Chapter 2 Part E:
LEADER air-cooled four-stroke engines (Zip 125, Skipper ST, Liberty 125, ET4 125, Fly 125, LX4 125, S125)

Refer to the beginning of Chapter 1 for model identification details

Contents

Degrees of difficulty

Easy, suitable for novice with little experience 

Fairly easy, suitable for beginner with some experience 

Fairly difficult, suitable for competent DIY mechanic 

Difficult, suitable for experienced DIY mechanic 

Very difficult, suitable for expert DIY or professional 

Specifications

General

Type	Single cylinder four-stroke
Capacity	124.01 cc
Bore	57.0 mm
Stroke	48.6 mm
Compression ratio	10.1 to 11.1 : 1

Camshaft

Intake and exhaust lobe height	
Zip 125, Skipper ST, Liberty 125, ET4	27.8 mm
Fly 125, LX 125, S125	
Intake	27.5 mm
Exhaust	27.2 mm
Left-hand journal diameter	
Standard	32.50 mm
Service limit (min)	32.44 mm
Right-hand journal diameter	
Standard	20.00 mm
Service limit (min)	19.95 mm
Camshaft endfloat	
Standard	0.11 to 0.41mm
Service limit	0.42 mm

Cylinder head

Warpage (max)	0.05 mm
Left-hand camshaft bearing housing diameter	32.500 to 32.525 mm
Right-hand camshaft journal housing diameter	20.000 to 20.021 mm
Rocker arm shaft housing	12.000 to 12.018 mm
Rocker arm shaft diameter	11.977 to 11.985 mm
Rocker arm internal diameter	12.000 to 12.011 mm
Valve seat width (max)	1.6 mm

Valves, guides and springs

Valve clearances	See Chapter 1
Intake valve	
Overall standard length	80.6 mm
Stem diameter	
Service limit (min)	4.960 mm
Guide bore diameter	
Standard	5.022 mm
Stem/valve guide clearance	
Standard	0.013 to 0.040 mm
Service limit	0.062 mm
Face width	3.1 mm
Exhaust valve	
Overall standard length	79.6 mm
Stem diameter	
Service limit (min)	4.950 mm
Guide bore diameter	
Standard	5.022 mm
Stem/valve guide clearance	
Standard	0.025 to 0.052 mm
Service limit	0.072 mm
Face width	3.0 mm
Valve spring free length (intake and exhaust)	n/a

Cylinder bore – aluminium cylinder

Bore diameter (measured 38.5 mm down from top edge of the cylinder, at 90° to piston pin axis)

Standard	
Size-code A	56.980 to 56.987 mm
Size-code B	56.987 to 56.994 mm
Size-code C	56.994 to 57.001 mm
Size-code D	57.001 to 57.008 mm
1st oversize	57.180 to 57.208 mm
2nd oversize	57.380 to 57.408 mm
3rd oversize	57.580 to 57.608 mm

Piston – aluminium cylinder

Piston diameter (measured 36.5 mm down from top edge of the piston, at 90° to piston pin axis)

Standard	
Size-code A	56.933 to 56.940 mm
Size-code B	56.940 to 56.947 mm
Size-code C	56.947 to 56.954 mm
Size-code D	56.954 to 56.961 mm
1st oversize	57.133 to 57.161 mm
2nd oversize	57.333 to 57.361 mm
3rd oversize	57.533 to 57.561 mm
Piston-to-bore clearance (when new)	0.040 to 0.054 mm
Piston pin diameter	14.996 to 15.000 mm
Piston pin bore diameter in piston	15.001 to 15.006 mm

Cylinder bore – cast iron cylinder

Bore diameter (measured 38.5 mm down from top edge of the cylinder, at 90° to piston pin axis)

Standard	
Size-code M	56.997 to 57.004 mm
Size-code N	57.004 to 57.011 mm
Size-code O	57.011 to 57.018 mm
Size-code P	57.018 to 57.025 mm
1st oversize	57.197 to 57.225 mm
2nd oversize	57.397 to 57.425 mm
3rd oversize	57.597 to 57.625 mm

Piston – cast iron cylinder

Piston diameter (measured 36.5 mm down from top edge of the piston, at 90° to piston pin axis)	
Standard	
Size-code M	56.944 to 56.951 mm
Size-code N	56.951 to 56.958 mm
Size-code O	56.958 to 56.965 mm
Size-code P	56.965 to 56.972 mm
1st oversize	57.144 to 57.172 mm
2nd oversize	57.344 to 57.372 mm
3rd oversize	57.544 to 57.572 mm
Piston-to-bore clearance (when new)	0.046 to 0.060 mm
Piston pin diameter	14.996 to 15.000 mm
Piston pin bore diameter in piston	15.001 to 15.006 mm

Piston rings

Ring end gap (installed) – Zip 125, Skipper ST, Liberty 125, ET4	
Top ring	
Standard	0.15 to 0.30 mm
Service limit (max)	0.40 mm
2nd ring	
Standard	0.20 to 0.40 mm
Service limit (max)	0.50 mm
Oil control ring	
Standard	0.20 to 0.40 mm
Service limit (max)	0.50 mm
Ring end gap (installed) – Fly 125, LX 125, S125	
Top ring	
Standard	0.15 to 0.30 mm
Service limit (max)	1.0 mm
2nd ring	
Standard	0.10 to 0.30 mm
Service limit (max)	1.0 mm
Oil control ring	
Standard	0.15 to 0.30 mm
Service limit (max)	1.0 mm
Ring-to-groove clearance – all models	
Top ring	
Standard	0.025 to 0.070 mm
Service limit (max)	0.080 mm
2nd ring	
Standard	0.015 to 0.060 mm
Service limit (max)	0.070 mm
Oil control ring	
Standard	0.015 to 0.060 mm
Service limit (max)	0.070 mm

Lubrication system

Engine oil pressure (at 90°C)	0.5 to 1.2 Bars @ 1650 rpm / 3.2 to 4.2 Bars @ 6000 rpm
Oil pump	
Inner rotor tip-to-outer rotor clearance (max)	0.12 mm
Outer rotor-to-body clearance (max)	0.20 mm
Rotor endfloat (max)	0.09 mm
Relief valve spring free length	54.2 mm

Connecting rod

Small-end internal diameter	
Standard	15.015 to 15.025 mm
Service limit (max)	15.030 mm
Big-end side clearance	
Standard	0.20 to 0.50 mm
Big-end radial freeplay	
Standard	0.006 to 0.018 mm
Service limit (max)	0.25 mm

Crankshaft

Combined width of flywheels and big-end	51.4 mm
Runout A (max)*	0.15 mm
Runout B (max)*	0.01 mm
Runout C (max)*	0.10 mm
Endfloat	0.15 to 0.40 mm

** See illustration 21.18 for runout measurement points*

Torque settings

Valve cover bolts	11 to 13 Nm
Cam chain tensioner spring cap bolt	5 to 6 Nm
Cam chain tensioner blade bolt	10 to 14 Nm
Cam chain tensioner bolts	11 to 13 Nm
Camshaft sprocket bolt	11 to 15 Nm
Camshaft retaining plate bolts	4 to 6 Nm
Cam timing mechanism bolt	7 to 8.5 Nm
Cylinder head nuts	
Initial setting	7 Nm
Final setting	+ 90°+ 90°
Cylinder head bolts (outside)	11 to 13 Nm
Oil pressure switch	12 to 14 Nm
Oil pump cover screws	0.7 to 0.9 Nm
Oil pump mounting screws	5 to 6 Nm
Oil pump sprocket bolt	10 to 14 Nm
Oil pump drive chain cover screws	3.5 to 4.5 Nm
Sump cover bolts	10 to 14 Nm
Alternator rotor nut	52 to 58 Nm
Alternator stator screws/pulse generator coil screws	3 to 4 Nm
Engine front mounting bolt	33 to 41 Nm
Crankcase bolts	11 to 13 Nm

1 General information

The engine unit is a single cylinder four-stroke, with fan-assisted air cooling. The fan is mounted on the alternator rotor, which is on the right-hand end of the crankshaft. The crankshaft assembly is pressed together, incorporating the connecting rod, with the big-end running on the crankpin on a bronze bearing. The crankshaft runs in plain main bearings. The crankcase divides vertically.

The camshaft is chain-driven off the left-hand end of the crankshaft, and operates two valves via rocker arms.

2 Operations possible with the engine in the frame

All components and assemblies, with the exception of the crankshaft/connecting rod assembly, can be worked on without having to remove the engine/transmission unit from the frame. However, access is extremely limited and if a number of areas require attention at the same time, removal of the engine is recommended.

3 Operations requiring engine removal

To access the crankshaft and connecting rod assembly and its bearings, the engine must be removed from the frame and the crankcase halves must be separated.

4 Major engine repair – general note

1 It is not always easy to determine when or if 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 rod 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 A full engine overhaul generally involves restoring the internal parts to the specifications of a new engine. The piston and piston rings are renewed and the cylinder is rebored. The valve seats are re-ground and new valve springs are fitted. If the connecting rod bearings are worn a new crankshaft assembly is fitted. 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 scooter 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 renewed. Often a dealer will handle the inspection of parts and offer advice concerning reconditioning and renewal. 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/transmission unit – removal and installation

Caution: The engine is not heavy, although engine removal and installation should be carried out with the aid of an assistant; personal injury or damage could occur if the engine falls or is dropped.

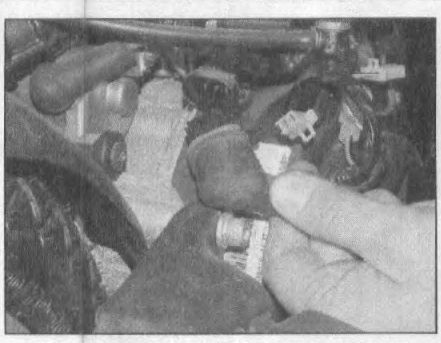
Removal

1 Support the scooter securely in an upright position. Note that the centre stand is bolted to the engine – if required, remove the belly panel (see Chapter 7) and support the frame on wooden blocks forward of the front engine mounting. 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 scooter is secure and will not topple over. If the sump is going to be removed, or the crankcases separated, drain the engine oil (see Chapter 1).

2 Remove the bodywork as required according to model (see Chapter 7). Remove the exhaust silencer (see Chapter 4).

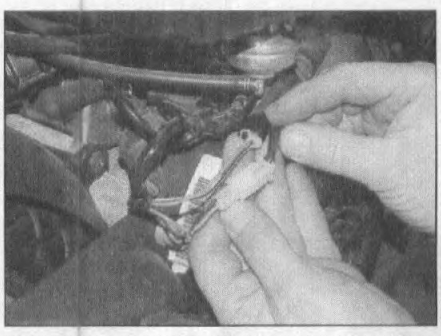
3 If the engine is dirty, particularly around its mountings, wash it thoroughly before starting any major dismantling work. This will make work much easier and rule out the possibility of dirt falling inside.

4 Disconnect the battery negative terminal (see Chapter 9). Trace the wiring from the alternator/pulse generator coil on the right-hand side of the engine and disconnect it at the multi-pin connector **(see illustration)**. Free the wiring from any clips and secure it clear of the engine. Pull the spark plug cap off the plug. Undo the nut securing the starter motor lead to the starter motor terminal **(see illustration)**.

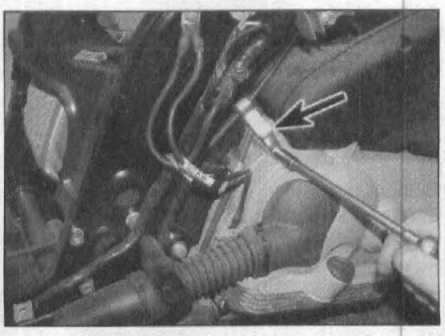


5.4a Disconnect the multi-pin wiring connector

5.4b Disconnect the lead from the starter motor terminal (arrowed)



5.5 Disconnect the choke and carburettor heater wiring connectors



5.6 Free the throttle cable clip (arrowed) . . .

5 Either remove the carburettor, or disconnect the fuel hose and vacuum hose from their unions on the fuel tap, and disconnect the throttle cable (see Chapter 4). If the carburettor is left in place, disconnect the automatic choke and carburettor heater wiring connectors **(see illustration)**.

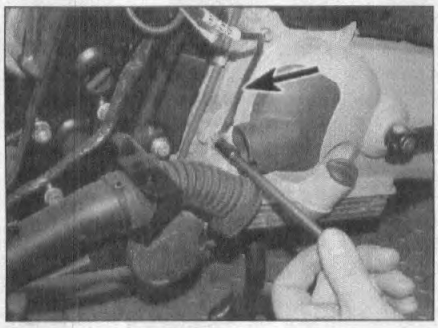
6 If not already done, temporarily undo the bolt on the drivebelt cover that secures the throttle cable clip and free the clip and cable **(see illustration)**.

7 Cut the cable tie that secures the drivebelt air duct to the front of the belt cover and detach the duct, then undo the bolt that secures the engine unit earth wire to the drivebelt cover **(see illustration)**.

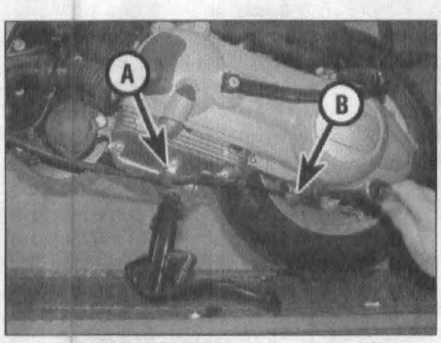
8 If required, remove the rear wheel (see Chapter 8). **Note:** *The rear wheel and centre stand provide a convenient support for the engine unit once it is removed from the scooter. However, it is useful to loosen the rear wheel nut at this point before disconnecting the rear brake.*

9 Disconnect the rear brake cable from the brake and detach the cable from the clamp and clips on the underside of the drivebelt cover **(see illustration)**.

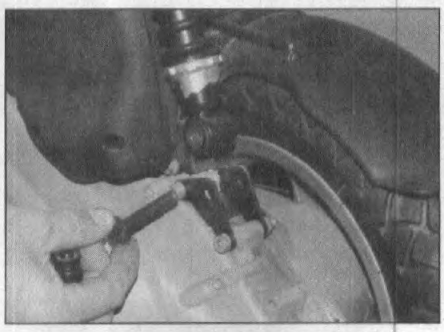
10 Remove the bolt securing the lower end of the rear shock absorber to the transmission casing and lower the engine unit carefully **(see illustration)**. If the rear wheel has been removed, support the engine unit on a wood block to prevent damage to the casing. Undo the nut securing the upper end of the shock to



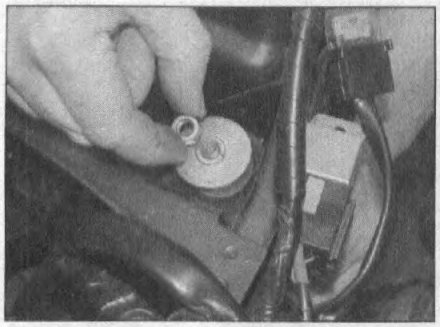
5.7 . . . and the engine earth wire (arrowed)



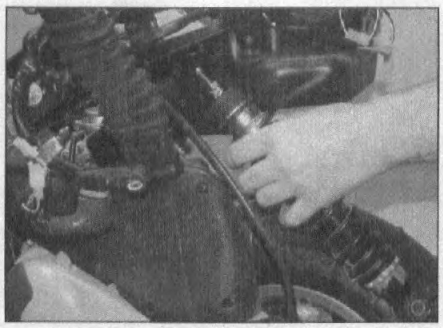
5.9 Free the brake cable from the clip (A) and clamp (B)



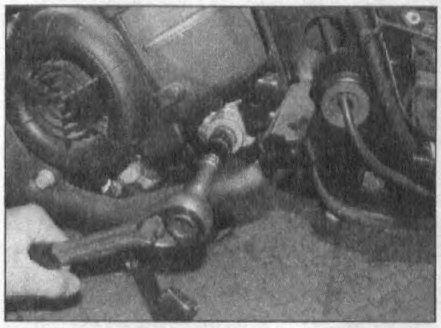
5.10a Undo the lower shock mounting bolt



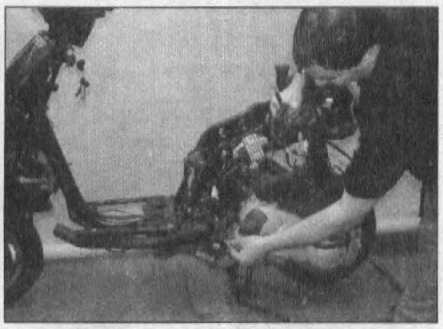
5.10b Undo the upper shock mounting . . .



5.10c . . . and remove the shock



5.11a Undo the nut on the front mounting bolt . . .



5.11b . . . then support the frame and withdraw the bolt

the frame and remove the shock **(see illustrations)**.

11 Check that all wiring, cables and hoses are well clear, then remove the front engine mounting bolt and lift the frame off the engine unit **(see illustrations)**.

Installation

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

a) Make sure no wires, cables or hoses become trapped between the engine and the frame when installing the engine.

b) Tighten the engine mounting bolt and shock absorber bolt to the torque settings specified at the beginning of this Chapter and Chapter 6.

c) Make sure all wires, cables and hoses are correctly routed and connected, and secured by any clips or ties.

d) Adjust the throttle and the rear brake cable (see Chapter 1).

e) If required, fill the engine with the specified quantity of oil (see Chapter 1 Specifications) and check the oil level as described in Daily (pre-ride) checks.

6 Disassembly and reassembly – general information

Disassembly

1 Before disassembling the engine, the external surfaces of the unit should be thoroughly cleaned and degreased to rule out the possibility of dirt falling inside. A high flash-point solvent, such as paraffin 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.

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 to permit notes to 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, recheck with the text.

4 When disassembling the engine, keep 'mated' parts that have been in contact with each other during engine operation together. These 'mated' parts must be re-used or renewed as an assembly.

5 Complete engine disassembly should be done in the following general order with reference to the appropriate Sections. Refer to Chapter 2G for details of transmission components disassembly.

Remove the valve cover.
Remove the camshaft and rockers.
Remove the cylinder head.
Remove the cylinder.
Remove the piston.
Remove the alternator.
Remove the starter motor (see Chapter 9).
Remove the sump cover.
Remove the oil pump.
Separate the crankcase halves.
Remove the crankshaft.

Reassembly

6 Reassembly is the reverse of the general disassembly sequence.

7 Valve cover – removal and installation

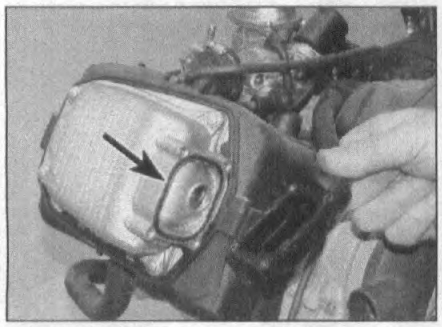
Note: *This procedure can be carried out with the engine in the frame. If the engine has been removed, ignore the steps which do not apply.*

Removal

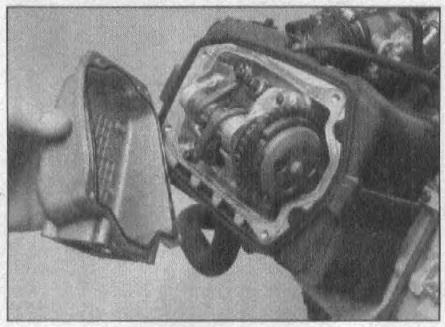
1 Remove the bodywork as required by your model to access the engine (see Chapter 7).

2 Undo the bolts securing the breather unit to the valve cover and lift it off **(see illustration)**. Discard the O-ring, as a new one must be fitted.

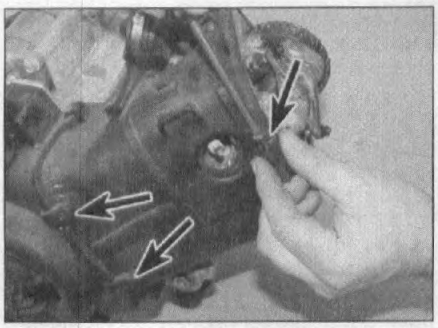
3 Unscrew the bolts securing the valve cover, then lift the cover off the cylinder head **(see illustration)**. If it is stuck, do not try to lever it



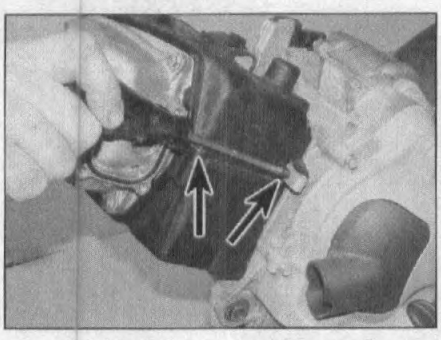
7.2 Remove the breather unit; note the O-ring (arrowed)



7.3 Lift off the valve cover



8.3 Undo the screws (arrowed)



8.4 Undo the screws (arrowed)

8.5 Ease the cowling apart carefully

off with a screwdriver. Tap it gently with a rubber hammer or block of wood to dislodge it. Remove the gasket and discard it, as a new one must be used.

4 If required, release the clip that secures the breather unit to the hose and disconnect the hose. Discard the clip, as a new one must be fitted on reassembly.

Installation

5 Clean the mating surfaces of the cylinder head and the valve cover with a suitable solvent.

6 Lay the new gasket into the groove in the valve cover, making sure it fits correctly.

7 Position the valve cover on the cylinder head, making sure the gasket stays in place, then install the cover bolts. Tighten the bolts evenly and in a criss-cross sequence to the torque setting specified at the beginning of the Chapter.

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

8 Cam chain tensioner – removal, inspection and installation

Note: *This procedure can be carried out with the engine in the frame. If the engine has been removed, ignore the steps which do not apply.*

Removal

1 Remove the bodywork as required by your model to access the engine (see Chapter 7).

2 Remove the carburettor and the intake manifold (see Chapter 4).

3 On the right-hand side of the engine, remove the screws securing the rear half of the engine cowling to the front half of the cowling and to the alternator cover **(see illustration)**.

4 On the left-hand side of the engine, remove the screws securing the rear half of the engine cowling to the front half of the cowling and to the crankcase **(see illustration)**. Note the clip for the carburettor breather hose secured by the crankcase screw.

5 The two halves of the cowling are clipped together on the left-hand side – carefully ease them apart and lift the rear half off **(see illustration)**.

6 Remove the valve cover (see Section 7).

7 Remove the cooling fan (see Section 17). Turn the engine in a clockwise direction using the alternator rotor nut, until the timing mark on the rotor aligns with the index mark on the crankcase, and the timing mark (2V) on the camshaft sprocket aligns with the index mark on the camshaft holder **(see illustrations 9.3a and 9.3b)**. At this point the engine is at TDC (top dead centre) on the compression stroke (both valves closed).

8 Unscrew the chain tensioner spring cap bolt and withdraw the spring from the tensioner body **(see illustration)**. Discard the sealing washer, as a new one must be fitted on reassembly.

9 Unscrew the two tensioner mounting bolts and withdraw the tensioner from the back of the cylinder **(see illustration)**.

10 Remove the gasket from the base of the tensioner or from the cylinder and discard it, as a new one must be used.

Inspection

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

12 Use a small screwdriver to release the ratchet mechanism on the tensioner plunger and check that the plunger moves freely in and out of the tensioner body **(see illustration)**.

13 If the tensioner mechanism or the spring are worn or damaged, or if the plunger is seized in the body, the tensioner must be renewed as an assembly. Individual components are not available.

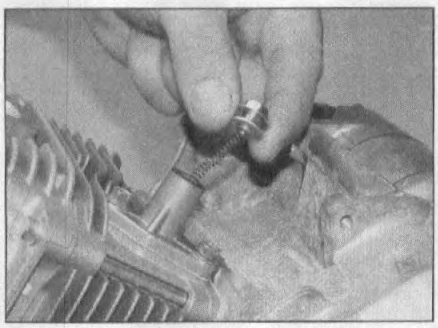
Installation

14 Turn the engine in a clockwise direction using the alternator rotor nut. This removes all the slack in the front run of the cam chain between the crankshaft and the camshaft and transfers it to the back run where it will be taken up by the tensioner.

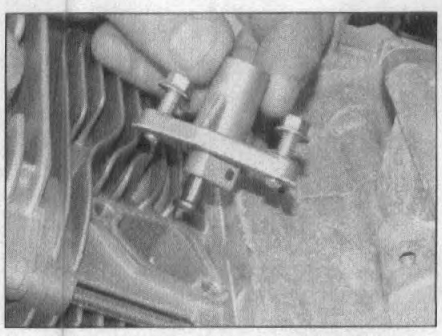
15 Release the ratchet mechanism and press the tensioner plunger all the way into the tensioner body **(see illustration 8.12)**.

16 Place a new gasket on the tensioner body, then install it in the cylinder and tighten the bolts to the torque specified at the beginning of the Chapter **(see illustration 8.9)**.

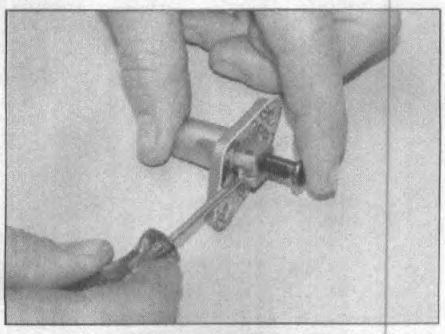
17 Install a new sealing washer on the spring cap bolt. Install the spring and cap bolt and



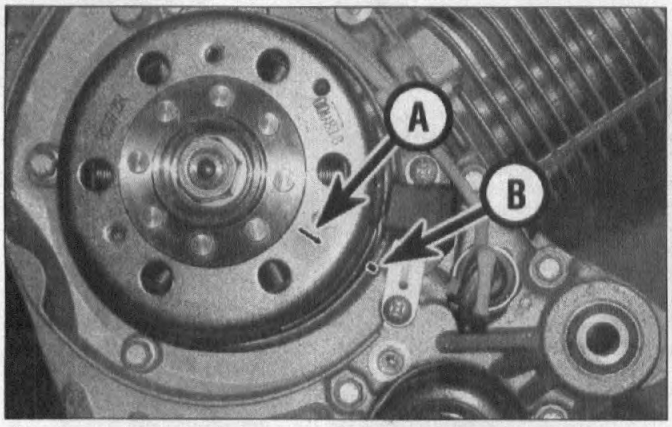
8.8 Remove the cap bolt and spring



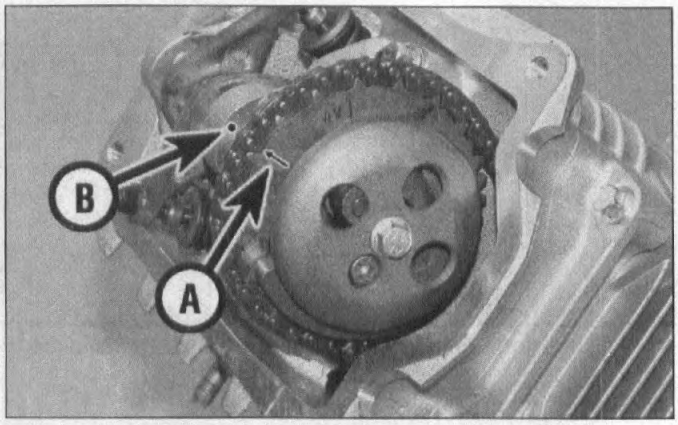
8.9 Remove the cam chain tensioner



8.12 Check the operation of the ratchet and plunger



9.3a Align rotor timing mark (A) with index mark (B)



9.3b Align 2V timing mark (A) with index mark (B)

tighten the bolt to the specified torque **(see illustration 8.8)**.

18 Check that the cam chain is tensioned as it passes over the camshaft sprocket. If it is slack, the tensioner plunger did not release when the cap bolt was tightened. Remove the tensioner and check the operation of the plunger again.

19 Install the cooling fan (see Section 17) and the valve cover (see Section 7). Install the remaining components in the reverse order of removal.

9 Cam chain, blades and sprockets – removal, inspection and installation

Note 1: *This procedure can be carried out with the engine in the frame although access to the top of the engine is extremely restricted. If the engine has been removed, ignore the steps which do not apply.*

Note 2: *The engine used to illustrate this Section was fitted with an automatic decompressor mechanism. This feature was discontinued during the production run of the LEADER engine. For details of the LEADER engine without this feature refer to Chapter 2F, Section 9).*

Removal

1 Remove the valve cover (see Section 7).

2 If the cam chain and crankshaft sprocket are to be removed, remove the oil pump driven sprocket, drive chain and drive sprocket (see Section 20).

3 Remove the cooling fan (see Section 17). Turn the engine in a clockwise direction using the alternator rotor nut, until the timing mark on the rotor aligns with the index mark on the crankcase, and the timing mark (2V) on the camshaft sprocket aligns with the index mark on the camshaft holder **(see illustrations)**. At this point the engine is at TDC (top dead centre) on the compression stroke (both valves closed).

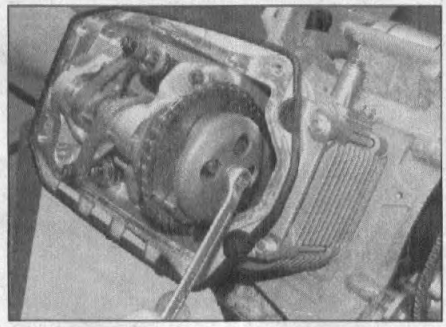
4 Undo the camshaft sprocket centre bolt and lift off the decompressor mechanism cover **(see illustrations)**. Hold the alternator to prevent the sprocket from turning.

5 Undo the decompressor mechanism bolt, then hold the bob weight return spring and withdraw the bolt and static weight **(see illustrations)**.

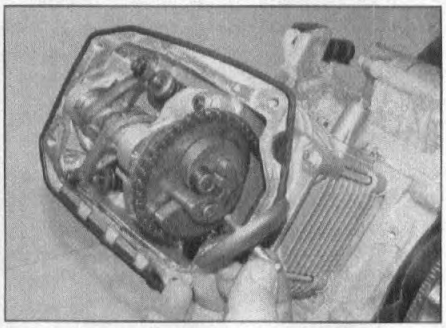
6 Lift off the bob weight – note the nylon bush on the back of the weight and how it locates in the slot in the cam chain sprocket **(see illustration)**. Remove the bush for safekeeping.

7 Remove the cam chain tensioner (see Section 8).

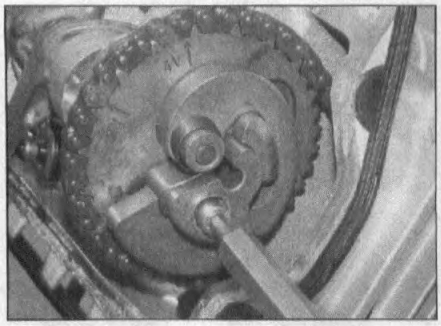
8 Lift the sprocket and its backing plate off



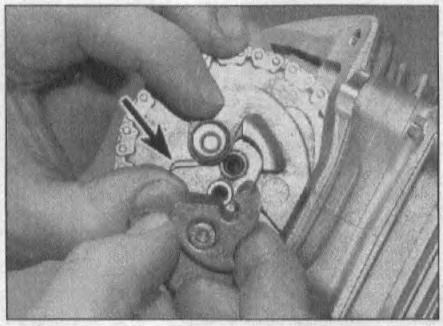
9.4a Undo the centre bolt . . .



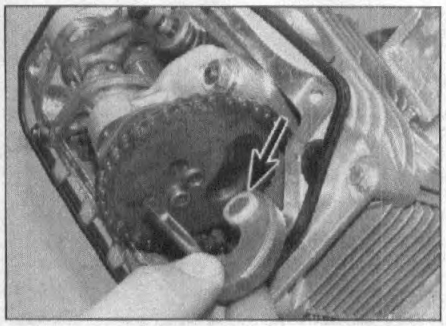
9.4b . . . and remove the decompressor mechanism cover



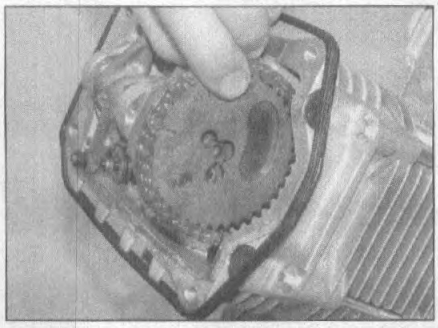
9.5a Undo the decompressor mechanism bolt . . .



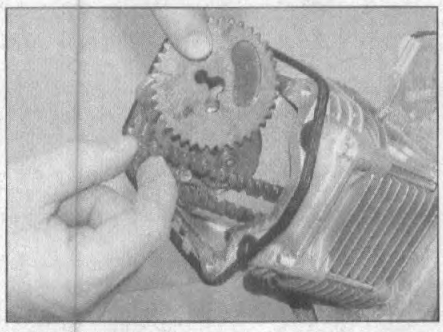
9.5b . . . and remove the static weight. Note the return spring (arrowed)



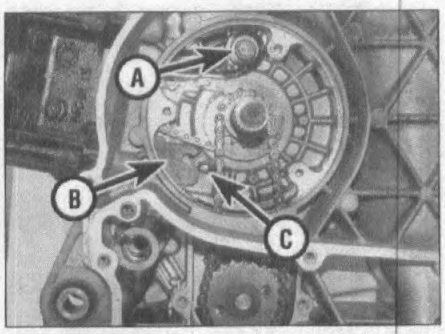
9.6 Remove the bob weight. Note the position of the bush (arrowed)



9.8a Lift off the sprocket and backing plate . . .



9.8b . . . and disengage it from the chain



9.10 Cam chain tensioner blade is secured by bolt (A). Lower blade (B) locates on peg (C)

the end of the camshaft, then disengage it from the camchain **(see illustrations)**.

9 If required, secure the chain with a cable tie to prevent it falling into the engine. If the chain is to be removed, mark it with paint so that if it is re-used it can be fitted the same way round. Remove the thrustwasher from the end of the crankshaft, then lower the chain down its tunnel and slip it off the sprocket on the crankshaft **(see illustrations 9.6a and 9.6b in Chapter 2D)**. Draw the sprocket off the crankshaft, noting how it locates on the pin on the shaft **(see illustration 9.6c in Chapter 2D)**.

10 If required, remove the bolt securing the cam chain tensioner blade to the crankcase and withdraw the blade, noting which way round it fits, and the spacer. The lower cam chain blade locates in a groove in the front edge of the cam chain tunnel in the cylinder. To remove the blade, first remove the cylinder head (see Section 11), then lift out the blade, noting how the lower end locates on the peg in the crankcase **(see illustration)**.

Inspection

11 Check the sprockets for wear and damaged teeth, renewing them if necessary. If the sprocket teeth are worn, the chain will also be worn and should be renewed.

12 Check the chain tensioner blade and guide blade for wear or damage and renew them if necessary. Damaged or severely worn blades are an indication of a worn or improperly tensioned chain. Check the operation of the cam chain tensioner (see Section 8).

13 Inspect the components of the decompressor mechanism. Check the nylon bush for wear and flat spots and renew it if necessary. Temporarily assemble the mechanism on the camshaft (see below) and check its operation – check the spring tension and ensure the bob weight does not bind on the cover.

Installation

14 If removed, install the lower cam chain blade (see Step 10). If removed, install the tensioner blade and spacer, then tighten the retaining bolt to the torque setting specified at the beginning of the Chapter. Ensure both blades are fitted the correct way round.

15 Install the sprocket on the crankshaft, aligning the notch in the sprocket with the pin on the shaft. Lower the cam chain down through the tunnel and fit it onto the sprocket. If the chain is being re-used, ensure it is fitted the right way round (see Step 9).

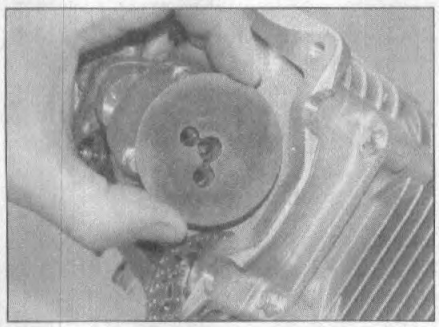
16 Check that the timing mark on the alternator rotor still aligns with the index mark on the crankcase and that the engine is at TDC on the compression stroke (see Step 3). Install the camshaft sprocket backing plate on the end of the camshaft **(see illustration)**. Slip the camshaft sprocket into the top of the chain, then take up the slack in the lower run of the chain and fit the sprocket onto the camshaft, aligning the timing mark on the sprocket with the index mark on the camshaft holder **(see illustration)**. **Note:** *To prevent the backing plate falling off the end of the camshaft while the sprocket is being installed, pass the blade of a small screwdriver through the centre of the sprocket, the backing plate and the camshaft.*

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

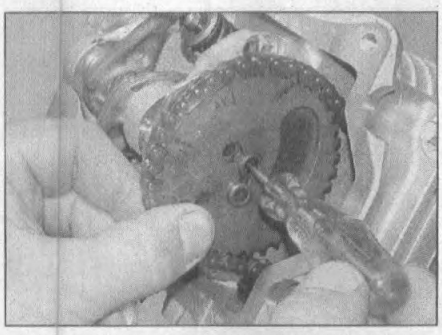
17 Apply some grease to the nylon bush and fit it onto the back of the cam timing bob weight, then install the bob weight – ensure the bush locates in the slot in the cam chain sprocket **(see illustration)**.

18 Lift the bob weight return spring and install the static weight, ensuring that the spring is located over the top of the static weight **(see illustration 9.5b)**. Tighten the decompressor mechanism bolt finger tight. Check the operation of the decompressor mechanism – the bob weight should move freely on its spindle and return to the rest position under the tension of the spring.

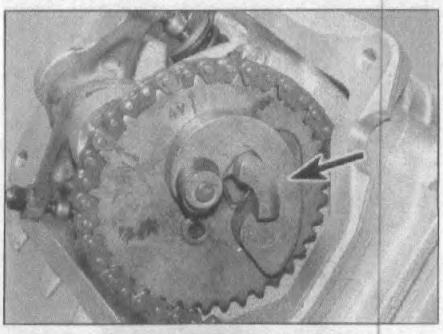
19 Install the decompressor mechanism cover, aligning the small hole in the cover with the head of the decompressor mechanism



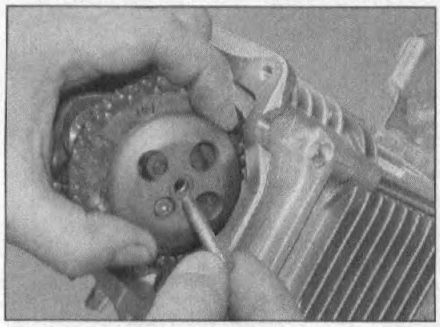
9.16a Install the backing plate . . .



9.16b . . . and the camshaft sprocket



9.17 Install the bob weight (arrowed)



9.19 Install the cover and centre bolt

bolt. Fit the camshaft sprocket centre bolt and tighten it finger tight **(see illustration)**.

20 Install the cam chain tensioner (see Section 8).

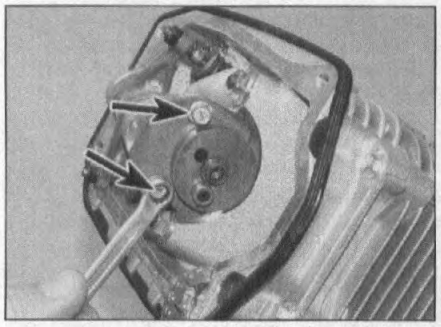
21 Tighten the camshaft sprocket bolt and the decompressor mechanism bolt. Hold the alternator to prevent the sprocket from turning.

22 Fit the thrustwasher onto the end of the crankshaft, then install the oil pump drive sprocket, chain and driven sprocket (see Section 20).

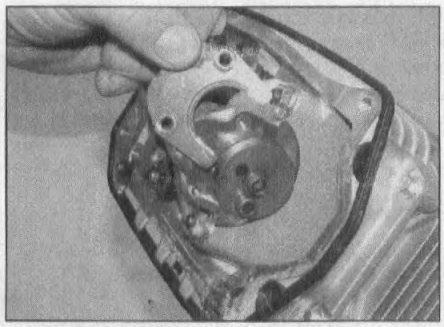
23 Install the remaining components in the reverse order of removal.

10 Camshaft and rockers – removal, inspection and installation

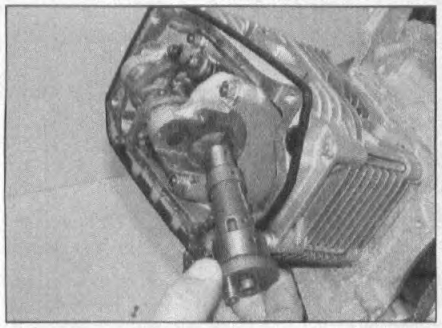
Note: *This procedure can be carried out with the engine in the frame although access to the top of the engine is extremely restricted. If the engine has been removed, ignore the steps which do not apply.*



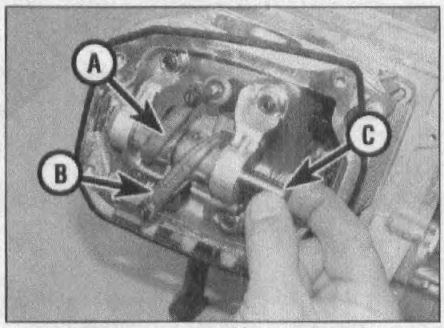
10.5a Undo the bolts (arrowed) . . .



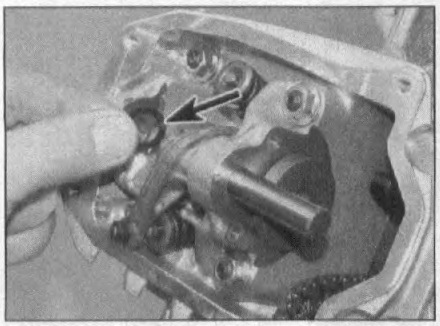
10.5b . . . and lift out the plate



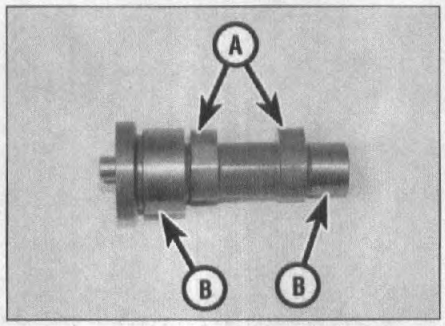
10.5c Withdraw the camshaft



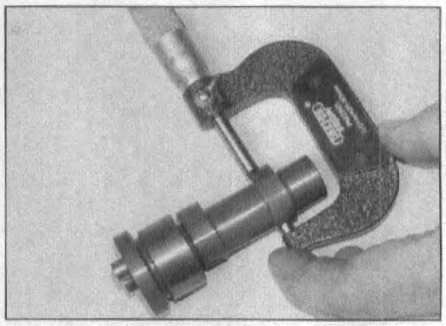
10.6a Intake rocker arm (A), exhaust rocker arm (B) and shaft (C)



10.6b Thrustwasher (arrowed) is fitted between the rocker arms



10.7a Inspect the camshaft lobes (A) and bearing journals (B)



10.7b Measuring the camshaft lobe height

Removal

1 Remove the valve cover (see Section 7).

2 Remove the cooling fan (see Section 17). Turn the engine in a clockwise direction using the alternator rotor nut, until the timing mark on the rotor aligns with the index mark on the crankcase, and the timing mark (2V) on the camshaft sprocket aligns with the index mark on the camshaft holder **(see illustration 9.3a and 9.3b)**. At this point the engine is at TDC (top dead centre) on the compression stroke (both valves closed).

3 If applicable, remove the decompressor mechanism (see Section 9).

4 Remove the camshaft sprocket (see Section 9), then secure the cam chain with a cable tie or length of wire to prevent it dropping into the engine. Stuff a clean rag into the cam chain tunnel to prevent anything falling into the engine.

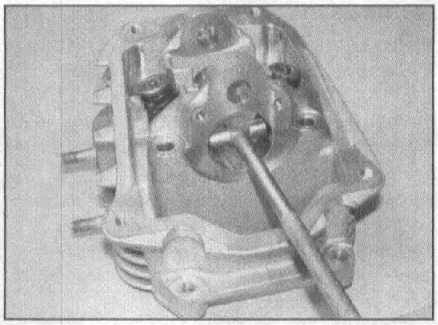
5 Undo the two bolts securing the camshaft retaining plate and lift out the plate **(see illustrations)**. Mark the end of the camshaft so that it can be refitted in the same position (TDC, both valves closed), then withdraw the camshaft from its housing **(see illustration)**.

6 Mark the rocker arms so they can be installed in their original positions. Support the intake valve (right-hand) rocker arm and slowly withdraw the rocker shaft until the arm is free and can be removed **(see illustration)**. Remove the thrustwasher located on the shaft between the rocker arms, then withdraw the shaft completely and remove the exhaust valve rocker arm **(see illustration)**.

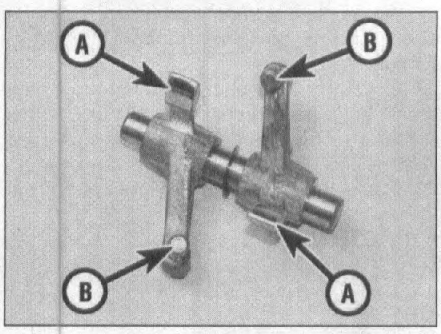
Inspection

7 Clean all the components with a suitable solvent and dry them. Inspect the camshaft lobes for heat discoloration (blue appearance), score marks, chipped areas, flat spots and spalling **(see illustration)**. Measure the height of both lobes with a micrometer and compare the results to the Specifications at the beginning of the Chapter **(see illustration)**. If damage is noted or wear is excessive, the camshaft must be renewed.

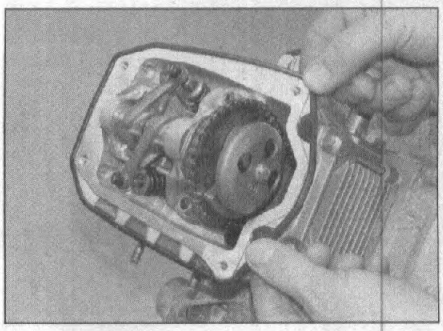
8 Check the condition of the camshaft bearing journals and the housing journals in the cylinder head **(see illustration 10.7a)**. Measure the camshaft journals with a



10.8 Measuring the internal diameter of the camshaft housing journals



10.10 Inspect the rocker arm faces (A) and adjuster screw tips (B)



11.3 Remove the engine cowling seal

micrometer and, if available, measure the internal diameter of the housing journals with a telescoping gauge and micrometer **(see illustration)**. Compare the results to the Specifications at the beginning of the Chapter and, if damage is noted or wear is excessive, renew the faulty component.

9 Lubricate the camshaft journals with clean engine oil, install the camshaft in the cylinder head and secure it with the retaining plate. The camshaft should rotate freely with no discernible up-and-down movement. If available, measure the camshaft endfloat with a dial gauge and compare the result to the Specifications at the beginning of the Chapter. If the endfloat is excessive, inspect the retaining plate and the slot in the camshaft for wear and renew the worn component.

10 Blow through the oil passages in the rocker arms with compressed air, if available. Inspect the rocker arm faces for pits and spalling **(see illustration)**. Check the articulated tip of the adjusting screw for wear. The tip should move freely but not be loose. Measure the internal diameter of each rocker arm, the internal diameters of the rocker shaft housings and the diameter of the rocker shaft and compare the results to the Specifications at the beginning of the Chapter. If damage is noted or wear is excessive, renew the faulty component.

Installation

11 Lubricate the camshaft journals with clean engine oil, then install the camshaft in the cylinder head. Ensure the cam lobes are facing the same way as on disassembly (see Step 5).

12 Lubricate the rocker shaft with engine oil. Slide the shaft through the left-hand housing and fit the exhaust valve rocker arm, the thrustwasher and the intake valve rocker arm onto the shaft in that order. Press the shaft fully into place. With the camshaft in the correct position there should be no pressure on the rocker arms. Align the camshaft retaining plate with the slot in the camshaft, slide the plate into position and secure it with the bolts. Tighten the bolts to the specified torque setting.

13 Follow the procedure in Section 9 to install the camshaft sprocket, decompressor mechanism and cam chain tensioner as applicable, then check the valve timing.

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

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

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

11 Cylinder head – removal and installation

Note: *This procedure can be carried out with the engine in the frame although access to the top of the engine is extremely restricted. If the engine has been removed, ignore the steps which do not apply.*

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

Removal

1 Remove the exhaust system (see Chapter 4) and the cooling fan (see Section 17). Pull the spark plug cap off the plug.

2 Follow the procedure in Section 8 to remove the engine cowling.

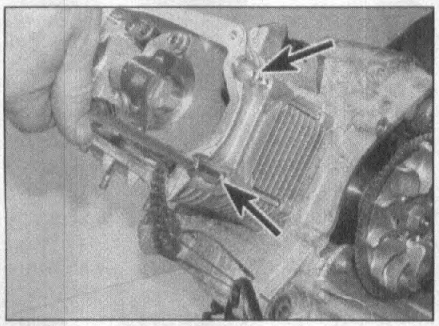
3 Remove the valve cover (see Section 7). Lift off the engine cowling seal **(see illustration)**.

4 If applicable, remove the decompressor mechanism (see Section 9).

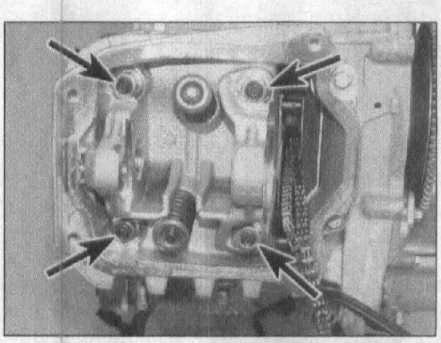
5 Remove the camshaft sprocket, then secure the cam chain with a cable tie or length of wire to prevent it dropping into the engine (see Section 9).

6 Undo the two cylinder head bolts on the left-hand side of the engine **(see illustration)**. Undo the four cylinder head nuts evenly, a little at a time, in a criss-cross pattern and remove them **(see illustration)**.

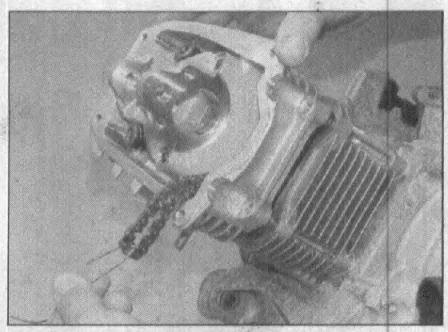
7 Lift the cylinder head off carefully, feeding the cam chain down through the tunnel in the head **(see illustration)**. If the head is stuck, tap around the joint face with a soft-faced mallet to free it. Do not attempt to free the head by inserting a screwdriver between the head and cylinder – you'll damage the sealing surfaces. **Note:** *Avoid lifting the cylinder off the crankcase when the head is removed, otherwise a new cylinder base gasket will have to be fitted (see Section 14).*



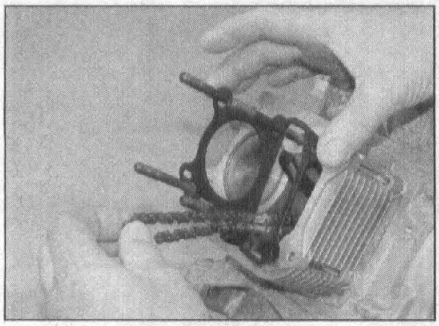
11.6a Undo the external cylinder head bolts (arrowed) . . .



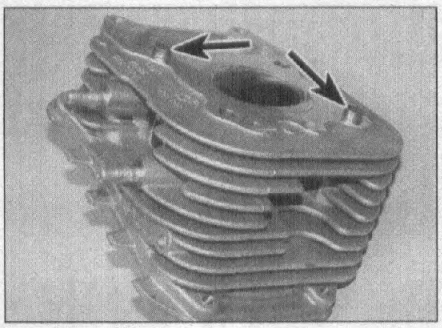
11.6b . . . then the internal cylinder head nuts (arrowed)



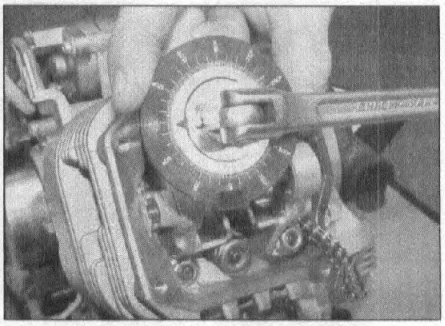
11.7 Secure the cam chain and lift off the cylinder head



11.8a Remove the head gasket



11.8b Note the dowels (arrowed) in the underside of the cylinder head



11.13 Using a torque angle gauge to tighten the cylinder head nuts

8 Remove the old cylinder head gasket and discard it, as a new one must be fitted on reassembly **(see illustration)**. Note the two dowels in the cylinder head and remove them for safekeeping if they are loose **(see illustration)**.

9 Inspect the cylinder head gasket and the mating surfaces on the head and cylinder for signs of leakage, which could indicate that the head is warped. Refer to Section 13 and check the head gasket mating surface for warpage.

10 Clean all traces of old gasket material from the cylinder head and cylinder with a suitable solvent. Take care not to scratch or gouge the soft aluminium. Be careful not to let any dirt fall into the crankcase, the cylinder bore or the oil passage.

Installation

11 Ensure both cylinder head and cylinder mating surfaces are clean, then lay the new gasket in place on the cylinder, making sure the oil passage holes are correctly aligned. Never re-use the old gasket.

12 Ensure both the dowels are in place in the head, then carefully lower the head onto the cylinder, feeding the cam chain up through the tunnel **(see illustration 11.8b)**. Make sure the dowels are correctly aligned with the gasket and the cylinder.

13 Lubricate the seating surfaces of the cylinder head nuts with clean engine oil, then install the nuts finger tight. Tighten the nuts evenly, in a criss-cross pattern, to the initial torque setting specified at the beginning of the Chapter. Now tighten them one at a time and in the same sequence, through 90° in one continuous movement, using a torque angle gauge **(see illustration)**. Now tighten them through a further 90°. **Note:** *If a torque angle gauge is not available see* ***Haynes Hint.***

> **HAYNES HINT** ***If a degree disc is not available, the angle for the torque setting can be determined by using the points on the cylinder head nut. Select one point on the nut as a reference and mark it with paint or a marker. Now select the second point clockwise 90° from it and mark its position on the head. Tighten the nut – when the mark on the first point aligns with the mark made on the head, it will have turned through the requisite number of degrees. Repeat the procedure to achieve the final torque setting.***

14 Install the two cylinder head bolts on the left-hand side of the engine and tighten them to the specified torque setting **(see illustration 11.6a)**.

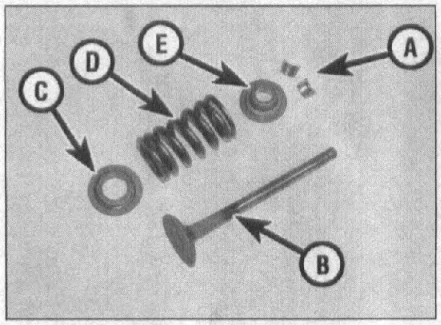
15 Install the camshaft sprocket and the remaining components in the reverse order of removal, referring to the relevant Sections or Chapters.

12 Valves/valve seats/valve guides – overhaul

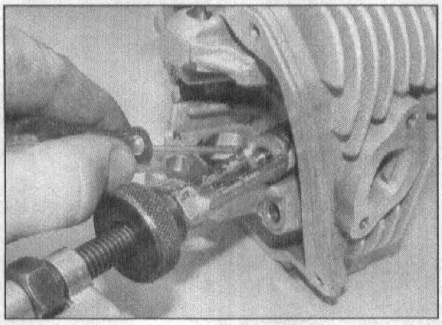
1 If a valve spring compressor is available, the home mechanic can remove the valves from the cylinder head, grind in the valves and renew the valve stem seal. If the necessary measuring tools are available, you can assess the amount of wear on the valves and guides and measure the valve-to-seat contact areas.

2 If the valve guides or the valve seats in the cylinder head are worn beyond their service limits a new head will have to be fitted.

3 After any servicing or repair work, be sure to clean the head thoroughly to remove any metal particles or abrasive grit that may still be present. Use compressed air, if available, to blow out all the holes and passages.



13.3 Valve components – collets (A), valve (B), spring seat (C), spring (D) and spring retainer (E)



13.5a Compress the valve spring and remove the collets

13 Cylinder head and valves – disassembly, inspection and reassembly

1 Disassembly, cleaning and inspection of the valves and related components can be done by the home mechanic if the necessary special tools are available. If there is any doubt about the condition of any components, have them checked by a Piaggio dealer.

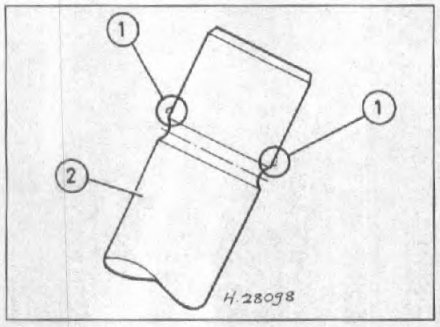
2 To disassemble the valve components without the risk of damaging them, a valve spring compressor suitable for motorcycle engines is absolutely necessary.

Disassembly

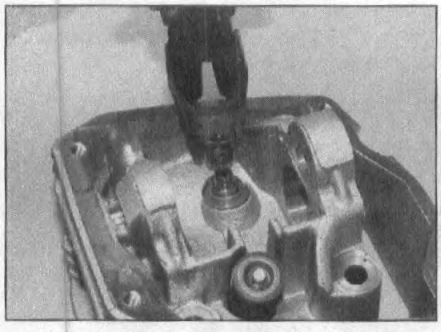
3 Before proceeding, arrange to label and store the valves and their related components so that they can be returned to their original location without getting mixed up **(see illustration)**.

4 If not already done, remove the camshaft and rockers (see Section 10), then clean all traces of old gasket material from the cylinder head with a suitable solvent. Take care not to scratch or gouge the soft aluminium.

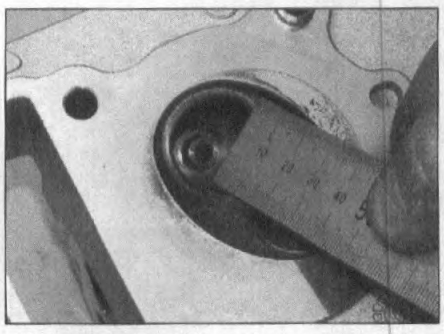
5 Compress the valve spring on the intake valve with a spring compressor, making sure it is correctly located onto each end of the valve assembly. Do not compress the spring any more than is absolutely necessary to release the collets. Remove the collets, using either needle-nose pliers, tweezers, a magnet or a screwdriver with a dab of grease on it **(see illustration)**. Carefully release the valve spring compressor and remove the spring retainer,



13.5b If the valve stem (2) won't pull through the guide, deburr the area (1) above the collet groove



13.5c Pull the stem seal off with pliers



13.12 Measuring the valve seat width (for greater precision use a vernier caliper)

noting which way up it fits, the spring, and the valve from the head. 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 **(see illustration)**. Once the valve has been removed, pull the valve stem oil seal off the top of the valve guide with pliers and discard it (the old seal should never be re-used) and remove the spring seat **(see illustration)**.

6 Repeat the procedure for the exhaust valve. Remember to keep the parts for each valve together and labelled so they can be reinstalled in the correct location.

7 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.

8 Clean the valve springs, collets, retainers, and spring seats with solvent and dry them thoroughly. Work on the parts from one valve at a time so as not to mix them up.

9 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

10 Inspect the head very carefully for cracks and other damage. If cracks are found, a new head will be required.

11 Using a precision straight-edge and a feeler gauge, check the head gasket mating surface for warpage. Lay the straight-edge across the head lengthways and diagonally, intersecting the stud holes, and try to slip the feeler gauge under it on either side of the combustion chamber. If the feeler gauge can be inserted between the straight-edge and the cylinder head, the head is warped and should be machined. Consult a Piaggio dealer or specialist engineer. If warpage has reached the limit listed in the Specifications at the beginning of the Chapter, a new head will have to be fitted.

12 Examine the valve seats in the combustion chamber. If they are deeply pitted, cracked or burned, it may be possible to have them repaired by a specialist engineer, otherwise a new head will be required. Measure the valve seat width and compare it to this Chapter's Specifications **(see illustration)**.

13 Measure the valve stem diameter **(see illustration)**. If the stem is worn beyond its service limit a new valve must be fitted. 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.The guides are measured at the ends and at the centre to determine if they are worn unevenly. Piaggio do not list new valve guides, so if any guide is worn unevenly, or if the valve stem/guide clearance is more than the service limit, have the head checked by a specialist engineer. It may be possible to bore out the guide and fit a sleeve in it, otherwise a new cylinder head will have to be fitted.

14 Inspect each valve face for cracks, pits and burned spots; measure the valve face and compare the result with the Specifications. Check the valve stem and the collet groove area for cracks **(see illustration)**. Rotate the valve and check for any obvious indication that it is bent. Check the end of the stem for pitting and excessive wear. Worn valve faces, or the presence of any of the above conditions indicates the need for new valves. If the stem end is pitted or worn, also check the contact area of the valve clearance adjuster in the rocker arm

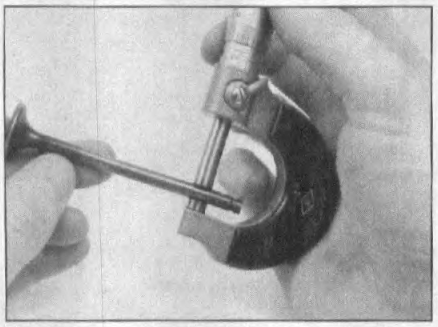
15 Inspect the end of each valve spring for wear and pitting. Stand the spring upright on a flat surface and check it for bend by placing a square against it **(see illustration)**. If the bend in a spring is excessive, it must be renewed. Piaggio do not specify a service limit for the valve springs, but it is good practice to fit new springs when the head has been disassembled for valve servicing.

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

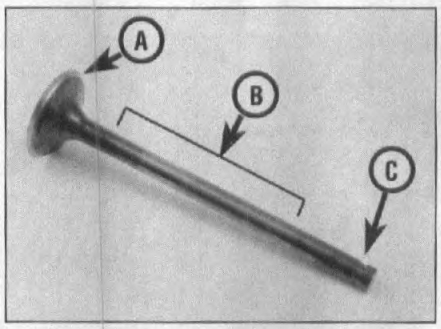
17 If the inspection indicates that no overhaul work is required, the valve components can be reinstalled in the head.

Reassembly

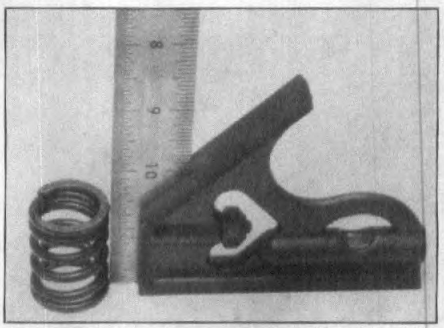
18 Unless a valve overhaul has been performed, before installing the valves in the head they should be ground in (lapped) to



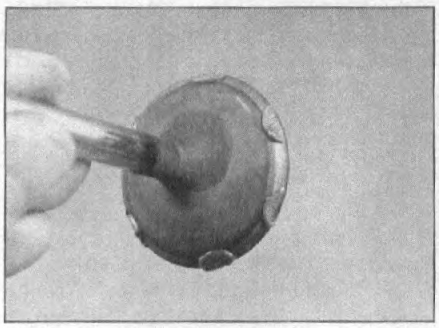
13.13 Measuring the valve stem diameter with a micrometer



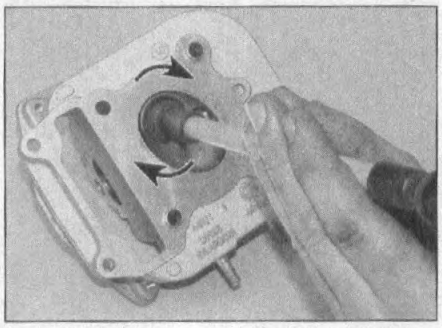
13.14 Check the valve face (A), stem (B) and collet groove (C) for signs of wear and damage



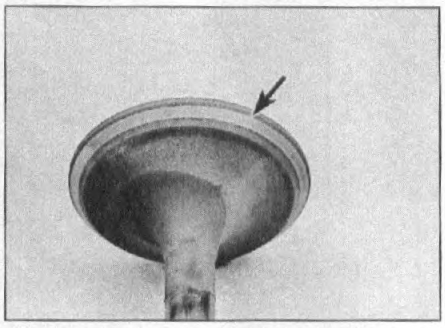
13.15 Check the valve springs for squareness



13.19 Apply the grinding compound very sparingly, in small dabs, to the valve face only



13.20a Rotate the tool back-and-forth between the palms of your hands



13.20b Valve contact area should show a uniform unbroken ring

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

19 Apply a small amount of coarse grinding compound to the valve face, 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.*

20 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 (ie, 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 areas are of uniform width and unbroken around the circumference **(see illustration)**.

21 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.

22 Repeat the procedure with fine valve grinding compound, then repeat the entire procedure for the other valve.

HAYNES HINT

Check for proper sealing of each valve by pouring a small amount of solvent into the valve port while holding the valve shut. If the solvent leaks past the valve into the combustion chamber the valve grinding operation should be repeated.

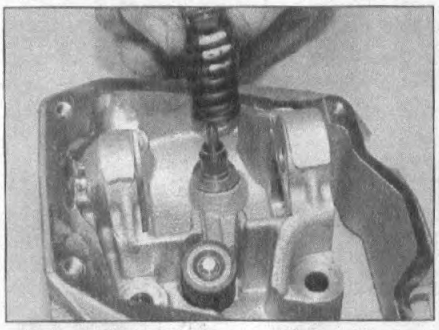
23 Lay the spring seat for the intake valve in place in the cylinder head, then install a new valve stem seal onto the guide. Use an appropriate size deep socket to push the seal over the end of the valve guide until it is felt to clip into place. Don't twist or cock it, or it will not seal properly against the valve stem. Also, don't remove it again or it will be damaged.

24 Lubricate the intake valve stem with molybdenum disulphide grease, then install it into its guide, rotating it slowly to avoid damaging the seal. 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 illustration)**.

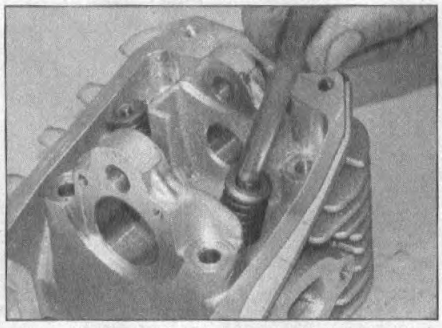
25 Apply a small amount of grease to the collets to help hold them in place as the pressure is released from the spring. Compress the spring with the valve spring compressor and install the collets **(see illustration 13.5a)**. When compressing the spring, depress it only as far as is necessary to slip the collets into place. Make certain that the collets are securely locked in their retaining grooves.

26 Repeat the procedure for the exhaust valve.

27 Support the cylinder head on blocks so the valves can't contact the workbench top, then very gently tap each of the valve stems with a soft-faced hammer **(see illustration)**. This will help seat the collets in their grooves.



13.24 Install the spring with the closer wound coils facing the head



13.27 Tap the valve stems to seat the collets

14 Cylinder – removal, inspection and installation

Note: *This procedure can be carried out with the engine in the frame although access to the top of the engine is extremely restricted. If the engine has been removed, ignore the steps which do not apply.*

Removal

1 Remove the cylinder head (see Section 11).

2 Note how the lower cam chain blade locates in a groove in the front edge of the cam chain tunnel in the cylinder, then lift out the blade, noting which way round it fits.

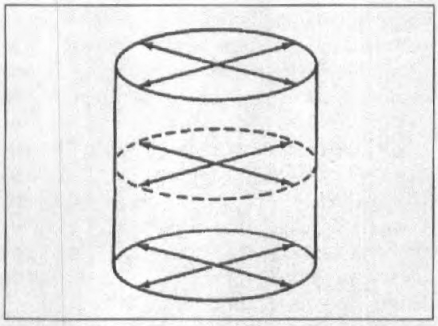
3 Lift the cylinder up off the studs, carefully feeding the cam chain down through the tunnel. Support the piston as it becomes accessible to prevent it hitting the crankcase. If the cylinder is stuck, tap around its joint face with a soft-faced mallet to free it from the crankcase. Don't attempt to free the cylinder by inserting a screwdriver between it and the crankcase – you'll damage the sealing surfaces. When the cylinder is removed, stuff a clean rag around the piston to prevent anything falling into the crankcase.

4 Note the two dowels in the cylinder and remove them for safekeeping if they are loose.

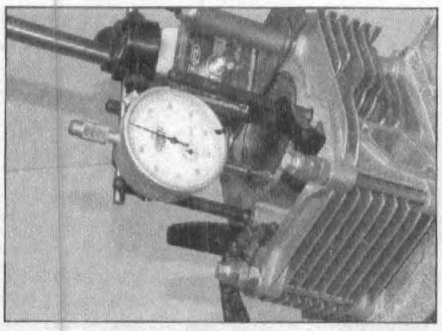
5 Remove the gasket carefully and make a note of the thickness (0.4, 0.6 or 0.8) stamped into the material. If the original cylinder and piston are used on reassembly, a new gasket of the same thickness should be used. Discard the old gasket.

Inspection

6 Inspect the cylinder bore carefully for



14.7 Measure the cylinder bore in the directions shown



14.13 Zero the dial gauge on the cylinder top gasket face

scratches and score marks. A rebore will be necessary to remove any deep scores (see Step 7).

7 Using telescoping gauges and a micrometer, check the dimensions of the cylinder to assess the amount of wear, taper and ovality. Piaggio recommend the bore is measured at 10 mm, 38.5 mm and 75 mm down from the top edge, both parallel to and across the crankshaft axis **(see illustration)**. Compare the results to the cylinder bore Specifications at the beginning of this Chapter.

Note: *Cylinders and pistons are size-coded during manufacture and it is important that they are of the same size-code. Piaggio list four size-codes (A to D) for this engine, in standard size and first, second and third oversizes (rebored cylinders). The size-code is stamped in the gasket surface at the top or base of the cylinder, and in the piston crown. When purchasing a new cylinder or piston, always supply the size-code letter.*

8 Calculate any differences between the measurements to determine any taper or ovality in the bore. Piaggio specify a wear limit of 0.05 mm between any of the measurements. If the cylinder is worn beyond this service limit, badly scratched, scuffed or scored, have it rebored by a Piaggio dealer or motorcycle engineer. If the cylinder is rebored, it will require an oversize piston and rings. If the cylinder has already been rebored to the maximum oversize and is worn or damaged, the cylinder must be renewed.

9 Measure the cylinder bore diameter 38.5 mm down from the top edge, then calculate the piston-to-bore clearance by subtracting the piston diameter (see Section 15) from the bore diameter. If the cylinder is in good condition and the piston-to-bore clearance is within specifications, the cylinder can be re-used.

10 Check that all the cylinder head studs are tight in the crankcase halves. If any are loose, remove them and clean their threads. Apply a suitable permanent thread locking compound and tighten them securely.

Installation

11 Check that the mating surfaces of the cylinder and crankcase are clean.

12 Three different thicknesses of cylinder base gasket are available from Piaggio. If the original cylinder and piston are being re-used, fit a gasket the same thickness as the original (see Step 5). If new components are being used, the cylinder must be assembled on the crankcase and piston (see Steps 17 to 19) without a base gasket, and a dial gauge mounted against the crown of the piston to establish which thickness is required.

13 Set the dial gauge in the mounting plate, and with the gauge tip resting against the cylinder top gasket face, zero the gauge dial **(see illustration)**. Rotate the crankshaft so that the piston is part way down the bore.

14 Clamp the mounting plate diagonally across two of the cylinder studs, and secure it by tightening the stud nuts to 28 to 30 Nm.

15 Rotate the crankshaft via the alternator rotor nut so the piston rises to the top of its stroke (TDC) and the gauge tip rests on the centre of the piston crown. At this point read off the dial gauge **(see illustration)**. The further the piston crown is below the top of the cylinder bore, the thinner the base gasket should be. If the reading is between 0 and 0.1 mm a 0.8 mm gasket is required, between 0.1 and 0.3 mm a 0.6 mm gasket is required, and between 0.3 and 0.4 mm a 0.4 mm gasket is required – refer to your Piaggio dealer for details.

16 Having established the correct gasket thickness, fit it to the crankcase **(see illustration)**. Never re-use the old gasket.

17 If required, install a piston ring clamp onto the piston to ease its entry into the bore as the cylinder is lowered. This is not essential as the 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 cylinder while this is done. Check that the piston ring end gaps are positioned as described in Section 16.

18 Lubricate the cylinder bore, piston and piston rings, and the connecting rod big- and small-ends, with the clean engine oil, then fit the cylinder down over the studs until the piston crown fits into the bore.

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

20 When the piston is correctly installed in the cylinder, press the cylinder down onto the base gasket.

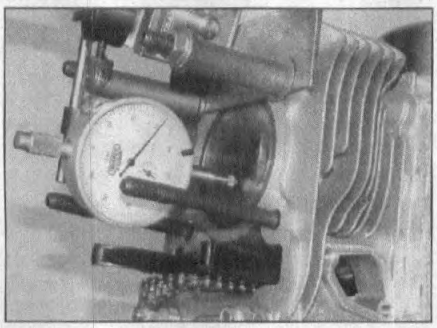
21 Fit the lower cam chain guide into the cam chain tunnel (see Step 2), then install the cylinder head (see Section 11).

15 Piston – removal, inspection and installation

Note: *This procedure can be carried out with the engine in the frame although access to the top of the engine is extremely restricted. If the engine has been removed, ignore the steps which do not apply.*

Removal

1 Remove the cylinder (see Section 14). Before removing the piston from the connecting rod, stuff a clean rag into the hole around the rod to prevent the circlips or anything else from falling into the crankcase. The piston should have an arrow marked on its crown which should face towards the exhaust valve. If this is not visible, mark the piston accordingly so that it can be installed the correct way round **(see illustration 16.1 in Chapter 2C)**. Note that the arrow may not be visible until the carbon deposits have been scraped off and the piston cleaned. There



14.15 Take the reading off the piston crown at TDC

14.16 Fit a new cylinder base gasket onto the crankcase

should also be a valve head recess on the intake valve side of the piston crown.

2 Carefully prise out the circlip on one side of the piston using a pointed instrument or a small flat-bladed screwdriver inserted into the notch **(see illustration 16.2 in Chapter 2C)**. Push the piston pin out from the other side to free the piston from the connecting rod. Remove the other circlip and discard them both, as new ones must be used. Use a socket extension to push the piston pin out if required.

> HAYNES HINT
> ***To prevent the circlip from flying away or from dropping into the crankcase, pass a rod or screwdriver with a greater diameter than the gap between the circlip ends, through the piston pin. This will trap the circlip if it springs out.***

> HAYNES HINT
> ***If a piston pin is a tight fit in the piston bosses, heat the piston gently with a hot air gun – this will expand the alloy piston sufficiently to release its grip on the pin.***

Inspection

3 Before the inspection process can be carried out, the piston rings must be removed and the piston must be cleaned. Note that if the cylinder is being rebored, piston inspection can be overlooked, as a new one will be fitted. All three piston rings can be removed by hand; a ring removal and installation tool can be used on the two compression rings, but do not use it on the oil control ring **(see illustration 16.3 in Chapter 2C)**. 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 should be marked at one end. Do not nick or gouge the piston in the process.

4 Scrape all traces of carbon from the top of the piston. 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 piston; the piston material is soft and will be eroded away by the wire brush.

5 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. Once the deposits have been removed, clean the piston with solvent and dry it thoroughly.

6 Inspect the 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. Also check that the circlip grooves are not damaged.

7 A hole in the piston crown is an extreme example 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.

8 Check the piston-to-bore clearance by measuring the bore (see Section 14) and the piston diameter. Measure the piston 36.5 mm down from the top edge of the piston and at 90° to the piston pin axis **(see illustration 16.8 in Chapter 2C)**. Subtract the piston diameter from the bore diameter to obtain the clearance. If it is greater than the specified figure, the piston must be renewed (assuming the bore itself is within limits, otherwise a rebore is necessary). Remember that the pistons and cylinders are size-coded – make sure you have matched components.

9 Use a micrometer and a telescoping gauge to determine whether there is wear between the piston pin and piston. Measure the piston pin diameter at both ends and the internal diameter of each pin boss in the piston and compare the results with the Specifications **(see illustrations 16.9a and 16.9b in Chapter 2C)**.

10 To check for wear between the piston pin and connecting rod small-end, measure the piston pin diameter at its centre and the internal diameter of the rod small-end **(see illustrations 16.10a and 16.10b in Chapter 2C)**. The piston pin should not be worn below its specified diameter and the small-end measurement should not be greater then the specified service limit. Renew any worn components; if the small-end is worn, a new connecting rod and crankshaft assembly will have to be fitted (see Section 21).

11 Piston ring-to-groove clearance can be measured to determine whether the ring grooves in the piston are worn. Install the rings on the piston (see Section 16), then use a feeler gauge to measure the clearance between the ring and groove and compare the result with the Specifications **(see illustration 16.11 in Chapter 2C)**. If the clearance is greater than the service limit, repeat the check using new rings, if the clearance is still too great, the piston should be renewed.

Installation

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

13 Lubricate the piston pin, the piston pin bore and the connecting rod small-end bore with clean engine oil. Install a new circlip in one side of the piston (do not re-use old circlips). Line up the piston on the connecting rod, making sure the arrow on the piston crown faces down towards the exhaust, and insert the piston pin **(see illustration 16.13a in Chapter 2C)**. Secure the pin with the other new circlip **(see illustration 16.13b in Chapter 2C)**. When installing 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 **(see illustration 16.13c in Chapter 2C)**.

14 Install the cylinder (see Section 14).

16 Piston rings – inspection and installation

1 New piston rings should be fitted whenever an engine is being overhauled. Before fitting the new rings, the end gaps must be checked with the rings installed in an unworn part of the bore.

2 To measure the installed ring end gap, insert the top ring into the bottom of the bore and square it up with the bore walls by pushing it in with the top of the piston. The ring should be about 15 mm from the bottom of the bore. 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 17.2 in Chapter 2C)**.

3 If the gap is larger or smaller than specified, double-check to make sure that you have the correct rings before proceeding. If the gap is too small the ends may come in contact with each other during engine operation, which can cause serious damage. Check the piston and bore diameters with the Specifications to confirm whether they are standard or oversize.

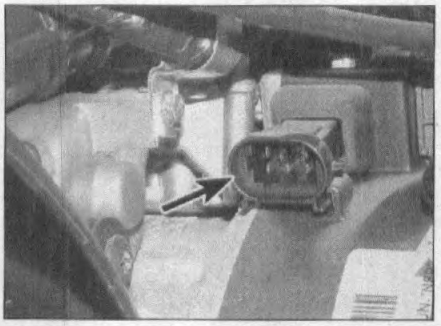
4 Excess end gap is not critical unless it exceeds the service limit. Again, double-check to make sure you have the correct rings for your engine and check that the bore is not worn.

5 Repeat the procedure for the other two rings.

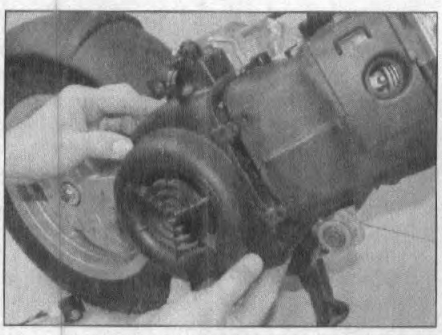
6 Once the ring end gaps have been checked, the rings can be installed on the piston.

7 The oil control ring (lowest on the piston) is installed first. Always install this ring by hand and do not expand the ring any more than is necessary to slide it into place. Next install the 2nd compression ring, noting that there is usually a marking or letter near one end to denote the upper surface of the ring. Finally install the top ring into its groove. A ring installation tool can be used on the two compression rings if desired.

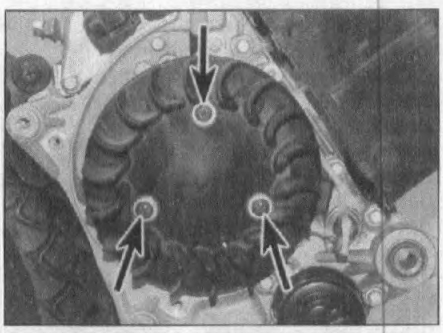
8 Once the rings are correctly installed, check they move freely without snagging and stagger their end gaps as shown **(see illustration 17.8 in Chapter 2C)**.



17.4 Unclip the connector (arrowed) from the cover



17.5 Lift off the alternator cover



17.6 Cooling fan is secured by three screws (arrowed)

17 Cooling fan – removal and installation

Note: *This procedure can be carried out with the engine in the frame. If the engine has been removed, ignore the steps which do not apply.*

Removal

1 Remove the bodywork as required by your model to access the alternator cover on the right-hand side of the engine (see Chapter 7).
2 If required, remove the exhaust system or silencer to gain clearance to draw the cover off the alternator rotor (see Chapter 4). If required, displace the fuel pump and filter assembly (see Chapter 4).
3 On machines fitted with a secondary air system, disconnect the SAS vacuum hose and the SAS pipe from the reed valve housing (see Chapter 1, Section 21).
4 Undo the clip that secures the wiring harness to the top of the alternator cover, then detach the alternator multi-pin connector from the cover **(see illustration)**.
5 Remove the screws securing the alternator cover and remove the cover **(see illustration)**.
6 Remove the three screws securing the cooling fan to the alternator rotor and remove the fan **(see illustration)**.

Installation

7 Installation is the reverse of removal.

18 Alternator rotor and stator – removal and installation

Note: *This procedure can be carried out with the engine in the frame. If the engine has been removed, ignore the steps which do not apply.*

Removal

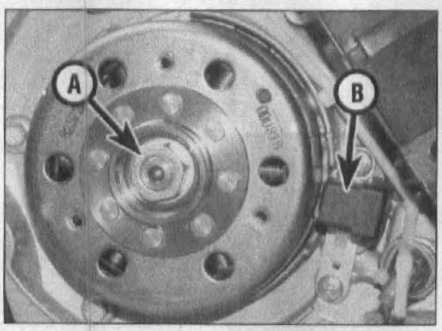
1 Remove the cooling fan (see Section 17).
2 To remove the rotor nut it is necessary to stop the rotor from turning **(see illustration)**. Piaggio produce a service tool (Part No. 020656Y) which locates in the holes in the rotor. A similar tool can be made **(see illustration 12.3 in Chapter 2A)**. A strap wrench can be used around the rotor periphery, although be careful not to damage the ignition pulse generator coil. With the rotor held securely, unscrew the nut.

HAYNES HiNT ***A rotor holding tool can easily be made using two strips of steel bolted together in the middle, with a bolt through each end which locates into the holes in the rotor. Do not allow the bolts to extend too far through the rotor holes otherwise the coils could be damaged.***

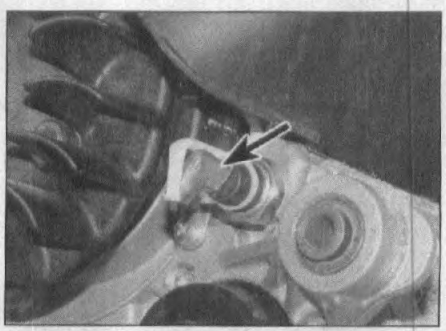
3 To remove the rotor from the crankshaft it is necessary to use the Piaggio service tool (Part No. 020162Y) **(see illustration 12.4a in Chapter 2A)** or a two-legged puller. If using the service tool, ensure that the centre bolt is backed-out sufficiently to allow the body of the tool to be screwed all the way into the threads provided in the rotor. With the tool in place, hold the body of the tool using a spanner on its flats while tightening the centre bolt (turn it clockwise) to draw the rotor off the end of the shaft. If using a two-legged puller, assemble the puller legs through the holes in the rotor and tighten the centre bolt down onto the crankshaft end until the rotor is drawn off **(see illustration 12.4b in Chapter 2A)**. If it is loose, remove the Woodruff key from the shaft, noting how it fits **(see illustration 12.4c in Chapter 2A)**.
4 To remove the stator, it is also necessary to remove the pulse generator coil as they come as a linked assembly. Disconnect the alternator wiring multi-pin connector. Undo the screw that secures the alternator wiring guide to free the wiring from the crankcase. Disconnect the oil pressure switch wiring connector **(see illustration)**.
5 Undo the screws that secure the pulse generator coil **(see illustration 18.2)**, then undo the screws that secure the stator and remove the two units together.

Installation

6 Install the stator and pulse generator coil onto the crankcase; ensure that the wiring for the generator coil and the oil pressure switch is correctly positioned. Install the stator and generator coil screws and tighten them to the specified torque.
7 Connect the oil pressure switch wiring connector, the alternator wiring multi-pin connector, and install the alternator wiring guide.
8 Clean the tapered end of the crankshaft and the corresponding mating surface on the inside of the rotor with a suitable solvent. Make sure that no metal objects have attached themselves to the magnets on the inside of the rotor. If removed, fit the Woodruff key into its slot in the shaft, then install the rotor onto the shaft, aligning the slot in the rotor with the key **(see illustrations 12.7a and 12.7b in Chapter 2A)**.
9 Install the rotor nut and tighten it to the torque setting specified at the beginning of the Chapter, using the method employed on removal to prevent the rotor from turning.
10 Position the rotor so that the raised section aligns with the pulse generator coil, then measure the air gap between the rotor



18.2 Alternator rotor nut (A). Note the pulse generator coil (B)



18.4 Oil pressure switch wiring connector (arrowed)

and the coil with a feeler gauge. The air gap should be between 0.34 to 0.76 mm. If the gap is outside the specified limits inspect the coil mounting for distortion. If the gap is too small the rotor may strike to coil and damage it; if the gap is too large the performance of the ignition system will be reduced.

11 Install the cooling fan (see Section 17).

19 Starter pinion assembly – removal, inspection and installation

Note: *This procedure can be carried out with the engine in the frame.*

Removal

1 Remove the drivebelt cover (see Chapter 2G).

2 Lift out the starter pinion assembly, noting how it fits **(see illustration)**.

Inspection

3 Check the starter pinion assembly for any signs of damage or wear, particularly for chipped or broken teeth on either of the pinions. Check the corresponding teeth on the starter motor pinion and the starter driven gear.

4 Rotate the outer pinion and check that it moves smoothly up and down the shaft, and that it returns easily to its rest position **(see illustration)**.

5 The starter pinion assembly is supplied as a complete unit; if any of the component parts are worn or damaged, the unit will have to be renewed.

Installation

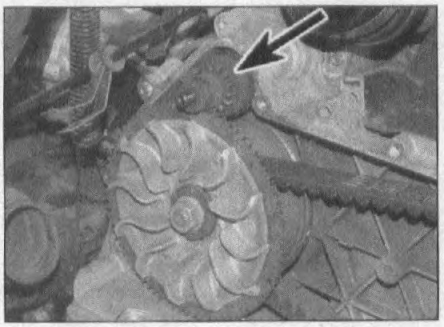
6 Installation is the reverse of removal. Ensure the inner pinion engages with the starter motor shaft.

20 Oil pump and relief valve – pressure check, pump removal, inspection and installation

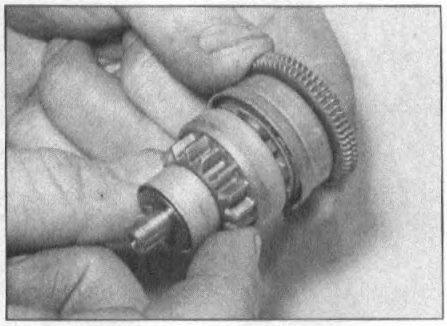
Note: *This procedure can be carried out with the engine in the frame.*

Pressure check

1 This engine is fitted with an oil pressure switch and warning light. The function of the circuit is described in Chapter 9.



19.2 Location of the starter pinion assembly



19.4 Check the pinion as described

2 If there is any doubt about the performance of the engine lubrication system, the oil pressure should be checked. The check provides useful information about the condition of the lubrication system. If you do not have the facilities to check the oil pressure yourself, have it done by a Piaggio dealer.

3 To check the oil pressure, a suitable pressure gauge (which screws into the crankcase) will be needed. Piaggio produce a gauge (Part No. 020193Y) and gauge adapter (Part. No. 020434Y) for this purpose.

4 Check the engine oil level (see *Daily (pre-ride) checks*), then warm the engine up to normal operating temperature and stop it. Support the scooter so that the rear wheel is clear of the ground.

5 Remove the alternator cover (see Section 17). Disconnect the oil pressure switch wiring connector **(see illustration 18.4)**, then unscrew the oil pressure switch from the crankcase and screw in the gauge adapter. Connect the pressure gauge to the adapter. Discard the pressure switch sealing washer, as a new one must be fitted on reassembly. If necessary, temporarily reconnect the exhaust system.

Warning: Take great care not to burn your hands on the hot engine unit, exhaust pipe or with engine oil when connecting the gauge adapter to the crankcase. Do not allow exhaust gases to build-up in the work area; either perform the check outside or use an exhaust gas extraction system.

6 Start the engine and increase the engine speed to 6000 rpm whilst watching the pressure gauge reading. The oil pressure should be similar to that given in the Specifications at the beginning of the Chapter.

7 If the pressure is significantly lower than the standard, either the oil strainer or filter is blocked, the pressure relief valve is stuck open, the oil pump is faulty, the piston oil jet in the crankcases has become dislodged, or there is considerable engine main bearing wear. Begin diagnosis by checking the oil filter and strainer (see Chapter 1), then the relief valve and oil pump (see Steps 11 to 38). If those items check out okay, the crankcases will have to be split to check the oil jet and the main bearings (see Section 21).

8 If the pressure is too high, either an oil passage is clogged, the relief valve is stuck closed or the wrong grade of oil is being used.

9 Stop the engine and unscrew the gauge and adapter from the crankcase.

10 Fit a new sealing washer to the oil pressure switch and install the switch. Tighten the switch, then check the oil level (see *Daily (pre-ride) checks*). **Note:** *Rectify any problems before running the engine again.*

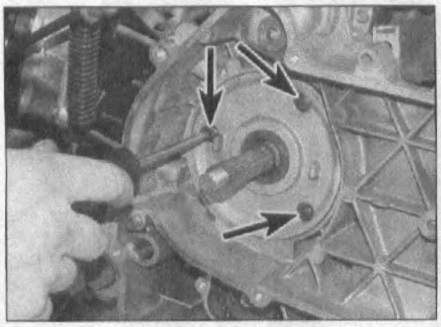
Oil pump and relief valve

Removal

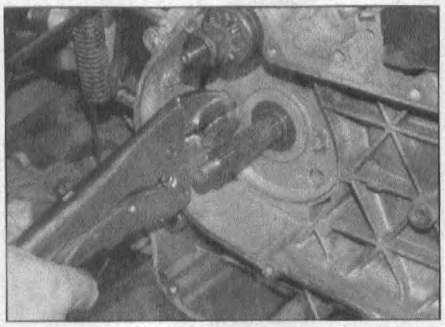
11 Drain the engine oil (see Chapter 1).

12 Remove the drive pulley and variator (see Chapter 2G).

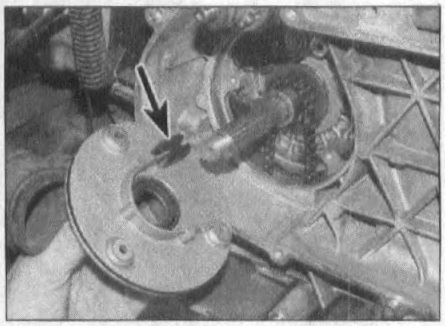
13 Remove the screws and washers securing the pump drive chain cover and remove the cover **(see illustrations)**. **Note:** *The cover is a tight fit in the casing; pull it out carefully by the cast projections.* Discard the cover O-ring, as a new one must be fitted on reassembly. Note the chain guide on the back of the cover **(see illustration)**



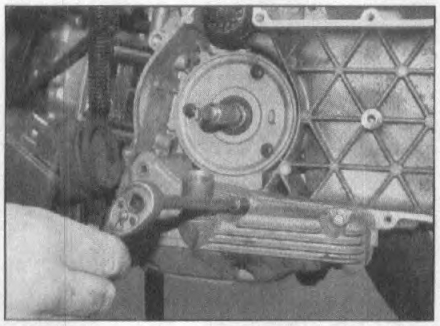
20.13a Undo the cover screws (arrowed) . . .



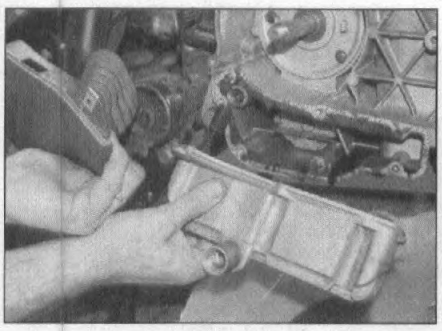
20.13b . . . and pull out the cover . . .



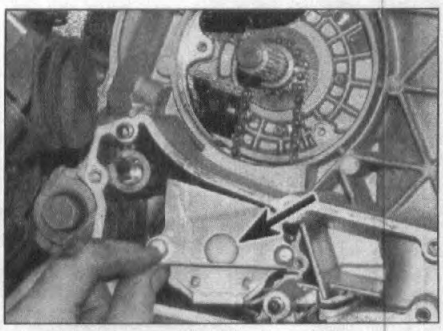
20.13c . . . noting the location of the chain guide (arrowed)



20.14a Undo the sump cover bolts . . .



20.14b . . . and remove the cover



20.15 Remove the pump sprocket plate (arrowed)

14 Undo the bolts securing the sump cover and remove the cover **(see illustrations)**. Note the position of the guide for the rear brake cable. Discard the gasket, as a new one must be used. Note how the relief valve spring locates on the lug on the inside of the cover and remove it carefully. If necessary, withdraw the relief valve from its location in the sump. Note the location of the cover dowels and remove them for safekeeping if they are loose.

15 Remove the screws securing the pump sprocket plate and remove the plate, noting how it fits **(see illustration)**.

16 Insert a pin punch or screwdriver through one of the holes in the pump sprocket and locate it against the pump body to stop the sprocket turning, then unscrew the sprocket bolt **(see illustration)**. Note the Belleville washer on the bolt.

17 Draw the sprocket off the pump and slip it out of the chain **(see illustration 21.7a in Chapter 2C)**. If required, draw the chain up into the transmission housing and remove it from the drive sprocket. **Note:** *Before the chain is removed, mark it so that it can be fitted the same way round.* Slide the drive sprocket off the end of the crankshaft **(see illustration 21.7c in Chapter 2C)**.

18 Remove the pump drive pinion and discard the O-ring, as a new one must be fitted. Undo the two screws securing the oil pump and remove the pump, noting how it fits **(see illustration 21.8 in Chapter 2C)**. Also remove the gasket from behind the pump and discard it, as a new one must be fitted.

Inspection

19 Clean the relief valve and spring in solvent. Inspect the surface of the valve for wear and scoring. Measure the free length of the spring and compare the result with the Specifications at the beginning of the Chapter. If the valve is worn or the spring has shortened, renew them. Inspect the valve housing in the casing; any dirt lodged in the housing will prevent the valve from seating properly and must be cleaned out carefully to avoid scratching the surface of the housing.

20 Remove the two screws securing the cover to the pump body, then remove cover **(see illustration)**.

21 Note the position of the reference marks on the pump rotors. It is not be necessary to disassemble the pump (individual components are not available) but, if required, remove the central circlip with circlip pliers, then lift out the rotors. Clean the pump body and rotors in solvent and dry them with compressed air, if available. Inspect the body and rotors for scoring and wear. If any damage, scoring, uneven or excessive wear is evident, renew the pump. If the pump has been disassembled, fit the rotors back into the body, ensuring that the reference marks are visible, and install the circlip.

22 Measure the clearance between the inner rotor tip and the outer rotor with a feeler gauge as shown, and compare the result to the Specifications at the beginning of the Chapter **(see illustration)**.

23 Measure the clearance between the outer rotor and the pump body and compare the result to the Specifications at the beginning of the Chapter **(see illustration 20.22)**. If either clearance measured is greater than the maximum listed, fit a new pump.

24 Lay a straight-edge across the rotors and the pump body and, using a feeler gauge, measure the rotor endfloat (the gap between the rotors and the straight-edge. If the clearance measured is greater than the maximum listed, fit a new pump.

25 Check the pump drive chain and sprockets for wear or damage, and renew them as a set if necessary.

26 If the pump is good, make sure all the components are clean, then lubricate them with clean engine oil.

27 Fit the cover, noting that it can only be fitted one way, and tighten the screws securely.

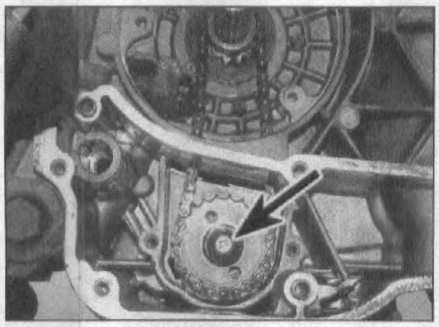
28 Rotate the pump shaft by hand and check that the rotors turn smoothly.

Installation

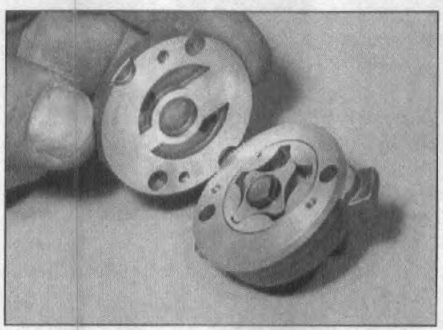
29 Lay a new pump gasket onto the crankcase, making sure the holes in the gasket align correctly with the oil holes.

30 Install the pump, noting that it can only be fitted one way, and tighten the screws to the torque setting specified at the beginning of the Chapter. Fit a new O-ring to the drive pinion and install the pinion.

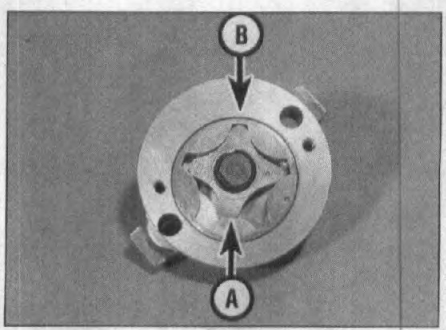
31 Slide the drive sprocket, with its shouldered end facing out, onto the crankshaft, then fit the drive chain around the sprocket and slip it down into the sump (see Step 17).



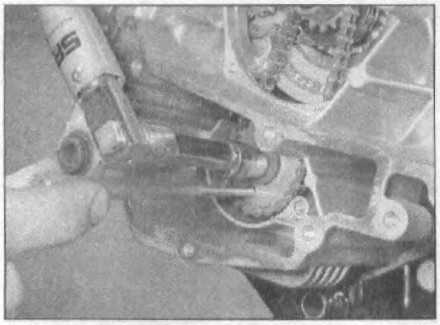
20.16 Undo the pump sprocket bolt (arrowed)



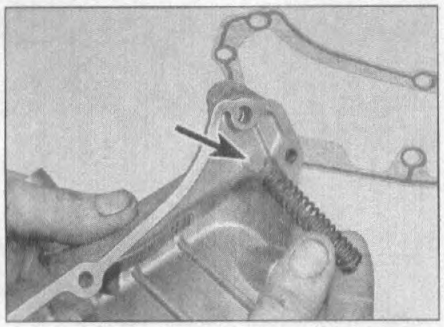
20.20 Remove the pump cover



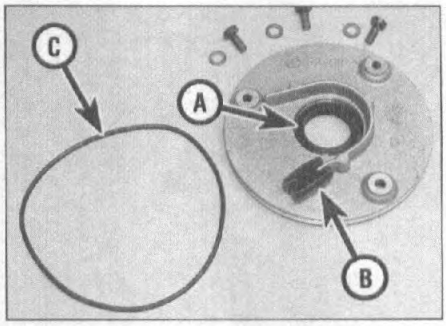
20.22 Measure inner-to-outer rotor clearance (A) and outer rotor-to-body clearance (B)



20.32 Hold the sprocket and tighten the bolt to the specified torque



20.35 Relief valve spring locates on lug (arrowed) inside cover



20.36 Pump drive chain cover oil seal (A), chain guide (B) and O-ring (C)

32 Fit the pump sprocket into the chain, then fit the sprocket onto the pump, aligning the flat with that on the pump shaft. Fit the Belleville washer onto the sprocket bolt so that the raised outer edge of the washer faces the pump sprocket, then install the bolt. Use the method employed on removal to stop the sprocket turning and tighten the bolt to the specified torque **(see illustration)**.

33 Install the pump sprocket plate and tighten its screws securely.

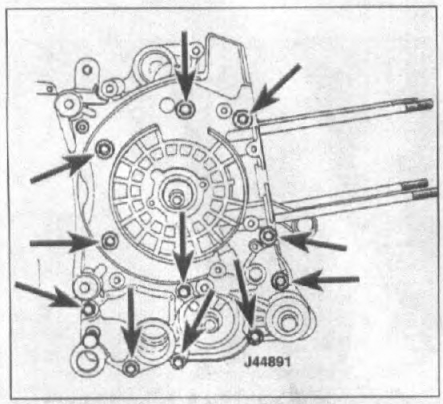
34 Remove any traces of old gasket from the sump cover and crankcase mating surfaces with solvent. Take care not to scratch or gouge the soft aluminium.

35 Lubricate the relief valve with clean engine oil, then install the valve into the casing. Fit the spring onto the lug on the inside of the sump cover **(see illustration)**. Ensure the dowels for the sump cover are in place and install the cover using a new gasket. Install the cover bolts and the clip for the rear brake cable, then tighten the cover bolts to the specified torque.

36 Check the condition of the centre oil seal in the pump drive chain cover **(see illustration)**. If there are any signs of oil leakage inside the drivebelt casing, renew the seal. If the chain guide is worn, unclip it and fit it the other way round, or fit a new guide. Fit a new O-ring onto the cover and smear it with grease. Slide the cover carefully over the crankshaft to avoid damaging the centre seal, align the holes for the fixing screws and install the screws and washers finger tight. Tighten the screws a little at a time, in turn, to draw the cover into the casing, then ensure the screws are tightened to the specified torque.

37 Install the drive pulley and variator (see Chapter 2G).

38 Fill the engine with the correct type and quantity of oil (see Chapter 1). Start the engine and check that there are no leaks around the sump.



21.4 Crankcase bolt locations (arrowed)

21 Crankcase halves, crankshaft and connecting rod

Note: *To separate the crankcase halves, the engine must be removed from the frame.*

Separation

1 To access the crankshaft and its bearings, the crankcase must be split into two parts.

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) Camchain, blades and sprockets (see Section 9).
b) Cylinder head (see Section 11).
c) Cylinder (see Section 14).
d) Alternator rotor and stator (see Section 18).
e) Variator (see Chapter 2G).
f) Starter motor (see Chapter 9).
g) Oil pump (see Section 20).
h) Centre stand (see Chapter 7).

3 Before separating the crankcases, measure the crankshaft endfloat with a dial gauge and compare the result with the Specifications at the beginning of the Chapter. Excessive endfloat is an indication of wear on the crankshaft or the crankcases and should be investigated when the cases have been separated.

4 Unscrew the eleven crankcase bolts evenly, a little at a time and in a criss-cross sequence until they are all finger-tight, then remove them **(see illustration)**. Support the engine unit on the work surface left-hand (transmission) side down. Carefully lift the right-hand crankcase half off the left-hand half, taking care not to score the surface of the right-hand main bearing on the crankshaft. If the halves do not separate easily, tap around the joint with a soft-faced mallet. **Note:** *Do not try and separate the halves by levering against the crankcase mating surfaces as they are easily scored and will not seal correctly afterwards.* Note the position of the two crankcase dowels and remove them for safekeeping if they are loose.

5 Lift the crankshaft assembly out of the left-hand crankcase, again taking care not to mark the bearing surface. Discard the gasket, as a new one must be fitted on reassembly.

6 Clean the crankcases thoroughly with solvent and dry them with compressed air. Clean the crankshaft assembly with solvent. **Note:** *Piaggio warn against blowing compressed air through the connecting rod oil passage to avoid the danger of compacting dirt and blocking the passage to the big-end bearing.*

7 Remove all traces of old gasket from the mating surfaces with solvent. Take care not to scratch or gouge the soft aluminium.

Caution: Be very careful not to nick or gouge the crankcase mating surfaces, or oil leaks will result. Check both crankcase halves very carefully for cracks and other damage.

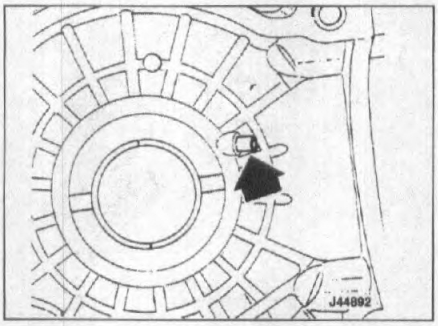
8 Note the position of the crankshaft oil seal in the right-hand crankcase half, then drive the seal out with a bearing driver or suitably-sized socket. Take care not to damage the surface of the main bearing.

Inspection

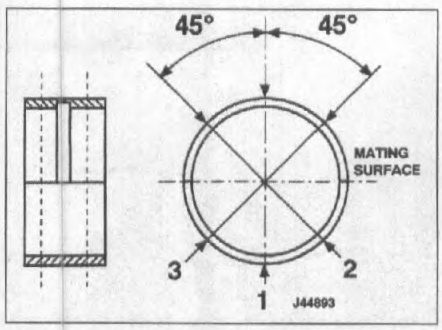
Crankcases

9 Small cracks or holes in aluminium castings can 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, renew the crankcase halves as a set.

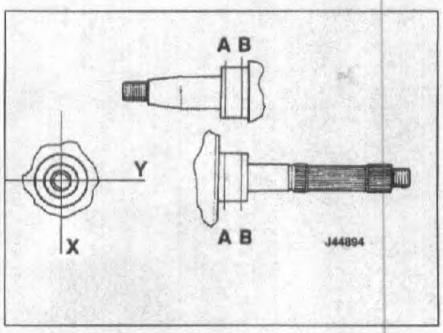
10 Damaged threads can be economically reclaimed by using a diamond section wire insert, of the Heli-Coil type, which is easily fitted after drilling and retapping the affected thread. Sheared studs or screws can usually



21.13 Left-hand crankcase half oil jet (arrowed)



21.15 Measure the main bearings



21.16 Measure the crankshaft journals

be removed with stud or screw extractors; if you are in any doubt consult a Piaggio dealer or specialist motorcycle engineer.

11 Always wash the crankcases thoroughly after any repair work to ensure no dirt or metal swarf is trapped inside when the engine is rebuilt.

12 Inspect the engine mounting bushes. If they show signs of deterioration, renew them both at the same time. To remove a bush, first note its position in the casing. Heat the casing with a hot air gun, then support the casing and drive the bush out with a hammer and a suitably-sized socket. Clean the bush housing with steel wool to remove any corrosion, then reheat the casing and fit the new bush. **Note:** *Always support the casing when removing or fitting bushes to avoid breaking the casing.*

13 Blow out the oil passages for the oil pump, relief valve, main bearing and piston oil jet in the left-hand crankcase half with compressed air **(see illustration)**. Blow out the oil passages for the main bearing, the cylinder head oil supply and the oil seal drain in the right-hand crankcase half.

14 Check the condition of the main bearings in each crankcase half. Each bearing comprises two halves – the surface of the lower half is plain and the upper half has an oilway in it. The surface of each bearing should be smooth with no scoring or scuff marks. The condition of the bearings and the corresponding crankshaft journals is vital to the performance of the engine lubrication system. If the bearings are damaged or worn, oil pressure will drop and the oil feed to the connecting rod big end and the cylinder head will be insufficient to prevent rapid wear and possible seizure.

15 Use a telescoping gauge and a micrometer to measure the internal diameter or each bearing in three directions as shown **(see illustration)**. Ensure that the measurements are taken in the centre of the bearing surface, either side of the oilway. The bearings are colour coded – on Zip 125, Skipper ST, Liberty 125 and ET4 models they are coded red, blue or yellow and on Fly 125, LX4 125 and S125 models they are coded yellow, green and blue. Ensure all three measurements for each bearing are within the specifications in the tables below. Piaggio do not supply new bearings; if any of the bearings are worn beyond the specifications new crankcase halves will have to be fitted. If there is any doubt about the condition of the bearings consult a Piaggio dealer.

Table 1: Crankshaft/main bearing fit – Zip 125, Skipper ST, Liberty 125, ET4

Crankcase main bearing		Crankshaft journal diameter	
Code	**Internal diameter**	**Class**	**External diameter**
Blue Red	29.019 to 29.034 mm 29.025 to 29.040 mm	1	28.994 to 29.000 mm
Yellow Blue	29.022 to 29.037 mm 29.028 to 29.043 mm	2	29.000 to 29.006 mm

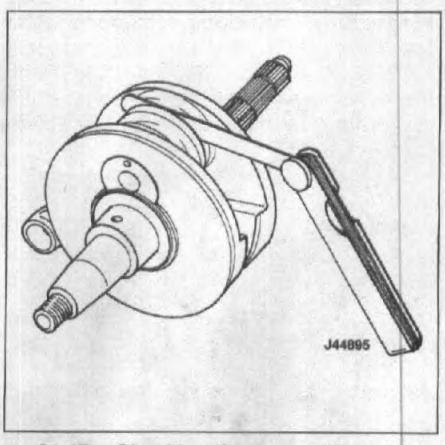
Table 2: Crankshaft/main bearing fit – Fly 125, LX4 125, S125

Crankcase main bearing		Crankshaft journal diameter	
Code	**Internal diameter**	**Class**	**External diameter**
Yellow Green	28.999 to 29.005 mm 28.999 to 29.005 mm	1	28.998 to 29.004 mm
Blue Yellow	29.005 to 29.011 mm 29.005 to 29.011 mm	2	29.004 to 29.010 mm

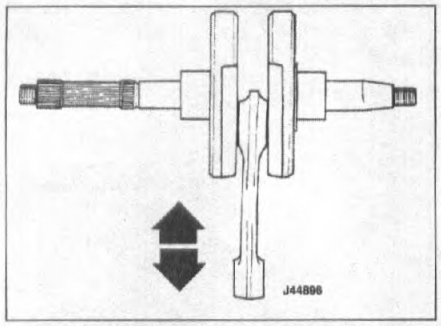
Crankshaft

16 Check the condition of the crankshaft journals. The surface of each journal should be smooth with no scoring, pitting or scuff marks. Use a micrometer to measure the diameter of each journal in two positions (A and B) and in two directions as shown **(see illustration)**. There are two size categories for the crankshaft journals, Class 1 and Class 2, which should match the colour-coding of the crankcase bearings. Compare the results with the appropriate table and ensure that the journal size is within the specifications for the appropriate bearing. If the crankshaft journals are damaged or worn beyond the specifications a new crankshaft will have to be fitted.

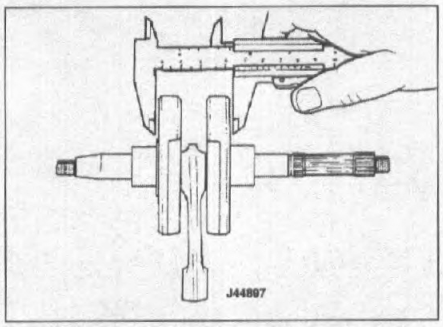
17 Measure the connecting rod big-end side clearance with a feeler gauge and compare it with the Specifications at the beginning of the Chapter **(see illustration)**. Measure the up-and-down (radial) play on the rod with a dial gauge and measure the width of the flywheels at several points to ensure they are



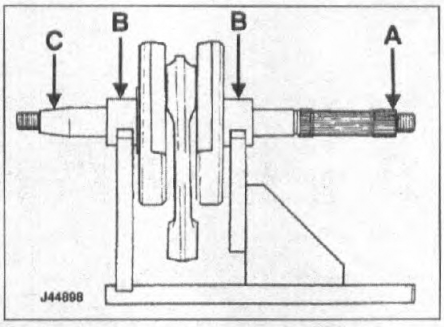
21.17a Checking the connecting rod big-end bearing side clearance



21.17b Measure the radial play on the connecting rod



21.17c Measure the width of the flywheels as described



21.18 Check the crankshaft runout

not out of alignment **(see illustrations)**. Compare the results with the Specifications at the beginning of the Chapter.

18 Place the crankshaft assembly on V-blocks and check the runout at the main bearing journals and at the ends of the shafts **(see illustration)**. If the runout exceeds the specified limit, or if either of the connecting rod measurements exceed the limit, the crankshaft assembly must be renewed.

Reassembly

19 Support the engine unit on the work surface left-hand (transmission) side down. Ensure that the crankcase mating surfaces are clean and that the crankcase dowels are in place, then install a new gasket.

20 Lubricate the main bearings and crankshaft journals with clean engine oil, then insert the crankshaft all the way into the left-hand half, positioning the connecting rod in line with the crankcase mouth. Guide the crankcase right-hand half over the crankshaft end and press it down until the two halves meet. Use a soft-faced mallet to help the casing seat, but don't apply too much pressure. **Note:** *If the crankcases do not meet, remove the right-hand half and investigate the problem – do not be tempted to pull the crankcases together using the bolts.*

21 Clean the threads of the crankcase bolts and install them finger-tight. Tighten the bolts evenly, in a criss-cross sequence, to the specified torque setting. Hold the connecting rod to prevent it hitting the crankcase mouth, then rotate the crankshaft to check that it is moves freely. If necessary, trim any excess crankcase gasket off the cylinder mating surface with a sharp knife.

22 Lubricate the new crankshaft oil seal with clean engine oil, then install it in the right-hand crankcase half in the same position as noted on removal. Use a bearing driver or a suitably-sized socket which contacts only the outer face of the seal to drive it into position. **Note:** *Do not press the oil seal too far into the casing.*

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

22 Initial start-up after overhaul

1 Make sure the engine oil level is correct (see *Daily (pre-ride) checks*).

2 Make sure there is fuel in the tank.

3 With the ignition OFF, operate the kickstart a couple of times to check that the engine turns over easily.

4 Turn the ignition ON, start the engine and allow it to run at a slow idle until it reaches operating temperature. Do not be alarmed if there is a little smoke from the exhaust – this will be due to the oil used to lubricate the piston and bore during assembly and should subside after a while.

5 If the engine proves reluctant to start, remove the spark plug and check that it has not become wet and oily. If it has, clean it and try again. If the engine refuses to start, go through the fault finding charts at the end of this manual to identify the problem.

6 Check carefully for oil leaks and make sure the transmission and controls, especially the brakes, function properly before road testing the machine. Refer to Section 23 for the recommended running-in procedure.

7 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 level (see *Daily (pre-ride) checks*).

23 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 rebored or a new crankshaft has been installed. In the case of a rebore, the machine will have to be run-in as when new. This means 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 not to maintain any one speed for too long. Experience is the best guide, since it's easy to tell when an engine is running freely. Once past the 600 mile (1000 km) mark, gradually increase performance, using full throttle for short bursts to begin with.

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.