

CHAPTER 3. ENGINE OVERHAUL

ENGINE REMOVAL	3-1
A. Preparation For Removal	3-1
B. Fuel Tank Removal	3-1
C. Removal of Other Parts	3-1
D. Engine Mounting Bolts and Engine Removal	3-3
ENGINE DISASSEMBLY	3-4
A. Cylinder and Cylinder Head	3-4
B. Rocker Arm Removal	3-5
C. Valve Removal	3-5
D. Piston Removal	3-5
E. Generator and Drive Sprocket Removal	3-5
F. Case Cover (Right), Primary Drive Gear and Clutch Assembly Removal ..	3-6
G. Kick Axle and Change Shaft Removal	3-7
H. Tachometer Gear Removal	3-7
I. Oil Pump Removal	3-7
J. Crankcase Disassembly	3-8
INSPECTION AND REPAIR	3-11
A. Cylinder Head Cover	3-11
B. Cylinder Head	3-11
C. Valves, Valve Guides, Valve Seats, and Valve Springs	3-11
D. Rocker Arms and Rocker Arm Shafts	3-16
E. Camshafts, Cam Chains, and Cam Sprockets	3-16
F. Cylinder	3-17
G. Piston and Piston Rings	3-17
H. Crankshaft and Connecting Rod	3-19
I. Oil Pump	3-19
J. Primary Drive	3-20
K. Clutch	3-20
L. Transmission	3-21
M. Starter	3-22
N. Crankcase	3-22
O. Bearings and Oil Seals	3-23



ENGINE ASSEMBLY AND ADJUSTMENT	3-24
A. Important Information	3-24
B. Starter Motor Unit	3-25
C. Shifter Transmission and Crankshaft	3-26
D. Crankcase Assembly	3-28
E. Kick Starter, Primary Drive Gear, Clutch Assembly, Oil Pump and Case Cover Right	3-29
F. Case Cover Left	3-33
G. Pistons, Cylinders and Cylinder Head	3-34
H. Camshaft and Chain Tensioner	3-34
I. Mounting the Engine	3-35

ENGINE OVERHAUL

ENGINE REMOVAL

NOTE: _____

It is not necessary to remove the engine in order to remove the clutch and/or the AC magneto.

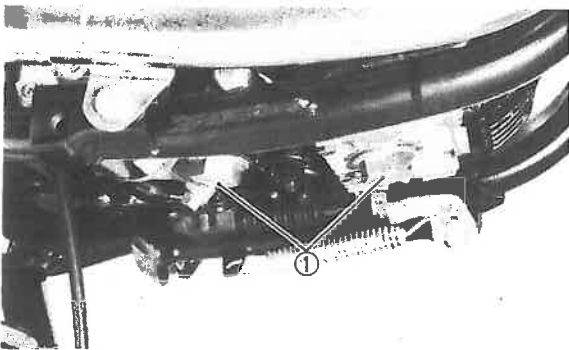
A. Preparation For Removal

1. All dirt, mud, dust, and foreign material must be removed from the engine before removal and disassembly. This will help keep foreign material out of the engine oil.
2. Before engine removal and disassembly, be sure that you have the proper tools and cleaning equipment. With them, you can perform a clean and efficient job.

NOTE: _____

When disassembling the engine, keep mated parts together. This includes gears, cylinders, pistons, and other parts that have been "mated" through normal wear. Mated parts must be reused as an assembly or replaced.

3. During engine disassembly, clean all parts and place them in trays in the order of disassembly. This will speed up assembly time and help assure that all parts are correctly reinstalled in the engine.
4. Place the motorcycle on its centerstand. Start the engine and let it warm-up. Stop the engine and drain the engine oil.

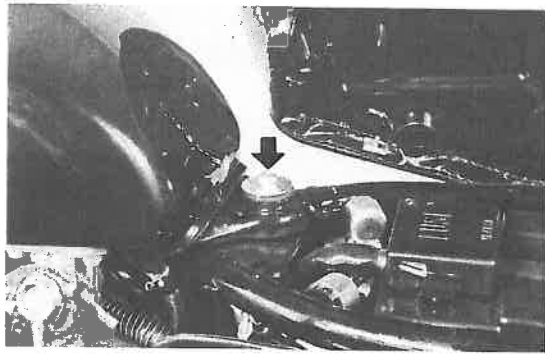


1. Drain plugs

5. Remove the battery.

B. Fuel Tank Removal

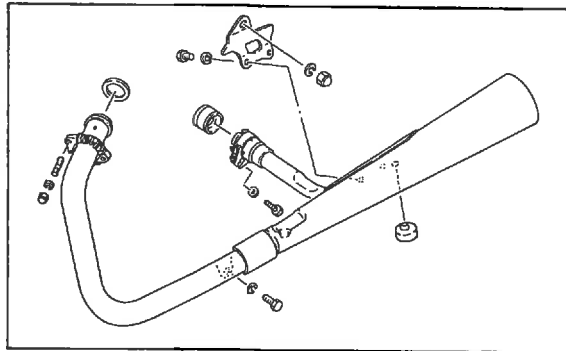
1. Turn fuel petcocks to "on" (there is no "off" position – fuel will not flow from a petcock on the "on" position unless the engine is operating). Disconnect fuel pipes and vacuum pipes from petcock.
2. Lift seat and remove fuel tank holding bolt. Remove fuel tank.



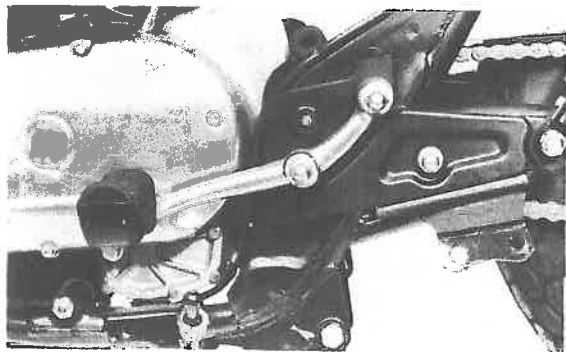
C. Removal of Other Parts

Remove the following parts in the order given.

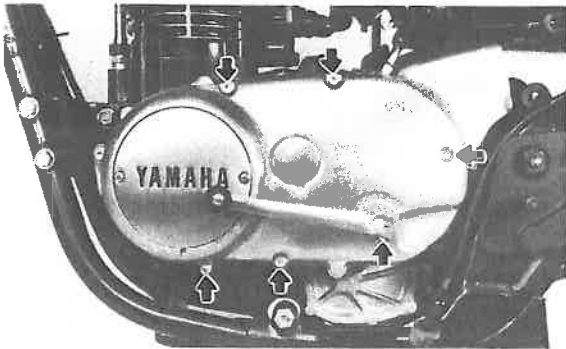
1. Exhaust pipes



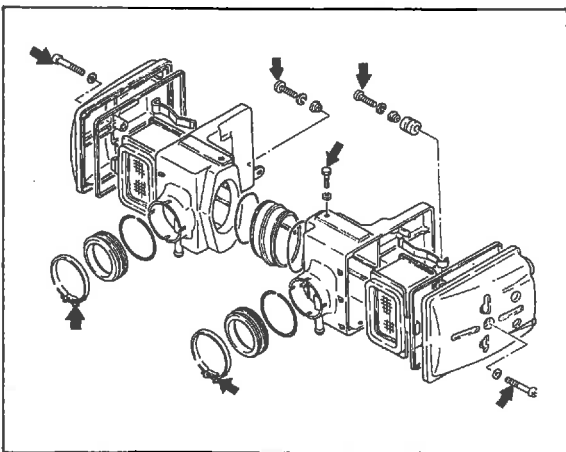
2. Horn (as a unit)
3. Both side footrests



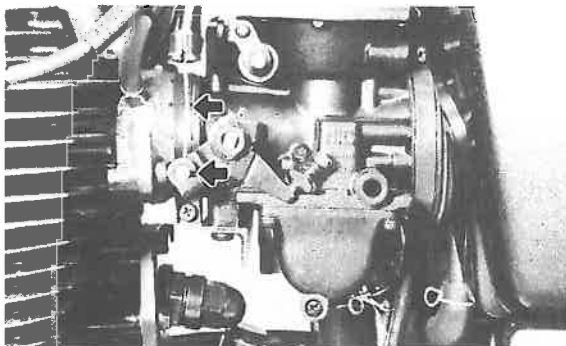
4. Change pedal and drive chain guide
5. Left-hand crank case cover and clutch cable.



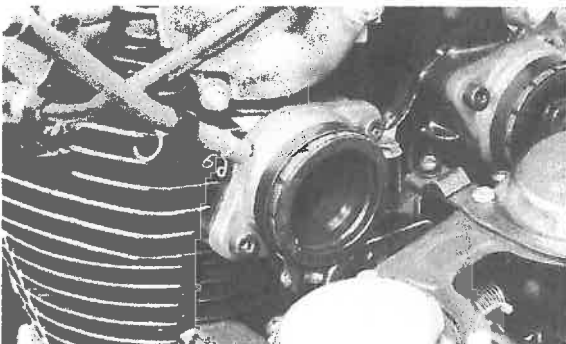
6. Side covers
7. Air cleaner assembly and ventilation hoses.



8. Carburetor, and throttle cable



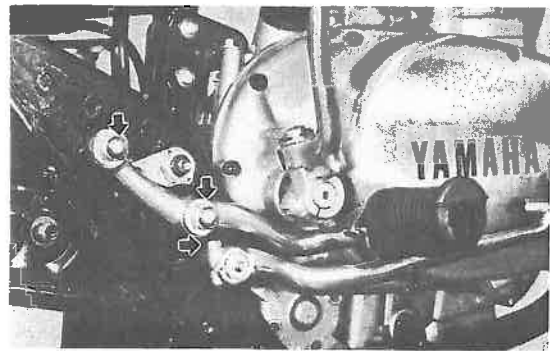
9. Intake manifold



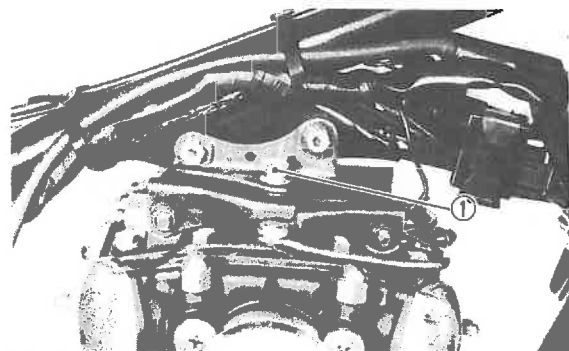
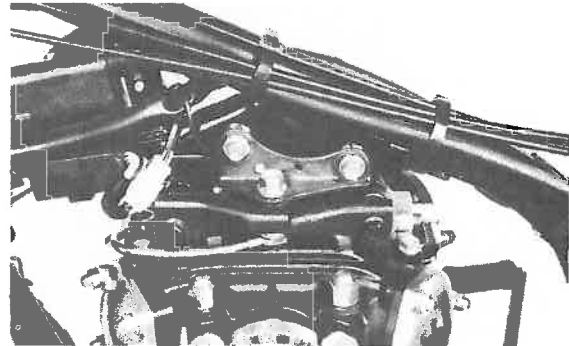
10. Brake pedal

NOTE: _____

When removing the brake pedal, check the alignment mark between the brake pedal and the shaft.



11. All wires and cables connecting engine and chassis
12. Top center engine mounting brackets (Remove only four bolts for easier re-assembly)

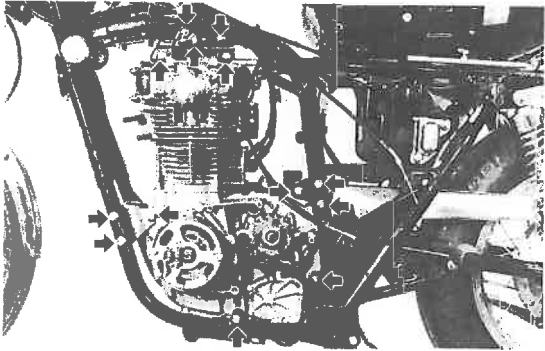


1. Better not to remove this

13. Drive chain (with special tool)

D. Engine Mounting Bolts and Engine Removal

1. Remove the mounting bolts in the order as shown.

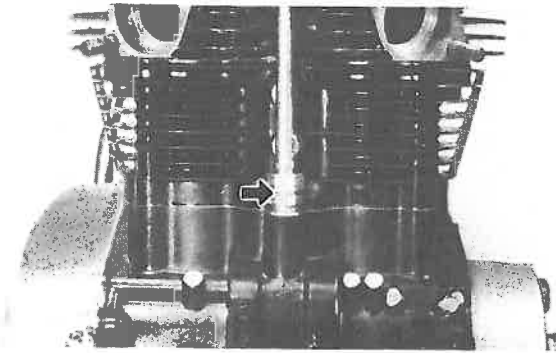


2. Remove the engine to the right.

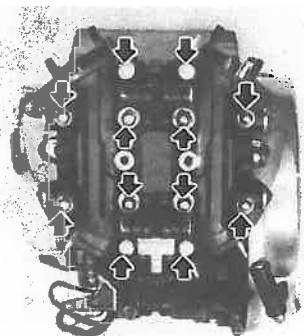
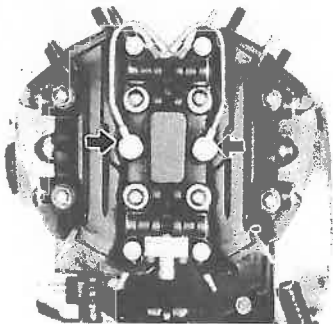
ENGINE DISASSEMBLY

A. Cylinder and Cylinder Head

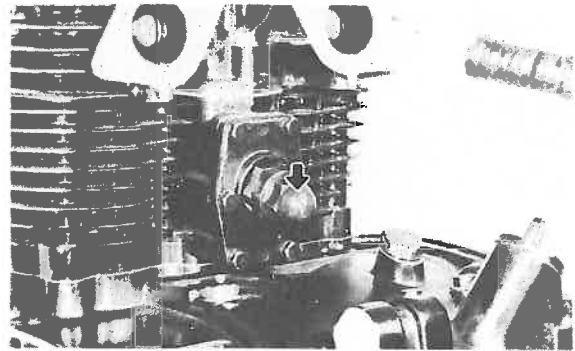
1. Remove the oil delivery and pipe fitting attached to the crankcase. Note placement of copper gaskets.



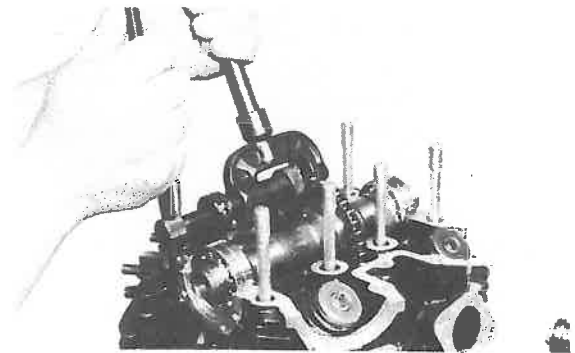
2. Remove all tappet covers.
3. Remove spark plugs.
4. Remove four cylinder head cover holding bolts, three cylinder head holding bolts and eight cylinder head holding nuts.



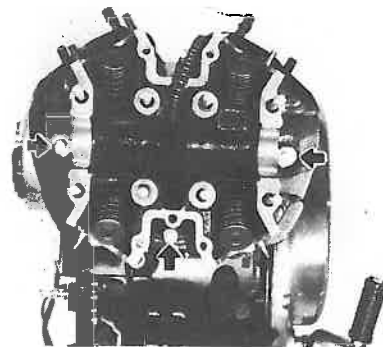
5. Remove the head cover. It may be necessary to tap each lightly with a soft hammer.
6. Remove the camshaft as follows.
 - a. Remove tensioner adjusting bolt to make the chain tension loose.



- b. Push out the master link pins with the cam chain cutter.

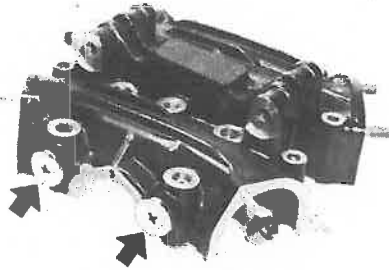


- c. Tie each end of the camchain with a wire to prevent it from falling into the crankcase.
7. Remove the cylinder head and cylinder.

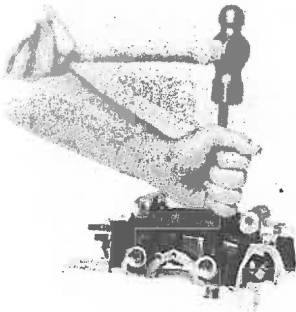


B. Rocker Arm Removal

1. Remove rocker shaft covers.



2. Remove shouldered sleeves and O-rings.

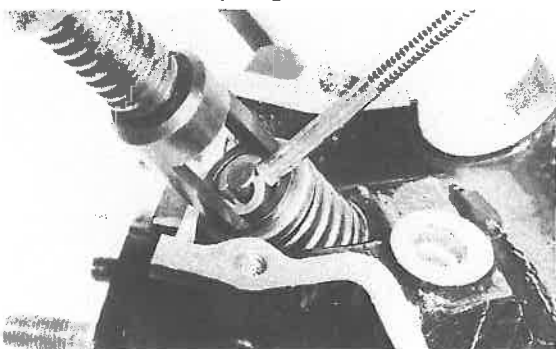


3. Withdraw rocker shafts with the special tool or 6 mm bolt.



C. Valve Removal

1. Compress the valve spring and then remove both retainer locks. Remove the compressor and lift off the retainer and springs.



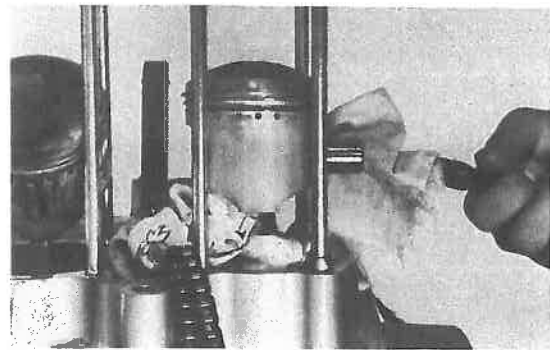
2. Remove valve stem seals.
3. Remove valves.

NOTE:

Deburr any deformed valve stem end. Use an oil stone to smooth the stem end. This will help prevent damage to the valve guide during valve removal.

D. Piston Removal

Remove piston pin clips, piston pins and pistons.

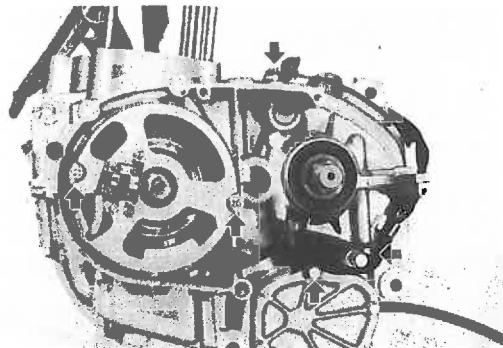


NOTE:

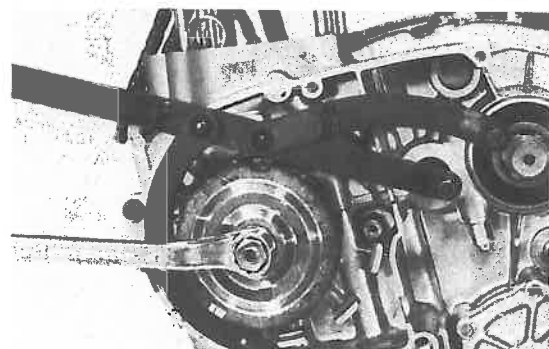
Before removing the piston pin clip, cover the crankcase with a clean rag so you will not accidentally drop the clip into the crankcase.

E. Generator and Drive Sprocket Removal

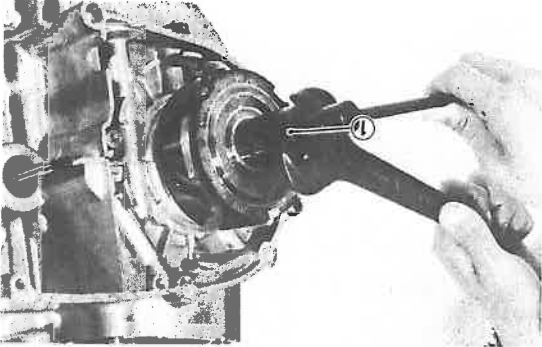
1. Remove the stator.



2. Remove the securing nut and lock washer.

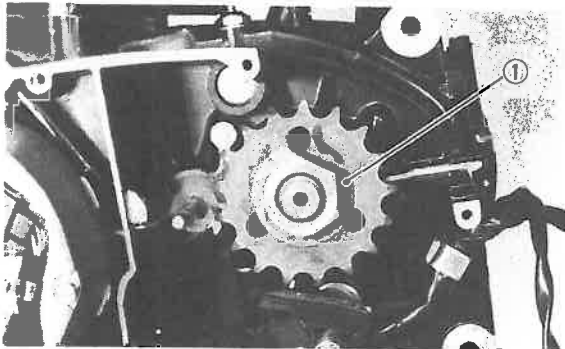


3. Mount the rotor puller (special tool) onto the rotor and pull the rotor off.



1. Rotor puller (90890-01070)

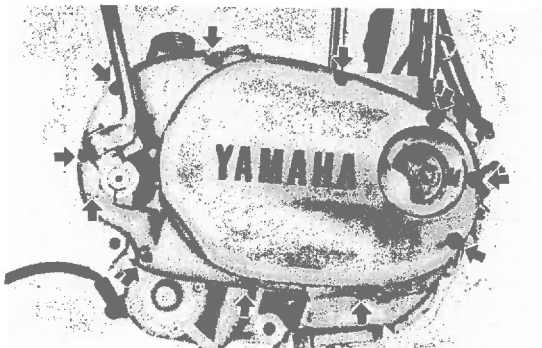
4. Flatten the lock washer and loosen the lock nut. Remove the drive sprocket.



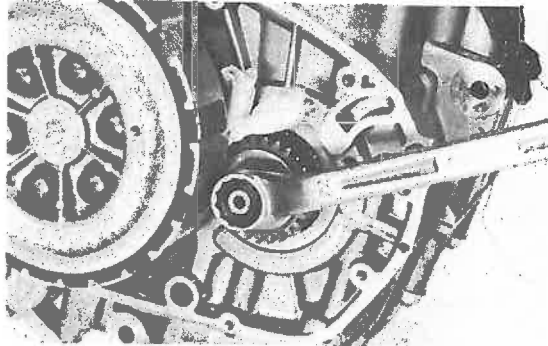
1. Lock washer

F. Case Cover (right), Primary Drive Gear and Clutch Assembly Removal

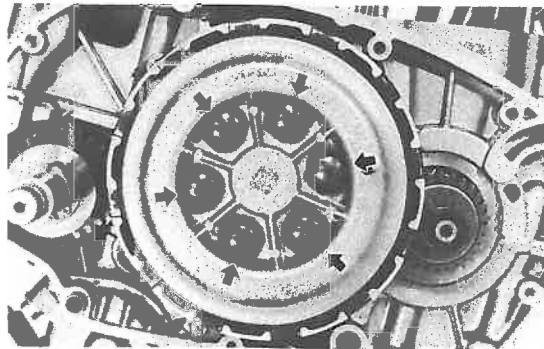
1. Remove the crankcase cover (right).



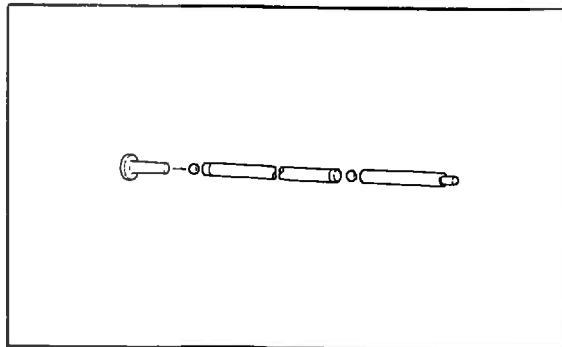
2. Loosen the drive gear securing nut by first placing a rag folded into many layers between the teeth of gears to lock them.



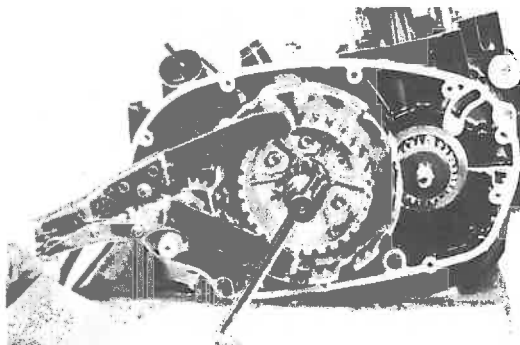
3. Remove six clutch spring screws and pressure plate.



4. Remove clutch plates, friction plates, push crown, two push rods and two balls.

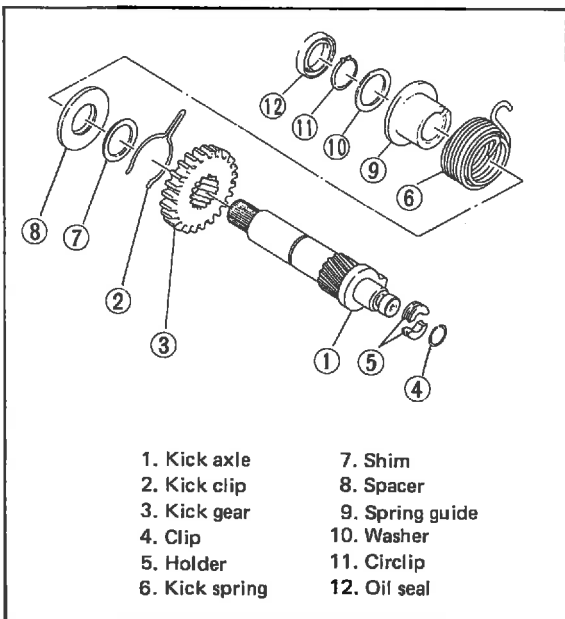
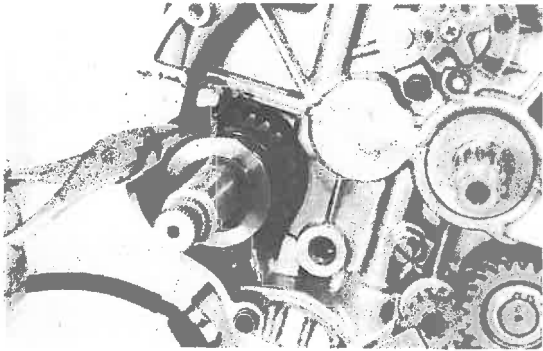


5. Hold the clutch unit with the holding tool (special tool), and unscrew the clutch boss lock nut.

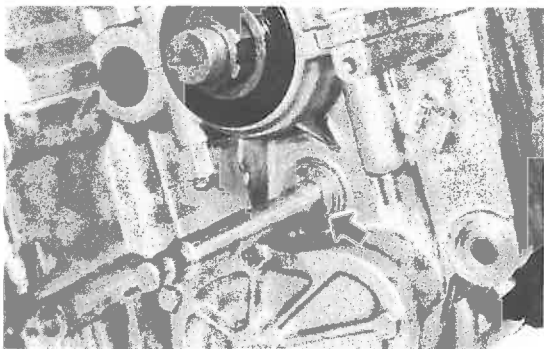


G. Kick Axle and Change Shaft Removal

1. Slip the bent spring off and pull the kick axle assembly out.

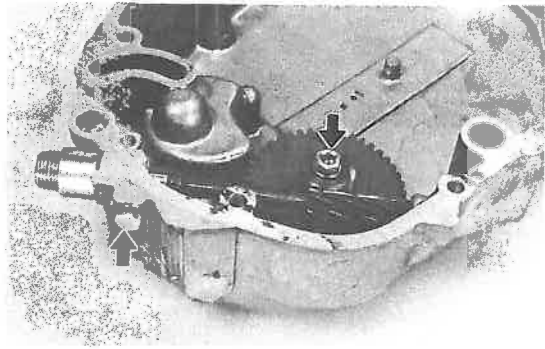


2. Remove circlip from left side of change shaft and pull the shaft out.

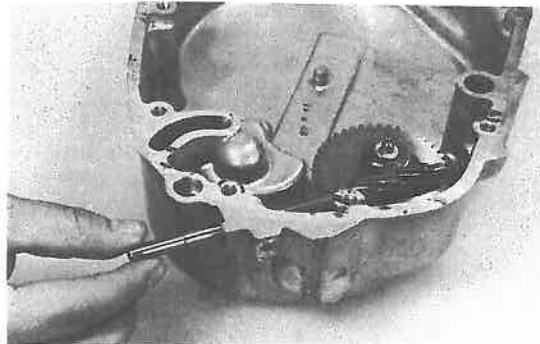


H. Tachometer Gear Removal

1. Remove the drive gear fitting bolt and the driven gear housing bolt.

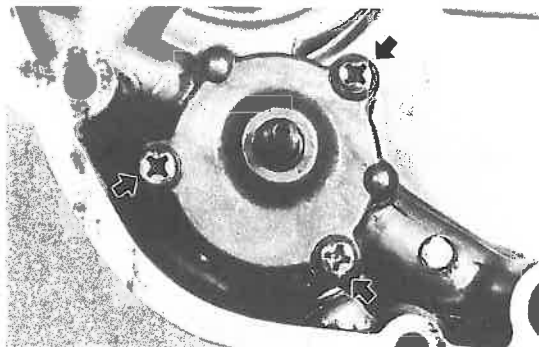


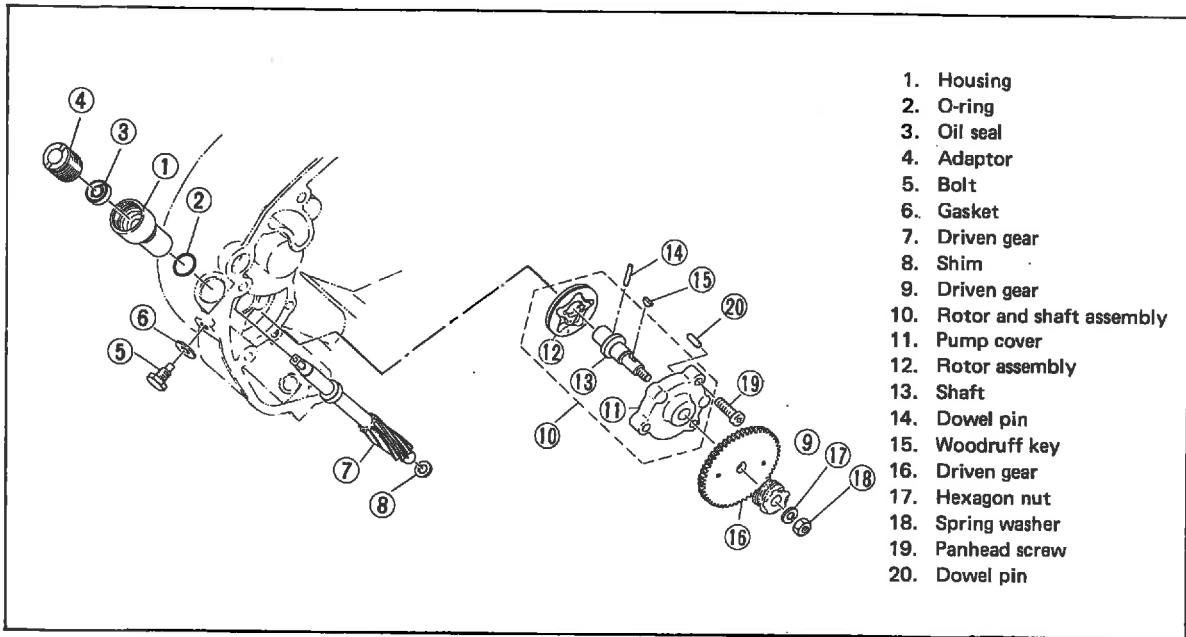
2. Remove the housing bolt and the driven gear.



I. Oil Pump Removal

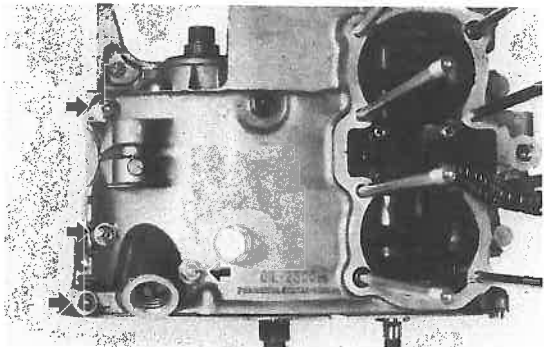
1. Remove the tachometer drive gear, oil pump driven gear, and key.
2. Remove the three Phillips screws.
3. Remove the pump unit.





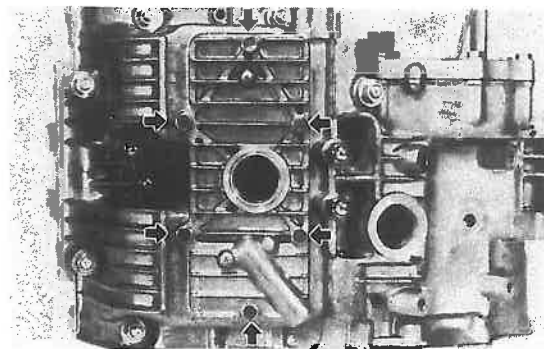
J. Crankcase Disassembly

1. Loosen the upper case securing bolts (4).

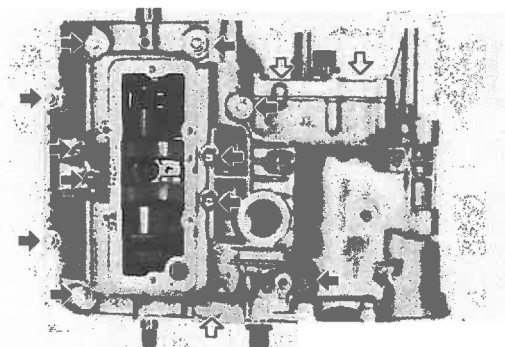


2. Loosen the strainer cover securing bolts (6).

Remove the cover, gasket and strainer.



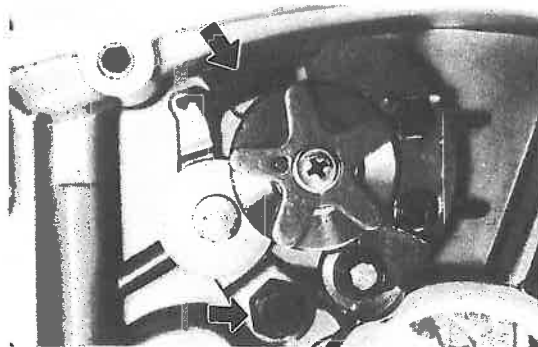
3. Loosen the lower case securing nuts (14).
 – The 6 crown nuts have copper washers.



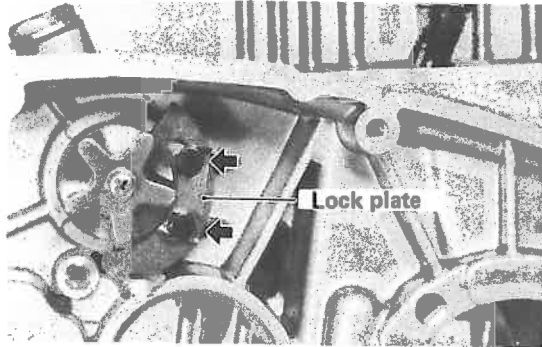
4. Use a soft rubber hammer to carefully separate the crankcases.

5. Remove the crankshaft and the transmission from the lower case.

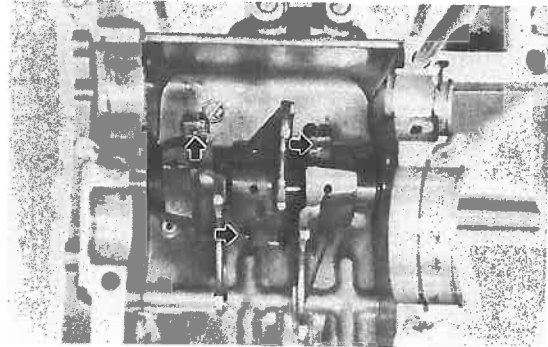
6. Remove the shift cam stopper bolt and spring.



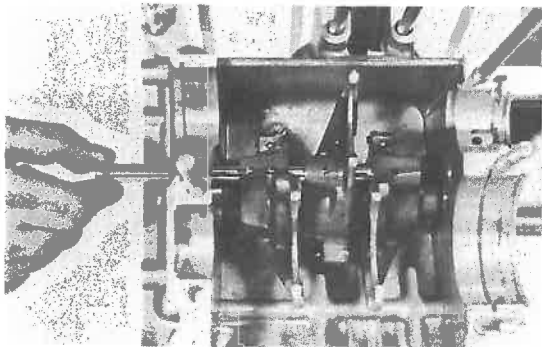
7. Flatten the lock washer and remove the bolts (2) and the stopper plate.



9. Remove the shift fork cotter pins and remove the pins (3).

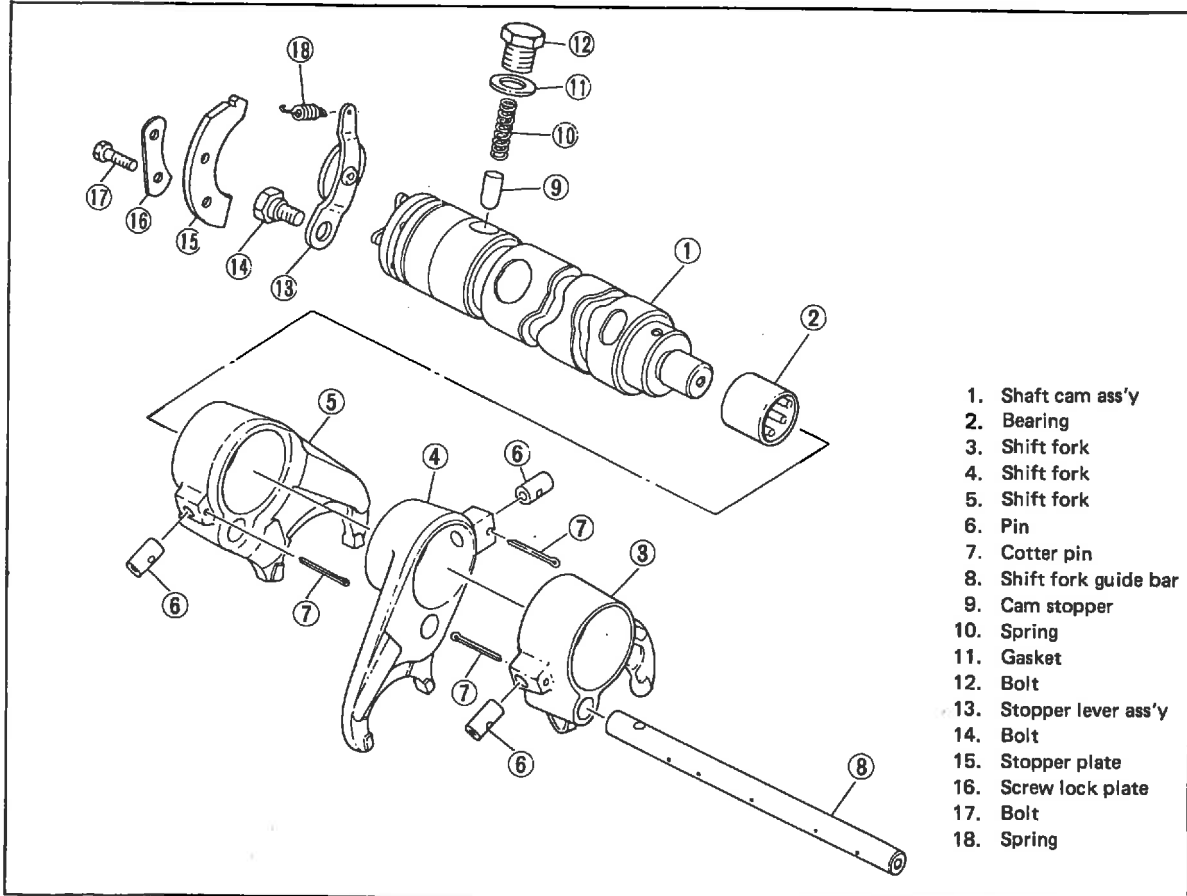


8. Pull out the guide bar.

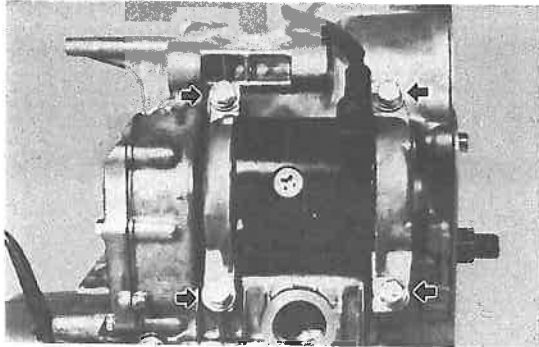


10. Pull out the shift cam.

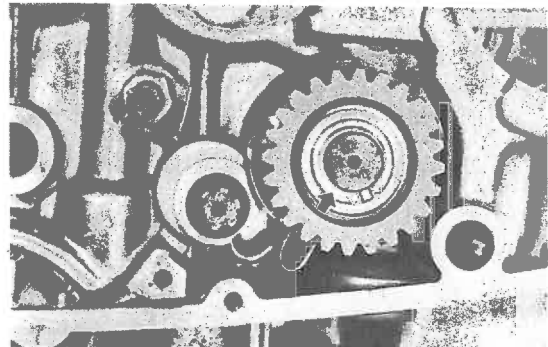
Shifter



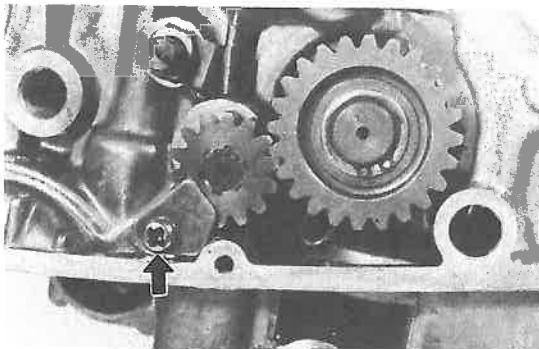
11. Loosen the starter motor securing bolts (4) and remove the motor.



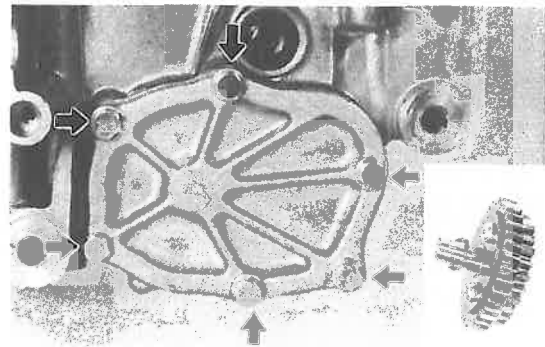
13. Remove the circlip and the wheel gear No. 3 and No. 4.



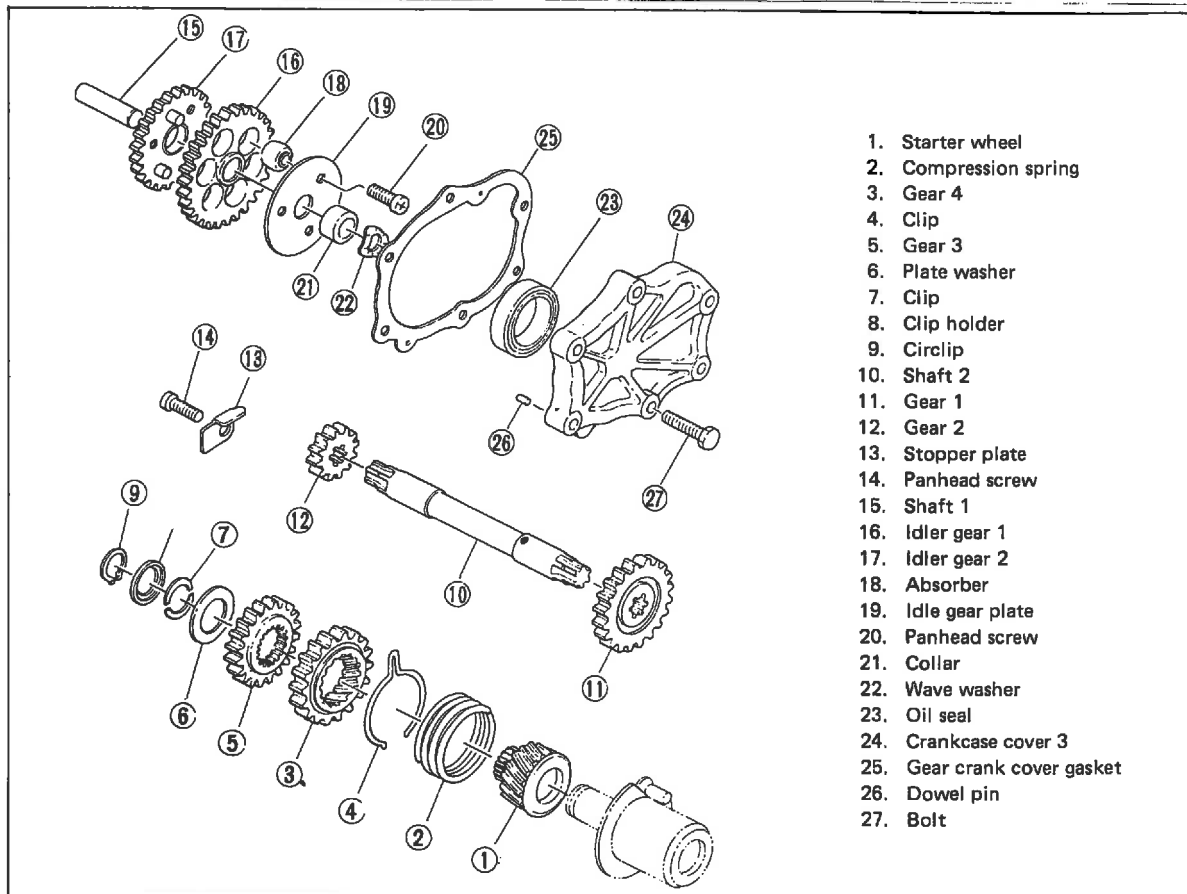
12. Loosen the stopper plate securing bolt and remove the drive gear No. 2. (Right hand by lower case)



14. Loosen the gear train cover securing bolts (6). Remove the idle gear No. 1 and No. 2. (Left hand by lower case)



Starter gear



- 1. Starter wheel
- 2. Compression spring
- 3. Gear 4
- 4. Clip
- 5. Gear 3
- 6. Plate washer
- 7. Clip
- 8. Clip holder
- 9. Circlip
- 10. Shaft 2
- 11. Gear 1
- 12. Gear 2
- 13. Stopper plate
- 14. Panhead screw
- 15. Shaft 1
- 16. Idler gear 1
- 17. Idler gear 2
- 18. Absorber
- 19. Idle gear plate
- 20. Panhead screw
- 21. Collar
- 22. Wave washer
- 23. Oil seal
- 24. Crankcase cover 3
- 25. Gear crank cover gasket
- 26. Dowel pin
- 27. Bolt

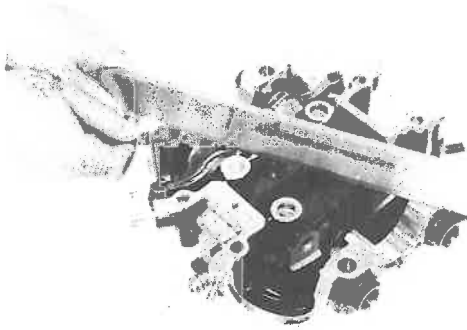
INSPECTION AND REPAIR

A. Cylinder Head Cover

Check the cylinder head cover warpage with a straightedge as shown.

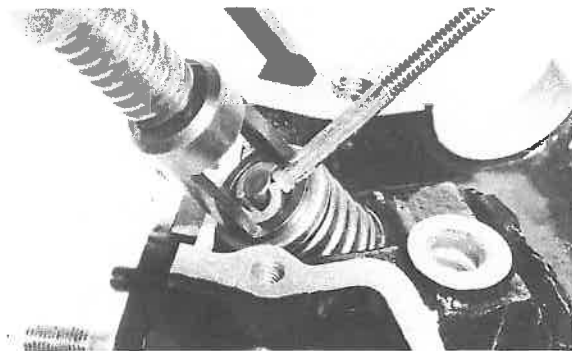
The warpage should not exceed the specified limit; if necessary, resurface the cylinder head cover. If the warpage exceeds allowable limit, the cylinder head should be replaced with a new one.

Cylinder head cover warpage:
less than 0.03 mm (0.0012 in)
Allowable limit: 0.25 mm (0.010 in)



B. Cylinder Head

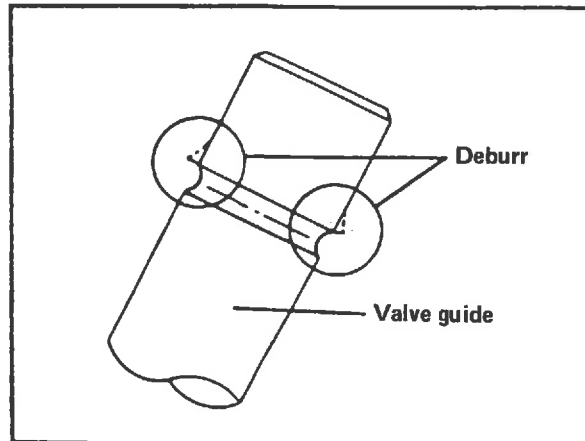
1. Remove the spark plugs.
2. Mount the valve spring compressor on the head and depress each valve spring. Remove the valve retainers with a magnet or tweezers, remove the valve springs.



3. Remove the valves. Mark each valve so it will be reinstalled in the same cylinder head.

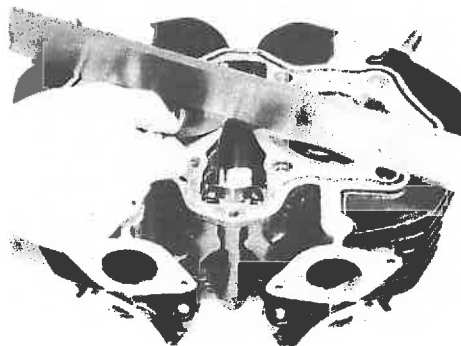
NOTE:

Deburr any deformed valve stem end. Use an oil stone to smooth the stem end. This will help prevent damage to the valve guide during valve removal.



4. Using a rounded scraper, remove the carbon deposits from the combustion chamber. Take care to avoid damaging the spark plug threads and valve seats. Do not use a sharp instrument. Avoid scratching the aluminum.
5. Check the cylinder head warpage with a straightedge as shown.
The warpage should not exceed the specified limit; if necessary, resurface the cylinder head. If the warpage exceeds allowable limit, the cylinder head should be replaced with a new one.

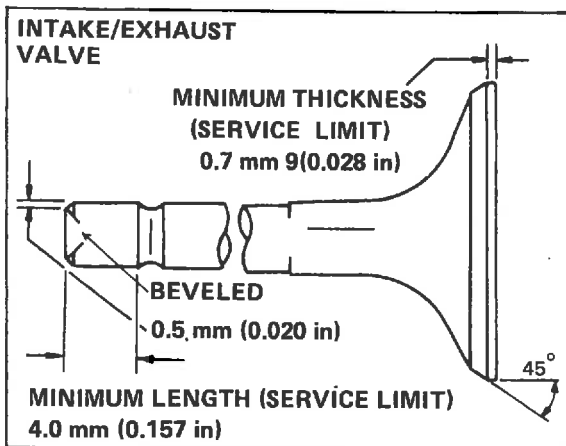
Cylinder head warpage:
less than 0.03 mm (0.0012 in)
Allowable limit: 0.25 mm (0.010 in)



C. Valves, Valve Guides, Valve Seats, and Valve Springs

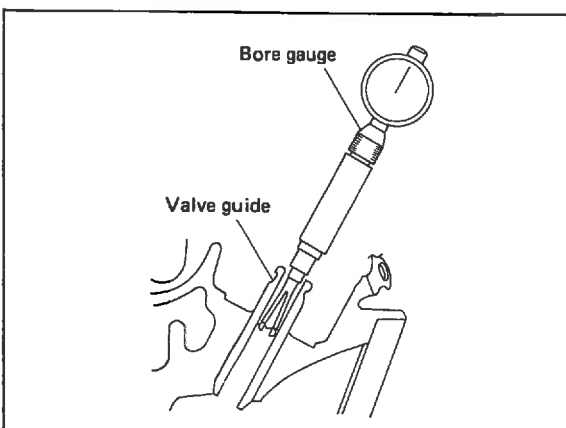
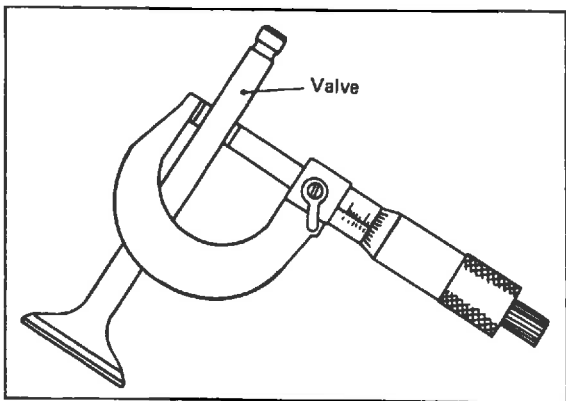
Valves

1. Check the valve face and the stem end for wear. If the valve face and/or the stem end are pitted or worn, grind the valve with a valve refacer. Replace the valve if any dimension exceeds the specifications in the illustration.



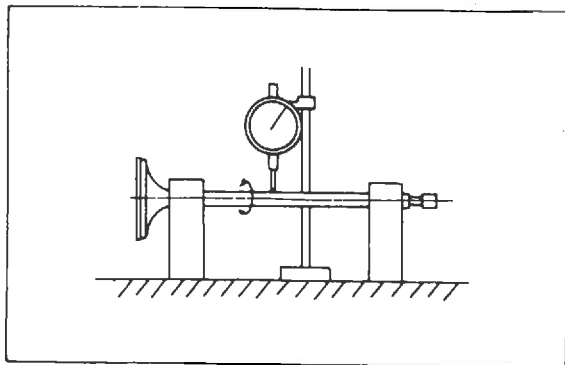
2. Valve stem wear must be measured and then combined with valve guide measurements to obtain guide clearance. This clearance must be within tolerances. If it exceeds the maximum limit, then replace either or both valve and guide, as necessary.

	Valve Stem Clearance	Maximum
Intake	0.020~0.044 mm (0.0008~0.0017 in)	0.10 mm (0.004 in)
Exhaust	0.035~0.059 mm (0.0014~0.0023 in)	0.12 mm (0.005 in)



3. Inspect the end of the valve stem. If the end appears to be "mushroomed" or has a larger diameter than the rest of the stem, the valve, valve guide, and oil seal should be replaced.
4. Place the valve on "V" blocks, and measure the amount of stem runout with a dial gauge. If it exceeds the maximum limit, replace the valve.

Maximum valve stem runout:
0.03 mm (0.0012 in)



Valve guides

If oil leaks into the cylinder through a valve due to a worn valve guide or if a valve is replaced, the valve guide should also be replaced.

NOTE:

The valve oil seal should be replaced whenever a valve is removed or replaced.

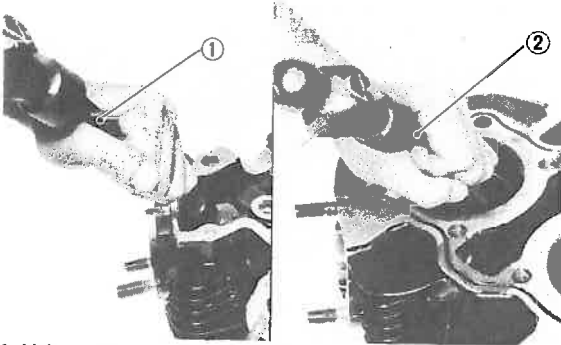
1. Measure the valve guide inside diameter with a small bore gauge. If it exceeds the limit, replace it with an oversize valve guide.

Guide diameter (I.D.):
Limit: 8.10 mm (0.319 in)

2. To ease guide removal and reinstallation and to maintain the correct interference fit, heat the head to 100°C (212°F). Use an oven to avoid any possibility of head warpage due to uneven heating.
3. Use the valve guide remover and valve guide installer to drive the old guide out and drive the new guide in.

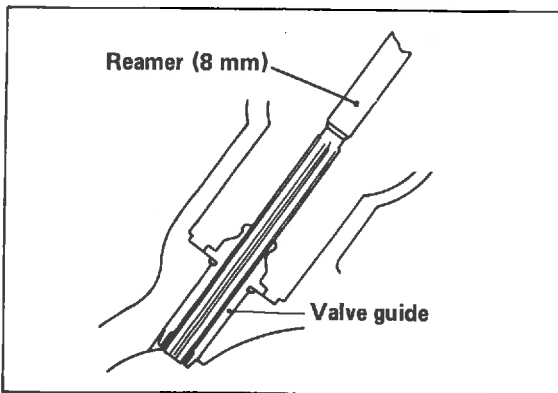
NOTE:

The valve guide oil seal should be replaced whenever a valve is removed or replaced.



1. Valve guide installer 2. Valve guide remover

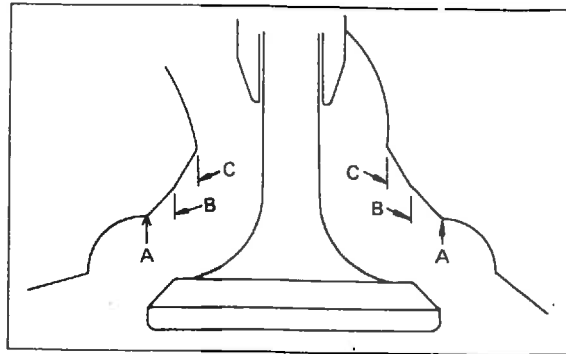
4. After installing the valve guide, use the 8 mm reamer (special tool) to obtain the proper valve-guide-to-valve-stem clearance.



5. After installing the valve guide in the cylinder head, the valve seat must be recut. The valve should be lapped to the new seat.

Valve seat

1. The valve seat is subject to severe wear. Whenever the valve is replaced or the valve face is resurfaced (see caution), the valve seat should be resurfaced at a 45° angle. If a new valve guides has been installed, the valve seat must be recut to guarantee complete sealing between the valve face and seat.



CAUTION:

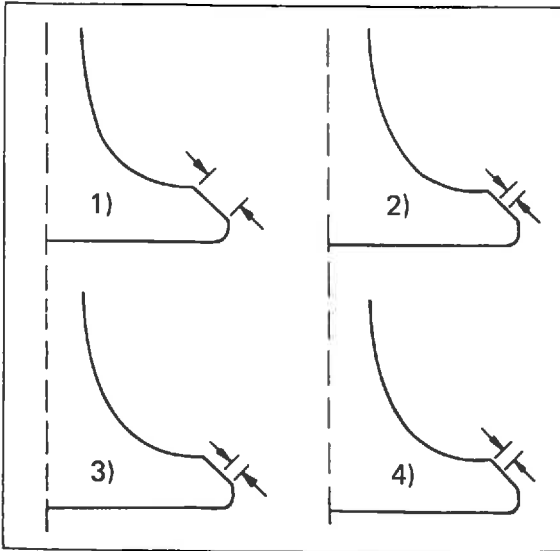
If the valve seat is obviously pitted or worn, it should be cleaned with a valve seat cutter. Use the 45° cutter. When twisting the cutter, keep an even downward pressure to prevent chatter marks.

If cutting section A of the valve seat, use a 30° cutter. If cutting section B, use the 45° cutter. If cutting section C, use the 60° cutter.

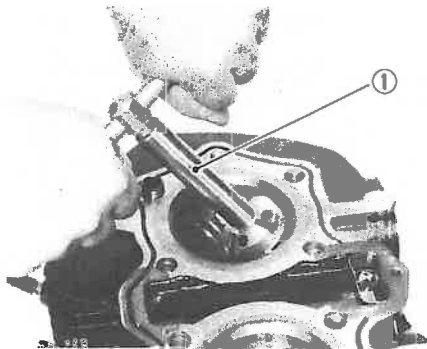
2. Measure the valve seat width. Apply mechanic's building dye (such as Dykem) to the valve face and valve seat, apply a very small amount of fine grinding compound around the surface of the valve face, insert the valve into position, and spin the valve quickly back and forth. Lift the valve, clean off all grinding compound, and check valve seat width. The valve seat and valve face will have removed the bluing wherever they contacted each other. Measure the seat width with vernier calipers. It should measure approximately 1.3 mm (0.051 in). The valve-seat contact area should be one uniform width. If valve seat width varies or if pits still exist, further cutting will be necessary. Remove just enough material to achieve a satisfactory seat.

	Standard Width	Wear Limit
Seat width	1.3±0.1 mm (0.051 ± 0.0039 in)	2.0 mm (0.080 in)

- If the valve seat is uniform around the perimeter of the valve face but is too wide or not centered on the valve face, it must be altered. Use either the 30°, 45°, or 60° cutters to correct the improper seat location in the manner described below:



- If the valve face shows that the valve seat is centered on the valve face but is too wide, then lightly use both the 30° and the 60° cutters to reduce the seat width to 1.3 mm (0.051 in).



1. Valve seat cutter

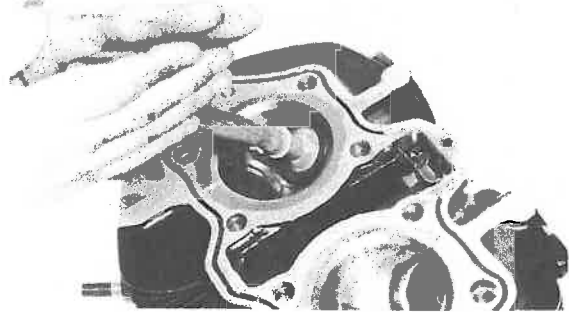
- If the seat shows to be in the middle of the valve face but too narrow, use the 45° cutter until the width equals 1.3 mm (0.051 in).
 - If the seat is too narrow and right up near the valve margin, then first use the 30° cutter and then the 45° cutter to get the correct seat width.
- If the seat is too narrow and down near the bottom edge of the valve face, then first use the 60° cutter and then the 45° cutter.

Lapping

The valve/valve seat assembly should be lapped if neither the seat nor the valve face are severely worn.

- Apply a small amount of coarse lapping compound to the valve face. Insert the valve into the head. Rotate the valve until the valve and valve seat are evenly polished. Clean off the coarse compound, then follow the same procedure with fine compound.

Continue lapping until the valve face shows a complete and smooth surface all the way around. Clean off the compound material. Applying bluing dye to the valve face and seat, and rotate the valve. Check for full seat contact which is indicated by a grey surface all around the valve face where the bluing has been rubbed away.

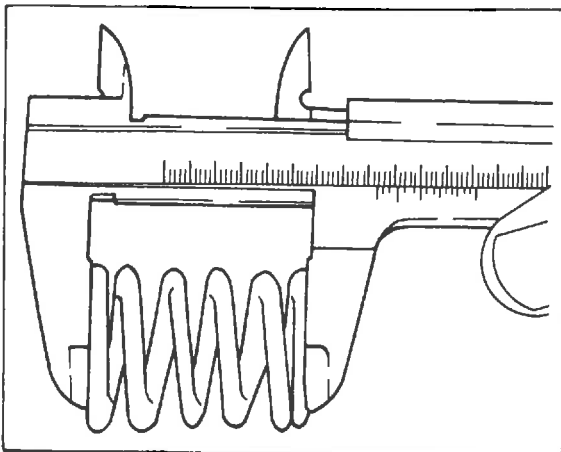


- After all work has been performed on the valve and valve seat and all head parts have been assembled, check for proper valve/valve seat sealing by pouring solvent into each of the intake ports, then the exhaust ports. There should be no leakage past the seat. If fluid leaks, disassemble and continue to lap with fine lapping compound. Clean all parts thoroughly; reassemble and check again with solvent. Repeat this procedure as often as necessary to obtain a satisfactory seal.

Valve springs

This engine uses two springs of different sizes to prevent valve float or surging. The valve spring specifications show the basic valve characteristics.

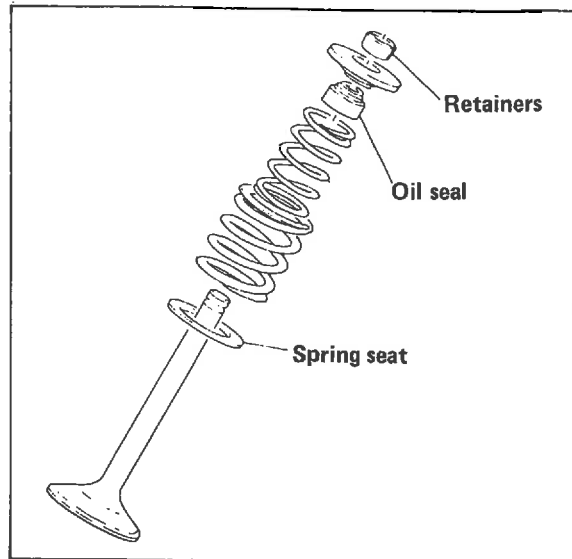
1. Even though the spring is constructed of durable spring steel, it gradually loses some of its tension. This is evidenced by a gradual shortening of free length. Use a vernier caliper to measure spring free length. If the free length of any spring has decreased more than 2 mm (0.080 in) from its specification, replace it.



2. Another symptom of spring fatigue is insufficient spring pressure. This can be checked with a valve-spring-compression-rate gauge. Test each spring individually. Place a spring in the gauge and note the spring pressure when the spring is compressed to the installed length (valve closed). If the pressure does not equal the specified value, replace the spring.

Valve Spring Specifications		
	Outer Spring	Inner Spring
Free length	42.6 mm (1.67 in)	42.0 mm (1.65 in)
Installed length (valve closed)	37.0 mm (1.457 in)	35.0 mm (1.378 in)
Installed pressure (valve closed)	17.7 kg (39.0 lb)	1.0 kg (22.0 lb)
Allowable tilt from vertical	2.5°	←

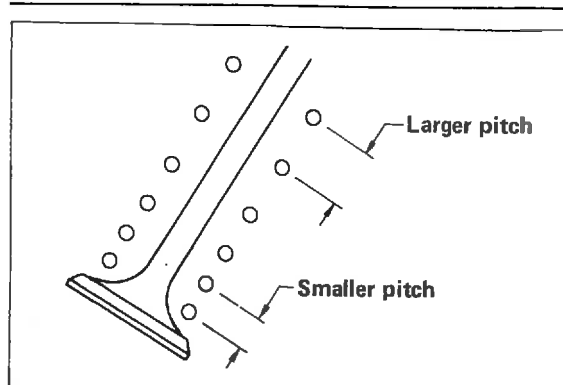
Valve installation



1. Lubricate the valve stem and the oil seal with a high-quality molybdenum disulfide motor oil or molybdenum disulfide grease.
2. Insert the valve in the cylinder head, and install the oil seal. Carefully fit the oil seal over the valve stem and push it into position on top of the valve guide.
3. Install the spring seat, and install both valve springs.

NOTE:

All valve springs must be installed with the larger pitch upward as shown.



4. Install the collar. Be sure it is properly seated on the valve springs.
5. Install the valve spring compressor, and compress the springs.
6. Install the valve retainers. Be sure the retainers properly engage the valve stem.

- Carefully remove the valve spring compressor.

WARNING:

Proceed slowly. If a retainer has not been properly installed, it could be ejected from the cylinder head.

- Gently tap the end of the valve stem with a plastic mallet. This will ensure that the retainers are properly seated in the collar.

D. Rocker Arms and Rocker Arm Shafts

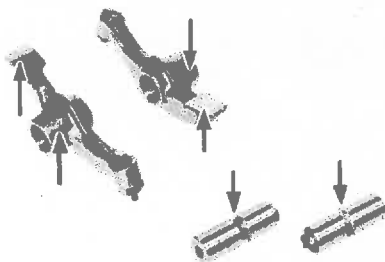
- The rocker arm usually wears at two locations: at the rocker shaft hole and at the cam-lobe-contact surface. Check these areas for signs of unusual wear.
- Measure the rocker arm inside diameter. If it exceeds specification, replace the rocker arm.

Maximum inside diameter:
15.018 mm (0.591 in)

- Measure the outside diameter of the rocker arm shaft. If it is less than the specified value, replace the rocker arm.

Minimum outside diameter:
14.985 mm (0.590 in)

- Calculate the clearance by subtracting the rocker-arm-shaft outside diameter from the rocker-arm inside diameter. If this clearance is greater than 0.033 mm (0.0013 in) replace either or both parts as necessary.



- The rocker arm shaft has been hardened; it should not wear excessively. If a groove can be felt in the bearing surface or if the shaft shows a blue discoloration,

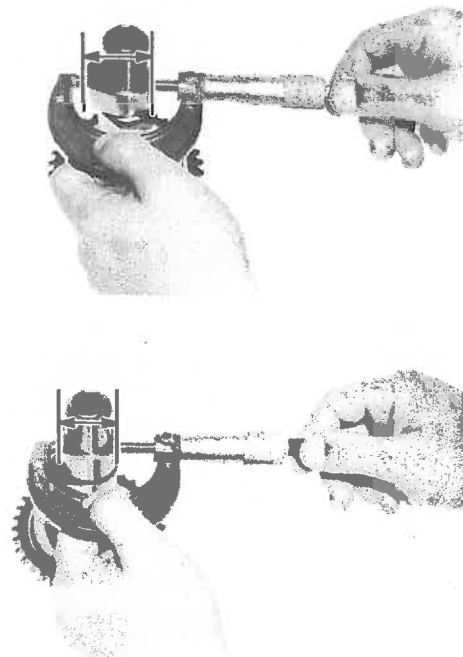
the shaft should be replaced and the lubrication system checked.

E. Camshafts, Cam Chains, and Cam Sprockets

The cam lobe metal surface may have a blue discoloration due to excessive friction. The metal surface could also start to flake off or become pitted.

- If any of the above wear conditions are readily visible, the camshaft should be replaced.
- Even though the cam lobe surface appears to be in satisfactory condition, the lobes should be measured with a micrometer. Cam lobe wear can occur without scarring the surface. If this wear exceeds the wear limit, valve timing and lift are affected. Replace the camshaft if wear exceeds the limit.

Wear Limit	A	B
Intake	39.84 mm (1.569 in)	32.09 mm (1.263 in)
Exhaust	39.88 mm (1.570 in)	32.15 mm (1.266 in)



Cam sprocket and cam bearing

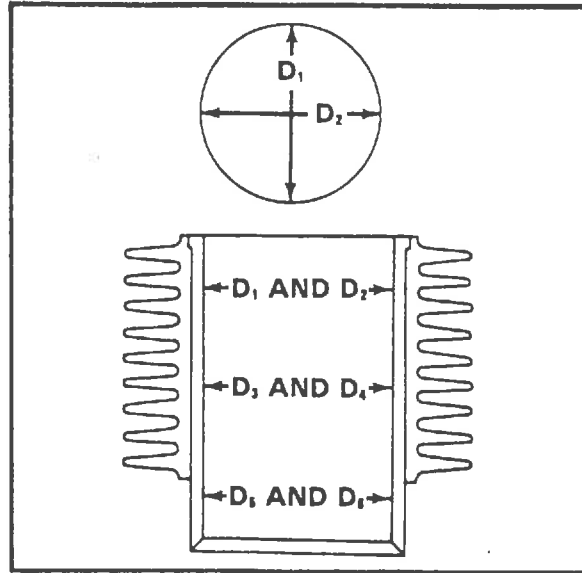
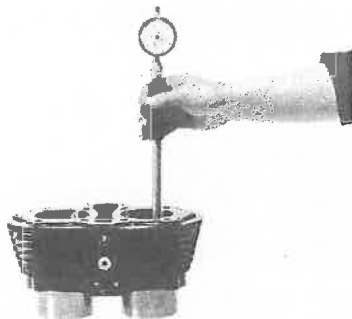
1. Check the cam sprocket for wear.



F. Cylinder

1. Visually check the cylinder walls for scratches. If vertical scratches are evident, the cylinder wall should be rebored or the cylinder should be replaced.
2. Measure cylinder wall wear in the manner as shown. If wear is excessive, compression pressure will decrease, and engine trouble will occur. Rebore the cylinder wall, and replace the piston and piston rings.

Cylinder wear should be measured at three depths by placing the measuring instrument parallel to and at right angles to the crankshaft. (See the illustration.) If the cylinder wall is worn beyond the wear limit, it should be rebored.



	Standard	Wear limit
Cylinder bore	75.0 mm (2.95 in)	75.1 mm (2.95 in)
Cylinder taper	—	0.05 mm (0.002 in)

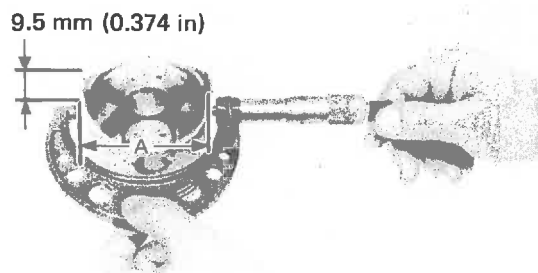
G. Piston and Piston Rings

Piston

1. Using the micrometer, measure the outside diameter of the piston at the piston skirt. Measurement should be made at a point 9.5 mm (0.37 in) above the bottom edge of the piston by placing the micrometer parallel to and at right angles to the piston pin.

Piston clearance:

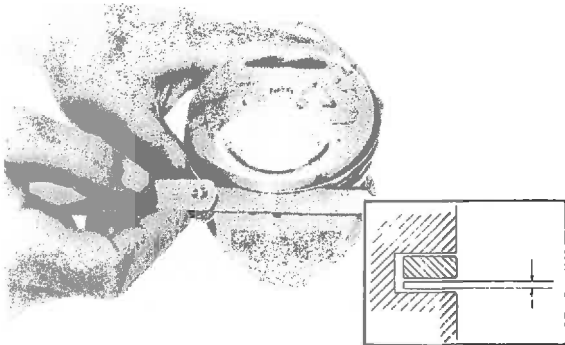
0.05 ~ 0.055 mm (0.0019~0.0022 in)



	Size A
Standard	75.00 mm (2.95 in)
Oversize 1	75.25 mm (2.95 in)
Oversize 2	75.50 mm (2.95 in)
Oversize 3	75.75 mm (2.99 in)
Oversize 4	76.00 mm (2.99 in)

- Piston ring/ring groove fit must have correct clearance. If the piston and ring have already been used in the engine, the ring must be removed, the ring groove cleaned of carbon, then the ring should be reinstalled. Use a feeler gauge to measure the gap between the ring and the land.

Side clearance	Top	0.04 ~ 0.08 mm (0.0016 ~ 0.0031 in)
	2nd	0.03 ~ 0.07 mm (0.0118 ~ 0.2753 in)



Piston ring

The oversize top and middle ring sizes are stamped on top of the ring.

Oversize 1	0.25 mm (0.0098 in)
Oversize 2	0.50 mm (0.0197 in)
Oversize 3	0.75 mm (0.0295 in)
Oversize 4	1.00 mm (0.0394 in)

The expander spacer of the bottom ring (oil control ring) is color-coded to identify sizes. The color mark is painted on the expander spacer.

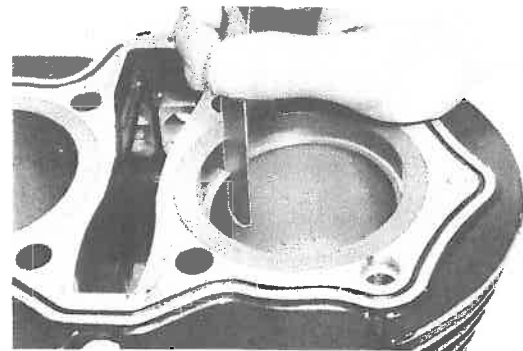
Size	Color
Oversize 1	Brown
Oversize 2	Blue
Oversize 3	Black
Oversize 4	Yellow

- Measure the end gap of each piston ring. Insert a ring into the cylinder, and push it approximately 20 mm (0.8 inches) into the cylinder. Push the ring with the piston crown so the ring will be at a right angle to the cylinder bore.
- Measure the ring end gap with a feeler gauge. If the end gap exceeds tolerance, replace the whole set of rings.

NOTE:

You cannot measure the end gap on the expander spacer of the oil control ring. If the oil-control-ring rails show excessive gap, replace all three rings.

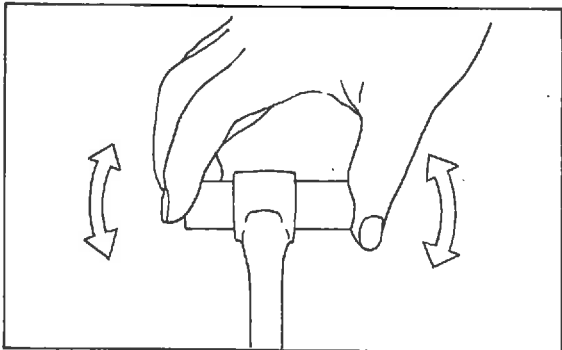
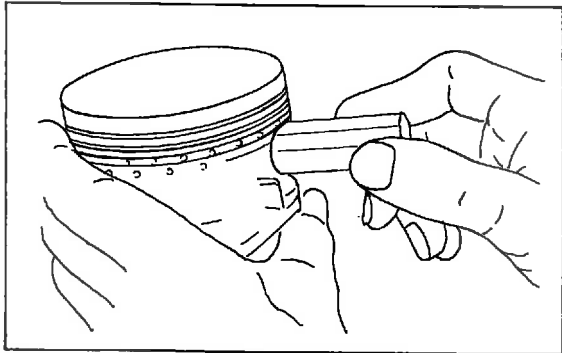
	Standard	Limit
Top ring	0.2 ~ 0.4 mm (0.0079 ~ 0.0157 in)	0.80 mm (0.0315 in)
2nd ring	0.2 ~ 0.4 mm (0.0079 ~ 0.0157 in)	0.80 mm (0.0315 in)
Oil control (Rails)	0.3 ~ 0.9 mm (0.0118 ~ 0.0354 in)	—



Piston pin

- Lightly oil the piston pin, and install it in the small end of the connecting rod.
- Check the free play. There should be no noticeable vertical play. If any free play exists, check the connecting rod for wear. Replace the pin and connecting rod as required.

3. Insert the piston pin in the piston, and check the free play. There should be no noticeable free play when the pin is in place in the piston. If the piston pin is loose, replace the pin and/or the piston as required.



H. Crankshaft and Connecting Rod

Crankshaft bearing

1. Bearings should be cleaned, dried, and the races visually checked for pits, rust spots, or chatter marks where the balls have dragged. If any of these conditions exist, the bearings should be replaced.

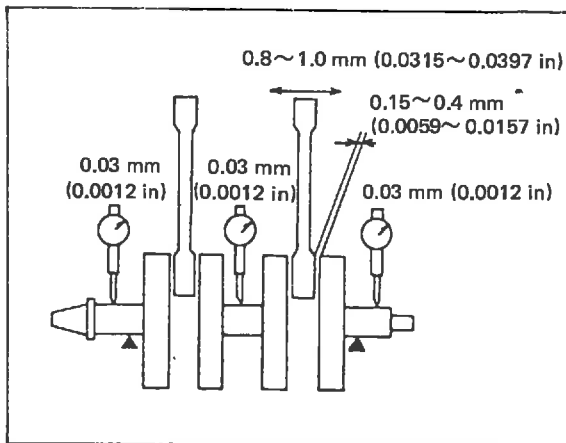
NOTE:

Lubricate the bearings immediately after examining them to prevent rust.

Crankshaft runout

1. Support the crankshaft at both ends on V-blocks. Rotate the crankshaft in the V-blocks, and measure the runout at the main bearing journals. Use a dial gauge.
2. If runout exceeds the specification, replace crankshaft.

Maximum crankshaft runout:
0.03 mm (0.0012 in)



I. Oil Pump

1. Measure the rotor width on both trochoid pumps. If the measurement exceeds specification, replace the pump.

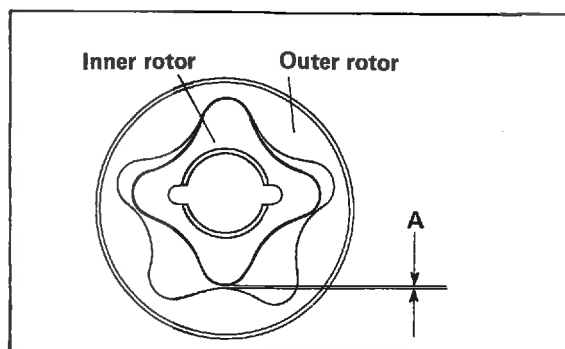
Rotor width:

Crankshaft pump: 6 mm (0.236 in)

2. Measure the inner-outer clearance of each rotor. Replace the pump if the clearance exceeds specifications.

Inner-outer clearance:

0.03~0.09 mm (0.0012~0.0035 in)



J. Primary Drive

The drive gear is mounted on the crankshaft; the driven gear is mounted on the transmission and is integrated with the clutch assembly.

Primary reduction ratio		
No. of teeth		Ratio
Drive	Driven	
27	72	2.666

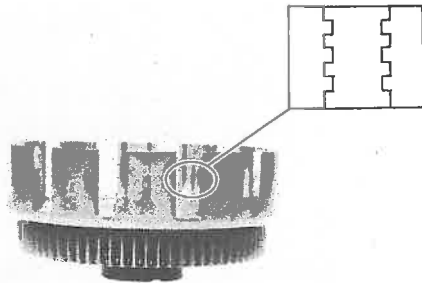
1. Check the drive gear and the driven gear for obvious signs of wear or damage from foreign material within the primary case.
2. If the primary drive is excessively noisy during operation, replace both the drive and the driven gears.

K. Clutch

Clutch housing

1. Check the dogs on the clutch housing. Look for cracks and signs of galling on the edges. If damage is moderate, deburr; if severe, replace the clutch

NOTE: _____
Galling on the clutch plate splines will cause erratic operation.



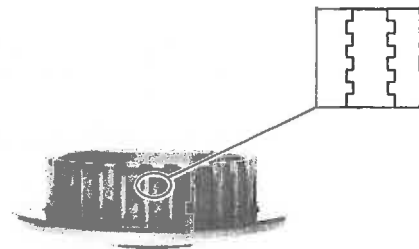
2. Check the clutch housing bearing for damage. If damaged, replace the bearing.

Clutch boss

The clutch boss contains a built-in damper beneath the first clutch plate (clutch plate 2). It is not normally necessary to remove the circlip and disassemble the built-in damper unless there is serious clutch chattering.

1. Check the splines on the clutch boss for galling. If damage is slight to moderate, deburr; if it is severe, replace the clutch boss.

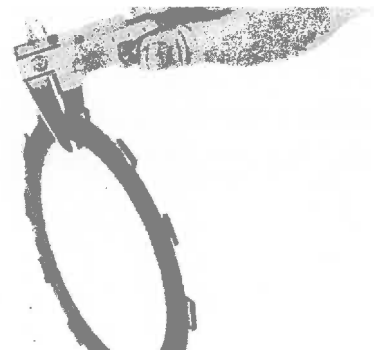
NOTE: _____
Galling on clutch plate splines will cause erratic operation.

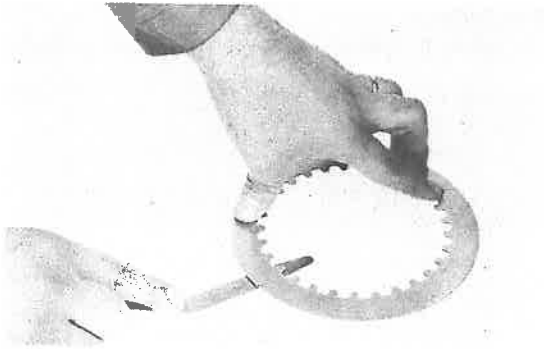


Friction and clutch plates

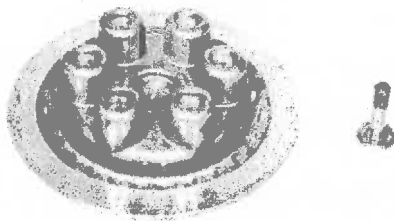
1. Check the clutch plates and friction plates for heat damage. Measure friction plate thickness at 3 or 4 points. Measure the clutch plates for warp with a feeler gauge and surface plate. Replace clutch plates or friction plates as a set if any is faulty or beyond wear limits.

	Standard	Wear limit
Friction plate thickness	3.0 mm (0.12 in)	2.7 mm (0.106 in)
Clutch plate warp limit	—	0.1 mm (0.004 in)



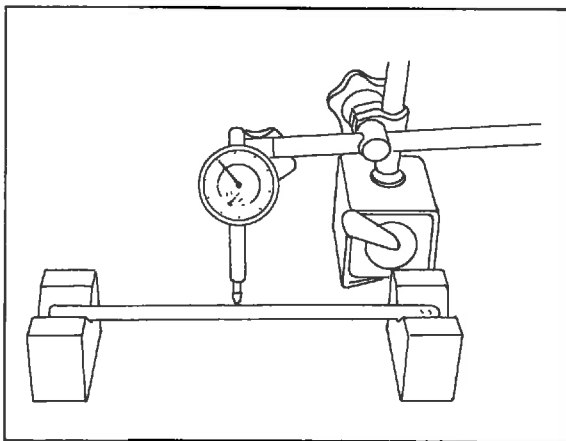


Clutch actuating mechanism



1. Check the short push rod for wear and damage; replace if damaged.
2. Check the short-push-rod thrust bearing for damage; replace if damaged.
3. By rolling the long push rod on the "V" blocks, check for bends. If any bend is found, replace the push rod.

Bend limit: 0.5 mm (0.02 in)



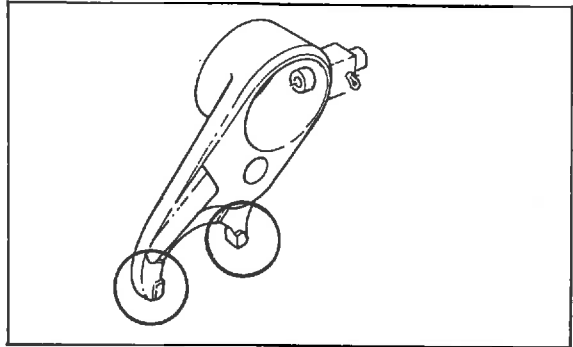
Clutch springs

1. Measure the clutch spring free length. Replace the springs as a set if any is less than minimum free length.

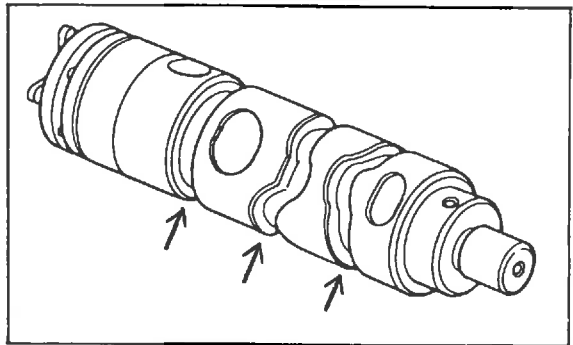
Clutch spring minimum length:
32.5 mm (1.28 in)

L. Transmission

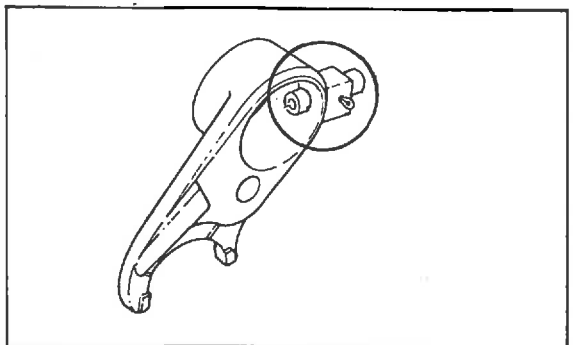
1. Inspect each shift fork for signs of galling on the gear contact surfaces. Check for bending. Make sure each fork slides freely on its guide bar.



2. Roll the guide bar across a surface plate. If the bar is bent, replace it.
3. Check the shift cam grooves for signs of wear or damage. If any profile has excessive wear and/or damage, replace the cam.



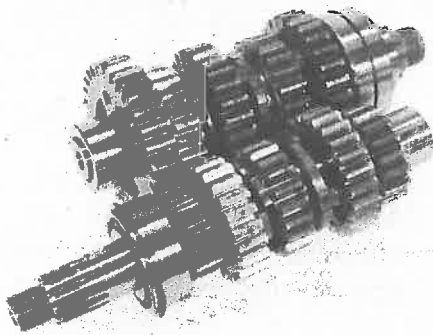
4. Check the cam followers on each shift fork for wear. Check the ends that ride in the grooves in the shift cam. If they are worn or damaged, replace the shift fork.



5. Check the shift cam dowel and side plate for looseness, damage, or wear. Replace as required.
6. Check the shift-cam stopper plate, circlip, and stopper for wear. Replace as required.
7. Check the transmission shafts using a centering device and dial gauge. If any shaft is bent beyond the specified limit, replace the shaft.

Maximum runout: 0.08 mm (0.0031 in)

8. Carefully inspect each gear. Look for signs of obvious heat damage (blue discoloration). Check the gear teeth for signs of pitting, galling, or other extreme wear. Replace as required.
9. Check to see that each gear moves freely on its shaft.
10. Check to see that all washers and clips are properly installed and undamaged. Replace bent or loose clips and bent washers.
11. Check to see that each gear properly engages its counterpart on the shaft. Check the mating dogs for rounded edges, cracks, or missing portions. Replace as required.

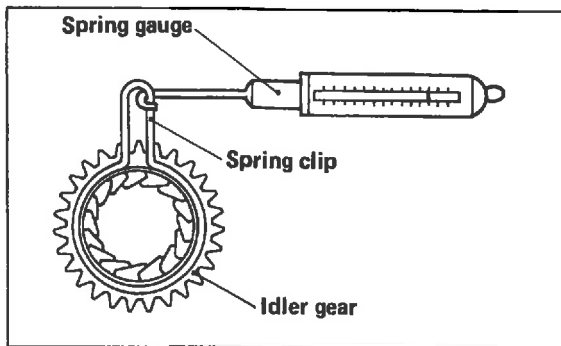


M. Starter

1. Check the surface of the idler gears for pitting or other damage. If the damage is severe, replace the gear(s).
2. Check the tension of the return spring. If it is damaged or fatigued, replace the spring.
3. Check the tension of both spring clips with a spring gauge. If either clip is not within specification, replace it.

Spring clip tension:

Idler gear # 2: 21.6N ~ 24.5N
(2.2 ~ 2.5 kg, 4.9 ~ 5.5 lb)
Kick gear: 11.8N ~ 16.7N
(1.2 ~ 1.7 kg, 2.6 ~ 3.7 lb)



N. Crankcase

1. Thoroughly wash the case halves in a mild solvent.
2. Clean all gasket mating surfaces and crankcase mating surface thoroughly.
3. Visually inspect the case halves for any cracks, road damage, etc.
4. Check all fittings not previously removed for signs of looseness or damage.
5. If bearings have been removed, check their seats for signs of damage (such as the bearing spinning in the seat, etc.).
6. Check oil delivery passages for signs of blockage.
7. If bearings have not been removed, oil them thoroughly immediately after washing and drying. Rotate the bearing, and check for roughness indicating damaged races or balls.
8. Check needle bearing(s) in the transmission for damage; replace as required.

O. Bearings And Oil Seals

Inspection

1. After cleaning and lubricating the bearings, rotate the inner race with a finger. If rough spots are noticed, replace the bearing.
2. Check the oil seal lips for damage and wear. Replace as required.

Removal

1. Pry oil seal(s) out of place with a screwdriver.
Replace all oil seals when overhauling the engine.

NOTE: _____

Place a piece of wood under the screwdriver to prevent damage to the case.

2. Drive out the bearing(s) with a socket and hammer or with a hydraulic press.

NOTE: _____

Bearing(s) are most easily removed or installed if the cases are first heated to approximately 95°~125°C (205°~257°F). Bring the case up to proper temperature slowly. Use an oven.

ENGINE ASSEMBLY AND ADJUSTMENT

A. Important Information

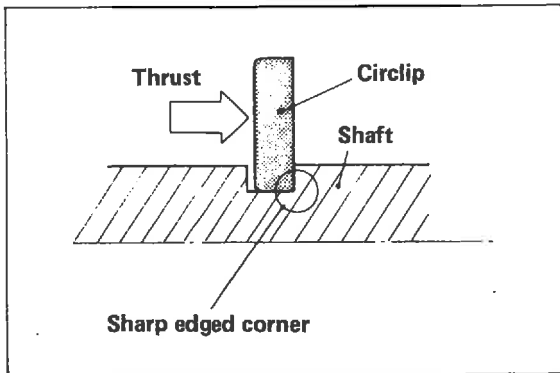
Gaskets and seals

1. All gaskets and seals should be replaced when an engine is overhauled. All gasket surfaces and oil seal lips must be cleaned.
2. Properly oil all mating parts and bearings during reassembly.

Circlips

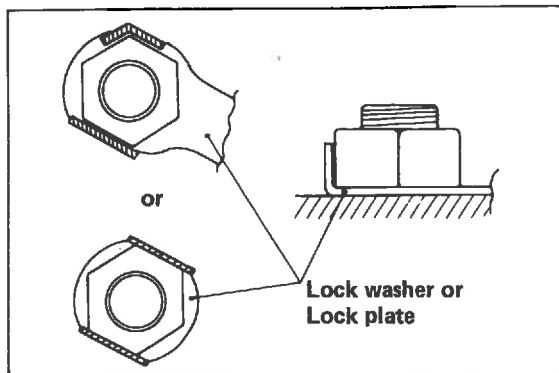
1. All circlips should be inspected carefully before reassembly. Always replace piston pin clips after one use. Replace distorted circlips.

When installing a circlip, make sure that the sharp edged corner is positioned opposite to the thrust it receives. See the sectional view below.



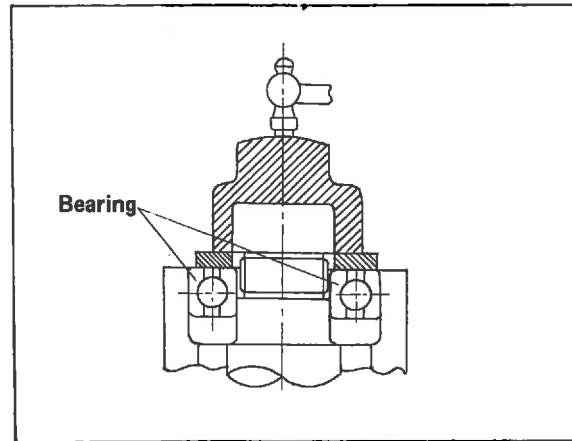
Lock washers/plates and cotter pins

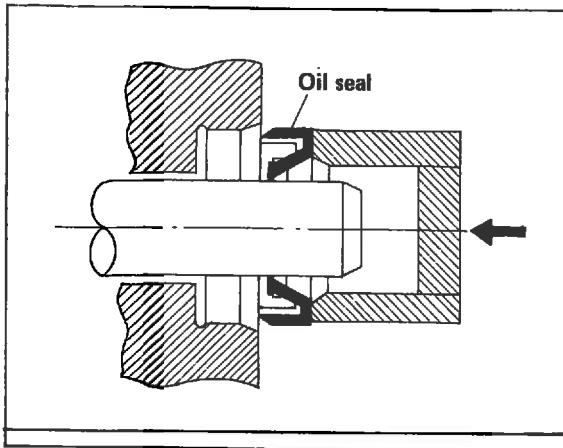
1. All lock washers/plates and cotter pins must be replaced when they are removed. Lock tab(s) should be bent along the bolt or nut flat(s) after the bolt or nut has been properly tightened.



Bearings and oil seals

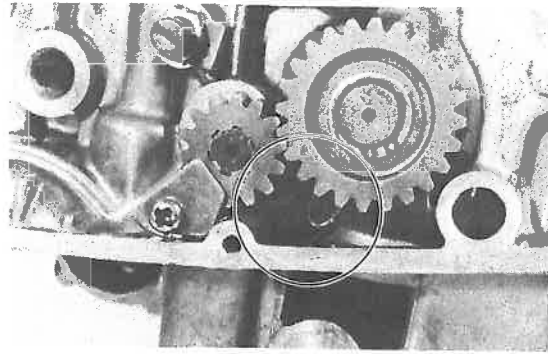
1. Install the bearing(s) and oil seal(s) with their manufacturer's marks or numbers facing outward. (In other words, the stamped letters must be on the side exposed to view.) When installing oil seal(s), apply a light coating of light-weight lithium base grease to the seal lip(s). When installing bearings liberally oil the bearings.





4. Install gear 2 and the plate stopper and tighten the screw.
5. Install the starter wheel gear and gears 4 and 3.
Install the circlip.

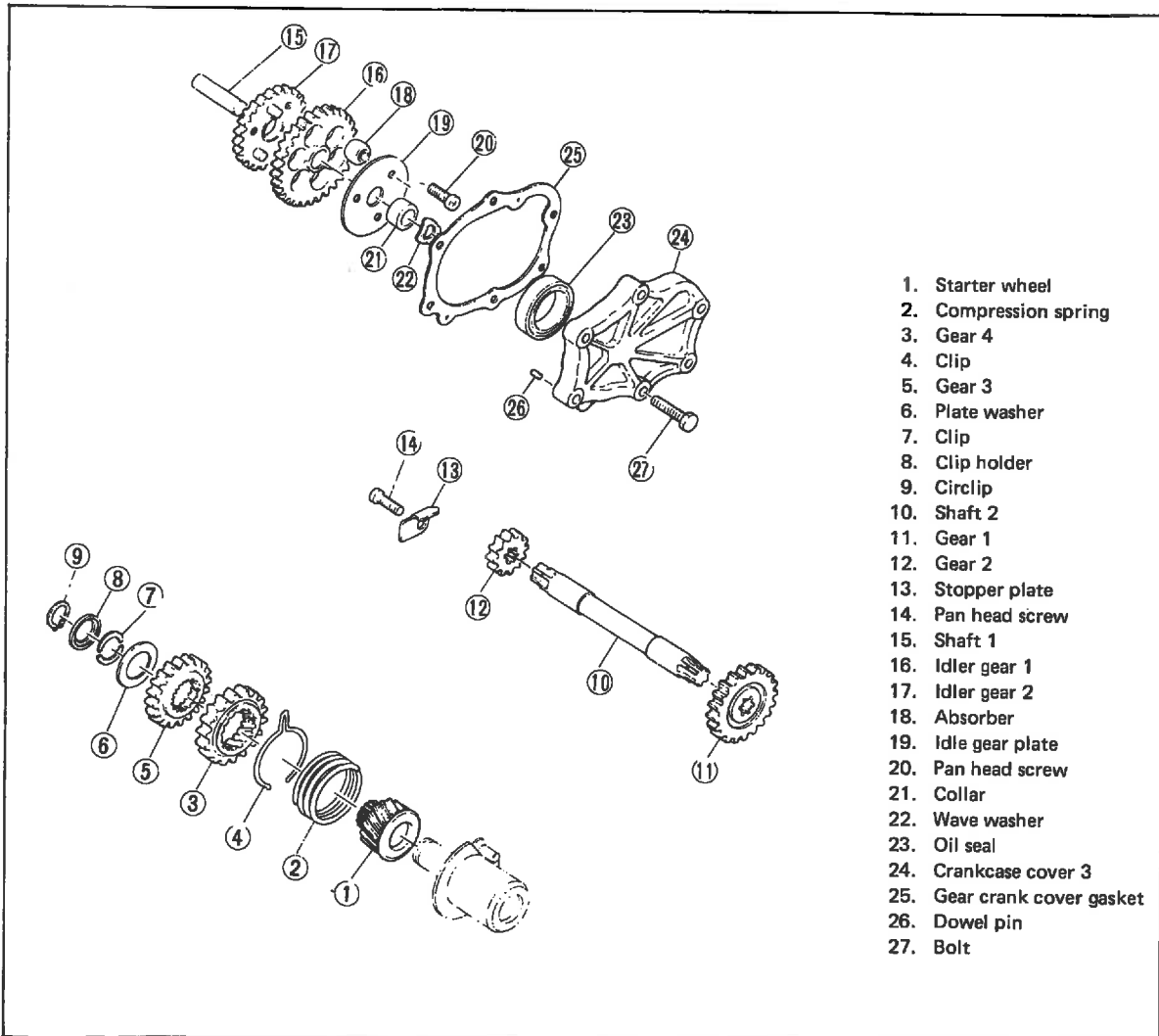
NOTE: _____
The spring clip should be located in the case gap.



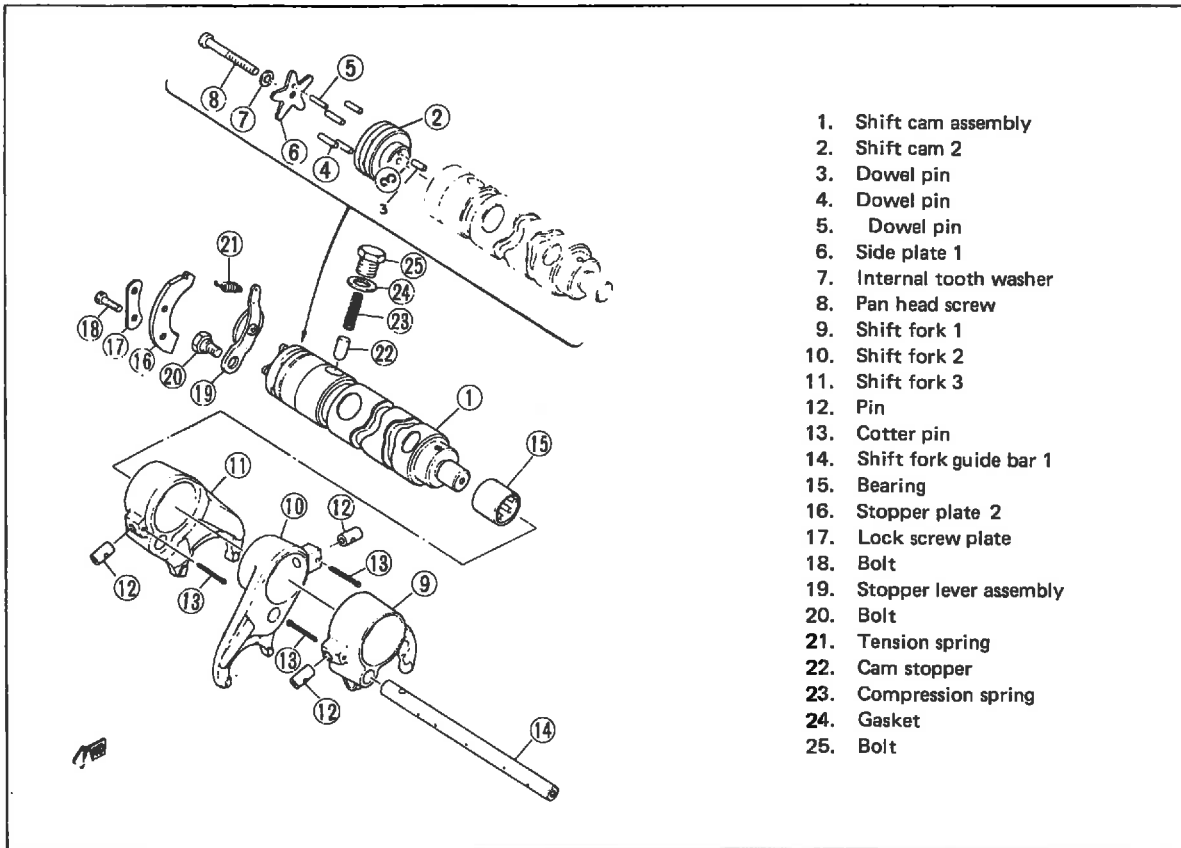
B. Starter Motor Unit

1. Place the lower half crankcase on the bench with its mating surface facing upward.
2. Install shaft 2 and gear 1.
3. Install shaft 1 and idle gears 1 and 2.

Starting motor unit



Shift Cam Fork



1. Shift cam assembly
2. Shift cam 2
3. Dowel pin
4. Dowel pin
5. Dowel pin
6. Side plate 1
7. Internal tooth washer
8. Pan head screw
9. Shift fork 1
10. Shift fork 2
11. Shift fork 3
12. Pin
13. Cotter pin
14. Shift fork guide bar 1
15. Bearing
16. Stopper plate 2
17. Lock screw plate
18. Bolt
19. Stopper lever assembly
20. Bolt
21. Tension spring
22. Cam stopper
23. Compression spring
24. Gasket
25. Bolt

C. Shifter, Transmission and Crankshaft

1. Install the shift cam into the crankcase and install the shift fork.
2. Install the shift fork guide bar.
3. Install the stopper plate and the stopper lever assembly.

TIGHTENING TORQUE:

Stopper plate: 9.81 Nm
(1.0 m·kg, 7.23 ft·lb)

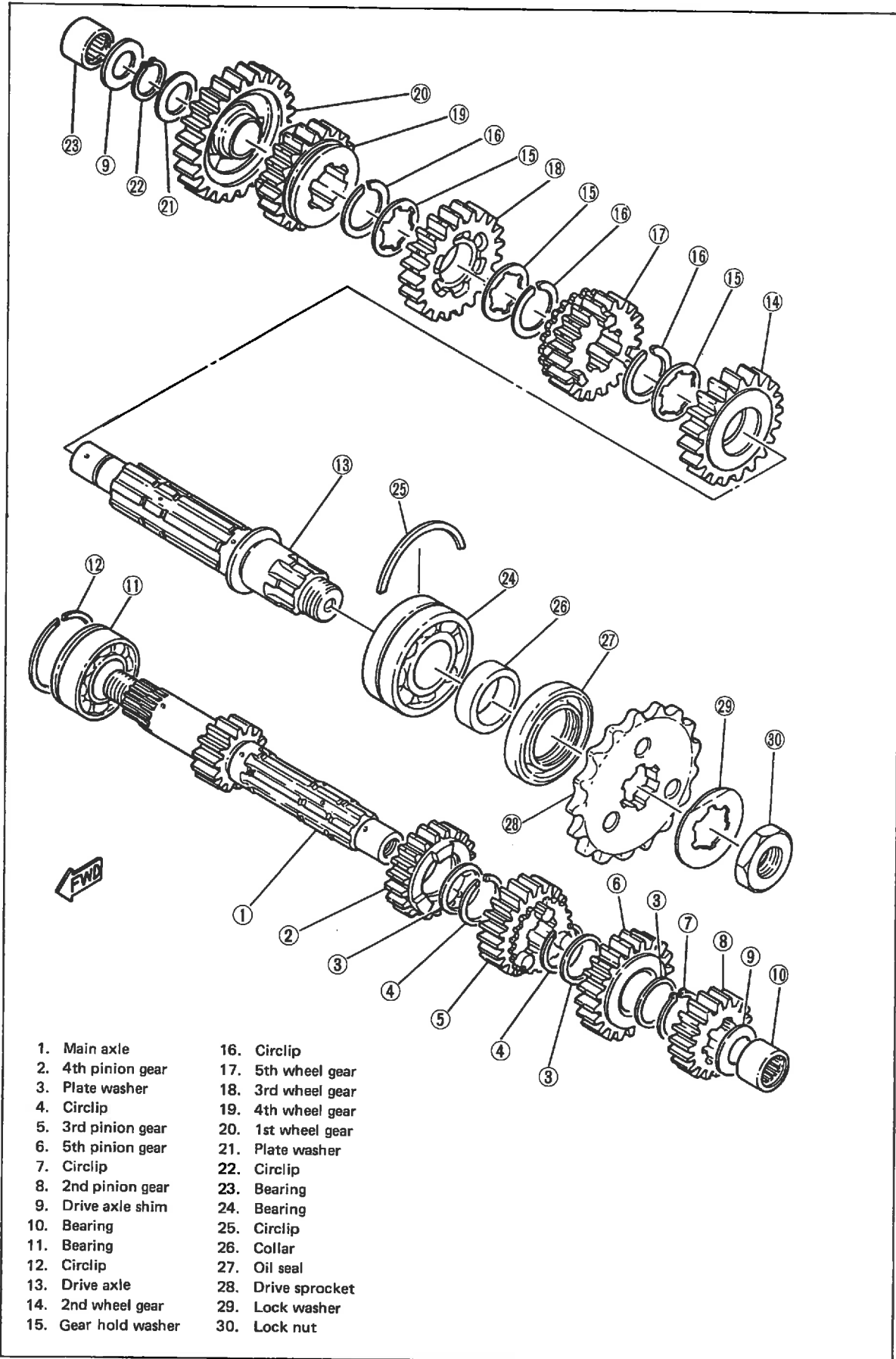
Stopper lever: 9.81 Nm
(1.0 m·kg, 7.23 ft·lb)

NOTE:

1. Install the bearing circlip into the case groove and then the oil seal projection into the corresponding case dent.
2. Apply a liberal amount of oil to each gear, bearing, and shift cam.
3. Apply a thin coat of grease to the oil seal lip.

4. Install the transmission assembly.

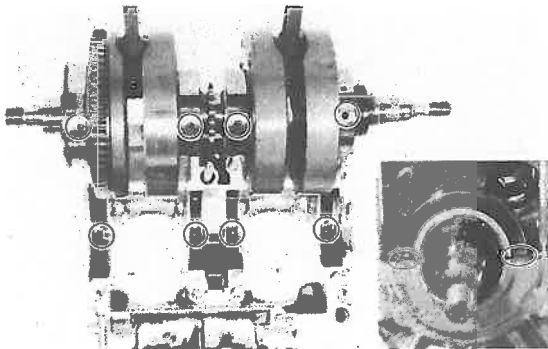
Transmission



5. Install the crankshaft.

NOTE:

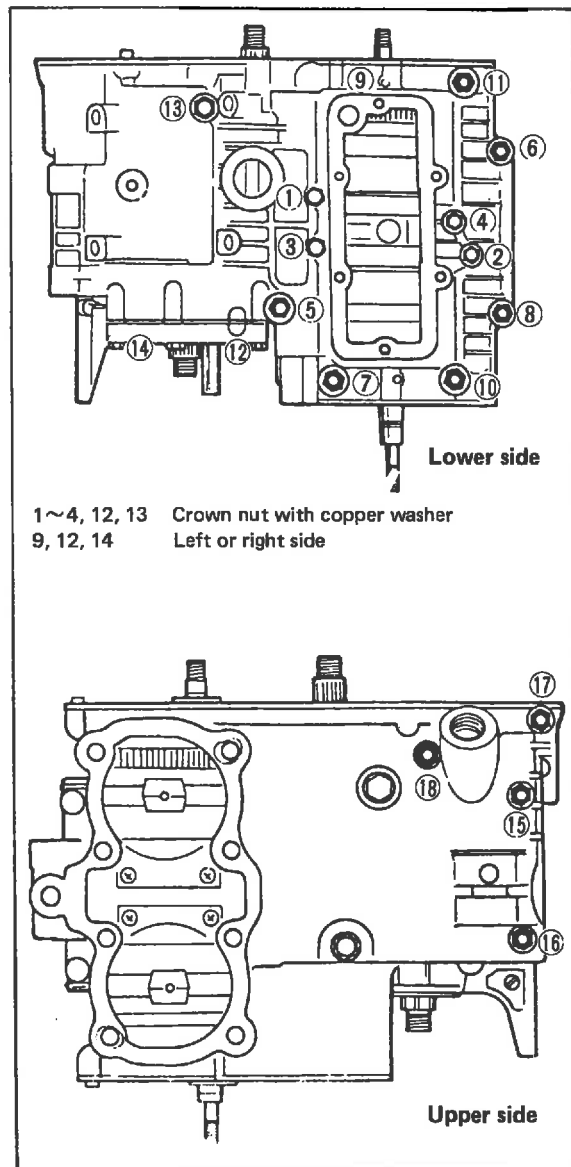
1. Apply a liberal amount of oil to the big end bearing and to the crank journal bearing.
2. Install the bearing circlip into the case groove.
3. Install the bearing dent onto the dowel pin on the case.
Correct bearing location can be ensured by the level line on the bearing.
4. Install the oil seal projection in the corresponding case dent.



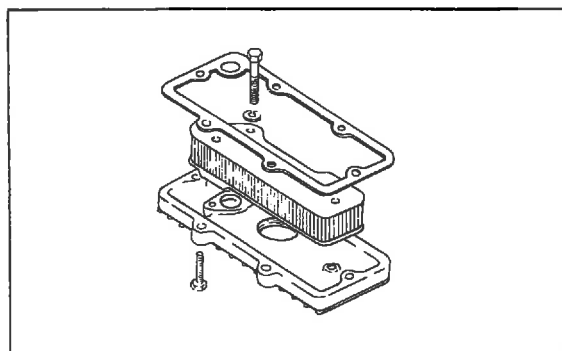
D. Crankcase Assembly

1. Apply Yamaha bond No. 4 to the mating surfaces of the upper and lower cases.
2. Install the upper case onto the lower case.
3. Tighten the securing bolts in the order as shown in the illustration.

TIGHTENING TORQUE:
20.6 Nm (2.1 m·kg, 15.19 ft·lb)



4. Install the oil strainer.



TIGHTENING TORQUE:
9.81 Nm (1.0 m·kg, 7.23 ft·lb)

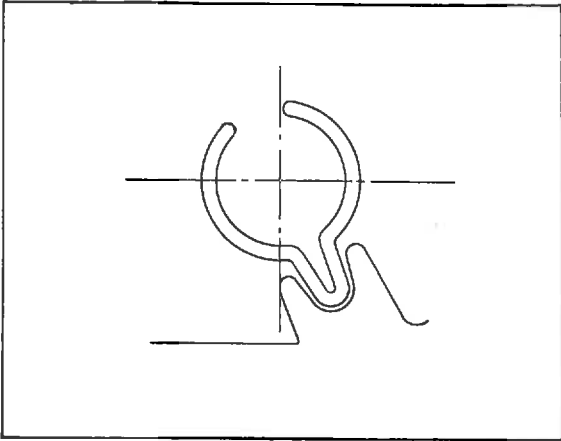
5. Install the starter motor.

TIGHTENING TORQUE:
9.81 Nm (1.0 m·kg, 7.23 ft·lb)

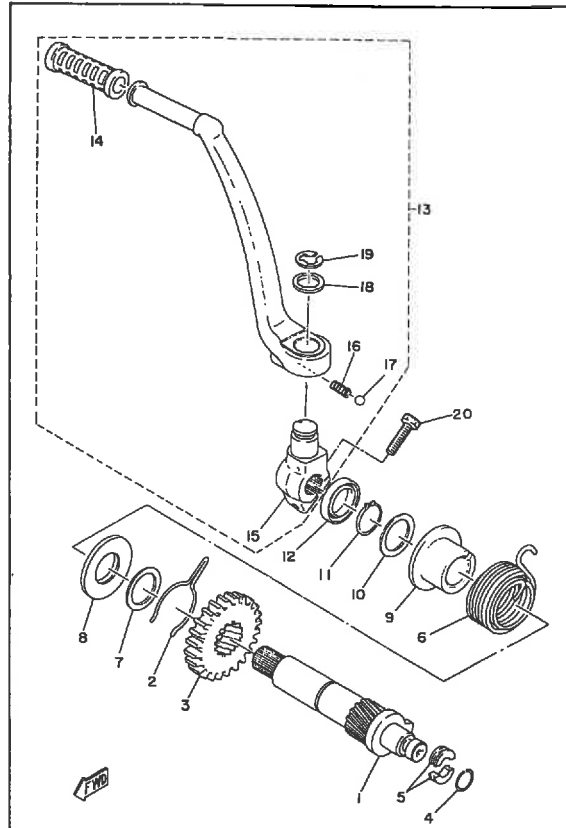
E. Kick Starter, Primary Drive Gear, Clutch Assembly, Oil Pump and Case Cover Right

1. Install the kick shaft.

The spring clip should be installed as shown in the illustration.



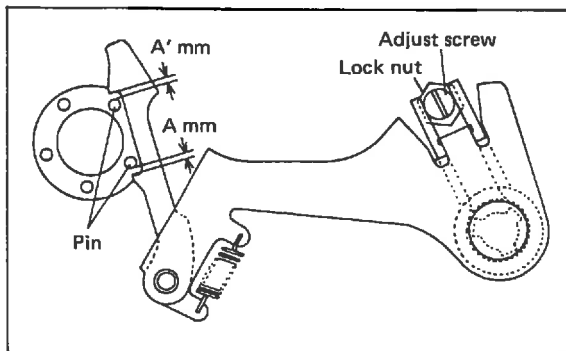
Kick Starter



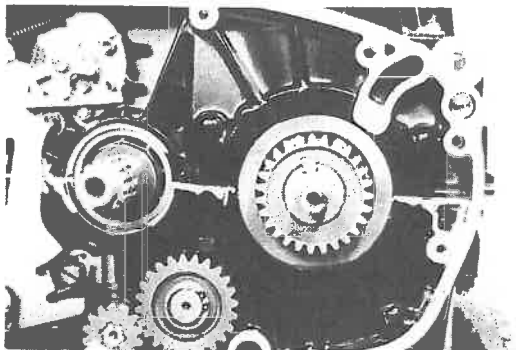
- | | |
|--------------------|----------------------|
| 1. Kick axle ass'y | 11. Circlip |
| 2. Clip | 12. Oil seal |
| 3. Kick gear (25T) | 13. Kick crank ass'y |
| 4. Clip | 14. Kick lever cover |
| 5. Holder | 15. Kick crank boss |
| 6. Kick spring | 16. Ball |
| 7. Shim | 17. Spring |
| 8. Spacer | 18. Plate washer |
| 9. Spring guide | 19. Circlip |
| 10. Plate washer | 20. Bolt |

2. Install the change shaft and the change lever.

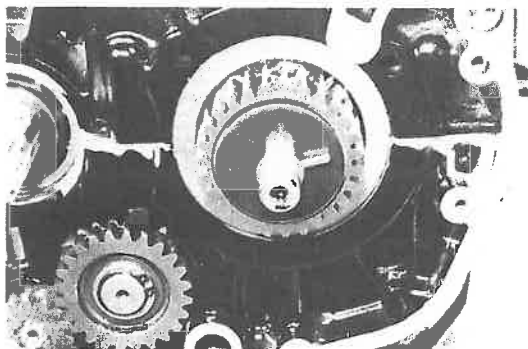
Check the gaps "A" and "A'" unless A is nearly equal to A', loosen the lock nut and adjust A with the adjust screw.



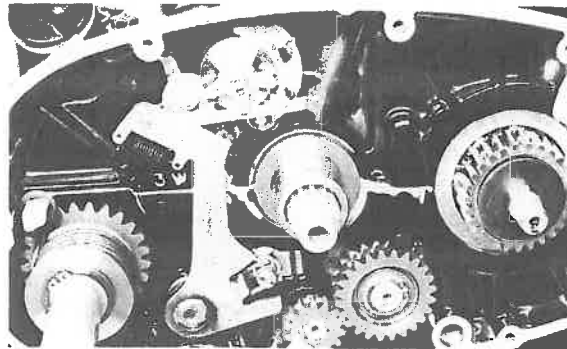
3. Install the primary drive gear onto the crankshaft. Install the key in the keyway.



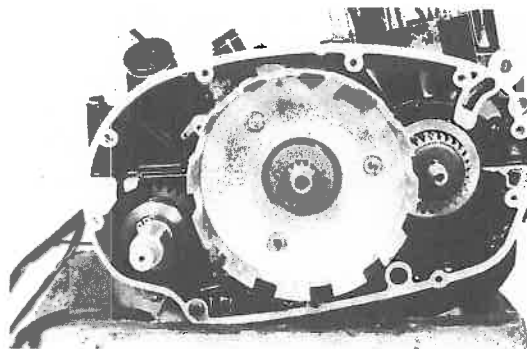
4. Install the plate washer, and securing nut onto the crankshaft. Finger-tighten the securing nut; do not torque it at this point.



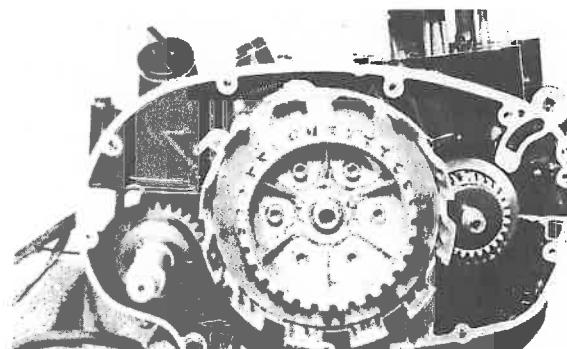
5. Install the plate washer, the thrust plate, the spacer, and the clutch housing onto the transmission main shaft.



6. Install the bearing, the thrust plate, and the clutch boss onto the transmission main shaft.



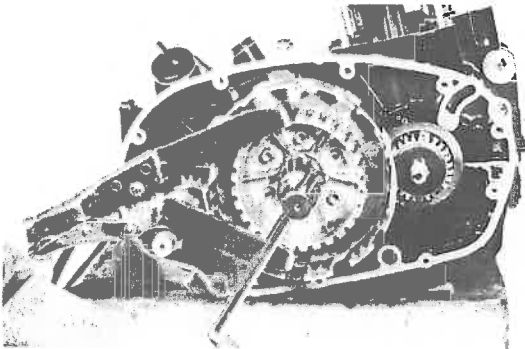
7. Install a new lock washer onto the transmission main shaft. Be sure the tab of the washer engages the slots in the clutch boss.



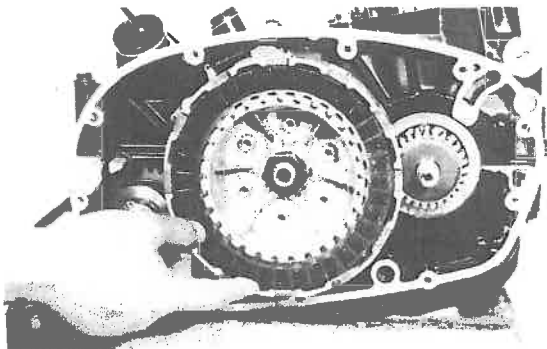
8. Install the clutch-boss securing nut. Using the clutch hub holder, tighten the clutch-boss nut and torque it to specification. Bend a lock tab against a nut flat.

TIGHTENING TORQUE:

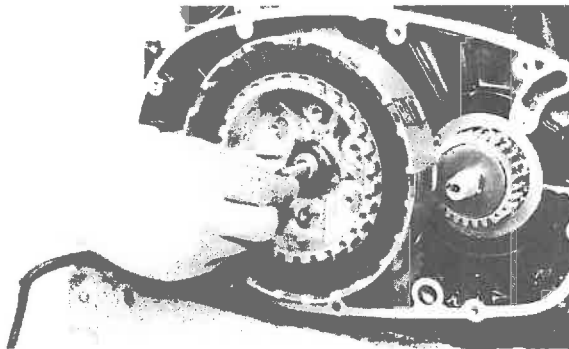
87.5 Nm (8.0 m·kg, 57.9 ft·lb)



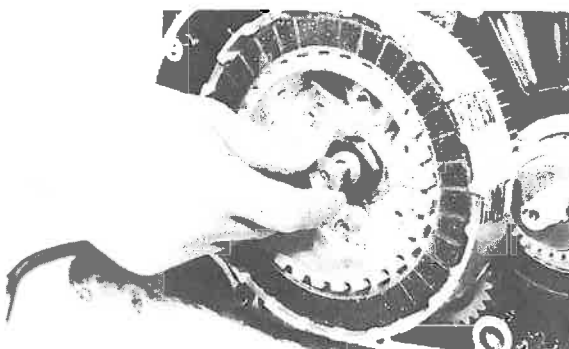
9. Install the friction and clutch plates. Begin with a friction plate and alternate clutch and friction plates until all of the plates are in the clutch boss.



10. Insert the ball, push rod #2, and the ball into the transmission main shaft.



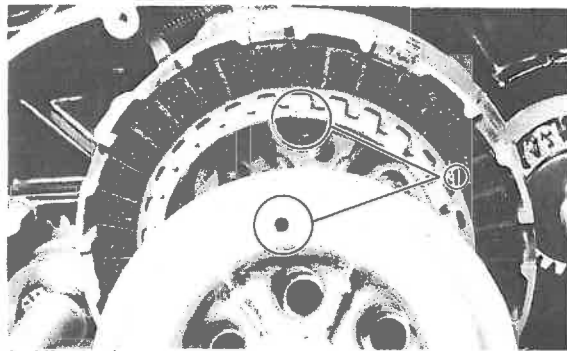
11. Install push rod #1 into the transmission main shaft.



12. Install the clutch pressure plate and the six clutch springs. Torque the clutch plate bolts to specification.

TIGHTENING TORQUE:

7.85 Nm (0.8 m·kg, 5.8 ft·lb)

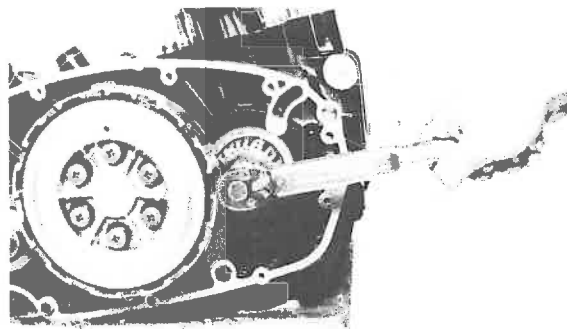


1. Alignmark

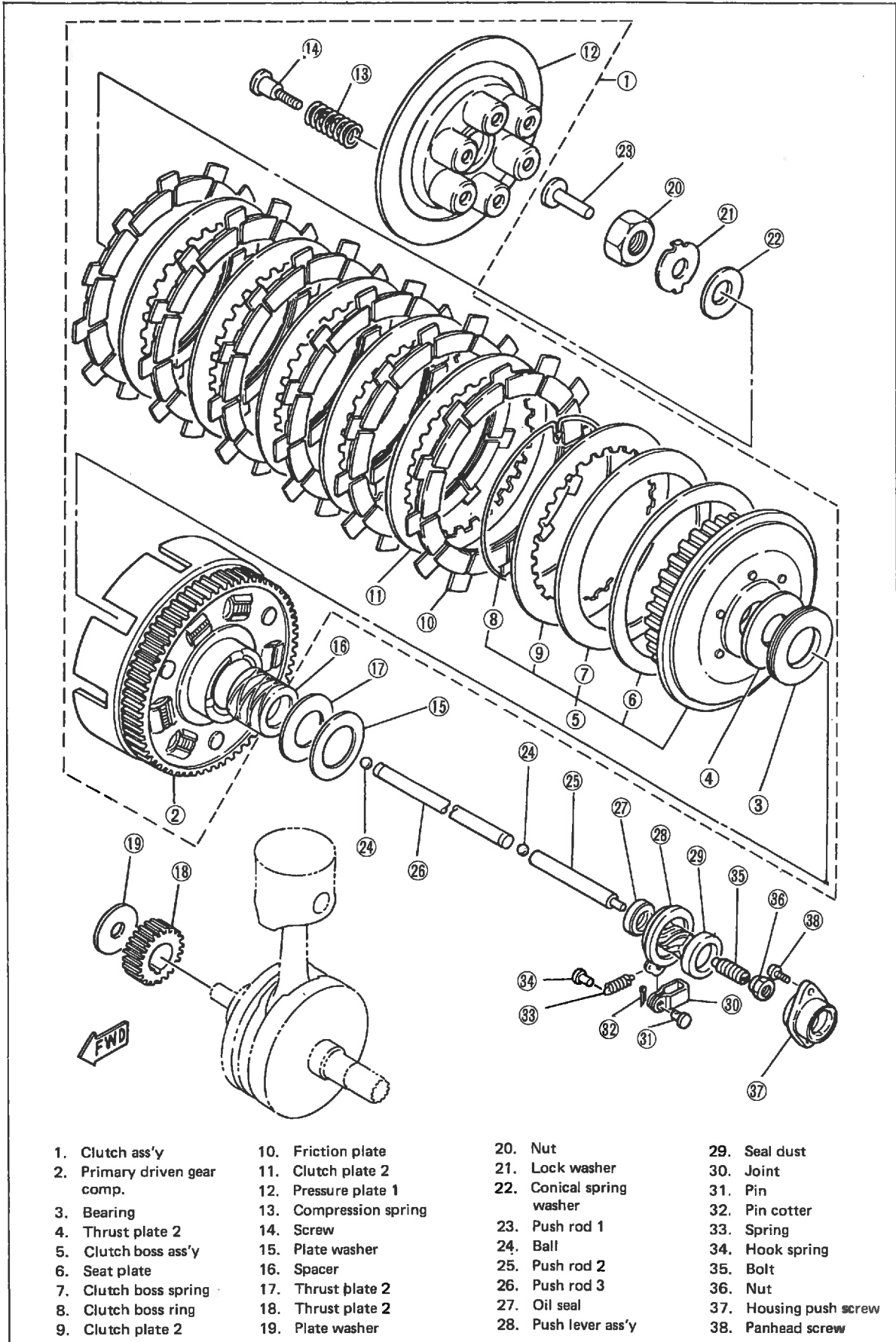
13. Place a small piece of rolled rug or a piece of lead between the primary drive gears as shown in the photograph. It will hold the gears so you can tighten the primary-drive securing nut. Torque the nut to specification, and bend the lock tab against a nut flat.

TIGHTENING TORQUE:

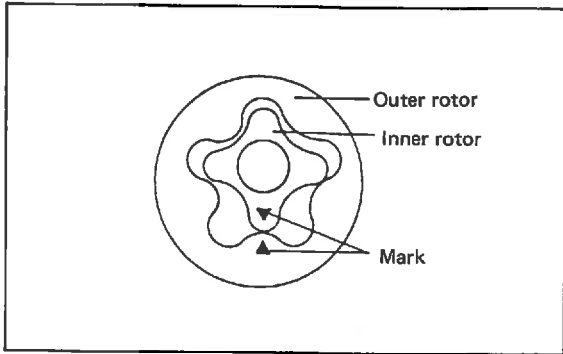
88.3 Nm (9.0 m·kg, 65.1 ft·lb)



Clutch

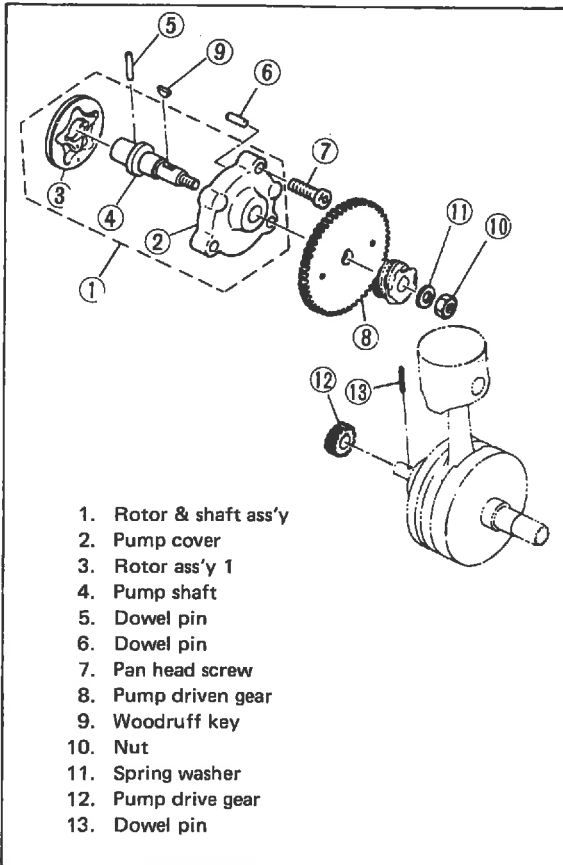


14. Install the dowel pin and the rotor assembly 1 onto the pump shaft. Install the pump cover.

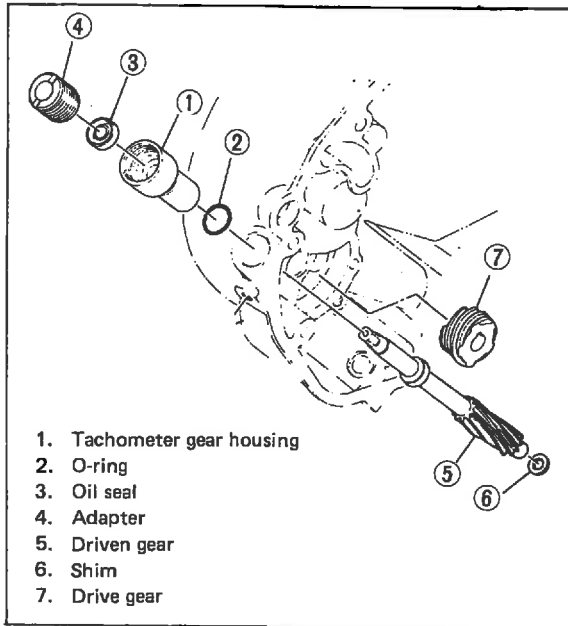


15. Install the woodruff key and the pump driven gear onto the pump shaft.
16. Install the tachometer driven gear onto the pump shaft.
17. Install the tachometer drive gear while rotating.
18. Tighten the tachometer driven gear set screw.
19. Install the tachometer housing into the case cover.

Oil Pump



Tachometer Gear



20. Install the right-side crankcase cover. Use a new gasket and tighten the securing bolts.

TIGHTENING TORQUE:

9.81 Nm (1.0 m·kg, 7.23 ft·lb)

21. Install the kick crank. Tighten the securing bolt.

TIGHTENING TORQUE:

19.6 Nm (2.0 m·kg, 14.5 ft·lb)

F. Case Cover Left

1. Install the key and the rotor assembly onto the crankshaft.
2. Tighten the securing nut using the rotor holding tool.

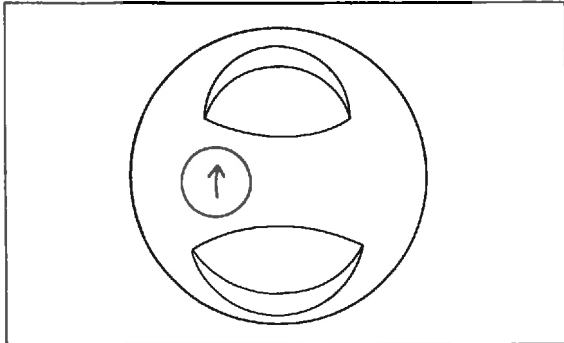
TIGHTENING TORQUE:

37.3 Nm (3.8 m·kg, 27.5 ft·lb)

3. Install the stator.
4. Install the neutral switch lead wire.
5. Install the chain guide.
6. Install the drive sprocket.

G. Pistons, Cylinders, and Cylinder Heads

1. Install the pistons on the rods. The arrow marks on the pistons should face the front of the engine.

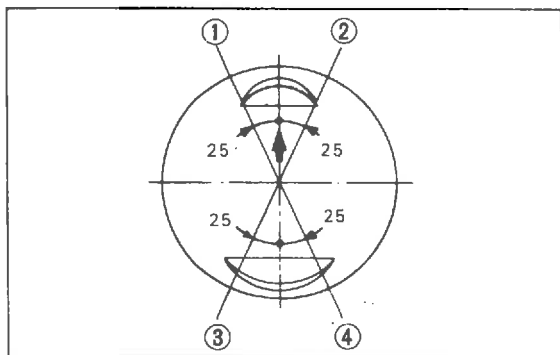


NOTE: Before installing the piston pin clips, cover the crankcase with a clean rag so you will not accidentally drop the clip into the crankcase.

2. Align the piston rings as shown.

CAUTION: Be sure the ends of the il ring expanders do not overlap.

NOTE: The manufacturer's marks or numbers stamped on the rings should be on the top of the rings.

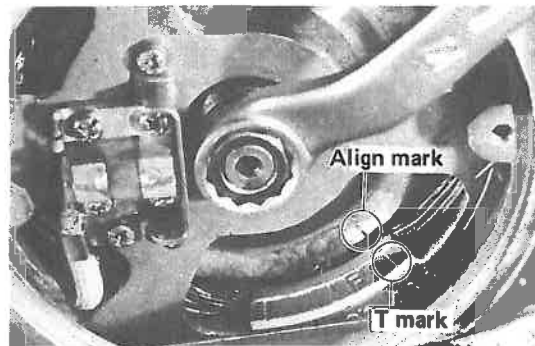


3. Liberally coat the pistons with oil, and install the dowels onto the crankcase.
4. Install a new cylinder-base gasket to the cylinder, and install a new o-ring around each cylinder liner.
5. Install the cylinders using the piston support plates and the piston ring compressors. Route the cam chain journal.

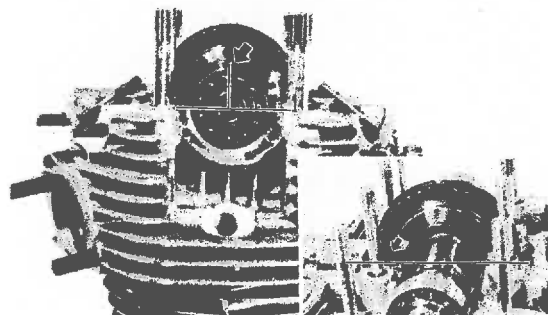
6. Remove the chain tensioner from the cylinder.
7. Install a new cylinder-head gasket.
8. Route the cam chain through the cam chain journal.
9. Install the cylinder head and tighten the securing bolts (3).

H. Cam Shaft and Chain Tensioner

1. Install the cam shaft so the cam sprocket key groove can be located on the left side.
2. Install the bearings onto the both sides of the cam shaft and bring them together close enough to each other.
3. Align the mark on the "T" mark on the stator.



4. Place the cam sprocket with its key groove on top, at the same time the punched mark on it being horizontal.



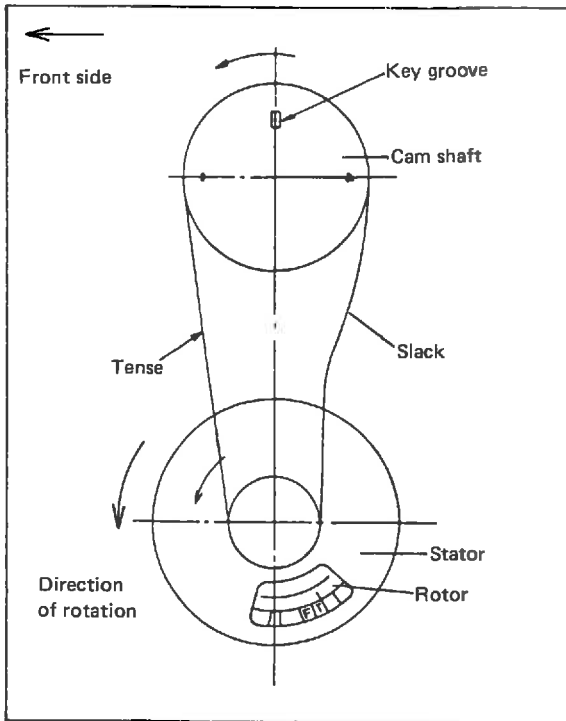
5. In the above condition, calk the cam chain with the cam chain tool.

NOTE: Always use a new chain joint.

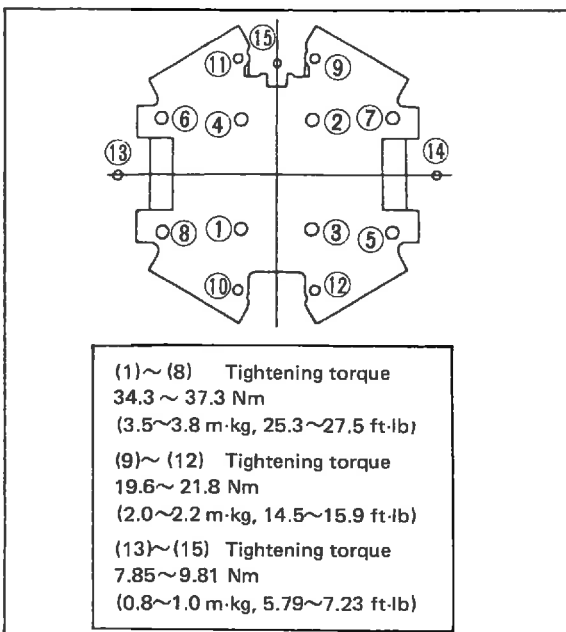
6. Adjust the chain tension.

NOTE:

1. Recheck the "T" mark on the rotor and the cam shaft key groove for alignment.
2. One chain link difference may make 10 degrees difference in valve timing.

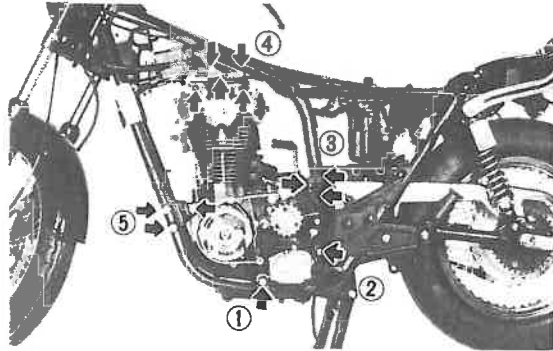


7. Apply HERME-SEAL (Yamaha-bond 5) to the mating surface of the cylinder head cover.
8. Finger-tighten the securing nuts and bolts, and tighten them in the order as shown in the illustration.



I. Mounting The Engine

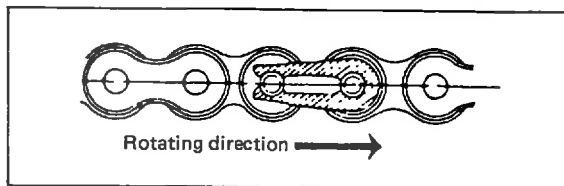
1. Install and finger-tighten the mounting bolts in the order as shown. Tighten the bolts as specified.



TIGHTENING TORQUE:

- (1) 88.3 Nm (9.0 m·kg, 65.1 ft·lb)
- (2) 45.1 Nm (4.6 m·kg, 33.3 ft·lb)
- (3) 40.2 Nm (4.1 m·kg, 29.7 ft·lb)
- (4) 17.7 Nm (1.8 m·kg, 13 ft·lb)(M8)
29.4 Nm (3.0 m·kg, 21.7 ft·lb)
(M10)
- (5) 45.1 Nm (4.6 m·kg, 33.3 ft·lb)

2. Install the drive chain to the drive and driven sprockets.
3. Install the chain-joint clip as shown in the illustration.



4. Install the tachometer cable.
5. Install the case cover (left) and the change pedal.

TIGHTENING TORQUE:

9.81 Nm (1.0 m·kg, 7.23 ft·lb)

6. Install the footpeg and the brake pedal.
7. Install the exhaust pipe assembly.
8. Install the carburetors.
9. Install the fuel tank.
10. Install the air cleaner assembly and the air cleaner joints.
11. Connect the fuel and vacuum lines.

12. Install or connect the following wires.

- a) Spark plug cap cords
- b) Starter motor lead wire
- c) A.C. Generator lead wire
- d) Throttle cable and clutch cable
- e) Lead wire for ground

13. Install the side covers.

14. Add Engine oil

2.5 L (2.2 Imp qt, 2.64 US qt)
