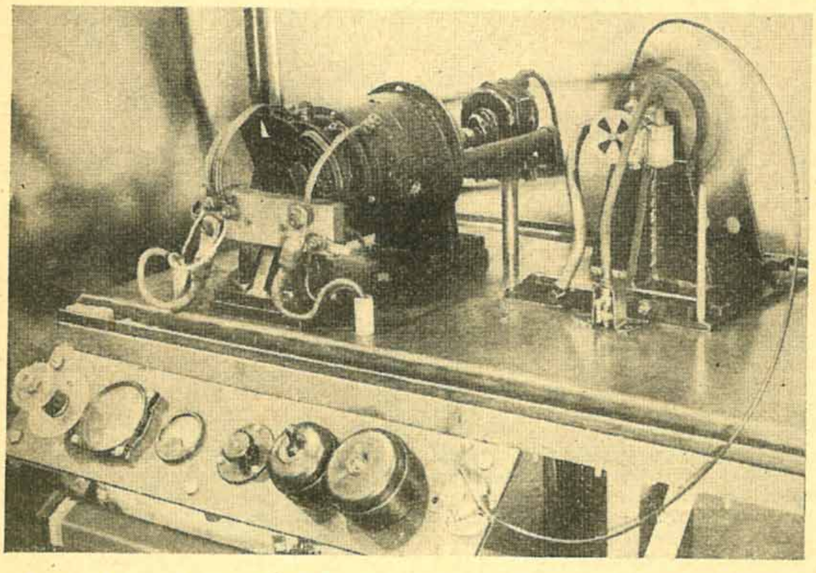
A REVOLUTIONARY POWER UNIT

Details and Performance of the 40 c.c. Rotary Two-stroke T.I. "Power Wheel" Shown at Earls Court

THERE is, of course, nothing new about the principle of the rotary engine. The idea of making the pistons and cylinders revolve around a fixed crankshaft was used by some of the earliest aircraft engine builders and, even before that, in 1905, the Barry motorcycle had an ingenious horizontally opposed rotary twin unit. But, so far as motorcycles are concerned, the general public had never, before the 1951 Earls Court Show, seen a *single*-cylinder rotary engine, as represented by the T.I. "Power Wheel."

The daring unorthodoxy of such a conception is enough to startle most engineers, but what really fascinated Show visitors was the application of the principle to pedal cycle propulsion. To design and construct a satisfactorily working single-cylinder rotary two-stroke engine is a bold enough feat, but to compress the whole arrangement into the confines imposed by the frame width and wheel diameter of an ordinary bicycle—that was something that really had to be seen.



Testing the engine of the "Power-Wheel" on the bench against an electric brake. The revolving blur behind the carburetter is the cylinder which is turning at some 3,600 *r.p.m.; at this speed the unit is producing* 0.7 *b.h.p., yet, the silver pencil balanced on the test rig remains upright.*

Most of the readers of "Motor Cycling," having seen in our November 15 issue the short illustrated account of this invention, will know that it comes from the drawing board of Cyril G. Pullin, F.R.Ae.S., M.I.Mech.E. Old hands will recollect that, as well as being a practical motorcyclist—he won the 1914 Senior T.T. on a Rudge—Mr. Pullin was the man responsible for that "years-before-its-time" luxury mount, the Ascot-Pullin which, in 1928, had such features as hydraulic brakes, a one-piece all-enclosing pressed-steel frame, instrument facia handle-bars and many very sensible detail refinements. Like its predecessor, the Pullin-Groom, the Ascot-Pullin was remarkable for the immense amount of thought put into its design and it is this quality which immediately comes to light when the latest Pullin production, the "Power Wheel," is subjected to close examination. And to see how thoroughly every possible contingency likely to arise in operation has been anticipated, let us take one of these units to pieces and discover how it ticks.

Initially, Mr. Pullin decided that the prime requisite in a bicycle power unit is smooth torque—first for the rider's comfort and, secondly, to protect the cycle itself from as many as possible of the additional shocks and strains imposed on it when it becomes power driven. To achieve a virtually vibrationless engine, he chose the rotary principle, but space and weight considerations prohibited the use of more than one cylinder. So he made it a two-stroke single—thereby dodging also the valve complications of a four-stroke—and secured complete balance of the cylinder side of the unit by mounting a counterbalance, in the form of magneto coil and core, on the opposite side of the crankcase. This assembly can spin on its main bearings with the equilibrium of a twin-bladed airscrew.

But what about the piston and connecting rod? These two components are counter-balanced by a bob-weight on the con.-rod big-end and this assembly is also able to rotate freely around the crankpin. So the masses revolving around the axle are all fully balanced and so are those revolving on the crankpin, the two sets of forces being "off centre" only by the length of the crankshaft throw—which is, of course, equal to half the stroke of the piston. In this case the stroke is 1⅜ ins. (34.9 mm). The bore is 1½ ins. (38.1 mm.) and the capacity 40 c.c.

Since the axle-crankshaft is fixed in the cycle frame (and, incidentally, there is nothing to prevent it being mounted in the front fork), it is the rotating crankcase that turns the driving wheel. In the "Power Wheel" this is done through a

(Below) "Motor Cycling's" Midland man, Dennis Hardwicke, takes out a Hercules cycle equipped with the T.I. "Power Wheel," when it was found that a speed of 18 *m.p.h. was easily maintained under favourable conditions.*

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train of four machine-cut gear wheels, giving a reduction of 14 to 1, and the engine revolves in the same direction as the driving wheel.

In essence, the "Power Wheel" consists of three parts, one is the petrol tank, another the rotating engine-cum-magneto coil hub-shell unit, and the third is the fixed crankshaft with the carburetter and stationary, die-cast aluminium side-plate that contains the brake, clutch housing, lighting dynamo and exhaust tail-pipe. Also in the "stationary department" is the magneto stator-plate.

Study of the accompanying drawings will show how these parts come together to make a drum-shaped, self-contained power unit fed by an external fuel tank. The latter is a rectangular, box-shaped container which, mounted on struts over the mudguard, also forms a luggage carrier.

The engine operates on a 25-to-1 petroil mixture, which is piped by gravity to a special small-bore Amal carburetter fitted with an air filter and a centrally drilled shutter-type choke, the orifice being calibrated to afford mixture of sufficient richness and volume for starting and slow-running purposes, but not for running under power. The starting procedure is as follows: the twist-grip is fully opened and the shutter control trigger depressed. As the machine is pedalled into action and gathers way, the grip is eased back when the choke automatically opens.

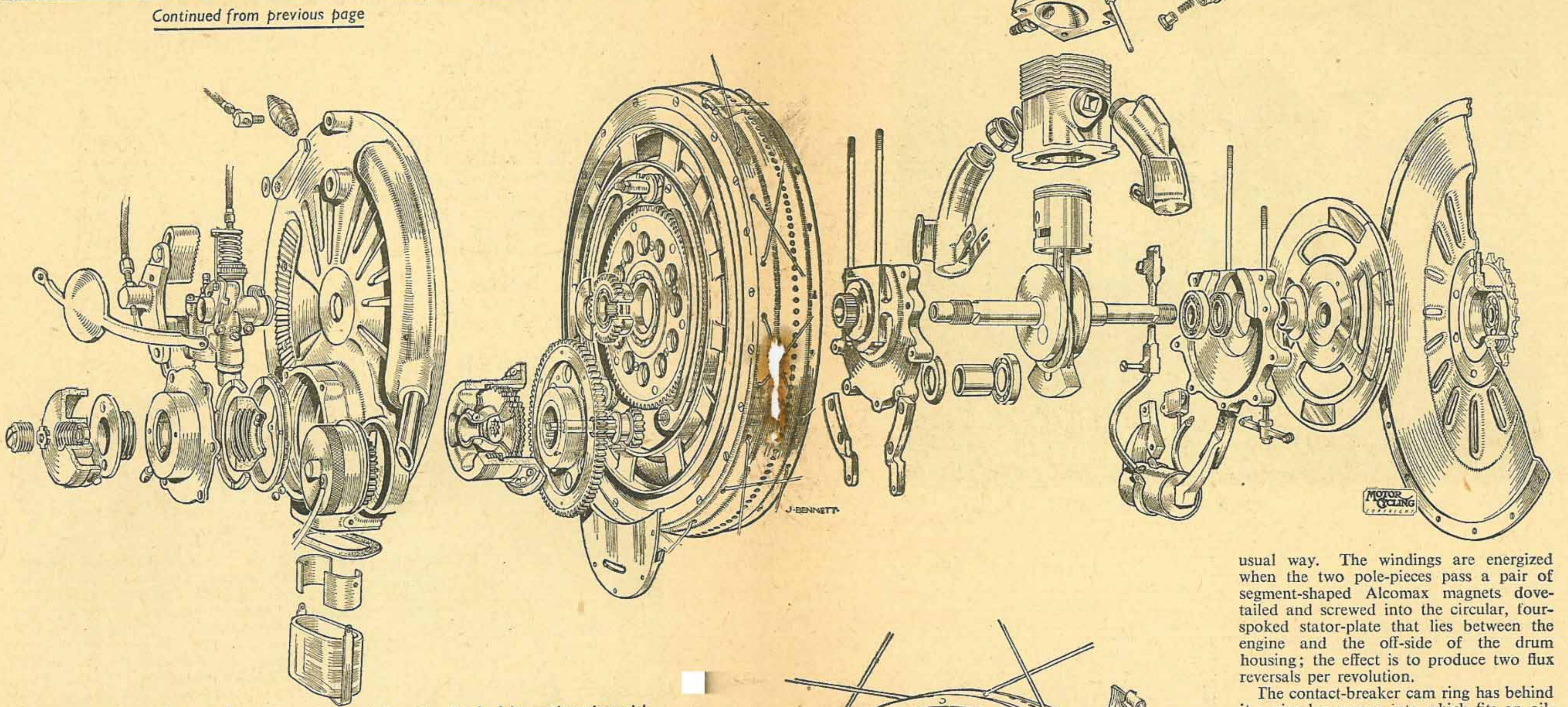
Rotary Valve

The mixture enters the aluminium-alloy crankcase (revolving on two standard $\frac{5}{8}$-in. ball journal races backed by synthetic rubber oil-seals) via the hollow 3 per cent. nickel-steel crankshaft. The intake bore is circular, except for about $\frac{3}{4}$ in. of its length coincident with the section of the shaft that is slotted to fit into the cycle fork-end. At this point the inlet passage is broached to oval section—to maintain axle strength and yet retain a constant cross-sectional area of 11/32 ins. in the bore.

The crankshaft has two circular $\frac{3}{8}$-in. wide webs joined by a $\frac{5}{8}$-in. diam. solid crankpin on which are mounted the I-section drilled-steel connecting rod and the $\frac{1}{8}$-in. diam. by $\frac{1}{4}$-in. uncaged big-end roller bearings. Also on the crankpin, concentrically fitted between the face of the nearside crank-web and the rod, is a bronze disc having a peripheral "ear" that engages in a recess cut in the bob-weight on the con. rod. Adjacent to the hollow mainshaft manifold opening, this disc has a crescent-shaped port cut through its face. Thus, as the con. rod rotates, so it turns the disc, whose port opening uncovers the inlet orifice in time with the firing cycle of the engine. Light springs assist crankcase compression to keep the disc valve pressed against the cheek of the crank-web.

The Transfer Tracts

Crankcase-compressed mixture reaches the combustion chamber through transfer ports cut in the walls of the cast-iron, "square" finned cylinder. The ports consist of two pairs of grooves running up the cylinder, each pair facing the fully floating gudgeon-pin ends (indeed, the "land" between each pair of grooves serves to locate the gudgeon pin's soft-metal end-pads); a 60-degree chamfer is given to the port ends to direct the flow of gas to the centre of the aluminium-alloy cylinder head. Rectangular porting "windows," registering with the grooves, are cut in the skirt of the aluminium piston, which has a flat top and two pegged, compression rings. The little-end is a phosphor-bronze bush, and the big-end bob-weight is keyed and screwed to the rod.



(Above.) Studied in conjunction with the text, this "broken open" drawing of the "Power Wheel" reveals how the crankshaft and main side-plate act as supports for the rotating engine components and for the clutch, brake, dynamo, etc. To the right is seen the magneto stator plate, incorporating the contact-breaker face cam and two segment-shaped magnets.

At right-angles to the transfer ports, and in the fore-and-aft line of the machine, are the two conical-shaped, opposing exhaust stubs, canted downwards away from the combustion chamber, also at 60 degrees.

A 10-mm. sparking plug is inserted at an upward inclination of 5 degrees from horizontal, at the "front" of the cylinder head; that is to say, its points are trailing in relation to the direction of the engine rotation. Apart from considerations of turbulence, the object of this careful inclination of ports and sparking-plug points is to ensure that the oil content of the gas shall be directed by centrifugal force to the centre of the cylinder head and thence through the exhaust ports, there being little chance of the sparking plug becoming deluged even after the engine has stood idle for some time.

Oil Recovery

From the exhaust stubs the gases escape into curved, cylindrical expansion chambers, whose outlets turn through 90 degrees into an annular passage—or centrifuge ring—formed in the face of the stationary side-plate; thence a tail pipe leads to atmosphere. An interesting feature of the exhaust system is that the unburned oil in the gas is caught in this centrifuge trough, whence it drains down over the reduction gears and is collected in a "Perspex" sump container situated at the base of the side-plate. It is claimed that 90 per cent. of the lubricant used is thus recovered.

Another unusual feature is found in the compression-release valve fitted opposite the sparking plug, on the trailing side of the cylinder head, and connected by a small pipe to the adjacent expansion chamber. A light spring keeps the valve off its seat at low revs., making it impossible for the rider to start up against full compression; but at an engine speed equal to about $2\frac{1}{2}$ m.p.h., centrifugal force closes the valve and the engine runs on full power. The converse occurs on slowing down, so that smooth stopping is ensured even without the use of the clutch.

Cylinder head, barrel and crankcase (the head joint being ground to fit) are held together against mechanical, combustion and centrifugal forces by four long, 50-ton high-tensile steel bolts, square-ended at their bases to prevent turning, and screwed for nuts at their cylinder-head extremities. One of these bolts has, at the square end, a short extension and this forms the pivot for the contact-breaker arm. The rubbing heel of the arm—if such un-anatomical description may be allowed—bears against a ring cam machined on the face of the magneto stator-plate. And this brings us to the electrical department of this remarkable unit.

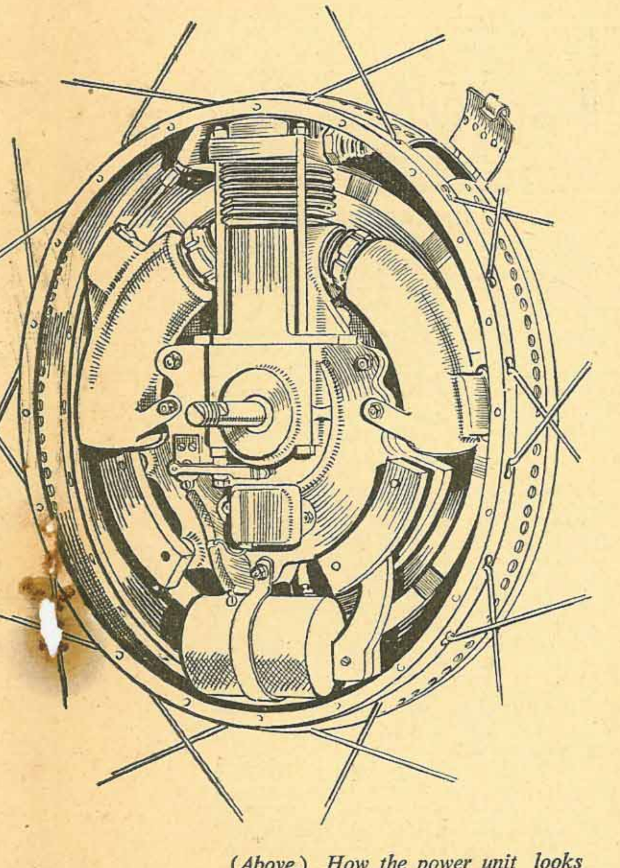
As already mentioned, the magneto coil is mounted diametrically opposite to the cylinder on what would, in a normal engine, be the base of the crankcase. Actually, the coil itself surrounds a laminated armature assembly in the shape of a yoke, the ends of which carry the pole pieces, the whole unit being through-bolted to the crankcase with special measures being taken to resist the effects of centrifugal force. The coil windings are connected via contact-breaker and condenser, and via an H.T. lead to the plug, in the usual way. The windings are energized when the two pole-pieces pass a pair of segment-shaped Alcomax magnets dovetailed and screwed into the circular, four-spoked stator-plate that lies between the engine and the off-side of the drum housing; the effect is to produce two flux reversals per revolution.

The contact-breaker cam ring has behind it a circular groove into which fits an oil-soaked felt washer, lubricant reaching the cam face through a small drilled oilway.

Dynamo Lighting

Current for lighting purposes is supplied by a small dynamo housed in the side-plate and having a pinion meshing with one of the clutch gears—thus light is provided so long as the engine runs, even though the cycle may be stationary with the clutch out. A parking light for use with a dry battery can be switched on if the engine is not in use.

Also housed in the side-plate, the clutch contains three Ferodo and two steel plates, all externally serrated. The input shaft is driven direct by a small pinion on the crankcase and the output wheel meshes with a pinion on the hub shell. Provision is made for withdrawing the clutch gear from mesh with the engine pinion so that the machine may be pedalled as an ordinary cycle, the hub shell revolving on its bearings around the "dead" engine.



(Above.) How the power unit looks from the off-side. The method of balancing the cylinder by the magneto armature may be seen; also the ingenious contact-breaker mounting, and the layout of the twin silencers. Note the door in the hub shell, giving access to the sparking plug which is readily detachable with the aid of a special spanner.

Bonded Brake Linings

Retardation is achieved by a two-shoe, 7-in. diam. internal-expanding brake. Mounted in the side-plate, the shoes—of $\frac{3}{8}$-in. width—have bonded-on material of a specially chosen friction co-efficient to afford a highly efficient, yet gentle, action. There is no cam or internal pull-off spring; instead, the shoes are actuated by a bobbin and link arrangement, the return spring being externally fitted against the operating arm.

Cooling is arranged on the impeller system. Both the side-plate and the hub-shell have radial louvres through which air is drawn inside the drum. It is then forced out by the fan action of the engine through a series of holes in the drum periphery, the number and diameter of the holes being calculated to maintain a temperature around the cylinder-head of about 180 degrees C. Incidentally, at a road speed of 20 m.p.h. the cylinder is doing approximately 100 m.p.h. and, it is claimed, it is this gyroscopic effect that helps to make the "Power Wheel" cycle an especially stable mount. As proof of the smooth-running qualities, it is said that a pencil may be balanced upright on the engine when undergoing bench tests at maximum revs. These, for road use, are controlled to 3,600 r.p.m., at which rate the unit produces .7 b.h.p. An extremely steep power curve results, giving good hill-climbing and acceleration powers; the curve flattens out at the controlled maximum revs., representing an all-out speed on the level of 20 to 25 m.p.h.

On the Road

Adding 15-16 lb. to the cycle's weight, the "Power Wheel, under ordinary conditions, is claimed to cover 250 miles per gallon The tank holds half-a-gallon and incorporates a reserve supply and a screw-down air-vent that allows the machine to be turned upside down for puncture repairs.

Last week a "Motor Cycling" staffman enjoyed a short run around the Birmingham houses on a Hercules cycle fitted with a "Power Wheel." The unit was brand new and, not having been run-in, was not yet developing its full power Nevertheless, on the level and out of the wind, it propelled the cycle and 6-ft. 12-stone rider at an 18 m.p.h. maximum with the smoothness of an electric motor Against a stiff headwind the speed was between 10 and 12 m.p.h. Taken from a standing start, a 1-in-12 gradient was easily climbed, there being no further need for pedalling after the initial dozen twirls required to get under way; starting was exceptionally easy but a rather rich mixture caused four-stroking under light loads.

Staging a last-minute Show surprise, Tube Investments, Ltd., of Rocky Lane, Aston, Birmingham, the manufacturers, are not yet in a position to quote either delivery dates or prices. Much will depend upon the material supplies position. Meanwhile, however, if the interest displayed at Earls Court may be taken as a guide, there is certainly a future for Cyril Pullin's truly "revolutionary" design.

ROYAL RIDER

KING LEOPOLD III, of Belgium, has ordered a 600 c.c B.M.W., type R.67/2. This is the second B.M.W His Majesty has had, the first being a 500 c.c. type R.51/2 model

MOBILOIL FILM SHOW

AT Elliott House, Enfield, Middx., on November 23, members of the Vagabond M.C.C. and neighbouring North London clubs enjoyed a 90-minute showing of the "Mobiloil" colour sound films dealing with British and American motorcycle and car events.

The Vacuum Company's Ian Forbes, who organized the evening's events, introduced Bill Doran and Bernal Osborne and at the conclusion of the film show an informal discussion took place

EXPORTS UP

EXPORTS of the bicycle and motorcycle industries to the end of October, 1951, were £35,141,626, as against £32,172,197 for the whole of 1950, which was a record year.

Australia (20 202) was the leading market for motorcycles—of which 78,458 have been exported, as against 62,086 in the corresponding period of 1950. Their value (£7,880,440) has gone up by more than £2,000,000. After Australia and U.S.A. (7,677) come New Zealand (4,325), Malaya (3,806), Switzerland (3,289) and Canada (3,195).

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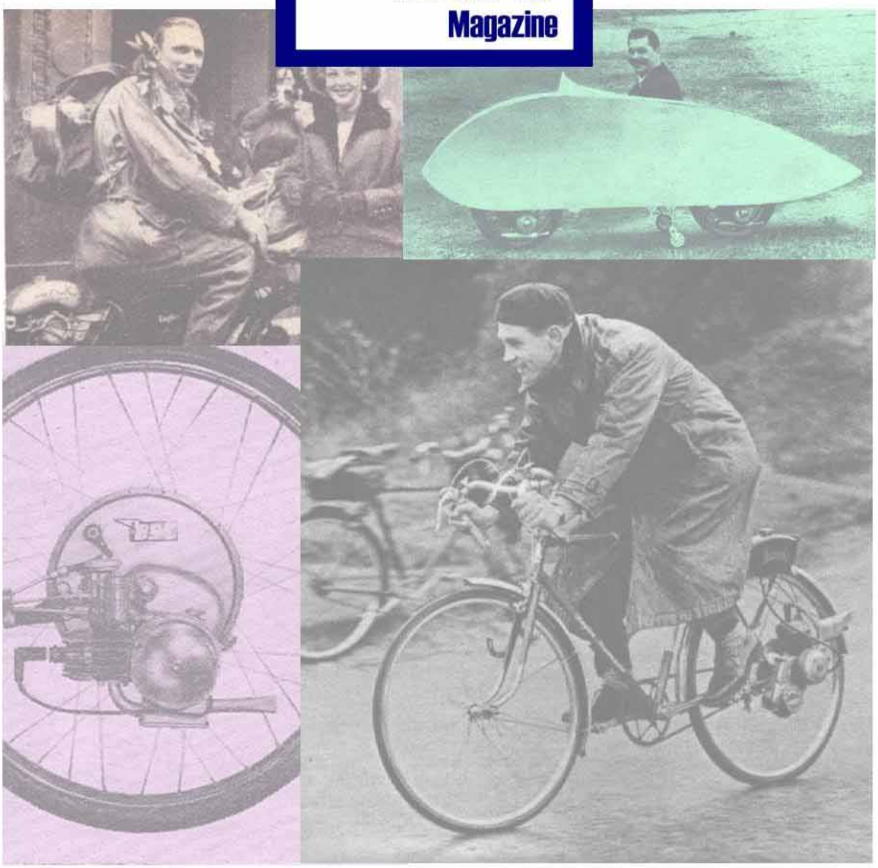

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