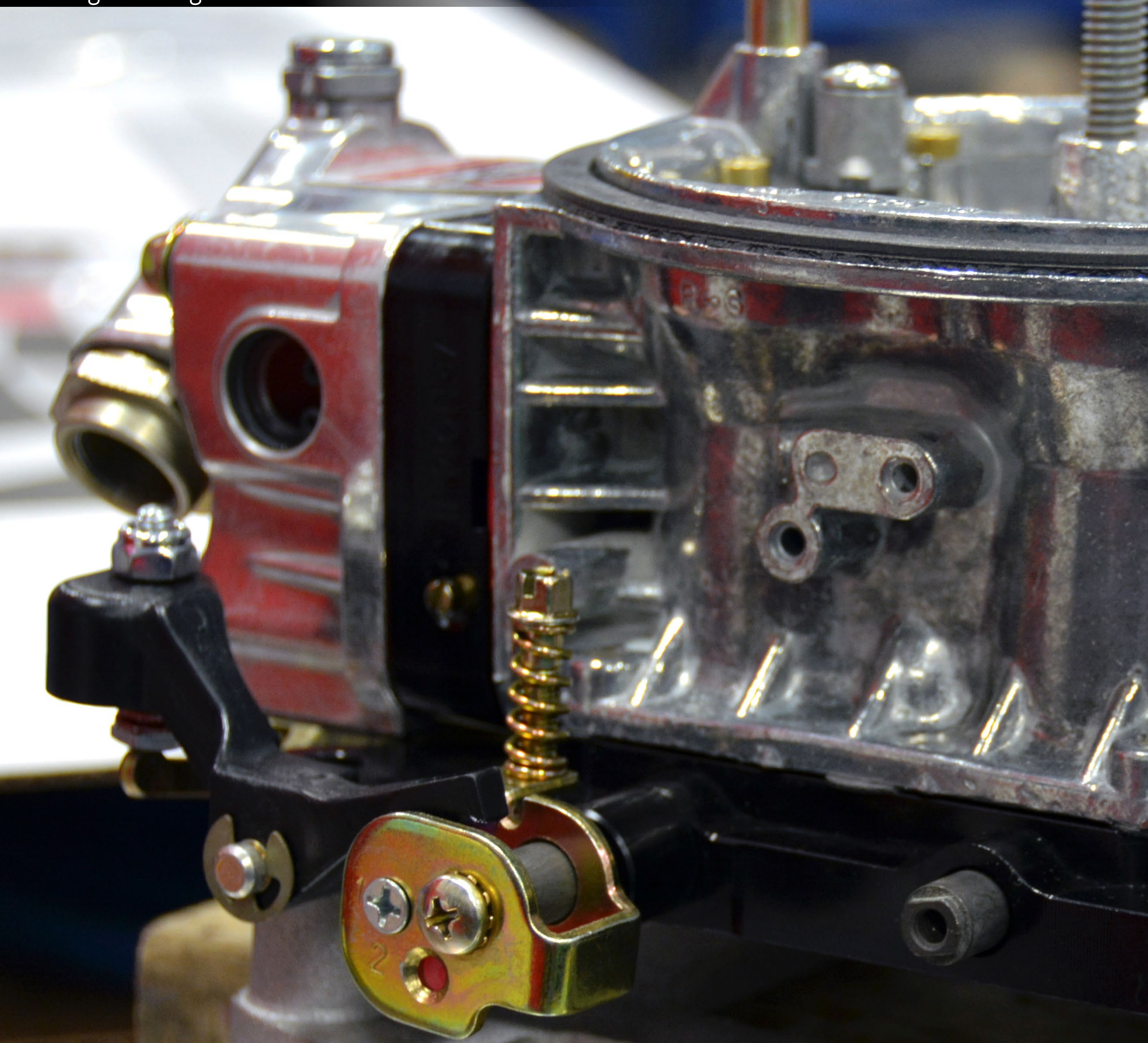
CARBURETION, PART 3: THE CONTINUING SAGA OF THE SEVEN CIRCUITS

-Greg McConiga



Shown here: Setting the float level can best be done with a bowl that has a built-in sight glass. Normally, the level is adjusted so that fuel is just at the lower edge of the glass to about a quarter of the way up. If there's no sight glass installed, the normal procedure is to set the level so that fuel just begins to spill out of the screw hole. There's also a temporary sight plug that can be installed, but I have

The concept of this terrific series from our Executive Technical Editor has evolved and grown from its original, less detailed, idea, which is a good thing. Here, Greg helps us really understand the idle, transfer, main, power, and accelerator pump circuits.

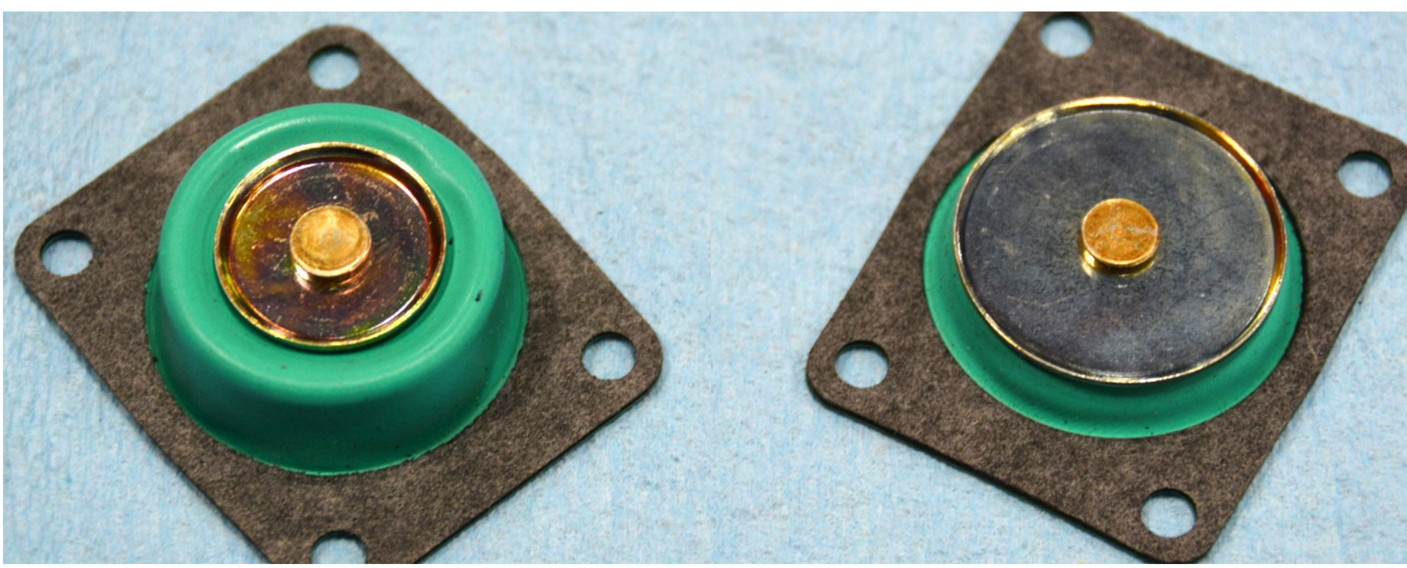
a hard time seeing through them and they're easily broken if you over tighten them. They seal with an O-ring, so very light pressure is all that's needed when you install them. Of course, fuel level on a Holley is always set with the engine running, so take all safety precautions to avoid a fuel spill and keep your hands away from moving parts.

A carburetor works because of differential pressures. In fact, the entire car works on differential pressure! The pressure of the fuel pump moves fuel into the bowl; the pressure of a spring closes a choke plate and air flow past the offset of the plate forces it open as air flow acts on larger and smaller areas producing a rotational "pressure" to open the choke. The lowered pressure inside the engine is used to actuate a choke pull-off. The low pressure created by piston pumping induces atmospheric pressure to force flow through the carb, and as air flows past the main and boost venturis that flow increases in speed as it decreases in pressure and creates a low-pressure signal causing atmospheric pressure to move fuel from the bowl into the main well, and from there into the engine air stream where it's drawn into the cylinders. Pressures can act in our favor or against it. For example, when they pulse or oppose the flows we're trying to increase or improve.

THE WET SIDE

The "big three" of fuel delivery are the idle, main, and transfer circuits, which are all fed from the main well. This well, in turn, is supplied by two incoming sources — the main jet and the power valve restrictor channels. The well then feeds two out-flow points, the main nozzle directly from the main well and the idle/transfer circuit through a cross-drilled channel that route fuel into an idle and transfer circuit well.

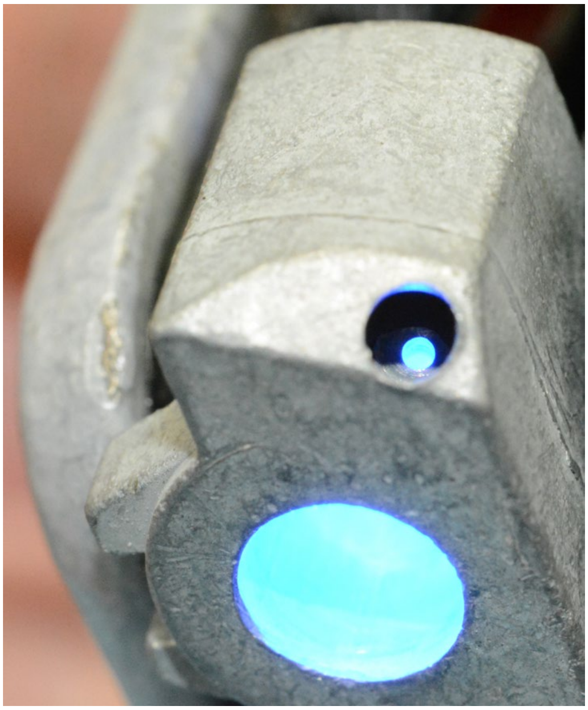
Once running, fuel demand on the main well causes its level to rise and fall slightly depending on total jet area feeding the well,



Once the nozzle is large enough, the total accelerator pump duration may suffer. 50 cc pump kits are available, which contain the pump arm, pump body, pump diaphragm or cup, return spring, and pump cam. Installation and adjustment only takes a few minutes with the carb on the bench. The only disadvantage to the larger pump cup is that each time you move the accelerator pedal, you pump more fuel into the engine, which dramatically impacts fuel economy. Not a consideration for drag racing, but if you're endurance racing or building a street/strip or touring car, it could be something to think about. If you don't need it, don't install it.

RPM, circuit activation, and air flow. This changing level provides a calibration point that is the result of and dependent on a properly-sized fuel pump and needle and seat, and a correctly-adjusted float system. This is a system — the pump pressure should be regulated if it rises over about 7-8 psi (your carb builder can tell you his or her preferred specification for pressure, and under what conditions that pressure should be measured). The needle size should be .110 inch up to about an 800 CFM carb, and .120 inch for a larger carb, and the float levels must be correctly set in order to calibrate fuel delivery. The whole fuel curve is set from bowl level.

A note about fuel pressure regulators: I'm not a fan if you can avoid them, particularly on street-driven, mechanical pump-equipped, pump gas cars. Pump gas volatility is all over the map these days and the typical non-return fuel pressure regulator is a great foam generator with its bouncing diaphragm and sharp edges. For race cars using an electric pump, a high-quality return-type pressure regulator is the only way to go since an electric pump has steady pressure and any foaming is confined to the return line back to the tank where it can settle down again. Watch your plumbing. Keep the return line at the other end of the tank from your suction line to avoid introducing vapor back into the suction of the pump.



The anti-siphon or anti-pullover nozzle has a cup or guard that surrounds the nozzle so that air flow won't cause fuel to be pulled out of the accelerator circuit. The check valves in the accelerator circuit both face in the same direction, so as the pump is relaxed fuel is drawn from the bowl, and as the pump is moved through its stroke fuel is shot through the nozzle. With enough air flow or pressure drop, it's possible to cause continuing flow through the pump circuit, or to have the circuit continue to flow after shut-down. Under the right circumstances, it's possible for fuel to keep flowing until the fuel bowl is siphoned dry, which can wash down cylinder walls, contaminate oil, or possibly lead to something as bad as a hydrostatic lock.

Above: A conventional or straight pump nozzle lacks the tube extension of a tube nozzle and the protective cup of the anti-siphon. This is another part I used to drill, but now just buy the sizes I need because I discovered that if I drilled them to size sometimes the discharge stream pattern was thrown off. The other problem is once you drill them and then take them back out, you have no idea what size they really are unless you measure them.

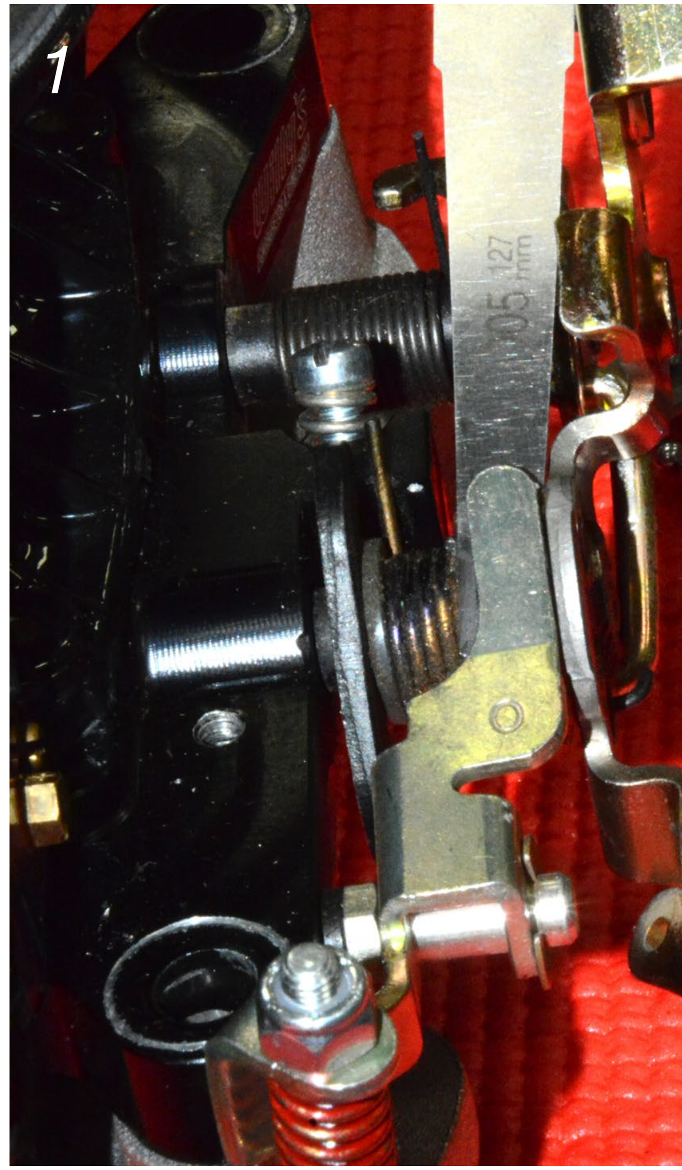
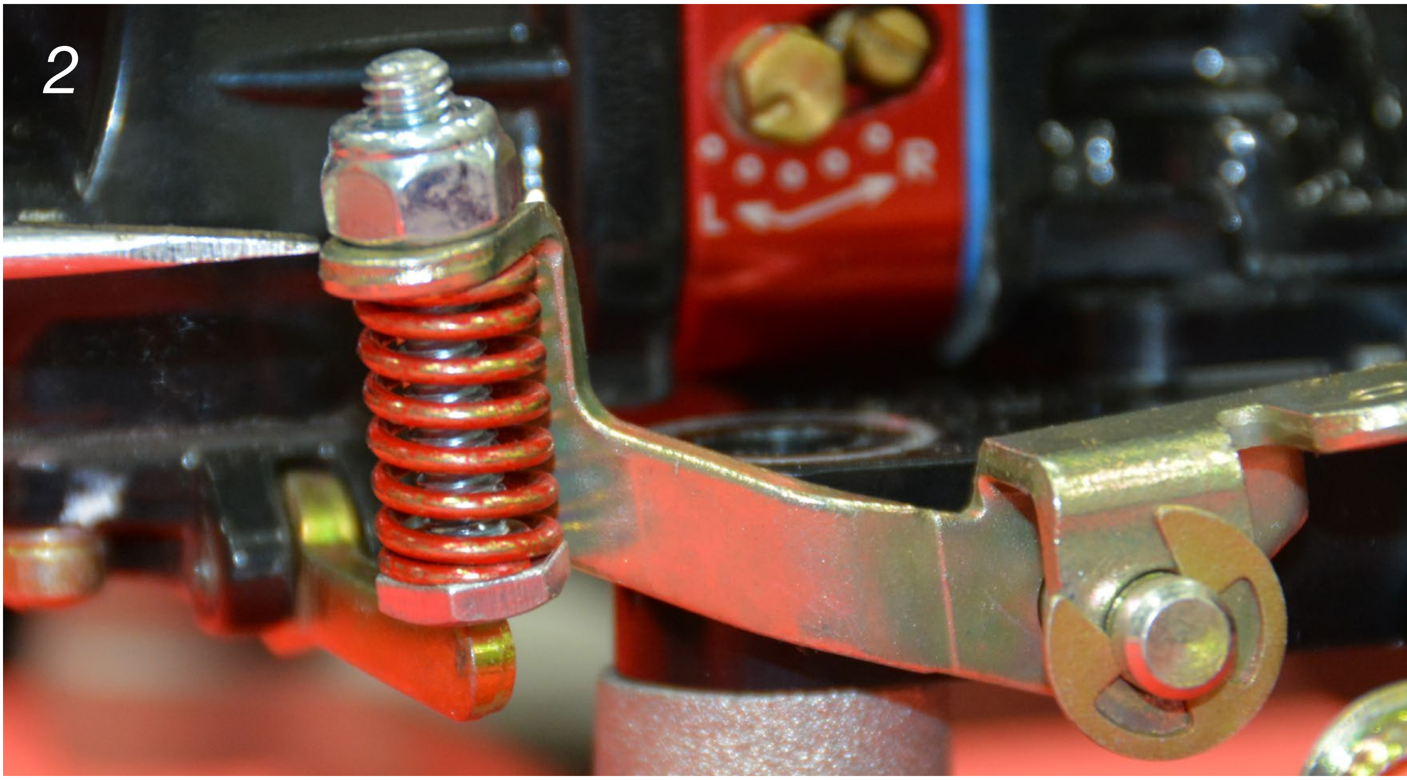


Figure 1-5, top right & opposite page: To adjust the pump duration spring, you simply hold the throttles wide open, confirm that the duration spring is strong enough to override the pump linkage, verify that the Nylock nut is fully seated against the pump arm, and adjust it until you've got something between .005 and .015 in. of clearance between the pump arm and the pump cam. The reason for the duration spring is to extend the length of time the fuel shot occurs by allowing the spring to override and apply pressure to the pump arm after the throttles have been moved to the wide-open position. It gives the non-compressible gasoline in the pump cup time to flow through the circuit and discharge out through the nozzles. Without it, we'd either just blow the diaphragm up or shoot the whole cup volume into the bore all at once going super rich for a second before falling off lean.

Holley makes several pump cams and each is color-coded and has two or three possible mounting positions. The number-one hole is typically earlier, and the number two and three holes are later. That's not all: in many cases, the later holes may increase total pump stroke and volume. Make sure to recheck duration spring adjustment if you move the cam from one position to another. All you really want to do is keep the pump from being over-extended and bottom out because stretching the pump will cause it to fail early.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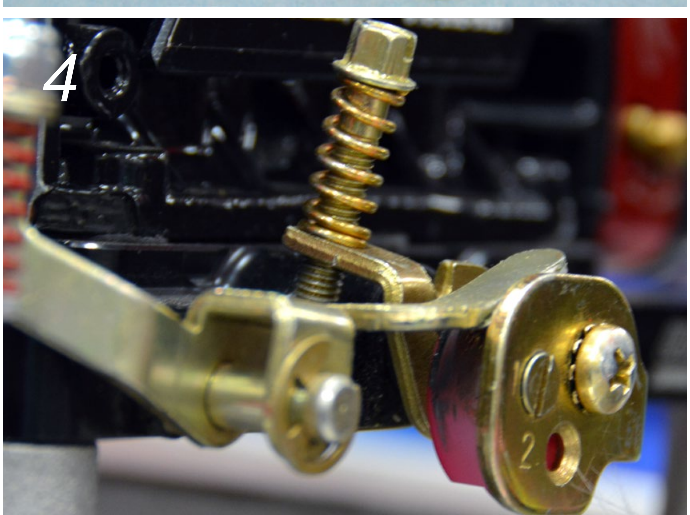
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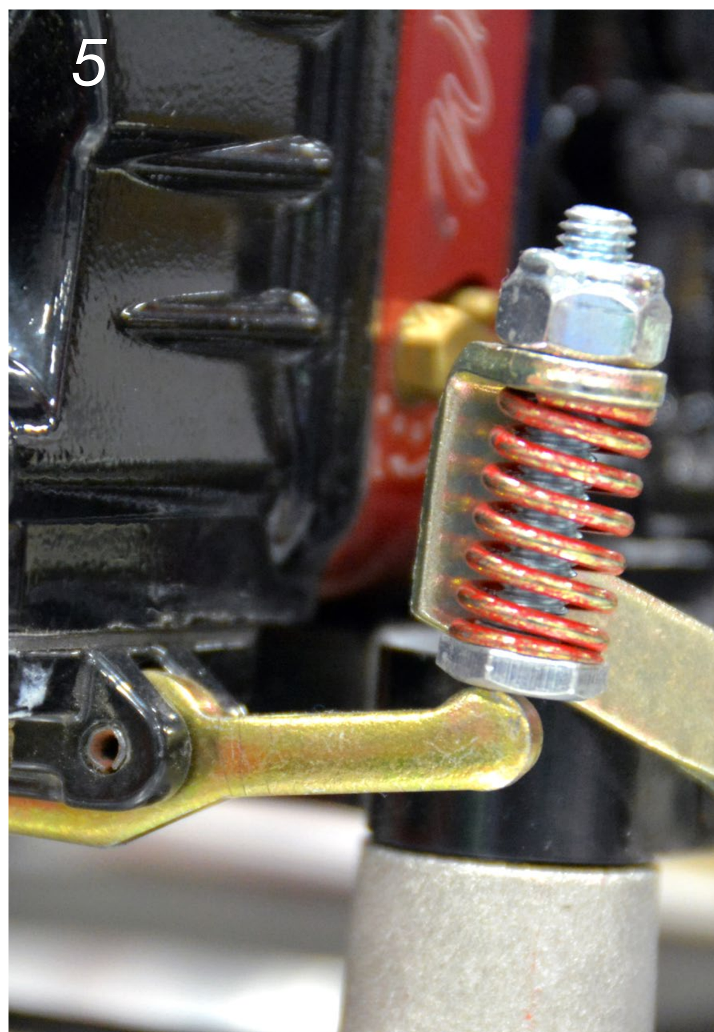
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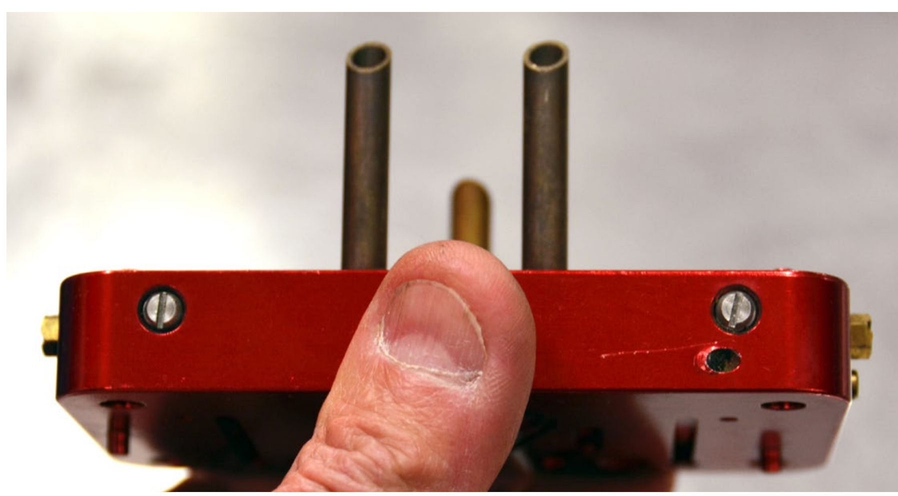
The main well level is designed to "auto-adjust" the spill height, which is the difference between the fuel level in the well and distance to the main nozzle feed port into the main body. As air flow increases with RPM, the flow through a fixed orifice isn't always linear with increased demand and increased pressure differential, and the carb signal or vacuum signal generated by the boost and main venturi is not linear at all. In fact, the boost signal curves upward with increased carb flow, with the signal difference gaining strength on the order of four times for a doubling of air flow through the barrel. This is why air bleeds, jet sizing, and the design of the emulsion system are so critical — they trim off the tendency of the carb to go rich at high RPM by dropping the main well level below successive emulsion side air feed holes, introducing more air into the mix which "bends" the increasingly rich fuel curve downward. The upper holes on the emulsion side trim low-speed operation and the lower holes trim high-speed mixture. A well-designed emulsion system and properly-sized air bleeds can produce an air/fuel mixture that is nearly perfect, particularly if you have access to a carb builder who wet flows his work and knows how to select the best booster design for your application.

As I've said before, there's just no reason not to use the services of a carb professional these days. In many cases, the prices are nearly the same as an out-of-the-box carb and you get a wet-flowed custom-built carb designed to work for your application. The amount of time you spend testing and tuning will be cut down to minutes instead of hours. If you're buying all-out, custom-engineered, very high-flow racing carbs, the prices can get up into the $1,500-$3,500 range, and from the very few I've had access to they're real works of art and worth every penny if your application demands that kind of flow rate (I must have it bad — they're so pretty I just like looking at them).

Can you cut and try your way to success? Sure. Is that a worthwhile use of time, your most limited resource? Probably not. Do you need to track-tune all the time for air quality? Depends on the class you run and engine displacement. If you're running a class that's down to the thousandth, you'll be tuning more than if you're running any of the stopped ET classes like Super Comp,



This is an interesting innovation from Willy's Carb Shop. The main jets are externally adjustable on this metering block. Brass tubes are inserted where the jets would normally be and there's a 5.5 mm, click-type nut just above the idle mixture screws on the side of the metering block with five positions from rich to lean. Pretty darned handy if you have to track-tune the main jets!

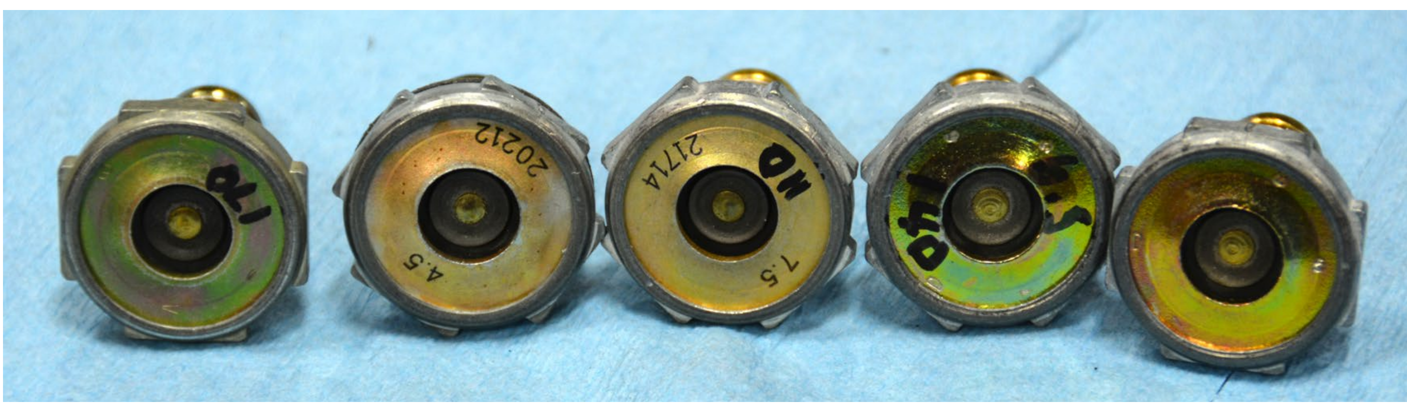
Super Gas, or Super Street. If you've got a lot of displacement, you may not see a great deal of improvement by jetting for conditions as large engines seem to be more forgiving of air/fuel ratios that are less than perfect. This all assumes that you're running on a budget and lack full data-gathering packages — the pros all use high-end Race Paks to gather every bit of data they can from the car, which can add another $2,000-$10,000 (or more!) to a build, plus when you first install a data recorder you end up saturated in data that then has to be interpreted and applied correctly. More confusion!

POWER CIRCUIT

On aftermarket metering blocks, the power valve restrictors are replaceable and you can adjust the total area of the jetting (total main jet plus total power valve restrictor area) for best performance under load. The power valve restrictors on Holley stock metering blocks are pre-drilled, so if you want more fuel you'll need to break out the wire drills and carefully and incrementally increase the restrictor diameter. If it comes to that, there are some very affordable billet metering blocks out there with replaceable emulsion and power valve restrictors that you might want to buy instead. If I were doing it, I'd toss the stock units in a drawer somewhere and buy billet.

You can tune with main jetting only, but that only changes the no-load air/fuel ratio. Main jets don't affect all circuits equally since they control the level in the main well, which changes the spill height on the main nozzles while having little or no impact on the idle and transfer circuits. This is because they pull their fuel from the bottom of the main well and have their own restrictors between the main well and the delivery channel. If you can tune the power valve restrictors, then you'll only affect the mixture under power conditions and that will have less impact on part-throttle mixture and fuel economy. You may also have to tune the power valve vacuum setting for your application.

The power valve should be selected so that the opening set point is about 2 in. Hg above the idle vacuum reading, taken in gear on an automatic. If your high-overlap, long-duration cam reads 7 in. Hg of vacuum at idle in gear, then a 4.5 in. power valve should do the job for you. Keep in mind that if your carb is sized too small, a very low-vacuum-rated power valve can be a problem at high RPM. If the carb is undersized, engine vacuum can build up again and shut down the power circuit as intake manifold vacuum builds back up with RPM. It's not uncommon to use a large throttle plate with a smaller venturi main body to get good throttle response and drivability, so keep an eye on that and run a vacuum gauge on the car if you think it might be an issue. For racing applications, it's sometimes necessary to plug off either the secondary power valve or the primary and secondary if need be and increase main jet size as much as needed to replace the fuel lost from the power valve restrictor. Replacing the power valve with a plug eliminates high RPM lean off when you're running a small carb on a large-displacement high-RPM engine. The only downside is that the engine tends to be a



There used to be two Holley power valves that I knew of. There was one for stock or near stock applications, and instead of a large rectangular window in it, it had four small holes drilled into it for fuel delivery. I haven't seen one of those for a long time. The Holley large picture-window power valve is pretty much standard in everything that's stock or near stock, and the special high flow "four door" power valve is used in racing applications.

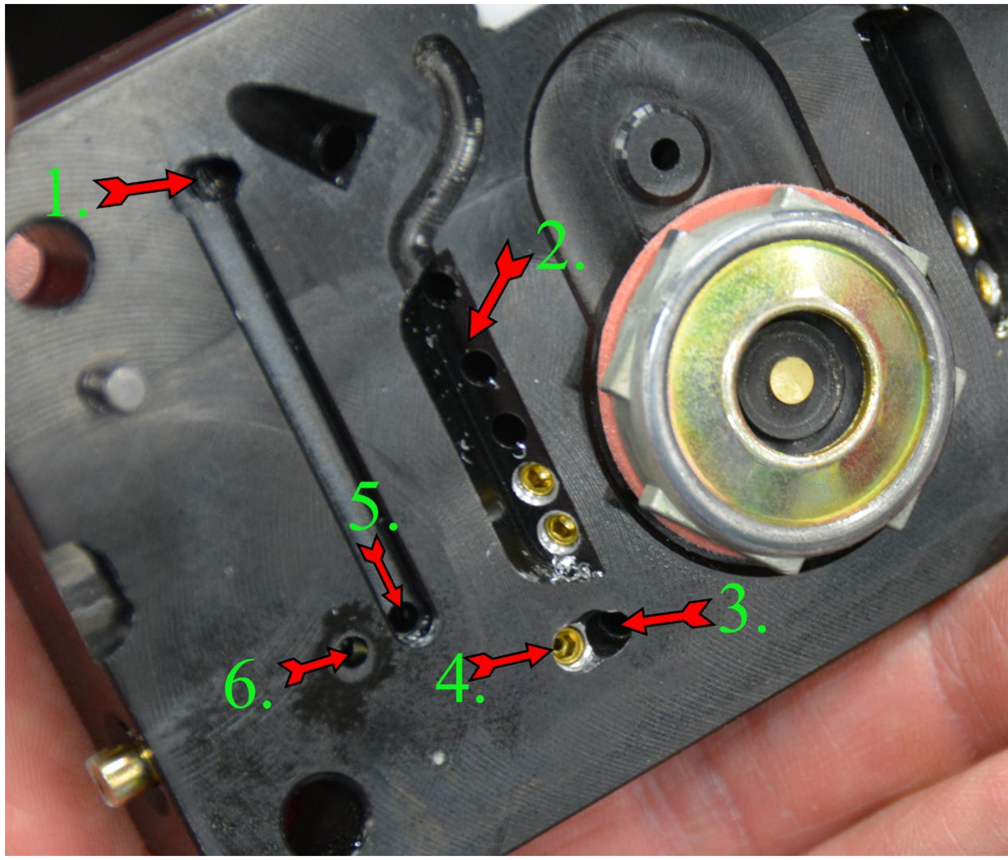
Holley power valves are stamped or inked with their opening set points, indicated in inches of vacuum Hg. They vary between 2.5 in. and 10.5 in. in one-inch increments and also are available as single-stage and two-stage, with two opening pressures on a single power valve to better trim the part-load mixture. The power valve installs into the metering block with a gasket or O-ring and seats into a deep chamfer so that fuel can flow into the channel the chamfer creates for 360 degrees so that the restrictors always see fuel.

little rich and blubbery at low- to mid-range operating speeds, and it's a little easier to foul spark plugs.

If you intend to change jets or power valve restrictors, your best result will be if you record all dimensions before you actually modify anything, and calculate the total area for all feeds into the well. If you take fuel out of the jet to lean off part throttle cruise, you can recover the needed fuel for full throttle enrichment by increasing the size of the power valve restrictor. The key is to know the total area of all jets and make any changes to that area in percent so you can roughly calculate what your changes will do. That said, knowing and recording the total area is just a baseline because jetting is more than just about area.

THE VAGARIES OF JETS

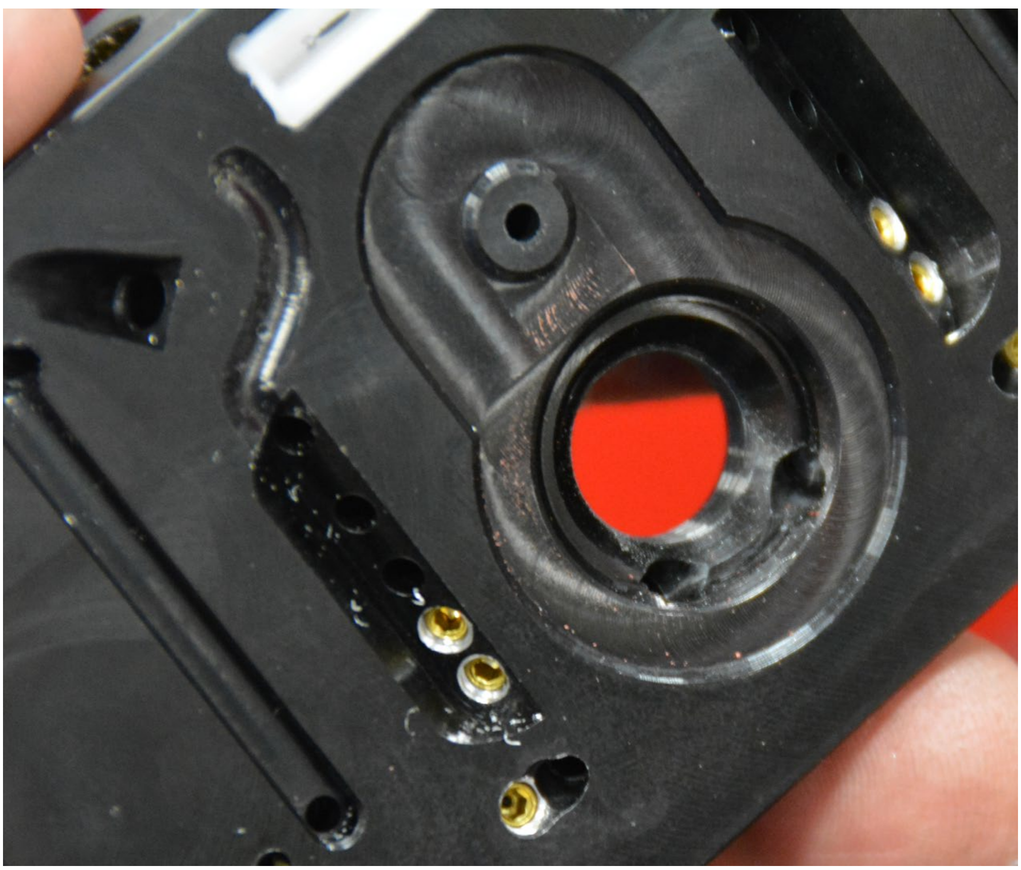
A word here about Holley jets. The number doesn't necessarily correlate to the jet size, and getting your mixture trimmed may take more than one try. Up to about a #70 jet, the number and the size of the hole in the jet are roughly the same, but above that they vary. Jet sizes are made to



This is an example of a billet metering block available from Pro Systems. The main well, the wet side, is on the other side of the block facing away from us in this photo, but this is the side that's most interesting. Older Holley's used a brass tube style emulsion system, but I haven't seen that for a long time. The wet side and the air side joined by the emulsion channel marked "2." In this case, the lower emulsion bleeds are plugged and the upper three emulsion bleeds are drilled in with no replaceable jets, much like a stock Holley metering block. Hole number three is drilled into the main well and forms the feed to the idle and transfer restrictor, labeled "4," which crosses over and upward to the idle air bleed feed point marked "1." The emulsion then drops down to the hole marked "5," which feeds the transfer slot, and behind that hole there's another cross drilling that feeds hole "6," which is the idle feed controlled by the idle needle with seats into the cross drilling between five and six. You can see how if flow increases through the transfer it will steal the fuel from the idle circuit.

yield about a 4.5-5.0% change in fuel flow per jet size, but they are far from precise. It's more accurate to state that jets increase by 3.5% with a plus or minus factor of about 1.5%, so it could be as little as 1% richer or it may be near 5% richer — it just depends on manufacturing that day — which explains why changing jetting is sometimes a little frustrating. If the jet you remove is on the rich end and the next size up you install is on the lean end, you may only see about one percent increase in fuel flow. There are close-limit jets available in sizes from 60 to 74, and these are indicated by a -1, -2, or -3 on the end of the jet number, meaning lean, mid-point, and rich end of the flow window for that jet number, which can help you tune in a bit better. You can check for main lean-off unloaded by running the engine up to 2,500-3,000 RPM and monitoring mixture, but to see what loaded operation is, you'll have to either drive it with wide bands in the pipes, or lash it down in a test cell with a gas analyzer.

Also know that the size of the orifice is only part of what determines the flow rate of the jet. The approach in and out of the bore and the bore finish are also part of the flow equation, which is why you should never drill jets, contrary to what the hot rodders of old commonly did. Buy what you need because drilling main jets doesn't yield a consistent result.



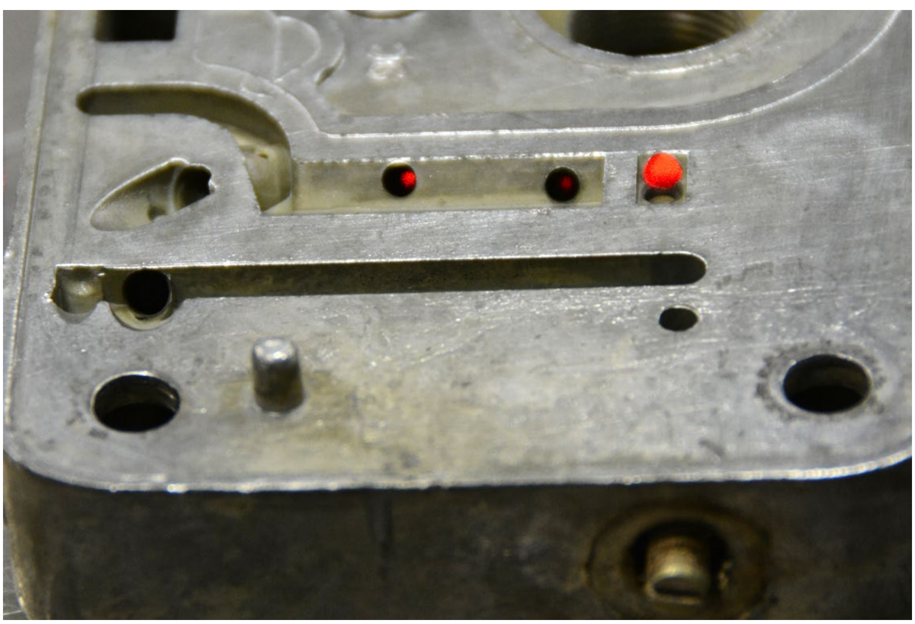
When you decant your new carb, take it apart and blow it all out. There's a lot of machining that goes into building a custom carb and you want to look it all over, baseline it, and make sure you get all the debris cleaned out of it. Sometimes they're cleaned up, sometimes they aren't. It only takes a few minutes to pop it apart and take a look. You can also see the chamfer and restrictor feed channel cut into the metering block for the power valve restrictors in this photo.

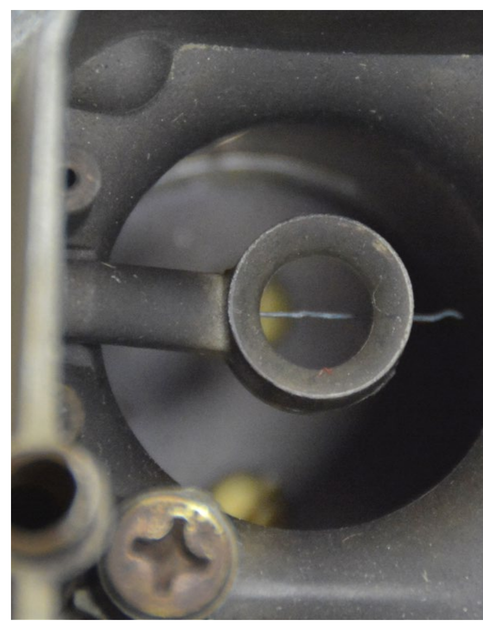
STARTING POINT

In my opinion, it's a good practice after you get your carb from your builder to tear it down, look it over, clean it all out, measure and record the transfer, idle, power valve restrictors, and jet sizes, along with the emulsion hole patterns and sizes. Baselining it means you can always refer back to the as-built data if you do any changes that later don't work out for you. I can't speak for all builders, but the carb man I use (Patrick James at Pro Systems) delivers his carbs with a spec sheet and a rich-lean jet window that I can reference. I've bought several of his carbs and I've never been disappointed with the cost, quality, or results he's given me.

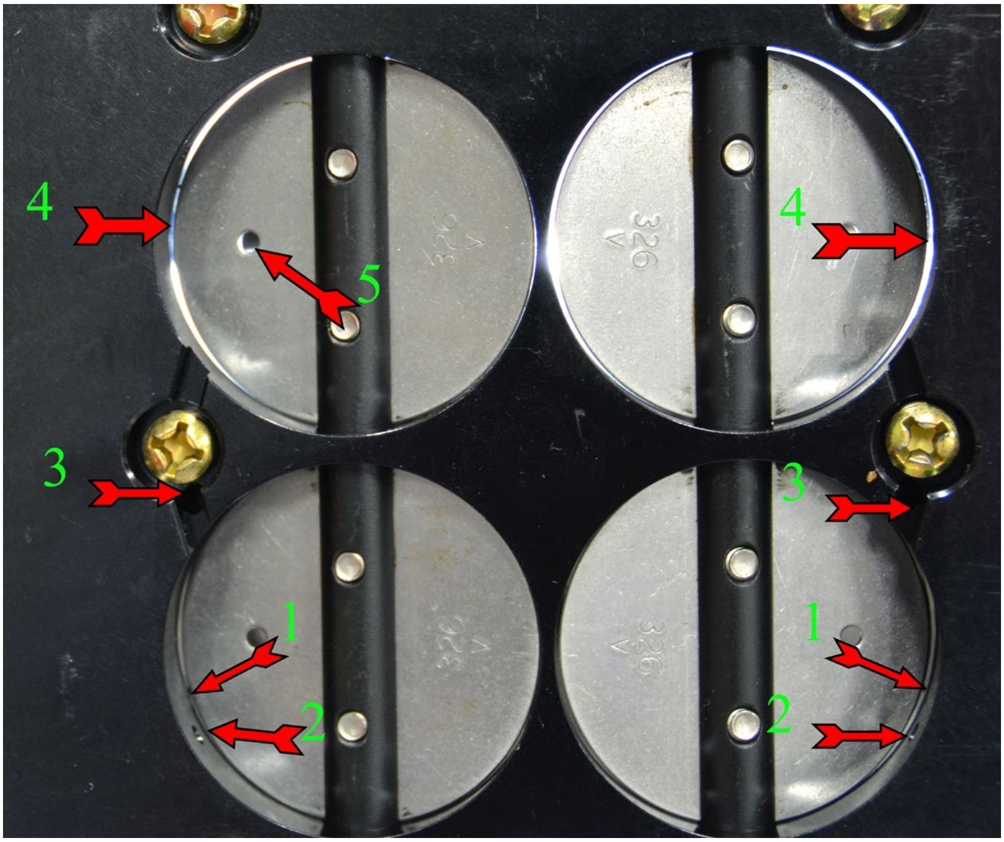
I usually start out with the carb "squared" with all four throttles opened just enough to expose a square area of the transfer slot. In other words, the throttle blade exposes an amount of the slot equal to the slot's width. Is this an absolute rule? Not necessarily. I do it because it gives me a uniform starting point and on a four-corner idle carb I can't see what it hurts. I'm a simple guy — I like simple and repeatable processes. If I have to adjust RPM, I then adjust the primary and the secondary throttle screws equally. Ditto for idle mixture, I set them all the same and move them all the same amount so that they're equal. I count my turns on everything and write it all down so I can track changes, or bench-set it if I have to have it apart for any reason.

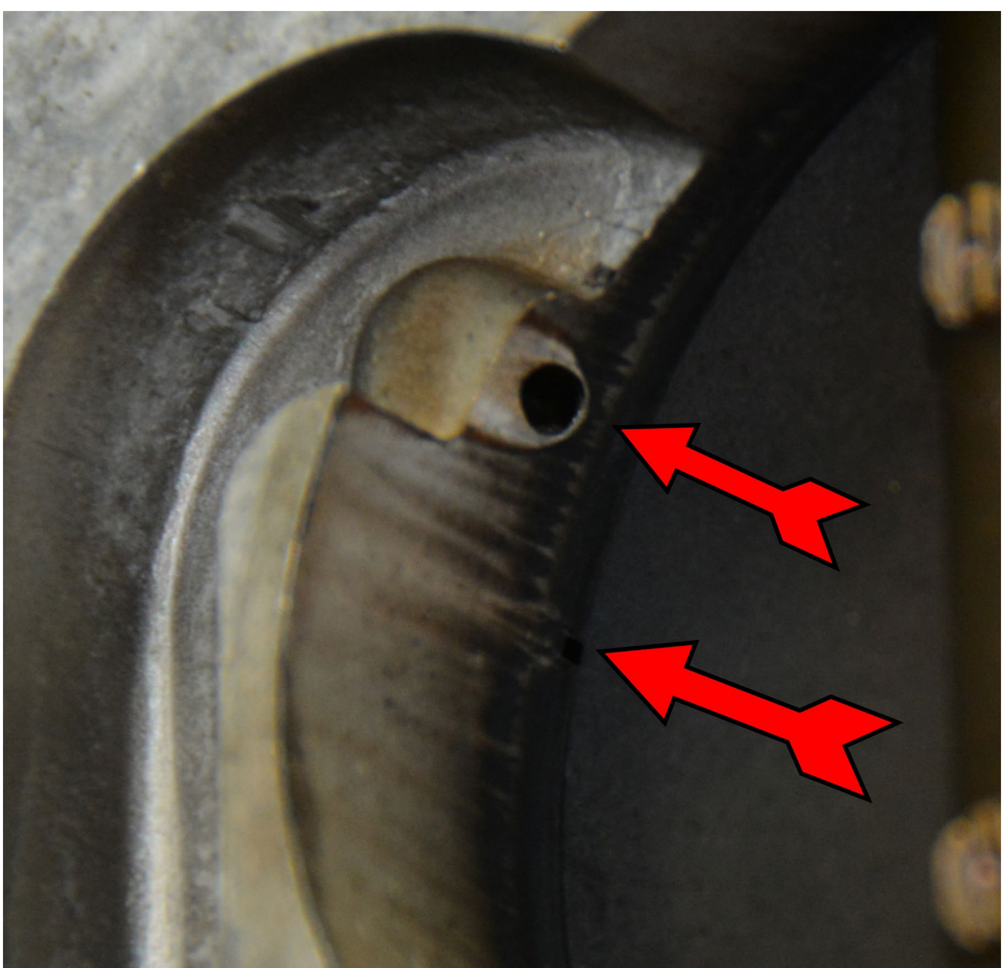
Remember that the transfer and idle circuits share the same fuel or wet side restrictor unless you're dealing with a three-





Here's a couple of photos of a stock Holley. I've fed a wire through the feed passage in the main body and through the nozzle. There are all manner of nozzles available for Holley carbs, some right from Holley, and several sources of custom-made pieces. They come in high shear, skirted, drop leg, straight and annular discharge design, with different amounts of gain or signal strength available. Changing nozzles is something your carb man does for you, and if you're buying custom-built carbs he'll make the decision for you based on the design and application criteria you give him when you order the carb. I pulled the plug out of this metering block and put a laser pointer in the passage so you could see the connection from the main well to the emulsion channel restrictors, and the feed channel from the main well to the transfer/idle fuel circuit.





Setting the throttle plates is done for timing. The stock throttle plate shown (natural aluminum) was pulled off a car, and at the upper arrow you can see the idle discharge port (the round hole). At the lower arrow, if you look carefully you can just make out the lower edge of the transfer port slot. The this runs vertically and is about a quarter-inch long. Its job is to provide fuel between the time idle fuel drops off and the main nozzles pull in. The black anodized throttle plate is from a custom-built carb, and it shows us a number of things. It's a four-corner idle since it has four idle discharge ports (marked at 2) and the shadow of the transfer slot shows up a bit better here as well (marked 1). The throttle openings are roughly equal (4), and the throttles have been drilled to help close up the plates at idle to avoid opening them so far that we start pulling in transfer fuel and robbing the idle circuit (5). The machined-in slots marked 3 are the feed to the vacuum side of the power valve circuit.

circuit carb, like some Dominators. If your camshaft requires opening the throttles too far to get a stable idle, you may find that you'll start shutting off the idle discharge flow below the throttle plate and render the idle mixture screws useless. The only reason to avoid excessive throttle opening is because the idle circuit and transfer circuit flow shifts between the lower discharge hole (idle) and the transfer slot depending on how much of the transfer slot is exposed to engine vacuum. Or, you may have to close the throttles down because you start to pull the main circuits in early, which can cause dripping from the boosters. As the throttles open, the flow through the transfer slot "steals" all the fuel previously delivered to, and controlled by, the idle mixture channel and the adjustment screw.

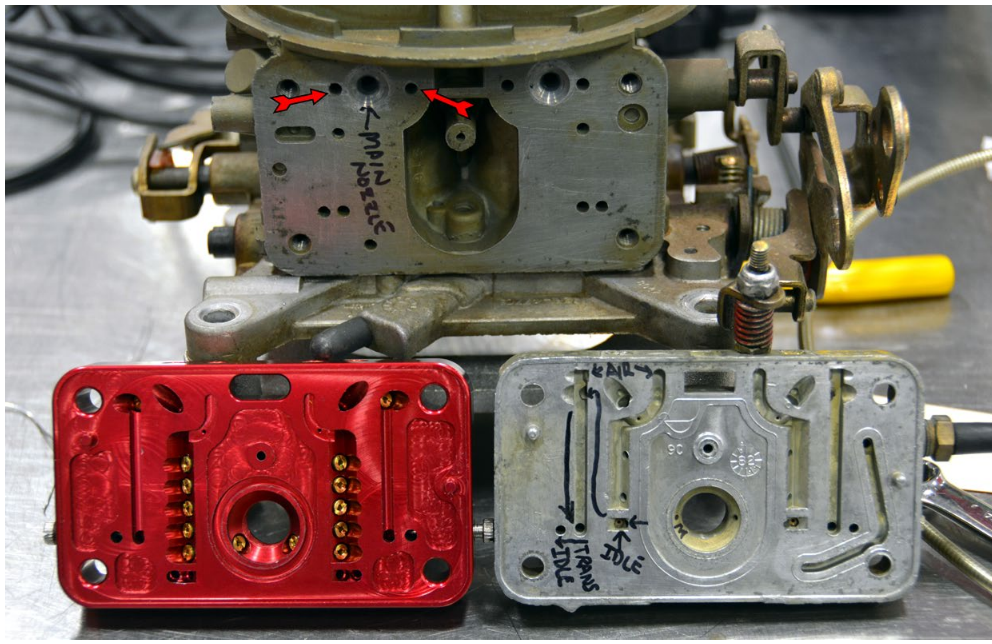
From there, I adjust the primary and secondary throttle plates equally to get the required idle speed. If you really have to jack the throttles open to get your idle speed right, you'll need to drill the throttle plates to allow enough of an air leak to close the throttles back down. You can always tell if you have to open the throttles too far when the idle mixture screws stop being effective as you wind them in and out, which tells you that you've got flow from the transfer circuit robbing the idle circuit. Normally, the idle mixture screws will be between 1-½ and 2 turns out for best idle, once the fuel restrictors and air bleeds are right sized and the carb throttle plates are evenly adjusted.

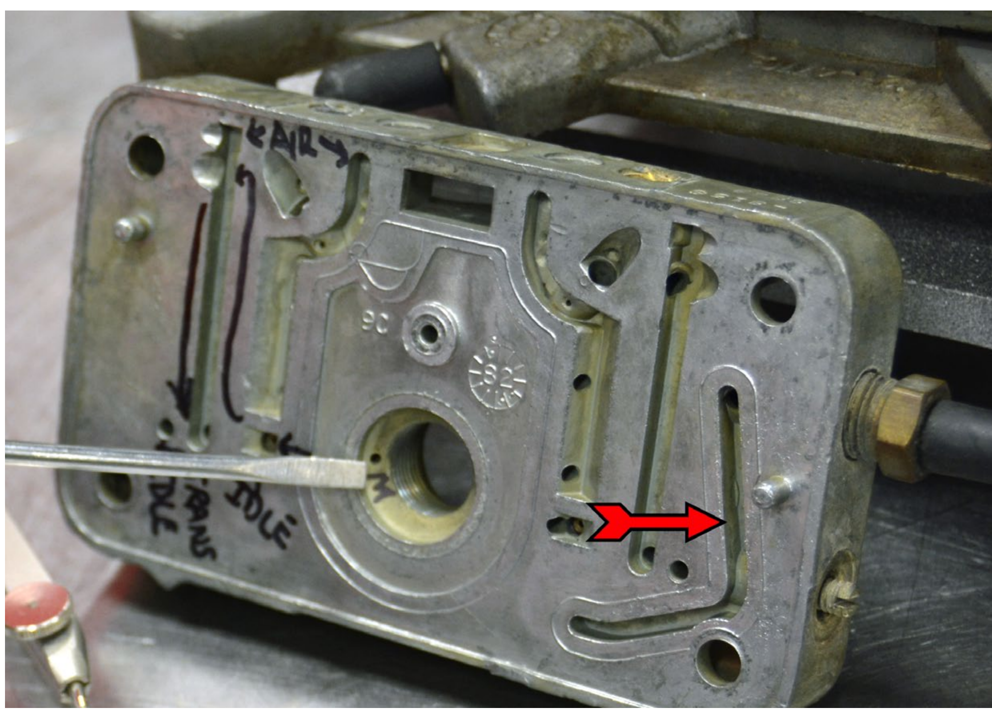
TOO MUCH IS JUST RIGHT

Can a carb be too big? Well, yes — and maybe. For the most part, it's hard to make a carb too big today given how many options there are for throttle bodies, main bodies, and booster designs unless you go full-on stupid with it. The "old school" answer is, "Yes, too big and you'll lose response because the venturi signal is too weak to pull fuel." It makes some sense — if the venturi is large and the displacement is small, then the air pump isn't big enough to cause adequate flow to pull a sufficient vacuum signal on the main nozzles to get flow early enough to make a smooth transition onto the mains. Given the design options that builders have today with booster nozzles, however, an outstanding carb man can custom build you a carb that is "too big" and still tire-shredding responsive. The good part is that bigger really is better for making top-end power, so if your carb guy can control the transitions and all-out top-end power is the name of your game, then make it big. Now, of course if you take it to the absolute extreme you can certainly make it too big, but you may be surprised at how big you can make it before it becomes undrivable.

ACCELERATOR PUMP CIRCUIT

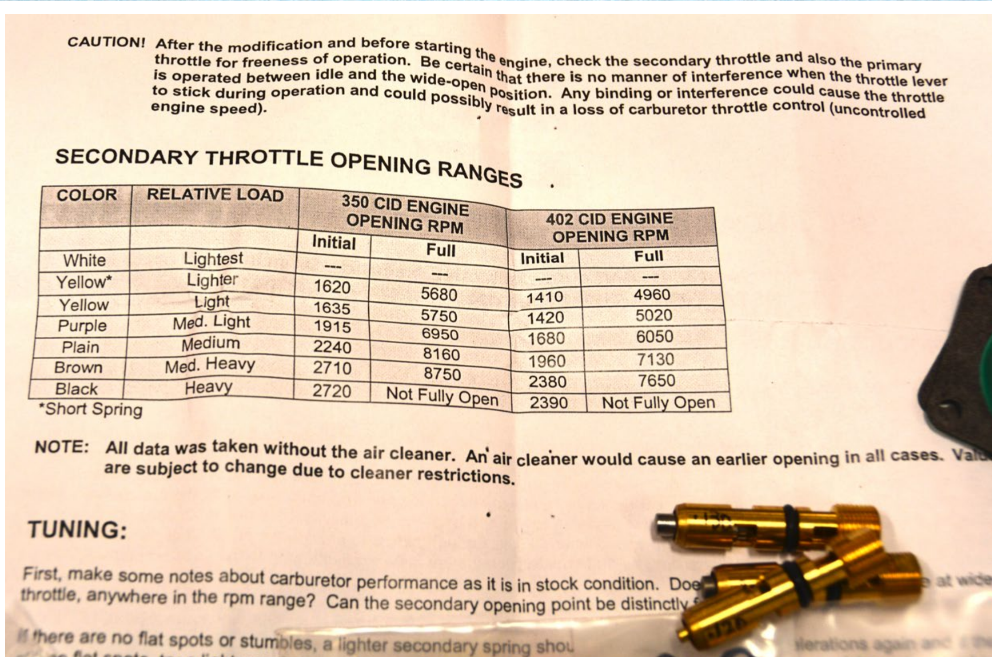
The accelerator pump is a simple circuit designed to overcome the difference in how fast air starts moving versus how fast fuel starts to move. Because fuel has more mass, it lags behind air and when the fuel lags the mixture leans out. The pump cup delivers fuel to the nozzle; the size of the nozzle determines the how much fuel is delivered (rate) and how long the shot of fuel lasts (duration). The duration is an accident of nozzle size — a larger nozzle dumps more fuel more quickly, so larger nozzle sizes increase rate, but decrease duration. If the 30 cc pump is too small to deliver the amount and duration in correct proportion, then a 50 cc pump kit is available for both primaries and secondaries. Those ratings are for 10 pump strokes, by the way, so it's 3 cc per stroke for the 30 cc pump and 5 cc for the 50 cc pump kit.





Metering blocks like the stock Holley on the right can be extensively modified and fixed, but the question is, Why would you do that? The Quick Fuel billet block shown has all screw-in jets, and if you don't need the vacuum port, indicated by the arrow, why go through all that work? The power valve restrictor on the stock block, pointed out by the screwdriver tip, is drilled into the block and can only be enlarged by more drilling, whereas the billet block uses a replaceable jet that you can tune more precisely and replace quickly if you miscalculate the fuel requirement. Drilling is fine, but if you go too far, putting material back in is kind of a trick. The arrows on the main body indicate the idle air bleed feed (to the left) and the main air bleed to the right, with the main nozzle feed centered between them. The idle restrictor on the stock block to the right is a drilled brass insert, located at the lower end of the transfer/idle crossover channel. On the billet block, there's a screw-in restrictor just visible at the top of the channel in the pocket at the left of the main nozzle feed port. Replaceable jets make tuning much easier and can be reversed if you make a mistake.

There are several tuning items in the accelerator circuit. Determining what you need to tweak or change in the pump circuit is accomplished with a test drive. Hesitations or backfires with rapid throttle movement indicate a lean condition and require one of several fixes. First of all, pump nozzles come in a number of sizes and in three configurations — tube, drilled, and anti-siphon. If you're lean, the first thing to do is change the pump nozzle, and each step should be an increase of .002-.003 in. If you find yourself with a nozzle size over about .040 in., you'll need to verify that you're using a hollow nozzle hold-down screw so that you're getting all the flow you should. If you get north of .037-.038 in., you might want to look at going to a 50 cc pump kit. The Holley accelerator pump also has a wide assortment of pump cams available, all with different delivery rates and delivery timing. Pump cams have at least two mounting holes in them. The #1 hole is typically used for cars idling at or under 950 RPM, while the #2 hole works well for cars with a higher idle. #1 hole tends to be earlier and less total lift, and #2 hole tends to be later with more total lift, but you have to check because that's not always true for all pump cams. They're easy to replace, so changing them and experimenting isn't too time-consuming.



CAUTION! After the modification and before starting the engine, check the secondary throttle and also the primary throttle for freeness of operation. Be certain that there is no manner of interference when the throttle lever is operated between idle and the wide-open position. Any binding or interference could cause the throttle to stick during operation and could possibly result in a loss of carburetor throttle control (uncontrolled engine speed).

SECONDARY THROTTLE OPENING RANGES

COLOR	RELATIVE LOAD	350 CID ENGINE OPENING RPM		402 CID ENGINE OPENING RPM	
		Initial	Full	Initial	Full
White	Lightest	---	---	---	---
Yellow*	Lighter	1620	5680	1410	4960
Yellow	Light	1635	5750	1420	5020
Purple	Med. Light	1915	6950	1680	6050
Plain	Medium	2240	8160	1960	7130
Brown	Med. Heavy	2710	8750	2380	7650
Black	Heavy	2720	Not Fully Open	2390	Not Fully Open

*Short Spring

NOTE: All data was taken without the air cleaner. An air cleaner would cause an earlier opening in all cases. Va are subject to change due to cleaner restrictions.

TUNING:

First, make some notes about carburetor performance as it is in stock condition. Doe throttle, anywhere in the rpm range? Can the secondary opening point be distinctly

If there are no flat spots or stumbles, a lighter secondary spring shou

If you're running a vacuum secondary Holley, you may need to tune the opening rate of the secondary throttles. Holley makes a variety of color-coded secondary diaphragm springs to accomplish that. The chart will help get you in the ballpark, but if you notice, the spring opening RPM is displacement-dependent, so there's a little cut-and-try involved when you do your tuning.

Once you've landed on the nozzle, screw, and pump size and cam, the last thing to do is correctly adjust the duration spring by holding the throttle wide open and adjusting the clearance between the pump arm and the cam to .005-.015 in. to avoid forcing the pump cup past its limits and damaging it. Just make sure that the adjusting nut on the duration spring is seated against the pump arm (no daylight under it) before you adjust the arm to cam clearance. The duration spring overrides the pump arm and follows the pump lever down, increasing the length of time the pump shot is delivered.

THE ANSWERS ARE OUT THERE

I hope this quick primer will get you started out on the right foot. There are several good books written by some outstanding authors on the Holley series of carburetors and I'd suggest you buy several and read them all if you're looking for a more complete understanding of carb theory, operation, and tuning. Each author has his own approach, so there's something to be learned from each of them and they're all worth reading. ■

There is a multitude of ways to determine if your carb is rich or lean. You can read plugs, use a wide-band oxygen sensor in the pipes, a five-gas analyzer, or if you have time and room for removal, you can pull the headers off and look at pipe and port color. Instrumentation is the quickest and easiest, but sometimes for old guys like me we like to look for that very light mousey grey color in the pipe to confirm what we read on our equipment. This port is reading rich to me, and confirms what my wide-band said, which was that it was reading at 12 to 1 all the time with no high-speed lean out.

Tube nozzles are nice because they direct the fuel right at the booster, and they can be "aimed" a bit by carefully positioning them when you tighten up the mounting screw. They do extend out into the air stream, which can lead to pullover, so that's something to watch for if you are rich and can't find any other answer. Observing operation with loaded air flow may be the only way to catch a pullover problem.