T.T. TECHNICALITIES

P. E. ("SLIDE RULE") IRVING

DISCUSSES THE DESIGN LESSONS OF THE ISLAND

PART ONE

TEN years ago I ceased writing this annual feature: I had to, really, because it can only be done by someone on the ground and I was then back in Australia. Graham Walker, under the pen-name of "Douglas Mann," stepped nobly into the breach but as I happen to be in Britain this year on a visit it was suggested that I should take over my old post-T.T. job.

The usual difficulty arose, of course—that of condensing the wealth of material available from the six races into readable form. Dealing, however, with first things first, the Formula 1 race with the field composed of virtually standard "over-the-counter" models, mainly Norton and A.J.S., provided no technical surprises. Out of 13 starters only one "Junior" retired and that due to rider fatigue, not to the machine, and only one "Senior" retired, this, of all unexpected things, being due to shaft failure on the lone, and rather elderly, B.M.W. Admittedly, only 113 miles were covered but the percentage of retirements at the same distance was much higher in all the other races.

Alastair King's victory in the 350 c.c. Formula 1 class demonstrated that at last the 7R A.J.S. is *really* going; factory information is that it develops 40½ b.h.p. at around 7,800 r.p.m.—which is not far behind the 350 c.c. M.V., reputed to wind out 43 b.h.p. at 10,200 r.p.m.! The Senior M.V.'s quoted power is 56 at 9,800 but, of course, one must remember that such figures (a) are those which the manufacturer *chooses* to disclose and may or may not be accurate and (b) are not directly comparable between one make and another because of differences between testing techniques, variations between brakes and whether the power is measured at the engine-shaft or after it has been transmitted through one or more sets of gears. Factors such as these may account for the 22 b.h.p. attributed to the 125 c.c. Ducati twin not giving this machine any noticeable advantage over the single with 19 b.h.p.

Carburation and Cooling

Another factor affecting road performance is the possible effect of streamlined shells and the position of the carburetter air intakes in relation to tanks or adjacent portions of the rider's anatomy. It may very well be that the unavoidably high placement of the intakes of a 500 c.c. single may lead to bad carburation or loss of power through undesirable eddies or even areas of low pressure at the intake, especially if the float chamber is mounted some distance away and possibly in an area of differing pressure. The correct functioning of a carburetter is dependent upon extremely small pressure differentials and a system which gives extremely good power under test-bed conditions may be subject to all sorts of vagaries in the final installation. That some thought has, in fact, been given to this matter is shown by the use of flat discs up to 6-in. in diameter affixed either in front of or just behind the mixing chambers on some models: King's Norton was so equipped. But, of course, these fittings also have the effect of deflecting hot air away from the intake. The Guzzi singles of a year or two back were probably the best performers of this type yet made; they drew their air from a spot up near the steering head which is certainly cool and probably a high-pressure area.

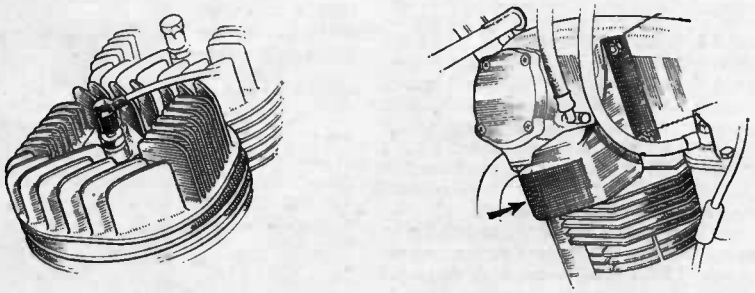
The M.Z. two-strokes have a different problem with their transversely mounted carburetters which extend outwards so far that local bulges had to be made in the fairings. Shields to protect the intake from cross-winds were used on the 125 M.Z.s but not on all the 250 twins. Both models are particularly sensitive to correct carburation, the twin more than the single.

On several makes, air ducts had been arranged to convey fresh air to the intakes. One or two of these had a suspicion of what Joe Craig used to term "panic engineering" about them, with little thought as to placing the inlet at a high-pressure spot on the fairing but some examples appeared to be both well placed and adequate in size. If I appear to be labouring this whole subject somewhat, no apology is due as it is a *most* important point; personally I would not be at all happy about carburation on a dolphin-faired model unless the whole machine, complete with dummy rider, could be tested in a wind-tunnel.

The same applies to cooling. Years ago it was found that large fins were better than small ones, not so much on account of their area but because they reached out beyond the "dead air" region behind the front mudguard. The modern cylinder, shut inside a fairing, can at best get less air than it did and no one can say whether what it does get hits the fins or not. It may well be that an intelligent use of baffles rather like those on the Honda—only more so—to guide air from the ingress slot and into close contact with smaller fins would provide superior cooling with a worthwhile reduction in size and weight. One only has to observe the small fin area of the B.M.W.s to realize that plenty of air is better than plenty of fin.

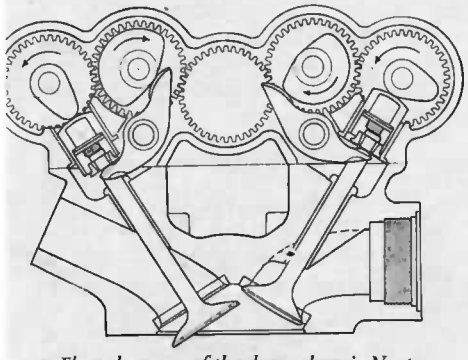
In the "Desmodromes"

So far as individual power-plants are concerned, most interest lay in the 250 c.c. and 125 c.c. classes, enriched this year by two eighth-litre twins — the



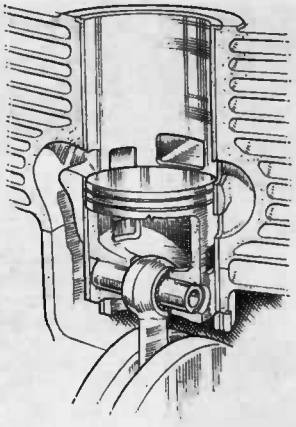
Two ways of plug cooling: air is deflected inwards by the head finning on the M.Z. twins (left) and by a sheet-metal scoop on the Hondas.

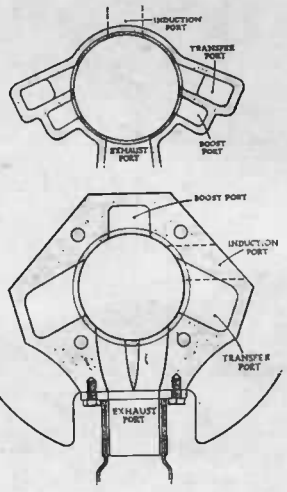
desmodromic Ducati and the more conventional double o.h.c. Honda. Technically, the former holds most interest, though its general construction is along the lines originated by Gilera and continued in the M.V.s in that a central section contains the pinion drive up to the valve gear. On each side of this central section what amounts to a complete single cylinder is dowelled and bolted; each tiny crankcase contains a crank assembly with circular flywheels, milled out for balance, with a pressed-in crank-pin and integral hardened mainshafts. The con-rod, of shallow H-section, has a hardened eye which runs on a single row of caged rollers and has a thin, bronze small-end bush though the single-cylinder rod—otherwise of similar design—has no bush. The inner shafts of the twin assemblies are formed with serrations of the Hirth pattern ground on the ends, these being pulled up tightly against similar serrations on the central gear-wheel to form a rigid assembly running in four bearings.



The valve gear of the desmodromic Norton has a five-gear train.

Up in what one might call the "desmodrome" of both twin and single Ducati engines are three camshafts with very narrow gears. The outer shafts open the valves through the agency of finger-type followers, the cams being milled out until they are in effect only loops of steel about 3 mm. thick. The inner shaft carries the cams which close the valves by means of reversed rockers with forked ends, small return springs, somewhat reminiscent of KTT Velocette rocker springs, being added, presumably to maintain contact between the valve collar, the split collets and the thimble on top of the shim. Adjustment is made by selection of collars and thimbles of appropriate sizes. Roughly the same idea is used on the "desmo" Norton which was considered too green to warrant starting it in the "Senior," but, in this instance, the greater span over the valves necessitates using the familiar five-gear train with the closing cams on the intermediate gears, and direct-attack followers are used instead of fingers.





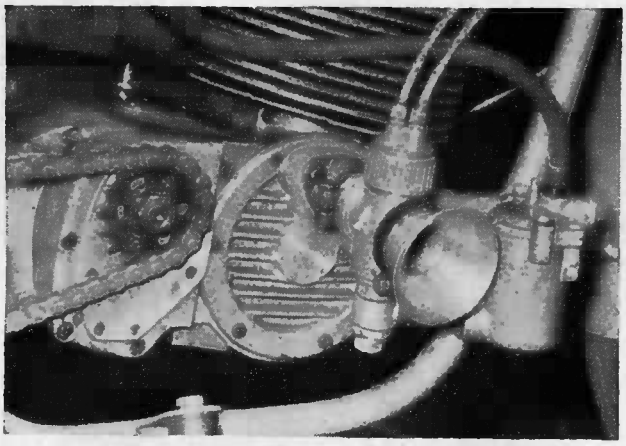
Two-stroke porting: in the E.M.C. (above and upper plan view), two boost ports lie adjacent to the transfers; the single boost port of the M.Z. (lower plan view) is opposite to the divided exhaust port.

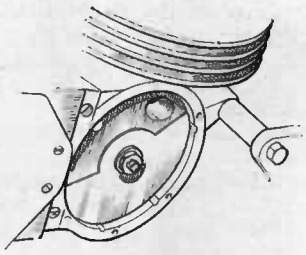
The idea of closing valves mechanically is quite old, but all the early editions incorporated springs which eventually held the valves on their seats. The modern idea, for which the credit must go to Mercedes, is to allow a clearance somewhere in the region of 10 thou. between each valve and its seat on the peak of the closing cam, the final closure being effected at very low speeds by reverse flow of gas and at higher speed simply by inertia. The practical limit of r.p.m. is fixed purely by the strength of the mechanism in relation to the stresses imposed by the cam form and it is said that the twin Ducati can be taken up to over 15,000 revs. without damage.

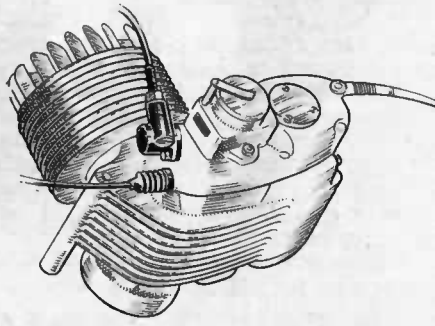
The Quick Two-strokes

Nevertheless, desmodromic operation is not, as yet, the full answer; the well-tried Ducati single, preferred on the twisty Clypse circuit to the twin, could not match either the double o.h.c. M.V. with hair-pin springs, or the M.Z. This two-stroke, in fact, was the fastest of the group, reputed to turn out 22 b.h.p. at something over 11,000 r.p.m.—a staggering figure partly accounted for by the ingenious rotary inlet valve consisting of a thin steel disc, cut away to give about 200° of port opening and floating between the crankcase wall and an outer plate. The cylinder barrel, fitted with a liner about 2 mm. thick, is machined all over from a solid billet of high silicon, low-expansion aluminium nearly 10 inches in diameter and offers immense rigidity with reduced liability to the barrel distortion which has always been a bugbear in two-strokes due to the wide difference in temperature and metal section in the region of the ports. The MZ exhaust arrangement is unusual in that two ports feed into a common outlet, a thin streamlined bar extending back an inch or so from the liner, but the inner surface of the port has been kept to a minimum by locally recessing the fins and also using a slip-joint in the exhaust pipe which is reasonably gas-tight but reduces feed-back heat to the cylinder.

The twin transfer ports are of normal shape, very large and well polished, but scavenging is augmented by a third port directly opposite the exhaust, fed via a port in the piston skirt and timed so that a small amount of charge is blown across the piston crown near bottom dead centre. This system ensures, too, that the underside of the piston is cooled at each stroke by fresh gas. It is also incorporated—though with two additional ports instead of one—in the E.M.C. which gives 18 b.h.p. with a piston-controlled inlet port. The 250 c.c. twin M.Z. so far as the cylinders and pistons are concerned, is simply a duplicate of the single with the crankcases bolted to a centre section as on the Ducati twin, but, in the East German device, the central gear runs in two bearings, while the inner mainshaft of each crank assembly is centred within this gear-wheel by a ground spigot, the torque being transmitted by splines. Each outer mainshaft runs in a bearing in the crankcase and extends through it to accept the splined disc-valve, and there is only 20 thou. clearance between the crankcase and the internal flywheels which have bevelled rims to give a clear flow of gas into the transfer ports. The piston crown is slightly domed and almost touches the head, except in the region of an offset depression, which is small enough to give a compression ratio of 14 to 1. A curious feature of the head design is the absence of fins







Details of the M.Z. "single." The view on the left shows the transverse mounting of the carburetter on the finned crankcase cover; on the right is the rotary valve which lies beneath. The mounting of the contact-breaker and rev.-counter drive and the heavily finned crankcase underside are seen below right.

over the actual combustion space; that this is no accident is shown by the fact that some fins, which had been there originally, have been subsequently milled away. In the race the twins were dogged with ignition trouble and mixture difficulties, but without any doubt, when these weaknesses are overcome, this engine will be very hard to beat indeed and, where the private owner is concerned, it enjoys a simplicity, compared with a modern four-stroke, which will make it a very attractive proposition.

Japanese Technique

This brings us to the Japanese Honda, which, though ingenious, is the reverse of simple, with its overhead exhaust camshaft driven by a vertical shaft and coupled to the inlet shaft by a train of gears. One of the most interesting points about this engine was purely one of production methods; it is usual for special engines to be made from sand castings, but all the major Honda components are die-castings, which either indicates that they will be making a lot or else that it is simpler in Japan to employ a few skilled die-makers and unskilled men in the foundry than to make wooden patterns which require skilled moulders. With a bolted-on sump, horizontally split crankcase, separate cylinders and numerous cover plates, the unit is far more complicated than even the Italian twins: but for all that it is a very workmanlike job. Admittedly, performing on the Island for the first time and anxious to put up a good showing as a team-mount—which it of course succeeded in doing—it appears that this make has quite a lot of leeway to make up before it can be a serious threat to the other contenders in its class.

Before leaving the subject of engines, a mention must be made of the G.M.S. With a 350 c.c. B.S.A. pushrod engine brought down to a quarter-litre by reducing its dimensions to 72 by 61 mm. it ran fourth in the 250 c.c. class, although, at 250 pounds, it was operating under a weight penalty. The motor is fitted with a solid crankshaft assembly, an outside flywheel and a con-rod with split, white-metalled big-end, and will run up to 9,000 r.p.m. peaking around 8,200 with standard B.S.A. cams but with RR 56 light-alloy tappets.

Induction and Exhaust Systems

It is, of course, well known that high power at ultra high revs. is obtainable largely by virtue of resonant vibrations in the inlet and exhaust systems, and the tendency to use a very long induction tract is quite marked. This in turn appears to permit the use of very large bore carburetters; the 7R A.J.S. used a 5 GP Amal of 1⅜ in. bore while the G.M.S. just mentioned used a 1 7/32 in.-bore Amal on the end of a rubber-hose induction pipe several inches long, the overall distances from valve to air intake being some 14 inches. This would appear to be about the optimum length for speeds around 8,000 r.p.m. and lengths were reduced steadily on engines with greater and greater shaft speed potential. Another noticeable design feature is the reduced offset in the inlet port from the centre line; in fact, in Italian engines both inlet and exhaust ports are invariably placed on or very close to the centre plane of the cylinder. The cylinder heads on both "works" B.M.W. outfits were machined for fuel injectors though only the old model, ridden by Fath, actually used this system, which has been found to be less suitable for a twisty circuit than conventional carburation with two bowls to each carburetter.

Sidecar Outfit Carburation

Newton's laws about the effects of gravity and acceleration have never been disproved, yet, despite this, several English sidecar outfits were fitted with only one float-bowl, mounted several inches to one side of the jet. Whatever the riders may think, carburation on a corner must be upset with this arrangement unless a swill pot is added, as it was on one B.S.A. outfit.

Flexibly mounted float-bowls are now almost universal and occasionally S.U. bowls were utilized on sidecar outfits equipped with petrol pumps and platform-mounted tanks. But the ultimate was to be seen on the solo B.M.W.s and the M.Z.s in which the bowls were only supported by the actual supply pipes and the short feed across to the jet!

Exhaust systems showed considerable variation, except amongst two-strokes, where the accepted thing is now a short pipe leading to a tapered expansion chamber about ten times the cylinder volume with quite a small outlet. The Adler tail pipes were fitted with restrictors with a hole approximately the size of a sixpence, though the M.Z. pipes were a clear 1⅛ in. diameter. In the fourstroke field, there were all sorts of lengths and shapes of megaphones, almost non-existent in the B.M.W.s and very large on the Senior Nortons; while some had reverse-cone ends, some did not. Generally speaking, however, the trend seemed to be towards a very long tapering megaphone with a major diameter not exceeding twice the pipe diameter.

Sparks

In the ignition department, magnetos are steadily losing ground to coils in the small capacity classes, distributors being eliminated on twins by employing two sets of contact-breaker points. The choice is probably determined by r.p.m., especially in two-strokes where a magneto would have to be run

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at engine speed although this argument is somewhat belied by the retention of magnetos on both sizes of M.V. However, 10,000 r.p.m. is rather different from 13,000 where centrifugal forces are concerned. On the score of weight the magneto is probably lighter because a distributor, coil and battery is not a very light combination. Cutting down on the battery weight can be a mistake; Ducatis prefer to carry a very large accumulator, weighing an extra two pounds, rather than risk the loss of efficiency through a voltage drop.

Two-plug heads are coming into favour with the very high revving engines, the Ducati plugs being fired by two coils, wired in series. The same idea was seen on Provini's M.V. but with an 8-volt battery. Resulting from space restrictions it is not easy to fit in a second plug and consequently this was usually of 10 mm. type, tucked in behind the camshaft drive with a 14 mm. variety in the conventional position. None of the larger capacity works engines used two-plug heads although some Nortons had been so modified, both plugs being fired simultaneously by a Cooper magneto.

The Honda was the only very small engine to use a magneto but finality in their plug positions had not been reached. Two engines had them in the conventional position but three others had the plugs inserted vertically, necessitating an ingenious mounting for the tank to enable it to be quickly swung upwards for the plug change.

(*To be continued*)

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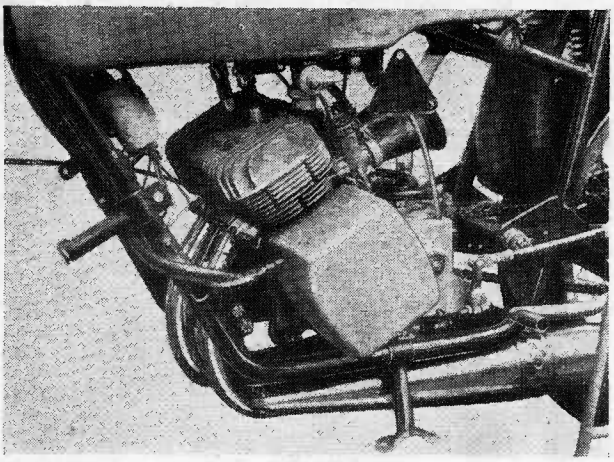


Claimed maximum—16,000 r.p.m.: the fabulously high-revving Suzuki twin two-stroke. Note the slotted barrel fins.

discussed by

PHIL IRVING, *M.I.Mech.E., M.S.A.E., M.I.P.E.*

PART TWO

IN the two-stroke engine group, six makes were entered in the 125 c.c. class and four in the 250 c.c. category; all of the latter were air-cooled twins, as were two of the former, the remainder being singles.

The MZs, in both sizes, showed little change from last year's, except for the position of the contact-breakers. On the single, the c.b. was moved over to the same side as the disc-valve and driven at half engine speed, which necessitated a small redesign of the valve-side mainshaft and the installation of a pair of gears. Exactly the same scheme in duplicate was used on the twin engine, so that each contact-breaker, which was equipped with two sets of points operated by a single-lobe cam, fired one cylinder.

The plugs on the twins were approximately central to the bores, instead of being offset forward in the position used last year and still retained on the singles. It appears that the change confers a little more "top end" power—i.e., in the region of 10,500 r.p.m.—but with a loss lower down which could be tolerated in the larger engine but not in the smaller.

The Ariel "Arrow," with the same 54 by 54 mm. dimensions as the MZ, gave a remarkably good account of itself by finishing seventh at just over 80 m.p.h. Though basically standard, the power unit had been modified in some details, including the use of elliptical-section con-rods (Scott fans please note!) and cylinder heads similar to standard, but reversed, and with the plugs central instead of angled.

Like every other T.T. two-stroke, with one exception, the Ariel was fitted with exhaust expansion chambers and small-diameter tail pipes, tuned for maximum power in the rev. range desired (around 7,500 in this instance). Although this broad general principle applied to all, the details varied, including plain outlet pipes, fish-tails, and (on the Suzuki) pipes which extended some two inches into the expansion chambers, presumably to exert a kind of "crab-pot" effect on pressure-waves travelling outwards.

The Suzuki (somewhat confusingly entered under its type name "Colleda") was beautifully made internally, the crankcase-gearbox unit being split horizontally, with the six-bearing crankshaft and both gearshafts of the all-indirect six-speed transmission placed centrally to the joint. For a stroke of only 41 mm. (44 mm. bore), the circular crank-webs, which ran just clear of the adjacent walls, were only about three inches in diameter by $\frac{3}{4}$ in. wide: as there was no other flywheel, the motor had to be kept spinning at enormous revs., 16,000 being quite lightly spoken of as the permissible maximum.

The Suzuki's separate cylinders with slotted fins were chrome-plated direct on the aluminium and porting was conventional in layout, but whilst the inlet port was divided by a bar to prevent ring breakage, the very large exhaust port, nearly equal in height to half the stroke, was unbarred.

The Yamaha, another Japanese twin two-stroke of 250 c.c. capacity, was very reminiscent of the Adler in its dimensions, porting and long induction pipes, but, like the Suzuki, suffered from piston trouble (either seizure or burning of the crowns) and did not give a very good account of itself.

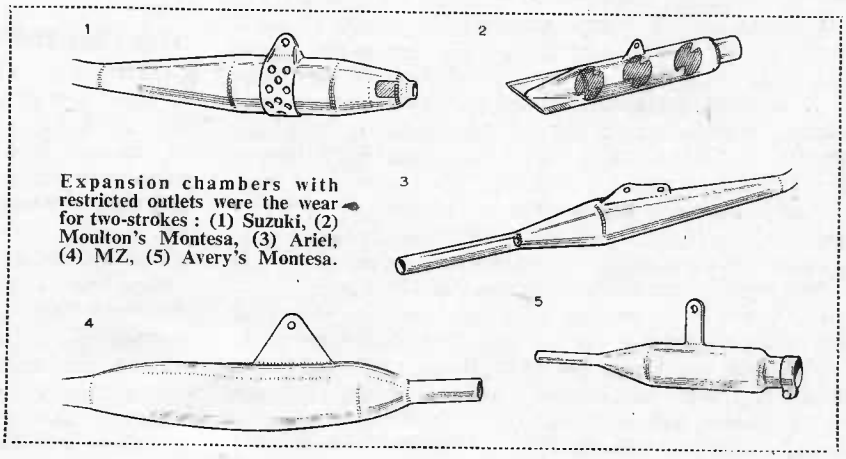
Not that they were alone in this respect; MZs also had their share. The piston remains the Achilles' heel of all two-strokes, despite the general use of very low-expansion aluminium alloys containing 16% silicon.

One engine which ran faultlessly throughout, even if at a speed which was very modest by racing standards, was the 250 c.c. Villiers twin housed in an M.V. frame. Absolutely standard in all respects, even to the single Villiers carburetter with air-cleaner attached, it was the only two-stroke to employ short, straight-through exhaust pipes.

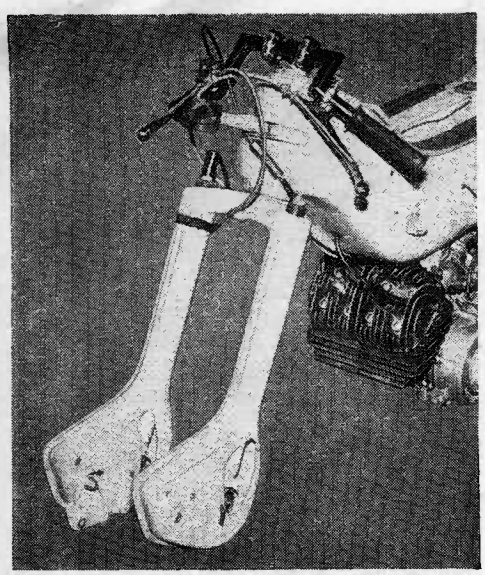
The Spanish Bultaco, weighing around 170 lb. and thus one of the lightest machines in the races (if not the lightest) was very similar to the standard product and, unlike most latter-day high-speed racers, utilized a chain for its primary drive instead of gears. This component, of $\frac{1}{2}$ in. pitch, performed quite satisfactorily at around 10-11,000 r.p.m. in practice; the machine was unfortunately prevented from starting by a minor (but at the time incurable) ignition defect.

Two interesting details in the Bultaco power unit were the semi-squish head, with lozenge-shaped combustion chamber, and the absence of an exposed top land on the piston, achieved by machining the top edge of the crown to come level with the upper leg of the L-shaped Dykes-pattern ring.

The vital part played by the exhaust system in high-speed engines was emphasized

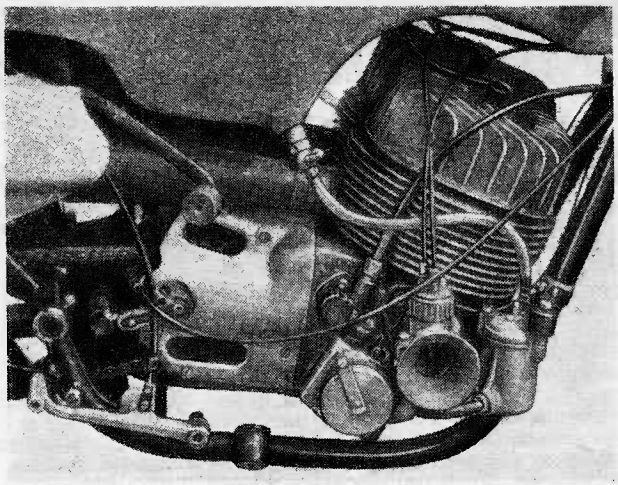


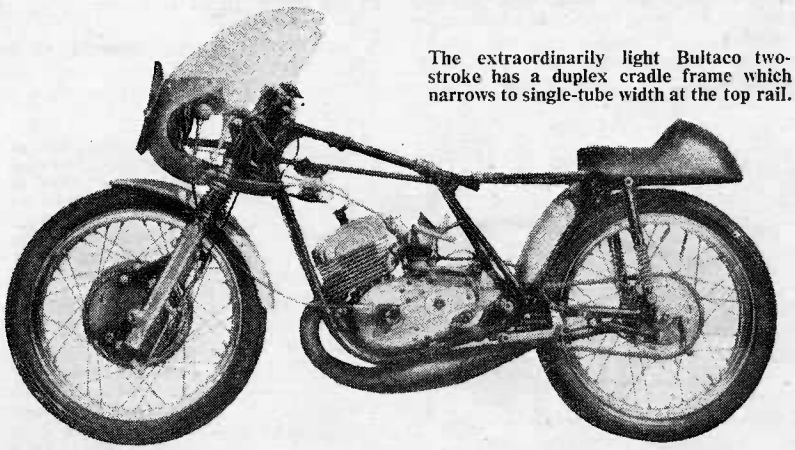
Expansion chambers with restricted outlets were the wear for two-strokes: (1) Suzuki, (2) Moulton's Montesa, (3) Ariel, (4) MZ, (5) Avery's Montesa.



(Left) Front end of the Ariel "Arrow," first British machine home in the 250 c.c. race, showing the standard forks and "reversed" cylinder heads.

(Right) Revised position for the contact-breaker on the MZ, now gear-driven from the mainshaft at half engine speed. Engine shown is the twin.





The extraordinarily light Bultaco two-stroke has a duplex cradle frame which narrows to single-tube width at the top rail.

by two occurrences—the large drop in speed of Anderson's MZ when an explosion within the expansion-chamber split this component asunder, and the loss of some 400 r.p.m. on Hailwood's Norton attributed to a 4-in. long split in the megaphone alongside the mounting bracket. Generally speaking, the pipe length in English machines has tended to shorten as their speed has risen, whereas the Continental trend on four-strokes running at 11,000 r.p.m. or thereabouts has been towards a much greater overall length, with the slow-taper megaphone extending nearly half-way.

This gives rise to the thought that, whereas the short system acts as an extractor to assist in scavenging, the system with twice the length may go even farther, drawing some mixture down into the pipe and then pushing it back again through the exhaust valve, in the same way that the "tuned" expansion chamber does in the case of the two-strokes.

Whilst this is speculation, it is certain that the usable speed-range has become fantastically narrow—less than 1,000 r.p.m. in some instances—and six-speed gearboxes with a drop of under 1,000 r.p.m. per ratio have become essential on a "250" or "125" to give it any chance of victory.

With six speeds, the amount of time spent in top gear will be only a small proportion of that spent in the others, and it is clearly better, on the score of overall efficiency, to make all the gears indirect, with the highest ratio giving, in effect, an overdrive to keep the revs below danger-point on fast downhill stretches. Even with five speeds, the minimum for present requirements, it might be preferable, if a conventional box is used, to make fourth the direct ratio and fifth a geared-up overdrive.

Several Lightweight "specials" were fitted with the five-speed Albion box, and some bigger models, notably McIntyre's A.J.S. which ran third in the Junior, employed the Daniell five-speed conversion set fitted to standard gearboxes.

Reports that there were more neutrals than gears were rather too frequent. Not that gearbox trouble was confined to English machines; Surtees' Junior M.V. lost first place through gears jumping out of mesh—a fault fraught with evil consequences if it occurs on a corner—and at least one Honda "four" and one MZ retired with a seized box and with damage to the gear-teeth respectively.

In the MZ box, 10 out of the 12 gears are mounted on caged roller bearings. The remaining two are fixed to their shafts, and the three selector forks are mounted on a cam-drum inside which is located the positive-stop change mechanism.

Only one case of chain failure occurred (as did one shaft failure), but there appeared to be a curious tendency towards reducing chainwheel sizes excessively in the smaller classes. The Honda gearbox sprocket had but 15 teeth, which must give the $\frac{5}{8}$-in. pitch x $\frac{3}{8}$-in. wide chain a very hard life. The choice of a $\frac{1}{2}$-in. chain instead of the usual $\frac{1}{4}$-in. was stated to be due to no Japanese chains of the latter size being available, and in the event Renold products were used.

That chain velocity, in itself, need cause no worry is shown by the big M.V.s, on which very large final sprockets are used, giving chain speeds of upwards of 6,000 ft./min.

In the ignition field, single and two-plug heads shared the honours equally, M.V.s using single plugs in the "fours" and dual plugs in the Lightweight twins and singles. Hailwood's Norton, together with three or four others of this make, used dual plugs, the second one, of 10 mm. size, being fitted abaft the camshaft drive housing. Both were fired by a Lucas two-spark magneto, no larger than the rotary-inductor model, with the secondary winding so devised that either plug would continue to fire, and the magneto would continue to function, whatever might happen to the other.

In effect, this engine has a single-plug head with a second plug added and consequently the firing points are not very far apart; whereas, judging from their external positions, the M.V. plugs are placed, as they should be for dual ignition, closer to the cylinder walls than they are to the centre.

On a few machines a new Lucas instrument, some 5 lb. lighter and less bulky than the present magneto, was tried experimentally.

Obviously the problem of delivering over 200 sparks per second with unfailing accuracy by conventional means is becoming increasingly serious. Thoughts are, in fact, being turned in the direction of electronic methods, with the circuit triggered off by weightless electro-magnetic media rather than by a contact-breaker which, being a mechanical, spring-controlled device, inevitably succumbs to the demands of ever-increasing speeds.

This, however, is at present only an intriguing possibility. In the meantime,

continental designers prefer coils to magnetos, except that both sizes of M.V. "four" retain the latter system, which is probably lighter than coil in this application, where a distributor is needed.

No new developments in carburetters were noted, except that several continental machines and the Honda employed flattish float-chambers with pivoted floats, instead of the conventional circular float actuating the needle-valve directly. If nothing else, the flat variety takes up much less space than the round one, which is useful on the sidecar B.M.W.s where the rider's legs fit between the carburetters and the power-units.

All the B.M.W.s (except Fath's, of course) used two bowls per carburetter for equalization of fuel level when cornering, but many British riders still unaccountably consider this precaution unnecessary. Fath's model employed fuel-injection direct into the cylinder, and doubts that this system would be suitable for a twisty circuit were dispelled by his best lap being fractionally faster than Camathias'. C. Vincent's push-rod B.S.A., the only four-stroke twin to use a single carburetter, went extremely well while it lasted to hold fifth place, thereby heading the English contingent, although for one lap only.

Fuel consumption and the necessary tank capacities presented some team managers with difficult problems. A fill-up was essential in the Senior, despite its reduction to six laps, but *might* have been averted in the Junior with an oversize tank. The question then was: would the weight of over 7 gal. offset the time-loss of a pit-stop? In nearly every case, the answer was "Yes"—even the M.V.s, which carry 7 gal. as a regular procedure, still had to be topped-up at half-distance.

The "125s" had no trouble with only three laps to do, but the twin MZs were fitted with 7½-gal. containers—evidence of high specific consumption, even allowing for their reputed output of 42 b.h.p. However, with their low carburetter position a large tank is less detrimental to handling than in a four-stroke where the weight must, perforce, be located high up.

In frame design there appeared to be no definite trend except a tendency to adopt duplex horizontal top tubes more as a method of simplifying the tank and its mounting than as a constructional feature. It might be said that there were as many frames with this feature as there were with single top tubes straddled by the tank.

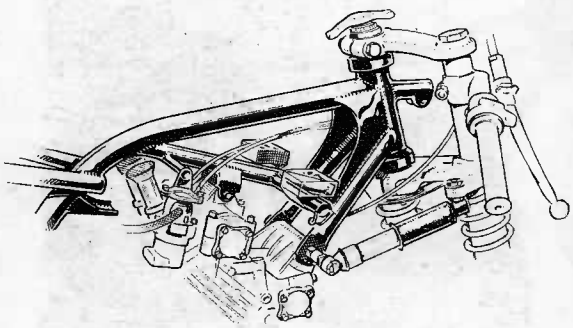
M.V. experimented in practice with several frames on both sizes of "four," the latest design using a shorter and stiffer rear fork with the axle clamped into the fork ends and the pivot-bearing carried by eccentrics for chain adjustment. A similar scheme was used on the Swedish-built frame of Anderson's 250 c.c. Velocette.

To take out the power unit, some portion of the M.V. frame has to be removed. Whereas the loop-tubes were the parts detached in three out of the four models, Hartle's Junior machine had the detachable single top-tube as used last year, so it would appear that there was little to choose between all the variants.

The Honda frames differed from last year's in using tubes instead of pressings to connect the steering column to the cylinder head, and the spine-tube was increased in diameter to 1¾ in. In both the fours and the twins, the cylinders had more forward inclination than last year's, but whereas the "125" seemed to handle well the navigation of the bigger model was reported to be a trifle uncertain.

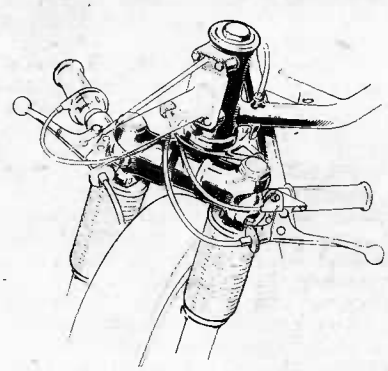
The Bianchi frame, common to both engine sizes, was most unusual (not to say peculiar) in having no fewer than four small-diameter tubes running from the head to the front of the power unit, with an oval-section top tube running back to the saddle-nose, where it joined a cross-member uniting two horizontal one-inch tubes on which the tank rested. In contrast to the apparent lightness of the main frame, the rear forks, made of welded pressings, were commendably generous in section area.

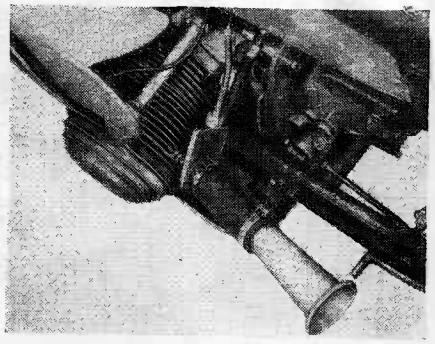
The Morinis used in practice had frames of "Featherbed" type, with additional vertical tubes welded in ahead of and behind the engine on both sides and an odd conglomeration of tubes supporting the steering column. The example which performed so well in the 250 c.c. race did not have these extra tubes, but instead two drilled straps, both of which broke, were used in the forward position.



(Left) Tubes, instead of pressings, now connect cylinder head to steering column on the Hondas; the sketch also shows the telescopic steering damper arrangement.

(Below) Cycle-type front-fork assembly of the Norton "Lowboy," with the stanchions clamped in a massive crown lug.





Induction system of Fath's direct-fuel-injection B.M.W., showing the slide throttle.

Notable were the many special frames produced for sidecar work with the idea of lowering the machine's c. of g. Most of these, built in this country, were of the type originated by E. T. Young—similar to a "Featherbed" but with the top rails running downwards to the gearbox, then upwards towards the rear spring mountings. Head angles were mostly around 75° and trail was, on occasion, zero or even negative, although one inch seems to provide ease of cornering without the lightheaded feeling given by negative trail.

Contrary to recent trends, the leading-link front fork suffered a set-back, the only "works" entries on which it was retained being the 125 c.c. MZs; the twin MZs used genuine Norton forks. Honda also reverted to telescopics, with the axle mounting offset so that alternative trails could be obtained by reversing the sliders.

The "Arrows" used the standard Ariel trailing-link forks, which apparently gave very good handling.

The major use of either Earles-type or short-leading-link forks was in the sidecar field, where they were commonly fitted, although Fath retained the very heavily built telescopics with which his ex-"works" model has always been equipped. A new departure was to be seen on the Norton "Lowboy," which had telescopic forks of cycle type, with a 1¾-in. steering-column tube joined to a massive crown lug in which the fork stanchions were clamped. This layout reduces the top weight considerably and, as the bars are fixed directly to the stanchions, the unbraced column tube has to deal only with fore-and-aft loading.

Anything else? Yes—brakes, in which there are no new developments to report, although one noted a strange tendency in Italian machines to use two-leading-shoe brakes on the rear wheel, sometimes in conjunction with "2 l.s." on the front, sometimes not. The tendency towards over-braking the smaller models seems to be arrested, and the redesigned Honda dual front anchors were reduced from 180 to 170 mm. diameter.

Dual front brakes were just about as popular as singles, the most potent example possibly being the two-leading-shoe ex-Gilera unit on McIntyre's A.J.S. Rear disc brakes were seen on two sidecar machines and both appeared to be in perfect condition.