CUSTOM PISTONS

BY FERGUS OGILVY

STEERING THROUGH THE PERILS OF CLOSE TOLERANCES

Gibtec Pistons, who is based in Denver, Colorado, is a new name in competition piston-making. But the company leaders are no apprentices to the craft.

Nick Plantus, one of the founding partners of the Michigan-based Diamond Racing in 1968 has now joined his colleague, Rob Giebas, who also served around twenty years with the same acclaimed Detroit operation.

Now specializing in the creation of custom billet pistons, Giebas' background is particularly well suited to its complexities, having devoted a decade to development programs for NHRA Pro Stock teams.

Any experienced racing man knows that the components of a successful race car should be compatible—all working in concert. But this formula is never more critical than with engine builders. Professional race engine builders are profoundly aware of how engine parts affect one another and have to be developed as an efficient group. For them, the key to successful race engine building lies in maximizing a power plant's performance by creating a combination of components that complement each other.

In most cases, developing complimentary components requires modifying readily available parts or creating custom ones. Off-the-shelf engine components are often acceptable to builders seeking modest performance gains, but they are hopelessly inadequate when summoned to generate significant power.

Nonetheless, whether off-the-shelf or custom, a change to one component requires changes to the others. As a basic example: any modification to the combustion chamber usually necessitates changes to the piston crown if for no other reason than to achieve the desired compression ratio.

When increasing compression ratios the whole combustion event accelerates. Thus, astute engine builders might decide to open the exhaust valve earlier. If they do, it is likely they will also reduce its size, permitting the use of a larger intake valve. In such cases the new piston crown needs careful redesign, accommodating changes in valve pockets and pocket depths to ensure adequate valve clearances. Other key characteristics include total combustion chamber volume (cc's) and flame travel around the dome.

In the recent past, builders would accomplish these changes by modifying pistons by hand. But today's digitizing and manufacturing technologies enable the modern piston maker to rapidly create custom piston designs that duplicate most combustion chamber shapes.

Laser scanning technology enables rapid design and custom machining

This leads us to the laser scanner, which has a primary influence over the custom billet-piston process, capturing precise shapes, engendering remarkable swiftness and contributing unerring versatility. Accordingly, the scanner is used not only to reverse engineer the concave surface of a combustion chamber, but also to scan a combustion chamber mold or an actual piston. Access to any one of these three essential components enables the piston maker to efficiently create new custom billet-piston designs. Notably, when actual pistons are sent to be modified, after laser scanning they are modified to the engine builder's modifications in a computer program called Solid Works.

A laser scanner creates a series of mesh lines that collect surface data. Depicted on a precision-ground granite table surface, the dots reflect an image back to the scanner which is transmitted to the computer.

The bulk of Gibtec's laser scanning is performed on a precision-ground granite surface table for accuracy. Compact scanning units capture three separate images of the object (combustion chamber, chamber mold or existing piston) and Rapid-Form software is used to accurately stitch the images together, creating a 3D mesh model. Total scanning time is approximately 20 minutes.

Other key factors that define the unique character of some of today's racing billet pistons are surface coatings, skinny piston rings and, above all, the secondary ring cut. From the beginning, an in-house coating facility was established at Gibtec, essentially to offer ceramic crown and molybdenum skirt coatings. Baked on for an hour at around 300 degrees Fahrenheit, the former deflects the heat from the crown; the latter reduces friction and scuffing on the skirts.

SKINNY RINGS

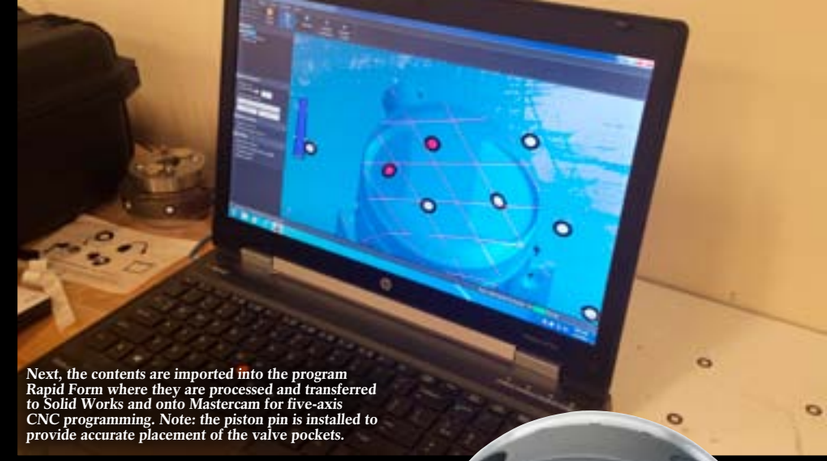
Regarding piston rings, Gibtec commonly employs 0.043in ring grooves for conventional 24-degree big-block Chevrolet drag race pistons. But at the other end of the spectrum, particularly in NHRA Pro Stock and Comp Eliminator, they prepare ring grooves to accept compression rings of 0.6mm (0.023in), 0.7mm (0.027in) or 0.8mm (0.031in). Generating a mere 0.5 – 0.7 pounds force of tension, these special light rings have little capacity to scrape away oil and, therefore, cylinder walls are honed to specific bore finishes appropriate for their use.

Although piston sets are usually within half a gram of each other, their singularly most important feature is the application of a secondary ring cut. This, according to Robbie Giebas, "transforms the race piston." Clearly, the objective is to achieve optimum ring seal and the best way to obtain it is by machining maximum flatness in the top ring groove and, critically, combining it with the finest surface finish. This they accomplish with their secondary ring cut formula and tellingly, "It is the last machining operation on the piston," confirms Giebas.

On-the-shelf, Gibtec offers a significant diversity of piston rings, including the AP coated stainless steel variants, as well as tool steel piston pins (H13 and M2) and a wide variety of big-block Chevrolet drag race pistons. Prepared for both nitrous and naturally aspirated engines, these pistons are usually of the full, round style.

Though a competition nitrous piston is visually indistinguishable to its naturally aspirated counterpart, the essential differences between the two are material type; the thicknesses of the crown, wall, skirt, and piston pin; the provision of gas ports; the depth of the top ring land, and the materials of which the top ring and oil control rings are made.

Finally, perhaps the biggest aid to engine builders engaged in new piston designs is Gibtec's ability to help. They'll alert the builder to any areas that appear problematic, recommending regions that may require more material and others less. ■



Next, the contents are imported into the program Rapid Form where they are processed and transferred to Solid Works and onto Mastercam for five-axis CNC programming. Note: the piston pin is installed to provide accurate placement of the valve pockets.

The inboard piston is distinguished from the full-round style by its lack of continuous skirt. When produced competently in billet, its stability defends against rocking in the bore, thus maintaining better ring seal.

WHETHER OFF-THE-SHELF OR CUSTOM, A CHANGE TO ONE COMPONENT REQUIRES CHANGES TO THE OTHERS

"Using the secondary ring cut formula," says Robbie Giebas, "transforms the race piston." The technique is introduced as the last machining operation and it guarantees a flat surface and a very fine surface finish.

SOURCE:

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