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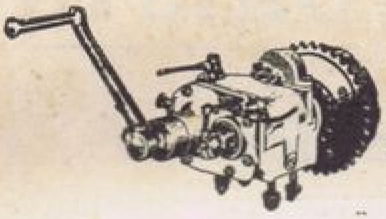

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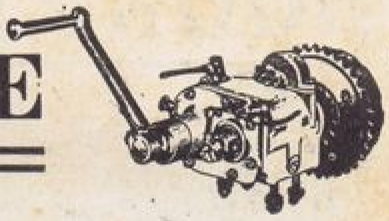

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THE BOOK OF THE P. & M.

A COMPLETE GUIDE FOR OWNERS AND PROSPECTIVE PURCHASERS OF P. & M. MOTOR-CYCLES

BY

W. C. HAYCRAFT

GIVING DETAILED ADVICE ON THE DRIVING, MAINTENANCE, AND OVERHAUL OF P. & M. PANTHERS, WITH CHAPTERS ON LUBRICATION, ENGINE PRINCIPLES, ELECTRIC LIGHTING, AND TROUBLE DIAGNOSIS

FOURTH EDITION

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1931

THE BOOK OF THE P. & M.

CHAPTER I

THE PANTHER MODELS

MESSRS. PHELON & MOORE, Ltd., whose works are at Cleckheaton, Yorkshire, need no introduction to readers. Their offspring, the famous "Panthers," whose rakish lines and inclined cylinders are so pleasing to the eye, have earned for themselves a well-merited reputation for road worthiness and general performance both in this country and abroad.

It is interesting to recall that the first P. & M. motor-cycle was produced about 1900. During the War the whole of the output of the P. & M. factory was taken over by the Government for use in the Air Force. Since the war the P. & M. concern have steadily progressed both in regard to design and in size of output.

THE 1931 "PANTHER" RANGE

Model	C.C.	Bore and Stroke (mm.)	Valves	Lubrication	Ignition	Gear Ratios (Three-speed)	Tyres (ins.)
25	247	67 × 70	—	Auto.	Mag.	16, 8·5, 5	26 × 3
50	498	84 × 90	O.H.V.	Semi-D.S.	Mag.	13, 6·6, 4·5	26 × 3·25
55*	498	84 × 90	O.H.V.	Semi-D.S.	Coil	13, 6·6, 4·5	26 × 3·25
60	598	87 × 100	O.H.V.	Semi-D.S.	Mag.	13, 6·6, 4·5	26 × 3·25
65*	598	87 × 100	O.H.V.	Semi-D.S.	Coil	13, 6·6, 4·5	26 × 3·25
90	490	79 × 100	O.H.V.	Semi-D.S.	Mag.	13, 6·6, 4·5	26 × 3·25
95*	490	79 × 100	O.H.V.	Semi-D.S.	Coil	13, 6·6, 4·5	26 × 3·25

The Two-stroke Model. This year, in order to cater for those riders desiring a high quality, low-priced utility machine, the firm

* These models have standard electrical equipment.

is still marketing the little 247 c.c. Villiers-engined sports model, which, of course, is eligible for the 30s. per annum tax with full electrical equipment. This machine, which has been considerably improved since 1930, costs but £36 15s. fully equipped, and, as with all Villiers-engined models, has an unusually good performance, and a remarkably low fuel consumption, 100 m.p.g. and 55 m.p.h. being within its capacity. It is well worth consideration by the man who wants a light-weight which will stand up to hard use without repair bills. Structurally, it is immensely strong and has many features in common with the larger four-stroke O.H.V. models. Among the improvements recently made to this model may be mentioned the fitting of four-point shock absorber forks; the provision of a central spring-up stand, an adjustable oil-feed to the primary chain; and a modification to the lighting system whereby the lamps are not automatically cut out when the engine ceases running.

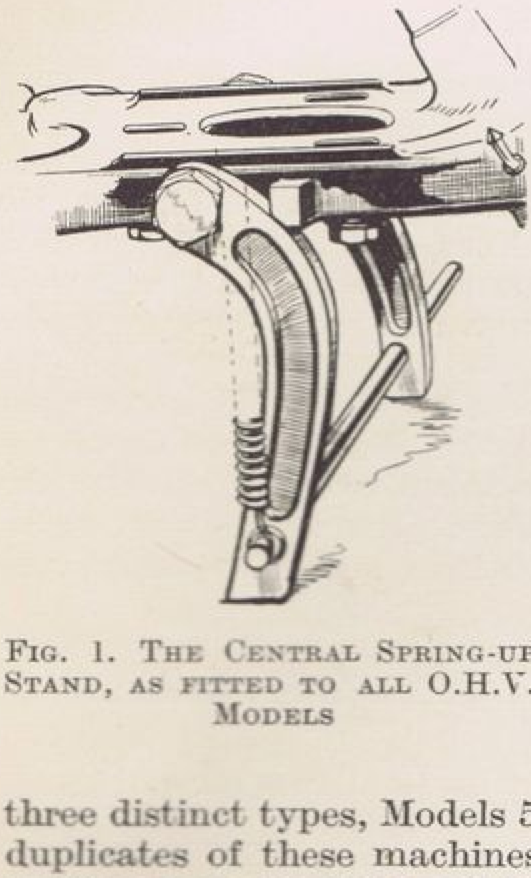


FIG. 1. THE CENTRAL SPRING-UP STAND, AS FITTED TO ALL O.H.V. MODELS

The Four-stroke O.H.V. "Panthers." As may be observed from the table on the previous page, there are six O.H.V. inclined engine models, namely, Models 50, 55, 60, 65, 90, and 95, and their respective prices are £54 15s., £59 6s., £56 5s., £60 16s., £62 10s., and £67 1s. Actually, however, there are really only three distinct types, Models 50, 60, and 90. The other models are duplicates of these machines, with the exception that magneto ignition is replaced by coil ignition and a standard lighting set is provided. Messrs. Phelon & Moore are now adopting coil ignition in common with many other manufacturers, because it does undoubtedly render starting up much easier and more certain. Further, in the case of the "Panthers," the fitting of a coil ignition set does away with the necessity of having a separate dynamo drive housed in an extension of the timing case, for the dynamo replaces the magneto and the contact-breaker is ingeniously mounted in the timing case.

Models 50 and 60 constitute ideal solo, pillion, or sidecar machines. Both possess remarkable stamina and are capable of being driven in a docile manner in traffic, in spite of their terrific acceleration and speed capabilities. "Tick-over" leaves nothing to be desired. The maximum speed of both machines is over

70 m.p.h., and there is a sufficient power reserve to enable most gradients to be zoomed up on top gear when riding solo. In the case of Model 60, the extra 100 c.c. engine capacity produces those few extra "horses" which are so useful to the sidecar tourist, especially in hilly districts, and with a four-speed gear-box this model has a superb performance. Under favourable conditions, 75 m.p.h. can be exceeded when riding solo. Special care has been taken by the designers of all recent "Panthers" to combine a sports performance with good flexibility and mechanical and exhaust silence. Indeed, this year's models are superior in these respects to any previous models, in spite of the fact that, from an engineering point of view, making a compromise of this nature involves great difficulties.

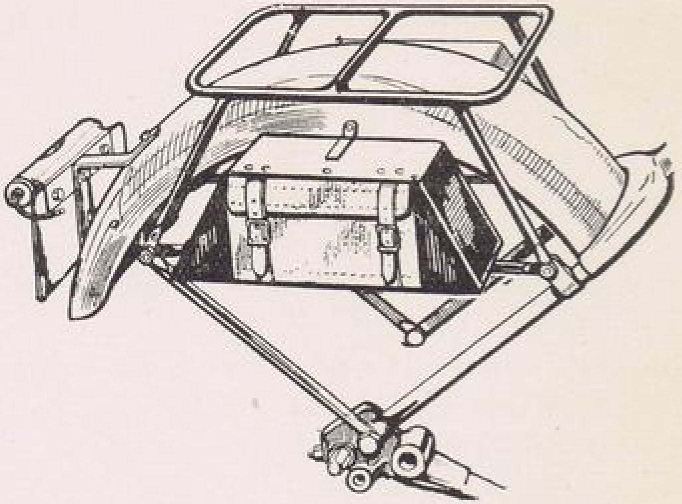


Fig. 2. The Quickly-detachable Carrier, which is an Extra for all Models

Model 90, or the "Redwing 90," by which name it is more usually known, is one of the most interesting of this year's models, for it departs from standard "Panther" practice in several ways, and has a performance altogether remarkable. The "Redwing" has a comfortable cruising speed of 52–58 m.p.h., at which speed it steadily eats up the miles with no fuss whatsoever. Acceleration in top gear is most violent right up to 40 m.p.h., and this to the sports rider means a lot, for the machine can be manœuvred in and out of traffic on main roads with absolute safety, especially having regard to the excellent coupled brakes now provided on all machines. Other excellent features of the "Redwing" are its exceptional hill-climbing abilities (it will ascend main road gradients of about 1 in 10 at 60 m.p.h.), its accessibility, and the ease with which it can be cleaned and kept in something like showroom condition.

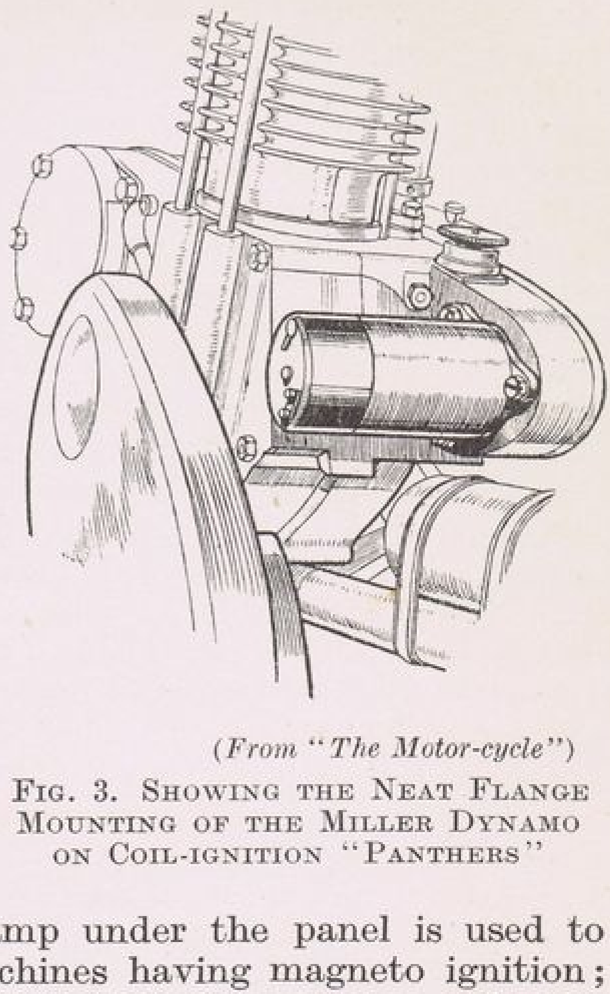
Present Features in Design. All O.H.V. "Panthers" have inclined two-port engines, with adjustable semi-dry sump lubrication and a special feed to the base of the piston and the valve guides. The standard engines are so designed that a complete overhaul can be undertaken without removal from the frame. Decompressors are provided to give easy starting, and an exhaust valve lifter is also fitted. All push-rods are entirely enclosed, and the overhead valve gear is housed in a neat rocker-box, which is directly lubricated from the engine, which has roller bearings for the mainshafts and big-end. The ammeter and switch are carried in a panel lying flush with the top of the petrol tank. A new type of Brampton fork, with four-point shock absorber adjustment, is used together with a powerful cradle frame having a redesigned forged steel head lug. All wheels have journal ball-bearings, and provision is made for a speedometer drive in the front hub and a shock absorber in the rear hub. Spring-up stands located beneath the gear-box are universally adopted. The brakes, which are of the internal expanding type, are interconnected and provided with hand adjustment. An independent handlebar control is used for the front brake. For further details, see the specification of the standard "Panther."

Finish. A chromium-plated finish is now used throughout for the metal parts, and this greatly facilitates cleaning, for chromium only requires the application of a damp cloth, and its lustre gradually increases with cleaning.

Any model can be supplied in the standard colour scheme, that is, with cream rims and light green guards and tank panels, for £1 5s. extra. The combination of these cellulose finishes presents a machine which is neither gaudy nor flashy, yet quietly distinct from any others. Any colour scheme can be supplied to a customer's requirements for a slight extra charge. The standard finish in enamel is black, with a double shade of green for the tank panels, and in all finishes the instrument panel in the tank is finished black with a gold line.

Deferred Payments. To meet those who prefer not to pay cash down the full amount for a "Panther," Messrs. Phelon & Moore have introduced a hire-purchase system whereby it is possible to obtain delivery of any "Panther" model on paying a small deposit (£13–£16). The balance is payable in twelve monthly instalments. It should be noted that the initial deposit does not cover the cost of an insurance policy.

Standard Electrical Equipment. This equipment, which is provided on all coil-ignition "Panthers" (unless *de luxe* equipment be specified instead), can be fitted to any "Panther" with magneto ignition for an extra six guineas. It is a Miller S.U.S. system, comprising a 6-volt, type DM3G Miller dynamo (driven in the case of coil-ignition machines by gearing at $1\frac{1}{3}$ engine speed direct off the rotary pump pinion in the timing case, and by a silent duplex roller chain and sprockets (see Fig. 14) off the magneto driving spindle at about the same speed on magneto-ignition machines); an Exide accumulator mounted behind the rear down tube; a 7-in. diameter Miller headlamp, with "Diplite" bulb controlled by a switch built integral with the handlebars, and a parking bulb; a special Miller tail-lamp, which can be used as an inspection lamp; a handsome chromium-plated, high-frequency clear-hooters electric horn mounted on the front mudguard, with a built-in control switch on the right-hand side of the handlebars; a lighting and ignition switch and charge-discharge ammeter mounted on the tank panel, together with a "tell-tale" warning lamp, which is wired into the contact-breaker circuit on coil-ignition models, so that if the engine is allowed to stop without switching off the ignition, and the contact points happen to be closed, then the light glows brightly under a red glass, thus warning the driver of a heavy discharge taking place. Should the engine stop with the ignition on and the contact-breaker points open, then no warning light will appear, as obviously there is no discharge of primary current. In order to standardize the panels on all types of machines, that is, with coil or magneto ignition, the warning light is retained even where a magneto is fitted; and in order to provide a useful outlet for the light of the warning lamp, this is wired in series with the tail-lamp of the machine. It follows that if the warning lamp is out, so is the tail-lamp, and an investigation can be immediately made. After dark the light from the warning lamp under the panel is used to illuminate the ammeter on machines having magneto ignition; whilst on coil machines, the fact that the light diminishes in strength as the charge increases is sufficient to denote whether charge is taking place or otherwise.



(From "The Motor-cycle")

FIG. 3. SHOWING THE NEAT FLANGE MOUNTING OF THE MILLER DYNAMO ON COIL-IGNITION "PANTHERS"

De Luxe Electrical Equipment. For the sum of £8 and £1 14s. complete *de luxe* electrical equipment may be specified for magneto and coil-ignition "Panthers" respectively. *De luxe* equipment includes three highly commendable features: the P. & M. patented twin headlamps, the neat instrument panel which is placed above the headlamps and actually forms a bracket for the lamps, and a "stop" light brought into action by the rear brake rod. Two 6-in. diameter Miller headlamps are mounted side by side, the fixing screws which pass through the instrument panel being set almost vertically, as may be seen at Fig. 4. The nearside head-lamp can be swivelled to the left by means of the twist-grip on the left side of the handlebars, and in swivelling it automatically cuts out the other lamp, so that the rider is in a position when meeting oncoming traffic not only to avoid causing dazzle but to project a powerful beam of light close to the kerb. With both lamps in the normal position and the tank panel switch in the *H* position, the road ahead is thrown into a blaze of light, and it is possible to proceed at speed to which one is accustomed by day. The P. & M. twin lamps are indeed a blessing to the night rider and marks an epoch in motor-cycle design. The tail-lamp, switch panel, generator, and battery are the same as those used with the

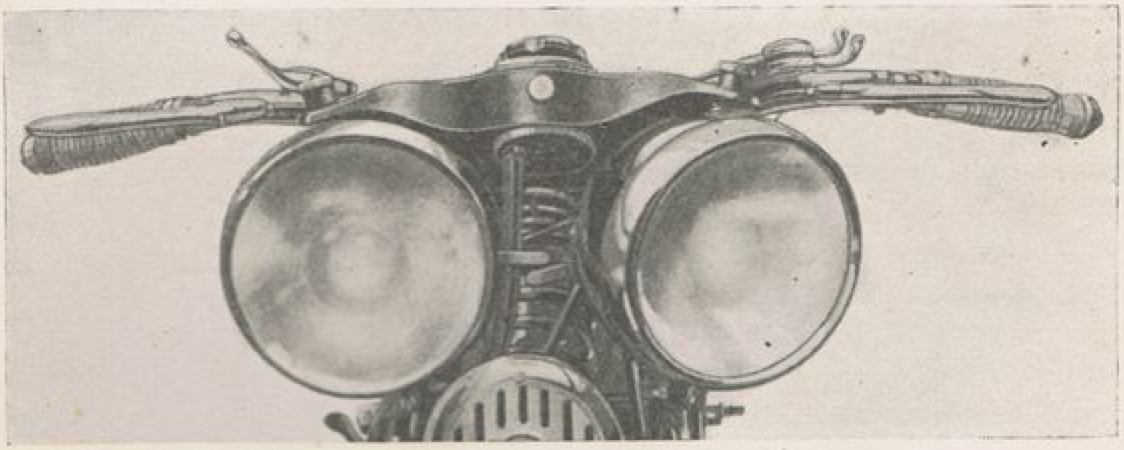
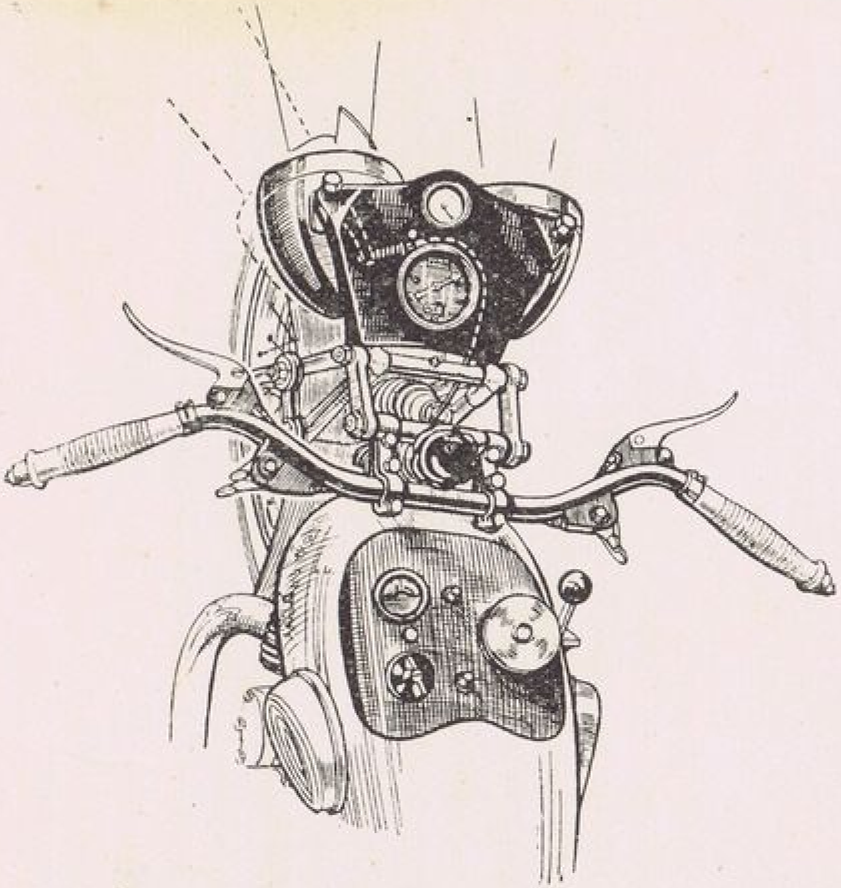


FIG. 4. FRONT VIEW OF TWIN HEADLAMPS

Note their imposing appearance. The nearside lamp is shown swivelled and dipped, in which position the offside lamp is automatically switched off

standard electrical equipment. Fig. 6 shows the "stop" light, which is ingeniously operated by the rear brake, and also serves to illuminate the identification numbers. (For further details of the Miller electrical equipment, see Chapter V.)

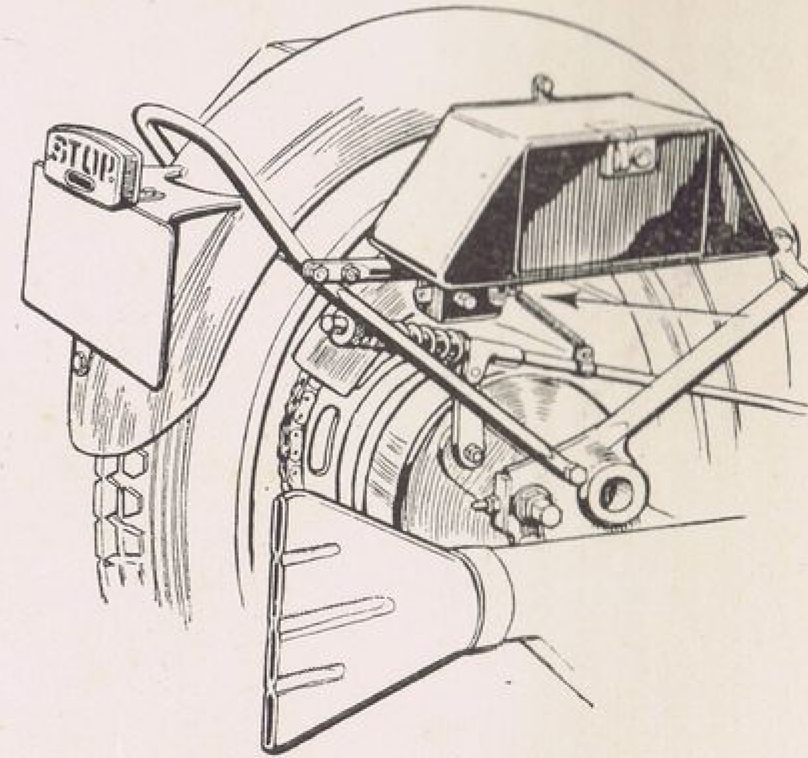
The Instrument Panel. This is, of course, an integral part of the twin-lamp mounting, and is to be found on all *de luxe* models. It is designed to house two things—a Smith chronometric speedometer and a Smith eight-day clock. These are extras, and can be specified for £2 5s. and £1 10s. respectively. The speedometer has an 80 m.p.h. dial and the needle is rock steady at all speeds. The drive is not taken from the gear-box, but from the front wheel. The disadvantages usually associated with this type of drive have been overcome by adopting an internal hub drive, as shown at Fig. 6A. The front hub contains the gear wheel, which drives the speedometer cable through the medium of the worm and wheel gear-box fitted to the brake anchor plate. This gear wheel is permanently screwed on to the hub shell, and, being inside the drum, is absolutely weatherproof, and free from mud and dust. Also the flexible drive has no bends in it at all, which makes for



(*From "The Motor-cycle"*)

Fig. 5. Plan View Showing Lamps, and Tank and Instrument Panels

To obviate dazzle, the left-hand lamp is moved by the left twist-grip into the position shown dotted

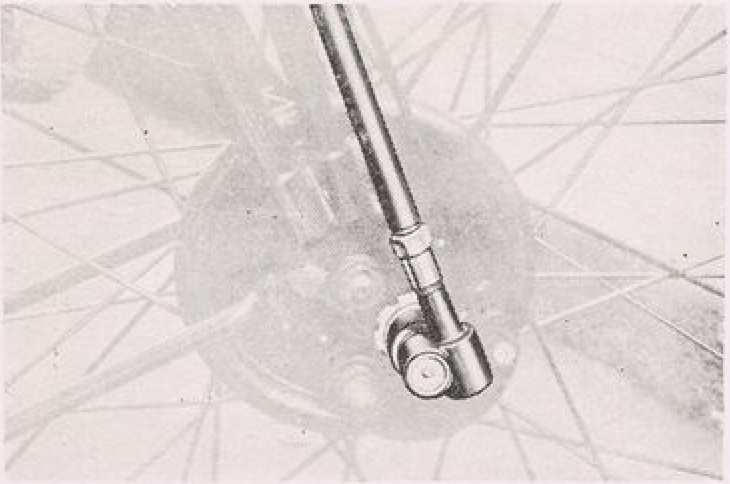


(*From "The Motor-cycle"*)

Fig. 6. The "Stop" Light Controlled by the Rear Brake Rod

higher efficiency and longer life. The drive can be readily detached.

Gear-boxes. It should be noted that foot control of the three-speed Sturmey-Archer gear-boxes can be had, instead of the standard gate-change control on the tank, for 15s. extra. The principle of the change must be thoroughly grasped before its advantages become apparent. Primarily, the gear can be changed without removing the hand from the handlebar, and by a uniform movement of the foot the different gears can be progressively changed at will. The gear lever always returns to one position, so that a downward movement means that the gear is changed



(S. Smith & Sons, Ltd.)

FIG. 6A. THE ENCLOSED FRONT HUB DRIVE FOR THE SMITH SPEEDOMETER

to the next ratio up, and an upward movement of the lever means that the gear is moved to the next ratio down. Because the right foot is in use whilst gear-changing, the brake pedal is placed on the left-hand side of the machine. It should also be noted that on any model for the sum of £3 a four-speed P. & M. gear-box, giving ratios of 12, 8, 5·4, and 4·5 to 1, can be specified. Multi-spring clutches are used throughout.

Miscellaneous Accessories. The following extras can be fitted to "Panthers," if desired, at the prices given below. These prices, however (and all prices mentioned in this handbook), are subject to revision by Messrs. Phelon & Moore without notice—

	£	s.	d.
Comprehensive insurance	6	10	–
Licence-holder		1	3
Carrier (see Fig. 2)		15	–
"Panther" mascot (natural colours)		7	6
"Panther" mascot (silver-plated)		9	6
Moseley or Lycett pillion cushion (green) . . .		16	6
Twist-grip ignition		7	6

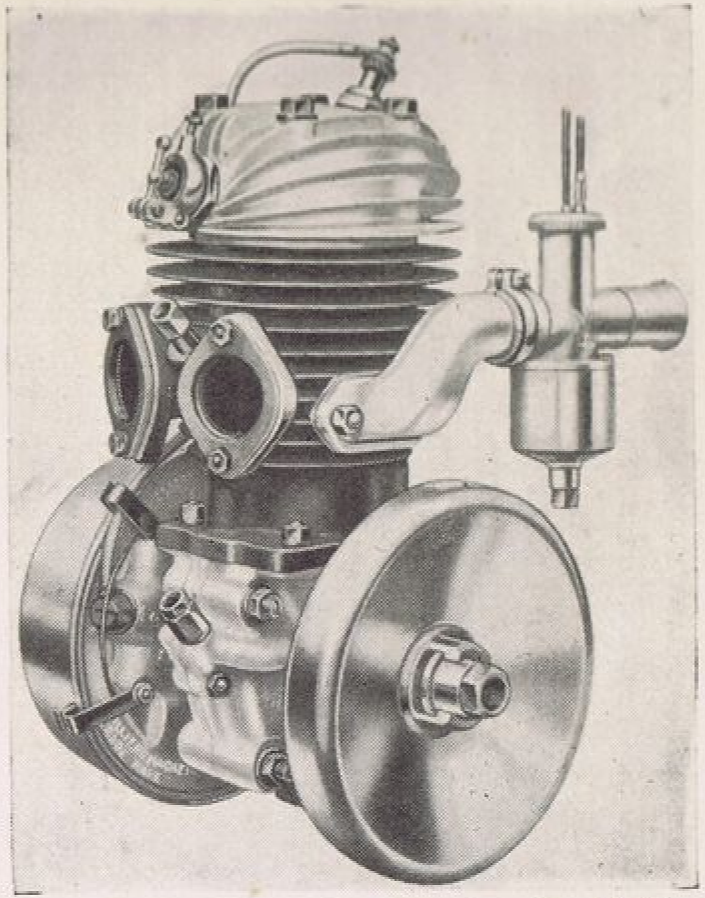
MODEL 25

The specification of this little lightweight "Panther," which is pre-eminently suitable for the town and business rider, is as follows—

The 2·47 h.p. Two-stroke Engine. This is a Villiers power unit known as the Mark XA, and it is provided with an aluminium alloy cylinder head and piston. It is a development of the Mark VIIIA engine, which had a cast-iron cylinder and piston. The bore and stroke are 67 mm. × 70 mm., giving a cubic capacity of 247 c.c. Decarbonization is, of course, with the detachable head, a simple matter. The engine (see Fig. 7) follows usual Villiers practice. The very neat cylinder head, to which is fixed at the front the handlebar-operated, pressure-release valve, is bolted direct to the cylinder barrel. No gasket is used. Removal of the head only entails undoing the four long retaining bolts, when the head can be lifted clear. The cylinder barrel has at the front two large diverging exhaust ports, to which are attached by a flange fitting the two chromium-plated exhaust pipes, which lead to a pair of P. & M. silencers, standard except that the exhaust pipe is blind-ended and drilled. Adequate silence is thus assured. The two-ring piston is attached to the steel connecting rod by a fully-floating gudgeon pin with soft metal end caps. It should be noted that the Mark XA engine has, in addition to the two ordinary piston rings, a special inertia ring placed immediately above the upper ring, but not kept in contact with the cylinder walls. The object of this inertia ring, which is free to rotate and has a slight amount of up-and-down movement, is to prevent the accumulation and subsequent carbonization of oil above the upper ring, a process which eventually fixes the rings solid in their grooves. A phosphor-bronze bush is used for the small-end bearing, and rollers are provided for the big-end bearing. The crankshaft assembly is the keynote of simplicity. As may be seen by Fig. 8, it consists of two large bob weights joined together by a large diameter crankpin, and with two heavy mainshafts fixed to their centres. These mainshafts run in long phosphor-bronze bearings pressed into the crankcase. Two external flywheels are used, one on each side of the engine. This makes for an exceptionally smooth torque and damps out any tendency for vibration. The offside flywheel also constitutes the magneto, which generates the current for both ignition and lighting purposes. (For further notes on the Villiers engine, see Messrs. Pitman's *Book of the Villiers Engine.*)

Lubricating oil recommended, Castrol XL.

Sparking plugs recommended, A.C. Sphinx-S.2, K.L.G.K.1, or Lodge H.1.



(The Villiers Engineering Co., Ltd.)

Fig. 7. The 2·47 h.p. Villiers Two-stroke Engine (MXA)

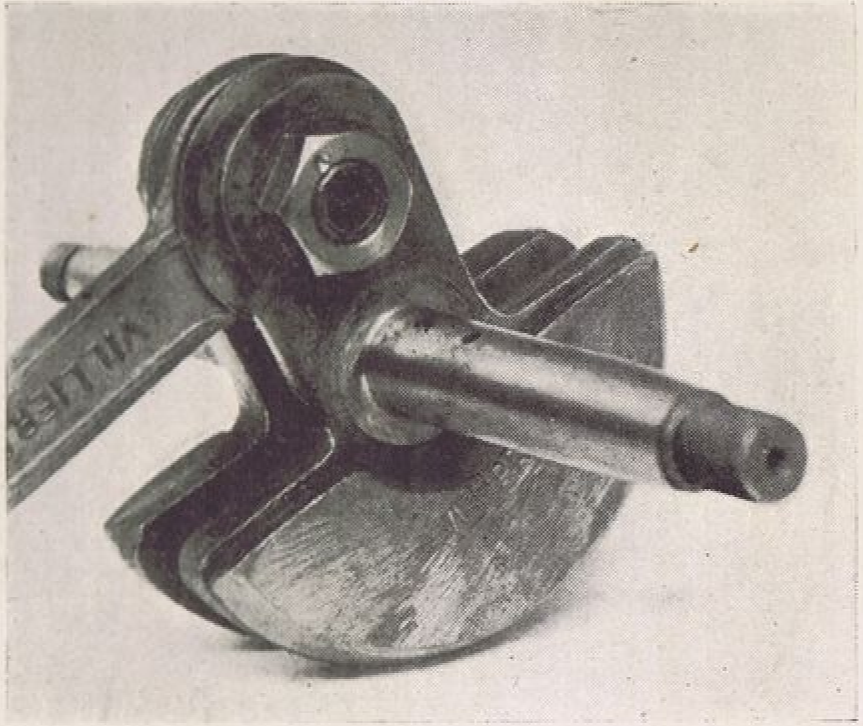


Fig. 8. The Villiers Crankshaft Assembly

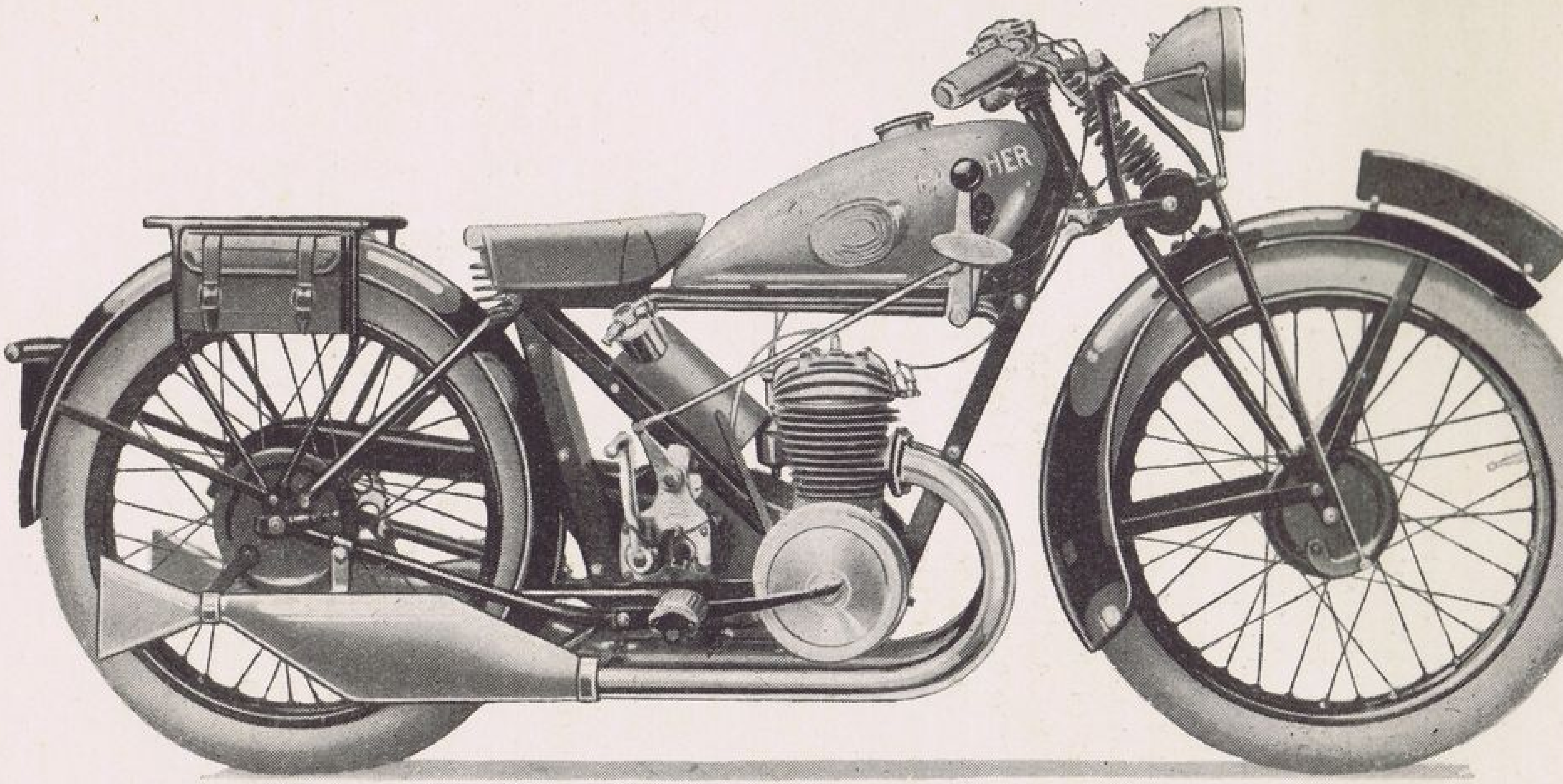


FIG. 9. MODEL 25—THE 2·47 H.P. VILLIERS "PANTHER"
This is the only two-stroke P. & M. machine now manufactured

Lubrication. This is effected by means of the Villiers patented automatic system. A mechanical pump delivers oil in proportion to the engine speed, but this system delivers oil roughly in proportion to the load on the engine. Variations in the crankcase pressure are utilized to supply oil direct to each bearing, and the crankcase pressure does, of course, vary according to the throttle opening. The automatic lubricator with sight feed, used in conjunction with the separate oil tank, is a Mark II pattern, and has a larger vent hole than on previous models. There is also a piece of loose wire in the vent, which serves to prevent the hole becoming stopped up, a matter of great importance, as is the maintenance of gas-light crankcase joints. With the engine in proper tune, the oil consumption should be 1,800 to 2,000 m.p.g.

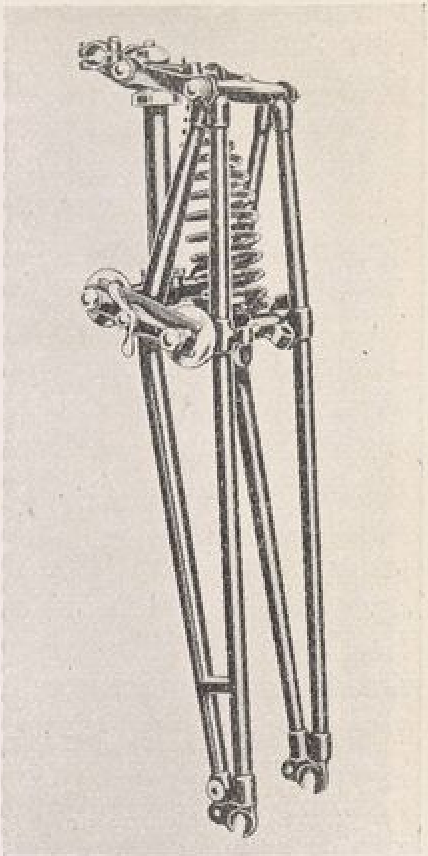
Carburettor. This is a variable jet Villiers instrument with twist-grip throttle control, and gives a petrol consumption under average conditions of 80 to 100 m.p.g. It has a compensating action which automatically regulates the strength of the mixture to suit varying engine conditions. The jet cannot become choked because the taper needle keeps it free from obstructions. It is clipped on the near side to the detachable flange-fitting induction pipe. A Villiers air-cleaner attached to the air intake of the carburettor filters all air passing through, and ejects dust and grit by means of a special aperture provided for that purpose, and so prevents clogged oilways and scoring of the cylinder.

Ignition. An intense spark is provided at all speeds by the Villiers flywheel magneto, the only rotating part of which is the flywheel itself, in which are the pole-shoes and magnets. All other parts remain stationary, and, therefore, no carbon brush, slip-ring, or other delicate bearings are required. The ignition may be advanced or retarded by means of a hand-lever mounted at the back of the magneto. This, however, does not, as in the case of an ordinary magneto, affect the spark intensity at all. An aluminium cover encases the magneto, and to inspect the contact-breaker this must first be removed.

Lighting Set. A 6-in. diameter Villiers headlamp, complete with switch and a small rear-lamp, are illuminated by means of the lighting coils in the flywheel magneto, which, of course, produces alternating current. No rectifier is necessary on this direct lighting set, owing to the absence of an accumulator. With a direct lighting set, the lamps receive current only so long as the engine is running; and since it is an offence to leave a machine unattended and without lights by night, it has been decided on this year's two-stroke "Panther" to augment the direct lighting system by a separate parking circuit, fed from a dry battery. The current consumption of the parking lamps is extremely low and the life of the "parking battery" is reasonably long. The parking switch is embodied in the headlamp, and should trouble occur, it is useful to remember that the headlamp and parking circuits are entirely independent of each other, and have two separate sources of energy supply.

Frame and Forks. The main frame member comprises a forged steel backbone embodying the steering head, tank rail, and saddle fixing. The sub-frame, which carries the engine, gear-box, and back forks, is built up of high grade $1\frac{1}{8}$ in. $\times \frac{1}{4}$ in. steel strip, and is constructed so as to provide a cradle having exceptional strength and absolute lateral rigidity. This type of frame was originally designed in 1927 for the lightweight "Panther," and reports on its behaviour have more than justified its retention on present lightweight models. One of its principal merits is that it obviates the necessity for lugs and brazed joints.

The front forks, as on previous models, are of Brampton manufacture (see Fig. 10). They are of the triangular girder pattern, built of round section tapered tubes, with a single centrally-placed compression spring. Grease-gun nipples are provided for the spindles, which are adjustable for end play. The two lower spindles have at their extremities four-point shock absorbers, with a single wing nut on the offside for adjustment. This is a most excellent feature, and greatly enhances the stability and riding comfort of the machine when travelling over bad road surfaces. The recoil of the forks on the front wheel meeting with resistance is allowed to take place slowly. It is highly important if the best results are to be obtained to keep the shock absorbers correctly adjusted (see p. 115).



(Brampton Bros., Ltd.)

FIG. 10. THE NEW BRAMPTON FORKS WITH FOUR-POINT SHOCK ABSORBERS

Tanks. A handsome bulbous-nosed petrol tank, finished in the standard "Panther" colours and constructed of pressed steel, is bolted to the main frame member, and has a capacity of $2\frac{1}{2}$ gal., which is sufficient for 200–250 miles. Two neat rubber knee-grips are fixed on either side. A separate oil tank, complete with the Villiers automatic lubricator (which has no moving parts), is mounted parallel to the rear sub-frame members, and holds 3 pt. of oil.

Gear-box and Clutch. The three-speed gear-box used is a slightly modified F.W. (featherweight) type, constant mesh Sturmey-Archer, specially designed for engines up to 250 c.c. The gear-lever positions—front to rear—are: 1st, N, 2nd, 3rd; and control is by a neat elliptical quadrant fixed at the front of the petrol tank, with the adjustable connecting rod running diagonally at about 45 degrees to the gear-box striker lever. The gear-box is mounted on a pressed steel platform, adjustment of the primary chain being made by sliding the box in the required direction, after slackening off the retaining bolts. Continuous alignment is governed by a single spigot on the base of the box registering with a slot punched in the mounting bracket. Securing the gear-box in position are two bolts, accessible from underneath by means of the box key provided in the tool kit. The gear-box, which is specially made by the Sturmey-Archer Co., used in conjunction with standard sprockets, provides a top gear ratio of 5 to 1, a second of 8½, and a bottom gear of 16 to 1; and, if properly lubricated with one of the following lubricants—Wakefield's "Castrolease Light," Speedwell "Crimsangere Light," or Mobilgrease—is very dependable. The gear-box is a constant mesh, countershaft gear, having a totally enclosed kick-starter mechanism, and three pairs of pinions only are used. The low gear wheel on the layshaft includes a "free-wheel" ratchet operated by a pawl on the kick-starter, which has a steel shaft, having as its bearing the layshaft axle bush. When the kick-starter return spring brings the crank back to its normal vertical position, a projection on the pawl engages with a fixed cam in the gear-box cover, and positively depresses the pawl out of action. All gear changes are effected by dogs and two sliding pinions simultaneously moved by a striker plate at the end of a horizontal rack, which receives lateral movement from a rocking segment.

The clutch used in conjunction with the gear-box is a three-plate multi-spring Sturmey-Archer, with cork inserts and the usual plunger type control.

Transmission. Both secondary and primary transmission are by Coventry "Ultimate" roller chains, measuring ½ in. × ·205 in. The primary chain case is unique in that it contains an integral oil reservoir for chain lubrication. Ordinary engine oil is filled into the chamber through the cap provided, the actual oil feed to the chain being brought about by a bundle of wicks, which carry the lubricant in the necessary quantity to the chain. The wicks are easily renewed should they become clogged or dirty, three pipe cleaners forming excellent substitutes for wire-centred wicks. Rear chain adjustment is provided for by thumbscrews in the rear fork ends, and it is highly important always to keep the rear wheel properly aligned.

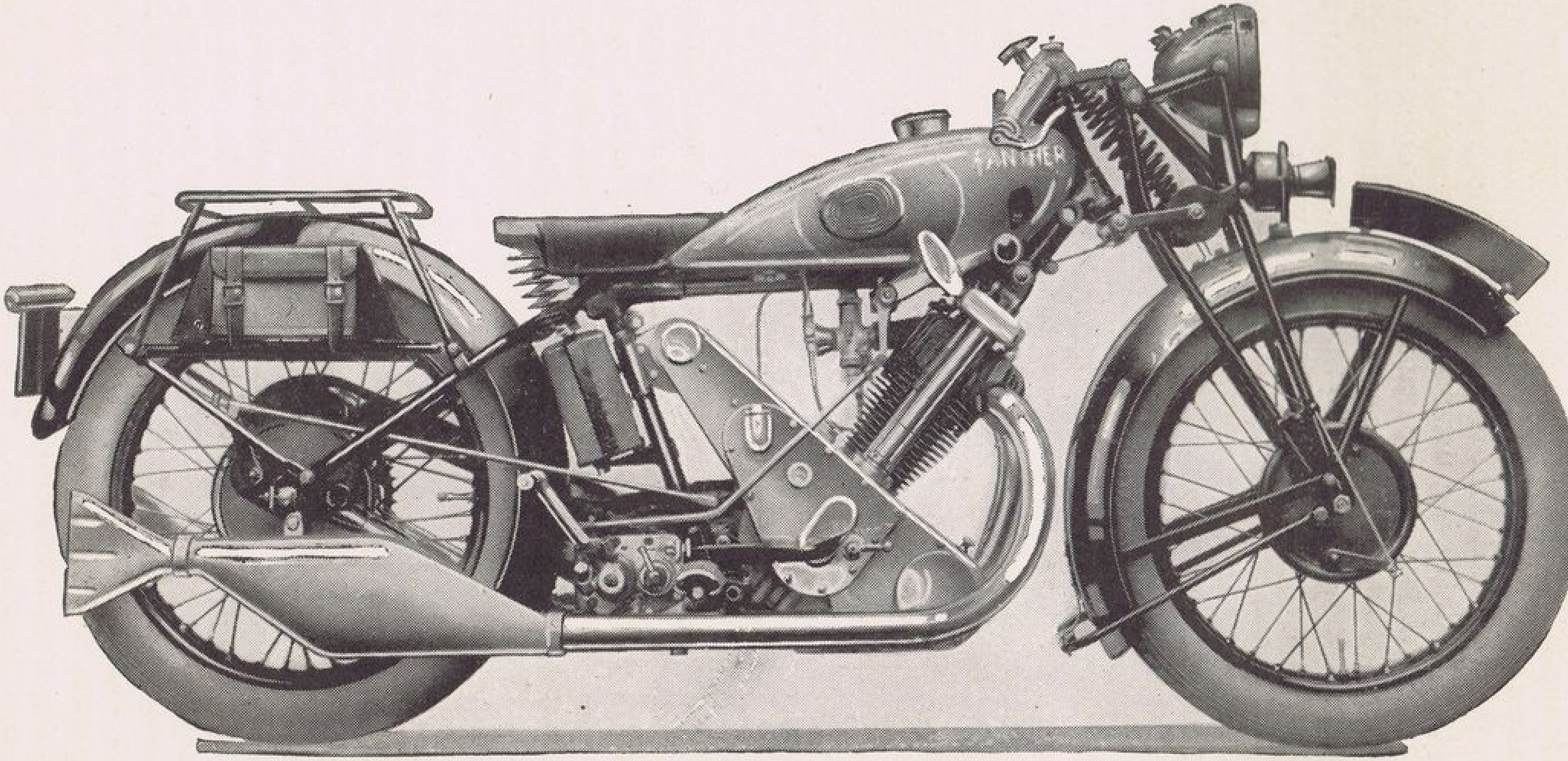


FIG. 11. THE 498 AND 598 C.C. 1930 O.H.V. "PANTHER," MODELS 50 AND 60

By comparing this illustration with Fig. 12, which shows a 1931 Model 55 or 65 "Panther," some of the principal improvements may at once be noted. In general design, the "Panther" remains unaltered

Brakes, Wheels, and Tyres. The wheels, which have ball journal bearings that do not require adjustment, are provided with internal expanding brakes. The diameters of the front and rear drums are 5 in. and 6 in. respectively. Both brakes are independent, a foot pedal being used to operate the rear brake and a handlebar inverted lever to operate the front one. Either brake can be quickly adjusted by means of conveniently placed thumbscrews. Dunlop low-pressure 26 in. × 3 in. tyres are fitted as standard, and are of the wired-on pattern with Schrader valves. Correct inflation pressures for front rear tyres are 18 lb. per sq. in. and 21 lb. per sq. in. respectively.

Miscellaneous Equipment. The specification includes semi-sports handlebars of pleasing contour, and adjustable for both height and angle; a Lycett "Aero" or Terry *de luxe* saddle bolted direct to the frame; a pair of fully adjustable footrests with large rubber pads; a central spring-up tubular stand brought into action with the greatest ease, without the necessity for handling it; a steering damper with frame anchorage; a fully-valanced front mudguard; two metal pannier tool boxes, with a complete set of tools; and a bulb horn, licence-holder, number plates, grease-gun, and tyre inflator.

Weight . . . 220 lb. Tax . . 30s. per annum

MODELS 50, 55, 60, 65

A description of the standard "Panther" specification covers all four of the above models, for Models 50 and 60 are identical except as regards the engine bore and stroke and also the compression ratios. In the case of Models 55 and 65, the specification differs from that of Models 50 and 60 in that coil ignition is provided, and also standard Miller S.U.S. lighting equipment. The "Panther" specification is as follows—

Standard "Panther" Engine. This is an orthodox inclined overhead valve power unit, with detachable two-port cylinder head. In the case of the Model 50 engine, the bore and stroke are 84 mm. × 90 mm., giving a cubic capacity of 498 c.c. The compression ratio is 5·4 to 1. In the case of Model 60, the bore and stroke are 87 mm. × 100 mm., giving a capacity of 598 c.c. In this engine the compression ratio is 6 to 1. In both cases the compression ratio is sufficiently low to allow of running either on No. 1 petrol or benzole mixture without any undue pinking.

Excellent features of the "Panther" engine are its extreme accessibility and the fact that it is possible to strip the engine almost entirely without removing it from the frame. The general design and construction of the engine may be gathered by reference to Fig. 13 and 14. The crankcase is of somewhat peculiar shape in order to house the semi-dry sump lubrication system, which is entirely contained by the engine, and to allow of the

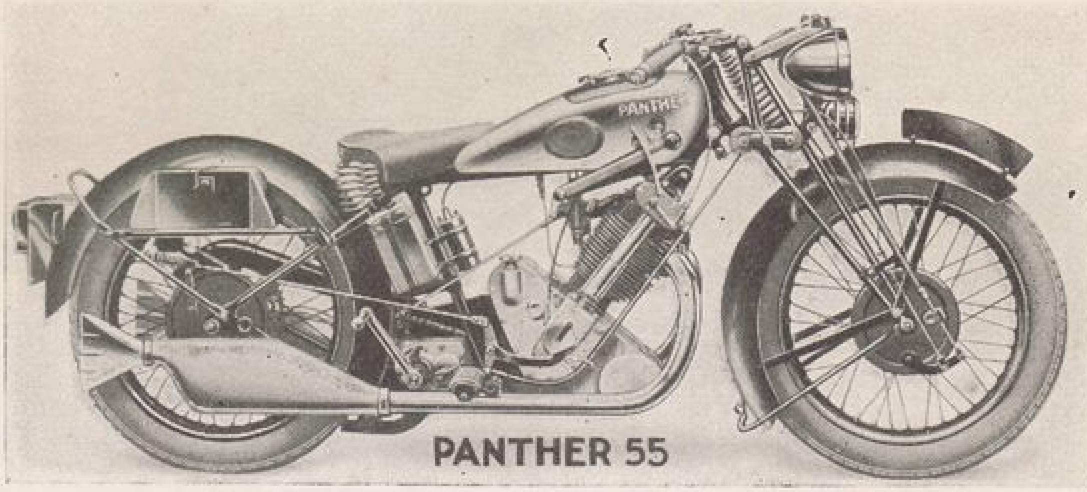


Fig. 12. The 498 and 598 c.c. 1931 O.H.V. "Panther," Models 55 and 65, with de luxe Electrical Equipment

These two models are identical except in regard to engine capacities and compression ratios. In the case of Models 50 and 60, magneto and not coil ignition is used, and this necessitates an additional chain drive for the Miller dynamo. (See Fig. 14)

engine being neatly and firmly installed in the frame. It is a two-piece aluminium casting split vertically in the usual manner.

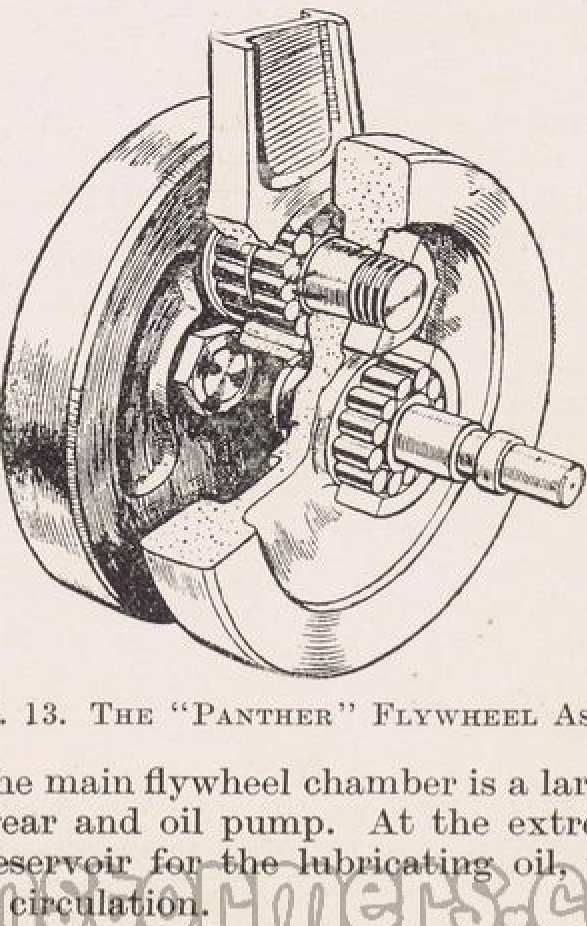


Fig. 13. The "Panther" Flywheel Assembly

To the right of the main flywheel chamber is a large compartment for the timing gear and oil pump. At the extreme front is the sump, a large reservoir for the lubricating oil, which is always kept in constant circulation.

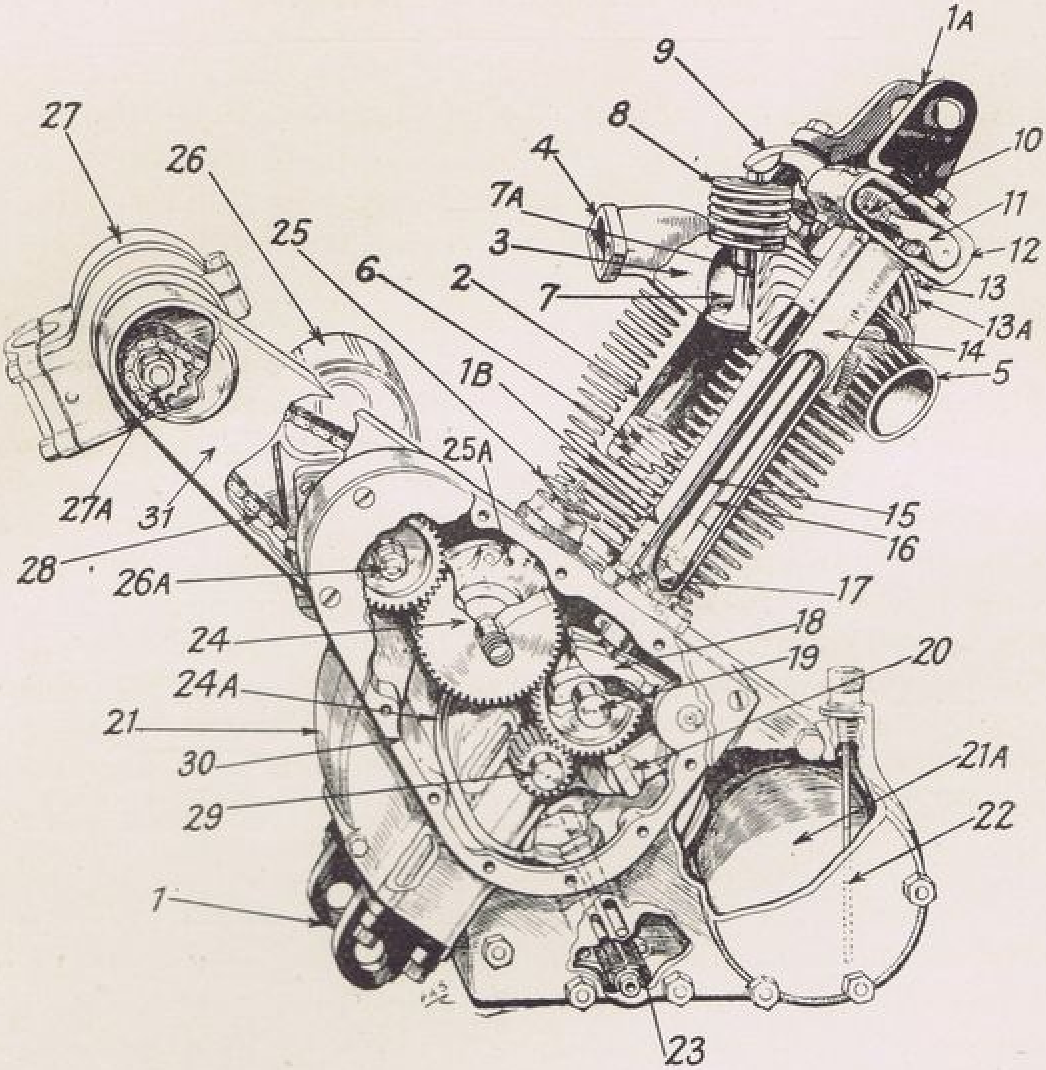


FIG. 14. CUT-AWAY VIEW OF STANDARD O.H.V. "PANTHER" ENGINE

Where coil ignition is fitted (see Fig. 18), the dynamo is fitted in place of the magneto, thus dispensing with the chain drive, and the contact-breaker is driven off the camshaft. (See also Fig. 40)

KEY TO FIG. 14

1. Lower fixing brackets
1A. Upper fixing brackets
1B. Engine-mounting rod (one of four)
2. Cylinder barrel
3. Cylinder head
4. Induction pipe
5. Right exhaust port
6. Piston
7. Inlet valve
7A. Inlet valve guide
8. Inlet valve spring
9. Inlet valve rocker
10. Inner inlet rocker arm
11. Inner exhaust rocker arm
12. Rocker-box (see Fig. 16)
13. Exhaust valve
13A. Exhaust valve spring
14. Telescopic push-rod cover
15. Inlet push-rod
16. Exhaust push-rod
17. Tappets
18. Cam levers
19. Integral camwheel and camshaft
20. Decompressor
21. Crankcase
21A. Oil reservoir
22. Dip-stick
23. Filter
24. Intermediate wheel and oil pump (see Fig. 47)
24A. Suction pipe
25. Pump regulator
25A. Auxiliary oil port
26. Magneto
26A. Magneto driving pinion
27. Dynamo
27A. Dynamo sprocket
28. Duplex roller chain
29. Engine pinion
30. Timing-case cover
31. Dynamo chain case

The flywheel assembly comprises two extra heavy-rimmed flywheels joined together by a large diameter crankpin, with a wide double-row roller bearing for the big end of the connecting rod. The flywheel mainshafts both have single-row roller bearings, but the elongated timing-side mainshaft has also a ball bearing in the timing case.

Under no circumstances should the private owner part the flywheels, for this operation is best performed by Messrs. Phelon & Moore, Ltd., who have special tools and jigs to ensure perfect realignment, which is essential to smooth running. The connecting rod is an *H* section, high tensile steel casting, with a phosphor-bronze bush pressed into the small-end for the fully-floating, hollow gudgeon pin, which measures no less than $\frac{7}{8}$ in. across its diameter. Needless to say, a gudgeon pin of these dimensions has a very long life, and small-end bearing trouble develops only after many thousands of miles, if the engine is properly lubricated. The same remark applies also in respect of the big-end and mainshaft bearings, which are of very robust design. This year it has been decided, in order to further reduce the intensity of the side thrusts of the piston on the cylinder walls, and to eliminate as far as possible any tendency for piston slap, to reduce the firing angle slightly by increasing to the extent of $\frac{1}{2}$ in. the effective length of the cylinder barrel and piston. The overall length of the power unit is incidentally increased by this amount. The increased bearing surfaces are conducive to greater silence and longer life. It should be mentioned that on all "Panther" engines manufactured between 1927 and 1930 non-floating gudgeon pins were used, the pins being clamped to the connecting rod small-ends by clinch bolts. The fully-floating gudgeon pins used on all present engines are prevented from scoring the cylinder walls by means of two spring circlips, placed one on each side of the piston boss. The pins are a light push fit in the piston boss and a free working fit in the connecting-rod bushes.

The piston itself is of aluminium alloy ribbed on the inside, and with a flat crown. It has two compression rings at the top, but no longer a scraper ring at the base of the lengthened skirt, which now plays a prominent part in the new piston-spread lubrication (described later). The piston skirt is specially designed to allow for the considerable expansion which occurs with aluminium, and is split at the sides under the bottom ring grooves. The gap at the piston ring slots should be with correctly-fitting piston rings ·006 in. to ·008 in.

The cylinder barrel, which on this year's models has been lengthened $\frac{1}{2}$ in., has no less than fifteen cooling fins decreasing in width as they approach the base, so as to ensure the engine running at its optimum working temperature and to prevent distortion occurring. The barrel is spigoted top and bottom, and between the base flange and the crankcase a special oil-retaining washer is fitted. This washer has an excrescence at one side, which fits behind the tappet guides, and on this excrescence a slot is cut which *must* register with, and indeed form a vital communication between, the oilway leading from the crankcase and the oilway passing up the cylinder barrel to a point from which oil is conveniently "spread" by the piston skirt. The actual method of retaining the cylinder to the crankcase is one of the unique P. & M. features. Instead of there being the more usual four-stud and nut fixing, four long rods, with hexagon heads at their bases, pass right through the engine, two on the driving and two on the timing side, and serve not only to anchor the engine

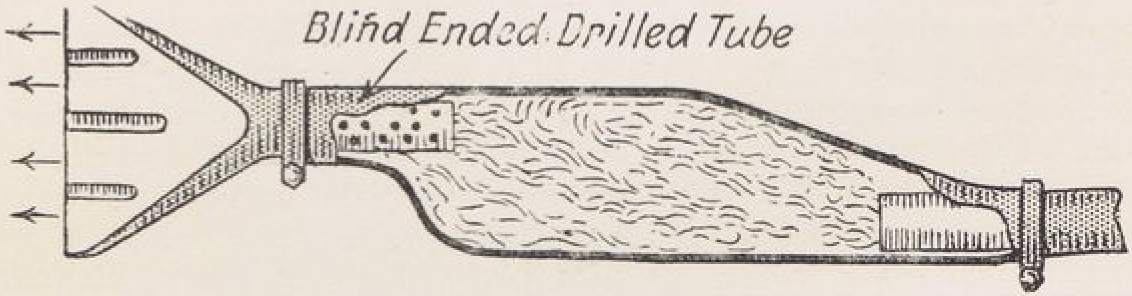


Fig. 15. Standard P. & M. Silencer

in the frame (*B*, Fig. 19) and form a cradle which is part of the frame design, but also to retain the cylinder barrel to the crankcase, the cylinder head to the cylinder barrel, and the rocker-box to the cylinder head (four studs and nuts also retain the rocker-box). It will thus be seen (see Fig. 62) that removal of the four upper rod nuts allows of all these parts being consecutively removed. Removal is further facilitated by the inclination of the power unit (and, of course, the rods) at 49 degrees in the frame.

The cast-iron cylinder head has a ground face, and seats on the cylinder barrel without the interposition of a gasket (fitted prior to 1926). Special packing pieces to enable the rocker-box to seat properly are now cast integral. The formation of the cylinder head interior is such as to provide excellent gas turbulence, and complete charging of the explosive mixture and exhaustion of the products of combustion. The combustion chamber is almost hemispherical, with the sparking plug in the centre. The inlet port, which is curved where it enters the cylinder, finally emerges horizontal, with a flange for carburettor attachment. There are two exhaust ports, both of which are heavily finned adjacent to the cylinder head. From these ports two chromium-plated exhaust pipes, with screwed connections, run in sweeping curves to a pair of standard silencers and fishtails fixed one on each side of the rear wheel. Fig. 15 shows the construction of the P. & M. silencer. It will be seen that in principle it is absurdly simple. The exhaust pipe is open-ended. The gases, after leaving this pipe, have to enter a blind-ended and drilled tube, which extends for some distance into the expansion chamber, whence they are conveyed to a large fishtail with vertical slit. In spite of the enormous power output of the "Panther" engine on large throttle openings and its semi-racing design, it is found that the present silencing arrangements reduces the "machine-gun" exhaust roar to a pleasant "zoom" which meets all legal requirements and is not offensive to the ears. On the contrary, while the exhaust note is quite inoffensive, it is still suggestive of the surging power that the "Panther" lets loose with a slight turn of the twist-grip. Back-pressure may be regarded as negligible.

Coupled with absence of much exhaust noise is absence of mechanical noise, which is so disliked by discriminating riders. This may be attributed to the high efficiency and enclosure of the valve gear. Special attention has been directed recently towards improving silence of running, and the valve lift has been decreased since 1930 with this object in view. Decreasing the valve lift has necessitated increasing the size of the valves and ports, and the result is a remarkable lessening of valve-operating noises with the same effective gas velocities through the ports. A general view of the valve and timing gear is shown at Fig. 14, and details of the overhead valve-operating mechanism are illustrated at Fig. 16.

The two hollow-headed, tulip pattern valves, which are turned up from high-grade steel, and have hardened bases, are placed in the cylinder head at an angle of 52 degrees to each other. As already mentioned, they have now a reduced lift, and to compensate for this the diameters of the valve heads and stems have been increased to $1\frac{7}{8}$ in. and $\frac{3}{8}$ in. respectively. Both valves are, theoretically, interchangeable. In practice, however, it is not advisable to change them over, especially after much valve grinding has been done, for each valve has its own slight seating peculiarities. The valve guides, which are of chilled cast-iron and provided with flanges upon which the lower valve spring collars rest, have this year been increased in length slightly, so as to give a greater bearing surface for the valve stems, and to diminish the tendency for the valves to "rock" slightly owing to side thrusts imposed by the rockers when wear develops in the guides. The guides are pressed into the cylinder head casting, and can readily be removed and replaced when necessary. A special feature on this year's standard "Panther" models is that both inlet and exhaust valve guides are positively lubricated from the rocker-box by means of oilways drilled in the cylinder head. There are no external pipes. As hitherto, duplex valve springs are used, but these are now longer, the outer springs having six coils. Two substantial collars and a split collet serve to anchor each pair of valve springs. The design of the collars (see Fig. 16)

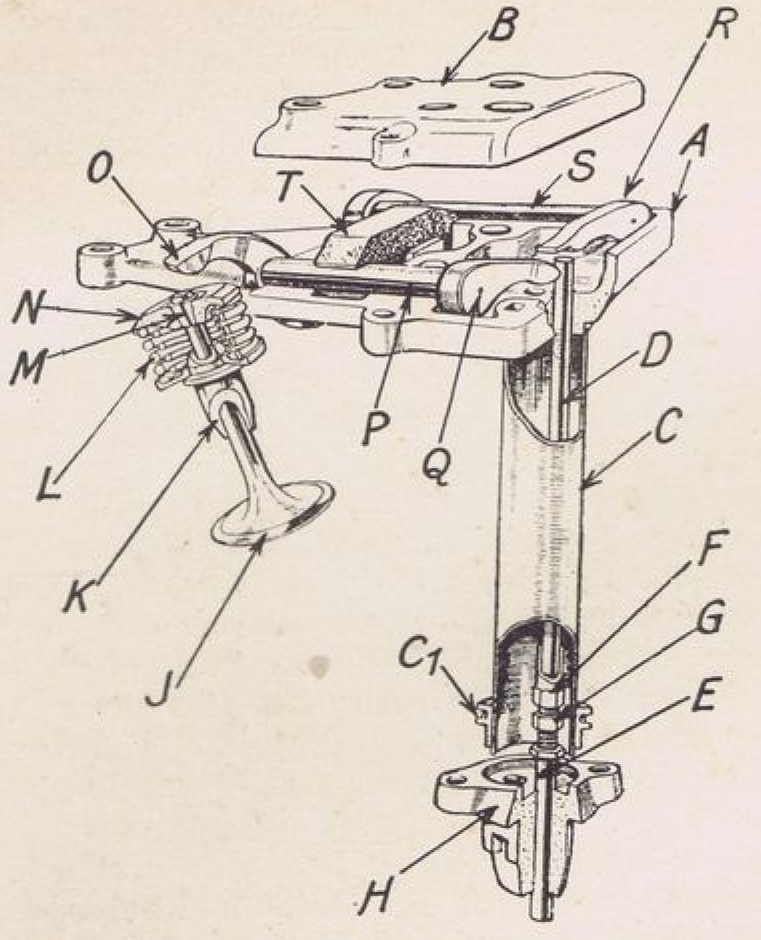


FIG. 16. SHOWING THE OVERHEAD VALVE MECHANISM

Above is shown the rocker-box on a 1930 standard engine. The 1931 rocker-box is somewhat different, access to the valve mechanism being given by removal of an end-plate, on which is mounted the entire exhaust valve-lifter mechanism. A lid is still provided for inspecting the felt pad. The rocker return spring is not shown

A = Rocker-box
B = Rocker-box cover (end-plate now used)
C = Telescopic push-rod cover
C_1 = Push-rod cover gland
D = Exhaust push-rod
E = Exhaust tappet
F = Tappet adjustable head
G = Lock-nut
H = Tappet guide
J = Inlet valve
K = Inlet valve guide
L = Inlet valve spring
M = Split collet
N = Valve spring collar
O = Inlet valve rocker
P = Inlet rocker shaft
Q = Inner inlet rocker
R = Inner exhaust rocker
S = Exhaust rocker shaft

ensures that the springs always lie truly concentric with the valve stems.

The 1930 "Redwing" type rocker-box is used except on the new "Redwing 90" engine. It comprises a very neat aluminium box, with an end-plate giving access to the interior. It is held to the cylinder head by two nuts between the cylinder fins and by the nuts at the top of the four long rods passing through the engine and terminating at the upper engine fixing lugs on top of the rocker-box. Three pairs of distance pieces are used to support the rocker-box above the cylinder head. All 1931 rockers are of the two-piece type, the actual valve-operation levers being separate from the two spindles and the push-rod levers. The loose levers are securely fixed to the spindle ends by means of tapers and keys, the units being held together by means of nuts screwed on to the ends of the rocker spindles. These hardened and ground spindles have now P.B. bushes of exceptional length. The felt pad which lubricates the spindle bushes is still retained and has an inspection lid, but no longer requires oiling from an extraneous source, for it derives its supply of lubricant from the oil blown up the telescopic push-rod tubes. After passing over the felt pad, the oil mist from the telescopic tubes is taken through ducts in the cylinder head to the valve guides, as already mentioned. The actual valve rockers have no hardened-ended adjusting screws, but rest direct upon the ends of the valve stems, valve clearance adjustment being carried out by means of adjustable tappets, except on the "Redwing 90." In order to ensure silence of operation and to enable the valve clearances to be accurately checked at the ends of the rocker arms, a common return spring is provided. This is anchored to two short levers fixed to the rocker spindles.

A different type of exhaust valve lifter is now fitted to all "Panther" models. Instead of there being the old pattern incorporating a large inverted handlebar lever giving, by Bowden cable, a direct upward pull on a small flanged device, with its flange below the inner end of the exhaust valve rocker (Fig. 40), the entire exhaust valve-lifter mechanism is completely housed on the rocker-box end plate, a comparatively long lever being fitted on the outside of the end plate (see Fig. 28). The effective leverage is so great that the Bowden cable from this lever is simply taken to a finger lever placed on the handlebars below the ignition lever. It should be mentioned, however, that the chief function of the exhaust valve lifter is to enable the engine to be rotated to a position when the decompressor can be brought into action.

The two one-piece silver steel push-rods are not mounted side by side, as on most O.H.V. engines, but one behind the other, the rearmost being that for the inlet valve. At the rocker-box two reamered holes serve as guides for the push-rods, whose flat tops are kept in contact with the rocker arms by means of the rocker return springs. The push-rod bases rest in the recessed tappet heads (*F*, Fig. 16), which can be screwed up or down on the tappets, when adjusting the valve clearances, after first loosening the lock-nuts. The lower of the three hexagons is solid with the tappet in each case, and is provided so as to enable the latter to be easily gripped when necessary. Both the inlet and exhaust push-rods are enclosed by a tubular cover, up which oil mist finds its way to the rocker-box and valve guides. This tubular cover can be telescoped at its lower end when it is desired to inspect or adjust the tappets. Early "Panther" engines showed a slight tendency for oil leakage at the push-rod cover base, but this trouble has now been eliminated by the adoption of a screwed

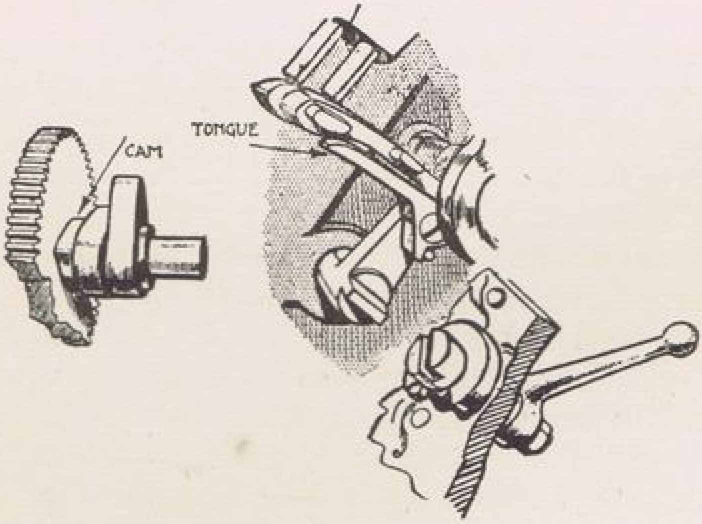
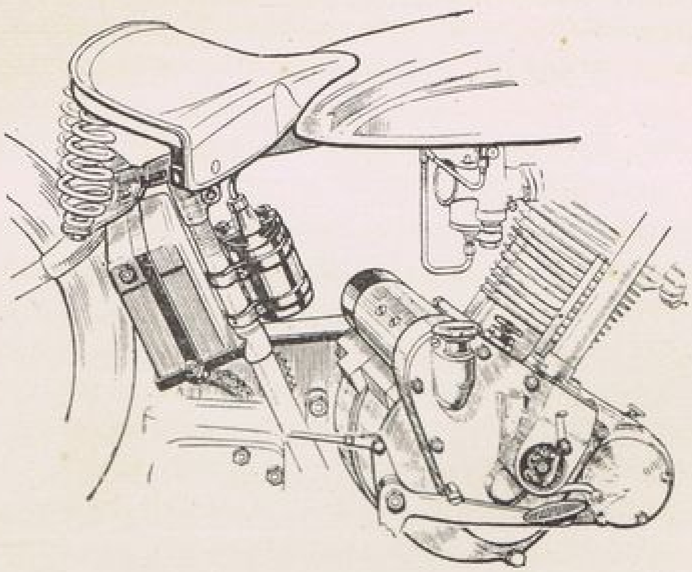


FIG. 17. THE DECOMPRESSOR

gland (C_1, Fig. 16) between the tube and the tappet guide casting. A special *C* key is provided in the tool kit for loosening and tightening this gland. The tappet guide is a one-piece bronze casting incorporating the two guide holes and the oil channels. It is bolted on to the crankcase by a flange and two small bolts, and, of course, can very readily be removed.

With regard to the timing gear, this is extremely simple and most efficient. Keyed to the tapered end of the offside main-shaft, which has a ball bearing in the timing case, is the engine pinion (see Fig. 14), and immediately above this, and driven off it at half-engine speed, is the one-piece camwheel, with the cam-shaft supported in self-aligning ball bearings at each end. Both pinions are marked for mesh. A new cam profile has been adopted, and it is claimed that this reduces the stresses on the valve springs to a marked extent, besides reducing valve clatter. Resting on the cams are two cam levers operating from a single bearing pin, and immediately above these rest the tappets. Just in front of the camwheel is the decompressor mechanism, the design of which will be understood by reference to Fig. 17 (see also Fig. 14). On this year's models there is a more pronounced "dwell" on the decompressor. It comprises an internal lever, at the end of which is a tongue which can be brought to bear upon an auxiliary cam placed in front of the main cams by pulling upwards the lever on the outside of the timing case. This operates the inner lever by means of a dog coupling. It should be noted that the decompressor, which gives approximately half-engine compression, is designed for *temporary* use. Frequent and unnecessary use will cause the tongue piece to wear rapidly. Sometimes the engine cannot be put on half compression until it has been rotated with the exhaust valve lifter raised until the auxiliary cam comes into the position necessary to bring the tongue piece into action. Moreover, raising the exhaust valve lifter automatically removes the lifter pressure. The decompressor lifts the exhaust valve slightly during the compression stroke only and is, therefore, a more effective aid to starting than the exhaust valve lifter.

The timing case contains two other gear wheels, the intermediate wheel containing the oil pump to the left of and engaging with the camwheel, and to the left of this the wheel fitted to the dynamo or magneto driving shaft, according to whether coil or magneto ignition is used. Both these wheels are marked for mesh with each other and with the camwheel. Where magneto ignition is fitted, the driving wheel, which is keyed to a shaft, at the back of which is a universal coupling, is the same size as the camwheel, so as to give the necessary 2 to 1 reduction. Also fitted to the shaft behind the timing case (whether electric lighting be fitted or not) is a sprocket, from whence the drive is taken to the dynamo sprocket by a silent duplex chain on electrically-equipped models. A neat chain case bolted to the timing case effectively protects the chain (see Fig. 14). The dynamo sprocket is not keyed, but is a friction fit only, and the sizes of the two sprockets are such as to drive the dynamo, which is held by a bracket clamped to the rear down tube, at approximately $1\frac{1}{3}$ engine speed. The dynamo is purposely mounted eccentrically so as to provide a means of tensioning the duplex chain. It is only necessary to do this to rotate the dynamo bodily in its mounting after loosening a single bolt. No stress whatever is imposed upon the magneto armature by the dynamo drive. In the case of coil ignition models, the dynamo replaces the magneto, thus doing away with the chain drive altogether, as well as the universal coupling, and the relative sizes of the driving and intermediate wheels are arranged to give a similar dynamo speed reduction. Owing to the fact that the Miller dynamo used does not incorporate a contact breaker to interrupt the L.T. current from the primary coil, a separate contact-breaker is housed in a projection at the front of the timing-case and driven off an extension of the camshaft on which it is a friction fit. The contact-breaker is thus placed in what can only be described as a truly praiseworthy position, having regard to accessibility and the question of easily checking the ignition timing. Fig. 18 illustrates this point clearly. The timing-case cover, in addition to carrying on its inner face two self-aligning ball races for the intermediate and camshaft wheels,



(*From "The Motor-cycle"*)

FIG. 18. SHOWING THE NEAT COIL IGNITION INSTALLATION

also carries a spring-loaded plunger, which retains the intermediate wheel against its spigot bearing, a necessary condition for proper functioning of the oil pump.

Lubricating oil recommended (50, 60, 90)	Castrol XL
Sparking plugs recommended . .	A.C. Sphinx S.2, Lodge H.1, or K.L.G.-K.1
Valve clearances (cold engine, 50, 60, 90)	·002 in. inlet, ·003 in. exhaust
Magneto setting (50, 60, 90) . . .	T.D.C. on full retard

Semi-dry Sump Lubrication (All Models). The "Panther" lubrication system displays advanced design, in spite of the fact that it was introduced about four years ago, since when it has functioned so satisfactorily that the only alterations lately made have been in regard to the filling arrangement and the special piston-spread method of lubricating the cylinder. It is simple, effective, and almost foolproof. Its principal characteristic is the entire absence of external pipes and the provision of an oil sump cast integral with the crankcase. There is thus no separate oil tank. The oil sump, which occupies the foremost part of the crankcase, has a capacity of $3\frac{1}{2}$ pt. Oil consumption works out to about 1,500 m.p.g. The filler cap, instead of being placed above it in a position where mud and dirt is most apt to accumulate, has now been moved to the rear of the timing case (see Fig. 18).

The oil, when poured into the large cap (which is removable by hand), runs through the timing-case to the sump, which is separated from the crankcase proper by an internal partition. An oil-depth gauge is fitted to the front of the sump, as on 1930 models. It comprises a notched rod (see Fig. 48) capped by a metal knob, the notches indicating the full, half-full, and danger levels. There is serious risk of damage to the engine if the oil level is allowed to fall below the danger point. Briefly, the action of the "Panther" semi-D.S. system is as follows—

Oil from the sump is drawn up from the suction side of a rotary double-plunger pump, housed at the back of the intermediate wheel (described and illustrated on pages 79–80), through a large tubular gauge filter in the sump (which this year has been slightly modified and provided with a special crankcase joint); and after reaching the pump *via* a short internal pipe, a quantity of oil, determined by the position of the pump regulator disc, is forced along a duct to the top of the crankcase, and up a duct in the cylinder barrel to a point just below the piston rings. The oil is then spread by the piston skirt to all parts of the cylinder walls, especially the thrust faces, and this ensures a constant film of oil being maintained between the cylinder and piston. On 1930 and previous O.H.V. "Panthers" the oil was forced to a point almost out of reach of the piston skirt, and splash lubrication was mainly relied upon for cylinder lubrication. The present system is without doubt much more efficient. It should be noted that it is possible to observe whether or not the oil pump is functioning, for an indicator needle projects from the regulator and is fully erected by the oil pressure when this is normal. It should also be noted that the oil regulator, which can be rotated a quarter of a revolution and adjusted when riding, is designed so that it cannot be turned right off. The oil pump itself contains no valves or springs. Excess oil from the cylinder base falls upon the flywheels and big-ends, whence it is thrown by centrifugal force up inside the piston and on to the small-end of the connecting rod and gudgeon pin. Surplus oil finds its way back to the sump by being thrown by the flywheels over the baffle separating the crankcase and sump. The oil is then cooled, filtered, and recirculated as before. The timing gears, cams, cam levers, tappets, and decompressor are lubricated by splash from the crankcase; but there is also an additional forced feed to the cams and timing gear from the pump by-pass. Surplus oil in the timing-case drains to a sump *via* a duct. Lubrication of the overhead valve gear is accomplished by oil mist being thrown up the telescopic push-rod cover and impregnating the special felt pad which is in contact with the rocker spindle bushes. Grease-gun nipples are no longer provided. Oil from the rocker-box also reaches the valve guides through oilways drilled in the cylinder head casting. (For further notes on the lubrication system, see Chapter IV.)

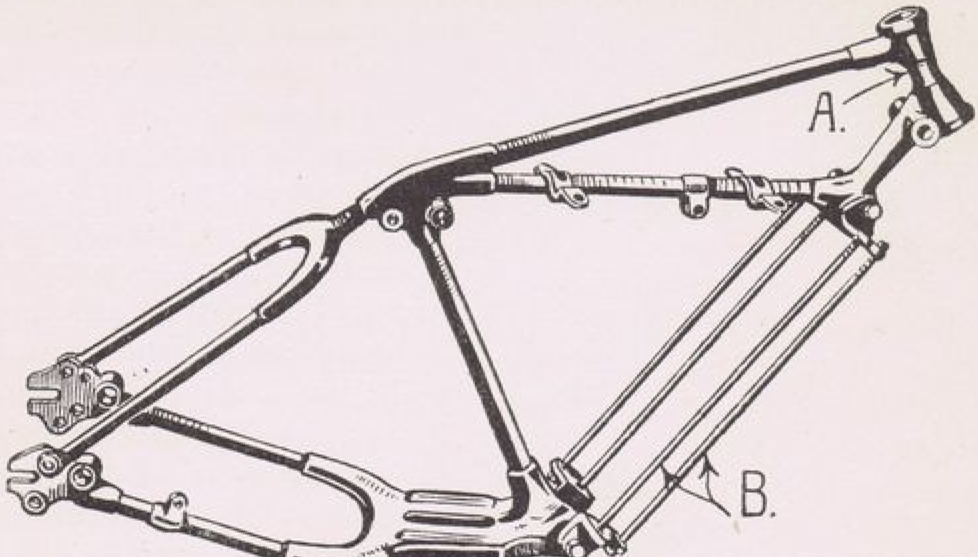
Carburettor. This is an Amal sports semi-automatic instrument, having a cross bore of $1\frac{1}{16}$ in. and bolted with a flanged air-tight fixing to the rectangular-ended cylinder-head induction pipe. Its type number is 6/024, and it has a bottom feed to the float chamber. The throttle has twist-grip control on the right side of the handlebars, while the air control is by a lever on the same side. A throttle stop limits the closing of the throttle slide and enables a quiet tick-over on the pilot jet to be obtained. There is also a separate pilot jet air adjustment. The main jet fitted as standard on all four models is a No. 170, with a throttle valve 6/5 in position 3. This combination gives a low fuel consumption (approximately 90 m.p.g.), fierce acceleration, and a very high maximum speed. For a small extra cost a special Amal air filter can be fitted to the air intake. Where this is done, it should be noted that the main jet size can advantageously be reduced by 10–15 per cent. Also a "pump" coversion set* is obtainable. (For further details of the Amal carburettor, see page 68.)

Ignition. A.C. Sphinx-S.2 two-point, short-reach sparking plugs are fitted as standard and give excellent all-round results. The recommended gap at the "Isovolt" electrodes is ·020 in. with magneto ignition and ·027 in. with coil ignition where the spark intensity at low speeds is greater. For fast riding or heavy passenger work it may be found advisable to fit a plug that will stand more heat, such as the Lodge-H.S.1 or H.1, or the K.L.G.-K.1. For very exacting conditions, fit a Lodge-H.S.3 or a K.L.G.-K.S.5, and for racing try a special Lodge-H.45 or a K.L.G.-268. There are, of course, many other types suitable (see page 106); but remember, as a general rule, the greater heat a plug will stand, the more susceptible it is to oiling up.

On magneto-equipped "Panthers" (50, 60, 90) a B.T.-H., type M1 magneto is bolted to the back of the crankcase and driven anti-clockwise by gearing from the timing-case (as described on page 71). A universal coupling disposes of any stresses that might be thrown on the armature shaft due to mis-alignment; and, further, provision is made so that when the magneto is removed by undoing the retaining bolts, it is not necessary to re-time the magneto on subsequent reassembly, for there are only two ways of replacing the magneto—the right and the wrong way. The B.T.-H. magneto is an orthodox rotating armature machine, further details of which appear on page 71. The correct "break" at the platinum contacts is ·012 in. On coil-ignition "Panthers" (55, 65, 95) a type D.M.3G. 6-volt dynamo of Miller manufacture

* This causes a spurt of fuel to be ejected from the jet on suddenly opening the trottle, and so gives instantaneous pick-up and easy starting without flooding.

is substituted for the magneto and supplies current to an Exide battery, type 3ES3, neatly strapped to a lug on the near down tube. Current from this battery, in addition to being utilized for the lighting set, is led to the Miller coil just in front of the battery. The primary coil circuit has connected in series with it the contact-breaker and condenser, which are housed on the front of the timing-case (Fig. 18), the contact-breaker cam being driven off an extension of the camshaft. At each "break" a H.T. current



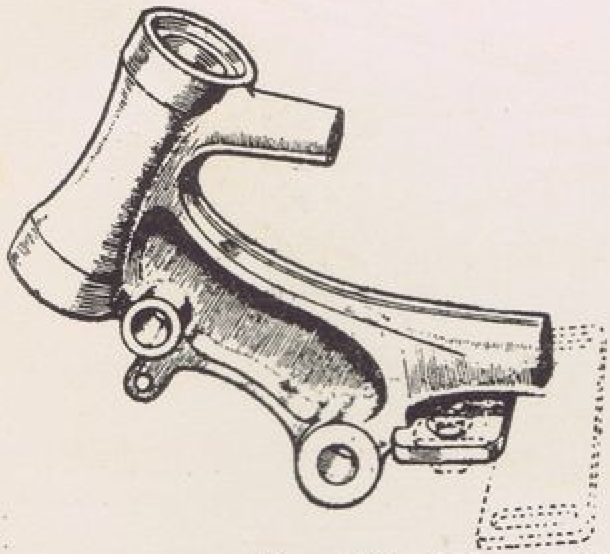
(From "The Motor-cycle")

FIG. 19. THE "PANTHER" FRAME

A = Forged steel head-lug *B* = Engine mounting rods

is induced in the secondary coil surrounding the primary, and this H.T. is led direct to the sparking plug. With coil ignition the "break" should be ·018 in. to ·02 in.

Frame and Forks. The frame remains substantially as for 1930, except that a new steering head-lug has been included. It is a scientifically-designed structure, combining great strength and rigidity with low weight. Straight steel tubes are used throughout (Fig. 19). It forms roughly three triangles, seen from the side, and it gives a wheelbase of 55 in., a saddle height of 27 in., a ground clearance of 5 in., and an overall length of 83 in. The lower part of the frame constitutes a massive casting, which serves as a bottom bracket for the three- or four-speed gear-box. The new steering head-lug is shown at Fig. 20. It is a one-piece, steel drop-forged member welded to the main frame tubes, and is designed to accommodate the extra $\frac{1}{2}$ in. lengthening of the engine made this year. The inclined power unit is housed in an extremely neat and satisfactory manner by means of a duplex cradle, consisting of four long hexagon-headed steel rods passing through the two lower one-piece fixing lugs, the crankcase and rocker-box, and secured to the upper one-piece fixing lugs by nuts screwed on to their ends. The lugs are secured to the frame by hollow steel thimbles passing into the frame lugs. These thimbles are each clamped by a single bolt and nut, removal of which (together with the thimbles) allows of the complete unit being dismantled or removed. To dismantle the engine in the frame it is only necessary to remove the upper nuts and tap down the four mounting rods (see Fig. 63). The "Panther" steering head is provided with two ball bearings, play being taken up by loosening the nut on the horizontal bolt just behind the head clip and tightening up the large capped nut below. All "Panther" frames have sidecar lugs provided.



(From "The Motor-cycle")

Fig. 20. The Forged Steering Head

The new Brampton forks embodying the patent four-point shock absorbers, with hand adjustment (see page 13) and a $4\frac{1}{2}$ in. spring action, are fitted to all models, and the effect of these, together with a slightly lower and more advanced saddle position, is to provide a degree of steering stability and manœuvrability never before equalled. Also the 1931 frame and fork modifications have further reduced the tendency for rear wheel bounce, and so enable a high cruising speed to be maintained without physical fatigue. Grease-gun nipples are provided on the forks for lubrication. A steering damper, with a bottom frame anchorage, is provided to ensure safety at high speed and to render sidecar driving easier. At ordinary speeds the "Panther" steering is so good that the damper is seldom required.

Gear-box and Clutch. Except where a P. & M. four-speed gear-box is specially ordered (see page 8), the gear-box specified is a special L.S. pattern, three-speed Sturmey-Archer, with bottom bracket fixing and a gate-change or foot control; and the standard solo gear ratios, giving two close tops and an emergency bottom for freak gradients or dense traffic, are—

Bottom, 4·5 to 1; middle, 6·6 to 1; top, 13·3 to 1.

The gear-box positions from front to rear are: 1st, *N*, 2nd, 3rd. Gear-box lubricants recommended are Wakefield's "Castrolease Light," "Speedwell Crimsangere Light," or "Mobilgrease." Full details of the gear-box construction and action will be found on page 71, and information on adjustment on page 108. A few features may here be mentioned. The gear-box housing is specially made for the "Panther," and is placed horizontal, so that the

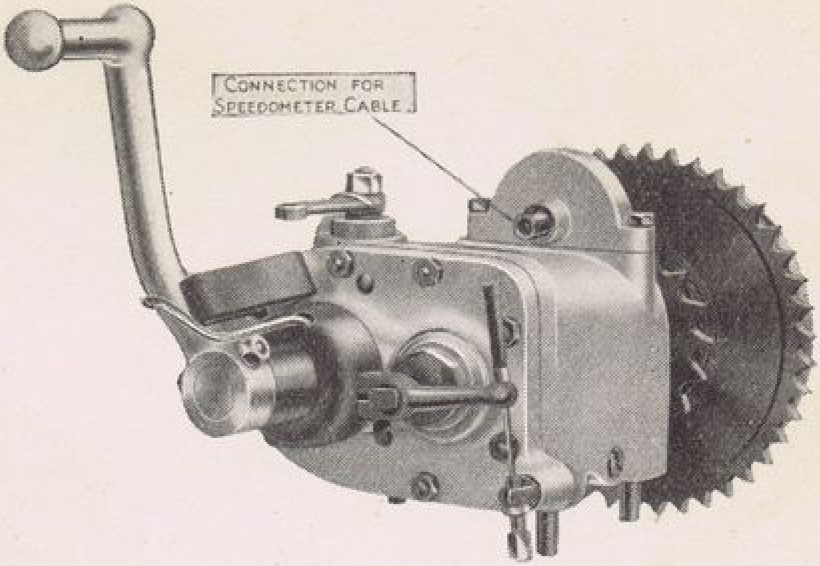


FIG. 21. THE THREE-SPEED, L.S. TYPE STURMEY-ARCHER GEAR-BOX AND CLUTCH

For a sectional view of this gear-box, see page 72. The speedometer drive is now taken from the front wheel

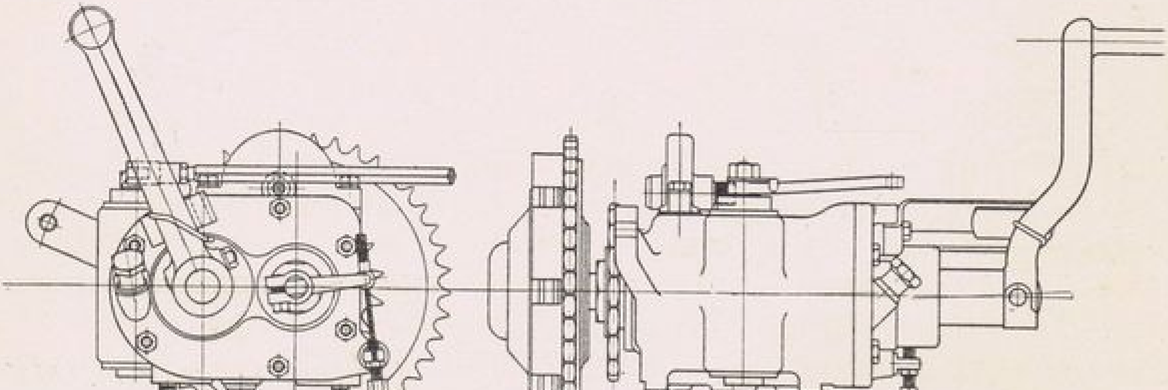
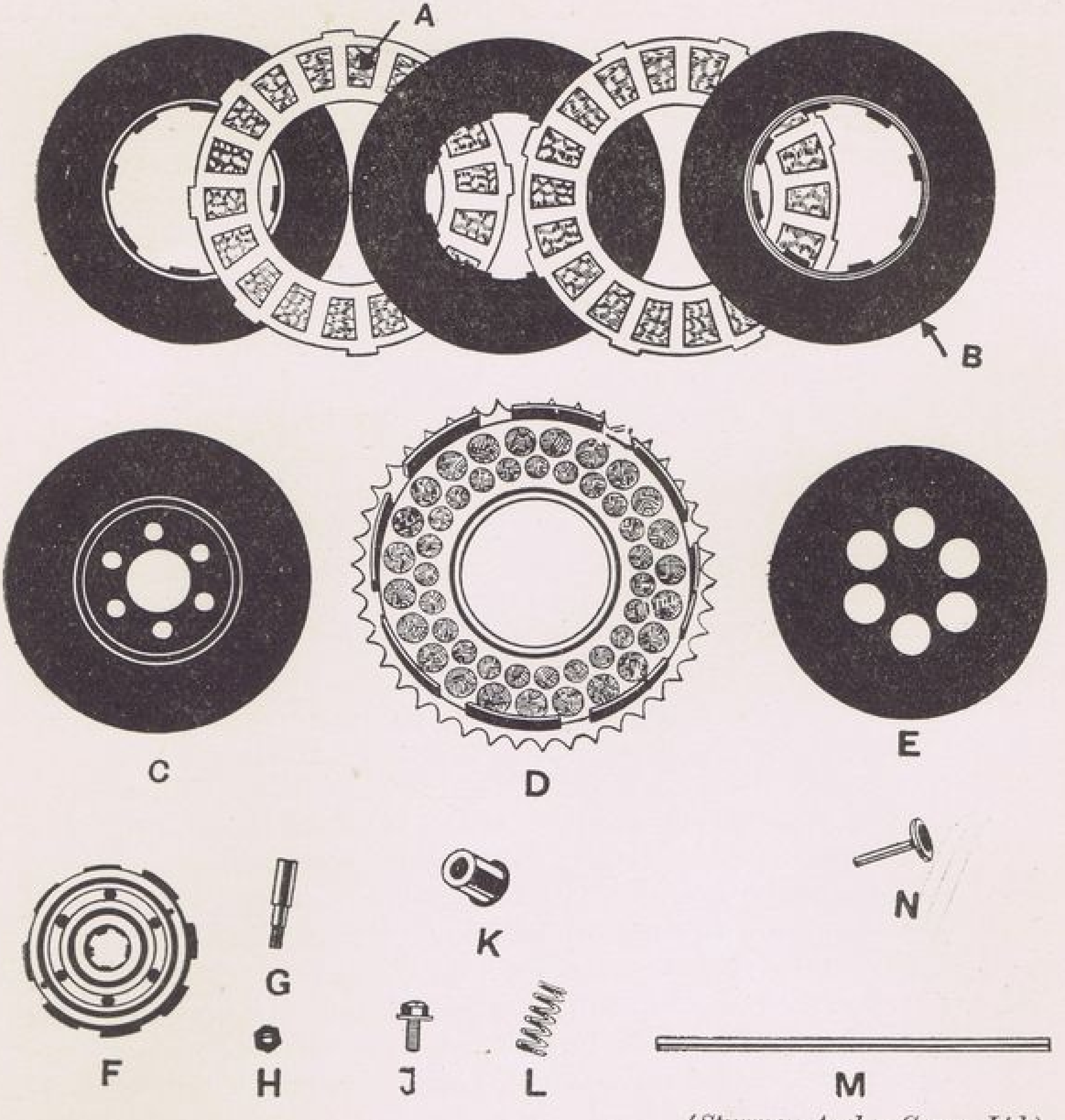


FIG. 22. END VIEW AND SIDE ELEVATION OF THREE-SPEED L.S. GEAR-BOX

layshaft lies behind the mainshaft and not on top of it, as on the standard type L.S. gear-box. Skefko self-aligning ball bearings are used throughout, and the outstanding features of the design is that three speeds and a kick-starter are provided by using only three pairs of pinions, which makes for lightness. The kick-starter mechanism is entirely enclosed, and the box presents a particularly neat and pleasing appearance. The usual cotter fixing is employed for the pedal crank. The pinions on the layshaft and mainshaft are so arranged that, when in high gear, the idle wheels are gearing down, thus considerably reducing friction. All pinions are in



(*Sturmey-Archer Gears, Ltd.*)

FIG. 23. THE PRINCIPAL PARTS OF THE STURMEY-ARCHER MULTI-SPRING CLUTCH

A = Friction insert plate
B = Driven plate
C = Back plate
D = Clutch sprocket
E = Clutch spring-box plate
F = Clutch centre
G = Clutch spring stud
H = Clutch spring-stud nut
J = Spring adjuster screw
K = Spring box
L = Clutch spring (one of six)
M = Clutch operating rod
N = Clutch button

constant mesh, and the well-known S.A. compensator is used, so that it is impossible to strip their teeth. Gear-changes are effected by moving two sliding pinions simultaneously by a stricker, whose outside arm has its fulcrum on top of the left side of the gear-box

(Figs. 21 and 22). Primary chain adjustment is effected by loosening the nuts on the three gear-box studs, which are fixed on the underside of the casting (Fig. 22), and pass through three slots in the frame bracket, and screwing up or unscrewing the adjuster screw as required.

The multi-spring clutch used in conjunction with the gear-box is also of Sturmey-Archer design. It comprises a back plate, a main clutch centre firmly secured by a nut to the splined mainshaft, and three driven plates separated by three frictional insert discs, the rearmost of which embodies the clutch sprocket, and is free to rotate on a brass cage roller bearing. Circular cork inserts of $\frac{5}{8}$ in. and $\frac{1}{2}$ in. diameter are used for the sprocket and oblong ones for the other discs. The driven plates engage at their peripheries with eight deep tongues and slots cut in the clutch-sprocket flange, and therefore always rotate with the sprocket. Six coil springs, spaced radially about the outer plate, keep the driven plates in full contact with the friction plates, except when the spring pressure is released by the handlebar clutch lever. Each spring is housed in a little tubular box, which fits on a $1\frac{1}{8}$ in. long stud screwed to the back plate, with a screw on the outside for adjusting the spring pressure. The multi-spring clutch is superior to the single spring type, in that a much more uniform pressure is brought to bear against the driving surfaces, and the plates are far less apt to tilt. It is important, however, to keep the clutch properly adjusted. With regard to the clutch-control mechanism, this comprises a lever on the left side of the handlebars actuating a Bowden cable, which transmits its pull to a small arm clamped to a quick-thread worm (see Fig. 44) housed adjacent to the offside mainshaft bearing. Thus when the clutch lever is raised, this worm rotates and, in doing so, advances and pushes forward a rod in the hollow mainshaft. At the other end of this rod is a small clutch button bearing directly upon the outer clutch cover. This button, of course, releases the clutch-spring pressure as it is pushed outwards. (For notes on clutch adjustment and dismantling, see page 107.)

Transmission. Coventry "Ultimate" chains are used for both primary and secondary transmission, the dimensions being $\frac{1}{2}$ in. × ·305 in. and $\frac{5}{8}$ in. × $\frac{3}{8}$ in. respectively. Lubrication of the primary chain, which is tensioned by a gear-box adjuster screw, is effected automatically by a short pipe leading from an engine breather on the driving side. The secondary chain, which is adjusted by two rear wheel draw-bolts in the fork ends, is also lubricated from the same source, but additional lubrication should be given from time to time. Adequate protection of the chains from road dirt is ensured by two efficient guards. The front guard encloses the entire primary chain and forms an oil case; but the rear guard protects the upper half only of the secondary chain, and so allows of its being readily inspected and adjusted.

In order to obviate any tendency for harshness of the rear transmission, a cush-hub shock absorber is provided in the rear wheel. It is extremely simple in construction, as may be seen in Fig. 24. The chain wheel has on its inner side three metal vanes equally spaced round its boss. Between these vanes and three similar vanes in the hub are inserted six rubber blocks in such a manner that there is alternately a metal vane and a rubber block. The total cush effect of these blocks is considerable, and ample freedom of movement of the chain wheel is provided by three

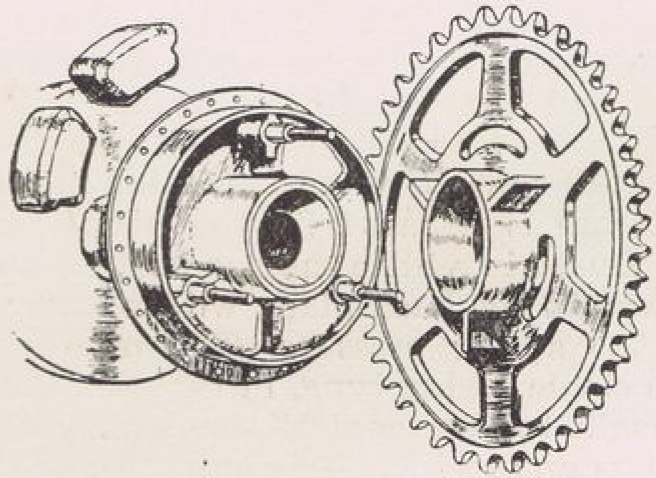
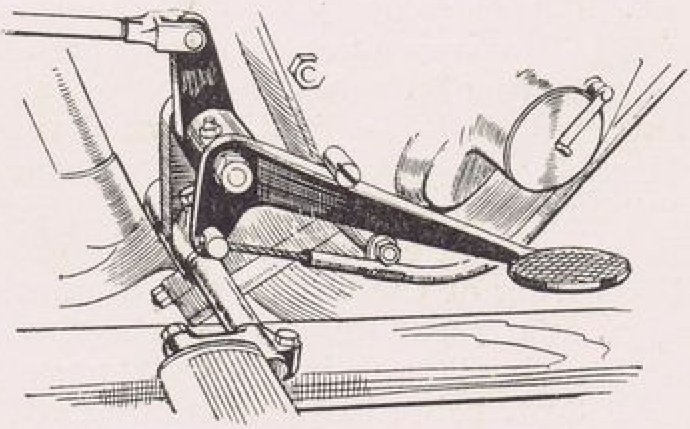


FIG. 24. THE CUSH HUB SHOCK ABSORBER

circumferential slots in the chain wheel, through which pass the retaining studs projecting from the centres of the hub vanes.

Brakes. Internal expanding brakes with 7 in. drums are fitted to both wheels. They are smooth in action and very powerful, which renders rapid retardation in heavy traffic quite safe. Little effort is required to put both brakes hard on. Although independent handlebar control of the front brake is provided in order to comply with existing legal requirements, and for use when only slight pressure is required, both brakes can be applied simultaneously by applying pressure to the foot pedal mounted on the offside above the footrest shaft. As may be seen in Fig. 25, the brake pedal is provided with two short cranks. To the upper one the rear brake rod yoke is secured, and to the lower one is fixed the end of a steel-encased Bowden cable running to the curved lever on the front brake anchor plate. This constitutes the interconnecting gear, which, though simple, is most efficient. Since a small amount of stretch occurs in the Bowden cable, although it is partly enclosed in a steel tube, it is important that the front brake is adjusted so that it commences to operate slightly in advance of the rear brake. Further compensation is automatically brought about by the slotted floating pivot foot lever. The construction of the lever is such that, after a certain amount of pressure has been exerted on the pedal, a further increase in pressure moves the front brake operation in excess of the rear, thus dividing the braking effort according to the reaction pressures between tyres and road. Adjustment of the front brake is provided in the form of two hand-operated milled nuts placed side by side on a transverse lug fixed to the front forks. Adjustment of the rear brake is by a milled nut with spring fitted to the end of the brake rod.

The P. & M. brakes do not include separate drums, for these are integral with the hubs, being forced and sweated on. The



(From "The Motor-cycle")

FIG. 25. BRAKE PEDAL SHOWING INTERCONNECTION OF TWO BRAKES

front and rear anchor plates are of similar construction. Two flanged steel brake shoes, to which are riveted the friction linings, are pivoted at one end and held normally out of contact with the drum by two strong tension springs. A "square" type of cam at the opposite side forces the shoes apart when pressure is applied to the brake pedal or handlebar lever. On models having *de luxe* electrical equipment (see page 5) a "stop" light is automatically brought into action when the brake pedal is applied.

Wheels and Tyres. The old type cone and cup ball bearings have now been dropped in favour of journal type ball bearings, which require no adjustment. These bearings, if properly lubricated, offer little friction and are extremely reliable. Grease nipples are provided on the hubs for lubrication. Large diameter axles are used, and the wheels are built up from heavy gauge spokes.

The tyres fitted as standard are 26 in. × 3·25 in. heavy cord, wired-on Dunlops, with Schrader valves for checking tyre pressures, which for solo riding should be 19 lb. per sq. in. for front covers and 21–23 lb. per sq. in. for rear ones.

Tank. There is, of course, only one tank, the oil being contained in the engine sump. The saddle fuel tank this year, which has a capacity approximately 2¼ gal., is practically the same as that used on last year's models, but is a trifle shorter, though still long enough to house the saddle nose at the rear end. The front end of the tank now accommodates the panel housing the ammeter and switch (where fitted). In order not to spoil the very handsome appearance of the tank, the lighting panel has been carefully shaped to conform with the tank contour. Although not lying flush with the tank, the panel projects above it only the smallest amount. This style of fitting gives the panel an integral appearance, and in no way does it resemble a box fitting or arrangement suggestive of its being fitted as an afterthought. It may be mentioned that the lighting panel reduces the tank capacity considerably less than would a tank-mounted speedometer. It might be thought that there is a slight risk of danger attaching to the housing of electrical wiring in the tank, but this is not so, for the wiring of the switch and ammeter is contained within a special compartment lined with asbestos. A meritorious feature of the "Panther" tank is that a reserve fuel supply is allowed for, about 3 pt. being trapped in one part. There are, of course, two petrol taps. Constructionally, the tank is the same as for 1930. It is built up from heavy gauge welded steel, and to prevent interior rusting is specially treated during manufacture with a composite petrol-proof varnish. The size of the filler cap has been increased to facilitate fuel replenishment. Rubber knee-grips are provided, and on either side of each grip there are two panels tastefully finished in green with cream linings. The front panels are inscribed with the word "Panther" and have the familiar panther head transfer.

Miscellaneous Equipment. Included in the standard "Panther" specification are the following items: a Lycett "Aero" or Terry *de luxe* saddle; handlebars adjustable for angle and position, with brazed-on control lever lugs, concealed wires, and rubber grips; adjustable footrests designed to prevent damage in the event of a spill; a low-lift spring-up central stand and a front stand; extra deep valanced mudguards, with lifting handle at back of rear-guard; oversize metal tool-bags, with a complete set of tools and strong locks; number plates; a high-frequency electric clear-hooters horn (on coil-ignition models), with chromium-plated front; a large tyre inflator; and grease-gun and grease nipples throughout.

Weight . . approximately 325 lb. Tax . . £3 per annum

MODELS 90, 95 ("REDWING")

These two models are identical to each other, except that Model 95 has coil ignition. The specification of both machines is practically the same as the standard "Panther" specification just described, with the exception of the engine, which, although

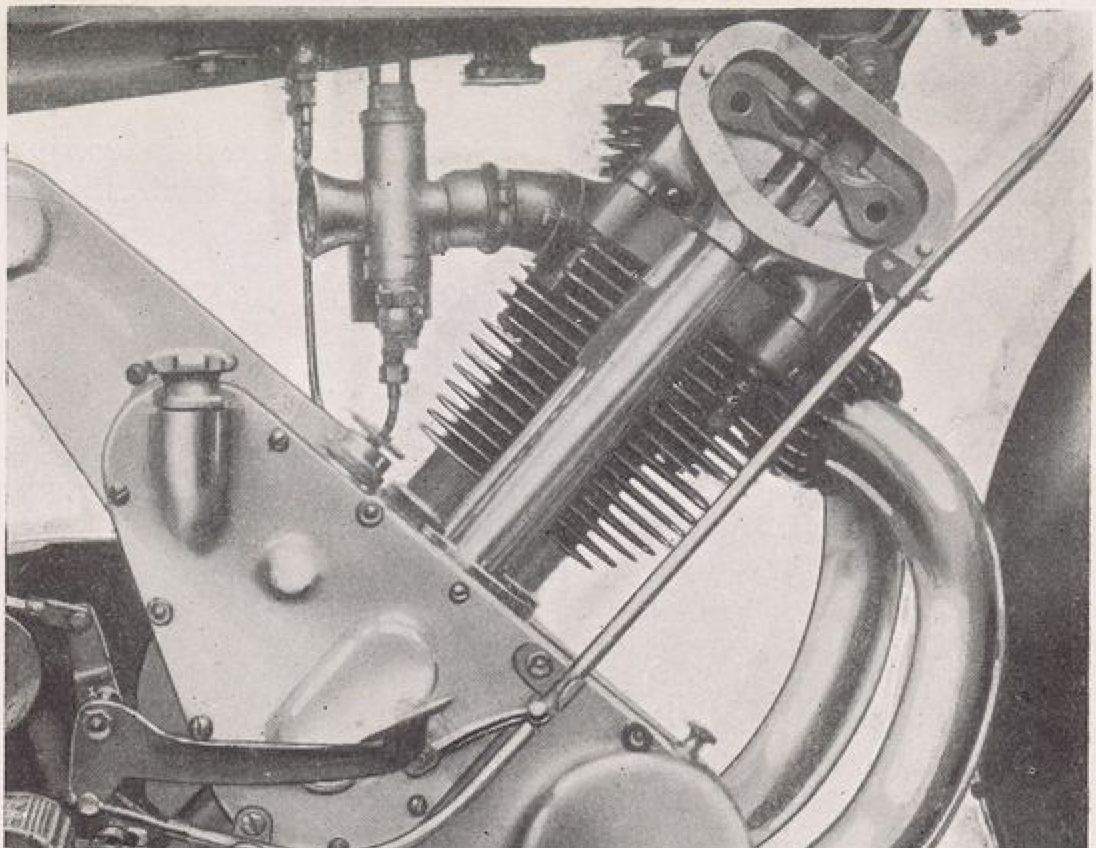


FIG. 26. CLOSE-UP VIEW OF THE NEW 4·90 H.P. "REDWING" ENGINE

Note the sturdy design of the rocker-box, the end plate of which has been removed to show the rockers. Observe also the decompressor on the timing case, and the steel tube used to enclose the flexible front brake cable

similar in many ways to the standard engine and previous "Redwing" engines, embodies many new important features, especially in regard to the valve-operating gear. Also the petrol tank, otherwise the same as the standard tank, is chromium plated, and the three-speed gear-box has foot-control. The new power unit has all the characteristic qualities of long life, reliability, and silence of the standard "Panther" engine, with a performance hitherto only associated with a racing engine. Many of its parts are interchangeable with other P. & M. engines. Below are given the chief items of interest in the new engine.

The 4·90 h.p. "Redwing" Engine. This engine is of a new type, as compared with previous "Panther" engines, in that the head and cylinder design are based on racing practice, whereas the old "Redwings" were merely highly-tuned standard engines. The "Redwing" or Model 90 engine has a bore and stroke of 79 mm. × 100 mm., giving a 490 c.c. engine against the previous capacity of 598 c.c.; but to set off against this is the fact that, whilst the Model 90 is a specially designed engine, all previous "Redwings" have been standard. In the first place, all sources of internal loss of energy have been eliminated as far as possible, and reciprocating masses have been lightened commensurable with a high factor of safety.

For instance, a short, light connecting rod is used in conjunction with a slipper piston having narrow rings and a circlip-fixed

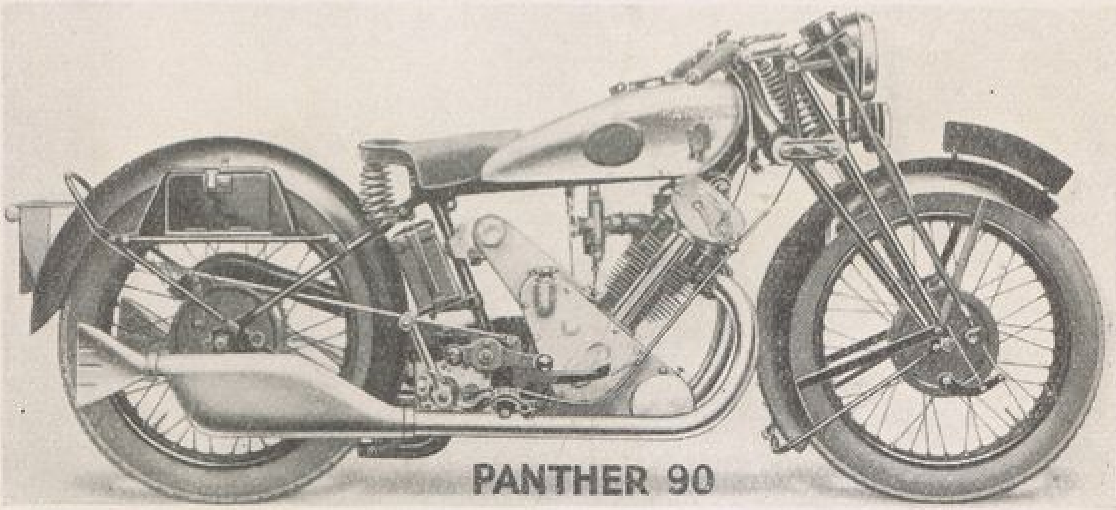
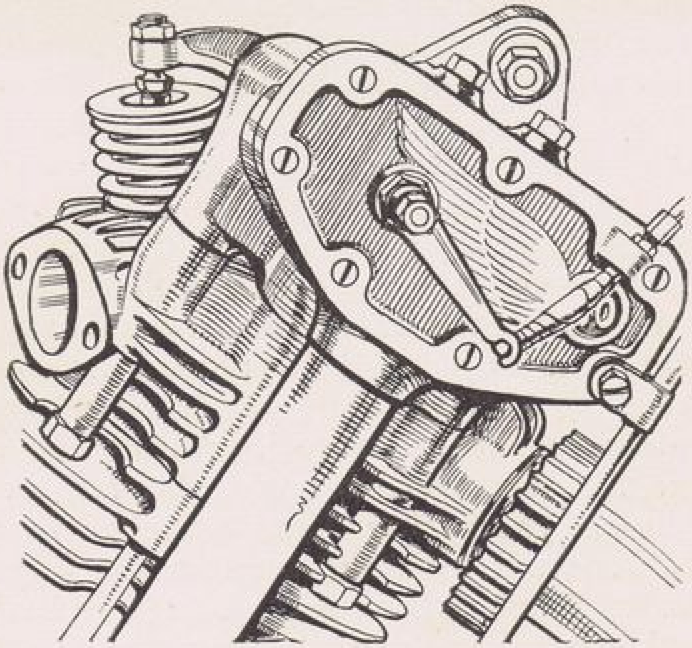


FIG. 27. THE 490 C.C. 1931 O.H.V. "REDWING," MODEL 90, WITH STANDARD ELECTRICAL EQUIPMENT

This imposing sports model differs from the standard "Panther" (Fig. 12) in that it has a new engine, a plated tank, and foot gear control. *De luxe* electrical equipment is extra.

gudgeon pin. The "Redwing" cylinder, cylinder head, and rocker-box are held down in the same manner as on the standard engine. Previous "Redwing" engines were fitted with a cylinder base washer, consisting of a steel ring 1/32 in. thick. This was removable and, in so doing, the compression ratio was lifted up approximately half an atmosphere. The 1931 "Redwing" engine has a fixed compression ratio of 6·5 to 1 and, except for the jointing base washer, with a hole in the excrescence behind the push-rod cover flange registering with the oil-feed duct from crankcase to cylinder, no removal plate is fitted. It follows that it is not now necessary to run on any special fuel, and any good benzol mixture will function quite well without undue pinking. The valves are fixed in the head at much greater angle ($72\frac{1}{2}°$) to each other than hitherto, and consequently the head is much more hemispherical than the somewhat flat head of the standard engine. The head is also polished on the inside, so that the velocity of the gases through the ports is not reduced by "skin friction." This practice is usual with sports engines. At 5,000 r.p.m. the "Redwing" engine has an output of approximately 25 b.h.p., a surprising performance for a 490 c.c. engine. The two tulip pattern valves, which are made from K.E. 965 steel drop forgings and have duplex coil springs, are definitely not interchangeable, being designed purely for maximum efficiency. The exhaust valve has a flatter head than the inlet valve. Both valves are automatically



(*From "The Motor-cycle"*)

FIG. 28. SHOWING THE "REDWING" ROCKER-BOX AND CYLINDER HEAD

Note the exhaust valve lifter on the end plate, which has the "Redwing" insignia embossed on it. The upper adjustment for the valve rockers is also clearly shown

lubricated by a small banjo fitting bolted to the near side of the rocker-box, oil mist being led direct to the valve stems by two small pipes.

The general arrangement of the aluminium "Redwing" rocker-box can be understood by reference to Figs. 26 and 28. It is somewhat similar to the standard rocker-box, but is much stouter and of generally heavier design. Owing to its size and the rather large overall length of the engine, it is necessary to remove the engine almost from the frame before commencing any dismantling work. As with the standard engine, four long rods passing right through the power unit are used both for mounting the engine and for retaining the cylinder, complete with head and rocker-box, to the crankcase. In addition, a number of cylinder head studs and nuts are used to fix the cylinder head to the cylinder barrel and the rocker-box to the cylinder head. On previous "Redwing" engines separate distance pieces were used to raise the rocker-box the necessary distance above the cylinder head. These are no longer used, the distance pieces being cast integral with the cylinder head, which considerably facilitates dismantling and reassembling. With regard to the rocker-box interior, the arrangement is very similar to that of the standard engine. It is a one-piece box, with a detachable end plate carrying the exhaust valve-lifter mechanism on the offside. The actual valve rockers and the inner push-rod rockers have two large diameter spindles carried in renewable phosphor-bronze bearings, which are lubricated directly by means of oil mist thrown up the tube enclosing the push-rods. Some of the oil mist, as already mentioned, is passed on to the valve guides and keeps the valves constantly lubricated. It should be noted that the efficiency of the valve lubrication system depends on the soundness of the rocker-box joint. The tube enclosing the push-rods cannot on this engine be telescoped, for, instead of the valve clearances (see page 103) being adjusted by means of adjustable tappets, provision is made on the valve rockers for this adjustment. Each rocker arm carries at its end a mushroom-headed screw, which bears on the end of the valve stem. A rocker return spring is used as on the other engines, each end of the spring being attached to a lever keyed to the spindle. A small lock-nut secures the adjustment. The inner rockers at the front of the rocker-box have ball-ended studs, which fit into the cupped silver steel ends of the $\frac{3}{4}$ in. diameter duralumin push-rods. There are no tappets whatever, the lower ball ends of the push-rods resting in sockets provided on the tops of the cam levers. Special attention has been given to the cam contours, and the valve lift is now slightly lower, so as to reduce mechanical noise. In other respects the timing-gear remains unaltered; a decompressor is fitted. Ignition, as with the "Panther," is by a B.T.-H. M.1 magneto or by a Miller coil-ignition set, already briefly referred to.

As during previous years, the "Redwing" engine requires something rather special in the plug line and, although a touring plug is fitted in the machine as sent out, a special plug is in the tool-box for fitting when it is required. The reason for this is obvious; the standard plug will withstand successfully all the heat and oil generated during running-in, and when the oil supply is cut down and the engine really "opened out," the special plug will be necessary. It should always be borne in mind that the special plug supplied, a Lodge H.45, will not withstand excess oil. The lubrication system adopted on this engine is, incidentally, a semi-dry sump system as used on the "Panther," and has the same type of milled disc regulator.

THE SCHNEIDER TROPHY MODEL SIDECAR

This sidecar has been designed to meet the ever-growing demand for a sports sidecar which gives the maximum comfort and protection for long-distance touring.

The body is of special design, incorporating bucket-type seat with well, the rounded back being hinged for access to locker.

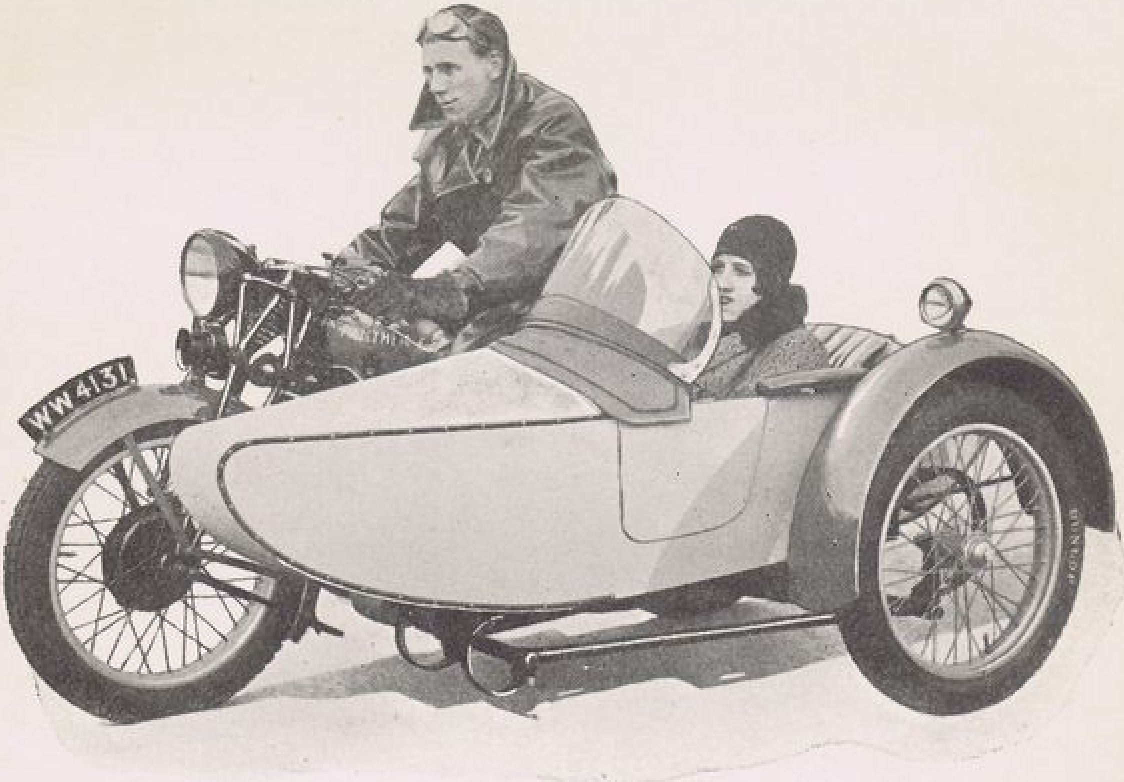


Fig. 29. The Schneider Trophy Model Sidecar

Finished in aluminium fabric with beading picked out to match tank colours, and upholstery light green to match the tank panels.

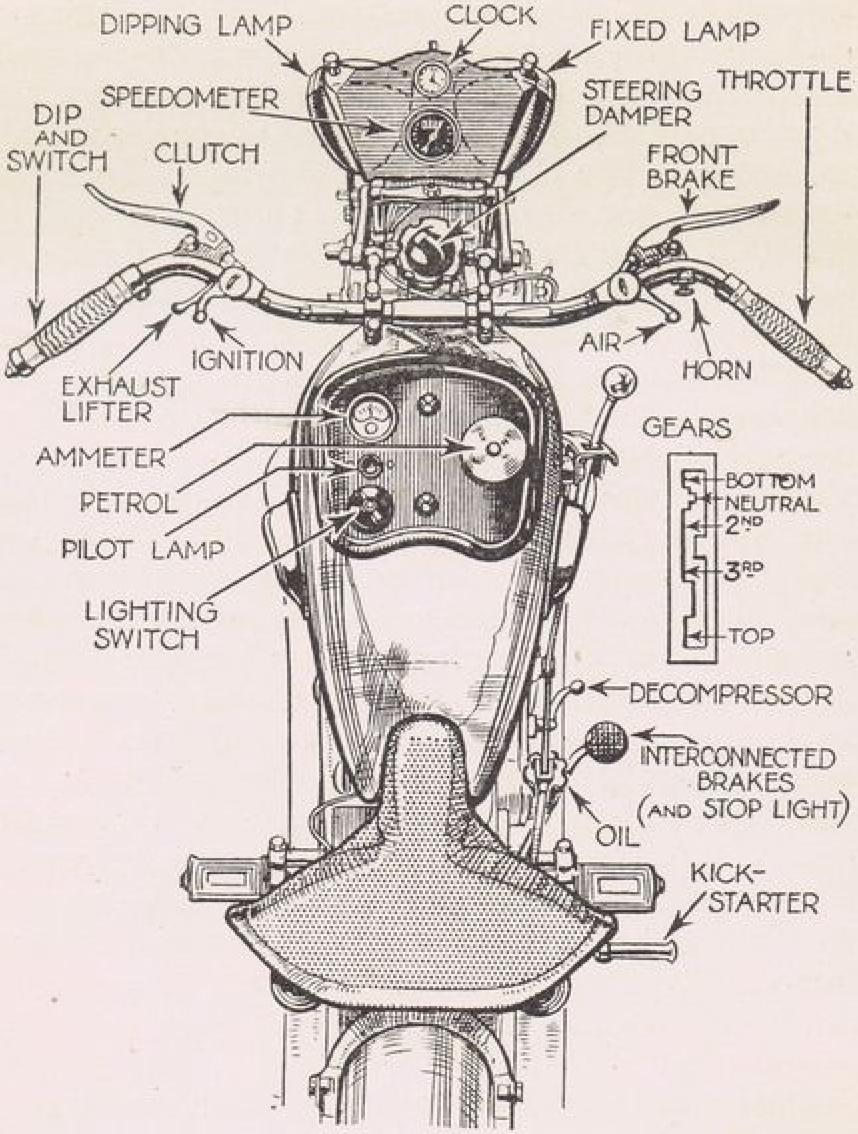
The chassis has immense strength but is of medium weight. C springs are fitted back and front and mounted in such a manner as to give a low centre of gravity and permit of ample clearance for abnormal conditions. All springs are fitted with grease gun nipples. A large, deeply valanced mudguard is sprung with the body.

The equipment includes 26 × 3·25 Dunlop cord tyre, sports wind screen, mat, and cover-all apron.

The chassis is fitted with special lugs to accommodate a detachable stand, which can be supplied if required. This will be of great assistance when removing rear wheel or sidecar wheel. The finish is in aluminium or coloured fabric optional without extra charge. Such extras as coach-painted finish or polished aluminium, four point attachment, and Miller electric lamp can be obtained for the very moderate sum of 10s. each.

A *de luxe* model Schneider Trophy sidecar (Model No. 2) is listed at £2 2s. extra, for which a luggage grid is provided and a specially strengthened windscreen with chromium-plated fittings. All parts on this model are also heavily chromium-plated, and the finish throughout is perfect.

For particulars of other types of sidecars, see the makers' separate sidecar list, a copy of which can be obtained from Messrs. Phelon & Moore, Ltd., whose address is 77 Mortimer Street, London, W.1.



(*From "The Motor-Cycle"*)

FIG. 31. THE 1931 "PANTHER" CONTROL LAY-OUT

THE P. & M. CONTROLS

Extreme neatness, ease of operation, and quick adjustment are the characteristics of the present "Panther" control arrangement. Indeed, there are few other machines to-day that can boast such symmetry and beauty of outline, unspoiled by untidy controls, as the "Panther." On this machine all control wires are entirely hidden from view.

The 1931 Villiers "Panther." This machine has nine controls, four belonging to the engine and five to the cycle parts. The engine controls are: (*a*) the throttle twist-grip on the right-hand side of the handlebars; (*b*) the air lever on the same side; (*c*) the ignition lever fixed to the engine; and (*d*) the pressure-release valve lever. The cycle controls are: (*a*) the gate-charge gear lever placed at the side of the tank; (*b*) the clutch lever on the left side of the handlebars; (*c*) the rear brake pedal on the offside; (*d*) the front brake lever on the right side of the handlebars; and (*e*) the steering damper on top of the steering column.

The 1931 O.H.V. "Panthers." The controls on the large capacity "Panthers" are shown in Fig. 31. Apart from the lighting switches on electrically-equipped 1931 models, there are nine controls, of which five are for the engine. They are: (*a*) the twist-grip throttle on the right side of the handlebars; (*b*) the air lever on the same side; (*c*) the ignition lever on the left side of the bars; (*d*) the exhaust valve-lifter lever below this; and (*e*) the decompressor fitted on the side of the timing-case. The cycle controls are: (*a*) the gate-change gear lever on the right side of the tank or the foot-change pedal placed in the position normally occupied by the brake pedal; (*b*) the clutch lever on the left side of the handlebars; (*c*) the brake pedal on the offside (or near side where a foot gear change is provided) operating the interconnected brakes and "stop-light" (where fitted); and (*d*) the front brake lever on the opposite side to the clutch lever. It should be noted that on all P. & M. machines the short finger levers are moved *outwards* to operate their respective movements or mechanism in the engine. An effective means of adjustment is provided for each control.

STARTING-UP

Before actually starting-up the engine, it is best to take a good look over the machine and get thoroughly conversant with the positions and actions of the various controls. Experiments may afterwards be made with them with the engine running on the stand.

Fuel and Oil Replenishment. Owing to the comparatively low compression ratios used on the latest "Panther" and "Redwing" engines, the use of practically any fuel is possible. Petrol-benzole mixture is specially recommended, as besides giving excellent power, it tends to increase the general flexibility of the engine. Carbon deposits when running on this fuel form slowly. For the two-stroke "Panther" ordinary petrol is as good as anything. Although a large gauze filter is included in the tank itself, it is, nevertheless, advisable when refueling from cans to see that a funnel incorporating a filter is used.

As regards oil replenishment, it is best to follow exactly the manufacturers' recommendations as regards the brand and grade (see pages 9 and 26), and not to change over from one brand to another without very good reason. On no account whatever replenish with loose oil supplied in bulk at some garages, as this entails the risk of damaging the entire engine. In the case of the Villiers "Panther," fill up the cylindrical oil tank behind the engine until the oil level is just below the filler cap orifice. After replenishment, make quite certain that the filler cap is screwed down absolutely tight, for with the Villiers lubrication system a pressure of about 4 lb. per sq. in. is maintained within the tank by the automatic regulator. 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. In the case of all the four-stroke "Panther" engines, the large filler cap at the rear of the timing-case should be removed and oil poured in until the engine sump, the level of oil in which is indicated by the dipstick, is from one-half to quite full (full position is shown by the top notch). No serious results are likely to follow temporary running of the engine with the sump almost exhausted, so long as the oil is not diluted, for whatever remains is kept in constant circulation; but it should be borne in mind that the more oil there is in circulation, the cooler it will keep, with therefore less risk of engine overheating occurring. The level of oil in the sump must not on any occasion fall below a point indicated by the bottom notch on the dipstick. Verification of the oil circulation with the engine running can be made on the two-stroke "Panther" and early S.V. "Panthers" with drip feed by means of the sight-glass provided on the oil tank, and by noting in the case of O.H.V. models whether the indicator needle on top of the disc regulator has risen to its fullest extent. After replenishing the oil sump, see that the filler cap is replaced properly. If this cap should unscrew and come out while the engine is running, all the oil will be blown out, and the engine and your legs will be saturated. Apart from this there is the imminent danger of a first-class engine seizure occurring.

Information concerning regulator adjustment will be found in Chapter IV. Beyond regular sump replenishment, its occasional draining, and cleaning of the filter, no attention is necessary to the P. & M. semi-D.S. lubrication system.

Tyre Inflation. All the O.H.V. "Panthers" are fairly heavy, and if the maximum mileage from the covers is to be obtained, together with comfort and good steering, it is absolutely essential to keep the tyres inflated to the correct pressures (given in specifications), which can readily be checked by applying a Schrader pressure gauge to the valves. Under- or over-inflated tyres wear quickly, and sometimes their life is abruptly terminated by concussion bursts that with normal pressures would not occur.

Starting the Engine (1930 and 1931 O.H.V.). Turn on the petrol and flood the carburettor* by holding down the plunger on top of the float chamber. Do not depress this plunger violently or with great rapidity: it is only necessary to do this gently and with as little force as possible, because this plunger operates direct on to the carburettor float, a light, delicate, sheet-metal body, which is easily damaged or punctured. The plunger should be released immediately that petrol drips from the small holes drilled in the carburettor body. The decompressor should now be brought into action by pulling upwards the lever situated on the front end of the timing-case cover. Should the engine be in such a position that the lever will not pull fully home, it is only necessary to lift the exhaust valve off its seat by means of the exhaust lifter (left-hand inverted lever on handlebar on 1930 models and longest of two finger levers on same side on 1931 models), thus releasing the pressure between the half-compression tongue piece, the exhaust cam lever, and the small decompressor cam on the camshaft. Now open the throttle, either by operating the twist-grip or by the lever, about one-fifth of its full movement. See that the ignition lever is fully retarded, that is, pushed away from you as far as possible on 1930 models (except sometimes where a Bosch lighting set is fitted) or pulled as far in as possible towards you on 1931 models), and that the gear lever is in the neutral position. The engine is now ready for starting, and should spring into life by a few sharp strokes of the kick-starter pedal after switching on the ignition on coil-ignition models. It is imperative that the kick-starter is operated as sharply as possible, to ensure a good spark from the magneto and consequent easier starting. When the engine has started, see that the kick-starter has returned properly to place in the spring stop. If this is not done, very bad wear will occur between the teeth of the starter ratchet and the engaging pawl. Should you forget this point at any time, the noise from the mechanism will remind you; it sounds like a very noisy bicycle free-wheel. Now press the decompressor lever out of action, and cultivate the habit of doing this immediately the engine has started. If you omit to do this, you will only be using half the cylinder capacity of your engine, besides which you will completely wear out the decompressor tongue piece and other components. Now advance the ignition lever, that is, push away from you (1931), and at the same time fully open the air slide in the carburettor by pushing away from you the air lever on the right side of the handlebars.

The engine should by now be running freely, and the throttle may be closed down until the engine is running at a "tickover"

* If an Amal "pump" type carburettor is used, it should not be flooded.

speed on the pilot jet. On all 1930–1931 models an adjustable carburettor throttle stop limits the closing of the throttle slide, so that once the engine has been started up it is necessary in order to stop it, to choke it with the air lever or else raise the exhaust valve lifter. Do not interfere with the throttle stop or pilot air adjustments unnecessarily, as these are carefully regulated by the manufacturers and should not require alteration. When running the engine in a garage, see that the door is left open, as the dangerous carbon monoxide gas accumulates quickly. Never race the engine for long periods in neutral gear, as this only creates high temperature in the cylinder head and around the exhaust port, causing the exhaust valve to work at a higher temperature than is necessary. Before actually starting the machine in motion, habitually glance down at the oil indicator, and make sure that it has risen out of the indicator body, thus proving that the pump is working satisfactorily and oil is circulating throughout the engine. Also have a glance at the exhaust, which should be tinged with blue smoke. Adjust the regulator (see page 81), if necessary.

Starting the Engine (1930 and 1931 Two-stroke). Turn on the petrol and oil, and gently flood the carburettor. Then after adjusting, if necessary, the tank oil regulator, turn the lever controlling the variable jet to the "rich" position, open the throttle lever one-quarter, and retard the ignition lever. Now lift the pressure release valve lever and kick the engine over slowly several times so as to charge the crankcase and cylinder fully, after which the engine can be made to fire by giving one vigorous kick on the starter pedal and dropping the release valve as the pedal nears the bottom. With the Villiers "Panther" it is rare to experience serious starting trouble, but be careful not to flood the carburettor excessively. As with the four-stroke engines, after starting up do not allow the engine to run faster than necessary to secure even running.

Difficulty in Starting. A number of diverse minor matters may make an engine difficult to start, but we are presuming you have a new machine delivered from the works, and we are therefore taking it for granted that everything is in order. In any case you can mistrust the "expert's" advice that your machine has a faulty magneto or requires a new sparking plug. If you have any difficulty, it is safer to attribute it to your inexperience; therefore, do not start making alterations to a machine built and tested by men who have spent their lives on that work, but be careful to avoid overflooding the carburettor, as this results in neat petrol being drawn into the cylinder and *this will not fire.* Naturally, it will be necessary to experiment with different positions of throttle and air controls until the best setting is found.

The correct setting of the Bowden controls are, of course, dependent upon there being no backlash at the levers, and if there is any it should be taken up by means of the adjustable cable stops. Difficult engine starting on the four-stroke "Panthers" is often due to giving too large a throttle opening, and the *importance of keeping the throttle lever or twist-grip nearly closed* cannot be over-emphasized. Only by so doing can a high velocity air current be induced over the pilot jet, as may be understood by reference to Fig. 41.

GEAR CHANGING

In connection with gear-changing, there are three most important points that should always be borne in mind: (1) never employ brute force on the gear lever; (2) always declutch before making a change; and (3) use the gear-box for the purpose for which it is designed (i.e. maintaining a reasonably high *engine* speed under adverse conditions). The art of gear-changing is easily and quickly mastered, but practice alone will enable perfect gear changes to be made. It is purely a question of the accurate co-ordination of several movements calling for a little judgment and precision.

In the case of an absolute novice, the first few runs are bound to be something in the nature of an ordeal, and the author most strongly advises him not to take his "Panther" on to main roads until he is absolutely sure that in an emergency he can trust his subconscious mind to manipulate the controls without hesitation in the proper manner. For practising gear-changing, the best course is to find a deserted piece of straight road and go through the various changes one by one until some degree of proficiency is obtained. Considerable caution should be exercised for some days, and high speeds should not be attempted until driving experience has been gained. When obtaining delivery of a new "Panther," the wisest course is, if the buyer lacks experience, to get his machine delivered by the nearest agent for a small charge.

Gear-changing on the O.H.V. "Panthers." These machines, as mentioned elsewhere, are provided with three-speed Sturmey-Archer or four-speed P. & M. gear-boxes, and have either a foot-pedal control or a gate-change gear lever. The process of gear-changing is much the same, however, in all cases.

It is assumed that the rider is seated on the machine with the engine running, and the gears in neutral. Then to set the machine in motion, disengage the clutch by lifting the handlebar lever fully, and keep the engine running lightly on a small throttle opening. Grasp the gear lever knob with the right hand or place the right foot on the gear pedal, and press forward the gear lever or depress the pedal from the neutral position into the first gear position. If the gear does not engage freely, move the machine slowly backwards or forwards by use of the legs until, without exerting any more pressure, the gear slips noiselessly into position. Now open the throttle gently and at the same time slowly release the clutch lever so that the engine is being slowly coupled to the rear wheel. As the clutch plates are allowed to come into contact with each other, the machine will gently glide away until after about three or four yards (on level road) have been travelled over, the clutch should be fully released. The machine will now be travelling freely forward in bottom gear, and, up to a speed of ten miles per hour, the engine will not be unduly " over-revved." The change from first to second should be made with as much precision and speed as possible, but it is always best, where acquiring experience, to do it slowly and firmly. The throttle should be slightly closed with the right hand and at the same time the clutch fully lifted. Now, with the clutch still out, move the gear lever or pedal from the first to the second gear position quickly and firmly and, when in position, release the clutch. The same procedure applies in respect of the other gears, the engine being accelerated in each gear in order to give the machine a certain amount of road speed before engaging the higher gear. It is inadvisable to miss out intermediate gears when changing up, as the sudden large alteration in speed is apt to cause a skid and tries the transmission rather severely, unless judicious use be made of the clutch. No ill-effects, however, are likely to follow as far as the gear-box itself is concerned, as all pinions are in constant mesh. No amount of running in any of the gears will damage the gear-box, but it is inadvisable to "rev" the engine continuously in the lower gears, owing to the risk of overheating the engine. Never, on any occasion, drift down hills in neutral and then attempt to engage the gears with machine still moving and the engine stationary. This is gear-box abuse, and the finest and toughest materials will not stand it for long. Should you stop your machine with the gear lever or pedal in any other place but neutral and you wish to place it in this position, move the machine either backwards or forwards slowly, and at the same time move the gear lever or pedal towards the neutral position. This must be done in order to move the dogs through their necessary meshes before striking neutral, although with foot-control neutral is very readily obtained. When changing down, move the gear lever smartly from one notch to the other or raise the foot pedal with the clutch fully lifted, and do not re-engage the clutch until the machine has slowed to a speed at which it normally travels at the same throttle opening with the gear to be engaged. Once the gear is fully home and the machine is already in motion, as is the case when changing, say, from top to third gear, the clutch may be released much quicker than when starting off from rest.

When you have acquired a certain amount of "road sense" and gained confidence in yourself, it is time to consider some of the finer points in driving your "Panther." Although the engine is exceptionally flexible, the power output increases as the engine revolutions go up—within certain limits. It is for that reason that a four-speed gear-box is often fitted, and full advantage should be taken of this valuable feature. Do not change up to a higher gear too soon and do not wait until the engine starts labouring before changing-down on a hill. Never slip the clutch as an alternative.

It is advisable, high-efficiency engines being very sensitive to ignition timing, never to advance the spark fully until fairly high revolutions have been reached, and gradually to retard the spark as the revolutions drop—as on hills, in traffic, etc. Always remember, however, that retarding the ignition lessens the power output, and if habitually done without cause may damage the exhaust valve.

Gear-changing on Two-stroke Models. Other than the hints for the O.H.V. models just given, no special notes on these machines, which also have three-speed gear-boxes, are called for, except to mention that with these high revving engines, special care must be taken to maintain engine speed on gradients. Unless this is done, considerable stresses are imposed on the engine.

GENERAL ADVICE

Use of Brakes. The "Panther" interconnected brakes have unusually good stopping power and are thus liable to abuse. Over-frequent and harsh brake application results in very heavy tyre wear and it also imposes unnecessary stresses on the transmission generally. The rider should cultivate the habit of driving on the throttle and applying the brakes lightly, except in case of emergency.

Running-in Engine. On taking delivery of a brand new "Panther" or "Redwing" model, certain care must be exercised for a period when driving, if the best results are to be ultimately attained. Careless handling during this running-in period may not only prevent the engine from even giving of its best, but it may actually ruin it. Certainly it is tempting to have a short "blind," but a rider should ask himself whether it is worth while. The reasons why running-in of a new engine is necessary are that, in the first place, the contacting metal surfaces are for some time comparatively soft and easily damaged; and, secondly, working clearances throughout are very small, with the result that the coefficient of friction is high and lubricating oil has considerable difficulty in reaching in the necessary quantity all the bearing surfaces. There is no real limit to the running-in period, and it

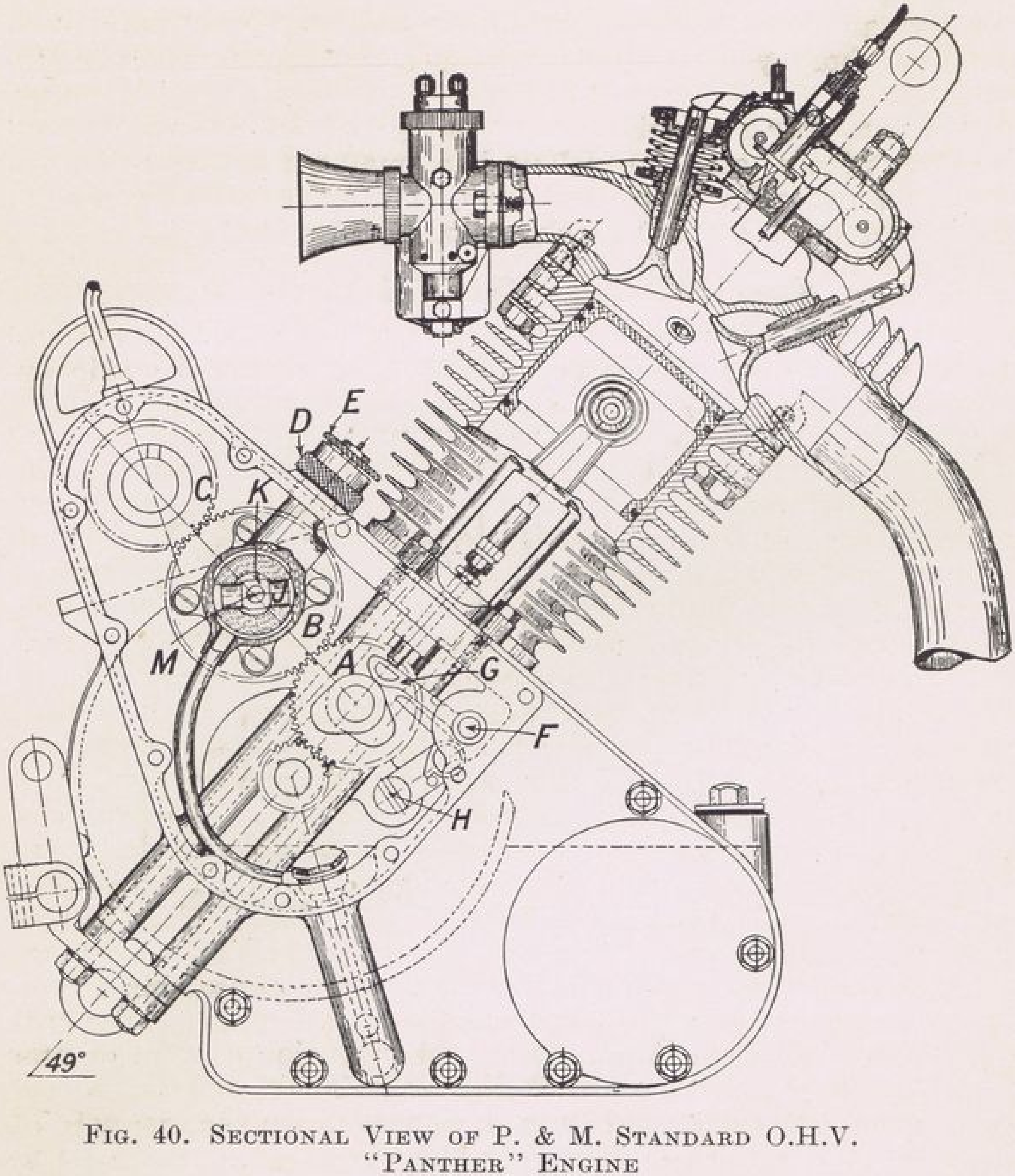


Fig. 40. Sectional View of P. & M. Standard O.H.V. "Panther" Engine

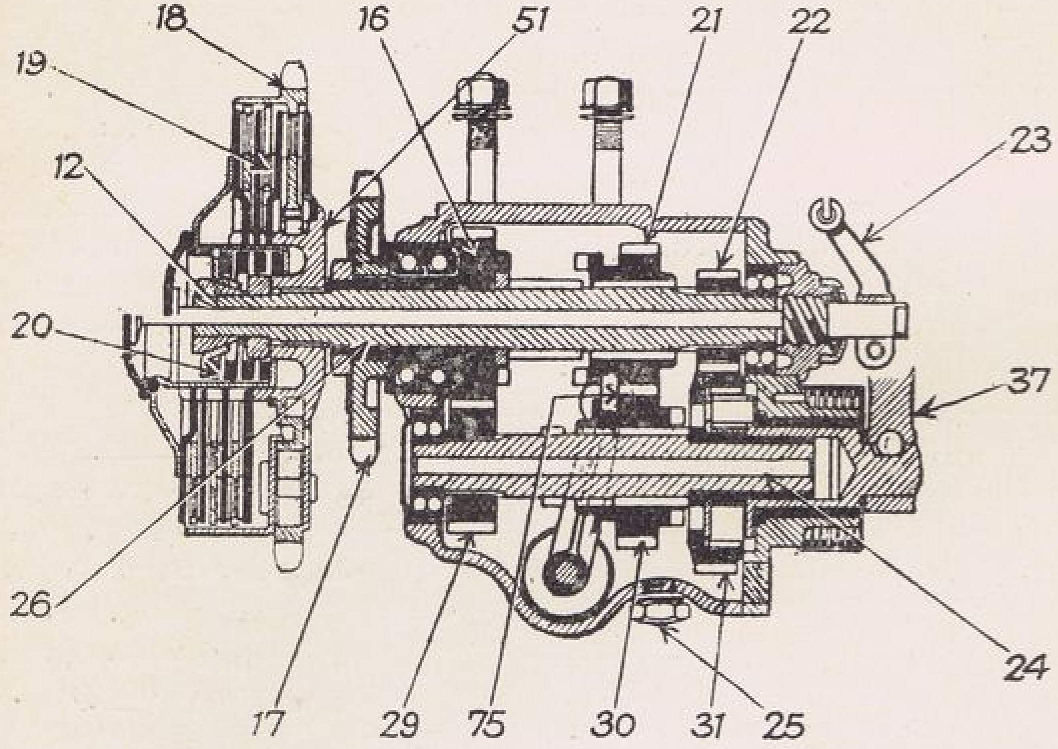
The above drawing shows the principal features of the "Panther" engine very clearly. The engine shown is actually a 1929 model. Present engines are similar except for detail modifications, such as a redesigned rocker-box, the elimination of a scraper ring, a new type of exhaust valve lifter, the fitting of a filter in the sump, longer valves, automatic valve lubrication, etc. The parts identified by lettering are as follows—

A = Camwheel
B = Intermediate wheel
C = Magneto drive shaft
D = Pump regulator collar
E = Regulator disc
F = Cam lever-bearing pin
G = Cam levers
H = Decompressor
J = Pump plunger
K = Plunger block
M = Pump plunger pin (eccentric)

Tuning and maintenance hints will be found on pages 116 and 127 respectively.

The B.T.-H. Type M.1 Magneto (Fitted to Models 50, 60, 90). This magneto, which is fitted on all present magneto-ignition "Panthers" and also on some earlier machines, is a neat and compact machine of the ordinary stationary magnet type. All B.T.-H. magnetos before dispatch from the works are thoroughly tested, and can be relied upon to deliver high-voltage sparks for a great number of years if kept clean and properly adjusted. The M.1 magneto is thoroughly waterproofed throughout, although in the case of the "Panther" its mounting at the rear of the engine protects it from road mud or dirt. The armature, which has an anti-clockwise rotation (driving side), revolves on ball bearings packed with grease. To prevent damage to the secondary windings in the event of the high-tension circuit being interrupted, a safety spark gap is provided. The earth electrode of this gap is a small hexagon-headed screw, fitted in the slip-ring end of the main housing, and locked by means of a tongued strip. Under no circumstances should this earth electrode be removed, as great care is necessary. The high-tension pick-up brush is housed in a neat flanged holder bolted above the slip-ring track. It is thus impossible for water to find its way on to the slip-ring. Fig. 43 shows a view of the contact-breaker end of the magneto, and the design of the contact-breaker (see also Fig. 59) can be seen. It has the usual type rocker-arm, with a fibre heel bearing against the cam ring, which can be rotated through about 25 degrees by the ignition lever. A self-contained return spring is fitted. The contacts, the inner one of which is adjustable, are of platinum and designed to operate with a gap of ·012 in. A neat cover encloses the entire contact-breaker mechanism. (For notes on the care of the magneto, see page 128.)

The Sturmey-Archer Three-speed L.S. Type Gear-box (Fitted to All Models). Referring to the sectional view at Fig. 44, the clutch body (51) is keyed to the tapered end of the mainshaft, and the clutch sprocket which becomes locked to the body by the springs (20) pressing the driven plates (19) against the friction inserts of the clutch sprocket. Thus so long as the engine is running and the clutch worm lever (23) is not causing the mainshaft plunger (12) to release the spring pressure, the mainshaft rotates on its ball bearings. On both sides a double-row ball bearing is used. Interposed between the thrust bearing on the left side and the mainshaft is a sleeve, to which are fixed the top gear dogwheel (16) and the gear-box sprocket (17). This sleeve is free to rotate on the mainshaft. The top gear dogwheel is in constant mesh with the layshaft driving pinion (29) keyed to the layshaft, so that whenever the layshaft is in motion the sleeve and gear-box sprocket transmitting the drive to the rear wheel also rotate at a speed equal to layshaft speed × ratio of the diameters of the two meshing pinions. Keyed to the end of the mainshaft opposite the clutch is the bottom gear pinion (22), and free to rotate upon the layshaft, and in constant mesh with it is the layshaft kick-starter driven dogwheel (31), which has a ratchet on its outer



(*Sturmey-Archer Gears, Ltd.*)

FIG. 44. SECTIONAL ARRANGEMENT OF STURMEY-ARCHER THREE-SPEED L.S., F.W. GEAR-BOX AND CLUTCH

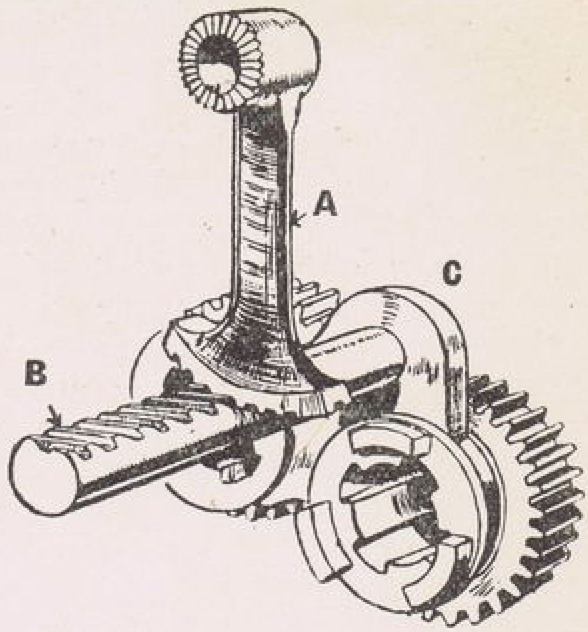
The gear-box is mounted in the "Panther" horizontal. The studs shown are not used

12—Clutch-operating plunger
16—Top gear dogwheel
17—Gear-box sprocket
18—Clutch sprocket
19—Clutch-driven plates
20—Clutch springs
21—Mainshaft sliding dogwheel
22—Bottom gear pinion
23—Clutch worm lever
24—Layshaft
25—Drain plug
26—Top gear dogwheel sleeve
29—Layshaft driving pinion
30—Layshaft sliding dogwheel
31—Layshaft kick-starter driven dogwheel
37—Kick-starter crank
51—Clutch body
75—Striking plate

face with which the kick-starter pawl engages, thus rotating the clutch sprocket direct *via* the fixed low-gear pinion and this dogwheel. The mainshaft is splined for a considerable portion of its length, the unsplined part being that adjacent to the low-gear pinion. Similarly, the layshaft is splined except adjacent to the driving pinion and near the centre. Two sliding dogwheels—one on the mainshaft and one on the layshaft—are simultaneously moved by a single striking plate (75, Fig. 44) and a conveniently-placed lever; internal indexing of the gear positions is provided by a spring-loaded plunger. The two sliding dogwheels are responsible for connecting the primary and secondary drives, and providing the three speeds, which are obtained as follows—

Top Gear (Third). The mainshaft and layshaft sliding dogwheels are moved to the extreme left (Fig. 44), until the mainshaft sliding dogwheel interlocks with the top gear dogwheel. The layshaft sliding dogwheel thus automatically becomes free to idle on the layshaft non-splined portion; while the top gear dogwheel gear-box sprocket and clutch sprocket rotate as a single unit, giving a direct or top gear drive.

Middle Gear (Second). The sliding dogwheels are moved across slightly to the right, allowing the short layshaft splines to engage with the corresponding keyways on the lower sliding dogwheel. The drive is then transmitted from the mainshaft *via* the two sliding dogwheels, layshaft, and layshaft-driving pinion back to the top gear dogwheel sleeve and gear-box sprocket. The resultant gear ratio obtained depends upon the relative diameter of the two pairs of gear wheels involved.



(Sturmy-Archer Gears, Ltd.)

FIG. 45. THE RACK AND SEGMENT CONTROL ON THE F.W. GEAR-BOX

Neutral. The sliding dogwheels are moved a trifle farther to the right into the position shown at Fig. 44, until the mainshaft sliding dogwheel leaves the mainshaft splines and simply idles on the mainshaft, causing no rotation whatever of the layshaft.

Bottom Gear (First). The sliding dogwheels are moved to the extreme right until the layshaft sliding dogwheel engages with the dogs of the layshaft kick-starter driven pinion. The mainshaft sliding dogwheel has now left the mainshaft splines, and idles while the mainshaft drive is transmitted to the layshaft by the bottom gear pinion and layshaft kick-starter driven dogwheel, and thence to the gear-box sprocket and secondary transmission *via* the layshaft driving pinion and top gear dogwheel. Two separate gear reductions occur, giving bottom gear.

The Sturmey-Archer Three-speed F.W. Type Gear-box (Fitted to Model 25). This light-weight gear-box, while of the same general design and construction as the F.W. type, has an entirely different gear-operating mechanism, comprising a rocking segment and rack.

Details of this mechanism are shown at Fig. 45. The method of operating the gears can readily be followed. The rocking segment *A* has cut on its underside skew teeth, which engage with corresponding teeth cut on the gear-shifting rod or rack *B*. Fixed to the opposite end of this rod is the striker plate *C*, the lower part of which fits in grooves round the two sliding dogwheels. It is thus clear that the effect of rocking the segment by means of the gear-box lever attached to its spindle is to move the sliding dogwheels to and fro, and so obtain the various gear changes.

The P. & M. Four-speed Gear-box (Extra, all Models). The constructional details and control mechanism of this gear-box are well shown in Fig. 46. The mainshaft *A* and layshaft *B* are mounted side by side, and carried in ball bearings, whose races are pressed into the gear-box shell on one side and the gear-box end-plate on the other side. The mainshaft carries on its outside extension the clutch and gear-box sprockets. The gear-box sprocket is not like the clutch keyed to the mainshaft, but is fitted to a sleeve which can revolve freely on the mainshaft. Also fitted to this sleeve, just inside the box, is the top gear dogwheel *F*, in constant mesh with the layshaft-driving pinion *G*. At the opposite end of the gear-box are two other pinions in constant mesh, the bottom gear pinion *E* keyed to the mainshaft and the layshaft kick-starter driven dogwheel *K*, able to rotate freely on the layshaft. It should be noted that with all gears, except top gear engaged, the drive is passed from the layshaft back to the top gear dogwheel sleeve and gear-box sprocket *via* the pinions *G*, *F*. Above the mainshaft is a special camshaft *N*, whose rotation causes two striking forks O_1, O_2 to move four sliding dogwheels, namely, the mainshaft and layshaft second and third-gear dogwheels, *C*, *D*, *J*, *H*. The two dogwheels *C*, *J* are splined to the shafts and, therefore, although able to move endwise, cannot rotate freely on the shafts. The dogwheels *D*, *H*, however, are able to move endwise and rotate freely. The kick-starter drive is taken through the bottom gears, the arrangement being similar to that employed on the Sturmey-Archer three-speed gear-box. The layshaft kick-starter driven dogwheel *K* has ratchet teeth cut on its dished outer face, and depressing the kick-starter crank causes a small pawl attached to its axle to rotate the dogwheel, which passes its movement on to the mainshaft and clutch sprocket through the bottom gear pinion *E*. The clutch itself is a five-plate type with six springs, whose pressure on declutching is released by means of a small lever on the offside pushing against a long rod floating in the hollow mainshaft, which in turn pushes forward a small clutch button in direct contact with the outer

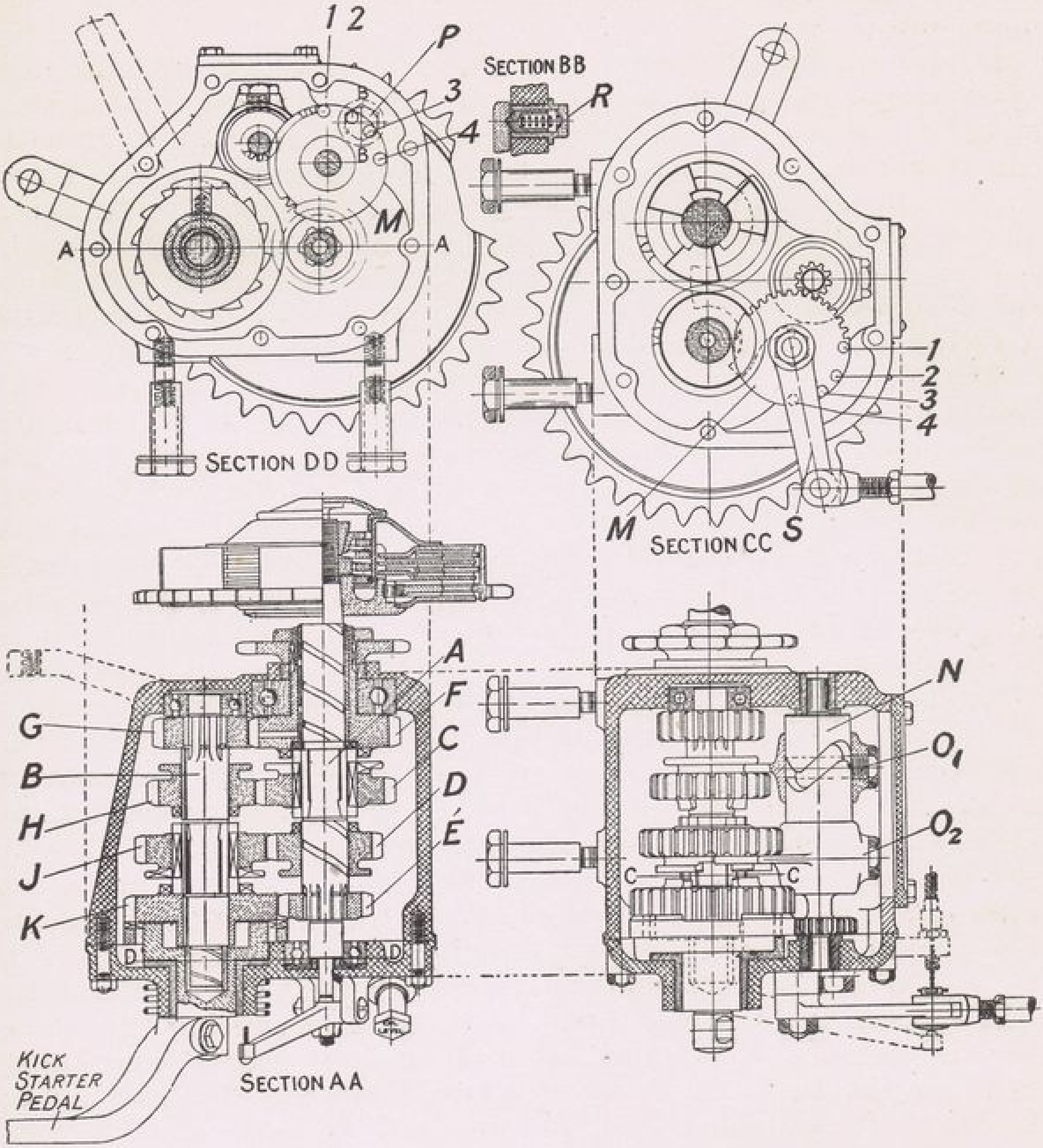


FIG. 46. GENERAL ARRANGEMENT OF THE P. & M. FOUR-SPEED GEAR-BOX

A = Mainshaft
B = Layshaft
C = Third gear mainshaft sliding dogwheel
D = Second gear mainshaft sliding dogwheel
E = Bottom gear pinion
F = Top gear dogwheel
G = Layshaft driving pinion
H = Third gear layshaft sliding dogwheel
J = Second gear layshaft sliding dogwheel
K = Layshaft kick-starter driven dogwheel
M = Indexing wheel
N = Camshaft
O_1, O_2 = Striking forks
P = Plunger fixing cap
R = End-plate plunger

clutch cover plate. Adjustment is provided by a hardened screw and lock-nut fixed to the lever. An ingenious method of obtaining a positive internal indexing of the gear positions is used on the P. & M. gear-box. The camshaft *N* has at its end opposite to the clutch a wheel *M*, on which are four shallow dimples spaced round the circumference. A spring-loaded plunger *R*, held by a cap *P* to the end-plate, bears on the back of these dimples and, of course, definitely locates the position of the wheel *M* as each dimple, which corresponds to a certain gear, comes into line with it. This indexing system not only makes for surer gear-changing, but also facilitates gear-control adjustments (page 109). The action of the gear-box is briefly as follows—

First Gear. The camshaft is rotated until the striker O_2 moves the second-gear sliding dogwheels *J*, *D* to the extreme left, causing the layshaft dogwheel, which slides on the layshaft splines, to interlock with the dogwheel *K*, which becomes fixed to the layshaft and rotates with it. The mainshaft sliding dogwheel remains free to idle on the mainshaft. The drive is thus transmitted from the clutch sprocket and mainshaft through the pinions *E*, *K* to the layshaft and back to the top gear dogwheel sleeve and gear-box sprocket *via* the pinions *G*, *F*. Two large gear reductions occur on either side of the gear-box, giving bottom gear.

Neutral. The second gear sliding dogwheels *J*, *D* are moved to the position shown in Fig. 46. No motion is imparted to the layshaft, because the dogwheel *J* is not connected to it and merely idles.

Second Gear. The second gear sliding dogwheels *D*, *J* remain in the neutral position, but the striker O_1 causes the mainshaft third-gear sliding dogwheel *C* to interlock with the dogwheel *D*, thus locking the latter to the mainshaft and causing the drive from the mainshaft to be transmitted *via* the second-gear sliding dogwheels to the layshaft and back through the pinions *G*, *F* to the top-gear dogwheel sleeve and gear-box sprocket. Two considerable gear reductions occur.

Third Gear. Here the layshaft third-gear sliding dogwheel *H* is locked to the layshaft by sliding across to the right the second-gear sliding dogwheel *J*, so that the dogs of both are in mesh. The mainshaft second-gear sliding dogwheel remains in the neutral position and idles, while the drive is taken from the mainshaft through the third-gear dogwheels *C*, *H* and back to the mainshaft sleeve *via* pinions *G*, *F*. There is only a slight gear reduction.

Fourth Gear. The third-gear sliding dogwheels are moved by the striker O_1 to the extreme right until the dogs on the mainshaft one interlock with the top gear dogwheel *F*, thus locking the mainshaft and the mainshaft sleeve together, giving a direct top gear drive. There is no gear reduction at all within the gearbox.

CHAPTER IV

LUBRICATION

By far the most important matter in connection with the care of a motor-cycle is proper lubrication of all working parts. Indeed, so vital is the question of lubrication that designers have of recent years still further reduced the number of parts requiring attention by the rider. The engine lubrication system used on the "Panthers" is practically automatic, but there still rests a definite responsibility on the part of the rider; and if he would derive the best service from his machine, he should pay due regard to the points mentioned in this chapter. Lubrication, which consists of maintaining a microscopically thin film of oil between all moving surfaces, can conveniently be subdivided into two main groups: (*a*) engine lubrication; (*b*) cycle lubrication. Engine lubrication, owing to the high speeds obtained and the great heat generated in the combustion chamber, is of paramount importance.

Every moving part of the machine requires oil, from the gear lever, which may be moved on an average every 20 miles, and then only for the fraction of an inch at the temperature of the atmosphere, to the piston which moves up and down at a very high temperature several thousand times a minute. The quantity of oil depends upon the number of times which the part is moved during a given period, but wherever there is friction, however little and infrequent, oil is necessary. We will start with the most important part, and deal with the engine.

ENGINE LUBRICATION

The Semi-dry Sump System. This system fitted to all present "Panther" models has already been dealt with at considerable length on page 26. As may be seen in Fig. 48, the whole of the oil in the engine is kept in constant circulation. Oil from the sump is drawn through a filter and suction pipe to the rotary oil pump, whence it is forced under pressure to a point in the cylinder about half-way up the piston stroke and to the timing-gear. The surplus supplied to the cylinder falling back upon the flywheels and crankshaft is splashed throughout the engine, and lubricates the main bearings, overhead valve gear, timing-gear, etc. All surplus oil finally is returned to the sump by being thrown back by the flywheels over a baffle. Whatever oil collects at the base of the timing-case drains to the sump *via* a duct cut in the crank-case casting.

The Rotary Oil Pump. The design of the rotary oil pump, which has no valves, may be understood by reference to Figs. 47 and 49. Fitted to the wall of the timing-case is a flanged and circular body hollowed out to receive the close-fitting pump rotor which forms the centre boss of the intermediate timing wheel (which has a clockwise rotation). The rotor itself is also hollowed, and on its thick circumference has two diametrically-positioned holes which act as bearings for a solid bronze plunger. Fitting over the centre of the plunger, and at right angles to it, is a square section block drilled to receive a stud fixed to the timing-case body eccentrically to the rotor. Thus, as the rotor revolves a

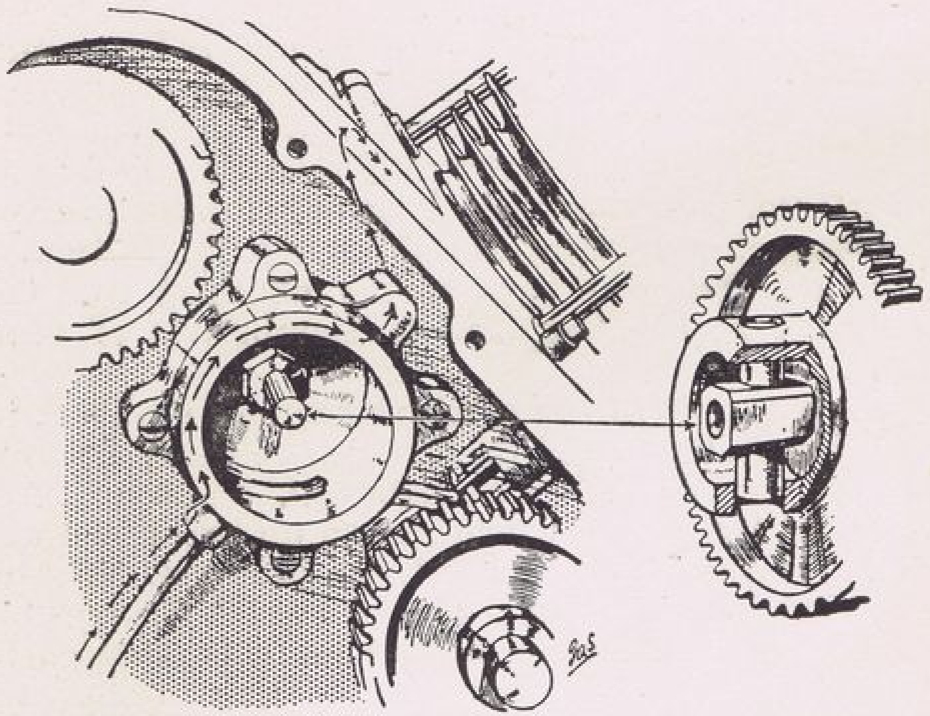


Fig. 47. Showing Drive of Rotary Oil Pump

reciprocating motion is imparted to the pump plunger, which constitutes a double-acting pump. As the plunger moves upwards in the rotor a vacuum is caused at the lower bearing hole since the rotor fits closely in the housing. This vacuum is arranged to occur as the reciprocating plunger end passes over a groove cut in the lower part of the housing. Oil is, therefore, sucked up from the sump *via* the filter and suction pipe, and fills up both the groove and the space vacated by the plunger. As the rotor further rotates, the end of the groove is passed, and the oil between the housing and plunger is trapped. Having reached the limit of its upward stroke, the plunger commences to reverse its motion and in doing so expels the oil into a small opening cut in the housing at the top. This oil is then led to the cylinder and piston by the main oilway, while some of it is by-passed to the timing-gear, as already referred to on page 27. A similar action is brought about alternately by each end of the reciprocating and rotating plunger. Thus a steady flow of oil is forced to the cylinder and other parts of the engine.

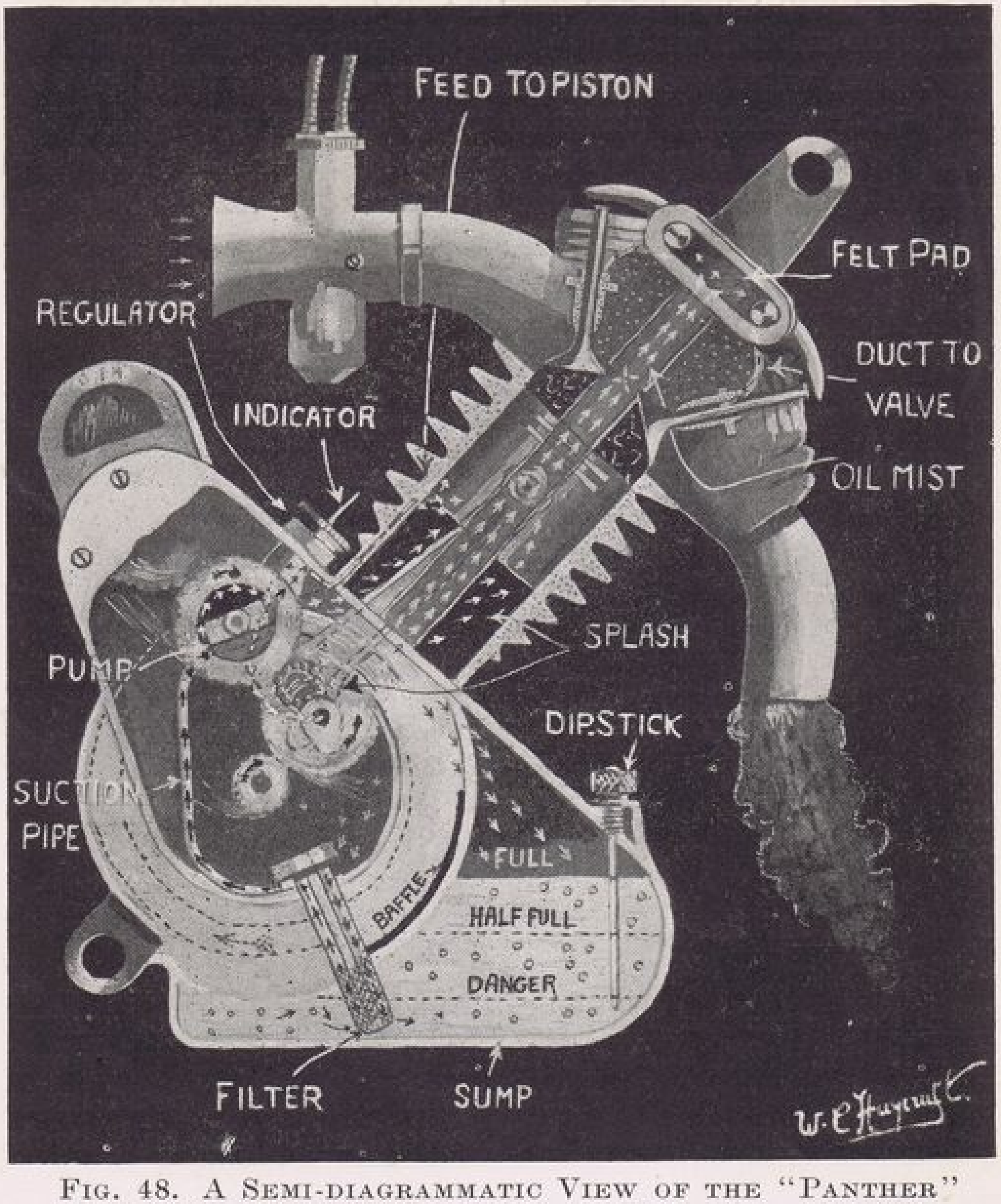


Fig. 48. A Semi-diagrammatic View of the "Panther" Engine Lubrication System

The approximate circulation of oil in the engine is shown by the arrows. Observe how the oil is drawn from the sump up to the rotary pump and forced to the piston and timing gear. The push-rods are not shown, but these are lubricated by oil mist on its way to the rocker-box. All main bearings are now lubricated by splash, but on the old T.T. engine oil was forced to the big end *via* a drilled crankshaft

Regulation of Rotary Pump. Above the pump-rotor housing, and integral with it, is a special housing containing the regulating barrel (see Fig. 49), a cylindrical body having a groove cut at its lower end, adjacent to the main oilway to the cylinder, in such a manner that a slight rotation of the regulator by means of the milled disc at its upper end causes the volume of oil permitted to pass along the main oilway to be varied at will. Below the milled disc (*E*, Fig. 40, cross-section) of the oil regulator is a thick collar *D*, also milled. This collar contains a felt ring, making an oil-tight joint with the face of the crankcase on to which it is screwed down. Should oil start leaking at this point, tighten the ring down with gas-pliers or other suitable tool, but do not overdo it—a reasonable pressure is all that is needed. The regulator disc, which is situated in such a position that it can easily be operated from the saddle, can be rotated a quarter of a revolution, the extreme positions being determined by two stops giving

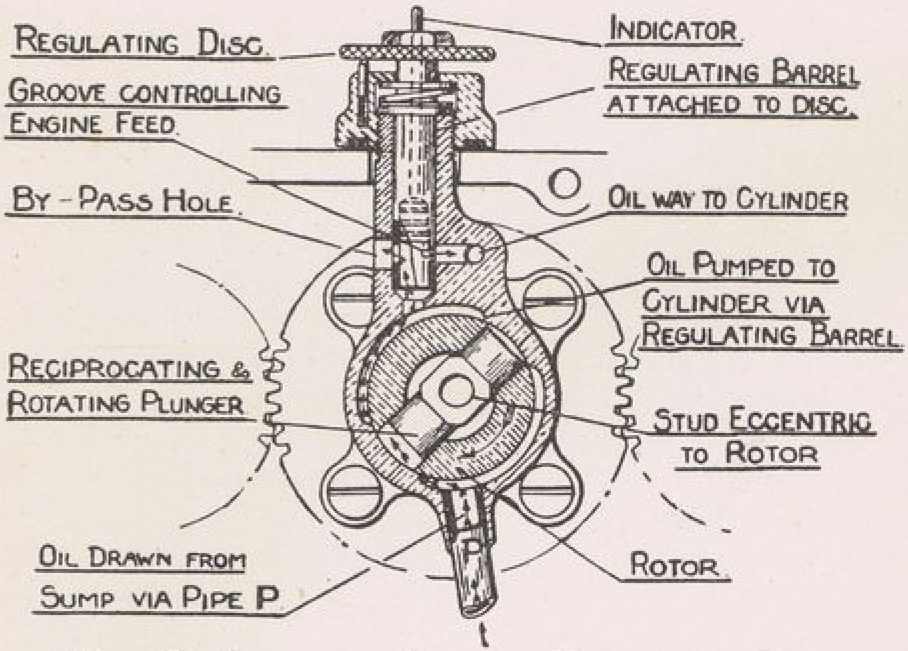


FIG. 49. SECTIONAL VIEW OF ROTARY OIL PUMP

maximum and minimum oil delivery. On the score of safety, the regulator is designed so that the oil supply cannot be entirely cut off. Passing through the regulating barrel is a short indicator rod free to move up or down. The lower end of this rod, as clearly shown in Fig. 49, is in contact with the main oil feed, and the pressure of the oil under normal working conditions is sufficient to raise it fully and so provide a reliable guide as to the proper functioning of the oil pump. Should the indicator not be raised when the engine is running with the regulator advanced, it would denote a very low oil level in the sump (see replenishment notes on page 49), a choked filter, a damaged suction pipe, or a serious defect in the pump itself. A habit should be cultivated of keeping at all times a watchful eye on the indicator.

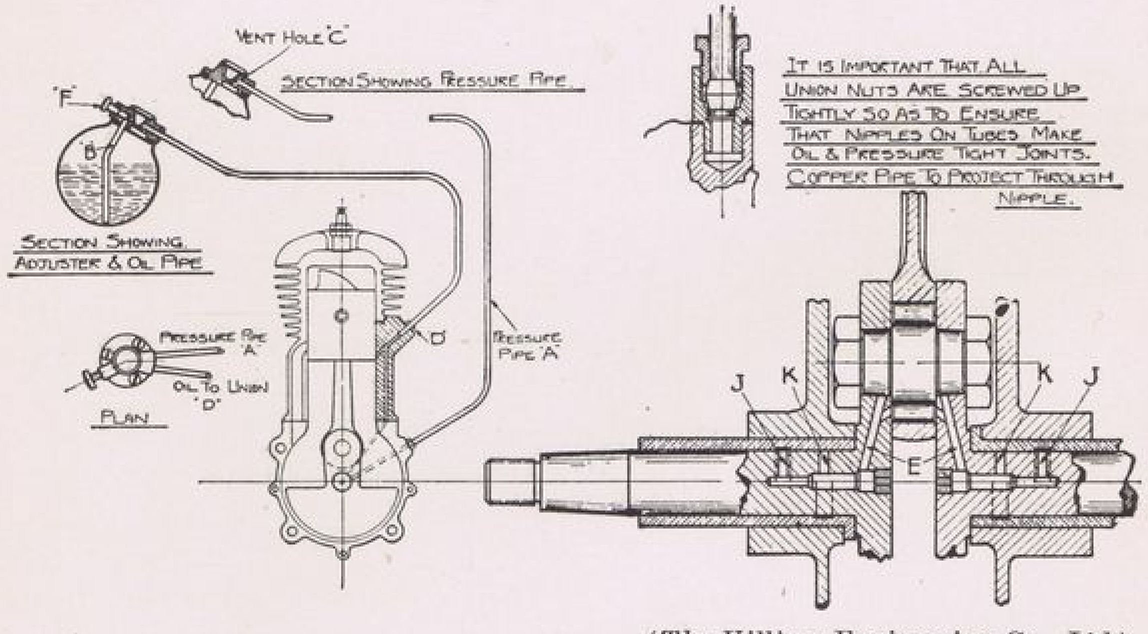
As regards the quality and quantity of oil supplied to the engine, use Castrol "XL" and exercise discretion as regards the regulator setting. When the machine is new, it is best to regulate the oil supply to cylinder and crankcase so that it is rather generous. This can be best ascertained when the engine has become thoroughly warm, when a thin blue haze should be emitted from the silencer fish tail. It is not necessary for the engine to smoke violently, as this is only wasting oil and forming undue carbon deposit on the piston and cylinder head. If a sidecar is attached, the oil supply should be made more generous than when riding solo. Also if you are going to indulge in a prolonged "blind" or tackle at high speed a very stiff hill, for your own sake and the sake of those who do their utmost to give a good after-sales service, turn on more oil. Never attempt to force the regulator disc beyond the stops. For ordinary main road touring, turn on the regulator three or four notches, but the oil supply should be decreased or increased whenever circumstances warrant it. No attention to the P. & M. semi-D.S. lubrication is required other than occasional cleaning of the filter and keeping the oil level high.

Cleaning Filter. Since all oil sucked from the sump by the pump has to pass through a tubular gauze filter on present "Panther" engines, it is necessary to remove this occasionally and clean it of the impurities collected on the outside. It is necessary in the case of a new machine to remove the filter after the first 100 miles and then to do so again after a further 200 miles has been covered. Thereafter it is only necessary to clean the filter every 800 miles. It should be pointed out that when the filter is withdrawn all oil in the sump will escape, and, if it is intended to use it again, a receptacle must be placed below the crankcase to catch it.

Rocker-box Lubrication. On all 1929–1931 "Panthers" the felt pad in the rocker-box (see Fig. 16) is automatically lubricated by oil mist thrown up the push-rod covers. Care should be taken to see that the covers, after being telescoped for tappet adjustment, bed down properly. In the case of models prior to 1929, a grease-gun full of Castrol "XL" should be applied to the rocker-box nipple once every 1,000 miles. On no account use grease, as this will not be absorbed by the felt pad.

Upper Cylinder Lubrication. On present O.H.V. models, both inlet and exhaust valve guides receive lubricant from the rocker-box (in the case of the standard and "Redwing" engines by short ducts and pipes respectively). It is a good plan, however, to mix about two teaspoonfuls of engine oil with a tankful of fuel, especially with earlier "Panther" engines having no automatic lubrication of the valves. Alternatively, half an ounce of the special upper cylinder lubricant, known as "Mixtrol," may be added to each gallon of fuel.

The Villiers Two-stroke Automatic Lubrication System. Brief reference has already been made to the Villiers system on page 12. The working of the system may be understood by reference to Fig. 50. Pressure from the crankcase passes along the centre of the mainshafts to the holes *J*, which register with grooves in the crankcase bushes, when the piston is descending. This pressure is transferred 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 of a siphon. The oil



(*The Villiers Engineering Co., Ltd.*)

FIG. 50. DIAGRAM OF VILLIERS AUTOMATIC LUBRICATION SYSTEM

passes the regulating screw *F*, and issues into the sight-feed bowl. From here the oil descends to the engine through union *D*. The oil then divides, part of it being sucked through a hole in the cylinder wall uncovered by the piston, and the rest passing 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 oilways *E* to the big end. When the engine stops, the pressure in the tank is released *via* the main bearings, but oil would continue to siphon out of the tank but for the vent-hole *C*, which permits air to pass into the sight-feed from the tank, and so enables oil in the pipe *D* to drain down to the engine without sucking up further oil from the 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 clear. On no account must the size of the vent hole be altered.

Adjusting Two-stroke Oil Supply. Within reasonable variations of temperature and load, the oil supply is self-adjusting. On new machines the Villiers automatic lubricator is adjusted to deliver rather more oil than is normally required. After covering 300 miles, the adjusting screw should be screwed in so that a faint blue exhaust haze is visible when the machine is pulling normally in top gear along a level road. In very cold weather it is advisable to give more oil. It should be noted that the sight feed is provided to ascertain if oil is circulating, not to gauge the quantity. Should the lubricator continue to deliver oil after the engine has stopped, this is probably due to a blocked vent hole. Filling up of the sight feed is usually due to air leaks under the glass.

Crankcase Breaker. If leakage of oil occurs at the crankcase joints and the engine exterior becomes saturated with oil, suspect a defective crankcase breaker. If the primary chain is running dry, this is almost certainly the trouble, and the breaker should be removed, inspected, and (if necessary) adjusted.

Magneto and Dynamo Lubrication. The armature bearings of the B.T.-H. magneto are packed with grease on original assembly, and require no further attention. With the Miller dynamo, a few drops of good quality oil should be inserted through the oiler at the driving end every 500 miles after the first 1,000 miles. A small quantity of grease should also be pressed into the hole at the commutator end bearing every 1,000 miles. On coil-ignition machines the Miller contact-breaker, housed on the timing-case, requires periodical attention. The cam should be smeared lightly with vaseline and the rocker-arm bearing pin, if tight, should be slightly oiled.

THE CYCLE PARTS

Speedometer Lubrication. In order to prevent wear and to give silent running of the Smith speedometer drive, the flexible shafting should be removed every 3,000 to 4,000 miles, and cleaned and well greased. A thin grease, such as Price's "Belmoline," is best suited for this purpose. It should be applied in small pieces or blobs all the way along, so that there is a fair supply of grease in the tube. Before refixing the flexible shafting to the speedometer and hub drive, a small portion of grease (enough to cover a finger-tip) should be pushed into the opening in the speedometer and drive where the shafting keys enter.

Gear-box and Clutch. Gear-box lubrication ranks next in importance to engine lubrication and, if neglected, is likely to incur heavy repair bills. The teeth of the meshing pinions have to bear the entire load and will stand up to their work so long as they do not run dry. Special care should be observed in the use of lubricants, and *thick grease must not be used.* The three-speed

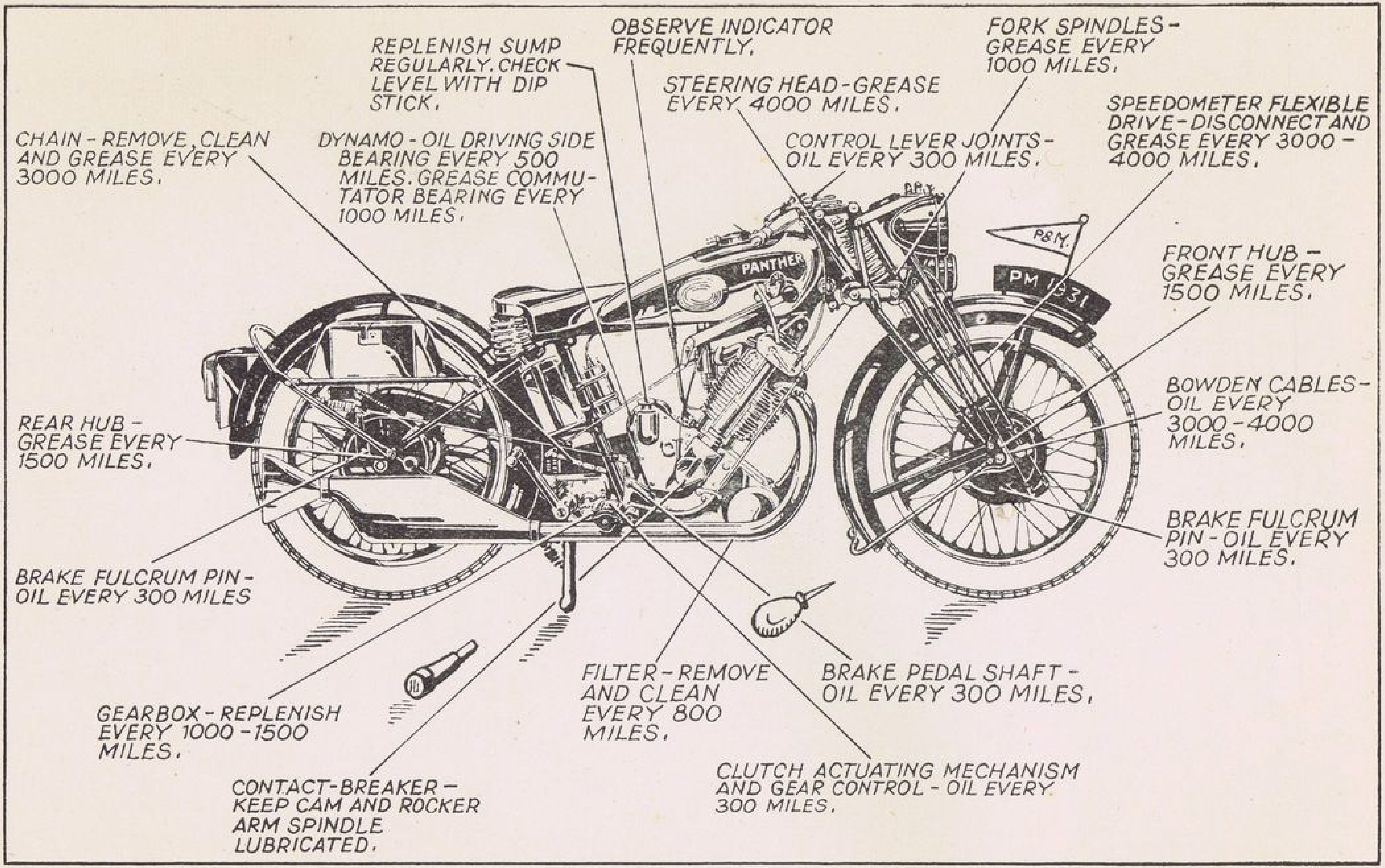


FIG. 51. SHOWING WHEN AND WHERE TO LUBRICATE THE "PANTHER"

The above chart, showing a Model 55 *de luxe* "Panther," is applicable in general to all O.H.V. models manufactured during the past few years. It is intended to serve as a guide rather than to be scrupulously followed. On models prior to 1929 it is necessary to inject engine oil into the rocker-box about once every 1,000 miles

Sturmey-Archer gear-boxes should be charged with ½ lb. of Wakefield's "Castrolease Light" or Speedwell's "Crimsangere Light," and recharged with ¼ lb. about every 1,000 to 1,500 miles. Where "Crimsangere" is used, add about three tablespoonfuls of engine oil. Both these lubricants are specially recommended for S.A. gear-boxes, although engine oil (Castrol "XL") can be used instead. When recharging, rotating the kick-starter will facilitate complete filling. The gear-boxes should be filled up to the level of the filler-cap orifices. The various joints in the gear-change mechanism should be kept oiled regularly to give easy and smooth changes. Also insert a little oil between the gear lever and quadrant notches.

With regard to the P. & M. four-speed gear-box, engine oil is recommended as a lubricant, because there is a long floating bush on the mainshaft which requires to be kept well oiled. The use of a grease or any other solid lubricant tends to make this bush run dry, and trouble quickly develops.

The clutches on all P. & M. machines are designed to run dry, and require no lubrication except in respect to the control mechanism, which should be oiled about every 300 miles. On the S.A. gear-boxes do not forget to oil the small clutch-operating worm. Should the clutch plates at any time become glazed with oil due to overfilling the gear-box or using too thin a lubricant, they should be dismantled and cleaned with petrol and a wire brush.

Chains. Both the primary and secondary chains are automatically lubricated by a pipe leading from the crankcase breather, and, provided the breather is functioning correctly, receive adequate lubrication from this source. It will, however, greatly prolong their life if they are removed, say, every 3,000 miles, cleaned in a bath of paraffin, and afterwards allowed to soak in a mixture of hot graphite grease and engine oil. There is no better treatment for transmission chains than this, as the lubricant permeates thoroughly every roller bearing. When cleaning the chains in paraffin it is a good plan, if time permits, to let the chains soak overnight. They may afterwards be hung on hooks to dry.

In the case of the two-stroke "Panther," the oil reservoir, which is integral with the primary chain-case, should be regularly replenished with engine oil; and if the wicks conducting the lubricant to the primary chain become clogged or dirty, they should be renewed, or pipe cleaners used as substitutes. Some engine oil should occasionally be applied to the secondary chain.

Fork Spindles and Steering Head. Grease-gun lubrication nipples are provided for the ball bearings in the steering head and the Brampton fork-link spindles. It is recommended that a charge of grease be injected into the steering-head nipple every 4,000 miles, and into the fork nipples about every 1,000 miles.

Grease should exude from the ends of the spindles. Owing to the protection afforded by the shock absorbers, less lubricant is required for the lower spindles.

Wheel Bearings. Grease nipples are provided on all wheel hubs, and the grease-gun should be applied to them about every 1,500 miles. Care should be taken to avoid excessive lubrication, or it will cause trouble with the brakes. Once a year clean out the hubs and pack the bearings with grease.

Brakes. Oil the brake fulcrum pins and other parts of the brake mechanism about once every 300 miles.

Bowden Controls. It will forestall the time when the Bowden cables snap if a certain amount of oil be applied about once every 300 miles to the handlebar lever joints, and those points where the cables are apt to bind or chafe at the handlebar controls. It will also pay to oil the entire lengths of the cables every 3,000–4,000 miles. By doing this longevity and smooth action of the cables is ensured.

CHAPTER V

MILLER ELECTRIC-LIGHTING EQUIPMENT

Miller electrical equipment is now used for lighting purposes on all electrically-equipped "Panthers." In the case of coil-ignition machines a DM3G dynamo supplies current to an Exide battery, from which current is fed to the coil and also the lamps when in use. On magneto-ignition machines a DM3G dynamo is also used with a separate contact-breaker (see Fig. 18); but, instead of being gear-driven from the timing-case as on coil-ignition machines, is driven by chain off the magneto shaft. The general arrangement of the coil-ignition system has already been dealt with in Chapter I, and in this chapter we are concerned mainly with the lighting system. For the benefit of enthusiastic riders who may desire to dismantle the Miller electrical equipment at some time or other, or make alterations, two useful wiring diagrams are given in this chapter. Any one having a rudimentary knowledge of electrical apparatus should be able to follow these. The notes given on the maintenance of the Miller equipment and the detection of faults are worthy of special attention.

THE DM3G MILLER DYNAMO

This machine, which carries a guarantee and is fully tested by the manufacturers, is of the third brush shunt-field regulating type, and incorporates a cut-out on the side opposite to the driving side. The armature, as may be seen in Fig. 53, has ball bearings at each end. Both the positive and third brushes are insulated from the frame of the dynamo, and the negative brush is earthed owing to its being screwed direct to the dynamo-bearing bracket. The dynamo output is 6 volts 4·5 to 5 amp. (although on coil machines this is greater), and an average lamp load of 3 amp. is generated at 1,800 r.p.m., which corresponds to a road speed on top gear of approximately 25 m.p.h. On all "Panther" machines the dynamo has an anti-clockwise rotation. Only two cables are used to connect the dynamo in the lighting system, the positive cable attached to the battery and the negative cable earthed to the frame.

The cut-out is housed under the dynamo cover, and it is fixed on the commutator end bracket. It consists of an electromagnet for attracting automatically an iron plate, which carries a silver contact point. When the dynamo is charging, this contact point

CHAPTER VI

ADJUSTMENTS AND OVERHAULING

In this chapter the author has endeavoured to present in a fairly logical sequence all essential information concerning the various adjustments and overhauling operations which every "Panther" owner has from time to time to carry out. Routine adjustments, decarbonization, and general overhauling have been treated in separate sections of this chapter so as to enable the reader to lay hands on the information he requires with a minimum of delay. No reference to lubrication is made, as this has already been fully dealt with in Chapter IV. When seeking advice on any particular subject dealt with here, the reader is advised also to peruse the corresponding data given in the specifications at the beginning of the book.

The accessibility of the "Panther" and the special method of mounting the engine make adjustments and overhauling a straightforward matter, and decarbonizing is by no means a tedious or difficult matter if the rider works on the engine methodically and uses the right tools for the job.

Care of New Machine. With the exception of the lubrication matters dealt with in Chapter IV, it should not be necessary to pay special attention to any details of the "Panther" during the first 1,000 miles, except that nuts and bolts may possibly settle, and require the application of a spanner to tighten them fully. It may also be found that the bedding down of various parts, such as the valves and the development of slight initial stretch in the control cables, will call for some minor adjustments to be made.

ROUTINE ADJUSTMENTS

There are a number of minor adjustments which it is desirable that the "Panther" rider should attend to every few hundred miles, or when circumstances necessitate these adjustments being made. If the rider values his machine, however, he will not wait till adjustment *has* to be made, but will carefully inspect his machine as a matter of routine and make the necessary adjustments before they become absolutely essential.

Cleaning. It requires a considerable amount of time to keep a motor-cycle in anything approaching "showroom" condition, but it is the author's opinion that, unless a machine be kept reasonably clean, the fullest pleasure and maximum efficiency cannot be obtained from it. Apart from the question of pride of ownership, dirt covers a multitude of defects and greatly accelerates depreciation in respect of market value. This is, of course, obvious. If neglected, a motor-cycle rapidly becomes shabby and an eyesore. After a ride in dirty weather, cleaning may take at least an hour. On no account should a machine be left soaking wet overnight. A serious amount of rusting may ensue.

It should be noted that chromium plating does not require and should not be treated with metal polish, for it does not oxidize

Fig. 57. Tappet Adjustment on Standard O.H.V. Engines

in the same manner as nickel-plating. The chromium-plated parts should be treated similarly to the enamel, and the surfaces will then improve with cleaning.

Periodical Inspection of Nuts. One of the most important points in connection with the care of a motor-cycle is to look over the machine frequently and apply a spanner to any nuts which have worked at all loose.

Valve Clearances. In order that the valves on the O.H.V. "Panthers" shall seat properly and have the correct degree of lift at all running temperatures, it is extremely important that the clearances between the rocker ends and the ends of the valve stems (*X*, Fig. 57) should be maintained correct (see page 26). The clearances should be checked occasionally with the feeler gauge on the magneto spanner, although it is unlikely that adjustment will be required unless a big mileage has been covered or the valves have recently been ground-in. The exhaust valve clearance is slightly larger than the inlet clearance, because the exhaust valve expands to a greater extent due to its being subjected to greater heat than the inlet valve. It is important to adjust or check the clearances with the engine *cold* or just warm, and the first thing to do is to see that both valves are fully closed by rotating the engine until the piston reaches top-dead centre on the firing stroke (i.e. after noticing the inlet valve close, put the engine on full compression, and then release the compression with the exhaust valve lifter). See that the decompressor is in the "off" position. There are two different adjustments—the tappet adjustment on the standard O.H.V. engines (Fig. 57) and the overhead rocker screw adjustment on the new "Redwing 90" engine (Fig. 58).

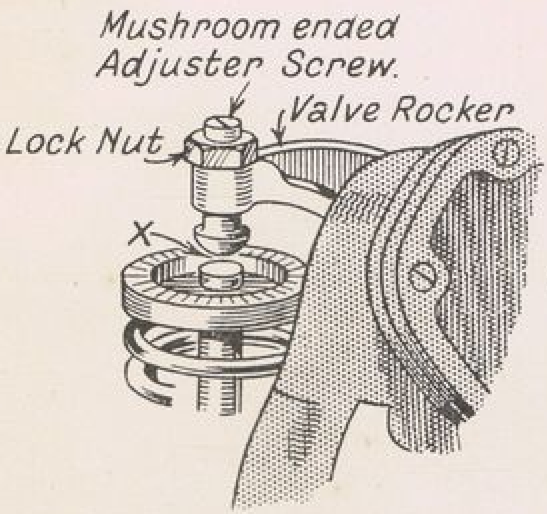


Fig. 58. The Overhead Adjustment on the "Redwing 90" Engine

To adjust the tappets on the standard O.H.V. engines, proceed as follows: Get out the two small spanners provided in the tool kit and then push upwards the lower ends of the telescopic tubes enclosing the push-rods. This will expose the tappets, which have adjustable heads, in whose cupped upper ends the push-rods rest. It will be noticed (see Fig. 57) that there are three hexagons on each tappet. The upper one is part of the adjustable head, the middle one is a lock-nut, and the bottom one is solid with the tappet. Loosen the lock-nut and then, holding the tappet by means of the bottom hexagon, unscrew or screw up the adjustable head until a feeler blade of the correct size will just enter without binding the space between the valve rocker and valve stem. Then tighten up the lock-nut and check the clearance again afterwards; proceed similarly with both tappets. Owing to the complete enclosure and lubrication of the valve gear, it is seldom necessary to make any adjustment, but it is nevertheless desirable to check the clearances occasionally. Incorrect valve clearances affect both the lift of the valves and also the valve timing, and some engines are very sensitive on the latter point.

In the case of the new "Redwing" engine, the valve clearances are checked as on the standard engines; but since there are no tappets, adjustment for each valve is effected by loosening the lock-nut securing the mushroom-ended adjuster screw to the rocker and rotating the screw a few turns with a screwdriver as required. Afterwards firmly retighten the lock-nut.

Exhaust Valve-lifter Adjustment. It is important to keep the exhaust valve-lifter control always adjusted, so that there is a small amount of backlash (say, $\frac{1}{32}$–$\frac{1}{16}$ in.) at the finger-operated lever on the handlebars, or the inverted hand lever in the case of "Panther" models prior to 1931. By backlash is meant lost motion taken up by the volute spring on the outside of the rocker-box end-plate or by the coil spring inside the rocker-box on early models. Adjustment is provided on all recent models in the form of a screwed cable stop and lock-nut on the rocker-box. After loosening the lock-nut, screw up or unscrew the stop a turn or two as required. Entire absence of backlash would cause the same ill-effects as would habitual running with the decompressor in the "on" position; the exhaust valve under such circumstances cannot seat properly, and there is thus loss of compression and burning of the valve and its seating, accompanied by intermittent banging in the exhaust system.

Decompressor. This has an entirely positive operation, and no adjustment is necessary or provided. Should its effectiveness gradually lessen, it is probable that the tongue piece (see Fig. 17) has worn and requires renewal.

The Sparking Plug. Difficult starting or occasional misfiring can usually be traced to a dirty or defective sparking plug. The life of a sparking plug is considerable, but the points of the electrodes gradually burn away and eventually the gap becomes enlarged considerably, and it is necessary to reset the points with the aid of a feeler gauge. The correct gap is ·02 in., except for coil ignition, where it is ·027 in. Excessive gap at the plug points means that the voltage required from the magneto is higher; and this not only renders starting difficult, but—what is worse—causes brush discharge inside the magneto. This discharge eventually causes internal corrosion, and the efficiency of the magneto is impaired. From time to time the plug should be removed and thoroughly cleaned with petrol, both inside and outside. All deposits of soot or charred oil must be eliminated, as these are apt to cause leakage and bad running. The insulation should be examined for cracks or flaws, and in very humid weather should be wiped dry with a rag before starting-up. The accepted method of testing for current at the plug terminal is to place a wooden-handled screwdriver, with steel blade, across the terminal and just touching the cylinder fin, when a spark should be visible on rotating the engine. To test the plug itself, remove it with the H.T. lead still affixed, clean it, lay it on the cylinder, and note whether it sparks satisfactorily when the engine is rotated. If it does not, scrap it. Always fit the correct type of plug recommended by the manufacturers. (See Chapter I.)

The A.C. Sphinx plugs fitted to the "Panther" are very suitable for the job they have to do, and it is practically unknown for serious magneto trouble to develop. Sparking plugs, however, sometimes get fouled with oil and carbon, especially during the early stages, when the supply of oil to the engine is allowed to be liberal. For this reason fit a good medium plug—i.e. one that will stand a reasonable amount of oil, and also a reasonable amount of heat. If, however, when the machine is run-in, and you are in the habit of travelling fast (or if heavy sidecar work is being done), it is advisable to substitute a plug that will stand more heat, such as a K.L.G.-K.1 or H.S.1, or Lodge H.1 (T.T. model, H.S.3; 90 model H.45). These plugs fail through oil more readily, however, than the standard plug fitted, so that care must be taken that too much oil is not delivered to the engine. This particularly applies when descending long gradients, and when riding in thick traffic. If, during a long stretch at large throttle opening, the engine becomes harsh and starts knocking—*there being a sufficiency of oil being delivered*—it is a sign of pre-ignition, and a plug should be substituted that will stand more heat. The following range of K.L.G. plugs progress in order of ability to withstand heat, but it must always be remembered that, in general, the more heat a plug will cope with, the less oil it will stand : G.1, 230, H.S.1, H.S.3, 244, and 268. Other makers usually have similar ranges, and will in all cases be pleased to advise you on the subject. Many of these plugs are " detachable " and may often be rendered serviceable again after they have been fouled by taking them apart and thoroughly cleaning them. Non-detachable plugs can sometimes be cleaned by soaking them in petrol, and scraping them carefully with a blunt penknife or a wire brush.

The Contact-breaker. The contact-breaker is the only part of the magneto likely to require attention, and is also the only part other than the H.T. pick-up which can safely be interfered with by the rider. Two types of contact-breaker are used on "Panther" machines : the rotating mechanism shown at Fig. 59 on the B.T.-H. magneto and a special type Miller contact-breaker housed in the timing-case cover on the coil-ignition machines. In the case of the B.T.-H. contact-breaker, the contacts are periodically opened and closed in the orthodox manner by means of a rocker-arm with fibre heel bearing on a cam-ring. The Miller contact-breaker is somewhat different. There is an adjustable contact point attached to an insulated terminal post; and a second contact, fixed to an uninsulated lever on which is a pad, which presses firmly on a cam fixed to the engine camshaft. Every two engine revolutions, the lever pad coming upon the raised portion of the cam, causes the contacts to open momentarily. During the remaining period of the cam's rotation, the cam leaves the pad, and this allows the contacts to meet and close the primary coil circuit. The contacts should be pressed firmly together by means of the spring. Binding at the pivot-pin bearing will weaken this pressure and prevent the smart make-and-break so essential for satisfactory results. To obviate this, occasional lubrication (see page 83) is necessary.

About every 1,000 miles the contact-breaker cover should be removed, and the contacts should be examined and the "break" checked with a feeler gauge. This should be ·012 in. and ·018 in. to ·02 in. in the case of the B.T.-H. and Miller contact-breaker respectively. If the clearance is excessive, the timing will be advanced, and the primary circuit will not remain closed sufficiently long. Misfiring of some kind will probably occur. Provided the contacts are kept clean and free from oil, adjustment is required only at long intervals. If adjustment is required, rotate the engine slowly until the points are fully open; and then, using the magneto spanner, slacken the lock-nut and rotate the fixed contact screw by its hexagonal head until the correct "break" is obtained, as indicated by a suitable feeler gauge. Afterwards retighten the lock-nut.

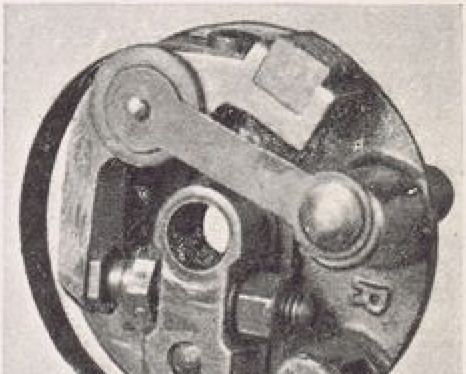


Fig. 59. B.T.H. Contact-breaker

If examination reveals that the contacts, instead of having a grey-frosted appearance, are burned or blackened (due to the presence of dirt or oil), it is advisable to clean them with *very fine* emery cloth and afterwards wipe over with a cloth damped in petrol. Every trace of dirt and oil must be removed. Should the contact surfaces be pitted and uneven, it is necessary to true them up with a very smooth file. Only the barest amount of metal must be removed, and it will greatly facilitate matters if the contact-breaker mechanism be firstly taken off the magneto armature or timing-case cover, as the case may be. (For further notes on the care of the magneto, see page 128.)

The Slip-ring. On the B.T.-H. magneto the slip-ring track should occasionally be cleaned by removing the flanged holder containing the carbon pick-up brush and rotating the engine slowly while holding a soft cloth moistened with petrol against the slip-ring. On replacing the pick-up be sure that the spring holding the brush in contact with the ring is free, and that the brush is not badly worn.

Clutch Adjustment. Should clutch slip be experienced (which would be indicated by intermittent engine racing and warming up of the clutch plates), there are two points where an adjustment may rectify matters—the clutch control and the clutch springs. A slipping clutch may also be due to worn inserts or oil on the plates, in which case the remedy is to renew the inserts or clean the plates with a rag damped in petrol. The commonest cause of clutch slip is absence of backlash in the control mechanism.

In the case of the O.H.V. "Panthers" with Sturmey-Archer L.S. three-speed gear-boxes, it is important that there should be approximately $\frac{1}{16}$ in. free movement of the worm lever (23, Fig. 44). If this movement, which is essential to proper engagement of the clutch plates, is not present, the Bowden cable stop should be adjusted accordingly. It may be necessary, in order to obtain the desired adjustment, to loosen the worm lever from the worm and rotate it a trifle, afterwards locking it in position.

On the two-stroke model and the four-speed O.H.V. "Panthers" the Bowden control is attached to the top end of the lever mounted on the side of the gear-box, and nearly at the bottom this lever carries a hardened threaded screw and lock-nut, the inner end of which comes into contact with the long rod passing right through the gear-box to the inside of the clutch. Adjustment is effected by screwing the above hardened screw farther in or out of the operating lever, and between the point of this screw and the end of the long rod there must be a little clearance when the clutch hand lever is *not* raised—i.e. when the clutch is fully engaged. Too little clearance will cause clutch-slip and too much will set up drag in the clutch when disengaged, and so make gear-changing difficult. An indication of this clearance is the amount you can move the clutch hand lever before it actually commences to disengage the clutch. This free movement should be kept as small as possible.

Where adjustment of the clutch control fails to cure clutch-slip, remove the primary chain case and screw up with a box spanner the six hexagon-headed screws on the outer plate, giving a turn or so to each. It is essential to adjust these screws uniformly, or the plates will tend to rock and bind.

Gear-control Adjustment (Present Models). An adjustment of the primary chain tension by sliding the gear-box backwards or forwards almost invariably upsets the adjustment of the gear control, and this must at once be seen to. An improperly-adjusted control not only renders gear-changing uncertain and difficult, but also invites damage to the gear-box. From time to time the adjustment should be checked.

On the three-speed "Panthers" the adjustment of the gear is effected by removing the pin from the top connection of the long control rod, and rotating the yoke piece a turn or so on the rod to lengthen or shorten it as required. With the control correctly adjusted, it should be possible to move the gear lever *an equal distance either side of the neutral position* before engaging first and second gears. By rocking the rear wheel to and fro while moving

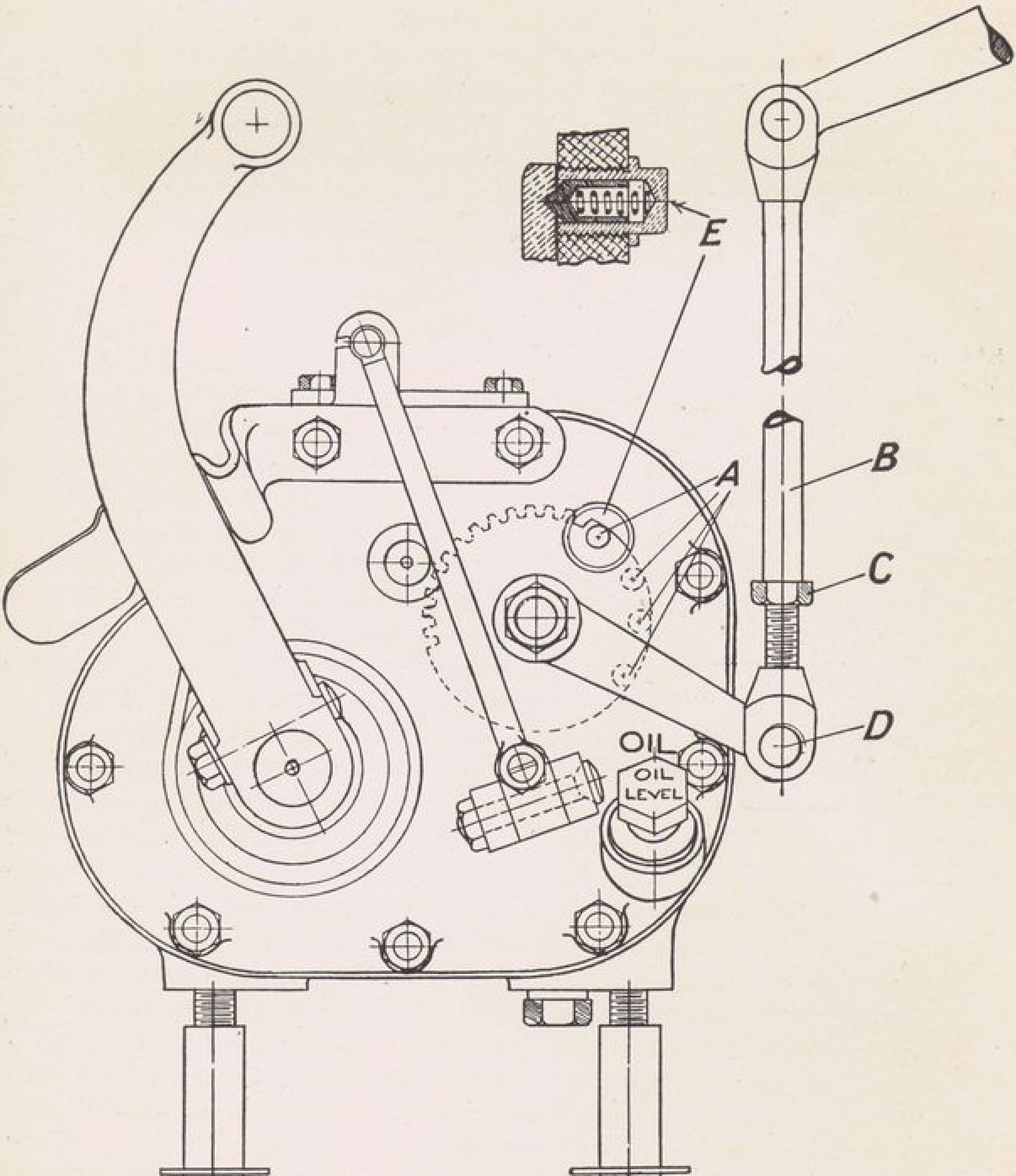


FIG. 60. THE P. & M. GEAR-BOX AND CLUTCH OPERATING MECHANISM

the gear lever, it is possible to find the exact positions where each gear commences to engage.

On the four-speed "Panthers," after adjusting the primary chain, it is also necessary to alter the length of the vertical gear operating rod (marked *B*, Fig. 60) in order that the gears will correctly mesh. In order to do this correctly, after you have carefully tightened up the three fixing bolts underneath the gear-box, take out the selector locking plunger carried in the hexagon-headed sleeve *E*, threaded into the gear-box cover, just above the filling plug. On looking into the hole vacated by the plunger, you will see a series of dimples cut in the face of the operating wheel, marked *A*, Fig. 60. Each one of these dimples corresponds to a certain gear which will be fully in mesh when the dimple is dead in the centre of the plunger hole. Therefore, by placing your gear lever into top gear position in the quadrant on the tank, you will then be able to adjust the length of the vertical rod from the gear lever on the tank to that on the gear-box, so that the top gear dimple is dead in the centre of the hole. The top gear dimple is the last one exposed as the lever on the gear-box is lowered. Fig. 60 shows gear-box in top gear position. If the locking-nut *C* on the adjustment is now screwed up tight, then all the other dimples will be correct for the respective gear positions. When replacing the gear operation pin *D* which connects the operation rod to the gear-box lever, do not forget also to fit a new split pin. Before attempting to move the gearbox, it must be remembered that in addition to the three main holding-down bolts underneath, there are two other nuts to be slacked off—one carrying an exhaust pipe bracket, and the other carrying the chain guard immediately behind the clutch.

Transmission Shock Absorber. No adjustment is required of either the early type metal shock absorber fitted to the engine shaft or the late pattern rear hub cush-drive. After a very big mileage, however, it is sometimes found that the six rubber blocks positioned between the metal vanes become worn and set up a certain amount of undesirable transmission snatch. The remedy is to renew the blocks, taking care that two blocks are inserted between each pair of vanes.

Brakes. These *must* be kept free from oil and correctly adjusted. The internal expanding type of brakes are very efficient when in good condition, and your life may depend on them when least expected. They should be kept adjusted so that only at the fully-off position are the wheels absolutely free to revolve with only the smallest amount of movement of brake pedal or hand lever necessary to bring them into action; 1927 models and later are equipped with hand adjustment, but previous models are fitted with brake rods, the ends of which are threaded for a sufficient length to enable them to be lengthened or shortened. When replacing the toggle pins removed for this adjustment *always use a new split pin* to hold it in place, and do not forget to tighten up the lock-nut on the threaded end. When your brake linings have worn so thin that the rivets become loose and the braking uncertain, replace them with a good brand of bonded asbestos such as Ferodo. Linings cut to length may be obtained from the Spare Parts Department of Messrs. Phelon & Moore, Ltd., practically by return of post.

It is important when adjusting the interconnected and compensated brakes on present "Panther" models to see that the front and rear brakes are correctly synchronized so as to obtain the maximum braking powers and freedom from skidding. To adjust the interconnected brakes, jack the machine up so that both wheels are quite clear of the ground, and then by hand rotate the front and rear knurled adjusting nuts, such that, with the brake pedal released, the front wheel is just free to revolve unimpeded; and when it becomes difficult to move against the application of the brake, the rear braking effect is only just noticeable. When correctly adjusted, both wheels must, of course, be able to spin freely with the foot-pedal released; and upon applying a moderate pressure, it should be observed that application of the handlebar lever does not cause any additional movement of the front brake expander lever pivoted on the offside of the anchor plate. A tendency for the rear wheel to skid usually indicates that the adjustment of the front brake, foot-controlled Bowden cable is insufficiently in advance of the rear. Any further compensation beyond the adjustment described is automatically effected by means of the specially designed foot lever, which has a floating pivot.

Wheel Bearings (Present Models). All present "Panther" models have journal type ball bearings in the hubs, and no adjustment is necessary. It is important, however, to see that the bearings are kept well lubricated (see page 86) and that the spindle nuts are done up tightly.

Wheel Bearings (1930 and Earlier Models). On these models the "Panther" front hub is fitted with taper rollers, and on no account must it be adjusted up tight. A small amount of shake must be allowed or serious trouble with the rollers will ensue. The rear hub does not need adjusting, as the bearings are of the journal type. On the light-weight machines, however, the following notes may be useful, as they are fitted with cup and cone bearings.

The correct adjustment of these is important both from the point of view of repair bills, and of the road-worthiness of the machine. Shake in the wheel should never on any account be allowed to develop, and to adjust them, the wheels should be removed from the frame. They are of the cup and cone type, the near, or left-hand end of the spindle carrying the moving or adjusting cones. The thin lock-nut on this side should be slacked off, and holding the outer end of the cone on the other side, the one under the lock-nut should be screwed in or out to tighten or loosen the bearing as may be required. When shake has been eliminated, the lock-nut should be tightened down on to the cone. Very great care should be exercised that the bearing is not made too tight, especially when tightening the lock-nut. The spindle should rotate freely in the wheel without appreciable shake. If, when rotating this spindle, hard spots are felt, it is due either to dirt in the races, a chipped ball, or a pitted race, and to eliminate the trouble the hub should be immediately dismantled, by screwing the moving or adjusting cone right off the spindle and taking the spindle carrying the fixed cone out through the other side. Should this fixed cone be loose, see that it is tightened up against the end of the thread before reassembling. Chipped balls or pitted cups or cones must be replaced with new ones. The cups may be removed from the hub by inserting a long blunt punch from the opposite side and gently knocking them out, the inner edge of the cup overlapping the inside of hub-shell. When removing wheels and dismantling hubs, remember where the various washers and distance pieces go, so that the wheel will be carried in the same position in the forks when they are replaced. Also see that the brake anchor plates are properly engaged with the stops mounted on the forks and rear stays. In this connection note that the rear brake assembly on machines of 1926 and later manufacture is locked to the spindle by an outside lock-nut. If this has been slacked off it will be easier to replace the back wheel in the frame if this lock-nut has been left slightly loose, but it is imperative that it be locked up after the wheel has been inserted before tightening up the main spindle nuts.

Tyres. The service obtained from tyres depends mainly on two things—inflation pressures and driving habits. As to the former, a certain margin is permissible, but too soft a tyre will " roll," wear out quickly, and cause bad steering, while too hard a tyre will be uncomfortable and cause the machine to " buck " on bad roads. On no account must *wired-on* tyres be ridden insufficiently inflated, as the valves may be torn out of the inner tubes. Security bolts fitted to *beaded edge* wheels should always be kept tight. As to driving, habitual *violent acceleration and violent braking* take *half* the life out of a tyre. The correct inflation pressure should be 30 to 31 lb. per sq. in. at the front and 33 lb. per sq. in. at the rear for beaded edge covers, and 19 lb. per sq. in. and 21–23 lb. per sq. in. for wired-on covers respectively. A pressure gauge should be used regularly for checking the pressures, and where these are found below those recommended, a few strokes of the pump should be given. In very hot weather the air in the tubes may expand very considerably during a day's run and produce abnormally high pressures. In this case the valve pins should be momentarily pressed down. Occasionally it is advisable to jack up the machine, slowly rotate each wheel, and gently remove any flints embedded in the rubber. Always jack up the "Panther" when leaving it for an appreciable period. Allowing the full weight to be supported by the wheels when stationary is bad both for tyres and wheels. There is also the risk of the covers being damaged by coming in contact with oil or paraffin.

Handlebar Adjustment. All P. & M. machines now have handlebars which can be adjusted for position to meet individual requirements. It is only necessary, in order to vary the reach of the bars, to slacken off the clamp nuts on the top of the centre portion and rotate the bars into the desired position. Adjustable footrests are also provided; and on taking over a new machine it is advisable, if the riding position is not entirely satisfactory, to experiment with different handlebar and footrest angles.

The Primary Chain. Stretch in this chain occurs only after a very considerable mileage, for the chain is entirely protected by the guard and automatically lubricated. As soon as the chain becomes at all slack, it should be retensioned by undoing the gear-box fixing sleeve nuts and drawing the box backwards by means of the adjuster screw until there is only about ½ in. up-and-down movement of the chain at the centre of its run in its tautest position. Having correctly tensioned the chain, retighten the gear-box fixing sleeve nuts and, if necessary, readjust the gear control (page 108). Chain adjustment is important, because badly-adjusted chains produce harsh running, wear out quickly, and damage the sprockets. There are also considerable friction losses.

The Secondary Chain. Stretching of this chain is more rapid than with the primary chain, and it requires to be adjusted, as well as lubricated, at regular intervals. Adjustment is effected by loosening the rear wheel spindle nuts and drawing back the wheel by tightening up uniformly the nuts on the adjusters at each side of the fork ends. Correctly adjusted, the chain should have an up-and-down movement at its centre of approximately ¾ in. Excessive slackness may result in the chain being thrown right off the sprockets by centrifugal force at high speed, and this, needless to say, is fraught with considerable danger. After a series of secondary chain adjustments have been made, it is usually found that the real wheel spindle approaches dangerously close to the end of the fork slots. The remedy is to shorten the chain and unscrew the adjustments until the wheel spindle is as far forward as possible. However, by the time a chain elongates seriously it generally becomes badly worn and requires renewal. A rough test of the condition of a chain is to hold a length between the hands and observe the extent to which it may be bent sideways.

When adjusting the rear chain, do not forget that the "Panther" rear wheel does not lie centrally in the back forks; and if its correct alignment is lost, you must line it up with the front wheel again (see page 134). It is therefore best, when tightening the rear chain, to slacken the rear spindle nuts only sufficiently to enable the spindle to slide with difficulty in the fork slots. The adjusters at each side should then be used to pull the spindle back, taking care that the nuts on them are given the same number of turns on each side. This should, of course, be discontinued as soon as the chain is sufficiently tight and the spindle nuts tightened up again thoroughly. Do not overlook the fact that moving the back wheel alters the adjustment of the rear brake.

Adjusting Dynamo Chain. As with the primary chain, the duplex chain driving the dynamo on magneto-ignition "Panthers" very rarely requires adjustment. When correctly tensioned there should be an up-and-down movement of about $\frac{1}{4}$ in. If the chain is slack, it is only necessary to loosen the dynamo clamping bolt (see Fig. 14) and rotate the dynamo bodily a small amount. The eccentric placing of the armature shaft will enable the adjustment to be readily made.

Coupling-up Chains. When replacing a chain after removal, the procedure is greatly facilitated if the chain is placed on the sprockets, so that the whole of the tension is resisted by the teeth of one of the sprockets. On replacing the spring link, see that the closed end faces the direction of chain travel.

Steering-head Adjustment. The steering of a "Panther" can easily be ruined if the steering head is allowed to develop play—moreover, it will almost certainly cause speed wobble, and will also probably damage the ball races. The best method of testing for this play is, when astride the stationary machine, to put the front brake hard on and rock the machine backwards and forwards, meanwhile holding a finger against the gap between the two ball-race housings just above the front end of the tank. Any movement can thus be immediately discerned and should be eliminated. To do this on 1930 and earlier models, slacken off the expander bolt, which is directly under the steering damper knob, and the large-capped nut immediately underneath should be gradually tightened down until the unwanted movement disappears, but still leaving the stem capable of rotating freely. On 1931 models an expander bolt is not used, and to adjust the steering head it is necessary to loosen the nut on the horizontal bolt behind the clip. It simplifies the procedure if the front end of the machine is chocked up, so that the front wheel is clear of the ground by placing a petrol can, or some such packing, under the engine sump. If, when the head is adjusted, it rotates with a jerky movement, it signifies that the ball races in the head are pitted and they should be renewed, but this work is best entrusted to the repair depot, or to a qualified garage. Do not forget to retighten the expander bolt after the adjustment.

Adjusting Steering Damper. The steering damper, mounted above the steering column, is designed for high speeds primarily, and its use when riding solo below, say, 40 m.p.h. is not justified owing to the excellent steering qualities of the "Panther." The main object of the damper is to eliminate any tendency for front wheel wobble, which sometimes occurs at high speed and is exceedingly dangerous. The ebonite damper knob should gradually be tightened down, with increase of throttle opening, when "opening out" on the straight. In the case of sidecar outfits, the use of the steering damper at comparatively low speeds is recommended, as it greatly increases the general steering stability.

Adjusting Fork Shock Absorbers. The Brampton forks (see Fig. 10) on all 1931 "Panthers" have shock absorbers of the four-point application type, and adjustment is made by slackening or tightening the wing nut on the side of the right-hand bottom fork link until the amount of damping is sufficient to stop any tendency for the forks to become too lively over bad road surfaces. There is no adjustment for shock absorbers of earlier design than 1931.

Fork Spindle Adjustment. Spindle lubrication (see page 85) is very important, and unless this is regularly attended to a partial or total seizure is bound to occur. The forks should be allowed a small amount of side play, but an excess of this might involve steering difficulties at high speeds, and it is advisable, therefore, to adjust the spindles at definite intervals. This is easily done in the following manner. Slacken all the spindle nuts, taking notice that those on the left-hand side of the machine have left-hand threads, and slacken off by turning in an opposite direction to the nuts on the right-hand side of the machine. By turning the spindles by means of the small squares milled on their ends the play between the bracket ends and the links may be varied, according to the direction of turning. Revolving the spindles in a clockwise direction increases the play, and in an anti-clockwise one decreases it. By this means the lower spindle dampers may be tightened, but it is not advisable to run with the forks too "dead." On the other hand, a fork which is too resilient is uncomfortable at high speeds. Each spindle should be tackled separately and finished before commencing upon another, as care must be taken that the adjustment is not carried too far, thus causing binding. They are correctly adjusted when the steel washers placed on the *insides* of the links are free to rotate without side play. Care should be taken that the nuts on both ends of the spindles are tightened securely, and it is advisable to slacken off the shock absorbers when making this adjustment.

Bowden Controls. Few things have a greater adverse effect on the performance of a machine than badly adjusted or slack control cables, especially where the carburettor is concerned. With the cables properly adjusted by the screw stops at the top of the mixing chamber, a very slight movement of the throttle lever or twist-grip from the fully-closed position should cause the throttle slide to commence to ascend. The same remark applies in regard to the air lever and ignition lever. Immediately slackness is

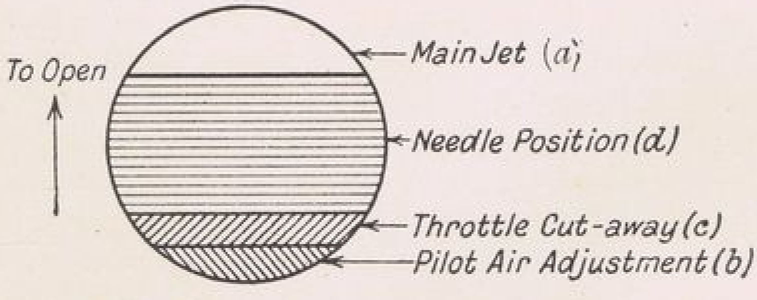


FIG. 61. RANGE AND SEQUENCE OF ADJUSTMENTS—AMAL CARBURETTOR

noticed, the backlash should be taken up by adjusting the cable stops. In the case of the clutch and exhaust valve-lifter controls, an applicable amount of backlash at the levers is desirable for obvious reasons.

TUNING THE CARBURETTOR

The Standard Amal Carburettor. Should the setting of this instrument not give entire satisfaction for particular requirements, there are four separate ways of rectifying matters as given herewith, and the adjustments should be made in this order: (*a*) Main jet ($\frac{3}{4}$ to full throttle); (*b*) pilot air adjustment (closed to $\frac{1}{8}$ throttle); (*c*) throttle valve cut-away on the air intake side ($\frac{1}{8}$ to $\frac{1}{4}$ throttle); and (*d*) needle position ($\frac{1}{4}$ to $\frac{3}{4}$ throttle). The diagram (Fig. 61) clearly indicates the part of the throttle range over which each adjustment is effective.

(*a*) To obtain the correct main jet size, several jets should be experimented with, and that selected should be the *one which gives maximum power and speed* on full throttle with the air lever three-quarters open. If maximum speed is the chief consideration, the jet size should be selected with the air lever fully open. For touring, to determine whether the jet is too large or too small, with throttle fully open, gradually close the air lever. If an increase in power is noticed, the jet is on the small size. If, however, when the air lever is opened fully, an increase of power is obtained, the jet is too large.

(*b*) To weaken slow-running mixture, screw pilot air adjuster outwards, and to enrich screw pilot air adjuster inwards.

Screw pilot air adjuster home in a clockwise direction. Place gear lever in "neutral." Slightly flood the float chamber by gently depressing the tickler, unless the latest Amal "pump" device is provided. Set magneto at half advance, throttle approximately one-eighth open, close the air lever, start the engine, and warm up. After warming up, reduce the engine revolutions by gently throttling down. The slow-running mixture will prove over-rich unless air leaks exist. Very gradually unscrew the pilot jet adjuster. The engine speed will increase, and must again be reduced by gently closing the throttle until, by a combination of throttle positions and air adjustment, the desired "idling" is obtained. It is occasionally necessary to completely retard the magneto before getting a satisfactory tick-over, especially when early ignition timing is used. If it is desired to make the engine idle with the throttle quite closed, the position of the throttle valve must be set by means of the throttle stop screw, the throttle lever during this adjustment being pushed right home. Alternatively, if the screw is adjusted clear of the throttle valve, the engine will be shut off in the normal way by the control lever.

(*c*) Given satisfactory "tick-over," set the magneto control at half-advance with the air lever fully open. Very slowly open the throttle valve, when, if the engine responds regularly up to one-quarter throttle, the valve cut-away is correct.

A weak mixture is indicated by spitting back through the air intake, with blue flames, and hesitation in picking up, which disappears when the air lever is closed down. This can be remedied by fitting a throttle valve with less cut-away. A rich mixture is shown by a black, sooty exhaust, and the engine falters when the air valve is closed. The remedy for this is a throttle valve with greater cut-away. Each Amal valve is stamped with two numbers, the first indicating the type number of the carburettor, and the second figure the amount of cut-away on the intake side of the valve in sixteenths of an inch, e.g. 6/4 is a type 6 V. with a 4/16 in. —i.e. a $\frac{1}{4}$ in. cut-away.

(*d*) Open air lever fully and the throttle half-way. Note if the exhaust is crisp and the engine flexible. Close the air valve slightly below the throttle, when the exhaust note and engine revolutions should remain constant. Should popping back and spitting occur with blue flames from the intake, the mixture is weak, and the needle should be slightly raised. Test by lowering the air valve gently. The engine revolutions will rise when the air valve is lowered slightly below the throttle valve.

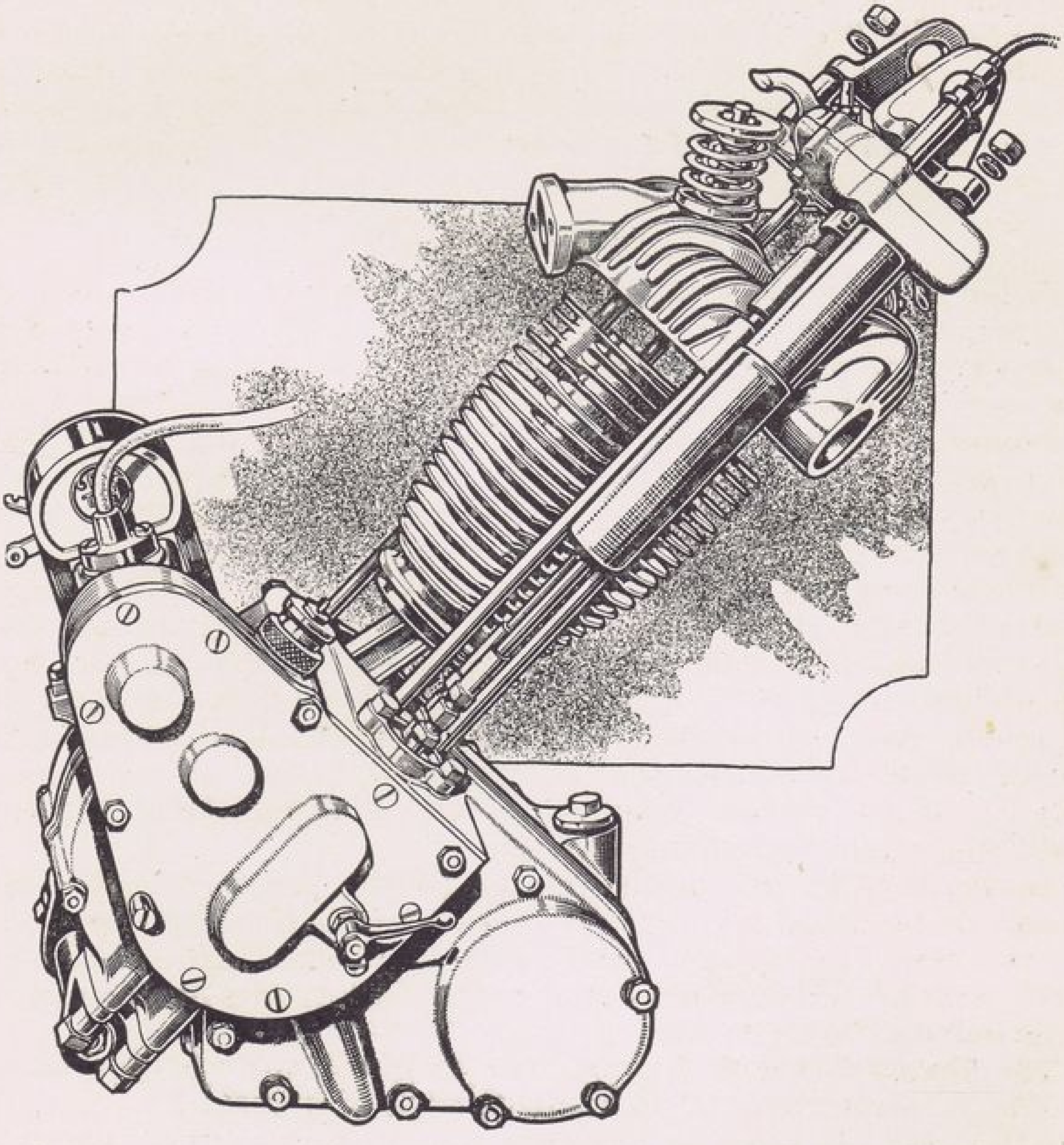
If the engine speed does not increase progressively with raising of the throttle, and a smoky exhaust is apparent with heavy-laboured running, and tendency to eight-stroke, the mixture is too rich and the needle should be lowered in the throttle valve. Having found the correct needle position, the carburettor setting is now complete, and it will be found that the driving is practically automatic once the engine is warmed up. For speed work the main jet may be increased by 10 per cent, when the air lever should be fully open on full throttle.

DECARBONIZATION

After about 2,000 miles have been covered, the accumulation of carbon deposits on the piston crown and in various parts of the combustion chamber results in the engine losing its original "kick," and there is a marked decline in general all-round performance, accompanied by a tendency for knocking under the slightest provocation. In addition, the exhaust note becomes "woolly," and loses its virile crispness and low boom. When this happens it is a sure indication that the time has come for undertaking a "top overhaul," or, in other words, for decarbonizing and grinding-in the valves. Carbon deposits are inevitable on internal combustion engines, and are due to three things: (*a*) burnt lubricating oil; (*b*) carbonization of road dust; and (*c*) incomplete fuel combustion. When decarbonizing it is always worth while inspecting the valve seatings and, *if necessary*, grinding-in the valves. Removal of the valves incidentally facilitates thorough cleaning of the ports.

In connection with decarbonization there are three types of engine to be taken account of: (*a*) the standard O.H.V. engine; (*b*) the new "Redwing" engine; and (*c*) the two-stroke engine. They will be considered in this order. All these engines have detachable cylinder heads.

The Standard O.H.V. Engine. The standard O.H.V. "Panther" engine is remarkable in that it can be decarbonized with the greatest ease. In order to dismantle the engine for decarbonizing, valve grinding, etc., it is *not* necessary to remove the complete engine from the frame, nor to disconnect front chain, chain guard, or rear brake. Place a petrol tin or some such support underneath the engine sump and remove H.T. lead, exhaust pipe, valve lifter wire, carburettor, the top main engine bolt and cones, and slide the bottom half of the telescopic tube enclosing the push rods upwards until it uncovers the bottom ends of the pushrods. The four nuts at the top of the long rods passing through the engine must then be removed, and on 1926 and later models two more between the fins of the cylinder, when the top engine lugs, distance pieces, rocker-box complete with telescopic tube and push rods, cylinder head, and cylinder barrel can be removed in that order, knocking the long engine rods downwards step by step. Be most careful when taking the cylinder head off the



(By courtesy of "Motor Cycling")

FIG. 62. THE STANDARD O.H.V. "PANTHER" ENGINE PARTLY DISMANTLED

cylinder barrel not to scratch the joint faces of either, for there is no washer used on present engines. As the piston is released from the cylinder barrel, take care to hold it, and so prevent damaging it. Take notice in what order the distance pieces come away from between the top lugs, rocker-box, and cylinder head, because there are three pairs, each pair being of different length, and when you have removed the cylinder do not forget to place a piece of clean rag in the mouth of the crankcase in order to exclude any particles of dirt or grit, etc., which would otherwise find their way into the crankcase.

All 1931 models have their gudgeon pins "circlip" fixed in the piston, and a pair of special pliers is supplied in the tool-kit of

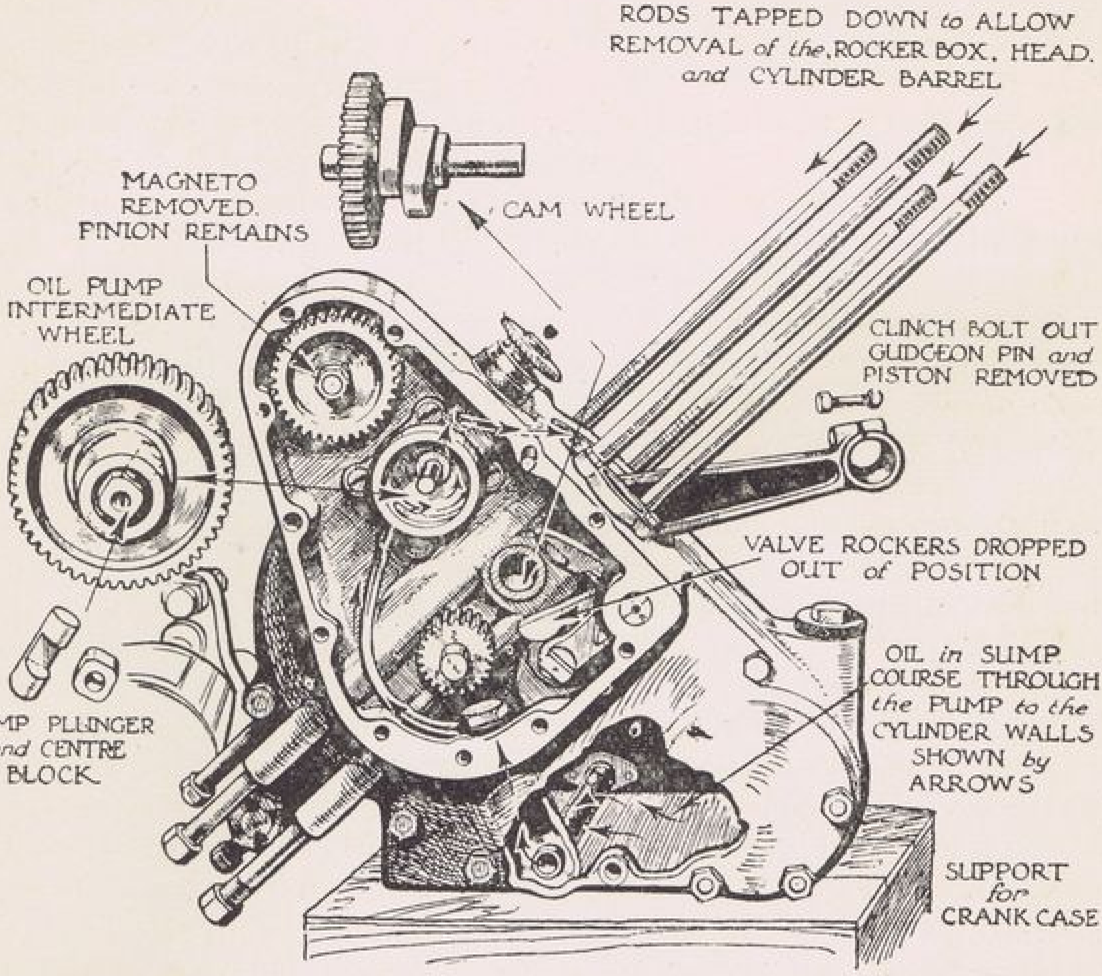


FIG. 63. THE STANDARD O.H.V. "PANTHER" ENGINE DISMANTLED WITHOUT REMOVAL FROM THE FRAME

The "Panther" engine is very readily taken apart and overhauled. It is in fact possible to strip the engine, as shown above, without removing it from the frame. It is very important, however, to support the crankcase as shown after the cylinder has been removed. The above illustration shows a 1927 engine with non-floating gudgeon pin

each machine for dealing with these fittings. The success of the circlip depends upon its fit in the groove provided, and it is essential that when each circlip is refitted it beds down right to the bottom of the groove. Do not grind or alter the circlips in any way, because, if you do, trouble with scored cylinders and ruined pistons is bound to follow. If a circlip is badly bent or damaged in any way whilst being removed, fit a new one; it is the cheapest and safest way in the long run.

By pushing out the gudgeon pin with your finger on models prior to 1927 or, in the case of 1927 models, by taking out the gudgeon pin lock screw and then pushing out the gudgeon pin, the piston can be taken in the hand for cleaning and polishing. It is advisable to see that the gudgeon pin is kept in the same position relative to the bosses in which it has been previously running. It is a good policy to mark the piston inside, so that you can replace it the same way round when reassembling. You may now proceed to scrape off all carbon from the top of the piston and cylinder head by means of an old knife. Avoid scratching the polished top of the piston, as bad scratches eventually start cracks when the aluminium becomes really hot under unfavourable running conditions. Besides removing all traces of carbon from the piston crown, it is also advisable to scrape off any deposits which may have formed on the inside of the piston. Such deposits tend to prevent the rapid dissipation of heat and contaminate the lubricating oil. Do not touch the outer piston walls. Every alternate decarbonization the piston rings should be very carefully removed (see page 123) and inspected, and all carbon deposits in the grooves and on the inside of the rings should be scraped off. It is not advisable, however, to disturb the piston rings too frequently. As a general rule, the valves should be removed and ground-in (see page 124) whenever decarbonizing is undertaken.

The O.H.V. " Redwing " Engine. The dismantling of the Model 90 engine for decarbonizing is rather more difficult than the similar operation for the standard O.H.V. engine fitted to Models 50 and 60. Owing to the length of the engine and stalwart nature of the rocker-box fitting, it is necessary to almost remove the engine from the frame before any work can be done upon it. This seems rather drastic, but when it is realized that this removal can be done in a very short time the operation is not so bad as it looks. The rocker-box, cylinder head, and cylinder barrel can be removed without actually taking the engine from the frame, but the job is far easier done by complete removal of the unit from any surrounding encumbrances. The best method of procedure is as follows: Remove the exhaust pipes, carburettor and magneto control wires, also the exhaust-lifter wire and H.T. wire to the plug. Take off the dynamo and front driving chains (on the magneto ignition model), brake pedal, and top and bottom engine bolts; and if the machine has coil ignition, remove all wires from the fixing terminals and pull out the dynamo leads to the panel and accumulator. Knock out the top fixing collar, leaving the punch in position through the top engine lugs and frame lug as a measure of safety to prevent the engine from falling down. With another punch, remove the bottom fixing collars and allow the engine to swing forward with the punch in the top lugs as a pivot. Now remove this punch and gently lower the engine to the ground. It is now possible to take off the cylinder barrel, head, and rocker-box in one complete unit. This is done by taking off the four engine-rod nuts, which hold the top lugs down on to the rocker-box; removing the telescopic tube flange screws; and simply drawing the above assembly away from the crank-case. When the piston leaves the cylinder, do not allow the connecting rod to fall forward and bruise the mouth of the crank-case. Should this happen, the bruise must be removed with a fine file. Having completely removed the cylinder unit, the rocker-box is easily removed by unscrewing the stud nuts, removing the oil pipe gland bolt, and lifting the rocker-box clear of the head. The head is removed from the cylinder by taking off the head stud nuts and parting the joints made between the top cylinder flange and the head. As with the standard engine, be careful not to scratch the faces of either the cylinder barrel or cylinder head. The piston can now be removed. It is circlip-fixed, and must, therefore, be removed in the same manner as on Models 50 and 60; and it is absolutely necessary that the advice given with regard to these circlips be carefully followed if damage to the cylinder is to be avoided. All carbon deposits may now be scraped off the piston and cylinder head in the usual manner. On no account use a caustic soda solution for loosening carbon on aluminium pistons.

The Two-stroke Engine. This engine can be decarbonized in an amazingly short time. It is only necessary to disconnect the H.T. lead to the sparking plug and the Bowden control cable attached to the pressure-release valve, when the aluminium head can be lifted clear of the cylinder barrel after first removing the four fixing bolts. If the head is prised off, very great care should be taken to avoid scratching the head joint face, as aluminium is a comparatively soft metal. The exhaust pipes need not be disturbed unless it is desired to remove the cylinder barrel with a view to taking off the piston and examining the piston rings. By placing the piston on bottom dead centre, the cylinder barrel can be drawn off the piston after removing the carburettor and undoing the four base nuts. To remove the piston itself, it is only necessary to push out the fully-floating gudgeon pin and lift off. Chip every piece of carbon off the piston, combustion chamber, and ports.

Examining and Removing Piston Rings. The efficiency of the engine is largely dependent upon the condition of the piston rings, for if there is any escape of gas past them they will prevent the maximum power being obtained from the engine. They should be scrupulously inspected at intervals. They should be full of spring, absolutely free in their grooves, and arranged on the piston in such a manner that their slots are opposite to each other (i.e. at 180 degrees). Where a scraper ring is fitted on the skirt, the position of the slot is immaterial, for the ring plays no part in maintaining compression. Both rings should be polished all over, and if they are bright it is proof positive that they are doing their duty. If, on the other hand, they are dull or stained at some places, they are not being kept permanently in contact with the cylinder walls, due to carbon deposits binding them in their grooves, or to actual looseness in their grooves sufficient to cause gas leakage past the undersides of the rings. There is only

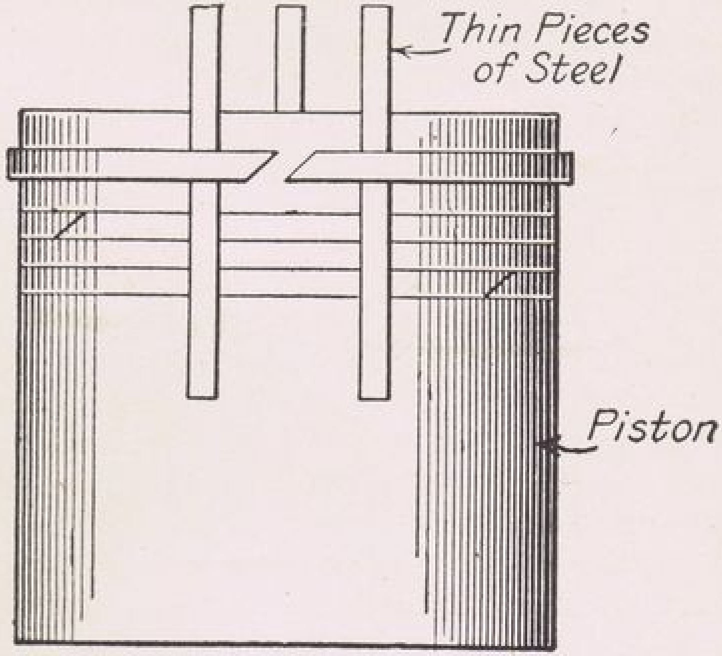


FIG. 64. HOW TO REMOVE PISTON RINGS

one remedy in this case, and that is to fit new rings obtainable from the manufacturers. Stuck rings can generally be loosened with paraffin. Piston rings are of cast-iron and of very small section. They are thus extremely liable to be broken during removal or replacement unless very great care is taken. They cannot safely be opened out wider than will allow them to be slipped over the piston crown. The best method of removing or fitting them is to insert three metal strips in the manner shown in Fig. 64. Be very careful to replace piston rings exactly as removed. When refitting rings or fitting new ones, thoroughly clean the grooves into which they fit.

Valve Removal. To remove the valves from the cylinder head on the O.H.V. engines, a spring compressor is essential, because the duplex coil springs are very powerful. The compressor recommended is the Hickman combined valve-holder and spring compressor. It can be obtained for the very modest sum of 5s. 6d.

It is suitable for all O.H.V. "Panther" engines, but in the case of the "Redwing 90" engine a small attachment is necessary. This is supplied with the compressor on request. As the illustration shows, the body of the tool is screwed into the sparking plug hole and the steel rod is then rotated or lifted until the cranked arm in the combustion chamber bears firmly against the centre of the valve head, thus pressing the valve against its seating. In this position the rod is secured by tightening up the wing nut

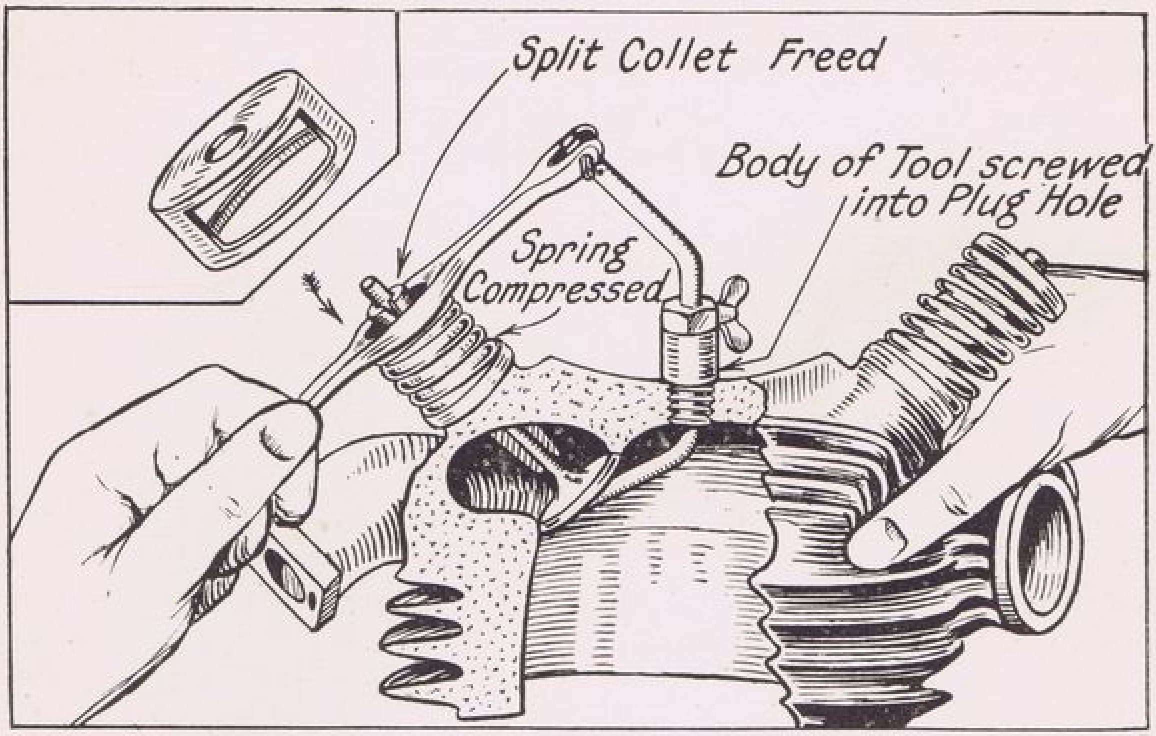


FIG. 65. REMOVING OVERHEAD VALVE WITH HICKMAN SPRING COMPRESSOR

The small inset shows the special attachment which fits over the spring collar on the "Redwing" engine

on the side of the body after first positioning the lever so that its centre portion rests over the valve stem on the spring retaining collar. In the case of the "Redwing 90" engine, the special attachment should first be slipped over the valve stem and spring collar. To compress the valve spring, exert a downward pressure on the lever and at the same time give a sharp tap on the spring collar so as to free the split collet. The valve spring can then be lifted off and the valve drawn out from the inside. Repeat the operation for both inlet and exhaust valves.

Grinding-in Valves. Generally speaking, the valves on the S.V. engines require to be ground-in once every 3,000 miles, and the valves on the O.H.V. engines once every 2,000 miles. The valves, however, should only be grounded-in when an examination reveals that the valves are not seating perfectly, due to pitting of the valve faces or seats. All pit marks should be removed. It may be mentioned here that excessive and unnecessary valve grinding will eventually result in the valves becoming pocketed (see Fig. 66), and there will be a loss of efficiency due to a reduction in gas velocity past the valves.

Where the pitting is found to be considerable, the valves should first be ground-in with a coarse grade grinding compound mixed with a little oil or paraffin, and afterwards finished off with a very fine grade. If the pitting is not serious, grinding-in with the fine abrasive alone will suffice to produce the desired effect. Only a small amount of grinding compound should be used at the time, and the valves should not be revolved round and round, but given a quarter turn backwards and forwards, being frequently raised

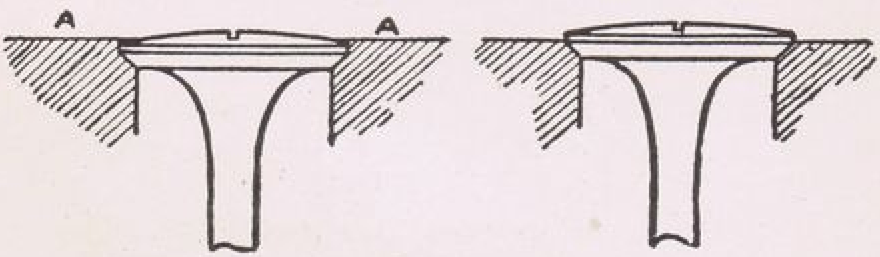


FIG. 66. DIAGRAM ILLUSTRATING HOW VALVES BECOME POCKETED AFTER FREQUENT REGRINDING

and dropped down in a different position. The O.H. valve, having split collars instead of a cotter, presents a fairly difficult proposition for grinding; but if you obtain a collar with a $\frac{3}{8}$ in. hole in it, and fit into the side a fairly long bolt, say $3\frac{1}{2}$ in. long by $\frac{1}{16}$ in. diameter, then you may use the screw to clamp the valve into the collar and also as a handle with which to turn the valve for grinding. Another method of gripping an O.H. valve is to employ a small hand vice. Certain types of chain rivet extractors can also be utilized for this purpose. After valve-grinding, the valves, valve seats, and ports should be most carefully cleaned with a paraffin-damped rag. Not the slightest particle of grinding compound must remain.

Grinding-in Cylinder Head and Barrel Faces. In the event of either of these members sustaining damage during dismantling, it will be necessary to grind them in as one would a valve, using a fine abrasive compound. Any bolt holes should first be filled up with thick grease to prevent the ingress of the abrasive.

Reassembly (Standard O.H.V. Engine). When you have removed all traces of carbon from the head, piston, and exhaust port, and ground-in the valves, you may start to reassemble. Fit the valves back into the head, not forgetting to grease the stems with a good graphite lubricant (except on the latest engines, where they are automatically lubricated), and being careful not to put the exhaust valve in the induction side, and *vice versa.* It is usually good policy to fit new valve springs, particularly if there are any signs of the old ones having weakened. If you own a T.T. machine, remember that T.T. valve springs are longer and stronger than standard springs.

Next, mount the piston on the connecting rod, smearing all bearing surfaces with clean engine oil. On 1927 models and later take care to lock the gudgeon pin securely and fit a new locking washer, and arrange so that the gaps on consecutive rings are as far away as possible from each other. The cylinder must then be placed in position, taking care not to break the piston rings as they are compressed to enter the cylinder bore, and that the oil transfer hole at the bottom of the casting is facing to the rear to register with the channel in the crankcase casting. Do *not* use jointing compound at the junction between cylinder and crankcase.

A special oil-retaining washer is now fitted between the crankcase top and the cylinder flange. If this washer is examined, it will be found to have an excrescence at one side which fits behind the tappet guides (or the tube flange in the case of the "Redwing" engine). It is *very important* that the position of this washer is unaltered, as further examination will reveal that a slot in the washer corresponds with the oil-feed hole from crankcase to cylinder. Before assembling the cylinder, clear out the oil-feed hole from the cylinder base into the bore. When assembling the head and rocker-box on 1931 machines, the trouble of the loose packing pieces can be entirely neglected, as it will be obvious to the observer that the packing pieces have been cast solid with the head. When placing the rocker-box in position, make sure that the small faces registering with the underside of the rocker-box and the top of the guide oil-feed ducts are perfectly clean, and that a small amount of jointing compound has been carefully smeared over one face. *The efficiency of the valve oiling system depends upon this joint.*

The remaining items can then be assembled in exactly the reverse order from dismantling, the following points requiring attention. The joint between cylinder and head should have been scraped clean, and should be given a thin coating of jointing compound immediately before replacing the head. The two nuts on the short studs projecting downwards from the head should be reasonably tightened before bedding the head completely down, and these should be given a final turn when the main assembly is complete. *Take care that the cylinder head beds down square.* The push-rods must be entered in the telescopic tube, placed in position in the guides provided at the top end. Finally, the nuts on the four long engine rods should be tightened down evenly, each one a little at a time till all are well down.

The T.T. models have four distance pieces of *equal* length, instead of the six on the standard model, in two of which flats are provided to give clearance for the telescopic tube. The push-rods on this model have ball-ended tops and care must be exercised that these are correctly engaged in the cups in the ends of the rockers. After reassembly, carefully readjust the tappet clearances.

Reassembly (O.H.V. "Redwing" Engine). This is quite straightforward, the assembly of the engine and its fitting in the frame being a reverse process of dismantling. Refit the piston and make sure that the circlips are properly bedded down. Then replace separately the cylinder barrel, cylinder head, and rocker-box. During the removal of the above parts, the push-rod cover tube will also have been removed from the crankcase, and it is advisable to part this from the rocker-box and refix into the crankcase. This operation is not absolutely necessary, but it will be found that the replacement of the long push-rods will be greatly facilitated by doing this. The push-rods can now be refitted, making sure that the bottom ball ends of the rods are fitted into the respective cups provided in the cam levers. The fitting of the top ends of the push-rods is best done by removing the rocker-box lid and guiding the ball ends of the rocker levers into the cup ends of the push-rods as the rocker-box is fitted to the head. When assembling the engine, do not allow the cylinder base packing washer to mask the oil-feed hole in any way. Also see that, after refitting the rocker-box, the oil-pipe gland nut is firmly retightened; finally, after bolting the engine down in the frame, readjust the valve clearances at the rocker-arms (see page 103).

Reassembly (Two-stroke Engine). Replace the piston, taking very great care that the steep face of the deflector head faces to the rear and the long sloping face to the front. Then gently replace the cylinder barrel over the piston, which should be at the bottom of its stroke, and tighten down the four stud nuts. When replacing the barrel, it is most important not to rotate it, or a ring may catch in one of the ports and break. The cylinder head can now be replaced, and the sparking plug, H.T. lead, and pressure release valve cable refitted. With the Mk. XA engine, the use of a jointing compound is not essential for the head, as the soft nature of the aluminium ensures a gas-tight joint being made on tightening down the four bolts which screw into the cylinder barrel. In the case of the cylinder barrel base, however, a washer must not be omitted. Use only a special washer, with the oilway holes correctly placed.

GENERAL MAINTENANCE AND OVERHAULING NOTES

Maintenance of the Amal Carburettor. Periodical cleaning is necessary to maintain efficient functioning of the carburettor, and should be carried out in the following sequence—

Disconnect petrol pipe. Unscrew holding bolt *Q* (Fig. 41) and remove float chamber complete. With box or set spanner, slacken the mixing chamber union nut *E*. Mixing chamber complete may now be removed from engine, by unscrewing the bolts holding the flange to the induction pipe. Unscrew mixing chamber lock ring, and pull out throttle valve needle and air valve. Remove main jet *P* and needle jet *O*. Mixing chamber union nut *E* may then be removed and jet block complete pushed out. If this is obstinate, tap gently, using a wooden stump inside the mixing chamber. Unscrew float chamber cover *W* and slacken lock-screw *X*. Withdraw the float by pinching the clip *V* inwards, and at the same time pull gently upwards.

Generally it is sufficient to wash all the parts in clean petrol, but if the carburettor has had extended service, check the following—

(*a*) FLOAT CHAMBER NEEDLE *U*. If a distinct shoulder is visible on the point of seating, renew this as soon as convenient.

(*b*) THROTTLE VALVE. Test in mixing chamber, and if excessive play is present it is advisable to renew this without delay.

(*c*) THROTTLE NEEDLE CLIP. This part must securely grip needle. *Free rotation must not take place*, otherwise the needle groove will become worn and necessitate a new part being fitted. *Be sure to refit the clip in the same groove.*

(*d*) JET BLOCK. If trouble has been experienced with erratic "idling," ascertain by means of a fine bristle that the pilot jet *J* is clear, and that the pilot outlet *M* in the mixing chamber is unobstructed.

Sometimes small flakes of enamel and plating find their way into the float chamber of the carburettor, if they have not already lodged in the petrol pipe or petrol tap. This effectively stops the supply of fuel to the carburettor which, in its turn, impedes the starting or even continuous running of the engine. The lack of adequate fuel supply can always be detected by the time the carburettor takes to flood, the normal period of flooding being only a few seconds.

Care of the B.T.-H. Magneto. When undertaking an annual overhaul, the following points should be attended to in order to ensure freedom from ignition trouble.

(*a*) Polish the contacts with a dead smooth file. To render the points accessible for cleaning, it is necessary to withdraw the contact-breaker from its housing by unscrewing the hexagon-headed retaining screw by means of the magneto spanner. The whole contact-breaker can then be pulled off the tapered armature shaft. Now push aside the locating spring and prise the rocker-arm off its bearing, when it will be possible to begin cleaning the points. Do not interfere with the spring-retaining screws. Before removing the rocker-arm, note whether the breaking of the contacts is at all sluggish by putting pressure on the fibre heel. If this is found to be the case, the bearing pin should be cleaned with very fine emery cloth and afterwards moistened with a little oil. When replacing the contact-breaker, care should be taken to ensure that the projecting key on the tapered portion of the contact-breaker base engages with the keyway cut in the armature spindle, or the whole timing of the magneto will be upset. The hexagon-headed screw should be tightened up with care; it must not be too slack (for it is part of the primary circuit) nor must undue force be used.

(*b*) If the machine has done a season's riding, remove the driving-end bearing plate and resoak the felt washer in good quality grease or replace with a new one.

(*c*) Remove the high tension pick-up by removing the two holder screws, and polish the moulding with a clean cloth. See that the carbon brush is working freely in its holder and that it is not unduly worn. Clean the slip-ring track and flanges by holding a soft cloth damped with petrol by means of a piece of wood on the ring while the engine is being slowly and very carefully rotated. A magneto run with a carbon brush absent, or sticking, produces nitric acid internally (due to the sparking), which destroys all the lubricant, and attacks both the metal and insulation of which the armature is composed. If the brush is accidentally broken, care must be taken that no pieces are allowed to remain inside, or serious damage will result.

(*d*) Examine the high-tension cable, and replace if the rubber shows signs of disintegrating.

(*e*) See that the contacts "break" to the correct extent (0·12 in.). It is seldom necessary, nor is it desirable, to dismantle the magneto. The armature of a magneto cannot be removed without loss of magnetism from the magnet and, unless facilities for remagnetizing are available, it is best not to dismantle. If you must dismantle, first remove the pick-up and the safety spark screw, or a broken slip-ring may result.

Testing Miller Condenser. If the contacts of the Miller contact-breaker housed in the timing-case cover on coil-ignition machines are badly burnt, the condenser should be tested and, if defective, replaced. To test the condenser, remove it and apply a lighting main's voltage to its terminals. To prevent the possibility of a short circuit occurring if the condenser has broken down, a lamp resistance should be used in series with it. If on removing the current from the main an appreciably snappy spark is obtained on shorting the condenser terminals, even after a few seconds' pause, it shows that the condenser is in order. If leaky or partially shorted, no spark will be obtained.

Magneto Alignment. If the magneto has been removed, care should be exercised when replacing it that the fibre centre piece of the coupling is neither too tight nor too loose when engaged with the metal pieces of the coupling, and that the armature is as nearly as possible central with the drive end of the coupling. Sufficient tolerance of movement is allowed by the magneto holding-down bolts to permit of this being done. It is important that the magneto be pushed as far as possible towards the coupling so that the units of the coupling are *fully meshed*.

Magneto Timing. Accurate magneto timing is extremely important. Many riders imagine that by advancing their timing they necessarily will get more speed. This is a fallacy, and it only throws unfair loads on the engine, spoiling its flexibility, and eventually damaging it throughout. For all normal road uses, the spark setting given at the end of the standard engine specification should be closely adhered to. Only for genuine racing purposes is it advisable to increase the spark advance beyond these limits, and even then undue spark advance should be avoided. It should always be remembered that should the timing be so far advanced that maximum explosion pressures are reached with the crank in true T.D.C. position, the big ends come in for a terrific hammering, for which they are not designed. The special P. & M. magneto coupling does away with the necessity for retiming if the magneto alone is removed. If the magneto drive has been removed for any purpose or disturbed, it may be necessary to retime it, and to do this proceed as follows—

Set the piston so that it is at the top of the compression stroke and as near the T.D.C. position as possible. Verify that it is on the compression and not the exhaust stroke by noting whether both valves are fully closed with the normal clearances at the valve rockers, and put the ignition lever on full retard. Then remove the timing-case cover and, on magneto-ignition machines, take off the nut holding the magneto-driving pinion (26, Fig. 14) to the tapered shaft. This pinion can now be brought out of engagement with the intermediate wheel and the magneto armature rotated into any desired position. With the ignition lever still on full retard, rotate the contact-breaker until the contacts are just breaking. To find the exact point of break, place a cigarette paper between the closed contacts and rotate the armature until the paper is just released, and no more, on pulling it gently. In this position the driving pinion should be meshed with the intermediate wheel. When first retightening the pinion lock-nut, the magneto should be prevented from further rotating by means of the contact-breaker or dynamo chain until the taper on the pinion bites. Do not, however, hold the contact-breaker for final tightening, or the keyway may be sheared.

On the coil-ignition engines an alteration to the magneto timing is effected by altering slightly the position of the contact-breaker cam on the camshaft. Clearly the relative positions of the camwheel and engine pinion could not be disturbed without

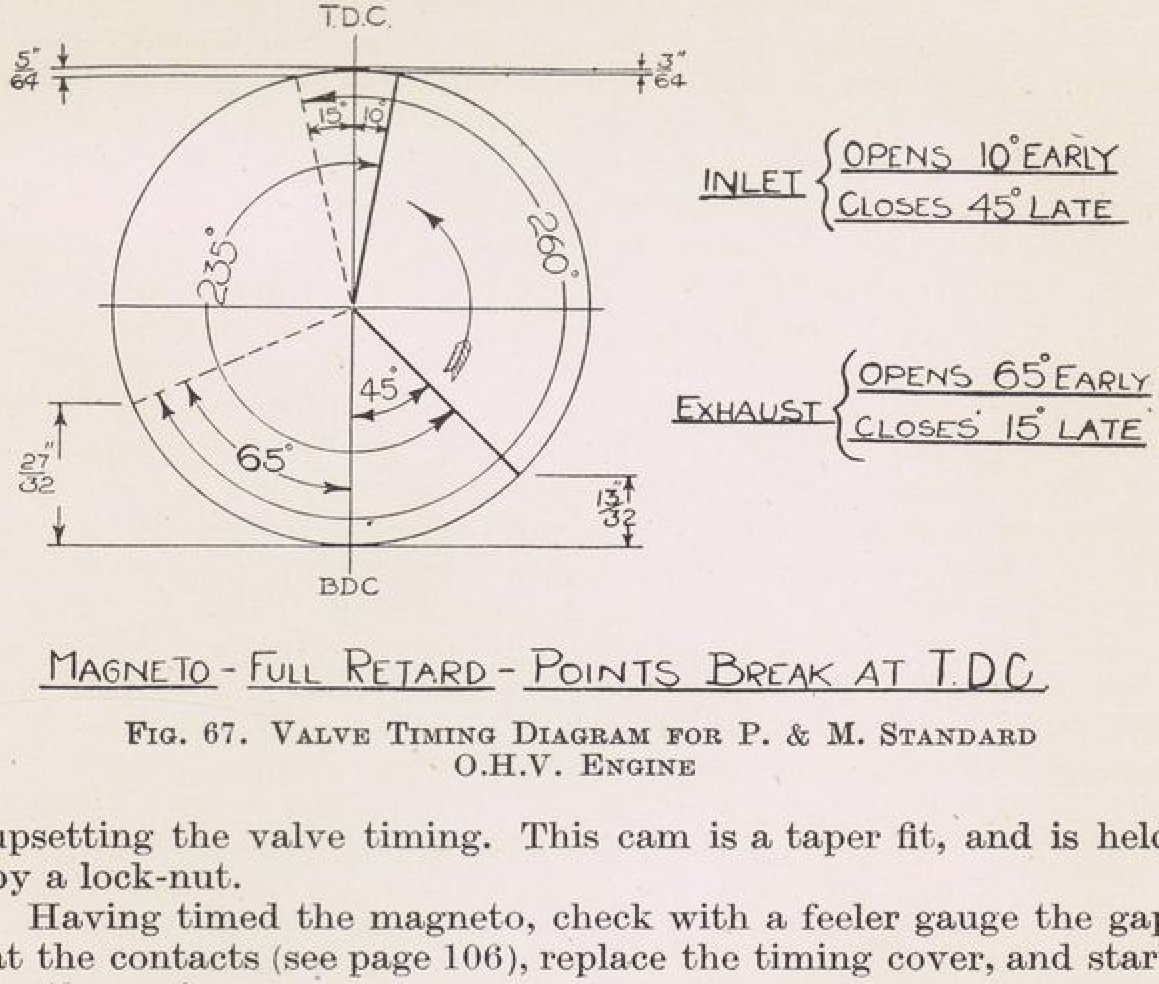


Fig. 67. Valve Timing Diagram for P. & M. Standard O.H.V. Engine

upsetting the valve timing. This cam is a taper fit, and is held by a lock-nut.

Having timed the magneto, check with a feeler gauge the gap at the contacts (see page 106), replace the timing cover, and start up the engine.

Valve-timing. On all P. & M. engines the timing-gear wheels are punch-marked to ensure correct replacement of the wheels, and the owner-driver is advised not to make any attempt at altering the setting, which has been determined with great accuracy by the manufacturers. As a matter of interest, the standard timing is shown in Fig. 67.

Dismantling and Assembling O.H.V. Timing Gear. Let us refer to Fig. 40. The timing-case cover carries on its inside face two self-aligning ball races, and a spring-loaded plunger. This plunger presses against the intermediate timing wheel *B* lying between the camshaft *A* and the magneto-drive shaft *C*, and holds this wheel (which carries the oil pump) fully home on its spigot bearing, which is very necessary to ensure the proper working of the oil pump. Therefore, do not lose this plunger, and do not forget to replace it when reassembling. To remove the cam levers *G*, the bearing pin *F* on which they rock must be withdrawn. To facilitate this, the outer end of the pin has a threaded hole into which one of the crankcase bolts may be screwed, and by gently tapping the inside face of a nut left on the outer end of this bolt the bearing pin will come out of the crankcase. This releases the two cam levers *and* a distance washer *behind them*, and on *no* account must this washer be forgotten when re-assembling. Also, when re-assembling, do not drive the bearing pin too far into the crankcase, as this will cause the cam levers to bind. If the pads on the cam levers where they bed on the cams show signs of wear, new levers should be fitted. The large intermediate toothed wheel carries the oil pump components—a brass plunger *J*, and engaged in this, a small square brass block *K*. When re-assembling, it is best to place the square block in the recess in the plunger, seeing that this is as central as possible, with the plunger in position in the timing wheel, and the whole assembly carefully replaced in its bearing (which is in effect the oil pump body). The pin *M* mounted in the crankcase in the centre of this bearing is placed eccentric to give motion to the pump plunger, and it will probably be necessary gradually to rotate this large wheel when replacing it to get the pin to register with the hole through the square block. When re-meshing the toothed wheels, care should be taken that the various punch marks correspond to ensure correct timing (see Fig. 67). Camshaft replacement must be preceded by the insertion of the decompressor mechanism *H* (see also Fig. 17), the tongue of which must be above the camshaft, and during insertion the cam levers must be raised to enable the cams to pass beneath them. Two punch marks will be found on the camwheel, one of which coincides with a corresponding mark on the main shaft pinion, and one with a mark on the large intermediate wheel.

When replacing the timing case cover, see that the faces of the self-aligning bearings are as square as possible, and also that the tongue on the decompressor shaft is in a position similar to that of the slot cut for it in the end of the shaft carried in the timing cover. Jointing compound should be smeared on the cover where it beds down on the timing case, old compound used on previous assembly having been scraped off.

Removing Standard O.H.V. Engine from Frame. If any serious work is going to be done on your "Panther" engine, it is always best to take the engine bodily from the frame. To do this, take off the chain case and primary chain. Now uncouple the magneto advance and retard wire, and detach the high-tension wire from the plug, pulling it through the channel in the tank and coiling it out of the way round the magneto. Take off the petrol pipe and remove the carburettor complete. The exhaust pipe and silencer may be removed complete without parting. The exhaust-lifter wire should now be removed. This is best done with the engine in such a position that the exhaust valve is fully open, grasping the outer cable just above the rocker-box and pulling upwards until the top slotted washer comes clear away

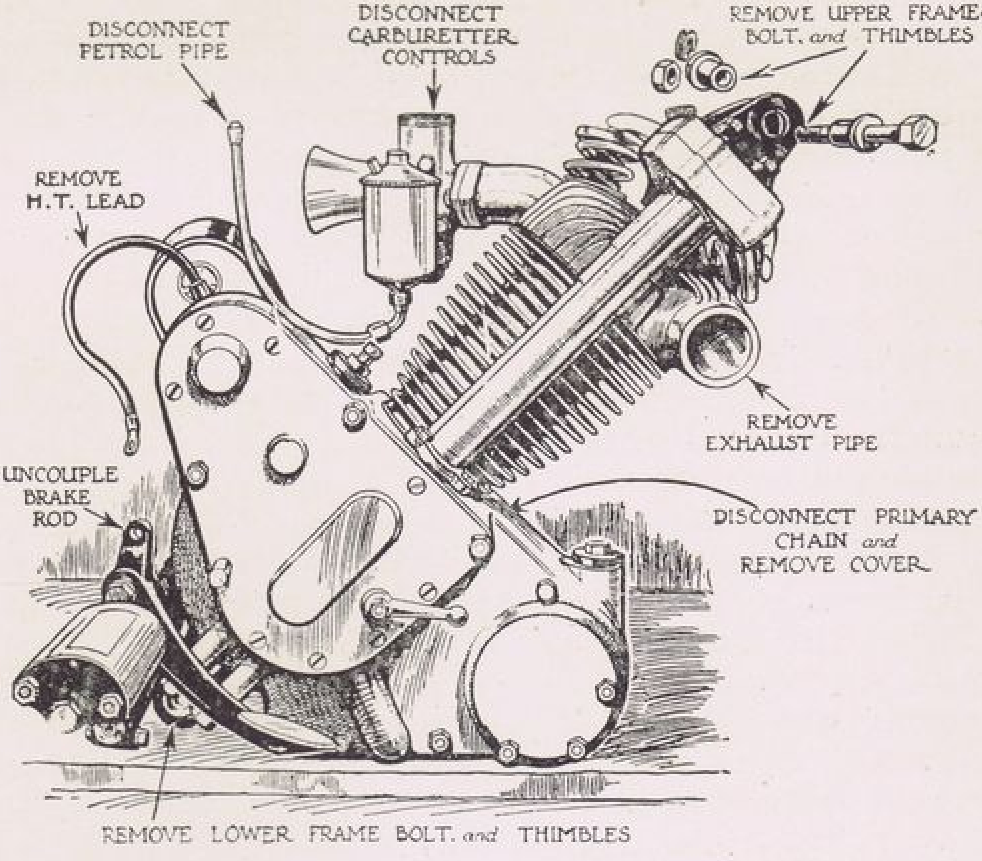


Fig. 68. How to Remove Standard O.H.V. Engine from the Frame

from the long collar. By pulling off the slotted washer this long collar may be then slid up the Bowden outer casing out of the way, when the nipple on the end of the Bowden wire can be disengaged. On 1931 engines the exhaust-valve lifter wire should be unhooked from the lever on the rocker-box end plate. The brake pedal should then be uncoupled from the front end of the brake rod, after which the engine will be clear of all fittings which are attached to it from other parts of the frame. Now remove top and bottom main engine bolts, *both* of which are fitted with split pins. These bolts each hold in place a pair of cones. Punch the bottom pair out first, then, after turning the front wheel to one side, allow the engine to swing forward, pivoted only on the top engine lugs and cones. Then prop the engine up on the ground and knock out the top pair of cones, when the engine will be entirely free of the frame and can be placed on the bench to be worked upon. On the T.T. models there are two bolts at the top end of the engine and *no cones*.

After the engine has been completely removed from the frame, it can be best replaced by putting in the top engine cones first and swinging the engine backwards and replacing the bottom cones. Do not forget to split-pin the bolts holding these cones in place.

Dismantling O.H.V. Rocker-box. On models prior to 1931 it is only necessary to undo the rocker-box cover fixing bolts and lift off the cover, thus exposing the rockers and spindles, which may be lifted out. On present engines two-piece rockers are used, and to withdraw these the rocker-box end plate, complete with exhaust valve-lifter mechanism, must be taken off and the rockers drawn out from this side, after first removing the nuts at the opposite end of the rocker-box. Be careful not to loose the keys holding the nearside rockers in position.

Dismantling Shock Absorber. On the O.H.V. "Panthers" three bolts hold the shock absorber and sprocket assembly to the rear hub, and the removal of them enables the rubber buffers inside to be taken out (see Fig. 24).

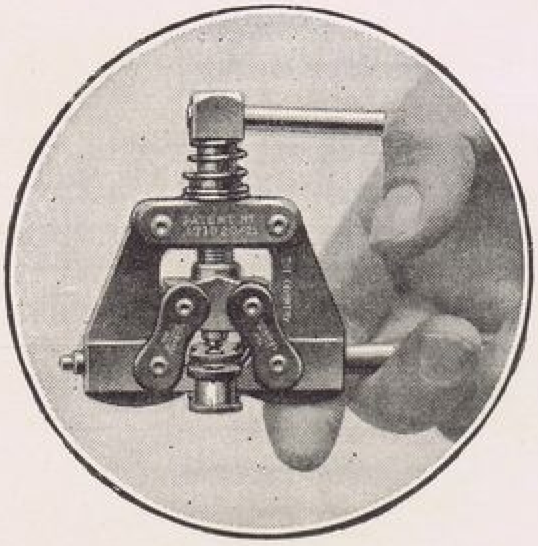
Removing Front Wheel. On the O.H.V. "Panthers," jack up the front wheel and then remove the cables fixed to the brake-expander lever, and also disconnect the lower end of the speedometer drive. After undoing the two axle nuts, the wheel will then fall out of position.

Removing Rear Wheel. Disconnect the rear brake by taking off the milled adjuster nut, undo the axle nuts, and the wheel will drop out after first removing the secondary chain and chain case.

Chain Repairs. Always carry a complete chain repair outfit and some spare links. For removing chain rivets, the extractor shown at Fig. 69 is admirably suited, and is manufactured by the Coventry Chain Co. To use extractor, see that the point is level with the lower surface of the nut, and open the jaws by pressing the tommy-bar and handle towards each other, and insert the chain so that the jaws grip the roller and the bottom of the inner plate rests upon the shoulders of the jaw. Turn the tommy-bar until the rivet is forced through the outer plate. Repeat the operation on the next rivet; the outer plates can then be removed with the fingers and the chain connected up with the necessary spare part.

Wheel Alignment. As stated on page 114, the rear wheel is not mounted central in the rear forks, and if correct alignment has been lost, it will be necessary to line up the back wheel with the front by means of a straight edge or length of cord. With the machine on the stand and the front wheel dead straight, a straight edge or stretched cord placed against the sides of *both front and back wheels*, low enough to clear any parts of the engine or other obstruction between the wheels, will show if the wheels are in line or not, by the absence or otherwise of a gap at either front or back of rear wheel. Adjustments with the chain adjusters can be made accordingly. When the wheels are correctly aligned the straight edge should touch the tyre sides at four points; front and back of both front and rear wheel.

When fitting or refitting a Schneider Trophy sidecar, place the sidecar in position, leaving all attachment nuts slack. The sidecar wheel should not run parallel with the machine wheels, or



(Coventry Chain Co., Ltd.)

Fig. 69. Showing How to Use the Coventry "Universal" Rivet Extractor

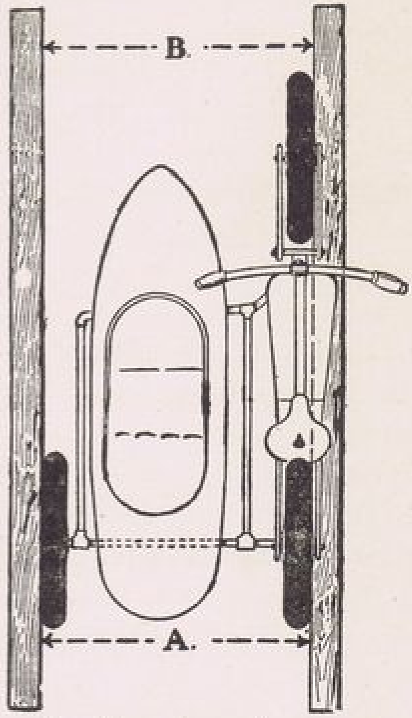


Fig. 70. Sidecar Alignment

The distance *B* should be $\frac{3}{4}$ in. less than the distance *A*

there would be a tendency for the machine to constantly pull to the left. The sidecar wheel should run in towards the machine $\frac{3}{4}$ in. (see Fig. 70). To align correctly, two straight edges 6 ft. long are necessary, which should be placed on the floor, one against the wheel rims of the machine, the other against the wheel rims of the sidecar. Now measure the distance between the edges immediately in front of the front wheel and at the rear of the rear wheel; the distance between the edges should be $\frac{3}{4}$ in. less at the front than at the rear. Finally retighten all nuts securely.

The Annual Overhaul. Special points to be noted in the complete overhaul are as follows—

Frame. Alignment, existence of flaws or cracks, play in spring forks, looseness of steering head, wear caused by friction of all attached parts, condition of enamel, fork damper.

WHEELS. Condition of rollers or balls, truth of wheels, alignment, loose spokes, condition of rims, wear of tyres.

CHAINS. Excessive wear, cracked or broken rollers, joints.

ENGINE. Oil leaks, compression leaks, main bearings, valves, valve guides and tappets, overhead-valve rockers, valve springs, valve seats and faces, cotters, condition of cylinder bore, piston. piston rings, play in big-end and small-end bearings, timing wheels, shafts and bearings, cams and camshaft.

GEARS. Condition of teeth on sprockets and pinions, damaged ball races and loose parts generally.

The examination should also include all control rods and cables, sump filter, clutch and brake linings, etc. To sum up, everything should be dismantled and readjusted, and replacements made where necessary.

Fitting New Small-end Brush. The correct procedure is as follows: Get an old bush slightly smaller than the one which is to be extracted and a larger one for it to fit into. An iron bolt is then run through the connecting rod, and the two bushes placed one on each side of the latter. By slowly tightening a nut on the bolt with a long spanner, the bush in the connecting rod can be gently pressed out. A new bush may be fitted in like manner, and if a trifle large externally can be eased off with emery cloth. See that oil grooves are provided on the new bush.

The P. & M. Four-speed Gear-box. In the event of trouble developing in the gear-box, unless you are fairly conversant with the operation and construction of it, it is preferable to send the box back either to the works or to the London repair depot, for attention. The following details are, however, given to assist those who desire to do their own overhauling. It is first necessary to remove the clutch altogether from the main shaft, and also the smaller sprocket behind it, after which the whole of the gear-box contents will come out with the end plate.

When re-assembling the gear-box, it is essential to time the gear operation correctly with the striking forks on the gear operation camshaft (marked N on the drawing, Fig. 46). Presuming that the gear wheels have been properly assembled on their respective shafts, and the striking forks (marked O_1 and O_2 on drawing) have been replaced in position, complete with operation shaft N, put the whole assembly into the gear-box so that each shaft end goes into its respective bearing or ball-race. The gear will then be complete, less end plate.

To time the gear operation correctly, turn the camshaft N by hand to such a position that the striking fork O_1, as seen through the top of the gear-box, moves the gear wheels C and H as far as possible towards the driving sprocket end of the gear-box, and by turning the main shaft (the shaft that carries the clutch) round, you will make sure that the engaging dogs on the wheels come properly into mesh and are not riding on their faces. The correct position is found when a slight rotation of the shaft *N* in either direction starts to move the fork O_1 away from the full mesh position. The fork O_2 remains stationary in its neutral position (that is, neither of the two lower gears is engaged) during this process. The gear-box is now in top or fourth gear position.

Taking the end plate, the operation wheel *M* is located in the various gear positions by the spring plunger *P*, which must be removed from the end plate by unscrewing cap *R*. Through the hole vacated by the cap *R*, four dimples can be seen in the operation wheel *M*, which correspond to the four gear positions when the wheel is correctly timed with the operation shaft *N*. Turn this wheel by the lever *S* until the top gear dimple (No. 1 in the drawing) is dead central with the hole for cap *R*, when the gear end plate, complete with foot starter assembly, can be fitted to the box, taking care to keep the foot starter lever in its topmost position. It should slide straight into place when the ends of the shafts have entered their respective bearings, provided that the camshaft *N* has been correctly set. If the end plate will not go right home, the cause is probably either that the camshaft or the operation wheel has not been set exactly right, and a very slight movement of either will enable the end plate to bed down. Do *not* try to force it down. Now fasten on the end plate by two or three of the fixing stud nuts, and check each of the gear positions with respect to the positions of the striking forks O_1 and O_2, and the dimples in the operation wheel *M*. This can easily be done by moving the lever *S* and at the same time moving the gears round by turning the main shaft. When the lever is moved so as to bring dimple No. 2 into the centre of the hole, the striking fork O_1 should have moved so as to mesh fully the dogs on the wheel *H* with those on the lay shaft nearest to wheel *J*. It should be noted that, as the dogs approach full mesh, the dimple approaches the centre of the hole, and when the dogs have just fully meshed, the dimple should be exactly in the centre of the hole. This holds good for every gear position.

On no account should the gear be assembled with the striking fork moving the wheels either into mesh or out again when the corresponding dimple comes into the centre of the plunger hole.

There is no dimple for neutral position, this coming between dimples 3 and 4. As a test for neutral, place the lever *S* in such a position that the centre of the space between dimples 3 and 4 is dead in the centre of the plunger hole, when the gear should rotate freely when the rear wheel driving sprocket is lightly held stationary.

If you have correctly timed your gear operation according to these instructions, replace all the fixing nuts and nip up just tight. Do not attempt to tighten the nuts up with a large key or undue force, or you will shear them off, or tear them out of the aluminium box. Replace spring plunger and cap, and screw up tight. Now take out the oil level plug and fill the box through the lid with X.L. or slightly heavier oil in summer, until the oil runs out from the level hole. This indicates the correct level of the lubricant, and on no account use more. Now replace the gear-box lid and tighten down the fixing screws.

The secondary shaft chain sprocket and clutch can now be refitted to the gear-box, and the whole assembly replaced in the frame of the machine, taking care that it is properly bedded down into the machined guides on the top surface of the gear-box bracket. It is here pointed out that prior to 1926 the *secondary shaft chain sprocket* is screwed on to its shaft (right-hand thread), its lock-nut having a *left-hand thread*; 1926 models and later, this sprocket is *splined* on to the shaft, the lock-nut having a *left-hand thread.* Do not couple up the gear lever on the tank to the gear-box until the gear-box has been bolted into the frame with the chains on and in correct tension, otherwise re-adjustment of the vertical connecting-rod may be necessary.

The Sturmey-Archer Three-speed Gear-box. The foregoing instructions refer to the P. & M. four-speed gear; and in view of the large number of "Panthers" now in use with Sturmey three-speed gears, the following will be of interest to riders of such models. The Sturmey-Archer gear-box is so well known to motorcyclists that it is hardly necessary to point out that, owing to its robust design and size, it may be termed foolproof. Provided it is correctly and regularly lubricated and adjusted, it will give many thousands of miles satisfactory service with a minimum of attention. Like all modern mechanism, its life and reliability depend on correct and regular lubrication, and one cannot too strongly recommend riders to pay particular attention in this respect. Use only a high-grade oil recommended by the manufacturers. (See page 26.)

To Dismantle. Disconnect clutch control wire, then remove the seven end plate nuts, and gently pull off the end plate or cover. Do not use a screwdriver or similar tool, as this will destroy the joint and the latter will fail to retain the oil when replaced. If the plate sticks, a few light blows with a hammer on the inner side of the kick start crank will have the desired effect. This will expose the complete interior to view. By disconnecting the operating arm, the low and middle gear pinions and layshaft can be withdrawn.

When replacing the cover plate, see that the self-aligning ball-bearings are not tilted. No force is necessary when replacing the cover plate. In the event of damage which calls for replaced parts, it will be found that any first-class motor-cycle agent is familiar with the Sturmey gear-box, and that spare parts can always be obtained quickly from the works at Cleckheaton or Mortimer Street, London, but in the unlikely event of a serious breakdown or complaint, the box should be returned direct to Messrs. Sturmey-Archer at Nottingham, or, in the case of South of England riders, to the London Sturmey-Archer service depot in Farringdon Road, E.C.

The following ratios are standard on O.H.V. Panther Models 50 and 60 for solo riding, and have been found the most suitable range for all-round conditions: Top 4·5, middle 6·62, bottom 13·23.

Where required, the following close ratios can be supplied: Top 4·5, middle 5·9, bottom 9·8.

In both cases these ratios are most suitable for solo work, and when a sidecar is fitted we recommend the rider to change the engine sprocket for one having one or two teeth less, according to the weight and type of sidecar fitted, and the load carried.

The rear wheel sprocket, up to and including 1925 models, is bolted direct to the hub (a transmission shock absorber being incorporated in the clutch) and presents no difficulty in removal. 1926 models and after are fitted with a hub incorporating a shock absorber. In this case three bolts hold the sprocket and shock absorber assembly to the hub, the removal of which releases the sprocket, which can then be pulled straight off. Occasional attention should be given to these bolts to ensure that they do not work loose.

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