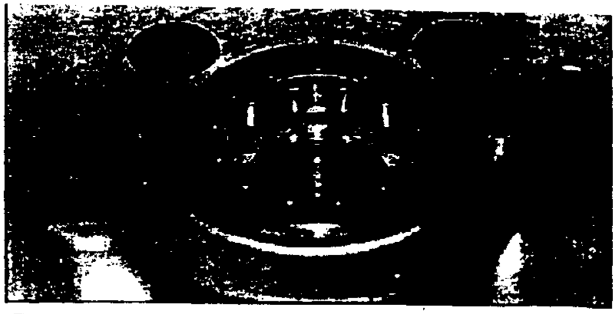
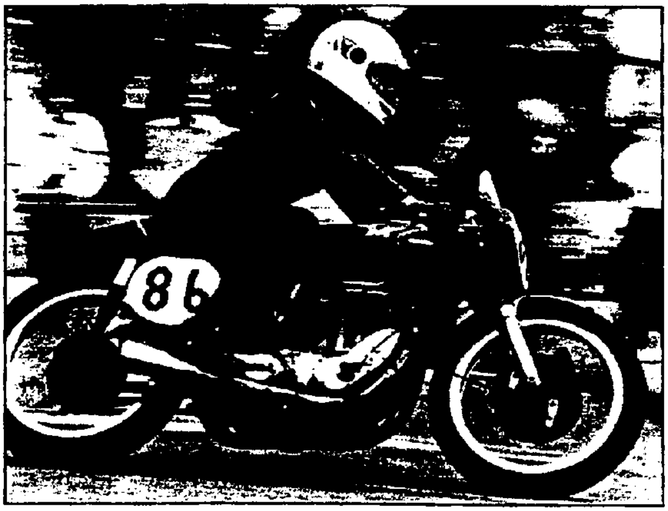
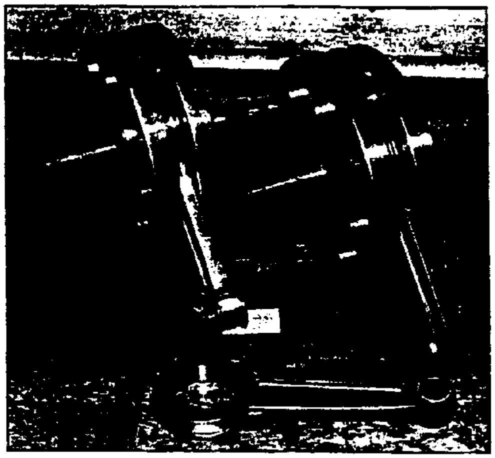


The timing side main bearing set-up. These roller bearings are now hard to find.



ABOVE: Ken de Groome riding his G80CS in the Isle of Man.
RIGHT: The standard G80CS rod with both an AMC and a Carillo G50 rod; both rods are fitted into CS flywheels.



MATCHLESS

Pushrod Power

BY KEN DE GROOME

Making a pushrod single as fast and reliable as a purpose-designed racing overhead camshaft single sounds impossible, but Ken de Groome has found a way to do just that with AMC's short-stroke G80CS. Here he explains how.

WHEN ENGINES ARE USED FOR TASKS for which they were not designed, certain weaknesses can sometimes become apparent. The Achilles heel on the Matchless G80CS engine which I adapted for roadracing, revealed itself in the form of recurring problems with the timing-side main bearings. The bronze bush would wear rapidly, and the roller bearing come loose in the crankcase (see picture 1). The cause, I found, was that even with a good-fitting axle in the flywheel, the axle would, under heavy stress, describe a path more normally associated with an egg whisk, instead of just spinning nicely within the bearings. The cure was drastic but totally effective and consisted of fitting newly-made flywheels machined from billets of EN24T. In spite of what it says in a number of books on AMC singles, it is worth noting that the original flywheels were made of nothing more than ordinary mild steel.

The new flywheels — several sets, in fact — were made to the original factory drawings, which is where I discovered the material specification. The only variation from standard short-stroke is that I use a balance factor of 70% to suit the Featherbed chassis of my machine; the standard G80CS factor is, incidentally, 66.3%, short-stroke only.

For use in my number one engine, I fitted a Carrillo G50 conrod into the flywheels; the number two motor, on the other hand, has a standard G50 component. Being ½in shorter than the standard item, both of these rods (picture 2) have a number of advantages over the standard item.

1) As I retained the standard stroke of 85.5mm, piston acceleration became higher around the all-important inlet valve-opening period. This has the effect of increasing gas speed at lower rpm and thereby improving cylinder filling, a relatively simple way of spreading the power band whilst using fairly drastic cam timings;

2) The shorter rod is lighter — always an advantage, provided that strength is not sacrificed;

3) You can buy a new Carrillo rod off-the-shelf: the standard G80CS conrod is not so easy to come by;

4) The whole engine has to be reduced in height by ½in (picture 3) which means that both the head/barrel assembly and the pushrods lose a little weight and gain a fair degree of rigidity.

Of course, you rarely get anything for nothing, and the drawback with the short rod is that at peak rpm, piston accelerations are starting to reach into unknown territory!

Onto the rod I fitted a 12 to 1 compression piston, modified in such a way that the actual ratio was brought down to 10.2 to 1 — a good deal more sensible considering the scarcity of parts for these engines. Surprisingly enough, it is now easier to buy new spares for the G50 and 7R models than it is for the G80CS, but this is something I hope to rectify shortly. When altering the shape of the piston crown (picture 4), I retained as much of the original squish band up the side of the crown as I could; I feel this is very important with ratios above about 9 to 1.

As you can see in the photograph, the piston is also reduced in length by ½in at the bottom of the skirt, which makes it a bit lighter and also stops it from colliding with the flywheels at bottom dead centre! I used to machine the flywheels down, partly to assist acceleration, but also to solve this problem of the relationship between the piston and flywheel. This had the desired effect, but made the bike just a touch too exciting in the wet: heavy flywheels are much nicer when riding the TT circuit, anyhow.

Although the piston is shorter than standard, it is still longer than either a G50 or Gold Star piston, and causes no problems whatsoever. Also helping to reduce the compression ratio are the deeper and more rounded-off valve pockets: both pockets are in fact ¹⁄₁₆in deeper than standard, whilst the inlet is to a larger diameter as well.

The squish area on the pistons should be set up to clear the head by .025in to .030in. This is best achieved by over-shortening the cylinder barrel, when removing the ½in, and then adjusting with an appropriate thickness of packer between the barrel and crankcase. The reason for doing it in this apparently obtuse way is that the pistons are not always as identical to one another as they should be.

While I'm on the subject, I may as well mention the fact that, as the barrel was shortened from the top, both of the O-ring grooves disappeared, along with the top fin (picture 5). I did at one time consider machining a new pair of grooves but found that, providing the head and barrel are lapped together and a *thin* smear of *Hylomar* applied, there is no problem of leakage. It does, however, help if the holes for the pushrods (in the top of the barrel) are made a little larger than the corresponding holes in the head, so that no ledge is apparent when the assembly is viewed from above.

Note the difference in overall height between these two motors; on the right is a standard CS lump.

The standard piston, 12 to 1, compared with the shorter, modified component.

The short barrel on the left has no O-ring grooves and is minus one fin.

Persuading the pushrod motor to perform in a manner similar to a G50 meant that I had to spend quite a bit of time burning the midnight oil, mainly in trying to get the valve gear to behave as I wanted. The three basic requirements were to obtain a decent valve-opening sequence without the cam followers self-destructing; to prevent excessive flexure of the pushrods; and to keep the valve train as light as possible without the first two problems rearing their ugly little heads.

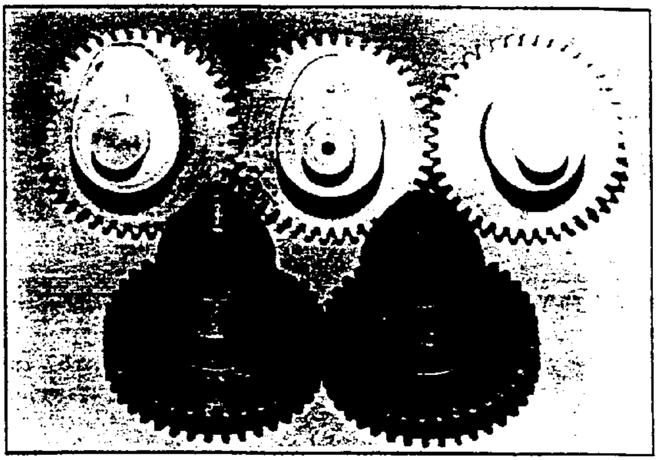
Once I decided not to use any of the cam profiles designed by AMC, the above three problems were quite easy to resolve. What I did was to use cams ground to a Gold Star profile. This latter has a base circle diameter of .955in, compared with the SH profile which has a diameter of 1.055in (picture 6). My biggest problem was that the SH profile was about the wildest cam — of the AMC profiles — which could be used without the follower foot digging into the cam flank. Reducing the base circle diameter allows a much higher lift to be used without this problem occurring.

Although AMC were aware of this drawback, they failed to deal with it properly. Their solution was to thicken-up the foot of the follower so that it stood less chance of breaking and, at the same time, reduce its length to save weight (picture 7). This did nothing to help the poor old cam and necessitated the use of longer pushrods which flexed even more than the originals. When, eventually, the bottom end was modified by AMC to accept a Norton type oil pump, larger diameter feet were used on the followers and, although these did cure the digging in problem, they weighed almost as much as the earlier ones — and were *still* too short!

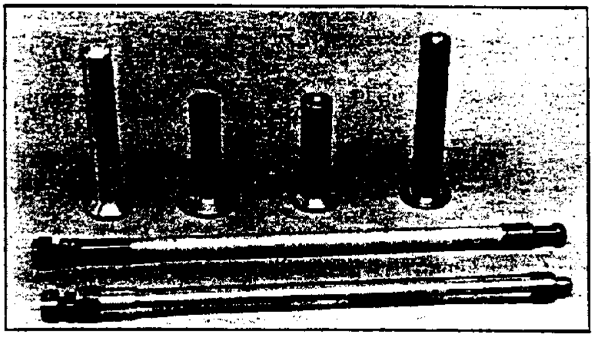
Using small base circle cams has enabled me to use cam followers made from light alloy, something which is just about feasible with SH cams as well. These alloy followers were made to the same general dimensions as the earlier long ones but were thickened up a little, as a precaution, around the foot. The long followers, along with the ½in reduction in barrel length, mean that the pushrods can be fairly short — short by AMC standards at any rate.

The pushrods are made from a larger diameter alloy tube than the originals — 7/16in as opposed to 3/8in — which increases their stiffness, or column strength, quite considerably. A steel endpiece is fitted at the bottom of each pushrod to provide a bearing surface compatible with the alloy followers — it is not a good idea to run light alloy against light alloy as the two surfaces may weld together. The top fitting is, however, made from alloy to accept a lightened version of the standard adjuster (picture 7).

For the sake of lightness (and also because it makes them look nice!) the rockers came in for a fair bit of lightening and polishing (picture 8). Gold Star type valve springs were fitted, in conjunction with very light steel collars. I did try alloy top collars, but just one failure was enough for me (picture 9). The result of all this fiddling with the valve gear is that I now have a pushrod 500 single which can, in the heat of the moment, be run up to 8,000 rpm, and probably



From bottom right, clockwise: standard pre-1954, standard post-1954, G80R exhaust, SH inlet and the Gold Star profile now used by Ken de Groome.

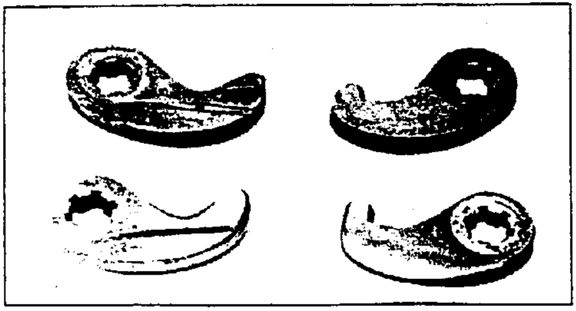


Cam followers, from right to left: standard, G80CS (both pre-1964), standard post-1964 and the alloy type favoured by Ken. In the foreground, his special pushrod and, behind, a standard item.

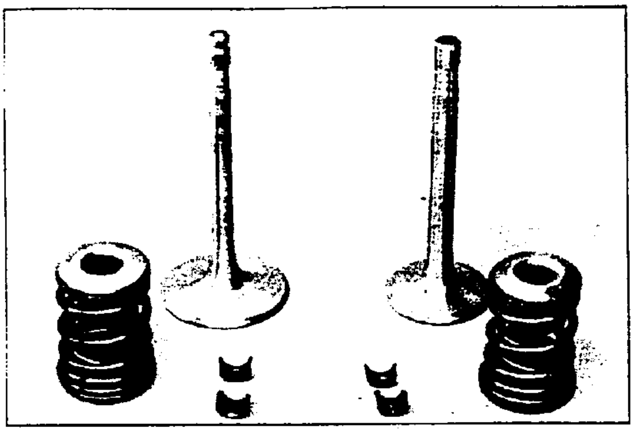
beyond, although I do not wish to risk finding out. My normal self-imposed limit is around 7,200 rpm.

The exhaust valve is a standard G80CS component which has had the sharp edges removed and been given a quick polish around the head area. The inlet, however, is another Gold Star item, from a DBD 34, given the same treatment as the exhaust valve and an additional collet groove to simplify fitting it into the CS head. The valves are fitted into bronze guides, which I make up to suit each individual head. I do not provide them with an oil-hole, which was normal practice on AMC engines, as quite enough oil finds its way around the valve gear area anyway. It should be noted that the modern trend is to fit seals over guides, and not to douse them in oil. The guides were also chamfered off at the top to further prevent the ingress of oil (picture 10).

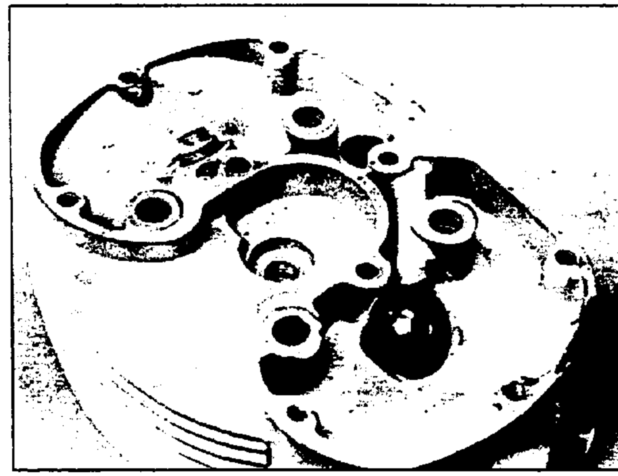
The head itself came in for a fair bit of alteration, the easiest part to deal with being the exhaust port which was just smoothed off as its shape was pretty good to start with. On the inlet side, the valve throat was opened up to accept the larger valve and generally reworked to improve the gas flow (picture 11).



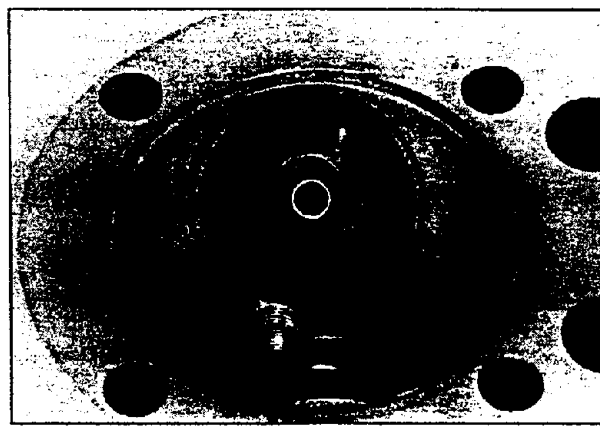
Modified rockers contrasted with the heavier standard components.



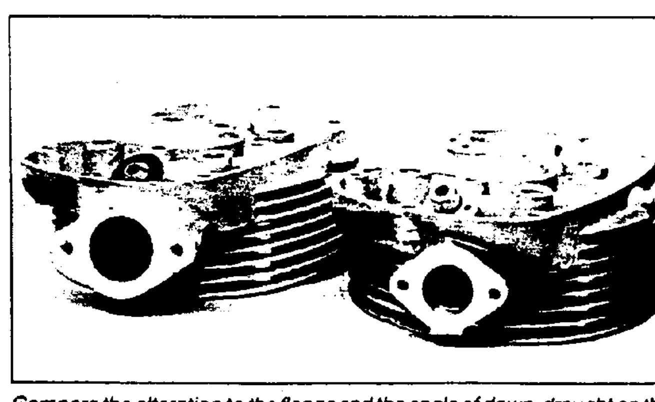
The valve cum valve spring set-up used in place of the standard hairpin arrangement.



Note how the valve guide tops are finished and the recess for the sparking plug.



The gas-flowed and widened inlet tract; the plug thread is now flush with the surface of the combustion chamber.



Compare the alteration to the flange and the angle of down-draught on the modified head, on the left, with the standard CS head on the right.

At the carburettor end of the inlet tract, a larger than standard flange was welded on to accept the 1³⁄₁₆in GP2 instrument I use; I have tried one with a bore of 1½in, but found no worthwhile gain in performance. When the flange was welded on, I took the opportunity to re-angle the inlet tract a little (picture 12). This served two purposes: it improved the port shape a little, and saved me having to cut a lump out of the genuine Manx oil tank to miss the carburettor. I'll let you deduce for yourself which was foremost in my mind!

On a standard G80CS, the sparking-plug has to fire the mixture through a small hole (or slot, on earlier motors) in the combustion chamber, which can make starting a shade difficult at times. I machined the cylinder head in such a way that the plug came through flush on the inside (picture 11) and then removed a little metal on one side of the hole so that no spare thread was exposed. The central plug in these motors is, in reality, slightly offset so to get the plug down into the chamber I found it necessary to counterbore the plug seating area from the top (picture 10).

A standard G80CS rockerbox is fitted, although a road-going component can be used if machined away to clear the two cylinder head sleeve nuts furthest from the pushrods. The only alterations that I made to the rocker-box were to blank off the valve lifter hole and delete the felts from the rocker spindles which do not seem to do much apart from make it awkward to get the spindles in.

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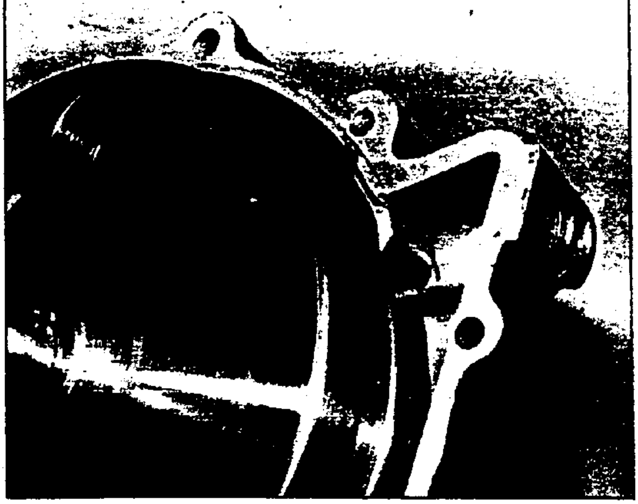
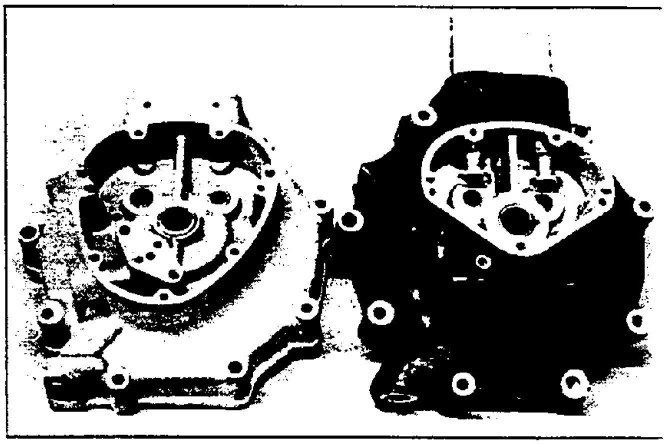
The slimmer bolt arrangement allows the motor to fit nicely in the frame.



One of the oil scrapers, each of which is retained by two countersunk screws.



The pre-1964 CS case on the right has far more metal supporting the two timing-side bearings. Note the grub screw locking the bush in situ.

Going back to the bottom end, in order that the engine could be fitted as low as possible without altering the frame, I found it necessary to reduce the width of the crankcase at the very point where the lower front stud passed through. This was done by counterboring in the area normally occupied by the nuts and washers of the stud concerned (picture 13). The hole on one side then had a threaded insert fitted and a thin headed bolt was passed through from the other side. I had to machine a little of the metal in the timing chest away to enable the cam follower to follow the base circle of the cam without fouling the cam bush housing. These cams, by the way, are *not* DBD34 specification; they would produce too high a valve-lift in a Matchless motor as the rocker ratios are different in BSA and AMC engines. The timing they give, however, is 60° - 90° inlet, and 86° - 64° exhaust, with .446in lift at the valve (checking clearance is .018in).

After a number of fruitless experiments,the crankcase breather was eventually left as standard; it seems to work quite well, providing no open breathers are fitted anywhere to upset the vacuum. Standard on 7R and G50 models, the one thing which especially helps, both with the breathing and oil scavenging, is the fitting of oil scrapers which "wipe" the flywheels clean as they pass (picture 14). This reduces the amount of oil being churned around and stops a lot of it going out through the breather. Before the timing side problems were resolved, the timing side roller main bearing became rather slack in its housing. This I tackled in the standard fashion by boring out the case and fitting a thin sleeve which, along with the new flywheels, cured the problem permanently.

I am often asked why I do not use the later Norton oil pump crankcases. The answer is that the later cases are not as strong as they at first appear. Compare the two types in picture 15 and it is plain which has the most meat around the main bearing. Another asset with the old plunger pump cases is that quite a number of long-stroke G80 bits will, or can be made to, fit them while spares for the later cases are getting very scarce indeed.

Should my modified version of the G80CS need further endorsement (and here I touch the biggest bit of wood I can find), I can assure you that over the past eight years it has been in almost constant use in short circuit racing and, with only a little help from the spare motor (barrel and piston), it has completed over 640 miles of the Isle of Man TT circuit under both racing and practice conditions. Yes, I know it conked out last year at Windy Corner — I forgot to say hello to the Manx fairies!

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