

## Camshaft, Camshaft Chain

### Camshaft, Camshaft Cap Wear Inspection

The journal wear is measured using plastigage (press gauge), which is inserted into the clearance to be measured. The plastigage indicates the clearance by the amount it is compressed and widened when the parts are assembled.

- Cut strips of plastigage to journal width. Place a strip on each journal parallel to the camshaft with the camshaft installed in the correct position and so that the plastigage will be compressed between the journal and camshaft cap.

[A] Plastigage Strip

- Install the camshaft caps, tightening the bolts in the correct sequence.

**Torque - Camshaft Cap Bolts: 12 N·m (1.2 kgf·m, 104 in·lb)**

### NOTE

- Do not turn the camshaft when the plastigage is between the journal and camshaft cap.
- Remove the camshaft caps again, and measure the plastigage width [A] to determine the clearance between each journal and camshaft cap. Measure the widest portion of the plastigage.
- ★ If any clearance exceeds the service limit, measure the camshaft journal diameter and the camshaft bearing inside diameter.
- ★ If any of the measurements is beyond the service limit, replace the worn part and check the clearance again.

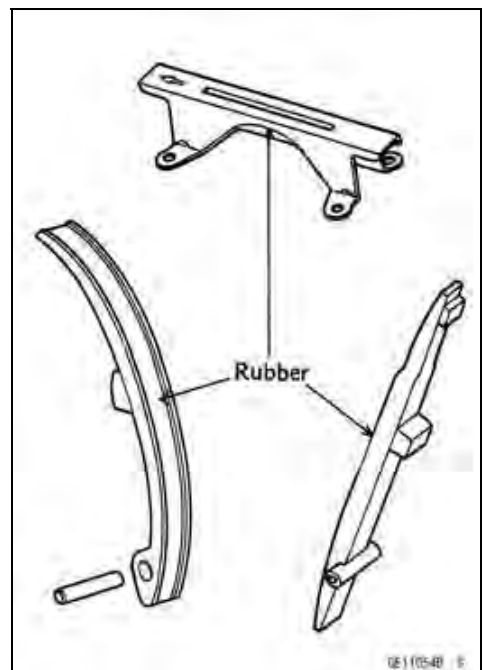
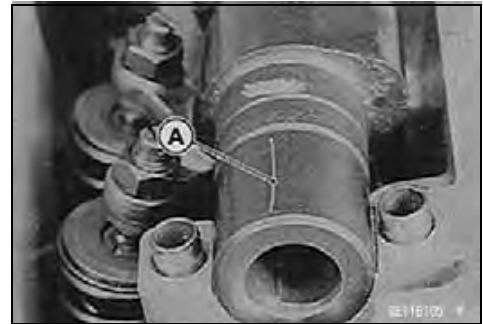
### Camshaft Journal, Camshaft Cap Clearance

**Standard: 0.030 ~ 0.071 mm (0.0012 ~ 0.0028 in.)**

**Service Limit: 0.16 mm (0.006 in.)**

### Camshaft Chain Guide Wear Inspection

- Visually inspect the rubber [A] on the guides.
- ★ If the rubber is damaged or cut, replace the guides.

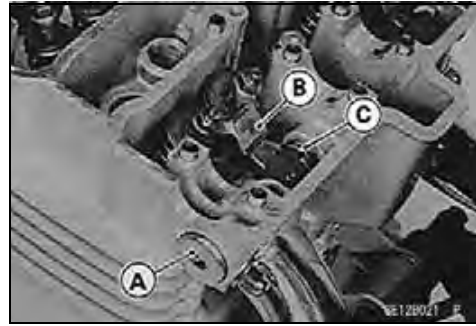


## 4-16 ENGINE TOP END

### Rocker Shaft, Rocker Arm

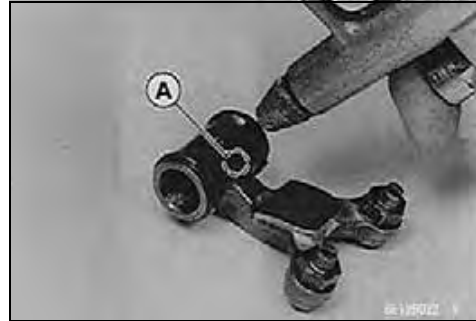
#### Rocker Shaft, Rocker Arm Removal

- Remove the camshafts (see Camshaft Removal).
- Unscrew the rocker shafts [A] and remove the rocker arms [B] and springs [C].
- Mark and record the rocker arm locations so that the rocker arm can be reinstalled in their original positions.



#### Rocker Shaft, Rocker Arm Installation

- Blow the rocker arm oil passage [A] clean with compressed air.
- Apply engine oil to all the rocker arms and the rocker shafts.



- Install the retainer spring [A] on each rocker arm so that the spring is placed to the camshaft chain side.
- Check that the O-rings are in good condition and install the O-rings onto the rocker shafts.
- Insert the shaft running it through the cylinder head, rocker arms and springs.
- Tighten the rocker shafts.

**Torque - Rocker Shafts: 39 N·m (4.0 kgf·m, 29 ft·lb)**

Install the camshaft (see Camshaft Installation).

- Check the chain timing.



## Oil Pipe

### Cylinder Head Oil Pipe Removal

- Remove the oil pipe mounting bolts [A] and pull the oil pipes [B] and O-rings out of the cylinder head.

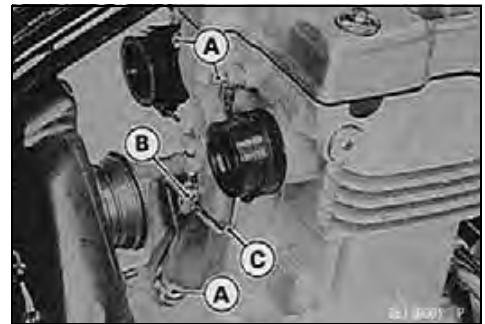


### Cylinder Head Oil Pipe Installation

- Flush out the oil pipes with a high-flash point solvent.
- Check that the O-rings are in good condition.
- ★ If they are damaged, replace them with new ones.
- Apply a small amount of oil to the O-rings.
- Fix the oil pipes properly into the cylinder head oil passage holes by pushing both ends at the same time.
- Install the oil pipe mounting bolts.

### Main Oil Pipe Removal

- Remove:
  - Carburetor (see Carburetor Removal in the Fuel System chapter)
  - Starter Motor (see Starter Motor Removal in the Electrical System chapter)
- Unscrew the banjo bolts [A] and mounting bolt [B].
- Remove the oil pipe [C].



### Main Oil Pipe Installation

- Flush out the oil pipes with a high-flash point solvent.
- Discard the used gaskets and install new gaskets on each side of the pipe fittings.
- Tighten the banjo bolts and mounting bolt to a snug fit, and then tighten them to the specified torque.

**Torque - Main Oil Pipe Upper Banjo Bolts:** 12 N·m (1.2 kgf·m, 104 in·lb)

**Main Oil Pipe Lower Banjo Bolt:** 20 N·m (2.0 kgf·m, 14.5 ft·lb)

**Main Oil Pipe Mounting Bolt:** 11 N·m (1.1 kgf·m, 95 in·lb)

## 4-18 ENGINE TOP END

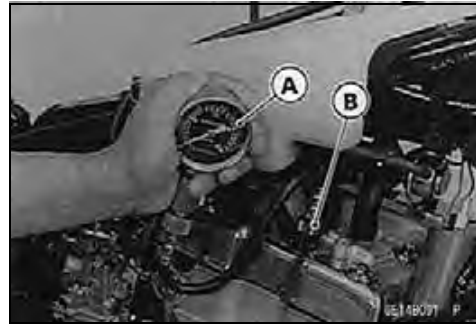
### Cylinder Head

#### Compression Measurement

- Remove the seat (see Seat Removal in the Frame chapter).
- Thoroughly warm up the engine so that the engine oil between the piston and cylinder wall will help seal compression as it does during normal running.
- Stop the engine, remove the fuel tank, ignition coil and spark plugs, and attach the compression gauge firmly into the spark plug hole.

**Special Tools - Compression Gauge, 20 kgf/cm<sup>2</sup> [A]: 57001-221**

**Compression Gauge Adapter, M12 × 1.25 [B]: 57001-1183**



- Measure the cylinder compression.
- Using the starter motor, turn the engine over with the throttle fully open until the compression gauge stops rising; the compression is the highest reading obtainable.

#### NOTE

- Be sure the battery is fully charged.
- Be sure no air leaks out of the cylinder head gasket.

#### Cylinder Compression (Usable Range)

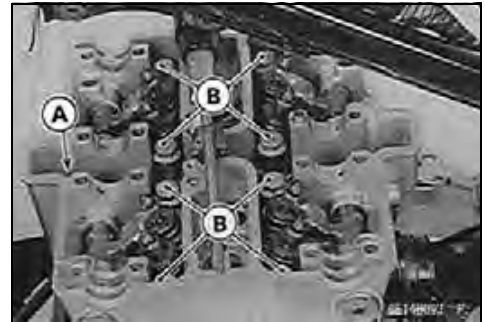
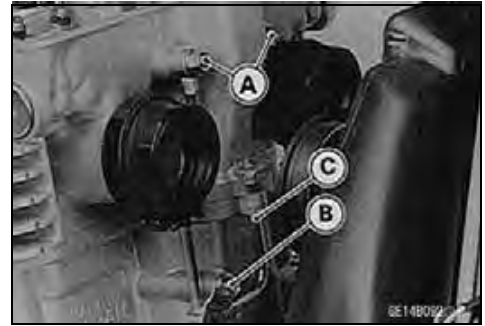
**961 ~ 1 471 kPa (9.8 ~ 15.0 kgf/cm<sup>2</sup>, 139 ~ 213 psi) @410 r/min (rpm)**

- Repeat the measurement for the other cylinder.
- ★ If cylinder compression is higher than the usable range, check the following:
  1. Carbon build-up on the piston head and cylinder head.
    - clean off any carbon on the piston head and cylinder head.
  2. Cylinder head gasket, cylinder base gasket - use only the proper gaskets for the cylinder head and base. The use of gaskets of the incorrect thickness will change the compression.
  3. Valve stem oil seals and piston rings - rapid carbon accumulation in the combustion chambers may be caused by damaged valve stem oil seals and/or damaged piston oil rings. This may be indicated by white exhaust smoke.
- ★ If cylinder compression is lower than the usable range, check the following:
  1. Gas leakage around the cylinder head - replace the damaged gasket and check the cylinder head for warping.
  2. Condition of the valve seating.
  3. Valve clearance - if a valve requires an unusually large adjustment to obtain proper clearance, the valve may be bent, and not seating completely.
  4. Piston/cylinder clearance, piston seizure.
  5. Piston ring, piston ring groove.

## Cylinder Head

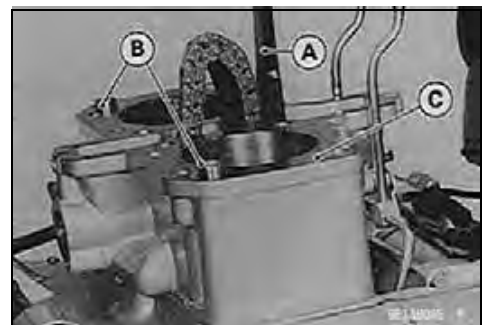
### Cylinder Head Removal

- Remove:
  - Cylinder Head Cover (see Cylinder Head Cover Removal)
  - Exhaust Pipes and Mufflers (see Exhaust Pipe, Muffler Removal)
  - Cam Chain Tensioner (see Chain Tensioner Removal)
  - Camshafts (see Camshaft Removal)
  - Carburetors (see Carburetor Removal in the Fuel System chapter)
- Remove the main oil pipe banjo bolts [A].
- Loosen the main oil pipe mounting bolt [B].
- Remove the rear 6 mm cylinder head bolt [C].
- Remove the front 6 mm cylinder head bolt [A] first, then remove the 10 mm cylinder head bolts [B]. This prevents excessive stress on the small bolts.
- Tap in the places shown with a mallet [A] to remove the cylinder head.



### Cylinder Head Installation

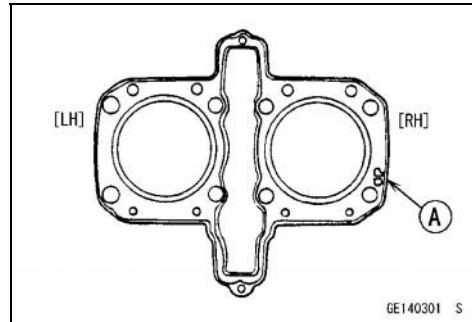
- Install the rear chain guide [A], knock pins [B] and gasket [C].



## 4-20 ENGINE TOP END

### Cylinder Head

- Install a new cylinder head gasket with “UP” [A] marked side positioning to the right.

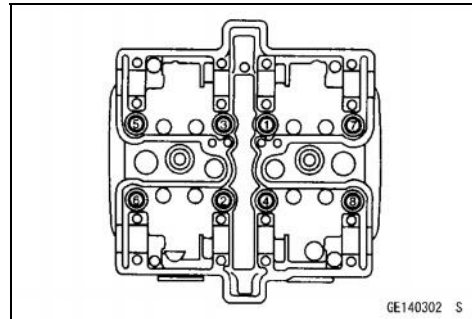


#### NOTE

- The camshaft caps are machined with the cylinder head so if a new cylinder head is installed, use the caps that are supplied with the new head.
- Tighten the 10 mm cylinder head bolts following the tightening sequence. Tighten them first to about one half of the specified torque.

**Torque - Cylinder Head Bolts 10 mm: 51 N·m (5.2 kgf·m, 38 ft·lb)**

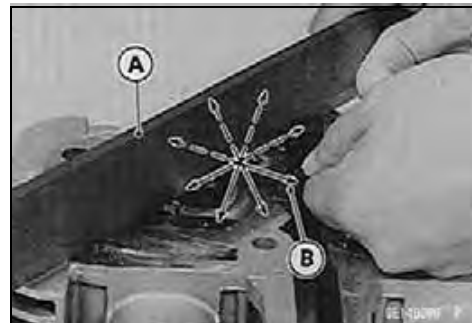
**Cylinder Head Bolts 6 mm: 9.8 N·m (1.0 kgf·m, 87 in·lb)**



- Tighten the 6 mm cylinder bolts.
- Install the camshafts, camshaft caps and top chain guide.
- Install the head oil pipes.

#### Cylinder Head Warp Inspection

- Clean the cylinder head (see Cylinder Head Cleaning).
  - Lay a straightedge [A] across the lower surface of the head at several different points, and measure warp by inserting a thickness gauge [B] between the straightedge and the head.
- ★ If warp exceeds the service limit, repair the mating surface. Replace the cylinder head if the mating surface is badly damaged.



#### Cylinder Head Warp

**Service Limit: 0.05 mm (0.002 in.)**

#### Cylinder Head Cleaning

- Remove the cylinder head (see Cylinder Head Removal).
- Remove the valves (see Valve Removal).
- Wash the head with a high-flash point solvent.
- Scrape [A] the carbon out of the combustion chamber and exhaust port with a suitable tool.

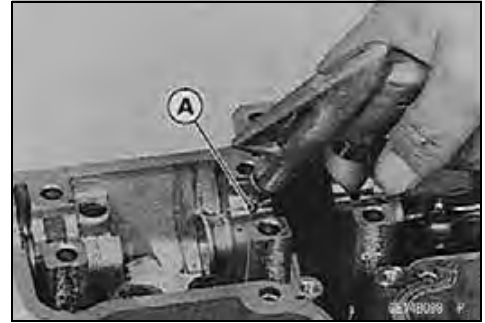


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**Cylinder Head**

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- Using compressed air, blow out any particles which may obstruct the oil passage [A] in the cylinder head.
- Install the valves (see Valve Installation).



## 4-22 ENGINE TOP END

### Valves

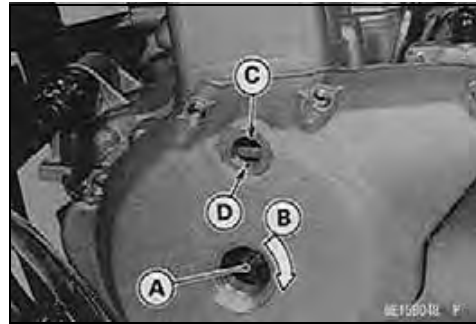
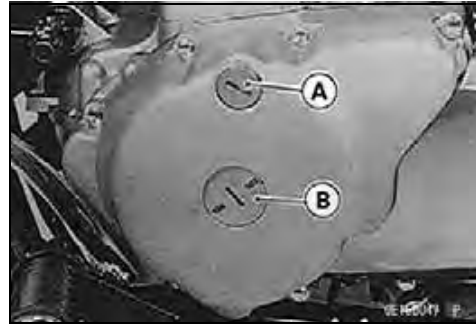
#### Valve Clearance Inspection

##### NOTE

- Valve clearance must be checked and adjusted when the engine is cold (room temperature).
- Remove the cylinder head cover (see Cylinder Head Cover Removal).
- Remove the cylinder head oil pipes (see Cylinder Head Oil Pipe Removal).
- Unscrew the upper [A] and lower [B] caps on the alternator cover.

**Special Tool - Filler Cap Driver: 57001-1454**

- Check the valve clearance when the pistons are at TDC.
- The pistons are numbered beginning with the engine left side.
- Using a wrench on the crankshaft rotation bolt [A], turn the crankshaft clockwise [B] until the "C" mark [C] on the rotor is aligned with the notch [D] in the edge of the upper hole in the alternator cover for #2 piston and "T" mark for #1 piston.



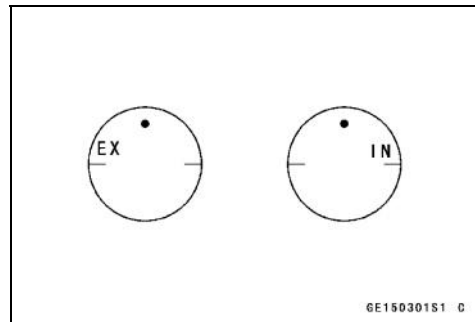
- Measure the valve clearance of the valves for which the cam lobe is pointing away from the rocker arm.
- Each piston has two inlet and two exhaust valves. Measure these two inlet or exhaust valves at the same crankshaft position.

##### Valve Clearance Measuring Position

**#2 Piston TDC at End of Compression Stroke →**

**Inlet valve clearances of #2 piston, and**

**Exhaust valve clearances of #2 piston**



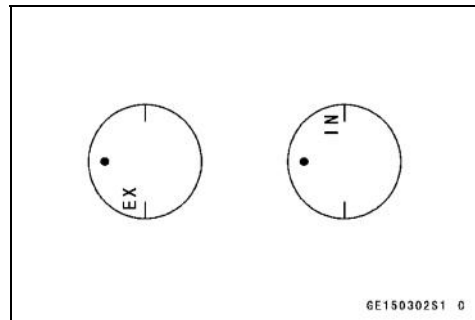
##### NOTE

- Check the valve clearance using this method only. Checking the clearance at any other cam position may result in improper valve clearance.

**#1 Piston TDC at End of Compression Stroke →**

**Inlet valve clearances of #1 piston, and**

**Exhaust valve clearances of #1 piston**





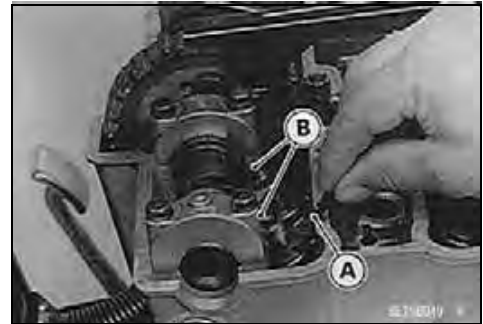
## Valves

- Measure the clearance of each valve by inserting a thickness gauge [A] between the adjusting screw [B] and the valve stem.

### Valve Clearance (when cold)

Inlet: 0.13 ~ 0.18 mm (0.0051 ~ 0.0070 in.)

Exhaust: 0.18 ~ 0.23 mm (0.0070 ~ 0.0091 in.)

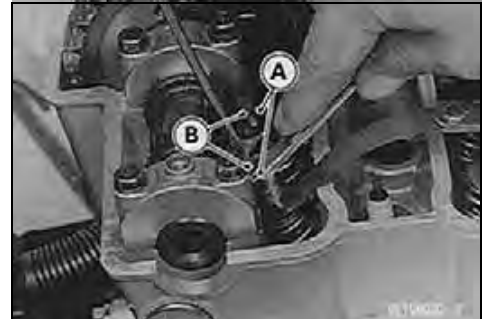


### Valve Clearance Adjustment

- ★ If the valve clearance is incorrect, loosen the locknut [A] and turn the adjusting screw [B] until the correct clearance is obtained.
- Tighten the locknut.

**Torque - Valve Adjuster Locknuts: 25 N·m (2.5 kgf·m, 18 ft·lb)**

- Install the two caps on the alternator cover.

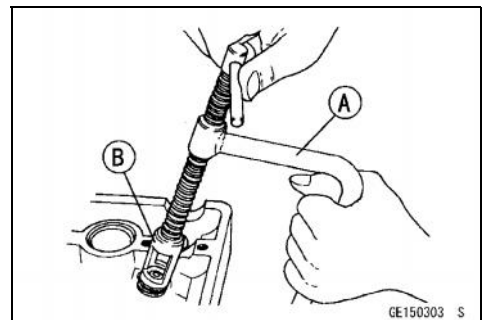


### Valve Removal

- Remove the cylinder head (see Cylinder Head Removal).
- Use a valve spring compressor assembly to press down the valve spring retainer, and remove the split keepers.

**Special Tools - Valve Spring Compressor Assembly [A]: 57001-241**

**Valve Spring Compressor Adapter,  $\phi 22$  [B]: 57001-1202**



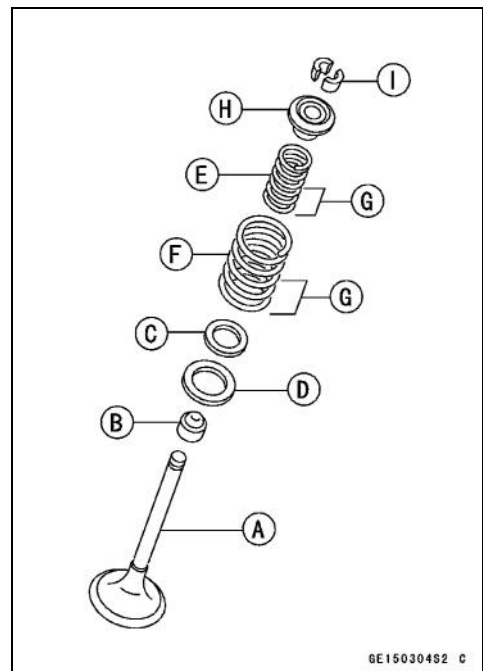
### Valve Installation

- Check to see that the valve [A] moves smoothly up and down in the guide.
- Check to see that the valve seats properly in the valve seat. If it does not, repair the valve seat.
- Replace the oil seal [B] with a new one.
- Apply a thin coat of molybdenum disulfide grease to the valve stem before valve installation.
- Be sure to install the inner [C] and outer [D] spring seats under the inner [E] and outer [F] springs.
- Install the springs so that the closed coil [G] end is facing toward the valve seat (downwards).
- Install the spring retainer [H], press it down with the valve spring compressor assembly, and fit the split keeper [I] into place.

**Special Tools - Valve Spring Compressor Assembly: 57001-241**

**Valve Spring Compressor Adapter,  $\phi 22$ : 57001-1202**

- Install the other removed parts.



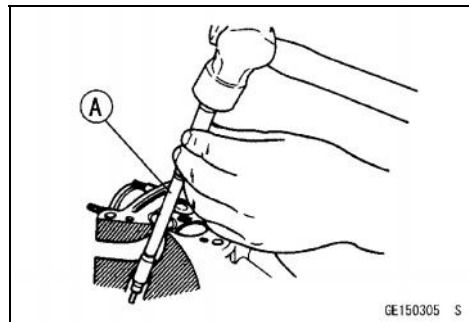
## 4-24 ENGINE TOP END

### Valves

#### Valve Guide Removal

- Remove:
  - Valve (see Valve Removal)
  - Oil Seal
  - Spring Seats
- Heat the area around the valve guide to about 120 ~ 150°C (248 ~ 302°F), and hammer lightly on the valve guide arbor [A] to remove the guide from the top of the head.

**Special Tool - Valve Guide Arbor,  $\phi 5.5$ : 57001-1021**



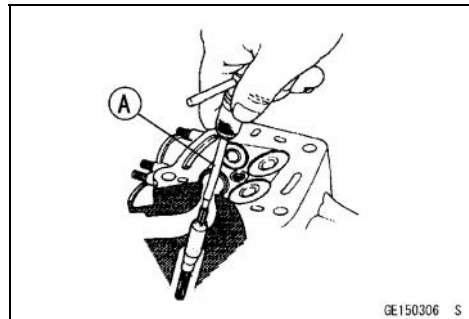
#### Valve Guide Installation

- Apply oil to the valve guide outer surface before installation.
- Heat the area around the valve guide hole to about 120 ~ 150°C (248 ~ 302°F).
- Drive the valve guide in from the top of the head using the valve guide arbor. The flange stops the guide from going in too far.

**Special Tool - Valve Guide Arbor,  $\phi 5.5$ : 57001-1021**

Ream the valve guide with a valve guide reamer [A] even if the oil guide is reused.

**Special Tool - Valve Guide Reamer,  $\phi 5.5$ : 57001-1020**



#### Valve Seat Inspection

- Remove the valve (see Valve Removal).
- Check the valve seating surface [A] between the valve [B] and valve seat [C].
- Coat the valve seat with machinist's dye.
- Push the valve into the guide.
- Rotate the valve against the seat with a lapping tool.
- Pull the valve out, and check the seating pattern on the valve head. It must be the correct width and even all the way around.
- Measure the outside diameter [D] of the seating pattern on the valve seat.
- ★ If the outside diameter of the valve seating pattern is too large or too small, repair the seat (see Valve Seat Repair).

#### Valve Seating Surface Outside Diameter

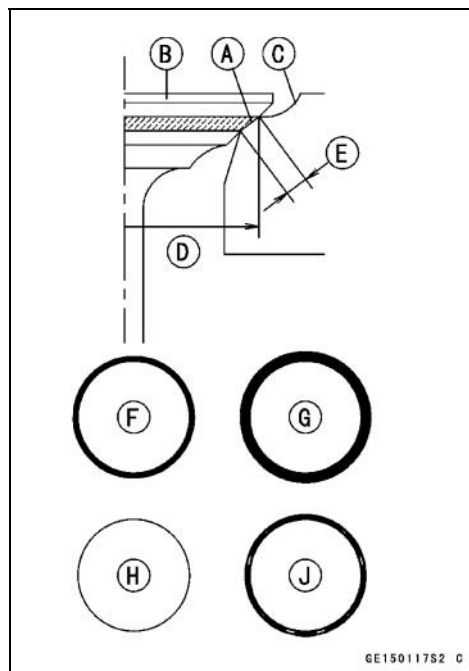
**Inlet:** 28.3 ~ 28.5 mm (1.114 ~ 1.122 in.)

**Exhaust:** 24.0 ~ 24.2 mm (0.945 ~ 0.953 in.)

#### NOTE

- The valve stem and guide must be in good condition, or this check will not be valid.

- ★ If the valve seating pattern is not correct, repair the seat (see Valve Seat Repair).
- Measure the seat width [E] of the portion where there is no build-up carbon (white portion) of the valve seat with a vernier caliper.
- Good [F]



## Valves

★If the width is too wide [G], too narrow [H] or uneven [J], repair the seat (see Valve Seat Repair).

### Valve Seating Surface Width

Inlet: 0.5 ~ 1.0 mm (0.0020 ~ 0.039 in.)

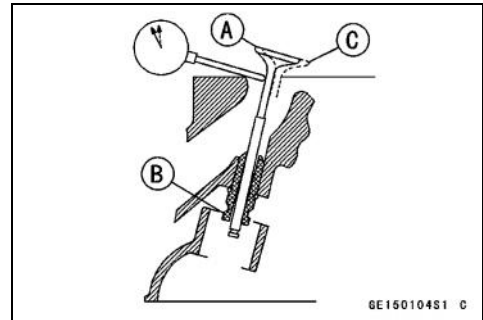
Exhaust: 0.5 ~ 1.0 mm (0.0020 ~ 0.039 in.)

### Measuring Valve-to-Guide Clearance (Wobble method) Inspection

If a small bore gauge is not available, inspect the valve guide wear by measuring the valve to valve guide clearance with the wobble method, as indicated below.

- Insert a new valve [A] into the guide [B] and set a dial gauge against the stem perpendicular to it as close as possible to the cylinder head mating surface.
- Move the stem back and forth [C] to measure valve/valve guide clearance.
- Repeat the measurement in a direction at a right angle to the first.

★If the reading exceeds the service limit, replace the guide.



### NOTE

- The reading is not actual valve/valve guide clearance because the measuring point is above the guide.

### Valve/Valve Guide Clearance (Wobble Method)

#### Standard:

Inlet 0.02 ~ 0.08 mm (0.0008 ~ 0.0032 in.)

Exhaust 0.07 ~ 0.14 mm (0.0028 ~ 0.0056 in.)

#### Service Limit:

Inlet 0.22 mm (0.009 in.)

Exhaust 0.27 mm (0.011 in.)

### Valve Seat Repair

- Repair the valve seat with the valve seat cutters.

#### Special Tools -

##### Inlet Valve

Seat Cutter 45°- $\phi$ 30.0 57001-1187

Seat Cutter 32°- $\phi$ 30.0 57001-1120

Seat Cutter 60°- $\phi$ 30.0 57001-1123

##### Exhaust Valve

Seat Cutter 45°- $\phi$ 24.5 57001-1113

Seat Cutter 32°- $\phi$ 25.0 57001-1118

Seat Cutter 60°- $\phi$ 25.0 57001-1328

Valve Seat Cutter Holder -  $\phi$ 5.5 57001-1125

Valve Seat Cutter Holders Bar 57001-1128

★If the manufacturer's instructions are not available, use the following procedure.

## 4-26 ENGINE TOP END

### Valves

#### Seat Cutter Operating Cares

1. This valve seat cutter is developed to grind the valve for repair. Therefore the cutter must not be used for other purposes than seat repair.
2. Do not drop or shock the valve seat cutter, or the diamond particles may fall off.
3. Do not fail to apply engine oil to the valve seat cutter before grinding the seat surface. Also wash off ground particles sticking to the cutter with washing oil.

#### NOTE

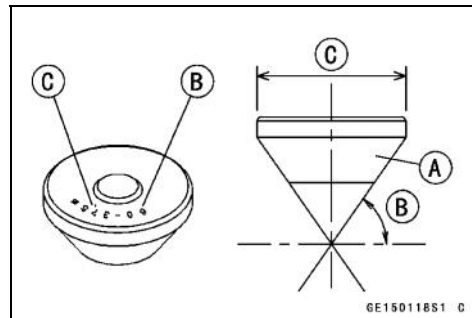
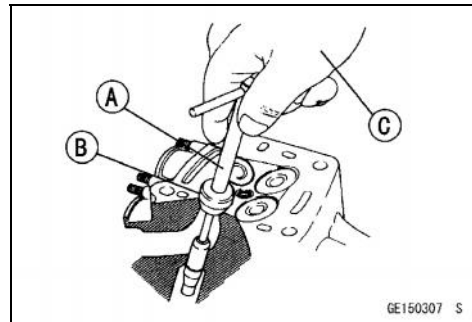
- Do not use a wire brush to remove the metal particles from the cutter. It will take off the diamond particles.
4. Setting the valve seat cutter holder [A] in position, operate the cutter [B] in one hand [C]. Do not apply too much force to the diamond portion.

#### NOTE

- Prior to grinding, apply engine oil to the cutter and during the operation, wash off any ground particles sticking to the cutter with washing oil.
5. After use, wash the cutter with washing oil and apply a thin layer of engine oil before storing.

#### Marks Stamped on the Cutter

- The marks stamped on the back of the cutter [A] represent the following.
- 60° ..... Cutter angle [B]  
30φ ..... Outer diameter of cutter [C]

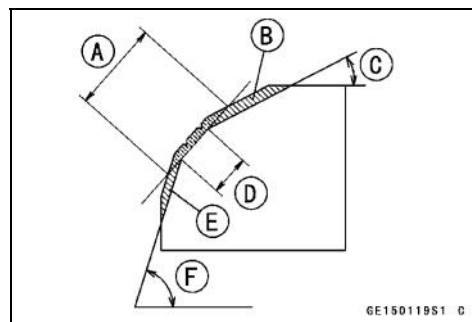


#### Operating Procedures

- Clean the seat area carefully.
- Coat the seat with machinist's dye.
- Fit a 45° cutter to the holder and slide it into the valve guide.
- Press down lightly on the handle and turn it right or left. Grind the seating surface only until it is smooth.

#### CAUTION

**Do not grind the seat too much. Overgrinding will reduce valve clearance by sinking the valve into the head. If the valve sinks too far into the head, it will be impossible to adjust the clearance, and the cylinder head must be replaced.**



Widened Width [A] of engagement by machining with 45° cutter  
Ground Volume [B] by 32° Cutter  
32° [C]  
Correct Width [D]  
Ground Volume [E] by 60° Cutter  
60° [F]

## Valves

- Measure the outside diameter (O.D.) of the seating surface with a vernier caliper.
- ★ If the outside diameter of the seating surface is too small, repeat the 45° grind [A] until the diameter is within the specified range.

Original Seating Surface [B]

### NOTE

- Remove all pittings or flaws from 45° ground surface.
- After grinding with 45° cutter, apply thin coat of machinist's dye to seating surface. This makes seating surface distinct and 32° and 60° grinding operation easier.
- When the valve guide is replaced, be sure to grind with 45° cutter for centering and good contact.
- If the outside diameter of the seating surface is too large, make the 32° grind described below.
- If the outside diameter [A] of the seating surface is within the specified range, measure the seat width as described below.
- Grind the seat at a 32° angle [B] until the seat O.D. is within the specified range.
- To make the 32° grind, fit a 32° cutter to the holder, and slide it into the valve guide.
- Turn the holder one turn at a time while pressing down very lightly. Check the seat after each turn.

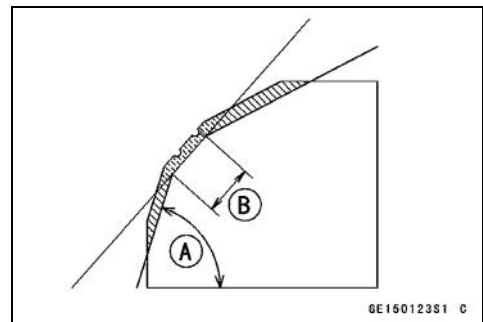
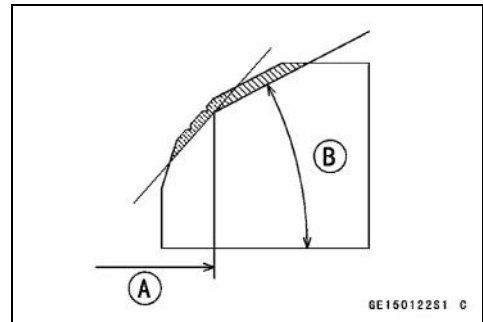
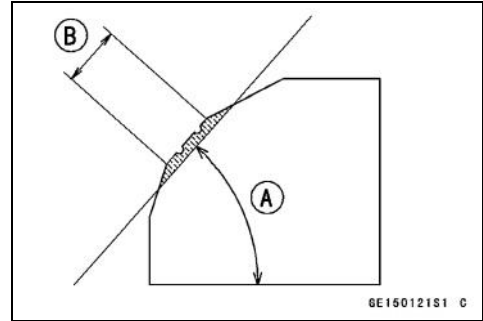
### CAUTION

**The 32° cutter removes material very quickly. Check the seat outside diameter frequently to prevent overgrinding.**

- After making the 32° grind, return to the seat O.D. measurement step above.
- To measure the seat width, use a vernier caliper to measure the width of the 45° angle portion of the seat at several places around the seat.
- ★ If the seat width is too narrow, repeat the 45° grind until the seat is slightly too wide, and then return to the seat O.D. measurement step above.

- ★ If the seat width is too wide, make the 60° [A] grind described below.
- ★ If the seat width is within the specified range, lap the valve to the seat as described below.
- Grind the seat at a 60° angle until the seat width is within the specified range.
- To make the 60° grind, fit a 60° cutter to the holder, and slide it into the valve guide.
- Turn the holder, while pressing down lightly.
- After making the 60° grind, return to the seat width measurement step above.

Correct Width [B]



## 4-28 ENGINE TOP END

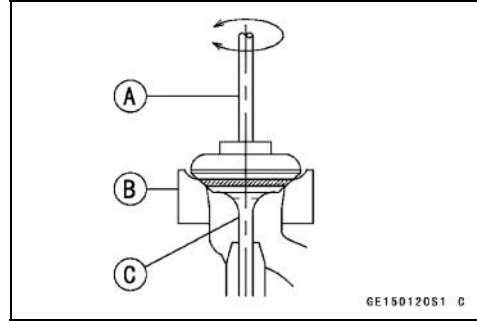
### Valves

- Lap the valve to the seat, once the seat width and O.D. are within the ranges specified above.
- Put a little coarse grinding compound on the face of the valve in a number of places around the valve head.
- Spin the valve against the seat until the grinding compound produces a smooth, matched surface on both the seat and the valve.
- Repeat the process with a fine grinding compound.

[A] Lapper

[B] Valve Seat

[C] Valve



- The seating area should be marked about in the middle of the valve face.
- ★ If the seat area is not in the right place on the valve, check to be sure the valve is the correct part. If it is, it may have been refaced too much; replace it.
- Be sure to remove all grinding compound before assembly.
- When the engine is assembled, be sure to adjust the valve clearance (see Valve Clearance Adjustment).