

PULLING ADDED PROFIT FROM PUSHRODS & LIFTERS

The Olympic record for lifting is 579 pounds, which is mighty impressive, even for a 350-pound human. Now consider that a racing valve lifter, with a weight measured in ounces, may have to struggle against a 1000-pound valve spring—and that may be the least of the stresses it faces.

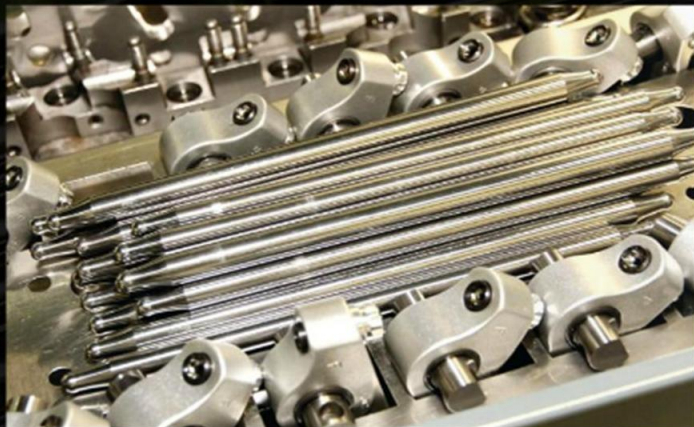
"Supercharging, turbocharging and nitrous require valvetrain parts that are stronger than before," noted Don Weber of Engine Pro, Wheat Ridge, Colorado. "The OEMs now sell street vehicles with twin turbochargers, which not only increase pressure on the valvetrain, but also heat. Valve spring pressure is just one part of the puzzle."

"Big motors, big spring pressures, and high rpm," added Kerry Novak of Crower Cams, San Diego, California, "are really hard on these parts."

It's fortunate then, that "materials and processing are always improving," reported Bill Godbold of Comp Cams, Memphis, Tennessee. "Our testing and modeling have grown by leaps and bounds, and our manufacturing capabilities have increased."

While Kirk Peters of Lunati in Olive Branch, Mississippi, reported "incremental evolution in all areas, including design, materials and quality control, lifters are high-stress components, and it's hard to find an area that we're not working on to make better and more durable products."

Meanwhile, the long-term progression toward ever-stiffer pushrods continues: "With increasing engine speed, we need the largest tube size we can fit in the engine," said Al Perkins of Manton



Pushrods, Lake Elsinore, California. "Valve spring pressures and rates are higher now than they have ever been, with larger cam cores and more lobe lift. And with higher cylinder pressures we see much more load on the exhaust pushrod as it tries to open the valve."

Here's how the racing aftermarket is meeting the challenge.

Mass, Pressure & Speed

As we mentioned above, valve spring pressure represents just one of the factors that stress a valve lifter. Cylinder pressure is also significant, although how significant depends on the application. Inertia seems to present the greatest challenge of all.

Peters characterized the force applied to the lifter from cylinder pressure as "definitely a factor that has to be accounted for during lifter design—but not at the top

of the list. However, the force required to move all the other valvetrain components plays a very large role in the maximum load a lifter will see."

"The energy in any system goes up with the square of speed," Godbold added, "and the forces on valvetrain components can grow even faster than the square of engine speed, as increased deflection takes up much of the intended lash ramp. With that in mind, high-speed engine components are always going to have to be made stronger—while designers also have to be very aware of mass."

"One of the major issues that comes with higher rpm," Peters agreed, "is that component weights in the valvetrain that we normally don't worry about begin to become a concern. When you consider that the energy in a system is related to the velocity of its mass squared, you

A variety of factors influence how pushrods and lifters operate in a race engine. Here, manufacturers of these critical valvetrain components discuss the latest developments and how these parts can thrive in exceedingly harsh environments.

By John F. Katz

can understand why it is that at higher rpm we see great gains when we reduce the mass of any valvetrain component." Lifters need to be stiff enough "to increase their resistance to deflection, but also reasonably weighted, to more easily follow the camshaft at higher speeds."

Higher valve spring pressures can actually help lifters more accurately follow the cam, according to Jack McInnis of Erson Carns, Louisville, Kentucky. "Spring pressures have tended to increase as a result of the more aggressive camshafts now in use. The increased spring load keeps the lifter wheel in contact with the cam lobe, which is important not only for valve events, but also to prevent impact damage to the lifters."

"More lifters are now being DLC coated," added Debbie Jackson of Precision Products Performance Center, Arden, North Carolina, "particularly for drag racers who are running much higher spring pressures, and in classes where steel valves are mandated." On the other hand, "lighter valvetrain components have allowed cam grinders to be more aggressive in their designs and reduce valve spring pressure."

Even so, as a cause of "lifter issues," said Peters, "valve spring pressure takes a back-seat" to valvetrain mass. High-force valve springs aren't so much the cause of lifter issues as they are indicative of a heavy valvetrain. "If you consider that the lifter has to follow the cam, and is the one part other than the cam that has to support the mass of all the other valvetrain parts, you can see that the mass of the entire system is what accounts for most of the load applied to the lifter. In a system where you may have 130 pounds of seat pressure and 370

pounds of open pressure, the lifter may actually see 3000-4000 pounds of force applied to it through the inertia loading that is required to move the valvetrain at high speed. So spring load and lifter load are connected—just not for the reasons one might have thought."

"There are basically two schools of thought," Godbold said. "One is to make all of the valvetrain components as robust as possible, and then use very high open spring loads to control dynamics. The other school wants to keep the spring loads as low as possible, and drastically reduce the mass of all other system components to allow higher speeds. Typically, the best path is a combination of being extremely mass conscious while increasing the system stiffness and strength as much as possible."

Scott Highland of Xceldyne and X2 in Thomasville, North Carolina, cautioned us not to obsess over rpm—at least not in the traditional V8 segments. "Engine speed has not skyrocketed in pushrod engines in recent years," he said, adding that it is more important to see "the valvetrain as a complete system. Most people want to



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combat problems such as breaking spring lips and spring pressure loss by adding more seat and open pressure. This is a patch at best, and does more harm than good to the pushrod-seat interface and to roller-lifter axles." Whereas, "the rewards of a properly tuned valve-train are parts that last exponentially longer, while preventing engine failures, which we all know are very expensive."

Success, then, requires balance. "Educating folks is the real challenge," said Chase Knight of Crane Cams, Daytona Beach, Florida. "In every motorsport other than drag racing, racers ask for the minimum spring pressure they can run—while the street and drag people want to pile on as much as possible. This can easily lead to premature wear and failures, especially where periods of idling are involved."

Bearings to Bushings

An additional challenge, said Godbold,

is presented by "the prevalence of ignition stutter kits to help speed turbo spool-up in drag racing." Racers often use an ignition cutoff not only to set launch rpm, but also to create ignition in the exhaust, to rapidly kick the turbine up to boost-producing speed. "These exhaust pressure spikes can lift the exhaust valves off their seats, resulting in drastic lash clearances. This is extremely abusive to the lifter wheel, bearing and axle. For these applications, or any others where the system is definitely out of control, softer bushing-style lifters spread out the load spikes more effectively, and are more forgiving in that environment."

This year, Engine Pro released a new line of bushing-style lifters. "Our Ultra Series Bushing Mechanical Roller Lifters provide up to 40 percent more load capacity than needle-bearing lifters," said Weber, "for use with modern extreme cam profiles and high spring rates. They

are fully rebuildable, and not for use with oil restrictors."

One of Lunati's newest products, added Peters, "is our series of bushed mechanical roller lifters. These lifters feature a highly durable bronze bushing that allows it to resist high-impact loads. They are also rebuildable and feature full-time pressure oiling."

Erson's new Ultra-Series mechanical roller lifters also feature a bushed wheel, "eliminating the needle bearings and providing superior high-rpm durability," said McInnis. "We have also introduced a new .947-inch-diameter lifter with an .840-inch diameter wheel. The larger wheel reduces bearing speeds, counteracting the increased speed that results from a large-diameter cam core."

Crower can rebuild its own roller lifters, which offers customers the option of installing new needle bearings, or

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