Chapter 1 Engine

Contents

Specifications

V-1000 model

Engine

Type	Air cooled, 90° V-twin four stroke
Bore	88 mm (3.46 in)
Stroke	78 mm (3.07 in)
Capacity	948.8 cc (57.9 cu in)
Compression ratio	9.2 : 1
bhp (SAE)	71 @ 6,500 rpm
Max rpm	
Direction of rotation	Clockwise, viewed from front

Valve clearances (engine cold)

Inlet	0.22 mm (0.009 in)
Exhaust	0.22 mm (0.009 in)

Valve timing

Inlet opens	20° BTDC
Inlet closes	52° ABDC
Exhaust opens	52° BBDC
Exhaust closes	20° ATDC

Note: Timing is set with valve clearances adjusted to 0.5 mm (0.020 in)

Valves

Seat angle	45° 30'
Inlet:	
head diameter	40.8 - 41.0 mm(1 .606 - 1.614 in)
stem diameter	7.972 - 7.987 mm (0.3138 - 0.3144 in)
Exhaust:	
head diameter	35.8 - 36.0 mm (1.409 - 1.417 in)
stem diameter	7.965 - 7.980 mm (0.3136 - 0.3142 in)
Valve guide inside diameter	8.00 - 8.022 mm (0.3149 - 0.3158 in)
Valve guide/stem clearance:	
inlet	0.013 - 0.050 mm (0.0005 - 0.0019 in)
exhaust	0.020 - 0.057 mm (0.0008 - 0.0022 in)
Valve guide outside diameter:	
inlet	14.064 - 14.075 mm (0.5537 - 0.5541 in)
exhaust	14.107 - 14.118 mm (0.55541 - 0.5558 in)
Valve guide housing inside diameter	14.00 - 14.018 mm (0.5512 - 0.5519 in)
Valve spring free length:	
outer	52.6 mm (2.07 in)
inner	44.7 mm (1.770 in)

Rocker arms

Bush inside diameter	15.032 - 15.059 mm (0.5918 - 0.5929 in)
Spindle outside diameter	14.982 - 14.994 mm (0.5899 - 0.5903 in)
Bush/spindle clearance	0.038 - 0.076 mm (0.0015 - 0.003 in)

Camshaft

Journal diameter:	
flywheel side	31.984 - 32.000 mm (1.2592 - 1.2598 in)
timing side	46.984 - 47.00 mm (1.849 - 1.850 in)
Housing diameter:	
flywheel side	32.025 - 32.050 mm (1.2607 - 1.2623 in)
timing side	47.025 - 47.050 mm (1.8511 - 1.8529 in)
Clearance:	
flywheel side	0.025 - 0.066 mm (0.001 - 0.0035 in)
timing side	0.025 - 0.066 mm (0.001 - 0.0035 in)

Tappets

Guide bore diameter:	
standard	22.021 - 22.00 mm (0.8669 - 0.8661 in)
1st oversize	22.071 - 22.050 mm (0.8689 - 0.8681 in)
2nd oversize	22.121 - 22.100 mm (0.8709 - 0.8700 in)
Tappet outside diameter	
standard	21.996 - 21.978 mm (0.8659 - 0.8652 in)
1st oversize	22.046 - 22.028 mm (0.8679 - 0.8672 in)
2nd oversize	22.096 - 22.018 mm (0.8699 - 0.8668 in)
Clearance	0.004 - 0.043 mm (0.0015 - 0.0016 in)

Crankshaft

Mainbearing journal outside diameter:	
flywheel side	53.970 - 53.931 mm (2.1248 - 2.1233 in)
timing side	37.975 - 37.959 mm (1.4951 - 1.4944 in)
Main bearing inside diameter:	
flywheel side	54.000 - 54.019 mm (2.1260 - 2.1267 in)
timing side	38.000 - 38.016 mm (1.4961 - 1.4967 in)
Clearance:	
flywheel side	0.030 - 0.068 mm (0.0011 - 0.0027 in)
timing side	0.025 - 0.057 mm (0.0010 - 0.0022 in)

Note: Main bearings are available in three oversizes of 0.20 mm (0.0079 in) increments

Big end journal diameter:	
standard class A	44.008 - 44.014 mm (1.7325 - 1.7328 in)
standard class B	44.014 - 44.020 mm (1.7328 - 1.7330 in)

Note: On original assembly the big-end journals are selectively matched with two classes of big end bearing. Class A marked white is matched with Class B crankshaft marked white. Class B bearings marked blue on the connecting rod are matched with Class A crankshaft, marked blue. When the crankshaft requires re-grinding three bearing oversizes are available.

Big-end bearing	
1st oversize	0.254 mm (0.010 in)
2nd oversize	0.508 mm (0.020 in)
3rd oversize	0.762 mm (0.030 in)

Big-end bearing clearance	0.050 - 0.085 mm (0.002 - 0.0032 in)
Big-end axial float	0.030 - 0.040 mm (0.0011 - 0.0015 in)
Small end bearing	
Small end bush diameter	22.025 - 22.045 mm (0.8670 - 0.8767 in)
Gudgeon pin diameter	22.00 - 22.004 mm (0.8661 - 0.8663 in)
Clearance	0.021 - 0.045 mm (0.0008 - 0.0017 in)

Cylinder barrel diameter

Class A	88.00 - 88.009 mm (3.4645 - 3.4649 in)
Class B	88.009 - 88.018 mm (3.4649 - 3.4652 in)

Note: Cylinders are selectively matched to pistons of same class on original assembly. On subsequent rebore, two oversizes of piston are available.

Pistons and rings

Piston outside diameter:	
Class A	87.933 - 87.942 mm (3.4619 - 3.4622 in)
Class B	87.942 - 87.951 mm (3.4622 - 3.4626 in)
Piston oversize:	
1st oversize	0.40 mm (0.0157 in)
2nd oversize	0.60 mm (0.032 in)
Ring end gap:	
compression rings	0.30 - 0.45 mm (0.0118 - 0.018 in)
oil control ring	0.25 - 0.40 mm (0.010 - 0.015 in)
Side clearance:	
top ring	0.030 - 0.062 mm (0.0011 - 0.0024 in)
2nd ring	0.030 - 0.062 mm (0.0011 - 0.0024 in)
3rd ring	0.030 - 0.062 mm (0.0011 - 0.0024 in)
oil control ring	0.025 - 0.040 mm (0.0010 - 0.0015 in)

850T, 850T3 and 850 California models

Engine

Type	Air cooled, 90° V-twin four stroke
Bore	83 mm (3.267 in)
Stroke	78 mm (3.070 in)
Capacity	844 cc (51.49 cu in)
Compression ratio	9.5 : 1
bhp (SAE)	68.5 @ 7,000 rpm
Direction of rotation	Clockwise, viewed from front

Valve clearances (engine cold)

Inlet	0.22 mm (0.009 in)
Exhaust	0.22 mm (0.009 in)

Valve timing

Inlet opens	20° BTDC
Inlet closes	52° ABDC
Exhaust opens	52° BBDC
Exhaust closes	20° ATDC

Note: Timing is set with valve clearances adjusted to 1.5 mm (0.060 in)

Valves

Seat angle	45° 30'
Inlet:	
head diameter	40.8 - 41.0 mm (1.606 - 1.614 in)
stem diameter	7.972 - 7.987 mm (0.3136 - 0.3144 in)
Exhaust:	
head diameter	35.8 - 36.0 mm (1.409 - 1.417 in)
stem diameter	7.965 - 7.980 mm (0.3136 - 0.3142 in)
Valve guide inside diameter	8.000 - 8.022 mm (0.3149 - 0.3158 in)
Valve guide/stem clearance:	
inlet	0.013 - 0.050 mm (0.0005 - 0.0019 in)
exhaust	0.020 - 0.057 mm (0.0008 - 0.0022 in)
Valve guide outside diameter:	
inlet	14.064 - 14.075 mm (0.5537 - 0.5541 in)
exhaust	14.107 - 14.118 mm (0.55541 - 0.5558 in)
Valve guide housing inside diameter	14.000 - 14.018 mm (0.5512 - 0.5519 in)

Valve spring free length:	
outer	52.6 mm (2.07 in)
inner	44.7 mm (1.779 in)

Rocker arms

Bush inside diameter	15.032 - 15.059 mm (0.5918 - 0.5929 in)
Spindle outside diameter	14.982 - 14.994 mm (0.5899 - 0.5903 in)
Bush/spindle clearance	0.038 - 0.079 mm (0.0015 - 0.003 in)

Camshaft

Journal diameter:	
flywheel side	31.984 - 32.000 mm (1.2592 - 1.2598 in)
timing side	46.984 - 47.000 mm (1.814 - 1.850 in)
Housing diameter:	
flywheel side	32.025 - 32.050 mm (1.2607 - 1.2623 in)
timing side	47.025 - 47.050 mm (1.8511 - 1.8529 in)
Clearance:	
flywheel side	0.025 - 0.066 mm (0.001 - 0.0035 in)
timing side	0.025 - 0.066 mm (0.001 - 0.0035 in)

Tappets

Guide bore diameter:	
standard	22.021 - 22.000 mm (0.8669 - 0.8661 in)
1st oversize	22.071 - 22.050 mm (0.8689 - 0.8681 in)
2nd oversize	22.121 - 22.100 mm (0.8709 - 0.8700 in)
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standard	21.996 - 21.978 mm (0.8695 - 0.8652 in)
1st oversize	22.046 - 22.028 mm (0.8679 - 0.8672 in)
2nd oversize	22.096 - 22.018 mm (0.8699 - 0.8668 in)
Clearance	0.004 - 0.043 mm (0.0015 - 0.0016 in)

Crankshaft

Main bearing journal diameter:	
flywheel side	53.970 - 53.931 mm (2.1248 - 2.1233 in)
timing side	37.975 - 37.959 mm (1.4951 - 1.4944 in)
Main bearing inside diameter:	
flywheel side	54.000 - 54.019 mm (2.1260 - 2.1267 in)
timing side	38.000 - 38.016 mm (1.4961 - 1.4967 in)
Clearance:	
flywheel side	0.030 - 0.068 mm (0.0011 - 0.0027 in)
timing side	0.025 - 0.057 mm (0.0010 - 0.0022 in)

Note: Main bearings are available in three oversizes of 0.20 mm (0.0079 in) increments

Big-end journal diameter:	
Class A	44.008 - 44.014 mm (1.7325 - 1.7328 in)
Class B	44.014 - 44.020 mm (1.7328 - 1.7330 in)

Note: On original assembly the big-end bearings are selectively matched with two classes of journal sizes. Class A marked white is matched with class B crankshaft, marked white. Class B bearings marked blue on the connecting rod are matched with class A crankshaft, marked blue. When the crankshaft requires re-grinding three bearing oversizes are available.

Big-end bearing:	
1st oversize	0.254 mm (0.010 in)
2nd oversize	0.508 mm (0.020in)
3rd oversize	0.762 mm (0.030 in)
Big-end bearing clearance	0.030 - 0.054 mm (0.0011 - 0.0021 in)
Big-end axial float	0.030 - 0.040 mm (0.0011 - 0.0015 in)
Small end bearing	
Small end bush diameter	22.025 - 22.045 mm (0.8670 - 0.8767 in)
Gudgeon pin diameter	22.000 - 22.004 mm (0.8661 - 0.8663 in)
Clearance	0.021 - 0.045 mm (0.0008 - 0.0017 in)

Cylinder barrel diameter

Class A	83.000 - 83.006 mm (3.2670 - 3.2679 in)
Class B	83.006 - 83.012 mm (3.2679 - 3.2681 in)
Class C	83.012 - 83.018 mm (3.2681 - 3.2684 in)

Note: Cylinders are selectively matched on original assembly with pistons of same class. Because the cylinder bore is chrome plated no subsequent rebore is possible

Pistons and rings

Piston outside diameter	
Class A	82.968 - 82.974 mm (3.2664 - 3.2668 in)
Class B	82.974 - 82.980 mm (3.2668 - 3.2669 in)
Class C	82.980 - 82.986 mm (3.2669 - 3.2671 in)
Ring end gap:	
compression rings	0.30 - 0.45 mm (0.0118 - 0.0180 in)
oil control ring	0.25 - 0.40 mm (0.010 - 0.0150 in)
Side clearance:	
compression rings	0.030 - 0.062 mm (0.0011 - 0.0024 in)
oil control ring	0.025 - 0.040 mm (0.0010 - 0.0015 in)

850 Le Mans model

Engine

Type	Air cooled 90° V-twin four stroke
Bore	83 mm (3.267 in)
Stroke	78 mm (3.070 in)
Capacity	844 cc (51.49 in)
Compression ratio	10.2 : 1
bhp (SAE)	80 @ 7,300 rpm
Max rpm	—
Direction of rotation	Clockwise, viewed from front

Note: All data, except for the following, is as given for 850T, T3 and California models

Cylinder barrel diameter

Class A	83.000 - 83.009 mm (3.2677 - 3.2680 in)
Class B	83.009 - 83.018 mm (3.2680 - 3.2684 in)

Note: Cylinders are selectively matched to piston of same class on original assembly. On subsequent rebore two oversizes of piston are available

Pistons and rings

Piston diameter:	
Class A	82.936 - 82.945 mm (3.2651 - 3.2655 in)
Class B	82.945 - 82.954 mm (3.2655 - 3.2660 in)
Piston oversize:	
1st oversize	0.40 mm (0.0157 in)
2nd oversize	0.60 mm (0.023 in)

750S and 750S3 models

Engine

Type	Air cooled 90° V-twin, four stroke
Bore	82.5 mm (3.247 in)
Stroke	70.0 mm (2.756 in)
Capacity	748.4 cc (45.66 cu in)
Compression ratio	9.8 : 1
bhp (SAE)	70 @ 7,000 rpm
Direction of rotation	Clockwise, viewed from front

Note: All data, except for the following, is as for 850T and T3 models

Valve timing

Inlet opens	40° BTDC
Inlet closes	70° ABDC
Exhaust opens	63° BBDC
Exhaust closes	29° ATDC

Cylinder barrel diameter

Class A	82.500 - 82.506 mm (3.2480 - 3.2482 in)
Class B	82.506 - 82.512 mm (3.2482 - 3.2484 in)
Class C	82.512 - 82.516 mm (3.2484 - 3.2486 in)

Pistons and rings

Piston diameter	
Class A	82.458 - 82.464 mm (3.2463 - 3.2465 in)
Class B	82.464 - 82.470 mm (3.2465 - 3.2467 in)
Class C	82.470 - 82.476 mm (3.2467 - 3.2469 in)

1 General description

The engines fitted to all the Moto Guzzi models covered in this manual are of similar configuration and basic design and share many identical components. The engine is a 90° V-twin mounted in line with the frame, so that the angled cylinders are positioned in the direct air flow for efficient cooling. To aid this and maintain lightness, all major castings are in aluminium alloy. The crankshaft is a one-piece unit supported on plain bearings at the front and rear. Both bearings are one-piece components integral with their cast aluminium housings. The H section connecting rods have split big ends with detachable shell bearings, the connecting rods being supported on a single journal.

A single camshaft driven by chain from, and mounted above the crankshaft, operates the valves via steel cup-type followers and aluminium pushrods. The camshaft incorporates the tachometer drive gear and the contact breaker cam drive gear at the front and rear respectively.

On V-1000 models, the aluminium cylinder barrels are fitted with steel liners, which may be over bored. All other models have chromed-plated bores which extend considerably the expected bore life, but which must be renewed when wear becomes excessive. Overboring is not possible.

Lubrication is provided by a helical gear oil pump driven by the camshaft chain. Oil is picked up from the sump via a mesh filter and is supplied under pressure to all the working parts of the engine, after passing through a cartridge type filter (not 750s and 850T models). The oil is returned to the sump by gravity.

2 Operations with engine unit in the frame

1 It is only necessary to remove the engine from the frame if the crankshaft or main bearings require attention.
2 Most other work may be undertaken fairly easily with the engine still in the frame.
3 Since removing the engine, which is heavy, requires partial dismantling of the rear drive and suspension, it is advantageous to do all such work with the engine in situ. If, however a major overhaul is to be undertaken when a large number of components must be detached, removal of the engine/gearbox unit will aid accessibility and general ease of working.
4 The following components may be removed with the engine in place:

Cylinder heads, barrels and pistons
Connecting rods and big-end bearings.
Camshaft
Alternator
Oil pump

3 Method of engine/gearbox removal

Unlike most motorcycles, the engine fitted to the Moto Guzzi cannot be lifted from the frame in the normal manner. Due to the configuration of the cylinders and to the close proximity of the engine/gearbox assembly to the frame tubes, it is necessary to lift the frame up and off the engine/gearbox unit, the latter assembly remaining on the ground supported by the sub-frame and rear stand. This can be accomplished after detaching the sub-frame from the main frame and removing the rear suspension swinging arm. In addition, all components interconnecting the engine with the frame must be detached or disconnected in the normal way. The engine and gearbox can be removed only as a unit and not as individual components.

4 Removing the engine/gearbox unit from the frame

1 Place the machine on the centre stand so that it is supported securely on level ground. Position a suitable container of more than 3.5 litres (7.3/6.0 US/Imp pints) capacity below the engine and remove the drain plug from the rear wall of the sump. If work is to be carried out on the gearbox, this too should be drained. The gearbox has a capacity of 0.6 litres (1.44/1.05 US/Imp pints). In both cases, oil drainage will be accelerated if the engine has been allowed to reach full working temperature first; the oil will be thinner and so flow more readily.
2 On V-1000 models the torque converter hydraulic fluid must be drained from the system. Remove the left-hand frame side cover to gain access to the fluid tank. The cover is located by hooks at the upper edge and by a push fit projection at the base. Unscrew the lower banjo bolt from the fluid reservoir and allow the fluid to drain from the reservoir and pipe. Note the filter screen incorporated in the banjo bolt. Detach the hydraulic fluid return pipe from the underside of the bell housing. Drain also the fluid in the oil cooler by detaching the lower of the two pipes on the right-hand side of the gearbox. The pipe union is secured by a domed nut.
3 On all touring models the panniers and pannier crashbars must be removed to gain access during further dismantling. Removal of the handlebar screen is also recommended, to prevent accidental damage to this component during frame lifting operations. The removal of these ancillaries is quite straightforward, all being secured by brackets and bolts.
4 Raise the dualseat so that it is held in the upper-most position by the support rod provided, and lift out the tool tray. Remove the frame side covers, each of which is retained by hooks at the upper edge and by a push fit projection passing into a frame mounted grommet at the base. Unclip the battery retaining strap and detach both main leads from the battery terminals. The battery is very heavy and is a tight fit between the frame members and adjacent cycle parts. Due to this removal can be difficult. The battery must be tilted to effect removal. **DO NOT** allow battery acid to spill onto the frame or other components.
5 Detach the strap securing the rear of the petrol tank to the frame. Ensure that both petrol taps are closed and then disconnect the petrol feed pipes at the tap unions. The pipes are retained either by screw clips or by spring clips. On models fitted with the electro-valve tap, disconnect the wire running to the solenoid body, integral with the tap. V-1000 models utilise a fuel level sensor which is screwed into the underside of the petrol tank. The sensor wire must be disconnected; it is a push fit.

Drainage of the petrol is not strictly necessary, although it will reduce overall tank weight and so facilitate removal. The tank may be lifted rearwards and away from the machine to clear the two front mounting bolts which pass into either side of the steering head lug. Note the mounting rubbers.
6 Loosen the clamps which hold the left-hand exhaust pipe and silencer at the connections with the H section balance pipe. Pull the silencer from position after removing the single silencer support bolt. Each exhaust pipe is retained at the exhaust port by a finned flange, secured on the cylinder head by two studs and nuts. The flange pulls down on to a split ring collar, which holds the pipe in place. Remove the two nuts from the left-hand flange and then pull the exhaust pipe from position on the cylinder head and balance pipe. The right-hand exhaust system components, together with the balance pipe, may be detached as a unit after removing the flange and silencer mounting bolt. Le Mans exhaust pipes are one-piece, having a non detachable balance pipe. Remove the two pipe. Remove the two pipes as a unit.
7 Remove the two screws which hold each carburettor top in place. Pull out each throttle valve assembly and carburettor top by grasping the control cable. Displace the return springs, disconnect the throttle valves from their respective cables and slide the carburettor caps from position. Refit the throttle valves and carburettor tops to their respective carburettors to prevent accidental interchanging of the matched parts. Temporarily, tie

the throttle cables to some convenient part of the frame to prevent snagging during further dismantling operations. Where cable controlled choke assemblies are utilised, remove the screw holding each assembly in position and pull the units from the carburettors, complete with cables. Detach the control lever assembly from the left-hand rocker box, where it is retained by a single socket screw.

8 Disconnect the interconnected petrol feed pipes from each carburettor by removing the single screw passing through the unions. Removal of the unions gives access to the filter screens. These should be removed now, to prevent loss. The carburettors are then free to be detached. On all models using an air filter, carburettor removal is accomplished most easily by detaching each inlet stub at the cylinder head and pulling the stubs complete with carburettors from the rubber intake duct. If required, the carburettors may be detached from the stubs by loosening the clamps. Each stub is retained by three socket screws passing through a flange. Note that the lower screw also retains the HT lead guide clip.

9 Where fitted, the air filter duct is retained on the breather box by a strap arrangement consisting of two steel strips and two long springs. Unhook the springs and pull the duct from position. Disconnect the four pipes leading to the breather box. All four pipes are a push fit on the individual unions. The breather box and air filter element may be removed after unscrewing the single nut at the forward end of the air filter box. Removal of the air filter box itself is not possible until the frame has been lifted from the engine. This is due to the limited clearance between the engine and adjacent frame tubes.

10 Remove the alternator cover from the extreme front of the engine. The cover is retained by four screws. Disconnect the push fit leads from the alternator stator and free the wiring grommet from the casing. Temporarily refit the cover, to protect the alternator. Disconnect the following wires at the components listed:

Oil pressure switch
Neutral indicator switch (not V-1000 model)
Side stand parking switch (V-1000 models only)
Starter motor solenoid
Contact breaker to coil leads

11 Apply the handlebar clutch lever and, using a wooden lever between the frame tube and clutch operating arm, (at the gearbox) detach the clutch control cable. A safety switch is interconnected with the clutch cable close to the abutment on the gearbox. The switch allows engine starting only when the clutch is disengaged. Prise the rubber boot away from the switch and detach the two push fit leads. Free the clutch cable from the gearbox abutment.

12 Disconnect the speedometer drive cable from the gearbox and the tachometer drive cable (where utilised) from the front of the timing cover. Both cables are retained by knurled rings. Note that the small crimped olive fitted to each cable end below the knurled ring is often loose, and so easily lost if care is not exercised.

13 On touring models the footboards should be removed. Each is retained by two pivot bolts, which have a nut and locknut.

14 Remove the clevis pin and split pin from both the gearchange link rod and rear brake operating rod (disc brake only). On touring models the shorter link rod should be disconnected. Removal of the operating levers is not strictly necessary but may improve working room. On machines fitted with a drum rear brake, the brake pedal should be removed from the splined pivot shaft. The pedal is secured by a pinch bolt.

15 Pull the push fit breather tube from the union immediately above the starter motor (not V-1000 models). Remove the nut and bolt which secures the lower flange of the starter motor to the engine casing. Support the weight of the starter motor, unscrew the upper bolt and lift the starter motor to the rear and clear of the machine.

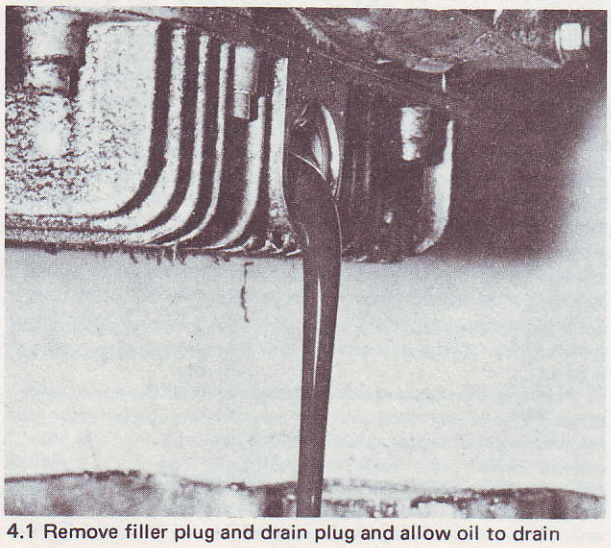
16 Remove the seven screws which secure the battery carrier plate to the gearbox and frame, and lift out the plate. Note that the rear left-hand bolt secures the battery earth strap.

17 The rear wheel and the swinging arm must now be removed to allow disconnection of the final drive shaft from the gearbox output shaft. Refer to Chapter 5, Section 8 for the relevant details.

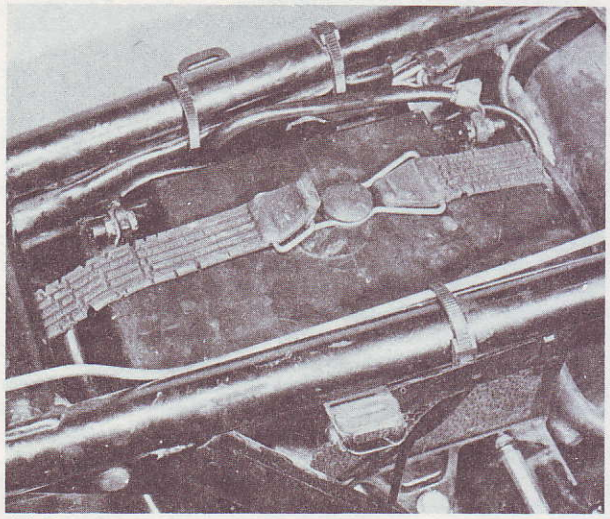
18 Place a number of wooden blocks below the front of the engine sump so that the weight of the engine is just taken. Remove the two socket screws and nuts which clamp together the lower ends of the front frame down tubes and the forward end of the two subframe tubes. On touring models these screws also secure the lower ends of the crashbars. The crashbars can be removed after unscrewing the upper securing bolts. Remove the nut from the front engine mounting bolt and carefully drive the bolt from position. Care should be taken not to damage the threads. On all but touring models the side stand is also screwed by this bolt.

19 The sub frame - attached to the engine - is now free from the main frame, which can be lifted up from the rear and wheeled away on the front wheel. It is recommended that two assistants be at hand during this operation, one of which can steer the frame via the handlebars, the other to steady the engine/gearbox unit.

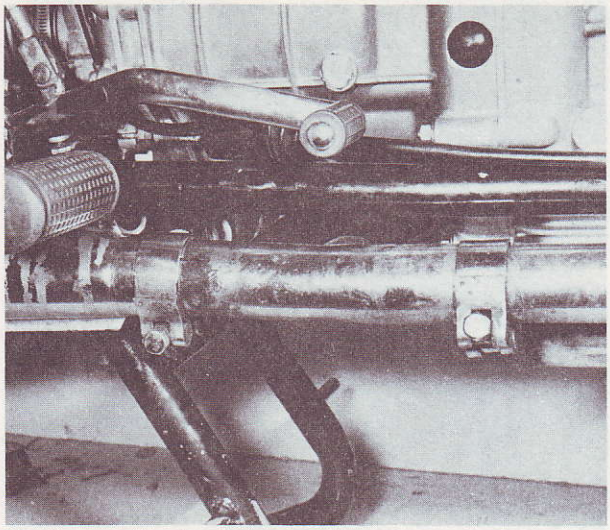
20 Once the frame has been lifted away, the sub frame may be detached by removal of the single bolt which passes through the two frame tube lugs and the gearbox mounting lug. Take care when removing the sub frame that the rear stand does not retract suddenly and catch the unwary individual across the knuckles.



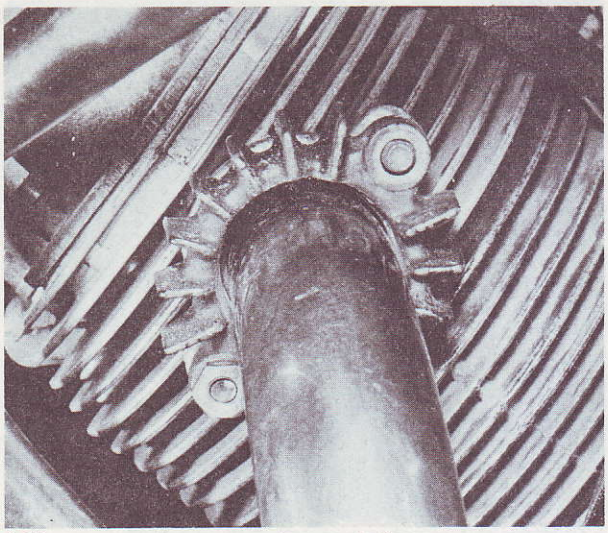
4.1 Remove filler plug and drain plug and allow oil to drain



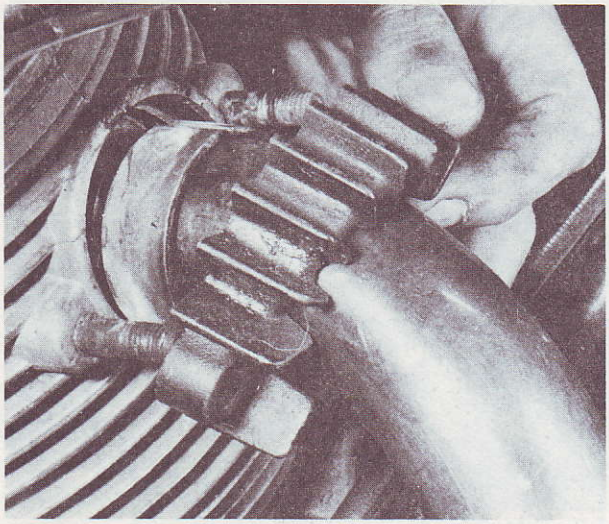
4.4 Detach strap and terminal and lift battery away



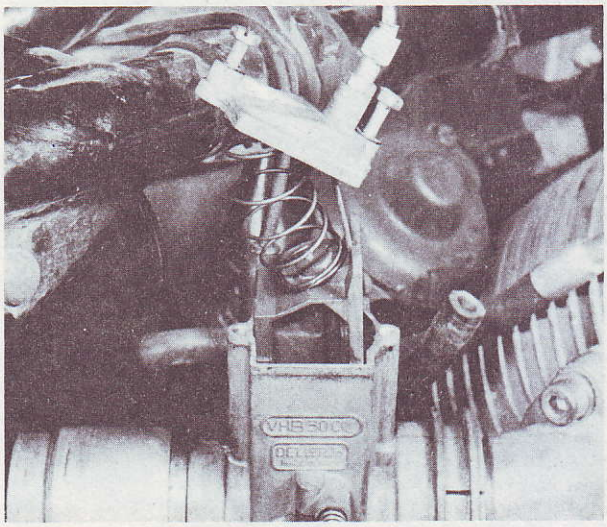
4.6a Loosen all exhaust clamps and ...



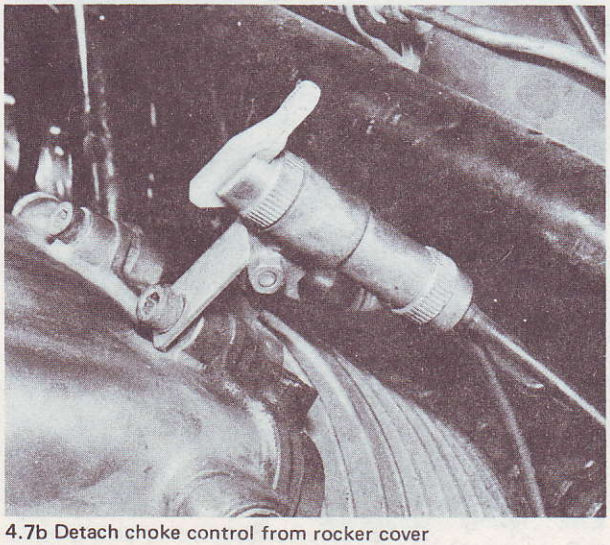
4.6b ... remove the two nuts from each flange



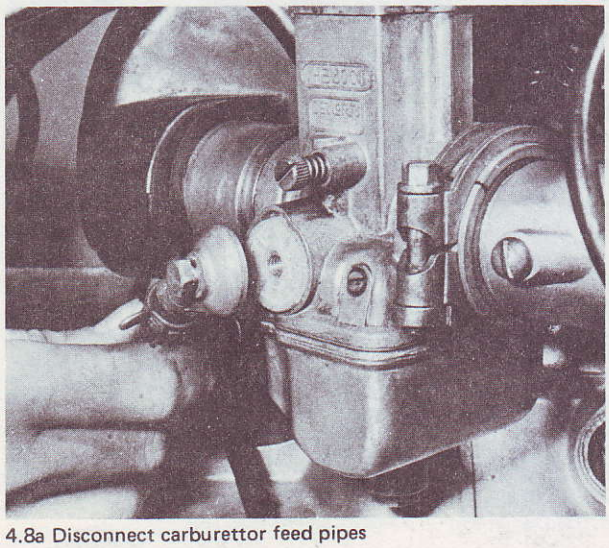
4.6c Pull the flange from the studs to release pipe



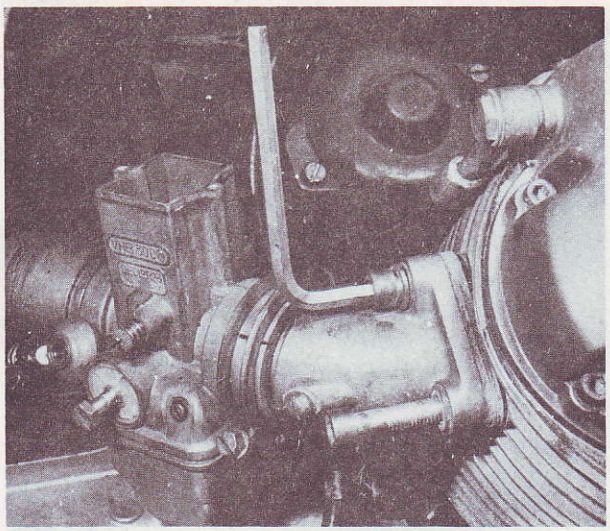
4.7a Unscrew carburettor tops and pull out slides



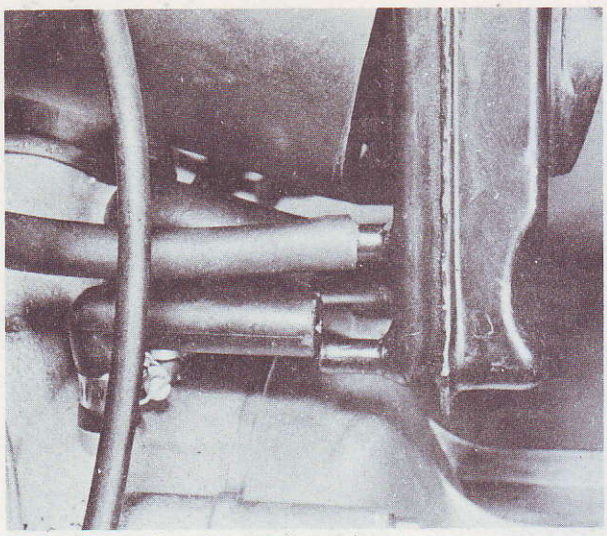
4.7b Detach choke control from rocker cover



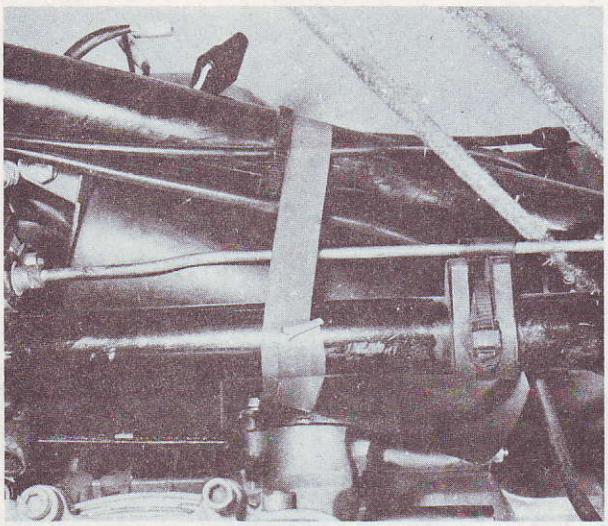
4.8a Disconnect carburettor feed pipes



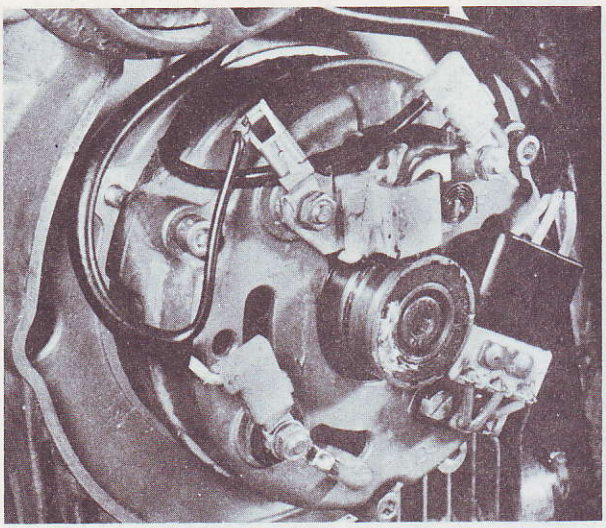
4.8b Remove carburettors complete with inlet stubs



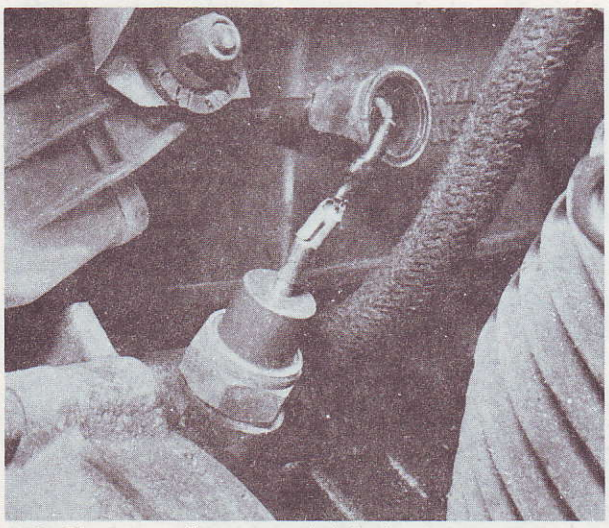
4.9a Pull hoses from breather box unions



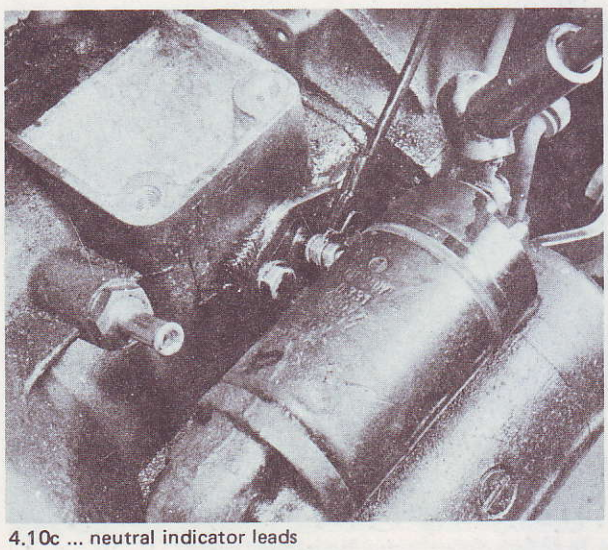
4.9b Tape air filter box to frame during removal



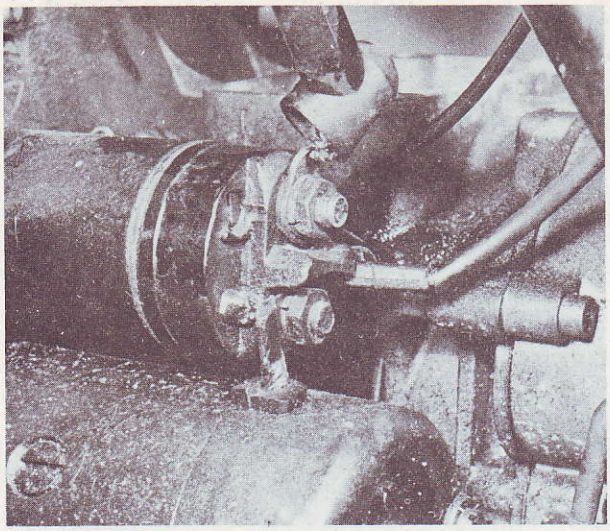
4.10a Note alternator lead positions and disconnect



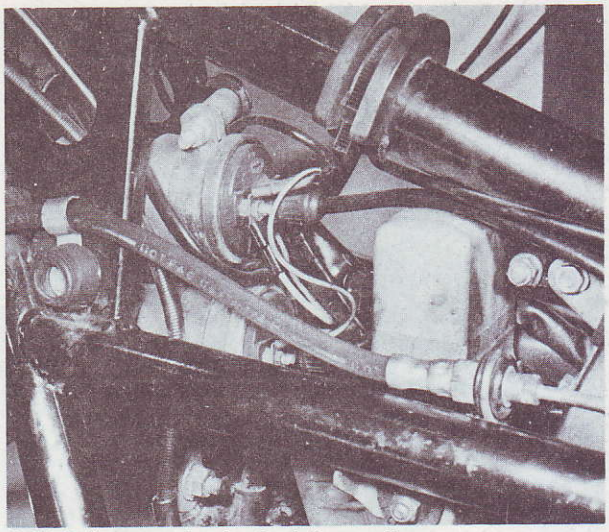
4.10b Disconnect oil pressure switch lead and ...



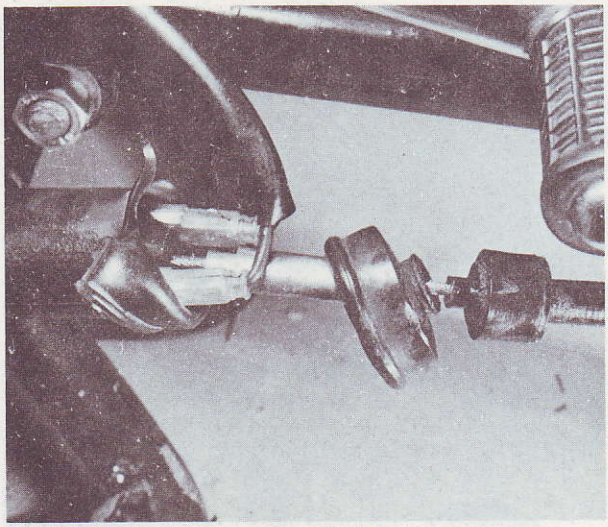
4.10c ... neutral indicator leads



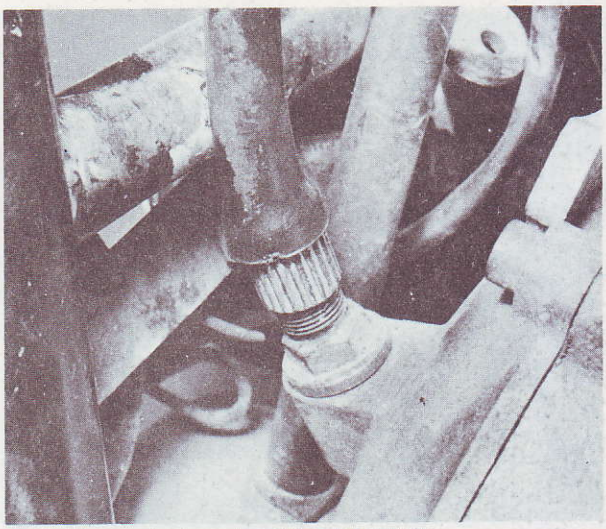
4.10d Remove also starter motor leads



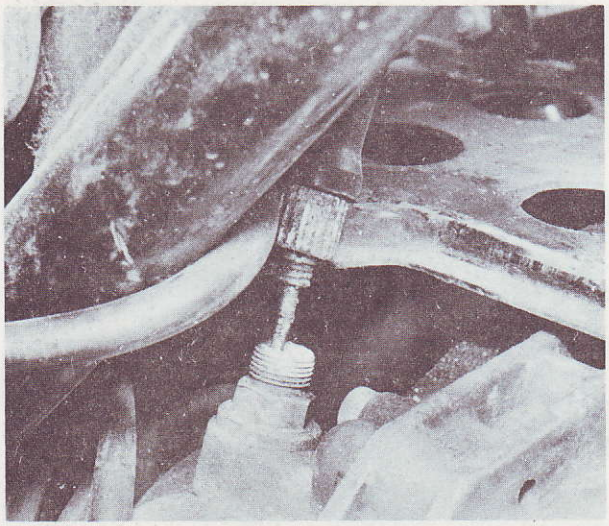
4.10e Pull contact breaker leads from coils ·



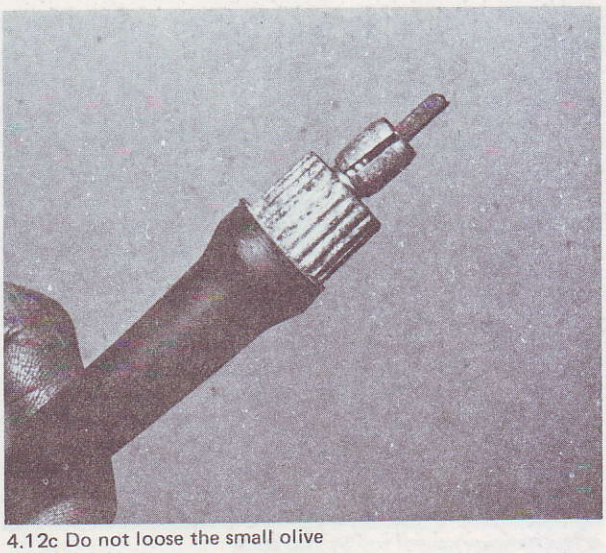
4.11 Prise boot off clutch cable switch to detach wires



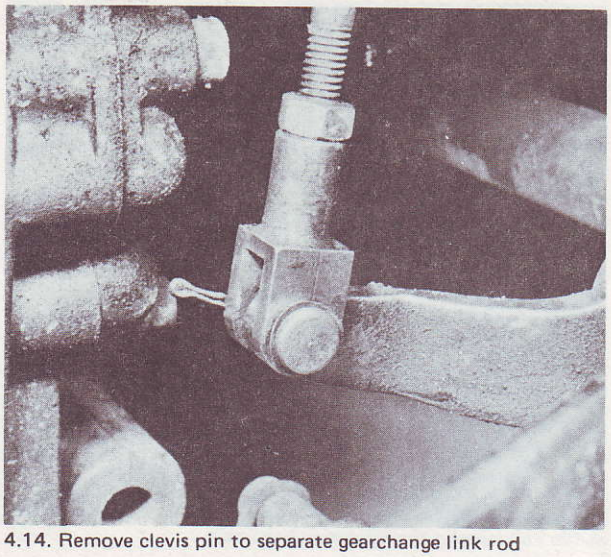
4.12a Unscrew tachometer cable followed by ...



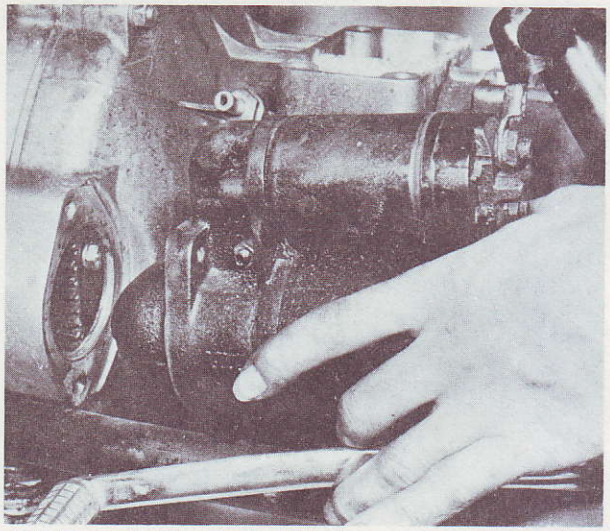
4.12b ... speedometer cable at gearbox



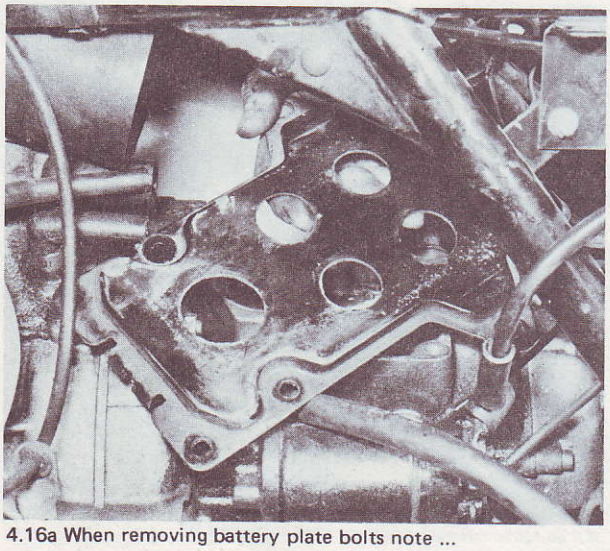
4.12c Do not loose the small olive



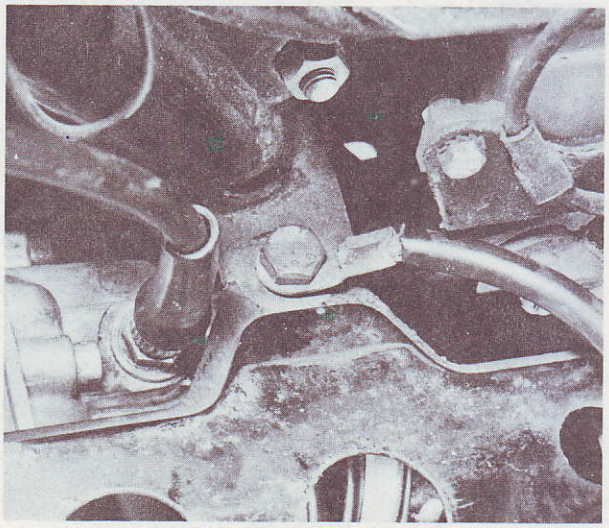
4.14. Remove clevis pin to separate gearchange link rod



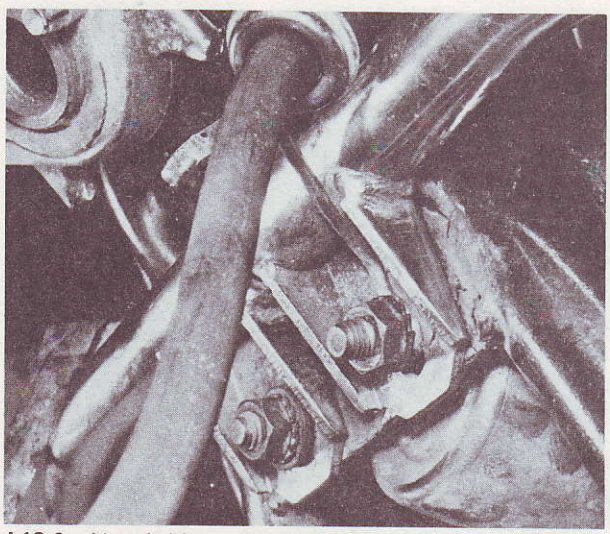
4.15 Detach starter motor, held by two bolts



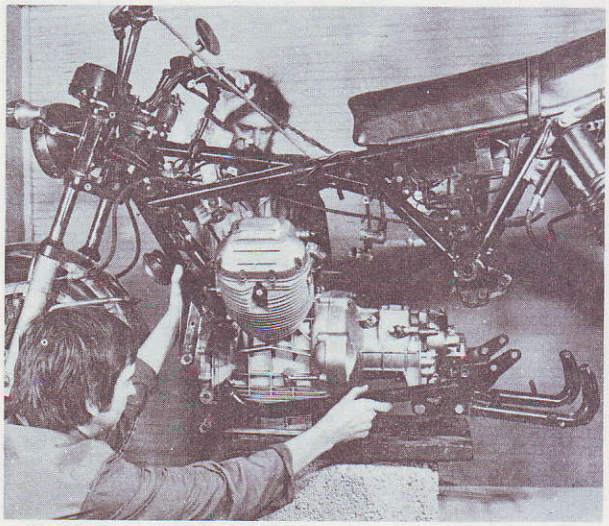
4.16a When removing battery plate bolts note ...



4.16b ... the bolt which holds the battery earth lead



4.18 Crashbars held at top by two bolts



4.19 Lift frame from engine with great care

5 Dismantling the engine/gearbox: general

1 Before commencing work on the engine, the external surfaces must be cleaned thoroughly. A motor cycle engine has very little protection from road dirt which will sooner or later find its way into the dismantled engine if this simple precaution is not observed.
2 One of the proprietary engine cleaning compounds such as Gunk or Jizer can be used to good effect, especially if the compound is allowed to penetrate the film of oil and grease before it is washed away. When washing down, make sure that water cannot enter the carburettors or the electrical system, particularly if these parts are now more exposed.
3 Never use force to remove any stubborn part, unless mention is made of this requirement in the text. There is invariably good reason why a part is difficult to remove, often because the dismantling operation has been tackled in the wrong sequence.

6 Separating the engine from the gearbox

1 The gearbox, which is retained on the rear of the engine by radially disposed nuts and studs, can be separated from the engine as a complete unit after removing these nuts.
2 On V-1000 models, it is ESSENTIAL that the engine/gearbox assembly is placed on the workbench, front end downwards with the crankshaft approximately vertical, before separation is accomplished. If this precaution is not observed, the fluid contained within the torque converter will spill out as the gearbox input shaft boss leaves the centre of the converter casing.
3 After separation, the torque converter fluid must be drained. The simplest method is to lift up and tip the engine unit, sufficiently to allow all the fluid to drain away. Alternatively, a small syphon pump can be used. A bicycle pump with the leather plunger cap inverted also makes a useful tool. After removing the fluid, place a cover over the torque converter orifice, to prevent the ingress of foreign matter.

7 Dismantling the engine: removing the cylinder heads, cylinder barrels and pistons

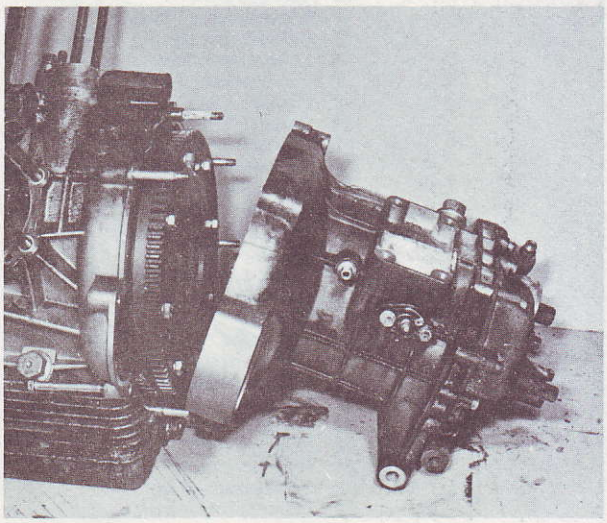
1 Each cylinder barrel/head assembly should be dismantled individually and the components stored separately, to prevent inadvertent interchanging of the matched parts. In addition, parts should be marked clearly so that they may be refitted in their original positions.
2 Commence dismantling by disconnecting the rocker oil feed pipes at the crankcase and at each cylinder head. The pipes are interconnected by a shared banjo union at the crankcase and by separate banjo unions at the cylinder heads.
3 Unscrew the eight socket screws which retain the rocker cover in place. Lift off the cover and remove the gasket. Remove both spark plugs and rotate the engine so that both valves on the cylinder in question are closed, ie, the piston is at TDC on the compression stroke. Remove the screw locating the exhaust rocker arm spindle in the cast bracket. Push out the spindle and remove the rocker arm, bronze washer and coiled spring washer. Lift out the pushrod. Repeat the procedure for the inlet valve components.
4 The cylinder head is retained by six nuts, one of which is of the socket type. Access to this nut can be gained only after removal of the socket cap screwed into the cylinder head. Loosen and remove the nuts and washers and lift off the rocker carrier bracket. Each of the four rocker carrier securing studs is fitted with a small 'O' ring. Using a small screwdriver ease the 'O' rings from position. If difficulty is encountered in removing the 'O' rings they may be cut through, as they will have to be discarded.

The cylinder head is now free to be removed. If necessary, a rawhide mallet may be used to break the seal between the cylinder head and the cylinder barrel and gaskets.Take care not to damage the aluminium fins.

5 Separate the cylinder barrel from the crankcase mouth, if necessary using a rawhide mallet to break the seal. Again take care not to damage the fins. **Do not use levers to displace the cylinder barrel.** Slide the cylinder barrel up along the holding down studs until the piston skirt is visible, but the piston rings are still in the cylinder bore. At this stage it is worth padding the crankcase mouth with clean rag to prevent pieces of broken piston ring or other foreign matter from falling into the crankcase. Support the piston and pull the cylinder barrel clear of the studs and piston. Remove the cylinder base gasket and note the two 'O' rings one of which is fitted to the upper stud and the other to the lower stud.
6 Before removing the piston a mark should be scribed on the inside of the skirt to identify to which cylinder the piston belongs. An arrow on the piston crown accompanied by the letters SCA indicates the front of the piston. Remove the gudgeon pin circlips, using a pair of snipe nose pliers. The gudgeon pin may be pushed out using a special gudgeon pin extractor tool, or drifted out using a suitable soft brass drift. If the latter technique is adopted, the connecting rod must be supported securely against the side thrust imposed. Failure to ensure this, may lead to a bent connecting rod or a damaged big-end bearing.
7 If the gudgeon pin is very tight, the piston should be heated, using a rag soaked in boiling water, or a flat iron applied to the piston crown. This will temporarily expand the aluminium piston.
8 Repeat the dismantling procedure on the second cylinder barrel/head assembly.

8 Dismantling the engine: removing the alternator

1 Remove the alternator cover which was replaced temporarily during earlier dismantling operations. Very carefully lift the two alternator brushes half out of their holders, securing them in this position by off-setting the brush springs. Remove the three long retaining screws and pull the alternator stator from position.
2 The alternator rotor is a tight fit on the tapered crankshaft end and will require drawing from position. **Under no circumstances should levers be employed in an attempt to remove the rotor** as damage will almost certainly result. The rotor is retained by a central socket screw which may also be used as the extractor. Remove the bolt and insert a piece of 2¼ x 3/16 in rod into the drilling in the crankshaft end. Refit the bolt and tighten it down very slowly until the rotor leaves the shaft. If the rotor is reluctant to move, **DO NOT continue tightening the bolt.** A smart tap on the bolt end with a hammer should release the rotor.
3 Store the alternator components in a safe place, to prevent damage.



6.1 Gearbox secured to engine by studs and bolts

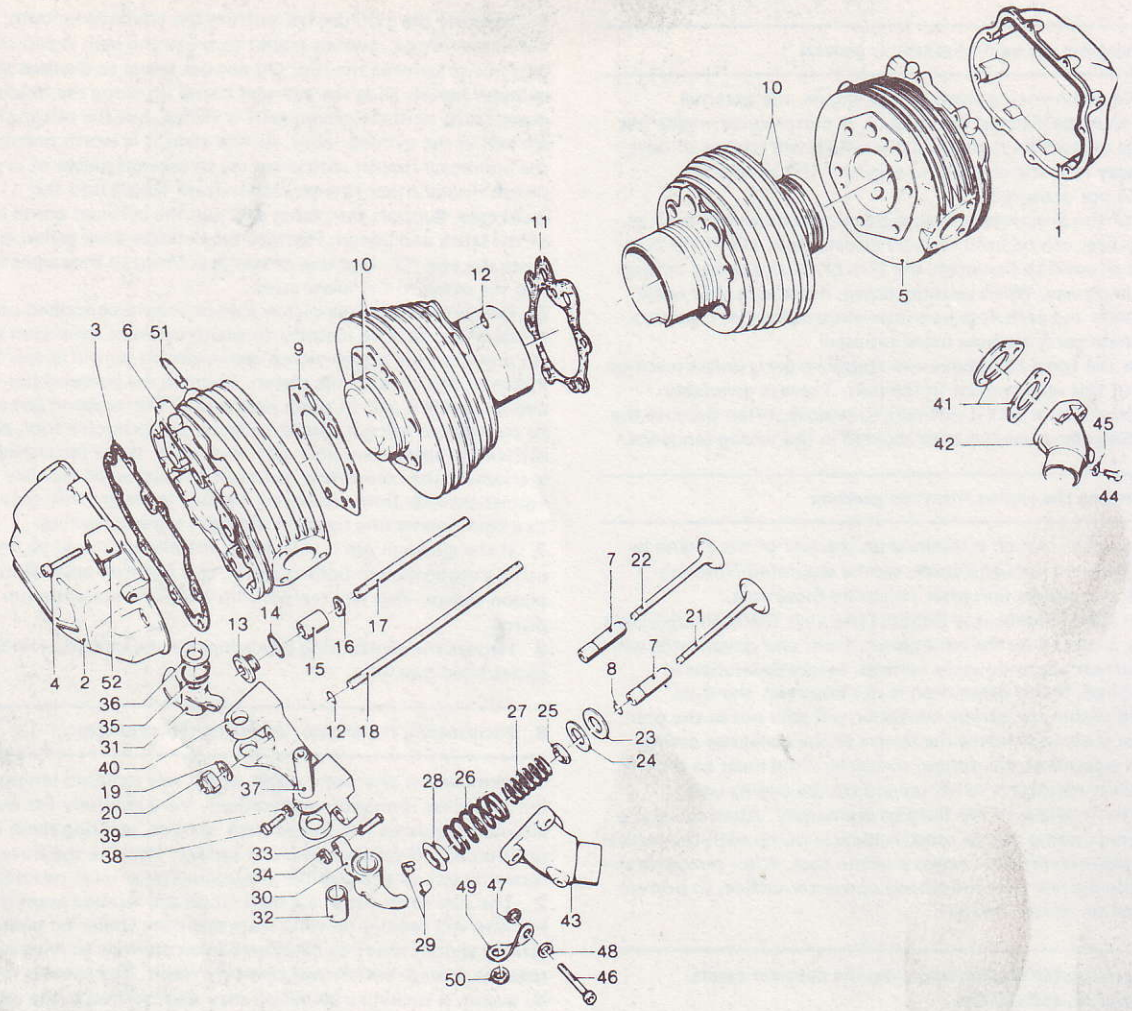
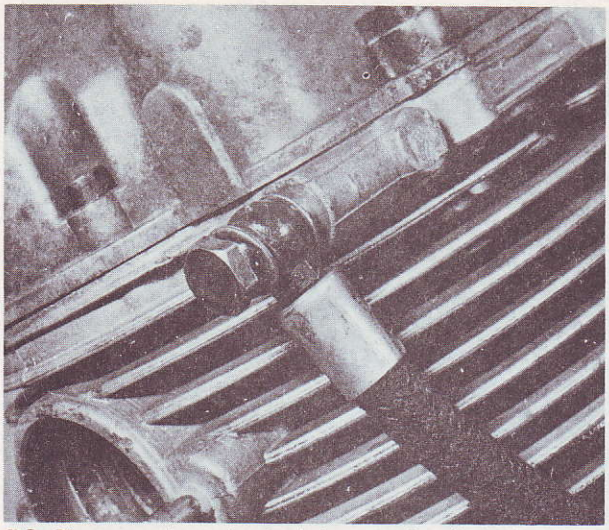
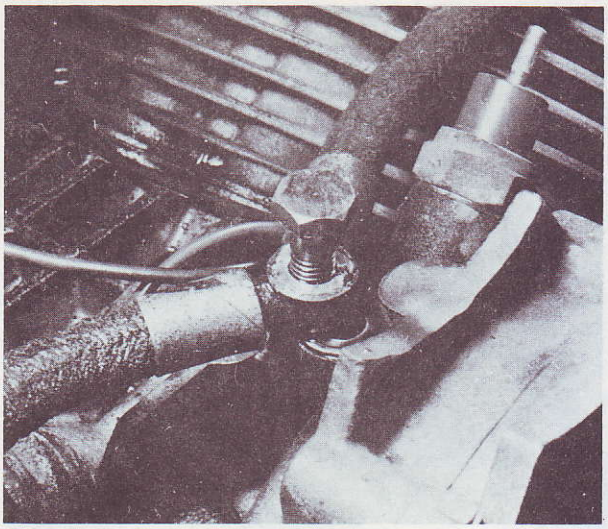


Fig. 1.1. Cylinder head and cylinder barrel - components

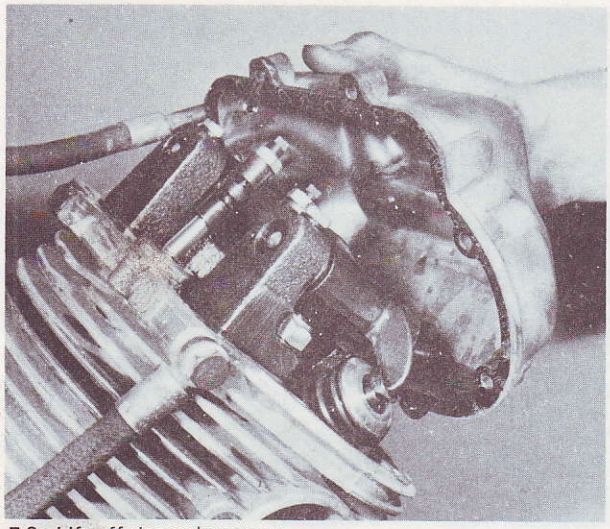
1 *RH rocker cover*
2 *LH rocker cover*
3 *Gasket - 2 off*
4 *Socket screw - 16 off*
5 *RH cylinder head*
6 *LH cylinder head*
7 *Valve guide - 4 off*
8 *Circlip - 4 off*
9 *Gasket - 2 off*
10 *Cylinder barrel and piston assembly - 2 off*
11 *Base gasket - 2 off*
12 *'O' ring - 10 off*
13 *Blanking plug - 25 off*
14 *'O' ring - 25 off*
15 *Sleeve socket nut - 2 off*
16 *Wave washer - 2 off*
17 *Short stud - 4 off*
18 *Long stud - 8 off*
19 *Washer - 10 off*
20 *Cylinder head nut - 10 off*
21 *Inlet valve - 2 off*
22 *Exhaust valve - 2 off*
23 *Washer - 4 off*
24 *Washer - 10 off*
25 *Spring seat - 4 off*
26 *Outer spring - 4 off*
27 *Inner spring - 4 off*
28 *Spring collar - 4 off*
29 *Collet set - 4 off*
30 *RH rocker arm - 2 off*
31 *LH rocker arm - 2 off*
32 *Rocker bush - 4 off*
33 *Tappet adjuster - 4 off*
34 *Locknut - 4 off*
35 *Endfloat spring - 4 off*
36 *Bronze washer - 4 off*
37 *Rocker shaft - 4 off*
38 *Locating screw - 4 off*
39 *Spring washer - 4 off*
40 *Rocker bracket - 2 off*
41 *Heat sink - 2 off*
42 *RH inlet stub*
43 *LH inlet stub*
44 *Socket screw - 2 off*
45 *Plain washer - 6 off*
46 *Socket screw - 6 off*
47 *Insulating washer - 6 off*
48 *Plain washer - 6 off*
49 *Cable guide - 2 off*
50 *Grommet - 2 off*
51 *Stud - 4 off*
52 *Choke lever bracket*



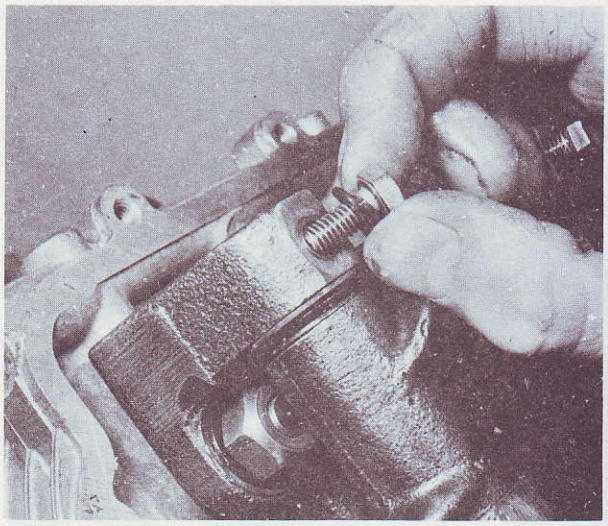
7.2a Disconnect the rocker feed pipe at each cylinder head ...



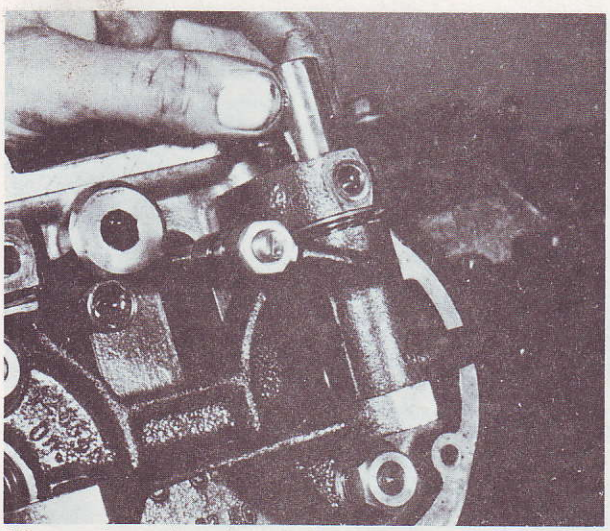
7.2b ... and at the central union on the crankcase



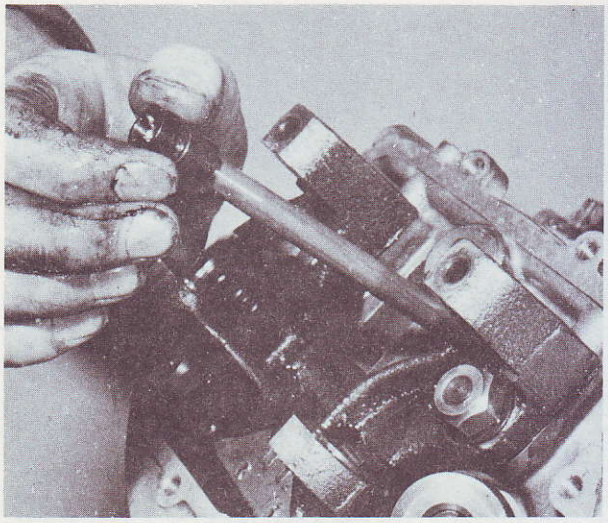
7.3a Lift off the rocker cover



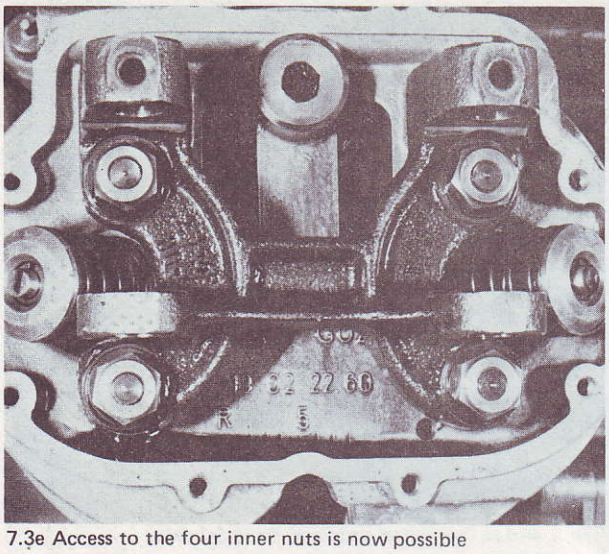
7.3b Unscrew the locating bolts and ....



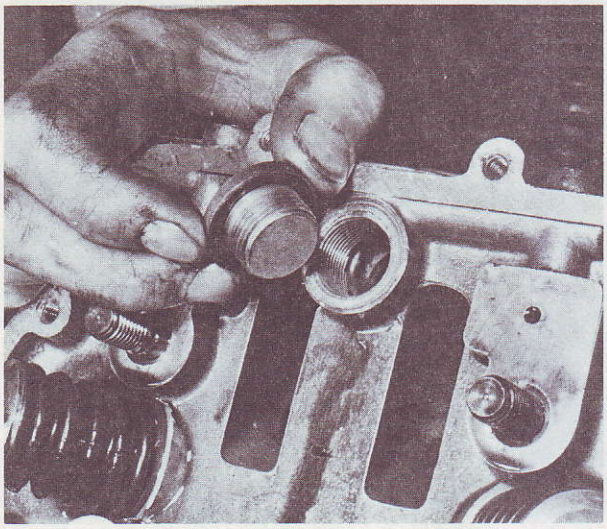
7.3c ... push out the rocker spindles



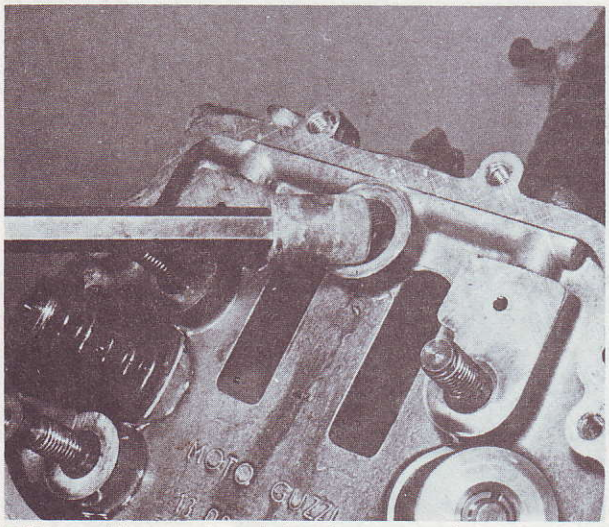
7.3d Lift pushrods from position



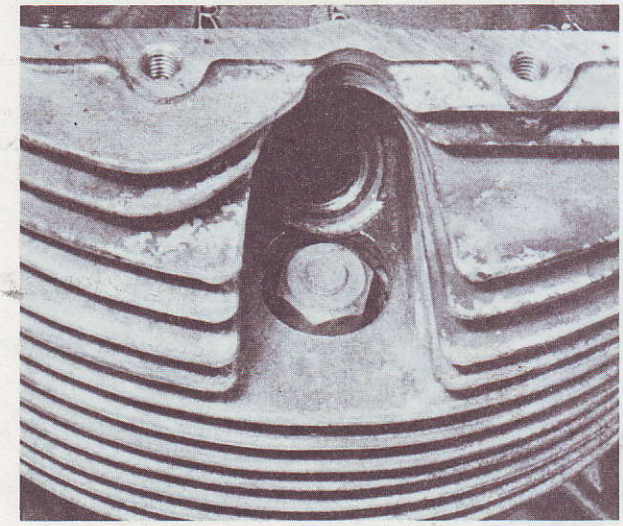
7.3e Access to the four inner nuts is now possible



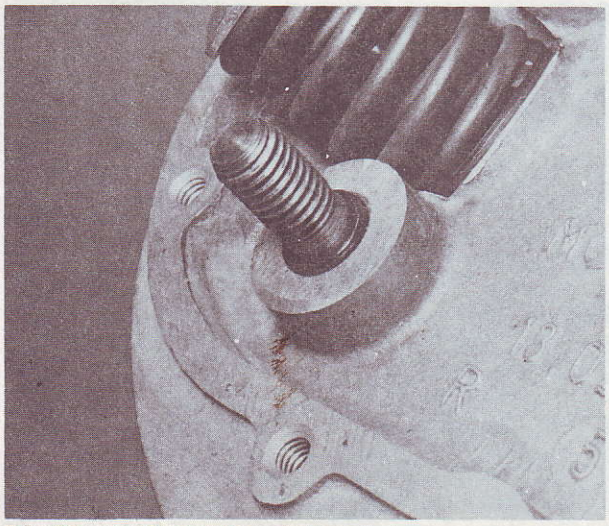
7.4a Remove the internal socket cap to ...



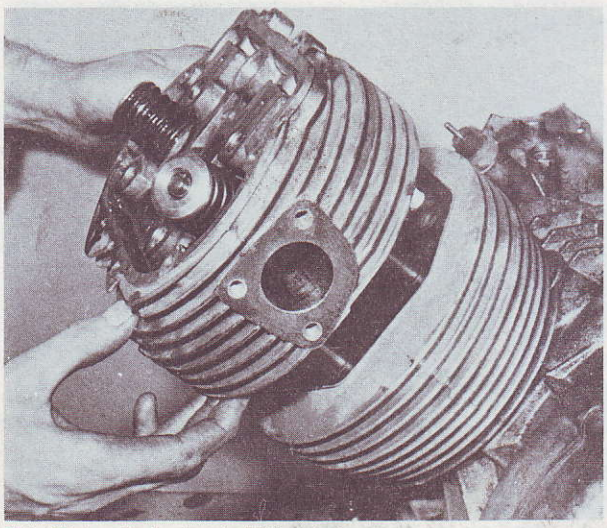
7.4b ... enable upper sleeve bolt to be unscrewed



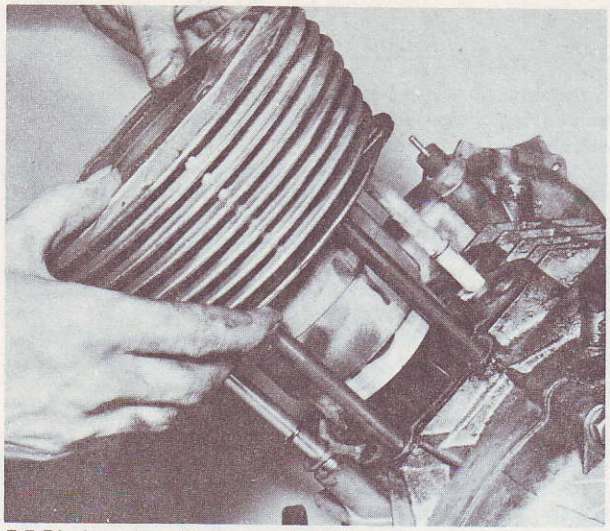
7.4c Do not forget lower nut near spark plug



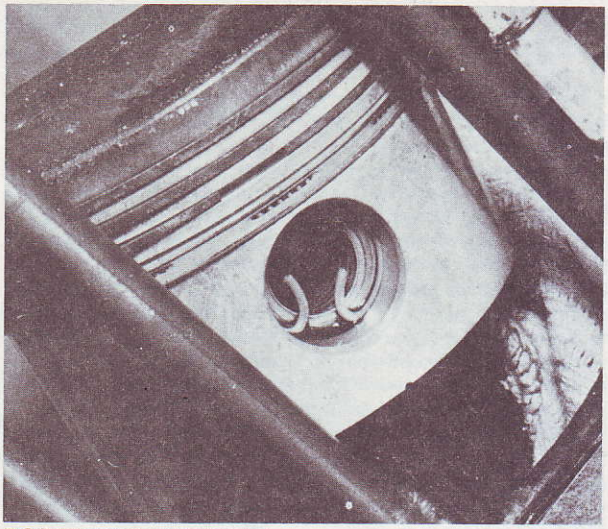
7.4d Prise the 'O' rings from the long studs



7.4e Slide cylinder head off the studs

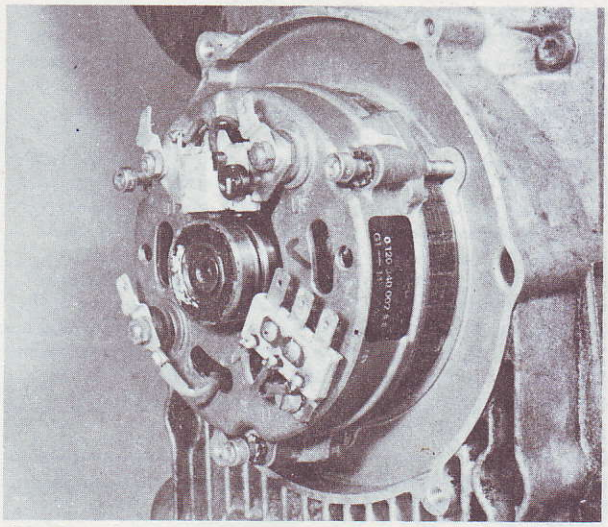


7.5 Displace the cylinder barrel and lift off



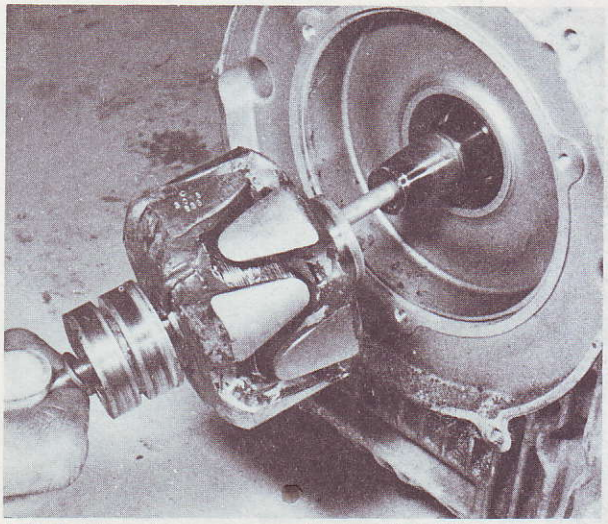
7.6 Prise out the circlips and ...

7.7 Push out gudgeon pin to free the piston



8.1a Remove alternator stator held by three screws

8.2a After removing centre screw insert short rod



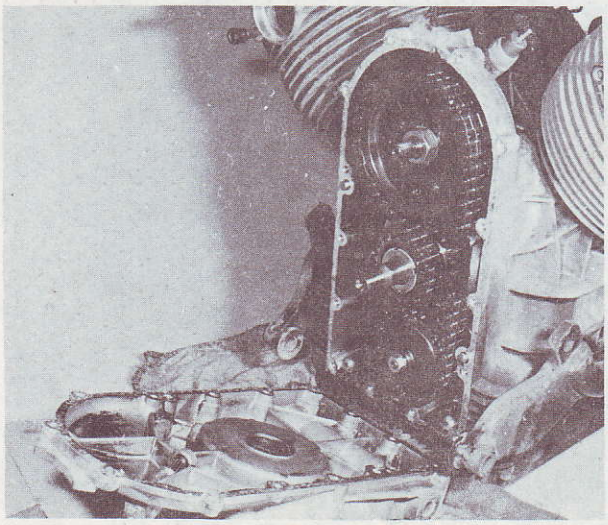
8.2b Rotate centre screw to push rotor off shaft taper

9 Dismantling the engine: removing the timing cover, timing chain and sprockets

1 Arrange the engine so that it is resting on the gearbox mounting studs. Loosen and remove the timing cover screws and lift the cover from position. The use of a rawhide mallet may be required to loosen the cover from the gasket.
2 Unscrew the camshaft sprocket nut, oil pump sprocket nut and crankshaft end nut. The latter component is of the ring type and is secured by a special tab washer. Bend down the ears of the washer before attempting to loosen the nut. This nut requires a peg type spanner for removal and refitting. A suitable tool is fabricated easily from a thick walled tube, one end of which is relieved with a file to form four short pegs.
3 To prevent rotation when loosening these three nuts, pass a close fitting steel rod through the small end eye of one connecting rod. Allow the rod to bear on two wooden blocks placed across the crankcase mouth.
4 Before the cam chain is detached, rotate the engine until the right-hand piston is at TDC on the compression stroke. Using a centre punch or scribe, mark the relative positions of the distributor body and crankcase, the body and contact breaker mounting plate and the contact breaker cam and distributor body. This will simplify ignition timing and distributor replacement.
5 The three chain sprockets must be lifted off their shafts simultaneously, together with the camshaft drive chain. The camshaft sprocket is a light push on the camshaft end and will lift off with ease. The remaining sprockets however may require careful easing from position, using short levers. Care should, of course, be taken to ensure no damage is done to any of the components against which the levers bear.
6 Remove the push fit drive pin from the camshaft end boss and prise the Woodruff key from the keyway in each of the two other shafts. The keys are easily lost so store them in a safe place.
7 Unscrew the two bolts which secure the chain tensioner arm. Each bolt is secured by a locking plate and is fitted with a distance piece between the arm and the wall of the casing.

10 Dismantling the engine: removing the distributor, camshaft and engine oil pump

1 Loosen the two bolts which retain the distributor clamping bracket. Remove the front bolt and swing the bracket outwards to clear the distributor boss. The distributor should be marked before removal as described in paragraph 4 of the preceding Section, to aid correct positioning when refitting. Lift the complete distributor from place.
2 Lift out the cam followers and mark each individual unit so that they may be replaced in their original positions. Detach the camshaft bearing end plate which is retained by three screws. Grasp the camshaft end and withdraw it, together with the end plate.
3 Loosen and remove the oil pump retaining socket screws and lift the oil pump from place. The oil pump is located accurately on two dowel pins and may be held securely in place. **DO NOT use levers to displace the pump.** Temporarily replace the oil pump sprocket and nut and use the sprocket as a means of purchase.



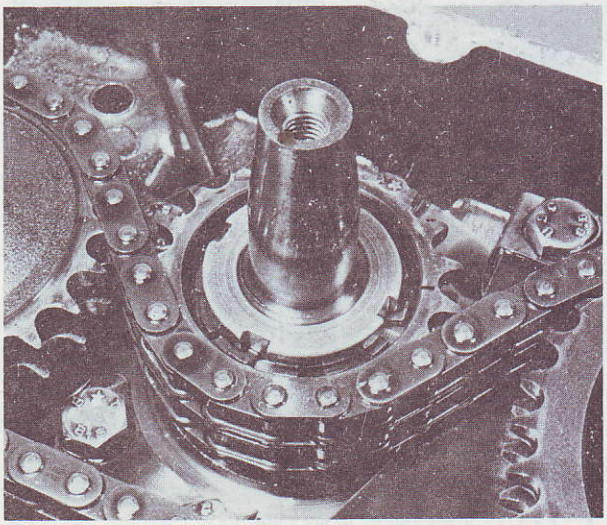
9.1 Remove the timing cover and gasket

11 Dismantling the engine: removing the clutch and flywheel (except V-1000 Convert model)

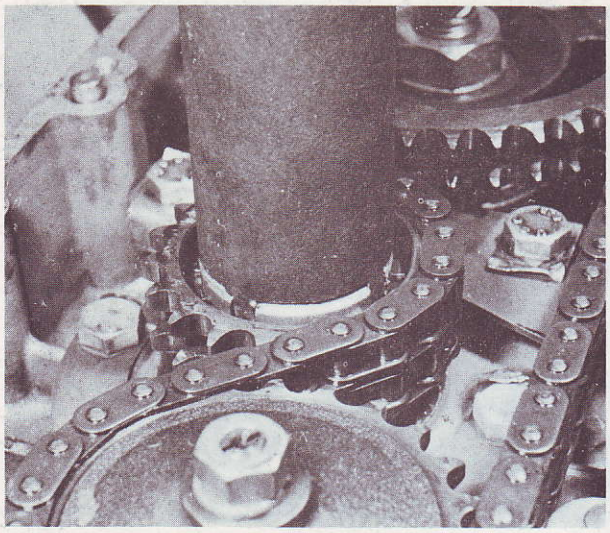
1 The clutch components are retained by eight bolts passing through the periphery of the starter ring gear into the flywheel face. Unscrew the eight bolts and lift off the starter ring gear. Remove the following components consecutively; outer friction plate, intermediate plain plate, inner friction plate, clutch thrust piece, spring back plate and eight clutch springs. Because the complete assembly is under pressure from the clutch springs, the eight bolts must be unscrewed evenly, about one turn at a time, so that the spring pressure is released in a controlled and even manner.
2 Before removing the flywheel, note the white paint mark on the crankshaft end boss which aligns with the TDC mark on the flywheel. This mark was made on original assembly to ensure ease of correct flywheel positioning with regard to crankshaft and timing mark relationship.
3 Remove the flywheel retaining bolts after bending down the ears of the locking plates which secure the bolts in pairs.

12 Dismantling the engine: removing the torque converter and flywheel (V-1000 Convert model only)

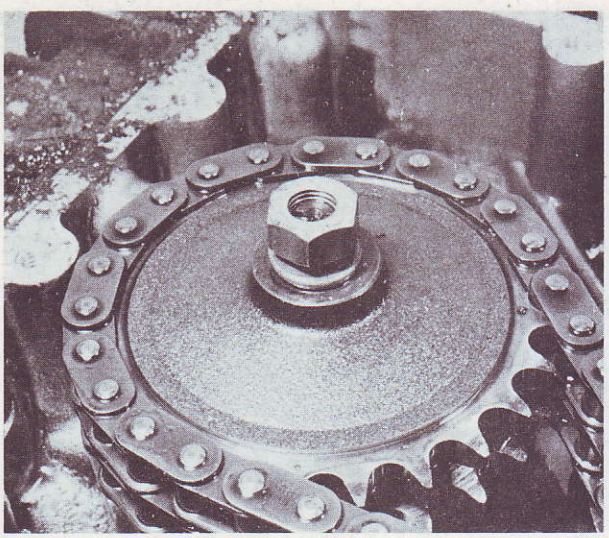
1 The torque converter is secured by four bolts, of which each is secured by a tab washer. After removal of the bolts the complete converter may be lifted out, followed by the starter ring gear.
2 Flywheel removal follows the technique detailed for all other models.



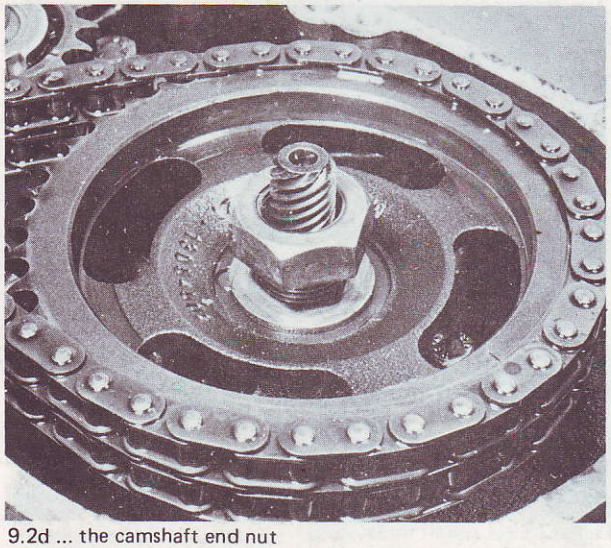
9.2a Bend down the multi-tab locking washer and ...



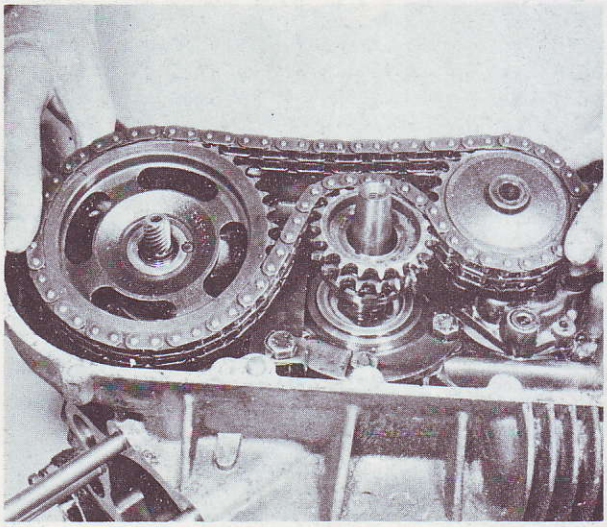
9.2b .. using a suitable tool remove the crankshaft nut



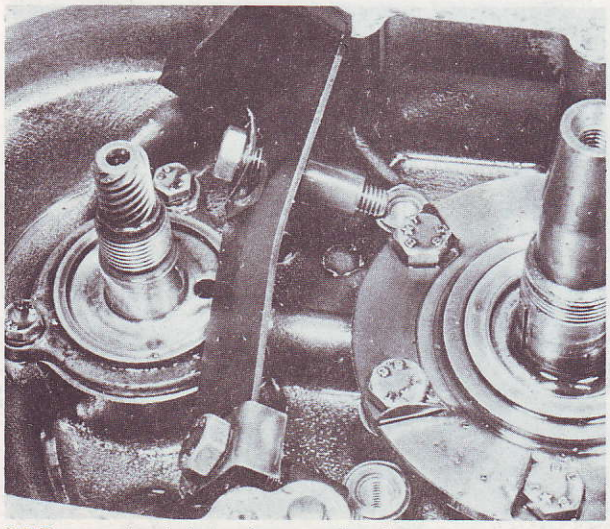
9.2c Remove the oil pump nut and ...



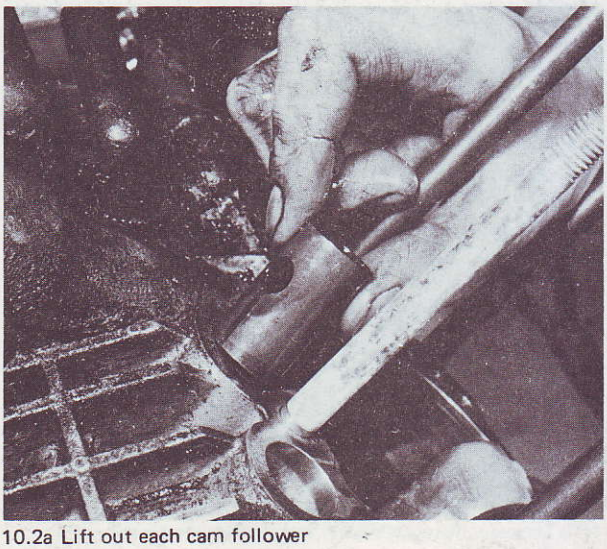
9.2d ... the camshaft end nut



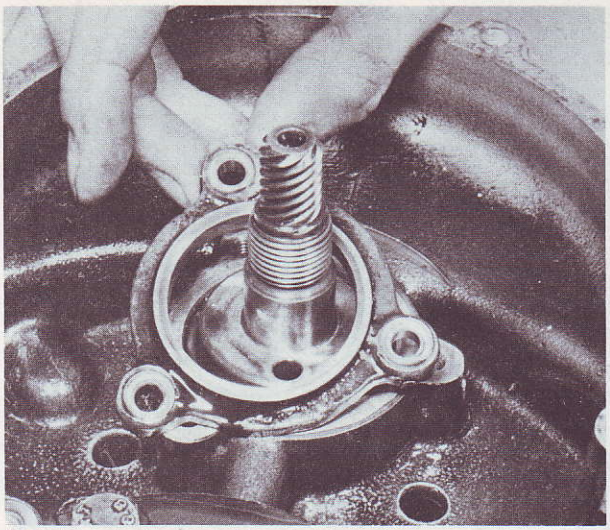
9.5 Lift off the three sprockets and chain as a unit



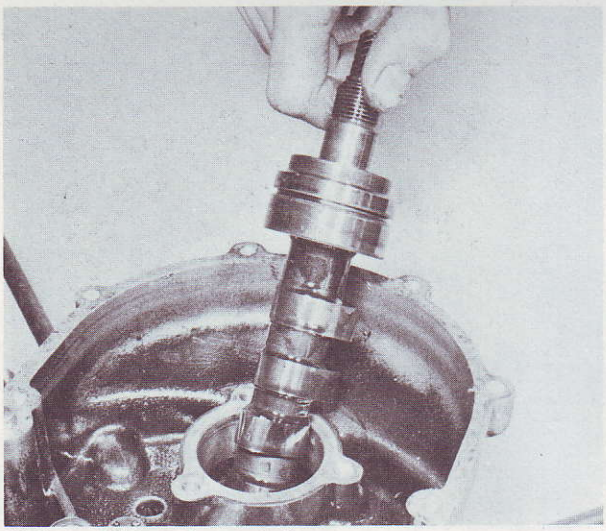
9.7 Remove the chain tensioner, noting the spacers



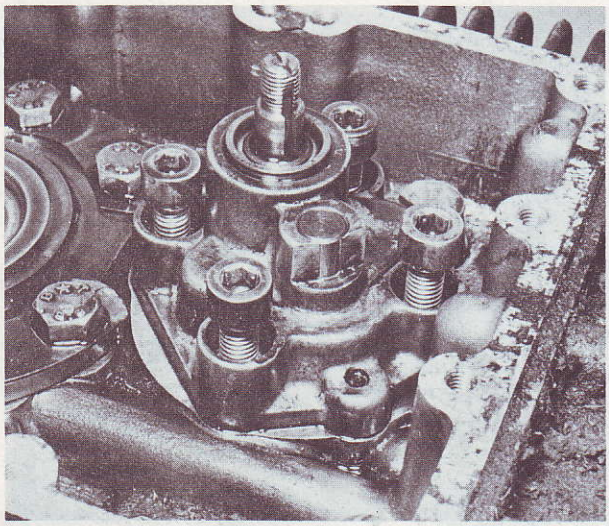
10.2a Lift out each cam follower



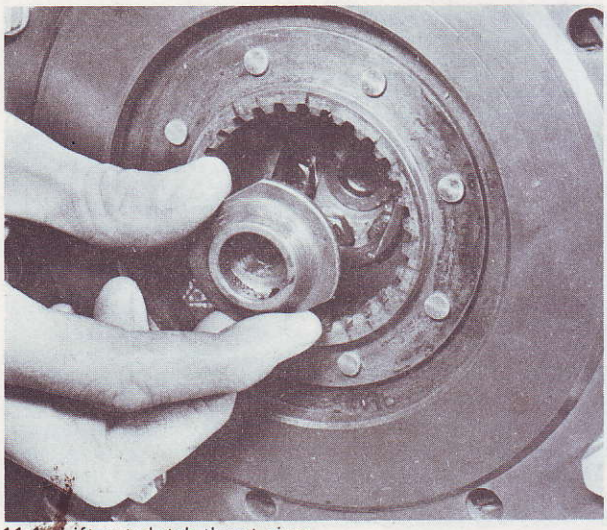
10.2b Detach the camshaft end plate and ...



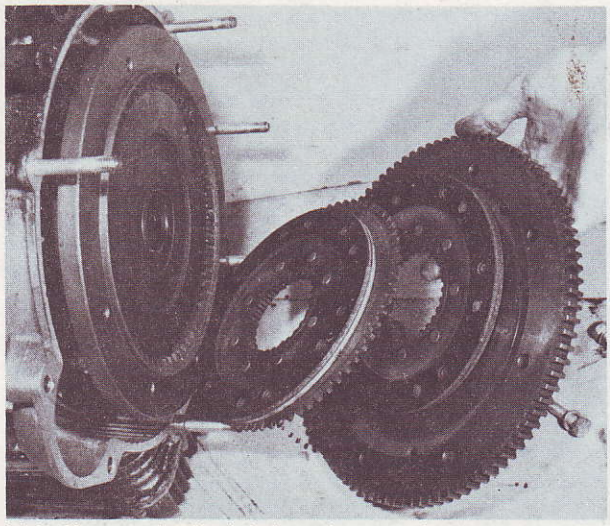
10.2c ... withdraw the camshaft



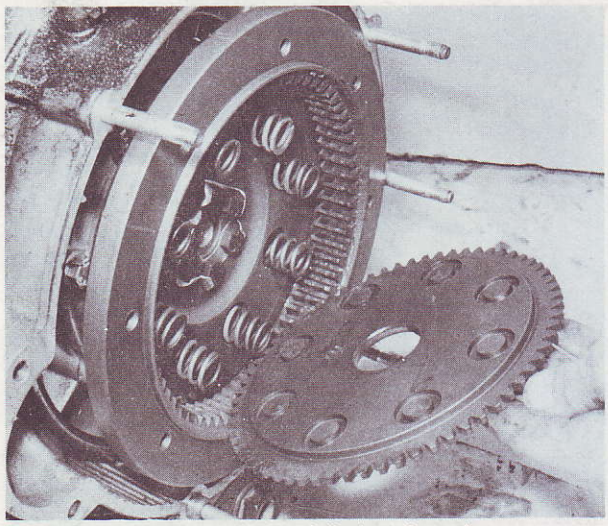
10.3 The oil pump is retained by four socket screws



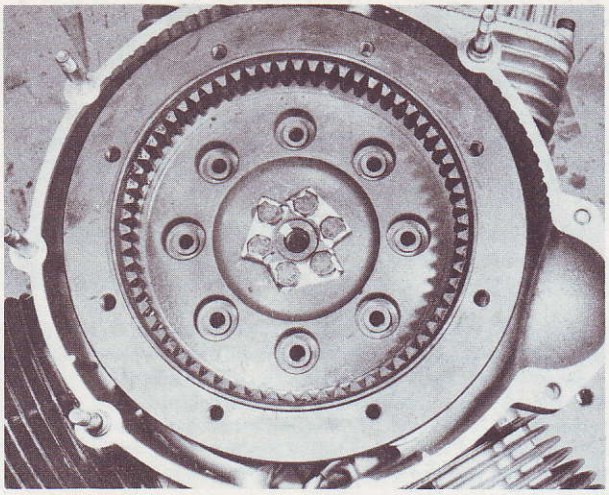
11.1a Lift out clutch thrust piece



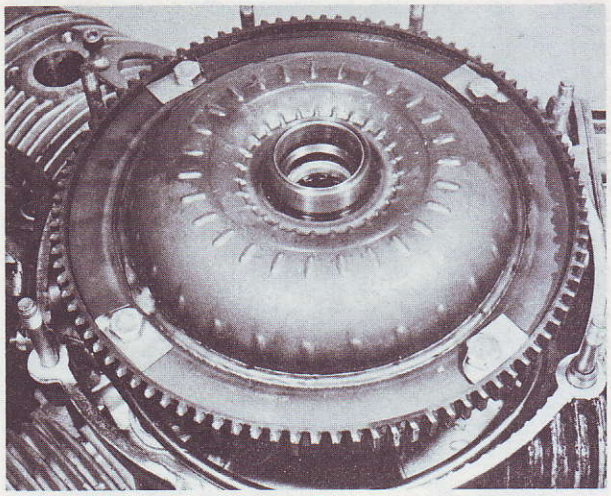
11.1b Unscrew the clutch bolts and remove the plates



11.2 Lift out the spring plate and displace the springs



11.3 Bend down tab washers to remove flywheel bolts



12.1 Torque converter is held by four secured bolts - V-1000

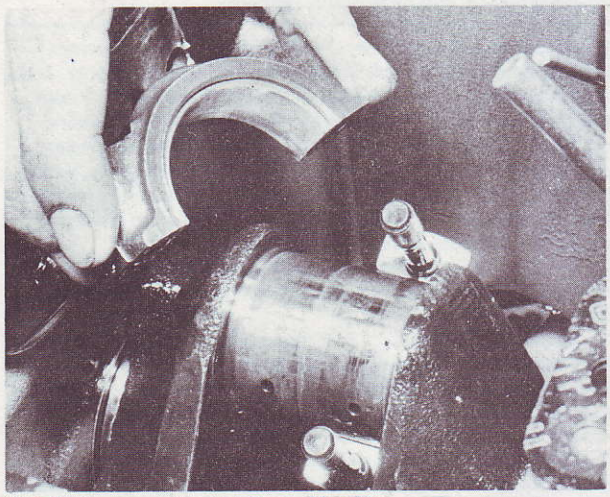
13 Dismantling the engine: removing the connecting rods and the crankshaft.

1 Invert the engine so that it is resting in an upright position on the cylinder head studs. Remove the sump bolts and lift the sump away, complete with the oil filter system.

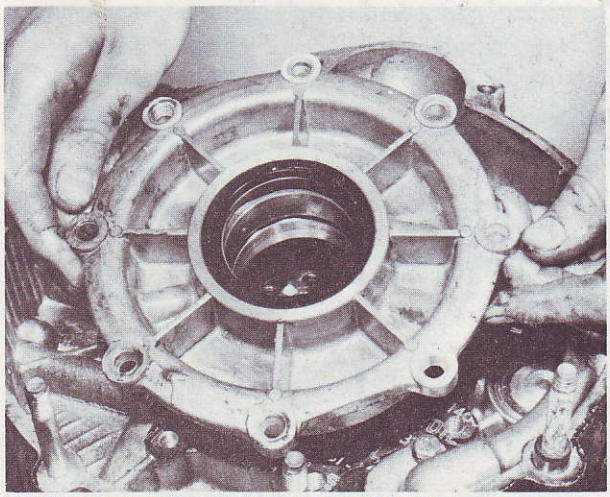
2 Before removing the connecting rods, mark each rod and big-end cap set so that they are refitted as a matched pair and in the same position on the big-end journal. Unscrew the big-end nuts and separate the caps from the rods. Remove the connecting rods and temporarily refit the big-end caps. Do not allow the bearing shells to be interchanged.

3 Reposition the engine so that the front is facing downwards and is supported on blocks, with the crankshaft end clear of the workbench. Loosen and remove the bolts from the rear main bearing housing after bending down the tab washer ears. The bearing housing is now free to be removed. If required, the housing may be drifted out by applying a soft nosed mallet to the front end of the crankshaft.

4 Removal of the crankshaft is straightforward. Lift the complete assembly out through the rear of the crankcase, turning it as necessary so that the webs clear the edge of the casing. Unless the front main bearing requires renewal, removal of the bearing housing is not required. The housing is retained by six bolts, secured in pairs by locking plates.

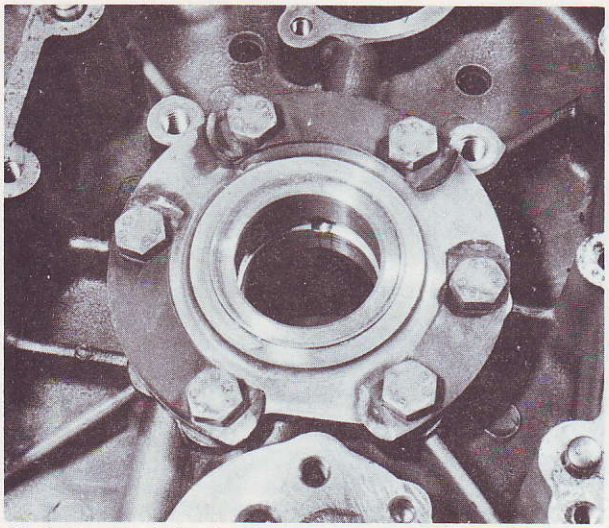


13.2 Mark caps and rods before removing



13.3 Detach the rear main bearing housing and ...

13.4a ... manoeuvre the crankshaft from position



13.4b Front main bearing housing - general view

14 Examination and renovation: general

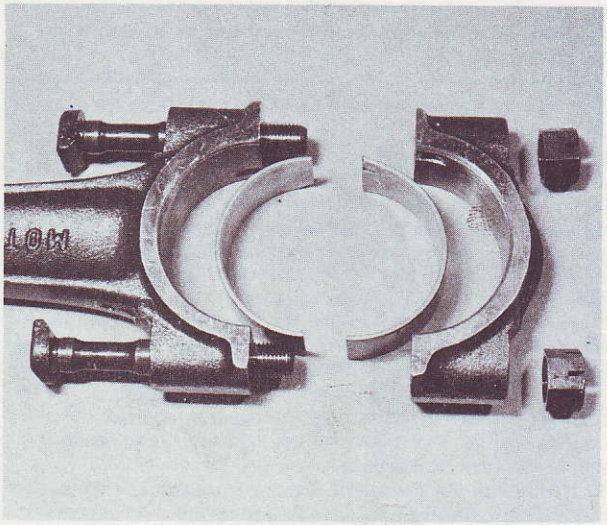
1 Before examining the parts of the dismantled engine for wear, it is essential that they should be cleaned thoroughly. Use a petrol/paraffin mix to remove all traces of old oil and sludge that may have accumulated within the engine and a cleansing agent such as Gunk or Jizer for the external surfaces. Special care should be taken when using these latter compounds, which require a water wash after they have had time to penetrate the film of grease and oil. Water must not be allowed to enter any of the internal oilways or parts of the electrical system.
2 Examine the crankcase castings for cracks or other signs of damage. If a crack is discovered, it will require specialist repair, or replacement.
3 Examine carefully each part to determine the extent of wear, if necessary checking with the tolerance figures listed in the Specifications Section of this Chapter. The following Sections of this Chapter describe how to examine the various engine components for wear and how to decide whether renewal is necessary
4 Always use a clean, lint-free rag for cleaning and drying the various components prior to reassembly, otherwise there is risk of small particles obstructing the internal oilways.

15 Crankshaft, crankshaft bearings and connecting rods: examination and renovation

1 Check the big-ends for wear, whilst assembled on the crankshaft, by pushing and pulling on the connecting rods. There should be no discernible play.
2 When dismantled, check each big-end width with a micrometer, and check with the dimension given in the Specifications. If the big-end shells are badly scored, they will have to be renewed. Endeavour to find out why they were scored - check oilways etc.
3 Check that the small end bushes are secure, and have no more than the allowable wear. If they need to be replaced, they must be pressed out. The new bush may be used to press the old bush from position. See the accompanying diagram. To restore the correct clearance between the bush and gudgeon pin, the bushes must be reamed out after fitting.
4 Inspect and measure the internal diameter of both main bearings and the diameters of the crankshaft journals. Renew the bearings, complete with housings, if the clearance exceeds that given in the Specifications. Ideally, if crankshaft or big-end wear has occurred, the bearing journals should be re-ground undersize and suitable bearings fitted. Some crankshafts are nitrided (a special hardening process) however, and if no journal ovality, scoring or tapering is found, regrinding may not be required. Consult a Moto Guzzi specialist for advice on this matter. Oversizes for both main and big-end bearings are available, in three categories.
5 It is essential that the main and big-end journals are re-radiused whenever the crankshaft undergoes regrinding. If this operation is overlooked, the stresses imposed may cause crankshaft failure. The correct radii are as follows:

Big-end bearing	*2.0 - 2.5 mm (0.078 - 0.090 in)*
Rear main bearing	*3.0 mm (0.118 in)*
Front main bearing	*1.5 - 1.8 mm (0.058 - 0.070 in)*

6 Check that the oilways in the crankshaft are quite clear. A high pressure air hose is suitable for removing all normal deposits. A centrifugal sludge trap is incorporated in the crankshaft, the chamber of which is closed by a socket blanking-plug in the forward crankshaft web. If removed, the plug must be refitted, using a locking fluid applied to the thoroughly cleaned threads. It is essential that the plug is quite tight as oil failure and other damage will occur if it unscrews.



15.2 Connecting rod components - general view

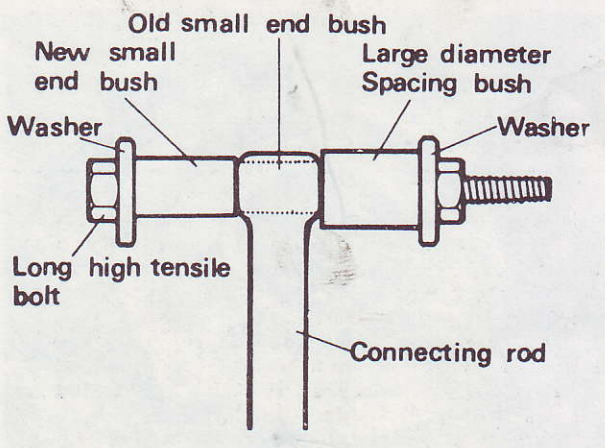


Fig. 1.2. Removal of small end bush

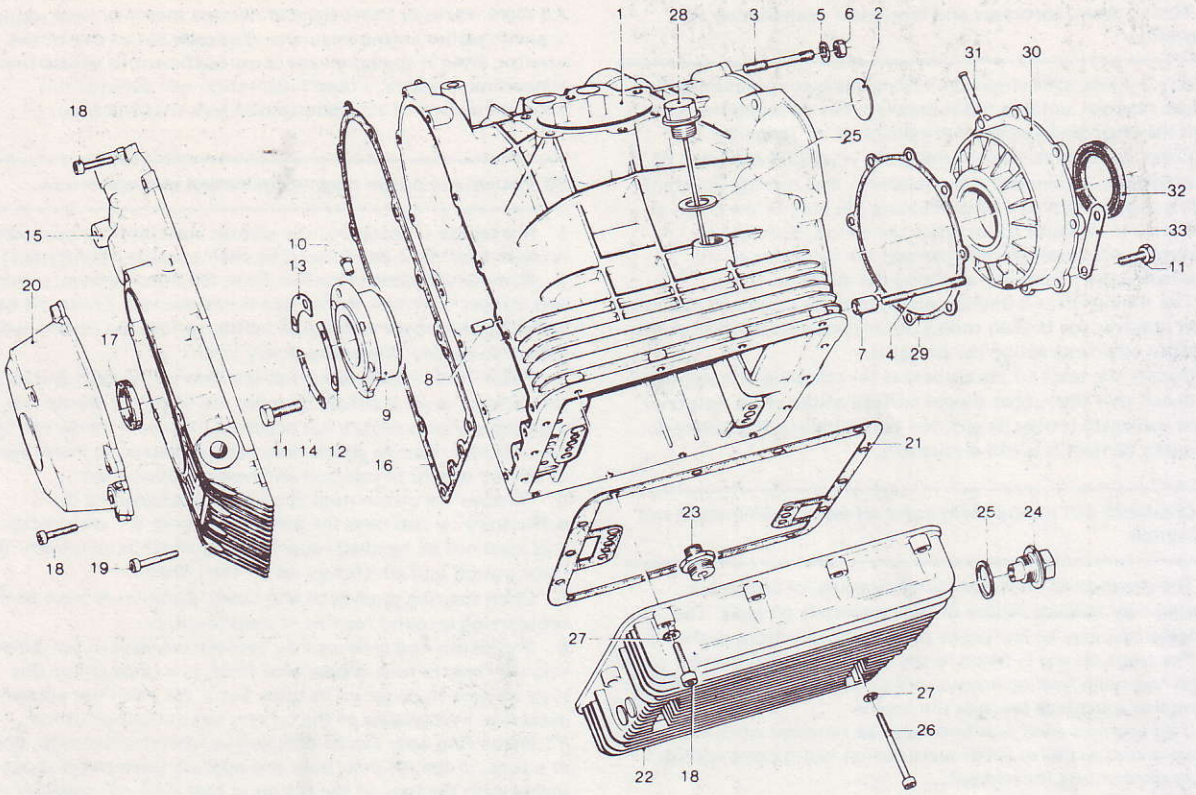


Fig. 1.3. Crankcase - component parts

1 *Crankcase*
2 *Core plug*
3 *Short stud - 4 off*
4 *Long stud - 2 off*
5 *Plain washer - 5 off*
6 *Nut - 6 off*
7 *Hollow dowel - 2 off*
8 *Hollow dowel - 2 off*
9 *Main bearing/housing*
10 *Oilway insert*
11 *Bolt - 14 off*
12 *Lock plate*
13 *Lock plate*
14 *Lock plate*
15 *Timing cover*
16 *Gasket*
17 *Oil seal*
18 *Socket screw - 26 off*
19 *Socket screw - 6 off*
20 *Alternator cover*
21 *Gasket*
22 *Jump*
23 *Filter union - not 750S or 850T*
24 *Drain plug*
25 *Washer*
26 *Socket screw - 4 off*
27 *Plain washer - 18 off*
28 *Oil filler cap/dipstick*
29 *Gasket*
30 *Main bearing/housing*
31 *Oil pipe*
32 *Oil seal*
33 *Lock plate*

16 Camshaft and pushrods : examination and renovation

1 The camshaft is unlikely to show signs of wear unless a high mileage has been covered or there has been a breakdown in the lubrication system. Wear will be most obvious on the flanks of the cams and at the peak, where flattening-off may occur. Scuffing or in an extreme case, discoloration, is usually indicative of lubrication breakdown.

2 If there is any doubt about the condition of the camshaft, it is advisable to renew it whilst the engine is completely dismantled. Comparison with a new camshaft is often the best means of checking visually the extent of wear.

3 Check the cam followers for wear or damage. Again it is extremely unlikely that any has occurred. Slight scoring may be removed using an oil stone, provided that the surface remains absolutely flat and square. The cam followers are designed to rotate slowly in order that wear is distributed evenly over the surface of the working face. Lack of rotation will be evident by a marked depression where the cam lobe has rubbed consistently. Check the fit of the cam followers in their respective slide-ways in the crankcase. Excessive clearance may be restored by fitting new followers, of which two oversizes are available. In extreme cases the slide-ways in the crankcase may have to be reamed to restore the surfaces.

4 Check the pushrods for straightness by rolling them on a flat surface. Replace any that are bent, since it is impractical to straighten them with accuracy. Check that the hardened end pieces are not loose, or the internal bearing surfaces worn, chipped or broken.

5 Check the clearance between the camshaft journals and the bearing surfaces. The camshaft runs directly in the aluminium crankcase. Wear is usually negligible, a matter that is fortuitous, because wear in the bearings will require renewal of the complete crankcase unit.

17 Timing chain, sprockets and tensioner: examination and renovation

1 It is unlikely that either the timing chain or sprockets will require renewal, unless a chain breakage has damaged the teeth. Both the chain and sprockets are designed for long life.
2 Check for uneven wear of the chain when still mounted on the crankcase, by removing the tensioner and turning the crankshaft a quarter turn at a time. Measure the play in the chain at each turn. If in doubt about chain condition, it should be renewed, since breakage may damage the sprockets or the crankcase - apart from immobilising the machine.
3 The timing chain is endless, and should be examined carefully when removed for broken rollers or cracked side plates or rivets damaged when extracting the sprocket.
4 Inspect the teeth of the sprockets for chipping or hooking.
5 Check that the rubber slipper surface of the chain tensioner is not damaged. It may be grooved but as long as the rollers do not make contact it is still serviceable.

18 Crankcase and timing chain cover oil seals: examination and renovation

1 The presence of oil in the clutch housing, or alternator housing may indicate failure of the crankshaft oil seals. The damaged seal may be drifted or prised carefully from position.
2 The front oil seal is fitted in the timing case and the rear seal in the rear main bearing housing. When refitting the seals, the spring side must face towards the engine.
3 It is recommended that both seals be renewed when the engine is dismantled as subsequent failure will require considerable dismantling for renewal.

19 Cylinder barrels: examination and renovation

1 The usual indications of badly worn cylinder bores and pistons are excessive oil consumption and piston slap, a metallic rattle which occurs when there is little or no load on the engine. If the top of the cylinder barrel is examined carefully, it will be observed that there is a ridge on the thrust side of each cylinder bore which marks the limit of travel of the uppermost piston ring. The depth of this ridge will vary according to the amount of wear that has taken place and can therefore be used as a guide to bore wear.
2 On all models the pistons are selectively matched on initial assembly to fit the cylinder barrels, and are stamped A, B or C on the the piston crown. The cylinder barrels are marked likewise. When taking cylinder barrel or piston measurements refer to the classification in the relevant Specifications at the beginning of the Chapter.
3 With the exception of V-1000 and Le Mans models, all models are fitted with chrome-plated cylinder bores. This type of bore has very good wearing properties, consequently a long life may be expected. Because the chrome layer is very thin, no overboring is possible. If wear becomes excessive or damage occurs to the bore, the complete cylinder barrel must be renewed. V-1000 and Le Mans models are fitted with an aluminium alloy cylinder barrel, utilising a traditional steel sleeve bore. Two sizes of oversize piston are available for fitting after reboring in the normal manner.
4 Measure the bore diameter using an internal micrometer. Three measurements should be taken, at the top, middle and bottom of each bore. A further three measurements should then be taken at 90° to the first positions. On models fitted with chrome bores, wear should not exceed 0.1 mm (0.004 in) over the largest bore diameter given for that classification of cylinder barrel in the Specifications. If wear exceeds this figure, the cylinder barrels must be renewed. Wear on steel cylinder bores should not exceed the greatest diameter given for that classification of piston.
5 Check the surfaces of each cylinder bore to ensure there are no score marks or other signs of damage that may have resulted from an earlier engine seizure or displacement of one of the circlips. Even if the bore wear is not sufficient to necessitate renewal or a rebore, a deep indentation will override this decision in view of the compression leak that will occur.

20 Pistons and piston rings: examination and renovation

1 If a rebore is necessary, the pistons and rings can be discarded because they must be replaced by their oversize counterparts.
2 Remove all traces of carbon from the piston crown, using a soft scraper to ensure the surface is not marked. Finish off by polishing the crown with metal polish, so that the carbon will not adhere so readily. **Never** use emery cloth.
3 Piston wear usually occurs at the base of the skirt and takes the form of vertical streaks or score marks on the thrust side. If a previous engine seizure has occurred, the score marks will be very obvious. Pistons which have been subjected to heavy wear or seizure should be rejected and new ones obtained.
4 Remove the piston rings carefully, by expanding them sufficiently to pass over the piston. The rings are very brittle, and must not be handled roughly. Note which groove each ring came out of, and which way up on each piston.
5 Clean the ring grooves of any burnt deposits. A piece of old broken ring is useful for this, if used carefully.
6 The piston ring grooves may become enlarged in use, permitting the rings to have greater side float. It is unusual for this type of wear to occur on its own, but if the side float appears excessive, new pistons of the correct size should be fitted.
7 Piston ring wear can be checked by inserting the rings, one at a time, in the cylinder bore and pushing them down about 1½ inches with the base of the piston so that they rest squarely in the bore. Using a feeler gauge check the end gap against the Specifications. If the gap exceeds the figure given, the rings should be renewed. On chrome bore cylinder barrels, new rings should **not** be fitted to old bores as the rings will not bed down on the highly polished surface.

21 Valves, valve springs, and valve guides: examination and renovation

1 Use a valve spring compressor to release each of the valves in turn. Keep the valves, valve springs and collets etc together in sets so that they are eventually replaced in their original location. Fitted below each spring lower seat are a number of shims and washers. Note the number of components used for each valve together with their relative positions.
2 After cleaning all four valves to remove carbon and burnt oil, examine the heads for signs of pitting or burning. Examine the valve seats in the cylinder head. The exhaust valves and their seats will require the most attention because they are the hotter running. If the pitting is slight, the marks can be removed by grinding the seats and valve heads together, using fine valve grinding compound.
3 Valve grinding is a simple, if somewhat laborious task. Smear a trace of fine valve grinding compound (carborundum paste) on the seat face and apply a suction grinding tool to the head of the valve. Oil the stem of the valve and insert it in the guide until it seats in the grinding compound. Using a semi-rotary motion, grind-in the valve head to its seat. Lift the valve occasionally to distribute the grinding compound more evenly. Repeat this application until an unbroken ring of light grey matt finish is obtained on both valve and seat. This denotes the grinding operation is now complete. Before passing to the next valve, make sure that all traces of the valve grinding compound have been removed from both the valve and its seat and that none has entered the valve guide. If this precaution is not observed, rapid wear will take place due to the highly abrasive nature of the carborundum base.

4 When deep pits are encountered, it will be necessary to use a valve refacing machine and a valve seat cutter, set to an angle of 45°. Never resort to excessive grinding because this will only pocket the valve in the head and lead to reduced engine efficiency. If there is any doubt about the condition of a valve, fit a new one.

5 Examine the condition of the valve collets and the grooves in the valve stem in which they seat. If there is any sign of damage, new parts should be fitted. Check that the valve spring collar is not cracked. If the collets work loose or the collar splits whilst the engine is running, a valve could drop in and cause extensive damage.

6 Measure the valve stems for wear, comparing them with the unworn portion that does not extend into the valve guide. Check also the valve guides for excessive play. Check that the end of the stem is not indented from contact with the rocker arm, making tappet adjustment difficult.

7 Check the free length of each valve spring and replace the whole set if any has taken a permanent set. Worn or 'tired' valve springs have a marked effect on engine performance and should preferably be renewed during each decoke as a minimum, especially in view of their low overall cost.

8 The valve guides are an interference fit in the cylinder head, and should be drifted out from the combustion chamber side, using a double diameter drift. Before attempting to move the guides, clean off any deposits of carbon from the portion of guide which projects into the valve port. This will ease removal and prevent damage to the cylinder head. New valve guides should be fitted in a similar manner, from the opposite side of the cylinder head, and then reamed out to give the specified valve guide (stem clearance).

Note: Before removal or installation of valve guides is undertaken, the cylinder head must be heated to 150°C (300°F) to expand the head and so aid fitting. Unless the cylinder head is heated evenly, distortion may occur and for this reason heating should take place in an oven. Generally, it is best to seek specialist advice when renewing valve guides, as there is always risk of distorting the cylinder head casting.

9 After fitting new valve guides the valve seats must be recut to restore concentricity of the seat with the guide bore. Grinding should then be carried out, as described in paragraph 3.

10 Check the sealing of valve by inverting the cylinder head and pouring paraffin or petrol into the combustion chamber. Allow the head to stand for some time and check that no liquid has seeped into either port.

19.2 Mark 'C' on piston indicates cylinder/piston classification

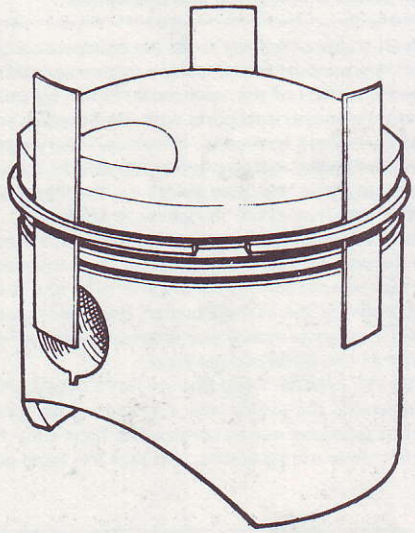
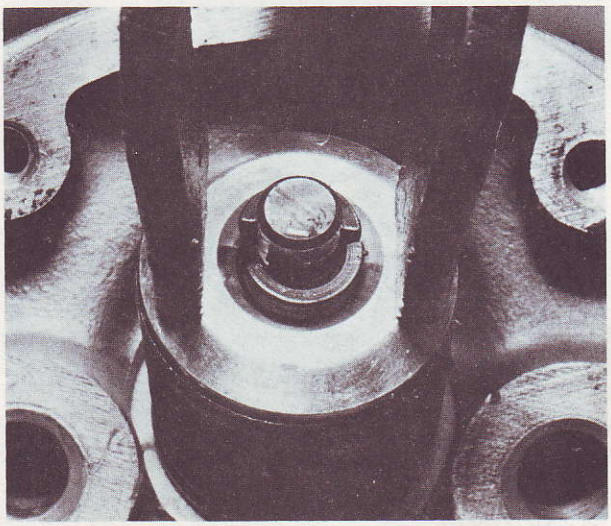
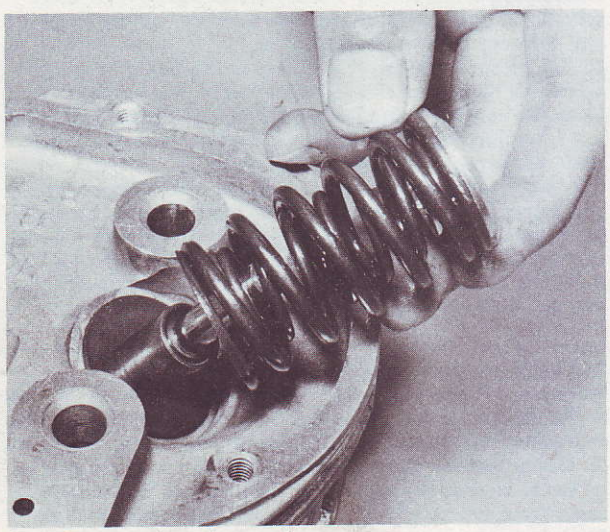


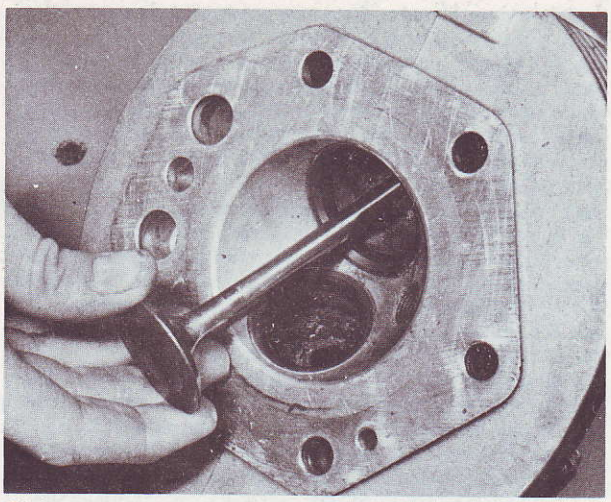
Fig. 1.4. Removing and replacing piston rings



21.1a Use compressor to displace valve collets



21.1b Remove the springs and ...



21.1c ... push out the valve

22 Cylinder heads: examination and renovation

1 Remove all traces of carbon from the combustion chambers and the inlet and exhaust ports, using a soft scraper which will not damage the surface of the valve seats. Finish by polishing the combustion chamber and ports with metal polish so that carbon does not adhere so readily. Never use emery cloth since the particles of abrasive will become embedded in the soft metal.
2 Check to make sure the valve guides are free from oil or other foreign matter that may cause the valves to stick.
3 If the valve seats are pocketed, as the result of excessive valve grinding in the past, the valve seats should be re-inserted. This is a specialist task which requires expert attention and is quite beyond the means of the average owner. Pocketed valves cause a marked fall-off in performance and reduced engine efficiency as a direct result of the disturbed gas flow.
4 Make sure the cylinder head fins are not clogged with oil or road dirt, otherwise the engine may overheat. If necessary, use a wire brush but take care not to damage the light alloy fins.
5 Check that there are no cracks, and that the valve guides are secure.

23 Rocker assemblies: examination and renovation

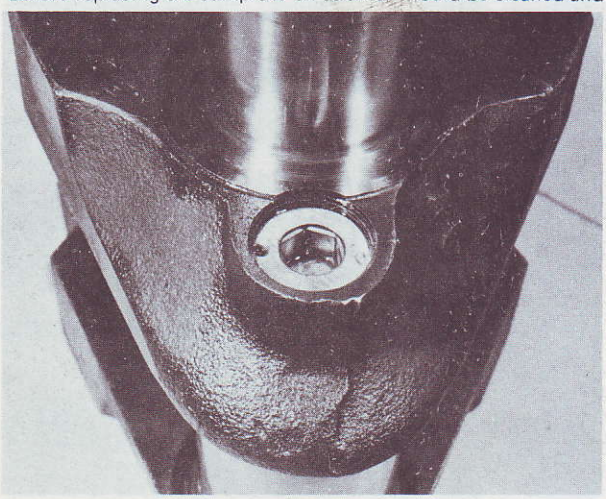
1 Examine carefully the outer surfaces of each rocker arm, to ensure there are no surface cracks or other signs of premature failure. The rocker arms should have a smooth surface to resist any tendency towards fatigue failure.
2 The rocker arms should be a good sliding fit on the rocker spindles without excessive play. Noisy valve gear will result from worn rocker arms and spindles and performance may drop off as a result of reduced valve lift. If play is evident, the rocker arms should be renewed and new spindles fitted.
3 Check the rocker arm adjuster and the end of the rocker which engages with the pushrod. Both these points of contact have hardened ends and it is important that the surface is not scuffed, chipped or broken, otherwise rapid wear will occur.
4 The spacer on the rocker spindle should revolve freely without endfloat.

24 Engine reassembly: general

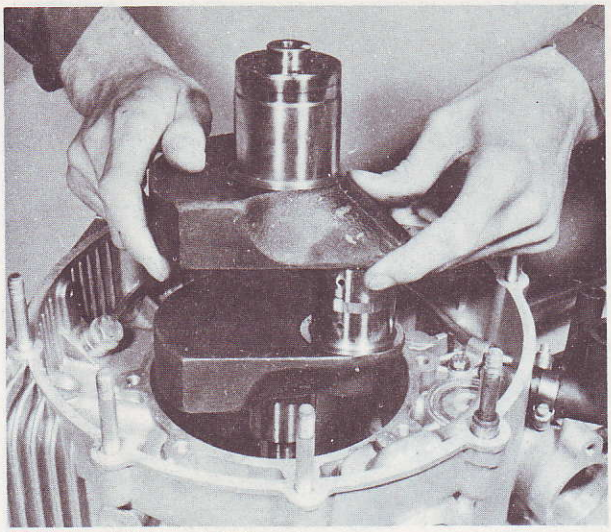
1 Before reassembly, the various engine components should be thoroughly cleaned and laid out close to the working area.
2 Gather together all the necessary tools and have available an oil can filled with clean engine oil. Make sure all the new gaskets and oil seals are to hand, also any replacement parts required. There is nothing more infuriating than having to stop in the middle of a reassembly sequence because a vital gasket or replacement part has been overlooked.
3 Make sure the reassembly area is clean and well lit and that there is adequate working space. Refer to the torque and clearance settings, wherever they are given. Many of the smaller bolts are easily sheared if they are overtightened. Always use the correct size spanner and screwdriver, never an adjustable or grips as a substitute. If some of the nuts and bolts that have to be replaced were damaged during the dismantling operation, renew them. This will make any subsequent reassembly and dismantling much easier.
4 Above all else, use good quality tools and work at a steady pace, taking care that no part of a reassembly sequence is omitted. Short cuts invariably give rise to problems, some of which may not be apparent until a much later stage.

25 Engine reassembly: replacing the crankshaft and connecting rods

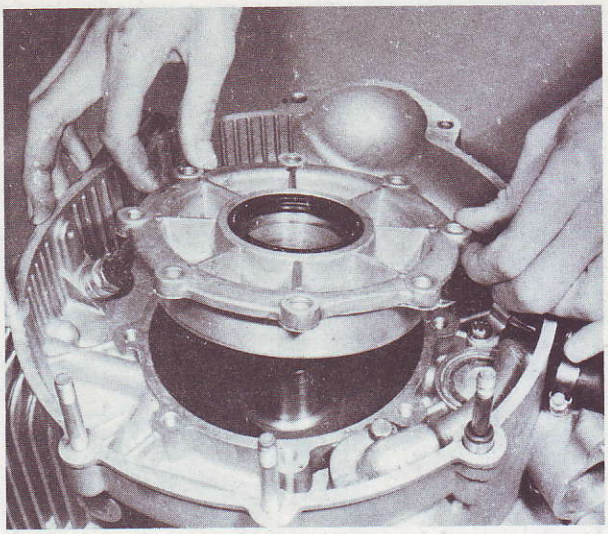
1 If the front main bearing housing was removed, it should be refitted first. **Ensure that the housing is replaced so that the oil ways align.**
2 Place the engine, front downwards, with the casing well clear of the workbench. Lubricate the front main bearing thoroughly and insert the crankshaft. Fit the oil seal to the rear main bearing housing, making sure it is fully home and the spring side is facing inwards. Lubricate the bearing and the seal lips, and refit the main bearing housing. The main bearing oil return pipe projecting from the housing must pass through the hole in the crankcase wall, and the oil ways between the housing and crankcase must line up. After tightening the housing bolts do not omit to bend up the ears of the locking plates. Check that the crankshaft rotates easily.
3 Reposition the engine so that it is supported on the cylinder head studs. Fit the big-end shells to the connecting rods and end caps, ensuring that the locating tongues on the shells locate correctly with the recesses in the holders. Lubricate the big-end journal and refit the connecting rods and caps. **The connecting rods must be fitted in their original positions on the big-end journals.** The oil hole in the left-hand connecting rod must face upwards (with the engine in the normal position) and the left-hand connecting rod downwards. In addition, the milled edges of the connecting rods and caps must all be on the same side. Tighten the big-end nuts to a torque setting of 4.6 - 4.8 kg m (33-35 ft lb).
4 Check again for easy rotation of the crankshaft. Binding of the big-end bearings can be caused by incorrect selection or displaced shells.
5 Whilst the engine is in this position the sump may be refitted. Before replacing the sump the oil strainer should be cleaned and



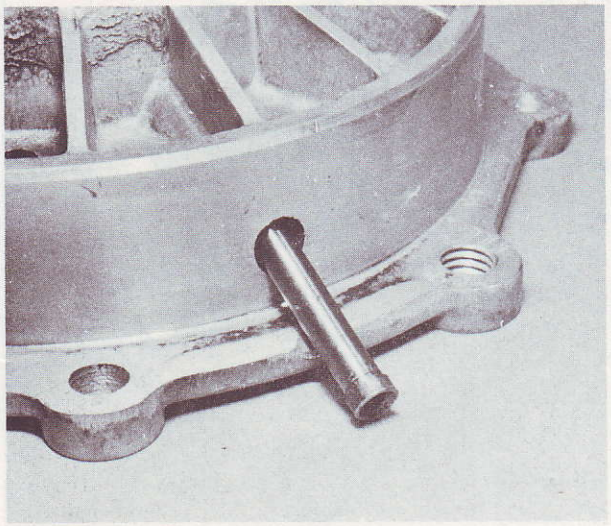
25.1 Crankshaft plug must be absolutely tight



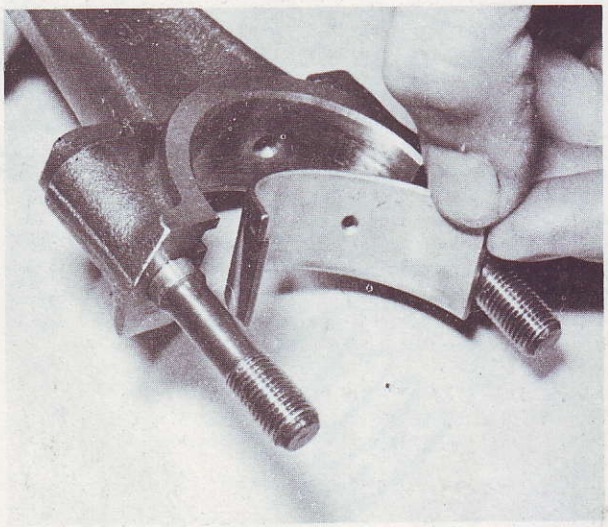
25.2a Insert the crankshaft and ...



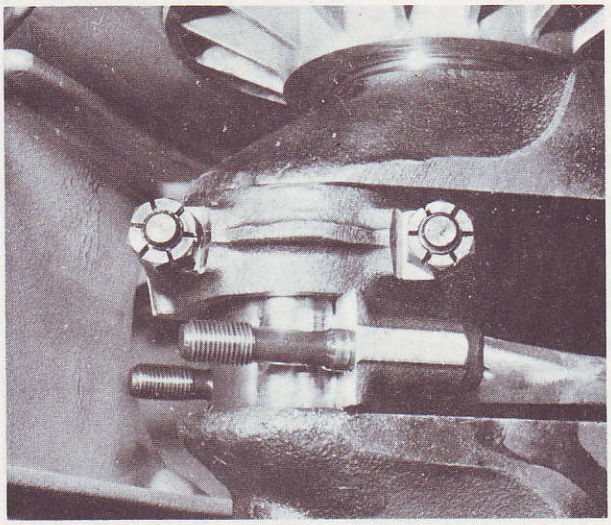
25.2b ... refit the rear main bearing housing and gasket



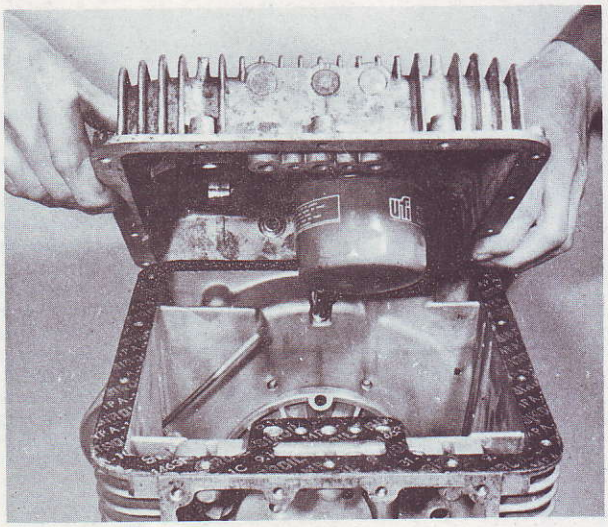
25.2c Do not omit the push fit pipe



25.3a Fit the big end bearing shells and ...



25.3b ... replace the connecting rods and caps



25.5 Refit the sump onto a new gasket

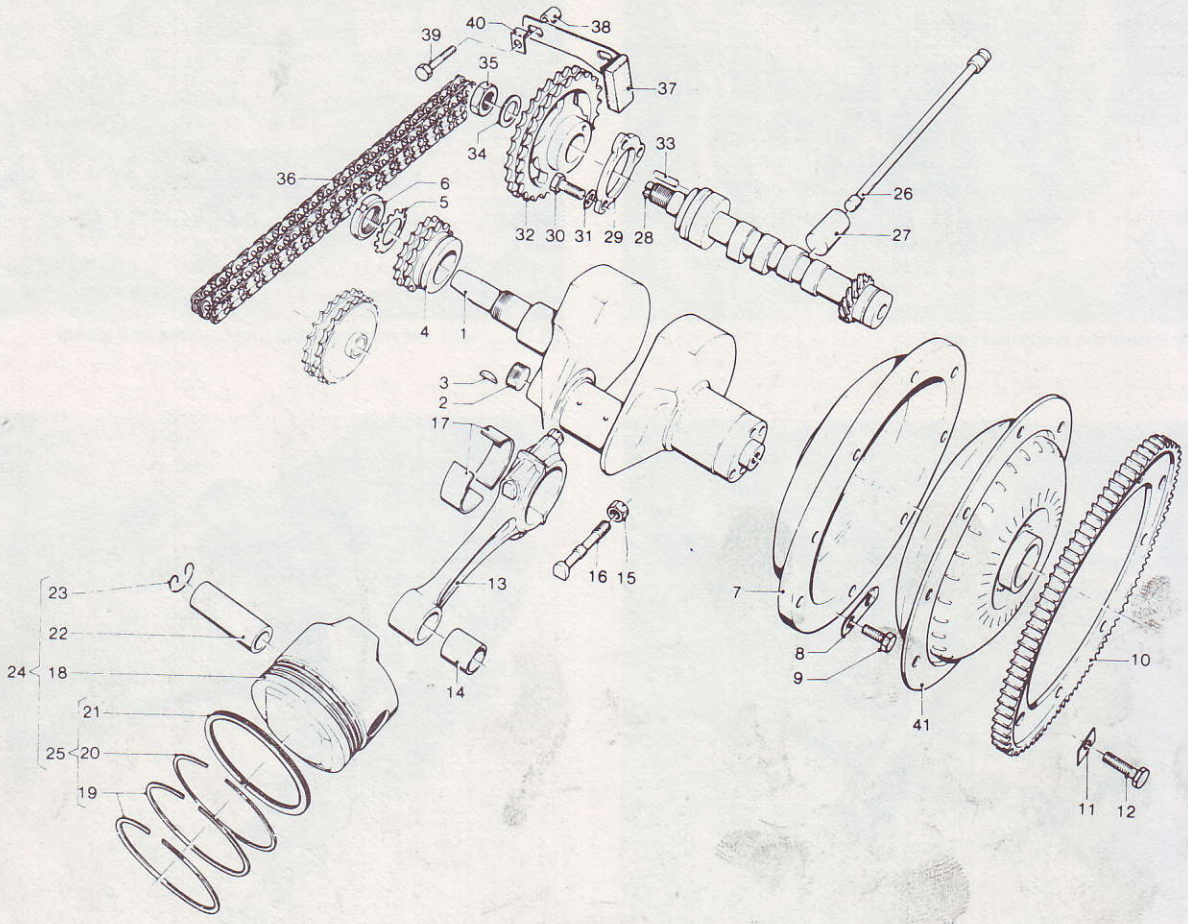


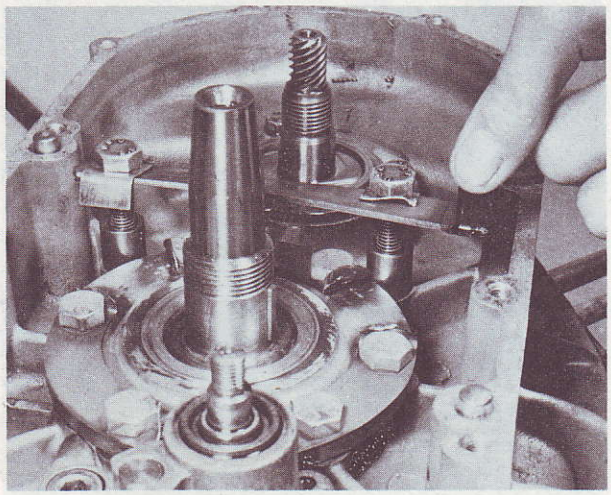
Fig. 1.5. Crankshaft and timing chest components

1 *Crankshaft*
2 *Plug*
3 *Woodruff key*
4 *Crankshaft sprocket*
5 *Tab washer*
6 *Peg nut*
7 *Flywheel - V-1000 type*
8 *Lock plate - 3 off*
9 *Bolt - 6 off*
10 *Starter ring gear - V-1000 type*
11 *Tab washer - 4 off*
12 *Bolt - 4 off*
13 *Connecting rod - 2 off*
14 *Smal-end bush - 2 off*
15 *Self locking nut - 4 off*
16 *Big-end bolt - 4 off*
17 *Big-end bearing shell set - 2 off*
18 *Piston - 2 off*
19 *1st and 2nd compression ring - 4 off*
20 *3rd compression ring - 2 off*
21 *Oil control ring - 2 off*
22 *Gudgeon pin - 2 off*
23 *Circlip - 4 off*
24 *Piston complete - 2 off*
25 *Piston ring set - 25 off*
26 *Pushrod - 4 off*
27 *Cam follower - 4 off*
28 *Camshaft*
29 *Flange*
30 *Bolt - 3 off*
31 *Spring washer - 3 off*
32 *Camshaft sprocket*
33 *Drive pin*
34 *Washer*
35 *Nut*
36 *Cam chain*
37 *Chain tensioner*
38 *Spacer - 2 off*
39 *Bolt - 2 off*
40 *Tab washer - 2 off*
41 *Torque converter - V-1000 only*

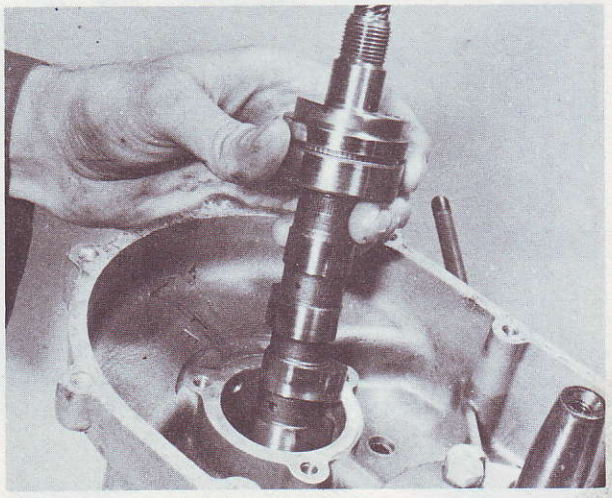
the oil filter (if utilised) renewed. In addition, the opportunity should be taken to dismantle and clean the oil pressure control valve. See Chapter 3.11 for details of the procedure.

26 Engine reassembly: replacing the camshaft, oil pump and timing the valves

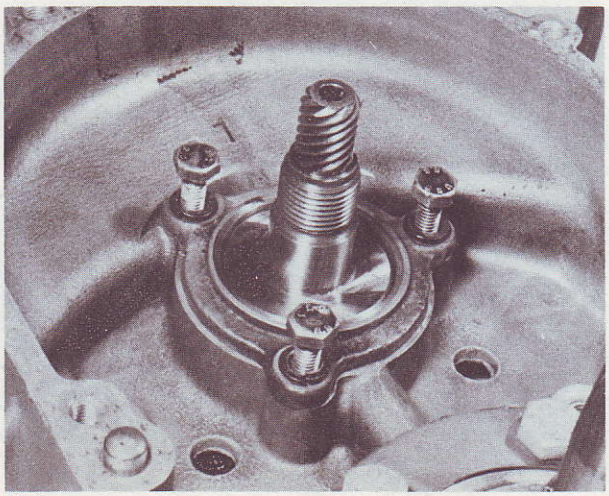
1 Place the timing chain tensioner arm in position in the casing with the distance piece on each bolt between the arm and the casing. Tighten the bolts lightly.
2 Lubricate the camshaft journal and insert the camshaft into the crankcase. Fit the endplate and tighten the three screws.
3 Position the oil pump in the casing and fit the four retaining bolts. The oil pump must be fitted so that the drive spindle is offset from the line of the crankshaft and camshaft. Tighten the four bolts evenly to 3 kg m (22 ft lbs), checking by rotation of the driveshaft that the pump gears do not bind.
4 Insert the drive pin into the eccentrically drilled hole in the camshaft and replace the Woodruff keys into the keyways of the other two shafts. Arrange the camshaft, crankshaft and oil pump sprockets on the workbench and fit the cam chain as it would be fitted on the engine. The timing mark on the camshaft sprocket should be aligned roughly with that of the crankshaft sprocket. Lift the complete assembly up and engage each sprocket with its respective shaft, holding the two sprockets in alignment.
5 Rotate the camshaft and crankshaft until the keys align with the keyways in the sprockets. Push the sprockets fully home on the shafts. The index marks on the two upper sprockets **must be in alignment.** One or two attempts may have to be made to ensure the timing is accurate.
6 Replace the sprocket retaining nuts and washers. The tab washer on the special crankshaft nut is inordinately difficult to bend up after the nut has been tightened, due to lack of space. It is worth bending up the extreme ends of the ears before refitting, to aid final securing of the nut.
7 As when loosening the nuts, rotation of the shafts may be prevented by passing a close fitting bar through the small end eye, resting on wooden blocks across the crankcase mouth.
8 Push the chain tensioner across towards the middle of the casing until all slack has been taken up. Hold the tensioner arm in the chosen position and tighten the two bolts. Rotate the crankshaft a number of times and check that the chain does not become overtight at any point. If this occurs, slacken the tensioner bolts and readjust at the tightest point. Secure the two bolts by means of their locking plates.
9 Place a new gasket on the timing chest mating surface and refit the cover. On V-1000 models the hexagonal drive piece fitted into the end of the camshaft must engage correctly with the converter oil pump drive boss. Fit the cover bolts and tighten them evenly, in a diagonal sequence, to avoid distortion.
10 When refitting the timing cover, lubricate the lip of the crankshaft oil seal.



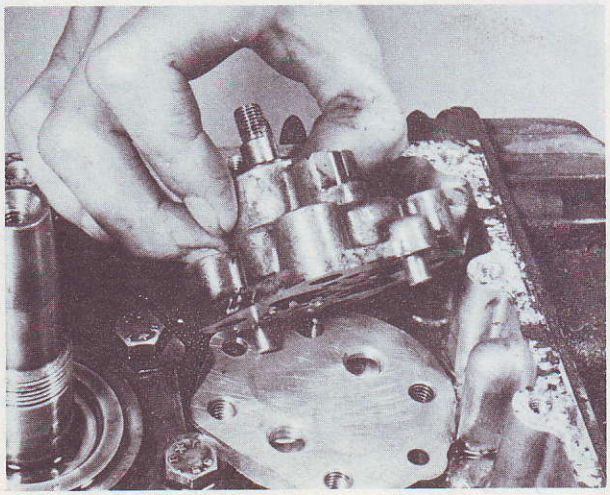
26.1 Position the chain tensioner and tighten the screw tightly



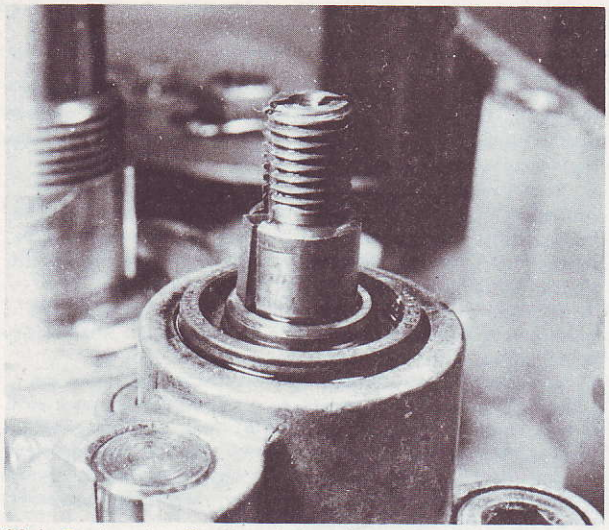
26.2a Insert the camshaft and ...



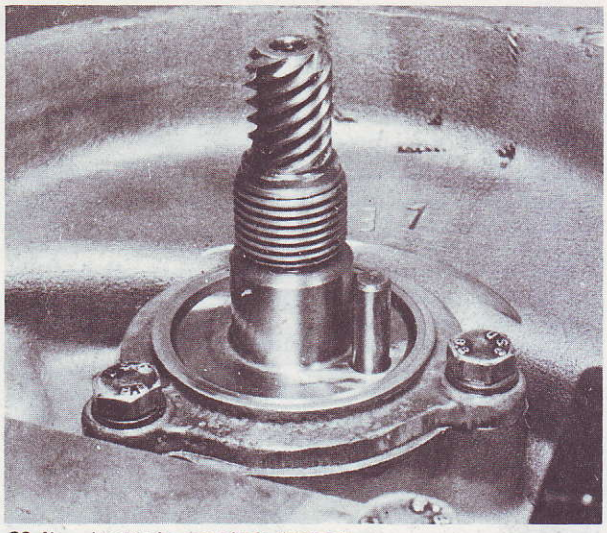
26.2b ... replace the end plate and screws



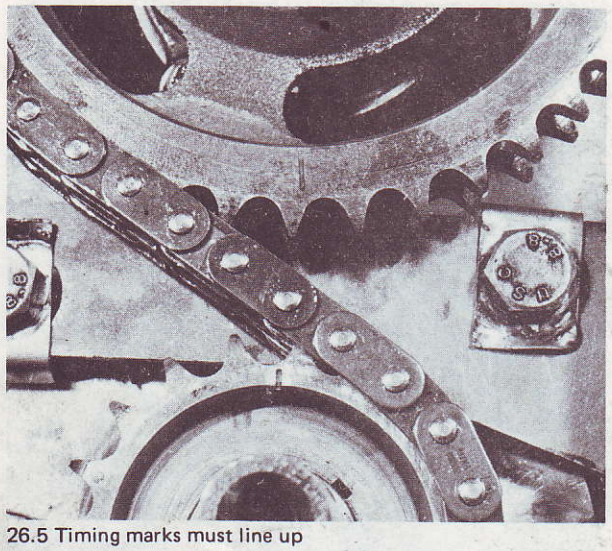
26.3 Place the oil pump in place, located by dowels



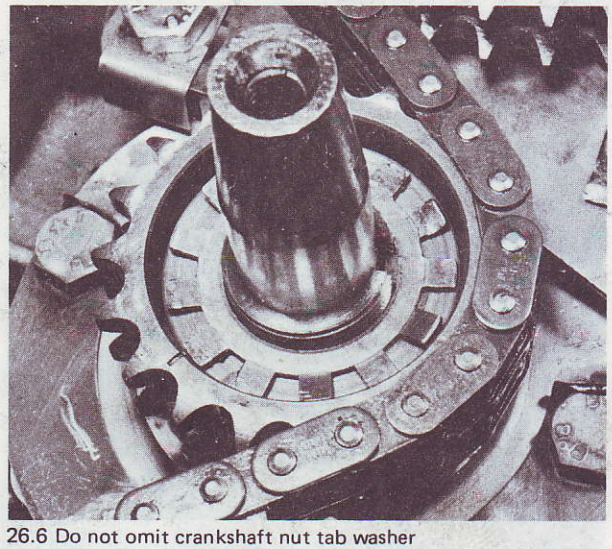
26.4a Replace the oil pump shaft and crankshaft Woodruff keys and ...



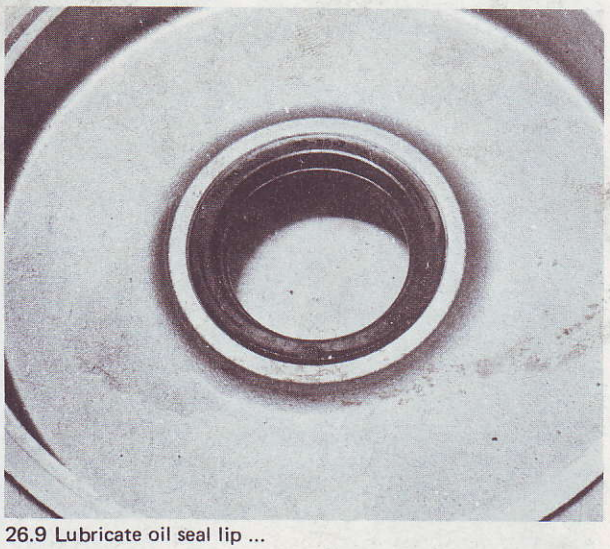
26.4b ... insert the camshaft drive pin



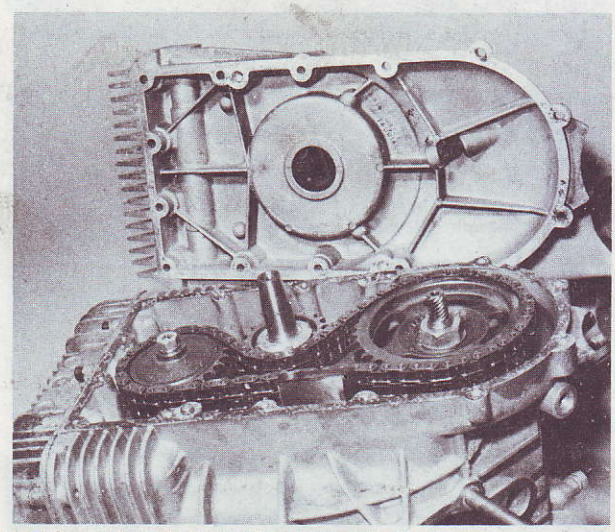
26.5 Timing marks must line up



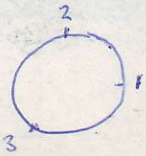
26.6 Do not omit crankshaft nut tab washer



26.9 Lubricate oil seal lip ...



26.10 ... before fitting timing cover onto crankcase

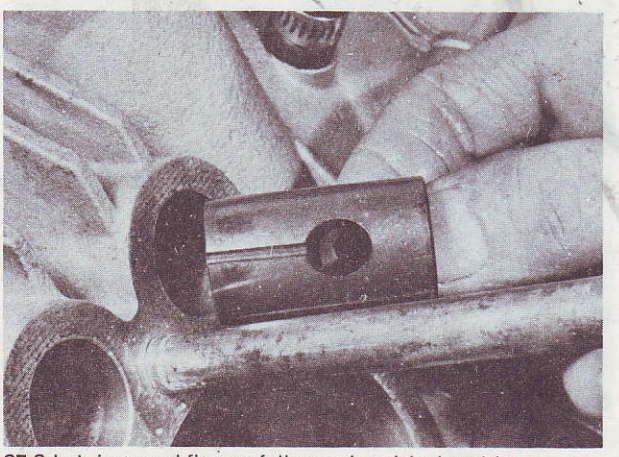


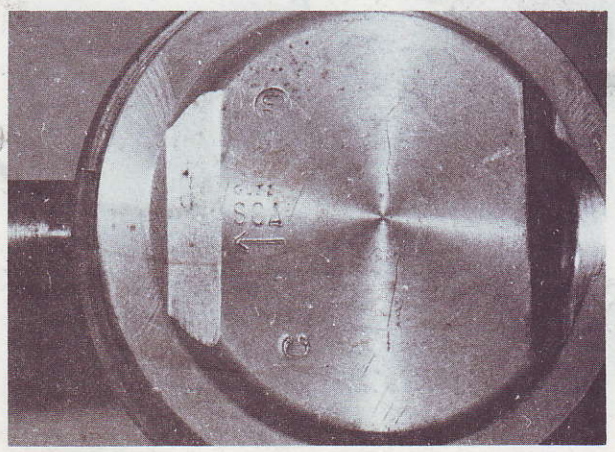
27 Engine reassembly: replacing the pistons, cylinder barrels and cylinder heads

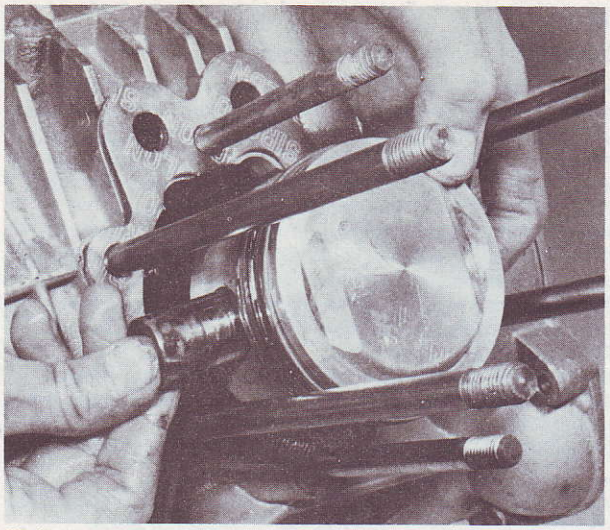
1 As with dismantling, the cylinder assemblies should be refitted individually, taking care that components from one assembly do not become interchanged with those of another. Care should be taken also that matched components are fitted in their original positions.
2 Lubricate and refit all four cam followers in their original positions.
3 Fit the piston rings to the piston of the cylinder being attended to. Fit the oil control ring from the skirt side and each of the compression rings from the crown side, commencing with the third ring. Thin strips of metal may be used to aid ring refitting and reduce the risk of breakage.
4 Lubricate the small end bush with clean engine oil. Refit one wire circlip to the piston. Warm the piston in boiling water and press the gudgeon pin fully home through the piston bosses and small end eye. The arrow cast on the piston crown must face forwards. Refit the second circlip and check that both are correctly seated in their locating grooves.
5 Position a new cylinder base gasket over the holding down studs, **ensuring that the oil hole in the gasket aligns with the oil hole in the cylinder seat mating surface.** Place a new 'O' ring on each of the two short holding down studs.
6 Refitting of the cylinder barrel is facilitated if the piston is supported squarely at TDC, on two wooden blocks. Lubricate the cylinder bore and position the ring gaps at 120° relative to one another. Place the cylinder barrel over the piston crown and compress each ring individually so that the barrel may be pushed home. A piston ring clamp will aid refitting. Remove the two support blocks and seat the cylinder barrel against the gasket.
7 Before refitting the cylinder head, the valves and springs must be installed by reversing the dismantling procedure. Do not omit the shims and washers which lie below the lower spring seat. Ensure that the two split collets engage correctly with the groove in the valve stem. After releasing the spring compressor, seat the valve collars by striking squarely on the end of the valve stem.
8 Place a new cylinder head gasket over the holding down studs. As with the cylinder base gasket, **it is important that the oil hole lines up with that of the cylinder barrel.** Place the cylinder head in position and fit an 'O' ring to each of the four long studs. Replace the rocker arm support bracket so that the spindle screw holes are at the top.
9 Refit the six cylinder head nuts and washers. The smaller wave washer fits the upper short stud. Tighten the cylinder head nuts down evenly, in a diagonal sequence, to a torque setting of 4 - 4.5 kg m (29 - 32 ft lb).
10 Insert both pushrods into the tunnel in the cylinder head so that the ball ends of each pushrod engage with the cam follower cups. Rotate the engine until the piston is at TDC, with both valves closed. Replace both rocker arms, bronze washers and double coil washers. The bronze washer should lie between the spring washer and support bracket. Insert the rocker spindles and, using a screwdriver in the slotted lower ends, rotate each spindle until the locating screws can be inserted and tightened.
11 Refit the rocker oil feed pipe to the cylinder head. If necessary, use two new sealing washers at the banjo union.
12 Before replacing the rocker cover, the valve clearances should be adjusted, using a feeler gauge. Refer to the Specifications for the correct clearance. Adjust the gap by means of the adjuster screw after slackening the locknut, with the piston at TDC on the compression stroke.
13 Replace the rocker cover together with a new gasket. Note that on some models the rearmost inner cover screw on the left-hand cylinder also retains the choke lever assembly.
14 Repeat the assembly procedure for the second cylinder.

28 Engine reassembly: replacing the flywheel and clutch (except V-1000 Convert model)

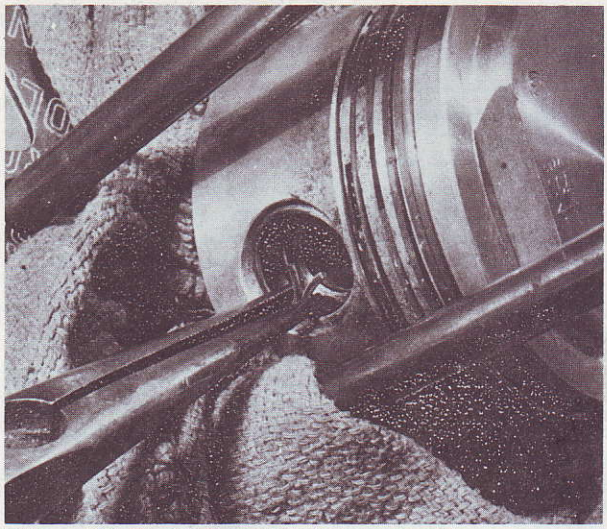
1 Place the flywheel on the crankshaft boss, rotating it until the TDC mark on the flywheel is aligned with the white index mark on the boss. This will ensure that the timing marks on the flywheel periphery are in correct relationship with the crankshaft. Insert the flywheel retaining bolts together with the shared lock plates. Tighten the bolts evenly and then secure them by bending up the ears of the plates.
2 Install each of the eight clutch springs in the recesses in the flywheel face. Apply a small amount of heavy graphite grease to the internal splines in the flywheel. Apply the grease sparingly to prevent any finding its way onto the clutch plates. Insert the clutch spring plate into position so that the index mark on the plate aligns with the TDC mark on the flywheel. This will aid alignment of the springs with the recesses in the rear of the spring plate.
3 Replace the two friction plates and the intermediate plate, followed by the starter ring gear. Insert and start the eight bolts, but do not tighten them at this stage. Because the two friction plates are fully floating when not under spring pressure they must be centralised before tightening down the starter ring gear, to enable easy entry of the splined boss of the gearbox input shaft. A special tool is recommended with which to accomplish this task. If this tool is not available the splined boss may be removed from the gearbox input shaft and used as the centraliser. When using the latter method, first insert the clutch thrust piece to aid centralisation of the boss.
4 With the tool in place tighten down the eight bolts evenly, about one turn at a time against the spring pressure. The centralising tool should be an easy sliding fit if the plates are positioned correctly. Remove the tool and insert the clutch thrust piece, if this has not been done already.


27.2 Lubricate and fit cam followers in original positions

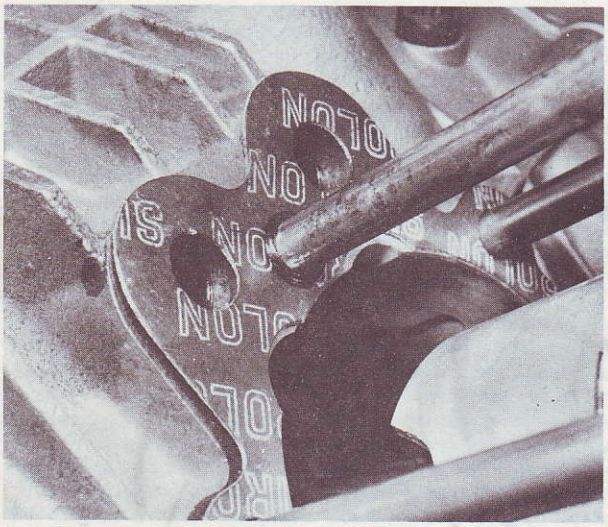

27.4a Arrow on piston must face forwards



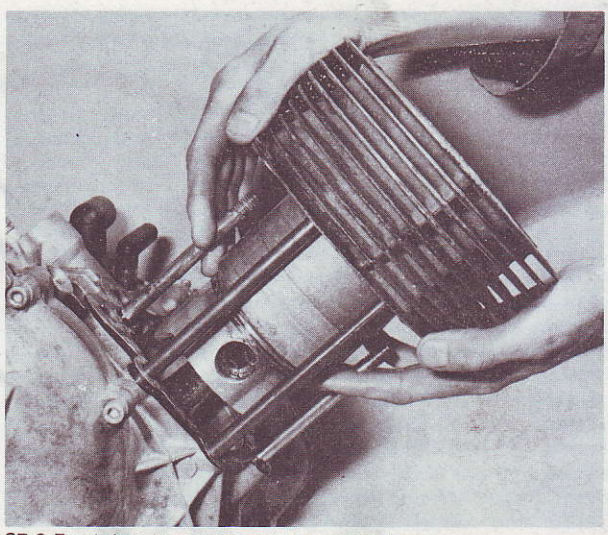
27.4b Insert gudgeon pin fully and ...



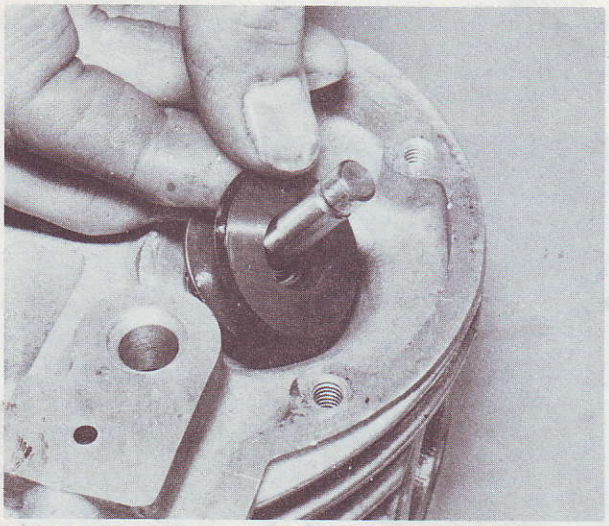
27.4c ... refit the circlip ensuring it seats correctly.



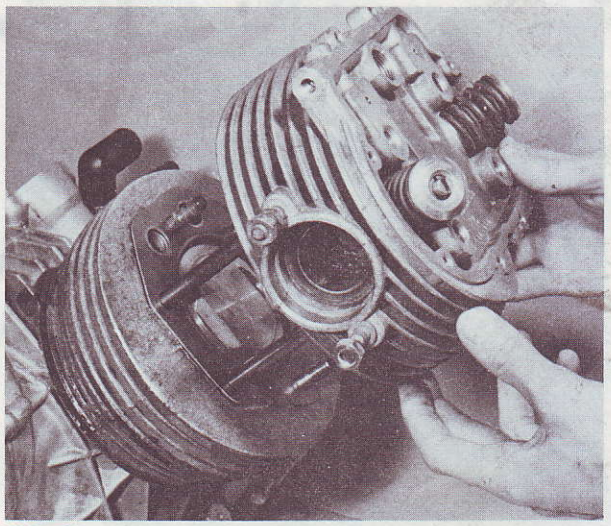
27.5 Fit new cylinder base gasket and 'O' ring



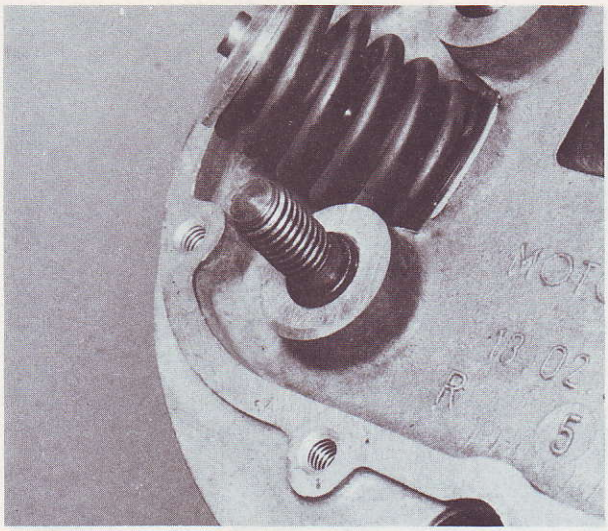
27.6 Feed the piston rings into the cylinder bore



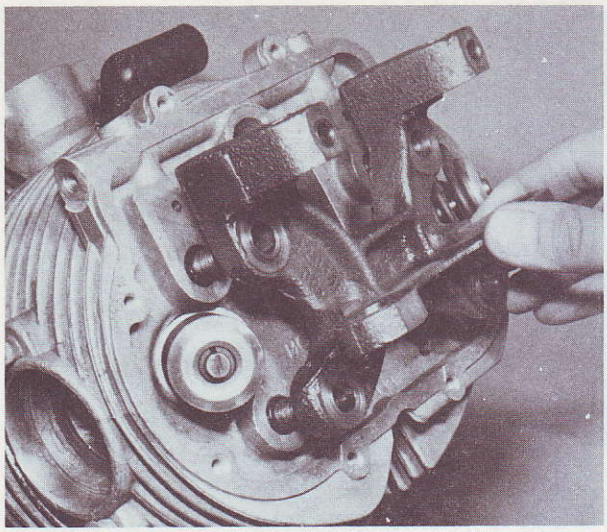
27.7 DO NOT omit correct number of shims



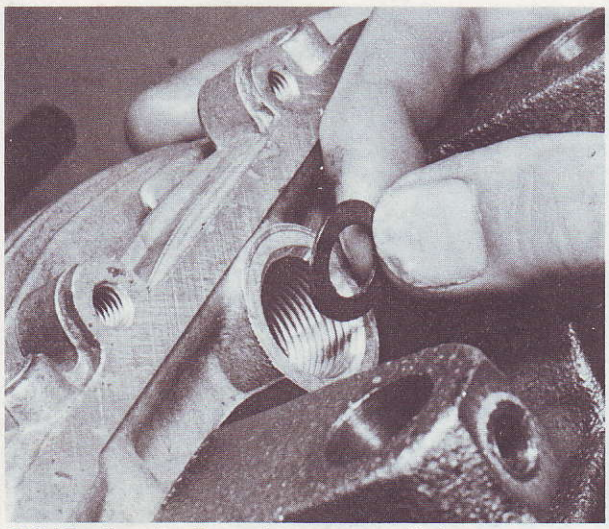
27.8a Fit cylinder head onto new gasket



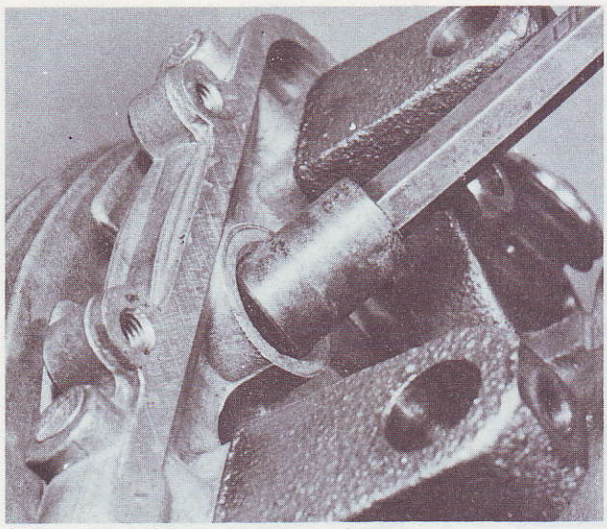
27.8b Place new 'O' rings on long stud



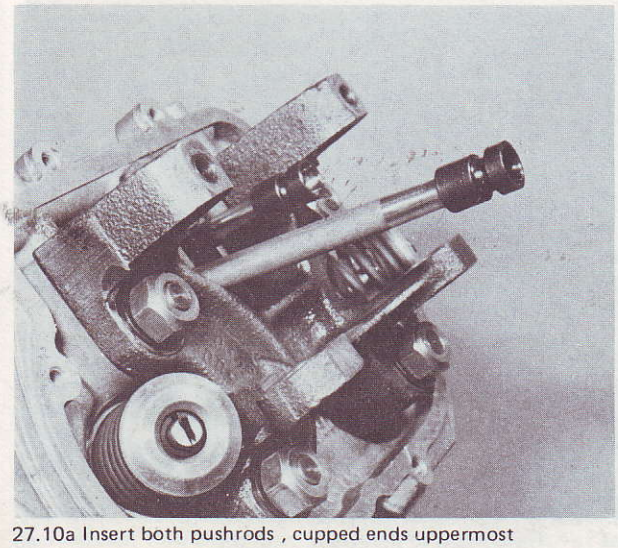
27.8c Replace the rocker support bracket



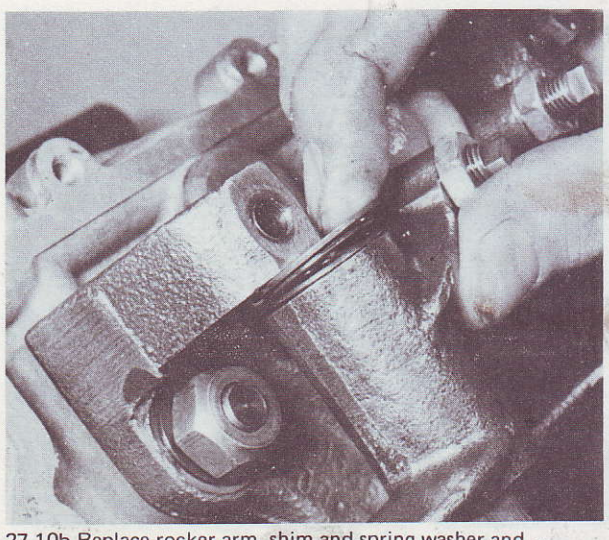
27.8d Small washer fits on short upper stud below ...



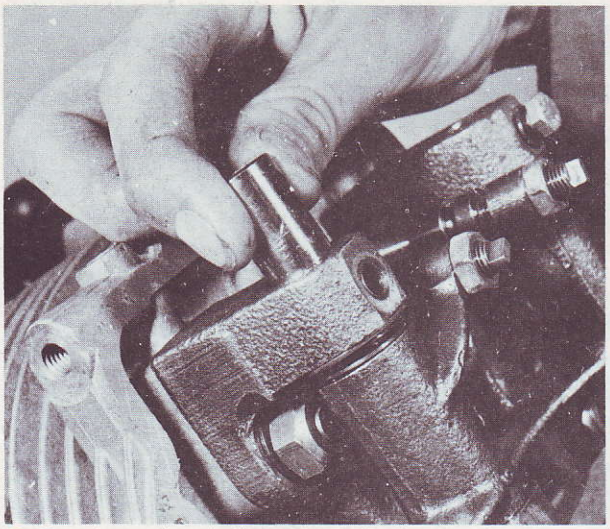
27.9 ... the special sleeve nut



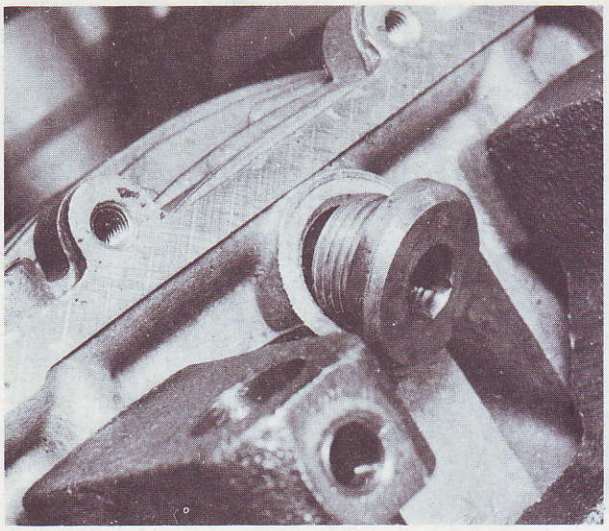
27.10a Insert both pushrods , cupped ends uppermost



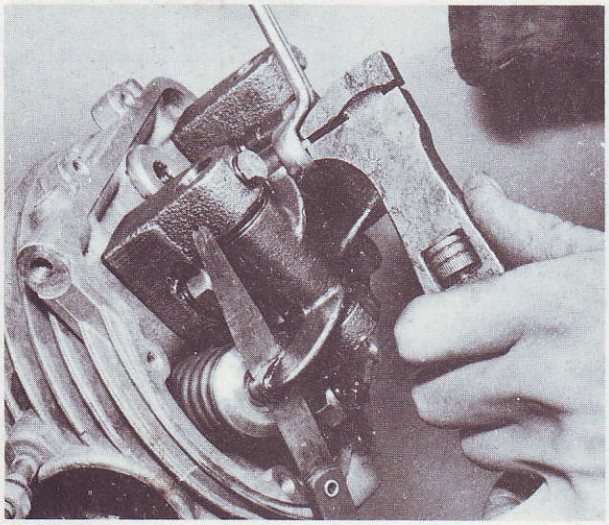
27.10b Replace rocker arm, shim and spring washer and ...



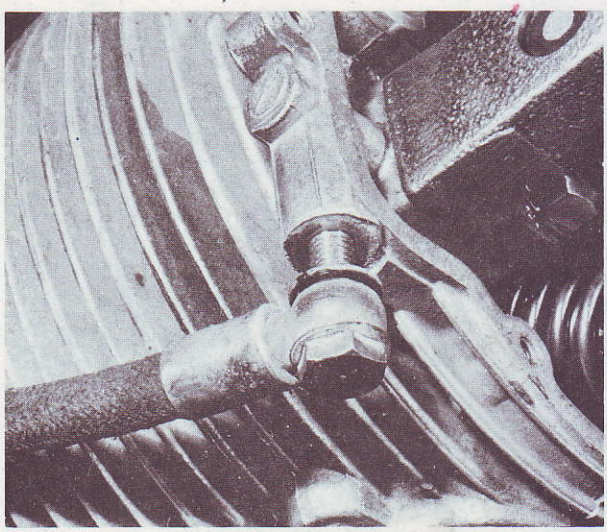
27.10c ... insert the spindle, so that hole aligns to take screw



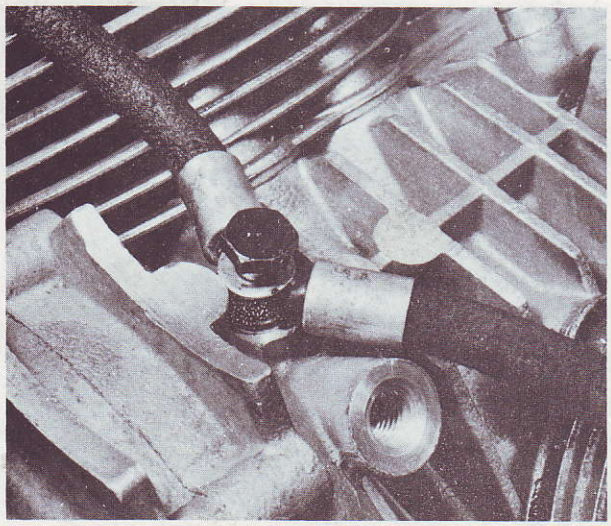
27.10d Do not omit internal cap



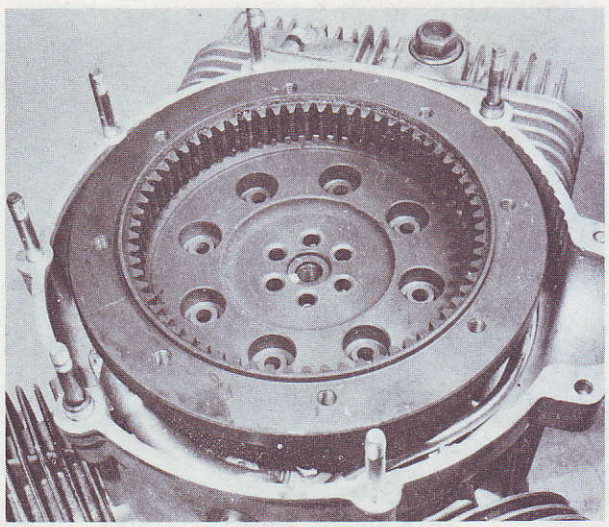
27.11a Check valve clearances before replacing cover



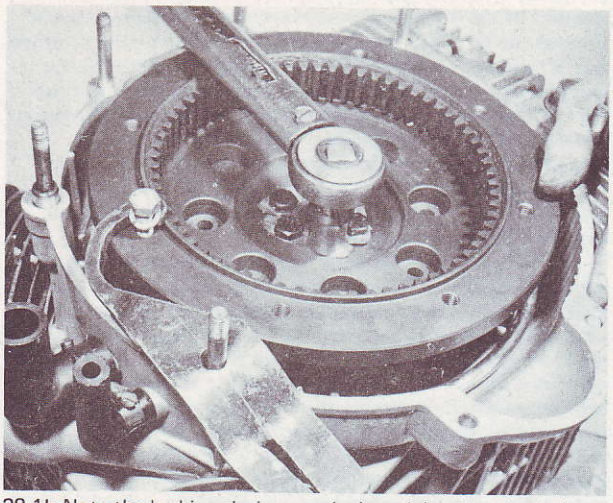
27.11b Use new sealing washers at upper and ...



27.11c ... lower unions on rocker feed pipes



28.1a Refit flywheel so that white mark aligns with TDC mark on flywheel ...



28.1b Note the locking device, used when tightening the bolts

29 Engine reassembly: replacing the flywheel and torque converter (V-1000 Convert model only)

1 Place the engine in the same position as that used during removal of these components. Refit the flywheel in the manner described for other models in the previous Section.
2 Position the starter ring gear and the torque converter on the flywheel and insert and tighten the bolts lightly. It is essential that the boss of the torque converter into which the gearbox input shaft fits, runs absolutely concentrically. If this precaution is not taken, difficulty may be encountered when trying to fit the gearbox to the engine. Additionally, oil leakage will occur at the oil seal. To check for correct location, a dial gauge or index gauge should be mounted on a bracket retained on one of the gearbox mounting studs. If eccentricity is apparent, remove the four retaining bolts and move the torque converter one quarter of a turn until the bolt holes again line up. Refit the bolts and check again. The maximum permissible run out measured on the outer surface of the boss is 0.05 - 0.06 mm (0.0019 - 0.0023 in).
3 When the torque converter is running true, tighten the bolts and secure them by means of the locking tabs.

30 Engine reassembly: joining the engine to the gearbox

1 Fitting of the gearbox onto the engine is straightforward on both manual and automatic models. If difficulty is encountered when inserting the splined boss into the centre of the clutch on manual gearbox models, a long-handled screwdriver may be inserted between the two mating surfaces, with which to rotate the flywheel.
2 The splined boss should be lubricated with a small quantity of graphite grease before assembly.
3 On V-1000 models, lubricate the torque converter boss with clean hydraulic fluid before fitting. It is not necessary to replenish the torque converter with hydraulic fluid at this juncture. The bush on the end of the input shaft must be fitted with the slotted end outwards, ie, towards the engine.
4 After pushing the gearbox fully home, fit and tighten the retaining nuts and washers.

31 Engine reassembly: replacing the distributor and alternator

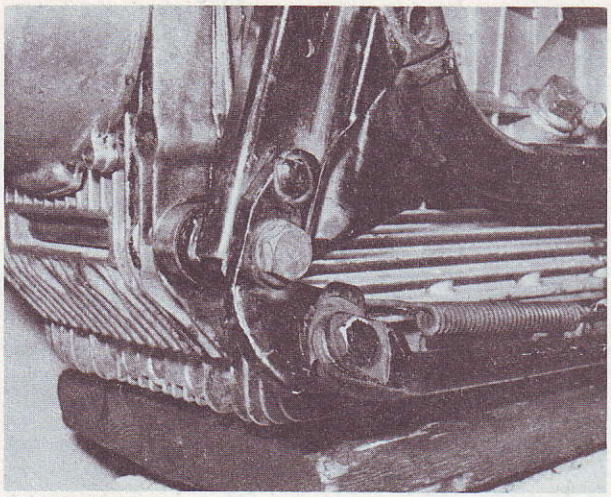
1 If during dismantling the relative positions of the distributor, contact breaker base plate and the contact breaker cam were scribe marked or punch marked, replacement of the distributor in the correct position is straightforward. Rotate the engine until the right-hand piston is at TDC on the compression stroke. Turn the contact breaker cam until the chosen mark aligns with that made on the body. Holding the cam in this position insert the distributor into the crankcase, so that the driven gear engages with the gear on the camshaft and the distributor and crankcase marks line up. Fit and temporarily tighten the distributor retaining clamp. The contact breaker gaps can now be set and the static ignition timing carried out as described in Chapter 4, Section 7.
2 Where index marks were not made during dismantling, the distributor may be refitted as an integral part of the static ignition timing procedure. The distributor should be inserted when the right-hand cylinder timing mark is visible in the crankcase aperture, and when the right-hand cylinder contact breaker points are just on the verge of opening. The distributor must be refitted with the direction indicating arrow on the distributor boss facing away from the right-hand cylinder. If this precaution is not taken, the standard ignition timing procedure will have to be rearranged.
3 Lubricate the alternator rotor boss so that on replacement, the boss may enter the timing cover oil seal more easily. Fit the rotor on the shaft and tighten the retaining socket screw. Position the stator over the rotor so that the multi-pin terminal is on the right. Align the bolt holes in the stator with those in the casing and push the stator fully home into the casing recess. Fit and tighten evenly the three socket screws. Free the brushes so that they contact the slip rings, under pressure from their springs.

32 Engine reassembly: refitting the engine in the frame

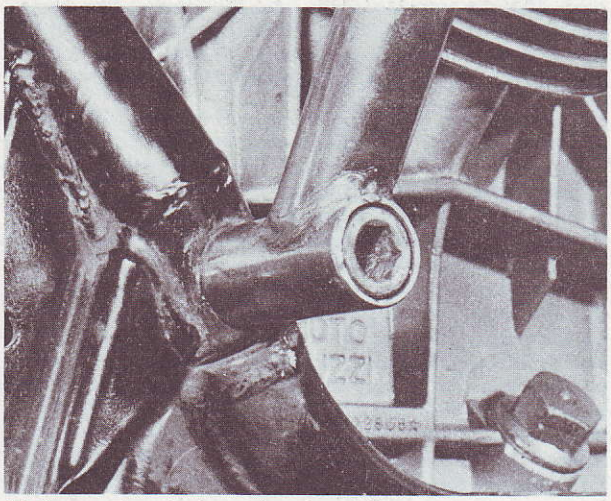
1 Before removing the engine/gearbox unit from the workbench, refit the two sub-frame members either side of the engine, together with the centrestand. At this stage the sub-frame should be secured by the gearbox mounting bolt.
2 Position the engine/gearbox unit on the floor, supported on the same blocks used when dismantling was being carried out. Ensure that the complete assembly is secure. Where utilised, the air filter box should be placed between the cylinders in approximately the correct position before the frame is lowered into place.
3 Wheel the frame assembly into position and lower it into place so that the sub-frame to main frame joining lugs are in approximately the correct relationship. It may be necessary to spring the two forward frame tubes outwards to clear the sub-frame lugs. Insert the two short socket bolts and fit the nuts loosely. On touring models the front crash bars must be fitted with these bolts. Insert the front engine mounting bolt and fit the nut. On non-touring models the bolt must be fitted from the left-hand side, together with the propstand. Ensure that the projection on the propstand bracket engages with the recess in the frame lug. **Do not** tighten any frame bolts at this stage.
4 Replace the rear swinging arm unit and the rear wheel by following the procedure described in Chapter 5, Section 8.
5 Position the battery carrier plate on the gearbox and fit and tighten the retaining bolts. **Do not** omit the battery earth strap which is secured by the left-hand rear bolt.
6 Fit and tighten the four sub-frame rear bolts. On touring machines the rear bolts retain the silencer support brackets. On other models the bolts secure the footrest bars. Now that all the sub-frame to main frame bolts have been refitted, they may all be tightened fully.

33 Engine reassembly: completion

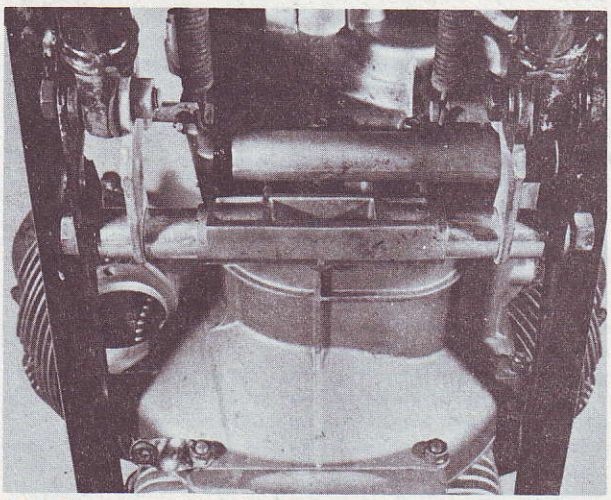
1 Refit the starter motor and connect the main leads to the solenoid. Reconnect also the neutral indicator wire at the switch (where utilised) and the wires at the remaining indicator switches. The wires running to the coils from the contact breaker set may also be replaced. Refer to the wiring diagrams if any doubt exists as to the correct wire positions.



32.3a Refit the front engine mounting bolt and ...



32.3b ... replace the front clamping socket screws



32.3c Note the position of the spacers on gearbox bolt

2 Insert a new air filter element (where utilised) into the air box and fit the breather box so that the central screw projects through the box end. Note that the flange plate on the breather box is located in one position by a projection and recess. Fit and tighten the end nut. If difficulty is encountered in fitting the nut and washer, detach the support bracket from the frame and then fit the nut and washer. The bracket can then be replaced on the frame tube with ease. Reconnect the four breather pipes which locate with individual unions on the breather box. On models not utilising an air filter, refit and reconnect the breather box.

3 On models fitted with an air filter box, replace the rubber duct and secure it in position with the strap and spring arrangement. Replace both carburettors, using new flange gaskets if the inlet stubs were separated from the cylinder heads. Note that the lower bolt securing each inlet stub also retains the HT lead guide clip. Reconnect the throttle cables to the throttle slides and carburettor tops. Fit the throttle return springs and replace the respective assemblies in the carburettors. Where cable controlled chokes are utilised, replace the control lever on the left-hand rocker cover and insert each choke assembly into the carburettors. Pass the petrol feed pipe assembly under the carburettors and reconnect the pipe to the carburettors. Do not omit the filter screens.

4 Replace the exhaust system using a new gasket ring at each port. The slot in each split port collar should face downwards. **Do not** tighten the exhaust flange nuts fully. Tighten the two nuts evenly until the gasket can be felt to be compressed slightly. If leakage occurs when the engine is run, the nuts may be tightened a little further.

5 Reconnect the leads running to the alternator. Refer to the relevant wiring diagram for the correct positioning of the wires. The three wire sockets should be refitted with the small projection on the rubber cover facing inwards. Engage the wiring grommet and wires in the recess in the top of the casing and replace the alternator cover and screws.

6 Refit the gearchange and rear brake link rods and levers. Use new split pins to secure the clevis pins. On touring models, the footboards should be refitted, to aid adjustment of the lever operating angles.

7 On V-1000 models, reconnect all the torque converter fluid system pipes. Use new banjo union sealing washers if there is any doubt as to their condition. Check that all the unions are secure and that the pipes are tracked correctly and not pinched at any point.

8 Reconnect the speedometer cable and tachometer cable (where utilised). Using a suitable lever operate the clutch release arm at the gearbox and reconnect the cable. **Do not** omit to replace the starter cut-out switch leads.

9 Refit the petrol tank and reconnect the pipes, securing them by means of the clips. Reconnect the electro-valve wire (where fitted) and the petrol level indicator wire on V-1000 models.

10 Replenish the engine with the correct quantity and grade of oil, through the filler orifice in the left-hand side of the crankcase. If the gearbox was overhauled, this too should be replenished with lubricant. On V-1000 models, refill the torque converter fluid reservoir with the correct specification hydraulic fluid. When the engine is started the fluid level will drop considerably as the torque converter system is progressively filled. The quantity should be augmented by the addition of more fluid as the level falls. When the level has stabilised, refill to the upper level mark.

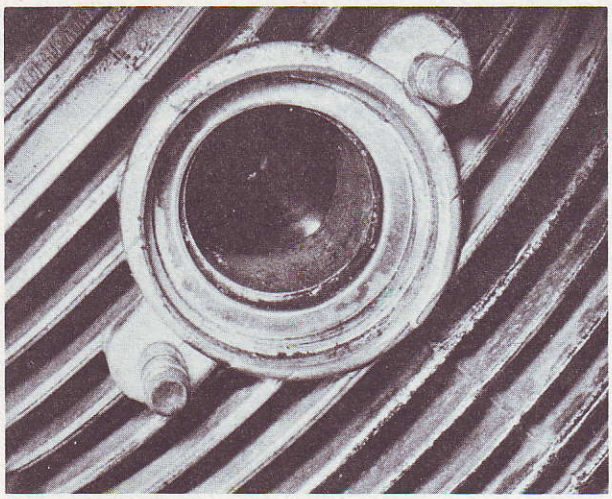
11 Replace the battery and reconnect the leads. The red lead must be connected to the positive (+) terminal and the black lead to the negative (–) terminal.

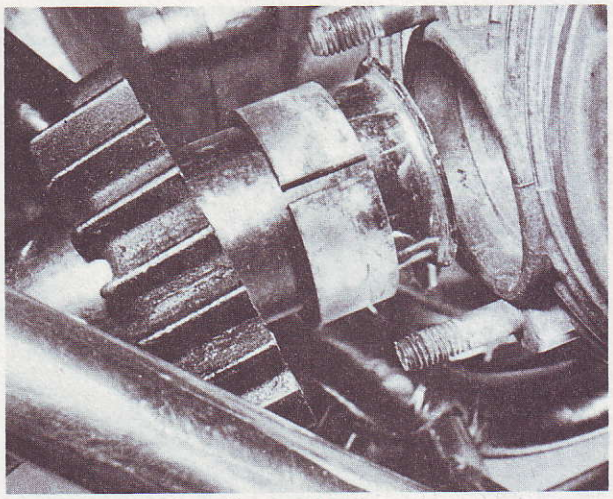
34 Starting and running the rebuilt engine

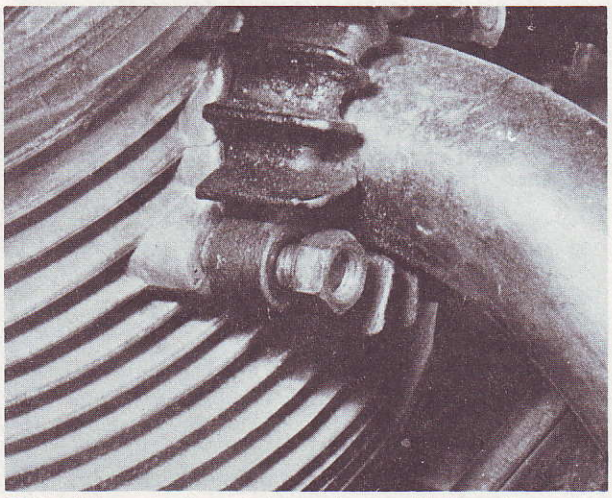
1 With the battery negative lead reconnected, check that all electrical accessories work. Do not operate the starter yet.

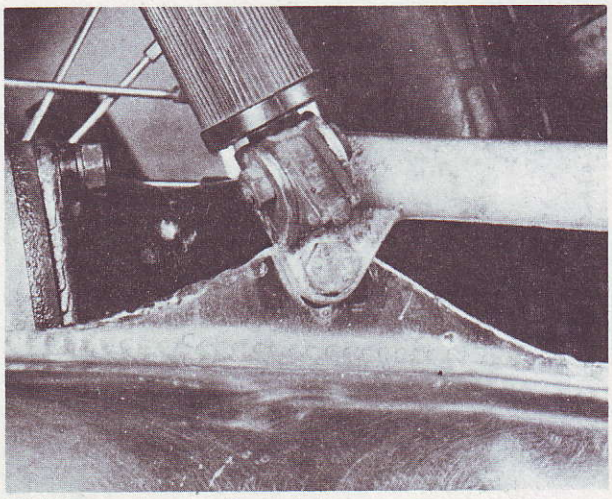
2 Go through each step of the reassembly procedure and

satisfy yourself that every task has been carried out correctly and all nuts or bolts have been tightened.
3 Turn the engine over by means of the rear wheel, with the gearbox in top gear, to make sure that it rotates freely.
4 Replace the spark plugs, correctly gapped and the spark plug caps.
5 Switch on the ignition and petrol and check that the oil and charge warning lights come on. Operate the starter and run the engine at fast tickover. If the warning lights do not go out, switch off immediately and investigate.
6 The exhaust will smoke considerably at first, due to oil present from reassembly. The smoke should clear gradually.
7 If the engine refuses to start, check that petrol is entering the carburettors, and that there is a spark at the plugs.
8 Check the timing with a stroboscope (see Chapter 4, Section 7).
9 Make sure that there are no oil leaks. Slight seepage can often be cured by further tightening when the engine has bedded down again.
10 Before taking the machine on the road, check that all controls operate freely, and both brakes are in adjustment. Also check that all housings have been refilled with oil.
11 If the engine has been rebored, or if a number of new parts have been fitted, a certain amount of running-in will be required. Particular care should be taken during the first 100 miles or so, when the engine is most likely to tighten up, if it is overstressed. Commence by making maximum use of the gearbox or in the case of the V-1000 model, not allowing the engine to labour so that only a light loading is applied to the engine. Speeds can be worked up gradually until full performance is obtained with increasing mileage. It is particularly important that chromed bores are run in very carefully. If this is not done, flaking of the chrome may result, necessitating renewal once more.
12 After running-in, the engine should be serviced, adjustments checked and bolts and nuts tightened. Drain and refill the sump.


33.4a Insert a new ring gasket into each port


33.4b The gap in the collar must face inwards


33.4c Tighten the flange bolts evenly to avoid distortion


33.4d Ensure that the silencer bolts are scure

35 Fault diagnosis: engine

Symptom	Cause	Remedy
Engine will not start	Contact breaker points closed or dirty	Check and readjust points.
	Flooded carburettor	Check whether float needle is sticking and clean.
	Loose or faulty HT cable	Check.
	Stuck valve	Clean valve stem.
Engine runs unevenly and misfires	Incorrect ignition timing	Check setting and adjust if necessary.
	Faulty or incorrect grades of spark plug	Clean or replace plugs.
	Fuel starvation	Check fuel lines and carburettor.
	Valve clearance too small	Readjust.
	Leaky valve	Regrind valve seat.
	Low compression	Check and rebore or replace cylinder barrels and rings.
Lack of power	Incorrect ignition timing (retarded)	Check and reset timing. Check action of automatic advance unit.
Engine pinks	Incorrect ignition timing (over-advanced)	Check and reset timing.
Excessive mechanical noise	Worn cylinder barrels (piston slap)	Rebore and fit O/S pistons, or renew cylinder barrels.
	Worn small end bearings (rattle)	Replace bearings, gudgeon pins and pistons.
	Worn big-end bearings (knock)	Replace shell bearings and regrind crankshaft.
	Worn main bearings (rumble)	Fit new bearings.
Engine overheats and fades	Lubrication failure	Check oil pump and oil pump drive.
Engine overheats	Timing retarded	Readjust.
	Incorrect spark plugs	Renew.