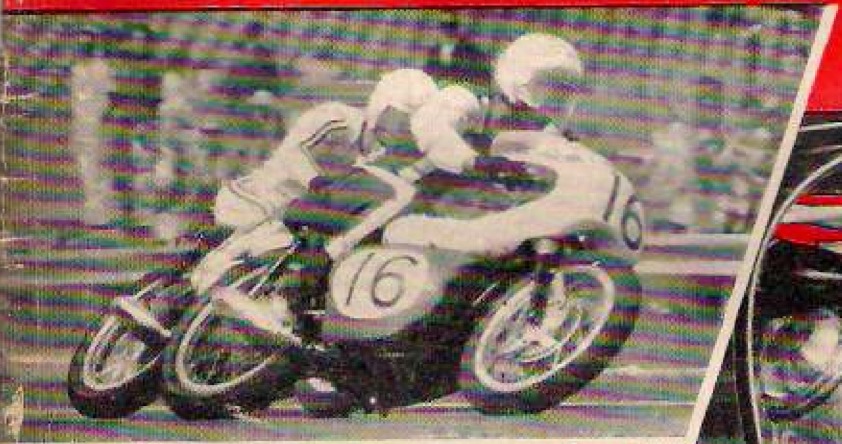
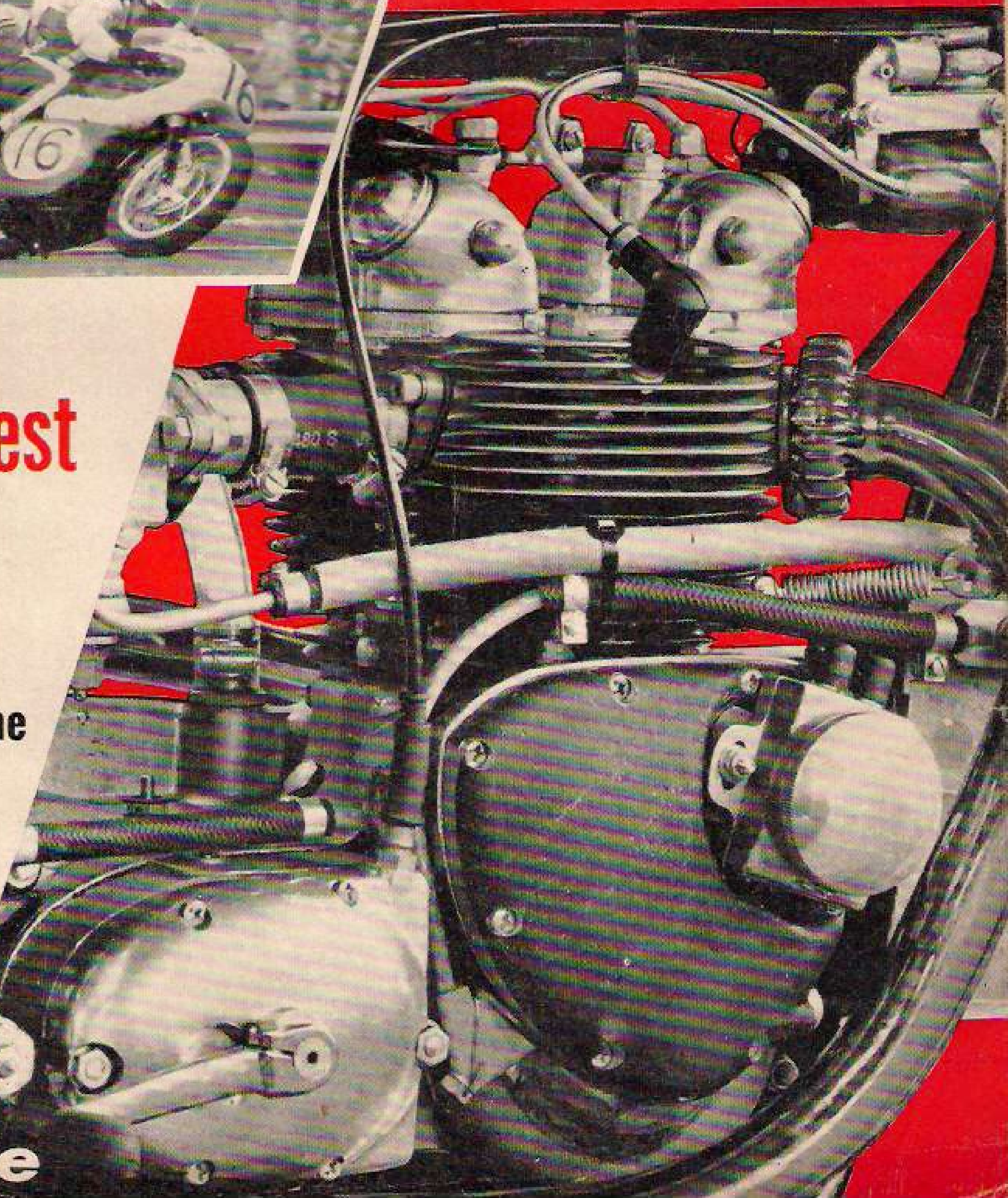
4 MAY 1967 * 1s 3d

Motor Cycle

Scottish Six Days Trial

First Report



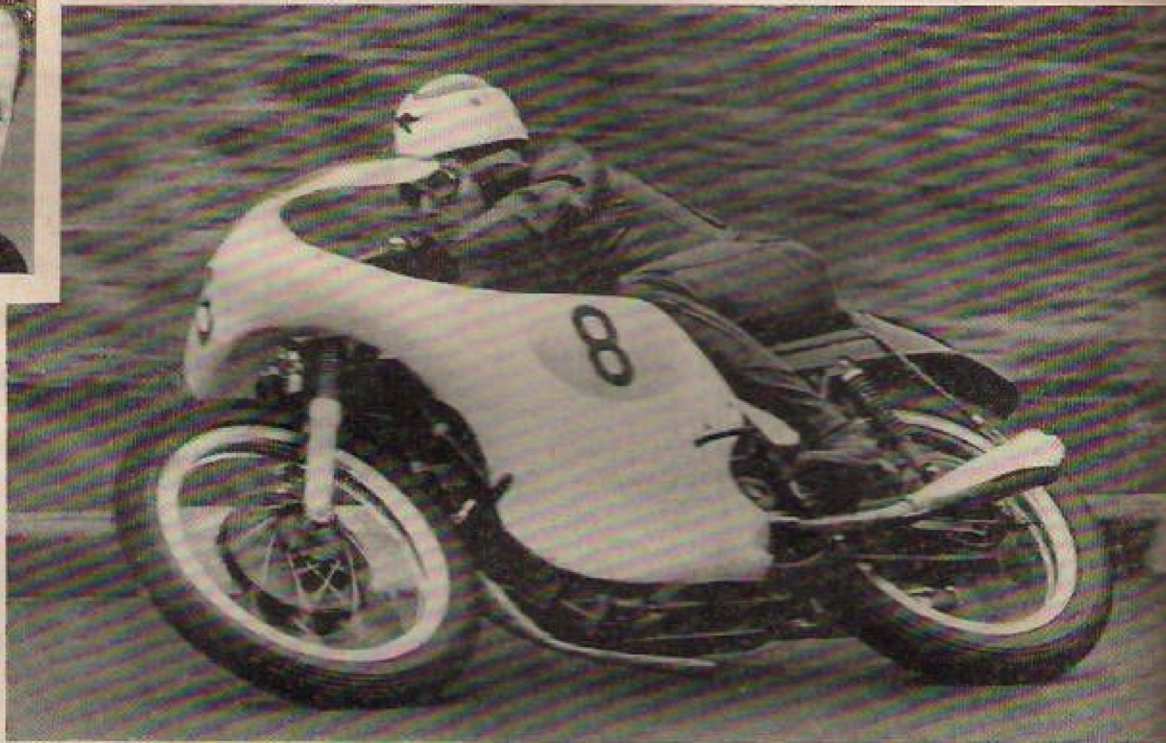


Win a Road-test Suzuki for 3d

Developing the High-speed TRIUMPH ▶

Motor Cycle

Doug Hele, AMIMechE



Developing the High-performance Triumphs

PART 1

Making them Steer

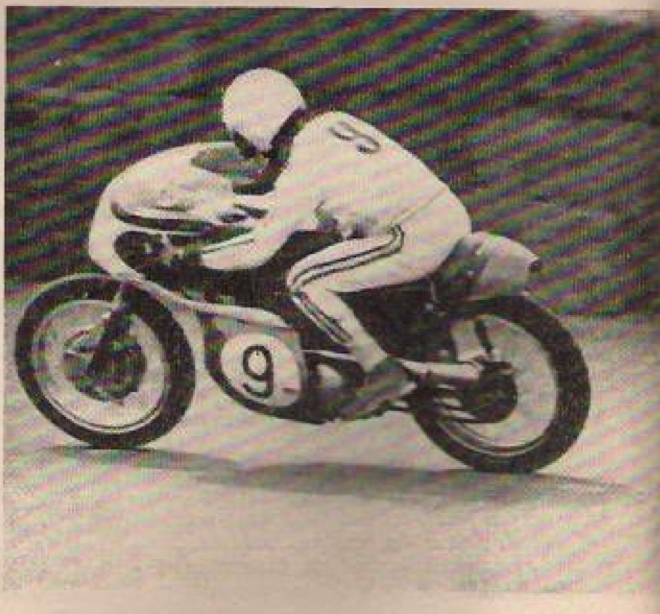
by Vic Willoughby

Pushrod five-hundreds make history. Above: On a Norton Dominator, Tom Phillis hurtles through Union Mills during his 100·36 mph lap in the 1961 Senior TT. Below: Winner Gary Nixon leads his Triumph team-mate Dick Hammer in the Daytona 200-miler

IN THE CHEERS that rang out for Triumph's spectacular one-two at Daytona there was an echo from the 1961 Senior TT. To blow off the mighty Harley-Davidson seven-fifties with a lap to spare in Florida, Gary Nixon and Buddy Elmore rode a brace of pushrod five-hundreds. And it was on a pushrod five-hundred—a Norton Dominator—that Tom Phillis made history in the 1961 Senior by turning the only 100-mph lap with a machine of that type in the course of finishing third.

The connection? Behind both achievements—as behind Elmore's Daytona win last year—was the brilliant, painstaking work of development engineer Doug Hele.

Engineeringwise, this year's Daytona results do less than justice to Hele and his dedicated experimental team. Six bikes were flown out from Meriden and as near as dammit their performances were identical. All six finished and had the riders all been as talented as Nixon, there was a potential Triumph one-two-three-four-five-six, with the best Harley finishing no higher than seventh!



Reluctant to leave the Midlands when Nortons moved to London, Hele switched to Triumphs 4½ years ago. With his Norton background he was convinced of the benefits of racing, not only for prestige but for really proving steering, performance and stamina.

Getting his way, however, has involved a constant struggle. Managements are apt to focus a frosty eye on costs and no tears would have stained the boardroom carpet had Doug pulled out of racing.

At best, top brass would probably judge three months' concentration just prior to Daytona to be enough to ensure success. But experience has taught Hele the unremitting effort needed to get to the top and stay there.

Hence his obstinacy in keeping one man, Jack Shemans, constantly occupied on the test bed with Daytona engine development.

Notwithstanding the importance of the US market to Triumphs, however, any idea that Doug Hele's work consists solely in getting a handful of bikes to the start line, or even the winner's enclosure, at Daytona once a year is an ocean wide of the mark.

The standard bikes you and I buy are his responsibility; and Doug's first problem, on peeling off his riding gear at Meriden, was steering.

Strangely enough, the only way in which his Norton experience was helpful here was in providing a yardstick—a superb standard by which to measure his progress.

Grafting Norton geometry on to the Triumph was useless because Triumphs had already gone over to integral construction of engine and gear box.

Indeed, a similar change at Nortons in an experimental six-fifty had brought steering difficulties (as a result of the rearward shift in weight distribution) which Hele had alleviated but not overcome by the time he left.

As the fastest bike in the range, the Bonneville was chosen for guinea-pig. Target was handling good enough for production-machine racing.

CAUSES

There followed 12 months of the closest liaison with Percy Tait whose enormous road-test and racing mileage was a great help.

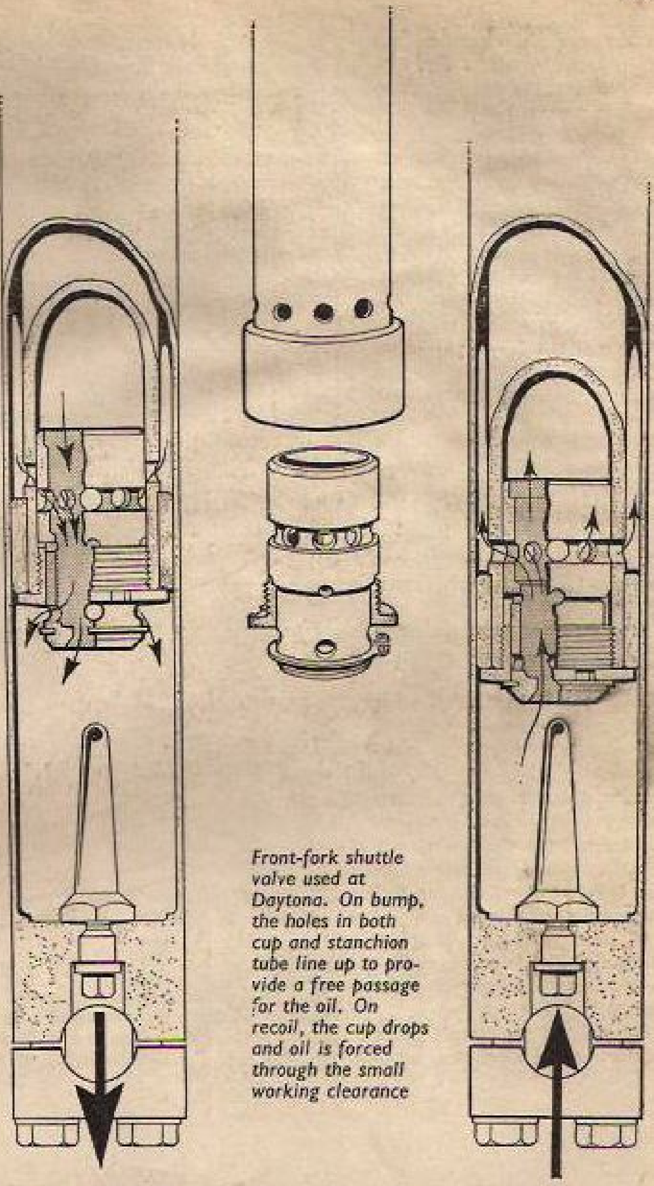
Designed by Brian Jones, the frame of the unit-construction Bonneville was structurally sound so it was necessary to look elsewhere for the causes of poor handling.

This meant using racing tyres, particularly at the rear. Standard covers, because of their greater radial depth relative to width, tended to camouflage steering development unless blown up to 35 psi.

(Incidentally, tests with triangular-section tyres—like the Dunlop racers designed to give larger contact areas when banked well over—proved it necessary to increase rear rim width for consistent results.)

Before getting down to cornering, there was the peculiar straight-line weaving at speeds of 100 mph upward to be tackled.

This, reasoned Doug, could be due to the front fork having too little downward travel for the machine's well-rearward weight distribution, so that the front wheel was easily lifted off the ground.



Front-fork shuttle valve used at Daytona. On bump, the holes in both cup and stanchion tube line up to provide a free passage for the oil. On recoil, the cup drops and oil is forced through the small working clearance

It is the job of fork trail, through simple castor action, to give straight-line stability—but all the trail in the world becomes useless the instant the wheel takes off.

Sure enough, reducing fork-spring preload by ¾in, so increasing downward travel by that amount, tamed the weaving a great deal.

On high-speed bends, however, steering remained too light and this suggested a need for reducing the head angle (to the horizontal) to get more trail.

True that was already a substantial 3⅞in but the *effect* of trail depends on the weight on the front wheel—and that is less with the Triumph layout than with the Norton.

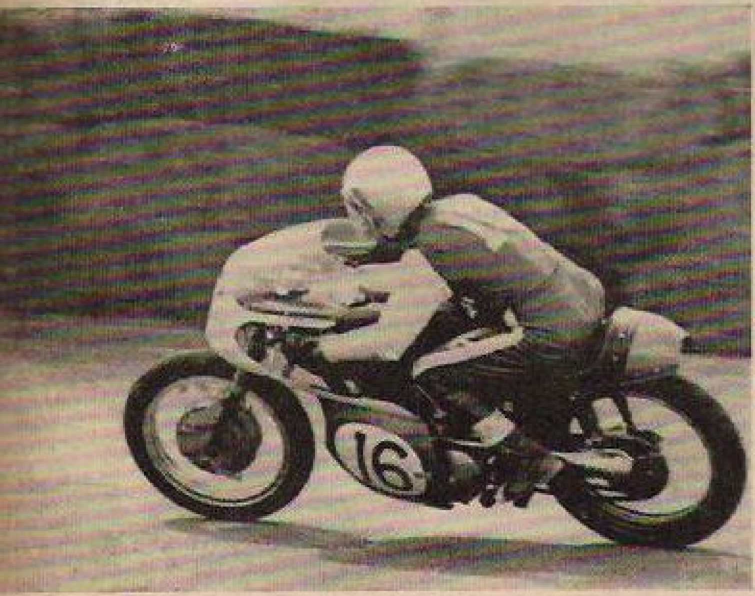
At the same time, Doug's Norton-trained eye judged the bike's centre of gravity to be too high. Short of scraping the hardware on the deck, he says, you just can't get it low enough.

When, in an S-bend, you haul a bike up from, say, 45 degrees left bank and flop it down to 45 deg the other side, it acquires inertia and wants to keep on banking over.

This inertia acts through the centre of gravity, so the higher that is the farther and faster it travels and the more reluctant it is to stop.

Musical types may discern in this the principle of the metronome. Anyway, the lower the c of g the more effortless a change of bank and the less reaction afterwards.

By a bit of ingenious conjuring, Hele altered both steering geometry and c of g in one move. After careful measurement on the drawing board,



he chopped a shade more than ¾in out of the frame top tube and rejoined the ends by sleeving and brazing!

Virtually this pivoted the front of the frame on the engine-mounting bolt: the effect was to add ½in to the trail, reduce the head angle to 63 deg and bring the engine ½in lower.

Of all the steering modifications, this one brought the most improvement.

No longer was it necessary to throw the bike down to get round a bend; little more than a nod of the head was called for—just like a Norton.

In finalizing the geometry, a still shallower head angle was tried. Though this brought an even greater sense of security on wet roads, once put into a corner the bike was reluctant to come out of it.

Development engineers, like other mortals, have to compromise.

For road work the steering problem was just about licked, but racing is a harder taskmaster.

It became necessary to stiffen the front-fork recoil damping, otherwise there was a tendency towards pitching in bends unless the power was either full on or right off.

Upshot was the simplest hydraulic shuttle valve ever—screwed into the bottom of the stanchion tubes.

On recoil, a cup simply slides over a ring of oil holes, leaving the oil to be forced through the small annular clearance between tube and cup, so checking fork extension.

The other racing modification was to alter the fork yokes so as to bring the wheel back ⅝in. This maintained the trail at 3¾in in spite of the fork being shortened an inch to get the c of g lower still.

Notwithstanding this lowering, it was found unnecessary to cut total fork travel, which remained a very useful 5⅜in.

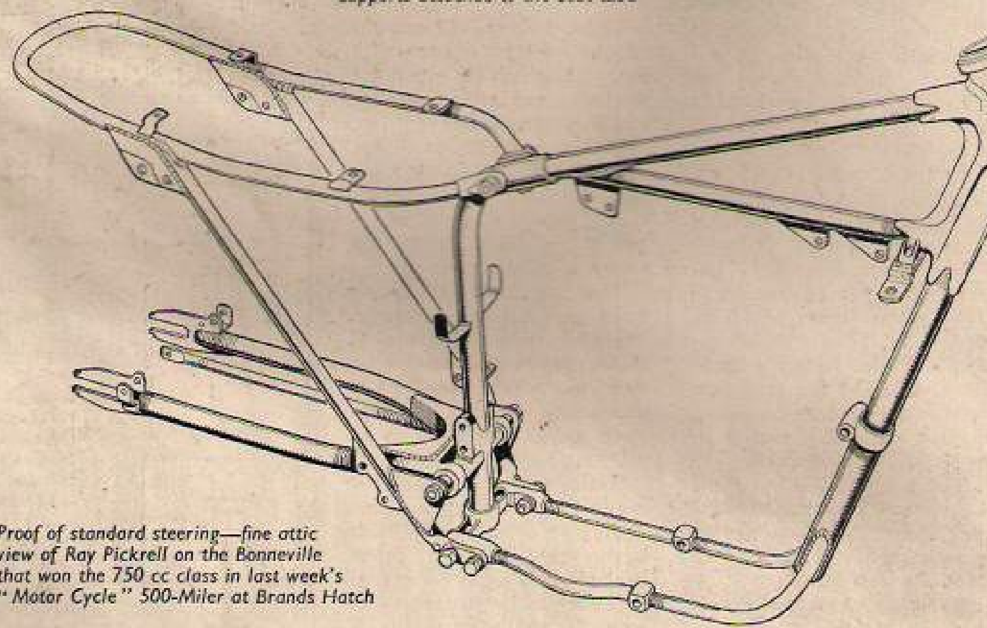
For the five-hundred and three-fifty all that had to be done was duplicate the modifications to the six-fifty; only difference is in rear-spring poundage—15 per cent softer because of the lighter weight.

What are the lessons of this particular phase of development? In broad terms, the emphasis is on the relationship of trail to head angle and the reliance of trail on front-end weight for effect.

A buckshee lesson from the racing programme is that even the slight difference in contact area between 18in- and 19in-diameter tyres is perceptible when cornering hard—a sharp reminder of our absolute dependence on the size and effectiveness of that vital contact patch.

Next week's Triumph development theme—MAKING 'EM GO!

Daytona frame with beefed-up rear fork, about 2 lb of surplus metal pared off various lugs and carburettor-bellmouth supports attached to the seat tube



Proof of standard steering—fine attic view of Ray Pickrell on the Bonneville that won the 750 cc class in last week's "Motor Cycle" 500-Miler at Brands Hatch

BY VIC WILLOUGHBY

Making them GO

HOW DOUG HELE DEVELOPED THE HIGH-PERFORMANCE TRIUMPHS

WHEN tracing Doug Hele's step-by-step development of Triumph steering last week, I mentioned that the fastest bike in the range was used as a guinea-pig. In engine development, too, he started at the top, with the Bonneville. The immediate problem was to find more power for production-machine racing—and here his 1961 experience with Tom Phillis's TT Dominator Norton sounded a warning. The warning was that, in the give and take of road racing, it is folly to put so much emphasis on boosting peak power that there is a substantial sacrifice in the middle of the rev range.

What use is an extra 2 bhp at peak revs if, as soon as the meter needle drops back when you change up, you are 3 or 4 bhp short? A good spread of power over the working rev range is much more use. On the Dominator, a hard-won 1,000 rpm and 2 bhp had failed to improve lap times because of the loss of punch for acceleration. During Bonneville engine development the lesson was repeated. In the 1964 marathon races the Triumphs, with 52 bhp, were outsped by the SS Nortons; the following year, with no more top power but a good deal more lower down, the Bonnies turned the tables.

Starting with 47 bhp, Doug Hele got to work on cam and follower design to improve breathing and scavenging.

This involved longer opening periods for both valves and higher lifts, not only when the valves were fully open but also at the critical point of top dead centre, overlap.

The reward was an immediate gain of 5 bhp but, since this was on open-megaphone exhausts, the next problem was to retain as much of the bonus as possible with the obligatory silencers.

Two courses presented themselves. The simpler one was to make a silencer to contain the megaphone; this was soon ruled out because of the excessive size the silencer would have to be.

The other approach was to reduce exhaust back pressure by coupling the two pipes as close to the ports as possible. Hence each (324 cc) cylinder discharges into a double exhaust system; and since each silencer virtually has to cope with an impulse of only 162 cc, silencing is improved as well as efficiency.

This is a variation on the BMW scheme of coupling the exhausts just before they reach the silencers to achieve extra quietness.

Because the Triumph exhausts were coupled at the port end, however, it was necessary to cut pipe diameter from 1½ to 1¼in (outside) to maintain gas velocity.

Proof of the scheme is that the 5 bhp bonus at peak revs was retained and only a little sacrificed lower down.

This gain was obtained without any change in carburettor size or compression ratio, though we may well see these stepped up in the next stage of development.

The new cam and follower layout focused attention on wear at these points.

Simple solution was to feed oil under pressure through radial holes into the hollow tappet stems; from there the oil emerges downward on to the rubbing surfaces.

An interesting sidelight is that the engine now runs cooler as a result of the more-efficient combustion and scavenging.

Doug found this at Nortons, too, and it is only to be expected when you remember that the more combustion heat you turn into useful work, the less is available for heating up the parts.

Considering the 1966 and 1967 Daytona results, with the five-hundreds this year lapping the speed bowl at 136 mph (on open megaphones), it is scarcely credible that Doug Hele turned his attention to the T100 engine no earlier than October 1965.

Starting from 34 bhp at 8,000 rpm (in standard roadster trim) there was a rapid jump to 45 bhp at 8,200 rpm as a result of such fundamental changes as two carburettors, open megaphones and more-sporting valve-lift curves; these resulted from cam and follower mods and called for stiffening of the hollow push-rods (by an increase in diameter) to prevent bending.

The astonishing thing is that peak power has since been pushed up to 50 bhp at 8,000 rpm with no falling off up to 8,700 rpm (at Daytona the bikes were geared to do 8,400 rpm in top).

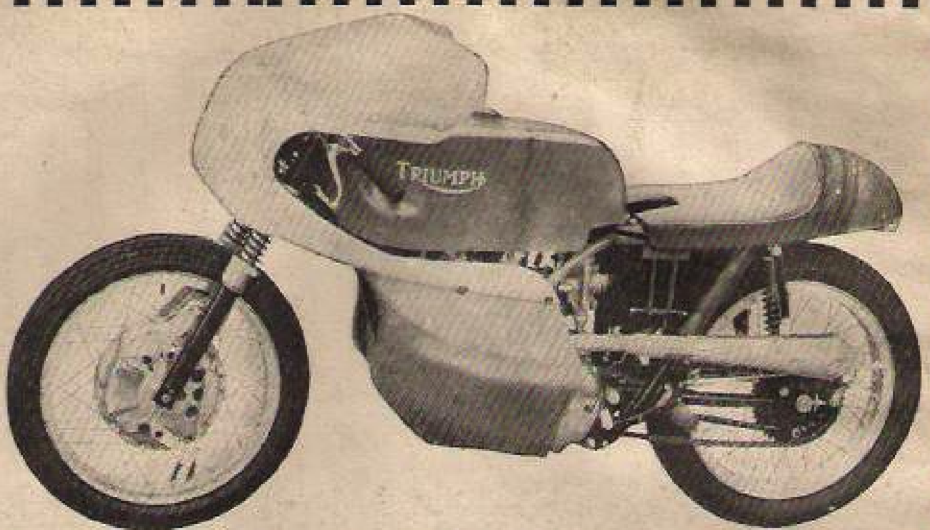
BETTER STILL

Even more dramatic evidence of the achievement of a wide spread of power is that 49 bhp is on tap at 7,700 rpm and 44 bhp as low as 6,500 rpm —an increase of 6½ bhp on the previous power there and a great boon every time an upward change pulls the revs back, as well as for accelerating out of corners.

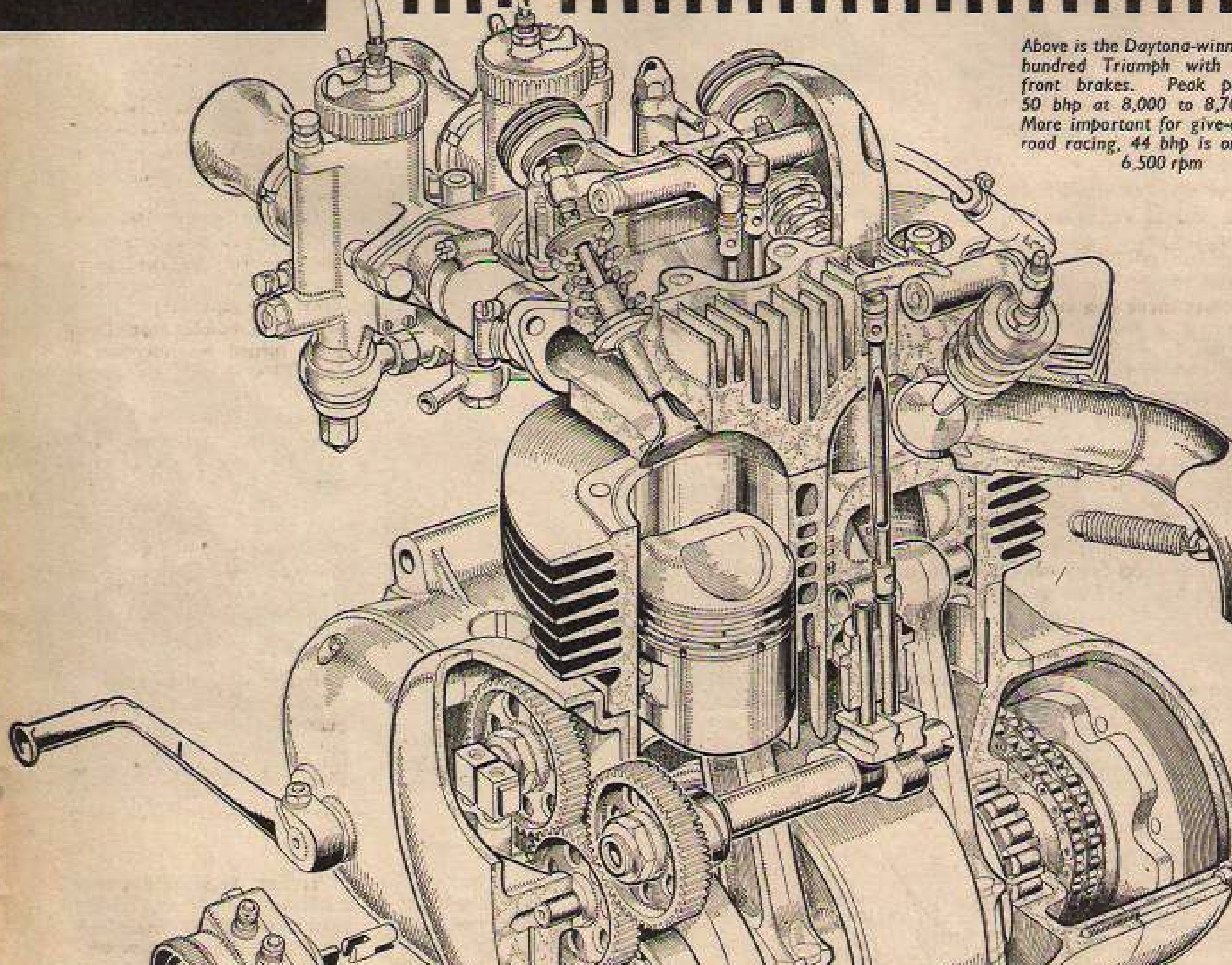
Again the benefit has come from pretty fundamental work —further development of the

DOUG HELE, AMIMechE

Part 2



Above is the Daytona-winning five-hundred Triumph with Fontana front brakes. Peak power is 50 bhp at 8,000 to 8,700 rpm. More important for give-and-take road racing, 44 bhp is on top at 6,500 rpm



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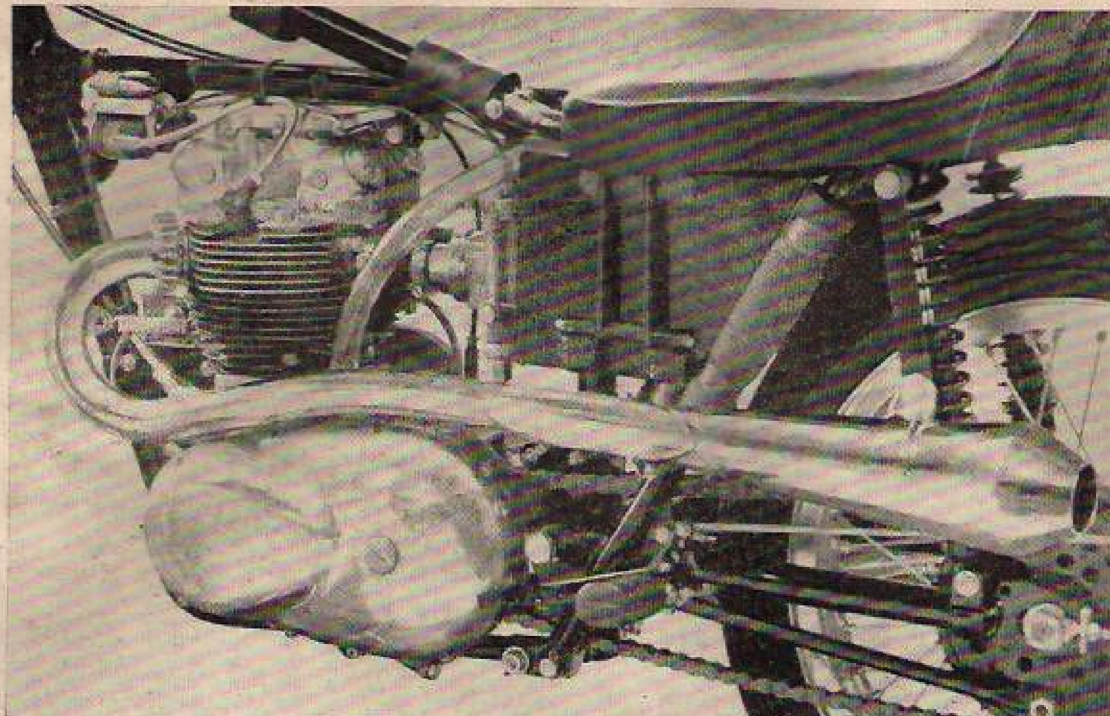
Innards of the latest T100 engine with the contac breaker and its drive shown separately (this arrangement was used only at Daytona). For the American classic, choke size of the Amal GP carburettors was increased to $1\frac{3}{16}$in though inlet-port size was kept at the standard $1\frac{1}{16}$in



Left: Drive-side close-up of one of the power units used at Daytona. Note the large-bore plastic pipe venting the primary chaincase to atmosphere. The crankcase breathes through the chaincase

On the right is the prototype of the ventilated Triumph double-leading-shoe front brake, so far used in a standard drum

Right: Percy Tait, chief tester at Triumphs and a key member of Doug Hele's development team, takes a stint on the Bonneville that won the "Motor Cycle" 500-Miler at Brands Hatch last month

valve-lift curves (Dominator background came in handy here), an increase in compression ratio (with particular attention to combustion-chamber shape) and improvement in the shape of the $1\frac{1}{16}$in-diameter inlet ports.

The principle here is to taper down the cross-section area so as to build up gas velocity to a maximum where the restriction on flow is greatest; that is, close to the valve head.

For Daytona, choke size of the Amal GP carburettors was increased from $1\frac{1}{8}$ to $1\frac{3}{16}$in but the cylinder-head porting was perfectly standard; the different diameters were blended by 4in canvas-reinforced rubber sleeves.

You and I might imagine that any old rubber hose piping would do for that job, provided it was the right size, but we'd be wrong.

The *type* of rubber is very critical if carburation is not to go haywire from 6,000 rpm upward.

Just how critical is shown by Doug's experience that a rigid carburettor mounting is preferable to using hoses of anything but the right grade.

Engineers dream of getting something for nothing and a rare example of achieving a gain for even less is seen in Hele's combined attack on crankcase breathing and primary-chain lubrication.

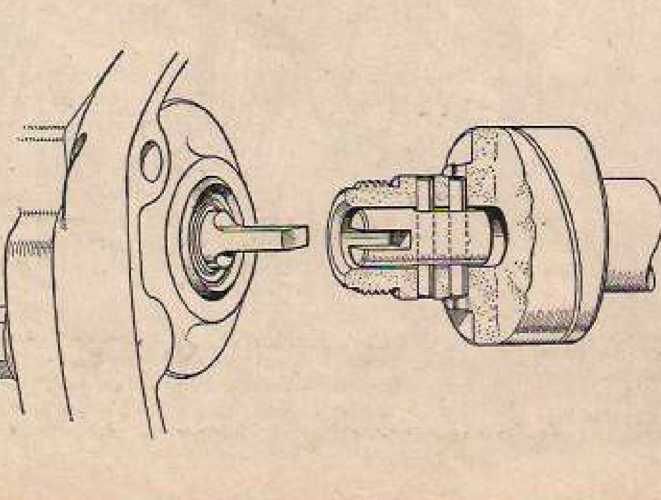
Motivation was a double worry. First that the standard breather (a timed valve in the inlet camshaft venting to atmosphere) might be overwhelmed by the increase in rpm; second that the $\frac{3}{8}$in duplex chain might find the going too hard.

Solution was to drop the timed breather and omit the oil seal from the drive-side roller main bearing; hence the crankcase breathes through that bearing into the chaincase, itself vented to atmosphere by a $\frac{3}{4}$in-bore plastic pipe at the top.

Then, three $\frac{1}{16}$in holes were drilled in the crankcase wall, level with the bottom chain run and just behind the engine sprocket, to spray oil mist on to the chain.

Result: an adequate oil level maintained in the chaincase, better chain condition and not a vestige of oil discharged from the breather pipe.

Below: Details of the Daytona contact-breaker drive. The tongued shaft is driven by a slotted coupling pegged in the end of the exhaust camshaft

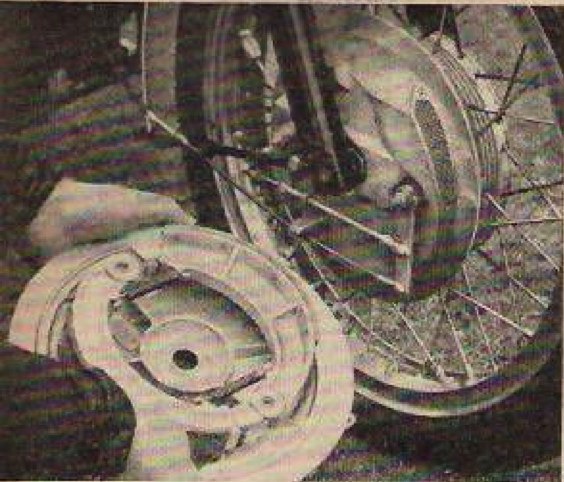


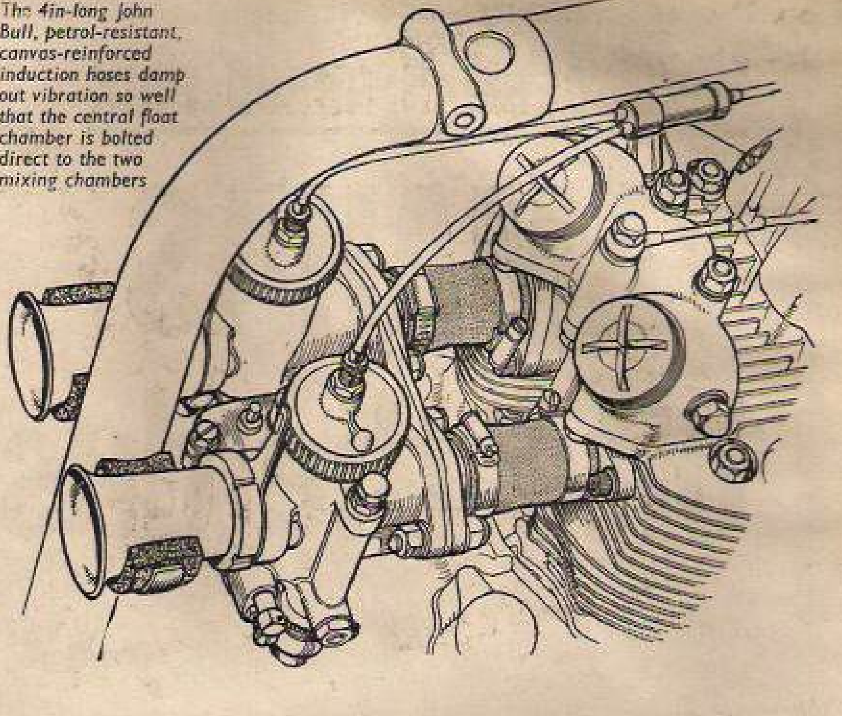
Peculiar to the Daytona machines was a contact breaker with two small ball bearings for the cam.

This was another concession to ultra-high revs which might otherwise cause the offset mass of the cam lobe to fling outward and upset the ignition timing.

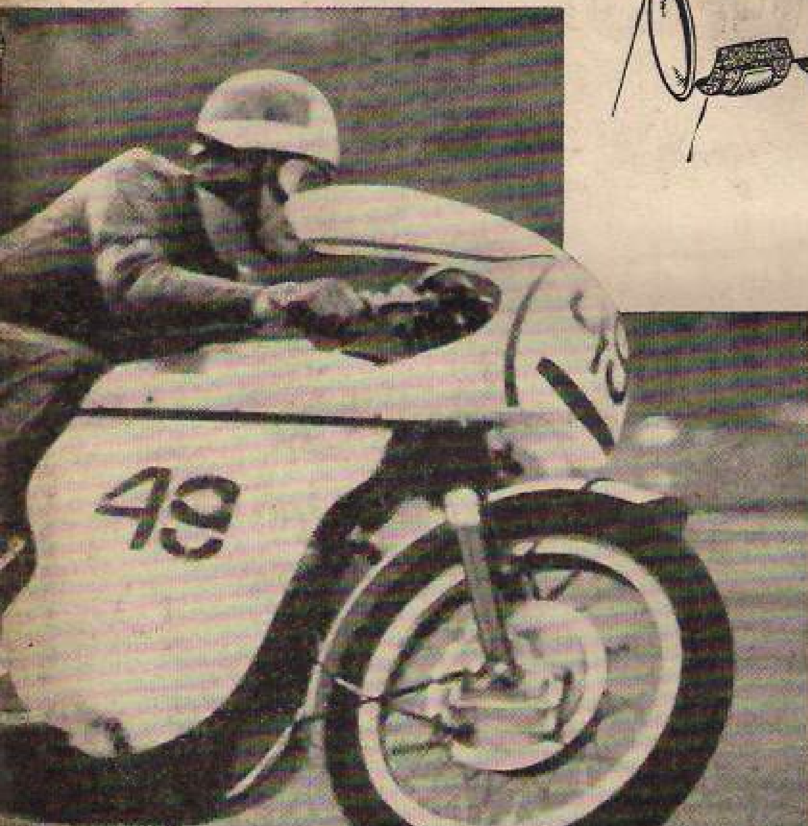
More noticeable still were the oil radiators in the scavenge line from pump to tank. Why were they fitted?

Well, Florida has a hot climate and the bikes are flat

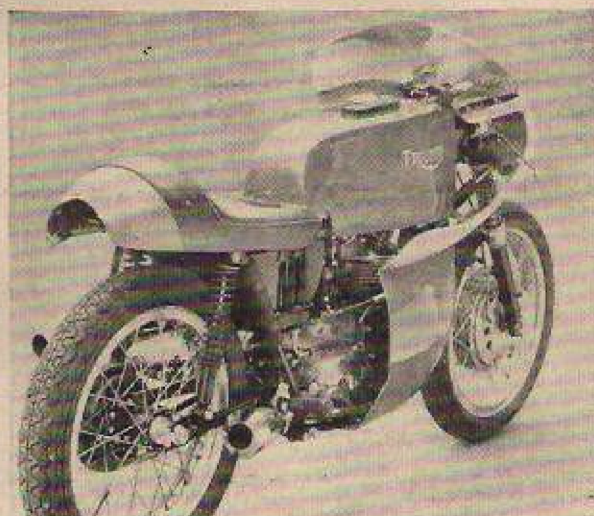




The 4in-long John Bull, petrol-resistant, canvas-reinforced induction hoses damp out vibration so well that the central float chamber is bolted direct to the two mixing chambers



The rear three-quarter shot below emphasizes the businesslike look of the Daytona-winning machine



out in top for 2½ miles every lap. On test, Triumph distributor Rod Coates had found the oil getting so hot that it thinned out too much for the plain big-end bearings.

With the coolers in use, maximum temperature of the SAE30-grade mineral oil stayed at a safe 80 deg C.

Every facet of Doug Hele's work shows the clear, incisive thinking and freedom from prejudice that mean so much in development work. How does he see future trends?

Except for out-and-out grand-prix racing, the fashion for disc brakes leaves him lukewarm. They require the added complication of hydraulic operation and the discs rust readily in damp weather.

True, production-machine racing can tax standard brakes too highly—hence the dual, 210mm (nearly 8¼in), double-leading-shoe Fontana brakes spoked into the front wheel at Daytona. But the Triumph brake now under development for production racing, and tried so successfully in last month's 500-Miler at Brands Hatch, is of drum type.

More gears will help as rising power inevitably involves some sacrifice of low-speed torque—but five speeds, says Doug, will be ample for big engines.

In suspension characteristics modern machines can hold their own with the best in car design. For a very long-term bet, though, there is always the slender possibility of interconnection of the front and rear systems.

Finally, what of that open secret, the seven-fifty parallel three?

Just a little more patience while the remaining teething troubles are eliminated—and we'll find it one of the silkiest and most awe-inspiring performers ever.

Why three cylinders? Simply because a high-performance seven-fifty parallel twin is not exactly at the top of the desirability stakes.