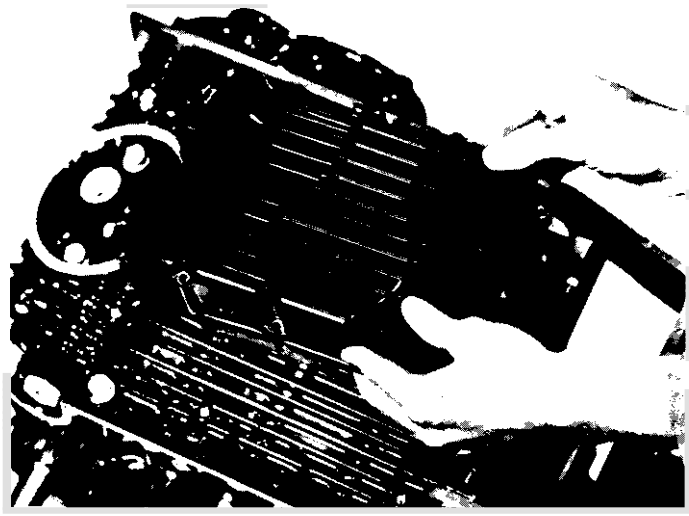
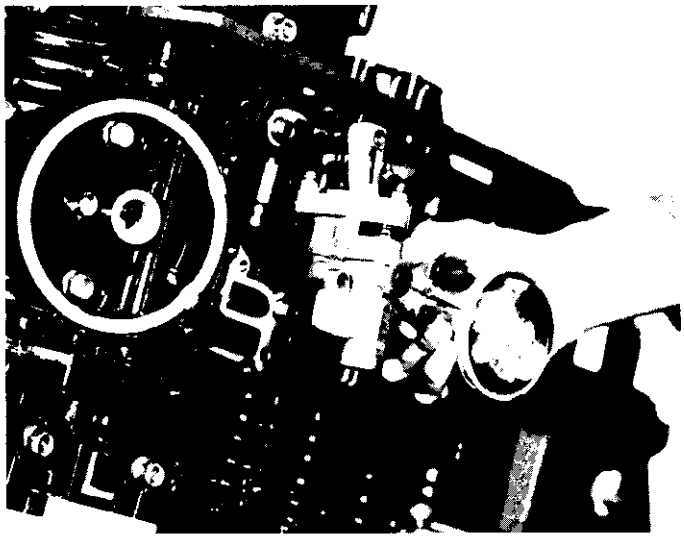
N. Oil Pump Removal and Disassembly

1. Remove strainer cover.

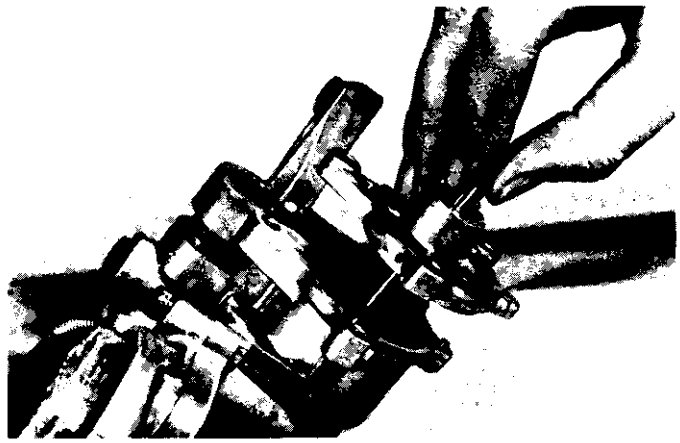


2. Remove oil pump.



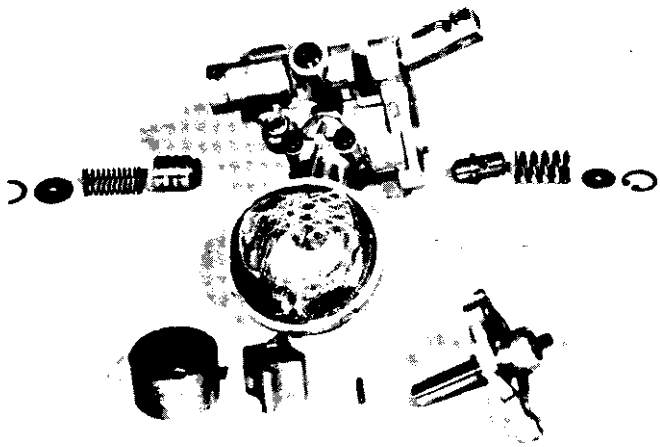
3. Remove oil pump driven gear.

4. Remove oil pump cover and rotor assembly.



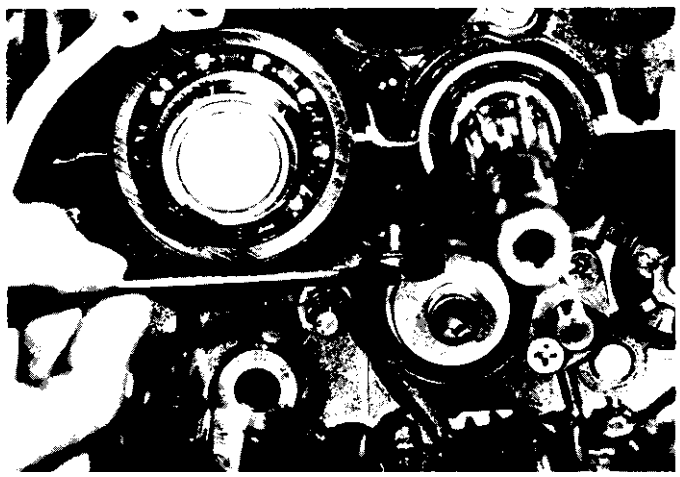
5. Remove pressure relief valve: remove circlip, washer, spring, and plunger.

6. Remove oil pump check valve: remove circlip, plug, spring, and plunger.



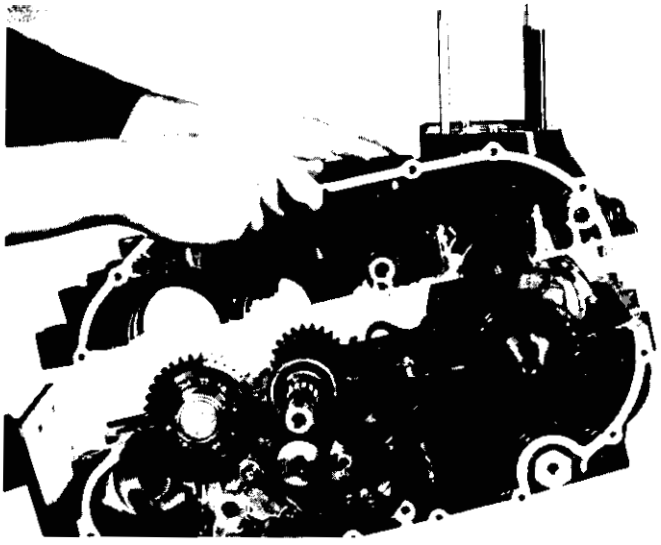
O. Crankcase Disassembly

CAUTION: There is one hidden crankcase holding bolt. This bolt is located near the transmission drive axle, as shown. This bolt must be located before proceeding with crankcase disassembly.



1. Loosen each bolt ½ turn, starting with the unnumbered bolt. Continue by loosening the highest numbered bolts first. The numbers of the bolts are cast in the cases. Numbers 24~ 15 are on the top case. Numbers 14–1 are on the bottom case.

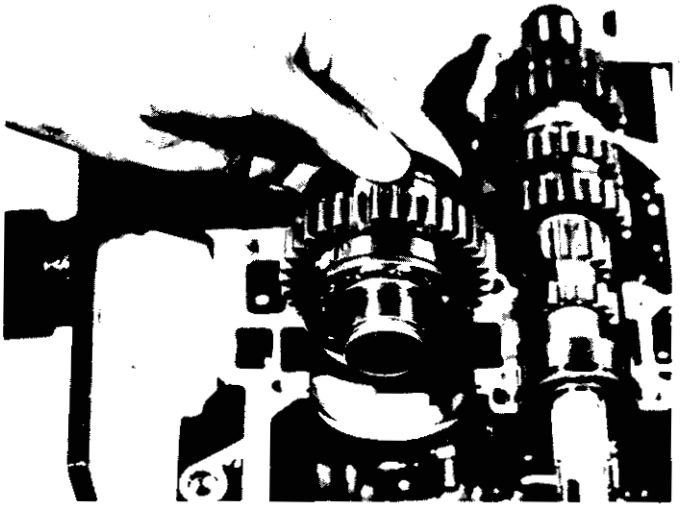
2. Remove all crankcase holding bolts. Use a soft rubber hammer to carefully separate the crankcases. The crankshaft and transmission shafts should stay in the bottom crankcase.



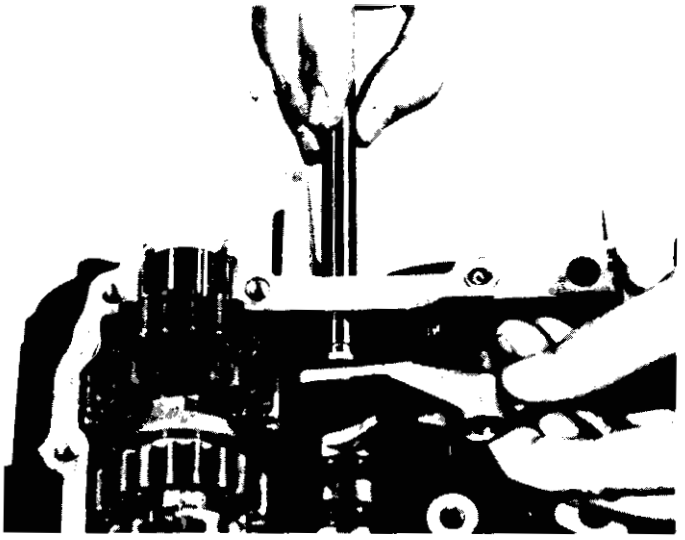
3. Remove crankshaft. Note location of special main bearing **('A'** bearing). This is a combination side thrust bearing and main bearing.

P. Transmission Disassembly

1. Remove middle driven gear.

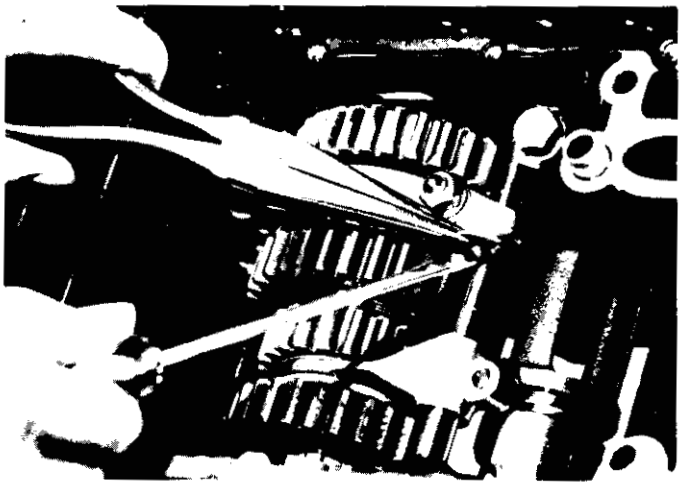


2. Remove shift fork guide bar circlip (E-clip). Remove guide bar.

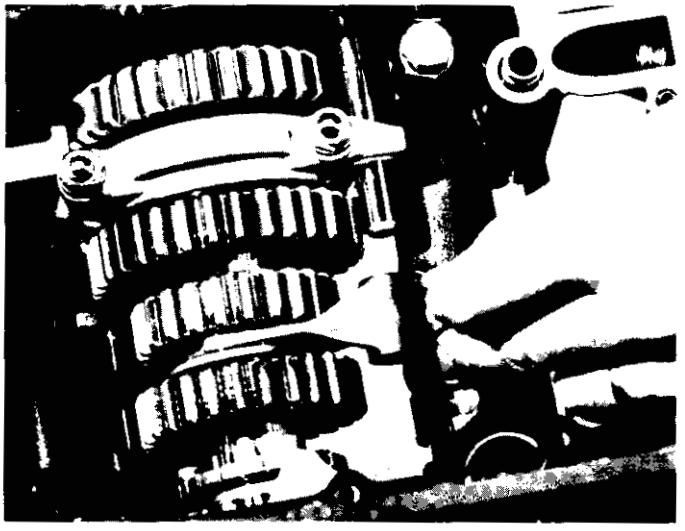


3. Remove main axle assembly.

4. Remove circlip (E-clip) holding shift fork guide two



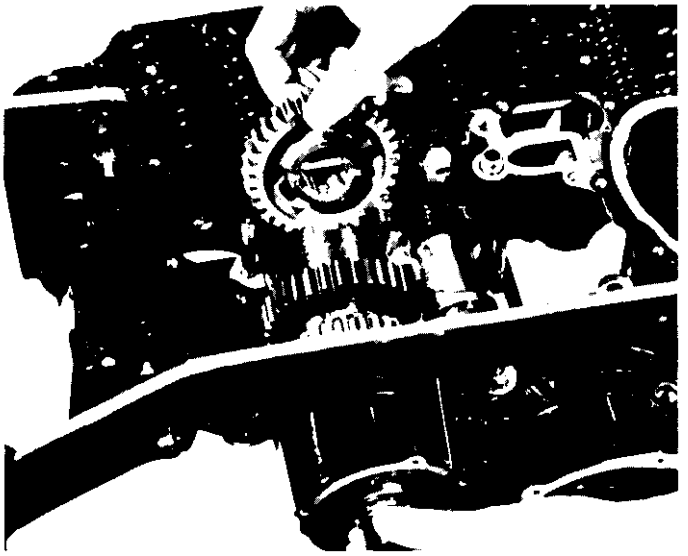
5. Remove guide bar, washer and both shift forks.

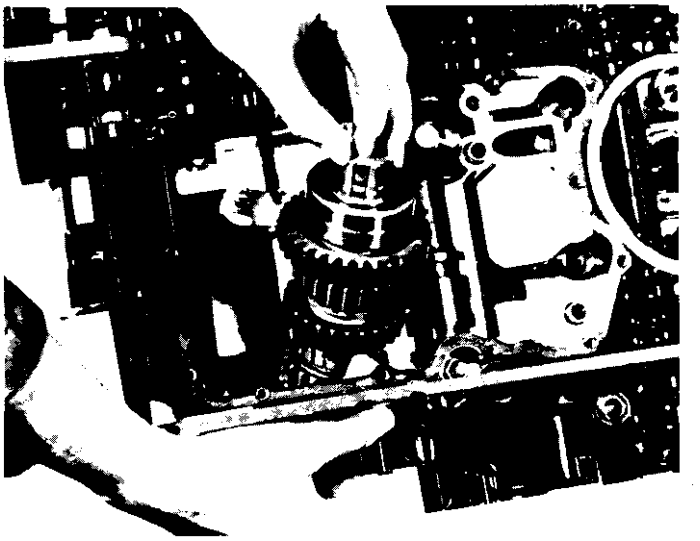


6. Remove bolt holding middle drive gear to drive axle. Remove spacer.

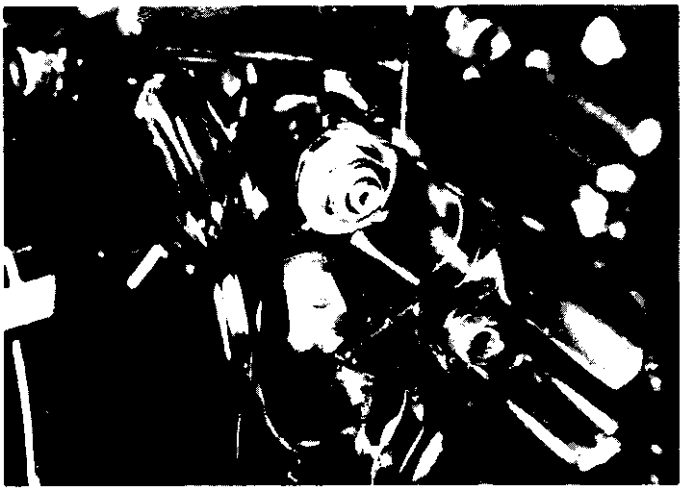
7. Loosen transmission bearing cap nuts ½ turn. Remove nuts and cap.

8. Remove middle drive gear. Push drive axle up at the bearing and out so that the middle drive gear can be removed. Remove drive axle.

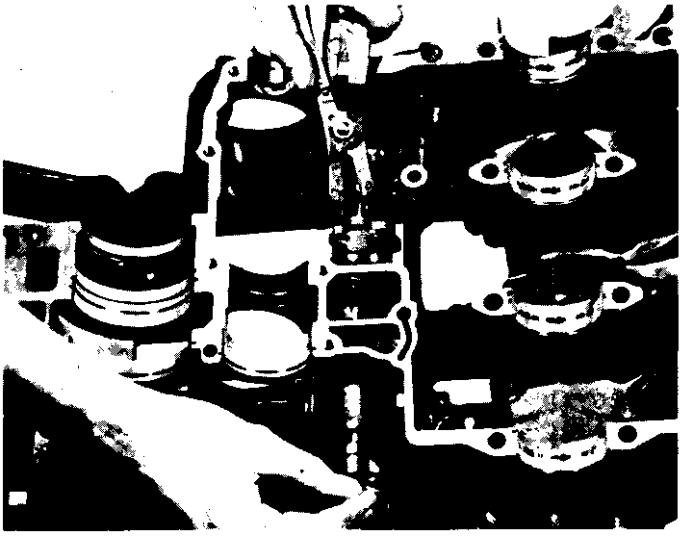




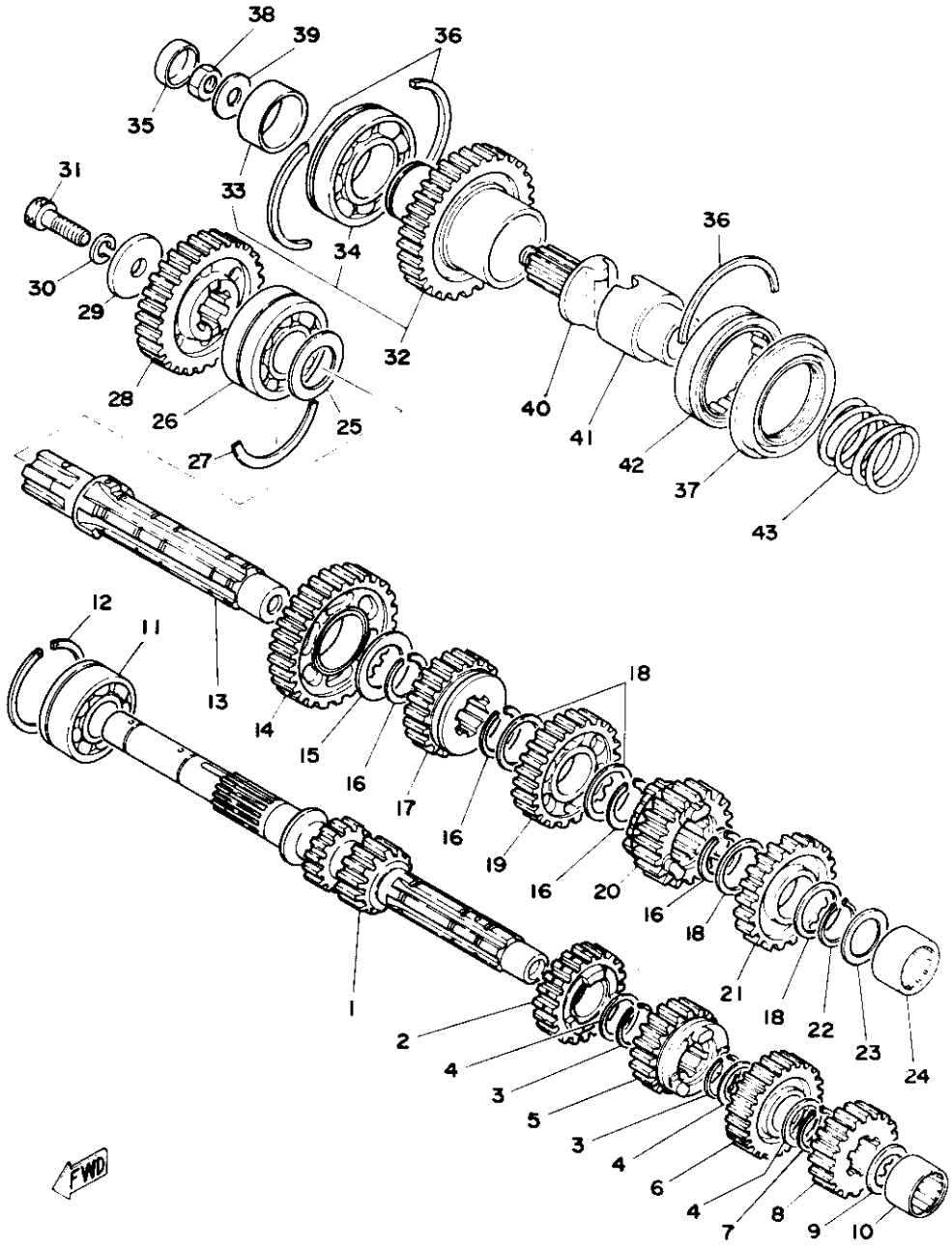
9. Remove shift cam detent and shaft cam securing bolt.



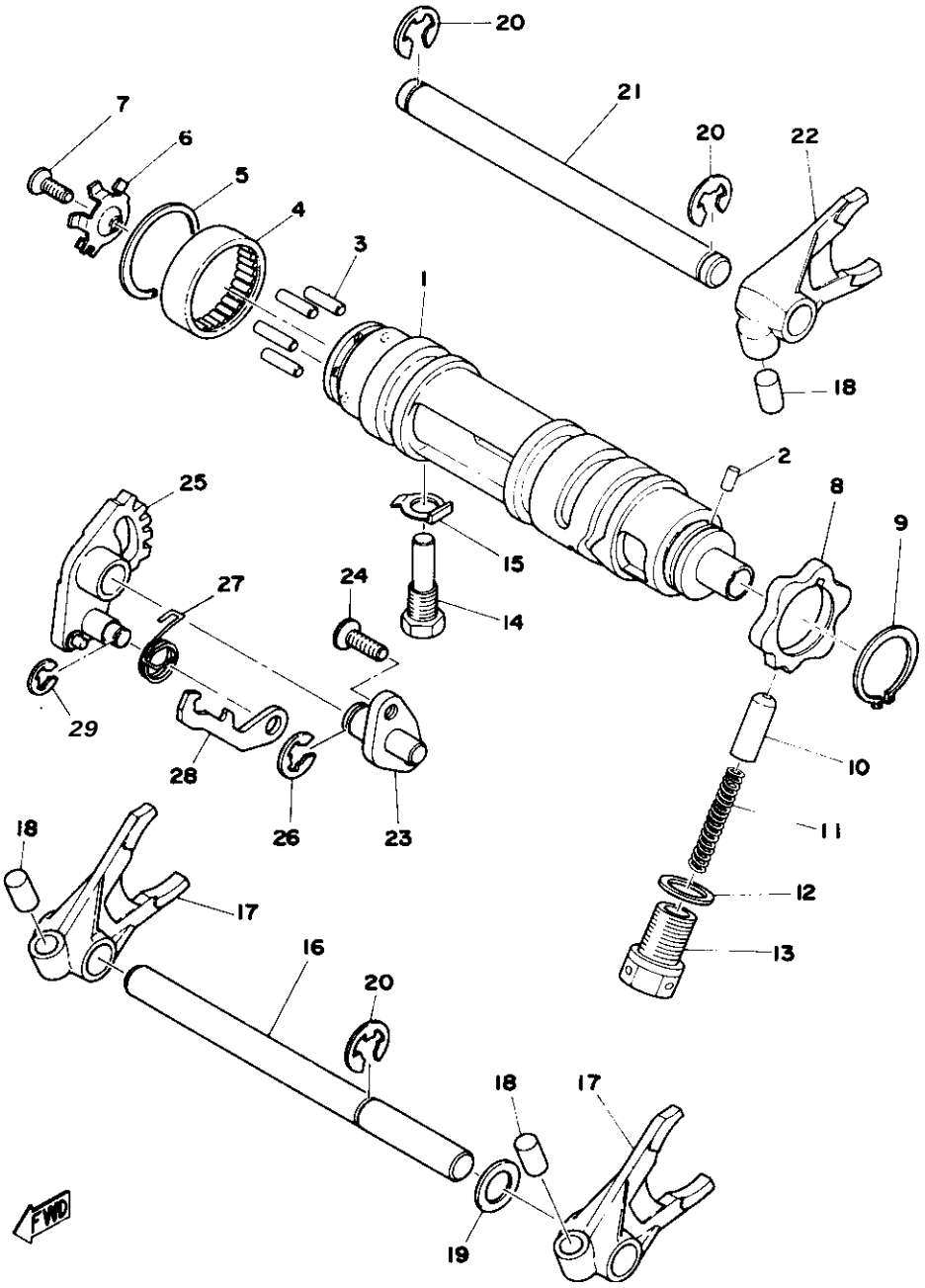
10. Remove circlip on shift cam stopper plate. Remove stopper plate and shift cam.



Further disassembly of the transmission shafts can be undertaken after study of the transmission illustration.



1 AXLE, main (13T)
2 GEAR, 4th pinion (21T)
3 CIRCLIP
4 WASHER, gear hold 5 (25.2-30-1.0)
5 GEAR, 3rd pinion (20T)
6 GEAR, 5th pinion (23T)
7 CIRCLIP (S-25)
8 GEAR, 2nd pinion (17T)
9 SHIM, drive axle
10 BEARING
11 BEARING (B5205 special)
12 CIRCLIP
13 AXLE, drive
14 GEAR, 1st wheel (32T)
15 WASHER, plate (30.2-40-2.0)
16 CIRCLIP
17 GEAR 4th wheel (23T)
18 SHIM
19 GEAR, 3rd wheel (26T)
20 GEAR, 5th wheel (22T)
21 GEAR, 2nd wheel (27T)
22 CIRCLIP (S-30)
23 SHIM, drive axle (24.2-33-1.6)
24 BEARING
25 WASHER, plate (30.2-40-2.0)
26 BEARING (B5206 special)
27 CIRCLIP
28 GEAR, middle drive (32T)
29 WASHER, plate
30 WASHER, spring
31 BOLT, hexagon socket head
32 MIDDLE DRIVEN GEAR COMP. (34T)
33 COLLAR (35-40-16)
34 BEARING (B6207 special)
35 PLUG
36 CIRCLIP
37 OIL SEAL (SW-48.8-72-9)
38 NUT, hexagon
39 WASHER, plate
40 CAM, driven
41 CAM, drive
42 BEARING
43 SPRING, compression



1	CAM, shift	11	SPRING, compression	21	BAR, shift fork guide 2
2	PIN, dowel (4-8)	12	GASKET, drain plug	22	FORK, shift 1
3	PIN, dowel (4-17.8)	13	SCREW	23	SHAFT, shift lever
4	BEARING	14	BOLT	24	SCREW, flat head
5	CIRCLIP (34 ø special)	15	WASHER, lock	25	LEVER, shift 2
6	PLATE, side	16	BAR, shift fork guide 1	26	CIRCLIP (E-9)
7	SCREW, flat head	17	FORK, shift 2	27	SPRING, torsion
8	PLATE, stopper	18	PIN, cam follower	28	LEVER, shift 3
9	CIRCLIP (S-30)	19	WASHER, plate (12-22-1.0)	29	CIRCLIP (E-7)
10	STOPPER, cam	20	CIRCLIP (E-10)		

3-3 INSPECTION AND REPAIR

A. Cylinder Head Cover

Place head cover on a surface plate. There should be no warpage. Correct by re-surfacing as follows:

Place #400 or #600 grit wet sandpaper on surface plate and re-surface head cover using a figure-eight sanding pattern. Rotate head cover several times to avoid removing too much material from one side.

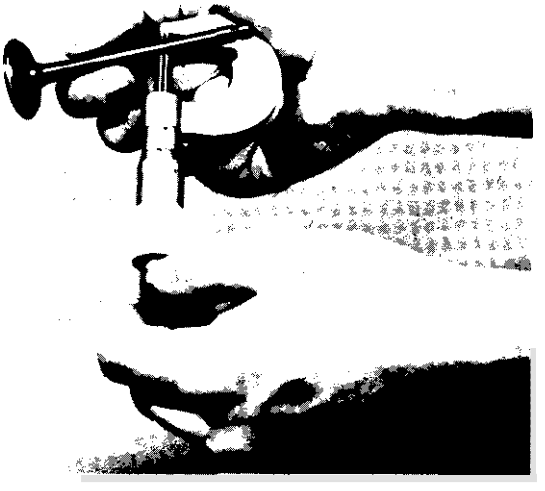
B. Cylinder Head

1. Remove spark plugs.
2. Remove valves.
3. Using a rounded scraper, remove carbon deposits from combustion chamber. Take care to avoid damaging spark plug threads and valve seats. Do not use a sharp instrument. Avoid scratching the aluminum.
4. Place on a surface plate. There should be no warpage. Correct by re-surfacing as follows:

   Place #400 or #600 grit wet sandpaper on surface plate and re-surface head using a figure-eight sanding pattern. Rotate head several times to avoid removing too much material from one side.

C. Valve, Valve Guide and Valve Seat

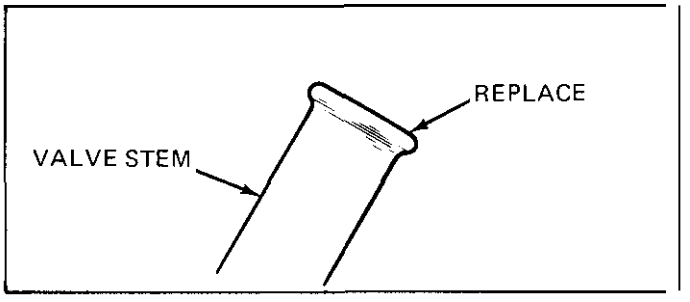
1. Valve stem wear must be measured and then combined with valve guide measurements to guide clearance. This clearance must be within tolerances. If it exceeds the maximum limit, then replace either or both valve and guide, as necessary.



Valve Stem Clearance		Maximum
Intake	.020-.041mm (.0008~.0016")	0.10mm (.004")
Exhaust	.035-.059mm (.0014~.0023")	0.12mm **(.005")**

2. Valve stem end

   Inspect end of 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.



3. Turn valve on a "V" block and measure the amount of stem runout with a dial gauge. If it exceeds the maximum limit, replace the valve.

Maximum Valve Stem Runout:
.03mm (.0012")

4. Valve guide and valve oil seal replacement

   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.

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

Guide diameter (I.D.):	7.01-7.02mm (.276-.277")	7.10mm (0.280')

   b. 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.

   c. Use the appropriate shouldered punch (special tool) to drive the old guide out and drive the new guide in.

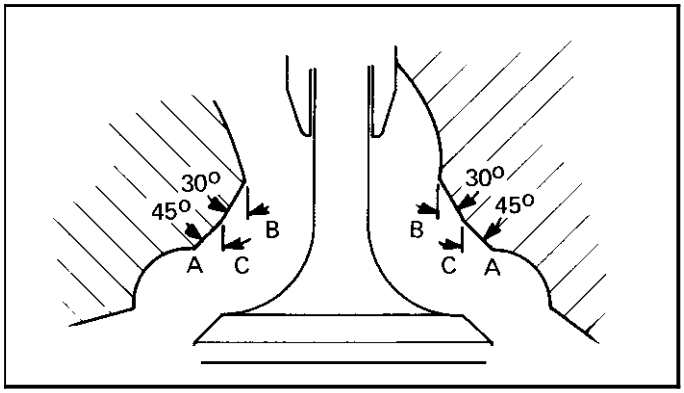
   NOTE: When a valve guide is replaced, the o-ring should also be replaced.

d. After installing the valve guide, use 7mm reamer (special tool) to obtain the proper valve clearance.

After fitting the valve guide into the cylinder head, be sure to grind the valve seat, and perform valve lapping. The valve must be replaced with a new one.

5. Grinding the valve seat

a. The valve seat is subject to severe wear similar to valve face. Whenever the valve face is resurfaced, the valve seat should also be re-surfaced at a 45° angle. In addition, if a new valve guide has been installed (without any valve repair), the valve seat should be checked 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, and when twisting the cutter, keep an even downward pressure to prevent chatter marks.

If cutting section "A" of the intake valve seat, use "FLAT" cutter (radius cutter). If cutting section "A" of the exhaust valve seat, use "FLAT" cutter (also: radiused). If cutting section "B", use the 45° cutter.

b. Measure valve seat width. Apply mechanic's bluing dye (such as Dykem) to the valve face, apply a very small amount of fine grinding compound around the surface of the valve seat, 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 will have removed the bluing wherever it contacted the valve face. Measure the seat width with vernier calipers. It should measure approximately 1.3mm (.05"). Also, the seat should be uniform in contact area. If valve seat width varies, or if pits still exist, then continue to cut with the 45° cutter. Remove just enough material to achieve a satisfactory seat.

	Standard Width	Wear Limit
Seat width	1.3mm (.050")	2.0mm (.080)

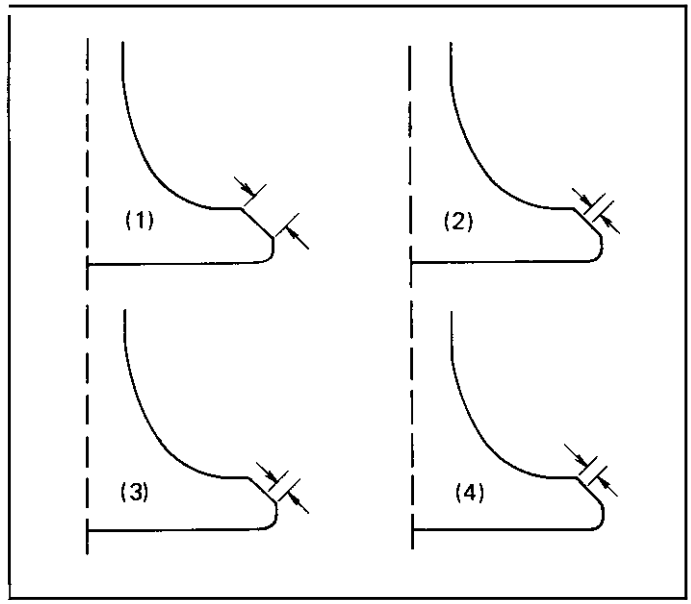
c. If the valve seat is uniform around the perimeter of the valve face, but is too wide or not centered on the valve face, it must be altered. Use either the "FLAT", 45° or **30°** cutters to correct the improper seat location in the manner described below:

1) If the valve face shows that the valve seat is centered on the valve face, but too wide, then lightly use both the "FLAT" and the 30° cutters to reduce the seat width to 1.3mm (.05").

2) If the seat shows to be in the middle of the valve face, but too narrow, use the 45° cutter until the width equals 1.3mm (.05").

3) If the seat is too narrow and right up near the valve margin, then first use the "FLAT" cutter and then the 45° cutter to get the correct seat width.

4) If the seat is too narrow and down near the bottom edge of the valve face, then first use the 30° cutter and then the 45° cutter.



6. Lapping the valve/valve seat assembly

a. The valve/valve seat assembly should be lapped if (1) neither the seat nor the valve face are severely worn, or (2) if the valve face and valve

seat have been re-surfaced and now require a final light grinding operation for perfect sealing.

b. Apply a small amount of coarse lapping compound to valve face. Insert the valve into the head. Rotate the valve until thevalveandvalve 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. Apply bluing dye to the valve face and rotate the valve face for full seat contact which is indicated by a shiny surface all around the valve face where the bluing has been rubbed away.

c. Valve leakage check

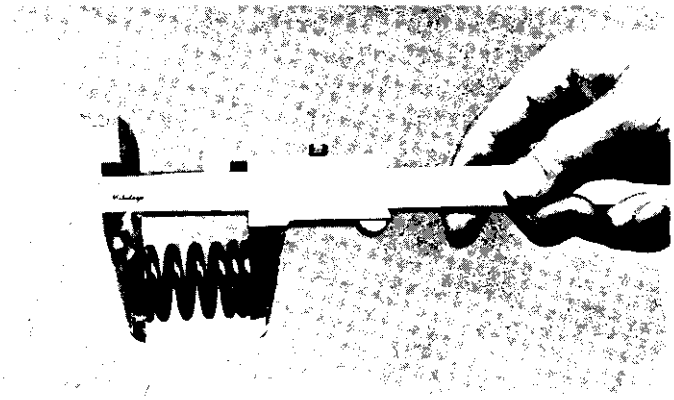
After all work has been performed on the valve and valve seat, and all head parts have been assembled, check for proper valve/valve seat sealing by pouring solvent into each of the intake ports, then the exhaust ports. There should be no leakage past the seat. If fluid leaks, disassemble and continue 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.

D. Valve Spring and Lifters

1. Checking the valve springs

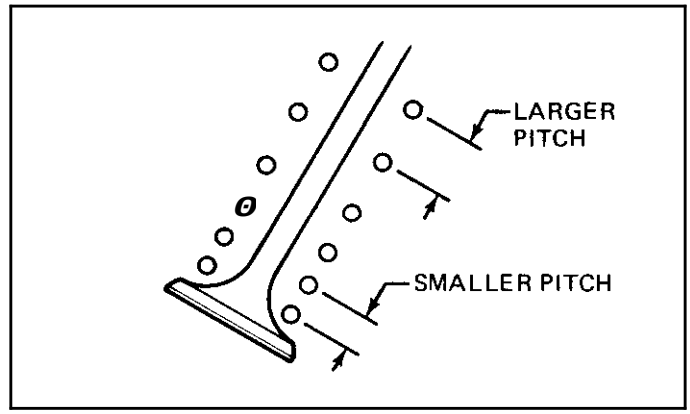
a. This engine uses two springs of different sizes to prevent valve float or surging. The chart below shows the basic value characteristics.

b. Even though the spring is constructed of durable spring steel, it gradually loses some of it's 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 2mm (.080") from its specification, replace it.



c. Another symptom of a fatigued spring is insufficient spring pressure when compressed. This can be checked using a valve spring compression rate gauge. Test each spring individually. Place it in the gauge and compress the spring first to the specified compressed length with the valve closed (all spring specifications can be found in the previous section, Valve Spring), then to the length with the valve open. Note the poundage indicated on the scale at each setting. Use this procedure with the outer springs, then the inner springs.

NOTE: All valve springs must be installed with greater pitch upward as shown.



	OUTER	INNER
Free length	39.9mm (1.571")	35.6mm (1.402")
Installed length (valve closed)	34.5mm (1.358")	31.5mm (1.240")
Installed pressure	16.27~18.73 kg (35.9~41.3 lb)	6.75~8.25 kg (14.9~18.2 lb)
Compressed length (valve open)	26.0mm (1.024")	23.0mm (.908")
Compressed pressure	49.29~56.71 kg (108.7~125 lb)	25.57~29.43 kg. (56.4~64.9 lb)
Allowable tilt from vertical	1.6mm (.063") or 2.5°	

2. Valve lifter

a. Check each valve lifter for scratches or other damage. If the lifter is damaged in any way, the cylinder head surface in which it rides is probably also damaged. If the damage is severe, it may be necessary to replace both the lifter and the cylinder head.

NOTE: For proper valve lifter-to-head clearance, always install lifters on their original valves.

E. Camshafts, Cam Chain and Cam Sprockets

1. Camshaft

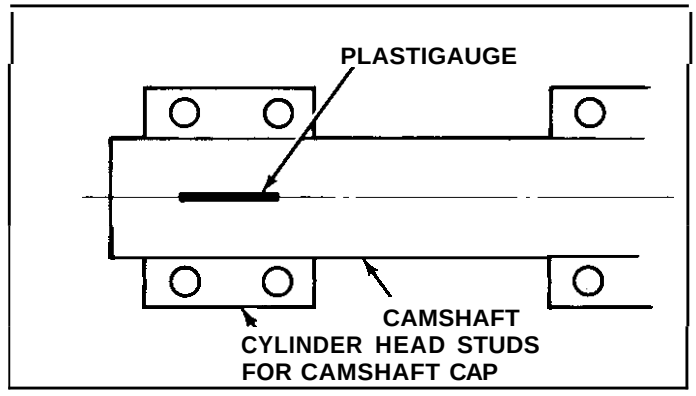
a. The cam lobe metal surface may have a blue discoloration due to excessive friction. The metal surface could also start to flake off or become pitted.

NOTE: The exhaust cam appears darker than the intake cam. This is due to a special hardening process and is not due to excessive enaine heat.

b. If any of the above wear conditions are readily visible, the camshaft should be replaced.

c. 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 a pre-determined amount, valve timing and lift are affected. Replace the camshaft if wear exceeds the limits.

d. Install the camshaft on the cylinder head. Place a strip of Plastigauge between camshaft and camshaft cap as illustrated (lengthwise along camshaft). Tighten the nuts with specified torque. Remove the camshaft cap and determine the clearance by measuring the width of the flattened Plastigauge.



Cap Nut Tightening Torque:
0.8~1.0 m-kg (5.8~7.2 ft-lbs)

NOTE: Do not turn camshaft when measuring clearance with Plastigauge.

Camshaft-to-cap Clearance:
Standard: .020~.054mm (.0008~.0021")
Maximum: 0.160mm (.006")

If camshaft-to-cap clearance exceeds specification, measure camshaft bearing surface diameter.

Bearing Surface Diameter:
Standard:24.97~24.98mm (0.9830~0.9835")

1) If camshaft diameter is less than specification, causing excessive clearance, replace camshaft.

2) If camshaft is within specification and camshaft-to-cap clearance is excessive, replace cylinder head.

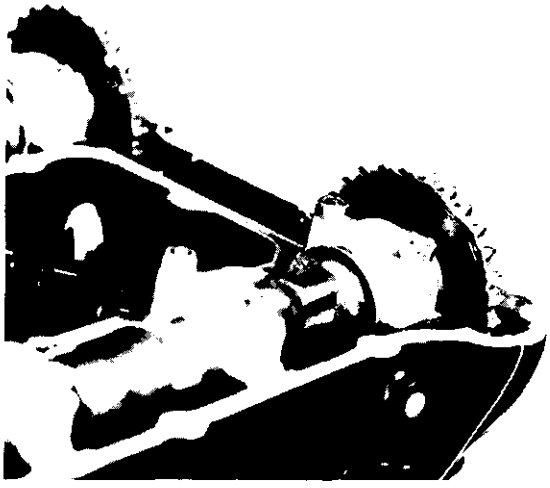
2. Cam Chain

Except in cases of oil starvation, the cam chain wears very little. If the cam chain has stretched excessively and it is difficult to keep the proper cam chain tension, the chain should be replaced.

3. Cam Sprockets

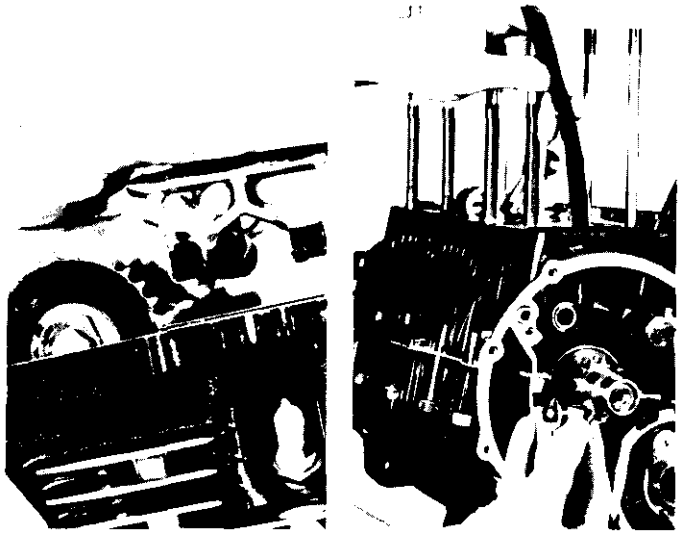
Check cam sprockets for obvious wear. Examine damping rubber on sides of cam sprockets. If the damping rubber is disintegrating, the sprocket should be replaced. Damaged

or disintegrating damping rubber will contaminate the engine oil and will lead *to* excessive engine noise.



4. Cam Chain Dampers

Inspect the top cam chain damper (stopper guide) and two **(2)** vertical (slipper-type) dampers for excessive wear. Any that shows excessive wear should be replaced. Worn dampers may indicate an improperly adjusted or worn-out cam chain.

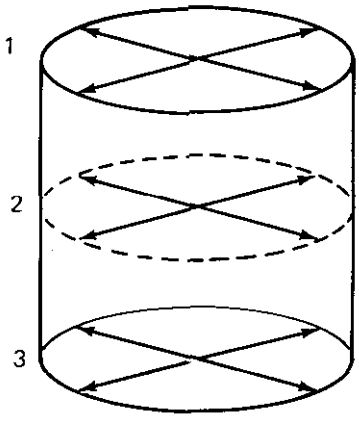


F. Cylinder

1. Inspect 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 as shown. If wear is excessive, compression pressure will decrease. Rebore the cylinder wall and replace the piston and piston rings.

Cylinder wear should be measured at three depths with a cylinder bore gauge. (See illustration.)



	Standard	Wear Limit
Cylinder bore	68.00~68.02mm (2.677~2.678 in.)	68.10mm (2.681 in.)
Cylinder taper	-------	0.05mm (0.002 in.)
Cylinder out-of-round	-------	0.05mm (0.002 in.)

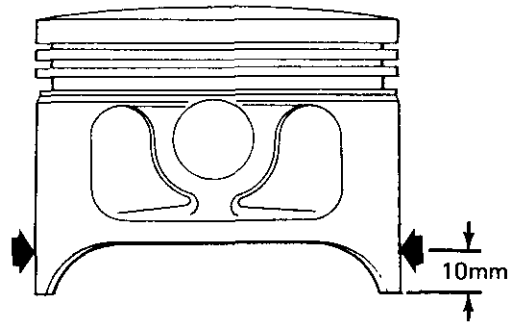
If the cylinder wall is worn more than wear limit, it should be rebored.

G. Piston And Piston Rings

1. Piston

a. Measure the outside diameter of the piston at the piston skirt.

Measurement should be made at a point l0mm in.) above the bottom edge of the piston. Place the micrometer at right angles to the piston pin.



	Size
Standard	**67.96mm** **67.97mm**
Oversize 1	**68.25mm**
Oversize **2**	**68.50mm**
Oversize 3	**68.75mm**
Oversize 4	**69.00mm**

b. Determine piston clearance as follows:

Minimum bore measurement
– Maximum Diston measurement
= Piston clearance

EXAMPLE:

68.02mm
– **67.97mm**
= **.05mm** piston clearance

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

Side clearance	Top	0.04-0.08mm **(0.0016—0.003** in.)
	2nd	0.03-0.07mm (0.001**2—0.0028** in.)

2. Piston Ring

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

Oversize 1	0.25mm
Oversize 2	0.50mm
Oversize 3	0.75mm
Oversize 4	**1.00mm**

b. 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

c. Push the ring into the bore and check end gap clearance with a feeler gauge.

NOTE: The end gap on the expander spacer of the oil control ring is unmeasureable. If the oil control ring rails show excessive gap, all three components should be replaced.

	Standard	Limit
Top/2nd ring	0.2~0.4mm **(.008~.016** in.)	0.80mm **(0.03** in.)
Oil control (Rails)	**0.2~0.9mm** **(0.008~0.035 in.)**	Visual **inspection**

H. Piston Pin

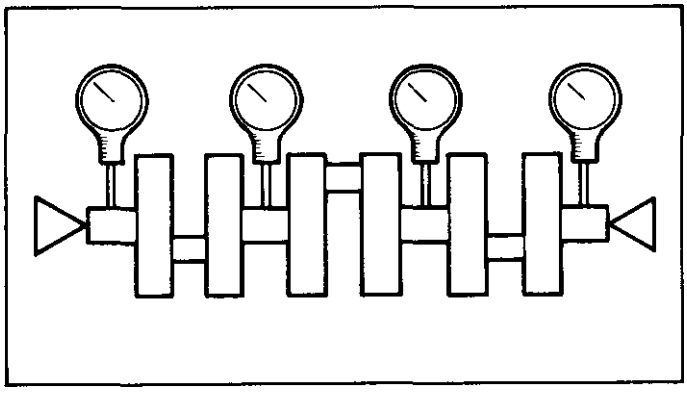
1. Apply a light film of oil to pin. Install in connecting rod small end. Check for play. There should be no noticeable vertical play. If play exists, check connecting rod small end for wear. Replace pin and connecting rod as required.

2. The piston pin should have no noticeable free play in piston. If the piston pin is loose, replace the pin andlor the piston.

I. Crankshaft

1. Crankshaft Run-Out

Support the crankshaft at both ends on V-blocks. Measure the amount of crankshaft run-out on the main bearing journals with a dial gauge while rotating crankshaft.



Run-out limit: .03mm (.001 in.)

If run-out exceeds limit, replace crank.

2. Inspection Of Inserts

Check the bearing inserts. If the inner orouter surface is burned, flaked, rough, scratched or worn, the insert should be replaced.

3. Measuring Main Bearing Oil Clearance

a. Clean all crankshaft and crankcase journal surfaces.

b. Place upper crankcase half upside-down on a bench. Install bearing inserts into top crankcase.

c. Install crankshaft into upper crankcase.

d. Place Plastigauge on crankshaft journal surface to be inspected.

NOTE: Do not move crankshaft until clearance check has been completed.

e. Install bearings inserts into bottom crankcase. Carefully, place lower crankcase onto upper crankcase.

f. Install crankcase holding bolts 1 through 10. Tighten to full torque in torque sequence cast on crankcase.

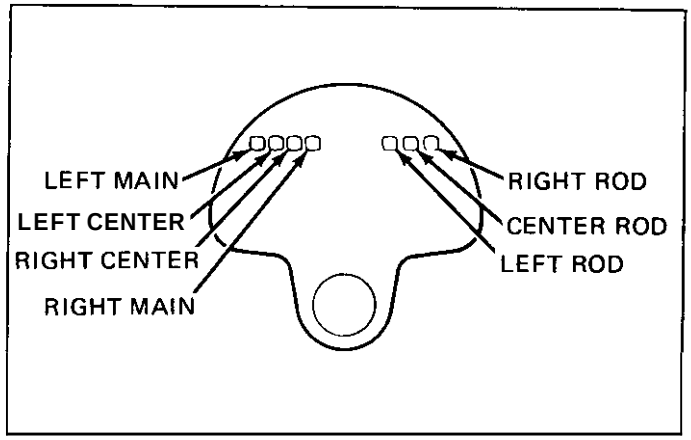
g. Remove bolts in reverse assembly order (10,9,8.. . . .etc.)

h. Carefully remove lower crankcase. Measure width of Plastigauge on crankshaft journals to determine clearance.

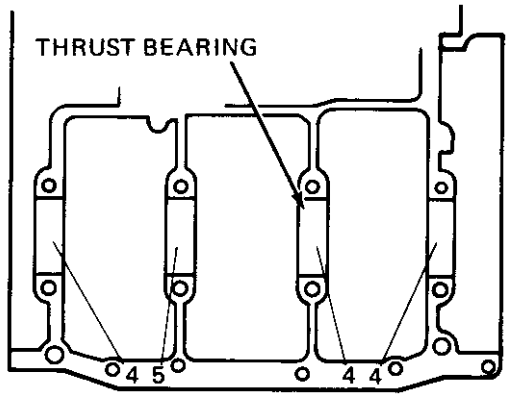
Main bearing oil clearance:
.022~.044mm
(.0008~.0017 in.)

4. Crankshaft Main Bearing Selection

a. Numbers used to indicate crankshaft journal sizes are stamped on the L.H. crank web. The first four (4) are main bearingjournal numbers, starting with the left journal and proceding to left center, right center, and right. The three **(3)** rod bearing journal numbers follow in the same sequence.



b. Each main bearing journal is numbered 1, 2 or **3.** Each crankcase bearing housing is numbered 4, 5 or 6. The proper insert selection is made by subtracting the crankcase number from the crankshaft journal number. The result is the insert size (number).



TOP CRANKCASE

Use the color code table to choose the proper insert.

INSERT COLOR CODE

No. 1	Blue
No. 2	Black
No. **3**	Brown
No. 4	Green
No. 5	Yellow

EXAMPLE:

Case No. (Minus) Journal No. = Insert No.

4 – 2

No. 2 insert is Black. Use a black main bearing insert.

NOTE: There is a special thrust bearing (insert) located in the No. 3 main bearing housing in the upper crankcase. The function of this insert is to provide a bearing surface for crankshaft side thrust.

c. When assembling, apply a liberal coat of motor oil to all bearing surfaces.

d. Observe normal crankcase holding bolt torque sequence.

J. Connecting Rod

1. Remove rod cap securing nuts, rod cap and inserts.

2. Inspection

a. Examine bearing inserts for scratches, flaking or other obvious signs of wear or damage. If the inner or outer surfaces are worn or damaged, the inserts should be replaced.

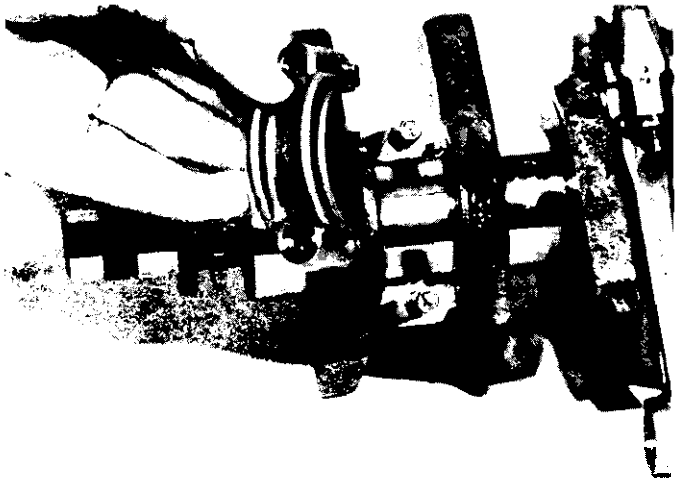
b. Examine the connecting rods and crankshaft.

3. Measure Rod Bearing Clearance

Measurement of rod bearing clearance is similar to main bearing clearance measurement.

a. Clean all bearing surfaces.

b. Place a piece of Plastigauge on connecting rod cap. Place cap on crankshaft journal. Do not allow the cap to move. Install special bolts and apply molybdenum grease to the threads. Install rod cap and nuts. Tighten rod caps evenly to specified torque:



Rod cap torque: 3.8 kg-m (27 ft-lbs)

c. Remove connecting rod and cap. Measure width of Plastigauge to determine oil clearance.

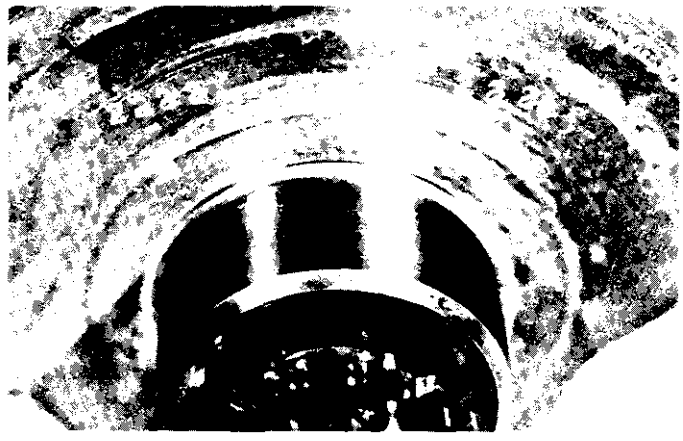
Oil clearance (rod):
.032~.054mm (.001~.002 in.)

d. Remove Plastigauge from bearing surfaces.

4. Selecting Rod Bearing Inserts

a. Connecting rod size numbers are indicated by 4. 5 or 6 and are marked in ink on the connecting rods and caps.

b. The rod bearing journal size numbers are indicated by 1, 2 or 3 and are stamped on the left end of the crankshaft,



c. The proper insert selection is made by subtracting the rod size number from the crankshaft journal number. Use the color code to choose the proper insert.

Rod No. (Minus)		Journal No.	=	Insert No.
5	–	**2**	=	3

No. 3 insert is Brown. Use brown bearing inserts.

EXAMPLE:

INSERT COLOR CODE

No. 1	Blue
No. 2	Black
No. 3	Brown
No. 4	Green
No. 5	Yellow

d. When assembling, apply a liberal coat of motor oil to all bearing surfaces.

NOTE: When applying final torque to the rod caos. Observe the following procedures:

Apply molybdenum disulfide grease to connecting rod bolt threads. Apply torque evenly to both ends of the cap. While tightening, if a torque of 3.3 m-kg (24 ft-lbs) or more is reached, DO NOT STOP tightening until final torque is reached. If tightening is interrupted between 3.3 m-kg and 3.8 m-kg, loosen the nut to less than 3.3 m-kg and start again. Tighten to full torque specification without pausing.

K. OIL PUMP

1. Check the clearance between housing and outer rotor.

Standard clearance:
0.09~0.015mm
(0.0035~0.0059 in.)

2. Check the clearance between outer rotor and inner rotor.

Standard clearance:
0.03~0.09mm
(0.0011~0.0035 in.)

3. Remove the relief valve and check valve plungers from oil pump assembly. Check the plungers for scratches and wear.

L. PRIMARY DRIVE

1. "Hy-Vo" Chain And Primary Gears

The "Hy-Vo" primary chain is a plate-and-pin type that does not use rollers as in the case *of* a conventional motorcycle drive chain. The plates of the chain form a mating surface for the primary gear teeth. That is, the primary gears actually mesh with the chain plates. This chain is extremely durable and, under normal conditions, can be expected to last the life of the motorcycle engine. However, if obvious damage is caused through serious oil starvation or abrasive oil contamination, the chain should be replaced.

2. Clutch Damper

a Remove circlip using a press and special tool. Press tool on collar no more than necessary to remove circlip. Damper springs may be damaged if excessive pressure is applied.

b. Inspect damper cam and pin surfaces. Check for smooth cam action (as illustrated by arrows). Check for excessive wear on cam and pin surfaces. If operation is not smooth or cam surfaces are severely worn, replace damper assembly.

c. Inspect plate washer and thrust bearing for wear or damage. Replace as necessary.