POWER UNIT

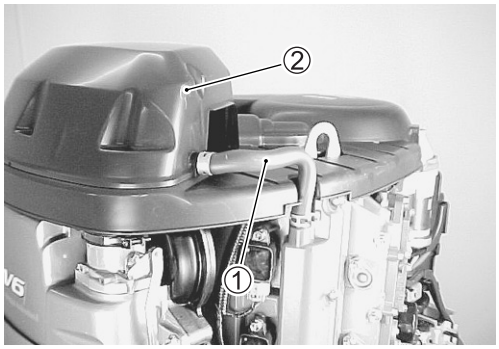
CONTENTS

RING GEAR COVER AND AIR INTAKE SILENCER CASE

REMOVAL

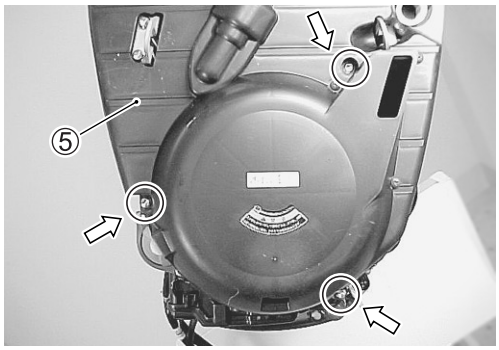
Prior to removing Ring gear cover:
- **Disconnect battery cables from battery.**

1. Loosen the clamp securing breather hose ①, then remove the breather hose from silencer case ②.

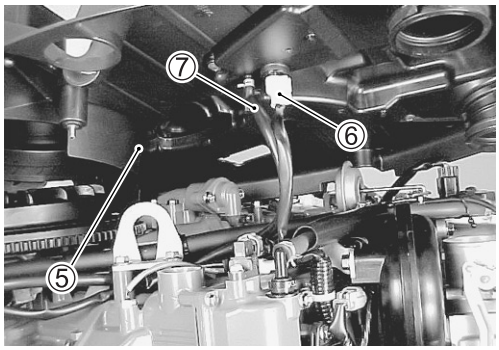


2. Loosen the clamps ③ securing STBD and PORT outlet tube to throttle body ④.

3. Remove the three (3) bolts securing ring gear cover ⑤.



4. Raise the ring gear cover and air intake silencer case ⑤ slightly and remove the intake air temp. sensor ⑥ and purge valve hose ⑦ from air intake silencer case.
   Continue raising and remove the cover and case.



INSTALLATION

Installation is reverse order of removal.

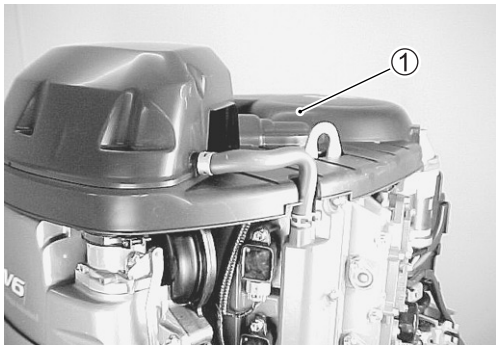
COLLECTOR ASSEMBLY

(For multi-stage induction model)

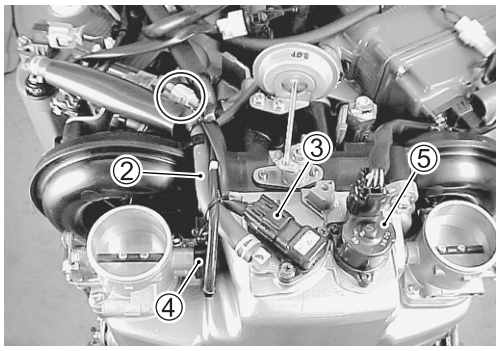
REMOVAL

Before removing collector assembly:
- **Disconnect battery cables from battery.**
- **Remove both side covers. (See page 7-2.)**

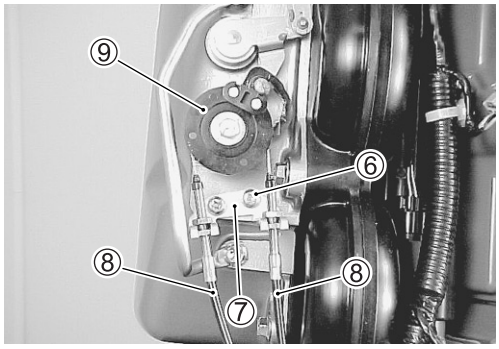
1. Remove the ring gear cover and air intake silencer case ①. (See page 6-2.)



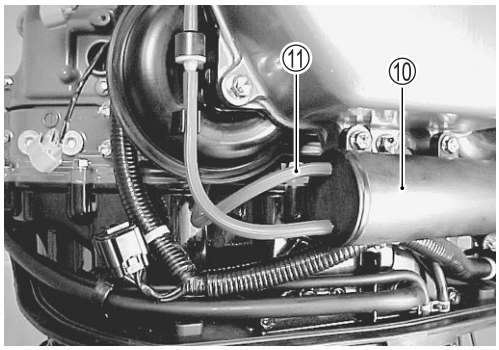
2. On the PORT side bank:
   Loosen the clamp securing PCV hose ②, then remove the PCV hose from collector cover.
3. Disconnect MAP sensor lead wire connector at MAP sensor ③.
4. Disconnect Throttle sensor lead wire connector from TPS (Throttle Position Sensor) ④.
5. Disconnect IAC valve lead wire connector at IAC valve ⑤.



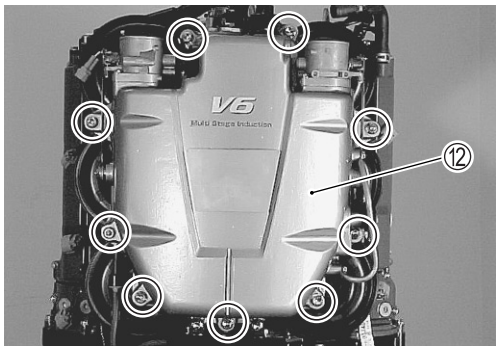
6. Remove two (2) screws ⑥ and cable bracket ⑦.
   Remove throttle cables ⑧ from throttle drum ⑨.



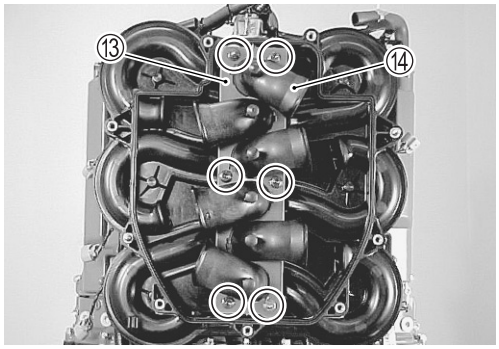
7. Remove the vacuum hose ⑪ from vacuum chamber ⑩.



8. Remove the seven (7) bolts and two (2) nuts securing collector cover ⑫, then remove the collector cover.

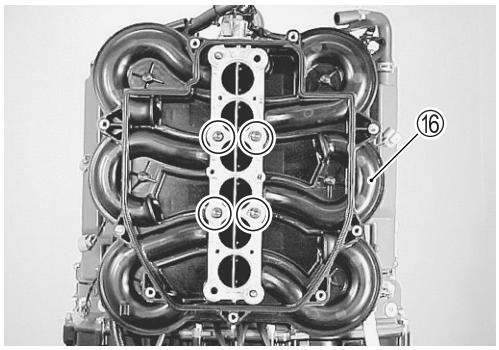


9. Remove the four (4) bolts and two (2) nuts securing funnel bracket ⑬, then remove six funnels ⑭ and funnel bracket.



10. Disconnect lead wire connector from VSV (Vacuum Switching Valve) ⑮.

11. Remove four (4) bolts and collector ⑯.



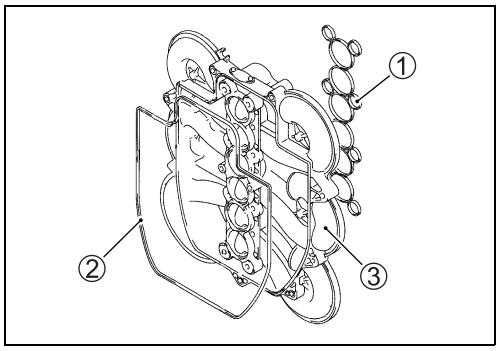
SYSTEM INSPECTION

Refer to “Multi-stage induction system/inspection” in section 3.

INSTALLATION

Installation is reverse order of removal with special attention to the following steps.

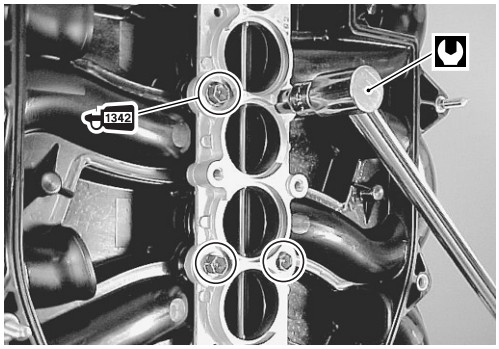
NOTE:
Do not re-use gasket. Always use a new gasket.



- Install gasket ①·② and collector ③, then tighten bolts, pre-coated with thread lock, to specified torque.

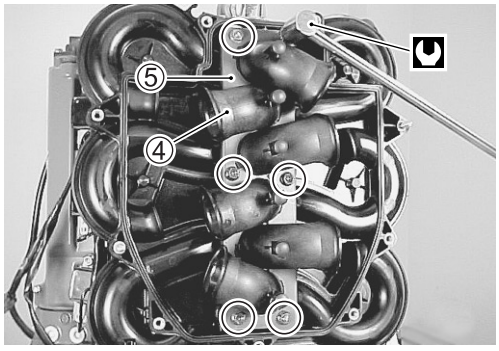
Collector bolt: 23 N·m (2.3 kg-m, 16.5 lb-ft)

1342 99000-32050: Thread lock "1342"

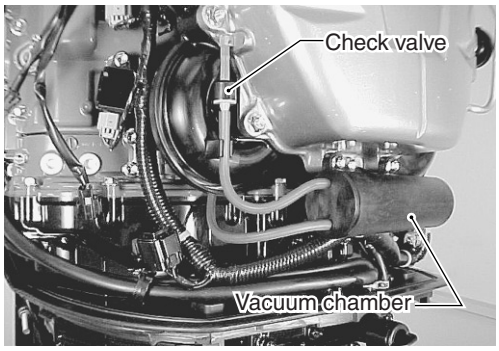


- Install funnels ④ and funnel bracket ⑤, then tighten bolts and nuts securely.

Funnel bracket bolt/nut: 23 N·m (2.3 kg-m, 16.5 lb-ft)

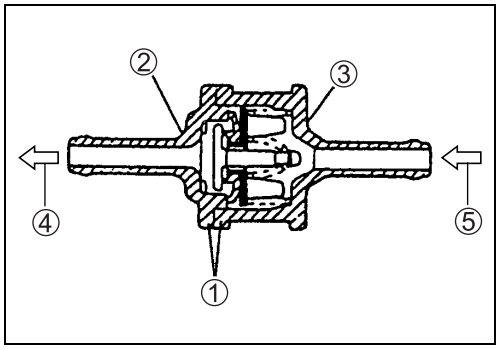


- Check to ensure that all removed parts are back in place.



NOTE:
Refer to figure at right when connecting check valve between vacuum hoses.

① Check valve ② Orange side
③ Black side ④ To vacuum chamber
⑤ From collector assembly



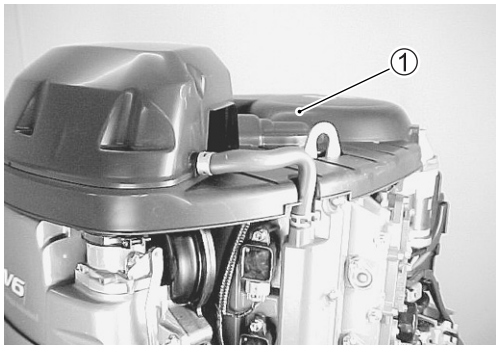
COLLECTOR ASSEMBLY

(For single-stage induction model)

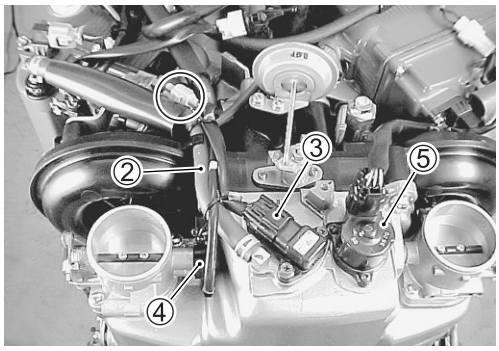
REMOVAL

Before removing collector assembly:
- **Disconnect battery cables from battery.**
- **Remove both side covers. (See page 7-2.)**

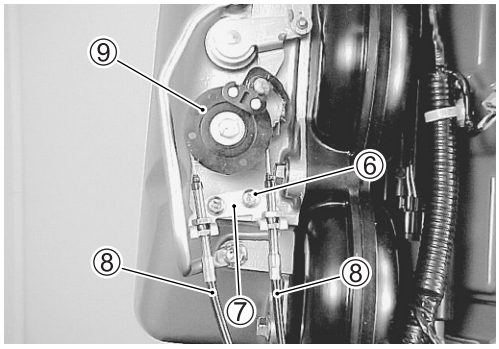
1. Remove the ring gear cover and air intake silencer case ①. (See page 6-2.)



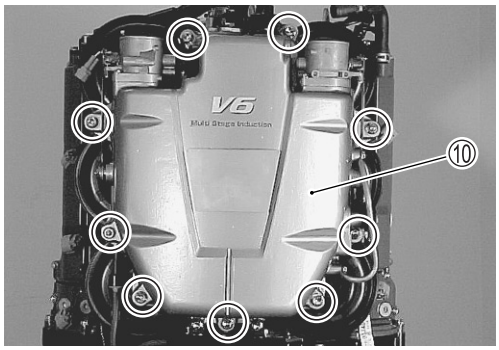
2. On the PORT side bank:
   Loosen the clamp securing PCV hose ②, then remove the PCV hose from collector cover.
3. Disconnect MAP sensor lead wire connector at MAP sensor ③.
4. Disconnect Throttle sensor lead wire connector from TPS (Throttle Position Sensor) ④.
5. Disconnect IAC valve lead wire connector at IAC valve ⑤.



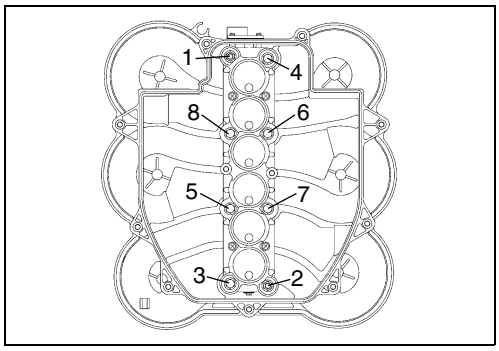
6. Remove two (2) screws ⑥ and cable bracket ⑦.
   Remove throttle cable ⑧ from throttle drum ⑨.



7. Remove the seven (7) bolts and two (2) nuts securing collector cover ⑩, then remove the collector cover.



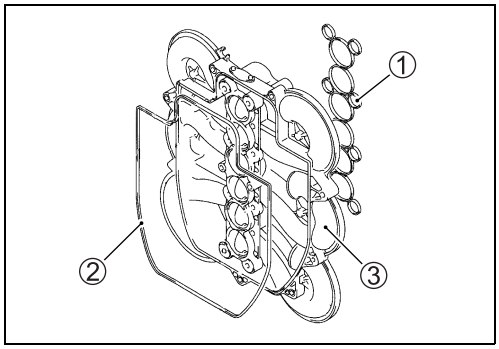
8. Remove the six (6) bolts and two (2) nuts securing collector ⑪, then remove collector.



INSTALLATION

Installation is reverse order of removal with special attention to the following steps.

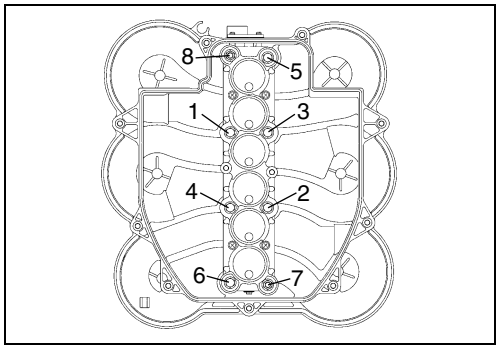
NOTE:
Do not re-use gasket. Always use a new gasket.

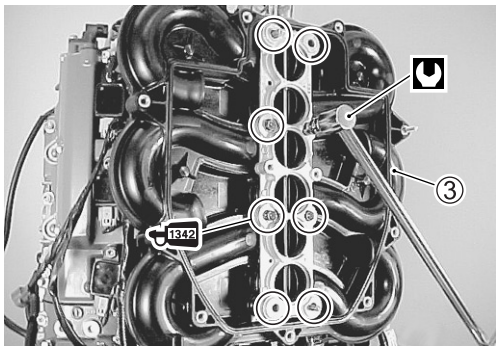


- Install gasket ①·② and collector ③, then tighten bolts and nut, pre-coated with thread lock, to specified torque.

Collector bolt: 23 N·m (2.3 kg-m, 16.5 lb-ft)

1342 99000-32050: Thread lock "1342"





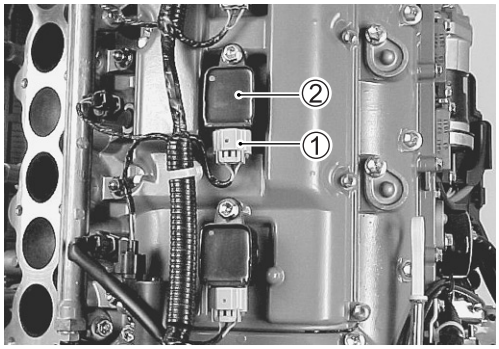
- Check to ensure that all removed parts are back in place.

CYLINDER HEAD COVER

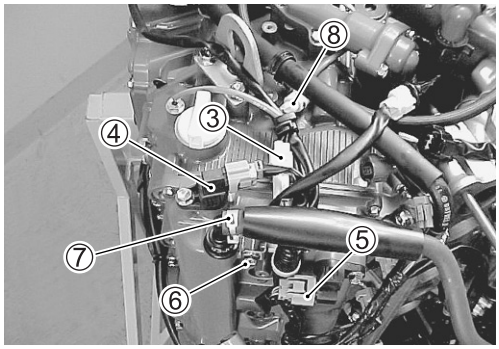
REMOVAL

Before removing cylinder head cover:
- **Disconnect battery cables from battery.**

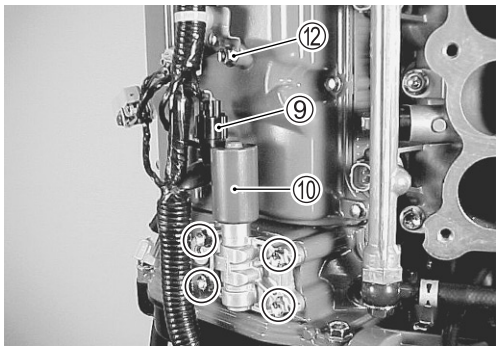
1. Remove the collector assembly. (See page 6-3, 6-6.)
2. Disconnect ignition coil connectors ①.
   Remove the bolts securing the ignition coils.
   Remove all ignition coils ② and spark plugs.



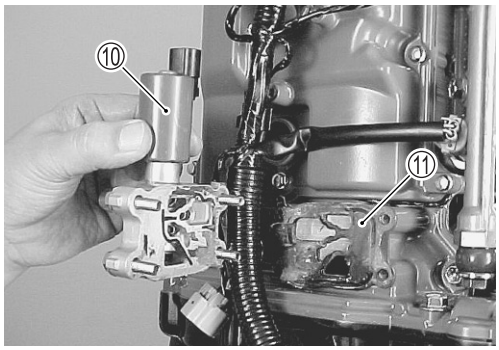
3. On the PORT side bank:
   - Disconnect EX. manifold temperature sensor lead wire connector ③.
   - On DF250 model, disconnect EX. CMP sensor lead wire connector ④ at sensor.
   - On DF250 model, disconnect IN. CMP sensor lead wire connector ⑤ at sensor.
   - Remove the bolt securing lead wire clamp plate ⑥.
   - Remove PCV valve ⑦ from cylinder head cover.



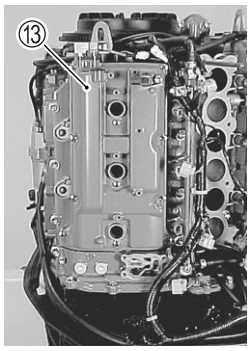
   - Disconnect cylinder temperature sensor lead wire connector ⑧.
   - On DF250 model, disconnect OCV lead wire connector ⑨ at OCV.
     Remove the four (4) bolts securing OCV ⑩, then remove OCV and discard OCV gasket ⑪.
   - Remove the bolt securing lead wire clamp plate ⑫.

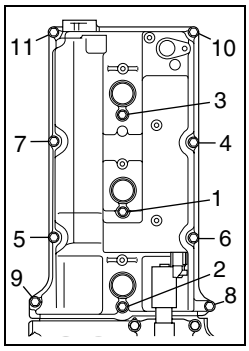


NOTE:
DF200/225 models are not equipped with OCV.

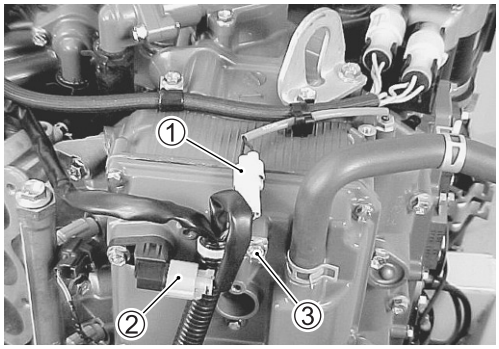


- Remove the eleven (11) bolts securing cylinder head cover ⑬ to the cylinder head, then remove the cylinder head cover.

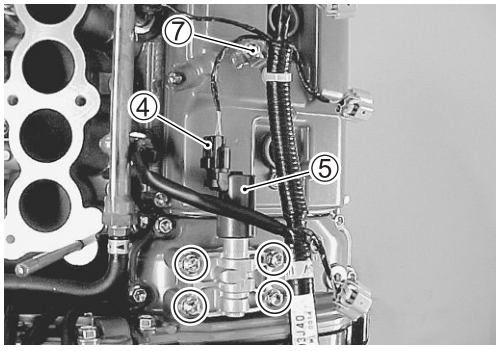




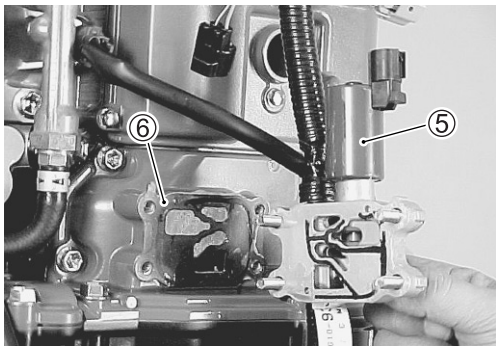
4. On the STBD side bank:
   - Disconnect EX. manifold temperature sensor lead wire connector ①.
   - Disconnect IN. CMP sensor lead wire connector ② at sensor.
   - Remove the bolt securing lead wire clamp plate ③.



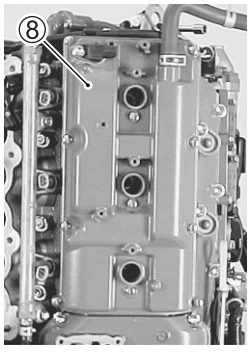
   - On DF250 model, disconnect OCV lead wire connector ④ at OCV.
     Remove the four (4) bolts securing OCV ⑤, then remove OCV and discard OCV gasket ⑥.
   - Remove the bolt securing lead wire clamp plate ⑦.

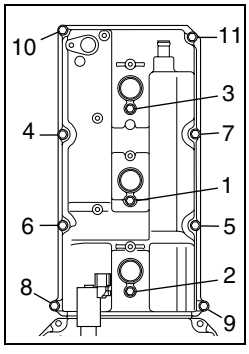


NOTE:
DF200/225 models are not equipped with OCV.



   - Remove the eleven (11) bolts securing cylinder head cover ⑧ to the cylinder head, then remove the cylinder head cover.



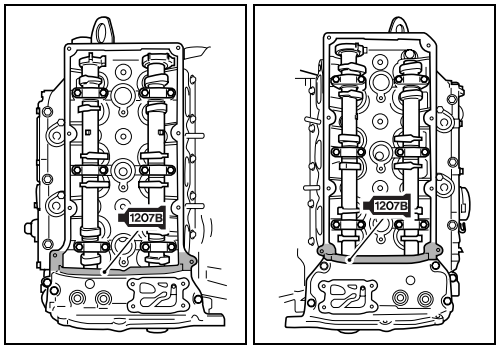


INSTALLATION

Installation is reverse order of removal with special attention to the following steps.

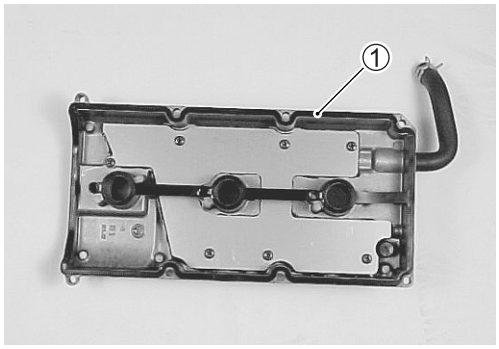
- Clean sealing surfaces on cylinder heads and covers.
- Remove oil, old sealant, and dust from sealing surfaces.
- After cleaning, apply sealant to cylinder heads sealing surface area as shown in figure.

1207B 99000-31140: SUZUKI BOND "1207B"



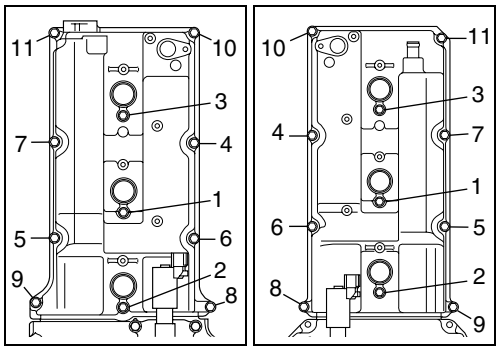
- Install new cylinder head cover gasket ① to head cover.

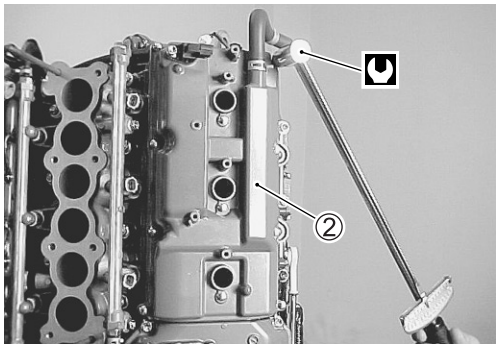
NOTE:
Examine cylinder head cover gasket for damage.
Always replace gasket with new one.



- Install cylinder head covers ② to cylinder heads, then tighten cylinder head cover bolts to specified torque.

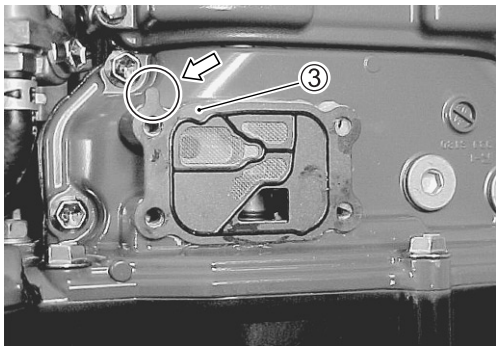
Cylinder head cover bolt: 11 N·m (1.1 kg-m, 8.0 lb-ft)





• On the DF250 model, install gasket ③ and OCV ④ and then tighten bolts securely.

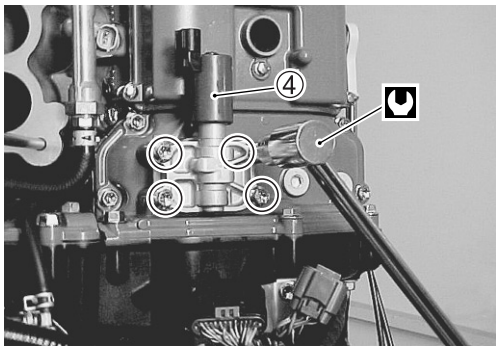
NOTE:
Position the projection of OCV gasket as shown right.



CAUTION

Do not re-use the OCV gasket, always replace with new one.

OCV bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



• Install collector assembly.
Refer to “Collector assembly” in this section for assembly.

FINAL ASSEMBLY CHECK

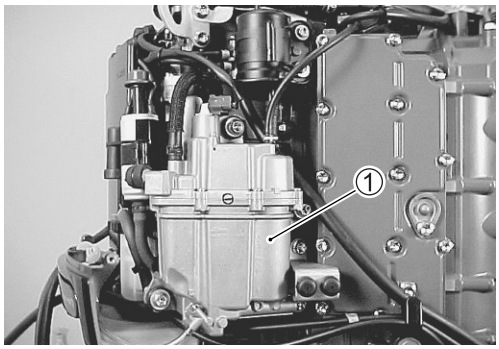
- All parts removed have been returned to their original positions.
- Wire and hose routing match’s service manual illustration.
- No oil leakage is evident during final test running.

POWER UNIT

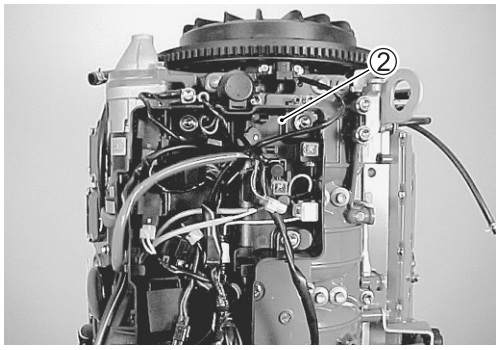
REMOVAL

Before removing power unit;
- **Relieve fuel pressure. (See page 5-3.)**
- **Drain engine oil.**
- **Disconnect battery cables from battery.**

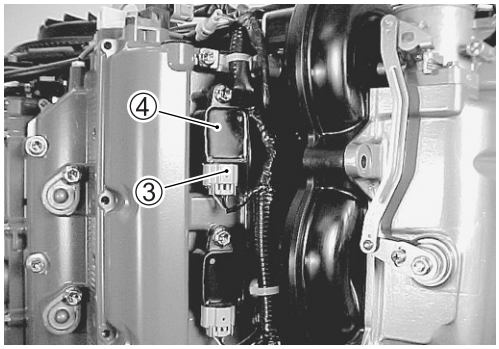
Remove the low pressure fuel pump/fuel vapor separator ① as a set. (See page 5-7.)



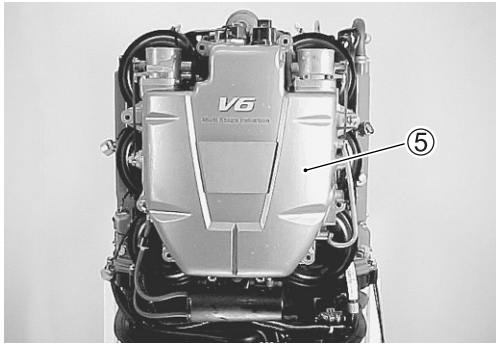
Remove the electric parts holder ②. (See page 4-26.)



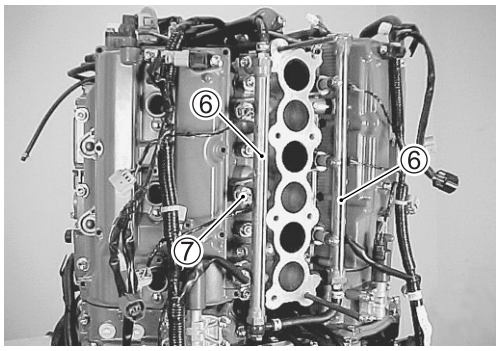
Disconnect ignition coil connectors ③.
Remove bolts securing the ignition coils ④.
Remove all ignition coils ④ and spark plugs.



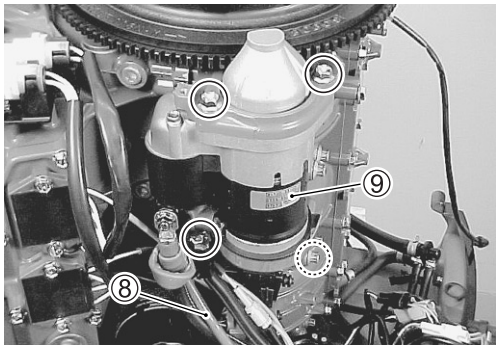
Remove the collector assembly ⑤. (See page 6-3, 6-6.)



Remove bolts securing fuel delivery pipe ⑥, then remove fuel delivery pipes and all fuel injectors ⑦. (See page 5-19.)

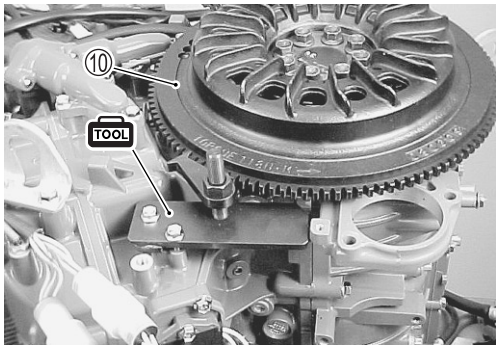


Remove nut and positive battery cable ⑧.
Remove starter motor ⑨. (See page 4-13.)

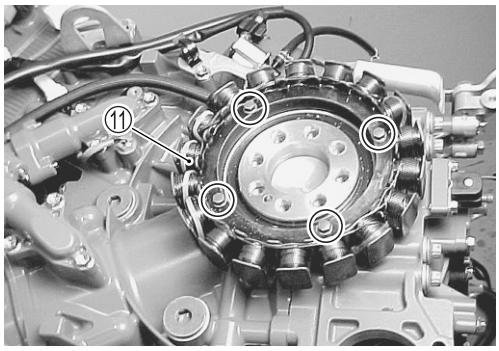


Remove flywheel ⑩. (See page 3-66.)

09916-99310: Flywheel holder

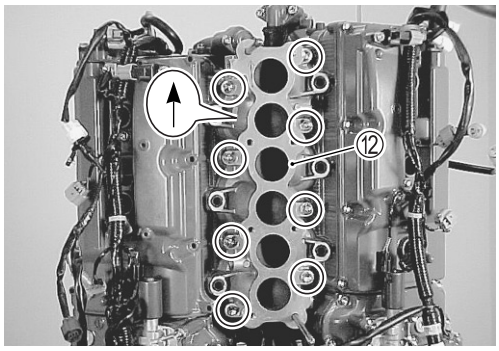


Remove battery charge coil ⑪. (See page 4-5.)

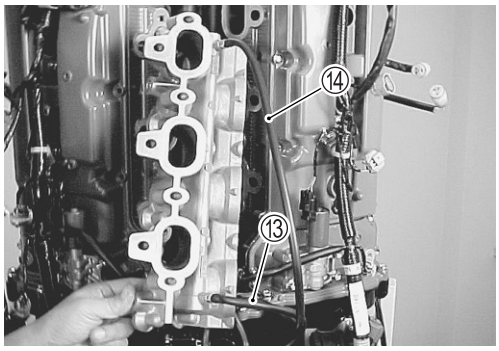


Remove four (4) bolts and four (4) nuts, then remove intake manifold ⑫.

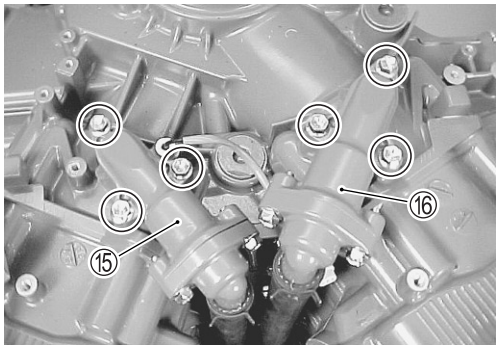
NOTE:
To prevent accidentally reversing the intake manifold on assembly, put an ID mark on top of the intake manifold.



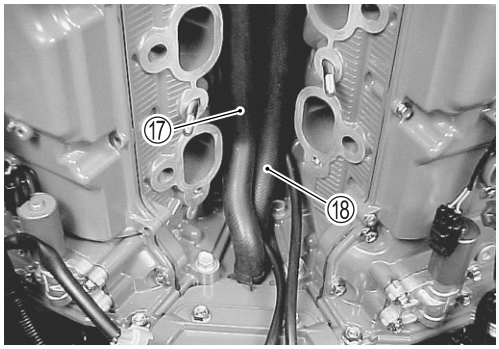
Disconnect water inlet hose ⑬ and outlet hose ⑭ from intake manifold.



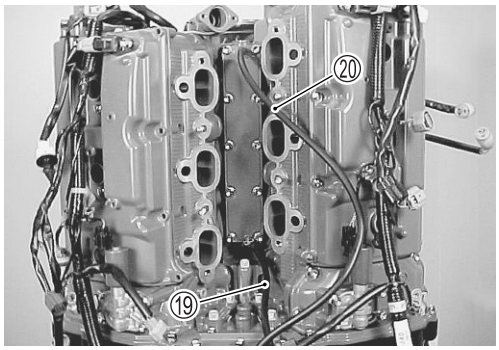
Remove three (3) bolts and PORT thermostat housing ⑮.
Remove three (3) bolts and STBD thermostat housing ⑯.



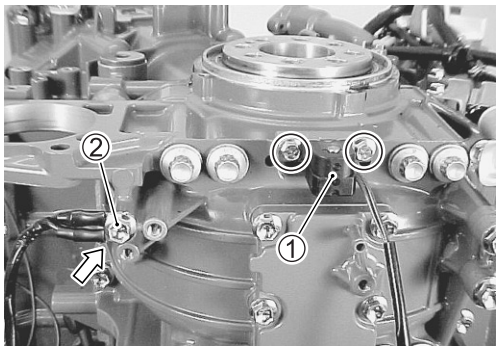
Disconnect PORT and STBD water return hose ⑰·⑱ from engine holder.



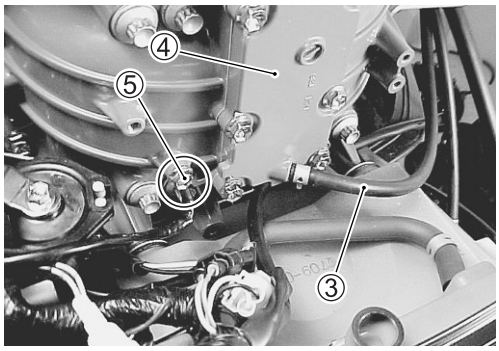
Disconnect water inlet hose ⑲ and outlet hose ⑳ from rear crankcase water jacket cover.



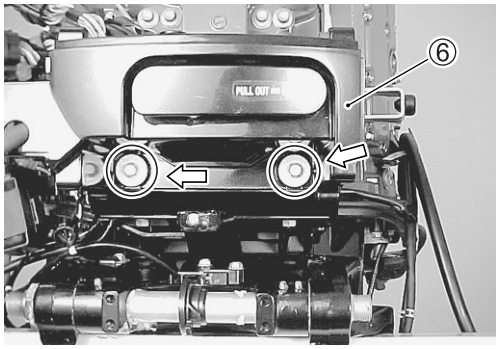
Remove screws and CKP sensor ①.
Remove the bolt ② securing the ground lead wire of engine main harness.



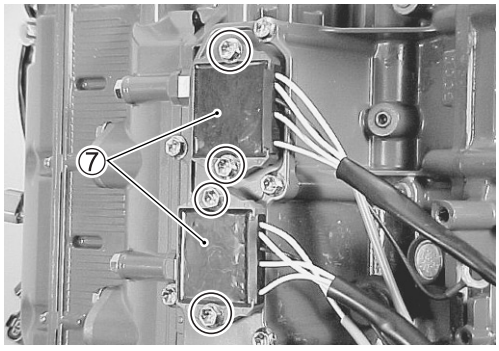
Disconnect water inlet hose ③ from the front crankcase water jacket cover ④.
Remove the bolt ⑤ securing the ground lead wire of PTT relay.



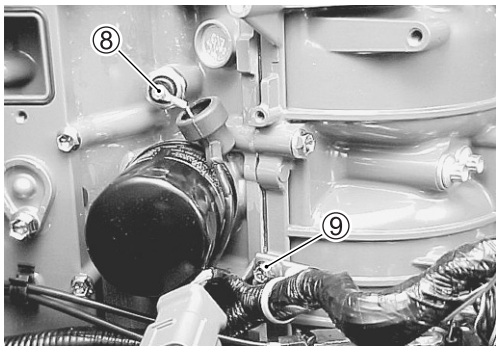
Remove two (2) bolts and front panel ⑥.



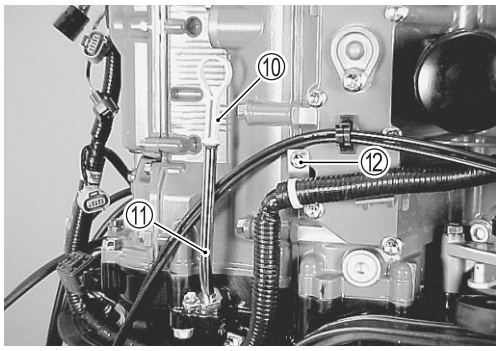
Remove bolts and two (2) Rectifier & regulators ⑦.
(See page 4-6.)



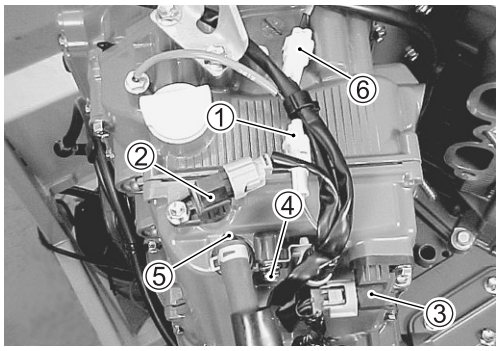
Loosen screw ⑧ and disconnect lead wire from oil pressure switch.
Remove the bolt ⑨ securing the engine main harness clamp plate.



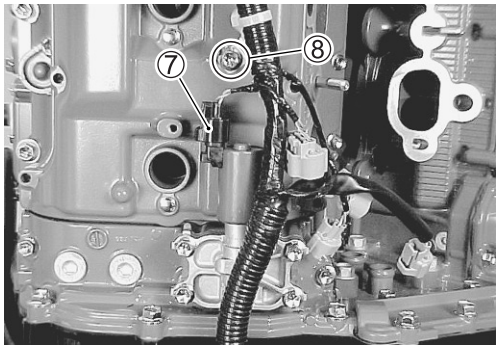
Remove oil level dipstick ⑩.
Remove bolt and oil level dipstick guide ⑪.
Remove the bolt ⑫ securing the engine main harness clamp plate.



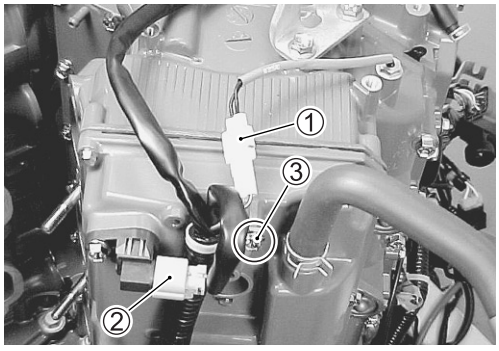
On the PORT side bank
- Disconnect EX. manifold temperature sensor lead wire connector ①.
- On DF250 model, disconnect EX. CMP sensor lead wire connector at sensor ②.
- On DF250 model, disconnect IN. CMP sensor lead wire connector at sensor ③.
- Remove the bolt ④ securing lead wire clamp plate.
- Remove PCV valve ⑤ from cylinder head cover.



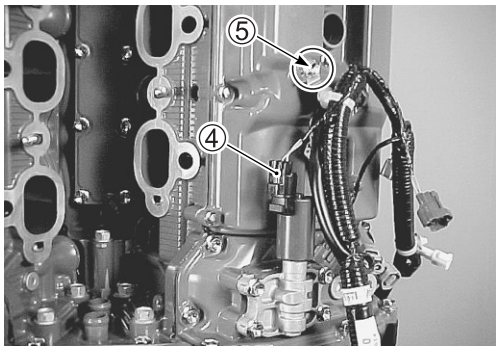
- Disconnect cylinder temperature sensor lead wire connector ⑥.
- On DF250 model, disconnect OCV lead wire connector ⑦ at OCV.
- Remove the bolt ⑧ securing lead wire clamp plate.



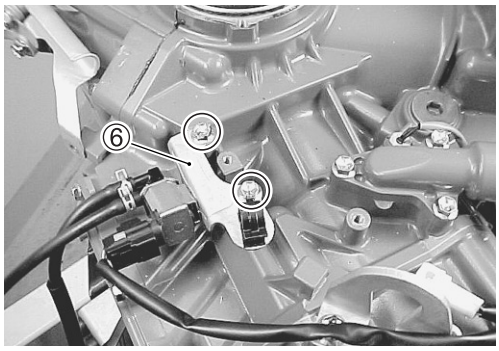
On the STBD side bank
- Disconnect EX. manifold temperature sensor lead wire connector ①.
- Disconnect IN. CMP sensor lead wire connector ② at sensor.
- Remove the bolt ③ securing lead wire clamp plate.



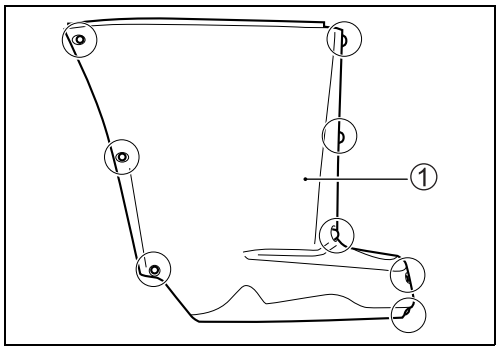
- On DF250 model, disconnect OCV lead wire connector ④ at OCV.
- Remove the bolt ⑤ securing lead wire clamp plate.



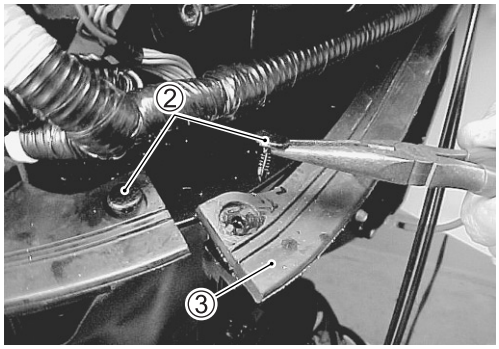
Remove bolts and purge valve bracket ⑥ (with purge valve).



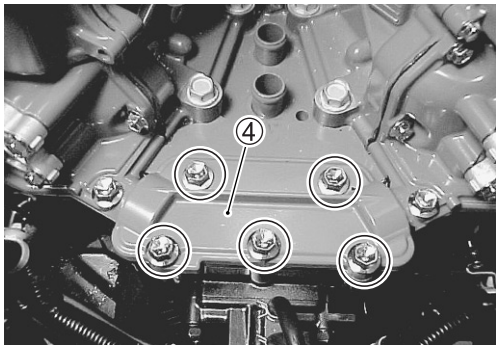
Remove oil pan cover ①. (See page 7-2.)



Remove pins ② and side cover seal ③.

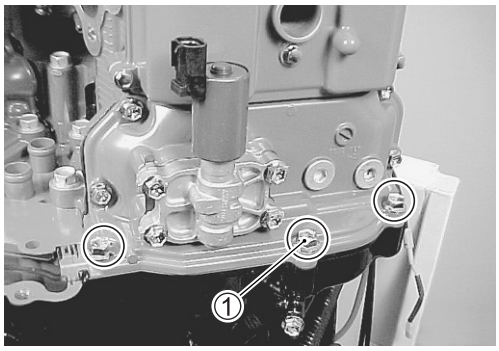


Remove five (5) bolts and upper engine holder cover ④.

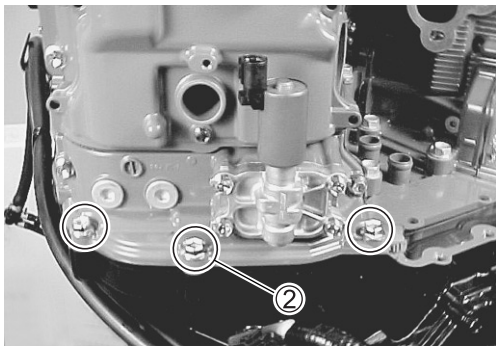


[From engine upper side]

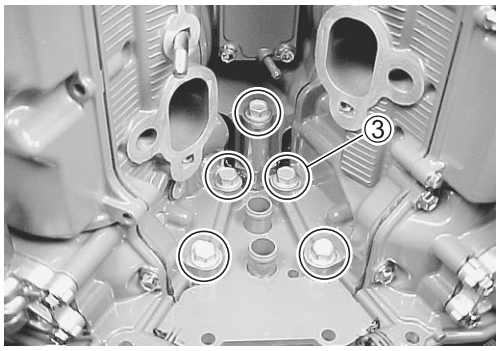
- On the STBD bank, remove three (3) bolts ①.



- On the PORT bank, remove three (3) bolts ②.

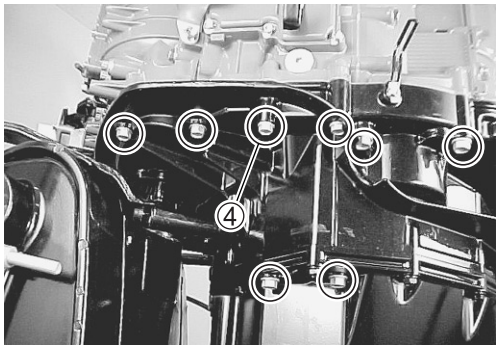


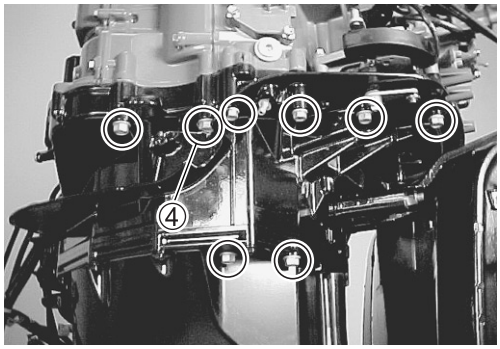
• Remove five (5) bolts ③.



[From engine under side]

• Remove sixteen (16) bolts ④.
Lift up and remove power unit from engine holder.





INSTALLATION

Installation is reverse order of removal with special attention to the following step.

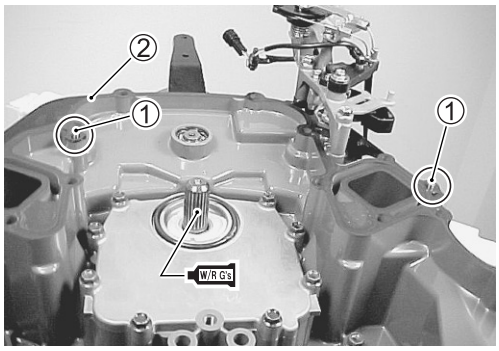
CAUTION

Do not re-use gaskets, O-rings and seals.
Always replace with new parts.

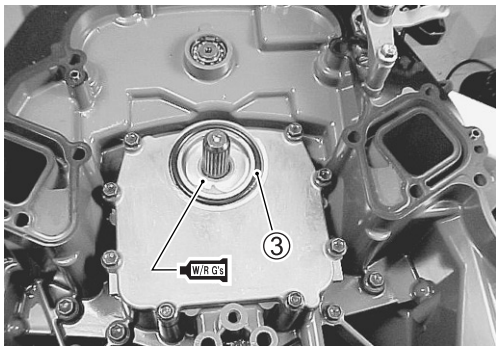
POWER UNIT

• Install dowel pins ①, gasket ②.
Apply Water Resistant Grease to driveshaft splines.

W/R G's 99000-31140: SUZUKI WATER RESISTANT GREASE

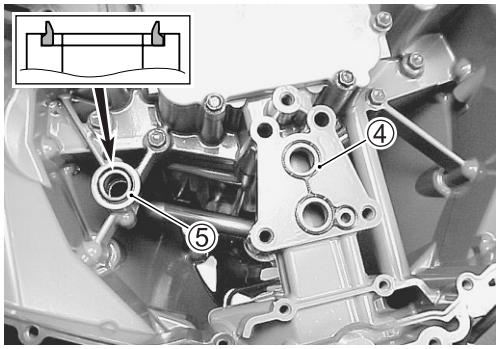


• Install O-ring ③ to mount oil seal cover, then apply enough Water Resistant Grease on O-ring.



• Install the water return seal ④ and engine holder seal ⑤.

NOTE:
Install seal ⑤ with lip facing upward.

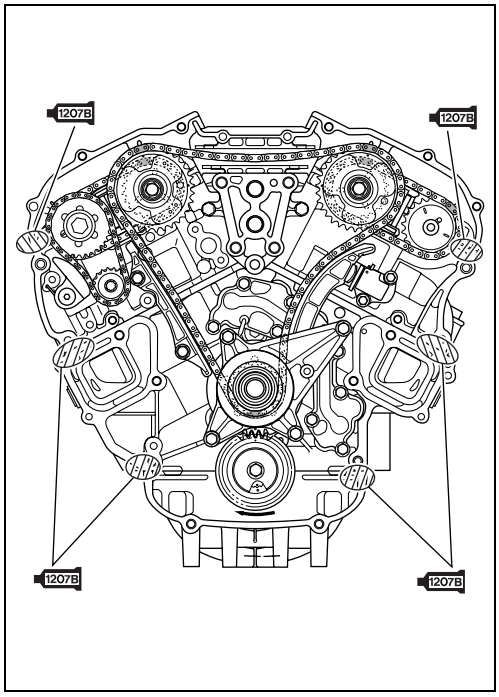


NOTE:
Before installing power unit, apply sealant to the six hatched areas shown in the illustration at right.

1207B 99000-31140: SUZUKI BOND "1207B"

• Lower the power unit onto engine holder.

NOTE:
Rotate crankshaft to aid alignment of driveshaft and counter shaft splines.

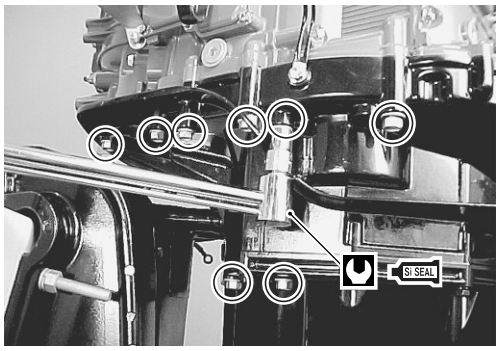


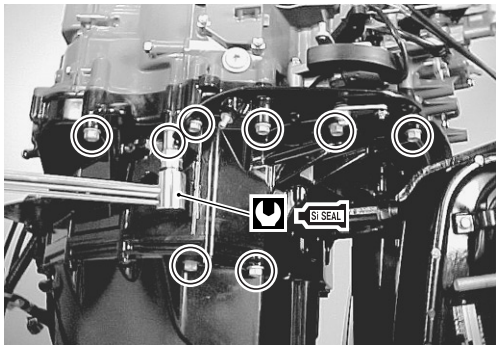
- Apply Suzuki Silicone seal to power unit mounting bolts and tighten bolts to specified torque.

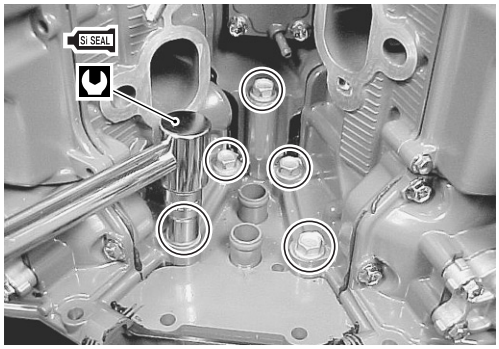
Si SEAL 99000-31120: SUZUKI SILICONE SEAL

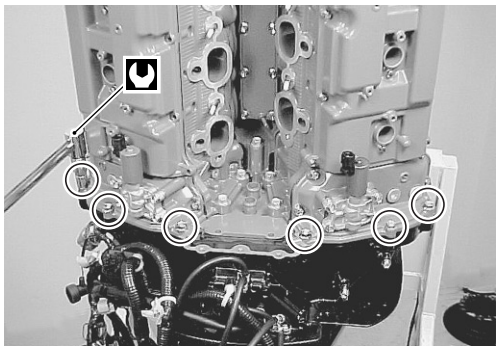
Power unit mounting bolt:

8 mm	**23 N·m (2.3 kg-m, 16.5 lb-ft)**
10 mm	**50 N·m (5.0 kg-m, 36.0 lb-ft)**



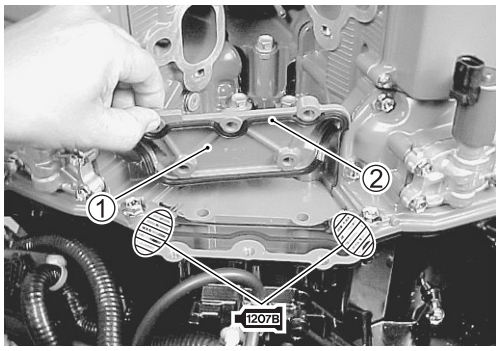






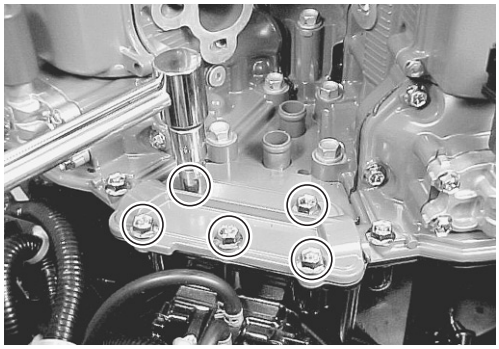
- Assemble new seal ② to upper engine holder cover ①, then install engine holder cover and tighten cover bolts to specified torque.

Engine holder cover bolt:
8 mm 23 N·m (2.3 kg-m, 16.5 lb-ft)



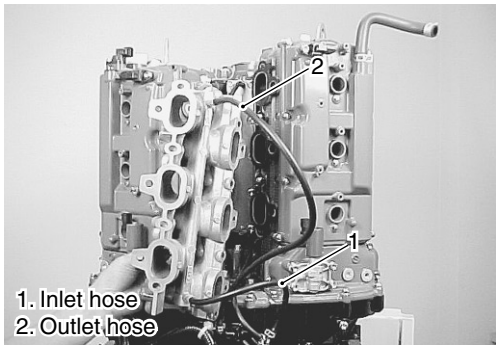
NOTE:
Before installing upper engine holder cover, apply sealant to the two hatched areas shown in the illustration at right.

1207B 99000-31140: SUZUKI BOND "1207B"



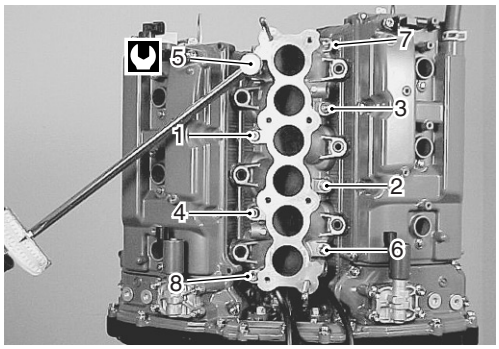
INTAKE MANIFOLD

- Connect inlet and outlet water hoses to the correct intake manifold fittings.



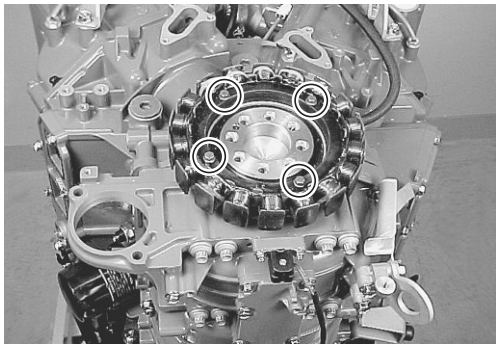
- Install gasket and intake manifold, then tighten bolts and nuts to specified torque.

Intake manifold bolt/nut:
8 mm 23 N·m (2.3 kg-m, 16.5 lb-ft)



FLYWHEEL

- Install battery charge coil. (See page 4-6.)

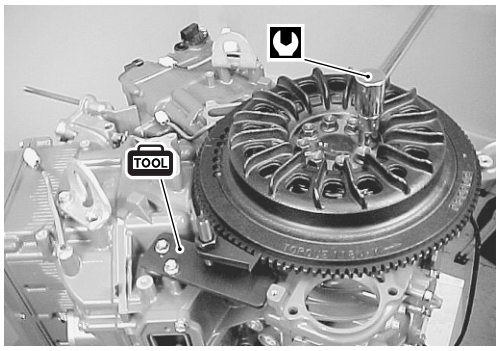


- Install flywheel and tighten flywheel bolts to specified torque. (See page 3-67.)

TOOL 09916-99310: Flywheel holder

Flywheel bolt: 118 N·m (11.8 kg-m, 85.3 lb-ft)

- Install CKP sensor. (See page 3-68.)



FUEL INJECTORS

- Install fuel injectors and fuel delivery pipes. (See page 5-20.)

COLLECTOR ASSEMBLY

- Install collector assembly.
  For collector assembly installation, see page 6-5, 6-7.

FINAL ASSEMBLY CHECK

Perform the following checks to ensure proper and safe operation of the repaired unit.

- All parts removed have been returned to their original positions.
- Fuel and water hose routing match's service manual illustration. (See page x-xx to x-xx.)
- Wire routing match's service manual illustration. (See page x-xx to x-xx.)
- No fuel leakage is evident when fuel system is pressurized. (See page 5-4.)
- No water leakage is evident during final test running.

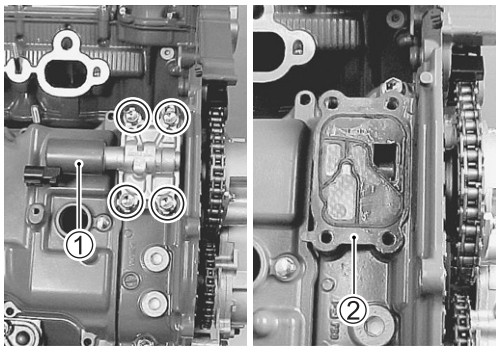
OIL PUMP

REMOVAL

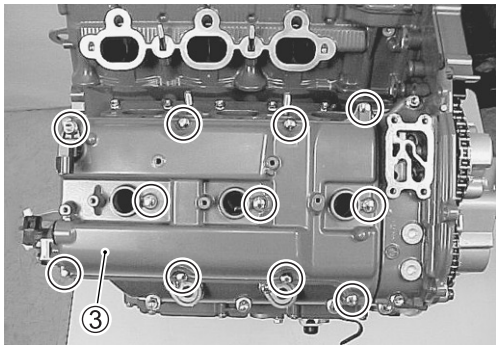
1. Remove the power unit. (See page 6-12 to 6-18.)

[On the PORT side bank]

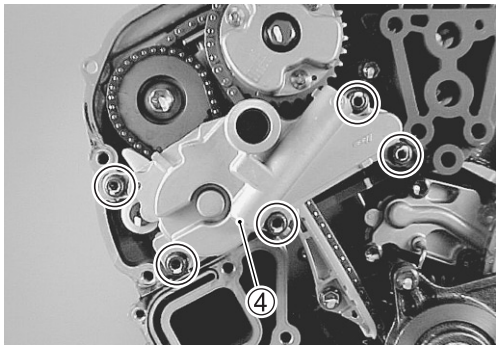
2. On DF250 model, remove the four (4) bolts securing OCV ①, then remove OCV and gasket ②.



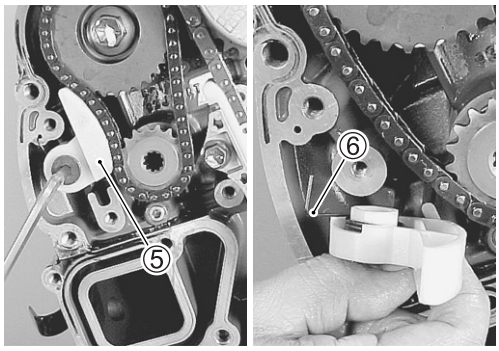
3. Remove the eleven (11) bolts securing cylinder head cover ③ to cylinder head, then remove the cylinder head cover.



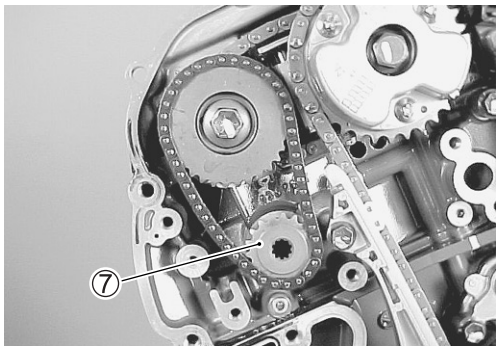
4. Remove the five (5) bolts securing oil pump ④, then remove the oil pump.
   Account for shim washer.



5. Remove the bolt, oil pump chain tensioner ⑤ and tensioner spring ⑥.

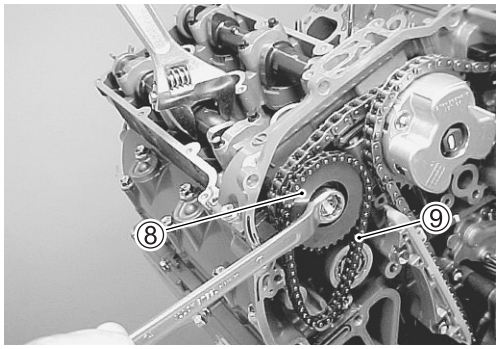


6. Remove the oil pump driven gear ⑦.



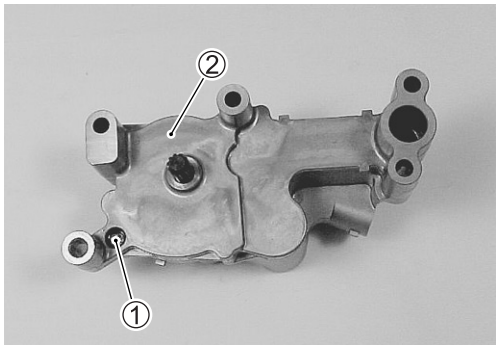
NOTE:
- *Sprocket bolt is LH thread.*
- *Hold camshaft by placing a wrench on the hexagon area of the camshaft.*

7. Remove the bolt securing oil pump drive sprocket ⑧ to camshaft, then remove the oil pump drive sprocket and chain ⑨.

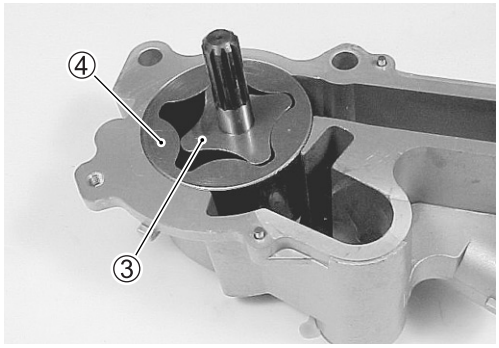


DISASSEMBLY

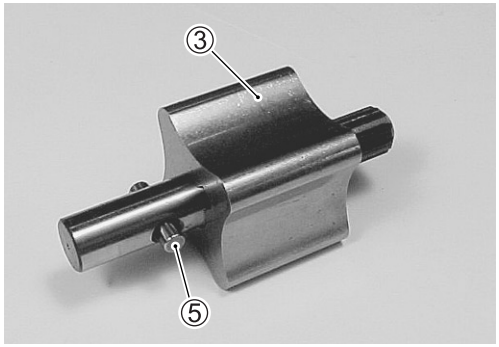
1. Remove the screw ① securing oil pump rotor plate ② to the oil pump case, then remove the oil pump rotor plate.



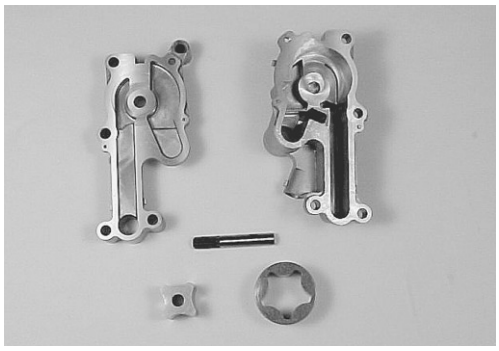
2. Take out inner rotor ③ and outer rotor ④.



3. Remove the pin ⑤ and inner rotor ③.



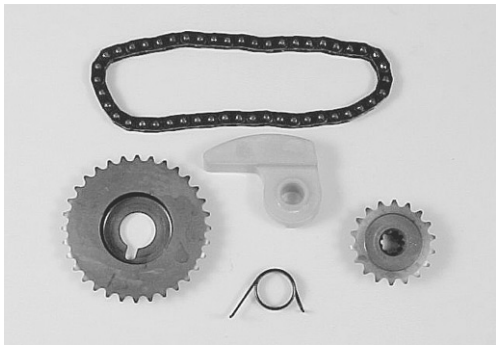
INSPECTION



OIL PUMP ASSEMBLY

Check outer and inner rotors, rotor plate and oil pump case for excessive wear or damage.
Replace as necessary.

NOTE:
If any repair is required on outer rotor, inner rotor and oil pump case/plate, replace them as an oil pump assembly.



DRIVE/DRIVEN SPROCKET

Check teeth of sprocket for wear or damage.
Replace as necessary.

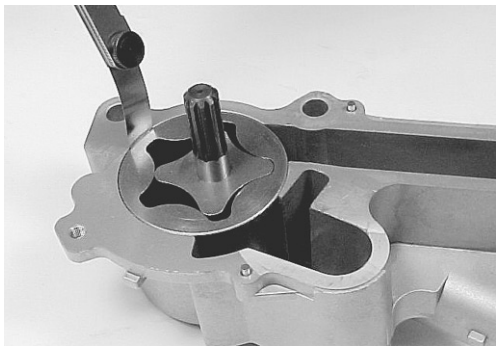
OIL PUMP DRIVE CHAIN

Check oil pump drive chain. Replace if worn or damage.

CHAIN TENSIONER

Check chain tensioner. Replace if worn or damage.

MEASURING PUMP COMPONENTS

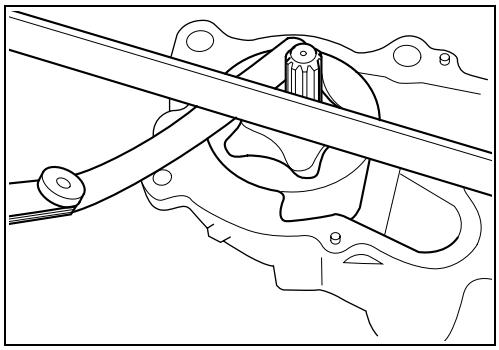


RADIAL CLEARANCE

Using a feeler gauge, measure radial clearance between outer rotor and case.

Radial clearance:
Service limit: 0.31 mm (0.0122 in)

If measurement is not within specifications, replace the outer rotor and/or case.



SIDE CLEARANCE

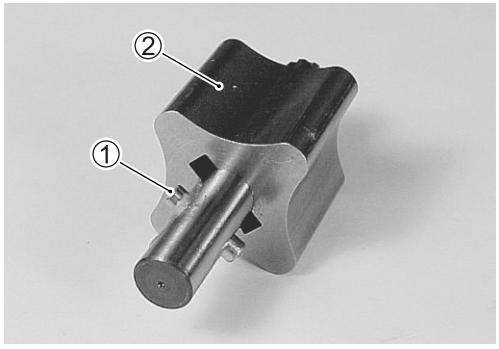
Using straightedge and feeler gauge, measure side clearance.

Side clearance:
Service limit: 0.15 mm (0.0059 in)

If measurement is not within specifications, replace the outer rotor and/or pump case.

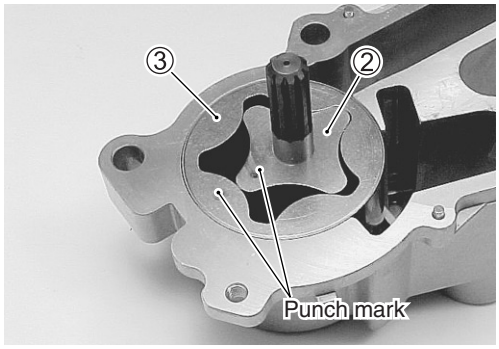
ASSEMBLY

1. Wash, clean and then dry all disassembled parts.
2. Apply thin coat of engine oil to inner and outer rotors, inside surfaces of oil pump case and plate.
3. Assemble pin ① and inner rotor ② to oil pump shaft.

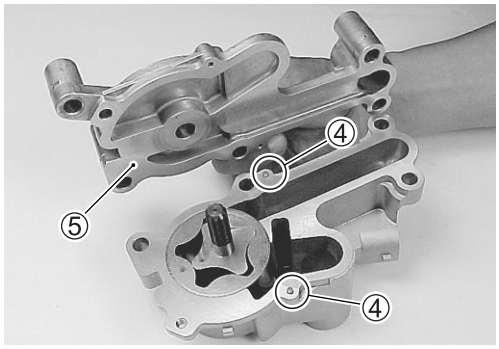


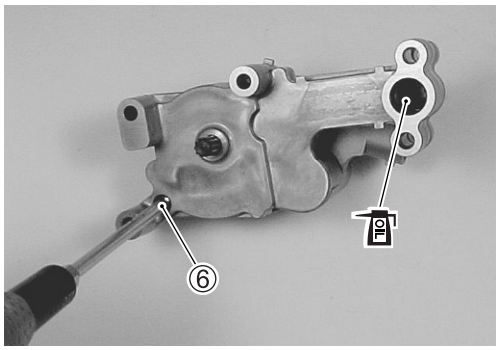
4. Install outer ③ and inner rotor ② to pump case.

NOTE:
When installing outer and inner rotors, the punch mark on each rotor must face rotor plate.



5. Install dowel pins ④ and rotor plate ⑤, and then tighten screw ⑥ securely.
   After mounting the rotor plate, make sure that each rotor turns smoothly by hand.
6. Pour approx. 50 ml (1.7 oz.) of engine oil into pump case for initial lubrication.



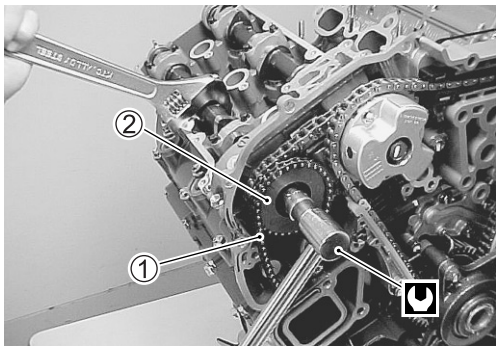


INSTALLATION

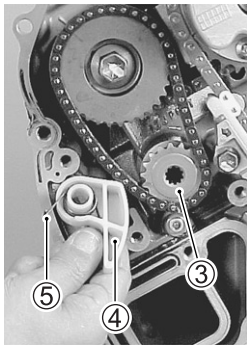
Installation is reverse order of removal with special attention to following steps.

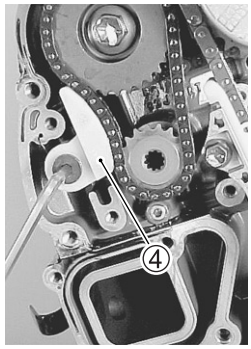
- Install oil pump drive chain ① and pump drive sprocket ② and tighten bolt securely.

Oil pump drive sprocket bolt: 78 N·m (7.8 kg-m, 56 lb-ft)



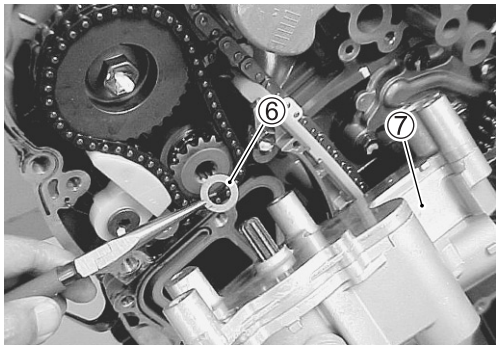
- Install oil pump driven gear ③, chain tensioner ④ and tensioner spring ⑤ as shown in figure, then tighten bolt securely.

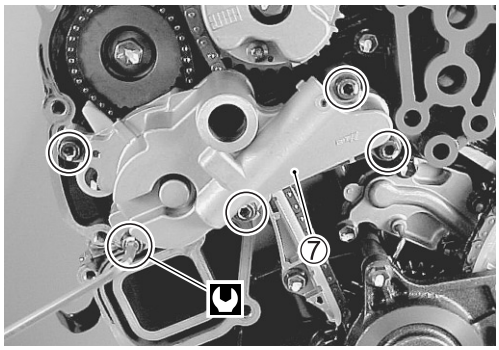




- Install washer ⑥ and oil pump assembly ⑦, then tighten five (5) bolts securely.

Oil pump bolt: 23 N·m (2.3 kg-m, 16.5 lb-ft)



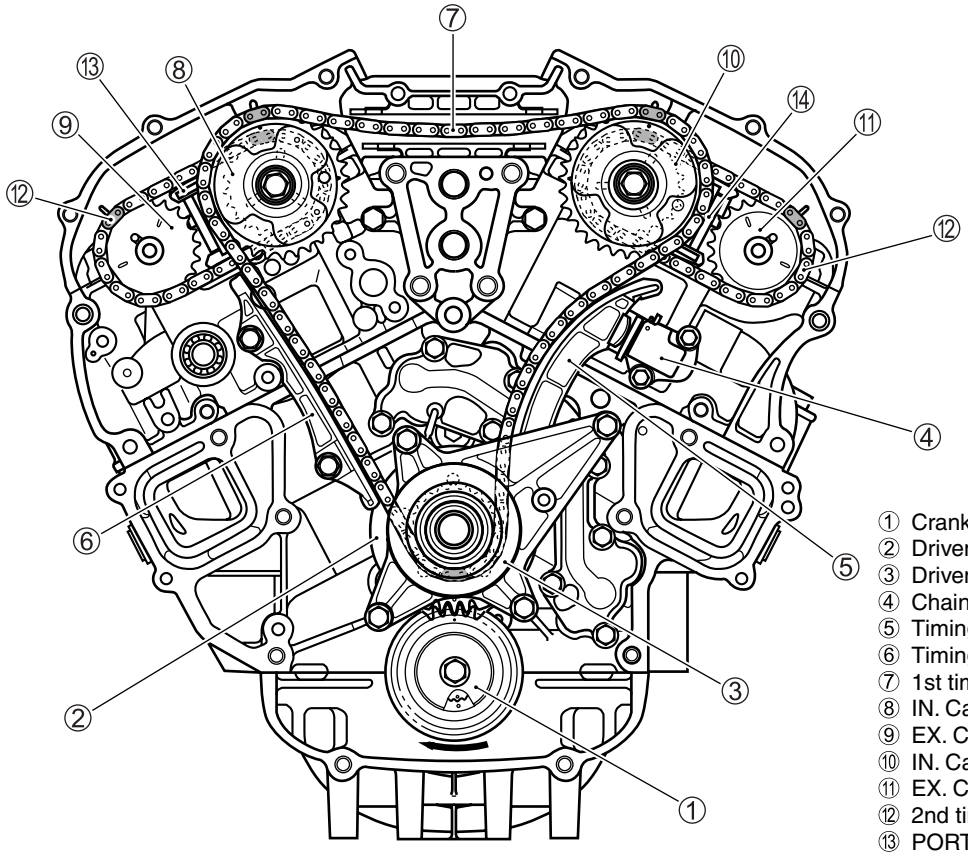


- Install cylinder head cover. (See page 6-10.)

TIMING CHAIN (VVT model)

REMOVAL

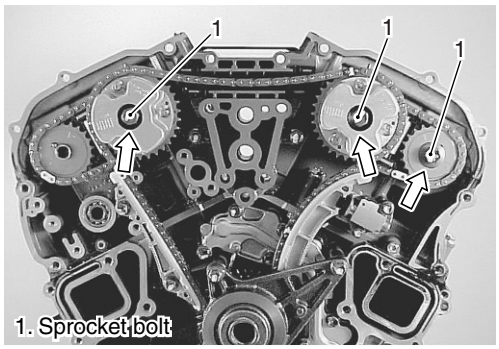
Prior to this service work:
- **Remove the power unit. (See page 6-12 to 6-18.)**



① Crankshaft/Drive gear
② Driven gear/Timing sprocket
③ Driven gear holder
④ Chain tensioner adjuster No. 1
⑤ Timing chain tensioner
⑥ Timing chain guide No. 2
⑦ 1st timing chain
⑧ IN. Camshaft timing sprocket (PORT)
⑨ EX. Camshaft timing sprocket (PORT)
⑩ IN. Camshaft timing sprocket (STBD)
⑪ EX. Camshaft timing sprocket (STBD)
⑫ 2nd timing chain
⑬ PORT chain tensioner
⑭ STBD chain tensioner

1. Remove the cylinder head cover. (See page 6-8 to 6-9.)
2. Remove the oil pump. (See page 6-23 to 6-24.)
3. Loosen the bolts securing IN./EX. camshaft timing sprockets to each cam shaft.

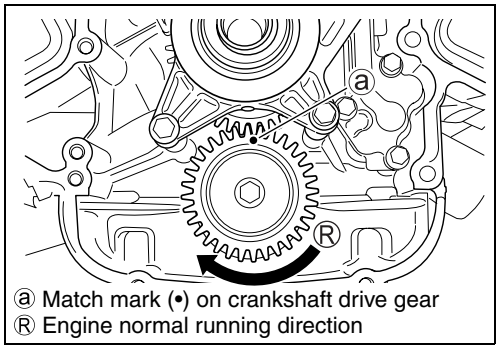
NOTE:
- *Sprocket bolt is LH thread.*
- *Hold camshaft by placing a wrench on the hexagon area of the camshaft.*



4. Turn the crankshaft in its normal running direction (Ⓡ_LH direction) until the match mark (•) on the crankshaft drive gear points to 12 o'clock (toward cylinder head).

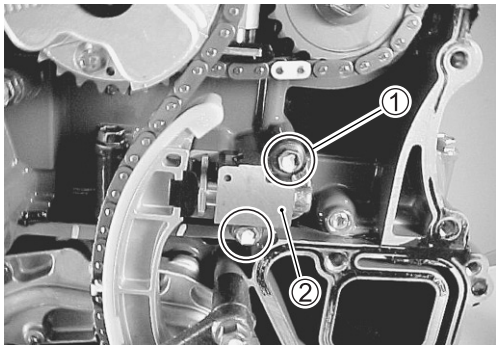
CAUTION

When timing chain has been removed, never turn crankshaft or camshaft.

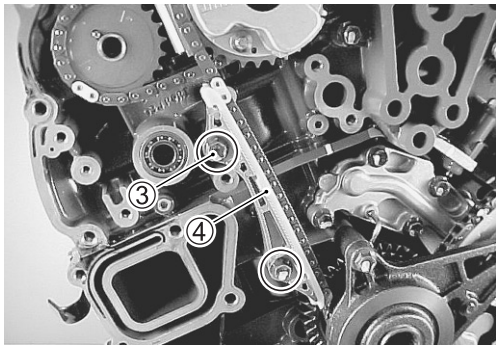


ⓐ Match mark (•) on crankshaft drive gear
Ⓡ Engine normal running direction

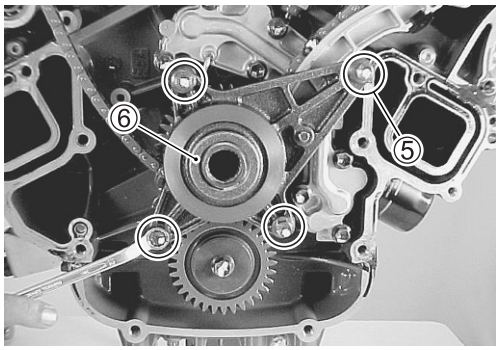
5. Remove the bolts ① and chain tensioner adjuster No. 1 ②.



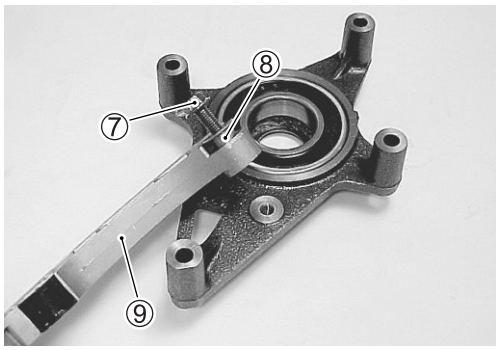
6. Remove the bolts ③ and timing chain guide No. 2 ④.



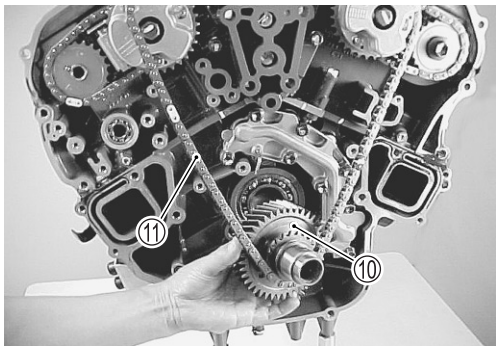
7. Remove the four (4) bolts ⑤ securing driven gear holder ⑥, then remove the driven gear holder (with timing chain tensioner).



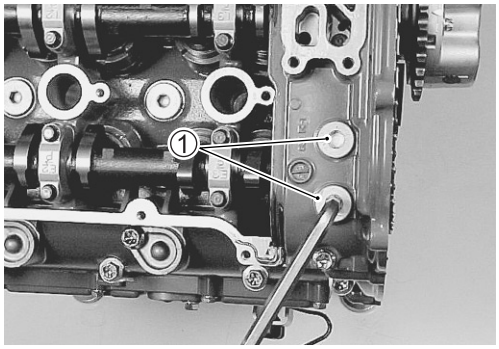
8. Remove the bolt ⑦, spacer ⑧, and timing chain tensioner ⑨.



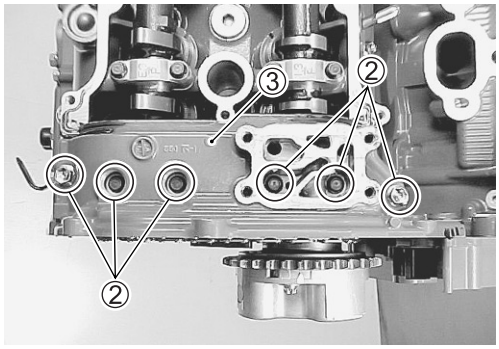
9. Remove the driven gear ⑩ and 1st timing chain ⑪.



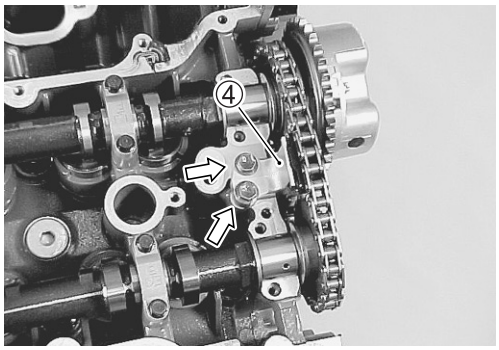
10. **[**On the PORT side bank**]**
    - Remove two (2) plugs ①.



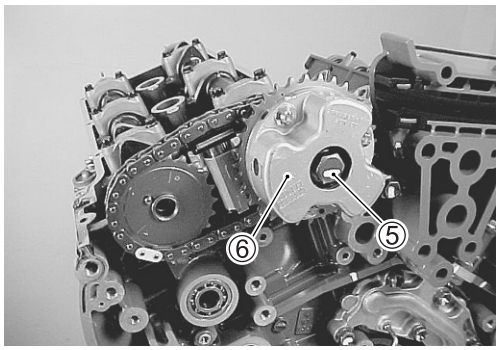
    - Remove the bolts ② securing lower camshaft housing ③, then remove the lower camshaft housing and dowel pins.



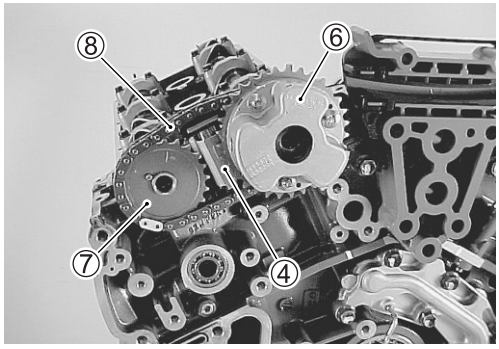
    - Remove two (2) bolts securing PORT chain tensioner ④.



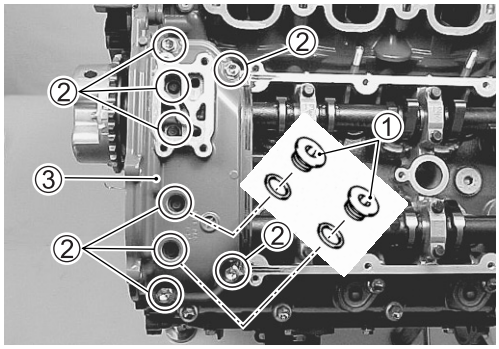
    - Remove the bolt ⑤ securing IN. camshaft timing sprocket ⑥.



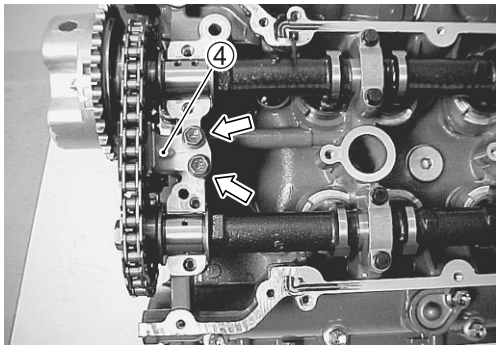
- Remove the IN. camshaft timing sprocket ⑥, EX. camshaft timing sprocket ⑦, 2nd timing chain ⑧ and PORT chain tensioner ④.
- Remove dowel pins from IN./EX. camshaft.



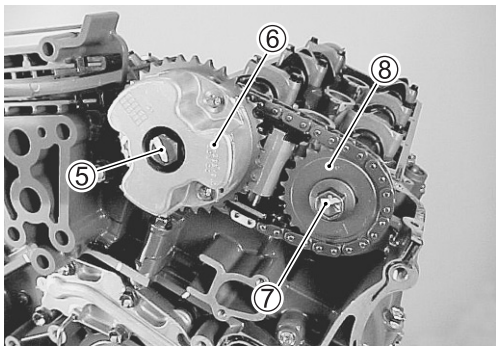
11. [On the STBD side bank]
- Remove two (2) plugs ①.
- Remove the bolts ② securing lower camshaft housing ③, then remove the lower camshaft housing and dowel pins.



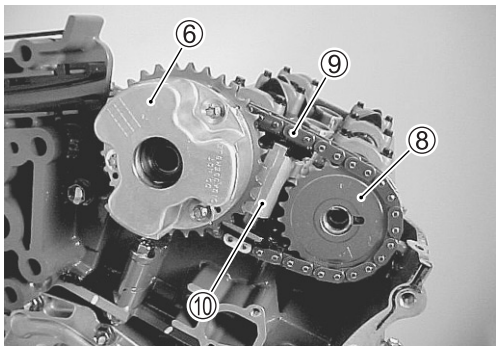
- Remove two (2) bolts securing STBD chain tensioner ④.



- Remove the bolt ⑤ securing IN. camshaft timing sprocket ⑥.
- Remove the bolt ⑦ securing EX. camshaft timing sprocket ⑧.



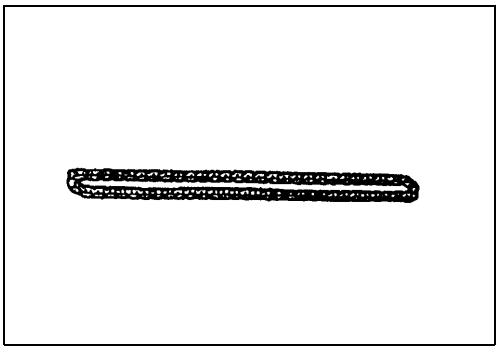
- Remove the IN. camshaft timing sprocket ⑥, EX. camshaft timing sprocket ⑧, 2nd timing chain ⑨ and STBD chain tensioner ⑩.
- Remove dowel pins from IN./EX. camshaft.



INSPECTION

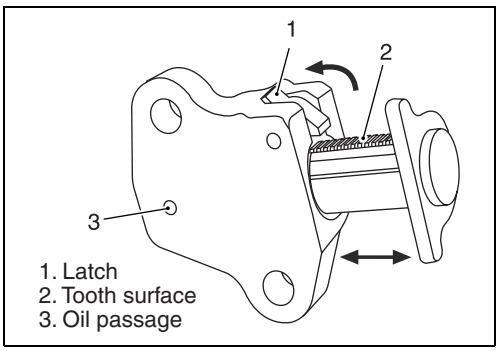
NOTE:
If any component is worn excessively, cracked, defective or damaged in any way, it must be replaced.

1ST TIMING CHAIN
- Inspect 1st timing chain.
  Replace if worn or damaged.

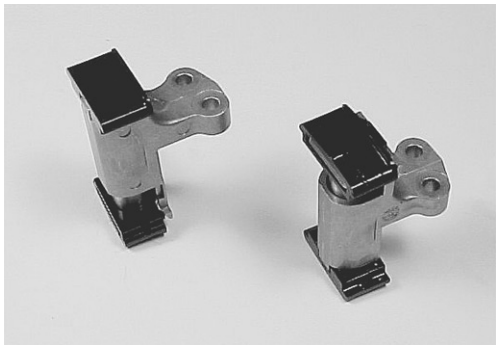


2ND TIMING CHAIN
- Inspect 2nd timing chain.
  Replace if worn or damaged.

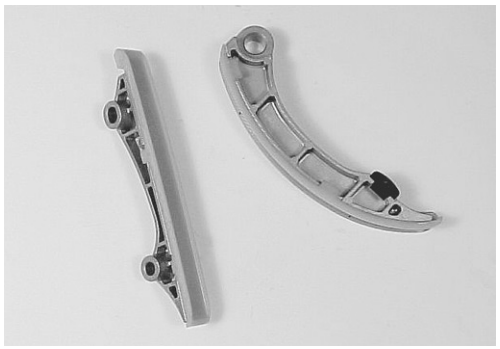
TENSIONER ADJUSTER NO. 1
- Inspect tensioner adjuster for smooth operation.
  Replace if faulty.
  Check oil delivery passage to tensioner.



PORT/STBD CHAIN TENSIONER
- Inspect chain tensioner for smooth operation.
  Replace if faulty.



TIMING CHAIN TENSIONER/CHAIN GUIDE NO. 2
- Check shoe for wear or damage.

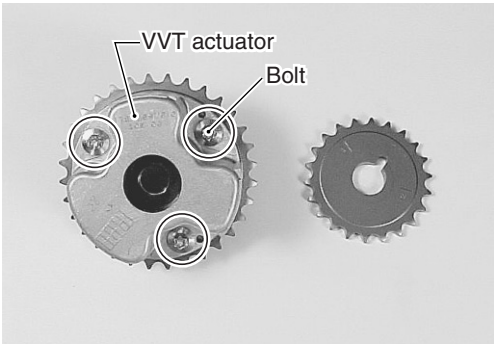


CAMSHAFT TIMING SPROCKET

- Check teeth of sprocket for wear or damage.

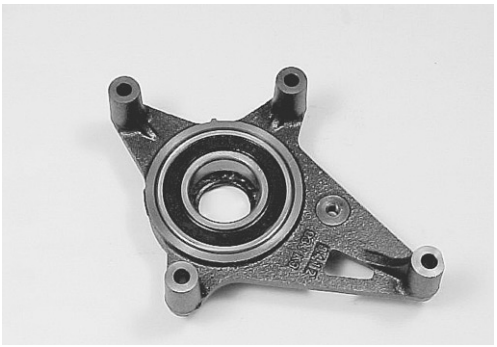
CAUTION

Do not attempt to remove bolts or disassemble the VVT actuator.

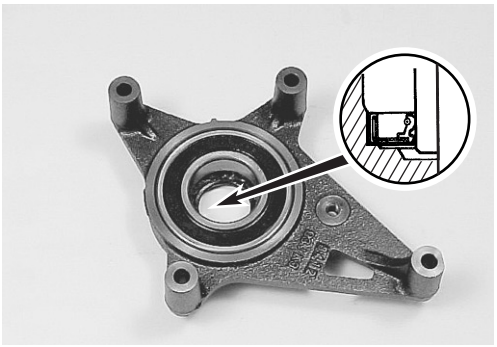


DRIVEN GEAR HOLDER

- Check driven gear holder.
  If cracks or other damage is found, replace holder.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough.
- Check oil seal.
  If excessive wear or other damage is found, replace seal.

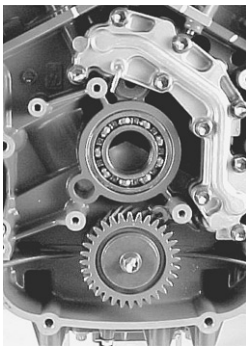


NOTE:
Install oil seal lip (spring side) facing as shown in figure.



DRIVE GEAR/DRIVEN GEAR/BEARING

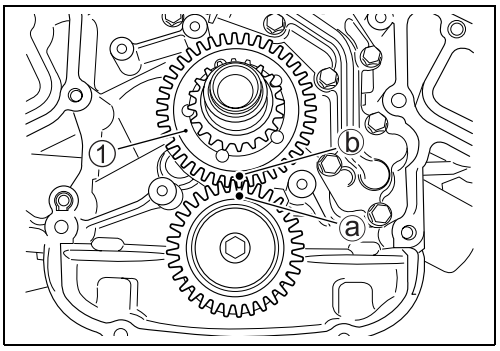
- Inspect drive and driven gears.
  Replace gear if damaged or worn.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough.



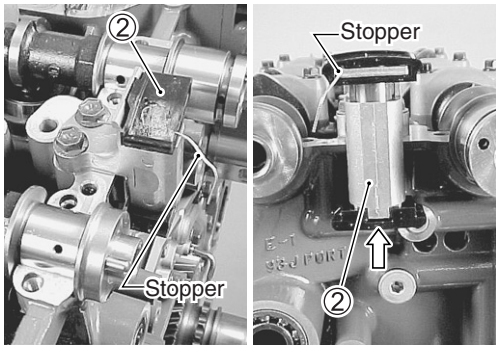
INSTALLATION

Installation is reverse of removal with special attention to following steps.

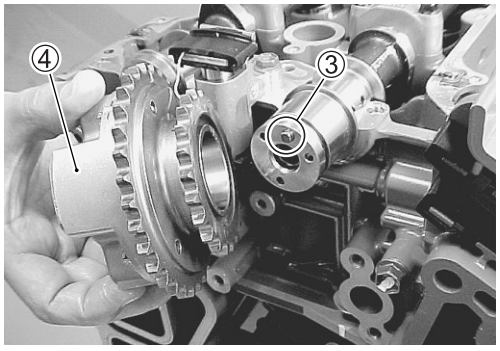
1. Check that the match mark (•) ⓐ on the crankshaft drive gear points to 12 o'clock (towards cylinder head).
2. Install the driven gear ① on the cylinder block so that the match mark (•) ⓐ aligns with match mark (•) ⓑ on the driven gear as shown in the illustration.



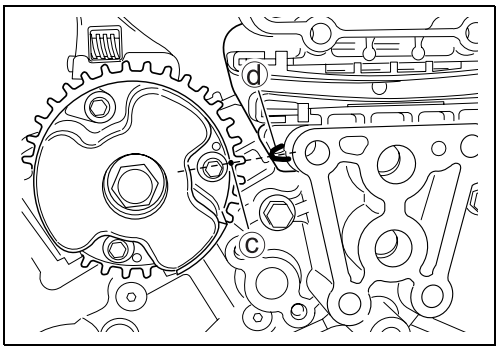
3. On the PORT side bank:
   (1) Install PORT tensioner ② and secure with bolts.
   (2) With plunger pushed back into body, insert stopper into body as shown in the illustration.
   After inserting stopper, check to make sure that plunger will not come out.



   (3) On the IN. camshaft, fit the dowel pin ③ and IN. camshaft timing sprocket ④ and tighten the sprocket temporarily with the bolt.
   Check that the match marks ⓒ·ⓓ are correctly aligned as shown in the illustration.

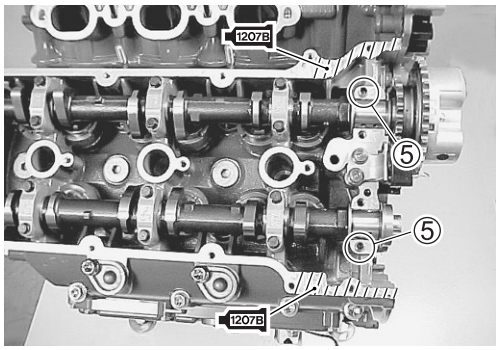


   Match mark ⓒ: •
   Match mark ⓓ: <



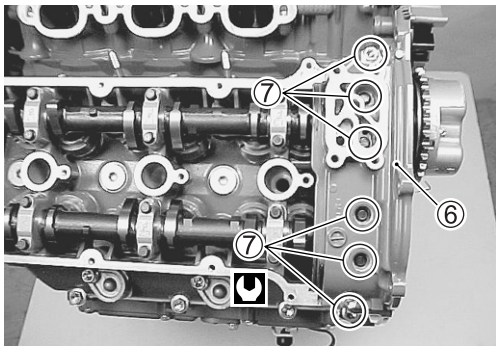
   (4) Remove oil, old sealant, and dust from sealing surface.
   (5) Apply sealant to lower camshaft housing sealing surface area as shown in figure.
   Install camshaft housing pins ⑤.

1207B 99000-31140: SUZUKI BOND "1207B"

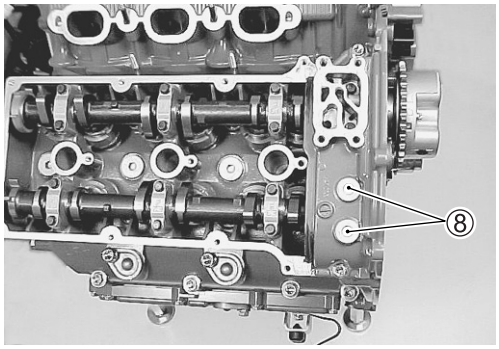


(6) Install lower camshaft housing ⑥.
Tighten lower camshaft housing bolts ⑦, pre-coated with engine oil, to specified torque.

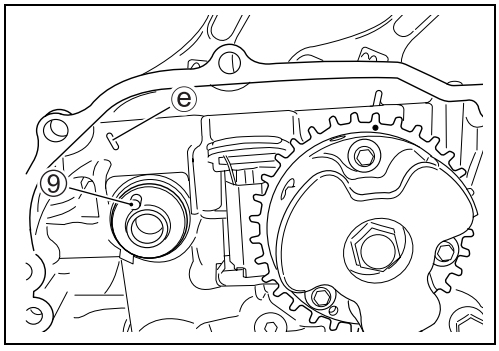
Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



(7) Install plugs ⑧ in lower camshaft housing.

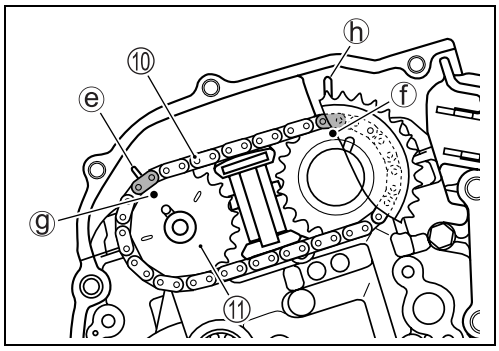


(8) Fit the dowel pin ⑨ on the EX. camshaft.
Check that the dowel pin is correctly aligned with the match mark ⓔ on the lower camshaft housing as shown in the illustration.

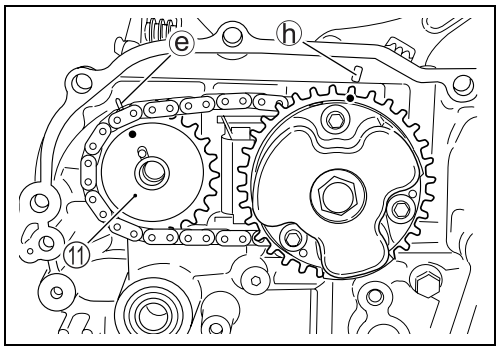


(9) Align the yellow plate of 2nd timing chain ⑩ with the match mark (•) ⓕ on the IN. camshaft timing sprocket, and fit the chain on the sprocket.
(10) Align the yellow plate of 2nd timing chain with the match mark (•) ⓖ on the EX. camshaft timing sprocket ⑪ and fit the chain on the sprocket.

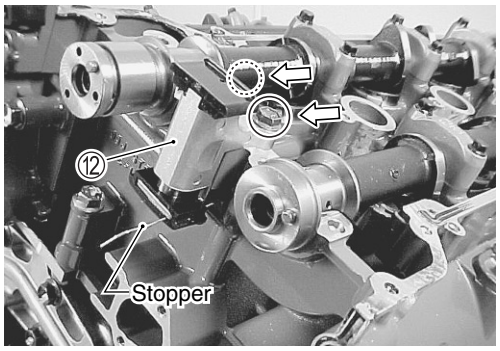
NOTE:
Install the sprocket so that the match mark and slit mark are both visible.



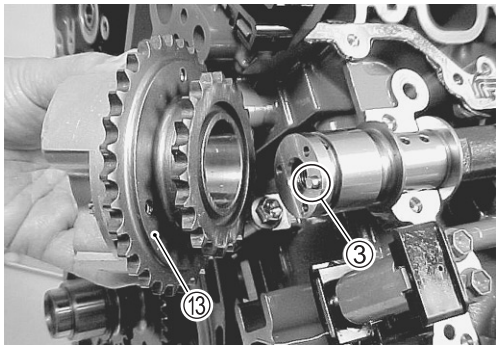
(11) Install the EX. camshaft timing sprocket ⑪ on the EX. camshaft.
Check that two yellow plates of the chain are correctly aligned with the match marks ⓔ/ⓗ on the camshaft housing as shown in the illustration.
(12) Remove the stopper from PORT tensioner.
(13) Apply engine oil to 2nd chain.



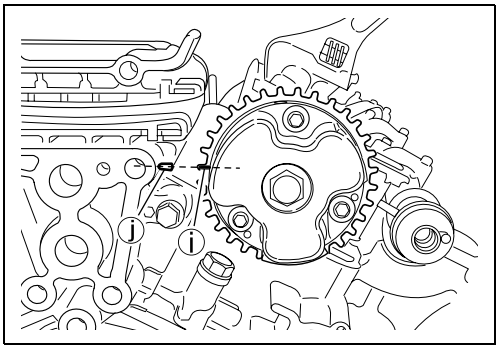
4. On the STBD side bank:
   (Install the STBD side 2nd timing chain in the same manner as the PORT side bank.)
   (1) Install STBD tensioner ⑫ and secure with bolts.
   (2) With plunger pushed back into body, insert stopper into body as shown in the illustration.
   After inserting stopper, check to make sure that plunger will not come out.



   (3) On the IN. camshaft, fit the dowel pin ③ and IN. camshaft timing sprocket ⑬ and tighten the sprocket temporarily with the bolt.
   Check that the match marks ⓘ/ⓙ are correctly aligned as shown in the illustration.

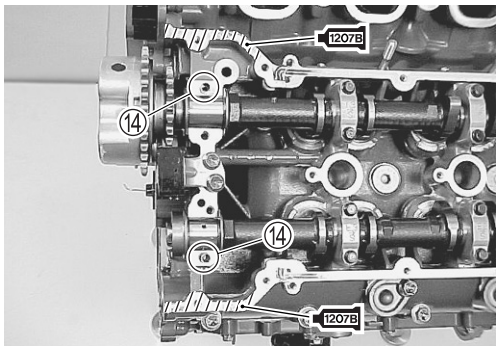


   Match mark ⓘ: ▪
   Match mark ⓙ: ▶



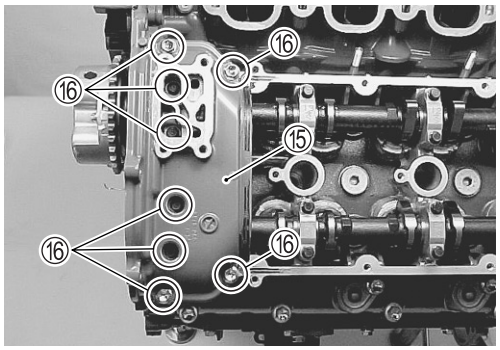
   (4) Remove oil, old sealant, and dust from sealing surface.
   (5) Apply sealant to lower camshaft housing sealing surface area as shown in figure.
   Install camshaft housing pins ⑭.

1207B **99000-31140: SUZUKI BOND "1207B"**

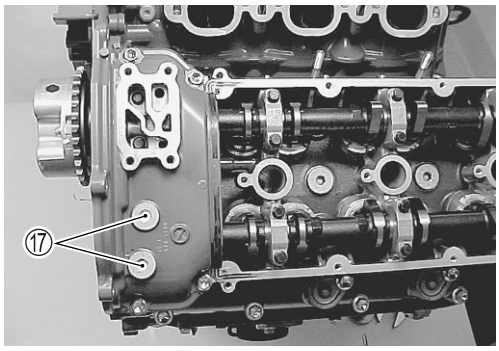


   (6) Install lower camshaft housing ⑮.
   Tighten lower camshaft housing bolts ⑯, pre-coated with engine oil, to specified torque.

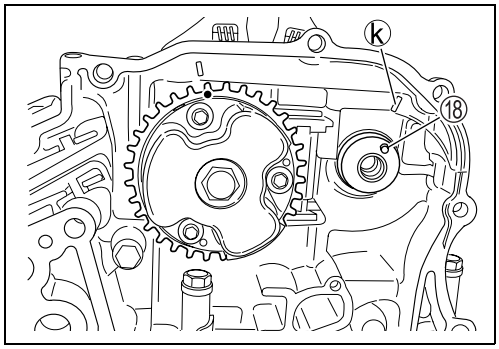
Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



(7) Install plugs ⑰ in lower camshaft housing.

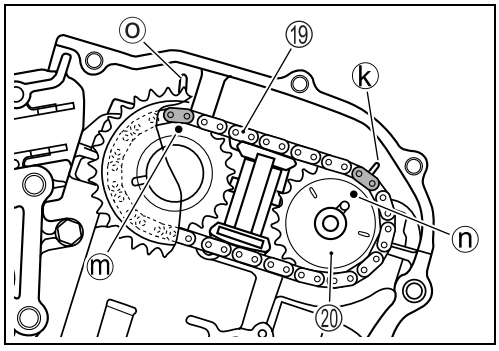


(8) Fit the dowel pin ⑱ on the EX. camshaft.
Check that the dowel pin is correctly aligned with the match mark ⓚ on the lower camshaft housing as shown in the illustration.

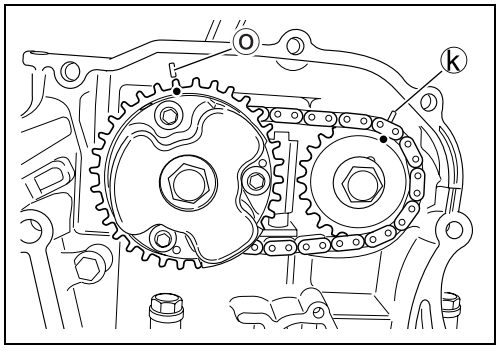


(9) Align the yellow plate of 2nd timing chain ⑲ with the match mark (•) ⓜ on the IN. camshaft timing sprocket and fit the chain on the sprocket.
(10) Align the yellow plate of 2nd timing chain with the match mark (•) ⓝ on the EX. camshaft timing sprocket ⑳ and fit the chain on the sprocket.

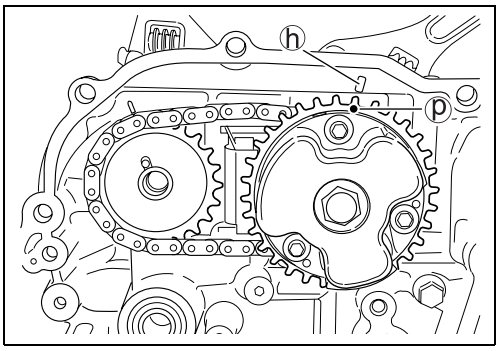
NOTE:
Install the sprocket so that the match mark and slit mark are both visible.

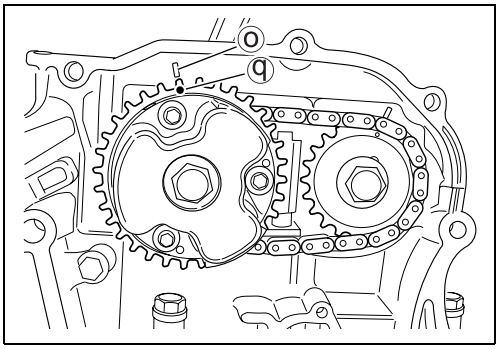


(11) Install the EX. camshaft timing sprocket ⑳ on the EX. camshaft, then tighten sprocket temporarily with the bolt.
Check that two yellow plates of the chain are correctly aligned with the match marks ⓞ/ⓚ on the camshaft housing as shown in the illustration.
(12) Remove the stopper from STBD tensioner.
(13) Apply engine oil to 2nd chain.

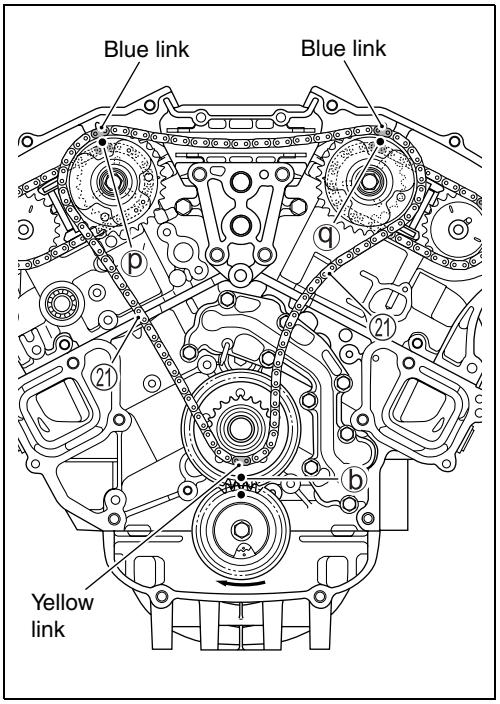


5. Check that the match marks (•) ⓟ/ⓠ on both the PORT & STBD side IN. camshaft timing sprockets are correctly aligned with the match marks ⓗ·ⓞ on the camshaft housing as shown in the illustration.

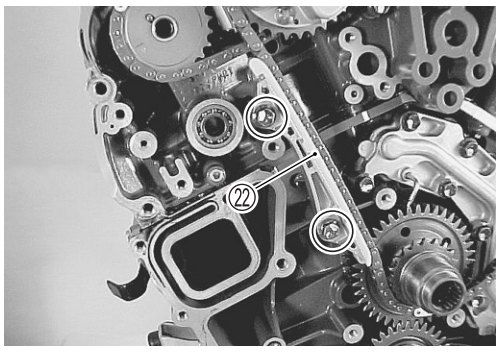




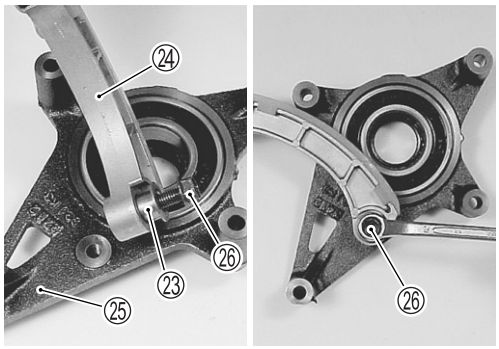
6. As shown in the illustration, fit the 1st timing chain ㉑ with one blue link aligned with the match mark (•) ⓟ on the PORT side IN. camshaft timing sprocket and one blue link aligned with the match mark (•) ⓠ on the STBD side IN. camshaft timing sprocket.
7. As shown in the illustration, fit the 1st timing chain with its yellow link aligned with the match mark (•) ⓑ on the driven gear.



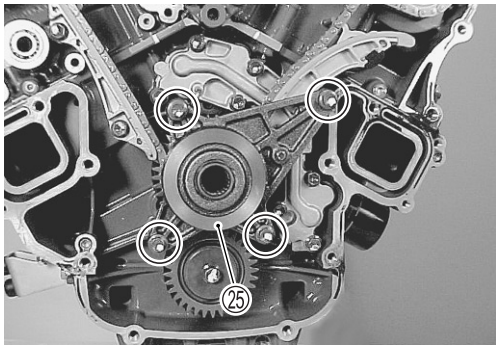
8. Install No. 2 timing chain guide ㉒, then tighten bolts securely. Apply engine oil to chain guide.



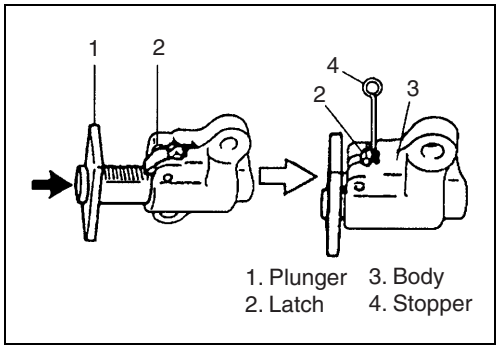
9. Insert the spacer ㉓ into chain tensioner ㉔.
   Install chain tensioner to driven gear holder ㉕, then tighten bolt ㉖ securely.
   Apply engine oil to chain tensioner.



10. Install driven gear holder ㉕, then tighten four (4) bolts securely.



11. With latch of tensioner adjuster ㉖ pushed in and plunger pushed back into body, insert stopper into latch and body.
    After inserting stopper, check to make sure that plunger will not come out.

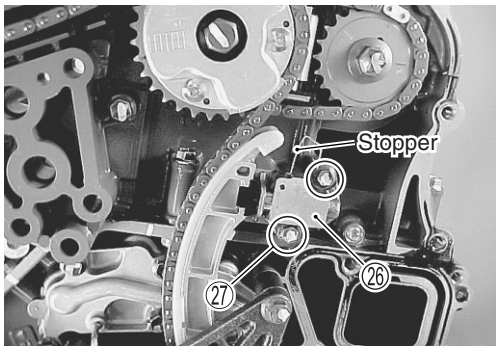


12. Install timing chain tensioner adjuster ㉖, then tighten bolts ㉗ to specified torque.

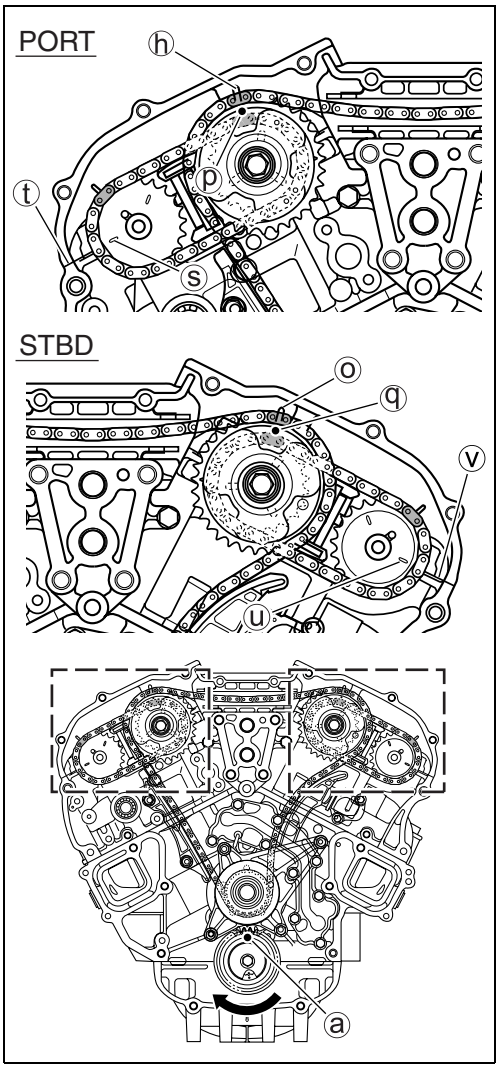
Tensioner adjuster bolt: 11 N·m (1.1 kg-m, 8.0 lb-ft)

Apply engine oil to timing chain.

13. Remove the stopper from tensioner adjuster.



14. Turn the crankshaft two (2) complete rotations in direction shown in figure.
    As shown in the illustration, check that all match marks are in alignment as written below when the match mark (•) ⓐ on the drive gear is pointing to 12:00 o'clock.
    - The match mark (•) ⓟ on the PORT side IN. sprocket aligns with the match mark ⓗ on the camshaft housing.
    - The match mark (•) ⓠ on the STBD side IN. sprocket aligns with the match mark ⓞ on the camshaft housing.
    - The match mark (slit) ⓢ on the PORT side EX. sprocket aligns with the mating face ⓣ of lower camshaft housing.
    - The match mark (slit) ⓤ on the STBD side EX. sprocket aligns with the mating face ⓥ of lower camshaft housing.

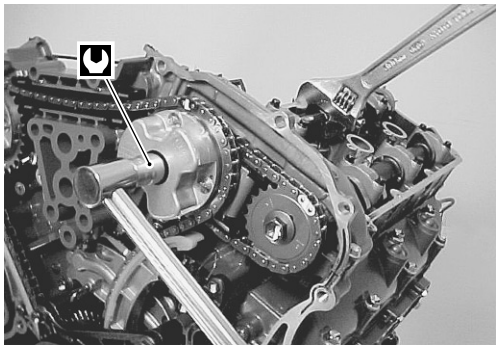


15. Tighten PORT/STBD IN. camshaft timing sprocket bolts to specified torque.

IN. camshaft timing sprocket bolt:
60 N·m (6.0 kg-m, 43.4 lb-ft)

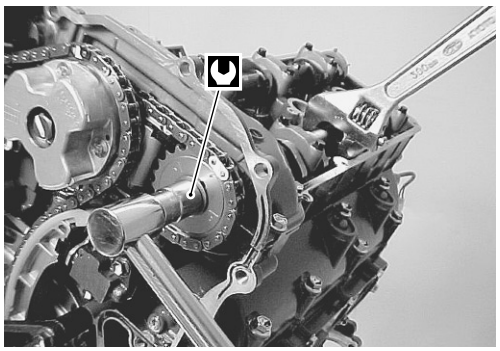
CAUTION

Do not over tighten to avoid damaging VVT actuator.



16. Tighten PORT/STBD EX. camshaft timing sprocket bolts to specified torque.

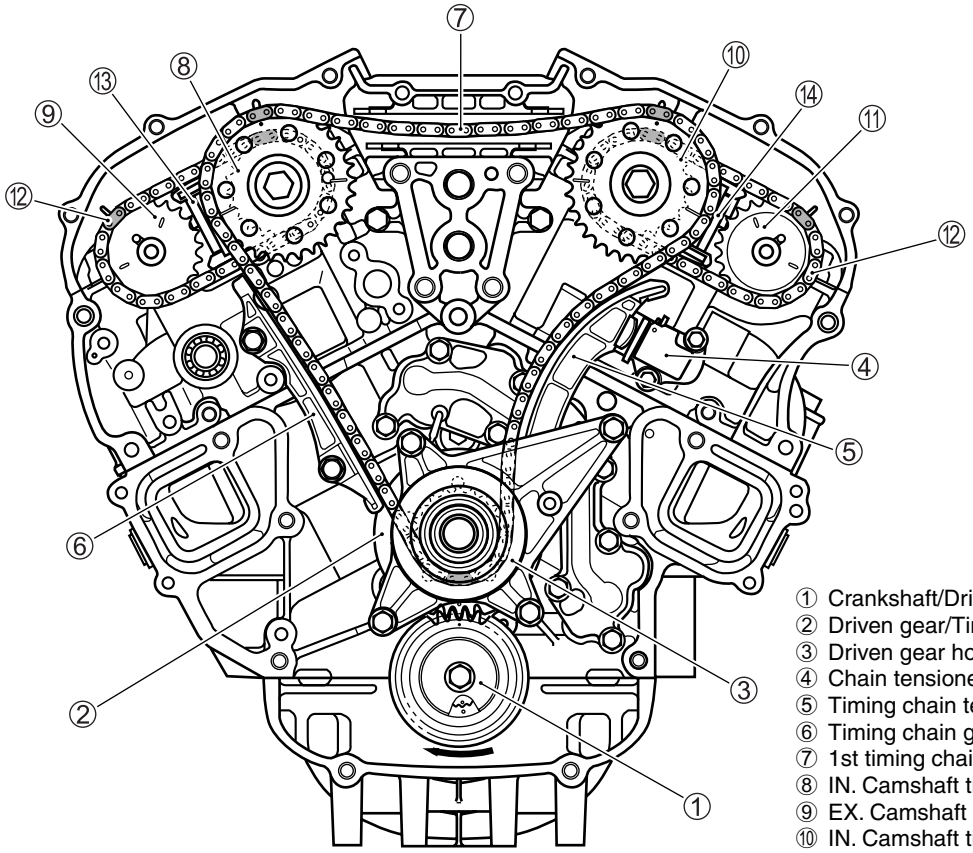
EX. camshaft timing sprocket bolt:
78 N·m (7.8 kg-m, 56 lb-ft)



TIMING CHAIN (Non-VVT model)

REMOVAL

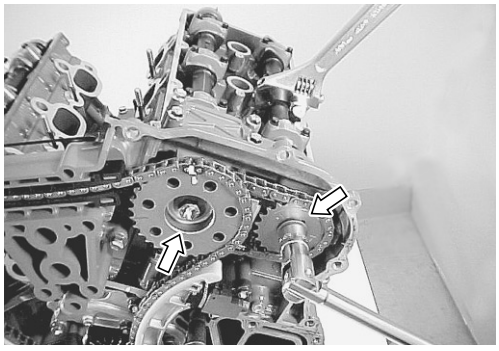
Prior to this service work:
- **Remove the power unit. (See page 6-12 to 6-18.)**



① Crankshaft/Drive gear
② Driven gear/Timing sprocket
③ Driven gear holder
④ Chain tensioner adjuster No. 1
⑤ Timing chain tensioner
⑥ Timing chain guide No. 2
⑦ 1st timing chain
⑧ IN. Camshaft timing sprocket No. 1 & 2 (PORT)
⑨ EX. Camshaft timing sprocket (PORT)
⑩ IN. Camshaft timing sprocket No. 1 & 2 (STBD)
⑪ EX. Camshaft timing sprocket (STBD)
⑫ 2nd timing chain
⑬ PORT chain tensioner
⑭ STBD chain tensioner

1. Remove the cylinder head cover. (See page 6-8 to 6-9.)
2. Remove the oil pump. (See page 6-23 to 6-24.)
3. Loosen the bolts securing IN./EX. camshaft timing sprockets to each cam shaft.

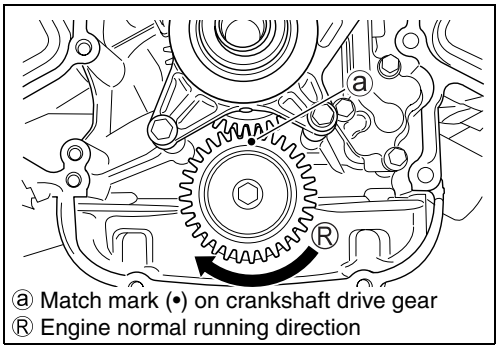
NOTE:
- *Sprocket bolt is LH thread.*
- *Hold camshaft by placing a wrench on the hexagon area of the camshaft.*



4. Turn the crankshaft in its normal running direction (Ⓡ_LH direction) until the match mark (•) on the crankshaft drive gear points to 12 o'clock (toward cylinder head).

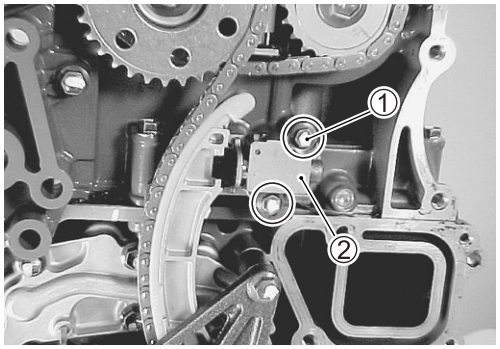
CAUTION

When timing chain has been removed, never turn crankshaft or camshaft.

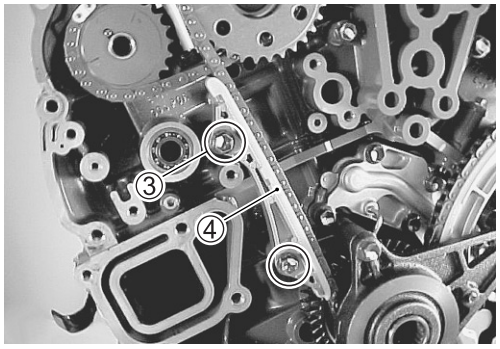


ⓐ Match mark (•) on crankshaft drive gear
Ⓡ Engine normal running direction

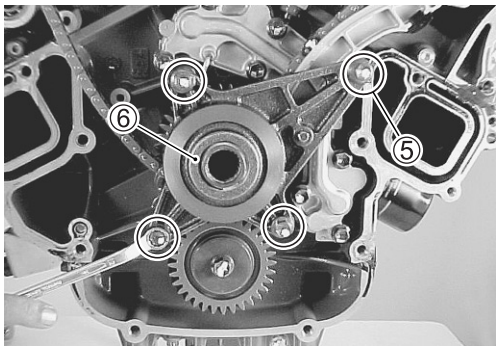
5. Remove the bolts ① and chain tensioner adjuster No. 1 ②.



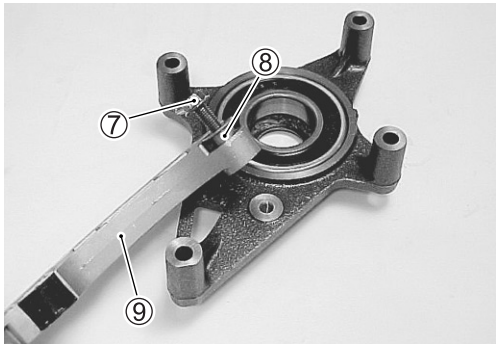
6. Remove the bolts ③ and timing chain guide No. 2 ④.



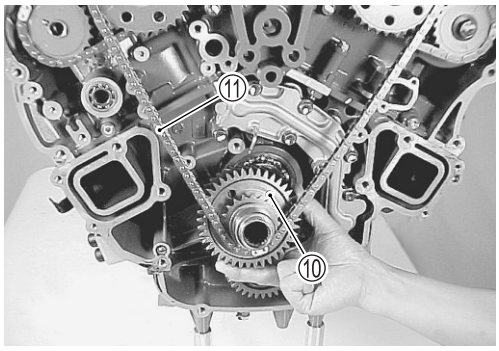
7. Remove the four (4) bolts ⑤ securing driven gear holder ⑥, then remove the driven gear holder (with timing chain tensioner).



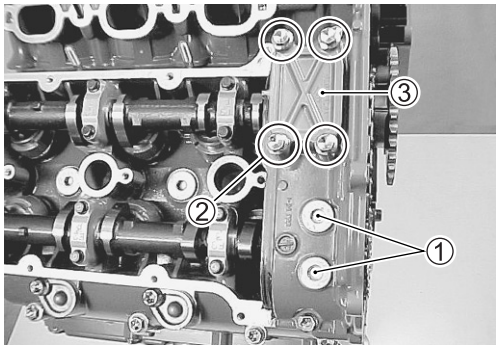
8. Remove the bolt ⑦, spacer ⑧, and timing chain tensioner ⑨.



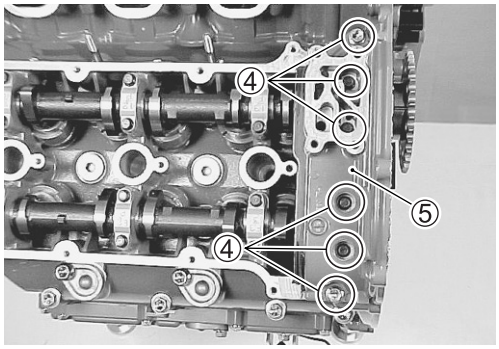
9. Remove the driven gear ⑩ and 1st timing chain ⑪.



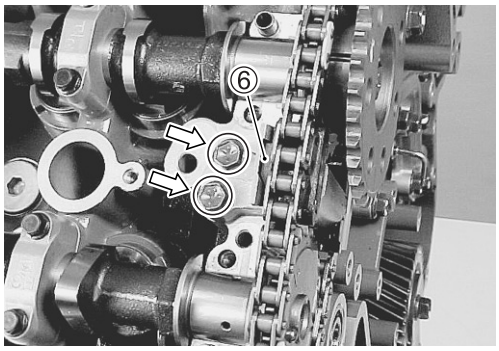
10. [On the PORT side bank]
    - Remove two (2) plugs ①.
    - Remove four bolts ② and plate ③.



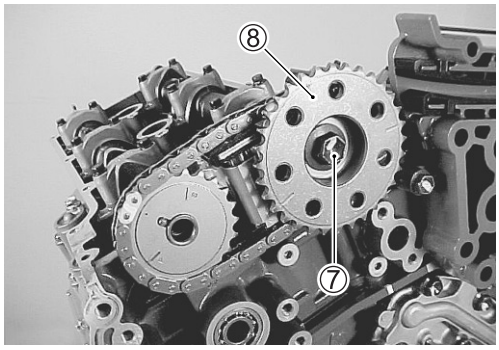
- Remove the bolts ④ securing lower camshaft housing ⑤, then remove the lower camshaft housing and dowel pins.



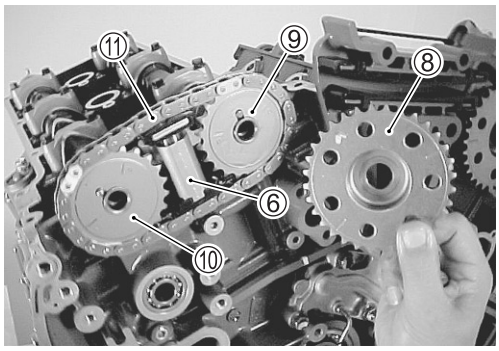
- Remove two (2) bolts securing PORT chain tensioner ⑥.



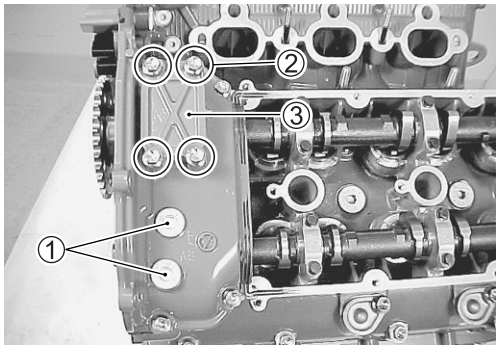
- Remove the bolt ⑦ securing IN. camshaft timing sprocket ⑧.



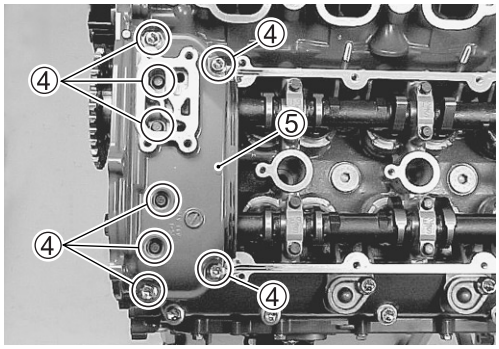
- Remove the IN. camshaft timing sprocket No. 1 ⑧, IN. camshaft timing sprocket No. 2 ⑨, EX. camshaft timing sprocket ⑩, 2nd timing chain ⑪ and PORT chain tensioner ⑥.
- Remove dowel pins from IN./EX. camshaft.



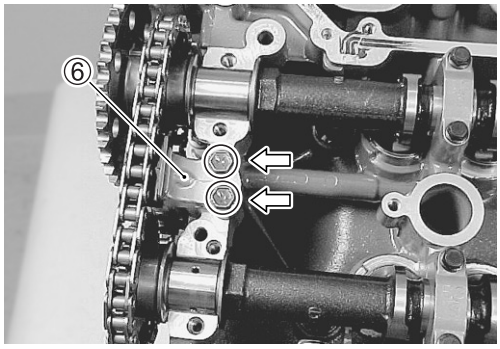
11. [On the STBD side bank]
    - Remove two (2) plugs ①.
    - Remove four bolts ② and plate ③.



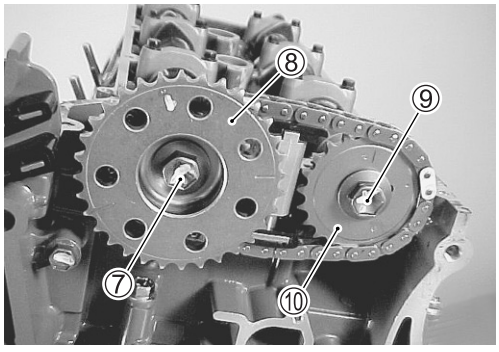
- Remove the bolts ④ securing lower camshaft housing ⑤, then remove the lower camshaft housing and dowel pins.



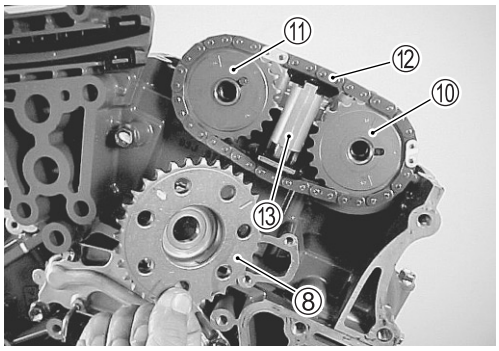
- Remove two (2) bolts securing STBD chain tensioner ⑥.



- Remove the bolt ⑦ securing IN. camshaft timing sprocket ⑧.
- Remove the bolt ⑨ securing EX. camshaft timing sprocket ⑩.



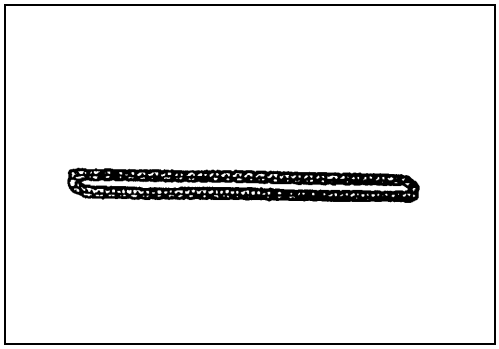
- Remove the IN. camshaft timing sprocket No. 1 ⑧, IN. camshaft timing sprocket No. 2 ⑪, EX. camshaft timing sprocket ⑩, 2nd timing chain ⑫ and STBD chain tensioner ⑬.
- Remove dowel pins from IN./EX. camshaft.



INSPECTION

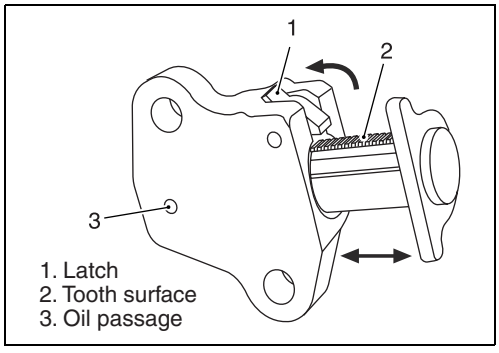
NOTE:
If any component is worn excessively, cracked, defective or damaged in any way, it must be replaced.

1ST TIMING CHAIN
- Inspect 1st timing chain.
  Replace if worn or damaged.

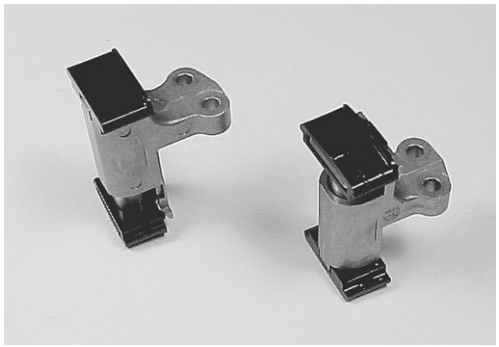


2ND TIMING CHAIN
- Inspect 2nd timing chain.
  Replace if worn or damaged.

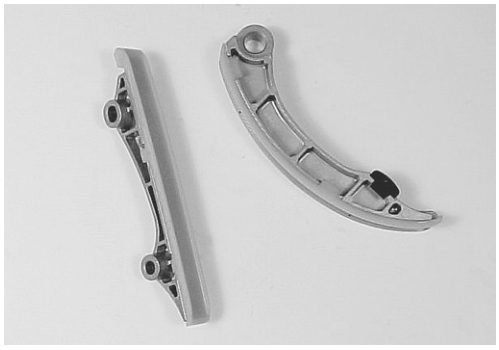
TENSIONER ADJUSTER NO. 1
- Inspect tensioner adjuster for smooth operation.
  Replace if faulty.
  Check oil delivery passage to tensioner.



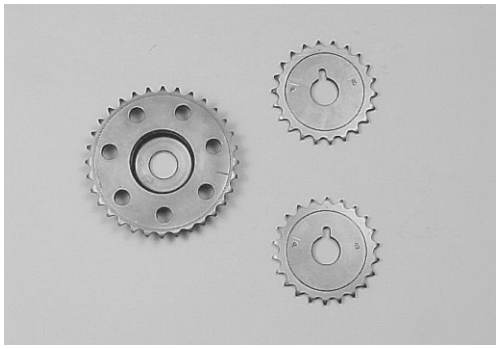
PORT/STBD CHAIN TENSIONER
- Inspect chain tensioner for smooth operation.
  Replace if faulty.



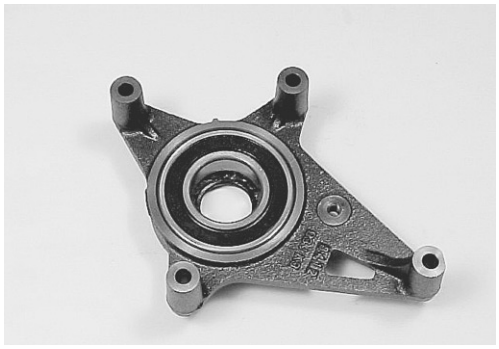
TIMING CHAIN TENSIONER/CHAIN GUIDE NO. 2
- Check shoe for wear or damage.



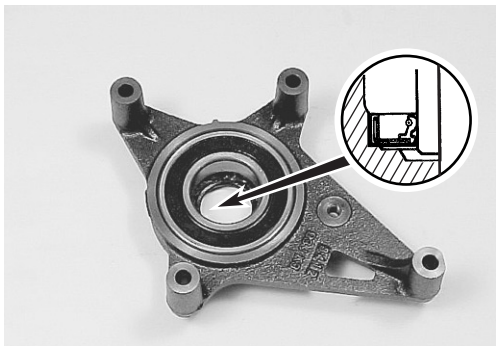
CAMSHAFT TIMING SPROCKET
- Check teeth of sprocket for wear or damage.



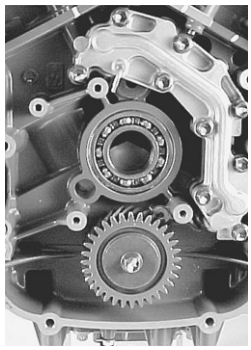
DRIVEN GEAR HOLDER
- Check driven gear holder.
  If cracks or other damage is found, replace holder.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough.
- Check oil seal.
  If excessive wear or other damage is found, replace seal.



NOTE:
Install oil seal lip (spring side) facing as shown in figure.



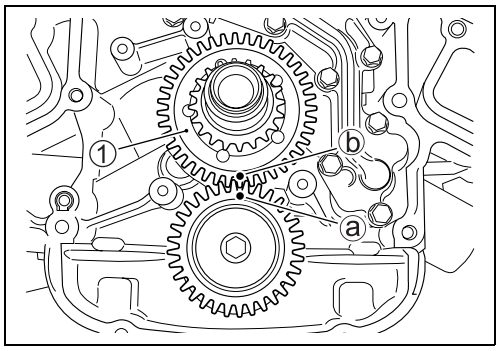
DRIVE GEAR/DRIVEN GEAR/BEARING
- Inspect drive and driven gears.
  Replace gear if damaged or worn.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough.



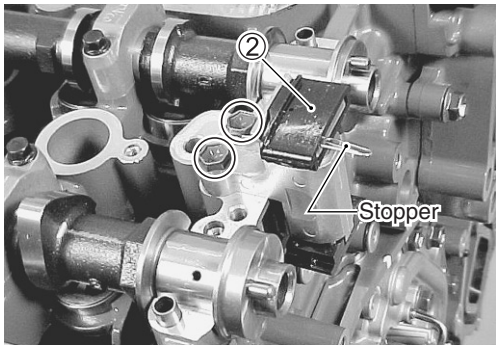
INSTALLATION

Installation is reverse of removal with special attention to following steps.

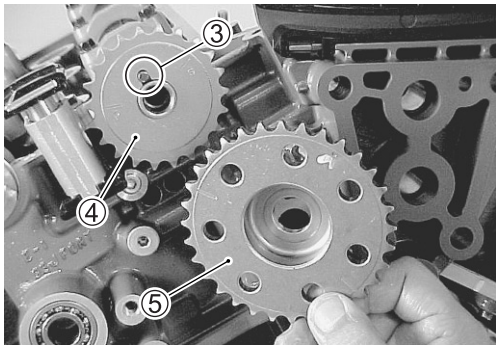
1. Check that the match mark (•) ⓐ on the crankshaft drive gear points to 12 o'clock (towards cylinder head).
2. Install the driven gear ① on the cylinder block so that the match mark (•) ⓐ aligns with match mark (•) ⓑ on the driven gear as shown in the illustration.



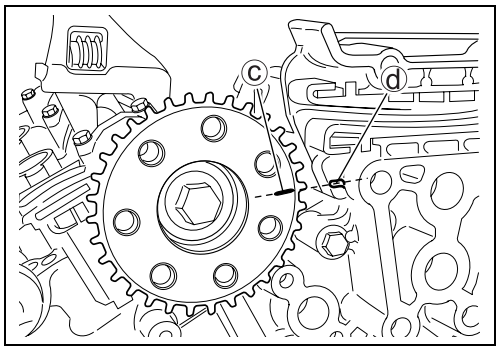
3. On the PORT side bank:
   (1) Install PORT tensioner ② and secure with bolts.
   (2) With plunger pushed back into body, insert stopper into body as shown in the illustration.
   After inserting stopper, check to make sure that plunger will not come out.



   (3) On the IN. camshaft, fit the dowel pin ③ and IN. camshaft timing sprocket No. 2 ④, timing sprocket No. 1 ⑤ and tighten the sprocket temporarily with the bolt.
   Check that the match marks ⓒ·ⓓ are correctly aligned as shown in the illustration.

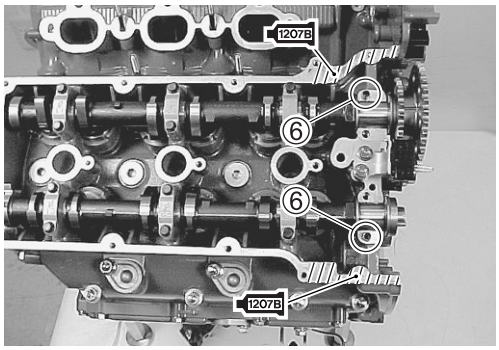


   Match mark ⓒ: —
   Match mark ⓓ: <



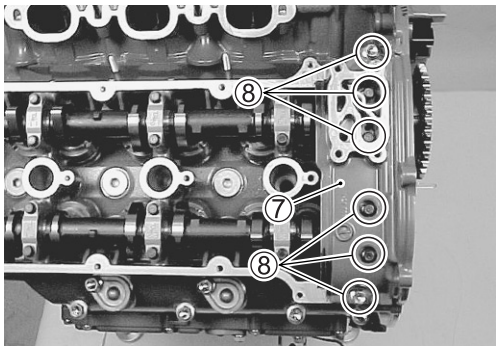
   (4) Remove oil, old sealant, and dust from sealing surface.
   (5) Apply sealant to lower camshaft housing sealing surface area as shown in figure.
   Install camshaft housing pins ⑥.

1207B **99000-31140: SUZUKI BOND "1207B"**

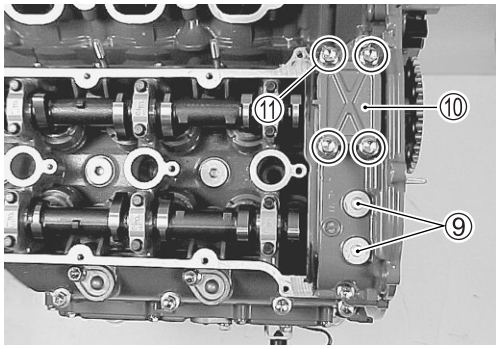


(6) Install lower camshaft housing ⑦.
Tighten lower camshaft housing bolts ⑧, pre-coated with engine oil, to specified torque.

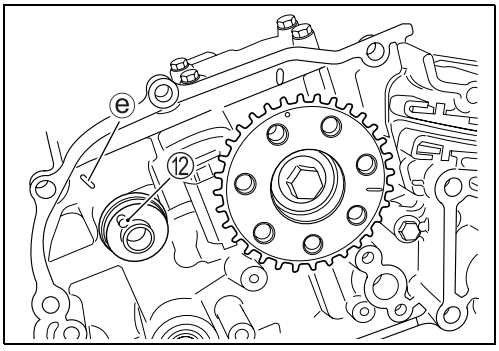
Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



(7) Install plugs ⑨ in lower camshaft housing.
Install plate ⑩, then tighten bolts ⑪ securely.

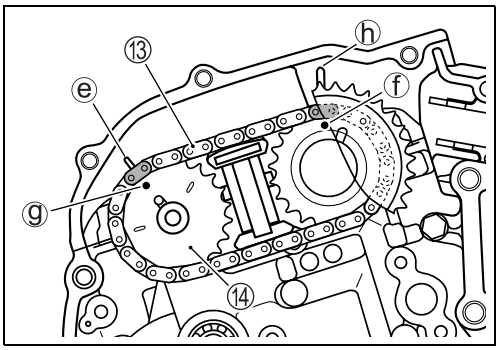


(8) Fit the dowel pin ⑫ on the EX. camshaft.
Check that the dowel pin is correctly aligned with the match mark ⓔ on the lower camshaft housing as shown in the illustration.

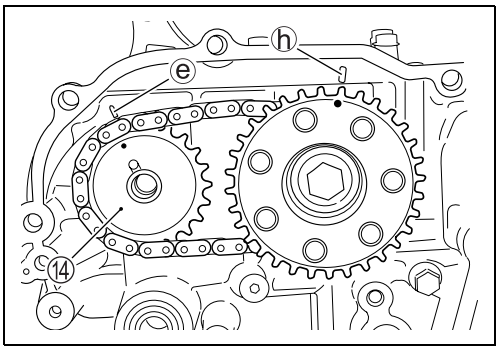


(9) Align the yellow plate of 2nd timing chain ⑬ with the match mark (•) ⓕ on the IN. camshaft timing sprocket No.2, and fit the chain on the sprocket.
(10) Align the yellow plate of 2nd timing chain with the match mark (•) ⓖ on the EX. camshaft timing sprocket ⑭ and fit the chain on the sprocket.

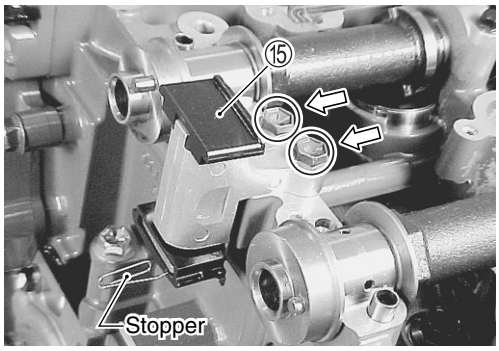
NOTE:
Install the sprocket so that the match mark and slit mark are both visible.



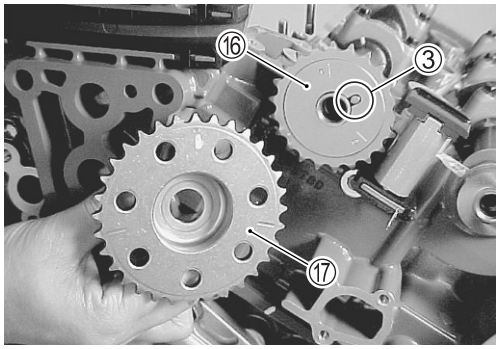
(11) Install the EX. camshaft timing sprocket ⑭ on the EX. camshaft.
Check that two yellow plates of the chain are correctly aligned with the match marks ⓔ/ⓗ on the camshaft housing as shown in the illustration.
(12) Remove the stopper from PORT tensioner.
(13) Apply engine oil to 2nd chain.



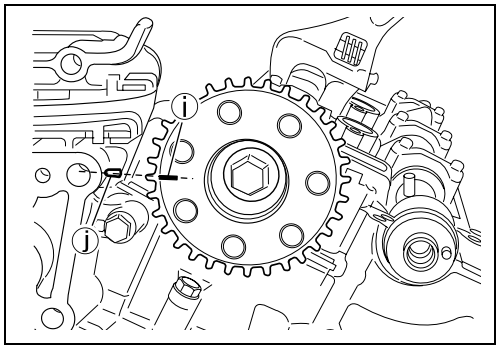
4. On the STBD side bank:
   (Install the STBD side 2nd timing chain in the same manner as the PORT side bank.)
   (1) Install STBD tensioner ⑮ and secure with bolts.
   (2) With plunger pushed back into body, insert stopper into body as shown in the illustration.
   After inserting stopper, check to make sure that plunger will not come out.



   (3) On the IN. camshaft, fit the dowel pin ③ and IN. camshaft timing sprocket No. 2 ⑯, timing sprocket No. 1 ⑰ and tighten the sprocket temporarily with the bolt.
   Check that the match marks ⓘ/ⓙ are correctly aligned as shown in the illustration.

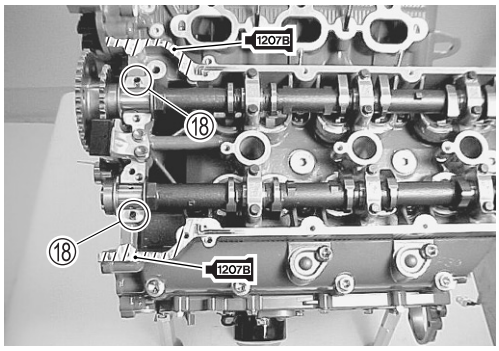


   Match mark ⓘ: —
   Match mark ⓙ: ⊃



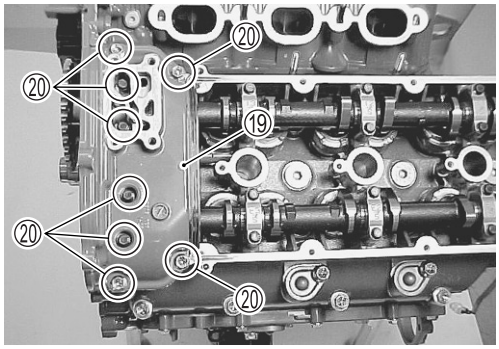
   (4) Remove oil, old sealant, and dust from sealing surface.
   (5) Apply sealant to lower camshaft housing sealing surface area as shown in figure.
   Install camshaft housing pins ⑱.

1207B 99000-31140: SUZUKI BOND "1207B"

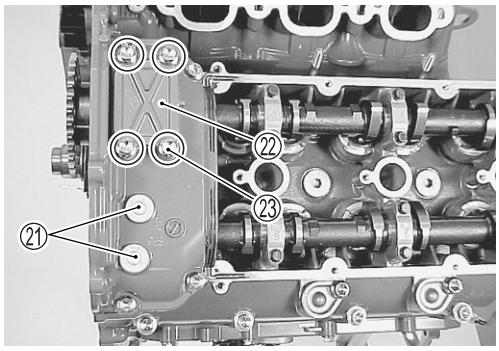


   (6) Install lower camshaft housing ⑲.
   Tighten lower camshaft housing bolts ⑳, pre-coated with engine oil, to specified torque.

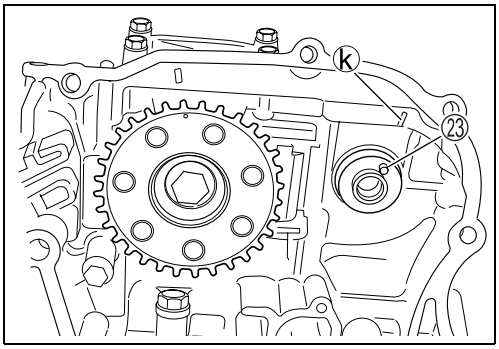
Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



(7) Install plugs ㉑ in lower camshaft housing.
Install plate ㉒, then tighten bolts ㉓ securely.

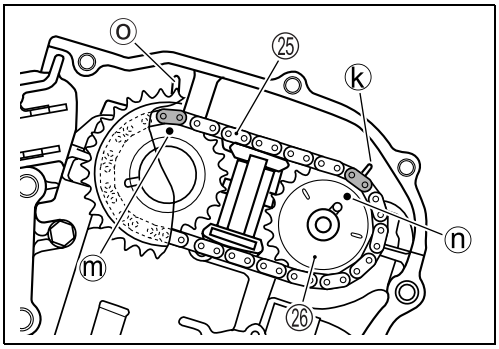


(8) Fit the dowel pin ㉔ on the EX. camshaft.
Check that the dowel pin is correctly aligned with the match mark ⓚ on the lower camshaft housing as shown in the illustration.

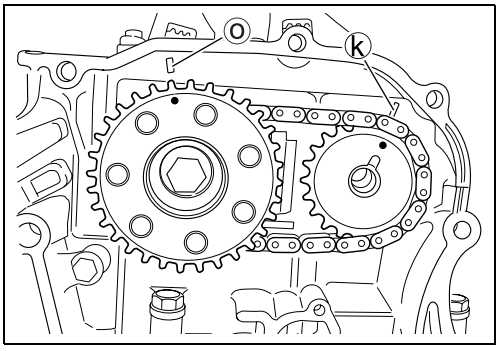


(9) Align the yellow plate of 2nd timing chain ㉕ with the match mark (•) ⓜ on the IN. camshaft timing sprocket No.2 and fit the chain on the sprocket.
(10) Align the yellow plate of 2nd timing chain with the match mark (•) ⓝ on the EX. camshaft timing sprocket ㉖ and fit the chain on the sprocket.

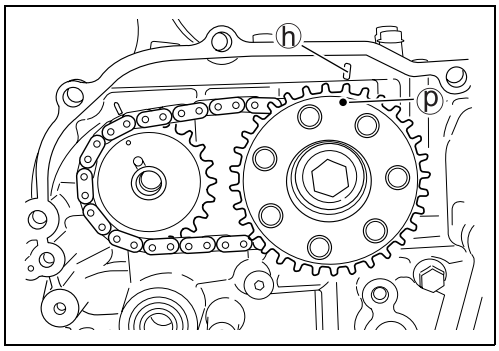
NOTE:
Install the sprocket so that the match mark and slit mark are both visible.

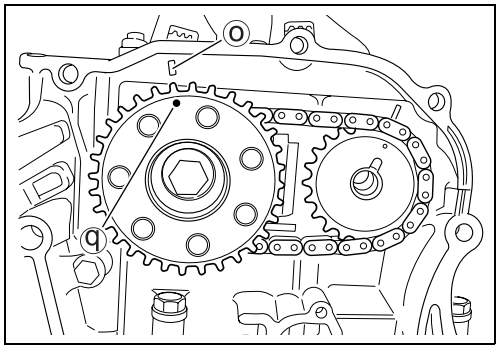


(11) Install the EX. camshaft timing sprocket ㉖ on the EX. camshaft, then tighten sprocket temporarily with the bolt.
Check that two yellow plates of the chain are correctly aligned with the match marks ⓞ/ⓚ on the camshaft housing as shown in the illustration.
(12) Remove the stopper from STBD tensioner.
(13) Apply engine oil to 2nd chain.

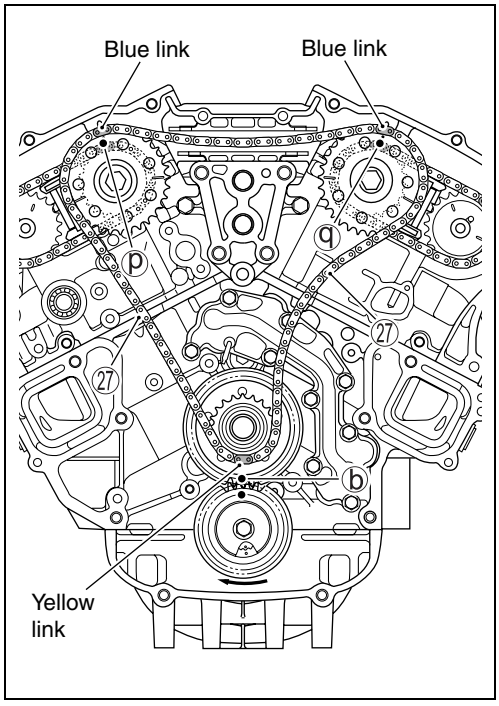


5. Check that the match marks (•) ⓟ/ⓠ on both the PORT & STBD side IN. camshaft timing sprockets No. 1 are correctly aligned with the match marks ⓗ·ⓞ on the camshaft housing as shown in the illustration.

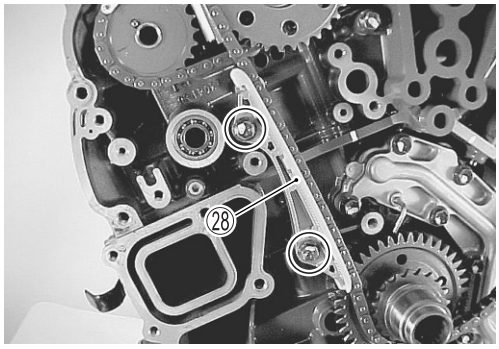




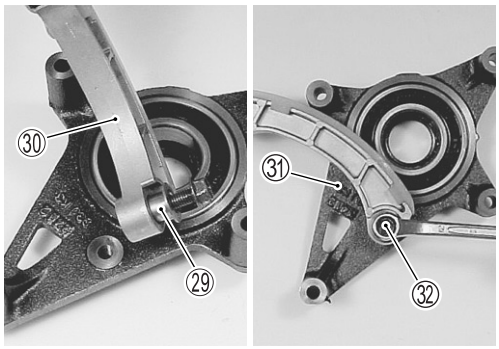
6. As shown in the illustration, fit the 1st timing chain ㉗ with one blue link aligned with the match mark (•) ⓟ on the PORT side IN. camshaft timing sprocket No. 1 and one blue link aligned with the match mark (•) ⓠ on the STBD side IN. camshaft timing sprocket. No. 1
7. As shown in the illustration, fit the 1st timing chain with its yellow link aligned with the match mark (•) ⓑ on the driven gear.



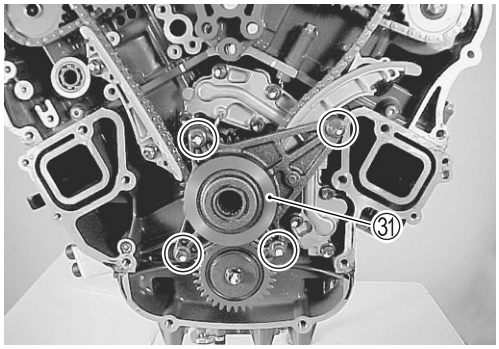
8. Install No. 2 timing chain guide ㉘, then tighten bolts securely. Apply engine oil to chain guide.



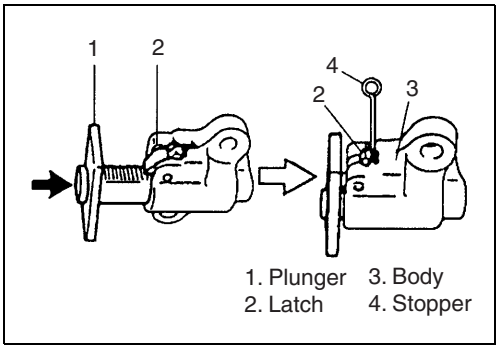
9. Insert the spacer ㉙ into chain tensioner ㉚.
   Install chain tensioner to driven gear holder ㉛, then tighten bolt ㉜ securely.
   Apply engine oil to chain tensioner.



10. Install driven gear holder ㉛, then tighten four (4) bolts securely.



11. With latch of tensioner adjuster ㉜ pushed in and plunger pushed back into body, insert stopper into latch and body.
    After inserting stopper, check to make sure that plunger will not come out.

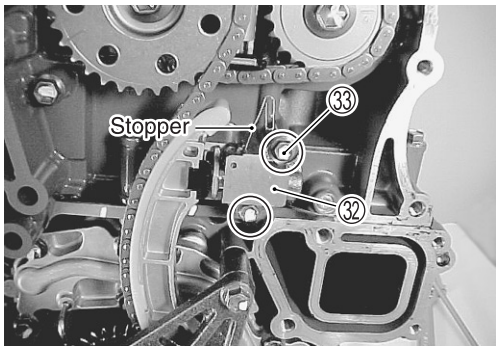


12. Install timing chain tensioner adjuster ㉜, then tighten bolts ㉝ to specified torque.

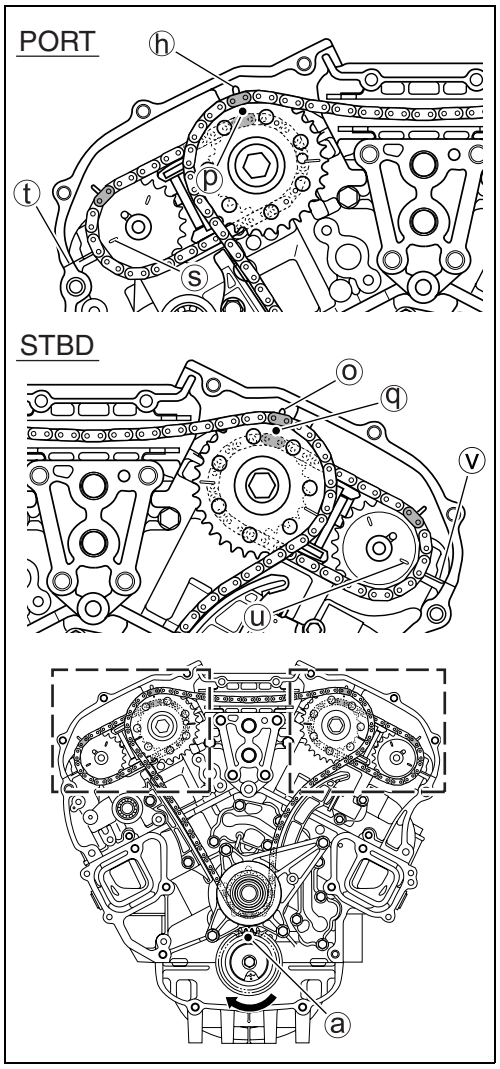
Tensioner adjuster bolt: 11 N·m (1.1 kg-m, 8.0 lb-ft)

Apply engine oil to timing chain.

13. Remove the stopper from tensioner adjuster.

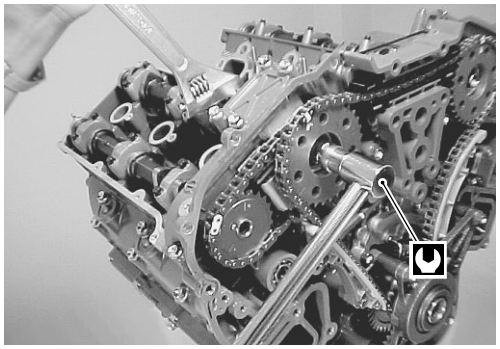


14. Turn the crankshaft two (2) complete rotations in direction shown in figure.
    As shown in the illustration, check that all match marks are in alignment as written below when the match mark (•) ⓐ on the drive gear is pointing to 12:00 o'clock.
    - The match mark (•) ⓟ on the PORT side IN. sprocket No. 1 aligns with the match mark ⓗ on the camshaft housing.
    - The match mark (•) ⓠ on the STBD side IN. sprocket No. 1 aligns with the match mark ⓞ on the camshaft housing.
    - The match mark (slit) ⓢ on the PORT side EX. sprocket aligns with the mating face ⓣ of lower camshaft housing.
    - The match mark (slit) ⓤ on the STBD side EX. sprocket aligns with the mating face ⓥ of lower camshaft housing.



15. Tighten PORT/STBD IN. and EX. camshaft timing sprocket bolts to specified torque.

IN. and EX. camshaft timing sprocket bolt:
78 N·m (7.8 kg-m, 56 lb-ft)



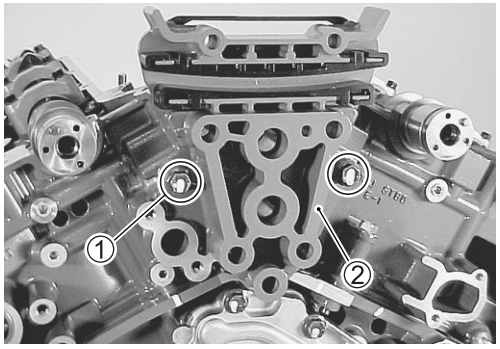
CYLINDER HEAD ASSEMBLY

(Cylinder head/valve/camshaft)

REMOVAL

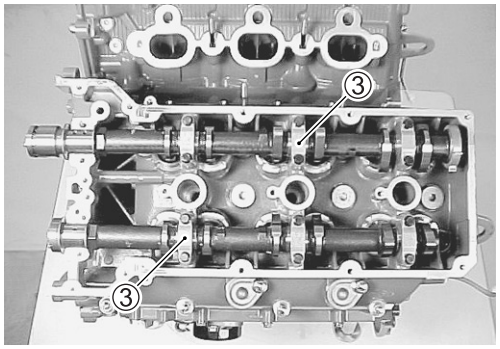
Prior to removing cylinder head:
- **Remove the power unit. (See page 6-12 to 6-18.)**
- **Remove the timing chain. (See page 6-28, 6-41.)**

1. Remove the bolts ① and timing chain guide base ②.



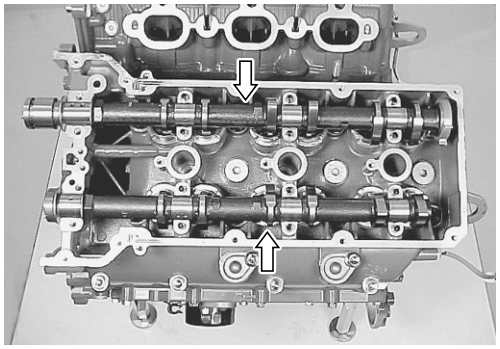
2. Remove the bolts securing the camshaft housing ③ to cylinder head, then remove each camshaft housing.

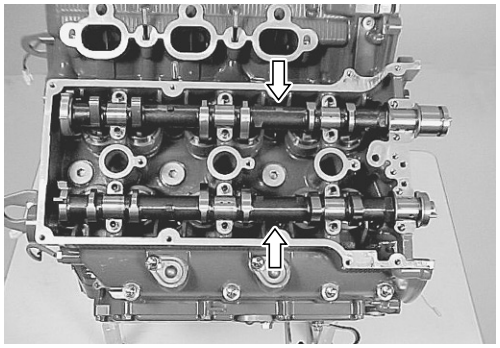
NOTE:
For ease of assembly, note position of each individual camshaft housing.



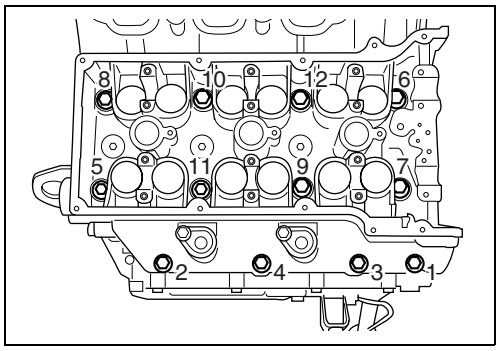
3. Remove intake/exhaust camshafts, tappets and tappet shims.

NOTE:
For ease of assembly, lay out tappets and record shim thickness for each individual cylinder/valve position.

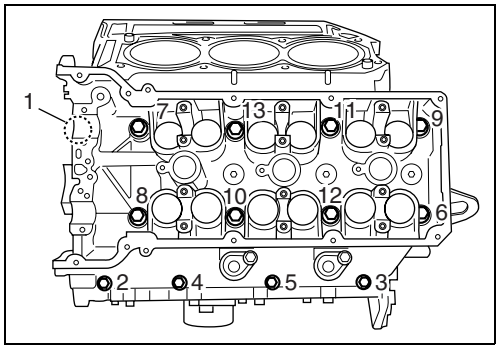




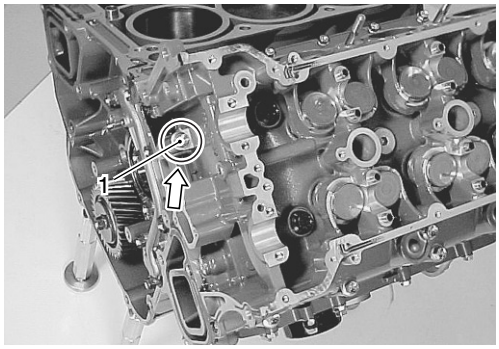
4. On the PORT side bank, loosen and remove twelve (12) cylinder head bolts in the order indicated in figure.
   Remove cylinder head assembly and head gasket.



5. On the STBD side bank, loosen first, then remove thirteen (13) cylinder head bolts according to sequence in figure. Remove cylinder head assembly and head gasket.



NOTE:
Do not forget to remove bolt in shown figure.



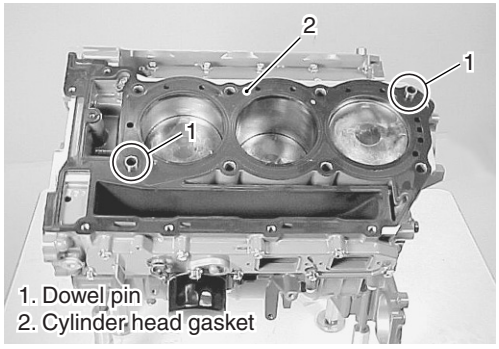
ASSEMBLY

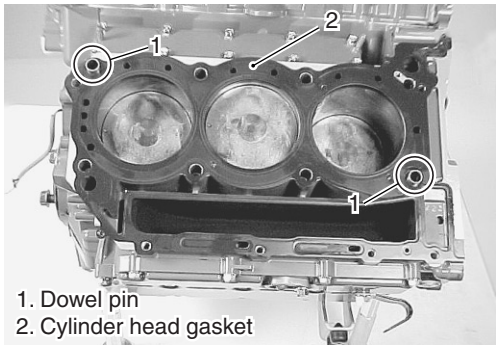
Assemble in reverse order of removal paying special attention to the following steps.

CAUTION

Do not re-use gasket. Always use a new gasket.

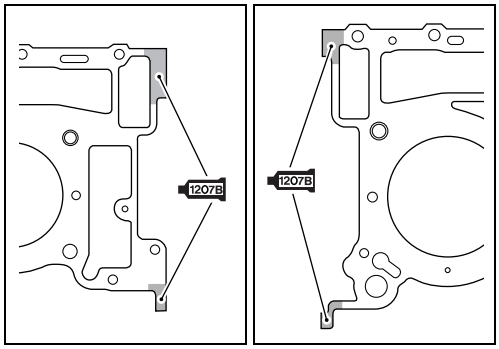
1. Insert the dowel pins and place a new cylinder head gasket into position on the cylinder.





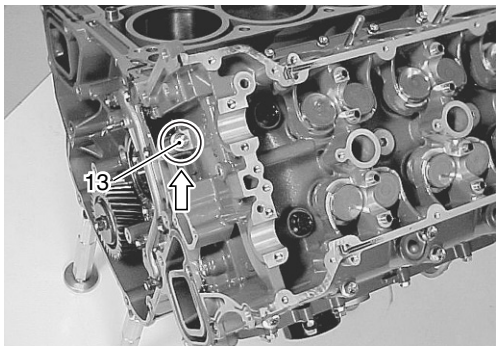
NOTE:
Before installing cylinder head gasket, apply sealant to both surfaces of the hatched areas shown in illustration.

1207B 99000-31140: SUZUKI BOND "1207B"



2. Position cylinder head on cylinder.
3. Apply engine oil to cylinder head bolts and tighten them gradually as follows.

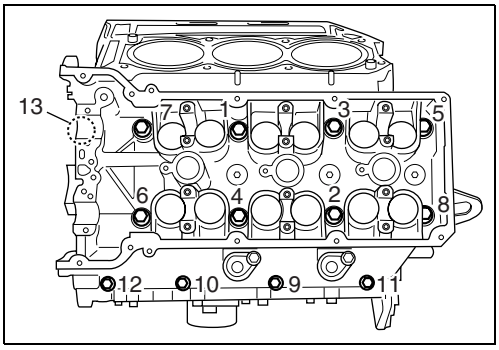
NOTE:
Do not forget to install bolt shown in figure.



(a) Tighten all bolts to 50 percent (%) of specified torque according to sequence in figure.

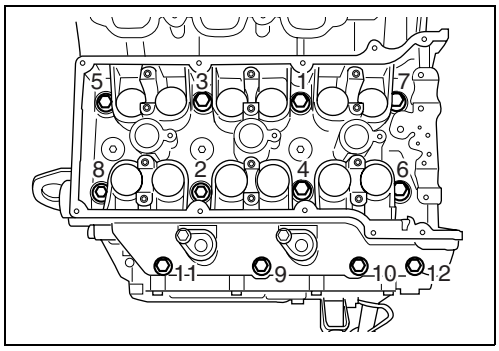
Cylinder head bolt:

1st step 11 mm 43 N·m (4.3 kg-m, 31.1 lb-ft)
8 mm 12 N·m (1.2 kg-m, 8.7 lb-ft)



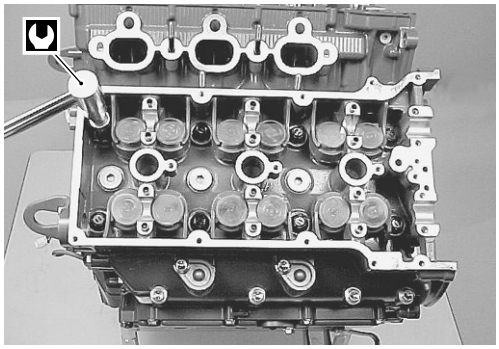
(b) Loosen all bolts to 0 N·m (0 kg-m, 0 lb-ft) according to reverse sequence in figure.
(c) Again tighten all bolts to 50 percent (%) of specified torque according to sequence in figure.

Cylinder head bolt:
3rd step 11 mm 43 N·m (4.3 kg-m, 31.1 lb-ft)
8 mm 13 N·m (1.2 kg-m, 8.7 lb-ft)



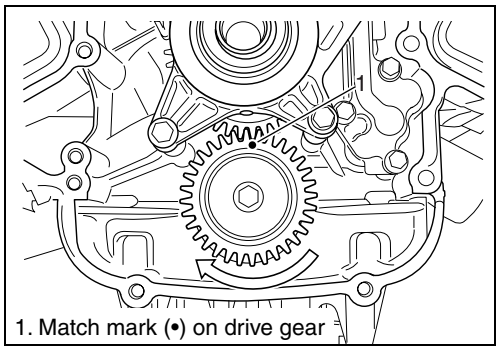
(d) Finally tighten all bolts to specified torque according to sequence in figure.

Cylinder head bolt:
Final step 11 mm 86 N·m (8.6 kg-m, 62.2 lb-ft)
8 mm 23 N·m (2.3 kg-m, 16.6 lb-ft)

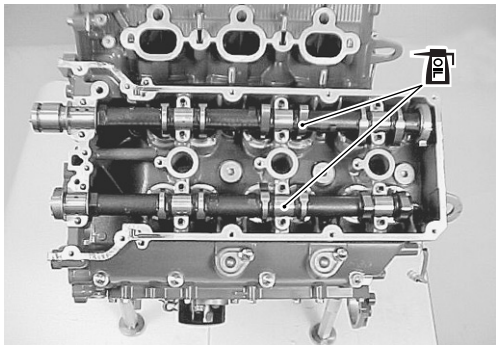


4. Apply engine oil around tappets and install in their original position.
Install tappet shims in their original position.

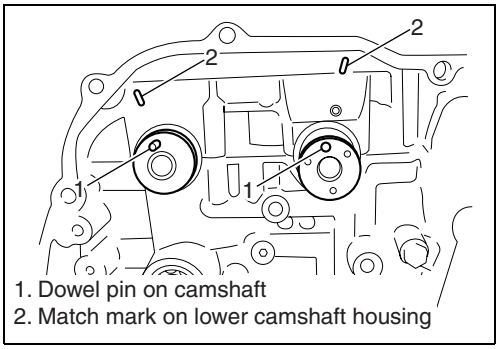
NOTE:
Before installing camshafts, turn crankshaft until the match mark (•) on the crankshaft drive gear points to 12 o'clock (toward cylinder head).


1. Match mark (•) on drive gear

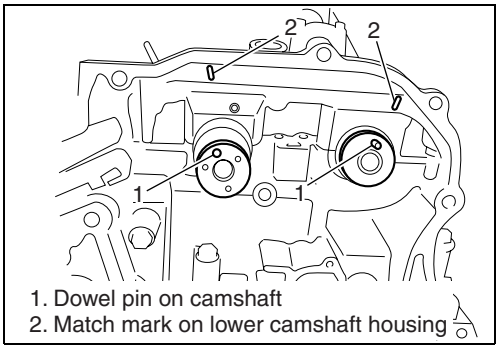
5. Apply engine oil to the surface of each camshaft lobe and journal, then install them as shown in figure.



NOTE:
When installing the camshaft, aligns dowel pin on the camshafts with the match mark on lower camshaft housing.

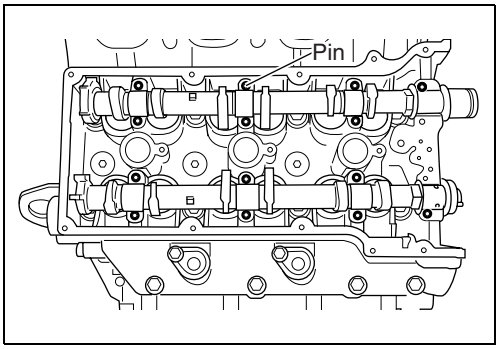


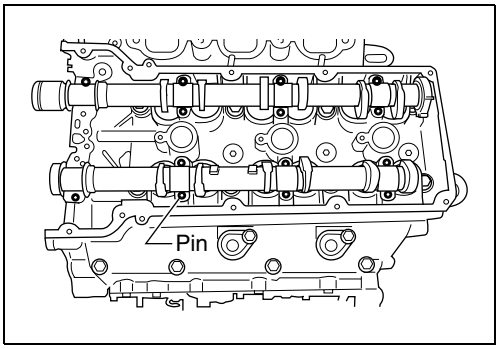
1. Dowel pin on camshaft
2. Match mark on lower camshaft housing



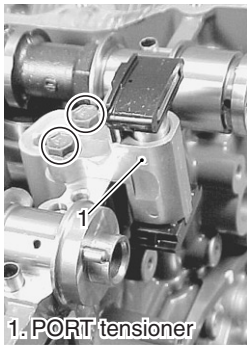
1. Dowel pin on camshaft
2. Match mark on lower camshaft housing

6. Install camshaft housing pins as shown in figure.





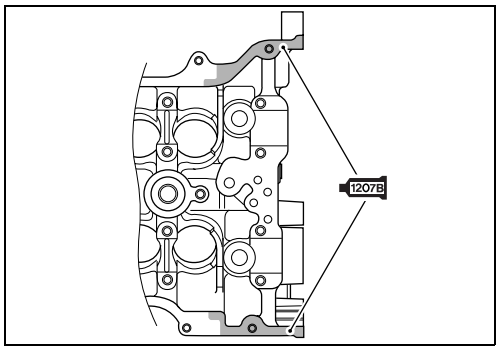
7. Install PORT tensioner and bolts, then tighten bolts securely.
   Install STBD tensioner and bolts, then tighten bolts securely.

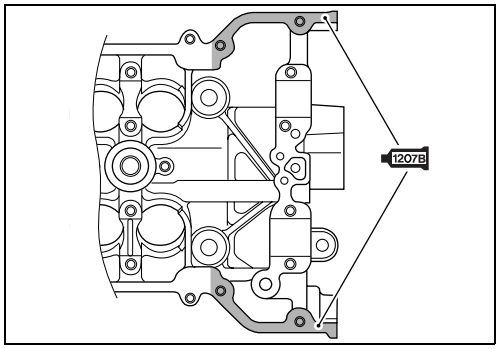


1. PORT tensioner 2. STBD tensioner

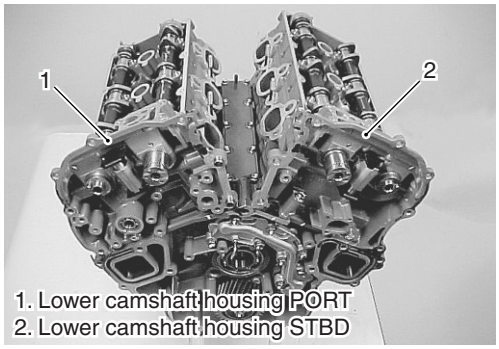
8. Apply sealant to lower camshaft housing sealing surface area as shown in figure.

1207B **99000-31140: SUZUKI BOND "1207B"**



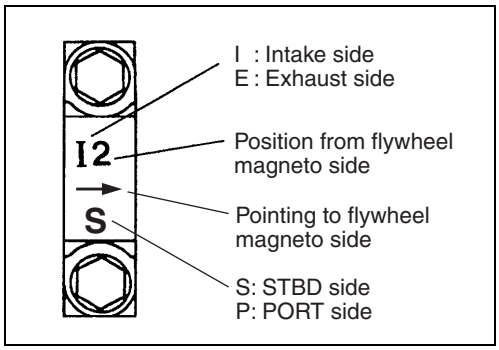


9. Install the lower camshaft housing.



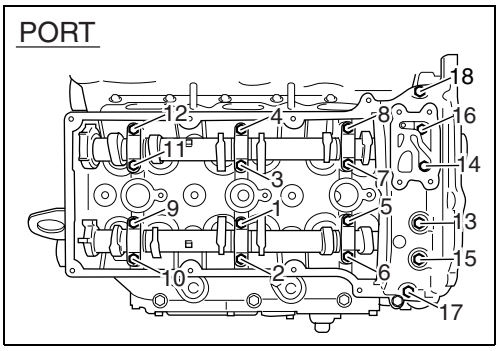
10. Check position of camshaft housing.
    - Embossed marks are provided on each camshaft housing indicating position and direction of installation.

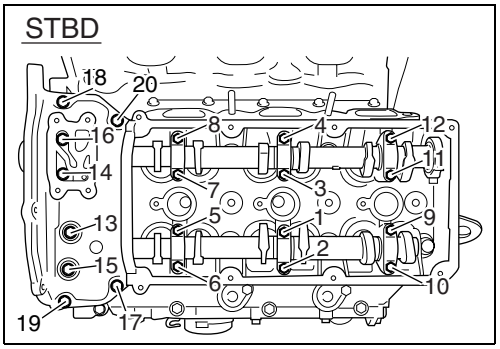
    Install housings as indicated by these marks.



11. Apply engine oil to housing bolts.
12. Lightly seat all housing bolts at first.
    Following sequence in figure, tighten bolts to 1/3 of specified torque, then 2/3 of specified torque and finally to full specified torque.

Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.7 lb-ft)

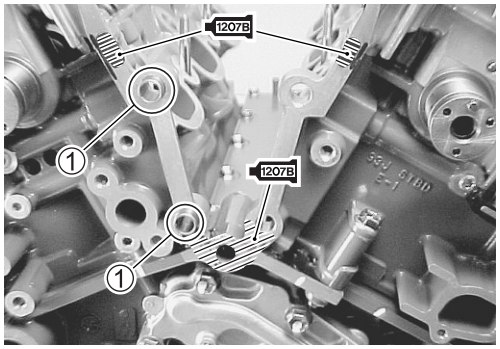


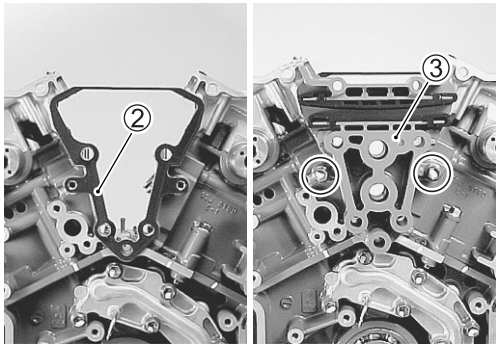


13. Install dowel pins ①, gasket ② and timing chain guide base ③, then tighten bolts securely.

NOTE:
Before installing timing chain guide base, apply sealant to hatched areas shown in illustration.

1207B 99000-31140: SUZUKI BOND "1207B"





14. Install timing chain. (See page 6-34, 6-47.)

15. Install oil pump assembly. (See page 6-27.)

16. Check tappet clearance and adjust as necessary. (See page 2-9.)

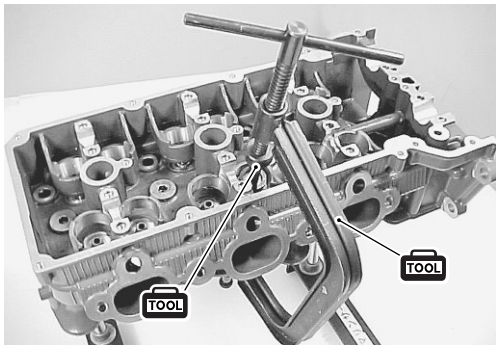
DISASSEMBLY

1. Remove tappets with shims.

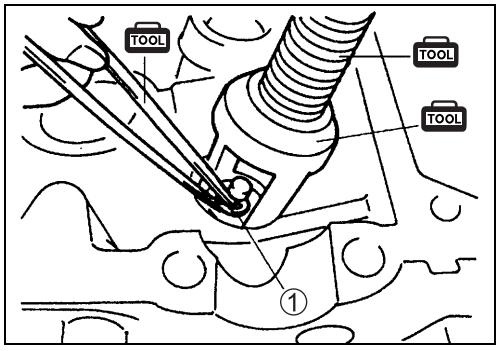
NOTE:
For ease of assembly, lay out tappets and record shim thickness for each individual cylinder/valve position.

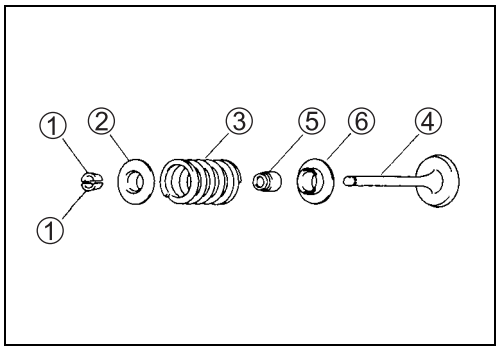
2. Using valve lifter and attachment, remove valve cotters ① while compressing valve spring.

TOOL **09916-14510: Valve lifter**
09916-14521: Attachment
09916-84511: Tweezers



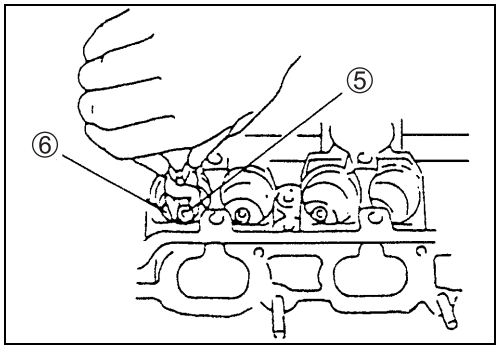
3. Remove valve spring retainer ②, valve spring ③ and valve ④.





4. Remove valve stem seal ⑤ and valve spring seat ⑥.

NOTE:
Reassemble each valve and valve spring in their original positions.

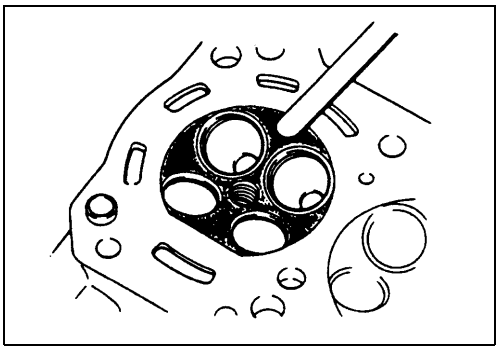


INSPECTION/SERVICING

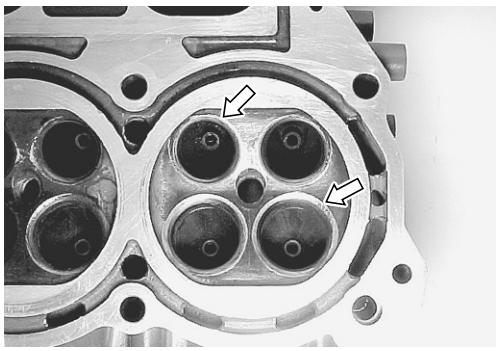
NOTE:
If cracks, excessive wear or other damage is found on any component, replace component.

CYLINDER HEAD
Remove all carbon from combustion chambers.

NOTE:
- *Do not use any sharp edged tool to scrape carbon off cylinder head or its components.*
- *Be careful not to scuff or nick metal surfaces when decarboning.*



Check cylinder head for cracks in intake and exhaust ports, combustion chambers, and head surface.

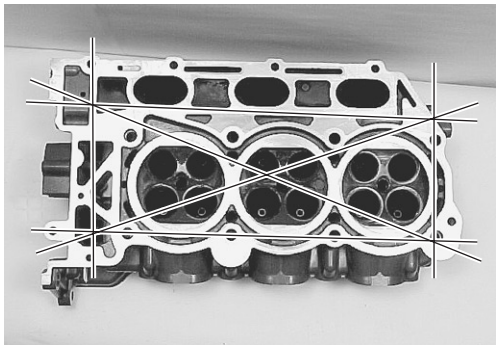


Valve seat
Check valve seat, if cracks or other damage is found, replace cylinder head.

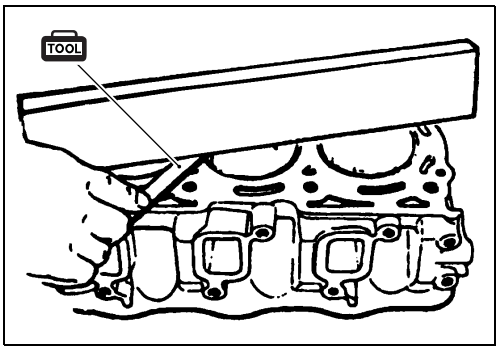
Cylinder head distortion
Using a straightedge and thickness gauge, measure cylinder head distortion (gasket surface) at a total of six (6) locations as shown.

TOOL 09900-20803: Thickness gauge

Cylinder head distortion
Service limit: 0.03 mm (0.001 in)



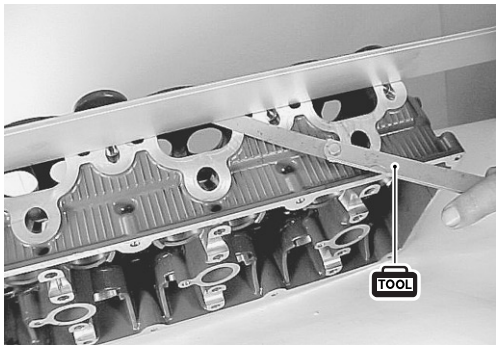
If measurement exceeds service limit, resurface or replace cylinder head.



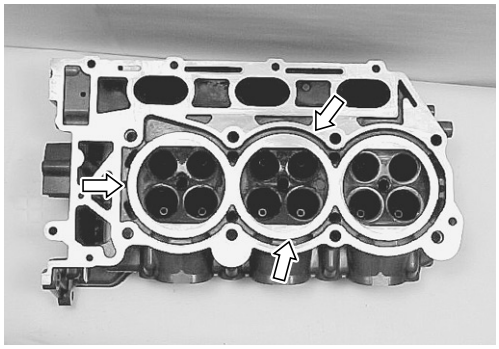
Manifold seating faces distortion
Using a straightedge and thickness gauge, check cylinder head to manifold seating faces.

Manifold seating faces distortion
Service limit: 0.10 mm (0.004 in)

If measurement exceeds service limit, resurface or replace cylinder head.



Water jackets
Check water jackets. If clogged or obstructed, clean water jackets.



CAMSHAFT
Cam face
Inspect cam face for scratches and wear.

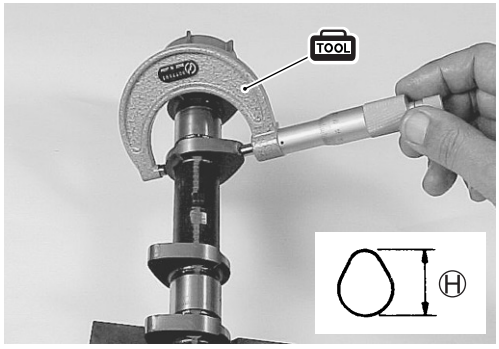
Cam wear
Using micrometer, measure cam height Ⓗ.

TOOL 09900-20202: Micrometer

Cam height
Standard:

DF200 IN. 43.020 – 43.180 mm (1.6937 – 1.700 in)
EX. 43.620 – 43.780 mm (1.7173 – 1.7236 in)
DF225 IN. 42.420 – 42.580 mm (1.6701 – 1.6764 in)
EX. 43.620 – 43.780 mm (1.7173 – 1.7236 in)
DF250 IN. 44.920 – 45.080 mm (1.7685 – 1.7748 in)
EX. 44.420 – 44.580 mm (1.7488 – 1.7551 in)

Service limit
DF200 IN. 42.920 mm (1.6898 in)
EX. 43.520 mm (1.7134 in)
DF225 IN. 42.320 mm (1.6661 in)
EX. 43.520 mm (1.7134 in)
DF250 IN. 44.820 mm (1.7646 in)
EX. 44.320 mm (1.7449 in)

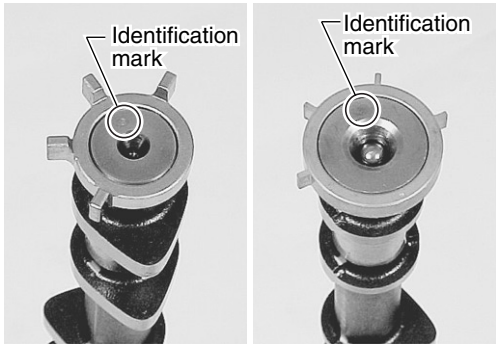


If measurement exceeds service limit, replace camshaft.

Camshaft identification

DF200, DF225 and DF250 camshafts differ as indicated below.

Model	Identification mark	
	IN.	EX.
DF200	0	0
DF225	1	0
DF250	2	2



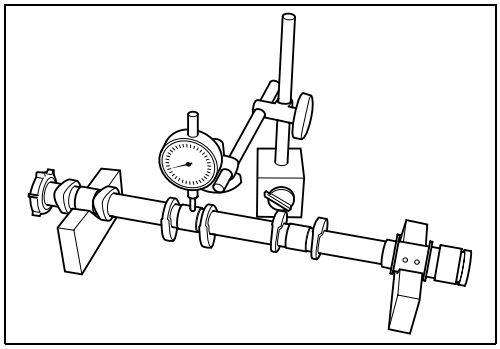
Camshaft runout

Support camshaft on a surface plate using a set of V-blocks.
Measure runout using a dial gauge.

09900-20606: Dial gauge
: "V" block set
09900-20701: Magnetic stand

Camshaft runout
Service limit: 0.10 mm (0.004 in)

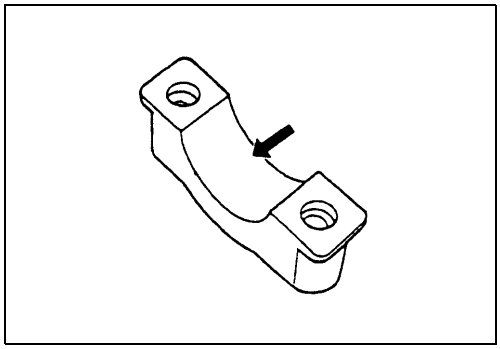
If measurement exceeds service limit, replace camshaft.



CAMSHAFT JOURNAL

Check camshaft journals and camshaft housing for pitting, scratches, wear or damage.
If any of the above conditions are found, replace camshaft or cylinder head with housing.

NOTE:
Camshaft housing and cylinder head must be replaced as a set.

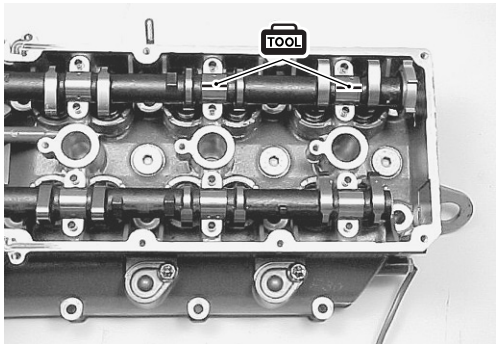


Camshaft journal oil clearance

Check journal oil clearance using Plastigauge as follows.

1. Clean housing and camshaft journals.
2. Install camshaft to cylinder head.
3. Place Plastigauge across the full width of camshaft journal (parallel to camshaft).

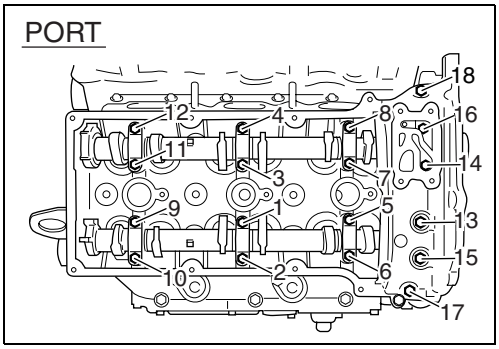
09900-22302: Plastigauge

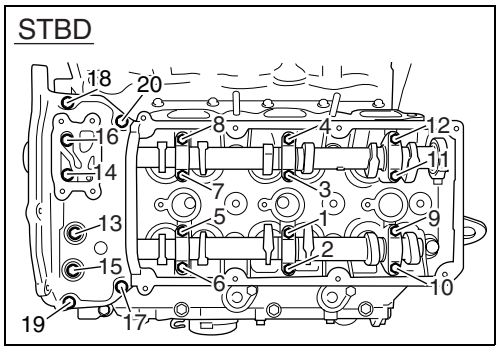


4. Install camshaft housing. Tighten housing bolts in 3 steps (1/3 of specification, 2/3 of specification, full torque specification) in the indicated order.

Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.7 lb-ft)

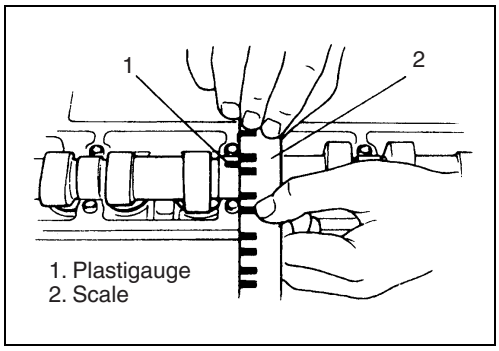
NOTE:
Do not rotate camshaft while Plastigauge is installed.





5. Remove camshaft housing.
6. Using scale on Plastigauge envelope, measure Plastigauge at its widest point.

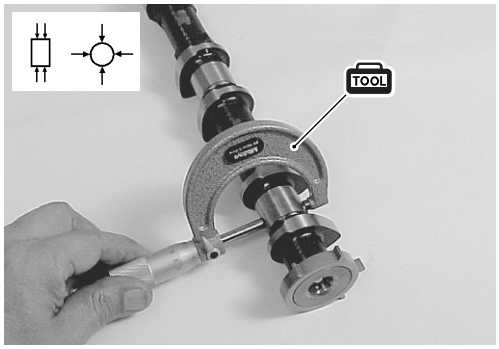
Camshaft journal oil clearance
Standard: 0.043 – 0.085 mm (0.0017 – 0.0033 in)
Service limit: 0.12 mm (0.0047 in)



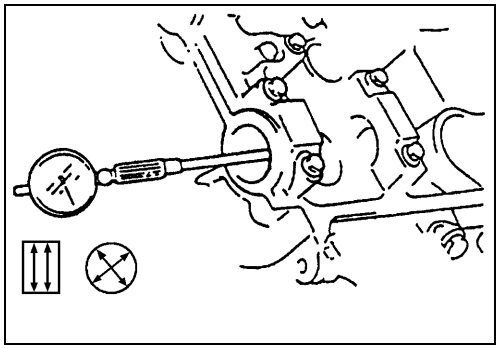
If journal oil clearance exceeds the service limit, measure camshaft journal (outside dia.) and camshaft housing (inner dia.). Based on measurements, replace camshaft and/or cylinder head with camshaft housing.

09900-20202: Micrometer (25 – 50 mm)

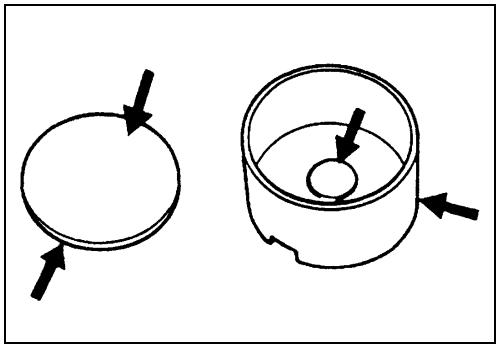
Camshaft journal outside diameter
Standard: 25.936 – 25.957 mm (1.0211 – 1.0219 in)



Camshaft journal (housing) inside diameter
Standard: 26.000 – 26.021 mm (1.0236 – 1.0244 in)



TAPPET/TAPPET SHIM
Wear of tappet and shim
Check tappet and shim for pitting, scratches, or damage.
If any above conditions are found, replace component.



Measure cylinder head bore and tappet outside diameter to determine cylinder head to tappet clearance.

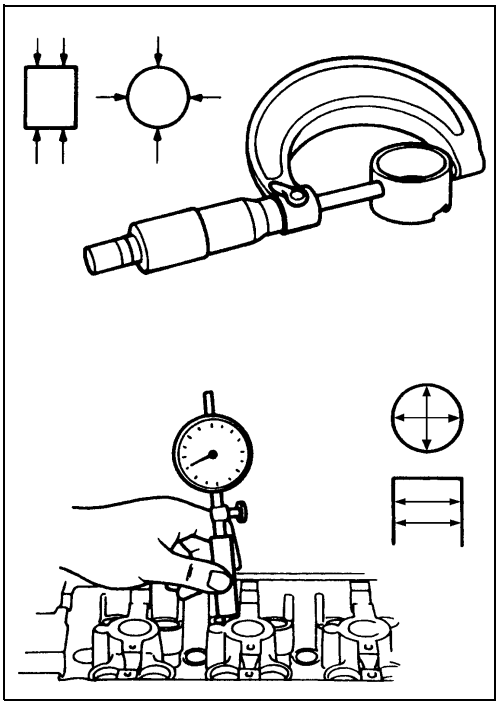
TOOL 09900-20202: Micrometer

If measurement exceeds service limit, replace tappet or cylinder head.

Cylinder head bore to tappet clearance
Standard: 0.025 – 0.066 mm (0.0010 – 0.0026 in)
Service limit: 0.150 mm (0.0059 in)

Tappet outer diameter
Standard: 33.959 – 33.975 mm (1.3370 – 1.3376 in)

Cylinder head bore
Standard: 34.000 – 34.025 mm (1.3386 – 1.3396 in)



VALVE/VALVE GUIDE

Valve guide to valve stem clearance

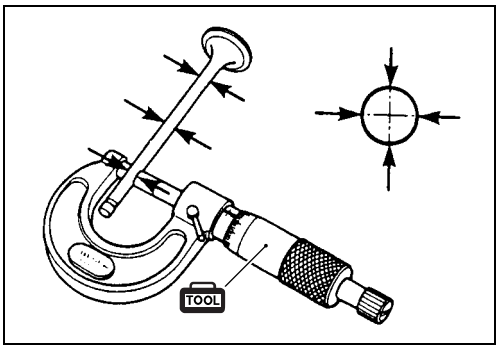
Using a micrometer and bore gauge, take diameter readings on valve stems and guides to check guide to stem clearance.
Be sure to take readings at more than one place along the length of each stem and guide.

TOOL 09900-20205: Micrometer

Valve stem outside diameter

Using micrometer, measure valve stem outside diameter.

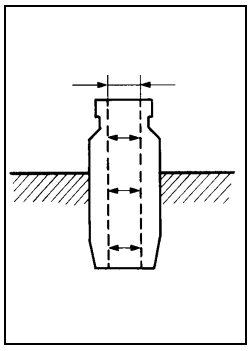
Valve stem outside diameter
Standard:
IN. 5.465 – 5.480 mm (0.2152 – 0.2157 in)
EX. 5.440 – 5.455 mm (0.2142 – 0.2148 in)

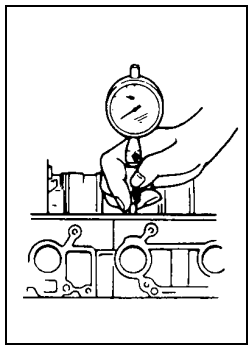


Valve guide inside diameter

Using a small bore gauge, measure valve guide inside diameter.

Valve guide inside diameter
Standard:
IN. 5.500 – 5.512 mm (0.2165 – 0.2170 in)
EX. 5.500 – 5.512 mm (0.2165 – 0.2170 in)





Valve guide to valve stem clearance

Valve guide to valve stem clearance

Standard:

IN. 0.020 – 0.047 mm (0.0008 – 0.0019 in)

EX. 0.045 – 0.072 mm (0.0018 – 0.0028 in)

Service limit:

IN. 0.070 mm (0.0028 in)

EX. 0.090 mm (0.0035 in)

If measurement exceeds service limit, replace valve and/or valve guide.

NOTE:

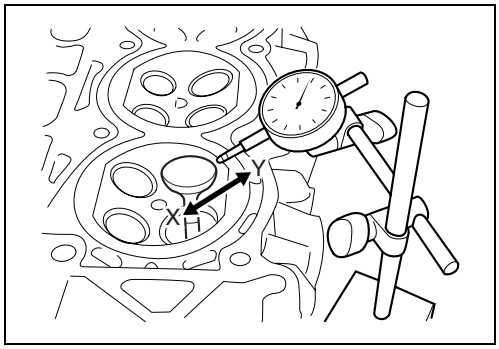
For valve guide replacement, see "VALVE GUIDE REPLACEMENT" section on page 6-70.

Valve stem deflection

If unable to measure valve guide inside diameter, check "Valve stem deflection".

TOOL **09900-20606: Dial gauge**

09900-20701: Magnetic stand



Measure valve stem deflection as follows:

(1) Install valve into valve guide.

(2) Position valve head at approx. 5 mm away from valve seat.

(3) Move valve head in the direction "X – Y", and measure deflection.

Valve stem deflection

Service limit:

IN. 0.14 mm (0.0055 in)

EX. 0.18 mm (0.0071 in)

If measurement exceeds service limit, replace valve.

If measurement still exceeds service limit with new valve, replace valve guide.

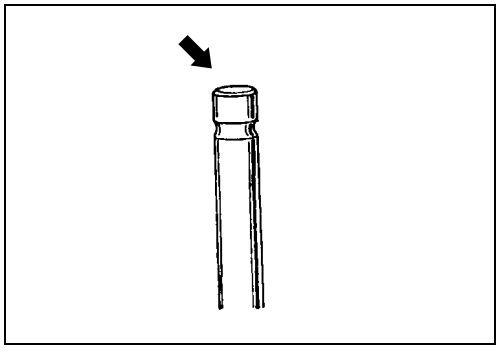
Valve stem end

Inspect valve stem end face for pitting and wear.

If pitting or wear is found, valve stem end may be resurfaced.

Use caution when resurfacing, do not grind away stem end chamfer.

When chamfer has been worn away, replace valve.



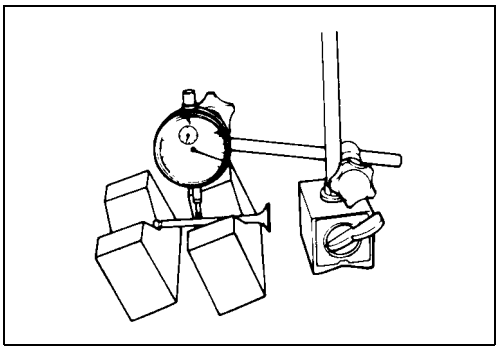
Valve stem runout

Measure valve stem runout.

09900-20606: Dial gauge
09900-20701: Magnetic stand
09900-21304: "V" block set

Valve stem runout
Service limit: 0.05 mm (0.0020 in)

If measurement exceeds service limit, replace valve.



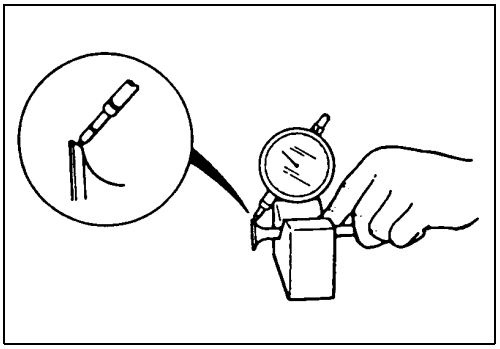
Valve head radial runout

Measure valve head radial runout.

09900-20606: Dial gauge
09900-20701: Magnetic stand
09900-21304: "V" block set

Valve head radial runout
Service limit: 0.08 mm (0.0031 in)

If measurement exceeds service limit, replace valve.



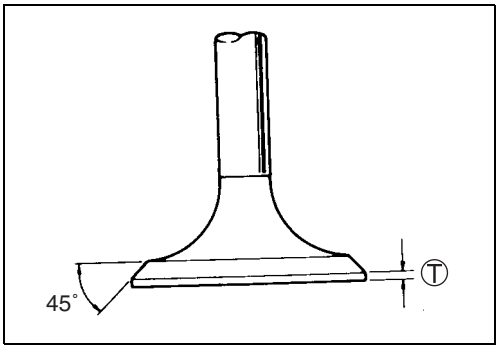
Valve head thickness

Measure thickness Ⓣ of valve head.

09900-20101: Vernier calipers

Valve head thickness
Standard:
IN. 1.1 mm (0.0433 in)
EX. 1.0 mm (0.0394 in)
Service limit:
IN. 0.7 mm (0.0276 in)
EX. 0.7 mm (0.0276 in)

If measurement exceeds service limit, replace valve.



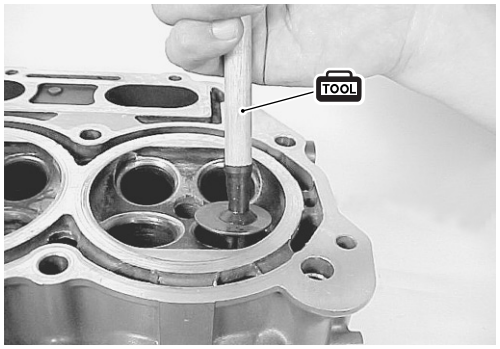
Valve seat contact width

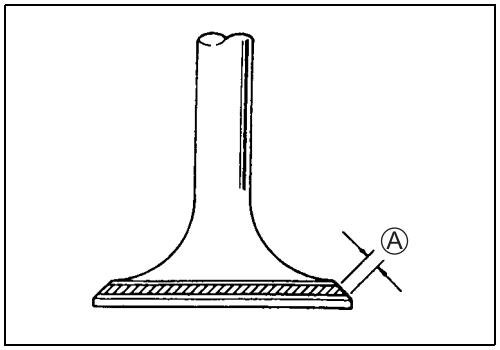
Measure valve seat contact width as follows:

(1) Remove all carbon from valve and seat.
(2) Coat valve seat evenly with Prussian blue (or equivalent).
(3) Install valve into valve guide.
(4) Put valve lapper on valve.

09916-10910: Valve lapper

(5) Rotate valve while gently tapping valve contact area against seat.
(6) Continuously pattern on valve seating face with Prussian blue.
(7) Measure valve seat contact width Ⓐ.





09900-20101: Vernier calipers

Valve seat contact width Ⓐ
Standard:
IN., EX. 1.1 – 1.3 mm (0.0433 – 0.0512 in)

If measurement exceeds specification, repair valve seat.

NOTE:
For valve seat repair, see "Valve seat servicing" section on page 6-69.

VALVE SEAT SERVICING

If valve seat contact width is out of specification, reface valve seat as follows:

- **Valve seat angle**
  Intake side : 15°, 45°, 60°
  Exhaust side : 15°, 45°, 60°

: Valve seat cutter (NEWAY634) 45°
: Valve seat cutter (NEWAY217) 15°
09916-22420: Valve seat cutter (NEWAY114) 60°

09916-24450: Solid pilot (NEWAY. N-100-5.52)
09916-54910: Handle (N-505)

NOTE:
Turn cutter clockwise, never counterclockwise.

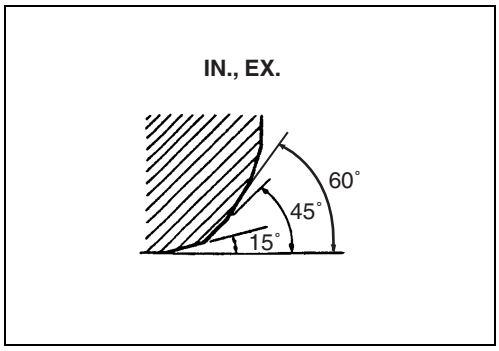
(1) Remove all carbon from valve and valve seat.
(2) Using 45° angle cutter, reface valve seat.
(3) Check valve seat contact width Ⓐ.
See the "Valve seat contact width" section on page 6-68.

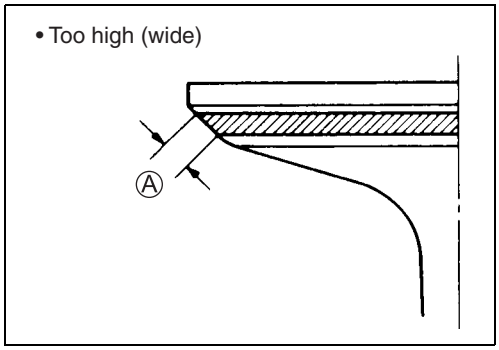
(4) • If width Ⓐ is too high (or wide), reface valve seat using 15° angle cutter.
• If width Ⓐ is too low (or narrow), reface valve seat using 60° angle cutter.

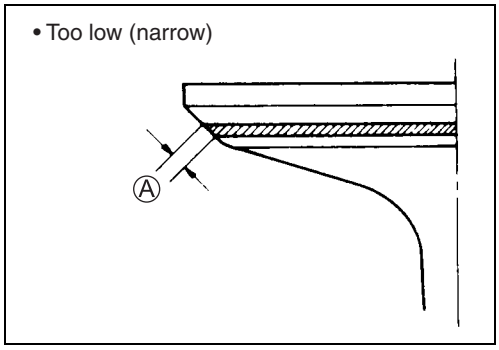
(5) Clean up any burrs using 45° angle cutter very lightly.

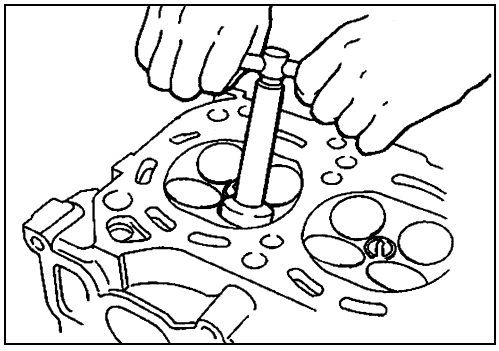
CAUTION

Cut seat areas minimally only.
Do not cut more than necessary.



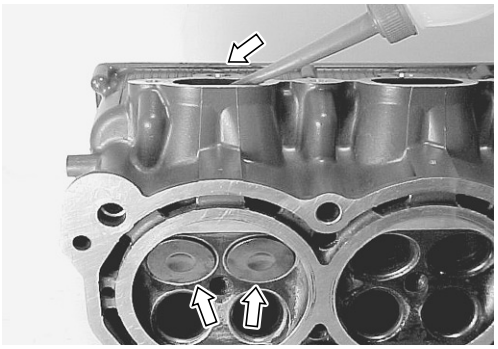






(6) Lap valve on seat in two steps, first with coarse grit lapping compound applied to face and the second with fine grit compound.
(7) Recheck valve seat contact width Ⓐ.

NOTE:
Clean and assemble cylinder head and valve components.
Fill intake and exhaust ports with solvent to check for leaks between valve seat and valve.
If any leaks occur, inspect valve seat and face for burrs or other things that could prevent valve from sealing.



VALVE GUIDE REPLACEMENT

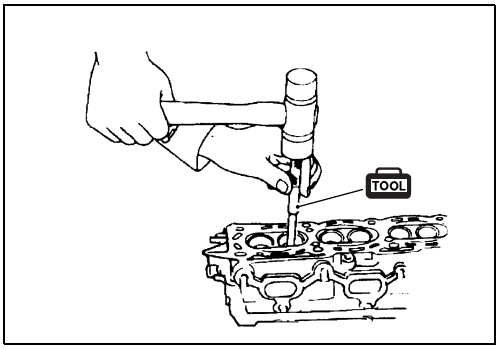
CAUTION

Be careful not to damage cylinder head when replacing valve guide.

(1) Using valve guide remover, drive valve guide out from combustion chamber side towards valve spring side.

TOOL 09916-44310: Valve guide remover

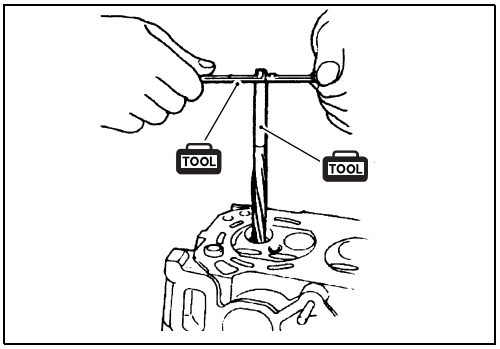
NOTE:
Do not reuse valve guide once it has been removed.
Always use a new valve guide (oversize) when assembling.



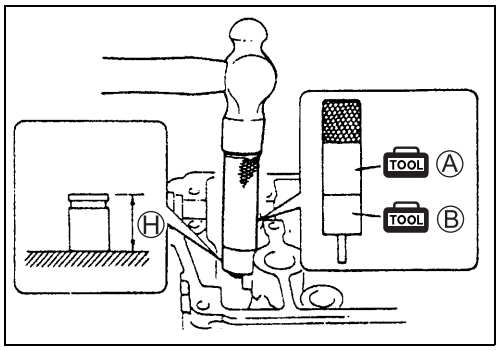
(2) Ream valve guide hole with ϕ10.5 mm reamer to true hole and remove burrs.

TOOL 09916-37320: Valve guide reamer (ϕ10.5 mm)
09916-34542: Reamer handle

NOTE:
Turn reamer clockwise, never counterclockwise.



(3) Install valve guide to cylinder head.
- Heat cylinder head to a temperature of 80 – 100 °C (176 – 212 °F).
  Apply heat uniformly so that head will not be distorted.
- Use special tools to drive new valve guide into hole.
  Drive in new valve guide until special tool (valve guide installer attachment) contacts cylinder head.
- After installing, check valve guide protrusion Ⓗ.



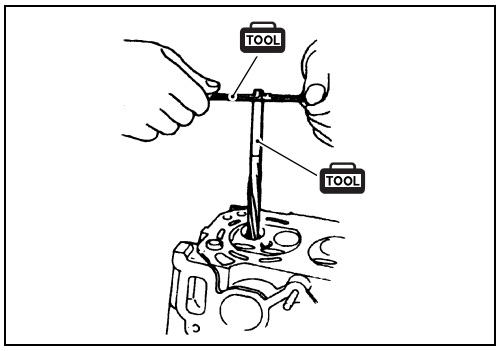
TOOL 09916-57330: Valve guide installer handle Ⓐ
09916-56011: Valve guide installer attachment Ⓑ

Valve guide protrusion Ⓗ
standard:
IN. & EX. 11.5 mm (0.4528 in)

(4) Ream valve guide bore with ϕ5.5 mm reamer.

TOOL 09916-34550: Valve guide reamer (ϕ5.5 mm)
09916-34542: Reamer handle

NOTE:
Clean and oil valve guide bore after reaming.



VALVE SPRING

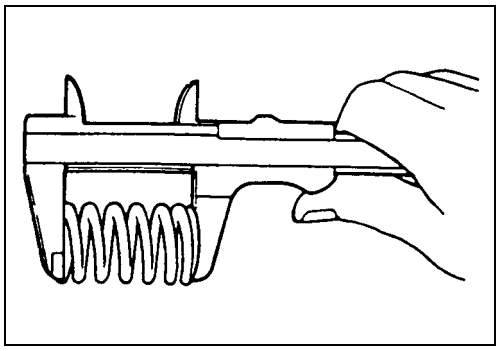
Valve spring free length

Check spring strength by measuring free length.

TOOL 09900-20101: Vernier calipers

Valve spring free length
Standard:
IN. & EX. 40.20 mm (1.5827 in)
Service limit:
IN. & EX. 38.60 mm (1.5200 in)

If lower than service limit, replace valve spring.



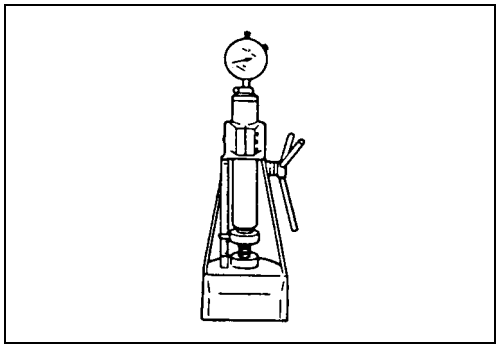
Valve spring preload

Measure valve spring preload.

TOOL 09900-20101: Vernier calipers

Valve spring preload
Standard:
IN. & EX. 147 – 173 N (15.0 – 17.7 kg, 33.0 – 38.9 lbs)
for 31.1 mm (1.22 in)
Service limit:
IN. & EX. 136 N (13.9 kg, 30.6 lbs)
for 31.1 mm (1.22 in)

If lower than service limit, replace valve spring.

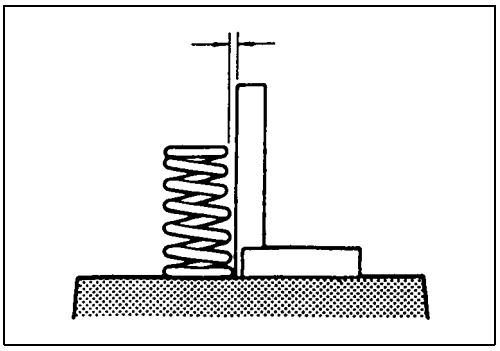


Valve spring squareness
Use a square and surface plate to check each spring for squareness (clearance between end of valve spring and square).

09900-20101: Vernier calipers

Valve spring squareness
Service limit:
IN. & EX. 2.0 mm (0.079 in)

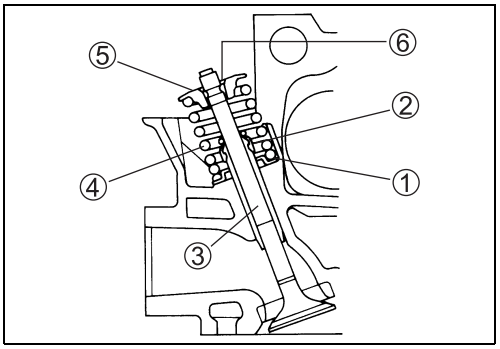
If measurement exceeds service limit, replace valve spring.



REASSEMBLY

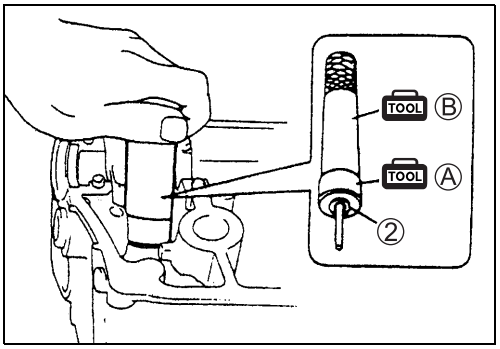
Reassemble in reverse order of disassembly paying special attention to the following steps.

VALVE
Install valve spring seat ① to cylinder head.



After applying engine oil to stem seal ② and spindle of special tool (Installer attachment), fit stem seal to spindle.
Then, pushing special tool by hand, install stem seal to valve guide.
Check to be sure that seal is properly fixed to valve guide.

09917-98221: Installer attachment Ⓐ
09916-57330: Installer handle Ⓑ



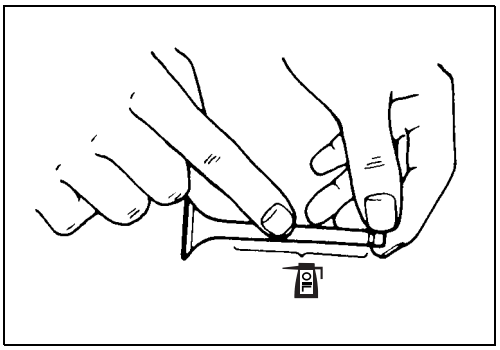
CAUTION

Do not reuse stem seal once removed.
Always install new seal.

Apply engine oil to stem seal, valve guide bore and valve stem.

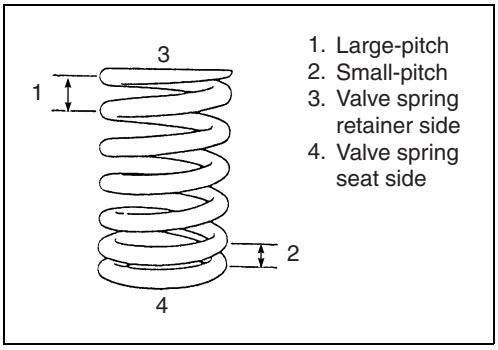
Install valve ③ to valve guide.

NOTE:
Reassemble each valve and valve spring to their original position.



Install valve spring ④, and valve retainer ⑤.

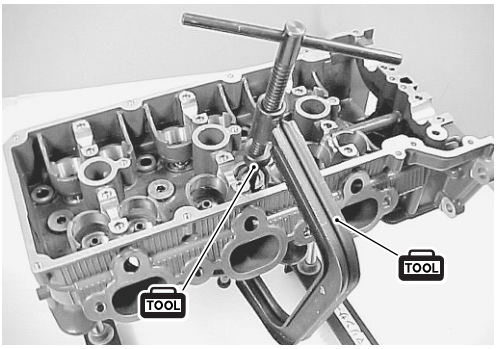
NOTE:
Set valve spring in place with narrow spiral area facing valve seat.

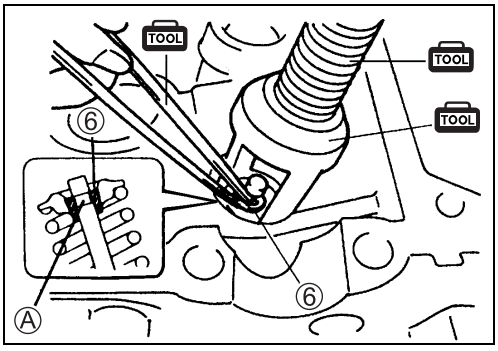


Hold valve spring compressed with special tool and install valve cotters ⑥.

Make sure valve cotters are properly seated in groove Ⓐ.

09916-14510: Valve lifter
09916-14521: Attachment
09916-84511: Tweezers



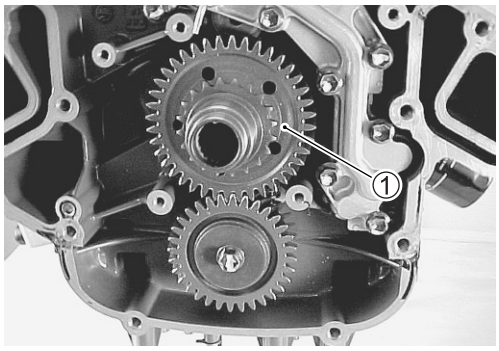


CYLINDER/CRANKSHAFT/PISTON

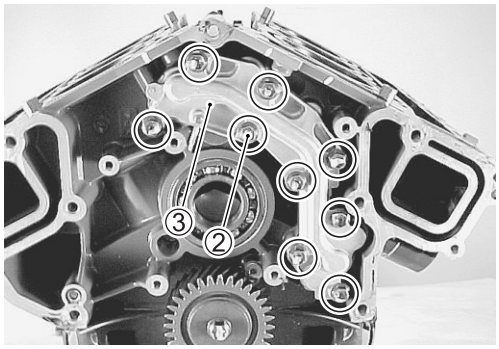
DISASSEMBLY

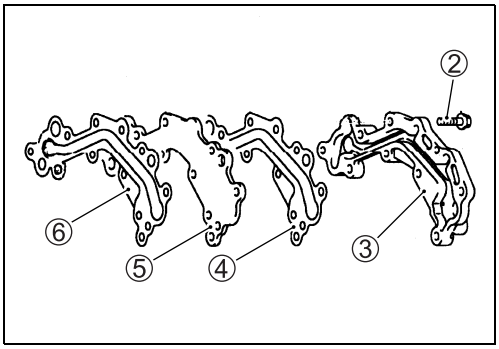
Before performing service work in this section:
- **Remove power unit. (See page 6-12 to 6-18.)**
- **Remove timing chain. (See page 6-28 to 6-53.)**
- **Remove cylinder head. (See page 6-54.)**

Remove the driven gear ①.

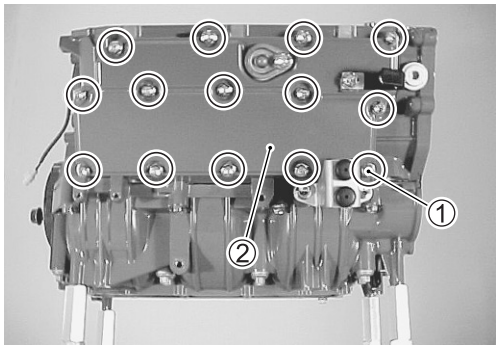


Remove the nine (9) bolts ② securing the oil gallery cover ③, then remove oil gallery cover ③, gasket ④, oil gallery plate ⑤ and gasket ⑥.





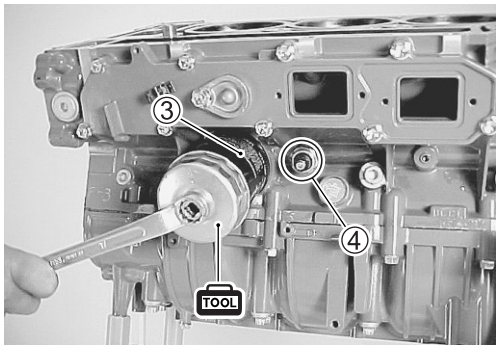
Remove the bolts ① and PORT exhaust cover ②.



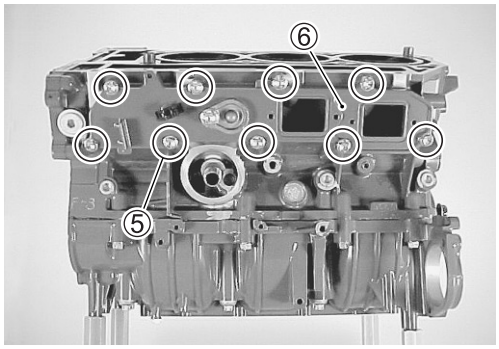
Remove oil filter ③.

09915-47341: Oil filter wrench

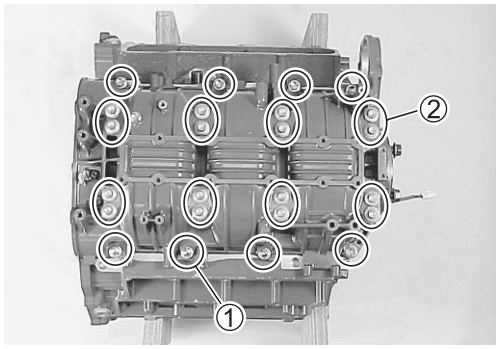
Remove oil pressure switch ④.



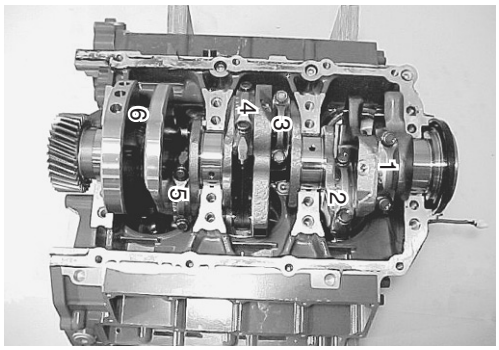
Remove the bolts ⑤ and STBD exhaust cover ⑥.



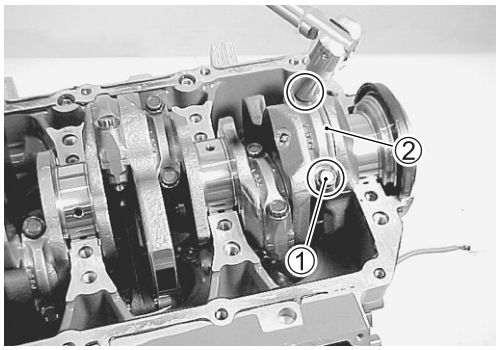
Remove eight (8) bolts ①.
Remove sixteen (16) bolts ②.
Remove crankcase from cylinder block.



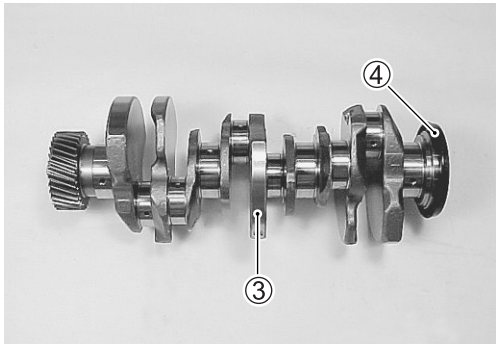
NOTE:
For proper assembly, mark cylinder number on all pistons, connrods, and conrod caps, using quick drying paint.



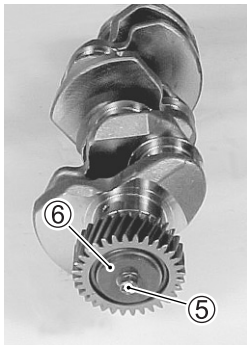
Remove all conrod cap bolts ① and conrod caps ②.

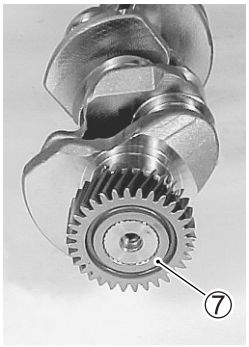


Remove crankshaft ③.
Remove oil seal ④ from crankshaft.

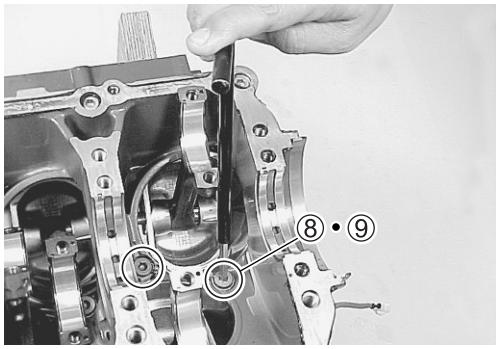


Remove the bolt ⑤, washer ⑥ and drive gear ⑦.





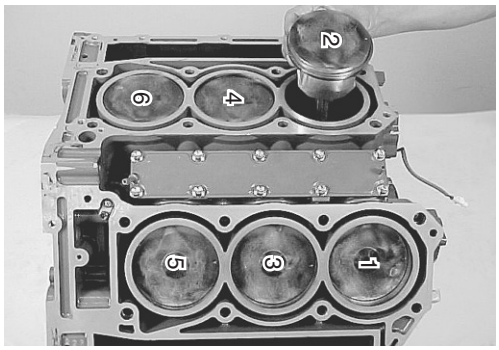
Remove bolts ⑧ and piston cooling jets ⑨ from each cylinder.



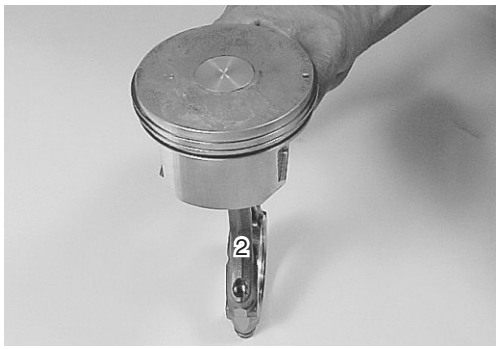
Mark cylinder number on pistons using quick dry paint.
Push piston (with conrod) out through the top of cylinder bore.

NOTE:

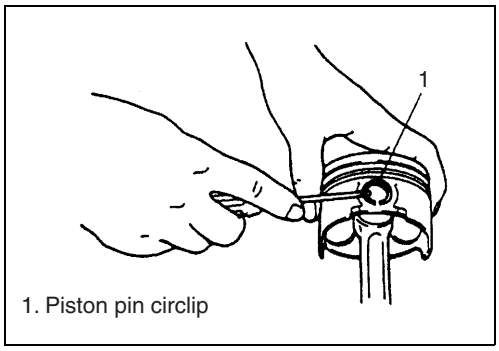
- *To prevent damage to piston rings, decarbon top of cylinder bore wall before removing piston.*
- *Reassemble each conrod cap to its original position after removing piston from bore.*



Remove two compression rings (top and 2nd) and oil ring from piston.
Mark cylinder number on conrod using quick dry paint.



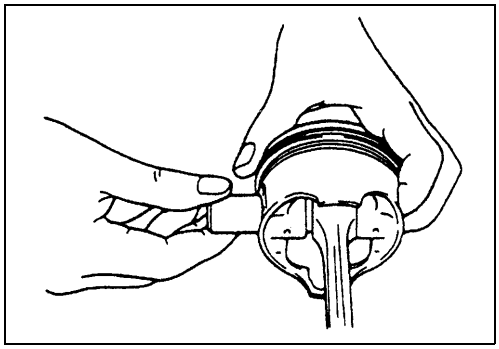
Remove piston pin circlips as shown.



1. Piston pin circlip

Remove piston pin from conrod.

NOTE:
Reassemble each piston, piston pin and conrod in their original combination and position.



INSPECTION/SERVICING

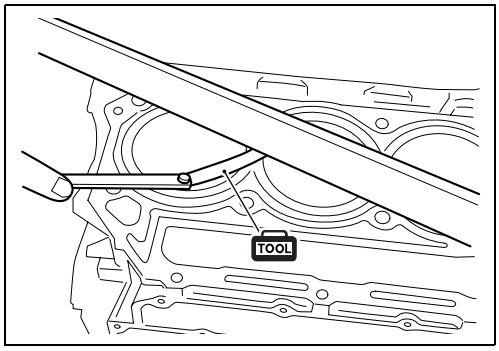
NOTE:
If cracks, excessive wear or other damage is found on any component, replace component.

CYLINDER

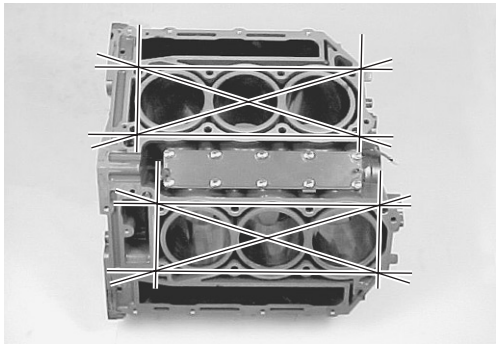
- **Cylinder distortion**
  Using a straightedge and thickness gauge, measure cylinder distortion (gasket surface) at a total of six (6) locations as shown.

09900-20803: Thickness gauge

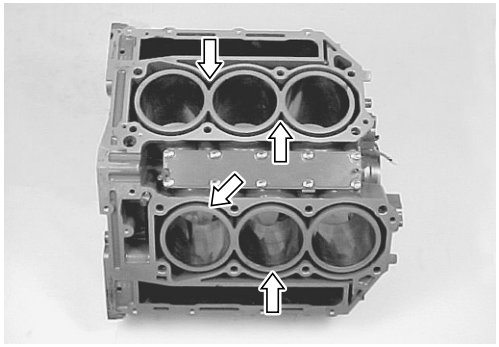
Cylinder distortion
Service limit: 0.05 mm (0.0020 in)



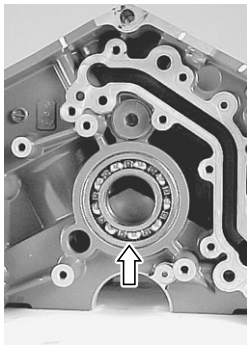
If measurement exceeds service limit, resurface or replace cylinder.



- **Water jackets**
  Check water jackets.
  If clog or obstruction is found, clean water jacket.



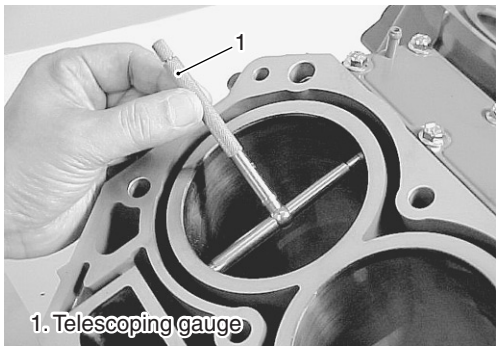
- **Driven gear/bearing**
  Inspect driven gear. Replace gear if damaged or worn.
  Inspect driven gear bearing. Replace bearing if pitted, noisy or rough.



- **Cylinder bore**
  Inspect cylinder walls for scratches, roughness, or ridges which indicate excessive wear.
  If cylinder bore is very rough, deeply scratched or ridged, bore cylinder and use oversize piston.

- **Cylinder bore wear (difference)**
  Using telescoping gauge, measure cylinder bore in both axial (vertical line, following crankshaft) and transverse (horizontal line across crankshaft) directions at two positions as shown in figure.

NOTE:
Purchase a commercially available telescoping gage for this measurement.

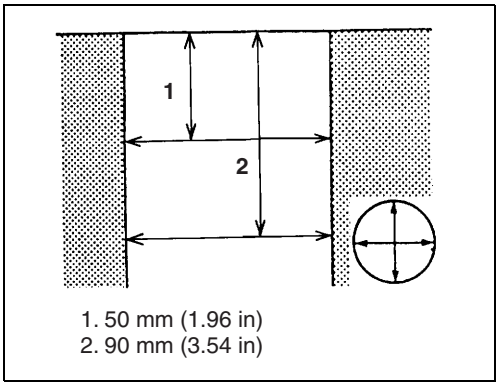


1. Telescoping gauge

Check for followings:
- Difference between measurements at the two positions (taper).
- Difference between axial and transverse measurement (out-of-round).

Cylinder bore wear (difference)
Service limit: 0.10 mm (0.039 in)

If measurement exceeds service limit, bore or replace cylinder.



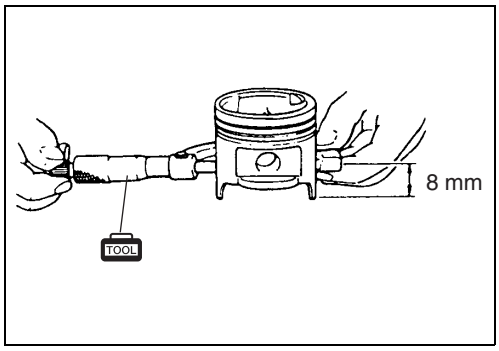
1. 50 mm (1.96 in)
2. 90 mm (3.54 in)

PISTON TO CYLINDER CLEARANCE

(1) Measure the piston diameter at a point 8 mm (0.315 in) above the piston skirt at a right angle to the piston pin bore.

TOOL 09900-20204: Micrometer

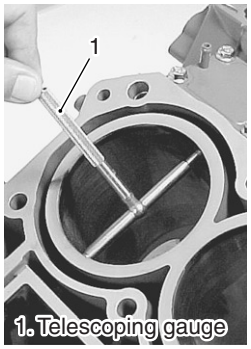
Piston skirt diameter
Standard: 94.970 – 94.990 mm (3.7390 – 3.7398 in)

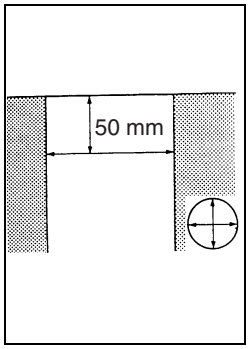


(2) Measure the cylinder bore at 50 mm (1.969 in) below the cylinder head gasket surface at a right angle to the crankshaft pin.

NOTE:
Purchase a commercially available telescoping gage for this measurement.

Cylinder bore diameter
Standard: 95.000 – 95.020 mm (3.7402 – 3.7409 in)





(3) Calculate the piston/cylinder clearance (Clearance equals difference between piston diameter and cylinder bore measurements).

Piston to cylinder clearance
Standard: 0.020 – 0.040 mm (0.0008 – 0.0016 in)
Service limit: 0.100 mm (0.0039 in)

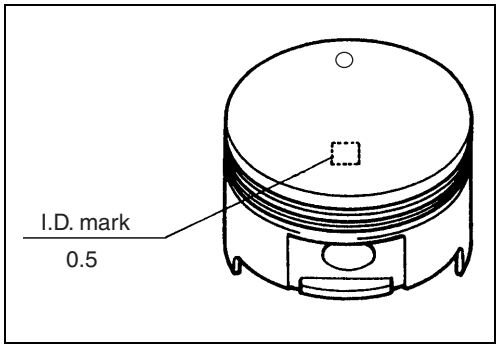
If clearance exceeds service limit, replace piston and/or cylinder or bore cylinder.

Identification of oversize piston/piston ring

One oversize piston/piston ring components, 0.50 mm, is available.
Oversize piston/piston ring are marked as shown, below.

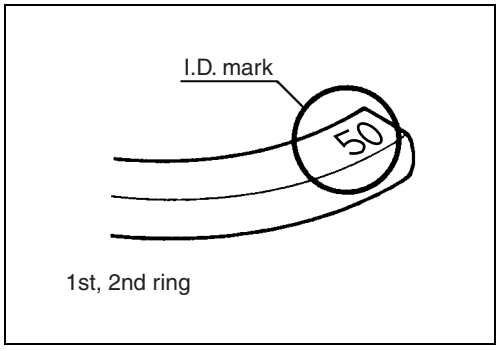
- **Piston**

Oversize	I.D. mark
0.50 mm	0.5



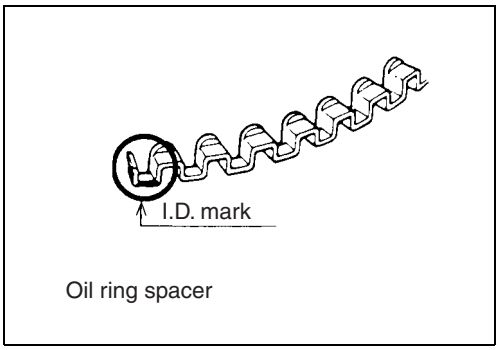
- **1st & 2nd Piston ring**

Oversize	I.D. mark
0.50 mm	50



• **Oil ring**

Oversize	I.D. mark
0.50 mm	One (1) Red paint



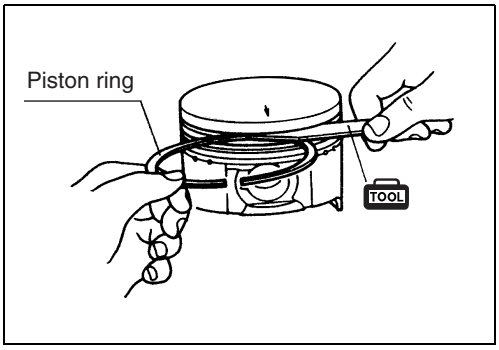
PISTON

• Inspect piston for faults, cracks or other damage. Damaged or faulty piston(s) should be replaced.

• **Piston ring to groove clearance**

Before checking, piston grooves must be clean, dry and free of carbon.

Fit piston ring into piston groove, and measure clearance between ring and ring groove using thickness gauge.



TOOL **09900-20803: Thickness gauge**

Piston ring to groove clearance

Standard:

1st 0.030 – 0.070 mm (0.0012 – 0.0028 in)

2nd 0.020 – 0.060 mm (0.0008 – 0.0024 in)

Service limit:

1st 0.12 mm (0.0047 in)

2nd 0.10 mm (0.0039 in)

If measurement exceeds service limit, replace piston and/or piston ring.

Piston ring groove width

Standard:

1st 1.22 – 1.24 mm (0.0480 – 0.0488 in)

2nd 1.21 – 1.23 mm (0.0476 – 0.0484 in)

Oil 2.51 – 2.53 mm (0.0988 – 0.0996 in)

Piston ring thickness

Standard:

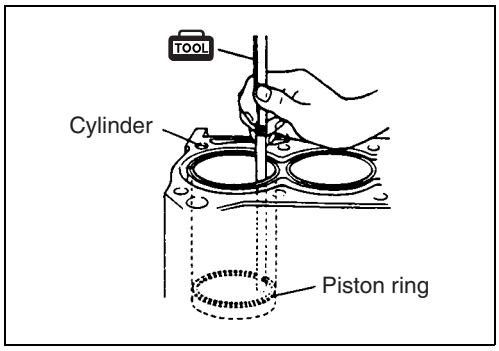
1st 1.17 – 1.19 mm (0.0461 – 0.0469 in)

2nd 1.17 – 1.19 mm (0.0461 – 0.0469 in)

PISTON RING

Piston ring end gap

Measure piston ring end gap with piston ring in the lowest position of cylinder bore.



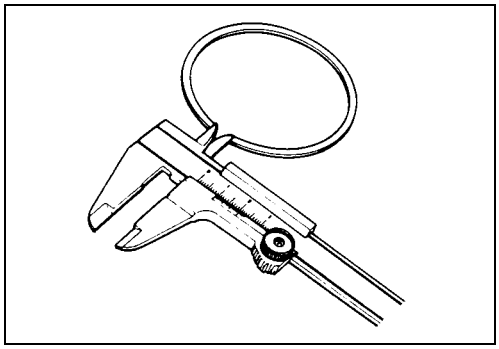
TOOL 09900-20803: Thickness gauge

Piston ring end gap
Standard:
1st 0.20 – 0.33 mm (0.0079 – 0.0130 in)
2nd 0.33 – 0.48 mm (0.0130 – 0.0189 in)
Service limit:
1st 0.70 mm (0.0276 in)
2nd 1.00 mm (0.0394 in)

If measurement exceeds service limit, replace piston ring.

Piston ring free end gap

Measure piston ring free end gap using vernier calipers.



TOOL 09900-20101: Vernier calipers

Piston ring free end gap
Standard:
1st Approx. 11.7 mm (0.4606 in)
2nd Approx. 13.2 mm (0.5197 in)
Service limit:
1st 9.3 mm (0.3661 in)
2nd 10.5 mm (0.4134 in)

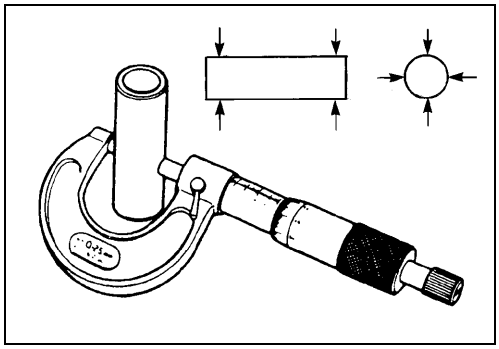
If measurement exceeds service limit, replace piston ring.

PISTON PIN

Check piston pin, conrod small end bore and piston pin hole for wear or damage.
If badly worn or damaged, replace component.

Piston pin clearance

- Check the piston pin clearance in the conrod small end. Replace the conrod if its small end is badly worn or damaged or if clearance exceeds service limit.



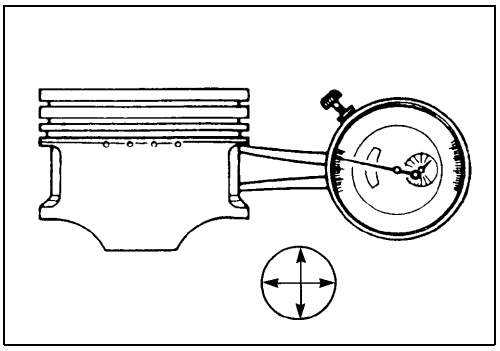
TOOL 09900-20205: Micrometer
09900-20605: Dial calipers

Piston pin outside diameter
standard: 21.996 – 22.000 mm (0.8660 – 0.8661 in)
Service limit: 21.980 mm (0.8654 in)

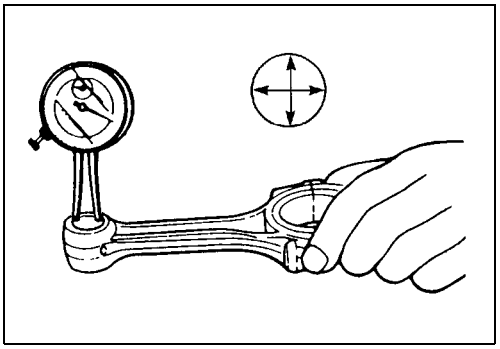
Piston pin hole diameter
Standard: 22.006 – 22.014 mm (0.8664 – 0.8667 in)
Service limit: 22.030 mm (0.8673 in)

Conrod small end bore
Standard: 22.003 – 22.011 (0.8663 – 0.8666 in)

Pin clearance in piston pin hole
Standard: 0.006 – 0.017 mm (0.0002 – 0.0007 in)
Service limit: 0.040 mm (0.0016 in)



Pin clearance in conrod small end
Standard: 0.003 – 0.014 mm (0.0001 – 0.0006 in)
Service limit: 0.05 mm (0.002 in)

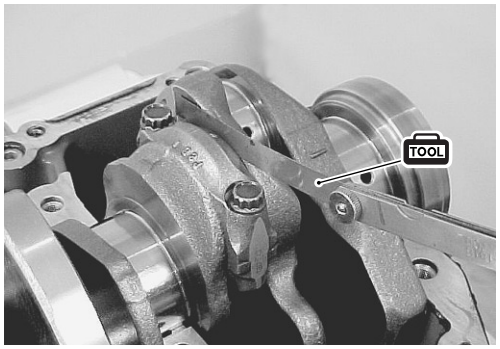


CONROD BIG END SIDE CLEARANCE

Measure conrod big end side clearance with conrod installed on crank pin as shown.

09900-20803: Thickness gauge

Conrod big end side clearance
Standard: 0.300 – 0.450 mm (0.0118 – 0.0177 in)
Service limit: 0.55 mm (0.0217 in)



If measurement exceeds service limit, replace conrod and/or crankshaft.

Conrod big end width
Standard: 20.750 – 20.800 mm (0.8169 – 0.8189 in)

Crank pin width
Standard: 21.100 – 21.200 mm (0.8307 – 0.8346 in)

CRANK PIN

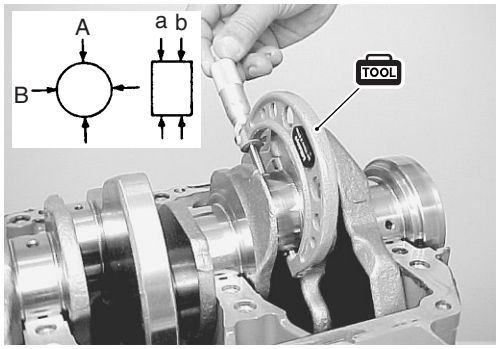
Inspect crank pin for uneven wear or damage.
Measure crank pin for out-of-round or taper with micrometer.
If crank pin is damaged, out-of-round or taper is out of service limit, replace crankshaft.

09900-20203: Micrometer

Out-of-round : A – B
Taper : a – b

Out-of-round and taper
Service limit: 0.01 mm (0.0004 in)

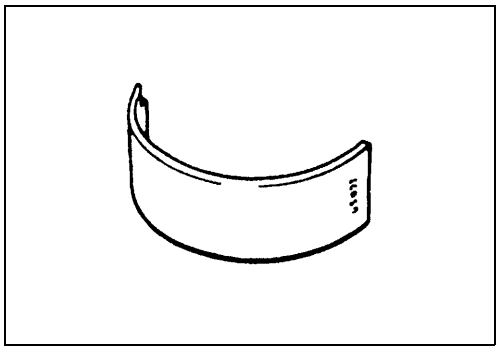
Crank pin diameter
Standard: 53.982 – 54.000 mm (2.1253 – 2.1260 in)



CONROD BEARING

Inspect bearing shell for proper contact pattern and signs of fusion, pitting, burning or flaking.

Bearing shells found in defective condition must be replaced.



Conrod big end oil clearance

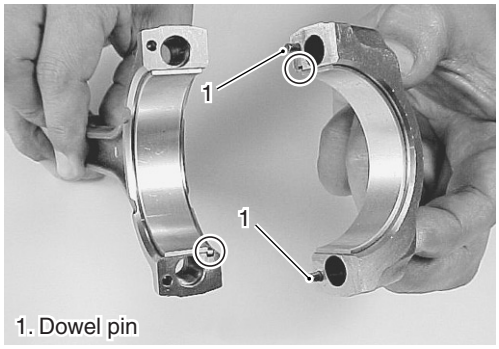
Check conrod big end oil clearance as follows;

(1) Clean surface of conrod, conrod cap, conrod bearing, and crank pin.

(2) Install conrod bearing onto conrod and conrod cap.

NOTE:

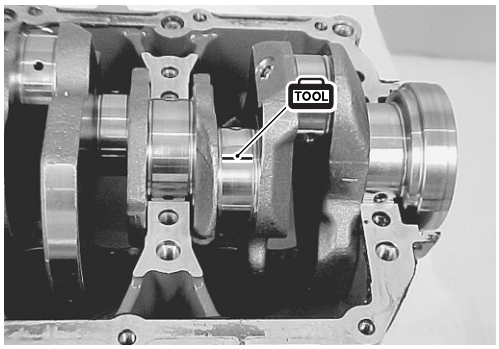
- *Reassemble each bearing and conrod cap to their original position.*
- *Do not apply oil to bearing.*



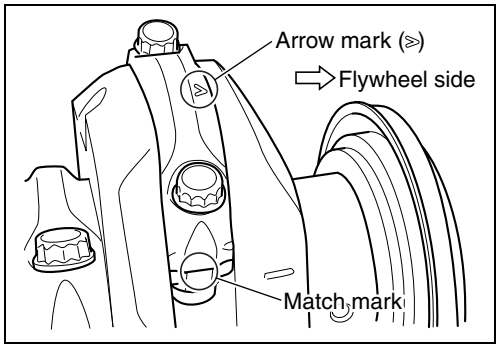
1. Dowel pin

(3) Place a piece of Plastigauge on crank pin parallel to crankshaft. Avoid placing Plastigauge over oil hole.

09900-22301: Plastigauge



(4) Install conrod cap (with bearing) to conrod with the arrow mark on cap toward flywheel side.



(5) Apply engine oil to conrod bolts and tighten bolt in two steps.

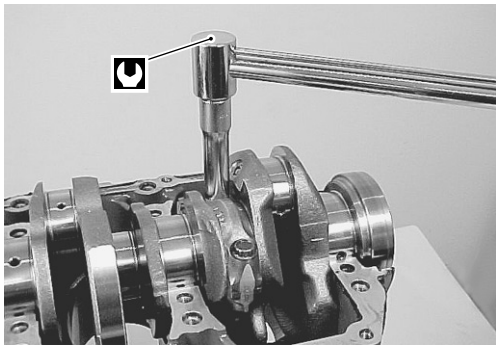
Conrod cap bolt:

1st step 31 N·m (3.1 kg-m, 22.4 lb-ft)

Final step 63 N·m (6.3 kg-m, 45.6 lb-ft)

NOTE:

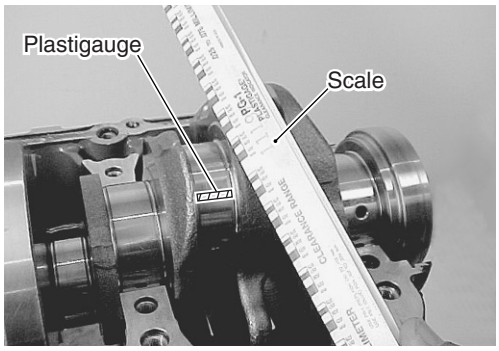
Do not rotate conrod with Plastigauge in place.



(6) Remove conrod and conrod cap from crank pin.
(7) Using scale on Plastigauge envelope, measure Plastigauge width at its widest point.

Conrod big end oil clearance
Standard: 0.045 – 0.063 mm (0.0018 – 0.0025 in)
Service limit: 0.080 mm (0.0031 in)

If measurement exceeds service limit, replace conrod bearing.



CRANKSHAFT

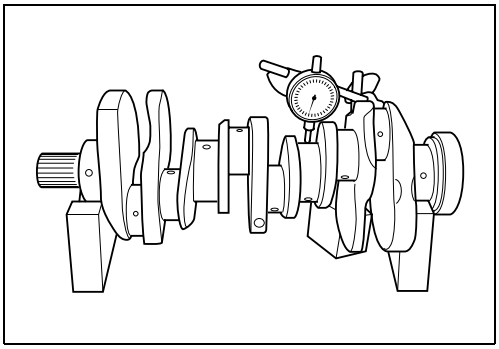
■ Crankshaft runout

Using a dial gauge, measure runout at center journal.

09900-20606: Dial gauge
09900-20701: Magnetic stand

Crankshaft runout
Service limit: 0.04 mm (0.0016 in)

If measurement exceeds service limit, replace crankshaft.



■ Crankshaft thrust play

Measure thrust play with crankshaft, thrust bearing, journal bearing and crankcase/cylinder block assembled in a normal manner.
Tighten crankcase bolts to specified torque.

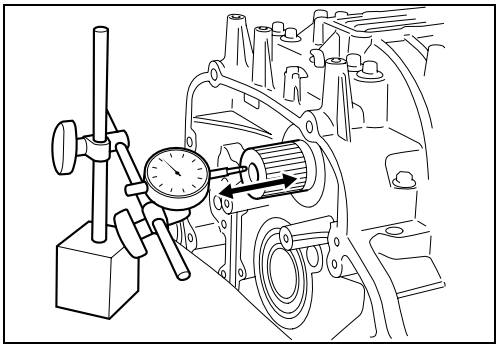
Crankcase bolt:
8 mm 27 N·m (2.7 kg-m, 19.5 lb-ft)
10 mm 52 N·m (5.2 kg-m, 37.6 lb-ft)

Use a dial gauge to read displacement in axial (thrust) direction of crankshaft.

Crankshaft thrust play
Standard: 0.11 – 0.31 mm (0.0043 – 0.0122 in)
Service limit: 0.35 mm (0.0138 in)

If measurement exceeds service limit, replace crankshaft thrust bearing.

Crankshaft thrust bearing thickness
Standard: 2.425 – 2.475 mm (0.0955 – 0.0974 in)

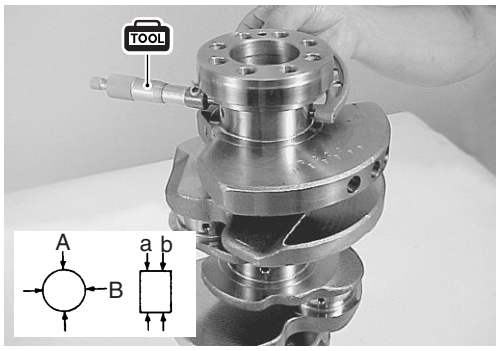


■ **Out-of-round and taper (uneven wear) of journals**

An unevenly worn crankshaft journal shows up as a difference in diameter at a cross section or along its length (or both).

This difference, if any, is determined by taking micrometer readings.

If any journal is badly damaged or if measurements exceed service limit, replace crankshaft.



TOOL 09900-20203: Micrometer

Out-of-round: A – B
Taper : a – b

Out-of-round and taper
Service limit: 0.01 mm (0.0004 in)

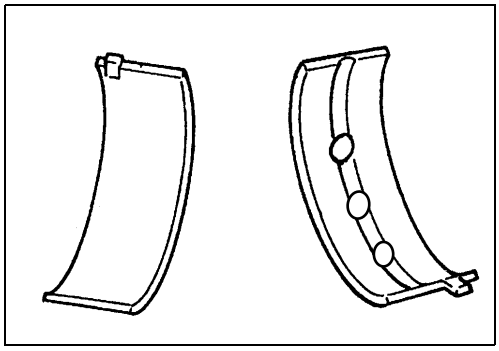
Crankshaft journal outside diameter
Standard: 64.988 – 65.006 mm (2.5586 – 2.5593 in)

CRANKSHAFT MAIN BEARING

Check bearings for pitting, scratches, wear or damage.

If any improper condition is found, replace both upper and lower halves.

Always replace both bearing halves, never replace only one half of a bearing set.



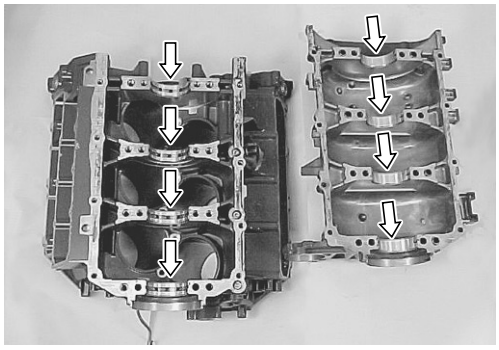
CRANKSHAFT JOURNAL OIL CLEARANCE

Check clearance using Plastigauge according to the following procedure.

NOTE:

Assemble each bearing in its original position before checking clearance.

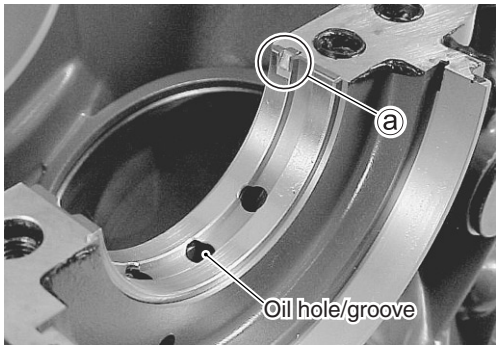
(1) Clean surface of bearing holder (crankcase, and cylinder), bearing, and main bearing journal.



(2) Install main bearing to cylinder and crankcase.

NOTE:

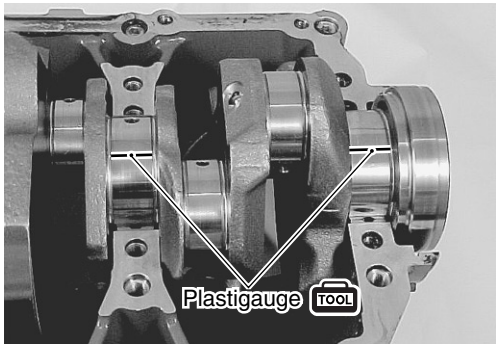
- *Align tab ⓐ of bearing with notch in cylinder and crankcase.*
- *Do not apply engine oil to bearing.*
- *Install lower bearing half with oil hole/groove towards cylinder side.*



(3) Install crankshaft to cylinder.
(4) Place a piece of Plastigauge across full width of bearing (parallel to crankshaft) on journal.
Do not place Plastigauge over oil hole.

09900-22301: Plastigauge

NOTE:
Do not rotate crankshaft while Plastigauge is installed.

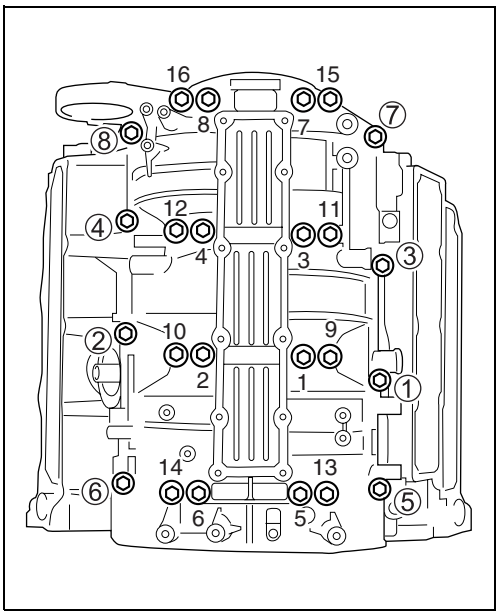


(5) Assemble crankcase to cylinder.
(6) Apply engine oil to crankcase bolts.
Tighten crankcase bolts in three (3) steps following the order indicated below.

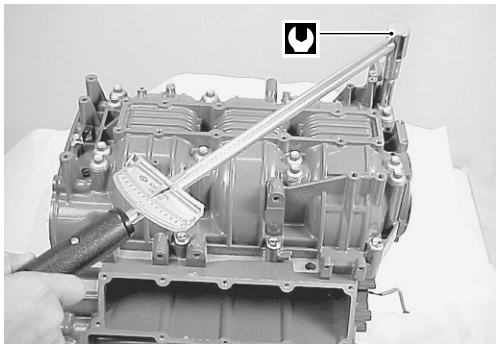
NOTE:
Tighten 10 mm (0.394 in) thread diameter bolts first (following the order shown in figure), then tighten 8 mm (0.315 in) thread diameter bolts.

Crankcase bolt (10 mm thread diameter):
1st step 11 N·m (1.1 kg-m, 8.0 lb-ft)
2nd step 42 N·m (4.2 kg-m, 30.0 lb-ft)
Final step 52 N·m (5.2 kg-m, 37.6 lb-ft)

Crankcase bolt (8 mm thread diameter):
1st step 6 N·m (0.6 kg-m, 4.3 lb-ft)
2nd step 21 N·m (2.1 kg-m, 15.0 lb-ft)
Final step 27 N·m (2.7 kg-m, 19.5 lb-ft)



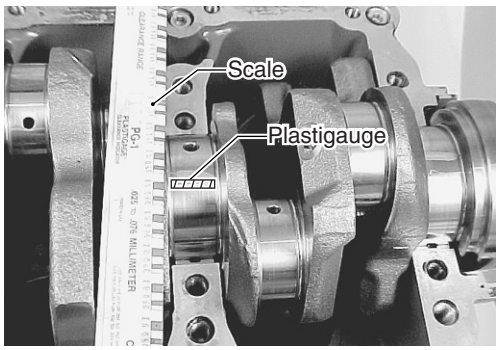
NOTE:
Crankcase must be torqued to specification in order to assure proper compression of Plastigauge and accurate reading of clearance.



(7) Remove crankcase from cylinder.
(8) Using scale on Plastigauge envelope, measure Plastigauge width at its widest point.

Crankshaft journal oil clearance
Standard: 0.024 – 0.044 mm (0.0009 – 0.0017 in)
Service limit: 0.065 mm (0.0026 in)

If measurement exceeds service limit, replace crankshaft main bearing.



NOTE:
For bearing replacement, see the "SELECTION OF MAIN BEARING" section on page 6-87.

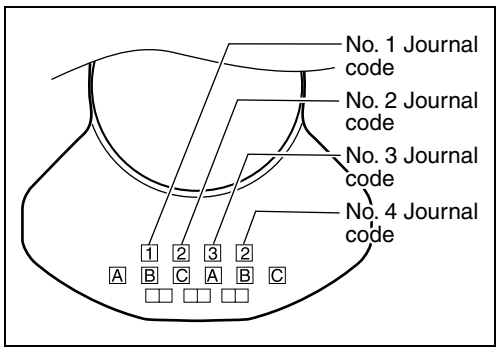
SELECTION OF MAIN BEARING

Whenever a bearing requires replacement, select a new bearing according to following procedure.

(1) First, check journal diameter.

As shown in figure, upper (flywheel side) crank web of No.1 cylinder has four (4) stamped code numerals.

The numerals (1, 2 & 3) represent the journal diameters shown below.

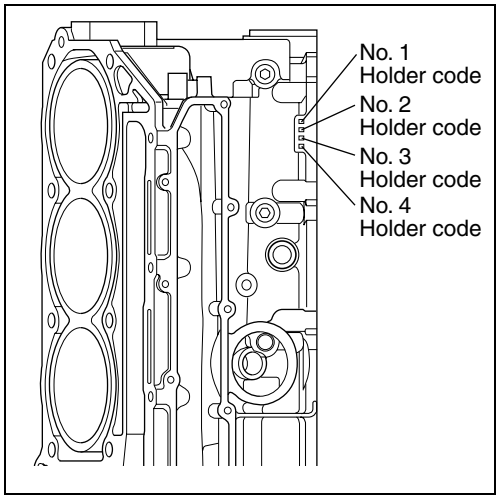


Numeral stamped	Journal diameter
1	65.000 – 65.006 mm (2.5591 – 2.5593 in)
2	64.994 – 65.000 mm (2.5588 – 2.5591 in)
3	64.988 – 64.994 mm (2.5586 – 2.5588 in)

(2) Next, check bearing holder inside diameter without bearing.

As shown in figure, the cylinder block STBD side has four (4) stamped code letters.

The letters (A, B & C) represent the bearing holder inside diameters shown below.

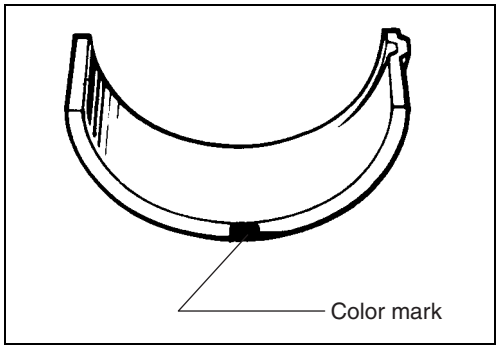


Code	Crank bearing holder inside diameter (w/o bearing)
A	70.000 – 70.006 mm (2.7559 – 2.7561 in)
B	70.006 – 70.012 mm (2.7561 – 2.7564 in)
C	70.012 – 70.018 mm (2.7564 – 2.7566 in)

(3) There are five (5) main bearings available, each of differing thickness.

To distinguish them, a color mark is painted at the position indicated in figure.

Each color represents the following thickness measured at the center of the bearing.



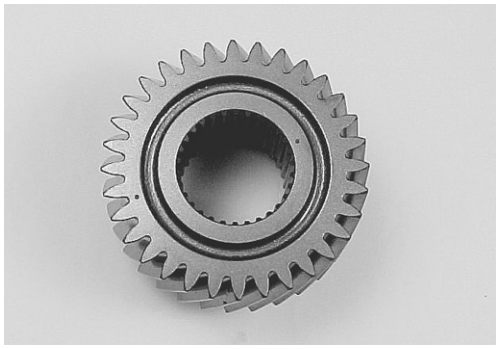
Color mark	Bearing thickness
Black	2.496 – 2.500 mm (0.0983 – 0.0984 in)
No color mark	2.499 – 2.503 mm (0.0984 – 0.0985 in)
Yellow	2.502 – 2.506 mm (0.0985 – 0.0987 in)
Blue	2.505 – 2.509 mm (0.0986 – 0.0988 in)
Pink	2.508 – 2.512 mm (0.0987 – 0.0989 in)

(4) Select crankshaft main bearing referring the below table.

		Numeral stamped on crank web (journal outside diameter)		
		1	2	3
Code stamped on cylinder block (Bearing holder inside diameter)	A	Black	No color	Yellow
	B	No color	Yellow	Blue
	C	Yellow	Blue	Pink

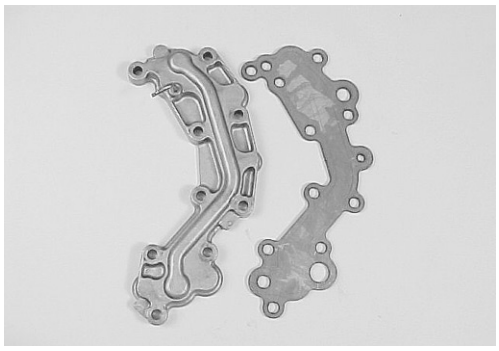
NOTE:
Measure crankshaft journal oil clearance again after installing new bearing selected. (See page 6-85.)

CRANKSHAFT DRIVE GEAR
Inspect drive gear. Replace gear if damaged or worn.



PISTON COOLING JET
Check the piston cooling jet.
If crack or other damage is found, replace the jet.
Clean the jet thoroughly to ensure there is no obstruction.

OIL GALLERY COVER/PLATE
Check the oil gallery cover and plate.
If crack or other damage is found, replace it.
Clean the oil jet thoroughly to ensure there is no obstruction.



OIL SEAL
Inspect condition. If cracked, cut or damaged, replace.

REASSEMBLY

Assembly is reverse order of disassembly paying special attention to the following steps.

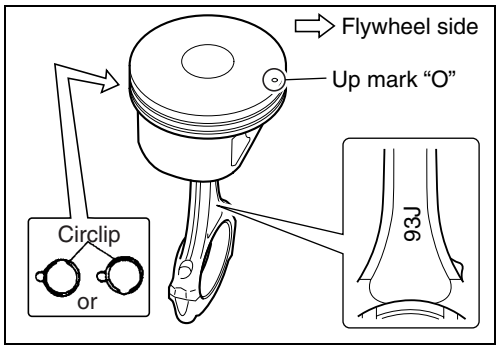
CAUTION

If original components are not replaced, each piston, piston pin and conrod is to be assembled and installed in its original order and position.

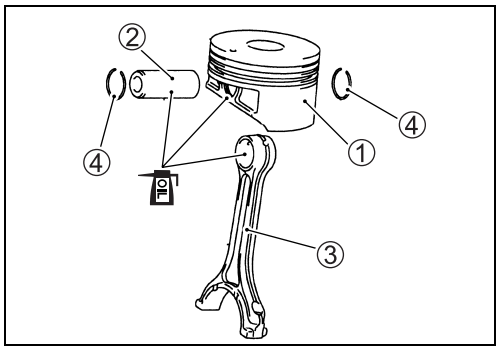
PISTON TO CONROD
Apply engine oil to piston pin ②, piston pin bore and conrod ③.
Assemble conrod ③ to piston ① as shown in figure and insert piston pin ② through piston and conrod.
Install piston pin circlips ④.

NOTE:

- *"93J" mark on conrod and up mark (○) on piston dome must face toward flywheel side.*



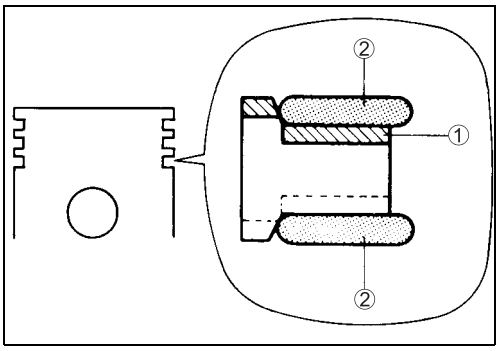
- *Circlip should be installed with gap facing either up or down as shown in figure.*
- *Always use new piston pin circlip.*



PISTON RING TO PISTON

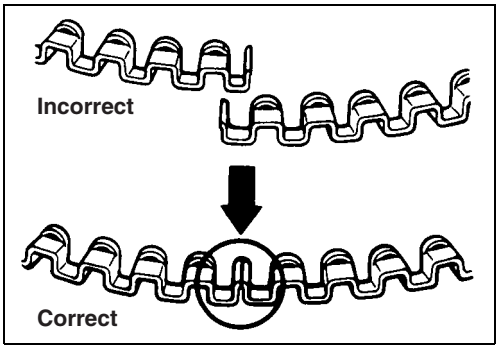
■ Oil ring

- Apply engine oil to piston rings.
- Install spacer ① first, then side rails ② to piston.



CAUTION

When installing spacer, do not allow spacer ends to overlap in groove.

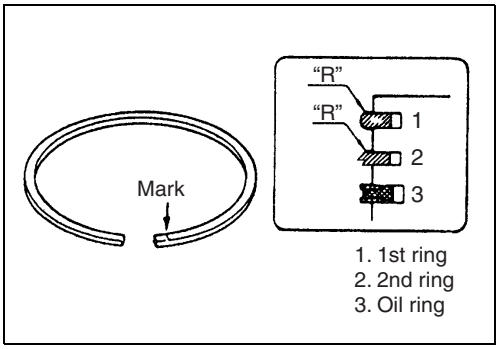


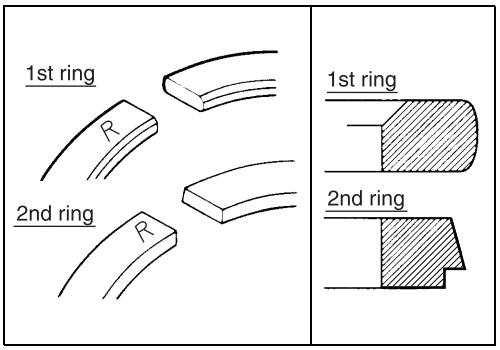
■ 1st and 2nd piston ring

- Apply engine oil to piston ring.
- Install 2nd ring and 1st ring to piston.

NOTE:

- *1st and 2nd ring differ in shape and color as shown in figure.*
- *Also indicated in figure, the 1st and 2nd ring are marked with the letter "R" which must face towards top of piston.*





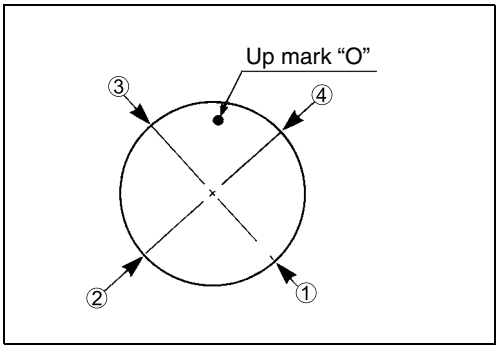
■ Ring gap direction

Position piston rings so gaps are staggered at approximately 90 degree angles as shown.

① 1st ring ③ 2nd ring
② Oil ring lower side rail ④ Oil ring upper side rail

CAUTION

Failure to stagger piston ring gaps may result in crankcase oil dilution.

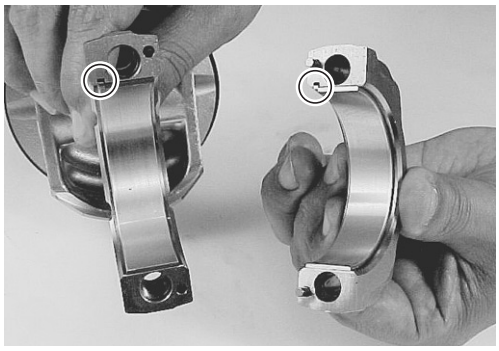


PISTON TO CYLINDER

Install conrod bearing to conrod and conrod cap.

CAUTION

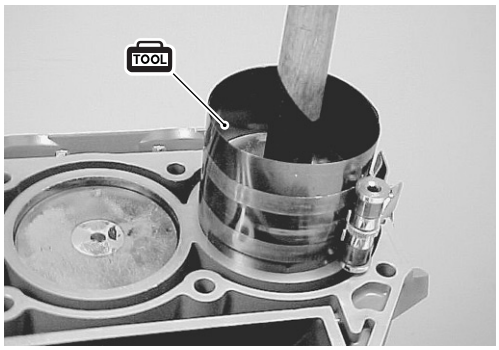
- **Assemble each conrod bearing to its original position.**
- **Do not apply oil between conrod and bearing or between bearing cap and bearing.**



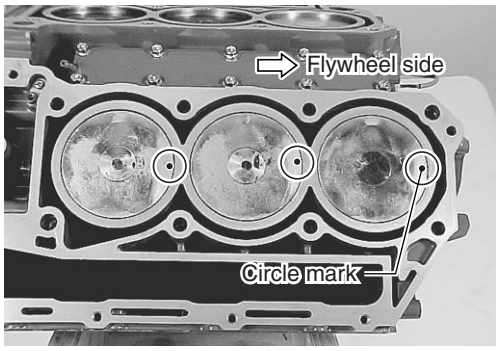
Apply engine oil to piston and cylinder walls.

Insert piston and conrod assembly into cylinder bore from cylinder head side using special tool.

TOOL 09916-77310: Piston ring compressor



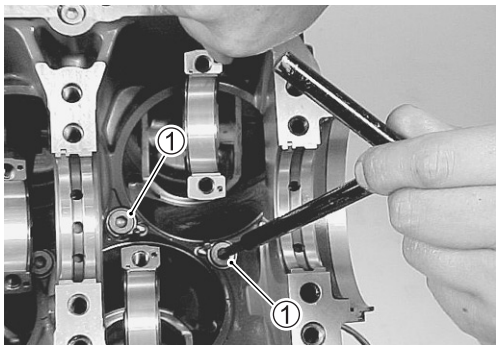
NOTE:
Position the "circle" mark (○) on piston head to flywheel side.



PISTON COOLING JET

Install the piston cooling jet ① in position, then tighten bolt securely.

Piston cooling jet: 20 N·m (2.0 kg-m, 14.5 lb-ft)



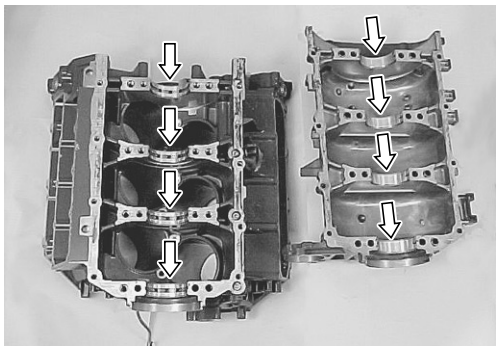
CRANKSHAFT TO CYLINDER

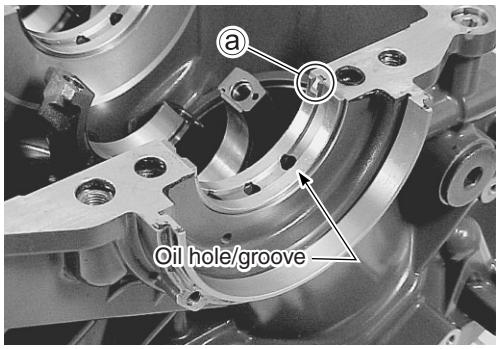
Install crankshaft main bearings in cylinder and crankcase.
Apply engine oil to bearings.

CAUTION

- **Assemble each bearing to its original position.**
- **Assemble main bearing half containing oil groove/hole to cylinder block.**
  Assemble the half without oil groove to crankcase.
- **Do not apply oil between crank bearing holder and crank main bearing.**

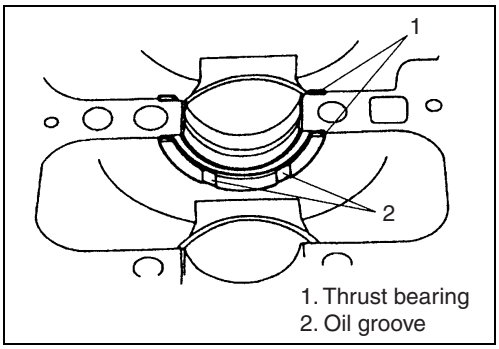
NOTE:
Align bearing tab ⓐ with notch in cylinder and crankcase.





Thrust bearing

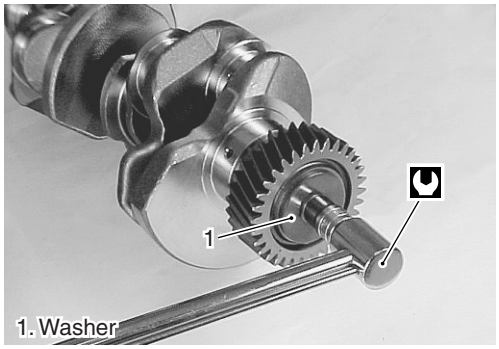
Apply engine oil to the thrust bearing and install in cylinder block overlaping both sides of the No. 3 main journal.
Oil groove on the thrust bearing must face towards crank webs.



Crankshaft drive gear

To assemble the drive gear on crankshaft, align the dot (•) mark on drive gear with the dot (•) mark on crankshaft, then install washer and secure with bolt.

Drive gear bolt: 48 N·m (4.8 kg-m, 34.7 lb-ft)



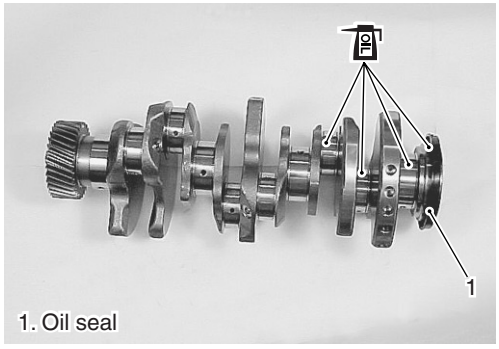
Crankshaft

Apply engine oil to upper oil seal lip.
Install upper oil seal to crankshaft.

CAUTION

Do not re-use seal removed. Be sure to use new seal.

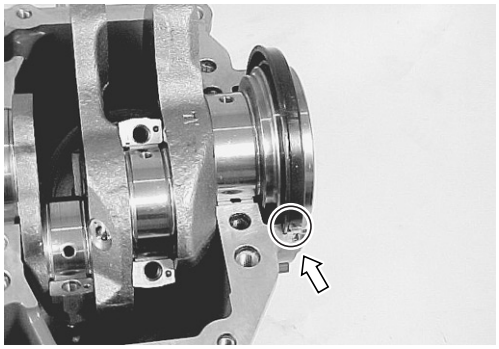
NOTE:
Install upper oil seal with its spring/lipped side facing inward.



1. Oil seal

Apply engine oil to crank pin and crankshaft main journal and install crankshaft in cylinder.

NOTE:
When installing crankshaft to cylinder, be sure to fit tab of seal in groove of cylinder.

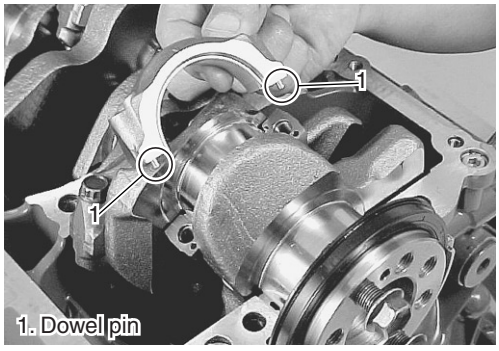


CONROD CAP

Apply engine oil to crank pin and conrod bearing.
Install dowel pins and conrod cap (with bearing) to conrod with arrow mark on cap toward flywheel side.

CAUTION

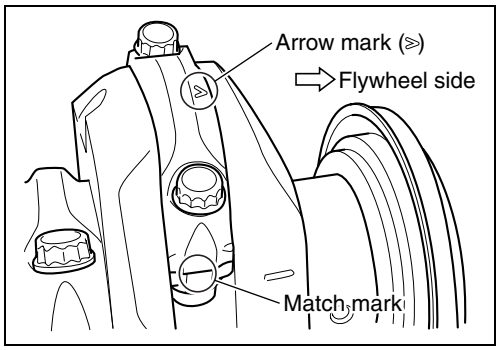
Reassemble each conrod cap to its original position.

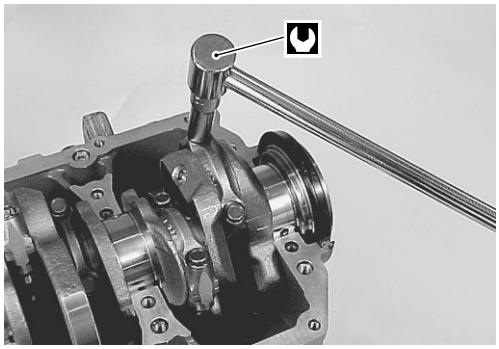


1. Dowel pin

Apply engine oil to conrod bolts.
Tighten conrod cap bolts in two steps.

Conrod cap bolt:
1st step 31 N·m (3.1 kg-m, 22.4 lb-ft)
Final step 63 N·m (6.3 kg-m, 45.6 lb-ft)





CRANKCASE TO CYLINDER

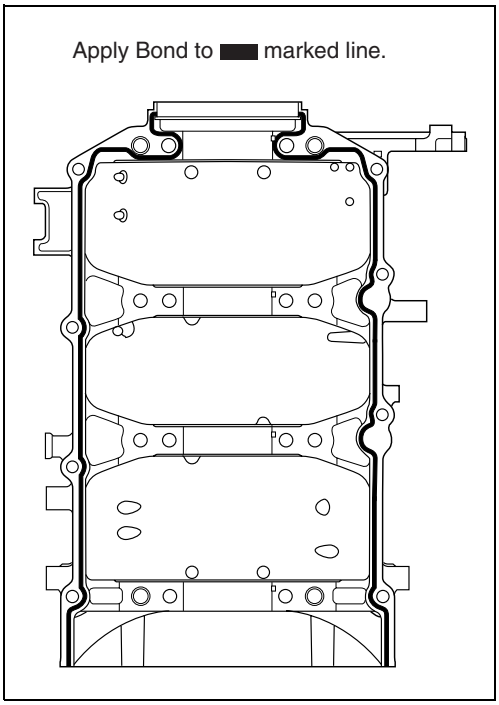
Clean mating surface of cylinder and crankcase.

Apply SUZUKI BOND to mating surface of crankcase as shown.

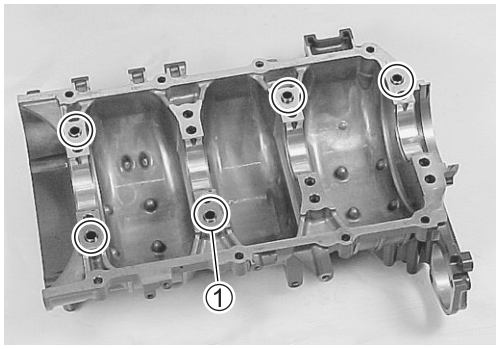
CAUTION

Apply bond to mating surface only.
Do not allow bond to contact surface of bearing.

1104 99000-31030: SUZUKI BOND No. "1104"



Install five (5) dowel pins ①.



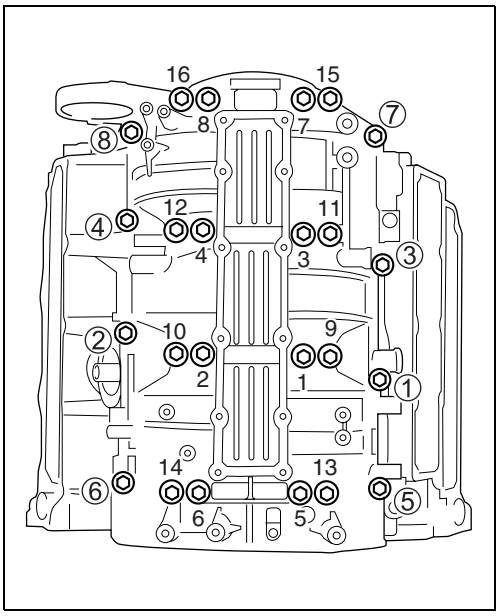
Install crankcase to cylinder.

Apply engine oil to crankcase bolts.

Tighten crankcase bolts in three (3) steps following the order indicated below.

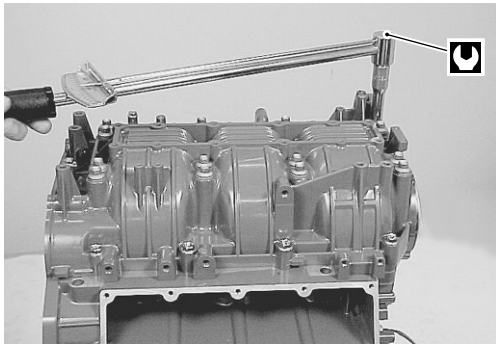
NOTE:

Tighten 10 mm (0.394 in) thread diameter bolts first (following the order shown in figure), then tighten 8 mm (0.315 in) thread diameter bolts.



Crankcase bolt (10 mm thread diameter):
1st step 11 N·m (1.1 kg-m, 8.0 lb-ft)
2nd step 42 N·m (4.2 kg-m, 30.0 lb-ft)
Final step 52 N·m (5.2 kg-m, 37.6 lb-ft)

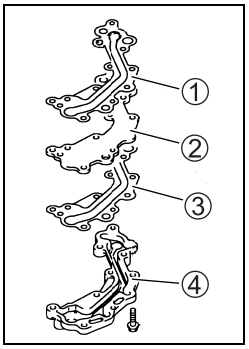
Crankcase bolt (8 mm thread diameter):
1st step 6 N·m (0.6 kg-m, 4.3 lb-ft)
2nd step 21 N·m (2.1 kg-m, 15.0 lb-ft)
Final step 27 N·m (2.7 kg-m, 19.5 lb-ft)

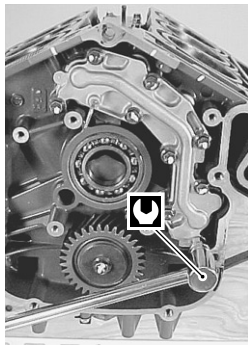


NOTE:
After tightening crankcase bolts, check to be sure that crankshaft rotates smoothly when turned by hand.

OIL GALLERY COVER/PLATE
Install the gasket ①, oil gallery plate ②, gasket ③ and oil gallery cover ④, then secure with bolts.

Oil gallery cover: 23 N·m (2.3 kg-m, 16.6 lb-ft)





CYLINDER HEAD
Install cylinder head. (See page 6-56 to 6-60.)

TIMING CHAIN
Install timing chain. (See page 6-34 to 6-40, 6-47 to 6-53.)

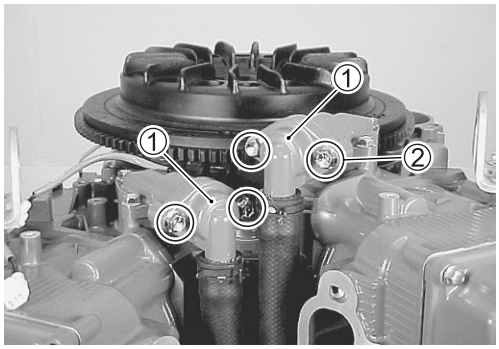
OIL PUMP
Install oil pump assembly. (See page 6-27.)

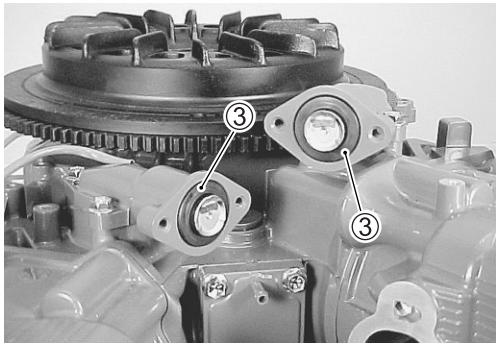
POWER UNIT
Install power unit. (See page 6-18 to 6-22.)

THERMOSTAT

REMOVAL

- Remove the ring gear cover and air intake silencer case. (See page 6-2.)
- Remove the two (2) bolts ② securing the thermostat cover ①, then remove the cover ① and thermostat ③.



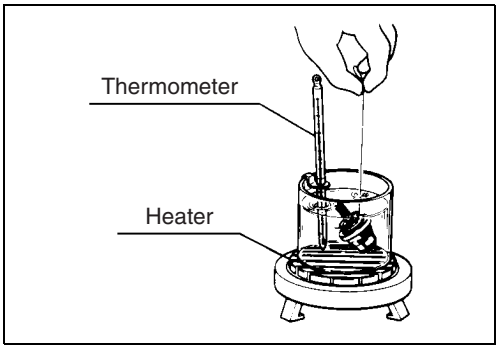


INSPECTION

- If salt deposits, corrosion, wear or other damage is found, clean or replace.

- **Thermostat operation**
  Check thermostat opening temperature as follows:
  - Insert a length of thread between thermostat valve/body and suspend thermostat in a container filled with water.
  - Place thermometer in container and heat water.
    Observe water temperature when thermostat valve opens and releases thread.

  Thermostat operating temperature
  Standard: 58 – 62 °C (136 – 143 °F)



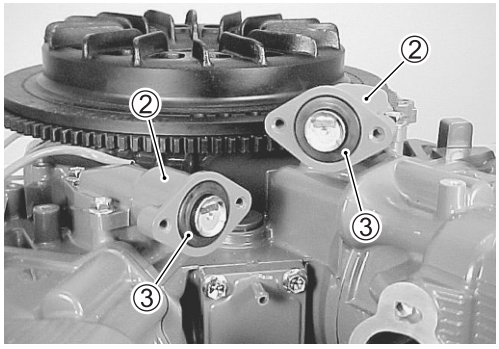
INSTALLATION

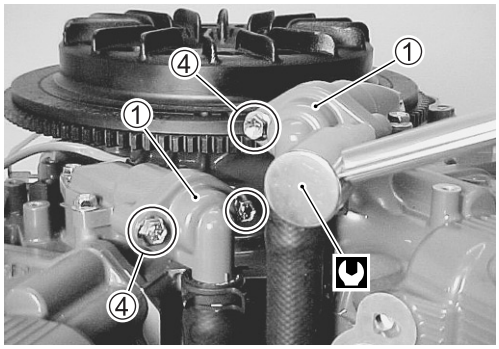
Installation is reverse order of removal with special attention to the following steps.

- Assemble thermostat ③ and thermostat cover ① to thermostat housing ② and secure with bolts ④.

Thermostat cover bolt: 10 N·m (1.0 kg-m, 7.2 lb-ft)

- Check to ensure that all removed parts are back in place.





OPERATION

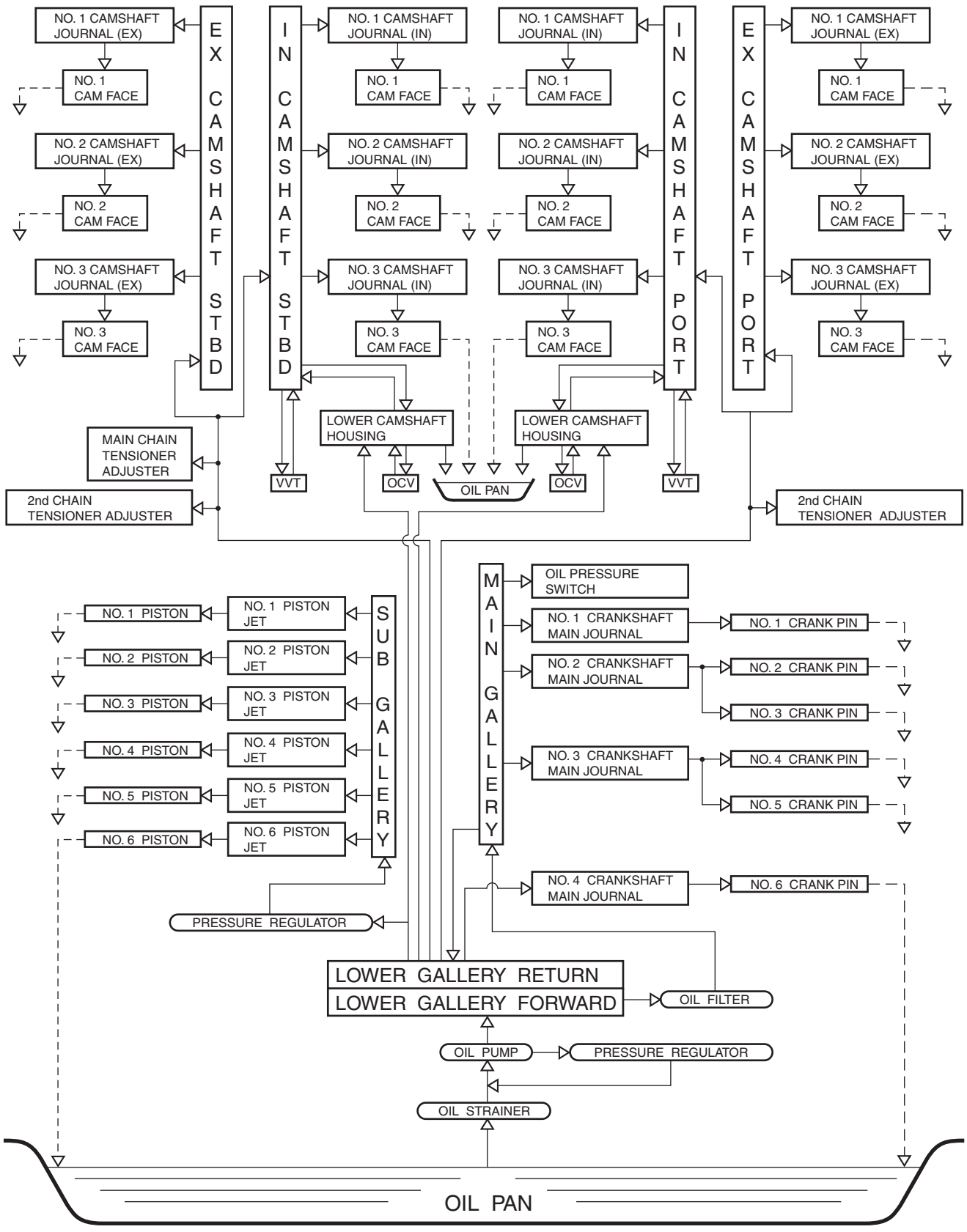
ENGINE LUBRICATION SYSTEM

The engine lubrication system uses a camshaft-driven oil pump that pressure feeds engine oil to the engine' moving parts. The chart below shows the lubrication system oil flow.

Engine oil is drawn up by the oil pump through the oil strainer. After passing through the oil filter, engine oil flows to the main gallery and lower gallery from which various passages distribute oil for lubrication and other engine functions requiring engine oil pressure to operate.

- Oil from the main gallery:
  Lubricates crankshaft journal bearings #1 through #3.
  Lubricates crank pins #1 through #5.
- Oil from the lower gallery:
  - Lubricates crank journal bearing #4 and crank pin #6.
  - Passes through the sub-gallery and sprays through six cylinder lubrication jets to lubricate the cylinder, piston pin and cylinder wall.
  - Passes through the cylinder head oil passage to lubricate the IN. and EX. camshaft journals and cam faces.
  - Flows to OCV, supplying pressurized engine oil to operate the VVT system. From the ECM controlled OCV, oil flows to the VVT actuator to advance, retard or maintain intake valve timing.

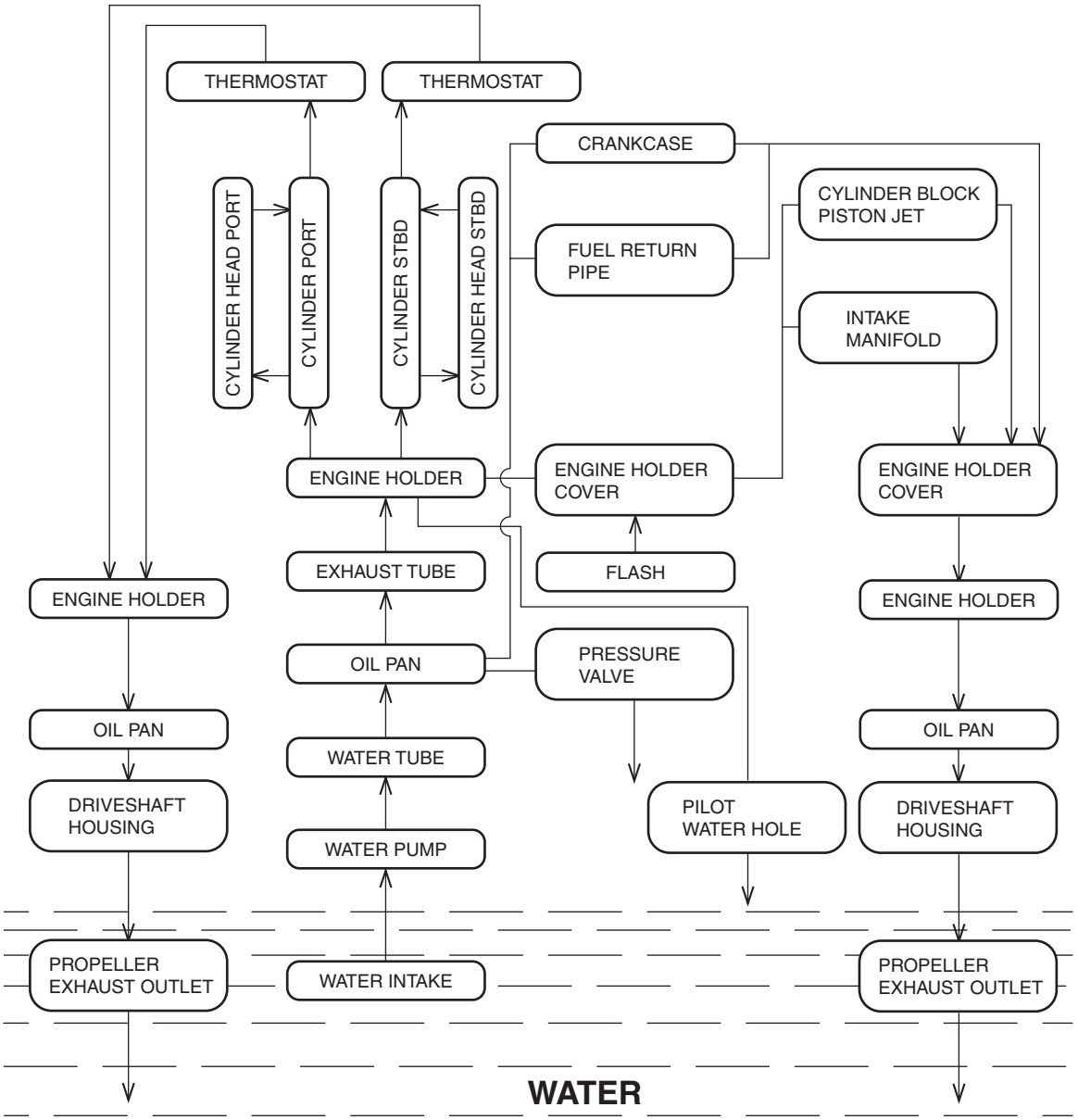
ENGINE OIL LUBRICATION CHART



WATER COOLING SYSTEM

The water cooling system includes the lower unit water pump, lower unit to power unit water supply tube, oil pan water pressure valve, power unit water passages and thermostats.
This system cools both the power unit and exhaust and is shown in schematic form below.
If overheating occurs, the components of the cooling system must be inspected for blockage, corrosion build-up or component damage.

Component inspection	Refer to page
Water pump/Impeller	9-11, 10-11
Water tube	7-9
Thermostat	6-96
Water pressure valve	7-26
Cylinder head	6-63
Cylinder block	6-78



PCV SYSTEM

(PCV: POSITIVE CRANKCASE VENTILATION)

Due to the necessary piston to cylinder clearance, unburned combustion gasses (blow-by) will naturally pass through and enter the crankcase.
The PCV system is provided to recirculate these gasses back to the combustion chamber to be reburned.
The system consists of cylinder head cover, PCV valve, breather hose, throttle body and collector.

UNDER LIGHT ENGINE LOAD CONDITIONS

When the throttle valve opening is small, air entering from the air intake silencer case is directed through the breather hose to the cam chamber. At this time, a high vacuum occurs inside the collector resulting in a minimal PCV valve opening.
Due to this high vacuum condition, blow-by gasses inside the cam chamber are taken into the collector (scavenged) along with the air flowing from the breather hose.
The volume of gasses is small at this time.

UNDER HIGH ENGINE LOAD CONDITIONS

When the throttle valve opening is large, the vacuum inside the collector decreases causing the PCV valve, assisted by an internal spring, to open fully.
With the PCV fully open, blow-by gasses inside the cam chamber are now directed (scavenged) through the valve into the collector.
At the same time, gasses passing through the breather hose are still being directed into the silencer case.