THE *Villiers* ENGINE

B. E. BROWNING

Motor Cycle Maintenance and Repair Series

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THE VILLIERS ENGINE

A PRACTICAL GUIDE
COVERING ALL MODELS

By

B. E. BROWNING

With 87 Illustrations

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PREFACE

IN setting down the information concerning the general care and maintenance of the Villiers engine, it is the author's desire to help the rider obtain maximum reliability and performance, and to assist the mechanic when called upon for service.

The popularity of the Villiers two-stroke engine is undoubtedly due to the simplicity of design and construction, with which are associated economy in fuel, low cost and freedom from trouble.

To maintain the maximum efficiency and performance, however, it is essential to observe several rules, and for the benefit particularly of the novice a section dealing with these is included.

Most riders are aware of the differences between a two-stroke and four-stroke engine, but it is felt that an understanding of the two-stroke principle will enable the rider to get the best results from his engine; consequently Chapter I describes in detail the basic construction of the engine.

Separate chapters are devoted to the carburetter and magneto, all types of each used being of Villiers design and manufacture.

Thanks are due to The Villiers Engineering Co. Ltd., and in particular to members of the Villiers Technical Staff for help given in the preparation of the book.

B. E. B.

NOTE ON THE SECOND EDITION

WITH the issue of this edition, the opportunity has been taken to add four chapters dealing with the latest Villiers engines and engine-gear units—the Mark 2F autocycle engine, and the Mark 1F, Mark 10D, and Mark 6E engine-gear units.

CONTENTS

CHAPTER I

THE TWO-STROKE ENGINE

THREE of the principal components of any internal-combustion engine are the piston, connecting-rod and crankshaft, and in the case of the Villiers two-stroke engine, these are the only moving parts.

The piston is made a gas-tight fit in the bore of the cylinder by the fitting of compression rings, commonly called piston-rings, positioned near the crown. The piston reciprocates in the cylinder bore, the length of travel or stroke being controlled by the crank-pin secured between the webs of the crankshaft.

Between the piston and crank-pin is fitted the connecting-rod, its function being to convert the reciprocating movement of the piston into rotary motion of the crankshaft.

The connecting-rod is a steel forging, light in weight and of a suitable section to carry the load imposed by the explosion pressure on the crown of the piston during the downward stroke. The top, or small-end, has a bronze bush in which is fitted the gudgeon-pin, the ends of the pin being located in internal bosses of the piston. Between the hole in the bottom, or "big-end", and the crank-pin are inserted alternate steel and bronze rollers.

For many years the Villiers engine was of the three-port design, the cylinder having one port for the inlet, one for the exhaust and one for the transfer of the charge from the crankcase to the combustion head. With this arrangement of ports the piston crown is shaped to form a deflector, the object of which will be understood later when explaining the cycle of operations.

During 1934 an entirely new design was introduced in which the cylinder has two exhaust and four transfer ports,

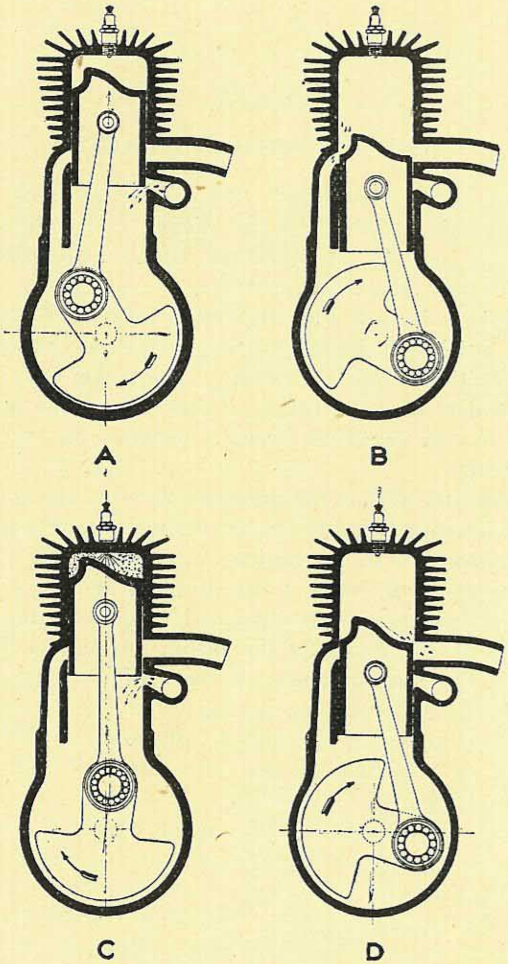


FIG. 1.---CYCLE OF OPERATIONS FOR VILLIERS THREE-PORT TWO-STROKE ENGINE.

1. On the upstroke of the piston a partial vacuum is created in the crankcase. The piston uncovers the inlet port and the mixture enters the crankcase. Meanwhile the charge is being compressed in the cylinder.

2. The compressed charge is fired and the piston descends on the power stroke, compressing the mixture in the crankcase.

3. At the bottom of the power stroke, the piston uncovers the exhaust and transfer ports; fresh mixture enters the cylinder via the transfer ports, and burned gases are expelled through the exhaust ports.

4. Start of a new cycle. The piston closes the exhaust and transfer ports and compresses the fresh mixture.

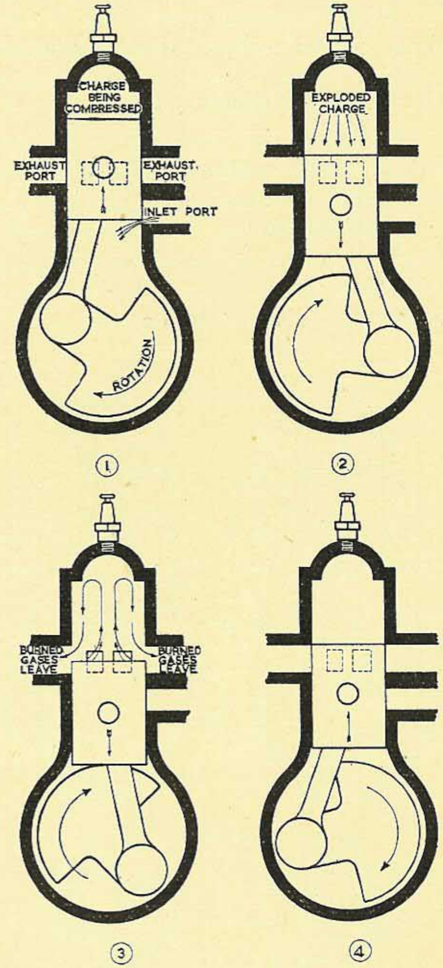


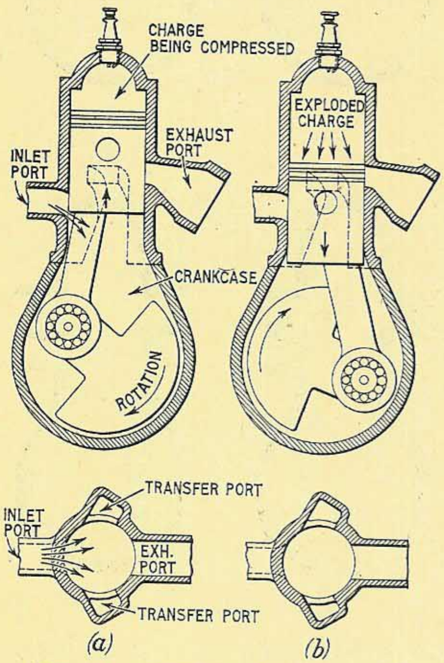
FIG. 2.—CYCLE OF OPERATIONS FOR ENGINE WITH FLAT-TOP PISTON, TWO EXHAUST PORTS AND FOUR TRANSFER PORTS.

the latter being so arranged that it is possible to use a piston having a flat crown of uniform section, thereby eliminating the usual deflector used with the three-port design.

Cycle of Operations

To enable the reader to more readily understand the working of the engine, diagrams of the various stages of each revolution of the crankshaft are given (see Fig. 1).

On the upward stroke of the piston a partial vacuum or suction is created, and as the bottom of the piston uncovers the inlet port, to which the carburetter is attached, a mixture of petrol and air enters the crankcase (see Fig. 1A).



(A) On the upstroke of the piston, a partial vacuum is created in the crankcase, and when the piston skirt uncovers the inlet port a mixture of petrol and air is drawn into the crankcase from the carburetter. Meanwhile the previous charge is being compressed at the top of the cylinder.

(B) The previous charge is fired by the sparking plug, causing the piston to descend and compress the mixture in the crankcase.

FIG. 2A.—CYCLE OF OPERATIONS, POST-WAR MOTOR-CYCLE ENGINES (FLAT-TOP PISTON).

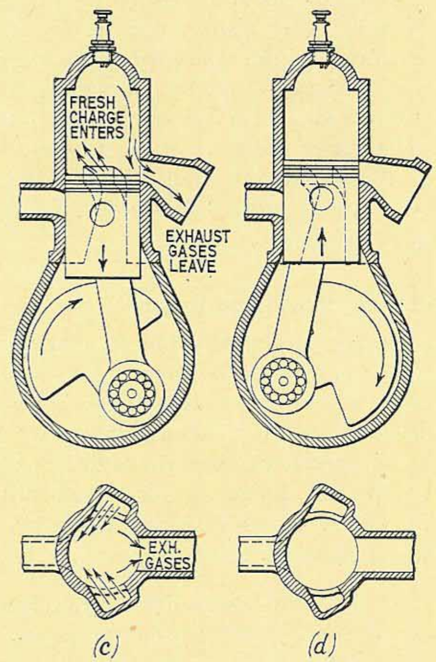
These engines have one exhaust port and two transfer ports.

The piston, on its descent, compresses the mixture charge, and when nearing the bottom of the stroke uncovers the transfer port, allowing the charge to enter cylinder (see Fig. 1B).

In the three-port design the piston crown is specially shaped so as to deflect the charge upwards into the cylinder-head.

The next upward stroke of the piston compresses the charge in the cylinder-head, and when the piston reaches the top or end of the stroke, the compressed gases are ignited by an electric spark at the plug fitted in the cylinder-head (see Fig. 1C).

The spark is timed to occur actually before the dead-top



(C) Near the bottom of the stroke, the piston top edge uncovers the exhaust and transfer ports. The burned gases escape through the exhaust port and a fresh charge enters the cylinder through the transfer ports.

(D) The piston starts a new cycle on its upward stroke, closing the exhaust and transfer ports compressing the fresh mixture and continuing as shown in diagram (A).

FIG. 2A (*continued*).—CYCLE OF OPERATIONS, POST-WAR MOTOR-CYCLE ENGINES (FLAT-TOP PISTON).

position of the piston, this time lag being necessary to allow the compressed charge to burn so as to give the maximum pressure when the piston has actually commenced its downward stroke. When nearing the end of the down or power stroke, the top of the piston first uncovers the exhaust port, allowing the exhaust gases to escape before the transfer port is uncovered by the opposite side of the piston (see Fig. 1D).

Whilst the piston is descending, the charge which has entered the crankcase on the previous upstroke is being compressed before entering the cylinder by way of the transfer ports.

From the above description the reader will see that the compressed charge is ignited in the cylinder-head every two strokes of the piston, thus giving a power impulse every revolution of the crankshaft, which accounts for the smooth or even torque of the two-stroke engine.

When the piston is at the bottom of the stroke, both exhaust and transfer ports are open, it being the aim of the designer to ensure that the whole of the burnt gases go through the exhaust port without allowing any of the new charge to escape at the same time.

Flat-topped Piston Engine

In the early part of this chapter, reference is made to the engine in which a flat-topped piston is used, and although the cycle of operations is exactly as in the three-port engine, the deflection of the incoming charge in the cylinder is effected by the special arrangement of the transfer passages.

This new design of cylinder and piston is now a feature of all Villiers motor-cycle and autocycle engines, some of the advantages over the three-port type being :—

(1) The elimination of the deflector gives a more symmetrical, lighter and better-balanced piston.

(2) Elimination of hot-spots, even distribution of metal in cylinder barrel and consequently less distortion, which allows a closer-fitting piston to be used.

(3) Hemispherical cylinder-head reducing the surface area and thereby increasing the thermal efficiency.

(4) Increased horse-power.

(5) Better scavenging of the exhaust gases before commencement of the compression stroke.

Fig. 2 shows the cycle of operations in a flat-topped piston engine having two exhaust ports and four transfer ports. This design of cylinder and piston is a feature of the Junior-de-Luxe autocycle engine (see Chapter VIII); Mark VIIID and Mark 9D engine-gear units (see Chapter IX); Mark XVII-A and Mark XVIII-A, 249-c.c. engines (see Chapter II).

At the end of 1948, three new motor-cycle and a new autocycle engine were introduced, the cycle of operations being as Fig. 2, the cylinders having one exhaust port and two instead of four transfer ports (see Fig. 2A).

The four engines referred to above are as follows :—

Autocycle Engine . .	Mk. 2F	98-c.c. Single-speed
Ultra Lightweight Motor-cycle Engine . .	Mk. 1F	98-c.c. Two-speed
Lightweight Motor-cycle Engine . . .	Mk. 10D	122-c.c. Three-speed
Lightweight Motor-cycle Engine . . .	Mk. 6E	196-c.c. Three-speed

Each of the above engines is dealt with in detail in separate chapters.

CHAPTER II

VILLIERS TWO-STROKE ENGINE RANGE

BEFORE describing in detail the various types of engines made, it is advisable to mention the method of marking employed to distinguish each model. Every engine has a number with one or more prefix letters stamped on one of the top crankcase lugs immediately below the cylinder base.

Each type of engine has a different prefix letter or letters, and if these are quoted together with the engine number, the makers can identify the model and date of manufacture, and so supply the correct spares when ordered. The relevant prefix letter or letters allocated to each type of engine is given in the descriptions of engines which follow.

The Earliest Villiers Engines

The first two-stroke engine was introduced in 1913, the bore and stroke being 70 mm., giving a capacity of 269 c.c. This engine had a non-detachable cylinder-head, cast-iron deflector-type piston, fixed gudgeon-pin, and was known as the Mark I.

Ignition was by a horseshoe-pattern magneto fitted in front of the engine, and driven by chain and sprocket from the crankshaft. Lubrication was by drip feed from a combined hand pump and sight-feed lubricator fitted in the tank of the motor cycle, and which at that time was almost common practice for lubrication of motor-cycle engines. The oil entered the crankcase via one of the four crankcase bolts, in the end of which was fitted a special union.

Between 1913 and 1922 models Mark II to V were added to the range, all being similar internally to the Mark I. Later models of the Mark IV, however, were fitted with the Villiers flywheel magneto, since when no other type of magneto has

been used on a Villiers two-stroke engine. A feature peculiar to the above models only are the horizontal cooling fins on both the barrel and head of the cylinder.

The engines described above are now obsolete, and spare parts are not available. Prefix letters of the Mark I to V are O, A, B, C and D respectively.

The Mark I to V engines were made for lightweight motor cycles in the days before variable-speed gearboxes incorporating a friction clutch were available, the usual drive to the rear

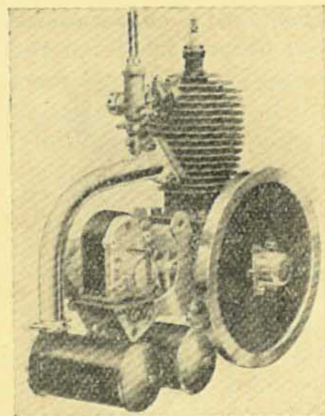


FIG. 3.—MARK IV 269-C.C. ENGINE.

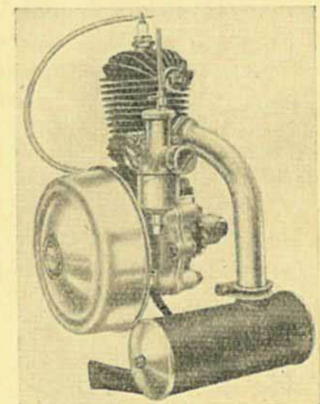


FIG. 4.—MARK VIII-C 147-C.C. ENGINE.

wheel being direct by V-belt, or by chain and belt through a plain two- or three-speed gearbox. To fill the need at that time Villiers designed and produced a multi-plate friction clutch which could be disengaged to provide a free engine; in other words, disconnect the drive from engine to rear wheel and so allow the drive to be taken up gradually from a standing position.

150-c.c. Class

The range of 147-c.c. engines was introduced in 1922, commencing with the Mark VI-C, prefix letter H, following with the Mark VII-C, prefix letter L, in 1923. Both engines have cast-iron pistons with fixed gudgeon-pins, one-piece cylinder and head with compression-release valve. The Mark VIII-C engine first produced in 1924, prefix letter W, was the first model to have a fully floating padded gudgeon-pin. Later models also had a patent inertia ring fitted to the piston, the object of this feature being the prevention of carbon formation and gumming up of the piston-rings.

This engine proved to be a very popular power unit for lightweight utility motor cycles and invalid chairs, and was in continuous production until the end of 1947. Bore and stroke of the above engines are 55 mm. × 62 mm., lubrication being by petroil mixture, and in common with all engines since the Mark V, the Villiers carburetter is standard equipment.

Various types of flywheel magnetos have been used :—

(1) Two-pole, ignition only.
(2) Two-pole, ignition and lighting.
(3) Four-pole, ignition and lighting.
(4) Six-pole, ignition and lighting.

Details of these magnetos are given in Chapter V.

Another engine in the 150-c.c. class is the Mark XII-C, prefix letters GY, introduced in 1931. This model has a bore/stroke ratio of 1·26, the bore being 53 mm. and the stroke 67 mm., giving a capacity of 148 c.c. On reference to Fig. 5 the twin exhaust ports and detachable induction manifold will be noticed, the latter feature allowing of alternative carburetter positions to suit the lay-out of individual motor-cycle manufacturers. Other features are a cast-iron deflector-type piston with floating gudgeon-pin and inertia ring, roller bearing "big-end", phosphor-bronze main bearings and lubrication by petroil mixture, special ducts being cast in the crankcase walls to convey lubrication to the bearings.

The Villiers middleweight carburetter, stub diameter $1\frac{1}{8}$ in., and having single- or double-lever control, is the standard fitting with the above model.

A similar model to the above but with a single exhaust port

was first made in 1934, being known as the Mark XV-C, prefix letters CUX.

172-c.c. Class

Four models of this capacity, with a bore of 57·15 mm. and a stroke of 67 mm., have been produced :—

(1) " Sports ", prefix letter T, lubrication by petroil mixture.

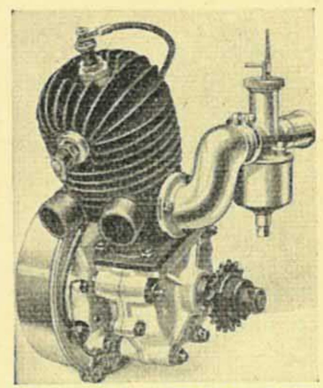


Fig. 5.—Mark XII-C 148-c.c. Engine.

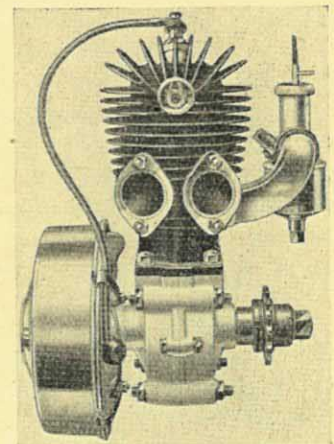


Fig. 6.—" Sports " 172-c.c. Engine.

(2) " Sports ", prefix letters TL, lubrication by Villiers patent automatic system.
(3) " Super Sports T.T.", prefix letters BZ.
(4) " Brooklands ", prefix letter Y.

The latter two engines have the patent automatic lubricating system as standard.

The " Sports " engines have one-piece cylinders, cast-iron deflector pistons, twin exhaust ports, detachable inlet manifold, and, except for the method of lubrication, are identical.

The " Super Sports T.T." engine has a detachable cylinder-head, aluminium piston, the magneto giving variable ignition, and a middleweight-pattern carburetter with two-lever control.

The "Brooklands" model was made specifically for racing events, the number produced being comparatively small. The cylinder barrel has a shrunk-on heavily finned aluminium jacket, high-compression cylinder-head, padded crankshafts and large-bore carburetter, the power output being 8·25 b.h.p. at 4900 r.p.m.

The above engines are now obsolete, and spares are not available.

200-c.c. Class

The Villiers engine has always been popular on the Continent, and in Germany before the war motor cycles with engines of less than 200 c.c. were tax free. To meet this demand the Mark 1E model was introduced. This engine has a bore and stroke of 61 mm. × 67 mm., the capacity being 196 c.c., and except for the bore is very similar in construction to the "Sports" model.

Two models were made: (1) for petroil lubrication, and (2) with automatic lubricating system, the prefix letters for both engines being 1E. These engines were in production from 1928 to 1938.

A similar engine but having one exhaust port and suitable for petroil lubrication only, known as the Mark 2E, was introduced in 1930, the prefix letters being XZ. This engine in common with the Mark 1E had a cast-iron piston fitted with the inertia ring, detachable inlet manifold and variable ignition.

A "Super Sports" edition of the 196-c.c. engine was introduced in 1929 (see Fig. 7). The bore and stroke are the same as the Mark 1E and 2E engines, but being designed to give a higher performance, the specification includes a deeply finned cylinder with large twin exhaust ports, detachable alloy head and aluminium piston with inertia ring, lubrication being the Villiers automatic system. The Villiers magneto giving variable ignition timing and the middleweight carburetter are standard equipment. Prefix letters KZ and KZS.

An entirely new 196-c.c. engine–gear unit was introduced in 1938. This model, the Mark 3E, prefix letters VV, had a bore and stroke of 59 mm. × 72 mm., flat-topped piston and cylinder having four transfer ports. The engine was built in unit with a three-speed gearbox having constant-mesh gears, single-plate cork-insert clutch driven by an endless roller chain enclosed in an oil-bath chaincase, the gear control lever being mounted directly on the gearbox. A six-pole ignition and lighting magneto was standard equipment.

At the end of 1948 the Mark 6E engine-gear unit (196-c.c.) was introduced. See Chapter XIII for details.

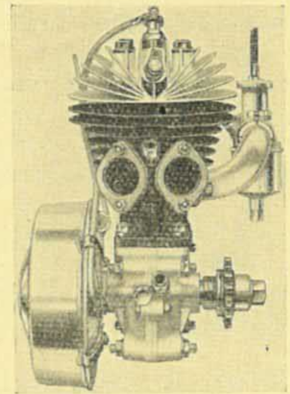


FIG. 7.—"SUPER SPORTS" 196-C.C. ENGINE.

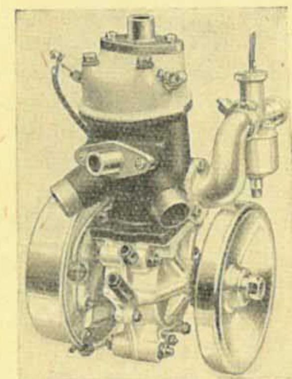


FIG. 8. — MARK XIV - A 249-C.C. WATER-COOLED.

250-c.c. Class

The Mark VI-A model, the first of the 247-c.c. range, was produced in 1922, being followed by the Mark VII-A in 1924, prefix letters being J and S respectively.

These engines were similar in construction, having cast-iron piston, fixed cylinder-head, with carburetter in front, single exhaust port and lubrication by petroil mixture.

The Mark VIII-A engine was of similar internal construction, except that the piston having a window-type transfer port was fitted. The cylinder had twin exhaust ports and detachable inlet manifold, the year of introduction being 1925, prefix letter X.

The next engines of this range, the Mark IX-A and X-A models, were first made in 1926 and 1929 respectively, and had aluminium pistons and detachable cylinder-heads, with automatic lubrication. A feature of these engines is the auxiliary flywheel on the driving side, which, with the even torque of the two-stroke engine, gives extremely smooth running, particularly at low road speeds. These two models are identified by prefix letters DZ and JZ.

The last of the 247-c.c. range is the Mark XVI-A model; this engine has the same bore and stroke as the others, namely, 67 mm. × 70 mm., and apart from the cylinder and head, is similar to the Mark X-A model. The cylinder has two circular exhaust stubs, the head being fixed by three bolts instead of four. Lubrication is by petroil only. Prefix letters AXF. This engine was introduced in 1934 and was used in large quantities for utility motor cycles until 1940, when production ceased because of the war.

In production at the same time as the 247-c.c. engines was the long-stroke model of 249 c.c., namely, the Mark XIV-A. This engine had a bore and stroke of 63 mm. × 80 mm., and was available in air- and water-cooled models, the latter type being as Fig. 8.

The specification of both the above types included a detachable cylinder-head, aluminium deflector piston with the patent inertia ring, long plain bearings to crankshaft, lubrication being by petroil or automatic system as required. The Villiers middleweight carburetter with separate controls to throttle and taper needle was standard, and either fixed or variable ignition was optional.

Although capable of 60 m.p.h., these engines were well known for their pulling powers at low engine speeds.

Mark XIV-A engines were first made in 1932, and were in continuous production until the early part of the war. Prefix letters BYP (air-cooled, petroil lubrication), BY (air-cooled, automatic system), and RY (water-cooled, automatic system).

The Mark XVII-A engine with a flat-topped piston and capacity of 249 c.c., bore and stroke as the Mark XIV-A, was introduced in 1934. The crankshaft is carried in single-row ball-journal bearings, crankcase compression being retained by bronze bushes bored to a very close clearance on the shafts. The advantages of this design over the three-port type of engine have already been enumerated in Chapter I, and, because of the all-round improvements obtained, all motor-

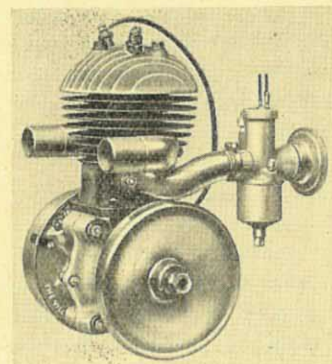


Fig. 9.—Mark XVII-A 249-c.c. Engine.

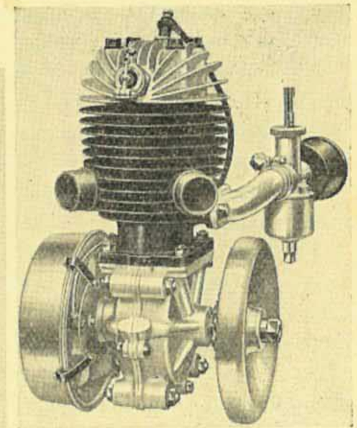


Fig. 10.—Mark XIV-B 346-c.c. Engine.

cycle engines introduced since 1934 have had a flat-topped piston and cylinder with four transfer ports.

The Mark XVII-A engine, prefix letters BYX (Fig. 9), was followed by the Mark XVIII-A model having the same cylinder and piston, but a modified crankshaft assembly. Double-row ball-journal bearings carry the driving shafts, the crankcase compression being retained by spring-loaded gland bushes. Lubrication of both engines is by petroil mixture.

The Mark XVIII-A model, prefix letters UU, is the last of the 250-c.c. class to be made for motor cycles.

350-c.c. Class

Between 1922 and 1928 five models, commencing with the Mark VI-B, having a capacity of 342 c.c. were produced, all engines having a bore and stroke of 79 mm. × 70 mm. respectively. The models Mark VI-B and VII-B were similar in construction to the 247-c.c. engines Mark VI-A and VII-A, having fixed cylinder-heads with single exhaust port, carburetter being in front, cast-iron pistons, fixed gudgeon-pin and plain crankshaft bearings, lubrication being by drip feed. Prefix letters K and M respectively.

The Mark VIII-B, IX-B, X-B models had detachable alloy cylinder-heads, twin exhaust ports and detachable inlet manifolds, aluminium pistons with floating gudgeon-pins and inertia ring, and plain driving-shaft bearings, specially grooved to suit automatic lubrication, prefix letters of these three models being AZ, CZ and HZ respectively.

The long-stroke model, the Mark XIV-B, was introduced in 1931, the bore and stroke being 70 mm. × 90 mm., giving a capacity of 346 c.c. This engine embodied all the improvements up to that time, the specification including a detachable alloy cylinder-head, aluminium piston with inertia ring, twin exhaust ports, detachable inlet manifold, auxiliary flywheel and four-pole magneto. The standard model was made for the automatic lubrication system (prefix letters YZ), but an alternative model for petroil lubrication was available (prefix letters YZP).

100-c.c. Class

During the year 1931 several British motor-cycle manufacturers introduced an ultra-lightweight machine powered by a Villiers 98-c.c. two-stroke engine, which was known as the Midget Model. Although of the three-port design, the arrangement of the ports was different from any other Villiers engine. The transfer and exhaust ports were placed on the side of the cylinder in line with the crankshaft and, therefore, the piston deflector was at right angles to the gudgeon-pin.

To prevent the gudgeon-pin entering the transfer port, a retaining disc was fitted in one of the piston bosses. The cylinder with integral exhaust and inlet stubs was inclined forward and had a fixed cylinder-head. This engine has a cast-iron piston with inertia ring, roller-bearing big-end, and crank-pin having parallel ends which are a forced fit in the crankshaft webs instead of the usual taper and lock-nut. The stroke and bore is 50 mm.; lubrication by petroil; prefix letters CY.

Included in the 100-c.c. class are the Junior, Junior-de-Luxe and Mark 2F autocycle engines, and the Mark 1F engine-gear unit. These models are dealt with separately in later chapters.

CHAPTER III

OVERHAULING AND SERVICING OLDER TYPE OF ENGINES

ALTHOUGH practically all Villiers motor-cycle engines now being produced have flat-topped pistons and ball-bearing crankshafts, and are dealt with in detail in later chapters, instructions for overhauling and servicing the older type of engines are given in this chapter. The construction of the two-stroke engine when compared with a four-stroke type appears so simple that one wonders where the power comes from, but to maintain satisfactory running it is necessary to give careful attention to every detail when overhauling.

Tools Required

Apart from the dismantling of the crankshaft assembly, the work can be done with the aid of tools usually found in the kit of the keen motor cyclist: these should include a hammer, a long screwdriver, tubular box and open-ended spanners, and a good-quality adjustable spanner. In addition to the latter, it will be found advantageous to have a Villiers hammer-tight spanner for the removal of the magneto flywheel, and also the sparking-plug spanner specially shaped to go between the cylinder-head fins. A good bench vice will also prove useful when major overhauls are being done and the engine is removed from the frame.

Before commencing even a minor overhaul it is advisable to remove all external dirt from the engine. A dirty engine means dirty hands, and adjustments or removal of parts cannot be properly done when the hands are covered with oil and road dirt. Paraffin and a stiff brush will usually remove all surface dirt, but before starting work place a large tray or pan underneath the crankcase. As the components are removed

they should be placed in a large tin or old saucepan containing clean paraffin, in which the parts can be left until given attention.

Cylinder Removal

Assuming the engine is to be completely decarbonised, it is, of course, necessary to remove the cylinder, but before this can be done, components such as carburetter and exhaust pipes have to be removed, and where a detachable head is fitted this can better be removed before releasing the four nuts securing the cylinder to crankcase. Before releasing the head-fixing bolts, take out the sparking-plug and release-valve unit where fitted.

There is no gasket or washer between the cylinder and head, the joint being metal to metal, and after removing the fixing bolts the head should lift away.

When removing the petrol and oil pipes it is advisable to use two small spanners, one on the tap or union, the other to release the union nut so as to avoid twisting of the soldered joint of the pipe.

Having removed the carburetter and exhaust pipe, the nuts securing the cylinder base can be unscrewed, but before attempting to lift cylinder, turn crankshaft until piston is at bottom of the stroke. Now lift cylinder free of piston with one hand, taking care not to turn the cylinder whilst being removed, otherwise the ends of the piston-rings may foul one of the ports, and, with the free hand, prevent the piston falling sharply against the connecting-rod or crankcase top. If it is not intended to dismantle the crankcase place a clean rag around the connecting-rod, so covering the opening in the top of crankcase. This precaution is necessary to prevent entry of dirt and carbon, which is difficult to remove unless the crankcase halves are separated.

Removing the Piston

Early models, including the Marks VI-C, VII-C, VI-B and VII-B, have a fixed gudgeon-pin which is prevented from turning by a split pin at either end and located in a slot cut across the gudgeon-pin hole in the piston. The hole is made slightly taper, the large end being marked "IN" and the opposite side or small end "OUT".

To remove the gudgeon-pin first pull out the split pin on the outside, using a pair of pliers, then remove any formation of carbon on the gudgeon-pin between the connecting-rod small-end bush and bosses of piston. Place one end of a round piece of brass or copper a little smaller in diameter than the hole in piston against the end of gudgeon-pin, and tap with a light hammer until the pin is free, at the same time supporting the piston in one hand. Replace the gudgeon-pin in the same manner, but entering the pin on the opposite side of piston from which it was driven out, refit split pin and open out the ends, making sure that no part of the split pin stands above the surface of the piston.

In later models, a floating gudgeon-pin is fitted; this can rotate in the piston bosses as well as in the small-end bush in the connecting-rod. Aluminium pads are fitted in the ends to prevent damage to the cylinder walls. When cold, this type of pin may be found to be a push fit in the piston, the necessary clearance between pin and piston to allow for floating being given by the expansion of piston bosses caused by the heat when the engine is running.

All engines having flat-topped pistons have parallel gudgeon-pins secured endways by circlips, the actual "float" being reduced to the minimum, because excessive movement will cause hammering of the pin against the circlip.

Always use new circlips, if possible, when refitting gudgeon-pins secured by circlips. Never fit a damaged circlip.

Removal of Piston-rings

Piston-rings, being made of cast iron, are very brittle and, therefore, must be handled very carefully to avoid breakage. Providing the rings are free in their grooves they can best be

removed by using three or four thin, flat strips of brass as indicated in Fig. 11, a soft metal being desirable to avoid cutting the piston, especially when this happens to be made in an aluminium alloy. The method employed to position the strips is as follows: Lift one end of each ring sufficiently to allow of insertion of the first strip between inside of rings and outside of piston; then having worked this strip about half-way round the piston, insert the next strip. When all the strips have been placed in position it will be found that rings are free from their grooves, and that they can be withdrawn, the top ring, of course, being removed first.

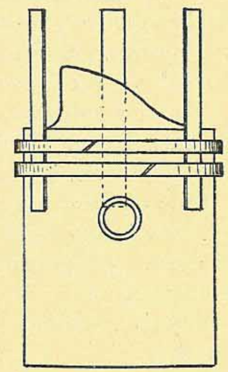


FIG. 11.—METHOD OF REMOVING PISTON-RINGS.

If the rings are found to be in a good condition, it is advisable to remove them, if only to clean away the carbon which usually forms on the bottom and sides of the grooves. Should the rings be stuck in the grooves it will be necessary to fit new ones and to thoroughly clean the grooves beforehand.

Earlier, mention has been made of the patent inertia ring fitted to some pistons. The object of this special ring is to prevent the formation of carbon, and consequent gumming up of the top piston-ring. The inertia ring is fitted between the piston-ring and top land, being allowed very little up and down movement but being free to rotate in the groove. This movement, which is continuous whilst the engine is running, prevents the accumulation of oil on the faces of the compression ring and consequent formation of carbon. The ends of the inertia ring are made to butt, thus leaving a space between inside of ring and bottom of groove, whilst the section of the inertia ring is such that the outer surface cannot touch the cylinder bore. Do not remove the inertia ring unless, through loss of temper or spring, the ends have become separated.

Cleaning the Piston

Removal of carbon, inside and outside, is made much easier if the piston has been immersed in paraffin for several hours previously.

Having removed the compression rings, commence operations on the inside of the piston, using a blunt screwdriver or similar tool to chip out the carbon from inside the deflector and crown. When dealing with an aluminium piston be careful not to remove the metal also.

The ring grooves can be cleaned by using the end of a broken hacksaw blade. If the ring-locating pegs are worn, replace with new ones, using a piece of screwed brass rod, afterwards cutting off flush with the outside of the piston land.

If the compression rings have not been gas-tight a deposit of carbon will probably be found on the piston skirt; this can usually be removed by rubbing with a rag which has been soaked in paraffin, or, in obstinate cases, by a piece of hard wood.

It is very important that no metal is removed, particularly in the case of an aluminium piston, as any increase in the clearance between piston and the cylinder bore will cause rattle.

The piston deflector should be polished with very fine emery cloth dipped in paraffin and, finally, the piston should be thoroughly brushed in petrol to remove any traces of emery and carbon. Stand to drain and dry out before refitting rings, and cover with a clean cloth.

Replacing Piston-rings

Compression rings must be gas-tight, and if the old rings are not bright all round, or are worn on the sides, they should be replaced with new ones. When fitting new rings it is very important to check the gap between ends when in the cylinder. In pistons not having the inertia ring, the rings are prevented from turning by a round, screwed peg $\frac{1}{8}$ in. diameter, and in such cases the gap between the ring ends must not exceed 0·008 in. (8 thous). Where the inertia ring is fitted the rings are located by a form of Woodruff key pressed into and across the grooves and, therefore, an allowance has to be made for the width of the key. The correct gap for the rings is 0·045–0·05 in. (45–50 thous).

To check the gap, insert the new ring into the cylinder bore, using the end of the piston-skirt to ensure the ring being square in the cylinder; the gap can then be checked by feeler gauge. Any used ring having a gap exceeding the above figures should be scrapped.

Dealing with the Cylinder and Head

It is assumed that where detachable, the head has already been removed and placed in a paraffin bath in order to soften and loosen the carbon deposit, both on the inside and outside. Quite a lot of the dirt and carbon can be removed from the outside of cylinder and head by using a wire brush and the tang end of a file, and that on the inside of the head by using a scraper. The surface of the combustion space should be as smooth as possible, but care must be taken not to alter the shape or to increase the volume.

Carbon should also be removed from the sparking-plug and release-valve threads, otherwise when fitting a new sparking-plug having a slightly longer body it will be impossible to screw down to the copper and asbestos joint washer. To clean the thread use an 18-mm. tap, or if one is not available, a useful makeshift can be made by using an old long-reach sparking-plug body on which grooves have been filed across the threads so as to form cutting faces.

The seating for the compression-release-valve body should be examined, and if the copper joint ring is still in position, remove and replace with a new one. Care must be taken whilst working on the head not to damage the joint face, otherwise a gas-tight joint will not be obtainable between the head and the top of the cylinder.

Where the cylinder and head is one casting, the inside carbon can be removed by chipping, using a long, blunt screwdriver, which, however, must not be allowed to scrape the walls of the cylinder. All traces of carbon must be removed, the surface of the combustion space being afterwards polished by a piece of emery cloth secured to the end of a piece of wood, the handle end of a broomstick being very suitable.

To remove carbon from the various ports it will be necessary to use bent scrapers, but it is important that no metal is removed, and that the corners are not bevelled. If the corners are bevelled the port timing will be altered, and there is the possibility of the piston-rings fouling when passing the ports.

Before giving the cylinder a final wash in clean paraffin, remove all traces of cylinder-base and inlet-manifold joint washers, and afterwards hang up to dry. The appearance of the cylinder can be improved by a coat of one of the black paints specially made for the purpose.

Cylinder Reboring

After a considerable mileage the bore of the cylinder will have increased in diameter, the amount being greater approximately half-way down, this being due to the thrust of the connecting-rod, which is greatest at this position of the piston stroke.

It is no use fitting new piston-rings of the standard size in a badly worn cylinder, and when the bore is found to exceed the original diameter by 0·008 in. (8 thous), the cylinder should be returned to the makers for reboring, the increase from the original size being 0·015 in. (15 thous) or 0·03 in. (30 thous), whichever is found necessary.

Oversize pistons and rings to these sizes are kept in stock for most of the older-type engines, and when a rebored cylinder and new piston have been fitted, it will be necessary to carefully run in for approximately 500 miles, as in the case of a new engine.

Compression-release Valve

Although only used generally when starting the engine, the head of the valve will in time become slightly distorted and, therefore, to retain compression, it is necessary from time to time to renew the valve seat by grinding. In addition, the valve body must be a gas-tight fit in the cylinder-head, and must seat against the copper joint washer which fits over the screwed end against the shoulder of the body.

Assuming that the complete valve has been removed from the cylinder-head, the hexagon portion of body should be held in a vice, and then holding the special nut next to the spring with a pair of pliers the valve can be unscrewed, using a screwdriver in the slot in head. Remove any carbon from the valve stem, and using a fine grinding paste between valve and seat, grind in the valve, employing a screwdriver to rotate the valve stem. Having thoroughly cleaned the parts in paraffin, place valve in body, fit a new spring, and screw on the special end-nut until really tight. In later models the valve stem has a groove into which the cable-clamp screw enters, so that should the end-nut become unscrewed the valve cannot drop into the cylinder. When replacing the control-cable clamp and screw a little free movement must be allowed in the outer cable to ensure that the valve returns to its seating. When refitting the valve unit in cylinder-head, it is advisable to use a new copper joint washer.

Engine Bearings

The engines dealt with in this chapter all have plain phosphor-bronze bearings for the crankshaft, and roller bearings for the crank-pin, and an examination for possible wear should be made whilst overhauling. The bearings in the crankcase carry the crankshaft, and also act as a seal, preventing the ingress of air into the crankcase on the suction or upstroke of piston, and the loss of compression on the downstroke. The clearance between the bearing-bush and the crankshaft has, therefore, to be as little as possible, allowing, of course, sufficient clearance for the lubrication of the shaft.

To make the examination the crankcase with crankshaft assembly must be removed from the frame of the motor cycle, and then held in a vice by one of the four main fixing lugs.

First test for amount of end-play between crankshaft webs and faces of bearing flanges by pushing the crankshaft over as far as possible and measuring by feeler gauge the gap between web and bearing flange. This gap or clearance should not exceed 0·012 in. (12 thous), with one 6-thou joint washer between the crankcase halves.

When the engine is originally assembled the total end-play or clearance is approximately 0·007 in. (7 thous). To ensure this amount of end-play alternative joint washers are available, these being 0·006 in. and 0·01 in. thick. Should the play in a worn engine be found to be excessive this can sometimes be reduced by fitting the thinner joint washer. The maximum up and down play or clearance between shaft and bush in a new engine is between 0·004 in. and 0·005 in. with driving-shafts, of course, running dead true; if the clearance is found to exceed 0·007 in., new bushes should be fitted.

To fit new driving-shaft bushes the crankcase halves must be separated. Care must be taken when pressing out the old bush, otherwise the crankcase wall will be distorted. The crankcase should be supported not on the joint face but on a bush or sleeve having a hole large enough to fit over the flange of the bush, and long enough to allow the bush to be pushed out free of the crankcase.

Before fitting a new bush clean out all oil ducts, grooves, etc., and remove any carbon from the crankcase wall. A number of bushes fitted to early types of engines had a flat on the flange which located against a step or shoulder machined on the inside boss of the crankcase, but when replacing bushes having the full flange, care must be taken to ensure that the new bush is fitted with the oil groove in the correct position. The fitting of new bushes is best carried out by the engine makers, who have the necessary equipment and tools for finishing the bore to the correct diameter.

Connecting-rod Bearings

The connecting-rod is made from a steel stamping, the big-end being hardened and ground to a very close tolerance,

whilst the small-end is fitted with a renewable bronze bush. When new, the components making up the big-end bearing are selectively assembled to give a total up-and-down clearance of 0·0015 in. (1½ thou) and a side clearance or end-play between connecting-rod and crank-webs of 0·007 in. (7 thous). Providing the necessary attention is given to the mixing of the petroil mixture, replacements of the bearing components should not be necessary until after completing approximately 15,000 miles. Unless the owner has the facilities for trueing up the crankshafts after replacements have been fitted, it is advisable to return the crankshaft assembly to the makers. When checking for up-and-down play, grip the connecting-rod firmly by the hand and attempt to lift vertically. It will be found that the con-rod can be moved sideways slightly, but do not confuse this movement with up-and-down play.

The small-end of the connecting-rod is fitted with a renewable bush. If the clearance between the bush and gudgeon-pin is found to be excessive a new bush and pin should be fitted. When removing the old bush no strain must be taken by the connecting-rod which would cause it to bend. The bush is best removed by using a mandrel hand press, the shafts being removed from the crankcase, but by using two special bushes and a draw-bolt the job can be done with the crankshaft *in situ*. To do this proceed as follows :—

Make a bush similar to the one to be removed, but having an outside diameter 0·03 in. smaller. Then make a bush having a hole 0·03 in. larger than the outside diameter of the bush to be removed. Place these special bushes one at either side of the fixed bush, and through the centre of the three bushes fit a screwed bolt with nut and washer. Tightening up the nut will cause the small bush to push out the centre one into the hole of the other outer bush. The new small-end bush can then be fitted in a similar manner, and after drilling the oil hole the bore should be line-reamered to the original size. It is most essential that the crank-pin and gudgeon-pin are parallel and in line with one another, and as the makers have the necessary equipment for checking and correcting any errors, the work of re-bushing and fitting of new big-end parts should be entrusted to them.

CHAPTER IV

LUBRICATION SYSTEMS

THE life and service given by an engine depend to a great extent on the attention given to lubrication, particularly during the first 500 miles, whether this is by : (1) drip feed, (2) Villiers automatic system or (3) petroil mixture.

Although all engines now being made are lubricated by petroil, there are a considerable number still in service using the other systems mentioned, and therefore the earlier methods of lubrication are also described in the following pages.

Drip-feed System

Early pattern Villiers engines were lubricated by the semi-automatic drip-feed system. In the front end of the petrol tank is built an oil compartment in which is fitted a hand pump. Attached to the outlet end of the pump is a chamber into which the oil is forced by the plunger or piston of the pump. The flow of oil into the chamber is regulated by the rider to suit the varying conditions, the head of the regulating screw having a graduated dial to enable quick settings to be made. In the top of the chamber, and making an air-tight seal, is a glass disc or window through which the oil can be seen. The plunger of the pump is returned by a spring, and when the pump barrel has emptied, the plunger has again to be depressed. In the outlet from the chamber is fitted a non-return valve to prevent air pressure from the engine crankcase blowing the oil back again. This system was fairly successful for the comparatively slow-running engines of the early days, but was dependent too much upon the human element.

Villiers Automatic System

The Villiers automatic system was used in order to overcome the disadvantages of the mechanical oil-pump and the hand-operated drip-feed system. A mechanical pump delivers oil only in proportion to the engine speed, and a hand pump depends entirely upon the human element, whereas actually oil should be fed to an engine in proportion to its load, and be entirely independent of human forgetfulness. In the Villiers automatic system, variations in the crankcase pressure are utilised to supply oil direct to each bearing. As the pressure in the crankcase varies according to the throttle opening, it will be realised that the more the throttle is opened, and consequently the heavier the load on the engine, the greater is the oil supply. Reference to Fig. 12, together with the following description, makes the oil circulation of this system quite clear.

Compressed air from the crankcase passes along the centre of the shafts to the holes J, which register with grooves in the crankcase bushes when the piston is descending. The air passes on through holes drilled in the crankcase to a union situated in front of the crankcase. From this point it is conveyed through the pressure pipe A to the top of the oil tank, raising the pressure in this, and forcing oil up the pipe B in the same way as soda-water is forced up the centre tube of a soda-syphon. The oil passes the regulating screw F, and issues into the cup of the sight feed, except in the Mark III lubricator, where it passes straight to the engine. From this the oil descends to the engine through a union D on the front of the cylinder, except in certain models where it passes straight to the crankcase. Here the oil divides, part of it being sucked through a hole in the cylinder wall uncovered by the piston, and the rest passing down to the crankcase, where it is again divided between the two main bearings. Grooves in these register with ports K in the crankshaft when the piston is ascending, and the surplus oil is sucked through the drilled oil-way E to the big-end.

When the engine stops, the pressure in the tank is released via the main bearings of the engine, but oil would continue to syphon out of the tank into the engine if provision were not made for this. The vent hole C prevents this, as, by per-

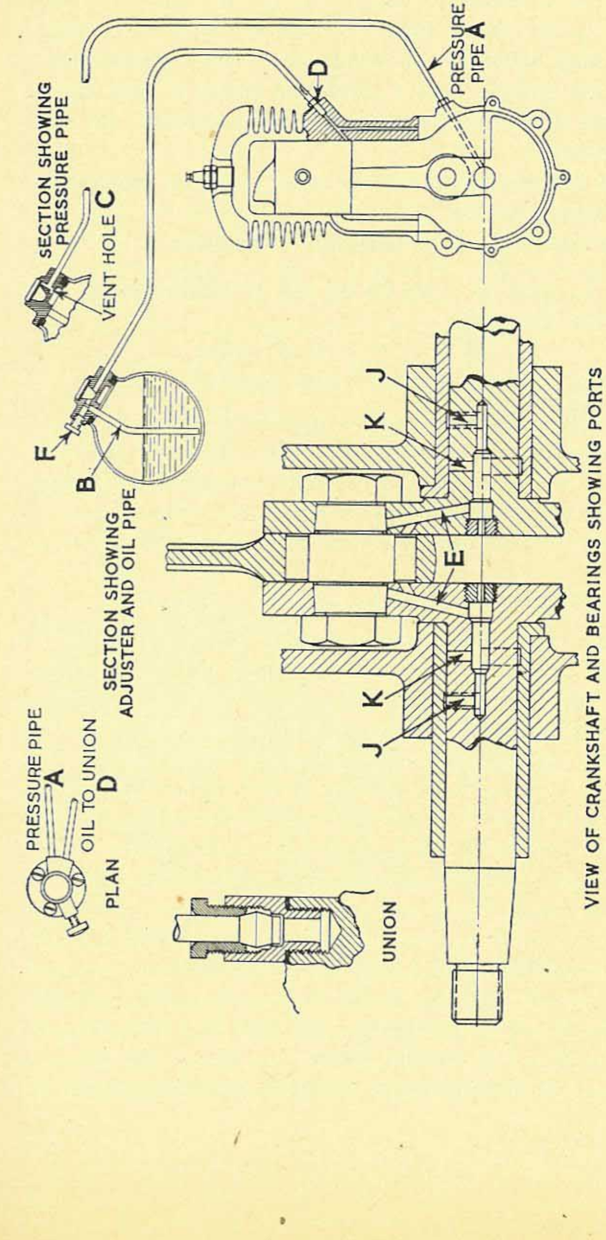


Fig. 12.—Villiers Automatic Lubricating System.

It is important that all union nuts are screwed up tightly so as to ensure that nipples on tubes make oil- and pressure-tight joints. Copper pipe to project through nipple.

mitting air to pass into the sight-feed cup from the tank, it enables the oil in the pipe D to drain down to the engine without sucking further oil up pipe B. There is a continuous flow of air through vent C while the engine is running, and this passes down to the engine with the oil, keeping the sight-feed cup clear.

It is of the utmost importance that the size of the vent hole should not be altered.

Three types of Villiers lubricators were made :—

Mark I. For use when the oil tank is itself a compartment of the main fuel tank.

Mark II. For fitting in separate oil tank.

Mark III. Where no sight feed is required.

The differences are merely a matter of arrangement, and the principle is precisely the same. In the Mark II and III lubricators the vent hole is larger in diameter, and there should be a small piece of wire loose in this hole. The object is to keep the hole quite clear and prevent an oil film choking it.

Running Instructions for Automatic Lubricator

All the unions, both at the lubricator and engine ends of the oil-pipes, are of the solderless type; each nipple has a taper at either end, and there is a corresponding internal cone on the unions and nuts. When the nuts are screwed up they squeeze in the nipples, making them grip on the pipes. It is important to keep these unions always tight. If they are taken apart, it may be necessary to fit new conical nipples when replacing to ensure getting a good joint again.

From the description above it will be seen that the system works on pressure, and therefore it is important that this is always maintained in the tank; consequently, the unions must be tight, and there should be no air leak from the oil compartment. Special attention should be paid to screwing the filler cap down firmly and making quite sure that it seats on its leather washer. *There must be no vent hole in the filler cap.* A common cause of pressure leakage is due to enamel on the threads of the filler cap collar, preventing the cap from screwing down fully. A similar trouble can arise from the washer being creased. It should always lie quite flat. The average pressure in the tank is about 4 lb. per square inch, and the maximum is only 6 lb., but the pressure must be maintained.

Failure to comply with this will result in over-oiling at low speeds and shortage of oil at speeds over 25–30 m.p.h.

Should the lubricator continue to deliver oil after the engine has stopped, this is due to syphonic action caused by the vent hole being choked. The vent hole, which is very small, should be cleaned with a single strand of Bowden wire. If the sight-feed bowl fills with oil, this is due to an air leak under the sight-feed glass.

The vent hole in the Mark I lubricator is in the sight-feed bowl itself. In the Mark II it is as shown in the diagram, whilst in the Mark III lubricator the vent hole is in the annular groove under the top washer.

It is important that all washers are kept in good condition, as any leakage will interfere with the correct working of the lubricating system.

Setting the Oil Supply

The flow of oil varies automatically according to the engine load and throttle opening. The screw F is used for adjusting the oil supply, being screwed in to reduce the supply. The correct setting has been obtained when a faint blue haze of smoke issues from the exhaust pipe as the machine is running normally in top gear on a level road. The sight feed is provided to ascertain if oil is flowing, and not to gauge the quantity. In very cold weather it is advisable to increase this setting.

Petroil System

Most riders of machines fitted with two-stroke engines are familiar with this system, but to obtain satisfactory results certain rules with regard to the mixing of the oil and petrol should be carefully observed. First, one brand only of lubricating oil should be used where possible, and after many years of experience Patent Castrol XL oil (SAE 30) has been found to give good results; therefore riders are recommended to use this brand regularly. Secondly, the mixture should be made before putting into the tank, but should at any time this not be possible, always put the petrol in first. The correct proportions are one part oil to sixteen parts petrol, or ½ pint to 1 gallon. Thoroughly mix by shaking in a clean can, and pour through a fine-mesh gauze into the fuel tank.

Except for replenishment this system calls for no further attention from the rider whilst the machine is being ridden, but if the cycle is to be laid up for more than two or three days, it is advisable to drain the carburetter, which, of course, can be done by turning off the tap before reaching one's destination. This will obviate difficulty in starting due to the oil separating and settling in the carburetter jet after standing for some time. The fact of the lubricating oil being suspended in the petrol is a big advantage, as the amount of oil entering the crankcase and cylinder is controlled by the carburetter throttle opening, which varies according to the load on the engine.

CHAPTER V

THE VILLIERS FLYWHEEL MAGNETO

BEFORE giving details of the various types which have been made since the introduction in 1922 of the first flywheel magneto, it may be of interest to explain the manner in which the electric spark is produced. The magneto really consists of two main components: the armature, on which is mounted the high-tension coil and lighting-coil cheeks, and the rotating flywheel which carries the magnets, pole pieces and the cam which separates the contact-breaker points once every revolution.

Now the magneto is really a small dynamo, but so constructed that the electricity is generated at a very high pressure, or voltage, and delivered as a rapid succession of sparks at the points of the sparking-plug fitted to the engine cylinder.

The ignition coil, in which the high voltage is built up, consists of a soft-iron core on which is wound a coil of comparatively heavy gauge copper wire known as the primary coil. Wound around but insulated from the primary coil are many turns of very fine-gauge copper wire which make up the secondary coil.

Rotation of the flywheel induces a current in the primary coil circuit, and when this circuit is broken by the separation of the contact points, a current of high pressure is induced in the secondary coil, causing a spark at the plug points. The circuit is easily followed by reference to the diagram, Fig. 13.

The armature plate D is secured to the engine crankcase, A is the ignition or high-tension coil, the heavy lines denoting the primary winding, and the fine lines the secondary winding. The condenser E, the function of which is explained later, is actually situated immediately underneath the contact breaker B. The sparking-plug C completes the circuit.

Rotation of the flywheel induces a low-tension current in the primary circuit (shown in Fig. 13 by heavy lines). When the contact points are closed, *i.e.*, in contact with one another, the current continues to the other end of the primary winding via the armature plate, which is "earthed" by contact with the engine crankcase. When this primary current is interrupted by the opening of the contact-breaker points the flux collapse which follows induces a very high-voltage current in the

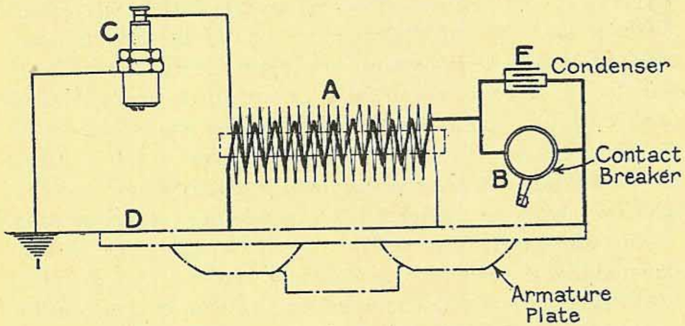


FIG. 13.—CIRCUIT DIAGRAM OF IGNITION SYSTEM.

A, Ignition or high-tension coil; B, contact breaker; C, sparking-plug; D, armature plate; E, condenser.

secondary winding which is led to the central electrode of the sparking-plug and back to earth through the plug body.

The Condenser

It will be seen from the diagram that this component is put in parallel with the contact-breaker points. One function of the condenser is to prevent sparking at the points when they open; in consequence of this, the rupture of the primary current is particularly sudden, assisting in the induction of the high voltage required.

The condenser is made up of pieces of tin-foil separated from one another by an insulating material such as waxed paper or mica, and the large surface capacity of the tin-foil carries the induced current in the primary winding when the points are suddenly separated by the cam secured to the

magneto flywheel. It must be pointed out that no magneto will function properly if the condenser is removed from the circuit or if the insulation of the condenser breaks down, so allowing a short circuit.

Testing the Condenser

The condenser should be tested on a 200–250 volt direct-current circuit. The reading of a meter should be between 0·2 and 0·4 micro-farads; if a reading lower than 0·2 is obtained the condenser should be discarded. The condenser should hold the bulk of this charge for at least 15 seconds. Discharge the condenser by touching the casing with the end of the attached lead, when a good spark should be seen and heard. The condenser will probably function correctly for a time if it only holds its charge for some 5 seconds, but will cause trouble later and should be replaced.

Testing the Ignition Coil

Check whether the small slotted grub-screw in flange of bobbin makes contact with the end of primary winding, otherwise there is the possibility that although the hexagon-headed terminal screw may be tight against the external lead to contact-breaker, actual contact is not being made with the end of coil in the bottom of the hole. When the hexagon-headed screw is removed, the slotted end of the insert screw can be reached with a narrow screwdriver. The end of the coil wire must not project through the hole in the side of the bobbin end, otherwise a short-circuit will occur through contact with the armature cheek.

A fixture for testing the ignition coil from a 6-volt battery is shown in Fig. 14. The cam which is fixed to the end of the motor spindle should be rotated at about 1500 r.p.m. The coil is held in two V-brackets A, the primary contact in the bobbin end pressing on the spring strip B on the base-board, which is in turn connected to the point plate of the contact-breaker.

A swivelling arm C, as shown, holds the coil down by press-

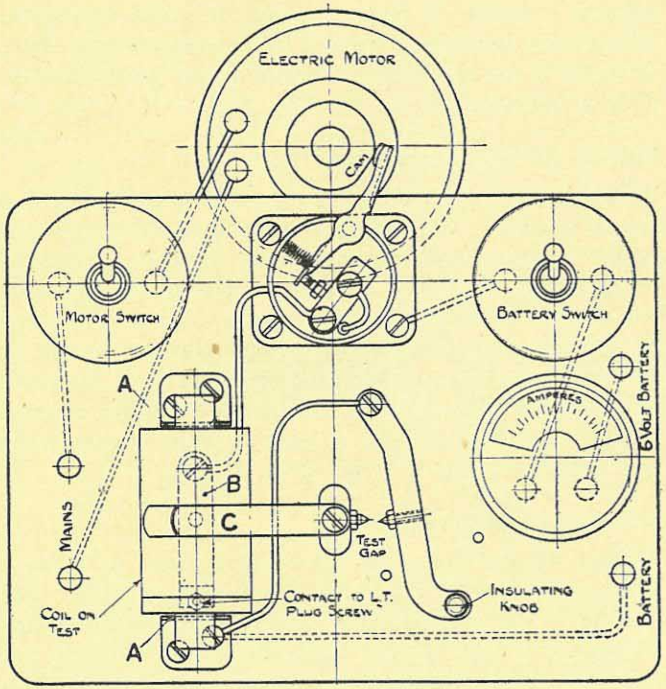


Fig. 14.—Ignition-Coil Test Set.

ing on the high-tension button and takes the high-tension current to the test-gap point. A serviceable coil should jump 5·5 mm., and it should also be possible to withstand running for about two minutes with a gap of about half-an-inch even if no spark occurs. If after running with a wide gap there is no missing on the 5·5-mm. gap, the coil can be passed as being in order.

The resistance of the coil as tested with an ohmmeter should be between 2000 and 4000 ohms; if below 2000 the coil should be scrapped, if above 4000 the coil may be serviceable, but corrosion in some form may be setting in, and replacement may be advisable.

A known good coil should be kept on hand in order to check the testing apparatus, because the 6-volt battery may be run down and the contacts of the testing fixture may be defective.

The point gap of the contact-breaker will be the standard of 0·014 in., but of course the points must be kept clean as in the magneto.

The ammeter is put into the circuit to check the continuity and insulation of the primary winding; if faulty the needle will be unsteady.

The Contact-breaker

This is the name given to the mechanism which breaks the contact in the primary winding. It consists of a circular box in which are fitted, on the underside, the condenser and fixing studs, whilst the fixed contact point and rocker-arm are contained in the upper portion.

The rocker-arm end which protrudes from the box makes contact with the flywheel cam whilst the contact points are separated, the correct gap between the points when fully open being 0·015 in. or $\frac{1}{64}$ in. The cam is actually relieved 0·03–0·04 in. to ensure that the rocker-pad is not touching the cam face whilst the contact points are closed.

To the end of the rocker-arm inside the box is fitted what is called a fixed contact point, the adjustable point being carried in a clamp fixed to, but insulated from, the rocker-box. The two screws holding the clamp are insulated from both the clamp and the leads from condenser and ignition coil, by special insulating bushes, which must be correctly fitted should it be necessary at any time to fit a new condenser.

The two leads, one from the ignition coil, the other from the condenser, are fitted next to the clamp, and then followed by the flanged insulating bush, the plain insulating bush being fitted underneath the clamp next to the condenser box.

The construction and assembly are illustrated in Fig. 15.

The contact-breaker assembly, as described above, has been a Villiers feature since the inception of the flywheel magneto.

Very few changes have been made in design and construction. During 1947 a modified design was introduced, in which the circular condenser box is retained, but a different method of point adjustment is employed.

The adjustable point is fixed to a bracket pivoted on one end and secured to the condenser box by one slotted screw, the bracket and screw being insulated from the box by fibre washers.

The complete contact-breaker assembly is interchangeable with the older pattern, but as two types of rocker-pads are

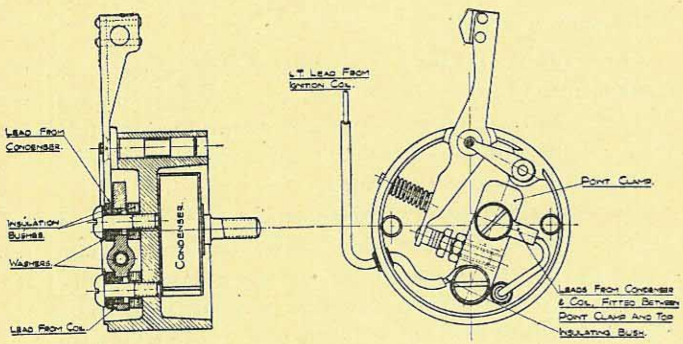


Fig. 15.—Old Type Contact-Breaker Assembly.

used it is necessary always to give the engine number when ordering spares.

To adjust the point gap turn flywheel clockwise until rocker-arm is fully raised, undo screw A (Fig. 16) holding point bracket B and place between the contact points the feeler gauge fitted to the screwdriver which is supplied with every engine. When tightening the screw use the special screw-driver supplied with each engine. If a too large screw-driver is used, the thread of the screw is likely to be stripped. Should the thread in the rocker-box be stripped, an additional hole, adjacent to the hole in which the screw was originally fitted, is provided.

The leads from condenser and ignition coil are secured to

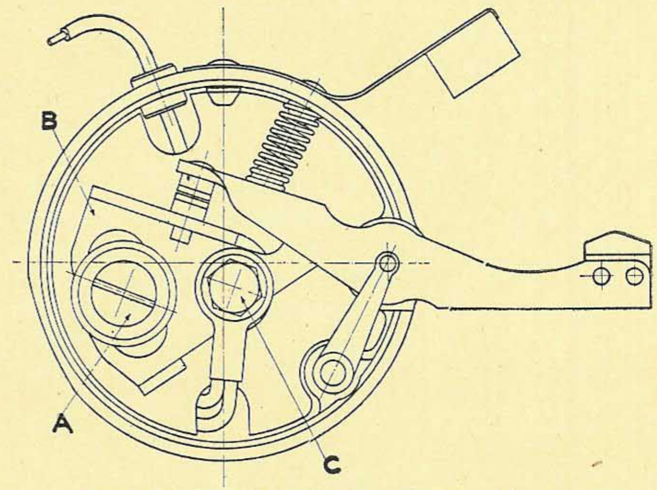


Fig. 16.—New Type Contact-Breaker Assembly.

the point bracket by one hexagon-headed screw C, which should not be disturbed when adjusting the contact points.

Occasionally remove the rocker arm and put a drop of oil on the spindle.

The Armature Plate

This is the name given to the stationary portion of the magneto on which the armature is built.

In later models the armature plate is fixed by screws to the crankcase.

On early engines, in which plain crankshaft bearings are used, the armature plate is located on the outside of the portion of the bush which protrudes from the crankcase. In the centre of the armature plate is fitted a split steel bush which can be compressed by a grub-screw to grip the crank-case bush, and so prevent the plate rotating.

In the days of slow-revving engines it was an advantage to be able to advance and retard the timing of the spark, and this was done by rotating the armature-plate assembly backwards or forwards, a hand lever being fitted for this purpose, and the split bush being adjusted to allow of the movement.

The disadvantage of this type of fixing is that by using too much pressure on the grub-screw the driving-shaft bush can be distorted and so cause a seizure.

The above method of fixing used on early pattern two- and four-pole magnetos was later superseded by a fixed armature plate, the plate being located on a spigot on the crankcase and held in position by two cheese-headed screws located inside the oil-well in the centre of the plate.

The ignition coil having a laminated core is held between

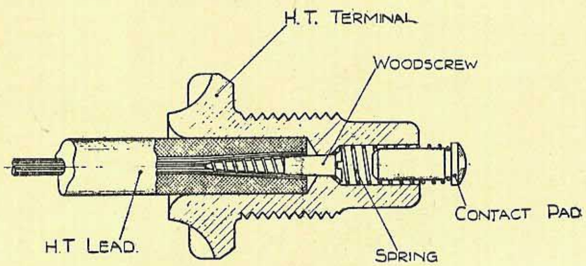


FIG. 17.—HIGH-TENSION PICK-UP ASSEMBLY.

the armature cheeks, and it is essential that good contact is made between the coil core and cheeks and between the cheeks and surface of armature plate in order to ensure a good *earth* connection.

The outer end of the secondary winding of the ignition coil terminates in a soldered disc which is situated about half-way along the outside of the coil, and it is against this disc that the " pick-up " end of the sparking-plug cable is to make contact. When replacing the coil care must be taken to see that the contact disc is in the correct position. The " pick-up " or high-tension terminal consists of an insulated moulding in one end of which is fitted a spring-loaded contact pad, and in the outer end is fitted the rubber-insulated lead to the sparking-plug. This terminal is now screwed into the armature-plate

casting, but was for a number of years held in position by a bow spring. The method of securing the pick-up spring and high-tension lead is shown in Fig. 17, and it is a good plan to smear the end of the lead with rubber solution or Bostik before fitting, to ensure the terminal being waterproof.

It is essential that the armature plate is a good fit on the driving-shaft bush, or, in the case of later engines, the crank-case spigot, otherwise the actual cheeks, will not be concentric with the pole shoes fixed in the flywheel, and the air gap will not be uniform. The air gap, or clearance, between the cheeks and pole shoes should not exceed 0·020 in., and be not less than 0·004 in., otherwise the ignition spark will be weak and starting difficult.

The Flywheel

This part of the magneto is made from a non-magnetic material such as aluminium or gunmetal to prevent loss of magnetic flux, the internal components consisting of pole shoes, magnets and the centre boss on which is formed the cam profile and which operates the " make and break " of the contact points.

Dealing first with the centre, or what is known in the works as the cam, it will be noticed that one of the fixing screws is unequally spaced. From this offset hole and the corresponding hole in the flywheel, all machining operations are located, so that the position of the cam " peak " in relation to the tip of pole shoes is always the same in a particular type of magneto.

The cam is secured to the flywheel by countersunk-headed screws which, after tightening, are riveted over, special equipment being used to carry out this work. The pole shoes are fixed in the flywheel, the sides making contact with the end of the magnets which are secured in position by a top plate held by the pole-shoe screws. After assembly and final machining operations, the complete wheel is balanced. The cam has a tapered centre hole having a ground finish, the amount of taper being 1 in 10 on the diameter, and as no key is used it is essential that both the hole and driving shaft are free from oil or grease when fitting the flywheel. The wheel is secured on the driving-shaft of engine by a centre nut which is imprisoned between flywheel and cam, the nut having a flange which draws the wheel from the shaft as it is unscrewed, thus obviating the use of a special extractor. It is very necessary that the centre nut is securely tightened, and this can best be done by using the Villiers hammer-tight spanner as mentioned in the chapter on overhauling. This spanner is obtainable from the Villiers Service Department and is available to suit the two sizes of nut which are in use; the engine number and model should be quoted when ordering. The nut, which has a right-hand thread, is unscrewed in an anti-clockwise direction looking at the face of the flywheel. The spanner should be placed on the nut and hammered round in that direction. After perhaps one turn it will be found to tighten; this is because the flange is now pulling against the flywheel. Continue hammering until the flywheel comes away from the shaft. It is not necessary to release the flywheel in order to adjust the contact points, the wheel being built so that this can be done through the space between the arms and the wheel.

Refitting the Flywheel and Ignition Timing

All the engines described in Chapter II have the ignition timing mark stamped on the face of the flywheel boss. This mark must be in line with the small slot cut in the end of the driving-shaft, but before finally tightening the flywheel centre nut, check the opening of the contact points with the position of the piston. The actual amount of advance, *i.e.*, the measurement from the top of piston to the top of the stroke, depends on the type or model of engine. A chart giving the recommended amount of advance for each model is given on page 62.

On later engines the timing marks are stamped on the outer edge of armature plate and on the flywheel rim, this method enabling more accurate timing to be obtained. The small slot cut in the end of driving-shaft is retained as an indication of

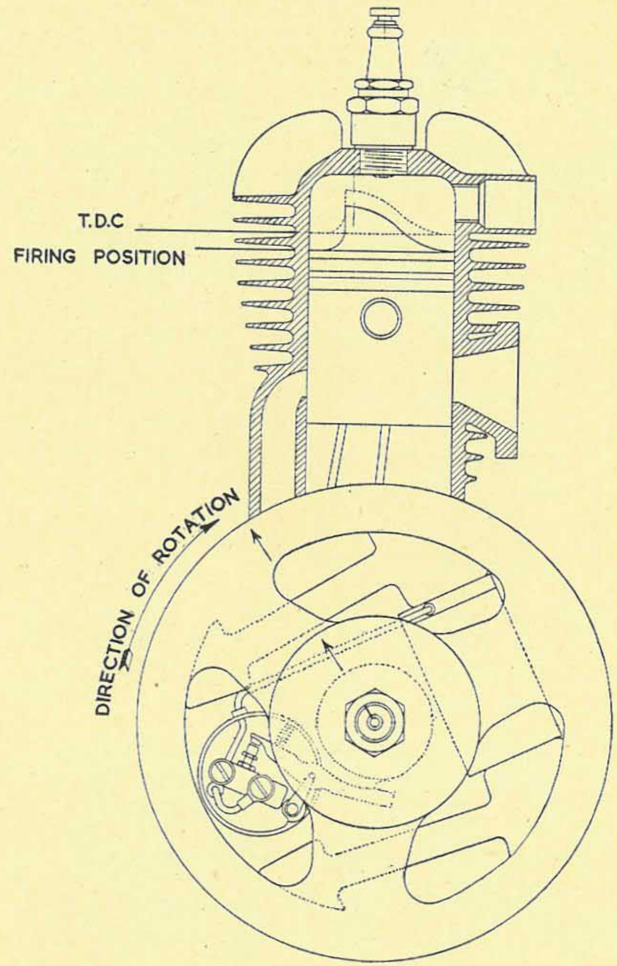


FIG. 18.—IGNITION TIMING DIAGRAM.
See page 62 for details of piston-firing position.

the crank-pin position, but is not actually used when timing. When the engine is first assembled the crankshaft is rotated clockwise looking at the magneto side until the piston reaches the predetermined position for the particular type of engine. The flywheel is then loosely fitted and rotated until the rocker-arm pad rests on the top of the cam. The contact points are now adjusted to give the correct opening of $\frac{1}{64}$ in., or 0·015 in., and having done this the flywheel is rotated clockwise until the points commence to open. The best way to ascertain this is to place a piece of cigarette paper between the points, and then rotate the flywheel until the paper can be withdrawn without tearing. The flywheel centre nut is then tightened and the wheel rotated clockwise to top dead centre. The timing marks are then stamped, one on the armature plate and the other dead opposite on the rim of flywheel. Subsequent magneto timing is then carried out by placing the marks opposite one another with the piston at top of stroke.

Types of Magnetos

Two-pole Magneto.—The Villiers flywheel magneto which was first fitted to the Mark IV engine was the two-pole pattern, and designed to provide ignition only. This magneto was known as the large type, the flywheel having an external diameter of 8¼ in.

Later, lighting coils were added to the armature-plate cheeks, the current being A.C. and fed direct to the head-lamp. The construction of this type of magneto less lighting coils is shown in Fig. 19.

With the introduction of the 147-c.c. engine, the Mark VI-C, etc., a smaller edition of the two-pole magneto was produced, the external diameter of the flywheel being 7 in. This magneto was available with or without lighting coils, the later type being illustrated in Fig. 20.

Four-pole Magneto.—During 1932 the four-pole magneto was introduced. The armature plate had two lighting coils in addition to the ignition coil, the method of fixing to the

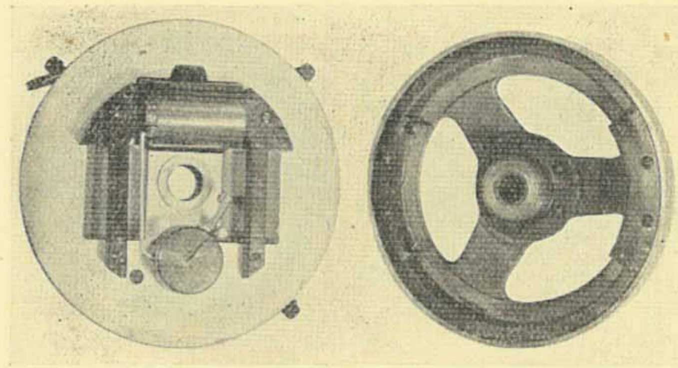


FIG. 19.—LARGE TWO-POLE MAGNETO WITHOUT LIGHTING COILS.

crankcase being either by split bush or two cheese-headed screws as described previously. The flywheel assembly is made up of four pole shoes equally spaced, the four magnets being held in position by top plates secured by the pole-shoe fixing screws. The construction of the armature plate and flywheel is clearly shown in Fig. 21.

Six-pole Magneto.—The construction of the six-pole magneto flywheel is similar to the four-pole pattern, but although six pole shoes are fitted, the number of magnets

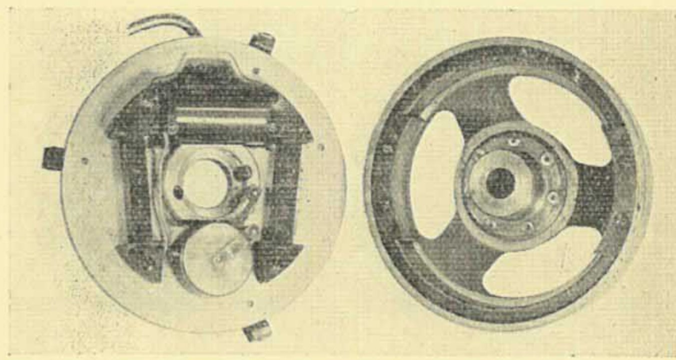


FIG. 20.—SMALL TWO-POLE MAGNETO WITHOUT LIGHTING COILS.

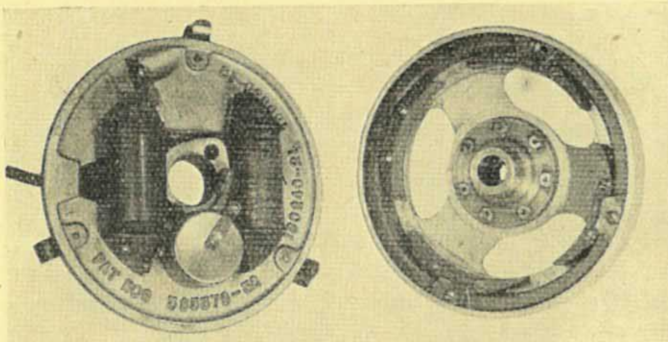


FIG. 21.—FOUR-POLE MAGNETO WITH LIGHTING COILS.

varies according to the requirements. The armature-plate assembly includes both lighting and ignition coils, and in the case of the former, separate coils for the head and tail lamps are fitted, the lighting cable from the magneto consisting of twin leads, coloured red and black.

To the leads are attached similarly coloured rubber-covered connectors, the red one being the head circuit and the black for the tail circuit, the two circuits being entirely independent. There are in service a number of six-pole magnetos having head coils only, in which case a single output lead is fitted.

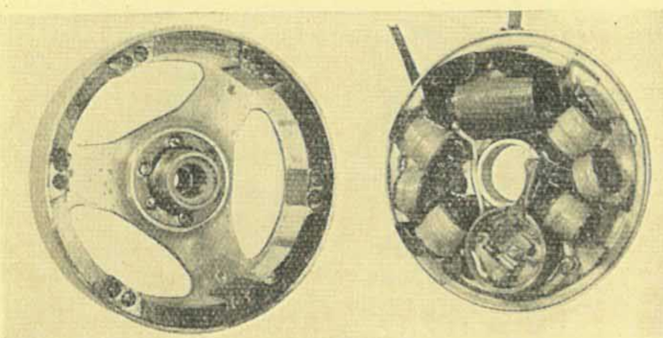


FIG. 22.—SIX-POLE MAGNETO WITH LIGHTING COILS.

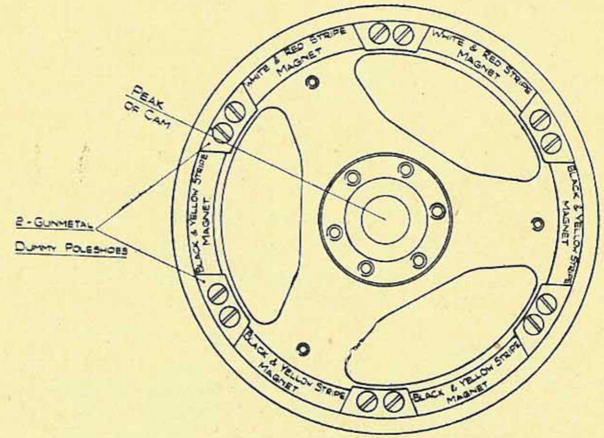


FIG. 23.—FLYWHEEL ASSEMBLY OF SIX-POLE 18-WATT MAGNETO.

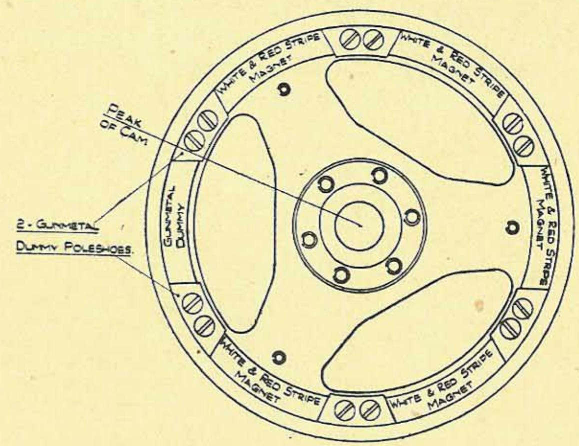


FIG. 24.—FLYWHEEL ASSEMBLY OF SIX-POLE 24-WATT MAGNETO.

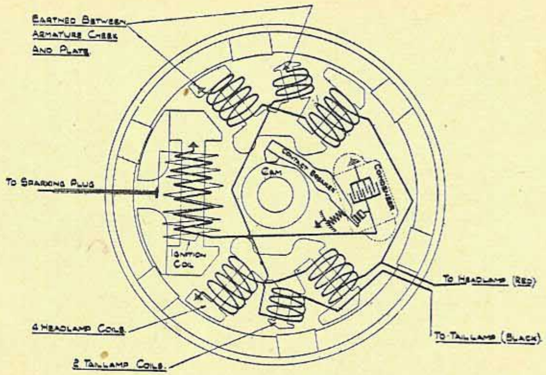


FIG. 25.—ARMATURE PLATE IGNITION AND LIGHTING WIRING DIAGRAM FOR SIX-POLE MAGNETO.

Magnetos are available giving A.C. lighting current of either 18 or 24 watts at 6 volts from the head coils, the output from the tail coils being 6 watts at 6 volts. The armature assemblies are identical for both outputs, but the flywheel for the larger output can be identified by the width of the magnets, which is $1\frac{7}{16}$ in. as against $1\frac{1}{8}$ in. for the 18-watt type.

The earth connection of the tail coil end is made by solder-

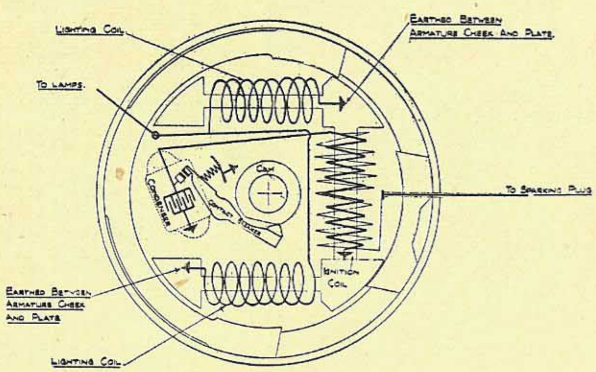


FIG. 26.—ARMATURE PLATE IGNITION AND LIGHTING WIRING DIAGRAM FOR THREE-POLE MAGNETO.

ing to the side of the cheek on which the coil is wound, and for the head coils the end is held between the coil cheek and the armature plate by the cheek-fixing screws. In cases where the lights fail or become dim, examination will often show that these connections are either broken or defective.

It is very important should it be necessary to entirely dismantle the magnets and pole shoes that these components are correctly reassembled in relation to the peak of the centre cam, and reference to Figs. 23 and 24 will make this clear. It will be noticed that in the 18-watt flywheel there are six magnets,

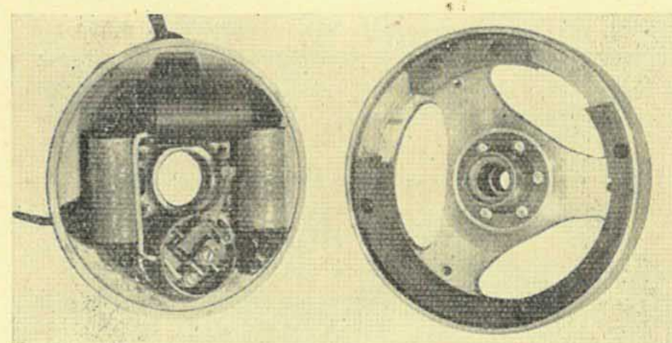


FIG. 27.—THREE-POLE MAGNETO WITH LIGHTING COILS.

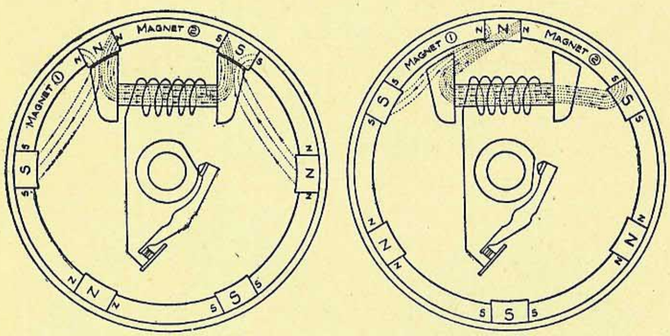
four of which are painted with a black and yellow stripe, the remaining two magnets having white and red stripes. Note the position of the two dummy pole shoes.

In the 24-watt flywheel there are five magnets, painted white and red, and one dummy magnet. Two of the pole shoes are dummies.

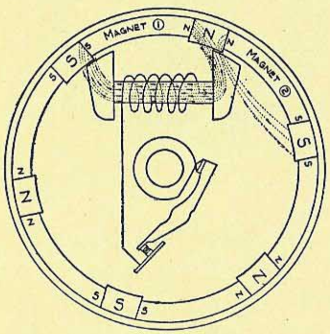
The separate circuits of the head and tail coils are shown in the wiring diagram, Fig. 25.

The condenser-box assembly fitted to all six-pole magnetos is the old type as shown in Fig. 15 on page 48.

New Six-pole Magneto.—For the new range of engines introduced at the end of 1948 entirely new six-pole magnetos are fitted. The construction of the flywheel is somewhat similar to the one shown in Fig. 22, page 56, but the armature-plate assembly is entirely different. A much greater output in lighting current is given which enables a 30-watt headlamp bulb to be used with the *direct* lighting set for the Mark



(*a*) (*b*)



(*c*)

FIG. 27A.—METHOD OF FLUX REVERSAL USED IN THE NEW SIX-POLE MAGNETO.

(*a*) Shows the magnetic flux path before the reversal which generates the high primary current required.

(*b*) Shows the flux path just before the actual point of reversal and

(*c*) Shows the path immediately after the reversal.

10D and Mark 6E engine-gear units described in later chapters.

At the beginning of this chapter, the method of producing the electric spark is explained, and the method of flux reversal used in the new six-pole magneto for obtaining the high primary current required is shown in the three diagrams, Fig. 27A. In (*a*) the flux from magnet 2 is seen to be passing through the coil core from left to right, and being more or less

unchanging is generating no current in the primary winding. In (*b*) the flux of magnets 1 and 2 is seen to be drawn out to breaking point at the left-hand coil end. In (*c*) we see where the flux has broken away from the attraction of the iron mass of the left-hand coil end and jumped with extreme rapidity to the iron right-hand coil end, where it passes through the coil core from right to left.

The rapid movement of the flux across the primary wires thus generates a high voltage in the primary winding, making a powerful electro-magnet of the ignition coil and causing the fine high-tension winding to be enclosed in a highly concentrated magnetic field. At this point the contact-breaker opens and causes a very rapid collapse of this field, generating in this fine secondary winding the very high voltage required to jump the points of the sparking plug in the cylinder.

This magneto comprises rotating magnets fixed in a flywheel, and the coil and contact-breaker mechanism are secured to a stationary aluminium plate, and the fine windings of coil do not, therefore, have to withstand the effect of centrifugal force. The stationary coil enables a direct connection to the plug wire to be made instead of having to provide a carbon brush and slip ring, as with a rotating armature. All parts are very robust, and the flywheel is secured to the crankshaft so that there is no possibility of wear or noise which is present when a chain or gear drive is used.

The number of magnets in the flywheel and the lighting-coil assemblies vary according to the engine to which the magneto is fitted, and details are given in the chapters dealing with each model.

The condenser-box assembly for the new six-pole magneto is as illustrated in Fig. 16, needing only a screwdriver for point adjustment. It should be noted that the rocker arm itself is earthed, but that every care must be taken to see that the adjustable point plate is properly protected from the contact-breaker box itself, by: (1) the large circular insulating washer under the plate; (2) the small insulating washer under the clamp screw brass washer; (3) the small black insulating bush in which the point plate pivots.

Three-pole Magneto.—This type of magneto providing both ignition and lighting is fitted to the Junior-de-Luxe autocycle engine, and, being mounted on the driving or near side of engine, the direction of rotation is anti-clockwise. A single lead from the magneto conveys the A.C. current direct to the

MAGNETO SPARK TIMING

Engine.	Capacity, c.c.	Timing in ins.
Midget	98	$\frac{11}{64}$
Junior	98	$\frac{7}{32}$
Junior-de-Luxe	98	$\frac{1}{4}$
Mk. VIII-D	125	$\frac{5}{16}$
Mk. 9D	125	$\frac{5}{16}$
Mk. VI-C	147	$\frac{5}{32}$
Mk. VII-C	147	$\frac{7}{32}$
Mk. VIII-C	147	$\frac{1}{4}$
Mk. XII-C	148	$\frac{1}{4}$
Mk. XV-C	148	$\frac{7}{32}$
Sports	172	$\frac{5}{16}$
Super Sports	172	$\frac{11}{32}$
S.S.T.T.	172	$\frac{11}{32}$
196 Super Sports	196	$\frac{5}{16}$
Mk. 1E	196	$\frac{7}{32}$
Mk. 2E	196	$\frac{7}{32}$
Mk. 3E	196	$\frac{3}{8}$
Mk. VI-A	247	$\frac{3}{16}$
Mk. IX-A	247	$\frac{5}{16}$
Mk. X-A	247	$\frac{5}{16}$
Mk. XVI-A	247	$\frac{5}{16}$
Mk. XIV-A	249	$\frac{3}{8}$
Mk. XVII-A	249	$\frac{7}{16}$
Mk. XVIII-A	249	$\frac{7}{16}$
Mk. IX-B	342	$\frac{5}{16}$
Mk. IX-BA	342	$\frac{5}{16}$
Mk. X-B	342	$\frac{5}{16}$
Mk. XIV-B	346	$\frac{3}{8}$
Mk. 1F	98	$\frac{1}{8}$
Mk. 2F	98	$\frac{1}{8}$
Mk. 10D.	122	$\frac{5}{32}$
Mk. 6E	196	$\frac{5}{32}$

The timing dimension is in all engines measured *before* top dead centre and, with the piston so positioned, the magneto contact points should be just about to open.

headlamp, the current for the tail lamp being controlled by the switch through a resistance so that the single-filament bulb can be fed by a dry battery for parking purposes. The new type of condenser-box assembly described on page 49, Fig. 16, is now fitted as standard, and is interchangeable with the old type as a complete assembly. A wiring diagram is shown in Fig. 26 and it should be noted that the one end of the lighting coils is earthed by being held underneath one of the coil cheeks, thus making contact with the armature-plate casting.

The assembly of the magneto components is clearly shown in Fig. 27.

The three-pole magneto as described above can be fitted to the original Junior autocycle engine, but as the output from the lighting coils is double that of the original two-pole magneto, it is necessary to change the bulbs as recommended on page 73.

SPARKING PLUG CHART

Recommended "Lodge" Types for Villiers Engines

Engine.	Capacity, c.c.	Plug.
Midget	98	C3
Junior	98	C14
Junior-de-Luxe	98	CB3
Mk. 1F and 2F	98	H14
VIIID and 9D	122	H3 or H1
10D	122	H14
VIIIC	147	C3
XIIC	148	CB3
Sports	172	CB3
Super Sports	172	HLS
1E and 2E	197	CB3
3E	197	CB3
5E	197	HLS
6E	197	HHN or HH14
XIVA	249	CB3
XVIIA	249	CB3
XVIII-A	249	CB3
XIV-B	346	CB3

CHAPTER VI

ELECTRIC LIGHTING SYSTEMS

SINCE about the year 1930 all lighting sets supplied with the Villiers engine have been the *direct* type. The term *direct* indicates that the alternating current from the magneto is taken direct to the head and tail lamps, the lamp bulbs being fed, therefore, only whilst the engine is running. With the introduction of the Mark 1F, 10D and 6E engines, both *direct* and *rectifier* sets are available, details being given in later chapters, but before describing the earlier types of *direct* lighting sets it may be of interest to riders of old machines to have details of the dynamo charging set in production prior to 1930.

Dynamo Charging Set

This lighting set consists of a flywheel magneto having two lighting coils and twin leads which are connected to the A.C. terminals of a Westinghouse metal-plate rectifier having special end brackets for attachment to the frame of the motor

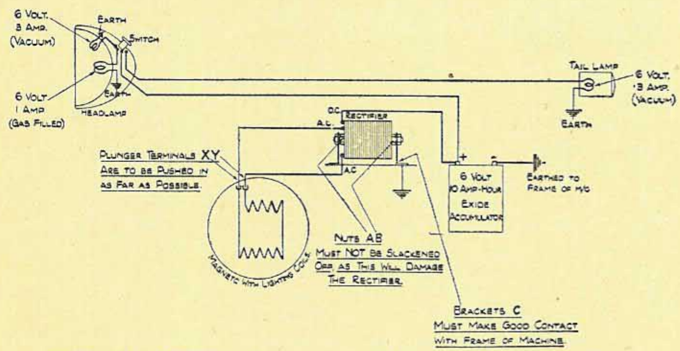


FIG. 28.—CIRCUIT DIAGRAM OF DYNAMO CHARGING SET.
Important: when accumulator is not in circuit, the plunger terminals should be disconnected.

cycle. The wiring diagram together with particulars of the correct bulbs to be used is given in Fig. 28.

A large number of these sets are still in use, and it may be of interest to owners to enumerate the necessary precautions to be taken to ensure satisfactory service :—

(1) Do not attempt to dismantle the rectifier; the nuts A and B must on no occasion be loosened or removed.

(2) Should it be necessary to remove the rectifier from the machine, the positive (+) terminal should be disconnected from the accumulator, and the plunger terminals X and Y should be pulled out of the armature plate.

(3) On no account should the engine be run when the accumulator is removed and the rectifier still in circuit; to prevent damage pull out the terminals X and Y.

(4) Make sure that the plunger terminals really make contact in their sockets.

(5) The brackets C of the rectifier must make metal-to-metal contact with frame of motor cycle.

(6) The rectifier must not be subjected to heat from the engine, but must be kept dry, as oil or water entering the rectifier casing will cause a short-circuit.

For details of bulbs to be used with this set see page 72.

Direct Lighting Sets

Two-pole Magneto without Parking Light.—This set was used with both the original large two-pole and small two-pole magnetos as already described, no provision being made for parking lights in head or tail lamps. The current was taken from the magneto direct to the headlamp switch which controlled both lamps, these being wired in series. The correct bulbs to use with these two magnetos are included in the list on page 72.

Two-pole Magneto with Parking Light.—With the improved small two-pole magneto, direct lighting sets having either a 5-in. or 7-in. headlamp were available, a dry battery for parking light being carried in a separate container fixed to the frame when the 7-in. lamp was used. The correct bulbs are listed on page 72.

Four-pole Magneto.—Similar lamps to those described above were available for use with the four-pole magneto, but owing to the greater output it was necessary to use a headlamp bulb of greater wattage. A single-filament tail bulb is used, the current from magneto passing through a resistance situated in the headlamp; this is necessary to prevent blowing of the filament, which is fed from the dry battery when parking. Later 7-in. pattern headlamps had double-filament bulbs fitted, control being by dipswitch on the handlebar. See page 72 for correct bulbs.

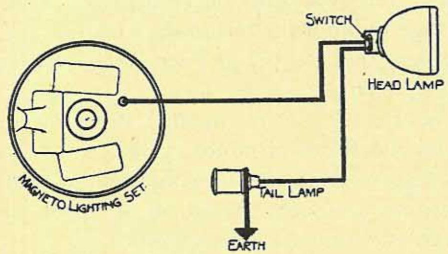


FIG. 29.—WIRING DIAGRAM FOR DIRECT LIGHTING SET—TWO-POLE MAGNETO WITHOUT PARKING LIGHT.

Direct Lighting Set with Six-pole Magneto.—This set when using a 24-watt bulb gives a driving light equal to the present-day light car, the output remaining practically constant at all engine speeds. Double-filament bulbs are fitted in head and tail lamps which, in the case of the tail light, eliminates the necessity for a resistance being provided in the wiring. As previously explained, magnetos giving 18 watts and 6 watts or, alternatively, 24 watts and 6 watts outputs are in use, but the lighting sets are identical except for the headlamp bulbs.

Before the war, headlamps of 5½ in. or 7 in. diameter were available together with the alternative bulbs mentioned above, but since 1940 only engines having the 5½-in. set have been in

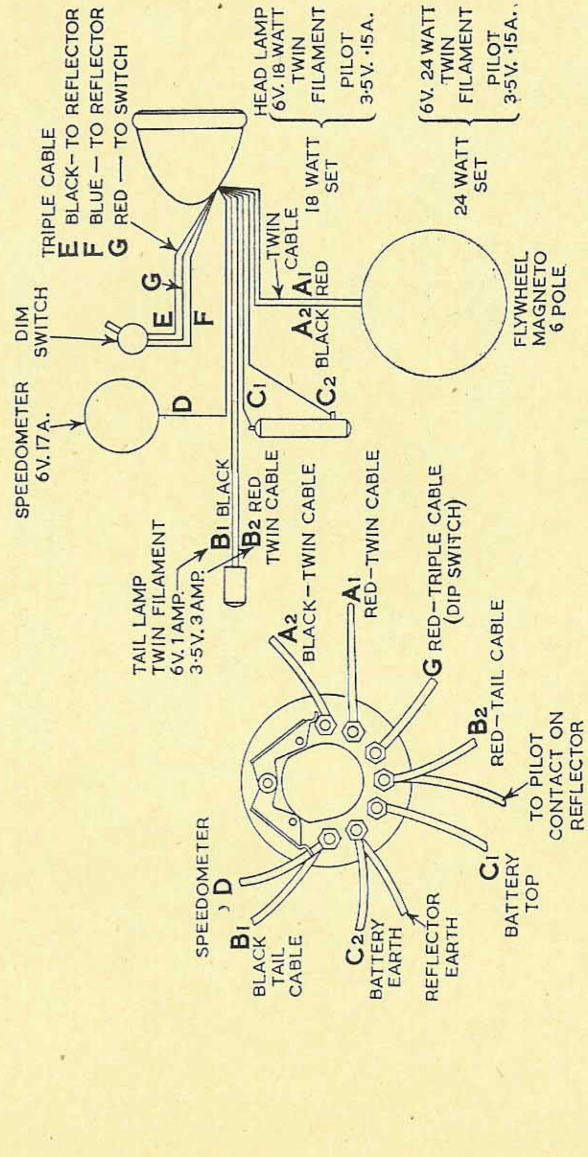


FIG. 30.—WIRING DIAGRAM FOR DIRECT LIGHTING SET WITH 7-IN. LAMP AND SIX-POLE MAGNETO.

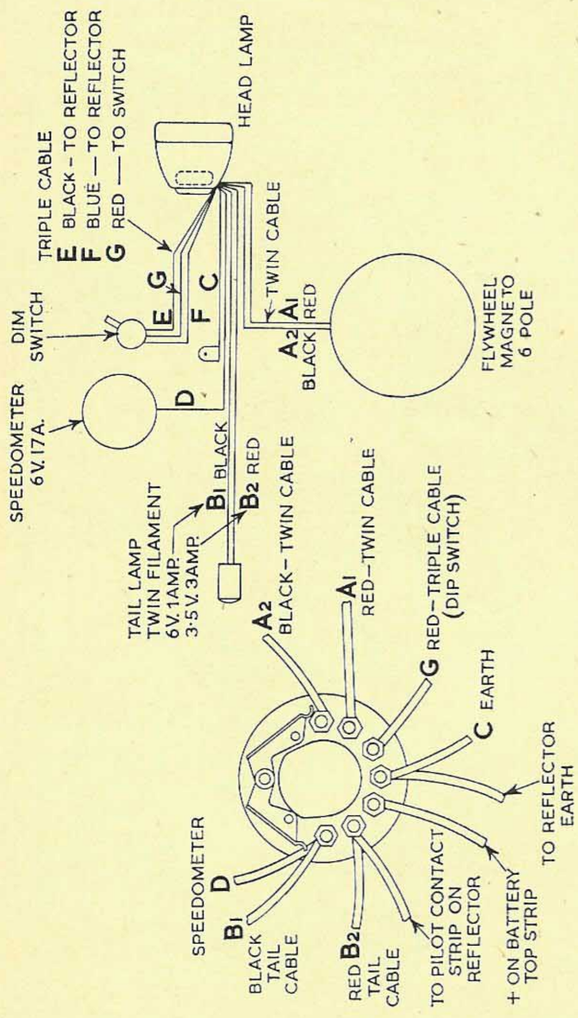


Fig. 31.—Wiring Diagram for Direct Lighting Set with 5½-in. Lamp and Six-Pole Magneto.
For particulars of headlamp bulbs, see page 72.

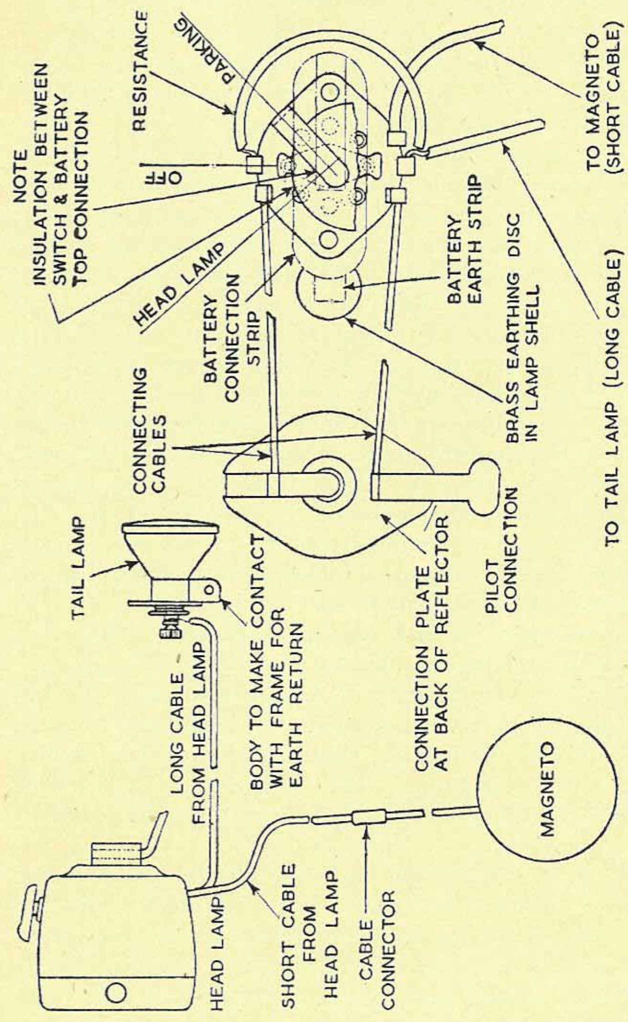


Fig. 32.—Wiring Diagram for Direct Lighting Set with 4-in. Headlamp and Three-Pole Magneto.

production. The switch connections in the 7-in. lamp are slightly different from those of the 5½-in., and reference to wiring diagrams Figs. 30 and 31 should be made.

Owing to the present-day difficulty in obtaining sufficient supplies of the double-filament tail-lamp bulb, sets are in use in which a single-filament double-contact bulb is fitted. In this case, it will be found that only the black lead of the twin cable is secured to the bulb holder, the red lead being turned back and taped, and one end of a separate lead being secured to the other terminal of the bulb holder, the other end being earthed to the frame. This is a temporary measure only, and when the correct bulb is available the turned-back lead can be refitted to the bulb holder. Should it be necessary at any time to fit a replacement bulb, care must be taken to fit this correctly so that the black lead connects with the 6-volt 1-amp. filament. Having fitted the bulb, check by moving the head-lamp switch to the L or dim position, and if the parking filament lights up, the bulb will be correctly fitted. The engine should not be running whilst the check is being made, otherwise there is the risk of blowing the parking filament should the bulb be wrongly fitted.

Direct Lighting Set with Three-pole Magneto.—This set is used exclusively with the Junior-de-Luxe autocycle engine and consists of a 4-in. headlamp with main and parking bulbs, and a tail lamp having a screw-cap bulb. A single lead from the magneto carries the lighting current to the headlamp switch which controls both lamps. The wiring connections to switch are shown in diagram in Fig. 32. The correct bulbs to use are given on page 73.

Early pattern headlamps had a special rubber mounting bracket in which was located a brass earthing strip, but present-day lamps have an earth terminal fitted to the under-side of lamp shell. It is most essential that both lamp bodies make metal contact with the frame in order to obtain the maximum light.

There are probably still in use a number of headlamps in which is fitted a single bulb which did duty for the main and

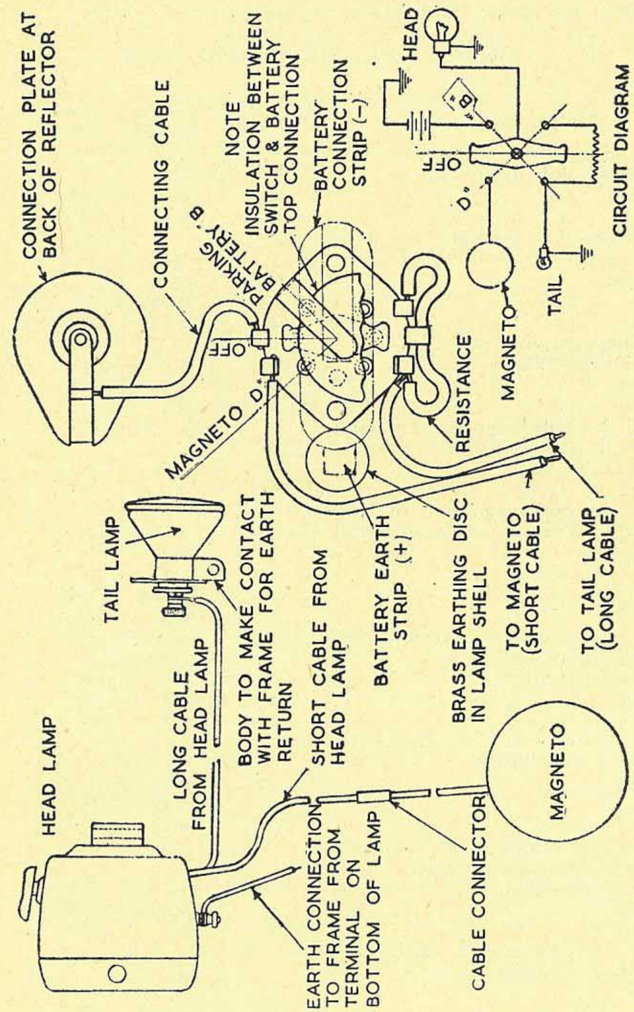


FIG. 33.—WIRING DIAGRAM FOR LIGHTING SET WITH HEADLAMP HAVING SINGLE BULB FOR MAIN AND PARKING.

BULBS FOR VILLIERS LIGHTING SETS

(D.C. = Double contact. S.C. = Single contact)

Type of set.	Voltage.	Current, amps.	Con-tact.
Large two-pole magneto :			
Head	4	0·5	D.C.
Tail	4	0·5	D.C.
Small two-pole magneto, less parking battery :			
Head	6	0·5 or 0·75	D.C.
Tail	4	0·75	D.C.
Rectifier charging set :			
Head (gas-filled) . . .	6	1	S.C.
Pilot	6	0·3	S.C
Tail	6	0·3	S.C.
Small two-pole magneto, 5-in. lamp with parking battery :			
Head and Pilot . . .	6	0·5	S.C.
Tail	6	0·3	S.C.
Small two-pole magneto, 7 in lamp with separate parking battery :			
Head	6	0·5 or 0·75	S.C.
Pilot	4	0·125	S.C.
Tail	6	0·3	S.C.
Four-pole magneto, 5½-in. lamp with parking battery :			
Head (gas-filled) . . .	6	1	S.C.
Pilot	3·5	0·3	S.C.
Tail	3·5	0·3	S.C.
When speedometer is illuminated alter as follows :			
Pilot	3·5	0·15	S.C.
Tail	3·5	0·15	S.C.
Speedometer	3·5	0·15	S.C.
Four-pole magneto, 7-in. lamp with separate parking battery : *			
Head (gas-filled) . . .	6	1	S.C.
Pilot	4	0·125	S.C.
Tail	6	0·3	S.C.
When speedometer is illuminated alter as follows :			
Tail	4	0·125	S.C.
Speedometer	6	0·17	S.C.

* When a dip-switch is fitted, fit a 6-volt 6/6-watt double-filament bulb.

BULBS FOR VILLIERS LIGHTING SETS (*continued*)

(D.C. = Double contact. S.C. = Single contact)

Type of set.	Voltage.	Current, amps.	Con-tact.
Two-pole magneto fitted to original 125-c.c. engine–gear unit :			
Head	6	0·5	S.C.
Pilot	3·5	0·3	S.C.
Tail	3·5	0·3	S.C.
When speedometer is illuminated alter as follows :			
Pilot and Tail	3·5	0·15	S.C.
Speedometer	3·5	0·15	S.C.
Six-pole magneto, 5½- and 7-in. headlamps :		(watts)	
18-watt: Head (double-filament)	6	(18/18)	D.C.
24-watt: Head (double-filament)	6	(24/24)	D.C.
Both sets: Pilot . . .	3½	0·15	S.C.
Tail (double-filament)	6	6-watt/ 3·5-volt 0·3 amp	D.C.
Speedometer . .	6	0·17	S.C.
Two-pole magneto, Junior autocycle engine :			
Head	6	0·5	S.C.
Pilot	4	0·3	S.C.
Tail	3·5	0·3	S.C.
Three-pole magneto, Junior-de-Luxe autocycle engine, with separate main and parking bulbs :			
Head	6	1	S.C.
Pilot	4	0·3	S.C.
Tail	4	0·3	S.C.
With single bulb for main and parking light :			
Head	6	1	S.C.
Tail	4	0·3	S.C.

parking lights, and for the benefit of owners a diagram of the wiring connections inside this lamp is given (see Fig. 33).

The magneto fitted to the original Junior autocycle engine was a two-pole pattern, and the correct bulbs to use with the lighting set are listed above.

The lighting sets used in post-war engines are described in later chapters.

CHAPTER VII

THE VILLIERS CARBURETTER

BEFORE giving details of the various types and models in use, it may be of interest, particularly to novices, to briefly describe the action of the carburetter.

The function of the carburetter is to supply the engine with a mixture of petrol and air which, when compressed by the piston of the engine, is ignited by the spark from the magneto.

Petrol-Air Mixture Supply

Liquid petrol issues through the jet orifice into a stream of rapidly moving air, by which process it is converted into a highly atomised vapour. The vacuum created in the crank-case sucks this vapour through the choke, or bore, of the carburetter, the amount passing into the crankcase being controlled by the throttle slide, the strength of the vapour or mixture depending on the proportion of petrol emerging from the jet and the air passing through the carburetter.

In most carburetters the size of the jet is fixed so that a set quantity of petrol with air is constantly fed to the engine. This proportion is determined for average running, but obviously it is desirable to vary this according to the engine requirements, because at times a much richer mixture, *i.e.*, a greater proportion of petrol to air, may be needed.

In the Villiers carburetter, the amount of petrol that is allowed to issue from the jet is automatically proportioned to the amount of air that is allowed to enter the crankcase, from which it follows that a wider range of engine conditions is covered than is the case in which the carburetter has a fixed et.

The carburetter is entirely automatic in its operation, and gives a correctly adjusted mixture over the whole range of

throttle opening. This is obtained by the taper needle attached to and working with the throttle, and to the special method of compensation employed.

Rich Mixture for Starting

An independent adjustment of the taper needle is provided on some models to give a specially rich mixture at times when required, such as when starting a cold engine, the methods employed to obtain the adjustment being as follows:—

(1) By a vertical rod engaging with a special quick-thread in the centre of the throttle, and which raises or lowers the taper needle $\frac{1}{4}$ in. for one complete turn. The bar is screwed right-hand so that turning anti-clockwise raises the needle, thereby richening the mixture. Should the throttle control cable restrict the required amount of turn, holes in the side of the bar give alternative positions for the operating rod (see Fig. 34).

(2) By a Bowden-operated control fitted to the handlebar. The nipple soldered to end of inner cable rests against the head of taper needle, which is kept in contact with the nipple by a spring, so that when the inner cable is moved up and down, the needle follows because of the spring pressure. The control is marked " rich " and " weak " to indicate the needle setting. On no account should the control lever be used as an ordinary " air-control lever " is used. It should remain stationary except when deliberately wishing to alter the size of the jet for starting from cold, or when an extra-rich mixture is required.

The carburetter described above is known as the " two-lever " pattern, and the construction, which is similar for Lightweight and Middleweight types, is shown in Fig. 35.

Action of the Carburetter

The action of the carburetter is very simple, and reference to the sectional drawings, Figs. 34 and 35, will make it clear.

Depressing the float by means of the tickler situated at the side of the body causes the petrol to rise and thereby creates a well of petrol at (*a*), which is sucked into the cylinder via the crankcase at the first kick of the starter. The size or area of the jet orifice (*b*) is controlled by the taper needle (*c*) with the opening and closing of the throttle, but for starting from cold

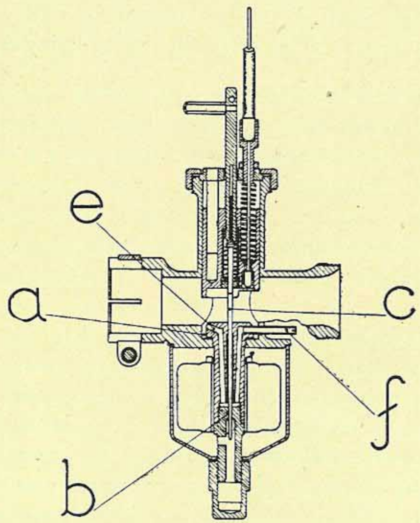


FIG. 34.—SECTIONAL ARRANGEMENT OF SINGLE-LEVER CARBURETTER.

the taper needle is raised in the jet independently of the throttle by means already explained. When the engine is warmed up the needle is lowered to weaken the mixture for normal running. The position of the needle relative to the throttle will then not be required to be altered until again starting from cold.

The automatic compensating action of the carburetter is now described. The mixture is supplied by the carburetter in two ways—first, by the suction of the piston on the orifice (*e*),

and secondly, by the force of the head of petrol through the jet (*b*) which is always submerged.

The suction of the engine on the orifice (*e*) draws air through the compensating tubes (*f*) across the top of the jet (*b*), where it mixes with and breaks up the petrol, and so issues from (*e*) into the main air stream as a partially atomised vapour.

If the load on the engine is increased, so reducing the

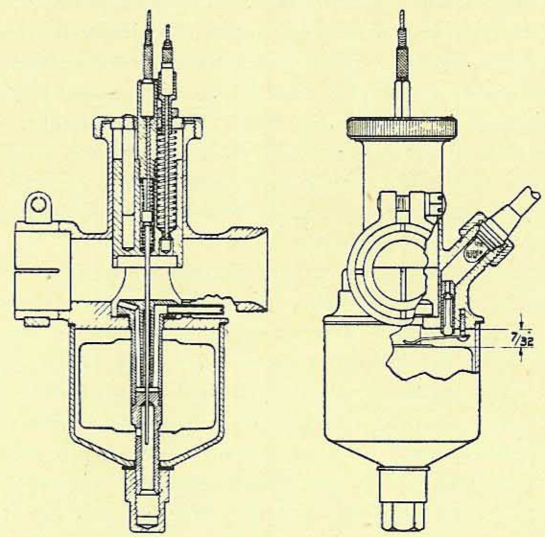


FIG. 35.—SECTIONAL ARRANGEMENTS OF TWO-LEVER CARBURETTER.

engine speed, as, for instance, when climbing, the suction on the orifice (*e*) is reduced. This would weaken the mixture but for the fact that the petrol issuing from the jet (*b*) is constant, thereby richening the partially atomised vapour coming through (*e*), the combined effect being that the mixture strength remains constant irrespective of engine speed or load. The main jet being in the centre of the float chamber, the mixture is not upset by the tilting of the machine. In the original Villiers carburetter, the needle controlling the entry of petrol into the carburetter rested directly on the float, but for some years a lever giving increased pressure on the needle seating has been interposed between the bottom end of needle and top of float. Should this lever become damaged or bent it should be reset to give a distance of $\frac{7}{32}$ in. between top of float and underside of carburetter body.

Tuning the Carburetter

Providing the correct combination of jet and needle is used, the carburetter will provide the correct mixture at all throttle positions and speeds. Having set the independent needle control when the engine has warmed up, the engine should be controlled by the throttle lever only. The combination of jet and needle size is determined when the first of any model is type-tested, and then during the testing of the production model it is only a question of adjustment to the needle position in relation to the end of the throttle.

All needles for all types of carburetters are marked on the side, the figures indicating the degree of taper. For most of the carburetters fitted to engines of 147 c.c. and over needles are available in the following sizes: 1½, 2, 2½, 3, 3½, 4, 4½, 5, 6, 7. The jet fitted at the bottom of the centrepiece varies in orifice size according to the type of carburetter, but in all cases identification figures are stamped either on the head or side of the centrepiece, and when ordering spares, these markings should be quoted, together with the number of the engine to which the carburetter is fitted. In no case should the jet be removed from the centrepiece, as this component cannot be supplied separately as a spare part.

To tune the carburetter, first obtain, by altering the jet-control lever, the most satisfactory position of the needle for slow running on the road when the engine is warm, and then open the throttle lever quickly. If the engine dies out it shows that the mixture is too weak, and a needle with a greater degree of taper should be fitted. If it is found possible to open it quickly and the engine is inclined to hunt, the mixture is obviously too "rich", and a needle with less taper should be fitted.

Again the mixture is shown to be too "rich" if when running at speed and the throttle is closed the engine hesitates or momentarily ceases to fire. When the needle best suited for speed is obtained, it will be the best one for economy and power.

Best Position for Jet Lever

There is no definite rule as to the best running position of the jet lever, but it is wise to set it so that when turned as far as it will go to the weak position, the mixture is actually too weak to run. This means that for normal running it will have to be a little way towards "rich", and would always give a margin of safety, otherwise if it were as far as it would go in the weak position, one would never be quite certain that one was running on the best setting.

If necessary, in the case of a single-lever carburetter, the small bar should be unscrewed from the needle rod and replaced in another hole at right angles to the previous one, so that the needle rod may be turned round farther. In the case of the two-lever carburetter, there is a screw with a lock-nut on the body of the handlebar control. By screwing this in, the mixture is made weaker, and by screwing it out, it is made "richer". It is very necessary that at all times the compensating tubes are clear. Should one be lost, on no account must this be replaced by a screw or plug. Should this be done the carburetter will not function satisfactorily.

TYPES OF CARBURETTER IN USE

Lightweight and Middleweight Carburetters

The types of carburetter previously described are known as the single-lever carburetter and the two-lever carburetter, and these are made in two sizes, namely, the Lightweight and Middleweight types.

The Lightweight is made to fit on a stub 1 in. in diameter and the Middleweight pattern is for a 1⅛-in. stub; the other main differences are the diameters of the choke, throttle and float chamber. The construction of both types is generally as shown in Figs. 34 and 35.

To Change the Taper Needle—Single-lever Carburetter

In early pattern carburetters, the needle-adjuster rod, which is screwed in the centre of throttle, was split and bulged on the end to prevent rotation due to vibration. To change the needle, remove carburetter from inlet manifold or cylinder, and unscrew the knurled top ring, when the throttle with needle can be withdrawn from the carburetter body. Unscrew the rod in centre of throttle; the taper needle with spring can then be pushed out from underneath.

Nowadays a special S-shaped damper is fitted, having a centre lip extended to engage in the slot cut in the end of the adjuster rod, so that the taper needle has to be removed from the bottom of the throttle. Before this can be done, however, the slotted, screwed bush surrounding the needle has to be undone; this is best done by using a special screwdriver made from a piece of tube long enough to clear the needle end, and having two tongues on the end to engage in the slots in the bush.

To Change the Taper Needle—Two-lever Carburetter

Remove the throttle with needle from the carburetter body as explained for the single-lever model. The needle, however, has to be removed from the top of the throttle, but before this can be done the hexagon throttle extension which carries the needle control cable has to be unscrewed; the needle with the spring under the head can then be pushed up through throttle.

It is advisable to fit a new spring when replacing the needle, because the old one may have taken a set, and it is very essential that the head of needle is kept in contact with end of control cable. Fit the new spring with the small end-coil next to head of needle. Replace throttle and top ring exactly as for the single-lever carburetter.

Dismantling Carburetter

Remove from engine and withdraw throttle as already explained. Turn carburetter upside down and unscrew nut securing float chamber. Remove the fibre washer, then float cup and fibre joint washer between cup and body. On older type carburetters not having the fuel needle lever fitted, the fuel needle will now be exposed, and will drop out if the body is turned over. When it is required to remove the fuel needle where the lever is fitted, it is first necessary to remove the centrepiece, and before this can be done, the compensating tubes have to be unscrewed from the head of the centrepiece. Under the head of centrepiece is fitted a fibre washer, which must be in position when reassembling. Having pushed the centrepiece up through the throttle bore, the fuel-needle lever can be swung on one side to allow the needle to come out.

Carburetters having a nut-and-nipple connection for the fuel pipe have filter gauzes inside the screwed connection in the body. At one time a cup-shaped filter was fitted at the bottom of the hole in addition to the detachable visible filter at the top, but the top filter only is now fitted, and with this in position the bottom filter should be removed. The body is now ready for cleaning, which is best done with petrol and a brush, and compressed air where available.

Reassembling Carburetter

First examine the body, making sure that the two small vent holes in the circular-shaped flange are clear. (In later models air enters the float chamber via the tickler.) Before refitting the fuel needle examine the taper portion, and if found to have any ridges or to be pitted, a new needle should be used. Should flooding occur after assembly the seating in the fuel bush can be remade by gently tapping the exposed end of the needle whilst in position, the needle lever, of course, being swung round out of the way. Next fit the centrepiece with fibre washer in position under head, and shank of centrepiece between the fork of fuel-needle lever; then screw in compensating tubes, using just sufficient force to tighten without damaging the slotted end. Place float on centrepiece, and check distance between float and underside of body, which, with float resting on fuel-needle lever, should measure $\frac{7}{32}$ in. Correct, if necessary, by bending the lever.

Refit the fibre float-cup washer, then the cup after having examined the top face and removed any foreign matter, followed by the small fibre washer, and lastly the bottom nut, which should be tightened only sufficiently to secure a petrol-tight joint. If too much force is used there is the danger of stripping the thread on the centrepiece.

When refitting the carburetter to engine, make quite certain that the body is pushed on to the manifold or cylinder stub as far as possible. There are two or four narrow slots in the body to allow the securing clip to function, and if the stub does not extend past the end of the slots, air will be sucked in, causing hard starting and erratic running. This point can be checked whilst the engine is running by putting a drop of thin oil on each slot; if there is a leakage the oil will be sucked in. If the carburetter will not push farther along the stub, a cure can be effected by binding with insulating tape.

Air Cleaners

Most present-day motor-cycle engines have an efficient air filter fitted to the carburetter when sent out, this usually being an oil-wetted pattern which requires cleaning about every 2000 miles or even less if the weather is dry and dusty.

The filter should be cleaned by dousing in petrol and then, when dry, immersing in thin engine oil. Allow to drain before refitting. This type of filter with a screwed adaptor for fitting to carburetter intake can be supplied to suit any of the older types of carburetter.

Midget Carburetter

This model was introduced at the same time as the Midget engine, and for some time was fitted exclusively to this model. Later it was used with the original 125-c.c. (Mark VIII-D) engine-gear unit, and also for certain Mark 9D engines.

The carburetter body is made to fit on a stub $\frac{7}{8}$ in. diameter, and can be identified by the word Midget inscribed on the knurled top ring. Throttle control is by a single lever only, the adjuster to take up cable slack being screwed into the centre of the top ring. A single compensating tube is fitted to the head of the centrepiece, the slotted end of the tube being visible in the centre of the choke after removal of end-cap or filter.

To change or adjust the taper needle, remove the throttle

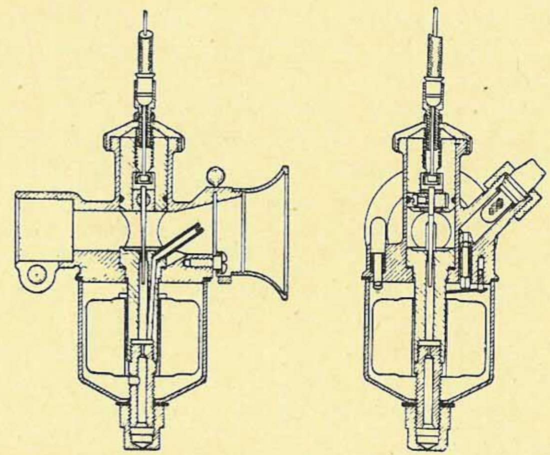


FIG. 36.—SECTIONAL ARRANGEMENTS OF MIDGET CARBURETTER.

with control cable after having unscrewed the top ring. In the side of the throttle will be seen the slotted head of a screw, but before this can be unscrewed, the retaining ring lying in the groove around the throttle must be removed. This retaining ring is fitted as a precaution against the screw entering the engine should it become detached from the centre sleeve. The taper needle is held by this screw in the sleeve, the adjustment being provided to obtain the initial setting to suit individual engines. The carburetter is dismantled as already described for the larger types, but to assist the user a sectional drawing, Fig. 36, showing the construction is reproduced. The fuel-needle lever, which is interposed between top of float and end of needle and is common to all carburetters, is clearly shown.

Junior Carburetter

This carburetter was originally made when the Junior autocycle engine was introduced, and whilst the action is similar to the Midget carburetter, the construction details vary in several respects.

Taper-needle Adjustment.—Unscrew top ring and remove throttle with control cable attached. In the centre at top of throttle will be seen a slotted screw; turning this clockwise lowers the needle, giving a weaker setting. Turning in an anti-clockwise direction gives a richer setting. The head of the taper needle is kept in contact with the adjuster screw by the coil spring fitted under the head. The adjuster screw is split at the lower end, the ends being opened slightly before screwing into the throttle so as to give a damper effect to prevent rotation. Should this screw lose its pressure, remove and open ends sufficiently to make screw tight when refitted. When adjusting the position of the taper needle do not give more than half a turn at a time to the adjuster screw, and if the adjustment has been entirely lost, start off by placing the end of the screw two threads, or $\frac{1}{16}$ in., from top of throttle.

Dismantling Junior Carburetter

Dismantling is carried out in the same manner as with the Midget-type carburetter, with the exception that there is no compensating tube to be removed before the centrepiece can be taken out.

Reference to Fig. 37 will show that the air enters the centrepiece along a hole drilled in the body itself, but to ensure that this hole matches up with the hole in the centrepiece, the latter component has to be located correctly. This is done by a small screw situated below and at the left side of the petrol union. This screw has to be removed before the centrepiece can be raised, and of course replaced when the centrepiece is refitted.

The fuel-pipe connection to carburetter consists of a banjo sweated to the pipe and secured to the carburetter body by a bolt on which are fitted two fibre joint washers and a gauze filter. This filter should be cleaned occasionally in petrol, and when refitting, the fibre washer with the larger hole should be fitted next to the head of the bolt. Do not use excessive pressure when tightening the bolt, otherwise there is a danger of stripping the thread inside the body. Remove the air-

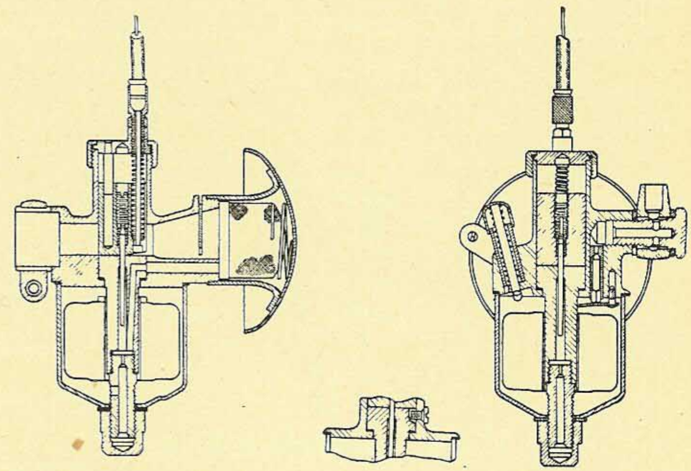


FIG. 37.—SECTIONAL ARRANGEMENTS OF JUNIOR CARBURETTER.

filter dome by unscrewing and clean the detachable filter by dipping in petrol.

The carburetter fitted to the Junior-de-Luxe engine has the petrol union on the opposite side to that of the original Junior-pattern carburetter, but apart from this feature the two carburetters are identical. The Junior-de-Luxe pattern can be used with the original Junior engine, but not vice versa.

Heavyweight Carburetter

This carburetter was made for and fitted only to the Mark XVIII-A engine, prefix letters UU, and as production of this engine as a motor-cycle power unit was discontinued early in the late war, the numbers in use are small compared with the other models already described.

One model only was made, having two-lever control, one to the taper needle (N) and the other to the throttle, but features such as pilot jet, inverted fuel needle (C) and a stub diameter of $1\frac{1}{4}$ in. were peculiar to this type only.

The sectional drawing, Fig. 38, shows the construction clearly.

The pilot jet which functions up to about one quarter

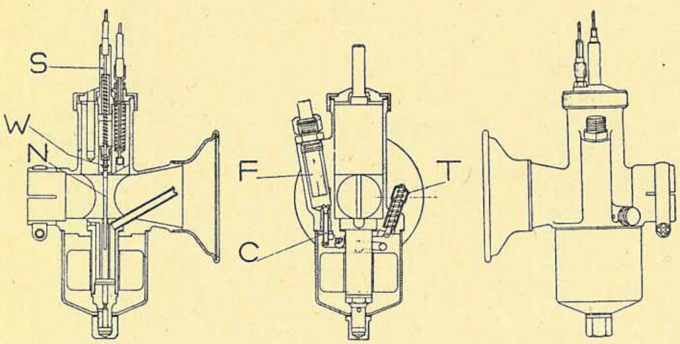


Fig. 38.—The Heavyweight Carburetter.

throttle opening is adjusted by a knurled screw situated at the base of the throttle chamber. To enrich the mixture, screw in clockwise, thereby reducing the air supply across the jet. A No. 2 needle is fitted as standard, and the position in relation to the end of throttle is adjustable irrespective of the lever control for raising the needle for cold starting. To adjust the needle unscrew the top sleeve (S) from the throttle, when the needle and holder will follow attached to the inner cable. The needle is held by a U-shaped wire (W) engaging with one of the several grooves in the needle. Extract the wire and reinsert in a higher or lower groove to give a richer or weaker mixture.

The fuel filter (F) is removable by unscrewing the hexagon union, and should be cleaned occasionally in petrol. Pressing the tickler (T) raises the fuel needle from the detachable seating, allowing fuel to enter the float chamber. The central compensating tube must be unscrewed before the centrepiece can be removed.

This carburetter was fitted to the first Mark 3E engines, prefix letters V.V., but later the Middleweight two-lever pattern of carburetter was used for these engines.

TRACING CARBURETTER TROUBLES

Constant Flooding

Flooding may be caused by :—

(1) Foreign matter on the fuel-needle seating.

(2) Dirt between centrepiece and float, causing jamming which prevents the float pressing against the fuel-needle lever.

(3) Punctured float made too heavy by entry of petrol.

(4) Tickler jamming when depressed, due to dirt or perhaps a broken return spring.

Spitting Back

A weak mixture is usually the cause and may be due to the following :—

(1) Incorrect setting of the taper needle control, which should be moved towards the " Rich " position.

(2) Restricted fuel supply to carburetter caused by :—

- (*a*) Dirty filter on petrol tap or in carburetter union.
- (*b*) Blocked petrol pipe.
- (*c*) Vent hole in filler cap of tank being partially obstructed.
- (*d*) Vent hole in carburetter body. In the Lightweight, Middleweight and Midget carburetters there are two vent holes in the base of the body, but in the Junior, Heavyweight and some of the later Lightweight models, the vent hole is in the tickler cap.

STANDARD CARBURETTER SETTINGS

Engine.	Capacity, c.c.	Carburetter.	No. of jet.	Taper needle.
Mk. VI-C . .	147	L/W	3	2½
Mk. VII-C . .	147	L/W	3	2½
Mk. VIII-C . .	147	L/W	3	2½
Mk. VI-A . .	247	M/W	3	2½
Mk. VII-A . .	247	M/W	3	2½
Mk. VIII-A . .	247	M/W	3	3
Mk. IX-A . .	247	M/W	3	4
Mk. IX-B . .	342	M/W	3	5
Sports . . .	172	M/W	3	3
T.T.S.S. . .	172	M/W	3	3½
Mk. 1E . .	196	M/W	3	3½
Mk. 2E . .	196	M/W	2	4
Mk. 3E . .	196	M/W	2	5
Super Sports . .	196	M/W	2	4
Mk. IX-BA . .	342	M/W	2	5
Mk. X-A . .	247	M/W	2	5
Mk. XVI-A . .	247	M/W	2	5
Mk. IX-BA . .	247	M/W	2	5
Mk. XIV-A . .	249	M/W	2	5
Mk. XVII-A .	249	M/W	51	2 Special
Watercooled .	249	M/W	2	6
Mk. XII-C . .	148	M/W	2	4
Mk. XV-C . .	148	M/W	2	4
Mk. XIV-B . .	346	M/W	2	5
Midget . .	98	Midget	8	5½ Midget
Junior . . .	98	Junior	8J	2
Junior-de-Luxe .	98	Junior	7J	2
Mk. VIII-D .	125	Midget	8	6
Mk. 9D . .	125	Midget	8	6
Mk. 9D . .	125	L/W	3	3
Mk. 9D . .	125	L/W Type 3/1	3	3 Special
Mk. 1F . .	98	Type 6/0	8 (Type 6/0)	20 (Type 6/0
Mk. 2F . .	98	Junior	8J	2½
Mk. 10D . .	122	Type 3/4	0·083	3
Mk. 6E . .	196	Type 4/5	0·081	4½

The L/W Type 3/1 carburetter has the internal adjustment to taper needle as shown in Fig. 60, p. 129.

(*e*) Water in petrol. This may only be in the carburetter, in which case remove the bottom nut of float cup and drain off, having first of all shut off the supply from tank.

(*f*) Fuel needle stuck in its seating, thus preventing fuel entering the float chamber.

(3) Air leaks where carburetter fits on to manifold or cylinder; the body must be a good fit, and pushed right on. A worn throttle slide will allow extra air to enter and thereby upset the mixture, and also allow the slide to flutter in the body, causing a rattle sometimes difficult to locate.

Engine Will Not Stop

When the throttle lever is in the closed position, the end of the throttle must rest on the top of the centrepiece, otherwise mixture will continue to be drawn into the crankcase. To check, remove the end-cap, or filter, and if the throttle is not right down, lower it by screwing in the cable adjuster at top of carburetter. If the full adjustment will not allow the throttle to fully close, the outer cable is probably trapped or has too many bends in it, which, in effect, shortens the inner cable, thus preventing the full movement. Another cause may be binding of the throttle due to dirt. The remedy is to remove throttle, clean and smear with a little thin oil before replacing.

CHAPTER VIII

JUNIOR AND JUNIOR-DE-LUXE AUTOCYCLE ENGINES

SINCE the introduction of the Junior autocycle engine, many thousands of riders have had their first experience of a motor-propelled cycle, and for their benefit it is felt that a separate chapter should be devoted to its servicing and maintenance. The engine has a bore and stroke of 50 mm., and a capacity of 98 c.c.

The original engine is known as the Junior model, the cylinder having three ports and a fixed head, and a piston with deflector top or crown. The cycle of operations is as shown in Fig. 1, page 10.

Junior Engine Specification

The engine is built as a unit with reduction gear, the drive to the two-plate cork-insert clutch being by enclosed roller chain running in oil. The cylinder has a fixed head in which is fitted a 14-mm. sparking-plug and directly underneath a compression-release valve operated by Bowden cable from the handlebar. A floating gudgeon-pin secured endwise by circlips is carried in the aluminium-alloy deflector-type piston having two compression rings located by pegs. The connecting-rod big-end consists of alternate steel and bronze

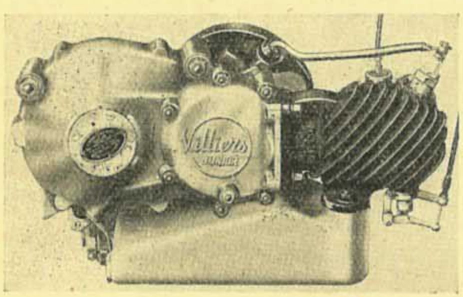


FIG. 39. — JUNIOR AUTOCYCLE ENGINE.

rollers carried on an overhung crank-pin which is a driving fit in the crankshaft web. The crankshaft is mounted on two ball bearings, there being a spring-loaded gland to prevent crankcase-compression leak into the clutch case. Bolted direct to cylinder exhaust port and supported at the rear is a large-capacity silencer. The construction of the unit is clearly shown in Fig. 40.

Decarbonising and Overhauling Junior Engine

The instructions given in Chapter III can be followed when dealing with the cylinder and piston, but as the remainder of the unit is very similar to the Junior-de-Luxe engine, the instructions given for the overhauling of this later type of engine (see page 93) should be followed when dealing with the other components. There are, however, one or two points requiring special attention.

Cylinder.—Between the hole in head in which is fitted the compression-release-valve body and the exhaust port will be found a hole which, when cleared of carbon, should pass a drill $\frac{1}{4}$ in. diameter. When the valve is depressed any obstruction in this release hole will make it difficult to turn the engine over when starting, therefore when decarbonising give special attention to this. The spring fitted to the release valve will in time lose some of its initial strength, and should be replaced, together with the copper joint washer on the valve-body seating. Frequent use of the release valve allows a deposit of carbon to form on the seat, and the valve head should therefore be ground in after removing the body from the cylinder.

Silencer.—To obtain the maximum power from the engine it is very important that the inside of silencer is kept clean, and the deposit of carbon and oil removed. At the rear end and opposite to the tail-pipe connection will be found a hexagon-headed plug. Remove this plug and the tail pipe, and through the holes rake out any deposit, using a rod with a bent end. Where a tail pipe and additional

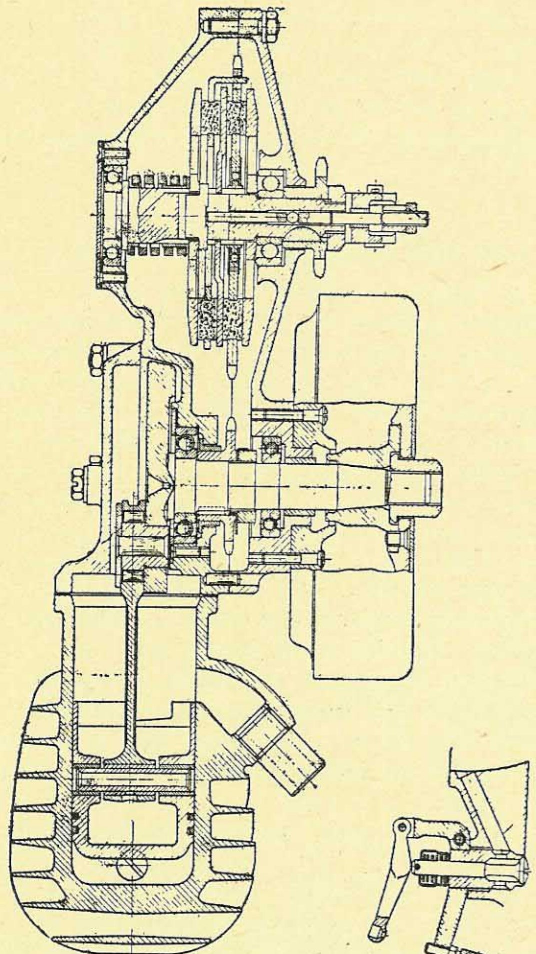


FIG. 40.—SECTIONAL ARRANGEMENT OF JUNIOR AUTOCYCLE ENGINE.

silencer are fitted, these components must also be thoroughly cleaned.

Refitting Piston.—The bottom of the skirt is cut away to clear the balance weight of the crankshaft, and as this cut-away is not central, care must be taken to refit the piston correctly on connecting-rod. The long slope of the piston deflector should be underneath or on the exhaust-port side of cylinder.

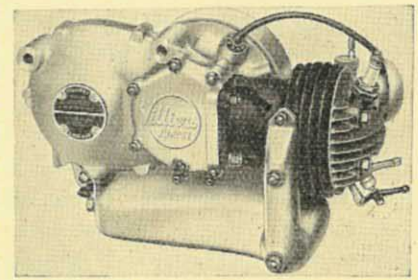


FIG. 41.—JUNIOR-DE-LUXE AUTOCYCLE ENGINE.

JUNIOR-DE-LUXE AUTOCYCLE ENGINE

The bore and stroke of this engine is the same as in the Junior model, and the complete units are interchangeable. The design of the engine portion differs in many respects, the piston having a flat top and a larger-diameter gudgeon-pin, whilst the cylinder has four transfer and two exhaust ports. In the aluminium detachable cylinder-head is fitted an 18-mm. sparking-plug and a compression-release valve communicating with one of the exhaust ports in the cylinder.

The Junior-pattern engine is not now in production, and when the de-Luxe model is fitted as a replacement engine, it is sometimes necessary to make a new petrol pipe, as the union to the carburetter is on the opposite side. The only other change necessary is to fit a 1-amp. or 6-watt bulb in the head-lamp in place of the ½-amp. or 3-watt originally used with the Junior engine.

Overhauling and Decarbonising

Decarbonising can be done with the engine in the frame, but, unless it is only necessary to remove carbon from the head and top of piston, it is more convenient to work on the engine after removal from the cycle.

Remove the complete unit after having detached the carburetter, rear chain, petrol pipe, control cables, lighting-cable connector, tail pipe with extra silencer if fitted and finally the two bolts by which the engine is secured in the frame.

Now hold the unit in a bench vice and remove release valve, sparking-plug, cylinder-head, inlet manifold, exhaust manifolds and silencer. After releasing the four base nuts, lift off cylinder without twisting, at the same time preventing the piston from tipping against the connecting-rod. The cylinder-head and exhaust manifolds should then be put in a tin containing paraffin; this will loosen the dirt and carbon, and make its removal later much easier.

The gudgeon-pin is held in the piston by circlips, and when one of these has been removed, the pin can be pushed out from the opposite side. The skirt of the piston is cut away to clear the balance weight of the crankshaft, and although the piston is reversible, it is advisable to replace it the same way round after cleaning.

Remove carbon from cylinder-head and piston following the instructions given in Chapter III.

If the engine has done a considerable mileage, the cylinder may require reboring, and to decide if this is necessary the bore must be measured by micrometer. A worn cylinder is usually larger in diameter at the centre, *i.e.*, approximately midway between the top and bottom, due to the maximum piston thrust at this position, and if the bore is found to be 1·977 in. or over, the cylinder should be returned to the makers for reboring and fitting with a 0·015 in. oversize piston. If the bore is badly scored, and will not clean up to the 0·015 in. oversize, the next and maximum oversize is 0·03 in. above the original bore, for which pistons are held in stock. When ordering spare pistons or compression rings, it should be specified whether they are for standard, 15-thous or 30-thous oversize cylinders.

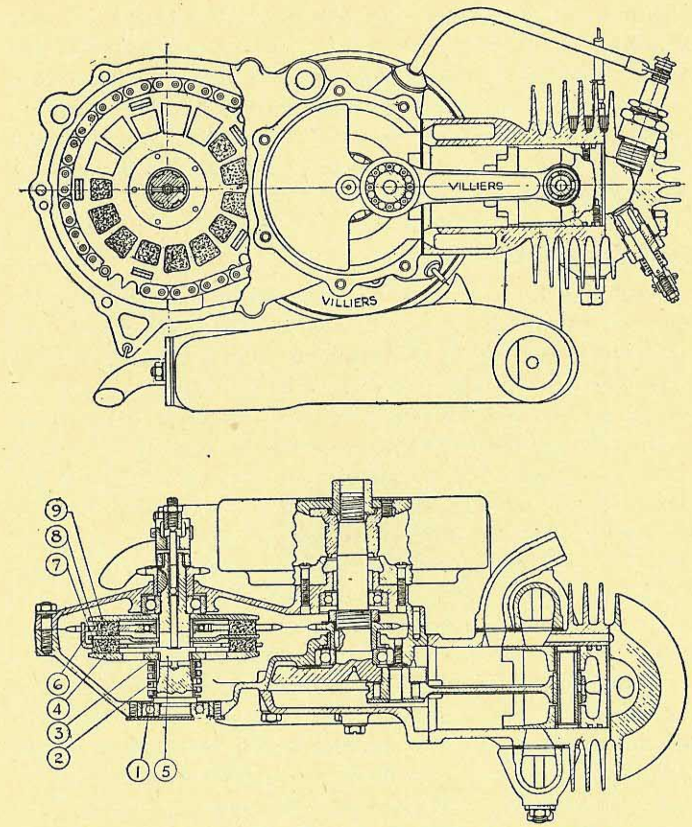


FIG. 42.—SECTIONAL ARRANGEMENTS OF JUNIOR-DE-LUXE AUTOCYCLE ENGINE.

(1) Short spring sleeve. (2) Spring. (3) Long sleeve. (4) Outer clutch plate. (5) Cotter. (6) Cork insert plate. (7) Dished plate. (8) Clutch sprocket. (9) Outer plate.

Silencer and Exhaust Manifolds

The silencer is similar in construction to that fitted to the Junior engine, and the same instructions apply for cleaning; but, instead of being fixed at the front direct to the cylinder, it is supported by exhaust manifolds, one at each side, one bolt passing through the silencer and manifolds at the lower end. Between the silencer and manifolds and between the cylinder and manifolds are fitted gaskets; should it be necessary to replace one of these a new set should be fitted, otherwise any variation in thickness will make it difficult for a gas-tight joint to be made.

Stripping the Engine

Assuming the engine to be still held in the vice, and the silencer, manifolds, etc., removed as before described, the next job is to remove the magneto. On some engines the magneto centre nut is exposed, whilst on others this is concealed by a domed flywheel cover, both types of cover being secured to the flywheel by three screws. Turning the centre nut anti-clockwise, using a spanner and hammer, will withdraw the flywheel from the crankshaft in the manner described in Chapter V, page 52. Do not use an open-ended or adjustable spanner; a box spanner specially made for the job can be obtained from the Service Department.

Next remove the magneto armature plate, which is secured to the clutch-case by four countersunk-headed screws. Remove the clutch bridge with control lever after having removed the two screws securing same. The hexagon nut securing the driving-sprocket can now be unscrewed, and the sprocket withdrawn using a two- or three-claw extractor placed behind the sprocket teeth. On later models there is a lock washer placed between the nut and sprocket, and the portion turned over against the side of the nut must be flattened back before attempting to unscrew the nut. Having removed the sprocket, lift and pull out the Woodruff key.

Before removing the nuts and set-screws holding together the two halves of the clutch-case, fit a bush on the clutch-shaft in place of the sprocket already removed. This bush, which should be $\frac{11}{16}$ in. long and not more than $\frac{3}{4}$ in. diameter outside, with a centre hole an easy fit on the clutch shaft, is held in position by a hexagon nut, the size across the corners being less than the hole in clutch-case. The nuts and screws before mentioned can now be removed and the clutch-case halves separated. Protruding from the joint faces at the front and rear are small lugs, and alternate light blows with a mallet on these lugs will gradually open the clutch-case. Another method of separating the case is to use an extractor fitted to the front end of the case in place of the armature plate already removed. The extractor is located on the centre boss, and secured by two or more of the armature-plate fixing screws.

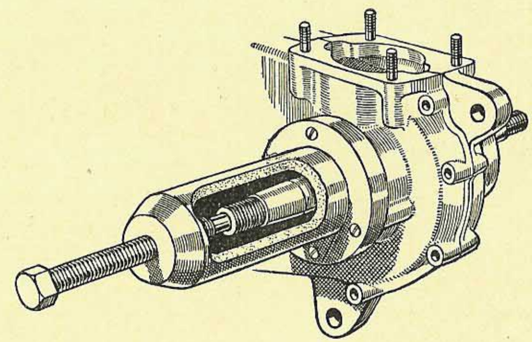


FIG. 43.—EXTRACTOR FOR SEPARATING CLUTCH-CASE.

The centre screw when rotated presses against the end of crankshaft (see sketch, Fig. 43).

With the clutch cover removed, the clutch assembly with the driving-chain will be exposed, but before the chain can be removed it is necessary to push the clutch-shaft with its bearing out of the clutch-case. To do this, remove the four screws securing the circular end plate fitted on the crankcase side of engine, and with a flat-ended brass punch tap the end of the clutch-shaft until free of the ball bearing. The clutch assembly can now be tilted towards the crankshaft and the chain removed from the clutch sprocket. Lift out the clutch assembly, and if not necessary to dismantle, put on one side until required for reassembly.

To Remove Crankshaft

To prevent rotation of crankshaft, insert a hard wooden wedge between crank-web and gap in crankcase, and, after flattening the tang of lock-washer, unscrew the lock-nut securing the driving-sprocket. Use an $\frac{11}{16}$-in. tubular box spanner, turned anti-clockwise looking at the magneto end of the crankshaft. The sprocket and key must then be removed. Next unscrew the six nuts and remove the crankcase half. The crankshaft with connecting-rod can then be removed by hitting the screwed end of shaft with a mallet or soft-metal punch, leaving the ball bearing in position. This bearing can be pushed out after removal of the retaining ring held by three countersunk-headed screws.

Behind the ball bearing is located the compression seal or gland bush, the flange of which is held against the crankcase face by a special spring fitted between the bearing and the bush. This gland bush carries no load and very seldom needs replacement, but the spring in time loses some of its initial tension, and it is advisable to replace when overhauling. The gland spring is held in position by the outer race of the ball bearing and must not rotate.

Big-end Replacement

The crank-pin is a driving fit in crank-web, and after fitting the alternate steel and bronze rollers between crank-pin and connecting-rod, the retaining washer is held in position by a special rivet fitted in the hollow crank-pin. The crank-pin is not supplied as a separate component, and when a replacement pin is required it is necessary to return the crankshaft assembly to the works. The hole in the driving-shaft is reground, and an oversize crank-pin is pressed in, new rollers and end washer being fitted at the same time. Whilst the engine is dismantled, examine the small-end of the connecting-rod for possible wear on the floating bush. Between the hole in the connecting-rod and the gudgeon-pin is fitted a phosphor-bronze bush; the end of the connecting-rod is hardened and

ground, and the bush is made a floating fit, three holes being provided for lubrication. The bush must be free enough to rotate, but there must not be any appreciable shake or play between either the gudgeon-pin and bush, or between the bush and connecting-rod.

Clutch

The clutch assembly is intended to run in oil, and if the level of lubricant in the chaincase has been maintained the wear of the corks should be very little, even after a considerable mileage has been covered. When the cork inserts are found to be worn and to need replacing, this is usually because the rider disengages the clutch to give a free engine whilst coasting downhill.

The corks when originally fitted to the sprocket and driving plate are machined to a thickness of $\frac{5}{16}$ in., thus leaving approximately $\frac{1}{16}$-in. projection on each side for wear. Re-corking should be done when this projection is reduced to a minimum of $\frac{1}{32}$ in., otherwise slipping will occur due to metal-to-metal contact of the driving and driven plates.

Dismantling Clutch

To dismantle the clutch, first turn over so that the three push-rods and ball can drop out of the hole in the shaft centre. Now place the assembly in a vice, holding the outer clutch plates between the jaws. Remove the hexagon nut; then the bush previously fitted in place of the driving-sprocket. When taking the clutch out of the vice, the spring pressure will probably push off the ball bearing; if not, the bearing must be pulled off. The other clutch parts will now come away, with the exception of the outer plate, which is prevented by the cotter fitted in the slotted shaft.

Unless the driving face of the outer plate is scored and needs refacing, the outer plate should not be removed; but if this is necessary, the clutch spring must be depressed to allow the cotter to be withdrawn.

Re-corking of the sprocket and driving plate can be done by the owner having the necessary equipment, but this is best done by the factory, where a stock is held to enable immediate despatch to be made.

When the clutch is disengaged the sprocket runs on a ball race which is a " push " fit over the splined shaft, and if found to be worn on the race diameter, should be replaced when reassembling the clutch.

Clutch Assembly

The clutch must be completely assembled as a unit before refitting in the clutch-case, and if the instructions for doing this are followed there should be no difficulty. Assuming the clutch to have been completely dismantled, proceed as below, reference being made to Fig. 42.

Hold the shaft, threaded end upwards, and slide on the short spring sleeve (1), spring (2), long sleeve (3), outer clutch plate (4). There are two outer plates, but number 4 is the one having the six lightening holes, and must be put on with the bevelled edge underneath. This plate must be pushed down a little against the spring to enable the cotter (5) to enter the slot in the shaft, the ears of the cotter resting on the top of the outer plate. Next place in position the cork insert plate (6) with driving tangs pointing upwards, then the dished plate (7) with the bulge downwards, and follow with the clutch sprocket (8). The ball race for sprocket together with the other outer plate (9) should be placed over the end of shaft, but it will be found that the splined hole in the outer plate will not engage with the splines of the shaft until the clutch spring is depressed. There are several ways of doing this, but as the rider is not likely to have special equipment available, the method of doing the job with aid of a vice only is described. Next to the outer plate (9) put on the ball bearing and the bush previously used, before separating the clutch-case. Now insert in the centre hole of the shaft a rod $\frac{3}{16}$ in. diameter by about 3 in. long, and over the end of this thread the hexagon nut also previously used. Insert the whole assembly endwise between the vice

jaws, and screw up until the outer face of the clutch plate is flush with the end of the splined portion of the shaft. Whilst screwing up, thread the ball race over the top of the splines, and see that the outer plate engages with the splines on the shaft. The ball bearing should now be pushed up to the shoulder of the shaft by the bush and nut, the assembly taken from the vice and the centre rod removed.

A special clutch-assembly fixture can be supplied by Villiers for use in service depots, and with this fixture is

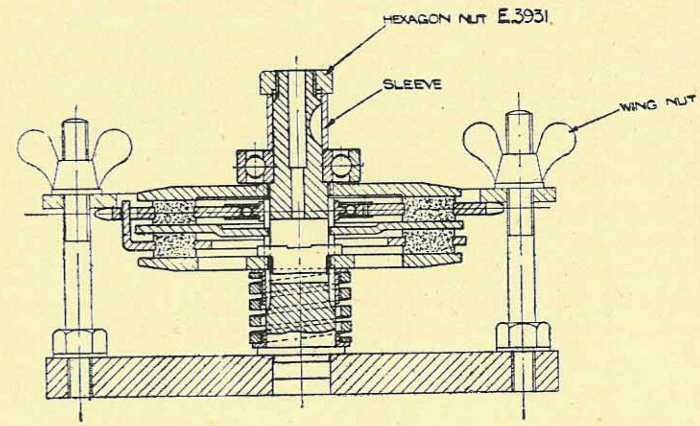


FIG. 44.—CLUTCH-ASSEMBLY FIXTURE.

supplied the slave bush and hexagon nut before described. When using this fixture, the clutch components are assembled in the order already mentioned, but, of course, it is not necessary to use the centre rod, the clutch spring being depressed by the two wing nuts. The construction of the fixture is shown in Fig. 44.

Reassembly of Engine

Before commencing to reassemble the engine, clean the joint faces of clutch-case, clutch cover and crankcase half removing any traces of the old joint washers. The crankshaft assembly is to be fitted first, but before this can be done attention to various details is necessary.

Examine the gland bush, particularly the back of the flange which makes contact with the face of the recess in the ball-bearing housing. The contact faces of both the flange and recess should be flat and smooth, otherwise there will be a leak of compression from the crankcase into the clutch-case.

After placing the gland bush in position, fit a new gland spring, and then press in the ball bearing as far as it will go, which should leave the outer race projecting a little above the housing. The retaining plate is next fitted, the heads of the three screws being flush with the plate when screwed home, otherwise they might foul the inner side of the crank-web.

The crankshaft with the connecting-rod assembly is now pushed through the ball bearing, being tapped into position with a mallet, and then the key for the driving-sprocket is placed in the keyway in the shaft. The sprocket with driving-chain on the teeth is now placed over the shaft, care being taken not to push the key out of position. Follow up with the lock-washer and sprocket nut, the final tightening of the latter being left until the crankcase half is fitted.

Smear a little seccotine or fish glue on the crankcase joint faces, fit a new joint washer, and then place crankcase half in position; when tightening joint nuts, make sure that the cylinder-base faces are flush. The sprocket nut can now be tightened, rotation of the crankshaft being prevented by the same wedge used when stripping the engine; afterwards turn up the lock-washer against one of the flat sides of the lock-nut. Now fit the circular end cap, with a new joint washer in position, to the crankcase side of the clutch-case, and in the housing press home the ball bearing until it touches the end cap.

Fitting Clutch Assembly

The clutch assembly can now be fitted, but before locating the end of the clutch-shaft in the bearing, tilt the assembly to allow the chain to be placed on the sprocket teeth. When this has been done, the shaft can be tapped into the ball bearing, using a mallet on the free end.

The clutch now being in position, the engine is ready for the fitting of the clutch cover, but before proceeding to do this examine the bronze bush through which the crankshaft has to pass. This bush does not carry any load unless the ball bearing fitted alongside has worn considerably, allowing the shaft to rub the inside of bush. The function of the bush is to prevent escape of lubricant into the magneto, and if the bush is found to be worn a new one should be fitted together with a new ball bearing which, when in position, should be at the bottom of the housing.

When ready to replace the clutch cover, smear a little fish glue or seccotine on the joint face of the clutch-case and with the two $\frac{3}{16}$-in.-diameter dowels in their holes, place in position a new paper joint washer. The clutch cover is now replaced, the crankshaft and slave bush fitted on the clutch-shaft acting as pilots, and the joint faces should be kept parallel whilst tightening the nuts of the joint studs. After fitting, remove the hexagon slave nut and bush from the clutch-shaft, fit sprocket key, then sprocket, lock-washer and nut; afterwards turning up the lock-washer against one of the sides of the nut. This lock-washer, which was not fitted to the Junior and early Junior-de-Luxe engines, can be obtained from the " Service Department " and fitted after removal of the sprocket-retaining nut.

The clutch bridge with clutch lever is next to be fitted, but before doing this the three push-rods and the $\frac{3}{16}$-in. ball have to be inserted in the following order: (1) long rod, (2) ball, (3) short rod, (4) medium-length rod. When the engine is back in the frame and the control cable connected up with the clutch lever, there must be a little clearance between the adjuster in the lever and the end of No. 4 rod, otherwise the clutch spring cannot exert the full pressure on the clutch corks, and slipping will occur; $\frac{1}{16}$ in. of movement at the cable end of the clutch lever is usually sufficient. If too much clearance is allowed, the full movement of the clutch lever will not be effective in separating the clutch plates. Wear of the clutch corks tends to reduce the clearance between the adjuster and the push-rod, because as the corks are reduced in thickness, the push-rods with ball are pushed gradually along the centre hole in the shaft.

Refitting Cylinder

The next operation is to fit the piston, cylinder, etc., but before commencing to do this make sure that the four cylinder-base studs are tight in the crankcase and clutch-case. These can be tightened by using a stud driver, but if one is not available use two nuts locked together on the stud and tighten by using a spanner on the top nut, afterwards releasing the nuts. Fit a new joint washer over the studs. The piston with rings can be placed in position when floating bush has been fitted in small-end of connecting-rod. It is advisable to replace the piston the same way round as originally fitted, otherwise the actual clearances between piston and cylinder may not be the same as before overhauling, resulting in loss of power until the rings have bedded themselves in.

The cylinder can now be fitted, care being taken not to rotate the barrel until the piston-rings have passed the exhaust ports. The fitting of the cylinder-head can be left until after timing the ignition, as the piston position can more easily be measured in the open bore of cylinder.

Silencer

The silencer, having been thoroughly cleaned internally, can now be fitted, and new joint washers should be used at both ends of the exhaust manifolds, the circular washers at the bottom ends being positioned whilst tightening up the nuts on the centre bolt. The exhaust manifolds being aluminium castings, it is necessary to evenly tighten up the fixing nuts to avoid breakages. It is advisable to use Villiers spares to ensure even thickness of top and bottom joint washers; the top washer on the carburetter side makes the joint for the exhaust and inlet manifolds.

Fitting Magneto Armature Plate and Flywheel

The magneto armature plate can now be fitted, after cleaning the back face which has to make metal-to-metal contact with the clutch-case in order to provide a good earth return for the ignition circuit. The armature plate should be positioned with the high-tension terminal at the top and the four fixing screws securely tightened.

The flywheel can now be mounted on the crankshaft and the centre nut finger-tightened to allow the flywheel to rotate without turning the crankshaft. Set the contact points as described in Chapter V and turn the crankshaft until the piston is at the extreme end of its outward stroke, the crankshaft being turned by gripping the final drive or countershaft sprocket. Now turn the crankshaft backwards until the piston is $\frac{1}{4}$ in. from the end of the stroke. Rotate the flywheel until the contact points commence to open, and then tighten the centre nut. The method of timing is fully described in Chapter V in the section " Refitting the Flywheel ", but to simplify the job for the novice, timing marks are stamped on the flywheel rim and armature plate. Near the high-tension terminal is a boss on which is stamped one timing mark, the other being on the inside edge of flywheel rim.

When timing the spark turn the engine until the piston is at the end of the stroke, place timing marks in line and tighten flywheel centre nut. The requisite amount of " advance " to the spark is allowed for when marking the flywheel during the engine assembly at the works.

Completing the Assembly

After timing, the cylinder-head can be fitted, the cylinder and head faces being cleaned beforehand. Before screwing in the sparking-plug examine the point gap. The recommended plug is the Lodge CB3, the point gap being 0·025–0·020 in., but with leaded petrol this can be increased to 0·03 in. with advantage.

The assembly of the engine is completed by the fitting of the compression-release valve in the cylinder-head. When attaching the control cable, after fitting the engine in the frame, ensure that clearance is given between the end of the valve stem and the operating lever, otherwise the valve will not seat and compression will be lost.

After fitting the engine in the frame and completing assembly of the other components ready for putting the autocycle on the road, do not forget to put lubricating oil in the chaincase. This should be done with the machine off the rear stand, oil being run in up to the level of the filler-plug hole. Use Castrol D oil (SAE 140).

CHAPTER IX

MARK 9D ENGINE-GEAR UNIT

WHEN first introduced this engine was known as the Mark VIII-D unit, the prefix letters being A.A. The specification of this engine included a connecting-rod big-end having all steel $\frac{1}{4}$ in. × $\frac{1}{4}$ in. rollers, a Midget-pattern carburetter fitted on the magneto side, and a two-pole magneto. Modifications in design were made later; these included a wider big-end of alternate steel and bronze rollers, renewable guide bush for gear selector, etc. The engine is known as the Mark 9D, having prefix letters A.A.A. followed by the engine number, the markings being made on the rear of the gear-box.

A later modification was the provision of a spring-loaded compression seal in the crankcase on the driving side, and for identification purposes a suffix letter A was added after the engine number, the prefix letters remaining A.A.A.

Tens of thousands of the Mark 9D unit have now been made, and so reliable has this engine proved, that no modifications in the basic design have been necessary for many years. Variations in carburetter manifolds, change-speed levers and minor details have been made to suit the individual manufacturers of lightweight motor cycles, but in this chapter it is intended to deal with the engine as made during and since the war.

Description of the Unit

The engine and three-speed gear are built as one assembly, the whole unit being held in the cycle frame at three points. From the sectional drawing it will be seen that the engine portion of the unit is of the latest design having a flat-top piston, cylinder with two exhaust and four transfer ports,

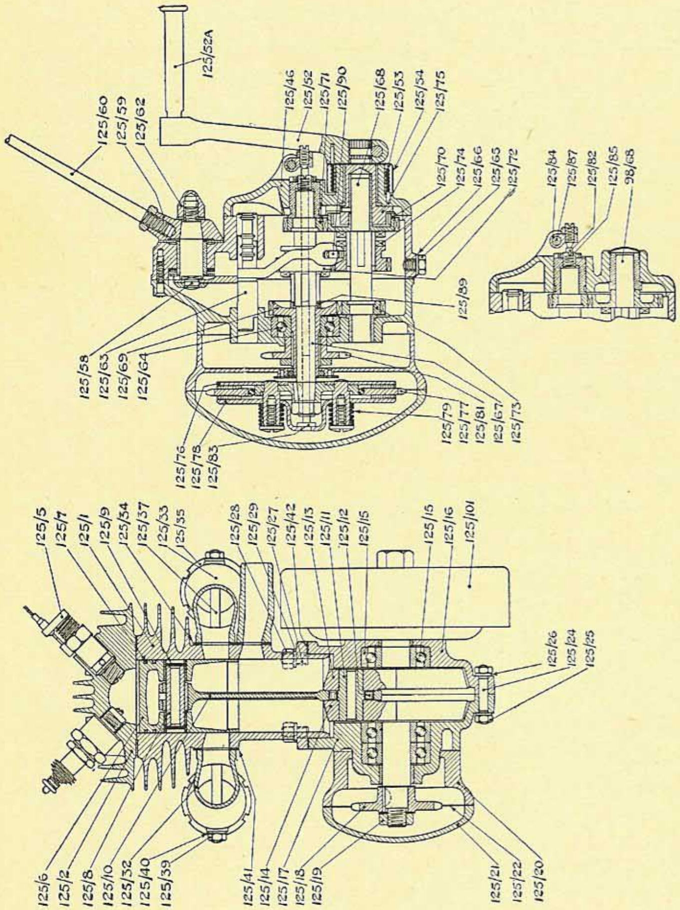


Fig. 45.—Sectional Views of Mark VIII-D 125-c.c. Engine–Gear Unit.

detachable alloy head and ball-journal bearings to the built-up crankshaft. The drive from crankshaft to clutch-shaft is by a $\frac{3}{8}$-in.-pitch roller chain, totally enclosed in an oil-bath chain-case. Ignition and lighting are provided by a six-pole flywheel magneto, having an output of 18 or 24 watts, according to specification. Lubrication of the engine is by petroil mixture.

Power is transmitted to the gearbox main-shaft through a single-plate clutch, the cork-inserted clutch sprocket running on a row of $\frac{3}{16}$-in.-diameter caged balls, whilst the clutch is disengaged by the depression of the six clutch springs. Control of the three gear ratios is by hand-lever mounted direct on the gearbox, an alternative fitting being a short lever in place of the long hand-lever, and to which is connected a "gate" control on the side of the petrol tank.

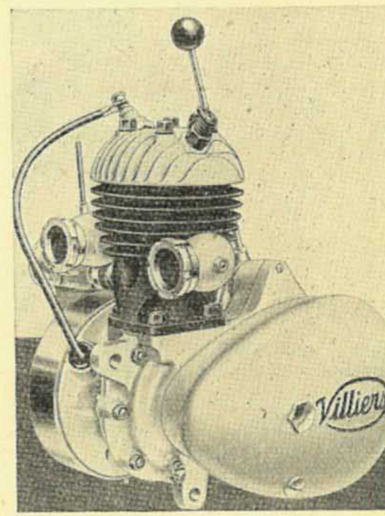


Fig. 46.—Mark 9D Engine–Gear Unit.

The gears of the three-speed box are in constant mesh, the drive in first and third gears being by face dogs, whilst the second gear is through the splined shafts, the two sliding gears moving together.

The gearbox ratios are 1 : 1, 1·62 : 1, 2·92 : 1 giving final ratios of 8·10 : 1, 13·12 : 1 and 23·6 : 1 when a 42-tooth sprocket is fitted to the rear wheel, the final drive or countershaft sprocket having 12 teeth.

The Lightweight-pattern carburetter is fitted as standard equipment, the single-lever or double-lever types being used according to requirements. A large number of Mark 9D

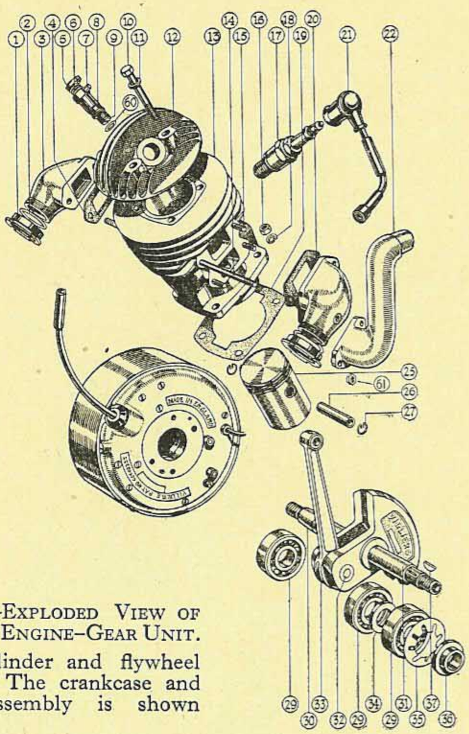


FIG. 47.—EXPLODED VIEW OF MARK 9D ENGINE-GEAR UNIT.

The cylinder and flywheel assembly. The crankcase and clutch assembly is shown opposite.

engines made during the last few years, and particularly those made for the Services during the war, were fitted with a single-lever carburetter of a type different to that described in Chapter VII, a separate air strangler for starting purposes being placed between the carburetter and air filter. Details of this carburetter are given later in this chapter.

Lubrication

Engine.—By petroil mixture of 1 part Patent Castrol XL oil to 16 parts petrol, thoroughly mixed before putting in fuel tank.

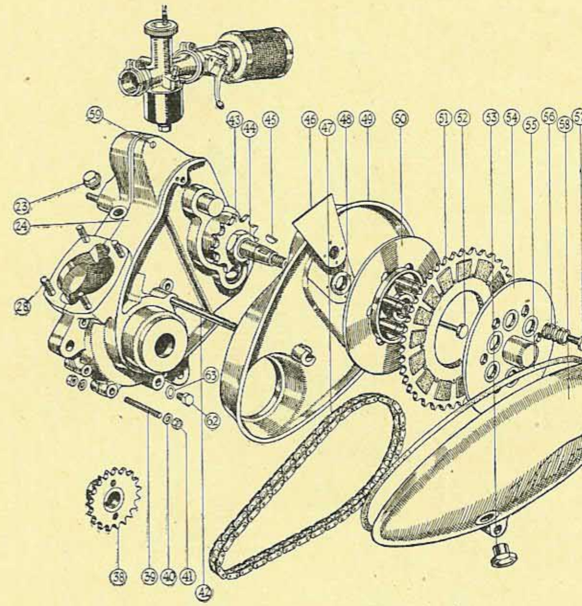


FIG. 47.—CRANKCASE AND CLUTCH ASSEMBLY.

Gearbox.—Remove filler plug (23, Fig. 47), situated on magneto side of gearbox and immediately behind cylinder base, and oil-level plug (45, Fig. 48). Fill up to level of plug hole with Castrol D oil, afterwards replacing both plugs. Top up to plug level every 2000 miles.

Chaincase.—Remove filler plug in side of case near bottom, and insert as much Castrol D oil as will enter, the plug hole being placed to give the correct level with machine standing vertically.

OVERHAULING THE UNIT

To completely overhaul the engine and gearbox it is necessary to remove the unit from the cycle frame. The method of mounting the engine is more or less the same for all makes of motor cycles, so that the instructions for dismantling gener-

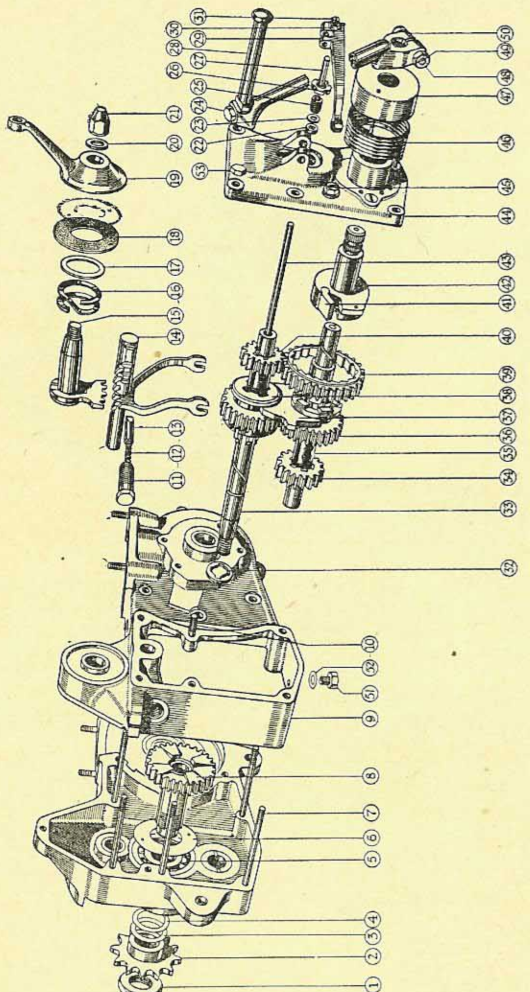


Fig. 48.—Exploded View of Mark 9D Gearbox.

ally apply, but for convenience details of the procedure to be followed in the case of the James M.L. model are given.

To Remove Complete Power Unit from Frame

Release the three nuts (C, Fig. 49), and remove pins (B) holding the silencer clips (A), two from cylinder to exhaust chamber, and one from exhaust chamber to tail pipe. Remove

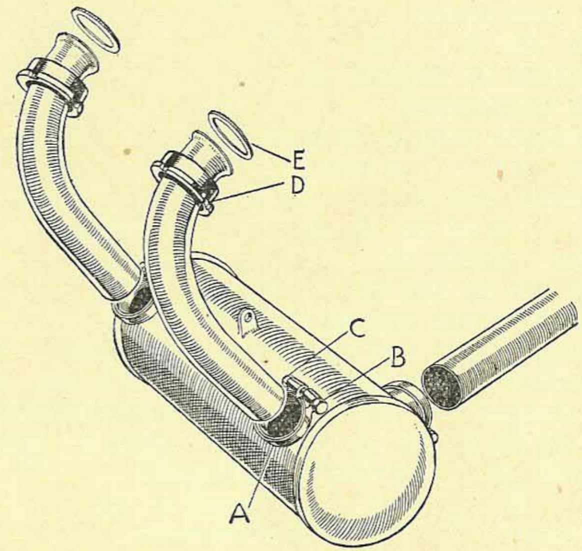


Fig. 49.—Exhaust Assembly.

pin and nut holding auxiliary silencer to frame chain-stay, and remove auxiliary silencer and tail pipe by a twisting motion.

Remove cylinder lock rings (D) securing front exhaust pipes, with a C-spanner. Remove copper-asbestos washers (E). Remove pin holding front silencer to frame tube. Remove silencer as a unit. Remove petrol pipe by unscrewing union nut at tank end and banjo bolt at carburetter end. Release square-head bolt (10, Fig. 60) securing carburetter to inlet manifold, and tilt carburetter to bring the float chamber outwards. Unscrew top lock ring (1, Fig. 60) and withdraw throttle and needle, care being taken not to damage the taper needle (4, Fig. 60). Remove carburetter complete with strangler and air cleaner by sliding backwards from inlet manifold.

Remove pin securing front end of chain-guard to gearbox, and remove guard after releasing bolt at chain-stay fork end. Remove spring connecting link from rear chain, and withdraw chain from gearbox sprocket, the gear control being in the neutral position. Remove gear rod by releasing the nuts securing the rod ball joints to the gear lever and to the gearbox lever at the rear end.

Disconnect compression-release-valve control-cable by releasing clamp screw (7, Fig. 47) in release-valve body. Release clutch cable at gearbox end, raising the clutch lever on gearbox to enable the cable nipple to be pushed out of slot. Disconnect lighting cable from magneto by unscrewing connector, and the two stand springs from stand cross-bar. Remove nuts from the three main engine-fixing bolts, and support the engine while the three bolts are removed. The engine should be tilted and removed from the right-hand side. The rear engine bolt must be refitted from the right-hand side, otherwise this will foul the clutch wire. Support the unit by holding the bottom engine-fixing lug in a vice.

To Remove Cylinder-head and Decarbonise

Disconnect the high-tension lead from the sparking-plug, and then remove the plug. Remove the compression-release valve using a spanner on the hexagon portion of body. Unscrew the four cylinder-head bolts with washers, and the head will come away from the cylinder. Remove carbon from inside of head, using a scraper made of soft material such as copper or brass, taking care not to mark or damage the joint face of the head. Clear carbon from inside of sparking-plug and release-valve holes, and remove copper joint washer from release-valve-body seating if this has not come away with the valve unit when being unscrewed. Dismantle release valve

by unscrewing the valve-stem nut (5, Fig. 47), remove spring (6) and push valve out. If the valve face is pitted, grind in using abrasive paste on the valve face, turning the valve with a screwdriver.

After renewing the seating, remove all trace of abrasive by cleaning in petrol, reassemble valve in body, fitting a new spring, finally making sure that the valve-stem nut is screwed on tightly. In early engines it was possible for the valve to drop into the cylinder should the stem nut become detached, but in later release-valve units the stem is grooved, and the clamp screw (7, Fig. 47) made longer to project into the groove so that the valve is held should the nut come off the stem. The new valve with longer screw can be fitted to existing valve bodies. Before refitting the complete release valve in the head, fit a new copper joint washer (60, Fig. 47).

The sparking-plug recommended for this engine is the Lodge type C3 Sintox, 18-mm. thread. This plug is detachable, and by unscrewing the gland nut, the central electrode may be removed for cleaning. When adjusting the plug gap always set the side points, not the central electrode. The gap should be 0·018–0·020 in., and if leaded petrol is used, increase the gap to 0·025 in.

To Remove Cylinder and Decarbonise

After a considerable mileage has been covered, the area of the exhaust ports is reduced by the deposit of carbon, and to remove this thoroughly it is necessary to take off the inlet and exhaust manifolds (3 and 22, Fig. 47), and also the gaskets. Having done this, the cylinder-base nuts can be released, but it will be found necessary to raise the cylinder before the nuts will come off the studs. When the four nuts have been removed lift off the cylinder vertically, without turning it on the piston. The carbon can now be removed from the ports, but the size and shape of the ports must not be altered. The bore of the cylinder should now be examined, and measured for wear. The maximum wear will be approximately half-way up the cylinder where the thrust of the piston is greatest; if the diameter is found to exceed 1·977 in., the cylinder should be returned to the works for reboring and the fitting of oversize piston and compression rings. It is no use fitting new standard-size rings to a worn cylinder. If the wear is not found to be excessive, the outside of the cylinder should be thoroughly cleaned, and then when dry given a coating of cylinder black, before refitting.

To Remove Piston and Compression Rings

Remove one of the two gudgeon-pin circlips (27, Fig. 47), using round-nosed pliers. The gudgeon-pin (26) should now push out unless prevented by carbon deposit between piston bosses and small-end of connecting-rod. Should it be necessary to tap out the gudgeon-pin, support the piston in one hand to prevent straining the connecting-rod. Lift piston clear of connecting-rod, and mark to ensure it being refitted in the same position relative to cylinder.

The gudgeon-pin should be a sliding fit in piston and small-end bushes, the maximum clearance allowed when new being 1½ thous (0·0015 in.). The pin should be replaced if found to measure 0·491 in. diameter or less.

Remove the two piston-rings, using three brass strips as described in Chapter III, Fig. 11, afterwards removing all carbon from the ring grooves and the inside of the piston, care being taken not to scratch the outside.

Refitting Piston-rings

Before replacing the rings on the piston they should be checked for wear by inserting each ring into the least-worn part of the cylinder barrel, *i.e.*, at the bottom, and checking width of ring gap with feeler gauge. If gap measures 0·030 in. or more, fit new rings to give a minimum gap of 0·007 in. The maximum gap for new rings is 0·011 in. Place rings on piston, using the same brass strips, radial location of rings being made by the peg in the grooves.

To Dismantle Engine and Gearbox

Assuming the cylinder, head and piston to be already removed proceed as follows :—

Remove cylinder-base washer. Drain oil from crankcase and gearbox. Remove the three screws securing flywheel cover, then the flywheel by turning the centre nut anti-clockwise as described in Chapter V. The magneto armature plate will come away after removing the four fixing screws, but

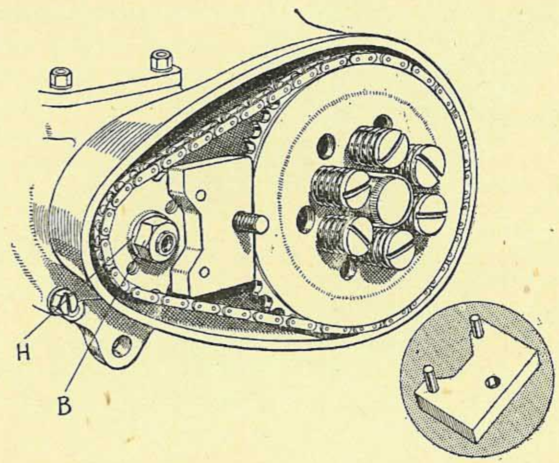


FIG. 50.—REMOVAL OF ENGINE-SPROCKET NUT.

this need not be removed unless it is necessary to break the crankcase joint.

Next release chaincase securing nut (53, Fig. 47) after placing under the chaincase a pan to catch the oil when the front cover is removed. Take care of the joint washer whilst the engine is dismantled. Before the rear portion of chaincase can be removed, the engine sprocket, primary chain and clutch assembly have to be withdrawn. To prevent the crankshaft rotating whilst the sprocket nut is being removed, the tool shown in Fig. 50 will be found useful. With the tool still in position remove the six clutch-spring screws, springs and front clutch plate. Withdraw the engine sprocket, with chain still in position, using an extractor shown in Fig. 51; the clutch sprocket and chain will come away at the same time as the engine sprocket. The sprocket key and any shims should now be removed from the crankshaft.

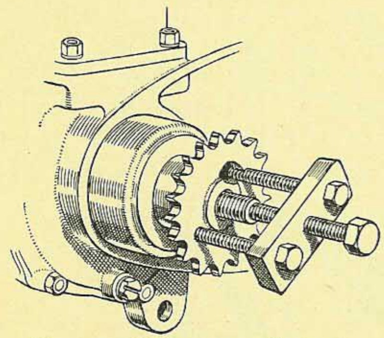


FIG. 51.—REMOVAL OF ENGINE SPROCKET.

Next, unscrew the hexagon nut securing the clutch centre, using a tool, Fig. 52, to prevent rotation of the centre. With this tool still in position, and the centre nut removed, fix the extractor, using two of the clutch-spring screws as shown in Fig. 53, and withdraw the clutch centre by screwing in the extractor centre screw against the end of the clutch-shaft.

Remove the countersunk-headed screw securing back half of chaincase to driving-side crankcase half; the screw is located inside the chaincase directly above the clutch-shaft. The chaincase half will now come away.

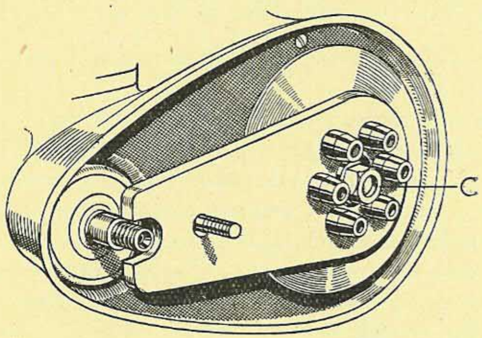


FIG. 52.—REMOVAL OF CLUTCH CENTRE NUT.

Remove the nuts securing the gearbox end cover (44, Fig. 48) and withdraw end cover with kick-start lever and clutch control lever *in situ.* Remove the seven studs (39, Fig. 47) securing the crankcase halves and also the screw (59) joining gearbox halves. In place of the armature plate, fix the extractor, Fig. 43, using the four screws previously removed. Turning the centre screw of the extractor will separate the crankcase halves, leaving the crankshaft assembly in position in the driving-side half. The engine can now be removed from the vice, and holding the case horizontally with the

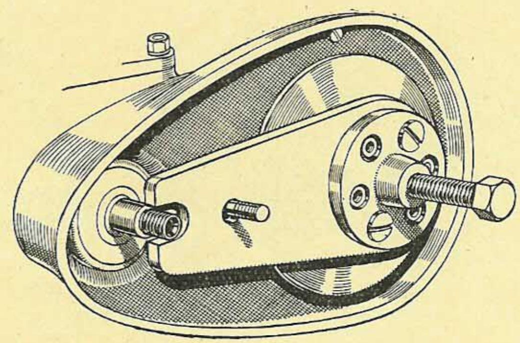


FIG. 53.—REMOVAL OF CLUTCH CENTRE.

sprocket end of shaft pointing upwards, tap end of the shaft with a mallet until free of the crankcase.

If the bearings remain in the crankcase these will have to be removed, as it is necessary when refitting the crankshaft to first assemble the bearings on the shafts. The bearings can be removed using an extractor as shown in Fig. 54. The split end of the mandrel is expanded (after placing inside the bearing) by the taper-headed central bolt. The bearing is removed by tapping the end of the extractor with a hammer and soft punch, the punch being smaller in diameter than the bore of the bearing. There are two ball bearings with a spacer between on the drive side of the crankshaft, and behind the outer bearing is situated a compression gland bush and spring

(36 and 35, Fig. 47); these will fall out when the bearing is removed.

The crankcase–gearbox halves now being separated, all the gear wheels can be removed, excepting the high-gear pinion (26 teeth) (8, Fig. 48). It is not necessary to disengage the change-speed quadrant with the operating fork except for renewals, in which case the outside gear control lever must be removed from its tapered spindle (no key is fitted) to allow the quadrant to swing round out of mesh with the selector fork. Remove the selector plunger (13, Fig. 48) and spring (12,

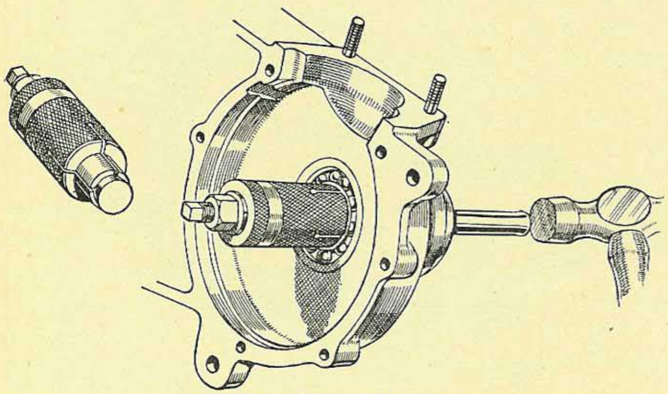


FIG. 54.—BEARING EXTRACTOR.

Fig. 48) by unscrewing the body (11, Fig. 48) which is situated immediately below the lug which carries the clutch control-cable adjuster.

To remove the high-gear pinion the hexagon nut (D, Fig. 55) against the driving-sprocket (E) must be removed by turning anti-clockwise, using a tool (Fig. 55) to prevent the sprocket turning. The pinion can now be pushed through the ball bearing. A felt washer and steel retaining ring are fitted behind the bearing, and if oil is working out round the sprocket boss the felt washer should be renewed. In the latest models a felt washer is not fitted, the oil being prevented from escaping by a spiral groove cut in the boss of sprocket.

To Dismantle End-cover Assembly

The kick-starter ratchet wheel (39, Fig. 48) probably remained in its position on the layshaft whilst the end-cover was being removed; if not, the wheel will easily pull away from the kick-start spindle. Undo nut (48, Fig. 48) and remove the clip bolt (49) at bottom of the kick-start lever; the lever will now pull off the splined spindle. Remove return spring (46) with cover, after noting which hole in end-cover

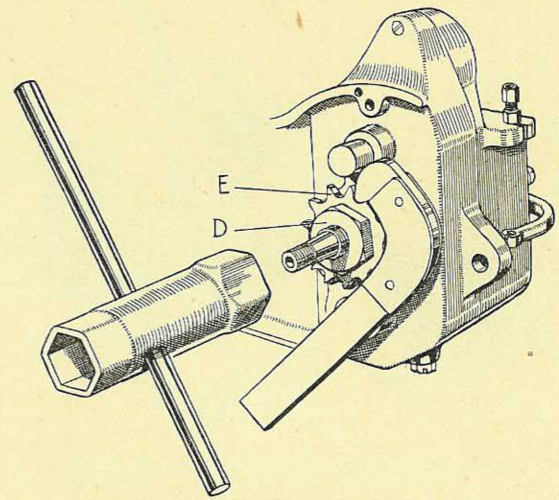


FIG. 55.—REMOVAL AND REPLACEMENT OF HIGH-GEAR PINION.

the end of spring engaged; leave the spring curled up inside cover. The kick-start spindle (42) with spring-loaded pawl will now pull out of bearing bush in end-cover. Examine the pawl for wear on driving edge, and replace if worn. Examine the stop for ratchet spindle. This is secured to the end-cover by a cheese-headed screw riveted over on the inside; it may be necessary to tighten the screw. Also examine the felt washer (22) at the bottom of the bearing bush for mainshaft; this washer prevents oil working out along the clutch push-rod and should be replaced when overhauling.

To Dismantle Driving-shaft Assembly

The removal of the crank-pin requires a special fixture (Fig. 56) in which the shafts are held while the crank-pin is forced out. If the connecting-rod only or big-end rollers require replacing, only one shaft need be removed from the crank-pin.

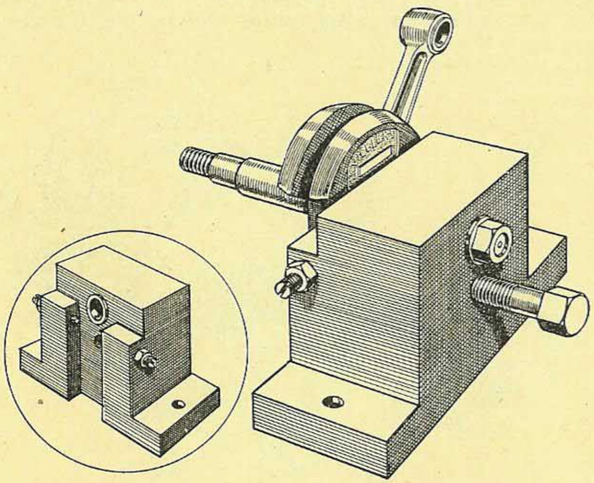


FIG. 56.—CRANK-PIN EXTRACTOR FIXTURE.

Side float of big-end is allowed for when building; do not mistake the float for up-and-down play; a small amount of rock is of no importance.

Fitting New Small-end Bush to Connecting-rod

If no special equipment is available, the old bush can be removed and the new bush fitted with the aid of a special bolt and bush as described in Chapter III. After fitting a new bush, drill oil hole through from the connecting-rod, and if necessary reamer bore to 0·494 in. to give running fit on the gudgeon-pin.

Driving-shaft Assembly

Press one end of the crank-pin into web of either driving shaft, keeping the crank-pin square with shaft face. Place connecting-rod big-end over crank-pin and fit rollers, alternately steel and bronze, six of each; fill up spaces with engine oil. Place other driving shaft on crank-pin as near in line as possible with other shaft, and press home to shoulder of crank-pin. Place the assembly between centres (Fig. 57) and

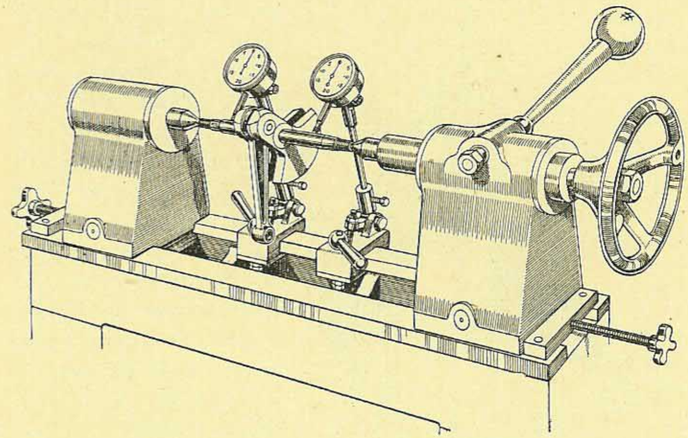


FIG. 57.—CHECKING ALIGNMENT OF DRIVING-SHAFT ASSEMBLY.

rotate by holding the connecting-rod; check alignment of shafts by the clock gauges and correct by tapping the balance weights with a lead hammer or mallet.

Maximum eccentricity allowed is 0·001 in. on clock gauge. There are three ball bearings on the driving shafts, two on the drive side (29, Fig. 47) and one on the magneto side; all are alike and interchangeable; the two on the drive side have a distance piece between (34, Fig. 47). The bearings are a light press fit on the shafts, and a fixture (Fig. 58) is used for this operation. The bearings should be lubricated with engine oil before inserting in the crankcase.

Gear-change Control (Internal)

This must be assembled before the crankcase halves can be joined up. Lay the magneto-side crankcase half flat on bench, outside face downwards. The bush which carries the change-speed quadrant projects through the boss on both sides; on the inside projection is first fitted the thin steel plain washer (17, Fig. 48) and against this goes the double-coil spring washer (16). Mesh the first tooth of quadrant (15) (left side with spindle underneath) with first space in rack of selector (14) (large end) and insert together the spindle ends into their bearings. Turn the case over and locate the fibre friction washer (18) on the projecting bush outside; follow with the change-speed lever (19), plain washer (20) and dome nut (21), but leave the final tightening-up on the taper spindle until the engine is put back into frame.

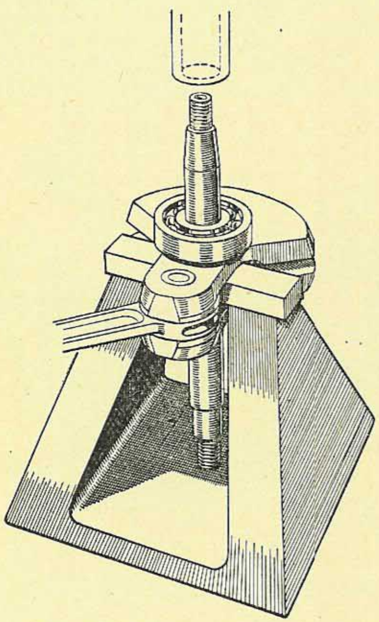


FIG. 58.—FIXTURE FOR FITTING BEARINGS.

High-gear Pinion

If the high-gear pinion has been removed, this must be refitted before joining up the crankcase halves. Push the pinion through its ball bearing, making certain that the end of the boss enters the felt washer held between the case and retaining washer. Replace the driving sprocket and any shims (3 and 4, Fig. 48) originally fitted, screw on hexagon nut and tighten, using the tool (Fig. 55) placed on opposite side of the sprocket to prevent rotation.

Joining Up Crankcase Halves

The crankcase halves are now ready for bolting together, but before proceeding to do this make sure that the $\frac{1}{4}$-in.-diameter dowel is in position in the magneto-side half. This dowel (which is a big-end steel roller) is situated at the gear-box end about $\frac{3}{4}$ in. above the mainshaft centre. Make certain that the oil-ways in the crankcase portions are clear by squirting oil into the ducts in the crankcase walls; if clear, the oil will run through into the bearing housings. The half casings are now dipped in boiling water; this is to expand the bearing housings to enable the shafts to be assembled without driving into position.

Take the driving side first, lay down flat, and in the bearing housing first insert the gland bush (36, Fig. 47), then the gland spring (35).

The driving-shaft assembly, with bearings already on the shafts, can now be inserted, the outer bearing being pushed home against the gland spring. Smear some gold size or seccotine evenly all over the joint face and fit in position the magneto-side case, locating by the dowel. Fit the seven studs (39, Fig. 47), with two nuts and washers to each, around the crankcase portion and tighten up. When cold the shafts should rotate freely; if not, a few light taps on each end of shafts usually removes any end-thrust on bearings. The assembly should now be held vertically in a vice by the bottom fixing lug.

To Refit Cylinder and Piston

Place the piston over the connecting-rod in the position originally fitted. Smear the gudgeon-pin with engine oil. Introduce the gudgeon-pin into the piston and pass it through the connecting-rod small-end bush until it butts against the circlip which was not removed from the piston. Refit other circlip, and make sure that each circlip lies snugly in its groove; *this is essential.*

Note.—Circlips bent or damaged in any way should be discarded and new circlips fitted. Fit new cylinder-base washer on crankcase, no jointing solution being required. Smear cylinder bore and piston surface with engine oil. Fit the cylinder barrel over the piston, taking care not to twist, causing ring ends to foul ports. Ensure each piston-ring is fully compressed in its groove, in turn, as the barrel passes over. Replace cylinder holding-down nuts and washers, screwing each in turn until all are tight.

To Replace the Cylinder-head

No gasket or joint washer is fitted between cylinder and head. The faces of cylinder barrel and head must be perfectly clean and dead flat. Place the head in position, the sparking-plug being on the driving side of the engine. Each cylinder-head bolt should have a plain steel washer under the head. Engage each bolt finger tight, and finally screw down each bolt a little at a time in turn until tight.

To Reassemble Gearbox

Between the high-gear pinion and the four-splined portion of mainshaft is fitted a thrust washer (32, Fig. 48); this washer takes the end pressure during clutch withdrawal and may have become worn; if so it requires replacing. The mainshaft has two pinions fitted: one of 21 teeth (38) slides on the four splines, the other of 15 teeth (40) is fixed on the five-splined portion. The mainshaft with thrust washer in position can now be fitted. Push the gear control lever back to low-gear position, bringing the operating fork towards the open end of the gearbox. The layshaft has two pinions fitted: one of 21 teeth (36) slides on the four splines, the other of 16 teeth (34) is fixed on the five-splined portion; the dogs on the face of the sliding pinion are fitted outwards to mesh with the kick-start ratchet pinion (39).

With the left hand, hold in position the layshaft sliding pinion in mesh with the mainshaft sliding pinion, with the sliding gear operator (37, Fig. 48) fitted between, the ears of the gear-operator fitting in operating fork ends (14).

The layshaft can now be pushed through the sliding pinion into its bearing, using the right hand. Push the gear control lever forward to slide gears into top-gear position, and insert the selector plunger, spring and screw, into the plunger body.

Fit the kick-start ratchet wheel (27 teeth) (39, Fig. 48) on the layshaft, meshing with the fixed pinion (15 teeth) on the mainshaft.

To Assemble Gearbox End-cover

The kick-start shaft must be a good fit in the end-cover bush if oil leakage is to be avoided; therefore replace bush and reamer to original maximum size, 0·813 in. diameter.

If the clutch-operating lever has not been removed, this will be necessary to enable adjustment to be carried out for end-play of the mainshaft.

Replace the felt washer (22, Fig. 48) in bottom of the main-shaft bush; this washer has a plain steel washer (23) fitted on each side. Release the circular lock-nut (26) and unscrew the barrel adjuster (25) a couple of turns.

Assemble the kick-start pawl, plunger and spring in the kick-starter spindle and insert in the cover bush; taking hold of the serrated end, rotate clockwise against the stop riveted to inside of cover. While holding the spindle, place cover in position on studs and fit two nuts finger-tight; the spindle can now be released and the other nuts can be fitted. Tighten all nuts.

Fit the return spring and cover on boss, the short end of spring being fitted in the middle one of the three holes in the cover. With the kick-start spindle at rest position, hold the kick-start lever (also at the rest position) just on end of serrations; rotate the spring cover anti-clockwise until the protruding end of the spring enters the hole in the starter lever, then push lever along serrations up to the shoulder on the spindle. Place the clamp bolt in position and screw up the nut.

After finally tightening all end-cover nuts, the adjustment for end-play of the mainshaft can be made, proceeding as follows :—

To enable the mainshaft to be turned, the clutch centre can temporarily be fixed in position and, with the gears in the neutral position, the shaft should rotate freely without any sign of end-play.

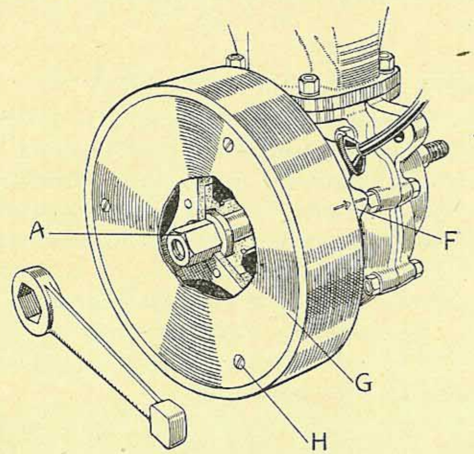


FIG. 59.—IGNITION TIMING MARKS.

End-play can be felt when push-pulling the shaft by holding the clutch centre; the maximum end-play should be 0·01 in. If more than this, the barrel adjuster must be screwed in and the lock-nut tightened. If the mainshaft bush is to be replaced, fit with inside groove at bottom of hole.

Refitting Primary Drive and Chaincase

Fit rear half of chaincase (49, Fig. 47). The faces must be clean and undamaged. The felt washer (48) in the gearbox end should be a good fit on the extension of the high-gear

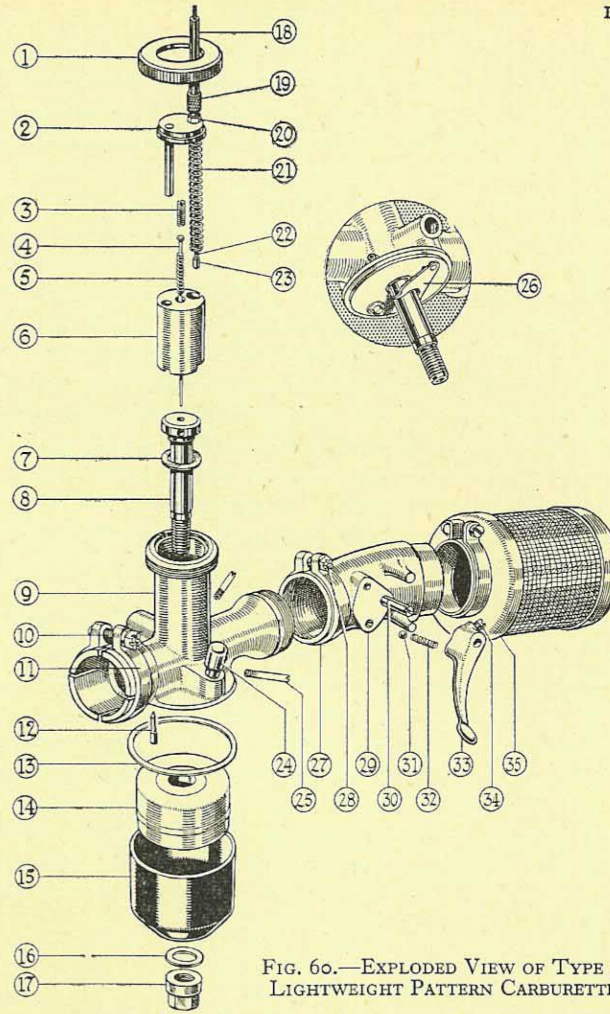


FIG. 60.—EXPLODED VIEW OF TYPE 3/1 LIGHTWEIGHT PATTERN CARBURETTER.

(1) Top ring; (2) top disc with guide peg; (3) screw, needle adjusting; (4) taper needle; (5) spring for taper needle; (6) throttle; (7) fibre washer for centre piece; (8) centrepiece and jet; (9) carburetter body; (10) screw, body clip; (11) body clip; (12) fuel needle; (13) washer for float cup; (14) float; (15) float cup; (16) fibre washer for bottom nut; (17) bottom nut; (18) control cable, outer; (19) control cable adjuster; (20) cable adjuster locknut; (21) throttle spring; (22) control cable, inner; (23) control cable nipple; (24) tickler with spring and cotter pin; (25) compensating tube; (26) float lever; (27) clip for strangler body; (28) screw for clip; (29) strangler body; (30) strangler spindle; (31) ball, strangler lever; (32) spring, strangler lever; (33) strangler lever; (34) screw, strangler lever; (35) air cleaner.

pinion to prevent oil leaks. Replace the countersunk-headed screw securing to drive-side crankcase. Refit Woodruff keys in crankshaft and gearbox mainshaft. Refit clutch centre to mainshaft; before fitting make sure that the six studs securing clutch-plate to centre are tight.

When fitting clutch-sprocket it is also necessary to assemble the engine-sprocket with driving-chain in position on both sprockets; it is impossible to fit the chain afterwards, as there is no detachable joint provided. Before fitting clutch-sprocket, examine corks for wear; if they have worn to less than $\frac{5}{16}$ in. thick, replace either with a new or re-corked sprocket.

Test engine-sprocket and clutch-sprocket teeth for alignment, and correct if necessary by shimming the engine-sprocket boss; to check, measure from face of the chaincase to the centre of both sprockets; correct alignment is when both measurements are the same. Fit washers and nuts to engine- and clutch-shafts. Fit the long push-rod (43, Fig. 48), then the short push-rod (52, Fig. 47). Fit the front clutch-plate over the six spring studs. Fit six springs all of the same free length. The free length of new springs is 1·225 in. maximum, 1·215 in. minimum. Fit six screws (57, Fig. 47); the heads of these must fit against the ends of studs when screwed home. After fitting the small dowel in front face of chaincase, place joint gasket in position. Fit front chain cover, locating on centre stud and small dowel. Fit the dome nut which secures both halves of chaincase to crankcase. Insert the short push-rod (27, Fig. 48) at control end of mainshaft. Refit clutch control lever (29), leaving the adjustment until engine unit is refitted in frame. Replace drain screws in crankcase and gearbox.

Refitting and Timing of Magneto

The armature plate is located on the crankcase spigot and is secured by four countersunk-headed screws. The position of the high-tension lead is approximately in line with the front fixing lug of crankcase. Before mounting the flywheel on shaft remove all traces of oil from both the shaft taper and

bore of flywheel cam, otherwise slipping is likely to occur. A little grease should occasionally be smeared on the cam profile to lubricate the rocker-pad.

The contact-breaker points should commence to open when the piston is $\frac{5}{16}$ in. before top of stroke. Timing marks are stamped on both the armature plate and flywheel rim (F, Fig. 59). The mark on the armature plate is found alongside the high-tension terminal and the mark on flywheel rim coincides when the piston is at dead top of stroke. When checking timing it is therefore only necessary to remove sparking-plug, turn flywheel until the two marks are opposite, when the piston should be at top of stroke. If the timing is found to be incorrect it will be necessary to release the flywheel on driving-shaft. Full instructions for doing this are given in Chapter V.

Carburetter

As mentioned earlier in this chapter, the Lightweight-pattern carburetter fitted to the Mark 9D engine used by the James Cycle Co. in their Military Model is of a different type to that described in Chapter VII. The carburetter is known as the Type 3/1, these numbers being stamped on the top of the stub immediately behind the body clip. The action is exactly the same as for all Villiers carburetters, but as in the case of the Junior carburetter, the taper needle position, when once set, remains constant in relation to the throttle.

A separate strangler for starting purposes is screwed on the intake, and attached to the outer end of strangler body is an oil-wetted air filter.

The illustration, Fig. 60, clearly shows the construction of the carburetter. Instructions for tuning, dismantling, cleaning, etc., are given in Chapter VII.

Acknowledgment

Thanks are due to the James Cycle Company for the loan of drawings used in this chapter.

CHAPTER X

MARK 2F AUTOCYCLE ENGINE

THE Mark 2F autocycle engine, which supersedes the Junior-de-Luxe model, was introduced at the Motor Show in November 1948. The two engines are not interchangeable, the Mark 2F engine being mounted inside the cycle frame, instead of underneath as in the case of the Junior-de-Luxe. During the ten years the Junior-de-Luxe engine was in production experiments and research were being carried on with a view to increased efficiency and reliability, and whilst several well-tried features of the earlier engine are retained, various improvements are incorporated in the design.

The cast-iron cylinder has one exhaust and two transfer ports, arranged as shown in Fig. 2A, page 12. A built-up crankshaft having a parallel crank-pin is used, a 25-mm. ball bearing being fitted close up against each crankshaft web. The engine is built in with a countershaft clutch, the drive to the clutch being by an endless roller chain running in an oil-bath chaincase.

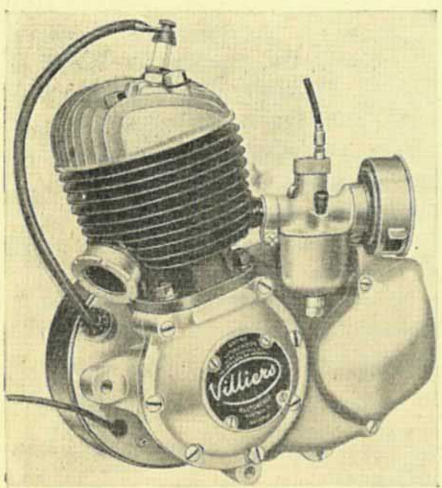


FIG. 61.—MARK 2F AUTOCYCLE ENGINE.

GENERAL DATA FOR MARK 2F ENGINE

Bore, 47 mm. (1·8504 in.).	Carburetter, "Junior" type:
Stroke, 57 mm. (2·244 in.).	Jet size, J8.
Capacity, 98 c.c. (6 cu. in.).	Taper needle, No. $2\frac{1}{2}$.
Horse-power, 2·0 at 3750 r.p.m.	Ignition timing, $\frac{1}{8}$ in. before T.D.C.
Engine sprocket, 17 teeth × $\frac{3}{8}$ in. pitch.	Contact breaker point gap, 0·015 in. max.
Clutch sprocket, 42 teeth × $\frac{3}{8}$ in pitch.	Lubrication, engine, Petroil mixture.
Final drive sprocket, 11 teeth × $\frac{1}{2}$ in. pitch. (Use "Coventry" chain No. 112045.)	Lubrication, chaincase, Castrol D oil (SAE 140).
Chain line, final drive, $1\frac{7}{8}$ ins.	Lighting set:
Sparking plug, Lodge H14, 14-mm.	Head, 6V–12W.
	Pilot, 4V–0·3A.
Plug point gap, 0·02 in.	Tail, 4V–0·3A.

The construction of the engine and clutch is shown in the drawing, Fig. 62.

Lubrication

The engine portion of the unit is lubricated by Petroil mixture made by mixing thoroughly $\frac{1}{2}$ pint of Castrol XL oil (SAE 30) with 1 gallon of petrol. On no account must the oil be put into the tank before mixing, and it is advisable to pour the mixture through a fine-mesh gauze when putting into the tank.

The chaincase and clutch-case is actually one compartment, and on the magneto side of the unit, immediately above the clutch-lever cover, will be found the oil-filler plug (see Fig. 63). Behind the clutch lever and below the centre of the clutch-case is situated the oil-level plug. Remove both plugs, and with both wheels on the ground pour in Castrol "D" Oil (SAE 140) until it runs out at the level-plug hole. Refit plugs securely. Examine for oil level every 500 miles and top up if necessary.

Starting the Engine

When the owner has had no previous experience of driving it is advisable to become accustomed to the use of the various

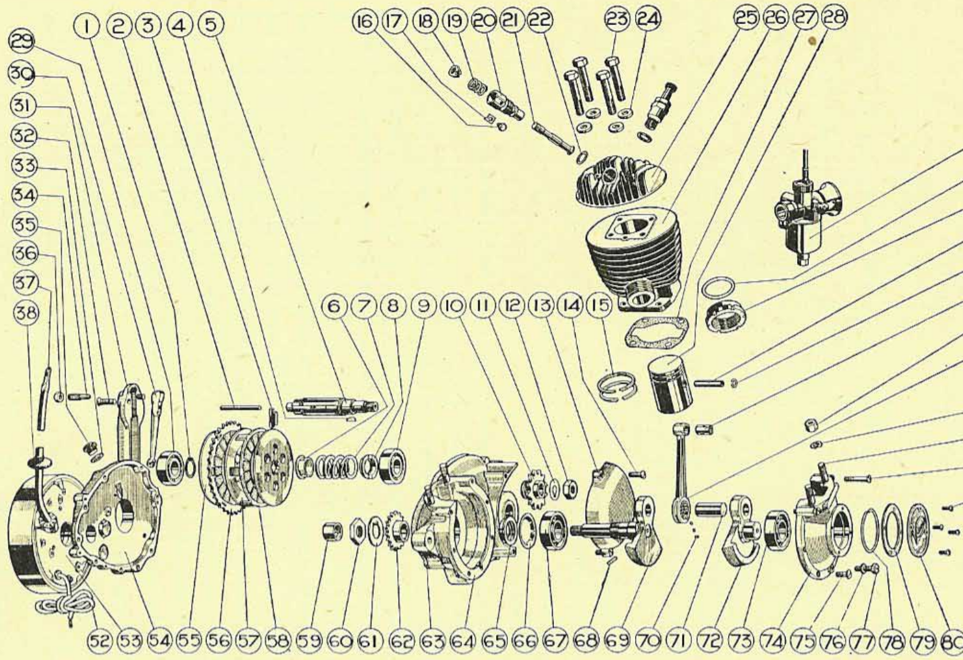


FIG. 62.—EXPLODED DRAWING OF THE MARK 2F UNIT.

KEY TO FIG. 62.—MARK 2F ENGINE.

1. Circlip, clutch shaft.
2. Clutch-operating rod.
3. Clutch cotter.
4. Key, driving sprocket.
5. Clutch shaft.
6. Clutch-spring bush.
7. Clutch spring.
8. Spring bush, split.
9. Clutch-shaft bearing.
10. Driving sprocket.
11. Sprocket lockwasher.
12. Sprocket locknut.
13. Chain cover.
14. Chain-cover screw.
15. Compression rings.
16. Release-valve screw.
17. Release-valve clamp.
18. Release-valve nut.
19. Release-valve spring.
20. Release-valve body.
21. Release-valve stem.
22. Release-valve washer.
23. Cylinder-head bolt.
24. Washer for bolt.
25. Cylinder-head.
26. Cylinder.
27. Cylinder-joint washer.
28. Piston.
29. Clutch-shaft bearing.
30. Clutch lever.
31. Clutch bridge.
32. Clutch-bridge screw.
33. Filler-plug washer.
34. Clutch-adjuster screw.
35. Oil-filler plug.
36. Adjuster-screw locknut.
37. H.T. cable.
38. Cable cover.
39. Carburetter.
40. Exhaust-nut washer.
41. Exhaust-pipe nut.
42. Gudgeon pin.
43. Gudgeon-pin circlip.
44. Small-end bush.
45. Cylinder-base-stud nut.
46. Connecting-rod.
48. Cylinder-stud washer.
49. Cylinder-base stud.
50. Left-hand crankcase screw.
51. End-plate screw.
52. Lighting cable.
53. Magneto assembly.
54. Clutch cover.
55. Outer clutch plate.
56. Clutch sprocket.
57. Centre clutch plate.
58. Clutch plate, corked.
59. Clutch-cover bush.
60. Engine-sprocket nut.
61. Engine-sprocket lockwasher.
62. Engine sprocket.
63. Clutch-cover gasket.
64. Crank and clutchcase.
65. Gland bush.
66. Gland-bush spring.
67. Driving-shaft bearing.
68. Engine sprocket key.
69. Right-hand drive shaft.
70. Crankpin rollers.
71. Crankpin.
72. Left-hand drive shaft.
73. Drive-shaft bearing.
74. Left-hand crankcase.
75. Screw for crankcase.
76. Drainscrew washer.
77. Drainscrew.
78. Bearing circlip.
79. End-plate washer.
80. End plate.

controls and, therefore, before attempting to start the engine, the cycle should be put on its stand, the rear wheel being off the ground.

The carburetter control lever is moved by the right hand and opens inwards to increase the speed of the engine.

The decompressor or compression-release valve, as it is

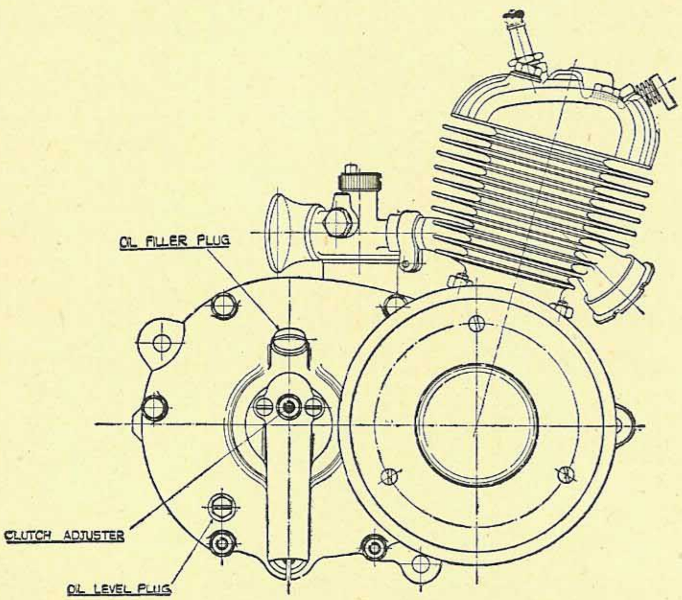


FIG. 63.—OIL FILLER PLUG, OIL-LEVEL PLUG AND CLUTCH ADJUSTER ON THE MARK 2F UNIT.

sometimes called, is controlled by a small lever usually fixed on the underside of the left handlebar and immediately in front of the clutch control lever.

The function of the decompressor is to release the pressure in the cylinder-head, so making it possible to rotate the engine by means of the pedalling gear when starting by this method.

The fuel tap can now be turned to the "on" position, and the strangler closed by lifting the lever at the rear of the

carburetter. Open the carburetter control lever about one-third of its total movement, and flood the float chamber by depressing the tickler. Rotate the engine by pedalling whilst sitting on the saddle, and the engine should start when the decompressor lever is released. As the engine warms up after running for half-a-minute or so, the strangler can be gradually moved to the fully-open position. In very cold weather, it may not be possible to do this immediately, in which case leave the strangler partly closed until the engine is warmed up; if opened up too quickly, spitting back through the carburetter will occur. When the engine is warm from previous running, it should not be necessary to either flood the carburetter or use the strangler when restarting.

Having started the engine by the pedals, the machine still being on the stand, withdraw the clutch by pulling up the clutch control lever; on some machines the lever is held in the "out" position by a spring-loaded trigger. The machine can now be pushed off the stand, the rider still being astride the saddle, and a get-away can be made by gently letting in the clutch, at the same time opening the throttle to take the load.

An alternative method of starting is by pushing the machine. Flood the carburetter, open the throttle and depress the compression-release valve as before, wheel the machine forward a couple of yards and release the valve-control lever, and then as the engine fires, pull up the clutch-control lever. With the clutch disengaged and the engine running, the rider can then mount the machine and move off by clutch and carburetter control.

Stopping the Engine

The engine is stopped by moving the control lever to the closed position; just before coming to rest, the release valve should be used to prevent the engine jerking over compression.

Failure to Start.—See Fault Finding Chart, pages 180–182.

Running-in

For the first 500 miles the engine must not be over-driven and the throttle should not be fully opened. The engine must not be allowed to race, or run at a high speed under a light load. Do not exceed 20 m.p.h. during the running-in period. After covering about 500 miles, it will very likely be necessary to weaken off the mixture by lowering slightly the taper needle in the carburetter. How to do this is explained in the section dealing with the carburetter.

Periodical Attention

It is advisable, in order to enjoy trouble-free riding, that the engine and machine should have periodical attention, and the following hints will help to keep the engine in good running order.

Every 500 miles, inspect the level of oil in the clutch-case by removing the level screw (see Fig. 63). Top up if necessary with the grade of oil previously recommended.

Examine the contact-breaker points after completing the first 500 miles, as the points may require adjustment after initial bedding in. The correct gap when the points are full open is 0·015 in. They should also be kept free from oil.

Every 2000 miles, remove the cylinder-head and scrape out the carbon. The edges of the exhaust port in the cylinder can be cleaned when the piston is at the bottom of the stroke. Clean the piston top.

It should not be necessary to remove the barrel and piston every 2000 miles—every 4000 miles should be sufficient.

Every 2000 miles, remove and clean the silencer, exhaust pipe and carburetter air filter.

Occasionally check the clutch-control cable adjustment. There should be a very small amount of slack in the clutch cable when the clutch is engaged. Adjust the clutch cable by means of the adjustment screw on the clutch-bridge casting (see Fig. 63). Screw the adjuster in until there is just a trace of slack in the cable; this is essential, otherwise the clutch may be slightly disengaged and cause slipping. Tighten the locknut after adjustment.

Periodically examine joints, cylinder-head, cylinder base, crankcase and clutch-case for gas or oil leaks, and tighten if necessary. Examine all visible nuts, bolts and screws for looseness.

The Carburetter

The Junior pattern carburetter is used with the Mark 2F unit, and a description of this component, together with instructions for adjustment and dismantling, are given in Chapter VII, pages 84–85. A different pattern of air filter is, however, fitted. The taper needle is a No. $2\frac{1}{2}$, set at the works $\frac{29}{32}$ in. out from the end of the throttle; after about 500 miles running it will probably be necessary to increase this figure slightly to reduce the mixture strength by screwing in the needle-adjusting screw.

The Magneto and Lighting Set

The magneto is of the latest six-pole pattern, the flywheel having four magnets and two dummies. Two of the magnets are required for ignition, the other two providing the current for the direct lighting set. The armature plate carries, in addition to the high-tension coil, and contact-breaker, one lighting coil. The lead from the lighting coil is connected to a screw insulated from the plate by special bushes. Also secured to this screw is the rubber-covered lead, at the other end of which is attached the lighting cable from the headlamp. The armature plate is secured to the clutch cover by four screws, and it is essential that the bosses on the back of the plate make a good clean contact with the clutch cover; this will ensure a good earth return and a uniform air gap between the pole shoes of the flywheel and the cheeks on the armature plate.

The flywheel is removed by unscrewing the centre nut after removal of the front cover, as described in Chapter V, page 52.

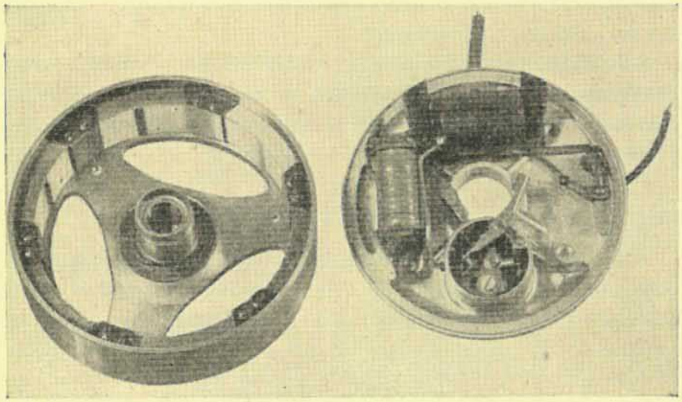


FIG. 64.—MAGNETO OF MARK 2F UNIT.

The contact-breaker is the type shown in Fig. 16, page 47. Occasionally a little grease should be applied to the felt pad to prevent the flywheel cam becoming dry and possibly squeaking.

The lighting set is the direct type, and is similar to the set previously used with the Junior-de-Luxe autocycle engine. Owing to the larger output of the Mark 2F magneto, however, a 12-watt headlamp bulb is required. The wiring of the set is as in the diagram, Fig. 65.

Overhaul and Maintenance

Major overhauls should be entrusted either to the Works or to an appointed depot for servicing Villiers engines. Special equipment is necessary for completely dismantling the engine, but there is quite a lot the amateur mechanic can do to keep the unit in good running order.

To maintain the maximum power, it is essential to prevent excessive formation of carbon in the cylinder-head, cylinder ports, exhaust pipe and silencer. Instructions for carrying out this work are given in Chapter III. Whilst the cylinder-head is removed, clear any carbon in the hole between the joint face and the hole for the release-valve body. Similarly,

the hole in the cylinder, between the top face and exhaust port, should be kept clear. If these holes become blocked, the compression cannot escape when the release valve is operated, and it will be hard to turn the engine when starting.

It is also very necessary in this type of two-stroke engine to ensure that there are no leaks in the various joints making up the crankcase. Keep tight the six countersunk-headed

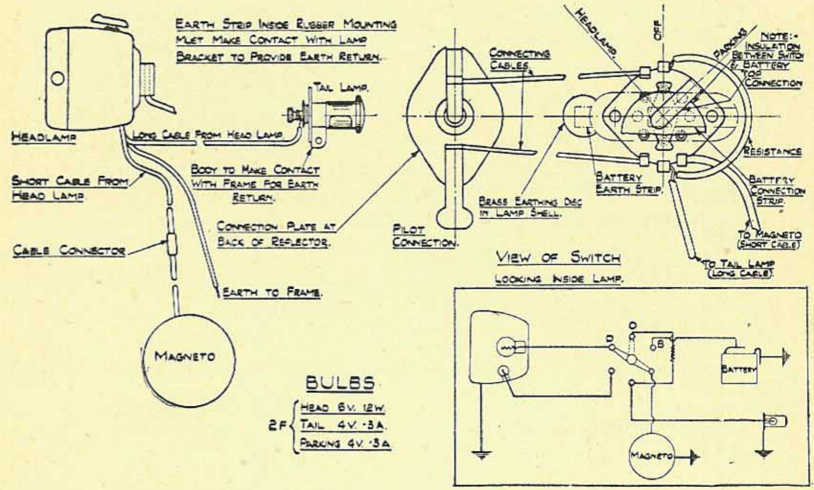


FIG. 65.—WIRING DIAGRAM OF DIRECT LIGHTING SET MARK 2F UNIT.

screws around the outside of the left-hand crankcase, also the bottom hexagon-headed screw which should be removed only when it is necessary to drain the crankcase. The four round-headed screws securing the circular plate to the crank-case should also be kept tight, and the joint washer replaced if there are signs of leakage. The four nuts at the cylinder base must also be tight to prevent leakage between cylinder and joint face of crankcase.

If the engine has done a considerable mileage it may be necessary to renew the gland bush which provides the compression seal between the crankcase and the clutch cover. The bush, which is spring-loaded endways, does not rotate, but is a very close fit on the boss of the driving sprocket. Loss of crankcase compression due to wear of the bush will cause loss of power, and as the crankcase is subject to alternate compression and suction there will be a tendency for the oil in the clutch-case to be sucked into the crankcase if the gland bush is not renewed. In later engines, number 394 and upwards, a gland bush having a spiral non-return oil groove is fitted; this prevents oil escaping into the crankcase. To fit a new bush it is necessary to remove the crankshaft assembly. This should be done by the works or by one of the approved Service Depots.

Checking Flywheel Magneto

Occasionally remove the flywheel cover and check the gap between the contact points; this should be 0·015 in. maximum when fully opened. Wear of the rocker-arm pad causes the gap to become smaller, and it is advisable, therefore, to inspect after the first 500 miles, and correct for any bedding down which may have taken place. If adjustment has been necessary, the spark timing in relation to piston should also be checked. Timing marks will be found on the flywheel rim and on the boss at back of armature plate (see Fig. 59, page 128). These marks should be in line when the piston is at the top of the stroke. The contact points should commence to open when the piston is $\frac{1}{8}$ in. before the top of its stroke. If the timing is found to be incorrect it will be necessary to release the flywheel on the driving shaft. Instructions for doing this are given on page 52, Chapter V.

CHAPTER XI

MARK 1F ENGINE-GEAR UNIT

THE engine portion of the Mark 1F unit is practically identical with the Mark 2F model already described in Chapter X. The cylinder-head, however, is not provided with a compression-release valve, and a different pattern carburetter is fitted. The engine is built in with a two-

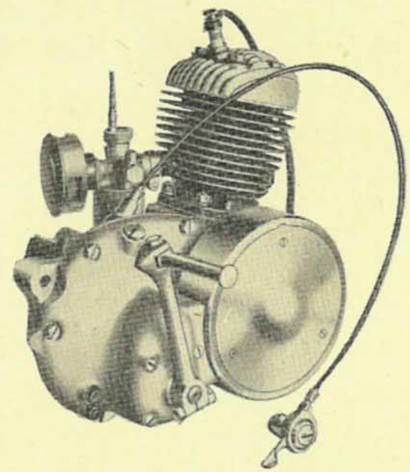


FIG. 66.—MARK 1F ENGINE-GEAR UNIT.

speed gearbox of the sliding-dog type, the control lever for which is mounted on the cycle handlebar. A neutral, or free engine position, between high and low gear is obtained by movement of the gear-control lever, and starting is by the foot-lever provided, the pedal folding back out of the way when not in use.

GENERAL DATA FOR MARK 1F ENGINE–GEAR UNIT

Bore, 47 mm. (1·8504 in.).
Stroke, 57 mm. (2·244 in.).
Capacity, 98 c.c. (6 cu. ins.).
Horse-power, max. 2·8 at 4000 r.p.m.
Engine sprocket, 17 teeth × ⅜ in. pitch.
Clutch sprocket, 42 teeth × ⅜ in. pitch.
Final drive sprocket, 14 teeth × ½ in. pitch. (Use "Coventry" chain No. 112045.)
Chain line, final drive, 2½ ins.
Sparking plug, Lodge H14, 14 mm.
Plug point gap, 0·02 in.
Gearbox ratios, 1 : 1 and 1·54 : 1.

Carburetter, type 6/0:
Jet size, 8.
Taper needle, No. 2½.
Ignition timing, ⅛ in. before T.D.C.
Contact-breaker point gap, 0·015 in. max.
Lubrication, engine, Petroil mixture.
Lubrication, gearcase, Castrol D oil (SAE 140).
Lighting set, direct type:
Head, 6V–18/18W S.B.C.
Pilot, 3·5V–0·15A M.E.S.
Tail, 6V–3W S.B.C.
Lighting set, rectifier type:
Head, 6V–12/12W S.B.C.
Pilot, 6V–3W M.B.C.
Tail, 6V–3W S.B.C.
Stop light, 6V–18W.

Lubrication

Instructions for lubrication, and the recommended lubricants are as for the Mark 2F unit, see page 133, Chapter X. However, because the clutch lever is on the opposite, or driving side, of the unit, the oil-filler plug for the gearbox will be found immediately above the kickstarter cover (see Fig. 67).

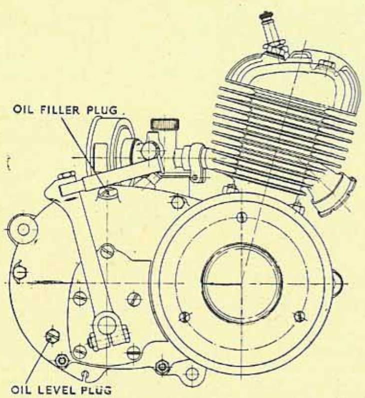


FIG. 67.—OIL FILLER AND OIL-LEVEL PLUGS MARK 1F UNIT.

Gear Control

The gear positions are controlled by hand through a "Bowden" cable, the control unit being clipped to the right-hand handlebar. Top or high gear is obtained by moving the hand lever inwards, or to the left towards the rider, as far as possible to the position marked H on the cover plate of the control unit. To give the bottom or low gear, the lever is moved over as far as possible to the right, and half-way between the "low" and "high" is the neutral or free-engine position.

Starting the Engine

Before starting the engine, make sure that the battery is connected or, if the battery is not in use, that the rectifier is disconnected.

When Cold.—Turn the petrol tap to the "on" position. Turn the strangler shutter so as to close the air slots. Open the throttle lever inwards about one-third of the full movement, then flood the carburetter by depressing the tickler.

If the back wheel is on the ground, put the gear-control lever into the neutral position, this operation being made easier if the machine is moved to and fro at the same time.

A firm push or two on the starter pedal should start the engine, and, as engine warms up, the strangler shutter should gradually be moved round to its fully open position. In very cold weather, it may not be possible to do this immediately, in which case leave it partly closed until the engine is warmed up.

When Hot.—As above, but do not flood carburetter or close strangler.

Failure to Start.—See Fault Finding Chart, pages 180, 181 and 182.

On the Road

Having started and warmed up the engine, sit astride the machine, and with both feet on the ground free the clutch by pulling up the control lever, which is usually fitted on the left handlebar. At the same time, with the right-hand move the gear-control lever outwards to the "low"-gear position, and, if necessary move the machine along so as to allow the *sliding-dog clutch* in the gearcase to fully engage with the *low-gear wheel.* Slowly release the clutch lever, and as the

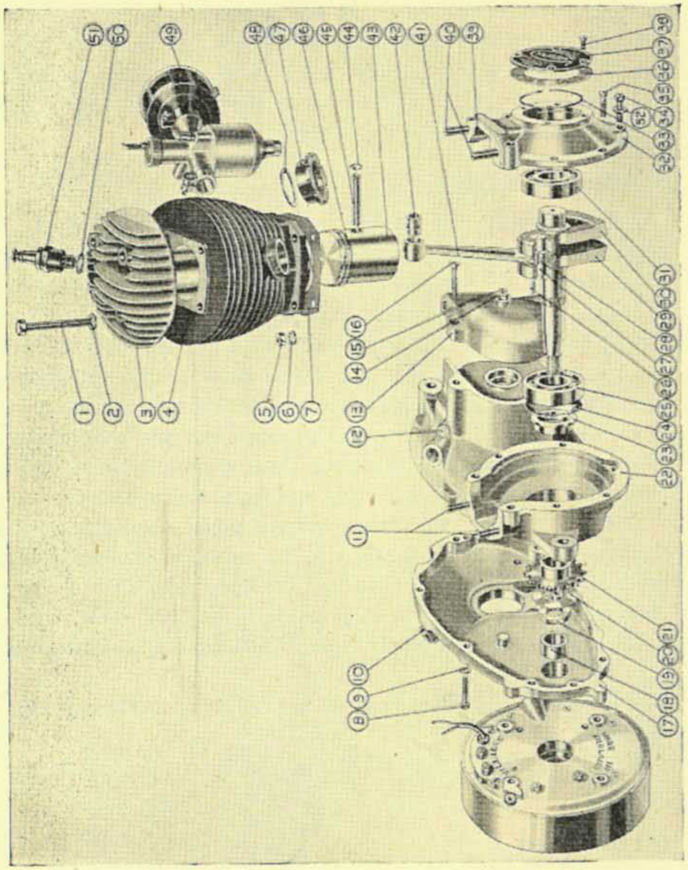


Fig. 68.—Exploded View of Engine, Mark 1F Engine-Gear Unit.

machine moves forward open the throttle to prevent the engine stalling whilst taking up the drive through the clutch. When a speed of about 12 miles per hour has been reached, the clutch lever should be raised, and the throttle almost closed simultaneously; then with the clutch disengaged move the gear lever inwards to the "high"-gear position, and immediately this has been done release the clutch lever and open up the throttle control. When changing down to the "low" gear, disengage the clutch and regulate the throttle control to give an engine speed in step with the low gear ratio. Do not hang on to top gear too long when hill climbing, and do not control the road speed by slipping the clutch except when in traffic.

Running-in

For the first 500 miles the engine must not be over-driven, and the throttle should not be fully opened. The engine must not be allowed to race, or run at a high speed under a light load. Do not exceed the following speeds until after 500 miles have been run: low gear, 12 m.p.h.; high gear,

Key to Fig. 68.—Mark 1F Engine.

1. Cylinder-head bolt.
2. Washer for bolt.
3. Cylinder-head.
4. Cylinder.
5. Cylinder-fixing-stud nut.
6. Spring washer for stud.
7. Cylinder-base gasket.
8. Clutch-cover bolt.
9. Washer for bolt.
10. Oil-filler plug.
11. Cylinder-base stud.
12. Selector-lever spindle.
13. Clutch bridge.
14. Adjuster-screw locknut.
15. Adjuster-screw, clutch.
16. Clutch-bridge screw.
17. Clutch cover.
18. Clutch-cover bush.
19. Engine-sprocket locknut.
20. Engine-sprocket lockwasher.
21. Engine sprocket.
22. Gearcase.
23. Gearcase gland bush.
24. Gearcase gland spring.
25. Right-hand ball bearing.
26. Key, engine sprocket.
27. Crankpin.
28. Crankpin rollers.
29. Right-hand driving shaft.
30. Left-hand driving shaft.
31. Left-hand ball bearing.
32. Left-hand crankcase.
33. Crankcase circlip.
34. Crankcase drain screw.
35. Crankcase screw.
36. End-plate washer.
37. Crankcase end plate.
38. End-plate screw.
39. Left-hand crankcase.
40. Cylinder-base stud.
41. Connecting-rod.
42. Connecting-rod bush.
43. Piston.
44. Gudgeon-pin circlip.
45. Gudgeon pin.
46. Compression ring.
47. Exhaust-pipe nut.
48. Exhaust-pipe washer.
49. Carburetter air filter.
50. Sparking-plug washer.
51. Sparking-plug.
52. Drain-screw washer.

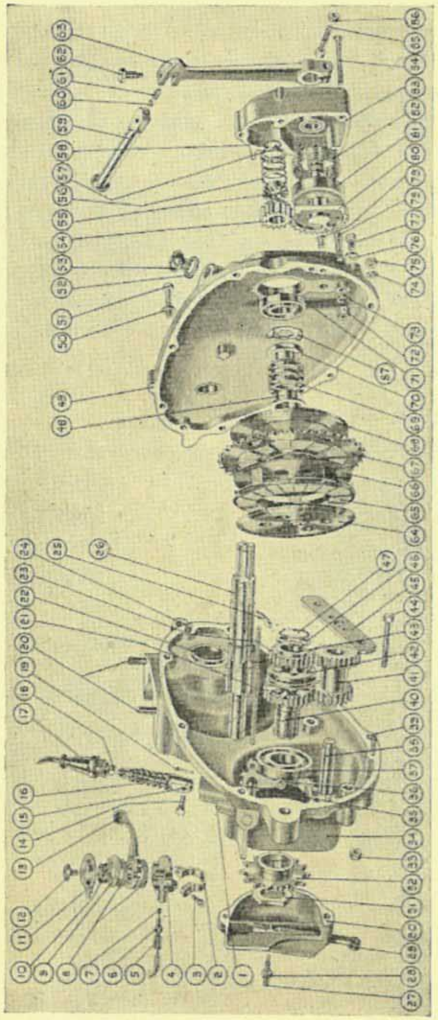


FIG. 69.—EXPLODED VIEW OF GEARBOX, MARK 1F ENGINE-GEAR UNIT.

KEY TO FIG. 69.—MARK 1F UNIT GEARBOX.

1. Selector stop pin.
2. Clip, gear control.
3. Clip screw.
4. Gear-control body.
5. Cable adjuster.
6. Adjuster locknut.
7. Cable nipple.
8. Fibre damper washer.
9. Friction plate.
10. Spring washer.
11. Top cover.
12. Top screw.
13. Gear-control lever.
14. Fork-pivot pin.
15. Selector-fork joint.
16. Gear-change spring.
17. Fork-joint guide.
18. Control-cable nipple.
19. Pivot-pin cotter.
20. Cylinder-base stud.
21. Long clutch rod.
22. Gearcase gland bush.
23. Short clutch rod.
24. Dowel pin.
25. Clutch cotter.
26. Clutchshaft.
27. Clutch-adjuster screw.
28. Locknut for screw.
29. Clutch lever.
30. Clutch bridge.
31. Driving-sprocket lock-nut.
32. Driving sprocket.
33. Nut, bridge bolt.
34. Gearcase.
35. Spindle, selector lever.
36. Gear-selector lever.
37. High-gear-wheel bearing.
38. Countershaft spindle.
39. Gearcase stud.
40. High-gear wheel.
41. Countershaft.
42. Sliding-dog clutch.
43. Low-gear wheel.
44. Bridge bolt.
45. Countershaft bridge.
46. Splined thrust washer.
47. Clutchshaft circlip.
48. Clutch-spring bush.
49. Clutch cover.
50. Cover-bolt washer.
51. Clutch-cover bolt.
52. Filler-plug washer.
53. Oil-filler plug.
54. Kickstarter pinion.
55. Kickstarter ratchet.
56. Kickstarter ratchet spring.
57. Spring-retaining washer.
58. Circlip, clutchshaft.
59. Kickstarter pedal.
60. Ball for pedal.
61. Spring for ball.
62. Pedal-pivot pin.
63. Kickstarter lever.
64. Clutch plate.
65. Clutch plate, corked.
66. Clutch plate, dished.
67. Clutch sprocket, corked.
68. Outer clutch plate.
69. Clutch spring.
70. Clutch-spring nut.
71. Bearing, clutchshaft.
72. Stop-pin nut.
73. Stop-pin washer.
74. Cover-stud washer.
75. Cover-stud nut.
76. Level-plug washer.
77. Oil-level plug.
78. Kickstarter stop pin.
79. Kickstarter spindle button.
80. Kickstarter shaft.
81. Kickstarter spring cap.
82. Kickstarter spring.
83. Kickstarter cover.
84. Kickstarter cover screw.
85. Kickstarter-lever bolt.
86. Nut for bolt.
87. Spring-nut lockwasher.

20 m.p.h. After covering the first 500 miles, the road speed can be gradually increased, but when hill climbing, change to the low gear before allowing the engine to labour in top gear. When the "running-in" mileage has been completed, it will be very likely necessary to weaken off the mixture by lowering slightly the taper needle in the carburetter; how to do this is explained in the section dealing with the carburetter.

Periodical Attention

In order to enjoy trouble-free riding, it is advisable that the engine and machine should have periodical attention, and the following hints will help to keep the engine in good running order.

Every 500 miles inspect the level of oil in the gearcase by removing the level screw (see Fig. 67) at the rear of the kickstarter housing. Top up if necessary with the grade of oil previously recommended.

Examine the contact-breaker points after the first 500 miles have been completed, as the points may require slight adjustment after initial bedding in. The correct gap when the points are fully open is 0·015 in. They should also be kept free from oil.

Every 2000 miles, remove the cylinder-head and scrape out carbon. The edges of the exhaust port in the cylinder can be cleaned when the piston is at the bottom of the stroke. Clean the piston top.

It should not be necessary to remove the barrel and piston every 2000 miles; every 4000 miles should be sufficient.

Every 2000 miles, remove and clean the silencer and exhaust pipe.

Every 5000 miles remove and wash out the air cleaner with petrol. Leave to dry, then dip into thin oil and leave to drain before replacing.

Occasionally check the clutch and gear-control cable adjustment. There should be a very small amount of slack in the clutch cable when the clutch is engaged, and in the gear-control cable when in top gear. Adjust the clutch cable by means of the adjustment screw on the clutch-bridge casting. Screw the adjuster (27, Fig. 69) in until there is just a trace of slack in the cable; this is essential, otherwise the clutch may be slightly disengaged and cause slipping. Tighten the lock-nut after adjustment. Adjust the gear-control cable by means of the cable gear adjuster midway along the cable. This is best done in top gear, *i.e.*, when the lever is in the closed position. There should be a trace of slack in the cable to ensure that top gear is fully engaged. If there is excessive slack, bottom gear will not be fully engaged when the lever is moved to the low-gear position.

Occasionally examine joints, cylinder-head, cylinder base, crankcase and clutch-case for gas or oil leaks and tighten if necessary. Examine all visible nuts, bolts and screws for looseness.

Carburetter

A Junior pattern, type 6/0, carburetter is used with the Mark 1F unit. This is similar to the one used with the Mark 2F unit, but is provided with an oil-wetted gauze air filter incorporating a strangler. The taper needle is a No. $2\frac{1}{2}$, set

1. Control cable.
2. Cable adjuster.
3. Adjuster locknut.
4. Top ring.
5. Top disc.
6. Cable nipple.
7. Needle adjuster.
8. Needle spring.
9. Throttle spring.
10. Taper needle.
11. Throttle.
12. Centrepiece.
13. Centrepiece washer.
14. Petrol-pipe banjo.
15. Banjo bolt.
16. Banjo-bolt washer.
17. Banjo gauze.
18. Banjo-bolt washer.
19. Body clip screw.
20. Body clip.
21. Float-cup washer.
22. Float.
23. Float cup.
24. Bottom-nut washer.
25. Bottom nut.
26. Cable sleeve.
27. Top cover.
28. Top-cover screw.
29. Spring washer.
30. Friction plate.
31. Fibre washer.
32. Cable nipple.
33. Control lever.
34. Control body.
35. Clip screw.
36. Tickler.
37. Fuel needle.
38. Toggle lever.
39. Locating screw.
40. Tickler cap.
41. Tickler spring.
42. Air cleaner.
43. Air-cleaner screw.
44. Air-cleaner clip.
45. Carburetter body.

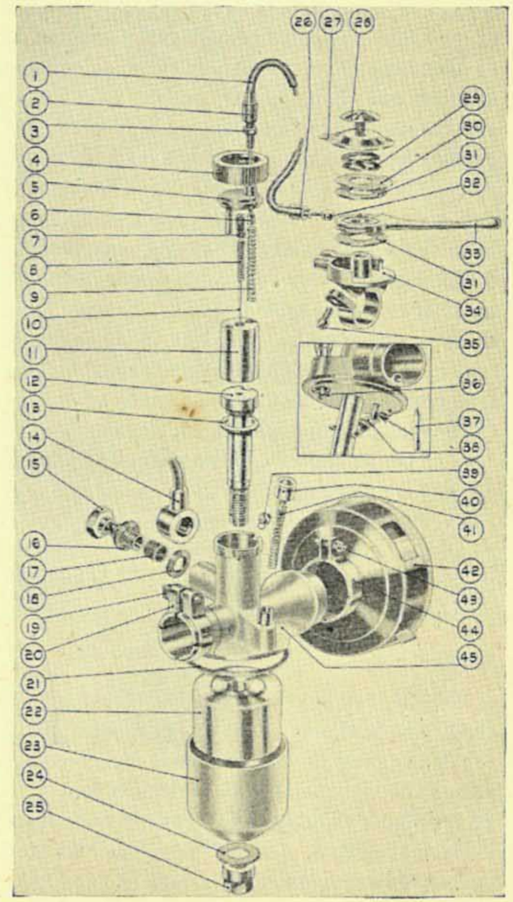


FIG. 70.—TYPE 6/0 CARBURETTER MARK 1F.

at the works $\frac{29}{32}$ in. out from the end of the throttle; instructions for adjustment and dismantling are given in Chapter VII, pages 84–85.

Magneto

The magneto is the latest six-pole pattern, the flywheel assembly being exactly the same as that used with the Mark 2F unit. The armature plate, which is fixed to the clutch-case by four screws, carries, in addition to the contact-breaker and ignition coil, two lighting coils. The leads from these coils are connected to screws insulated from the armature-plate casting by special bushes, and to the projecting ends of the screws is attached a twin rubber-covered lead having black and red cables. When the rectifier lighting set is used, the black cable is connected to the negative or — side of the 6-volt battery, the red cable being joined to the two leads from the rectifier (see wiring diagram, Fig. 74). When a direct lighting set is used, one of the leads, it does not matter which, is connected to the lead from the headlamp, the other lead being earthed by connection to a clean portion of the cycle frame (see wiring diagram, Fig. 73).

The construction of the magneto is clearly shown in the exploded drawing, Fig. 71.

In the flywheel magneto are fitted four magnets and two dummies. Should these components be removed at any time, it is very important that they are reassembled in the correct position in relation to the peak of the centre cam (see Fig. 72).

Lighting Sets

Two types of lighting sets are in use with the Mark 1F unit, the "rectifier" and "direct" patterns. In the rectifier lighting set the alternating current from the magneto is converted by a selenium-type rectifier to direct current for charging a 6-volt accumulator; and with this type of set a stop-light and electric horn can be fitted. In the "rectifier" set there is a slight loss of current due to rectification from A.C. to D.C., and a 12/12-watt bulb is therefore used.

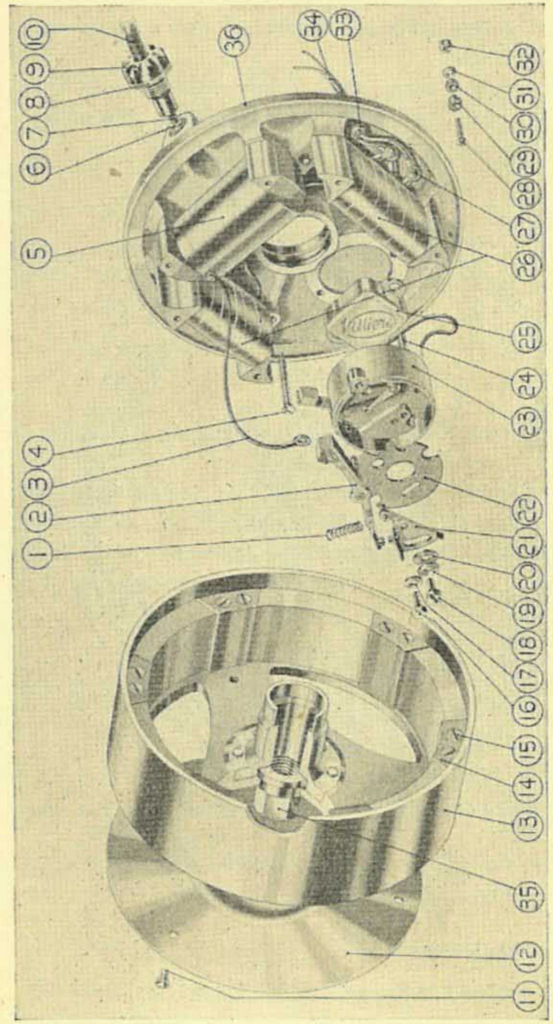


FIG. 71.—EXPLODED VIEW OF MARK 1F UNIT MAGNETO.

1. Spring-rocker arm.
2. Rocker-arm.
3. Lead from ignition coil.
4. Armature fixing screw.
5. Ignition coil.
6. H.T. spring pad.
7. H.T. spring.
8. Felt washer.
9. H.T. terminal.
10. H.T. cable.
11. Screw cover.
12. Cover.
13. Flywheel.
14. Plate, shoe.
15. Screw, shoe.
16. Contact screw.
17. Washer screw.
18. Locking screw.
19. Brass washer.
20. Fibre washer.
21. Point bracket.
22. Insulating pad.
23. Condenser box.
24. Fixing stud.
25. Condenser.
26. Lighting coils.
27. Terminal screw.
28. Terminal screw.
29. Insulating bush.
30. Insulating bush.
31. Brass washer.
32. Brass nut.
33. Rubber grommet.
34. Twin lead.
35. Centre nut.
36. Armature plate.

When the "direct" lighting set is used the whole current output of the lighting coils can be utilised and a 18/18-watt headlamp bulb is fitted.

When a "rectifier" set is used, before starting, make sure that the battery or accumulator is connected; disconnect the rectifier if the battery is not in use.

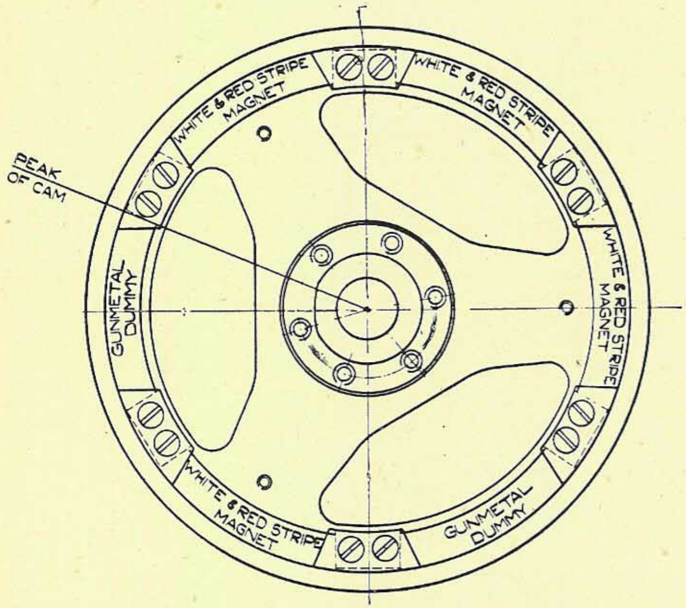


FIG. 72.—MAGNETO FLYWHEEL ASSEMBLY, MARK 1F AND 2F UNITS.

For details of the wiring for the respective sets and correct bulbs to use see Figs. 73 and 74.

Overhaul and Maintenance

The engine portion, as previously explained, is practically identical with the Mark 2F unit, so that the same instructions given in Chapter X apply to the Mark 1F unit, with the exception that no release valve is fitted in the cylinder-head.

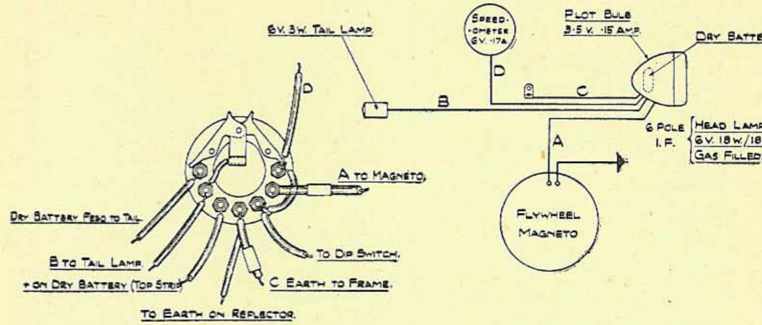


FIG. 73.—"DIRECT" LIGHTING SET WIRING DIAGRAM FOR MARK 1F UNIT.

A crankcase gland bush having the oil-return groove is now provided, but in engines up to number 7790, a bush having a plain bore is fitted. This modified bush can be fitted to earlier engines, but as the crankcase has to be split, and special tools are necessary, the fitting should ge done either by the Works or by an approved Service Depot.

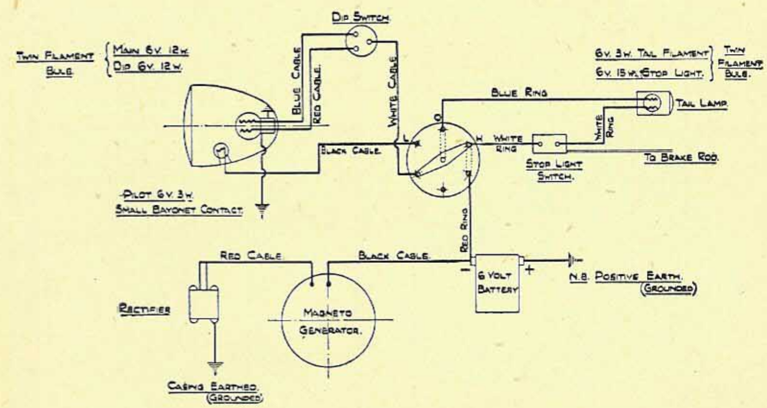


FIG. 74.—"RECTIFIER" LIGHTING SET WIRING DIAGRAM FOR MARK 1F UNIT.

Gear-control-cable Adjustment

The sliding dog fitted to the clutchshaft is moved along from top to bottom gear and vice versa by means of a control lever fitted to the right handlebar of the cycle. Movement of the lever outwards gives the bottom or low gear, and when the lever is returned as far as possible, inwards, a spring at the gearbox end of the cable pushes the lever operating the sliding dog into the top- or high-gear position. To allow the dogs to fully engage, a little free movement must be allowed for the control lever when taking up the pull on the cable. To allow this to be done, an adjuster with locknut is provided approximately midway along the control cable. To increase the free movement, screw in the adjuster, afterwards tighten the locknut. In cases where this midway adjuster is not fitted, the adjuster fitted in the control-lever body can be used.

CHAPTER XII

MARK 10D ENGINE-GEAR UNIT

THE Mark 10D unit consists of separate engine and gearbox bolted together to form one complete assembly. The cylinder porting is arranged as shown in Fig. 2A, page 12, and although a compression-release valve is not fitted as standard, a special cylinder-head is available when required. Ignition is by the six-pole Villiers flywheel magneto, which also provides current for lighting. The carburetter is a Villiers type 3/4, with combined air filter and strangler for cold starting, control being by a single lever or twist grip.

The gearbox provides three speeds, and has a totally-enclosed kickstarter mechanism and a positive gear change, operated by the right foot. The construction comprises a main and layshaft, and one pair of sliding gears; the gearwheels are always in mesh. The speeds or gears are selected by means of a patented ratchet mechanism making gear-change positive. It is impossible for a gear to be missed; the foot gear-control pedal returns to a normal position after each operation in readiness for the next change. The pedal is lifted by the toe to change to lower gears and pressed downwards to obtain a higher gear. The gearbox is fitted with a two-plate cork-insert clutch disengaged by means of a lever on the gearbox

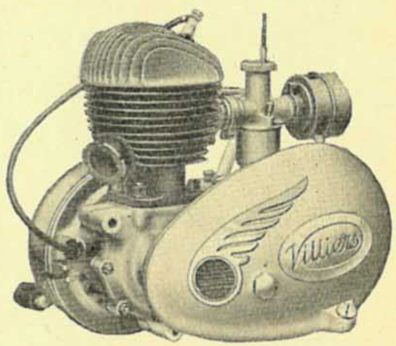


FIG. 75.—MARK 10D ENGINE-GEAR UNIT.

GENERAL DATA FOR MARK 10D ENGINE-GEAR UNIT

Bore, 50 mm. (1·9695 in.).
Stroke, 62 mm. (2·440 in.).
Capacity, 122 c.c. (7·44 cu. ins.).
Horse-power, max. 4·8 at 4400 r.p.m.
Engine sprocket, 18 teeth × $\frac{3}{8}$ in. pitch.
Clutch sprocket, 51 teeth × $\frac{3}{8}$ in. pitch.
Final drive sprocket, 15 teeth × $\frac{1}{2}$ in. pitch. (Use Renold chain No. 110044.)
Chain line, final drive, $2\frac{3}{16}$ in.
Sparking plug, Lodge H14, 14-mm.
Plug point gap, 0·02 in.
Gearbox ratios, 1 : 1, 1·4 : 1, 2·66 : 1.
Carburetter, type 3/4 :
  Jet size, No. 3.
  Taper needle, No. 3.
Ignition timing, $\frac{5}{32}$ in. before T.D.C.
Contact-breaker point gap, 0·015 in. max.
Lubrication, engine, Petroil mixture.
Lubrication, gearbox and chain-case, Castrol D oil (SAE 140).
Lighting set, direct type :
  Head, 6V–30/30W S.B.C.
  Pilot, 3·5V–0·15A M.E.S.
  Tail, 6V–3W S.B.C.
Lighting set, rectifier type :
  Head, 6V–24/24W S.B.C.
  Pilot, 6V–3W S.B.C.
  Tail, 6V–3W S.B.C.
  Stop light, 6V–18W.

through a Bowden cable and a lever on the handlebar. Reference to Fig. 77 will show how the various gears and shafts are fitted, and how the three speeds are obtained by moving the sliding wheels into their positions along the shafts.

Gear Ratios

The Mark 10D unit was introduced at the end of 1948, and for units produced during approximately the next twelve months the gearbox ratios were 1 : 1, 1·7 : 1, 3·25 : 1. Gears giving closer ratios were then introduced, and a suffix letter D after the engine number indicates that these are fitted,

KEY TO FIG. 76.—MARK 10D ENGINE.

1. Cylinder-head bolt.
2. Washer for bolt.
3. Cylinder-head.
4. Cylinder.
5. Exhaust-pipe nut.
6. Piston.
7. Compression rings.
8. Cylinder-base stud.
9. Right-hand crankcase.
10. Right-hand bearing.
11. Right-hand driveshaft.
12. Driveshaft bearings.
13. Sparking-plug.
14. Inlet manifold.
15. Manifold gasket.
16. Cylinder-base gasket.
17. Gudgeon pin.
18. Gudgeon circlip.
19. Joint washer.
20. Connecting-rod.
21. Left-hand driveshaft.
22. Crankpin.
23. Bearing distance piece.
24. Compression gland spring.
25. Compression gland.
26. Left-hand crankcase.
27. Drainscrew washer.
28. Crankcase drainscrew.
29. Gearbox fixing stud.

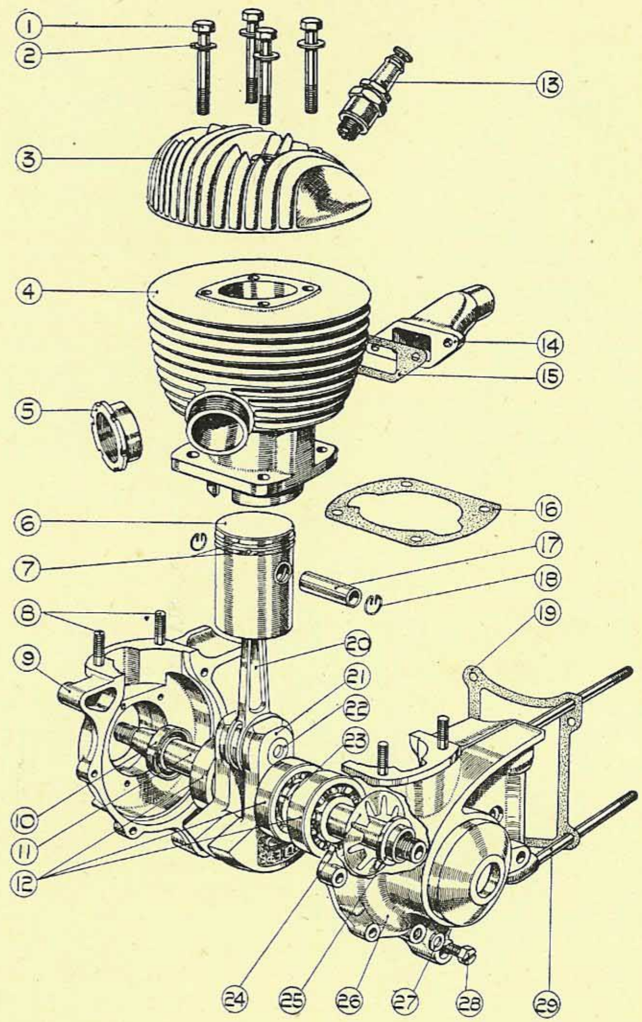


FIG. 76.—EXPLODED DRAWING OF MARK 10D ENGINE.

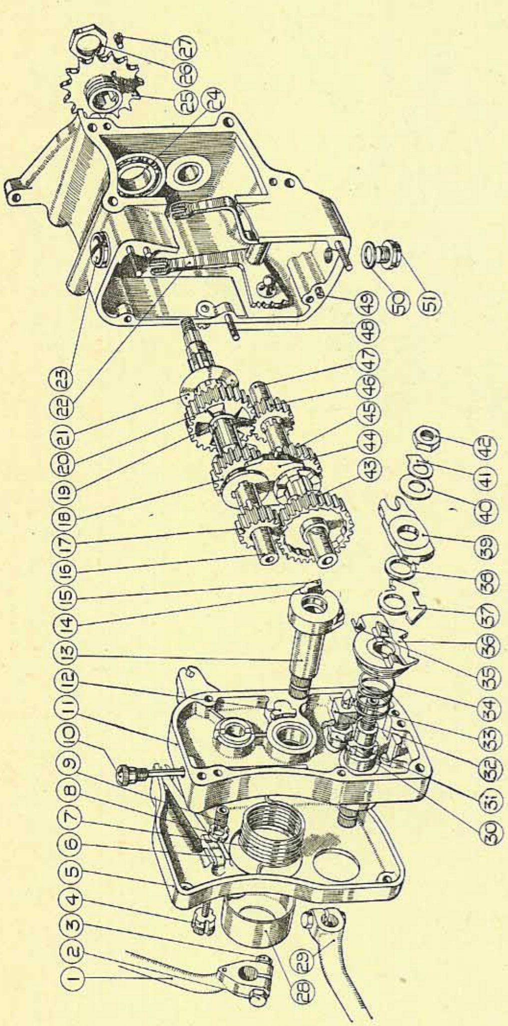


FIG. 77.—EXPLODED VIEW OF GEARBOX, MARK 10D UNIT.

1. Kickstarterl ever.
2. Lever clamp bolt.
3. Nut for bolt.
4. Lever adjusting screw.
5. Gearbox dust cover.
6. Clutch lever.
7. Kickstarter return spring.
8. Adjuster bush locknut.
9. Adjuster bush.
10. Oil dipstick.
11. Gearbox end plate.
12. Kickstarter stop piece.
13. Kickstart shaft.
14. Kickstart plunger.
15. Kickstart pawl.
16. Mainshaft.
17. Mainshaft fixed pinion.
18. Mainshaft sliding pinion.
19. Mainshaft pressure washer
20. High gear pinion.
21. Bearing sealing washer.
22. Selector quadrant.
23. Oil-filler plug.
24. Ball bearing.
25. Countershaft sprocket.
26. Sprocket locknut.
27. Locknut lockscrew.
28. Kickstarter spring cap.
29. Operating foot lever.
30. Plunger box nut.
31. Operating spindle.
32. Plunger box.
33. Selector plunger.
34. Ratchet spring.
35. Operating pawl spring.
36. Operating pawl.
37. Operating plate.
38. Spindle distance washer.
39. Operating lever.
40. Spindle washer.
41. Spindle lockwasher.
42. Spindle nut.
43. Ratchet pinion.
44. Sliding pinion operator.
45. Layshaft sliding pinion.
46. Layshaft fixed pinion.
47. Layshaft.
48. End-plate stud.
49. End-plate dowel.
50. Drainscrew washer.
51. Drainscrew.

the ratios being as given under the data heading. The wide-ratio gears are available for competition work. Owners of units having the wider ratios can convert their gearboxes by obtaining the two necessary gear-wheels; these are the high-gear pinion and layshaft fixed pinion having twenty-four and eighteen teeth respectively.

Crankcase Seals

The suffix letter D also indicates that a rubber oil seal is fitted to the drive side of engine crankcase in place of the spring-loaded bronze bush originally fitted. All engines are numbered, and the figures preceding the engine number indicate the specification to which the engine is built, *e.g.*, 932/1000D. Engines having a lower specification number and no suffix letter have spring-loaded compression seals fitted to both sides of crankcase. Engines built to specification numbers 932 to 943 inclusive, and later, have a rubber seal fitted to the magneto side also.

Lubrication

The engine portion of the unit is lubricated by Petroil mixture poured into the tank and made by mixing thoroughly ½ pint of Castrol XL oil (SAE 30) to 1 gallon of petrol. When this oil is unobtainable, Shell X100, Double Shell, or Mobiloil A may be substituted. For the gearbox and chaincase, Castrol D oil (SAE 140) should be poured through the filler-plug holes up to the level of the filler plug in the chaincase front cover, and to the level of the small plug at the back of the gearbox. Oil should not be allowed to fall below the level of the bottom of the dipstick, which is to be found near the filler plug of the gearbox. SAE 90 oil should be used for cold conditions or SAE 80 for extremely cold climates.

Running-in

The useful life of a motor-cycle engine depends to a great extent on how it is used during the first 500 miles. During this period the machine should not be driven at more than

30 m.p.h. in top gear, 20 m.p.h. in middle and 8 m.p.h. in bottom gear. Do not allow the engine to labour in top gear, change to lower gear and slightly close throttle to prevent the engine racing.

Periodical Attention

In order to enjoy trouble-free riding it is advisable that the engine and machine should have periodical attention. The following hints will help to keep the engine and machine in good running order.

Daily, check level of petrol mixture in tank and fill up if necessary.

Every 1000 miles, examine the level of the oil in the gearbox and chaincase. Top up if necessary.

Every 5000 miles drain gearbox by removing the drain plug in the bottom of the box and refill with fresh oil. The chaincase can be drained by removing the front cover, as no drain plug is provided. It is advisable to do this when the engine is warm, as the oil will drain away more quickly. Fill up with new oil of the appropriate grade.

Examine the contact-breaker points after the first 500 miles have been completed, as the points may require slight adjustment after initial bedding in. The correct gap when the points are fully open is 0·015 in. They should be kept free from oil.

Every 2000 miles, remove the cylinder-head and scrape out carbon. The edges of the exhaust port in the cylinder can be cleaned when the piston is at the bottom stroke. Clean the piston top. It should not be necessary to remove the barrel and piston every 2000 miles; every 4000 miles should be sufficient.

Every 2000 miles, remove and clean the silencer and exhaust pipe.

Every 5000 miles, remove and wash out the air cleaner with petrol. Leave to dry. Dip into thin oil and leave to drain before replacing. More frequent cleaning will be necessary under dusty conditions.

Clean the spark-plug points and set to a gap of 0·020 in. Do not overtighten when refitting the plug.

Clutch and Clutch-cable Adjustment

Occasionally check the clutch and clutch-cable adjustment. Adjust the knurled knob above the kickstarter boss until definite freedom is felt at the end of the lever projecting out of the dust cover. If this freedom is excessive the clutch will not free properly. If there is appreciable slackness in the clutch cable, this can be taken up by means of the cable adjuster on the gearbox cover. A slight trace of slack should be felt in the cable, otherwise the clutch may be slightly disengaged and cause slipping.

Tighten the locknut on the cable adjuster after adjusting the cable. Occasionally examine joints, cylinder-head, cylinder base, crankcase, gearbox and chaincase for gas or oil leaks and tighten if necessary.

Examine all possible nuts, bolts and screws for tightness.

Starting the Engine

See that the gear is in neutral or free engine. This position can be obtained by lifting the gear-control pedal until bottom gear is engaged, then press down the pedal approximately half the normal travel, when the neutral will be found. It should then be possible to rotate the back wheel without revolving the engine. Turn the fuel tap to the " on " position, and when the engine is *cold* depress the tickler on the carburetter until fuel appears, showing that the float chamber is full. Close the strangler in the air cleaner, open the throttle approximately one-third of the total movement of the throttle lever or twist grip and depress the kickstarter once or twice to draw an initial charge of mixture into the engine. Then give a sharp kick downwards, when the engine should start. Open the strangler fully as soon as the engine is sufficiently warm to run with it in the open position. The engine should not be run on the road with the strangler closed, as this may cause oiling up of the sparking-plug, lack of power and waste of fuel. When the engine is hot do *not* flood the carburetter or close the strangler.

When a rectifier lighting set is fitted be sure before starting that the battery is connected, or, if the battery is not in use, that the rectifier is disconnected.

Failure to Start.—See Fault Finding Chart, pages 180, 181 and 182.

Carburetter

The Villiers type 3/4 carburetter, Figs. 78 and 79, is fitted to the Mark 10D engine. These numbers will be found stamped on the inlet stub immediately behind the clip (No. 19). The setting of the carburetter is done when testing the machine, but the standard setting of the No. 3 taper needle when assembled is $2\frac{13}{32}$ in. out from end of the throttle. After approximately the first 500 miles, when the engine has been run in, it will probably be necessary to weaken the mixture by lowering the taper needle. This is done by screwing in the adjuster to be found at the top, in the centre of throttle, see Fig. 78 (28).

Operation of Carburetter

The function of the carburetter is to supply a mixture of fuel and air in correct proportions under all running conditions. In the Villiers carburetter, the float chamber (25, Fig. 78) surrounds the jet centre piece (23), and in it an annular float (24) rises as the fuel enters the chamber until the correct level is obtained. The fork lever (5), which rests on the top of the float, lifts the fuel needle (6), which has a conical end and shuts off the fuel supply by closing the hole in the bush.

In the Mark 10D carburetter fuel enters the jet body through a hole (A, Fig. 79), and passes through the jet in which the long taper needle operates, and passes up through an offset hole (B) in the centre piece. The position of this needle relative to the slide can be altered by removing the screwed ring and top disc and screwing up or down the small screw

in the centre of the slide. Screw in the screw to weaken the mixture, *i.e.*, lower the needle. Screw out the screw to enrich the mixture. The screw should not be loose in the throttle slide, as it is likely to move and alter the setting. It is split to make it grip the hole. Should the screw be loose

1. Control cable.
2. Cable adjuster.
3. Adjuster locknut.
4. Throttle spring.
5. Toggle lever.
6. Fuel needle.
7. Banjo-bolt washers.
8. Banjo bolt.
9. Banjo gauze.
10. Air cleaner.
11. Compensating tubes.
13. Top disc.
16. Needle spring.
17. Throttle.
18. Taper needle.
19. Body clip.
21. Tickler
22. Cup-joint washer.
23. Centre piece and jet.
24. Float.
25. Float cup.
26. Bottom-nut washer.
27. Bottom nut.
28. Needle adjuster.

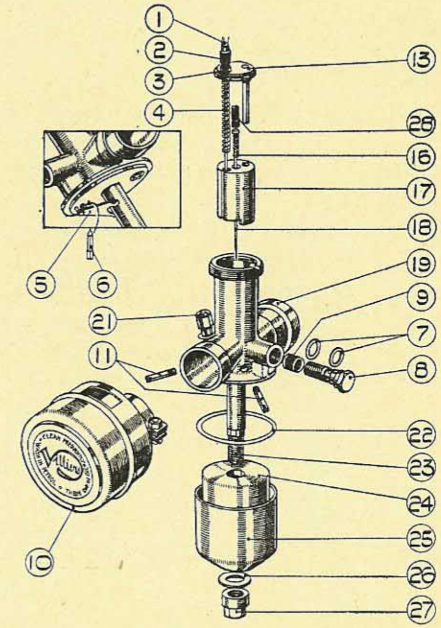


FIG. 78.—EXPLODED DRAWING OF TYPE 3/4 CARBURETTER, MARK 10D UNIT.

the split portion should be gently prised apart. Note the taper-needle spring should be fitted with the small coil under the head of the needle.

The slide (17, Fig. 78) operated by the throttle cable controls the air supply and is fitted with taper needle (18) which extends below the slide, through the centre piece and into the needle jet. When the throttle slide closes the air supply, the largest diameter of the needle nearly closes the fuel outlet, but when the slide is lifted, admitting more air, the smaller diameter of the needle now in the jet allows more fuel to pass. A suitable combination of jet size, needle position and taper will give a correct mixture strength at all throttle openings.

On both the Mark 10D and Mark 6E carburetters, a further refinement to compensate for engine speed, which also assists in atomising the fuel, is provided. The offset hole (C, Fig. 79) in the centre piece allows air to enter just above the needle jet, which it should be noted is submerged. This hole communicates with the atmosphere through a tube (D). The size of this hole in the centre piece determines the amount of correction provided.

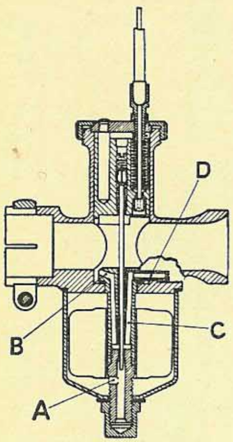


FIG. 79.—SECTION THROUGH TYPE 3/4 CARBURETTER.

Dismantling Carburetter

To remove the throttle slide from the body, open the throttle lever or twist grip to its full extent, undo the top screwed ring, when the throttle slide complete with the top disc can be withdrawn. Take care not to damage or bend the taper needle. If it is necesary to detach the throttle-control cable, turn the control lever to the closed position, to compress the throttle spring. The nipple on the end of the cable can then be pulled out of the recess and the cable withdrawn through the slot in the side of the slide. To remove the taper needle, unscrew the adjuster from the centre of the throttle and push up the needle from the underneath, taking care not to lose the small spring from underneath the head of the needle.

To remove the centrepiece and fuel needle, first unscrew the bottom nut (27, Fig. 78) underneath the float-chamber cup. Next remove the fibre washer (26), the cup (25) with float inside and, if loose, the fibre washer (22) between cup

and carburetter body. Then remove the two compensating tubes (11) using a small screwdriver. The centrepiece (23) with fibre washer under its head can now be be pushed up through the throttle bore. When the centrepiece is removed the fuel-needle lever (25) can swing round, and will thus allow the fuel needle (6) to drop out of its seating; the needle should therefore be removed at the same time as the centrepiece and kept in a safe place until required for assembly. No attempt should be made to remove the fuel-needle lever (5) from the carburetter body. It should not be necessary to remove the tickler (21) unless the vent hole in the base of the body is blocked, in which case remove the split cotter pin at the end of tickler, which will release the tickler and its spring. One vent hole is at the bottom of hole where the spring fits, the other being in the side of the tickler cap.

The air cleaner, which should be removed for cleaning approximately every 2000 miles, is held on to the carburetter body by a clip. Clean by immersing in petrol; when dry, dip in thin machine oil and allow to drain before refitting.

Reassembly of Carburetter

Reassembly is the reverse process to that of dismantling. The fuel needle should be fitted point first, the fuel-needle lever should then be placed so that the needle is held in position whilst the centrepiece is replaced. The fibre washer must be in position under head of centrepiece so that the compensating tubes can be screwed in. Do not use too much force when refitting the tubes, or when tightening the bottom nut after replacing the float-chamber cup.

Tracing Carburetter Troubles.—See notes on pages 87–89, Chapter VII.

Magneto and Lighting Sets

The magneto is the Villiers six-pole pattern referred to in the latter part of Chapter V, pages 59–62. The armature plate and flywheel assemblies are illustrated in Fig. 80.

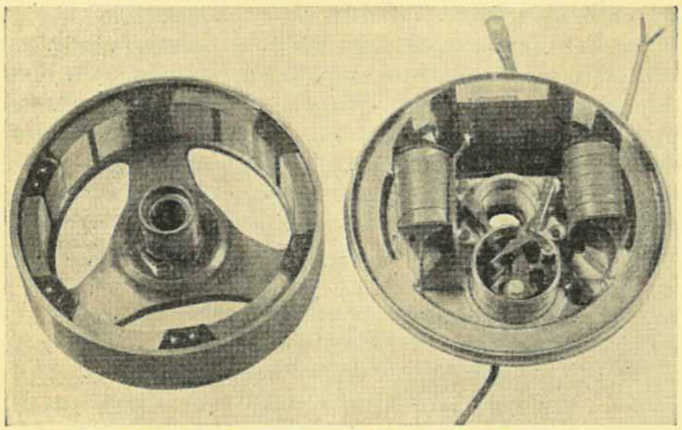


FIG. 80.—MAGNETO OF MARK 10D UNIT.

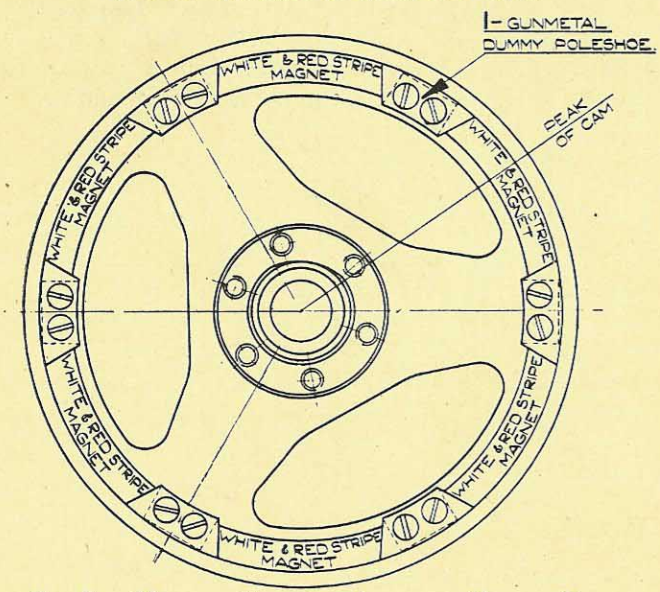


FIG. 81.—MAGNETO FLYWHEEL ASSEMBLY, MARK 10D AND MARK 6E UNITS.
This has six magnets, five non-pole shoes and one dummy pole shoe.

Flywheel Assembly

The flywheel assembly consists of six magnets, and five iron and one dummy pole shoes, held in position by six top plates, the plate over the dummy pole shoe being made from a non-ferrous material. The position of the dummy pole shoe

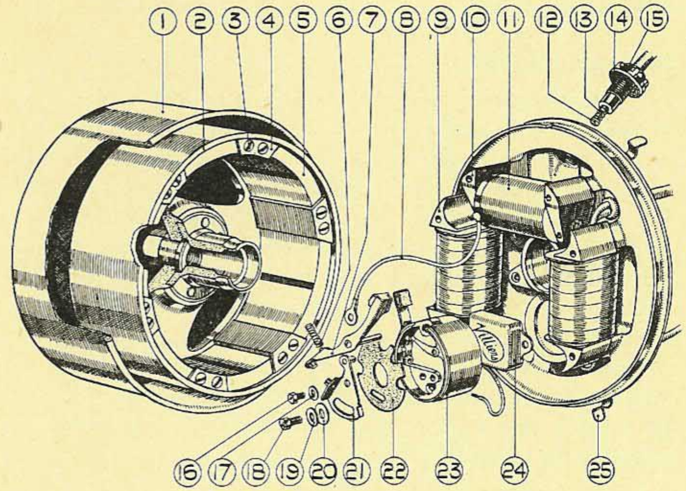


FIG. 82.—EXPLODED DRAWING OF MAGNETO MARK 10D AND MARK 6E UNITS.

1. Magneto cover.
2. Flywheel assembly.
3. Pole screw.
4. Pole-shoe plate.
5. Magnets.
6. Rocker-arm spring.
7. Rocker arm.
8. Low-tension lead.
9. Lighting-coil cheek.
10. Ignition-coil cheek.
11. Ignition-coil.
12. H.T. pick-up pad.
13. H.T. pick-up spring.
14. Felt washer.
15. H.T. terminal.
16. L.T. connection screw.
17. Washer for screw.
18. Point bracket lock-screw.
19. Brass washer.
20. Insulating washer.
21. Point bracket.
22. Insulating pad.
23. Condenser box.
24. Condenser.
25. Flywheel cover clip.

in relation to the peak of the centre cam is most important, and should it be necessary to entirely dismantle the flywheel the components must be correctly reassembled. Reference to Fig. 81 will make this clear. The fitting of new magnets or pole shoes should always be done by the Works or approved Service Depots, since the machining of the pole shoes has to be done after assembly.

The centre boss or "cam" fits on the tapered portion of the crankshaft, the hole is a ground finish and no key is used. The wheel is secured on the crankshaft by the centre nut having a flange which draws the wheel from the shaft as it is unscrewed, thus obviating the use of a special extractor. See Chapter V for further details. The centre nut is exposed upon removal of the flywheel cover.

Timing the Ignition

The method of timing the ignition is exactly as described for the Mark 1F engine in the previous chapter, except that the timing mark on the armature plate consists of a narrow slot cut in the spigot which carries the flywheel cover. This slot should coincide with the mark on flywheel rim when the piston is at the top of the stroke, the amount of advance, namely $\frac{5}{32}$ in., having been allowed for when marking the flywheel. To check, loosen flywheel on crankshaft and set piston $\frac{5}{32}$ in. *before* top of stroke, rotate flywheel until the contact points commence to open, tighten flywheel sufficient to rotate crankshaft, re-check timing and, if found correct, finally tighten the centre nut. Full details for carrying out this operation are given in Chapter V, pages 52–54.

Magnetising the Magnets

Very powerful magnets are used, made from the highest-quality magnet material obtainable. These are extremely stable, and no loss of magnetism will occur during the life of the engine. The flywheel can be detached from the armature plate without danger of affecting the magnetic strength, and there is no need to put a "keeper" over the flywheel, even though this remains detached for long periods. No appreciable improvement will be obtained by re-magnetising.

The Armature Plate

The assembly consists of the armature plate, contact-breaker with condenser, and ignition and lighting coils.

On later engines the assembly carries the rubber oil and compression seal in the adaptor fitted at the back of the plate. The contact-breaker assembly is as shown in Fig. 16 and described in Chapter V, page 49. The lighting-coil assembly is the same for either direct or rectifier types of lighting sets, but the method of making the connections between the magneto and lighting sets differs (see wiring diagrams, Figs. 83–84).

The armature plate should not be removed except in

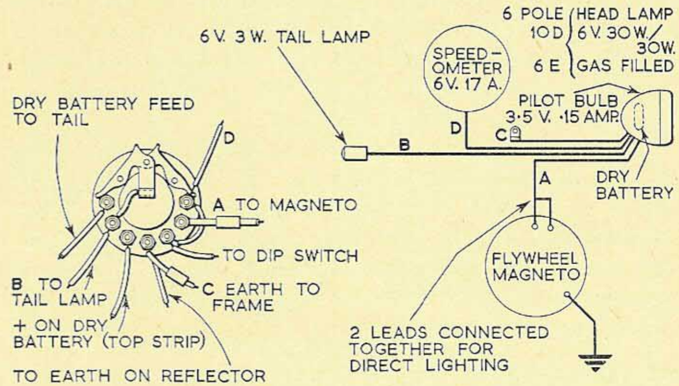


FIG. 83.—WIRING DIAGRAM, "DIRECT" LIGHTING SET, MARK 10D AND MARK 6E.

case of damage, and when replacing make sure that both contact faces are clean and dry so as to provide a good *earth* for the ignition circuit. Should it be necessary to replace the H.T. cable, make certain that the spring-loaded pad makes contact with the disc on the ignition coil (see Fig. 17, page 50).

Lighting Sets

When the *direct* set is used, the full output from the lighting coils is taken by the lamp bulbs, but the current is available only whilst the engine is running. No precautions are necessary except to make certain that all connections between the magneto and lamp cables are well made, clean and insulated from contact with the motor-cycle frame. It is essential that a good *earth* return is provided by metal-to-metal contact between the bodies of the head and tail lamps and their respective brackets and rear number-plates.

With the *rectifier* lighting set other precautions are necessary in addition to the above. The A.C. current from the magneto is converted to D.C. by means of a Selenium-type rectifier so as to charge a 6-volt battery. It is essential that if the battery is taken off the machine, the connections to the rectifier are also detached, as otherwise the full load of the magneto may puncture the rectifying cells and cause failure. It is also important that the lead from magneto to the rectifier should not short to earth, as this will partially demagnetise the magneto if the battery is in circuit.

The rectifier circuit is arranged so as to give the full charging rate with the headlamp switch in the " H " position, and half-charge in the " off " position for daylight riding. When the battery cannot be kept fully charged due to excessive night riding, the full charging rate can be obtained by joining together the two top terminals of the switch shown in the wiring diagram, Fig. 84.

Care of the Battery (Rectifier Set)

Once a month unscrew the filler caps of each cell and pour in a small quantity of distilled water to bring the acid level with the tops of the separators. Do not use tap water, as it contains impurities detrimental to the battery.

Acid should not be added unless this is accidentally spilled out of the battery. This should be replaced by diluted sulphuric acid of the same specific gravity as in the cells.

Keep the battery terminals clean. Many lighting troubles can be traced to unseen corrosion between the surfaces of a perfectly tight joint, and in the case of the battery this corrosion takes place much more frequently than at other electrical contacts. The positive is earthed to reduce this effect to a minimum.

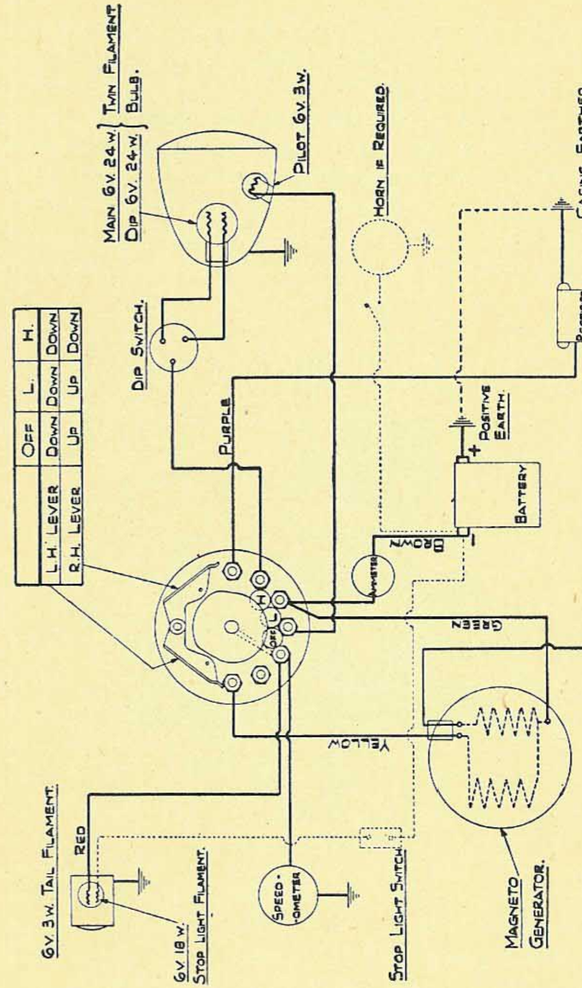


FIG. 84.—WIRING DIAGRAM, " RECTIFIER " LIGHTING SET, MARK 10D AND MARK 6E.

Rectifier

The rectifier will need no attention and is practically fool-proof. Reference to the wiring diagram Fig. 84 will show that the casing has to be *earthed* by attachment to some portion of the cycle frame. The rectifier should be placed where it can be kept reasonably dry, but at the same time exposed to the atmosphere, otherwise overheating may occur.

CHAPTER XIII

MARK 6E ENGINE-GEAR UNIT

THE Mark 6E and 10D units are interchangeable in respect of the frame-fixing lugs, and although the gear-boxes are identical, the larger engine has a primary chain of $\frac{1}{2}$-in. pitch as against the $\frac{3}{8}$-in. chain used on the Mark 10D unit.

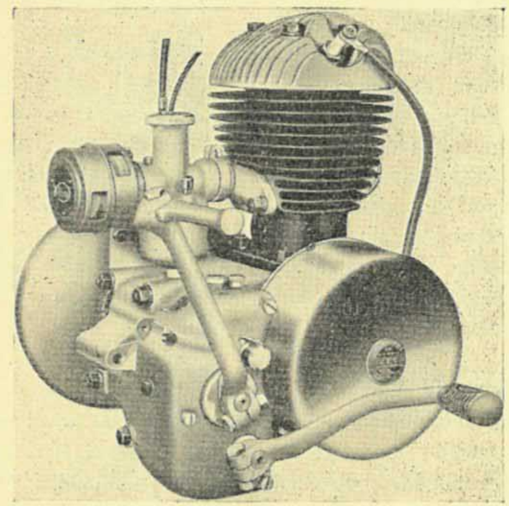


FIG. 85.—MARK 6E ENGINE-GEAR UNIT.

The design of the two units is similar in most respects, but the cylinder-head of the larger engine is fitted with a compression-release valve, and the carburetter has a separate cable control for the taper needle. The Mark 6E unit, when introduced at the end of 1948, had a gearbox giving the wider ratios, and the change to the closer ratios was made to both

GENERAL DATA FOR MARK 6E ENGINE-GEAR UNIT

Bore, 59 mm. (2·3235 in.).	Clutch sprocket, 38 teeth × $\frac{1}{2}$-in. pitch.
Stroke, 72 mm. (2·834 in.).	Carburetter, type 4/5 :
Capacity, 197 c.c. (11·70 cu. ins.).	Jet size, No. 1.
Horse-power, max., 8·4 at 4000 r.p.m.	Taper needle, No. 4$\frac{1}{2}$.
Engine sprocket, 19 teeth × $\frac{1}{2}$ in. pitch.	Sparking plug, Lodge HH14 or HHN 14 mm.

Other Data as for the Mark 10D unit, Chapter XII.

engines at the same time; the suffix letter D at the end of the engine number indicates that gears giving the closer ratios are fitted.

Engines built to specification numbers 944 to 957 inclusive and number 960 have the rubber oil seal on the magneto side. Engines built to the above specification numbers also having the suffix letter D have a rubber oil seal fitting on the drive side of crankcase. Engines built to a lower specification number and no suffix letter have spring-loaded compression seals fitted to both sides of the crankcase.

Lubrication, Running-in, Periodical Attention.—The instructions given for the Mark 10D unit, Chapter XII should be followed.

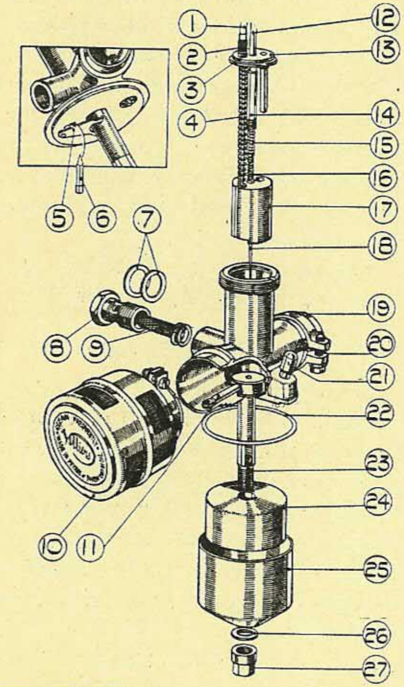
Starting the Engine

The instructions for starting the Mark 10D unit apply, but as no strangler is fitted to the air cleaner, the necessary mixture enrichment for starting from cold is obtained by moving the mixture-control lever on the handlebar to the position marked " rich." After the engine has started the lever should be returned to the normal operating position.

Carburetter

The Villiers type 4/5 carburetter is fitted to the Mark 6E engine. The construction is clearly shown in the exploded and sectional drawings, Figs. 86 and 87. The operation of the

carburetter is exactly as for the Mark 10D carburetter, but for some engines a limit jet is screwed into the hole A in the needle jet body through which the long taper needle operates. The position of this needle can be varied by means of the control



1. Throttle-control cable.
2. Cable adjuster.
3. Adjuster locknut.
4. Throttle spring.
5. Toggle lever.
6. Fuel needle.
7. Banjo-bolt washers.
8. Banjo bolt.
9. Banjo gauze.
10. Air cleaner.
11. Compensating tube.
12. Jet-control cable.
13. Top disc.
14. Throttle extension.
15. Needle-return spring.
16. Needle spring.
17. Throttle.
18. Taper needle.
19. Body clip.
20. Body-clip screw.
21. Tickler.
22. Cup-joint washer.
23. Centrepiece and jet.
24. Float.
25. Float cup.
26. Bottom-nut washer.
27. Bottom nut.

FIG. 86.—EXPLODED VIEW OF TYPE 4/5 CARBURETTER FITTED TO MARK 6E UNIT.

lever on the handlebar, the needle being raised to enrich the mixture and lowered to weaken.

Dismantling Carburetter

To remove the throttle and throttle-control cable, follow the instructions given for the Mark 10D carburetter. The taper needle with spring can be removed after unscrewing the

M

hexagon extension (14, Fig. 86) from the throttle (17). Before the centrepiece (23) can be removed, the compensating tube (11) has to be unscrewed. This is situated inside the air intake, and the slotted end can be seen after removal of the air filter. The special circlip which fits in a groove in the tube should always be in position to prevent possible entry into the cylinder should the tube become unscrewed. Further dismantling and reassembly of the carburetter can be carried out by following the instructions given in the previous chapter dealing with the Mark 10D carburetter.

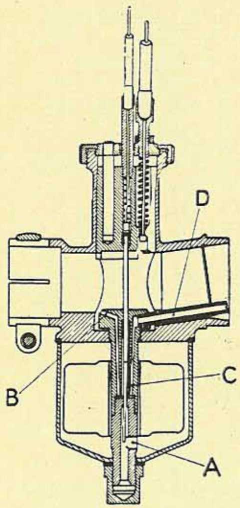


Fig. 87.—Sectional Arrangement Mark 6E Carburetter

Tracing Carburetter Troubles.—See notes on pages 87–89, Chapter VII.

Magneto and Lighting Sets

The magneto, except for weight of flywheel, is identical in every way with the Mark 10D model. The flywheel rim is wider and consequently heavier; therefore when ordering spares it is essential to quote either the full engine number or the code number which is stamped on the flywheel rim. As explained in Chapter XII (Mark 10D), the same magneto is used for both the direct and rectifier lighting sets, these again being identical for both the 122-c.c. and 196-c.c. engines.

Spares and Service

For the convenience of readers who may have occasion to communicate with the makers, the address of the Villiers Engineering Co. Ltd. is Marston Road, Wolverhampton. The telephone number for the offices is Wolverhampton 21666, and for the Service Department, Wolverhampton 20851.

APPENDIX

TRACING TROUBLES

For the satisfactory running of any Villiers engine it is essential that three main conditions are fulfilled, and by making a systematic and intelligent investigation the faults can usually be located and rectified. Usually when the engine stops, symptoms give a clue to the cause, but where this is not the case, the trouble can be more easily diagnosed by following a definite method of investigation.

The three conditions mentioned above are as follows:—

1. The required quantity of combustible mixture (petrol and air) must enter the engine, which means that a sufficient supply of fuel must be available at the carburetter and that the throttle should open and close freely.
2. There must be a good spark at the plug points, when under compression, and at the correct time in relation to the position of piston on its upward stroke.
3. The engine must be in good mechanical condition, there must be good compression in cylinder and crankcase, and no air leaks at the various joints.

When cause of the trouble is not evident carry out a preliminary examination covering the following points, but if this fails to trace the cause reference should be made to the Fault-Finding Chart.

Having made sure that there is "Petroil" in the tank, and tap is in the on position, depress tickler to check if there is any stoppage or obstruction in the fuel supply either in the tap, fuel pipe, banjo union or fuel-needle seating. Being satisfied that fuel is reaching the carburetter, next unscrew sparking-plug and with high-tension lead attached lay on cylinder-head. Test by turning engine by means provided, and if the spark is satisfactory it is possible that the timing is incorrect. Finally examine the carburetter controls to make certain the throttle is actually opening when the control lever is moved.

FAULT-FINDING CHART

Sequence of Testing.	Possible Trouble.	Remedy.
ENGINE WILL NOT START. Depress tickler on carburetter to check whether fuel is reaching carburetter.	No fuel reaching carburetter.	Turn Tap to ON, refill tank, clear air vent in filler cap.
	Air lock in petrol pipe.	Turn on reserve tap where fitted.
If no fuel, even when tap is on and fuel is in tank:	Choked petrol pipe, filter on tap, filter in banjo.	Remove and clean out.
	Fuel needle sticking in seating.	Dismantle carburetter and fit new needle.
Test for spark by holding sparking-plug body on cylinder-head.	Leak along insulation of plug or high-tension lead.	Try a new plug of the type recommended and/or new high-tension lead.
If still no spark:	Plug points may be oily or sooted up.	Clean plug or fit new one.
Test for spark at end of high-tension lead held ⅛ inch from cylinder fins.	If no spark at end of high-tension lead, contact-breaker point gap may be too narrow or points pitted, or dirty, or oily.	Adjust point gap to 0·015 inches. Clean.
	Moisture on insulation of condenser box.	Clean and dry out.
	High-tension pick-up not making good contact on ignition coil due to corrosion or misplacement.	Clean and correct.
	Cracked insulation of adjustable contact-breaker point.	Renew.
	Damaged insulating sleeving on wires connecting contact-breaker to coil or condenser.	Replace with new sleeving.
	Faulty connection to low-tension wire of ignition coil.	Correct.
	Faulty condenser.	Replace.
	Faulty ignition coil.	Replace.
If above tests are O.K., but engine will not start.	Mixture may be too rich due to use of strangler, or raising of taper needle when engine is warm, or incorrect setting of taper needle.	Open throttle wide and depress kick-starter several times to clear engine of "Petroil" mixture, adjust taper needle, drain crankcase.
	Air leaks at carburetter stub or manifold joint, causing weak mixture.	Correct.
	Incorrect ignition timing due to flywheel having slipped on driving-shaft taper.	Check, following instructions given for respective type of engine.
ENGINE FOUR OR EIGHT STROKES. Strangler may not be fully open or taper needle control in the "RICH" position. Air filter where fitted may need cleaning.	Mixture too rich.	Lower taper needle by moving to "WEAK" position. Lower needle by adjuster where fitted in throttle.
Check by watching for excessive smoke from exhaust pipe or silencers.	Engine may four stroke for a little while after standing due to accumulation of oil in crankcase.	Usually ceases when engine has been running for a few minutes unless too much oil has been mixed with the petrol.
	Flooding of carburetter.	Persistent flooding is usually due to dirt under fuel-needle seating, or sticking fuel needle, or damaged seating or punctured float.
ENGINE LACKS POWER.	Engine out of tune, bearings worn.	Overhaul.
	Unsuitable sparking-plug.	Replace with recommended type.
	Loss of compression.	Tighten cylinder-head bolts. Worn piston-rings.
	Incorrect "Petroil" mixture.	Correct mixture is 1 part oil–16 parts petrol.
	Excessive carbon deposit on piston crown and cylinder-head.	Decarbonise.

FAULT-FINDING CHART (*continued*)

Sequence of Testing.	Possible Trouble.	Remedy.
	Ex haust system choked with carbon.	Clean out silencer and exhaust pipes.
	Incorrect carburetter setting.	Check with Setting Chart.
	Air-cleaner choked.	Wash in petrol, drain and dip in thin oil.
	Obstruction in fuel supply.	Clean out tap, fuel pipe and filters.
	Incorrect ignition timing.	Check against Timing Chart.
	Brakes binding.	Adjust.
	Driving chains too tight.	Adjust.
ENGINE WILL NOT RUN SLOWLY.	Weak mixture due to air leaks at carburetter stub or manifold joint, crankcase and cylinder base joints.	Tighten all joints.
	Crankcase drain screw loose or missing.	Tighten or replace.
	Worn crankshaft bearings or leaking compression gland.	Replace.
	Ignition timing too far advanced.	Correct.
ENGINE SUDDENLY STOPS FIRING.	Sparking-plug lead detached.	Replace and tighten nut.
	Plug points bridged by oil, carbon, or deposit caused by use of leaded petrol.	Clean or replace.
	Short circuit of high-tension current by water on high-tension lead.	Dry out.

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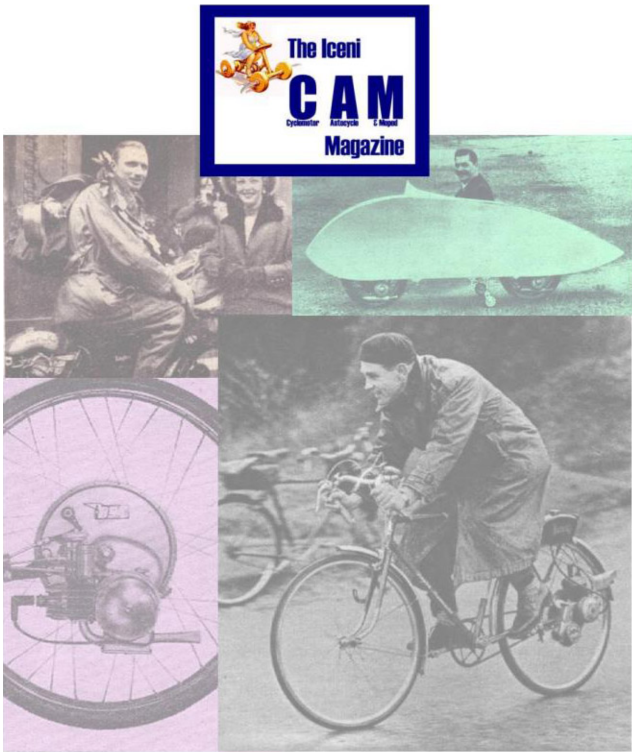

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