Words by Keith Calver

Tech

This month, Keith tackles the age-old problem of fitting a 1275 head on to a 998 block.

Before getting into the full engine build on the 998 project, I decided to take a good look at something that has been argued about since the inception of the 12G940 heads — what is needed to fit a 12G940 1275cc large-bore engine head on to a small-bore block. That's anything sub-1275, so encompasses 850s, 998s (1000s) and 1098s (1100s).

Purchasing a modified small-bore cylinder head that provides anything like the airflow capability of a 12G295 is costly, which isn't surprising given the amount of time and effort that goes in to the process. I know — I've done plenty! Even the very good 12G202 heads used on the 1098 motors are a serious rarity these days.

The valves in the 1275 head are further apart than the small-bore variants, causing the exhaust valve to over-hang the block by quite a margin, especially with a larger diameter valve (1.15 inch as opposed to 1 inch). You can only go to a 1.04 inch diameter exhaust valve in the small-bore heads before a collision, unless the block is bored out to at least 0.06 inch. The shallower chamber design in the 1275 head means the valve head can be perilously close to hitting the block before full valve lift is reached.

When using a standard camshaft and standard ratio rockers you can get away with it, but since the cam is a serious limiting factor in the performance stakes of an A-Series engine you really want a decent cam profile. That invariably means more valve lift and exhaust valve head/block interface unless steps are taken. Incidentally, combustion chamber size is not a problem — the small-bore motors generally have around 24.5cc capacity while the 1 275 heads typically have 21.4cc, meaning an automatic, decent and useful compression ratio hike.

The valve pockets need machining into the block if serious valve lift is used (eg in race engines), but small-bore motors do not particularly like big valve lift — sticking on 1.5 to 1 ratio rockers sacrifices mid-range performance for a very meagre gain at peak power. So how far can the valve lift thing be pushed before pocketing the block is necessary? There are good profiles about that have cam lifts of up to 0.29 inch. Used with a standard ratio rocker that typically gives 1.22 to 1 at the valve and, allowing for valve clearance of 0.015 inch, total lift at the valve of 0.339 inch.

Most standard 1275 heads have an exhaust-valve-face to head-face depth of 0.29 inch. So we need to find at least 0.05 inch extra depth between the head face and the exhaust valve face. Some would include the 0.03 inch head gasket thickness, but I prefer to use that as a safety margin.

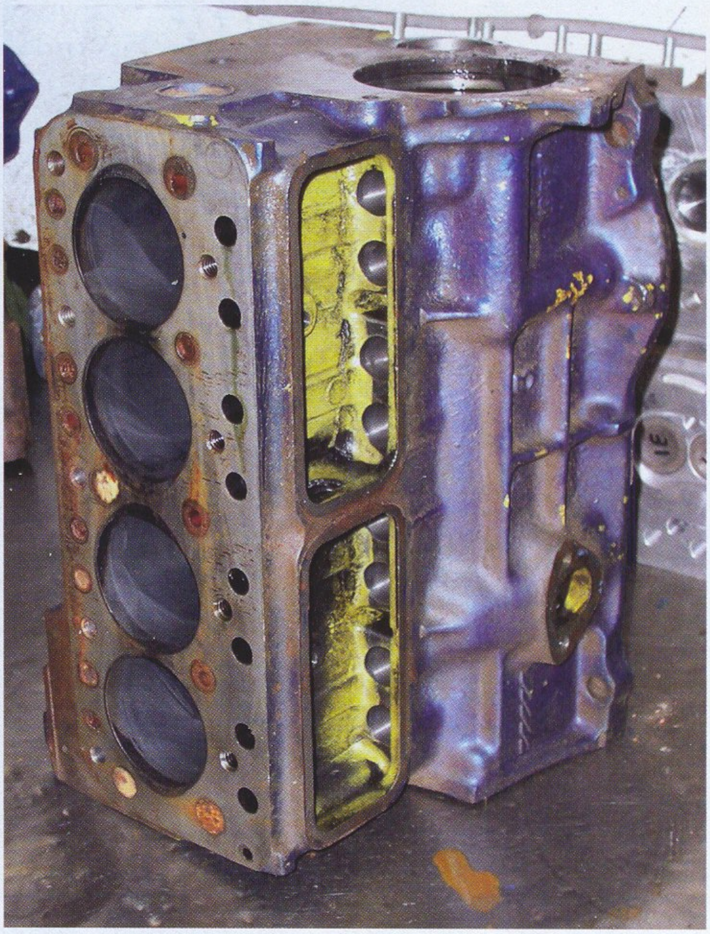
There are various ways to increase that all-important distance. You can grind the face of the exhaust valve off quite a bit, but this is expensive and time-consuming. It also leaves nearly no margin from the seat edge to valve face, meaning a sharp edge and a flow-restricting heat rise in the head. You can recess the valve seats into the head to give clearance, but wouldn't that adversely affect airflow? And what about the mismatch between inlet and exhaust valve stem heights?

It's necessary to pinch a bit here and there. If the valves are clapped out and need replacing then so will the guides. Go for race-quality valves as these have a smaller margin by design (0.05 inch instead of the standard 0.06 or 0.08). Re-facing the seats on the valves is almost always necessary. On the exhausts you do it quite a bit to get the margin to 0.05 inch, then back-cut the valve with a 30-degree angle to reduce the seat widths to 0.04 or 0.05 inch. The rest can be made up by recessing the valve seats in the head. Many believe that this massively reduces effective airflow, but having checked it out I disagree (see the relevant table of flow test results).

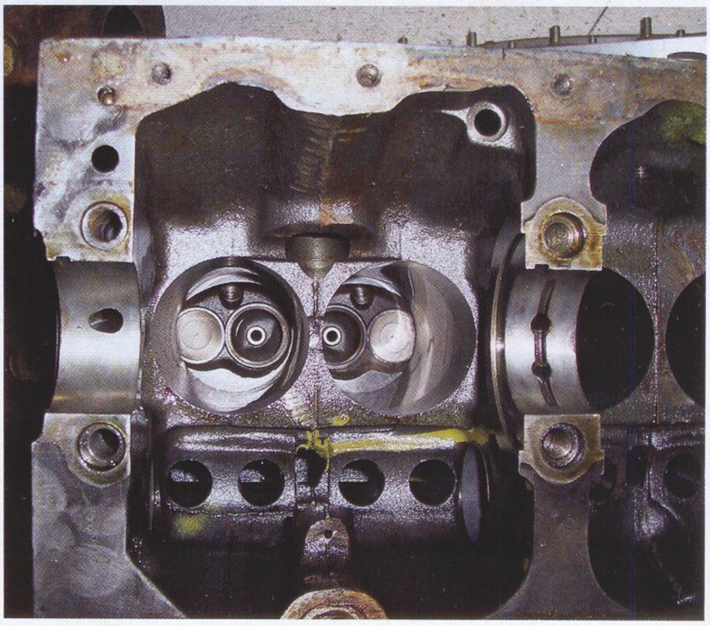
On these heads I have aimed for an exhaust-valve-face to head-face clearance of 0.36 inch to allow a minimum skim of the face, making sure the exhaust-valve to block clearance is OK. The extra 0.03 inch the gasket thickness affords is then a decent safety margin.

Discuss these mods with your chosen engineer and get a quote. If it's huge, go someplace else as the work only takes an hour or two at the very most. It makes for a cheap performance head for a mildly tuned small-bore motor, and make sure you use a large-bore head gasket!

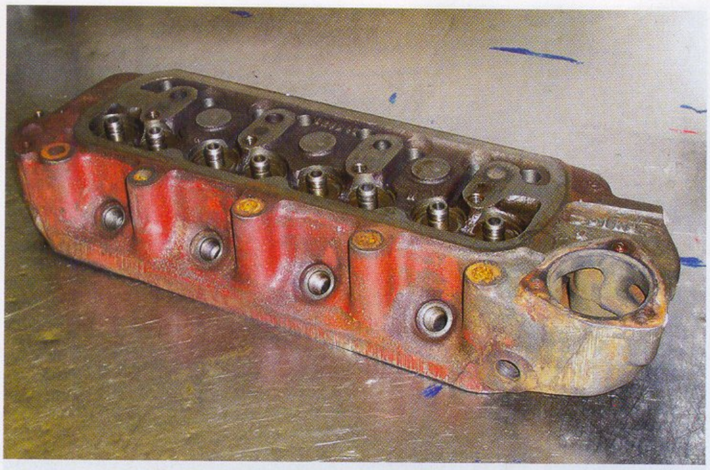
The conclusion is: the flow bench tells no lies. The standard 1275 head, with massively recessed valves to give the required valve-to-block clearance, supplies sufficient airflow capability for a decent fast-road small-bore engine. Next time round, we'll see what sort of performance it'll deliver once I've built the project engine and had it rolling roaded.



A. The trusty 998 block — the basis for the project engine. It spent several years being thrashed round a quarter-mile oval in a field in class one grass tracking. Bores worn beyond a next-size-up rebuild make it an ideal candidate!

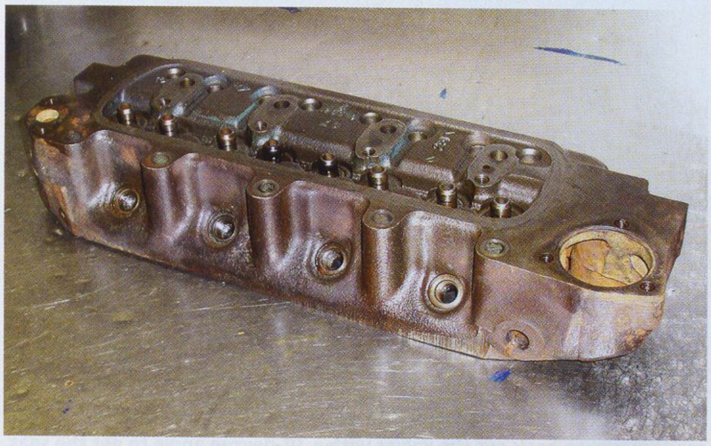


B. When fitting a 1275 head on a 998 block, the exhaust valves overhang the bore sides. Normal practice is to cut valve relief pockets in the top of the block, but this can be expensive.



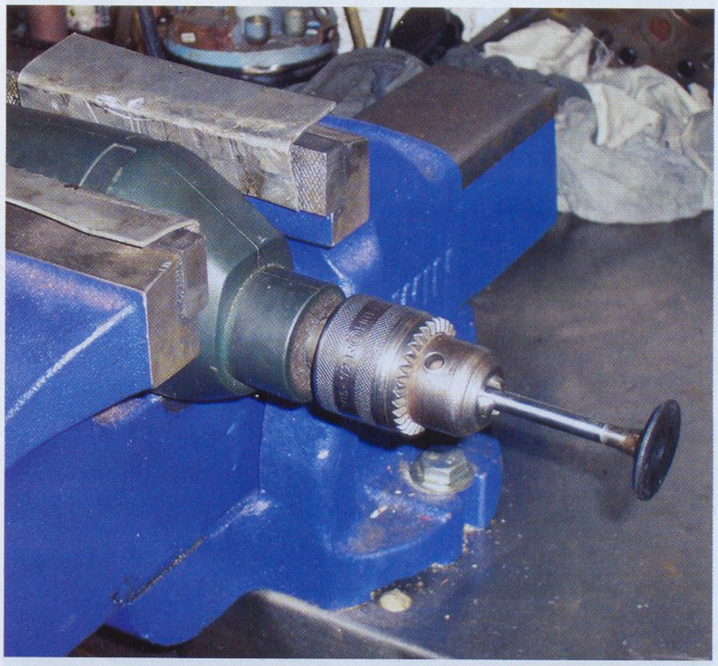
1. Test head number one: a standard A-plus 1275, easily identified as such by the sculptured upper surface around the thermostat and heater tap areas. This is a Metro head but is the same as just about all other A-plus castings — the only difference from the MG and Van Den Plas Metro heads is the larger size inlet valve (35.7 mm as opposed to 33.3 mm), which can only be identified by having the head off the block and measuring it. This particular head had exhaust seat inserts already fitted.

2. Test head number two: the latest multi-point injection head. The three tapped holes on the flat surface immediately in front of the thermostat housing area carry the alternator bracket. The casting was altered to allow for this inside the thermostat housing recess so some fettling is needed to get a thermostat in it. I included it in the test to see if any differences exist in flow performance against the other two. They're all inserted for unleaded fuel use.



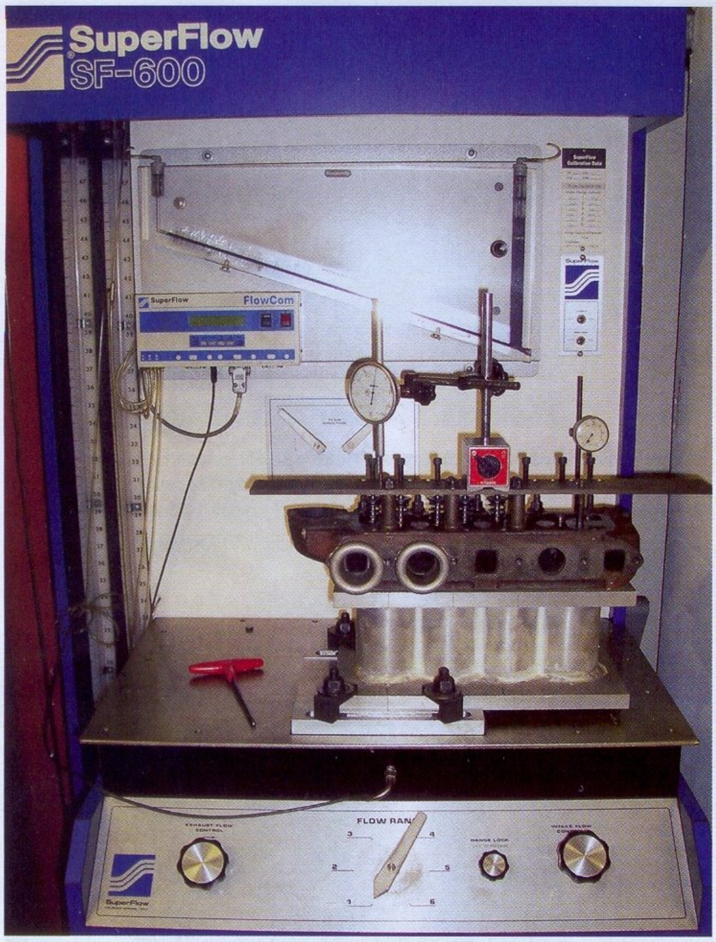
3. Test head number three: a pre-A-plus standard 1275 head casting, identified by the large flat upper surfaces around the thermostat and heater tap areas. Now somewhat rarer than the A-plus casting types.

4. Here are the old valves from test head one. They are in remarkably good condition so we'll re-use them. The light grey deposit on the exhaust valves is synonymous with unleaded fuel use.



5. To clean valves I mount an electric drill in a vice, fit the valve stem into the chuck, switch it on and use abrasive tape to clean the debris off. Something like 80 grit to get the worst off and then finish with 220 grit. Wet and dry won't cut it — it really needs to be cloth-backed, like Emery cloth for example.

6. The result of a few minutes' work with the drill and abrasive tape — nice shiny valves.



7. Time to flow test the three heads. This is a Superflow SF600E equipped with the Flowcom, a brilliant piece of kit. This particular bench is owned by Dave Powell at Performance Unlimited (01904 489332). I made a special jig for my SF600E bench that duplicates an A-Series block, making testing each chamber far easier and quicker. Modified Mini Spares centre SU ram stacks help make intake flow consistent round the port entry/exit. See the relevant table on page 116 for flow test results.

8. Having tested the three heads as standard with standard spec valves, it's time to make the mods required for a 1275 head to be fitted to a 998 block without having to machine valve relief pockets. First, assess the head for suitability. You need one that is around 0.35 inch or more from the head face to the chamber roof, measured at the valve pocket recess machined in at the factory around the valve seat. Record the readings for future reference. The weird measuring stick is a depth micrometer — I'm sure your local engineer will do this for you if you don't have your own (not many people do!).

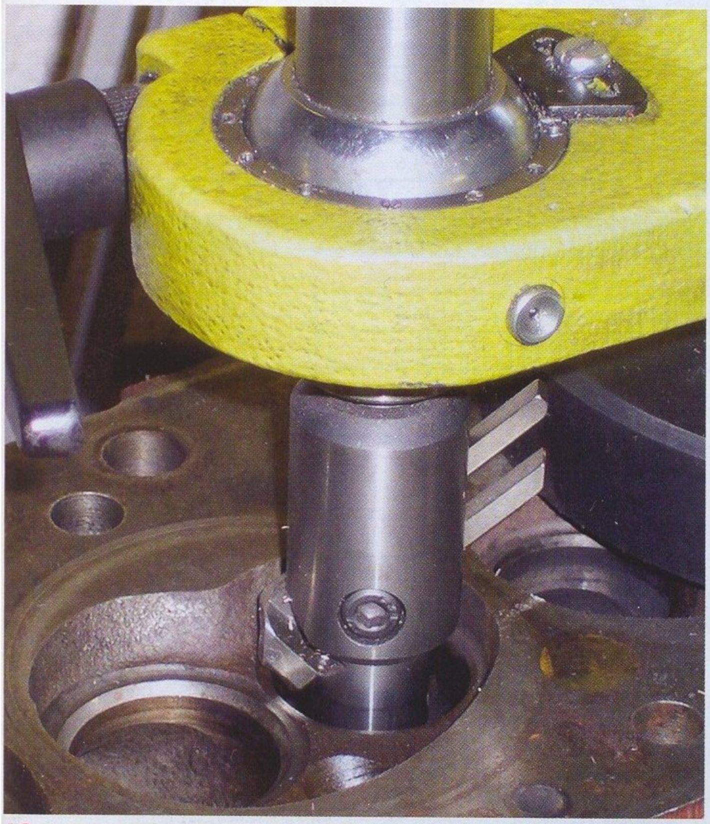
The two A-plus heads came out in the right vicinity; the pre-A-plus one was somewhat shallower at 0.325 inch. I decided to use this for one of the exercises that didn't require a deeper chamber.

9. Repeat the depth exercise to assess the head face to valve face depth. Here all three heads had the same depth, give or take the odd thousandth of an inch. On the pre-A-plus casting this was probably caused by valve seat recession — seat erosion during use. You need to know the depths so the valves can be made to miss the block.

10. The exhaust valves need modifying in a couple of operations. The valve on the left has had the valve seat re-faced and the seat is now a lot wider than standard. This reduces the margin between the outer edge of the seat and the face of the valve — essential for the clearance we want. Be careful, though: too thin a section will cause too much heat to be held in the valve head. Standard valves have between 0.06 and 0.08 inch as the margin thickness. You can get this down to 0.045 inch, but aim for 0.05.

After reducing the margin the seat is massively wide. This isn't a bad thing on the exhaust valve but I was testing the flow difference the head mods made, so back-cut the valves with a 30-degree angle to get the seat back to around 0.04 inch wide (as seen on the valve on the right).

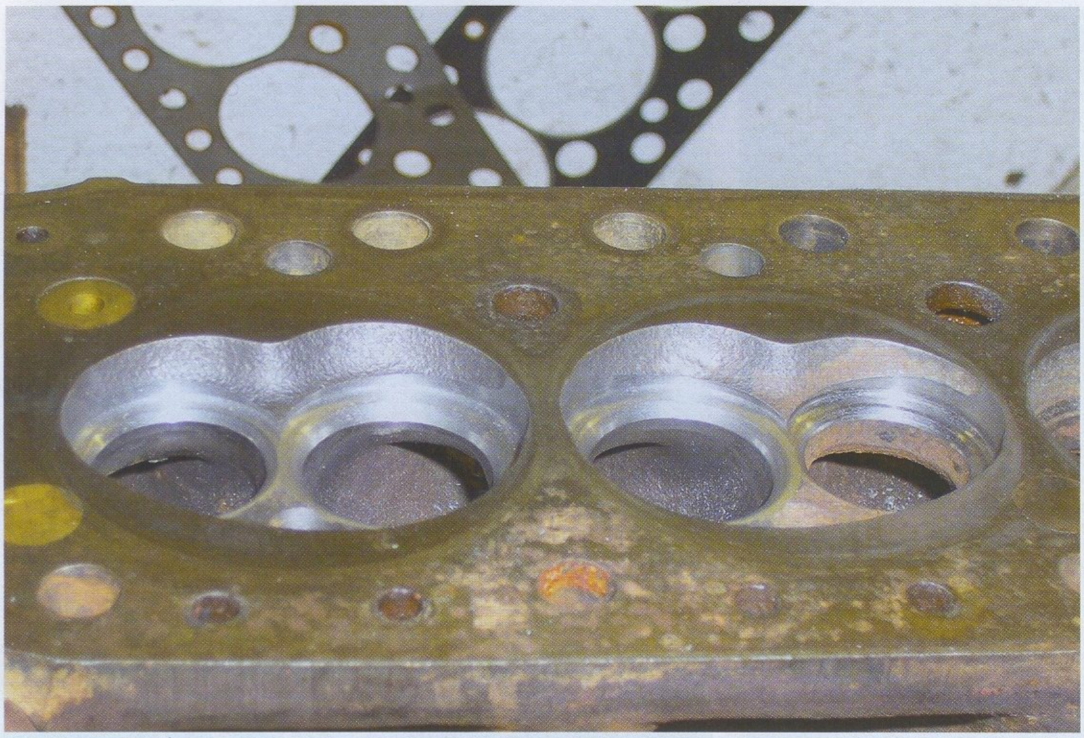
11. The inlet valve seats were also re-faced and then a 30-degree back cut applied to reduce the seat width as per the exhaust valves. This gives better airflow, particularly when the valve seat width is less than the head seat width.



12. This is my seat cutter — a **MIRA**. It uses a rotating pilot that locates in the valve guide, and multi-angle tools to cut three angles at the same time — top-cut above the seat, the seat and then an under-cut below the seat. Messing with these angles gives interesting effects. Here I'm using a fairly standard 30-degree top-cut, 45-degree seat and 60 degree under-cut. Seat width is 0.05 inch.

13. Here are the standard seats prior to re-cutting. The seat outer edges are at the same level as the chamber roof valve reliefs — no top-cut angle and no under-cut angle, just wide 45-degree angles.

14. Here are the new three-angle seats recessed down into the chamber to sink the exhaust valves far enough down to give clearance to the block when the exhaust valve is at full lift. The inlets are not cut down quite as far as this is unnecessary. You can clearly see the colour of the beryllium-copper exhaust valve seat inserts, which were fitted at the factory for unleaded fuel compatibility.



15. On the pre-A-plus head I recessed the seats to the required depths on the exhausts, cut the inlets down so the seats were at the same level then used a radius tipped tool to make new reliefs around the valve seat outer diameter (as done at the factory). I made the circumference as big as possible (without going outside the head gasket fire ring line) to un-shroud the valves as much as possible, theoretically improving the conditions for better airflow. Identical seat angles/widths were used, as on the A-plus head.

	Standard A-plus 1275 head				Standard MPi head				Standard pre-A-plus head			
Lift	Exhaust 1	Inlet 1	Inlet 2	Exhaust 2	Exhaust 1	Inlet 1	Inlet 2	Exhaust 2	Exhaust 1	Inlet 1	Inlet 2	Exhaust 2
0.050	18.8	20.4	20.5	18.2	19.4	21.3	22.4	18.4	19.5	21.5	19.0	19.1
0.100	36.0	39.3	39.1	34.0	37.0	39.5	40.2	34.2	35.8	40.0	39.4	35.3
0.150	52.0	56.0	56.2	47.3	50.7	57.9	58.1	45.4	50.2	57.8	56.2	47.7
0.200	59.3	70.7	70.7	54.4	59.3	72.5	72.9	52.2	61.2	71.6	70.9	56.7
0.250	65.8	78.7	78.0	60.1	66.4	81.6	82.0	57.8	70.6	80.6	79.8	64.8
0.300	71.0	86.5	85.9	64.1	71.2	88.2	88.8	62.3	75.7	88.9	87.2	70.7
0.350	75.0	92.0	91.5	67.3	74.5	93.8	94.4	65.6	81.5	95.2	93.2	73.7
0.400	77.9	97.2	96.5	69.2	76.6	97.5	98.1	67.8	84.6	99.2	97.3	76.5

	A-plus head with recessed valve seats				Pre-A-plus head with chamber roof retrimmed				Standard 12G295 head			
Lift	Exhaust 1	Inlet 1	Inlet 2	Exhaust 2	Exhaust 1	Inlet 1	Inlet 2	Exhaust 2	Exhaust 1	Inlet 1	Inlet 2	Exhaust 2
0.050	19.4	21.4	21.0	18.2	20.1	23.0	21.1	18.8	16.2	19.1	17.9	16.0
0.100	38.1	40.3	40.0	35.7	40.0	41.0	39.9	35.1	29.3	38.1	38.2	29.7
0.150	47.2	60.3	61.1	44.0	46.5	60.7	59.0	46.2	42.2	51.9	51.4	41.9
0.200	57.0	76.5	77.5	52.4	54.4	76.3	75.0	53.9	53.4	65.2	65.6	52.5
0.250	65.3	88.0	88.2	59.7	61.7	88.1	87.4	61.5	57.3	73.5	74.1	57.2
0.300	71.3	95.7	95.2	65.4	69.0	95.5	95.2	67.9	60.3	81.1	81.1	61.0
0.350	75.6	100.0	98.8	69.5	74.9	100.1	98.3	72.7	62.7	87.2	87.0	63.6
0.400	77.6	101.5	99.4	72.3	81.2	101.9	99.3	76.5	64.4	92.4	91.9	65.1

Note: 'Exhaust 1' is the exhaust valve in chamber one (thermostat end) and 'Exhaust 2' is the exhaust valve in chamber two. Inlet valves are numbered in the same way.

Results

The main table shows the flow test results of the three individual and standard heads. The same valves were used in each head, even down to fitting the same valves in the same sequence. For comparison the smallest table shows the airflow of a standard 12G295 Cooper head. It's clear to see that the 1275 heads out-flow the 12G295 by a decent margin — where a five per cent gain is pretty impressive.

The other table shows the flow results of the heads modified by having the valve seats recessed to give the required clearance. The A-plus head had the seats recessed using a 30-degree top-cut above the valve seat, while the pre-A-plus head used the same angles and seat width as the A-plus but was trimmed in the chamber face to reduce the depth of the 30 degree top-cut depth to a more 'normal' depth of a few thousandths of an inch.

Astonishingly, the recessing of the valves hardly reduced flow at all. The exhausts were almost unchanged except for a slight glitch at the 0.15 and 0.2 inch on the A-plus head with just recessed valves, and actually increased flow on the pre-A-plus head on the number one end exhaust port, but decreased on the number two centre exhaust port. The most astounding thing is the way the recession increases flow on the inlet valves by quite a margin in the 0.2 inch to 0.35 inch zone — just where it's most useful!