COMMANDO WORKSHOP MANUAL

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INTRODUCTION

THIS manual has been compiled as a practical guide to enable owners who are competent to undertake major overhauls and dealers' service staff completely to service Norton Commando models. Technical data is included to enable the operator to check parts for wear against normal dimensions.

Where instruments for measuring engine and gearbox parts are available, reference to the technical data should be made to determine if replacement is necessary, or otherwise.

Torque wrenches should be used during assembly, particularly on stressed parts such as connecting rod bolts. A table of torque wrench approved settings is included in technical data.

Routine maintenance and normal running adjustments are detailed in the Riders' Handbook issued with each new Norton Commando motorcycle.

Recommended Lubricants

Efficient lubrication is of vital importance and it is false economy to use cheap grades of oil. When buying oils or grease it is advisable to specify the brand as well as the grade and, as an additional precaution, to buy from sealed containers.

ENGINE

Ambient temperature above 50°F. (10°C.) use S.A.E. 20/50 or straight S.A.E. 50.
Ambient temperature above 32°F. (0°C.) use S.A.E. 20/50 or straight S.A.E. 30.
Ambient temperature below 32°F. (0°C.) use S.A.E. 10/30 or straight S.A.E. 20.
The following brands are recommended:

Mobiloil	Energol	Shell
Castrol	Essolube	Regent Advanced Havoline

GEARBOX

Ambient temperature above 32°F. (0°C.) S.A.E. 50 or GX 90 Mobilube.
Ambient temperature below 32°F. (0°C.) S.A.E. 30.

WHEEL HUB AND FRAME PARTS

Mobilgrease MP	Energrease C3	Shell Retinax A or C.D.
Castrolease LM	Regent Marfax Multipurpose	ESSO Multipurpose

TELEDRAULIC FRONT FORKS

Mobiloil Arctic (S.A.E. 20)	Energol (S.A.E. 20)	Shell X-100 Motor Oil 20/20W (S.A.E. 20)
Castrolite (S.A.E. 10W-30)	Essolube 20 (S.A.E. 20)	Regent S.A.E. 20

REAR CHAINS

Mobilgrease MP	Energrease A.O.	Regent Marfax Multipurpose
Esso Fluid Grease	Castrolease Grease Graphited	Shell Retinax A or C.D.

Lubrication System

Lubrication system

Oil flows by gravity from the oil tank, assisted by suction from the oil feed pump, via a coarse mesh oil filter in the oil feed pipe—at the oil tank end—to the oil pump.

Oil after passing through the feed pump, is forced under pressure to the engine, through a drilling in the timing cover to the crankshaft. A by-pass from the main oil feed conveys oil to the top part of the engine to lubricate moving parts in the cylinder head.

Oil from the cylinder head, drains by gravity, to the crankcase—via an oil passage drilled in the cylinder barrel—to a pre-determined oil level in the timing chest, to lubricate the two chains. The overspill drains to the sump portion of the crankcase.

Oil accumulated in the sump is returned to the oil tank—after passing through the filter contained in the sump drain plug—under the influence of the oil return pump.

Oil pressure relief valve

The pressure relief—or blow off—valve is mounted in the timing cover, adjacent to the cylinder head oil feed union. The valve consists of a spring loaded steel sleeve which is pre-set at the factory with packing discs to enable the valve to lift at 45/55 lbs. per square inch. Oil escaping from the valve is diverted back to the oil feed side of the pump. This valve does not require routine attention.

Crankcase release valve

The release valve is housed in the drive side crankcase, actuated by the camshaft. The valve is timed and ported to release positive pressure from the crankcase caused by piston displacement. The valve consists of the following parts:—

(1) Stationary plate (below the camshaft bush).
(2) Rotary plate (actuated by the camshaft).
(3) Spring to keep the rotary plate in contact with the stationary plate.

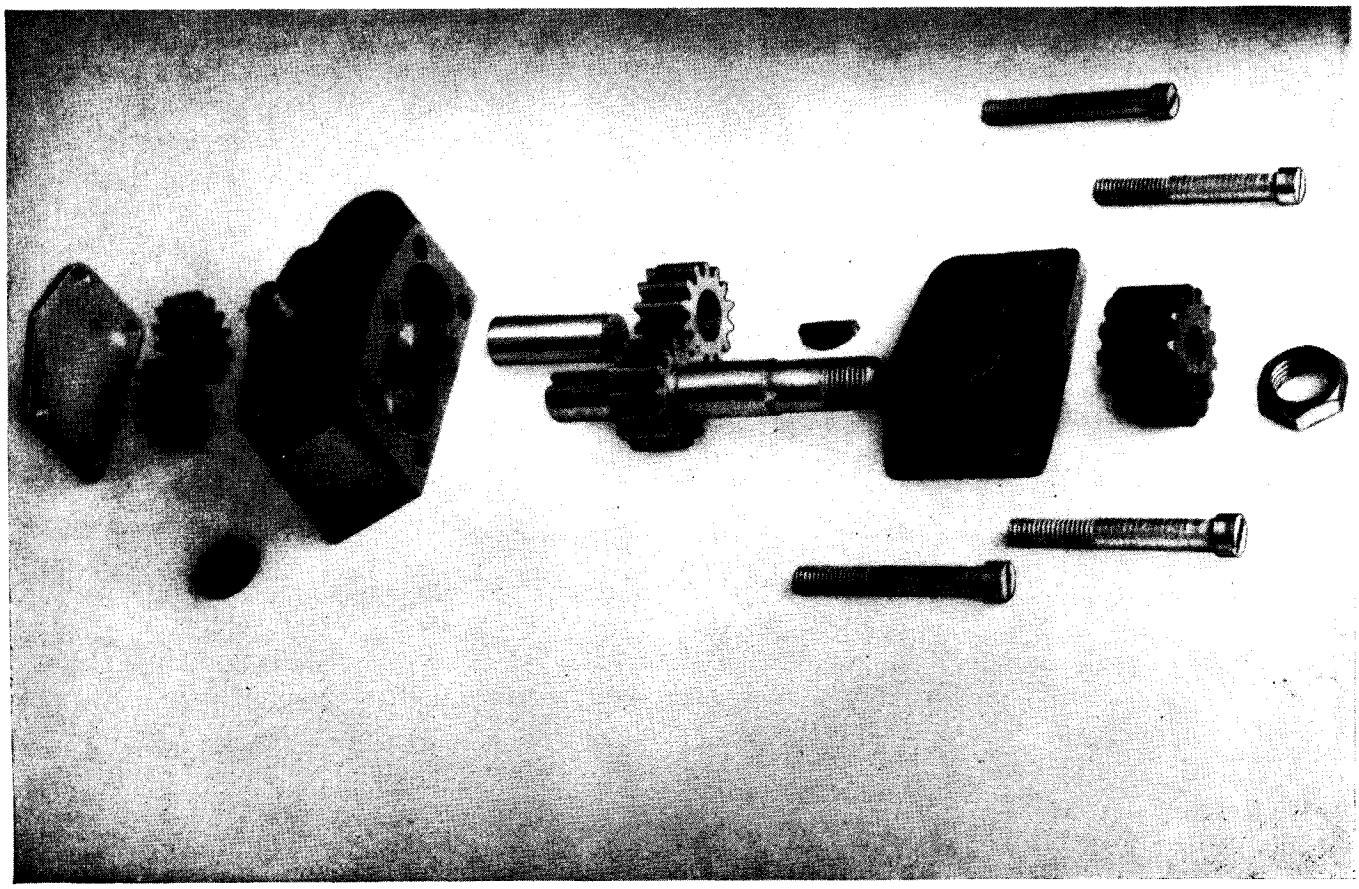
The oil pump

The gear type pump dismantled is shown in Figure 1. The oil return side of the pump can be identified by the wider gears which have twice the pumping capacity of the oil feed side of the pump, designed to keep the sump free from excess oil. Providing clean oil is continually circulating—when the engine is running—the pump cannot become deranged.

Checking the oil pump

To remove the oil pump refer to paragraph 'Dismantling the engine'. When rotating the oil pump by hand, the gears should rotate freely. A tendency to partially jam indicates the presence of foreign matter in the gear teeth. To remedy, dismantle the pump for cleaning as described elsewhere. Check the pump for end float—by pulling and pushing on

FIG. 1 *The Oil Pump*



the drive spindle (end float should be NIL) check the four pump plate screws for security. When end float is manifest to any noticeable extent, the efficiency of the pump will be adversely affected and the unit should be returned to the dealer for service.

Before refitting the pump, check the face of the pump body, where it abuts against the crankcase, by using a straight edge on this face across the two stud holes. A slight bow in the pump body face will create an air leak, which will adversely affect the pick up of oil from the sump. To rectify, the pump body should be rubbed down on a surface plate—until it is perfectly flat—then ensure that the pump interior is scrupulously clean and free from abrasive.

Dismantling the oil pump

An examination of the pump will show that the two end plates are either flush, or slightly below the pump body. It follows that if one—or both plates are proud of the pump body after assembly—an air tight joint between the pump and the crankcase cannot be made.

With the worm drive removed (this is not essential)

Remove four pump body screws.

Remove the brass end plate.

Remove the iron plate with shaft and drive key—the drive pinion is usually a close fit on the shaft—a light tap with a brass drift will dislodge the pinion.

Remove the idler shaft from feed side.

Remove the return idler pinion.

Remove the two drive pinions.

Assemble the pump in reverse sequence and note the small radius on the oil return gear should face the inside of the pump body.

The oil pump seal

The conical shaped oil seal (see Figure 1), made from oil and heat resisting material, is located on the oil pump body by a steel ferrule—which is a press fit. If the conical shaped seal is deformed, it should be discarded and a replacement used Part No. T.272, to prevent oil, under pressure. leaking between the seal and the concave face in the timing cover, thus curtailing the oil delivery to the crankshaft.

If the oil seal is normal, when the timing cover is in position, pressure on the seal should move the timing cover away from the crankcase, making a gap approximately .010". If this pressure does not exist, fit a new seal, alternatively use shim washers—between the seal and the body—to obtain the desired pressure.

Timing cover oil seal

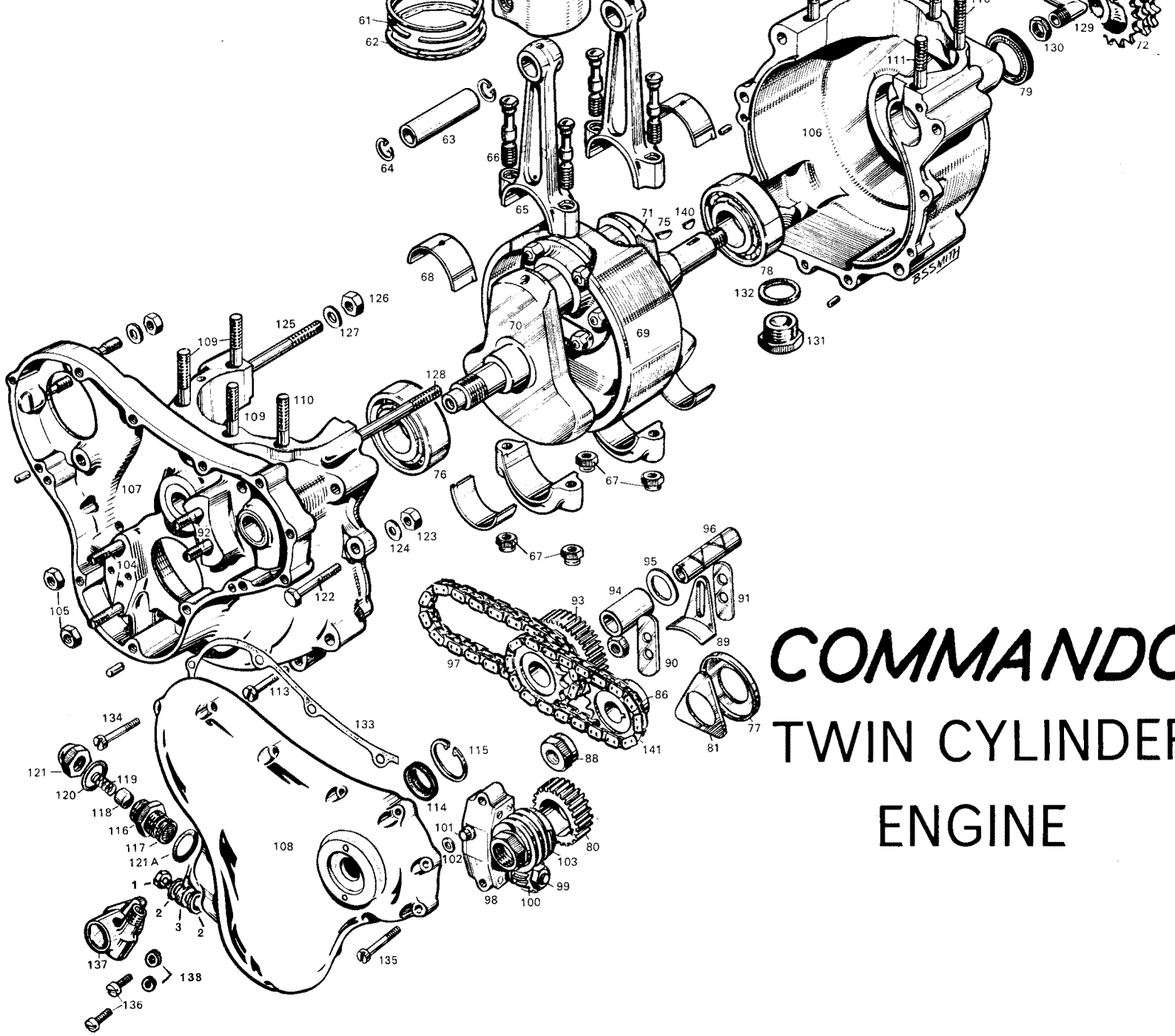
Oil under pressure from the oil feed pump, passes through the steel ferrule in the pump body—which locates the conical oil seal—through a drilled oil passage in the timing cover entering a cavity which houses the oil seal encircling the plain portion of the timing side crankshaft. The slight restriction caused by the close fitting connecting rod bearings, builds up pressure in the cavity, making the oil seal more effective. If, after considerable mileage, the seal is worn, or deformed—during the process of refitting the timing cover—the seal should be replaced (Part No. 048023).

To replace the oil seal

Take out the circlip—prise out the seal; gently heat the cover, press home the new seal with the METAL BACKING OUTWARDS. Refit the circlip. Apply a small amount of clean oil on the plain portion of the crankshaft to facilitate entry.

Checking oil pressure

A pressure gauge with a scale reading of 0 to 100 lbs. per square inch, can be attached to the timing cover at the point where the union for the cylinder head oil feed pipe is attached. The recorded pressure should be between 45 to 55 lbs. per square inch, when the oil is at normal running temperature.



COMMANDO

TWIN CYLINDER ENGINE

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1 Banjo bolt for oil feed pipe.
2 Washer for banjo bolt.
3 Rocker feed pipe assembly.
4 Domed nut for rear cap.
4A Stud for rear cap.
5 Washer for domed nut.
6 Rocker box cap (rear).
7 Sealing washer for rear cap.
8 Nut for rocker box front cap stud.
9 Rocker box cap (front).
10 Sealing washer for front cap.
11 Stud for front cap.
12 Rocker inlet, right hand.
13 Rocker inlet, left hand.
14 Rocker exhaust, right hand.
15 Rocker exhaust, left hand.
16 Rocker ball end.
17 Rocker adjuster.
18 Nut for adjuster .
19 Rocker shaft.
20 Thrust washer for shaft.
21 Spring washer for shaft.
22 Joint washer for shaft.
23 Locking plate for shaft.
24 Retaining plate for shaft.
25 Joint washer for plate.
26 Bolt for shaft retaining plate.
27 Dowel for rocker box cap (rear).
28 Inlet manifold.
29 Allen bolt manifold to head.
30 Allen bolt for head steady plate.
31 Washer for bolt.
33 Cylinder head, with valve guides.
34 Finned locking nut for exhaust pipe.
35 Gasket cylinder head to barrel.
36 Cylinder barrel.
37 Washer, cylinder base to crankcase.
38 Cylinder head bolt (long).
39 Cylinder head bolt (short).
40 Stud, cylinder barrel to head.
41 Stud, cylinder head to barrel.
42 Nut, cylinder head to barrel stud.
43 Valve, exhaust.
44 Valve guide, inlet or exhaust.
45 Valve spring, inner.
46 Valve spring, outer.
47 Valve spring, top cap.
48 Valve spring, bottom collar.
49 Valve collet.
50 Push rod complete, inlet.
51 Push rod complete, exhaust.
52 Push rod, top end.
53 Push rod, bottom end.
54 Tappet, right hand.
55 Tappet, left hand.
56 Tappet location plate.
57 Screw for location plate.
58 Piston complete, left hand.
59 Piston complete, right hand.
60 Piston ring, compression, top, chrome.
61 Piston ring, compression, bottom, plain.
62 Piston ring, scraper.
63 Gudgeon pin.
64 Circlip for gudgeon pin.
65 Connecting rod.
66 Big end cap bolt.
67 Nut for cap bolt.
68 Big end bearing shell, lower. Big end bearing shell, upper.
69 Flywheel.
70 Crankshaft, timing side.
71 Crankshaft, driving side.
72 Engine sprocket, 26 teeth.
73 Retaining nut for rotor.
74 Washer for rotor.
75 Key for engine sprocket.
76 Mainshaft bearing, timing side.
77 Sealing washer, timing side bearing.
78 Mainshaft roller bearing, driving side.
79 Driving side shaft oil seal.
80 Half time pinion.
81 Backing plate for pinion.
82 Camshaft.
83 Stationary plate, camshaft breather.
84 Rotary plate, timing breather.
85 Spring for breather.
86 Camshaft sprocket.
87 Key for sprocket.
88 Nut for sprocket and rev.-counter drive.
89 Chain tensioner slipper.
90 Plate for chain tensioner (thick).
91 Plate for chain tensioner (thin).
92 Stud for chain tensioner.
93 Intermediate gear, with sprocket.
94 Bush for intermediate gear.
95 Washer for intermediate gear.
96 Spindle for intermediate gear.
97 Driving chain for ignition.
98 Oil pump assembly.
99 Nut for oil pump spindle.
100 Worm gear wheel (on pump).
101 Feed bush for pump.
102 Sealing washer for feed bush.
103 Pump driving worm (on mainshaft).
104 Stud, oil pump to crankcase.
105 Nut for stud.
106 Crankcase, driving side only.
107 Crankcase, timing side only.
108 Timing cover (for rev.-counter fixing).
109 Crankcase cylinder base stud.
110 Crankcase cylinder base stud $\frac{5}{16}$" diameter.
111 Crankcase cylinder base stud $\frac{3}{8}$" diameter.
112 Nut, cylinder base stud $\frac{3}{8}$".
113 Screw, timing to driving side crankcase sump.
114 Mainshaft oil seal, in timing cover.
115 Circlip, mainshaft oil seal.
116 Pressure release body (only).
117 Wire gauze complete.
118 Pressure release piston.
119 Pressure release spring.
120 Pressure release union nut washer.
121 Pressure release body nut.
121A Washer for pressure release union.
122 Crankcase bolt (short).
123 Nut for bolt.
124 Washer for bolt.
125 Crankcase top stud (rear).
126 Nut for stud.
127 Washer for stud.
128 Crankcase top stud (front).
129 Elbow for crankcase breather pipe.
130 Nut for crankcase breather elbow.
131 Crankcase oil sump filter body.
132 C and A washer, filter body.
133 Timing cover gasket.
134 Timing cover screw (long).
135 Timing cover screw (short).
136 Fixing screw, revolution counter drive.
137 Gearbox revolution counter drive.
138 Washer for fixing screw.
140 Key for alternator rotor.
141 Driving chain for camshaft.
142 Stud, inlet manifold to carburetter.
143 Nut for stud.
144 Washer for stud.
145 Heat resisting washer.

Engine Service

Models after Engine No. 131257 (see page 52)

Decarbonising the engine

There is no stipulated mileage when the engine should be decarbonised, the necessity to undertake this work is usually indicated by a gradual loss of power accompanied with an increase in petrol consumption. If the engine performance has not deteriorated, the petrol consumption is normal, no useful purpose is served by removing the cylinder head.

The only risk, by running the engine for prolonged intervals between decarbonising, is the possibility of exhaust valve burning. This is caused by separation of the additives—used in modern fuels—on combustion which builds up on the valve and becomes trapped between the valve and the valve seat in the cylinder head. Gas leakage past the valve when on its seat is responsible for the valve burning. Before removing the cylinder head check for derangement;

Rocker clearance.
Contact breaker gap.
Ignition timing.
Throttle cables for lost motion.
Try also the effect of two new spark plugs.

Removing the cylinder head

Have available the following equipment:—

(A) Decoke gasket set Part Number 060911.
(B) Socket wrench (ring spanner) for $\frac{1}{8}$" Whitworth form.
(C) Socket wrench (ring spanner) for $\frac{5}{16}$" Whitworth form.
(D) 'C' spanner for exhaust pipe finned nuts—Part Number SHU/29.
(E) Tubular box key $\frac{1}{4}$" Whitworth form.
(F) Open end spanner $\frac{3}{16}$" Whitworth form.
(G) Allen key size $\frac{7}{32}$".
(H) Feeler gauge .006" and .008".

To remove cylinder head

1. Remove rider's seat by releasing the two captive knurled knobs—retained by a pin passing through the boss. Raise the seat to clear the two fixing brackets and draw backwards, clear of the machine.
2. Disconnect the two fuel pipes at the tank end.
3. Take out the two front gas tank fixing bolts, remove the rubber ring securing the rear end of the gas tank.
4. With care—to avoid damage—carefully lift and remove the tank clear of the machine.
5. Remove both spark plugs, right and left exhaust pipes, leaving the mufflers in position. Use the 'C' spanner to unscrew the finned nuts, slacken the muffler clip bolt securing the muffler to the exhaust pipe.
6. Remove the cylinder head oil feed pipe—two banjo pins—take care of the washers used.
7. Remove cylinder head torque bracket—three bolts passing through the bracket—three Allen screws securing plate to cylinder head.
8. Remove both rocker covers.
9. Remove four Allen screws fixing the two carburetter manifolds—take away both carburetters.
10. Remove five nuts below the cylinder head, five bolts on the top of the cylinder head. The cylinder head can now be separated from the cylinder barrel. If difficulty exists, a light blow with a soft-faced mallet, under the exhaust ports for the cylinder head, will cause the cylinder head to separate from the cylinder.
11. Lift the cylinder head—to clear the push rods—then it can be taken away from the engine.

Dismantling the cylinder head

With the cylinder head removed, it is preferable to remove all carbon formed on both valve heads also the sphere of the cylinder head, before the valves are taken out of the head. The intention is to prevent carbon chippings entering the recess in the ports, where the valve guides are situated, which can be difficult to dislodge.

Valve check

It can be decided if the valve seatings are gas tight, or otherwise, before the valves are taken out of the head by:

Wiping the sphere of the head until it is dry.

Stand the head with the exhaust ports vertical.

Nearly fill both ports with gasoline and leave standing for a short while.

If the seatings are sound, gasoline will not leak past the valves.

Deal with the inlet valves in a similar manner, with care to wipe the head dry, before filling gasoline into the ports. It is worthwhile making this check *after* the valves have been ground to verify the seatings are gas tight.

Removing the valves

Take out the stud for the inlet rocker cover. Use a proprietary valve spring compressor tool to compress the valve springs, then remove the valve keepers (collets), identify the location of each valve so that they can be refitted in their original position. Carbon on the valve stem and throat of the valve is removed with a knife—use fine emery or abrasive cloth on the stem sparingly. Use the abrasive longitudinally, the same way as the valve operates.

The valve stem diameter can be measured for wear and checked against the normal dimensions given in technical data.

Valve grinding

Valve grinding should be kept to a minimum, the valve seat should be refaced if badly pitted. Most dealers have suitable equipment for this purpose. The seat angle is 45°.

Excessive grinding will result in destroying the seat angle of the valve, also on the seating in the cylinder head, so preventing a satisfactory gas seal.

A short length of close fitting rubber hose pressed over the valve stem can be used to turn the valve during the process of grinding. Do not use a rotary motion—which will form continuous lines on the seatings—turn the valve 180° each way until a matt surface is seen on both the valve and seat in the cylinder head. Avoid depositing grinding paste on the valve stem which can cause a lapping process when the engine is running. Pass a piece of fluff-proof rag through the valve guides, after valve grinding has been completed.

Valve springs

Heat-insulating washers are used between the valve spring seat and the cylinder head to prevent heat transference from the cylinder head to the valve springs. It is desirable to check the free length of all valve springs against the measurement given in technical data. If the free length of any spring is below $\frac{3}{16}$" the normal length the spring should be discarded and replaced. Part Number 22839 (inner) 22838 (outer).

All springs are "rated"; the two close coils should abut against the bottom valve spring seat.

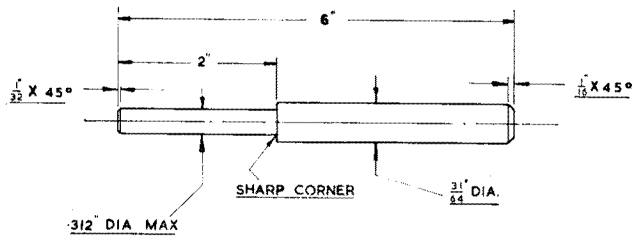
Loss of valve spring pressure—due to the springs partially collapsing—will adversely affect maximum R.P.M.

Valve guides

The four valve guides are dimensionally, and materially, identical. They are a force fit in the cylinder head, an attempt to drive out the guide from the cylinder head without pre-heating will impair the interference fit of the guide in the head, as a result of scruffing. There is also the attendant risk of breaking the guide. The head should be pre-heated by placing it on a hot plate or in a domestic oven to a temperature up to, and not exceeding 200° Centigrade. A valve guide drift can be made to the dimensions shown in Figure 2 which can be used for both valve guide fitting and removal.

Refitting the valve guides

The cylinder head must be pre-heated as described for valve guide removal, for reasons already explained. To enable the guide to enter the valve guide hole in the cylinder head, parallel to the bore, insert the valve through the port, hold it firmly against its seat in the cylinder head, then pass the guide over the valve stem protruding and press home as far as possible. Using the valve guide drift, drive the guide home so that the flange on the guide abuts against the cylinder head. The valve seat in the cylinder head should now be concentric with the axis of the valve guide bore, which will obviate the necessity to re-cut the valve seat in the cylinder head.



DRIFT FOR REMOVING VALVE GUIDES T2011

MAT^{L}: MILD STEEL.

FIG. 2

Refitting the valves

Should it be necessary to replace any of the four valves on the Commando engine, it is essential that correct replacements are used. The valves used are similar in appearance to those fitted to earlier models, but the overall length of both the inlet and exhaust valves, are dissimilar to those used on earlier engines. The Part Number for the inlet valve is 25501, the exhaust 25500. Replacement valves should be checked for overall length against the dimensions given in technical data, to ensure the correct type are fitted. Apply some clean engine oil to the valve stem before fitting—ensure the heat resisting washer is in place—assemble the valve springs with top and bottom collars, then compress the springs. A little grease applied to the valve stem (where the keepers, or collets, are located) will retain them whilst the spring pressure is being released.

Removing the cylinder barrel

When decarbonising, the cylinder should not be disturbed, without good reason. If the oil consumption is normal, it can be assumed that the cylinder bore and piston rings are in good order.

With both pistons on the top of the stroke, carbon formed on the piston crowns can be removed by using a cheap six inch steel rule, or scraper.

There is an annular gap between the top land on the piston and the cylinder barrel. Carbon chippings can collect in this space, which are difficult to extract without the use of an air line.

These chippings, if not removed, can become trapped between the valves and the seatings in the cylinder head when the engine is first run after refitting the cylinder head. Without an air line the chippings can be removed by:

Turn the engine until the pistons are about half an inch down the stroke.

With the index finger, press a small quantity of clean grease into the gap between the top land of the piston and the cylinder barrel.

Turn the engine in an opposite direction past top centre of the stroke until the pistons are about half an inch down the stroke. A ring of grease with carbon chippings embedded will form in the cylinder bore, which can be easily removed.

Repeat this process to ensure all carbon from the piston has been removed.

Nine nuts secure the cylinder to the crankcase; as these nuts are unscrewed the cylinder must be raised to enable the nuts to clear the base studs.

Before the cylinder is taken off, lift it sufficiently to enable some clean rag to be inserted into the aperture in the crankcase—under the pistons—thus safeguarding the possibility of a broken portion of a piston ring falling into the sump.

Removing the tappets

The tappets are located in the lower part of the cylinder barrel—retained by four 2 BA screws (two to each plate) passing through a separating plate for each tappet.

To remove the tappet sever the securing wire for the plate retaining screws—remove the screws.

The tappets are machined in pairs and must be refitted in the same order as removed, they do not inter-change.

Before refitting the tappets, apply a little clean oil and ensure the bevelled edges are side-by-side facing the front of the engine. Inadvertent reversal will restrict oil drainage, also prevent lubrication. Firmly tighten the plate retaining screws and secure with steel wire linking the two screws.

Removing the rockers

The spindles supporting the rockers are a close interference press fit in the cylinder head. The assembly sequence of the retaining plate for the spindles is shown in Figure 3. The interference fit of the spindles will be reduced by expansion after heating the head. A draw bolt $\frac{5}{16}$" diameter with 26 T.P.I. together with a short length of steel tube with a bore diameter of over .499" (spindle diameter) can be used to draw out each spindle. With this bolt inserted in the steel tube—screwed into the rocker spindle will extract the spindle, as the bolt is tightened. Take out the rockers; do not misplace the shim washer .015" thick.

The spindle should be smooth when the rocker operates. Any roughness, or blemish, should be removed by the use of fine abrasive strip where the rocker operates—*not* at the spindle ends.

Removing the rocker ball end

The ball end in each rocker is a parallel interference fit in the rocker. To remove the ball end, support the end of the rocker, use a drift to extract the ball end. It will be observed that there is a drilling in the rocker to convey oil from the rocker spindle to lubricate the ball end and push rod cup. Check drilling for obstruction. The ball end should be fully spherical with a mirror-like finish.

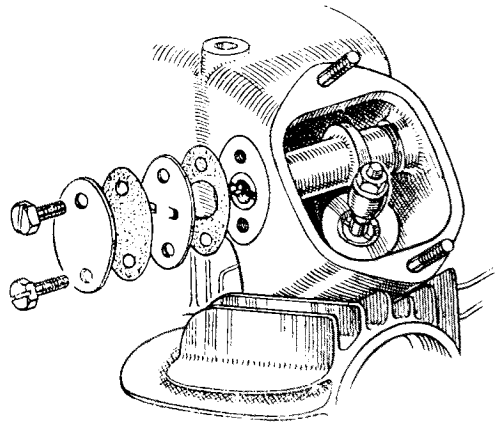


FIG. 3 *Rocker—removal*

Fitting the ball end

The oil hole in the ball end must register with the oil drilling in the rocker. For easy location, with a pencil scribe a line along—and across—the oil hole.

Insert the ball end with the scribed line in register with the oil drilling and press home as far as possible.

Refitting the rockers

The correct location of the rocker spindle is with the oil hole facing *away* from the centre of the cylinder head. The slot at the end of the spindle is horizontal—to engage with both tags on the spindle locating plate (Figure 3).

Assemble in the following order:—

1. Shim washer
2. Rocker
3. Spring washer
4. Press home the rocker spindle
5. Oval paper gasket
6. Oval plate with tags engaged in spindle slot
7. Paper gasket
8. Oval plain plate
9. Two fixing bolts.

Note: An oil leak can develop if the end of the rocker spindle is not just below the gasket face on the cylinder head.

Removing the pistons

The gudgeon (wrist) pin is a close press fit in the piston bosses, an attempt to drive out this pin without applying heat will distort the piston skirt.

Use a pair of pin pointed pliers to compress and extract the outside gudgeon (wrist) pin circlip. Heat can be applied with the use of an electric iron placed on the piston crown. Alternatively, use some rag soaked in very hot water, on the piston, which should cause the piston to expand sufficiently to enable the pin to be pushed out of the piston. Should the pin resist removal do not use force—use a sharp pointed scraper, or pen knife to remove a burr or carbon deposit alongside the circlip recess.

Fitting piston rings

The scraper or oil control piston ring originally fitted has been selected as the most suitable for the Commando engine (Part Number 06.0954.) Non-regular rings should not be fitted as a substitute.

Fit the oil control ring in the following sequence:—

1. Wind one of the two thin rails over the piston, position the rail clear, and slightly below the lower ring groove.
2. Fit the corrugated expander ring in the lower groove —with care that both ends abut—*the ends must not overlap*. The two ends are coloured which should be visible, if correctly positioned.
3. Move the thin rail previously fitted up, and into the ring groove, starting at the butt joint of the expander ring—to prevent overlapping. The rail is located on the stepped part of the expander ring.
4. Fit the remaining rail, from the top part of the piston, into the ring groove, locate it on the other stepped part of the expander ring. The ring gap on the two rails and the expander rings are equi-spaced round the piston (120° apart).
5. Fit the plain ring, which is taper faced and marked Top—for location—into the middle ring groove.
6. Fit the top ring, which is chromium plated and cargraph treated, into the top ring groove.

Note: The red coating on this ring must not be removed.

Fitting the pistons

The pistons are "handed" and the location in the engine is stamped on the piston crowns viz: LH EXHAUST. The additional mark A or B is for piston grading. Heat the pistons, as described for removal—apply clean engine oil on the pin before insertion. Fit the circlip with a rotary motion—check to make sure it is correctly located. If the circlip has become deformed during the process of removal, discard it and fit a replacement Part Number 23276.

Engine push rods

Push rods used in the Commando engine—like the valves—are similar in appearance to those used on earlier type engines, but are dissimilar in length. If replacements are used, the overall length should be checked against the dimensions given in technical data. The correct Part Number for inlet push rod is 25515; the exhaust is 25516.

This part of the engine is usually trouble free. If on examination one or more push rods are found to be bent the cause can be due to:—

(A) The engine has been run with excessive rocker clearance, allowing the ball end on the rocker to make contact with the rim of the cup end of the push rod. The crippling load, under this condition would bend the push rod.

(B) Non-regular valve springs have been supplied or fitted in error—the springs becoming coil bound when the valve is at full lift causing the push rod to bend.

Refitting the cylinder

To avoid piston ring breakage during the process of fitting the cylinder, piston ring clamps are essential, particularly to ensure entry into the cylinder of the thin rails for the oil control ring. These clamps are inexpensive and are shown in position in Figure 4. To support both pistons, a plate used on the crankcase and below the piston skirts is illustrated

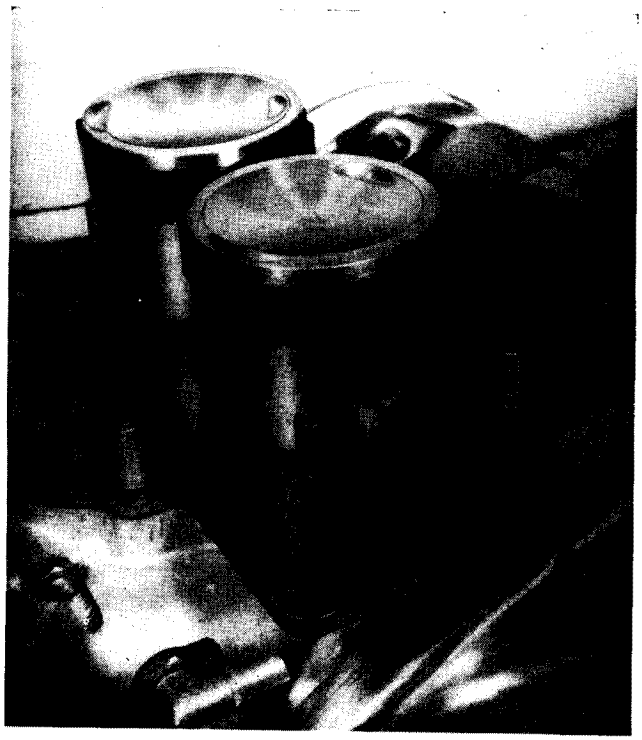


FIG. 4
Piston Ring Clamp assembled

also. This tool can be made from a piece of stout plywood, its use, together with the piston ring clamps will enable the cylinder to be fitted with comparative ease.

It is essential to use a new cylinder base gasket, to safeguard against oil leakage, also subsequent attention to the engine. Remove every trace of the old gasket adhering to the cylinder and crankcase face. Check the crankcase face for bruises, or burrs; flatten with a fine oil stone. Place the new gasket on the crankcase (jointing compound is not used) put the piston support plate in position. Take up the cylinder—engage both pistons square with the bore—a sharp downwards press will enable both pistons to enter the cylinder and dislodge the piston ring clamps, which can be un-linked and taken away with the piston support plate. Raise the cylinder slightly to fit the cylinder base stud nuts, which must be tightened diagonally, NOT one side at a time.

Refitting the cylinder head

With both pistons on the top of the stroke place a new cylinder head gasket on the cylinder, put the cylinder head onto the cylinder barrel.

Take up the four push rods—the inlet are the two longest rods, used in the midway position.

Tilt the cylinder head backwards (see Figure 5) to enable the push rods to enter the tunnels cast in the cylinder barrel.

Starting from the left, fit one short push rod (exhaust) one long push rod (inlet centre position).

The second long push rod (centre position).

Finally the remaining short push rod (exhaust).

Ensure all push rods are located in the cupped portion in the tappets.

To enable the four push rods to engage with the ball end on the rockers, the cylinder is raised approximately $\frac{1}{4}$" and supported in this position. The two short cylinder head sleeve nuts (used below both exhaust ports) placed horizontally in between the cylinder head and cylinder barrel will act as a support.

Locate the push rods with the rocker ball ends if difficulty exists; use a short length of stout wire to manipulate the rods into position.

Take away the two sleeve nuts—used to support the cylinder head—lower the cylinder head into position.

Refit the cylinder head holding down bolts and nuts; tighten in the sequence shown in Figure 6. See technical data for torque loading figures.

Rocker adjustment

Have available .006" and .008" feeler gauges. The correct clearance between the rocker and end of the valve is .006" for the inlet, .008" for the exhaust—this adjustment is made with the engine cold.

The engine must be positioned so that the tappet in the cylinder is clear of the quietening curve on the camshaft.

Deal with the right side inlet valve first by:—

Turning the engine until the *left* side inlet valve is fully open.

Releasing the right side inlet rocker adjuster bolt lock nut.

With a spanner on the square part of this bolt unscrew it a few turns until there is clearance between the bolt and the valve end.

Place the .006" feeler gauge on the valve end.

Screw down the adjuster bolt until it just "nips" the feeler gauge.

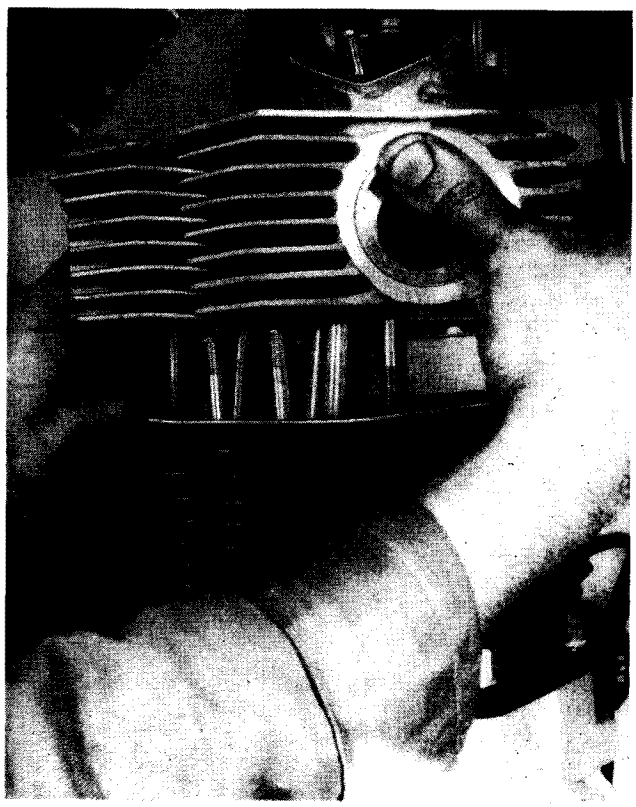
Tighten the adjuster bolt locknut.

If the clearance is correct the gauge should just slide through the gap formed by the valve and adjuster bolt.

Turn the engine again until the *right* side inlet valve is fully open.

Deal with the left side inlet valve in a similar manner.

FIG. 5 *Fitting Cylinder Head*



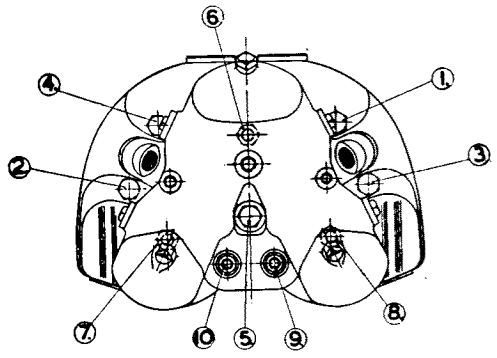


FIG. 6

Order of tightening down Cylinder Head nuts and bolts

Use the same procedure for the exhaust rockers with .008" feeler gauge for correct clearance.

Recheck the clearance after the adjuster bolt lock nut has been tightened.

Apply clean oil in the push rod cups.

Refit the rocker covers.

Note: If the rocker cover gaskets are renewed, jointing compound is not necessary.

Fit and firmly tighten the torque stay plate.

Put back the exhaust pipes, with other parts removed in the reverse order described for removal.

Road test the machine sufficiently far enough to enable the engine to reach its normal running temperature.

When the engine has cooled down after test, retorque all the cylinder head bolts and nuts.

Check and reset the rocker clearance.

Special precaution

After road test, firmly and positively retighten the two exhaust pipe finned nuts.

Engine Overhaul

If, after considerable mileage, attention to the lower part of the engine is necessary, the engine can be removed from the frame leaving the gearbox in position.

Special tools

In addition to the usual workshop tools the following special tools are required to dismantle the clutch and engine.

(A) Compressor tool for diaphragm clutch Part No. 06-0999.
(B) Engine drive sprocket and clutch hub extractor tool Part No. 06-0941.
(C) Camshaft sprocket extractor Part No. EST 12.
(D) Small timing pinion extractor Part No. ET 2003.
(E) Piston ring clamps.

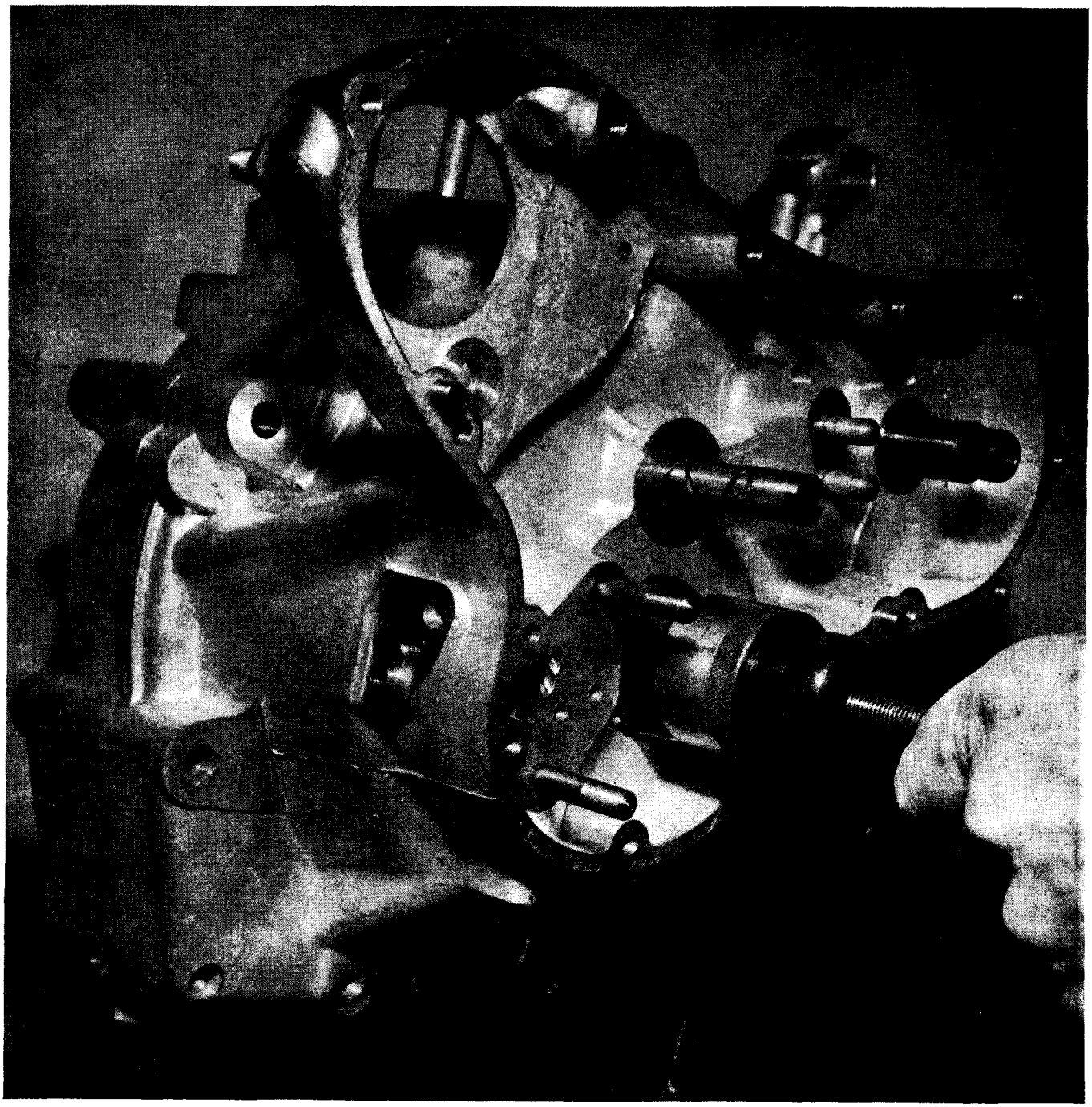


FIG. 7 *Timing Pinion tool in use (ET 2003)*

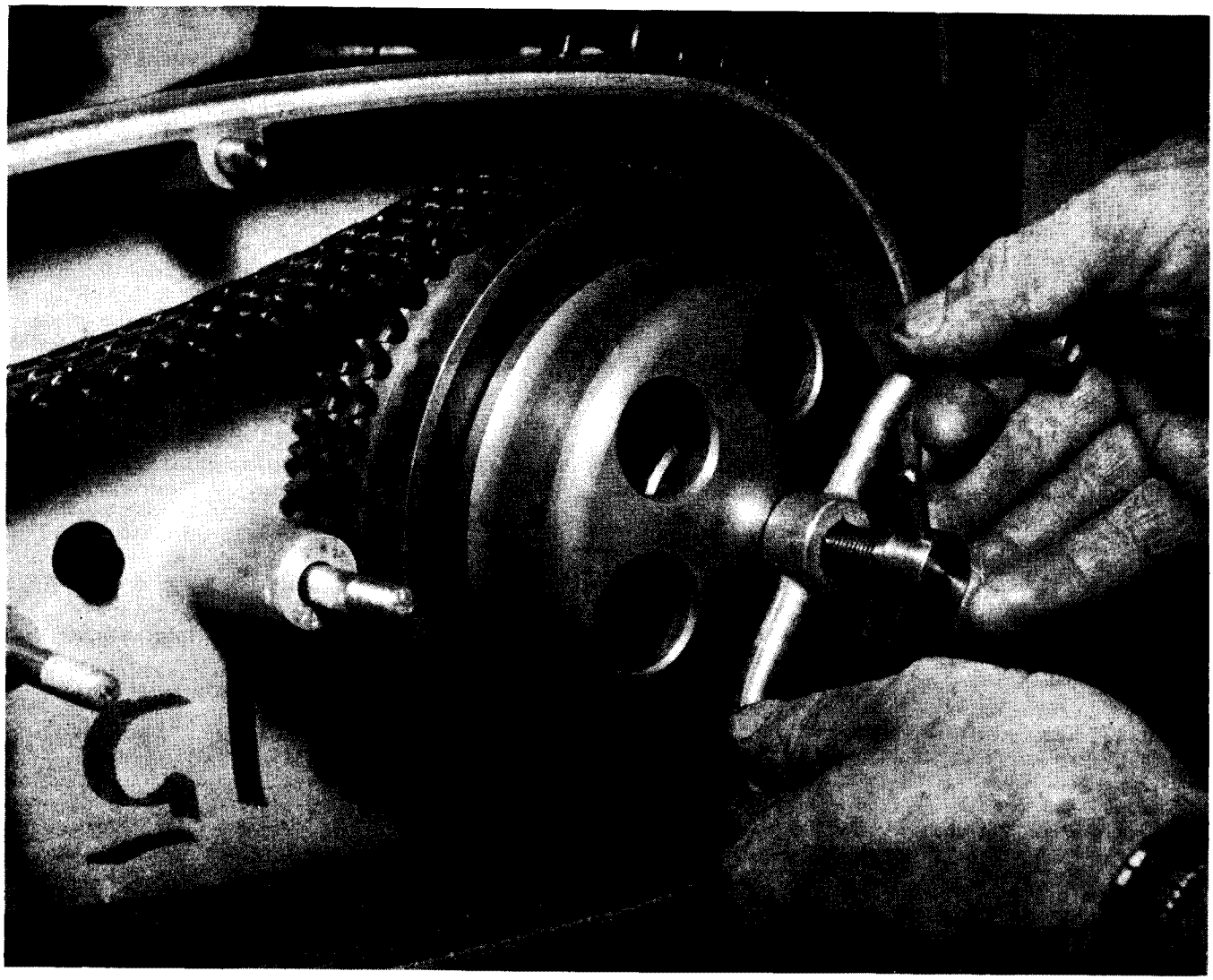


FIG. 8 *Clutch Tool in use*

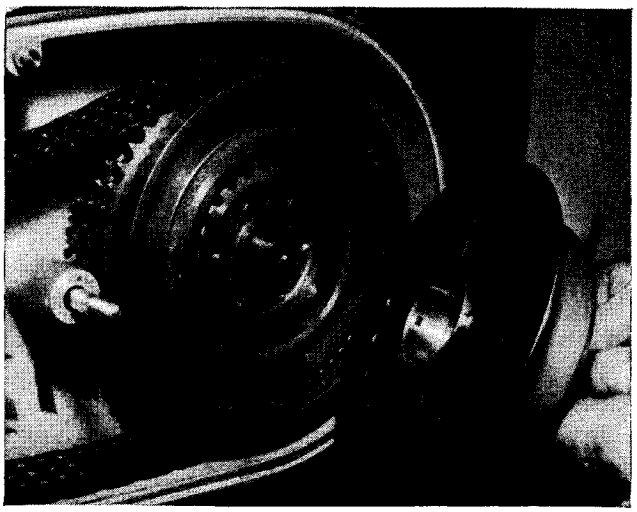
Removing engine

Use the following sequence to take the engine out of the frame.

1. Release the two knurled knobs securing the seat (the knobs are captive, retained by a pin through the boss), lift seat to clear the two slotted brackets and remove by pulling seat backwards.
2. Disconnect the two petrol pipes at tank end—take out two front tank fixing bolts—detach rubber securing rear end of tank and lift the tank clear of the frame.
3. Take out the four screws securing the top caps on each carburetter, and withdraw the throttle and air slides. (Attach these temporarily to the frame tube out of harm's way).
4. Detach the two spark plug covers attached to the high tension cables.
5. Remove the muffler clamp bolts securing exhaust pipes to each muffler, unscrew the two exhaust pipe finned nuts—take away both exhaust pipes.
6. Remove frame torque stay plates (three nuts for each plate) also three Allen screws securing plate to cylinder head.
7. Drain oil tank; disconnect both oil pipes at tank and engine end.
8. Take off gear shift lever.
9. Disconnect tachometer drive cable (engine end).
10. Remove battery cover; disconnect the positive battery wire (to avoid a short circuit). Disconnect by pulling out the two wires from the alternator and two wires for the contact breakers, attached to the fourway connector (located between the two rear engine plates).
11. Remove left side foot peg with brake pedal.
12. Use a tray below the primary chaincase (to catch oil), remove the central dome nut with washer—the outer portion of the chaincase can now be removed. This nut is $\frac{3}{4}$" across flats.
13. Remove stator for alternator—three nuts—with care, pull out the two wires attached to the alternator (ONE WIRE AT A TIME) through the rubber grommet in the back portion of the primary chaincase. Take off the three spacers on the alternator studs.
14. Remove sleeve nut ($1\frac{1}{16}$" across flats) with lock washer securing rotor for the alternator. Take off the rotor, washer, spacer and woodruff key in the shaft. The rotor has a parallel bore—a tool is not required to extract.

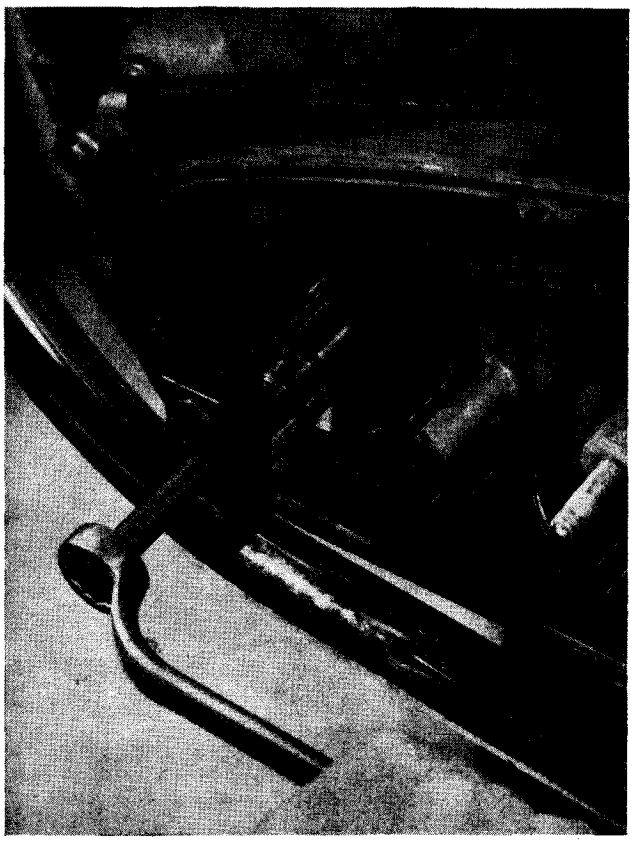
15. The triplex primary chain is endless, in consequence the engine sprocket and clutch sprocket are removed simultaneously. Release the clutch push rod adjuster screw lock nut a few turns and take out the screw.
16. Take up the clutch diaphragm spring compressor tool Part No. 06-0999, screw in the central bolt for this tool into the diaphragm spring centre. Tighten the nut on the central bolt until the diaphragm spring is free to revolve in the clutch sprocket—and no further. Take out the circlip retaining the diaphragm spring from the recess in the clutch sprocket (a slot is machined in the end of the circlip to facilitate extraction). The diaphragm spring, with tool attached, can be taken out (see Figure 9.)
17. Fit the clutch hub tool 06-1015 over the clutch hub (to prevent it turning). Remove the nut and washer securing the clutch hub to the gear box mainshaft (a 14 mm spark plug spanner fits this nut).
18. Fit the engine sprocket extractor tool by entering the two outside bolts into the two screwed holes in the engine sprocket. Tighten the central bolt in the tool, a sharp blow with a hammer on the head of the central bolt will separate the sprocket from its shaft.
19. Usually the clutch hub with sprocket can be removed from the gearbox mainshaft without the use of an extractor tool. Where difficulty exists, use the engine sprocket extractor for this purpose.
20. The engine sprocket—clutch sprocket with chain can now be removed. Watch for the shim washers behind the clutch sprocket—used to adjust the chain line.
21. Three bolts secure the rear portion of the primary chaincase to the crankcase. Straighten the three tab washers securing the bolts—take out the three bolts—the chaincase can now be removed. Take off the gasket from the crankcase for the chaincase.

FIG. 9 *Clutch diaphragm removed*



22. Take off the rubber tube attached to the elbow union on the drive side crankcase.
23. Detach the earth wire attached to the bottom crankcase stud on the left side of the crankcase.
24. Before the engine mounting plates are removed the engine must be supported under the crankcase to prevent the engine dropping down in between the lower frame tubes. A block of wood under the crankcase can be used or alternatively a steel rod under the crankcase and over the lower frame tubes will suffice.
25. Take off the self-locking nut from the bolt passing through the front engine mounting and the frame. Withdraw the bolt from the right side of the frame. Remove the front engine mounting assembled complete by moving the assembly downwards to clear the frame tubes.
26. Remove the three studs passing through the rear engine plates and crankcase. With the engine support mentioned in paragraph 24 removed, the engine, together with both carburetters attached can be lifted out of the frame from the right side of the machine. The air filter to carburetter rubber connection will come away as the engine is taken out of the frame.

FIG. 10. *Removing Engine Sprocket*



Dismantling the Engine

Have available complete gasket set 060910. Wash down the crankcase exterior with a solvent, particularly the bottom part of the crankcase, where road grit can accumulate, to avoid fouling the work bench. Take out the crankcase sump plug to drain oil. It is preferable to dismantle the timing gear before removing the cylinder head, spark plugs and cylinder barrel, to protect both pistons and to provide resistance by compression during the process of removing parts used in the timing side of the engine.

Dismantle the engine in the following sequence:—

1. Remove the timing cover (12 screws). A light tap with a soft-faced mallet on one side of the cover whilst pulling on the tachometer drive will enable the cover to separate from the crankcase.
2. Remove the oil pump (two nuts). The pump can be pulled off the two fixing studs. Do not misplace the conical rubber seal attached to the pump.
3. Remove the oil pump worm nut LEFT HAND THREAD.
4. Remove camshaft chain tension slipper (two nuts), take off the outside plate (thick one), the tension slipper then the thin plate.
5. Remove nut securing camshaft sprocket; use extractor tool Part No. EST.12 to extract the sprocket from the camshaft. Use a suitable distance piece between the central bolt and the end of the camshaft. The camshaft sprocket has a parallel bore.
6. Tap out, with a suitable punch, the spring pin passing through the ignition chain sprocket boss and the shaft for the distributor.
7. Take off the camshaft sprocket and chain together, the intermediate gear pinion, and ignition chain with its sprocket. Pinch the top and bottom run of the camshaft chain during removal and wire the top and bottom run of the chain together (see Figure 14) which will avoid disturbing the valve timing when refitting. Watch for the thrust washer behind intermediate pinion.
8. Remove small timing pinion from timing side crankshaft —use extractor tool ET.2003. Take out the pinion key, the star-shaped thrust washer and steel oil seal.
9. Remove the cylinder head, cylinder barrel and both pistons as detailed in chapter "Engine Service".

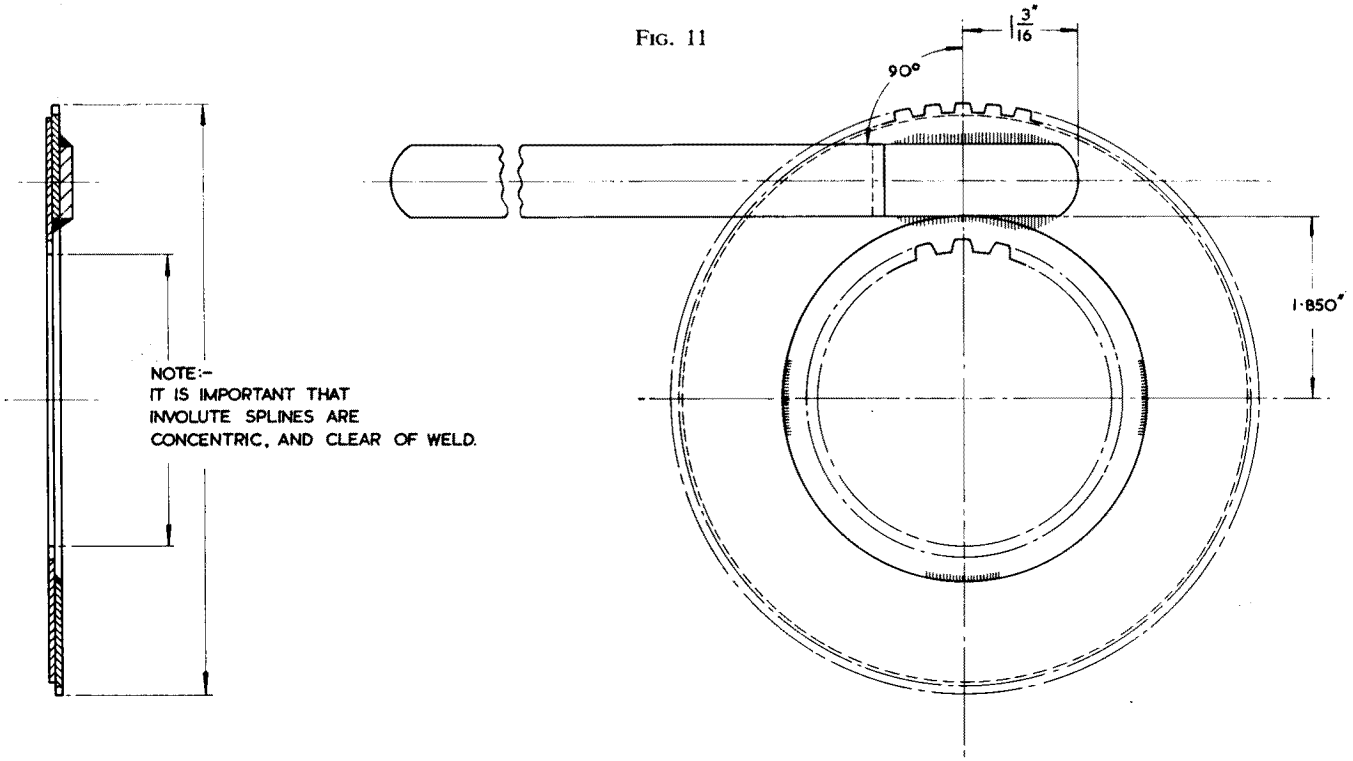
Separating the crankcase

The ignition distributor can be left on the timing side part of the crankcase when the two halves of the crankcase are separated. To remove the distributor assembly, remove one bolt from inside the crankcase and the two stud nuts outside. The distributor complete with gasket can then be removed.

Separate the crankcase by:—

1. Removing all the studs passing through the crankcase and the two cheese-headed screws from the lower part of the crankcase.
2. Take up the crankcase assembly with both hands, with the drive side crankshaft pointing to the bench. The act of thumping the assembly with the drive side shaft against the bench, will cause the drive side part of the crankcase to separate, leaving the inner member of the roller bearing on the crankshaft.
3. Take out the camshaft, the spring and rotary release valve plate. The inner member of the timing side ball bearing is a close fit on the timing side crankshaft. To protect the end of the shaft and to prevent the entry

FIG. 11



CLUTCH HUB TOOL 06-1015

of foreign matter into the oil passage drilled in the crankshaft, a sleeve tool as shown in Figure 13 should be used. This tool and the method of forcing the crankshaft out of the ball bearing is shown in Figure 12 which is self explanatory.

Removing the roller bearing

The inner member is a close fit on the shaft which is vitally important.

The roller path can be examined for wear or damage by taking out one roller. Use a stout pair of pliers to grip each side of the roller, when a sharp upward jerk of the pliers will extract the roller.

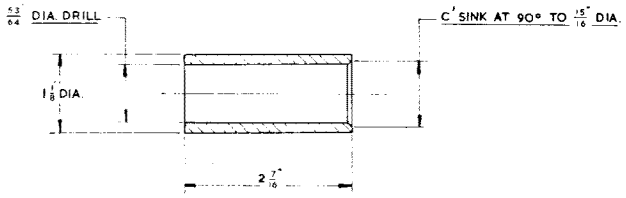
Check and examine the entire diameter of the roller path, through the aperture made when the roller is removed.

The inner member can be removed with the use of two sharp edge wedges placed each side of the steel sleeve and crankshaft which will move the bearing member sufficiently far enough to enable a regular claw-type extractor to be used for final removal.

Removing the roller bearing sleeve

To remove the bearing sleeve, the drive side crankcase must be heated, by using a domestic oven or hot plate to a temperature of approximately 200° Centigrade. With crankcase in this condition, the action of dropping the crankcase on to a flat wood bench (to avoid bruising the crankcase face) will dislodge the bearing sleeve.

FIG. 13

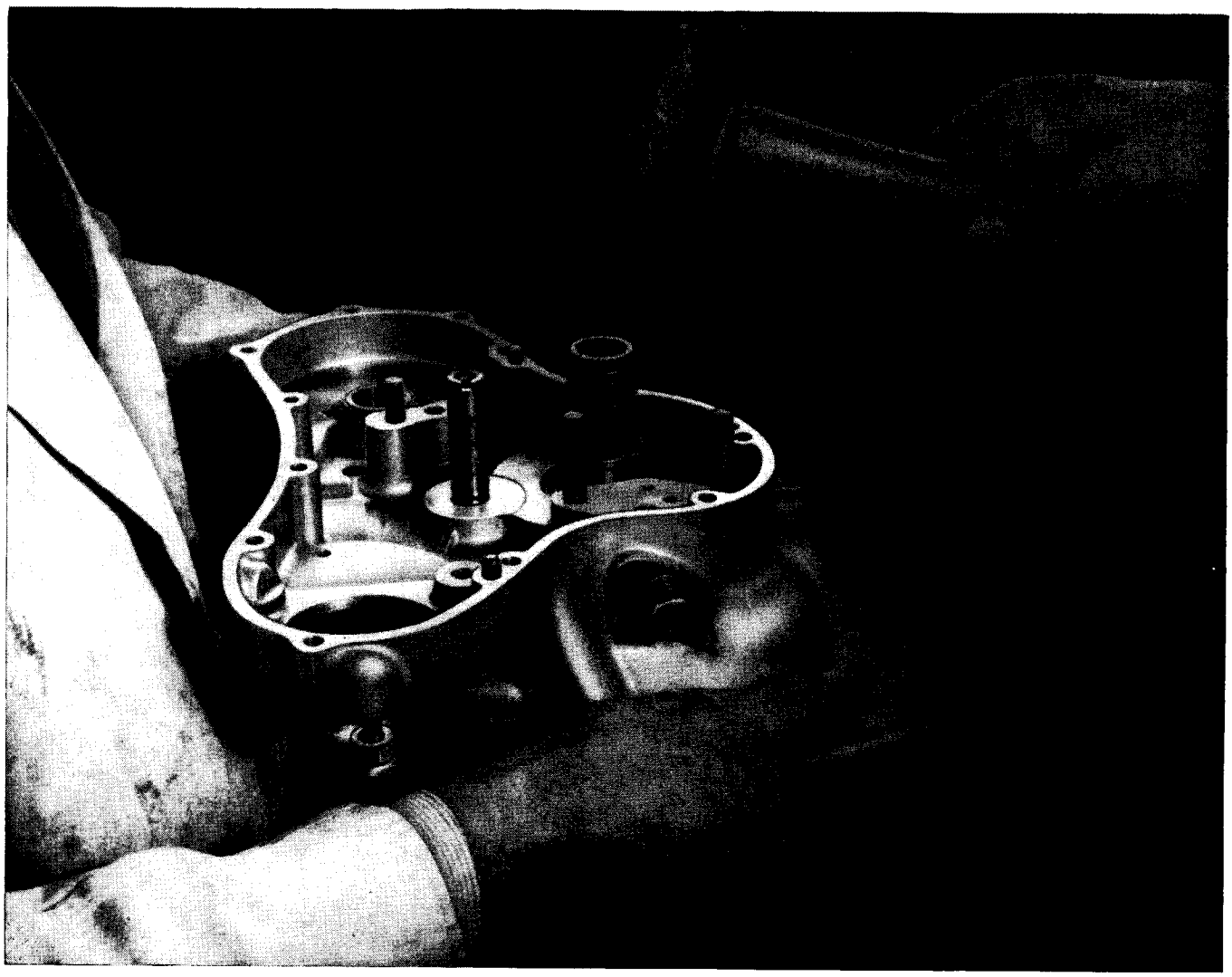


CRANKSHAFT REMOVING SLEEVE

Removing the ball bearing

Heat the crankcase as described for removing the roller bearing sleeve, using the same method of removal, taking care that the intermediate pinion shaft does not move.

FIG. 12 *Removing the Crankshaft*



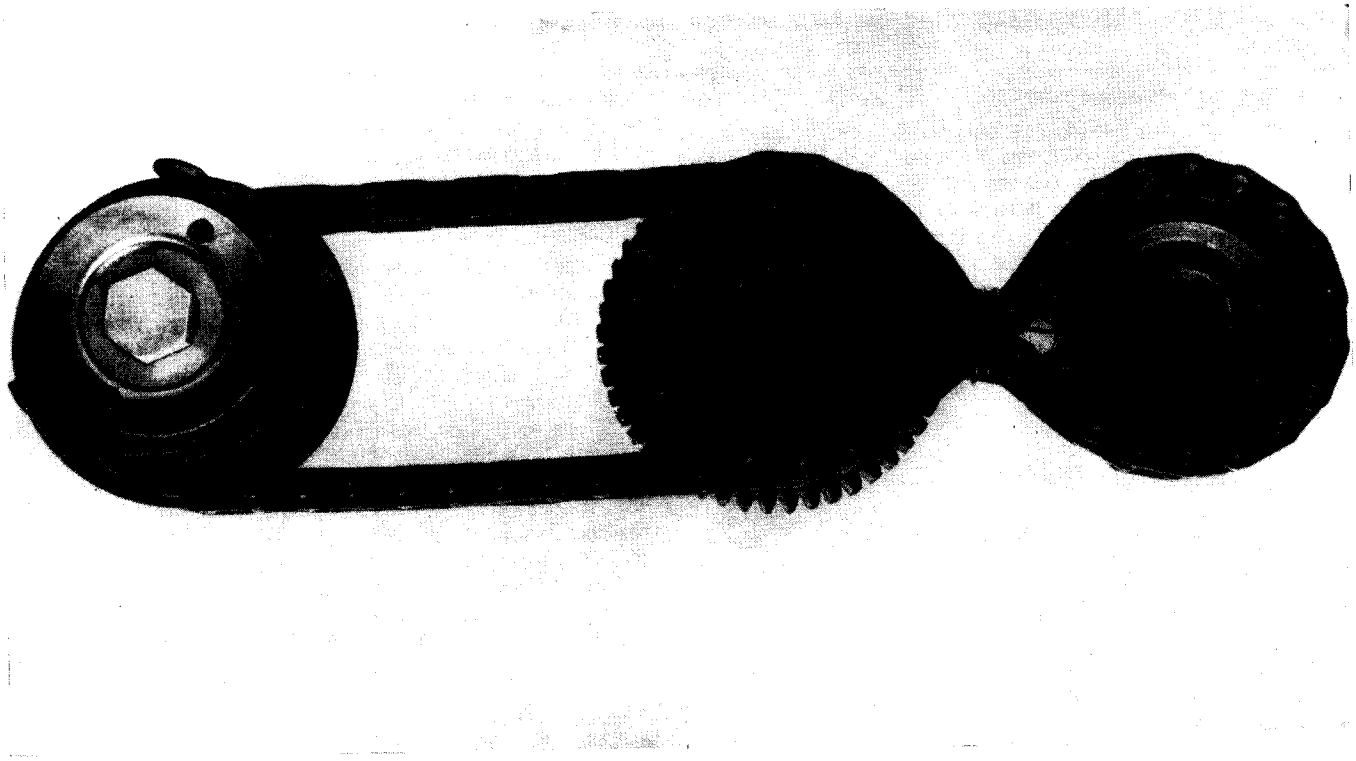
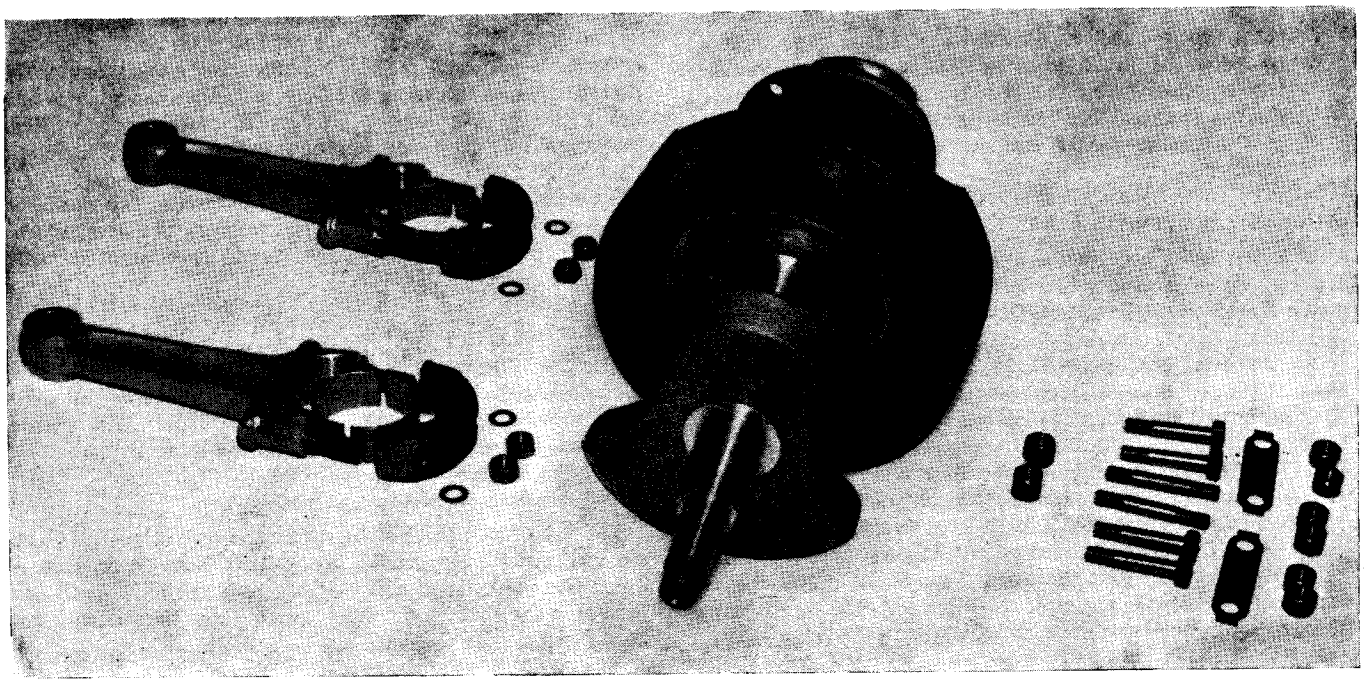


FIG. 14 *Retaining Valve Timing .*

FIG. 15 *The Crankshaft*



The Crankshaft

Removing the connecting rods

Remove the two self-locking nuts holding the connecting rod; a sharp jerk away from the crankshaft will separate the detachable cap from the connecting rod. If the cap jams half way up the studs, tap it back and repeat the process. With the detachable cap removed, it will be observed there is an oblique mark on the cap which registers with a similar mark on the connecting rod to indicate the correct location for the detachable cap when it is refitted. The caps do not interchange as they are machined *in situ* with the connecting rod. The connecting rod bearing shells can be taken out without difficulty.

The crankshaft

The crankshaft journals, where the connecting rods operate, are not prone to wear even after considerable mileage, providing clean oil of the correct viscosity has been continually circulating when the engine is running. There is a cavity in both crankshaft cheeks, where sludge and foreign matter can collect, which must be removed by cleaning when the crankshaft is serviced.

The journals must be perfectly smooth. Score marks, due to contaminated oil circulating, should be removed by re-grinding.

Maximum permissive ovality, before re-grinding is .001". The normal dimensions are given in technical data.

Dimensions for re-grinding in three stages are shown on page 23.

Note: It is vitally important to restore the radius on each journal after re-grinding. The journals must have a mirror-like finish, by lapping with the finest grade abrasive tape obtainable.

Dismantling the crankshaft

1. Mark the flywheel to identify its position for reassembly in its original position.
2. Straighten the two tab washers, take off the nuts for the two studs. Remove four nuts for the bolts passing through the assembly—the end cheeks can be removed from the flywheel as illustrated. Extreme care should be taken to avoid bruising the faces on the crank cheeks, which will affect true running when the crankshaft is reassembled. The oil passages and the cavities in the crank cheeks can be cleaned as previously described.

Assembling the crankshaft

The four bolts used in the crankshaft assembly are made from high tensile steel which must not be replaced by bolts made from inferior material. The Part No. for these bolts is T.2033.

As the bolts are "peened" by a centre pop punch the threads for the nuts can become damaged during removal. The use of new nuts for this vital part of the engine is therefore recommended. The Part No. for the two long top nuts is 23280—the six short nuts have Part No. T.2031. If the two tab washers are damaged by straightening they should also be replaced (Part No. T.2032). The faces on both crank cheeks, also the flywheel, must be perfectly flat and free from bruises or blemish. Pass the bolts through the crank cheek into the flywheel—engaged in the locating dowel. Fit the second crank cheek and fit the tab washers to the lower studs. Assemble the fixing nuts, tighten them diagonally, then deal with each nut in turn and make sure they are very, very tight. Turn back the tab washer, "peen" with a centre punch the remainder of the nuts.

Fitting the connecting rods

Undersize shells for the connecting rods are available, for use when the crankshaft journals have been reground. The connecting rods and caps must not be filed to absorb movement. When the maximum permissible ovality on the journals has been reached, the journals must be reground to restore concentricity.

Before assembling the connecting rods, check the bolt holes in each connecting rod for swarf or particles of metal that can become trapped under the head of the bolts retaining the detachable caps. Fit the shells to both connecting rods; assemble connecting rods with the small oil holes facing away from the centre of the crankshaft.

Use new self-locking nuts Part No. 23253, tighten with a torque wrench set to 25 ft. lbs. Use a Wesco oil gun to force clean engine oil through the crankshaft until the oil emerges each side of the connecting rods.

Checking oil pump seal

Before assembling the engine, and fitting the timing chains with sprockets, verify that the conical oil seal, on the oil pump, is effective by:—

1. Temporarily fitting to the crankcase the oil pump, securing the pump with the two stud nuts.
2. Put the timing cover into position, push it home and release. If the conical oil seal is effective it will push the timing cover away, leaving a gap of approximately .010" between the cover and the crankcase. If the seal is not effective replace it with a new one, Part No. T.272. Shim washers, used behind the seal and the pump body can be used, providing the conical portion is not deformed or damaged.

Timing cover oil seal

The seal encircling the plain extension on the timing side crankshaft—housed in the timing cover—is designed to prevent oil leakage under pressure from the oil pump. When the engine is overhauled, after considerable mileage, this seal should be examined. If doubt exists use a replacement, Part No. 048023.

To remove the oil seal, take out the circlip, prise out the seal—gently heat the timing cover, press in the new oil seal *with the metal backing outwards*, the sharp edge of the seal facing away from the cover.

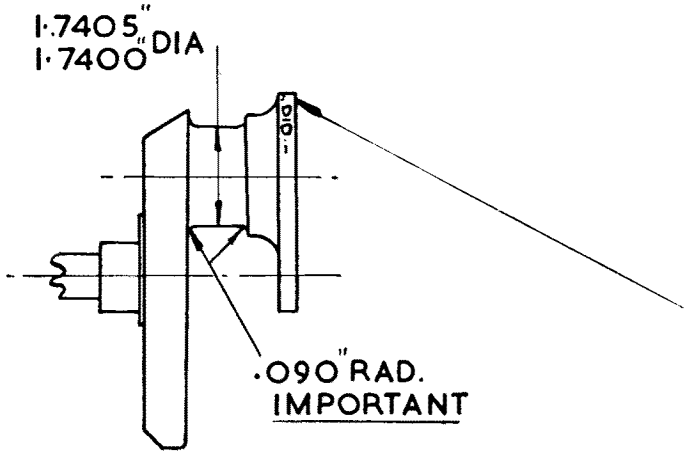
Intermediate pinion shaft

The shaft for the intermediate pinion is a close press fit in the crankcase. A circlip at the inner end prevents the shaft from moving inwards towards the crankshaft. To remove the shaft, heat the crankcase, pull out the shaft.

Fitting the intermediate pinion shaft

The shaft has a small hole in one end, the other end has a large hole and is slotted. To fit the shaft, heat the crankcase, insert the shaft, small end inwards with the oil hole drilled central in the shaft at 6 o'clock, press home the shaft until it is in contact with the circlip.

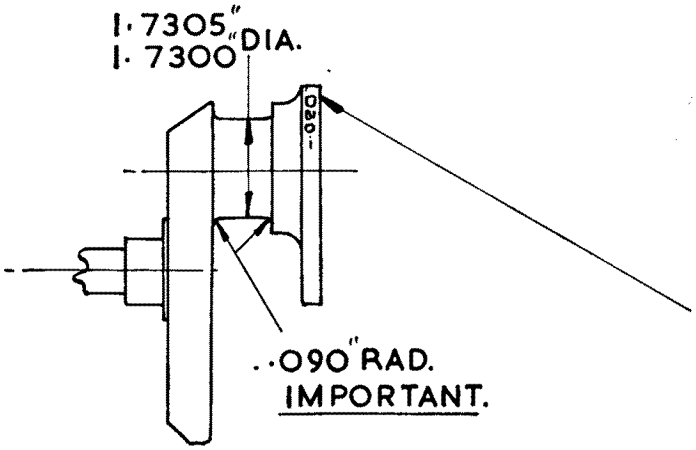
Re-grinding dimensions Commando crankshaft



FIRST RE-GRIND

GRIND THE CRANKPIN TO 1·7405"/1·7400" DIA. WITH ·090" FACE RADIUS.

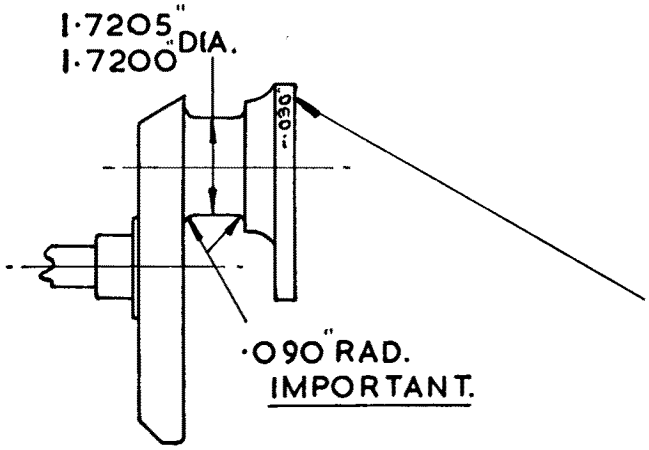
STAMP -·010" HERE.



SECOND RE-GRIND

GRIND THE CRANKPIN TO 1·7305"/1·7300" DIA. WITH ·090" FACE RADIUS.

STAMP -·020" HERE.



THIRD RE-GRIND

GRIND THE CRANKPIN TO 1·7205"/1·7200" DIA WITH ·090" FACE RADIUS.

STAMP -·030" HERE.

The driving side crankcase oil seal

A worn oil seal in this part of the engine will allow oil from the crankcase to be discharged into the primary chaincase.

To replace, the seal can be pressed out from inside the crankcase; the new seal, Part No. T.2187, is pressed into the crankcase, with the sharp edge inwards viz: the widest aperture facing outwards.

The sump filter

The crankcase drain plug incorporates a corrugated shaped gauze, to filter oil returned from the crankcase sump to the oil pump. To dismantle the filter take out the circlip, the metal washer, the gauze; also the interior of the plug can be cleaned.

A $\frac{7}{8}$" Whitworth hexagon spanner is used to tighten firmly the sump filter plug.

Assembling the engine

Cleanliness in working is an important factor to get the best results. Every moving part in the engine must be treated with clean oil before assembly. It is an advantage to treat highly stressed parts, such as the camshaft and tappets, with a coating of non-scruffing material such as molybdenum disulphide. Clean the face joint on the timing and driving side crankcase. Remove all traces of jointing compound used previously. Use a fine oil stone to remove burrs or bruises that can prevent an oil tight joint.

Fitting the driving side bearing

When a new bearing is fitted it is most important that a correct replacement is used. The bearing is of the single "dot" type, Part No. 17824; a substitute should not be fitted.

FIG. 16 *Extracting the Camshaft*

The inner member for the roller bearing is a press fit on the crankshaft, it is immaterial which way the bearing is fitted as there is a radius on both sides of the inner member. With the crankshaft suitably supported, an arbour press is used to press the bearing member fully home on the crankshaft. Heat the crankcase—to fit the roller bearing sleeve—as described in paragraph "Dismantling the engine", insert the sleeve square with the bearing housing in the crankcase and press home before the crankcase temperature falls.

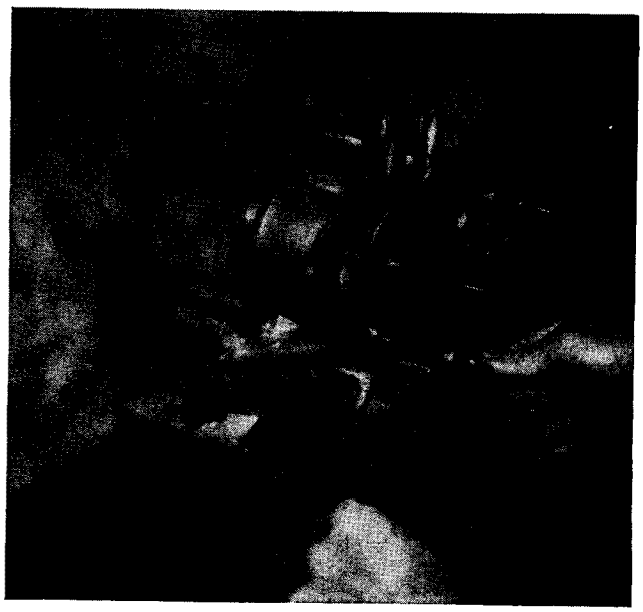
Fitting the timing side bearing

A single "dot" ball bearing Part No. 17822 must be used. Heat the crankcase as described in paragraph "Dismantling the engine". Insert the bearing squarely with the bore, then press home.

Assembling the crankcase

1. Take up the drive side crankcase, apply clean oil on the roller bearing, assemble the case on to the roller bearing with the connecting rods positioned as shown in Figure 16.
2. Invert the crankshaft with case, insert the rotary plate for the crankcase release with the two projections pointing outwards, followed by the spring. Engage the camshaft with the two projections on the rotary plate as shown in Figure 16. When the camshaft is correctly positioned it should move up and down, with finger pressure on the end of the camshaft, under the influence of the spring.
3. Apply a thin coating of non-flaking jointing compound to the joint face for the drive side crankcase, particularly on the bottom part of the crankcase, where oil can leak by gravity.
4. Take up the timing side crankcase, refit the distributor if removed, apply some oil to the ball bearing, then pass the crankcase over the projecting crankshaft and camshaft. The crankcase bearing will go on to the crankshaft bearing more easily if the crankcase is gently heated.
5. Fit the crankcase uniting bolts—the two cheese-headed screws at the lower part of the crankcase, then tighten.

FIG. 17 *Rod supporting Connecting Rods*



6. Assemble in the following order:—
   Oil seal dished washer.
   Star shaped pinion plate.
   Key for the small pinion in crankshaft.
   Small timing pinion, with care not to dislodge the key.
   Thrust washer on the intermediate pinion shaft.
7. Rotate crankshaft until the mark on the small timing pinion is at 12 o'clock. Take up the two timing chains with the intermediate gear, sever the wire on the chain, assemble the pinion with both chains in the crankcase with the mark on the intermediate gear pinion in register with the mark on the small timing pinion. The intermediate pinion is marked with white paint for easy identification. Assemble ignition chain, sprocket and spring pin.

Note: If the camshaft drive chain has been removed, or replaced, the camshaft sprocket and intermediate gear must be correctly located. Six outer plates on the camshaft chain should separate the mark on the intermediate gear and the mark on the camshaft pinion (see Figure 18 which shows the two sprockets correctly located).

8. To prevent the crankshaft rotating during the process of tightening the nut for the camshaft pinion and the oil pump worm drive nut, a bar is inserted through both connecting rods as shown in Figure 17. Fit and tighten the camshaft sprocket nut. Fit the oil pump worm drive nut LEFT HAND THREAD. A cutaway timing cover—for dealers' service staff use—is useful to support the intermediate pinion shaft whilst tightening the camshaft pinion sprocket nut, also to enable the ignition and camshaft chain to be adjusted correctly. The cutaway cover is shown in Figure 19.

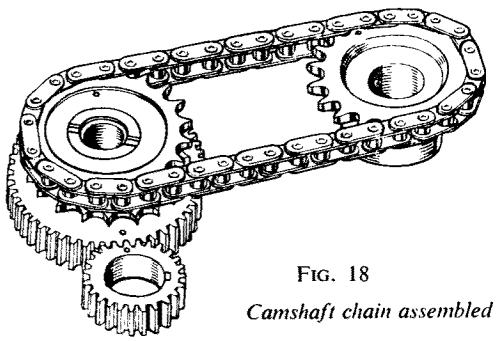


FIG. 18
Camshaft chain assembled

9. Apply sparingly a thin coating of jointing compound on the pump body face, where it abuts against the crankcase. Fit the oil pump, run down the two nuts evenly—not one at a time—tighten the nuts (see torque spanner settings).

FIG. 15 *Cut-Away Timing Cover*

10. Fit one of the two camshaft driving chain tensioner plates, with the longest portion from the bolt hole downwards, then the slipper, followed by the second tensioner plate; put back the two slipper fixing nuts loosely.
11. Adjust the camshaft driving chain by moving the slipper, leaving $\frac{3}{16}$" up and down movement (slack) in the top run of the chain, tighten the tensioner plate nuts. (See torque spanner settings).
12. Adjust the ignition timing chain by releasing the two stud nuts, one bolt fixing the distributor. Turn the distributor body, leaving $\frac{3}{16}$" up and down movement (slack) in the top run of the chain. Retighten the nuts and in particular the bolt inside the timing cover with its lock washer, which must be securely tightened.
13. Refit both pistons, cylinder barrel with cylinder head in the reverse sequence described in chapter "Engine Service". It is also possible to assemble the cylinder head, with push rods in the cylinder, to be fitted to the crankcase as a sub-unit, the cylinder head bolts can be torqued when the cylinder has been bolted to the crankcase.
14. Use a new gasket, fit the timing cover—six long and six short screws—the long screws are situated on the left of the centre of the cover.
15. The engine can now be reinstalled in the frame.

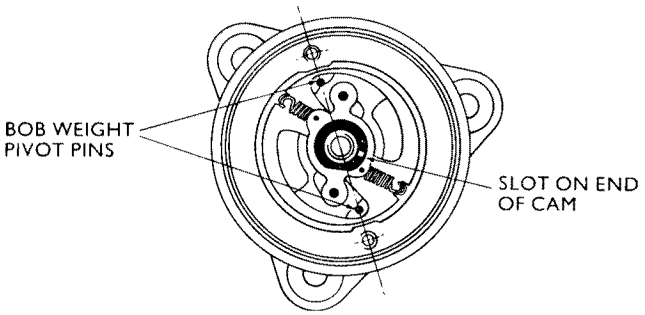


FIG. 20 *Contact Breaker location (approximate)*

Refitting engine

1. Introduce the engine into the frame from the right side of the machine. Fit the three studs and nuts passing through the rear engine mounting and the crankcase.

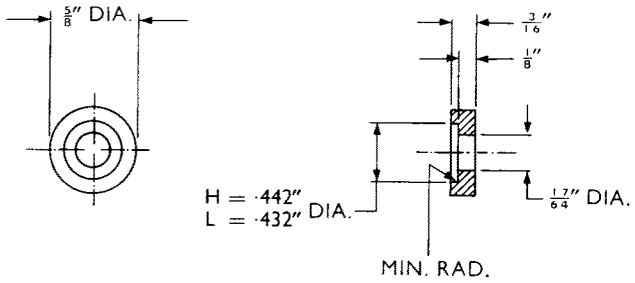


FIG. 21.
Locking Washer for Auto-Advance and Retard Unit

2. Support the engine (as described in paragraph 24 "Engine overhaul"), fit the front engine mounting complete, insert the fixing bolt, tighten self-locking nut with wrench set to 300 in./lbs. Tighten the nuts on the three rear engine mounting studs.
3. Continue the assembly in the reverse sequence described in chapter "Engine overhaul". Set the rocker adjustment as already described.

Primary chain alignment

After engine overhaul, before assembling the clutch and engine sprocket, check the chain line by placing a straight edge on both the engine and clutch sprocket. Correct alignment must be established, by using shim washers placed over the gearbox mainshaft, before the clutch and engine sprockets are finally assembled.

Setting ignition timing

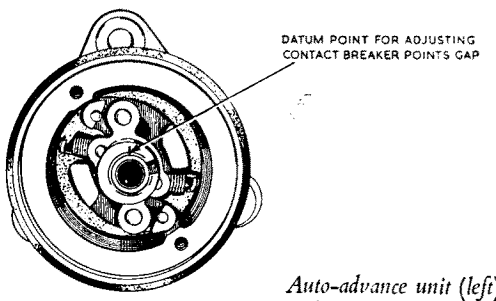
The ignition timing can be either set, or checked with the engine stationary, or with the engine running at 2,000 revs. per minute, with the use of a stroboscope.

A line marking on the rotor for the alternator is made during manufacture to register when the pistons are on the top dead centre of the stroke.

Adjacent to this marking, a degree plate with a two degree scale reading is attached to the outer portion of the primary chaincase.

Normally the LEFT contact breaker set in the distributor (to which a yellow and black wire is attached) is used for ignition on the DRIVE SIDE cylinder.

The contact breaker gap must be checked and adjusted for each cylinder, before the ignition timing is either reset, or adjusted.



Auto-advance unit (left) and contact-breaker assembly

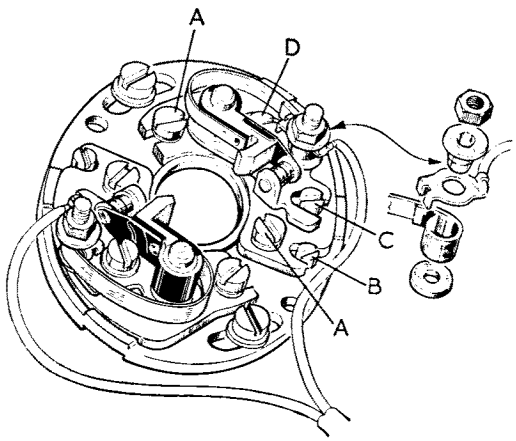


FIG. 22

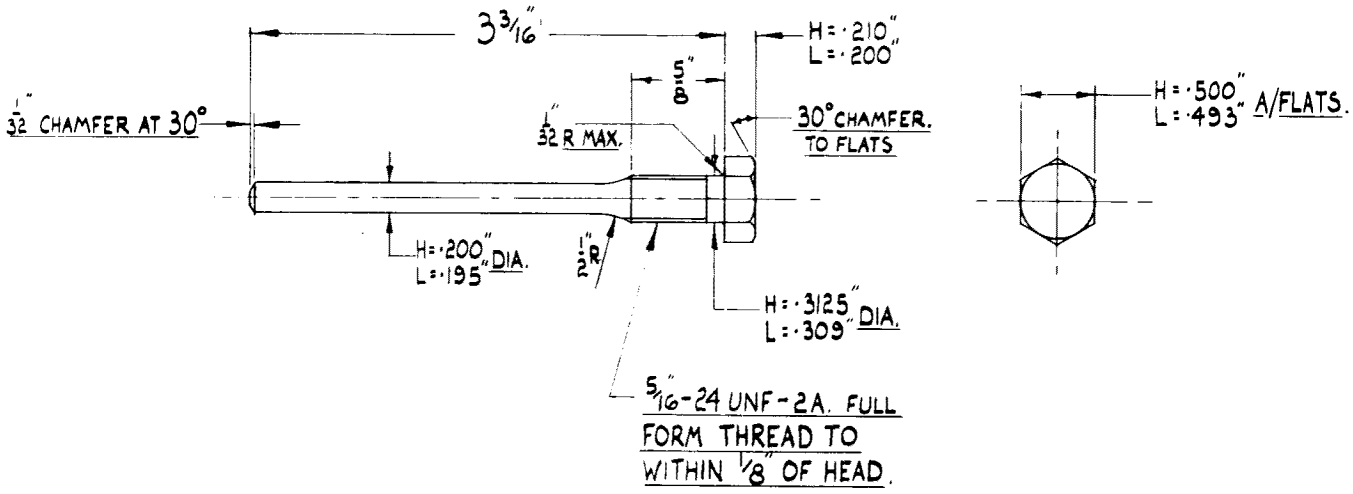


FIG. 23 *Extractor Bolt for Auto-Advance and Retard Unit*

The contact breaker Type 6CA

The contact breaker assembly is shown in Figure 22. A separate contact set on a moveable mounting plate is used for each cylinder, thus making it possible to accurately set the ignition timing on either cylinder.

Both contact breaker sets are mounted on a circular base plate, secured by two cheese-headed screws passing through slotted holes. The two screws should be central in the slotted holes when assembled.

A datum mark is made on the face of the cam, used to obtain a uniform contact breaker gap for each cylinder, when adjustment is made.

The cam is a taper fit on the distributor shaft and is retained by the central fixing bolt.

Adjusting the contact breaker gap

This adjustment must be made when the nylon heel on the contact breaker is in line with the datum mark on the cam. The normal contact breaker gap is .014″ to .016″. If adjustment is necessary:—

1. Release the contact breaker plate screw (D) Figure 22.
2. Manipulate the eccentric adjusting screw (C) until the contact breaker gap is correct.
3. Tighten the plate screw (D).
4. Then deal with the opposite contact breaker in a similar manner.

To reset ignition timing

1. Take off the inlet valve rocker cover.
2. Rotate engine until the DRIVE SIDE inlet rocker goes down and returns—the drive side piston is now on the firing stroke.
3. Take out the central bolt in the contact breaker assembly —use the draw bolt Part No. 06-0934 to extract the contact breaker cam assembly from the distributor shaft. Take off inspection cap on chaincase.
4. Position the engine with the mark on the rotor to register with 28 degrees on the timing scale. (Each line represents two degrees).
5. Position the contact breaker cam as shown in Figure 20 which is an approximate setting.
6. To lock the auto advance unit in the fully advanced position, use a washer for the central cam fixing bolt with a hole in the washer sufficiently large enough to clear the cam post projecting and to bear on the cam itself. Turn the cam to the full advance position and tighten the bolt. A special washer for workshop use is shown in Figure 21 together with its dimensions.

Checking ignition timing (engine stationary)

1. Use a low wattage 12 volt bulb and holder with a short length of wire soldered to the bulb holder body. Attach a second length of wire to the bulb connection. Connect one wire to the left contact breaker spring, the remaining wire to a convenient earth point on the engine.
2. Turn the ignition switch. If the timing is correct the bulb should light when the mark on the rotor registers with 28 degrees on the timing plate.

To adjust ignition timing

1. If the required adjustment is slight, release slightly the two contact breaker plate securing screws (A) and rotate the eccentric screw (B) so that the lamp bulb will light at 28 degrees when the engine is moved.
2. Retighten the two contact breaker plate securing screws (A).
3. If the adjustment required is considerable, release the two screws passing through the slotted plate and make the adjustment by moving the complete assembly.
4. Rotate the engine forward 180 degrees to make the same adjustment on the opposite cylinder.
5. Take out the central bolt—remove the temporary washer used—fit the regular washers and tighten the central cam fixing bolt. For contact breaker and auto advance unit maintenance see "Electrical Section".

Check ignition timing (engine running)

1. Attach the strobe lamp to the engine, in accordance with the lamp maker's instructions.
2. Take off the inspection cover from the primary chaincase. Remove the contact breaker cover.
3. Run the engine at 2,000 r.p.m. with the strobe lamp in position; the marking on the rotor should register with 28 degrees on the indicator plate if the timing is correct.

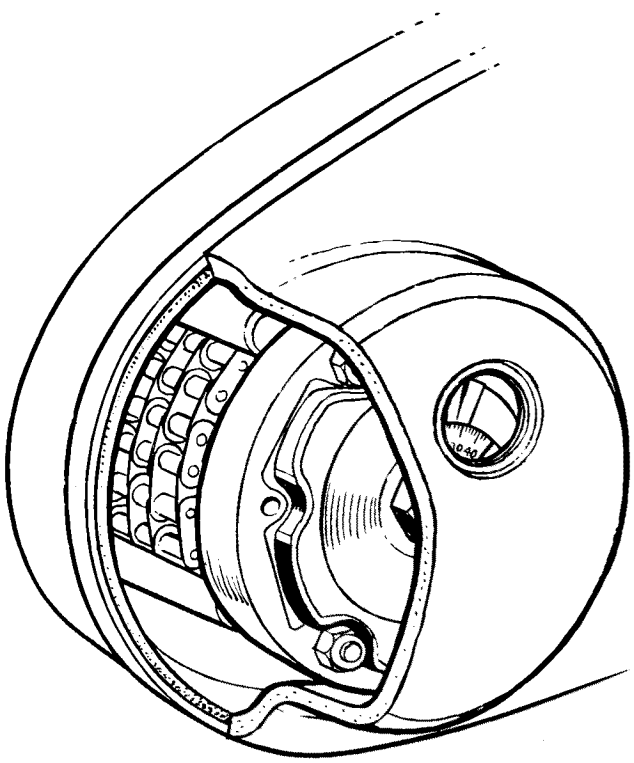


FIG. 24 *Timing Degree Plate*

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4. To advance or retard the ignition timing, refer to paragraph "To adjust ignition timing" (1) to manipulate the eccentric screw B to obtain the correct timing.
5. Check timing on opposite cylinder.

Valve timing

No useful purpose will be served by deviating from the valve timing established when the engine is first assembled by the factory, for, if an improved engine performance could be obtained—by an alteration to the valve timing—such alteration would be incorporated during initial engine assembly at the factory.

If so desired, the valve timing can be checked by:—

1. Mounting a degree plate on the drive side crankshaft, where the rotor for the alternator is fitted.
2. Using a pointer attached to the engine to register the top dead centre position of the engine—to record the degree when the valve opens or closes.
3. Increase the rocker clearance on all four valves to give a clearance of .016″.
4. Use a .003″ feeler gauge between the valve end and the rocker to register when the valves start to open or close. The mean valve timing figures taken from a number of engines is as follows:—
   Inlet valve opens 50° before top dead centre.
   Inlet valve closes 74° after bottom dead centre.
   Exhaust valve opens 82° before bottom dead centre.
   Exhaust valve closes 42° after top dead centre.
   Reset rocker clearance to .006″ inlet valves—.008″ exhaust valves.

The Gearbox

Dismantling the gearbox

To dismantle the gearbox, with the gearbox casing in the frame, have available the special tool to remove the clutch and engine sprocket outlined in the chapter "Engine overhaul". For access to the gearbox internals, proceed by:—

(A) Remove the outer portion primary chaincase and engine sprocket as detailed in paragraphs 15 to 20, chapter "Engine overhaul".

(B) Remove the steel sleeve on the mainshaft (use two screwdrivers) to expose the circlip encircling the mainshaft—take out the circlip.

The figures in parenthesis against the ensuing instructions refer to Figure 25.

Removing the outer cover

Remove the drain plug (15) to drain oil.
Remove the inspection cap (66) take off the clutch cable.
Remove the bolt for gear shift indicator, leave the pedal on.
Remove the kickstart crank bolt (90), take off the crank.
Remove the five cheese-headed screws fixing cover (68).
Remove the cover by pulling off, using the gear shift pedal.

Removing the inner cover (47)

Remove the ratchet plate and spindle (5).
Remove the clutch operating arm and roller (82).
Remove the lock ring (80), take away the body and ball.
Remove the mainshaft nut (74).
Remove the seven nuts fixing the cover (89).
Remove the cover, tap the edge and pull off (47).

Removing the internals

Remove the low gear pinion on mainshaft (39).
Remove the striker fork spindle (25) by unscrewing.
Remove the two striker forks (33 and 34).
Remove the clutch push rod (21).
Remove the mainshaft with the gears on it (11).
Remove the layshaft gears (12).

Removing the sleeve gear (23)

Remove the screw fixing the lock plate (4).
Remove the sleeve gear sprocket nut (5), *left hand thread.*
Remove the sprocket (6) from the splines.
Remove the distance piece, behind sprocket.
Remove the gear from the bearing (17).

Removing the cam plate (26)

Remove the dome nut (20) take out the plunger and spring.
Remove the two bolts (28 and 29).
Remove the cam plate and quadrant (26).

Removing the gear bushes

Remove the bushes by pressing out—note location first the bushes are brittle (oilite) use care in fitting. Size *in situ*, 0.81325″—0.81200″.

Removing the main bearing (17)

Remove the oil seal (16) by prising out.
Remove the bearing by warming the case and press out.

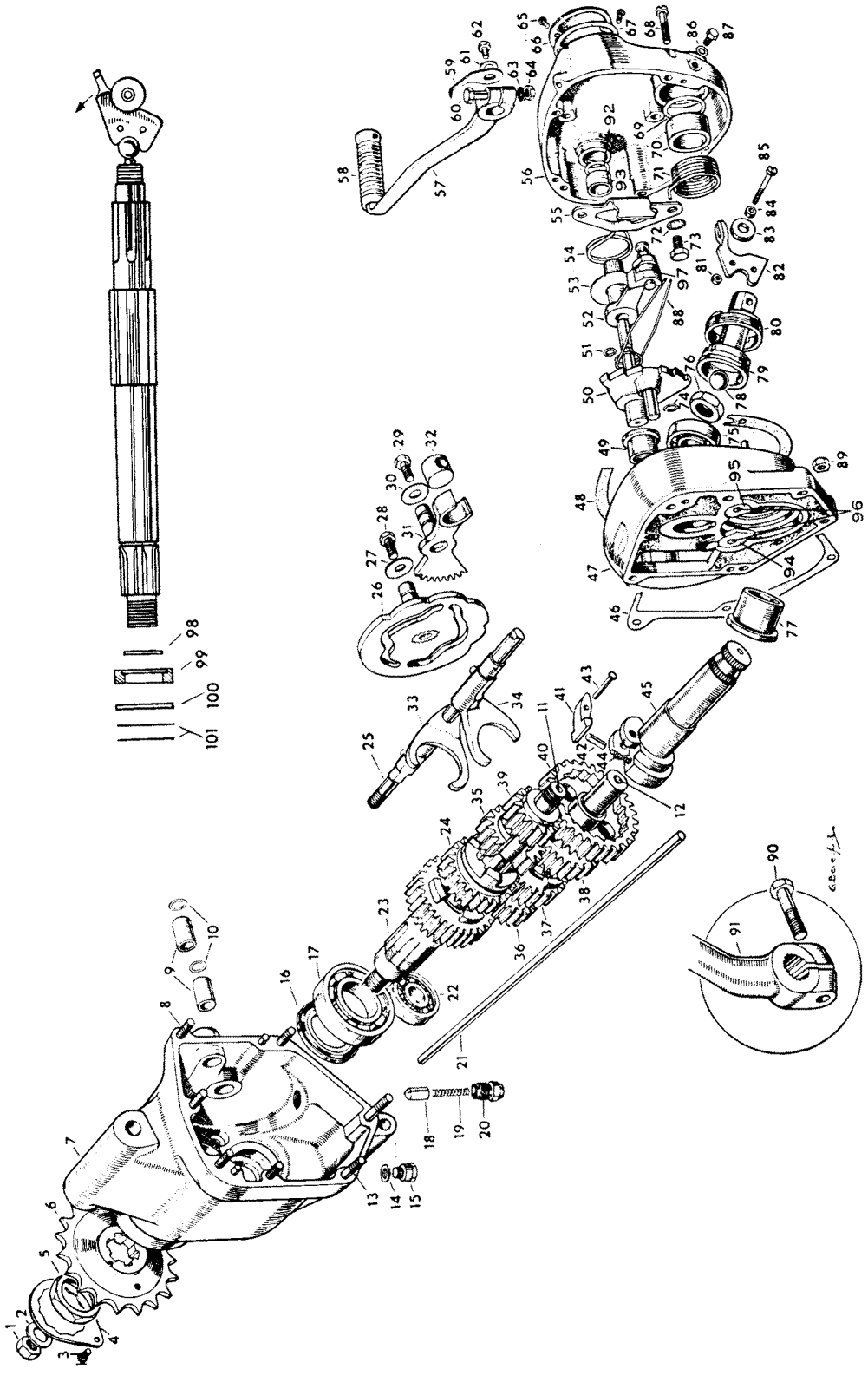


FIG. 25 *The Gearbox*

Removing the bushes

Remove the kickstart bush (77) by warming the cover, pressing out from the *outside*; ream new bush to 0.6875″ to 0.6865″.

Remove the footchange spindle bush—it has a blind hole; heat the cover, screw a coarse threaded tap into the bush and pull out.

Assembling the gearbox

Fit the main gear bearing (17), heat the case.

Fit the sleeve gear (23) the distance piece and seal (16).

Fit the sleeve gear sprocket and nut—this must be very firmly tightened.

Fit the lock plate and its screw.

Fitting the cam plate

This plate must be correctly positioned to index the four gears.

Fit the quadrant (31) with bolt and washer. Lift the lever portion of quadrant, with radius on lever to be in line with the top stud for the cover (top gear).

Insert cam plate so that the first two teeth in the quadrant are visible through the slot in the cam plate—then fit the bolt and washer (27 and 28).

Fitting the internals

Fit the mainshaft with the third gear (24) on shaft.

Fit the second gear (35) with striker fork (33) in the slot in the pinion.

Fit the projection on striker fork in cam plate.

Fit the first gear (39).

Fit the layshaft assembled with gear (36) gear (37) gear (38) with the other striker fork in (38) engage projection in cam plate, insert the layshaft in its bush.

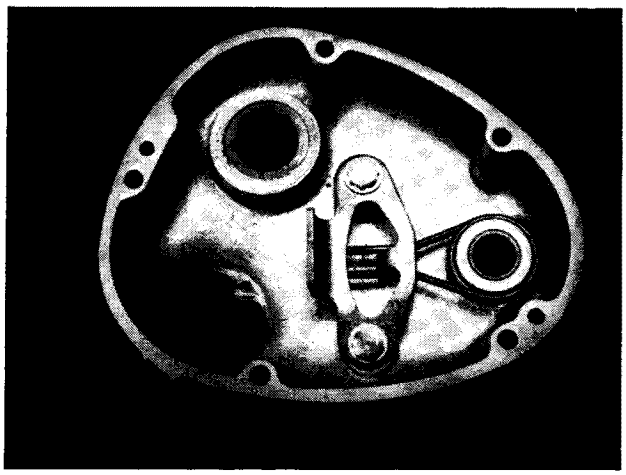
Line up the two holes in both striker forks, insert the spindle (25) and screw home.

Fit the first gear (40).

To complete the assembly

Put back the roller (32), line up to take foot shift spindle. Use new gasket and fit the inner cover. Before tightening the body lock ring (80), position the lever (82) so that it is in line with the clutch cable entry to give a straight pull. Refill one pint of S.A.E. 50 oil.

FIG. 26 *Gear shift Pedal Spring*



Replacing the gear shift spring

Take off the outer cover (56) then the quadrant (50) with the pawl spring behind it. Tap out the gearshift sleeve (52), washer (53). Take out two bolts (73), remove plate. The spring assembled is shown in Figure 29.

Replacing the kickstarter spring

1. Remove the gearbox outer cover (56), the inner gearbox cover (47) as described in paragraph "Dismantling the gearbox".
2. Detach the kickstarter return spring from the gearbox cover and from the kickstarter shaft. (Use a tool like a button hook for this operation).
3. Fit the kickstarter spring with the hole in the shaft at 12 o'clock engaged in the end—that is turned down vertically—into the hole in the shaft.
4. Using the tool suggested, hooked in the opposite end of the spring, pull the spring sufficiently for the end to engage with the locating hole drilled in the cover.
5. Replace the inner and outer covers. Refill with one pint of S.A.E. 50 oil.

Removing the gearbox

The gearbox assembly can only be removed when the engine is taken out of the frame.

Disconnect the rear chain, take out the top and bottom gearbox fixing bolts, turn the assembly anti-clockwise (from kickstarter side). The gearbox can then be removed from the rear engine mounting.

Replacing gearbox outer cover

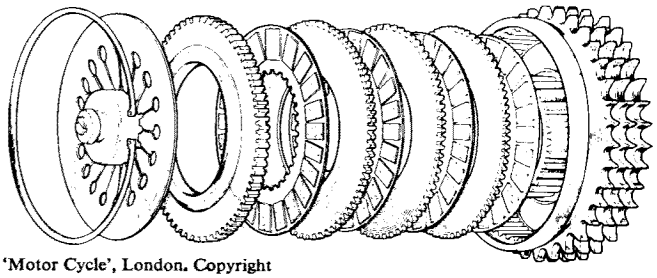
Use a new gasket for the outer cover, Part No. 040055. If the gear shift pawl spring has been removed, or replaced, the spring must be correctly positioned to enable the gears to be selected as the spring is not reversible. An examination of this spring will show that one leg of the spring is straight, the other spring leg is cranked.

The correct spring location is with the straight leg of the spring in the uppermost position. Position both spring legs on each edge of the rocking pawl as shown in Figure 29.

The clutch

The diaphragm clutch in a dismantled form is shown in Figure 27. The assembly sequence is self-explanatory, the clutch needs no adjustment other than to maintain free movement between the clutch operating push rod and the operating lever inside the gearbox cover (see paragraph "Clutch cable adjustment"). As the clutch plate friction inserts tend to settle down—this has the effect of absorbing the free movement of the clutch operating mechanism, which can result in the clutch ceasing to grip, by reason of relieving pressure on the diaphragm spring.

FIG. 27 *Clutch assembly*



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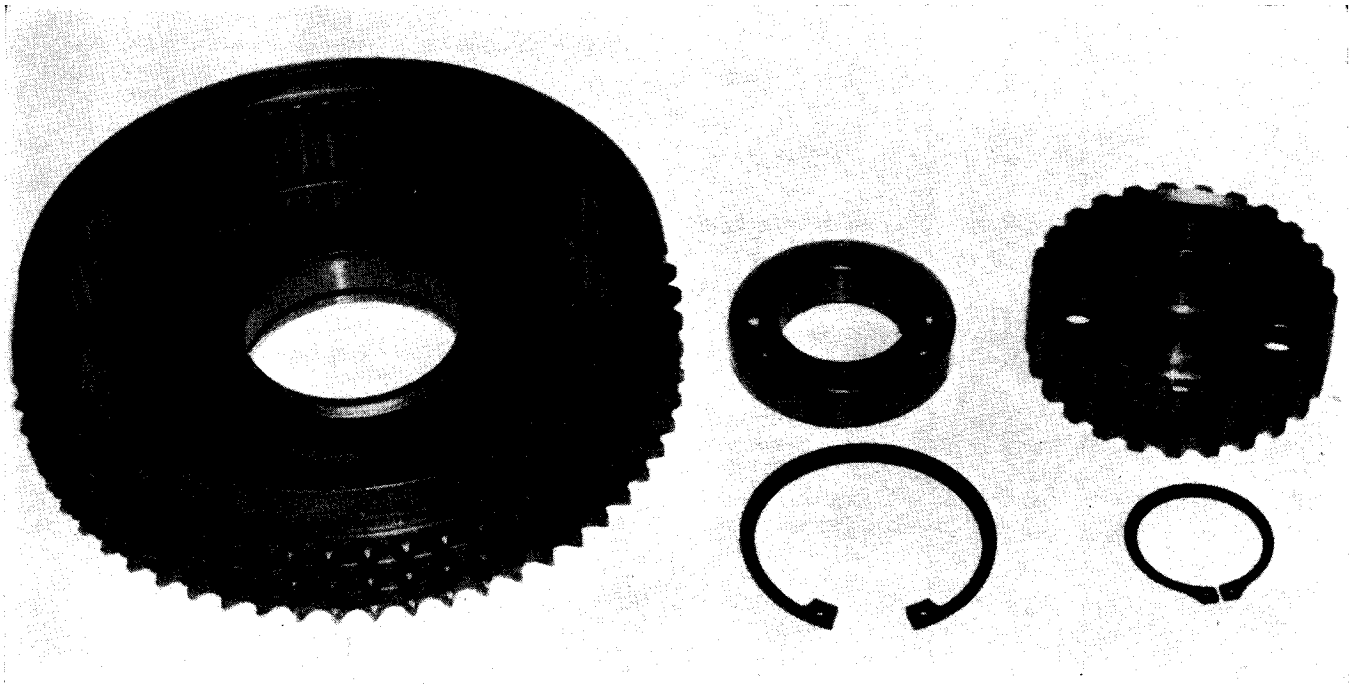


FIG. 28 *Clutch Bearing dismantled*

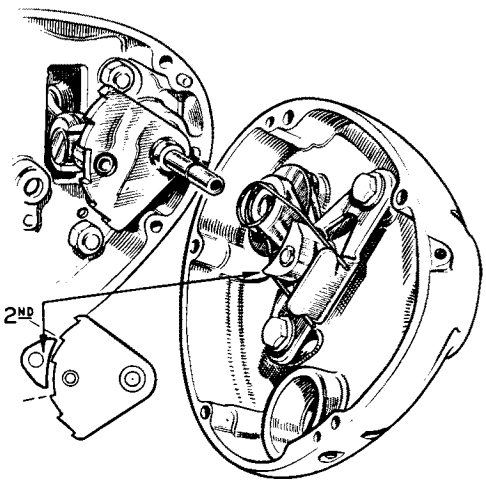
The clutch bearing

The clutch hub runs on a journal bearing which is a close fit in the clutch sprocket, located by circlip.

To remove the clutch bearing

1. Take out the circlip retaining the clutch hub with sleeve extension (the smallest of the two circlips).
2. Press out the clutch hub.
3. Take out the circlip for the bearing (the largest of the two circlips).

FIG. 29 *Gear shift Pawl Spring*



4. Press out the bearing from inside the clutch sprocket.

Refitting the clutch bearing

Apply a little anti-centrifuge grease on the bearing—refit the parts removed in the reverse order described for removal.

Clutch cable adjustment

To enable the clutch to function satisfactorily, it is important that the correct amount of free play in between the clutch operating mechanism is maintained. The principle used for operating the clutch is shown in Figure 25.

To adjust clutch cable

1. Run back the clutch cable adjuster lock nut, screw down as far as possible the clutch cable adjuster, at the handlebar end of the clutch cable.
2. Take off the large inspection cap on the primary chaincase.
3. Release the nut locking the slotted push rod adjusting screw, in the boss for the diaphragm spring.
4. Screw in gently the slotted adjusting screw until contact with the clutch push rod can be felt—unscrew the adjusting screw one quarter of a turn.
5. With care that the adjusting screw does not move, retighten the adjusting screw lock nut—use a screwdriver to hold the adjusting screw with a ring spanner to tighten the lock nut.
6. Unscrew the clutch cable adjuster leaving $\frac{3}{16}$" to $\frac{1}{4}$" free movement between the inner and outer casing for the clutch cable—tighten the cable adjuster lock nut.

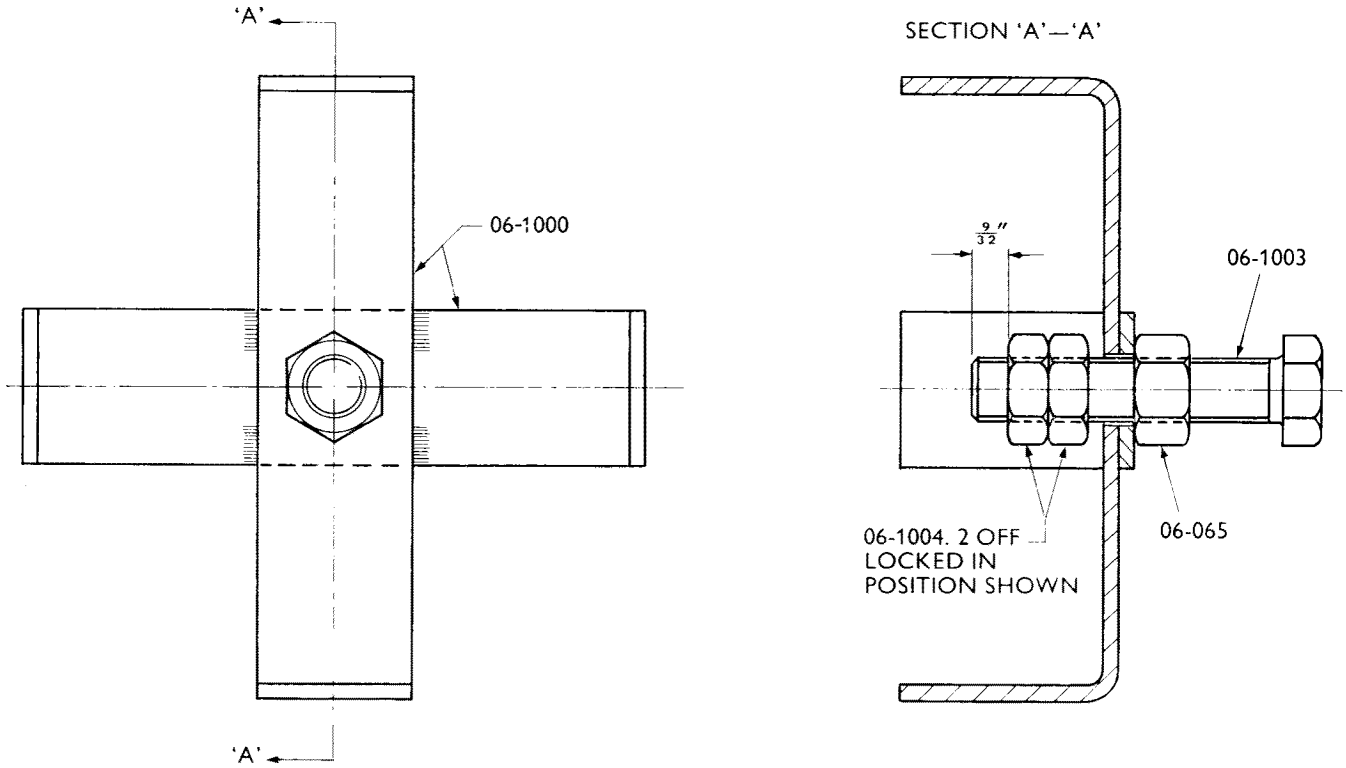


FIG. 30 *Workshop Clutch Diaphragm Tool*

Chain Adjustment

To adjust primary chain

The gearbox is fitted in the rear engine support mounting by two bolts passing through the engine mounting plates and the gearbox casing. On releasing the nut for the top gearbox fixing bolt the gearbox can pivot on the bottom bolt, thus allowing the primary chain tension to be adjusted. To adjust the primary chain:—

1. Remove the central inspection cap from the primary chaincase.
2. Release the nut for the top gearbox fixing bolt.
3. Unscrew several turns the *front* nut on the chain adjusting bolt to pull the gearbox backwards (located on the right side of the rear engine mounting).
4. Tighten the *rear* nut on the chain adjuster bolt slowly, until the primary chain is just tight—which can be felt with the index finger through the inspection cap aperture.
5. Unscrew several turns the *rear* nut on the adjuster bolt then tighten the *front* adjuster bolt nut a trifle at a time until the chain whip is $\frac{3}{8}$" in the centre run of the chain.
6. Tighten the rear adjuster bolt nut firmly. Rotate the engine to check the chain tension in more than one position. Tighten the top gearbox fixing bolt nut.

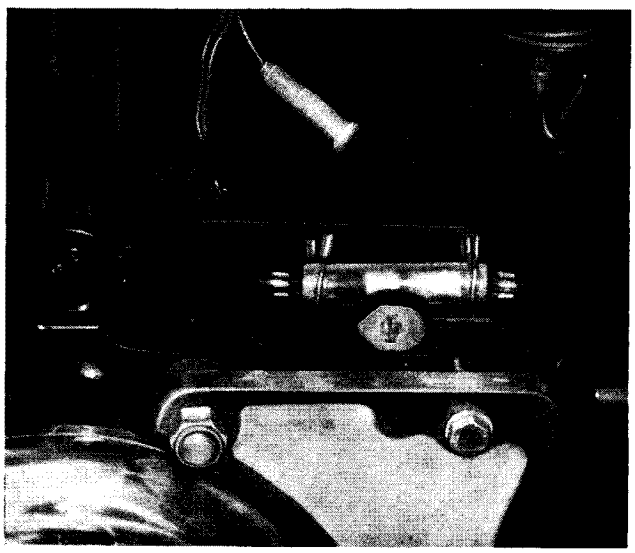
It is important to first adjust the chain tight, so that the final adjustment is to move the gearbox forwards to prevent the gearbox moving when changing into a higher gear.

Note: Moving the gearbox from its original position will affect the tension of the rear chain, which should be corrected.

Rear chain adjustment

1. Release slightly the rear wheel spindle nuts.
2. Release the adjuster lock nuts, move the two chain adjuster bolts an equal amount to either tighten or slacken the chain until there is $\frac{3}{4}$" whip in the bottom run of the chain.
3. Tighten the chain adjuster lock nuts and wheel spindle nuts—then check chain adjustment in more than one place.

FIG. 31 *Chain Oiler Cartridge*



Removing the rear chain guard

1. Take out the front and lower fixing bolt. Release the bottom nut for the left side rear suspension unit.
2. Move the chain guard forward—to clear the rear attachment—raise the rear end to remove the guard.

Rear chain lubrication

The rear chain is positively lubricated by oil by-passed from oil returning from the engine. A plastic hose connected to a 'T' piece on the oil tank conveys oil to the rear chain via a felt cartridge—to act as a restrictor. The plastic hose terminates close to the rear chain.

A clip to locate the plastic hose is attached to the rear chain guard fixing bolt. The location of the felt cartridge is shown in Figure 31.

The primary chaincase

The outer portion of the primary chaincase is retained by a nut for the central fixing bolt. By removing the fixing nut the outer portion of the chaincase can be removed.

The oil sealing band

The rubber sealing band is located in a channel cast in the rear portion of the primary chaincase; the sealing band can be removed by prising it out of the channel.

Rear portion primary chaincase

The rear portion of the primary chaincase is attached to the drive side crankcase by three bolts with tab washers to secure the bolts. The engine sprocket, together with the clutch, must be taken off for access to the three fixing bolts. The tab washers must be turned back after refitting the bolts.

A sliding oil seal surrounding the gearbox mainshaft is incorporated in the rear portion of the chaincase. The seal consists of two steel discs with a felt sealing washer interposed.

The steel discs are not detachable, being spot welded during assembly. The felt oil seal can be removed by prising it out—to fit a replacement.

Front Forks

Lubrication (The figures in parenthesis refer to Figure 33).

For routine maintenance, refer to riders handbook. Use one of the recommended grades of S.A.E. 20 oil shown in the table of lubricants.

Steering head adjustment

If movement develops in the steering head bearings and is not corrected promptly, vibration will be produced, and damage to these bearings will inevitably occur. Usually, movement in these bearings can be detected when the front brake is applied. Additionally, the bearings can be checked for movement by:—

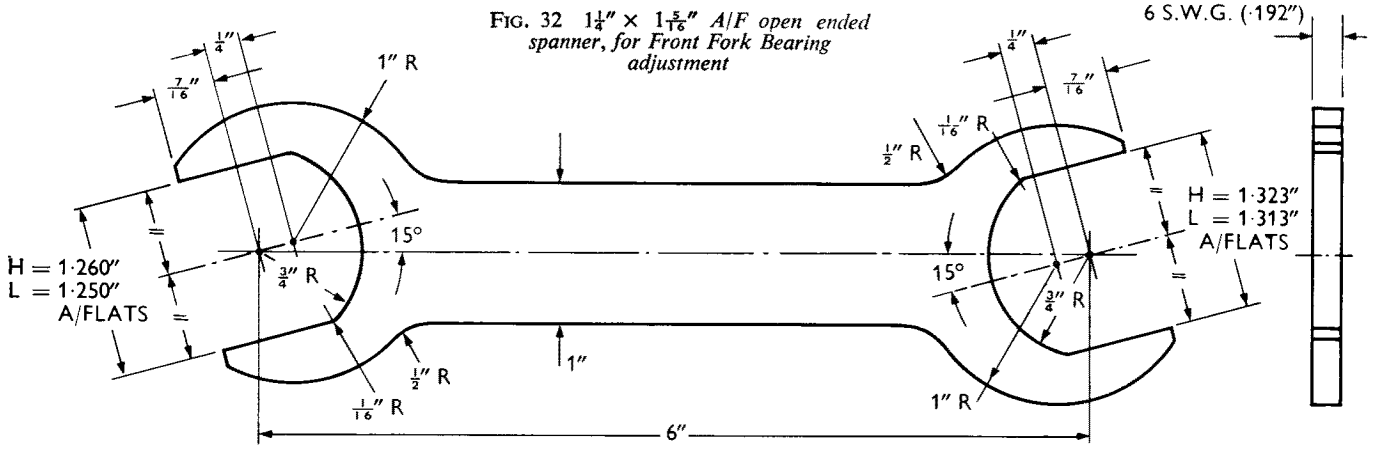
1. Raising the front wheel clear of the ground as shown in Figure 34. Place the fingers of the left hand on the point where the handlebar lug meets the top part of the frame head lug.
2. Grasp the extreme end of the front fender with the right hand, lift the entire assembly up and down, when movement will be felt by the left hand.
3. To adjust the bearing; to eliminate movement, release both fork tube clamping nuts (28) release slightly the fork crown and column nut (37).
4. With a thin open-end spanner, tighten a trifle at a time the fork head race adjusting nut until all movement is taken up, without friction on the bearings.
5. Tighten the column nut (37), the two clamping nuts (28).

To drain the front forks

A container to catch oil drained, should be placed under one of the front fork legs with the machine on the central stand.

1. Take out one of the two cheese-headed drain screws and washers at the bottom of the fork leg—take the machine off the central stand.
2. Apply the front brake—to stop the machine moving forwards—work the forks up and down to eject the oil. Repeat the process for the other leg.
3. Put the machine on the central stand and refit the two cheese headed drain screws with washers.

FIG. 32 $1\frac{1}{4}$" × $1\frac{5}{16}$" *A/F open ended spanner, for Front Fork Bearing adjustment*



4. Remove the two top fork tube bolts (34). Raise the front wheel—to expose the front fork springs—use a wooden box, or block of wood under the front wheel for support.
5. Detach both damper rods from the front fork top bolts (34), use two spanners, set aside the tachometer and speedometer in their covers.
6. Remove the support for the front wheel to allow the forks to fully extend, fill 150 cc of S.A.E. 20 oil to each fork tube. As the air space between the spring and the fork tube is small, the oil should be filled slowly to avoid overspill.
7. Refit the damper rods to the top bolts—firmly tighten the lock nuts.

Dismantling the front forks

The front forks can be dismantled, for examination of the damper mechanism or fork springs—leaving the steering column, handlebar lug and attachments in position. The fork legs can also be removed individually.

FRONT FORK ASSEMBLY

1 Fork main tube.
2 Main tube bush.
3 Main tube bottom bush.
4 Main tube bottom bush circlip.
5 Fork slider left hand.
6 Fork slider right hand.
7 Fork end drain plug.
8 Washer for plug.
9 Oil damper tube.
10 Oil damper rod.
11 Oil damper tube bolt.
12 Washer for bolt.
13 Washer for tube.
14 Nut for rod top.
15 Nut for rod bottom.
16 Damper tube cap.
17 Piston locating peg.
18 Oil damper valve cup.
19 Oil damper valve cup slotted ring.
20 Main tube lock ring with cup.
21 Main spring.
22 Main spring locating bushes.
23 Spring cover tube.
24 Spring top cover tube securing plate.
25 Screws securing plate.
26 Crown lug complete with column.
27 Pinch stud for crown lug.
28 Nut for stud.
29 Dust cover.
30 Fork head race adjuster nut.
31 Top cover left hand.
32 Top cover right hand.
33 Main tube top cover ring.
34 Fork main tube filler and retaining plug.
35 Washer for plug.
36 Fork head clip.
37 Fork crown and column lock nut.

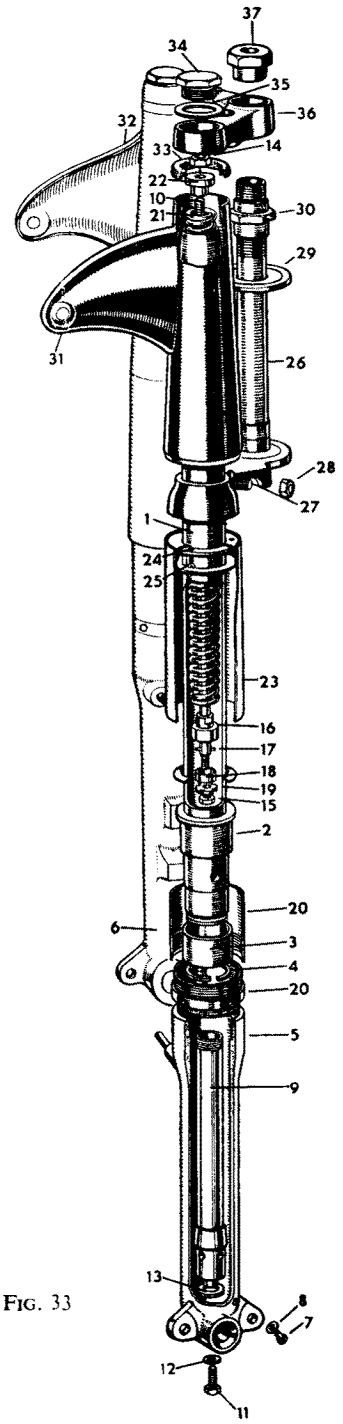


FIG. 33

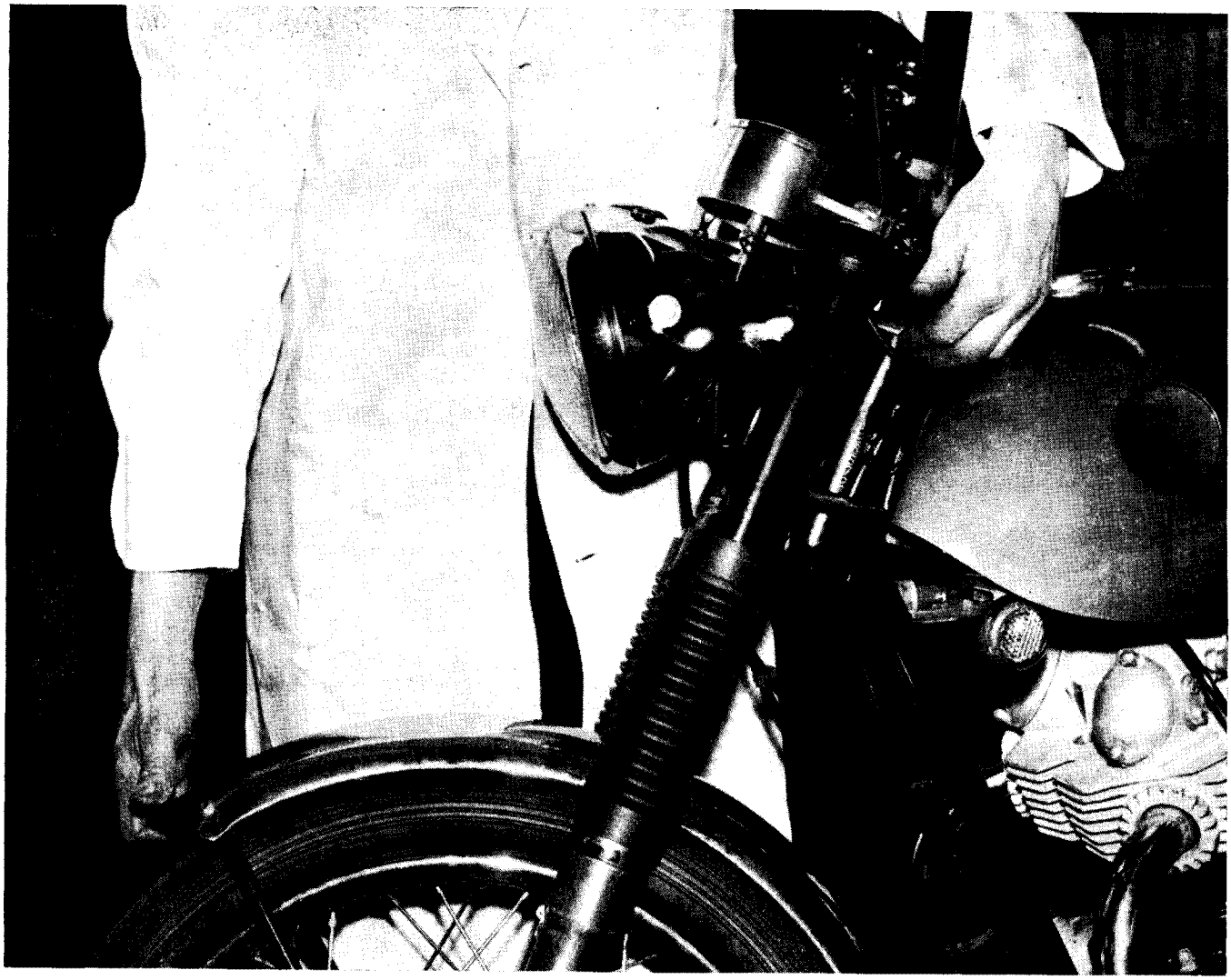


FIG. 34 *Checking Steering Head Bearings*

To remove one fork leg

1. Support the machine with a box under the engine, remove front wheel, detach the brake cable, take off the front fender with stays.
2. Release the fork tube clamp (28), take out the top fork bolt (34), lay aside the instrument secured by this bolt, detach the damper rod.
3. The inner fork tube has a taper on the end that engages with the handlebar lug, a sharp downwards jerk on the bottom slider should enable the fork tube to be extracted —if the fork tube does not come away—put back the top fork bolt only (34), screw in a few turns. A sharp blow with a soft-faced mallet will separate the fork tube from the top lug. The fork tube with slider and spring can be taken away from the front forks.

Dismantling fork inner tube

1. Remove the damper tube fixing bolt (11), unscrew the bottom screwed extension—take off the fork slider.
2. Take out the damper tube with spring, remove nut on top end of spring (14), unscrew the damper tube cap (16)—use a tommy bar inserted through the holes in the damper tube.
3. Remove the oil seal, sealing washer with flanged bush from the top taper end of the fork inner tube, if the oil seal is to be used again.
4. Remove the circlip (4), take off the fork tube steel bush.

Assembling the fork tube

Remove any trace of rust on the fork tube with abrasive tape. The portion of the fork tube (where the oil seal operates) must have a mirror-like finish—any roughness or blemish on the tube will damage the oil seal and make it ineffective. Put back the dismantled parts in the reverse order described for dismantling.

Removing forks as a unit

1. Remove the handlebars, the drive cables for tachometer and speedometer, the lamp wires for these instruments.
2. Remove the two fork tube top bolts (34), the tachometer and speedometer, support the front wheel with a box to expose the springs—disconnect both damper tubes.
3. Remove the fork crown column nut (37) with a soft-faced mallet. Give the underside of the handlebar lug (36) a few sharp blows to part it from the fork inner tubes.

4. Take off the headlamp—leave it suspended by the wiring loom, remove the front wheel. The forks can then be withdrawn through the frame. Watch for the 36 $\frac{1}{4}$" dia. ball bearings.

Removing steering head bearings

The bearing cups are a press fit in the frame lug. Use a short length of steel tubing through the head lug to drive out the cups—moving the steel tubing to alternate edges of the cup so that it will come out parallel with its housing.

Use a taper wedge or old screwdriver to remove the cone bearing on the fork column.

Reassembling the front forks

If the forks have been completely dismantled, the following precautions should be observed during assembly.

1. The fork inner tube must be clean and smooth, with clean oil applied before assembly.
2. The flanged bush should be a close free sliding fit—replace the bush if there is undue clearance between the bush and the fork inner tube.
3. The flanged bush, the paper washer and oil seal are passed over the fork inner tube from the top taper end.

Note: The oil seal is fitted with a spiral spring inside the seal towards the paper washer for the flanged bush.

4. The fork tube clamping nuts (28) must be firmly tightened.
5. Use some stiff grease on the cone bearing for the fork column—to retain the 18 $\frac{1}{4}$" diameter steel ball bearings. Use similar grease in the top bearing cup in the frame to retain the 18 $\frac{1}{4}$" diameter ball bearings during the process of refitting the front forks. Ensure the correct number of steel balls are used in both ball races.

Rear suspension units

These are sealed units. The damping fluid—filled during assembly—is sufficient for the serviceable life of the unit.

Each unit is adjustable to three positions by means of the 'C' spanner supplied in the rider's toolkit.

The soft, or normal position is when the segment, welded to the unit body is in contact with the topmost position of the cam face, viz. rotated to the limit in an anti-clockwise position—viewed from above the unit. Rotation, by use of the 'C' spanner in a clockwise direction pre-loads the spring into a stronger position. *Both* units must have identical adjustment.

A grating noise, audible when the units are moving can be rectified by:—

1. Remove the units—one at a time.
2. Compress the unit spring—take out the top split collar.
3. Remove the unit dust cover, apply some anti-centrifuge grease on the outside diameter of the spring, then reassemble.

Steering lock

The key-operated lock, which is a thief-proof device, is pressed into the front fork handlebar lug.

To remove, it can be driven out from the underneath portion of the lock.

A number is stamped on the lock base for identification.

The Frame (Registered design)

Removing the oil tank

The oil tank is located by a plain stud passing through a rubber grommet at the bottom of the oil tank. To remove the oil tank:—

1. Drain off the oil content—remove the two oil pipes connecting the oil tank to the engine.
2. Remove the rubber hose from the crankcase release valve where it joins the top left of the oil tank, remove the rubber hose for the oil tank vent pipe connected to the air filter on the top right of the tank.
3. Take out the two rubber-bonded studs securing the tank to the frame located at each side of the tank at the top. Move the tank outwards and up—to clear the lower locating stud.

Removing the air filter

To clean, or replace the air filter element:—

1. Remove cover for battery compartment by using a coin in the Rotolok catch, at the bottom of the cover.
2. Slide the cover in the direction of the front wheel to remove.
3. Take off the Zener diode from its mounting by releasing the Rotolok catch.
4. Remove two bolts clamping the air filter front and back plate—the filter element can be withdrawn downwards for removal.

Removing the rear mudguard

1. Take out the rear wheel.
2. Remove the self-locking nut securing the rear mudguard to the frame cross member.
3. Remove the bolt fixing the mudguard or the rear fairing bracket.
4. Remove bolt fixing mudguard to rear number plate, disconnect the two rear lamp cables from the connector.

Removing the rear fairing

The rear fairing is attached to the frame by the two top rear suspension bolts together with a bracket under the fairing connected to the rear frame loop.

1. Remove the two top bolts for the rear suspension units (the knurled discs are captive).
2. Remove the bolt for the rear loop clip bracket.
3. Disconnect the two rear lamp cables.

To remove the battery carrier

To take off the battery carrier, the following parts are dismantled, the methods for removing these sub units are described in the frame section of this manual.

1. Rear wheel.
2. Rear mudguard bottom fixing bolt.
3. Electric horn (disconnect two cables.)
4. Oil tank.

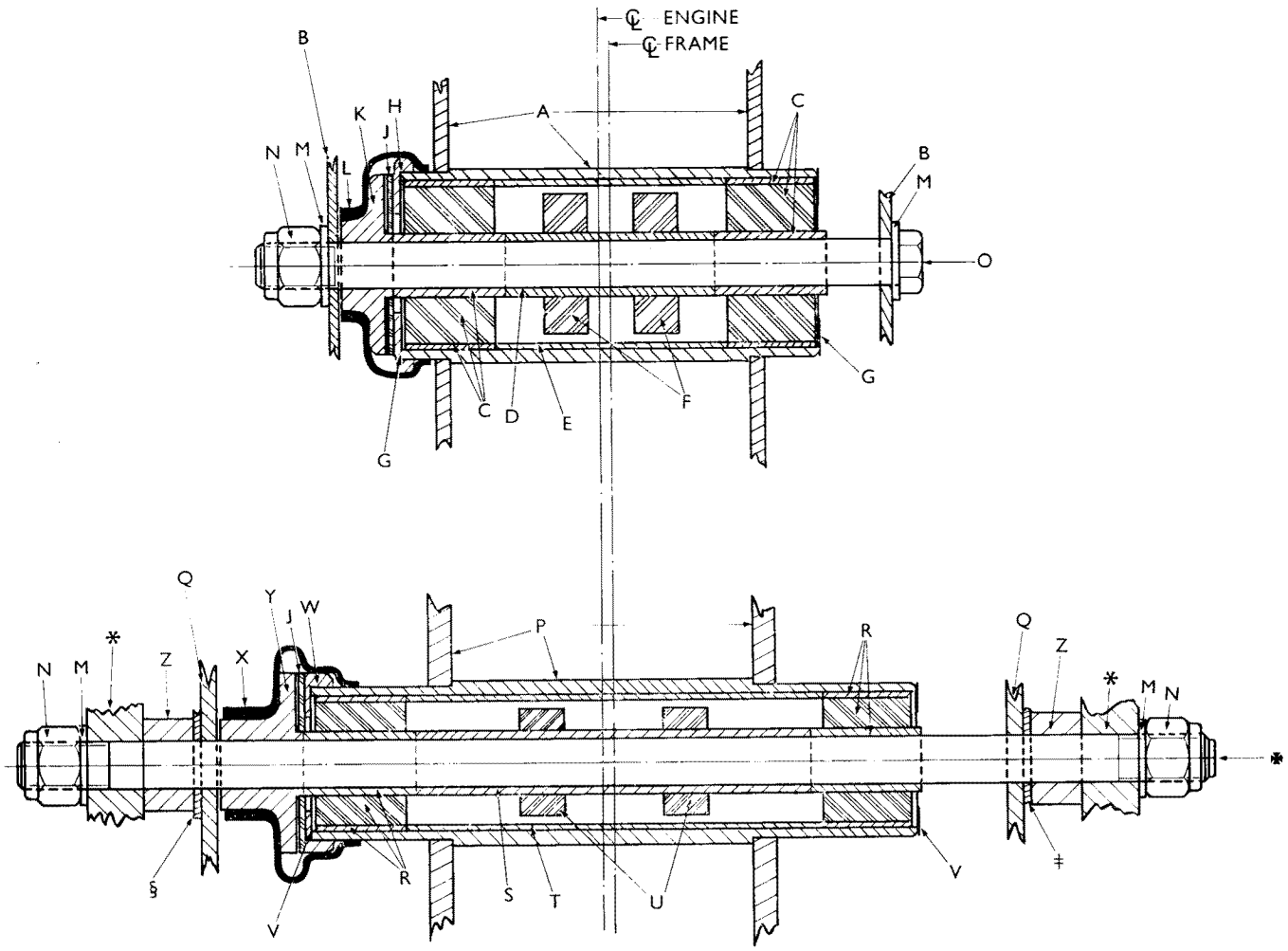


FIG. 35

A	06-0418	Front engine mounting assembled	1 off
B	06-0415	Frame front engine mounting plate	2 off
C	06-0421	Front engine mounting bush	2 off
D	06-0427	Metalastik spacer tube (front)	1 off
E	06-0771	Front engine mounting bearing spacer	1 off
F	06-0428	Front engine mounting rubber spacer	2 off
G	06-0686-9	Front engine mounting shim	as required
H	06-0684	Front engine mounting tube cap	1 each end—2 off
J	06-0578	Mounting plate shim (polyurethane)	1 each end—4 off
K	06-0422	Front mounting spacer (engine plates)	1 each end—2 off
L	06-0773	Front engine mounting gaiter	1 each end—2 off
M	000008	Washer	1 each end—4 off
N	06-0438	Nut	3 off
O	06-0423	Front engine mounting bolt	1 off
P	06-0424	Rear engine mounting assembled	1 off
Q	06-0414	Rear engine mounting plate (frame)	2 off
R	06-0432	Rear engine mounting bush	2 off
S	06-0434	Metalastik spacer tube (rear)	1 off
T	06-0772	Rear engine mounting bearing spacer	1 off
U	06-0435	Rear engine mounting rubber spacer	2 off
V	06-0775-8	Rear engine mounting shim	as required
W	06-0685	Rear engine mounting tube cap	1 each end—2 off
X	06-0774	Rear engine mounting gaiter	1 each end—2 off
Y	06-0436	Rear mounting spacer (engine plates)	1 each end—2 off
Z	06-0472	Spacer	1 each end—2 off
*	06-0468	Footrest support plate	2 off
✠	06-0437	Rear engine mounting stud	1 off
‡	06-0831	Front support bracket R.H.	1 off
§	06-0832	Front support bracket L.H.	1 off

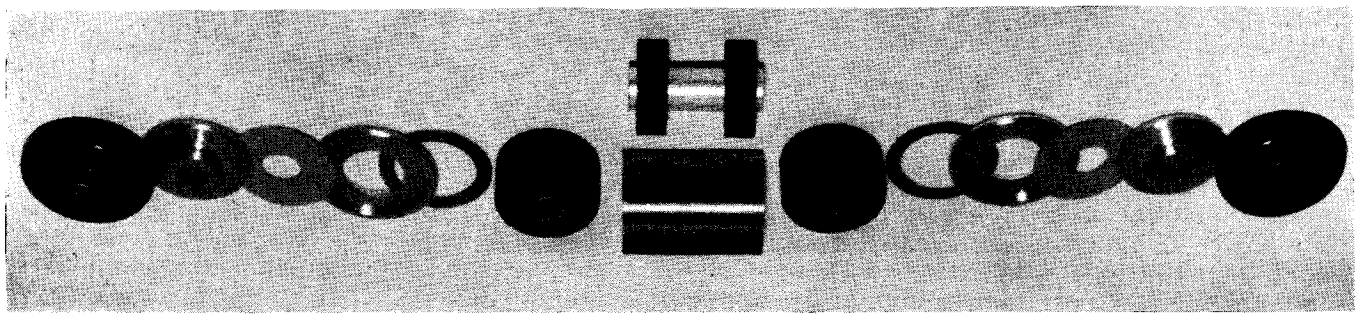


FIG. 36 *Front Engine Mounting Assembly*

5. The battery.
6. Air filter back plate (see footnote).
7. Condenser pack cables and earth wire.
8. Chain oiler cartridge clip and harness clip.
9. Zener diode (Rotolok).
10. Two wires for ignition switch.

The battery carrier platform is slotted at the front end. Take out the two rear bolts in the footrest plate—slacken the two front nuts—the battery carrier can be lifted at the rear end to remove.

Note: The tab washers on the air filter back plate must be turned back to prevent the bolts becoming detached.

Removing the side stand

The hinge pin is a press fit in the stand lug, located by a circlip at each end. Remove circlip, detach the stand spring—drift out the hinge pin to remove stand leg. Take out two bolts to remove stand bracket.

Removing the central stand

1. Disconnect the central stand return spring from the right side stand stop plate.
2. Take out the two central stand hinge bolts and nuts—the stand can be removed.

The front engine mounting

With the engine mounting bolt torqued to 25 ft. lbs. the total side play should be .020-.025". If the normal side play is reduced, the mounting bush will not function.

Checking front engine mounting side play

If the combined side play measured on each side of the unit exceeds .025", the shim washers should be exchanged.

If the engine plate portion of the assembly is moved and then released, the assembly should react by the elasticity of the engine mounting bush. If this reaction does not occur, the shim washers fitted are too thick and must be re-shimmed to give a total of .020-.025" clearance. This is a vital adjustment, which must be effected accurately.

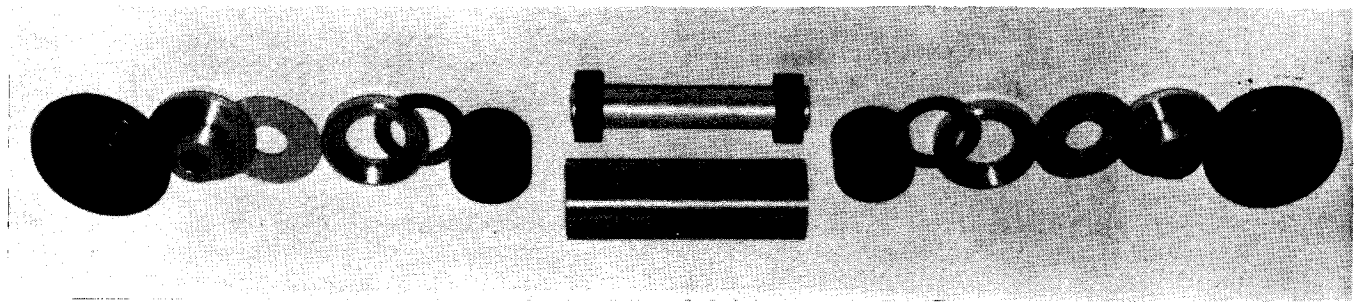
Checking rear engine mounting side play

The amount of side play, .010-.015", for this mounting can also be checked with the unit assembled in the frame. The check should be made on the right side of the mounting by using the same method as described for checking the front mounting.

Fitting new shims for rear engine mounting

1. Take off the right side nut to the bolt passing through the engine mounting assembly.
2. Drive out the bolt sufficiently far enough to enable the spacer (K) and the cap (H) to be removed for access to the shim washer.

FIG. 37 *Rear Engine Mounting Assembly*



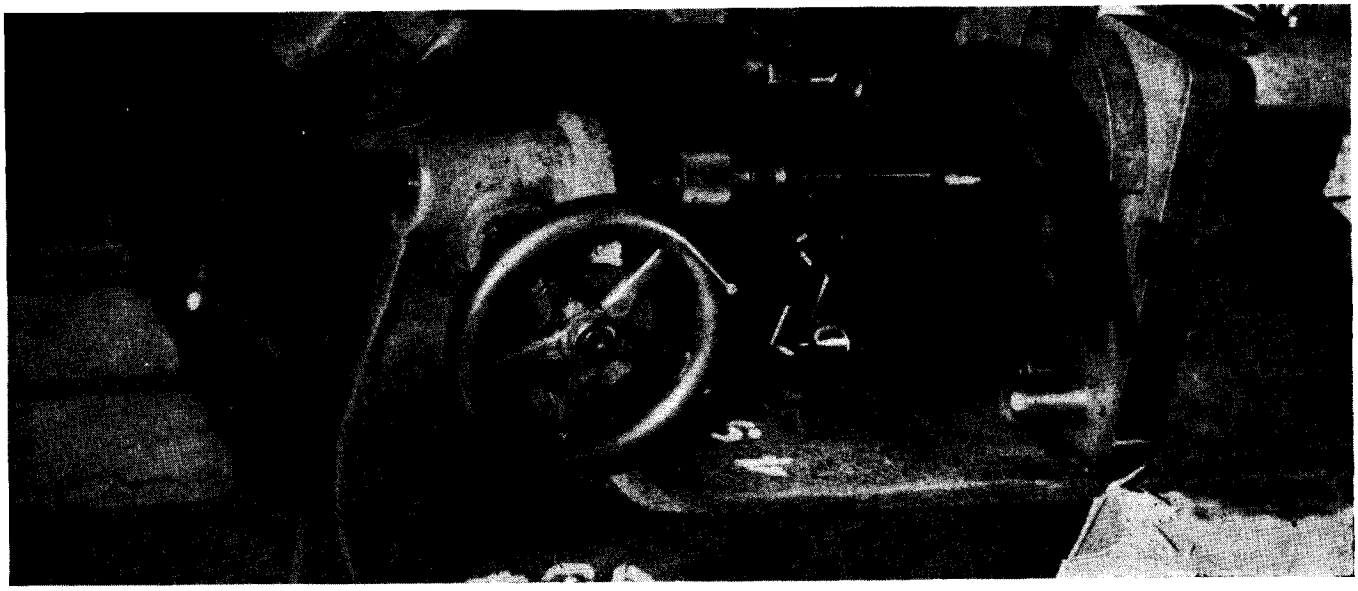


FIG. 38

3. Take out the existing shim washer—replace it with the shim washer selected.
4. Assemble the parts removed, drive back the mounting bolt—torque to 25 ft. lbs.—then recheck the side play—readjust if required.

Removing rear engine mounting (see also paragraph "Swinging Arm").

To service the rear engine mounting or to replace the mounting bushes the following dismantling is necessary:—

1. Remove engine (see chapter "Engine overhaul").
2. The oil tank.
3. The hinge spindle for the swinging arm.
4. The gearbox (see chapter "The gearbox").

Removing the engine mounting bush

To remove the engine mounting bush (C), and the two rubber spacers (F), an arbour press is used with a suitable mandrel inserted through the assembly. The method used is shown in Figure 38. With the engine mounting suitably located, the mandrel under pressure will press out the bushes and spacers as shown in the general arrangement drawing (Figure 35).

The swinging arm

The swinging arm pivots on two flanged bushes in both ends of the swinging arm supported by the swinging arm spindle, which passes through the rear engine mounting plate. To remove the spindle:—

1. Take out the screwed rod securing the two end plates for the swinging arm bushes.
2. Remove the lock bolt—central in the rear engine mounting—which secures the swinging arm spindle, which is threaded on the right side. Use a ½" UNF bolt to extract spindle, which must be removed to take off mounting.

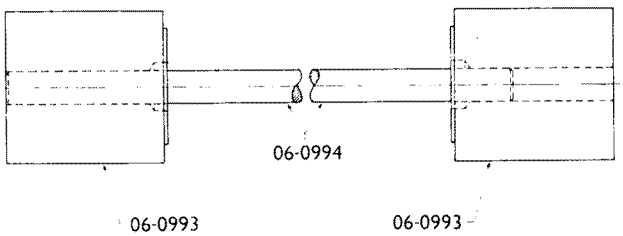


FIG. 39 *Assembling Tool complete (front engine mounting bushes)*

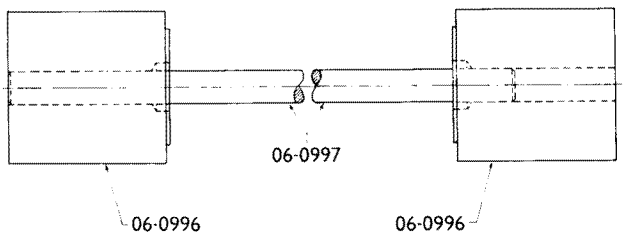


FIG. 40 *Assembling Tool complete (rear engine mounting bushes)*

To remove the swinging arm

With the pivot spindle removed take off:—

1. Rear wheel—disconnect the rear chain.
2. Rear brake.
3. Rear chain guard and chain oiler tube clip.
4. Two rear suspension unit bottom bolts. The swinging arm can be taken away from the frame.

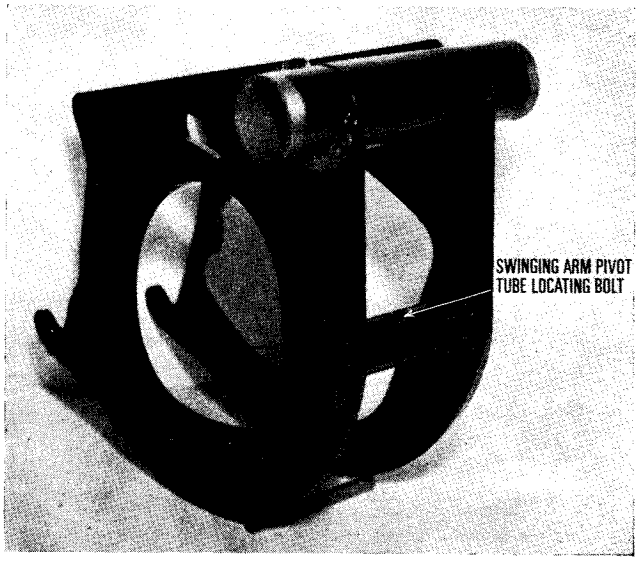


FIG. 41 *Rear Engine Mounting Plate*

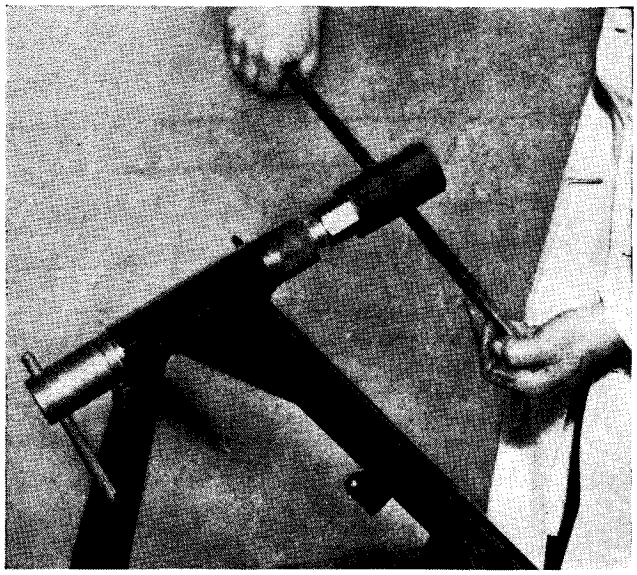


FIG. 42 *Fitting Frame Races*

The swinging arm bushes

The two flanged bushes, use an 'O' ring in the dust plate, also in the recess for the bush in its housing, as an oil seal. The bushes are a press fit; to remove, take out the two 'O' rings, support the end of the swinging arm—use an arbour press to remove both bushes.

Fitting the bushes

Place the dust plate over the bush with the recess for the 'O' ring facing inwards. Press in the bush.

Fit the large 'O' ring in the dust plate with the small 'O' ring in the bush recess for the swinging arm. New bushes do not require reaming after fitting.

Fitting the frame races

A draw bolt used to press home the top and bottom frame race is shown in Figure 42. All traces of enamel or foreign matter must be removed to enable both races to be positioned correctly in the frame housing.

Wheels and Brakes

Front wheel removal

With the machine on the central stand:—

1. Take out the split clip with clevis pin—unscrew the brake cable adjuster—remove the cable.
2. Take off the wheel spindle nut on the right side of the machine—release the left side fork slider pinch bolt.
3. Support the wheel with one hand—use a tommy bar through the hole drilled in the wheel spindle—pull out the spindle.

Refitting front wheel

1. Remove rust formed on the spindle—apply a little grease.
2. Put the wheel back in the fork with care to locate the brake plate in the brake torque stop.
3. Fit the wheel spindle (see the dust cover is in position), tighten the spindle nut. Tighten the slider pinch bolt.
4. Refit the brake operating cable.

Note: If the fork motion is stiff, after refitting the wheel, release the right side spindle nut up and down sharply to relieve side stress on the fork members, then retighten the spindle nut.

Removing rear wheel

The rear wheel is detachable from the brake drum and sprocket, secured by three extended nuts. With the rear wheel clear of the ground:—

1. Remove three rubber grommets (4) from the right side hub disc. Take off the three extended nuts (8).
2. Unscrew the wheel spindle (20), withdraw spindle through the hub.
3. Take away the distance piece (19); the speedometer drive (39) can be left attached to the drive cable.
4. Pull the wheel clear of the three driving studs (6) to remove.

Removing the rear brake drum

1. Disconnect the rear brake operating cable.
2. Remove the connecting links from the rear chain.
3. Remove nut for dummy spindle (22) with washer (21); take out the brake drum with brake plate assembled, from the fork ends.

Refitting rear wheel

Put back the rear wheel in the reverse order described for removal with the following precautions:—

(A) Before tightening the rear wheel spindle (20) ensure the two driving dogs in the speedometer drive (39) are properly engaged in the two slots in the hub bearing lock ring (14).

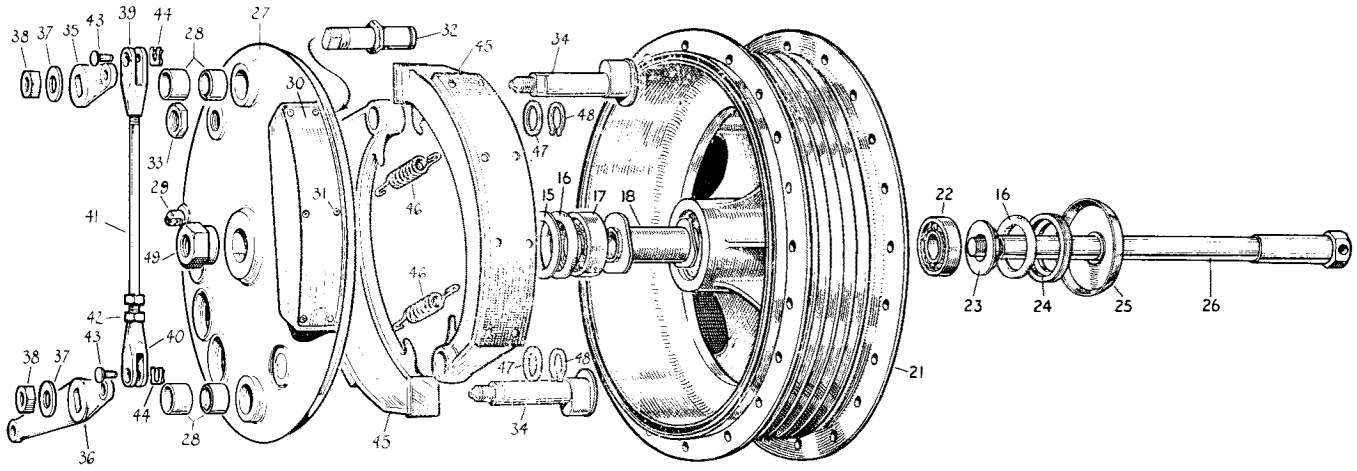


FIG. 43 *Front Hub*

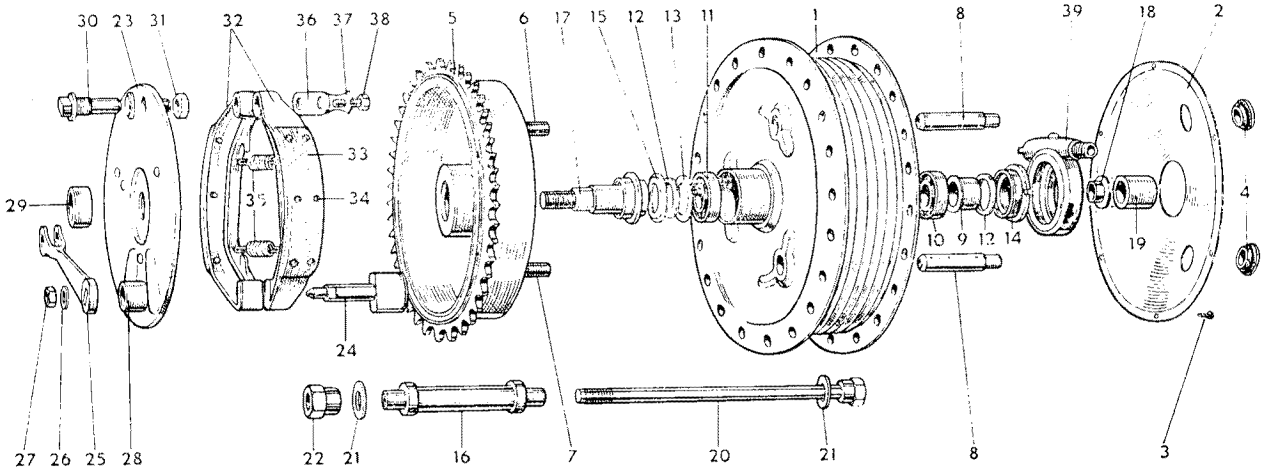


FIG. 44 *Rear Hub*

(B) Position the speedometer drive cable before finally tightening the wheel spindle.

Dismantling rear wheel hub

The wheel hub bearings are packed with grease during initial assembly. When the bearings are removed they should be cleaned and fresh grease applied (see table of lubricants). Further attention should not be required until 10,000 miles has been covered. With wheel removed to dismantle:—

1. Unscrew the hub bearing lock ring (14) LEFT HAND THREAD. Take out felt washer (12) distance piece (9).
2. Take up the rear wheel spindle (20), fit to it the washer (21) also the spacer (19).
3. Insert the wheel spindle with the washer and spacer on it, through the rear hub. A few sharp blows with a soft-faced mallet on the end of the spindle will move the bearing until it abuts against the reduced diameter in the hub.
4. Use a short length of steel tube with an outside diameter slightly smaller than the internal diameter of the bearing. Drift out the bearing (10).
5. Invert the wheel, then drift out the double row bearing, which will take with it the steel cup for the felt washer (15), the felt washer (12) and thin steel washer (13). Clean and grease the bearings.

Assembling the rear wheel hub

First, fit the single row bearing (10), then assemble parts removed in the reverse order described to dismantle. When assembled, "peen" the steel cup (15) against the hub with a suitable punch.

Dismantling front wheel hub

With the front wheel removed:—

1. Unscrew the hub lock ring (24) right hand thread. Use a peg spanner or pin punch if a spanner is not available. Should the lock ring be difficult to remove, use gentle heat on the hub in the vicinity of the lock ring.
2. Remove felt washer (16) the spacer (23). Use the front wheel spindle as a drift by passing the spindle through the wheel hub from the brake side.
3. A few gentle blows on the end of the wheel spindle with

a soft-faced mallet will drive the double row bearing (18) into the hub and, at the same time, push out the single row bearing (22). Any further attempt to drive the double row bearing in the hub can damage the spacer tube between the two bearings.

4. Take out the wheel spindle, invert the wheel again, insert the wheel spindle through the hub, position the spindle central in the spacing tube—then drift out the double row bearing—ejecting the large steel washer, the felt washer and the thin steel washer.

Assembling front hub

Clean and repack bearings with fresh grease; use one of the recommended lubricants.

1. Press home the single row bearing into the left side of the hub followed by the distance washer (flat side against the bearing), then the felt washer and lock ring.
2. Fit the distance tube into the hub (small end first) until it abuts against the bearing, already fitted.
3. Fit the double row bearing—with care that the bearing starts square in the hub—use the wheel spindle to drive the bearing home, until it abuts against the distance tube.
4. Fit the thin steel washer (the smallest of the two), the felt washer and finally the large washer. Lightly "peen" the washer with a centre punch alongside the wheel hub.

Wheel balancing

Should it so happen that the wheels are out of balance—due to variation in the construction of the tyre and inner tube—this can have an adverse effect on road holding at high road speed particularly in the case of the front wheel. It is not possible to balance the wheel in its normal position by reason of friction caused by the oil seals for the hub bearings.

To accurately balance the wheel:—

1. Remove it from the frame.
2. Obtain a steel rod, together with two unlubricated ball bearings (to reduce friction).
3. Mount the wheel—with the rod through the hub supported by the two bearings, on a stand—two wooden boxes will do. A workshop stand for this service is shown in Figure 45.

If the wheel is correctly balanced, it should remain stationary in any position. If out of balance the heaviest part of the wheel—usually where the tyre valve is used—will slowly come to a standstill at the bottom of the circumference (6 o'clock).

Counter balance weights to attach to the wheel spokes are available. As an alternative, strips of lead sheet attached to the wheel spokes can be used. Secure the lead strips with adhesive tape, with a coating of jointing compound to seal.

Front brake adjustment

Adjustment, to compensate for cable stretch and brake lining wear, can be made by unscrewing the brake cable adjusters located at the handlebar end of the brake cable, also on the front brake plate.

The brake link rod is preset at the factory. The rod length should not be altered unless the brake shoes are serviced.

To reset the link rod

1. Release the lock nut on the link rod, take out the top clevis pin and retaining clip.

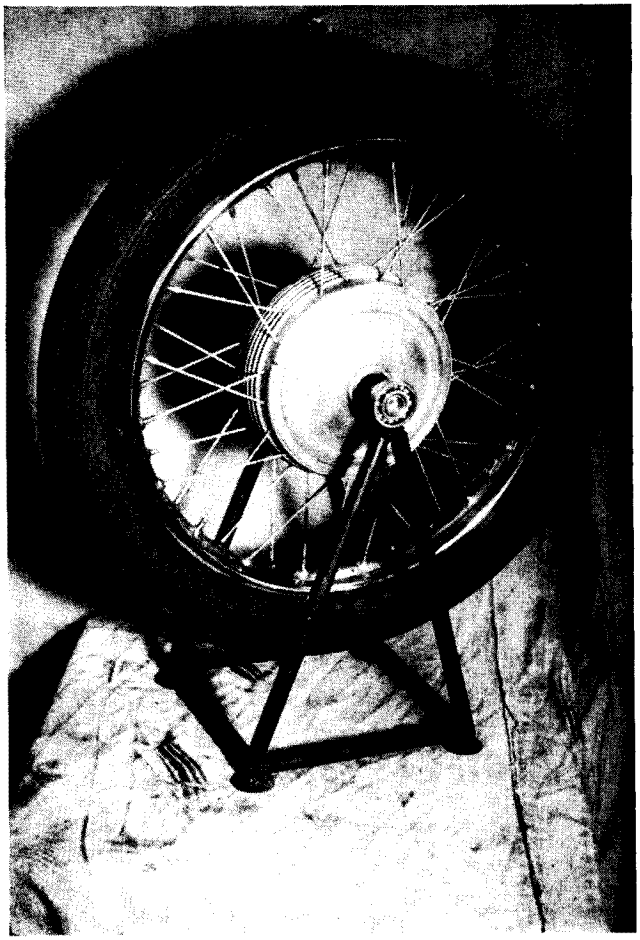
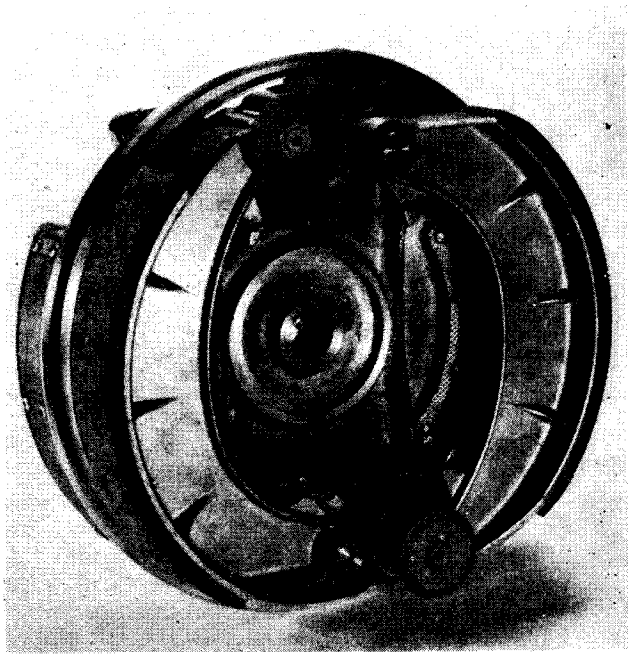


FIG. 45 *Balancing the Road Wheels*

FIG. 46 *Front Brake assembled*



2. With the assistance of a second person, apply pressure on both brake expander levers to press the brake shoes hard against the brake drum.
3. Whilst maintaining this pressure, adjust the brake rod length, so that the top clevis pin will enter the yoke end on the link rod. Fit the clip and tighten the lock nut on the link rod.
4. Manipulate the cable adjuster so that the wheel will spin freely, with a minimum of movement in the operating lever.

Centralising the brake shoes

1. Release the front wheel spindle nut.
2. Apply pressure on the front brake operating lever. Maintain the pressure, then tighten the spindle nut. Reset the cable adjuster if required.

Front brake air scoops

The air scoops on the front brake plate are intentionally sealed off by blanking plates. Where prevailing conditions permit, for additional cooling, the blanking plates fore and aft can be removed.

1. Remove eight screws retaining the blanking plates and wire mesh. Discard the blanking plates. Use suitable washer under screw heads to secure the wire mesh.

Rear brake adjustment

The rear brake is cable operated in conjunction with the Commando frame design. Under no circumstances must this operation be altered to rod operation. Adjustment is effected by the use of the brake cable adjuster nut at the brake expander lever end.

Centralising the brake shoes

Release the rear wheel spindle nuts on the brake side. Press on the brake operating pedal, maintain the pressure and retighten the wheel spindle nuts. This will ensure that both brake shoes make simultaneous contact with the brake drum, and permit a close adjustment with freedom from brake binding.

The front brake

After a very considerable mileage, continual adjustment will cause the brake expander cams to occupy a position whereby the available leverage is considerably reduced, with a loss of brake efficiency. It is at this stage the brake shoes, or brake shoe linings should be replaced to restore brake efficiency.

Removing the brake shoes

1. With the brake plate removed from the wheel, hold the brake plate in a smooth-jaw vice clamped on the slotted brake cable stop.
2. Remove the two circlips for the pivot pins.
3. Use a pair of pliers—or mole wrench—extend the brake shoe spring to clear its anchorage on the brake shoe.

Refitting the brake shoes

Check the two expanders for free movement, use a grease gun on the two nipples, wipe off surplus grease.

With the brake plate held in the vice:—

Refit the two brake shoes, the two circlips. Attach a shoe spring to the projection on the brake shoe, grip the free end of the spring with pliers or a mole wrench. Extend the spring sufficiently to engage the loop on the spring with its anchorage.

Dismantling the rear brake

To remove the brake shoes with the brake plate removed:—

1. Hold the brake plate in a smooth-jaw vice clamped on the torque lug, take off the nut and washer (26-27), remove the expander lever (25).
2. Use a screwdriver placed between the loop on the brake shoe spring and the hole in the brake shoe for the spring —a slight thump with the palm of the hand will dislodge the spring. Deal with the remaining brake shoe spring in a similar manner.
3. Straighten the tab washer (37) at both ends—remove the two fixing bolts (38), take off the tie plate (36), remove the brake shoes.
4. Remove the expander cam (24), remove traces of rust with abrasive tape so that the spindle for the cam works freely in the bush. Apply a smear of clean grease for assembly later.

Removing the cam expander bush

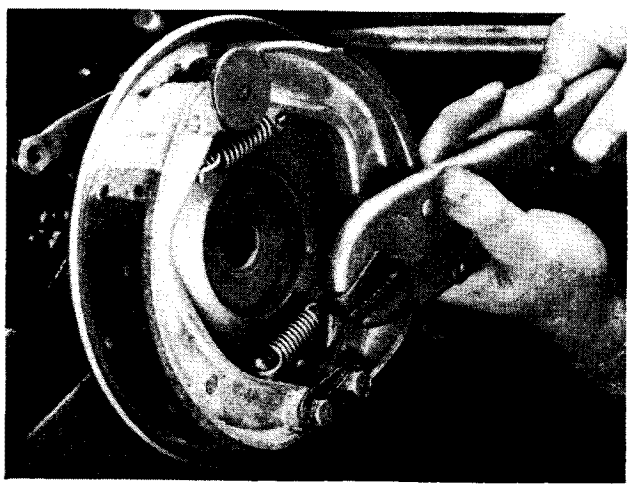
The bush for the expander cam spindle is detachable from the brake plate. To remove, take off the lock nut, unscrew the bush. The bush, Part No. E.5082, should be replaced if the movement between the expander spindle and the bush is excessive.

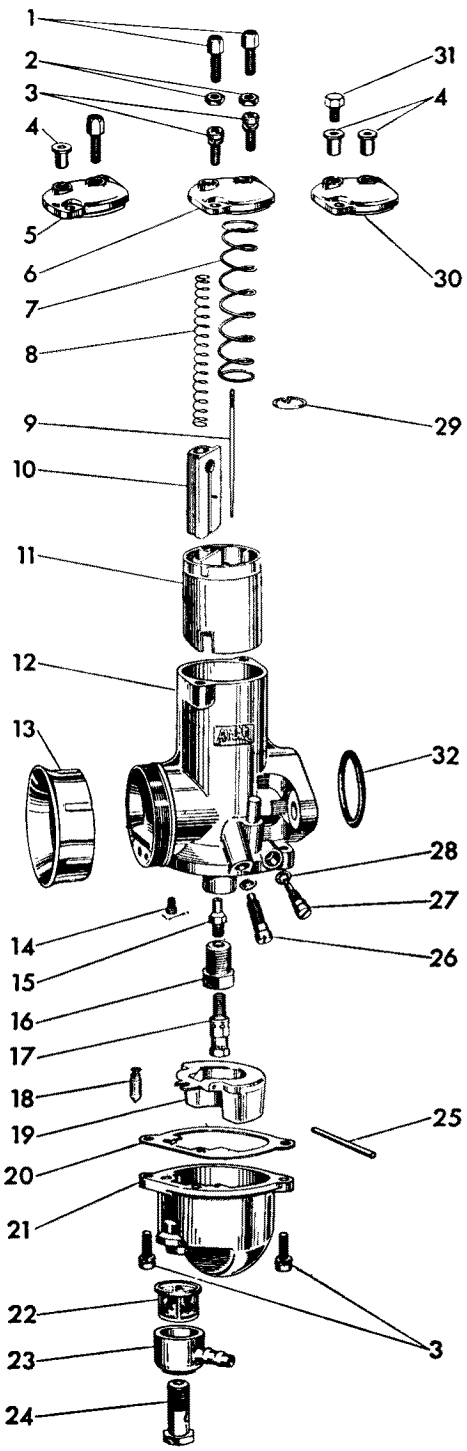
Assembling the rear brake

With the brake plate held in a vice as described previously:—

1. Put back both brake shoes, the tie plate, tab washers and bolts; turn up the ends of the tab washer.
2. To fit the brake shoe springs, anchor the end of the spring furthest away from the operator. Use a length of stout string in the free end of the spring—expand the spring with one hand—guide the spring into its anchorage with the free hand. A thin blade screwdriver can also be used for this purpose.
3. Finally fit the expander lever.

FIG. 47 *Fitting Brake Shoe Spring*





Amal concentric carburettor

1 Cable adjuster
2 Cable-adjuster locknut
3 Float-chamber and mixing-chamber-top securing screws
4 Cable ferrules
5 Mixing-chamber top for adjuster and ferrule
6 Mixing-chamber top (standard)
7 Throttle-valve spring
8 Air-valve spring
9 Throttle needle
10 Air valve
11 Throttle valve
12 Carburettor body and tickler assembly
13 Air-intake tube
14 Pilot jet
15 Needle jet
16 Jet holder
17 Main jet
18 Float needle
19 Float
20 Float-chamber washer
21 Float-chamber body
22 Filter
23 Banjo union
24 Banjo bolt
25 Float spindle
26 Throttle-stop adjusting screw
27 Pilot-air adjusting screw
28 'O' Rings
29 Needle clip
30 Mixing-chamber top for two ferrules
31 Plug for mixing-chamber top
32 'O' ring for flange sealing

Carburetters

Amal twin concentric type 930 carburetters are used for the Commando engine.

The carburetter settings given in the technical data have been determined to give maximum performance, with progressive acceleration, using the normal exhaust system and air filter.

The carburetter settings are satisfactory for machines operating at an approximate altitude of 3,000 feet above sea level. Increased altitude tends to produce a rich mixture—thus, as the altitude increases a smaller jet is required.

Machines permanently operating at altitudes between 3,000 to 6,000 feet above sea level reduces the main jet size to the extent of five per cent.

Dismantling the carburetter (see Figure 48).

1. Remove the two screws (3) securing the mixing chamber top cap, take out the throttle and air slide with needle attached.
2. Remove the needle clip (29) to release the needle. The slides can now be taken off the control cables. Use an air line to clear choked jets.
3. Remove the two screws (3) securing the float chamber body.

Assembling the carburetter

Use care to locate the float needle (18) in the forked extension for the float, also to correctly locate the gasket (20). When fitting the slides, make sure the throttle needle (9) enters the jet tube.

Warning

The throttle needles 622/124, the needle jets 622/122 and jet holder 622/128 are of a new type—first fitted to Commando models. The new type needle can be identified by two circular rings at the top end of the needle (the old type had three rings).

The new needle jet has the orifice at the bottom of the jet together with a small "bleed" hole. The new jet holder is longer than the early type.

If any of the above parts are replaced it is vital that correct replacements are used.

Synchronising the carburetters

When the two throttle control cables, from the junction box to the carburetters, vary in length—due to the outer casing contracting or the inner wires stretching—this results in an uneven movement of the throttle slides when the twist grip is operated.

To synchronise:—

1. Remove two bolts clamping air filter plate.
2. Remove air filter element downwards and out.
3. Unscrew as far as possible the two throttle stop adjusting screws (26).
4. Fully close the twist grip control.
5. Release the cable adjuster lock nuts (2), screw down the two cable adjusters (1).
6. Insert the index finger of one hand through one of the carburetter intakes and press on the throttle slide—to prevent the slide from moving.
7. Slowly unscrew the cable adjuster until all play has been taken up. Tighten the adjuster lock nut.
8. Deal with the second carburetter in a similar manner. Put back the air filter element.

Start the engine and adjust the throttle stop adjusting screw to get the correct idling speed. It may be necessary to manipulate the pilot air adjusting screw (27) to obtain positive idling. Each cylinder can be dealt with individually by taking off one of the spark plug leads and caps.

Air filter

The air filter element should be cleaned or renewed at periodic intervals, particularly when the machine is operating in a dust laden atmosphere.

Electrical Equipment

The capacitor

The 2 MC is an electrolytic POLARISED unit, which can be irreparably damaged if incorrectly connected. The capacitor *must* be positioned with the terminals pointing downwards.

Terminal identification

Looking at the terminal end of the unit, two Lucar terminals of different sizes will be observed. The small ($\frac{3}{16}$") terminal is the POSITIVE earth (ground) terminal; for identification the rivet for this terminal has a red spot. The double ($\frac{1}{4}$") Lucar terminal is the NEGATIVE connection.

Running with the battery removed

After disconnecting the two battery terminals—before running the engine—it is essential to insulate the NEGATIVE battery terminal with insulating tape to prevent a short circuit, should the terminal make contact with the frame.

Checking the capacitor

A defective capacitor will not be apparent with the battery in circuit. Periodically check the unit by disconnecting the battery to determine if the engine will start; also there is full lighting whilst the engine is running.

Motorcycle Alternator Model RM 21

(Positive Earth)

Description

The alternator produces an alternating current (a/c) by means of a six-pole permanent-magnet rotor which rotates within a stationary six-pole laminated-iron stator assembly.

The rotor is attached to the engine crankshaft, which revolves at engine speed. The stator sub-assembly, comprising the windings and laminations, is attached to the primary chaincase.

The full generated a/c output of the alternator is externally connected to a separate bridge-type full-wave rectifier which converts the alternating current to a direct current (d/c) for battery charging.

Maintenance

The alternator and associated equipment requires no maintenance except for an occasional check to ensure that all the external cable connections are clean and tight. The rectifier securing nut should make good electrical contact. If it should be necessary to remove the alternator rotor from the engine crankshaft, the use of magnetic keepers is not necessary, but keep the rotor away from magnetically-attracted metal foreign matter.

Testing the alternator charging system in situ

Note: The effectiveness of the charging system depends upon the battery being able to accept and hold a state of charge. A battery having an internal fault such as a shorted cell, or sulphated plates, can cause high or low confusing ammeter readings respectively. For this reason, before suspecting the charging system, first ensure that the battery is in fact satisfactory. If, because of a fault in the charging system, the battery is in a low state of charge, independently recharge the battery or alternatively fit a substitute battery before carrying out the following tests:—

ELIMINATING THE ZENER DIODE AND THE EMERGENCY-START CAPACITOR AS A CAUSE OF THE CHARGING SYSTEM FAILURE.

1. Leaving the cable connections to the rectifier undisturbed, connect the negative (black) connection of a moving coil d/c voltmeter of 0-20 volt range to the centre terminal of the rectifier, and connect the other voltmeter connection to a good earth point on the engine or frame. Providing the battery to rectifier circuit is in order the voltmeter will read battery voltage.
2. Start the engine and run it at approximately 3,000 rev./min. The voltmeter should register 14.4-16.4 volts.
3. If the voltmeter reading is as stated this confirms that the alternator, rectifier, emergency-start capacitor and the Zener diode are working satisfactorily and the fault is obviously confined to the circuit between the rectifier (voltmeter connection) and the battery, including the ammeter and battery earth connection. Check the cable connections in this portion of the circuit.
4. If, however, the voltmeter reading remains unchanged (at battery voltage) or rises to a voltage below or above the limits quoted, proceed to test in accordance with paragraph 5.
5. An incorrect voltage reading at the centre terminal of the rectifier could be due to one of the following causes:—

(A) A zero reading, or low reading:
Unsatisfactory alternator-rectifier output, faulty Zener diode, or emergency-start capacitor.

(B) A higher than normal reading:
Faulty Zener diode.

In the case of the preceding paragraph (A):—

Disconnect the Zener diode, and with the voltmeter connected between the centre terminal of the rectifier and earth, start the engine and slowly raise its speed. The voltmeter reading should quickly exceed the Zener diode regulated voltage of 14.4-16.4 volts. If so, the alternator and rectifier and the emergency-start capacitor are all satisfactory, and the Zener diode must be suspected of having a premature operating voltage. Prove the Zener diode by substitution.

If, however, a zero or low voltage is still registered (with the Zener diode disconnected) the cause could be unsatisfactory output from either the rectifier or the alternator or a faulty emergency-start capacitor.

Disconnect the emergency-start capacitor and retest.

If a rising voltage can now be obtained, the capacitor is faulty and must be replaced.

If a rising voltage still cannot be obtained, either the rectifier or alternator is unsatisfactory.

Checking the alternator voltage (a/c) output

Remove the two alternator cables (usually green/yellow and white/green) from the rectifier outer terminals (see Figure 51).

Connect between these two cable-ends, a 1 ohm load resistor and an a/c moving-coil voltmeter (the resistor and voltmeter being in parallel with each other).

With the engine running at 3,000 rev./min. the voltmeter should register 9.0 volts (min.).

If the alternator output voltage is satisfactory, and if the charging circuit between the centre terminal of the rectifier and the battery earth connection is also satisfactory, a failure in the charging system can only be due to the rectifier unit. Check the rectifier fixing point (earth) and if this is found to be satisfactory, the rectifier can be assumed to be faulty and must be proved by substitution.

If, however, the alternator output voltage is not satisfactory, with either a zero or low voltage voltmeter reading, the cause could be either a faulty rotor or stator winding assembly.

Rotor: This may have become partially de-magnetised, the loss of magnetic energy having been caused either by misuse, or a faulty rectifier. In either case the only practical way to test the rotor is by substitution. After fitting the replacement rotor, ensure that the rectifier is also satisfactory.

Stator-winding assembly: If the encapsulated windings develop an insulation fault, the stator assembly will have to be replaced.

A short circuit between any part of the stator windings and the stator lamination pack is confirmed if the bulb lights when a 110 volt a/c 15 watt test lamp circuit is connected between either of the stator cable terminal ends and the stator laminations.

It is not possible to easily carry out a winding open-circuit test and a suspect stator assembly must be tested by substitution.

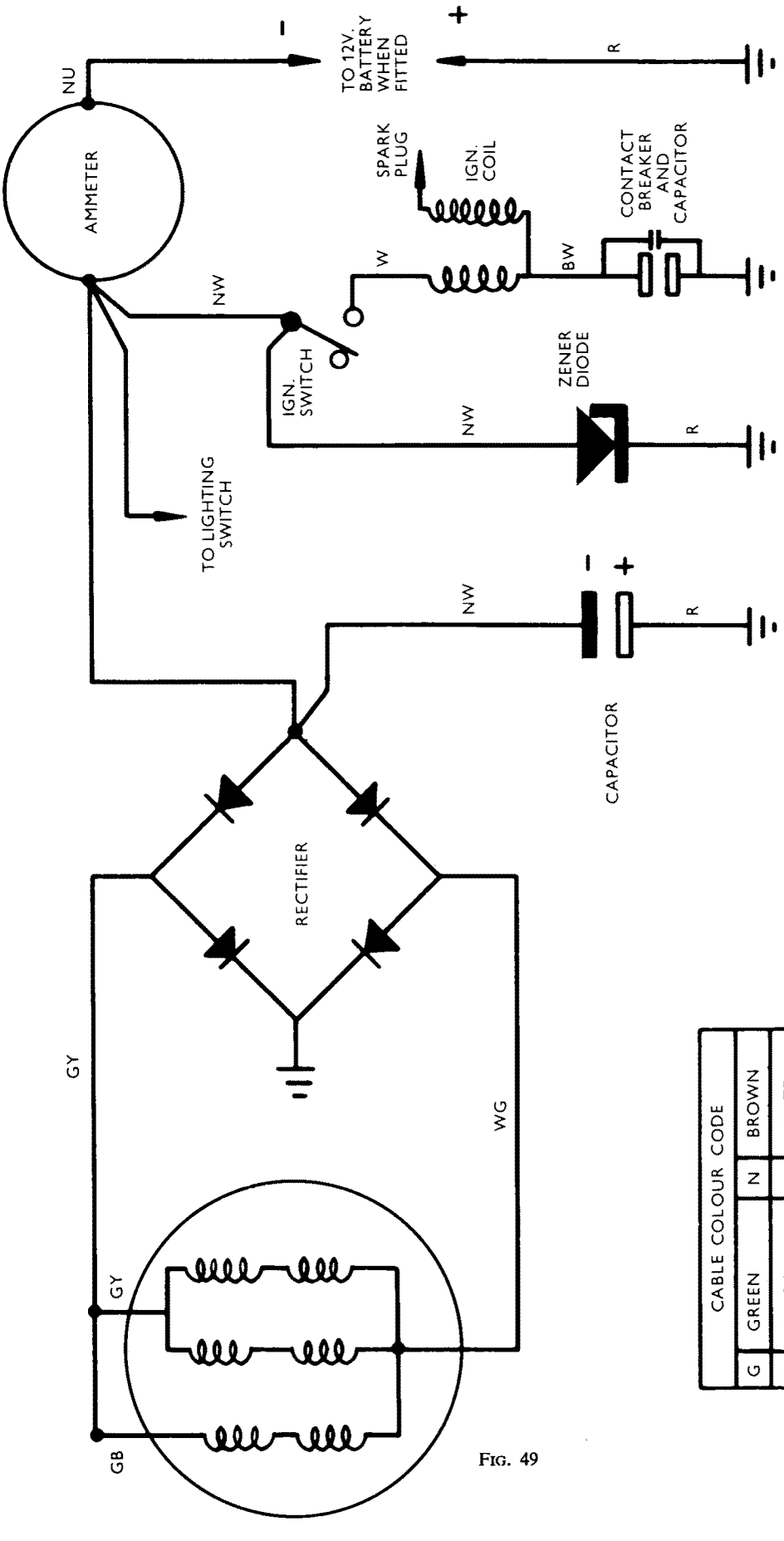

AMMETER
NU
TO 12V. BATTERY WHEN FITTED
SPARK PLUG
IGN. COIL
CONTACT BREAKER AND CAPACITOR
W
BW
NW
IGN. SWITCH
ZENER DIODE
TO LIGHTING SWITCH
CAPACITOR
RECTIFIER
GY
WG
GB
ALTERNATOR
CABLE COLOUR CODE
G GREEN
B BLACK
R RED
Y YELLOW
N BROWN
W WHITE
U BLUE

FIG. 49

Zener Diode Charge Control

(Serial No. 49345)

As the battery becomes recharged its terminal voltage rises, and when it reaches approximately 14 volts the Zener diode, which up to this point has opposed the passage of current, becomes partially conductive and thus provides an alternative path for a small part of the alternator output. Further small rises in battery voltage result in large increases in diode conductivity until, at approximately 15 volts (the on-charge voltage of a fully charged 12 volt battery), the bulk of the alternator output is by-passed and the system off-load voltage is stabilized.

If, now, an electrical load such as the headlamp is switched on, the system voltage will fall below 15 volts and less current will flow through the diode, the balance being diverted to feed the load. In the event of the load being heavy enough to depress the system voltage below 14 volts, the Zener diode will revert to its high-resistance state of virtual non-conductivity and all of the generated output from the alternator will go to meeting the current demands of the battery and equipment.

Test procedure

Disconnect the lead from the Zener diode and connect ammeter (in series) between the diode Lucar terminal and lead previously disconnected. The ammeter red or positive lead must connect to the diode terminal.

Connect d/c voltmeter across Zener diode and heat-sink. The red or positive lead must connect to the heat-sink which is earthed to the machine frame by its fixing bolts and a separate earth lead. The black lead connects to the Lucar terminal.

Ensure that all lights are "off", start the engine, and gradually increase engine speed, while at the same time observing both meters.

Note: It is essential that the batteries are in a good condition and in a reasonably good state of charge. If battery condition is uncertain, it should be temporarily replaced by a good battery for this test.

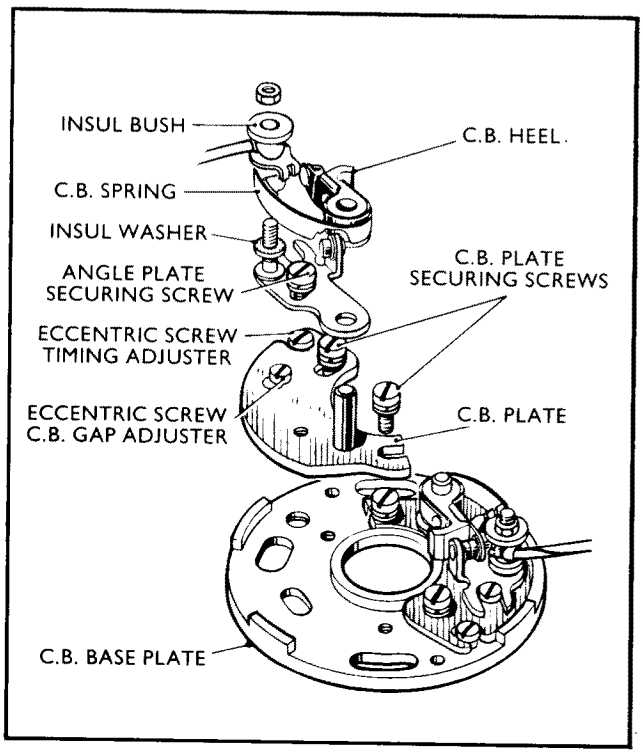
1. When the voltage across the Zener diode reaches 12.75 volts, the Zener current ammeter must indicate zero.
2. Increase engine speed until a Zener current of 2 amperes is indicated on the ammeter. At this value a satisfactory Zener diode should cause a reading on the voltmeter of between 14.4-16.4 volts.

Test conclusions

If the ammeter in test (1) registers any current at all before the voltmeter indicates that the voltage across the Zener is 12.75 volts, then a replacement Zener diode must be fitted.

If test (1) proves satisfactory, but in test (2) a higher voltage than that stated is registered on the voltmeter, before the ammeter registers 2 amperes, then a replacement Zener diode must be fitted. Torque the fixing nut to 28 in./lbs.

The Contact Breaker 6CA



Adjustment for the contact breaker is described in paragraph "Setting ignition timing". A breakdown of the contact breaker is shown in Figure 50. The condensor pack is remotely mounted in the battery carrier compartment.

Specification

Contact breaker gap	....	0.014″-0.016″ (0.35mm-0.4mm)
Contact breaker spring load (measured at contacts)	....	18 oz. F-24 oz. F.
Extractor thread	....	$\frac{5}{16}$″ UNF

Maintenance

1. After the first 500 miles (800 km) of a new contact breaker or new contact set:
   (A) Turn the engine until one of the contact breakers is open to maximum distance.
   (B) Insert a 0.015″ (0.38mm) flat feeler gauge between the contacts.
   (C) If the gap is correct the gauge will be a sliding fit. If adjustment is necessary, maintain the position giving maximum opening of the contacts and slacken the fixed contact (angle plate) locking screw. Rotate the fixed contact eccentric screw adjuster until the gauge can be inserted as a sliding fit. Tighten the locking screw and recheck the gap.

FIG. 50 *Part exploded view of model 6CA Contact Breaker*

(D) Repeat the above operation on the other contact breaker.

2. Every 6,000 miles (9,650 km):

(A) Examine the contact breaker. Contacts that are burnt, blackened or showing evidence of pitting and piling should be cleaned with a fine carborundum stone or emery cloth. Cleaning is best carried out with the contacts removed (see "Dismantling").

(B) After cleaning, remove grease and metal dust with a petrol-moistened cloth.

(C) Before reassembly, smear the contact breaker heel pivot post with Mobilgrease No. 1.

(D) Check and set the contact breaker gaps as described under 1 (C).

(E) Rotate the engine until one of the contact breaker's heel is in the middle portion of the cam that provides the open period of the contacts.

(F) Smear the cam either side of this heel with Shell Retinax A or equivalent grease.

(G) Rotate the engine and check that a small amount of grease is being carried by the leading edge of each contact breaker heel.

Dismantling

1. Unscrew and remove the nut securing the contact breaker spring to the anchor post.
2. Lift off the spring and heel together with the insul bush, capacitor lead and contact breaker lead terminations.
3. Unscrew and remove the fixed contact (angle plate) securing screw and lift off the fixed contact.

Reassembly

Contacts

It should be noted that the contact breaker lead termination and the capacitor lead termination should be positioned with both tags inside the curve of the spring. This is important as fouling of the contacts may occur if placed in any other position.

Automatic advance unit

The correct manner of assembly will be apparent on inspection. However, two points should be carefully noted.

1. Each spring has a tapered loop at one end. This end should be attached to the cam pin.
2. The cam has two weight location pins and the longest of these pins is designed to fit into the radiused range slot.

The rectifier

The full-wave rectifier with coloured connections is shown in Figure 51. Maintenance is confined to checking the central bolt for security.

The ignition coils

The two coils, in tandem, are secured to the frame by two bolts with double clips. During engine service, when the petrol tank is removed, check all the coil connections for security.

Stop lamp switch

The switch is attached to the rear brake pedal. The switch bracket is slotted for adjustment, when the brake pedal position is altered.

The rear lamp

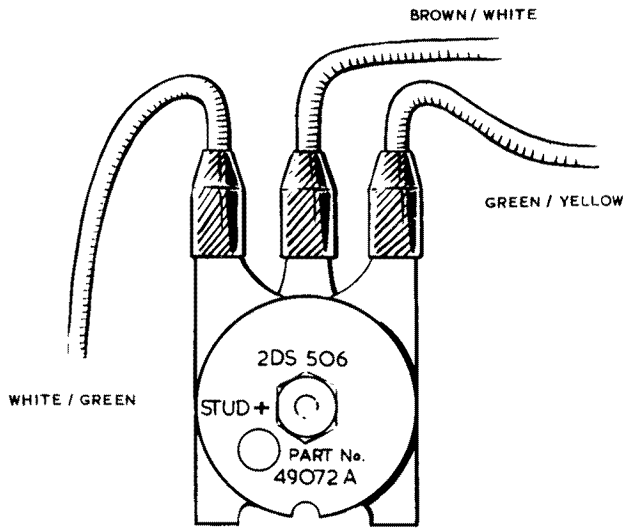
The lamp is secured by two bolts. To remove the lens for access to the stop lamp bulb, take out the two lens fixing screws.

The headlamp

To change the main bulb, release the screw on top of the lamp body, the light unit can then be removed. Press down the cap for the bulb compartment—turn anti-clockwise—the cap can be removed. The main bulb can now be removed.

FIG. 51

FULL-WAVE RECTIFIER



REC1920

JOSEPH LUCAS LTD., BIRMINGHAM, ENGLAND.

The Battery

Lucas lead-acid batteries Model PUZ5A (12 volt)

The battery has a moulded translucent case, through which the electrolyte level can be seen. A coloured line on the side of the battery indicates the correct level at which the electrolyte should be maintained.

While the battery is being charged, water is lost due to gassing and evaporation. This makes it necessary to frequently (preferably each week) check the level of electrolyte and, if necessary, replace the loss of distilled water. It is normal for the level of electrolyte to rise whilst the battery is being charged and for this reason, to avoid any tendency to over-filling of the battery, it is important to check the level of electrolyte and top-up the battery only during off-charge periods.

To take a hydrometer reading, tilt the battery to bring sufficient electrolyte above the separator guard. If the level of the electrolyte is so low that a hydrometer reading cannot be taken, no attempt should be made to take a reading after adding distilled water until the battery has been on charge for at least 30 minutes.

Measure the specific gravity of the acid in each cell in turn. The reading given by each cell should be approximately the same; if one cell differs appreciably from the others, an internal fault in that cell is indicated.

The appearance of the electrolyte drawn into the hydrometer when taking a reading gives a useful indication of the state of the plates: If it is very dirty, or contains small particles in suspension, it is possible that the plates are in a bad condition.

The battery must not be subjected to a heavy discharge test.

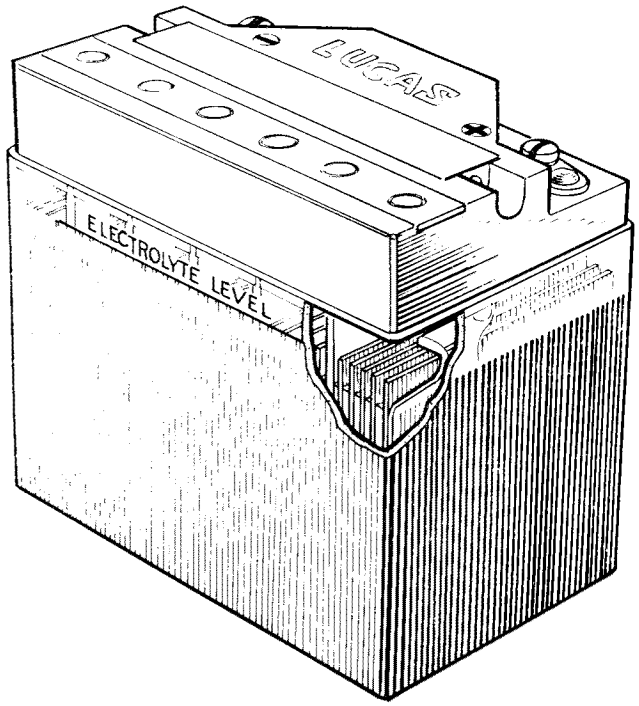
Maintenance: Occasionally wipe away all dirt and moisture from the top of the battery and ensure that the connections are kept clean and tight.

If the motorcycle is to be out of use for a considerable time, the battery should be removed and maintained in a good state of charge, by applying a short freshening charge approximately every two weeks.

The specific gravity of a fully charged battery is 1.270-1.290 at 60° for climates normally below 80° F. (27° C.) and 1.210-1.230 at 60° F. for climates above 80° F. (27° C.).

The recharge rate of a PUZ5A battery is 1.0 amp.

FIG. 52 *Battery model PUZ5A*



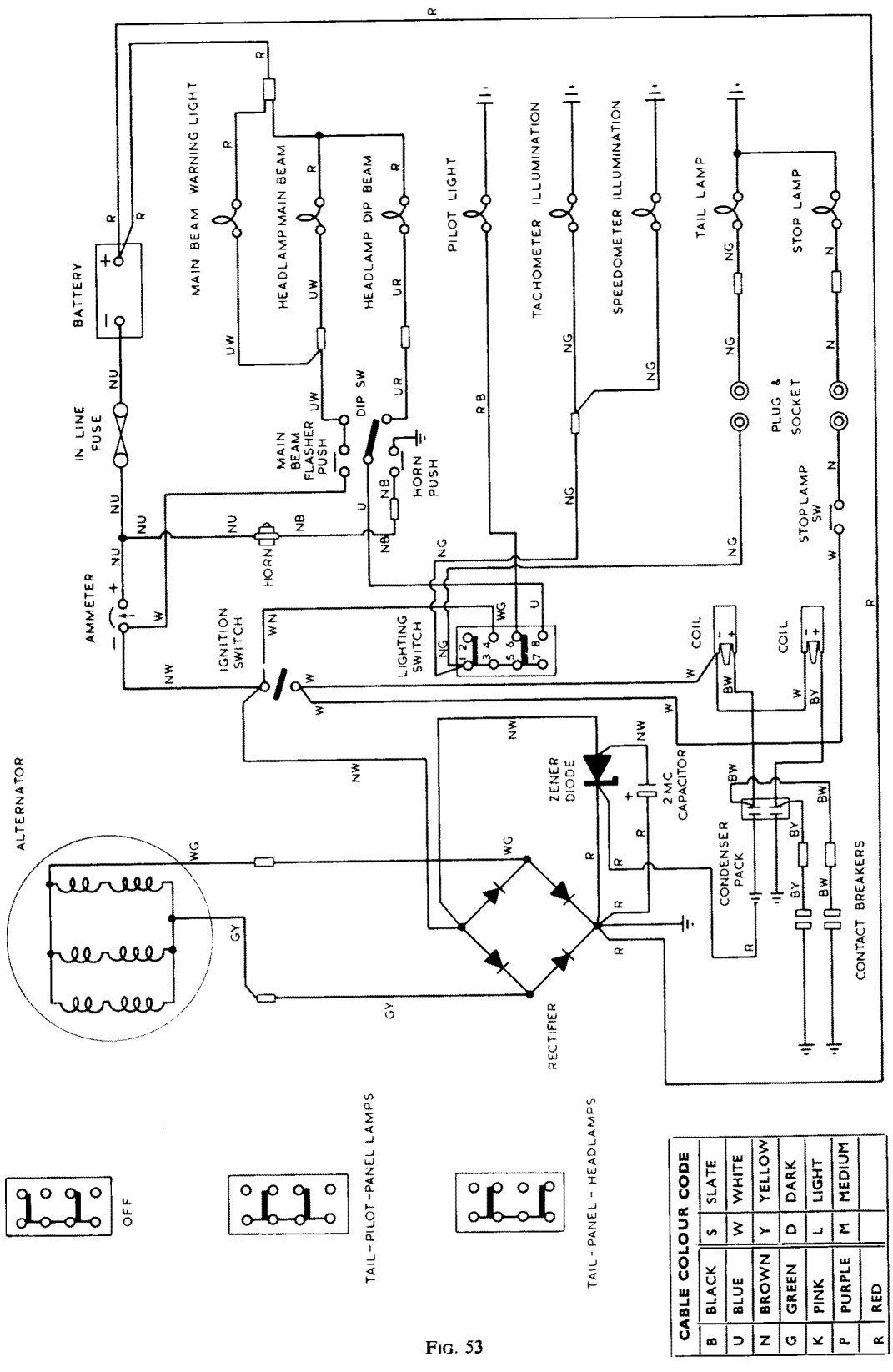

BATTERY
MAIN BEAM WARNING LIGHT
HEADLAMP MAIN BEAM
HEADLAMP DIP BEAM
PILOT LIGHT
TACHOMETER ILLUMINATION
SPEEDOMETER ILLUMINATION
TAIL LAMP
STOP LAMP
IN LINE FUSE
MAIN BEAM FLASHER PUSH
DIP SW.
HORN PUSH
PLUG & SOCKET
STOP LAMP SW
AMMETER
HORN
IGNITION SWITCH
LIGHTING SWITCH
COIL
COIL
ALTERNATOR
ZENER DIODE
2 MC CAPACITOR
CONDENSER PACK
CONTACT BREAKERS
RECTIFIER
OFF
TAIL - PILOT - PANEL LAMPS
TAIL - PANEL - HEADLAMPS
CABLE COLOUR CODE
B BLACK
U BLUE
N BROWN
G GREEN
K PINK
P PURPLE
R RED
S SLATE
W WHITE
Y YELLOW
D DARK
L LIGHT
M MEDIUM

FIG. 53

Models after Engine No. 131257

Engine Camshaft Chain

To examine, or adjust the camshaft chain, on engines where the contact breaker is actuated by the engine camshaft, the timing cover must be removed by:

Disconnect the rocker box oil feed pipe union nut from the timing cover.

Remove cap for contact breaker (two screws).

Remove contact breaker base plate (two hexagon bolts and washers) with the wires attached.

Remove auto advance unit central bolt.

Insert withdrawal bolt 06-0934, gently tighten this bolt to separate the unit from the camshaft. Take out timing cover screws (12). Note location—three different lengths are used—then remove the timing cover.

With the cover removed, oil will seep from the oil drilling adjacent to the oil pipe junction block. Use a timing cover screw to temporarily blank off seepage.

Adjust the camshaft chain as described in Paragraph 11, page 26.

Contact Breaker Oil Seal

An oil seal, Part No. 034053, is housed in the timing cover, which encircles the plain portion of the camshaft, to prevent oil entering the contact breaker compartment.

When refitting the timing cover, to prevent damage to the oil seal as it passes over the camshaft, a guide bush, Part No. 06-1359, must be used.

To use the guide bush, the threaded portion is screwed onto the camshaft as far as it will go. A little oil used on the outside diameter of the guide bush will facilitate assembly.

Removing the Oil Seal

Prise the seal out of its housing with a sharp pointed tool.

Fitting the Oil Seal

Warm the timing cover, press the seal into position, with the metal backing facing the contact breaker compartment.

Setting Ignition Timing

Before refitting the auto advance unit:

Remove cap on primary chain case to expose the indicator plate.

Position the engine on the drive side cylinder so that the mark on the rotor registers with 28° on the indicator plate.

Insert the auto advance unit with the rivets for the bob-weights in line with the two screw holes for the contact cover —the slot in the cam face should now be at approximately 9 o'clock.

Fit the contact breaker base plate—the yellow and black ead is for the drive side cylinder.

Finally check and adjust the timing as described on page 27.

Models after Engine No. 131257

Engine Camshaft Chain

To examine, or adjust the camshaft chain, on engines where the contact breaker is actuated by the engine camshaft, the timing cover must be removed by:

Disconnect the rocker box oil feed pipe union nut from the timing cover.

Remove cap for contact breaker (two screws).

Remove contact breaker base plate (two hexagon bolts and washers) with the wires attached.

Remove auto advance unit central bolt.

Insert withdrawal bolt 06-0934, gently tighten this bolt to separate the unit from the camshaft. Take out timing cover screws (12). Note location—three different lengths are used—then remove the timing cover.

With the cover removed, oil will seep from the oil drilling adjacent to the oil pipe junction block. Use a timing cover screw to temporarily blank off seepage.

Adjust the camshaft chain as described in Paragraph 11, page 26.

Contact Breaker Oil Seal

An oil seal, Part No. 034053, is housed in the timing cover, which encircles the plain portion of the camshaft, to prevent oil entering the contact breaker compartment.

When refitting the timing cover, to prevent damage to the oil seal as it passes over the camshaft, a guide bush, Part No. 06-1359, must be used.

To use the guide bush, the threaded portion is screwed onto the camshaft as far as it will go. A little oil used on the outside diameter of the guide bush will facilitate assembly.

Removing the Oil Seal

Prise the seal out of its housing with a sharp pointed tool.

Fitting the Oil Seal

Warm the timing cover, press the seal into position, with the metal backing facing the contact breaker compartment.

Setting Ignition Timing

Before refitting the auto advance unit:

Remove cap on primary chain case to expose the indicator plate.

Position the engine on the drive side cylinder so that the mark on the rotor registers with 28° on the indicator plate.

Insert the auto advance unit with the rivets for the bob-weights in line with the two screw holes for the contact cover —the slot in the cam face should now be at approximately 9 o'clock.

Fit the contact breaker base plate—the yellow and black ead is for the drive side cylinder.

Finally check and adjust the timing as described on page 27.