Traditional Powerhouses:

CARBURETORS

THE laptop-lugging advocates of EFI have done an excellent job of associating carburetors with automotive antiquity—when, in fact, instead of asking why carburetors are still used in racing, we should be asking for what possible reason they wouldn't be. Production automobiles haven't run magneto ignition for nearly a century. More recently, recirculating-ball steering has retreated from all but the heaviest-duty pickup trucks. Yet no one would even consider burdening a Top Fuel dragster with the weight of a battery ignition; or want to negotiate the ruts, bumps, and lumps of a rugged dirt track with a rack-and-pinion. And no one thinks to ask why.

"Carburetors remain the core of our business," noted Blane Burnett of Holley Performance Products, Bowling Green, Kentucky. "Every weekend, in every state across America, countless racers and enthusiasts enjoy Saturday night drag racing, circle track racing, and other types of motorsport—everything from truck pulls to mud bogs to boat racing and more. And many of those competitors will always prefer the high performance a carburetor delivers for an economically achievable price."

Mike Laws of BLP Racing Products in Orlando, Florida, reported strong, continuing demand for racing carburetors in "circle track, drag racing, street/strip, truck pulling, etc." When we asked where in racing demand for carburetors might be declining, he replied, "Nowhere that I can think of."

"The good, old, four-barrel carburetor continues to be popular," confirmed Booth Platt of Proform, Warren, Michigan, "especially since they have become easier to tune, and provide more features at a reasonable price. Our carburetor sales have been growing for years, with

By John F. Katz

& MECHANICAL FUEL INJECTION

both our Race and Street series as popular as ever."

Simply put, carburetors ceased to suit the needs of the masses when the masses became emission-controlled. As a high-performance racing component, however, the carburetor is not merely surviving but improving every year, as it benefits from continuous development as a specialized racing component. We'll summarize some of the most recent, and most significant developments on the pages that follow. We'll also look into mechanically metered fuel injection, which, like the carburetor, was effectively banished from OEM vehicles by emissions requirements. It continues to offer many of the performance advantages of electronic fuel injection—without the weight, complexity, and vulnerability of the electronics.

Advanced Tuning

Dave Braswell of Braswell Carburetion in Tucson, Arizona, explained why racing carburetors must continue to improve: "Race engine performance increases every year—almost exponentially—so what worked on a race engine five years ago definitely won't work on a race engine today." Meanwhile, "quality has improved considerably because of better manufacturing processes and equipment. Everything is CNC'd now, where it used to be on rotary transfer. When you're not supplying an OE manufacturer, you don't have to save three cents on every carburetor, and you can perform better quality machine work."

Smaller production runs have also allowed a change from zinc castings to aluminum. "Zinc was cheap," Braswell explained, "and you could run a half-million units without replacing the die." Aluminum is more abrasive and must be cast at higher temperatures, reducing die life to about 75,000 units. But on motor racing's smaller scale, 75,000 is a lot of carburetors. More recently, Braswell has replaced his traditional billet aluminum metering blocks with die castings, "which are lighter and more cost-effective. They basically replicate the parts we were machining from billet, and they perform every bit as well."

Still, Braswell continued, the major trend "over the past two years has been toward multiple air bleeds," providing more precise control over the fuel curve. For example, "at higher rpm, a carburetor tends to draw excess fuel and run rich. But with an additional high-speed air bleed you can dilute the signal from the booster. It's like sucking soda through a straw that has a hole in it; the harder you suck, the more air you draw in. And the air displaces the fuel"—resulting in a closer-to-ideal mixture.

Changes to body castings are less common, said Braswell, however, "we just recently redesigned the Quick Fuel 4700PS carburetor, where we changed the shape of the venturi entrance—we redesigned the whole casting—to make it lighter and more competitive in Pro Stock and other high-rpm applications."

Braswell has also "put a tremendous amount of work into our 4760" (whose base is the same as a Holley 4150), "for the 602/604 and LS3 525 crate motors used in dirt track racing. We've recalibrated everything, and made metering plates specific for the application. And we've improved horsepower, drivability, throttle response and fuel mileage."

And in conjunction with K&N, Braswell has developed a nine-inch "warm up" air cleaner for dirt track racing. "The crews usually set the engines on high idle for five or 10 minutes to warm the oil, and they take off the air cleaner so they can access and tune the carburetor. But our air cleaner sticks up about six inches above the carburetor," permitting full access while still protecting the engine from ingesting dirt. A conventional, drop-base air cleaner would of course be installed for the actual race. Finally, Braswell assured us that, thanks to a new supplier, his "supply problem with carburetor floats is history. We now have 14 different floats available, for every imaginable application."

"We are always looking for ways to

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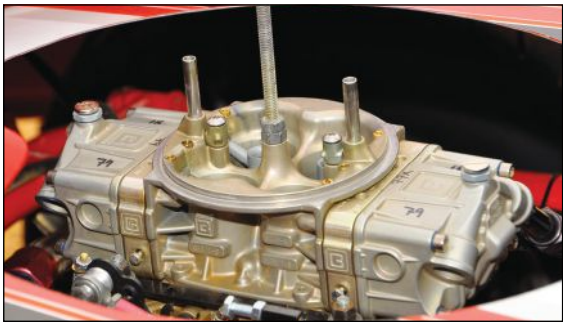
improve the overall performance of our carburetors," noted Zach Baker of Quick Fuel Technology, Bowling Green, Kentucky. Baker confirmed a focus on enhanced tunability. "By adding fuel circuits in the blocks, we can influence the fuel curve and improve the signal. For example, our new three-circuit metering blocks for our QFX-Series carbs include an intermediate channel for better tuning, and angled intermediate feeds for improved fuel control during acceleration and cornering."



Carburetors appear in a variety of race classes at tracks across North America, and the technology behind them continues to improve. One supplier explained that because race engine performance increases every year—almost exponentially—what worked on a race engine five years ago isn't likely to work on that same engine today. Those technological advances are further enhanced by improved quality through better manufacturing processes and equipment.

Bill Wetzel added that Quick Fuel "has just introduced a streetable version of our QFX-Series carbs. The QFX Pro-Street provides all the tunability features and performance of our larger QFX, but in smaller 750 and 975 cfm sizes, for customers interested in more performance on the street."

BLP's Laws agreed that, the "size, power and efficiency of today's racing engines are driving continuing development in racing carburetors," citing, among other elements, "improvements in venturi and throttle-bore shapes, increased airflow, improved fuel control in the bowl, and better control of emulsified fuel—all in a smaller, lighter package. Controlling a desired air/fuel ratio pattern throughout an engine's useful rpm range has always been challenging, but we answer that

challenge by providing high-quality components that match our customers' needs. Our new upper fuel jet provides yet another tool for fine-tuning, especially in the upper-rpm range, allowing engine builders to control AFR with a degree of precision they've never seen before. One of the best builders in the nation told us it provides EFI-like control—and it's all done with a screwdriver and a set of jets." Additionally, "our newest 4150 carb can flow over 1600 cfm."

BLP's billet line of 4150 style main bodies includes the billet aluminum Lil Bo, which instead of four separate venturis is machined with two large oval throats. "It basically flows the same 1200–1250 cfm as a Dominator, on a 4150 base plate," explained Tony Morris. The similar Mini-Bo exploits the same design and shares the 4150 base, but has 5 percent smaller venturis for a flow rate around 1050 cfm; while the BX-4 is sized like the Lil Bo but uses a more conventional four-barrel configuration.

Relatively new from BLP is the Bomax fuel bowl, designed to reduce aeration. Instead of the standard 6–7 psi, the Bomax bowl requires an inlet pressure as low as 2 psi, thanks to an oversized needle-and-seat assembly featuring a huge 0.250-inch orifice. "Because you have the volume, you don't need the pressure," Morris explained, "and therefore you don't have as much aeration."

"It supplies enough fuel for over 1500 horsepower on a gas-powered, single-carb-engine," Laws added.

Bomax is an option that can be fitted to almost any BLP carburetor.

Holley, said Burnett, "has been working aggressively to keep up with the needs of today's more demanding, higher-horsepower engines. With our Gen III Dominator line, we've released several new carburetor sizes, ranging up to nearly 1500 cfm, which has already gone on to win big races in NHRA Pro Stock.

"Another goal of our new race carburetors was to design and develop components and calibrations that are more application-specific—for oxygenated fuels, E85, two-four configurations, etc.—

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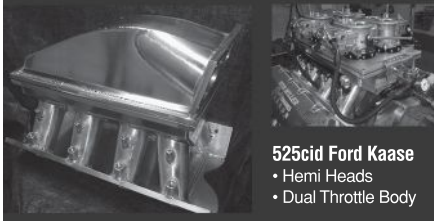
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and we've established some great test partnerships that have helped make that happen." Holley has released an E85 version of its Ultra XP "small bore" unit (600–950 cfm), "for racers who use ethanol-based fuels; and has re-released the 4412, a two-barrel 500 cfm Ultra XP also tuned for E85. "Now we are in the process of releasing circle track specific XP applications in the 650 and 750 cfm sizes, as well as methanol-specific calibrations for the 950 cfm XP, and 1050 and 1150 cfm Dominators."

Sprint cars are by far the industry's largest market for mechanical fuel injection because of the requirement for a lightweight and reliable system, reported one manufacturer. He explained that a car with EFI would be at a disadvantage in this class because the required alternator and battery would greatly increase the weight of the vehicle. Photo courtesy of Hilborn Fuel Injection.

Proform's new Race Series carburetors "deliver a combination of quality components and plenty of adjustability, all for a great price," said Platt. "Our all-aluminum main body and components weigh less and dissipate heat better than zinc—that's two things racers are always looking for."

InjectionDirections

Like the carburetor, mechanically metered fuel injection has persisted in particular race applications, and for similar reasons—i.e., it's still the best tool for the job. Individual Runner (IR) systems, which replace the conventional manifold, remain popular in drag racing and street performance, while still utterly dominating alcohol-fired sprint cars.

Brad Cauzillo of Kinsler Fuel Injection in Troy, Michigan, explained the particular strengths of electronic versus mechanical metering. "EFI is excellent for precise metering and control of ignition advance—God's gift to any turbo motor. For street performance and road race cars, EFI allows not only precision fuel metering, but self-learning fuel metering, with excellent fuel economy and low emissions." On the other hand, "mechanical metering is still the ultimate for sprint cars, as it doesn't have any wires to fail as the vehicle shakes across the ruts and bumps in the track. For running alky and especially nitro, mechanical injection can flow huge amounts of fuel. That's why we sell both types."

Don Enriquez of Hilborn Fuel Injection in Aliso Viejo, California, added, "Sprint cars are by far the largest market for mechanical fuel injection, where a lightweight and reliable system is required. A car with EFI would be at a disadvantage in this class, as the required alternator and battery would dramatically increase the weight of the vehicle."

In alcohol-fueled bracket racing, Enriquez continued, "mechanical and electronic injection systems go head-to-head with neither type dominating the win column. At wide-open throttle, a mechanical system is quite efficient and, once understood, easily tuned. EFI offers the advantages of spot-on tuning and data logging, which can help the average racer extract the maximum potential, whether tuning for power or weather."

Kinsler's Cauzillo listed some recent improvements. "A year ago we developed our Torque Valve, to lean out the fuel curve below the torque peak. The constant flow metering system has always run a bit too rich in that area. The Torque Valve remains closed up to about 2500 rpm (or about 9 psi), then it opens to send fuel back to the tank through a metering jet." The valve closes around 4500 rpm (approximately 25 psi) to richen the mixture at peak torque, which arrives around 5500 rpm. "Some racers have found that this makes the engine far more responsive and drivable."

Fuel injection systems—both electronic and mechanical—depend on high-pressure fuel delivery, and Kinsler has continued to raise its maximum system pressure for better atomization. "Five

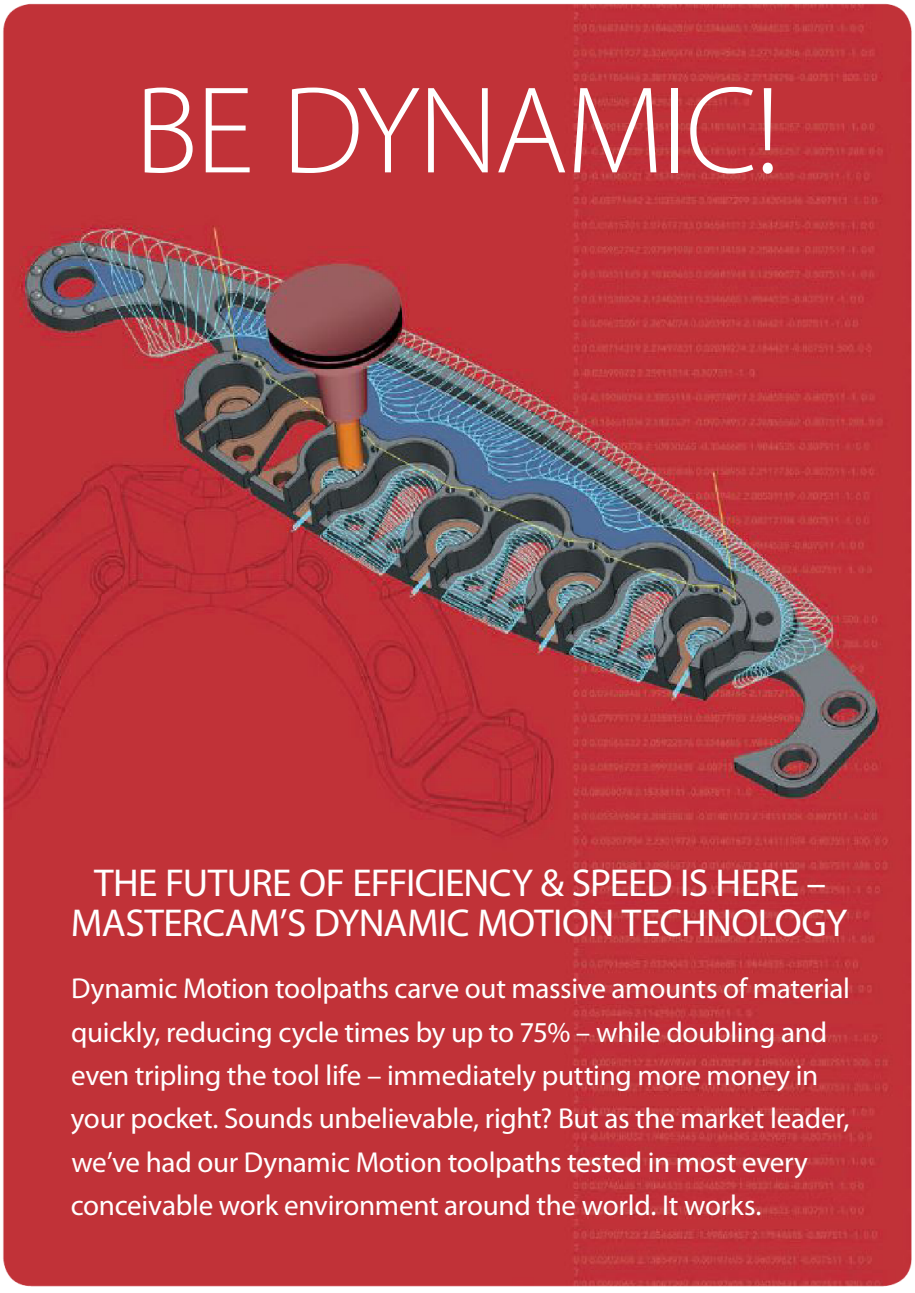
years ago it was 75 psi at 8000 rpm," said Cauzillo. "It's now up to 125 psi on most systems and as high as 180 psi on some." Anticipating the need for these higher fuel pressures, Kinsler developed the Tough Pump, which is used in top racing categories, such as World of Outlaws sprint cars, he added. "We've brought materials, tolerances, and coatings to an all-new level. We've not had a single pump fail in the field since we introduced the Tough Pump eight years ago. We believe the standard model is good for at least 200 psi, and we can make special builds for up to 400 psi."

Nozzles have improved as well. "We now make nozzles with deflector tips up to 6.5 inches long," said Cauzillo, "to put the fuel right at the center of the port, at the gasket surface. This directs more fuel to the back of the intake valve, with less wetting of the port wall. We minimize the diameter of these long deflectors to minimize airflow restriction. Most of the 410 sprint cars that have adapted these new nozzles have picked up power."

Another "top priority," according to Cauzillo, "is making the throttles operate smoother, to give the racer more control at part throttle. We offer all-ball-bearing throttle shafts, and a unique, non-linear linkage that opens the throttles at only one-third the normal rate at low throttle openings, then 'catches up' in speed as it approaches wide open." Blade angle at idle has been re-thought as well. "We always used to use 14 degrees. Now we run some as low as 5 degrees—but everything has to be perfect to be sure there is no sticking in the throttle bore."

Ron's Fuel Injection of Tucson, Arizona, offers a wide range of mechanical systems. The Terminator, T2, and Flying Toilet include throttle bodies that bolt onto a manifold in place of a carburetor. Ron's also makes "hat" systems for blowers, and IRs sized for small engines and motorcycles. "Drag racing is still our biggest market by far," said Jeremy Camacho, "although the mud truck classes have started to expand for us at a very good pace."

He added that, like carburetors,



mechanical fuel injection systems continue to benefit from "subtle but effective" changes. At Ron's, recent advances have focused on the barrel valve, which "we have refined to be more durable. We've also made different spools for specific fuels, and for boosted applications. And we've done a good amount of work on our blower setups to make them more user-friendly."

As a high-performance racing component, the carburetor is not merely surviving, but rather improving every year as it benefits from continuous development as a specialized racing component. Racers may not be aware of the newest features, so it's up to salespeople to point out these new developments and explain to customers how new products can improve performance on the race track. Photo courtesy of Quick Fuel Technology.

Additionally, Camacho continued, "we've made more of our parts modular, so they can be used in different configurations. We now have barrel valves and throttle bodies that can interchange with different applications. Barrel-valve scrolls can be changed to accommodate different fuels, and we can provide additional bypasses if needed. We're streamlining the system to make it more cost-effective for the customer. And while our base system can be tailored to individual applications, we are also offering more individual styling options, including custom colors, brass bushings, and braided stainless hoses."

Ron's also manufactures fuel pumps and bypasses that can be used with carburetors or fuel injection. "Many customers will buy a fuel pump kit for their carburetor, with the intention of switching over to fuel injection at a later date."

For all that divides fuel injection from

carburetion, these two mechanical fuel-delivery technologies still influence each other. "We use an annular discharge sleeve in our QFi throttle body to atomize the fuel," noted Baker, "a concept came from the annular-style booster we use in some of our carburetors."

And according to Laws, BLP's billet main bodies can also function as throttle bodies for fuel injection.

"The carburetor manufacturers look at what we do," Cauzillo added, "and vice versa. We are both trying to develop throttles that flow more efficiently, so we can reduce their diameter for better part-throttle control and more torque. The Europeans have been at this forever; look how small the runners are on a racing Ferrari."

CarburetorQuestions

Naturally, we asked our experts about choosing the right carburetor for a particular application. "The right size carburetor can be derived from a simple formula," said Burnett. "Multiply the engine's cubic-inch displacement by the maximum rpm, and divide that number by 3456. Take the result and multiply it by the engine's approximate volumetric efficiency. Use 80 percent for a stock engine"—that is, multiply by 0.80. "For a mildly modified engine, use 0.85, and for a highly modified race engine, use 0.95." This will give you the cfm you need.

But cfm isn't all you need to know. Wetzel added, "Horsepower requirements, compression ratio, camshaft type, and whether power adders are used; plus vehicle weight, transmission type and, most importantly, the type of driving. And even this is not an all-inclusive list. But at Quick Fuel we have a dedicated and knowledgeable technical staff who can assist in making the right choice."

We also asked our experts to tell us about the questions their customers frequently ask—and how they answer them. "Typical questions revolve around fuel pressure, cfm, and mechanical versus vacuum secondaries," Baker replied. "Regarding fuel pressure, we recommend 6.5 psi. CFM is relative to engine displacement, rpm, desired horsepower, and where the engine will be used. Secondary activation is also dependent on the setup of the vehicle and what it will be used for."

"The issue we address most often," added Braswell, "is racers running too much fuel pressure. If you have to run over 7 1/2 pounds on a single four-barrel, or more than 6 pounds on a dual quad, your needle-and-seat is way too small."

Another common problem, according to Baker, is off-idle stumble. "The solution is to readjust the throttle-plate position and the mixture screws, and to increase the size of the nozzle on the accelerator pump," he said.

Carburetor sales remain strong due to their popularity in drag racing, circle track racing, truck pulls, mud bogs, boat racing, and more. One contact noted that many of these competitors will always prefer the high performance a carburetor delivers for an economically achievable price. Photo courtesy of BLP.

Holley, said Burnett, "has produced several videos that answer the majority of the questions that we receive on a regular basis through our tech line. These videos are featured on our YouTube channel (www.youtube.com/HolleyPerformance) absolutely free of charge."

InjectionInquiries

Fuel injection customers have questions, too. "There are two common questions, actually," said Enriquez, "one about tuning the system as a whole—including the barrel valve, main jet, and high speed—and the other about fine-tuning the butterflies. Properly adjusted butterflies help idle quality, throttle tip-in and part-throttle performance. We have videos on our website (www.hilborninjection.com) that demonstrate

the entire process in detail." One-on-one education is still the best option for learning how to tune a mechanical system, "but our videos describe in detail the changes the racer should consider, the expected outcomes, and the targets to shoot for."

"Another common problem we encounter is when racers run alcohol with no high-speed bypass," Enriquez continued, "usually because they are trying to apply their previous experience with gasoline injection to an alcohol injector. There's a common misconception that when the engine goes flat at high rpm, the tune-up should be lean; but with alcohol, the typical concern is over-fueling. Or the racer has leaned the main jet to correct the over-fueling at high rpm but has no mid-range torque. Further questioning reveals there is no high-speed bypass in the system, and therefore the correct fueling through the curve cannot be established. For high-rpm use with mechanical injection on alcohol, a high-speed bypass is strongly recommended for maximum potential."

Some of the most common questions Kinsler answers also involve fuel curve: "'My system's all messed up! It runs too rich or too lean at some point.' Sometimes we can figure it out over the phone; some need to be sent to us," explained Cauzillo. In the latter case, however, "we always figure out what's wrong on our flow bench, which quickly tells us the facts—especially about nozzle distribution problems."

Camacho, of Ron's Fuel Injection, cited "the many misconceptions about fuel injection: Will my oil be milky? Is injected methanol harder on parts? Will the huge fuel pump required work with my small engine? The answer to all of these is that a system built for your application is not going to milk the oil or kill parts. There's no one-size-fits-all in fuel injection, and buying a system that isn't set up for your engine is a bad idea. Bigger is not always better—and sometimes the money you save buying a used fuel injection system goes right out the window when you have to change everything else to it work with your combination." PRI