

Automotive Engines Theory and Servicing

Ninth Edition

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James D. Halderman



Chapter 31

Crankshafts, Balance Shafts, and Bearings

ALWAYS LEARNING

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OBJECTIVES (1 OF 2)

- 31.1** Explain the purpose of crankshaft, crankshaft construction, and crankshaft oiling holes.
- 31.2** Discuss the different engine crankshaft types.
- 31.3** Explain the purpose and function of counterweights.
- 31.4** Discuss engine balance, and explain externally and internally balanced engines.

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OBJECTIVES (2 OF 2)

- 31.5** Explain the purpose of balance shafts.
- 31.6** Discuss crankshaft service.
- 31.7** Describe engine bearings and discuss the importance of bearing clearance.
- 31.8** Discuss camshaft bearings.

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CRANKSHAFT (1 OF 2)

- Purpose and Function
 - Power from expanding gases in the combustion chamber is delivered to the crankshaft through the piston, piston pin, and connecting rod
- The crankshaft includes the following parts:
 - Main bearing journals
 - Rod bearing journals

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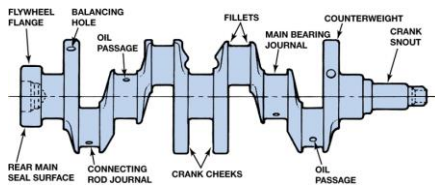
CRANKSHAFT (2 OF 2)

- Crankshaft throws
- Counterweights
- Front snout
- Flywheel flange
- Keyways
- Oil passages

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FIGURE 31-1 Typical crankshaft with main journals that are supported by main bearings in the block. Rod journals are offset from the crankshaft centerline.



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CRANKSHAFT CONSTRUCTION

- Forged
- Cast Crankshafts
- Billet Crankshafts



FIGURE 31-5 Wide separation lines of a forged crankshaft.

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CRANKSHAFT OILING HOLES

- The crankshaft is drilled to allow oil from the main bearing oil groove to be directed to the connecting rod bearings.



FIGURE 31-8 Crankshaft sawed in half, showing drilled oil passages between the main and rod bearing journals.

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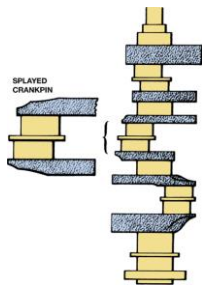
ENGINE CRANKSHAFT TYPES

- V-8 Engine Arrangement
- Four-cylinder Engine Crankshafts
- Five-cylinder Engine Crankshafts
- Three-cylinder Engine Crankshafts
- Inline Six-cylinder Engine Crankshaft
- 90-degree V-6 Engine Crankshafts
- 60-degree V-6 Engine Crankshafts

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FIGURE 31-11 A splayed crankshaft design is used to create an even-firing 90 degree V-6.



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COUNTERWEIGHTS

- Crankshafts are balanced by counterweights, which are cast, forged, or machined as part of the crankshaft.
- A crankshaft that has counterweights on both sides of each connecting rod journal is called fully counterweighted.

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FIGURE 31-12 A fully counterweighted 4-cylinder crankshaft.



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EXTERNALLY AND INTERNALLY BALANCED ENGINES (1 OF 2)

- Most crankshaft balancing is done during manufacture.
- Holes are drilled in the counterweight to lighten and improve balance.
- Sometimes these holes are drilled after the crankshaft is installed in the engine.

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EXTERNALLY AND INTERNALLY BALANCED ENGINES (2 OF 2)

- Some manufacturers are able to control casting quality so closely that counterweight machining for balancing is not necessary.
- Engine manufacturers balance an engine in one of two ways: Externally or internally balanced.

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ENGINE BALANCE

- Primary and Secondary Balance

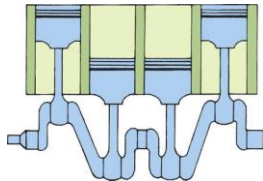


FIGURE 31-17 In a 4-cylinder engine, the two outside pistons move upward at the same time as the inner pistons move downward, which reduces primary unbalance.

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BALANCE SHAFTS

- Purpose and Function
- Balance Shaft Applications

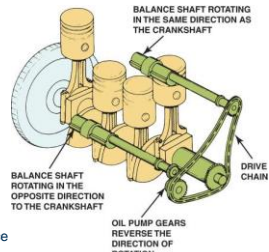


FIGURE 31-19 Two counter-rotating balance shafts used to counterbalance the vibrations of a 4-cylinder engine.

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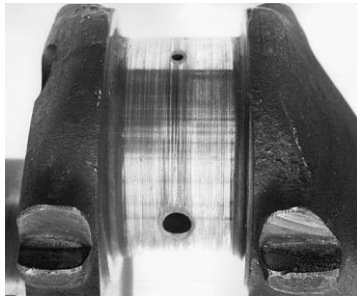
CRANKSHAFT SERVICE (1 OF 2)

- Crankshaft damage includes:
 - Worn journals
 - Scored bearing journals
 - Bends or warpage
 - Cracks
 - Thread damage (flywheel flange or front snout)
 - Worn front or rear seal surfaces

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FIGURE 31-22 Scored connecting rod bearing journal.



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CRANKSHAFT SERVICE (2 OF 2)

- Measuring the Crankshaft
- Crankshaft Grinding
- Crankshaft Polishing
- Welding a Crankshaft
- Stress Relieving the Crankshaft
- Storing Crankshafts

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ENGINE BEARINGS (1 OF 2)

- Introduction
- Types of Bearings
- Bearing Materials
- Bearing Manufacturing
- Bearing Sizes
- Bearing Loads

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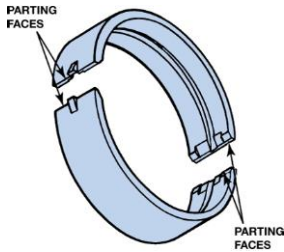
ENGINE BEARINGS (2 OF 2)

- Bearing Fatigue
- Bearing Conformability
- Bearing Embedability
- Bearing Damage Resistance

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FIGURE 31-29 The two halves of a plain bearing meet at the parting faces.



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BEARING CLEARANCE

- Importance of Proper Clearance
- Checking Bearing Clearance
- Bearing Spread and Crush

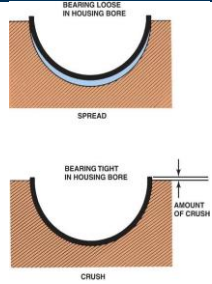
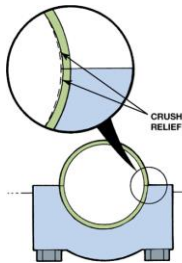


FIGURE 31-36 Bearing spread and crush.

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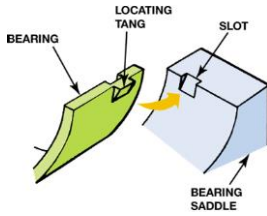
FIGURE 31-37 Bearings are thinner at the parting line faces to provide crush relief.



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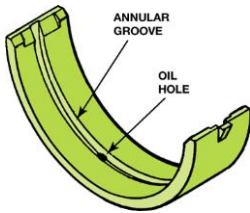
FIGURE 31-39 The tang (lug) and slot help index the bearing in the bore.



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FIGURE 31-40 Many bearings are manufactured with a groove down the middle to improve the oil flow around the main journal.



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CAMSHAFT BEARINGS

- Types of Camshaft Bearings
- Camshaft Bearing Installation

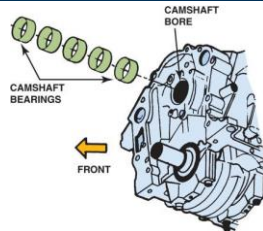
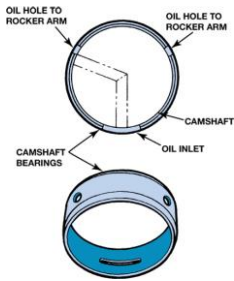


FIGURE 31-41 Cam-in-block engines support the camshaft with sleeve-type bearings.

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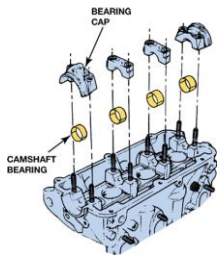
FIGURE 31-42 Camshaft bearings must be installed correctly so that oil passages are not blocked.



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FIGURE 31-43 Some overhead camshaft engines use split bearing inserts.



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SUMMARY (1 OF 3)

- Cast crankshafts have a narrow mold parting line, and forged crankshafts have a wide parting line.
- Even-fire 90-degree V-6 engines require that the crankshaft be splayed to allow for even firing.
- Oil for the rod bearings comes from holes in the crankshaft drilled between the main journal and the rod journal.

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SUMMARY (2 OF 3)

- A vibration damper is used to dampen harmful twisting vibrations of the crankshaft.
- Most crankshafts can be reground to be 0.01, 0.02, or 0.03 in. undersize.
- Most engines are internally balanced.

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SUMMARY (3 OF 3)

- Most engine bearings are constructed with a steel shell for strength and are covered with a copper-lead alloy.
- Bearings should have spread and crush to keep them from spinning when the crankshaft rotates.

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