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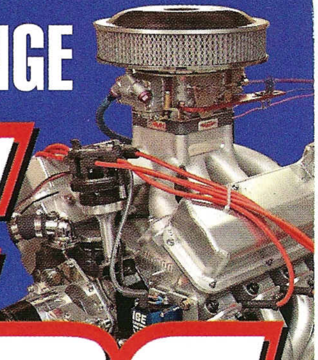

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CARB-U-

We Go Deep Into The Tuning Variances Of Holley's 650, 750, 950, And 1,000-cfm HP Carbs

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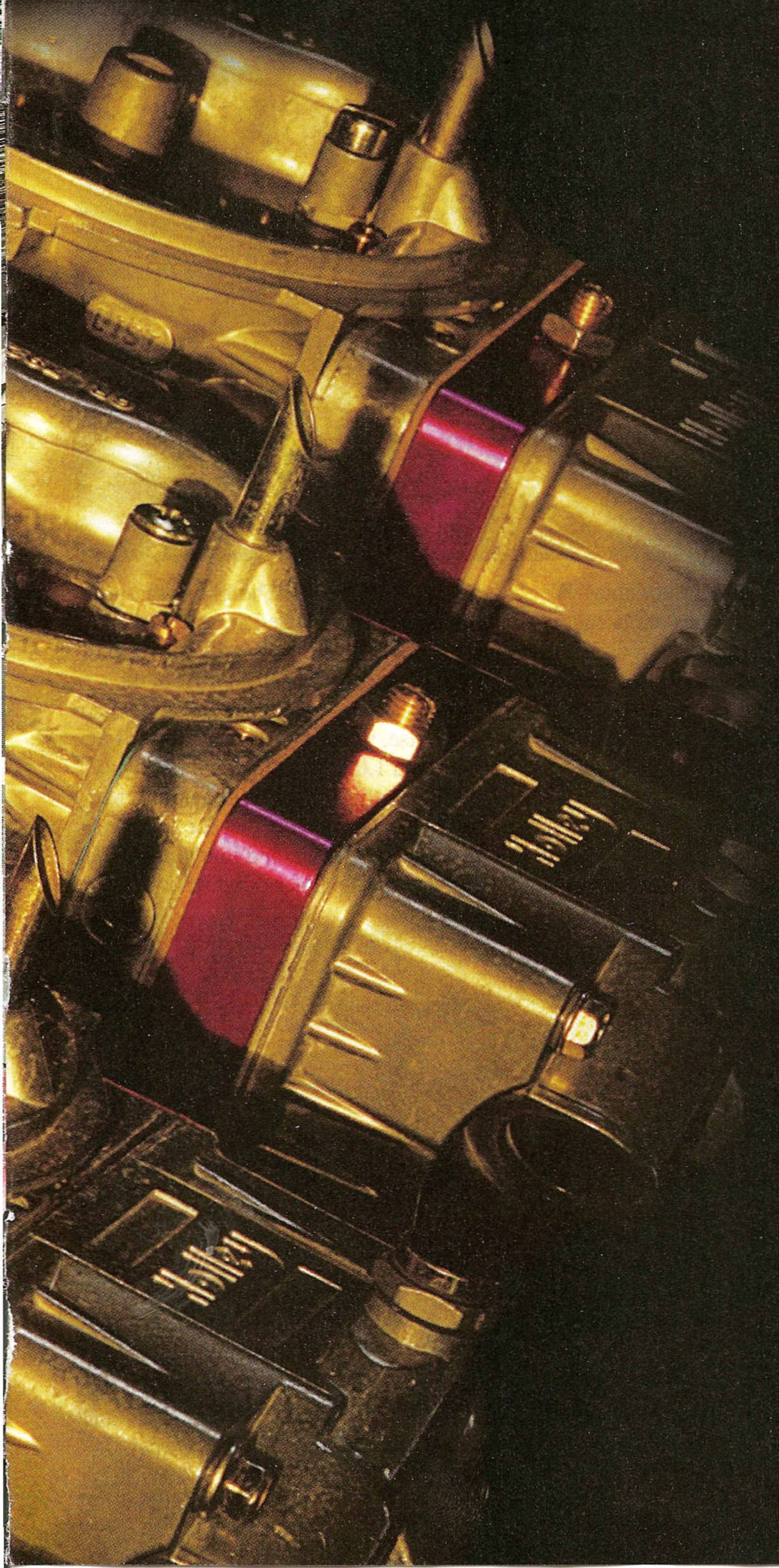


By David Freiburger
Photography By David Freiburger

After a couple of decades messing with Holley carbs on the dyno, on the street, and at the track, we've got a pretty good notion of which carb to pick for a given application, yet we've never done the exact test seen here. In this story we'll test and tune Holley's 650-, 750-, 950-, and 1,000-cfm HP-series carbs on a single engine using a Superflow 902 engine dyno to datalog all the relevant info. We can then dig into how carb sizing affects tune-up and engine operation.

THE MULE

We wanted to test with a typical street/strip, pump-gas engine, so we nabbed a Ford Racing 392ci crate engine out of stock at Westech Performance. The 392 is a 351-based Windsor using a new Sportsman block with a bore and stroke of 4.030x3.850 inches and a compression ratio of 9.7:1. While Ford offers a version with upgraded heads, this one has the base GT-40 aluminum castings with 1.95/1.54-inch valves. The intake is a Ford-part–numbered Edelbrock Victor Jr. single-plane, and we used Hooker headers with 1 ¾-inch tubes and 18-inch collector extensions. The only variation from box-stock was a Comp Cams Extreme Energy hydraulic roller cam with 232/240 degrees of duration at 0.050, 0.565/0.574-inch lift, and a lobe separation angle of 112 degrees. The stock distributor triggered an MSD Digital 7 box and was set to 35 degrees of total ignition advance. All the testing was done with 91-octane gas provided by Rockett Brand, and we had Lucas 5-30 synthetic in the sump.

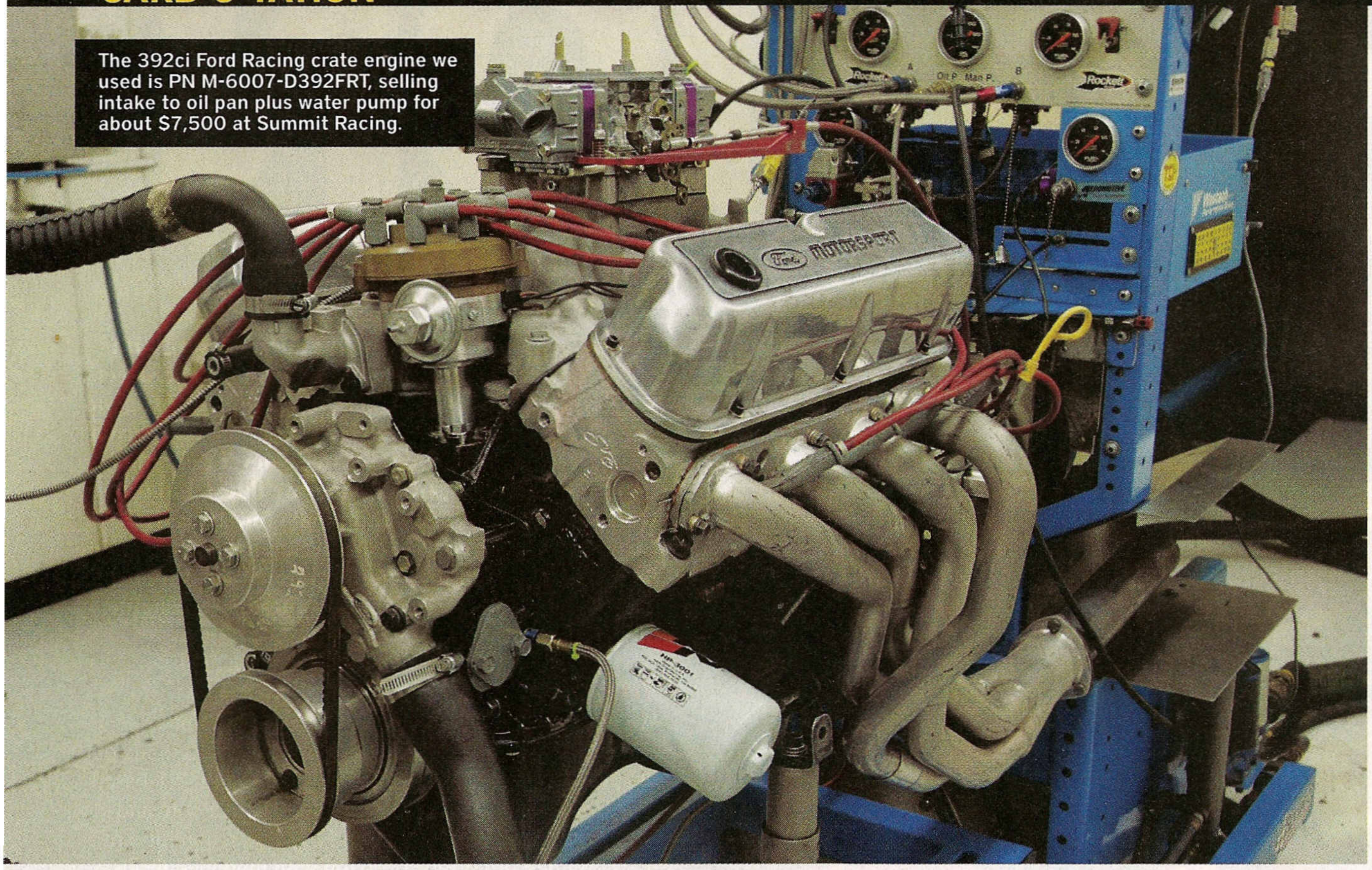
THE CARBS

Each of the carburetors we tested was from Holley's HP line, and included a 650 Street HP, a 750 Street HP, a 950 Ultra HP, and a 1,000 HP. The specifics of each carb can be seen in the chart included in this story.

The difference between a Street HP and a regular HP-series carb lands mostly in the factory tune-up ,and it changes depending on the carb size you're considering. In our case, the 650 Street HP used straight boosters rather than the downleg style used in all the other carbs.

Our one Ultra-series carb was the 950. The difference between an Ultra and a regular HP carb is the addition of a billet-aluminum baseplate and billet metering blocks with adjustable emulsion bleeds.

All the carbs were run with Holley's out-of-the-box high- and low-speed air bleeds and emulsion bleeds. We changed the front power valves from 6.5s to 8.5s in each case, and jetted them according to the notes you'll read



The 392ci Ford Racing crate engine we used is PN M-6007-D392FRT, selling intake to oil pan plus water pump for about $7,500 at Summit Racing.

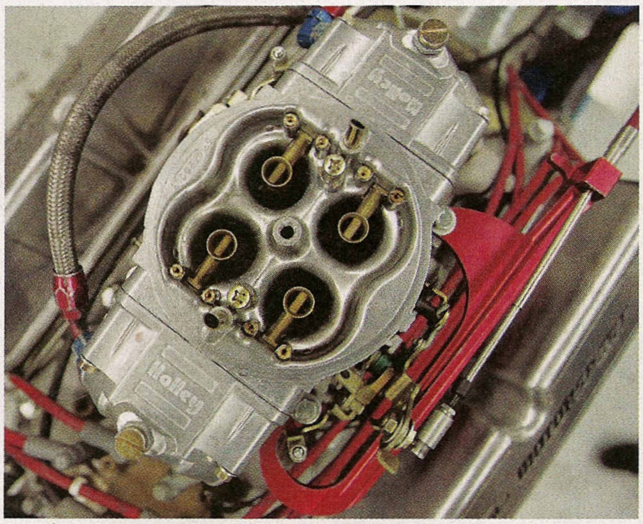
ahead. Both the 750 and 1,000-cfm units were equipped with Percy's Adjust-a-Jet plates; learn about those in the sidebar.

THE TEST PARAMETERS

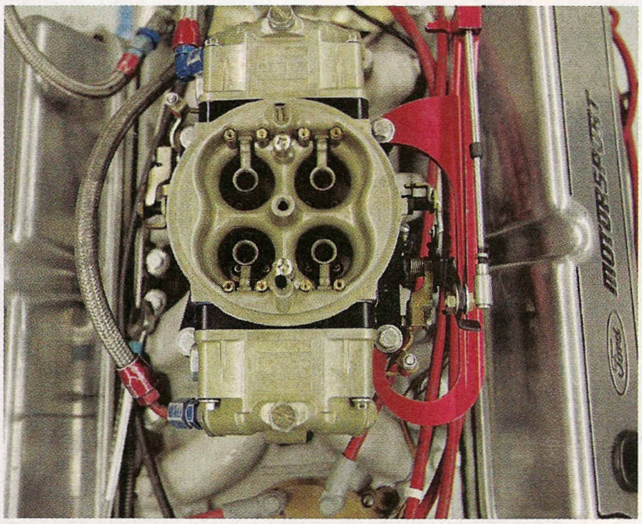
To evaluate the performance of each carb, we decided that the tune-up variable to maintain as a constant was air/fuel ratio (afr) at peak horsepower (while also keeping afr throughout the power curve as similar as possible). We maintained afr as the constant because, as you'll see, each carb uses a different amount of incoming air and fuel to deliver the same afr in the pipe, even at similar power levels. How can that be? That's the meat of what we're about to learn.

AIRFLOW

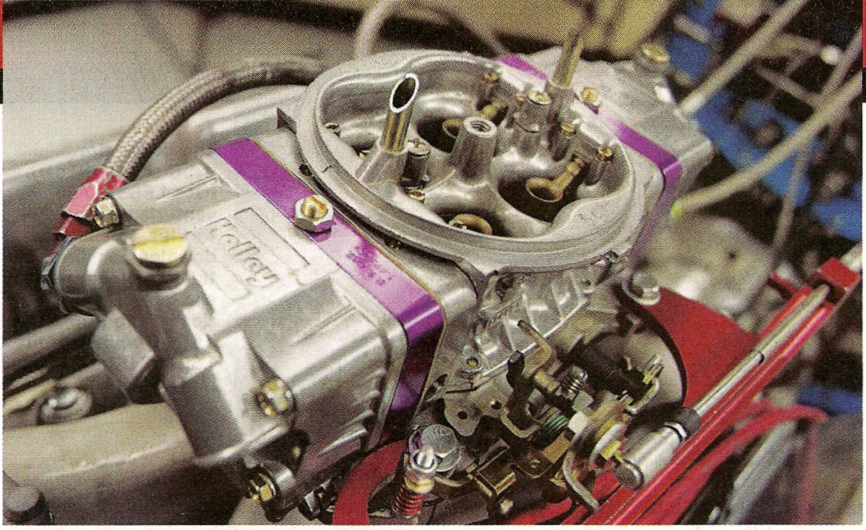
There are two things to know before we get into test results. The first is that just because a carb is rated at, say, 650 cfm, does not mean it necessarily moves 650 cubic feet per minute of air from the atmosphere into the engine at any time. Likewise, swapping from a 650-cfm carb to a 1,000 does not guarantee that significantly more air will get into the engine. The reason is that for any given displacement, rpm, and inlet/outlet restriction (the latter of which includes



The 650 Street HP differs from the regular 650 HP only in the factory-delivered tune-up. Both versions use straight boosters.



The 950 Ultra HP is one of our favorite carbs for more radical engines, but it did not show any advantage in this test.



The 750 HP proved to be our pick for the best all-around carb on our test engine. The Street HP version is shiny; if you want the classic dichromate finish, you'll need to buy a regular HP.

a huge gamut of components that affect power production), the engine can only consume so much air. Changing from a smaller carb to a larger one only makes a significant change in airflow through the engine if the smaller carburetor posed a restriction to begin with.

Second, it's critical to understand that the cfm number that is datalogged with a typical dyno will not correlate to the advertised cfm number of the carb, or even to the cfm that can be derived by placing that carb on either a wet or dry flow bench. Holley four-barrels are traditionally rated at a pressure drop of 1.5 inches of water (also see the "Ignore the Numbers" sidebar). Meanwhile, the air hat that's placed atop the carburetor on an engine dyno measures dry air at a pressure drop that's variable according to the demands of the engine being tested. You can't take the dyno-data cfm number and apply that directly to an advertised carb cfm number.

Armed with a little background, now you can analyze the measured airflow data from our test, as illustrated in the accompanying Chart 1.

The similarity of those numbers backs up our point that larger carburetors do not necessarily deliver proportionally greater airflow through the engine. This Ford 392ci mill can only use roughly 590 cfm at 5,800 rpm, and larger carbs do not change that demand. An engine with more displacement, more horsepower, or more rpm would have more airflow. Less cubes, less power, and less rpm means less airflow. From the data, however, we can derive that the 650 carb flowed 5 to 10 less cfm and therefore posed a slight restriction that can reduce peak horsepower potential.

The Ultra-series Holley carbs feature billet baseplates and metering blocks, and have these adjustable emulsion bleeds that can help tune street driveability to perfection.

THE TUNE

So far we've established that all the carbs flow roughly the same volume of air when installed on this engine. However, each carb uses a different combination of venturi diameter, booster type, and throttle-plate diameter. The combination of the booster and the venturi can be viewed as a constriction in a pipe that has the atmosphere at one end and the engine at the other. The engine itself creates the pressure drop that causes atmospheric pressure to push air into the engine, flowing through the venturi.

The law of conservation of mass states that the mass flow into a constriction must equal the mass flow out of the constriction. Since mass moving over a unit of distance per unit of time (cubic feet per *minute* gives us the unit of time) must remain the same at all points, the airspeed at the constriction must be higher than the airspeed before or after the constriction. A carb's venturis increase airspeed in this way.

Now we get to Bernoulli's principle: As the velocity of a fluid increases, the pressure exerted by that fluid decreases. In this case, air is the fluid. Therefore, the airspeed increase across the venturis causes a pressure drop, or what we unscientifically call a vacuum. It's that vacuum that draws fuel out of the carburetor's boosters and into the engine.

The smaller the area of the venturis, the greater the airspeed through the carburetor, the greater the pressure drop, and the more fuel that's sucked from the boosters. A Holley's main jets feed fuel directly to the boosters, so a carb with smaller venturis sucks harder on the boosters and requires smaller jets to flow the same volume of fuel than a carb with larger venturis and less airspeed.

You'll sometimes hear a bench racer say something along the lines of, "I went to a bigger carb, so I had to take some jet out of it." Actually, the inverse is often required. Review the sidebar "Carb Comparo" chart to see how the larger carbs required a combination of

IGNORE THE NUMBERS

Don't believe every cfm number you read. You should know that a carburetor's factory cfm rating may or may not be based on scientific testing. For example, an Edelbrock 750 carb flows less air on a test bench than a Holley 750 carb; this fact alone does not inherently make one or the other "better" or "worse." Also, Holley may list one carb at 650 cfm and another at 670 cfm even though they have the same combination of venturi diameter, butterfly diameter, and booster size.

Another example is the Holley 950 HP that uses a 750-type body and an 850-type baseplate; clearly, this does not add up to more cfm, but it does mate a smaller venturi with a larger throttle plate, which increases airspeed and makes for a good-performing carb (in fact, the 950 HP is one of our all-around favorites).

This inflation of claims came from the days when carb tuner companies started to brag about airflow numbers and carb companies had to fudge things around to compete. It's all in the marketing. Investigating the actual specs of the venturi, booster, and butterflies can be educational, and all that info is listed in the Holley catalog.

PERCY'S ADJUST-A-JET

Here's the biggest time saver we've seen in a long time. The Adjust-A-Jet from Percy's High Performance is an additional plate that sandwiches between the float bowls and the metering plates of your Holley carb. It eliminates the stock screw-in jets and replaces them with an orifice with an adjustable restriction that you can tune in seconds with an open-end wrench and a screwdriver without ever taking apart the carb. It's pure genius.

Steve Brule at Westech tested the Percy's blocks by first tuning an engine with conventional jets, then installing the Adjust-A-Jet parts and setting the adjusters to the number of turns that Percy's instructions claimed equated to the same jet sizes. The result in fuel slow in lbs/hr and in air-fuel ratio was dead nuts. The plates slightly increase the volume of fuel in the bowls, but the fuel level is not altered, so it has no effect on afr.

These things saved us a ton of time and hassle. Get a set. You need them.

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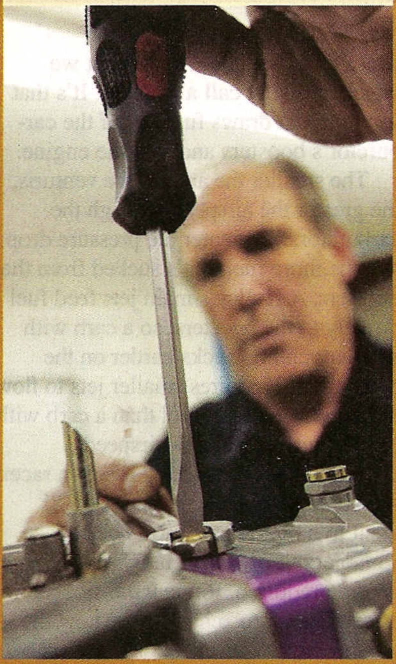
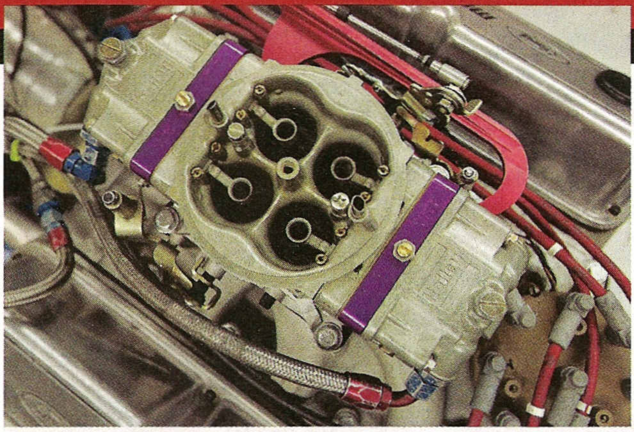




The 1,000-cfm 4150-series HP carb uses 1.563x1.750 venturis and butterflies. This one has downleg boosters, though annular is also available. Point of curiosity: the 1,050-cfm 4500 Dominators are 1.690x2.00 with annular boosters.

larger jets and to deliver roughly the same fuel flow; larger air bleeds are also a contributor in some cases.

FUEL USE

The other bench-racing standard you'll hear is, "You don't want that big ol' carburetor or you'll use too much gas." We've often dismissed that one. It turns out that it's true, but for reasons that the average Internet message-board expert likely has not considered.

We've established that each carb flowed about the same amount of air, so one would think they would each need to deliver the same volume of fuel to create a like air/fuel ratio. This wasn't the case. In our testing we found that the larger the carb, the more fuel that was required to achieve our target air/fuel ratio. For example, the 650 carb needed 210 lbs/hr of fuel at peak horsepower to deliver 12.9:1 afr, while the 950 used 217 lbs/hr for 12.7:1.

The differences are slight, and perhaps the 7 lbs/hr is enough to make the 950 carb run 0.2:1 richer than the 650. However, we suspect that the larger carb with its slower airspeed is not atomizing the fuel as well, and that it therefore needs more fuel flow to achieve the same power and a similar recorded air/fuel ratio.

This can be somewhat confirmed if you'll allow us a bit more bench racing. The 750 carb actually showed us the least fuel consumption of all the carbs, flowing 204 lbs/hr at peak power. It used the least fuel overall, yet made more power at the same afr as the 650. Our conclusion was that the downleg boosters in the 750's 1 ⅜-inch venturis (1 ⅜ inches versus the 650's 1 ¼) created a more advantageous fuel droplet size than the straight boosters in the 650's 1 ¼-inch venturis.

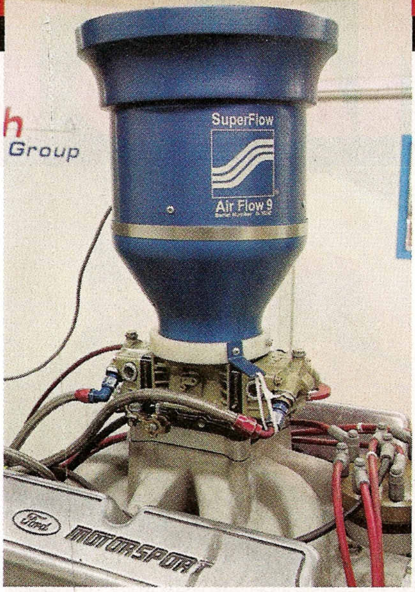
DRIVEABILITY

The other major issue with airspeed in the carburetor is driveability, a factor

CARB COMPARO

This chart will give you an overview of the models of carbs used in our test and how we tuned them. The idle vacuum and air/fuel ratio numbers are based on a no-load idle speed of 900 rpm. (Note: The 950 and 1,000 have factory air holes in each throttle blade, the 650 and 750 do not.) The numbers for the air bleeds represent the low-speed setting first, then the high-speed; all the bleeds are as factory delivered. The jets shown here are what were required for us to even up the tune for each carb. All the air/fuel numbers are based on lambda readings rather than calculations.

	650	750	950	1,000
Part Number	0-82651	0-82751	0-80676	0-80513
Series	Street HP	Street HP	Ultra HP	HP
Venturi Size	1.250	1.375	1.375	1.563
Throttle blade	1.688	1.688	1.750	1.750
Booster type	Straight	Downleg	Downleg	Downleg
Idle vacuum	12.1	12.3	12.8	12.6
Idle afr	14.0	13.8	14.2	13.7
Jets	66/73	71/73	76/81	77/77
Air Bleeds	68/41	71/28	68/32	75/25
Peak Lb/Hr	210	204	217	213
Peak cfm	584	591	593	595
Peak power afr	12.9:1	12.7:1	12.7	12.7:1



In our test, Superflow's air hat was used to calculate the cfm of dry air consumed by the engine with each carb. An oxygen sensor was used to collect air/fuel ratio data.

that's tough to quantify on an engine dyno. In general, the higher the airspeed the snappier the throttle response (as long as the carb is not posing so much of an inlet restriction as to kill power). By that standard, the 650 or 750 carbs would be the best choice on this 392.

The problem with low airspeed can be seen on the dyno as the engine is loaded at WOT at just 2,000 rpm to start each pull. This is a dynamic situation unlike anything you'd see in a car unless you're doing dragstrip launches with a very low-stall torque or towing at WOT in overdrive up a hill. Even so, the larger the carb, the unhappier it is about metering fuel at low engine speeds and high loads. The 950 was quite finicky at 2,000 rpm and WOT, and the 1,000-cfm carb almost wouldn't run at all in that situation. The problem becomes less dramatic as engine speed increases and load decreases, but still, a typical street car owner will have more tuning to do and more bog-and-stumble problems the closer he comes to having too big a carb.

POWER

Finally, we get to the point that most guys want to start with: horsepower and torque. We've seen many times that if you're dyno racing for a peak number, you want to use the largest carb. The same was true here. The 650 made the lowest peak power numbers of 470.1 lb-ft at 4,300 rpm and 457.6 hp at 5,700. The 1,000-cfm carb made the biggest numbers, but not by much: it gained 1.2 lb-ft and 6.5 hp. That's clearly not worth the reduced driveability with the 1,000-cfm unit. A complete view of the comparative power production from 2,000 to 6,000 rpm can be seen in the accompanying Chart 2, "Power Averages."

CONCLUSIONS

In all, we stumbled into a good test mule because this engine made decent street power but did not require a huge carb to get there, so all the jugs were on a level playing field and we were able to narrow down tuning differences. Most of what we showed empirically is that bigger carbs need bigger jets in order to flow the same fuel volume as a smaller carb. Intuitively, we surprised ourselves with the conclusion that the 650 might not really be a bad choice for this combo, but reassured ourselves by confirming our longtime belief that a 750 carb on a street motor under 6,000 rpm is almost always a safe call. *EM*

THE POWER CHART

We decided that the 750 was the best overall carb for the 392ci Ford crate engine. It made a tad more power than the 650 and would be more tractable than the larger units. Here's the complete power curve with the 750.

392 FORD WINDSOR STROKER
750 HOLLEY STREET HP CARB

SUPERFLOW 902 ENGINE DYNO
TESTED AT WESTECH PERFORMANCE GROUP

RPM	LB-FT	HP	RPM	LB-FT	HP
2,000	380	145	4,100	470	367
2,100	377	151	4,200	471	377
2,200	375	157	4,300	470	386
2,300	375	164	4,400	470	394
2,400	376	172	4,500	469	402
2,500	378	180	4,600	467	409
2,600	381	189	4,700	465	416
2,700	384	198	4,800	462	423
2,800	389	207	4,900	460	429
2,900	395	318	5,000	458	436
3,000	403	230	5,100	455	442
3,100	412	243	5,200	451	447
3,200	421	257	5,300	447	451
3,300	429	270	5,400	441	454
3,400	437	283	5,500	436	457
3,500	444	296	5,600	431	460
3,600	450	309	5,700	425	461
3,700	455	320	5,800	417	460
3,800	459	332	5,900	408	458
3,900	463	344	6,000	399	456
4,000	467	356			

RATED CARB CAPACITY VS. RECORDED AIRFLOW

CARB	CFM @ 5,800 RPM	AVG CFM, 2,000-6,000
650	584	410
750	591	413
950	593	413
1,000	595	416

Chart Notes: It can be seen that the large carbs did provide a reduced restriction resulting in a modest increase in airflow, but the additional flow was nowhere near proportional to the size increase in carb capacity, and the gains diminished as the carbs became larger and larger.

RATED CARB CAPACITY VS. POWER AVERAGES

SUPERFLOW 902 ENGINE DYNO
TESTED AT WESTECH PERFORMANCE GROUP

CARB	AVG LB-FT	AVG HP
650	428.5	330.6
750	431.1	332.8
950	429.4	331.8
1000	431.6	333.5

Chart Notes: As can be seen, the larger carbs generally trended upwards with a slight increase in power; however, the small spread indicates that even the baseline carb is reasonably capable of providing for an engine at this power level and displacement. Considering the effects on other operating parameters and the trade-offs involved, this is a good illustration that bigger is not always best.

SOURCES:

COMP CAMS
(901) 795-2400
www.compcams.com

FORD RACING
www.fordracing.com

HOLLEY PERFORMANCE PRODUCTS
(270) 781-9741
www.holley.com

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