PISTONS FOR POWER

Making More Power Reliably Through Pistons Technology

By Steve Dulcich

When it comes to pistons for a high-performance engine, the average builder or enthusiast looks at a limited number of criteria. Even for some pro engine builders, the only questions they want answered are: What is the size? What is the compression ratio? Sure, in the old days that was about all you had to choose from, and looking in a catalog, you'd find those 10:1 pistons at 0.030 over and you were pretty much done. If you were a little more curious, you might have looked at the chart in the back of the catalog and found out what cylinder head combustion chamber volume actually gave you that 10:1 compression—and that was about all you had to work with.

Today, piston choices have never been broader, and there are many quality manufacturers that will cut you a set of slugs in just about any configuration you can dream up. Among the very best in the business is CP Pistons, a manufacturer that is known for putting quality and precision first. Want proof? While visiting CP, we found out the company was actually being used by several OEM auto manufactures to supply and machine pistons for some of their very high-end flagship production high-performance vehicles, as well as their factory-backed race engines. At that level, you only deal with the best.

[1] CP offers a wide range of high-quality stocking pistons for popular applications, and the engineering and technical sales staff is capable of supplying custom or semi-custom pistons for virtually any applications. The pistons are modeled and engineered for a customer's unique engine application.

[2] Touring the facilities at CP, we were impressed with the production line and process used in manufacture. Many of the techniques are unique to CP and were designed to produce the highest quality products possible.


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MANUFACTURING HORSEPOWER

If you are a serious engine builder, you would have long graduated from the basic piston selection criteria described earlier. There are numerous factors in piston configuration that anyone can see, and they can definitely influence the power potential of a set of pistons. First, we have the piston crown configuration, which is an element of the design closely related to the cylinder head design. Factors here are the dome or dish shape, the quench and squish areas and location, and the valve pocket location and depth. These are all things you can see, and all have an influence on power output and even mechanical clearances. In its shelf piston lines, CP designs in extra clearance for today's more aggressive cam timing, as well as diametrical clearance for popular larger valve sizes. The finer details at the notches include subtle radii at the critical edges, or even fully rolled forms to promote airflow when the piston and valves are in close proximity. You may not think about just where the air needs to travel when the valve is shoved deep into the piston at near TDC, but these are factors that can add or subtract horsepower in a running engine.

Moving down the piston, we have the piston ring pack—again, an area that seems easily quantifiable by the specs. In the old days, most replacement pistons were cut for fat 5/64-inch compression rings, with a larger-than-life amount of iron rubbing on iron. Things have changed for the better, with even OEM manufacturers going to thinner ring sections with lower friction materials. It used to be a freshly assembled big-block with iron 5/64-inch rings would take 75 lb-ft of torque or more just to turn over with a breaker bar. That is a phenomenal amount of frictional load, wasted power,


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wear, and heat burden imposed on the cooling system. Cutting the ring pack width has two advantages—a huge reduction in frictional losses, and because of the decreased physical space, required thinner rings allow for tighter compression height or more flexibility in ring placement.

Traditionalists often fear the thin ring pack, considering the thick old-style rings better in terms of longevity or strength. The reality is that those old dimensions were products of cheap materials and wide machining tolerances. While back in the day a 1/16-inch compression ring package was considered "race-only," higher

[3] After initial machining, forgings are warehoused to age and settle before production machining is begun. CP pistons are manufactured in the USA from the forging process to the finished product.

[4] Machining accuracy is a product of the sequence, fixturing, and machining technique. All of these areas of the process are developed to produce the best product possible. We noted that where a process can be forced through a single step in the name of cost savings, CP will split the operation into separate machining stages to reduce distortion and improve the accuracy of the final product.

[5] At each stage of the manufacturing process, the piston is inspected. The culture is to reject any item that does not meet the strict manufacturing specifications.

[6] At the end of the manufacturing process, each piston is de-burred by hand, cleaned, and then is ready for installation.

"Traditionalists often fear the thin ring pack, considering the thick old-style rings better in terms of longevity or strength."

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precision and improved materials have brought ring section thickness and materials to ever higher standards. Production engines of today feature much thinner ring sections, precision materials, and extremely tight tolerances to dramatically improve power, sealing, and durability. If you are not taking advantage of this improvement in technology, you are leaving power and longevity behind. Modern narrow section nitride steel rings, generally in 1.5 or 1.2mm width, represent a major drop in friction, heat, and bore wear and better conform to the cylinder wall.

Other advancements in pistons that you can readily see include the skirt design and pin configuration. You'll find pistons in more applications with a reinforced "box"-type of forging, rather than the more familiar full-round style common in the past. These types of pistons offer a strength advantage and accommodate a shorter pin. The shorter pin configuration is both lighter and stronger, allowing

[7] The validation process includes a dedicated climate-controlled inspection facility, where detailed analysis of the finished product can be performed. The high level of manufacturing quality and verification has made CP the choice in some of the most exotic and demanding OEM piston applications.

[8] CP shelf pistons are designed to offer the racer or performance enthusiast enhanced features in replacement pistons. These Chevy pistons come with deeper valve notches to accommodate modern performance camshafts and radial clearance for common larger aftermarket valves.

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pin diameter reduction, which further decreases weight.

What you do not see is the design work that goes into friction reduction and enhanced piston stability. Although a piston appears to be round in the skirt area, the skirt is actually machined with a cam shape in the horizontal axis, and a barrel profile in the vertical axis. These two design elements work together to set the actual working contact surface of the skirt to maintain piston stability. By varying the cam and barrel specifications, both the surface area and location of the piston's contact with the bore are specifically designed for the applications. Other factors include the balance of the piston, setting the center of mass in the design stage for improved piston dynamics in a high-rpm engine. Lateral stability is yet another design element, and here CP uses proprietary contact areas in line with the pin axis to keep the piston straight in the bore. The guys at CP tell us designing a piston that is low in drag and high in stability will add up to more power.

Finally, we had a chance to tour the production facility at CP, and going through the manufacturing process step by step, we gained an appreciation for the manufacturing subtleties that lead to a more accurately manufactured piston. Machining a piston from a raw forging will induce stresses and distortions in the final machine work. Here, an emphasis is given to the sequence and production techniques that will yield a far more accurately manufactured finished product. At CP, this improved manufacturing begins with the fixturing system used throughout the manufacturing process. Their proprietary technique was developed to minimize piston distortion in manufacture, while optimizing location and accuracy in machining. The result is pistons that set the standard in the industry for precision. [EM]

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[9] The "box"-style skirt results in an extremely ridged piston, which utilize a shorter pin for less defection and lighter weight.

[10] While you will not see it at a casual glance, the cam and barrel shape and the specifics of the load-bearing and contact areas of the piston are designed to minimize friction while maximizing stability. The result is reduced drag and improved cylinder sealing for more power.

[11] A piston's teammate in sealing the bore is the piston ring. CP has embraced modern ring technology with dramatically improved materials and narrow ring section width. The result is a very durable and lightweight ring package with minimal friction and outstanding combustion sealing.

SOURCE:

CP PISTONS
(949) 567-9000
cp-carrillo.com