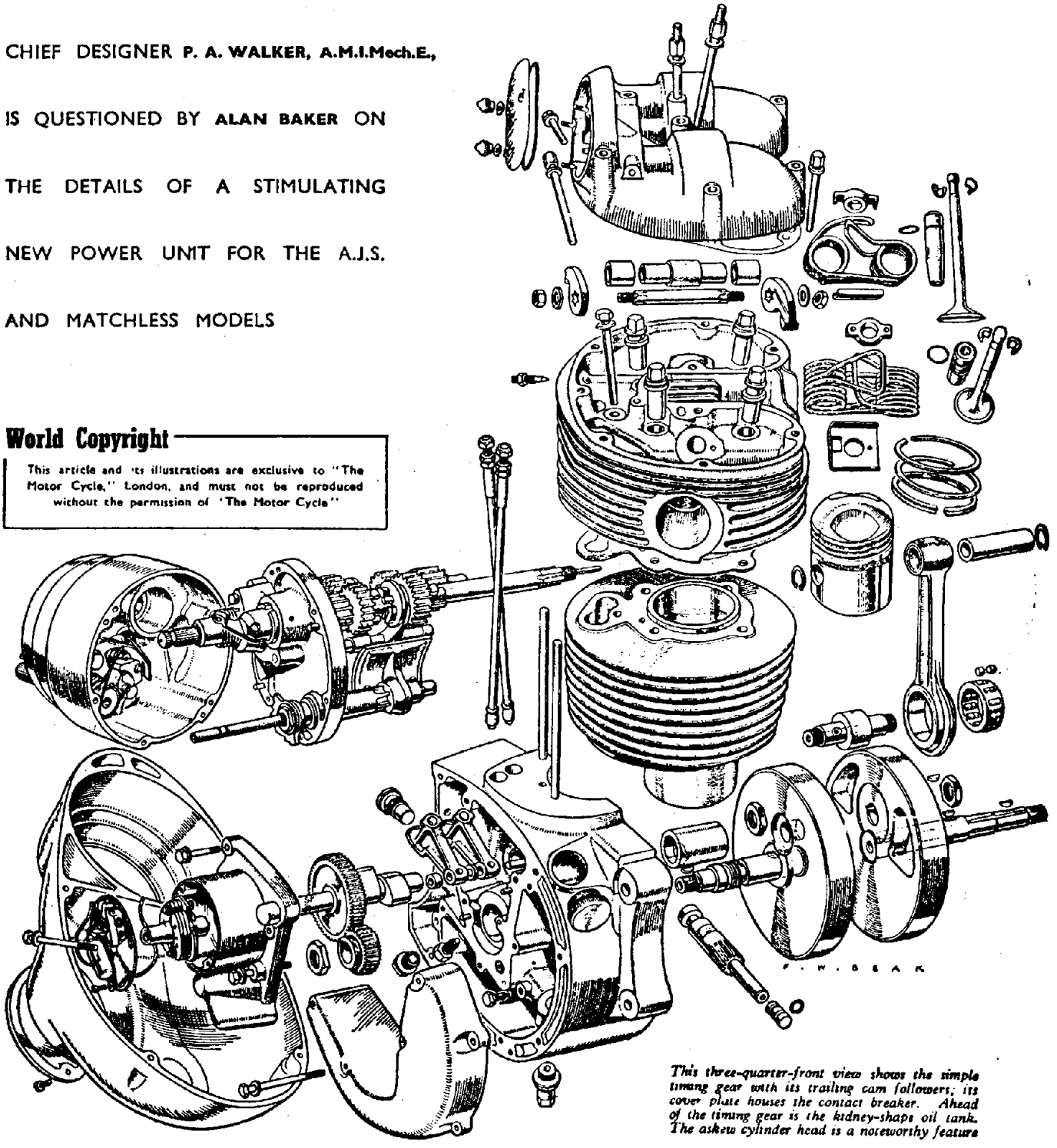
MODERN ENGINES

248 c.c. Overhead-valve A.M.C.

CHIEF DESIGNER **P. A. WALKER, A.M.I.Mech.E.,** IS QUESTIONED BY **ALAN BAKER** ON THE DETAILS OF A STIMULATING NEW POWER UNIT FOR THE A.J.S. AND MATCHLESS MODELS



This three-quarter-front view shows the simple timing gear with its trailing cam followers; its cover plate houses the contact breaker. Ahead of the timing gear is the kidney-shape oil tank. The askew cylinder head is a noteworthy feature

WHY is the two-fifty—for long the Cinderella of the motor-cycle world—now climbing so quickly to popularity? The simple answer is that the new quarter-litre breed is so superior to the pre-war variety that the ordinary motor cyclist is impressed; he can no longer regard a two-fifty as something of a toy. Designers have started work on their two-fifties from scratch, embodying all they have learned in the meantime. As a result, today's machines are up to 10 m.p.h. faster than their pre-war equivalents.

Latest power unit to join the ranks of British two-fifties is the intriguing A.M.C. overhead-valve single fitted to the Model 14 A.J.S. and the G2 Matchless. It is the fifth entirely new engine—and the third new four-stroke—to emerge from the Woolwich factory since the war.

My initial acquaintance with the new engine in February, before it was announced, impressed me both as regards the engineering soundness and the technical merit of the originality displayed in the unit's conception. Some of the reasons for the unusual features were revealed in our review of March 13. Two weeks ago I was able to question chief designer Philip Walker in greater detail.

Preliminary work on the engine began early in 1956. To learn something of its background, I first asked Mr. Walker what terms of reference were given him for the project. They were uncompromising: the unit had to be outstanding in both appearance and performance. To achieve that modern look which is so difficult to define, clean and integrated lines were essential and the performance was to exceed that of any comparable engine on the market.

Production cost, obviously, had to be kept to reasonable limits but there was to be no sacrifice of those qualities of reliability and retention of tune for which the larger A.J.S. and Matchless engines are renowned. The design was to be robust enough to withstand not merely the power output envisaged for the present but also whatever increases were likely to accrue from later development. Such was the paragon envisaged by the board of directors.

"What guiding principles," I asked, "did you lay down for yourself?" Mr. Walker replied that he settled for a single—for simplicity and lower cost—and a relatively short stroke as it would keep down the height and permit the high revolutions necessary for the desired output. Other requirements were induction turbulence for good combustion at low r.p.m., a long piston to ensure quiet operation and minimum wear, and trailing cam followers.

I pointed out that any single-o.h.c. unit performed satisfactorily with one trailing and one leading cam follower, but was politely accused of trying to make a virtue of necessity! A leading follower (paradoxical term) gives rise to additional loading on the cam surface and hence lower mechanical efficiency and more rapid wear.

Returning to the slightly over-square dimensions, I suggested that a greater bore/stroke ratio than 1.08 to 1 would have permitted larger valves and hence the possibility of still better top-end performance. The reply was that valves could be too big and, in any event, good breathing was only part of the story. Efficient combustion was equally necessary. Too large a bore could be a disadvantage with the high compression ratios permitted by modern fuels, since the combustion chamber was likely to be rather attenuated with, consequently, a large surface area and long flame travel. With a shallow chamber, too, there was difficulty in obtaining adequate clearance between valves and piston during the overlap period.

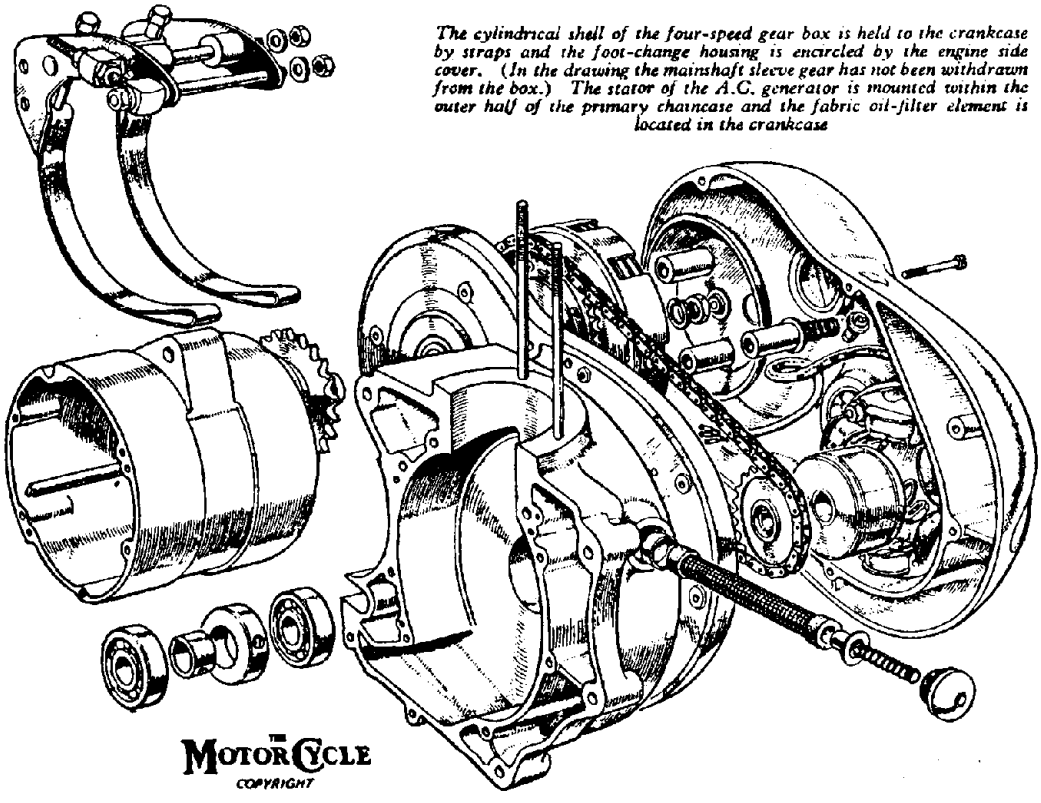
Looking at the complete power unit, one is at once struck by two points of unorthodoxy. The first is that the cylinder head is on the skew: the plane of the valve stems, instead of being longitudinal, is rotated through 21½ degrees clockwise, viewed from above. It would have been possible to utilize trailing cam followers with a square-on head by bringing the camshaft farther forward relative to the crankshaft.

However, that would have meant either that the rockers would not be interchangeable or that one or both pushrods would be slightly inclined laterally, with consequent side thrust on the follower or followers. The rotated head permits the use of identical rocker components without follower side thrust and it has the important benefit of exposing the sparking plug and exhaust port more directly to the cooling air stream.

Second departure from normal practice is the semi-unit construction in which a separate gear box is employed but an appearance of unity has been cleverly achieved. The gear-box shell is of circular section and lies in a similarly shaped seating behind the crankcase to which it is secured by steel straps. Because the main-shaft is eccentric to the shell, rotation of the box provides a means of adjusting the primary chain.

Phil Walker admitted to having covered many sheets of paper with ideas for blending the gear box into a streamlined right-hand side to the unit. In a moment of inspiration came the solution: to extend the circular end cover (which carries the gear and kick-starter pedals) into a close-fitting hole in the engine side cover. Nothing could be simpler or neater. I asked why a separate gear box had been chosen in place of the bolted-up box of the two-stroke engines. There were two reasons.

First, it was felt that from the user's viewpoint a separate engine and gear box were preferable for ease of overhaul or replacement. Secondly, the provision of



The cylindrical shell of the four-speed gear box is held to the crankcase by straps and the foot-change housing is encircled by the engine side cover. (In the drawing the mainshaft sleeve gear has not been withdrawn from the box.) The stator of the A.C. generator is mounted within the outer half of the primary chaincase and the fabric oil-filter element is located in the crankcase

ample adjustment, without the use of a slipper or jockey sprocket, ensured that the chain's full life could be utilized. Either form of tensioner was an additional absorber of power and something else to wear. A non-adjustable chain of the same dimensions was acceptable on the two-fifty two-stroke because of its smoother torque and appreciably lower power output. I was reminded that a cylindrical gear box is not without precedent at Woolwich, one having been employed on the famous old Model H Matchless.

Before we turned to more detailed considerations I discussed with Mr. Walker the location of the cylinder axis ¼in ahead of the crankshaft axis. This *désaxé* arrangement, found in a number of car engines, is intended to reduce any tendency to piston slap by causing the piston to move more gently across the cylinder from the non-thrust to the thrust face at the top of the stroke. Moreover, the reduced angularity of the connecting-rod at maximum combustion pressure makes the best use of that part of the power stroke.

When I queried the practical value of such a relatively small offset I was told that the amount chosen was considered to be the best compromise. More offset would further reduce any tendency to piston noise at low r.p.m. but would result in more friction at higher r.p.m. at the other end of the stroke. An incidental advantage of placing the cylinder forward was to give a little more room for the cams and followers. Because of the offset, the stroke is actually 0.003in greater than twice the crank throw.

The crankshaft is of orthodox built-up construction. It employs 6½in-diameter flywheels of high-tensile cast iron. Of Ubas (En.32) steel, the mainshafts have flanged inner ends and are pressed into the wheels with key location, a method—proved in racing—which provides the maximum length of support in the wheels. Also a parallel, press-in fit, the KE805 crankpin is secured by nuts and carries a roller-track sleeve of En.351 nickel-chromium case-hardening steel

Firm support of the shaft, essential for high-speed reliability, is given by the use of two spaced ball bearings on the drive side and a long bronze bush on the timing side. The underside of the bush is relieved to provide clearance for the oil-pump worm drive.

For rigidity, the big-end eye of the connecting-rod (of 1 per cent chromium steel with a hardened sleeve to form the roller track) is ribbed. I queried the use of two side-by-side rows of ½ × ¼in rollers in the Duralumin cage rather than a single row of long rollers which would have a slightly greater bearing area. The answer was that the oil feed to the big end emerges from the crankpin on the centre line of the bearing; the adjacent chamfers of the rollers ensure that there is no restriction of flow. Positioning of the outlet holes in the pin is such that complete wetting of the rollers takes place before the oil escapes under centrifugal action.

With two cams on a common shaft and no idler gear the timing mechanism is reduced to the minimum, with consequent quiet running and durability. The built-up rockers with their live spindles follow the construction employed satisfactorily on A.M.C. single-cylinder engines for 25 years.

From the previously quoted output (18 b.h.p.) the cams appeared to be an unusually good compromise between performance and quiet operation, so I inquired whether there was anything unusual about their design. Mr. Walker said that the profile had been carefully calculated by a method which, though perhaps not commonly employed, did not differ in principle from others. However, the follower layout, the short Duralumin pushrods and the light valves permitted the combination of a fairly severe cam form with quietening ramps of effective proportions.

Only points of interest on the cast-iron cylinder barrel are the length of its spigot into the crankcase (1⅛in), the deep finning and the cast-in tunnel for the pushrods. Because of the rotated cylinder head the tunnel, of figure-eight section, has a helical twist.

Of DTD424 aluminium alloy, the cylinder head has cast-in valve-seat inserts of high-expansion austenitic iron. The inserts are of conical form and have a locating dog to prevent any possibility of movement in the head. As on other A.M.C. singles, hairpin valve springs are employed. Such springs pick up less heat from the head than do the coil variety and it is easier to keep their surge frequency outside the operating range of the engine, thus eliminating valve bounce.

A compromise between gas-flow and compactness requirements, the part-spherical combustion space is of medium depth. Although the size difference between the Jessops G2 exhaust valve and the silicon-chromium inlet valve is greater than usual, both are proportioned in accordance with the needs of the engine. By virtue of its more favourable seat-length/surface-area ratio a small valve runs cooler than a large one, so it is beneficial to keep the exhaust valve as small as possible.

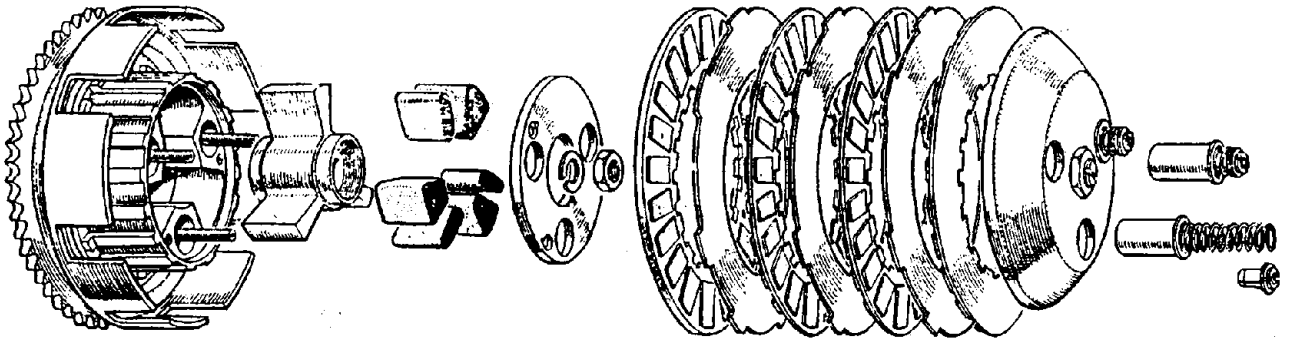
Because of the difference in valve-head diameters the 75 degrees between the valve stems are divided unequally: the inlet valve is inclined at 35 degrees and the exhaust at 40 degrees to the vertical.

"At 1⅛in," I said, "your carburettor choke diameter would not disgrace a touring five-hundred single. With a large carburettor the good cylinder filling obtained at high r.p.m. is usually offset by poor torque at the bottom—the result of low gas speeds and poor mixing of the charge. Yet I know from experience of this engine on the road and a sight of its bench-test curves that your horses can walk as well as run. How have you achieved this apparent paradox?"

Phil Walker replied: "As I mentioned earlier, efficient breathing is not everything. We have devoted a lot of study to inlet-tract shape in order to combine good gas flow with adequate turbulence. You will note that the port is offset by 10 degrees to the right of the plane of the valves. This directs the mixture towards the sparking plug, which is thus scoured of residual exhaust gases, and the charge is given a rotational swirl to ensure thorough mixing.

"As a result we get efficient burning at low speeds and this property has enabled us to obtain the necessary bottom-end torque without recourse to a small carburettor which would hamper the breathing at higher speeds." If the rotational swirl were overdone the consequence could be worse than none at all. Too high a rate would cause centrifuging of the charge to the outside of the combustion chamber and leave a dead area in the middle.

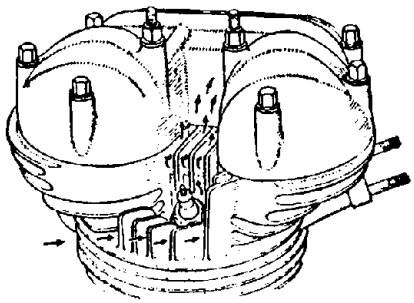
To facilitate gas exit the exhaust port is also offset to the right, by 11½ degrees, and I asked whether on that account there was not a tendency for more than usual of the charge to go straight out past the exhaust valve on overlap. On the con-



In the clutch centre is a vane-type transmission shock absorber embodying rubber blocks. The driven plates have bonded-on friction material

trary, I was told, the layout chosen gives minimal losses and a low specific fuel consumption.

The production piston, giving a compression ratio of 7.8 to 1, has a split skirt and the usual A.M.C. wire winding below the scraper ring to control expansion. Its crown has a shallow dome and recesses for valve-head clearance. I remarked on its difference from a prototype piston, seen earlier in the development department, which had a higher, reflex hump and no recesses. The change in design had been



Diagonal finning on the head promotes air flow over the plug and combustion chamber

made to standardize certain dimensions to permit the use of higher-lift cams should they be introduced for more potent variants.

We then turned our attention to the lubrication system. As indicated earlier, the pump is worm driven from the timing-side mainshaft. It is of the type fitted to other A.M.C. singles in which a rotating, double-ended plunger is given a reciprocating movement by means of a cam track and peg. The rate of oil circulation is a little more than four gallons an hour at 60 m.p.h. in top gear.

Of 2½-pint capacity, the kidney-shape oil tank is an aluminium casting bolted to the outside of the right-hand crankcase half and concealed by the engine side cover. The crankcase forms the inner wall of the container. Wet-sump lubrication was considered but it was decided to retain the traditional dry-sump system because of the resultant lower overall height of the engine. In spite of the shielded container, oil temperature remains satisfactorily low even under the hardest possible driving.

Part of the oil delivered by the feed side of the pump passes to the big-end bearing via the worm chamber and drillways in the mainshaft—another long-used A.M.C. arrangement. The remainder travels up internal passages in barrel and head to the rocker gear, including the inlet valve guide, and drains back down the pushrod tunnels to the timing gear, whence it overflows into the crankcase. Scavenged oil from the case is forced through an internal fabric filter element on the left of the engine before returning to the tank.

My next question concerned the reason for rocker-gear lubrication from the pressure side of the pump rather than the scavenge side, since the second method is employed by a number of manufacturers. In reply, Mr. Walker said that they preferred to feed the rocker gear with filtered, comparatively cool oil; with a scavenge-side feed the oil was at a higher temperature and usually considerably aerated.

The crankcase breather is of timed type. To the drive-side mainshaft, serving as a spacer between the main bearings, is keyed an iron sleeve, a port in which communicates with the crankcase by drillways in the shaft. Surrounding the sleeve is a stationary Duralumin ring grooved internally over 180 degrees of its circumference. In the middle of the groove is a radial hole venting to the rear of the crankcase. A breather of this type has not previously been employed but it is essentially simple and possesses the advantage for high-speed operation of having no reciprocating parts. It is worth recording that a similar device is featured on the latest 7R racing model.

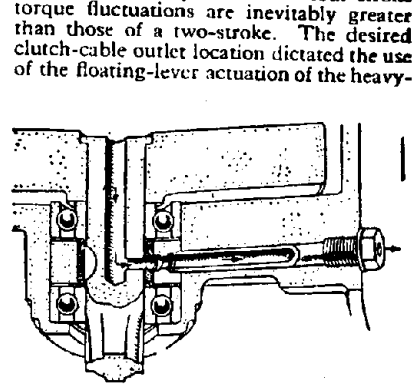
The designed balance factor of the engine is 62½ per cent of the reciprocating masses, a text-book figure for a single-cylinder unit. Thanks to the widely spaced attachment points and stiff frame construction, the inherent resistance to vibration is good and the arbitrary factor has proved in practice to be just about spot-on.

I suggested that since this was the third new A.M.C. engine to have A.C. electrical equipment, the company must be convinced of its overall superiority for roadster machines. This was confirmed by Mr. Walker. He said they were satisfied that the earlier teething troubles had been overcome by the electrical manufacturers. Reliability was at least equal to that of the traditional magneto and D.C. dynamo and the alternator offered economic and mechanical advantages while aiding modern styling of the power unit.

The stator is mounted within the outer half of the chaincase rather than on the inner half or on the crankcase. Although the arrangement means that both joints have to be dowelled to provide accurate location of the stator relative to the rotor, the scheme facilitates machining of the joint faces. The same practice is, of course, utilized on the larger singles.

To obtain an effective oil seal where the gear-box mainshaft passes through the chaincase, a substantial felt ring on the shaft is carried in a slide covering the hole in the case. The slide, built up from two pressings, has sprung edges which grip the case wall; the assembly moves with the shaft when the gear box is turned to adjust the chain.

Although the gear-box internals are identical with those of the two-fifty two-stroke, the clutch resembles that of the larger models in that it embodies a rubber-block transmission shock absorber, considered necessary because four-stroke torque fluctuations are inevitably greater than those of a two-stroke. The desired clutch-cable outlet location dictated the use of the floating-lever actuation of the heavy-



The timed crankcase breather comprises a ported sleeve, keyed to the drive-side mainshaft, and a stationary ring which vents to the rear of the case

weight gear box rather than the ball-and-groove system of the two-strokes. Heat dissipation of the clutch is improved by bonding the oil-resisting Ferodo MS6 friction material to the four driven plates instead of using inserts.

"I am afraid," said Mr. Walker in closing, "that details of power output and torque are not at present for publication. But you have seen for yourself in the test house that the figure of 18 b.h.p. quoted in the earlier description is being comfortably exceeded. And that, don't forget, is with a normal silencer fitted."

TECHNICAL DATA

CAPACITY: 248 c.c.

BORE: 69.85mm.

STROKE: 64.85mm (crank throw, 32.385mm because of ¼in *désaxé* of cylinder).

COMPRESSION RATIO: 7.8 to 1.

PISTON-RING END GAP: Compression and scraper rings, 0.008 to 0.013in.

PISTON-RING SIDE CLEARANCE: Compression and scraper rings, 0.003in.

VALVE CLEARANCE: Inlet and exhaust, 0.010in when cold.

VALVE TIMING: With 0.010in valve clearance, inlet opens 35½ deg before top dead centre and closes 111½ deg after bottom dead centre; exhaust opens 114½ deg before bottom dead centre and closes 38½ deg after top dead centre.

IGNITION TIMING: On full advance, contact-breaker points begin to separate 34 deg before top dead centre.

PISTON CLEARANCES: Top land, 0.0295 to 0.0325in; at wire winding, 0.0105 to 0.0125in; intermediate, 0.0005 to 0.0015in; at bottom of skirt, 0.0005in (mean).

ENGINE DIMENSIONS: Crankshaft drive-side ball bearings, ¾in bore × 2in outside diameter × 7/16in wide; timing-side bush ¾in bore × 1¾in outside diameter × 1.788 to 1.794in long. Crankpin, 1.20350 to 1.20375in diameter × 0.704 to 0.706in long over journal. Big-end bearing comprises two rows of 10 ¼ × ¼in rollers; small-end bush, ¾in bore × 15/16in outside diameter × 1in long; connecting-rod length, big-end to small-end centres, 5¾in. Inlet-valve diameters: head, 1 5/8in; throat, 1.351in; stem, 5/16in. Exhaust-valve diameters: head, 1 7/16in; throat, 1.0695in; stem, 5/16in. Valve-seat angle, 45 deg; valve lift, 0.342in.

CARBURETTOR: Amal type 376/99 Monobloc, 1 1/16in choke diameter, 12 deg of down-draught; 180 main jet; No. 3½ throttle valve; throttle needle clip fitted in middle groove.

PRIMARY TRANSMISSION: ¾in pitch × 0.225in wide roller chain on 6¾in nominal centres (¾in adjustment provided for gear box). Chain length, 73 pitches; 21-tooth engine sprocket, 50-tooth clutch sprocket.

GEAR-BOX DIMENSIONS: Shaft centres, 1.643in. Mainshaft sleeve-gear roller bearing, 32mm track diameter × 52mm outside diameter × 15mm wide; mainshaft sleeve-gear bushes, 0.689in bore × 0.814in outside diameter × ¾in long; mainshaft ball bearing, ¾in bore × 1 7/16in outside diameter × ⅝in wide. Layshaft drive-side bush (flanged), ¾in bore × 1¼in outside diameter × ¾in long; layshaft bush in kick-starter axle (flanged), ¾in bore × ¾in outside diameter × 1¼in long. Internal gear ratios, 2.95, 1.85, 1.30 and 1 to 1.