MODERN ENGINES

VILLIERS STARMAKER

Designer BERNARD HOOPER dissects a brilliant layout

INTERVIEWED BY BOB CURRIE

- ALUMINIUM-ALLOY FLYWHEEL!
- BUILT-IN RESONANCES
- TWO PHASED CARBURETTORS
- NEEDLE BEARINGS GALORE
- UNUSUAL METAL-FACED CLUTCH

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THE VILLIERS ENGINEERING COMPANY LIMITED · WOLVERHAMPTON · STAFFS

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BE it on Cotton, D.M.W., Greeves or James, something new and highly exciting had emerged from the Villiers stable; and at the London Show at Earls Court the crowds pressed forward to study the Wolverhampton bombshell. A single with twin carbs!

Yes; and there were many other novelties in the design. Full-disc flywheels; a nigh-indestructible, all-metal clutch; needle-roller bearings here, there and everywhere; a massive light-alloy cylinder barrel and head. And to cap it all, a reputed output of 25 b.h.p. at 6,500 r.p.m.

Man principally responsible for the Starmaker was Bernard Hooper, assisted on the transmission side by John Favill. And at the Villiers factory Bernard and John gave me their reasons for the adoption of this or that feature. But how did the project start? Bernard Hooper explained.

"About three years ago we began to feel that our scrambles engine, the 34A, was reaching the end of its development. We could take it up to 22½ b.h.p., but we wanted still more.

"Obviously, a redesign was necessary—yet it would have meant, virtually, a new engine, even if we could have incorporated some 34A parts. Then, too, the gear box would have been inadequate for really high performance. Much better to take a clean sheet and start again from scratch.

"First, we wanted the smallest possible crankcase volume, which implied completely circular flywheels and close clearances. But the real starting point was the connecting rod. Once the strength and dimensions of that were calculated, then we could work back to the clearances needed for the crank webs.

"The ideal rod would be oval in section, for improved gas flow, but that isn't the best section for strength. The Starmaker rod, a steel component, has an H-section, but with the leading and trailing edges feathered for better streamlining. It is only ¼in thick at its maximum, so the flywheels can be very close together."

In the Starmaker, the crankshaft webs and shaft extensions are one-piece forgings in nickel-chrome-molybdenum steel, while the shouldered crankpin is pressed into place then made to grip the webs more tightly by means of expander plugs forced into the crankpin bore.

NO TWIST

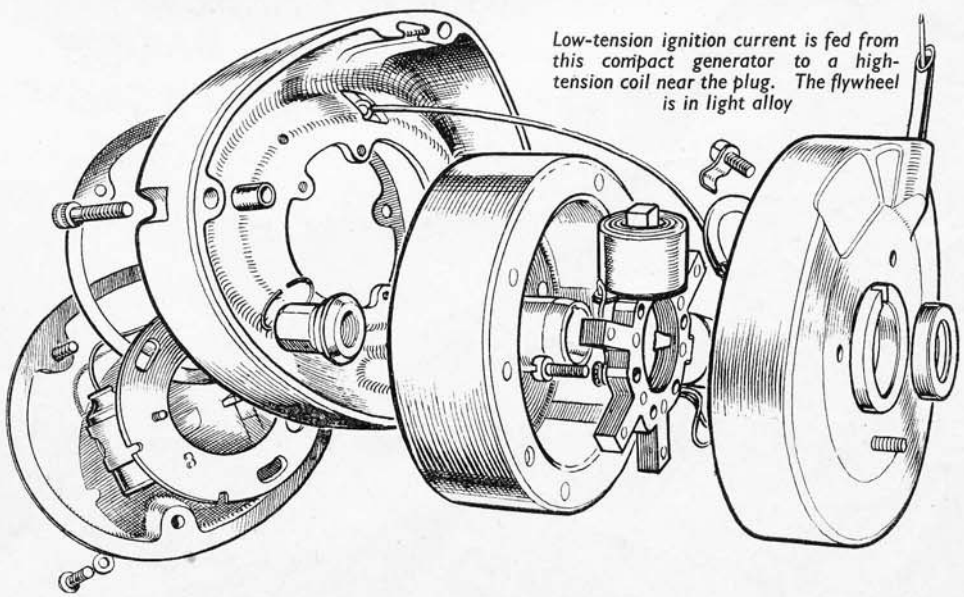
"Integral shaft-ends and webs seem to me an expensive way of doing things," I commented, "though I can see that the principle does result in a really rigid shaft assembly. But on the subject of rigidity, do you feel that a pressed-in crankpin (as in the 34A) is sufficient?"

"Expensive forgings?" echoed Bernard. "Not necessarily, once the tools are made and you can produce in quantity. And this is a production engine, after all. Every one will be exactly alike. Scrambling certainly does throw a strain on the crankshaft and we wanted as strong an assembly as we could devise.

"The Starmaker crankpin has a thinner wall than that of the 34A, and we can use larger - diameter expander plugs with a good core strength. This shaft won't twist, believe me!"

John Favill chipped in, to point out the main-bearing arrangements. "The shaft," he explained, "is carried on two lipped roller bearings, placed as near to the middle of the shaft as we could get them.

"The bearings lie directly under the crankcase walls and —an important point, we felt —there are radial external ribs



Low-tension ignition current is fed from this compact generator to a high-tension coil near the plug. The flywheel is in light alloy

■ ALUMINIUM-ALLOY FLYWHEEL!
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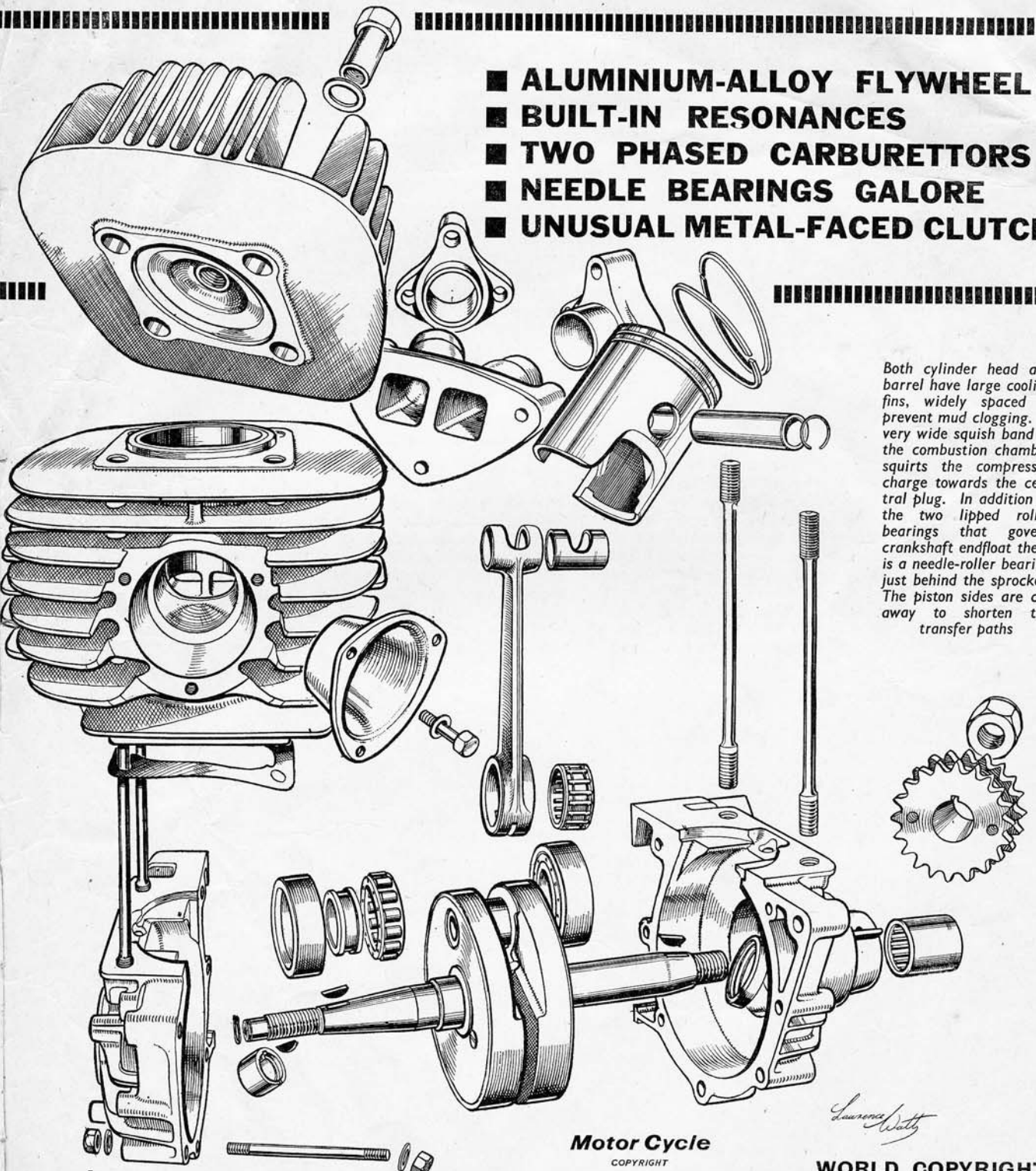

Both cylinder head and barrel have large cooling fins, widely spaced to prevent mud clogging. A very wide squish band in the combustion chamber squirts the compressed charge towards the central plug. In addition to the two lipped roller bearings that govern crankshaft endfloat there is a needle-roller bearing just behind the sprocket. The piston sides are cut away to shorten the transfer paths

Laurence Watts

Motor Cycle
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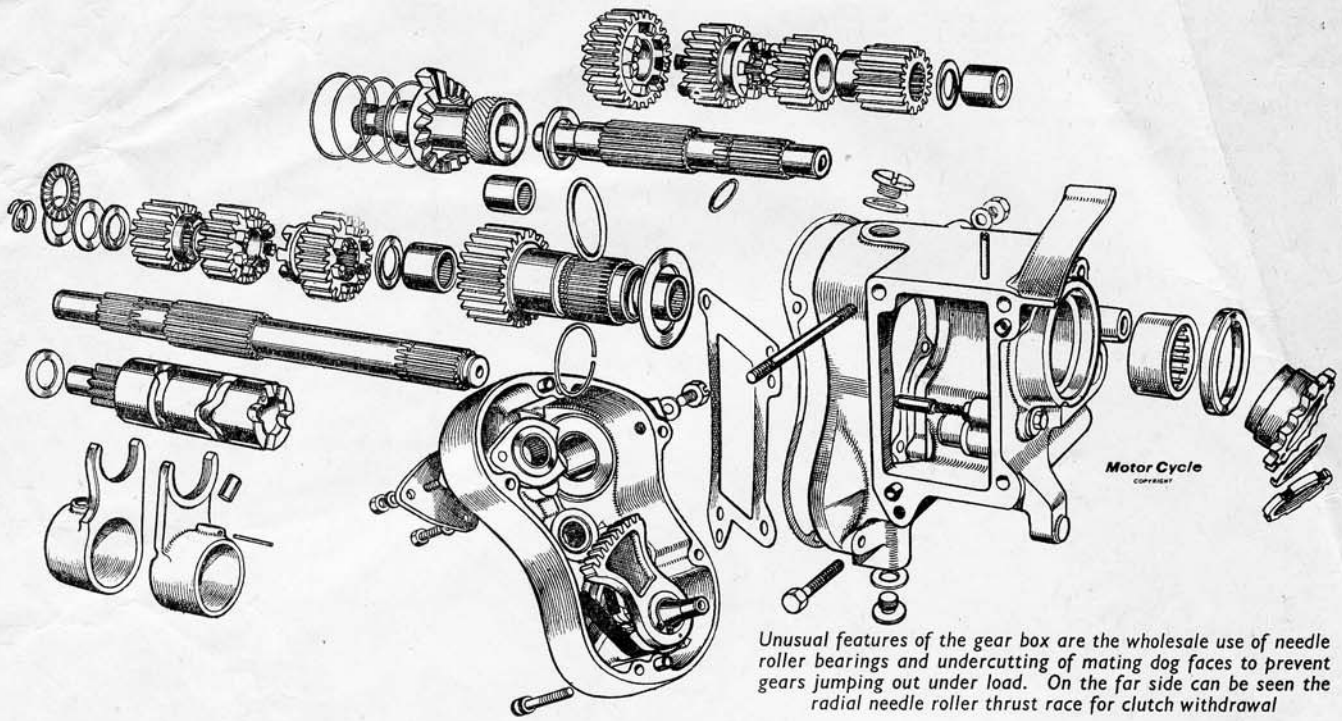
TECHNICAL DATA

CAPACITY: 247 c.c. **BORE:** 68mm **STROKE:** 68mm
COMPRESSION RATIO: 12 to 1
PISTON-RING END GAP: 0.007 to 0.012in, plus 0.094in allowance for ring peg; side clearance, 0.003 to 0.005in
IGNITION TIMING: 19½ degrees (0.095in) before top dead centre, with points just opening
ENGINE DIMENSIONS: Main roller bearings (2), Hoffman, 25mm bore × 52mm outside diameter × 15mm wide. Crankpin diameter, 0.984in. Big-end bearing, 1.26in outside diameter × 0.63in wide. Small-end bush bore, 0.675in. Connecting-rod centres, 5in.
CARBURETTORS: Amal Monobloc type 389, 1⅛in choke.



Unusual features of the gear box are the wholesale use of needle roller bearings and undercutting of mating dog faces to prevent gears jumping out under load. On the far side can be seen the radial needle roller thrust race for clutch withdrawal

on the crankcase for added support. On the drive side, as close to the sprocket as possible, there is an additional needle-roller bearing."

"You also have a needle-roller bearing in the big-end eye. That's unusual. But what are the advantages over —say—a crowded roller bearing?" I wanted to know.

Again John gave the answer. "It's a caged-needle bearing, and that's a much better proposition than ordinary rollers. Where there is a cage, you know where the rollers are going; loose, crowded rollers have to make their own way, as it were, and you get skidding and scuffing.

UNBURSTABLE

"But the big point is that use of needle rollers enables us to have a much smaller big-end than would otherwise be the case. Less inertia!"

Outboard of the unit, on the right, is the ignition plant—which has been variously described as "flywheel magneto" and "energy transfer." I asked Bernard Hooper for the correct description.

"Well," he said, "it's an alternator—and it is energy transfer in that all leads from the unit are low tension while the separate high-tension coil is mounted as close to the sparking plug as possible.

"That way, we can have a compact unit without restricting the size of the coil. Note the light-alloy flywheel, by the way, the first one of its type that we have employed.

17,000 R.P.M.

"Previous generator flywheels have been in gunmetal, but we calculated that light-alloy would be more resistant to bursting at high r.p.m.; in fact, we have tested the new flywheel to 17,000-plus r.p.m. Besides, a heavy wheel increases the shock loading on the shaft and could cause twisting. The light job assists in obtaining quick acceleration; and the effect is particularly noticeable when rapid gear changes are being made."

"Can we now discuss the cylinder?" I asked. "It is, I note, in light alloy, but with a cast-in iron liner. Any particular bonding methods employed?"

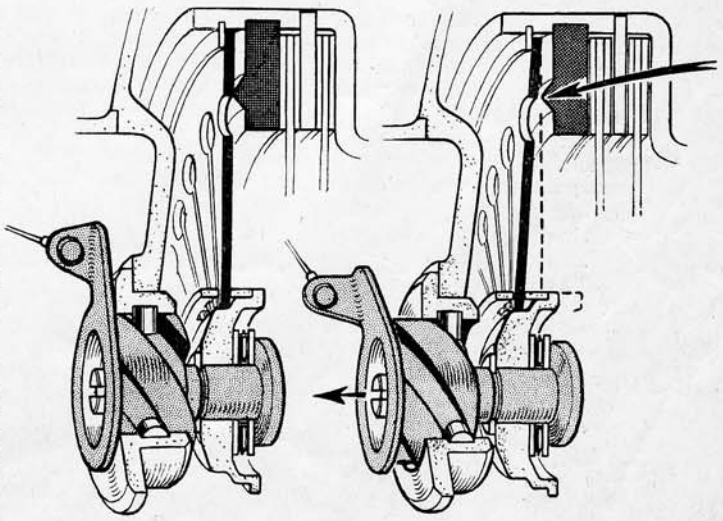
"Not ordinary iron," Bernard corrected me. "That's spun-cast austenitic iron, I'll have you know! We chose it because it has an expansion rate only slightly less than that of light alloy.

"To obtain a good bond between the iron and the alloy we rough-machine the upper external surface of the liner. All liner ports are machined, by the way—not cast—and we use the machined ports to locate the shell-moulded sand cores of the cylinder.

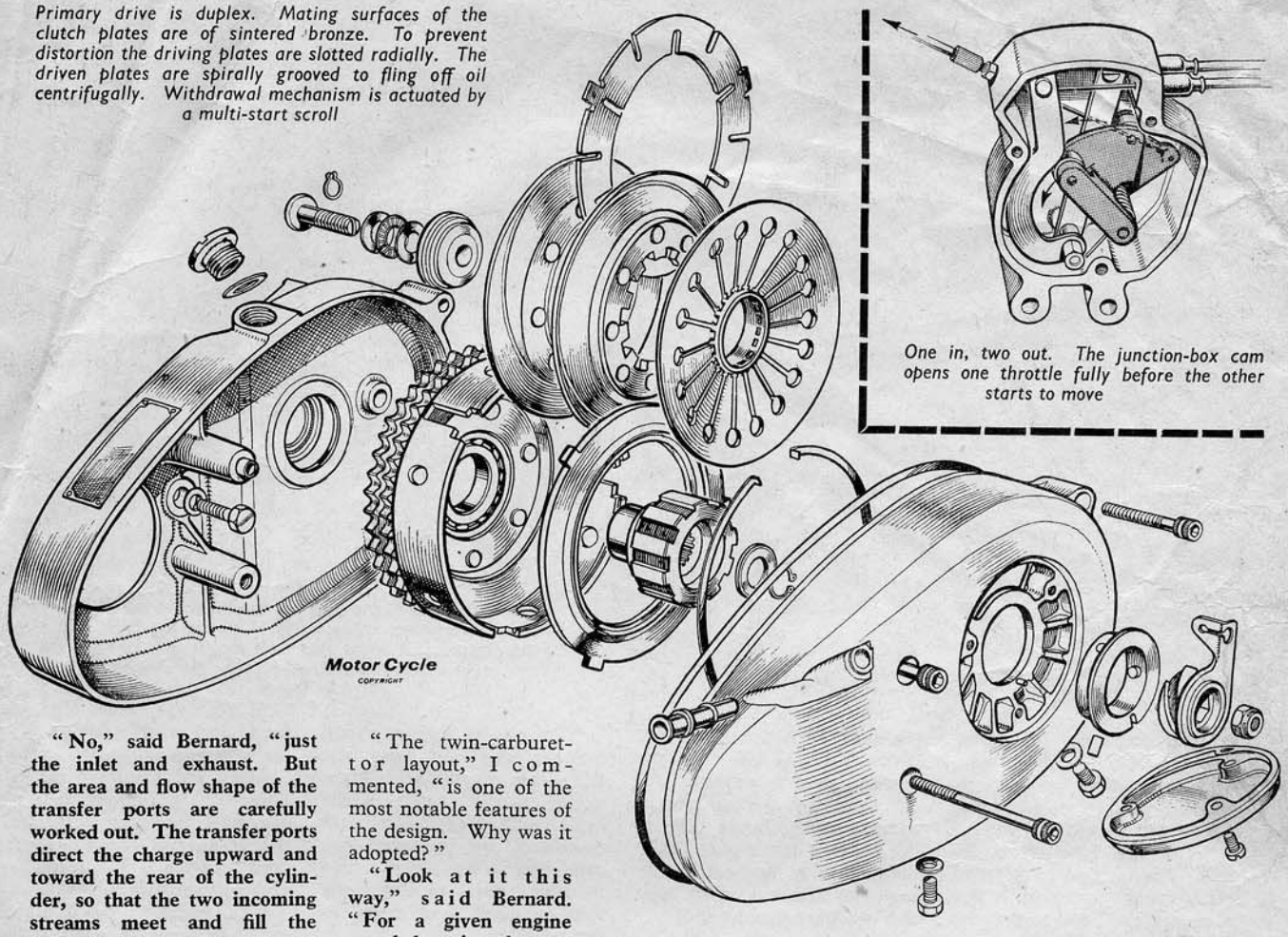
"Widely spaced fins, to resist the clogging effect of mud, and with slots so that the inlet and exhaust areas are isolated and distortion is inhibited. The fins project well out into the airstream, and those around the transfer ports project still further, to obtain maximum benefit."

"Talking of ports," I broke in, "do you calculate the resonances for all three—inlet, exhaust *and* transfer?"

How the diaphragm clutch spring works. Dished in the free state, the spring is restrained in the clutch drum by a circlip. Just inboard of the periphery the spring presses on a circular ridge on the pressure plate. The withdrawal race operates at the centre of the spring



Primary drive is duplex. Mating surfaces of the clutch plates are of sintered bronze. To prevent distortion the driving plates are slotted radially. The driven plates are spirally grooved to fling off oil centrifugally. Withdrawal mechanism is actuated by a multi-start scroll



One in, two out. The junction-box cam opens one throttle fully before the other starts to move

"No," said Bernard, "just the inlet and exhaust. But the area and flow shape of the transfer ports are carefully worked out. The transfer ports direct the charge upward and toward the rear of the cylinder, so that the two incoming streams meet and fill the cylinder from the rear.

"Theoretically, rectangular port openings would be better —though, in practice, oval openings ease the passage of the piston rings. So we have to compromise, though it does make calculation rather more complicated.

"Port size and timing is tied up with the primary compression ratio which, in the Starmaker, stands at the very high figure of 1.69 to 1."

Combustion-chamber shape is unorthodox, comprising a mushroom recess in the cylinder head, with a central sparking-plug position, and very wide squish bands.

Villiers, explained Bernard Hooper, had conducted numerous experiments before deciding on the final shape. Advantages? Increased turbulence, giving better resistance to detonation and, therefore, smoother running at the high (12 to 1) compression ratio employed.

"The twin-carburettor layout," I commented, "is one of the most notable features of the design. Why was it adopted?"

"Look at it this way," said Bernard. "For a given engine speed there is only one correct size of carburettor. To get maximum performance at high speeds you need a larger-bore carburettor than for good torque at low speeds; by using two carburettors we get the best of both worlds.

"There is no gain in peak power over, say, a single Amal GP carburettor—but it does mean that we can use conventional carburettors of the type with which riders are already familiar. Easier starting is another point in favour of the dual arrangement.

UNDERCUT DOGS

Why the rubber-tube connections between the carbs and the engine? Mainly, so that the unit can be mounted readily in various makes of frame.

"All right," I conceded. "Well, let's move on to the gear box. But first; why no shock-absorber on the engine shaft, or in the clutch centre?"

"Manufacturers asked us for a small-diameter engine sprocket, which leaves no room for incorporating a shock absorber. And the clutch, as you will see, is of unconventional pattern in which it would have been difficult to make suitable shock-absorbing provision. However, it is an easy enough matter to mount a shock absorber in the rear hub, and some makers are already doing this."

New throughout, the gear box employs a multitude of needle-roller bearings ("Freer running, and a better engineering job for heavy-duty work," explained John Favill) while another interesting feature is the adoption of involute splines, resulting in a stronger shaft with more even stress distribution.

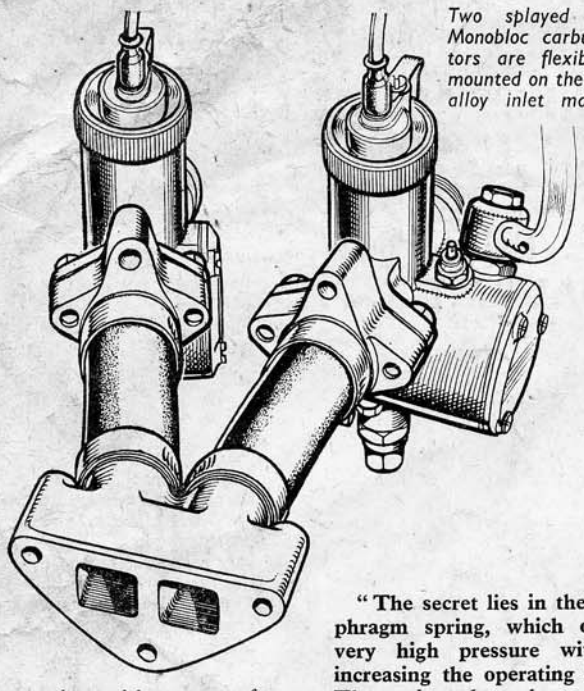
Sliding dogs are undercut, and angled faces ensure really positive engagement.

"This type of dog," said Bernard, "requires less actual gear movement than before, easing the load on the operating mechanism and giving us a sweeter gear box all round. Note, too, that clutch thrust is not taken by the sleeve gear; instead, there is a needle-roller thrust race at the remote end of the main shaft. Again, the result is sweeter operation."

"All-metal clutches were used on some vintage models," I recalled, "but they went out of favour years ago."

"Yes," agreed Bernard, "mainly because it was difficult to provide a sufficiently high spring pressure without making the clutch extremely heavy to operate.

"But there are big advantages, notably in durability and resistance to abuse. We



Two splayed Amal Monobloc carburettors are flexibly mounted on the light-alloy inlet manifold

use sintered-bronze surfaces, with spiral grooves so that oil is flung clear of the working surfaces. Another good point—very little movement is necessary; just a few thou, and the plates are free.

"The secret lies in the diaphragm spring, which offers very high pressure without increasing the operating load. The spring plate pivots on a ridge on the pressure plate, and there is a leverage ratio of about 5 to 1.

"That means that a pressure of, for instance, 150 lb at the centre of the spring is equivalent to 750 lb at the pressure line.

EASY PULL

"The clutch characteristics are completely different from those of a normal component, for the maximum load occurs just as the clutch starts to free. From then on, the pull on the handlebar lever becomes progressively easier.

"The scroll mechanism, housed in the primary chaincase, gives a further reduction ratio. As you see, the mechanism is very compact, with the scroll fully immersed in oil and the operating cable passing right into the oil mist inside the case. Less maintenance required, of course, with the clutch cable operating in ideal conditions."

To suit the Starmaker engine, Villiers have produced a tapered resonance box ("Call it a quietener, rather than a silencer," said Bernard). Initial experiments were carried out with a conventional expansion chamber, but it was found that only a small difference in exhaust-pipe length made a big difference in the torque produced by the engine.

BETTER TORQUE

But Bernard's "quietener" resulted in a more flexible unit, which was much less sensitive to variations in pipe length; further, mixture strength became less critical. Finally, he found he was producing just as much peak power as before, while the torque curve had actually improved.

"Just one last question," I said. "Will riders find any difference in handling a Starmaker-engine scrambler, as compared with the existing 34A?"

"Yes," said Bernard Hooper, "they will have more revs available, without any loss of flexibility. But the technique will have to be learnt. The engine should be allowed to build up revs, and that means hanging on to a gear for rather longer than at present. The lighter flywheel, too, might prove embarrassing until a rider becomes used to the characteristics of the engine."

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