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MATCHLESS MOTOR CYCLES

A PRACTICAL GUIDE COVERING ALL MODELS FROM 1938

[illegible]

By

F. W. NEILL

[illegible]

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PREFACE

This book has been compiled from the makers' technical records, with the object of providing in a concise form information which will enable owners of Matchless motor cycles and of proprietary machines fitted with Matchless engines to service and maintain them in good order.

Periodical attention to the parts will ensure that reliability which the rider expects; failure to provide this attention will nullify the efforts of the designer to produce a fast and reliable machine.

Machines made from 1933 are covered, including engines fitted to the Coventry Eagle, O.E.C., O.K. Supreme and Morgan Three-Wheeler. Competition Models and Teledraulic forks are dealt with. Wiring diagrams are given for most types of electrical equipment fitted.

In conclusion, the Author would thank the Associated Motor Cycles, Ltd., Messrs. Joseph Lucas, Ltd., H. Miller & Co., and H. Burman & Sons, and the Editors of *The Motor Cycle Trader* and *Motor Cycling* for their co-operation and permission to reproduce their illustrations in this book.

The publishers wish to thank the Associated Motor Cycles, Ltd., for permission to use the "Matchless" trade mark in the cover design.

F. W. Neill.

NOTE ON THE SECOND EDITION

The opportunity has been taken to include necessary servicing information on Matchless models up to and including 1949.

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CONTENTS

CHAPTER I

1933 MODELS

MATCHLESS motor cycles made from 1933 form the subject of the following chapters. Owing to the considerable number of different models produced during this period, it is impossible to give full details of every model. Instructions are, therefore, given for the most popular machines, and for those of unorthodox design, such as the "Silver Hawk" and "Silver Arrow".

A table showing the models made in 1933 is given below. The "Silver Arrow" and "Silver Hawk" are dealt with in Chapter II.

1933 MODELS

Model.	Bore, mm.	Stroke, mm.	Cubic Capacity, c.c.	Engine.
33/D7	62·5	80	246	Side-valve.
33/D2	62·5	80	246	O.H.V.
33/D3	69	93	347	O.H.V.
33/D6	69	93	347	O.H.V.
33/D5	82·5	93	498	Side-valve.
33/C	85·5	101·6	586	Side-valve.
33/C/S	85·5	85·5	495	O.H.V.
33/X/3	85·5	85·5	990	Side-valve twin.
Silver Arrow	54	86	400	Side-valve twin.
Silver Hawk	50·8	73	593	O.H.C. 4-cylinder.
33/D80	82·5	93	498	O.H.V.

All 1933 models use dry-sump lubrication. Oil is pumped to the O.H.V. rocker gear from a by-pass taken

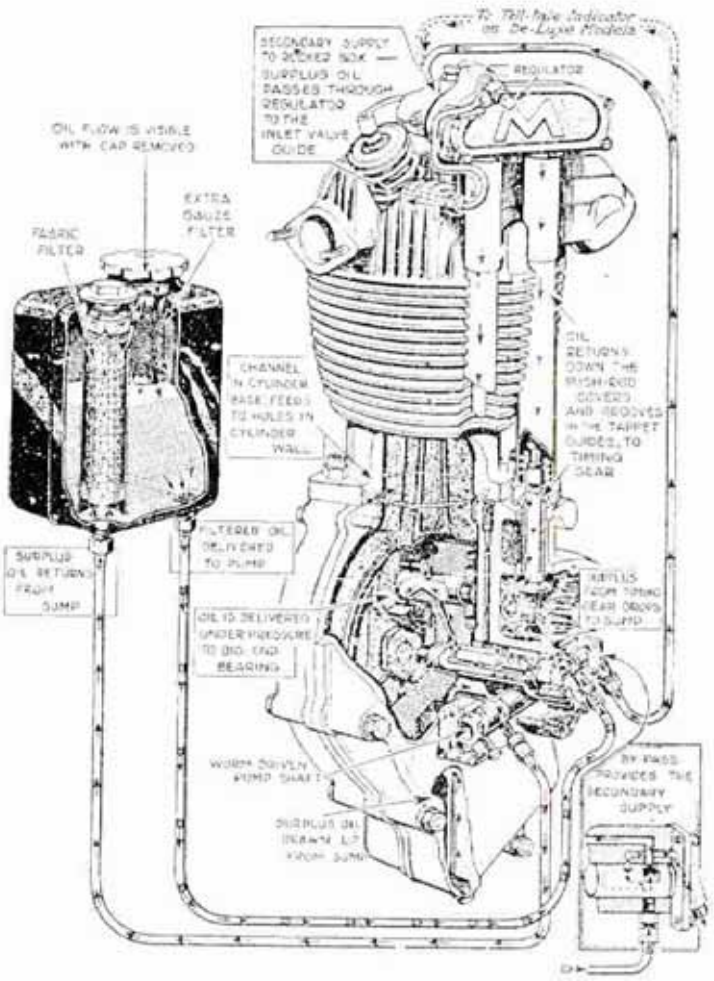


FIG. 1.—DRY-SUMP LUBRICATION SYSTEM FOR O.H.V. ENGINE (MODEL D80).

from the main supply. The general arrangement of the engine is shown in Fig. 1. All single-cylinder engines are inclined in the frame.

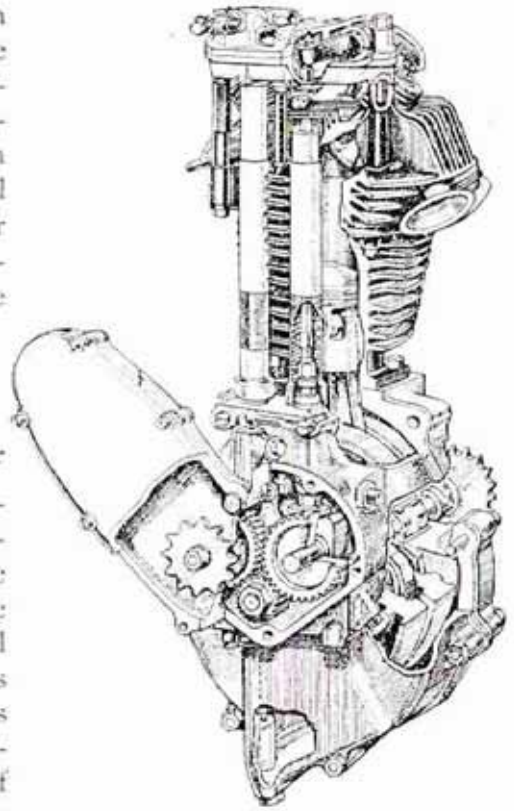


FIG. 2.—CUT-AWAY SECTION OF ENGINE.

The Decompressor

A decompressor for compression release is used in place of the usual valve-lifter; as this device is somewhat unusual, a brief description of its action is given.

The decompressor is brought into action, before starting the engine, by moving the small lever, mounted on the timing cover, to its "on" position, approximately at right angles to the engine. This brings another lever, mounted on the horizontal shaft passing through the timing cover, into position to engage with a small cam behind the teeth on the inlet cam wheel. Just before

the piston reaches the top of the compression stroke, the secondary cam makes contact with the lever, which raises the exhaust valve about 0·010 in. to release compression and allow the engine to be rotated. This ensures an easy start without a backfire. The decompressor lever should be returned to the "off" position, pointing to the front wheel, when the engine is running. The second lever can be seen in the cut-away section of the timing gear in Fig. 2.

A valve-lifter is fitted to big-twin engines.

Engine Service for Side-valve Models

The 250- and 500-c.c. side-valve models are not fitted with detachable cylinder-heads. To decarbonise, remove the sparking-plug, carburetter controls and exhaust pipe, then the aluminium valve cones or caps. Take away the valve-chest cover, and remove the three cylinder holding-down nuts. The cylinder can then be removed.

Place a screwdriver on one of the valve-spring bottom collars and gently tap the free sides of the collars; the springs will compress to permit the removal of the valve cotter. Take out both valves, and chip out carbon in the combustion chamber with a long screwdriver. Get rid of all loose carbon and grind-in the valves. The valve-springs are interchangeable and have a free length of $2\frac{3}{8}$ in. Clean out the valve-guides and apply a little graphite grease to the valve-stems before replacing.

Check the rings in the cylinder after the carbon has been removed from piston crown; do not use abrasive or emery—an old knife or scraper is best. Wash the piston in paraffin and ensure that the piston rings are perfectly free in their grooves. Space the ring gaps at

120 degrees to each other and smear the piston with clean oil.

Fit a new cylinder-base washer and replace the cylinder.

Turn the engine round several times to allow the valves to settle down and set the tappets at 0·004 in. for inlet and 0·006 in. for exhaust, when the engine is cold. It is essential to carry out this adjustment when the piston is on T.D.C. (top dead centre) of the firing stroke. Apply a little jointing compound on the washer for the valve cover, but do not overtighten the retaining knob or nut.

Engine Service for O.H.V. Models

To decarbonise any O.H.V. model, it is necessary to drain the petrol tank and remove the pipe connecting the two halves of the tank, as well as the carburetter. Take away the oil-pipe for lubricating the inlet valve, exhaust pipes and petrol pipe, not forgetting the sparking-plug, which may be difficult to unscrew when the cylinder-head is removed. Raise both bottom portions of the push-rod cover tubes, turn the engine so that both valves are closed and remove the rocker-box holding-down bolts. The rocker-box and push-rods can be taken away on the right-hand side of the engine. The push-rods will interchange, but it is advisable to replace them in the order removed. Now take away the cylinder-head bolts. A cylinder-head gasket is used on the 33/D80 model, but a ground joint, without gasket, is used on models D2, D3, D6 and C/S. Clean out all carbon in both the sphere of the head and exhaust port; then remove both valves. Clean burnt oil from the exhaust-valve stem with fine emery, working up and down the stem and not round it.

Look for evidence of the valve-guide touching the

throat of the valve; if there is contact, tap the guide back, but exercise care, as these guides are brittle. An old bolt $\frac{3}{8}$ in. diameter inside the guide, tapped lightly with a steel drift, will help to move the guide.

Check the valve-springs for free length. On O.H.V. models, with the exception of model D8o, the length of the springs should be: inner $1\frac{13}{16}$ in., outer $2\frac{1}{16}$ in. On the D8o model, the free length of the springs is $2\frac{1}{8}$ in. for the outer and $2\frac{3}{16}$ in. for the inner. Replace the springs if they have closed up $\frac{1}{4}$ in. or more. New valve-springs will act as a tonic to any O.H.V. engine and will, in most cases, improve petrol consumption.

Remove carbon from the piston crown with an old knife or scraper—do not use abrasive or emery cloth.

Split-skirt pistons are used, the split facing the front of the machine.

It is preferable to grind on the cylinder-head to the barrel with the cylinder removed. When a satisfactory joint is made, there should be a continuous matt surface on both the cylinder-barrel face and the seating for the cylinder-head. Jointing compound to make the seal is not recommended. On D8o models a solid copper gasket is used; if undamaged, it can be made fit for further service by heating on a gas-ring until cherry-red and then plunging it into cold water to anneal.

Now turn to the rocker-box, and make sure the oil-sealing rubbers are in perfect condition; if not, they should be replaced to avoid subsequent attention to this part of the engine. On the model D8o, rubber sealing rings for the centre of the tappet tubes were originally fitted and these should be replaced by the latest type cork washers. The rubbers are inclined to swell and close up

on the push-rods and so prevent oil from draining into the crankcase, as intended.

Rocker-boxes on 1933 models other than the D8o are not positively lubricated. Needle rollers are used and these are packed with high temperature melting-point grease and usually do not need frequent attention. It would be opportune to examine the interior of the rocker-box when it is removed for decarbonising the engine.

To reassemble the engine, replace the cylinder-base washer, smear the piston with oil and re-fit the cylinder, cylinder-head, and, finally, the rocker-box. Reverse the order described for dismantling, rotate the engine several times to allow the valves to settle down, then with the piston on T.D.C. of the firing stroke, re-set the tappets. On O.H.V. models, there should be no appreciable up-and-down movement with the push-rods or rockers; the valve end-caps should be just free to rotate. If the decompressor is to function satisfactorily, the tappet clearance, particularly that of the exhaust valve, must be correct.

Oil Leaks

When oil leaks occur, these usually take place at the push-rod cover tubes. To remedy:

(1) See that oil seals are in good order.

(2) Check crankcase release. This is on the driving side of the crankcase, behind the front chaincase. When the release valve is dismantled, make sure the diaphragm is not trapped between its seat and the crankcase. When reassembling, apply a slight smear of

grease to the diaphragm seat to hold the diaphragm in position during assembly.

(3) Make certain that the oil-holes in tappet guides are free; obstruction here will prevent oil draining into the timing chest. These slots can be enlarged to $\frac{1}{8}$ in. if desired.

(4) If there is abnormal crankcase pressure due to leakage past the rings with the oil-seal arrangements in order, check cylinder for size and rebore if necessary.

Excessive Oil Consumption

A choked or dirty oil filter will prevent oil returning to the tank in a normal manner. To test if the filter is at fault, remove it and replace the filter cap, then run the machine for some distance; if there is improvement, renew the filter or wash in petrol. If there is no improvement after dealing with the filter, have the cylinder measured for wear; the original diameter can be taken from the unworn part. For actual size, see data on cylinder sizes. If wear exceeds 0·008 in., rebore; if not, try a new piston with a scraper ring in the third groove, which is bound to make an improvement. Excess oil to the valve-guides will increase oil consumption.

Engine Noises

Usually all these engines are particularly quiet. A rattle that sounds like piston slap, audible when the engine is running light, and coming from the big-end assembly, is usually heard when accumulated clearances on the crankpin, liner and rollers are manifest to a total of 0·0015 in. To remedy, lap out the connecting-rod and

fit oversize rollers. The noise is more pronounced on the D80 models.

Lubrication—see 1939 models (Chapter V).

Engine Overhauls

It is desirable to take off the cylinder and piston when removing the engine from the frame on O.H.V. models. Take off the clutch and engine sprocket before lifting the cylinder. The shock-absorber sleeve is a close fit on the driving-side shaft, and the space between the sleeve and the crankcase does not permit the use of a sprocket puller. When the fixing nut is released, gently drive two wedges or two screwdrivers at 180 degrees from each other between the sleeve and the crankcase. The shaft has a taper, and, with the wedges in position, give the threaded end of the shaft a sharp blow with a stick of brass and a light hammer, to avoid damage to the thread. The shock should cause the sleeve to leave its shaft.

Taking out the timing gear, release the small pinion nut (*left-hand* thread), then remove the oil-pump guide-screw, rear pump end-cap and the pump plunger. When all bolts holding the two crankcase halves together are removed, the crankcase can be separated. Roller bearings are fitted to the driving-side shaft (makers' Part No. AE22). A bronze bush is used for the timing side of the engine. If this bush is replaced, care should be taken to ensure that the new bush is reamed to the drawing size, *i.e.*, $\frac{7}{8}$ in. $\frac{-0{\cdot}00075}{-0{\cdot}00000}$ in. The steel sleeve for the roller bearing is a force fit in the crankcase. To remove the sleeve, place the driving side of the crankcase over a gas-ring,

slightly heat the case, and the steel sleeve will fall out. All the 1933 models were not fitted with detachable liners in the connecting-rod.

Big-end bearings for all the 250-c.c. models are common and are used on engines made up to 1939. This applies also to the liner for the connecting-rod, which was first issued as a spare, separate from the connecting-rod, in 1934. The same crankpin is fitted to the "Silver Arrow", but with a different type connecting-rod liner. On all engines, where a plain bush is used for the timing-side shaft, the flywheels must have 0·015 in. to 0·020 in. end-play. The bronze bush can either be driven in or pulled out to obtain this movement. The flywheel assembly is held over on the driving side of the engine, under the influence of the shock-absorber spring, which must be removed before the end-play can be checked. The pump plunger has no special position, neither is it timed in relation to the worm on the timing-side axle. It is of utmost importance that the guide-screw is correctly located in the annular groove before it is finally tightened. Use the fingers to register this screw (not a spanner), unless it is tight in its thread, which is most unlikely.

Replacing Timing Gear (Single-cylinder Models)

All pinions are marked. Details of the actual valve openings are given in the data table for 1939 models. The method of replacing cams is as described for 1939 models (page 98).

To Reassemble Decompressor

Reassembly of the decompressor is a little "tricky". Assuming the cam wheels have been fitted to the markings,

take the decompressor lever and insert with the tapered or thin edge towards the exhaust tappet. The cams will have to be withdrawn a trifle (not out of engagement) to do this. Stick a paper washer on the timing cover, and offer it up on the spindles of the two cams. The horizontal shaft for actuating the decompressor lever will be out of position with the hole in the decompressor lever. Use a wheel-spoke or something similar, inserted in the gap formed by the timing cover and crankcase; the decompressor lever can be then raised until it registers with the shaft by which it is operated. Withdraw the spoke and tap home the timing cover. Engage the decompressor by moving the lever and test if assembly is correct, as the lever may have fallen off the shaft whilst the cover was tapped home.

Re-timing Magneto

Replace the magneto chain with the driving sprocket and tighten the top sprocket nut, leaving the lower one loose with the sprocket in position. Turn the engine and set piston on T.D.C., both valves closed. Fully advance the magneto control lever and turn the engine *backwards* until the piston is at the required distance, as given in the table on page 31, *down* the stroke. Check magneto points to 0·012 in. gap; then set the contact-breaker so that the points are just about to open. Tighten the lower sprocket nut. Re-check and finally firmly tighten the top sprocket nut.

To Adjust Valve Tappets on O.H.V. Models

First expose the tappet requiring adjustment by telescoping the tappet-rod cover tube. Then with a suitable

thin spanner hold the tappet, and at the same time slack off the lock-nut securing the adjustable tappet head. Then screw the head up or down, as may be required, to obtain the correct clearance, which, it must be noted, is checked at the valve end; after this securely tighten the lock-nut against the tappet end.

The correct clearance between the rocker-ends and valve-stems, when the valves are down on their seatings and with engine cold, is the nearest approach to nil obtainable. It should be observed that the hardened steel valve-stem caps are free to be revolved with the fingers while, at the same time, no perceptible up-and-down movement of the rocker is possible. The decompressor lever must, of course, be set to the "off" position whilst checking valve clearances.

Valve Timing on O.H.V. Models

The correct setting for the closing and opening of valves is as follows: inlet commences to open 20 degrees, or $\frac{1}{8}$ in., before top of exhaust scavenging stroke, and closes 67 degrees, or $\frac{13}{16}$ in., up the compression stroke. Exhaust valve commences to open 75 degrees, or $1\frac{1}{16}$ in., from bottom of firing stroke, and closes 28 degrees, or $\frac{1}{4}$ in., down induction stroke. To test valve timing, the tappets must first be set to provide 0·014 in. clearance between the overhead rocker-pads and the valve-ends.

To Adjust Tappets on Models 33/D7 and 33/D5

Remove the valve-spring cover, and, with a suitable thin spanner, hold the tappet and slack off the lock-nut securing the adjustable tappet head. Then screw the head up or down, as may be required, to obtain the

correct clearance; after this securely tighten the lock-nut. The correct clearances are 0·006 in. for both inlet and exhaust.

Note.—Tappet clearances should be tested while the engine is warm (not hot) and the decompressor lever should be in the normal running position marked "off".

BIG-TWIN ENGINES

Model X3 990-c.c.

The engine has a bore size of 85·5 mm. and stroke of 85·5 mm. Dry-sump lubrication is employed; for details of lubrication, see Chapter V. Detachable cylinder-heads were used with enclosed valve-springs. A magdyno unit was fitted as standard for ignition and electric lighting respectively and a four-speed Sturmey-Archer gearbox.

Decarbonisation

It is a simple process to remove the heads and clean out carbon deposit in combustion chambers and piston crowns. The details given already in this chapter also apply to this engine.

Usually, machines of this type are fitted with sidecars, and if the engine is being cleaned up on account of heavy petrol consumption, attention should be paid to the following:

(1) Make sure the valve-springs have not lost tension; their free length is $1\frac{3}{4}$ in.

(2) Ensure that the valves are seating properly, especially the inlet valves.

(3) Check the inlet pipe connections where they join the cylinder; also where the carburetter clips on to the inlet pipe.

When the valves are ground-in, there should be a continuous matt surface round the valve-seat and the seating in the cylinder. This is sometimes misleading and owners should not take it for granted that the seating is in order by the condition of the valves and their seats. It is a good plan to apply a smear of red lead mixed with oil on the valve-seatings, and insert the valve into the cylinder, then with a screwdriver in the slot provided, press on the driver head and rotate the valve one complete turn and take it out. If the seating in the cylinder is correct, a deposit of red lead will show up all round the seating; if this is not so, have the seating re-cut (angle 45 degrees) with a suitable valve-seating cutter. If there is a leakage past the inlet valves, blow-back will take place and fuel will be wasted, resulting in heavy petrol consumption.

Uneven Running at Slow Speeds—all Twin 990-c.c. Models

It is not always easy to make a twin engine run slowly and "tick over" evenly. Owners usually take a pride in this, and the following details will help when trouble of this kind occurs.

First, locate the cylinder that is at fault and remember that the carburetter supplies the same mixture to *both* cylinders. Next, check tappets, 0·004 in. for inlet and 0·006 in. for exhaust; then set plug points to 0·018 in. to

0·020 in. gap, and make sure that the electrodes are clean.

If irregular running persists, test for air leaks. To do this, obtain a rubber plug, similar to the type used for the ordinary kitchen sink. Insert a short piece of copper tube in the centre of the rubber plug, to fit tightly. Obtain a length of rubber tubing to connect to the copper tube. Remove the carburetter and fit the rubber plug into the inlet pipe. Now turn the engine until the *front* exhaust valve is just about to close. In this position, both *inlet* valves are shut. A second person is required for this test, to watch the connection of the inlet pipe where it joins the cylinder, as well as the inlet valve-guides. Light a cigarette and suck in a good mouthful of smoke, place the rubber tubing between the lips and blow hard. If there is an air leak, the observer will be able to determine *where* the leakage takes place by the smoke emerging from that point.

The most likely place for an air leak is at the joint of the inlet pipe where it is connected to the cylinder. Use of jointing compound, which should be allowed to set before re-testing, should have the desired result. The preceding test is one employed by factory testers, and is an infallible one.

If there is no improvement after dealing with the fault as previously described, check the ignition setting on each cylinder; any variation must be associated with the cam-ring in the magneto portion, and this can only be rectified by Messrs. Joseph Lucas, Ltd.

Once it is established that there are no air leaks and everything else is in order, turn to the pilot jet adjustment as described elsewhere.

Ignition Timing

Some doubt may exist as to the correct position of the H.T. cables, and to which cylinder they should be connected. All magdynos are marked close to the brush-holders or H.T. pick-ups, as they are sometimes called. No. 1 is always connected to the rear cylinder. To decide which cam on the contact-breaker cam-ring is to be used for any particular cylinder, to set the ignition, the following procedure should be carried out.

Unscrew the nut fixing the magneto-drive sprocket on the engine end. Pull the sprocket off its shaft (use a tyre lever with one end bent at 90 degrees). Disconnect the H.T. lead from the rear cylinder; hold the brass terminal with one hand and turn the magdyno slowly in the correct direction of rotation. Immediately a "shock" is felt, examine the interior of the contact-breaker, when it will be easily determined which cam on the cam ring is to be used for timing the particular cylinder.

Engine Service

Various types of cylinder-heads have been used on these big-twin engines, but generally the only alteration has been in connection with the position of the sparking-plug. Cylinder-heads with the sparking-plug fitted near the *centre* are the most efficient, and should be used if detonation or indifferent running occurs at slow speeds. Cylinder-heads are mostly interchangeable on all models.

Side-by-side connecting-rods are fitted, with offset gudgeon-pin bushes. Detachable liners for the connecting-rods are used to enable the big-end assembly to be renewed without replacing the connecting-rods. If

the connecting-rods have been removed for attention, they should be replaced as in Fig. 3.

Split-skirt pistons are a standard fitment; the split in the piston skirt should be in front, or facing the front of the machine.

A bronze bush is used for the timing-side axle bearing; oil is fed direct to this bearing, and from here passages in the timing-shaft allow oil to be pumped to the big-end assembly via a hole drilled in the timing-side flywheel.

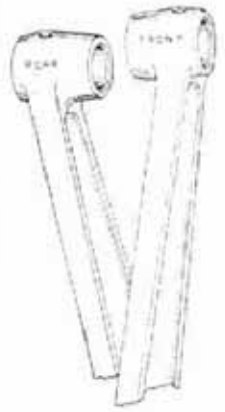


Fig. 3.—Arrangement of Twin Connecting Rods.

Flywheel end-float should be 0·015 in. to 0·020 in. This clearance is made by either driving in or pulling out the bronze timing-side axle bush—shim-washers are *not* used.

If end-play between the flywheels and the crankcase is excessive, this may be due to a groove, cut in the driving-side wheel, rubbing on the steel sleeve used for the roller bearing. To remedy, have the flywheel face machined back clear of the groove, and make up a steel washer of the required thickness. This washer need not be hardened, but it must be flat.

Timing-side Bush

Oil is fed directly to this bearing. The bush does not require frequent renewal. Should the bush be replaced, the internal diameter is most important and it should be reamed in position to $\frac{7}{8}$ in. $\begin{matrix}+0{\cdot}00075\\-0{\cdot}0000\end{matrix}$ in. Wear on this

bearing will create backlash between the small pinion and the cam-wheel, with timing-gear noise. These remarks apply also to the cam-wheel bushes, the normal diameter of these being ½ in. $\frac{+\ 0{\cdot}0005}{-\ 0{\cdot}0005}$ in. with bushes *in situ*.

Note.—The oil groove in the cover bush should be on the *outside*, to prevent oil leaking from the timing chamber.

Driving-side Bearing

This is a built-up bearing, using ¼ in. × ¼ in. rollers in a cage, run in a steel sleeve which is a force fit in the crankcase. To remove this sleeve, heat slightly the driving-side half crankcase, when the sleeve will drop out.

Replacing Cam Levers

When dismantling the timing gear, note carefully the order in which the parts are removed, and take care to store the four distance collars in a safe place. The cam levers are replaced in the following order: (1) rear inlet, (2) front inlet, and (3) either exhaust cam levers.

Replacing Timing Gear

Both the cam-wheel and the timing pinion are marked. If the mark on the small pinion cannot be seen, unscrew the pinion fixing nut a turn or so, as this can obscure the marking. The pinion fixing nut has a *left-hand* thread.

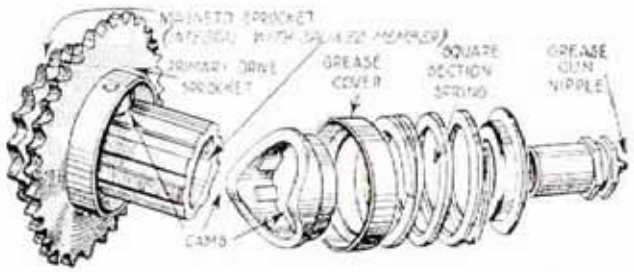
Details of the actual valve timing are given in the data table on page 104 for later models of this type, as all 990-c.c. engines are similar in this connection. Check with 0·016 in. tappet clearance.

To Adjust Tappets on 990-c.c. Twin Models.—See 1939 Models, Chapter V.

TRANSMISSION

Chains

The primary chain on 1933 models runs in oil, and should need very little attention, other than occasional adjustment and the oil kept up to the correct level in the case (verify level weekly). The inspection cap orifice is



[By courtesy of "Motor Cycling".

FIG. 4.—SHOCK-ABSORBER ASSEMBLY.

positioned to prevent overfilling. The rear chain should be removed every 1,500 to 2,000 miles in summer, and every 1,000 miles during winter, and thoroughly washed in paraffin. After carefully wiping, it should then be immersed in a bath of molten tallow, or, as a poorer substitute, ordinary engine oil. If the latter is used, the chain should be laid in soak overnight in order to ensure penetration to all link joints. If treated in this manner, at least 8,000 to 10,000 miles of satisfactory service should be obtained.

The shock-absorber assembly is shown in Fig. 4. A

grease gun should be applied to the grease nipple to lubricate the shock-absorber cam from time to time.

To Adjust Magneto Chain

Adjustment of the magneto driving chain is obtained by tilting the magneto bodily by means of its hinged platform—a screwed adjuster bolt, easily accessible, being provided for the purpose. When making adjustments, it is desirable first to remove the chain cover, then slightly slacken the crankcase bolt upon which the platform pivots and also the crankcase bolt upon which the adjuster screw is mounted. Now, to tighten the chain adjustment, unscrew the upper adjuster nut about half a turn, and tighten the lower one a corresponding amount. Repeat as necessary, but be careful to leave the two adjustment nuts tightly secured. Lastly, re-tighten the two crankcase bolts and refix chain cover.

Note.—The correct chain adjustment should allow a whip or movement of $\frac{1}{4}$ in. to $\frac{1}{2}$ in. as the top run of the chain is lightly pressed up and down midway between the sprockets.

To Adjust Front Chain

To obtain adjustment for the primary chain, provision is made to swing the gearbox bodily upon its lower fixing bolt. It will be observed that the upper fixing bolt operates in slotted holes to permit of the necessary movement. To make the adjustment, the offside nut of the top gearbox fixing bolt must first be slackened. Then to tighten the chain adjustment, first slack off the nut on the adjuster bolt nearest the engine and turn the nut farthest from the engine clockwise until the correct chain

adjustment is obtained; re-tighten the nut nearest the engine and also the top gearbox fixing-bolt nut. Correct chain adjustment should allow a whip or movement of $\frac{3}{8}$ in. to $\frac{1}{2}$ in. as the top run of the chain is pressed up and down midway between the sprockets.

To Adjust Rear Chain

Put down the centre prop stand, slack off the rear-wheel spindle nuts, and adjust chain as required by means of the bolts which pass through each of the fork ends; after this securely tighten the spindle nuts. The correct adjustment (which should allow a whip of $\frac{3}{8}$ in. to $\frac{1}{2}$ in. when the chain is pressed up and down) should be obtained for the tightest place.

Note.—Before tightening the rear chain, the adjustment of the front chain should be inspected; if attention to each is required, the latter should be treated first.

To Adjust Wheel Bearings

To adjust either front- or rear-wheel bearings, which are of the taper roller type, first slack off the left-hand side spindle nuts. Then loosen the outer of the two lock-nuts on the inner side of fork ends and turn the inner of these two nuts in the required direction, *i.e.*, clockwise to tighten the bearing adjustment, and contra-clockwise to loosen. After making the adjustment and before tightening the outside spindle nut, be careful to tighten securely the outer of the two lock-nuts inside the fork end, after which the axle nut must be securely tightened.

Important note.—It must be understood that taper roller bearings must not be adjusted tightly. It is

possible quite unknowingly to impose an enormous crushing strain on the slightly tapered rollers without it being made apparent by undue friction. Slight slackness must, therefore, always be maintained.

To Adjust Steering-head

The steering-head should be occasionally tested for adjustment by exerting pressure upwards from the extreme tips of the handle-bars, while the steering damper, if fitted, is completely slackened off. Should any shake be apparent, the top lock-nut on steering column should be slackened off and the lower nut screwed down until all trace of slackness has disappeared, when the top lock-nut should be again tightened down.

Front Fork Adjustments

Provision is made for taking up side or end wear of the various fork spindle bearings. The need for adjustment will be made apparent by a click or creaking noise when the steering-head is abruptly turned. By placing the fingers partly over the spindle link end and partly upon the lug through which the spindle passes, while the steering-head is turned, first ascertain which spindle or spindles require adjustment. Then after slacking off both nuts, turn the spindle bodily by means of its hexagonal end, left hand or contra-clockwise to take up slack, or *vice versa* to slacken. Do not turn more than half a revolution before a re-trial. Care is essential to guard against over-tightening, when the fork will become stiff in action or most probably refuse to function. The fibre washers fitted between the lug ends and the spindle side-plates are not provided for frictional purposes, but to prevent

actual seizure in the event of the spindle adjustment being too tight. The necessary friction damper effect is provided independently and is adjusted as follows.

The fork action damper can best be adjusted while the cycle is actually in motion, and a badly corrugated surface, such as may be found on many bus routes, provides the best conditions for testing purposes. The ebonite damper hand-nut should be screwed sufficiently tight to make the fork action sluggish under the above conditions, and will require very little variation for other conditions of road surface to provide the maximum degree of comfort.

Carburetter—see 1939 models.

Technical Data for 1933 Models

	D2.	D3.	D5.	D8s.	C.	CS.	X3.	A4.	B.
Top gear	6·2	6·9	5·1	4·3	4·9	4·9	4·3	5·9	5·7
Third gear	7·6	7·7	6·1	6·2	6·3	6·3	5·7	7·8	6·3
Second gear	10·0	8·3	13·2	7·3	8·7	8·7	7·6	10·4	10·0
First gear	16·0	16·6	—	12·9	14·6	14·6	12·6	27·5	17·0
Jet size No.	140	110	130	180	150	150	110	55	75
Throttle slide	5·0·4	5·0·4	6·0·5	2½·0·4	6·0·4	6·0·4	6·0·4	4·0·4	4·0·4
Compression ratio	6·5	6·5	4·5	6·2	5·1	6·1	5·0	8·0	6·3
Ignition setting * (in.)	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛
Engine sprocket (Solo)	20	21	24	24	21	21	21	23	23

* With magneto control lever fully advanced, piston position before T.D.C.

CHAPTER II

"SILVER ARROW" AND "SILVER HAWK" MODELS

THE Matchless "Silver Arrow" was first introduced in 1930, with rear-frame springing. The engine is a 26-degree twin monobloc of the side-valve type, and is remarkably silent in operation and famed for easy starting. The 1930 model used a three-speed gearbox, subsequently changed to a four-speed gearbox of the Sturmey-Archer type.

The "Silver Hawk" was first introduced in 1931 and was the first multi-cylinder O.H.C. engine to be placed on the market in this country. The engine is a double twin of 26 degrees, with shaft drive and bevel gear operating the cam-gear and driving the magdyno by a horizontal shaft. Like the "Silver Arrow", no oil pipes are used for the delivery and return to the tank. A pipe is fitted to convey oil to the overhead rocker gear, returning by gravity to the crankcase.

Both the "Silver Arrow" and the "Silver Hawk" were taken out of production only on account of the small demand for machines of this class at the time, and not because of any inherent faults. It was only after these machines were no longer available that they became extremely popular.

A compression release is not used on account of the small cylinder bore.

"SILVER ARROW"

Engine Service

A detachable head is fitted, which simplifies decarbonising of the combustion chamber. No special precautions are necessary with exception that the inlet valve-seats should be carefully examined, as, common to all twins, a bad seat in the cylinder will cause blow-back, with loss of power and heavy petrol consumption.

Sudden Loss of Power

When this occurs, examine the rubber coupling which drives the magdyno. Wear in the driving-stud holes will affect the ignition timing. Wear on the coupling is usually due to mal-alignment of the magdyno, and if this instrument is inclined to "wobble" when the engine is running, release the fixing bolts slightly and move the dyno. unit until the "wobble" ceases, then re-tighten fixing bolts. A new rubber drive will be required if the stud holes have become elongated.

A fall-off in power may be due to a piston seizure, on account of insufficient lubrication. The pistons are lubricated by oil flung from the big-end, apart from the supplementary oiling by way of the groove in the cylinder base. If there is sufficient oil in the tank and the pump is rotating, the passage for the oil feed to the big-end should be suspected and examined. An air-tight joint must be made between the crankcase and the oil-tank, otherwise the pump will suck air in preference to oil.

Noisy Timing Gear

Noisy timing gear is extremely rare on this type of

engine, which is renowned for its high degree of mechanical silence. To test for this fault, run the engine on the stand slowly and press with a screwdriver handle on the rubber coupling. This load will stop backlash in the gears, which is usually due to excessive flywheel end-play. Use shim-washers behind the timing pinion to take up the excessive movement and the noise will stop.

Magneto Timing

The design of the magneto drive is unusual, and for this reason details of the method to be adopted for timing the magneto are given below.

Release the magdyno fixing bolts passing through the engine plate and draw back the magdyno until the coupling is disengaged. Release the nut (*left-hand thread*) which fixes the coupling driver, and pull the plate off its shaft. A sprocket drawer is advisable, although the plate can be given a sharp tap at the back to release it. Do not tap too hard, otherwise the bush for the drive shaft will move in its housing and create end-play. Take off the tappet cover, turn engine until No. 1 (rear cylinder) piston is on the T.D.C. of its stroke, with both valves closed. Return the magdyno to its original position and turn the coupling and armature in the direction of rotation—*i.e.*, clockwise—until the fibre pad on the contact breaker touches the cam on the right side in the contact breaker, used for timing the No. 1 (rear) cylinder. Fully retard the ignition control lever, make sure that the engine has not moved, and set the contact points so that they are just about to break. Push the driving plate back on to its shaft (taper used), and, taking care that it does not move, pull back again the magdyno and firmly

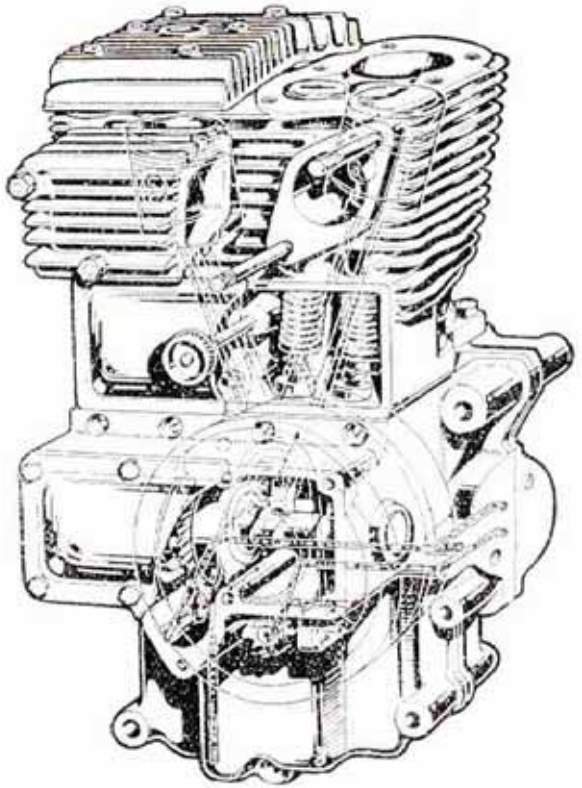


FIG. 5.—SECTIONAL VIEW OF "SILVER ARROW" ENGINE SHOWING OIL PASSAGES

tighten the *left-hand* nut. Replace the magdyno and re-check timing; if in order, replace the fixing bolts through the engine plate.

"Silver Arrow" Lubrication

Dry-sump lubrication is used, oil being forced under pressure to the cylinder, big-end and timing gear. Oil

collected in the sump is returned to the oil-tank via a fabric filter, which was used on the later "Silver Arrow" models. The oil supply and return are made by oil passages drilled in the crankcase, which register with oil-pipes built in the oil-tank. This is bolted to the crankcase and an air-tight joint must be made if the system is to function satisfactorily. De Luxe models had an oil indicator in the instrument panel. Should this device be troublesome, it can be dispensed with, and a direct connection from the front of the oil-pump housing to the timing gear can be made. The oil-pump itself is perfectly reliable, providing there is sufficient oil in the tank. The rider can always be assured that the pump is functioning correctly by removing the oil-tank cap and observing if oil is being returned to the tank. The long pipe-line to the panel, coupled with the low pressure of oil from this part of the system, can be affected by cold weather. The oiling system and feed lines can best be followed by reference to Fig. 5.

"SILVER HAWK"

Lubrication

Lubrication is very much the same as the "Silver Arrow". The oil-tank is mounted on the crankcase; the only exterior oil-pipes are those feeding the rocker gear and for conveying oil back to the tank. Condensation in the cylinders should be ejected from the engine as quickly as possible by opening the throttle several times sharply when starting with a cold engine. Evidence of condensation will also be seen in the oil-tank, in which case the oil in the tank should be topped up frequently.

The oil level should not fall below the half-way mark indicated outside the tank. The crankcase release is in the oil-tank. A small "stack" pipe is fitted, with the object of allowing oil, carried back by leakage past the piston rings, to settle in the oil-tank, and pressure generated to be released into the atmosphere. An external oil-pipe from the front of the oil-pump housing is carried up to the instrument panel to an indicator; from here oil drains by gravity to the rocker-box and bevel chamber. The oil level is controlled by a drain-pipe back to the oil-tank. Oil is supplied to the bearings of the vertical shaft by gravity, through spiral grooves cut in the shaft bushes. Oil is thrown by the revolving bevel gear into the chamber for the camshaft, the level being maintained by a drain passage, passing surplus oil back to the bevel chamber. The whole assembly is practically submerged in oil up to the level of the drain-pipe from the top bevel chamber.

Modified Oiling System

In later models, the oil-supply pipe to the rocker-box, instead of going to the right-hand side of the box, is carried to the left-hand side, and the union on the right-hand side of the rocker-box is sealed. A groove is cut in the large camshaft bush. The new arrangement enables oil to pass through the rocker-box and lubricate, in its passage, the cam, rockers and bevels. The other oil-pipe is connected from the rocker-box to the oil-tank.

The oil indicator can be discarded if troublesome—the oil-pipe being carried direct to the rocker-box. When the oil delivery to the rocker-gear is unsatisfactory, it is

usually due to wear on the relieved tip of the oil-pump guide-screw, which controls the motion of the pump. A new screw usually corrects this fault. Increasing the oil supply to this part of the engine can only be made by enlargement of the hole in the pump, using a "Kip" grinder, but this is best done by the makers. If the alteration is not made correctly, the system may be adversely affected. Fabric filter should be cleaned periodically.

Oiling Faults

Oil leakage from the rocker-gear may be due to stoppage in the two copper pipes inserted into the cylinder block. See that these passages are clear when the head is removed for attention. Over-oiling or heavy consumption may be caused by the following:

(1) Worn piston rings (the piston should have the scraper ring in the third groove).

(2) Air leak where the oil-tank is bolted to the crankcase.

(3) Oil going down the valve-guides, due to choked pipes in cylinder. Reducing the length of the valve-guides clear of the chamfered portion on the valve will probably effect a cure.

(4) Little or no oil to rocker-box gear. Examine the relieved tip of the pump guide-screw for wear, or flat, causing lost motion.

(5) Oil leaking into front chaincase. Piston rings tight in groove, or else bush for driving-side axle has been reversed.

Re-timing Ignition

Should it be found necessary at any time to re-set the ignition timing, it should be done as follows:

(1) Remove the two off-side fixing bolts and loosen only the near-side bolt securing the ignition unit. Draw the entire unit back upon its platform about $\frac{1}{2}$ in., when the head of the third bolt can be passed through the large end of the pear-shaped slot provided in the platform. The unit may now be drawn back until the rubber coupling is disengaged so that the coupling comes away with the unit instead of remaining on the driver attached to the engine shaft.

(2) Apply a spanner to the nut securing the driving disc on the engine shaft and turn clockwise to loosen, the nut in question having a *left-hand* thread. Next, gently lever the driving disc off the taper-end of the shaft to which it is attached, but do not remove. *Tighten* the left-hand-thread fixing-nut sufficiently to permit the disc to be turned on the taper-end shaft with some pressure from the fingers. Slide the ignition unit back into proper position with the holes in the rubber disc engaging the pins on the loosely fitted driver.

(3) Set the piston of No. 1 cylinder (right-hand front) to $\frac{3}{8}$ in. before the top of its firing stroke (*i.e.*, when both valves are closed).

(4) Fully advance the ignition lever, and, after removing the distributor cap, turn the shaft of the ignition unit by means of the rubber coupling in its normal direction of rotation until the contact points are just breaking on the No. 1 cam. The correct cam may, of course, be identified by the position of the pick-up rotor arm which, on the No. 1 cam, will be opposite the H.T. cable entry marked 1.

(5) Taking great care not to move either the engine or the loosely fixed driver, again slide the ignition unit back upon its platform and carefully tighten the left-hand-thread nut securing the driving disc, when the unit may be again tightened down upon its platform.

It should be explained here that, looking down on the distributor cap when seated on the cycle, the right rear socket No. 1 carries the cable for No. 1 cylinder (right-hand front), the left rear socket No. 3 carries the

cable for No. 3 cylinder (left-hand front), the left side front socket No. 2 carries the cable for No. 2 cylinder (right-hand rear), and, lastly, the right side front socket No. 4 carries the cable for No. 4 cylinder (left-hand rear).

The above details apply to the original design. The makers of the dyno. unit altered the position of the key-way for the rotor and unfortunately there is no identification on the instrument to indicate the type fitted. This alteration also affects the position of the H.T. leads, therefore the exact firing position must be carefully checked on all four cylinders. To test if the firing order is correct, start the engine on the stand or run with ¼ throttle. Short both the front sparking-plugs, using a long screwdriver with insulated handle, and note if the firing cylinders are running evenly. Repeat this on the rear plugs, and, if the front cylinder misfires or runs at a slower speed, check the firing order and position where the spark occurs. The front and rear cylinders should run at the same speed if ignition is correct.

Hard Starting and Bad Slow Running

Sluggish valves, due to weak springs or burnt oil on valve-stems, will make starting difficult. See that mica washers are fitted under valve-springs (free length is 2⅜ in.).

The pilot jet in the carburetter is most important; if inoperative, slow running will be poor, and starting exceedingly difficult. A main jet size 75 was originally fitted, with throttle slide 4 × 4. If engine starts and "flutfs" out when the throttle is opened, clean out the

pilot passage and look for an air leak at the carburetter flange. Sports-type sparking-plugs are recommended, such as Lodge H.1 or K.L.G. Type M50. Ignition is set with the piston $\frac{3}{16}$ in. before T.D.C., control lever fully advanced.

Tappet Adjustment

Tappets are set to 0·004 in. clearance for all valves with the engine cold. Make this adjustment when the piston is on T.D.C. of the firing stroke.

Chains

The front chain is kept in adjustment by the tensioning device. The oil level must be maintained, otherwise the duplex chains will wear and the clutch will also be affected. Use 50 per cent. oil and 50 per cent. paraffin, which will relieve clutch drag. Only one type of engine sprocket is fitted for both the "Silver Arrow" and "Silver Hawk". When sidecars are attached, a larger rear-wheel sprocket is used to reduce gear ratios.

Engine Noises

Noises from the engine are usually due to backlash in between the camshaft driving gears. Backlash can be taken up by removing the shim-washers fitted between both the top and bottom flange joints. This brings the bevels in closer engagement. The two Oldham couplings should be a close fit if engine noise is to be avoided. Wear on the bush in the crankcase for the shaft which drives this dyno. unit will cause play between the gears, apart from oil leakage from this point.

Engine Service—Decarbonising

Although the period during which an engine will run satisfactorily without decarbonisation depends largely upon driving conditions, it is nevertheless advisable to carry out this operation once every 3,000 miles. The need for decarbonising will be indicated by a tendency for the engine to "pink" or "knock" when ascending hills or on accelerating, particularly so when hot. Although possible without disturbing the petrol tank, the process of decarbonising is considerably simplified by sliding the tank back into the approximate position normally occupied by the saddle. The procedure is as follows: first remove the saddle-nose bolt and then slack off only the two nuts securing the saddle springs to the frame of the saddle. The springs may then be turned in order to unscrew them from the spring-frame side-plates to which they are anchored, when the saddle may be removed. Next remove the two bolts securing the petrol tank at its front end and also the nut and bolt securing the rear end. Then disconnect petrol pipe, top end of the gear-rod and the small tie bracket supporting the gear quadrant from the top bevel gear housing. The tank may now be slipped back into the position indicated, leaving the entire top of the engine clear.

Next remove sparking-plugs and cylinder-head stay. Then remove the silencer and exhaust pipes and after withdrawing the carburetter air and throttle valves, detach the carburetter body to prevent any damage to it occurring while the cylinder-head is removed. Unscrew the top gland-nut of the vertical shaft covering the tube and slide this nut together with the metal collar and rubber gland

washer down the tube sufficiently to expose the top vertical shaft Oldham coupling joint. Next, remove the two valve inspection covers and disconnect the oil-pipes from the camshaft housing.

Lift the distributor cap on the dynamo unit, and gently revolve the engine until the pick-up rotor arm is pointing to the approximate position shown in Fig. 6. The object of this is explained later, and it is only necessary to remark here that in the indicated position all the marks on the various timing gears coincide. Taking care not to move the engine further, unscrew the twelve holding-down bolts for the cylinder-head and camshaft assembly, removing all but the two centre ones. The cylinder-head and camshaft housing may now be lifted off. Then separate the two units, taking care not to revolve the camshaft or to damage the impregnated asbestos washers on the underside of the camshaft housing, which should be gently laid aside to await refitting. Care must also be taken of the small hardened steel valve end-caps and the cylinder-head gaskets; the latter should be scraped and cleaned and also laid aside carefully until required. All carbon deposit should next be removed from the cylinder-head

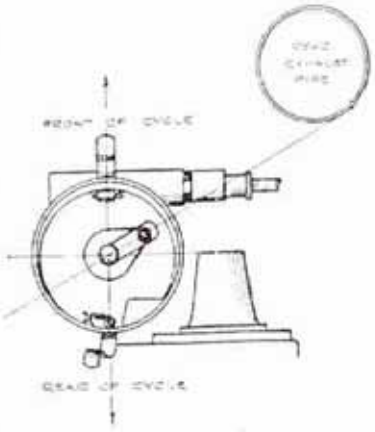


FIG. 6.—POSITION OF ROTOR ARM WHEN MARKS ON ALL BEVEL WHEELS ARE TOGETHER ("SILVER HAWK").

and valve-heads by means of a suitable scraper or an old penknife.

Re-fitting Cylinder-head

Before re-fitting the head, the carbon deposit must be removed from piston tops. To do this, revolve the engine until one piston is at the top of its stroke, and after covering the other three cylinder tops with a calico rag to prevent admission of any carbon chips, carefully scrape the piston top with a suitable scraper or an old penknife, afterwards wiping off all traces of the deposit. Repeat the process until all pistons have been dealt with, in each case covering the cylinder tops to prevent chips entering, and, lastly, carefully wipe the top face of cylinder block. Now carefully revolve the engine until the pick-up rotor on the ignition unit comes to the position already described in the removal instructions and then lay the cylinder-head gaskets in their correct positions on the cylinder block.

Next, gently place the cylinder-head and camshaft assembly in position, when, if the camshaft has not been moved, the top vertical shaft joint should roughly register. Gently work this joint into correct engagement and then introduce the various cylinder-head holding-down bolts, making sure that they each pass through the corresponding holes in both asbestos jointing washers and cylinder-head gaskets. Screw all the bolts down finger-tight only, and then, going over each with a spanner in the order shown in Fig. 7, gently tighten down. Lastly, again in the order shown, apply more pressure until all are firmly and evenly tightened down.

There are four positions in which the vertical joint can

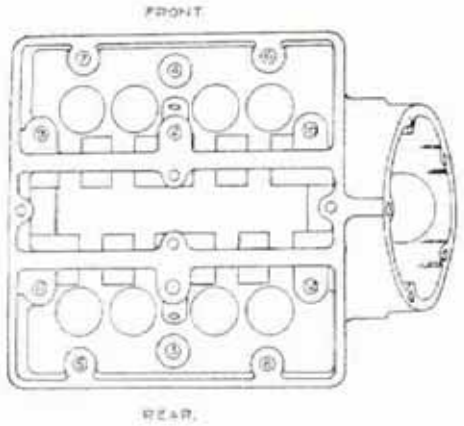


FIG. 7.—ORDER OF SLACKENING AND RE-TIGHTENING CYLINDER HEAD FIXING BOLTS ("SILVER HAWK").

be coupled, only one of which, however, will give the correct synchronisation of valve and ignition timing. If the camshaft has not been revolved during the dismantling or re-erection process, the correct connection will be automatically obtained. Should there be any doubt on the matter the correction, if made before the head is fitted, will save a good deal of unnecessary labour, and in such an event all that is necessary is to remove the top bevel chamber cap (secured by five cheese-headed screws). Then, whilst holding the camshaft housing up sufficiently, turn the end of the shaft projecting from the housing until all the marks on the bevel gear teeth coincide. Providing the engine has been revolved to give the described position for the pick-up rotor, the tongue portion of the vertical shaft coupling will be in the correct position to engage the corresponding slot in the shaft projecting from the camshaft housing. Having completed the re-fitting of cylinder-head, slide the top vertical shaft covering tube gland-nut and washer up into position and firmly screw home.

Re-fit the pick-up cap and then gently revolve the

engine and, in turn, check each valve rocker for correct clearance, making any adjustment necessary while the tank is still well out of the way. As already mentioned, the correct clearance is 0·004 in. Re-fit the valve inspection covers, sparking-plugs and cables, camshaft housing oil-pipes, carburetter, cylinder-head stay, petrol tank, gear quadrant stay, gear-rod, saddle and exhaust pipes, all in their order of removal, when the machine is again ready for the road.

Important note.—In the event of new cylinder-head gaskets and/or asbestos impregnated washers for the camshaft housing being fitted, some special precautions are necessary to ensure success. After fitting the new washers or gaskets, the cylinder-head must be firmly bolted down as already described. Then slide the petrol tank back into position and connect up the petrol pipe only and run the engine until it is well hot (warm will not suffice). This process is to ensure the settling down of the new washers. While still hot, again tighten down the various cylinder-head fixing bolts in the order prescribed, and, when nearly cool, carefully adjust all rocker clearances and finally fix valve-spring covers and refix petrol tank, etc. The above precaution is vitally necessary, and it will be found possible to tighten the cylinder-head bolts considerably after the heating-up process. This is due to the jointing washers closing down under the influence of heat and pressure.

To Remove Gearbox ("Silver Hawk")

First remove the near-side foot-rest hanger, then withdraw the foot-rest rod, together with the off-side hanger and distance tube. Place a receptacle of some kind

underneath the front chaincase to catch the oil in, and, after removing the fourteen screws securing the outer plate of this case, gently remove the plate, taking particular care to avoid any buckling or damage to the joint faces. Next, gently withdraw the two spring tensioning blades in one unit, together with the spring shoe. This may best be done by pulling the rear ends of the spring blades out of their anchorage with a pair of pliers, and at the same time working the spring shoe outward with the fingers.

Remove the six clutch-spring screws and then the springs and thimbles, when the clutch plates may be drawn off the clutch hub. Remove the respective nuts securing the engine shaft sprocket and the clutch hub to the gearbox mainshaft. Release the engine shaft sprocket, and draw it, using the special extractor provided in the tool-kit, together with the clutch sprocket and front chain, off in one unit. Draw off the clutch hub, which is a sliding fit only on the splined gearbox shaft, and gently remove the oil-sealing disc and spring fitted at the rear of this hub. Disconnect and remove the rear chain. It will now be necessary to lean the near-side of the cycle against a wall, or alternatively, jack up with boxes of suitable height in order to permit the removal of the prop stand. This is accomplished by detaching the spring and then removing the pivot bolt. The stop bolt must then be removed, together with the two distance tubes between the rear engine plates through which the two stand bolts pass. From the off-side of the cycle, remove the foot-rest hanger, front portion of rear-brake rod, brake pedal, exhaust pipe, clutch cable and the two bolts which pass through the gearbox shell,

and also cradle plates. Next, remove all nuts securing the off-side cradle plate; also the two bolts securing the cradle plate to the platform and the bolt securing the platform support bracket. Remove this small bracket and the silencer support arm.

Next, remove the split-pin from the gear-rod yoke end attached to the gear striker lever on the gearbox, and withdraw the pin. The off-side cradle plate may now be removed. After removing the nut securing the near-side of gearbox tie-bar, the box itself may be removed and the speedometer cable detached.

The replacement of all parts must be carried out in the reverse order to their removal, but the following details require special attention:

(1) Before tightening the tie-bar nuts or the bolts which secure the gearbox to the cradle plates, make sure that the shallow tongue or feather on the gear-box shell registers correctly with the groove provided for it on the cradle plate.

(2) When the clutch hub and oil-retaining washer are being re-fitted, ensure that the nuts on the back of the former register with the serrations on the washer, which is intended to revolve with the hub. Do not omit the spring for this oil-retaining disc and make certain that it is in its correct position.

(3) Do not, in any circumstances, run the engine until the oil level has been restored in the front chain-case.

Although a lengthy description is necessary to explain gearbox removal, in practice it will be found quite straightforward should the occasion arise.

Clutch Adjustment

In the event of clutch slip being experienced, the adjustment of the clutch-operating cable should be suspected. When adjusted correctly, it should be possible to move the clutch-operating arm on the gearbox not less than $\frac{1}{32}$ in. laterally, to and fro with the fingers, and if this free movement cannot be felt, the cable stop should be adjusted accordingly. Alternatively, the screw which operates on the clutch push-rod may be slackened off, but if the adjustment is made here, it is important that the nut securing this screw is carefully re-tightened.

To Remove Gearbox ("Silver Arrow")

(1) Mark both H.T. cables 1 and 2 to correspond with the figures stamped on the magdyno adjacent to the pick-ups, then detach both pick-ups, which, as will be seen, are secured by the pressure of small, flat springs.

(2) Remove the bakelite contact-breaker cap, and withdraw the steel cam-ring.

(3) Remove the countersunk head screw which secures the advance and retard cable spring-box to the magdyno, when this spring may be gently withdrawn.

(4) Unscrew the magdyno base bolts, and slide the unit back on the platform to disengage the coupling. By detaching the various dynamo cables, including the negative battery cable, the entire unit may be removed.

(5) Remove the battery clamp and disconnect the positive cable sleeve connector fitted about 6 in. from the battery terminal. This connection is covered by a rubber sleeve, which can quite easily be moved to permit disconnection. The battery may then be removed.

(6) Remove the four small bolts which pass through the top of the magneto and battery platform, and the two nuts by which the forward end of the platform is secured to the engine crankcase.

(7) Take off the short front brake-rod, and detach the gear rod from the gear striker lever on the gearbox.

(8) Detach the clutch-cable nipple from the clutch worm lever via the slotted hole and unscrew the cable stop from the

slotted yoke attached to the gearbox, when the cable can be slipped through the slot provided.

(9) Remove the left-side foot-rest hanger, and the outer half of the front chaincase.

(10) Detach the connecting links of both driving chains.

(11) Remove the two bolts which pass through the slotted holes in the rear engine plates, and slacken off considerably all the nuts securing the off-side rear plate; force the two plates apart to release the shallow tongue cut on the gearbox side, and the entire box can be lifted clear.

The replacement of all parts must be carried out in reverse order and care must be taken to tighten all bolts securing the engine plates and the gearbox. The various dynamo cables are identified by means of coloured sleeves and must be fixed as shown on the wiring diagram. It will be found advisable to connect the advance and retard cable to the magdyno before this unit is actually fixed in position. After fixing the cable spring-box, care must be exercised to see that the cam-ring is replaced with the narrow slot engaging with the projecting tongue on the advance and retard cable end, by means of which the cam-ring is revolved in its housing to provide the variable ignition setting controlled by the handle-bar lever.

To Adjust Front Forks and Fork Damper Action—see 1933 models (Chapter I).

Spring Frame Attention ("Silver Hawk" and "Silver Arrow")

The rear-wheel springing arrangements are extremely simple in layout, and possess perfect lateral rigidity. The moving portion carrying the rear wheel is hinged on "Silentbloc" bearings, and requires no lubrication or other attention whatsoever. The spring damping action is arranged by means of fibre discs which slide across both faces of two parallel steel plates bolted to the

frame seat lug. Since these plates are not adjustable, provision against wear of the inner friction discs is made by clamping the spindles which carry the discs in the top-bridge lug. Although wear of the friction discs is almost negligible, nevertheless, once each season, or after every 5,000 miles, the two clamping bolts in the top-bridge lug should be slackened off, and the hand-adjusting ebonite nuts screwed up as tightly as possible, in order to draw the spindles out of the clamping lug. The pinch bolts should be again tightened securely and the damper hand-nuts re-adjusted to give the desired degree of friction. It will be found that the amount of friction required to give the maximum comfort varies considerably with the road surface—*i.e.*, the rougher the surface, the more damping action will be required. For all normal conditions, it will be found quite satisfactory to adjust this damping action in exactly the same manner as prescribed for the front forks, taking care to adjust each side nut to give, as near as can be judged, equal pressure. Rubber-stop buffers are provided to limit the spring-frame movement, but only an exceptionally severe jolt will compress the spring sufficiently to bring the buffers into action, and the remedy is to apply more friction.

To Adjust Wheel Bearings—see 1933 models (Chapter I).

VALVE TIMING—"SILVER HAWK" AND "SILVER ARROW"

	"Silver Hawk."	"Silver Arrow."
Inlet opens B.T.D.C.	20°	10°
Inlet closes A.B.D.C.	65°	55°
Exhaust opens B.B.D.C.	65°	60°
Exhaust closes A.T.D.C.	25°	10°

Taken with 0·008 in. tappet clearance.

CHAPTER III

1934–1935 MODELS

MACHINES made during the 1934–1935 period were basically the same as those in 1933. A 250-c.c. model (34/F4) was introduced in 1934 and is described below.

1934 250-c.c. Model F4

Apply a grease gun to the grease nipples on the rocker-box (see Fig. 8) every 300 miles. Other lubrication details are the same as for 1933 models.

To Decarbonise

Remove silencer and exhaust pipe as one unit, then sparking-plug and petrol pipe. Take off carburetter and lay it on the saddle. By releasing the four bolts holding down the rocker-box, the entire assembly of rocker-box and push-rods with tubes can be taken away on the right side of the engine. Put the two valve end-caps in a place of safety, and make sure they are replaced when engine is reassembled. The cylinder-head can be removed by unscrewing the four holding-down bolts. If the cylinder-head gasket is damaged, replace it by a new one.

To Grind-in Valves

In the case of the model F4, valve grinding is advised on each occasion when decarbonisation is undertaken.

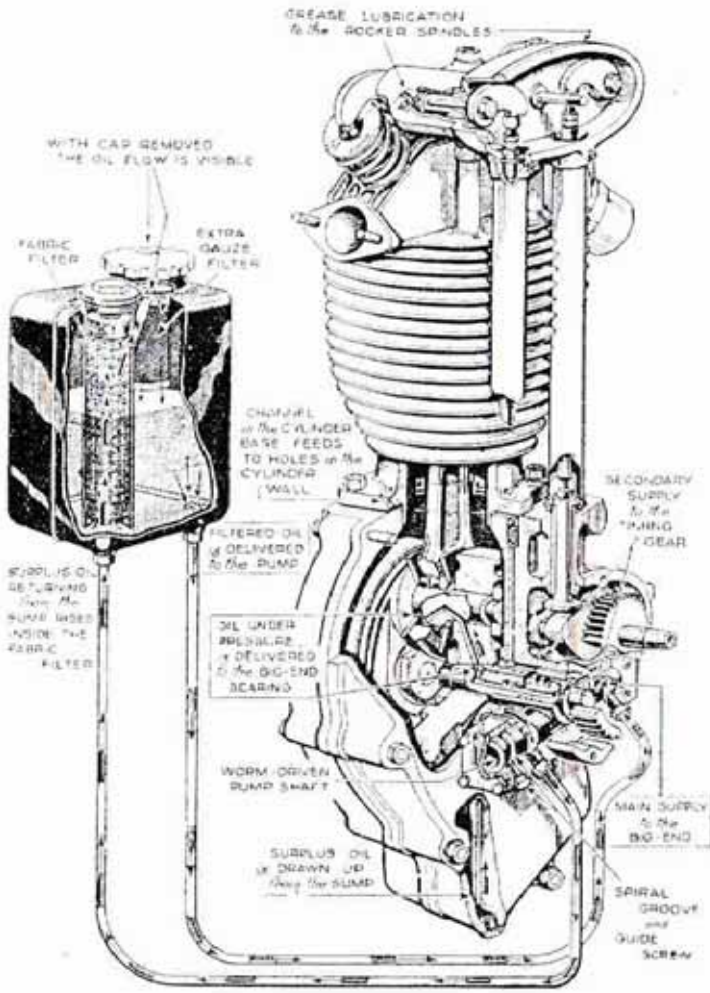


FIG. 8.—ENGINE LUBRICATION SYSTEM FOR MODEL 34/F.

After the cylinder-head has been removed, to remove the valves it will be found convenient to rest the head of each valve in turn on a small block (wood, preferably) while the spring is being compressed, to allow of the removal of the taper valve-cap divided collar. It may be necessary to give the valve-spring cap a sharp tap to release this taper collar. After removing all carbon deposit, the face of each valve seating should be smeared with a good grinding paste and the valve revolved slightly backwards and forwards (never revolve completely) while light pressure is applied to the head. During this operation it is advisable occasionally to raise the head off its seating and turn in the guide slightly, afterwards repeating the backwards and forwards movement.

Generally, only one application of grinding paste will be ample for the inlet, but two or three applications may be necessary to restore entirely the exhaust-valve seating. After this grinding in has been satisfactorily accomplished, all traces of the grinding mixture should be carefully washed off with petrol, and both valve-stems and guides cleaned thoroughly. Prior to re-fitting, it is advisable to smear each valve-stem with graphite grease.

To Adjust Tappets

Remove the O.H.V. rocker-box cover and revolve the engine until the valve requiring adjustment is fully open. Next slack off the lock-nut for the push-rod adjustable end. Turn the engine until the valve is closed, and carefully unscrew the adjustable push-rod end until the correct adjustment is obtained. Turn the engine again until the valve is fully open, and, taking care not to disturb the adjustment obtained, securely tighten down the

lock-nut. Check the adjustment carefully with the nut tight.

Note.—Correct clearance between rocker-ends and valve-stems when valves are down on their seatings and engine cold is the nearest approach to nil obtainable. It should be observed that the hardened steel valve-stem caps are free to be revolved with the fingers while, at the same time, no perceptible up-and-down movement of the rocker is possible. The decompressor lever must necessarily be set to the "off" position when checking valve clearances.

To Re-time Coil Ignition

Remove the bakelite contact-breaker cover and slacken the screw securing the contact-breaker cam. With a small punch operating in one of the slots in this cam give a sharp but light tap. This will loosen the cam on the taper end of the shaft to which it is fitted. Set the piston $\frac{5}{16}$ in. before T.D.C. with ignition lever fully advanced, then gently turn the cam with the fingers in an anti-clockwise direction until the contact points are just about to part. In this position, carefully re-tighten the cam-fixing screw and replace the bakelite cap. It is essential to obtain exactly the prescribed piston setting on the compression stroke—*i.e.*, the stroke at the top of which both valves are closed.

To Adjust the Dynamo Chain

Adjustment of the dynamo chain is arranged by revolving the dynamo unit in its cradle mounting. The correct adjustment should permit a movement of about $\frac{1}{4}$ in. to $\frac{3}{8}$ in. as the top run of the chain is lightly pressed

up and down midway between the sprockets. When checking, try a number of positions and obtain the described adjustment at the tightest place.

To adjust, first slacken the dynamo clamp bolt and then twist the unit bodily in its mounting in a forward or clockwise direction to tighten. Always check the adjustment after the clamp bolt has been re-tightened. With the Model F it will be found that the tension of both dynamo and primary chains can be checked by passing the fingers through the inspection cap orifice, it being, of course, necessary to remove the cap for the purpose. This cap is released upon unscrewing the knurled-edge screw.

To Adjust Primary Chain

To obtain adjustment for the primary chain, provision is made to swing the gearbox bodily on its lower fixing bolt. It will be observed that the upper fixing bolt operates in slotted holes to permit of the necessary movement. To make adjustment, the off-side nut of the top gearbox fixing bolt must first be slackened. Then to tighten the chain adjustment, first slack off the nut on the adjuster bolt nearest the engine and turn the nut farthest from the engine clockwise, until the correct chain adjustment is obtained. Re-tighten the nut nearest engine and also the top gearbox fixing nut. Correct chain adjustment should allow a whip or movement of $\frac{3}{8}$ in. to $\frac{1}{2}$ in. as the top run of the chain is pressed up and down midway between the sprockets.

Note.—Owing to the movement of the gearbox—necessary for correcting the chain—some small alteration to the gear-rod adjustment may be necessary;

therefore, upon completion of the former, the adjustment of the gear control must always be checked and corrected if necessary.

To Adjust Rear Chain

Put down the centre prop stand, and slack off the rear-wheel spindle nuts. Adjust the chain as required by means of the bolts which pass through each of the fork ends, after which securely re-tighten the spindle nuts. The correct adjustment (which should allow a whip of $\frac{3}{8}$ in. to $\frac{1}{2}$ in. when the chain is pressed up and down) should be obtained for the tightest place.

Before tightening the rear chain, the adjustment of the front chain should be inspected, and if attention to each is required, the latter should be treated first.

Important.—Care is necessary when tightening the rear chain to leave the wheel in correct alignment. When correct, a piece of thin string stretched taut across both wheels, about 4 in. from and parallel with the ground, should be observed to just touch each tyre at both sides of the wheel centre. A straight wooden batten about 5 ft. long can be used for checking wheel alignment, applied in the same way as the string.

To Adjust Wheel Bearings

The wheel bearings on this model are of the ball, cup and cone type. Although care in adjustment to avoid over-tightening is required, it is not necessary to adjust with a slight shake as with taper roller bearings. To adjust either wheel bearing, first slack off the near-side axle nut, as well as the thin lock-nut on the inner side of the fork end; then, with the special spanner provided,

turn the cone in a clockwise direction until all shake is taken up; after this, slack off a trifle and re-tighten the locking-nut and outer axle nut.

Steering Head Adjustment—see 1933 models (Chapter I).

Front Forks, Spindle Adjustment

The method of endwise adjustment is identical on this model as for the 1933 models, except that hexagonal-headed spindles are used; it is therefore only necessary to slacken the near-side nuts to permit of spindle rotation. It is unnecessary to disturb the adjustment of the spindle which carries the hand damper control on either model.

Fork Damper—see 1933 models (Chapter I).

Carburetter—see 1939 models (Chapter V).

Engine Service

A detachable liner was fitted to the connecting-rod to enable the big-end to be renewed when required. The liner and the crankpin are the same as are used on all 250-c.c. models made up to 1939. Two ball bearings (R.L.S.7) are used for the driving-side axle. If the plain bush for the timing side is replaced, this should be reamed in position to $\frac{7}{8}$ in. $\frac{+\ 0{\cdot}00075}{-\ 0{\cdot}00000}$ in.

A felt washer is not used to stop oil leaking into the contact-breaker chamber. A special bush with a spiral groove is fitted—the groove should be on the outside of the bush housing.

1935 Models

For lubrication details, reference should be made to models previously described. The general layout of the engines is practically the same as for 1934 models, with

the exception of the introduction of a valve lifter in place of the decompressor used on earlier models. Fig. 1 illustrates the D80 model (500-c.c., O.H.V.).

Engine Service—see 1933 models.

It should be mentioned that the clearance between the rocker-box and the bottom of the petrol tank is very close. If engine noise is heard, or a "knock" is audible when the load is taken up by the engine, make sure the rocker-box is not in contact with the base of the petrol tank. Raise the tank to allow clearance, as desired. This applies chiefly to 500-c.c. O.H.V. models.

Gearbox 500-c.c. Models—see 1939 models (Chapter VII) for Burman-type gearbox.

Gearbox, 250-c.c. and 350-c.c. Models

The Lightweight Burman gearbox was fitted to 250-c.c. and 350-c.c. models.

If the gears disengage under load, this is rarely due to one particular fault, but to a combination of circumstances. To remedy, first try fitting a new rocking pawl. Check the lever at the rear of the gearbox end-cover; if this is loose on its shaft, lost motion will result, and affect indexing of the gears. Wear on any of the dogs, on both the pinions and the gearbox shafts, will have a similar effect. If the trouble is not with the gear-change operating mechanism, it is in the interests of the user to send the complete gearbox to the gearbox makers, for their attention.

Foot-change Mechanism (Lightweight Gearbox)

Prior to 1936, the operating gear was mounted outside

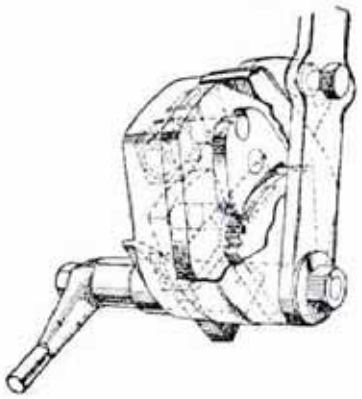


FIG. 9.—SPRING-BOX AND ROCKING-PAWL.

the gearbox. These gearboxes can be converted into the totally enclosed type with new parts, by changing the gearbox end plate. This arrangement is shown in Fig. 9.

If difficulty in selecting the gears takes place, first turn to the pawl in the spring-box, as damage on either end of the pawl will prevent the gears from engaging correctly. Sometimes reversing the pawl has the desired effect. The operating lever is also illustrated in Fig. 10. If the foot-change assembly rocks sideways, use shim-washers to take up movement, with the assembly perfectly free to move when the pedal is operated.

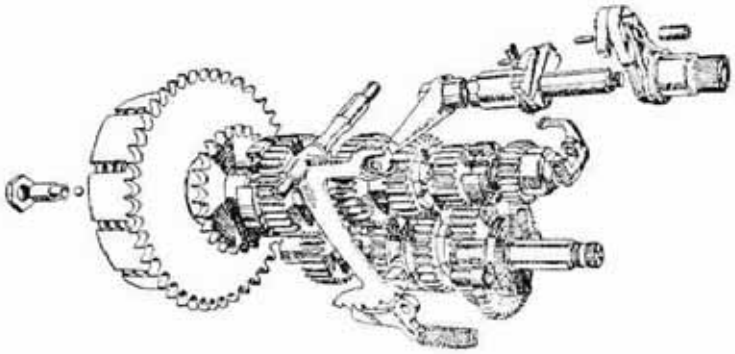


FIG. 10.—FOOT-CHANGE LIGHTWEIGHT GEARBOX. Showing spring-loaded rocking lever.

Clutch (Lightweight Gearbox)

A three-plate clutch is used on all lightweight gearboxes. Friction plates are fitted with Ferodo inserts; cork is not recommended by the makers of the machine. Should clutch slip occur with cork inserts, they can burn out and leave the rider stranded.

Clutch Operating-lever Adjustments

The clutch operating-lever adjustment can be effected by either altering the adjuster for the clutch cable or by the screwed stud in the pressure plate. When the clutch inserts settle down, or wear, the length of the push-rod is increased and this takes up the play between the rod and its operating lever on the gearbox itself. The adjustment should be made so that when the operating lever on the gearbox begins to press on the push-rod, the lever should be approximately at right angles to the ground or parallel with the gearbox shaft. Should the adjusting stud be screwed home too far, the lever will have a bending action on the push-rod.

Clutch Slip—see details for 1939 models (Chapter VII).

Harsh Transmission

Roughness in the transmission can be caused by the shock absorber in the clutch breaking down. If there is undue movement between the clutch sprocket and the clutch drive, this indicates that the shock-absorber rubbers are either worn or broken up. Wear here should be dealt with as soon as possible by replacing the worn rubbers, to avoid breaking the rubber plate and securing bolts, which can drop into the chaincase. The

threads of the securing bolts are burred to prevent the nuts from falling off. A new set of bolts and nuts is desirable when the rubbers are replaced or examined.

Medium and Heavyweight Gearboxes—for normal service instructions refer to 1939 models.

Clutch Operation (Medium and Heavyweight Gearboxes)

The lever operating the clutch is exposed and is shown in Fig. 11. An adjusting stud, as fitted to the clutch-

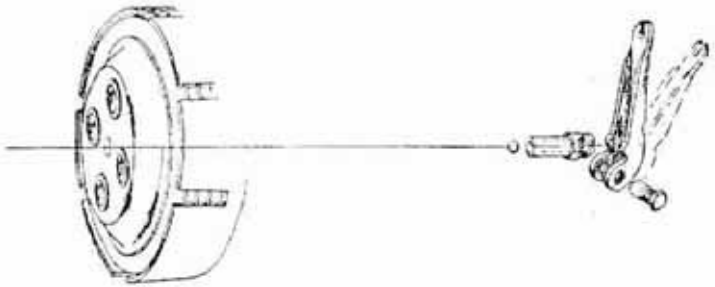


Fig. 11.—Clutch and Clutch-Operating Mechanism Used on C.P.-Type Gearbox.

spring pressure plate on the lightweight models, is not used. Major adjustment to the operating mechanism is made by releasing the clutch cable to allow the lever on the gearbox to clear the adjusting screw, Fig. 11. Altering the position of the adjusting screw has the effect of either lengthening or shortening the push-rod, as desired. A ¼ in. ball is fitted in the end of the sleeve; this can fall out should the sleeve be removed.

Clutch Drag

The use of unsuitable oil in the front chaincase will

cause the friction plates to "stick"; engine oil as recommended by the makers should be used. In severe cases of clutch drag, examine the slots in the clutch driver for dents caused by the tongues of the friction plates. Wear at this point will prevent the clutch plates from moving sufficiently to free the clutch. If the wear is slight, filing the slots will correct this fault. The clutch may be a little noisy after doing this, by reason of the backlash created. Slight backlash can be taken up by drawing out the metal on the tongues for the friction plates; the tongues should be placed on a hard, flat surface and gently tapped to draw out the metal. A little backlash is necessary, otherwise the clutch will also "drag" on this account.

RECOMMENDED LUBRICANTS FOR MATCHLESS MOTOR CYCLES

For Engine Lubrication in Summer: Castrol "Grand Prix"; Triple Shell; Mobiloil "D"; Essolube "Racer"; Motorine "B de Luxe".

For Engine Lubrication in Winter: Castrol "XXL"; Double Shell; Mobiloil "BB"; Essolube "Racer"; Motorine "C".

For Gearbox Lubrication, and All Frame Parts Using Grease: Castrolease "Medium"; Shell "Retinax" Grease C.D.; Mobilgrease No. 2; Esso Grease; Belmoline "C".

For Teledraulic Front Forks: Castrolite; Single Shell; Mobiloil "Arctic"; Essolube 20; Motorine "E".

For Rear Chains: Tallow.

The use of running-in compound containing colloidal graphite added to the engine oil is recommended for running-in a reconditioned or new engine.

CHAPTER IV

1936–1937 MODELS

FOR the 1936 season all single-cylinder engines were vertically situated in the frame, whereas previous models were fitted with inclined engines. The models made for the 1936 season are as outlined in the table below :

Model.	Bore, mm.	Stroke, mm.	Cubic Capacity, c.c.	Engine.
		"Clubman" Models		
36/G2	62·5	80	250	O.H.V.
36/G2M	62·5	80	250	O.H.V.
36/G3	69	93	350	O.H.V.
36 G80	82·5	93	500	O.H.V.
		Tourist Models		
36/D5	82·5	93	500	S.V.
36/X4	85·5	85·5	990	S.V.

G2 models.—Basically the same as model F4, made in 1934 (see previous chapter). Coil ignition fitted; Burman four-speed H.P.-type gearbox.

G2M models.—The same as the G2 model, with the exception that a magneto was used in place of coil ignition.

Model G3.—Hairpin valve-springs were introduced. Fig. 12 shows the general layout and lubrication system.

Model G80.—This is basically the same as the 350-c.c. engine, but the O.H.V. rocker-gear is positively lubricated from the oil pump.

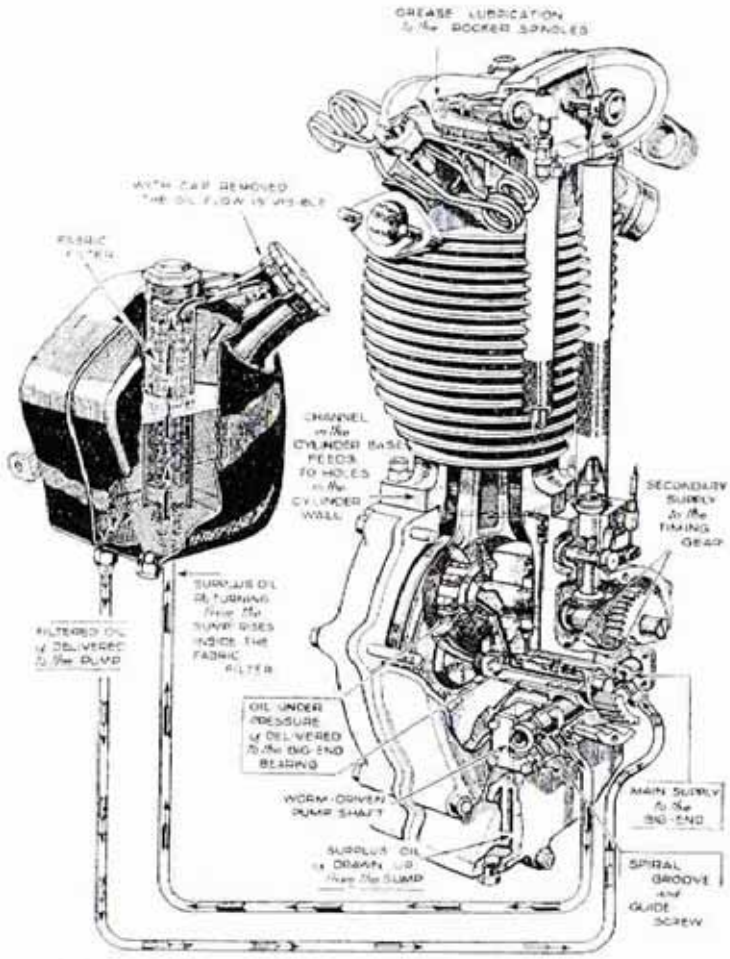


FIG. 12.—ENGINE LUBRICATION SYSTEM FOR MODEL G3.

Model D5.—This has an improved side-valve engine with detachable cylinder-head. A mediumweight C.P.-type gearbox was fitted. Instruction is as for 1934 models.

Model X4.—Basically the same as previous models, but with changes in the connecting-rods and big-end assembly. Forked-type connecting-rods were first introduced for this season. Lubrication details for both gearbox and engine are as for 1939 models.

Engine Service—1936

To decarbonise, it is necessary, on O.H.V. models, to drain and remove the petrol tank for easy working. Two petrol taps and a suitable petrol pipe can be fitted to avoid the necessity of draining the petrol tank for this kind of work. On all engines of the O.H.V. class, it is necessary to turn the engine until both valves are closed, before attempting to remove the rocker-box. The method of removing the cylinder-head and rocker-gear is straightforward, and no special precautions are necessary. The push-rods should be placed so that they can be re-assembled in the same order as they are removed, when re-fitting the rocker-box. Do not overlook the valve end-caps, as the valves will be ruined without the caps in a short space of time.

Note.—Cylinder-head gaskets are used on all 1936 models.

Valve Grinding

Usually only a small amount of grinding is necessary with the inlet valve. Should the exhaust valve-seat show signs of "pitting", the valve should be re-ground by a

suitable machine, otherwise the seating will take a "saucer" shape and a good seal will not be made.

When the valves have been ground-in, a continuous matt surface should show on both the valves and their seatings in the cylinder, or, in the case of O.H.V. engine, in the cylinder-head. As a check, apply a smear of red lead mixed with oil on the seating of the valve, apply pressure on the valve-head and rotate it one complete turn. Examination of the seat in the cylinder or cylinder-head will ensure whether continuous contact is made. This is most important with engines of the twin-cylinder class, as blow-back can occur and affect both performance and, in particular, petrol consumption. With O.H.V. engines, petrol can be poured into the ports to test for leakage past the valve-seats.

Replacing the Driving-side Bearings

On all single-cylinder engines, two separate ball bearings are used. To reassemble, first fit one ball race and see that it is home against the face of the housing. Next, fit the smallest of the two spacing collars, which is actually a distance piece, then the larger of the two spacing collars, which is an oil seal covering the path for the ball bearing, and, finally, the second ball race. These bearings should be a close fit in the crankcase, and fitting will be made easier if heat is applied before fitting.

Small-end Bearing (All Engines)

The gudgeon-pin is a sliding fit in the piston. A number of riders are of the opinion that this bearing should be a close fit, which is not intended by the makers. It is intended for a pad of oil to be maintained between

the gudgeon-pin and the bosses in the piston. A number of owners replace the gudgeon-pin and the gudgeon-pin bush without good reason. It is very rare for a noise to emanate from the small-end bearing, and, in the case of an engine noise, the owner should look elsewhere before replacing this particular bearing. It should be explained that if the gudgeon-pin seizes in the piston, the piston will be ruined during the removal of the gudgeon-pin bush; seizure cannot occur if the gudgeon-pin is a floating fit. The absence of noise from this part of the engine is no doubt due to its generous dimensions.

1937 Models

Model.	Bore, mm.	Stroke, mm.	Cubic Capacity, c.c.	Engine.
37/G2	62·5	80	250	O.H.V. (Coil).
37/G2M	62·5	80	250	O.H.V. (Mag.).
37/G3	69	93	350	O.H.V.
37/G80	82·5	93	500	O.H.V.
37/G2MC	62·5	80	250	O.H.V. (Competition).
37/G3C	69	93	350	O.H.V. (Competition).
37/G80C	82·5	93	500	O.H.V. (Competition).
37/G7	62·5	80	250	S.V. (Coil).
37/G5	82·5	93	500	S.V. (Coil).
37/X	85·5	85·5	990	S.V. (Twin).

Dry-sump lubrication is used on all models similar to earlier engines. Side-valve engines have detachable cylinder-heads. A four-speed gearbox with positive foot-change is used on all these machines.

Engine Improvements

A new type of cylinder-barrel and head was introduced for both 250-c.c. and 500-c.c. side-valve models.

On the 500-c.c. engine the valve-seats were staggered and the exhaust valve-seat was moved away from the cylinder bore. This engine, with its new type of cylinder-head, was remarkably efficient for its class. Machines fitted with a sidecar should have an engine sprocket with eighteen teeth, to avoid detonation, unless a good grade of fuel can be used.

The big-twin was completely redesigned and produced as a fast touring solo mount, with a high maximum speed. Engine details in the main are similar to the 1939 models.

Quickly detachable rear wheels were introduced on the 350-, 500- and 990-c.c. twin models. The lightweight models retained the ball and cup bearing, which are not quickly detachable. Taper roller bearings are used on the heavyweight machines, and service for wheels is described fully for the 1939 models.

Big-end Assembly—1937, 350- and 500-c.c. Models

In an attempt to overcome the rattle from the big-end, mentioned for earlier models, an extra row of rollers (three rows) and a new type crankpin were fitted. This rattle is not due to wear, but is a peculiarity of the engine, and it is only owing to the high degree of mechanical silence of the valve-gear that the noise is heard. This noise is often mistaken for piston slap because no noticeable movement (up and down) can be felt on the connecting-rod; however, if the connecting-rod can be rocked sideways to any extent, oversize rollers must be used if the engine is to be free from mechanical noise. As already stated, the noise can occur when an accumulated clearance of 0·0015 in. is measured. When considering

this, do not overlook the fact that it has accumulated on the crankpin, connecting-rod liner, also the $\frac{1}{4} \times \frac{1}{4}$ in. rollers, and is, of course, a negligible amount. The use of Pool petrol has been the cause of crankpin breakage, mainly when riders allow the engine to "pink" unduly. Breakages were unknown before the war, even when pistons with a compression ratio of 7·5 to 1 were used. The crankpin has been strengthened for the army models, as well as for the civilian machines turned out since 1945. The latest type crankpin can be used on the 1937 engines by enlarging the holes in the flywheels for crankpin to $\frac{7}{8}$ in. diameter $\frac{+0{\cdot}00075}{-0{\cdot}0005}$ in.

FIG. 13.—LAPPING TOOL.

Note.—When oversize rollers are to be used the connecting-rod liner will have to be lapped to enable the rollers to pass the unworn diameter. This will also ensure concentricity of the liner. The makers use a lapping tool, the design of which is too complicated for the average rider to make in his own workshop. As a point of interest, the tool is shown in Fig. 13.

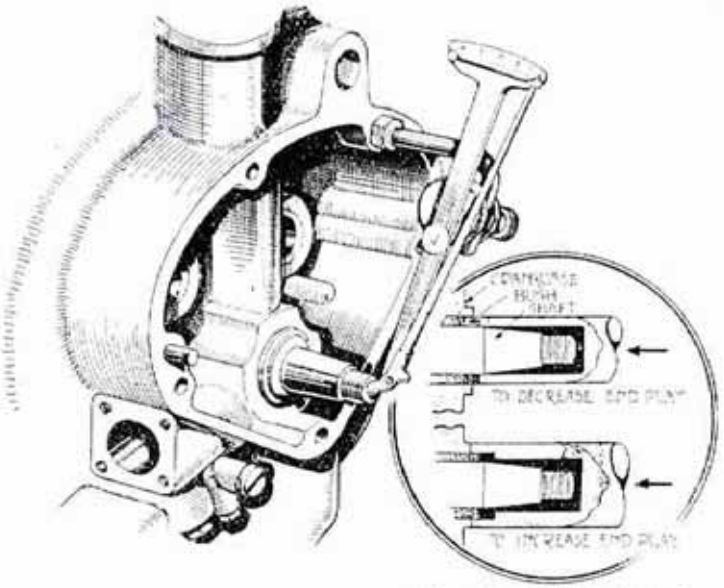
It will be seen that by screwing down the nut, the cast-iron cylinder can be expanded as far as the metal will flex.

Testing Flywheels for Side-play

It is essential that end-float in the flywheels to the extent of 0·015 in. to 0·020 in. is allowed when new timing-side bush is fitted. Fig. 14 shows an easy method of checking the amount of movement between the flywheels and the crankcase. It is, of course, understood

that the shock-absorber on the engine shaft is *not* assembled during this operation.

It will be seen in Fig. 14 that the end-play is adjusted by moving the timing-side bush. A piece of steel tubing, the same size as the bush itself, can be used for driving in the bush to reduce the end movement. Conversely,



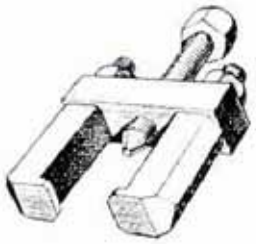
(By courtesy of "Motor Cycling").

FIG. 14.—METHOD OF CHECKING THE AMOUNT OF MOVEMENT BETWEEN FLYWHEELS AND CRANKCASE.

a piece of steel tubing to go over the *outside* diameter of the bush is used for drawing back the bush to increase the flywheel end movement. A light blow on the tubing with a small hammer will move the bush as desired. The method applies to all Matchless engines made since 1930. The bush normally protrudes $\frac{1}{32}$ in. proud of the crankcase face.

Removing Small Timing Pinion

On all Matchless-made engines, the small timing pinion is a taper fit on the timing-side axle; its fixing nut has a *left-hand* thread. This does not apply to the Matchless engines fitted to the Morgan Three-Wheeler. To remove the pinion a sprocket-removing tool is desirable to avoid damage to the teeth on the pinion. A suitable tool is shown in Fig. 15, which can be made if good workshop facilities are available.



[By courtesy of "Motor Cycling".

FIG. 15.—SPROCKET REMOVING TOOL.

If a tool of this kind is not available, the pinion will have to be levered off its shaft. A tyre lever, with one end turned at 90 degrees, and ground or filed until it will pass behind the pinion and the crankcase, can be used. Alternatively, a small wedge can be driven in between the pinion and the crankcase, with inconsequential damage to the pinion. Do *not* attempt to drive the shaft off the pinion unless the pinion is supported against the crankcase bush.

Timing Gear Noise

If the timing gear gradually becomes noisy, and assuming tappet clearance is correct, it is usually due to worn bushes for the cam-wheels, or the timing-side axle. In some cases, a new small pinion will help to take up backlash in the gears normally responsible for valve-gear noise.

When investigating valve-gear noise, disconnect the

valve-lifter cable; it may be short and holding the exhaust tappet away from the base circle of the cam.

Rocker-box

End-play in the rocker-arms is usually blamed for valve-gear noise, but unless the end-play is most excessive, a noise will not occur from this part of the engine. The rocker bushes locate the end movement on all O.H.V. engines, and excessive movement can be taken up either by (1) driving out one or both bushes; or (2) reducing the overall length of the steel sleeve working in the bushes.

In (2), the end of the sleeve must be finished at complete right angles to the axis of the sleeve, and unless this can be carried out properly and with suitable gear, use method (1).

Oil Leaks from Rocker-box

New felt sealing rings are usually required to rectify this fault, assuming, of course, that the bushes are not worn. One of the rocker bushes should be removed to replace the felt ring, and when the new ring is fitted, make up a piece of $\frac{5}{8}$ in. steel with a point, or reduced end, and insert through the felt ring; this will force it into position in its recess. Do not ream the rocker bushes with the felt ring in position, otherwise a proper seal will not be made.

Note.—Should the rockers be replaced, check the new ones against the originals. Rockers were strengthened in later models—the latest type, although similar in design, are thicker and can foul the top of the rocker-box when the valve is at full lift. This applies to all O.H.V. engines made since 1934, using steel rocker-arms. Failure

to correct for this will result in either a bent push-rod or damaged cam, and possibly damage to the foot of the tappet.

Re-fitting the Rocker-box

When re-fitting the rocker-box, carefully examine the highest part and see if there is evidence that the rocker-box has been fouling the bottom of the petrol tank. If so, raise the tank as desired, when it is replaced. Pressure on the bottom sealing rubbers creates an oil-tight joint when the rocker-box is bolted down. If the push-rod tubes can be moved with the fingers sideways, there is insufficient pressure on the rubbers. Take off the rocker-box and fit a steel washer under the rubbers, over the tappet guides, to increase the pressure on the rubber rings. This applies only to the single-piece push-rod cover tube.

Crankcase Release Valve

On all Matchless engines, the crankcase release is mounted on the driving side of the crankcase, and consists of the release-valve body, diaphragm and release pipe. These parts are screwed into a boss machined in the crankcase, close to the driving-side shaft. The release-valve body has a serrated seat, to allow pressure generated in the crankcase to escape into the atmosphere. The diaphragm moves back on to a flat seating in the crankcase when the piston is going upwards or when the pressure is negative. This action prevents the entry of foreign matter into the engine. It follows that, if the diaphragm is unable to move, pressure generated in the crankcase cannot be released; this results in oil leakage,

and, in some cases, the oil consumption will be affected. Oil mist is usually discharged from the release pipe, which can be extended by using a piece of petrol-proof tubing of suitable length to blow on to the rear chain for lubrication. When the discharge is excessive, look for over-oiling, due to leakage past the piston rings, or oil failing to return to the tank from the sump.

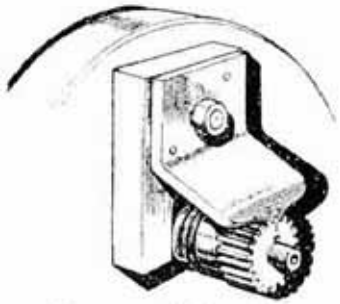
When reassembling the release valve, the diaphragm can become trapped between the release body and seat in the crankcase. Apply a smear of grease on the serrated seat in the body to hold the diaphragm in during assembly. The release valve is not very accessible, but can be dismantled without taking down the front chaincase if long box spanners are used.

Replacing the Timing-side Shaft

On all engines this shaft has a taper shank where it fits into the flywheel. The securing nut is prevented from becoming detached by a 3 B.A. grub screw. It is important that the shaft, if replaced or removed, is correctly positioned, otherwise the oil supply to the big-end will be affected, and the timing gear will be incorrect if assembled to the makers' markings.

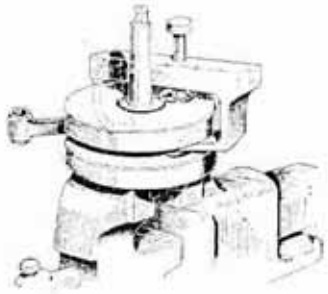
When the shaft is assembled by the makers, a locating fixture is used. Without the use of this fixture, it is essential to ensure that the oil-hole in the taper lines up with the hole in the flywheel and is in complete register. A pencil mark through the centre of the hole in the shaft will act as a guide when the shaft is replaced, to guide it into the hole in the flywheel. The fixing nut must be tight, but not overtightened, as this might split the hole in the flywheel.

To test the oil passage through the shaft and to the big-end, obtain an old gudgeon-pin bush and place it on the timing shaft. Oil squirted by a suitable gun, applied on the hole drilled in the old bush, will enable oil to be forced through the shaft and the big-end bearing, which can be readily observed. It is a good plan to do this when the big-end is dismantled or replaced, as a check that the oil passages are in order. An illustration of a shaft-locating fixture recommended for service outside the factory is shown in Fig. 16.



[By courtesy of "Motor Cycling".

FIG. 16.—SHAFT-LOCATING FIXTURE.



[By courtesy of "Motor Cycling".

FIG. 17.—METHOD OF SEPARATING FLYWHEELS.

Separating the Flywheels

The crankpin has parallel shanks and is a force fit in the flywheel. A hand-press together with two bars of stout steel placed under the flywheel to be removed is normally used for parting the flywheels. When these are not available, a clamp or separating tool can be made up quite easily if suitable workshop facilities are available. Fig. 17 shows the simple construction of this tool, with claws welded on to the puller bar. Two tools of this

kind will be needed in dealers' workshops specialising in engine overhauls for all types of flywheels.

Balancing the Flywheels

Each flywheel is balanced before issue by the makers. Replacements can be used without further attention to this part of the engine. Some owners reduce the total weight of the flywheels for rapid acceleration, but the benefit of such an alteration is questionable.

From a standing start, reduction in flywheel weight can easily set up wheel spin, in which case no benefit will result. There is a possible advantage in reducing the flywheel weight when once the machine is in motion, or over distances of one-quarter or half-mile courses.

Checking Connecting-rod Alignment—see details for Competition models (Chapter X).

TECHNICAL DATA FOR 1937 MODELS

Details.	250 S.V.	250 O.H.V.	350 O.H.V.	500 S.V.	500 O.H.V.	990 S.V.
Top gear	6·4	6·1	5·8	5·0	5·0	4·2
Third gear	9·0	8·5	7·5	6·4	6·4	5·4
Second gear	11·5	10·9	10·3	8·8	8·8	6·7
First gear	19·1	18·0	15·6	13·3	13·3	11·4
Jet size	55	120	150	150	180	130
Throttle slide	4×4	5×3	6×4	6×4	29×4	6×4
Compression ratio	5·1	6·3	6·5	5·1	6·2	5·1
Ignition setting (ins.)	¼	⅜	⅜	¼	⅜	¼
Engine sprocket, Solo.	16	17	18	21	21	24

Sparking-plugs: H1 for O.H.V.; C3 for S.V. models.

CHAPTER V

1938 AND 1939 ENGINES

MATCHLESS models for the years 1938 and 1939 are similar in design and are, therefore, dealt with together. The chief variation from the 1937 range is in the introduction of the special Clubman models. The engines of the latter were fitted with a combined cylinder-head and rocker-box, with enclosed hairpin valve-springs; both inlet and exhaust valves are positively lubricated. The following table shows the models made for the 1938–1939 season.

Model.	Bore, mm.	Stroke, mm.	Cubic Capacity, c.c.	Engine.	Ignition.
38/G7–39/G7	62·5	80	250	S.V.	Coil.
38/G2–39/G2	62·5	80	250	O.H.V.	Coil.
38/G2M–39/G2M	62·5	80	250	O.H.V.	Magneto.
38/G3–39/G3	69	93	350	O.H.V.	Magneto.
38/G4–39/G4	69	93	350	O.H.V.	Magneto.*
38/G5–39/G5	82·5	93	500	S.V.	Coil.
38/G80–39/G80	82·5	93	500	O.H.V.	Magneto.
38/G90–39/G90	82·5	93	500	O.H.V.	Magneto.*
38/X–39/X	85·5	85·5	990	S.V.	Magneto.

The letter "C" included in the engine number denotes Competition models.
* Special Clubman models.

Engine Lubrication System

The engine is lubricated on the dry-sump system. The main bulk of oil is carried in a tank; from there it is

led by gravity to a pump, which forces the oil through a series of channels to the various parts requiring lubrication. The oil is then allowed to drain into the crankcase sump, from which it is extracted and returned to the oil-tank by the pump. This process is continuous while the engine is turning. As the oil-pump is designed so that it is capable of exhausting a greater amount of oil than it is capable of injecting into the engine, the crankcase sump is kept free of excess oil. Therefore, never allow the oil-tank to become empty, or nearly so; there being no reserve of oil in the engine, an empty tank means an immediate shortage of oil to the working parts.

Engine Oil Circulation

The oil-pump has only one moving part—the plunger, which has both a rotating and reciprocating motion. The plunger is rotated by the timing-side flywheel axle, and, while rotating, moves forwards and backwards under the influence of a small guide-screw which engages in a profiled groove cut in the rear end of the plunger.

As the plunger moves in its housing in one direction, the large end draws oil from the crankcase sump, and the smaller end is delivering oil to the various channels provided. On the reverse movement of the plunger, the large end returns to the tank the oil it has already drawn from the sump, while the smaller end takes in a fresh charge of oil from the tank in readiness for delivery to the engine on the next movement of the plunger.

Oil returning to the oil-tank is compelled to pass through a filter in the form of a felt cartridge, before emerging at the spout immediately underneath the oil-tank filler cap to rejoin the main supply of oil in the tank.

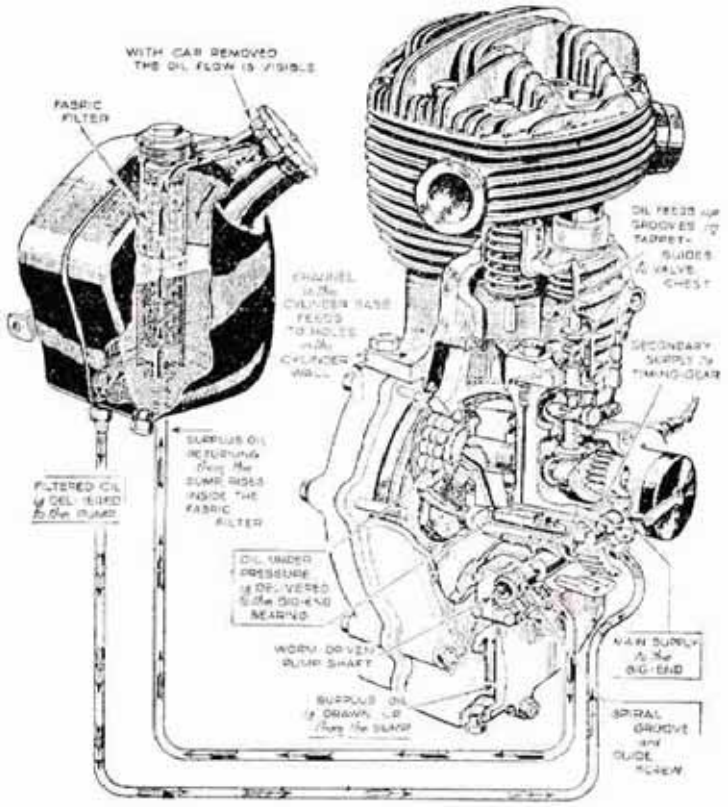


FIG. 18.—SIDE-VALVE ENGINE LUBRICATION SYSTEM.

The felt filter effectively removes all dirt and other foreign matter which the oil may have collected during its passage through the engine.

Reference to Figs. 18 and 19 shows that the oil-pump forces oil through :

(1) A channel to the timing-side flywheel axle bearing, and then through a drilled passage in the

flywheel, to the big-end bearing, the splash from which passes into the interior of the cylinder.

(2) A channel, controlled by a ball valve, direct to the cylinder, so that this, the most vital part of the engine, receives an adequate supply of oil, particularly at high engine speeds.

(3) A channel to the timing-gear case, in which the oil is allowed to "build up" to a pre-determined level, after which all surplus oil drains back into the crankcase sump via a hole cut between the timing-gear case and the flywheel chamber.

(4) On overhead-valve models only, a pipe is fixed to the oil-pump housing front cap and leads to the rocker chamber; by this means all the overhead rocker mechanism and valves are positively lubricated. An ingenious arrangement of oil jets pass a pre-determined quantity of oil, which eventually travels down the push-rod cover tubes and through grooves machined in the tappet guides into the timing-gear case; from there the oil drains back into the crankcase sump, as detailed in paragraph (3).

The Oil Tank

At periods not greater than 5,000 miles the oil-tank should be drained, thoroughly washed out with petrol, and then refilled with fresh, clean oil. A drain plug is provided in the bottom of the tank to facilitate this process.

The felt cartridge oil filter in the oil-tank should be removed and thoroughly washed in petrol on each occasion the engine is decarbonised, or not less often than every 1,500 miles. By unscrewing the hexagon-headed

cap in the top of the tank and lifting away the spring and dished washer, the filter may then be withdrawn from the tube in which it fits.

On all single-cylinder machines, access to the filter is facilitated by removing the two nuts retaining the saddle springs to the saddle frame, and raising the saddle. The filter can then be easily withdrawn in the direction towards the rear wheel.

Oiling Adjustment on O.H.V. Models

The correct delivery of oil to each part of the engine is arranged internally by suitably dimensioned passages, and no provision is made for external adjustment of the oil supply except for the oil feed to the inlet valve-stem on all overhead-valve models. The adjuster on overhead-valve models consists of a needle-pointed screw that can be locked in position by a thin lock-nut. This screw is located in the cylinder-head. Once the adjuster is set it requires little or no adjustment. The approximate correct setting is half a complete turn from the fully closed position.

Valve squeak generally indicates that this valve is not passing enough oil, in which case the needle valve should be unscrewed a trifle. Excessive oil consumption, an oily exhaust, or an oiled plug, in the case of a new machine, usually indicates that the needle-valve is passing too much oil, in which case it should be screwed home, a trifle at a time, till the symptoms disappear.

Fig. 19 shows the oiling system on models G2, G2M and G2MC. The oil circulation on models G3, G3C, G4, G80, G90 and G90C is identical, except that the oil feed to the inlet valve-stem is cast integrally in the cylinder-head

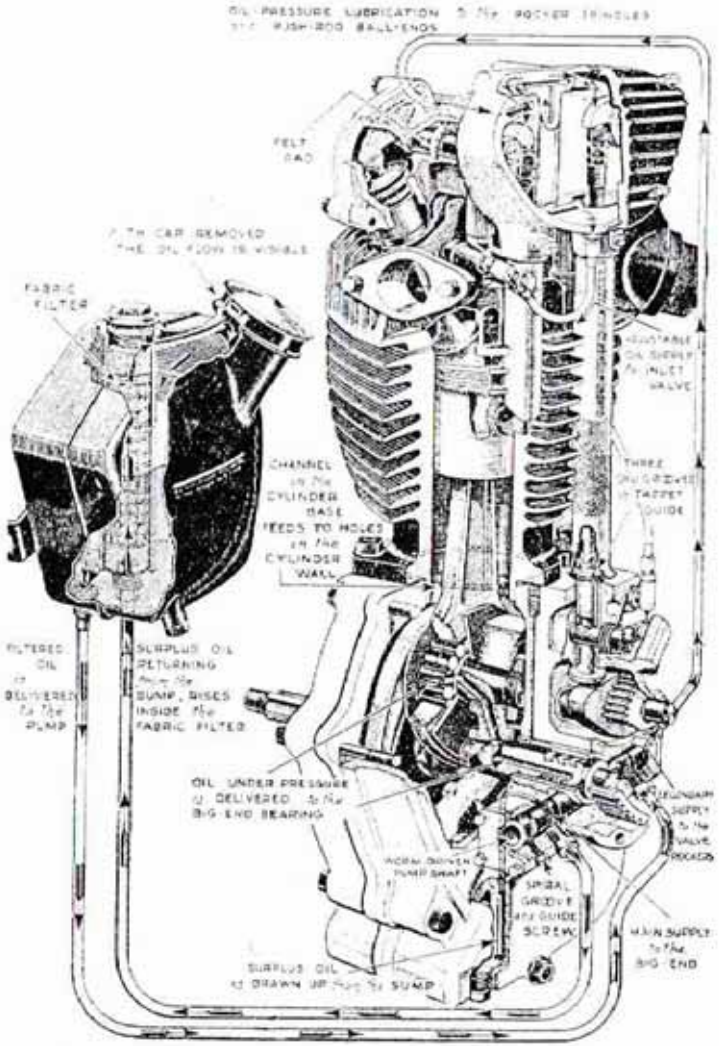


FIG. 19.—ENGINE LUBRICATION SYSTEM WITH DIRECT OIL-FEED FROM PUMP TO ROCKER-GEAR.

in place of the external oil-pipe shown above; also there is an internally cast oil passage taking oil to the exhaust valve. The design of the rocker assembly is of course different.

Overhead Exhaust Valve-stem Lubrication

On all 350 and 500 overhead-valve models there is an oil channel cast in the cylinder-head leading oil direct to the exhaust valve-stem. No adjustment is provided for this oil feed; the oil passage allows oil to flow against the stem, and oil not immediately used by the stem is then by-passed back to the crankcase sump. This constant flow of oil against the stem, followed by the instant removal of the surplus, prevents the oil passage becoming choked with burnt oil. This feature, coupled with the means of lubricating the inlet valve-stem, is a definite advance in engine lubrication design.

Valve-stem Lubrication on Side-valve Models

On all side-valve models, each valve-guide is furnished with a grease nipple in order that each valve-stem can be directly lubricated by means of a grease gun. Only a small quantity of graphite grease, or one of the recommended grades of grease, should be injected through each nipple at intervals not more often than every 500 miles.

Fig. 20 shows the oiling system for the 990-c.c. Twin, which is common to all 990-c.c. models described, and to engines fitted to the Morgan Three-Wheeler. On the O.H.V. Twin, the oil-pipe at D is carried to the rocker-box. The grease nipples for valve-guide lubrication are also shown in Fig. 20.

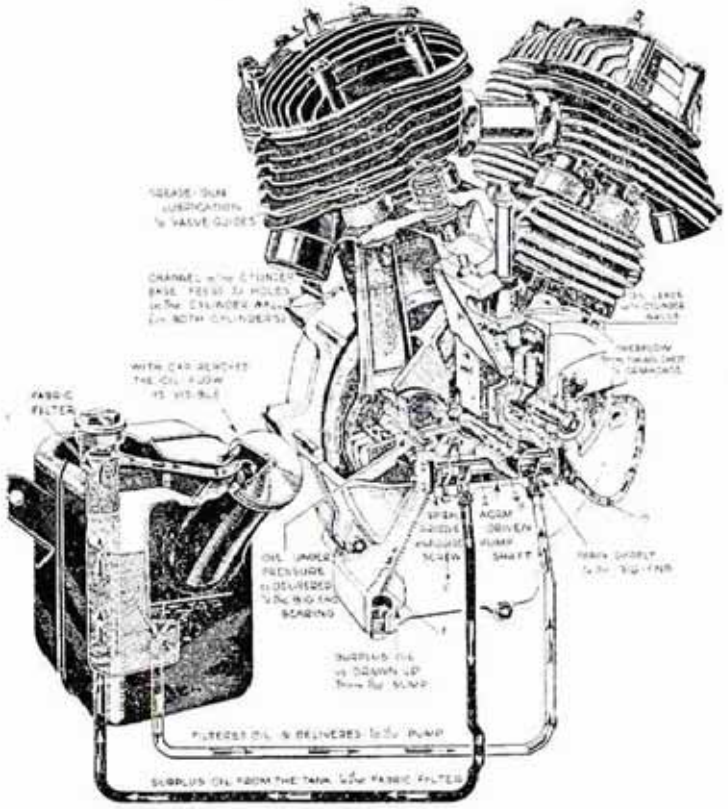


FIG. 20.—BIG-TWIN LUBRICATION SYSTEM.

Oil-pump plunger is rotated by worm on shaft B under influence of screw C. Clean oil is drawn through port D on backward motion of pump plunger. Forward motion returns oil from passage E via filter to oil-tank.

Checking Oil Circulation

Provision is made to observe the oil in circulation, and it is advisable to do this before each run. If the filler cap is removed, the returning oil can be seen running

from the small spout just inside the filler-cap orifice. This check should be made immediately after starting the engine from cold. This is because, while the engine has been stationary, oil from all parts of the interior of the engine has drained back into the crankcase sump, so that until this surplus is cleared, the return flow is very positive and continuous. Therefore, if the oil circulation is deranged, the fact is apparent at once, by the lack of a steady return flow.

At other times, the return flow is somewhat spasmodic and mixed with air bubbles. This is due partly to the fact that the return portion of the oil-pump plunger has greater pumping capacity than that portion delivering fresh oil, and partly to the variations in the amount of oil in suspense in the crankcase according to the engine speed. For example, upon a sudden acceleration, the return flow may completely cease for a time, only, of course, to resume at a greater rate than normal upon deceleration.

Removing the Oil-pump Plunger

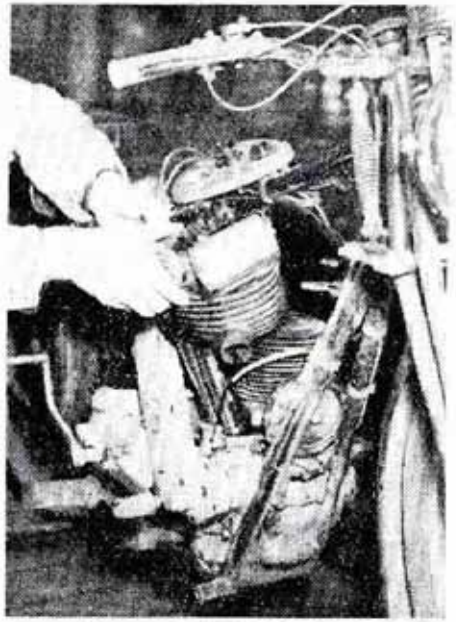
To remove the oil-pump plunger: drain the oil-tank, remove the four bolts holding the oil-pump housing rear cap to the crankcase and take away the cap, unscrew the oil-pump plunger guide-screw. This screw has a hexagon head, and is screwed into the oil-pump housing portion of the crankcase. It is located in the under-side of the housing, just in front of the rear cap. It is at right angles to the plunger and its reduced end engages in the profiled groove cut in the rear end of the pump plunger. After unscrewing the guide-screw, the pump plunger can be extracted from its housing.

Warning.—If, for any reason, the engine is dismantled, the oil-pump plunger *must* be removed before the two halves of the crankcase are separated.

Replacing the Oil-pump Plunger

To replace the oil-pump plunger, see that the interior and exterior of the plunger and its housing are free from dirt. Then smear the plunger with clean engine oil. Insert the narrow end of the plunger in the rear end of the plunger housing and gently push it into place. Next, introduce the guide-screw into its hole and while gently screwing this, slightly move the plunger in a to-and-fro motion until the narrow end of the guide-screw is felt to engage in the profiled groove cut in the end of the plunger. Once the guide-screw has engaged in the groove it should be screwed right home. If the screw does not engage in the groove, and it is tightly screwed against the body of the plunger, the plunger will be prevented from rotating, so that, when the engine is turned for starting, the teeth on the plunger and on the timing-side flywheel axle will be stripped. Therefore, great care must be taken to prevent this occurring.

Now replace the end-caps. It will be noticed that there is a paper washer under each end-cap, and if either, or both, are damaged, it is necessary to replace with new. Both the end-caps must be an air-tight fit on the pump housing, and consequently it is advisable to smear one side of each washer with a small quantity of liquid jointing compound, and to place that side in contact with the end-cap. Note that the cap on the front end of the housing is retained by four cheese-headed screws, and the cap on the rear end is retained by four hexagon-headed bolts,



[By courtesy of "The Motor Cycle Trade".

FIG. 21.—CYLINDER-HEAD REMOVAL ON 350 AND 500-C.C. O.H.V. "SINGLES".

except on side-valve models where bolts are used for both caps.

Engine Service

The petrol tank was modified for both the 1938 and 1939 models. The alteration allows the instrument panel to pass through the aperture in the tank, without disconnecting the wires for the electric system, when removing the petrol tank on models G3, G4, G80 and G90.

On models G2 and G2M, the instrument panel cannot be passed through the tank. To raise the petrol tank in order to provide sufficient room for access to the engine to dismantle parts of it, remove the petrol pipe, tank-connection pipe and the four tank-fixing bolts with their rubber pads and metal washers. Slide the tank backwards until its rear end is resting on the nose of the saddle and insert a wooden block, or other suitable packing, under the forward end of the tank, so as to support the tank at a height sufficient to permit access to the rocker-box fixing bolts. (See Fig. 21.)

To Remove and Replace the Rocker-box (Models G2, G2M and G2MC)

To remove the rocker-box, first raise the tank and disconnect the oil-pipes; remove the two detachable caps enclosing the valve-springs. Next, turn over the engine until both push-rods are free; this is when the piston is at the top of its compression stroke and both of the valves are closed. Should the rocker-box bolts be removed with either, or both, of the valves raised, damage may occur to the rocker-box.

Remove the four bolts that secure the rocker-box, also the four bolts retaining the cylinder-head to the barrel, and the complete rocker-box with rockers assembled and the push-rod cover tubes can be lifted away. While doing this, remove the two long tappet push-rods from the cover tubes, and be careful to lay them aside so that they may be identified, because these should not be interchanged. Finally, remove the two steel caps on the valve-stems.

When refitting the rocker-box, take care that the tappets are both "down" (piston at the top of its compression stroke). Remember to replace the steel caps on the valve-stems, and see that the valve-spring cups are located correctly. The assembly is best done by first of all sliding the rocker-box approximately in position. Make certain that the lower ball ends of the long push-rods are located in the tappet tops, after which, see that the valve-spring cups fit snugly in their respective positions, whereupon the four fixing bolts can be screwed down. Remember each fixing bolt has a metal washer on it. Screw down each bolt, bit by bit, in turn, until all are fully home.

Tappet clearances must always be checked after refitting the rocker-box, and adjusted if necessary.

To Remove and Replace the Cylinder-head (Models G2, G2M and G2MC)

To remove the cylinder-head, raise the petrol tank and remove the rocker-box and the exhaust pipe and silencer as one unit. Unscrew the top cap of the carburetter mixing chamber, withdraw the throttle and air slides, and remove the sparking-plug. Remove the four bolts retaining the cylinder-head to the cylinder-barrel and the head is then free to be taken away. A copper gasket is fitted between the head and the barrel, and if this is damaged in any way, a new one should be used when refitting the head. Screw down the cylinder-head bolts bit by bit, in turn, until all are fully home.

Cylinder-head (Models G3, G3C, G4, G80, G90 and G90C)

To remove the cylinder-head on these models, take off the petrol tank, and disconnect the main oil-pipe to the centre of the cylinder-head. Unscrew the top cap of the carburetter mixing chamber, withdraw the throttle and air slides and remove the sparking-plug. Remove the exhaust pipe and silencer as one unit. Turn over the engine until both valves are closed, with the piston at the top of its compression stroke. Remove the four bolts retaining the cylinder-head. It is necessary to raise the head as high as the frame will permit at the moment of taking the head away from the barrel. A gasket is fitted between the head and the barrel, and if this is damaged in any way, a new one should be used

when refitting the head. See that there is a washer on each cylinder-head bolt. Finally, check the tappet adjustment and, if necessary, re-set.

Cylinder-head (Models G5, G7 and X)

Remove the sparking-plug, unscrew the nuts or bolts fixing the head to the cylinder-barrel, take away the washer that is under each nut and the head is then free to be taken away. If the head-fixing nuts have a dry, rusted appearance, it is advisable to soak them thoroughly with paraffin before attempting to unscrew them.

A gasket is fitted between the cylinder-head and barrel; if this adheres to either head or barrel, it should be gently eased off. An ordinary table knife is an excellent "tool" with which to do this. If the gasket is damaged it should be replaced with a new one when refitting the head. The top face of the cylinder-barrel, the face of the cylinder-head, and both sides of the gasket must be quite clean before they are refitted. To facilitate subsequent removal of the head-fixing nuts, it is a good tip to smear the threads with graphite grease.

After the head has been replaced, and after the engine has run for a short time, it is advisable to go round the cylinder-head fixing nuts again while the engine is warm, as it is most likely that they can all be screwed up a bit tighter.

To Remove the Cylinder-barrel

To remove the cylinder-barrel on models G2, G2M and G2MC, first raise the petrol tank, take off the rocker-box and cylinder-head, and then remove the four nuts that retain the barrel to the crankcase. This will leave

the barrel free to be taken away. While doing this, take care to ensure that the piston assembly does not receive damage.

On models G3, G3C, G4, G80, G90 and G90C, the petrol tank must be removed and then proceed as above.

On G5 and G7 models, after removing the cylinder-head undo all the bolts that retain the exhaust pipe and silencer to the main frame, and remove the pipe and silencer as one unit. Remove the tappet-cover plate and turn over the engine till both valves are closed, with piston at the top of its compression stroke. Then remove the three nuts that retain the barrel to the crankcase.

To remove the cylinder-barrels on model X, take off the cylinder-heads and remove the front and rear exhaust pipe and silencer, as separate units, by removing all the bolts and slackening all the nuts that retain them to the main frame. (The rear pipe is secured to the frame by a bracket close to its front end.) Unscrew the two union nuts that retain the inlet pipe to the cylinders. This will enable the inlet pipe, complete with the carburetter, to be taken away. Next, remove the two tappet-cover plates. Turn over the engine till both of the valves of the front cylinder are closed. Then remove the three nuts that retain the front cylinder to the crankcase. Remove the rear cylinder in exactly the same manner as the front cylinder.

To Remove Piston

To remove a piston, having already removed the cylinder-barrel, fill the throat of the crankcase with rag.

Then, using the special pliers supplied by the makers,

compress the two ends of one of the gudgeon-pin circlips and extract the circlip from the piston. It is immaterial which clip is extracted, because the gudgeon-pin is parallel. Push the gudgeon-pin out of the piston, withdrawing it from the side from which the circlip was removed. This action frees the piston from the connecting-rod. The gudgeon-pin is an easy sliding fit in the piston and the gudgeon-pin bush so that there should be no difficulty.

To Remove and Replace Valves (Models G2, G2M and G3MC)

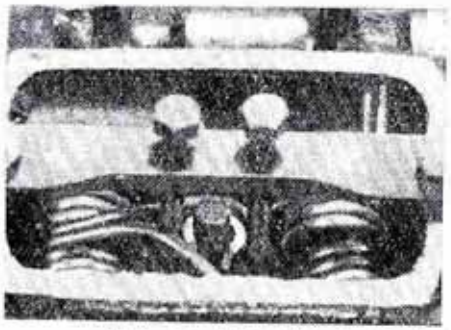
After the cylinder-head has been removed in the manner already described, it will be found convenient to rest the head of each valve, in turn, on a small wood block while the valve-springs are compressed, to allow the valve-spring cap divided collets to be removed from the grooves cut in the valve-stems. These collets are a taper fit, and it may be necessary to give the valve-spring cap a sharp tap in order to release them. On removal of the split collet, the pressure on the valve-spring cap should be released to permit the removal of the valve-spring cap and the springs.

To replace the valves, smear each stem with engine oil and then reverse the procedure described above.

The Valves on Models G3, G3C, G4, G80, G90 and G90C

Before the valves can be removed, it is necessary to withdraw the overhead rockers. After the cylinder-head has been removed in the manner already described, proceed as follows :

Remove the two aluminium plates that are retained to the top of the cylinder-head by two bolts in each plate. Remove the aluminium plate that is retained to the side of the cylinder-head by a knurled nut, and also unscrew and remove the two plated caps that are screwed into the left-hand side of the cylinder-head. It is necessary to remove the rocker-arm over the valve before the valve-springs can be removed.



[By courtesy of "The Motor Cycle Trader".

FIG. 22.—VALVE REMOVAL TOOL IN POSITION AND COTTERS LOOSENED ON 350-C.C. O.H.V. ENGINE.

Proceed by releasing the nut for the rocker-axle in the push-rod chamber. Unscrew the rocker-axle nut on the opposite end, using a $\frac{5}{16}$ in. box spanner. Tap out the rocker-axle, using a stick of brass as a drift, to avoid damage to the thread. The valve-rocker will leave the shaft during this process. Next, proceed to remove the valve. A special valve-spring compressing tool is required (see Fig. 22) to facilitate this operation; it consists of a bar having two pointed screws threaded in it. The bar is fixed across the top face of the valve-spring chamber with the two pointed screws engaging in the depressions cut in the valve-spring top cap, and it is held in position by the two small bolts that normally secure the aluminium cover over the valve-spring chamber.

Each pair of valve-springs is positioned by a mounting block which is secured by two screws. The four screws for the valve-spring mounting blocks will be observed in the apex of the cylinder-head; each screw is locked in position by a lock-nut. If these screws are slackened, the mounting blocks with the valve-springs may be removed from the head. Note the position of the valve-springs in the block, and ensure the springs are fitted correctly on assembly. The valve will seize, due to side pressure, if the springs are replaced incorrectly; if in doubt, refer to Fig. 23.

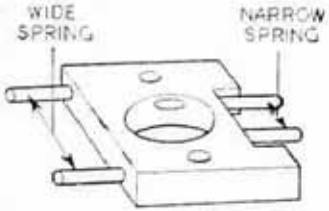


FIG. 23.—VALVE-SPRING HOLDER.

To reassemble a valve, proceed as follows:

The mounting block and the two valve-springs must be laid in position. Then compress the valve-springs using the valve-spring compressing tool, insert the valve, and place the taper split collet in position. Unscrew the two screws so that the pressure on the springs is taken off evenly, and, while doing this, observe that the collet is retained in its correct position.

The next operation is to secure the valve-spring bottom block by means of the two positioning screws, at the same time seeing that the coils of both springs are clear of all parts of the casing. Do not use excessive force on these screws; their object is merely to locate the springs, so that, while in operation, the springs do not foul any part of the confined chamber in which they work.

Replace the overhead rocker. Fully tighten the nut

on the valve-end rocker (left-hand side) first, and then fully tighten the nut that retains the rocker-arm on the push-rod end of the spindle (right-hand side).

The two top aluminium covers may now be replaced, but the side cover should be left off until the head has been fitted to the cylinder-barrel, in order that the tappet adjustment may be checked, and, if necessary, re-set.

To Remove and Replace the Valves (Models G5, G7 and X)

To remove a valve, first remove the cylinder-head and the tappet-chest cover, as already described, and then, using a stout screwdriver, or other suitable lever, raise the valve-spring bottom collar; at the same time, hold the valve down on its seat, and withdraw the valve cotter. This action will free the valve so that it may be extracted.

Tappet Adjustment on all O.H.V. Models

The top ends of the long tappet push-rods have screwed extensions. These are locked in position by nuts, and this provides tappet adjustment. The correct tappet clearance between the rocker-ends and the valve-ends, when the valves are completely closed and the engine is cold, is the nearest possible approach to nil. This means that the push-rods should be free enough to be revolved by the fingers without any binding, and, at the same time, there should be no appreciable up-and-down movement. To adjust the tappet clearance, remove the rocker-box cap to obtain access to the adjustable screwed ends mentioned above. Turn the engine until the piston is at the top of its compression stroke, in which position

both of the valves will be closed. With spanners, hold the body C and slacken lock-nut B (Fig. 24). Then screw, in or out, the head A, until the clearance is nil. Next, tighten lock-nut B and re-check the clearance. Finally, replace the rocker-cap, taking care to replace the fibre washer under each knurled nut. Do not over-tighten these nuts, because the joint is made with a rubber fillet, and undue pressure is not necessary. Excessive pressure may crack the cap.

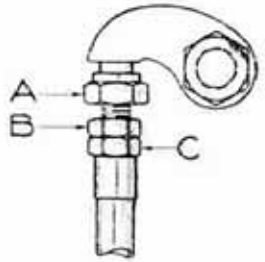


FIG. 24.—O.H.V. TAPPET ADJUSTMENT.

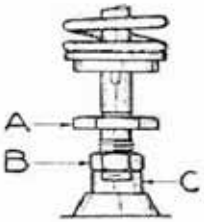


FIG. 25.—SIDE-VALVE TAPPET ADJUSTMENT.

Tappet Adjustment on all Side-valve Models

The top ends of the tappets have screwed heads. These are locked in position by nuts and this movement provides tappet adjustment (see Fig. 25). The correct clearances between the valve-stems and the tappet heads, when the valves are completely closed and the engine is warm (not hot), are:

Model G5—Inlet 0·004 in. Exhaust 0·006 in.
Model G7—Inlet 0·012 in. Exhaust 0·012 in.
Model X —Inlet 0·004 in. Exhaust 0·006 in.

To adjust the tappet clearance: Remove the tappet chamber cover and turn over the engine until both

valves are closed. With spanners, hold the body C and slacken the lock-nut B. Then screw, in or out, the tappet head A until the clearance is as set out in the above table. Next, tighten lock-nut B and re-check the clearance. Finally, replace the tappet-chamber cover. Note that this has a cork washer and it is advisable to stick this washer to the cover with some liquid jointing compound.

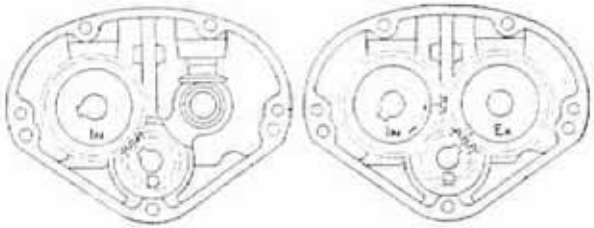


FIG. 26.—SETTING TIMING GEARS (ALL MODELS EXCEPT X).

Valve Timing on all Models except X

The timing gears are marked to facilitate replacement; when checking the valve timing, the tappet clearances must be set to 0·016 in. (See data on page 104.) To re-set the timing gears: Turn over the engine till the mark on the small timing pinion D, Fig. 26, is in line with the centre of the inlet (rear) camshaft bush. Insert the inlet camshaft "IN" so that the mark on it is in mesh with the mark on the small pinion D. Then rotate the engine in a *forward* direction till the mark on the small timing pinion D is in line with the centre of the exhaust (front) camshaft. Then insert the exhaust camshaft "EX" so that the mark on it is in mesh with the mark on the small timing pinion D.

Valve Timing (Model X only)

The timing gears are marked to facilitate their replacement. The valve timing is given in the data table on page 104, and, when checking it, the tappet clearances must be set to 0·016 in.

To re-set the timing gears obtain four bolts, or pieces of metal, each about $1\frac{3}{4}$ in. long and not more than $\frac{7}{16}$ in. in diameter, and proceed as follows:

Remove the tappet-chamber covers from the cylinders and turn over the engine until the mark on the small timing pinion is pointing to the centre of the bush for the timing camshaft. Take all spring pressure off the timing cam levers by placing the pieces of metal between the valve-spring bottom collars and the base of the valve chamber. Next, insert the camshaft so that the mark on it is exactly opposite to the mark on the small timing pinion.

Cam Contour

Owing to the presence, on the cam flanks, of what are technically known as quietening curves (which actually are very slight inclines from the base circles of the cams to the feet of the humps), it is necessary to make certain that the tappet ends are on the base circles when checking valve clearances. It is for this reason that the clearances should be checked when the piston is at the top of its compression stroke, at which position both tappets are well clear of the quietening curves. For the same reason, it is necessary to check the valve timing with a tappet clearance of 0·016 in., which is sufficient to skip the slight incline.

To Re-time the Ignition

Have available a stout screwdriver, or an old-type tyre lever having a short turned-up end, and a bar of metal not less than $\frac{3}{16}$ in. in diameter and approximately $5\frac{1}{2}$ in. long (the tommy bar of a tubular box spanner is suitable).

To prepare for re-timing: On magneto models, remove the sparking-plug, outer cover of magneto chaincase and contact-breaker cover. On coil ignition models, remove the sparking-plug and the contact-breaker cover. On all O.H.V. models, remove the rocker side cover plate. On all side-valve models, remove the tappet-chamber cover plate (the plate on the rear cylinder on model X).

Then proceed as follows, according to the model.

Models G2M, G2MC, G3, G3C, G4, G80, G90 and G90C.—Unscrew the nut that retains the lower magneto sprocket and gently lever the sprocket from the taper on the camshaft to which it is attached.

Turn over the engine until both valves are closed, and, with the rod inserted through the plug-hole, feel the piston till, by partially rotating the engine, forwards or backwards, the piston is felt to be at the extreme top of its stroke. Place a mark on the bar, level with the top of the plug-hole, remove the bar, measure above the mark the advance recommended in the table on page 104 and record the position on the bar. Place the handle-bar ignition control lever in the fully advanced position, re-insert the bar in the plug-hole and slightly rotate the engine *backwards* until the upper mark on the bar is level with the top of the plug-hole.

By turning the sprocket on the magneto shaft, rotate the magneto in an anti-clockwise direction (as seen when

viewing sprocket) until the contact-breaker points are just about to separate. Tighten the nut on the camshaft, taking care not to move the engine and/or the magneto shaft when doing so. Recheck the setting.

Model X.—Proceed exactly as described above, but time on the rear cylinder and the lower of the two humps, or cams, on the contact-breaker cam-ring.

Models G2, G5 and G7.—To time the ignition on these models, slacken the screw securing the contact-breaker cam, and, with a small punch operating in one of the slots in this cam, give a sharp but light tap. This will loosen the cam from the tapered end of the shaft to which it is attached.

Turn over the engine until both valves are closed and set the piston position as described for models G2M, etc., above. When this has been done, gently rotate the contact-breaker cam, with the fingers, in an anti-clockwise direction, until the contact points are just about to separate, in which position carefully retighten the screw that retains the cam. Recheck the setting.

Before timing the ignition, check the gap between the contact points, and adjust if necessary. To find the exact moment for the commencement of the point separation, place a piece of tissue paper between the points and turn the magneto armature until the paper is just released, and no more, by a gentle pull.

Carburation

The petrol level is maintained by a float and needle-valve, and in no circumstances should any alteration be made to it. In the event of a leaky float, or a worn needle-valve, the part should be replaced with new.

The petrol supply to the engine is controlled (1) by the main jet, and (2) by means of a taper needle which is attached to the throttle-valve and operates in a tubular extension of the main jet.

The main jet controls the mixture from three-quarters to full throttle, the adjustable taper needle from three-quarters down to one-quarter throttle, the cut-away portion of the intake side of the throttle valve from one-quarter down to about one-eighth throttle, and a pilot jet, having an independently adjusted air supply, takes care of the idling from one-eighth throttle down to the almost closed position.

These various stages of control must be kept in mind when any adjustment is contemplated.

With the standard setting it is possible to use full, or nearly full, air in all conditions, except, perhaps, when the engine is pulling hard uphill or is on full throttle, when some benefit may be obtained by slightly closing the air control.

Weak mixture is always indicated by popping, or spitting, at the air intake. A rich mixture usually causes bumpy or jerky running, and, in some cases of extreme richness, is accompanied by the emission of black smoke from the exhaust.

A rough test to ascertain if the setting is correct, is to warm up the engine, and, with the ignition fully retarded, and the air about three-quarters open, slowly open the throttle to full open, during which the engine should respond without a misfire, but upon a sudden opening of the throttle, it should splutter and stop. (The engine should not be run more than a few seconds with the ignition fully retarded.)

To check the setting of the pilot jet and its air control,

warm up the engine, then, with the ignition about two-thirds advanced and the air about three-quarters open, the engine should idle positively and evenly when the throttle is almost closed. If it fails to do so, adjust the pilot jet air-screw, inwards or outwards, until even firing is obtained. (The pilot jet air-screw will be observed at the base of the mixing chamber and its position is locked by a nut.) This adjustment is not unduly sensitive, and it should be possible to obtain the correct adjustment in a few seconds.

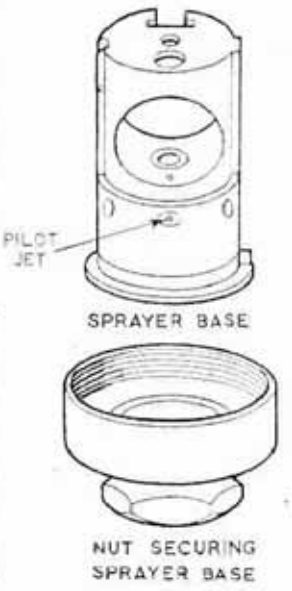


FIG. 27.—LOCATION OF PILOT JET.

In the event of the adjustment of the air-screw failing to provide the required result, it is possible that the pilot jet is obstructed with dirt. The pilot jet is actually a passage cut in the sprayer base, or choke, and is very small, so there is always a latent danger of this becoming choked. Upon removing the float chamber and the large union nut at the bottom of the mixing chamber, the sprayer base can be pushed out of the mixing chamber, and the jet can then be cleared by using a strand of fine wire. Fig. 27 shows clearly the location of the pilot jet in the sprayer base, or choke.

A throttle stop-screw, which is locked in position by a nut, is located in the side of the mixing chamber. This screw runs obliquely into the chamber and is situated above the pilot jet air-adjusting screw.

The position of the throttle stop-screw determines the position of the throttle when "closed". Some riders prefer to set this so that when the throttle control (twist grip) is in the closed position, the throttle is completely closed, and the engine cannot run. Others prefer to set it so that when the throttle control is "closed", the throttle is prevented from completely closing and the engine can therefore continue to run at idling speed.

Late ignition usually causes a great increase in petrol consumption.

Twist Grip Adjustment

A screw is provided in one half of the twist-grip body to regulate the spring tension on the twist-grip rotating sleeve. This screw is locked by a nut and must be screwed into the body to increase the tension. The most desirable state of adjustment is when the grip is quite free and easy to turn, but, at the same time, will stay in the position in which it is placed.

Technical Data for 1938-1939 Engines

Horse Power (A.C.U. rating).	G2, G2MC, G2M, G7	2·46
	G3, G3C, G4	3·47
	G5, G80, G90, G90C	4·98
	X	9·9
Valve Timing (with 0·016 in. tappet clearance).		
Inlet opens B.T.D.C.	All except X	20°
		32° (1945–49)
	X	15°
Inlet closes A.B.D.C.	All except X	67°
		63° (1945–49)
	X	50°
Exhaust opens B.B.D.C.	All except X	78°
	X	58°
Exhaust closes A.T.D.C.	All except X	28°
	X	12·5°

Ignition Advance (max.) in. of piston position before T.D.C.	G5, X	¼
	G2	5/16
	All except G2, G5, X	7/16
		½ in. (1945–49)
Tappet Clearance (in.)		
Inlet	All O.H.V.	Nil.
	G7	0·012
	G5, X	0·004
Exhaust	All O.H.V.	Nil.
	G7	0·012
	G5, X	0·006
Sparking-Plug Gap (in.)	All	0·018 to 0·020
Size of Main Jet	G80, G90, G90C	180
	G3, G3C, G4, G5	150
	X	130
	G2, G2MC, G2M	120
	G7	55
Size of Choke	G7	4–058
	G2, G2M, G2MC	5–058
	G5	6–057
	G3, G3C, G4, X	6–058
	G80, G90, G90C	29–068
Size of Throttle Slide	G7	4 × 4
	G2, G2M, G2MC	5 × 3
	G3, G3C, G4, G5, X	6 × 4
	G80, G90, G90C	29 × 4
Petrol-Tank Capacity (gallons).	All except G2MC, G3C, G90C	3
	G2MC, G3C, G90C	2
Oil-Tank Capacity (pints)	All	3
Piston-Ring Gap	0·003 in.–0·004 in. per 1 in. in bore size.	
Standard Compression Ratio	G2	6·33 to 1
	G2M, G2MC	6·0 to 1
	G7	4·7 to 1
	G3, G3C, G4	6·6 to 1
	G5	5·0 to 1
	G80, G90, G90C	5·9 to 1
	X	5·4 to 1
Sparking-Plug	S.V.—Lodge C1 or K.L.G. F50	
	O.H.V.—Lodge H14 or K.L.G. F70	

CHAPTER VI

POST-WAR ENGINES

POST-WAR models were introduced for the 1945 season and are confined to two models only, *i.e.*, 350- and 500-c.c. O.H.V. machines. With certain improvements the same design was continued up to 1949. Owners of 1945–1949 models can refer to technical data for 1939 models (pages 104–105), as engines are identical. The engine alterations are as follows :—

1947 Models

(1) Introduction of increased oil-pump speed with new timing-side axle for pump drive (two-start type).

(2) Larger oil return passage in timing-half crankcase with larger diameter oil-return pipe.

(3) Two-piece oil-pump guide screw pin.

(4) Connecting-rod shortened $\frac{1}{2}$ in. with lower gudgeon pin in piston to reduce angle of tilt on piston at T.D.C.

(5) The use of a long plain bush for timing-side bearing, in place of roller bearing with short bronze bush.

Engines with "B" included in the engine number indicate plain bush of latest type.

Note : The improved oil-pump delivers the same amount of oil per stroke at twice the speed of the earlier type pump.

1948 Models

The 1948 models were basically as for 1947, with the following alterations :—

(1) Annular groove for two-start pump increased to $\frac{1}{4}$ in. with guide pin to suit.

(2) Wire-wound pistons fitted to late 1948 deliveries.

(3) 500-c.c. crankcase and flywheel for both models with engine numbers above 8,000.

(4) 7-in. brakes.

1949 Models

Lower part of engine as for 1948 models. Improvements confined to :—

(1) New-type cylinder, cylinder-head and rocker-box.

(2) New valves with hardened ends; new guides.

(3) Hairpin valve springs.

(4) Valve lifter transferred from crankcase to rocker-box.

(5) Wire-wound pistons for both models.

Engine Service for 1945–1949 Models

First refer to 1939 O.H.V. engines as described in the previous chapter, which also applies to the above models.

Lubrication

Parts for the two-start pump are identified by "2s." stamped on both the oil-pump plunger and timing-side axle. A new-type pump will not interchange with the old type without suitable timing-side axle and crankcase alterations. A new timing-half crankcase with oil pipe and alteration for larger union in the oil tank are necessary.

Heavy Oil Consumption or Over-Oiling

A modification to the oil-pump plunger for 1947–1948 models was introduced by grinding back the flat on the small diameter of the plunger to the extent of 0·040 in. With the early type pump plunger the hole for delivery (in flat on plunger) is central. With the modified plunger this has the appearance of the hole being moved to one side (see Fig. 27A). When oil consumption is heavy

(normal 2,500 m.p.g.), a modified oil-pump plunger, which curtails the oil supply to the top part of the engine, will greatly improve the oil consumption. For extreme economy replace the felt sealing ring for the inlet rocker.

Original. Modification.

FIG. 27A.—OIL-PUMP PLUNGER MODIFICATION FOR 1947–1948 MODELS.

Piston Noise

Piston noise is entirely a matter of clearance between the cylinder and piston; the generous finning on the cylinder amplifies slight piston noise and it can be termed "fin" ring. The latest wire-wound piston uses a running clearance of 0·001 in., which is exceedingly small for an alloy-type piston. The wire-wound piston cannot be used in the 1945–1946 models, unless the connecting-rod is exchanged at the same time. The position of the gudgeon pin on the wire-wound piston is lower by $\frac{1}{2}$ in. and there is insufficient space on the earlier type pistons for the wire binding to be used, which explains why the new type connecting-rod must be employed.

The new type piston is best suited to a new or unworn cylinder, otherwise the clearance will be in excess of that recommended by the makers. The cylinder should therefore be rebored before using a piston of the wire-wound type.

Only one oversize piston is available, namely, plus 0·020 in. The normal cylinder size for the 500-c.c. engine is 3·250 in., with a tolerance of plus or minus 0·0005 in. Rebore to 3·270 in. with the same tolerance.

With the 350-c.c. engine the normal cylinder-bore size is 2·7187 in. plus or minus 0·0005 in. Rebore to 2·7387 in. with the same tolerance. The actual clearance is allowed for in the finished size of the piston.

Timing-Gear Noises

An intermittent noise from the timing gear at low engine speeds, which disappears as the engine speed increases, can be due to end-play between the camshaft and the crankcase. This usually occurs on the inlet cam. To locate the cause of the noise, remove the magneto chain-case, run the engine on the stand until the noise is reproduced. Press on the end of the shaft which drives the lower magneto sprocket with the wooden handle of a screwdriver, or similar tool, and if the noise ceases, end-play is the cause. A shim washer can be fitted over the shaft, or the outside bush can be moved inwards.

Compression Plate

Standard fitting on all 500-c.c. models since 1939. Removing the plate increases ratio to 7·24 to 1. Use 25 per cent. benzole, 75 per cent. Pool with this ratio or No. 1 fuel.

High-Compression Pistons

Obtainable for models 1947–49 with short connecting-rod ($6\frac{7}{8}$ in. centres).

Compression Ratios

500-c.c. . . 8·9 to 1 (with $\frac{1}{8}$-in. plate 7·25 to 1)
350-c.c. . . 9·5 to 1 (with $\frac{1}{16}$-in. plate 8·4 to 1)

Use methanol, or 50/50 fuel. For methanol increase main jet 100 per cent.; use needle jet orifice 0·113 in. diam.

CHAPTER VII

STEERING, WHEELS AND TRANSMISSION

THE following notes cover models from 1938, but some of the instructions given also apply to previous models, and are referred to, where necessary, in the earlier chapters.

Steering-head Adjustment

The steering-head races are of the floating, self-aligning type, and have spherical seats. The two races in the head lug and the race in the head clip are all identical.

Occasionally test the steering-head for correct adjustment by exerting pressure, upwards, from the extreme ends of the handle-bars. The steering damper should be completely slack. Should any shake be apparent, jack up the front of the machine so that all weight is taken off the front wheel, slacken the top nut on the steering column, and screw down the lower nut until all trace of slackness has disappeared. Then tighten the upper nut while holding the lower nut.

Fork-spindle Adjustment

Never attempt to adjust more than one spindle at a time. Slack off both spindle nuts, and, by means of the small hexagon on the right-hand side of the spindle, turn the spindle in a clockwise direction to take up play between the fork girders and the links. Do not turn the spindle more than half a revolution before tightening the two

spindle lock-nuts and testing the adjustment. Guard against having the adjustment too tight, because the fork will then be very stiff in action, or, most probably, refuse to function. The washers which are fitted on the spindle ends are not provided for frictional purposes, but to prevent actual seizure in the event of the fork-spindle adjustment being too tight.

Fork and Steering Damper Adjustment

The fork damper is best adjusted when the machine is actually in motion. A road with a badly corrugated surface provides the best conditions for this purpose. The ebonite hand-nut should be screwed home, in a clockwise direction, sufficiently to make the fork action sluggish in the circumstances described above, and subsequently should require very little attention for other conditions.

The steering damper is controlled by the ebonite hand-nut mounted on top of the steering column. This nut should be turned in a clockwise direction to increase the damping action. Normally, very little damper action is required or is desirable.

To Remove Front Wheel

To remove the front wheel on models G2, G2M and G7 (ball-bearing type), place the machine on the rear and front stands. Unscrew the knurled nut on the front-brake rod and remove it. Unscrew the speedometer cable from the speedometer gearbox. Slacken both nuts on the front-wheel axle; if the two washers on the axle are slid outwards, along the axle, till they are clear of the recesses in the fork-end lugs, the wheel is free to drop out.

To refit the front wheel, reverse the procedure described above, taking care to engage the slot in the brake cover plate with the peg brazed to the inside of the left fork girder.

On the model G2MC, instructions are as above, except that instead of unscrewing a knurled nut, remove the split pin and pin retaining the front-brake yoke-end to the front-brake expander-lever.

On the other models, the procedure is the same as for model G2MC, with the addition that the nuts and bolt securing the front-brake anchor-plate to the left fork girder have to be removed.

To Remove the Rear Wheel (Models G2, G2M and G7, Ball-bearing type)

To remove the rear wheel, place the machine on the rear stand and disconnect the rear-lamp cable-connector. Take away the two nuts and washers that retain the back half of the rear mudguard to the fixed front half, and slacken the two nuts that retain the rear tubular arch to the studs in the rear fork ends. This will enable the rear half of the rear mudguard with the tubular arch to be taken away from the machine. Take out the bolt that retains the rear-brake anchor-plate to the rear-fork tube. Revolve the rear wheel until the spring connecting link in the rear chain is accessible and remove the spring link. Loop up the two free ends of the chain so that they are out of the way. Remove the knurled adjusting nut from the rear end of the rear-brake rod. Slacken the nut on either side of the rear-wheel axle, undoing each nut two or three turns, and this will leave the rear wheel free to be withdrawn, towards the rear, till it is clear of the machine.

After replacing the rear wheel, check the rear brake adjustment.

To Remove Rear Wheel (Models G2MC, G3, G3C, G4, G5, G80, G90, G90C and X).

The rear wheel is of the quick detachable type, and, in order to remove it, there is no need to disturb any part of the rear brake and final drive.

To remove the rear wheel, remove the rear-lamp cable and rear half of the mudguard, as above. Remove the three square-headed sleeve-nuts that secure the hub flange to the brake drum. Remove the nut on the wheel centre solid spindle (left-hand side of the machine), and withdraw the spindle from the right-hand side of the machine. This action will free the distance piece fitted on the centre solid spindle and located between the inside of the right fork end and the hub. By moving the wheel to the right, in order to disengage it from the driving studs in the brake drum, it is free to be taken away from the machine.

In no circumstances must the centre solid spindle be removed until the machine is placed on the rear stand, and the spindle must always be in position before the machine is taken off the stand.

If it is desired merely to remove the inner tube of the rear tyre, this can be done without removing the wheel from the machine. Place the machine on the rear stand, remove the tube from the tyre. Remove the nut on the rear wheel centre solid spindle (on left side of machine), withdraw the spindle and spring the right fork sufficient to allow the distance piece on the solid spindle and located between the inside side of the fork end and the hub to drop out. This will leave sufficient space between the

fork end and the hub to enable the inner tube to be taken away.

Periodically test, with spanners, the nut on the centre solid spindle and the three sleeve-nuts and keep them tight. If the sleeve nuts are loose, a dull hammering will be felt, and heard, when driving at slow speeds. If this is noticed, tighten the three sleeve-nuts without delay.

Wheel Bearings on Models G2, G2M and G7

The wheel bearings are of the ball-and-cone type. A complete bearing for one wheel consists of axle, fixed cone (deep cone on right-hand side), adjusting cone (shallow cone on left-hand side), two cups, set of $\frac{5}{16}$ in. steel balls (ten each side), lock washer (next to cone on left-hand side), thick lock-nut (on right-hand cone), thin lock-nut (on left-hand cone), and two dust caps.

The cups are pressed into the hub shell. The adjustment of the cone and thick lock-nut, on the right-hand side of the wheel, is never altered. Screwing the left-hand side cone on, or off, the axle provides the necessary movement for adjusting the ball bearings.

The adjustment should be made so that, while the bearing is free to revolve without any binding, there is no appreciable end-play. To adjust, remove the wheel from the machine. Take away the brake cover plate. This will expose the thin lock-nut on the left-hand side of the axle. Slacken this nut, and, with the thin cone spanner, screw "On" or "Off" the cone till the adjustment is correct. Finally, tighten the lock-nut, recheck the adjustment, and replace the brake cover plate and the wheel.

Wheel Bearings on Models G2MC, G3, G3C, G4, G5, G80, G90, G90C and X

The wheel bearings are of the taper roller type. A complete bearing consists of the following parts: hollow spindle, two sets of rollers (mounted in two cages), and two outer bearing rings.

The outer bearing rings are pressed into the hub shell. That on the left-hand side has a positive location—a spring ring fits into the shell to locate this ring. That on the right-hand side can be adjusted in position. The adjustment is obtained by a ring screwed into the hub shell and abutting against the movable bearing ring. The adjusting ring is locked in position by a large circular locking ring.

It is of the utmost importance that the bearings are not adjusted too tightly, as this would ruin them in a very short time. There must always be a slight degree of end-play. This should be about 0·002 in. To adjust: slacken the large locking ring on the right-hand side of the hub. Then, screw inwards, or outwards, the adjusting ring on which the locking ring is threaded, until the correct adjustment is obtained (inwards to tighten, outwards to loosen the bearing adjustment). Finally, tighten the locking ring, taking care that the adjusting ring does not creep forward and make the bearings too tight. Always check the adjustment after tightening the locking ring.

To Dismantle Wheel Bearing (Models G2, G2M and G7)

To dismantle a wheel bearing, remove the wheel and then the brake cover plate. This will expose the thin

lock-nut on the left-hand side of the axle. Remove this nut and the lock washer that is under it. Place the wheel over a pan, or paper, to catch the steel balls that will be released as a result of unscrewing the cone on the left-hand side of the axle. Having unscrewed this cone, the spindle, complete with the cone and lock-nut on the right-hand side, can be withdrawn from the hub (from the right-hand side of the hub).

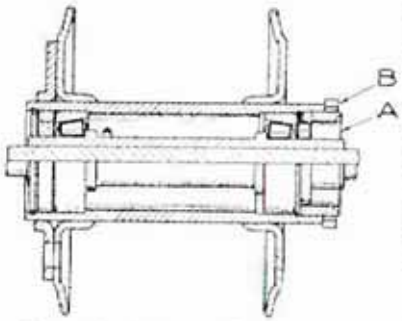


FIG. 28.—WHEEL BEARING: (A) ADJUSTING-RING. (B) LOCKING-RING.

If it is desired to remove the cups, it is first necessary to remove the two dust caps that are lightly pressed into the hub ends; when this has been done, the cups can be pressed out from either end.

To Dismantle Wheel Bearing (Models G2MC, G3, G3C, G4, G5, G80, G90, G90C and X)

To dismantle the bearings—having removed the wheel from the machine—proceed as follows:

If the wheel is a front wheel, remove the nut on the left-hand side of the centre solid spindle, withdraw the spindle and remove the brake cover plate. Slacken the locking-ring B (Fig. 28) on the right-hand side of the hub, and completely unscrew the adjusting-ring A, which will come away with the locking-ring B. A dished plate, felt washer and a plain plate are then free to be removed.

A spring ring will be observed on the opposite side of the hub, just under the hub shell. Removal of this will permit the removal of another felt washer assembly consisting of two metal plates, a felt washer and a spacing ring.

The hollow spindle, complete with rollers and cages and one outer bearing ring, can then be pressed out of the hub shell, from either end, leaving one outer bearing ring in position. If desired, this remaining ring can then be driven, or pressed, out.

To Assemble Wheel Bearing (Models G2, G2M and G7)

Thoroughly clean all parts, as well as the interior of the hub. Then, if the cone on the right-hand side of the wheel has been removed from the axle, it must be replaced so that it occupies the same position as before, and the thin lock-nut must be fully tightened down on to it. As a guide to the correct position, the distance from the face of the lock-nut to the right-hand end of the axle should be $\frac{23}{32}$ in. on the front axle, and $\frac{15}{16}$ in. on the rear axle.

If the cups have been removed these should be pressed into position in the hub shell, and the dust caps replaced.

Next, place ten steel balls in each cup, keeping them in position with thick grease or vaseline. Then pass the axle into the hub, from the right-hand side, and screw on the left-hand cone until the adjustment is correct. Replace the lock washer and lock-nut, fully tightening the nut down on to the washer.

Finally, recheck the adjustment, replace the brake cover plate, inject a quantity of grease into the hub, and the wheel is ready for fitting to the machine.

To Assemble Wheel Bearing (Models G2MC, G3, G3C, G4, G5, G80, G90, G90C and X)

It will be noticed that the tracks for the rollers on the hollow spindle are not evenly spaced. It is essential that the longer end of the spindle is assembled in the hub so that it is on the adjusting side (right-hand side of wheel).*

Thoroughly clean all parts as well as the interior of the hub. Press one of the outer bearing rings into the plain end of the hub so that the thinner end of the ring is inward, and its position a little nearer the centre of the hub than it normally occupies. Take care, when pressing this ring into the hub, that it is quite square to the hub body.

Replace the felt washer and plate assembly and, finally, replace the spring ring.

From the threaded end of the hub, force back the outer bearing ring until the felt washer assembly is tight against the spring ring; introduce the hollow spindle, entering the shorter end first, and push it, without undue force, as closely to the outer bearing ring as is possible.

Press the second outer bearing ring (thinner edge inwards), into the hub shell until there is about $\frac{1}{16}$-in. play in the bearings.

Replace the right-hand side felt-washer assembly, followed by the screwed adjusting ring with its locking ring, and proceed to adjust the bearing as previously described. Inject a quantity of grease into the hub and the wheel is then ready for fitting to the machine.

Brake Pedal and Rod Adjustment

The position of the rear-brake foot-pedal can be

* Left-hand side for post-war models.

adjusted within narrow limits. This is done by means of a small bolt screwed into the heel of the pedal. The adjusting bolt is locked with a thin nut. After altering this adjustment always check the rear-brake rod adjustment as described previously.

A finger-operated nut on the rear end of the rear-brake rod provides a means of making minor adjustment to the rear brake. This nut is locked in position by a spring that encircles the brake rod. (*Note.*—A spring is not fitted on models G2, G2M and G7.)

FIG. 29.—BRAKE SHOE WITH DETACHABLE HEEL PAD.

The finger-nut should be screwed on the rod so far that the brake shoes are just clear of the brake drum when in the "Off" position. When making this adjustment it is advisable to have the machine on the rear stand so that it may be observed that the wheel is free to revolve when the brake is "Off".

Brake Shoe Adjustment (Models G2MC, G3, G3C, G4, G5, G80, G90, G90C and X)

As the brake linings wear, this can be taken up by suitably adjusting the finger-nut on the rear-brake rod, but, after some considerable mileage, this continual adjustment causes the brake expander to lie in such a position that the leverage available is considerably reduced and consequently the brake loses in efficiency. To overcome this difficulty, the brake shoes are fitted with detachable heel pads. As will be seen from Fig. 29, these fit in the heel of each brake shoe and take the thrust of the brake cam or expander.

When it no longer becomes desirable to take up the wear of the brake linings by adjustment of the finger-nut on the brake rod, the brake shoes should be removed and then, if the steel pads are taken away from the shoes, one or more steel shim-washers can be placed on the stem of each pad. This will have the effect of centralising the cam expander, thereby restoring the efficiency of the brake. When the wear is taken up in this manner, it is, of course, necessary to slack out the brake-rod finger-nut adjustment, and to reset that adjustment to suit the new position of the brake shoes.

The front brake shoes are also fitted with detachable heel pads, thereby providing major adjustment for the front brake.

Front Brake Adjustment

Models G2, G2M and G7.—Major adjustment of the front brake is made by the knurled nut that screws on to the front brake rod. Minor adjustment of the front brake may be made by the cable adjuster located in a lug on the left fork girder. The brake cable passes through this adjuster, which is locked in position by a nut. To "take up" the front brake adjustment, this adjuster should be unscrewed from the fork girder.

Model G2MC.—Major adjustment of the front brake is made on the heel pads in the brake shoes. Minor adjustment of the front brake is made by the knurled nut mounted near the top end of the front brake rod.

Models G3, G3C, G4, G5, G80, G90, G90C and X.—Major adjustment of the front brake is made on the heel pads in the brake shoes. Minor adjustment of the front brake is made by the front brake cable adjuster.

To Remove the Outer Half of the Front Chaincase (all Models except X)

The outer half of the front chaincase is retained to the back half by a centre nut and an exterior metal band. Between the metal band and the chaincase is a rubber fillet, or packing strip. To take off the outer half of the chaincase, it is necessary to remove the finger-adjusting nut from the rear end of the rear-brake rod. The rear-brake foot-pedal has to be fully depressed before the outer half of the case can be taken away.

To replace, clean both sides of the outer half of the case and also the outer face of the rear half of the case. Place a line of liquid jointing compound on the face of the front half of the case, and, by depressing the rear brake foot-pedal, place the outer half of the case in position.

Replace the centre washer and nut, and, when tightening the nut, move the outer half of the case, as necessary, to make it register with the back half. Smear some more liquid jointing compound round the edges of the case and press the rubber fillet in position, so that the two free ends meet at the rear of the larger end of the case.

Then, refit the metal band, starting at the narrow front end of the case, and, drawing the two free ends together with one hand, replace the binding screw with the other.

Replace the rear-brake rod finger-adjusting nut, and adjust its position.

Finally, after the jointing compound has set, remove the inspection cap in the outer half of the case, and fill with engine oil.

To Remove the Outer Half of the Front Chain-case (Model X)

Remove the plated dome over the clutch. The front half of the chaincase may be taken away if the rear-brake foot-pedal is depressed.

Remove the complete clutch from the gearbox mainshaft as follows :

Unscrew the five clutch-spring adjusting nuts and remove the spring pressure plate, complete with the five clutch springs and the five clutch-spring cups. Extract the clutch plain steel plates and the clutch friction plates. Unscrew the centre nut that secures the clutch hub to the gearbox mainshaft, and remove the spring and plain washers. Withdraw the clutch hub, which is a splined and parallel fit on the shaft; lift away the large metal washer and the tubular spacing piece behind it.

The six bolts that fix the clutch case to the sprocket are now exposed. Lever the ends of the tab washers away from the heads of the bolts by using a screwdriver and then tap them flat. Unscrew the six fixing bolts and the clutch case may be taken away.

Removal and replacement of the outer half of the case is as described for other models. It is retained by a centre fixing bolt and metal band.

To refit the clutch :

Show up to the clutch sprocket the clutch case and fit the six fixing bolts, taking care that a tab washer is under each two adjacent bolts. Screw the bolts right home and then turn up the two ends of each tab washer, knocking the turned-up ends close against one of the flats of each bolt head.

Place the tubular spacing piece on the gearbox mainshaft, followed by the large metal washer. Replace the clutch hub on the shaft and push it right home. Follow this by replacing the plain metal washer, the spring washer, and, finally, the nut. Make sure the nut is fully tightened.

Replace the four clutch plain steel plates and the three clutch friction plates, taking care that each friction plate has a plain plate on either side of it. Follow this by replacing the spring pressure plate with the five clutch-spring cups, and five clutch springs, and refit the five clutch-spring adjusting nuts.

Screw these nuts right home as far as they will go, and then slacken each, in turn, five complete revolutions. Finally, replace the clutch plated dome with its six fixing screws.

Front Chain Adjustment

To provide front chain adjustment, the gearbox hinges on its lower fixing bolt, while the top fixing bolt can slide in slots cut in the engine plates to allow the hinging movement. This movement is controlled by an eyebolt, which encircles the top fixing bolt, and the threaded end of which passes through a block that is secured to the right-side engine plate.

By altering the position of the eyebolt in the block, the gearbox top fixing bolt can be moved in its slots. This action swings the gearbox, and, according to the direction of the swing, the front chain can be tightened or loosened. The gearbox must be swung backwards to tighten the chain.

The movement of the eyebolt in the block is controlled by two nuts that are threaded on it and are located on either side of the block.

By testing through the front chaincase inspection cap orifice, it can be felt whether the front chain adjustment is correct. If the chain can whip, or move, about $\frac{3}{8}$ in., as it is pressed up and down midway between the sprockets, the adjustment is correct. Check the whip in more than one position.

Rear Chain Adjustment

To provide rear chain adjustment, the rear wheel is bodily moved in the frame. To provide this movement, the rear-wheel axle is anchored in open-ended slotted fork ends, and the movement is controlled by a bolt screwed into each fork end. Each bolt impinges on the rear axle and is locked in position by a nut. A collar is placed on each bolt, between the nut and the fork end, to facilitate access to the nut, except on model X.

To tighten the rear chain on models G2, G2M and G7, slacken the nut on either side of the rear-wheel axle.

On the other models, slacken the nut on the centre solid spindle and the nut that locks the brake-drum sleeve to the fork end. Both of these nuts are on the left-hand side of the machine and are concentric to each other.

On all models proceed as follows to tighten the rear chain :

Slacken the nut on each chain adjuster bolt and screw it two or three turns towards the hexagon head of the bolt. Screw each bolt farther into the fork end, in turn, until the chain adjustment is correct, taking care to move each bolt an equal distance. If the chain can whip, or move, about $\frac{3}{8}$ in. to $\frac{1}{2}$ in. as it is pressed up and down midway between the sprockets, the adjustment is correct. Finally, tighten

the wheel spindle nuts, re-check the whip and screw the nuts on the chain-adjusting bolts tightly down to the fork ends.

Notes on Chain Adjustment

Before tightening the rear chain, the adjustment of the front chain should be checked, and, if attention is necessary, this should be adjusted first. It should be remembered that altering the adjustment of the front chain affects the adjustment of the rear chain. Also, that altering the adjustment of the rear chain will probably upset the adjustment of the rear brake. Therefore, after altering the adjustment of the rear chain, always check the adjustment of the rear brake, and, if necessary, re-adjust the brake.

The whip of chains should be tested midway between the two sprockets. Always turn the sprockets and test in several positions, and set the adjustment for the tightest position found. This is because chains never wear evenly, and there is usually one position where the chain is tighter than in any other.

When adjusting the rear chain care should be taken to leave the rear wheel in correct alignment. When correct, a piece of thin string stretched taut across both wheels, about 4 in. from and parallel to the ground, should just touch each tyre at both sides of the wheel centres. Alternatively, a straight wooden batten, about 5 ft. long, is handy to use for checking wheel alignment. This should be applied, as in the case of string, parallel to and about 4 in. from the ground.

The method of cleaning the rear chain is as described on page 27, Chapter 1.

Dynamo Chain Adjustment

The dynamo armature shaft is eccentric to the body of the dynamo. Therefore, by partially revolving the dynamo in its housing (the engines plates), the distance between the two dynamo driving sprockets can be varied.

Provision is made to revolve the dynamo in order to adjust the driving chain. This is done by applying a thin spanner to the boss that is cast on the driving side of the dynamo body. (On models G2M, G2MC, G3, G3C, G4, G80, G90, G90C and X, this boss is just under the word "LUCAS", while on Models G2, G5 and G7 it is under the letters "D.V.R.")

To adjust the chain, remove the inspection cap from the front-chain case and slacken the dynamo clamping bolt. Rotate the dynamo, in a forward direction, until, by passing a finger through the inspection cap orifice, it can be felt the dynamo chain has a whip of about ¼ in. This adjustment is important. Finally, tighten the dynamo clamping bolt, recheck the whip and replace the inspection cap.

Should it ever be necessary to remove the chain sprocket from the dynamo armature shaft, it is absolutely essential to hold the sprocket with a spanner, while loosening the sprocket retaining nut. Before attempting to loosen the nut, it is essential to remove the spring ring that encircles it, and the lock washer next to the spring ring. There are two flats on the boss of the sprocket to accommodate a spanner. The above action is necessary to relieve the armature shaft of any twisting or bending stress and must also be taken when refitting the sprocket.

Magneto Chain Adjustment

The magneto platform hinges on its rear fixing bolt, and this provides movement to enable the magneto driving chain to be adjusted. The whip of the driving chain should be ¼ in.

To Remove the Dynamo

The following instructions apply to all Matchless models fitted with a separate dynamo. The dynamo should be taken out of the engine plate on the left or driving side of the engine. To do this, proceed as follows:

Release the rear-brake rod and place a receptacle in position to catch oil from the case. Take off screw retaining metal band for chaincase, also nut for chaincase bolt, and remove outer portion of the case. Next, unscrew one or two turns the nuts fixing the shock-absorber spring, also the nut fixing dynamo-shaft sprocket. Before attempting to release the sprocket nut, first remove the circlip and lock washer before spanner is applied. Refer to the previous instructions given for the dynamo sprocket and use a supporting spanner on flats machined on this sprocket. Now turn to the clutch and take out both the friction and steel plates. Use a box spanner on the nut for the gearbox shaft which holds the sprocket in position. To prevent the gearbox shaft from rotating, engage the gear and either place a bar through the rear-wheel spokes, close up to the nipples, or else ask a second person to apply pressure on the rear-brake expander-lever. If the tommy bar for the box key is given a few light taps, the nut (right-hand thread) should unscrew

without difficulty. The nut retaining shock-absorber spring can now be unscrewed, also dynamo sprocket nut. Both chains can now be removed. Raise the tab washers on the three bolts fixing the rear portion of the chaincase to the crankcase, with a chisel or old screwdriver, and take out the fixing bolts. Disconnect cables attached to dynamo and release dynamo clamp bolt situated between engine plates. There is a slot in the engine plate to allow screw retaining a chain-line locating plate to pass through this slot. Rotate dynamo until screw referred to registers with the slot, and withdraw dynamo on the left or driving side of the engine.

GEARBOX AND CLUTCH

Burman four-speed gearboxes, foot-operated, are fitted to all models as follows:

250-c.c. model	Lightweight, H.P.-type.
350-c.c. model	Mediumweight, C.P.-type.
500-c.c. model	Mediumweight, C.P.-type.
990-c.c. model	Heavyweight, B.A.P.-type.

Competition models use the C.P. type with low bottom gears and have C.P.B.L. stamped on the gearbox. The only difference between the standard and competition-type gearbox is confined to the main driving gear and lay-shaft fixed pinion.

Note.—The mediumweight gearbox can be fitted to the 250-c.c. models if the engine plates and dynamo clamping parts are exchanged at the same time.

If the gearbox is dismantled and the grease emptied, refill with 1¾ pints, and add a further 2 oz. every 1,000 miles. Leakage of grease from the ball bearing is usually due to over-filling and will cease when the normal level of grease is reached.

The Clutch

Fig. 30 shows the clutch fitted to the C.P.-type gearbox, with clutch-operating mechanism. Except for detail differences, the design is similar to the clutch used on the B.A.P. type. The number of clutch friction plates fitted is, however, different.

It is essential that there is about $\frac{1}{32}$ in. clearance between the fork plunger B and the nose on the lever A, when the clutch cable is fitted.

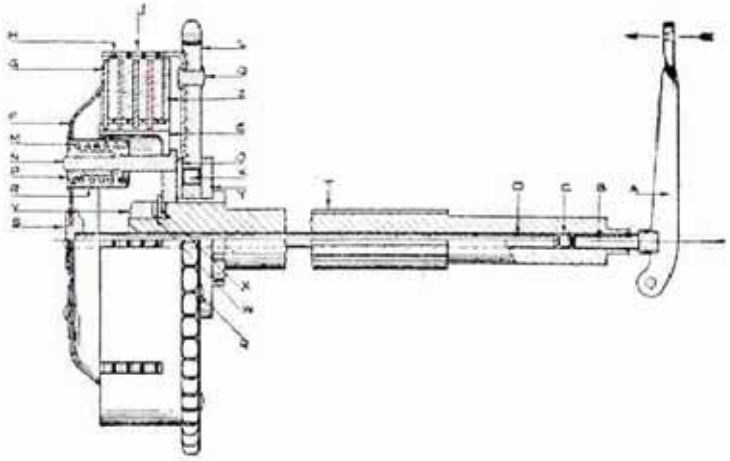


FIG. 30.—CLUTCH AND CLUTCH-OPERATING MECHANISM (C.P.-TYPE GEARBOX).

(A) Clutch operating lever. (B) Operating plunger. (C) Ball. (D) Thrust rod. (E) Clutch centre. (F) Spring pressure plate. (G) Plain steel clutch plate (thin). (H) Friction clutch plate (with inserts). (J) Clutch case. (K) Roller for chainwheel bearing (24 used). (L) Chainwheel. (M) Spring. (N) Stud. (O) Washer (thin) for chainwheel bearing. (P) Adjustment nut for clutch spring. (Q) Rivet for chainwheel and clutch case. (R) Cup for clutch spring. (S) Hard centre of spring pressure plate (not supplied separate from plate). (T) Mainshaft for gearbox. (V) Nut retaining clutch centre to mainshaft. (W) Washer (spring). (X) Washer (plain). (Y) Washer (thick). (Z) Plain steel clutch plate (thick).

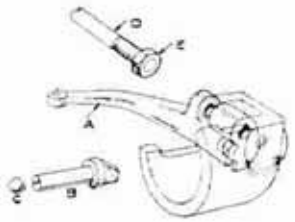


FIG. 31.—CLUTCH-OPERATING MECHANISM USED ON H.P.-TYPE GEARBOX. (A) Operating lever for clutch. (B) Short push-rod. (C) Steel ball. (D) Hinge pin. (E) Lock-nut for pin.

Fig. 31 shows the clutch-operating mechanism as used on the H.P.-type gearbox. In operation, the clutch cable lifts the lever A and exerts pressure on the thrust-rod B on the long push-rod, which passes through the gearbox mainshaft. Here, again, it is essential there is movement between the operating lever and the thrust-rod, to the extent of $\frac{1}{32}$ in. Screwed in the centre of the outside clutch plate is a stud, locked by a nut. Alteration to the clutch withdrawal mechanism can be effected by moving this stud in the required direction. See that the lock-nut is firmly secured.

Clutch Slip

If, for any reason, the clutch is slipped unduly by the driver, the friction inserts will wear down, and, in effect, lengthen the push-rod. Adjustment will then have to be made by removing the small plate on the kick-starter-case cover, and moving the sleeve-nut, retained by the plate, on both the C.P. and B.A.P.-type gearboxes. Screwing in the sleeve-nut will increase the clearance between the clutch thrust-rod and the operating lever, when clutch slip has taken place. In the case of the H.P.-type gearbox, unscrew the stud in the outer plate to create a similar effect.

To rectify clutch slip, remove any glaze on the friction inserts, with glass-paper or a wire brush. Renew the

clutch springs, which will undoubtedly have lost tension on account of the heat generated by the slipping clutch.

Clutch Drag

Check the position of the clutch-spring adjusting-screws—they should be unscrewed an equal number of turns. Screws should be unscrewed four complete turns from the screwed-home position. Next, check the amount of play in the operating lever on the handle-bar—$\frac{1}{8}$ in. to $\frac{1}{4}$ in. movement is allowed. If the trouble persists, dismantle the clutch and wash the friction plates in paraffin.

Gearbox Troubles after Prolonged Use

Gears disengaging under load are usually due to damage on internal teeth, caused by bad gear changing or continued clutch drag.

Uncertain gear indexing or selection is usually due either to a damaged rocking pawl, quadrant engaging with pawl, or, in the case of the H.P. box, a broken pawl spring. Should the trouble be confined to the top gear, the bush for the mainshaft in the main gear may be protruding. Movement on the kickstarter case (loose nuts) and the fixing studs will have an adverse effect on gear selection.

Note.—When replacing either of the springs used for the foot-change pawl or pedal (H.P. type), see that the legs of the springs are separated, and one leg is placed each side of the pin.

To Reassemble Foot-change—C.P. and B.A.P. Type

The toothed sector and pinion on the end of the cam-shaft must be correctly "timed" or positioned. To

replace the foot-change assembly, turn the pinion (with a pair of pliers) until the letter " O ", which is stamped on the pinion, is at nine o'clock or exactly 270 degrees. Look at the toothed sector for the letter " O ", also stamped on this part of the assembly. Replace the sector with the letter " O " registering with the same mark on the small pinion, and the gears will be correctly indexed when the assembly is completed.

The H.P. type does not use a camshaft and small pinion. A rocking lever, which is spring-loaded, is utilised to move the gears as desired.

Noisy Gears after Prolonged Use

This is usually brought about either by worn layshaft bushes or worn layshaft small pinion engaging with main gear.

Clutch Control

It will be appreciated that, as the result of wear on the clutch inserts (in the clutch friction plates), the plates will tend to close up towards each other. This action increases the effective length of the clutch-rod, while, on the other hand, the clutch operating inner wire tends to stretch in use. It is essential that there is $\frac{1}{32}$ in. clearance on the clutch-rod.

Although these two actions will neutralise each other, inasmuch as the first (plates closing down) makes the effective length of the clutch thrust-rod longer, and the second (inner wire stretch) will make the clutch-rod effective length shorter, the fact remains it is necessary, from time to time, to adjust the rod clearance as well as take up cable stretch.

Fig. 30 will show the necessity for this clearance, because it will be noticed that if the clutch thrust-rod is too long, the clutch-spring pressure will be exerted solely on the clutch-rod and not on the clutch steel and friction plates. This will allow the clutch to slip, instead of transmitting the engine power through the gears to the rear wheel.

Clutch slip caused in this manner will rapidly ruin the fabric inserts in the clutch friction plates, and cause the clutch-rod to wear in a most rapid manner. In addition, the slip may be so intensive that very considerable heat is generated, and this may ruin the hardening and tempering of the clutch springs, and the two ends of the clutch thrust-rod.

Therefore, see that the clutch-operating gear is adjusted correctly, and, by regular inspection, see that the adjustment is maintained.

Clutch-operating Lever Assembly and Adjustment

Fig. 32 shows the gearbox clutch-operating lever and its parts, as used on all C.P. and B.A.P. gearboxes fitted to models G2MC, G3, G3C, G4, G5, G80, G90, G90C and X.

175-X-4 is the clutch-operating lever, and 66-X-7 is the pin on which it hinges. 329-X is the ful-

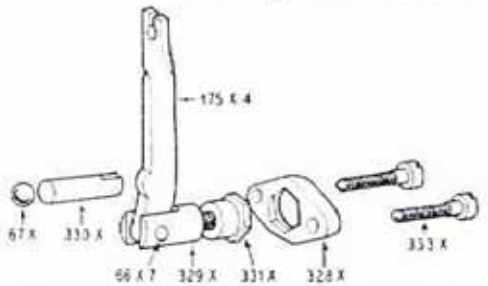


FIG. 32.—GEARBOX CLUTCH-OPERATING LEVER PARTS.

crum for the lever, and this slides in the kickstarter-case cover, its position being determined by the sleeve-nut, 331-X.

The fork, 330-X, transfers the pressure from the clutch-operating lever, 175-X-4, through the ball, 67-X, to the clutch thrust-rod which passes through the centre of the gearbox shaft.

Pressing the handle-bar clutch lever thus releases the

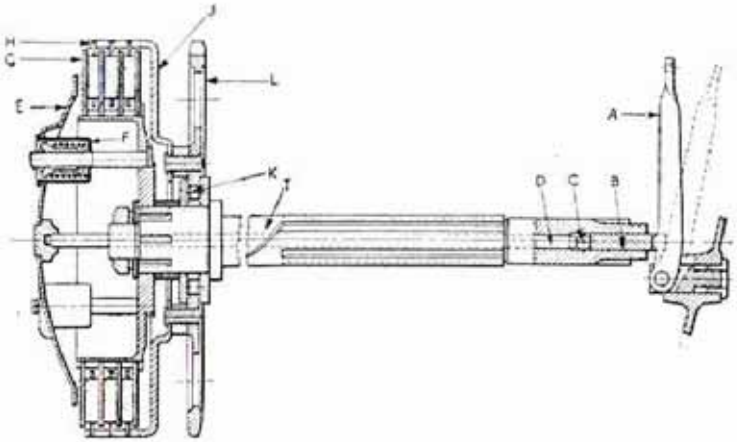


FIG. 33.—ILLUSTRATING CLUTCH OPERATION.

pressure on the clutch plain plates (G) and the clutch friction plates (H) (Fig. 33), and enables the clutch sprocket (L), to revolve on its bearing (K) without rotating the clutch hub, which is secured to the mainshaft (T). Consequently no power is transmitted to the rear wheel, and the clutch is said to be "out" or free.

On allowing the handle-bar clutch lever to return to its normal position so that the gearbox clutch-operating lever (A) (Fig. 33) is free, the clutch thrust-rod (D), ball (C),

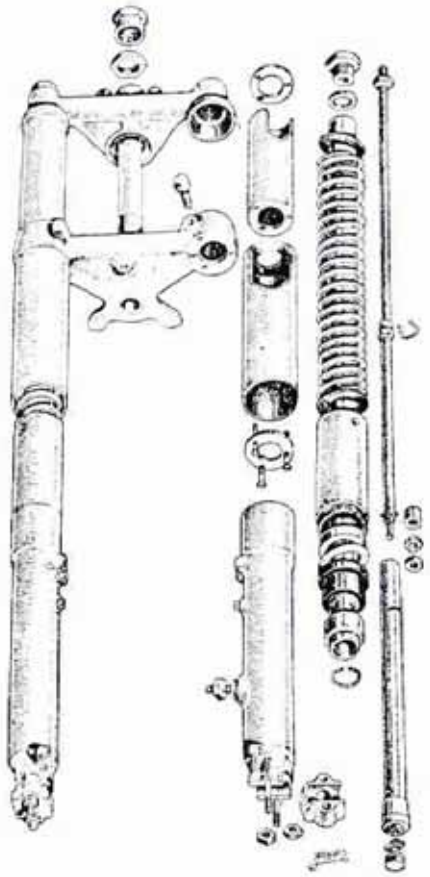
and fork (B), move to the right, under the influence of the pressure exerted by the clutch springs (F). The whole of the spring pressure is thereby transferred to the clutch-spring pressure plate (E), and this forces the clutch plain plates (G) tightly against the clutch friction plate (H), so that the power transmitted by the engine to the clutch sprocket is transferred, via the clutch case (J), to the friction plates (H), and through them to the steel plates (G), to the clutch hub, which causes the mainshaft (T) to revolve.

The clutch push-rod is adjusted by means of the adjusting sleeve-nut, 331-X (Fig. 32). Altering the position of this sleeve-nut will either increase or decrease the clearance between the clutch-operating lever, 175-X-4, and the thrust-rod, 330-X. Should alteration be made to the position of the sleeve-nut, make sure the locating plate fixing screws are firmly secured when the adjustment is completed.

TELEDRAULIC FORKS

A number of riders will wish to fit these forks to their Matchless machines, when available. They will not interchange with the girder-type fork, without alteration. Teledraulic forks will fit heavyweight frames (500-c.c. models) for machines made since 1935, as the head lug and steering races are the same as used on the present-day models. On the 250- and 350-c.c. machines the head lug is shorter to the extent of $\frac{1}{2}$ in. The following alterations are necessary:

500-*c.c. Models.*—Exchange large front brake for light-weight type. Fit present-day front-wheel spindle (other hub parts are the same). Arrange for speedometer to



[By courtesy of "Motor Cycling".

FIG. 34.—TELEDRAULIC FORKS.

be driven either from rear wheel or gearbox.

Note.—There is no provision for speedometer drive on 1938 and 1939 gearboxes. Fit ⅞ in. handle-bars. Connect controls to take ⅞ in. bar.

250- *and* 350-*c.c. Models.*—Shorten the two top fork cover-tubes to extent of ½ in. Shorten fork stem, or use distance piece ½ in. wide. Use present-day front wheel spindle. Arrange for speedometer drive, as with 500-c.c. models. Suitable front guard with stays will be required for both models.

Lubrication of Forks

A special light grade of oil is used in these forks. 6½ oz. is filled to each fork tube, and, if leakage does not occur, it is not necessary to "top up" or replenish the oil. A heavy-grade oil will cause the forks to be sluggish in operation; use only recommended grades.

Assembly of Forks

The forks are put together in sub-assemblies, in the following order:

(1) Fork crown and cover tubes (top and bottom).
(2) Inner tube assembly.
(3) Slider and damper tube assembly.

Fit top and bottom portions of fork cover tubes.

Fork tube assembly.—Assemble parts used on the centre fork tube in the following order: Leather washer; fork spring; leather washer; slider extension (unscrewed end first); oil seal (leather side first); paper washer; bakelite bush (flanged end first); buffer spring (if fitted); and steel bush and retain by circlip (make sure it is home in its groove).

Damper tube assembly.—Fit pin to hole and damper rod; place damper valve (steel cup) with pin inside cup; next, valve-seat (brass); screw home the ¼ in. nut on rod; and insert above assembled parts into the damper tube. Slip the steel plunger sleeve over the rod (sleeve has a groove in the centre). Locate plunger sleeve until groove registers with slot milled in the damper tube, and secure by the plunger sleeve clip, or wire.

Fork slider assembly.—This sub-assembly (damper tubes) can now be fitted to each of the bottom sliders. See that a fibre washer is used under the head for the tube bolt. A thin-walled box spanner will be required to tighten the damper bolt. Remember, the left slider is the one with the brake-anchor stud. Finally, the $\frac{5}{16}$ in. nut is fitted to the rod.

Note.—The brake-anchor stud, if removed, can be easily replaced if a blob of grease is put on the end of a piece of strip steel, with the bolt stuck in the grease. Taking care the bolt does not fall, introduce the steel strip down the slider until the bolt registers with the hole, and pull it through. This bolt must be tight, to avoid oil leakage.

Fitting the Fork Tube Assembly

With all its fittings as previously described, force home the tube into the top handle-bar lug. The pinch-bolts on the fork-crown lug must be unscrewed before tubes are fitted. Pull the tubes home with the top bolt and re-tighten the fork-crown pinch-bolt.

Now fit the fork slider with damper tube assembled. The oil seal should be a tight fit on the centre tube and must be pushed up inside the slider extension before the slider thread can be engaged. Use a piece of copper wire to " fish up " the damper tube and then attach the rod to one of the fork-tube top bolts and lock with the nut already on the rod.

Screw home the fork sliders and fill 6½ oz. of correct oil to each fork tube and tighten top bolts. When the front wheel is replaced, leave the cap nuts loose, then work the forks up and down to allow the centre tubes to work freely, then re-tighten wheel-fixing nuts on the bottom caps.

The fork centre tubes assembled with the slider and damper tube can be fitted to the tube lugs as a single unit. A tool will be needed to draw the tubes into the top lug.

Technical Data, 1938–39 Models

Inflation Pressures. (Approximate lb. per square inch.)

Models.	Front.	Rear.
G2, G2M, G7	16	18
G3, G5, G80	17	20
G2MC, G3C, G4	20	24
G90, G90C	20	24
X	18	18

For riders of abnormal weight, or if a pillion passenger is carried, increase the above pressures to the extent of 2 lb.

Top Gear Ratios

Model.	Top Gear.	Engine Sprocket Teeth.
250-c.c. Standard	6·25	16
250-c.c. Competition	6·56	16
350-c.c. Standard	5·55	19
350-c.c. Competition	6·17	16
500-c.c. Standard	5·0	21
500-c.c. S/C	5·52	19
500-c.c. Competition	5·52	19
990-c.c. Solo	4·53	24
990-c.c. S/C	4·94	22

Note.—The gearbox sprockets for the 350-c.c. models used on the Competition machines are of a different pitch to those used on the Standard models.

Intermediate Ratios

Gearbox Type.	Top.	Third.	Second.	First.
H.P.	1	1·4	1·97	2·97
C.P.	1	1·28	1·76	2·67
C.P. Competition	1	1·51	2·08	3·16
B.A.P. (four-speed)	1	1·26	1·57	2·67

To determine actual ratios, multiply top-gear ratio with figures given in the above table.

POST-WAR MODELS

Frame and Fork Service 1945–1949 Models

Details of front forks for the 1945–6–7 models are as described on page 135. Lighter fork springs of the three-rate type were used for the 1947 models, with buffer springs fitted immediately behind the bottom steel bush. These additional springs will prevent the forks extending when the front wheel leaves the ground during cross-country runs. Lubrication details are given on page 136.

1948–1949 Teledraulic Forks

The damper tube and rod fitted to earlier type teledraulic forks was discarded and substituted with a shuttle damper mounted on each fork inner tube. In addition, a much lighter fork spring was fitted. These alterations provide a light and easy fork movement with added comfort to the rider. Material alterations apply only to the alloy handlebar lug mounted on top of the forks. With this type of fork it is important that an air leak does not occur from the two bolts which pass through the handlebar lug into the fork centre tubes. Air pressure is built up which augments the normal spring pressure.

If forks have been dismantled, or leakage takes place, it is essential that the front wheel is raised clear of the ground by placing a box beneath the crankcase to *fully extend the forks*. Ensure there is 10 oz. of oil of the recommended type (see page 63) filled to each fork leg. The oil content is most important; therefore make certain that every drop of oil is drained before refilling with the recommended amount of fluid. With the drain plugs removed, turn

the front wheel first to the left and then to the right in order that the oil remaining in the sliders can be drained. Leave the forks extended; clean both bolts for fork tubes and washers to remove oil or grease (1948 models only), then coat the threads of both bolts with jointing compound, which should be allowed to dry before forks are used. On the 1949 models new-type top bolts with rubber sealing rings are employed, dispensing with the above treatment; these can be fitted to 1948-type forks.

In some cases a clicking noise is made, either when the front brake is applied with fork at full deflection, or when the machine is ridden over steps with the same effect. To rectify, carefully check the oil content, then add an additional $\frac{1}{2}$ oz. making a total of $10\frac{1}{2}$ oz.

Oil Leaks

A super seal is fitted to each fork slider. Oil leakage above the slider may be due to an excess of oil which can break down the oil seal. To remedy, replace seal. The seal is a force fit in the slider in order to prevent leakage past the outside diameter. Apply local heat to slider, which will expand, thus facilitating removal and access to the oil seal.

Forks for Sidecar Work

Solo-type springs, as fitted to 1947–8–9 models, are not suitable for sidecar work. Replace these with springs of 1945–1946 or W.D. type and fit an alloy distance piece $\frac{3}{4}$ in. wide on top of each fork spring; also a narrow distance piece $\frac{1}{4}$ in. wide, at the bottom of each spring, using normal oil content. *Do not use thick oil* to stiffen

fork motion. Distance pieces are obtainable from the makers of the machine.

Note : A steering damper (obtainable from the makers) is usually required when a sidecar is attached.

Attaching a Sidecar

Owners who intend to attach a sidecar to post-war models should refer to details given above for alteration to fork springs and use of steering damper.

The trail or castor action of the front forks is suitable for either solo or sidecar use. The only alteration required in addition to the forks is a smaller engine sprocket. The solo sprocket on 500-c.c. models has 21 teeth, which must be replaced with a sprocket of either 18 or 19 teeth, dependent on the weight and size of the sidecar attached.

The 350-c.c. model was not intended for sidecar use, but as the frame, wheels and gearbox are the same, the machine will not be adversely affected if a sidecar is fitted. With this model use an engine sprocket with 16 teeth.

All post-war models do not incorporate sidecar lugs in the frame assembly ; clip-on fittings can be obtained from the makers of the sidecar chassis. The makers of the machine do not make or stock fittings of this kind. Where difficulty is experienced in obtaining suitable sidecar connections owners should apply to T. C. Munday and Co., Ltd., 124 Dalberg Road, London, S.W.2, who are sidecar specialists for Matchless machines.

Wheel and Brake Service 1945–1949 Models

For details on brake and wheel service, refer to previous information given for 1939 models, which applies to all post-war models.

Gearbox 1945–6–7 Models

No alteration was made to this part of the machine ; details given for 1939 models apply.

Gearbox 1948–1949 Models

A fluid lubricant (engine oil) is used in place of light grease previously used. Original oil level was 1½ pints, but has now been reduced to 1 pint only. Oil leaks will occur if level is exceeded.

Note : Early deliveries of 1948 models were fitted with 1947 type gearboxes. Oil should be used only with gearboxes stamped " 48 " on the kickstarter case. A small amount of oil (half a teacup) is of benefit with non-fluid-lubricated gearboxes.

Clutch Drag

A grating noise on engaging first gear denotes clutch plates are sticky. Depressing the kickstarter with clutch lever out will free ; alternatively, dismantle clutch and wash all plates in paraffin. Buckled steel plates will also cause clutch drag.

CHAPTER VIII

MATCHLESS ENGINES FITTED TO OTHER MOTOR CYCLES AND THE MORGAN THREE-WHEELER

MATCHLESS engines have been used as the power unit in Coventry Eagle, O.K. Supreme and O.E.C. motor cycles, and in the Morgan Three-Wheeler.

The make of machine and type of engine fitted to other makes of motor cycle are given in the following tables. These details will interest owners of these machines when the makers' instruction book is not available. Nearly all these engines are covered in previous chapters.

COVENTRY EAGLE, 1938

Model.	Engine.	Type.
P50/1	498 O.H.V.	38G80
P50/2	498 O.H.V.	38G80
P35/1	347 O.H.V.	38G3
P35/2	347 O.H.V.	38G3
P25/1	246 O.H.V.	38G2M
P25/2	246 O.H.V.	38G2M

Technical details given for the 1938 Matchless engines in Chapter V apply to the above models.

Note.—Carburetter settings are arranged by the makers of the machine, but should apply to the Matchless models described, if the exhaust system is orthodox.

O.K. SUPREME 1939

Model.	Engine.	Type.
BA/39	349 O.H.V.	38G3 (Coil ignition)
JA/39	349 O.H.V.	38G3 (S/c machine)
GA/39	349 O.H.V.	39G4
HA/39	498 O.H.V.	39G90
CA/39	349 O.H.V.	38G3 (Magneto ignition)
DA/39	498 O.H.V.	38G80

Technical details given for the 1939 and 1938 Matchless engines in Chapter V are applicable to the above engines.

O.E.C. MACHINES 1938

Model.	Engine.	Type.
250 Ensign	246 O.H.V.	37G27
350 Cadet	347 O.H.V.	37G3
500 Commander	498 O.H.V.	37G80

O.E.C. 1939 MODELS

Model.	Engine.	Type.
39O.E.C.-26	347 O.H.V.	39G3
39O.E.C.-G4	347 O.H.V.	39G4
39O.E.C.-8	498 O.H.V.	39G80
39O.E.C.-G9	498 O.H.V.	39G90

Refer to technical details for 1938 and 1939 Matchless engines in Chapter V.

MORGAN THREE-WHEELERS

Three types of Matchless engines were supplied to the makers of the Morgan three-wheeler :

Model M.X. —990 Side-Valve Watercooled.
Model M.X.2—990 O.H.V. Aircooled.
Model M.X.4—990 O.H.V. Watercooled.

It is noteworthy that these engines proved to be extremely reliable and each prototype was bench-tested for six hours at two-thirds load.

Model M.X. (Side-Valve Watercooled).—The bottom portion is very much the same as the Matchless engine, with the exception of the camshaft driving the contact breaker. This arrangement is common to all the engines of Matchless make fitted to the Morgan. Side-by-side connecting-rods were used on the side-valve models, and service details given for the 1933 Matchless models apply.

Model M.X.2. (O.H.V. Aircooled).—This engine developed 39·1 b.h.p. at 4,200 r.p.m. The standard compression ratio was 6·2, and a few engines were fitted with a high-compression piston giving a compression ratio of 7·5 to 1, the latter being identified by means of the domed crown with clearance machined in the crown for the valves.

Note.—The standard pistons for both the side-valve and O.H.V. are identical up to 1936, when forked-type connecting-rods were introduced.

Model M.X.4. (O.H.V. Watercooled).—This is the best engine of the three; it developed 41·2 b.h.p. at 4,200 r.p.m., and was delightfully smooth with a high maximum speed. Owing to the similarity of the crankcase assembly, the three types are described as a whole.

Lubrication

This is basically the same as in the 1933 Matchless models. Oil is pumped from a by-pass on the pump to the rocker gear on the O.H.V. models. Using a series of jets in the rocker-box, oil is directed on to the push-rod ball ends. The inlet valve is positively lubricated and controlled by a regulating screw mounted in a crosshead on the cylinder-head. Normal setting is half a turn open from the fully shut-off position.

Poor delivery to the O.H.V. gear is usually due to wear on the oil-pump guide-screw, under the influence of which the motion of the pump is controlled. Replace this screw if a flat is worn on it.

Heavy oil consumption.—See details for 1933 and 1939 Big-Twin models (pages 16 and 82).

Oil Leaks

If this takes place from the rocker-box, replace the felt sealing rings for the rocker-shaft. Felt wicks to meter the oil passages are fitted in the oil passages for the rocker-box; renew these at the same time. These wicks are retained by pins or small " nails " without heads, and the dissimilarity in material will identify these pins.

Leakage from Push-Rod Tubes.—This can be caused by:

(1) Bad sealing rings.

(2) Abnormal crankcase pressure due to (*a*) worn rings or cylinder, or (*b*) crankcase release inoperative.

If the foregoing are in order, ensure that the holes in the tappet guides are not obstructed, thus preventing oil from draining into the crankcase. Early engines had rubber sealing rings for the centre of the push-rod tubes; replace these with the latest type made from cork.

Side-valve engines are rarely affected with oil leaks.

Warning.—The valve lifter should not be disconnected, otherwise the rod operating the valve lifter will make contact with the teeth on the cam wheel, with serious results.

The valve lifter has close tolerance, and small wear on the trigger levers will cause the lifter to be ineffective.

The trigger levers for the side-valve and O.H.V. are not identical on the cam contour. Owing to the lost motion that can occur with ordinary Bowden cable, "Bowdenex" cable should be used to increase the efficiency of the valve lifter.

Engine Service

The positions of the cylinders described below are as from the driver's seat, *i.e.*, left hand or right hand.

Refer to details given for the 1933 big-twin engines for normal renewals.

To Reassemble Timing Gear

Assuming the cam wheel and small pinion have been removed, proceed as follows:

Rotate engine until crankpin can be seen through the aperture for the cam-wheel bush inside the valve chest. Get the centre mark for the crankpin dead central with this aperture. Taking care that the flywheels do not move, introduce the cam-wheel with its mark pointing to six o'clock or 180 degrees, again ensure that the flywheels do not move, slide the starter pinion on its shaft with its mark registering with the mark on the cam-wheel. The valve timing should now be approximately correct. Valve timing can be checked against the figures given in the technical data for these engines (page 149).

To Set Ignition Timing

It should be remembered that the cam for the ignition contact breaker rotates in the same direction as the flywheels. The contact-breaker cam with the sharpest peak is used to time the left-hand cylinder.

Rotate the engine until the piston is on T.D.C. of the firing stroke (both tappets free). Fully advance the ignition control lever; now turn the engine backwards until the piston is $\frac{5}{32}$ in. before T.D.C. on the side-valve models or $\frac{3}{8}$ in. on the O.H.V. models, then set the contact points to just about to break.

To obtain the above settings with any degree of accuracy, insert a wheel-spoke, or piece of stiff wire, through the sparking-plug hole and make a mark on the spoke to register with the seating for the sparking-plug when the piston is at T.D.C. Then make a similar mark above the previous one on the spoke to the recommended amount. Now turn the engine backwards until the top mark registers with the seating of the sparking-plug. Insert a thin piece of paper between the contact points, and rotate the small cam until the paper can be pulled free. Lock the cam in this position and re-check.

Technical Data for Morgan Engines

	Side-Valve.	O.H.V.
Valve Timing (with 0·016 in. tappet clearance)		
Inlet opens before T.D.C.	16°	22°
Inlet closes after B.D.C.	52°	60°
Exhaust opens before B.D.C.	58°	56°
Exhaust closes after T.D.C.	12°	23°
Ignition Timing.		
Piston position before T.D.C., control lever fully advanced	$\frac{5}{32}$ in.	$\frac{3}{8}$ in.
Carburetter.		
Main jet size	140	180
Needle position	No. 3	No. 3
Throttle slide	6/4	20/4

CHAPTER IX

ELECTRICAL SECTION

MACHINES with magneto ignition are fitted with Lucas electrical equipment; those with coil ignition have Miller equipment.

On models fitted with compensated voltage control it is only when the battery is in a run-down condition during daylight running that the ammeter will show a charge rate as high as from 5 to 6 amps. Under normal conditions, the charge rate is between 2 and 4 amps, depending on the state of the battery. The system is designed to maintain a fully charged battery without the risk of overcharging, which is so commonly experienced with lighting sets having only switch-charging control.

If the dynamo output is not satisfactory, have the voltage control unit checked before attempting to remove the dynamo.

Dynamo

Before removing the dynamo cover for any reason, disconnect the positive wire from the battery, otherwise there is a danger of reversing the polarity of the dynamo or short-circuiting the battery, either of which might cause serious damage.

Occasionally examine the dynamo brushes. They can be removed from their holders when the spring lever is held aside. They should slide freely in their holders and make good contact with the commutator. If the brushes are dirty or greasy, clean them with a cloth

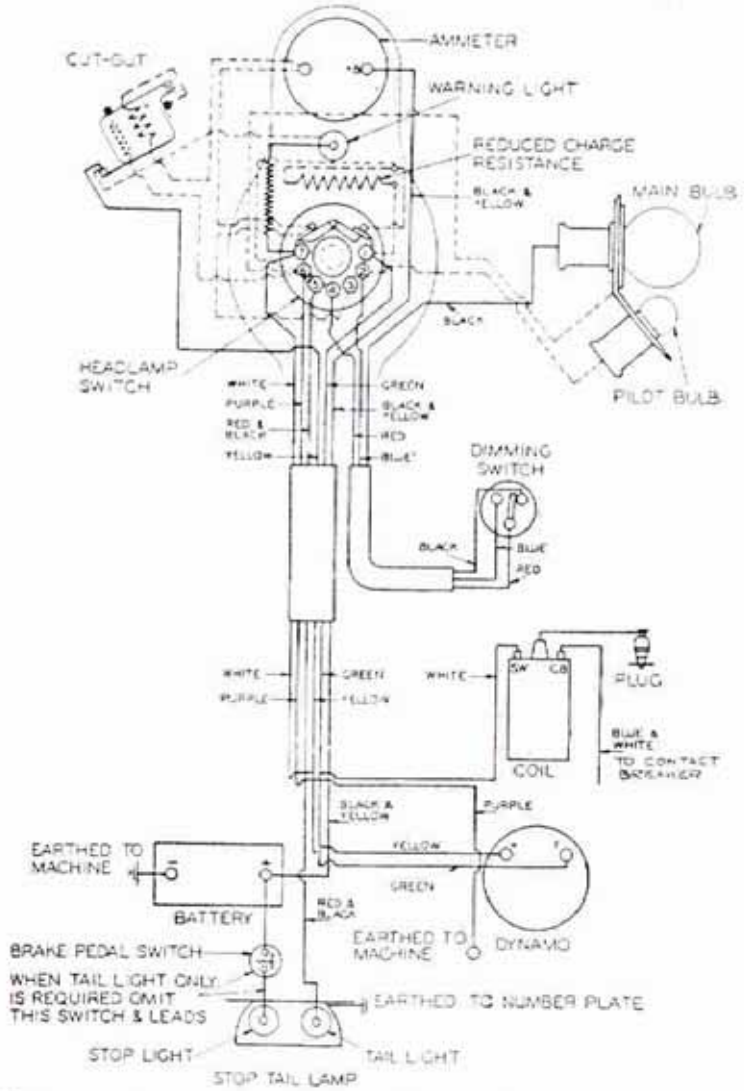


FIG. 35.—WIRING DIAGRAM OF MILLER CHARGING, LIGHTING AND COIL IGNITION EQUIPMENT (THIRD BRUSH DYNAMO) FOR 1934 250-C.C. MODELS.

moistened with petrol. Replace the brushes in their original position.

After long service, when the brushes have become so worn that they will not bear properly on the commutator, they should be replaced with new. Brushes are sold in complete sets.

Magneto

Occasionally remove the high-tension pick-up ; remove the carbon brush and spring from the brass-lined sleeve of the pick-up and clean away all traces of oil and carbon dust with petrol and rag. Clean the slip ring, which is on the end of the magneto armature and on which the carbon brush presses. The best way to do this is to wrap one or two folds of a soft duster on the unsharpened end of a pencil, insert this in the opening disclosed by the removal of the pick-up and push gently against the bottom of the slip ring, at the same time revolving the engine. Replace the carbon brush and spring in the pick-up and fix the pick-up to the magneto. Examine the high-tension cable, and if it appears perished, denoted by small cracks, replace with new.

About every three months remove the contact-breaker cover and examine the contacts.

If the contact breaker is of the face-cam type, one contact point is mounted on the narrow end of the spring blade ; the other point is adjustable and screws into the face of the magneto and is locked in position by a nut. If the points are burned or blackened, clean them with the finest grade of emery cloth and afterwards clean with a rag that is moist with petrol. Check the gap between the two points by turning the engine till both points are

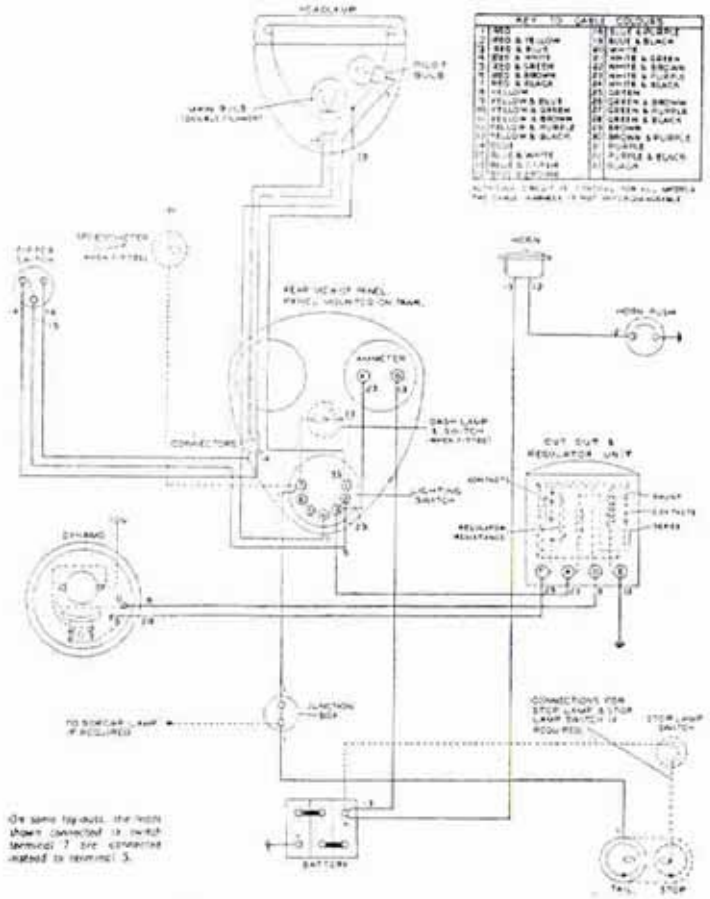


Fig. 36.—Wiring Diagram of Lucas Electrical Equipment with Compensated Voltage Control (with Instrument Panel).

separated and measure the gap. The gap should be 0·012 in. A gauge this thickness is a part of the magneto spanner. The gauge should just pass between the points without any binding or slackness. If necessary,

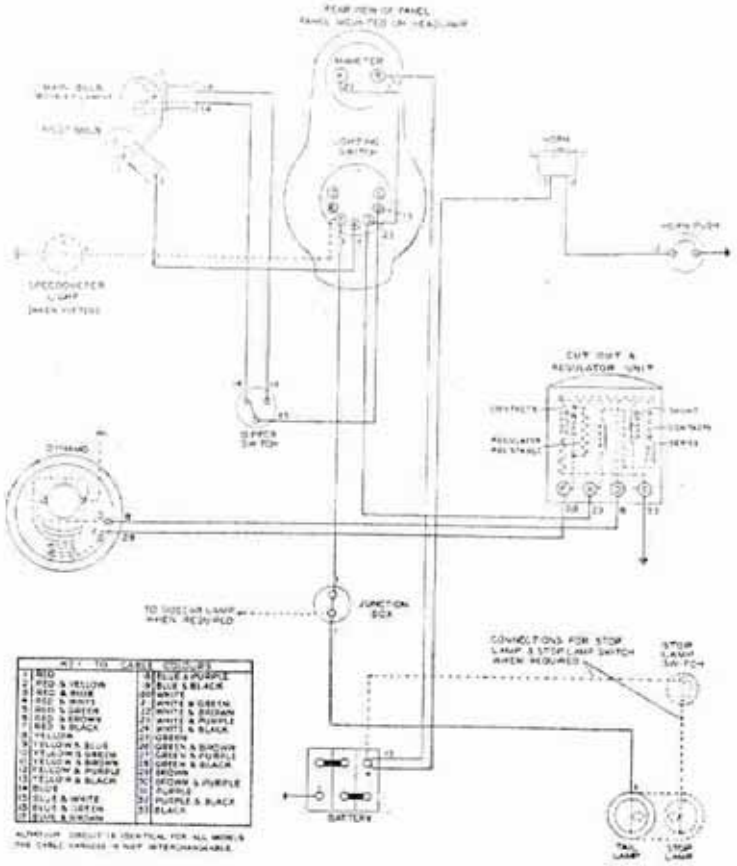


FIG. 37.—WIRING DIAGRAM OF LUCAS ELECTRICAL EQUIPMENT WITH COMPENSATED VOLTAGE CONTROL (WITHOUT INSTRUMENT PANEL).

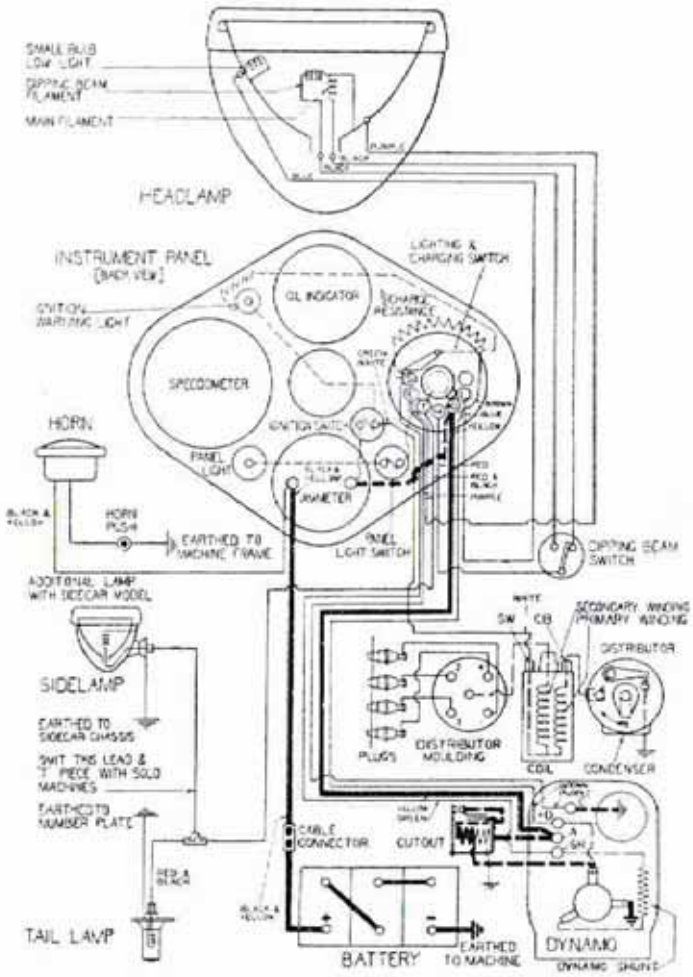


FIG. 38.—WIRING DIAGRAM FOR THE "SILVER HAWK."

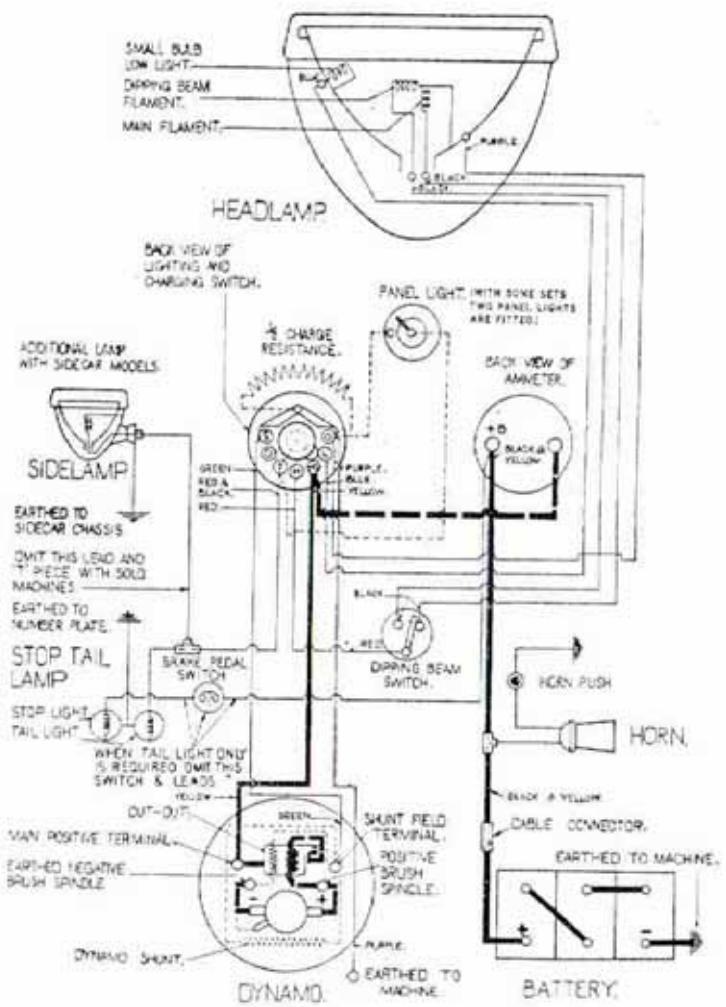
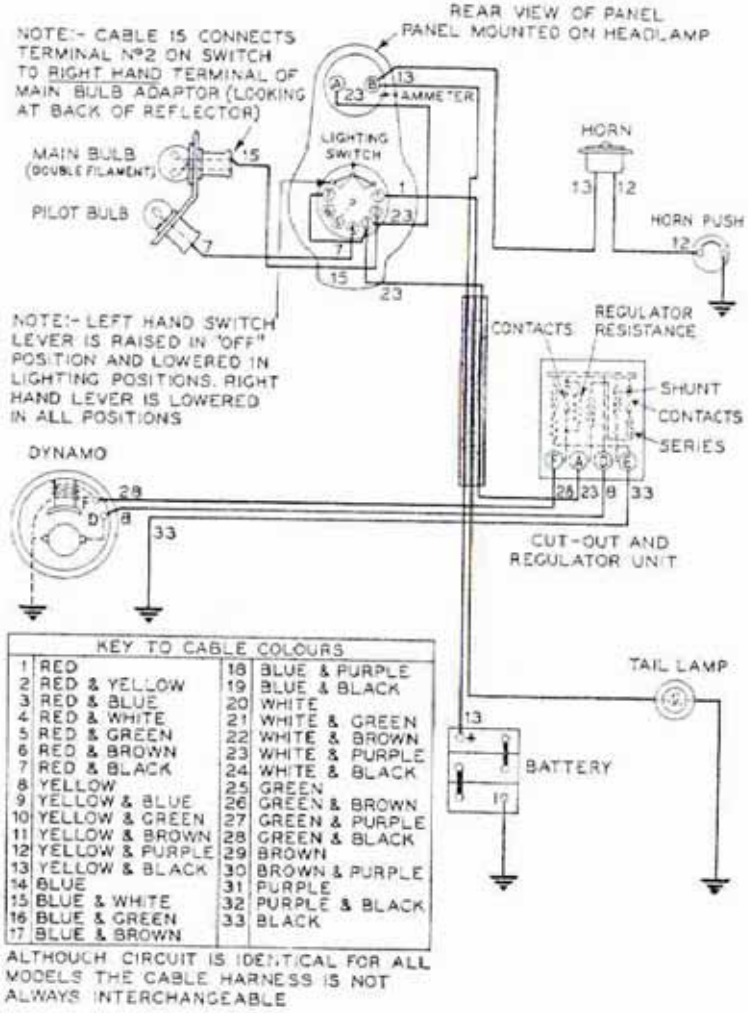


FIG. 39.—WIRING DIAGRAM FOR LUCAS "MAGDYNO" EQUIPMENT FOR 1933–1936 MODELS.



KEY TO CABLE COLOURS			
1	RED	18	BLUE & PURPLE
2	RED & YELLOW	19	BLUE & BLACK
3	RED & BLUE	20	WHITE
4	RED & WHITE	21	WHITE & GREEN
5	RED & GREEN	22	WHITE & BROWN
6	RED & BROWN	23	WHITE & PURPLE
7	RED & BLACK	24	WHITE & BLACK
8	YELLOW	25	GREEN
9	YELLOW & BLUE	26	GREEN & BROWN
10	YELLOW & GREEN	27	GREEN & PURPLE
11	YELLOW & BROWN	28	GREEN & BLACK
12	YELLOW & PURPLE	29	BROWN
13	YELLOW & BLACK	30	BROWN & PURPLE
14	BLUE	31	PURPLE
15	BLUE & WHITE	32	PURPLE & BLACK
16	BLUE & GREEN	33	BLACK
17	BLUE & BROWN		

ALTHOUGH CIRCUIT IS IDENTICAL FOR ALL MODELS THE CABLE HARNESS IS NOT ALWAYS INTERCHANGEABLE

FIG. 40.—WIRING DIAGRAM FOR EX-W.D. MODELS.

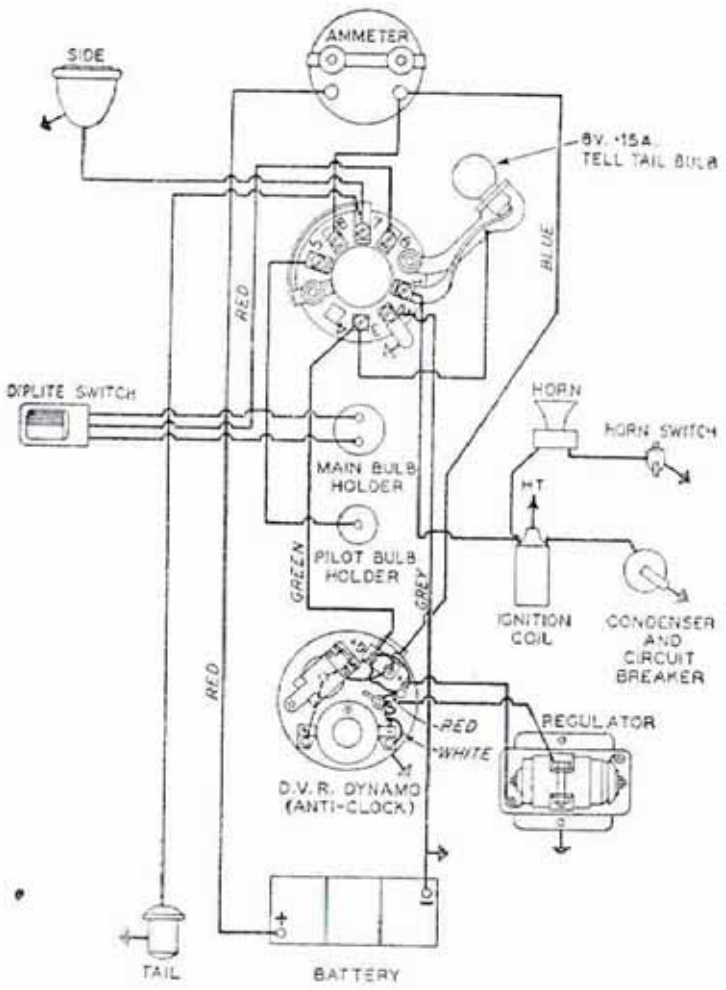


FIG. 41.—WIRING DIAGRAM FOR MILLER CHARGING, LIGHTING AND COIL IGNITION (COMPENSATED VOLTAGE CONTROL).

adjust the gap by slackening the lock-nut on the adjustable point and screwing the point in or out. Then tighten the lock-nut and recheck the gap.

On some models the magneto has a rotating type of contact breaker (ring-cam type). One contact point is mounted on the end of a steel rocker arm and the other, which is adjustable, is screwed into a brass block in the centre of the contact breaker. To decrease the gap between the points this adjustable point is unscrewed.

It is essential the rocker arm of the ring-cam type of contact breaker is quite free. If its movement appears to be sluggish, slacken the two screws that secure the two ends of the rocker arm spring, swing aside the spring blade that retains the arm in position and pull the arm from the pin on which it hinges. Clean the steel pin, and the fibre bush mounted in the rocker arm, with rag moistened with petrol, and lubricate the pin with an extremely minute quantity of vaseline, finally replacing the arm and the spring blade and tightening the two spring-retaining screws.

Coil Ignition Contact Breaker

The gap should be 0·018 in. and a gauge this thickness should just pass between the points without any binding or slackness. If necessary, adjust the gap by slackening the lock-nut on the adjustable point and screwing this point in or out. Then tighten the lock-nut and recheck the gap.

The interior of the aluminium housing should be kept clean of oil and this can best be done by applying a little petrol with a brush. After doing this, make sure all petrol has been wiped and has dried out before starting.

CHAPTER X

COMPETITION AND RACING

THE details given for Competition Models have been compiled for the benefit of riders who have little knowledge of trials and the preparation of their machines for events of this kind. The writer has had a fair measure of success for a period of several years, including such events as the Scottish Six Days and International Six Days trials, and had the honour to represent this country in the British teams on five separate occasions, and was also a member of the winning team on two occasions. Experienced trials riders will probably consider the information given to be very elementary, but possibly some of the points mentioned will prove useful.

Riders who intend to take up trials seriously should make reliability their keyword. It is a common occurrence for riders to retire in both trials and scrambles, due to some part or parts of the machine and engine failing, or falling off. Such circumstances, in a number of cases, are due to lack of preparation, and not bad luck, which is usually claimed. Some riders are inclined to pay too much attention to the engine, in an endeavour to get maximum power and highest speed. At the same time, important details on the frame and transmission are either overlooked or receive scanty attention. It follows that systematic preparation is essential to ensure that the machine and its fittings are reliable as far as possible.

Modern trials are now termed "Sporting Trials",

and usually the time taken to cover the course is not seriously taken into account. However, there are one or two exceptions. The rider should have time, during the event, for instance, whilst waiting at the start of a section, to check the rear-chain adjustment, inflate or deflate the tyres as the occasion or type of section necessitates, and give the machine a quick run over. A little oil on the chain will help to save the "odd coppers" for replacing the chain after short service. Factory-supported riders do this, because their skill in riding and looking after the machine gives them the best possible chance of success. Attention of this kind is of vital importance in trials of the long distance (Six Days) type.

Engine Preparation

The engine should be tuned to give good power at slow speed, without seriously affecting the acceleration. The following compression ratios are recommended for solo machines:

250-c.c.	350-c.c.	500-c.c.
6·5 : 1	5·8 to 6·3 : 1	5·4 to 5·8 : 1

Engine Clearances

Engines will run at a much higher temperature in trials than they would on the open road. Therefore close clearance between working parts is undesirable. If a new cylinder and piston are fitted, or the cylinder is re-bored, there should be an extra clearance over the standard size, to the extent of 0·001 in., which is usually effected by enlargement of the cylinder bore. Tight valve-guides will cause the valve to "hang up" or stick in the guide under these conditions.

High engine temperature will also affect the valve-

springs, which should be checked each time the cylinder-head is removed. Inner spring has a " free " length of $1\frac{13}{16}$ in. and the outer $2\frac{1}{16}$ in. Fit new ones when they have closed up $\frac{1}{4}$ in. or more.

Make sure the oil passages in the cylinder-head are free when the cylinder-head has been cleaned out, by squirting paraffin through the holes drilled in the head.

Valves and Valve-Guides

Do this also, when new guides have been fitted, to check the alignment of the oil-holes in the guide. Valve-guides should protrude outside the head to the extent of $\frac{1}{2}$ in. for the inlet valve and $\frac{5}{8}$ in. for the exhaust valve.

Both valve-stems when issued by the makers are chromium-plated on the stems. The object is to minimise the possibility of the valve seizing or " picking up " metal from the guides when the parts are first used. The chrome deposit has a soapy-like surface and tends to polish the internal diameter of the valve-guides.

Grind the valves to their respective seatings. The 350-c.c. valves are dissimilar in size, but on the 500-c.c. models both valves are the same size, but made from different material. It is essential that the valves for the 500-c.c. models are replaced correctly. These valves are either marked by etching on the valve-head or stamped on the top of the stem above the collet grooves, either INLET or EXHAUST.

Pass a piece of clean rag through both valve-guides after grinding, and apply a little engine oil to the valve-stems before assembly.

To obtain the maximum efficiency from the engine, the carburetter outlet and carburetter distance piece

should have a smooth finish, and before reassembling the valves, fit the carburetter and distance piece to the cylinder-head to determine if the bore is free from abrupt changes in diameter; also see that the packing piece registers with the inlet port in the cylinder-head. To do this it may be necessary to either " flare out " or chamfer the parts where they join, so that they are in complete register and match up—this will provide an uninterrupted flow of gas, thus improving the volumetric efficiency of the engine. As to the carburetter packing piece, the aluminium type is preferable, although the composition type will prevent heat from the head running back to the carburetter, which is not always desirable.

See that the valve end-caps are free to rotate on the valve-stems, otherwise wear may take place, if contact with the rocker is continually made with the cap in one particular position.

The cylinder-head can now be put aside for assembly later.

Piston

Next turn to the piston and check ring-gap with rings inserted in cylinder barrel; push the rings down the bore, using the piston skirt to do so. This will set the rings square with the bore, when the ring-gap can be checked, which should be 0·003 in. to 0·004 in. for each 1 in. in cylinder bore size.

Compression Plate

For " plonking " tactics, a compression plate, obtainable from the makers, can be fitted between the cylinder

base and the crankcase. Two steel washers will have to be fitted over the tappet guides and under the bottom sealing rings to account for the thickness of the compression plate. These parts were a standard fitment on the Army engines. A standard-type piston, using the compression plate on the 350-c.c. engine, will reduce the compression ratio from 6·3 to 5·8 to 1.

On the 500-c.c. models made in 1939, compression plates were used as part of the engine assembly, which should be retained for ordinary trials work. Removing this type of plate will increase the compression ratio from 5·9 to 7·24 to 1, which is really a 50% petrol and 50% benzole ratio; unfortunately this is not now available.

The cylinder barrel can now be fitted, with new cylinder-base washers, rubber rings for the bottom of the push-rod tubes and a new rocker-box gasket, used on the 1939 and present-day engines.

Carburetter

Before replacing the carburetter, take it to pieces and clean out the pilot passages (see Fig. 27); also check the flange on the carburetter body by placing on it a straight-edge or rule. If it is buckled, file it flat before reassembling the jet-block.

The illustration of the carburetter (Fig. 42) shows a hole drilled in the outlet, which may interest owners of ex-W.D. machines. This hole (No. 9) was used to prevent petrol entering the engine when the petrol-taps were left ON, with the machine on the stand. The hole should be sealed with a metal plug of suitable size, with a force fit, and do not overlook the petrol taps when the machine is parked on the stand.

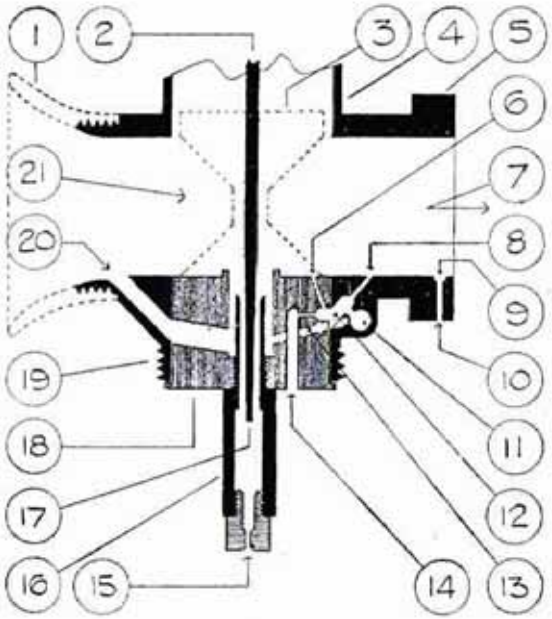


FIG. 42.—CARBURETTER JET BARREL OR CHOKE.

Showing pilot-, main-, and needle-jets. (1) Air tube. (2) Jet needle. (3) Upper portion of the jet barrel or choke. (4) Mixing body. (5) Flange. (6) Air balance passage (pilot by-pass). (7) Direction of gas flow to inlet port of engine. (8) Pilot outlet (passage to inlet port for mixture provided by pilot-jet). (9) and (10) Drain passage for unvaporised petrol. (11) Threaded hole, to accommodate pilot-jet air adjusting screw, the far end of which communicates with the passages 8, 13 and 14. (12) Enlarged end of pilot-jet. This is drilled in the jet barrel or choke. (13) Passage to conduct air to pilot-jet mixing chamber. (Also feeds air to the pilot-jet air adjusting or metering screw.) (14) Passage for petrol supplied to pilot-jet: this is drilled in the jet barrel, or choke, and its lower end is below the level of petrol in the float chamber. Suction on the pilot-jet causes petrol to rise in this passage and pass through the pilot-jet. (15) Main-jet. (16) Needle-jet. (17) Lower (tapered) end of the jet taper needle. (18) Lower portion of the jet barrel, or choke. (19) Thread for mixing chamber union nut. (20) Passage to conduct air to the needle-jet well and also to the pilot-jet mixing chamber (W.D. type only). (21) Direction of main air flow through choke of carburetter.

All the tuning and care on the engine will be valueless if the carburetter is not set properly, and the importance of the pilot-jet is again stressed. If it is necessary to screw home, or nearly home, the pilot regulating screw, either the pilot orifice is small or there is an air-leak. With the pilot working properly, it should be possible to make the engine run unevenly or " rich ", by screwing home the regulating screw.

Fig. 42 is a carburetter of the Army type. The holes over the primary choke are not shown. This is because Army-type carburetters were designed for use with air-filters—all air taken into the engine has to pass through the air-filter. Nevertheless, the principle of the carburetter is the same. On all civilian-type carburetters there is a small " bleed " hole drilled in the body underneath the passage for the pilot adjusting screw. The carburetter makers use this hole to prevent owners completely closing off the air which passes over the pilot passage. This small hole can be sealed if intelligent use is made of the regulating screw—this will give a full control over the pilot adjustment. It should be explained that the size of the pilot-jet is fixed and governed by the size of the hole drilled in the jet-block. The action of the regulating screw is to vary the " quality " of the fuel, and not the " quantity ".

Unscrewing the regulating screw allows more air to be taken in, which weakens the mixture; conversely, screwing in the regulating screw has the opposite effect. It will now be quite clear as to the effect of sealing the " bleed " hole previously described. A quick test to ascertain if the pilot is fouled can be effected by making a fine point on a match-stick. Start the engine and insert

the point of the match into the " bleed " hole, which will cause the engine to run rich and unevenly with the regulating screw in the closed position. The pilot acts as a " bridging " jet, and a weak place, or spot, will be evident when the pilot is set on the weak side.

A lot of time is wasted on setting the carburetter by both experienced and inexperienced riders, by permitting the engine to get too hot whilst the carburetter is being set.

The following " drill " is recommended:

(1) Check tappets.
(2) Plug points gap 0·018 in. to 0·020 in.
(3) Start engine on stand.
(4) Retard ignition lever about one-eighth of its movement.
(5) Let engine idle by closing back throttle.

If the pilot is correctly set, the slow running should be positive. Retard the ignition lever fully, and the engine should continue to idle at a slower speed. If the engine stops, re-start and re-set the regulating screw by screwing in the screw slowly until the slow running is positive. Snap open the throttle once or twice, and re-check for slow running. The throttle-slide stop-screw will have to be readjusted until the desired engine speed is arrived at. Retarding the ignition puts the engine under load—it should be possible to open the throttle, providing the ignition is correctly set, up to two-thirds throttle with engine running evenly, and without any " spitting back ". With this setting the rider can rest assured that he will be able to drive at very slow speeds, without " losing the engine ".

Make these adjustments as quickly as possible, because if the engine becomes unduly hot a false setting will be arrived at when the machine is actually in motion. It is in these circumstances that time is wasted on this adjustment. It should not be necessary to alter the main jet size; the only alteration that may be needed is to vary the position of the taper needle. Usually (on civilian models) this is secured in the second notch from the top of the needle. For maximum power, if petrol consumption is not taken into account, place the needle in the third notch from the top.

Forks

Girder-type fork-links can be altered to either increase

or decrease the trail or castor action, by either increasing or decreasing the length of the two bottom fork-links. If alternative fork-links are made, they must be sound in design and material for such a vital part of the machine. The length of the fork-spring is important. When this spring has closed up or decreased in length, the steering, particularly at high speeds, will be affected. The links should be out of parallel to the ground and highest at the frame end. Packing pieces can be fitted on top of the fork-spring to raise the frame and keep the castor action constant, also increase ground clearance.

The forks should be damped down by hand-knob to give a sluggish movement. If the damper is not efficient a solution of powdered resin and methylated spirit (1% of resin only) lightly brushed on the friction discs will improve its efficiency. Ovality in the fork members can be rectified by bushes fitted by the makers. It is rare for the spindles to wear if lubricated from time to time.

Mudguard and Tyre Clearance

In the case of a standard machine, the mudguard clearance is not sufficient (by reason of appearance) for sporting trials. The rider will have to increase the clearance by longer guard stays on the front guard, and make sure the fittings altered are sound. Alteration to the rear guard is not so easy. Riders with workshop facilities can move the rear mudguard bridges and fit longer stays to permit the use of a 26-in. × 4·00-in. tyre, and at the same time increase the clearance to prevent mud piling up and having a braking effect on the wheel. A maximum clearance of 2½ in. to 3 in. is ample for the rear mudguard. Shortening the rear guard will cause

mud to be thrown over the rider's back, and will make the machine generally dirty; do not shorten the guard unduly. In passing, it may be mentioned that the extension on the rear chain-guard is important. Mud can be carried by the tyre until it piles up at the chain-stays and will be forced into the front chaincase, where the gearbox mainshaft enters the case. The aperture for the dyno. shaft (if dyno. is removed) can be sealed by using another chaincase inspection cap in this position.

Waterproofing

The best known medium for keeping water off the H.T. point of the magneto is undoubtedly plasticine. Apply this material copiously round the brush-holder, to completely cover the brush-holder and H.T. cable entry. The contact-breaker cover round the joint can be treated likewise. A small hole is drilled in this cover; this should not be sealed unless deep water-splashes are expected, in which case the hole should be reopened as soon as the trial is finished.

Insulating tape completely covering the porcelain of the sparking-plug, also the brass terminal on the H.T. cable, is the best arrangement. This will prevent a quick change of the sparking-plug, but it will be worth while. Wet leaves blown on the plug can cause the engine to falter, and result in a stop, traversing an observed section. K.L.G. plug WF.70 is waterproof.

Water can enter the engine via the crankcase release in a water-splash. A piece of petrol-proof tube joined to the release pipe and carried up on to the seat-tube of the frame will help. Use a little jointing compound to stick the rubber tube on to the copper pipe. If the H.T. cable

is held to the frame by metal clips, discard these and use insulating tape. When water-splashes are not included in the course the rubber tube can be directed on to the rear chain for lubrication. Insulation on the H.T. cable can break down and cause the engine to cut out on heavy load.

Control Cables

The benefit of well-lubricated control cables can be appreciated by experience. It is important that at least the throttle and clutch cable are well lubricated. Soaking the control cables first in paraffin and then in thin oil will help. The most common cause of cable breakage is stiff nipples in the control levers. If the large nipple cannot revolve as the lever is moved, a bending action on the cable will occur. This causes the cable to fray and eventually fail.

SCRAMBLES AND GRASS-TRACK MACHINES

Riders usually have the same machine for both scrambles and trials. Trials gear ratios are generally suitable for both types of event. The large step-up in gear ratios from the ultra low gear needed for trials is a problem on certain scramble courses. It is most unlikely that riders will go to the trouble of exchanging the main gear and layshaft pinion mentioned in the paragraph dealing with the gearbox.

Engine

The easiest way to increase the efficiency of the engine is to increase the effective compression ratio, by using a

high-compression piston. Suitable fuel will be required, about which more will be said later.

Two types of piston are available for the 350-c.c. models—Type M.123, compression ratio 8·18 to 1, and Type M.125, compression ratio 10·09 to 1 (a compression plate $\frac{3}{32}$ in. thick will reduce the ratio to 8·14 to 1).

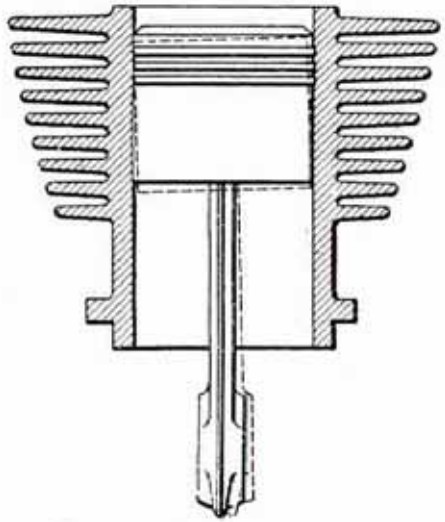


FIG. 43.—CHECKING CONNECTING-ROD ALIGNMENT USING OLD CYLINDER.

Piston type M.123 is suitable for 50% benzole and 50% No. 1 fuel, and although the M.125 piston was intended for racing fuel, for short-distance events, where full throttle driving is of short duration, petrol–benzole fuel could be used.

A good-quality sparking-plug will be needed for both these pistons, which has a fairly high heat factor and a good oil factor at the same time.

An old cylinder sectioned can be used to check the connecting-rod alignment (see Fig. 43) when these special pistons are fitted, which will help in the search for more power and speed.

Special cams are not sold, but the standard valve timing is very efficient. A new type cam was introduced during the war, and is worth while fitting. The comparative valve timing is shown for this cam against the original fitted.

Early-type Cam.	Latest-type Cam.
Inlet valve opens 20° B.T.D.C.	Inlet valve opens 32° B.T.D.C.
Inlet valve closes 67° A.B.D.C.	Inlet valve closes 63° A.B.D.C.

Readings taken with 0·016 in. tappet clearance.

To maintain engine efficiency, valve-springs should be exchanged, say, after every three to four meetings, purely as a precautionary measure.

The exhaust-pipe length is important; at some meetings riders, usually novices, will remove the silencer without any other alteration, and because the engine makes more noise, it is assumed that it will go faster. In fact, it is usually the reverse, unless the carburetter is re-set to compensate for the removal of restriction in the silencer. On racing machines the exhaust-pipe length is carefully tested, and the capacity of the pipe is measured in fluid ounces, so that each pipe is exactly the same. The actual length, therefore, must be in the nature of an experiment. A short pipe will lose its extractor effect—a good length to start with would be 4 in. behind the rear wheel axle. A sliding extension can be made up and

adjusted to get the best result in both acceleration and maximum speed.

Setting the Main Jet

With an open exhaust pipe the standard jet will have to be increased, apart from the increase in compression ratio. Start with a larger jet—say, 170 for the 350 c.c.—and test for the best jet size. The best indication of the correct jet size is the condition of the sparking-plug points. Riders who can, without breaking the law, drive their machines with an open exhaust pipe for some distance can arrive at the correct jet size by driving the machine flat out for about ½ mile and then shut the throttle sharply to avoid engine idling, then look at the plug points. A white colour indicates weak mixture, a dark or sooty colour is due to "rich" mixture, and the tester should aim for the points to be a brown or chocolate colour. The engine is usually fastest with a small jet, but not for long if driven at full throttle for any length of time.

If the above test cannot be carried out, play for safety and use a jet at least two sizes above the standard jet.

Should special racing fuel be used, the passages for the petrol feed will have to be enlarged and the needle jet exchanged. An increase in jet size by 100% is normally made, when the orifice for the jet will be larger than the orifice for the petrol-type needle-jet.

There is no advantage in using racing fuel, other than cooling, unless the compression ratio is in the region of 12 to 1. A formula for special racing fuel is given below. To ensure that fuel supply is adequate, twin petrol pipes will be an advantage, using racing fuel. The hole in the

petrol-tank filler-cap is $\frac{1}{16}$ in., and must be free from obstruction to permit fuel to flow freely to the carburetter.

FORMULA FOR SPECIAL FUELS

R.D.1.	P.M.S.2.
50% alcohol. 28% naphtha. 5% benzole. 15% acetone. 2% castor oil.	50% alcohol. 47·5% benzole. 2·5% naphtha.

Note.—Methyl alcohol and *not* ethyl alcohol must be used in this specification.

RECOMMENDED SPARKING-PLUGS

18-mm. type: K.L.G. M.80; K.L.G. 356.
14-mm. type: K.L.G. F.70; K.L.G. 583.

If the cylinder barrel is reduced in overall length to increase the compression ratio, the permissible reduction in length will have little benefit as regards acceleration and maximum speed. Do not discard the head gasket, with the same object in mind. There should be at least 3 mm. extra movement on the valves, when at full lift, before contact with the piston crown is made. This has been allowed for with use of the special pistons, and is mentioned in the event of the cylinder being shortened and the standard piston retained.

Steering

The normal steering-head angle is 61 degrees. Competition models use an angle of 63 degrees. This is accomplished by setting the frame tubes, and is best done by the makers.

The use of a 21-in. front wheel, with teledraulic forks, will increase the trail or castor action. A generous amount of trail (usually $3\frac{3}{8}$ in.) is useful for trials, but not for short-circuit grass tracks. Trail helps to keep the front wheel straight when road speed is above 15 to 20 m.p.h. If the trail is excessive the machine will not go round bends nicely, and will have a tendency to go straight on.

On standard machines the makers compromise with a steering angle and trail to make the steering safe and to enable fast corners to be negotiated with safety.

Checking Wheel Alignment

Use a long wooden batten with a straight edge placed along the rear tyre edge, move the rear wheel in the required direction so that the batten makes contact with both the front and rear tyre edges at the same time. Make allowance if a larger tyre is used on the rear wheel and see that the gap for the front wheel is equal and parallel.

To be successful the machine must be reliable—pay attention to the control-lever fulcrum screws and nuts, centre pop the end of the screws for security.

Scrambles play havoc with rear chains. Should a rear chain jump the sprocket teeth, this is not bad luck, but bad preparation and attention. If the rear chain is soaked in oil, run the machine for a few miles and readjust the chain, which will loosen after the oil has been squashed out of the rollers. Small points of this kind all help for a trouble-free ride.

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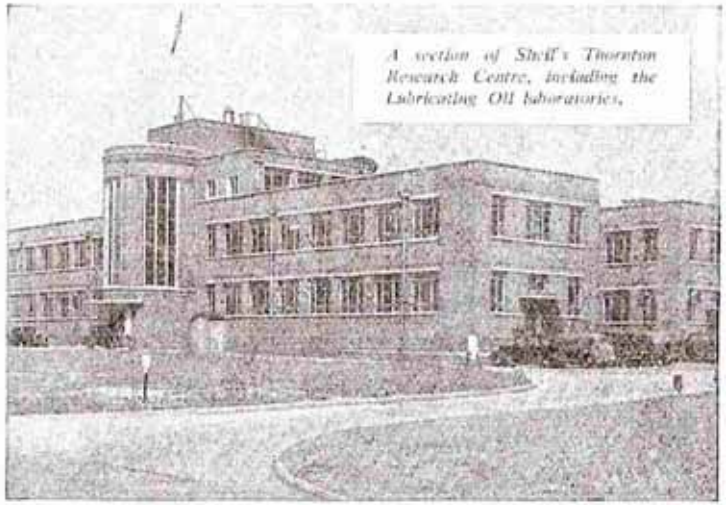

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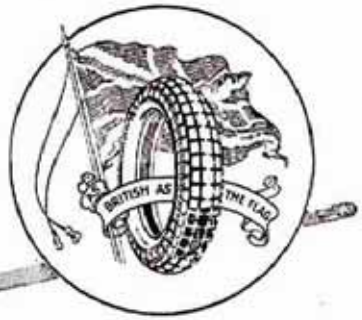

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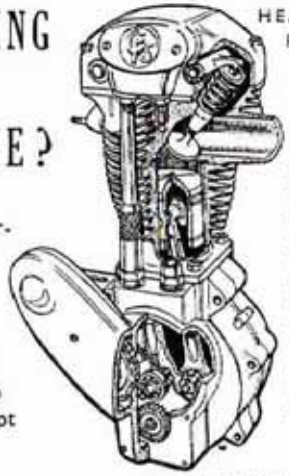

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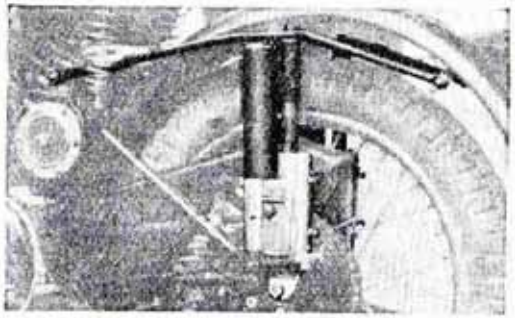

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