






Chapter 2

Engine, clutch and transmission

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Degrees of difficulty

<p>Easy, suitable for novice with little experience</p> 	<p>Fairly easy, suitable for beginner with some experience</p> 	<p>Fairly difficult, suitable for competent DIY mechanic</p> 	<p>Difficult, suitable for experienced DIY mechanic</p> 	<p>Very difficult, suitable for expert DIY or professional</p> 
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Specifications

2»2 Engine, clutch and transmission

Camshafts

Intake lobe height

YZF models

Standard	32.75 to 32.85 mm
Service limit (min)	32.70 mm

FZS models

Standard	32.75 to 32.85 mm
Service limit (min)	32.70 mm

Exhaust lobe height

YZF models

Standard	32.55 to 32.65 mm
Service limit (min)	32.50 mm

FZS models

Standard	32.45 to 32.55 mm
Service limit (min)	32.00 mm

Journal diameter. 22.967 to 22.980 mm

Journal holder diameter. 23.000 to 23.021 mm

Journal oil clearance

Standard	0.020 to 0.054 mm
Service limit	0.080 mm

Runout(max)

YZF models	0.06 mm
FZS models	0.03 mm

Cylinder head

Warpage (max). 0.05 mm

Valves, guides and springs

Valve clearances. see Chapter 1

Intake valve

Stem diameter

Standard	3.975 to 3.990 mm
Service limit (min)	3.950 mm

Guide bore diameter

Standard	4.000 to 4.012 mm
Service limit (max)	4.042 mm

Stem-to-guide clearance

Standard	0.010 to 0.037 mm
Service limit (max)	0.080 mm

Head diameter. 23.9 to 24.1 mm

Face width. 1.56 to 2.40 mm

Seat width

Standard	0.9 to 1.1 mm
Service limit	1.6 mm

Margin thickness

Standard	0.6 to 0.8 mm
Service limit	0.5 mm

Valve lift

YZF models

Standard	7.652 to 7.852 mm
Service limit	7.500 mm

FZS models

Standard	7.65 to 7.85 mm
Service limit	7.50 mm

Exhaust valve

Stem diameter

Standard	3.960 to 3.975 mm
Service limit (min)	3.935 mm

Guide bore diameter

Standard	4.000 to 4.012 mm
Service limit (max)	4.042 mm

Stem-to-guide clearance

Standard	0.025 to 0.052 mm
Service limit (max)	0.100 mm

Head diameter. 20.9 to 21.1 mm

Face width 1.56 to 2.40 mm

Valves, guides and springs (continued)

Exhaust valve (continued)

Seat width	
Standard	0.9 to 1.1 mm
Service limit	1.6 mm
Margin thickness	
Standard	0.6 to 0.8 mm
Service limit	0.5 mm
Valve lift	
YZF models	
Standard	7.452 to 7.652 mm
Service limit	7.300 mm
FZS models	
Standard	7.40 to 7.60 mm
Service limit	7.25 mm
Valve stem runout (max)	0.04 mm
Valve springs free length (intake and exhaust)	
Standard	40.09 mm
Service limit (min)	37.5 mm
Valve spring bend (max)	1.8 mm

Cylinder block

Bore

Standard	62.000 to 62.010 mm
Service limit (max)	62.100 mm
Warpage (max)	0.05 mm
Ovality (out-of-round) (max)	0.07 mm
Taper (max)	0.09 mm
Cylinder compression	see Chapter 1

Pistons

Diameter (measured 5.0 mm up from skirt, at 90° to piston pin axis)	61.960 to 61.975 mm
Piston-to-bore clearance	
Standard	0.025 to 0.050 mm
Service limit (max)	0.070 mm
Piston pin diameter	
Standard	16.991 to 17.000 mm
Service limit (min)	16.975 mm
Piston pin bore diameter in piston	
Standard	17.002 to 17.013 mm
Service limit (max)	17.040 mm
Piston pin-to-piston pin bore clearance	
Standard	0.002 to 0.022 mm
Service limit	0.065 mm

Piston rings

Top ring

Ring width	2.2 mm
Ring thickness	0.8 mm
Ring end gap (installed)	
Standard	0.15 to 0.30 mm
Service limit (max)	0.60 mm
Piston ring-to-groove clearance	
Standard	0.020 to 0.075 mm
Service limit (max)	0.100 mm

2nd ring

Ring width	2.3 mm
Ring thickness	0.8 mm
Ring end gap (installed)	
Standard	0.25 to 0.40 mm
Service limit (max)	0.70 mm
Piston ring-to-groove clearance	
Standard	0.020 to 0.055 mm
Service limit (max)	0.100 mm

Oil ring

Ring width	2.30 mm
Ring thickness	1.50 mm
Side-rail end gap (installed)	0.10 to 0.35 mm

2»4 Engine, clutch and transmission

Clutch

YZF models

Friction plates	
Quantity - black type	2
Thickness	
Standard	2.92 to 3.08 mm
Service limit (min)	2.80 mm
Quantity - ordinary type	7
Thickness	
Standard	2.92 to 3.08 mm
Service limit (min)	2.80 mm
Plain plates	
Quantity	8
Thickness	1.9 to 2.1 mm
Warpage (max)	0.1 mm
Clutch springs - long	
Quantity	3
Spring free length	
Standard	40.4 mm
Service limit (min)	39.9 mm
Clutch springs - short	
Quantity	3
Spring free length	
Standard	38.3 mm
Service limit (min)	37.5 mm
Pushrod bend (max)	0.3 mm

FZS models

Friction plates	
Quantity - ordinary type	8
Thickness	
Standard	2.94 to 3.06 mm
Service limit (min)	2.80 mm
Quantity - second innermost plate with larger internal diameter	1
Thickness	
Standard	2.94 to 3.06 mm
Service limit (min)	2.80 mm
Plain plates	
Quantity	8
Thickness	1.9 to 2.1 mm
Warpage (max)	0.1 mm
Clutch springs	
Quantity	6
Spring free length	
Standard	34.9 mm
Service limit (min)	34.3 mm
Clutch housing thrust clearance	
Standard	0.05 to 0.13 mm
Service limit	0.20 mm
Clutch housing radial clearance	0.005 to 0.041 mm
Pushrod bend (max)	0.3 mm

Lubrication system

Oil pressure	see Chapter 1
Relief valve opening pressure	64 to 78 psi
Oil pump	
Inner rotor tip-to-outer rotor clearance	
Standard	0.03 to 0.09 mm
Service limit (max)	0.15 mm
Outer rotor-to-body clearance	
Standard	0.03 to 0.08 mm
Service limit (max)	0.15 mm
Rotor end-float	
Standard	0.03 to 0.08 mm
Service limit (max)	0.15 mm



Connecting rods

Big-end side clearance	
Standard	.0.160 to 0.262 mm
Service limit (max)	.0.500 mm
Big-end radial clearance	
Standard	.0.043 to 0.066 mm
Service limit (max)	.0.080 mm
Big-end oil clearance	
Standard	.0.043 to 0.066 mm
Service limit (max)	.0.080 mm

Crankshaft and bearings

Main bearing oil clearance	
Standard	.0.025 to 0.043 mm
Service limit (max)	.0.080 mm
Runout (max)	.0.03 mm

Transmission

Gear ratios (no. of teeth)	
Primary reduction	.1.708 to 1 (82/48T)
Final reduction	
YZF models	.3.133 to 1 (47/15T)
FZS models	.3.200 to 1 (48/15T)
1st gear	.2.846 to 1 (37/13T)
2nd gear	.1.947 to 1 (37/19T)
3rd gear	.1.545 to 1 (34/22T)
4th gear	.1.333 to 1 (28/21T)
5th gear	.1.190 to 1 (25/21T)
6th gear	.1.074 to 1 (29/27T)
Shaft runout (max)	.0.02 mm

Selector drum and forks

Selector fork shaft runout (max)	.0.05 mm
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Torque settings

Alternator cover bolts	.12 Nm
Cam chain tensioner blade bolts	.10 Nm
Cam chain tensioner cap bolt	.20 Nm
Cam chain tensioner mounting bolts	.10 Nm
Camshaft holder bolts	.10 Nm
Camshaft sprocket bolts	.24 Nm
Clutch cover bolts	.12 Nm
Clutch nut	.70 Nm
Clutch spring bolts	.8 Nm
Connecting rod cap nuts (see text)	
Initial setting	.15 Nm
Final setting	.Turn a further 90°
Coolant inlet union to cylinder block bolts	.10 Nm
Coolant outlet union to cylinder head bolts	
YZF models	.7 Nm
FZS models	.10 Nm
Coolant pipe bolts (water pump to inlet union) (YZF models)	.7 Nm
Crankcase	
6 mm bolts	.12 Nm
8 mm bolts	.24 Nm
Cylinder head nuts	
Initial setting	.20 Nm
Final setting	.35 Nm
Engine mounting bolts	
YZF models	
Front mounting bolts	.54 Nm
Left-hand front mounting bolt lug pinch bolts	.64 Nm
Lower rear mounting bolt nut	.48 Nm
Upper rear mounting bolt nut	.48 Nm

2»6 Engine, clutch and transmission

Torque settings (continued)

Engine mounting bolts (continued)

FZS models	
Exhaust system mounting bracket nut . . . . .	.40 Nm
Front mounting bolt nuts . . . . .	.55 Nm
Front mounting bracket bolts . . . . .	.33 Nm
Lower rear mounting bolt nut . . . . .	.55 Nm
Upper rear mounting bolt nut . . . . .	.55 Nm
Upper rear mounting bracket bolts . . . . .	.33 Nm
Front sprocket cover bolts . . . . .	.10 Nm
Gearchange shaft centralising spring locating pin	
YZF models . . . . .	.22 Nm
FZS models . . . . .	.10 Nm
Oil cooler bolt . . . . .	.63 Nm
Oil pipe banjo bolts . . . . .	.20 Nm
Oil pipe clamp bolt . . . . .	.10Nm
Oil pump assembly screw . . . . .	.7 Nm
Oil pump mounting bolts . . . . .	.10 Nm
Oil seal retainer plate bolts . . . . .	.10Nm
Oil strainer housing bolts . . . . .	.10Nm
Oil sump bolts . . . . .	.12 Nm
Selector fork shaft and selector drum retainer plate bolts/locating pin . . . . .	.10 Nm
Starter clutch body bolts . . . . .	.30 Nm
Starter clutch bolt . . . . .	.80 Nm
Starter clutch cover bolts . . . . .	.12 Nm
Stopper arm bolt . . . . .	.10 Nm
Top cam chain guide bolts . . . . .	.10 Nm
Valve cover bolts . . . . .	.10Nm
Valve cover end cover bolts (FZS models) . . . . .	.9 Nm

1 General information

The engine/transmission unit is a liquid-cooled in-line four cylinder unit with four valves per cylinder. The valves are operated by double overhead camshafts which are chain driven off the crankshaft. The engine/transmission assembly is constructed from aluminium alloy. The crankcase is divided horizontally.

The crankcase incorporates a wet sump, pressure-fed lubrication system which uses a gear-driven, dual-rotor oil pump, an oil filter and by-pass valve assembly, a relief valve and an oil level switch. The pump is driven by a gear on the back of the clutch housing. The oil is cooled by a cooler which is fed off the engine cooling system.

The alternator is on the left-hand end of the crankshaft, and the starter clutch is on the right-hand end.

Power from the crankshaft is routed to the transmission via the clutch. The clutch is of the wet, multi-plate type and is gear-driven off the crankshaft. The transmission is a six-speed constant-mesh unit. Final drive to the rear wheel is by chain and sprockets.

2 Operations possible with the engine in the frame

The components and assemblies listed

below can be removed without having to remove the engine/transmission assembly from the frame. If however, a number of areas require attention at the same time, removal of the engine is recommended.

Valve cover
Camshafts
Cylinder head
Cylinder block, pistons and piston rings
Clutch
Oil pump
Gearchangemechanism
Alternator
Pick-up coil assembly
Starter clutch
Oil filter and cooler
Oil sump, oil strainer and oil pressure relief valve (YZF models)
Starter motor
Water pump
Selector drum and forks (YZF models)

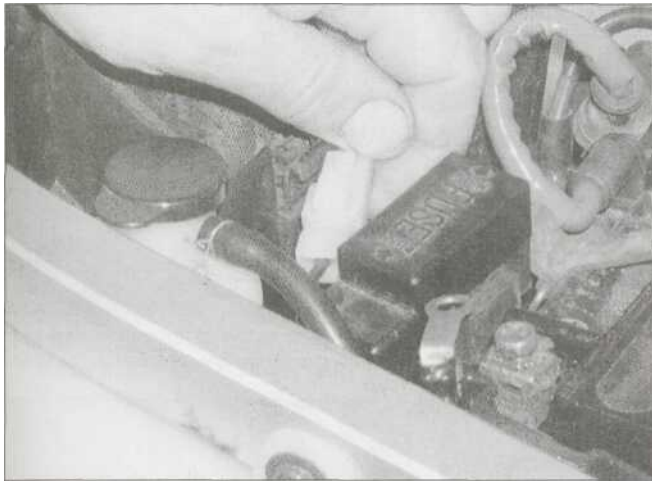
3 Operations requiring engine removal

It is necessary to remove the engine/transmission assembly from the frame to gain access to the following components.

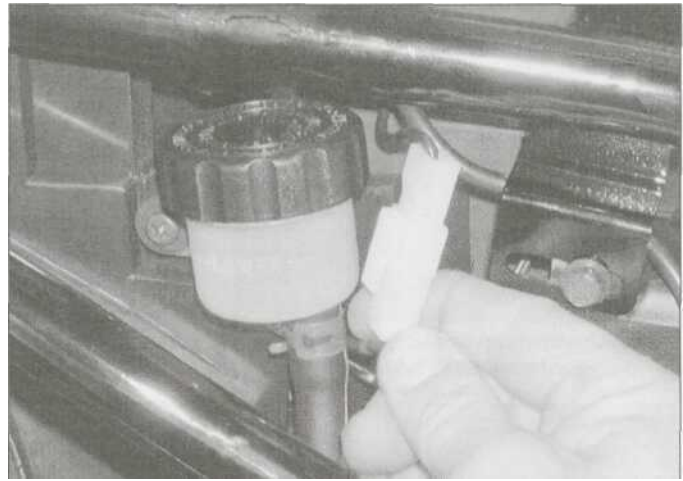
Oil sump, oil strainer and oil pressure relief valve (FZS models)
Transmission shafts
Selector drum and forks (FZS models)
Connecting rods and bearings
Crankshaft and bearings

4 Major engine repair - general note

- 1 It is not always easy to determine when or an engine should be completely overhauled, as a number of factors must be considered.
- 2 High mileage is not necessarily an indication that an overhaul is needed, while low mileage, on the other hand, does not preclude the need for an overhaul. Frequency of servicing is probably the single most important consideration. An engine that has regular and frequent oil and filter changes, as well as other required maintenance, will most likely give many miles of reliable service. Conversely, a neglected engine, or one which has not been run in properly, may require an overhaul very early in its life.
- 3 Exhaust smoke and excessive oil consumption are both indications that piston rings and/or valve guides are in need of attention, although make sure that the fault is not due to oil leakage.
- 4 If the engine is making obvious knocking or rumbling noises, the connecting rods and/or main bearings are probably at fault.
- 5 Loss of power, rough running, excessive valve train noise and high fuel consumption rates may also point to the need for an overhaul, especially if they are all present at the same time. If a complete tune-up does not remedy the situation, major mechanical work is the only solution.
- 6 An engine overhaul generally involves restoring the internal parts to the



5.6a Negative wire wiring connector - YZF models



5.6b Negative wire wiring connector • FZS models

specifications of a new engine. The piston rings and main and connecting rod bearings are usually replaced and the cylinder walls honed or, if necessary, re-bored, during a major overhaul. Generally the valve seats are re-ground, since they are usually in less than perfect condition at this point. The end result should be a like new engine that will give as many trouble-free miles as the original.

7 Before beginning the engine overhaul, read through the related procedures to familiarise yourself with the scope and requirements of the job. Overhauling an engine is not all that difficult, but it is time consuming. Plan on the motorcycle being tied up for a minimum of two weeks. Check on the availability of parts and make sure that any necessary special tools, equipment and supplies are obtained in advance.

8 Most work can be done with typical workshop hand tools, although a number of precision measuring tools are required for inspecting parts to determine if they must be replaced. Often a dealer will handle the inspection of parts and offer advice concerning reconditioning and replacement. As a general rule, time is the primary cost of an overhaul so it does not pay to install worn or substandard parts.

9 As a final note, to ensure maximum life and

minimum trouble from a rebuilt engine, everything must be assembled with care in a spotlessly clean environment.

5 Engine - removal and installation

Caution: *The engine is very heavy. Engine removal and installation should be carried out with the aid of at least one assistant. Personal injury or damage could occur if the engine falls or is dropped. A hydraulic or mechanical floor jack should be used to support and lower or raise the engine if possible.*

Removal

1 Support the motorcycle securely in an upright position using an auxiliary stand (YZF models) or the centrestand (FZS models). Work can be made easier by raising the machine to a suitable working height on a hydraulic ramp or a suitable platform. Make sure the motorcycle is secure and will not topple over (see *Tools and Workshop Tips* in the Reference section). When disconnecting any wiring, cables and hoses, it is advisable to mark or tag them as a reminder to where they connect.

2 If the engine is dirty, particularly around its mountings, wash it thoroughly before starting any major dismantling work. This will make work much easier and rule out the possibility of caked-on lumps of dirt falling into some vital component.

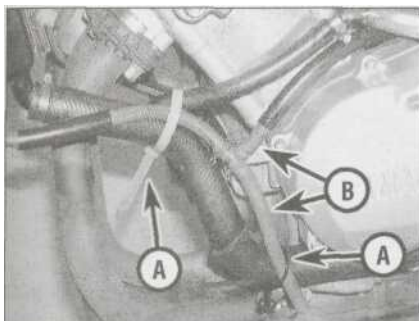
3 Remove the seat, side covers, fairing side panels (YZF models) and fairing (see Chapter 8).

4 Remove the fuel tank (see Chapter 4).

5 Drain the engine oil and the cooling system (see Chapter 1). On FZS models, remove the oil filter (see Chapter 1).

6 Disconnect the negative (-ve) lead from the battery, then disconnect the positive (+ve) lead (see Chapter 9). Also disconnect the wiring connector joining the negative wire to the negative lead (see illustrations). Feed the lead through to the engine, noting its routing, and coil it on the crankcase so that it does not impede engine removal.

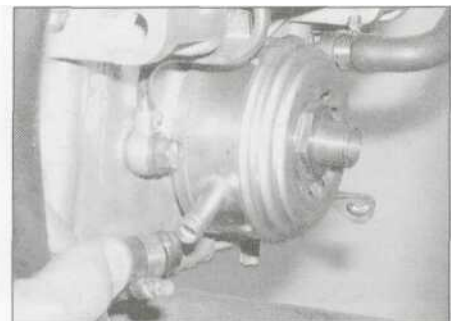
7 On YZF models, release the ties securing the air intake system drain hose to the radiator outlet hose and position the drain hose clear, noting how the branch hose sits on top of the crankcase (see illustration). Slacken the clamp securing the coolant hose to the water pump and the clamp securing the coolant hose to the right-hand side of the oil cooler and detach the hoses (see illustrations). Remove the radiator along with these hoses (see Chapter 3).



5.7a Release the cable ties (A) and draw out the carburettor air vent hose (B)

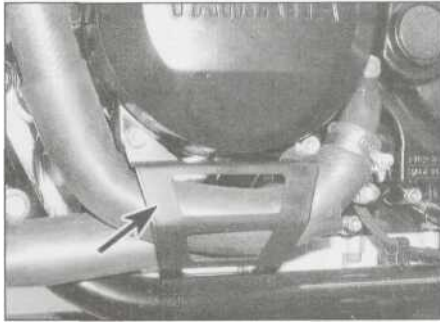


5.7b Slacken the clamps and detach the hoses from the water pump ...



5.7c ... and the right-hand union on the oil cooler

2*8 Engine, clutch and transmission



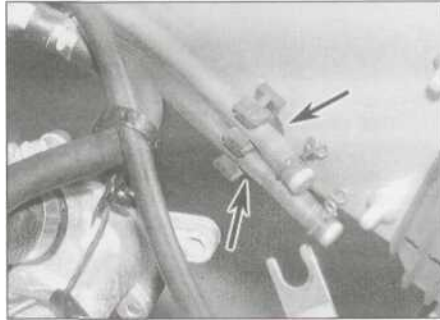
5.8a Unscrew the two bolts and remove the hose guard (arrowed)



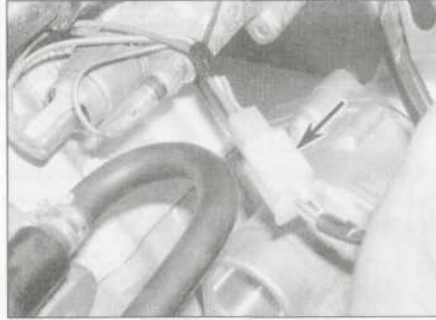
5.8b Slacken the clamp (arrowed) and detach the hose



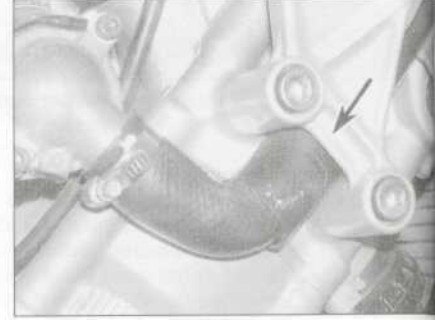
5.8c Slacken the clamps (arrowed) and detach the hoses, noting which fits where!



5.10 Detach the vacuum take-off hoses either from the manifold or from the clips (arrowed) on each frame beam



5.11a Disconnect the wiring connector (arrowed)



5.11b Remove the thermostat housing along with the hose, noting its routing between the engine mounts (arrowed)

8 On FZS models, unscrew the two bolts securing the coolant hose guard to the alternator cover and remove the guard (see illustration). Slacken the clamp securing the coolant hose to the union on the front of the engine and detach the hose (see illustration). Also slacken the clamps securing the coolant hoses to the unions on the water pump, noting which fits where, and detach the hoses (see illustration). Remove the radiator along with these hoses (see Chapter 3).

9 Remove the exhaust system (see Chapter 4).
10 Remove the carburetors (see Chapter 4). Plug the intake manifolds with clean rag. On YZF models, either detach the vacuum take-off hoses from the intake manifolds and position them clear, or release the hoses from their clips on each side of the frame and coil them around the manifolds (see illustration).

11 On YZF models, disconnect the temperature sensor and fan switch wiring at the main connector (see illustration). Remove the thermostat housing (see Chapter 3) along with the hose to the radiator, noting how it fits between the right-hand front engine mounting bolts (see illustration).

12 On FZS models, release the clamps securing the coolant outlet hoses to the unions on the back of the engine and detach the hoses. Also displace the turn signal and starter circuit cut-off relays from the mounts on the left-hand side of the frame, then draw the four wiring connectors out from behind them (see illustration).

13 Trace the alternator and ignition pick-up coil wiring from the top of the alternator cover and disconnect it at the connectors (see illustrations). Release the wiring from any

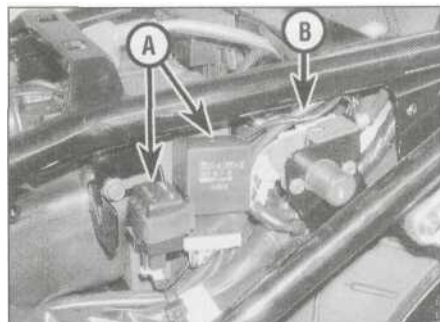
clips or ties, noting its routing, and coil it so that it does not impede engine removal.

14 Trace the neutral switch and oil level sensor wiring from the left-hand side of the engine and disconnect it at the connectors (see illustrations 5.13a and 5.13b). Release the wiring from any clips or ties, noting its routing, and coil it so that it does not impede engine removal.

15 Trace the sidestand switch wiring from the stand and disconnect it at the connector (see illustrations 5.13a and 5.13b). Release the wiring from any clips or ties, noting its routing, and feed it down to the switch.

16 Disconnect the spark plug caps from the spark plugs and secure them clear of the engine.

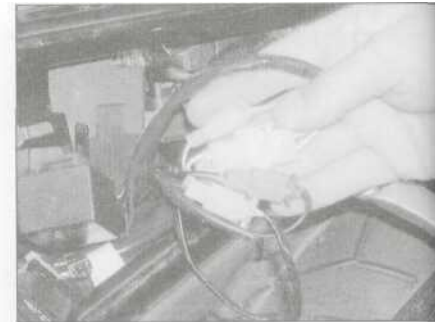
17 Pull back the rubber cover on the stator motor terminal, then unscrew the nut and



5.12 Displace the relays (A) and draw out the wiring connectors (B)



5.13a Alternator/pick-up coil/neutral switch/oil level sensor/sidestand switch wiring connectors - YZF models



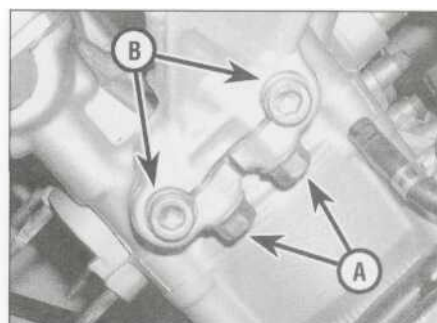
5.13b Alternator/pick-up coil/neutral switch/oil level sensor/sidestand switch wiring connectors - FZS models



5.17 Unscrew the nut and detach the starter motor lead from the relay



5.19 Detach and remove the crankcase breather hose if required



5.21 a Slacken the pinch bolts (A), then remove the left-hand front mounting bolts (B)...

detach the lead (see illustration). Secure it clear of the engine.

18 Remove the front sprocket (see Chapter 6). Detach the clutch cable from the release lever in the sprocket cover (see Section 17).

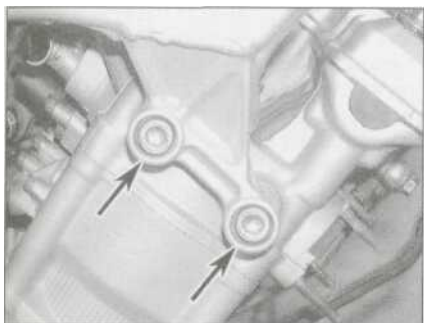
19 On YZF models, if required, detach the crankcase breather hose from the crankcase and remove it (see illustration). On FZS models, detach the crankcase breather hose from either the crankcase or the front of the air filter housing, or both.

20 At this point, position an hydraulic or mechanical jack under the engine with a block of wood between the jack head and crankcase. Make sure the jack is centrally positioned so the engine will not topple in any direction when the last mounting bolt is removed. Take the weight of the engine on the

jack. It is also advisable to place a block of wood between the rear wheel and the ground, or under the swingarm, to prevent the bike tilting back onto the rear wheel when the engine is removed. Check around the engine and frame to make sure that all wiring, cables and hoses that need to be disconnected have been disconnected, and that any remaining connected to the engine are not retained by any clips, guides or brackets connected to the frame. Check that any protruding mounting brackets will not get in the way and remove them if necessary.

21 On YZF models, slacken the pinch bolts on the mounting lugs for the left-hand front mounting bolts (see illustration). Unscrew and remove the left-hand and right-hand front mounting bolts, noting the washers with the

right-hand ones (see illustration). Unscrew the nut securing the exhaust system mounting bracket to the right-hand end of the lower rear engine mounting bolt and remove the bracket and the washer (see illustration). Unscrew the upper and lower rear engine mounting bolt nuts, but do not yet withdraw the bolts (see illustration). Make sure the engine is properly supported on the jack, and have an assistant support it as well, then withdraw the upper and lower rear mounting bolts (see illustration). Carefully lower the engine a little, then bring it forward slightly so that the gearchange shaft is clear of the sidestand switch, then lower it more and manoeuvre it out from the right-hand side (see illustration). Remove the collars from the left-hand front mounting lugs (see illustration).



5.21 b ... and the right-hand front mounting bolts (arrowed)



5.21 c Unscrew the nut and remove the bracket and washer



5.21 d Remove the nuts (arrowed) from the rear mounting bolts



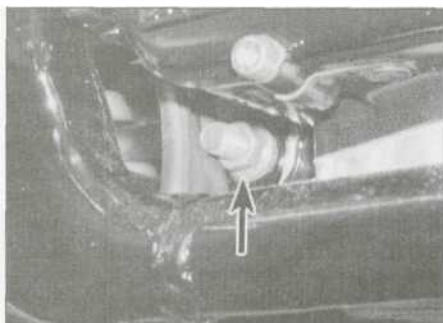
5.21 e Withdraw the bolts (arrowed) from the left



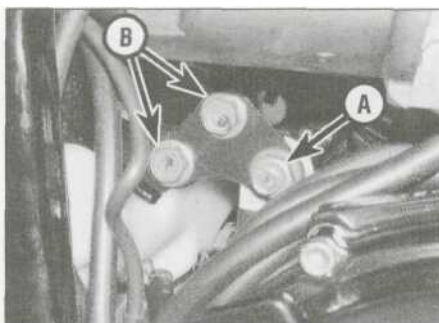
5.21 f Manoeuvre the engine out of the frame



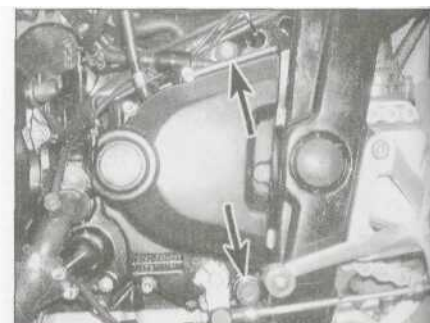
5.21 g Remove the collars from the left-hand front mounting



5.22a Unscrew the nut (arrowed) on the lower rear bolt...



5.22b ... the nut (A) on the upper rear bolt and the bracket bolts (B)



5.22c Withdraw the bolts (arrowed) from the left

22 On FZS models, unscrew the nuts and bolts securing the front engine bracket to the engine and the frame on each side and remove the bracket. Unscrew the lower rear engine mounting bolt nut, but do not yet withdraw the bolt (see illustration). Unscrew the upper rear engine mounting bolt nut and the bolts securing the bracket to the right-hand side of the frame (see illustration). Remove the bracket, noting how it fits, but do not yet withdraw the upper mounting bolt. Make sure the engine is properly supported on the jack, and have an assistant support it as well, then withdraw the upper and lower rear mounting bolts (see illustration). Carefully manoeuvre the engine out of the right-hand side of the frame.

Installation

23 Installation is the reverse of removal, noting the following points:

- Make sure no wires, cables or hoses become trapped between the engine and the frame when installing the engine.
- Many of the engine mounting bolts are of different size and length. Make sure the correct bolt is installed in its correct location, with its washer if fitted. Install all of the bolts and nuts finger-tight only until they are all located, then tighten them in the order given below to their torque settings as specified at the beginning of the Chapter.
- On YZF models, before the engine is mounted, install the collars for the left-hand front mounting bolts, making sure their shouldered ends face the inside (see illustration 5.21g). With the aid of an



5.23 Do not forget the washers with the right-hand front bolts

assistant place the engine unit on top of the jack and block of wood and carefully raise the engine into position in the frame, making sure the mounting bolt holes align (see illustration 5.21f). Also make sure no wires, cables or hoses become trapped between the engine and the frame. Locate all the mounting bolts, not forgetting the washers with the right-hand front mounting bolts (see illustration), and tighten them finger-tight. Now tighten the lower rear mounting bolt nut, then the upper rear mounting bolt nut, then the front mounting bolts, and finally the pinchbolts on the mounting lugs for the left-hand front mounting bolts, tightening them all to their specified torque settings (see illustrations 5.21d, 5.21b and 5.21a). Slide the washer and exhaust system mounting bracket onto the right-hand end of the lower rear engine mounting bolt (see illustration 5.21c), but leave the nut loose so that the bracket be aligned with the exhaust system when it is installed, and then tighten the nut to the specified torque.

- On FZS models, with the aid of an assistant, manoeuvre the engine into position in the frame, making sure the mounting bolt holes align. Also make sure no wires, cables or hoses become trapped between the engine and the frame. Slide the upper and lower rear mounting bolts through from the left-hand side (see illustration 5.22c), then install the upper rear mounting bracket and tighten the bracket bolts and mounting bolt nuts finger-tight only (see illustration 5.22b and 5.22a). Install the front mounting bracket and tighten its frame and engine bolts and nuts finger-tight. Now tighten the upper rear mounting bolt nut, then the lower rear mounting bolt nut, then the front engine mounting bolt nuts, followed by the front bracket bolts, and finally the upper rear bracket bolts, tightening them all in that order to their specified torque settings.
- Use new gaskets on the exhaust pipe connections.
- Make sure all wires, cables and hoses are correctly routed and connected, and secured by any clips or ties.

- Refill the engine with oil and coolant (see Chapter 1).
- Adjust the throttle and clutch cable freeplay and engine idle speed (see Chapter 1).
- Adjust the drive chain slack (see Chapter 1).
- Start the engine and check for any oil or coolant leaks before installing the body panels.

6 Engine disassembly and reassembly - general information

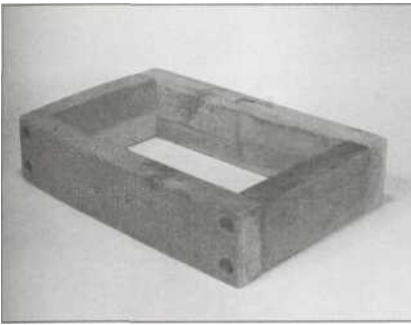
Disassembly

1 Before disassembling the engine, the external surfaces of the unit should be thoroughly cleaned and degreased. This will prevent contamination of the engine internals, and will also make working a lot easier and cleaner. A high flash-point solvent, such as paraffin (kerosene) can be used, or better still, a proprietary engine degreaser. Use old paintbrushes and toothbrushes to work the solvent into the various recesses of the engine casings. Take care to exclude solvent or water, from the electrical components and intake and exhaust ports.

A **Warning: The use of petrol (gasoline) as a cleaning agent should be avoided because of the risk of fire.**

2 When clean and dry, arrange the unit on the workbench, leaving suitable clear area for working. Gather a selection of small containers and plastic bags so that parts can be grouped together in an easily identifiable manner. Some paper and a pen should be on hand so that notes can be made and labels attached where necessary. A supply of clean rag is also required.

3 Before commencing work, read through the appropriate section so that some idea of the necessary procedure can be gained. When removing components it should be noted that great force is seldom required, unless specified. In many cases, a component's reluctance to be removed is indicative of an incorrect approach or removal method - if in any doubt, re-check with the text.



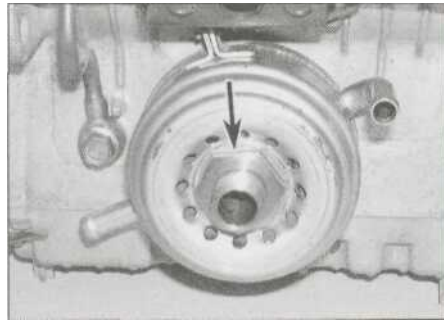
6.4 An engine support made from pieces of 2 x 4 inch wood

4 An engine support stand can be made from short lengths of 2 x 4 inch wood bolted together into a rectangle to help support the engine if required (see illustration), though the engine will sit nicely on the flat bottom of the sump, and there are two pegs at the front to keep it stable. The perimeter of the mount should be just big enough to accommodate the sump within it so that the engine rests on its crankcase.

5 When disassembling the engine, keep 'mated' parts together (including gears, cylinders, pistons, connecting rods, valves, etc. that have been in contact with each other during engine operation). These 'mated' parts must be reused or replaced as an assembly.

6 A complete engine/transmission disassembly should be done in the following general order with reference to the appropriate Sections.

- Remove the valve cover
- Remove the camshafts
- Remove the cylinder head
- Remove the cylinder block
- Remove the pistons
- Remove the clutch
- Remove the alternator/pick-up coil assembly (see Chapter 9)
- Remove the starter motor (see Chapter 9)
- Remove the gearchange mechanism
- Remove the oil pump



7.4 Unscrew the oil cooler bolt (arrowed)

- Remove the oil sump
- Separate the crankcase halves
- Remove the crankshaft
- Remove the transmission shafts
- Remove the selector drum and forks

Reassembly

7 Reassembly is accomplished by reversing the general disassembly sequence.

7 Oil cooler - removal and installation



Note: The oil cooler can be removed with the engine in the frame. If the engine has been removed, ignore the steps which do not apply.

Removal

- 1 On YZF models, remove the fairing side panels (see Chapter 8, Section 3).
- 2 Drain the engine oil and remove the oil filter (see Chapter 1). Drain the cooling system (see Chapter 1), or have some means of blocking or clamping the hoses to avoid excessive loss of coolant.
- 3 Slacken the clamp securing each hose to the cooler and detach the hoses (see illustration 5.7c).

4 Unscrew the cooler bolt using a 30 mm socket and remove the cooler, noting how the tab on the cooler locates on the crankcase (see illustration). Discard the O-ring as a new one must be used.

Installation

5 Installation is the reverse of removal, noting the following:

- a) Use a new O-ring and smear it with clean engine oil. Make sure it seats in its groove (see illustration).
- b) Locate the tab on the cooler between the lugs on the crankcase (see illustration).
- c) Tighten the cooler bolt to the torque setting specified at the beginning of the Chapter.
- d) Make sure the coolant hoses are pressed fully onto their unions and are secured by the clamps (see illustration 5.7c).
- e) Fit a new oil filter and fill the engine with oil (see Chapter 1).
- f) Refill the cooling system if it was drained, or check the level in both the radiator and the reservoir and top up if necessary (see Chapter 1).

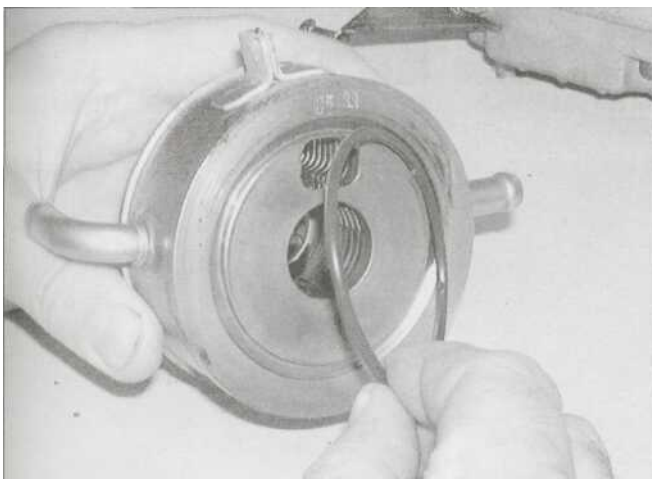
8 Valve cover - removal and installation



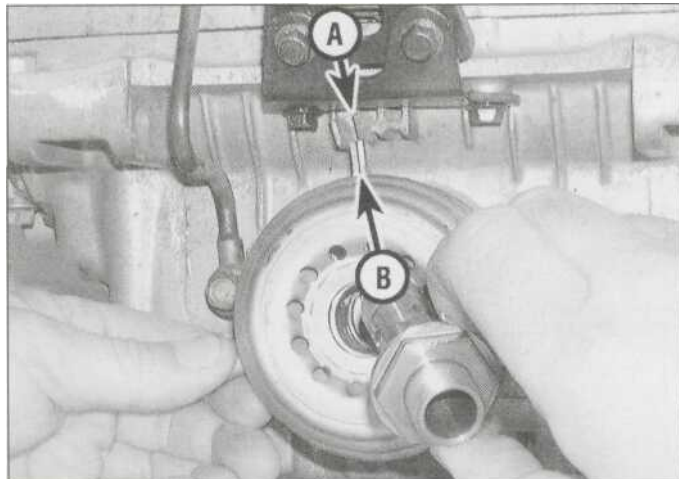
Note: The valve covers can be removed with the engine in the frame. If the engine has been removed, ignore the steps which do not apply.

Removal

- 1 On YZF models, remove the seat and fairing side panels (see Chapter 8), the fuel tank, the air filter housing and the carburetors (see Chapter 4), and the radiator (see Chapter 3). Release the rubber straps from the coil mounting plate and free the wiring loom, then disconnect the right-hand handlebar switch and cooling fan wiring connectors, and the

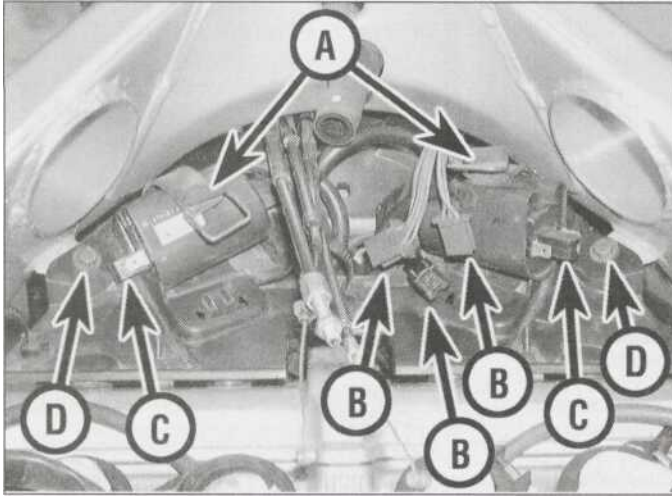


7.5a Use a new O-ring when installing the cooler



7.5b Locate the tab (B) between the lugs (A)

2*12 Engine, clutch and transmission



8.1 a Release the rubber straps (A), disconnect the wiring connectors (B) and (C), and unscrew the bolts (D)



8.1 b Remove the coil mounting plate, noting how it fits

primary circuit wiring connectors from the coils, noting which fits where (**see illustration**). Feed the cooling fan connector down through the hole in the mounting plate. Pull the spark plug caps off the plugs. Unscrew the two bolts and remove the coil mounting plate assembly (**see illustration**).

2 On FZS models, remove the seat and fairing (see Chapter 8), and the fuel tank (see Chapter 4). Unscrew the bolt securing the thermostat housing (**see illustration**). Unscrew the bolts securing the end covers and remove the covers, noting the arrow on the inside which must point up on installation

(**see illustrations**). Pull the spark plug caps off the plugs and secure them clear of the engine, noting which fits where.

3 Unscrew the bolts securing the valve cover and remove it (**see illustration**). If the cover is stuck, do not try to lever it off with a screwdriver. Tap it gently around the sides with a rubber hammer or block of wood to dislodge it. On FZS models, if the engine is in the frame, manoeuvre the cover out from the left-hand side - there is not very much clearance so take care not to damage the paintwork (**see illustration**).

Installation

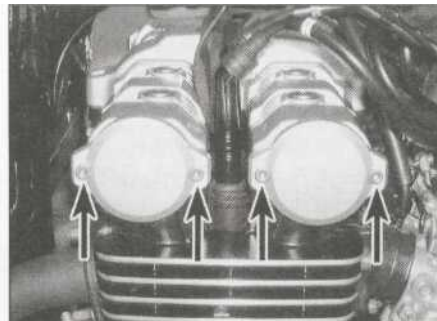
4 Examine the valve cover gasket for signs of damage or deterioration and fit a new one if necessary. Similarly check the rubber grommets on the cover bolts - they fit with the large-lipped side facing down.

5 Clean the mating surfaces of the cylinder head and the valve cover with lacquer thinner, acetone or brake system cleaner.

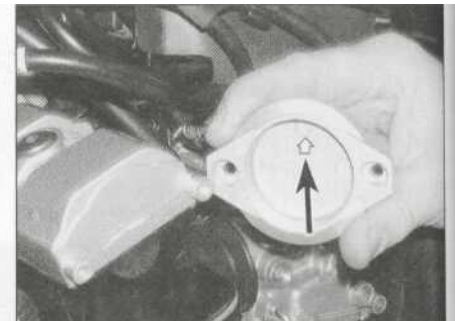
6 Fit the gasket into the valve cover, making sure it locates correctly into the groove and the small tab in the middle section faces the front (**see illustration**). Use a few dabs of



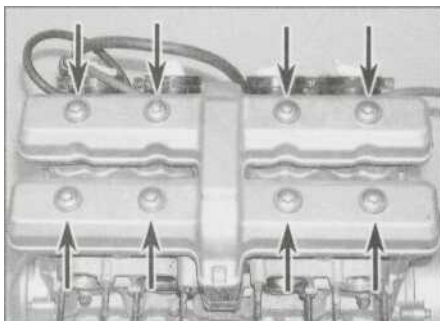
8.2a Unscrew the bolt securing the thermostat housing



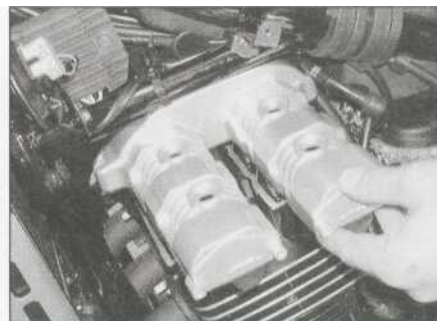
8.2b Unscrew the bolts (arrowed) and remove the covers ...



8.2c ... noting the arrow which must point up



8.3a Valve cover bolts (arrowed)



8.3b On FZS models, remove the cover carefully from the left-hand side

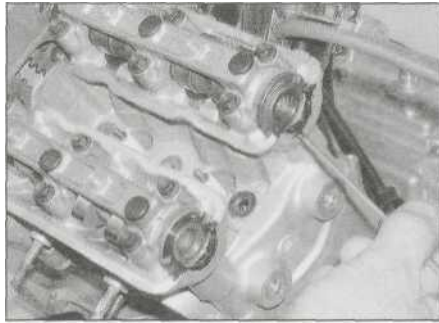


8.6 Fit the gasket into the groove in the cover

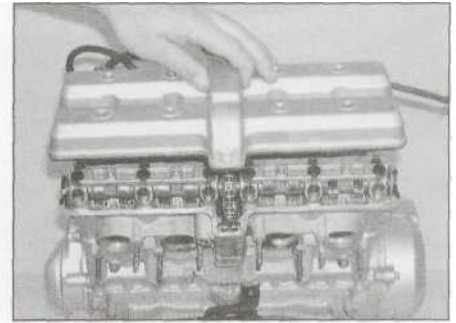
grease to keep the gasket in place while the cover is fitted.

7 Apply a suitable sealant to the cut-outs in the cylinder head where the gasket half-circles fit (see illustration). Position the valve cover on the cylinder head, making sure the gasket stays in place (see illustration). Install the cover bolts and tighten them to the torque setting specified at the beginning of the Chapter.

8 Install the remaining components in the reverse order of removal.



8.7a Apply the sealant to the cutouts in the head ...



8.7b ... then install the cover

9 Cam chain tensioner and guides - removal, inspection and installation

1

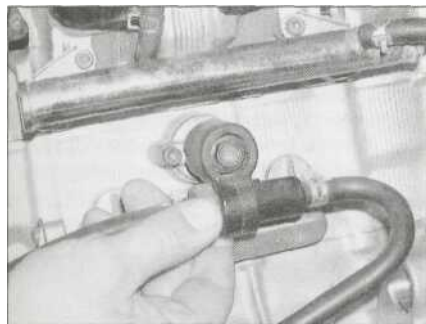
Note: The cam chain tensioner and guides can be removed with the engine in the frame.

Caution: Once you start to remove the tensioner bolts, you must remove the tensioner all the way and reset it before tightening the bolts. The tensioner extends itself and locks in place, so if you loosen the bolts partway and then retighten them, the tensioner or cam chain will be damaged.

Cam chain tensioner

Removal

1 On YZF models, pull the carburettor heater system hose holder off the tensioner body (see illustration). On FZS models, remove the carburettors (see Chapter 4).



9.1 Pull the hose holder off the tensioner body

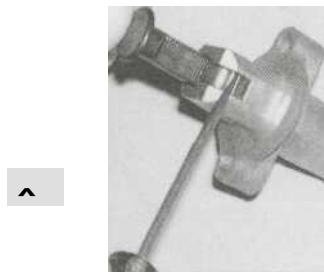


9.2 Unscrew the cap bolt (arrowed) and withdraw the springs



9.3 Unscrew the tensioner bolts (arrowed) and remove the tensioner

fV-f



9.6 Release the ratchet mechanism to free the plunger



9.9a Install the tensioner using a new gasket...



9.9b ... and tighten the bolts to the specified torque

2 Unscrew the tensioner cap bolt and withdraw the springs from the tensioner body (see illustration).

3 Unscrew the two tensioner mounting bolts and withdraw the tensioner from the back of the cylinder block, noting which way up it fits (see illustration).

4 Discard the tensioner body gasket as a new one must be used.

Inspection

5 Examine the tensioner components for signs of wear or damage.

6 Release the ratchet mechanism from the tensioner plunger and check that the plunger moves freely in and out of the tensioner body (see illustration).

7 If the tensioner or any of its components are worn or damaged, or if the plunger is seized in the body, the tensioner must be

renewed. Individual internal components are not available.

Installation

8 Release the ratchet mechanism and press the tensioner plunger all the way into the tensioner body (see illustration 9.6).

9 Fit a new gasket onto the tensioner body, then fit the tensioner into the engine, making sure the "UP" mark faces up and the ratchet release lever is on the bottom (see illustration). Tighten the bolts to the torque setting specified at the beginning of the Chapter (see illustration).

10 Check the condition of the sealing washer on the cap bolt and replace it if it is worn or damaged. Install the springs and cap bolt and tighten the bolt to the specified torque setting (see illustration).

2»14 Engine, clutch and transmission



i



9.10 Note that there are two springs, one fitting inside the other - make sure they are both installed

11 Remove the alternator cover (Section 10, Step 2) (see illustrations 10.2a and 10.2b) and turn the crankshaft anti-clockwise through two full turns using a socket on the rotor bolt. This will allow the tensioner to set itself properly. Install the cover and tighten the bolts to the specified torque setting.

12 It is advisable to remove the valve cover (see Section 8) and check that the cam chain is tensioned and all the timing marks are in alignment (see Section 10). If the chain is slack, the tensioner plunger did not release when the spring and cap bolt were installed. Remove the tensioner and re-check it. Again check the timing marks (see Section 10), then install the valve cover (see Section 8).

13 On YZF models, fit the carburettor heater system hose holder onto the tensioner body (see illustration 9.1). On FZS models, install the carburettors (see Chapter 4).

Cam chain guides

Removal

14 Remove the valve cover (see Section 8).
15 To remove the top cam chain guide, unscrew the four bolts securing it to the cylinder head, noting that these bolts also secure the camshaft holders (see illustration).
16 To remove the front cam chain guide, lift it out of the front of the cam chain tunnel, noting

9.15 Removing the top cam chain guide

which way round it fits and how it locates (see illustration).

Inspection

17 Check the sliding surfaces of the guides for excessive wear, deep grooves, cracking and other obvious damage, and renew them if necessary.

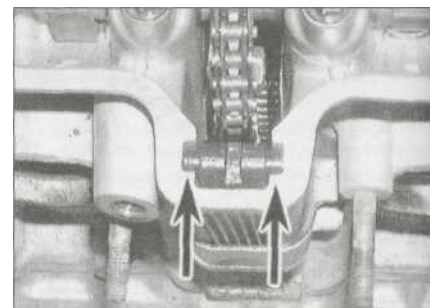
Installation

18 Install the front guide blade into the front of the cam chain tunnel (see illustration 9.16), making sure it locates correctly onto its seat and its lugs locate in their cut-outs (see illustration).

19 Install the top guide onto the cylinder head and tighten the mounting bolts to the torque setting specified at the beginning of the Chapter (see illustration 9.15).

20 Install the valve cover (see Section 8).

9.16 Lift the front guide out of the engine



9.18 Make sure the lugs locate correctly in the cutouts (arrowed)

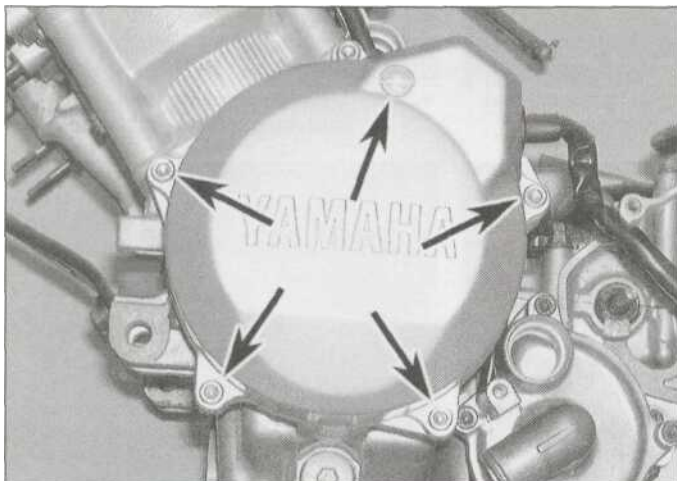
Removal

1 Remove the valve cover (see Section 8).
2 Unscrew the bolts securing the alternator cover and remove the cover, on FZS models noting the hose guard secured by the bottom bolts (see illustrations). Remove the two dowels for safekeeping if they are loose. The engine can be turned using a 19 mm socket | on the alternator rotor bolt and turning it in an anti-clockwise direction only. Alternatively, ! place the motorcycle on an auxiliary stand so that the rear wheel is off the ground, select a high gear and rotate the rear wheel by hand in its normal direction of rotation.
3 Turn the engine until the line next to the "T"

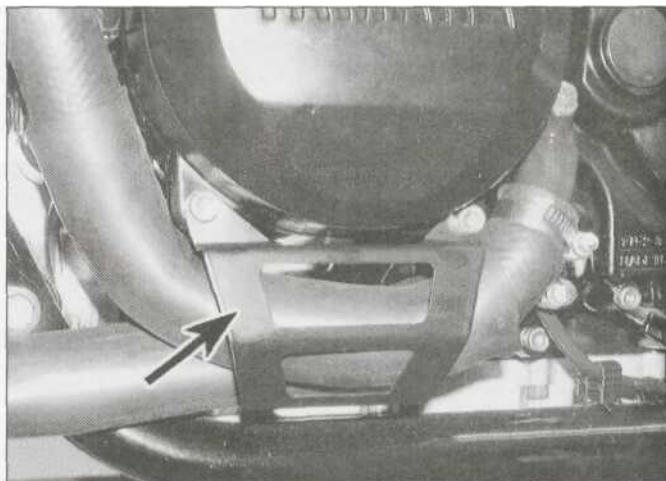
10 Camshafts and followers-removal, inspection and installation

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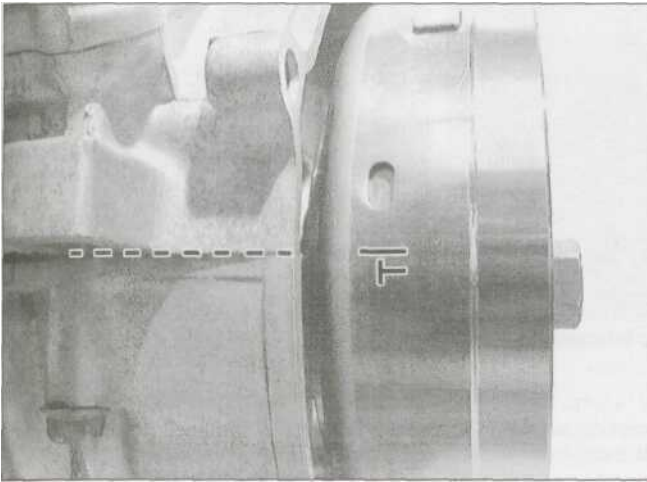
Note: The camshafts can be removed with the engine in the frame. Place rags over the spark plug holes and the cam chain tunnel to prevent any component from dropping into the engine on removal.



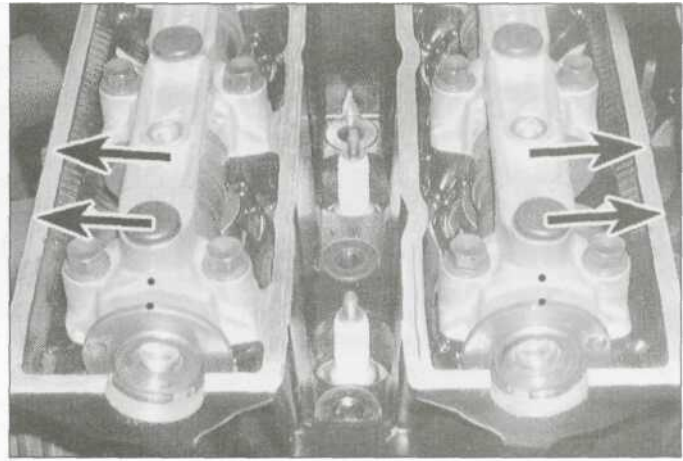
10.2a Unscrew the alternator cover bolts (arrowed)...



10.2b ... on FZS models, noting the hose guard (arrowed)



10.3a Turn the engine until the line next to the "T" mark aligns with the crankcase mating surfaces at the front...



10.3b ... and the dots are aligned and the camshaft lobes face away from each other (FZS model shown) - on YZF models note that the intake camshaft dots are positioned slightly off the vertical, at the 1 o'clock position

mark on the rotor aligns with the crankcase mating surfaces at the front of the engine (see illustration), the camshaft lobes for the No. 1 (left-hand) cylinder face away from each other and the dot on the end of each camshaft aligns with the dot on the camshaft holder (see illustration). If the cam lobes are facing towards each other and the dots do not align, rotate the engine anti-clockwise 360° (one full turn) so that the line next to the "T" mark again aligns with the crankcase mating surfaces. The camshaft lobes will now be facing away from each other and the dots will be aligned, meaning the No. 1 cylinder is at TDC (top dead centre) on the compression stroke.

4 Before disturbing the camshafts, make a note of the timing markings between each camshaft and its holder and how they align. With the No. 1 cylinder at TDC, the punchmark on the left-hand end of each camshaft end faces up and aligns with the mark on the top of the camshaft holder (see

illustration 10.3b). If you are in any doubt as to the alignment of the markings, or if they are not visible, make your own alignment marks between all components, and also between a tooth on each sprocket and its corresponding link on the chain, before disturbing them. These markings ensure that the valve timing can be correctly set up on assembly without difficulty. As it is easy to be a tooth out on installation, marking between a tooth on each sprocket and its link in the chain is especially useful.

5 Remove the cam chain tensioner (see Section 9).

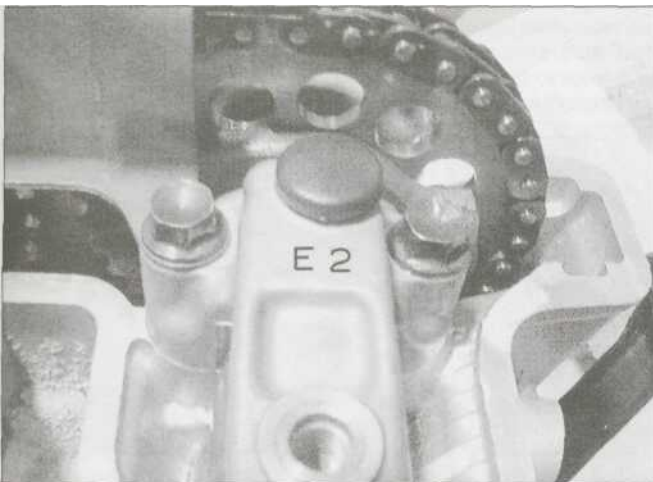
6 Remove the top and front cam chain guides (see Section 9).

7 Before removing the camshaft holders, make a note of which fits where. All the holders are marked with a letter and number to denote their location - 11 is the intake camshaft holder on the left-hand side, 12 is the intake camshaft holder on the right-hand side, E1 is the exhaust camshaft holder on the

left-hand side, E2 is the exhaust camshaft holder on the right-hand side (see illustration). Also each holder is marked with an arrow - on YZF models the arrow on each intake camshaft points forwards, and on each exhaust camshaft points backwards, while on FZS models the arrow on each holder points to the right-hand side of the engine.

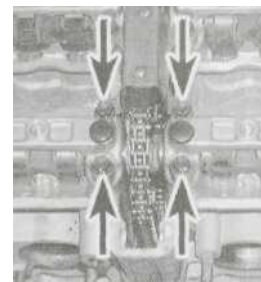
Caution: A camshaft could break if the holder bolts are not slackened as described and the pressure from a depressed valve causes the shaft to bend. Also, if the holder does not come squarely away from the head, the holder is likely to break. If this happens the complete cylinder head assembly must be replaced; the holders are matched to the cylinder head and cannot be replaced separately.

8 Unscrew the remaining camshaft holder bolts for the camshaft being worked on (one bolt on each holder secures the top cam chain guide and has already been removed) (see illustration). Slacken them evenly and a little



10.7 Note the location markings on each holder before removing them

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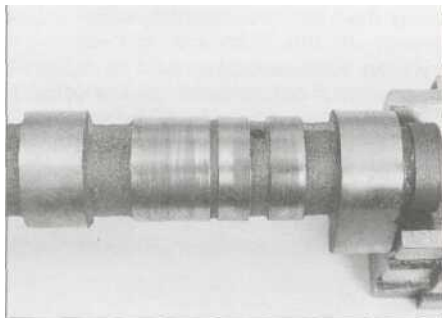
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10.8a Exhaust camshaft holder bolts (arrowed)

10.8b Removing the intake camshaft

at a time in a criss-cross pattern, starting from the outside and working towards the centre, slackening the bolts above any lobes that are pressing onto a valve last in the sequence so that the pressure from the open valves cannot cause the camshaft to bend. Remove the bolts, then lift off the camshaft holders, noting how they fit. Retrieve the dowels from either the holder or the cylinder head if they are loose (see illustration 10.26a). Remove the camshafts, rotating them towards the centre of the engine as you do (see illustration). Keep all mated parts together. While the camshafts are out, don't allow the cam chain to go slack and do not rotate the crankshaft - the chain may drop down and bind between the crankshaft and case, which could damage these components. Wire the chain to another component or secure it using a rod of some sort to prevent it from dropping.



10.10 Check the journal surfaces of the camshaft for scratches or wear



10.11 a Check the lobes of the camshaft for wear - here's an example of damage requiring camshaft repair or renewal

10.9a Lift out the follower . . .

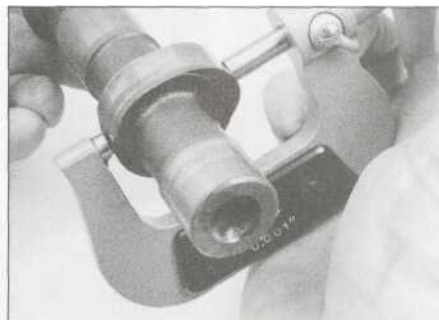
If the followers and shims are being removed from the cylinder head, obtain a container which is divided into sixteen compartments, and label each compartment with the location of its corresponding valve in the cylinder head and whether it belongs with an intake or an exhaust valve. If a container is not available, use labelled plastic bags. Remove the cam follower of the valve in question, then retrieve the shim from the inside of the follower (see illustrations). If it is not in the follower, pick it out of the top of the valve using either a magnet, a small screwdriver with a dab of grease on it (the shim will stick to the grease), or a screwdriver and a pair of pliers (see illustration 10.21a). Do not allow the shim to fall into the engine.

Inspection

10 Inspect the bearing surfaces of the camshaft holders and the corresponding journals on the camshaft. Look for score marks, deep scratches and evidence of spelling (a pitted appearance) (see illustration).

11 Check the camshaft lobes for heat discoloration (blue appearance), score marks, chipped areas, flat spots and spelling (see illustration). Measure the height of each lobe with a micrometer (see illustration) and compare the results to the minimum lobe height listed in this Chapter's Specifications. If damage is noted or wear is excessive, the camshaft must be replaced. Also, be sure to check the condition of the followers.

12 Check the amount of camshaft runout by



10.11b Measure the height of the camshaft lobes with a micrometer



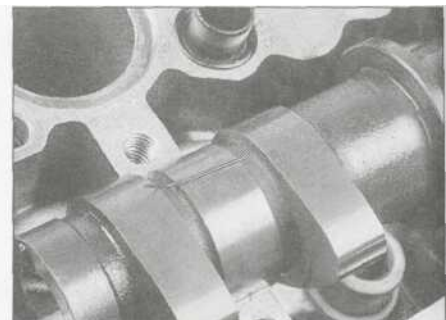
10.9b . . . and remove the shim from inside the follower

supporting each end of the camshaft on V-blocks, and measuring any runout using a dial gauge. If the runout exceeds the specified limit the camshaft must be replaced.

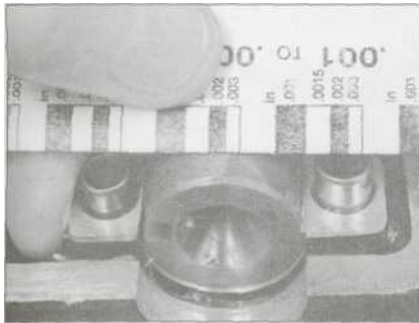
Refer to 'Tools and Workshop Tips' in the Reference section for details of how to read a micrometer and dial gauge

13 Next, check the camshaft bearing oil clearances. Check each camshaft in turn! rather than at the same time. Clean the camshaft, the bearing surfaces in the cylinder head and camshaft holders with a clean lint-free cloth, then lay the camshaft in place in the cylinder head.

14 Cut some strips of Plastigauge and lay one piece on each bearing journal, parallel with the camshaft centreline (see illustration). Make sure the camshaft holder! dowels are installed (see illustration 10.26a). Lay the holders in their correct place in the cylinder head (see Step 7). Tighten the bolts! evenly and a little at a time in a criss-cross pattern, working from the centre of the camshaft outwards (i.e. starting with the bolts! that are above valves that will be opened] when the camshaft is tightened down), to the torque setting specified at the beginning of the Chapter. Whilst tightening the bolts, make! sure the holders are being pulled squarely down and are not binding on the dowels. While doing this, don't let the camshafts rotate.



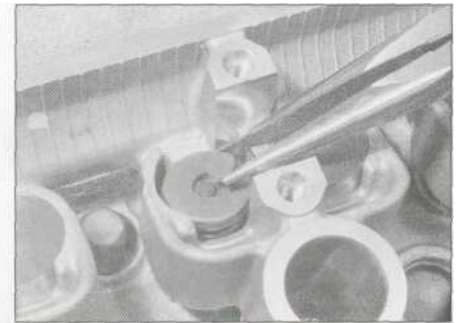
10.14 Lay a strip of Plastigauge across each bearing journal, parallel with the camshaft centreline



10.16a Compare the width of the crushed Plastigauge to the scale printed on the Plastigauge container



10.16b Measure the cam bearing journals with a micrometer



10.21 a Fit the shim into the recess in the top of the valve ...

15 Now unscrew the bolts evenly and a little at a time in a criss-cross pattern, starting from the outside and working towards the centre, and carefully lift off the camshaft holders.

16 To determine the oil clearance, compare the crushed Plastigauge (at its widest point) on each journal to the scale printed on the Plastigauge container (see illustration). Compare the results to this Chapter's Specifications. If the oil clearance is greater than specified, measure the diameter of the camshaft bearing journal with a micrometer (see illustration). If the journal diameter is less than the specified range, replace the camshaft with a new one and recheck the clearance. If the clearance is still too great, replace the cylinder head and holders with new ones. If the camshaft bearing journal diameter is within its range, replace the cylinder head and holders with new ones.

Before replacing camshafts
or **journal holders**
because of damage, check with local machine shops specialising in motorcycle engine work. In the case of the camshafts, it may be possible for cam lobes to be welded, reground and hardened, at a cost far lower than that of a new camshaft. If the bearing surfaces in the holders are damaged, it may be possible for them to be bored out to accept bearing inserts. Due to the cost of new components it is recommended that all options be explored before condemning them as trash!

17 Except in cases of oil starvation, the cam chain wears very little. If the chain has stretched excessively, which makes it difficult to maintain proper tension, if it is stiff or the links are binding or kinking, replace it with a new one. Refer to Section 25 for replacement.

18 Check the sprockets for wear, cracks and other damage. If the sprockets are worn, the cam chain is also worn, and so is the sprocket on the crankshaft. If severe wear is apparent, the entire engine should be disassembled for inspection.

19 Inspect the cam chain guides and tensioner blade (see Sections 9 and 25).

20 Inspect the outer surfaces of the cam followers for evidence of scoring or other damage. If a follower is in poor condition, it is probable that the bore in which it works is also damaged. Check for clearance between the followers and their bores. Whilst no specifications are given, if slack is excessive, replace the followers. If the bores are seriously out-of-round or tapered, the cylinder head and the followers must be replaced.

Installation

21 If removed, lubricate each shim and its follower with molybdenum disulphide oil (a 50/50 mixture of molybdenum disulphide grease and engine oil) and fit each shim into its recess in the top of the valve, with the size marking on each shim facing up (see illustration). Make sure each shim is correctly seated in the top of the valve assembly, then install each follower, making sure it fits squarely in its bore (see illustration). *Note: It is most important that the shims and followers are returned to their original valves otherwise the valve clearances will be inaccurate.*

22 Make sure the bearing surfaces on the camshafts and in the cylinder head are clean, then apply molybdenum disulphide oil (a 50/50 mixture of molybdenum disulphide grease and engine oil) to each of them. Also apply it to the camshaft lobes.

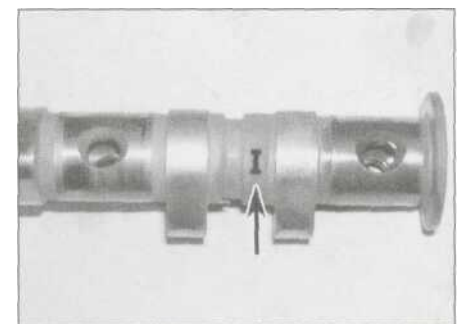
23 Check that the "T" mark on the rotor still aligns with the crankcase mating surfaces at the front of the engine (see Step 3) (see illustration 10.3a)

24 Fit the exhaust camshaft, identifiable by

10.21b ... then install the follower

the letter E cast into it (see illustration 10.25), through the cam chain and onto the front of the head, making sure the No. 1 (left-hand) cylinder lobes are facing forwards and the punchmark on the camshaft left-hand end is facing up (see illustration). Fit the cam chain around the exhaust sprocket, aligning the marks between sprocket tooth and link if made. When fitting the chain, pull up on the front run to remove all slack from it.

25 Now fit the intake camshaft, identifiable by the letter I cast into it (see illustration), through the cam chain and onto the back of the head, making sure the No. 1 cylinder lobes are facing back and the punchmark on the camshaft end is facing up (see illustration 10.8b). Fit the cam chain around the intake sprocket, aligning the marks between sprocket tooth and link if made. When fitting the chain, pull it tight to make sure there is no slack between the two camshaft sprockets.



10.25 Each camshaft is identifiable by the letter cast into it

10.24 Install the exhaust camshaft and fit the chain onto the sprocket



10.26a Install the dowels .



10.26b ... and lubricate the camshaft holders

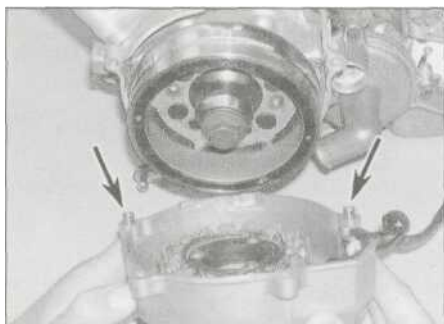


10.26c Tighten the holder bolts to the specified torque

26 Fit the camshaft holder dowels into the cylinder head (see illustration). Make sure the bearing surfaces in the holders are clean, then apply molybdenum disulphide oil (a 50/50 mixture of molybdenum disulphide grease and engine oil) to them (see illustration). Lay the holders in their correct place in the cylinder head (see Step 7), then position the top cam chain guide (see illustration 9.15). Install all the bolts and tighten them evenly and a little at a time in a criss-cross pattern, working from the centre of the camshaft outwards, (i.e. starting with the bolts that are above valves that will be opened when the camshaft is tightened down), to the torque setting specified at the beginning of the Chapter (see illustration). Whilst tightening the bolts, make sure the holders are being pulled squarely down and are not binding on the dowels.

Caution: The camshaft is likely to break if it is tightened down onto the closed valves before the open valves. The holders are likely to break if they are not tightened down evenly and squarely.

27 At this point check that all the timing marks are still in exact alignment as described in Steps 3 and 4. Note that it is easy to be slightly out (one tooth on the sprocket) without the marks appearing drastically out of alignment. If the marks are out, verify which sprocket is misaligned, then unscrew its bolts and slide it off the camshaft, then disengage it from the chain. Move the camshaft round as required, then fit the sprocket back into the chain and onto the camshaft, and check the marks again.



10.32 Make sure the dowels (arrowed) are in place when installing the cover

Caution: If the marks are not aligned exactly as described, the valve timing will be incorrect and the valves may strike the pistons, causing extensive damage to the engine.

28 With everything correctly aligned, and if slackened, tighten the sprocket bolts to the torque setting specified at the beginning of the Chapter - remove one of the rubber plugs in the top of each holder and insert a screwdriver or bar through the hole in the camshaft to prevent it turning, or alternatively counter-hold the alternator rotor.

29 Install the front cam chain guide (see Section 9).

30 Install the cam chain tensioner (see Section 9). Turn the engine anti-clockwise through two full turns and check again that all the timing marks still align (see Steps 3 and 4).

31 Check the valve clearances and adjust them if necessary (see Chapter 1).

32 Install the alternator cover and tighten the bolts to the torque setting specified at the beginning of the Chapter, not forgetting the dowels if removed (see illustration), and the hose guard on FZS models (see illustrations 10.2a and 10.2b).

33 Install the valve cover (see Section 8).

11 Cylinder head - removal and installation

Caution: The engine must be completely cool before beginning this procedure or the cylinder head may become warped.

Note 1: The cylinder head can be removed with the engine in the frame. If the engine has been removed, ignore the steps which don't apply.

Note 2: On YZF models, it is possible to split the cam chain, therefore it is not necessary to remove camshafts - refer to Section 25 for details on how to split and join the chain, taking note of all the information given, and do not split the chain until the camshafts are correctly positioned as described in Section 10, Steps 3 and 4. The camshafts have access holes in them for the cylinder head nuts. Remove the rubber bungs in each camshaft holder to access the holes.

If the engine has been correctly built, this will posit/on the split-link between the camshaft sprockets, so there is no need to turn the camshafts after the chain is removed, which should not be done. If the chain is not positioned with the split-link visible, the engine will have to be turned until the link is visible. This will mean the camshafts are not correctly positioned, and will have to be turned after the chain has been removed to align the holes - this could cause a valve to contact a piston, causing serious damage, so the camshafts should be removed prior to removing the cylinder head, meaning you won't have to split the chain.

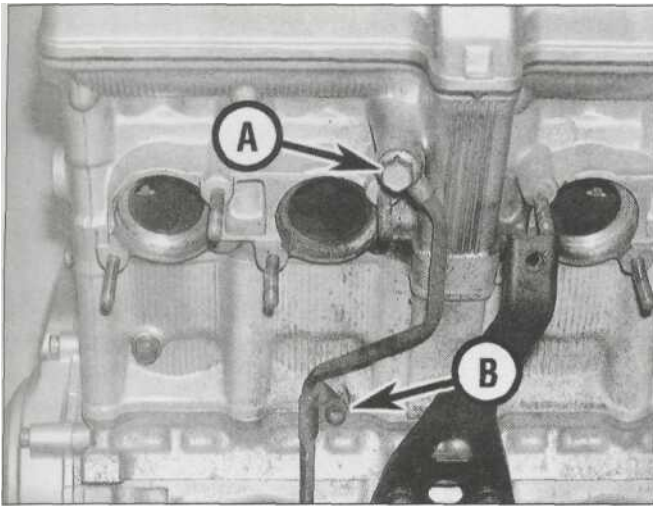
Before splitting the cam chain, make a reference mark between a link on the chain and a tooth on the sprocket on each side of the split link so that it can be installed in exactly the same position, making the timing easier to set up.

Unscrew the cylinder head nuts using a suitable hex key in a socket extension. With the camshafts in situ, it is not possible to remove the cylinder head nuts and washers, so great care must be taken on installation not to cock the washers or cross-thread the nuts.

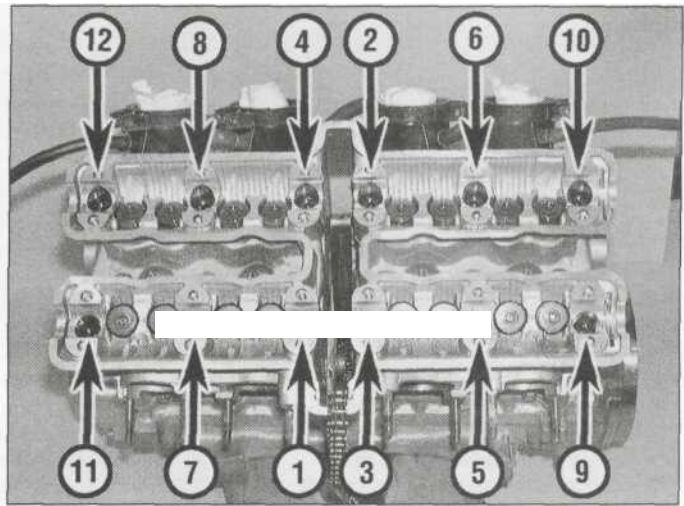
If the cylinder head is being removed purely to access the pistons or cylinder block, then removal of the camshafts is not necessary, as long as you are certain that they are in good condition and do not need checking. If the engine is being taken down because of general wear and age, it is of course necessary to remove the camshafts and to check them carefully along with all other components. In the event of any damage in an engine, tiny particles of metal could enter the lubrication system and affect every bearing surface and component, so you should check the camshafts too.

Removal

- 1 Remove the exhaust system (see Chapter 4). Plug the exhaust ports with clean rag.
- 2 Remove the carburettors (see Chapter 4). Plug the intake manifolds with clean rag.
- 3 Remove the valve cover (see Section 8) and the camshafts and followers (see Section 10) (see Note 2 above).
- 4 On YZF models, either detach the vacuum take-off hoses from the intake manifolds, or



11.5 Oil pipe top banjo bolt (A) and clamp bolt (B)



11.8a Cylinder head TIGHTENING sequence - slacken the bolts in reverse order

release the hoses from their clips on the frame and coil them around the manifolds so they do not get in the way (see illustration 5.10).

5 Unscrew the oil pipe banjo bolts and clamp bolt and detach the pipe (see illustration). Discard the banjo bolt sealing washers as new ones must be used. Note that if the engine has been removed, and the cylinder block is not being removed, only remove the top banjo bolt securing the pipe to the head - there is no need to remove the whole pipe.

6 Drain the cooling system (see Chapter 1). Slacken the clamp(s) securing the coolant hose(s) to the outlet union(s) on the back of the cylinder head and detach the hose(s). If required, unscrew the bolts securing the union(s) and pull the union(s) out of the head. Discard the O-rings as new ones must be used.

7 On YZF models, slacken the pinch bolts on the mounting lugs for the left-hand front engine mounting bolts, then unscrew and remove the left-hand and right-hand front engine mounting bolts, noting the washers with the right-hand ones (see illustrations 5.21 a and 5.21 b).

8 The cylinder head is secured by twelve nuts

(see illustration). Slacken the nuts evenly and a little at a time in a reverse of the numerical tightening sequence shown until they are all slack, then remove the nuts and their washers, using either a magnet, a screwdriver, or a piece of wire hooked over at the end to lift them out (see illustration).

9 Pull the cylinder head up off the block (see illustration). If it is stuck, tap around the joint faces of the cylinder head with a soft-faced mallet to free the head. Do not attempt to free the head by inserting a screwdriver between the head and cylinder block - you'll damage the sealing surfaces. Remove the old cylinder head gasket and discard it as a new one must be used. Remove the collars from the left-hand front mounting lugs for safekeeping if required (see illustration 5.21 g).

10 If they are loose, remove the dowels from the cylinder block. If they appear to be missing they are probably stuck in the underside of the cylinder head.

11 Check the cylinder head gasket and the mating surfaces on the cylinder head and block for signs of leakage, which could indicate warpage. Refer to Section 13 and check the flatness of the cylinder head.

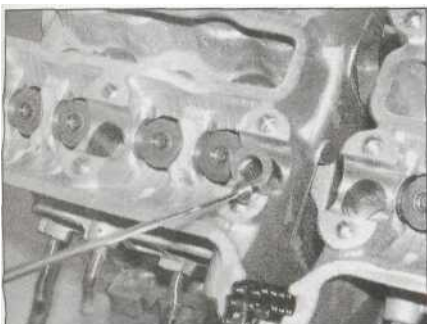
Installation

12 Clean all traces of old gasket material from the cylinder head and block. If a scraper is used, take care not to scratch or gouge the soft aluminium. Be careful not to let any of the gasket material fall into the crankcase, the cylinder bores or the oil passages.

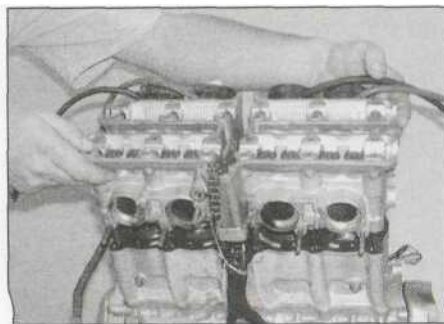
irard*	<i>Refer to 'Tools and Workshop Tips' for details of gasket removal methods.</i>
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13 If removed, fit the dowels into the cylinder block (see illustration 11.14). Lubricate the cylinder bores with new engine oil. If removed, install the collars for the left-hand front mounting bolts, making sure their shouldered ends face the inside (see illustration 5.21 g)

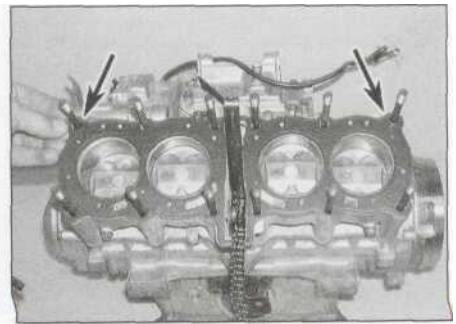
14 Ensure both cylinder head and block mating surfaces are clean, then lay the new head gasket in place on the cylinder block, making sure the "UP" mark faces up, it locates correctly over the dowels and all the holes are correctly aligned (see illustration). Never re-use the old gasket.



11.8b Using a magnet to remove the washers

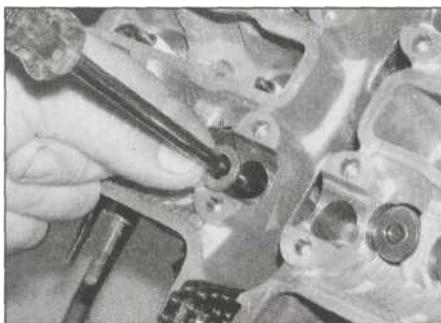


11.9 Carefully lift the head up off the block

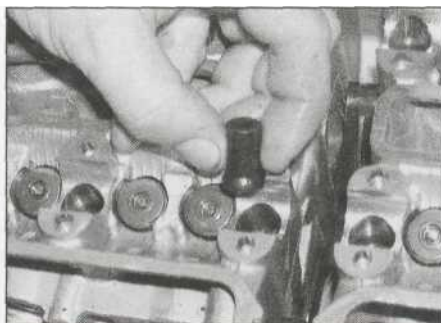


11.14 Lay the new gasket over the dowels (arrowed) and onto the head

2»20 Engine, clutch and transmission



11.16a Use a screwdriver as shown to locate the washers ...



11.16b ... then install the nuts ...



11.16c ... and tighten them to the specified torque

15 Carefully fit the cylinder head onto the block, making sure it locates correctly onto the dowels (see illustration 11.9).

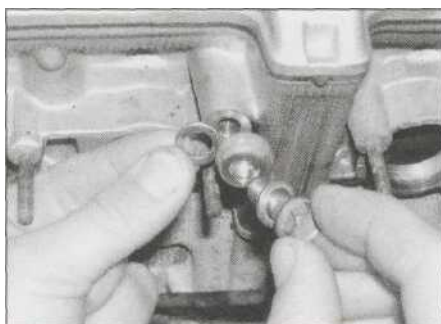
16 Lubricate the threads of the cylinder head nuts with clean engine oil. Install the nuts with their washers and tighten them finger-tight (see illustrations). Now tighten the nuts in the correct numerical sequence (see illustration 11.8a) and in two stages, first to the initial torque setting specified at the beginning of the Chapter, then to the final torque setting (see illustration).

17 On YZF models, install the left-hand and right-hand front engine mounting bolts, not forgetting the washers with the right-hand ones (see illustration 5.23), and tighten them to the specified torque setting (see illustrations 5.21b and 5.21a). Now tighten the pinch bolts on the mounting lugs for the left-hand front mounting bolts to the specified torque.

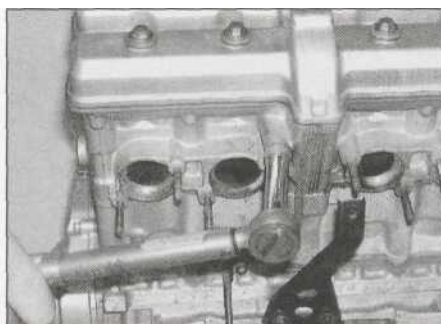
18 If removed, install the coolant outlet union(s) using new O-rings and tighten the bolts to the specified torque setting. Attach the hose(s) to the union(s) and tighten the clamp(s) securely.

19 Install the oil pipe, using new sealing washers on each side of the union(s), and tighten the banjo bolt(s) and the clamp bolt to the specified torque settings (see illustrations).

20 On YZF models, either attach the vacuum take-off hoses to the intake manifolds or secure the hoses in their clips on the frame, according to your removal procedure (see illustration 5.10).



11.19a Use new sealing washers on each side of the unions ..



11.19b ... and tighten the bolts to the specified torque

21 Install the remaining components in a reverse of their removal sequence, referring to the relevant Sections or Chapters (see Steps 1, 2 and 3). Fill the cooling system (see Chapter 1).

12 Valves/valve seats/valve guides - servicing

1 Because of the complex nature of this job and the special tools and equipment required, most owners leave servicing of the valves, valve seats and valve guides to a professional.
2 The home mechanic can, however, remove the valves from the cylinder head, clean and check the components for wear and assess the extent of the work needed, and, unless a valve service is required, grind in the valves (see Section 13).

3 The dealer service department will remove the valves and springs, replace the valves and guides, recut the valve seats, check and replace the valve springs, spring retainers and collets (as necessary), replace the valve seals with new ones and reassemble the valve components.

4 After the valve service has been performed, the head will be in like-new condition. When the head is returned, be sure to clean it again very thoroughly before installation on the engine to remove any metal particles or abrasive grit that may still be present from the valve service operations. Use compressed air, if available, to blow out all the holes and passages.

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13 Cylinder head and valves - disassembly, inspection and reassembly

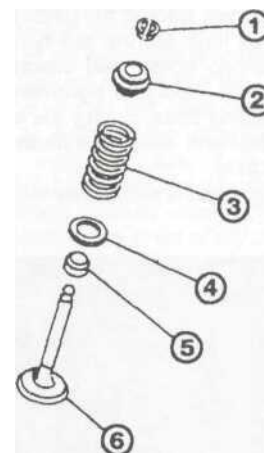
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1 As mentioned in the previous section, valve overhaul should be left to a Yamaha dealer. However, disassembly, cleaning and inspection of the valves and related components can be done (if the necessary special tools are available) by the home mechanic. This way no expense is incurred if the inspection reveals that overhaul is not required at this time.

2 To disassemble the valve components without the risk of damaging them, a valve spring compressor *is* absolutely essential. Make sure it is suitable for motorcycle work.

Disassembly

3 Before proceeding, arrange to label and store the valves along with their related components in such a way that they can be returned to their original locations without getting mixed up (see illustration). A good way to do this is to use the



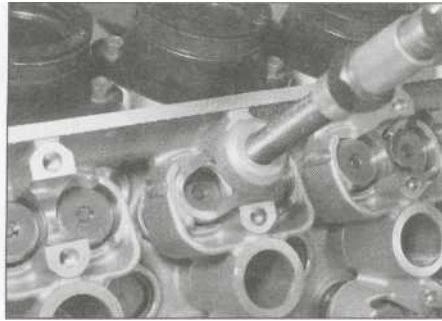
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13.3 Valve components

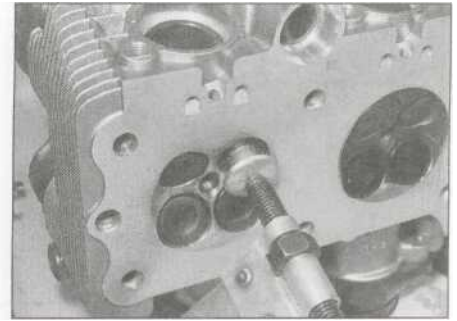
- | | |
|-------------------|-----------------------|
| 1 Collets | 4 Spring seat |
| 2 Spring retainer | 5 Valve stem oil seal |
| 3 Valve spring | 6 Valve |



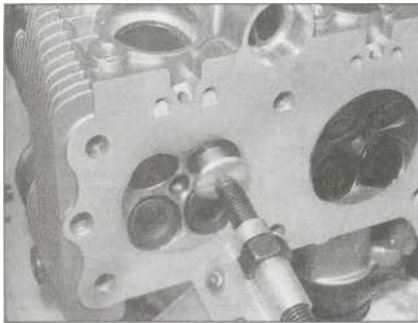
13.5a Compressing the valve springs using a valve spring compressor



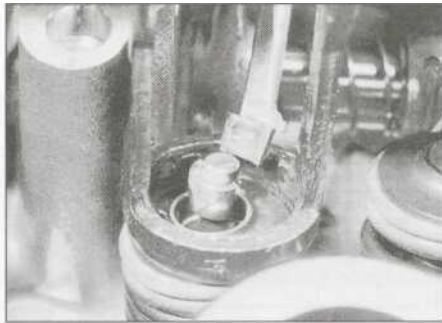
13.5b Make sure the compressor is a good fit both on the top ...



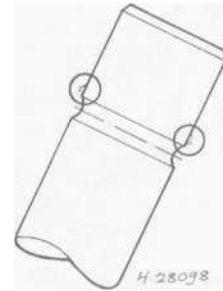
13.5c ... and the bottom of the valve assembly



13.5d Use a spacer between the plate and the valve if the plate is too big



13.5e Remove the collets with needle-nose pliers, tweezers, a magnet or a screwdriver with a dab of grease on it



13.5f If the valve stem won't pull through the guide, deburr the area above the collet groove

same container as the shims are stored in (see Section 10), or to obtain a separate container which is divided into sixteen compartments, and to label each compartment with the identity of the valve which will be stored in it (i.e. number of cylinder, intake or exhaust side, inner or outer valve). Alternatively, labelled plastic bags will do just as well.

4 Clean all traces of old gasket material from the cylinder head. If a scraper is used, take care not to scratch or gouge the soft aluminium.

Refer to 'Tools and Workshop Tips' for details of gasket removal methods.

5 Compress the valve spring on the first valve with a spring compressor, making sure it is correctly located onto each end of the valve assembly (see illustrations). On the underside of the head make sure the plate on the compressor only contacts the valve and not the soft aluminium of the head - if the plate is too big for the valve, use a spacer between them (see illustration). Do not compress the springs any more than is absolutely necessary. Remove the collets, using either needle-nose pliers, tweezers, a magnet or a screwdriver with a dab of grease on it (see illustration). Carefully release the valve spring compressor and remove the spring retainer, noting which way up it fits, the spring, the spring seat, and the valve from the head (see illustration 13.3). If the valve binds in the guide (won't pull through), push it back

into the head and deburr the area around the collet groove with a very fine file or whetstone (see illustration).

6 Repeat the procedure for the remaining valves. Remember to keep the parts for each valve together and in order so they can be reinstalled in the same location.

7 Once the valves have been removed and labelled, pull the valve stem seals off the top of the valve guides with pliers and discard them (the old seals should never be reused).

8 Next, clean the cylinder head with solvent and dry it thoroughly. Compressed air will speed the drying process and ensure that all holes and recessed areas are clean.

9 Clean all of the valve springs, collets, retainers and spring seats with solvent and dry them thoroughly. Do the parts from one valve at a time so that no mixing of parts between valves occurs.

10 Scrape off any deposits that may have formed on the valve, then use a motorised wire brush to remove deposits from the valve heads and stems. Again, make sure the valves do not get mixed up.

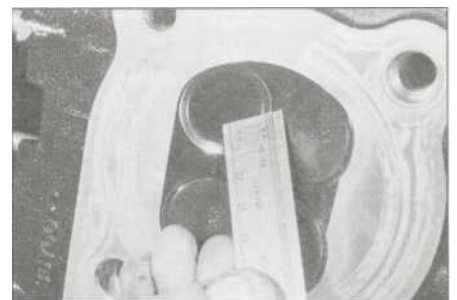
Inspection

11 Inspect the head very carefully for cracks and other damage. If cracks are found, a new head will be required. Check the cam bearing surfaces for wear and evidence of seizure. Check the camshafts for wear as well (see Section 10).

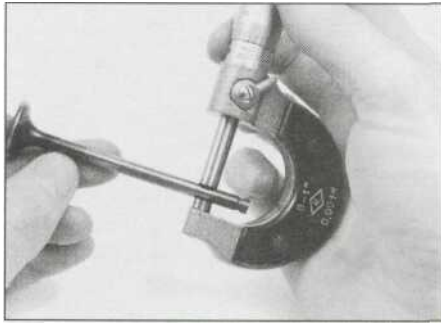
12 Using a precision straight-edge and a feeler gauge set to the warpage limit listed in the specifications at the beginning of the

Chapter, check the head gasket mating surface for warpage. Refer to *Tools and Workshop Tips* in the Reference section for details of how to use the straight-edge.

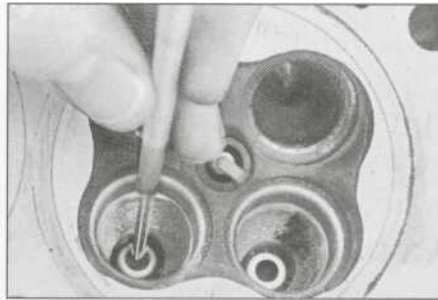
13 Examine the valve seats in the combustion chamber. If they are pitted, cracked or burned, the head will require work beyond the scope of the home mechanic. Measure the valve seat width and compare it to this Chapter's Specifications (see illustration). If it exceeds the service limit, or if it varies around its circumference, valve overhaul is required. If available, use Prussian blue to determine the extent of valve seat wear. Uniformly coat the seat with the Prussian blue, then install the valve and rotate it back and forth using a lapping tool. Remove the valve and check whether the ring of blue on the valve is uniform and continuous around the valve, and of the correct width as specified.



13.13 Measure the valve seat width with a ruler (or for greater precision use a vernier caliper)



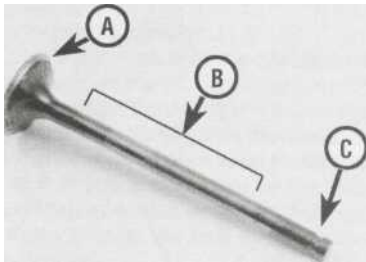
13.14a Measure the valve stem diameter with a micrometer



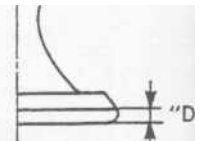
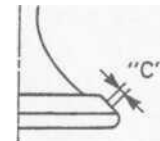
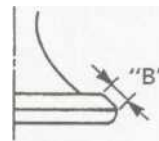
13.14b Insert a small hole gauge into the valve guide and expand it so there's a slight drag when it's pulled out



13.14c Measure the small hole gauge with a micrometer



13.15a Check the valve face (A), stem (B) and collet groove (C) for signs of wear and damage



•A"

13.15b Valve head measurement points

A Head diameter

B Face width

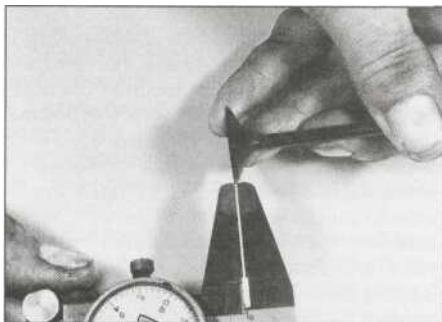
C Seat width

D Margin thickness

14 Measure the valve stem diameter (see illustration). Clean the valve guides to remove any carbon build-up, then measure the inside diameters of the guides (at both ends and the centre of the guide) with a small

hole gauge and micrometer (see illustrations). The guides are measured at the ends and at the centre to determine if they are worn in a bell-mouth pattern (more wear at the ends). Subtract the stem diameter from the valve guide diameter to obtain the valve stem-to-guide clearance. If the stem-to-guide clearance is greater than listed in this Chapter's Specifications, renew whichever components are worn beyond their specification limits. If the valve guide is within specifications, but is worn unevenly, it should be renewed.

16 Rotate the valve and check for any obvious indication that it is bent. Using V-blocks and a dial gauge if available, measure the valve stem runout and compare the results to the specifications (see illustration). If the measurement exceeds the service limit specified, the valve must be replaced. Check the end of the stem for pitting and excessive wear. The presence of any of the above conditions indicates the need for valve servicing. The stem end can be ground down, provided that the amount of stem above the collet groove after grinding is sufficient.



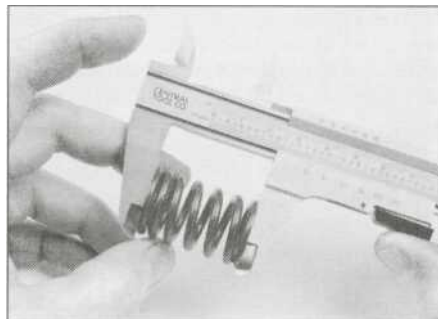
13.15c Measure the valve margin thickness as shown

15 Carefully inspect each valve face, stem and collet groove area for cracks, pits and burned spots (see illustration). Measure the valve margin thickness and compare it to the specifications (see illustration). If it is thinner than specified, replace the valve. The margin is the portion of the valve head which is below the valve seat (see illustration).

17 Check the end of each valve spring for wear and pitting. Measure the spring free length and compare it to that listed in the specifications (see illustration). If any spring is shorter than specified it has sagged and must be replaced. Also place the spring upright on a flat surface and check it for bend by placing a ruler against it (see illustration).



13.16 Check the valve stem for runout using V-blocks and a dial gauge



13.17a Measure the free length of the valve springs



13.17b Check the valve springs for squareness



13.21 Apply the lapping compound very sparingly, in small dabs, to the valve face only

If the bend in any spring is excessive, it must be replaced.

18 Check the spring retainers and collets for obvious wear and cracks. Any questionable parts should not be reused, as extensive damage will occur in the event of failure during engine operation.

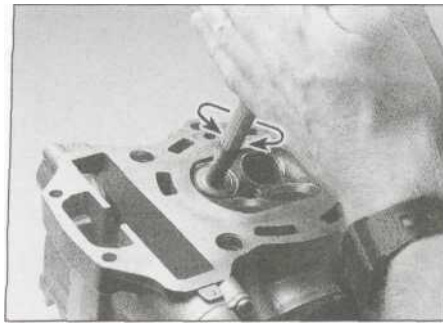
19 If the inspection indicates that no overhaul work is required, the valve components can be reinstalled in the head.

Reassembly

20 Unless a valve service has been performed, before installing the valves in the head they should be ground in (lapped) to ensure a positive seal between the valves and seats. This procedure requires coarse and fine valve grinding compound and a valve grinding tool. If a grinding tool is not available, a piece of rubber or plastic hose can be slipped over



13.25 Press the valve stem seal into position using a suitable deep socket



13.22a Rotate the valve grinding tool back and forth between the palms of your hands

the valve stem (after the valve has been installed in the guide) and used to turn the valve.

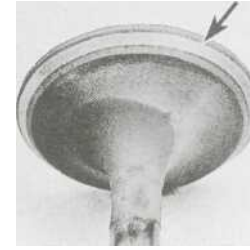
21 Apply a small amount of coarse grinding compound to the valve face and some molybdenum disulphide oil (a 50/50 mixture of molybdenum disulphide grease and engine oil) to the valve stem, then slip the valve into the guide (**see illustration**). **Note:** Make sure each valve is installed in its correct guide and be careful not to get any grinding compound on the valve stem.

22 Attach the grinding tool (or hose) to the valve and rotate the tool between the palms of your hands. Use a back-and-forth motion (as though rubbing your hands together) rather than a circular motion (i.e. so that the valve rotates alternately clockwise and anti-clockwise rather than in one direction only) (**see illustration**). Lift the valve off the seat and turn it at regular intervals to distribute the grinding compound properly. Continue the grinding procedure until the valve face and seat contact area is of uniform width and unbroken around the entire circumference of the valve face and seat (**see illustrations**).

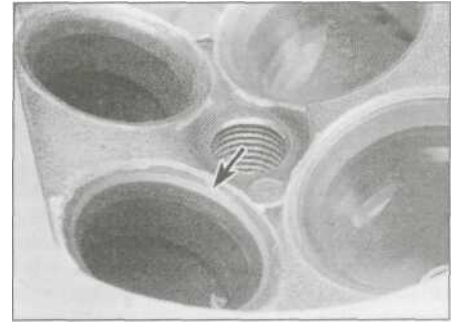
23 Carefully remove the valve from the guide and wipe off all traces of grinding compound. Use solvent to clean the valve and wipe the seat area thoroughly with a solvent soaked cloth.

24 Repeat the procedure with fine valve grinding compound, then repeat the entire procedure for the remaining valves.

25 Working on one valve at a time, lay the



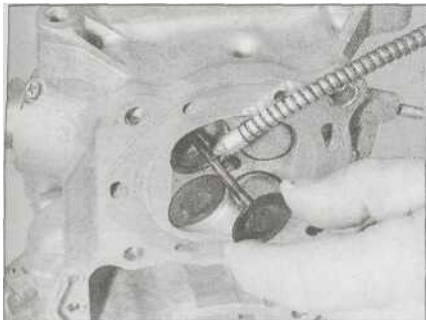
13.22b The valve face and seat should show a uniform unbroken ring ...



13.22c ... and the seat (arrowed) should be the specified width all the way round

spring seat in place in the cylinder head, with its shouldered side up so that the spring fits into it, then fit a new valve stem seal on the guide (**see illustration**). Use an appropriate size deep socket to push the seal over the end of the valve guide until it is felt to clip into place. Don't twist or cock the seal, or it will not seal properly against the valve stem. Also, don't remove it again or it will be damaged.

26 Coat the valve stem with molybdenum disulphide oil (a 50/50 mixture of molybdenum disulphide grease and engine oil), then install it into its guide, rotating it slowly to avoid damaging the seal (**see illustration**). Check that the valve moves up and down freely in the guide. Next, install the spring, with its closer-wound coils facing down into the cylinder head, followed by the spring retainer, with its shouldered side facing down so that it fits into the top of the spring (**see illustrations**).



13.26a Lubricate the stem and slide the valve into its correct location



13.26b Fit the valve spring with its closer-wound coils facing down ...



13.26c ... then fit the spring retainer

A

2»24 Engine, clutch and transmission

27 Apply a small amount of grease to the collets to help hold them in place as the pressure is released from the spring (see illustration). Compress the spring with the valve spring compressor and install the collets (see illustration). When compressing the spring, do so only as far as is necessary to slip the collets into place. Make certain that the collets are securely locked in the retaining groove.

28 Support the cylinder head on blocks so the valves can't contact the workbench top, then very gently tap the valve stem with a soft-faced hammer. This will help seat the collets in the groove.

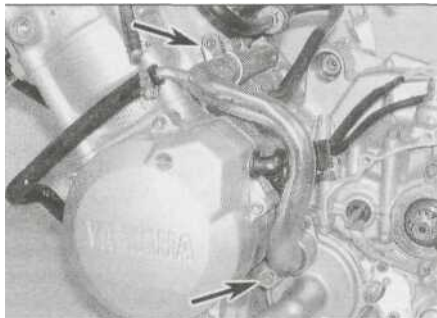
Check for proper sealing of the valves by pouring a small amount of solvent into each of the valve ports. If the solvent leaks past any valve into the combustion chamber area the valve grinding operation on that valve should be repeated.

29 Repeat the procedure for the remaining valves. Remember to keep the parts for each valve together and separate from the other valves so they can be reinstalled in the same location.

14 Cylinder block - removal, inspection and installation

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Note: The cylinder block can be removed with the engine in the frame.



14.2a Unscrew the bolts (arrowed) and remove the pipe



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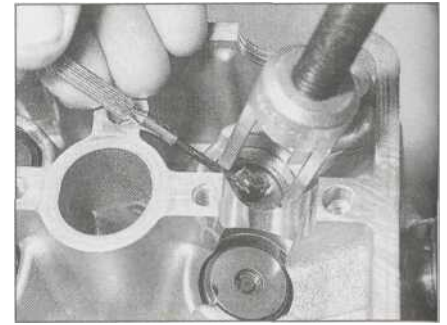
14.2b If required, unscrew the bolts (arrowed) and remove the union

13.27a A small dab of grease will help to keep the collets in place on the valve while the spring is released

Removal

- 1 Remove the cylinder head (see Section 11).
- 2 On YZF models, unscrew the bolts securing the coolant pipe to the water pump and the inlet union on the back of the block and remove the pipe (see illustration). Discard the O-rings as new ones must be used. If required, pull the carburettor heater system hose holder off the tensioner body (see illustration 9.1), then unscrew the bolts securing the inlet union to the back of the block and remove the union (see illustration). Discard the O-rings as new ones must be used.
- 3 On FZS models, slacken the clamp securing the coolant hose to the inlet union on the front of the block and detach the hose (see illustration 5.8b). If required, unscrew the bolts securing the inlet union to the front of the block and remove the union. Discard the O-rings as new ones must be used.
- 4 Hold the cam chain up and lift the cylinder block up, then pass the cam chain down through the tunnel (see illustration). Do not let the chain fall into the crankcase - secure it with a piece of wire or metal bar to prevent it from doing so. If the block is stuck, tap around the joint faces of the block with a soft-faced mallet to free it from the crankcase. Don't attempt to free the block by inserting a screwdriver between it and the crankcase - you'll damage the sealing surfaces. When the block is removed, stuff clean rags around the pistons to prevent anything falling into the crankcase. Remove the dowels from the

14.4 Lift the block up off the crankcase



13.27b Compress the springs and install the collets, making sure they locate in the groove

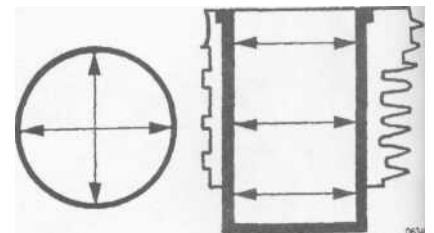
mating surface of the crankcase or the underside of the block if they are loose. Be careful not to drop them into the engine.

5 Remove the gasket and clean all traces of old gasket material from the cylinder block and crankcase mating surfaces. If a scraper is used, take care not to scratch or gouge the soft aluminium. Be careful not to let any of the gasket material fall into the crankcase or the oil passages.

Inspection

Caution: Do not attempt to separate the liners from the cylinder block.

- 6 Check the cylinder walls carefully for scratches and score marks.
- 7 Using a precision straight-edge and a feeler gauge set to the warpage limit listed in the specifications at the beginning of the Chapter, check the block gasket mating surface for warpage. Refer to *Tools and Workshop Tips* in the Reference section for details of how to use the straight-edge. If warpage is excessive the block must be replaced with a new one.
- 8 Using telescoping gauges and a micrometer (see *Tools and Workshop Tips*), check the dimensions of each cylinder to assess the amount of wear, taper and ovality. Measure near the top (but below the level of the top piston ring at TDC), centre and bottom (but above the level of the oil ring at BDC) of the bore, both parallel to and across the crankshaft axis (see illustration). Compare the results to the specifications at the beginning of the Chapter.



14.8 Measure the cylinder bore in the positions shown with a telescoping gauge, then measure the gauge with a micrometer

9 If the precision measuring tools are not available, take the block to a Yamaha dealer or specialist motorcycle repair shop for assessment and advice.

10 If the cylinders are worn beyond the service limit, or badly scratched, scuffed or scored, the cylinder block must be renewed. Yamaha do not supply oversize pistons and rings, negating the possibility of a rebore. It may however be worth checking with aftermarket parts suppliers, but first check with a Yamaha dealer or specialist that the liners are thick enough and of the correct material to withstand a rebore.

11 If the block and cylinders are in good condition and the piston-to-bore clearance is within specifications (see Section 15), the cylinders should be honed (de-glazed). To perform this operation you will need the proper size flexible hone with fine stones (see *Tools and Workshop Tips*), or a bottle-brush type hone, plenty of light oil or honing oil, some clean rags and an electric drill motor.

12 Hold the block sideways (so that the bores are horizontal rather than vertical) in a vice with soft jaws or cushioned with wooden blocks. Mount the hone in the drill motor, compress the stones and insert the hone into the cylinder. Thoroughly lubricate the cylinder, then turn on the drill and move the hone up and down in the cylinder at a pace which produces a fine cross-hatch pattern on the cylinder wall with the lines intersecting at an angle of approximately 60 degrees. Be sure to use plenty of lubricant and do not take off any more material than is necessary to produce the desired effect. Do not withdraw the hone from the cylinder while it is still turning. Switch off the drill and continue to move it up and down in the cylinder until it has stopped turning, then compress the stones and withdraw the hone. Wipe the oil from the cylinder and repeat the procedure on the other cylinder. Remember, do not take too much material from the cylinder wall.

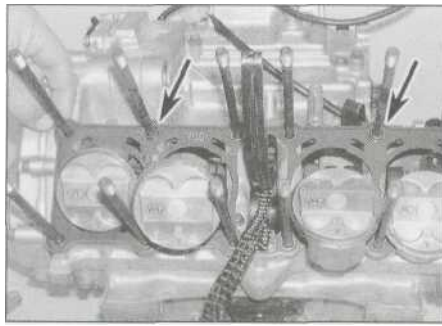
13 Wash the cylinders thoroughly with warm soapy water to remove all traces of the abrasive grit produced during the honing operation. Be sure to run a brush through the bolt holes and flush them with running water. After rinsing, dry the cylinders thoroughly and apply a thin coat of light, rust-preventative oil to all machined surfaces.

14 If you do not have the equipment or desire to perform the honing operation, take the block to a Yamaha dealer or specialist motorcycle repair shop.

Installation

15 Check that the mating surfaces of the cylinder block and crankcase are free from oil or pieces of old gasket. If removed, fit the dowels into the crankcase (see illustration 14.16).

16 Remove the rags from around the pistons. Lay the new base gasket in place on the crankcase, making sure the "UP" mark faces up, it locates correctly over the dowels and all



14.16 Lay the new gasket over the dowels (arrowed) and onto the crankcase

the holes are correctly aligned (see illustration). Never re-use the old gasket.

17 If required, install piston ring clamps onto the pistons to ease their entry into the bores as the block is lowered. This is not essential as each cylinder has a good lead-in enabling the piston rings to be hand-fed into the bore. If possible, have an assistant to support the block while this is done.

Rotate the crankshaft until the inner pistons (2 and 3) are uppermost and feed them into the block first. Access to the lower pistons (1 and 4) is easier since they are on the outside.

18 Lubricate the cylinder bores, pistons and piston rings, and the connecting rod big and small ends, with clean engine oil, then install the block down over the studs until the uppermost piston crowns fit into the bores (see illustration). At this stage feed the cam chain up through the block and secure it in place with a piece of wire to prevent it from falling back down.

19 Gently push down on the cylinder block, making sure the pistons enter the bores squarely and do not get cocked sideways. If piston ring clamps are not being used, carefully compress and feed each ring into the bore as the block is lowered. If necessary, use a soft mallet to gently tap the block down, but do not use force if the block appears to be stuck as the pistons and/or rings will be damaged. If clamps are used, remove them once the pistons are in the bore.



14.21 a Fit a new O-ring onto each end of the pipe ...

14.18 Carefully lower the block onto the pistons

20 When the pistons are correctly installed in the cylinders, press the block down onto the base gasket, making sure it locates correctly onto the dowels.

21 On YZF models, if removed, install the coolant inlet union using new O-rings and tighten the bolts to the torque setting specified at the beginning of the Chapter (see illustration 14.2b), then fit the carburettor heater system hose holder onto the tensioner body (see illustration 9.1). Fit a new O-ring onto each end of the coolant pipe, then press the pipe into the water pump and inlet union simultaneously until the O-rings are felt to locate, then install the pipe bolts and tighten them to the specified torque (see illustrations).

22 On FZS models, if removed, install the coolant inlet union using new O-rings and tighten the bolts to the torque setting specified at the beginning of the Chapter. Fit the coolant hose onto the inlet union on the front of the block and tighten the clamp securely (see illustration 5.8b)

23 Install the cylinder head (see Section 11).

15 Pistons- removal, inspection and installation

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Note: The pistons can be removed with the engine in the frame.

Removal

- 1 Remove the cylinder block (see Section 14).
- 2 Before removing the piston from the



14.21b . . . and press it into place

in

V

15.2 Note the mark on the piston which must point forwards

connecting rod, and if not already done, stuff a clean rag into the hole around the rod to prevent the circlips or anything else from falling into the crankcase. Use a sharp scribe or felt marker pen to write the cylinder identity on the crown of each piston (or on the inside of the skirt if the piston is dirty and going to be cleaned) as it must be installed in its original cylinder. Each piston should also have a triangle mark or "EX" on its crown which should face the exhaust side of the bore (see illustration). If this is not visible, mark the piston accordingly so that it can be installed the correct way round.

3 Carefully prise out the circlip on one side of the piston using needle-nose pliers or a small flat-bladed screwdriver inserted into the notch (see illustration). Push the piston pin out from the other side to free the piston from the connecting rod (see illustration). Remove the other circlip and discard them as new ones must be used. When the piston has been removed, install its pin back into its bore so that related parts do not get mixed up. Rotate the crankshaft so that the best access is obtained for each piston.

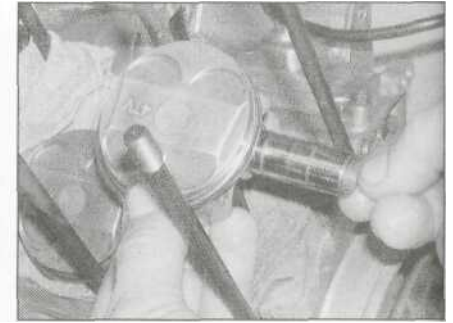
HAYNES HINT To prevent the circlip from pinging away, pass a rod or screwdriver, whose diameter is greater than the gap between the circlip ends, through the piston pin. This will trap the circlip if it springs out.



15.5 Removing the piston rings using a ring removal and installation tool



15.3a Prise out the circlip ..



15.3b .. then push out the pin and remove the piston

HIRIT If a piston pin is a tight fit in the piston bosses, soak a rag in boiling water then wring it out and wrap it around the piston - this will expand the alloy piston sufficiently to release its grip on the pin. If the piston pin is particularly stubborn, extract it using a drawbolt tool, but be careful to protect the piston's working surfaces.

Inspection

4 Before the inspection process can be carried out, the pistons must be cleaned and the old piston rings removed.

5 Using your thumbs or a piston ring removal and installation tool, carefully remove the rings from the pistons (see illustration). Do not nick or gouge the pistons in the process. Carefully note which way up each ring fits and in which groove as they must be installed in their original positions if being re-used. The upper surface of each ring has a manufacturer's mark or letter at one end.

6 Scrape all traces of carbon from the tops of the pistons. A hand-held wire brush or a piece of fine emery cloth can be used once most of the deposits have been scraped away. Do not, under any circumstances, use a wire brush mounted in a drill motor to remove deposits from the pistons; the piston material is soft and will be eroded away by the wire brush.

7 Use a piston ring groove cleaning tool to remove any carbon deposits from the ring

grooves. If a tool is not available, a piece broken off an old ring will do the job. Be very careful to remove only the carbon deposits, Do not remove any metal and do not nick or gouge the sides of the ring grooves.

8 Once the deposits have been removed, clean the pistons with solvent and dry them thoroughly. If the identification previously marked on the piston is cleaned off, be sure to re-mark it with the correct identity. Make sure the oil return holes below the oil ring groove are clear.

9 Carefully inspect each piston for cracks around the skirt, at the pin bosses and at the ring lands. Normal piston wear appears as even, vertical wear on the thrust surfaces of the piston and slight looseness of the top ring in its groove. If the skirt is scored or scuffed, the engine may have been suffering from overheating and/or abnormal combustion, which caused excessively high operating temperatures. The oil pump should be checked thoroughly. Also check that the circlip grooves are not damaged.

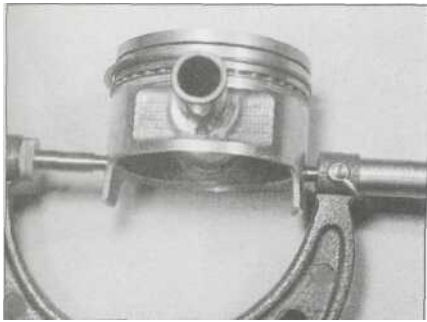
10 A hole in the piston crown, an extreme to be sure, is an indication that abnormal combustion (pre-ignition) was occurring. Burned areas at the edge of the piston crown are usually evidence of spark knock (detonation). If any of the above problems exist, the causes must be corrected or the damage will occur again.

11 Measure the piston ring-to-groove clearance by laying each piston ring in its groove and slipping a feeler gauge in beside it (see illustration). Make sure you have the correct ring for the groove (see Step 5). Check the clearance at three or four locations around the groove. If the clearance is greater than specified, renew both the piston and rings as a set. If new rings are being used, measure the clearance using the new rings. If the clearance is greater than that specified, the piston is worn and must be renewed.

12 Check the piston-to-bore clearance by measuring the bore (see Section 14) and the piston diameter. Make sure each piston is matched to its correct cylinder. Measure the piston 5.0 mm up from the bottom of the skirt and at 90° to the piston pin axis (see illustration). Subtract the piston diameter from the bore diameter to obtain the



15.11 Measure the piston ring-to-groove clearance with a feeler gauge



15.12 Measure the piston diameter with a micrometer at the specified distance from the bottom of the skirt

clearance. If it is greater than the specified figure, the piston must be renewed (assuming the bore itself is within limits, otherwise a new cylinder block must be installed).

13 Apply clean engine oil to the piston pin, insert it into the piston and check for any freeplay between the two (see illustration). Measure the pin external diameter, and the pin bore in the piston (see illustrations). Calculate the difference to obtain the piston pin-to-piston pin bore clearance. Compare the result to the specifications at the beginning of the Chapter. If the clearance is greater than specified, renew the components that are worn beyond their specified limits. Repeat the checks between the pin and the connecting rod small end (see Section 27).

14 Remove the two small-end oil jets - they are a push-fit (see illustration). Discard their O-rings as new ones must be used. Clean the

15.13a Slip the pin (A) into the piston (B) and try to rock it back and forth. If it's loose, replace the piston and pin

jets in solvent and blow them through, using compressed air if available, to ensure they are not blocked. Fit a new O-ring onto each jet and press them back into the crankcase (see illustrations).

Installation

15 Inspect and install the piston rings (see Section 16).

16 Lubricate the piston pin, the piston pin bore and the connecting rod small-end bore with clean engine oil (see illustration).

17 Install a new circlip in one side of the piston (do not re-use old circlips) (see illustration). Line up the piston on its correct connecting rod, making sure the triangle or "EX" mark on the piston crown faces forwards, and insert the piston pin from the other side (see illustration 15.3b). Secure the pin with the other new circlip. When installing



15.13b Measure the external diameter of the pin ...

the circlips, compress them only just enough to fit them in the piston, and make sure they are properly seated in their grooves with the open end away from the removal notch.

18 Install the cylinder block (see Section 14).

16 Piston rings- inspection and installation

Inspection

1 It is good practice to renew the piston rings when an engine is being overhauled. Before installing the new piston rings, the ring end gaps must be checked with the rings installed in the cylinder.

2 Lay out the pistons and the new ring sets so the rings will be matched with the same piston



15.14a Pull the oil jets (arrowed) out of the crankcase



5.14b Fit a new O-ring onto each jet...

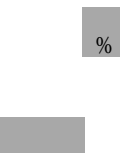


15.16 Lubricate the components with clean engine oil

15.17 Do not over-compress the circlips when fitting them into the piston

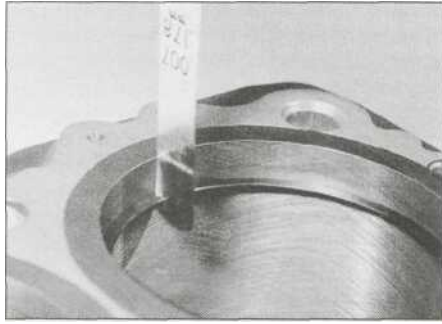


15.13c ... and the internal diameter of the bore in the piston

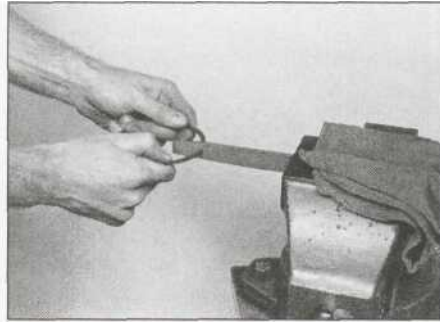


5.14c ... and fit them back into the crankcase

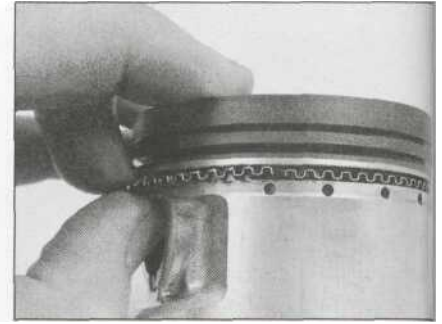




16.3 Measuring piston ring installed end gap



16.5 Ring end gap can be enlarged by clamping a file in a vice and filing the ring ends



16.9a Install the oil ring expander in its groove...

and cylinder during the end gap measurement procedure and engine assembly.

3 To measure the installed ring end gap, insert the top ring into the top of the first cylinder and square it up with the cylinder walls by pushing it in with the top of the piston. The ring should be about 20 mm below the top edge of the cylinder. To measure the end gap, slip a feeler gauge between the ends of the ring and compare the measurement to the specifications at the beginning of the Chapter (**see illustration**).

4 If the gap is larger or smaller than specified, double check to make sure that you have the correct rings before proceeding.

5 If the gap is too small, it must be enlarged or the ring ends may come in contact with each other during engine operation, which can cause serious damage. The end gap can be increased by filing the ring ends very carefully with a fine file. When performing this operation, file only from the outside in (**see illustration**).

6 Excess end gap is not critical unless it exceeds the service limit. Again, double-check to make sure you have the correct rings for your engine and check that the bore is not worn.

7 Repeat the procedure for each ring that will be installed in the cylinders. When checking

the oil ring, only the side-rails can be checked as the ends of the expander ring should contact each other. Remember to keep the rings, pistons and cylinders matched up.

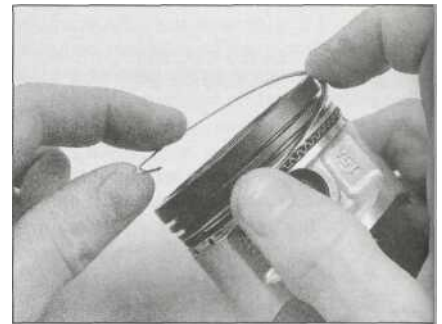
8 Once the ring end gaps have been checked/corrected, the rings can be installed on the pistons.

Installation

9 The oil control ring (lowest on the piston) is installed first. It is composed of three separate components, namely the expander and the upper and lower side rails. Slip the expander into the groove, then install the upper side rail (**see illustration**). Do not use a piston ring installation tool on the oil ring side rails as they may be damaged. Instead, place one end of the side rail into the groove between the expander and the ring land (**see illustration**). Hold it firmly in place and slide a finger around the piston while pushing the rail into the groove. Next, install the lower side rail in the same manner. Make sure the ends of the expander do not overlap.

10 After the three oil ring components have been installed, check to make sure that both the upper and lower side rails can be turned smoothly in the ring groove.

11 The upper surface of each compression ring has a mark or letter at one end which must face up when the ring is installed on the piston.

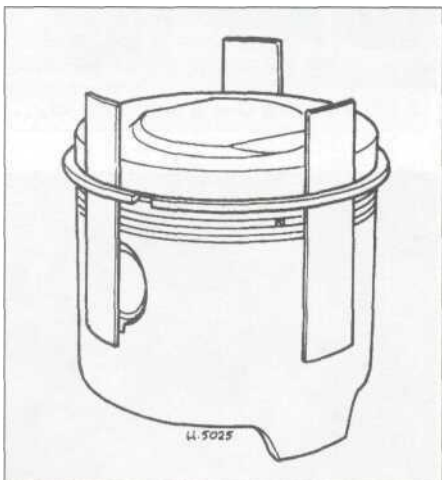


16.9b ... and fit the side rails each side of it. The oil ring must be installed by hand

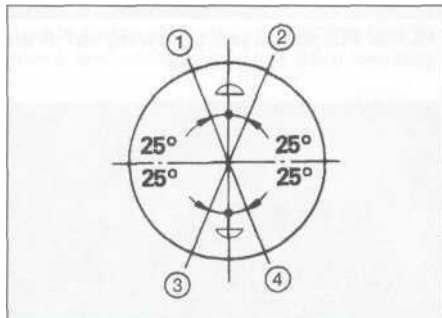
12 Fit the second ring into the middle groove in the piston. Do not expand the ring any more than is necessary to slide it into place. To avoid breaking the ring, use a piston ring installation tool (**see illustration 15.5**), or pieces of old feeler gauge blades (**see illustration**).

13 Finally, install the top ring in the same manner into the top groove in the piston.

14 Once the rings are correctly installed, check they move freely without snagging and stagger their end gaps as shown (**see illustration**).



16.12 Old pieces of feeler gauge blade can be used to guide the ring over the piston



16.14 Stagger the ring end gaps as shown

- 1 Top compression ring
- 2 Oil ring lower rail
- 3 Oil ring upper rail
- 4 Second compression ring

17 Clutch - removal, inspection and installation

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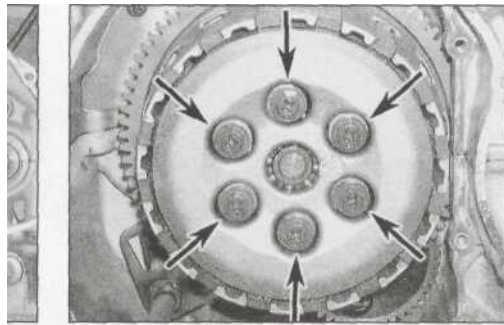
Note: The clutch can be removed with the engine in the frame. If the engine has been removed, ignore the steps which don't apply.

Removal

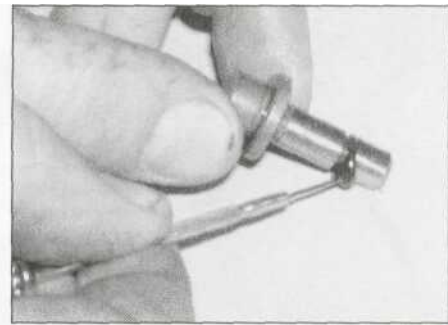
- 1 Drain the engine oil (see Chapter 1).
- 2 On YZF models, remove the right-hand fairing side panel (see Chapter 8, Section 3).
- 3 Working evenly in a criss-cross pattern, unscrew the clutch cover bolts (**see illustration**). Lift the cover away from the engine, being prepared to catch any residual oil which may be released as the cover is removed.
- 4 Remove the gasket and discard it. Note the positions of the two locating dowels fitted to the crankcase and remove them for safe-keeping if they are loose.



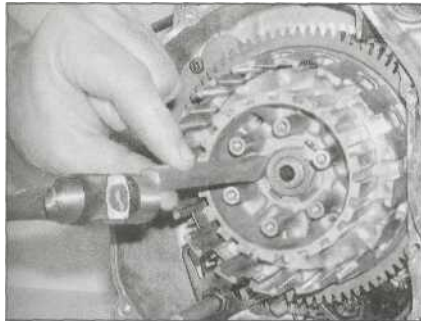
17.3 Unscrew the bolts (arrowed) and remove the cover



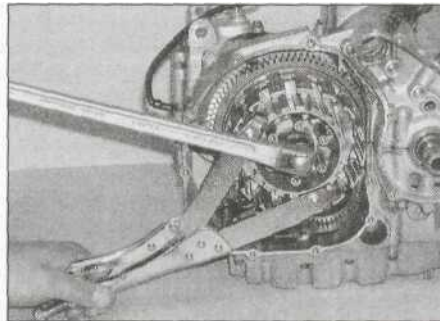
17.5a Clutch pressure plate bolts (arrowed)



17.5b Remove and discard the end-piece O-ring



17.7a Bend back the lockwasher tabs

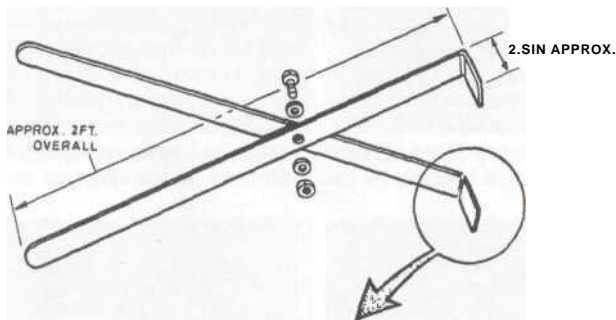


17.7b Slackening the clutch nut using a commercially available holding tool

5 Working in a criss-cross pattern, gradually slacken the clutch spring bolts until spring pressure is released (see illustration). Counter-hold the clutch housing to prevent it turning. Remove the bolts and springs, then remove the clutch pressure plate and the pushrod end-piece (see illustrations 17.30a and 17.29d). Discard the O-ring on the end-piece as a new one must be used (see illustration). On YZF models, note that there are two different lengths

of clutch spring. If required also remove the ball bearing and pushrod from inside the shaft - you may need a magnet or magnetised screwdriver to draw them out (see illustrations 17.29c and 17.29b). Otherwise, remove the front sprocket cover, then push the rod into the engine until the ball bearing comes out of the other end of the shaft, and withdraw the pushrod from the left-hand side of the engine (see Step 19) (see illustration 17.19).

TOOL TIP



FILE EDGE OF JAW TO CORRESPOND WITH PROFILE OF CLUTCH CENTRE SPLINES

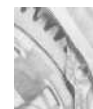
A clutch centre holding tool can easily be made using two strips of steel with the ends bent over, and bolted together in the middle.

6 Grasp the complete set of clutch plates and remove them as a pack. Unless the plates are being replaced with new ones, keep them in their original order. On YZF models, note that the outer and inner friction plates are a different colour (black) to the rest. On FZS models, note the anti-judder spring fitted with the second innermost friction plate, and that the plate has a larger internal diameter than the rest to accommodate the spring.

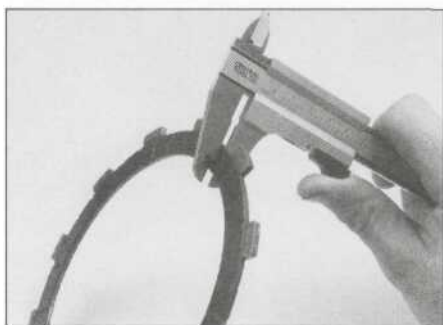
7 Bend back the tabs on the clutch nut lockwasher (see illustration). To remove the clutch nut the transmission input shaft must be locked. This can be done in several ways. If the engine is in the frame, engage 1st gear and have an assistant hold the rear brake on hard with the rear tyre in firm contact with the ground. Alternatively, the Yamaha service tool (Pt. No. 90890-04086), or a similar commercially available or home-made tool, made from two strips of steel bent at the ends and bolted together in the middle (see Tool tip), can be used to stop the clutch centre from turning whilst the nut is slackened (see illustration). Unscrew the nut and remove the lockwasher from the input shaft, noting how it fits (see illustration 17.27b). Discard the lockwasher as a new one must be used on installation.

8 Remove the clutch centre and the outer thrust plate from the shaft (see illustrations 17.27a and 17.26).

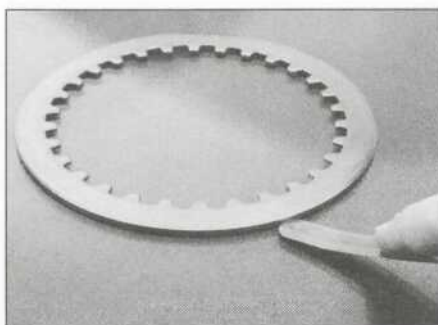
9 Support the clutch housing and withdraw the large sleeve from its centre (see illustration). To get a grip on the sleeve, grasp the housing and wiggle it out and in - it should draw the sleeve out far enough to grip it. If



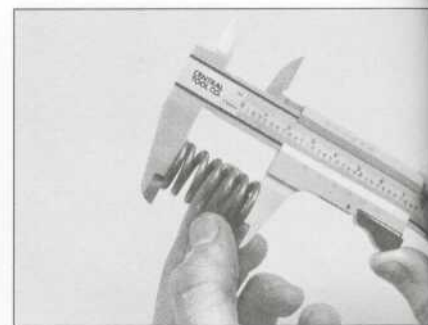
17.9 Remove the inner sleeve



17.12 Measuring clutch friction plate thickness



17.13 Check the plain plates for warpage



17.14 Measure the free length of the springs

difficulty is experienced in getting a grip on the sleeve, install a 6 mm bolt (a clutch cover bolt is the correct size) into one or both of the threaded holes and pull the sleeve from the housing.

10 Withdraw the caged needle roller bearing from the housing if it didn't come away with the sleeve, and then remove the housing from the engine, noting how it engages with the primary drive gear and the oil pump driven gear (see illustration 17.24).

11 Remove the inner thrust plate and the thrust washer from the shaft (see illustrations 17.23 and 17.23a).

Inspection

12 After an extended period of service the clutch friction plates will wear and promote clutch slip. Measure the thickness of each friction plate using a vernier caliper (see illustration). If any plate has worn to or beyond the service limit given in the Specifications at the beginning of the Chapter, the friction plates must be renewed as a set. Also, if any of the plates smell burnt or are glazed, they must be renewed as a set.

13 The plain plates should not show any signs of excess heating (bluing). Check for warpage using a flat surface and feeler gauges (see illustration). If any plate exceeds the maximum permissible amount of warpage, or shows signs of bluing, all plain plates must be renewed as a set.

14 Measure the free length of each clutch spring using a vernier caliper (see illustration). If any spring is below the service

limit specified, renew all the springs as a set.

15 Inspect the clutch assembly for burrs and indentations on the edges of the protruding tangs of the friction plates and/or slots in the edge of the housing with which they engage. Similarly check for wear between the inner tongues of the plain plates and the slots in the clutch centre. Wear of this nature will cause clutch drag and slow disengagement during gear changes as the plates will snag when the pressure plate is lifted. With care a small amount of wear can be corrected by dressing with a fine file, but if this is excessive the worn components should be renewed.

16 Inspect the sleeve and caged needle roller bearing in conjunction with the clutch housing's internal bearing surface. If there are any signs of wear, pitting or other damage the affected parts must be renewed.

17 Check the pressure plate and its bearing for signs of wear or damage and roughness (see illustration). Check the pushrod end piece, ball bearing and pushrod for signs of roughness, wear or damage. Replace any parts necessary with new ones. Check that the pushrod is straight by rolling it on a flat surface - if it is bent by more than the limit, replace it with a new one.

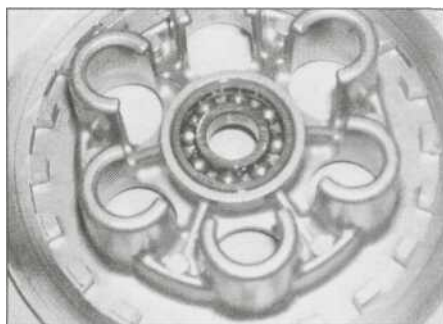
18 On FZS models, check the clutch centre anti-judder spring and its seat for wear or damage, and renew them if required.

19 The clutch release mechanism, housed in the front sprocket cover, and the pushrod oil seal should be also be checked. On YZF models remove the left-hand fairing side panel (see Chapter 8, Section 3). Unscrew the

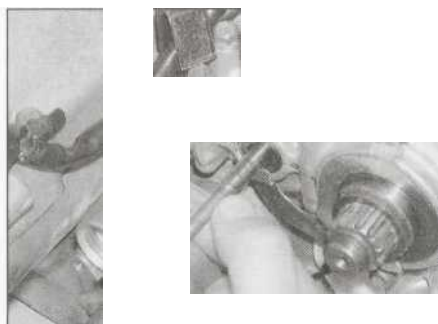
gearchange lever linkage arm pinch bolt and slide the arm off the shaft, noting any alignment marks (see illustration 18.2). If no marks are visible, make your own before removing the arm so that it can be correctly aligned with the shaft on installation. Unscrew the bolts securing the front sprocket cover and displace the cover (see illustration 18.3). There is no need to detach the cable from the cover unless you want to (see Section 18). Note the position of the dowels and remove them if loose. Discard the gasket as a new one must be used. If not already done, withdraw the clutch pushrod and check it for straightness by rolling it on a flat surface (see illustration).

20 Check the clutch release mechanism for smooth operation and any signs of wear or damage. Remove the two screws securing the mechanism to the cover and remove it cleaning and re-greasing if required (see illustration). Apply a dab of grease to the pushrod end.

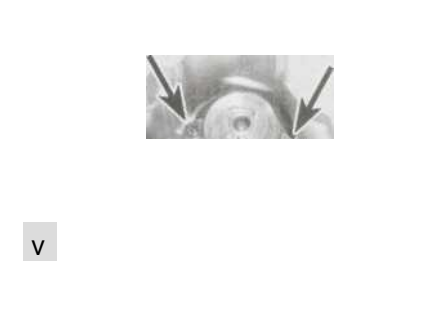
21 Check the pushrod oil seal for signs of oil leakage and replace it if necessary. To replace it, first remove the front sprocket (see Chapter 6), then unscrew the bolts securing the oil seal retainer plate and remove the plate (see illustration). Lever out the old seal using a screwdriver, then drive a new seal squarely into place. Apply a suitable non-permanent thread locking compound to the retainer plate bolts and tighten them to the torque setting specified at the beginning of the Chapter. Install the engine sprocket (see Chapter 6). removed, fit the sprocket cover dowels into



17.17 Check the bearing in the pressure plate

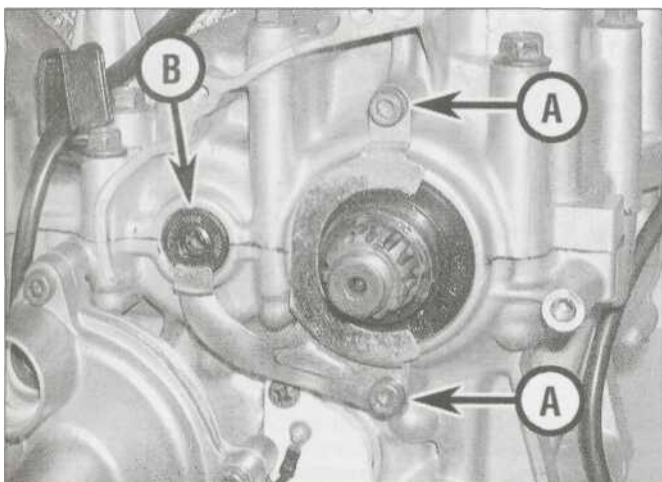


17.19 Withdraw the clutch pushrod

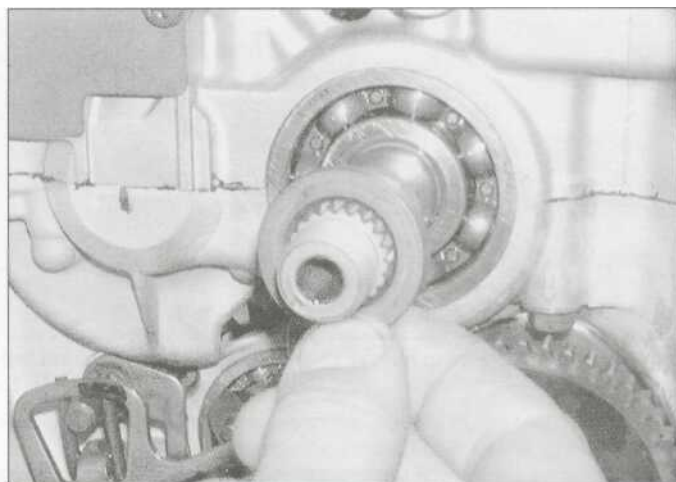


V

17.20 The release mechanism is secured by two screws (arrowed)



17.21 Remove the oil seal retainer bolts (A) to access the pushrod seal (B)



17.23a Fit the thrust washer.

the crankcase. If removed, attach the clutch cable to the cover (see Section 18). Install the cover using a new gasket, making sure it locates correctly onto the dowels, and tighten its bolts to the specified torque setting (see illustrations 18.8a, 18.8b and 18.8c). Slide the gearchange linkage arm onto the shaft, aligning the marks, and tighten the pinch bolt (see illustration 18.2).

Installation

- 22 Remove all traces of old gasket from the crankcase and clutch cover surfaces.
- 23 Slide the thrust washer and the inner

- thrust plate onto the shaft (see illustrations).
- 24 Lubricate the needle roller bearing and sleeve with clean engine oil. Install the clutch housing, without its needle roller bearing and sleeve, and support it in position, making sure it is engaged correctly with the primary drive gear on the crankshaft (see illustration).
- 25 Install the needle bearing and the sleeve, with its bolt holes facing out, into the middle of the clutch housing (see illustration).
- 26 Lubricate the outer thrust plate with clean engine oil and fit it onto the shaft (see illustration).

- 27 Install the clutch centre onto the shaft splines, then install the new lockwasher, engaging its tabs with the slots (see illustrations). Install the clutch nut and, using the method employed on removal to lock the input shaft, tighten the nut to the torque setting specified at the beginning of the Chapter (see illustrations). **Note:** Check that the clutch centre rotates freely after tightening. Bend up the tabs of the lockwasher to secure the nut (see illustration).
- 28 Build up the clutch plates as follows: On YZF models, first fit a black friction plate, then



17.23b ... and inner thrust plate onto the shaft

17.24 Slide the housing into place so that it engages the primary drive gear ...

17.25 ... then fit the needle bearing and the sleeve into the middle of the housing



17.26 Fit the outer thrust plate .

17.27a ... then slide the clutch centre onto the splines

17.27b Install the lockwasher, fitting the smaller bent tabs into the slots in the centre

2»32 Engine, clutch and transmission

*N

C



17.27c Fit the nut...

17.27d ... and tighten it to the specified torque



17.27e Bend up the lockwasher tabs to secure the nut

^

X



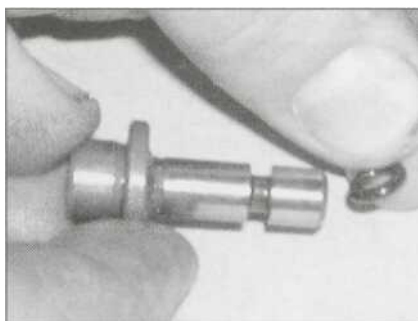
17.28a On YZF models, fit a black friction plate first



17.28b ... then fit a plain plate ...

I

17.28c ... then a normal friction plate, and I so on, finishing with a black friction plate I



17.29a Fit a new O-ring into the groove in the end-piece

17.29b Insert the pushrod ...



17.29c ... then the ball bearing ...



17.29d ... and the end-piece

17.30a Install the pressure plate, aligning the castellations ...

W, s* <t>

17.30b ... then fit the springs and bolts ..





17.30c ... and tighten them to the specified torque

a plain plate, then alternate friction and plain plates until all are installed, making sure the outermost friction plate is a black one (see illustrations). Coat each plate with engine oil prior to installation. On FZS models, first fit a friction plate, then a plain plate, then install the anti-judder spring. Now fit the friction plate with the larger internal diameter over the spring. Now alternate plain and friction plates until all are installed. Coat each plate with engine oil prior to installation.

29 Fit a new O-ring onto the pushrod end-piece (see illustration). Lubricate the release bearing in the pressure plate, the pushrod end-piece, O-ring, ball bearing and pushrod with a lightweight lithium soap-based grease. Slide the pushrod into the shaft so that its tapered end faces the left-hand side, then fit

17.31 a Fit the gasket onto the dowels (arrowed)...

the ball bearing and the end-piece (see illustrations).

30 Install the pressure plate onto the clutch, aligning it so that the castellations on the back locate correctly into the slots in the clutch centre - there is no alignment mark, so you may need to turn the plate a few times before the bolt holes align and the castellations locate (see illustration). Install the springs and the bolts with their washers, on YZF models making sure that you alternate between long and short springs, so that none of the same are next to each other (see illustration). Tighten the bolts evenly in a criss-cross sequence to the specified torque setting (see illustration). Counter-hold the clutch housing to prevent it turning when tightening the spring bolts.



17.31b ... then fit the cover

31 Insert the dowels in the crankcase, then install the clutch cover using a new gasket and tighten its bolts evenly in a criss-cross sequence to the specified torque setting (see illustrations).

32 Refill the engine with oil (see Chapter 1).

33 On YZF models, install the fairing side panel(s) (see Chapter 8).

18 Clutch cable-removal and installation



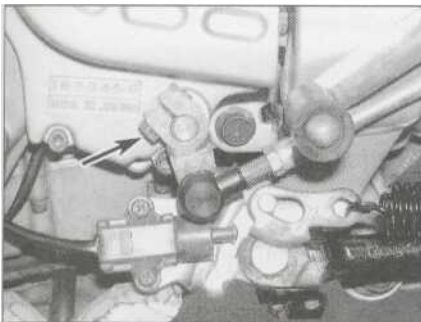
Removal

1 On YZF models, remove the left-hand fairing side panel (see Chapter 8, Section 3).

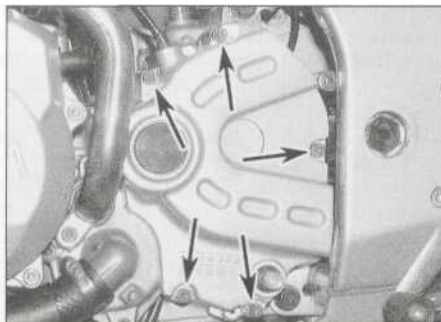
2 Unscrew the gearchange linkage arm pinch bolt and slide the arm off the shaft, noting any alignment marks (see illustration). If no marks are visible, make your own before removing the arm so that it can be correctly aligned with the shaft on installation.

3 Unscrew the bolts securing the sprocket cover to the crankcase and displace the cover (see illustration). Note the position of the dowels and remove them for safekeeping if loose. Discard the gasket as a new one must be used.

4 Bend out the tab in the cable retainer on the end of the release mechanism arm, then lift the arm and slip the cable end out of the retainer, noting how it fits (see illustrations). Withdraw the cable from the cover (see illustration).



18.2 Unscrew the bolt (arrowed) and slide the arm off the shaft



18.3 Sprocket cover bolts (arrowed)



18.4a Bend down the retaining tab . . .

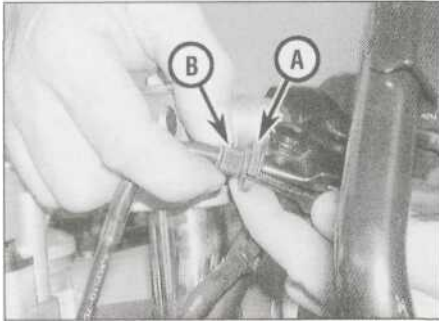


18.4b ... then detach the cable end from the release arm ...



18.4c ... and draw it out of the cover

2»34 Engine, clutch and transmission



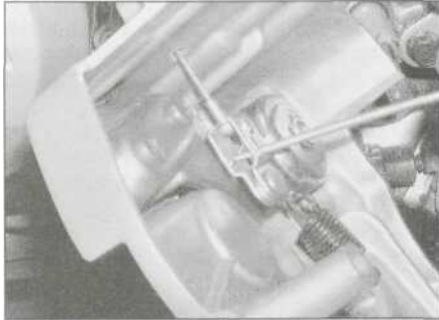
18.5 Slacken the locking (A) and screw the adjuster (B) in



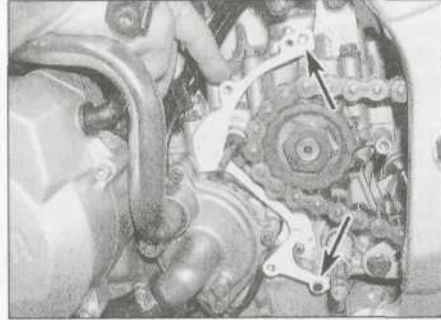
18.6a Align the slots and slip the cable out of the bracket...



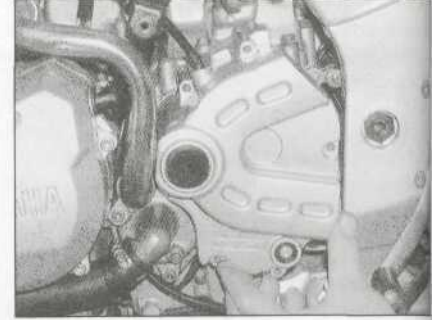
18.6b ... and the nipple from the lever



18.7 Bend up the tab to secure the cable in the lever



18.8a Fit the gasket onto the dowels (arrowed)...

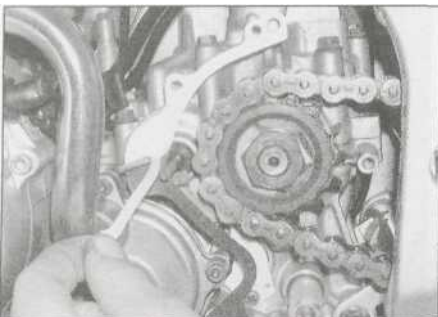


18.8b ... then fit the cover

5 Fully slacken the locking on the adjuster at the handlebar end of the cable then screw the adjuster fully in (see illustration). This resets it to the beginning of its adjustment span.

6 Align the slots in the adjuster and lockwheel with that in the lever bracket, then pull the outer cable end from the socket in the adjuster and release the inner cable from the lever (see illustrations). Remove the cable from the machine, noting its routing and any guides or clips.

Before removing the cable from the bike, tape the lower end of the new cable to the upper end of the old cable. Slowly pull the lower end of the old cable out, guiding the new cable down into position. Using this method will ensure the cable is routed correctly.

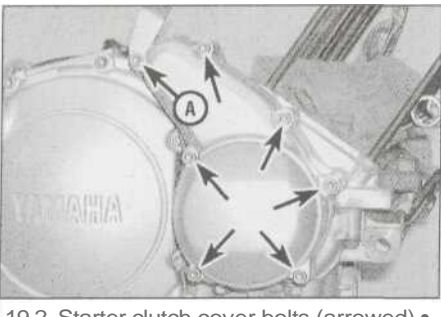


18.8c Peel the cover off the gasket if it has a sticky side

Installation

7 Installation is the reverse of removal. Apply grease to the cable ends. Make sure the cable is correctly routed. Bend in the retainer on the release mechanism arm to secure the cable end (see illustration). Before installing the cover, check the clutch release mechanism for smooth operation and any signs of wear or damage (see illustration 17.20). Remove the two screws securing the mechanism to the cover and remove it for cleaning and re-greasing if required. Apply a dab of grease to the pushrod end.

8 If removed, fit the sprocket cover dowels into the crankcase. Install the cover using a new gasket, making sure it locates correctly onto the dowels, and tighten its bolts to the specified torque setting (see illustrations). Note that on the gasket supplied by Yamaha, a protective layer must be peeled off to expose a sticky side (see illustration).



19.2 Starter clutch cover bolts (arrowed) • on YZF models, note the idle speed adjuster holder (A)

9 Slide the gearchange linkage arm onto the shaft, aligning the marks, and tighten the pinch bolt (see illustration 18.2).

10 Adjust the amount of clutch lever freeplay (see Chapter 1).

19 Starter clutch and idle/reduction gear - removal, inspection and installation

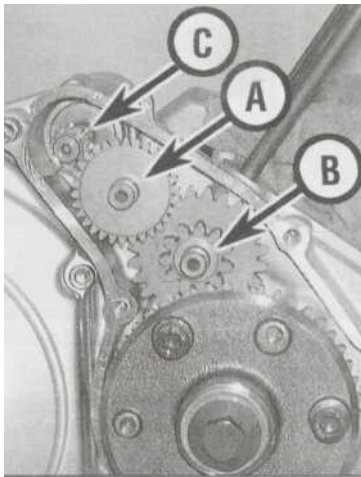
Note: The starter clutch and idle/reduction gear assembly can be removed with the engine in the frame.

Removal

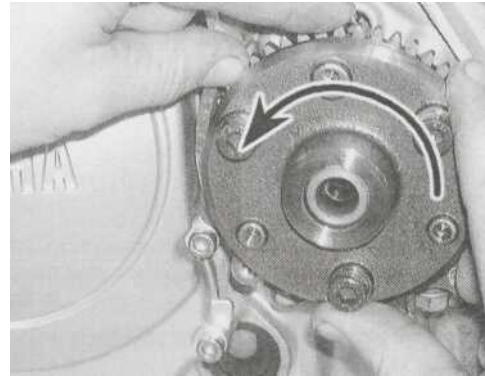
1 On YZF models, remove the right-hand fairing side panel (see Chapter 8, Section 3).
2 Unscrew the bolts securing the starter clutch cover, on YZF models noting the idle speed adjuster holder, and remove the cover, being prepared to catch any residue oil (see illustration). Remove the gasket and discard it. Note the position of the locating dowels and remove them for safe-keeping if loose.

3 Withdraw the starter No. 1 idle/reduction gear shaft, then remove the gear, noting which way round it fits and how it engages with the No. 2 idle/reduction gear and the starter drive gear (see illustration). Withdraw the starter No. 2 idle/reduction gear shaft and remove the gear, noting which way round it fits. Withdraw the starter drive gear.

4 Before proceeding further, the operation of the starter clutch can be checked while it is « *situ* ». Check that the starter driven gear on the back of the clutch is able to rotate freely anti-



19.3 Remove the starter No. 1 (A) and No. 2 (B) idle/reduction gear shafts and gears and the starter drive gear (C)



19.4 The gear should rotate freely in the direction shown



clockwise as you look at it, but locks when rotated clockwise (see illustration). If not, it is faulty.

5 To remove the starter clutch bolt it is necessary to stop the starter clutch and crankshaft from turning using one of the following methods:

- a) If the engine is in the frame, engage 1st gear and have an assistant hold the rear brake on hard with the rear tyre in firm contact with the ground.
- b) If the cylinder block has been removed, use a con-rod stopper or block of wood under the pistons.

c) If the engine has been removed, refer to Chapter 9 and remove the alternator cover, then use an alternator rotor holding tool to counter-hold the rotor while unscrewing the starter clutch bolt. Alternatively, counter-hold the rotor bolt - it is tighter than the starter clutch bolt and so will not slacken. Unscrew the bolt and remove the washer (see illustration).

Caution: If a rotor holding strap is used, make sure it does not contact the raised sections on the outside of the rotor.

6 To remove the starter clutch from the shaft it is necessary to use a rotor puller. Yamaha

provide a special tool (part No. 90890-01362), or alternatively a similar commercially available tool (for purchase or hire) can be set up using the threaded holes in the front of the starter clutch. Remove the Woodruff key from the slot in the crankshaft for safekeeping (see illustration). Slide the starter driven gear off the crankshaft (see illustration).

7 Clean all old gasket from the cover and crankcase.

Inspection

8 Fit the starter driven gear into the starter clutch and, with the clutch face down on a workbench, check that the gear rotates freely in a clockwise direction and locks against the rotor in an anti-clockwise direction (see illustration). If it doesn't, replace the starter clutch with a new one.

9 Withdraw the starter driven gear from the starter clutch. If it appears stuck, rotate it clockwise as you withdraw it to free it from the starter clutch.

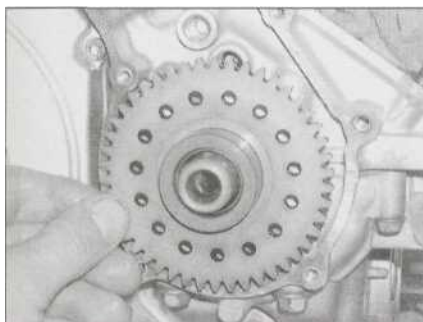
10 Check the bearing surface of the starter driven gear hub and the condition of the sprags inside the clutch body (see illustration). If the bearing surface shows signs of excessive wear or the sprags are damaged, marked or flattened at any point, they should be renewed. Also check the



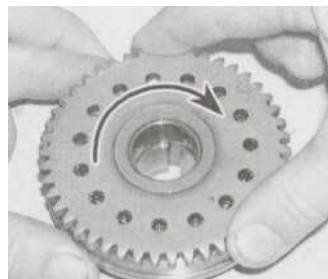
19.5 Unscrew the bolt and remove the washer



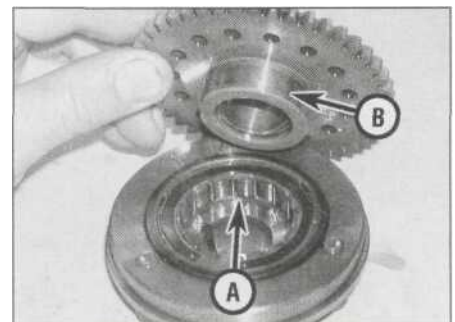
19.6a Remove the Woodruff key,



19.6b ... and slide the starter driven gear off the shaft



19.8 The gear should rotate freely in the direction shown



19.10a Check the sprags (A) and the surface of the hub (B)



19.10b Also check the needle bearing (arrowed) in the crankcase . . .

condition of the bearings for the starter drive gear and replace them with new ones if necessary (refer to *Tools and Workshop Tips* in the Reference Section) - there is a needle bearing in the crankcase and a roller bearing in the cover (see illustrations).

11 Examine the teeth of the starter idle/reduction gears and the corresponding teeth of the starter drive and driven gears and starter motor shaft. Renew the gears and/or starter motor if worn or chipped teeth are discovered.

12 To replace the starter clutch sprag assembly, hold the clutch body and undo the three bolts. Separate the sprag assembly from the body and install the new one. Apply a suitable non-permanent thread locking compound to the bolts and tighten them to the torque setting specified at the beginning of the Chapter. Lubricate the starter clutch sprags with new engine oil.



19.10c ... and the roller bearing (arrowed) in the cover

Installation

13 Lubricate the hub of the starter driven gear with clean engine oil, then slide it onto the shaft (see illustration 19.6b).

14 Fit the Woodruff key into its slot in the end of the crankshaft (see illustration 19.6a). Slide the starter clutch assembly onto the end of the shaft, aligning the slot in the clutch with the Woodruff key, and making sure they engage correctly without the key becoming dislodged (see illustration). Fit the starter driven gear into the clutch, rotating it clockwise as you do so to spread the rollers and allow the hub of the gear to enter. Install the starter clutch bolt and its washer (see illustration 19.5) and tighten the bolt to the torque setting specified at the beginning of the Chapter, using the method employed on removal to stop the clutch from turning (see illustration).



19.14a Slide the starter clutch onto the shaft...

15 Smear some molybdenum disulphide oil (a 50/50 mixture of molybdenum disulphide grease and engine oil) onto the starter driven gear and fit it into the crankcase (see illustration). Smear some molybdenum disulphide oil onto the No. 2 idle/reduction gear shaft and gear, then position the gear with its smaller pinion facing out and slide™ the shaft (see illustration). Smear some molybdenum disulphide oil onto the No. 11 idle/reduction gear shaft and gear, then position the gear with its smaller pinion facing in, making sure it meshes correctly with the drive and No. 2 gears, and slide in the shaft! (see illustration).

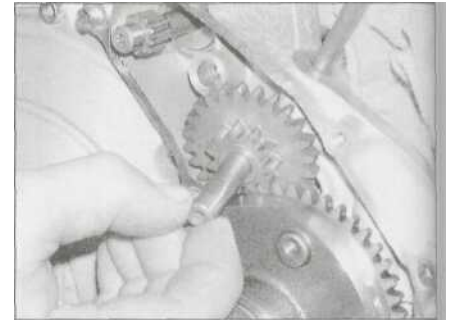
16 If removed, fit the dowels into the crankcase, then install the starter clutch cover! using a new gasket, making sure it locatesj correctly onto the dowels (see illustrations). Tighten the cover bolts evenly in a criss-cross| sequence to the specified torque setting, on|



19.14b ... and tighten the bolt to the specified torque



19.15a Install the starter drive gear ...



19.15b ... the No. 2 idle/reduction gear and shaft...



19.15c ... and the No. 1 idle/reduction gear and shaft

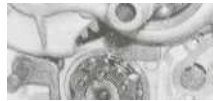


19.16a Fit the gasket onto the dowels (arrowed)...

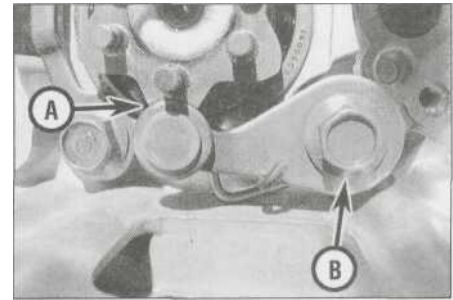
19.16b ... then fit the cover...



20.4 Slide off the collar



20.5 Draw the selector arm/shaft assembly off the selector drum and out of the casing



20.6 Note how the roller locates in the neutral detent (A), then unscrew the bolt (B) and remove the arm and spring

YZF models not forgetting to secure the idle speed adjuster holder with the rear top bolt (see illustration 19.2).

17 Check the engine/transmission oil level and top up if necessary (see *Daily (pre-ride) checks*).

18 On YZF models, install the right-hand fairing side panel (see Chapter 8).

20 Gearchange mechanism - removal, inspection and installation

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Note: *The gearchange mechanism can be removed with the engine in the frame. If the engine has been removed, ignore the steps which don't apply.*

Removal

1 Make sure the transmission is in neutral. On YZF models, remove the fairing side panels (see Chapter 8, Section 3).

2 Unscrew the gearchange lever linkage arm pinch bolt and slide the arm off the shaft, noting any alignment marks (see illustration 18.2). If no marks are visible, make your own before removing the arm so that it can be correctly aligned with the shaft on installation. Unscrew the bolts securing the front sprocket cover and displace the cover (see illustration 18.3). There is no need to detach the cable from the cover unless you want to (see Section 18). Note the position of the dowels and remove them if loose. Discard the gasket as a new one must be used.

3 Remove the clutch (see Section 17), and if

the stopper arm and selector drum are being removed, also remove the oil pump (see Section 21).

4 Slide the collar off the left-hand end of the gearchange shaft (see illustration).

5 Note how the gearchange shaft centralising spring ends fit on each side of the locating pin in the casing, and how the pawls on the selector arm locate onto the pins on the end of the selector drum (see illustration 20.11). Grasp the end of the shaft and withdraw the shaft/arm assembly (see illustration).

6 If required, note how the stopper arm spring ends locate and how the roller on the arm locates in the neutral detent on the selector drum, then unscrew the stopper arm bolt and remove the arm and spring, noting how it locates (see illustration).

Inspection

7 Check the selector arm for cracks, distortion and wear of its pawls, and check for any corresponding wear on the selector pins on the selector drum. Also check the stopper arm roller and the detents in the selector drum for any wear or damage, and make sure the roller turns freely. Replace any components that are worn or damaged with new ones.

8 Inspect the shaft centralising spring and the stopper arm return spring for fatigue, wear or damage (see illustration). If any is found, they must be replaced with new ones. Also check that the centralising spring locating pin in the crankcase is securely tightened. If it is loose, remove it and apply a non-permanent thread locking compound to its threads, then

_____OS_____;

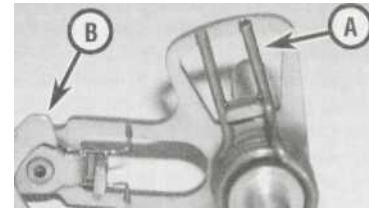
20.8 Check the centralising spring (A) and pawl mechanism (B) as described

tighten it to the torque setting specified at the beginning of the Chapter.

9 Check the gearchange shaft for straightness and damage to the splines. If the shaft is bent you can attempt to straighten it, but if the splines are damaged the shaft must be replaced. Also check the condition of the shaft oil seal in the left-hand side of the crankcase. If it is damaged, deteriorated or shows signs of leakage it must be replaced with a new one. Lever out the old seal and drive the new one squarely into place, with its lip facing inward, using a seal driver or suitable socket (see illustrations).

Installation

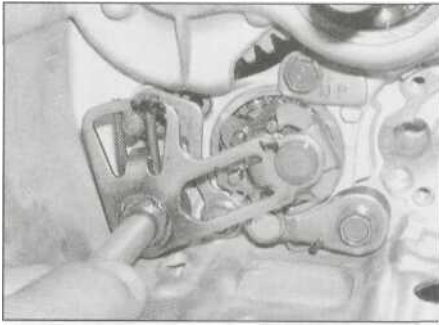
10 If removed, apply a suitable non-permanent thread locking compound to the stopper arm bolt. Locate the stopper arm spring, then install the stopper arm, locating the arm onto the neutral detent on the



20.9a If required, lever out the old seal . . .

20.9b . . . and press or drive a new one in

20.9c Also check the oil seals (arrowed) in the sprocket cover



20.11 Make sure the selector arm and centralising spring locate correctly

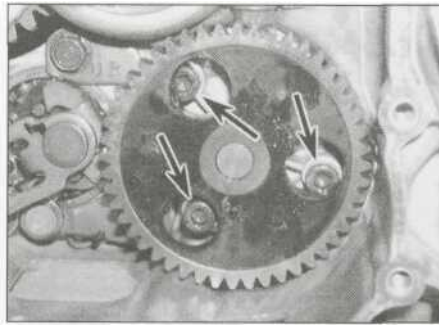
selector drum and making sure the spring ends are positioned correctly, and tighten the bolt to the specified torque setting (**see illustration 20.6**).

11 Apply some grease to the lips of the gearchange shaft oil seal in the left-hand side of the crankcase. Slide the shaft into place and push it all the way through the case until the splined end comes out the other side. Locate the selector arm pawls onto the pins on the selector drum and the centralising spring ends onto each side of the locating pin (**see illustration**).

12 Slide the collar onto the left-hand end of the shaft (**see illustration 20.4**).

13 Install the oil pump if removed (see Section 21), and the clutch (see Section 17).

14 If removed, fit the sprocket cover dowels into the crankcase. If detached, connect the clutch cable to the release mechanism (see Section 18). Install the cover using a new



21.4 Oil pump bolts (arrowed) - align the holes in the gear with the bolts as shown

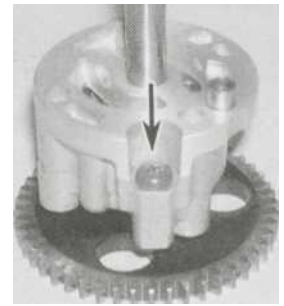
gasket, making sure it locates correctly onto the dowels, and tighten its bolts to the specified torque setting (**see illustrations 18.8a, 18.8b and 18.8c**). Slide the gearchange linkage arm onto the shaft, aligning the marks, and tighten the pinch bolt (**see illustration 18.2**).

21 Oil pump - removal, inspection and installation

Note: The oil pumps can be removed with the engine in the frame. If the engine has been removed, ignore the steps which don't apply.

Removal

- 1 Drain the engine oil (see Chapter 1).
- 2 Remove the clutch (see Section 17).
- 3 Turn the oil pump driven gear to align the holes in the gear with the pump mounting bolts.



21.5a Remove the screw (arrowed)...

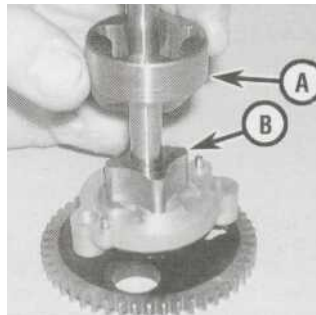
4 Unscrew the bolts and withdraw the pump from the engine, being prepared to catch any residue oil (**see illustration**). Discard the gasket as a new one must be used. Remove the dowel from either the pump housing or the crankcase if it is loose.

Inspection

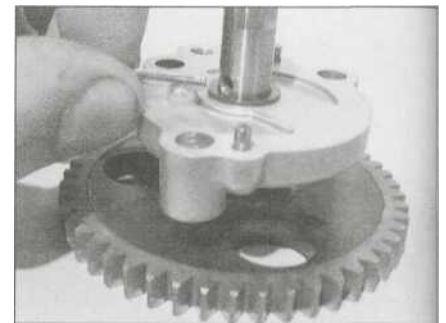
5 If required, the pump can be disassembled for cleaning and inspection. Remove the single assembly screw, then draw the pump body off the driveshaft (**see illustrations!**). Remove the outer rotor, then slide the inner rotor off the shaft (**see illustration**). Note which way round the rotors fit and how the drive pin in the shaft locates in the slots in the inner rotor. Remove the drive pin, then slide the washer and pump cover off the shaft (**see illustrations**). Remove the locating pins from the cover for safekeeping if they are loose (**see illustration**).



21.5b ... and draw the body off the shaft



21.5c Remove the outer rotor (A), then the inner rotor (B)



21.5d Remove the drive pin ...



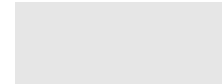
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21.5e ... and the washer ...



21.5f ... then draw the cover off the shaft

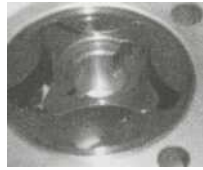


21.5g Remove the locating pins if they are loose



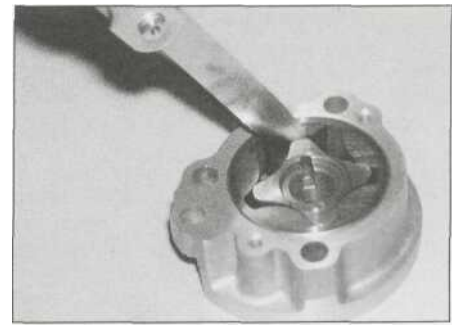
21.7 Look for scoring and wear, such as on this outer rotor

6 Clean all the components in solvent.
 7 Inspect the pump body and rotors for scoring and wear (**see illustration**). If any damage, scoring or uneven or excessive wear is evident, replace the pump (individual components are not available).
 8 Fit the outer rotor into the pump body, then fit the inner rotor into the outer rotor (**see illustration**). Measure the clearance between the inner rotor tip and the outer rotor with a feeler gauge and compare it to the maximum clearance listed in the specifications at the beginning of the Chapter (**see illustration**). If the clearance measured is greater than the maximum listed, replace the pump with a new one.
 9 Measure the clearance between the outer rotor and the pump body with a feeler gauge and compare it to the maximum clearance listed in the specifications at the beginning of the Chapter (**see illustration**). If the clearance



21.8a Fit the rotors into the body

measured is greater than the maximum listed, replace the pump with a new one.
 10 Lay a straight-edge across the rotors and the pump body and, using a feeler gauge, measure the rotor end-float (the gap between the rotors and the straight edge (**see illustration**). If the clearance measured is greater than the maximum listed, replace the pump with a new one.
 11 Check the pump driven gear for wear or damage, and replace it with a new one if necessary - it is integral with the shaft. If the gear is very worn, also check the drive gear on the back of the clutch housing - if this too is damaged or worn beyond service, a new housing must be fitted.
 12 If the pump is good, make sure all the components are clean, then lubricate them with new engine oil. Fit the locating pins into the cover if removed (**see illustration 21.5g**). Slide the pump cover followed by the washer



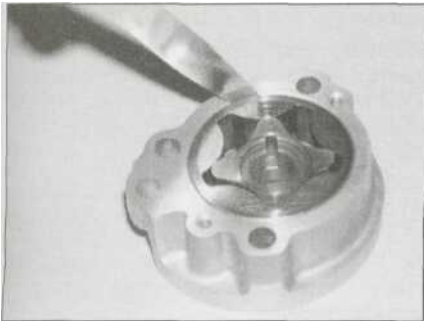
21.8b Measuring inner-to-outer rotor clearance

onto the shaft, then fit the drive pin through the hole in the shaft (**see illustrations 21.5f, 21.5e and 21.5d**). Slide the inner rotor onto the shaft, with the slots in the rotor facing down so that they locate over the drive pin (**see illustration**). Fit the outer rotor onto the inner rotor, then fit the pump body over the outer rotor (**see illustration 21.5c and 21.5b**). Install the assembly screw and tighten it to the torque setting specified at the beginning of the Chapter (**see illustration**).

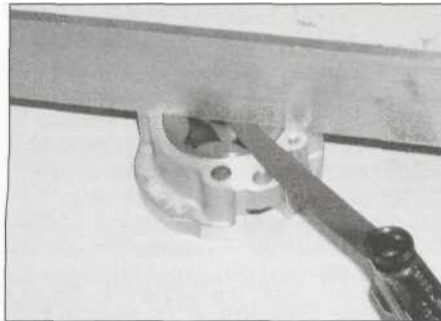
13 Rotate the pump shaft by hand and check that the rotors turn smoothly and freely. If not, replace the pump with a new one.

Installation

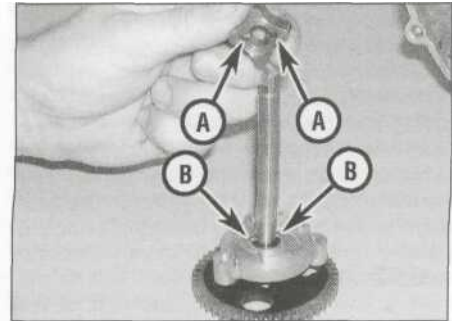
14 If removed, fit the dowel into the pump body (**see illustration**). Fit a new gasket onto the pump, making sure it locates over the dowel (**see illustration**). Align the tab on the end of the pump driveshaft so that it will locate



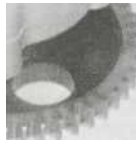
21.9 Measuring outer rotor-to-body clearance



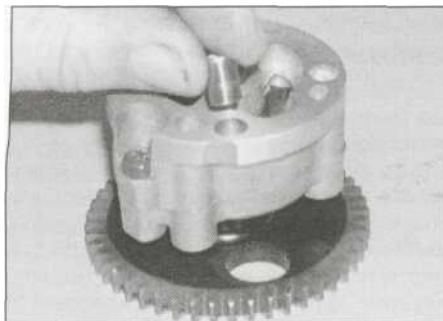
21.10 Measuring rotor end-float



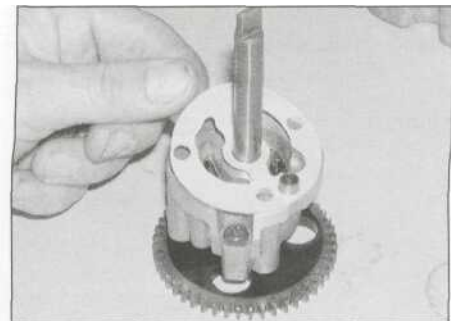
21.12a Locate the slots in the rotor (A) over the drive pin ends (B)



21.12b Install the screw and tighten it to the specified torque



21.14a Install the dowel,



21.14b ... then fit a new gasket

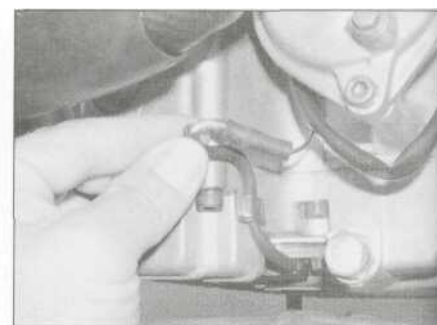
2«40 Engine, clutch and transmission



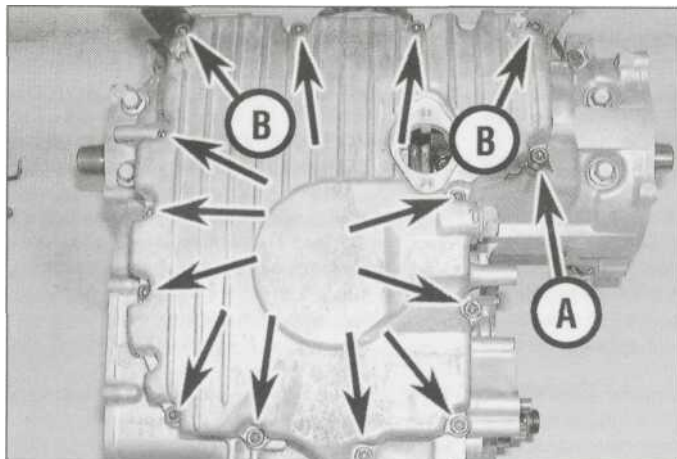
21.14C Install the pump, and make sure the shaft end locates correctly in the water pump



21.14d Apply a suitable non-permanent thread locking compound to the mounting bolts



22.2 Disconnect the oil level sensor wiring connector

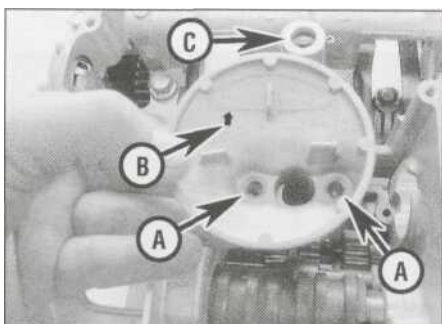


22.3 Unscrew the bolts (arrowed) and remove the sump, noting the position of the wiring clamp (A) and on YZF models the fairing side panel brackets (B)



22.4a Lever off the oil strainer cover . . .

into the slot in the water pump driveshaft, then install the pump, aligning the arrow on the pump body with that on the crankcase, making sure the dowel locates correctly (**see illustration**). Wiggle the gear if necessary to locate the shaft end in the water pump. Turn the pump gear to align the holes in the gear with the pump mounting bolt holes. Apply a suitable non-permanent thread locking compound to the mounting bolts and tighten them to the torque setting specified at the beginning of the Chapter (**see illustration**).



22.4b ... then unscrew the bolts (A) and remove the housing, noting the directional arrow (B). Also remove the pressure relief valve (C)

15 Install the clutch (see Section 17).

16 Fill the engine with the specified quantity and type of new engine oil (see Chapter 1).

22 Oil sump, oil strainer and pressure relief valve-removal, inspection and installation

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Note: On YZF models, the oil sump, strainer and pressure relief valve can be removed with the engine in the frame. If the engine has been removed, ignore the steps which don't apply. On FZS models, the engine must be removed from the frame.

Removal

1 On YZF models remove the exhaust system (see Chapter 4). On FZS models, remove the engine (see Section 5).

2 Drain the engine oil (see Chapter 1). Either remove the oil level sensor if required (see Chapter 9), or trace the wire from the switch and disconnect it at the connector behind the front sprocket cover - on YZF models you may have to remove the cover to access it (see Section 20, Step 2) (**see illustration**).

3 Unscrew the sump bolts, slackening them evenly in a criss-cross sequence to prevent

distortion, and remove the sump (**see illustration**). On all models, note the position of the wiring clamp. On YZF models, note the positions of the fairing side panel brackets. Discard the gasket as a new one must be used. Note the positions of the dowels and remove them if they are loose.

4 Lever off the oil strainer cover, taking care not to distort the rim, then unscrew the strainer housing bolts and remove the housing (**see illustrations**).

5 Pull the pressure relief valve out of the crankcase (**see illustration 22.4b**). Discard the O-ring as a new one must be used.

Inspection

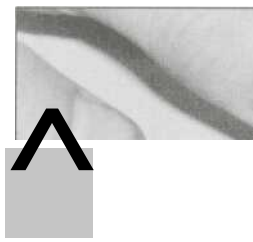
6 Remove all traces of gasket from the sump and crankcase mating surfaces, and clean the inside of the sump with solvent.

7 Clean the oil strainer in solvent and remove any debris caught in the mesh. Inspect the strainer for any signs of wear or damage and replace it with a new one if necessary.

8 Push the relief valve plunger into the valve body and check that it moves smoothly and freely against the spring pressure (**see illustration**). If not, replace the relief valve with a new one - individual components are not available.

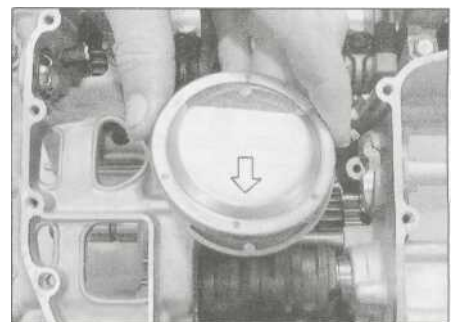


22.8 Check the relief valve



22.9 Fit a new O-ring onto the valve

or
m



22.10 Fit the strainer cover with the arrow pointing to the rear of the engine

Installation

9 Fit a new O-ring onto the relief valve and smear it with grease, then push the valve into its socket in the crankcase (see illustration).

10 Install the oil strainer housing, making sure the arrow points to the front of the engine (see illustration 22.4b). Apply a suitable non-permanent thread locking compound to the bolts and tighten them to the torque setting specified at the beginning of the Chapter. Press on the strainer cover until it is felt to click into place, making sure the arrow points to the rear of the engine (see illustration).

11 If removed, fit the sump dowels into the crankcase. Lay a new gasket onto the sump (if the engine is in the frame) or onto the crankcase (if the engine has been removed and is positioned upside down on the work surface) (see illustration). Make sure the holes in the gasket align correctly with the bolt holes.

12 Position the sump onto the crankcase (see illustration), then install the bolts, not forgetting the oil level sensor wiring clamp, and on YZF models the fairing side panel brackets (see illustration 22.3), and tighten them evenly and a little at a time in a criss-cross pattern to the specified torque setting.

13 Either install the oil level sensor if removed (see Chapter 9), or connect the wire at the connector (see illustration 22.2). On YZF models, install the sprocket cover if removed (see Section 20, Step 14).

14 Fill the engine with the correct type and quantity of oil (see Chapter 1).

15 On YZF models install the exhaust system (see Chapter 4). On FZS models, install the engine (see Section 5). Start the engine and check for leaks around the sump and oil filter cover.

23 Crankcase halves - separation and reassembly

Separation

1 To access the cam chain and tensioner blade, connecting rods, crankshaft, bearings, and the transmission shafts, the crankcase must be split into two parts.



22.11 Fit the new gasket, making sure the dowels (arrowed) are in place ...

2 To enable the crankcases to be separated, the engine must be removed from the frame (see Section 5). Before the crankcases can be separated the following components must be removed:

- a) Valve cover (Section 8).
- b) Cam chain tensioner and guides (Section 9).
- c) Camshafts (Section 10).
- d) Cylinder head (Section 11).
- e) Cylinder block (Section 14).
- f) Oil sump (Section 22).
- g) Clutch cover and starter clutch cover (see Sections 17 and 19).

3 The alternator and starter clutch can remain attached to the crankshaft if required, though it is advisable to remove them for ease of assembly, and essential to remove them if any work is being done on the crankshaft.

4 If the crankcases are being separated for removal of the transmission shafts, remove the clutch (see Section 17).

5 If the crankcases are being separated as part of a complete engine overhaul, remove the following components:

- a) Oil cooler (Section 7).
- b) Pistons (Section 15)
- c) Clutch (Section 17).
- d) Starter clutch and idle/reduction gear assembly (Section 19).
- e) Gearchange mechanism (Section 20).
- f) Oil pump (Section 21).
- g) Water pump (Chapter 3).
- h) Starter motor (Chapter 9).
- i) Alternator (Chapter 9).
- j) Oil strainer and pressure relief valve (see Section 22).

22.12 ... then fit the sump

k) Neutral and oil level switches (see Chapter 9).

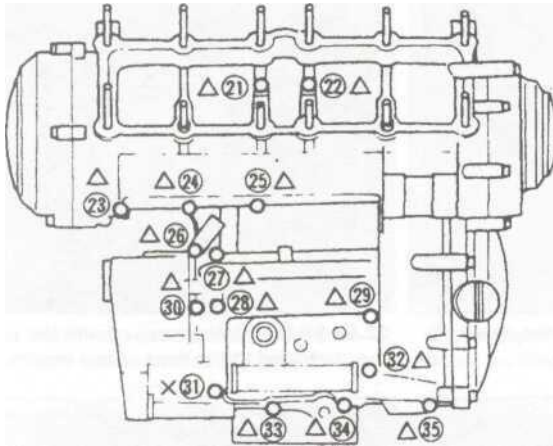
6 Unscrew the bolts securing the oil seal retainer plate on the left-hand side of the engine and remove the plate (see illustration).

7 Unscrew the upper crankcase bolts evenly and a little at a time in a reverse of the numerical sequence shown and as marked on the crankcase (the number of each bolt is cast into the crankcase), until they are finger-tight, then remove them (see illustration overleaf). Note any washers, leads and wiring guides fitted with the bolts. **Note:** As each bolt is removed, store it in its relative position, with its washer, lead or guide where applicable, in a cardboard template of the crankcase halves. This will ensure all bolts are installed in the correct location on reassembly.

8 Turn the engine upside down so that it rests on the cylinder head studs.

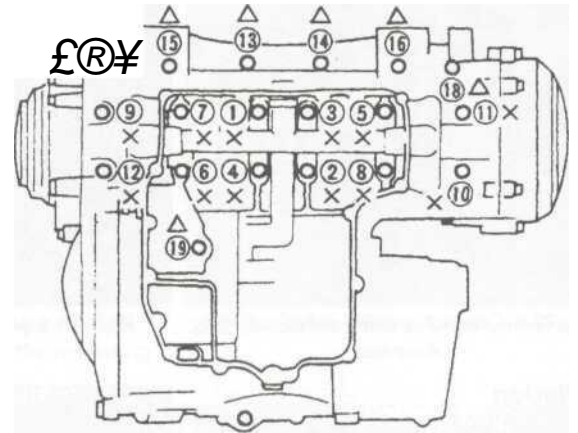


23.6 Unscrew the bolts (arrowed) and remove the plate



23.7 Upper crankcase bolts

Numbers indicate tightening sequence



23.9a Lower crankcase bolts

Numbers indicate tightening sequence

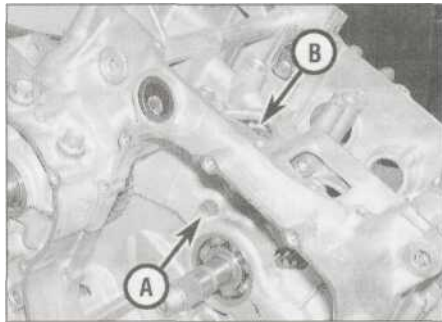
9 Unscrew the lower crankcase bolts evenly and a little at a time in a reverse of the numerical sequence marked on the crankcase (the number of each bolt is cast into the crankcase), until they are finger-tight, then remove them (see illustration). Access bolt No. 19 using a socket extension through the hole in the crankcase (see illustration). Note the washers fitted with some of the bolts, and on YZF models the radiator bracket. **Note:** As each bolt is removed, store it in its relative position, with its washer and cable guide where applicable, in a cardboard template of the crankcase halves. This will ensure all bolts are installed in the correct location on reassembly.

10 Carefully lift the lower crankcase half off the upper half, using a soft-faced hammer to tap around the joint to initially separate the halves if necessary (see illustration 23.18). **Note:** If the halves do not separate easily, make sure all fasteners have been removed. Do not try and separate the halves by levering against the crankcase mating surfaces as they are easily scored and will leak oil. Tap around the joint faces with a soft-faced mallet.
 11 Remove the locating dowel from the crankcase if it is loose (it could be in either crankcase half) (see illustration 23.16).
 12 Refer to Sections 24 to 31 for the removal and installation of the components housed within the crankcases.

transmission shafts and selector drum and forks (if installed), particularly around the bearings, with clean engine oil, then use a rag soaked in high flash-point solvent to wipe over the mating surfaces of both crankcase halves to remove all traces of oil.
 16 If removed, install the locating dowel in one crankcase half (see illustration).
 17 Apply a small amount of suitable sealant (such as Yamaha Bond 1215) to the outer mating surface of one crankcase half (see illustration).

Caution: Do not apply an excessive amount of sealant as it will ooze out when the case halves are assembled and may obstruct oil passages. Do not apply the sealant on or too close (within 2 to 3 mm) to any of the bearing inserts or surfaces.

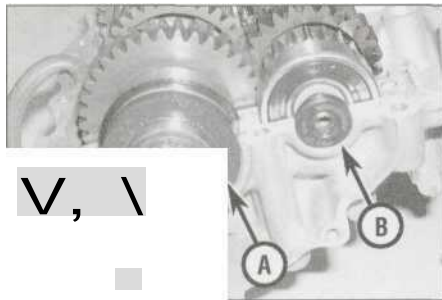
18 Check again that all components are in position, particularly that the bearing shells are still correctly located in the lower crankcase half. Carefully fit the lower crankcase half onto the upper crankcase half, making sure the selector forks (if installed) locate correctly into their grooves in the transmission shaft gears, the cam chain I tensioner blade locates in the tunnel, and the dowel locates correctly. Feed the breather pipe through its guide hole in the lower crankcase (see illustration).



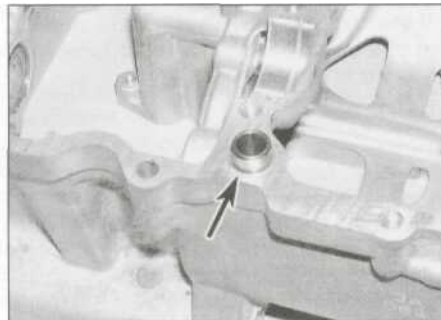
23.9b Access bolt 19 (A) via the hole (B)

Reassembly

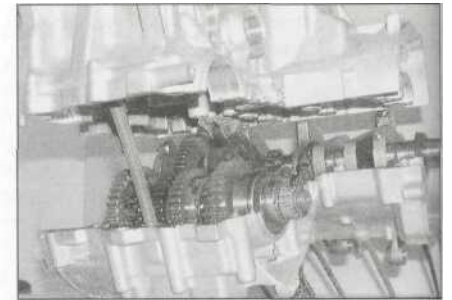
13 Remove all traces of sealant from the crankcase mating surfaces.
 14 Ensure that all components and their bearings are in place in the upper and lower crankcase halves. If the transmission shafts have not been removed, check the condition of the output shaft oil seal on the left-hand end of the shaft and the clutch pushrod oil seal on the left-hand end of the input shaft, and replace them with new ones if they are damaged or deteriorated (see illustration).
 15 Generously lubricate the crankshaft,



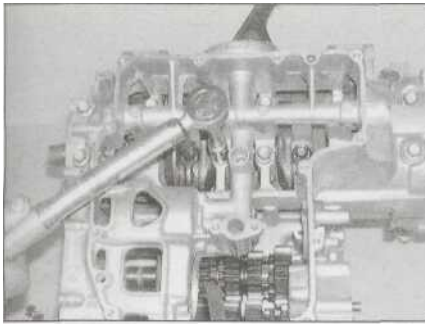
23.14 Check the condition of the output shaft oil seal (A) and the clutch pushrod oil seal (B)



23.16 Install the dowel (arrowed) if removed



23.18 Fit the lower half onto the upper half, making sure all components locate correctly



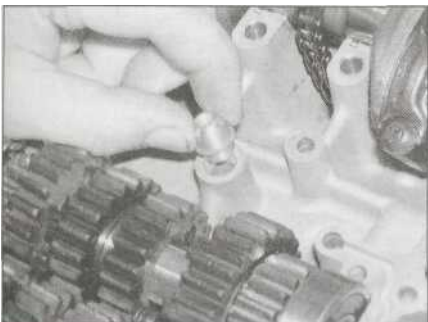
23.20 Tighten the crankcase bolts to the specified torque

19 Check that the lower crankcase half is correctly seated. Note: *The crankcase halves should fit together without being forced. If the casings are not correctly seated, remove the lower crankcase half and investigate the problem. Do not attempt to pull them together using the crankcase bolts as the casing will crack and be ruined.*

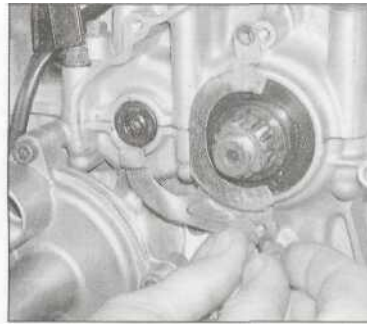
20 Clean the threads of the 8 mm lower crankcase bolts and apply molybdenum disulphide oil (a 50/50 mixture of molybdenum disulphide grease and new engine oil) to their threads. Insert them with their washers in their original locations (see illustration 23.9a). Clean the threads of the 6 mm lower crankcase bolts and apply new engine oil to their threads. Insert them (with the radiator bracket on bolts 13 and 14 on YZF models) in their original locations (see illustration 23.9a). Secure all bolts finger-tight at first, then tighten them evenly and a little at a time in the correct numerical sequence to the torque settings specified at the beginning of the Chapter (see illustration).

21 Turn the engine over. Clean the threads of the upper crankcase bolts and apply new engine oil to their threads. Insert them, not forgetting the copper washer with bolt 29, earth lead with bolt 35, small wiring guide with bolt 23, and large wiring guide with bolt 26 in their original locations (see illustration 23.7). Secure all bolts finger-tight at first, then tighten them evenly and a little at a time in the correct numerical sequence to the torque settings specified at the beginning of the Chapter.

22 With all crankcase fasteners tightened,



24.1 Remove the oil nozzle and discard the O-ring



23.23 Install the oil seal retainer plate

check that the crankshaft and transmission shafts rotate smoothly and easily. Check that the transmission shafts rotate freely and independently in neutral, then rotate the selector drum by hand and select each gear in turn whilst rotating the input shaft. Check that all gears can be selected and that the shafts rotate freely in every gear. If there are any signs of undue stiffness, tight or rough spots, or of any other problem, the fault must be rectified before proceeding further.

23 Install the oil seal retainer plate onto the left-hand side of the crankcase (see illustration). Apply a suitable non-permanent thread locking compound to the threads of the bolts and tighten them to the specified torque setting.

24 Install all other removed assemblies in the reverse of the sequences given in Steps 2, 3, 4 and 5, according to your procedure.

24 Crankcase halves - inspection and servicing

1 After the crankcases have been separated, remove the crankshaft, cam chain and tensioner blade, transmission shafts and selector drum and forks, and any other components or assemblies not already removed, referring to the relevant Sections of this and other Chapters (see Steps 2, 3, 4 and 5 in Section 23). Also remove the oil passage nozzle and its O-ring (see illustration). Discard the O-ring as a new one must be used.

2 The crankcases should be cleaned thoroughly with new solvent and dried with compressed air. All oil passages and oil nozzles should be blown out with compressed air.

3 All traces of old gasket sealant should be removed from the mating surfaces. Minor damage to the surfaces can be cleaned up with a fine sharpening stone or grindstone. Check both crankcase halves very carefully for cracks and other damage.

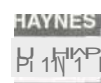
Caution: *Be very careful not to nick or gouge the crankcase mating surfaces or oil leaks will result.*

4 Small cracks or holes in aluminium castings may be repaired with an epoxy resin adhesive as a temporary measure. Permanent repairs

can only be effected by argon-arc welding, and only a specialist in this process is in a position to advise on the economy or practical aspect of such a repair. If any damage is found that can't be repaired, replace the crankcase halves as a set.

5 Damaged threads can be economically reclaimed by using a diamond section wire insert, of the Heli-Coil type, which is easily fitted after drilling and re-tapping the affected thread.

6 Sheared studs or screws can usually be removed with screw extractors, which consist of a tapered, left-thread screw of very hard steel. These are inserted into a pre-drilled hole in the stud, and usually succeed in dislodging the most stubborn stud or screw.



Refer to 'Tools and Workshop Tips' for details of installing a thread insert and using screw extractors.

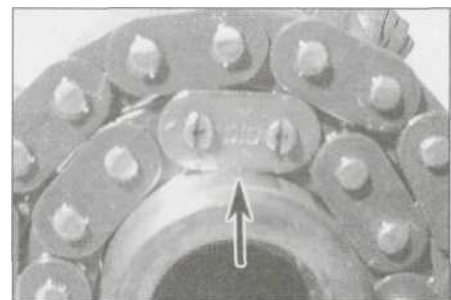
7 Install the crankshaft, cam chain and tensioner blade, transmission shafts and selector drum and forks, before reassembling the crankcase halves. Do not forget to install the oil passage nozzle using a new O-ring (see illustration 24.1).

25 Cam chain and tensioner blade - removal, inspection and installation

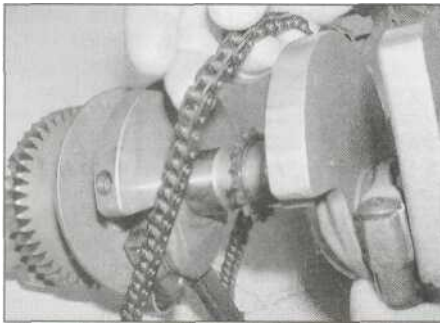
Removal

Cam chain

1 On YZF models, the original equipment cam chain fitted has a staked-type split-link which can be disassembled using either a Yamaha service tool, or one of several commercially-available drive chain cutting/staking tools, so you don't have to remove the crankshaft. Such chains can be recognised by the split-link side plate's identification marks (and usually its different colour), as well as by the staked ends of the link's two pins which look as if they have been deeply centre-punched, instead of peened over as with all the other pins (see illustration). If a new chain is needed, check



25.1 Note the difference between the split-link (arrowed) and the other links to identify it



25.3 Slip the cam chain off the crankshaft sprocket and remove it

with your dealer whether the chain comes as a split-link type, and whether it is supplied with the link split or staked. If it is a split-link type and it comes split, then there is no need to disassemble the engine and remove the crankshaft to replace the chain, though the cylinder head must be removed to avoid the possibility of a piston contacting a valve when the crankshaft is being turned without the chain attached to the camshafts. If the chain is being split to remove the cylinder head, and is not being replaced, you will need to obtain a new split-link from your dealer as you cannot re-use the old one. **Note:** *Due to the tricky nature of splitting and joining chains, it may be better to have the chain joined by a Yamaha dealer and then fit it conventionally directly around the crankshaft and build the engine up as though the chain were never split. Although this involves more work, it could save a lot of money if a badly staked chain comes apart when the engine is running.*

A **Warning:** Use ONLY the correct service tools to disassemble the split-link - if you do not have access to such tools or do not have the skill to operate them correctly, have the chain removed by a dealer service department or bike repair shop.

2 On YZF models, if you decide to split the chain and do the work yourself, remove the valve cover (see Section 8), the cam chain tensioner (see Section 9) and the cylinder head (see Section 11). Before splitting the cam chain, make a reference mark between a



JP

25.5 The cam chain tensioner is secured by two bolts (arrowed)

link on the chain and a tooth on the sprocket on each side of the split link so that it can be installed in exactly the same position, making the timing easier to set up. Split the existing chain at the split link. Temporarily join the new chain to the rear run of the old one using the master link, then pull the new chain through using the old chain, turning the crankshaft anti-clockwise using the alternator rotor bolt at the same time, taking great care that the chain does not come off the sprocket on the crankshaft and become trapped between it and the crankcase - keep the chain taut on both runs at all times with help from an assistant.

3 On FZS models, and on YZF models if the chain is not being split, remove the crankshaft (see Section 28). Remove the cam chain from around its sprocket (see illustration).

Tensioner blade

4 Remove the crankshaft (see Section 28).

5 Unscrew the bolts securing the tensioner blade base to the crankcase and remove the blade (see illustration).

Inspection

Cam chain

6 Check the chain for binding, kinks and any obvious damage and replace it with a new one if necessary. Check the camshaft and crankshaft sprocket teeth for wear and renew the cam chain, camshaft sprockets and crankshaft as a set if necessary.

Tensioner blade

7 Check the sliding surface and edges for excessive wear, deep grooves, cracking and other obvious damage, and replace it with a new one if necessary. Also check the condition of the pivot hardware on the base.

Installation

8 Installation of the chain and blade is the reverse of removal. Apply a suitable non-permanent thread locking compound to the tensioner blade bolts and tighten them to the torque setting specified at the beginning of the Chapter.

9 On YZF models, if the chain has been split, refer to Section 8 in *Tools and Workshop Tips* in the Reference Section when joining the chain, bearing in mind that it refers specifically to a final drive chain - a cam chain does not have O-rings. Stake the new link using the drive chain cutting/staking tool, following carefully the instructions of both the chain manufacturer and the tool manufacturer. DO NOT re-use old joining link components. After staking, check the joining link and staking for any signs of cracking. If there is any evidence of cracking, the joining link and side plate must be replaced with new ones. Measure the diameter of the staked ends in two directions and check that it is evenly staked.

26 Main and connecting rod bearings - general information

1 Even though main and connecting rod bearings are generally replaced with new ones during the engine overhaul, the old bearings should be retained for close examination as they may reveal valuable information about the condition of the engine.

2 Bearing failure occurs mainly because of lack of lubrication, the presence of dirt or other foreign particles, overloading the engine and/or corrosion. Regardless of the cause of bearing failure, it must be corrected before the engine is reassembled to prevent it from happening again.

3 When examining the connecting rod bearings, remove them from the connecting rods and caps and lay them out on a clean surface in the same general position as their location on the crankshaft journals. This will enable you to match any noted bearing problems with the corresponding crankshaft journal.

4 Dirt and other foreign particles get into the engine in a variety of ways. It may be left in the engine during assembly or it may pass through filters or breathers. It may get into the oil and from there into the bearings. Metal chips from machining operations and normal engine wear are often present. Abrasives are sometimes left in engine components after reconditioning operations, especially when parts are not thoroughly cleaned using the proper cleaning methods. Whatever the source, these foreign objects often end up embedded in the soft bearing material and are easily recognised. Large particles will not embed in the bearing and will score or gouge the bearing and journal. The best prevention for this cause of bearing failure is to clean all parts thoroughly and keep everything spotlessly clean during engine reassembly. Frequent and regular oil and filter changes are also recommended.

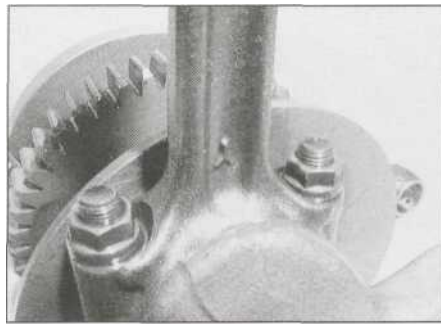
5 Lack of lubrication or lubrication breakdown has a number of interrelated causes. Excessive heat (which thins the oil), overloading (which squeezes the oil from the bearing face) and oil leakage or throw off (from excessive bearing clearances, worn oil pump or high engine speeds) all contribute to lubrication breakdown. Blocked oil passages will also starve a bearing and destroy it. When lack of lubrication is the cause of bearing failure, the bearing material is wiped or extruded from the steel backing of the bearing. Temperatures may increase to the point where the steel backing and the journal turn blue from overheating.

Refer to 'Tools and Workshop Tips' for bearing faultfinding.

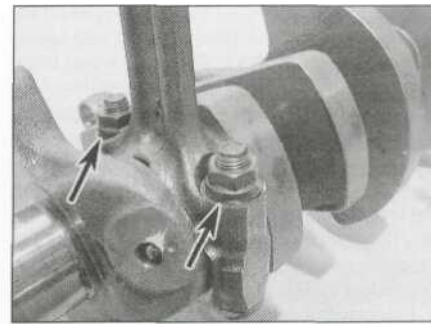
THIUT



27.2 Measure the connecting rod side clearance using a feeler gauge



27.3 Note the "Y" mark, which must face the left-hand side of the engine



27.4 Unscrew the nuts (arrowed) and remove the connecting rods

6 Riding habits can have a definite effect on bearing life. Full throttle low speed operation, or labouring the engine, puts very high loads on bearings, which tend to squeeze out the oil film. These loads cause the bearings to flex, which produces fine cracks in the bearing face (fatigue failure). Eventually the bearing material will loosen in pieces and tear away from the steel backing. Short trip riding leads to corrosion of bearings, as insufficient engine heat is produced to drive off the condensed water and corrosive gases produced. These products collect in the engine oil, forming acid and sludge. As the oil is carried to the engine bearings, the acid attacks and corrodes the bearing material.

7 Incorrect bearing installation during engine assembly will lead to bearing failure as well. Tight fitting bearings which leave insufficient bearing oil clearances result in oil starvation. Dirt or foreign particles trapped behind a bearing insert result in high spots on the bearing which lead to failure.

8 To avoid bearing problems, clean all parts thoroughly before reassembly, double check all bearing clearance measurements and lubricate the new bearings with clean engine oil during installation.

27 Connecting rods - removal, inspection and installation

JA

Removal

1 Remove the engine from the frame (see Section 5) and separate the crankcase halves (see Section 23). Remove the crankshaft (see Section 28).

2 Before removing the rods from the crankshaft, measure the side clearance on each rod with a feeler gauge (see illustration). If the clearance on any rod is greater than the service limit listed in this Chapter's Specifications, replace that rod with a new one.

3 Using paint or a felt marker pen, mark the relevant cylinder identity on each connecting rod and cap. Mark across the cap-to-connecting rod join, and note the "Y" mark on each connecting rod which must face to the left-hand side of the engine to ensure that the

cap and rod are fitted the correct way around on reassembly (see illustration). Note that the number and letter already across the rod and cap indicate rod size and weight grade respectively, not cylinder number.

4 Unscrew the connecting rod cap nuts and separate the cap from the crankpin (see illustration). Do not remove the bolts from the caps. Immediately install the relevant bearing shells (if removed), bearing cap, and nuts on each piston/connecting rod assembly so that they are all kept together as a matched set to ensure correct installation. Note that Yamaha specify that new bolts and nuts should be used on reassembly, and also for the oil clearance check, as the bolts are of the stretch type which can only be used once. Using the old bolts for the clearance check could lead to inaccurate results.

Inspection

5 Check the connecting rods for cracks and other obvious damage.

6 Apply clean engine oil to the piston pin, insert it into its connecting rod small-end and check for any freeplay between the two (see illustration). If freeplay is excessive, measure the pin external diameter (see illustration 15.13b). Compare the result to the specifications at the beginning of the Chapter. Replace the pin with a new one if it is worn beyond its specified limits. If the pin diameter is within specifications, replace the connecting rod with a new one. Repeat the measurements for all the rods.

7 Refer to Section 26 and examine the

connecting rod bearing shells. If they are scored, badly scuffed or appear to have seized, new shells must be installed. Always renew the shells in the connecting rods as a set. If they are badly damaged, check the corresponding crankpin. Evidence of extreme heat, such as discoloration, indicates that lubrication failure has occurred. Be sure to thoroughly check the oil pump and pressure regulator as well as all oil holes and passages before reassembling the engine.

8 Have the rods checked for twist and bend by a Yamaha dealer if you are in doubt about their straightness.

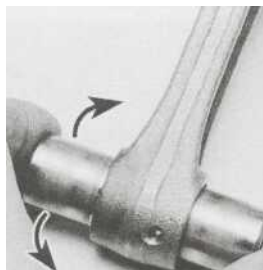
Oil clearance check

9 Whether new bearing shells are being fitted or the original ones are being re-used, the connecting rod (big-end) bearing oil clearance should be checked prior to reassembly. Obtain new bolts and nuts for the connecting rods and discard the old ones.

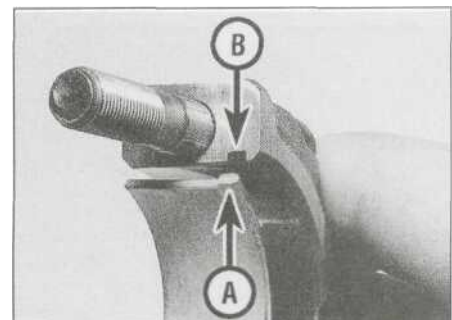
10 Clean the backs of the bearing shells and the bearing locations in both the connecting rod and cap, and the crankpin journal.

11 Press the bearing shells into their locations, ensuring that the tab on each shell engages the notch in the connecting rod/cap (see illustration). Make sure the bearings are fitted in the correct locations and take care not to touch any shell's bearing surface with your fingers.

12 Cut a length of the appropriate size Plastigauge (it should be slightly shorter than the width of the crankpin). Place a strand of Plastigauge on the crankpin journal.



27.6 Slip the piston pin into the rod's small-end and rock it back and forth to check for looseness



27.11 Make sure the tab (A) locates in the notch (B)

13 Apply molybdenum disulphide grease to the bolt shanks and threads and to the seats of the nuts, then fit the bolts into the cap (see illustration 27.25a). Fit the connecting rod and cap onto the crankshaft (see illustration 27.25b). Make sure the cap is fitted the correct way around so the previously made markings align, and that the rod is facing the right way (see Step 3). Fit the nuts and tighten them finger-tight, making sure the connecting rod does not rotate on the crankshaft (see illustration 27.25c).

14 Tighten the cap nuts to the initial torque setting specified at the beginning of the Chapter, making sure the connecting rod does not rotate on the crankshaft (see illustration 27.26a). Now tighten each nut in turn and in one continuous movement a further 90°, using either a degree disc (see illustration 27.26b), or by marking the nuts as described in the *Haynes Hint*. If the nut is mistakenly tightened by more than the specified torque or angle, remove the nuts and bolts, replace them with new ones and begin the procedure again.

HAYNES HINT *If a degree disc is not available, the angle can be determined by using the points on the connecting rod cap nut. There are six points on the nut, so the angle between each point is 60°. Select one point as a reference and mark it with paint or a marker. Now select the midway on the nut flat between the first and second points clockwise from it and mark its position on the connecting rod cap. Tighten the nut - when the mark on the nut aligns with the mark made on the connecting rod cap, it will have turned through 90°.*

15 Slacken the cap nuts and remove the connecting rod, again taking great care not to rotate the rod or crankshaft.

16 Compare the width of the crushed Plastigauge on the crankpin to the scale printed on the Plastigauge envelope to obtain the connecting rod bearing oil clearance (see illustration 28.20). Compare the reading to the specifications at the beginning of the Chapter.



27.25a Fit the bolts into the cap ...



27.21a Big-end journal size numbers (A), main journal size numbers (B)

17 On completion carefully scrape away all traces of the Plastigauge material from the crankpin and bearing shells using a fingernail or other object which is unlikely to score the shells.

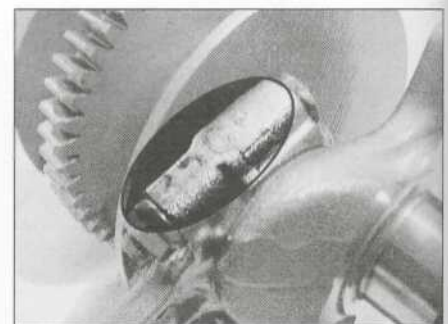
18 If the clearance is within the range listed in this Chapter's Specifications and the bearings are in perfect condition, they can be reused. If the clearance is beyond the service limit, replace the bearing shells with new ones (see Steps 21 and 22). Check the oil clearance once again (the new shells may be thick enough to bring bearing clearance within the specified range). Always replace all of the inserts at the same time.

19 If the clearance is still greater than the service limit listed in this Chapter's Specifications, the big-end bearing journal is worn and the crankshaft should be replaced with a new one.

20 Repeat the bearing selection procedure for the remaining connecting rods.

Bearing shell selection

21 Replacement bearing shells for the big-end bearings are supplied on a selected fit basis. Code numbers stamped on various components are used to identify the correct replacement bearings. The crankshaft journal size numbers are stamped on the outside of the crankshaft web on the left-hand end (see illustration). The right-hand block of four numbers are for the big-end bearing journals (the left-hand block of six numbers are for the main bearing journals). The first number of the four is for the left-hand (No. 1 cylinder) journal, and so on. Each connecting rod number is



27.21 b The connecting rod number is marked on the flat side of each rod

marked in ink on the flat face of the connecting rod and cap (see illustration).

22 A range of bearing shells is available. To select the correct bearing for a particular connecting rod, subtract the big-end bearing journal number (stamped on the crank web) from the connecting rod number (marked on the rod). Compare the bearing number calculated with the table below to find the colour coding of the replacement bearing required.

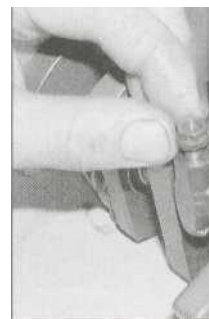
Number	Colour
1	Blue
2	Black
3	Brown
4	Green

Installation

23 Clean the backs of the bearing shells and the bearing locations in both the connecting rod and cap.

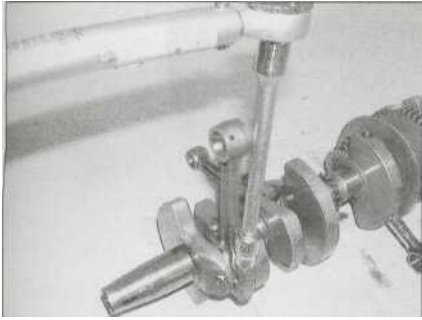
24 Press the bearing shells into their locations, making sure the tab on each shell locates in the notch in the connecting rod/cap (see illustration 27.11). Make sure the bearings are fitted in their correct locations and take care not to touch any shell's bearing surface with your fingers. Lubricate the shells with clean engine oil.

25 Obtain new bolts and nuts for the connecting rods and discard the old ones. Apply molybdenum disulphide grease to the bolt shanks and threads and to the seats of the nuts, then fit the bolts into the cap (see illustration). Assemble the connecting rod and cap on the crankpin (see illustration). Make sure the cap is fitted the correct way around so the previously made markings



27.25c ... and fit the nuts

27.25b ... then assemble the rod on the crankshaft...



27.26a Tighten the nuts, first to the specified torque ...



27.26b ... then by the specified angle

align, and that the rod is facing the right way (see Step 3). Fit the nuts and tighten them finger-tight (**see illustration**). Check again to make sure all components have been returned to their original locations using the marks made on disassembly.

26 Tighten the cap nuts to the initial torque setting specified at the beginning of the Chapter (**see illustration**). Now tighten each nut in turn and in one continuous movement a further 90°, using either a degree disc, or by marking the nuts as described in the *Haynes Hint* above (**see illustration**). If the nut is mistakenly tightened by more than the specified torque or angle, remove the nuts and bolts, replace them with new ones and begin the procedure again.

27 Check that the rods rotate smoothly and freely on the crankpin. If there are any signs of roughness or tightness, remove the rods and re-check the bearing clearance. Sometimes

tapping the bottom of the connecting rod cap will relieve tightness, but if in doubt, recheck the clearances.

28 Install the crankshaft (see Section 28).

28 Crankshaft and main bearings - removal, inspection and installation

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Removal

1 Remove the engine from the frame (see Section 5) and separate the crankcase halves (see Section 23).

2 Lift the crankshaft out of the upper crankcase half, taking care not to dislodge the main bearing shells, then remove the cam chain from it (**see illustration and 25.3**). Remove the oil seal from the left-hand end of the shaft and discard it as a new one must be used (**see illustration**).

3 The main bearing shells can be removed from the crankcase halves by pushing their centres to the side, then lifting them out (**see illustration**). Keep the shells in order.

4 If required, separate the connecting rods from the crankshaft (see Section 27). Note: *If no work is to be carried out on the crankshaft or connecting rod assemblies, there is no need to separate them.*

Inspection

5 Clean the crankshaft with solvent, using a rifle-cleaning brush to scrub out the oil passages. If available, blow the crank dry with

compressed air, and also blow through the oil passages. Check the primary drive gear and cam chain sprocket for wear or damage. If any of the teeth are excessively worn, chipped or broken, the crankshaft must be replaced with a new one. If wear or damage is found, check the driven gear on the clutch housing.

6 Refer to Section 26 and examine the main bearing shells. If they are scored, badly scuffed or appear to have been seized, new bearings must be installed. Always replace the main bearings as a set. If they are badly damaged, check the corresponding crankshaft journals. Evidence of extreme heat, such as discoloration, indicates that lubrication failure has occurred. Be sure to thoroughly check the oil pump and pressure regulator as well as all oil holes and passages before reassembling the engine.

7 Give the crankshaft journals a close visual examination, paying particular attention where damaged bearings have been discovered. If the journals are scored or pitted in any way a new crankshaft will be required. Note that undersizes are not available, precluding the option of re-grinding the crankshaft.

8 Place the crankshaft on V-blocks and check the runout at the main bearing journals using a dial gauge (**see illustration**). Compare the reading to the maximum specified at the beginning of the Chapter. If the runout exceeds the limit, the crankshaft must be replaced.

Oil clearance check

9 Whether new bearing shells are being fitted or the original ones are being re-used, the main bearing oil clearance should be checked before the engine is reassembled. Main bearing oil clearance is measured with a product known as Plastigauge.

10 Clean the backs of the bearing shells and the bearing housings in both crankcase halves, and the main bearing journals on the crankshaft.

11 Press the bearing shells into their cut-outs, ensuring that the tab on each shell engages in the notch in the crankcase (**see illustration 28.27a**). Make sure the bearings are fitted in the correct locations and take care not to touch any shell's bearing surface with your fingers.



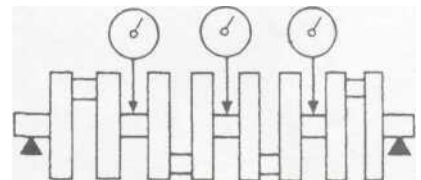
28.2a Carefully lift the crankshaft out of the crankcase



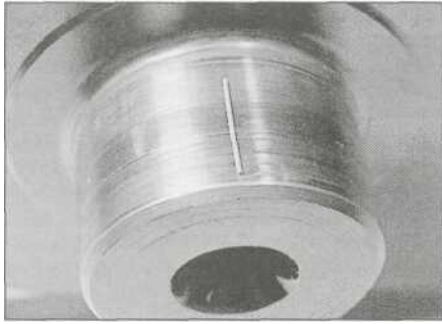
28.2b Remove the oil seal and discard it



28.3 To remove a main bearing shell, push it sideways and lift it out



28.8 Measuring crankshaft runout



28.13 Lay a strip of Plastigauge on each journal parallel to the crankshaft centreline

12 Ensure the shells and crankshaft are clean and dry. Lay the crankshaft in position in the upper crankcase.

13 Cut several lengths of the appropriate size Plastigauge (they should be slightly shorter than the width of the crankshaft journals). Place a strand of Plastigauge on each journal, making sure it will be clear of the oil holes in the shells when the lower crankcase is installed (see illustration). Make sure the crankshaft is not rotated.

14 If removed, install the locating dowel in one crankcase half (see illustration 23.16). Carefully install the lower crankcase half on to the upper half, making sure the dowel locates correctly (see illustration 23.18). Check that the lower crankcase half is correctly seated.

Note: Do not tighten the crankcase bolts if the casing is not correctly seated.

15 Clean the threads of the 8 mm lower crankcase bolts and apply molybdenum disulphide oil (a 50/50 mixture of molybdenum disulphide grease and new engine oil) to their threads. Insert them with their washers in their original locations. Clean the threads of the 6 mm lower crankcase bolts and apply new engine oil to their threads. Insert them in their original locations. Secure all bolts finger-tight at first, then tighten them evenly and a little at a time in the correct numerical sequence to the torque settings specified at the beginning of the Chapter (see illustrations 23.9a and 23.9b).

16 Turn the engine over, making sure the crankshaft does not rotate. Clean the threads of the upper crankcase bolts and apply new engine oil to their threads. Insert



28.20 Measure the width of the crushed Plastigauge (be sure to use the correct scale - metric and imperial are included)

them, not forgetting the copper washer with bolt 29, in their original locations. Secure all bolts finger-tight at first, then tighten them evenly and a little at a time in the correct numerical sequence to the torque settings specified at the beginning of the Chapter (see illustration 23.7).

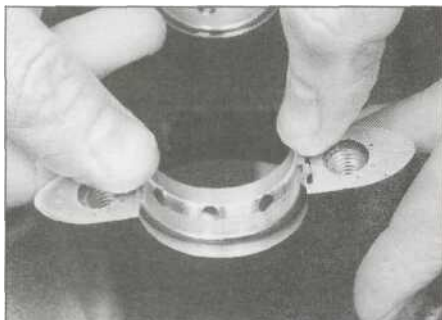
17 Unscrew the upper crankcase bolts evenly and a little at a time in a reverse of the numerical sequence marked on the crankcase (the number of each bolt is cast into the crankcase) (see illustration 23.7), until they are finger-tight, then remove them, and place them back in the cardboard template, if used.

18 Turn the engine upside down so that it rests on the cylinder head studs, making sure the crankshaft does not rotate.

19 Unscrew the lower crankcase bolts evenly and a little at a time in a reverse of the numerical sequence marked on the crankcase (the number of each bolt is cast into the crankcase) (see illustration 23.9a), until they are finger-tight, then remove them, and place them back in the cardboard template, if used. Carefully lift off the lower crankcase half, making sure the Plastigauge is not disturbed.

20 Compare the width of the crushed Plastigauge on each crankshaft journal to the scale printed on the Plastigauge envelope to obtain the main bearing oil clearance (see illustration). Compare the reading to the specifications at the beginning of the Chapter.

21 On completion carefully scrape away all traces of the Plastigauge material from the crankshaft journal and bearing shells; use a fingernail or other object which is unlikely to score them.



28.28a Make sure the tabs on the shells locate in the notches in the cutouts



28.28b Generously lubricate all the bearing shells



28.24 Main bearing housing numbers

22 If the oil clearance falls into the specified range, no bearing shell replacement is required (provided they are in good condition). If the clearance is beyond the service limit, refer to the marks on the case and the marks on the crankshaft and select new bearing shells (see Steps 24 and 25). Install the new shells and check the oil clearance once again (the new shells may bring bearing clearance within the specified range). Always renew all of the shells at the same time.

23 If the clearance is still greater than the service limit listed in this Chapter's Specifications (even with replacement shells), the crankshaft journal is worn and the crankshaft should be replaced.

Main bearing shell selection

24 Replacement bearing shells for the main bearings are supplied on a selected fit basis; Code numbers stamped on various components are used to identify the correct replacement bearings. The crankshaft journal size numbers are stamped on the outside of the crankshaft web on the left-hand end (see illustration 27.21 a). The left-hand block of six numbers are for the main bearing journals (the right-hand block of four numbers are for the big-end bearing journals). The first number of the six is for the left-hand (No. 1) journal, and so on. The main bearing housing numbers are stamped into the upper crankcase half (see illustration). The first number of the six is for the right-hand (No. 6) journal, and so on. Note that if there is only one number stamped into the crankcase, it means that all the journals are the same number.

25 A range of bearing shells is available. To select the correct bearing for a particular journal, subtract the main bearing journal number (stamped on the crank web) from the main bearing housing number (stamped on the crankcase), then add 1. Compare the bearing number calculated with the table below to find the colour coding of the replacement bearing required.

Number	Colour
1	Blue
2	Black
3	Brown
4	Green
5	Yellow
6	Pink

29.2a Remove the clutch pushrod oil seal...

Installation

26 Clean the backs of the bearing shells and the bearing cut-outs in both crankcase halves, and the main bearing journals on the crankshaft. If new shells are being fitted, ensure that all traces of the protective grease are cleaned off using paraffin (kerosene). Wipe the shells and crankcase halves dry with a lint-free cloth. Make sure all the oil passages and holes are clear, and blow them through with compressed air if it is available.

27 If removed, fit the connecting rods onto the crankshaft (see Section 27).

28 Press the bearing shells into their locations. Make sure the tab on each shell engages in the notch in the casing (see illustration). Make sure the bearings are fitted in the correct locations and take care not to touch any shell's bearing surface with your fingers. Lubricate each shell with clean engine oil (see illustration).

29 Fit a new oil seal onto the left-hand end of the crankshaft (see illustration 28.2b). Slip the cam chain around the sprocket on the crankshaft (see illustration 25.3), then lower the crankshaft into position in the upper crankcase, making sure all bearings remain in place (see illustration 28.2a)

30 Reassemble the crankcase halves (see Section 23).

29 Transmission shafts - removal and installation

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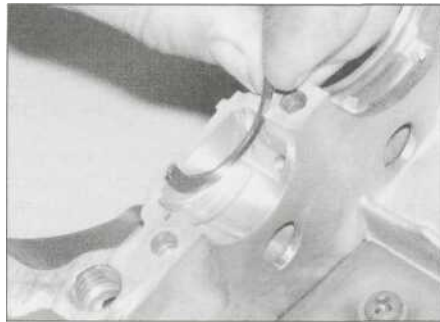
Removal

1 Remove the engine from the frame (see Section 5) and separate the crankcase halves (see Section 23).

2 Remove the clutch pushrod oil seal from the left-hand end of the input shaft (see illustration). If required, remove the oil seal from the left-hand end of the output shaft (see illustration).

3 Lift the input shaft and output shaft out of the crankcase, noting their relative positions in the crankcase and how they fit together (see illustration). If they are stuck, use a soft-faced hammer and gently tap on the ends of the shafts to free them.

29.2b ... and if required the output shaft oil seal



29.4a Remove the half-ring retainers from the crankcase or the bearings ...

4 Remove the three bearing half-ring retainers from the crankcase, noting how they fit (see illustration); if they are not in their slots in the crankcase, remove them from the bearings themselves on the shafts. Also remove the needle bearing cap from the right-hand end of the output shaft (see illustration).

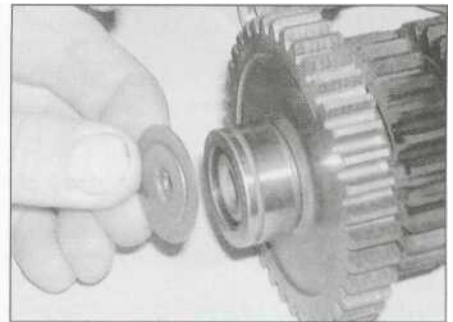
5 If required, the shafts can be disassembled and inspected for wear or damage (see Section 30).

Installation

6 Install the bearing half-ring retainers into their slots in the upper crankcase half (see illustration 29.4a)

7 Fit the needle bearing cap onto the right-hand end of the output shaft (see illustration 29.4b). Lower the output shaft into position in the upper crankcase, making sure the ball bearing locating pin faces back and locates in its recess, and the grooves in the bearings

29.3 Lift the transmission shafts out of the crankcase



29.4b ... and the output shaft end cap

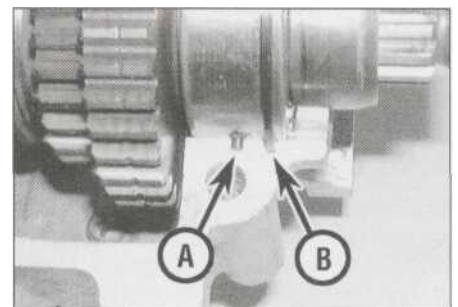
engage correctly with the half-ring retainers (see illustrations).

8 Lower the input shaft into position in the upper crankcase, making sure the locating pin on the ball bearing on the right-hand end of the shaft faces forward and locates in its recess, and the groove in the bearing engages correctly with the half-ring retainer (see illustration 29.3).

9 Check the condition of the output shaft oil seal and renew it if it is in any way damaged, worn or deteriorated, or if there were any signs of leakage from it. Smear the lips of the seal with grease. Slide the oil seal onto the left-hand end of the output shaft (see illustration 29.2b). Also check the condition of the clutch pushrod oil seal and renew it if it is in any way damaged, worn or deteriorated, or if there were any signs of leakage from it.



29.7a Install the output shaft,



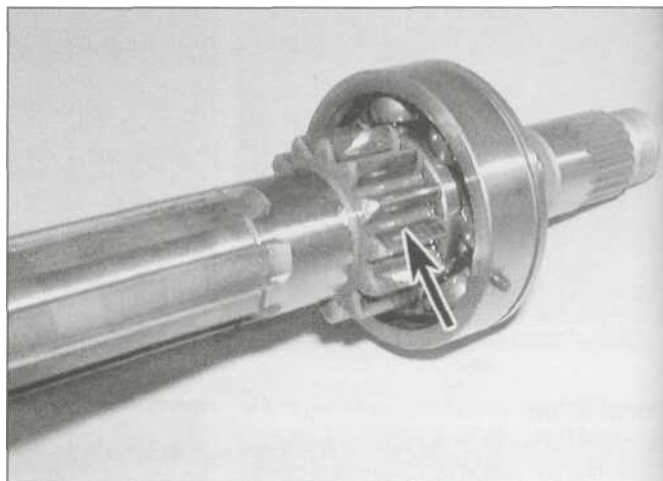
29.7b ... making sure the ball bearing locating pin faces back and locates in its recess (A), and the grooves in the bearings engage correctly with the half-ring retainers (B)



1fa



30.3 Use a puller, or a press, to remove the 2nd gear pinion



30.6 The 1st gear pinion (arrowed) is integral with the shaft

Smear the lips of the seal with grease. Fit the seal against the left-hand end of the input shaft (see illustration 29.2a)

10 Make sure both transmission shafts are correctly seated and their related pinions are correctly engaged.

Caution: If the ball bearing locating pins and half-ring retainers are not correctly engaged, the crankcase halves will not seat correctly.

11 Position the gears in the neutral position and check the shafts are free to rotate easily and independently (i.e. the input shaft can turn whilst the output shaft is held stationary) before proceeding further.

12 Reassemble the crankcase halves (see Section 23).

30 Transmission shafts - disassembly, inspection and reassembly

1 Remove the transmission shafts from the upper crankcase (see Section 29). Always disassemble the transmission shafts separately to avoid mixing up the components.

When disassembling the transmission shafts, place the parts on a long rod or thread a wire through them to keep them in order and facing the proper direction.

Input shaft

Disassembly

2 Remove the bearing from the left-hand end of the shaft (see illustration 30.20). Do not remove the bearing from the right-hand end unless it or the shaft are being replaced.

3 Remove the 2nd gear pinion from the left-hand end of the shaft using a puller. It will be easier to set the puller up with the legs behind the 6th gear pinion, and draw the 2nd and 6th pinions off together (see illustration). Note:

On the model stripped down, an hydraulic press was needed to remove the 2nd gear pinion as it was so tight on the shaft. Take the shaft to a properly equipped workshop if necessary.

4 Slide the 6th gear pinion (if not already done) and the combined 3rd/4th gear pinion off the shaft (see illustrations 30.18 and 30.17).

5 Remove the circlip securing the 5th gear pinion, then slide the spline washer and the pinion off the shaft (see illustrations 30.16c, 30.16band30.16a).

6 The 1st gear pinion is integral with the shaft (see illustration).

Inspection

7 Wash all of the components in clean solvent and dry them off.

8 Check the gear teeth for cracking, chipping, pitting and other obvious wear or damage. Any pinion that is damaged must be replaced with a new one.

9 Inspect the dogs and the dog holes in the gears for cracks, chips, and excessive wear especially in the form of rounded edges. Make sure mating gears engage properly. Replace the paired gears with new ones as a set if necessary.

10 Check for signs of scoring or bluing on the pinions and shaft. This could be caused by overheating due to inadequate lubrication. Check that all the oil holes and passages are clear. Replace any damaged pinions with new ones.

11 Check that each mobile pinion moves freely on the shaft but without undue freeplay.

12 The shaft is unlikely to sustain damage unless the engine has seized, placing an unusually high loading on the transmission, or the machine has covered a very high mileage. Check the surface of the shaft, especially where a pinion turns on it, and replace the shaft if it has scored or picked up, or if there are any cracks. Damage of any kind can only be cured by replacement. Check the shaft runout using V-blocks and a dial gauge and

replace the shaft with a new one if the runout exceeds the limit specified at the beginning of the Chapter.

13 Check the washers and circlips and replace any that are bent or appear weakened or worn. Use new ones if in any doubt.

14 Referring to *Tbo/s and Workshop Tips* ("check Section 5) in the Reference Section, check the bearings and replace them with new ones if necessary.

Reassembly

15 During reassembly, apply molybdenum disulphide oil (a 50/50 mixture of molybdenum disulphide grease and new engine oil) to the mating surfaces of the shaft and pinions. When installing the circlips, do not expand the ends any further than is necessary. Install the stamped circlips so that their chamfered side faces the pinion it secures (see *Correct fitting of a stamped circlip* illustration in *Tools and Workshop Tips* of the Reference section).

16 Slide the 5th gear pinion, with the pinion dog holes facing away from the integral 1st gear onto the shaft (see illustration). Slide the spline washer onto the shaft, then fit the circlip, making sure it locates correctly in the groove in the shaft (see illustrations).

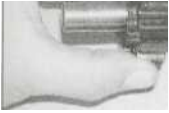
17 Slide the combined 3rd/4th gear pinion onto the shaft with the larger 4th gear pinion facing the 5th gear pinion (see illustration).

18 Slide the 6th gear pinion onto the shaft (see illustration).

19 Press the 2nd gear pinion onto the left-hand end of the shaft using a press or tubular drift, referring to *Tools and Workshop Tips* ("Section 5) in the Reference Section if required (see illustration). Set the pinion so that the distance between the outside edge of the 2nd gear pinion and the outside edge of the 1st gear pinion (which is integral with the shaft) is 125.8 mm (see illustration).

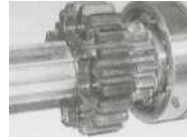
20 Fit the bearing onto the left-hand end of the shaft (see illustration). If removed, also fit a new right-hand bearing.

21 Check that all components have been correctly installed (see illustration).

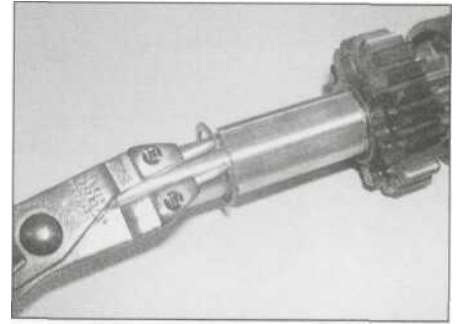


ft/I

30.16a Slide the 5th gear pinion ...



30.16b ... and the spline washer onto the shaft..



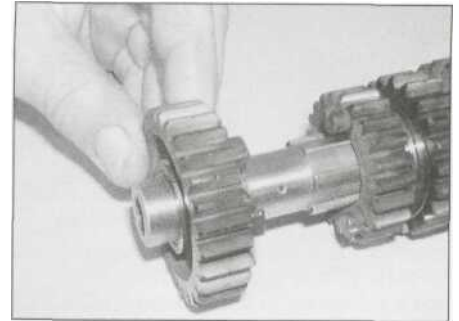
30.16c ... then fit the circlip .



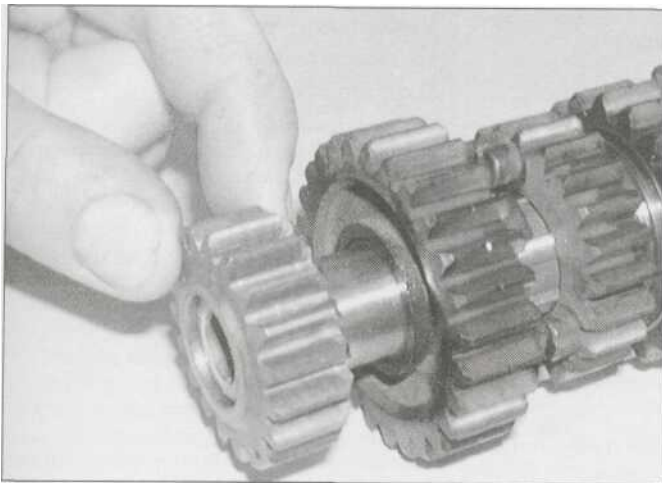
30.16d ... making sure it locates correctly in the groove



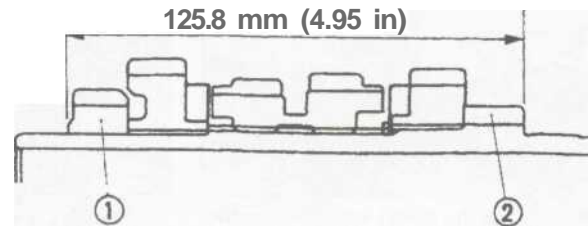
30.17 Slide the combined 3rd/4th gear pinion onto the shaft...



30.18 ... followed by the 6th gear pinion ...



30.19a ... then press on the 2nd gear pinion .



30.19b ... and set it so the distance between the 2nd (1) and 1st (2) pinions is as specified

Output shaft

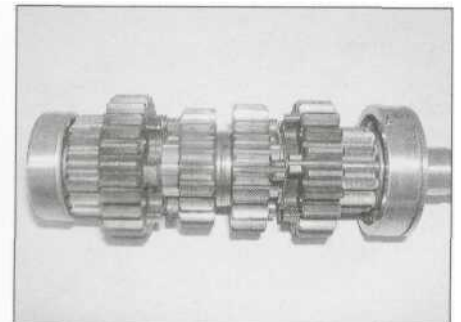
Disassembly

22 Remove the needle bearing and thrust washer from the right-hand end of the shaft (see illustrations 30.31 b and 30.31 a). Do not remove the spacer and bearing from the left-hand end unless they or the shaft are being replaced with new ones - a puller is needed to draw them off the shaft. Note the thrust washer that fits behind the bearing.

23 Slide the 1st gear pinion and the 5th gear pinion off the right-hand end of the shaft (see illustrations 30.30b and 30.30a).



30.20 Fit the bearing onto the left-hand end of the shaft



30.21 The assembled input shaft

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30.28a Slide the 2nd gear pinion ...



30.28b ... and the spline washer onto the shaft...



30.28c ... and secure it with the circlip, making sure it locates correctly in its groove



30.29a Slide the 6th gear pinion ...



30.29b ... the 3rd gear pinion .



30.29c ... the 4th gear pinion .



30.29d ... and the spline washer onto the shaft...

24 Remove the circlip, then slide the spline washer, the 4th gear pinion, the 3rd gear pinion and the 6th gear pinion off the shaft (see illustrations 30.29e, 30.29d, 30.29C, 30.29b and 30.29a).

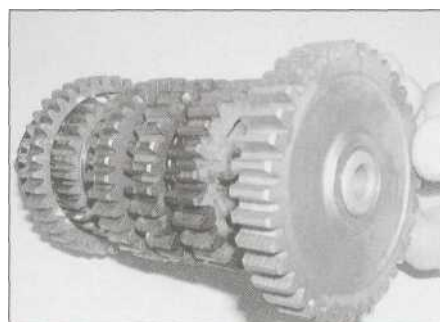


30.30a Slide the 5th gear pinion ...



30.29e ... and secure them with the circlip, making sure it locates correctly in its groove

25 Remove the circlip securing the 2nd gear pinion, then slide the spline washer and the 2nd gear pinion off the shaft (see illustrations 30.28c, 30.286 and 30.28a).



30.30b ... and the 1st gear pinion onto the shaft..

Inspection

26 Refer to Steps 7 to 14 above.

Reassembly

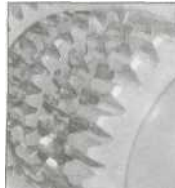
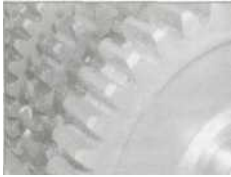
27 During reassembly, apply molybdenum disulphide oil (a 50/50 mixture of molybdenum disulphide grease and new engine oil) to the mating surfaces of the shaft and pinions. When installing the circlips, do not expand the ends any further than is necessary. Install the stamped circlips so that their chamfered side faces the pinion it secures (see *Correct fitting of a stamped circlip* illustration in *Tools and Workshop Tips* of the Reference section).

28 Slide the 2nd gear pinion and the spline washer onto the right-hand end of the shaft and secure it with the circlip, making sure it locates correctly in its groove in the shaft (see illustrations).

29 Slide the 6th gear pinion onto the right-hand end of the shaft, with selector fork groove facing to the right (see illustration). Slide the 3rd gear pinion, the 4th gear pinion and the spline washer onto the shaft and secure them with the circlip, making sure it locates correctly in its groove (see illustrations).

30 Slide the 5th gear pinion onto the shaft, with its selector fork groove facing the 4th gear pinion, then slide the 1st gear pinion onto the shaft (see illustrations).

31 Fit the thrust washer and needle bearing onto the right-hand end of the shaft (see illustrations). If removed, also fit the thrust washer, left-hand bearing, using a new one, and the spacer, onto the left-hand end of the



30.31 a ... then fit the thrust washer ...

30.31 b ... and needle bearing

30.32 The assembled output shaft

shaft, using a tubular drift or press if necessary, referring to *Tools and Workshop Tips* (Section 5) in the Reference Section if required.

32 Check that all components have been correctly installed (**see illustration**).

31 Selector drum and forks - removal, inspection and installation

Note: *The selector drum and forks can be removed without separating the crankcase halves.*

Removal

1 Remove the oil sump (see Section 22). The selector drum and forks are located in the lower crankcase half. Make sure the transmission is in neutral.

2 Remove the gearchange mechanism (see Section 20).

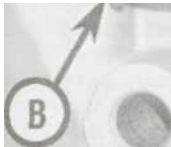
3 Unscrew the bolts and the locating pin securing the selector fork shaft and selector drum retainer plates and remove the plates, noting how they fit (**see illustration**).

4 Before removing the selector forks, note that each fork is lettered for identification. The right-hand fork has an "R", the centre fork a

"C", and the left-hand fork an "L" (**see illustration**). These letters face the right-hand side of the engine. If no letters are visible, mark them yourself using a felt pen.

5 Support the selector forks and withdraw the shafts from the casing, then move the forks away from the selector drum so that the guide pins are no longer engaged in the grooves (**see illustrations**).

6 Withdraw the selector drum from the right-hand side of the casing, then remove the forks (**see illustration**). Once removed from the case, slide the forks back onto their shafts in their correct order and way round.

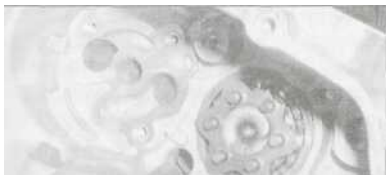


ir i



31.3 Unscrew the bolts (A) and locating pin (B) and remove the retainer plates, noting how they fit

31.4 Note the letter on each fork denoting its position



31.5a Withdraw the shafts ..

31.5b ... then disengage the fork guide pins from the selector drum grooves

31.6 Withdraw the drum and remove the forks, noting how they fit

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31.13 Position the drum so the neutral detent points down (arrowed)

Inspection

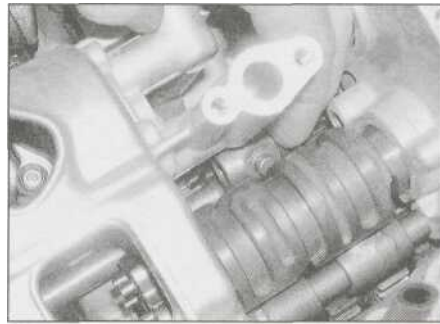
7 Inspect the selector forks for any signs of wear or damage, especially around the fork ends where they engage with the groove in the pinion. Check that each fork fits correctly in its pinion groove. Check closely to see if the forks are bent. If the forks are in any way damaged they must be replaced with new ones.

8 Check that the forks fit correctly on their shaft. They should move freely with a light fit but no appreciable freeplay. Check that the fork shaft holes in the casing are not worn or damaged.

9 The selector fork shafts can be checked for trueness by rolling them along a flat surface. A bent rod will cause difficulty in selecting gears and make the gearshift action heavy. Replace the shafts with new ones if bent.

10 Inspect the selector drum grooves and selector fork guide pins for signs of wear or damage. If either show signs of wear or damage they must be replaced with new ones.

11 Check that the selector drum bearing rotates freely and has no signs of roughness or excessive freeplay between it and the drum or crankcase (when installed) (see *7bo/s and Workshop Tips* (Section 5) in the Reference Section for more information on bearings). Replace the selector drum with a new one if necessary - the bearing is not available separately, though it would be worth checking with a bearing specialist before consigning the drum to the bin. Also check that the neutral switch contact plunger in the other end of the drum is free to move in and out under spring pressure. If required, remove the



31.14 Position the fork against the drum so the guide pin is in the groove then slide the shaft through the fork

screw securing the contact plate and remove the plunger and spring for inspection or replacement.

Installation

12 Refer to Step 4 for the correct location of each fork (see **illustration 31.4**). Locate each fork in the groove in its gear, noting that the fork marked "C" fits in the input (front) transmission shaft, and the forks marked "L" and "R" fit into the output (rear) shaft, with the forks positioned according to the letter (Left, Centre and Right) and with the letters facing the right-hand side of the engine (see **illustration 31.6**). Position the forks so that they will not get in the way of the selector drum as it is installed.

13 Align the selector drum so that the neutral detent points to the bottom of the engine and slide the drum into the crankcase (see **illustration**).

14 Lubricate each selector fork shaft with clean engine oil, then slide them into the crankcase (see **illustration 31.5a**) and through the fork(s) and into the bore (see **illustration 31.5b**), making sure the guide pin on the end of each fork locates in its groove in the drum as you do (see **illustration**).

15 Install the fork shaft and selector drum retainer plates with the "UP" marks facing up and out, making sure they locate correctly (see **illustration 31.3**). Apply a suitable non-permanent thread locking compound to the bolts and locating pin and tighten them to the torque settings specified at the beginning of the Chapter.

16 Install the gearchange mechanism (see Section 20) and the sump (see Section 22).

32 Initial start-up after overhaul

- 1 Make sure the engine oil level and coolant level are correct (see *Daily (pre-ride) checks*).
- 2 Make sure there is fuel in the tank, then turn the fuel tap to the "ON" position, and set the choke.
- 3 Start the engine and allow it to run at a moderately fast idle until it reaches normal operating temperature.
- 4 As no oil pressure warning light is fitted, an oil pressure check must be carried out (see Chapter 1, Section 31).
- 5 Check carefully for oil and coolant leaks and make sure the transmission and controls, especially the brakes, function properly before road testing the machine. Refer to Section 33 for the recommended running-in procedure.
- 6 Upon completion of the road test, and after the engine has cooled down completely, recheck the valve clearances (see Chapter 1) and check the engine oil and coolant levels (see *Daily (pre-ride) checks*).

33 Recommended running-in procedure

- 1 Treat the machine gently for the first few miles to make sure oil has circulated throughout the engine and any new parts installed have started to seat.
- 2 Even greater care is necessary if the engine has been extensively overhauled - the bike will have to be run in as when new. This means greater use of the transmission and a restraining hand on the throttle until at least 600 miles (1000 km) have been covered. There's no point in keeping to any set speed limit - the main idea is to keep from labouring the engine and to gradually increase performance up to the 600 mile (1000 km) mark. These recommendations can be lessened to an extent when only a partial overhaul has been done, though it does depend to an extent on the nature of the work carried out and which components have been renewed. Experience is the best guide, since it's easy to tell when an engine is running freely. If in any doubt, consult a Yamaha dealer. The table (left) shows the maximum engine speed limitations, which Yamaha provide for new motorcycles, that can be used as a guide.
- 3 If a lubrication failure is suspected, stop the engine immediately and try to find the cause. If an engine is run without oil, even for a short period of time, severe damage will occur.

Guide to running in speeds

Up to 100 miles (150 km)	8000 rpm max
100 to 300 miles (150 to 500 km)	9000 rpm max
300 to 600 miles (500 to 1000 km)	10,000 rpm max
Over 600 miles (1000 km)	12,500 rpm (FZS) 13,000 rpm (YZF)

Vary throttle position/speed. Do not use full throttle
Vary throttle position/speed. Do not use full throttle
Vary throttle position/speed. Use full throttle for short bursts
Do not exceed tachometer red line