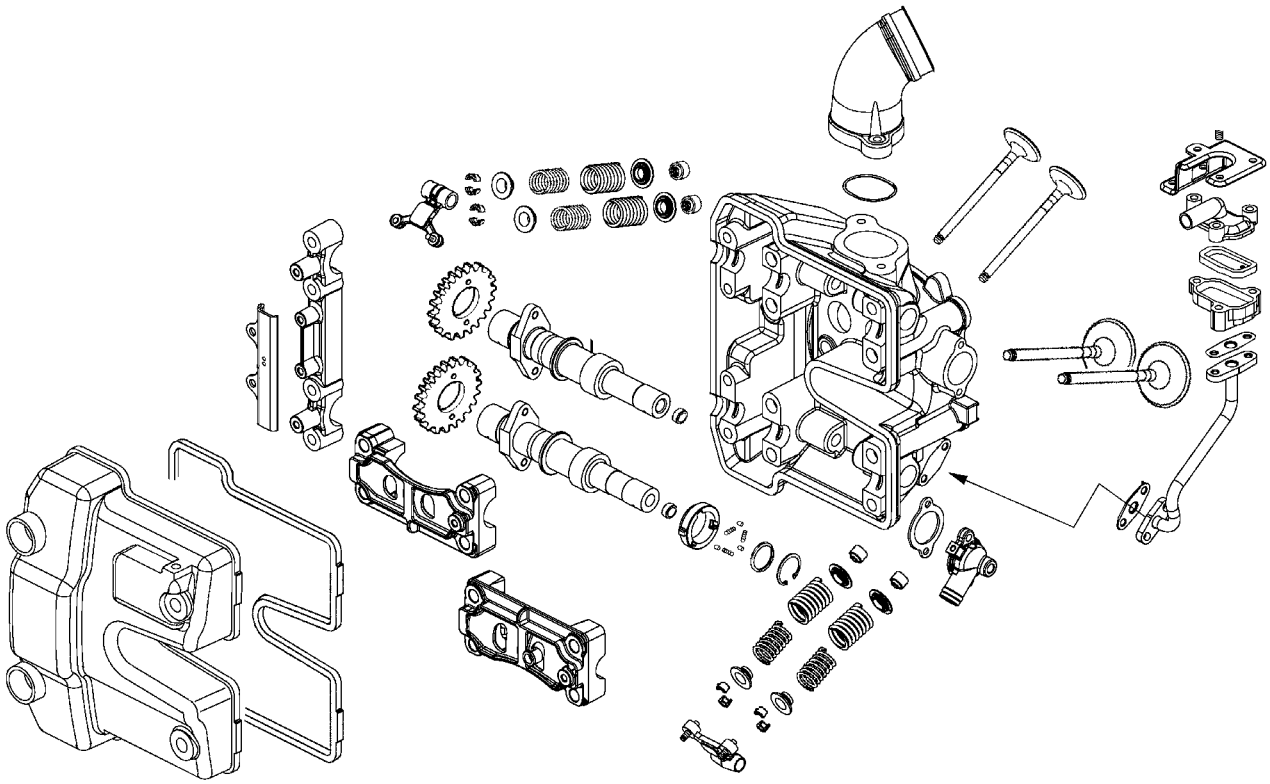
CYLINDER HEAD/VALVES

8. CYLINDER HEAD/VALVES

SCHEMATIC DRAWING



8. CYLINDER HEAD/VALVES

SERVICE INFORMATION

GENERAL INSTRUCTIONS

- The cylinder head can be serviced with the engine installed in the frame. Coolant in the radiator and water jacket must be drained first.
- When assembling, apply molybdenum disulfide grease or engine oil to the valve guide movable parts and valve arm sliding surfaces for initial lubrication.
- The valve rocker arms are lubricated by engine oil through the cylinder head engine oil passages. Clean and unclog the oil passages before assembling the cylinder head.
- After disassembly, clean the removed parts and dry them with compressed air before inspection.
- After removal, mark and arrange the removed parts in order. When assembling, install them in the reverse order of removal.

SPECIFICATIONS

Unit: mm (in)

Item		Standard	Service Limit
Valve clearance (cold)	IN	0.1 mm (0.004 in)	—
	EX	0.1 mm (0.004 in)	—
Cylinder head compression pressure		13 kg/cm^2 (185 psi, 1300 kPa)	—
Cylinder head warpage		—	0.05 (0.002)
Camshaft cam height	IN	37.2614 (1.4905)	37.11 (1.4844)
	EX	37.0084 (1.4803)	36.86 (1.4744)
Valve rocker arm I.D.	IN	10 (0.4)～10.015 (0.4006)	10.1 (0.404)
	EX	10 (0.4)～10.015 (0.4006)	10.1 (0.404)
Valve rocker arm shaft O.D.	IN	9.975 (0.399)～9.99 (0.3996)	9.9 (0.396)
	EX	9.975 (0.399)～9.99 (0.3996)	9.9 (0.396)
Valve stem O.D.	IN	4.975 (0.199)～4.99 (0.1996)	4.925 (0.197)
	EX	4.955 (0.1982)～4.97 (0.1988)	4.915 (0.1966)
Valve guide I.D.	IN	5 (0.2)～5.015 (0.2006)	5.03 (0.2012)
	EX	5 (0.2)～5.015 (0.2006)	5.03 (0.2012)
Valve stem-to-guide clearance	IN	0.01 (0.004)～0.037 (0.0015)	0.08 (0.0032)
	EX	0.03 (0.0012)～0.057 (0.0023)	0.1 (0.004)

TORQUE VALUES

Cylinder head bolt (13)	13 N•m (1.3 kgf•m, 9 lbf•ft)	Apply engine oil to threads
Cylinder head bolt (1 – 4)	48 N•m (4.8 kgf•m, 35 lbf•ft)	Apply engine oil to threads
Cylinder head bolt (5 – 12)	23 N•m (2.3 kgf•m, 17 lbf•ft)	Apply engine oil to threads
Cylinder head cover bolt	10 N•m (1 kgf•m, 7 lbf•ft)	
Cylinder head cover bolt	10 N•m (1 kgf•m, 7 lbf•ft)	
Breather separator bolt	13 N•m (1.3 kgf•m, 9 lbf•ft)	
Cam chain tensioner bolt	12 N•m (1.2 kgf•m, 9 lbf•ft)	
Tensioner pivot bolt	10 N•m (1 kgf•m, 7 lbf•ft)	
Rocker arm shaft	45 N•m (4.5 kgf•m, 32 lbf•ft)	

SPECIAL TOOLS

Valve spring compressor E040

TROUBLESHOOTING

- The poor cylinder head operation can be diagnosed by a compression test or by tracing engine top-end noises.

Poor performance at idle speed
- Compression too low

Compression too low
- Incorrect valve clearance adjustment
- Burned or bend valves
- Incorrect valve timing
- Broken valve spring
- Poor valve and seat contact
- Leaking cylinder head gasket
- Warped or cracked cylinder head
- Poorly installed spark plug

Compression too high
- Excessive carbon build-up in combustion chamber

White smoke from exhaust muffler
- Worn valve stem or valve guide
- Damaged valve stem oil seal

Abnormal noise
- Incorrect valve clearance adjustment
- Sticking valve or broken valve spring
- Damaged or worn camshaft
- Worn cam chain tensioner
- Worn camshaft and rocker arm

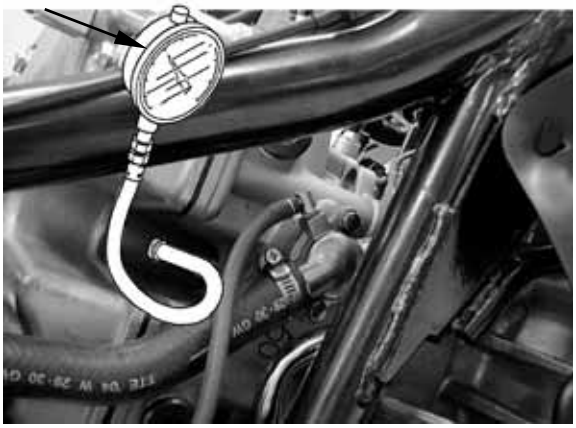
CYLINDER COMPRESSION TEST

Warm up the engine to normal operating temperature.
Stop the engine and remove the spark plug cap and remove the spark plug (page 3-7).

Park Plug Cap

Compression Gauge

Install a compression gauge into the spark plug hole.



Open the throttle all the way and crank the engine with the starter motor until the gauge reading stops rising.
The maximum reading is usually reached 4 – 7 seconds.

* To avoid discharging the battery, do not operate the starter motor for more than seven seconds.

Compression pressure:
13 kg/cm^2 (185 psi, 1300 kPa)

Low compression can be caused by:
- Blown cylinder head gasket
- Improper valve adjustment
- Valve leakage
- Worn piston ring or cylinder

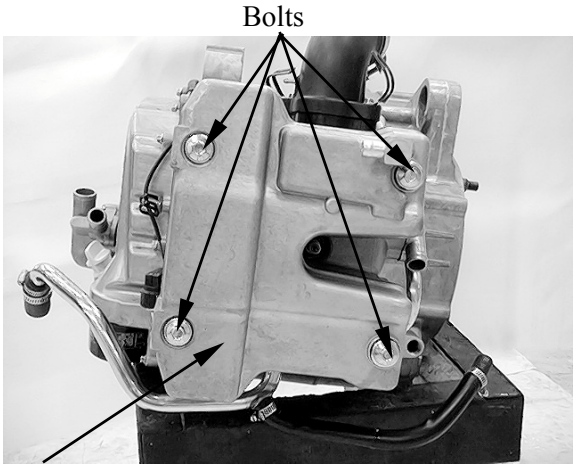
High compression can be caused by:
- Carbon deposits in combustion chamber or on piston head

CYLINDER HEAD COVER

DISASSEMBLY

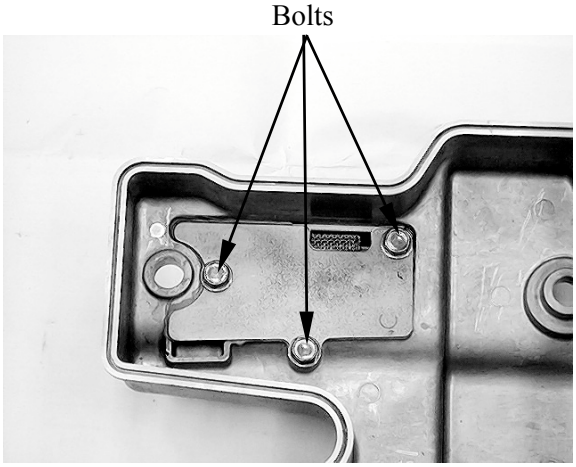
Remove the floorboard (page 2-6).
Remove the spark plug caps (page 8-4)
Disconnect the crankcase breather hose from the cylinder head cover (page 7-3).

Remove the four bolts and head cover.

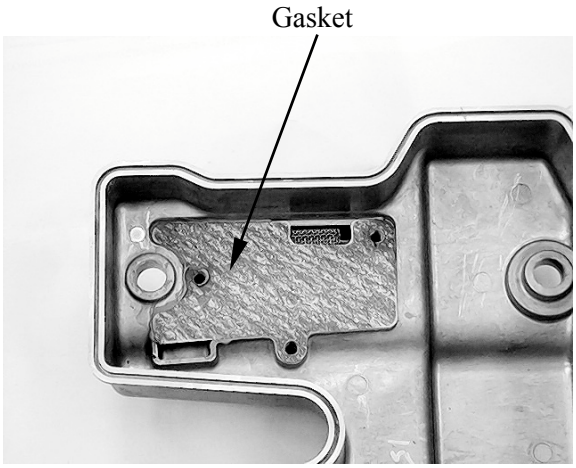


Remove the cylinder head cover packing.

Remove the bolts and breather separator.



Remove the gasket.



ASSEMBLY

Assembly is in the reverse order of disassembly.

Torque:

Breather separator bolt:

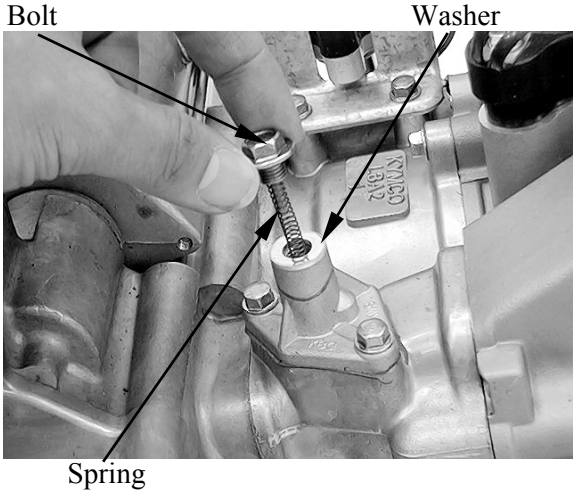
13 N•m (1.3 kgf•m, 9 lbf•ft)

CAMSHAFT REMOVAL

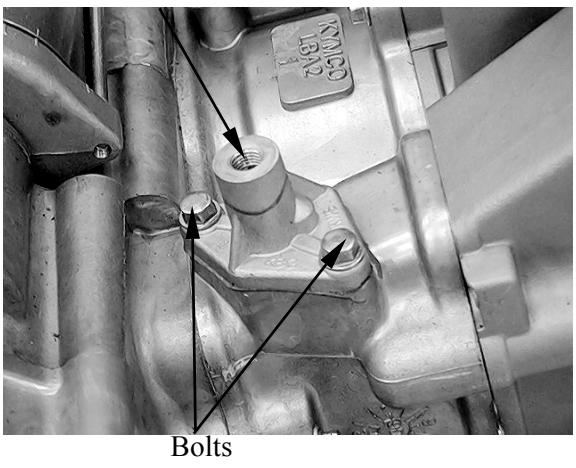
Remove the cylinder head cover (page 8-5).

Turn the crankshaft clockwise and align the "T" mark on the flywheel with the index mark on the right crankcase cover (page 3-9).

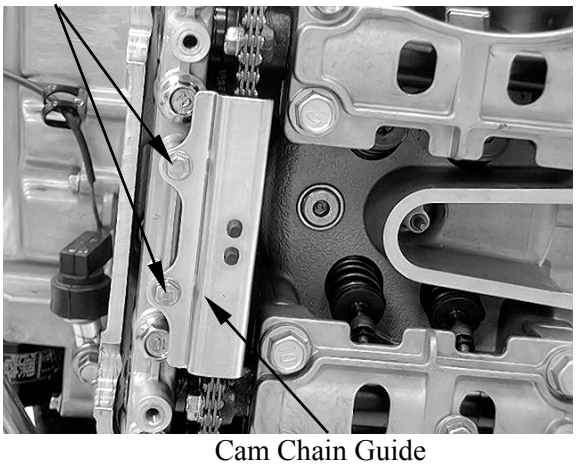
Remove the cam chain tensioner lifter sealing bolt, spring and sealing washer.



Remove the two bolts, cam chain tensioner and gasket.

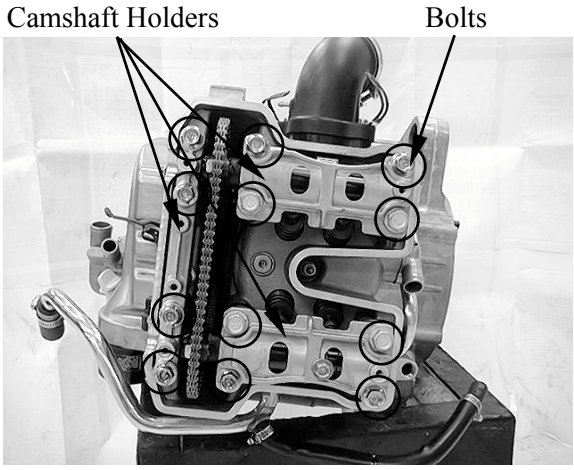


Remove the two bolts and cam chain guide.

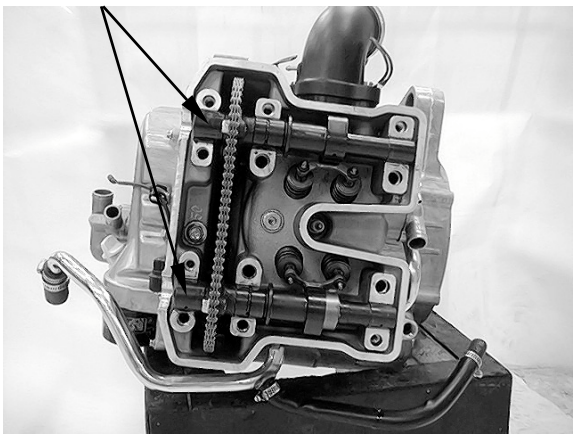


Loosen and remove the twelve camshaft holder bolts in a crisscross pattern in several steps, then remove the camshaft holders.

* Suspend the cam chain with a piece of wire to prevent the chain from falling into the crankcase.



Remove the camshafts



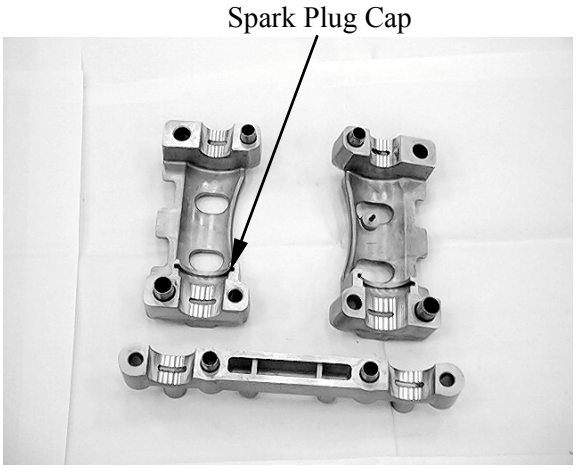
INSPECTION

Cam chain guide

Inspect the am chain slipper surface of the cam chain guide for wear or damage.

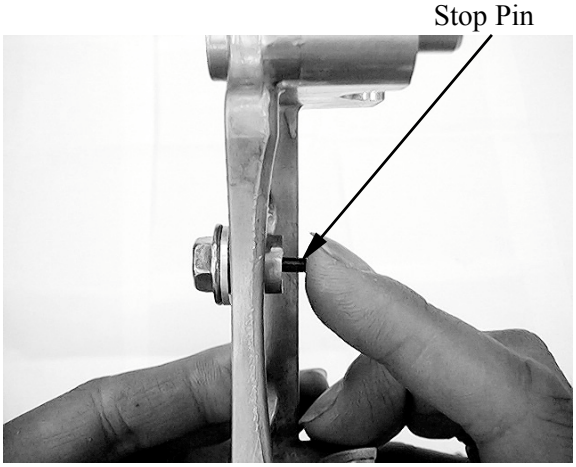
Camshaft holder

Inspect the bearing surface of each camshaft holder for scoring, scratches, or evidence of insufficient lubrication.



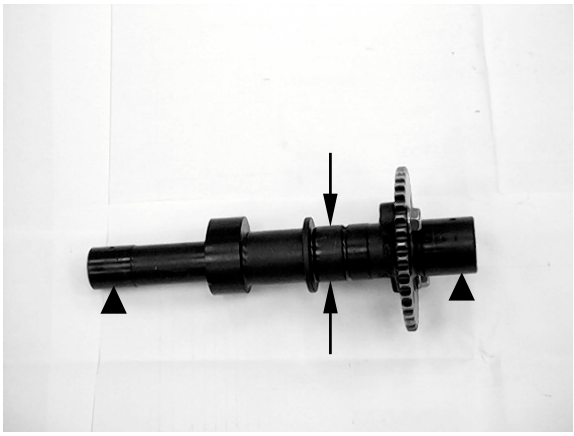
Check the stop pin spring on the exhaust camshaft holder for damage.

Replace the stop pin assembly with a new one if the spring is damage.



Camshaft
Support both ends of the camshaft with V-blocks and check the camshaft runout with a dial gauge.

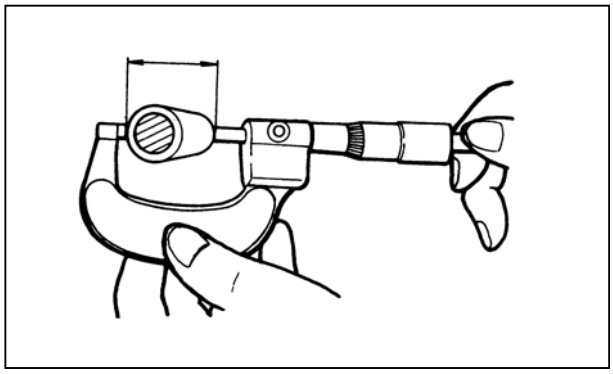
Service limit: 0.05 mm (0.002 in)



Inspect camshaft lobes for pitting/scratches/blue discoloration.

Measure the cam lobe height.
Service Limits: IN : 37.11 mm (1.4844 in)
EX: 36.86 mm (1.4744 in)

If any defects are found, replace the camshaft with a new one, then inspect lubrication system.

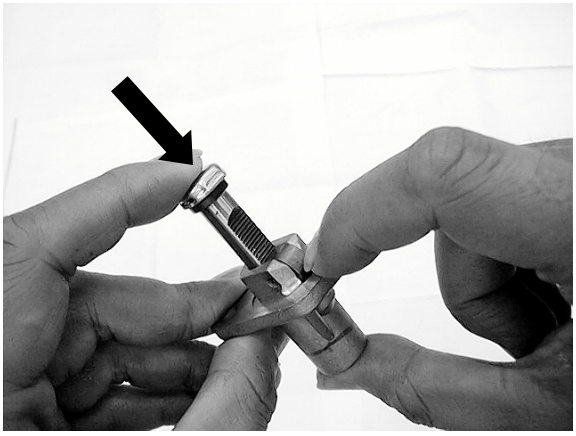


Check the decompression system by turning the decompressor cam on the exhaust camshaft.
You should be able to turn the decompressor cam clockwise smoothly, but the decompressor should not turn counterclockwise.

Cam chain tensioner

Check the one-way cam operation (tensioner)

Unsmooth operation → Replace.

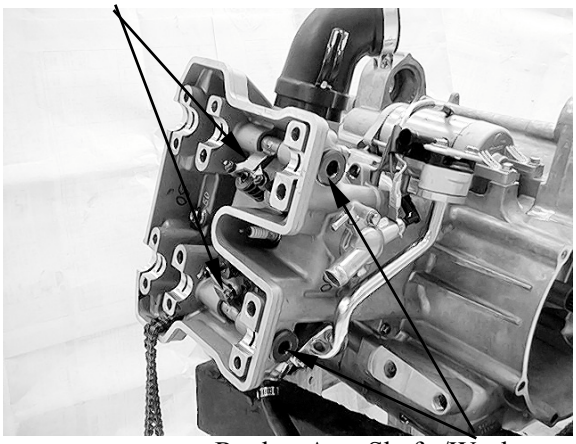


ROCKER ARMS REMOVAL

Remove the camshaft (page 8-6)

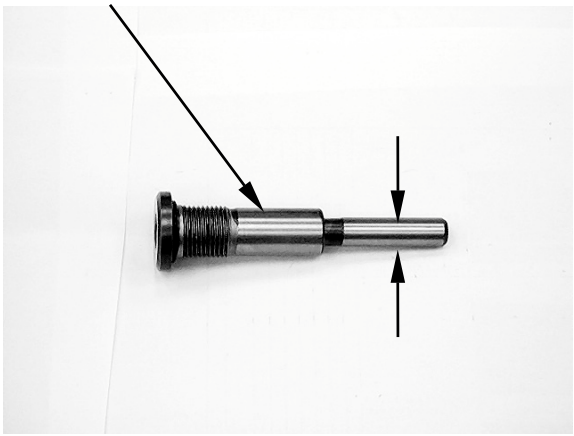
Remove the rocker arm shafts and washers, then remove the rocker arms.

Rocker Arms



Rocker Arm Shafts/Washers

Rocker Arm Shaft



INSPECTION

Rocker arm shaft

Inspect the rocker arm shaft for blue discoloration or grooves.

If any defects are found, replace the rocker arm shaft with a new one, then inspect lubrication system.

Measure each rocker arm shaft O.D.

Measure the I.D. of each rocker arm.

Measure arm to shaft clearance.

Replace as a set if out of specification.

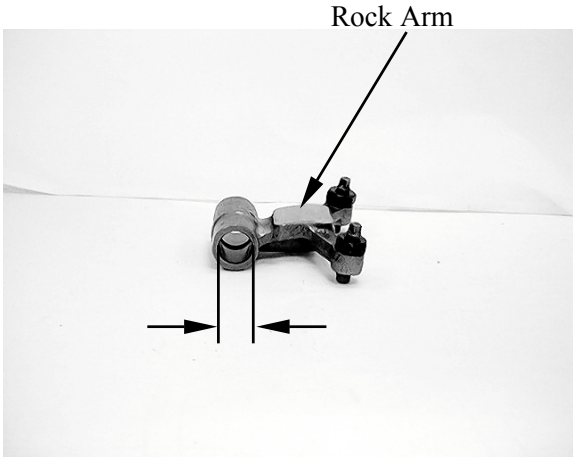
Service limits: 0.1 mm (0.004 in)

Inspect the rocker arm bore, cam lobe contact surface and adjuster surface for wear/pitting/scratches/blue discoloration.

If any defects are found, replace the rocker arm shaft with a new one, then inspect lubrication system.

Measure each rocker arm shaft O.D.
Measure the I.D. of each rocker arm.
Measure arm to shaft clearance.
Replace as a set if out of specification.

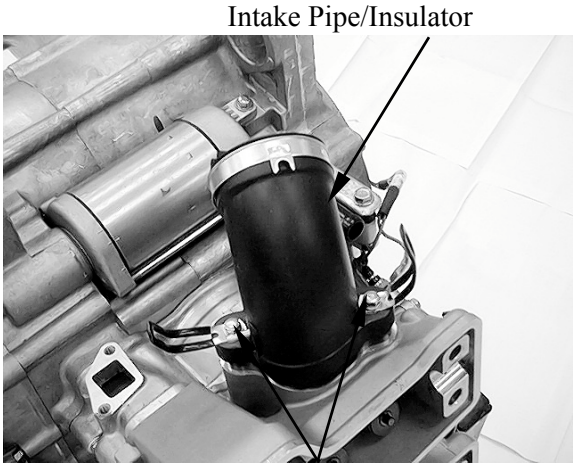
Service limits: 0.1 mm (0.004 in)



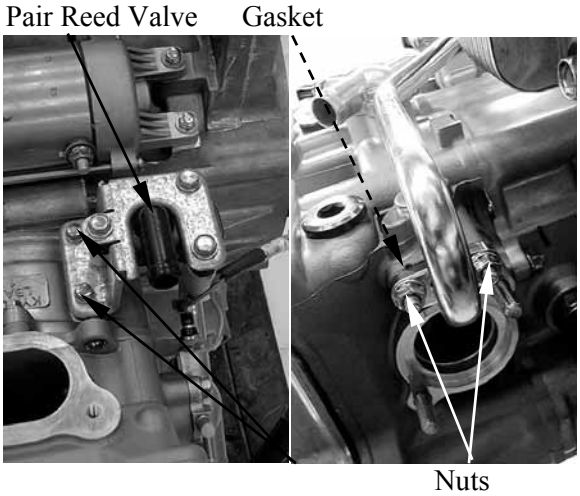
CYLINDER HEAD REMOVAL

Remove the rock arms (page 8-10).

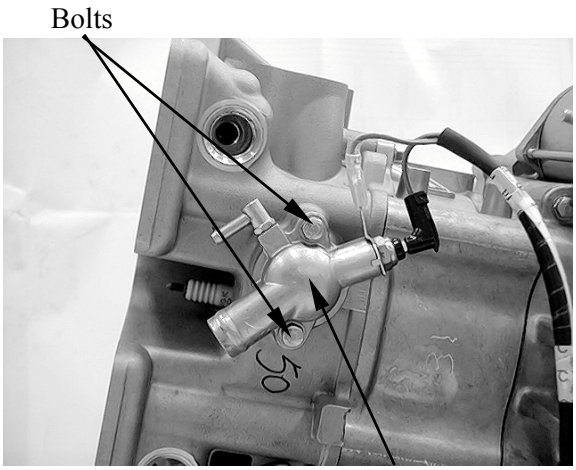
Remove the two bolts, intake pipe and insulator.



Remove the two bolts, two nuts, pair reed valve and gasket.

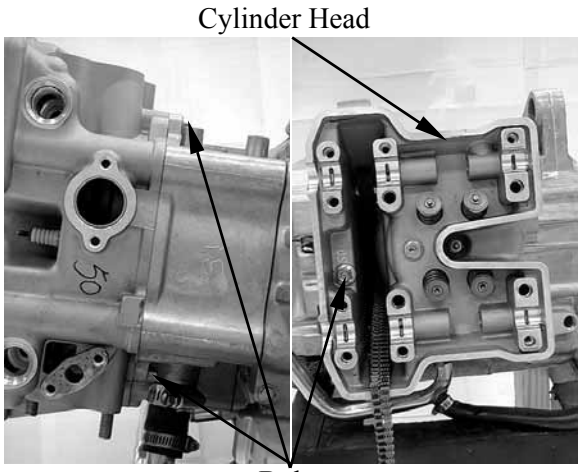


Remove the two bolts, water joint, gasket and water stop collar.

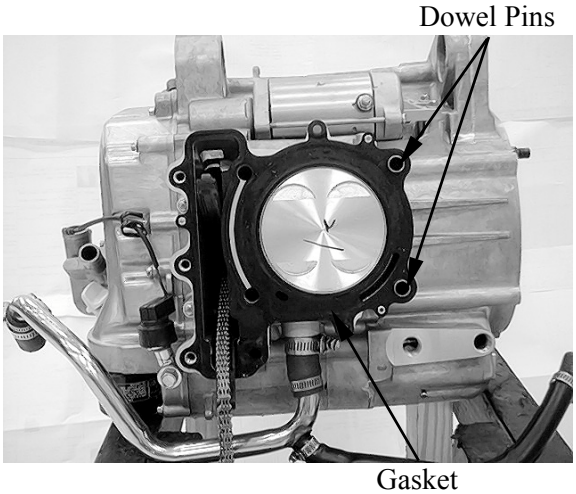


Water Joint/Gasket/Water Stop Collar

Remove the three bolts and cylinder head.



Remove the dowel pins and cylinder head gasket.

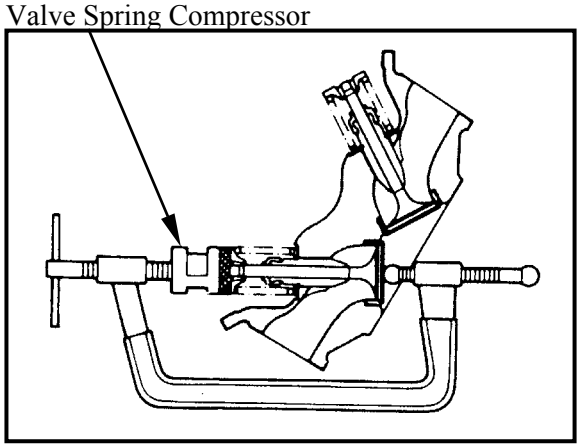


DISSASEMBLY
CYLINDER HEAD DISASSEMBLY

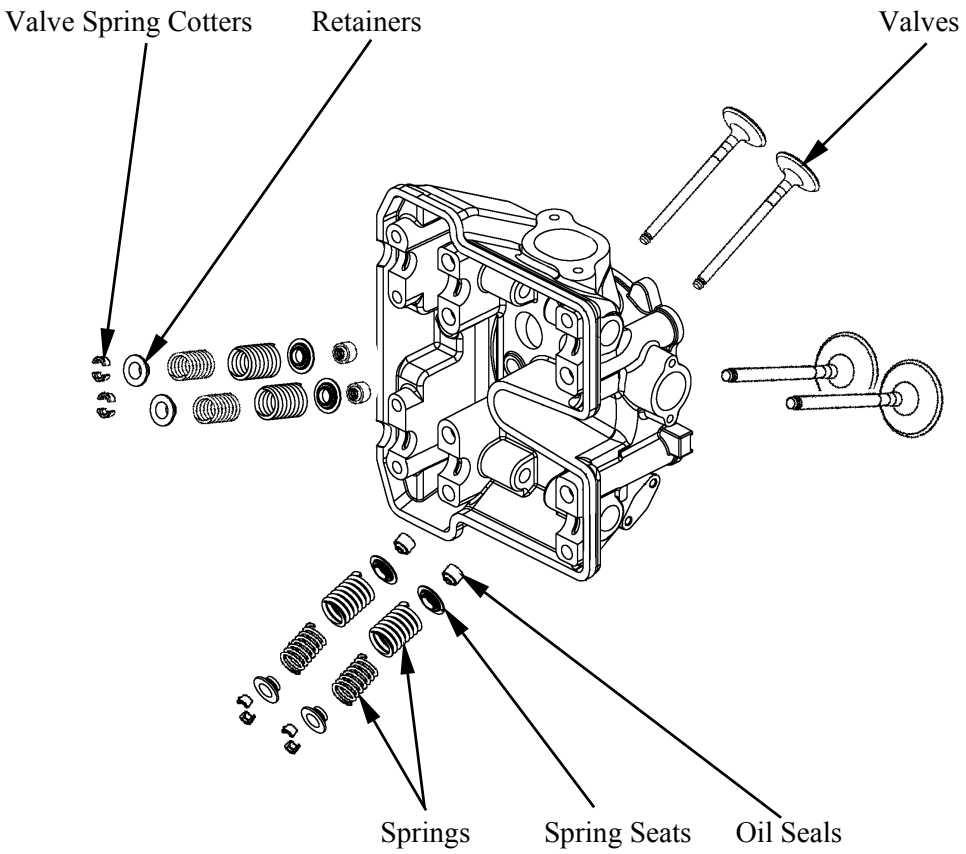
Remove the valve spring cotters, retainers, springs, spring seats, oil seals and valves using a valve spring compressor.

*
- Be sure to compress the valve springs with a valve spring compressor.
- Mark all disassembled parts to ensure correct reassembly.

Valve Spring Compressor



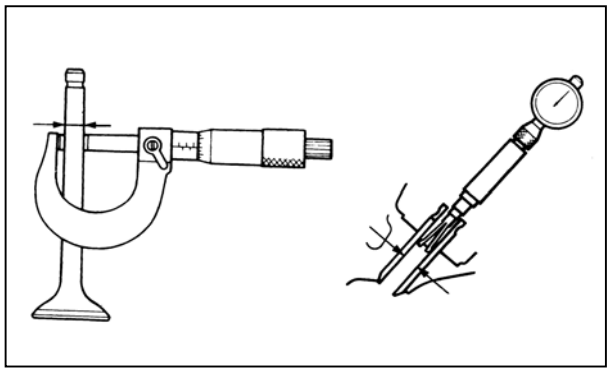
Special tool:
Valve Spring Compressor E040



8. CYLINDER HEAD/VALVES

VALVE /VALVE GUIDE INSPECTION

Inspect each valve for bending, burning, scratches or abnormal stem wear.
If any defects are found, replace the valve with a new one.



Check valve movement in the guide.

Measure each valve stem O.D.

Measure each valve guide I.D.

Subtract each valve stem O.D. from the corresponding guide I.D. to obtain the stem-to-guide clearance.

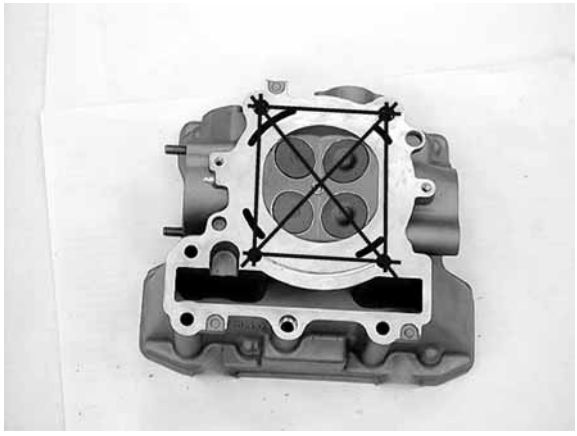
Service limits:

IN: 0.08 mm (0.0032 in)
EX: 0.1 mm (0.004 in)

* If the stem-to-guide clearance exceeds the service limits, replace the cylinder head is necessary.

CYLINDER HEAD INPECTION

Check the spark plug hole and valve areas for cracks.

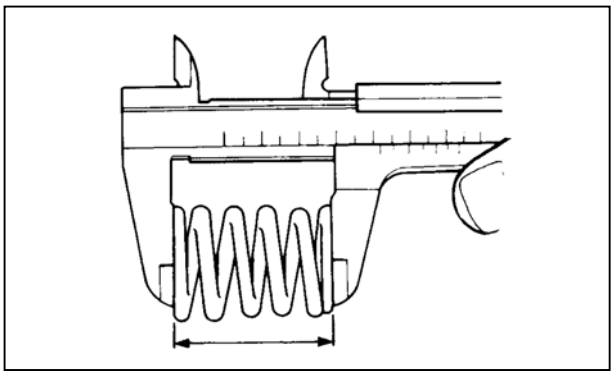


Check the cylinder head for warpage with a straight edge and feeler gauge.

Service Limit: 0.05 mm (0.002 in)

VALVE SPRING INSPECTION

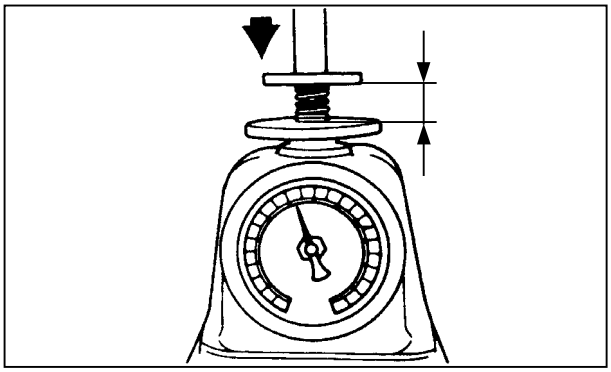
Measure the free length of the inner and outer valve springs.



Service Limit: Inner: 35.2 mm (1.408 in)
Outer: 39.8 mm (1.592 in)

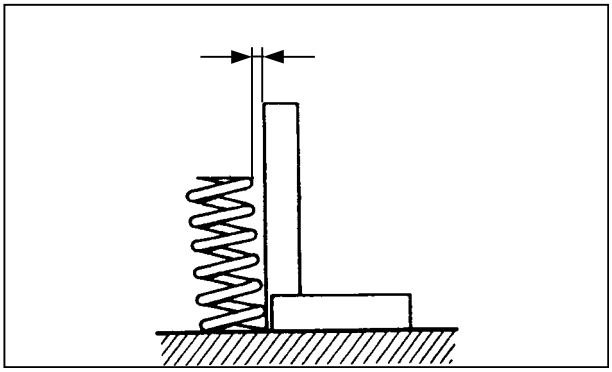
Measure compressed force (valve spring) and installed length.
Replace if out of specification.

Standard:
Inner: 3.5 kg (at 28.7 mm, 1.148 in)
Outer: 13 kg (at 31.43 mm, 1.2572 in)



Measure the spring tilt.
Replace if out of specification.

Standard: Inner: 1.2 mm (0.048)
Outer: 1.2 mm (0.048)



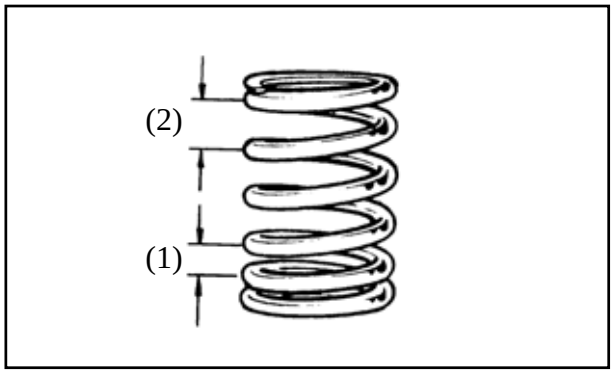
ASSEMBLY

Install the valve spring seats and oil seal.

✳ Be sure to install new oil seal.

Lubricate each valve with engine oil and insert the valves into the valve guides.

Install the valve springs with the small-pitch portion (1) facing cylinder head. (2) Large-pitch portion.

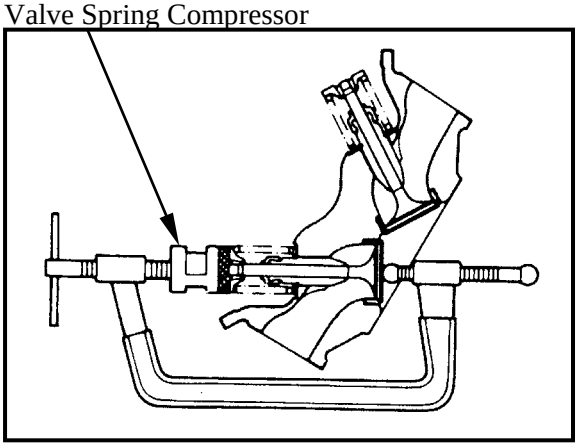


Put on the valve sparing retainers.
Compress the valve springs using the valve spring compressor, then install the valve cotters.

✳
- When assembling, a valve spring compressor must be used.
- Install the cotters with the pointed ends facing down from the upper side of the cylinder head.

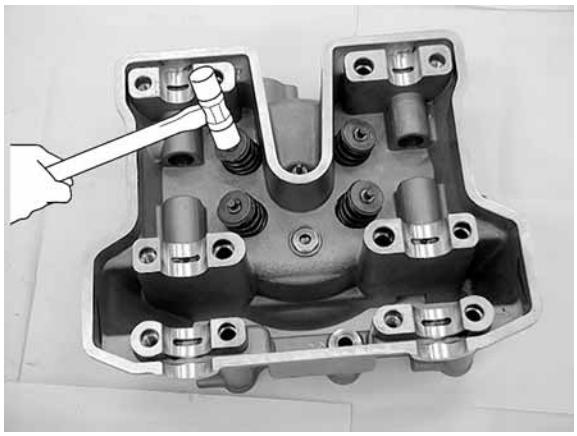
Special tool:
Valve Spring Compressor E040

Valve Spring Compressor



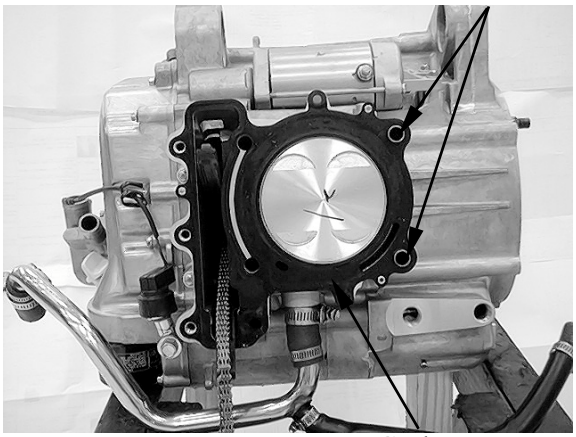
Tap the valve stems gently with a plastic hammer for 2～3 times to firmly seat the cotters.

* Be careful not to damage the valves.



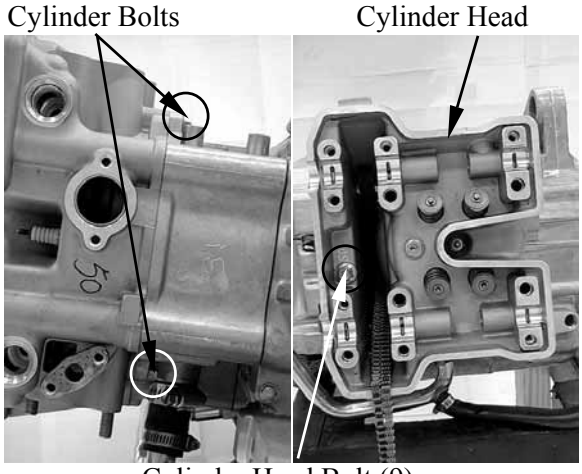
CYLINDER HEAD INSTALLATION

Install the dowel pins and new cylinder head gasket as shown.



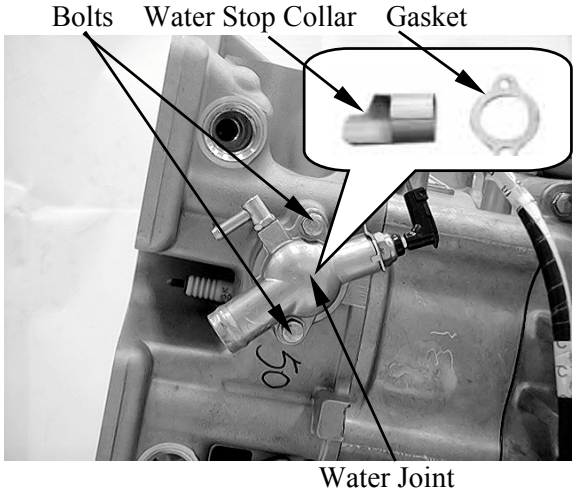
Install the cylinder head.

Apply engine oil to the cylinder head bolt (9) threads.
Install the two cylinder bolts and cylinder head bolt (9) but do not tighten them.

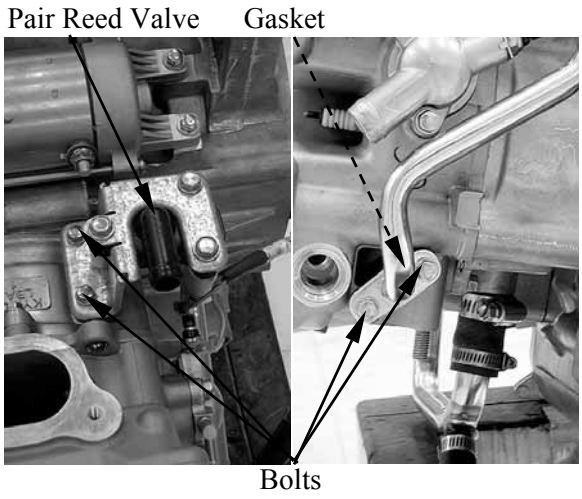


Install the water stop collar, gasket and water joint.
Install and tighten the two bolts to the specified torque.

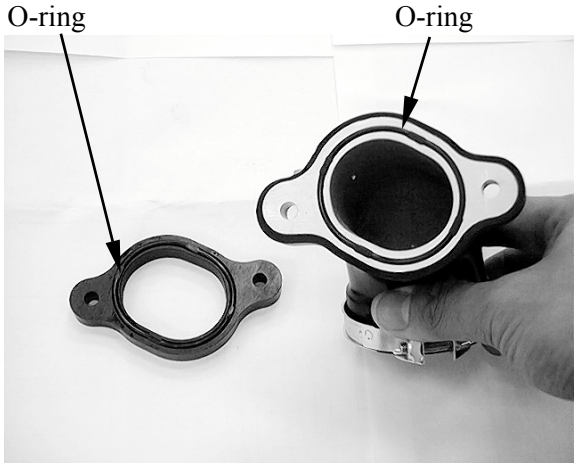
Torque: 12 N•m (1.2 kgf•m, 9 lbf•ft)



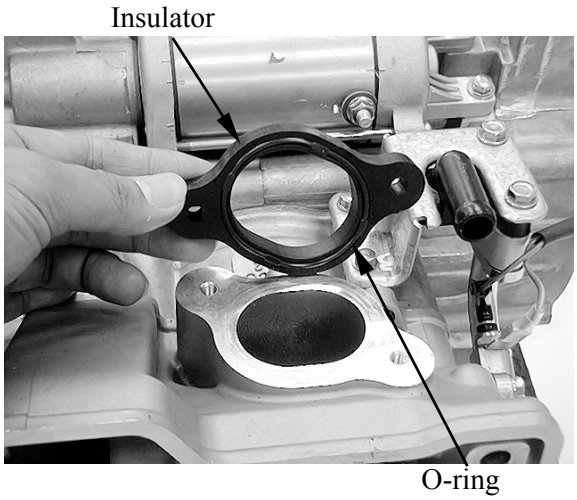
.
Install gasket and pair reed valve.
Install and tighten the four bolts securely.



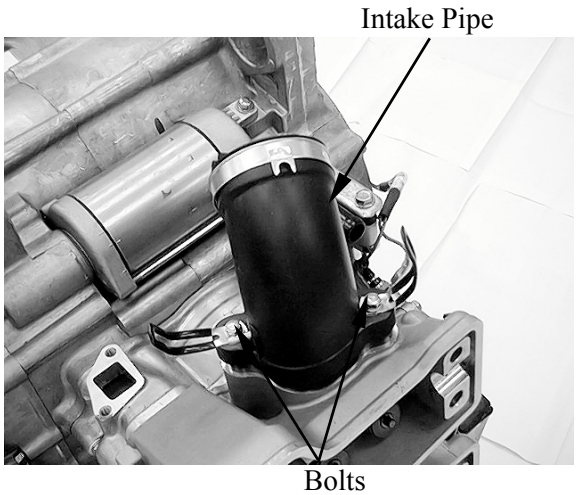
Install the new O-rings onto the insulator and intake pipe.



Install the insulator with the O-ring face the cylinder head.



Install the intake pipe and tighten the two bolts securely.

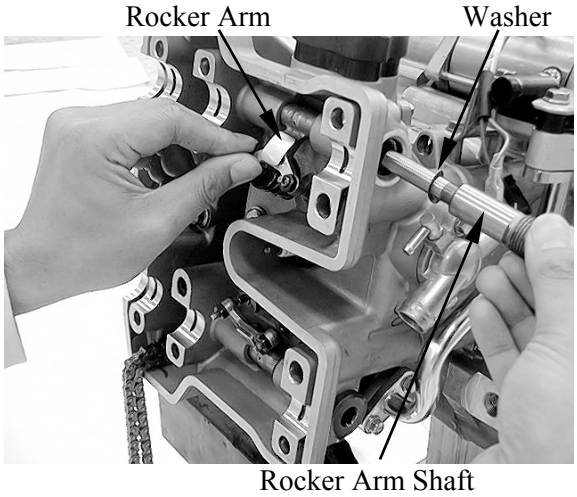


ROCKER ARM INSTALLATION

Apply engine oil to the rocker arms and rocker arm shafts

Install the rocker arms, rocker arm shafts and washers.
Tighten the rocker arm shaft to the specified torque.

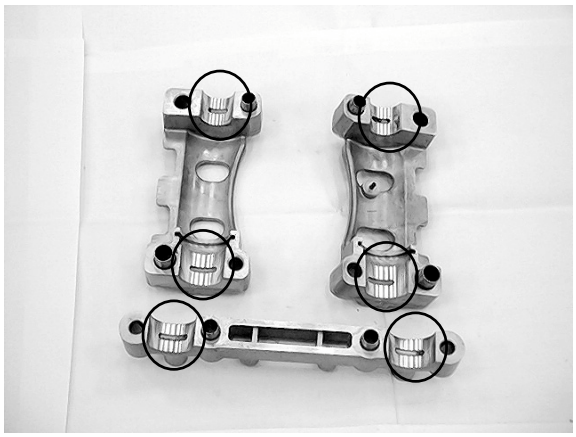
Torque: 45 N•m (4.5 kgf•m, 32 lbf•ft)



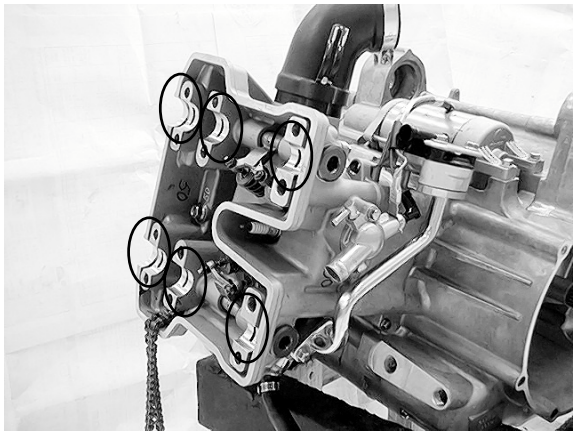
CAMSHAFT INSTALLATION

Turn the crankshaft clockwise, align the "T" mark on the flywheel with the index mark on the right crankcase cover (page 3-9).

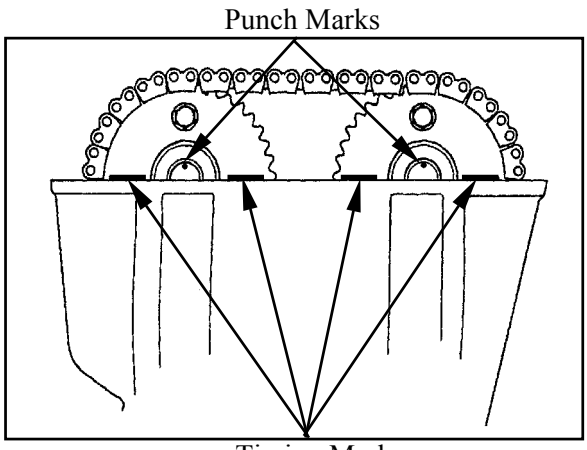
Apply molybdenum disulfide oil to the camshaft journals of the camshaft holder.



Apply molybdenum disulfide oil to the camshaft journals of the cylinder head.



Install the cam chain over the cam sprockets and then install the intake and exhaust camshafts.



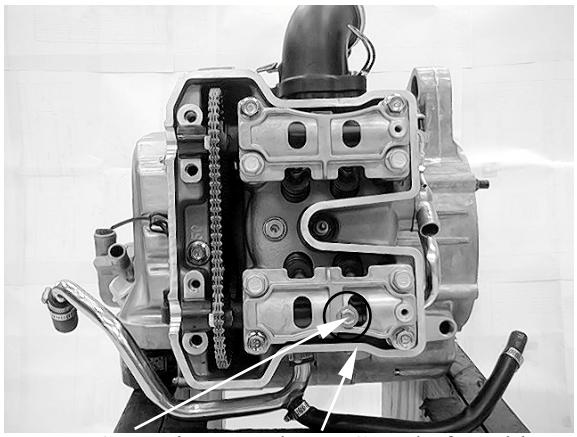
* ♦ Install each camshafts to the correct locations.
  "IN": no decompressor cam
  "EX": has a decompressor cam (page 8-9)
  ♦ Make sure the timing marks on the cam sprockets are flush with the cylinder head upper surface and punch marks face upward as shown.

Install intake and exhaust camshaft holders to the correct locations.

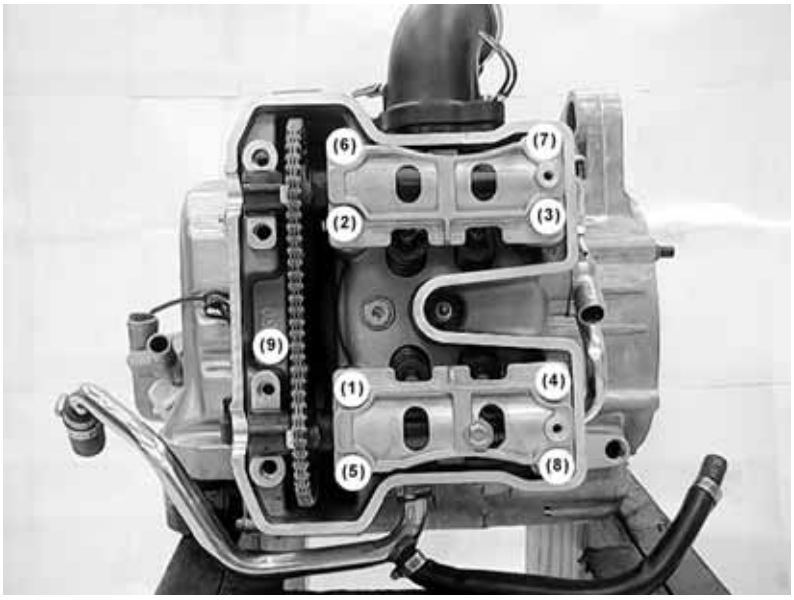
* Install each camshaft holders to the correct locations.
"IN": no stop pin.
"EX": has a stop pin.

Apply engine oil to cylinder head bolt (No. 1 – 9) threads.

Install and tighten the holder bolts (No. 1 – 9) in a crisscross pattern in four steps to the specified torque as follow diagram.


Stop Pin Exhaust Camshaft Holder

	Tighten the bolts to the specified torque in sequence N•m (kgf•m, lbf•ft)								
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Step 1	18 (1.8, 13)	←	←	←	12 (1.2, 9)	←	←	←	←
Step 2	48 (4.8, 35)	←	←	←	23 (2.3, 17)	←	←	←	←

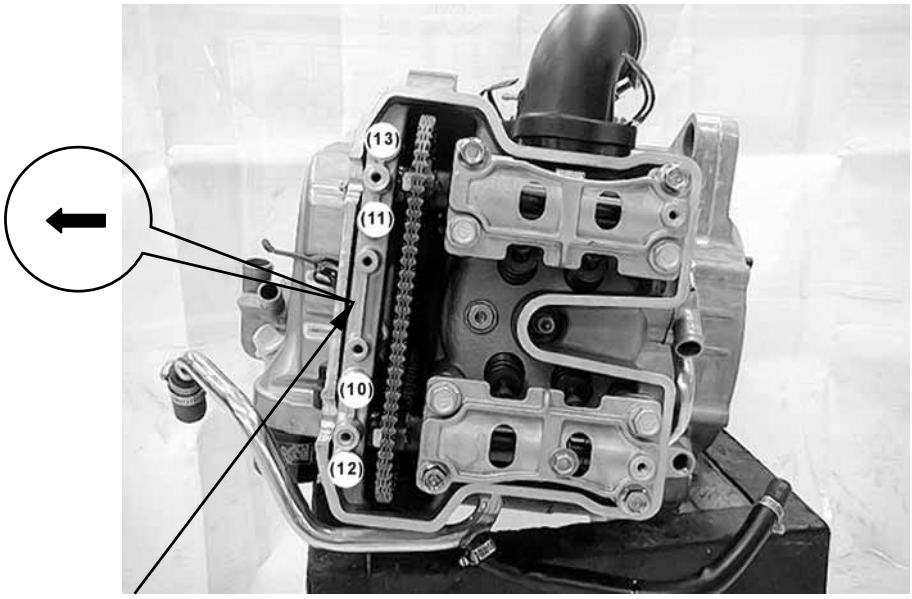


Install the common camshaft holder by arrow mark facing outside.

Install and tighten the holder bolts (No. 10 – 13) in a crisscross pattern in four steps to the specified torque as follow diagram.

* Apply engine oil to cylinder head bolt (No. 10 – 13) threads.

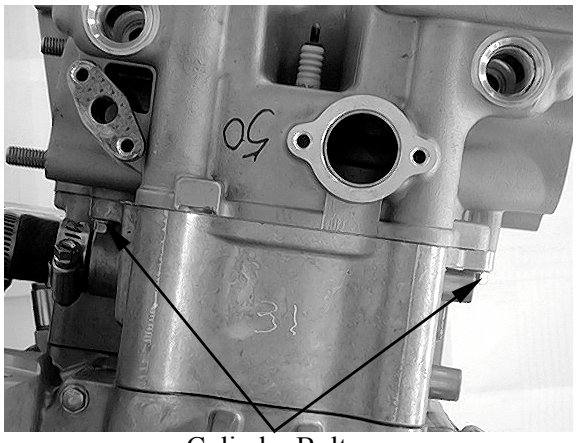
	Tighten the bolts to the specified torque in sequence N•m (kgf•m, lbf•ft)								
	(10)	**(11)**	**(12)**	**(13)**					
Step 1	12 (1.2, 9)	←	←	←					
Step 2	23 (2.3, 17)	←	←	←					



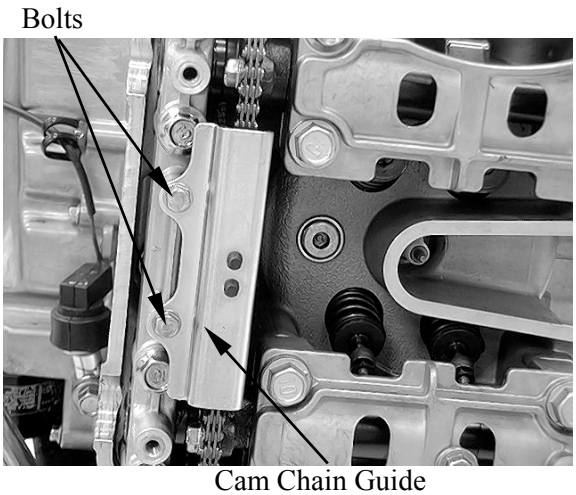
"Arrow" Mark

Tighten the two cylinder bolts to the specified torque.

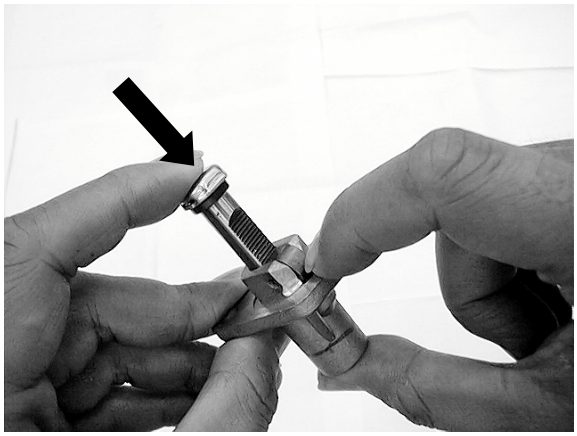
Torque: 10 N•m (1 kgf•m, 7 lbf•ft)


Cylinder Bolts

Install the cam chain guide and tighten the two bolts securely.

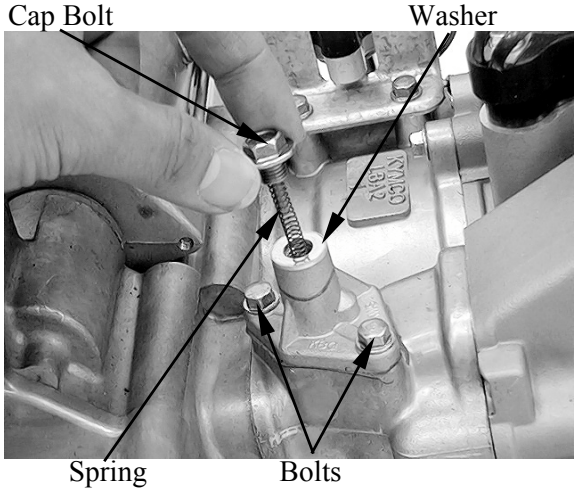


Release the timing chain tensioner one-way cam and push the tensioner rod all the way in.



Install the tensioner with a new gasket onto the cylinder.
Install and tighten the tensioner bolts to specified torque.

Torque: 12 N•m (1.2 kgf•m, 9 lbf•ft)



Install the spring, washer and timing chain tensioner cap bolt to specified torqur.

Torque: 10 N•m (1 kgf•m, 9 lbf•ft)

Adjust the valve clearance (page 3-9).

CYLINDER HEAD COVER INSTALLATION

Install the cylinder head packing into the groove of the cylinder head cover.

Install the cylinder head cover onto the cylinder head and tighten the cylinder head cover bolts to the specified torque.

Torque: 10 N•m (1 kgf•m, 7 lbf•ft)