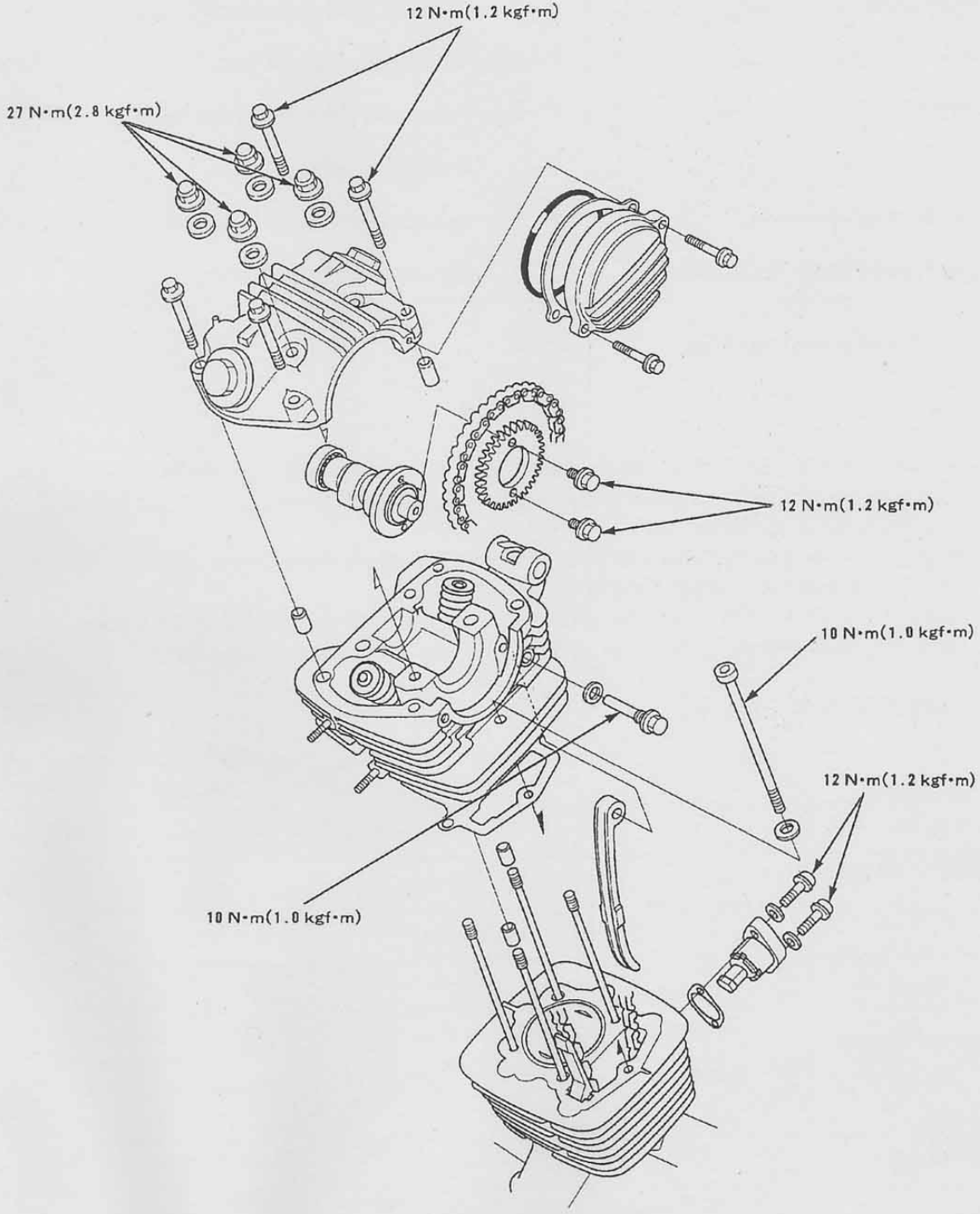
- **Cylinder Head/Valve**



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♦ Service Information

• General

- For the service work in this section, dismount the engine from the frame.
- Apply Molybdenum solution to camshaft bearings and cam slipper surface before assembly for initial lubrication.
- Engine oil is supplied to the camshaft through the oil passage in the cylinder. Clean the passage before assembling the cylinder head.
- Clean all disassembled and inspected parts with compressed air and dry them.
- Mark the removed parts so as to be able to re-install to the original place.

• Specifications

Item				Standard	Service limit
Compression				1,275kPa (13.0kgf/cm²) – 930rpm	-
Valve clearance (cool)			IN	0.10 ± 0.02mm	-
			EX	0.10 ± 0.02mm	-
Cylinder head warpage				-	0.10mm
Cam shaft	Cam lobe height		IN	31.372 – 31.612mm	31.1mm
			EX	31.212 – 31.452mm	31.0mm
	Runout			-	0.03mm
Valve, valve guide	Valve stem external diameter		IN	5.450 – 5.465mm	5.42mm
			EX	5.430 – 5.445mm	5.40mm
	Valve guide bore		IN	5.475 – 5.485mm	5.50mm
			EX	5.475 – 5.485mm	5.50mm
	Stem guide clearance		IN	0.010 – 0.035mm	0.06mm
			EX	0.030 – 0.055mm	0.08mm
	Valve seat width		IN / EX	1.1 – 1.3mm	1.5mm
Valve spring	Free length	Inner	IN / EX	39.2mm	38.0mm
		Outer	IN / EX	44.9mm	43.5mm
Rocker arm, sub rocker arm	Rocker arm bore			12.000 – 12.018mm	12.05mm
	Rocker arm shaft ext. diameter			11.966 – 11.984mm	11.93mm
	Arm – shaft clearance			0.016 – 0.052mm	0.08mm

- **Torque settings**

Spark plug	18N.m (1.8kgf-m)	
Tappet hole cap	15N.m (1.5kgf-m)	]
Valve adjust lock nut	14N.m (1.4kgf-m)	] apply oil to threads and seats
Cylinder head cover nut	27N.m (2.8kgf-m)	]
bolt	12N.m (1.2kgf-m)	
Cylinder head bolt	10N.m (1.0kgf-m)	
Cam sprocket bolt	12N.m (1.2kgf-m)	
Cam chain tensioner socket bolt	12N.m (1.2kgf-m)	
sealing screw	4N.m (0.4kgf-m)	
Cam chain tensioner slider bolt	10N.m (1.0kgf-m)	
Timing hole cap	10N.m (1.0kgf-m)	
Crankshaft hole cap	8N.m (0.8kgf-m)	

- **Special tools**

Compression gauge attachment	07510-MB00101
Wrench 10 x 12mm	07708-0030200
Tappet adjust wrench	07708-0030300
Valve spring compressor	07757-0010000
Valve guide remover 5.5mm	07742-0010100
Valve guide reamer 5.485mm	07984-0980001
Cutter holder 5.5mm	07781-0010101
Valve seat cutter	
45° seat surface cutter (33mm)	07780-0010800
45° seat surface cutter (29mm)	07780-0010300
32°flat cutter (30mm)	07780-0012200
32°flat cutter (33mm)	07780-0012900
60°interior surface cutter (30mm)	07780-0014000

- **Troubleshooting**
- Engine top end problems can be diagnosed by a compression test, or by tracing noises with a sounding rod or stethoscope.
- If it is difficult to start or idling is unstable, inspect a crankcase breather tube for smoke. Piston rings may be broken or stuck if smoke is coming out.

Unstable idling
- Low compression

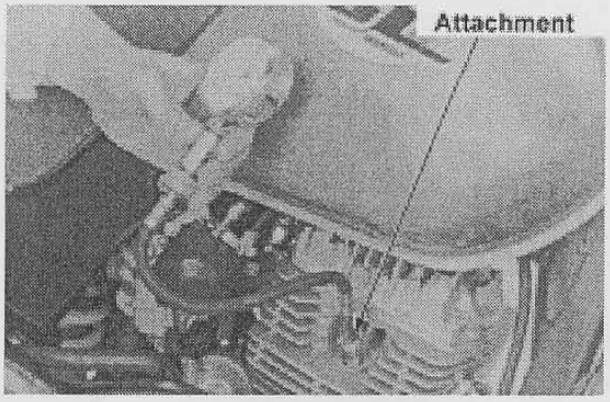
Low compression
- Improper valve clearance
- Burnt or faulty valve
- Improper valve timing
- Faulty valve spring
- Faulty valve seat contact
- Cylinder head gasket leak
- Cylinder head warped/cracked
- Faulty installation of a spark plug

High compression
- Carbon built up in combustion chamber and piston

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

Noise
- Improper valve clearance
- Burnt valve or broken valve spring
- Worn/damaged cam shaft
- Damaged cylinder / piston

- **Cylinder compression**



Note:
Warm up the engine before measuring the compression.

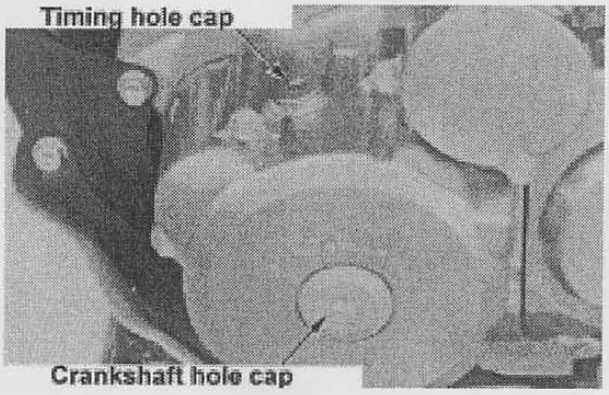
Remove the spark plug.
Connect the compression gauge attachment to the plug hole.
Connect the compression gauge.

- Special Tool:

Compression gauge attachment: 07510-MB00101

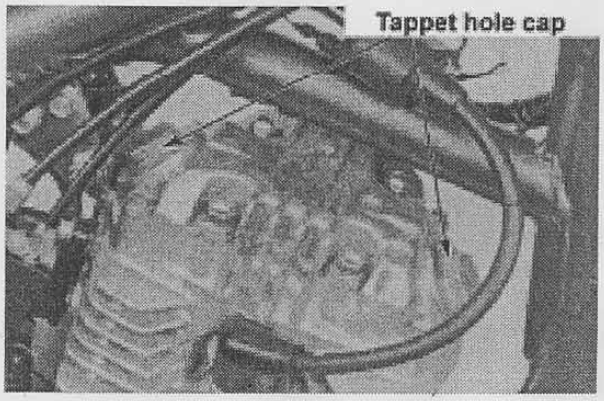
- **Notes:**
- **Check there is no leak from the attachment and the gauge joints.**
- **Do not crank the starter for more than seven seconds.**

Fully open the throttle valve.
Engage the starter motor and measure the compression.
Cylinder compression: 1275kPa (13.0kgf/cm²) – 930rpm



If the compression is too high, inspect the piston head and the cylinder head for carbon build up.
If the compression is too low, add small amount of oil from a plug hole and try again.
If the compression becomes higher, inspect the cylinder, piston and piston ring (sec. 8).
If there is no difference in compression, inspect the cylinder head valve and surroundings.

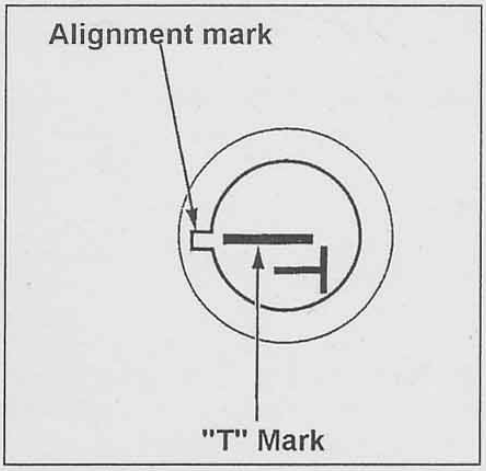
- ♦ **Valve clearance**
- **Inspection**



Note:
Valve clearance should be measured / adjusted while the engine is cold (35°or below).

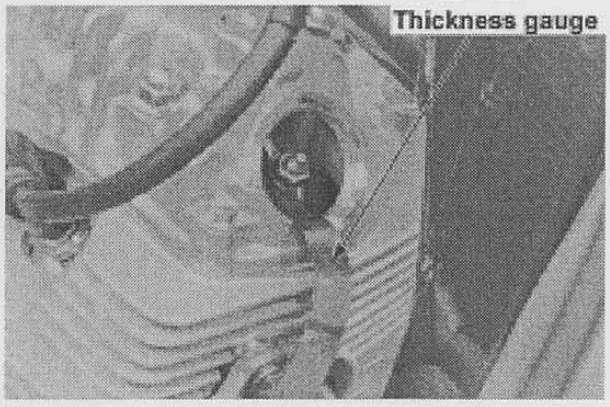
Remove the crankshaft hole cap and timing hole cap.
Remove the fuel tank (2-10)
Remove the tappet hole cap.

Turn the crankshaft counter clockwise and align the "T" mark on a flywheel to the alignment mark on a left crankcase cover to bring TDC (feel loose fit when you shake a rocker arm). If it is not at TDC, turn further one round and align the marks.



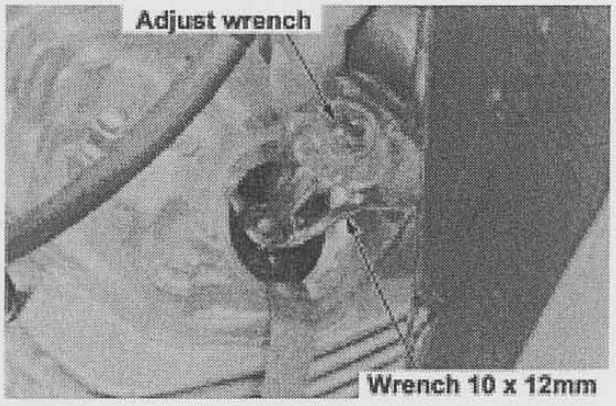
Insert thickness gauge between the valve adjust screw and the valve stem to measure the valve clearance.

Valve clearance: IN: 0.10 ± 0.02mm
EX: 0.10 ± 0.02mm



- **Adjustment**

If the adjustment is required, loosen the valve adjust lock nut and turn the adjust screw to adjust the valve clearance.



Special tool

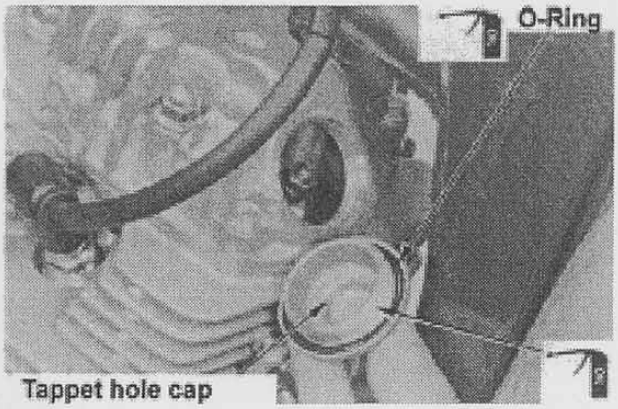
Tappet adjust wrench	07708-0030300
Wrench, 10 x 12mm	07708-0030200

Hold the adjust screw to tighten the lock nut.

Torque: 14N.m (1.4kgf-m)

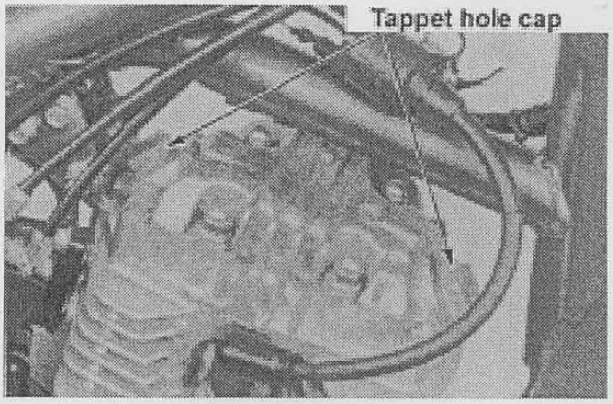
After tightening the lock nut, measure the valve clearance.

Inspect the O-Ring on the tappet hole cap for its installation and damage.
Replace if necessary.
Apply engine oil to the O-Ring.
Apply engine oil to the tappet hole cap thread and the seat.



Install the tappet hole caps and tighten them.

Torque: 15N.m (1.5kgf-m)

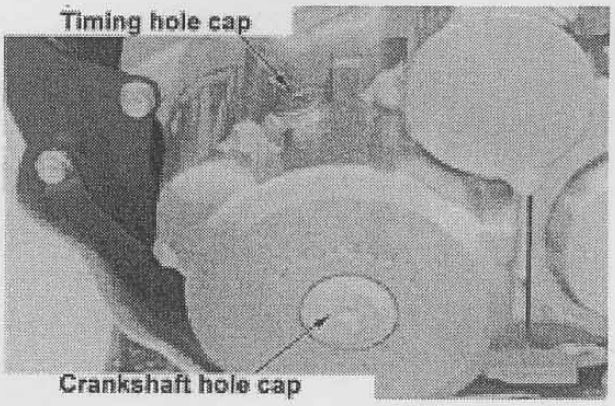


Inspect the crankshaft hole cap and the timing hole cap O-Rings for damage and their attachment. Replace if necessary.

Apply engine oil to the O-Rings.

Set and tighten the crankshaft hole cap and the timing hole cap.

Torque: Crankshaft hole cap
8N.m (0.8kgf-m)
Timing hole cap
10N.m (1.0kgf-m)



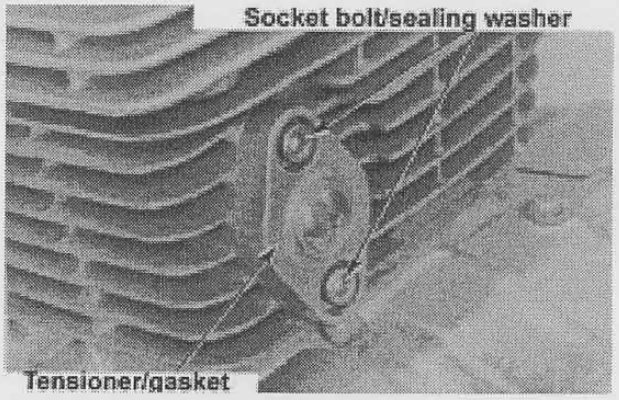
Install the fuel tank (2-11)

- **Cylinder head removal**

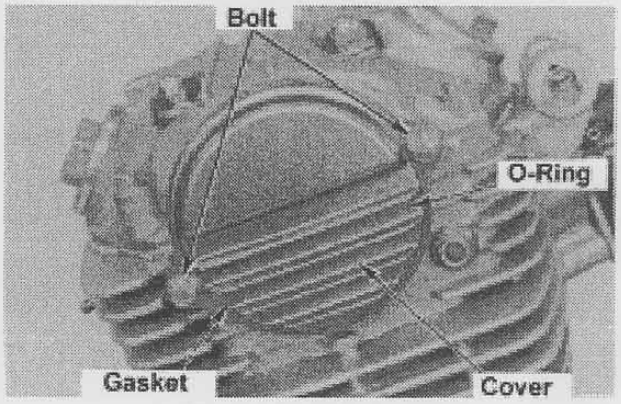
Unmount the engine from the frame (6-3)
Remove the starter motor (16-5)

Remove cam chain tensioner socket bolts and sealing washers.

Remove the cam chain tensioner and the gasket.
Remove a crankshaft hole cap and a timing hole cap.



Remove bolts to remove a cam sprocket cover.
Remove the gasket and an O-Ring.

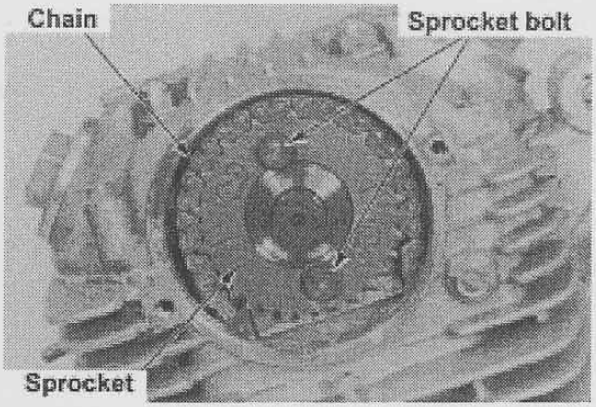


Turn the crankshaft counter clockwise to align the marks to bring TDC (7-4).

Remove cam sprocket bolts.

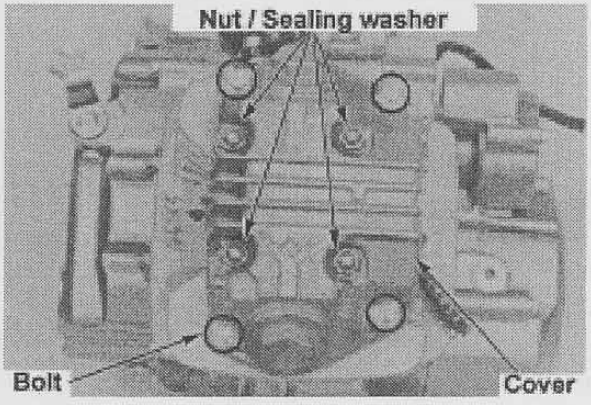
Move the cam sprocket from a camshaft flange to remove cam chain from the cam sprocket.

- **Notes:**
- **Do not drop bolts inside the crankcase.**
- **Sling the cam chain with a wire to prevent it falling into the crankcase.**

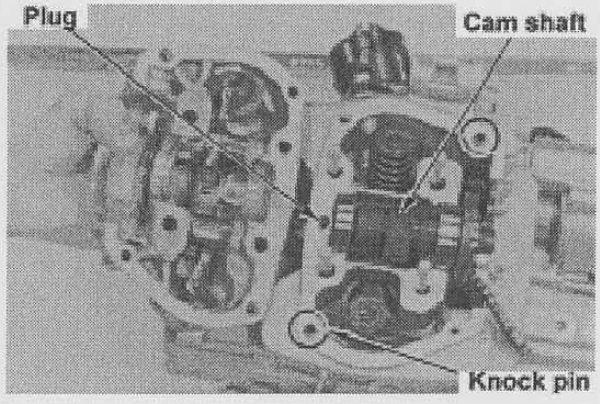


Remove cylinder head cover bolts/nuts and remove sealing washers and the cylinder head cover.

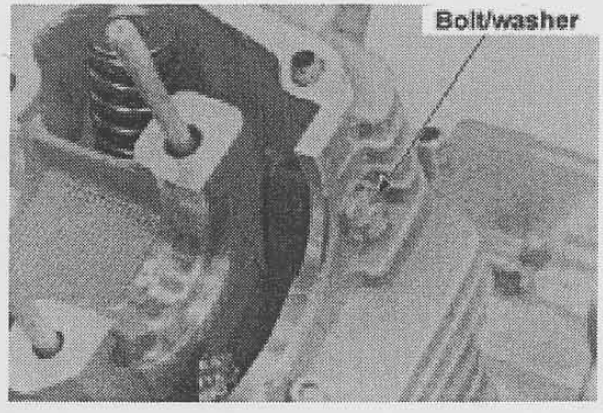
Note:
Unscrew the bolts/nuts in a crisscross pattern, 2 or 3 steps.



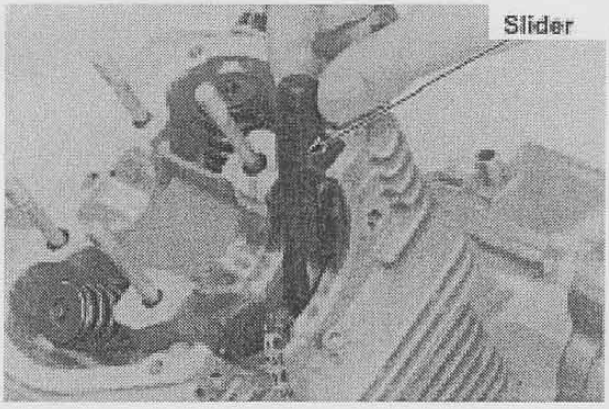
Remove the camshaft, and oil hole plug and the knockpin.



Unscrew the cam tensioner slider bolt and remove the washer.



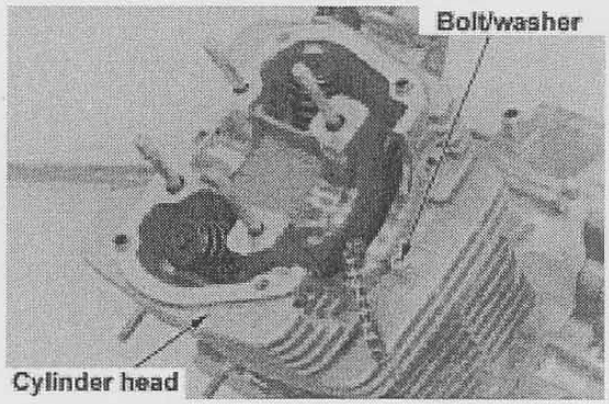
Remove the cam chain tensioner slider.



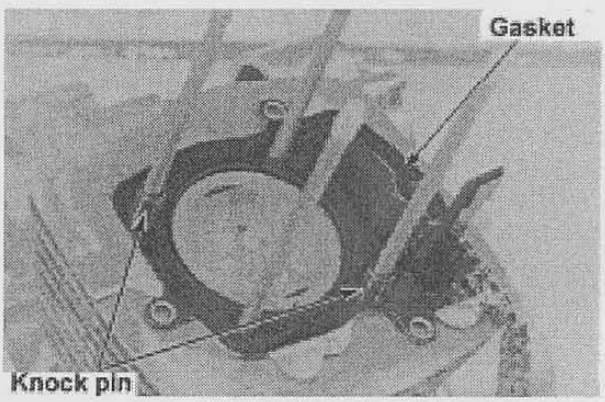
Unscrew the cylinder head bolt and remove the washer to remove the cylinder head.

General Caution

Do not damage the mating surface with the cylinder when removing.

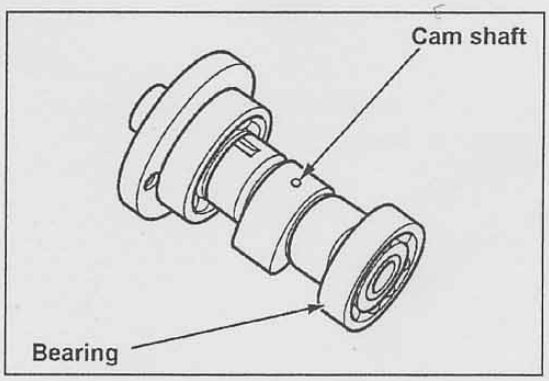


Remove the gasket and knockpins.



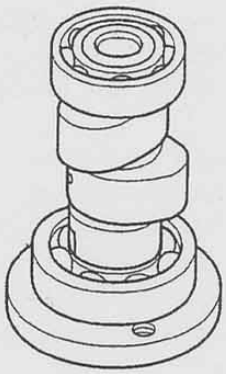
- **Camshaft inspection**

Rotate the outer race of the bearing by finger and check for smooth movement.
If it is faulty, replace the camshaft.



Inspect the cam surface for damage.
Measure the cam lobe height.

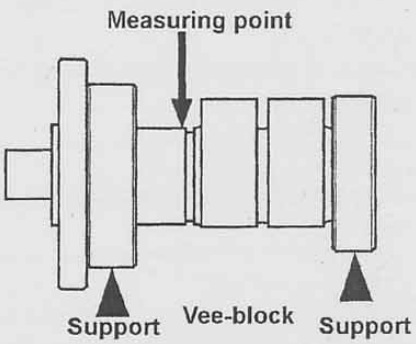
Service limit: IN 31.1mm or less
EX 30.0mm or less → replace



Place the camshaft on V-blocks and measure the runout with a dial gauge.

Service limit: 0.03mm or above → replace

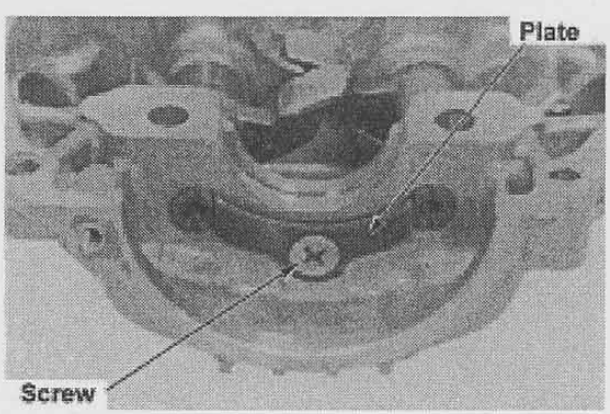
The runout is ½ of the measured value.



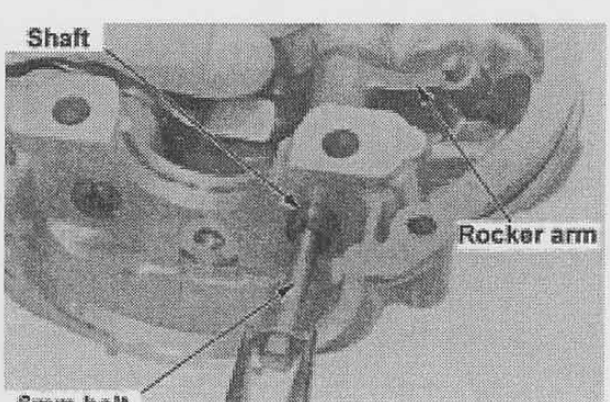
- **Cylinder head cover disassembly**

Remove a cylinder head cover (7-5).

Unscrew the rocker arm shaft plate screw to remove the rocker arm shaft plate.



Temporarily set a 6mm bolt (cylinder head cover bolt can be used) to the rocker arm shaft.
Pull the bolt to remove the rocker arm shaft and the rocker arm.



DTA

- **Rocker arm, rocker arm shaft inspection**

Inspect the rocker arm for damage and wear.
If damage/wear was discovered on the rocker arm slipper surface, inspect the cam surface on the camshaft (7-7).

Measure the rocker arm bore.
Service limit: 12.05mm or above → replace

Inspect the rocker arm shaft for damage and wear.
Measure the external diameter of the rocker arm shaft.

Note:
Measure at the position where the locker arm contact.

Service limit: 11.93mm or less → replace
Calculate the clearance between the rocker arm shaft and the rocker arm.
Service limit: 0.08mm

- **Cylinder head disassembly**

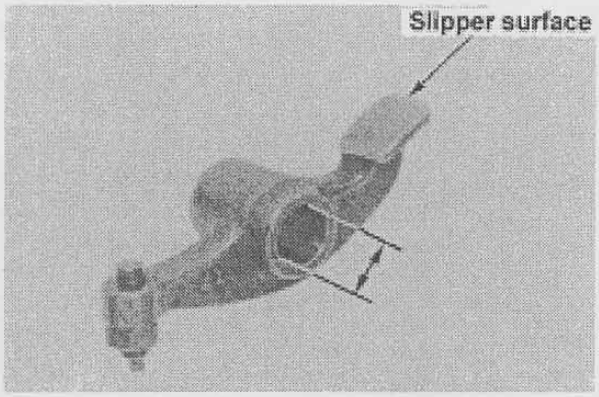
Unscrew bolts to remove the insulator and O-Ring.
By using a valve spring compressor, remove the following parts:
- valve cotter
- retainer
- spring
- valve
- stem seal
- spring seat

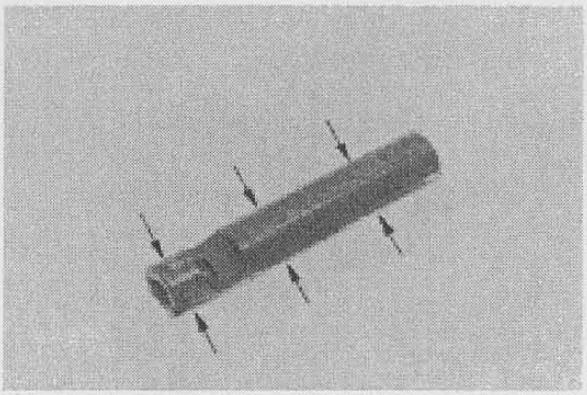
Special tool
Valve spring compressor 07757-0010000

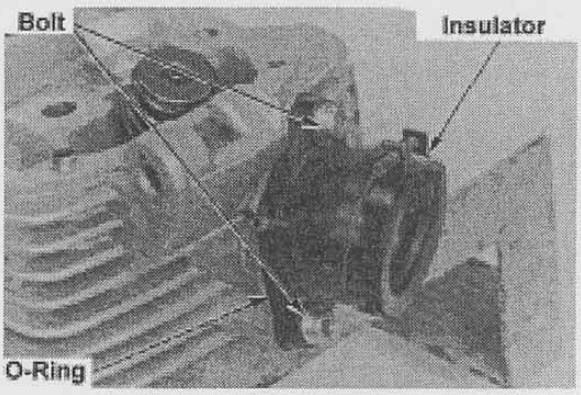
General Caution

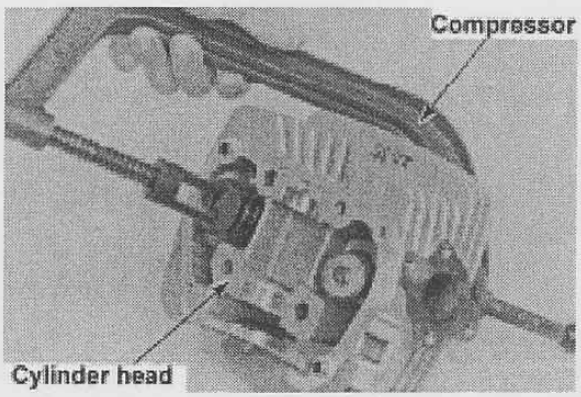
Do not over compress the valve spring.

Note:
Mark all parts so as to be able to re-install them to the original place.









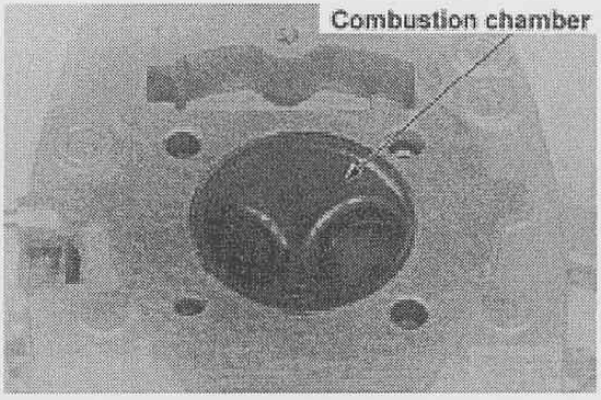
- **Cylinder head inspection**

Remove carbon build up in the combustion chamber and the exhaust port.

Clean the mating surface with the cylinder.

General Caution

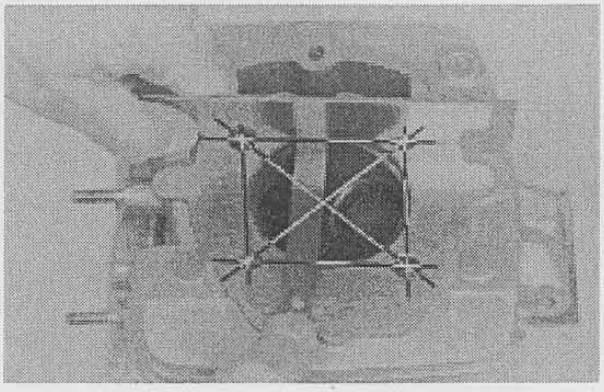
Do not damage the mating surface and the valve seats.



Inspect the spark plug hole and the valve seat surrroundings for cracks.

Measure the cylinder head warpage by using a straight edge and thickness gauge.

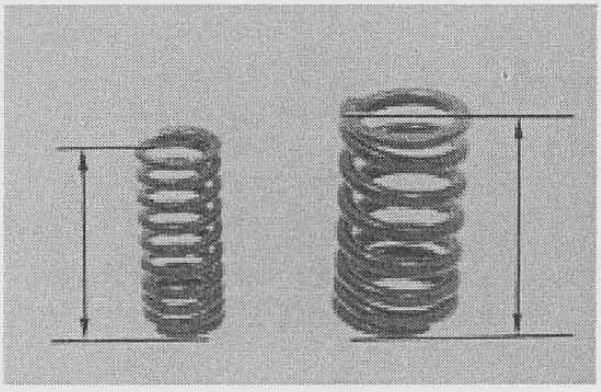
Service limit: 0.10mm or above → replace



- **Valve spring inspection**

Inspect the valve springs for damage and deformation.
Measure the free length of the springs.

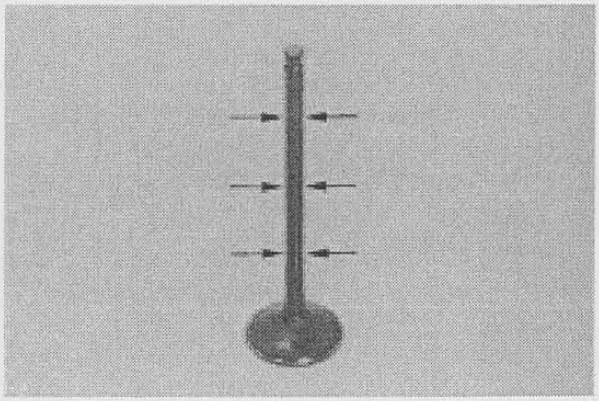
Service limit: Inner 38.0mm or less → replace
Outer 43.5mm or less → replace



- **Valve inspection**

Inspect the valves for bending, scratch and abnormal stem wear.
Insert the valve to a valve guide to check its operation.
Measure the outer diameter of the valve stem at the positions where the valve guide contact.

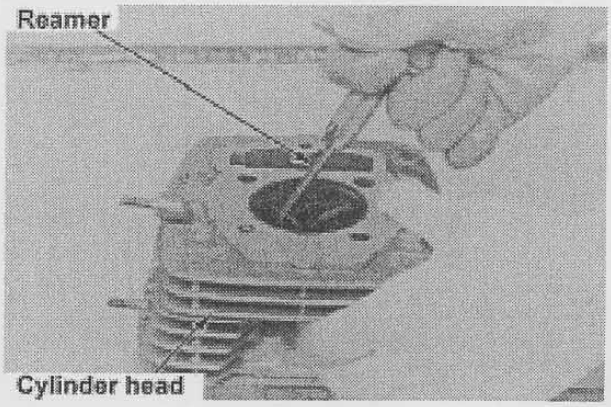
Service limit: IN: 5.42mm or less → replace
EX: 5.40mm or less → replace



- **Valve guide inspection**

Remove built up carbon by using a reamer before measuring the valve guide.

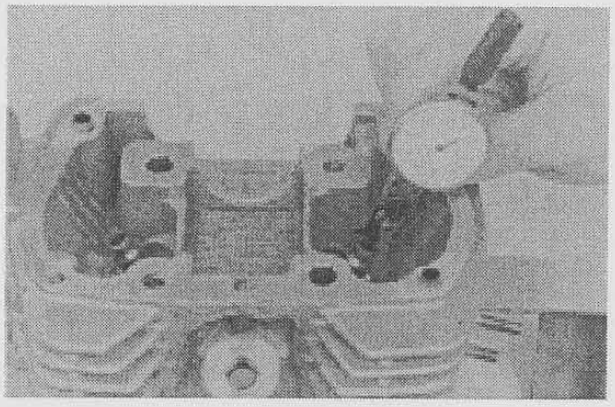
> **Note:**
> **Spin the reamer clockwise when moving the reamer. Otherwise, it will scratch the interior surface of the guide.**



Special tool:
Valve guide reamer
(5.485mm) 07984-0980001

Measure the valve guide bore.
Service limit: IN: 5.50mm or above → replace
EX: 5.50mm or above → replace

Calculate the clearance between the valve stem and the valve guide.
Service limit: IN: 0.06mm
EX: 0.08mm



> **Note:**
> **If the clearance is beyond the limit, calculate the clearance with a new guide. If the number is still beyond the limit, replace the valve too.**

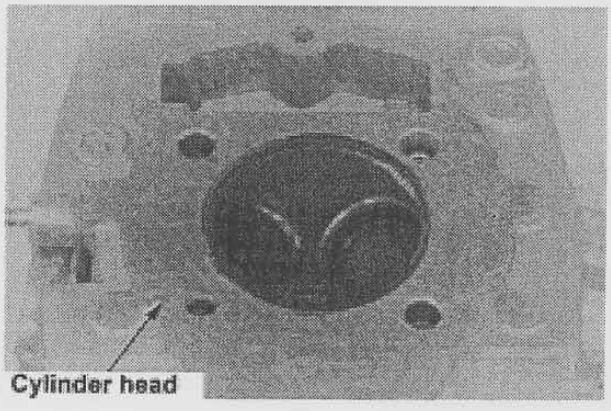
- **Valve guide replacement**

> **Note:**
> **Reface the valve seats whenever the valve guides are replaced.**

Heat whole cylinder head to 100 ~ 150°c.

General Caution

> Do not use a torch to heat the cylinder head. It may cause warping.



Warning

> To avoid burns, wear heavy gloves when handling the cylinder head.

Drive out the valve guide from the combustion chamber side.

Special tool: Valve guide remover 5.5mm
07742-0010100

General Caution

Do not damage the mating surface with the cylinder.

Apply oil to the new O-Ring and set it to the new valve guide.

Drive in the new guide from the camshaft side.

Special tool: Valve guide remover 5.5mm
07742-0010100

Insert the reamer from the combustion chamber side of the cylinder head and ream the valve guide.

Special tool: Valve guide reamer, 5.485mm
07984-0980001

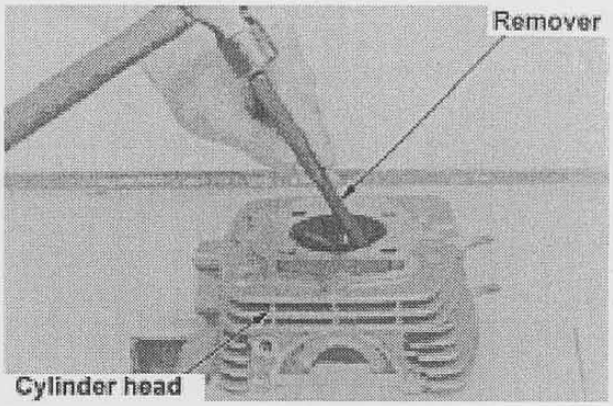
- **Notes:**
- **Do not tilt the reamer from original inclination.**
- **Turn the reamer clockwise while inserting or removing it.**

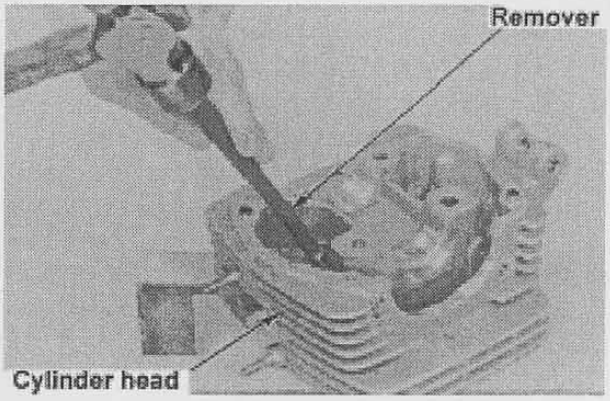
Clean all cutting residue out of the cylinder head.
Adjust the valve seat.

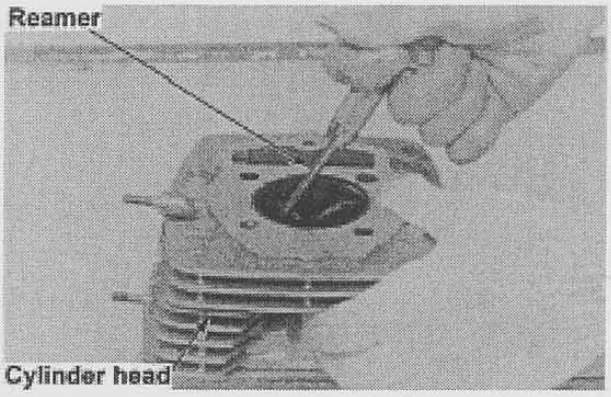
- **Valve seat inspection / refacing**

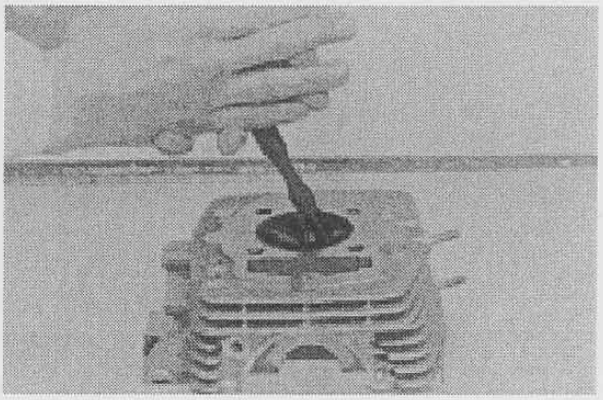
- **Valve seat inspection**

Remove built up carbon from the valve.
Replace the valve if there is abnormal wear or roughness on the valve face.
Apply a light coating of Prussian blue to the cylinder head valve seat.
Install the valve, lap it against the seat and remove it without turning the valve.



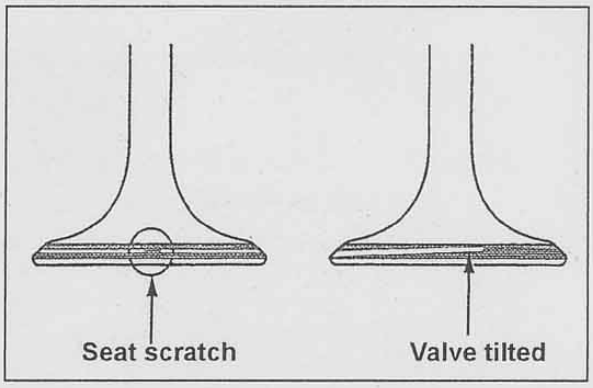






Inspect the coating on the valve surface in order to find out the seat condition.

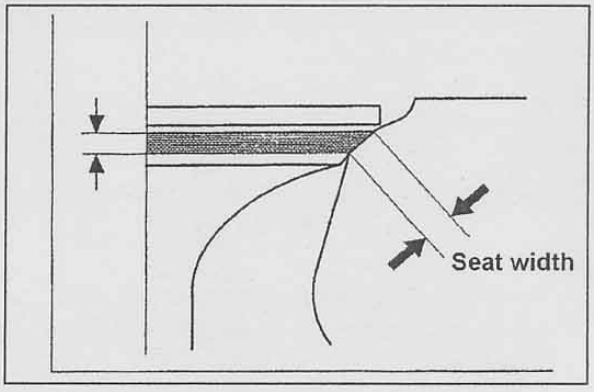
Reface the valve seat if there is any scratch on it.
If the valve is tilted, inspect the clearance between the valve guide and the stem and replace the valve guide if the clearance is within the limit (7-11).



Measure the seat width of the valve face.

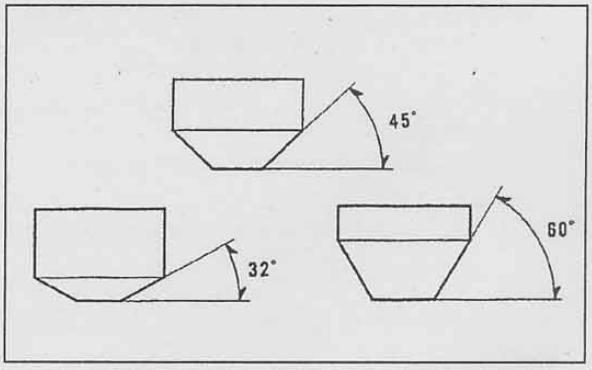
Standard: 1.1 ~ 1.3mm
Service limit: 1.5mm

If the seat width is out of limit, too high/low or unequal, reface the valve seat with valve seat cutters.

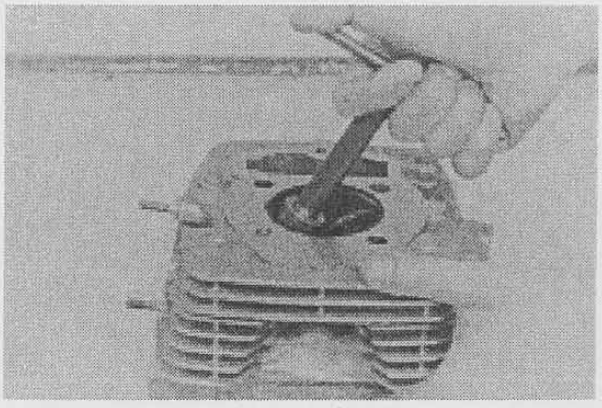


- **Valve seat refacing**

Use valve seat cutters for refacing.
Refer to the manufacturer's instructions when using the cutters.

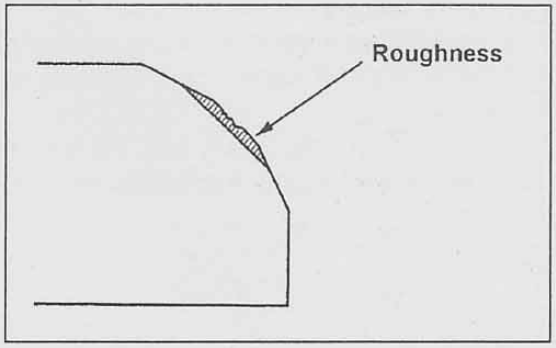


When refacing, apply 4 ~ 5kg of force by hand and turn the cutter to one direction.



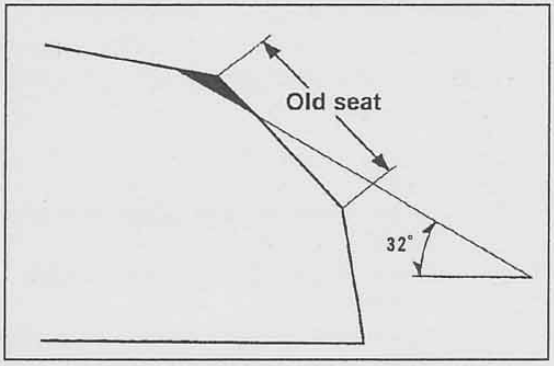
Note:
Apply engine oil to the cutter and remove cutting residue while refacing.

Use a 45°cutter to remove all roughness and irregularities from the seat.

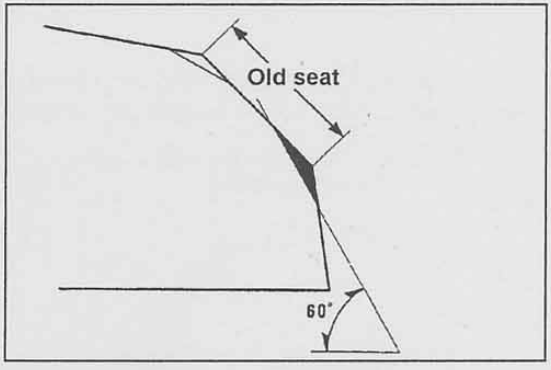


- **Note:**
- **Reface the seat when the valve guide is replaced.**
- **Do not cut too much.**

Use a 32°cutter to remove ¼ of the existing valve seat material.

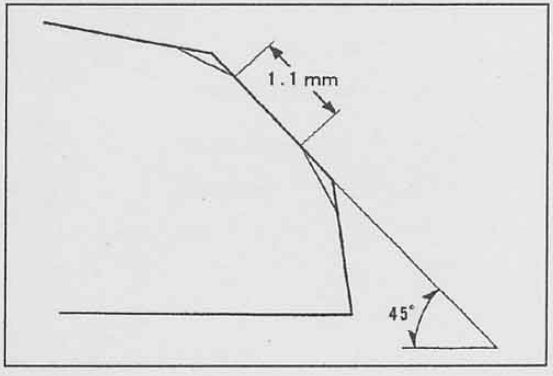


Use a 60° cutter to remove the bottom ¼ of the old seat.

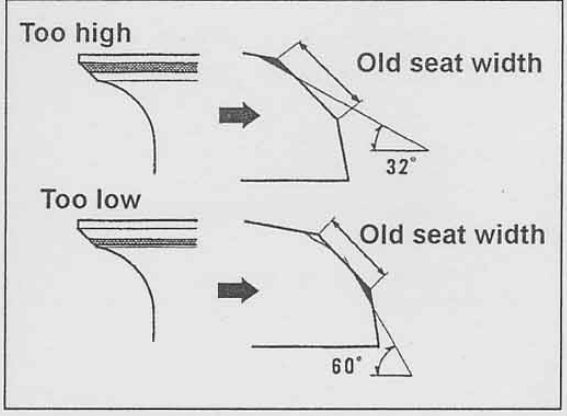


Use a 45° cutter to cut the seat to the proper width.

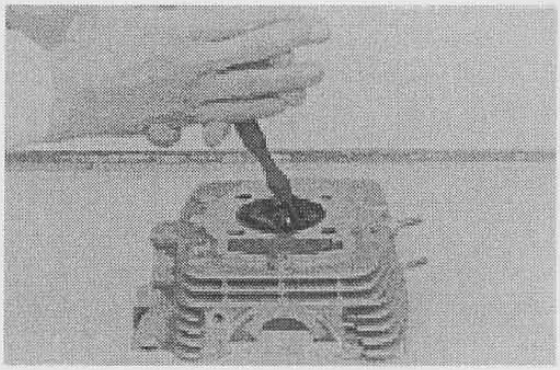
Standard width: 1.1 ~ 1.3mm



Inspect the valve seat contact.
If the contact area is too high, cut the seat with a 32°cutter and adjust the width with a 45°cutter.
If the contact area is too low, cut the seat with a 60°cutter and adjust the width with a 45°cutter.

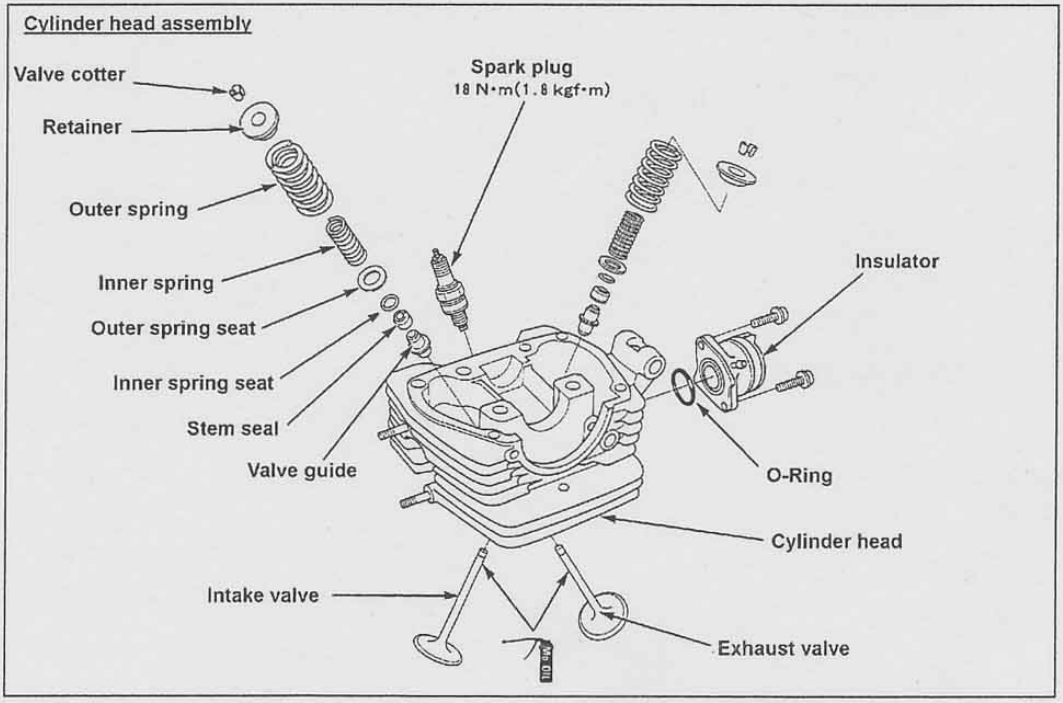


Apply a light coating of valve lapping compound to the valve seat. Lap the valve and seat, using a rubber hose or other hand lapping tool.

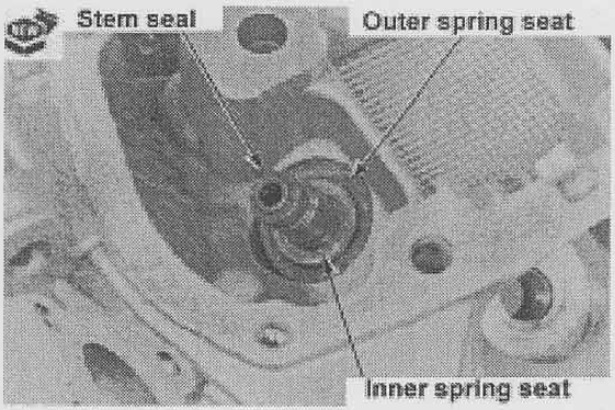


- **Notes:**
- **Do not allow lapping compound to enter the valve guide.**
- **Do not apply excessive force when lapping.**
- **To avoid unequal wear of the seat, rotate the valve while lapping.**

Clean the cylinder head and the valve after lapping.
Re-measure the valve seat width after all refacing.

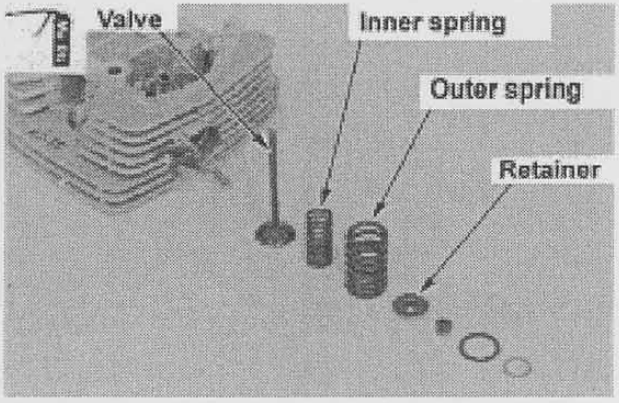


Install the outer spring seat, inner spring seat and a new stem seal to the cylinder head.



Apply Molybdenum disulfide oil to the valve stem and the valve guide interior surface and install the valve.

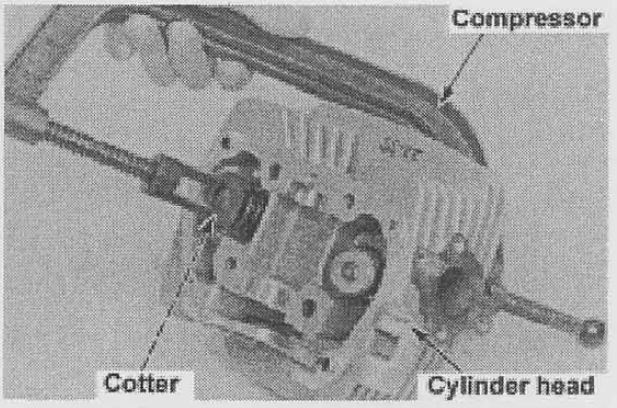
Note:
When installing the valve, insert it to the guide by turning it slowly to avoid scratching the stem seal.



Install the valve springs and the retainer.

Note:
Face the fine-pitch end of the springs to the cylinder head when installing.

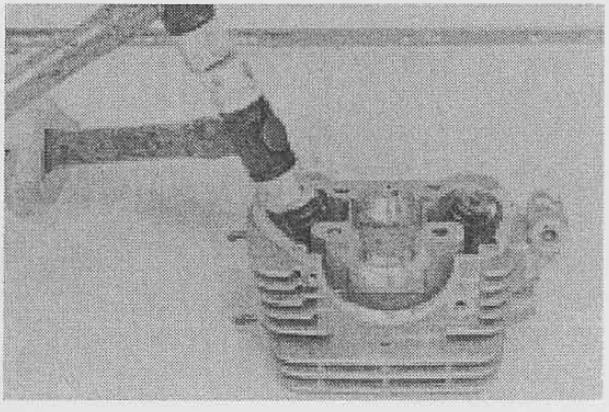
Compress the valve spring by using a valve spring compressor in order to install a valve cotter.
Special tool: Valve spring compressor
07757-0010000



General Caution

Do not over compress the valve spring.

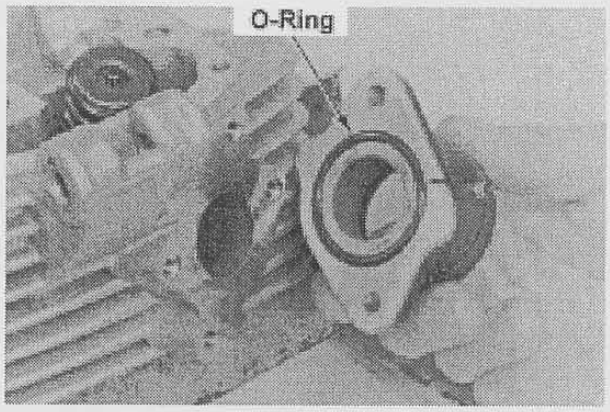
Tap the valve stem end for a few times to fit the cotter to the valve.



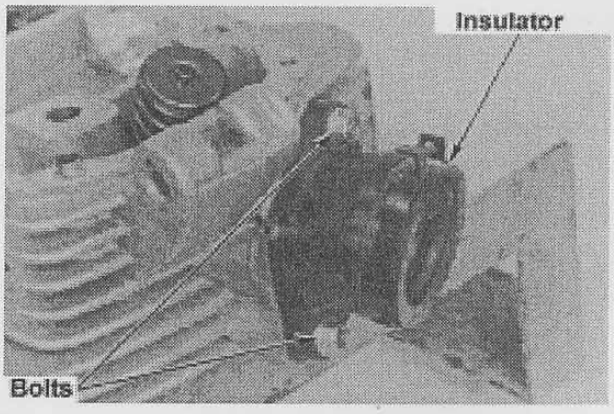
General Caution

Do not damage the valve.

Inspect an O-Ring on the insulator and replace if necessary.

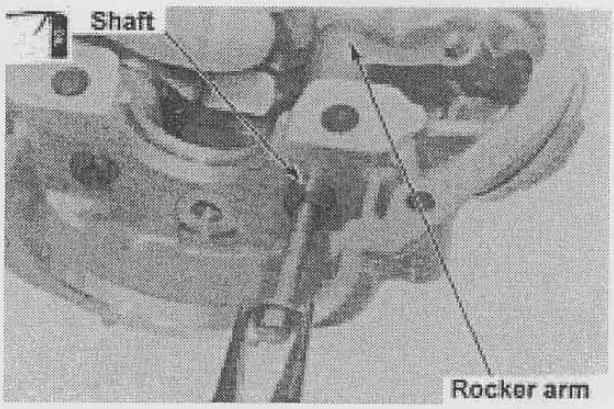


Install the insulator to the cylinder head and tighten bolts.

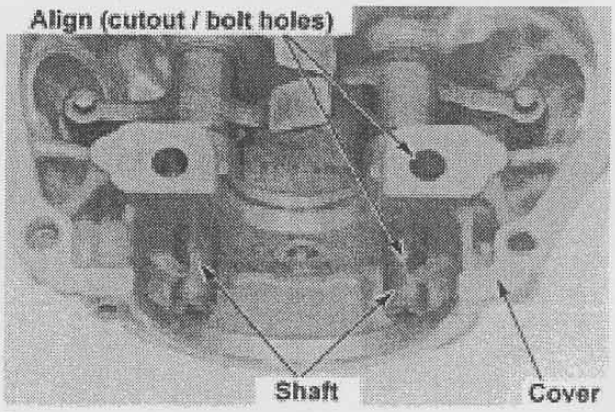


- **Cylinder head cover installation**

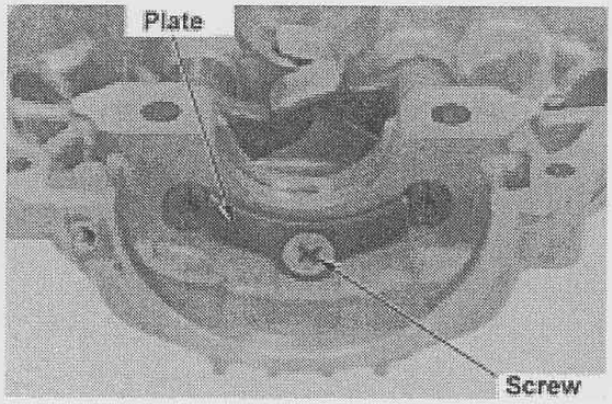
Apply engine oil to the rocker arm where a rocker arm contacts.
Install the rocker arm and the rocker arm shaft.



Install the rocker shaft by facing the cutout side to the plate and align the cutout with head cover bolt holes.

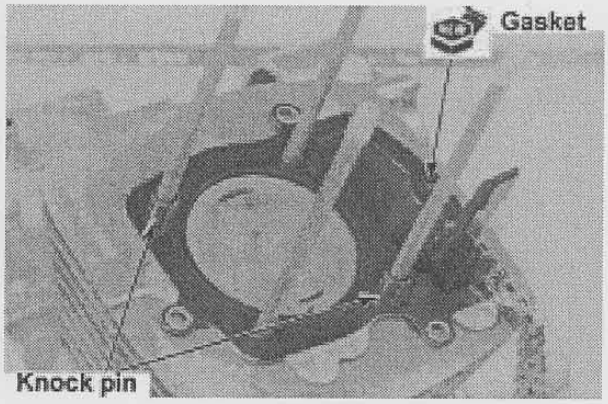


Install a rocker arm shaft plate and tighten the screw.



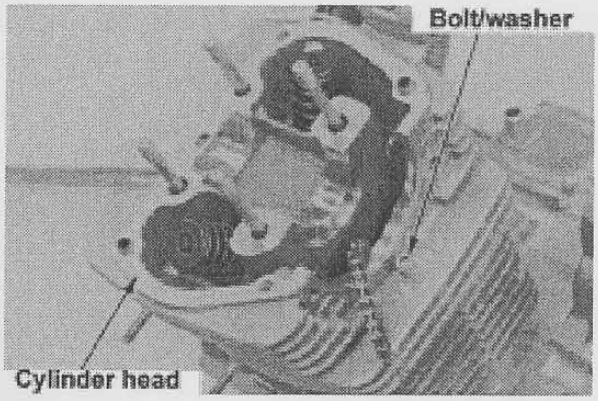
- **Cylinder head installation**

Note:
When cleaning the top surface of the cylinder, seal oil holes with cloths to prevent mud or any other items entering the engine.

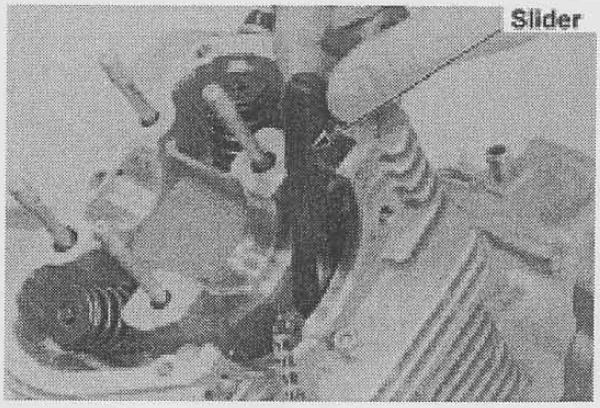


Clean gasket material from the cylinder mating surface.
Install knockpins and a new cylinder head gasket.

Install the cylinder head and install cylinder head bolt/washer.



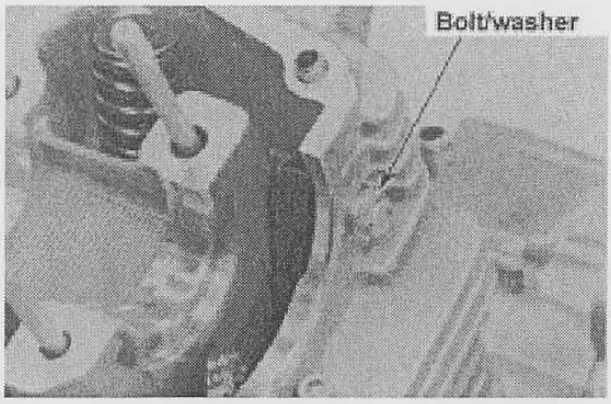
Install a cam chain tensioner slider.



Install cam chain tensioner slider bolt/washer.

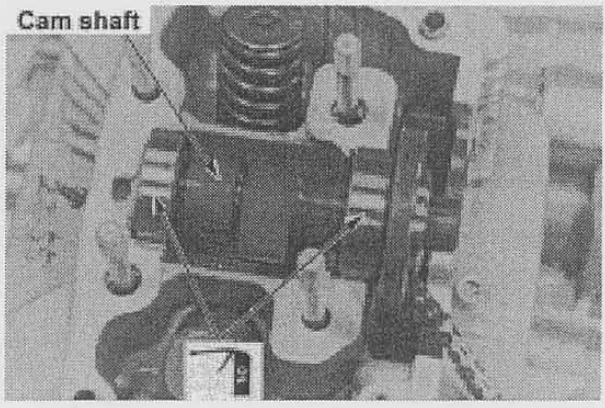
Torque: 10N.m (1.0kgf-m)

DTA.



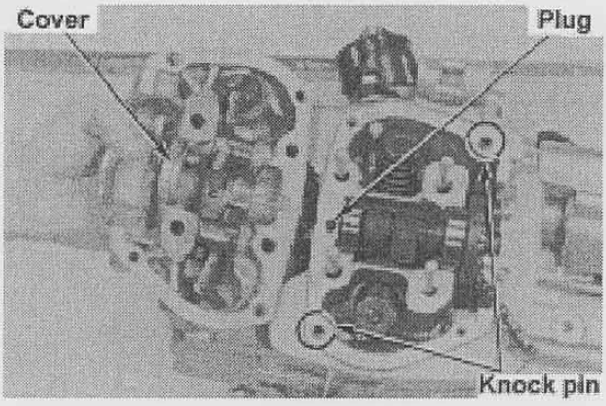
Apply engine oil to the cam shaft bearings.

Face the cam lobe on the shaft to the combustion chamber and install the shaft to the cylinder head.

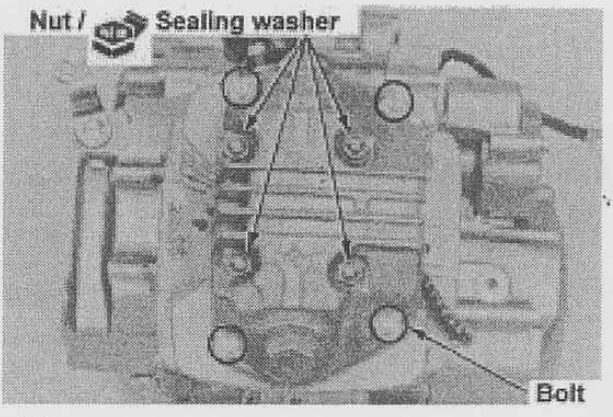


> **Note:**
> **Install the shaft so as to have the bolt hole on the shaft perpendicular to the mating surface.**

Install knockpins and an oil hole plug.
Fill clean engine oil to the oil pan until the cam surface is covered with the oil.
Apply liquid sealant to the cylinder head cover mating surface and install the cover to the cylinder head.



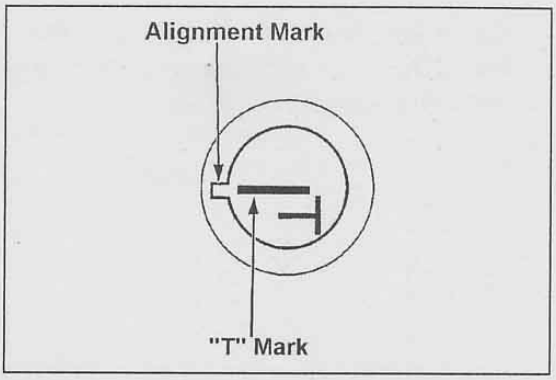
Apply oil to the cylinder head cover nut thread and seats and install them with new sealing washers.
Install cylinder head cover bolts.
Tighten the cylinder head cover bolts/nuts.



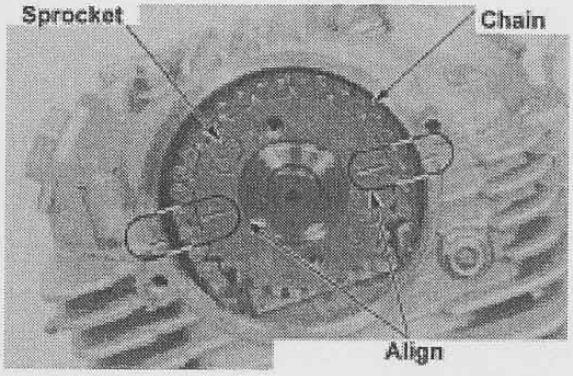
- **Notes:**
- **Tighten the cylinder head cover nuts first**
- **Tighten in a crisscross pattern for 2, 3 steps for both nuts and bolts.**

Torque: **Nut: 27N.m (2.8kgf-m)**
Bolt: 12N.m (1.2kgf-m)

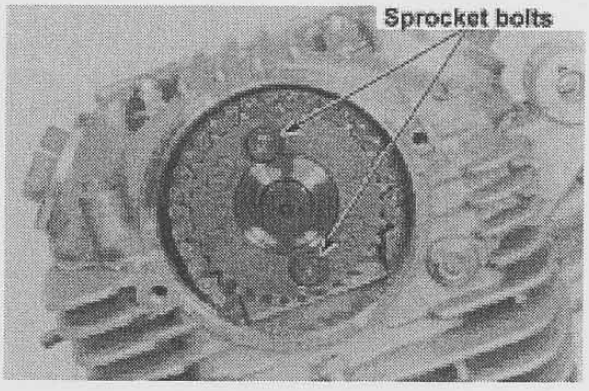
Turn the crankshaft counter clockwise to align "T" mark on a flywheel with an alignment mark on a left crankcase cover.



Install a cam sprocket to cam chain.
Align the lines on the sprocket with the alignment lines on the cylinder head cover when installing.

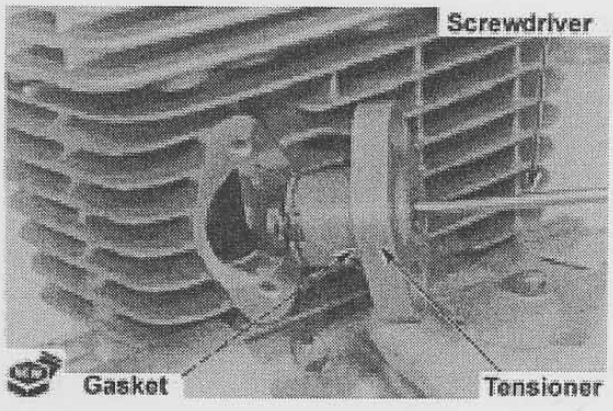


Install and tighten the cam sprocket bolts.
Torque: 12N.m (1.2kgf-m)



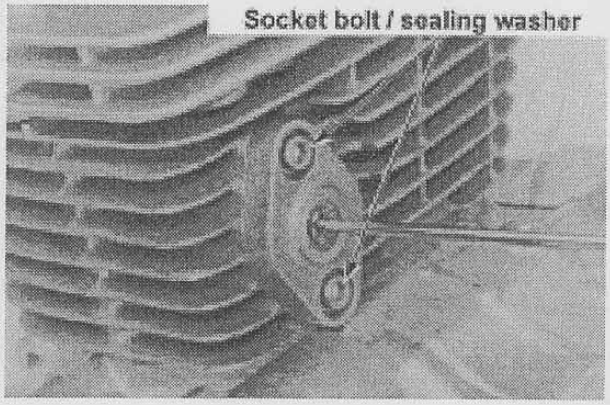
Note:
Do not drop bolts into the crankcase.

Unscrew cam tensioner sealing screws and remove an O-Ring.
Turn the screwdriver clockwise to bring the tensioner rod to the tensioner body.
Install new gasket to the cam chain tensioner.



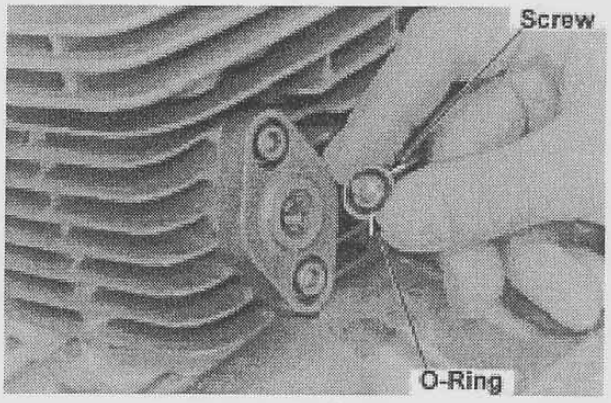
Install the cam chain tensioner to the cylinder and tighten the cam chain tensioner socket bolts with sealing washers.

Torque: **12N.m (1.2kgf-m)**

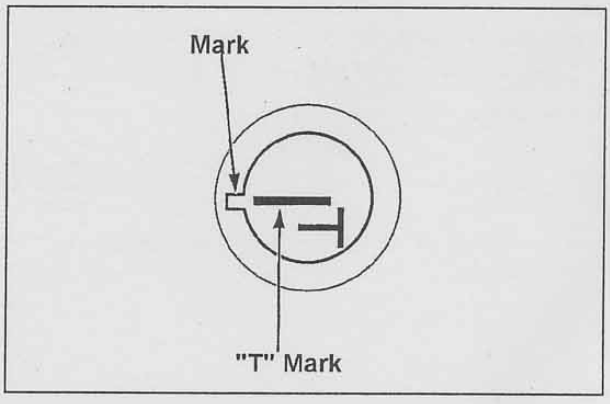


Remove the screwdriver and install the cam chain tensioner screw and the O-Ring.

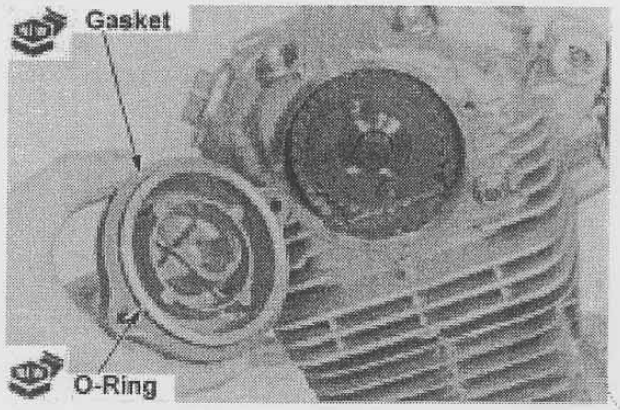
Torque: **4N.m (0.4kgf-m)**



Check the lines on the cam sprocket are aligned with the cylinder head edges when the "T" mark on the flywheel is aligned with the mark on the left crankcase cover.



Inspect the O-Ring and replace if necessary. Install new gasket and O-Ring.



Install the cam sprocket cover and tighten bolts.

Inspect / adjust the valve clearance (7-4).
Install a starter motor (16-11).
Mount the engine to the frame (6-4).