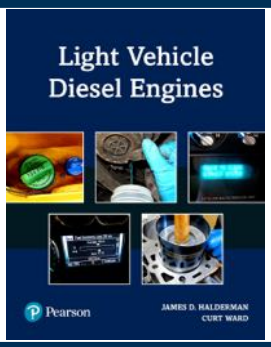
Light Vehicle Diesel Engines

First Edition



Chapter 8

Diesel Engine Assembly

LEARNING OBJECTIVES (1 of 2)

8.1 Prepare for the Light Vehicle Diesel Engine (A9) ASE certification test content area “B” (Cylinder Head Diagnosis and Repair) and “C” (Engine Block Diagnosis and Repair).

8.2 Explain short block and cylinder head preparation.

8.3 Discuss final short block assembly.

8.4 Describe camshaft installation and piston/rod installation.

LEARNING OBJECTIVES (2 of 2)

8.5. Explain cylinder head installation procedure.

8.6. Discuss torque-to-yield (TTY) head bolts.

8.7. Explain valve train assembly and final assembly of an engine.

DETAILS (1 of 1)

- Read
  - Read all instructions specifications, etc.
- Understand
  - Everything stated in instructions
  - Call company to be sure
- Follow
  - Follow all of the instructions
    - Do not pick easy procedures & skip others

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SHORT BLOCK PREPARATION (1 of 4)

- **Items to Check:** **Page 94**
  - Surface Finish
  - Checking Surfaces Before Assembly
  - Preparing Block For Studs
  - Preparing Threaded Holes

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FIGURE 8–1 Deburring all sharp edges is an important step to achieve proper engine assembly.

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FIGURE 8–2 thread chaser (top) is preferred tool to clean threaded holes because it cleans without removing metal compared to a tap (bottom).

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CYLINDER HEAD PREPARATION (1 of 1)

- Cylinder Head Items To Check
  - Surface finish of deck specified for head gasket
  - All valves should be checked for leakage
  - All valve springs checked for pressure & installed height
  - Check for proper pushrod length
  - If replacement rocker arms are used
    - Be sure geometry and total lift meet factory specifications

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SHORT BLOCK ASSEMBLY (1 of 4)

- **Pages 94-95**
  - Installing Cups And Plugs
  - Cam Bearings
  - Measuring Main Bearing Clearance
  - Lip Seal Installation

CAUTION: Avoid using Teflon tape on threads of oil gallery plugs or coolant drain plugs. Tape is often cut by threads and thin strips of tape are then free to flow through oil galleries. Tape can cause a clog, thereby limiting lubricating engine oil to important parts of engine.

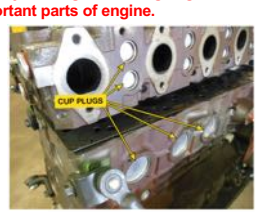

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FIGURE 8–3 This Cummins 6.7-liter inline six-cylinder diesel engine uses many cup plugs to block off coolant openings.

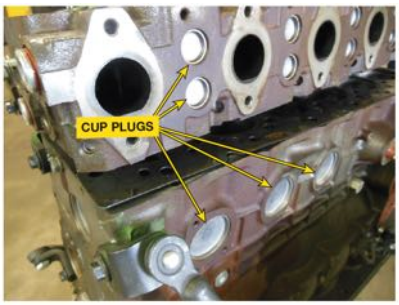

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FIGURE 8–4 Sealer should be applied to the cup plug before being driven into the block

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Figure 8–5 Screw-type puller being used to install a new cam bearing. most cam bearings are crush fit. The full round bearing is forced into the cam bearing bore. most vehicle manufacturers specify that the cam bearings be installed "dry" without lubrication to help prevent them from spinning, which would cause the bearing to block the oil feed hole.

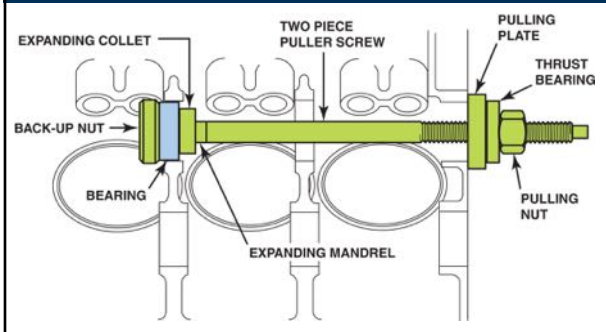

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FIGURE 8–6 Typical main bearing set. Note that the upper halves are grooved for better oil flow and the lower halves are plain for better load support. This bearing set uses the center main bearing for thrust control. Notice that the upper bearing set has the holes for oil, whereas the lower set does not.

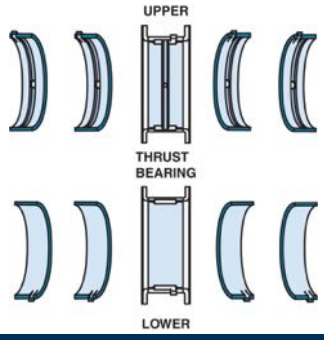

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FIGURE 8–7 width of plastic gauging strip determines oil clearance of main bearing. An alternate method of determining oil clearance includes careful measurement of crankshaft journal and bearings after they are installed, and the main housing bore caps are torqued to specifications. Most main and rod bearing clearance falls within 0.001 and 0.002 inch.

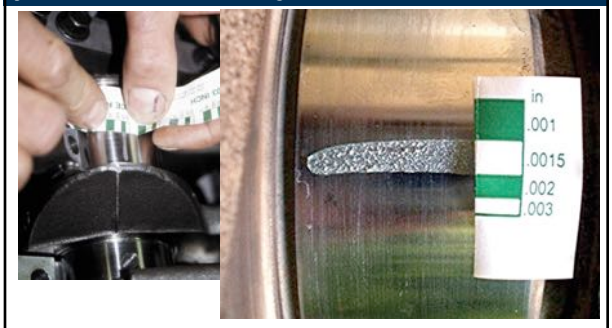

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Figure 8–8 Lip-type rear main bearing seal in place in the rear main bearing cap. The lip should always be pointing toward the inside of the engine.

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"One to Two"

TECH TIP

When engine technicians are talking about clearances and specifications, the unit of measure most often used is thousandths of an inch (0.001 inch). Therefore, a clearance expressed as "one to two" would actually be a clearance of 0.001 to 0.002 inch. The same applies to parts of a thousandth of an inch. For example, a specification of 0.0005 to 0.0015 inch would be spoken of as simply being "one-half to one and one-half." The unit of a thousandth of an inch is assumed, and this method of speaking reduces errors and misunderstandings.

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"One to Two" NOTE:

NOTE: Most engine clearance specifications fall within one to two thousandths of an inch. The written specification could be a misprint. SO, if specification does not fall within this general range, double-check clearance value using a different source.

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CAUTION

CAUTION: Teflon seals should not be lubricated. This type of seal should be installed dry. When engine is first started, some of Teflon transfers to the crankshaft to create a Teflon-to-Teflon surface. Even touching seal with your hands could remove some of outer coating on seal and cause a leak. Carefully read, understand, and follow installation instructions that come with seal.

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SHORT BLOCK ASSEMBLY (2 of 4)

- **Pages 97-**
  - Crankshaft Installation
  - Thrust Bearing Clearance
  - Main Bearing Tightening Procedure

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Fogging Oil and Assembly Lube

TECH TIP

When assembling engine, parts should be coated with a light oil film to keep them from rusting. This type of oil is referred to as fogging oil and is available in spray cans. SEE FIGURE 8–9.
During engine assembly, internal parts should be lubricated. While engine oil or grease could be used, most experts recommend the use of a specific lubricant designed for engine assembly. This lubricant, designed to remain on the parts and not drip or run, is called assembly lube. SEE FIGURE 8–10.

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Figure 8–9 Fogging oil is used to cover bare metal parts when the engine is being stored to prevent corrosion.

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Figure 8–10 Engine assembly lube is recommended to be used on engine parts during assembly.

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QUESTION 1: ?

What items are checked when assembling a short block?

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ANSWER 1:

Items to Check are:
Surface Finish
Checking Surfaces Before Assembly
Preparing Block For Studs
Preparing Threaded Holes
.

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PISTON/ROD INSTALLATION (1 of 4)

- Text Pages 98-100
  - Checking Piston Rings
  - Piston Markings
  - Connecting Rod Bearing Clearance
  - Piston Installation
  - Connecting Rod Side Clearance

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PISTON/ROD INSTALLATION (2 of 4)

- Piston Ring Gap Note
  - NOTE: If gap is greater than recommended, some engine performance lost. However, too small a gap will result in scuffing, because ring ends can be forced together during operation, which forces the rings to scrape the cylinders

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FIGURE 8–11 feeler gauge is used to check piston ring gap.

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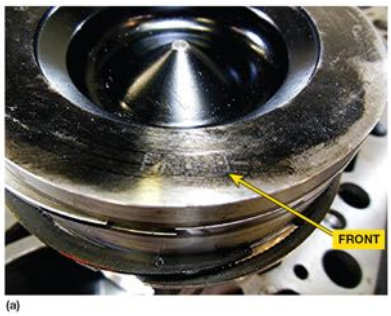
FIGURE 8–12 (A) Cummins 6.7-liter six-cylinder piston showing that the word "front" is marked on the top

- Notch, arrow, or word "front" on piston head indicating front.
- Correctly position piston pin offset toward right Side of engine



(a)

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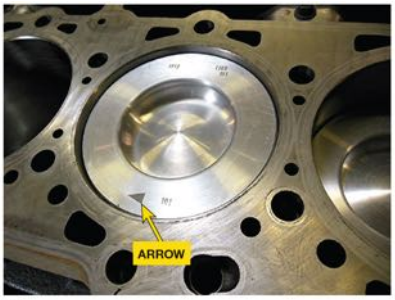
FIGURE 8–12 (B) Duramax diesel engine uses an arrow on the top of the piston to indicate the front of the engine.



(b)

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FIGURE 8–13 on V-type engines that use paired rod journals, the side of the rod with the large chamfer should face toward the crank throw (outward).

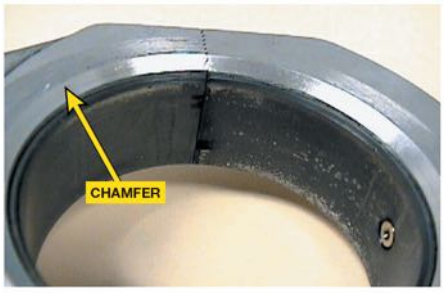

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Figure 8–14 One method of piston ring installation showing the location of ring gaps. Always follow the manufacturer's recommended method for the location of ring gaps and for ring gap spacing.

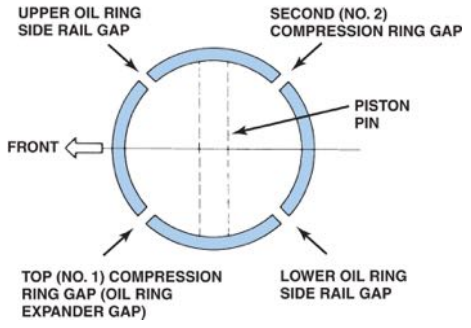

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Figure 8–15 This style of ring compressor uses a ratchet to contract the spring band and compress the rings into their grooves

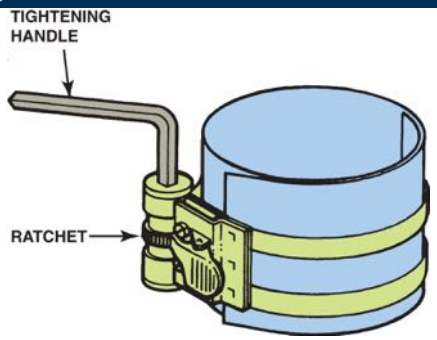

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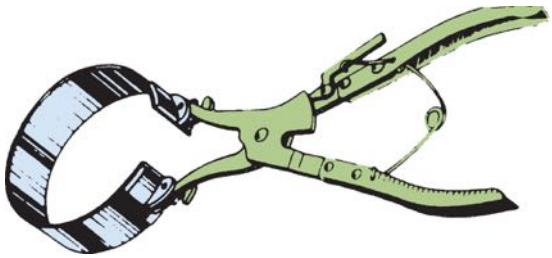
Figure 8–16 This pliers-like tool is used to close the metal band around the piston to compress the rings. An assortment of bands is available to service different size pistons.



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PISTON/ROD INSTALLATION (3 of 4)

- Piston Installation: Pages 99-100
  - Sample steps 1-12
  - NOTE: Always Use Correct OEM
  - Procedure Found in Service Information
- Connecting Rod Bearing Clearance P100
- Connecting Rod Side Clearance P100

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FIGURE 8–17 Installing a piston using a ring compressor to hold the rings into the ring grooves of the piston and then using a hammer handle to push the piston into the bore. Connecting rod stud protectors have been installed to help prevent possible damage to the crankshaft during piston installation.

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FIGURE 8–18 connecting rod side clearance is measured with a feeler gauge.

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CYLINDER HEAD INSTALLATION (1 of 4)

- Clamping Force: Pages 100-101
- Head Bolt Torque Sequence
- Fastener Consideration
- Thread Lubricant

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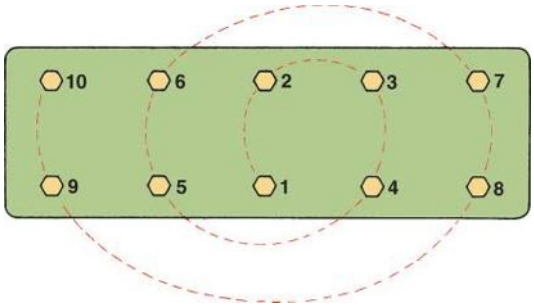
FIGURE 8–19 Typical cylinder head tightening sequence.



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Watch Out for Wet and Dry Holes

TECH TIP

Engines use head bolts that extend through top deck of block & end in coolant passage. These holes are called wet holes. When installing head bolts into holes that end up in coolant, always use sealer on threads of head bolt. Some engines have head bolts that are "wet," whereas others are "dry" because they end in solid cast-iron material. Bolts being installed into dry holes do not require sealant, but still require some oil on threads for lubrication. Do not put oil into dry hole because bolt may bottom out on oil. Liquid oil cannot compress, so force of bolt tightened transferred to block by hydraulic force, which can crack block.

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Tech Tip Note

TECH TIP

NOTE: Apply oil to a shop cloth and rotate the bolt in the cloth to lubricate the threads. This procedure lubricates the threads without applying too much oil.

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TORQUE-TO-YIELD HEAD BOLTS (1 of 4)

- **Text Pages 101-103**
  - Definition and Terminology
  - Bolt Construction
  - Torque-to-yield Procedure
  - Torque Angle Method

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FIGURE 8–20 The maximum clamping force is achieved when the bolt is stretched to its yield point.

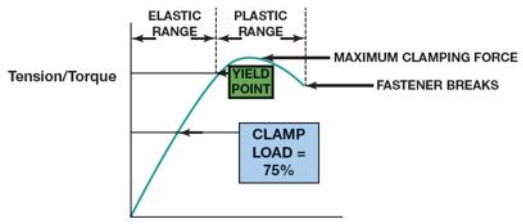

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FIGURE 8–21 To ensure consistent clamp force (load), many manufacturers are recommending the torque-angle or torque-to-yield method of tightening head bolts. The torque angle method specifies tightening fasteners to a low-torque setting and then giving an additional angle of rotation. were used.

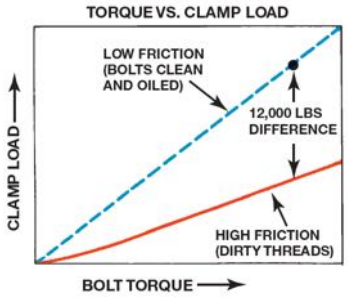

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FIGURE 8–21 Notice that difference in clamping force is much smaller than it would be if just a torque wrench with dirty threads were used.

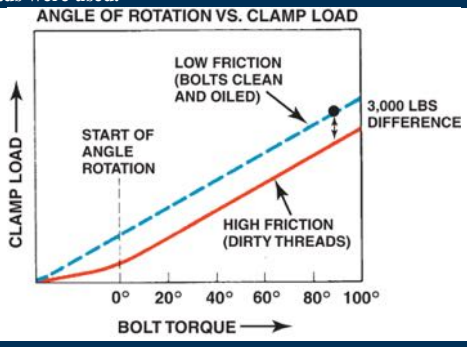

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FIGURE 8–22 Torque angle can be measured using a special adaptor.

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FIGURE 8–23 an electronic torque wrench showing number of degrees of rotation. These very accurate torque wrenches can be programmed to display torque or number of degrees of rotation.

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What Do the Markings on the Head Gasket Mean?

FREQUENTLY ASKED QUESTION

Most light diesel engines use head gaskets that are of a specific thickness to insure that compression ratio is correct. Various thickness of head gaskets are used to fine-tune head installed height that can vary due to machining tolerances of block deck & cylinder head gasket surfaces. Always check service information for information on these markings and thickness of gasket so the engine can be restored to proper specifications after being disassembled. SEE FIGURE 8–24.

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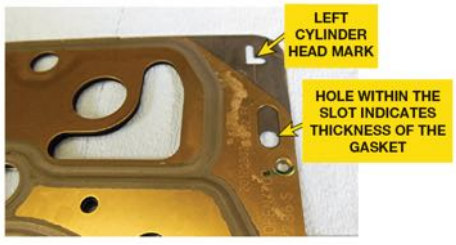
FIGURE 8–24 A head gasket from the left cylinder head on a Duramax V-8 diesel engine. The "L" means it is for the left head and the hole in the slot indicates its thickness.



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VALVE TRAIN ASSEMBLY (1 of 4)

- **Text Pages: 103-104**
  - Timing Gears for Cam-In-Block Engines
  - Timing Drives for OHC Engines
  - Timing Gear Installation
  - OHV Engine Lifter & Pushrod Installation
  - Valve Lash Adjustment

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FIGURE 8–25 special holding fixture is required when installing the camshafts on the Fiat Chrysler 3.0 liter V-6 diesel engine to keep them aligned and in the proper position before the timing chain is installed

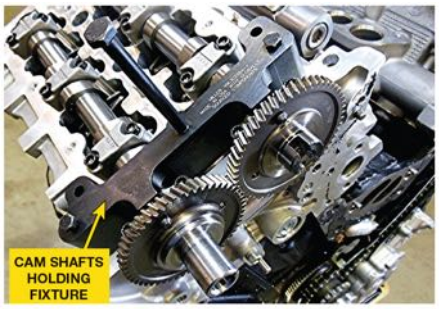

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FIGURE 8–26 timing gears on Duramax diesel engine can be seen through an opening in timing cover for te high-pressure pump to camshaft. Duramax diesel HP Pump is timed so that fuel pressure regulator (FPR) solenoid commands at same time as piston stokes, which helps reduce vibration and noise.

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FIGURE 8–27 The valve lash is being checked on a Duramax diesel engine. Always follow the vehicle manufacturer's specified procedures.

VALVE LASH ADJUSTMENT

Some diesel engines use solid roller lifters: Duramax V-8, Cummins & require valve lash, be adjusted to a specified clearance

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FIGURE 8–28 1/8 to 3/16 inch (3 to 5 mm) bead of RTV silicone on a parting surface with silicon going around the bolt hole..

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FINAL ASSEMBLY (1 of 4)

- **Text Pages 104-105**
  - **Timing Cover Installation**
  - **Oil Pan Installation**
  - **Prelubricating the Engine**

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What is "Torque Paint"?

FREQUENTLY ASKED QUESTION

Whenever a major fastener is tightened to proper torque at assembly plant, a dab of paint is applied to head of fastener to indicate that it was properly torqued. This is part of quality control procedure used to help ensure that all fasteners are properly tightened to factory specification. SEE FIGURE 8–29

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FIGURE 8–29 Torque paint applied to the head of the fastener indicates that it has been properly torqued to factory specification

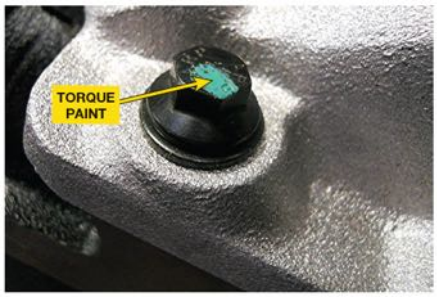

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FIGURE 8–30 Using a hammer to straighten the gasket rail surface of the oil pan before installing a new gasket. When the retaining bolts are tightened, some distortion of sheet metal covers occurs. If the area around the bolt holes is not straightened, leaks can occur with the new gasket.

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Summary (1 of 2)

- Before assembling an engine, the technician should read, understand, and follow all instructions that came with the parts and gaskets to ensure proper assembly.
- Assembling the short block includes preparing the block, and installing the crankshaft, camshaft, and the piston/rod assemblies.
- Soft core plugs are also called expansion plugs, freeze plugs, or Welsh plugs.

Summary (2 of 2)

- All bearing oil clearances should be checked using a micrometer, telescoping gauges, or Plastigage.
- Piston ring end gap should be checked before the pistons are installed.
- Cylinder head bolts should be properly tightened and in the specified sequence.
- Timing chain or gear covers are installed using the specified gaskets or sealers.