NIGEL'S RUSH CW460 MEGA-BUILD IS IN FULL SWING; LAST MONTH'S CHAPTER COVERED THE INSTALLATION OF THE HIGH PERFORMANCE BRAKING AND FUELLING SYSTEMS. OVER THE NEXT TWO ISSUES WE FOLLOW NIGEL'S QUEST TO DEVELOP AND INSTALL THE ULTIMATE V8 RUSH POWERPLANT. TEAMING UP WITH ONE OF THE MOST RENOWNED ROVER SPECIALISTS IN THE COUNTRY - RPI ENGINEERING - HERE IS HOW THE CW460'S BESPOKE ENGINE AND BOX WAS CRAFTED. FROM THE INITIAL CONCEPT TO FINAL INSTALLATION, YOU ARE ABOUT TO BECOME EXTREMELY WELL-ACQUAINTED WITH AN ASTONISHING POWERHOUSE. WE AT KIT CAR MAGAZINE JUST CAN'T WAIT TO SEE WHAT SHE'S LIKE ON THE TARMAC!

RUSH CW460 CHAPTER 5

Nigel, Kit Car's Tech' Ed' and in-house builder.

When building a kit car, especially if one of its primary aims is performance, the engine is unquestionably the single most critical component. In the vast majority of my previous projects I have sourced donor engines and lavished hundreds of hours and significant investment to create some rather special V8s. In the case of the Rush CW460, I specifically wanted a powerplant to eclipse my previous projects. As a result it demanded some rather special upgrades. After weeks of research it soon became apparent to create such a bespoke V8 would require some serious expertise, and even though I had previously handcrafted a fuel injected 3.9 litre unit for my Westfield Seight, it was time to call on the experts - but who?

You can count on one hand the UK-based specialists who solely deal with the Buick-derived lump, which, in many ways is similar in design to the American small block families. Less apparent, however, are the numerous idiosyncrasies which are unquestionably unique to this V8 variant. Such expertise in overcoming the shortfalls and building on the strengths is actually extremely hard to find, and in my mind there is only one candidate: RPi Engineering. Having visited the Norfolk-based business several months back, it was refreshing to experience an approach to engine building which didn't unduly focus on horsepower and torque. You may think this is an odd statement when all and sundry (including the press) talk relentlessly about such statistics. In reality, what truly matters is a powerplant that delivers a rewarding and reliable driving experience. Some of the ingredients which immediately spring to mind are faultless starting, vibration-free operation, an even idle, instantaneous throttle response, a seriously impressive torque curve and no overheating issues. Only after all of these have been accomplished (and a few more besides) need you concern yourself with dyno figures. A run on the rollers is imperative, naturally, but more to fine-tune an installation rather than to be able to quote peak power output. Having driven many kit cars of varying breeds, I can categorically state if you ignore any of the above qualities for the sake of a few extra horses it can easily detract from your overall driving pleasure and the usability of your pride and joy.

THE SPEC

Having carefully selected RPi Engineering to create my masterpiece, the process began of defining the ultimate Rush powerplant. My requirements were demanding to say the least. I wanted an engine installation which would have hair-trigger throttle response yet deliver effortless torque throughout the entire rev range. The exact figure was not imperative, but I was looking for ballistic performance from my CW460, a sub-four second 0-60, a sub-thirteen second quarter mile, and a top end of 160 mph plus. As for presentation, the unit had to allow me to produce a show-quality installation. Finally, the engine had to be capable of meeting SVA emission requirements. As for budget, I didn't actually have one, but the end figure for the engine and box went well into five figures - yes, five! You will have to wait until next month for an exact breakdown of the hardware used and associated costs but, oh boy, what an engine!

THE TEAM

The team had been assembled and my broad specification was on the table. Over the following six weeks, Chris Crane (RPi's MD) and I worked closely together, specifying each component in turn. Everything was considered, from the choice of block right through to the injection system, even a long email exchange over the colour of the fuel rail! As the specification started to take shape (without compromise in any quarter, I must add) my mind continually alternated between boyhood excitement and the alarming realisation of the insanity of what we were trying to achieve.

Once the specification stage was complete, Chris took a further three weeks to assemble the components from varying specialists throughout the UK. He has no qualms in admitting he doesn't undertake all component development in-house. His approach is to utilise the very best the UK engine tuning community has to offer, bring it all together and, finally, create the ultimate. He compares his approach to a Michelin star restaurant: source the best ingredients from approved suppliers, add some in-house modifications and only then get his Master Chef, Holly, to bring everything together. Three weeks may still sound excessive but, remember, much of the hardware is handmade and some items (being extremely new to the UK market) are in short supply, the heads being a good example; more about this next month.

THE CALL

Even after all the components had been collated, a small selection (such as the inlet manifold and trumpet assembly) were sent to specialists for additional cosmetic work and porting. Only on their return did I receive a call from Chris to be invited once again to the RPi premises to witness Holly assemble my engine.

JUST BEFORE WE GET STUCK INTO THE BUILD

Before I give you a blow-by-blow account of the V8's assembly, I must comment on how amazing the end result actually looks. As I type these words, I keep walking into the garage to remind myself of what Chris, Holly and the RPi team have created. It is a true credit to all those involved and unquestionably exceeds all my expectations. Once complete she was aptly named the Raptor F85.

THE BUILD

Here we go then. Arriving at RPi Engineering at 8:30 am was a little challenging when you consider I live five hours away. The expectation of witnessing my V8 being built by Holly, however, made the 3 am alarm call a little sweeter. After a mug of hot coffee and a chat with the man himself, I was ushered into the sacred 'build room' and was immediately confronted by a huge array of pristine components lined up in military fashion. Pistons, con rods, bearings, camshaft, followers, injectors, plenum and lots more besides. After a swift inspection of my significant investment I turned around and was confronted by the bare block. Clamped firmly into a well-used engine stand, it was patiently awaiting commencement of the build. Setting up my camera tripod, I perched myself against a bench, opened my note pad and started to shadow Holly's every move.

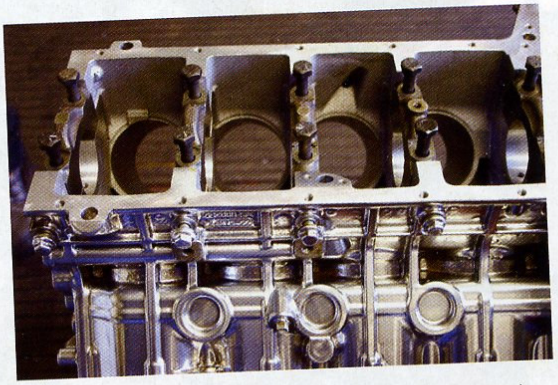
THE BLOCK

The selection of the block for any engine build is critical, none more so than with a Rover V8 project. Unlike American small blocks, capacity is primarily determined by bore diameter rather than by simply utilising a longer crankshaft throw (stroke). Hence, if you want a big cubed Rover V8 you must go for a later, larger capacity block, but beware: as explained in the RPi feature in the May 2008 issue of this mag, the combination of increased bore size and tooling inaccuracies has resulted in the liner to water jacket walls becoming alarming thin, in some cases only 1 mm! Over time, cracks can form across these narrow walls, resulting in a gradual loss of coolant and loosening of liners, causing irreversible damage.

This gives many kit car builders a real dilemma, since 80% of 3.9 litre and above Rover V8 blocks are compromised in this manner - not a good start for a performance engine, especially when you are spending thousands of pounds. In my case, the solution was a brand new 4.6 block with casting quality I had not previously witnessed and also, more importantly, water jacket walls within tolerance. The company behind this superb piece of quality engineering is the well-respected Mahle Powertrain Ltd., formally Cosworth Technologies!

The only way for Mahle to produce such high quality castings was to start from scratch and create brand new tooling, and that's exactly what they did - at huge cost I might add! The net result is that RPi can now offer an unlimited supply of brand new blocks, cast and machined to exceptionally tight tolerances throughout. Even better, being based on the later, largest capacity V8 variant all blocks are cross bolted, providing the ultimate in strength - an ideal starting point for high output engines.

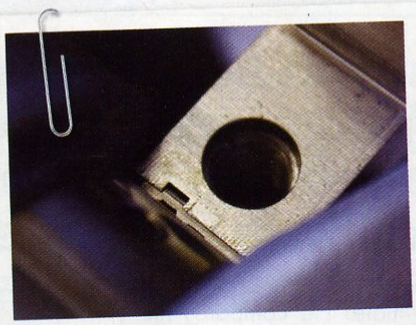
As you can probably guess, such a COSCAST 4.6 litre block was handpicked by Chris to form the foundations of my Raptor F85. If that were not enough to make this powerplant rather special, it proudly boasts engine number '1': the very first production unit to come out of the new Mahle tooling. On the cosmetic front, the block subsequently underwent a high temperature powdercoat bake in chrome. This technique is used by many superbike manufacturers and the net result is a block which looks like it has been chromium plated from top to toe – just take a look at the pictures.



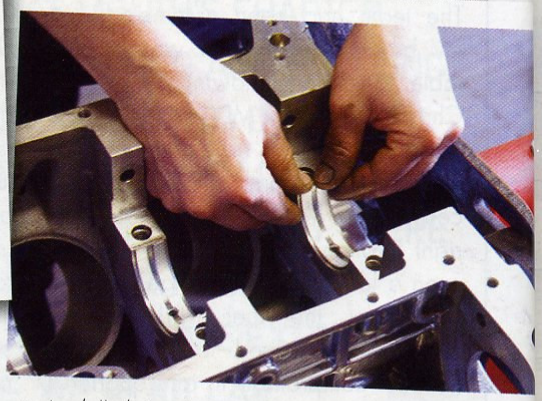
Brand new COSCAST 4.6 litre block, chrome powdercoated - the perfect foundation for Nigel's Raptor F85.

MAIN BEARING SHELLS

With the glinting block on the stand, Holly began inserting the upper half of the big end shells, five in total. Using hand pressure only, a smear of Graphogen graphite paste was applied to aid insertion. Orientation was carefully checked to ensure each shell's key was aligned correctly with the corresponding block recess. Once all five were in situ, a cursory stroke of Holly's index finger ensured everything was seated correctly. Such simple yet essential checks are something you notice when watching a professional engine builder at work – it's not rocket science, but a culmination of such additional checks ensure a trouble-free assembly.



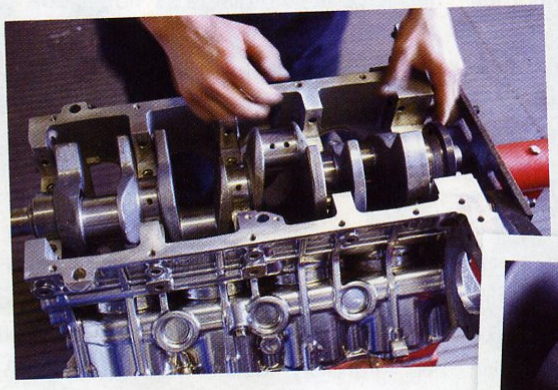
Shell's keyway in close-up.



Main shells being placed into block.

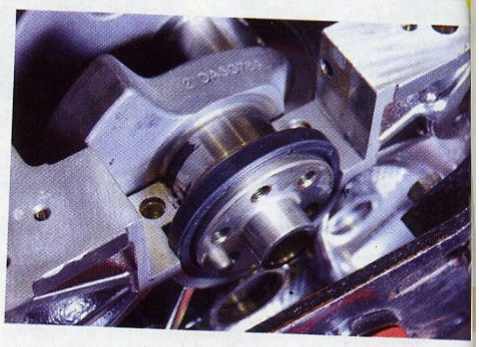
CRANKSHAFT

The choice of crankshaft was simple: a standard OEM 4.6 litre component fabricated from cast iron and, naturally, dynamically balanced. This may surprise a few readers who might expect such a high specification engine deserving of a forged steel upgrade. Such cranks have never actually been produced in any quantity, a good indication the standard component is well up to the job. OK, you can get a crank machined from solid billet, but time has shown the standard cast item is good for 6,500 rpm, possibly even more. My requirement was for a not-too-shabby red line nudging 5,500 rpm, so no worries in this department. The limiting factors in a Rover V8 as revs increase are more likely to be the con rods and hydraulic followers. It is on these items that you should initially focus if stratospheric rpm is your goal.

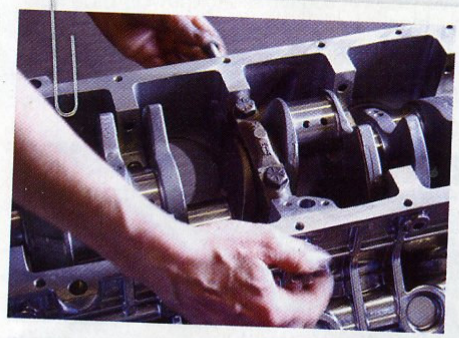


Holly lowers the crank into position.

Prior to installation, Holly slid the one-piece rubber rear end seal (as fitted to all later engines) onto the crank's tail. Once in position the whole assembly was slowly lowered until it was seated in the shells. When in situ, Holly gently rotated the assembly, ensuring there was no undue resistance due to unforeseen misalignment.



Rear main seal in position. This is the far superior one-piece rubber type. Some early engines actually used rope!

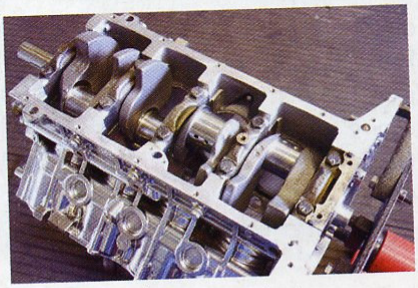


Middle end cap being bolted into place. Here, Holly is inserting the cross bolts.

MAIN BEARING CAPS

As previously mentioned my COSCAST 4.6 block utilised the ultimate cross bolted main bearing cap configuration. In plain English, this means each end cap has four bolts holding it into the block, two from the bottom and one from each side. Most engines (earlier Rover V8s included) only have the former, and potential engine imbalance at high rpm can loosen the bolts, and cause catastrophic failure. It is almost unbelievable to think this actually happens, but any serious engine builder would always suggest a block with a cross bolted main if reliable high performance is your aim.

The sequence of fitting and torquing down the Raptor's end caps once mated with their big end shell seemed a fastidious process and one which Holly followed painstakingly. Starting with the centre cap, he meticulously cleaned each bolt (even though they were all new!) and applied a small amount of 'Loctite' to each, a procedure he followed religiously with all bottom end fasteners for additional reassurance. Tightening the top two bolts first, followed by the side two, all four were torqued to the correct value. The order of main bearing cap insertion was 3 – 2 – 4 – 1 – 5 (5 = rear of engine). Even though this was a straightforward and potentially quick process, Holly stopped between each operation to rotate the crank by hand to once again ensure resistance did not increase unduly. The idea behind this repetition was to detect any issue immediately. In addition it's worth pointing out torque wrenches can lose accuracy within a matter of months. RPi ensure all such devices in their premises are professionally recalibrated on a bi-monthly basis.



All five main bearing caps in situ.

PISTONS AND RODS

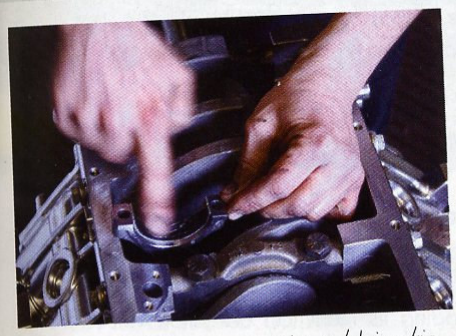
As with the crankshaft, the rods and pistons were standard fare, delivering a respectable compression ratio of 9.35:1, the highest fitted to any Rover V8 powered production car. Utilising a small dished crown, these dynamically balanced cast pistons and rods are ideal for fast road use. It is well documented that these assemblies are capable of achieving a heady 6,000 rpm, again ideal for my Rush. On the subject of pistons, Chris could have quite easily opted for a considerably higher compression ratio (such as 11:1 or even higher) to gain a few more horses but at phenomenal additional expense and modifications. This seemingly simple upgrade, however, introduces a considerable risk of pinking if normal fuel pumps are used. Since the tipple for my CW460 is to be standard unleaded, a compression ratio of 9.35:1 is perfectly suited to my requirements - another example of RPi's approach placing drivability above the temptation of a few more horsepower.

Pistons and end caps being prepared for insertion.

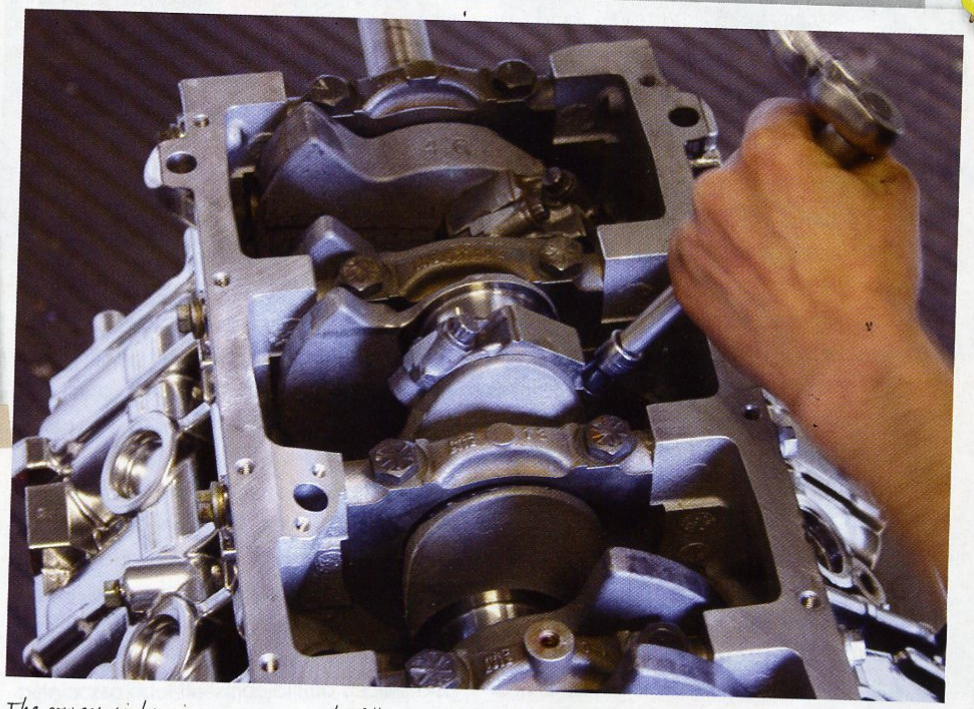
Using a ring compressor to insert all eight pistons into the COSCAST block.

The Rover V8 has two opposing pistons for each crank journal. Holly likes to ensure both rods are seated on the same journal prior to adding the big ends. It is not essential, but is a practice which ensures everything sits comfortably prior to final torquing. Utilising brand new upgraded stretch bolts, each was torqued up to 25 Nm and then rotated another 90 degrees. To ensure this process was followed without error, Holly marked each bolt head with a line prior to rotating the additional 90 degrees. Interestingly, it is this last process which actually stretches the bolts - just enough to optimise component clamping, but not too much to snap them. This explains why the overtightening (or the reuse of) these rather expensive fasteners can have catastrophic results.

As with the fitment of the main bearing caps, the crank was turned periodically during the whole operation.

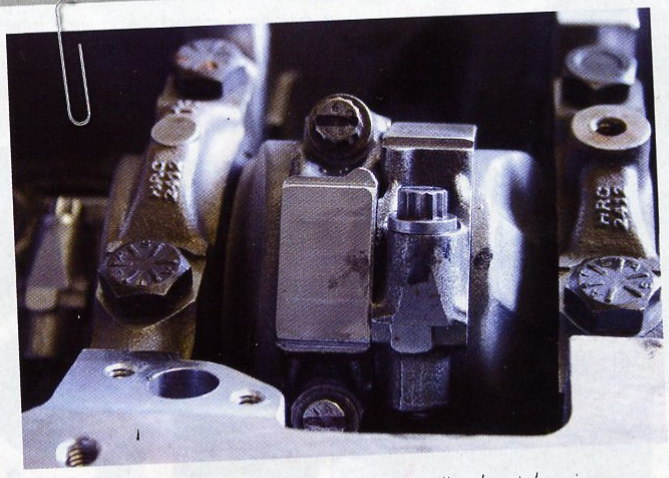


Application of lithium grease prior to bolting big ends onto the crank journal.



The correct tightening process must be followed to avoid overstretching the big end bolts.

Holly took care to ensure each con rod was kept with its matching end cap by marking each pair with a corresponding number. Picking up the pistons in turn he rotated the rings to stagger the gaps, a standard practice in any engine rebuild to minimise blowpast. A ring compressor was then used to help guide the pistons into the block, with the addition of a squirt of oil to aid lubrication.



Note the lines on the bolt heads - these tell Holly the tightening procedure is complete.

CAMSHAFT AND FOLLOWERS

At this time Holly had invested just over two hours in the build and a bacon butty van was hooting its horn somewhere outside; a convenient point for a pause and a moment to take stock of the next job in hand - the camshaft.

As we consumed Norfolk's finest, Holly detailed how important camshaft selection is when building a performance engine. He explained how phrases such as 'fast road' or 'race spec' catch the eye of inexperienced builders and, combined with claims of an immediate 20 bhp gain, usually seal the deal.

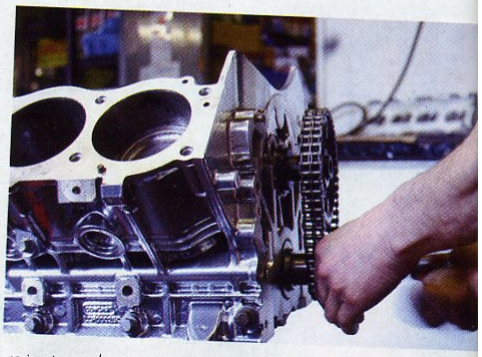
In the case of the Raptor F85 the last thing we wanted was an overaggressive profile. Even though peak bhp would benefit, the downsides would include a potentially lumpy tickover and an emissions nightmare. RPi recommend a range of Piper camshafts specifically matched to differing engine upgrades.

Lined up for the Raptor was a Piper 285 Stealth Max, a bespoke profile individually selected to be the company's ultimate street camshaft. Matched with the other upgrades proposed for the Raptor F85, I could expect amazing extended power gains throughout the entire rev range and even beyond 6,000 rpm. Such gains, however, do not demand heavy-duty valve springs, fly cut pistons or solid lifters, all of which are best avoided in a usable road engine for a multitude of reasons.

Rotating the rapidly growing engine through 180 degrees allowed Holly to insert the 16 lobe Piper camshaft into the block whilst taking great care not to damage or dislodge any of the white metal bearings.

Once in situ, a set of Piper full vernier pulleys were installed on the end of the cam and crankshaft. Opting for a duplex arrangement (double width chain) is a good investment, not only minimising the risk of chain stretch but also allowing Holly the opportunity to dial-in the cam with the adjustable Piper pulley set.

Piper 285 camshaft and hydraulic followers.


Fitting the duplex timing gear.

DIALLING-IN THE CAM

Dialling-in a camshaft is one of those jobs which takes a significant amount of time, and hence is usually only undertaken on race engines. My Raptor was getting the full works, however, which included this ultimate fine adjustment. The principle of this process is to ensure the piston and valve chain are perfectly synchronised. In the case of the Piper 285, the inlet valve on cylinder number 1 should be at its maximum lift at 107 degrees - not 106 or 108, but 107 degrees exactly. If you build an engine with non-adjustable pulleys (as most people do) there is not the luxury of fine-tuning this critical variable. However, to get the best from the Raptor, I witnessed the whole procedure as follows:

Step 1: Holly first attached his trusty timing dial to the crankshaft - basically a large metal disc with degrees and minute increments marked around its circumference.

Step 2: A dial gauge was bolted on the block and the crank rotated until piston number 1 (front right) was exactly at the top of it travel, otherwise known as 'top dead centre' (TDC).

Step 3: A pointer was then bolted to the block and positioned so its tip rested on the timing dial at zero degrees exactly.

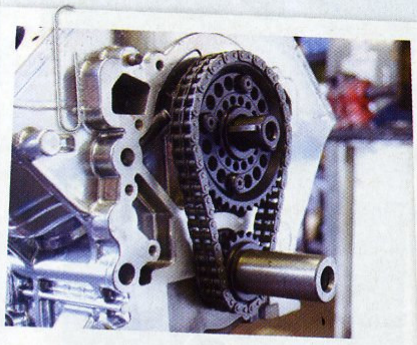
Step 4: A follower was lubricated with oil and placed on the camshaft lobe associated with the inlet valve for cylinder number 1.

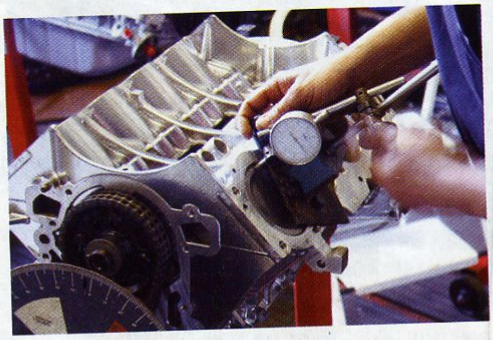
Step 5: The dial gauge was once again bolted to the block, but this time rested on the top surface of the previously inserted lifter.

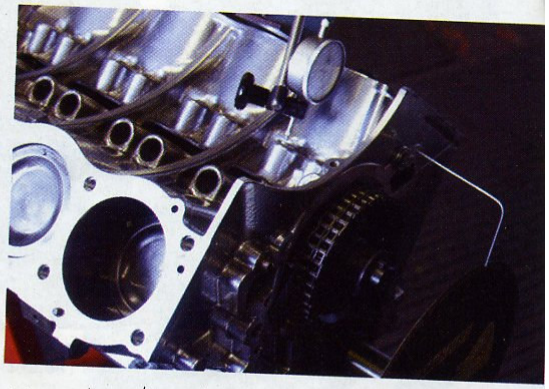
Step 6: Holly then rotated the crankshaft slowly until the lifter reached the top of its travel. This was indicated by the dial gauge reading its maximum deflection value. The position of the pointer on the dial gauge was carefully noted. This procedure was repeated several times to get an average reading. The correct reading should have been 107 degrees, but in my case the timing was half a degree retarded.

Step 7: To correct this inaccuracy Holly unbolted the centre of the camshaft duplex sprocket, rotated the centre accordingly and retightened.

Step 8: Step 6 was then repeated to ensure the recalibration was spot-on. When Holly was fully satisfied, Loctite was applied to the sprocket set screws to ensure future movement was impossible.

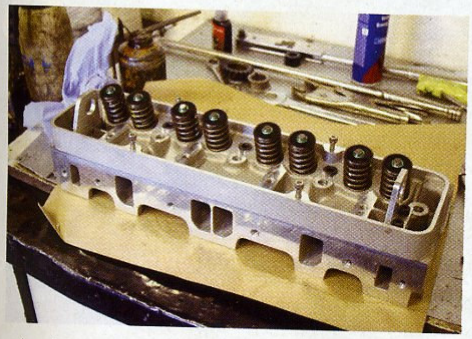

Note top sprocket is adjustable to allow dialling-in of the cam.


Getting TDC of cylinder number 1.

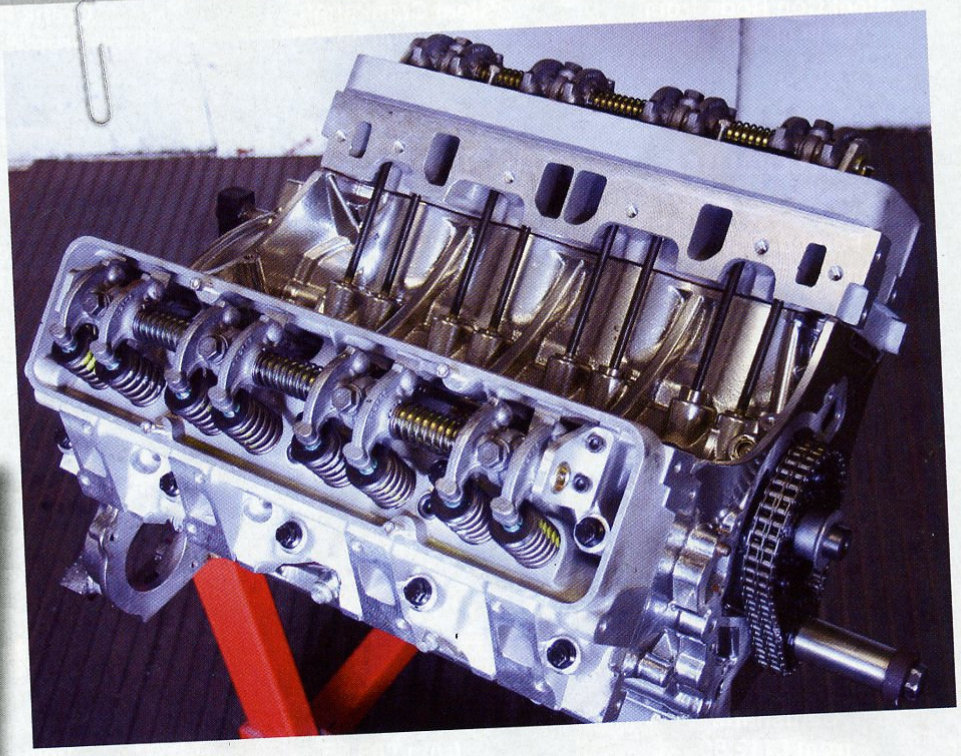

Measuring when inlet follower for cylinder number 1 is fully open.

READY FOR THE HEADS

The next point was to fit the heads, and next month I will reveal what Chris had in store for my Raptor. Heads modified to stage 1, 2, 3, 4 ... or maybe something a little more special? I have included a couple of pictures to test your skills of observation, but for now it is back to the garage for me. Next month I'll conclude the coverage of the Raptor's creation and you can see the 4.6 unit in all her glory. For more pictures, visit my website www.nigeldean.co.uk.



What heads are in store for Nigel's Raptor F85?



Next month Holly concludes the build.

A FINAL WORD ON RPI

RPi Engineering can meet every kit car builder's needs in the Rover V8 department, be it an alternator, piston set, short engine, block, carburettor kit, gearbox, bell housing kit or even a full turnkey Raptor F85. You too could get your greasy mitts on one of these very, very special engines. If nothing else, do visit their website (www.v8engines.com) and have a good look, especially if you are considering a Rover V8 in your project. If tempted, give the guys a call on 01603 891209 and they will offer some sound, free professional advice regardless of your budget. Alternatively, access their eBay shop (via the website) and you will find a massive selection of V8 hardware, from blocks ... to pistons ... to ignition leads ...

TEENAGER'S TAKE

Yes, it's me again Kit Car readers. I know what you are thinking whilst drinking your coffee and reading this with grease stained hands, once you start to read my section you finally wake up! This month's article is especially boring – no offence Dad. Well, with Pip the pup in our house, things are starting to hot up on the stress front! He's twelve weeks old you see and yesterday Dad stepped in a delightful brown parcel Pip left for him in the garage. He was totally unaware and promptly trod it into his already cack-coloured carpet. Now it's actually got another shade to it! Then, in came Mum wondering what all the fuss was about and stepped in it too! Lovely.

Oh and I almost forgot, Pip is in his teething, destructible mood at the moment and chews everything in sight. This included Dad's handbrake cable which he was not so pleased about! I just don't understand why he lets him wander freely around his garage. The puppy pen he made in five minutes flat was used for about the same length of time. As soon as the dog started whining, out he came. It means Mum is always trying to brush little shavings of metal out of his curly coat and remove screws/pipe/gravel from his jaws. The other day the troublesome puppy decided to get his teeth into a tube of blue poster paint. Much to Dad's dismay he was left with a blue dog which he then had to bathe before Mum got home, as she had left him in charge of the new baby! No prizes for guessing who was wetter at the end of the cleansing session and what state the bath was left in.

So, no catastrophic disasters to report this month apart from an impressively big Mr Whippy, a partly chewed handbrake cable coated in fresh doggy saliva and a puppy looking like he had landed from outer space. Wonder what's in store next month?

Nigel's daughter, Evie, with another of her Teenager's Take.