Words and photography by Keith Calver

Tech

1275 engines are in increasingly short supply, so here's how to get the best out of your Mini's 988 lump.

Last month we looked at how well a small-valved, large-bore (1275) head flowed when messed with to fit a 998 block. The result was pretty astonishing — a seriously cheap way of getting a decently flowing head on to a 998 engine. The ultimate goal, though, was to achieve this and still be able to fit a performance cam without everything colliding and causing disintegration in the engine department. So we needed to fit this head to a suitably built engine and see what it would give, while trying to keep costs down.

There is no substitute for cubic inches where increased performance is concerned, but there's an impending problem — a shortage of 1275 power units. 998s are also becoming rarer since most got scrapped when the large-bore alternative was inserted in its place, so we need to start making the most of what we have. To this end Mini Spares (www.minispares.com, 01707 607700) has recently invested in producing a range of pistons to extend the life of what A-Series engines are left, starting with plus-0.08 inch over-size for the 998 engine. Since an engine rebuild usually require a re-bore, I decided to use a worn out plus-0.06 inch 998 block, originally destined for the scrap yard, as the basis for this project.

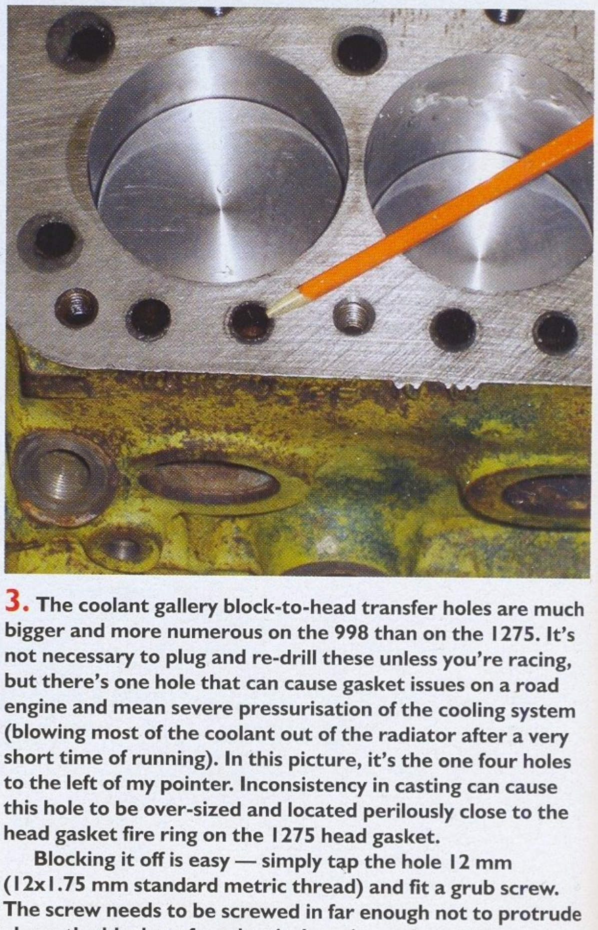
The standard A-Series camshafts aren't exactly scintillating in the performance department so a cam change always improves things, but we need to limit the amount of lift used because of the exhaust valve over-hanging the block — 0.29 inch at the cam with standard rockers is the limit. I decided to fit one of my Australian mate's RE13 spec cams, which I've recently had some terrific results with in large-bore engines. It costs no more than your archetypal re-profiled cam. The specification was suggesting some quite serious performance so I decided to fit a 1.75 inch HIF SU since a 1.5 inch SU gets a bit restrictive around 75 bhp.

After installation, initial running and setting up I took it, and my friend Nicola's Stage 1-kitted A-plus 998cc, to Pete at Alwyn Kershaw just outside York (01759 373399). Pete said a good standard 998 would show 60 bhp on these rollers and Nicola's engine gave a solid 77 bhp, even with a fuel pump delivering insufficient fuel, well above the usual 20 per cent increase seen with a Stage 1 kit. The project motor gave a blistering 91 bhp at 6500 rpm and was strong from 5500 rpm to just over 7000 rpm, pulling a sturdy 63 lbf.ft from 2500 rpm in a fairly flat line-up to a peak of 79.5 lbf.ft at 5750 rpm. Absolutely astonishing. There was an issue with the dizzy: the advance curve needs changing quite dramatically from what was expected, so idle and low speed running are not perfect yet. But once you hit 2500 rpm it goes like a scalded cat!

"It's not perfect yet, but once you hit 2500 rpm it goes like a scaled cat!"

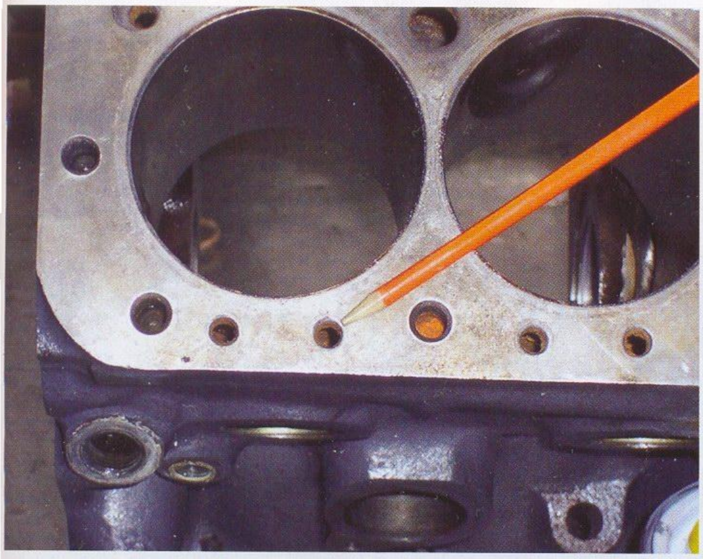
1. Pistons that can save those worn out 998 blocks already at maximum bore will be available very soon from Mini Spares. They're superbly manufactured in a very robust aluminium alloy, boast a far higher percentage of silicone than many other pistons, and are flat topped to give a more favourable compression ratio using purpose-made high-quality piston rings. Only three of the latter are used (two compression and one oil control) to keep drag to a minimum, commensurate with optimum ring to bore sealing.

2. Note the elongation of the main bearing oil feed. As standard this hole is usually at least half covered by the crankshaft bearing, drastically reducing oil flow to the main and big end bearings. The elongation dramatically improves that flow/feed and is easily done by inserting a main bearing and scribing into the block using the bearing oil hole as a guide. Then either file out or use a die-grinder/Dremel type tool to elongate the hole to match the scribed line.

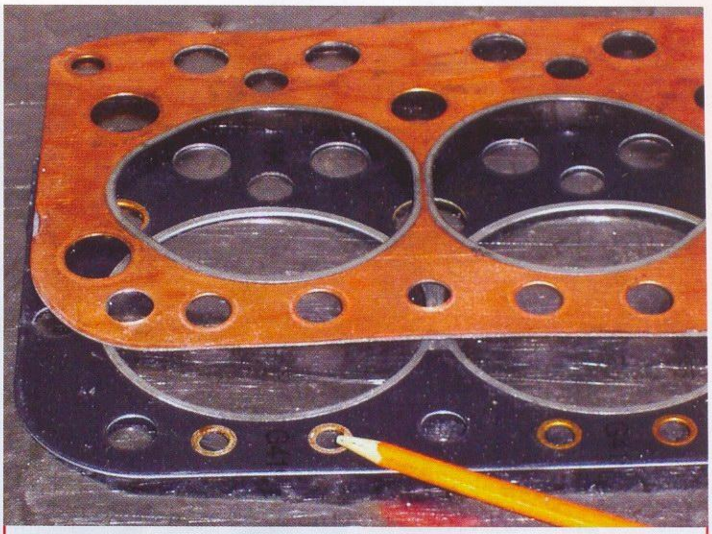


3. The coolant gallery block-to-head transfer holes are much bigger and more numerous on the 998 than on the 1275. It's not necessary to plug and re-drill these unless you're racing, but there's one hole that can cause gasket issues on a road engine and mean severe pressurisation of the cooling system (blowing most of the coolant out of the radiator after a very short time of running). In this picture, it's the one four holes to the left of my pointer. Inconsistency in casting can cause this hole to be over-sized and located perilously close to the head gasket fire ring on the 1275 head gasket.

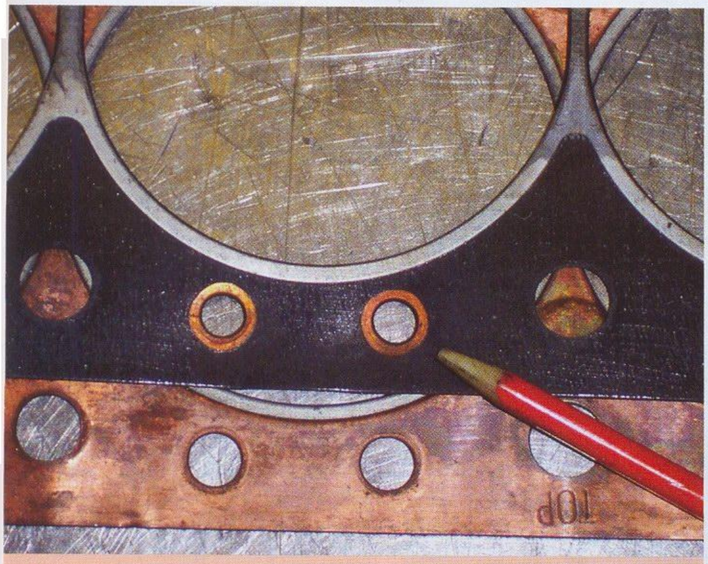
Blocking it off is easy — simply tap the hole 12 mm (12x1.75 mm standard metric thread) and fit a grub screw. The screw needs to be screwed in far enough not to protrude above the block surface, but it doesn't need re-drilling to allow water through since the corresponding hole in the 1275/12G940 head is blocked off by a brass plug.



4. Here are the corresponding holes in a large-bore block. Much smaller.



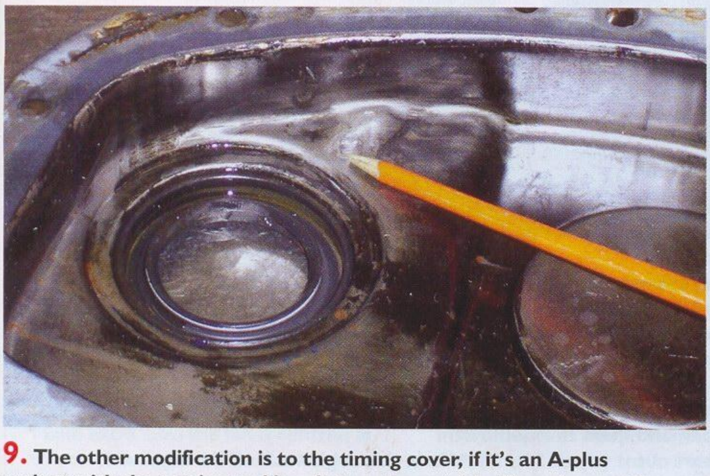
5. This is the reason for blocking the holes in the 998 and re-drilling them — the small-bore copper-composite head gasket shown above the latest spec black Felpro-type large-bore head gasket clearly shows the difference in size. The compression rings around the coolant transfer holes in the large-bore head gasket do not properly fit around the corresponding holes in the small-bore block and are also slightly off-centre. If you are doing a full engine rebuild (including having the block deck re-faced) then block the holes off in the small-bore block and re-drill them slightly smaller using the large-bore gasket as a template.



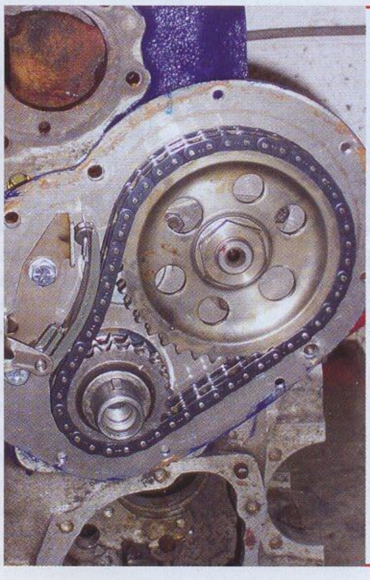
6. I would highly recommend using the AF460 copper-composite type large-bore head gasket when fitting the 1275/12G940 head to a 998 block where the coolant transfer ports are not being re-aligned. The coolant transfer port holes in this gasket are a little larger than the black Felpro-type gaskets, the sealing rings are less rigid and on the whole they tend to seal better.

7. When changing to a duplex (twin row chain) cam drive set-up — advisable where performance cams and stronger valve springs are used — it's necessary to alter a couple of things. First is the front plate to main cap retaining bolts. As standard where simplex (single row chain) cam drives are fitted, these are standard-type bolts.

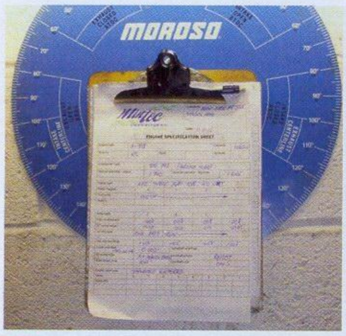
8. They need replacing with counter-sunk type screws/bolts. Ideally use either a proper countersink bit with a 45-degree taper to countersink the area around the retaining bolt holes so that the countersunk-type screws/bolts fit flush with the front plate.



9. The other modification is to the timing cover, if it's an A-plus variant with the service tool bracket on the outside. There's a small protuberance inside the cover caused by the pressing in this area, and if not dealt with it rubs on the wider duplex chain. Simply tap it out with a ball pein hammer or with a drift.

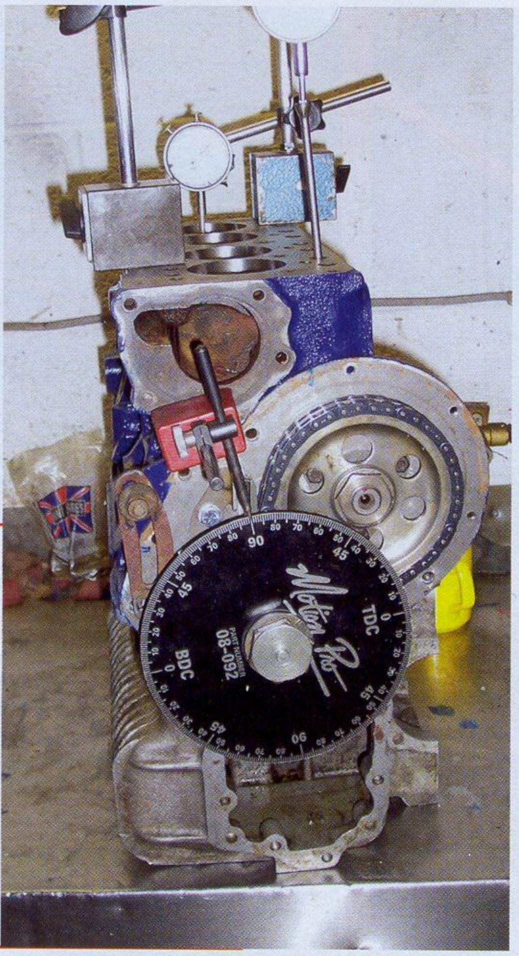


10. Here's the duplex kit fitted along with the existing A-plus simplex chain tensioner. Despite it not running quite centralised on the duplex set-up I highly recommend running one — it keeps cam timing (and therefore ignition timing) scatter down to a minimum as the chain stretches in use. It also eliminates the audible rattle of a stretched cam chain further down the line.

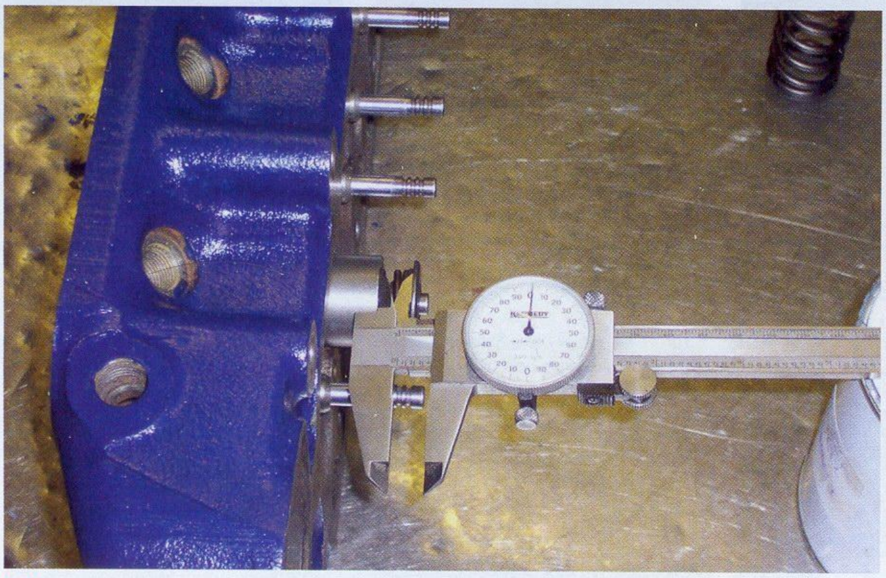


11. Essential to all engine builds — taking notes. Recording the parts used, clearances/tolerances set, cam timing, valve lift and compression ratio details saves head scratching in the future.

12. Timing the cam in is essential to get good performance, as cam grind differences of a mere half-a-degree can dramatically change a cam's performance. Getting the cam timing out by more than a degree can further affect how it works and the performance it gives. If you have the right equipment, timing takes minutes to do. There are alternative ways of doing the cam timing without this kit though (covered in *Minimag* back in 1997, or see my website www.calverst.com).



13. With cam timing set, check all the carefully planned modifications and calculations have worked. To do this, I set pistons one and four at top dead centre, fitted the exhaust valves to the head using weak springs (those used for spacing the rockers apart are ideal) then fitted the head to the block using several head studs for reference alignment. Using a zeroed DTI sited on the valve spring cap I carefully pushed the valve open with my finger until it hit the block. Perfect — 0.35 inch without a head gasket fitted. The cam lift is 0.29 inch, with a rocker ratio of 1.22 that gives 0.354 inch valve lift less the valve clearance setting of 0.016 inch, giving an optimal valve lift of 0.338 inch. So there's a 0.012 inch clearance between the exhaust valve and the block — not much, but add in the 0.03 inch thickness of the head gasket and we have a prospective 0.042 inch clearance.



14. To finish off the head build after fitting new guides and recessing the valve seats you need to correct the valve spring fitted heights. Failure to do means a serious shortage of spring pressure, leading to power sapping and valve seat-damaging valve float. Lack of spring pressure also means the valve train does not follow the cam profile accurately, causing a loss in performance and premature damage to the cam lobes.

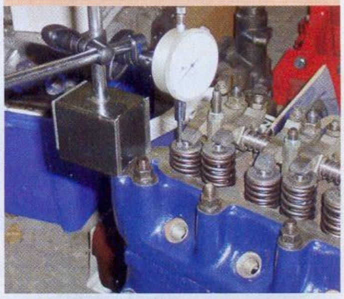
The reduction in spring pressure is caused by sinking the valve further into its seats, therefore effectively lengthening the valve stem sticking out the top. This means the spring is not as squashed as it should be to give the right pressure. I measure the fitted spring height (from where the valve spring sits against the head and the underside of the top cap) using a special spacer that is exactly 1 inch tall. It allows fitment of an inner spring (of dual springs) along with the top cap and retaining collets, as shown here. The extra gap from my spacer to the underside of the top cap is measured with a vernier calliper, and then with this measurement I can sort out suitable thickness spring shims to make the fitted height right. They will be different inlet to exhaust as we have sunk the exhaust valves in further than the inlets.

15. After a thorough wash-off the head was assembled. I use these Teflon-lined valve stem seals — they're far better than the standard rubber jobs and last a lot longer with going hard or brittle.

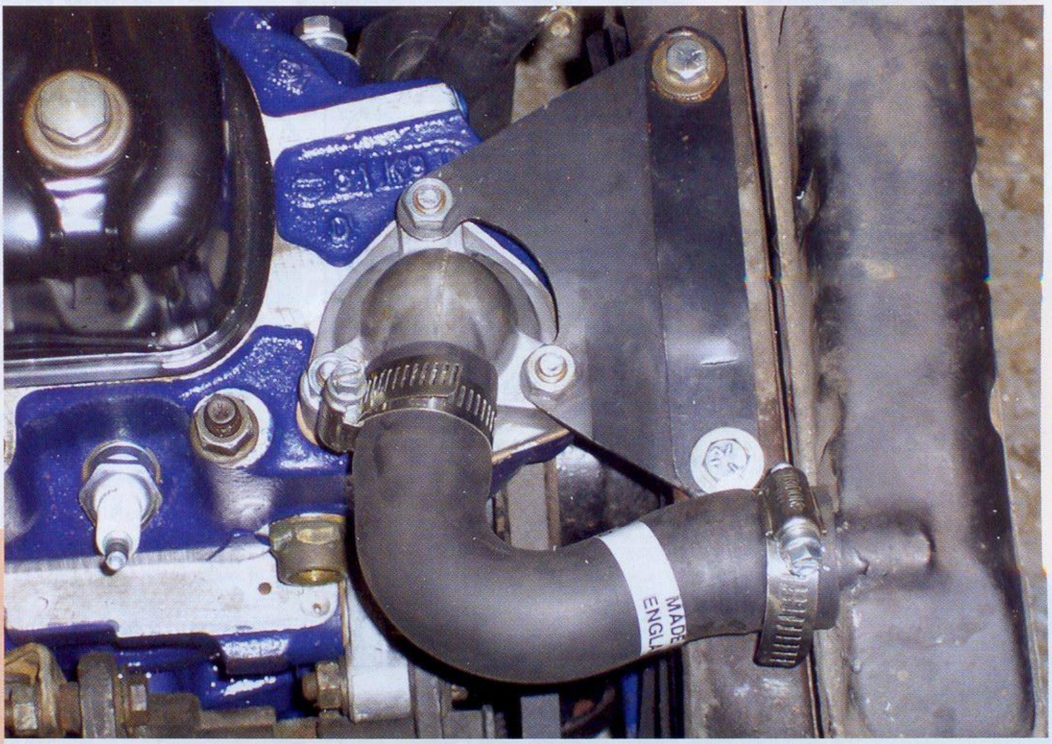
16. The complete assembled head!

17. Double check the chamber capacity and calculate the compression ratio with a piece of plate glass and a burette. The capacity will be more than the 21.4cc (approx) of the standard 12G940 head because of the work on the valves and seats to get the necessary running clearances. This measured up at 24cc, so with the larger bore diameter giving a new engine capacity of 1062cc and allowing 4cc for the large-bore head gasket (pistons are flush with the block deck) that gives a static compression ratio of 10.48 to 1. Perfect for a high performance street 998 with a serious cam like this RE13 spec one.

18. With the head, rocker gear and valve train components fully assembled, double check the working actual clearance. With the head torqued down and valve clearances set at 0.016 inch, the valves recorded lifts between 0.0327 inch And 0.33 inch. Considering no attempt was made to redress rocker attitude/geometry, that's pretty impressive. The calculated lift is 0.338 inch, giving us an extra prospective 0.008 inch clearance. A quick check of what the valve hits the block at gives 0.38 inch, meaning 0.05 inch running clearance. Excellent.



19. The finished assembled engine ready for installation. Note the flow-efficient block to filter head transfer pipe. I really don't like the standard set-up — it's very restrictive.



20. The thermostat housing on the large-bore head points straight forward, as opposed to the slightly sideways small-bore one. A different top hose and top radiator bracket are needed, and luckily the Cooper S had them fitted as standard and readily available. The bracket to cowl fixings are different but this is easily sorted by cutting off a couple of short lengths of fuel hose and inserting them into the S-style grommets, then using large flat washers and 0.75-UNF short bolts to secure the bracket to the cowl. Make extra sure the fan is centred in the cowl though — if the fan blade hits the cowling there'll be fan blades shrieking in all directions, with possible radiator damage too!

21. To find out what the motor was producing I used a rolling road, but I needed something to gauge it by. My friend Nicola let me use his freshly Stage 1-kitted Mini — here it is being hooked up to the test instruments at Alwyn Kershaw: a Sun Ram12 run by the immensely experienced Pete. Nicola was chuffed with the performance of his 998, and I highly recommend the facilities at Alwyn Kershaw.