YAMAHA

9.90

XS1 (1970) XS1B (1971) XS2 (1972)

TX650 (1973) TX650A (1974)

COMBINED

Service Manual

LIT 11613-06-01

NOTICE

This manual has been written by Yamaha Motor Company for use by Authorized Yamaha Dealers and their qualified mechanics. In light of this purpose it has been assumed that certain basic mechanical precepts and procedures inherent to our product are already known and understood by the reader.

Without such basic knowledge, repairs or service to this model may render the machine unsafe, and for this reason we must advise that all repairs and/or service be performed by an Authorized Yamaha Dealer who is in possession of the requisite basic product knowledge.

Other information is produced by the U.S. distributor, Yamaha International Corporation, and is necessary to provide total technical coverage regarding the product.

The Research, Engineering, and Service Department of Yamaha are continually striving to further improve all models manufactured by the company. Modifications are therefore inevitable and changes in specifications or procedures will be forwarded to all Authorized Yamaha Dealers and will, where applicable, appear in future editions of this manual.

YAMAHA 650 SERIES SERVICE MANUAL

1st EDITION JUNE 1972
2nd REVISED EDITION OCTOBER 1972
3rd REVISED EDITION DECEMBER 1973
4th REVISED EDITION AUGUST 1974

2nd PRINTING APRIL 1975
3rd PRINTING JANUARY 1976
4th PRINTING OCTOBER 1976

LIT - 11613-06-01

FOREWORD

This service manual has been designed to furnish all dealers and service personnel with specific information concerning this series, including disassembly and assembly procedures, inspection and analyzation of worn parts, and subsequent repair or adjustment procedures.

The manual should be thoroughly read. This will provide full familiarity with the design of this machine and all correct repair procedures.

Because Yamaha engineers are constantly searching for new and more efficient engine advancements, it is possible that some of this information may be modified in the future. Any significant change in design, adjustments, or repair procedures will be forwarded to all Authorized Yamaha dealers.

CONTENTS

APPENDICES

GENERAL SPECIFICATIONS XS1–XS1B

(See page 121 for XS2-TX650, page 158 for TX650A)

Dimensions:	
Overall Length	85.4 in (2170 mm)
Overall Width	35.6 in (905 mm)
Overall Height	45.3 in (1150 mm)
Wheelbase	55.5 in (1410 mm)
Min. Ground Clearance	5.9 in (150 mm)
Weight (Net)	**XS1B-409 lbs. (XS1-439 lbs.)**
Weight Distribution	**XS1B-Front 182, Rear 227 lbs. (XS1-Front 195, Rear 244 lbs.)**
Performance:	
Max. Speed	**110 + mph**
Fuel Consumption (on paved level road)	82.5 mpg at 37 mph (35 km/l at 60 km/h)
Climbing Ability	26 degrees
Minimum Turning Radius	98.4 in (2500 mm)
Braking Distance	46 ft. at 31 mph (14 m at 50 km/h)
Engine:	
Weight (Dry)	135 lbs.
Type	Twin cylinder Air-cooled 4 stroke W/S.O.H.C.
Lubrication System	Pressure lubricated, wet sump.
Bore and Stroke	75x74 mm (2.953x2.913 in.)
Displacement	39.8 cu.in. (653 cc)
Compression Ratio	8.7 : 1 **(8.4:1 XS1B E/N 23129~)**
Compression Pressure	145 lbs/in^2 **(AVE)**
Maximum Power	53 BHP/7000 rpm
Maximum Torque	40.1 ft-lbs/6000 rpm (5.5 kg-m/6000 rpm)
Cylinder Description	Twin parallel cylinders, aluminum with cast iron sleeves.
Camshaft Timing	Intake BTDC 47° (Open) ABDC 67° (Close) Exhaust BBDC 60° (Open) ATDC 41° (Close)
Valve Clearance (cold)	**IN: .076 mm (.003 in.)** **EX: 0.15 mm (.006 in.)**
Sump Capacity	3.2 Qt. (3.0 L)
Ignition Timing (fully retarded)	**13°– 17° B.T.D.C. (40° BTDC Fully advanced ±2°)**
Piston Clearance	0.002–0.0022" (0.050–0.055 mm)
Starting System	Kick Starter
Carburetor:	
Type	**BS38 x 2**
Manufacturer	**MIKUNI**
Venturi Size	**30.6 mm diameter**
Main Jet	**#130**
Needle Jet	**Z-6**
Pilot Fuel Jet	**42.6**
Starter Jet	**0.6**
Jet Needle	**4JN19 – 4th Stage**
Fuel Valve Seat	**2.5**
Float Level	**25 mm**
Air Screw	**1 turn out**
I. D. Mark	**E3**
Pilot Outlet	**0.7 ϕ**
Pilot Bypass #1	**0.8 ϕ**
Pilot Bypass #2	**1.0 ϕ**
Air Jet	**1.2 ϕ**
Cutaway	**–**
Air Vent	**4.0 ϕ**

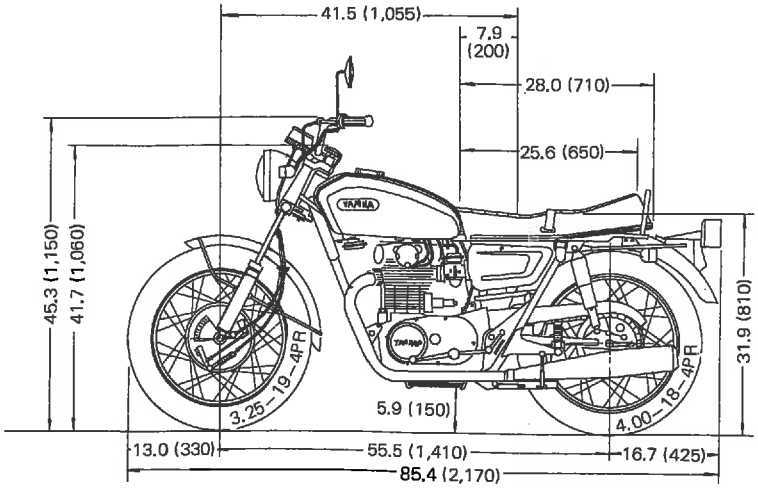
2 GENERAL SPECIFICATIONS

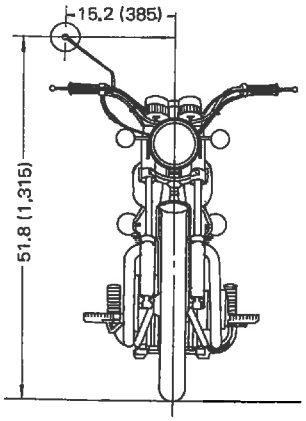
Air Filter:	**Dry, paper filter X2**	
Clutch:		
Type	Wet, multi-disc. (6 friction + 5 metal plates.)	
Primary Drive: Type:	Spur gear (straight cut)	
Reduction Ratio (gear and total)	72/27 (2.667 : 1)	
Transmission: Type:	Constant mesh, five speed, wide-ratio	
1st	31/14 = 2.214 (5.904)	Internal engine ratio (Pri. x Trans.) Multiply by drive chain ratio for overall gearing
2nd	27/17 = 1.588 (4.235)	
3rd	26/20 = 1.300 (3.466)	
4th	23/21 = 1.095 (2.920)	
5th	22/23 = 0.956 (2.550)	
Oil	SAE 20W/40	
Secondary Reduction System:		
Type	Single Row Chain	
Secondary Reduction Ratio:	34/17 = 2.0 : 1	
Chassis:		
Frame Type	Tubular steel, double cradle type	
Fuel Tank Capacity	3.3 U.S. gals. (12.5 L)	
Suspension System, Rear	**Swing Arm w/oil damped, adjustable shocks**	
Fork Travel	130 mm	
Fork Oil Quantity (each)	**223cc (7.5 oz.)**	
Caster	63°	
Trail	98 mm (3.9 in.)	
Front Rim Size	1.85B x 19	
Spoke Diameter, Length & Number	Inner 3.5ϕ x 160.5 mm. Outer 3.5 x 160 mm.	
Front Tire		
Size	3.25 - 19 4PR	
Tread design	K70	
Inflation pressure	23 - 25 lbs/in^2	
Rear Rim Size	2.15B x 18	
Spoke Diameter, Length & Number	Inner 4ϕ x 152.0 mm. Outer 4ϕ x 151.5 mm.	
Rear Tire		
Size	4.00 - 18 4PR	
Tread design	K70	
Inflation Pressure	28 - 30 lbs/in^2	
Front Brake Type	Internal expansion, double leading shoe	
Diameter & width	200 mm x 35 mm (7.9 in. x 1.38 in.)	
Rear Brake Type	Internal expansion, single leading shoe	
Diameter & width	180 mm x 30 mm (7.1 in. x 1.18 in.)	
Generator:		
Type	Alternator	
Model	LD 115	
Manufacturer	HITACHI	

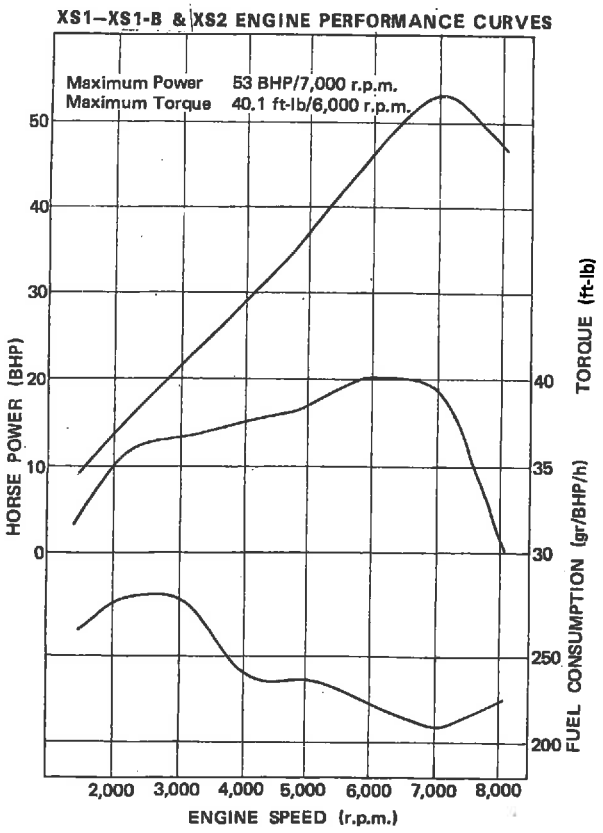
Rectifier:		
Model		SD6D-9
Manufacturer		HITACHI
Regulator:		
Model		TLIZ - 49
Manufacturer		HITACHI
No load voltage rate		14.5 volt/2000 RPM
Ignition System:		
Type		Battery ignition
Ignition Timing (fully retarded)		13° – 17° BTDC (Fully retarded) (40° ± 2° BTDC Fully advanced)
Breaker Point Gap		0.30–0.40 mm (0.012–0.016 in.)
Spark Plug	Manufacturer	N.G.K.
	Heat Range	B-8ES
Ignition Coil	Manufacturer	HITACHI
	Voltage output	10kV. @4,000 RPM
Battery:		
Model		12N 5.5-3B
Manufacturer		G.S.
Capacity		12V 5.5 A.H.
Dimensions		5.36 x 2.36 x 5.16" (134 mm x 59 mm x 129 mm)
Lighting System:		
Headlight		- 12V - 50W/40W
Taillight		12V/8W
Stoplight		12V/23W
Neutral Light		12V/3W
Flasher Indicator Light		12V/3W
Flasher Light		12V/27W
High Beam Indicator		12V/2W
Speedometer Light		12V/3W
Tachometer Light		12V/3W

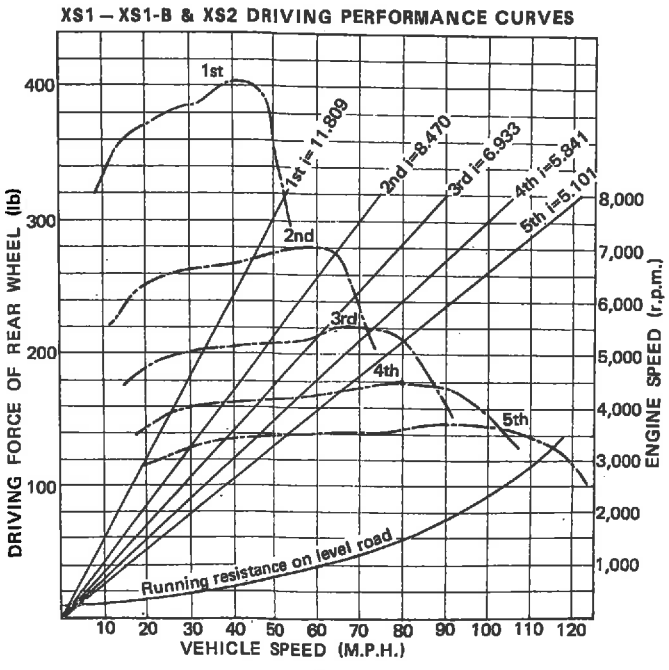
EXTERNAL VIEWS

(Dimensions typical – may vary slightly model to model.)



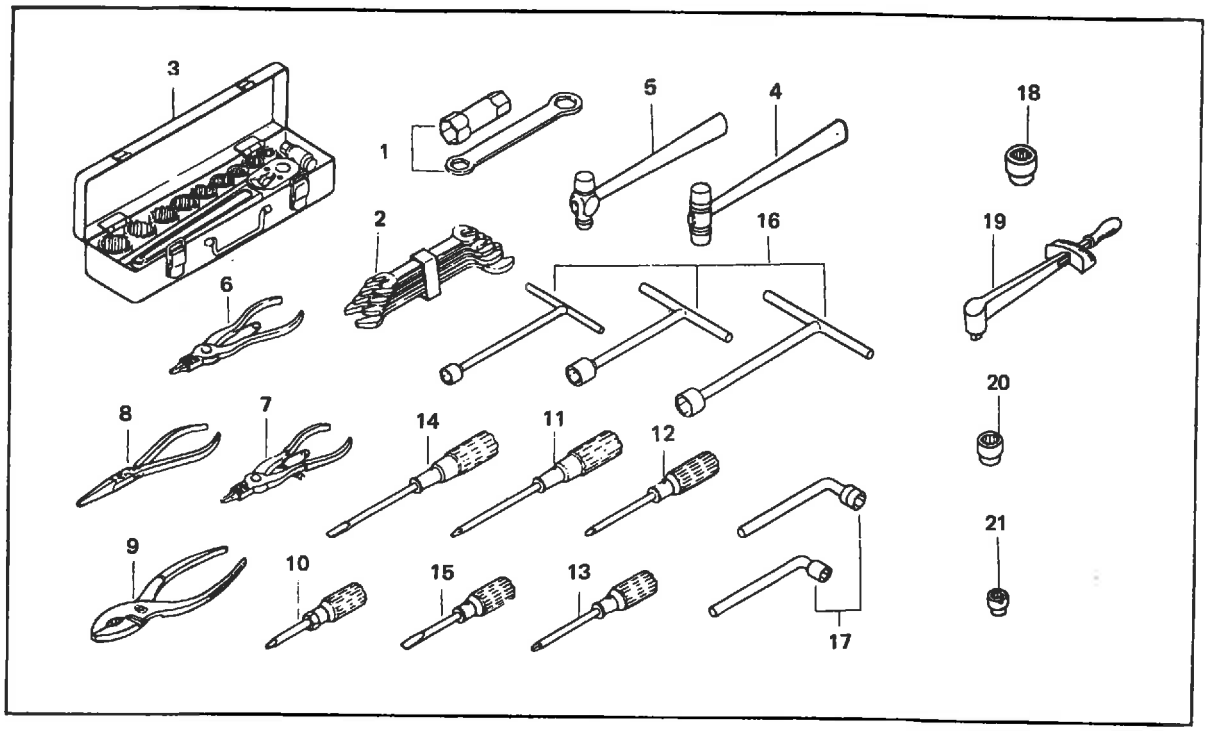






SERVICE TOOLS

1. Standard Tools



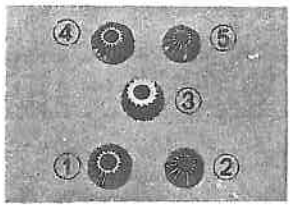
1. Plug wrench
2. Open-end wrenches
3. Socket wrenches
4. Soft-faced hammer
5. Steel hammer
6. Circlip pliers ST type
7. Circlip pliers RT type
8. Needle nose pliers
9. Pliers
10. Phillips-head screwdriver
11. Phillips-head screwdriver (Large)
12. Phillips-head screwdriver (Medium)
13. Phillips-head screwdriver (Small)
14. Slot-head screwdriver (Medium)
15. Slot-head screwdriver (Small)
16. T-type socket wrench
17. Socket wrench
18. Socket wrench (29mm)
19. Torque wrench
20. 13mm Socket (for Torque wrench)
21. 10mm Socket (for Torque wrench)

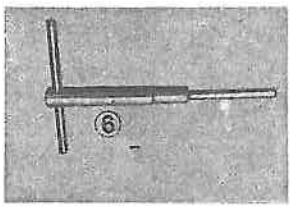
In addition to the above tools, the YAMAHA electrotester, tachometer (engine speedometer) and battery specific gravity hydrometer.

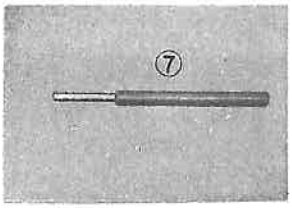
2. Miscellaneous Tools

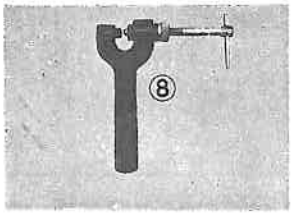
1. Grease
2. YAMAHA Gear oil
3. YAMAHA Bond (No. 5)
4. Wiping materials
5. Overhauling stand
6. Parts tray
7. Oil drain pan
8. Oil cup
9. YAMAHA (Bond No. 4)

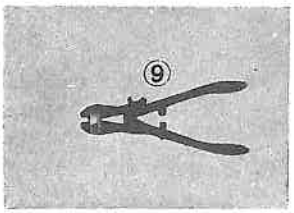
3) Special Tools

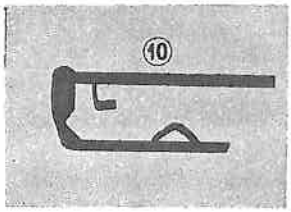


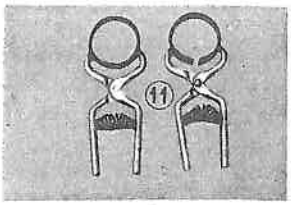


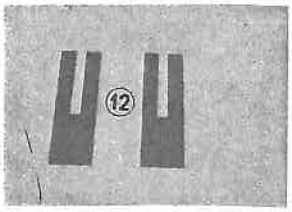


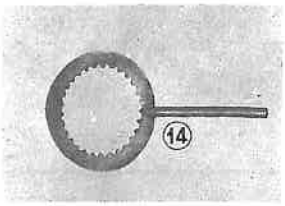


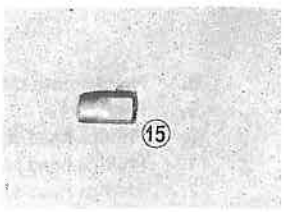












Valve seat cutters:

1. 45°–40mm dia. (intake)
2. 45°–34mm dia. (exhaust)
3. 65°–42mm dia. (exhaust/intake)
4. Radius–intake
5. Radius–exhaust
6. Seat Cutter Pilot 8.0mm
7. Valve Guide Installation and Removal Tool
8. Cam Chain Link Cutter
9. Cam Chain Link Riveter
10. Valve Spring Compressor
11. Piston Ring Compressors
12. Piston Support Plates
13. Armature Puller
14. Clutch Holding Tool
15. Fork Tube Adaptor (For DS3 Type Tool / XS1-XS1B)

MAINTENANCE & LUBRICATION CHARTS

Interval recommendations and lubricant types listed in the Maintenance and Lubrication Charts are based upon general averages. Extremes in environment or usage may dictate shorter maintenance intervals, different lubricants, or shorter lubrication intervals.

Therefore, all recommendations regarding types and intervals are to be considered a guide only. Intervals should not be exceeded but may be shortened as required. Lubricant types may be up-graded, but never down-graded.

PERIODIC MAINTENANCE INTERVALS

Page	Item		Remarks	Initial				Thereafter Every	
				250	500	1000	2000	1000	2000
89	Brake system (complete)	ALSO PREOPERATION CHECK	Check/Adj. as req'd. - repair as req'd.		0	0	0		0
65	Clutch		Check/Adjust as required		0	0	0		0
99	Battery		Top-off/Chk. spec. gravity monthly, or →	0		0		0	
114	Spark Plug(s)		Inspect/Clean or replace as req'd.	0	0	0	0		0
87	Wheels & Tires		Pressure/Spoke Tension/Runout	0	0	0		0	
79	Fittings & Fasteners		Tighten before each trip and/or →	0	0	0		0	
97	Drive Chain		Tension/Alignment ②	0	0	0		0	
10	Engine Oil Level Check		Unit level-Engine warm	0	0	0		0	
–	Air Filter		Foam type - See Service Notes ①	0	0	0		0	
78	Air Filter(s)		Dry type - Clean/Replace as req'd.			0	0		0
66	Fuel Petcock(s)		Clean/Flush tank as req'd.	0		0	0		0
115	Ignition Timing		Adjust/Clean or replace pts. as req'd.		0	0	0		0
77	Carburetor Adjustment		Check operation, synch., fittings		0	0	0		0
75	Carburetor Overhaul		Clean/Repair as req'd.						4,000
64	Cylinder Compression		Preventive Maintenance Check	0	0	0	0		0
25	Decarbonize Engine		As Required (Includes Exhaust System)				0		4,000
32	Camshaft Drive Chain		Adjust tension	0		0	0		0
45	Primary Oil Filter(s)		Clean/Replace as required	0		0	0		0
44	Oil Filter System (Complete)		Clean All - Includes traps, etc.				0		4,000
31	Valves		Adjust/Regrind as required			0	0		0

SERVICE NOTES:

1. Foam element air filters must be damp with oil at all times to function properly. Remove, clean and oil filter at least once per month or every 500-1,000 miles; more often if possible. See "Lubrication Intervals" for additional details.

   Note: If unit is subjected to extremely hard usage, such as dirt riding, etc., clean and lube filter.

2. Drive chain must also be lubricated every 200-250 miles. If unit is subjected to extremely hard usage, such as racing or dirt riding, chain tension, alignment, lubrication and cleanliness must be checked constantly. See "Lubrication Intervals" for additional details.

LUBRICATION CHART

Page	Item		Remarks	Type	Initial				Thereafter Every		
					250	500	1000	2000	1000	2000	4000
10	Engine Oil	PREOP. CHECK	Warm engine before draining	#1	0		0	0		0	
98	Drive Chain		Lube/Adjust as req'd.	#2			See			Notes	
98	Drive Chain		Remove/clean/lube/adjust	#2				0		0	
–	Air Filter		Foam type	#9			See			Notes	
–	Control & Meter Cables		All - apply thoroughly	#3		0	0			0	
–	Throttle Grip & Housing		Light Application	#4			0			0	
–	Tach & Speedo Gear Hsgs.		Light Application	#4				0			0
–	Rear Arm Pivot Shaft		Apply until grease shows	#5			0			0	
–	Brake Pedal Shaft		Light Application	#4			0			0	
–	Change Pedal Shaft		Light Application	#4			0			0	
–	Stand Shaft Pivot(s)		Light Application	#4			0			0	
85	Front Forks		Drain comp./chk. specs.	#2		chk		0			0
–	Steering Ball Races		Inspect thoroughly/med. pack	#6				0			0
111	Point Cam Lubr. Wick		Very light application	#7			0				0
130	Hyd. Brake Fluid Res.		See Notes	#8	chk		chk		chk		
88	Wheel Bearings		Do not over-pack	#6				0			0

1. For average operation at ambient temperatures of 30-90°F. use Yamalube 4-cycle or SAE 20W-40 type "SE" motor oil.
2. Use SAE 10W-30 type "SE" motor oil. (If desired, specialty type lubricants of quality manufacture may be used.)

   Note: Drive chain must be lubricated every 200-250 miles. If unit is subjected to extremely hard usage, chain must be inspected constantly and serviced as required.
3. Use SAE 10W-30 type "SE" motor oil. (If desired, or at ambient temperatures below 30°F., a graphite base "dry" lubricant of quality manufacture may be used.)
4. Light duty: Lithium soap base (white) grease. Heavy duty: Standard 90 wt. lube grease. (Do not use lube grease on throttle/throttle housing.)
5. Use standard lube grease — smooth, not coarse.
6. Medium-weight wheel bearing grease of quality manufacture – preferably waterproof.
7. Light-weight machine oil.
8. Change yearly or 8,000 miles. Use quality manufacture corresponding to D.O.T. #3 specifications. Keep clean. Do not allow water, etc., to contaminate. Do not mix types when adding.
9. Use SAE 10W-30. Must be damp with oil at all times to function properly. Always clean before oiling. Apply oil moderately, do not over-oil. Clean and oil monthly or every 500-1,000 miles; more often if possible. If unit is subjected to extremely hard usage, such as dirt riding, etc., clean and lube filter daily.

FEATURES

I. ENGINE

A. Valve and Camshaft Mechanism
The use of a single overhead camshaft is beneficial in two ways: First, it contacts the rocker arm in a more positive manner than standard push rod valve arrangements, which allows the engine to rev higher. Secondly, there are less moving parts to wear. Also, the overhead camshaft is driven by a long-lasting single row endless chain that is directly connected to the crankshaft.

B. Twin, Constant Vacuum Carburetors
The throttle slide in this type carburetor is raised by engine vacuum, not a cable. The amount of vacuum to the carburetor is controlled by a butterfly valve in the carburetor venturi.

C. Trochoidal Oil Pump
The XS650 used a rotary valve type oil pump. It is operated by a set of gears which connect the pump directly to the crankshaft. This means that oil is pumped under constant pressure to the engine at all times.

D. Five Speed Transmission
The wide ratio five speed synchromesh transmission permits full usage of engine power under all conditions.

II. FRAME

A. Design
The frame incorporates the double down tube, full-cradle type design which provides strength for proper engine support and rigidity to prevent flexing.

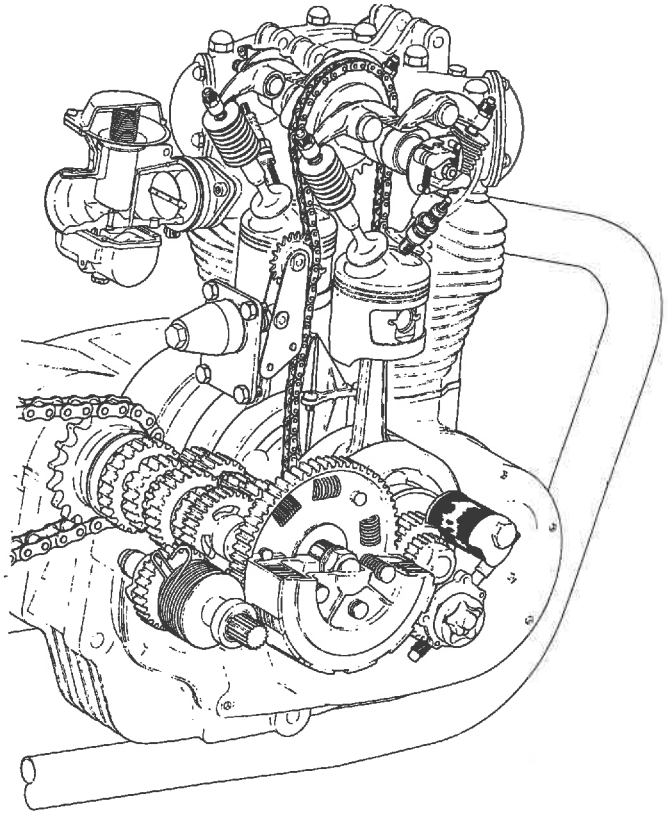
B. Brakes
The front wheel is fitted with a double leading shoe with 200 sq. in. of braking surface. The hub also has a fully functional air scoop for cooling. (XSI-XSIB)

PRE-OPERATION CHECK CHART

Item	Routine	Page
BRAKES	Check Operation/Adjustment/Hyd. Reservoir (XS2-TX650)	125
CLUTCH	Check Operation/Lever Adjustment	65
ENGINE OIL	Top-off as required	64
DRIVE CHAIN	Check Alignment/Adjustment/Lubrication	97
BATTERY	Check Electolyte Level Weekly/Top-off Monthly	99
SPARK PLUG(S)	After Break-In, Check Color/Cond'n. Weekly/1,000 mi.	114
AIR FILTER(S)	Dry Type - Must be clean	78
WHEELS & TIRES	Check Pressure/Runout/Spoke tightness/Axle nuts	87
FITTINGS/FASTENERS	Check All - Tighten as necessary	SEE TORQUE TABLE
LIGHTS/SIGNALS	Check Headlight/Tail-stop lights/Turn signals, etc.	117

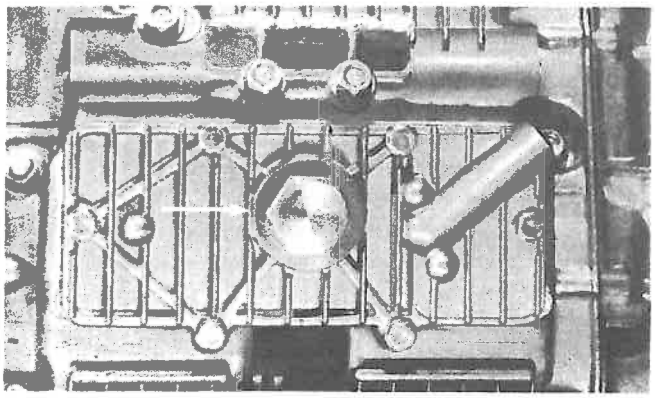
Preoperation checks should be made each time the machine is used. Such an inspection can be thoroughly accomplished in a very short time; and the added safety it assures is more than worth the time involved.

CHAPTER 1. ENGINE

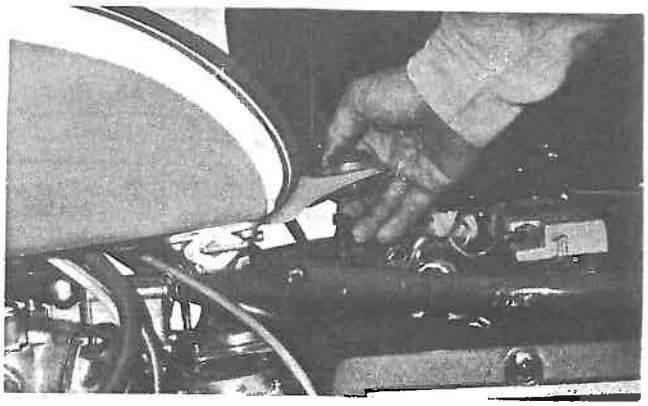


A) Removing Engine from Frame

1) Drain the oil. Two drain plugs in the bottom of the crankcase must be removed to entirely drain both the engine and the transmission.
Refill: 3.2 qts. Yamalube 4-cycle or SAE 20W/40 "SE"

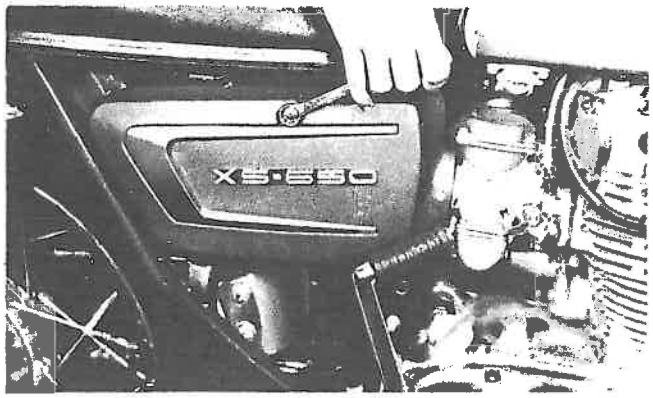


2) Shut off both fuel petcocks and disconnect the fuel crossover tube. Lift the seat.
Lift the rear of the tank to clear the mounting bushing from the anchor pin, then slide the tank back to free it from the front tank mounts.

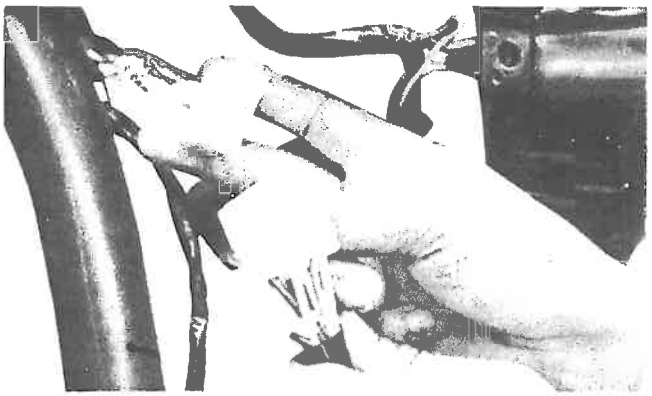


3) Remove both frame side covers.

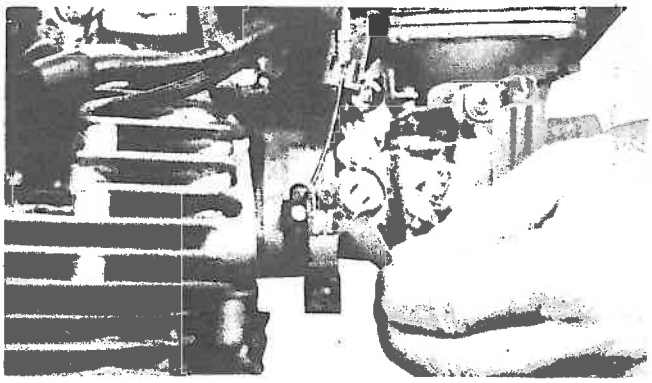
NOTE: The cover is secured by a 13 mm bolt. Under the head are a flat washer, spring washer, and flat washer. Reinstall in the same order.



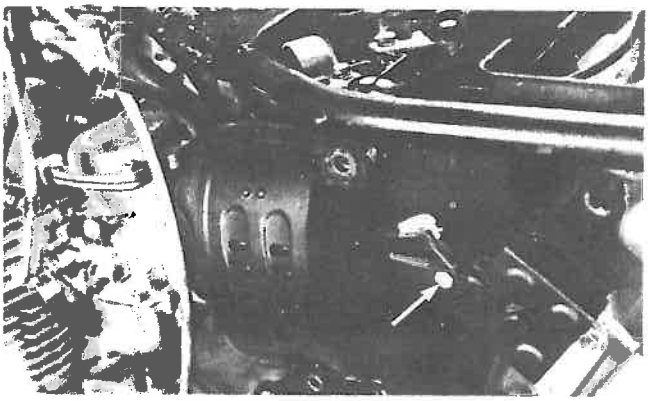
4) Disconnect the alternator wire loom at the multiple connector. It is located just behind the air filter housing.



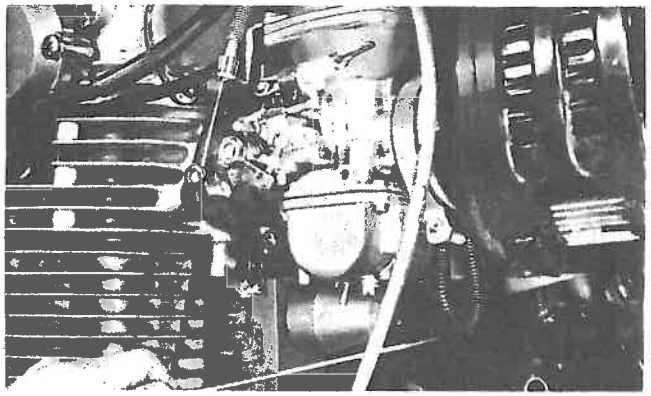
5) Remove the throttle cable from each carburetor.



6) Disconnect the air cleaner mounting bolts: one on top, under the seat, one on the side cover.



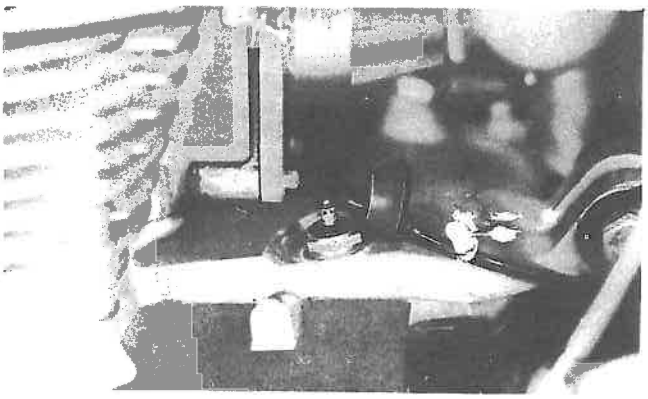
7) Disconnect the fuel balance tube (#2) between the carburetor float bowls. Pay strict attention to the linkage between the carburetor starter levers so that it is not damaged during removal. Loosen screw #1 and remove the left carburetor (with air cleaner attached). Repeat this procedure for the right carburetor.



#1 Carb. Tightening Screw
#2 Fuel Balance Tube

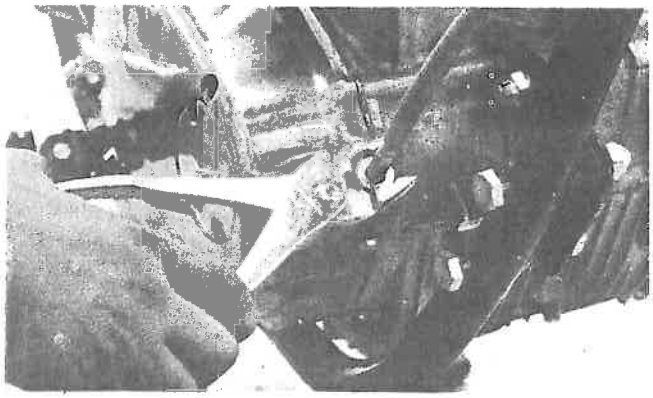
8) Disconnect the engine breather tube which is located above and between the carburetors.

9) Remove the neutral light lead on top of the engine.

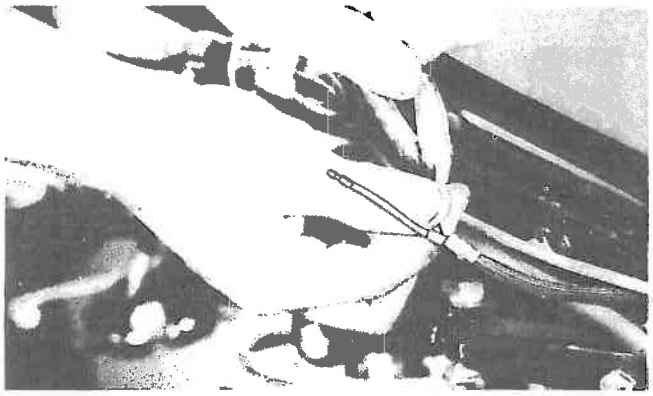


10) Remove both spark plug high tension leads.

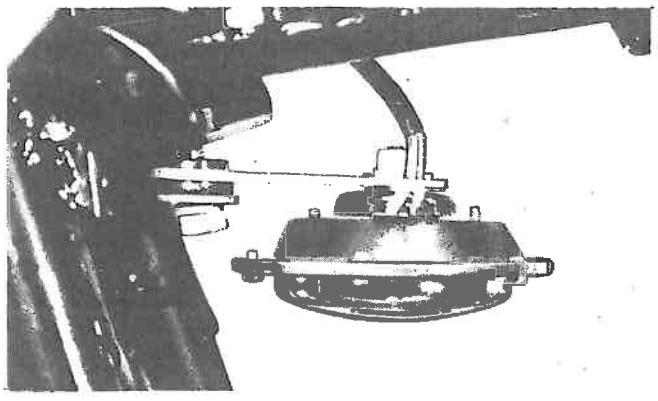
11) Remove the tachometer cable from the engine right front side.



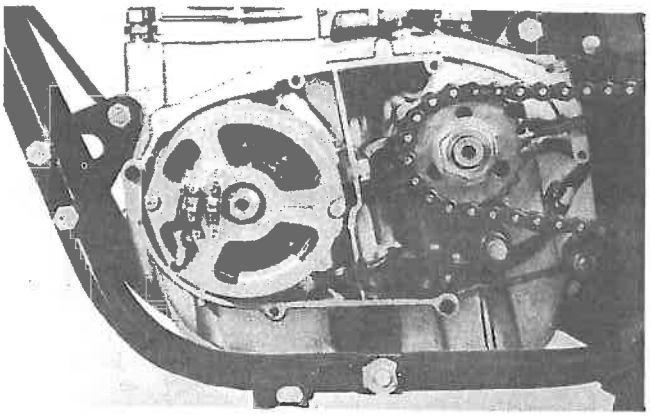
12) Disconnect the point wires at the condenser and ignition switch multiple connectors. (under tank)



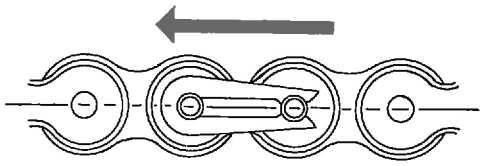
13) Remove the horn. It is located directly behind the steering head and below the secondary ignition coil. When removing this part, it is easiest to take off the horn and bracket as a unit.



14) Remove the left-hand engine case cover. This eases drive chain removal and installation



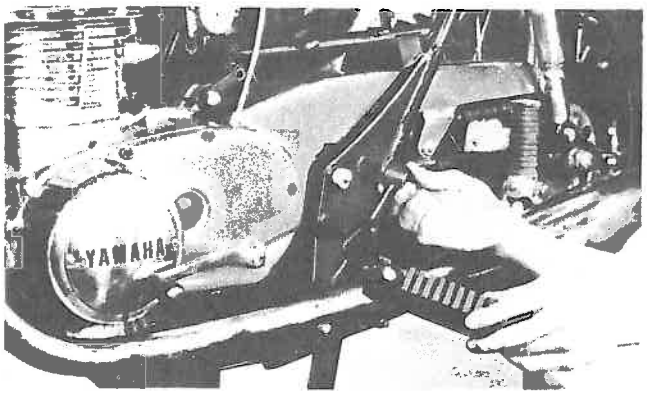
15) Remove the drive chain. During assembly be sure to position the master link retaining clip so it faces the direction of chain travel.



Direction of Travel

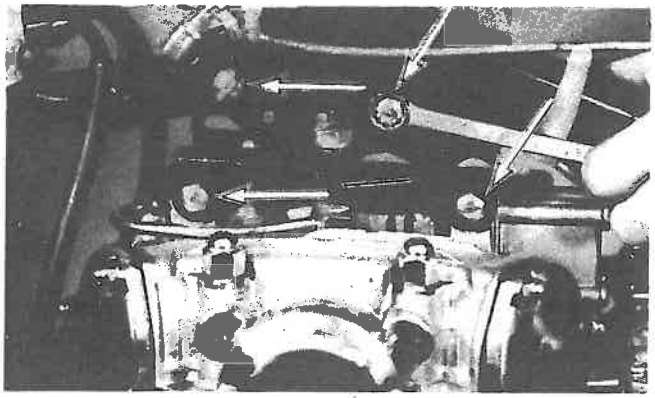
Master Link Clip Position

16) Remove the left foot peg. It is mounted over two rubber bushings. These bushings will come off with the foot peg. When installing the foot peg, insert the rubber bushings into the foot peg with the lip end of the bushings on the outside of the mounting hole.

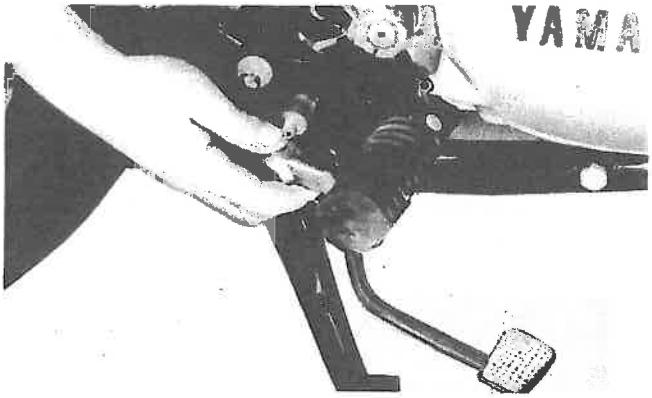


17) Remove both exhaust pipe assemblies.

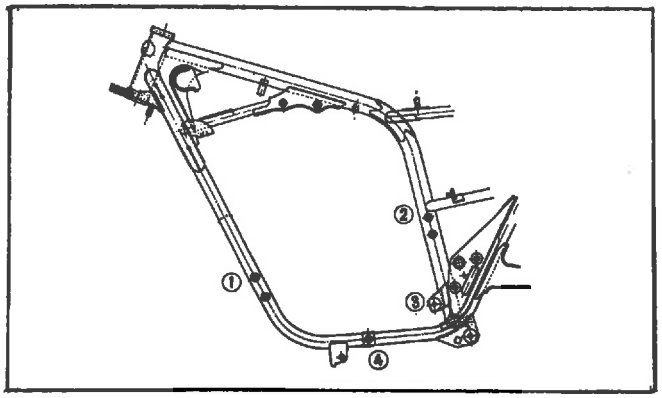
18) Remove the top center engine mounting brackets. Remove them in the manner shown in this picture as reassembly is easier and faster than if the bracket is removed in individual pieces.



19) Remove the brake pedal to provide access to the lower rear engine mounting bolt.

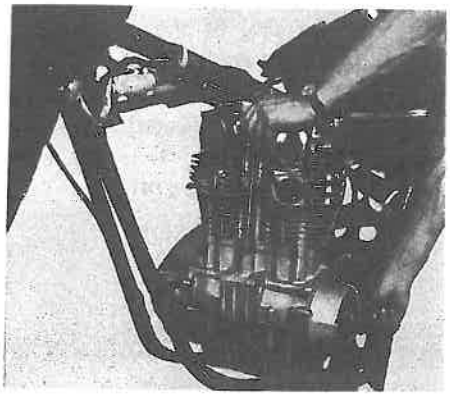


20) Remove all other engine mounting bolts and brackets in order of the number sequence as shown in the **drawing below. Remove the bottom center bolt last.**



21) XS2 – Remove decompression lever cable at cylinder head.

22) Remove the engine. Lift it out the left hand side.



B) Installing the Engine into the Frame

Engine installation is basically a reversal of the removal procedure. To make installation easier, it is best to position the engine in the frame and insert the bottom middle bolt first. The remaining engine mounting bolts and brackets can then be installed. When tightening engine mounting bolts, torque the 10mm bolts to 3.5–4.0 kg/m (25–28 ft/lbs) and the 8mm bolts to 2.0–2.5 kg/m (14–18 ft/lbs).

C) Engine Disassembly Notes:

1) Keep all parts in separate sections to aid in reassembly.
2) All gaskets, cotter pins, O-rings, and circlips, if damaged or worn, should be replaced.
3) Always use proper tools (as listed in the Tools Section) and proper repair techniques. A set of metric Allen wrenches must be available due to the use of Allen-head screws.
4) Clean all parts with solvent, and if any part has a drilled oil passage, blow the passage out with compressed air.
5) Tighten all nuts and bolts in proper rotation (in cases such as head nuts or case bolts) beginning with the larger bolts (if any) and then going back over and tightening the smaller bolts in the proper sequence.
6) Always check the torque specifications section for correct torque, and use a torque wrench.
7) After completing each section check to make sure every procedure has been done properly and completely to avoid having to go back and do it again.
8) Occasionally, after several hours operation on a rebuilt engine, oil leaks will develop. This is caused by gasket compression. Re-torque all cylinder holding bolts should this occur.

In addition, other fittings MAY loosen during the "settling in" period after a rebuild. Make a point of checking motor mounts, brackets, etc., after 20 – 30 hours engine operation.

D) Cylinder Head Cover (Disassembly)

Removal and disassembly of the cylinder head cover requires the removal of the engine from the frame.
The cylinder head cover consists of:

1. Oil delivery tube (connected to cover at top)
2. Rocker covers (4)
3. Rocker shaft hole covers (4)
4. Rocker shaft
5. Rocker arm
6. Cylinder head cover sleeves and O-rings.

In addition, the cylinder head cover helps to support:

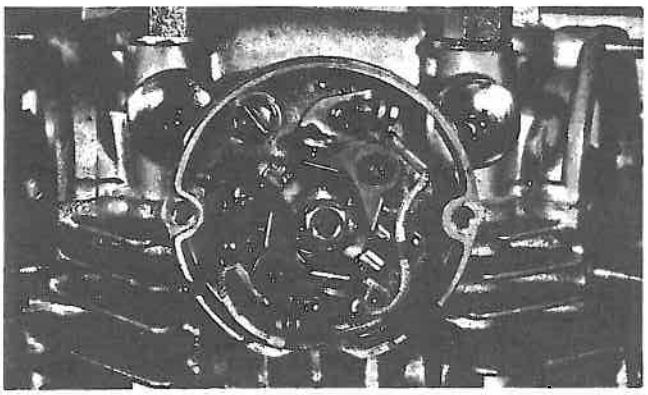
1. Ignition point assembly
2. Governor unit (centrifugal ignition advance unit)

1) Oil Delivery Line Removal

The oil delivery line is located at the front of the engine between the cylinders. Disconnect it at the crankcase and at the head where it is held in place by two banjo bolts.

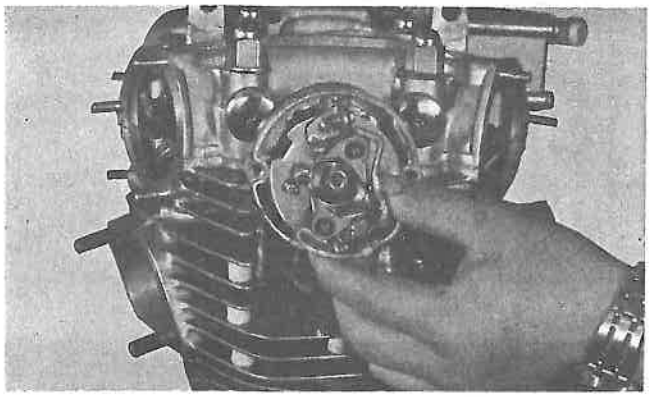
2) Ignition Breaker Point Removal

a) Although the ignition system has a dual point arrangement they are, in effect, mounted on a single backing plate. The points can be removed as a unit.



b) The point assembly backing plate is held in place by two slotted-head screws. Remove the screws and the plate assembly will slip off.

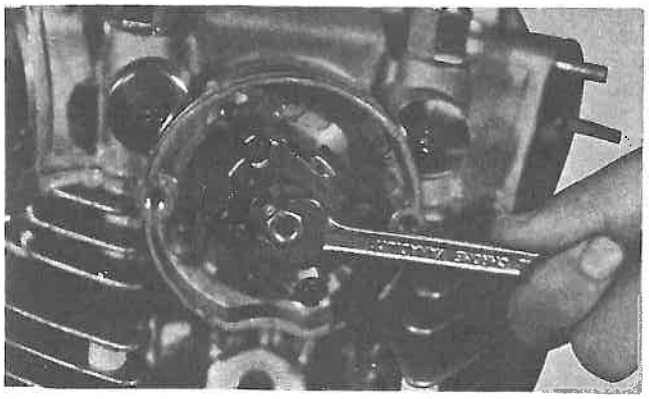
c) Remove the three Phillips screws anchoring the point housing. The housing can now be tapped loose and removed.



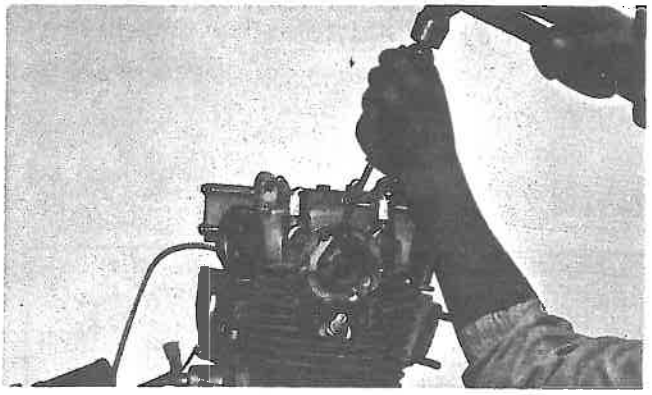
3) Advance (Governor) Unit

a) Remove the lock nut (1) and notched plate (2).

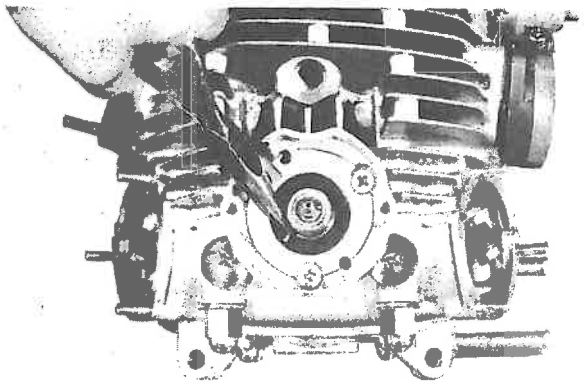
b) Pull the advance rod out the left camshaft side (point side). To aid in future assembly, it is best to reassemble the notched plate, lock washer, and lock nut onto the rod and set it aside.



c) Use a punch and hammer to loosen the ring nut that secures the entire ignition advance unit. As this ring nut is loosened, slide the advance unit out; otherwise the ring nut will bind up.



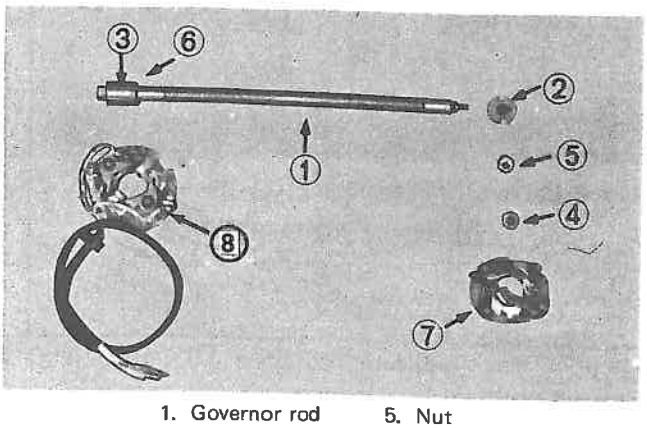
d) Remove the advance unit locating pin.



e) Finally, remove the advance unit housing which is held in place by three phillips-head screws. The housing might need a light tap to break it loose from gasket adhesion. Use a soft-head hammer.

4) **Governor (Advance) Rod Unit**

a) Description:
The entire unit consists of the advance rod, a notched ignition advance disk, an ignition point cam, two locating pins, and a lock washer and nut for each end.

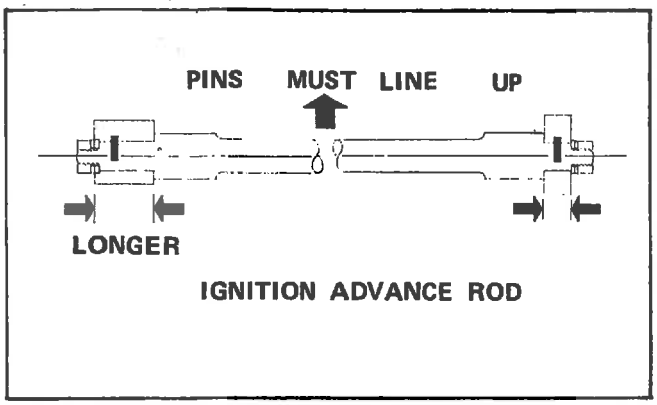


1. Governor rod
2. Disk
3. Point cam
4. Lock washer
5. Nut
6. Shim(s)
7. Governor
8. **Point Ass'y.**

b) Disassembly procedure:

b-1) The notched disk, lock washer, and lock nut have already been removed. The point cam can be removed next. It is held by a lock washer and nut. Remove these pieces and slip the point cam off. A spacing washer behind the cam should also be removed, if one is present.

b-2) Two locating pins are pressed into drilled holes in the rod. Normally there is no need to remove them. However, if one should come out, it must be pressed back into its hole so that it lines up with the other locating pin.



c) Assembly procedure:

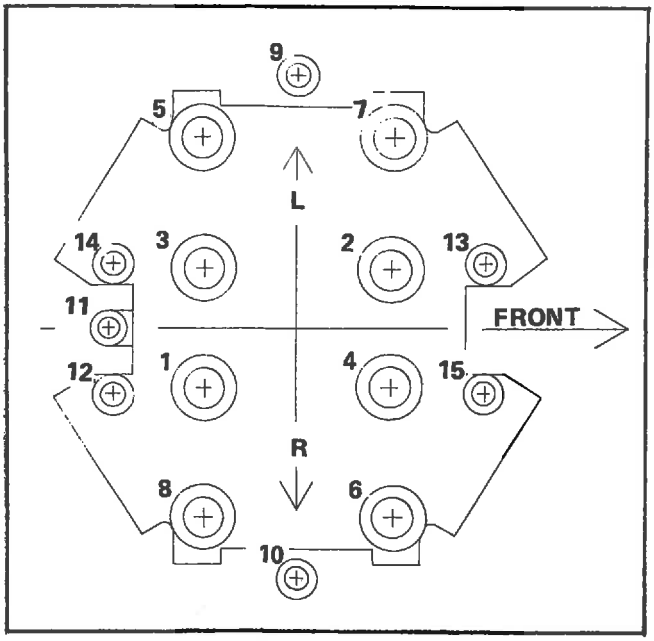
c 1) Both ends of the advance rod appear to be identical. However, one machined end is longer than the other. The point cam slips onto the longer end. The advance disk fits over the shorter end. The point cam and its spacing washer both have locating grooves that must line up with the locating pin. This prevents improper assembling.

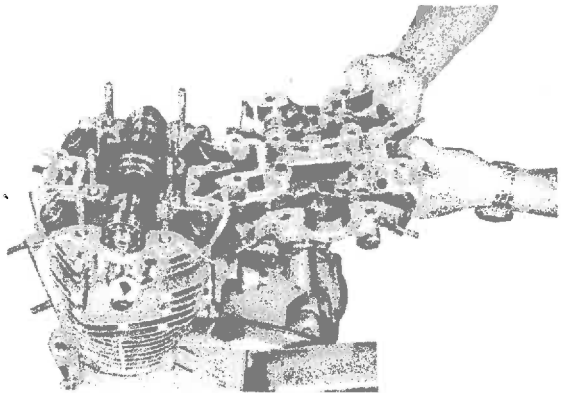
5) Cylinder Head Cover Removal

a) Remove all four tappet covers. Then remove the eight head cover retaining nuts and four retaining bolts. Remove the cover. Tap around the edges with a rubber hammer tc free the cover if necessary. Never use a metal-head hammer.

CAUTION

Loosen the nuts and bolts in sequence, starting with the inner nuts.

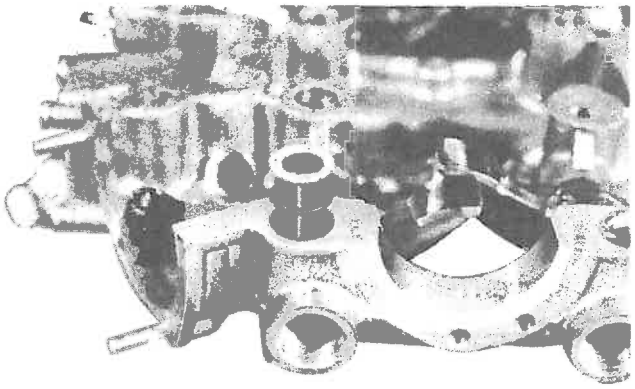




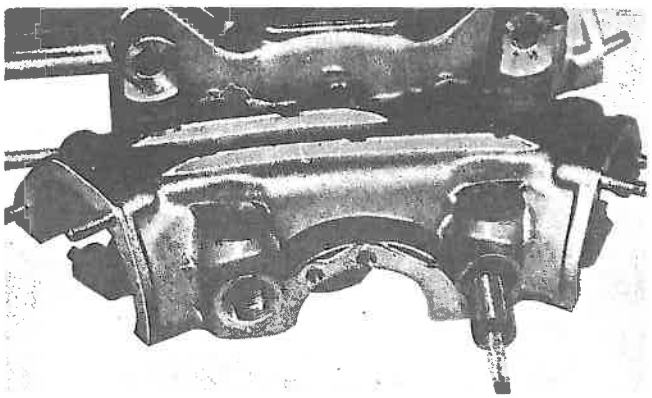
6) Rocker Arm and Rocker Shaft Removal

a-1) First, remove all four rocker shaft covers. Then remove the shouldered sleeves and O-rings (see picture). Insert a 6 mm screw into the tapped shaft, and withdraw the rocker shaft. It should slide out easily. Lift the rocker arm out of the head cover. Repeat this procedure for each rocker assembly.

Note:
Keep each mating rocker arm and shaft assembly separated. Reinstall them as a unit.

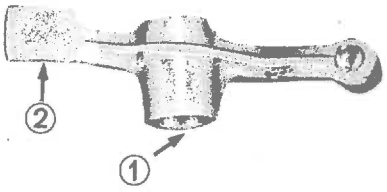


a-2) Reinstall the shafts using the 6 mm screw. That way, the threaded hole will be properly positioned for future disassembly; without the hole and screw it is very difficult to remove the shaft.

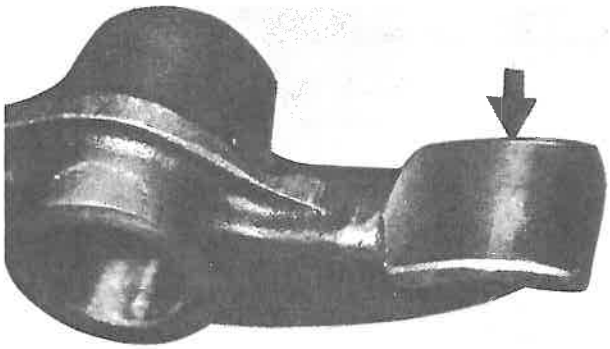


b) Rocker Arm and Rocker Shaft Wear

b-1) The rocker arm usually wears at two spots: (1) at the rocker shaft hole where it rubs against the rocker shaft, and (2) at the cam lobe contacting surface.

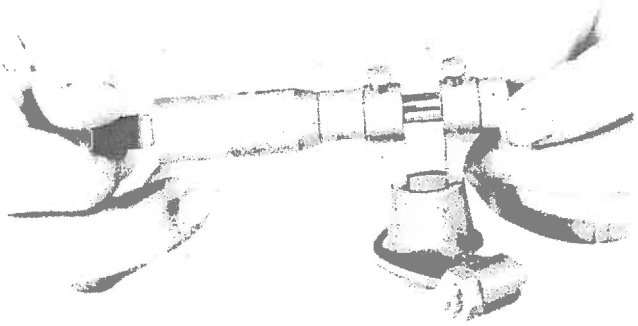


b-2) Check the cam lobe contacting surface of the rocker arm for grooves in the surface, for deep and obvious scratches, flaking of the hardened surface, or a blue discoloration of the metal (obvious evidence of too much heat). Check the mating cam lobes in the same manner.



b-3) If any grooves are readily apparent, replace the rocker arm. Do not try to repair the surface by cleaning with an oil stone or emery cloth as this will change the curvature of the follower and thereby the rate of valve opening.

b-4) Measure the rocker shaft hole in the rocker arm Standard size is 15.03 mm.



5) Rocker shaft diameter measures 14.98 mm when new. The shaft has been hardened and it should not wear excessively. If a groove has developed in its surface that can be felt, or if it shows a blue discoloration, then the shaft should be replaced and the lubrication system (pump and passages) checked.

6) Standard clearance between the rocker shaft and hole should be 0.05 mm. If measurement shows more than 0.10 mm clearance, replace either or both parts as necessary.

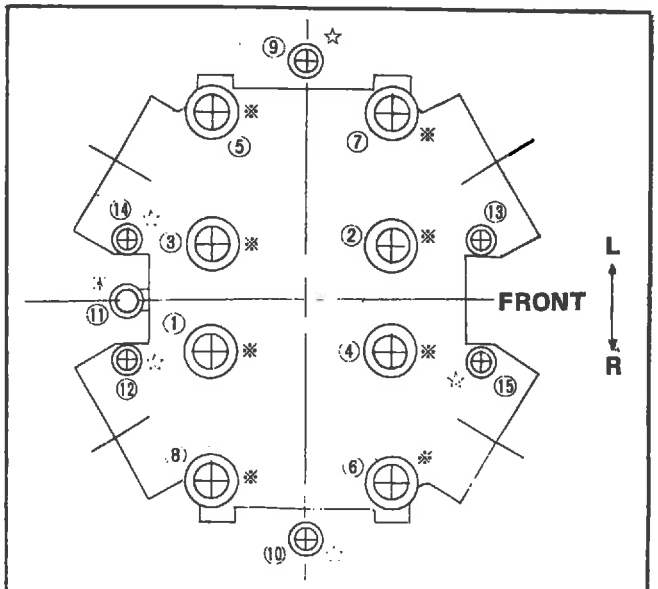
7) **Assembling the Cylinder Head Cover**

a) All head cover components can be installed in the head cover in reverse order of removal, beginning with rocker arms and rocker shafts. Be sure to coat all surfaces with oil as the parts are reassembled.

b) All rocker arms are identical and all rocker shafts are identical, which makes them interchangeable. However, try to keep the arms and shafts together as four individual sets (one arm and one shaft to a set) and to reinstall them in the head cover in their original location. Also, when installing the rocker shafts, see that the drilled and tapped end points outward to facilitate future disassembly. Complete this phase of assembly by installing the shaft hole covers.

8) **Installing the Cylinder Head Cover and Attached Parts**

a) Coat the head and cover mating surfaces with a non-hardening sealant (Yamaha Bond #4) and slip the head cover into position on the head. Install all head cover retaining nuts and retaining bolts and thread them down until lightly seated. USE A TORQUE WRENCH to tighten these nuts and bolts to the proper torque setting, and in proper torque sequence. Tightening torque for 10 mm studs is 3.5 kg/m (25 ft/lbs), for 8 mm it is 2.0 kg/m (14 ft/lbs), and for 6 mm it is 1.0 kg/m (7 ft/lbs).



10 mm 3.5 kg/m (25 ft/lbs)
8 mm 2.0 kg/m (14 ft/lbs)
6 mm 1.0 kg/m (7 ft/lbs)

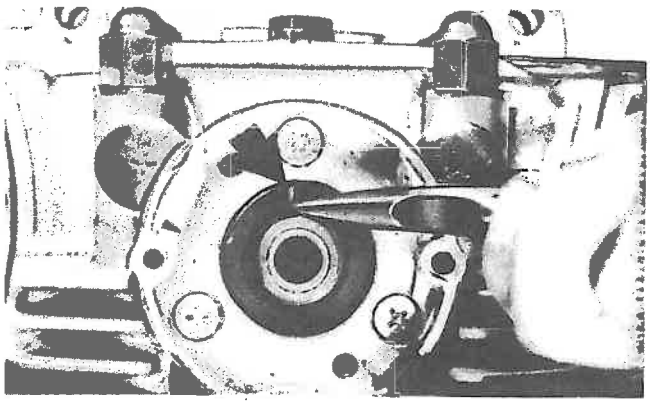
TIGHTENING SEQUENCE

CAUTION

If the stud threads are not lubricated prior to cylinder head cover assembly, it is possible to shear a stud when tightening cover nuts. Therefore, apply a liberal coating of 30 weight oil to all threads first, and then torque the head cover down.

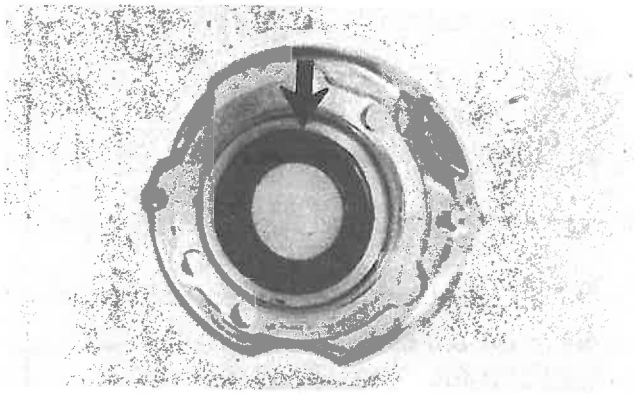
b) Install the ignition points housing and the centrifugal advance housing. These housings are identical and can only fit on the machine one way.

c) Install the Centrifugal advance unit locating pin.

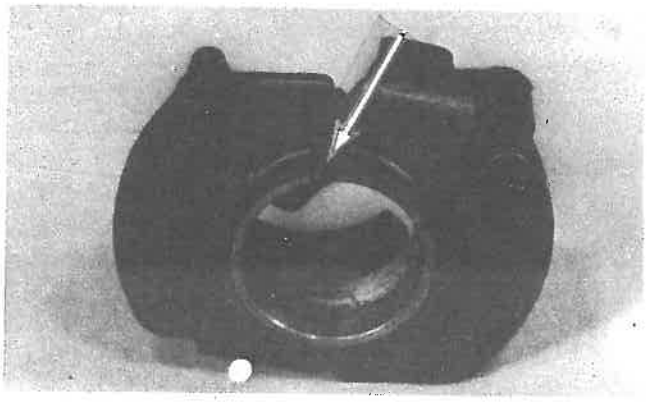


d) If necessary, insert a new gasket between the housing and head covers. Also, if any oil residue is found on the ignition points, then the rubber seal may be leaking. Check the seal for grooves, creases, or any deformity that would permit oil to leak past. If found, replace the seal.

NOTE:
Grease the seal lip before installing the housing.

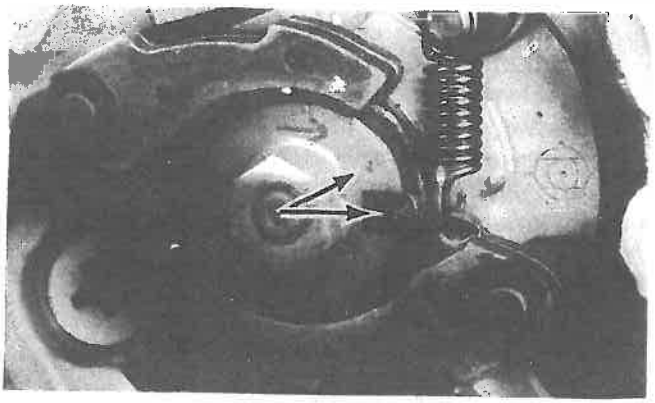


e) Mount the governor (centrifugal advance) unit in its housing. It can only fit one way as there is a notch in the back of the unit that must line up with the locating pin. Next, screw the ring nut onto the camshaft end until tight and then use a punch and hammer to completely tighten the ring nut.

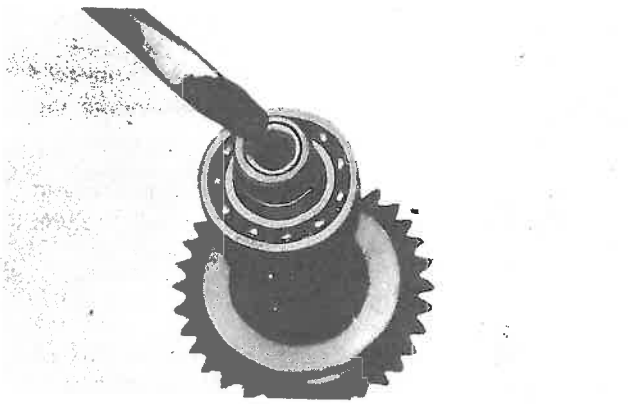


f) Place the disk into position and engage the centrifugal weight arms into the proper disk slots.

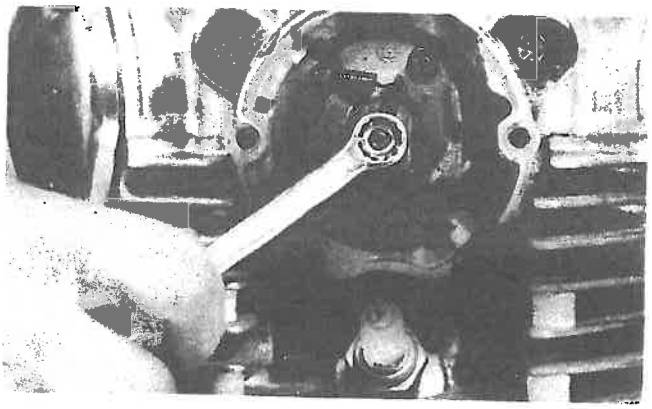
CAUTION: Make sure the disk surface with the arrow showing direction of rotation faces outward. Also, there is a color mark on the backing plate and the notched disk. The color marks must be aligned and the weight arms located in the slots. If the notched disk is installed 180° out of rotation, or if the directional arrow on the disk is not facing out, operation of the advance unit will be impaired.



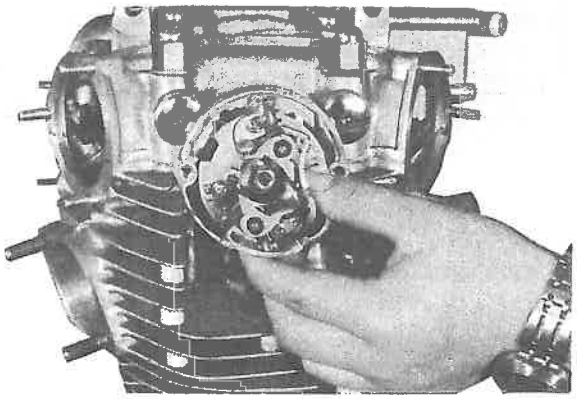
g) Before inserting the governor rod, both supportive needle bearings (located inside each end of the camshaft) should be lubricated with a light-weight grease. These bearings support the point cam rod and every time this unit is taken apart these bearings should be greased.



h) Slide the governor rod into the camshaft from the ignition points side. A locating pin sticks up at the threaded end of the governor rod. Install the rod and rotate it until this locating pin slips into the inner notch in the governor unit disk. Next install and tighten the lock nut.



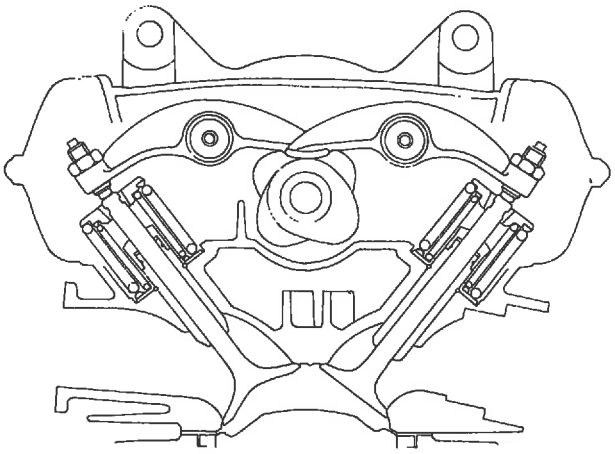
i) Install the ignition point assembly. Do this by expanding the two sets of points and slipping the assembly over the point cam. The point assembly is designed to fit only one way. Position the right cylinder points (stamped "R" on the plate just below the points) at the top of the housing. Install and tighten both securing screws.



j) Make sure the point wire rubber grommet is in good condition and installed correctly, then secure the point housing cover in place.

k) Install the oil delivery line. (After the engine has run sufficiently to warm up to operating temperature, check for oil leaks at this point if necessary.)

E) Cylinder Head

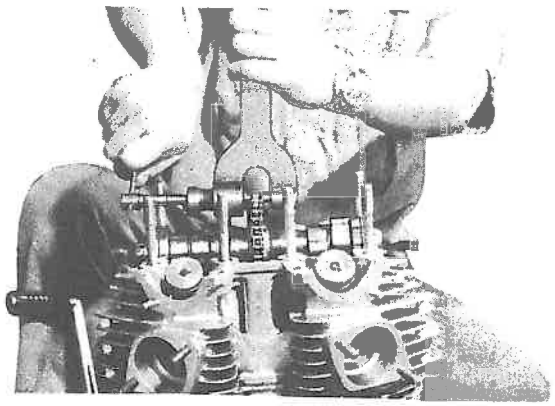


Cutaway View of Cylinder Head

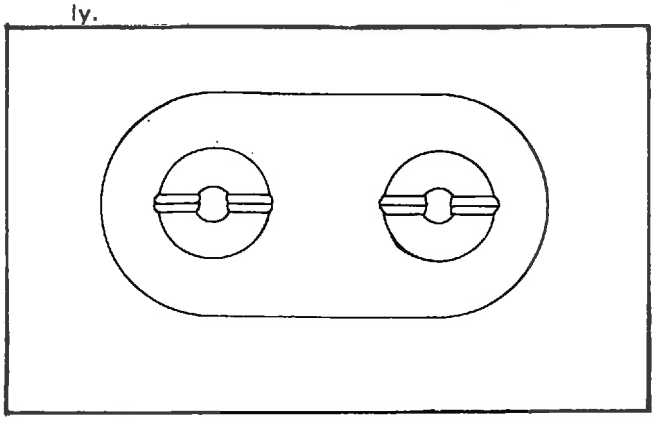
1) Cam Chain Removal

a) The single row cam drive chain connects the camshaft to the crankshaft. The chain is "endless" in that there is no master link to disassemble it, other than the link riveted at the factory when the chain was first installed.

b) A chain breaker (in Special Tool kit) must be used to remove a selected link. Place a rag around the sprocket to prevent metal chips from falling into the engine.

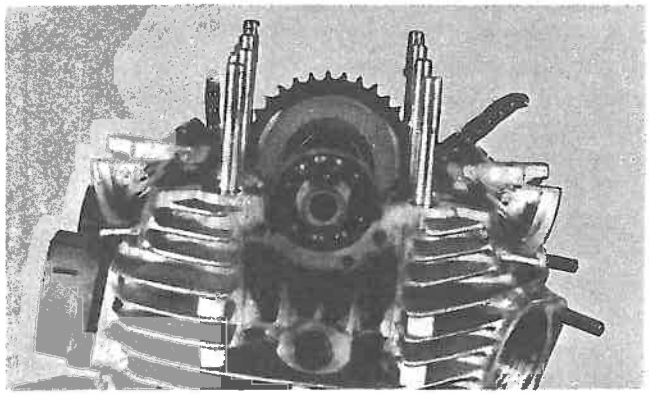


c) Separate the chain link that was originally riveted at the factory. The rivet heads on this link have punch marks and slots across the heads. Replace this unit with new parts during reassembly.



CAUTION

d) Attach a wire to a chain link on each side of the link to be separated. Do this before separating the chain to prevent the chain from dropping into the crankcase. After separating the chain anchor both retaining wires to prevent the chain from dropping down.



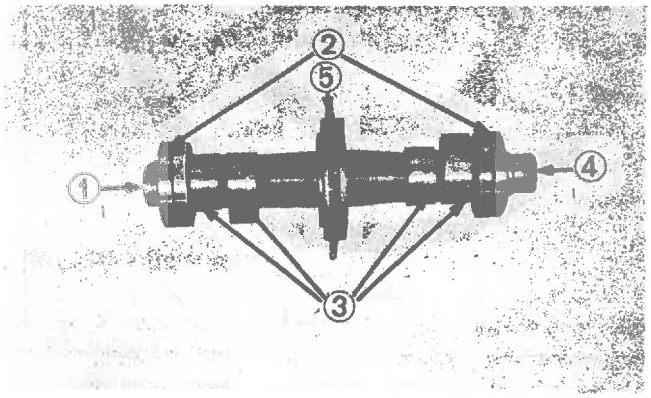
1) Remove the chain, clean it in solvent, then examine for wear.

2) If the engine is not to be disassembled, pull a length of wire through with the chain during removal in order to provide a means of reinstalling the chain after cleaning and checking.
It is also a good idea to have a mechanic's mechanical claw on hand to help feed the chain around the guide bars on the lower drive sprocket during reassembly.

NOTE:
Checking Cam Chain Wear:
Check the cam chain using the same methods as when the secondary drive chain is checked.

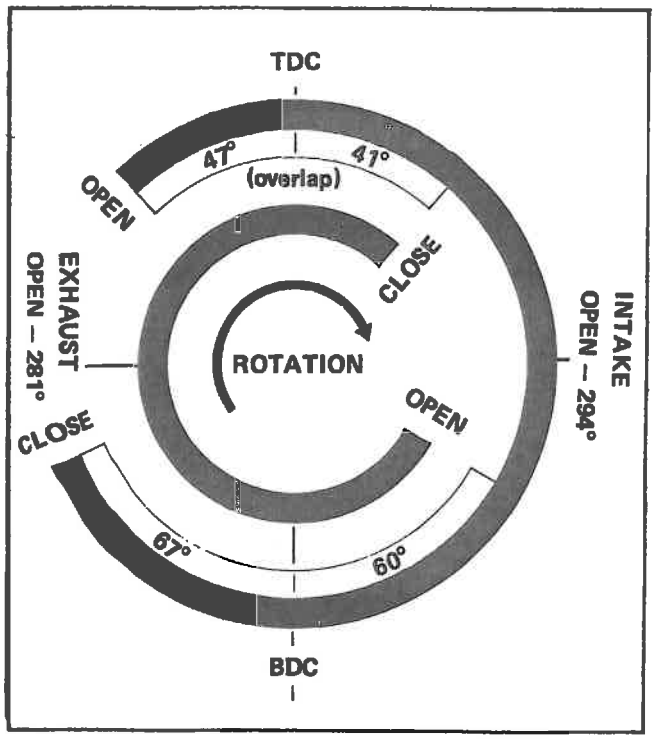
2) Camshaft

a) The XS650 engine uses a single overhead camshaft. All four cam lobes (2 intake and 2 exhaust) are located on one shaft. The cam lobes have been specially tempered to resist wear. The camshaft is connected to the crankshaft by a single row endless chain. Sprocket ratio is 2:1, which turns the camshaft at half crankshaft rpm. The camshaft is supported on top of the cylinder head by four single row ball bearings, two at each end.



1. Needle bearing
2. Single row ball bearings (4)
3. Cam lobes
4. Governor mounting threads
5. Camshaft sprocket (34 teeth)

b) The ignition points fit against, but do not mount directly to, the left end of the camshaft. The camshaft right end is threaded and the ignition governor (centrifugal advance) unit mounts directly to this end. The shaft is hollow and the governor rod slips through this passage to link the governor unit with the ignition points unit. Each end of this drilled passage is fitted with a needle bearing to support the rod and a small labyrinth seal to prevent governor rod lubricating oil from leaking into both units, especially the ignition points unit.



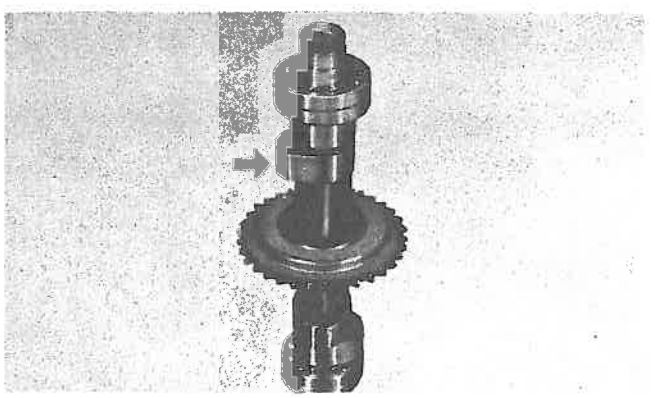
c) The intake valve opens 47° before top dead center and closes 67° after bottom dead center, which means the intake valve is held open 294°. The exhaust valve opens 60° before bottom dead center and closes 41° after top dead center. It remains open for a duration of 281°. From 67° ABDC to 60° BBDC on the compression stroke, both valves are closed for combustion.

3) Camshaft Removal

a) With the camshaft drive chain removed (or held away by safety wire), the camshaft can be lifted out of the head.

4) Camshaft Wear

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. This is due to poor lubrication, incorrect clearances (from poor adjustment or valve bounce), or due to normal wear.

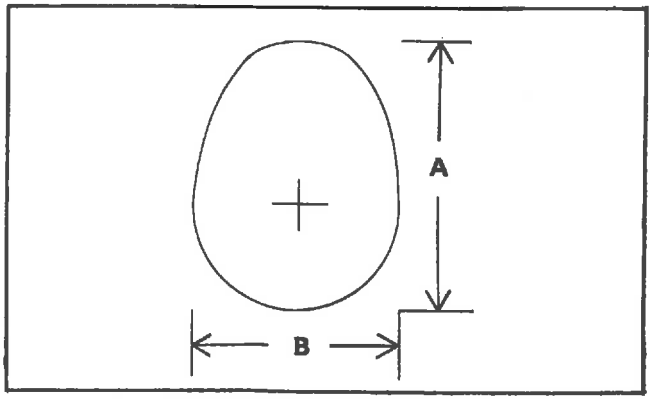


b) If any of the above wear conditions are readily visible, the camshaft should be replaced. Also, the corresponding rocker arm contacting surface should be checked for similar wear and replaced if obvious wear is noted.

c) Even though the cam lobe surface appears to be in satisfactory condition, the lobes should be measured with a micrometer. If wear exceeds a predetermined amount, valve timing and lift are affected. Replace the camshaft if wear exceeds the limits listed below.

	Cam Lift (A)		Base Circle Diameter (B)	
	Standard Value	Wear Limit	Standard Value	Wear Limit
Intake	39.88 ± 0.05	39.75	32.19 ± 0.05	32.12
Exhaust	40.03 ± 0.05	39.79	32.24 ± 0.05	32.17

(All dimensions given in millimeters.)



d) All camshaft bearings should be removed, 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 bearing(s) should be replaced.

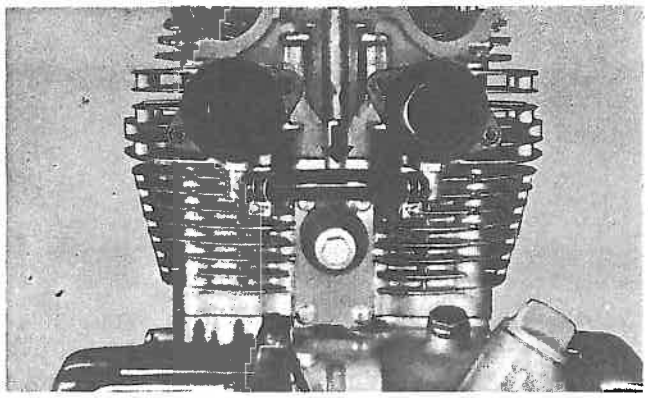
NOTE:
Lubricate the bearings immediately after examining them to prevent rust formation.

5) Carburetor Manifold Removal

The rubber manifolds are secured to the head by two Allen-head screws each. Remove the screws and the manifolds.

6) Intake Port Equalizer Tube

Check for cracks or collapsed sections. If any defective section is found, replace the tube.

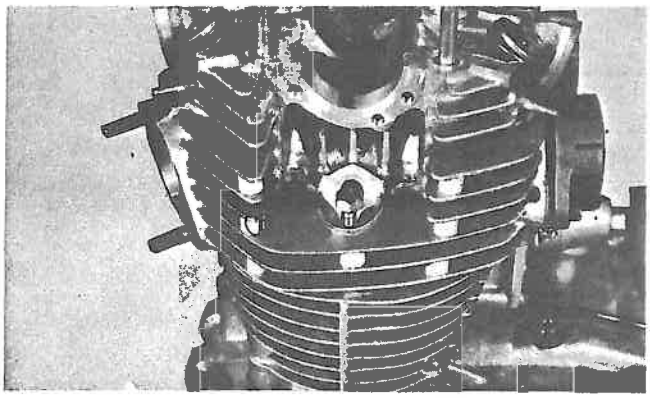


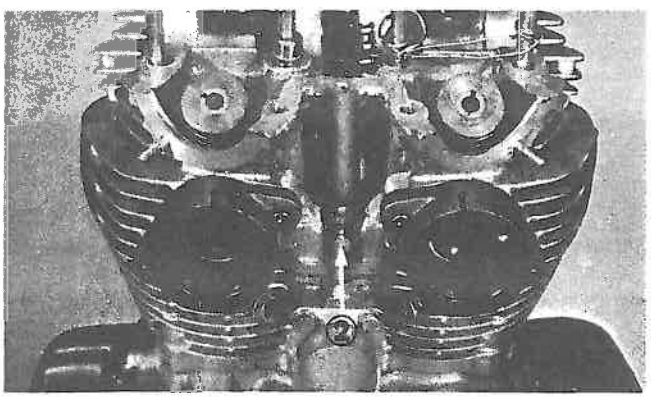
NOTE:

Make sure the coil spring is present inside the tube, this spring is necessary in order to keep the tube from collapsing.

7) Cylinder Head Removal

a) The head is now held in place by two hex-head screws (#1) beneath each spark plug hole and one 6 mm screw (#2) which is located between the intake manifolds. Remove the bolts and slide the cylinder head up over the studs. While performing this operation, hold the safety wires so the cam chain does not fall into the crankcase.





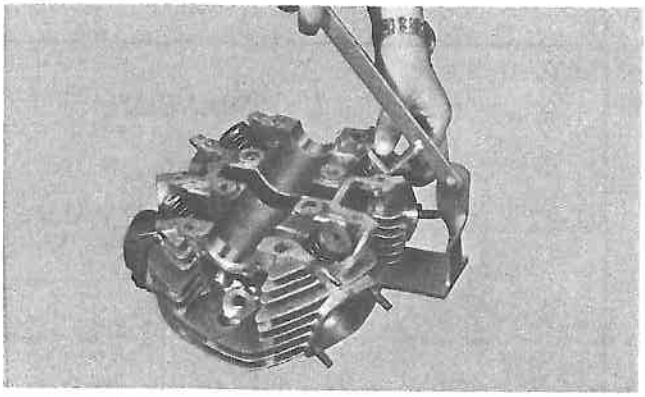
8) Cylinder Head Wear

a) There must be no head warpage. Clean the head thoroughly with solvent, dry it, and lay it on a machined surface plate. If warpage is extreme, the head will rock back and forth. Check for lesser warpage by running a .001" – .002" feeler gauge under the head mating surface. If the gauge slips in between the head and the surface plate anywhere around the perimeter, then the head must be re-surfaced.

b) Place a sheet of #400 grit emery paper on the surface plate and slide the head mating surface across this paper in a figure 8 pattern to remove any measureable warpage. If more than .0025" needs to be removed, the head should be taken to a machine shop for milling. **Milling should not exceed .010" as this will affect valve head/piston dome clearance.**

9) Valve Removal

a) A valve spring compressor is available in the Special Tool kit. Compress the valve spring and then remove both keepers. Remove the compressor and lift off the collar and springs.



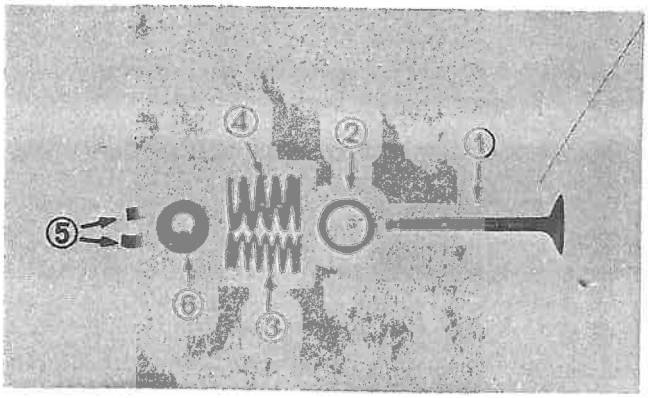
NOTE:

The keepers might be partially stuck in the collar. Use a rubber hammer to tap the edge of the collar a few times to loosen the keepers.

b) Pull the valve out. If the stem tip or keeper groove edges are slightly expanded, causing difficult removal, do not force the valve out as the valve guide inner diameter might be damaged. First, use a fine file to remove any lip that exists on the stem and then remove the valve.

NOTE:

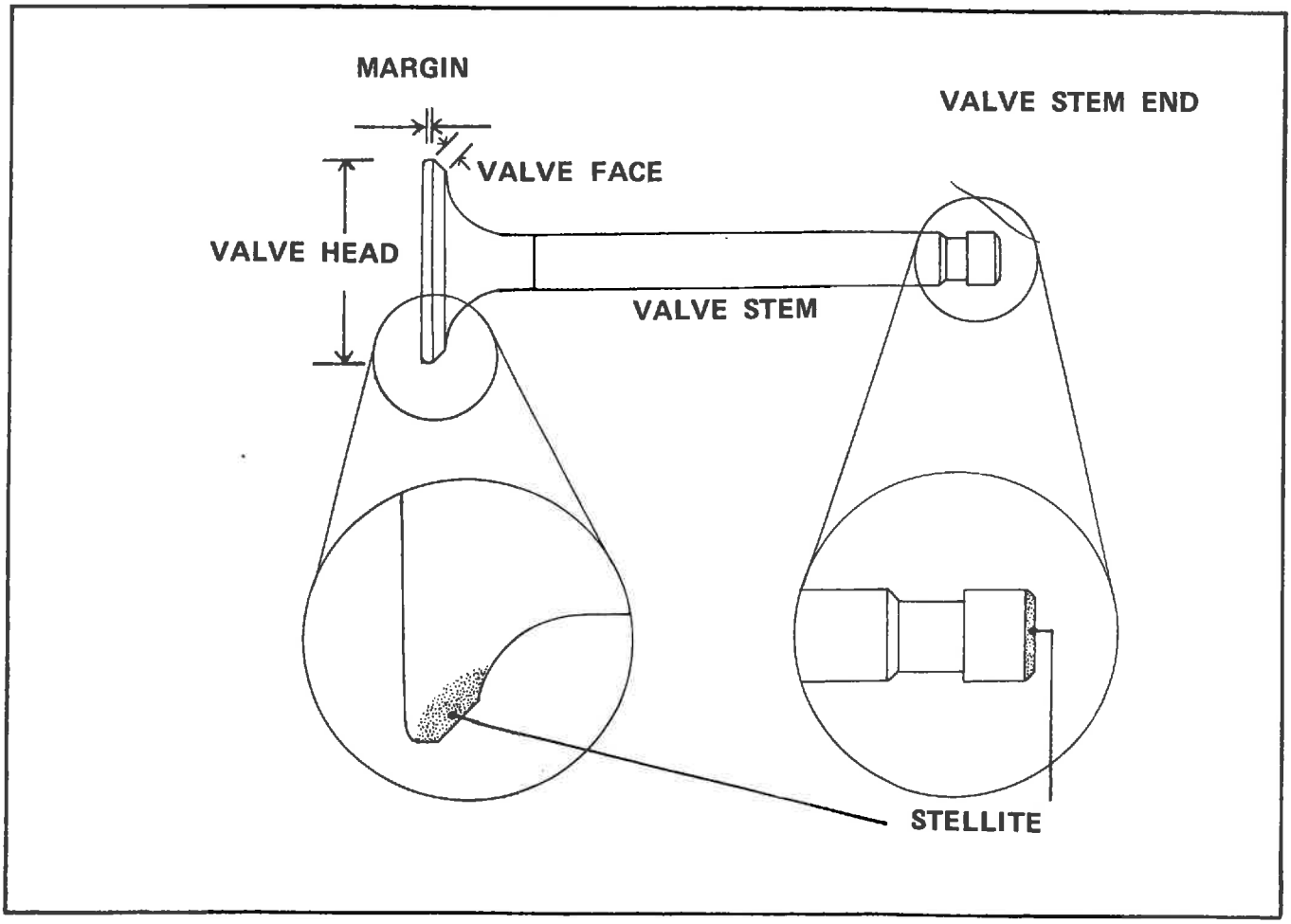
Be sure to remove the valve stem seal before removing the valve. Otherwise the seal could be damaged.



1. Valve
2. Valve spring seat
3. Inner valve spring
4. Outer valve spring
5. Keepers
6. Collar

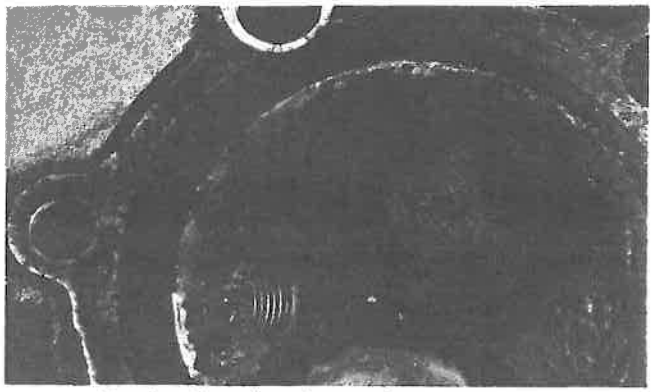
10) Valve Description

The head is equipped with four valves; two intake valves and two exhaust. The stem tip and valve face of each is plated with Stellite (hardened metal) to keep wear at a minimum. The intake valve head diameters are larger to provide less restriction for the incoming fuel/air change.

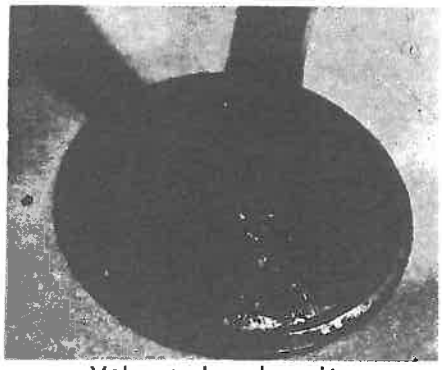


11) Decarbonization of the Head and Components

Carbon deposits build up in the combustion chambers, on the valves, and in the exhaust ports. Thoroughly clean all parts with a blunt scraper, then wash in solvent and dry with compressed air. The parts can then be examined and measured for wear.



Combustion chamber carbon deposits.



Valve carbon deposits.

12) Valve Wear

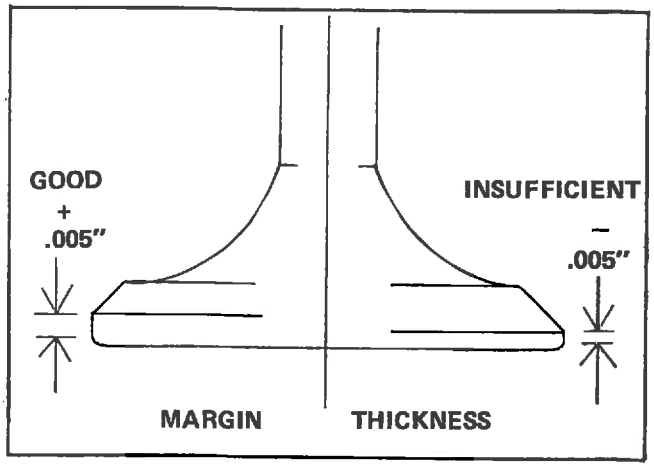
a) Check the valve stem tip for an indentation caused by the adjustor constantly striking the tip. If this indentation is .4-.5 mm (.015"-.020") deep, or more, then regrind the tip surface flat. Remove only the material necessary, no more. Use a commercial valve grinder with the appropriate adaptor mounted on it to grind the tip.

b) Valve stem wear must be measured and then combined with valve guide measurements to arrive at a stem-to-guide clearance. This clearance must be within the tolerances shown below. If it exceeds the maximum limit, then replace either or both parts as required.

c) The valve should also be checked for a bent stem. Roll the stem along the edge of a surface plate and visually check for stem warpage. Replace the valve if any warpage exists.

NOTE:
When checking the stem for warpage, be sure all carbon has been cleaned off.
Otherwise, an accurate check cannot be made.

d) Check the valve for pits, carbon deposits, warpage (including the entire head), and actual chips broken off the margin. If warpage exists or if the surface is chipped, replace the valve. If it is just pitted and/or carboned up, lap it to the valve seat. If it does not clean up by lapping then use a mechanical grinder to resurface the valve face. After grinding, check valve margin thickness. If it has been reduced to a sharp edge because of grinding, the valve should be replaced as this thin edged margin can readily heat up and cause pre-ignition.



e) Check the stem for scratches. These occur when carbon collects in the valve guide and then hardens. As the stem continually rubs against this hard carbon, scratches are worn in the stem. Replace the valve if deep scratches are found.

			Original Clearance	Replacement Clearance
Intake	Valve Guide ID	* 8mm $^{+.019}_{+.010}$	.020 – .044mm	.100mm
	Valve Stem OD	8mm $^{-.010}_{-.025}$		
Exhaust	Valve Guide ID	* 8mm $^{+.019}_{+.010}$	.035 – .059mm	.120mm
	Valve Stem OD	8mm $^{-.025}_{-.040}$		

*NOTE: XS2-106692~: GUIDE I.D. : 8mm $^{+0.040}_{+0.030}$ =

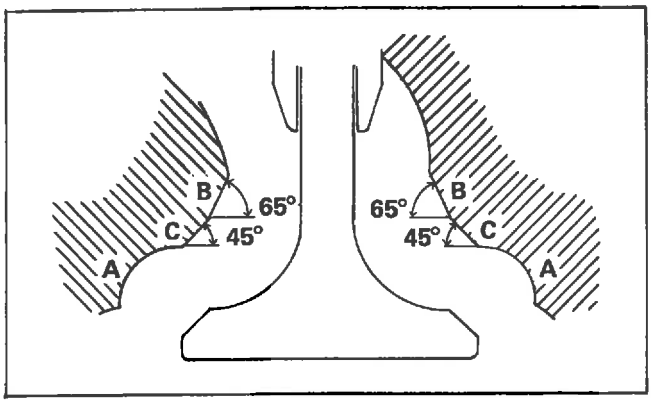
INT.	.040–.065mm	.110mm
EXH.	.055–.080mm	.130mm

13) Grinding the Valve Seat

a) The valve seat is subject to severe wear similar to the valve face. Whenever the valve face is resurfaced, the valve seat should also be resurfaced 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 cutter int. 3R (radiused cutter). If cutting section 'A' of the exhaust valve seat, use cutter EXH 8R (also radiused).

If cutting section "B", use the 65° cutter.

If cutting section "C", use the 45° cutter.

b) Measure valve seat width. Apply mechanic's blueing 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 griding compound, and check valve seat width. The valve seat will have removed the blueing wherever it contacted the valve face.

Measure the seat width with vernier calipers. It should measure approximately 1.3 mm. 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.

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 "R" (radius), 45°, or 65° cutters to correct the improper seat location in the manner described below:

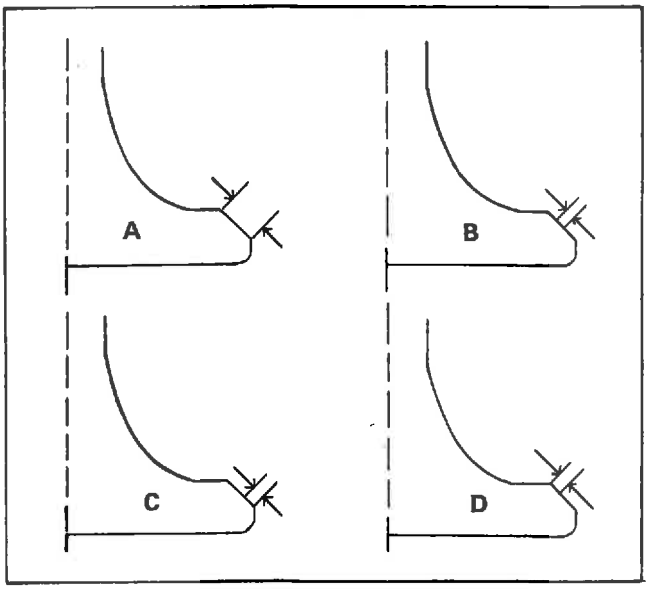
	Standard Width	Wear Limit
Seat Width	1.3mm (.051")	2.0mm (.078")

(A) If the valve face shows that the valve seat is centered on the valve face, but too wide, then lightly use both the "R" and the 65° cutters to reduce the seat width to 1.3 mm.

(B) 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.

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

(D) If the seat is too narrow and down near to bottom edge of the valve face, then first use the 65° cutter and then the 45° cutter.



14) 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 resurfaced and now require a final light grinding operation for perfect sealing.

b) Apply a small amount of coarse lapping compound to the valve face. Insert the valve into the head. Rotate the valve until there is a burnished spot all the way around the valve face. 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 all compound material. Apply blueing 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 blueing has been rubbed away.

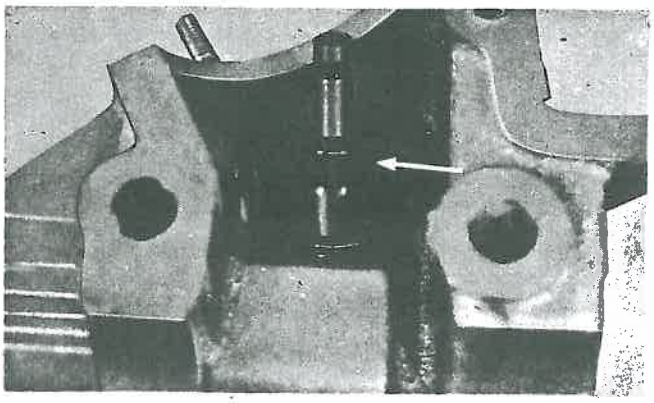
NOTE:
The valve can most easily be rotated if a section of flexible rubber hose of 5/16" ID is slipped over the valve stem and spun.

15) Valve Leakage Check

a) 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 this fluid leaks, disassemble the valve assembly and continue to lap with fine compound. Clean all parts thoroughly, reassemble and check again with solvent. Repeat this procedure as often as necessary to obtain a satisfactory seal.

16) Valve Stem Seal

a) This seal slips down over the valve stem to prevent excessive amounts of oil from passing down stem and into the combustion chamber. If this seal is cracked, split, or hardened, replace it.



16) Valve Springs

a) Both inner and outer springs must sit vertical when on a flat surface. Check with a square. If not vertical, replace, as spring will cause valve to "cock" in guide, causing excessive wear.

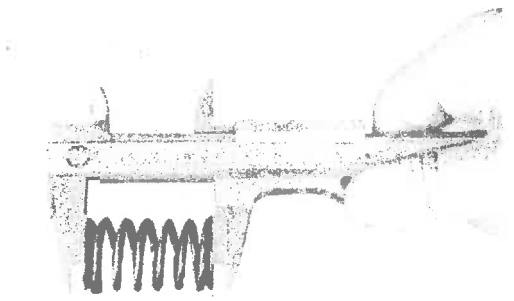
b) Both inner and outer springs are "Butt-ground" to provide verticality (see 17-a, above) and full seating. If less than 3/4 of the O.D. of the spring fits flush against its seat or collar, replace it. Otherwise, the condition in 17-a, may occur.

c) The XS650 engine uses two springs of different size to prevent valve float or surging.
The chart below shows the basic value characteristics.

VALVE SPRING SPECIFICATION CHART

	OUTER	INNER
Diameter of wire	4.2 mm.	2.9 mm.
Direction of winding	Right Hand	Left Hand
Total Winding	6.25	8.0
Free Length	42.55 mm.	42.0 mm.
Installed Length (Valve Closed)	37 mm.	35.0 mm.
Installed Pressure	17.7±1.25 kgs. (39.02± 2.75 lbs.)	10±0.7 kgs. (22.05± 1.54 lbs.)
* Compressed Length (Valve Open)	27.5 mm.	25.5 mm.
Compressed Pressure	57.5±4.0 kgs. (126.78±8.82 lbs.)	27.2±1.9 kgs. (59.97±4.19 lbs.)
* Measured without collar. Tolerance: ± 3%		

d) Even though the spring is constructed of durable spring steel, it gradually loses some of its tension. This is evidenced one way by a gradual shortening free length. Use a vernier caliper to measure spring free length. If the free length of any spring has reduced more than 2 mm (.080") from its specification, replace it.

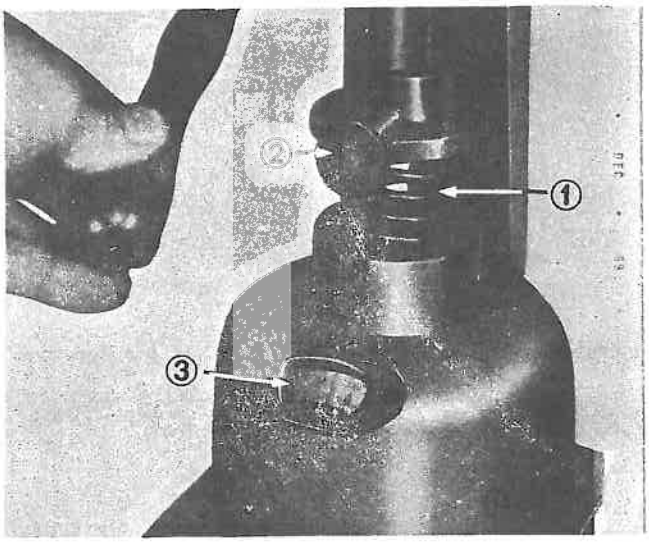


e) Another symptom of a fatigued spring is insufficient spring pressure when compressed. This can be checked using a valve spring compression rate gauge.

(1) Individual spring

(2) Length measuring scale

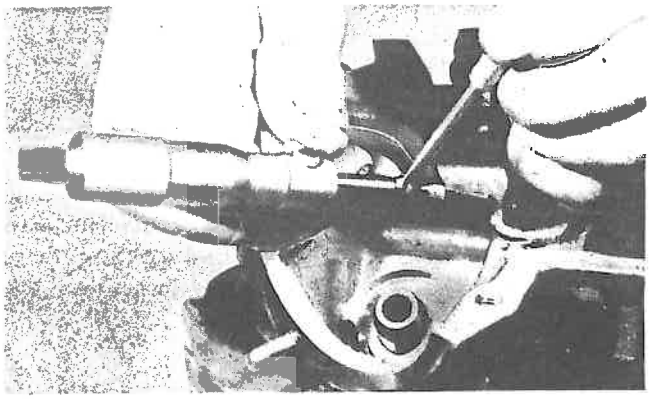
(3) Pounds pressure scale



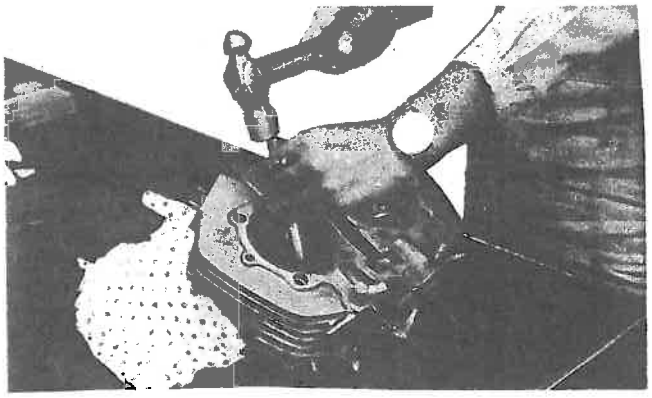
Test each spring individually. Place it in the gauge and compress the spring first to the specified compressed length with the valve closed (all spring specifications can be found in previous section, Valve Spring) then to the length with the valve open. Note the poundage indicated on the scale at each setting. This procedure must be performed on the outer springs, then the inner springs. Take several readings and "average" results.

18) Valve Guide

a) The inside diameter must be measured with a ball gauge. Measure at each end and in the center of the drilled passage. Compare this measurement, using the largest measurement of these spots, with factory specifications listed in Valve Description. If this measurement exceeds the maximum tolerance, replace the guide.



b) The valve guide is replaceable. It is held in the head by an interference fit of approximately .04 mm (.0015"). To ease guide removal and reinstallation, and to maintain the correct interference fit, heat the head to 200~400° Farenheit. If possible, use an oven to avoid any possibility of head warpage due to uneven heating.



c) Use the appropriate shouldered drift (Special Tools Kit) to drive the old guide out and the new guide in.

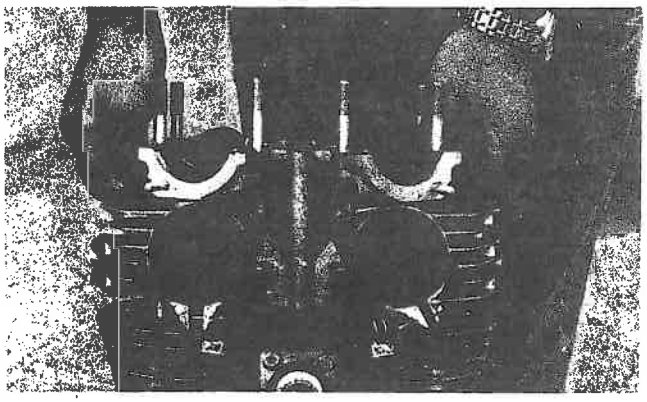
19) Installing the Head

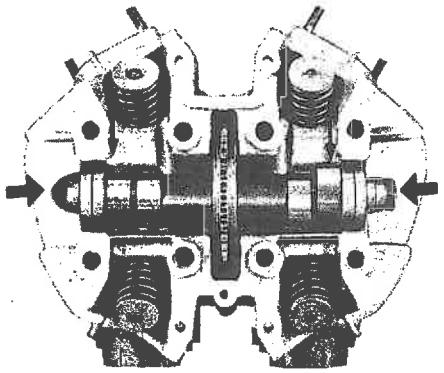
a) A new head gasket must be installed. The gasket can correctly fit only one way. Slip the cylinder head over the studs and onto the cylinder.

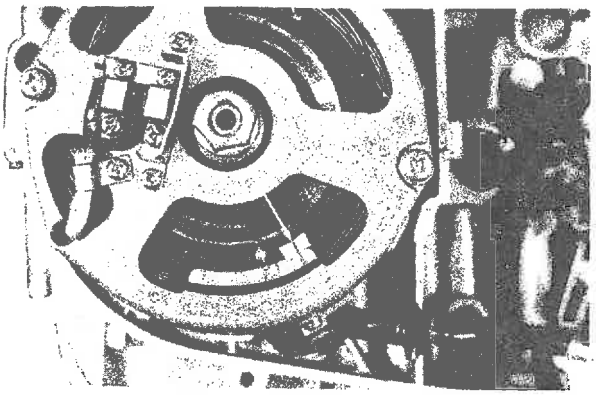
b) While performing this step push the cam chain safety wires up through the slot in the head and pull the cam chain up. Install and tighten both retaining bolts and the one 6 mm screw.

NOTE:

After completing this phase, plug the spark plug holes to prevent anything from dropping into the cylinder.

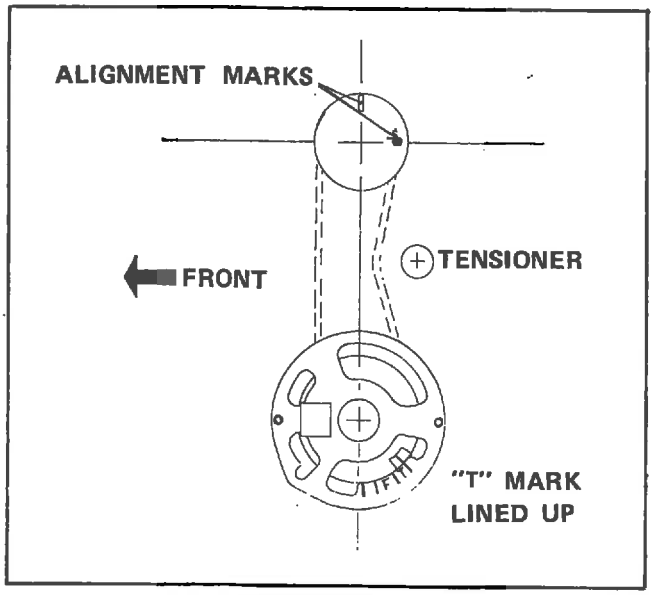






b) Next, rotate the pistons to TDC, as varified by lining up the rotor timing mark with the "T" (top) mark on the stator.

If the stator has been removed, use the "dowel pin" process described in the Valve Timing section carefully equalizing the "dead point" of piston travel by turning the crankshaft forward and backward a few degrees at TDC. Make sure the piston is at the top of its compression stroke first. Otherwise, an opening valve may catch the dowel pin.



20) Installing and Timing the Camshaft

a) Slide all cam bearings in toward the center of the camshaft as far as possible. Place the camshaft into position with the camshaft threaded end on the right-hand side. Holding both cam bearings in toward the cam sprocket, move the cam back and forth until the cam chain driven sprocket is aligned with the crankshaft drive sprocket. This can be determined by observing the position of each cam bearing in its bearing boss. The inner bearing on each side must be overlapping equal distance from the inner edge of the cam bearing bosses.

c) There is a groove in the left side of the cam sprocket. Position this groove so that it lines up with the sprocket centers. This can be checked. The punch mark on the camshaft sprocket must be parallel with the head gasket surface. Lay a straight edge across the head surface and check the punch mark.

d) Reconnect the cam chain. The chain tensioner has been loosened during disassembly. Therefore, the cam chain will have excessive slack. To avoid incorrect timing, the cam chain should be installed with no slack in the cam chain on the front portion (opposite side from the tensioner). Any slack on the back chain portion can be taken up with the tensioner.

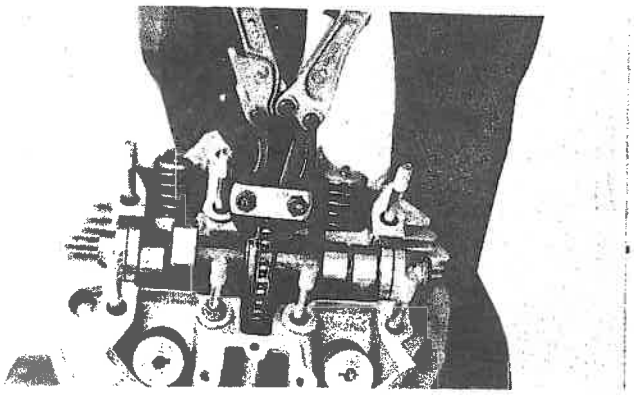
e) Join the chain together by installing and riveting a new chain link. Always use a new link each time the chain is reconnected. (Use a chain riveter, not a hammer and punch, to mushroom the rivet ends). The Parts Book lists the replacement link to use.

IMPORTANT

Make the proper chain tension adjustment.

f) **After completing the cam chain adjustment recheck the rotor timing mark and cam sprocket timing groove positions to guarantee that they did not rotate out of position during chain installation.**

(See #25)



21) Checking Valve Timing With a Degree Wheel

If the camshaft is not timed to open the valves in correct relation to crankshaft rotation, performance will be poor and engine misfire can occur.

a) Important. Make sure the cam chain tensioner has been properly adjusted.

b) Adjust all valves to special valve timing clearances. (.012" Intake; .012" Exhaust; engine COLD.)

c) Remove the left-hand case cover and stator. Mount the degree wheel to the rotor lock bolt.

d) Remove a spark plug and a place wooden dowel pin in the hole. Rotate the engine in a counterclockwise direction (from left side) and find Top Dead Center on the compression stroke (valves are both closed) by watching the piston rise and fall as indicated by dowel pin position.
Mount a pointer at the degree wheel so that it points to "O" on the wheel with the engine at TDC.

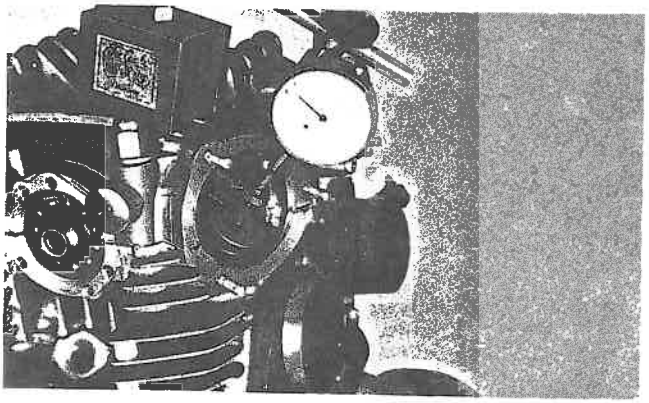
e) Mount the dial indicator over an intake valve tappet adjustor.

f) Rotate the crankshaft in a counter-clockwise direction (from left side). Watch the mounted dial indicator. Note when all clearance is taken up and the valve just starts to open.

g) Check the pointer position (in degrees on the wheel). The dial indicator should show the valve open 47° before top dead center after all valve tappet clearance has been taken up. Remember, "O" on the degree wheel is Top Dead Center. The intake valve must close 67° after bottom dead center; a total of 294°.

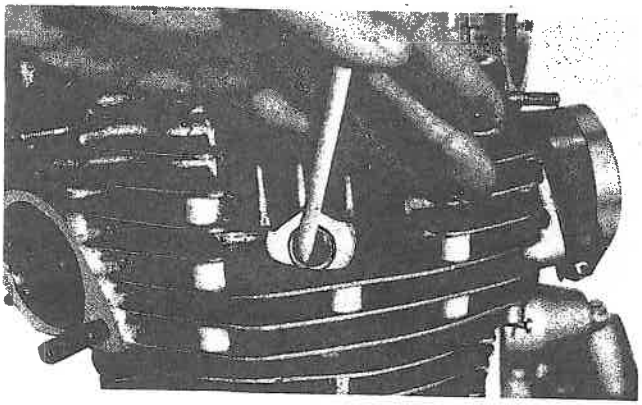
h) If the valve starts to open 37° or 57° before top dead center, the camshaft sprocket is one tooth off in its alignment with the crankshaft sprocket. The cam chain must be loosened and the camshaft rotated to its correct position.

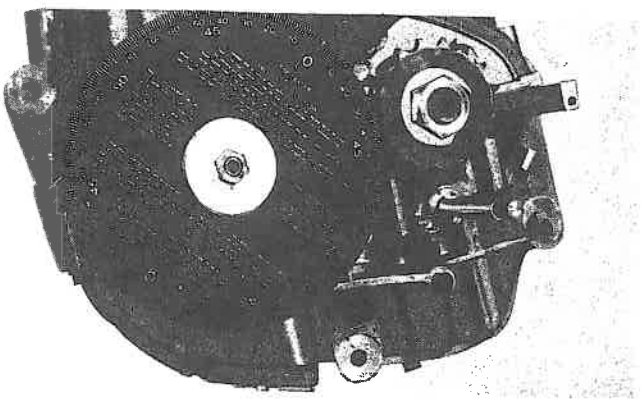
i) **Reset the valve clearance back to standard specifications .003" intakes .006" exhaust.**



NOTE:

Valve timing is off by approximately 10° for every tooth the camshaft sprocket is misaligned. Always reset valves to "Running" tolerances after checking timing.



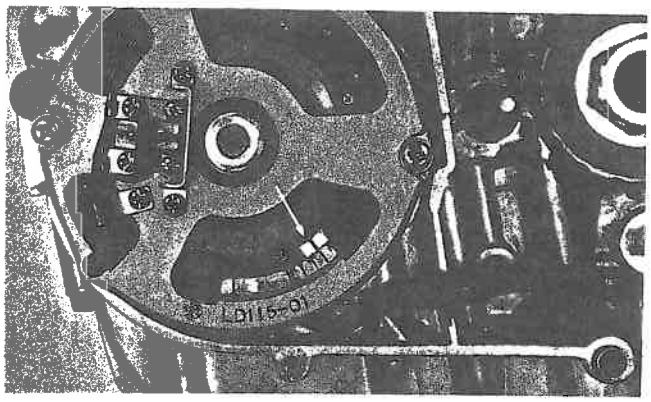


22) Valve Adjustment

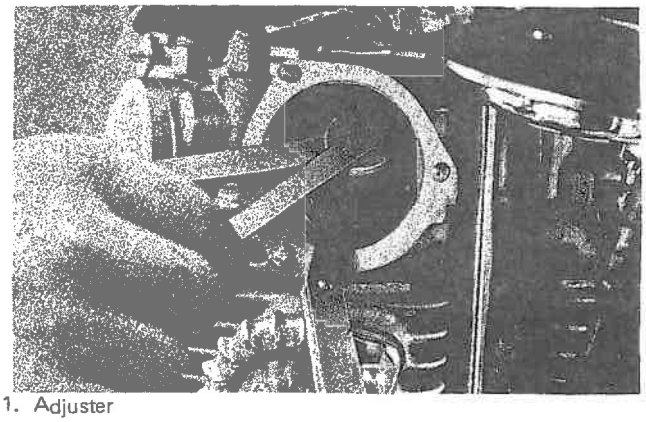
Improper valve clearance causes poor engine performance and possible engine damage. If there is too little clearance, the valve is held partially open. This permits blowby past the valve and drop in compression. If there is too much clearance there will be excessive engine noise and the valve will not open fully which will create partial blockage of airflow at the port.

a) Remove all four tappet covers and the alternator cover.

b) Next, align the "T" mark on the stator with the timing mark on the rotor. This places the pistons at top dead center. One of the cylinders is now at the top of its compression stroke. The cylinder that is on the compression stroke has both valves shut. This can be noted by observing which cylinder has clearance at both valve adjustors.



c) Use a feeler gauge to determine the existing clearance. The exhaust valve clearance should measure .15mm (.006"), the intake clearance should measure .076mm (.033"). (engine cold)



1. Adjuster
2. Lock nut
3. Tappet clearance

d) Loosen the lock nut and use the valve adjusting tool found in the XS1B Tool kit. Turn the adjustor in or out to obtain the correct clearance. Hold the adjustor solid to prevent it from moving and thoroughly tighten the lock nut. Recheck the clearance after tightening.

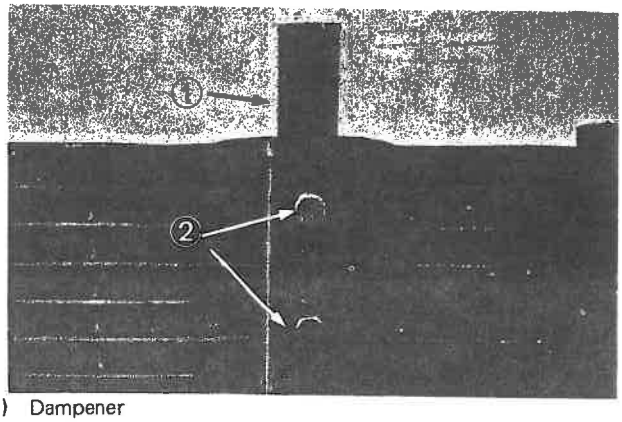
e) Rotate the crankshaft one complete revolution and once again line up the rotor and stator marks. The valve train of the other cylinder is now in position for adjustment.

CAUTION

ADJUST TAPPET CLEARANCE ONLY WHEN THE ENGINE IS COLD.

23) Cam Chain Vibration Dampener (opposite the tensioner)

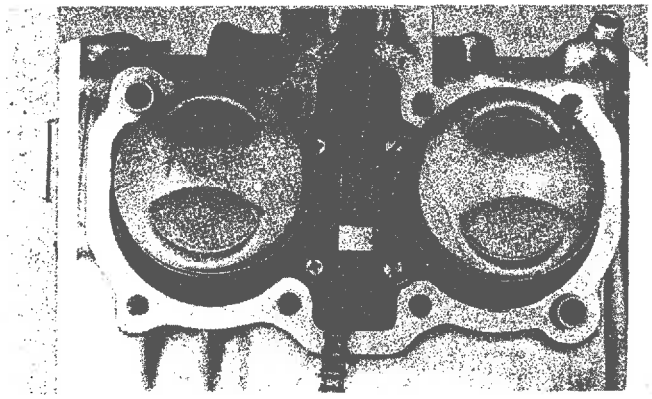
a) This rubber dampener (1) prevents the cam chain from bowing out because of chain weight and engine rpm. It is located in the hollow cavity between the cylinders and to the front, opposite the tensioner. It receives little abuse from the chain and should last indefinitely. However if the cam chain loosens sufficiently to rub hard against the rubber dampener it could wear out. It is held in place by two bolts (2) at the front of the cylinder. Remove these two bolts to lift the dampener out.



(1) Dampener
(2) Set screws

24) Cam Chain Idler Assembly (in engine case)

a) The rubber faced dampener supports the cam chain, helping to keep it running straight between the camshaft sprocket and crankshaft sprocket.



b) The entire unit mounts in the top engine case half; in the center cavity between the two pistons. Remove the four securing screws and (after the cylinders are removed) the unit can be removed.
Check for tearing or excessive wear.

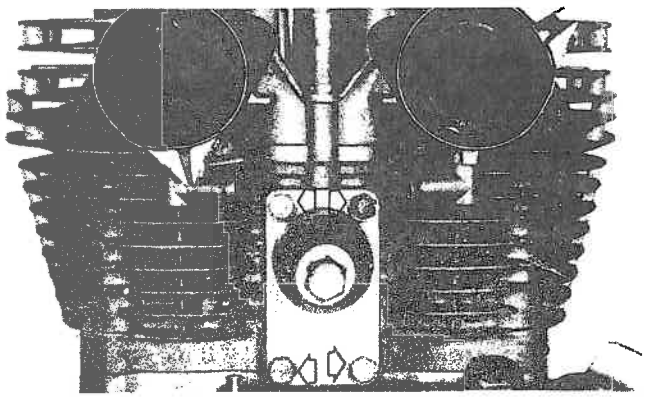
c) Note the position of the two slotted screws, these have a tapered shoulder for proper location in the cases, during reassembly replace as shown.

25) Chain Tensioner

a) The chain tensioner consists of a steel wheel that is held against the cam chain by a spring and a locked in-place push rod. This roller (which spins on needle bearings) takes up any free play in the chain. In addition, a rubber dampener solidly mounted to the tensioner arm, just below the steel wheel, helps to guide the cam chain. Because of gradual chain wear, an adjustment is required periodically.

b) Four 6 mm bolts hold the tensioner housing in place. Remove these and pull the unit out of the cylinder.

c) Reverse this procedure to install the unit. During installation, install a new gasket coated on both sides with Yamaha Bond #4.

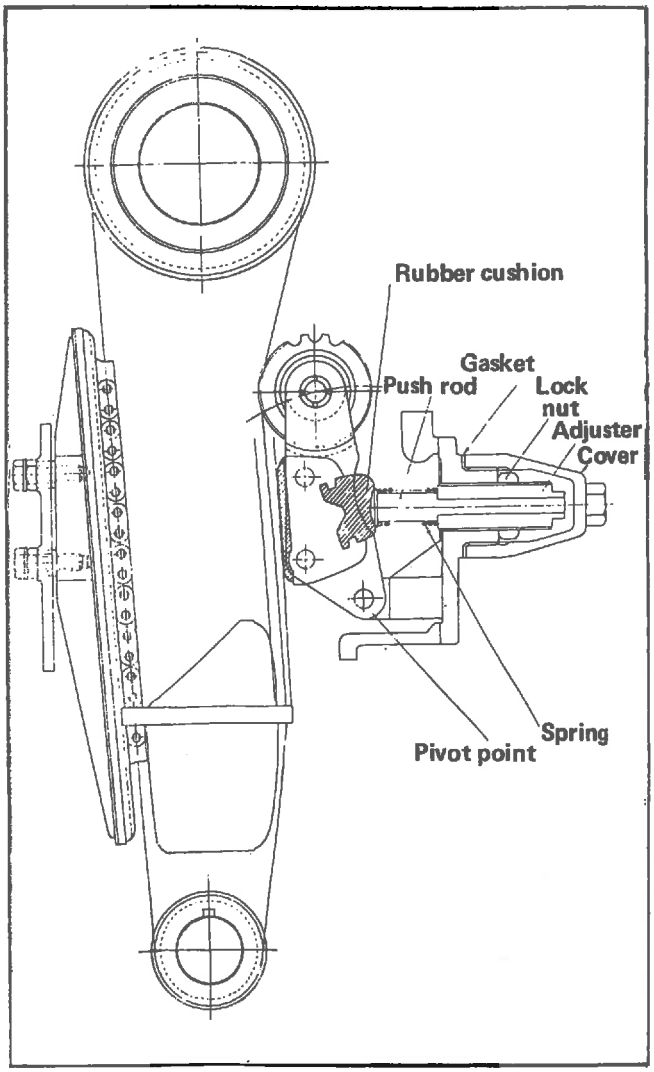


d) **Rotate the crankshaft in a counterclockwise direction (from the left side of the engine) to place all slack in the area of the chain tensioner.**

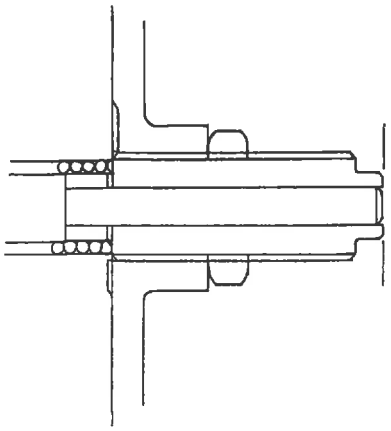
e) Remove the cast metal protective cover.

f) Loosen the tensioner lock nut.

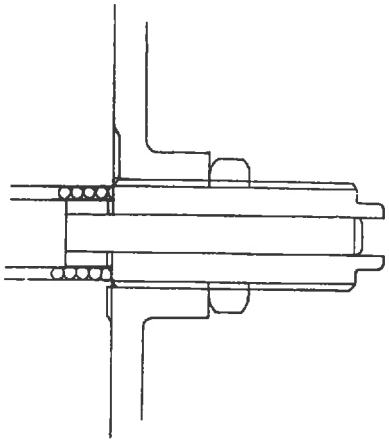
g) Use a 22 mm wrench to turn the adjustor in until the push rod (inside adjuster) is flush with the end of the adjustor.



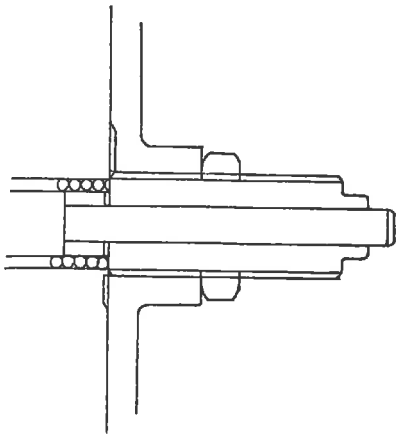
h) Tighten the lock nut and install the cover. Check this adjustment every 2,000 miles.



Tensioner correct



Tensioner needs adjustment



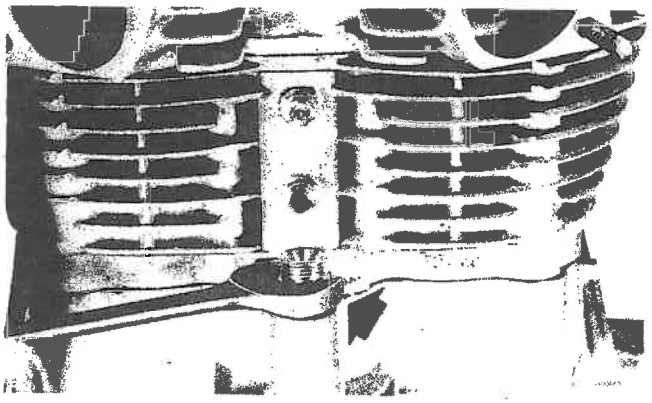
Tensioner needs adjustment

F) Cylinder & Piston Assembly

The cylinder is constructed of aluminum with cast iron sleeves. It has a cavity down the center of the cylinder that serves two purposes. First, it provides a channel for the cam chain to run in between the camshaft and the crankshaft. Secondly, it provides a space for air circulation that aids in cooling both cylinders.

1) Cylinder Removal

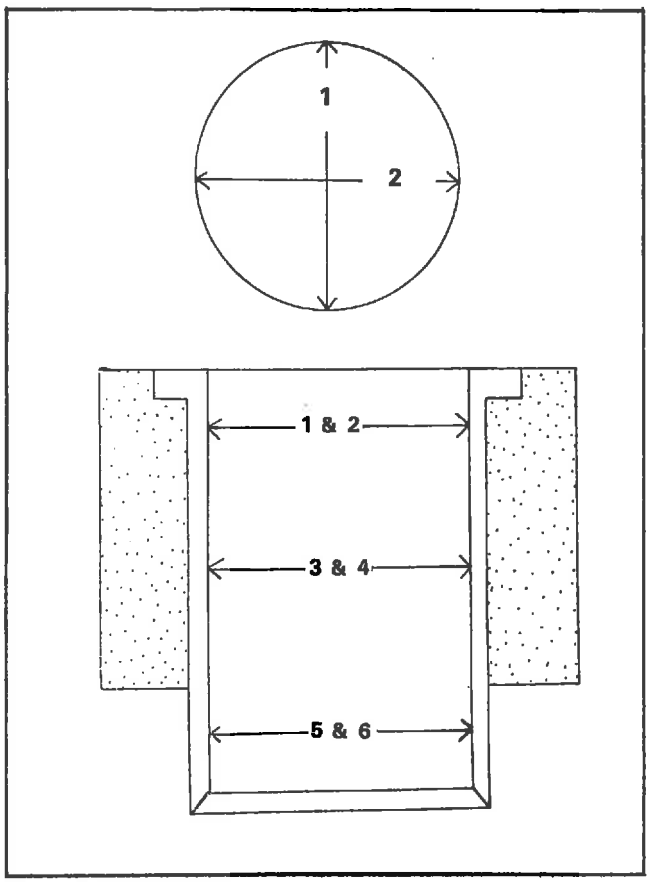
a) With the head cover and cylinder head removed, remove the oil line fitting at the front base of the cylinder. The cylinder is now free to be lifted off. The cylinder might have to be tapped a few times with a rubber hammer to break the base gasket adhesion. As the cylinder is lifted for removal, place shop rags in the crankcase opening beneath both pistons to keep any contamination or parts (such as circlips) from dropping into the crankcase.



2) Cylinder Wear and Repair Procedures

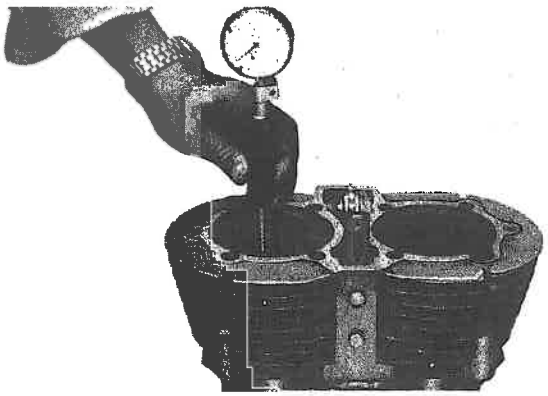
a) Constant friction between the bore and piston, plus microscopic particles of contamination that enter through the intake, cause a gradual wear of the bore. This wear can be detected by measuring various points in the bore and comparing these measurements against standard specifications.

b) This drawing shows the places to take bore measurements with a cylinder measuring gauge (tool available through Yamaha International).



c) Subtract the bottom bore measurement from the top bore measurement. The difference between these two dimensions is called the cylinder "taper". Check to see if the amount of taper is still within specified limits.

	Standard	Wear Limit
Cylinder Bore (mm)	75	75.1
Cylinder Taper (mm)	.005	.05



d) The bore might be lightly damaged with scratches or nicks. Run a hone through the bore a few times to see if the bore cleans up. If these scratches are too severe, a hone cannot remove them, and a cylinder rebore would be necessary. (Pistons are available in four oversizes: .25mm, .50mm, .75mm and 1.0mm.)

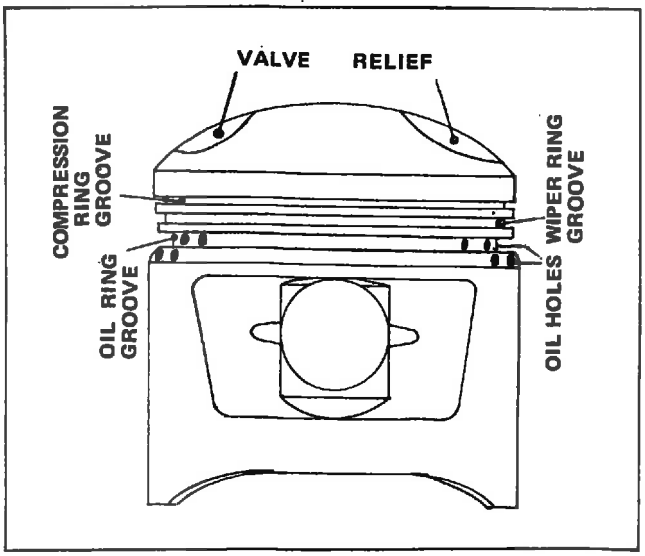
NOTE:
The hone should be used in a low rpm drill and the hone should be moved back and forth through the entire bore at an even speed. This should result in a "cross-hatch" pattern which aids ring seating.

e) If the cylinder has been in use many miles, a ridge may form at the upper edge of the bore. This is mostly carbon. Normally this ridge can be removed by scraping with a soft scraper (to prevent damage to the bore). This ridge is automatically removed if the cylinder is bored out. Care should be taken that the ridge is completely removed if the cylinder is just to be honed. If scraping does not remove the ridge, previous to honing, a ridge reamer must be used to finish removing the ridge (reamer is commercially available).

3) Piston

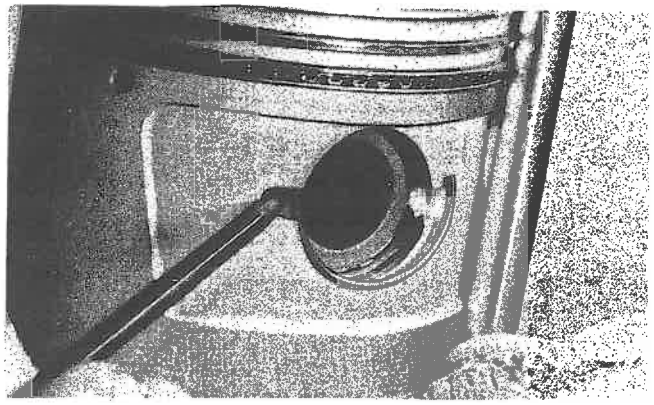
The piston crown is domed. It also has two relief areas for valve head clearance during engine operation. The relief areas are unequal in size since the intake valve is larger than the exhaust. An arrow is stamped on the crown to indicate piston position for installation. The piston should be installed with the arrow pointing forward.

Oil drain holes have been drilled in the oil scraper ring groove and in the piston wall just beneath the bottom groove. This provides an escape path for oil scraped off the cylinder wall. It also provides a path for lubrication to the piston pin and bearing.

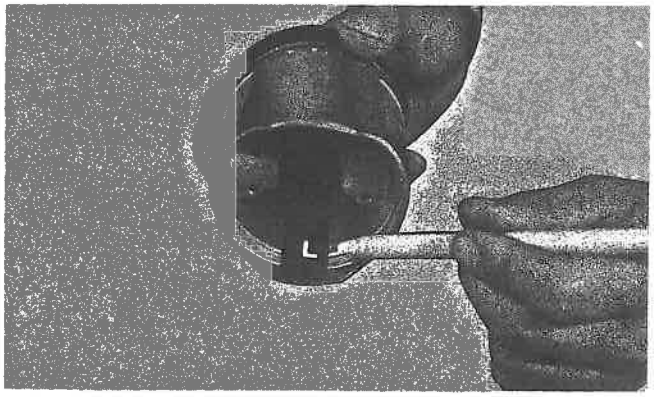


4) Piston Removal

a) Remove the outer circlip from each piston. Support the piston by hand and push out the piston pin using a soft drift (do not use a hammer). Lift the piston off and set it to one side with the piston pin.



b) Each piston must be marked as to which cylinder it came from to ensure identical match-up during re-installation. Lightly scribe an "L" inside the left piston skirt and an "R" inside the right piston skirt.



5) Piston Wear

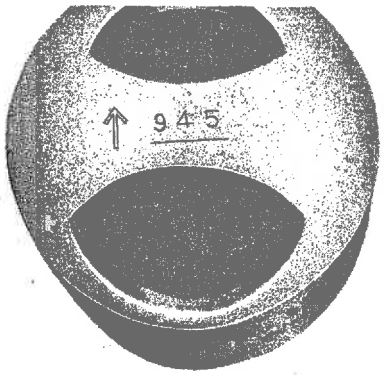
a) First, check the piston for cracked or broken sections; including the crown, ring lands, and skirt. Also check the piston crown for possible metal disintegration due to excessive heat in the combustion chamber.

b) If severe score marks are found on the skirt, this can be attributed to insufficient lubrication sometime during engine operation or improper clearance. If these marks can be removed with fine emery cloth the piston can be used again.

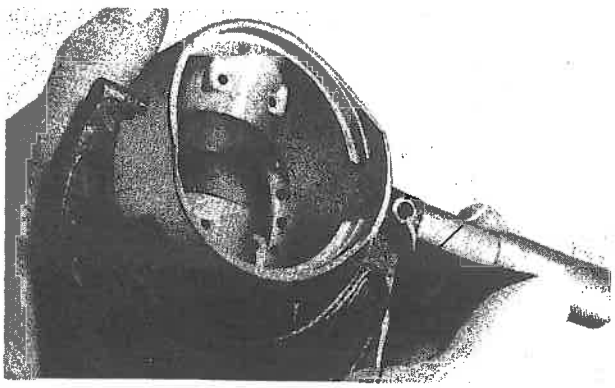
c) All of the above wear conditions may require piston replacement (except as noted). If a defective piston is reinstalled, the engine will not perform satisfactorily and premature engine failure may occur.

d) Check for additional wear by measuring piston diameter 20 mm (3/4") from the bottom of the skirt and at right angles to the piston pin holes. Piston standard size is 75 mm.

e) Standard piston wear usually does not exceed .02 mm. This measurement is important when determining piston-to-cylinder clearance.



Piston size mark



Measuring maximum piston diameter

6) Piston Clearance

a) Piston-to-bore clearance is the difference between minimum cylinder bore measurement and maximum piston diameter. Standard clearance is .050—.055 mm (.0020"—.0022"). If measurements prove that the clearance equals .10 mm or more, it is excessive, and one of two corrective measures must be taken to bring the clearance back within tolerances.

b) **First if cylinder taper is within tolerances, and if** the cylinder can be cleaned up by honing, then obtain a larger size standard piston that is large enough to obtain the correct clearance.

c) **Secondly bore and hone out the cylinder to the size of a first oversize piston, plus the correct clearance.**

d) **How to Calculate Standard Size Piston-to-Cylinder Clearance from Stamped Numbers**
Nominal piston standard size is 75 mm. The number stamped on the piston crown is the actual size. (The 74 is dropped.)

EXAMPLE:

.954 on crown really means 74.954 mm piston diameter, or .046 mm undersize.

Cylinder standard bore size is marked in large numbers on the very bottom of the cylinder. It equals 75 mm PLUS the amount marked.

EXAMPLE:

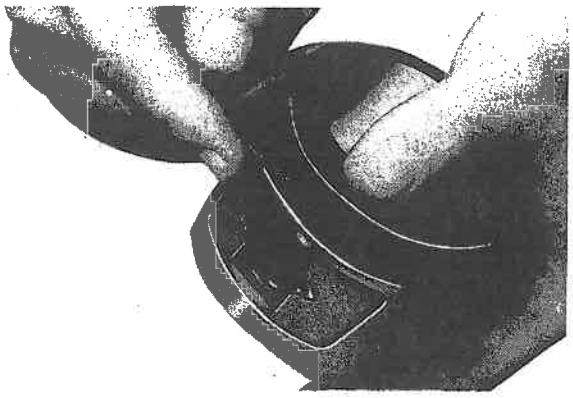
.007 marked on cylinder really means 75.007 mm cylinder bore, or .007 mm oversize.
If the above piston is used with this cylinder, total clearance would be .053 mm (.0021").

EXAMPLE:

75.007 (Cylinder)
−74.954 (Piston)
.053 (Clearance)

7) Cleaning Piston Ring Grooves

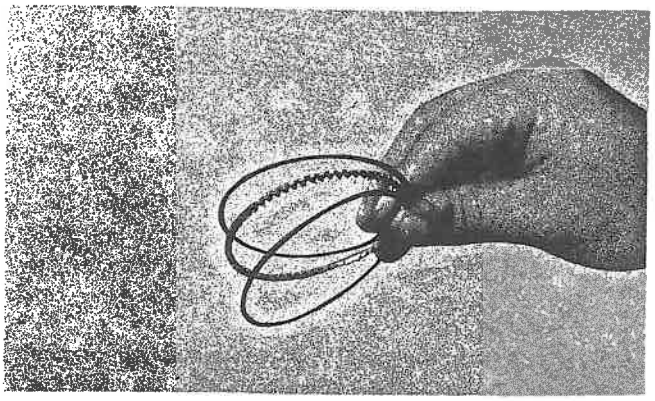
a) Carbon and varnish gradually build up in the ring grooves. Remove the rings and use the blunt end of a discarded ring to clean all carbon from the grooves. The oil ring (bottom) should not require this procedure. Check to make sure the oil relief holes are not blocked.



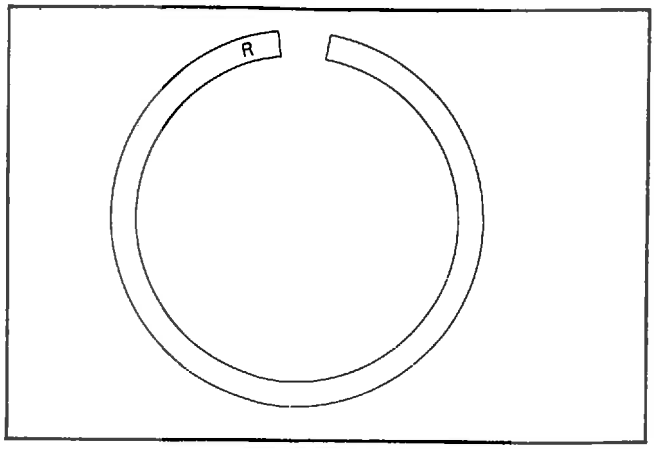
8) Piston Ring Removal and Installation

The piston is equipped with three rings. Remove them in sequence, starting with the top ring. Installation of these rings is basically a reversal of the above process, except for the bottom (oil control) ring.

a) Oil control Ring Installation (Installed first):
The oil control ring consists of three separate parts, two identical rails and one expanding spacer. First, slip the spacer over the piston, and into the bottom groove. Neither rail has a particular top side. So, install one rail into the bottom part of the groove and then position the last rail, either side up, into the top part of the groove. Finally, position the three end gaps approximately 120° from each other.

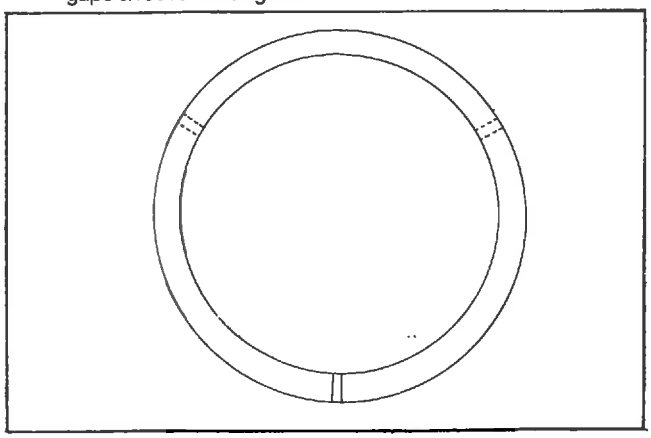


b) Middle and Top Ring Installation:
Install the middle ring and top ring. Each ring is stamped with an "R" on one side that must face up toward the piston crown when installed.



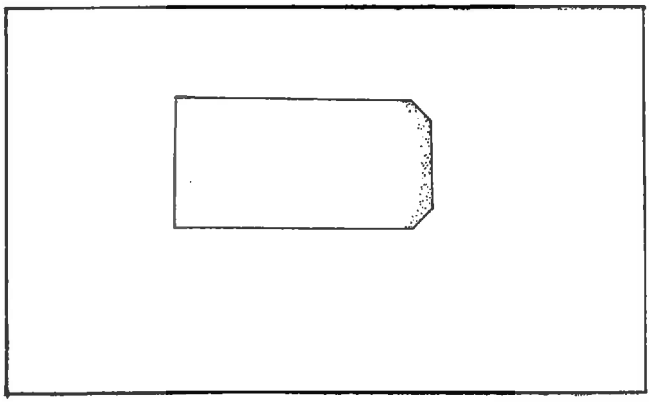
c) Spacing of All Ring End Gaps:
All ring end gaps must be off-set from one another to prevent the leakage of compression and oil.
Stagger their positions evenly around the perimeter of the piston.

NOTE:
The oil control ring has three gaps. Use the top rail's gap to judge where the compression and wiper ring gaps should be aligned.

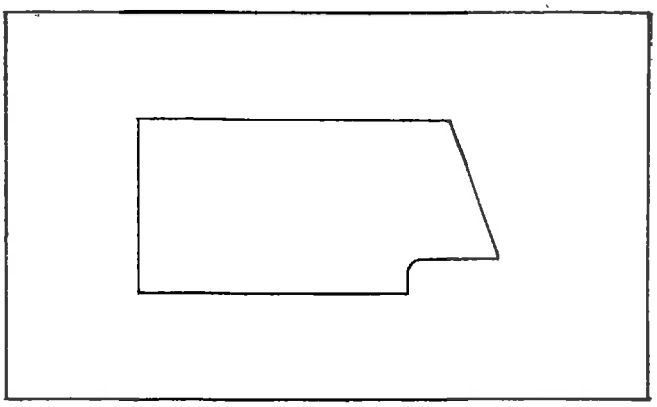


9) Piston Ring Description

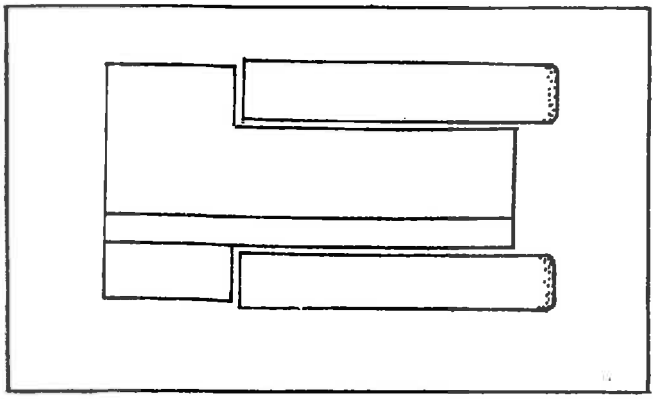
a) Top ring:
This is the compression ring. It must provide efficient sealing and must be able to withstand the greatest amount of heat. The outer edge is chrome plated for wear and heat resistance. Both outer edges of this ring are beveled (see the drawing of ring cross-sectional view) to provide a good compression sealing edge.



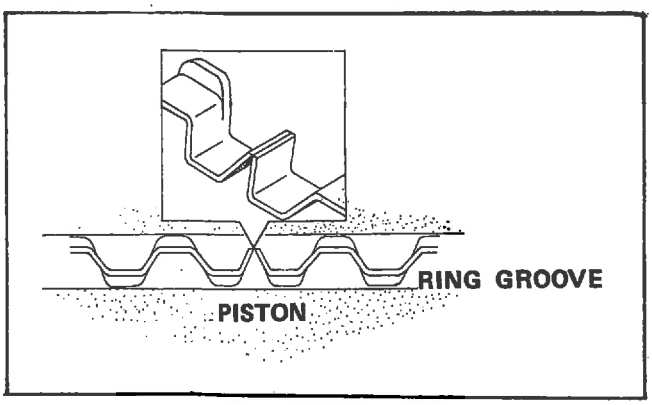
b) Middle ring:
This second ring is cast iron. It serves as a "wiper" ring to scrape excess oil from the cylinder wall. The bottom of the ring is notched to aid this process. It flexes slightly, which provides a narrow and effective scraping edge.



c) Bottom ring:
This ring's purpose is to trap and remove oil from the cylinder wall. The ring consists of three separate components: top and bottom spring steel rails, and a stainless steel wave type expanding spacer. Oil is trapped between the two rails and is forced out the holes drilled in the piston ring groove. The rail outer edge is chrome plated to resist wear.

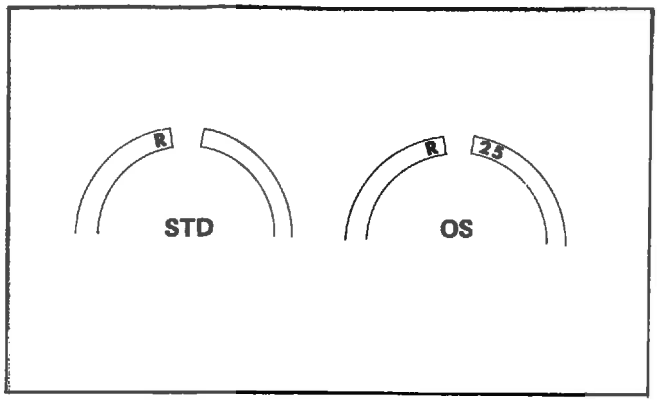


d) The expander spacer, because of its design, pushes both rails against the ring groove sides. In addition, the spacer is equipped with a projecting inner lip that pushes both rails out, creating an excellent oil trapping action.



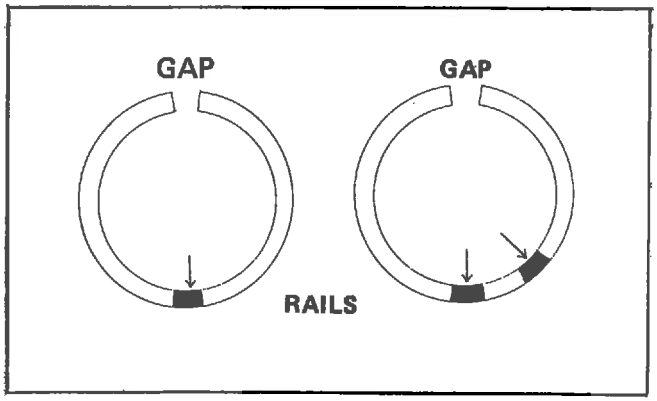
10) Piston Ring (standard and oversize) Identification Code

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



SIZE (mm)	MARK
Standard	None
Oversize 1st	25
2nd	50
3rd	75
4th	100

b) All three pieces of the bottom (oil control) ring are color-coded to identify sizes. The color marks are painted on the ring, 180° opposite the end gap (see next page).



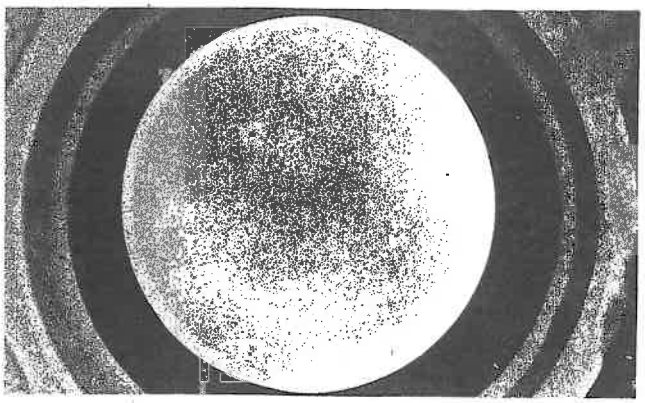
SIZE		COLOR	
Standard		Blue	(1 mark)
Oversize 1st	25 (0.25mm)	Blue	(2 marks)
2nd	50 (0.50mm)	Red	(1 mark)
3rd	75 (0.75mm)	Red	(2 marks)
4th	100 (1.0 mm)	Yellow	(1 mark)

11) Piston Ring Wear

a) All three rings experience the same type of wear. Any check applied to one ring can be used to also test the others.

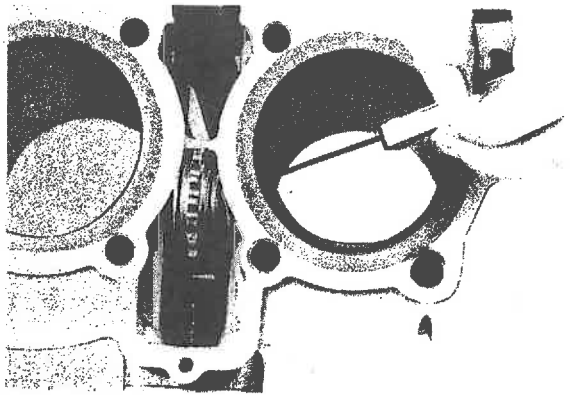
b) Before checking for wear, clean all carbon from the ring surface. This insures an accurate wear check.

c) Check for gaps between the ring contacting edge and the cylinder wall. Push the ring into the bore (with an inverted piston to make sure it is not cocked). Slip a piece of white paper beneath the cylinder bore (for visual contrast) and check the outer perimeter for visible gaps between the ring and the cylinder wall.



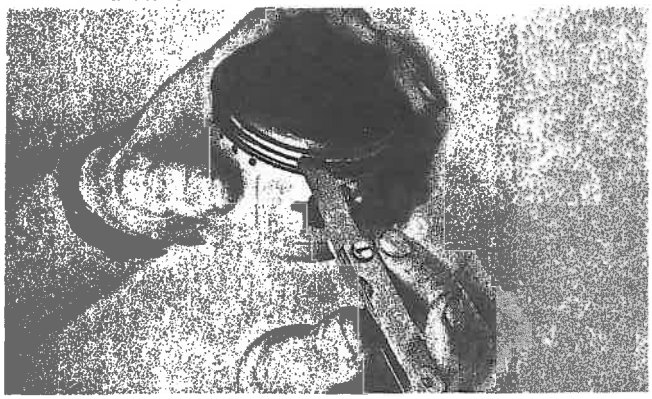
d) With the ring still positioned in the bore, check end gap clearance with a feeler gauge. Standard specifications and maximum wear limits are listed below.

NOTE:
The end gap on the expander spacer of the oil control ring is unmeasurable. If the oil control ring rail(s) show excessive gap all three components should be replaced.



	Standard Gap(mm)	Wear Limit
Compression Ring	.2 – .4	.8
Wiper Ring	.2 – .4	.8
Oil Control (Rails)	.3 – .6	1.0

e) 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, and then the ring should be reinstalled. Use a feeler gauge to measure the gap between the ring and the land. The standard tolerance is .0016" (0.04 mm) to .0032" (0.08 mm). The wear limit is .006" (.15 mm) maximum allowable clearance.



f) **NOTE:** There must be no side gap clearance at all on the oil control ring. If any clearance exists, the expander spacer has become fatigued. Replace the ring.

g) If any of the previous three wear checks prove any of the rings to be worn beyond acceptable tolerances, REPLACE THE ENTIRE SET.

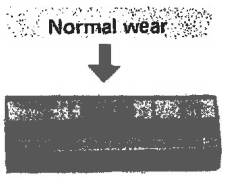
CAUTION

Whether the rings are new or used, they must always be checked for correct ring end gap clearances. This applies to all three piston rings.

12) Piston Pin

NOTE: Early XS1's utilized a needle-type wrist pin bearing. This was dropped in favor of "bushing-type" design.

a) **The piston pin does not spin in a bearing. Instead, the small end of the connecting rod has been hardened so that the rod small end boss acts as an integral bushing type bearing for the pin. If continuous operation creates a groove in the pin surface, replace the pin and examine the rod small end boss for possible replacement. A dull finish at the center section of the pin may be noticed. This is normal operating wear and does not indicate a defective pin (unless this dull surface is pitted).**



b) Check the pin for blue discoloration. This discoloration is caused by heat and is an indication of inadequate lubrication. The pin should be replaced and the lubrication system and rod checked.

CAUTION

Whenever the piston pin is replaced, check the connecting rod small end for wear which might require rod replacement.

13) Piston Installation

a) Lubricate the piston pin with oil prior to piston installation.

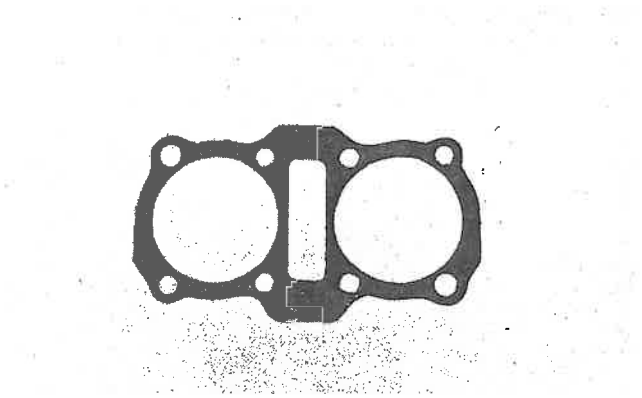
b) Mount the piston (rings installed) onto the connecting rods. Be sure the arrow stamped on the piston crown points forward. Also make sure that the left piston (already marked during removal) is fitted to the left-hand connecting rod. This guarantees that all previous clearances remain unchanged unless new parts are installed or cylinder work is done.

NOTE:

The piston pin should be a thumb-press fit into the piston. After the pin has been installed, lock it in place with two new circlips. Never use old circlips.

14) Cylinder Installation

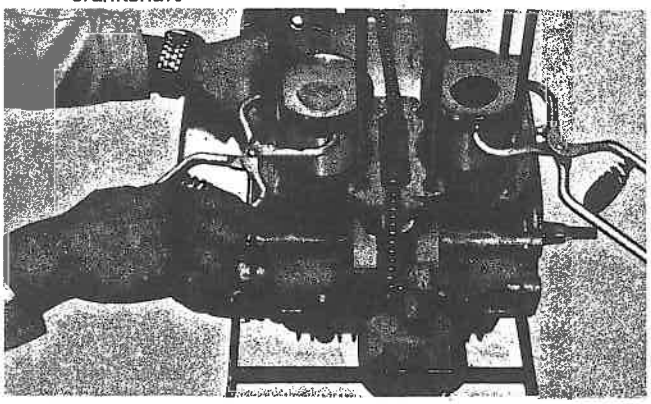
a) Make sure the crankcase and cylinder bottom matching surfaces are clean, then install a new base gasket.



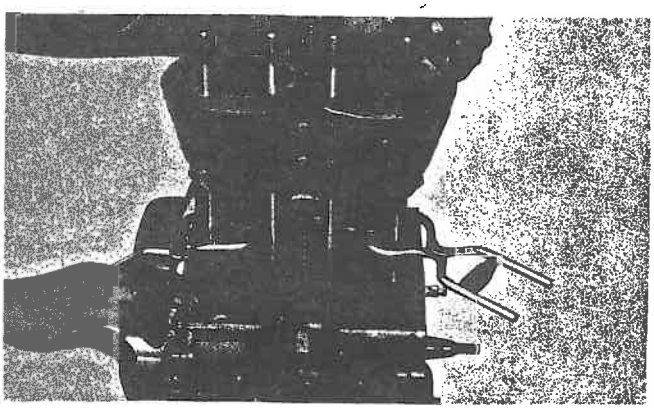
b) Check to see that the cylinder base O-rings are in place. Replace as necessary to avoid oil leakage.

c) Slip a piston support plate (found in Special Tool Kit) under each piston skirt. This prevents the pistons from being pushed down during cylinder installation. Place a rag under each support plate to protect the new bare gasket.

crankshaft



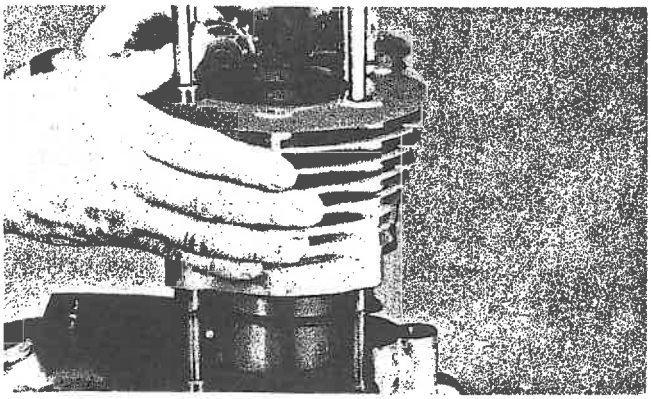
d) Lubricate the piston, pin and rings. Position and tighten the ring compressors (found in Special Tool Kit) so the rings can slip up into the cylinder without catching on the bottom of the cylinder. Lubricate both bores. Slip the cylinder down over the studs until it slips over the pistons and rests on the ring compressors.



e) Rotate the crankshaft so that the pistons slide up into the bores. Remove the ring compressors and piston bases, then push the cylinder down until it butts against the crankcase.

NOTE:

All parts should be well lubricated during assembly. When a newly rebuilt engine is started for the first time the oil supply passages will be empty and there will be a short period when no oil is delivered to various parts. It is a good idea to kick the engine over several times prior to starting to fill these passages.

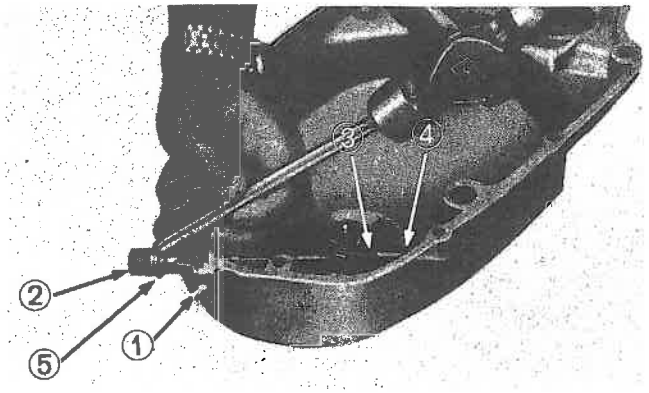


G) Primary Case

1) Tachometer Drive Removal

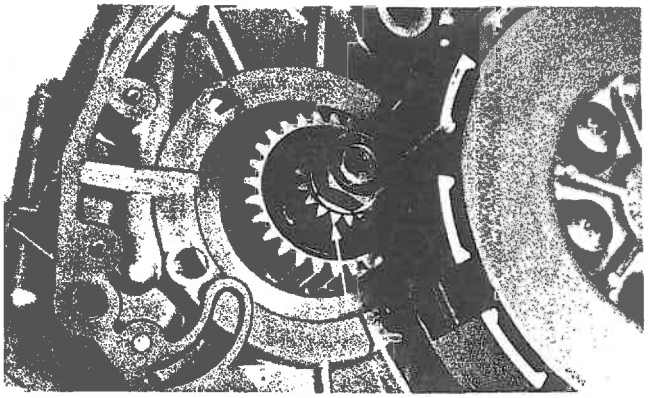
The tachometer gearing is located in the inside section of the right-hand engine case cover. Remove the case cover to remove the gears.

a) Completely unscrew the tachometer shaft lock nut (1). Drive the tachometer housing (2) out with a hammer and punch.
b) Lift the tachometer driven gear (3) out of the case.
c) Install the shaft in reverse order. Make sure the copper washer (4) is seated under the shaft. Also, check the housing O-ring (5) and replace if necessary.

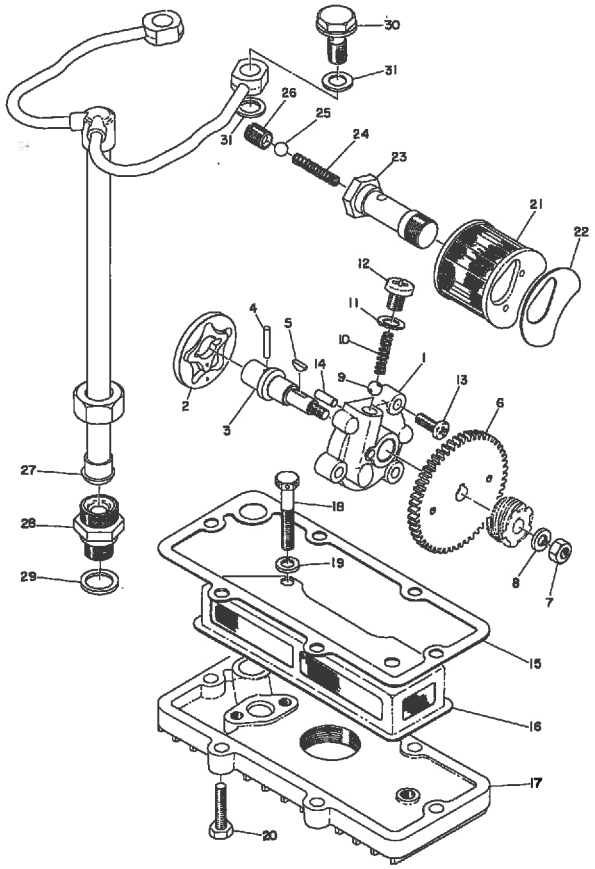


2) Oil Pump Drive

a) The pump is driven by a straight cut gear fitted to the crankshaft (outside the primary drive gear).

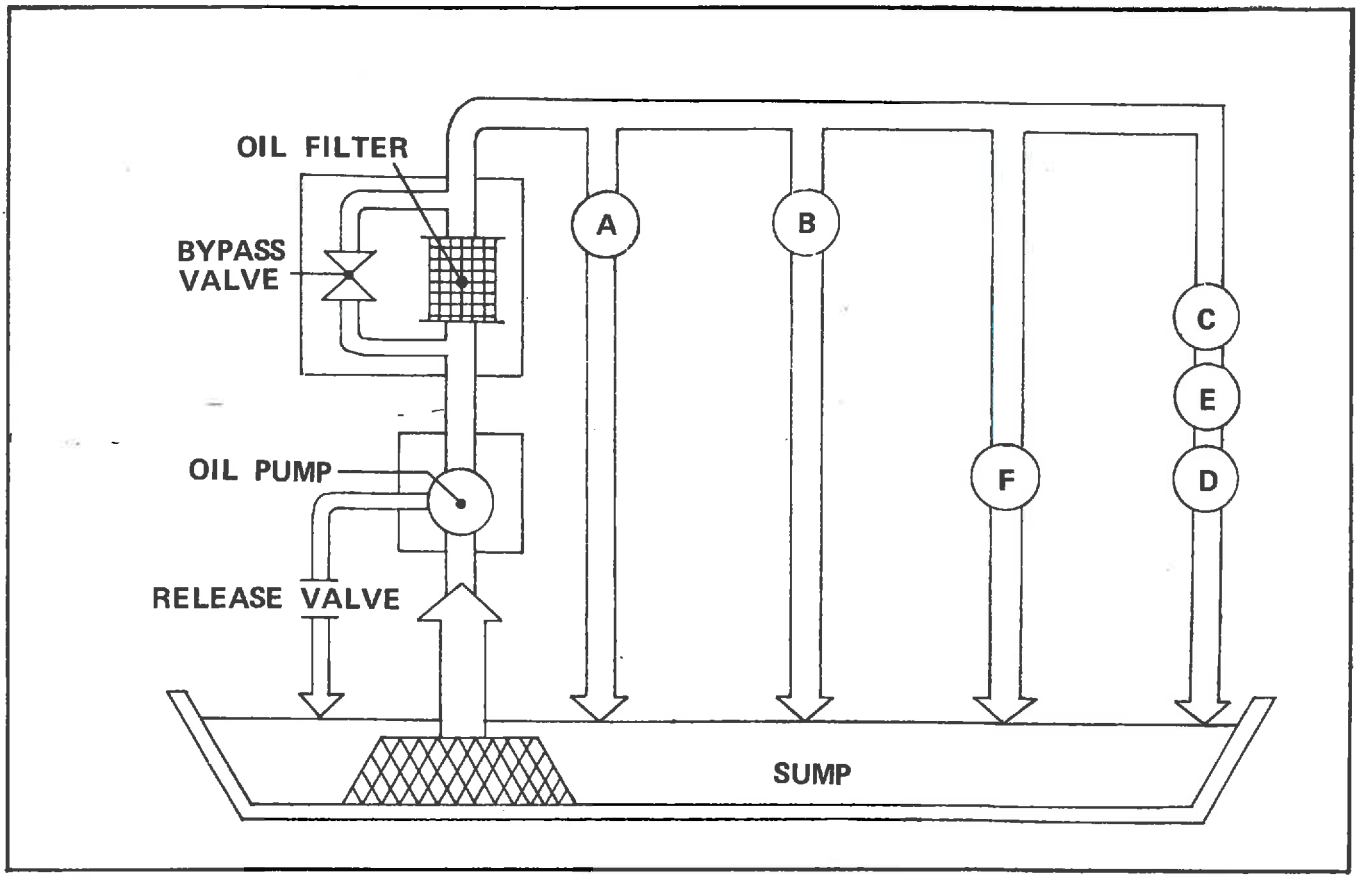


OIL PUMP



1. COVER, pump
2. ROTOR ASS'Y.
3. SHAFT
4. PIN, dowel (3-16.8)
5. KEY, woodruff
6. GEAR, driven (43T)
7. NUT
8. WASHER, spring
9. BALL (¼")
10. SPRING, release
11. GASKET
12. SCREW, pan head
13. SCREW, pan head
14. PIN, dowel
15. GASKET, strainer
16. STRAINER
17. COVER, strainer
18. BOLT
19. WASHER, spring
20. BOLT
21. ELEMENT, oil
22. GASKET, element
23. SCREW, element
24. SPRING, bypass
25. BALL (¼")
26. SCREW, spring
27. PIPE, delivery 1
28. BOLT, banjo 1
29. GASKET, banjo bolt 1
30. BOLT, banjo 2
31. GASKET, banjo bolt 2

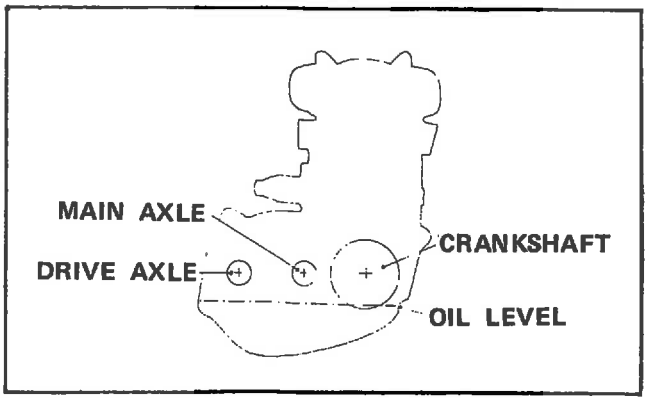
3) Oil Lubrication System



a) This machine has a "wet sump", pressure feed oiling system. Oil is stored in the crankcase. Oil passes through a wire screen filter in the bottom of the crankcase to the trochoidal oil pump (rotary type rather than plunger type). Because of pump design, oil pump pressure pulses are so frequent as to provide constant, unfluctuating oil pressure to all vital parts.

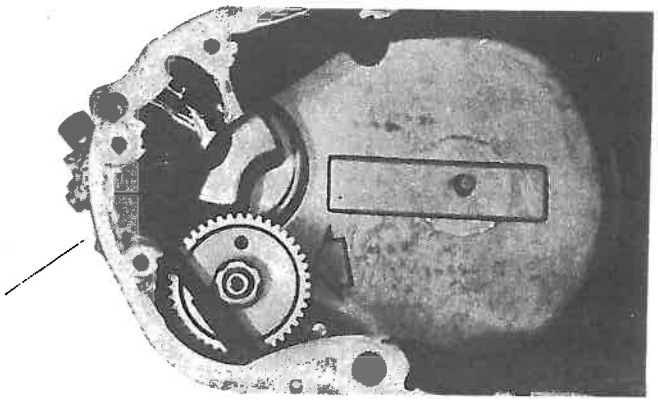
b) Oil from the pump is pushed through a fine wire mesh filter into oil passages in the cases and delivered under pressure to the following parts:
   (a) Crankshaft main bearings
   (b) Connecting rod big end
   (c) Transmission main axle
   (d) Clutch bearing
   (e) Shift fork guide bar
   (f) Rocker arms

c) The following parts are lubricated by "oil splash":
   (a) Crankshaft
   (b) Connecting rod small end
   (c) Cam chain
   (d) Piston and cylinder walls
   (e) Primary drive and driven gears

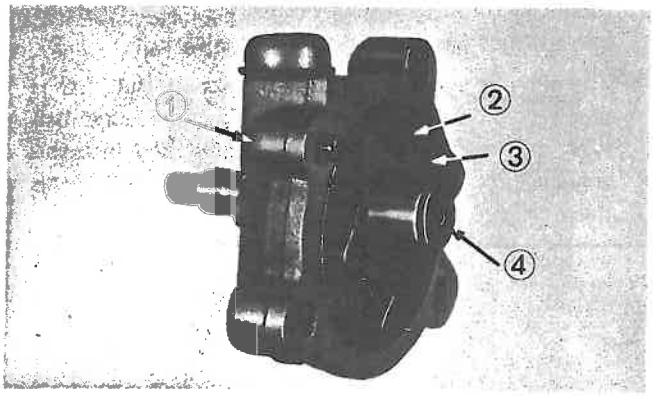


d) The oil pump is fitted with a bypass valve (check ball and spring) that permits the oil from the pump to be redirected back to the oil reservoir in case of excessive pressure in the delivery passages.

e) The oil pump fits into a cavity at the inner front portion of the right-hand case cover (behind the tachometer drive unit).



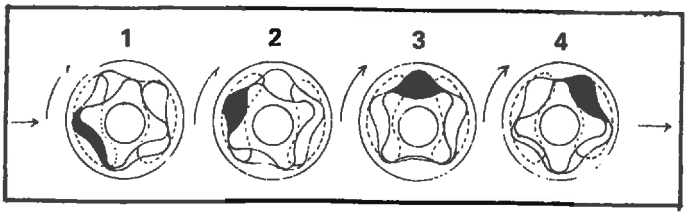
f) This is a picture of the pump after it has been removed from the cavity. The cover is constructed of aluminum and all other pump parts are made of steel.



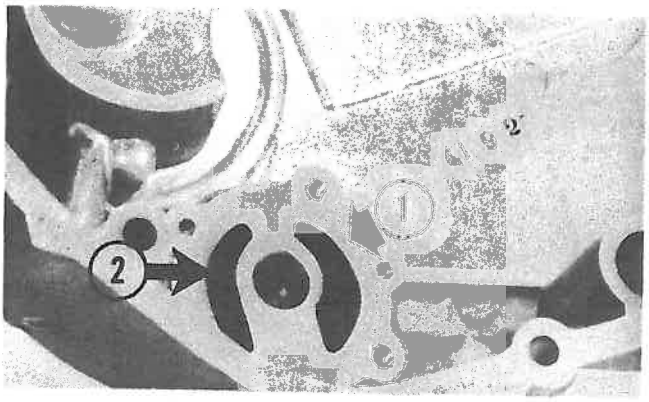
1. Aluminum Cover
2. Outer rotor
3. Inner rotor
4. Shaft

g) The shaft (#4), spins in the cover (#1). A four-pointed inner rotor (#3) is turned by the shaft. The outer rotor (#2) has five rounded notches. As the inner rotor spins, it turns the outer rotor (just like two gears intermeshed). The inner and outer rotor spin at different speeds thereby creating a changing gap between them. The gap is the oil chamber.

h) **Steps 1 through 4 (below)** show how the oil chamber first increases in size as it sucks in oil (intake passage shown in dotted outline), and then pushes the oil out the outlet passage (also shown in dotted outline). Because the rotor is equipped with four tips, there are always four stages of pumping strokes occurring, supplying a constant pressure.

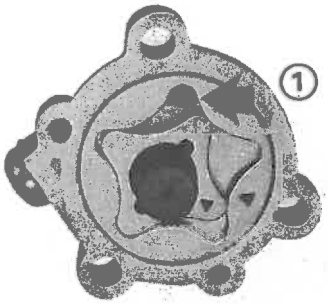


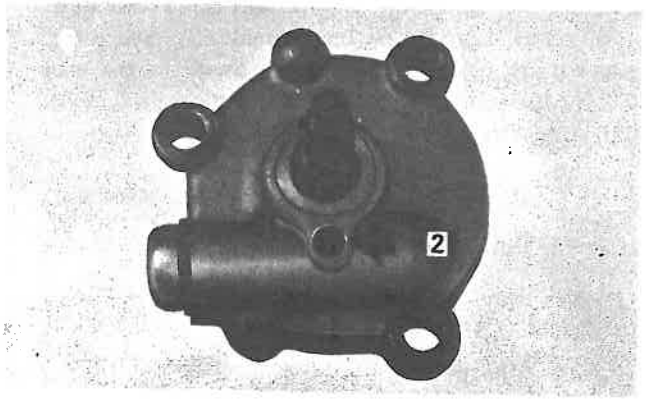
i) This picture shows the intake cavity (1) and the outlet cavity (2). Oil flows through the intake passage, into the pump. The oil pump forces it out, through the oil filter, into the oil delivery passages.



Oil inlet and outlet holes
(pump removed)

j) The cover has a drilled hole (1) that leads to a pressure relief check ball. If too much pressure develops the check ball valve releases oil back into the crankcase (2).

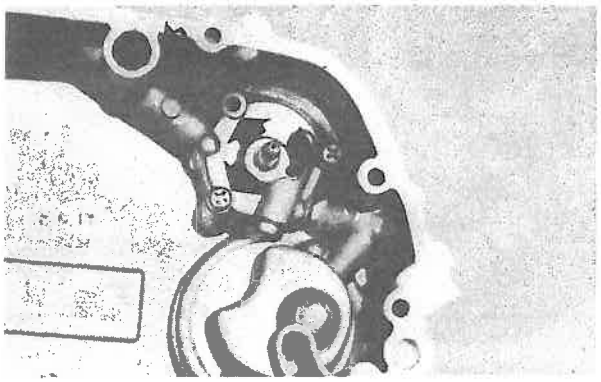




Removal and Installation

l The oil pump driven gear slips off the shaft after the tachometer drive gear has been removed. The key in the shaft must also be removed.

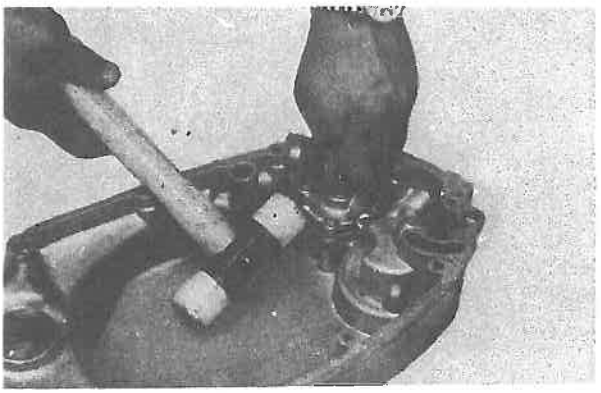
l Remove the three Phillips-head retaining screws.



oving oil pump set screws

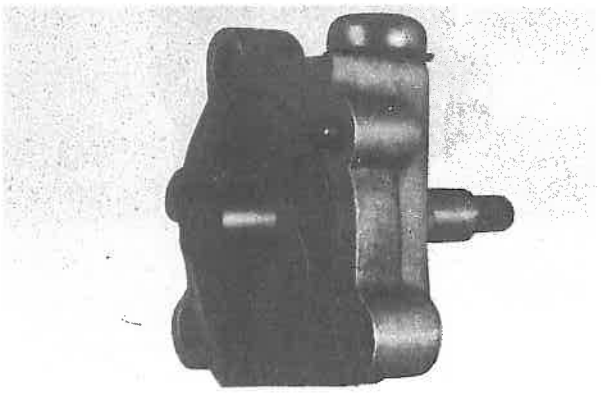
Pull up on the pump shaft while tapping on the pump until the unit comes loose.

l Lift out the inner and outer rotors if they do not come out as a unit.

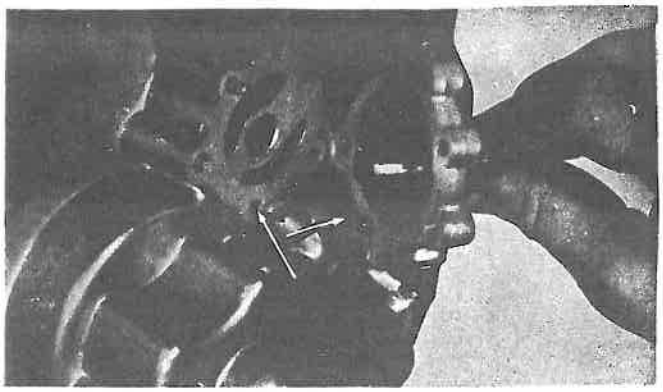


r about to be removed

Installation of the oil pump is basically a reversal of the removal procedure. Install the shaft, inner rotor, and outer rotor into the pump cavity in the case cover (be sure the notch in inner rotor lines up with the pin in the shaft).



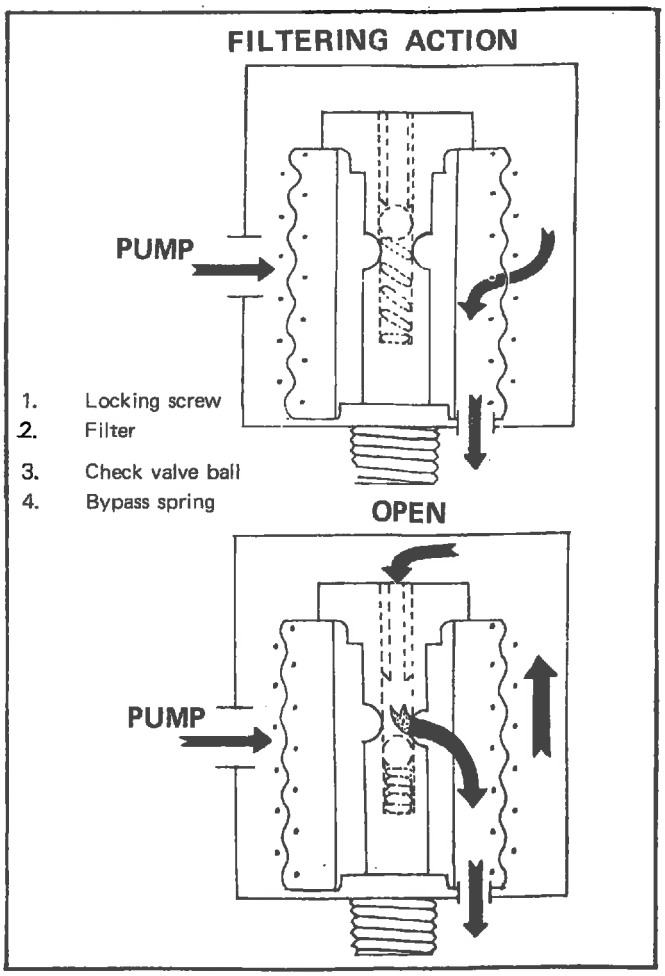
f) Slip the cover into place, using the locating pin to position the unit.



5) Oil Filter

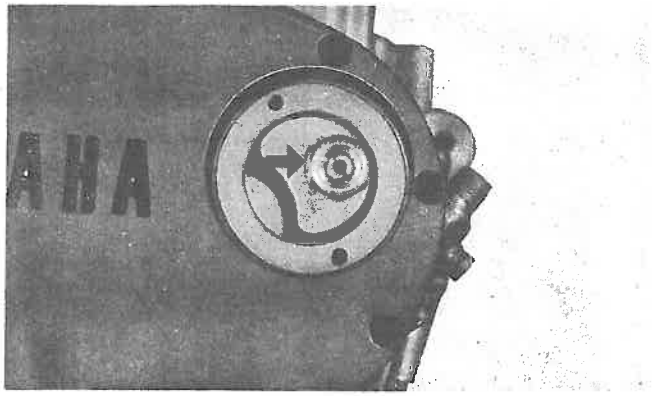
a) The stationary type oil filter, which is bolted into a recessed well in the outer right-hand cover, is constructed of fine wire mesh. Oil from the pump is forced in through the outer surface of the filter and into a drilled passage leading to the engine.

b) The filter is equipped with a bypass. If the filter is plugged, oil is forced through a spring-loaded ball type check valve in the locking bolt and into the engine delivery passage. In this manner, oil delivery to the engine will not be stopped by a clogged filter.

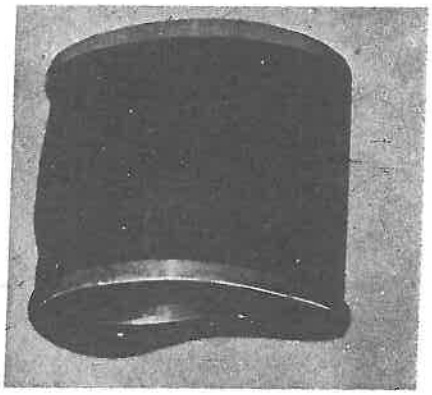


6) Oil Filter Servicing

a) The oil filter cavity in the right-hand case cover is covered by a plate held in place by two Allen screws. A circular groove cut in the plate mating surface holds an "O" ring for sealing purposes. Removing the cavity plate reveals the oil filter retaining bolt. Remove the bolt and slip the filter out.



Filter securing bolt removal



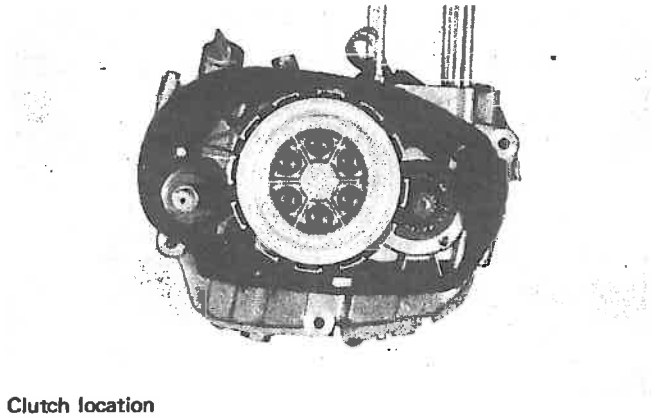
Dirty oil filter

b) With the filter out of the machine, check the rippled outer surface for trapped particles. Thoroughly clean the filter with solvent and high pressure air. Also, after the filter has been removed from the machine, clean out the oil filter cavity in the case cover.

c) Installation is accomplished by reversing the above procedure. Do not overly tighten the filter securing bolt or the filter could collapse. Also, check the cover O-ring and replace it if it is damaged.

7) Clutch & Drive Gear

a) The primary drive assembly, located on the right-hand side, consists of straight cut primary drive and driven gears with a ratio or 72/27 (2.666:1). The clutch is mounted directly to the primary driven gear. The entire clutch assembly is bolted to the transmission main axle.

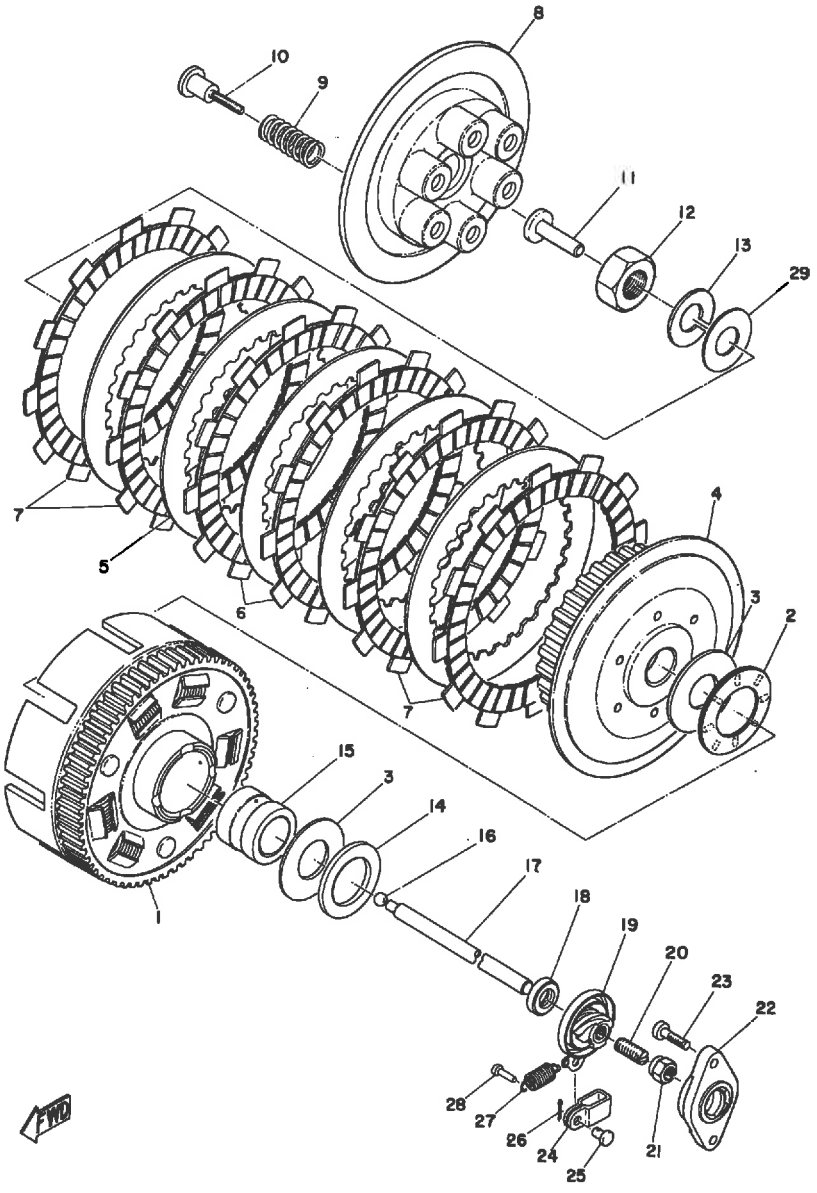


Clutch location

b) The wet, multi-plate clutch consists of five metal clutch plates and six friction plates. All six friction plates use cork friction material, but on four plates the cork is mounted on a fiber plate, while the remaining two plates consist of cork mounted on aluminum.

Six clutch springs provide the tension to hold all plates against one another. The clutch hub bushing is pressure oil fed from the main axle.

CLUTCH

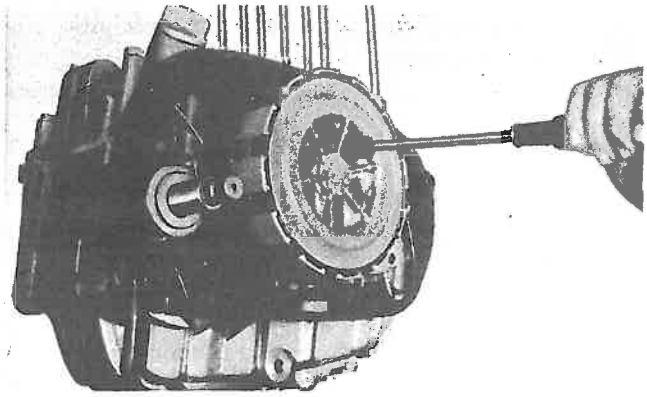


1. Driven Gear ass'y (72T)
2. Bearing
3. Thrust (2) Plate (25-50-2.0)
4. Clutch Boss
5. Clutch Plate
6. Friction plate (1)
7. Friction plate (2)
8. Pressure plate
9. Clutch spring
10. Spring screw
11. Push (1) rod
12. Lock nut
13. Spring washer
14. Plain washer (24.2-36-1.0)
15. Spacer
16. Ball (5/16")
17. Push rod
18. Oil seal (SD-8-25-6)
19. Push lever ass'y
20. Adjusting screw
21. Adjusting nut
22. Push screw housing
23. Panhead screw
24. Joint
25. Pin
26. Cotter pin
27. Return spring
28. Spring hook
29. Plain washer

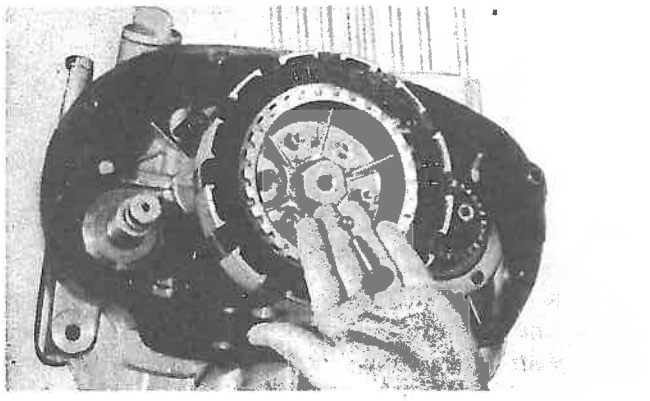
8) Clutch Removal

a) Remove all six clutch spring screws and pull off the pressure plate

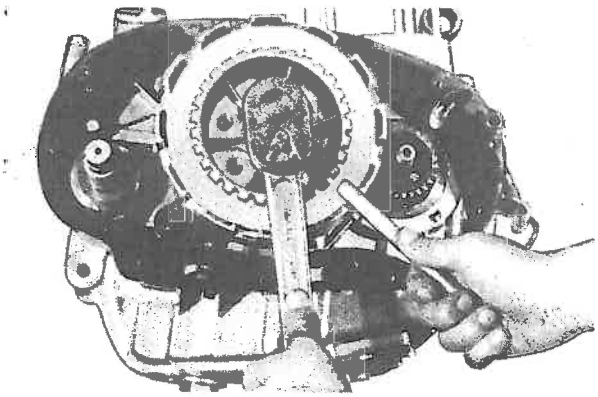
NOTE:
Loosen the screws in easy stages using a cross pattern.



b) Pull out the push crown, the ball directly behind the push crown, and the push rods behind the ball. It is most easily removed from the other end of the main shaft.



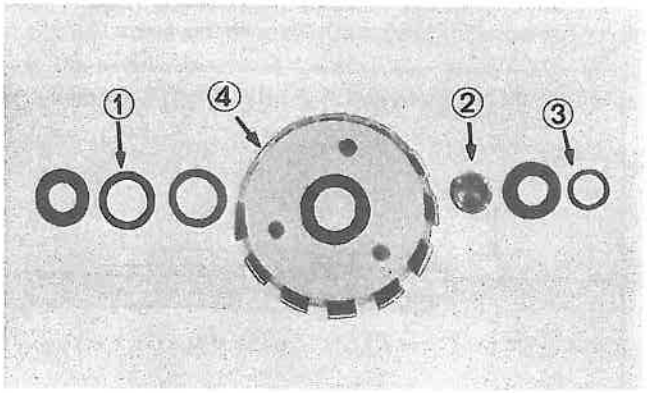
c) Hold the clutch unit with the holding tool (found in the Special Tool kit), and unscrew the clutch boss lock nut.



Removing lock nut. Clutch held stationary.

d) Slide out the clutch boss and clutch plates. Behind the boss are two thrust washers with a flat thrust bearing in between. Remove these parts.

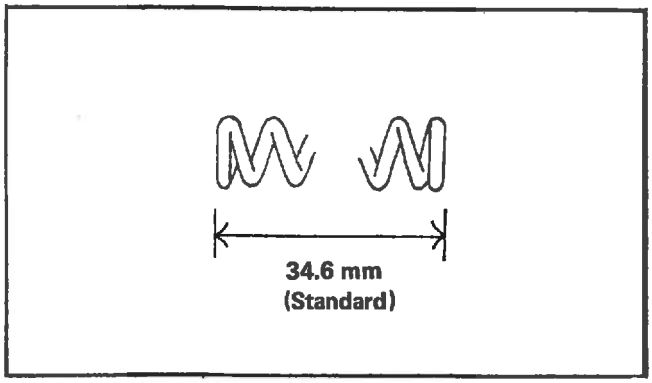
e) The clutch housing is now free. After pulling the housing off, slide off the clutch bushing spacer and thrust washer(s) behind the spacer.

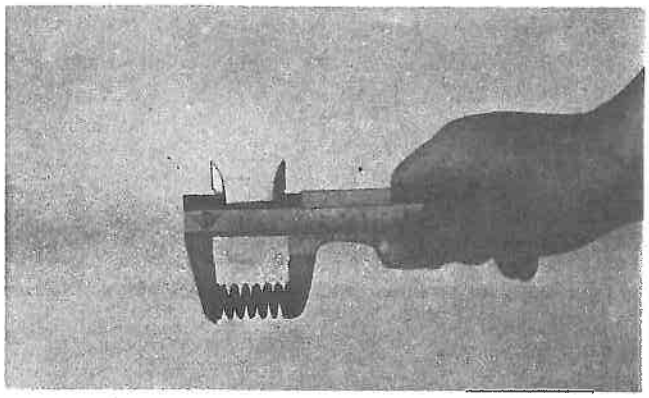


1. Thrust bearing and washers (between clutch boss and housing)
2. Bushing spacer
3. Washers (right against axle bearing)
4. Clutch housing

9) Clutch Spring Wear

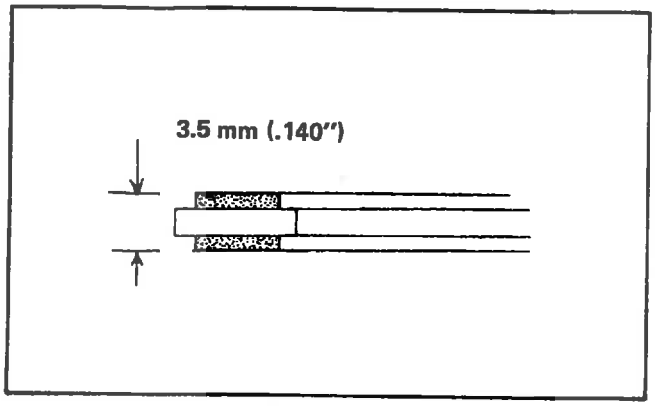
a) Measure the spring free length with vernier calipers. If standard length has shortened by 1 mm (.04") or more, replace the spring.





10) Friction Plate Wear

a) Standard thickness is 3.5 mm (.140"). If wear has decreased the thickness to 3.1 mm (.122") replace the plate (measure at two or three points).



11) Clutch Plate Wear

a) These plates must be flat. Lay each one on a surface plate and check both inner and outer edges for signs of "dishing" (a bow in the plate surface). Replace the plate if warpage exists.

b) Run a feeler gauge around the inner and outer edges. Replace any plate that is warped sufficiently to permit a .2 mm (.008") feeler gauge to slide under either edge.

12) Push Rod

a) Roll the push rod over a surface plate. If the rod is bent, or if deep grooves have been worn in the rod, replace it.

13) Clutch Installation

a) Reverse the clutch removal sequence. Tighten the clutch boss lock nut to 13 kg/m (93 ft/lbs).

(See page 162 for TX650A information.)

CAUTION

Be sure the two flat thrust washers and one flat thrust bearing are installed behind the clutch boss. Also, grease the flat thrust bearing and thrust washer closest to the clutch housing to prevent these parts from sliding forward, out of position, during clutch boss installation.

b) When installing the clutch spring bolts, screw them in until they bottom fully (approximately .8 kg/m – 5 ft/lbs. torque).

IMPORTANT NOTE: When installing the six friction plates (between the metal clutch plates), install two fiber-backed plates, then both aluminum-backed plates, and finally the remaining two fiber-backed friction plates, with the appropriate clutch plates between each friction plate.

14) Primary Drive Gear

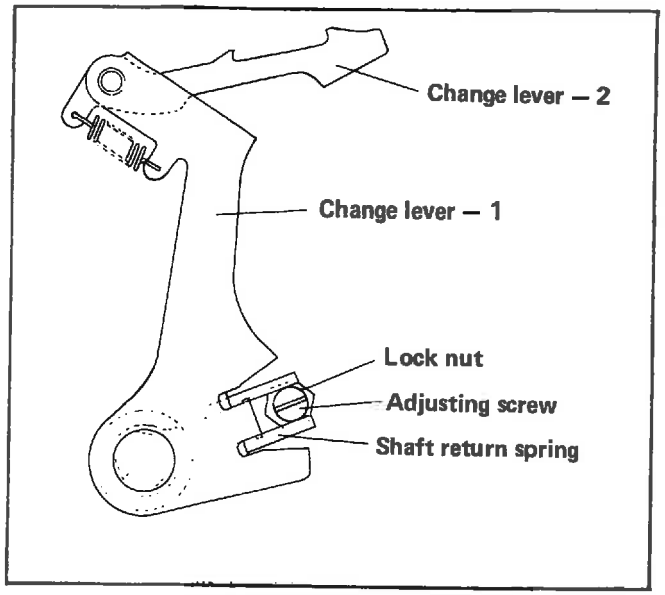
a) A nut and lock washer hold the primary drive gear (and pump drive gear in front of it) on the crankshaft. Remove the nut and washer and slide the primary drive gears off. Use a gear puller if the primary drive gear does not come off easily. A square-shaped key fits into a crankshaft keyway to prevent the drive gear from spinning.

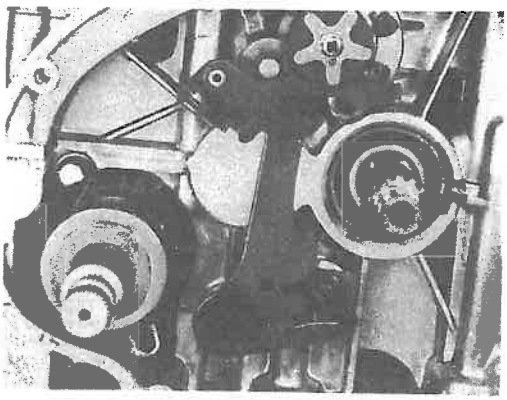
b) To install the primary drive gear, slide it onto the crankshaft. Next, line up the keyways in the gear and the shaft and insert the square-shaped key. Install and tighten the lock nut to 12 kg/m (85 ft/lbs).

CAUTION

If the primary drive gear and primary driven gear teeth do not match up fully (if there is visible tooth overlay to one side), check the possibility of incorrect clutch installation.

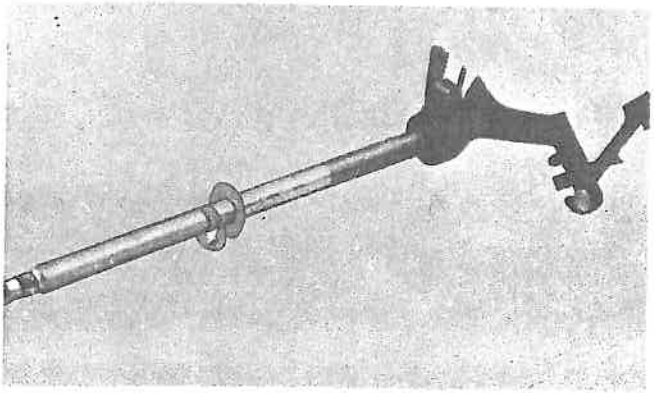
15) Shift Shaft Assembly Removal





Shift shaft unit in neutral position

a) Remove the shift shaft retaining "C" clip and washer (left-hand side), then pull the entire assembly out from the right-hand side.

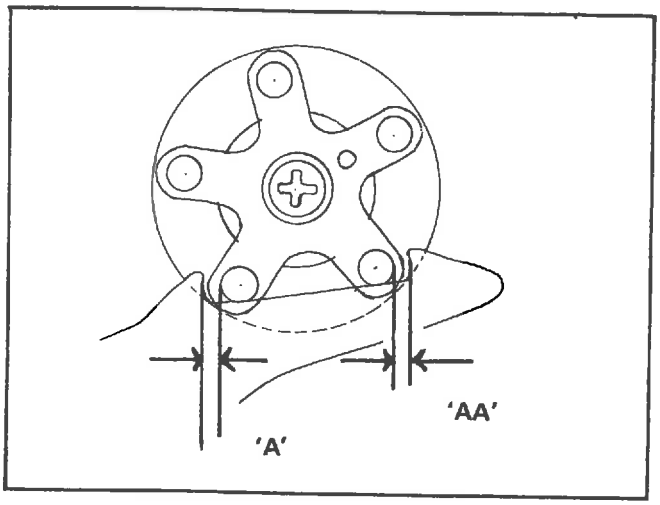


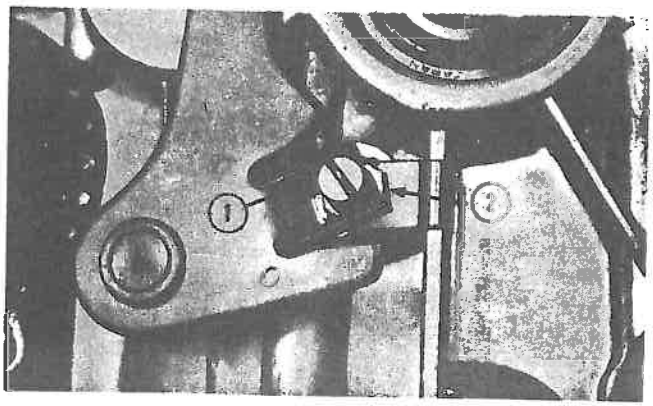
b) Installation is accomplished by inserting the shift shaft from the right-hand side and installing the washer and "C" clip.

16) Shift Adjustment

a) If shifting adjustment is correct, distances "A" and "AA" will be equal (see this page). It these are not equal, loosen the screw lock nut (2) and rotate the eccentric screw (1) until "A" and "AA" become equal. Retighten the lock nut and bend up the tab.

NOTE:
Make this adjustment in second, third, or fourth gear.

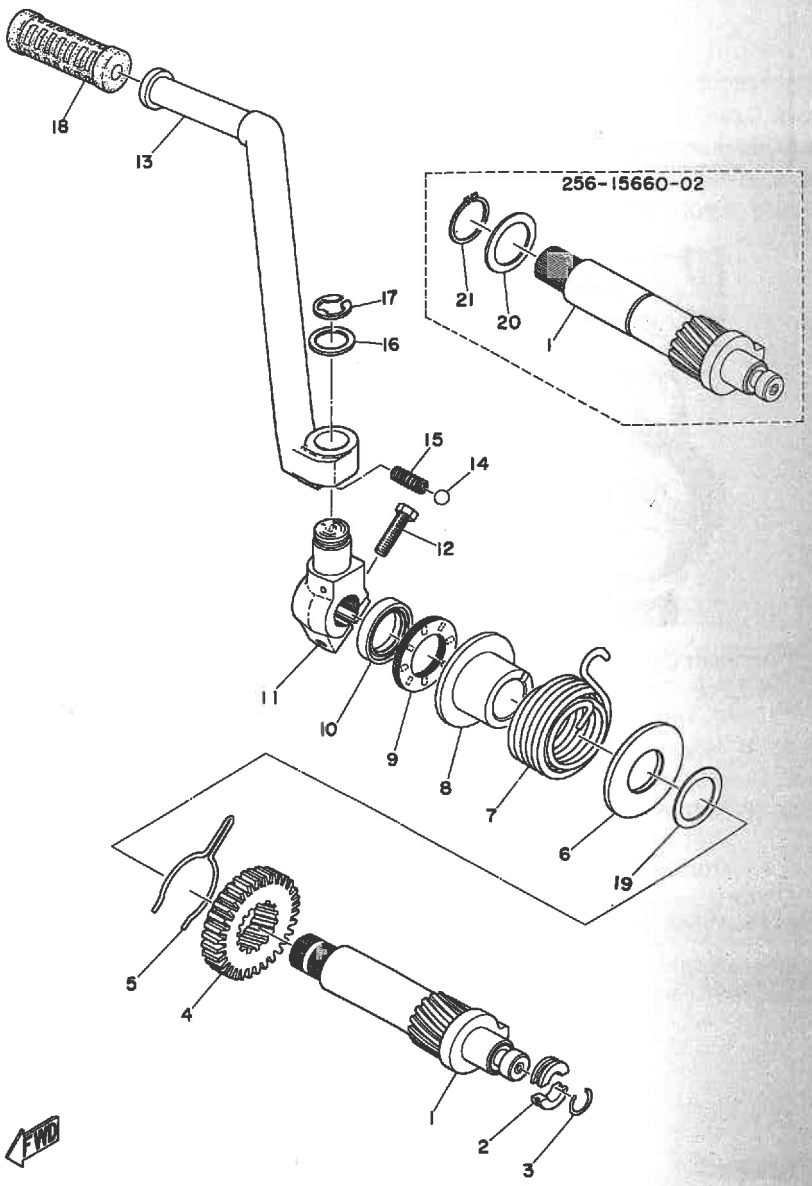




17) Kick Starter Assembly

(See page 162 for TX650A information.)

STARTER



1. Kick axle ass'y
2. Holder
3. Clip
4. Kick gear
5. Kick clip
6. Spacer (25.4—53-4)
7. Skick spring
8. Spring guide
9. Thrust bearing
10. Oil seal (SD-25-35-7)
11. Kick crank boss
12. Bolt
13. Kick crank
14. Ball (5/16")
15. Boss stopper spring
16. Washer
17. Circlip (E-12)
18. Kick lever cover
19. Shim (25.5-35-0.5)
20. Shim (25.2-36-1.0)
21. Circlip (S-25)