7. CYLINDER HEAD/VALVES

SERVICE INFORMATION

GENERAL

- This section covers maintenance of the cylinder head, valves and camshaft. These services can be done with the engine installed in the frame.
- When disassembling, mark and store the disassembled parts to ensure that they are reinstalled in their original locations.
- Clean all disassembled parts with cleaning solvent and dry them by blowing them off with compressed air before inspection.
- Be careful not to damage the mating surfaces when removing the cylinder head cover and cylinder head.

SPECIFICATIONS

Unit: mm (in)

ITEM				SPECIFICATIONS	SERVICE LIMIT
Cylinder compression	Valve clearance at standard (decompressor effected)			637 – 735 kPa (6.5 – 7.5 kgf/cm², 92 – 107 psi) at 600 min⁻¹ (rpm)	———
	Valve clearance at 1 mm (0.04 in) (decompressor not effected)			1,177 – 1,275 kPa (12.0 – 13.0 kgf/cm², 171 – 185 psi)	———
Cylinder head warpage				———	0.10 (0.004)
Valve and valve guide	Valve clearance		IN	0.10 ± 0.02 (0.004 ± 0.001)	———
			EX	0.12 ± 0.02 (0.005 ± 0.001)	———
	Valve stem O.D.		IN	4.975 – 4.990 (0.1959 – 0.1965)	4.96 (0.195)
			EX	4.955 – 4.970 (0.1951 – 0.1957)	4.94 (0.194)
	Valve guide I.D.		IN/EX	5.000 – 5.012 (0.1969 – 0.1973)	5.03 (0.198)
	Stem-to-guide clearance		IN	0.010 – 0.037 (0.0004 – 0.0015)	0.07 (0.003)
			EX	0.030 – 0.057 (0.0012 – 0.0022)	0.09 (0.004)
	Valve seat width		IN/EX	1.1 – 1.2 (0.04 – 0.05)	2.0 (0.08)
Valve spring	Free length	Inner	IN/EX	43.44 (1.710)	42.51 (1.673)
		Outer	IN/EX	44.03 (1.733)	42.83 (1.686)
Rocker arm	Rocker arm I.D.		IN/EX	11.500 – 11.518 (0.4528 – 0.4535)	11.53 (0.454)
	Rocker arm shaft O.D.		IN/EX	11.466 – 11.484 (0.4632 – 0.4521)	11.41 (0.449)
	Rocker arm-to-shaft clearance		IN/EX	0.016 – 0.052 (0.0006 – 0.0020)	0.10 (0.004)
Sub rocker arm	Sub-rocker arm I.D.		IN/EX	7.000 – 7.015 (0.2756 – 0.2762)	7.05 (0.278)
	Sub-rocker arm shaft O.D.		IN/EX	6.972 – 6.987 (0.2745 – 0.2751)	6.92 (0.272)
	Sub-rocker arm-to-shaft clearance		IN/EX	0.013 – 0.043 (0.0005 – 0.0017)	0.10 (0.004)
Camshaft	Cam lobe height		IN	30.772 (1.2115)	30.583 (1.2041)
			EX	30.819 (1.2133)	30.629 (1.2059)
	Runout			———	0.03 (0.001)

TORQUE VALUES

Cylinder head cover bolt (6 mm)	12 N·m (1.2 kgf·m, 9 lbf·ft)
(8 mm)	24 N·m (2.4 kgf·m, 17 lbf·ft)
Rocker arm shaft	27 N·m (2.8 kgf·m, 20 lbf·ft) Apply a locking agent to the threads.
Sub-rocker arm shaft	23 N·m (2.3 kgf·m, 17 lbf·ft) Apply a locking agent to the threads.
Cam sprocket bolt	20 N·m (2.0 kgf·m, 14 lbf·ft) Apply a locking agent to the threads.
Cylinder head bolt (10 mm)	39 N·m (4.0 kgf·m, 29 lbf·ft) Apply oil to the threads and flange surface.
(6 mm)	10 N·m (1.0 kgf·m, 7 lbf·ft)
Cam chain tensioner set plate bolt	10 N·m (1.0 kgf·m, 7 lbf·ft)
Oil pass pipe bolt (7 mm)	12 N·m (1.2 kgf·m, 9 lbf·ft)
Valve hole cap	15 N·m (1.5 kgf·m, 11 lbf·ft) Apply clean engine oil to the O-ring.
Engine hanger plate bolt (10 mm)	64 N·m (6.5 kgf·m, 47 lbf·ft)
(8 mm)	26 N·m (2.7 kgf·m, 20 lbf·ft)

TOOLS

Special	
Valve guide driver	07942 – MA60000
Valve guide reamer (5.010 mm)	07984 – MA60001
Common	
Valve spring compressor	07757 – 0010000
Optional	
Cutter holder, 5 mm	07781 – 0010400
Valve seat cutter	
— Flat cutter, 25 mm (32° EX)	07780 – 0012000
— Flat cutter, 30 mm (32° IN)	07780 – 0012200
— Interior cutter, 30 mm (60° IN/EX)	07780 – 0014000
— Seat cutter, 27.5 mm (45° EX)	07780 – 0010200
— Seat cutter, 33 mm (45° IN)	07780 – 0010800

TROUBLESHOOTING

- Engine top-end problems usually affect engine performance. These problem can be diagnosed by a compression te or by tracing engine noises to the top-end with a sounding rod stethoscope.
- If the performance is poor at low speeds, check for white smoke in the crankcase breather tube. If the tube is smokey, check for a seized piston ring (Section 8)

Low compression
- Valves:
  - — Incorrect valve adjustment
  - — Burned or bent valve
  - — Incorrect valve timing
  - — Weak valve spring
- Cylinder head:
  - — Leaking or damaged head gasket
  - — Warped or cracked cylinder head
- Decompressor system
  - — Decompressor out of adjustment

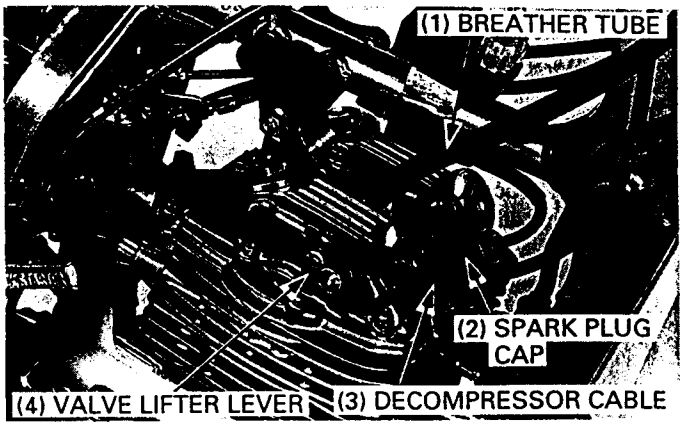
Excessive smoke
- Worn valve stem or valve guide
- Damaged stem seal

Excessive noise
- Incorrect valve adjustment
- Sticking valve or broken valve spring
- Worn or damaged rocker arm or camshaft
- Loose or worn cam chain
- Worn or damaged cam chain tensioner
- Worn cam sprocket teeth

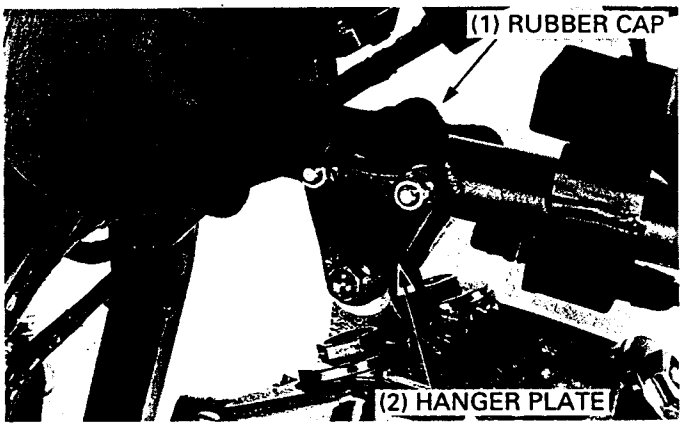
Rough idle
- Low cylinder compression
- Intake air leak
- Decompressor out of adjustment

CYLINDER HEAD COVER REMOVAL

Remove the seat (page 2-2).
Remove the fuel tank (page 5-3).
Remove the decompressor cable from the valve lifter lever.
Remove the breather tube.
Remove the spark plug cap.



Remove the rubber caps and upper hanger plates.

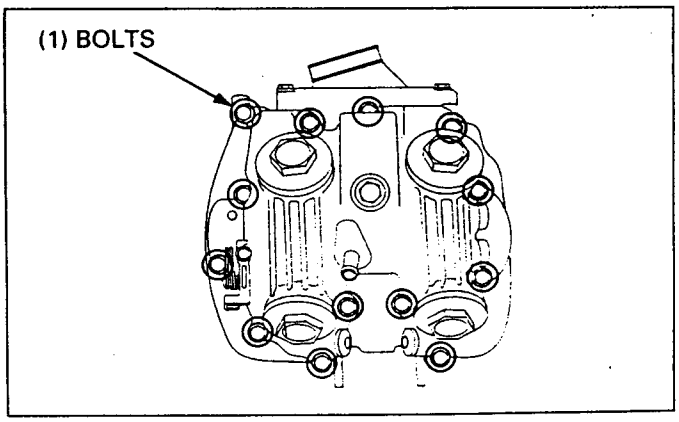


Remove the crankshaft hole cap and timing hole cap.
Rotate the flywheel counterclockwise to align the "T" mark with the index notch. Make sure that the piston is at TDC (Top Dead Center) on the compression stroke.
Remove the cylinder head cover bolts and cylinder head cover.

NOTE

- Loosen the bolts in a crisscross patern in two or more steps.

Remove the gasket and dowel pins.

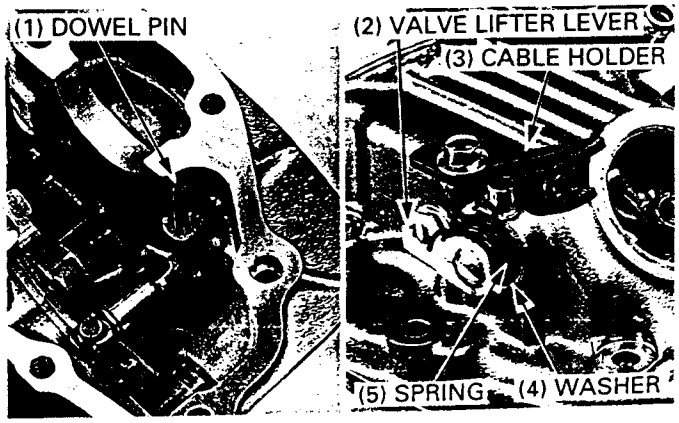


CYLINDER HEAD COVER DISASSEMBLY

Remove the valve hole caps.
Cut a groove in the dowel pin with a grinder and remove the dowel pin using the special tools.
TOOLS:

Pin puller	**07936 – MA70100**
Remover weight	**07936 – 3710200**

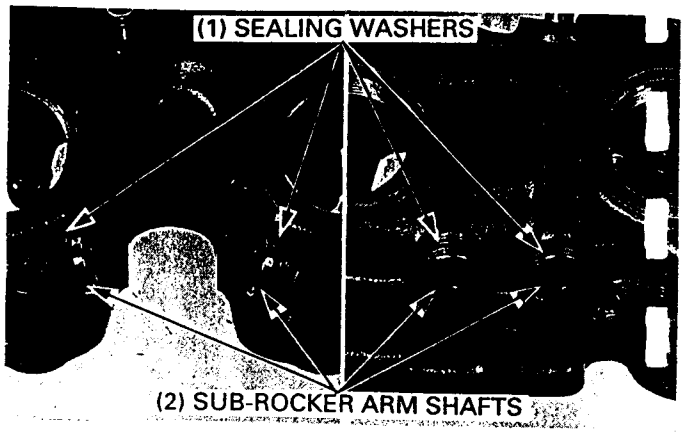
Remove the following:
— Valve lifter lever
— Spring
— Washer
— Seal
— Decompressor cable holder



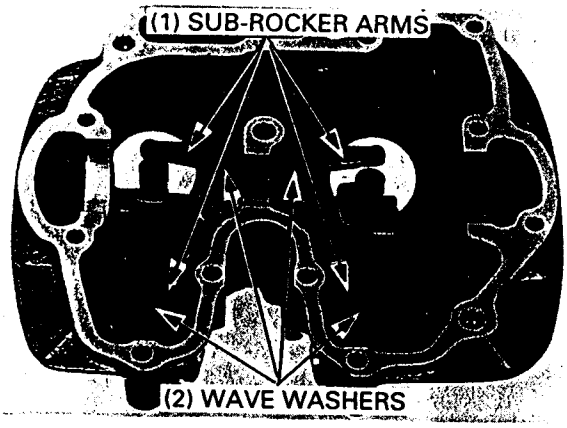
Remove the following:
— Sub-rocker arm shafts
— Sealing washers

NOTE

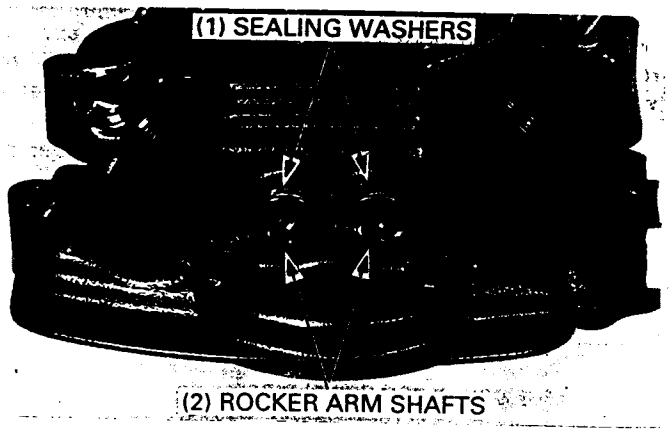
- Note the location of all parts during disassembly so you can reinstall the parts in their same positions.



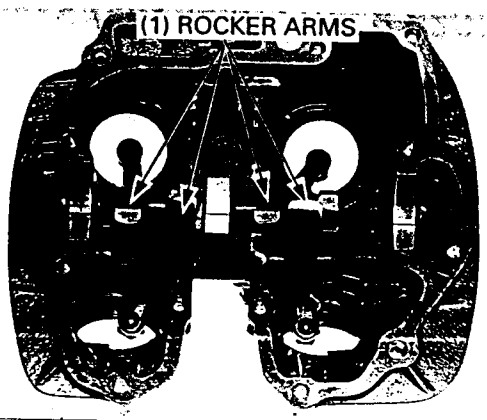
— Sub-rocker arms
— Wave washers



— Rocker arm shafts
— Sealing washers



Remove the rocker arms form the cylinder head cover.

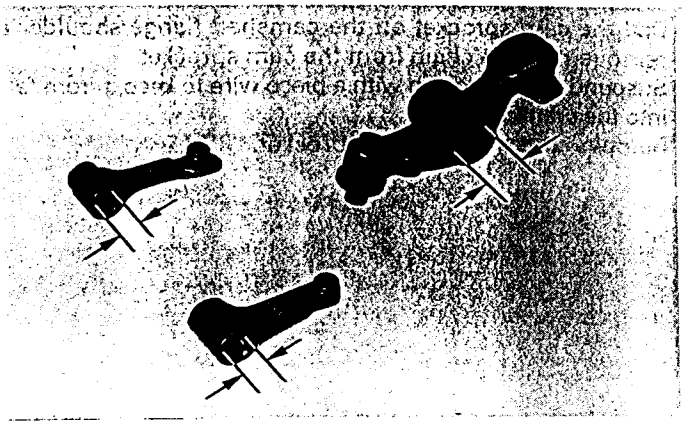


ROCKER ARM AND SUB-ROCKER ARM INSPECTION

Inspect the rocker arms and sub-rocker arms for wear or damage.

NOTE

- Inspect the cam lobe if the rocker arm sliding surface is worn or damaged.



Measure the I.D. of the rocker arms and sub-rocker arms.

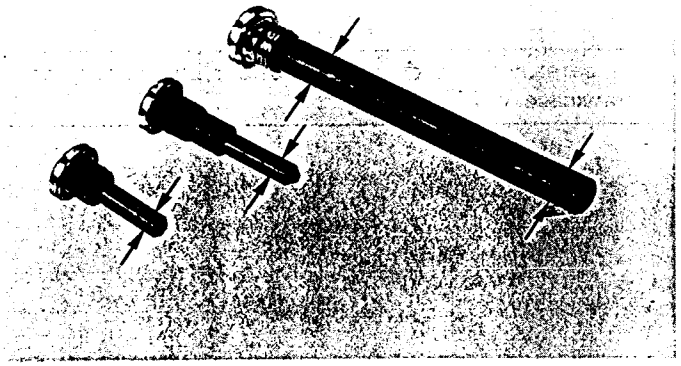
SERVICE LIMITS:
Rocker arm (IN/EX): 11.53 mm (0.454 in)
Sub-rocker arm (IN/EX): 7.05 mm (0.278 in)

ROCKER ARM SHAFT AND SUB-ROCKER ARM SHAFT INSPECTION

Inspect the rocker arm shafts and sub-rocker arm shafts for wear or damage.

Measure the O.D. of the rocker arm shafts and sub-rocker arm shafts.

SERVICE LIMITS:
Rocker arm shaft (IN/EX): 11.41 mm (0.449 in)
Sub-rocker arm shaft (IN/EX): 6.92 mm (0.272 in)

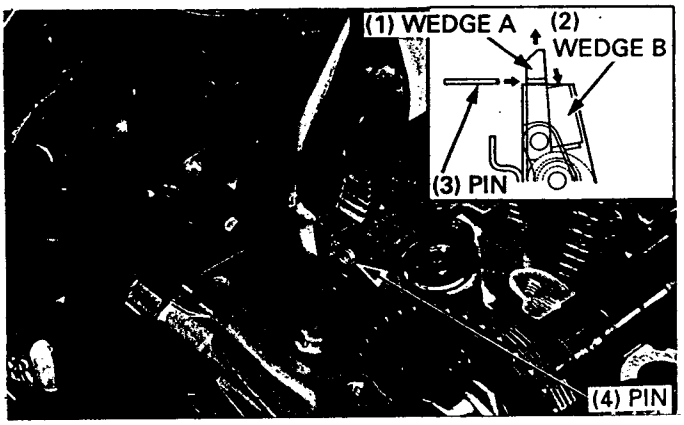


Calculate the rocker arm-to-shaft and sub-rocker arm to shaft clearance.

SERVICE LIMIT: 0.10 mm (0.004 in)

CAMSHAFT REMOVAL

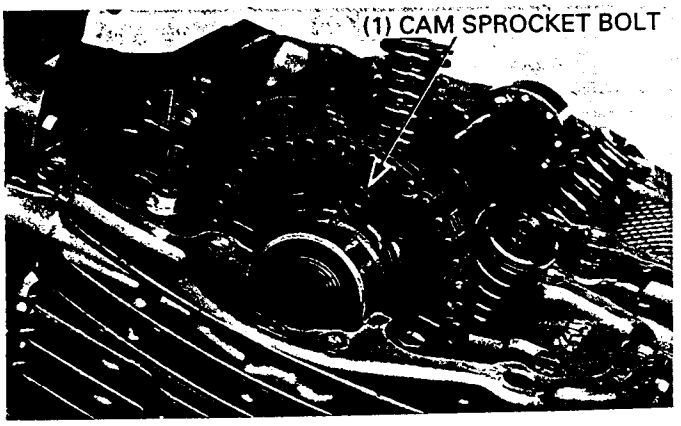
Remove the cylinder head cover (page 7-3).
To release the cam chain tensioner, push down wedge B, then pull up on wedge A with pliers.
Insert a pin (or paper clip) into the hole in wedge A, as shown.



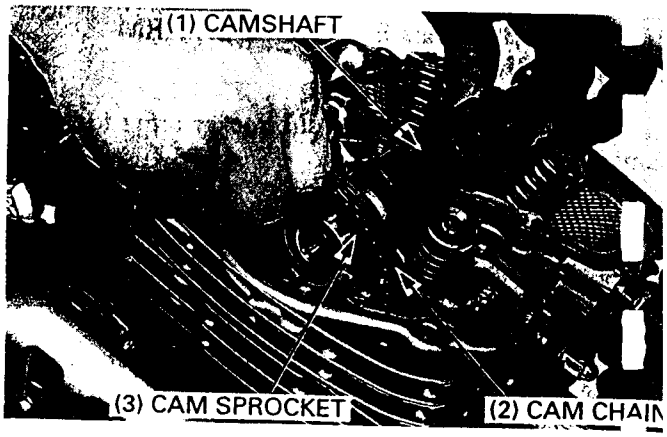
Remove the crankshaft hole cap.
Turn the crankshaft and remove a cam sprocket bolt.
Rotate the crankshaft, then remove the other cam sprocket bolt.

NOTE

- Be careful not to drop the bolts into the crankcase.



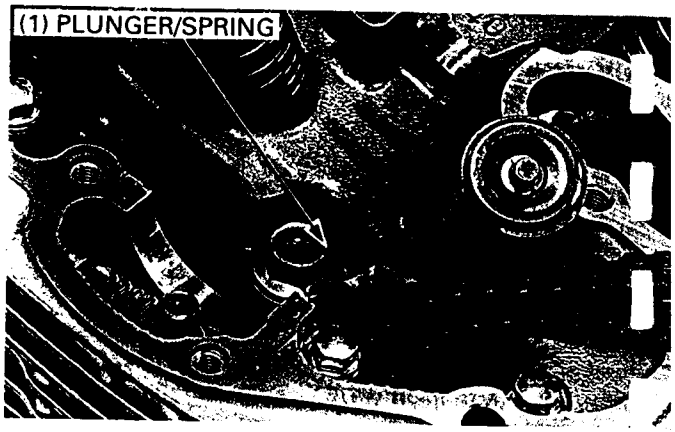
Pull the cam sprocket off the camshaft flange shoulder and remove the cam chain from the cam sprocket.
Suspend the cam chain with a piece wire to keep it from falling into the crankcase.
Remove the camshaft and sprocket.



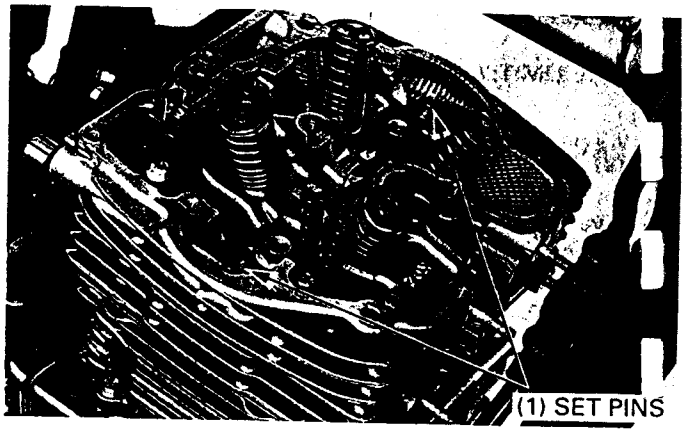
Remove the plunger and spring.

NOTE

- Be careful not to drop the plunger and spring into the crankcase.

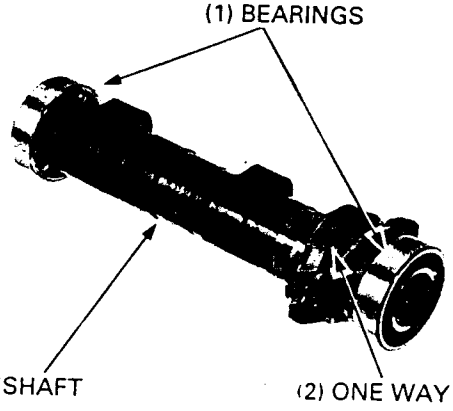


Remove the camshaft bearing set pins.



CAMSHAFT INSPECTION

Turn the outer race of the bearings with your finger.
The bearings should turn smoothly and quietly.
Remove the bearings, if they need replacement.
Be sure the one way clutch outer rotates in one direction only.



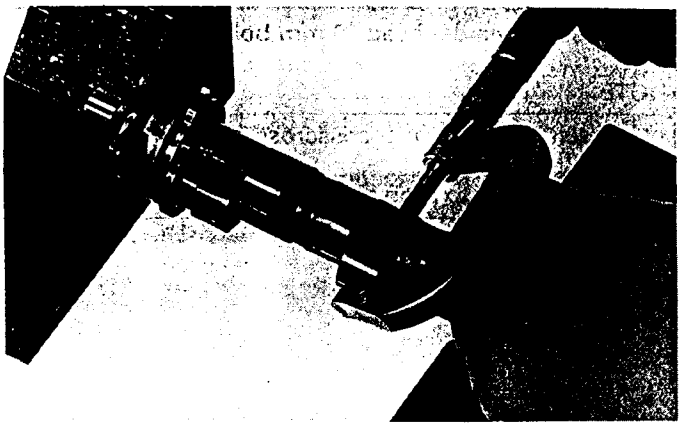
Remove the bearings from the camshaft.
Check each cam lobe for wear or damage.

NOTE

- Inspect the rocker arm sliding surface if the cam lobe is worn or damaged.

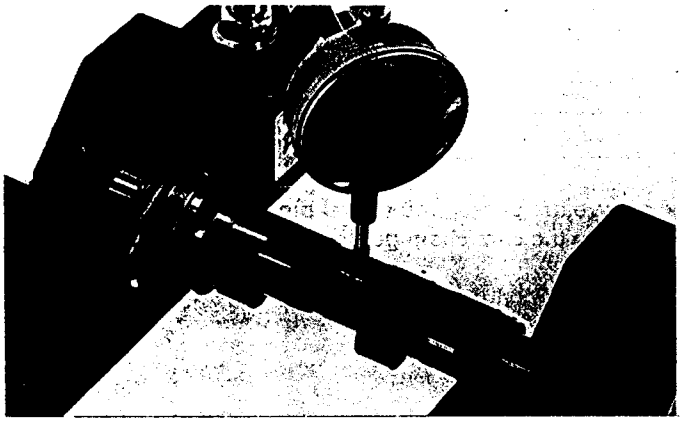
Measure the cam lobe height.

SERVICE LIMITS: INTAKE: 30.583 mm (1.2041 in)
EXHAUST: 30.629 mm (1.2059 in)



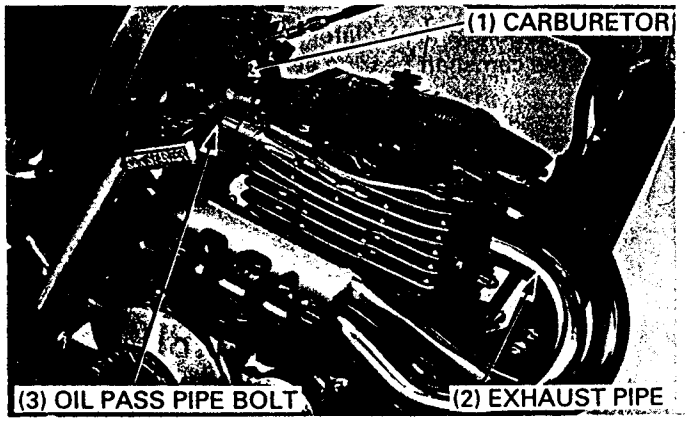
Check the camshaft runout with a dial indicator.
Support both ends of the camshaft with V-blocks.
Actual runout is 1/2 of the total indicator reading.

SERVICE LIMIT: 0.03 mm (0.001 in)

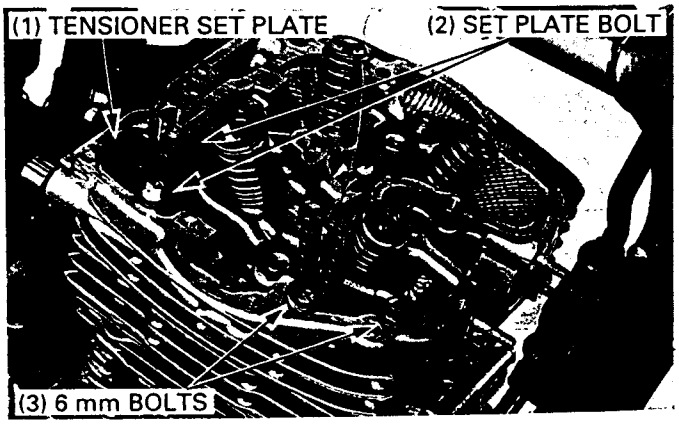


CYLINDER HEAD REMOVAL

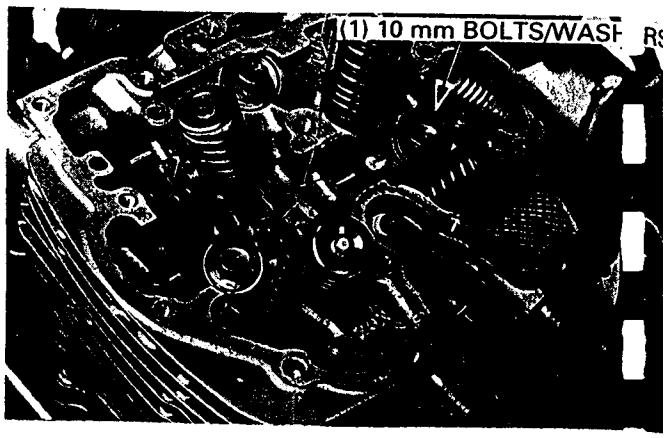
Remove the cylinder head cover (page 7-3).
Remove the cam shaft and cam sprocket (page 7-5).
Remove the exhaust pipe (page 2-3).
Remove the oil pass pipe joint bolts and two sealing washers from the cylinder head.
Remove the carburetor from the insulator (page 5-5).



Remove the two cam chain tensioner set plate bolts.
Remove the set plate.
Remove the cylinder head 6 mm bolts.



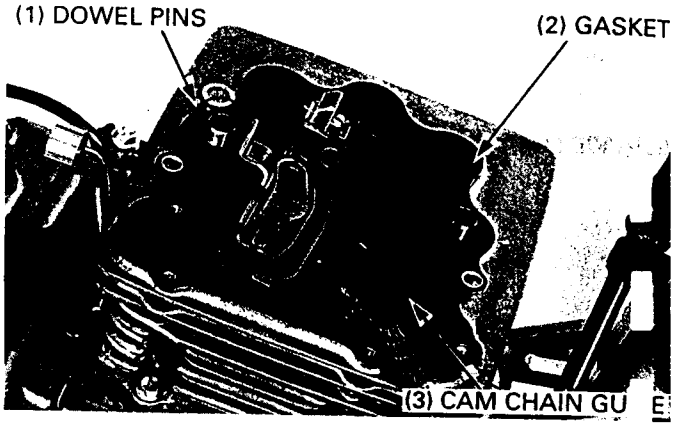
Remove the cylinder head 10 mm bolts and washers.



NOTE

- Loosen the bolts in a crisscross pattern in two or more steps.
- Be careful not to drop the washers into the crankcase.

Remove the cylinder head.

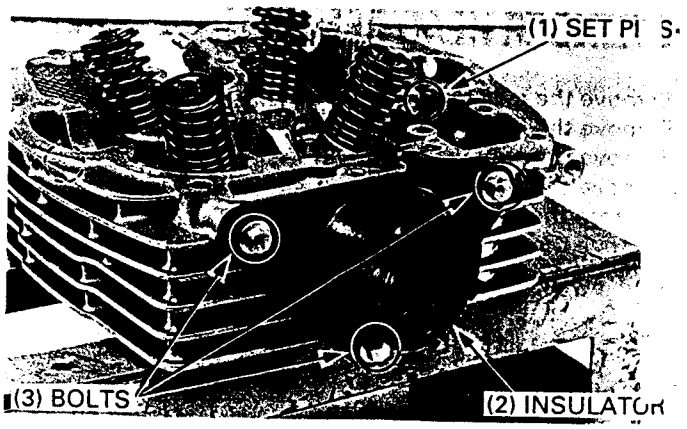


CAUTION

- *Be careful not to damage the cylinder head mating surfaces.*

Remove the gasket and dowel pins.
Remove the cam chain guide.

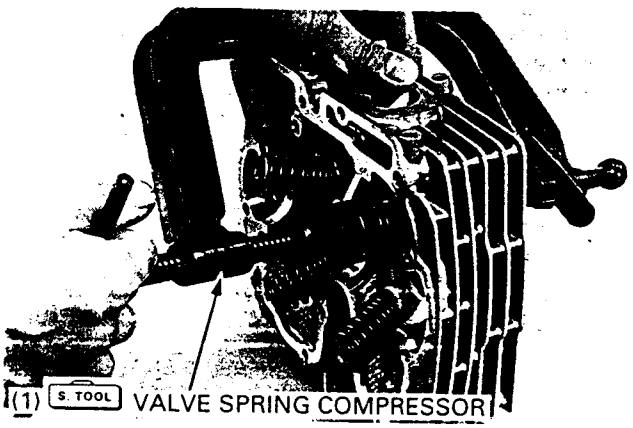
Remove the bolts and insulator from the cylinder head.
Remove the camshaft bearing set pins.



CYLINDER HEAD DISASSEMBLY

Remove the valve spring cotters, retainers, springs, valves and spring seats with a valve spring compressor.

TOOL:
Valve spring compressor **07757 – 0010000**



CAUTION

- *To prevent loss of tension, do not compress the valve springs more than necessary to remove the cotters.*

NOTE

- Mark all parts to ensure that they are reassembled in their original locations.
- Whenever the stem seals are removed, replace them with new ones.

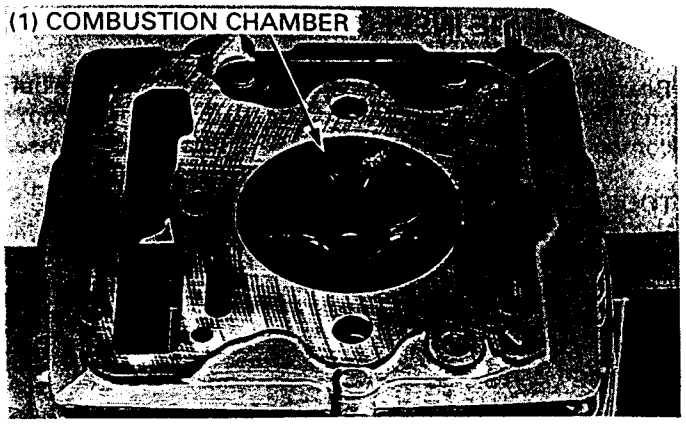
CYLINDER HEAD INSPECTION

Remove the carbon deposits from the combustion chamber or exhaust port.
Clean the head gasket surface of any gasket material.

CAUTION

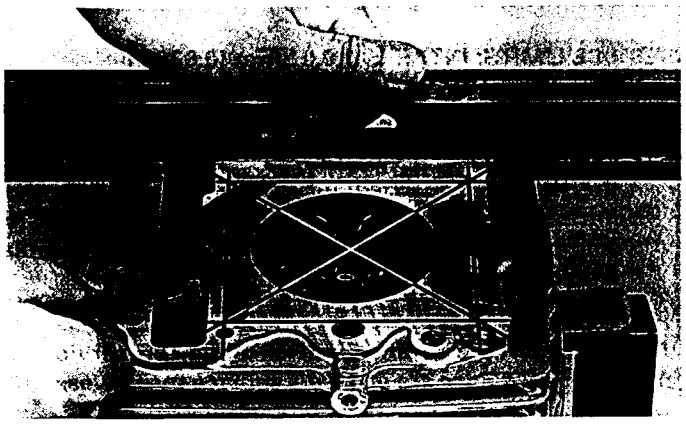
- *Use care not to scratch the combustion chamber or the head gasket surface.*

Check the spark plug hole and valve areas for cracks.



Check the cylinder head diagonally two ways for warpage with a straight edge and a feeler gauge.

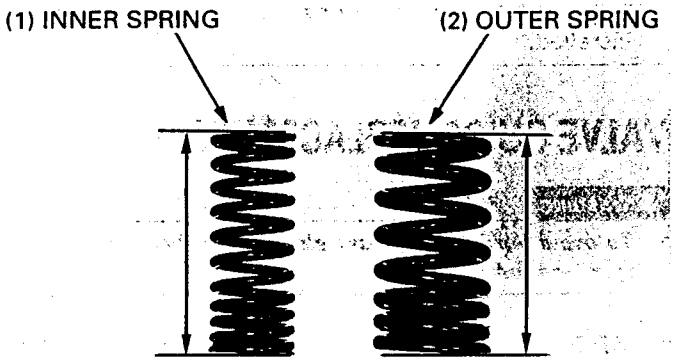
SERVICE LIMIT: 0.10 mm (0.004 in)



VALVE SPRING INSPECTION

Measure the free length of the inner and outer valve springs.

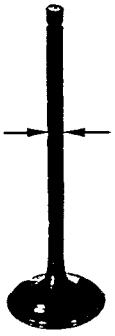
SERVICE LIMITS: INNER: 42.51 mm (1.673 in)
OUTER: 42.83 mm (1.686 in)



VALVE INSPECTION

Inspect each valve for trueness, burning, scratches or abnormal stem wear.
Check the valve movement in the guide. Measure and record each valve stem O.D..

SERVICE LIMITS: INTAKE: 4.96 mm (0.195 in)
EXHAUST: 4.94 mm (0.194 in)



VALVE GUIDE INSPECTION

Ream the guides to remove the carbon build-up before checking the valve guide I.D.. Insert the reamer from the combustion chamber side and always rotate it clockwise.

TOOL:
Valve guide reamer (5.010 mm) 07984 – MA60001

Measure and record each valve guide I.D. using a ball gauge or inside micrometer.

SERVICE LIMITS:
INTAKE/EXHAUST: 5.03 mm (0.198 in)

Calculate the stem-to-guide clearance.

SERVICE LIMITS: INTAKE: 0.07 mm (0.003 in)
EXHAUST: 0.09 mm (0.004 in)

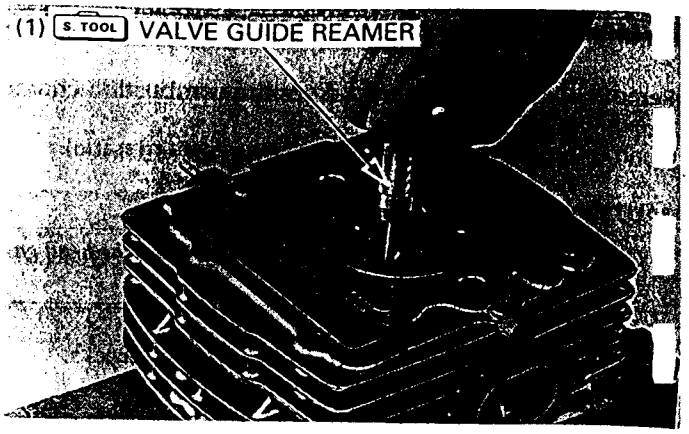
NOTE

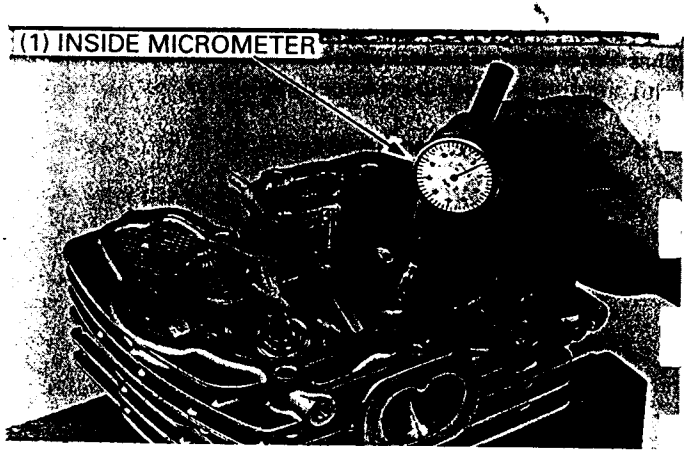
- **If the stem-to-guide clearance exceeds the service limit, determine if a new guide with standard dimensions would bring the clearance within tolerance. If so, replace the guides as necessary and ream them to fit.**

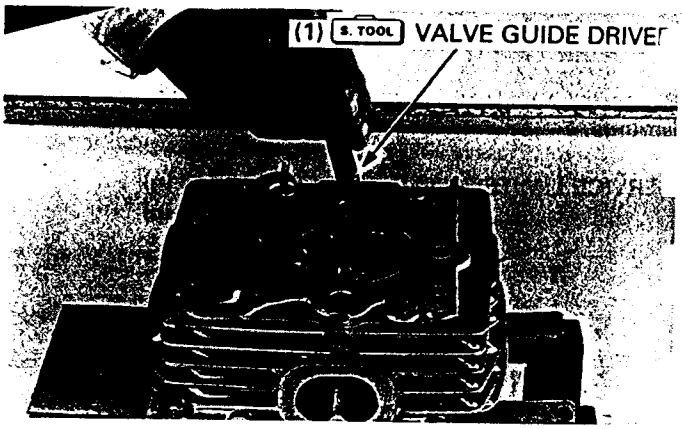
If stem-to-guide clearance still exceeds the service limit after the new guides are installed, replace the valves.

NOTE

- Reface valve seats whenever new valve guides are installed.







VALVE GUIDE REPLACEMENT

⚠ WARNING

- ***To avoid burns, wear heavy gloves when handling the heated cylinder head.***

CAUTION

- *Do not use a torch to heat the cylinder head; it may cause warping.*

Heat the cylinder head to 100 – 150°C (212 – 300°F).
Support the cylinder head and drive out the guides from the combustion chamber side.

TOOL:
Valve guide driver 07942 – MA60000

CAUTION

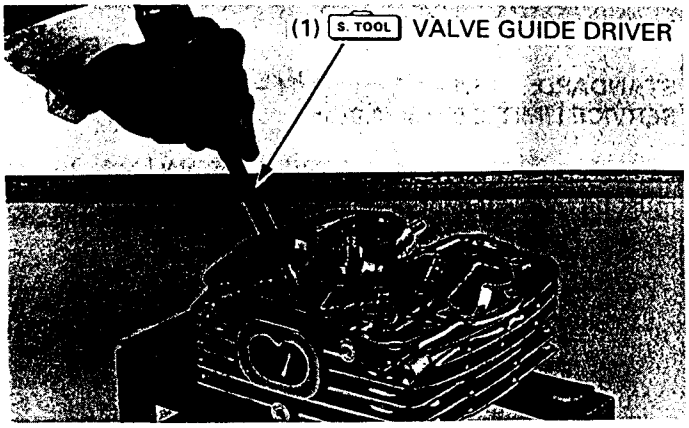
- *Do not damage the cylinder head during guide removal.*

Install a new O-ring on a new valve guide.
Install a new valve guide from the top of the head, then check that it was not damaged during installation.

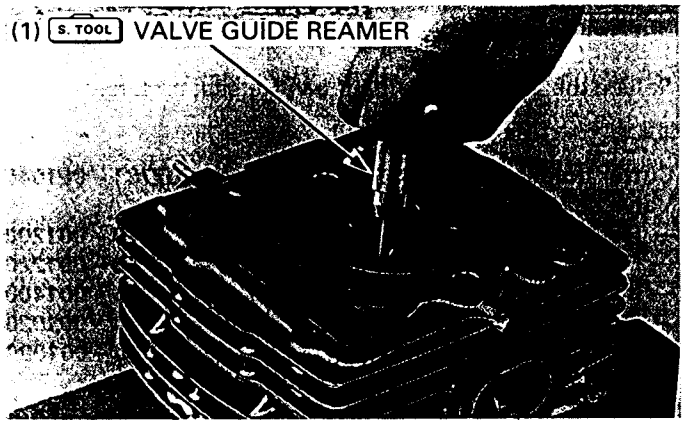
TOOL:
Valve guide reamer (5.010 mm) 07984 – MA60001

NOTE

- Use cutting oil on the reamer during this operation.
- Rotate the reamer while inserting and removing it.



Ream the new valve guides after installation.
Insert the reamer from the combustion chamber side and always rotate the reamer clockwise.
Clean the cylinder head thoroughly to remove any metal particles.
Reface the valve seats (page 7-11).



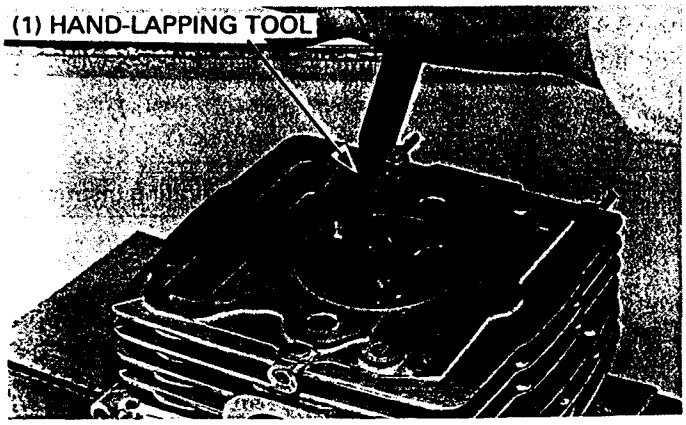
VALVE SEAT INSPECTION AND REFACING

INSPECTION

Clean the intake and exhaust valves thoroughly to remove carbon deposits.
Apply a light coating of Prussian Blue to each valve face. Lap each valve and seat using a rubber hose or other hand-lapping tool.

NOTE

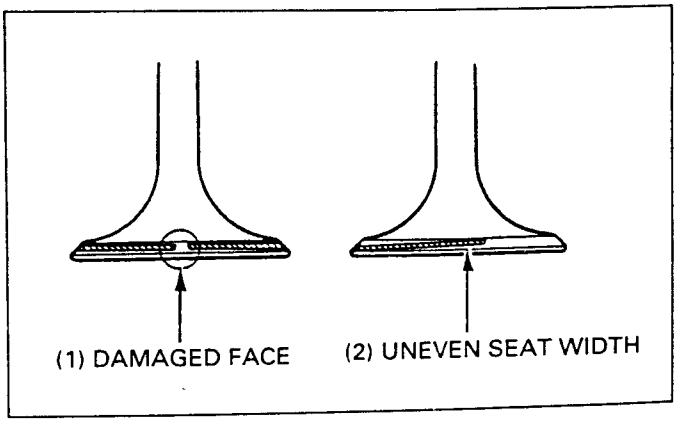
- Valves cannot be ground. If the valve face is burned or badly worn or if it contacts the seat unevenly, replace the valve.



Remove the valve and inspect the face.
- Uneven seat width:
  — Bent or collapsed valve stem;
  Replace the valve and reface the valve seat.
- Damaged face:
  — Replace the valve and reface the valve seat.

Measure the valve seat width.

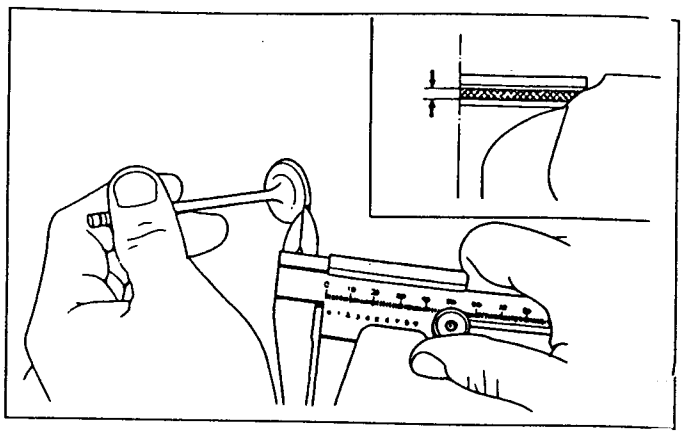
SERVICE LIMIT: 2.0 mm (0.08 in)



Measure the valve seat width.

STANDARD: 1.1 – 1.2 mm (0.04 – 0.05 in)
SERVICE LIMIT: 2.0 mm (0.08 in)

If the seat is too wide, too narrow, or has low spots, the seat must be refinished for good sealing.

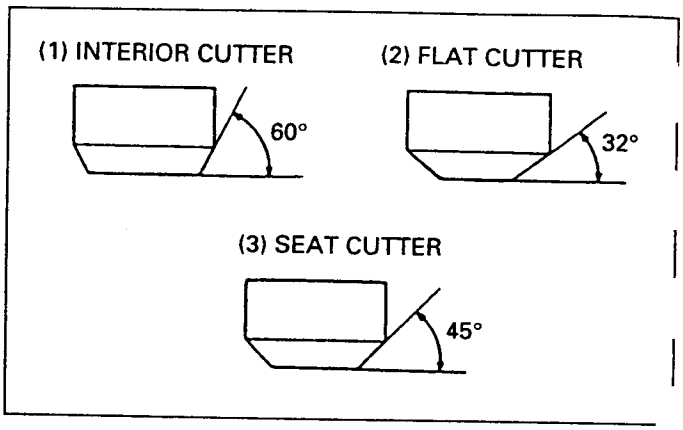


REFACING

Reface the valve seats with the valve seat cutters.

TOOL:

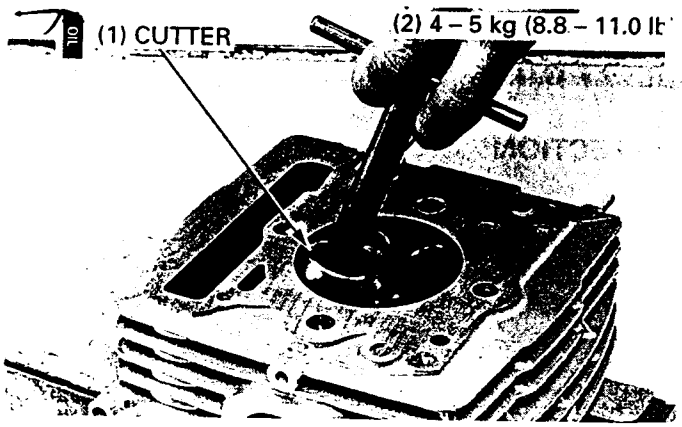
Cutter holder, 5 mm	**07781 – 0010400**
Valve seat cutter	
— Flat cutter, 25 mm (32° EX)	**07780 – 0012000**
— Flat cutter, 30 mm (32° IN)	**07780 – 0012200**
— Interior cutter, 30 mm (60° IN/EX)	**07780 – 0014000**
— Seat cutter, 27.5 mm (45° EX)	**07780 – 0010200**
— Seat cutter, 33 mm (45° IN)	**07780 – 0010800**



Valve seat cutters, a grinder or equivalent valve seat refacing equipment are recommended to correct a worn valve seat.

NOTE

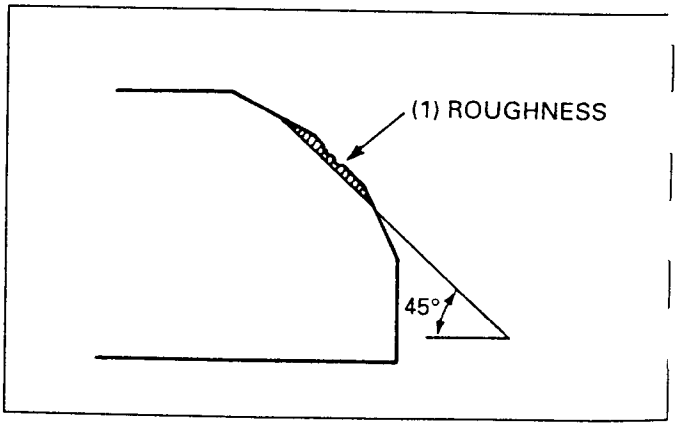
- Follow the refacing manufacturer's operating instructions.



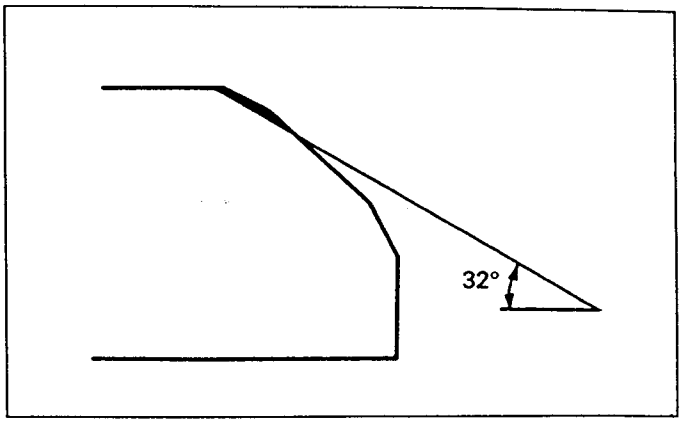
Use a 45 degree cutter to remove any roughness or irregularities from the seat.

NOTE

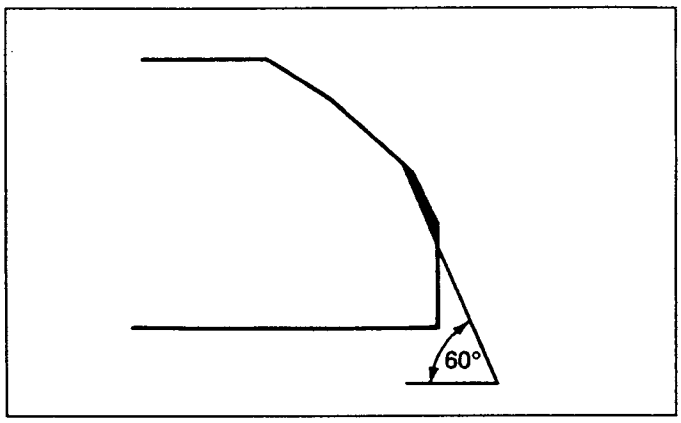
- Reface the seat with a 45 degree cutter whenever a valve guide is replaced.



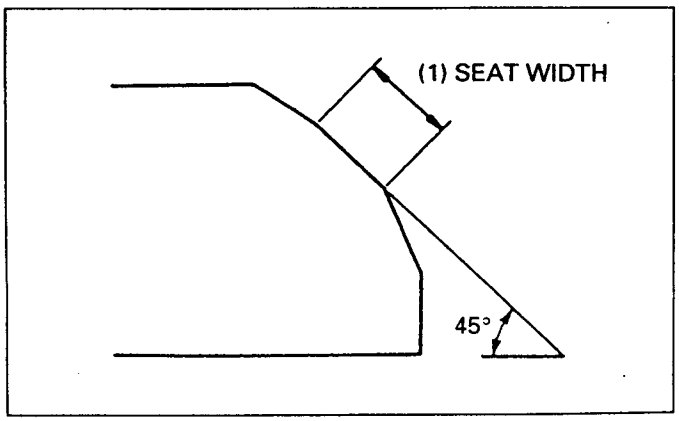
Use a 32 degrees cutter to remove the top 1/4 of the existing valve seat material.



Use a 60 degree cutter to remove the bottom 1/4 of the old seat.
Remove the cutter and inspect the area you have refaced.



Install a 45 degree finish cutter and cut the seat to the proper width.
Make sure that all pitting and irregularities are removed.
Refinish if necessary.



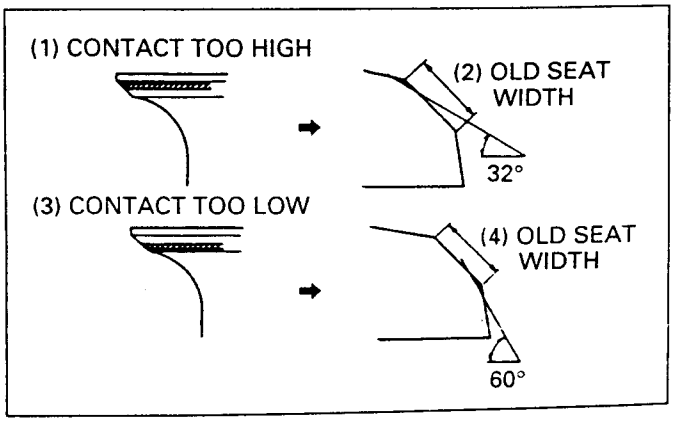
Apply a thin coating a Prussian Blue to the valve seat.
Press the valve through the valve guide and onto the seat to make a clear pattern.

NOTE

- The location of the valve seat in relation to the valve face is very important for good sealing.

If the contact area is too high on the valve, the seat must be lowered using a 32 degree flat cutter.

If the contact area is too low on the valve, the seat must be raised using a 60 degree inner cutter.

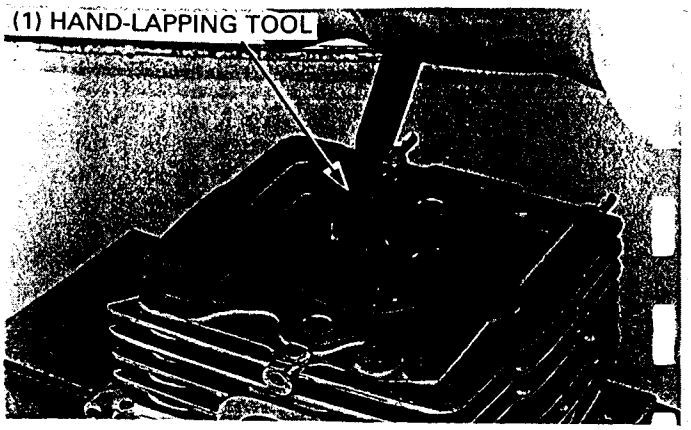


Refinish the seat to specifications, using a 45 degree finish cutter.
After cutting the seat apply lapping compound to the valve face, and lap the valve using light pressure.

After lapping, wash all residual compound off the cylinder head and valve.

NOTE

- Do not allow lapping compound to enter the guides.

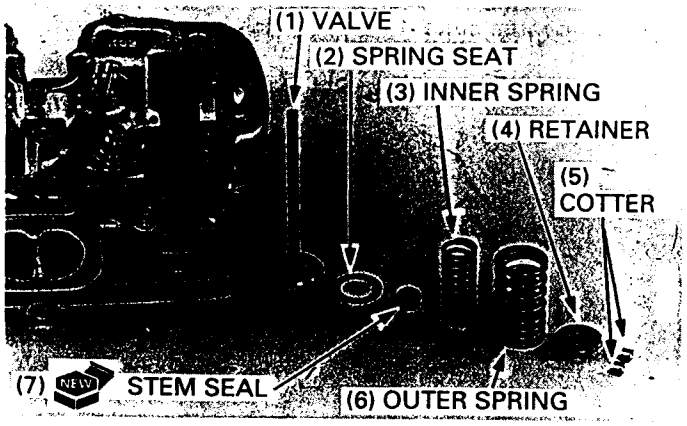


CYLINDER HEAD ASSEMBLY

Install the spring seats and new stem seals in the cylinder head.

Lubricate each valve stem and valve guide inner surface with molybdenum disulfide oil and insert the valve into the valve guide. To avoid damage to the stem seal, turn the valve slowly when inserting.

Install the valve springs with the tightly wound coils facing the combustion chamber and install the retainers.

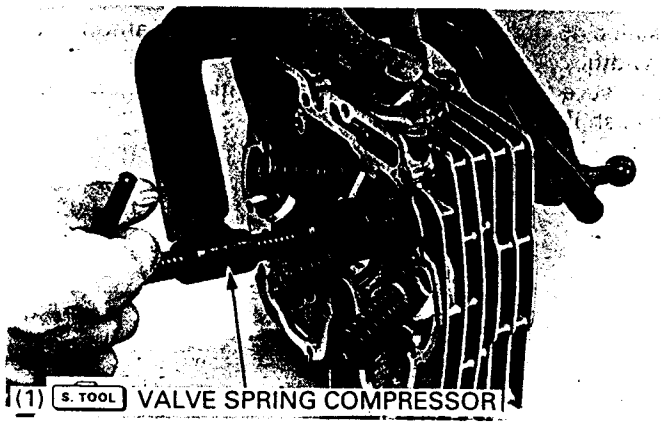


Compress the valve springs using the valve spring compressor, then install the valve cotters.

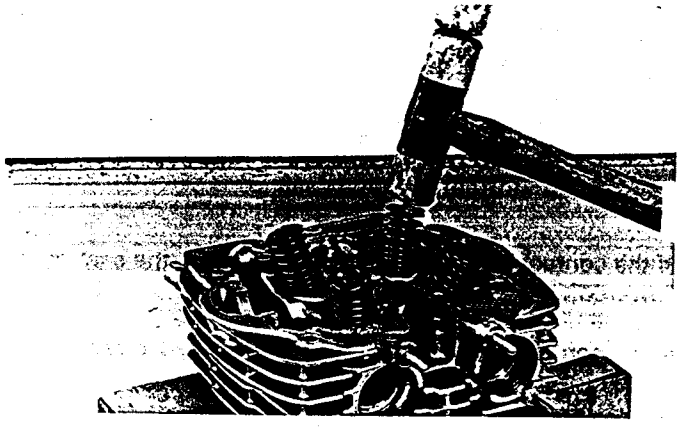
TOOL:
Valve spring compressor **07757 – 0010000**

CAUTION

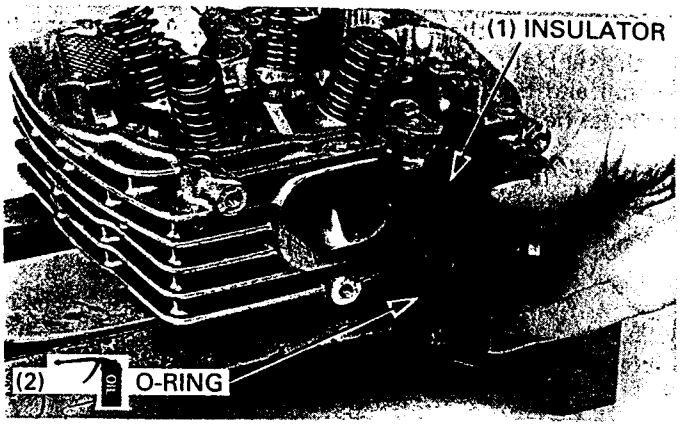
- *To prevent loss of tension, do not compress the valve spring more than necessary.*



Support the cylinder head above the working bench surface to prevent possible valve damage, then gently tap the valve stems with two plastic hammers as shown to seat the cotters.



Check the O-ring in the insulator for wear or fatigue.
Apply oil to the O-ring and install the carburetor insulator to the cylinder head.



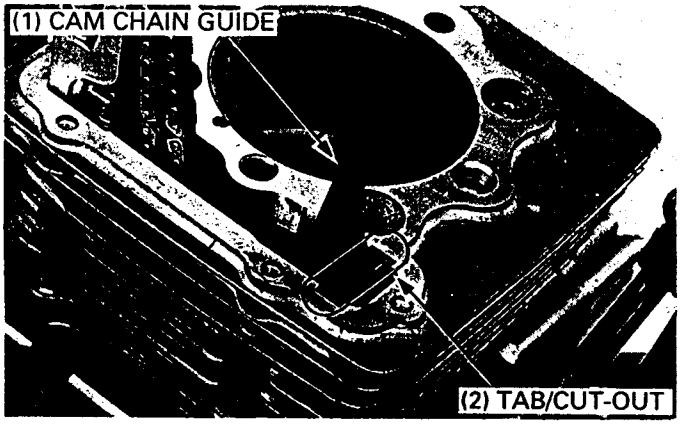
CYLINDER HEAD INSTALLATION

Remove the cylinder gasket and thoroughly clean the gasket surface.

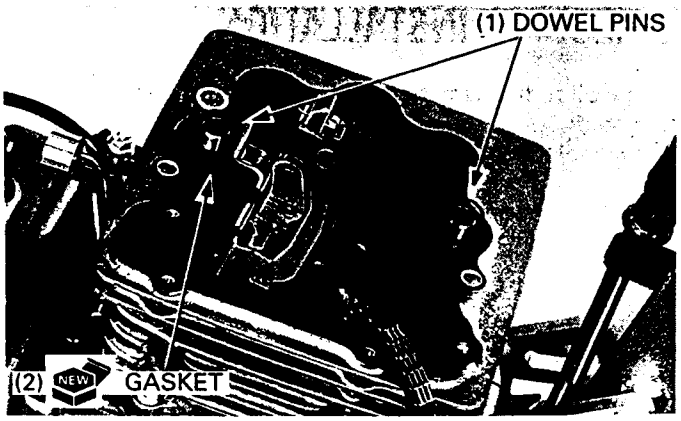
Install the cam chain guide.

NOTE

- Fit the cam chain guide tab in the cylinder cut-out as shown.
  Push the guide in until it bottoms in the crankcase guide hole.



Install the dowel pins and new cylinder head gasket.



Install the cylinder head.

CAUTION

- *Be careful not to damage the cylinder head mating surfaces.*

Apply engine oil to all cylinder head bolts and tighten the four 10 mm cylinder head bolts in a crisscross pattern in two or more steps.

TORQUE: 39 N·m (4.0 kgf·m, 29 lbf·ft)