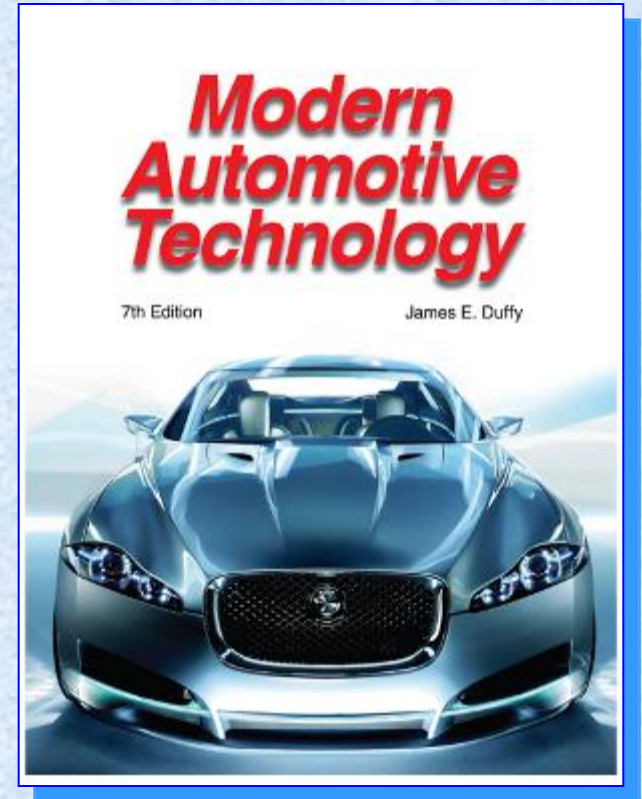


powerpoint for

Modern Automotive Technology

by

Russell Krick



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Chapter 50

Engine Bottom End Service

Contents

- Cylinder block service
- Balancer shaft service
- Piston service
- Piston pin service
- Connecting rod service
- Piston ring service

(Continued)

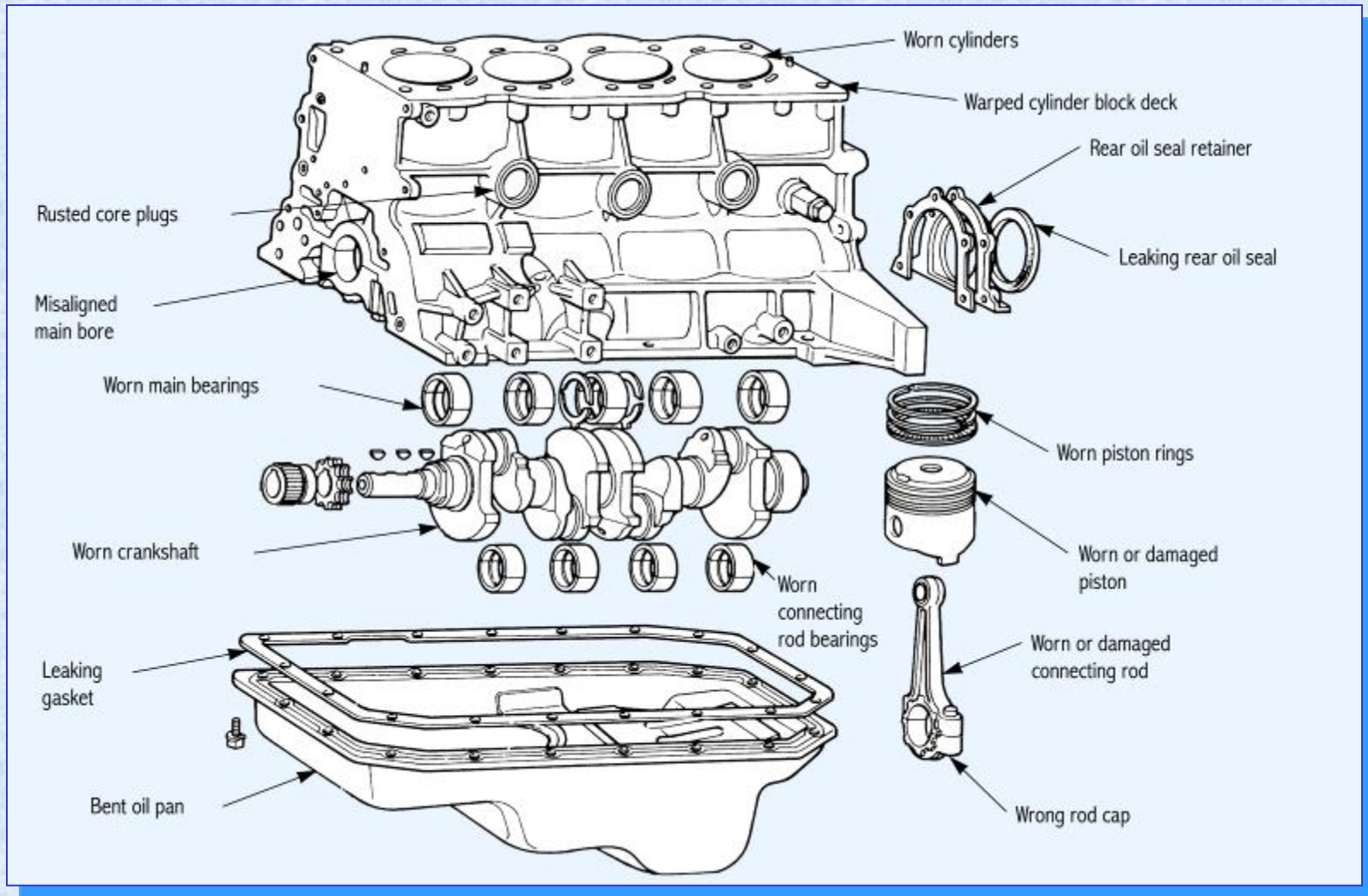
Contents

- Crankshaft service
- Installing a piston and rod assembly
- Torque-to-yield bolts
- Engine balancing
- Final assembly of engine

Cylinder Block Service

- Common block service tasks:
 - check the block for cracks and distortion
 - inspect the cylinders for damage
 - measure the cylinders for wear
 - hone or deglaze the cylinder walls
 - clean the cylinders after honing
 - install core plugs

Parts Requiring Service



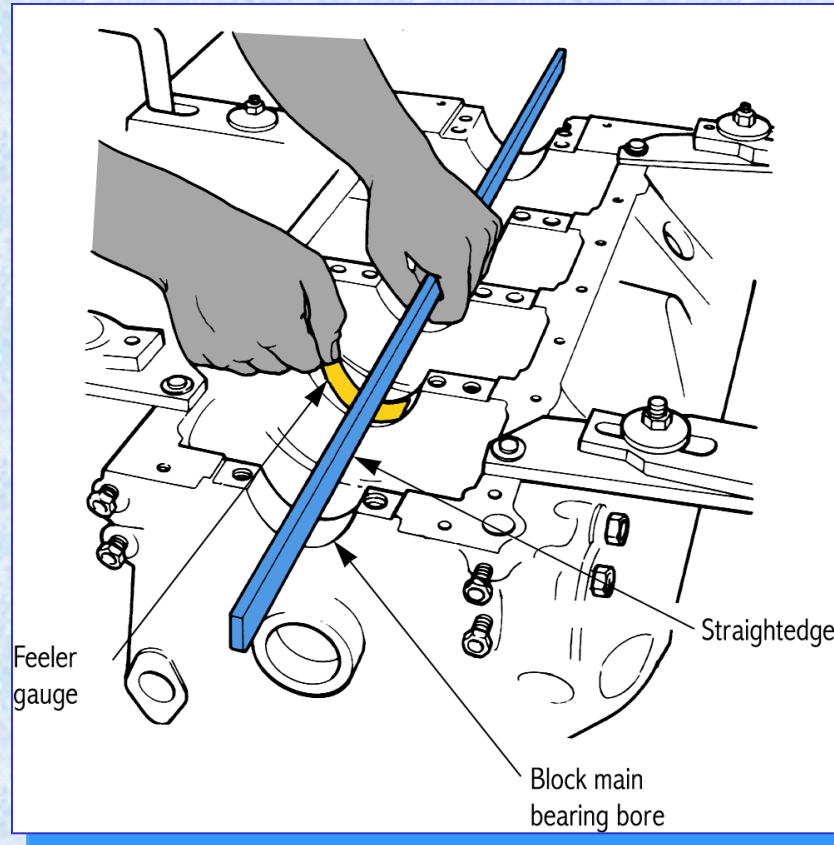
Block Pressure Testing

- To make sure the block is not cracked:
 - block all passages
 - submerge the block in a water tank
 - force compressed air into the passages
 - cracks or pores will show up as air bubbles leaking out of the block

Checking Main Bores

- ❑ Overheating can cause the block to warp or twist, causing main bearing alignment problems
- ❑ Check with a straightedge and feeler gauge
 - lay the straightedge on the bores
 - slide the feeler gauge between the straightedge and bores

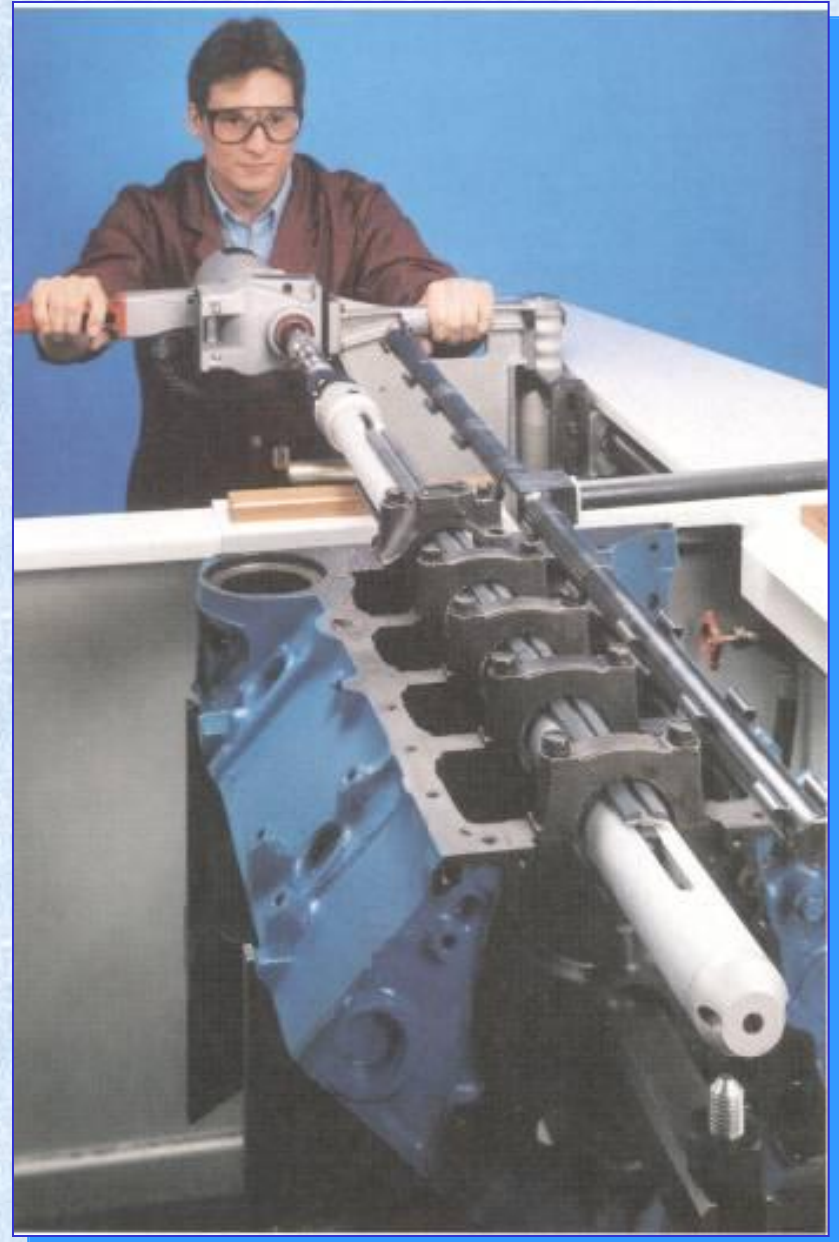
Checking Main Bores



The thickest feeler gauge that fits equals the misalignment

Boring Bar

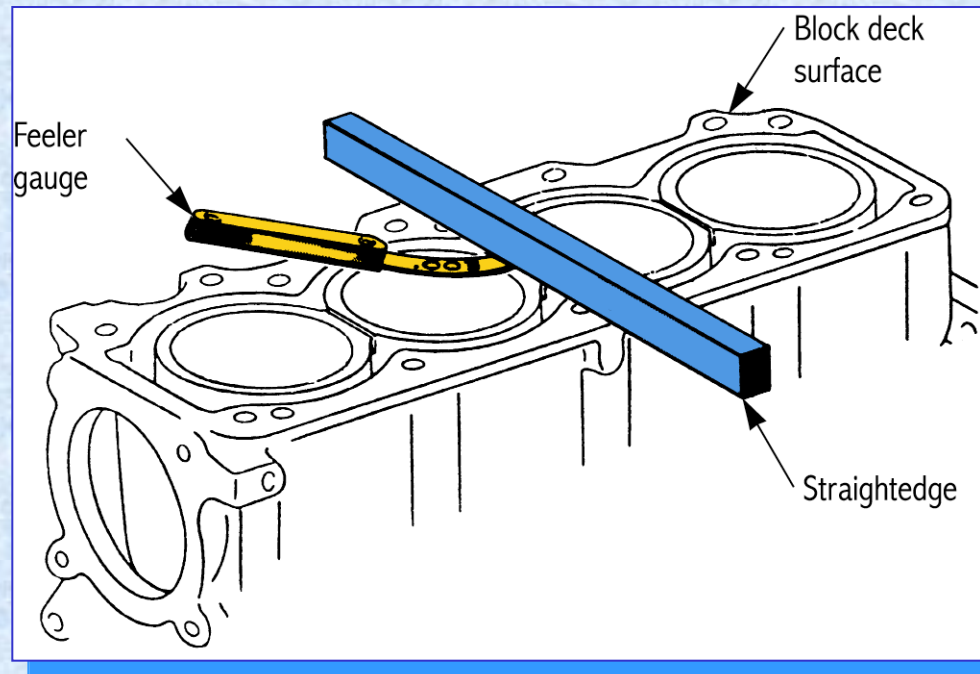
Used to true up the
block's main bore



Measuring Deck Warpage

- Measure with a straightedge and feeler gauge on the head gasket surface
 - lay a straightedge on the clean block surface
 - slide a feeler gauge between the straightedge and block
 - the thickest feeler gauge that fits indicates warpage

Measuring Deck Warpage



Maximum allowable warpage is about
0.003"–0.005" (0.08 mm–0.13 mm)

Milling Machine



Used to resurface cylinder block decks
and cylinder heads

Thread Cleaning and Repair



Run a tap through threaded holes to remove debris and locate damaged threads

Cylinder Wear

□ Cylinder taper

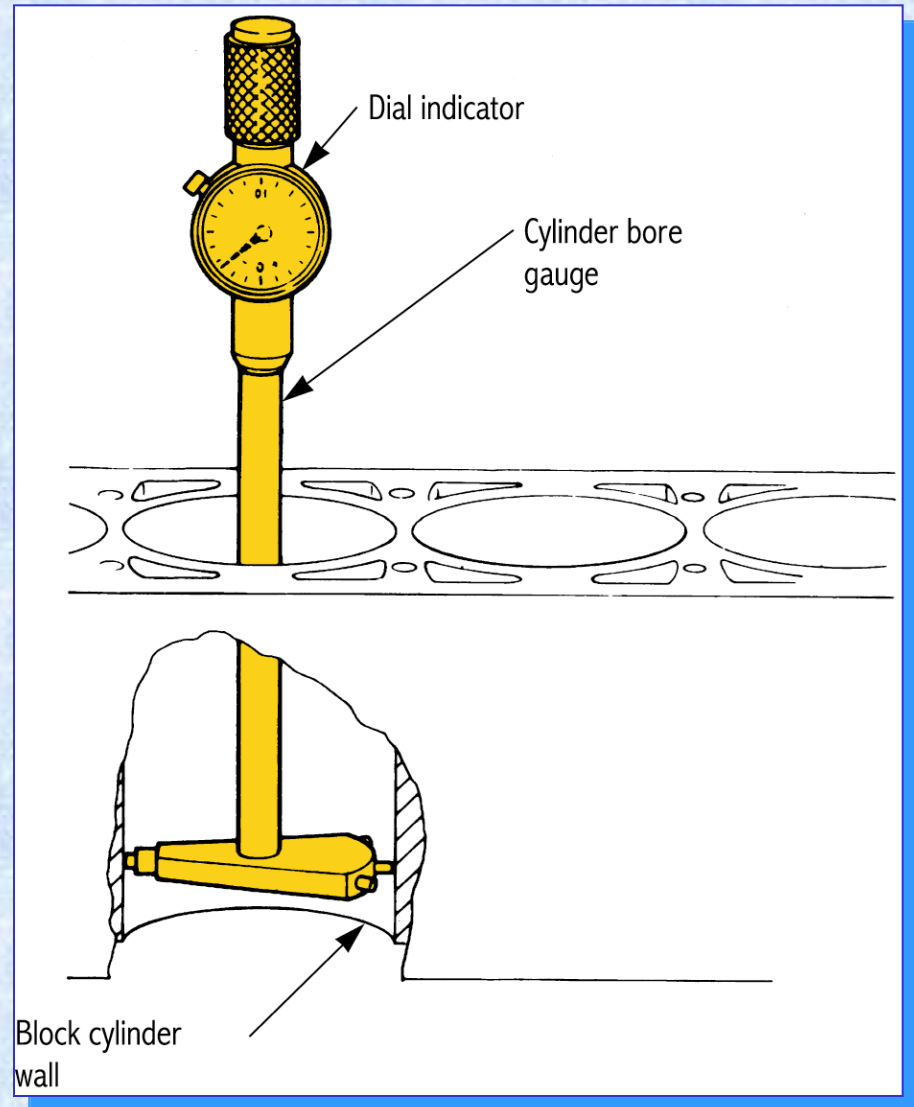
- difference in diameters at the top and bottom of the cylinder
- caused by less lubrication at the top

□ Cylinder out-of-roundness

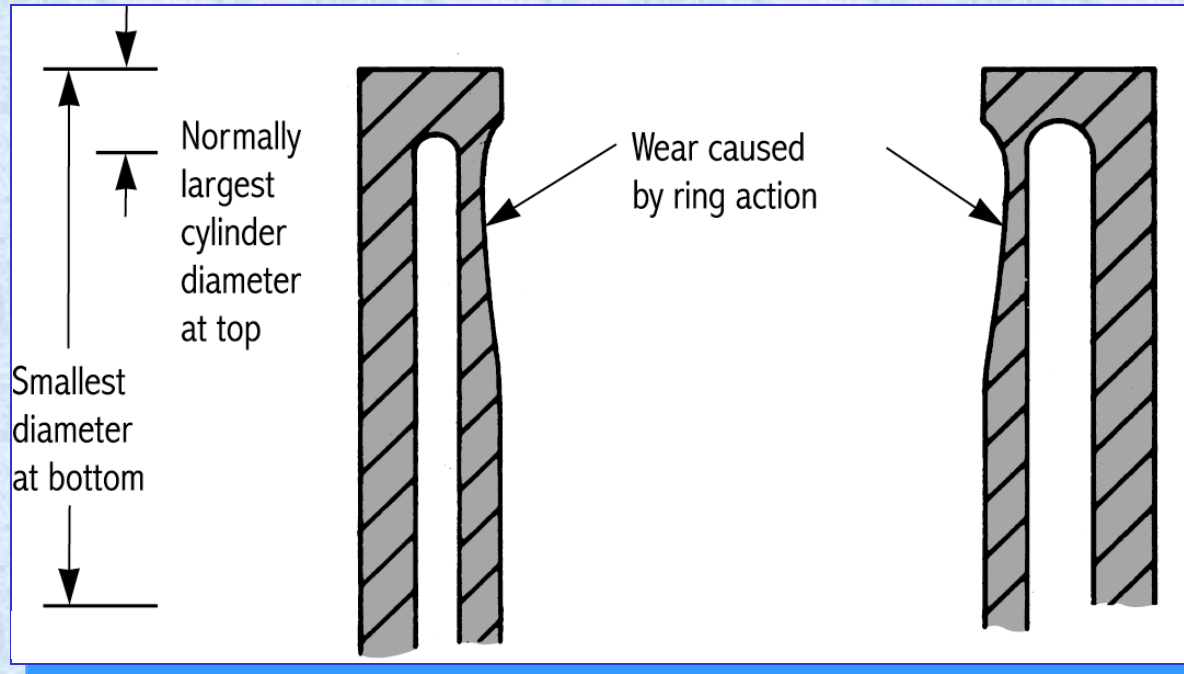
- difference in diameters measured front-to-rear and side-to-side
- piston thrust action makes the cylinder wear more at right angles to the crankshaft

Cylinder Bore Gauge

- ❑ Slide the gauge up and down the cylinder
- ❑ Indicator movement indicates changes in diameter

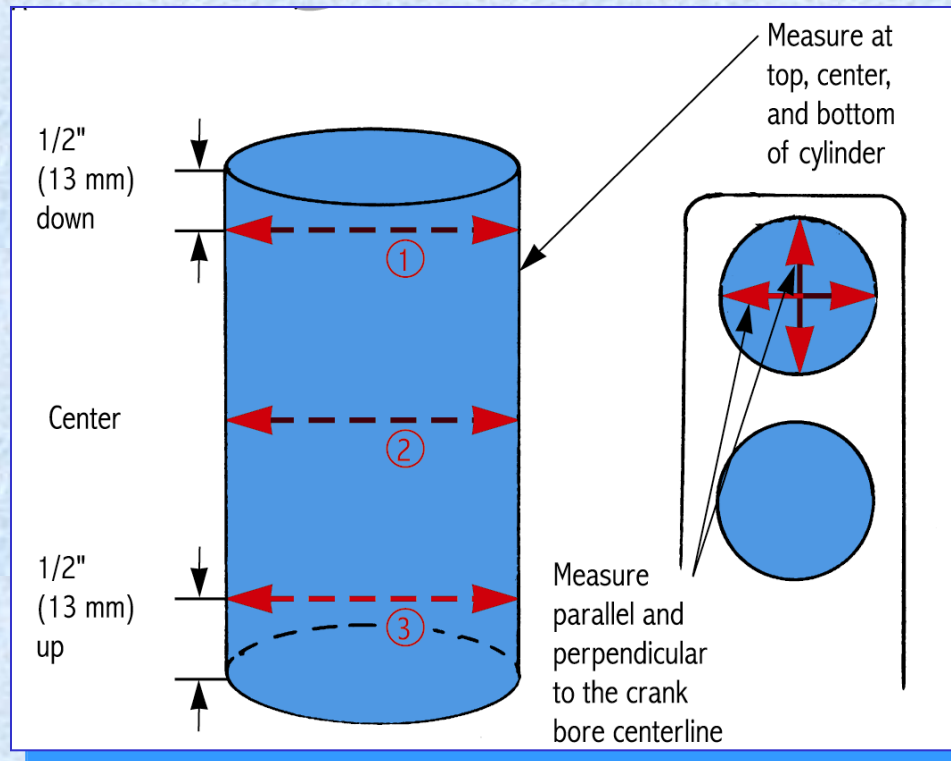


Cylinder Taper



More wear at the top of the cylinder

Cylinder Measurements

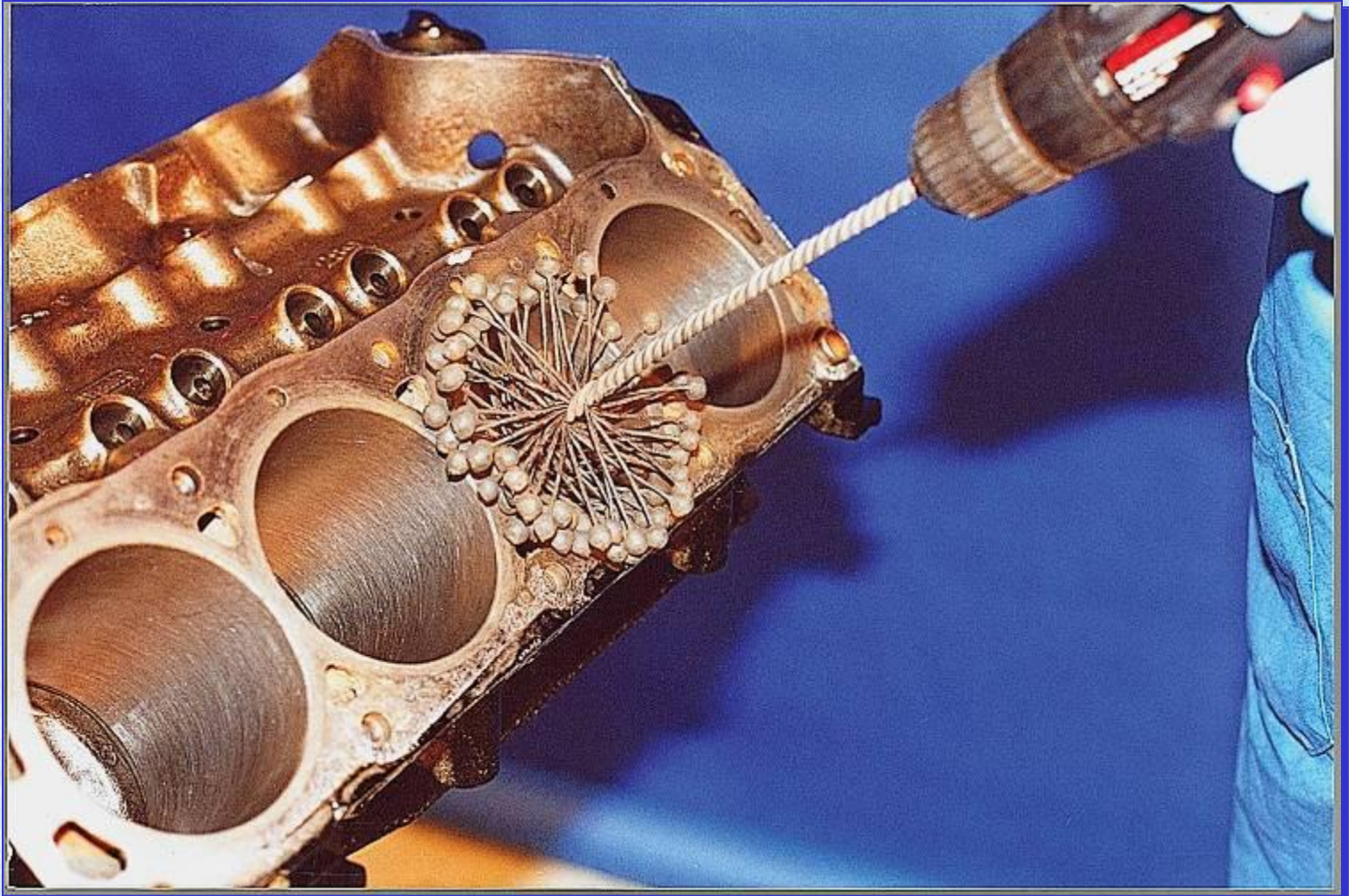


Measuring taper and out-of-round

Cylinder Honing

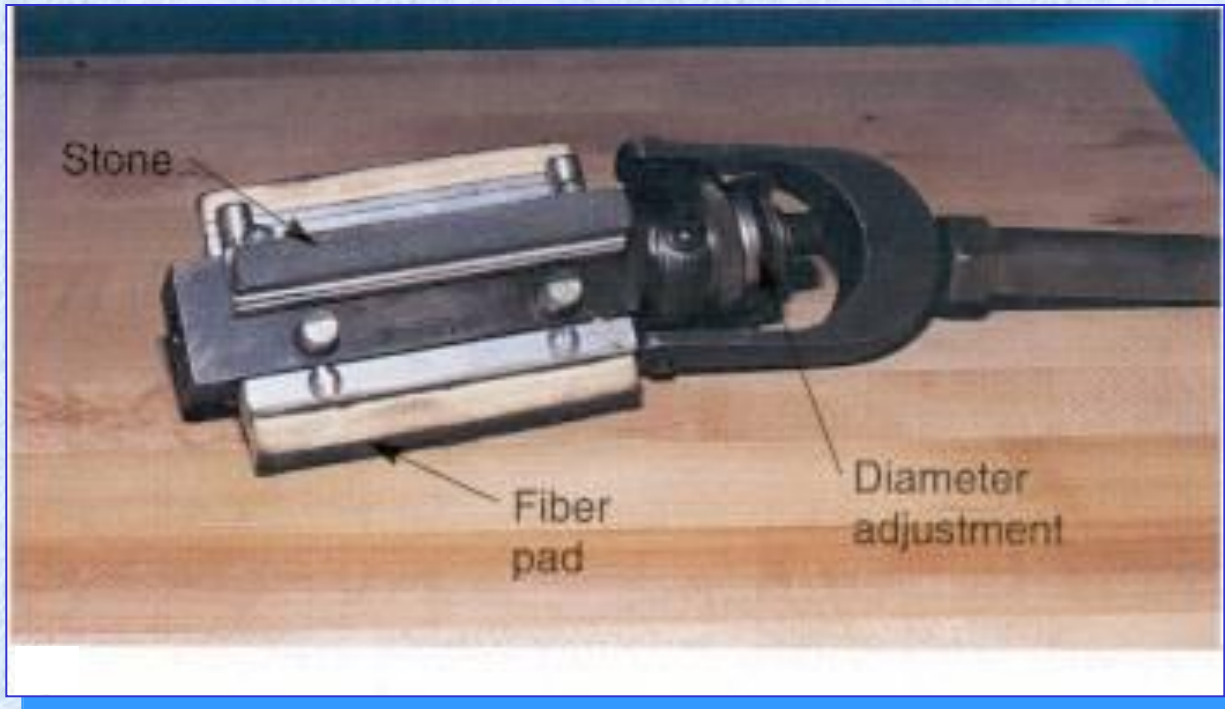
- ❑ Trues worn cylinders
- ❑ Breaks the glaze on used cylinders before installing new rings
- ❑ Smooths rough cylinders after boring
- ❑ Most hones are used in a large, low-speed electric drill

Brush Hone



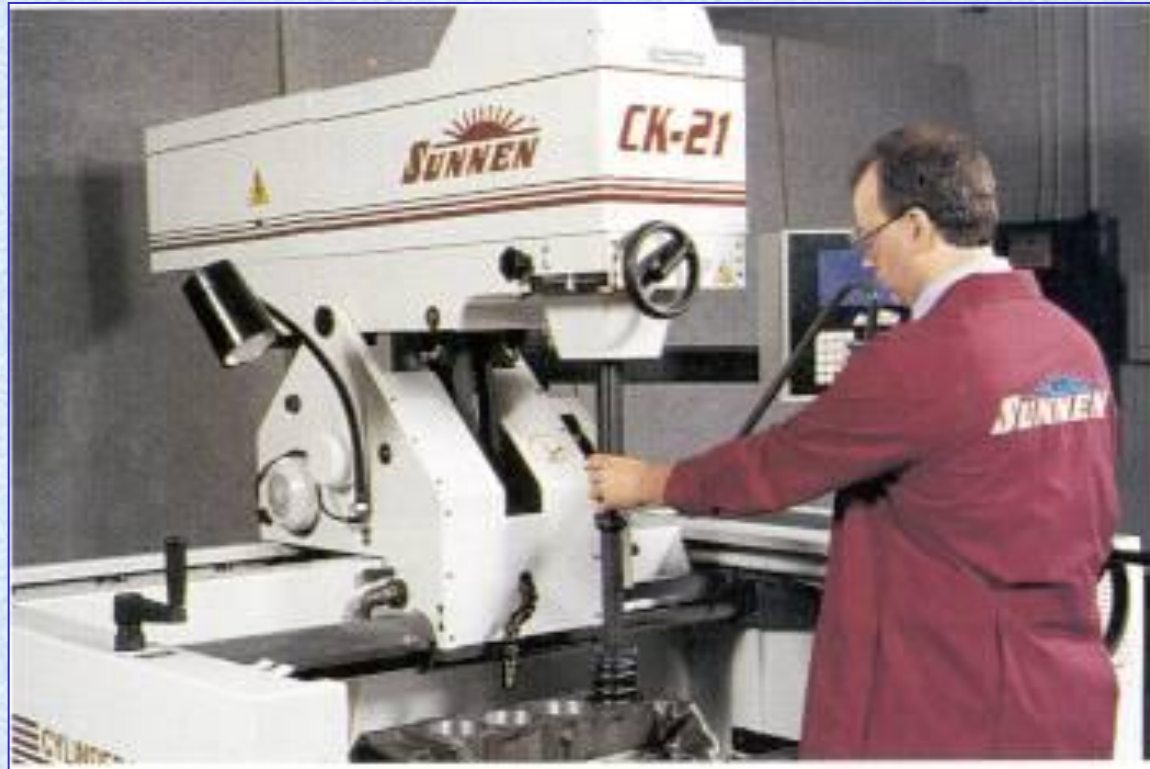
Used for light honing to restore surface

Rigid Hone (Sizing Hone)



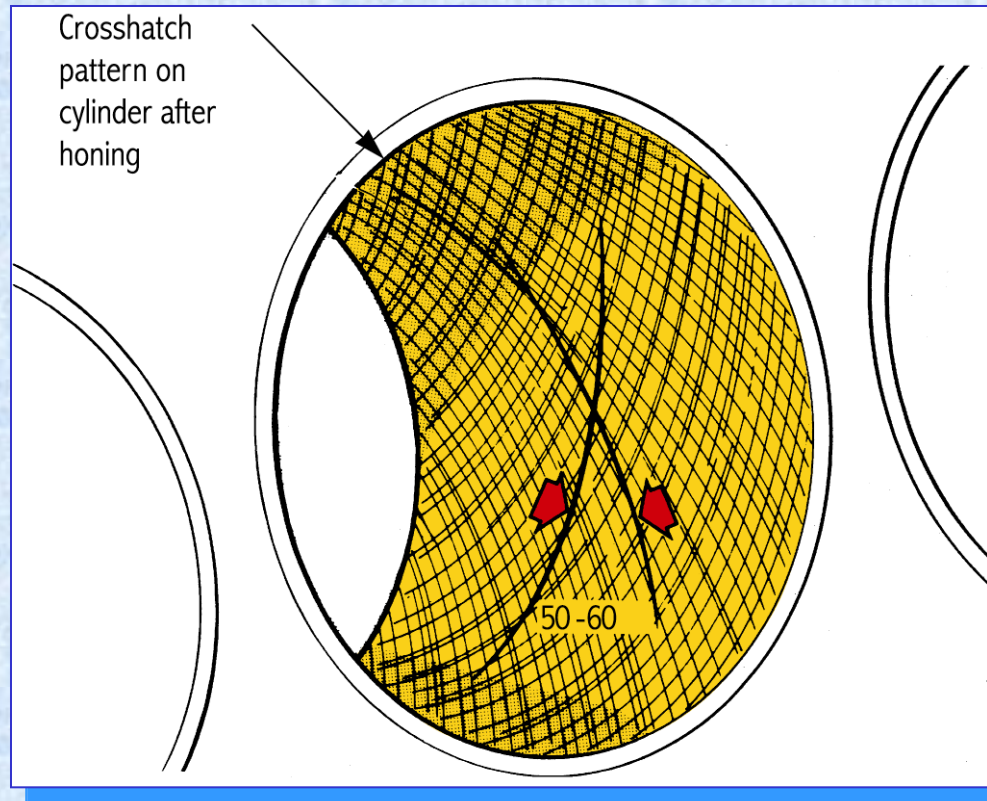
- ❑ The adjustable stones lock into a preset position
- ❑ Removes some taper and out-of-round

Honing Machine



Used to rigid hone the cylinders

Honing a Cylinder



Move the hone up and down fast enough to produce a 50° – 60° crosshatch pattern

Cleaning Cylinder Walls

- ❑ It is very important to remove all honing grit
- ❑ Grit can act like grinding compound on internal engine parts
- ❑ Wash out the cylinders with soap and water
- ❑ Wipe the cylinders down with an oily rag until they are perfectly clean

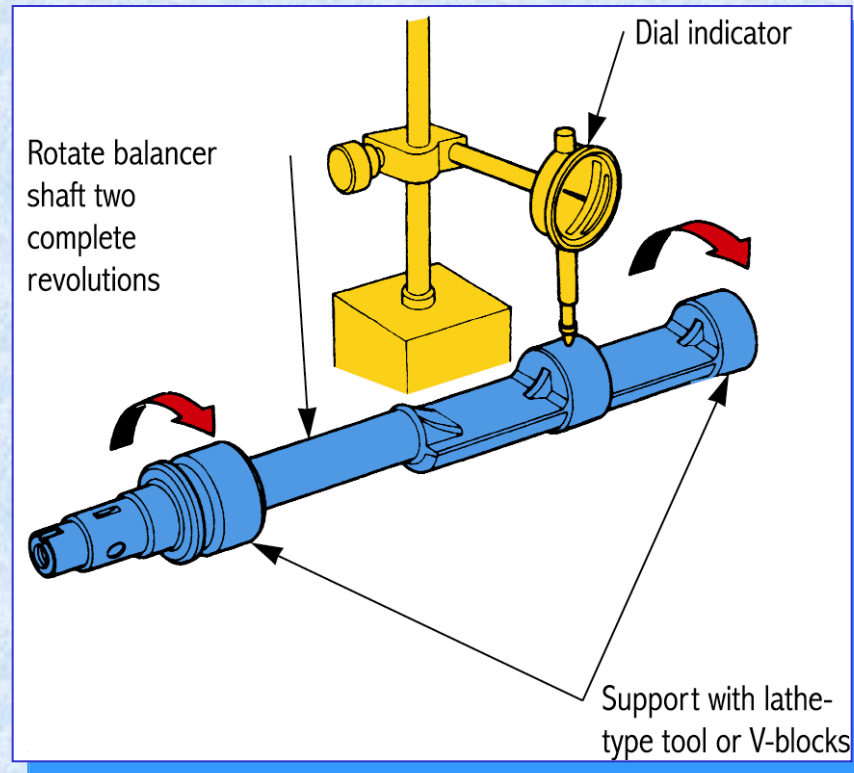
Cylinder Block Boring

- ❑ Removes deep scratches, scoring, or excess wear
- ❑ After boring, oversize pistons must be used
- ❑ The “overbore limit” is the largest allowable diameter increase
 - typically 0.030"–0.060"

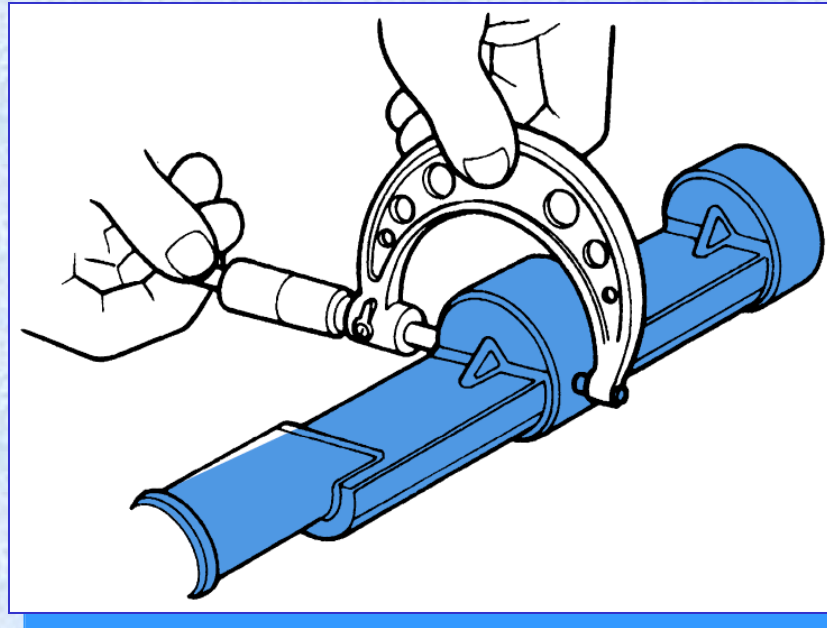
Balancer Shaft Service

- Common service tasks:
 - measure shaft runout (bend)
 - measure journal wear
 - measure bearing clearance

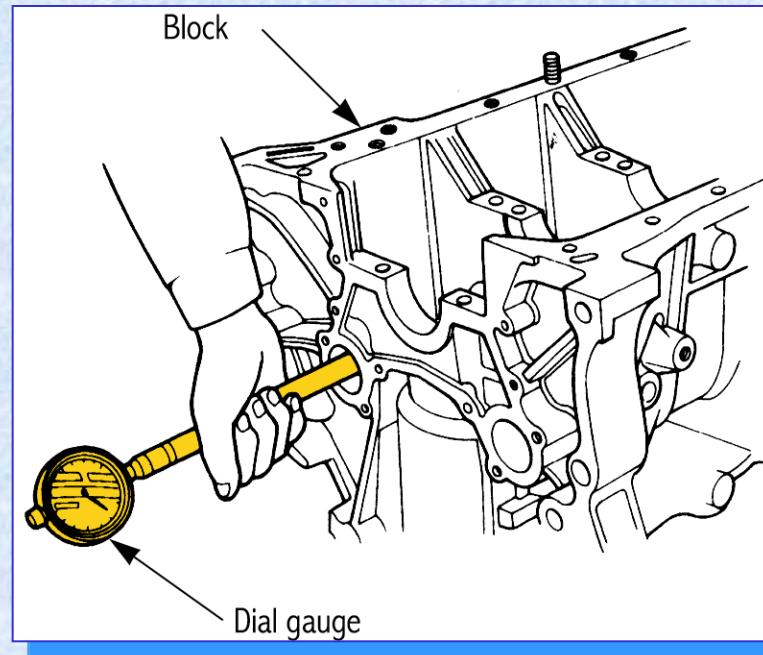
Measuring Shaft Runout



Measuring Journal Wear



Measuring Bearing Size

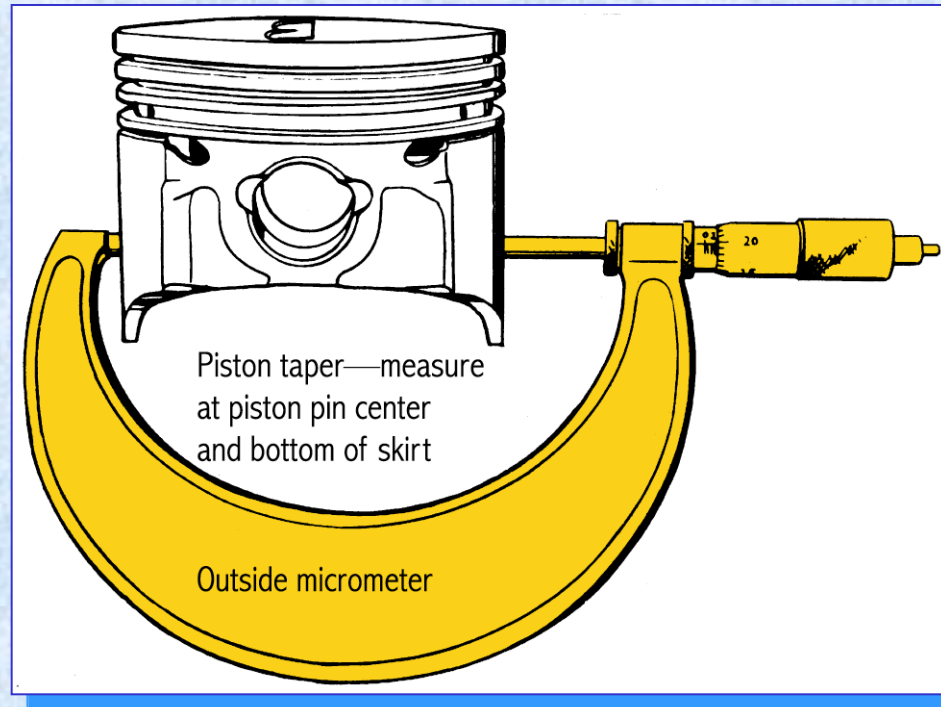


Compare bearing size to journal size
to calculate the clearance

Piston Service

- Pistons may require repair or replacement because of damage:
 - cracked skirts
 - worn ring grooves
 - cracked ring lands
 - worn pin bores

Measuring Piston Wear



If wear exceeds specifications,
replace or knurl the piston

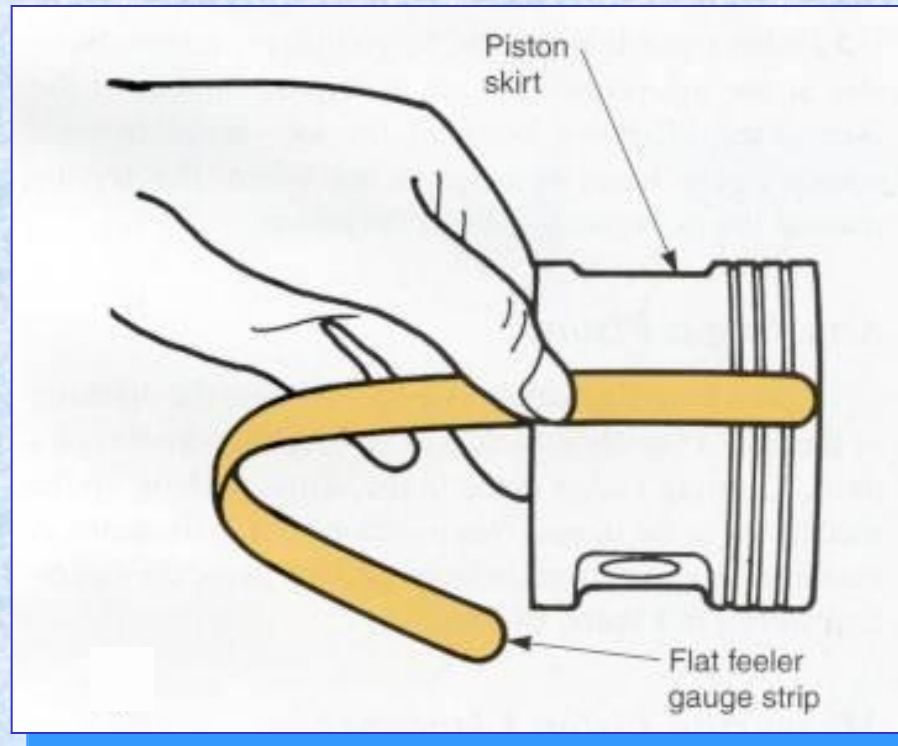
Knurling a Piston

- ❑ Increases the skirt diameter by a few thousandths of an inch
- ❑ Squeezes metal outward around small dents

Measuring Piston Clearance (Method 1)

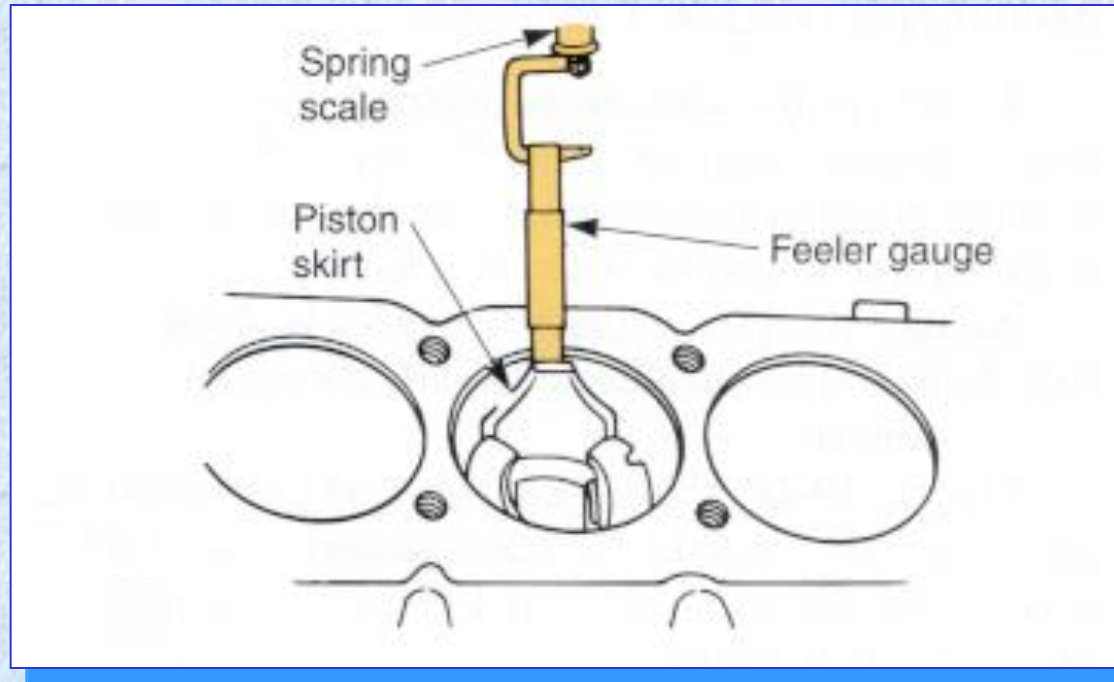
- ❑ Subtract the piston diameter from the cylinder diameter
- ❑ The difference equals the piston clearance
- ❑ Average clearance is about 0.001" (0.025 mm)

Measuring Piston Clearance (Method 2)



Place a long feeler gauge on the piston skirt;
insert the piston and gauge into the cylinder

Measuring Piston Clearance (Method 2)

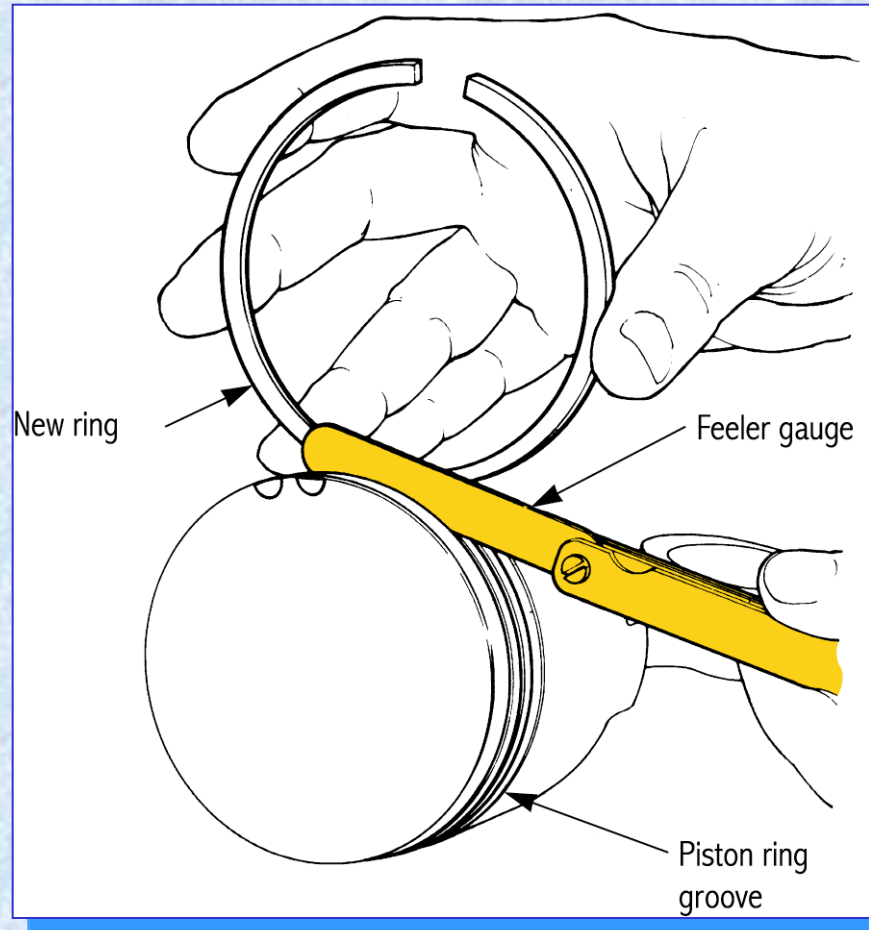


- ❑ Use a spring scale to pull out the piston
- ❑ When the scale reads a specified force, the gauge size equals the piston clearance

Measuring Piston Ring Side Clearance

- ❑ Side clearance is the space between the side of a compression ring and the inside of the piston groove
- ❑ To measure:
 - insert a new ring into the groove
 - slide a feeler gauge between the ring and groove
- ❑ If the clearance is beyond specs, replace the piston or install a ring spacer

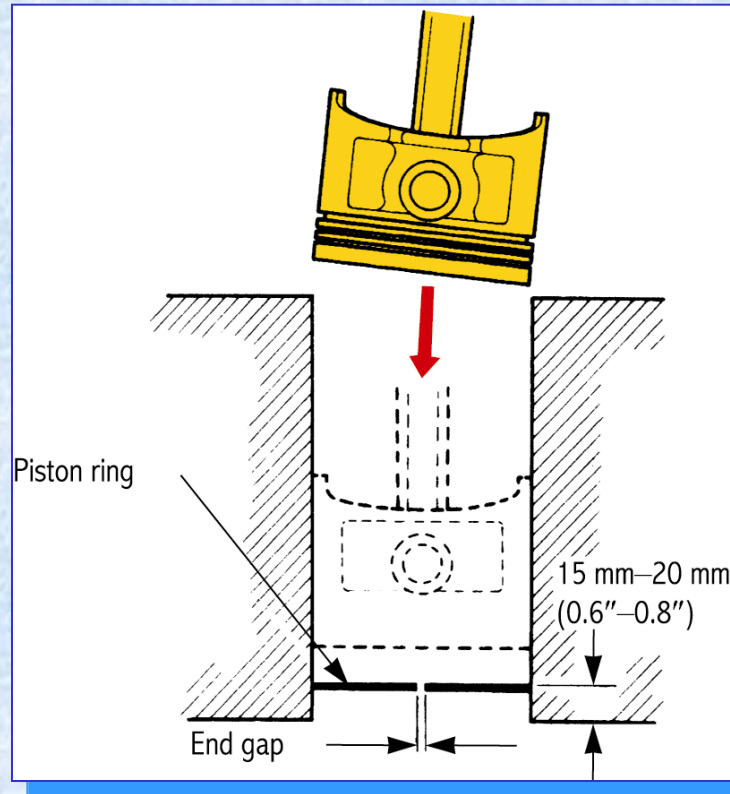
Measuring Piston Ring Side Clearance



Piston Ring Gap

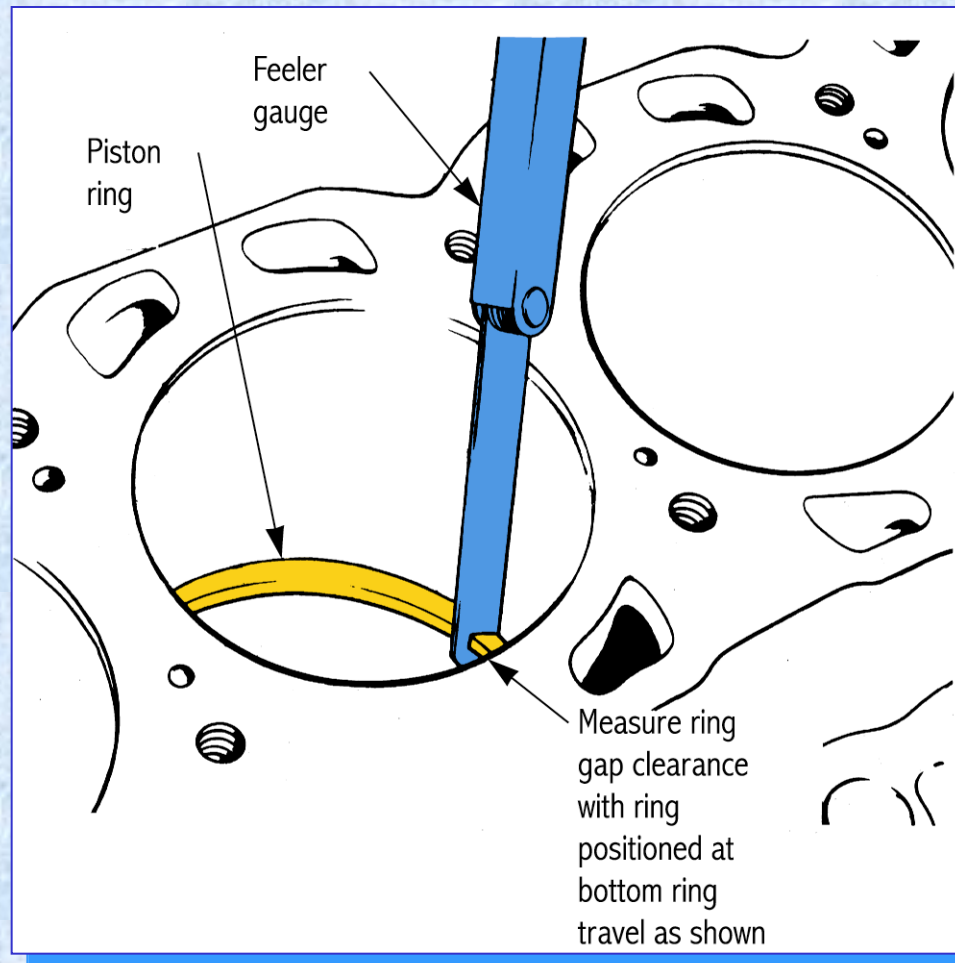
- ❑ Ring gap is the clearance between the ends of a ring when the ring is installed in the cylinder
- ❑ If the gap is too small, the ring could lock up and score the cylinder when heated
- ❑ If the gap is too large, excess blowby may occur

Measuring Piston Ring Gap



Insert a ring into the cylinder and push it to the bottom of ring travel

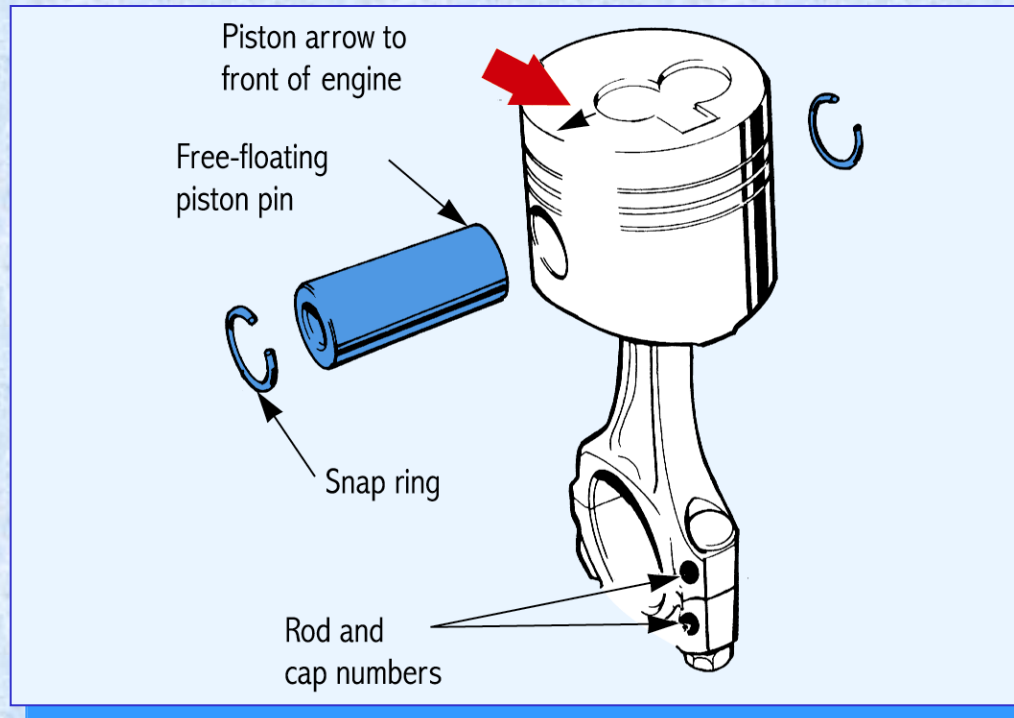
Measuring Piston Ring Gap



Piston Pin Service

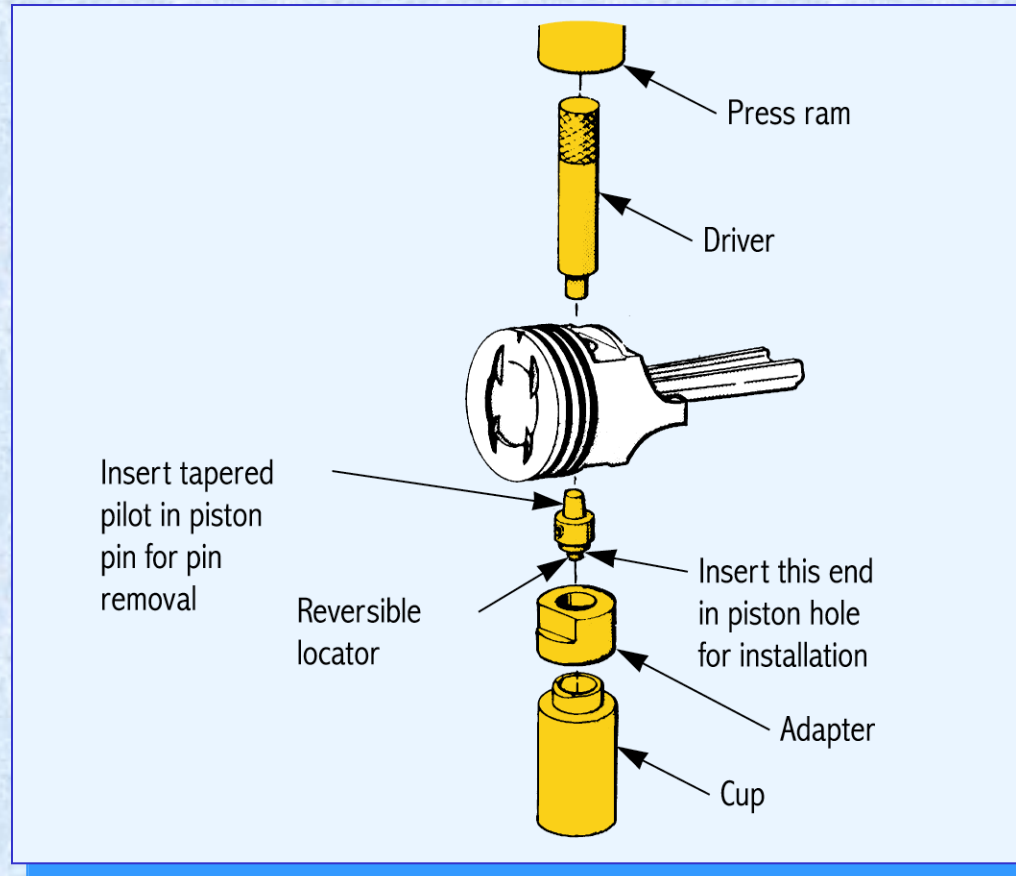
- Two types of piston pins are used:
 - Free-floating
 - the pin will turn in both the rod and the piston
 - Press-fit
 - the pin is force-fit in the rod, but turns in the piston

Free-Floating Pin Service



Remove the snap rings and push out the pin;
replace the piston if the pin bore measures
larger than specs

Pressed-In Pin Service



Use a press and a driver setup; compare the pin and bore wear to specs

Piston Pin Installation

- Make sure the piston is in the right direction in relation to the connecting rod
- Piston markings usually point to the front of the engine

Connecting Rod Service

- Rods are subjected to tons of force
- They may wear, bend, or even break

Rod Small End Service

- Measure the bore with a telescoping gauge and a micrometer
- If the bore is worn beyond specs, replace the rod bushing
- The pin will have to be “fitted” in the rod

Rod Big End Service

- Remove the bearing insert
- Reinstall the rod cap
- Torque to specs
- Measure the bore diameter on both edges and in both directions
- Any difference in edge diameters equals taper
- Any difference in cross diameters equals out-of-roundness

Rod Service Machine



Rods may be reground using this machine

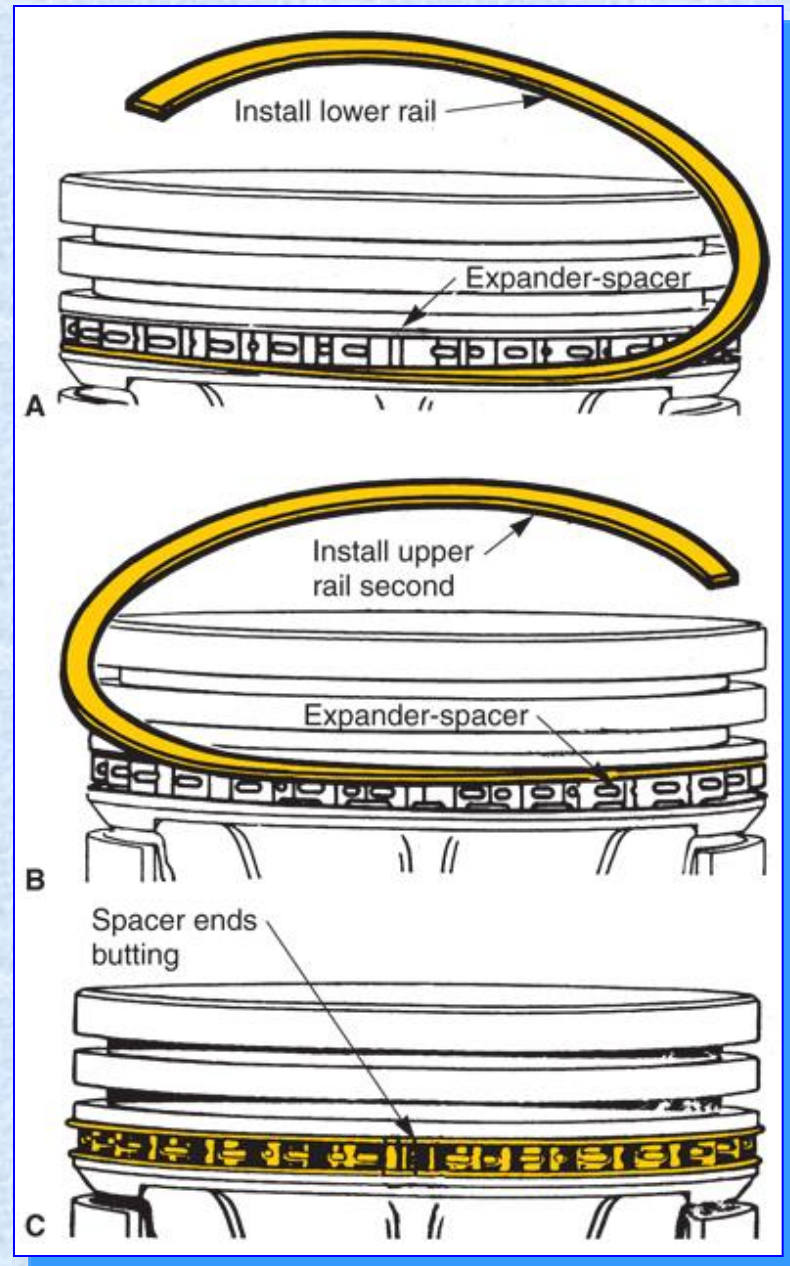
Checking Rod Straightness

- A rod alignment fixture is needed
- Check to see if the small end and big end are perfectly parallel

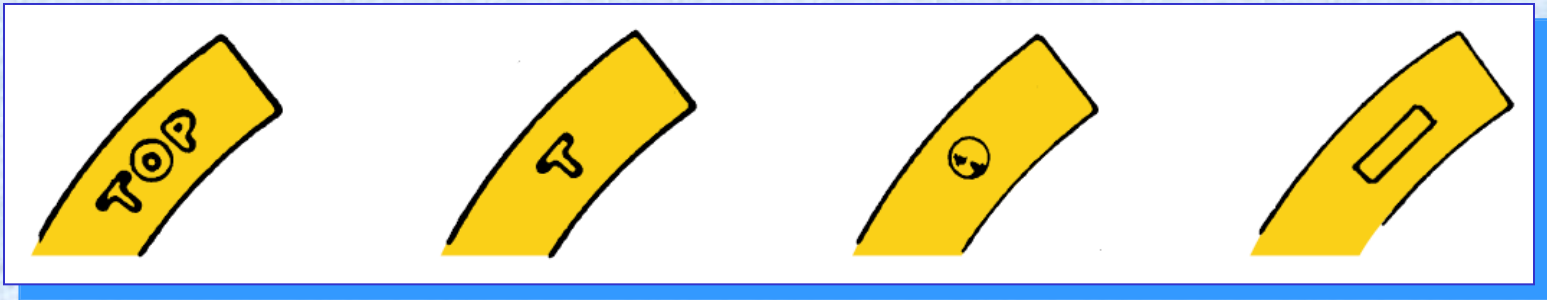
Piston Ring Service

Installing Oil Ring

- A. Fit the expander into its groove, and then install the bottom oil rail
- B. Spiral the rail top in above the expander
- C. The expander ends must not overlap



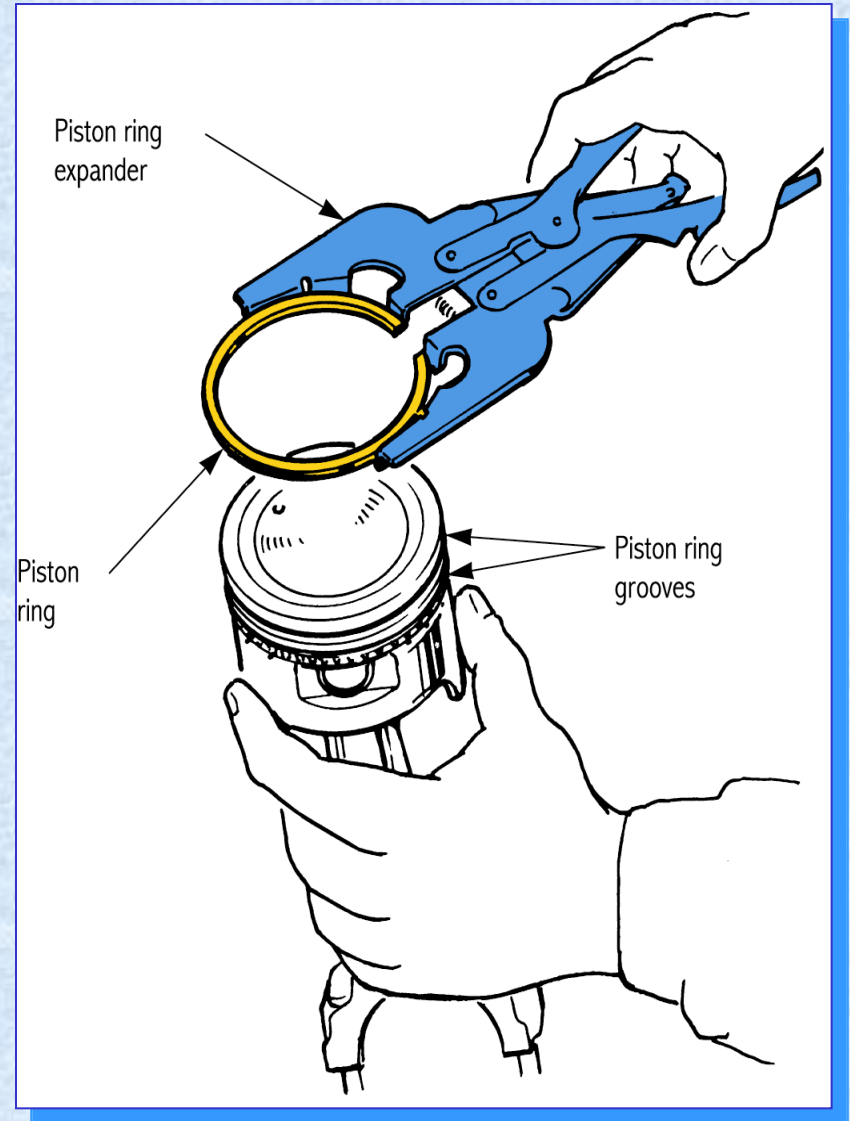
Compression Rings



Markings identify the top of each ring and which ring goes into which piston groove

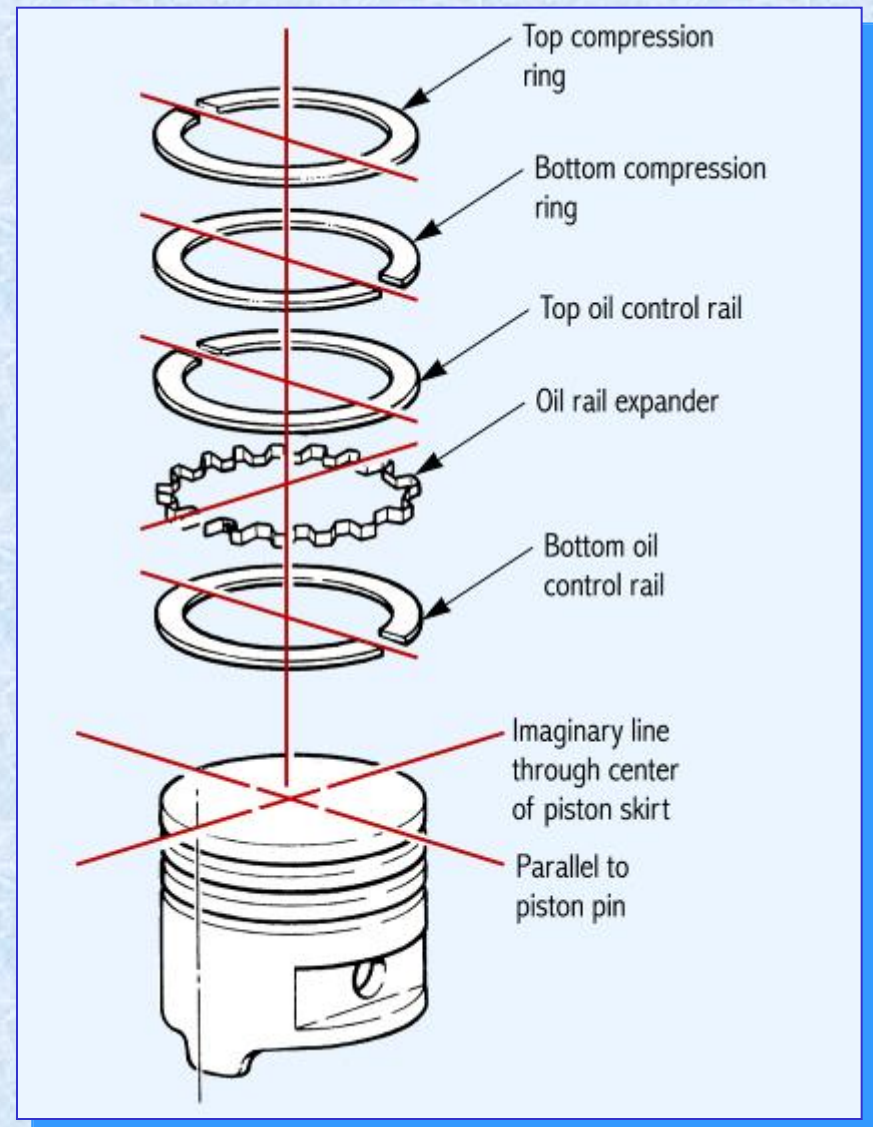
Installing Compression Rings

Use a piston ring
expander



Piston Ring Gap Spacing

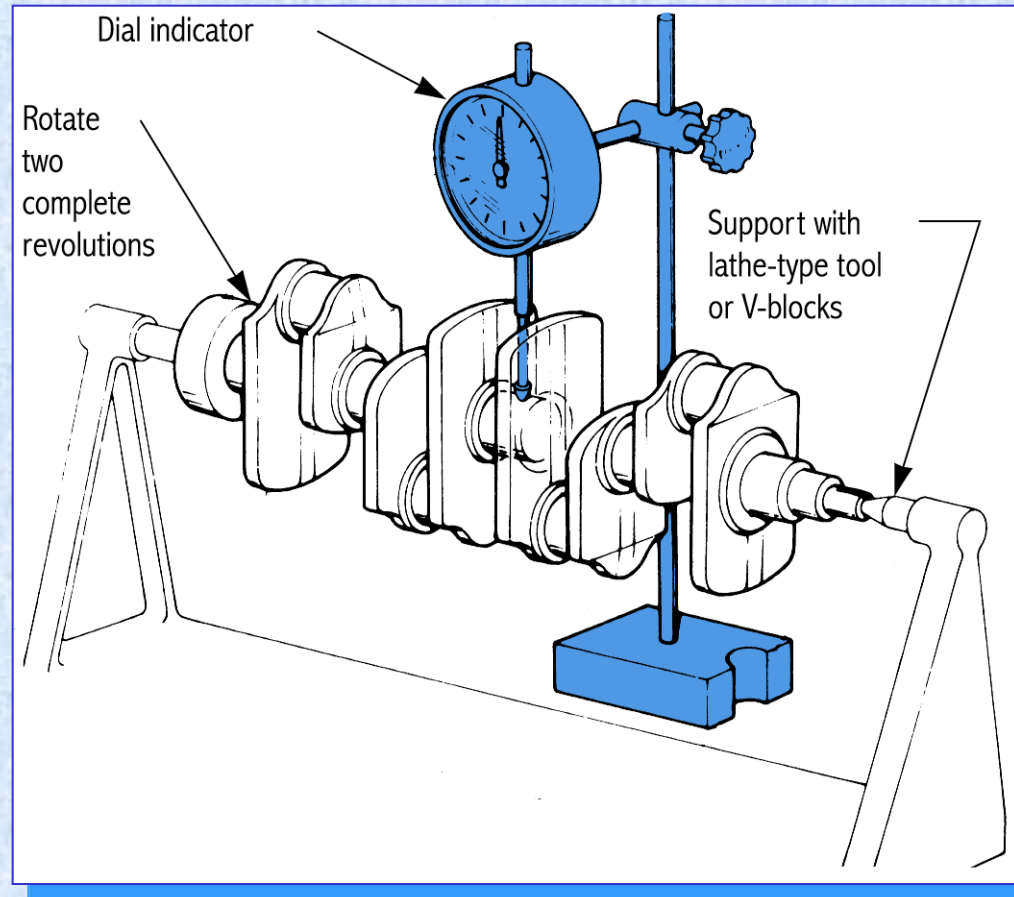
Recommended
spacing can reduce
blowby and ring wear



Crankshaft Service

- Make sure the crankshaft is perfectly clean
- Use compressed air to blow out all the oil passages
- Inspect for scratches, scoring, or signs of wear

Checking Crankshaft Straightness

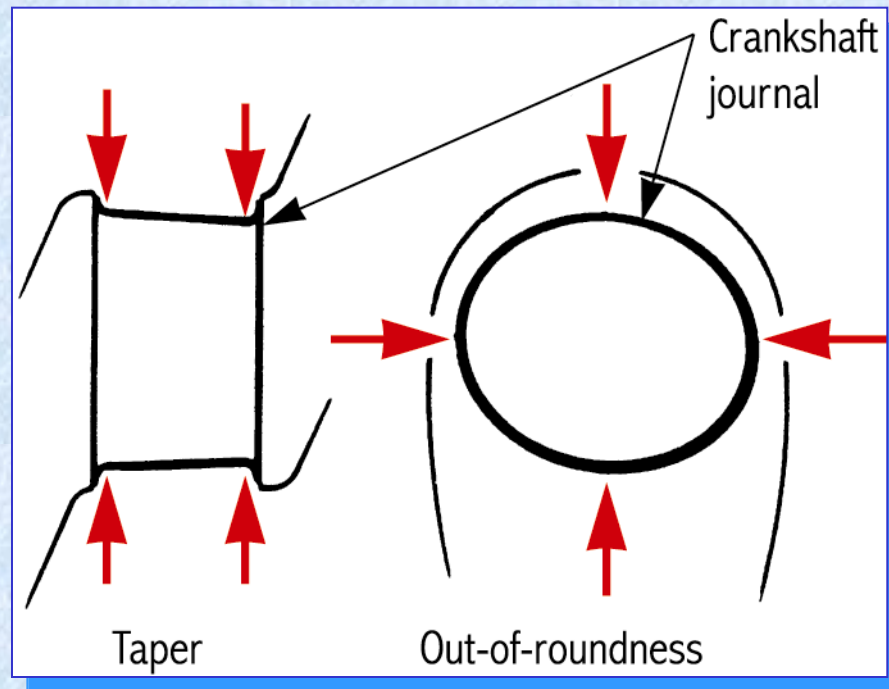


Indicator movement equals bend

Measuring Journal Taper and Out-of-Roundness

- ❑ If one side is worn more than the other, the journal is tapered
 - measure both ends of the journal
- ❑ If the journal is worn more on the top than on the bottom, it is out-of-round
 - measure across the journal from side to side and then from top to bottom

Measuring Journal Taper and Out-of-Roundness



Measuring Journal

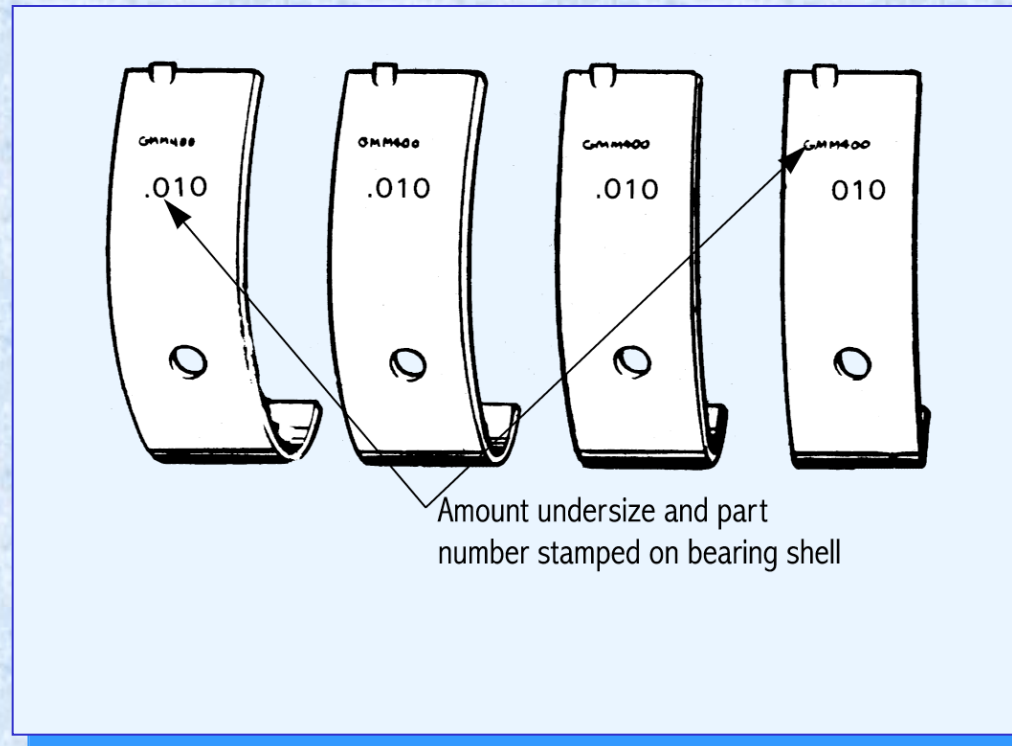
If wear is excessive,
the crankshaft must
be replaced or
turned to accept
undersize bearings



Turning or Grinding

- Turning a crankshaft:
 - grinding the rod and main journals to a smaller diameter
- Undersize bearings
 - needed after the crankshaft has been turned
 - new bearings are thicker to provide correct bearing-to-journal fit

Undersize Bearings



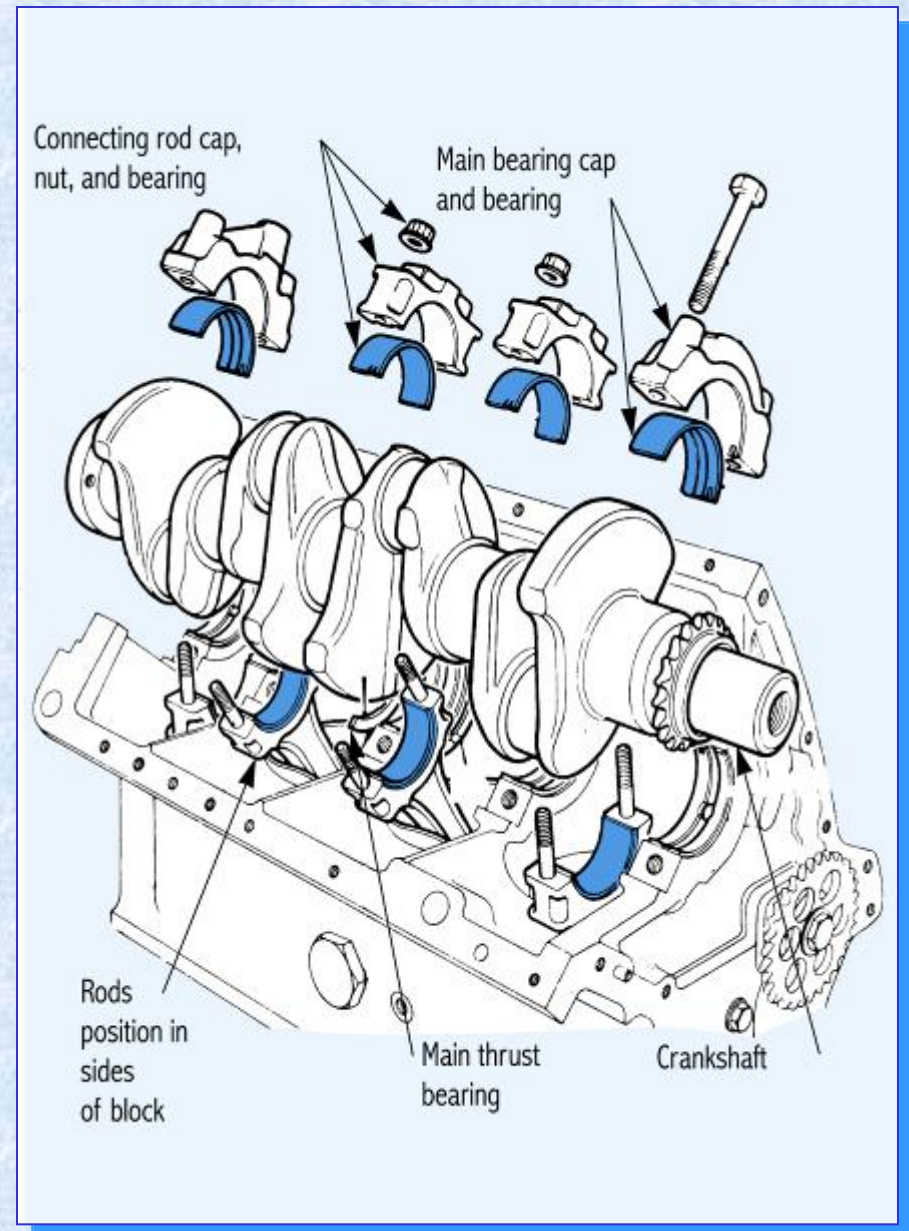
These bearings are 0.010" undersize

Installing Crankshaft Bearings

- ❑ One bearing insert goes into the block
- ❑ The matching insert goes into the main cap
- ❑ Make sure the oil holes in the bearings align with the oil holes in the block

Installing Crankshaft Bearings

Installation without head, piston, or connecting rod removal

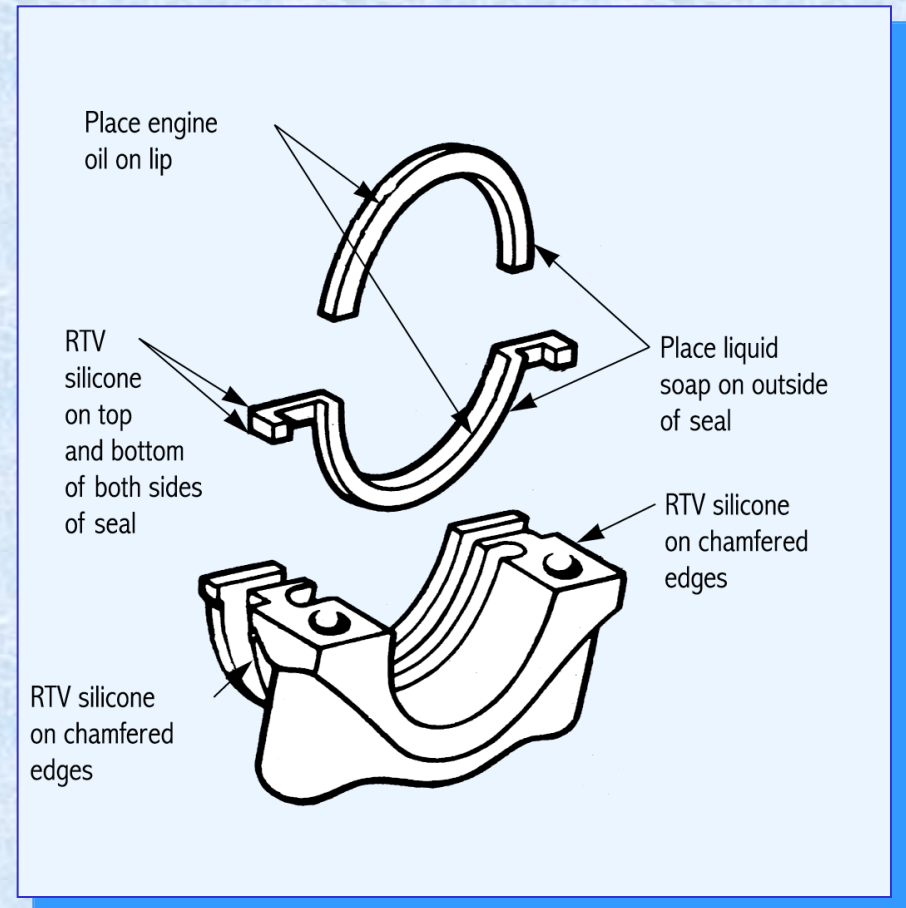


Installing Rear Main Oil Seal

- Three types of seals:
 - two-piece synthetic rubber seal
 - two-piece rope seal
 - one-piece synthetic rubber seal

Two-Piece Synthetic Rubber Seal

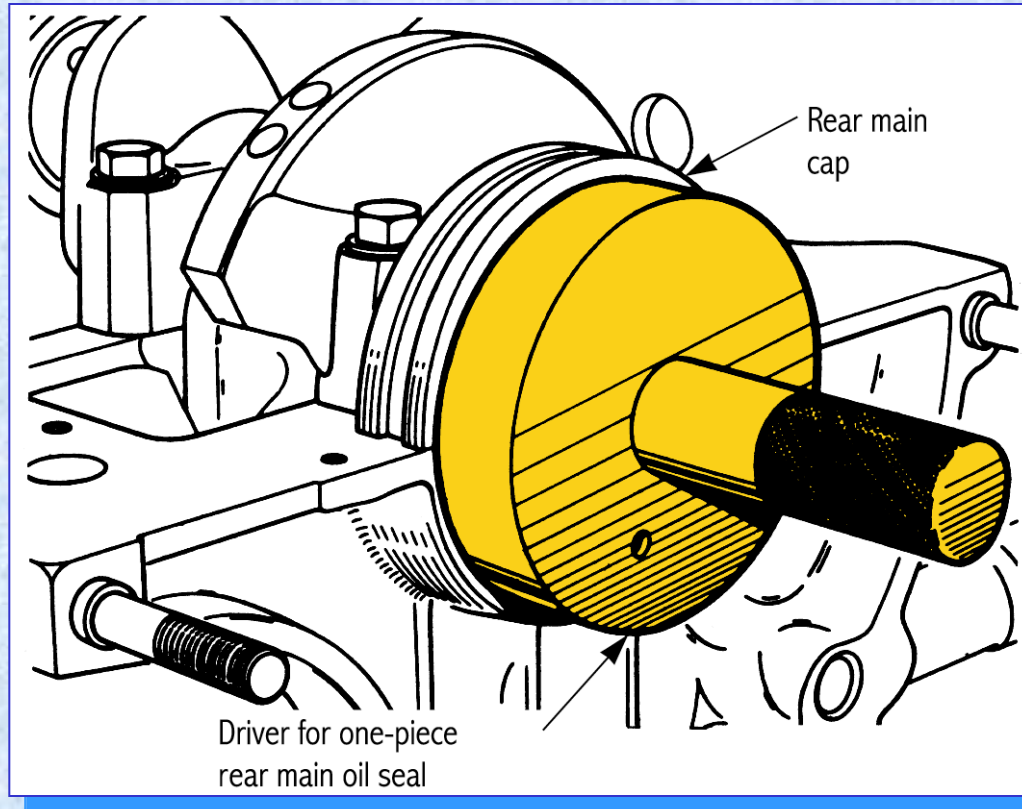
Press into place in the block and rear main cap, with the sealing lip toward the inside of the engine



Two-Piece Rope Seal

- Work down into the rear main cap and the block
- Use a razor to cut the seal flush with the cap and block parting line

One-Piece Synthetic Rubber Seal



Install with special driver

Installing the Crankshaft



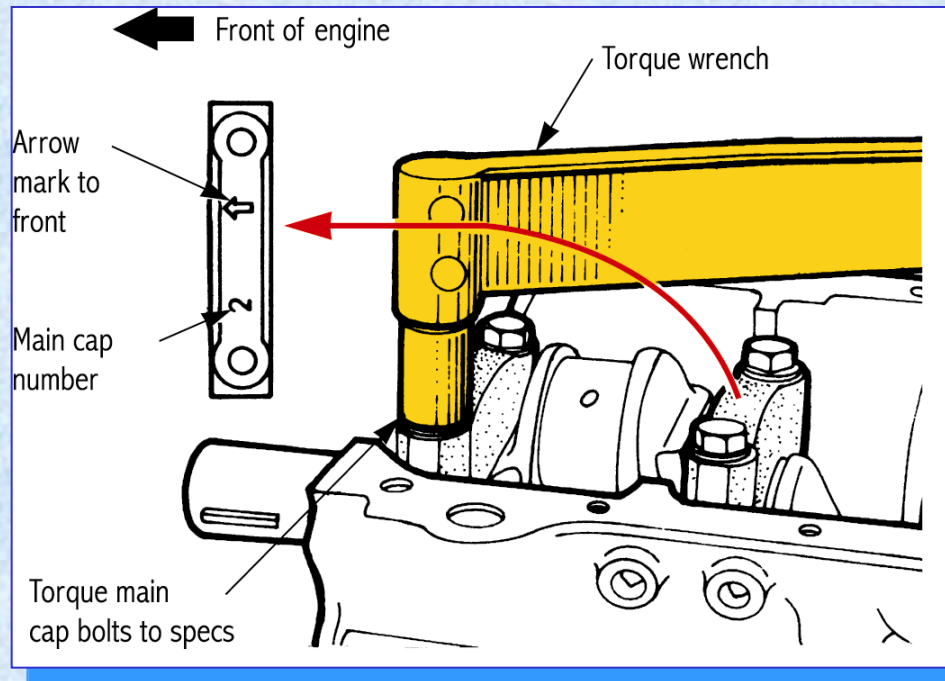
Coat the faces of the bearing inserts
with assembly lube or motor oil

Installing the Crankshaft



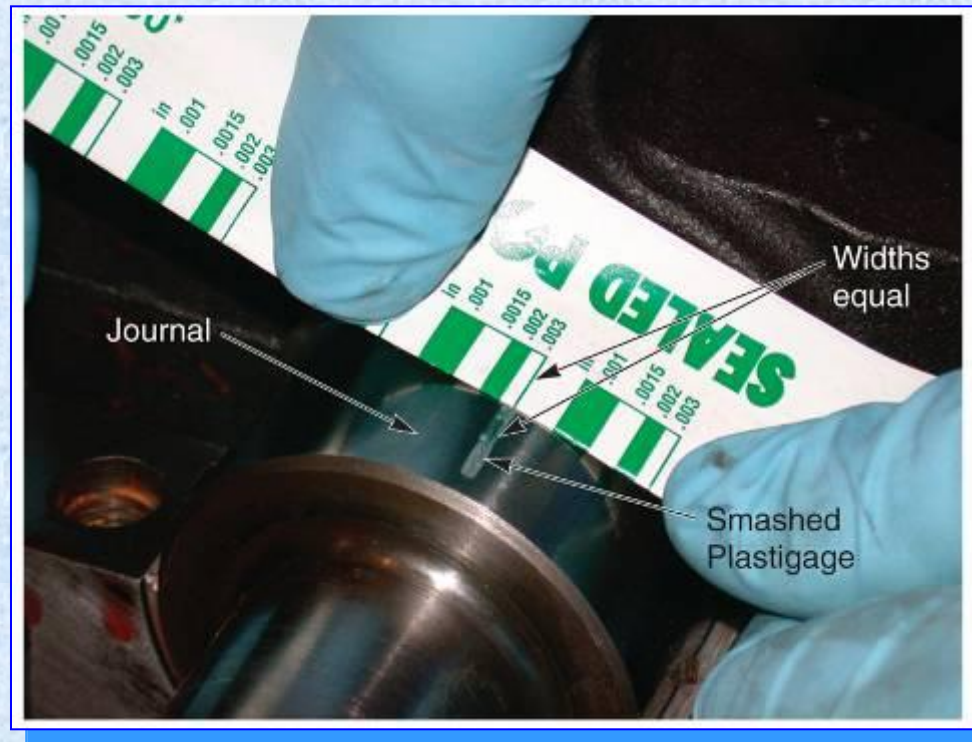
Carefully lay the crankshaft into place

Checking Main Bearing Clearance



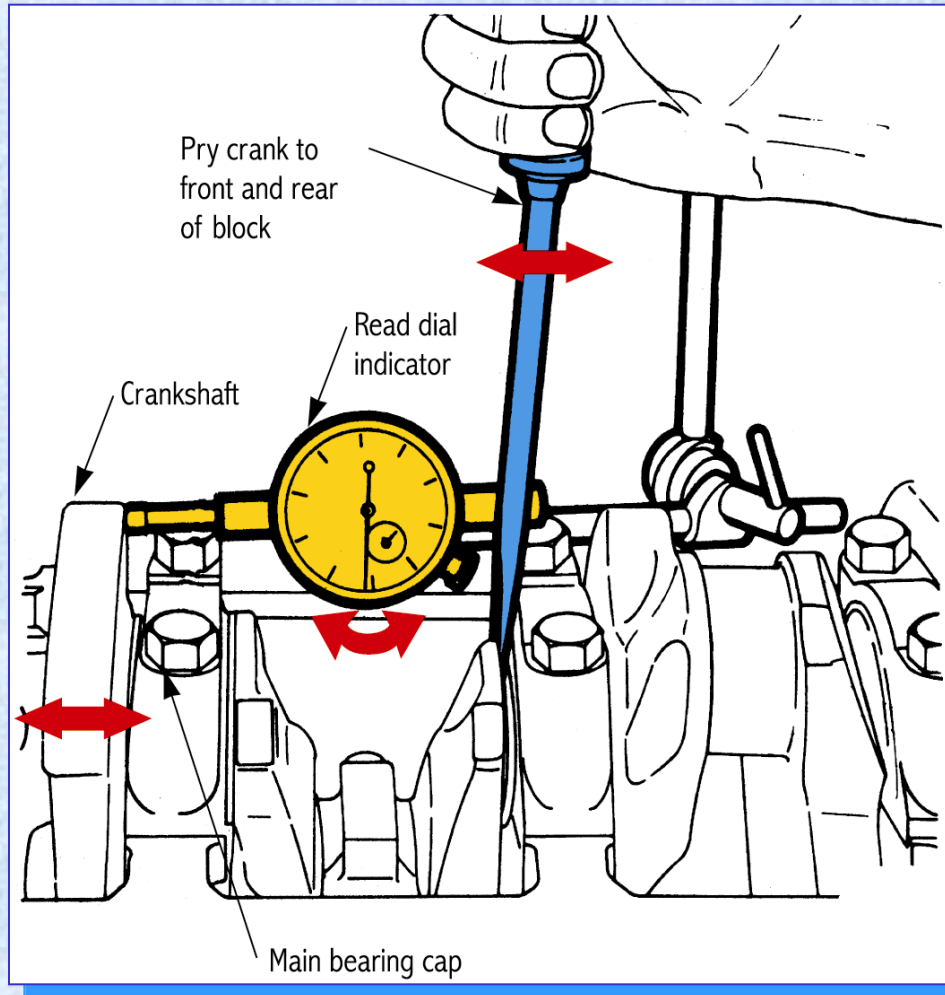
- Place Plastigage on an unoiled journal
- Install the cap and torque to specs

Checking Main Bearing Clearance



Remove the cap and compare the Plastigage to the paper scale

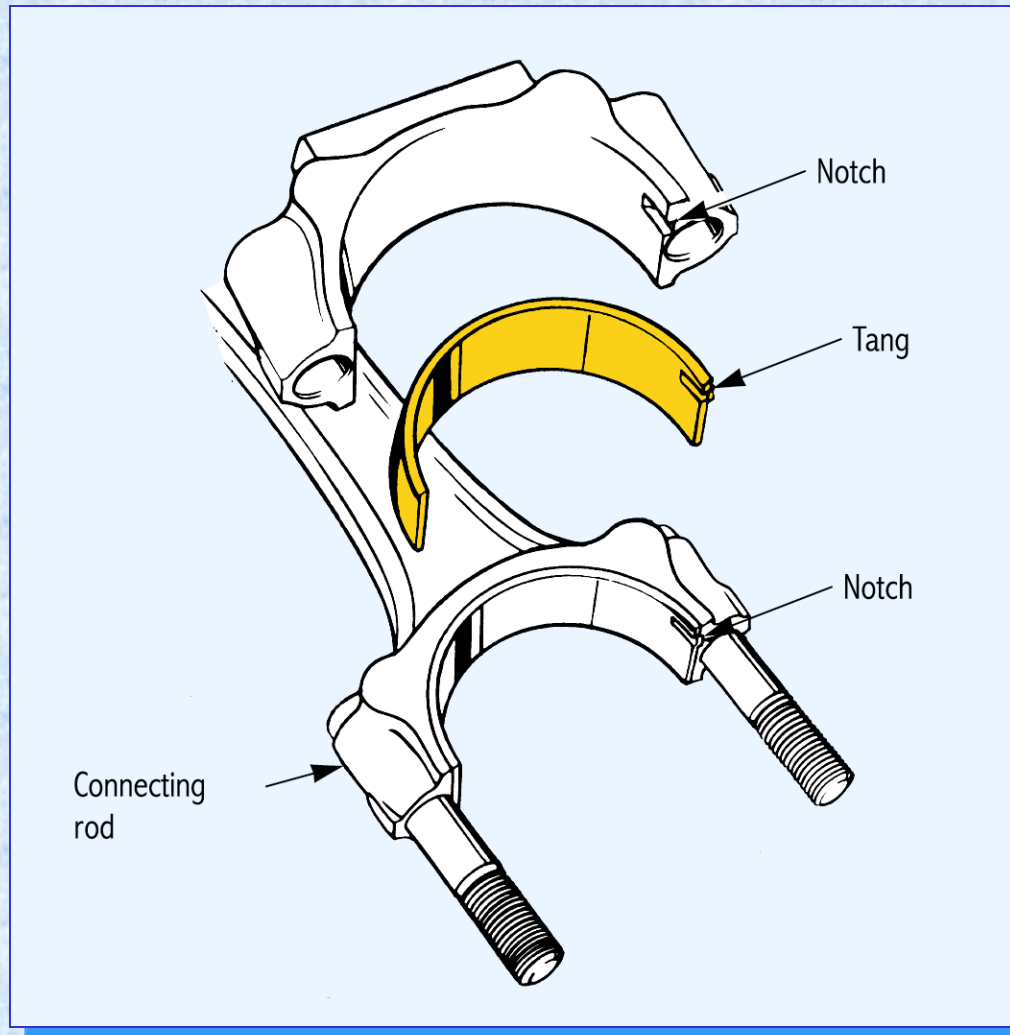
Checking Crankshaft End Play



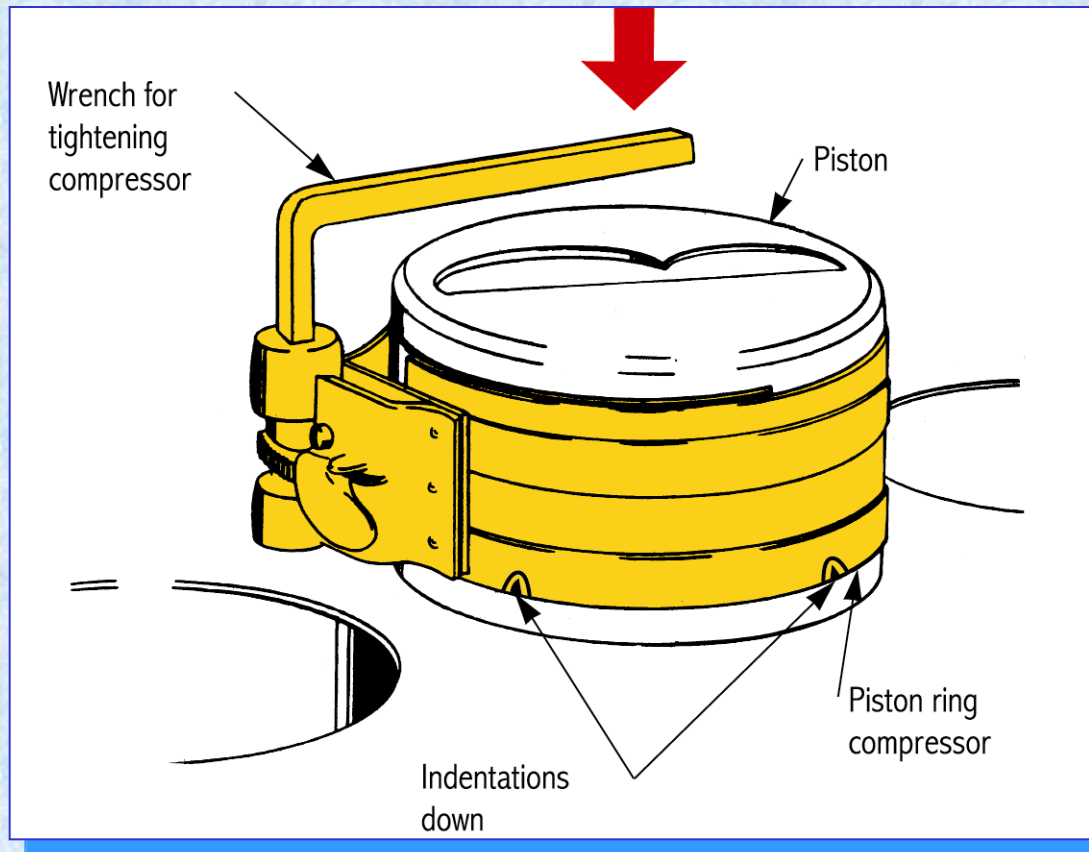
Installing a Piston and Rod Assembly

- Oil the piston and rings
- Fit the unoiled bearing inserts into the rod and cap
- Oil the bearing faces
- Compress the rings and protect the crankshaft
- Install the piston and rod in the block

Install Bearings

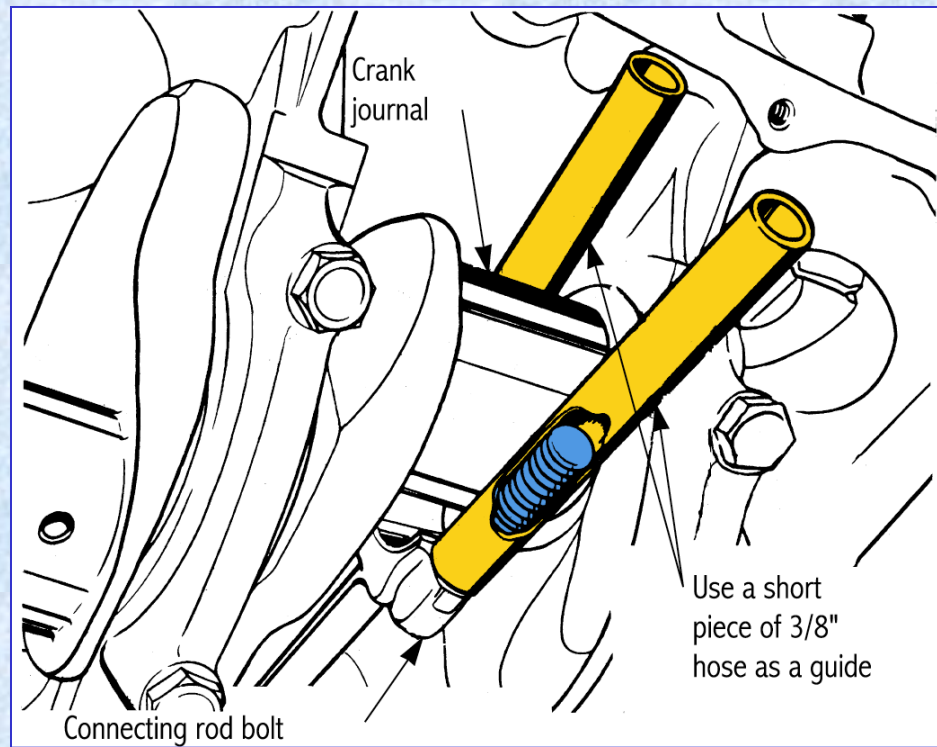


Compress Rings



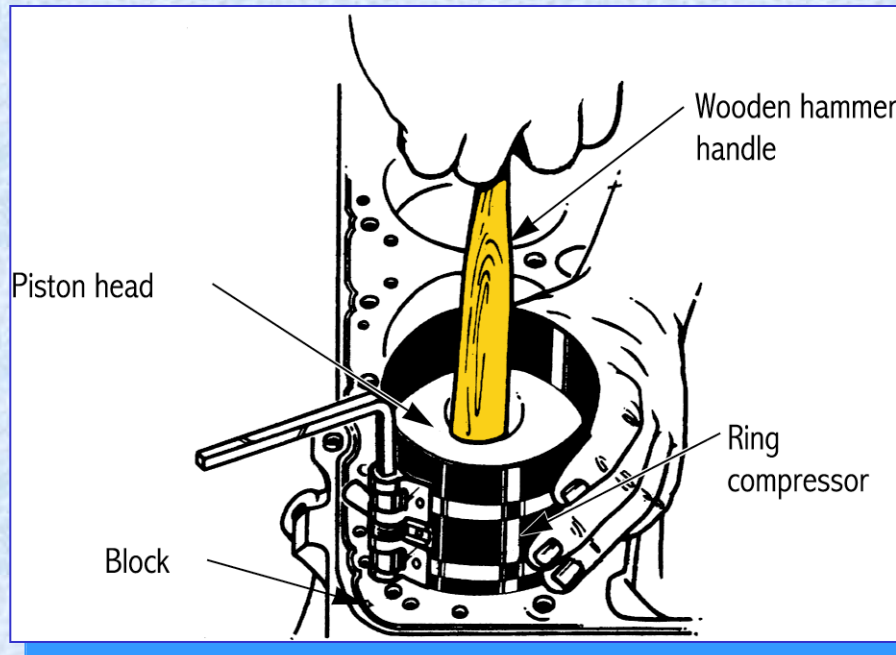
After checking the ring gap spacing,
install the ring compressor

Protect Crankshaft Journal



Do not let the rod bolts nick the crankshaft journals during installation

Install Piston and Rod

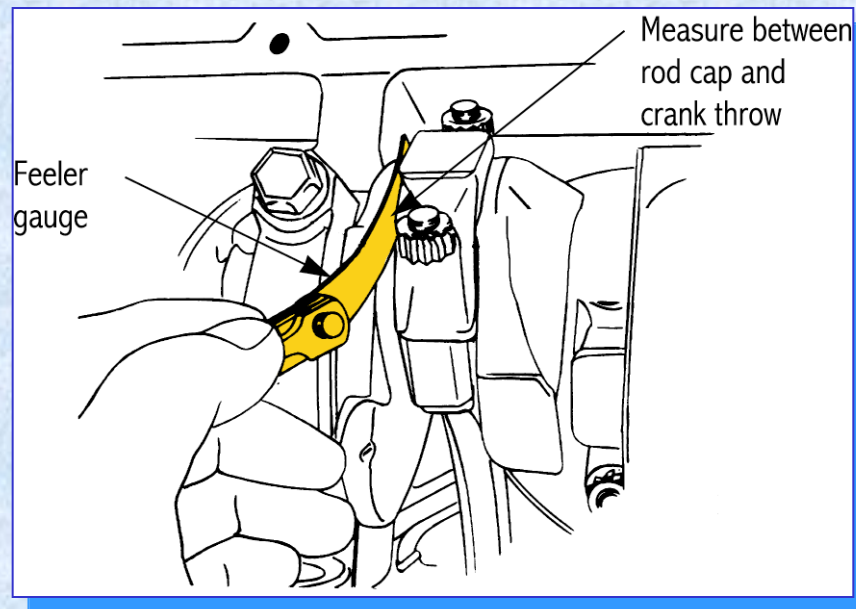


Guide the rod over the crankshaft as you tap the piston into the cylinder

Install Rod Caps

- Make sure the numbers on the rod and the cap are the same
- Torque the fasteners to specs using a torque wrench

Checking Rod Side Clearance

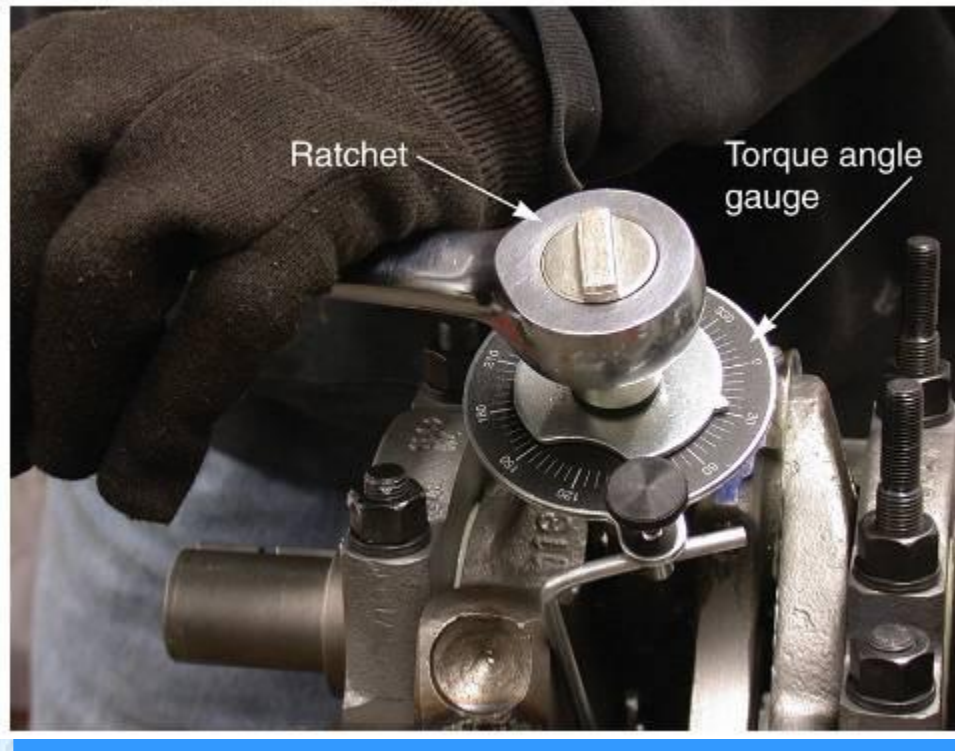


Use a feeler gauge to measure side clearance

Torque-to-Yield Bolts

- Bolts are tightened to a preset yield, or stretch, point
- Use new bolts
- Install the bolts and torque to specs
- Install a torque angle meter on the torque wrench and zero the pointer
- Turn the bolt until the meter reads as specified

Installing Torque-to-Yield Bolts



Using a torque angle gauge

Engine Balancing

Prevents engine vibration when the weight of the reciprocating parts is altered

Piston and Rod Balancing

- ❑ Pistons, rings, piston pins, connecting rods, and bearings are weighed on an accurate scale
- ❑ Material is machined or ground off the pistons and rods until all pistons weigh the same and all rods weigh the same
- ❑ All rod big ends and rod small ends should weigh the same

Crankshaft Balancing

- ❑ The crankshaft, front damper, and flywheel are balanced on a machine
- ❑ A balancing machine will show where weight should be added or removed from the crankshaft, damper, and flywheel

Final Assembly of Engine

- With the pistons and rods installed and torqued, install all the other parts on the block:
 - oil pump and oil pan
 - cylinder heads
 - camshaft drive
 - manifolds