

# 12. CRANKSHAFT/PISTON/CYLINDER

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## SERVICE INFORMATION

### GENERAL

- The crankcase must be separated to service the crankshaft and piston/connecting rod. Refer to section 11 for crankcase separation and assembly.
- Mark and store the connecting rods, bearing caps, pistons and bearing inserts to be sure of their correct locations during reassembly.
- The crankpin and main journal bearing inserts are select fit and are identified by color codes. Select replacement bearings from the code tables. After selecting new bearings, recheck the oil clearance with plastigauge. Incorrect oil clearance can cause major engine damage.

### SPECIFICATIONS

Unit: mm (in)

ITEM		STANDARD	SERVICE LIMIT
Crankshaft	Connecting rod side clearance	0.10 – 0.25 (0.004 – 0.010)	0.30 (0.012)
	Crankpin bearing oil clearance	0.028 – 0.052 (0.0011 – 0.0020)	0.06 (0.002)
	Main journal bearing oil clearance	0.020 – 0.038 (0.0008 – 0.0015)	0.05 (0.002)
	Runout	—	0.05 (0.002)
Piston, piston rings	Piston O.D. at 15 mm (0.6 in) from bottom	66.965 – 66.985 (2.6364 – 2.6372)	66.90 (2.634)
	Piston pin bore I.D.	17.002 – 17.008 (0.6694 – 0.6696)	17.02 (0.670)
	Piston pin O.D.	16.994 – 17.000 (0.6691 – 0.6693)	16.98 (0.669)
	Piston-to-piston pin clearance	0.002 – 0.014 (0.0001 – 0.0006)	0.04 (0.002)
	Piston ring end gap	Top	0.10 – 0.20 (0.004 – 0.008)
		Second	0.18 – 0.30 (0.007 – 0.012)
		Oil (side rail)	0.2 – 0.7 (0.01 – 0.03)
	Piston ring-to-ring groove clearance	Top	0.020 – 0.050 (0.0008 – 0.0020)
		Second	0.015 – 0.050 (0.0006 – 0.0020)
Cylinder	I.D.	67.000 – 67.015 (2.6378 – 2.6384)	67.10 (2.642)
	Out-of-round	—	0.10 (0.004)
	Taper	—	0.10 (0.004)
	Warpage	—	0.10 (0.004)
Cylinder-to-piston clearance		0.015 – 0.050 (0.0006 – 0.0022)	0.10 (0.004)
Connecting rod small end I.D.		17.016 – 17.034 (0.6699 – 0.6706)	17.04 (0.671)
Connecting rod-to-piston pin clearance		0.016 – 0.040 (0.0006 – 0.0016)	0.06 (0.002)

## CRANKSHAFT/PISTON/CYLINDER

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### TORQUE VALUES

Connecting rod bearing cap nut	25 N•m (2.6 kgf•m, 19 lbf•ft)	Apply oil to the threads and seating surface.
Crankcase bolt (main journal)	25 N•m (2.6 kgf•m, 19 lbf•ft)	Apply oil to the threads and seating surface.

### TOOLS

Inner driver C	07746-0030100	
Attachment, 30 mm I.D.	07746-0030300	
Universal bearing puller	07631-0010000	Equivalent commercially available in U.S.A.

## TROUBLESHOOTING

### Cylinder compression is too low, hard to start or poor performance at low speed

- Leaking cylinder head gasket
- Worn, stuck or broken piston ring
- Worn or damaged cylinder and piston

### Cylinder compression too high, overheats or knocks

- Carbon deposits on the cylinder head and/or piston crown

### Excessive smoke

- Worn cylinder, piston or piston ring
- Improper installation of piston rings
- Scored or scratched piston or cylinder wall

### Abnormal noise

- Worn piston pin or piston pin hole
- Worn connecting rod small end
- Worn cylinder, piston or piston rings
- Worn main journal bearings
- Worn crankpin bearings

### Engine vibration

- Excessive crankshaft runout

## CRANKSHAFT

Separate the crankcase halves (page 11-3).

### SIDE CLEARANCE INSPECTION

Measure the connecting rod side clearance.

**SERVICE LIMIT: 0.30 mm (0.012 in)**

If the clearance exceeds the service limit, replace the connecting rod.

Recheck and if still out of limit, replace the crankshaft.



*Be careful not to damage the crankpin, main journal and bearing inserts.*

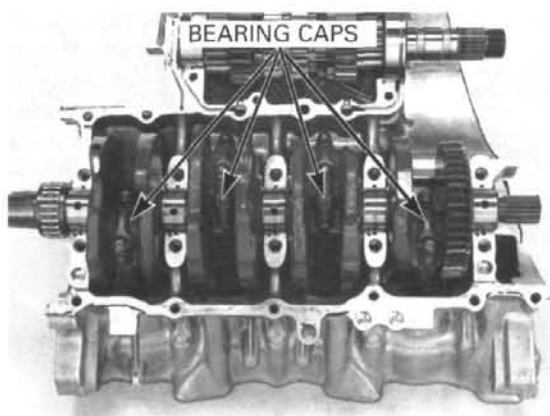
### REMOVAL

Mark the bearing caps and bearings as you remove them to indicate the correct cylinder for reassembly.

Remove the connecting rod bearing cap nuts and bearing caps.

Tap the side of the cap lightly if the bearing cap is hard to remove.

Remove the crankshaft.



### INSPECTION

Hold the crankshaft both end.

Set a dial gauge on the center main journal of the crankshaft.

Rotate the crankshaft two revolutions and read the runout.

**SERVICE LIMIT: 0.05 mm (0.002 in)**

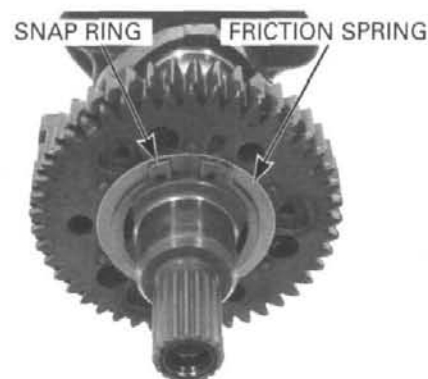


Check the primary drive gear and sub-gear teeth for abnormal wear or damage.

### PRIMARY DRIVE SUB-GEAR REMOVAL

Remove the special snap ring and friction spring.

Remove the primary drive sub-gear, gear springs and stopper pins.

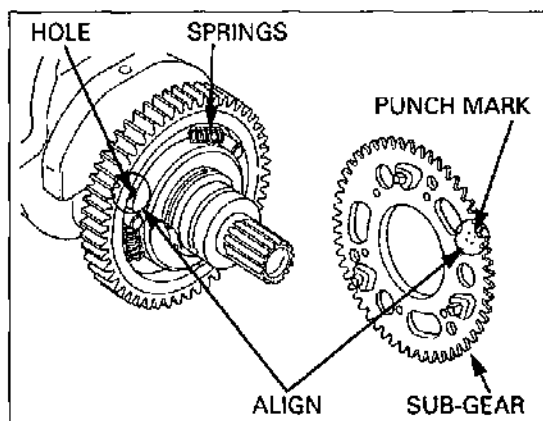


### PRIMARY DRIVE SUB-GEAR INSTALLATION

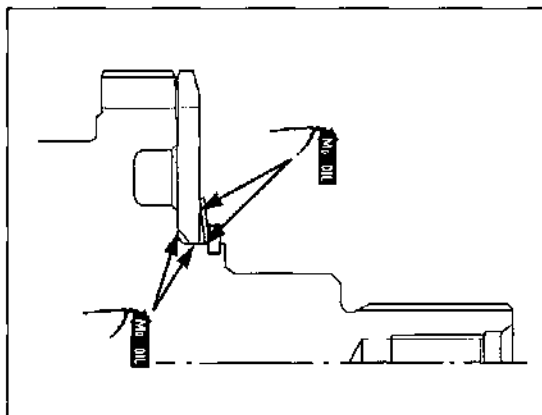
Install the stopper pins and gear springs onto the primary drive gear as shown.

Apply molybdenum oil solution to the sub-gear sliding surface and friction spring sliding surface. Temporarily install the sub-gear by aligning the punch mark with the hole in the primary drive gear.

Install the friction spring onto the sub-gear.

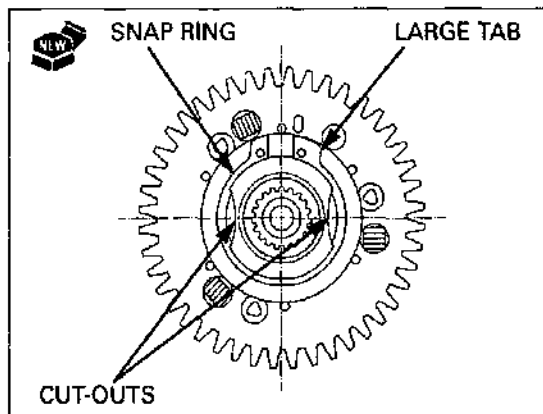


Install the sub-gear onto the primary drive gear so it evenly touches the primary drive gear by prying the sub-gear with a 5-mm pin or screwdriver as the stoppers on the reverse side of the sub-gear push against the gear springs.



*Install with the large tab facing the right and the chamfered side facing the gear.*

Install a new snap ring into the ring groove in the crankshaft securely with the end gap at a right angle to the crankshaft cut-outs. Be sure to align the large tab edge with the sub-gear groove as shown.



### STARTER CLUTCH NEEDLE BEARING REPLACEMENT

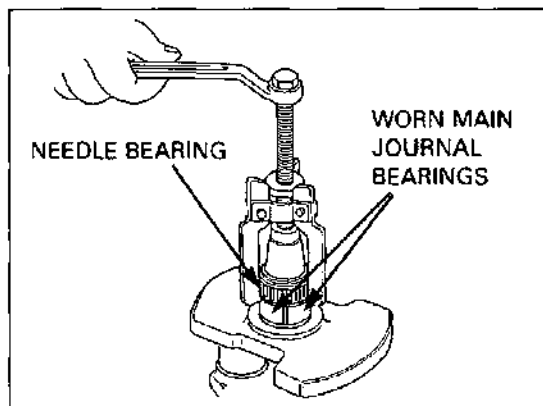
*To protect the crankshaft main journal from the bearing puller claws, cover the mainshaft journal properly. You can use worn main journal bearings for protectors.*

Remove the needle bearing with a commercially available universal bearing puller.

#### TOOL:

Universal bearing puller

07631-0010000  
(equivalent commercially available in U.S.A.)



Press with the marked side facing up.

Press a new needle bearing onto the crankshaft using a hydraulic press and special tools until its edge is flush with the groove in the crankshaft. Make sure that the height from the crankshaft end is 27.6 – 27.9 mm (1.09 – 1.10 in).

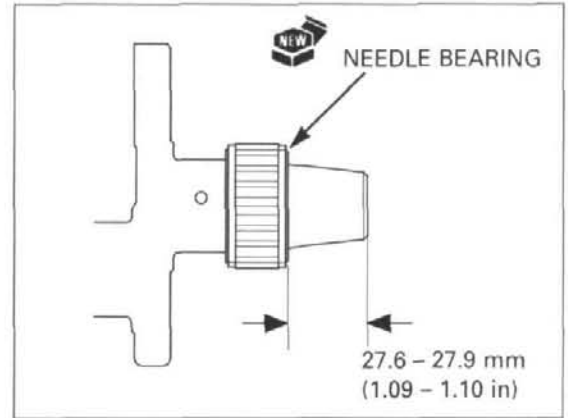
## TOOLS:

Inner driver C

07746-0030100

Attachment, 30 mm I.D.

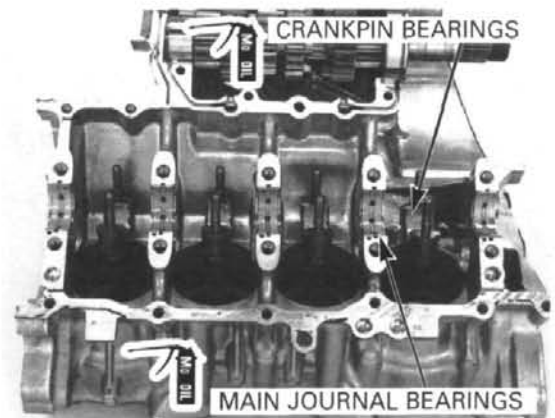
07746-0030300



## INSTALLATION

Do not get the molybdenum oil solution onto the connecting rod bolts and bearing cap nuts. The oil may prevent the cap nuts from being tightened to the correct torque.

Apply molybdenum oil solution to the main journal bearing sliding surfaces on the upper crankcase and the crankpin bearing sliding surfaces on the connecting rods.

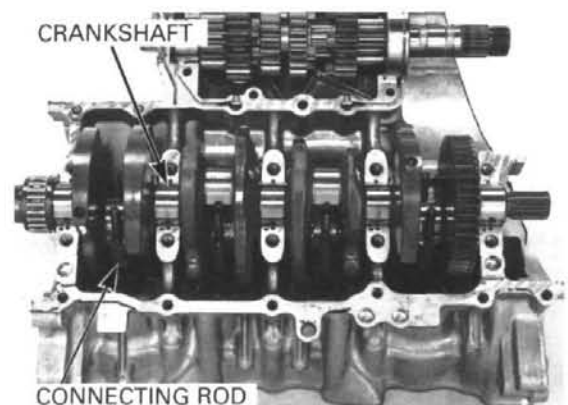


Apply molybdenum oil solution to the thrust surfaces of the crankshaft as shown.



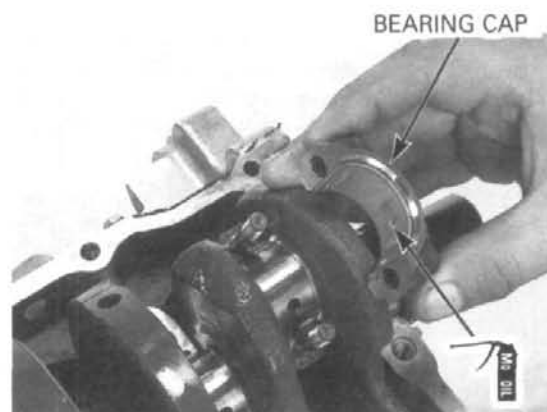
Lower all of the pistons to top dead center to avoid damaging the crankpin with the connecting rod bolts. Carefully install the crankshaft onto the upper crankcase.

Set the connecting rods onto the crankpins.



## CRANKSHAFT/PISTON/CYLINDER

Apply molybdenum oil solution to the crankpin bearing sliding surfaces on the bearing caps. Install the bearing caps by aligning the I.D. code on the connecting rod and bearing cap. Be sure each part is installed in its original position, as noted during removal.



Apply oil to the bearing cap nut threads and seating surfaces and install the cap nuts. Tighten the nut in two or three steps and torque them.

**TORQUE: 25 N·m (2.6 kgf·m, 19 lbf·ft)**

Assemble the crankcase halves (page 11-12).



## MAIN JOURNAL BEARING

### NOTICE

*Do not interchange the bearing inserts. They must be installed in their original locations or the correct bearing oil clearance may not be obtained, resulting in engine damage.*

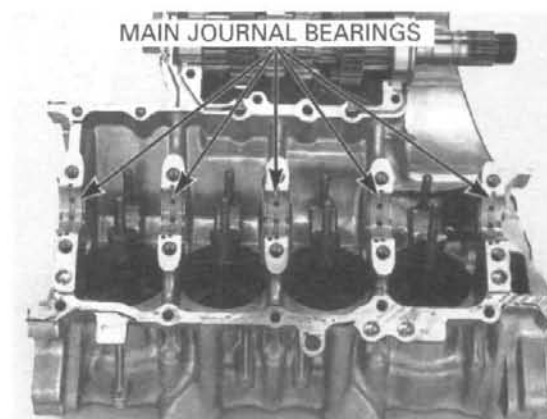
Remove the crankshaft (page 12-3).

### BEARING INSPECTION

Inspect the main journal bearing inserts on the upper and lower crankcase for unusual wear or peeling. Check the bearing tabs for damage.

### OIL CLEARANCE INSPECTION

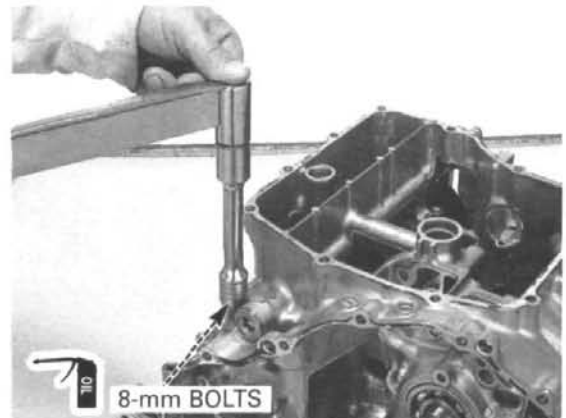
Clean off any oil from the bearing inserts and main journals. Install the crankshaft onto the upper crankcase. Put a strip of plastigauge lengthwise on each main journal and avoid the oil hole.



*Do not rotate the crankshaft during inspection.*

Install the dowel pins and oil orifices.  
Carefully install the lower crankcase on the upper crankcase.  
Apply engine oil onto the main journal 8-mm bolt threads and seating surfaces and install them.  
Tighten the 8-mm bolts in a crisscross pattern in two or three steps.

**TORQUE: 25 N·m (2.6 kgf·m, 19 lbf·ft)**



Remove the 8-mm bolts and lower crankcase.  
Measure the compressed plastigauge at its widest point on each main journal to determine the oil clearance.

**SERVICE LIMITS: 0.05 mm (0.002 in)**

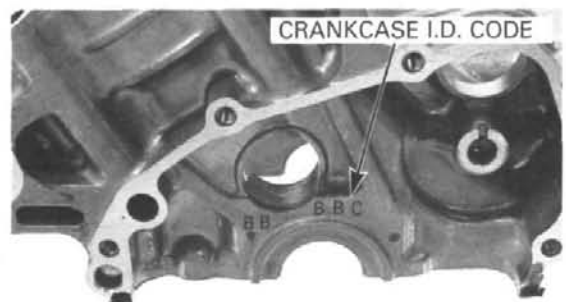
If main bearing clearance exceeds the service limit, select the correct replacement bearings.



Letters (A, B or C) on the left side of upper crankcase are the codes for the bearing support I.D.s from left to right.

## BEARING SELECTION

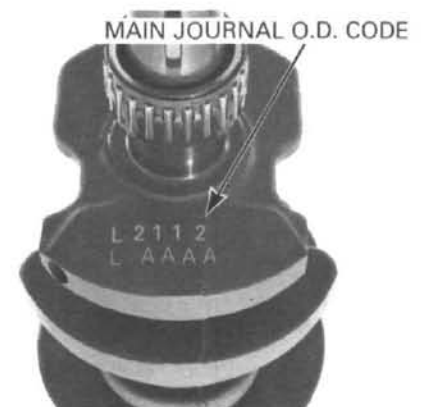
Record the crankcase bearing support I.D. code letters from the left side of the upper crankcase as shown.



Numbers (1, 2 or 3) on the crank weight are the codes for the main journal O.D.s from left to right.

Record the corresponding main journal O.D. code numbers from the crank weight.

Cross reference the main journal and bearing support codes to determine the replacement bearing color code.





## CRANKSHAFT/PISTON/CYLINDER

MAIN JOURNAL BEARING SELECTION TABLE:

Unit: mm (in)

			BEARING SUPPORT I.D. CODE		
			A	B	C
			33.000 – 33.006 (1.2992 – 1.2994)	33.006 – 33.012 (1.2994 – 1.2997)	33.012 – 33.018 (1.2997 – 1.2999)
MAIN JOURNAL O.D. CODE	1	30.000 – 30.006 (1.1811 – 1.1813)	E (Pink)	D (Yellow)	C (Green)
	2	29.994 – 30.000 (1.1809 – 1.1811)	D (Yellow)	C (Green)	B (Brown)
	3	29.988 – 29.994 (1.1806 – 1.1809)	C (Green)	B (Brown)	A (Black)

**BEARING THICKNESS:**

A (Black)    Thick  
B (Brown):    ↑  
C (Green):    ↓  
D (Yellow):    ↓  
E (Pink)    Thin

**IDENTIFICATION COLOR**



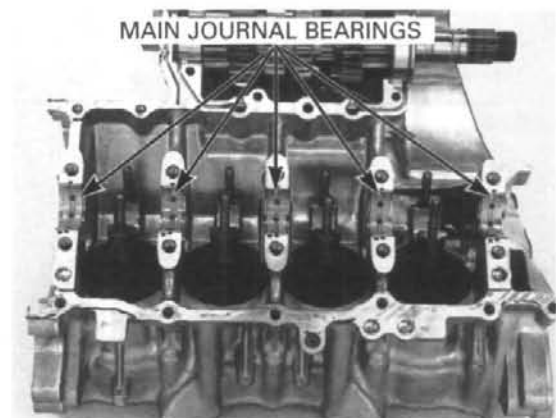
**NOTICE**

After selecting new bearings, recheck the clearance with a plastigauge. Incorrect clearance can cause severe engine damage.

### BEARING INSTALLATION

Clean the bearing outer surfaces and crankcase bearing supports.

Install the main journal bearing inserts onto the crankcase bearing supports, aligning each tab with each groove.



## CRANKPIN BEARING

**NOTICE**

Do not interchange the bearing inserts. They must be installed in their original locations or the correct bearing oil clearance may not be obtained, resulting in engine damage.

Remove the crankshaft (page 12-3).

### BEARING INSPECTION

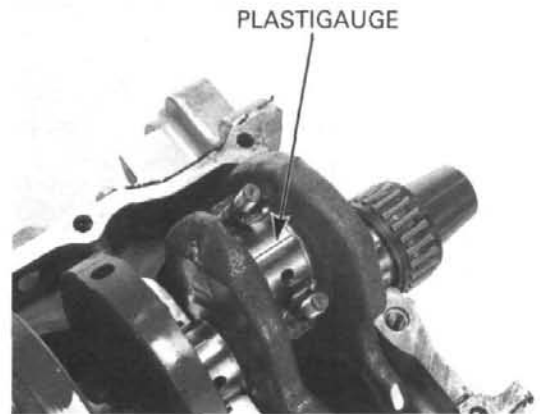
Check the bearing inserts for unusual wear or peeling.  
Check the bearing tabs for damage.

**CRANKPIN BEARING INSERTS**



### **OIL CLEARANCE INSPECTION**

Clean off any oil from the bearing inserts and crankpin.  
Carefully install the crankshaft onto the upper crankcase.  
Set the connecting rods onto the crankpin.  
Put a strip of plastigauge lengthwise on the crankpin and avoid the oil hole.



Carefully install the bearing caps by aligning the I.D. code.  
Apply engine oil to the connecting rod bearing cap nut threads and seating surfaces and install them.  
Tighten the cap nuts in two or three steps.

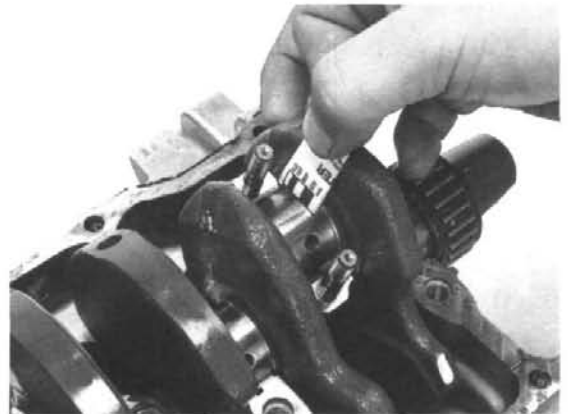
**TORQUE: 25 N·m (2.6 kgf·m, 19 lbf·ft)**



Remove the nuts and bearing cap.  
Measure the compressed plastigauge at its widest point on the crankpin to determine the oil clearance.

**SERVICE LIMIT: 0.06 mm (0.002 in)**

If the oil clearance exceeds the service limit, select the correct replacement bearings.



### **BEARING SELECTION**

*Numbers (1 or 2) on the connecting rods are the codes for the connecting rod I.D.*

Record the connecting rod I.D. code number (1 or 2) or measure the I.D. with the bearing cap installed without bearing inserts.



CONNECTING ROD I.D. CODE

## CRANKSHAFT/PISTON/CYLINDER

Letters (A or B) on the crank weight are the codes for the crankpin O.D.s from left to right.

If you are replacing the crankshaft, record the corresponding crankpin O.D. code number (A or B).

If you are reusing the crankshaft, measure the crankpin O.D. with a micrometer.

Cross-reference the crankpin and rod codes to determine the replacement bearing color.



**CRANKPIN BEARING SELECTION TABLE:**

Unit: mm (in)

			CONNECTING ROD I.D. CODE	
			1	2
			34.000 – 34.008 (1.3386 – 1.3389)	34.008 – 34.016 (1.3389 – 1.3392)
CRANK PIN O.D. CODE	A	31.492 – 31.500 (1.2398 – 1.2402)	C (Yellow)	B (Green)
	B	31.484 – 31.492 (1.2395 – 1.2398)	B (Green)	A (Brown)

### BEARING THICKNESS:

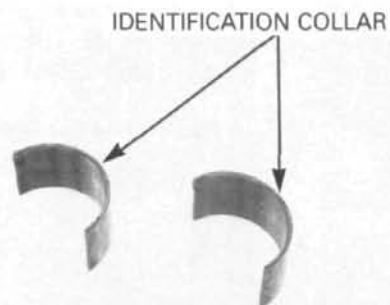
A (Brown): Thick

B (Green):

C (Yellow): Thin

### NOTICE

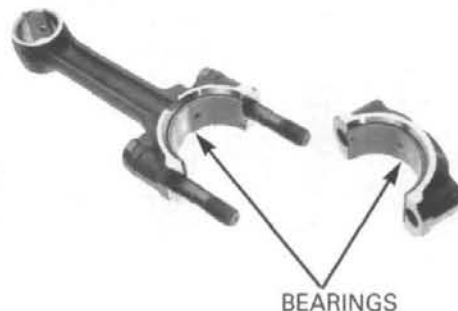
After selecting new bearings, recheck the clearance with a plastigauge. Incorrect clearance can cause severe engine damage.



## BEARING INSTALLATION

Clean the bearing outer surfaces, bearing cap and connecting rod.

Install the crankpin bearing inserts onto the bearing cap and connecting rod, aligning each tab with each groove.

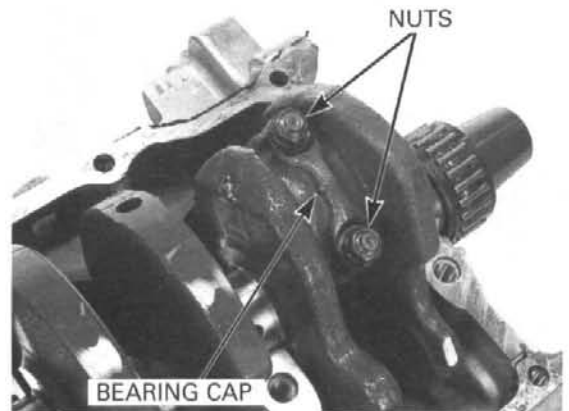


## PISTON/CYLINDER

*Mark all the parts as you remove them to indicate the correct cylinder for reassembly.*

### PISTON/CONNECTING ROD REMOVAL

Remove the nuts and connecting rod bearing cap.



*Do not try to remove the connecting rod/piston assembly from the bottom of the cylinder; the assembly will be locked so that the oil ring expands in the gap between the cylinder liner and the upper crankcase.*

Remove the piston/connecting rod assembly from the top of the cylinder.



### PISTON REMOVAL

Remove the piston pin clip with pliers. Push the piston pin from the piston and connecting rod, and remove the piston.



### PISTON DISASSEMBLY

*Do not damage the piston ring by spreading the ends too far.*

Spread each piston ring and remove it by lifting up at a point opposite the gap.



## CRANKSHAFT/PISTON/CYLINDER

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*Clean carbon deposits from the ring grooves with an old piston ring. Never use a wire brush; it will scratch the groove.*

Remove any carbon deposits from the piston ring grooves.



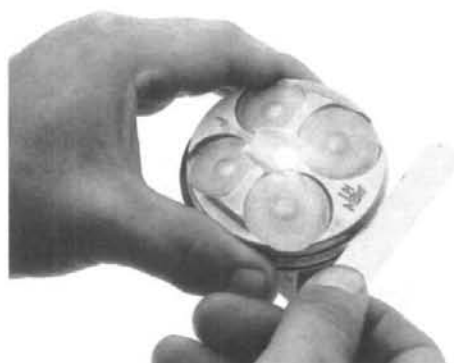
### PISTON INSPECTION

Temporarily install the piston rings to their proper position with the mark facing up.

Measure the piston ring-to-ring groove clearance with the rings pushed into the grooves.

#### SERVICE LIMITS:

Top/second: 0.08 mm (0.003 in)



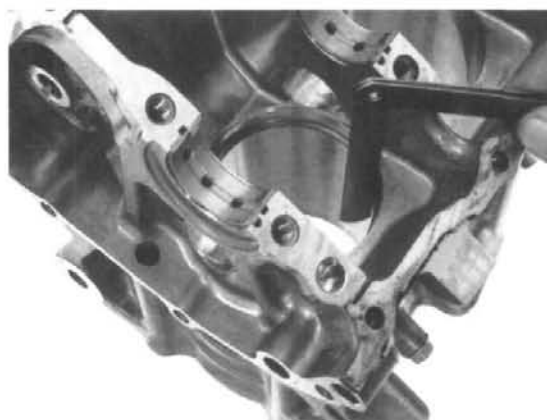
Insert the piston ring squarely into the bottom of the cylinder and measure the ring end gap.

#### SERVICE LIMITS:

Top: 0.4 mm (0.02 in)

Second: 0.5 mm (0.02 in)

Oil (side rail): 1.0 mm (0.04 in)



Measure the piston pin bore.

SERVICE LIMIT: 17.02 mm (0.670 in)



Measure the O.D. of the piston pin.

**SERVICE LIMIT: 16.98 mm (0.669 in)**

Calculate the piston-to-piston pin clearance.

**SERVICE LIMIT: 0.04 mm (0.002 in)**



## CONNECTING ROD INSPECTION

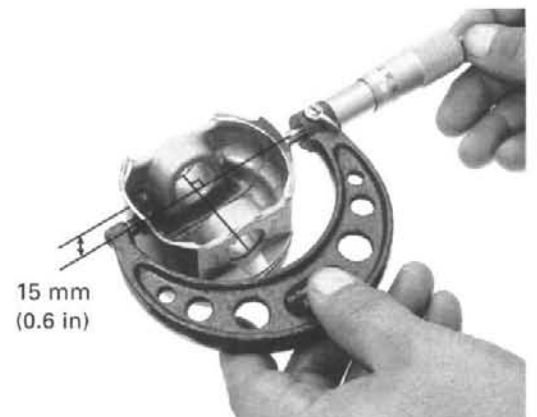
Measure the connecting rod small end I.D.

**SERVICE LIMIT: 17.04 mm (0.671 in)**



Measure the diameter of the piston at 15 mm (0.6 in) from the bottom and 90 degrees to the piston pin hole.

**SERVICE LIMIT: 66.90 mm (2.634 in)**



## CYLINDER INSPECTION

Inspect the cylinder bore for wear or damage.

Measure the cylinder I.D. in the X and Y axes at three levels.

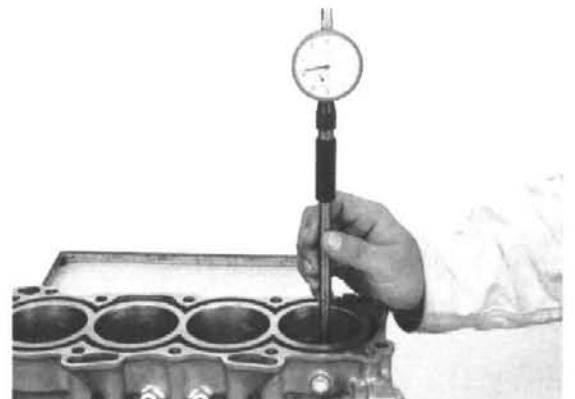
Take the maximum reading to determine the cylinder wear.

**SERVICE LIMIT: 67.10 mm (2.642 in)**

Calculate the piston-to-cylinder clearance.

Take a maximum reading to determine the clearance. Refer to page 11-5 for measurement of the piston O.D.

**SERVICE LIMIT: 0.10 mm (0.004 in)**



## CRANKSHAFT/PISTON/CYLINDER

Calculate the taper and out-of-round at three levels in the X and Y axes. Take the maximum reading to determine them.

### SERVICE LIMITS:

**Taper:** 0.10 mm (0.004 in)

**Out of round:** 0.10 mm (0.004 in)

The cylinder must be rebored and an oversize piston fitted if the service limits are exceeded.

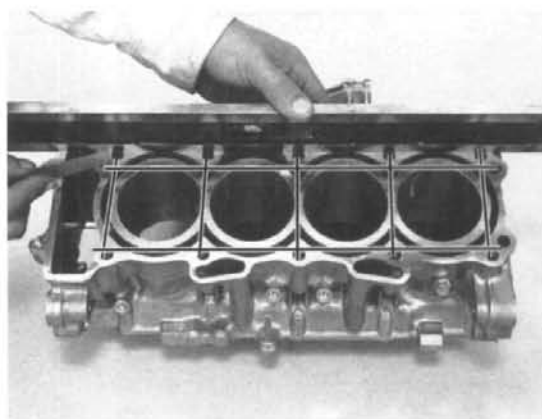
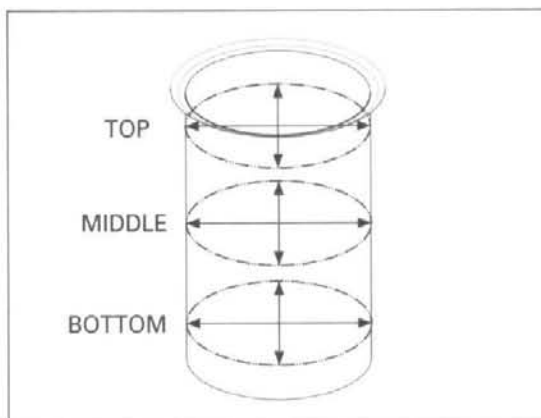
The following oversize piston is available:

**0.25 mm (0.010 in)**

The piston to cylinder clearance for the oversize piston must be: 0.015 – 0.050 mm (0.0006 – 0.0020 in).

Inspect the top of the cylinder for warpage.

**SERVICE LIMIT: 0.10 mm (0.004 in)**



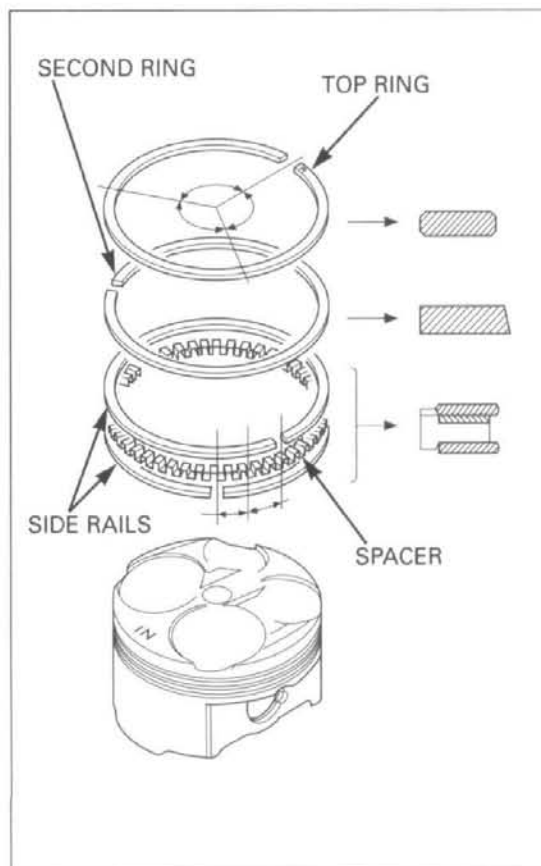
## PISTON ASSEMBLY

Carefully install the piston rings into the piston ring grooves with their marks facing up.

- Apply oil to the piston rings.
- Avoid piston and piston ring damage during installation.
- Install the piston rings with the marks facing up.
- Do not mix the top and second rings; the top ring is narrower than the second ring in width.

Stagger the piston ring end gaps 120° apart from each other.

Stagger the side rail end gaps as shown.

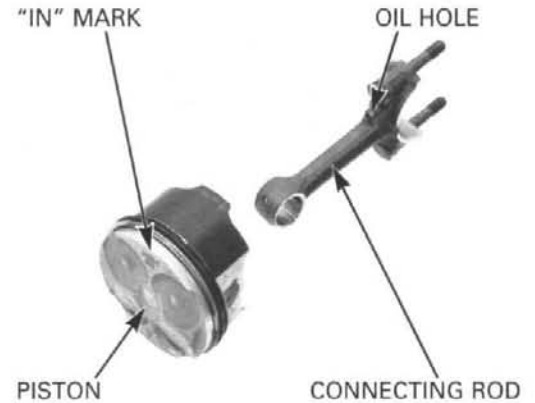


## PISTON INSTALLATION

Apply molybdenum oil solution to the connecting rod small end inner surfaces and piston pin outer surfaces.

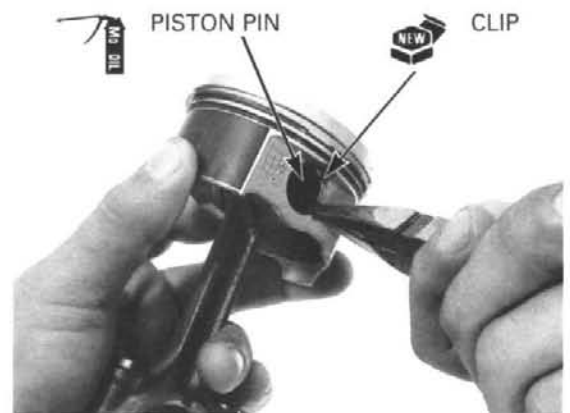
Install the piston pin into the piston and connecting rod.

*Install the piston so the "IN" mark faces the same direction as the oil hole in the connecting rod.*



Install new piston pin clips into the grooves of the piston pin hole.

- Make sure that the piston pin clips seated securely.
- Do not align the piston pin clip end gap with the piston cut-out.



Apply engine oil to the cylinder wall, piston and piston rings.

Install the piston/connecting rod assembly into the cylinder using a commercially available piston ring compressor tool.

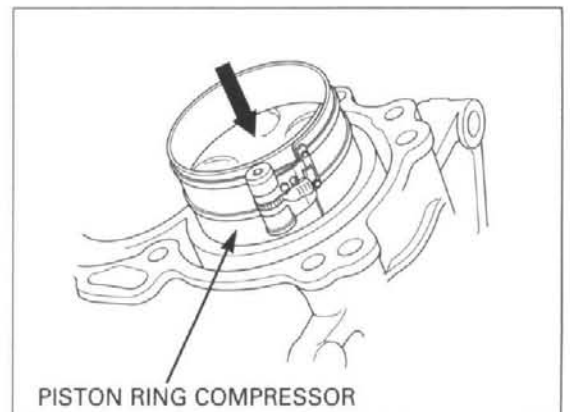
*Install the piston/connecting rod assembly with the piston "IN" mark facing to the intake side.*

### NOTICE

- While installing the piston, being careful not to damage the top surface of the cylinder, especially around the cylinder bore.
- Be careful not to damage the cylinder sleeve and crankpin with the connecting rod bolt threads.

*Make sure the ring compressor tool sits flush with the top surface of the cylinder.*

Use the handle of a plastic hammer to tap the piston into the cylinder.





## CRANKSHAFT/PISTON/CYLINDER

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Apply molybdenum oil solution to the crankpin bearing surfaces.

Install the bearing cap.

Make sure the marks on the caps are aligned with the marks on the connecting rods.

Apply oil to the connecting rod nut threads and seating surfaces.



Install the connecting rod nuts and tighten the nuts gradually and alternately, then tighten them to the specified torque.

**TORQUE: 25 N·m (2.6 kgf·m, 19 lbf·ft)**

