VALVES, VALVE

By John F. Katz

VALVES, like little pistons, reciprocate as the engine turns. They have to be accelerated precisely and stopped suddenly, putting weight at a premium. Even when open, they stand in the path of the incoming charge or outgoing exhaust, making their shape critical to flow. And the valves on the outgoing side have to face the full, withering heat of just-combusted exhaust gas.

Higher horsepower and high-winding rpm have stressed valves for decades. Now, small-displacement engines packing multi-valve heads—and often turbocharging, too—are pushing the limits even further.

"Three hundred horsepower per liter is common in road and rally racing today," noted Willy Tagliavini of Supertech Performance, San Jose, California, "and more than twice that in drag race engines running on gasoline. That kind of power and heat is very hard on the exhaust valves, which tend to warp and leak."

The thermal qualities of a small, turbocharged engine and of a traditional-size, normally aspirated V8 are different, explained Daniel Urrutia Jr. of Ferrea Racing Components, Fort Lauderdale, Florida, citing gas mass, volume, energy, pressure and temperature. "High-volumetric-efficiency engines generate higher cylinder pressures and temperatures. In general, it is the exhaust valve that needs to be considered, so it does not deform under heat and pressure," he said.

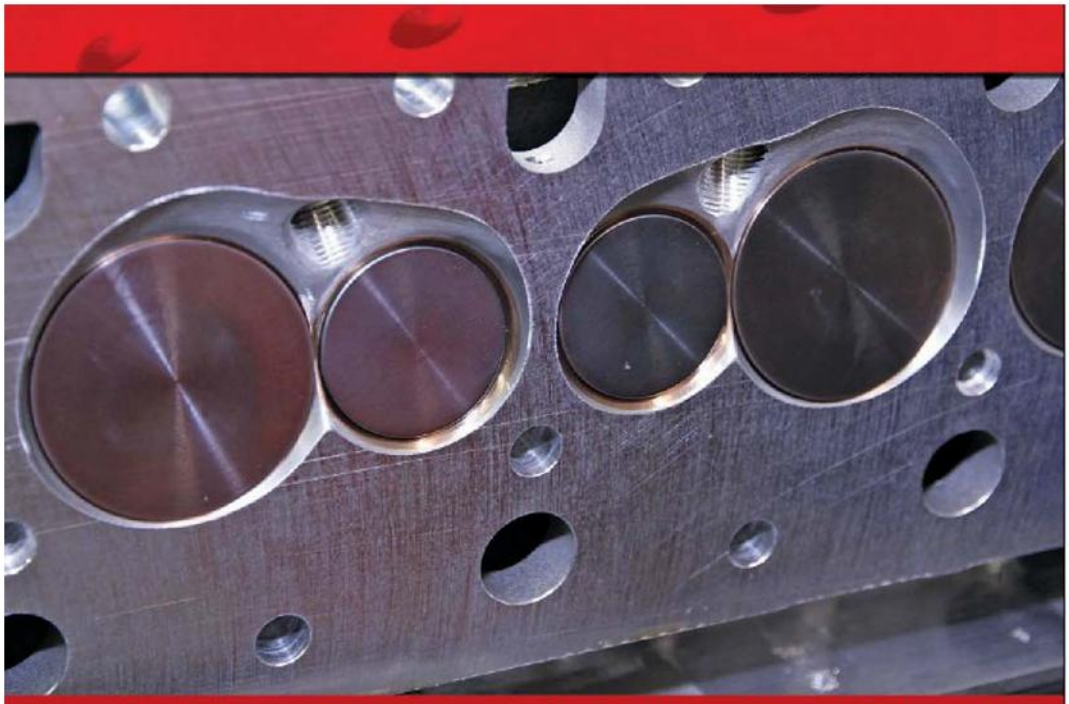
"Smaller engines may incorporate more aggressive cam profiles, more boost and/or more rpm to make more horsepower," added Will Kibblewhite of Kibblewhite Precision Machining, Pacifica, California. "Valve weight becomes critical with each of these."

In the pages that follow, we'll examine how aftermarket valve manufacturers are meeting critical needs on both sides of the cylinder head.

Some Like It Hot

The contradictory demands of high temperature and high rpm often dictate the use of different materials for intake and exhaust valves. "An intake valve is always being cooled by the new charge," explained Tagliavini, "so you can choose the material based on the level of racing, class regulations and budget. You can choose a titanium valve if regulations and budget allow, or stainless steel, and make it lighter with a hollow stem, smaller stem diameter, dished face, etc.

"But the exhaust valve is a different story, and in most cases you have to go the opposite way," he continued. "You need to use a high-temperature alloy such as Inconel or Nimonic, and you need more material on the neck of the valve, sometimes even a larger stem diameter to resist temperature distortion. With the trend toward smaller turbocharged engines, we see more hollow-stem, sodium-filled exhaust valves, even at the factory level. In certain high-



Among the more significant trends in valve engineering today are lighter weight and increased flow, with different head profiles for engines with power adders such as turbocharging, supercharging and nitrous oxide, according to one manufacturer. While keeping the valves as light as possible is essential, the challenge for engineers in optimizing valve mass is to maintain critical structural thickness so the valve can endure in these highly efficient applications, he added.

end race series, sodium-filled titanium valves are in common use."

"At the very high end," confirmed Don Weber of Engine Pro, Wheat Ridge, Colorado, "the issue of weight has been addressed with hollow-stem valves, and with hollow-stem titanium valves at the very top. For extreme heat applications, we see sodium-filled, hollow-stem valves. The sodium adds weight, but in a twin-turbo engine, weight is less of an issue than the ability of the valve to survive in that environment."

"Titanium valves are being pushed to the limit by hollow-stem designs and reductions in key cross-sectional areas," added Urrutia, "to lose as many grams as possible without sacrificing flow characteristics or strength."

Kibblewhite noted how "the evolution of PVD coatings has changed how titanium valves are used. The coating we currently use has extended the life of titanium valves in applications where change intervals were relatively short, and allowed them to

SEATS & GUIDES

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