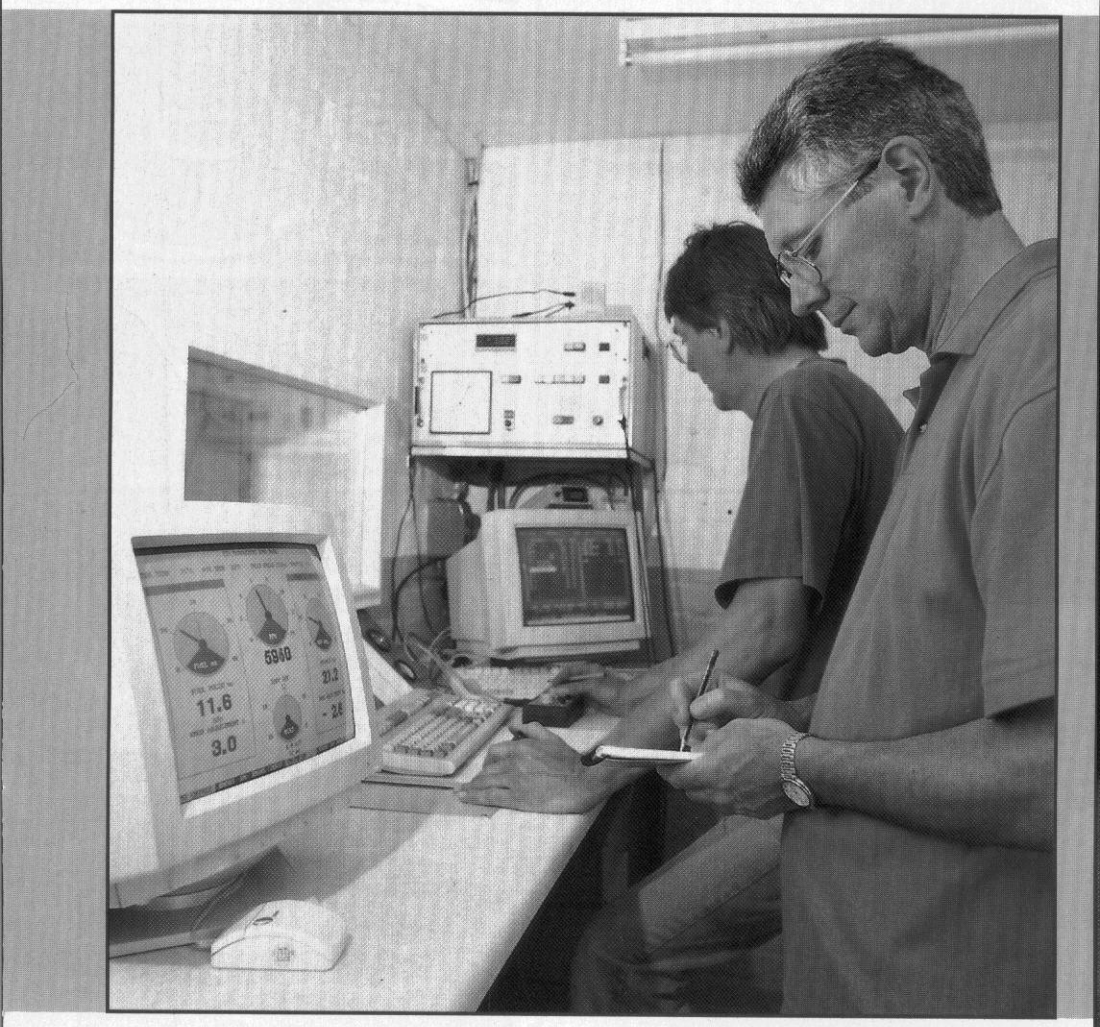
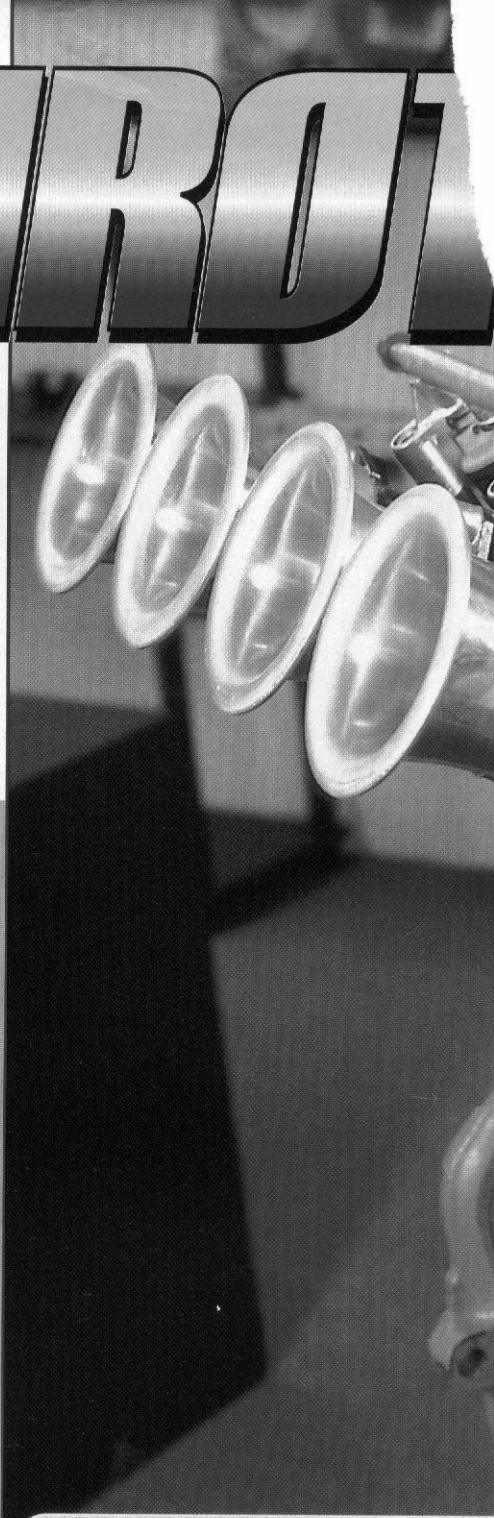
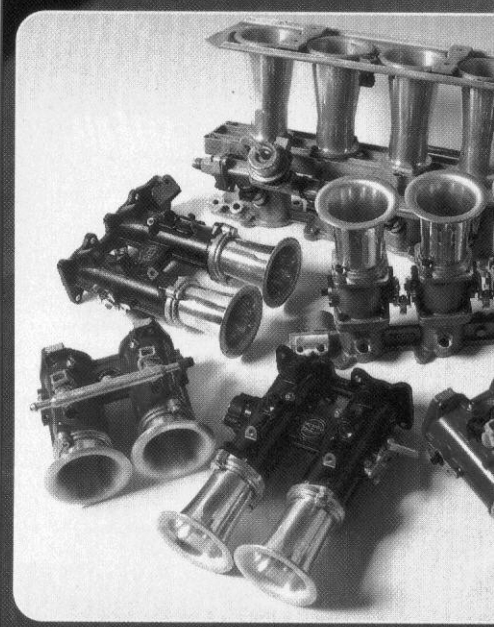
FULL THRO

Carbs or throttle bodies? Direct injection or manifolds? Dave Walker dyno tests all the fuel injection options with Vauxhall specialists QED with some very interesting results. One thing is certain, for serious power you need fuel injection



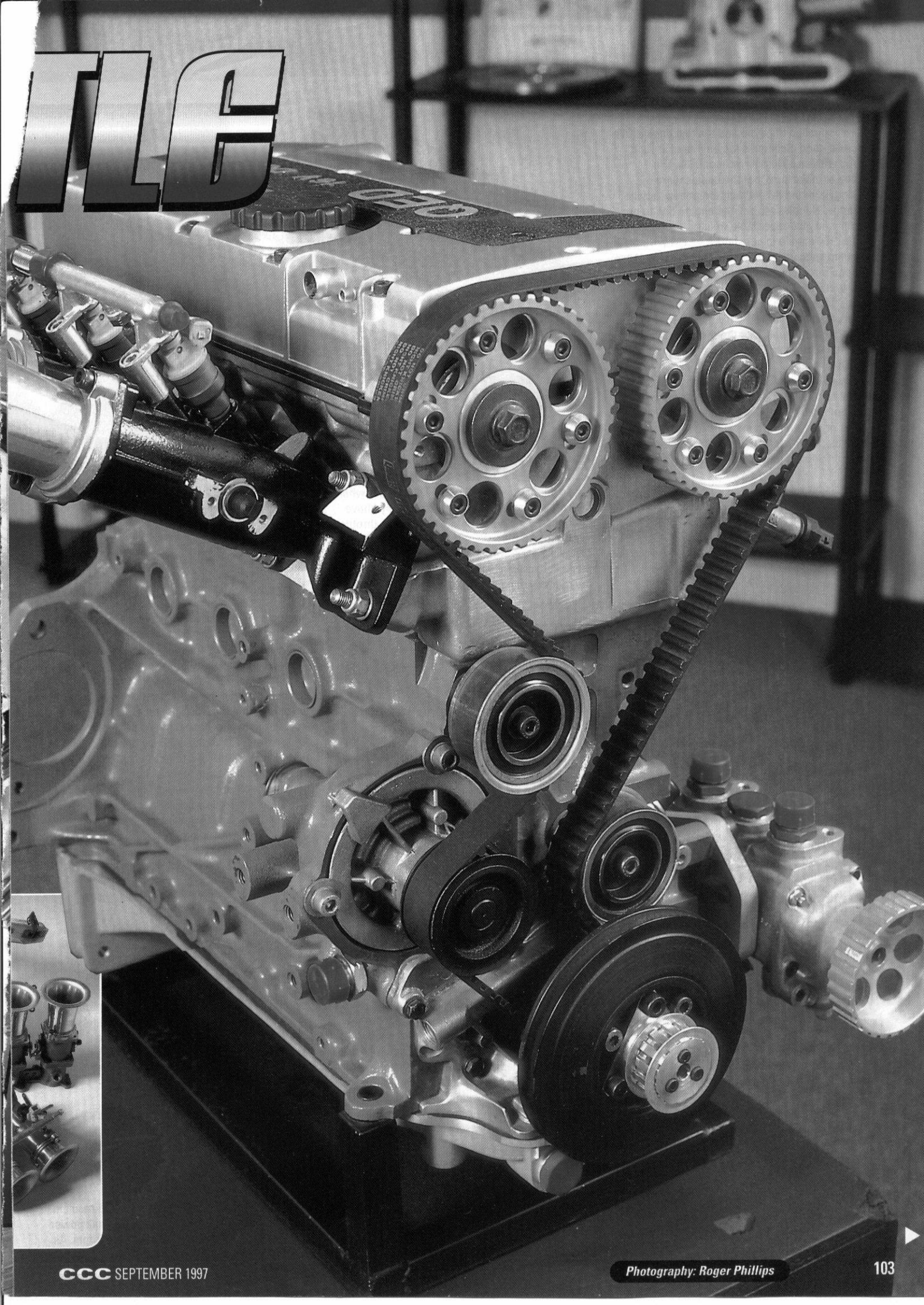




It all started when I cut up some old Weber carbs to make a DIY injection system. I machined and painted my bodies to make them look like the genuine article and before long I was cutting and welding tubes to make up all sorts of different throttle body configurations.

Look at the throttle bodies available commercially and you will find various types on the market. We have bodies to fit on carb manifolds, dead straight bodies with combined manifolds and tapered throttle bodies. You also have slide throttles, butterfly bodies and (the latest rave) - roller barrel throttles.

Our rather ambitious plan was to gather together as many different types of bodies as we could and dyno test the lot of them. For this we needed help, plus an engine to test them on. Ken Snailham at QED is well known for his Lotus twin-cam and Vauxhall 16v engines. He also has a dyno and more than a few engines about the place. Like ourselves, Ken was also interested in testing



Photography: Roger Phillips

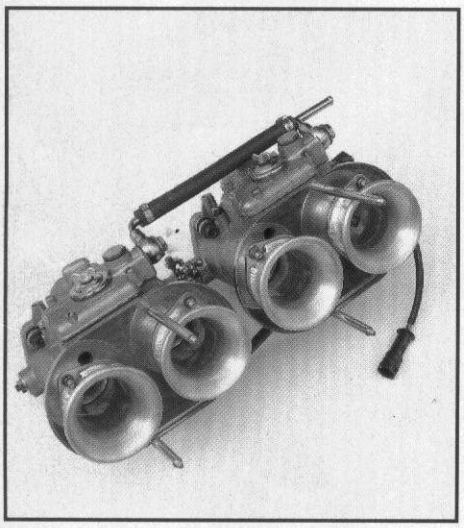
different throttle bodies and between us we came up with a plan.

Ken supplied the dyno and the test engine. We choose a good clubman spec engine of around 230bhp with an 8000rpm rev capability. We wanted to make sure that the bodies were working hard and to test their effect over a wide rev range. Needless to say the engine had to be reliable and give repeatable results.

The 16v engine in question was a Caterham fit dry-sump spec with standard crankshaft, but 12 to 1 Omega forged pistons and steel billet rods. Cams were QED's 450 (lift) rally spec jobs. The exhaust was a dyno job of 4-1 design having primary diameters of 1.75in I/D by 33in long with a 30in secondary length into the dyno extraction systemch secondary length into the dyno extraction system.

It was sporting 48DCOE carbs on a Caterham manifold and a mapped ignition system. For the tests we opted to use the DTA management system since Ken has it installed in the dyno for all his development work. He knows the software inside out and it's one less variable to worry about.

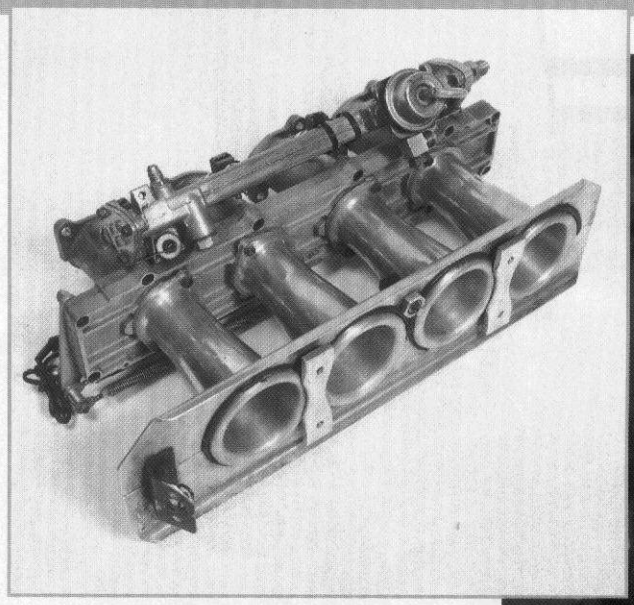
Here's how it went.



48DCOE Weber carbs

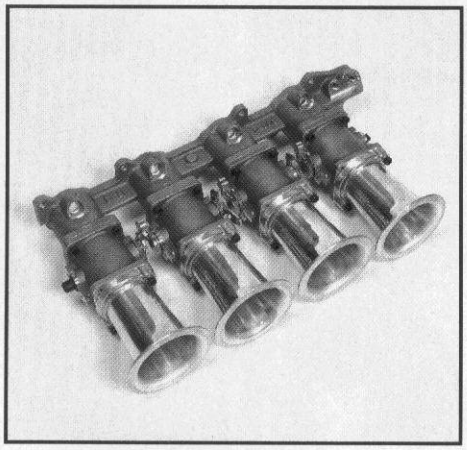
The first job was to jet the carbs and this turned into a bit of a nightmare. As Ken said: "before I had this sophisticated dyno kit, life was easy, but now that everything can be logged to a singlebhp you can see what you are missing". What we found was that no combination of air jet/main jet and emulsion tube would give us the right fuelling across the rev range.

After two hours of messing about we decided to cheat. We picked out the best power from each combination at each rpm break point. This means that we had a power curve that couldn't really be attained but it did give us the best power base settings to compare the bodies against. Peak power was disappointing. Ken reckoned that this engine should be giving close to 230bhp but we were only seeing 215 at 7500rpm peak.



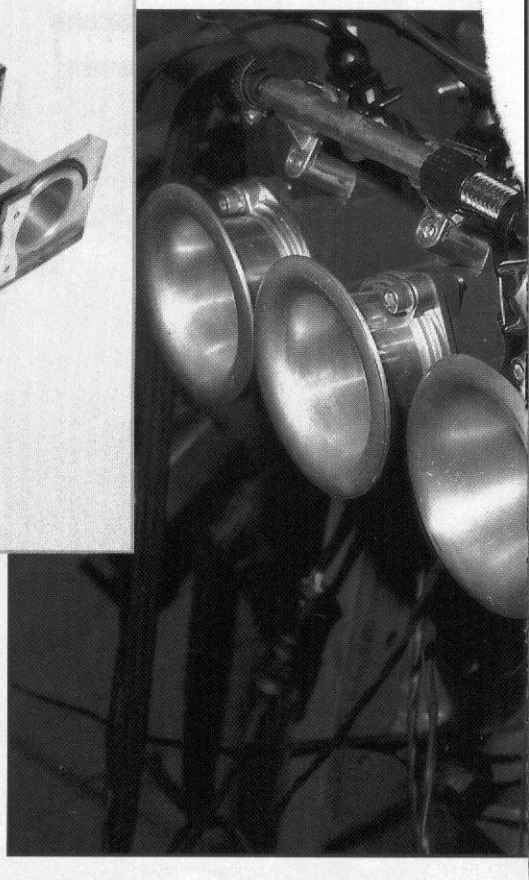
Slide throttles: 44mm slide, 260mm O/Length

These came from an old BTCC Touring Car where they are no longer in fashion. Personally I have heard nothing but bad things about slide throttles - sticking and horrible part throttle driveability. But on the dyno we were getting quite a result with them. Power was better everywhere across the rev range with a peak of 228bhp at 8000rpm. What's more we were doing it with less fuel!



S.B.Developments. Taper throttle body: 45mm butterfly, 220mm O/Length

When I explained to Steve Broughton at SB Developments what we were up to he was more than happy to supply a set of taper body throttles for us to test. Well he could have said bugger off given that QED is a rival company! The taper bodies are available from Jenvey dynamics, but not the inlet manifold to fit them to the Vauxhall engine which is SB Developments' exclusively. Steve went to some pains to point out though, that he has found them very sensitive to the exhaust



system which is why he has developed an exhaust manifold and system to sell with the bodies as a kit. All the same we were welcome to try them out in a back-to-back test.

Initial results were a little disappointing with less power than the slide throttles and the carbs up to 6000rpm. But then the taper bodies recovered to give almost the same peak as the slide throttles. It would be easy to sit back and condemn the idea of a taper body as being negative rather than positive, but I felt they needed another look with a longer intake trumpet.

Ken said it was worth a try but he didn't expect to see any big gains over such a short change in overall length.

S.B.Developments. Taper: 45mm butterfly 250mm O/Length

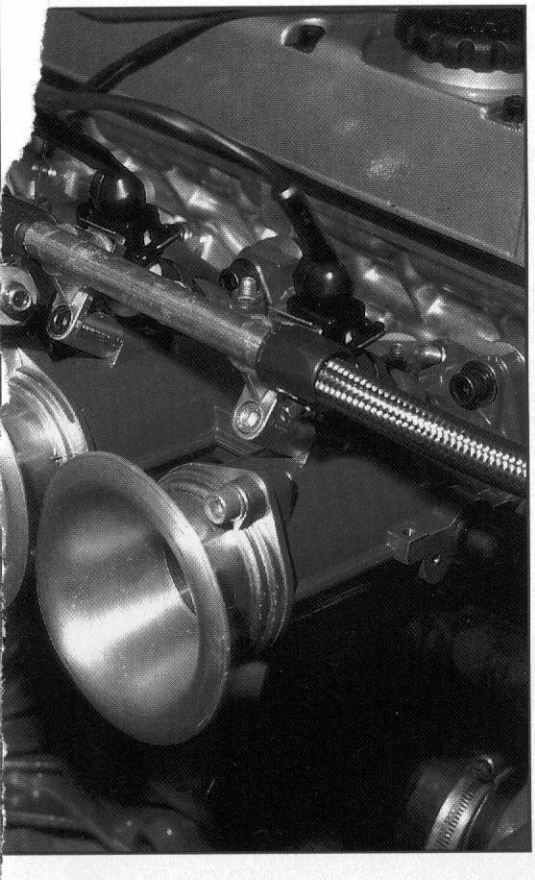
Straight away we matched the slide throttles at 4000rpm, or at least within one bhp of them. We were a few brake shy at 6000 and 7000rpm but at 8000rpm we were bang on the money with 228bhp once again. It would have been interesting to try exactly the same length as the slide throttles but we didn't have any other choice of trumpets so another 10mm on length may have made things better – or worse – you never know with engines.

QED Throttle Bodies 45mm O/Length 245mm

Ken has his bodies cast with the inlet manifold integral with the body. This saves on the cost of a manifold and ensures alignment. The QED bodies, like the SB Dev ones, were angled to give a straight shot into the port.

They gave pretty much the expected result in that they were giving about the same peak power at 226bhp but we had a slight loss at 5000rpm. As

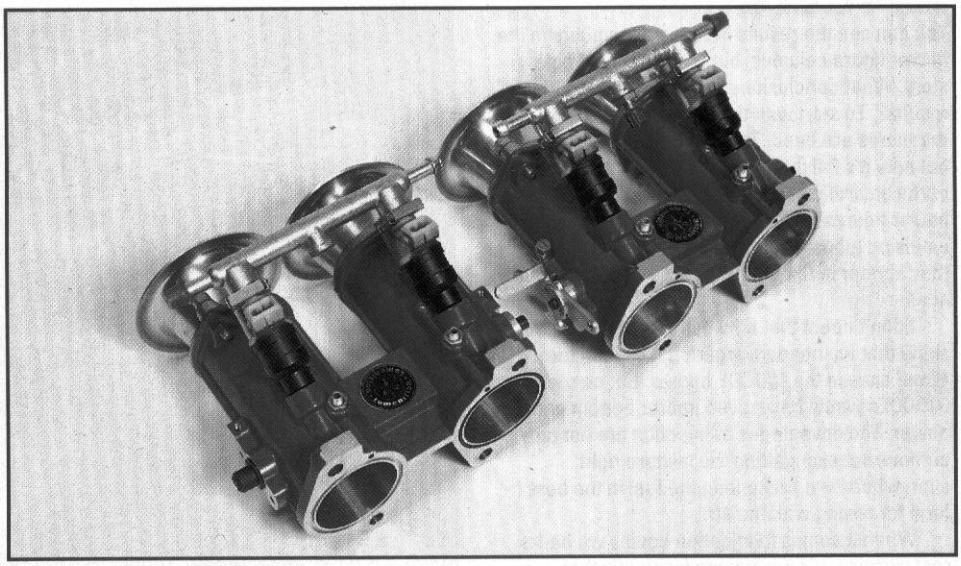
FULL THROTTLE



we were later to find out, 5000rpm is a critical running speed on this engine, but more of that later. We initially tried to fit the longer trumpets, but these were 48mm on the bore and so left a big step in the intake of the 45mm body. We aborted the run after logging a couple of steps.

QED Throttle Bodies 48mm O/Length 275mm

We actually ran these bodies last, but it seemed logical to include them now. Basically we wanted to try the straight QED body with the longer trumpets. Ken didn't expect any peak power gain from the larger body size since he only fits 48mm bodies when he is getting 250bhp and over. This actually gave the worst result at 5000rpm with just 129bhp but at 8000rpm we were back to normal with 227bhp. If nothing else, this proved that you don't need the same size in throttle body as you do in carbs, 45mm is plenty large enough for 230+bhp.



Lumenition Throttle Bodies 48mm, O/Length 235mm

This was exactly the same length as the carbs we started out with and the only reason we used 48mm bodies was that we only had 48mm bodies to play with. Ken predicted an interesting result here. He said that he wouldn't be surprised if we saw more mid-range torque with the carburettor inlet manifold, than with the straight intake systems. This isn't something he has measured before, it was just a feeling that came from testing the Ecotec manifolds (see previous CCC feature). I didn't believe that a bend in the inlet was going to do any good, in fact I have always found that straight works best - at least on the flow bench.

But Ken's hunch proved to be right on the money. The Lumenition body on the carb manifold gave us 149bhp at 5000rpm with practically no penalty at higher revs. Maybe it was a couple of brake down, but in the real world you would never know it, while the extra punch at 5000rpm would be a real benefit. Do not throw away those carburettor manifolds just yet!

Lumenition Throttle Bodies: 48mm, 265mm O/Length

We checked and double checked this one at 5000rpm. We couldn't believe 161bhp! Compare this to the rest of the bunch and there is no comparison. If you take the 45mm straight body for comparison we have a power gain of 24bhp. At 7000rpm it held up within a few bhp of the best, but at 8000rpm it simply died a death at 213bhp. This still compares well to the original carbs, but nothing like the same Lumenition bodies with the shorter trumpets.

There's no doubt about it, fuel injection throttle bodies combined with a good engine management system is the way to go. CCC's exhaustive test took two days and 18 gallons of fuel!

RESULTS

You can see the results in terms of numbers in the power figure columns, but that isn't the whole story. What conclusions can we draw from these results? To start with the obvious conclusion is that carbs are dead. The DCOE has had a long run, but now it's finished. Remember that we gave the carbs an artificial head start by giving the best power figures for several combinations of jets and emulsion tubes. They wouldn't even be as good as they appear in the charts - which isn't very good at all.

I don't doubt that flow bench testing would show that we needed larger chokes than the 42mm ones in the 48DCOE bodies. But changing to 50DCOEs would have given poorer bottom end power. The advantages of injection are not only air flow, but also getting the mixture right everywhere and presenting the fuel in the best form for mixing with the air.

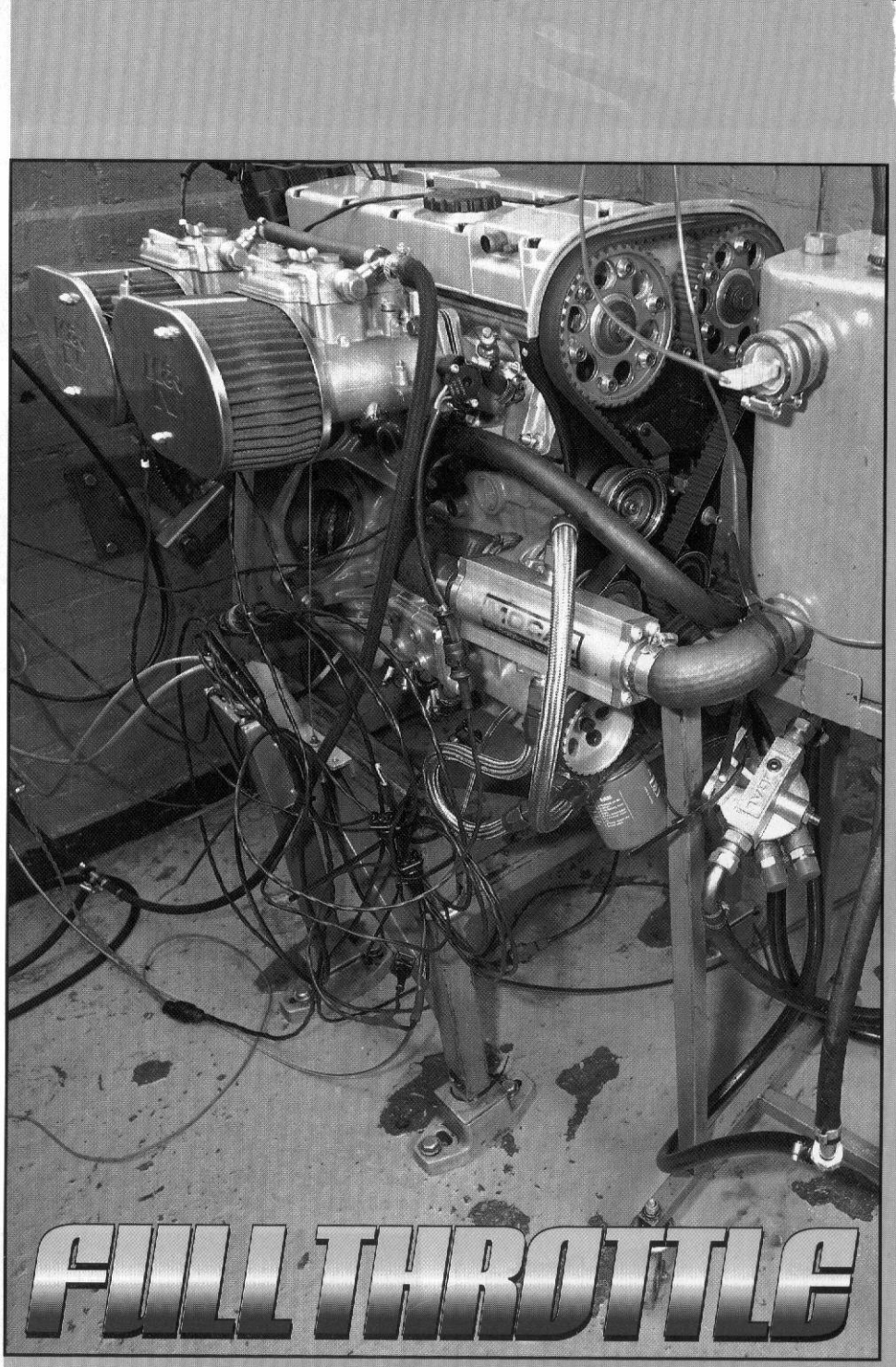
When it comes to injection bodies we had a real surprise. It's my opinion (currently that is, I reserve the right to change my mind) that the internal shape of the body makes no difference at all. If it passes enough air, something you can measure on a flow bench, that's the starting point. But it is the pulse tuning that we can get from changing lengths that is the really critical factor - and you can't measure that on a flow bench.

The obvious conclusion is that carbs are dead. The DCOE has had a long run, but now it's finished

The biggest surprise was finding that a bend in the inlet gave us much bigger changes in power from tuning the overall length. Initially I did wonder if this was due to the turbulent air in the inlet manifold turning the short side of the port better than a straight shot, and then reaching a limiting factor at higher rpm. However, if you look at the figures you see that the same manifold on a shorter length trumpet gives excellent top end power. The only conclusion I can draw from all this is that we are seeing the effect of two tuned lengths in the manifold system. One reflection at the junction of the manifold and body, another at the intake of the trumpet. It looks to me that at 5000rpm they combine to increase cylinder filling and at 8000 they combine to oppose it.

Ken Snailham's initial "gut feeling" about inlet manifold systems appears to be dead right, they can give a lot more mid-range power when you get the tuned length right. Ken now wants to go on and carry out some more tests, using a pulse plate against the intakes to see if he can duplicate the mid-range gains without losing the top end grunt. With a bit of luck CCC will be there making notes, drinking all Ken's coffee and reporting back.

Finally I would like to say a big "than you" to Ken's customer, the owner of the engine which we used to burn 18 gallons of fuel while conducting these tests. I would like to, but I can't for two reasons. First I don't know the customer's name, and secondly he/she didn't know we were using their engine. Let's keep that our little secret okay?



Below the results table says it all, the writing is on the wall for carbs, at high revs they just get left behind. Most interesting figure is the Lumenition/manifold set up: 161bhp at 5000rpm!

RESULTS TABLE

	4000	5000	6000	7000	8000
CARBS	113	141	191	213	212
SLIDE THROTTLES	115	143	196	223	228
S.B.D. *(taper)*	110	139	188	218	227
S.B.D. *(+long)*	114	142	193	220	228
QED	114	137	194	222	226
QED *(long)*		100		192	
QED 48mm *(long)*	111	129	189	219	227
LUMENITION	115	149	196	221	226
LUMENITION *(long)*	112	161	191	219	213