

# Chapter 2 Part D:

## Four-stroke engines






### (ET4 50, Liberty 50 4T, Zip 50/100 4T, Fly 50/100 4T, LX4 50)

Refer to the beginning of Chapter 1 for model identification details

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## Degrees of difficulty

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

## Specifications

### General

|                          |                             |
|--------------------------|-----------------------------|
| Type . . . . .           | Single cylinder four-stroke |
| Capacity                 |                             |
| 50 cc engines . . . . .  | 49.9 cc                     |
| 100 cc engines . . . . . | 96.2 cc                     |
| Bore                     |                             |
| 50 cc engines . . . . .  | 39.0 mm                     |
| 100 cc engines . . . . . | 50.0 mm                     |
| Stroke                   |                             |
| 50 cc engines . . . . .  | 41.8 mm                     |
| 100 cc engines . . . . . | 49.0 mm                     |
| Compression ratio        |                             |
| 50 cc engines . . . . .  | 11.5 to 12.0 : 1            |
| 100 cc engines . . . . . | 10.5 to 11.5 : 1            |

### Cylinder head

|  |                     |
|--|---------------------|
| Warpage (max) . . . . .                                | 0.05 mm             |
| Left-hand camshaft bearing housing diameter . . . . .  | 32.015 to 32.025 mm |
| Right-hand camshaft journal housing diameter . . . . . | 16.000 to 16.018 mm |
| Rocker arm shaft housing . . . . .                     | 11.000 to 11.018 mm |
| Rocker arm shaft diameter (min) . . . . .              | 10.970 mm           |
| Rocker arm internal diameter (max) . . . . .           | 11.030 mm           |

## 2D•2 Four-stroke engines (ET4 50, Liberty 50 4T, Zip 50/100 4T, Fly 50/100 4T, LX4 50)

### Camshaft

|                                      |                     |
|--------------------------------------|---------------------|
| Intake and exhaust lobe height ..... | 25.935 mm           |
| Left-hand journal diameter           |                     |
| Standard .....                       | 12.002 to 12.010 mm |
| Service limit (min) .....            | 11.98 mm            |
| Right-hand journal diameter          |                     |
| Standard .....                       | 15.977 to 15.985 mm |
| Service limit (min) .....            | 15.96 mm            |
| Camshaft endfloat (max) .....        | 0.50 mm             |

### Valves, guides and springs

|  |                   |
|--|-------------------|
| Valve clearances .....                             | See Chapter 1     |
| Intake valve                                       |                   |
| Overall standard length .....                      | 70.1 mm           |
| Stem diameter                                      |                   |
| Standard .....                                     | 4.985 mm          |
| Service limit (min) .....                          | 4.970 mm          |
| Guide bore diameter                                |                   |
| Standard .....                                     | 5.000 to 5.012 mm |
| Service limit (max) .....                          | 5.022 mm          |
| Face width .....                                   | 1.5 mm            |
| Seat width .....                                   | 1.6 mm            |
| Exhaust valve                                      |                   |
| Overall standard length .....                      | 69.2 mm           |
| Stem diameter                                      |                   |
| Standard .....                                     | 4.975 mm          |
| Service limit (min) .....                          | 4.960 mm          |
| Guide bore diameter                                |                   |
| Standard .....                                     | 5.000 to 5.012 mm |
| Service limit (max) .....                          | 5.022 mm          |
| Face width .....                                   | 1.6 mm            |
| Seat width .....                                   | 1.6 mm            |
| Valve spring free length (inlet and exhaust) ..... | n/a               |

### Cylinder bore – ET4 50, Liberty 50 4T, Zip 50 4T

**Note:** The following specifications are for parts supplied for ET4 50, Liberty 50 4T and Zip 50 4T models when first introduced. Specifications for parts supplied at a later date may differ (see **Cylinder bore** – Fly 50 4T, LX4 50).

|                    |                     |
|--------------------|---------------------|
| Standard           |                     |
| Size-code A .....  | 38.986 to 38.993 mm |
| Size-code B .....  | 38.993 to 39.000 mm |
| Size-code C .....  | 39.000 to 39.007 mm |
| Size-code D .....  | 39.007 to 39.014 mm |
| 1st oversize ..... | 39.186 to 39.214 mm |
| 2nd oversize ..... | 39.386 to 39.414 mm |
| 3rd oversize ..... | 39.586 to 39.614 mm |

### Piston – ET4 50, Liberty 50 4T, Zip 50 4T

**Note:** The following specifications are for parts supplied for ET4 50, Liberty 50 4T and Zip 50 4T models when first introduced. Specifications for parts supplied at a later date may differ (see **Piston** – Fly 50 4T, LX4 50).

|  |                     |
|--|---------------------|
| Piston diameter (measured 27 mm down from top edge of the piston, at 90° to piston pin axis) |                     |
| Standard   |                     |
| Size-code A .....  | 38.954 to 38.961 mm |
| Size-code B .....  | 38.961 to 38.968 mm |
| Size-code C .....  | 38.968 to 38.975 mm |
| Size-code D .....  | 38.975 to 38.982 mm |
| 1st oversize .....   | 39.154 to 39.182 mm |
| 2nd oversize .....   | 39.354 to 39.382 mm |
| 3rd oversize .....   | 39.554 to 39.582 mm |
| Piston-to-bore clearance (when new) .....  | 0.025 to 0.039 mm   |
| Piston pin diameter  |                     |
| Standard .....   | 12.996 to 13.000 mm |
| Service limit (min) .....  | 12.990 mm           |
| Piston pin bore diameter in piston .....   | 13.005 to 13.010 mm |

### Cylinder bore – Fly 50 4T, LX4 50

**Note:** The following specifications are for parts supplied originally for Fly 50 4T and LX4 50 models.

|                    |                     |
|--------------------|---------------------|
| Standard           |                     |
| Size-code A .....  | 38.993 to 39.000 mm |
| Size-code B .....  | 39.000 to 39.007 mm |
| Size-code C .....  | 39.007 to 39.014 mm |
| Size-code D .....  | 39.014 to 39.021 mm |
| 1st oversize ..... | 39.193 to 39.221 mm |
| 2nd oversize ..... | 39.393 to 39.421 mm |
| 3rd oversize ..... | 39.593 to 39.621 mm |

### Piston – Fly 50 4T, LX4 50

**Note:** The following specifications are for parts supplied originally for Fly 50 4T and LX4 50 models.

|  |                     |
|--|---------------------|
| Piston diameter (measured 27 mm down from top edge of the piston, at 90° to piston pin axis) |                     |
| Asso piston – standard   |                     |
| Size-code A .....  | 38.954 to 38.961 mm |
| Size-code B .....  | 38.961 to 38.968 mm |
| Size-code C (with Asso cylinder) .....   | 38.968 to 38.975 mm |
| Piston-to-bore clearance (when new) .....  | 0.032 to 0.046 mm   |
| Asso piston – standard   |                     |
| Size-code C (with Shiram cylinder) .....   | 38.963 to 38.970 mm |
| Piston-to-bore clearance (when new) .....  | 0.037 to 0.051 mm   |
| Size-code D .....  | not available       |
| Shiram piston – standard   |                     |
| Size-code A .....  | 38.949 to 38.956 mm |
| Size-code B .....  | 38.956 to 38.966 mm |
| Size-code C .....  | not available       |
| Size-code D (with Shiram cylinder) .....   | 38.970 to 38.977 mm |
| Piston-to-bore clearance (when new) .....  | 0.037 to 0.051 mm   |
| Shiram piston – standard   |                     |
| Size-code D (with Asso cylinder) .....   | 38.975 to 38.982 mm |
| Piston-to-bore clearance (when new) .....  | 0.032 to 0.046 mm   |
| 1st oversize .....   | 39.154 to 39.182 mm |
| 2nd oversize .....   | 39.354 to 39.382 mm |
| 3rd oversize .....   | 39.554 to 39.582 mm |
| Piston-to-bore clearance (when new) .....  | 0.032 to 0.046 mm   |
| Piston pin diameter (all)  |                     |
| Standard .....   | 12.996 to 13.000 mm |
| Service limit (min) .....  | 12.990 mm           |
| Piston pin bore diameter in piston (all) .....   | 13.005 to 13.010 mm |

### Cylinder bore – Zip 100 4T, Fly 100 4T

|                    |                     |
|--------------------|---------------------|
| Standard           |                     |
| Size-code A .....  | 49.993 to 50.000 mm |
| Size code B .....  | 50.000 to 50.007 mm |
| Size code C .....  | 50.007 to 50.014 mm |
| Size code D .....  | 50.014 to 50.021 mm |
| 1st oversize ..... | 50.193 to 50.221 mm |
| 2nd oversize ..... | 50.393 to 50.421 mm |
| 3rd oversize ..... | 50.593 to 50.621 mm |

### Piston – Zip 100 4T, Fly 100 4T

|  |                     |
|--|---------------------|
| Piston diameter (measured 27 mm down from top edge of the piston, at 90° to piston pin axis) |                     |
| Standard   |                     |
| Size code A .....  | 49.948 to 49.955 mm |
| Size code B .....  | 49.955 to 49.962 mm |
| Size code C .....  | 49.962 to 49.969 mm |
| Size code D .....  | 49.969 to 49.976 mm |
| 1st oversize .....   | 50.148 to 50.176 mm |
| 2nd oversize .....   | 50.348 to 50.376 mm |
| 3rd oversize .....   | 50.548 to 50.576 mm |
| Piston-to-bore clearance (when new) .....  | 0.038 to 0.052 mm   |
| Piston pin diameter  |                     |
| Standard .....   | 12.996 to 13.000 mm |
| Service limit (min) .....  | 12.990 mm           |
| Piston pin bore diameter in piston .....   | 13.005 to 13.010 mm |

**Piston rings**

## Ring end gap (installed)

|                                |                 |
|--------------------------------|-----------------|
| Top ring – 50 cc engines       |                 |
| Standard                       | 0.08 to 0.20 mm |
| Service limit (max)            | 0.35 mm         |
| 2nd ring – 50 cc engines       |                 |
| Standard                       | 0.05 to 0.20 mm |
| Service limit (max)            | 0.30 mm         |
| Top ring – 100 cc engines      |                 |
| Standard                       | 0.10 to 0.25 mm |
| Service limit (max)            | 0.40 mm         |
| 2nd ring – 100 cc engines      |                 |
| Standard                       | 0.10 to 0.25 mm |
| Service limit (max)            | 0.35 mm         |
| Oil control ring – all engines |                 |
| Standard                       | 0.20 to 0.70 mm |
| Service limit (max)            | 0.80 mm         |

## Ring-to-groove clearance

|                     |                   |
|---------------------|-------------------|
| Top ring            |                   |
| Standard            | 0.030 to 0.065 mm |
| Service limit (max) | 0.080 mm          |
| 2nd ring            |                   |
| Standard            | 0.020 to 0.055 mm |
| Service limit (max) | 0.070 mm          |
| Oil control ring    |                   |
| Standard            | 0.040 to 0.160 mm |
| Service limit (max) | 0.200 mm          |

**Lubrication system**

## Oil pump

|  |         |
|--|---------|
| Inner rotor tip-to-outer rotor clearance (max) | 0.15 mm |
| Outer rotor-to-body clearance (max)            | 0.20 mm |
| Rotor endfloat (max)                           | 0.09 mm |

**Connecting rod**

## Small-end internal diameter

|                     |                     |
|---------------------|---------------------|
| Standard            | 13.015 to 13.025 mm |
| Service limit (max) | 13.030 mm           |

## Big-end side clearance

|                     |                 |
|---------------------|-----------------|
| Standard            | 0.15 to 0.30 mm |
| Service limit (max) | 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 | 45 mm   |
| Runout A (max)                          | 0.15 mm |
| Runout B (max)                          | 0.02 mm |
| Runout C (max)                          | 0.10 mm |

**Torque settings**

|   |               |
|---|---------------|
| Valve cover bolts                       | 8 to 10 Nm    |
| Cam chain tensioner spring cap bolt     | 5 to 6 Nm     |
| Cam chain tensioner blade bolt          | 5 to 7 Nm     |
| Cam chain tensioner bolts               | 8 to 10 Nm    |
| Camshaft sprocket bolt                  | 12 to 14 Nm   |
| Rocker shaft stopper bolt               | 3 to 4 Nm     |
| Cylinder head nuts                      |               |
| Initial setting                         | 6 to 7 Nm     |
| Final setting                           | + 90°+ 90°    |
| Cylinder head-to-block bolts            | 8 to 10 Nm    |
| Oil pump driven sprocket bolt           | 12 to 14 Nm   |
| Oil pump mounting screws                | 5 to 6 Nm     |
| Oil pump cover screws                   | 0.7 to 0.9 Nm |
| Alternator rotor nut                    | 40 to 44 Nm   |
| Crankcase bolts                         | 8 to 10 Nm    |
| Engine front mounting bolt              | 33 to 41 Nm   |
| Rear shock absorber lower mounting bolt | 33 to 41 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, incorporating the connecting rod, with the big-end running on the crankpin on a needle roller bearing. The crankshaft runs in caged ball 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 and its bearings, can be worked on without having to remove the engine/transmission assembly from the frame. If, however, a number of areas require attention at the same time, removal of the engine is recommended, as it is easy to do so.

## 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 An engine overhaul generally involves restoring the internal parts to the specifications of a new engine. The piston rings and main and connecting rod bearings are usually renewed and, if necessary, the cylinder is rebored. Generally the valve seats are reground, since they are usually in less than perfect condition at this point. The end result should be a like-new engine that will give as many trouble-free miles as the original.

7 Before beginning the engine overhaul, read through the related procedures to familiarise

yourself with the scope and requirements of the job. Overhauling an engine is not all that difficult, but it is time-consuming. Plan on the 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

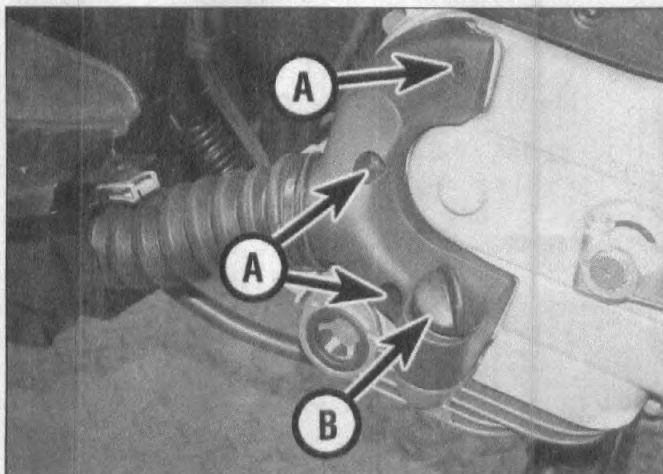
**Caution:** *The engine is not heavy, although engine removal and installation should be carried out with the aid of an assistant; personal injury or damage could occur if the engine falls or is dropped.*

### Removal

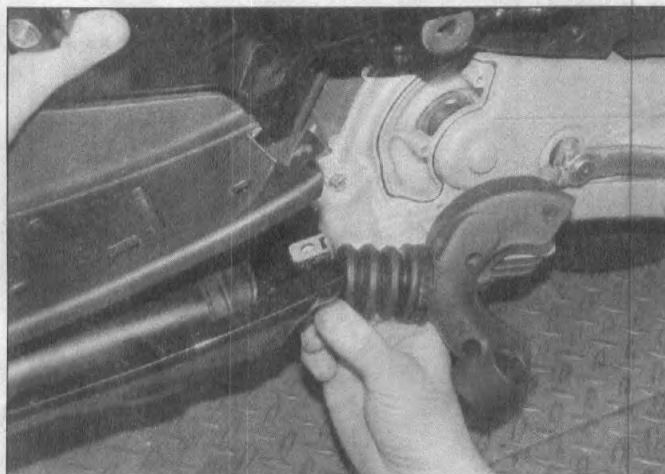
1 The procedure for removing the engine is the same as for air-cooled LEADER models (see Chapter 2E, Section 5), with the following additions.

2 Undo the three screws that secure the drivebelt air duct to the front of the belt cover, then unscrew the oil filler cap and displace the duct (see illustrations).

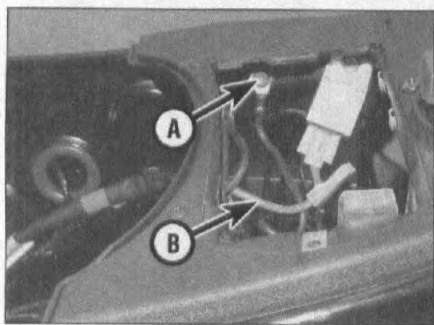
3 Remove the battery (see Chapter 9). Trace the red wire from the starter motor to the solenoid mounted on the right-hand side of the battery location and disconnect it, then



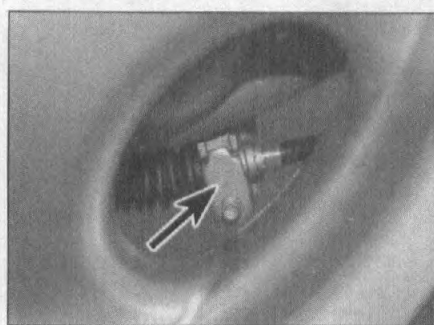
5.2a Undo the screws (A) and the cap (B) . . .



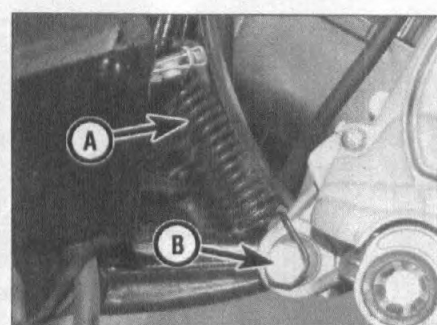
5.2b . . . then displace the duct



5.3 Engine earth (A) and starter motor wire (B)



5.5 Location of rear brake cable clamp (arrowed)



5.6 Disconnect the spring (A) from the engine bolt (B)

undo the screw securing the engine earth wire (see illustration). Cut the cable ties securing the starter motor and earth wire to the frame and secure the wires to the engine unit.

4 No carburettor heater is fitted.

5 The rear brake cable is clamped at the back of the drivebelt cover (see illustration).

6 Place a suitable temporary support under the metal section of frame forward of the engine mounting bracket, then disconnect the lower end of the spring from the head of the front engine mounting bolt, noting how it fits (see illustration).

7 Remove the rear shock absorber and rest

the weight of the scooter on the temporary support.

8 Remove the front engine mounting bolt and manoeuvre the engine unit out of the frame (see illustrations). Note the spacer on the left-hand side of the mounting bolt.

### Installation

9 Installation is the reverse of the removal procedure. 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. This will prevent contamination of the engine internals, and will also make working a lot easier and cleaner. A high flash-point solvent, such as paraffin can be used, or better still, a proprietary engine degreaser such as Gunk. 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 inlet and exhaust ports.

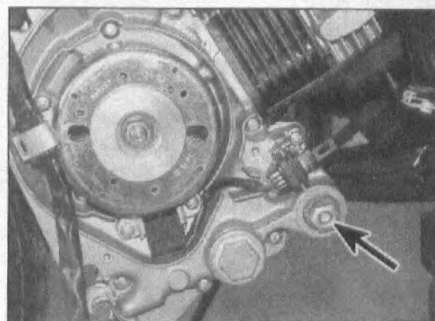


**Warning:** The use of petrol (gasoline) as a cleaning agent should be avoided because of the risk of fire.

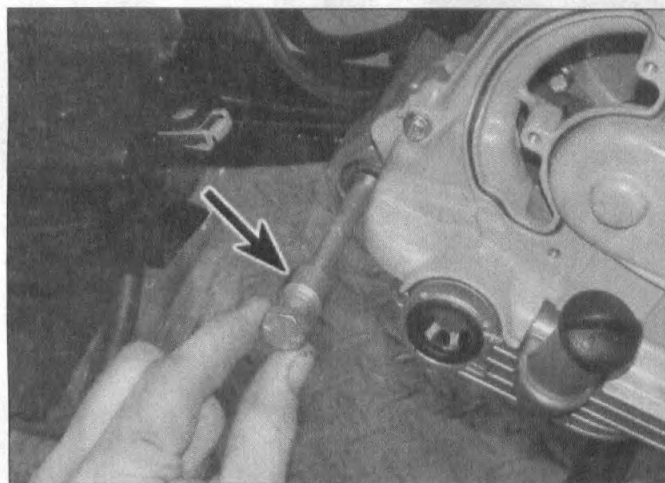
2 When clean and dry, arrange the unit on the workbench, leaving a suitable clear area for working. Gather a selection of small containers and plastic bags so that parts can be grouped together in an easily identifiable manner. Some paper and a pen should be on hand to permit notes to be made and labels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



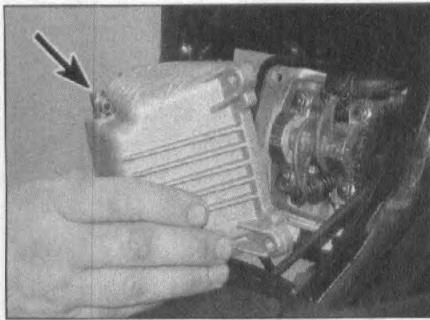
5.8a Undo the nut (arrowed) on the front mounting bolt . . .



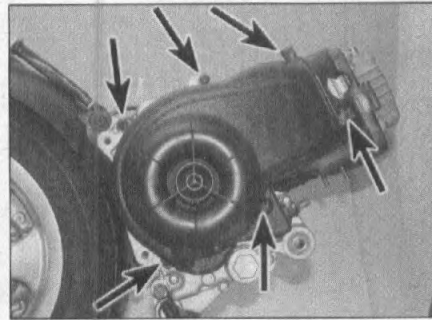
5.8b . . . then withdraw the bolt, noting the position of the spacer (arrowed) . . .



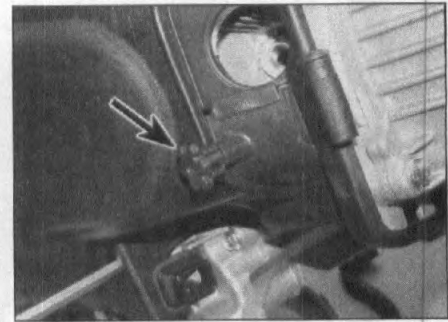
5.8c . . . and manoeuvre the engine out



**7.4** Remove the valve cover; note the breather hose union (arrowed)



**8.4a** Location of alternator cover fixings



**8.4b** Upper end of cover is secured by knurled knob (arrowed)

**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 accomplished by reversing 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

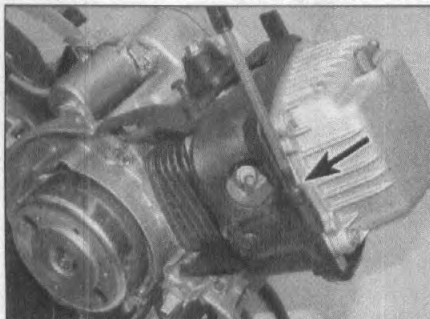
- 1** Remove the bodywork as required by your model to access the engine (see Chapter 7).
- 2** Release the clip securing the breather hose to the union on the valve cover and pull off the hose (see illustration 7.4).
- 3** Undo the cam chain tensioner cap bolt and withdraw the spring from the tensioner body (see Section 8). **Note:** A lug inside the valve cover pretensions the (lower) cam chain guide blade. The tensioner cap bolt and spring must

be removed before the valve cover is removed, and installed after the valve cover is fitted to avoid over-tightening the cam chain.

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

#### Installation

- 5** Clean the mating surfaces of the cylinder head and the valve cover with a suitable solvent.
- 6** Lay the new gasket onto 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 cam chain tensioner spring and cap bolt, then install the remaining components in the reverse order of removal.



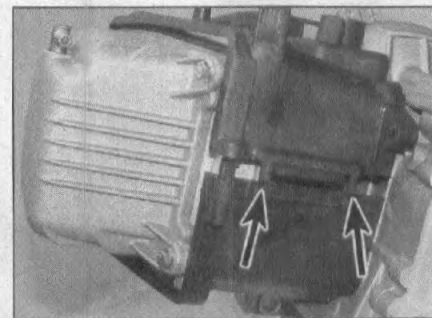
**8.5a** Cowling halves are joined by screws on the right-hand side . . .



**8.5b** . . . and the left-hand side



**8.5c** Rear cowling half is secured to crankcase. Note the clip (arrowed)



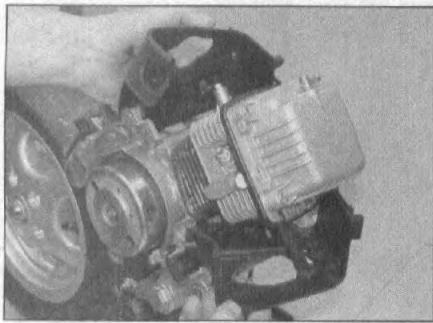
**8.5d** Release the clips (arrowed) . . .

### 8 Cam chain tensioner – removal, inspection and installation

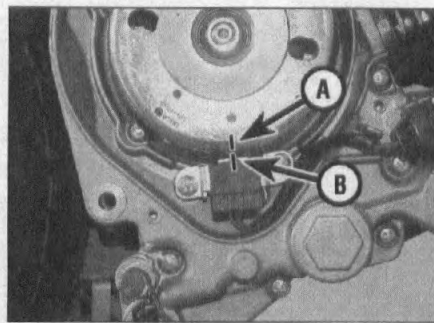
**Note:** This procedure can be carried out with the engine in the frame. If the engine has been removed, ignore the steps which do not apply.

#### Removal

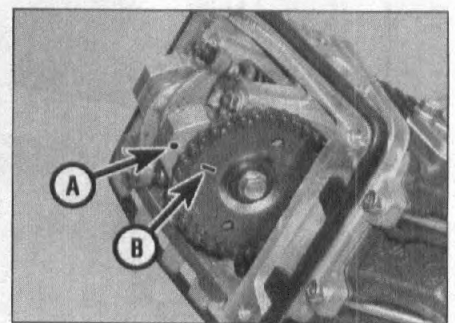
- 1** Remove the bodywork as required by your model to access the engine (see Chapter 7).
- 2** Remove the carburettor and the inlet manifold (see Chapter 4).
- 3** On machines fitted with a secondary air system, release the clip securing the hose to the reed valve cover and disconnect the hose. Release the clip securing the hose to the back of the cover and disconnect the hose.
- 4** Undo the screws securing the alternator cover and lift off the cover (see illustration). Note the upper cover fixing is a knurled knob (see illustration). Remove the cooling fan (see Section 17).
- 5** Undo the screws securing the rear half of the engine cowling to the front half of the cowling and to the crankcase (see illustrations). Note



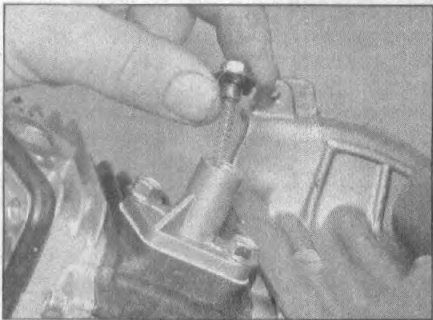
8.5e ... then ease the cowling apart carefully



8.7a Second timing mark on rotor (A) should align with pulse generator pick-up (B)



8.7b Index mark (A) should align with timing mark (B)



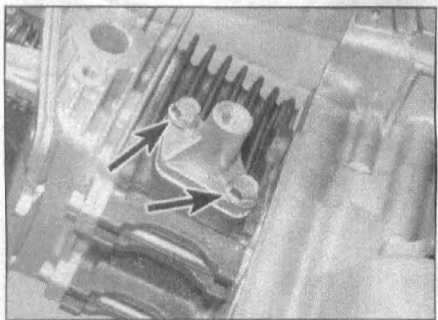
8.8 Remove the cap bolt and spring

the clip for the carburettor breather hose secured by the crankcase screw (see illustration). 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 illustrations).

6 Remove the valve cover (see Section 7).

7 Turn the engine in a clockwise direction using the alternator rotor, until the second timing mark on the rotor aligns with the pulse generator coil pick-up, and the timing mark 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).

8 Unscrew the chain tensioner cap bolt and withdraw the spring from the tensioner body (see illustration).



8.9 Cam chain tensioner is retained by two bolts (arrowed)

9 Unscrew the two tensioner mounting bolts and withdraw the tensioner from 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 Release the ratchet mechanism from the tensioner plunger and check that the plunger moves freely in and out of the tensioner body (see illustration).

13 If the tensioner or any of its components are worn or damaged, or if the plunger is seized in the body, they must be renewed. Individual components are available.

### Installation

14 Turn the engine in a clockwise direction using the alternator rotor. This removes all the slack between the crankshaft and the camshaft in the front run of the chain 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 engine and tighten the bolts to the torque specified at the beginning of the Chapter (see illustration 8.9).

17 Install the valve cover (see Section 7).

**Note:** A lug inside the valve cover pretensions

the (lower) cam chain guide blade. The tensioner cap bolt and spring must be installed after the valve cover is fitted to avoid over-tightening the cam chain.

18 If necessary, install a new O-ring on the cap bolt. Install the spring and cap bolt and tighten the bolt to the specified torque (see illustration 8.8).

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

## 9 Cam chain, blades and sprockets – 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.

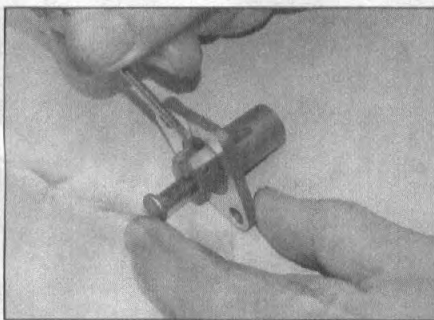
### Removal

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

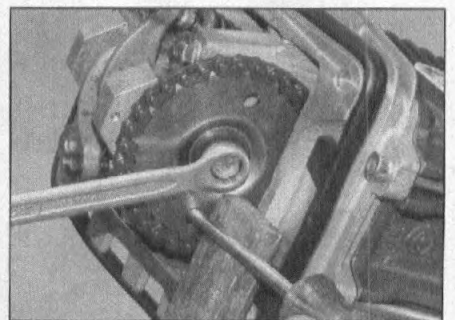
2 If the cam chain and crankshaft sprocket are being removed, remove the oil pump driven sprocket, drive chain and drive sprocket (see Section 20).

3 Undo the camshaft sprocket centre bolt (see illustration). To prevent the sprocket from turning, use the Piaggio service tool (Part No. 020565Y) or a suitable holding tool fitted into the hole(s) in the sprocket. If necessary, protect the gasket surface of the cylinder head with a piece of wood.

4 Remove the centre bolt and Belleville

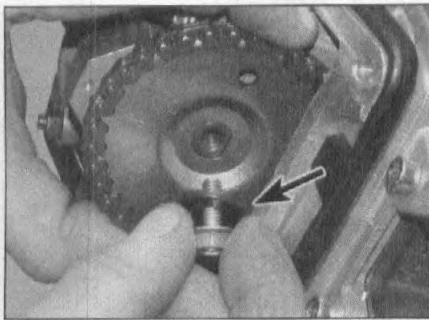


8.12 Check the operation of the ratchet and plunger

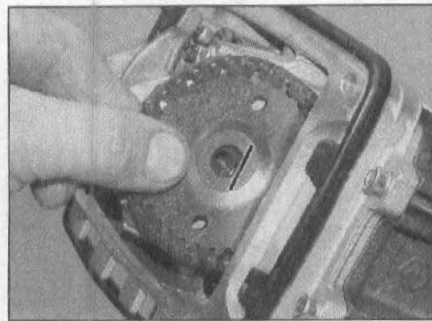


9.3 Lock the sprocket and undo the centre bolt

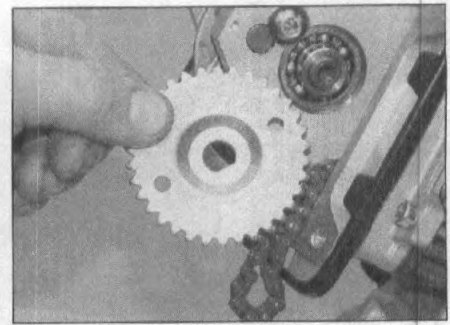




9.4 Remove the bolt and Belleville washer (arrowed)



9.5a Note how the centre hole aligns with the end of the camshaft . . .



9.5b . . . then lift off the sprocket . . .

washer, noting which way round the washer fits (see illustration).

5 Note how the straight-edge on the end of the camshaft aligns with the centre hole in the sprocket, then lift off the sprocket and disengage it from the camchain (see illustrations). Remove the sprocket spacer for safekeeping (see illustration).

6 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 illustration). Draw the sprocket off the pin on the crankshaft, noting how it locates over the pin on the shaft (see illustration).

7 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 (see illustration).

8 The cam chain guide blade is secured by the cylinder head. To remove the blade, first remove the head (see Section 11), then lift out the blade. Note how the lower end of the blade locates in the U-shaped lug in the crankcase (see illustration 9.7).

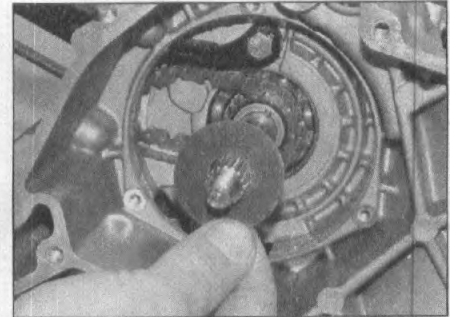
### Inspection

9 Check the sprockets for wear, cracks and other damage, renewing them if necessary. If the sprocket teeth are worn, the chain is also worn. If wear this severe is apparent, the entire engine should be disassembled for inspection.

10 Check the chain tensioner blade and



9.5c . . . and remove the spacer



9.6a Remove the thrustwasher . . .

guide blade for wear or damage and renew them if necessary. If they are worn or damaged, the chain may be worn out or improperly tensioned. Check the operation of the cam chain tensioner (see Section 8).

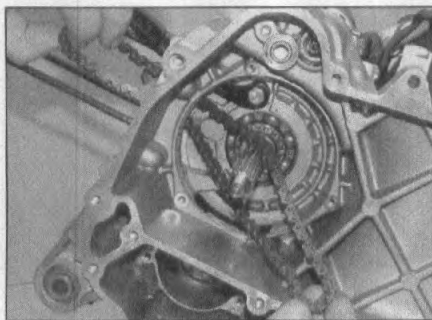
### Installation

11 If removed, install the guide blade and the tensioner blade, making sure they are the correct way round. Tighten the tensioner blade bolt to the torque setting specified at the beginning of the Chapter.

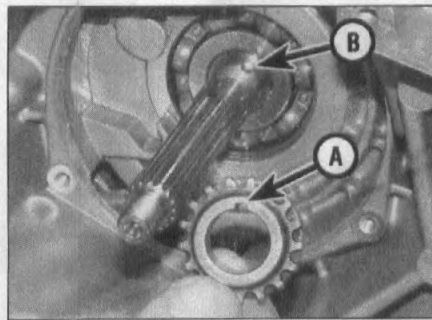
12 If removed, install the sprocket onto the crankshaft, aligning the cutout in the sprocket with the pin on the crankshaft (see illustration 9.6c). Also fit the camshaft sprocket spacer (see illustration 9.5c).

13 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 6).

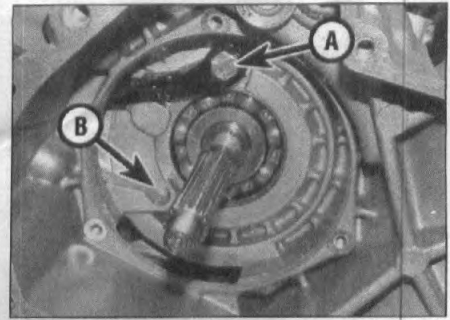
14 Check that the timing mark on the alternator rotor still aligns with the pulse generator pick-up (see illustration 8.7a). Slip the camshaft sprocket into the top of the chain, then fit the sprocket onto the camshaft, aligning the straight-edges between the sprocket and the shaft end (see illustration 9.5a). Ensure that any slack in the chain is at the back of the engine so that it is later taken up by the tensioner, and that the timing mark on the camshaft holder (see illustration 8.7b). Secure the sprocket with the centre bolt and Belleville washer. **Note:** The outer edge of the Belleville washer should be positioned against the sprocket on installation. Insert a length of dowel or a similar tool through the hole in the cylinder for the cam chain tensioner, then press it against the tensioner blade and ensure that the timing marks are still aligned.



9.6b . . . then lift out the cam chain



9.6c Notch in sprocket (A) locates on pin (B)



9.7 Tensioner blade is secured by bolt (A). Guide blade locates in lug (B)

**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.

**15** Using the method employed on removal to prevent the camshaft sprocket turning, tighten the bolt to the torque setting specified at the beginning of the Chapter (see illustration 9.3).

**16** If removed, fit the thrustwasher onto the end of the crankshaft (see illustration 9.6a), then install the oil pump drive sprocket, chain and driven sprocket (see Section 20).

**17** Install the remaining components in the reverse order of removal.

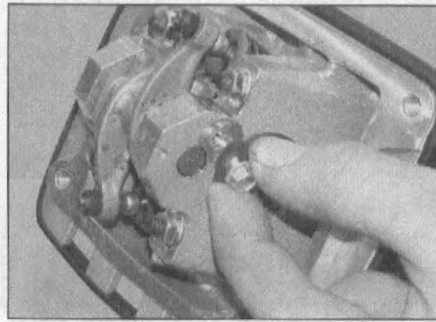
**10 Camshaft and rockers – removal, inspection and installation**



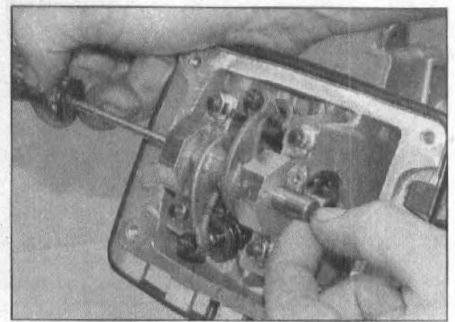
**Note:** This procedure can be carried out with the engine in the frame although access to the top of the engine is extremely restricted. If the engine has been removed, ignore the steps which do not apply.

**Removal**

- 1** Remove the valve cover (see Section 7).
- 2** Remove the camshaft sprocket (see Section 9). Secure the chain with a cable tie to prevent it dropping into the engine. Stuff a clean rag into the cam chain tunnel to prevent anything falling into the engine.
- 3** Undo the stopper bolt and remove the bolt and washer (see illustration).
- 4** Mark the rocker arms so that they can be installed in their original positions, then insert a screwdriver into the right-hand end of the camshaft holder and press out the rocker shaft (see illustration). Support the exhaust valve (right-hand) rocker arm as the shaft is withdrawn and remove it once it is free (see illustration). Withdraw the shaft completely and remove the intake valve rocker arm, then assemble the rockers in their original positions on the shaft (see illustration).
- 5** Before removing the camshaft, temporarily install the stopper bolt and washer and check that the camshaft rotates freely with no discernible up-and-down movement. If available, measure the camshaft endfloat with



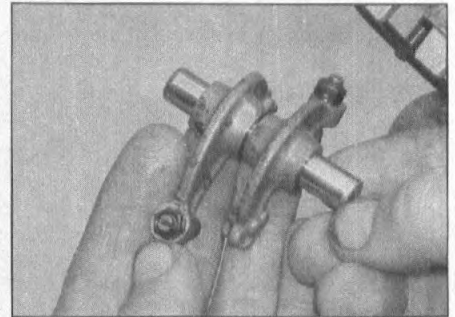
**10.3** Remove the stopper bolt and washer



**10.4a** Press out the rocker shaft ...



**10.4b** ... and remove the rocker arms



**10.4c** Keep the rocker arms and shafts in their original positions

a dial gauge and compare the result to the specification at the beginning of the Chapter. If the endfloat is excessive, remove the camshaft and inspect the shaft journal, bearings and bearing housings for wear.

**6** Remove the stopper bolt and washer. The camshaft and bearing must be drawn out of the camshaft holder – Piaggio provide a service tool (Part No. 020450Y) to do this. Alternatively, use the set-up shown (see illustration). Thread the centre bolt all the way into the end of the camshaft, then gradually turn the outside bolts exerting even pressure against the face of the camshaft holder to pull out the camshaft (see illustration).

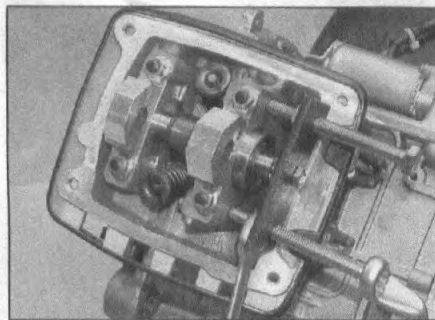
**Inspection**

**7** Clean all of the components with solvent and dry them. Inspect the camshaft lobes for

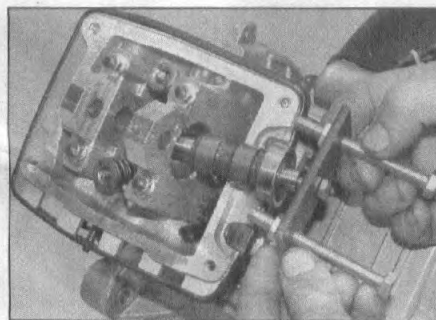
heat discoloration (blue appearance), score marks, chipped areas, flat spots and spalling (see illustration). Measure the height of both lobes with a micrometer and compare the results to the specifications at the beginning of the Chapter (see illustration 10.7b in Chapter 2E). If damage is noted or wear is excessive, the camshaft must be renewed.

**8** Check the condition of the camshaft bearing (see illustration 10.7). If it is in any way worn, runs noisily or roughly, or has excessive play, it must be renewed. If necessary, draw the bearing off the camshaft using a suitable puller. When installing the new bearing, heat it to aid installation and press it onto the shaft, pressing on the inner race only.

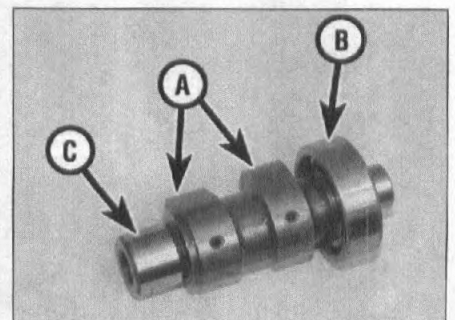
**9** Measure the camshaft journal with a micrometer and, if available, measure the internal diameter of the housing journal with a telescoping gauge and micrometer (see



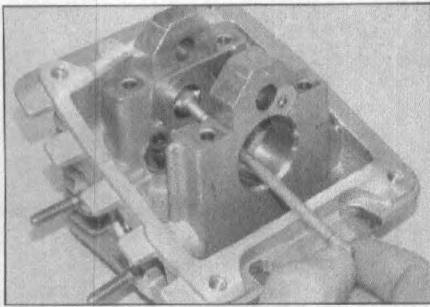
**10.6a** Using the set-up described ...



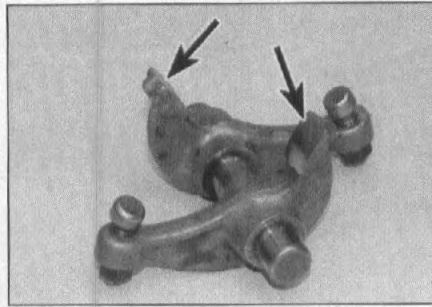
**10.6b** ... to remove the camshaft and bearing



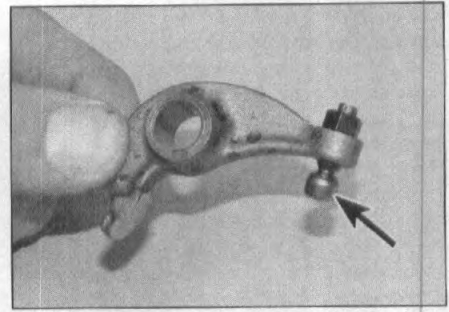
**10.7** Inspect the camshaft lobes (A), bearing (B) and bearing journal (C)



10.9 Measuring the internal diameter of the camshaft housing journal



10.10a Inspect the rocker arm faces . . .



10.10b . . . and the articulated tip of the adjusting screw (arrowed)

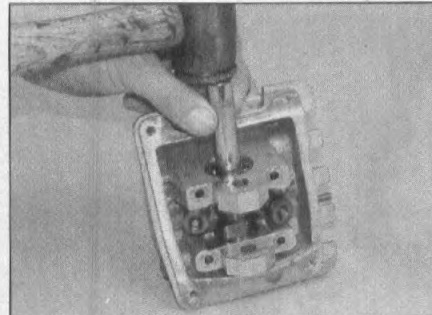
illustration). Compare the results to the specifications at the beginning of the Chapter and, if damage is noted or wear is excessive, renew the faulty component.

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 (see illustration). 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.

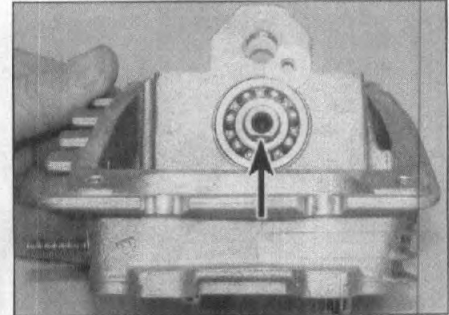
### Installation

11 Lubricate the camshaft bearing and journal with clean engine oil, then install the camshaft. The camshaft should be pressed all the way into its holder; if necessary, use a suitably-sized socket that bears on the inner race of the camshaft bearing only, to tap the shaft into place (see illustration). Ensure the camshaft is positioned with the straight-edge on the end of the shaft facing downwards (see illustration).

12 Lubricate the rocker shaft with engine oil. Slide the shaft through the left-hand housing and fit the intake valve rocker arm and then the exhaust valve rocker arm onto the shaft in that order (see illustration 10.4b). Press the shaft fully into place. With the camshaft in the correct position there should be no pressure on the rocker arms. Install the stopper bolt and washer



10.11a Ensure the camshaft is pressed all the way into its holder



10.11b Straight-edge should face downwards

and tighten the bolt to the torque setting specified at the beginning of the Chapter.

13 Follow the procedure in Section 9 to install the camshaft sprocket, 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.

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). Pull the spark plug cap off the plug.

2 Follow the procedure in Section 8 to remove the cam chain tensioner, then follow the procedure in Section 9 to remove the camshaft sprocket. Secure the cam chain with a cable tie to prevent it falling into the engine.

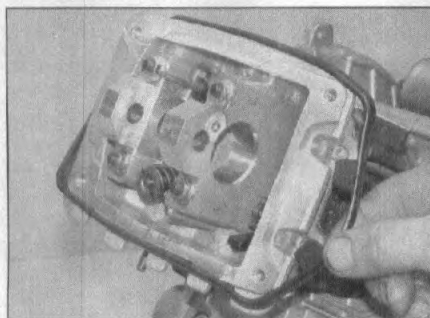
3 Lift off the engine cowlings seal, noting how it fits (see illustration).

4 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).

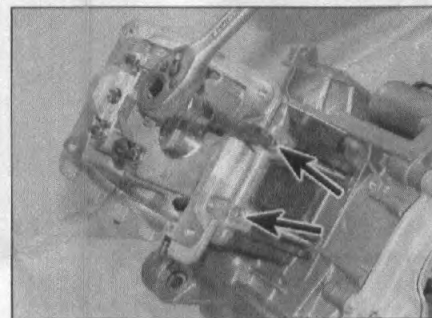
## 11 Cylinder head – removal and installation



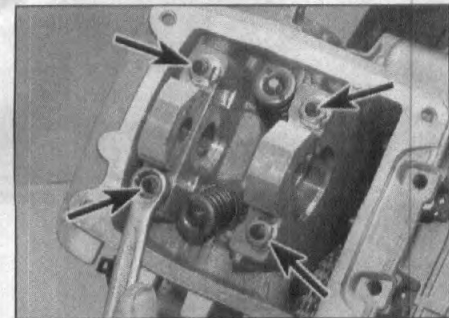
**Note:** This procedure can be carried out with the engine in the frame although access to the



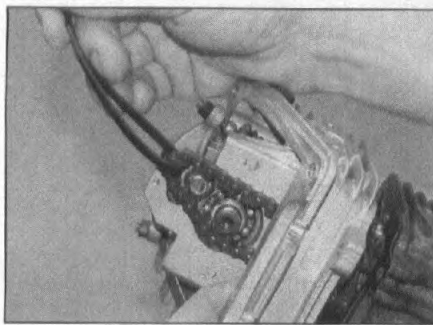
11.3 Remove the engine cowlings seal



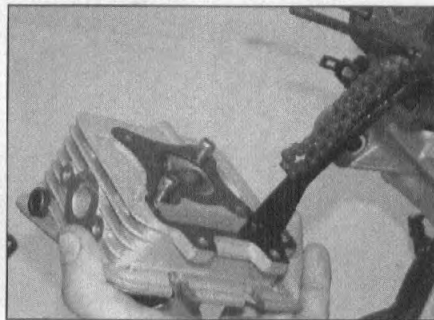
11.4a Undo the external cylinder head bolts (arrowed) . . .



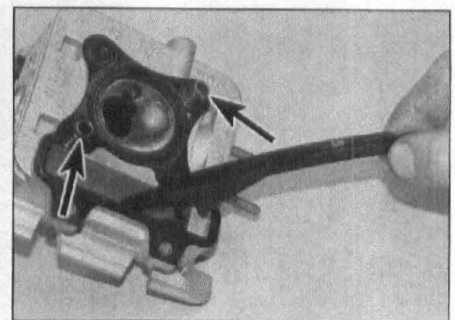
11.4b . . . then the internal cylinder head nuts (arrowed)



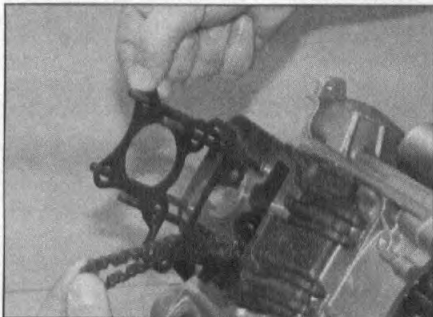
11.5 Support the cam chain and lift off the cylinder head



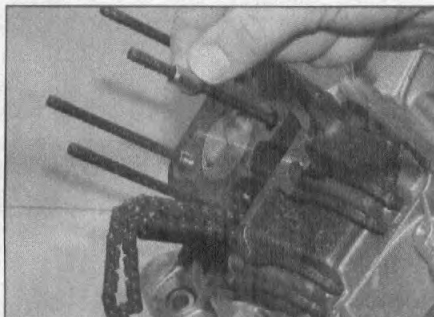
11.6a Note how the guide blade fits ...



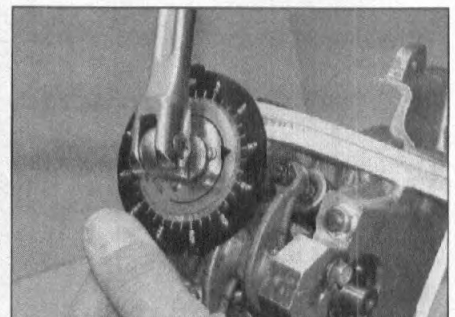
11.6b ... then remove it from the head. Note the dowels (arrowed)



11.7 Remove the head gasket



11.10 Install the dowels in the top of the cylinder



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

5 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).

6 The cam chain guide blade is clipped to the lower edge of the chain tunnel in the head and will lift out with it – detach the blade, noting how it fits (see illustrations). Note the location of the two dowels either in the head or the cylinder, and remove them for safekeeping if they are loose.

7 Remove the old cylinder head gasket (see illustration). Two types of gasket are fitted – a steel gasket (approximately 0.3 mm thick when new) or a fibre gasket (approximately 0.95 mm thick when new). Always fit a new gasket of the same type when installing the cylinder head.

8 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.

9 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

10 Ensure both cylinder head and cylinder mating surfaces are clean. Slide the dowels down the cylinder studs and install them in the top of the cylinder (see illustration). Lay the new gasket in place on the cylinder, making sure the oil passage holes are correctly aligned. Never re-use the old gasket.

11 Carefully lower the head onto the cylinder, feeding the cam chain up through the tunnel (see illustration 11.5). Make sure the dowels are correctly aligned with the head and the gasket.

12 Install the cylinder head 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*.

13 Install the two cylinder head bolts on the left-hand side of the engine and tighten them to the specified torque setting (see illustration 11.4a).

14 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



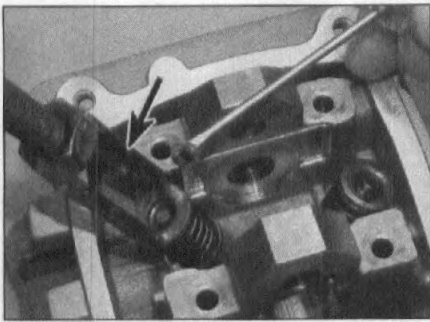
#### HAYNES HINT

*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.*

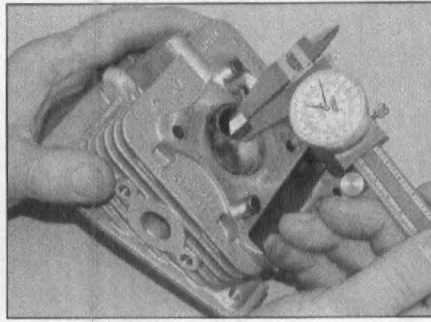
1 If a valve spring compressor is available, the home mechanic can remove the valves from the cylinder head, grind in the valves and renew the valve stem seals. If the necessary measuring tools are available, you can assess the amount of wear on the valves and guides and measure the valve-to-seat contact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

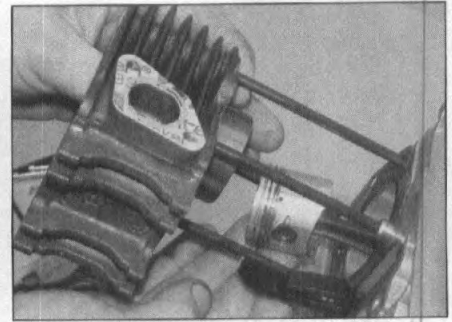
3 After any servicing or repair work, be sure to clean the head thoroughly to remove any metal particles or abrasive grit that may still be present. Use compressed air, if available, to blow out all the holes and passages.



13.5 Using an adapter (arrowed) on the valve spring compressor



13.6 Measuring the valve seat width with a vernier caliper



14.2 Support the piston as the cylinder is raised

### 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.

**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 13.3 in Chapter 2E).

**4** The procedure for disassembly, inspection and reassembly of the cylinder head and valves is the same as for air-cooled LEADER models (see Chapter 2E, Section 13), with the following additions.

**5** When compressing the valve springs, it may be necessary to place a suitable spacer against the valve head to prevent the compressor pressing on the inside of the cylinder head. It may also be necessary to use an adapter to locate the compressor onto the spring retainer (see illustration).

**6** For greater accuracy, measure the valve seat width with a vernier caliper (see illustration).



14.4 Remove the base gasket carefully

### 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.

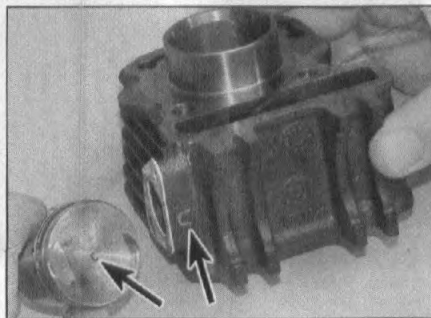
#### Removal

**1** Remove the cylinder head (see Section 11).

**2** 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 (see illustration). If the cylinder is stuck, tap around its joint faces 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.

**3** Note the two dowels in the crankcase and remove them for safekeeping if they are loose.

**4** Remove the gasket carefully (see illustration). If the gasket is marked with a thickness (0.4 or 0.5) make a note of the thickness. If the original cylinder and piston are used on reassembly, a new gasket of the same thickness should be used. If the gasket is not marked, the piston height will have to be measured on reassembly (see Steps 9 to 11). Discard the old gasket.



14.7 Piston and cylinder are stamped with a size-code as shown

#### Inspection

**5** The procedure for inspection of the cylinder is the same as for air-cooled LEADER models (see Chapter 2E, Section 14), with the following additions.

**6** Piaggio recommend the bore is measured at 10 mm, 30 mm and 50 mm down from the top edge, both parallel to and across the crankshaft axis.

**7** The cylinder size-code is stamped into the outside of the cylinder adjacent to the cam chain tensioner location (see illustration).

#### Installation

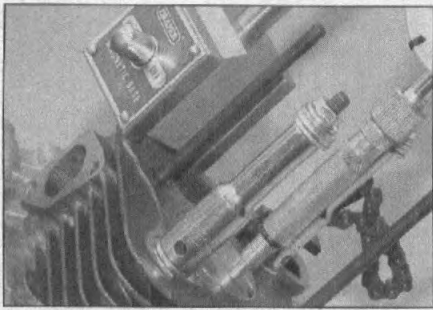
**8** The procedure for installation of the cylinder is the same as for air-cooled LEADER models (see Chapter 2E, Section 14), with the following additions.

**9** Two different size cylinder base gaskets 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 4). If the original gasket was not marked, or if new components are being used, the cylinder must be assembled on the crankcase and piston without a base gasket, and a dial gauge mounted against the crown of the piston to establish which thickness is required.

**10** Use suitable spacers and the cylinder head nuts to tighten the cylinder down against the crankcase. 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 a small distance down the bore.



14.10 Zero the dial gauge on the cylinder top gasket face



14.11 Take the reading off the piston crown at TDC

11 Now rest the tip of the gauge on the centre of the piston crown and rotate the crankshaft via the alternator rotor so the piston rises to the top of its stroke (TDC). At this point read off the dial gauge (see illustration). The further the piston crown is above the top of the cylinder bore, the thicker the base gasket should be. If the engine is fitted with a steel head gasket and the reading is between 0.15 and 0.25 mm a 0.4 mm gasket is required, between 0.25 and 0.35 mm a 0.5 mm gasket is required. If the engine is fitted with a fibre head gasket and the reading is between 0.85 and 0.95 mm a 0.4 mm gasket is required, between 0.95 and 1.05 mm a 0.5 mm gasket is required.

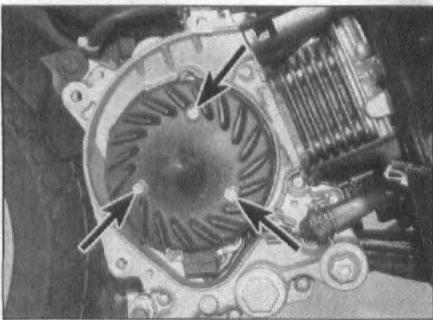
15 Piston – removal, inspection and installation



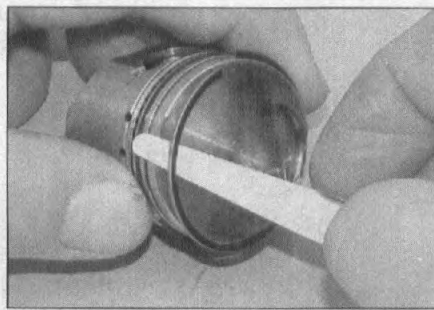
**Note:** This procedure can be carried out with the engine in the frame although access to the top of the engine is extremely restricted. If the engine has been removed, ignore the steps which do not apply.

1 The procedure for removal, inspection and installation of the piston is the same as for four-stroke engines described in Chapter 2C, Section 16, with the following additions.

2 To avoid breaking the rings, use an old feeler gauge blade to ease them off the piston (see illustration). 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 (see illustration).



17.3 Cooling fan is secured by three screws (arrowed)



15.2a Using a thin blade to remove the piston rings

3 When checking the piston-to-bore clearance, measure the piston 27 mm down from the top edge of the piston and at 90° to the piston pin axis.

16 Piston rings – inspection and installation

1 The procedure for inspection and installation of the piston rings is described in Chapter 2C, Section 17.

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

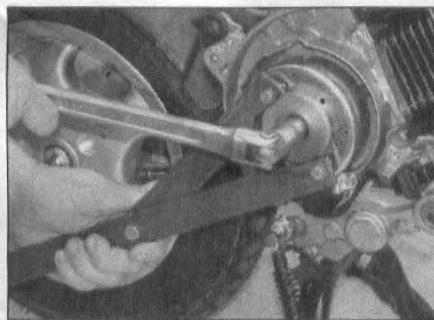
1 Remove the bodywork as required by your model to access the alternator cover on the right-hand side of the engine (see Chapter 7).

2 Remove the screws securing the alternator cover and remove the cover (see illustrations 8.3a and 8.3b).

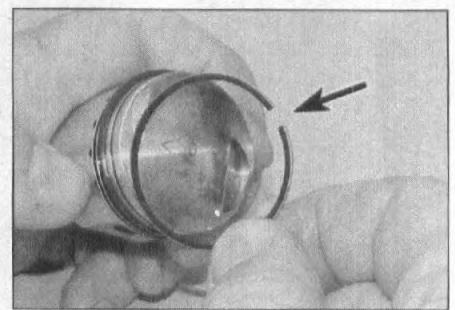
3 Remove the three screws securing the cooling fan to the alternator rotor and remove the fan (see illustration).

Installation

4 Installation is the reverse of removal. Note that the screw holes are offset so that the fan can only be fitted in one position on the rotor.



18.2 Hold the alternator rotor and undo the centre nut



15.2b Check for a mark at one end of the piston ring

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

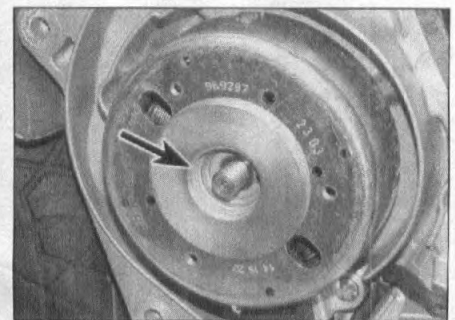
1 Remove the cooling fan (see Section 17).

2 To remove the rotor nut it is necessary to stop the rotor from turning. Piaggio produce a service tool (Part No. 020656Y) which locates in the holes in the rotor. A similar tool can be made (see illustration). With the rotor held securely, unscrew the nut.



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) 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 (see illustration). With the tool in place, hold the body of the tool using a spanner on its flats while tightening the



18.3a Service tool screws into threads provided

centre bolt (turn it clockwise) to draw the rotor off the end of the shaft (see illustration). 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). If it is loose, remove the Woodruff key from the shaft, noting how it fits.

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, noting how it locates in the crankcase, then undo the screws that secure the stator and the pulse generator coil (see illustration). Lift off the stator/pulse generator coil assembly (see illustration).

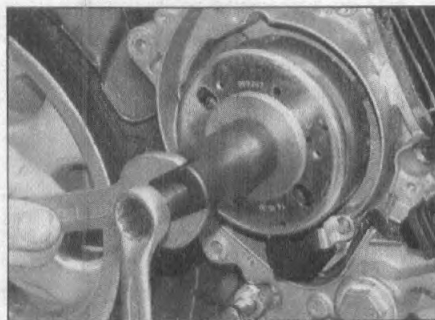
### Installation

5 Install the stator and pulse generator coil onto the crankcase; ensure the multi-pin connector positioned. Install the stator and generator coil screws and tighten them securely.

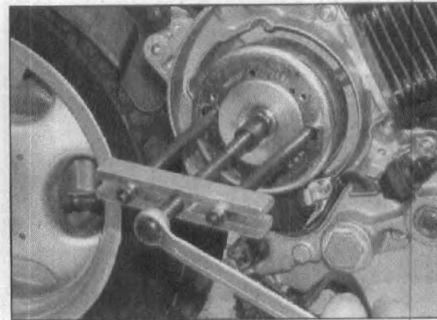
6 Clean the tapered end of the crankshaft and the corresponding mating surface on the inside of the rotor with a suitable solvent. Make sure that no metal objects have attached themselves to the magnets on the inside of the rotor. If removed, fit the Woodruff key into its slot in the shaft, then install the rotor onto the shaft, aligning the slot in the rotor with the key.

7 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.

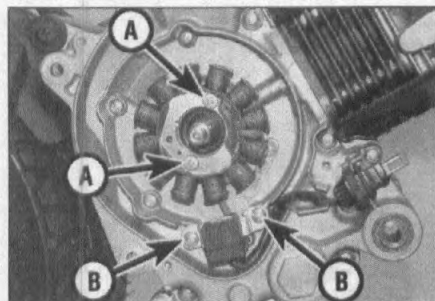
8 Install the remaining components in the reverse order of removal.



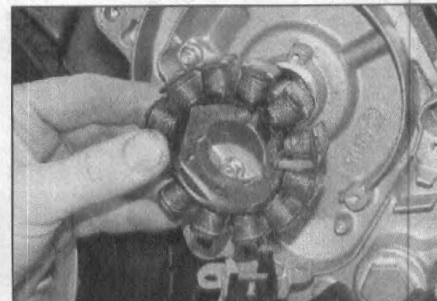
18.3b Using the service tool to remove the alternator rotor



18.3c Using a two-legged puller to remove the alternator rotor



18.4a Alternator stator is secured by screws (A), pulse generator coil is secured by screws (B)



18.4b Lift off the stator/generator coil assembly

3 Undo the bolts securing the sump cover, noting the position of the clip for the rear brake cable, and remove the cover (see illustration). Be prepared to catch any residual oil when the cover is removed. Discard the gasket, as a new one must be used on reassembly.

4 Undo the bolts securing the pump drive chain cover, then carefully lever the cover out (see illustration). Discard the cover O-ring, as a new one should be used. Note the chain guide on the back of the cover (see illustration)

5 Undo the bolts securing the pump sprocket

## 19 Starter pinion assembly – removal, inspection and installation



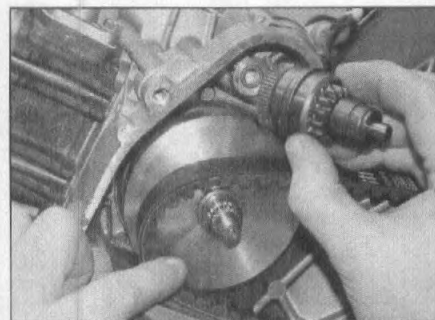
**Note:** This procedure can be carried out with the engine in the frame.

1 Follow the procedure in Chapter 2G to remove the drivebelt cover and the starter driven gear.

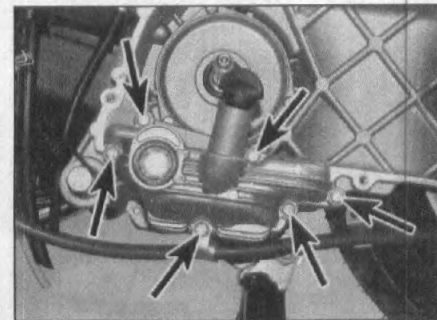
2 Hold the variator in position on the crankshaft and lift out the starter pinion assembly, noting how it fits (see illustration).

3 The procedure for inspection of the starter pinion assembly is the same as for air-cooled LEADER models (see Chapter 2E, Section 19).

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



19.2 Lift out the starter pinion assembly



20.3 Undo the sump cover bolts

## 20 Oil pump – removal, inspection and installation

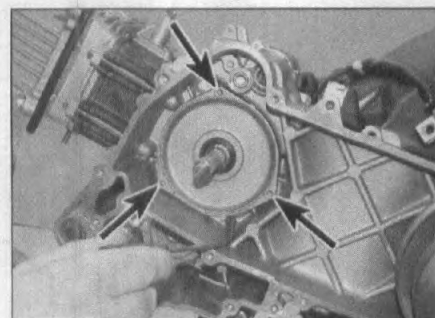


**Note:** This procedure can be carried out with the engine in the frame.

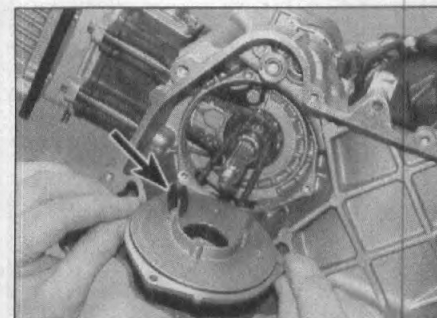
### Removal

1 Drain the engine oil (see Chapter 1).

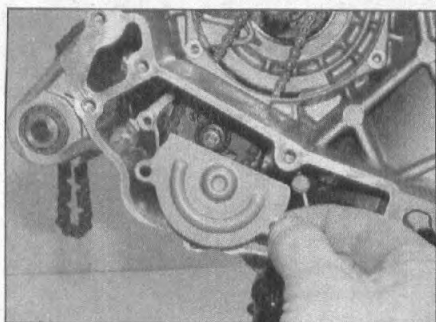
2 Remove the drive pulley and variator (see Chapter 2G).



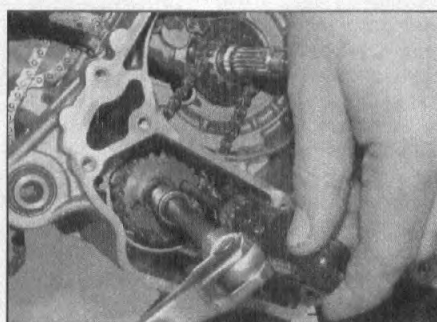
20.4a Undo the cover bolts (arrowed) and lever out the cover



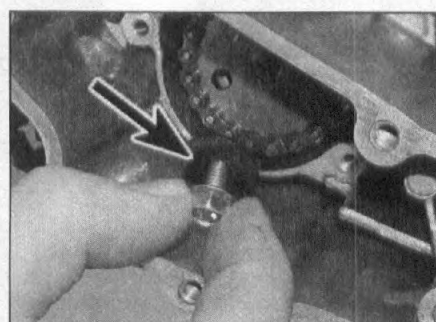
20.4b Note the location of the chain guide (arrowed)



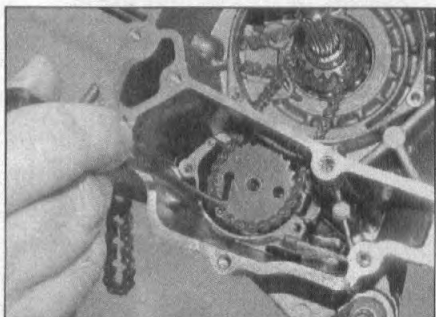
20.5 Remove the pump sprocket plate



20.6a Undo the pump sprocket bolt



20.6b Remove the bolt and Belleville washer (arrowed)

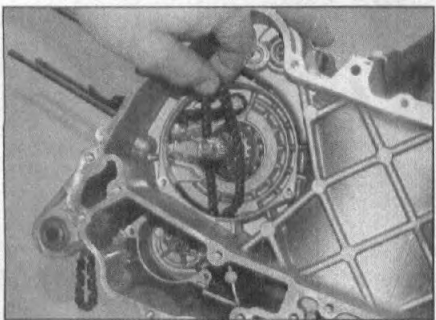


20.6c Pull the sprocket off the pump

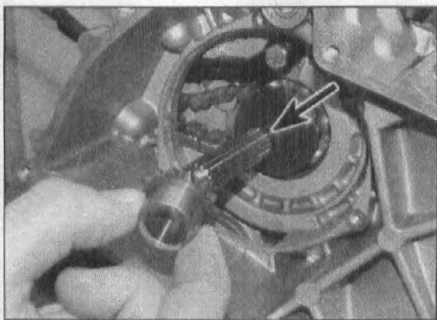
plate and remove the plate, noting how it fits (see illustration).

6 Insert a pin punch or screwdriver through one of the holes in the driven sprocket and locate it against the pump body to stop the sprocket turning, then unscrew the sprocket bolt (see illustration). Remove the bolt and Belleville washer, noting which way round the washer fits (see illustration). Pull the sprocket off the pump and slip it out of the chain (see illustration).

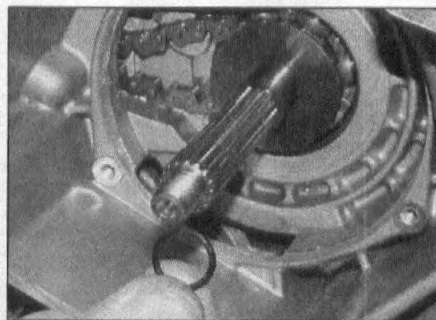
7 If required, draw the chain up into the transmission housing and remove it from the drive sprocket (see illustration). **Note:** Before the chain is removed, mark it so that it can be fitted the same way round. Slide the drive sprocket off the end of the crankshaft, noting which way round it fits. Note the position of the O-ring on the shaft (see illustration). Slide the O-ring off the shaft and discard it, as a new one must be fitted (see illustration).



20.7a Remove the chain ...



20.7b ... then slide off the sprocket noting the O-ring (arrowed)



20.7c Remove the O-ring from the crankshaft

8 Undo the two screws securing the oil pump and remove the pump. Also remove the gasket from behind the pump and discard it, as a new one must be used.

### Inspection

**Note:** No relief valve is fitted to this lubrication system.

9 The procedure for disassembly and inspection of the oil pump is the same as for air-cooled LEADER models (see Chapter 2E, Section 20), with the following addition.

10 Check the condition of the oil seal in the drive chain cover and renew it if it is damaged or if oil is leaking into the drivebelt casing. Check the chain guide and renew it if it is worn (see illustration 20.4b).

### Installation

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

- Make sure the holes in the pump gasket align with the oil holes.
- Tighten the pump mounting screws to the torque setting specified at the beginning of the Chapter.
- Lubricate the new crankshaft O-ring with clean engine oil and fit it onto the crankshaft carefully to avoid damage.
- Install the drive sprocket with its shouldered end facing out.
- Fit the Belleville washer on the pump sprocket bolt with the outer edge of the washer against the sprocket.
- Tighten the sprocket bolt to the specified torque setting.

- Fit a new O-ring to the drive chain cover.
- Fit a new gasket to the sump cover.
- Fill the engine with the correct type and quantity of oil (see Chapter 1). Start the engine and check for oil leaks around the sump.

## 21 Crankcase halves, crankshaft and connecting rod



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

### Separation

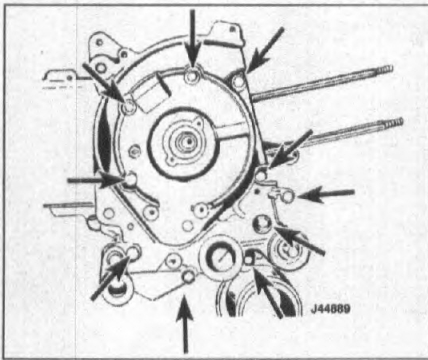
1 To access the crankshaft and its bearings, the crankcase must be split into two parts.

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:

- Camchain, blades and sprockets (see Section 9).
- Cylinder head (see Section 11).
- Cylinder (see Section 14).
- Alternator rotor and stator (see Section 18).
- Variator (see Chapter 2G).
- Starter motor (see Chapter 9).
- Oil pump (see Section 20).
- Centre stand (see Chapter 7).

3 Unscrew the ten crankcase bolts evenly, a little at a time and in a criss-cross sequence until they are all finger-tight, then remove them





21.3 Crankcase bolt locations (arrowed)

(see illustration). Carefully lift the right-hand crankcase half off the left-hand half. Lift the crankshaft out of the left-hand (transmission side) crankcase. Note the two dowels and remove them for safekeeping if they are loose.

4 Remove the oil seal from the right-hand crankcase half, having taken careful note of its fitted position. Clean all traces of old gasket sealant from both crankcase halves with a suitable solvent. Take care not to scratch or gouge the soft aluminium.

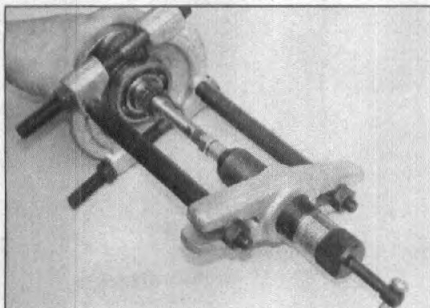
### Inspection

5 Refer to Chapter 2E, Section 21 for general crankcase inspection procedures.

6 Check the condition of the main bearings. The right-hand bearing will remain on the crankshaft and the left-hand bearing will be held in the crankcase half. The bearings should spin freely and smoothly without any rough spots or excessive noise. Renew them if there is any doubt about their condition.

7 The right-hand bearing should be removed from the crankshaft using an external bearing puller. Make sure that the puller clamp or legs fit securely behind the bearing and are in no danger of slipping out, and thread the alternator rotor nut onto the crankshaft to protect the end of the shaft (see illustration). Note which way round the bearing is fitted. To fit the new bearing the crankshaft must be supported securely with the right-hand end uppermost. Heat the new bearing in an oil bath to 120°C then install it on the shaft and press it into position with a suitable length of tube that bears on the inner race only.

8 Before removing the left-hand bearing, heat



21.7 Removing the main bearing from the crankshaft

the bearing housing using a hot air gun to aid removal, then drive the bearing out with a bearing driver or suitably-sized socket. Note which way round the bearing is fitted. Reheat the bearing housing then press the new bearing into position with a suitably-sized socket that bears on the outer race only.

9 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 not out of alignment (see illustrations 21.17b and 21.17c in Chapter 2E). Compare the results with the specifications at the beginning of this Chapter.

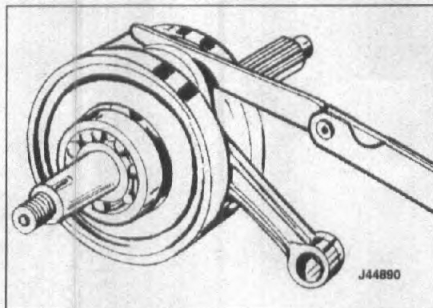
10 Place the crankshaft assembly on V-blocks and check the runout at the main bearing journals and at the ends of the shafts (see illustration 21.18 in Chapter 2E). **Note:** The right-hand main bearing must be removed from the shaft for this check. If the runout exceeds the specified limit, or if either of the connecting rod measurements exceed the limit, the crankshaft assembly must be renewed.

### Reassembly

11 Lubricate the new crankcase oil seal with clean engine oil and 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.

12 Lubricate the big-end and main bearings with engine oil and insert the crankshaft into the left-hand crankcase half, positioning the connecting rod in line with the crankcase mouth. Apply a suitable gasket sealant to the crankcase mating surface. Guide the right-hand crankcase half over the crankshaft end, pressing it over the right-hand main bearing. If necessary, heat the bearing housing with a hot air gun and 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.

13 Clean the threads of the crankcase bolts and install them finger-tight. Tighten the bolts evenly, in a criss-cross sequence, to the torque setting specified at the beginning of this



21.9 Checking the connecting rod big-end bearing side clearance

Chapter. Support the connecting rod and rotate the crankshaft to check that it moves freely.

14 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 bike 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.

