Lords of the rings

Chris Teagles

Incremental changes to piston and ring technology can add up to a big benefit. Chris Pickering talks to one of the leading experts in the field

ABOVE A Coventry Climax piston produced by Omega

THEY say it's the little details in life that matter. And that certainly seems to hold true when it comes to pistons. You'd struggle to measure some of the subtle changes in geometry that Omega Pistons applies to its historic racing parts, let alone pick them out with the naked eye. But they're there.

The same goes for the advances in heat treatments and manufacturing techniques that help the piston to stand up to the rigours of competition. Outwardly there's very little to distinguish the new parts from their period counterparts; it's the small differences that add up to a significant improvement.

Founded in 1972, Omega is able to draw on a wealth of experience, not least that of managing director Fred Hadley, who has been with the company since the start. These days, however, the facilities have grown to include state of the art 3D modelling software and an extensive CNC machining suite.

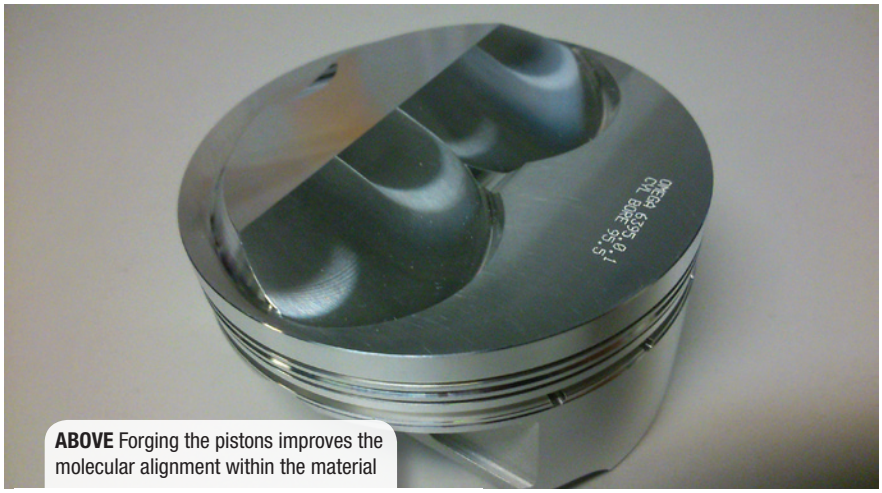
The recent surge in interest in historic racing has seen the order books swelling, with something like 50 per cent of the business now devoted to classic and vintage pistons. "Historic racing is a big part of what we do, both for cars and bikes," explains general manager, Andy Baker. "Some of the designs are completely new to us, whereas in other instances we're dusting off original tooling that was used in the '70s or '80s."

Where required, Omega can put a modern twist on these designs, such as up-to-date ring technology and skirt profiles, he explains: "In the past all the ovality and the barrelling was put on manually, but now we have two very sophisticated CNC machines. That means we can tailor the profiles far more to suit individual engines."

Designing the skirt profile can be a deceptively complex job. Two pistons which have the same clearance on paper can have very different thermal expansion characteristics in practice.

It comes down to a mixture of cold hard science and engineering intuition, says Baker: "If you take the 2-litre Ford Pinto engine, for example, we know a huge proportion of the engines now being raced have actually come out of the scrap yard. Prior to being dug out they were sat in the scrap yard with three inches of water in the bottom with half an inch of sediment, so the bottom of that block is going to get hotter than the top and it's going to get hotter than it would have done when it was new 40 years ago. We're only talking tenths of a thou, but [with CNC machining] we can change the profile very easily to suit that characteristic."

Omega tends to use a high strength aluminium alloy called 2618A, which is a derivative of the Rolls Royce RR58 material that can trace its origins back to the Merlin



ABOVE Forging the pistons improves the molecular alignment within the material

engine. Advances in heat treatment and ageing have led to significant improvements to the material since it first made the leap to motorsport in the 1950s, however. Unusually, both are carried out on site. For some applications Omega also uses coatings, although with so many historic blocks made from cast iron the benefits are not always as dramatic as they can be in modern engines.

Originally, most historic pistons would have been cast. Omega does still produce high-grade castings from LM13 aluminium alloy in its on-site foundry, but these days they only account for a small part of the business. Likewise, some pistons – usually one-offs or prototypes – are machined from billet. Most, however, are forged.

It all begins with aerospace-grade alloy bar received in 'F condition', which has been extruded repeatedly to generate a very dense grain structure. Forging the pistons improves the molecular alignment within the material, leading to an exceptionally strong part, which is then heat treated (again in-house) to a variation of 'T6 condition'.

RINGS OUTLAST ENGINE

One of the main areas for development is the ring pack and the associated grooves, Baker explains: "We can get rings now which are 1 mm wide nitrided steel that will last longer than the engine. Back in the '70s steel rings just weren't available. The old cast iron rings used to wear a lot quicker so they had to be thicker and you might have had a 1.75 mm ring in its place, causing far more friction."

Older rings are typically far more susceptible to thermal collapse , so they run much higher static tension to give the right characteristics at working temperature. This means there are significant friction benefits to running a modern ring pack.

"Recently we did an old Aston Martin that represented the very best technology in its day, but looking at the ring pack today you wonder how it even ran," he says. "The tension was so high I struggled to push it in with my fingers and the radial depth and height were huge. A modern piston for this engine would still have to have the same deck height and dome height to achieve the right compression ratio, plus the same valve cut-outs etc, but with a modern ring pack and better profile you've got a lot less friction."

It's a similar story with gudgeon pins. On a lot of old engines the gudgeon pins span virtually the whole width of the piston, with buttons on the end to retain them. Thanks to better materials, improved fasteners and modern machining techniques it's now safe to use a circlip. In some instances this means 20 mm can be removed from the length of the pin. Even if the regulations don't permit any changes to the external dimensions, there are still advantages to be gained from tricks such as enlarging the internal diameter. It's not unknown to shave 40 or 50 g off the weight of the original pins, Baker explains. And don't forget, that's per cylinder, right at the business end of the reciprocating assembly.

There's also a trend at the moment for engine builders to fit much longer conrods to their engines. This allows the compression height to be reduced, with much smaller skirts, to reduce the length. The overall stroke remains the same, but the reduced weight of the piston this allows more than compensates for the longer conrod.

"We are the only specialist piston manufacturer in the UK which can take care of forging, heat treatment and the production of gudgeon pins and piston rings under one roof," concludes Baker. "And because this is all done in-house we can spend a lot of time refining the details." HRT

ABOVE & BELOW 3D CAD is now an essential part of Omega's development process

ABOVE A cross-braced piston for a Volvo B230