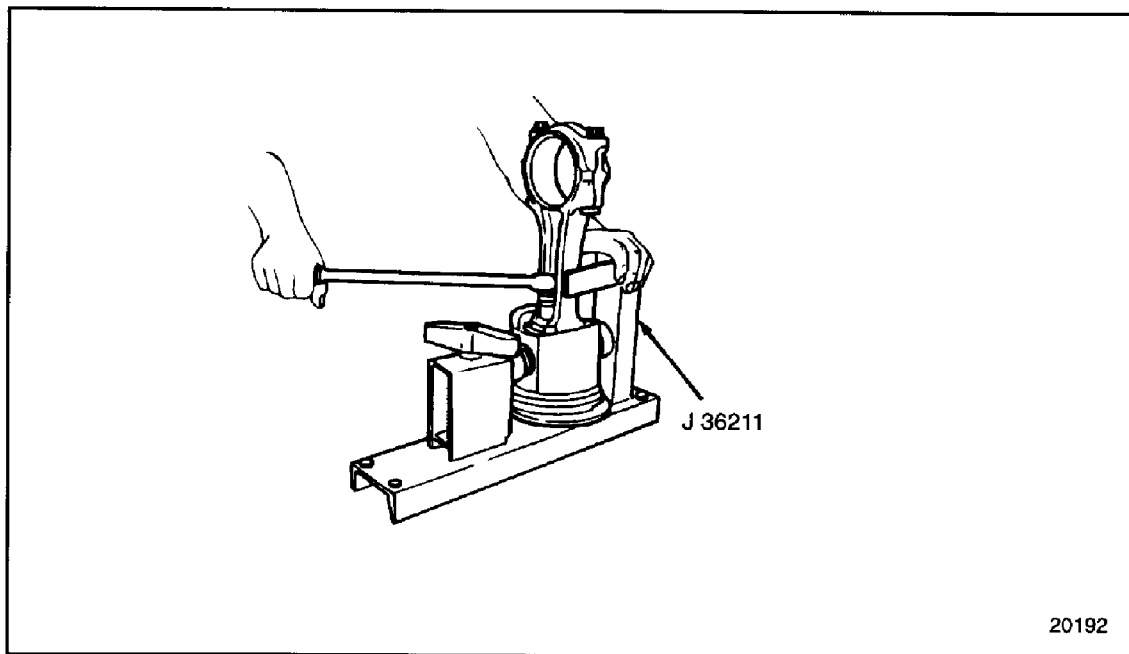
**NOTICE:**

Stamping cylinder numbers would damage the components.

It is best to use a paint pencil. For cast iron pistons mark the pin, skirt, bushing, and dome ear at the front. For forged steel pistons, mark the pin, skirt and dome.

Disassemble the cast iron piston and connecting rod assembly as follows:

1. Place the piston, dome down, on the round plate of the piston and connecting rod holding fixture, J 36211. See Figure 1-241.

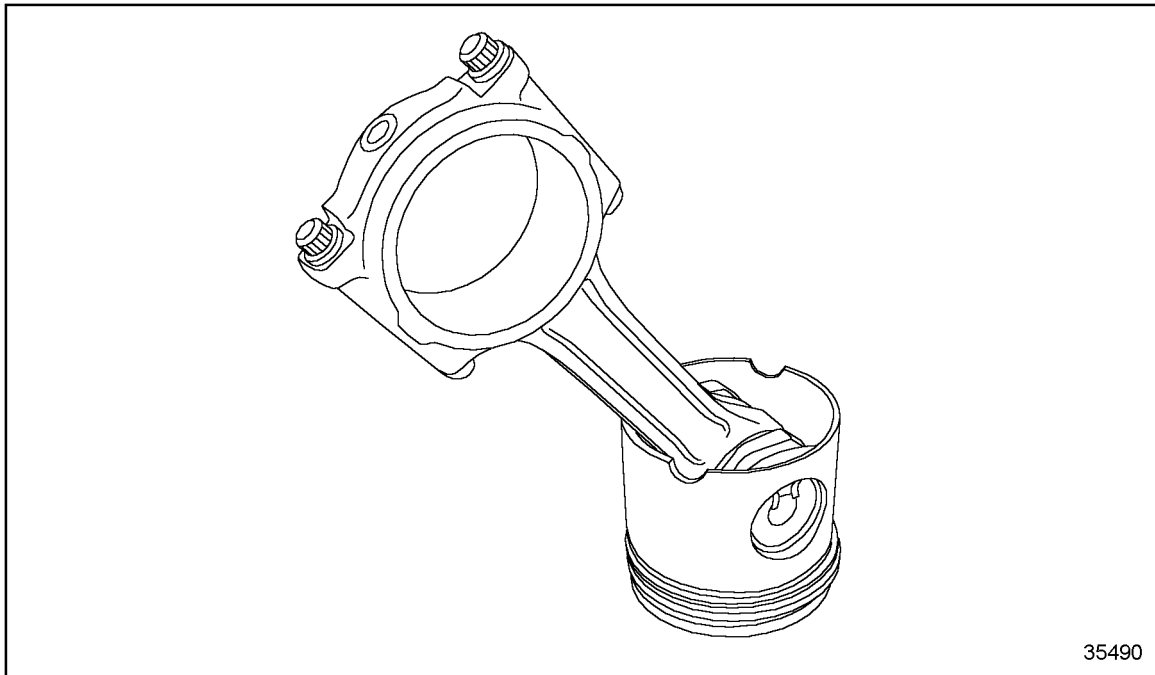


**Figure 1-241 Piston Connecting Rod Holding Fixture**

2. Slide the movable portion of the fixture until it contacts the piston pin and tighten the handle.
3. Loosen the two bolts that secure the connecting rod to the piston pin and remove the two bolts and spacers.
4. Remove the connecting rod.
5. Remove the piston, pin and skirt from the holding fixture.

Disassemble the forged steel piston and connecting rod assembly as follows:

1. Place the piston dome down on the table. See Figure 1-241a



**Figure 1-241a Positioning of the Piston and Connecting Rod Assembly**

2. Using the required snap ring pliers, remove the circlip-type snap rings from the piston skirt.
3. Slide out the piston pin and remove the connecting rod from the piston.
4. Disassemble the piston dome from the skirt.

### **1.18.3.1 Inspection of the Piston and Connecting Rod Assembly**

Refer to Section 1.17.3 for disassembly and inspection of the piston and piston rings.

Refer to Section 1.19.3 for disassembly and inspection of the connecting rod.

**NOTE:**

Upper connecting rod bushings are not servicable. If found damaged replacement of the connecting rod is required.

### **1.18.4 Assembly of the Piston and Connecting Rod Assembly**

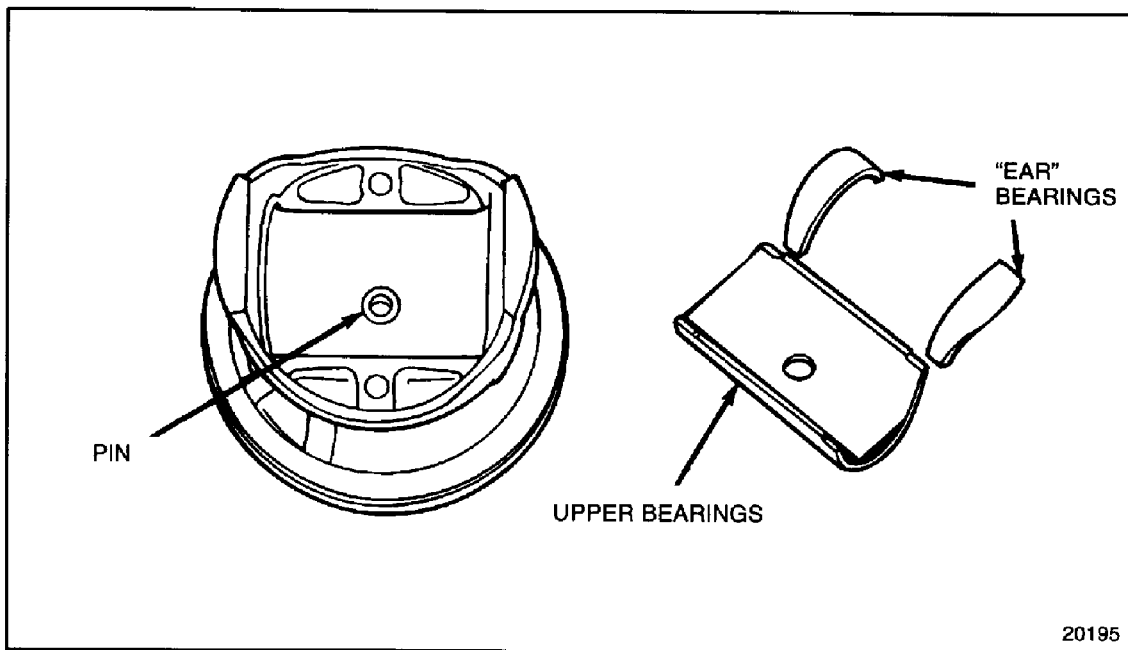
Assemble the cast iron piston and connecting rod assembly as follows:

**NOTICE:**

The connecting rod-to-piston pin attaching bolts and spacers are specially designed components. No other bolts or spacers may be used. Piston pin bolts are considered one-use items and **must** be replaced with new bolts when removed for any reason. Failure to observe this precaution may result in bolt loosening or breaking during engine operation, which may cause serious engine damage.

1. Discard used piston pin bolts and replace with new bolts.
2. For specifications on reusing piston assembly components. Refer to Section 1.18. Because of the low clearance fit between the piston pin and three-piece pin bearing, care in handling and cleanliness of piston dome bore, bearings and, piston pin are important. Otherwise, assembly may be impossible.
3. The pin bore and bearing backs should be wiped clean prior to installation of the bushings in the piston dome.
4. Installing piston pin bearings (with the piston dome standing on the rim) requires the upper bearing piece to be inserted through the end of the pin bore and dropped over the retaining pin.
5. The lower bearing pieces are inserted flat side in by tilting the bearing at approximately a 30° angle from the vertical away from the dome ear.
6. Set the edge of the bearing parting line on the edge of the upper piece notch and rotate the lower bushing up and into place.

7. The lower bearing can then be pushed full into the bore with the thumb. See Figure 1-242.



**Figure 1-242** Piston Dome and Bearing Details

8. Lubricate the piston pin bearings with clean engine oil.
9. Set the piston skirt on the piston dome.
10. Align the piston pin holes in the dome and skirt.
11. Check the piston pin for foreign matter in the bolt holes.
12. Lubricate the pin with clean engine oil and install in the bores with the bolt holes facing the connecting rod, away from the dome.

**NOTE:**

The piston pin may feel considerably tighter than with conventional designs and possibly may not be turned easily by hand. Proper pin and bearing installation should result in a piston assembly in which the pin can be turned with the connecting rod while the piston dome is standing on the rim and the piston skirt is held with the other hand.

13. Apply a small amount of International Compound #2<sup>®</sup>, or equivalent, to the bolt threads and bolt head contact surfaces and both ends of the spacers.



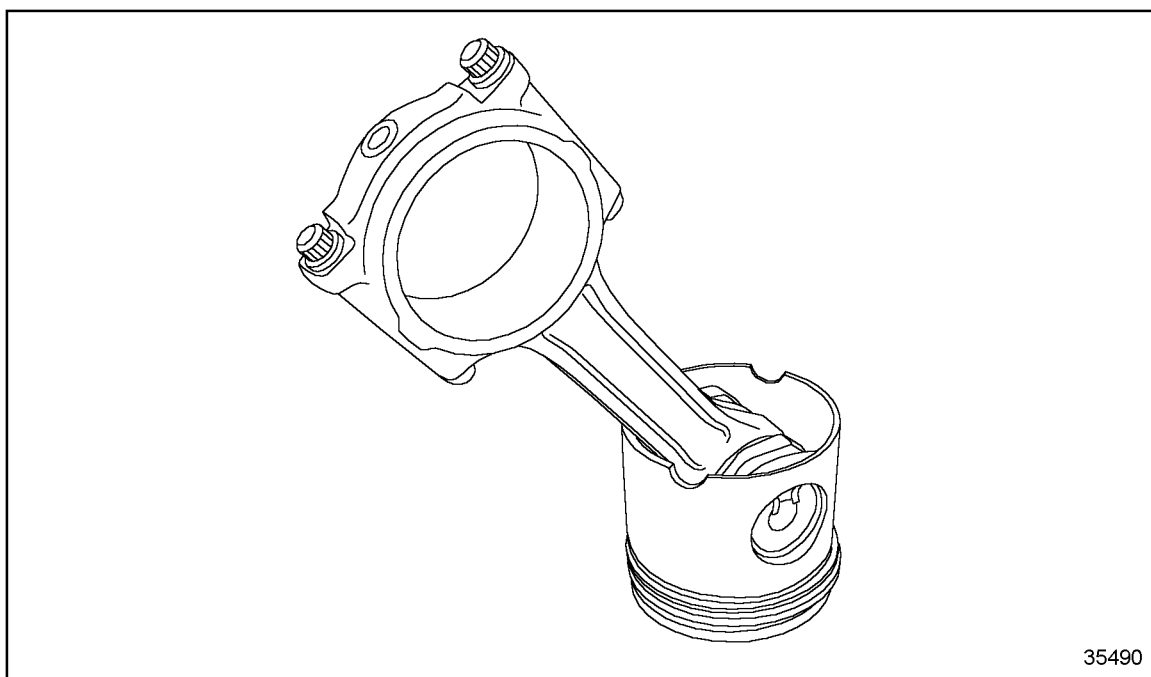
**NOTICE:**

The connecting rod-to-piston pin attaching bolts and spacers are specially designed components. No other bolts or spacers may be used. Piston pin bolts are considered one-time use items and must be replaced with new bolts when removed for any reason. Failure to observe this precaution may result in bolt loosening or breakage during engine operation, which may cause serious engine damage.

14. Install the spacers on the two special connecting rod-to-piston attaching bolts.
15. After clamping the connecting rod in holding fixture, J 36211, torque each piston pin bolt to 95-122 N·m (70-90 lb·ft).
16. Complete the process by tightening the bolts to 150-164 N·m (111-121 lb·ft) final torque.

Assemble the steel piston and connecting rod as follows:

1. Position the piston dome on it's rim. See Figure 1-242a



**Figure 1-242a**      **Positioning of Piston Dome**

2. Set the piston skirt on the piston dome.
3. Place the piston skirt on the piston dome with the notches facing away from the dome.
4. Align the piston pin bores of the dome and skirt.
5. Lubricate the piston pin bearings in the dome and connecting rod with clean engine oil.

6. Using the required snap ring pliers, install one of the circlip-type snap rings into the recess in the piston skirt. Orient the snap ring gap to either the 12 o'clock or 6 o'clock position.
7. Lubricate the pin with clean engine oil.
8. Position the end of the connecting rod inside the piston dome.
9. Install piston pin into the pin bores through rod until it rests against the previously installed snap ring.
10. Using the required snap ring pliers, install the other circlip-type snap ring into the recess in the piston skirt to lock the pin in place. Orient the snap ring gap to either the 12 o'clock or 6 o'clock position.

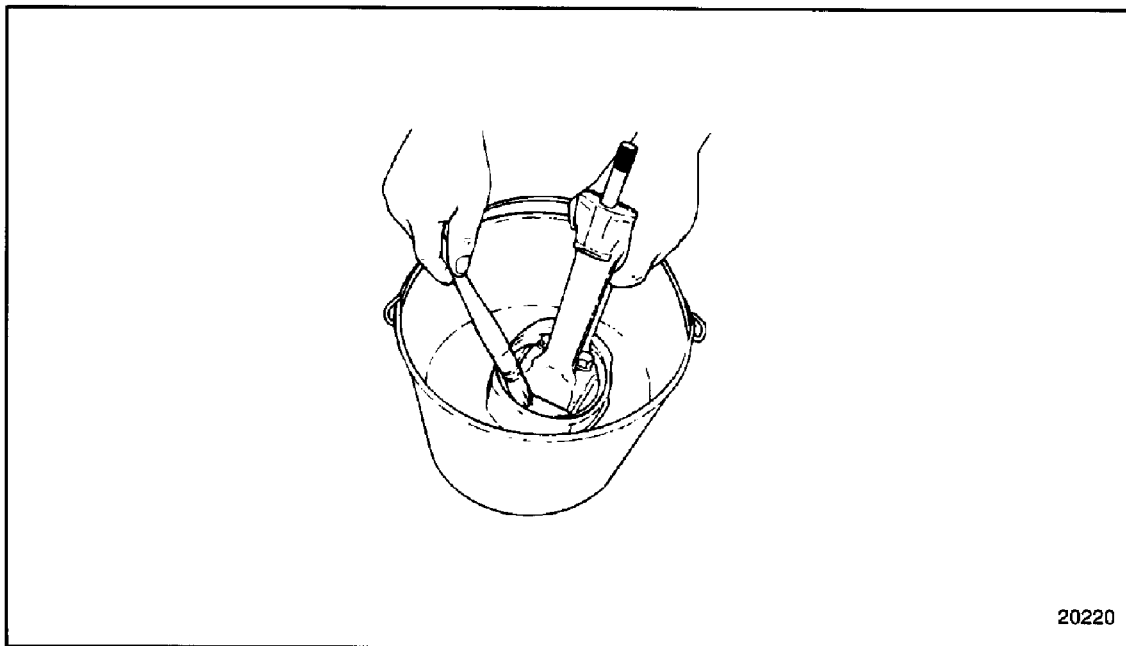
### 1.18.5 Installation of Piston and Connecting Rod Assembly

Use piston ring compression tool, J 35598-A, to install the piston and connecting rod assembly to the engine as follows:

NOTICE:
Inspect the piston ring compressor for nicks or burrs, especially at the non-tapered inside diameter end. Nicks or burrs on the inside diameter of the ring compressor may result in damage to the piston rings.

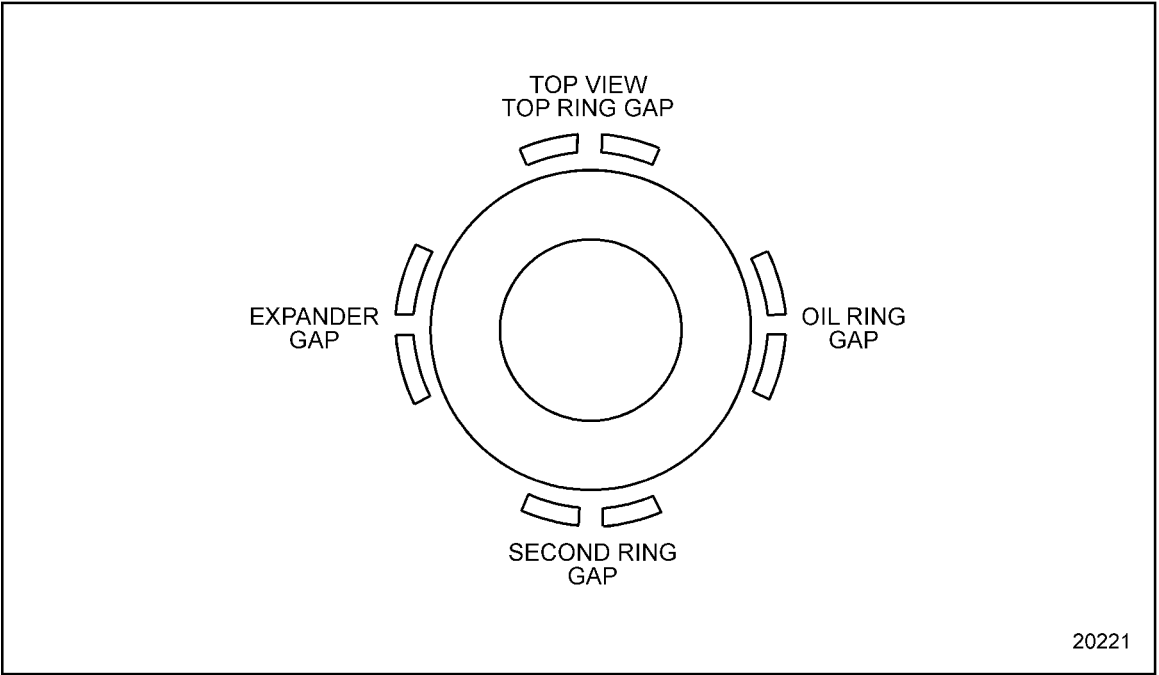
1. Add clean engine oil to a clean drain pan at least 305 mm (12 in.) in diameter, until the level reaches approximately 76 mm (3 in.).
2. Place the piston and connecting rod assembly into the pan, with the dome of the piston on the bottom of the pan.

3. Coat the piston liberally with the engine oil, saturating the piston rings and lands.  
See Figure 1-243.

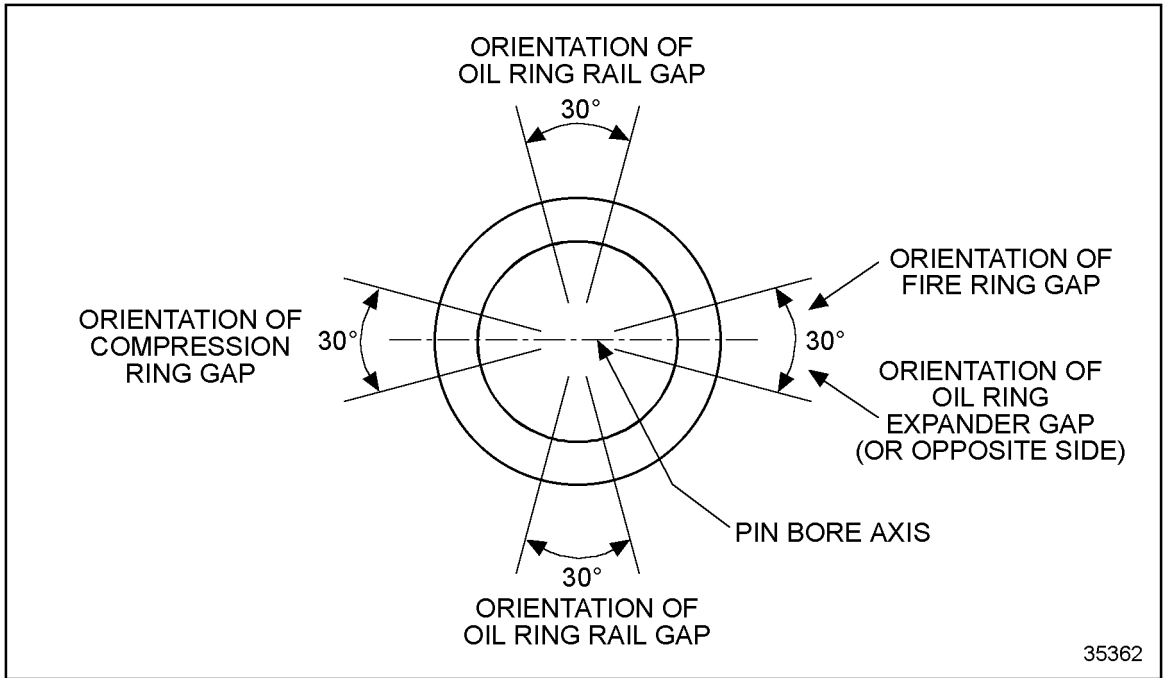


**Figure 1-243      Piston and Connecting Rod Assembly Lubrication**

4. Position (stagger) the piston ring gaps properly on the piston at 90° intervals. See Figure 1-244 for diesel and see Figure 1-245 for natural gas engines.

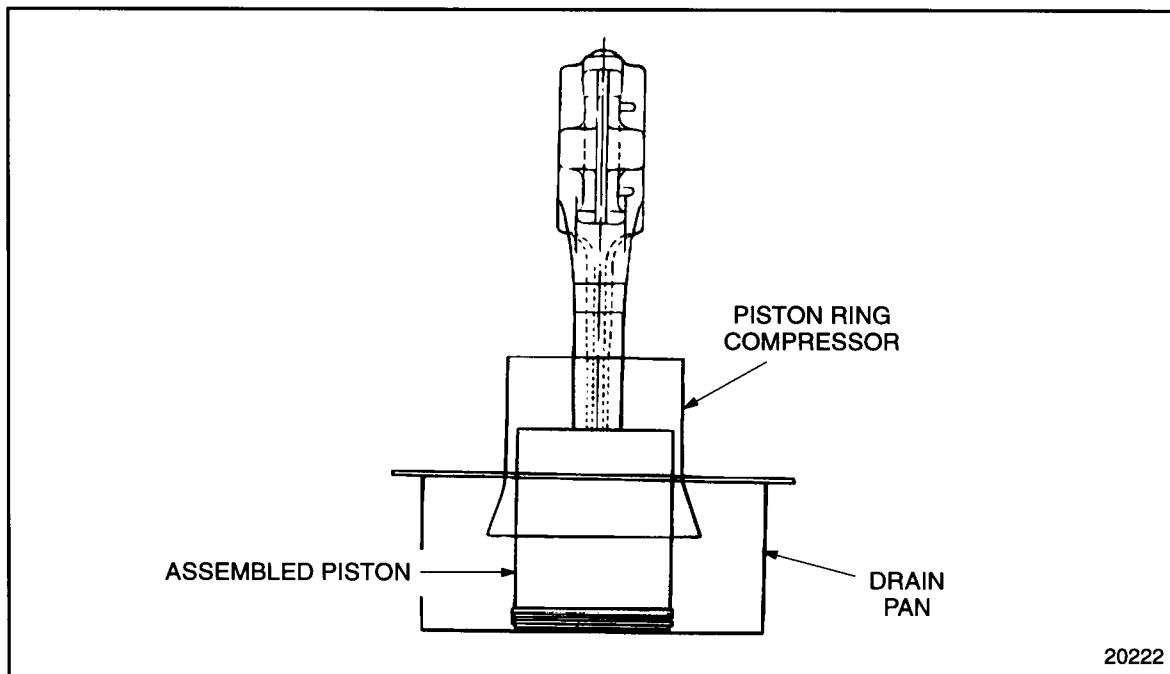


**Figure 1-244 Piston Ring Positioning (Diesel)**



**Figure 1-245 Piston Ring Positioning (Natural Gas)**

5. Place the piston, dome down, in the bottom of the pan. Center the dome of the piston. See Figure 1-246.



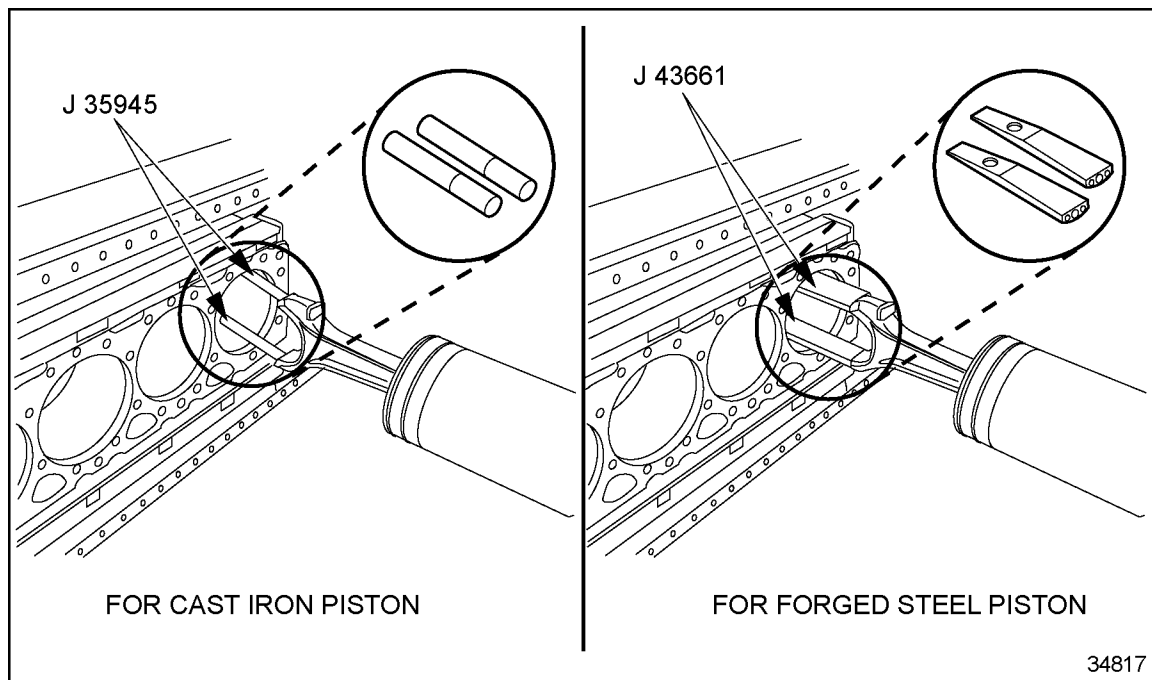
**Figure 1-246**      **Installing Piston and Connecting Rod Assembly into Ring Compressor**

6. Coat the inside diameter of the ring compressor liberally with clean engine oil from the pan.
7. Install the tapered end of the piston ring compressor over the end of the connecting rod, and down onto the piston. As the ring compressor slides down the piston to the piston ring area, apply slow, even pressure on both sides of the ring compressor to compress the rings.
8. Slide the ring compressor down until it contacts the bottom of the drain pan.
9. Position the crankshaft so that the connecting rod journal for the cylinder being worked on is at bottom-dead-center.
10. Remove the cap from the connecting rod.

**NOTICE:**

Do not allow the connecting rod to contact the cylinder liner on installation, or damage to the liner may occur. The numbers on the side of the connecting rod and cap identify the rod with the cap and indicate the particular cylinder in which they are used. If a new service connecting rod is to be installed, the same identification numbers must be stamped in the same location (on the tang side of the rod and cap) as on the connecting rod that was replaced.

11. Install connecting rod guides, ( J 35945 for cast iron, or J 43661 forged steel piston) over the ends of the connecting rod bolts to prevent damaging the crankshaft journals or the joint face of the rod. The guides also prevent the connecting rod from contacting the liner and damaging the surface. See Figure 1-247



**Figure 1-247 Connecting Rod Guides Installation**

**NOTE:**

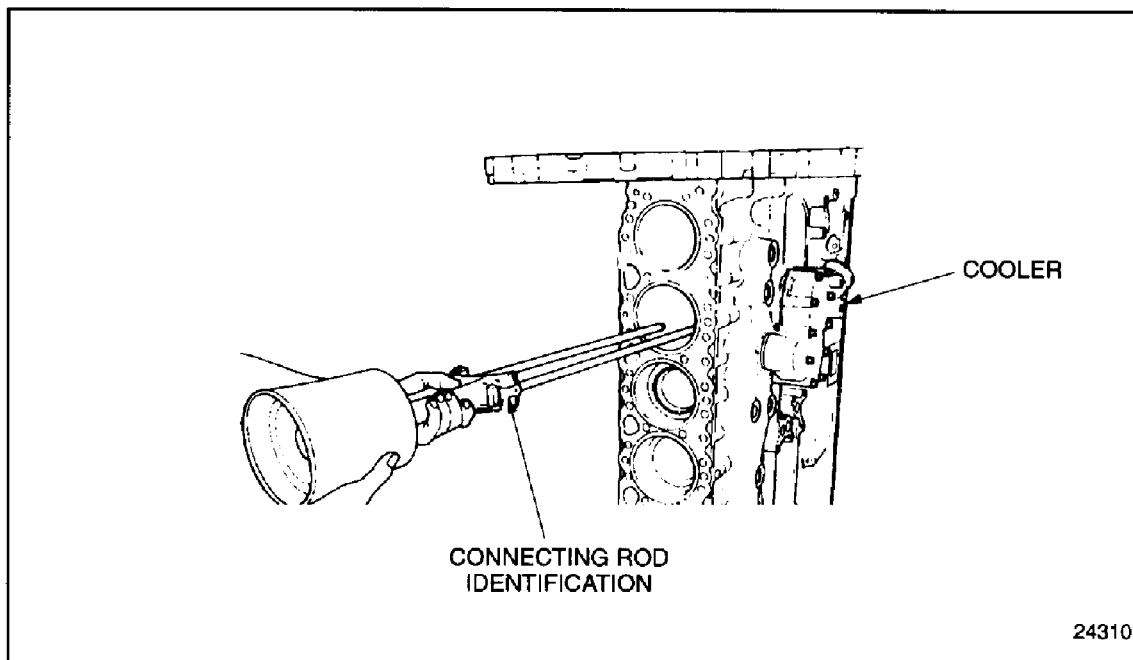
The connecting rod guides are threaded at the upper end and attach to the rod bolts.

12. Grasp the connecting rod assembly with one hand, and the piston ring compressor with the other. Lift the assembly out of the pan, and allow excess oil to drain back into the pan.

**NOTE:**

Do not allow the piston to slide out of the bottom of the ring compressor. **DO NOT** lift the assembly using the connecting rod guides.

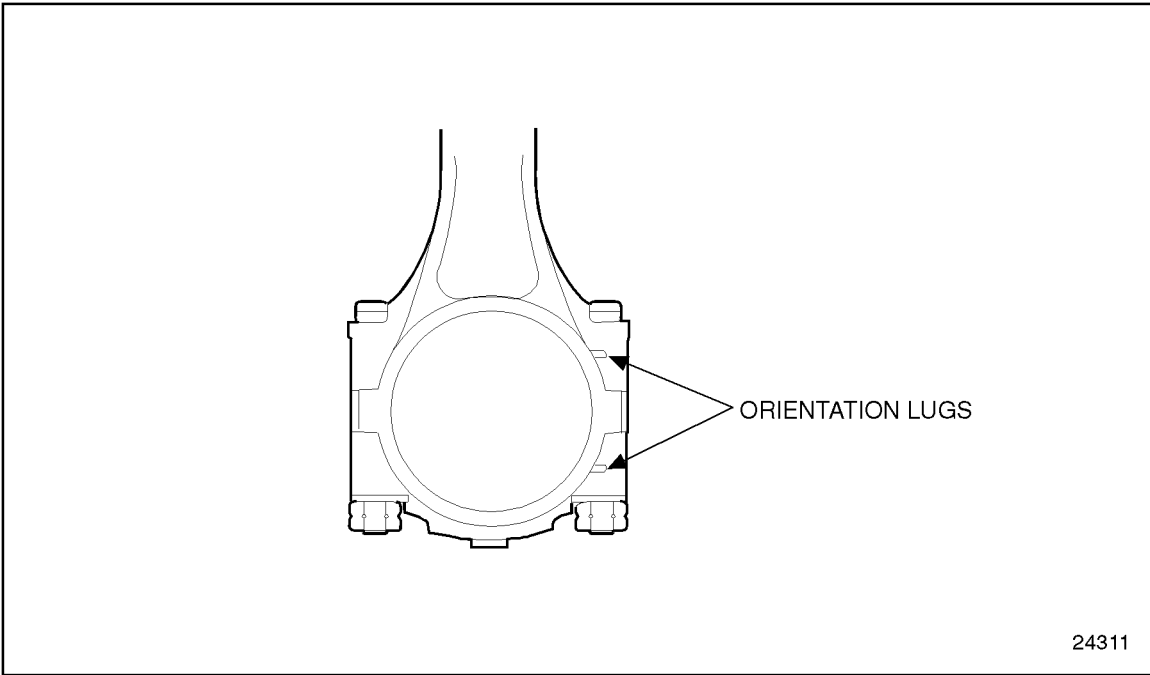
13. With the crankshaft throw in the bottom position, place the ring compressor and the piston and connecting rod assembly over the cylinder it is to be installed in, being sure the No. on the connecting rod is towards the cooler side of the engine. See Figure 1-248.



**Figure 1-248**      **Connecting Rod Indexing**

**NOTE:**

There are orientation lugs cast into one side of the upper and lower sections of the connecting rod. These orientation lugs face the front of the engine. See Figure 1-249.



**Figure 1-249**      **Orientation Lugs**



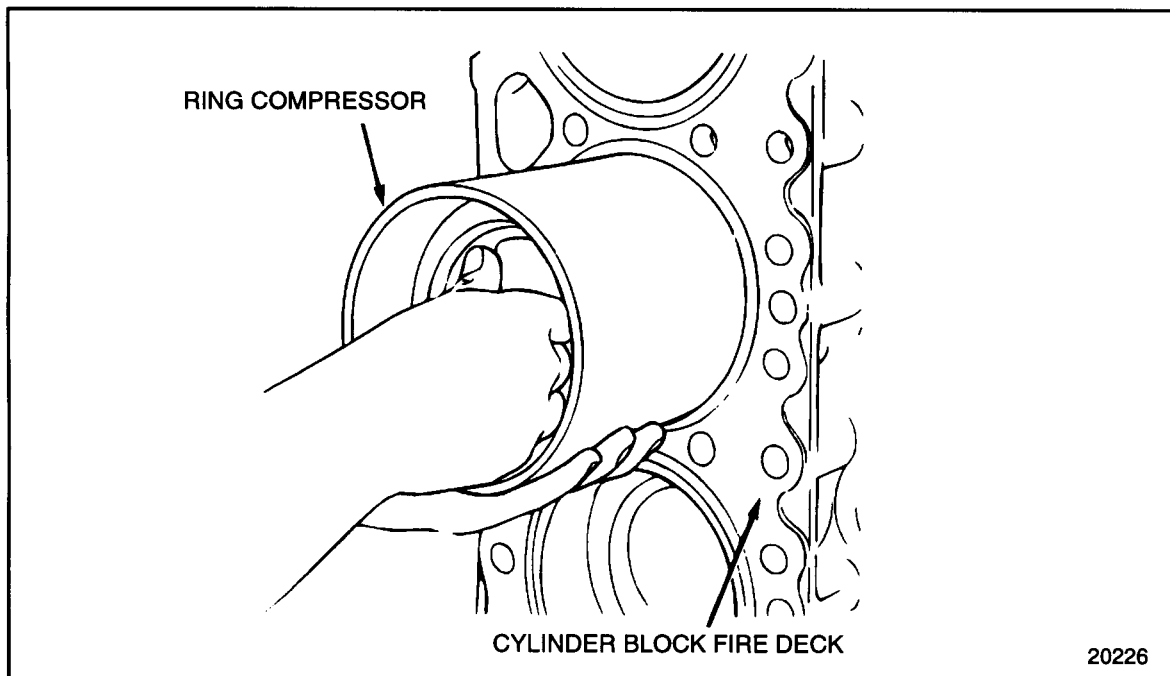
**NOTICE:**

When installing a forged steel piston into the engine, care must be taken to avoid damaging the piston cooling nozzle installed at the base of the cylinder bore. Before loading the piston into the liner, turn the connecting rod so that the bearing end is offset approximately 10-15 degrees and not perpendicular to the crankshaft, as is the case with cast iron pistons. This will ensure that the rod end does not strike the nozzle when the piston is pushed in. Once the rod end is past the nozzle, turn the rod so that the bearing end is perpendicular to the crankshaft journal.

**NOTICE:**

Failure to orient the piston connecting rod properly during forged steel piston installation may result in the bearing end of the rod striking the nozzle, causing damage to the nozzle or loosening it from the block. A damaged, bent, or loosened nozzle may cause a loss of main gallery oil pressure. In these cases, piston overheating or lack of adequate lubrication may result in severe engine damage.

14. Install the ring compressor, with piston and connecting rod inside, into the proper cylinder until the ring compressor is resting squarely on the cylinder liner. See Figure 1-250.



**Figure 1-250 Use of Ring Compressor**

**NOTICE:**

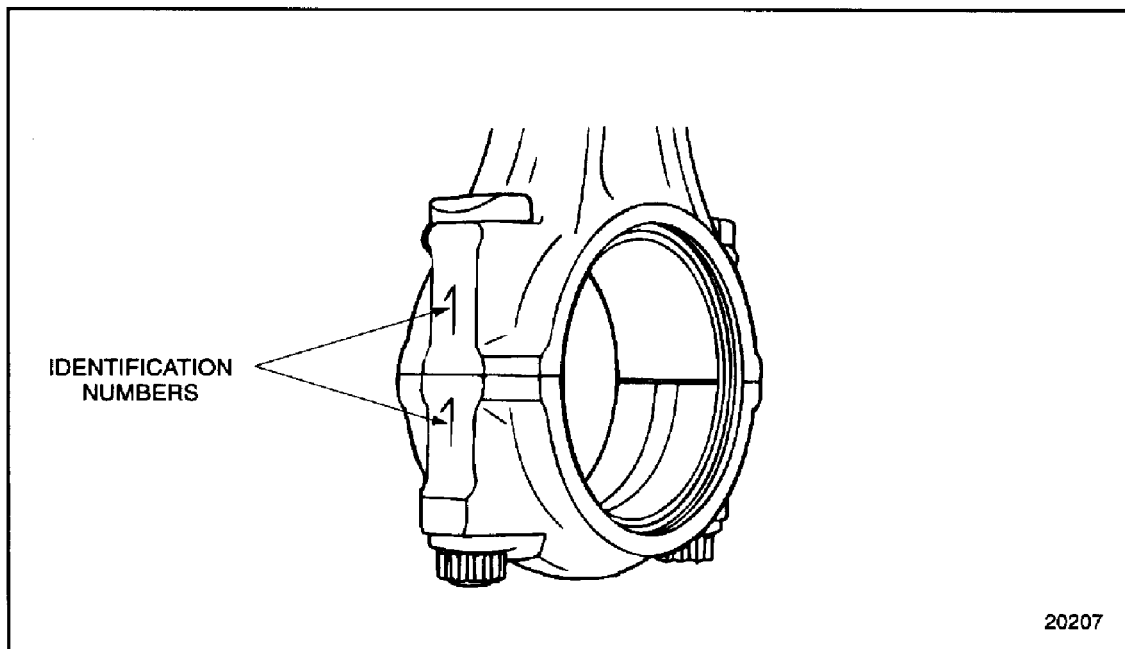
Do NOT force the piston into the liner. The oil ring expander applies considerable force on the oil ring. Therefore, care must be taken during the loading operation to prevent ring breakage.

15. Push the piston and connecting rod assembly down into the liner until the piston is free of the ring compressor.
16. Remove the piston ring compressor.
17. Push or tap the piston and connecting rod assembly into the liner until the upper bearing shell is firmly seated on the appropriate crankshaft journal.
18. Remove the protective sleeves from the ends of the connecting rod bolts.

**NOTE:**

Be sure the connecting rod bolts have not been unseated or turned and the bearing locating tang is in its proper location.

19. Place the lower bearing shell in the connecting rod cap, indexing the tang on the bearing with the notch in the cap.
20. Lubricate the bearing shell with clean engine oil.
21. Install the bearing cap. The No. on the cap and rod should be on the same (oil cooler) side. See Figure 1-251.



**Figure 1-251 Connecting Rod and Cap Identification**

22. Torque the connecting rod bolts alternately to 160-185 N·m (118-137 lb·ft).

23. Check connecting rod side clearance by moving the rod from crank cheek-to-crank cheek. If there is no clearance, check bearing cap installation.
24. Install the remaining piston and rod assemblies in the same manner.
25. Install a new head gasket. Refer to Section 1.2.5.
26. Install the cylinder head. Refer to Section 1.2.5.
27. Install the lubricating oil pump and balance shaft assembly inlet pipe and screen assembly, and the lubricating oil pump. Refer to Section 3.2.5.
28. Install the oil pan. Refer to Section 3.9.3.
29. Complete any other engine assembly as necessary.
30. After the engine has been completely assembled, refill the crankcase to the proper level on the dipstick. Refer to Section 13.5.1.
31. Close the drain cocks and fill the engine with the recommended coolant. Refer to Section 13.5.4.

**NOTE:**

Coolant system maintenance is very important. Bleed off all of the air from the system and top off.

32. If new parts such as pistons, rings, cylinder liners or bearings were installed, operate the engine on the run-in schedule. Refer to Section 11.8.2.
33. Refer to Section 11 for verification of proper piston and connecting rod assembly installation.

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