

# Automotive Engines Theory and Servicing

Ninth Edition

## Automotive Engines Theory and Servicing

Ninth Edition  
James D. Halderman



## Chapter 7

Measuring Systems  
and Tools

ALWAYS LEARNING

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## OBJECTIVES

- 7.1** Compare the English customary measuring system and the metric system of measure.
- 7.2** Discuss the purpose of tape measures, micrometers, and depth micrometers.
- 7.3** Discuss the purpose of telescopic gauges, small-hole gauges, and vernier dial calipers.
- 7.4** Discuss the purpose of the straightedges, dial indicators, feeler gauges, and dial bore gauges.

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## ENGLISH CUSTOMARY MEASURING SYSTEM (1 OF 3)

- The English customary measuring system was established about A.D. 1100 in England during the reign of Henry I.
- The foot was determined to be 12 inches and was taken from the length of a typical foot.
- The yard was determined to be the length from King Henry's nose to the end of his outstretched hand.

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## ENGLISH CUSTOMARY MEASURING SYSTEM (2 OF 3)

- The mile came from Roman days and was originally defined as the distance traveled by a soldier in 1,000 paces or steps.
- Other English units, such as the pound (weight) and volume (gallon), evolved over the years from Roman and English measurements.

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## ENGLISH CUSTOMARY MEASURING SYSTEM (3 OF 3)

- The Fahrenheit temperature scale was created by Gabriel Fahrenheit (1686–1736) and he used 100°F as the temperature of the human body, which he missed by 1.4 degrees.
- On the Fahrenheit scale, water freezes at 32°F and water boils at 212°F.

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## METRIC SYSTEM OF MEASURE

- Linear Metric Measurements
- Volume Measurement
- Weight Measurement
- Pressure Measurements
- Derived Units

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## LINEAR MEASUREMENTS (TAPE MEASURE/RULE) (1 OF 2)

- A tape measure or machinist rule divides inches into smaller units.
- Each smaller unit is drawn with a line shorter than the longer unit.

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## LINEAR MEASUREMENTS (TAPE MEASURE/RULE) (2 OF 2)

- The units of measure include:
  - 1 inch
  - 1/2 inch
  - 1/4 inch
  - 1/8 inch
  - 1/16 inch

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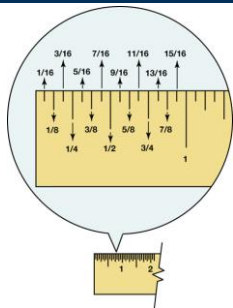
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**FIGURE 7-1** A rule showing that the larger the division, the longer the line.



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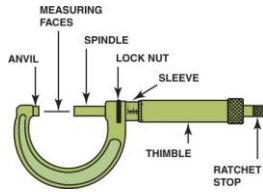
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## MICROMETER (1 OF 2)

- A micrometer is the most used measuring instrument in engine service and repair.



**FIGURE 7-3** A typical micrometer showing the names of the parts. The sleeve may also be called the barrel or stock.

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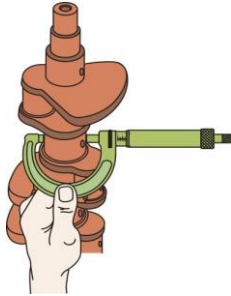
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## MICROMETER (2 OF 2)

- Crankshaft Measurement
  - Out-of-round
  - Taper
- Camshaft Measurement



**FIGURE 7-7** Using a micrometer to measure the connecting rod journal for out-

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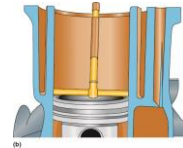
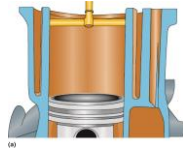
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## TELESCOPIC GAUGE

- A telescopic gauge is used with a micrometer to measure the inside diameter of a hole or bore.



**FIGURE 7-11** When the head is first removed, the cylinder taper and out-of-round should be checked below the ridge (a) and above the piston when it is at the bottom of the stroke (b).

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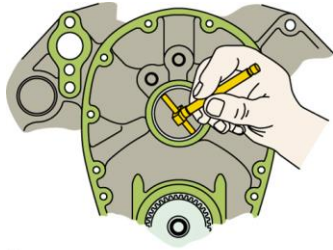
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**FIGURE 7-12** (a) A telescopic gauge being used to measure the inside diameter (ID) of a camshaft bearing. (b) An outside micrometer used to measure the telescopic gauge.



(a)

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**FIGURE 7-12** (a) A telescopic gauge being used to measure the inside diameter (ID) of a camshaft bearing. (b) An outside micrometer used to measure the telescopic gauge.



(b)

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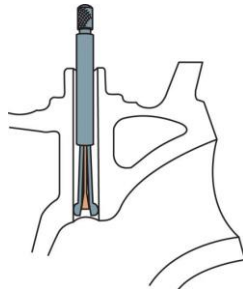
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## SMALL-HOLE GAUGE

- A small-hole gauge (also called a split-ball gauge) is used with a micrometer to measure the inside diameter of small holes such as a valve guide in a cylinder head.



**FIGURE 7-13** Cutaway of a valve guide with a hole gauge adjusted to the hole diameter.

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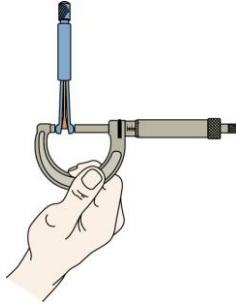
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**FIGURE 7-14** The outside of a small hole gauge being measured with a micrometer.



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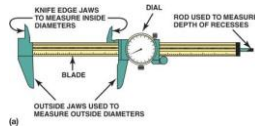
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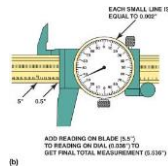
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## DIAL CALIPER

- A dial caliper is normally used to measure length, inside and outside diameters, and depth.



**FIGURE 7-15** (a) A typical vernier dial caliper. This is a very useful measuring tool for automotive engine work because it is capable of measuring inside, outside, and depth measurements. (b) To read a vernier dial caliper, simply add the reading on the blade to the reading on the dial.



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## FEELER GAUGE

- A feeler gauge is an accurately manufactured strip of metal that is used to determine the gap or clearance between two components.
- A feeler gauge can be used to check the following:
  - Piston ring gap
  - Piston ring side clearance
  - Connecting rod side clearance
  - Piston-to-wall clearance

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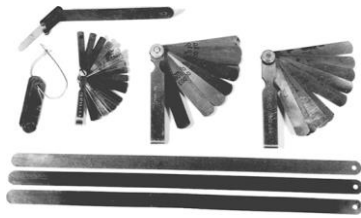
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**FIGURE 7-16** A group of feeler gauges (also known as thickness gauges), used to measure between two parts. The long gauges on the bottom are used to measure the piston-to-cylinder wall clearance.



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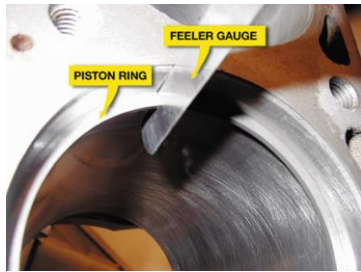
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**FIGURE 7-17** A feeler gauge, also called a thickness gauge, is used to measure the small clearances such as the end gap of a piston ring.



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## STRAIGHTEDGE (1 OF 2)

- A straightedge is a precision ground metal measuring gauge that is used to check the flatness of engine components when used with a feeler gauge.

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## STRAIGHTEDGE (2 OF 2)

- A straightedge is used to check the flatness of the following:
  - Cylinder heads
  - Cylinder block deck
  - Straightness of the main bearing bores (saddles)

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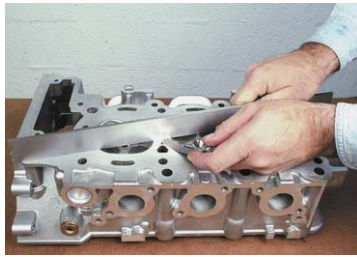
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**FIGURE 7-18** A straightedge is used with a feeler gauge to determine if a cylinder head is warped or twisted.



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## DIAL INDICATOR

- A dial indicator is a precision measuring instrument used to measure crankshaft end play, crankshaft runout, and valve guide wear.
- A dial indicator can be mounted three ways, including:
  - Magnetic mount
  - Clamp mount
  - Threaded rod

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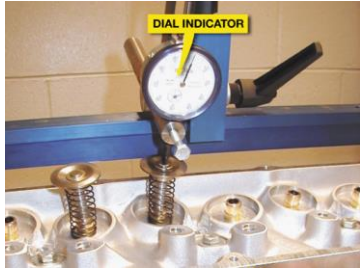
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**FIGURE 7-19** A dial indicator is used to measure valve lift during flow testing of a high-performance cylinder head.



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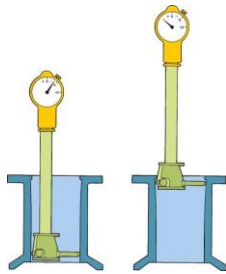
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## DIAL BORE GAUGE

- A dial bore gauge is an expensive, but important, gauge used to measure cylinder taper and out-of-round as well as main bearing (block housing) bore for taper and out-of-round.



**FIGURE 7-20** A dial bore gauge is used to measure cylinders and other engine parts for out-of-round and taper conditions.

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## DEPTH MICROMETER

- A depth micrometer is similar to a conventional micrometer except that it is designed to measure the depth from a flat surface.

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FIGURE 7-21 A digital readout depth micrometer.



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### SUMMARY (1 OF 3)

- A tape measure or machinist rule can be used to measure linear distances.
- A micrometer can measure 0.001 in. by using a thimble that has 40 threads per in.
- A micrometer is used to check the diameter of a crankshaft journal as well as the taper and out-of-round.

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### SUMMARY (2 OF 3)

- A camshaft bearing and lobe can be measured using a micrometer.
- A telescopic gauge is used with a micrometer to measure the inside of a hole or bore.
- A small-hole gauge is used with a micrometer to measure small holes such as the inside diameter of a valve guide in a cylinder head.

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### SUMMARY (3 OF 3)

- A vernier dial caliper is used to measure the outside diameter of components.
- A feeler gauge is used to measure the gap or clearance between two components.
- A dial indicator and dial bore gauge are used to measure differences in a component.

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