

# **How To Set-up and Tune a Weber or Holley Carburetor**

**By Performance Carburetor Science**

## **Preface**

Weber and Holley carburetors have been around for many years and continue to be some of the finest carburetors ever produced. Weber's are very popular in the performance Jeep world with Weber conversion kits. Webers do have a sort of "Black Magic" reputation when it comes to set-up and tuning, however, but this doesn't have to be the case. By following a few very specific rules regarding set-up and using an air and fuel monitor, precise tuning can be easily had. If you've already spent the money on a Weber, it makes sense to take a few extra steps and take full advantage of the carburetor's capability.

We must keep in mind that there's no such thing as perfect, "out of the box" calibration. The factory does a fantastic job of setting these up with a combination of jets that work pretty well across the board but a vehicle with headers and a performance cam running up in the mountains of Colorado is going to require a different jet combination than a relatively stock engine near sea level. For obvious reasons, the factory can't custom jet every order so a suitable compromise must be made.

It is my intent to provide you with the information necessary to achieve a level of calibration that is typically reserved for fuel injection but is also specific to your vehicle and location. Using a wide-band air/fuel monitor, you can keep a very detailed record of how much fuel is being delivered and also track it's progression through the different circuits of the carburetor and under different driving conditions. Monitoring your air/fuel ratio in this manner will help you to calibrate the jetting combination to a level of precision that you just can't attain reading spark plugs.

This guide assumes that your engine and ignition are in a good state of tune. I've seen plenty of carb kits installed because the ignition wasn't up to par. A point I also need to emphasize is that testing on a warm, sunny day will yield a slightly different result than the same test on a damp, cloudy day. The idea is to find a fantastic level of tune and not drive yourself crazy every time the barometer drops. If you notice an increasing or decreasing trend in your air/fuel ratio as the season changes and would like to compensate for that, by all means, go for it as you now have the tools.

This can also be used to fine-tune the fuel curve should any performance upgrades be installed in the future. Performance camshafts, intake manifolds, exhaust systems and even ignition upgrades will most surely need a correction of the fuel curve to receive the full benefit of any performance part.

It would also be nearly impossible for me to cover every nuance for every Weber or Holley produced so some generalizations will have to be assumed. What I have been able to do, however, is to cover the important areas that are pretty standard across the board that will definitely help to increase the performance of your carburetor.

Some basics before you get started are to make sure that no “tune-up” parts are needed. Double check the cap and rotor, plug wires and spark plugs. Make sure the fuel filter is clean and installed correctly. If you’re using the dual-outlet, return style fuel filter, make sure the filter is installed with the smaller, return line oriented at the top and the filter is as level as possible.

Always test with the air filter installed so make sure it’s in good order as well as the PCV and EGR valve. Double check for vacuum leaks and exhaust leaks. All of these little things can add up and throw off your testing.

## Table of Contents

|   |        |
|---|--------|
| Adaptor Plates                            | Pg. 01 |
| Curb Idle Throttle Plate Position         | Pg. 01 |
| Holley Idle and Transition Circuits       | Pg. 04 |
| Lean-Best Idle                            | Pg. 08 |
| Idle Jet Size and the Progression Circuit | Pg. 10 |
| Tuning with Idle Air Bleeds               | Pg. 12 |
| Fuel Pressure and Tuning With the Float   | Pg. 16 |
| Main Circuit Operation                    | Pg. 19 |
| Power Valve Tuning                        | Pg. 20 |
| Main Jet Calibration                      | Pg. 22 |
| Tracking Results                          | Pg. 23 |
| Air Corrector Jets and Emulsion Tubes     | Pg. 23 |
| Accelerator Pump Tuning                   | Pg. 27 |
| Summary                                   | Pg. 28 |
| Recommended Reading and Resources         | Pg. 30 |

## **Adaptor Plates**

The adaptor plates, if any are to be used, need a close inspection and possible attention prior to assembly to avoid problems with vacuum leaks. They are often delivered with uneven mating surfaces, casting flash and just about any number of abnormalities that you can think of.

It is well worth your time to give them a close inspection before the install. By using a straight edge over the entire mating surface of each side of the adaptor plates, you'll be able to tell if the surface is flat. They often need some sort of work in this area and some filing and/or sanding may be needed to ensure a flat surface. Place a sheet of wet/dry sandpaper on a flat surface, oil it and grind away.

Once the adaptor plates have a good, flat surface to work with, you can go ahead with the assembly of the plates. It's a good idea to lightly smear some wheel bearing grease over both sides of the mounting gaskets to ensure a good seal. You may want to perform a test assembly to make sure the mounting bolts are long enough. I've seen kits that actually required a trip to Home Depot for bolts that were a touch longer than the ones supplied.

Once the plates are secured to the manifold, you can thread the carb studs into the top plate. This is a part of the initial assembly where some mistakes can be made. If the studs are actually tightened down, they will serve to pry the adaptor plates apart and possibly cause an air leak. Rather than tightening the studs down, you can simply coat the threads with blue Loc-Tite, screw them down until they just make contact with the lower plate, back them out 1/8<sup>th</sup> turn and walk away until the Loc-Tite has set.

Be careful not to over-tighten the brass PCV port if it threads into the adaptor plate. The material around the threaded hole is sometimes thin and can crack if too much pressure is applied.

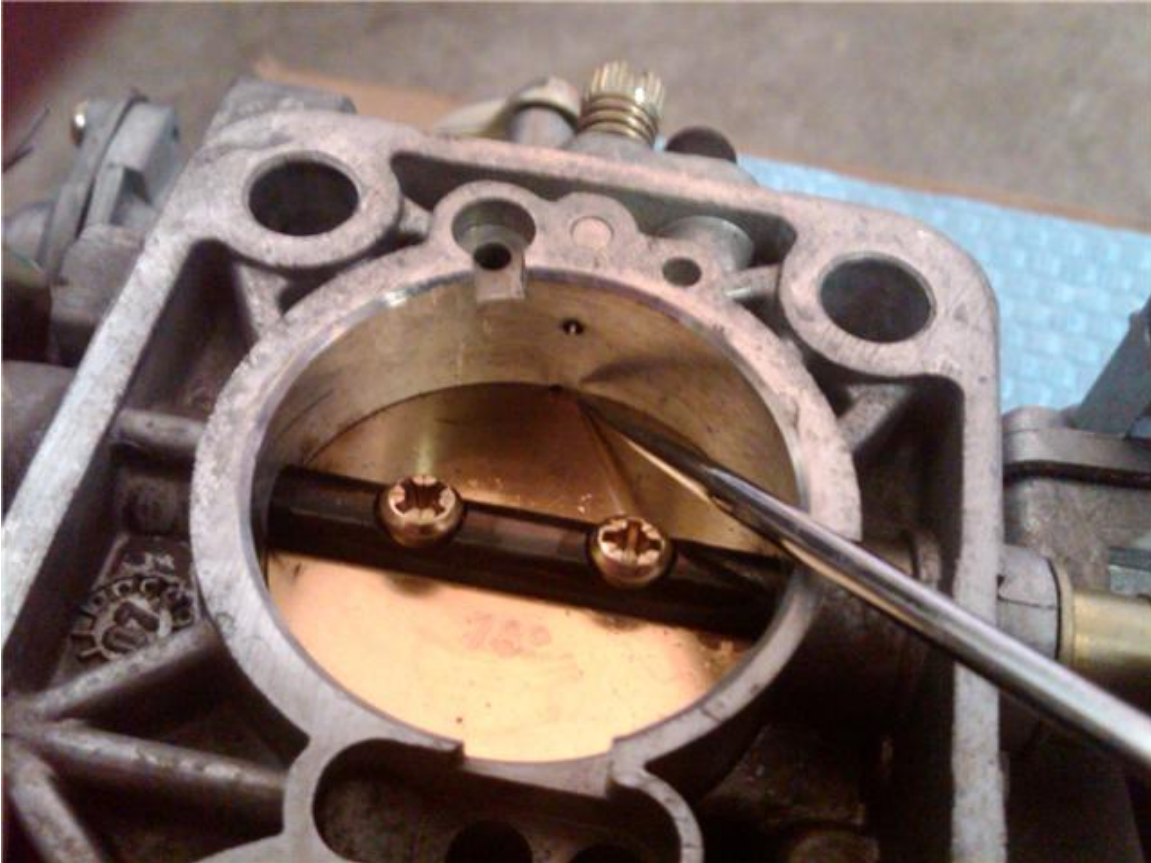
## **Curb Idle Throttle Plate Position**

Here's where the vast majority of complaints and confusions arise when it comes to setting up a carb.

When I'm installing a new carb, the first thing I like to do is to flip the carb upside down and determine the maximum amount that the throttle plate can be opened for a proper curb idle throttle plate position.

To do this, you'll need to use your fingers or insert a piece of 3/8" tubing between the air horn and the choke plate to hold the choke plate open while you move the throttle from idle to wide open. You should hear a 'click' as the fast-idle cam disengages and the throttle plates should return to their fully-closed position.

From there, use a screwdriver to unscrew (counter-clockwise) the idle speed adjustment screw to the point where it loses contact with the linkage. From the point that the idle speed adjustment screw just makes contact with the linkage, slowly turn the adjustment screw in (clockwise), counting in at least 1/8<sup>th</sup> turn increments, until just the very outer edge of the first primary progression hole is exposed. It should look similar to a crescent moon, something like this on the 38DGS.



*This photo shows the ideal position of the throttle plate for a curb idle setting. Note how only the very edge of the first progression port is exposed. This position was attained with less than a quarter of a turn in from the idle speed screws contact with the lever and allows full operation of both the idle and progression circuit. This position with a properly sized idle jet provides a smooth, 650 rpm idle.*

This screw setting, what ever it may be, is considered your absolute maximum idle speed screw adjustment and can not be exceeded when tuning otherwise your performance and mileage will surely suffer.



*This photo shows how much of the progression hole is exposed with the idle speed screw being turned only  $\frac{3}{4}$  of a turn in from its contact with the lever on a synchronous Weber. As you can see, almost the entire vertical diameter of the progression hole is now exposed. When this occurs, the mixture screws will have minimal effect on the idle when adjusted and the engine will likely have a very rich idle and an off-idle stumble.*

For a Weber 32/36, this screw setting should be no more than  $1\frac{1}{2}$  turns in. For a Weber 38, it will be no more than a  $\frac{1}{2}$  turn in. When this screw setting is exceeded, the engine will pull from the progression circuit rather than the idle circuit and will likely have a rich or stinky idle, which is an indication that a larger idle jet is needed.

If your carburetor is already mounted and you're unsure if the progression hole is being exposed at idle, a way to tell with the 32/36 DGV is to hook up a vacuum gauge to the 'spark port' on the carburetor. The proper curb idle position should read "0" vacuum at the spark port. This maximum setting is crucial and a properly sized idle jet will allow your engine to idle without exceeding the above mentioned screw settings. To be honest, if you read no more than 2 inches of vacuum at idle, I'd call it good.

Whether it's a larger idle jet on a Weber or a little more involved work on most Holleys, the correction for an over-exposed progression port or transition slot is nearly always the same being a larger volume of air and fuel needs to be made available to the engine below the throttle plates.

## Holley Idle and Transition Circuit

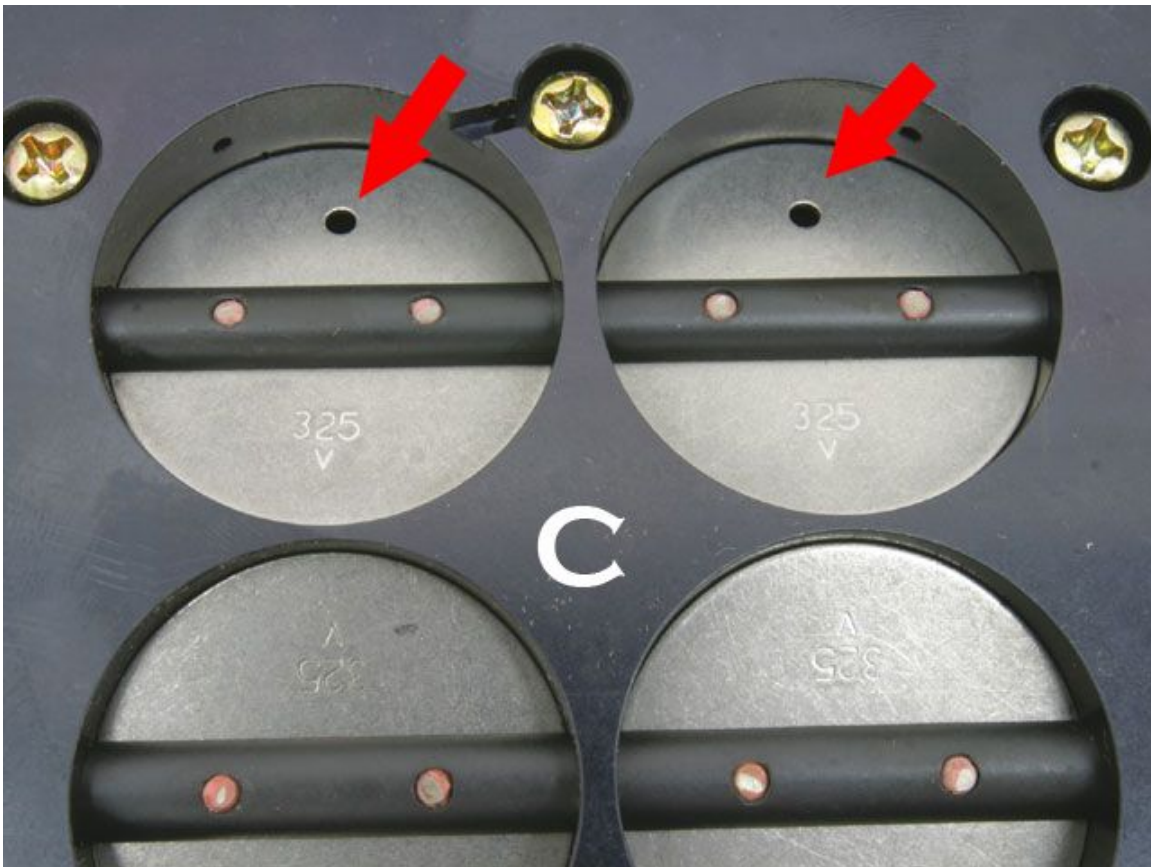
The ideal setting if your carb uses transition slots is usually attained when .020 thousandths of an inch of the transition slot can be seen below the throttle plates, like the progression hole in the photo above. .030 to .040 thousandths on most models is an indication you may need to do some work. The quickest possible fix for a situation where the primary throttle plates are open too far at idle and exposing too much of the transfer slot is to open the secondary throttle plates just a touch. The stop is usually located underneath the base plate (some models have a speed screw on the secondary throttle shaft) and the increase in idle speed will usually allow you to close the primary side to within spec. If it's a four-corner idle carb, this isn't always the best idea as you usually just transfer the problem from one side of the carb to the other but it can work if only a little correction is needed.



*This photo is courtesy of CarCraft Magazine and shows the desired amount of transfer slot exposure when properly set up.*

A little-known trick can also be put to good use by drilling a small hole in each primary throttle plate halfway between the edge of the throttle plate and the throttle shaft on the same side of the plate as the transition slot. If this procedure is needed to correct the throttle plate position at idle, starting with a 1/16<sup>th</sup> inch hole and retesting is usually the best way to go. Should further enlargement be needed, only increase the hole in 1/32<sup>nd</sup>

increments and retest each time. This trick also applies to Weber carburetors, especially the smaller, progressives that have only one idle circuit. Just make sure you've exhausted all other means before you decide that drilling is needed.

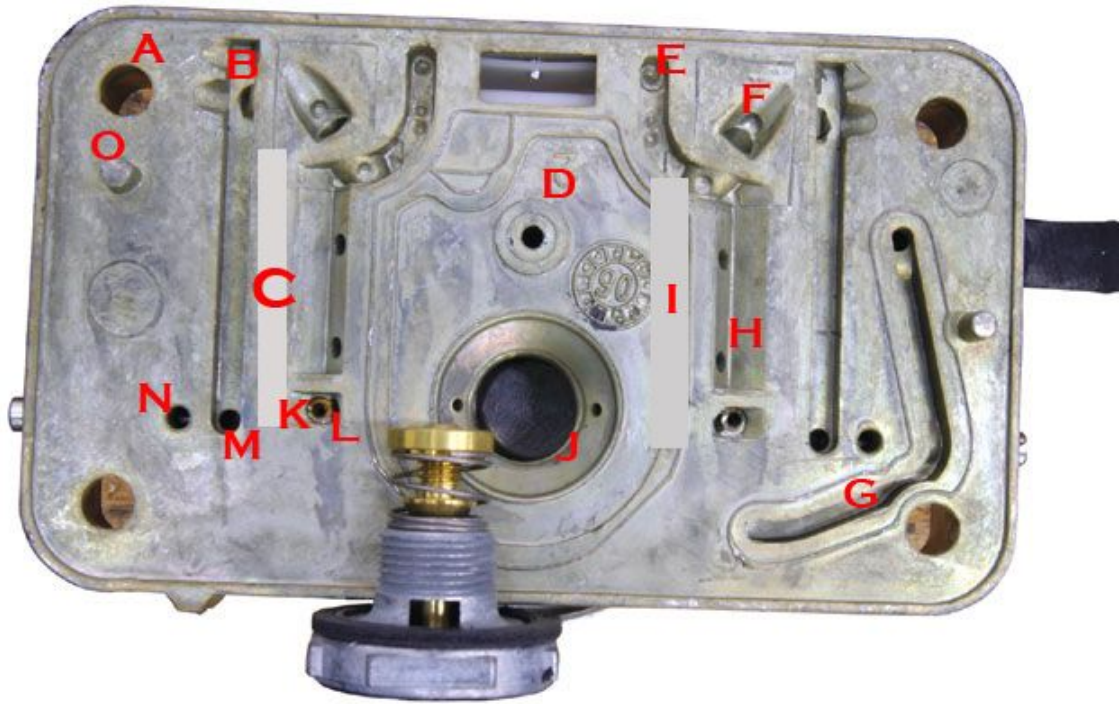


*This photo is courtesy of CarCraft Magazine and perfectly illustrates the small holes drilled in the primary throttle plates used to help correct an improper curb idle throttle plate position.*

Once you are able to get enough air through to allow a proper throttle plate position at idle, some fine-tuning of the idle circuit's mixture may be needed. This can be tedious work and requires a wire drill kit but it can be well worth your effort. If the mixture screws don't respond to adjustment, assuming that your power valve isn't either blown or open at idle, by enlarging the idle-feed restrictor, located in the metering block, in .002 thousandths inch increments, a larger mixture volume can be made available to the idle and transition circuit. A richer mixture can be pulled from the idle circuit by a reduction in the size of the idle air bleed, which is basically an air-corrector jet for the idle circuit, or a leaner mixture by increasing its size but changing the idle air bleed has a larger effect on the transition circuit during light driving. This will be the main area of your focus for adjustments once you begin testing the air/fuel ratio under part-throttle conditions.

Careful here, it's very easy to remove material but much more difficult to put it back so make changes in very small increments and make sure that that's what's needed!





*Letter 'L' is the location of the Idle Feed Restrictor on some Holley carburetors. Also compliments of CarCraft Magazine. Other models have them located at "B" and still others are pressed in from the top of the metering block. Yeah, I know... The preferred location is 'L' and they can be re-located fairly easily.*

We'll discuss the balance between the idle feed restrictor and the idle air bleeds in further detail in a later chapter.



*This photo, compliments of Barry Grant, shows the position of the air bleeds. If you'll follow the leg of the booster venturi up to the body of the carburetor towards the float bowl, the little, brass fitting towards the center of the carb with the tiny hole is the high-speed air bleed. The brass fitting towards the outside of the carb with the larger hole is the low-speed air bleed.*

Attention to detail in this step is crucial to the operation of your carburetor and I do recommend taking the carb off and having a look at the position of the throttle plate in relation to the transition slot or progression hole if you're having problems with the idle. Make a note of how many turns in on the speed screw are required to get the proper throttle plate position and make sure you don't exceed it once the carb is re-installed.

The "Maximum Mixture Screw Setting" leaves a little more room to maneuver, however, which I will explain further shortly...

### Torque Tip:

Many smaller, progressive carbs with single idle circuits have a hard time idling with the correct throttle plate position. Switching the distributor over to manifold vacuum can often-times correct this by firing the plug at a more opportune time under idle conditions. It will also provide the added benefit of better cold starts, improved throttle response and better gas mileage. I've personally run manifold vacuum for many years on many

different engines and highly recommend its use. It's even more beneficial when large cams are used. The vacuum canister may take some tweaking but the results are worth the effort.

## **Lean-Best Idle**

Now that we've covered the importance of the throttle shaft's position (it's extremely important) and the carb has been mounted in a manner that will prevent an air leak, we can move on to setting the mixture screws and using their position to determine a suitable idle jet size.

With the 38 DGES, I like to turn both mixture screws in clockwise until they lightly seat and back them out two turns for my starting point. Start the engine and let it warm up, making sure the choke is fully opened. We're looking for the smoothest running engine speed that we can obtain without using the idle speed screw.

Begin adjusting the mixture screws inward in  $\frac{1}{4}$  turn increments, one then the other, then wait a few seconds and listen to the engine respond.  $\frac{1}{8}$ th turn increments are fine, just remember to keep track of where you are. I often find it helpful to run a fast idle for a few seconds after each adjustment and then let the engine return to idle. The idle speed should begin to pick up and the engine smooth out. Keep going in this fashion until the adjustments do very little to nothing and then it actually starts to slow down or sound worse. Stop there. Now slowly back them out in  $\frac{1}{8}$ th turn increments to the point where the engine sounded the best. This is considered to be the lean-best idle. Then, just make a note of how many turns out you are from its seated position.

From here, I really like to take the vehicle out on the streets and warm it up well. Then I'll come back and go through the procedure again. The water temp may be the same, but the combustion chambers, intake manifold and carburetor will be much hotter.

If, at this point, you find the idle speed to be higher than you like, you can lower the idle speed screw to your desired setting, run through the mixture adjustment procedure again and be done.

If you found that the engine picked up by turning the mixture screws outwards, rather than inwards, beyond two turns on a 38 DGES, a larger idle jet will most likely be needed. A good quality idle speed found just less than 2 turns would be a good indication of an idle jet size that will provide you with good mileage.

For a 32/36 DGEV, lean-best idle being found at or near 2.5 turns out on the mixture screw means that the current primary idle jet size will likely provide you with good fuel economy. Beyond that though, is a pretty strong indication that an increase in idle jet size is needed on the primary side.

Selecting an idle jet where the lean-best idle is found with the mixture screw in the  $1 \frac{3}{4}$  turns out range on a 32/36 DGEV progressive and roughly 1 turn out on a 38 DGES will

usually provide more performance and acceleration but could come at the cost of some fuel mileage.

Although it isn't very common, it is possible to need smaller idle jets. The first indication of this will be a lean-best idle coming with usually less than a full turn out on the mixture screws on the 38 DGES and about 1.5 turns out for the 32/36 DGEV. All of this assumes that the Maximum Idle Speed Screw setting has not been exceeded and that you still have zero vacuum at the vacuum advance or "S" port.

I like to start at 2 turns out on a Holley and try to end up with a lean-best idle somewhere around 1 turn out when done. That will usually give you enough room to fine tune the idle with the mixture screws. If two turns won't do it, you may end up having to enlarge the idle-feel restrictors.



*This photo shows the location of the secondary idle jet on a Weber 38 DGES. You'll find the jet situated in the jet holder, which is the large, brass screw head just below the air filter base. There is one for the primary circuit on the opposite side of the carburetor. Each jets size will be stamped into the jet itself. Larger numbers allow more volume of air and fuel to pass through the jet and smaller numbers reduce the volume.*

## **Idle Jet Size and the Progression Circuit**

The term “idle jet” on a Weber is a bit misleading and is probably more-aptly referred to as a “low-speed” jet as it meters the carburetor’s mixture from idle up through roughly 2,000 rpm under part-throttle conditions. On progressive Webers, the secondary “idle jet” meters the mixture as the secondary throttle plate moves off of its seat to the point where the air flow through the secondary bore increases enough to pull the main circuit into action.

On most street-driven and trail vehicles, the carburetor will spend the majority of its time on the progression circuit so the majority of mileage calculations will come from the fine-tuning of this circuit.

The ignition systems found on the majority of vehicles running the Weber or Holley style carburetor will safely ignite the fuel under part-throttle, lean-cruise mixture ratios in the high 14:1 levels to just barely above 15.0:1. Keeping the mixture in that range, with 14.7:1 being ideal, will lead to the best economy but may come at the cost of some acceleration. High-end ignitions with multi-spark ignition boxes and high-energy coils can often run a little leaner.

Just remember that a melted piston caused by running too lean will quickly eat up any money you may have saved at the gas pump!

According to most printed instructions, mixture screws beyond 1 ½ turns out on a synchronous Weber and 2 ½ turn out on a progressive will require a larger idle jet. The problem with this is that it fattens up (richens) the entire progression circuit for the sake of the idle. I’m not here to debunk any factory settings as they provide the end user with a great way to get close to an ideal setting using nothing more than a screwdriver and a good ear. Using an air/fuel monitor, however, you can “see” exactly what’s happening under actual driving conditions. That’s why I say to test the air/fuel ratio of the progression circuit before changing idle jets.



*This photo shows how the progression holes on a Weber become exposed as the throttle opens. Holley carburetors typically use what's called a "transition slot" rather than a pattern of holes but its function is the same.*

I was able to find lean best with the 50 idle jets roughly around 1 3/4 turns out on the mixture screws. Although the jet was beginning to show some weakness in the acceleration category, it was still a very useful jet (no hesitation, no lean stumbles, etc.) and returned impressive fuel mileage.

I've found lean-best with the 55 idle jets right at 1.5 turns out on the mixture screws and the 55 seems to be an all around, good performer. It seems to have a good blend of fuel economy and acceleration.

A pair of 60 idle jets came in somewhere around a full turn out on the mixture screws. Although acceleration and throttle response was up, the mixture ratio was down. It was a really good performer without being overly wasteful but it's not to be considered an 'economy' jet.

The 65 idle jets were just sick rich.

When testing the 50, 55, 60 and 65 idle jets, at no point did I have to touch the idle speed screw to keep my desired 650 rpm idle. All that was needed was another run-through of the lean-best procedure.

Quick note: The addition of a header, upgraded ignition or plenty of other things will affect your final mixture screw settings to some degree so don't take my numbers as an absolute final. Your ignition advance settings will also play a big role in your screw settings and idle quality. I run a little more initial advance, around 10\* to 12\* degrees, but I also use manifold vacuum as the source to my vacuum canister. If I ran the 'normal' 6\* initial advance for many stock vehicles and used spark ported for my vacuum canister, I likely would have had a hard time finding lean-best idle with the 50 idle jets and I'm certain that the air/fuel ratio would have been adversely affected on all of them.

## **Tuning with Idle Air Bleeds**

Often times, simply changing the idle jets or idle-feed restrictors is enough to get good fuel delivery from the low-speed circuit. Sometimes, however, a few extra steps can be necessary to alter the fuel curve.

If you've shelled out some cash and bought a carb with adjustable idle-air bleeds, you're already half-way there and you just need to determine which way you need to go and order a few sizes in that direction and test. If not, you'll need to spend some time with a drill. As I stated earlier about it being impossible for me to cover the procedure for every carburetor that may be installed on your engine, I can let you follow the procedure for a Weber. Chances are good that it'll be pretty close.

You'll first need to determine what size air bleed came in the carb you're working with and whether you need larger or smaller air bleeds. I like to compare the air/fuel ratio between the slightest of throttle input to the air/fuel ratio up around 1,500 to 1,800 rpm. For example, if you have a case where the ratio is quite rich just off idle, but seems good up closer to 2,000 rpm, and tuning it out with the mixture screws doesn't fix the problem, reducing the idle jet or idle-feed restrictor size will help lean out the 'tip-in' point and a small reduction in idle air bleed size will help keep the mixture strength adequate as the rpm climbs up closer to 2,000 rpm.

Another example may be when the mixture is good just off idle but tends to lean out as you get closer to 2,000 rpm. This would be a case where the idle jet or idle-feed restrictor size can be left alone but a slight reduction in idle air bleed size would again pull a richer mixture towards 2,000. The opposite would be true if the mixture was good at first but wanted to get richer and the fix would be a slightly larger idle air bleed. That can be a tricky one because you'll need to make sure that it's the progression or transition circuit that's actually getting richer and not the main circuit coming into action.

I'd like to emphasize the point of using the feel of the cars acceleration in addition to the monitor at this point. You actually don't need a monitor if you're able to listen to the sound of the engine and have a good feel for it.

Having said that, let's get to the procedure. You'll need a 10/32 tap and the corresponding drill bit, some hex slotted, counter-sink brass plugs, an allen wrench and a run of tiny 'wire' drill bits. The bits need to be in .002 thousandths or .5 mm increments.

Get two or three sizes larger and two or three sizes smaller than the size of your current air bleed, unless you're already sure which way you need to go. Really good plumbing supply houses are likely to have this stuff. If not, a very nice kit can be sized for you by Paul at Performance Oriented, [www.performanceoriented.com](http://www.performanceoriented.com).

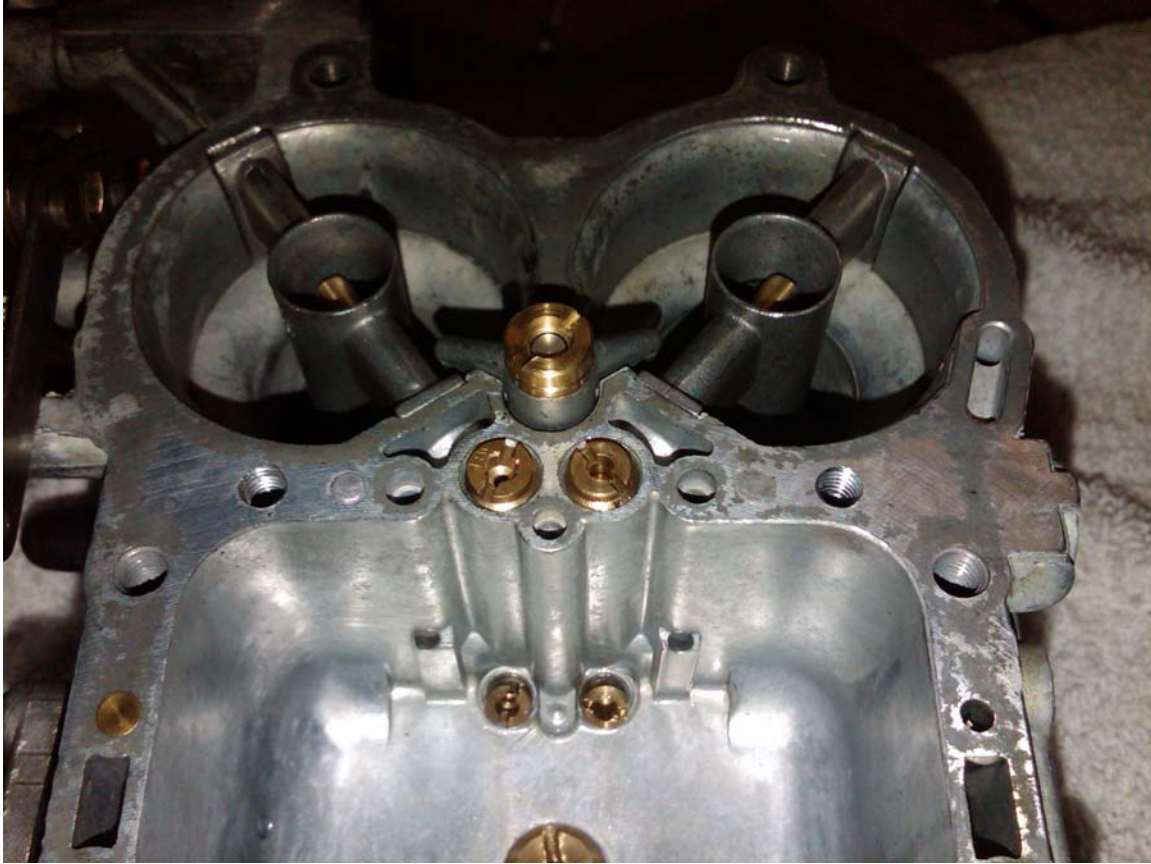


*Notice on the bag I have the metric and standard size of the bit. The small bags I use to keep the air bleeds in are marked the same way.*

Once you know the current size of your idle air bleed, you'll have to drill it out and tap the holes for the new plugs. Grease is your friend here as it'll catch a good bit of the cuttings but you'll have to use compressed air and give the carb a really thorough cleaning. If you're working with a Weber, you can pull the idle jets out and use a screw driver to pack the passages under the air bleed with grease. Be sure to grease up the tap as well.

Take the first size drill bit that you'd like to test and drill a hole in a pair of brass plugs. Do yourself a favor and use plastic bags and a marker or something to keep track of bit sizes and the new air bleeds. They're nearly impossible to differentiate between each other.





*Notice the tapped air bleeds on the outside of the larger, Air Correctors.*

Once the holes are tapped and the carb has been thoroughly cleaned out, your new air bleed can be threaded in and drive tested. Although it's possible to mess up a perfectly good carburetor if you're not careful, I'm particularly fond of this modification and the adjustability that it leaves you. It can be very useful in making sure that the fuel delivery is sufficient to bring the engine up to the speed where the main circuit can take over without making the off-idle delivery excessively rich.

It's also useful in bridging the gap between two idle jet or idle-feed restrictor sizes. If one jet isn't quite rich enough but the next one is too rich, the smaller fuel jet can be used with a slight reduction in idle air bleed size to basically split the difference and vice-versa.



Because so much of your carburetor's time is spent in the progression circuit, which is metered by the idle jets or idle-feed restrictors, it's important to get this mixture right if any sort of economy is going to be realized.

I'd like to note that I've chosen to stay a touch on the rich side for most of my settings. Inline six cylinders aren't known for their excellent mixture distribution qualities and some cylinders often run leaner than others. Since the oxygen sensor reads an average of all six cylinders, my opinion is that an excessively lean condition is never acceptable and any lean cylinders need to be considered. This will be even more important in the sections concerning main jets and full-power enrichment.

If you'll follow this procedure and keep an eye on the air fuel monitor, you'll be able to correctly size an idle jet that will provide you with a clean, economical fuel mixture for your particular vehicle and location. Just be sure to go back through the lean-best idle procedure after each jet change.

Another quick note: A simple  $\frac{1}{4}$  turn either way on the mixture screws will affect the mixture of the entire progression circuit so they can definitely be used to fine-tune a close jet selection at running speed.

### Torque Tip:

Vaporized fuel molecules take up 200 times more volume than the same fuel molecule in liquid state. That occupies a tremendous amount of space in the intake manifold that would otherwise contain oxygen rich air. Factory engines have a really bad habit of providing way too much heat to the intake manifold and vaporizing the fuel.

If you live in a place that rarely sees temperatures below freezing and run an aluminum intake manifold, I highly recommend removing any source of additional heat to the manifold, or at least doing your best to minimize it. You'll likely find an increase in torque and throttle response everywhere in the engines operating range.

Typically, the only down side to this modification is a few additional miles of driving needed to bring the manifold up to temp.

## **Fuel Pressure and Tuning with the Float**

Assuming that your float level is set correctly already, some minor changes in the transition from the progression circuit to the main circuit can be made by fine adjustments to the float level.

Let's say that you found the fuel mixture starting to richen from your 14.7:1, lean-cruise ratio at a point in the rpm range that you typically spend a lot of cruising time, say 1,800 rpm. By lowering the float just a 1/16<sup>th</sup> of an inch, you can extend the point that the main jet begins to "tip in" by 100 or 200 rpm which will allow you to lean-cruise on the progression circuit at your desired 1,800 rpm.



*This photo shows how the top plate is situated to set the float. I have lowered the float level 1/16<sup>th</sup> of an inch to delay the main circuit by almost 200 rpm. This is about as low as I would recommend going, 3/4 of an inch, or a lean transition into the main circuit will likely occur. Brass floats will require a different initial setting but this tuning method still applies.*

The same idea is true if the progression circuit starts to lean out just before the main circuit “tips in” in which raising the float by only a 1/16<sup>th</sup> of an inch can bring the main circuit in a little bit earlier. From an economy standpoint, this makes more sense than installing a larger idle jet or turning the mixture screw out a little which will serve to richen the entire progression circuit for the sake of one small period at the end of its operation.

There will be a fine line between ‘lean-cruise’ and ‘lean-hole’ when you accelerate so pay attention to the air/fuel monitor and make sure that the fuel level isn’t low enough to cause a lean hole between the progression circuit and main circuit.

Also, you’ll probably need to go back through this section if different air corrector jets are installed when tuning the main circuit.

For Holley carburetors, I highly recommend the use of clear sight glasses in the fuel bowls instead of the standard plugs. It’ll make setting the float level much easier and safer. The dual float bowls on Holleys provide a little maneuverability in that the floats don’t have to be set at exactly the same level to reach your goals.

I need to make a quick note on fuel pressure. Many Weber carburetors are shipped with a brass contact needle and seat assembly. I'm assuming this is done in an effort to reduce production costs and also the retail cost to the final consumer. It does, however, leave a little to be desired in the area of performance and reliability.

If the stock, brass contact needle and seat assembly is kept in place, a fuel pressure regulator will have to be used and that can potentially lead to several issues. The regulators that can be picked up "on the cheap" have a tendency towards erratic and fluctuating flow and pressure, which can make troubleshooting a nightmare, but also to outright failure of the regulator.

Much higher quality "Viton-tipped" needles can be installed which will eliminate the need to run a pressure regulator with a stock fuel pump and can be found in rebuild kits or through a phone call to Redline/World Pac or Carbs Unlimited.

Holley and Demon carbs usually fall somewhere between 6.5 and 7.5 psi. and the stock fuel pumps can usually work, depending on the engine's horsepower. Should a high volume pump be needed for max output, a regulator is usually required. If that's the case, I highly recommend the use of a good quality diaphragm bypass regulator.



*This photo clearly shows the difference in the area of contact between the needle and seat. The brass-tipped, factory installed needle on the left has a tendency to basically pound out where it contacts the seat with every pulse of the fuel pump. The Viton-tipped needle on the right has a*

*much larger area of contact and the softer material at the tip also serves to absorb any pulses from the pump.*

## **Main Circuit Operation**

Contrary to many beliefs, the purpose of the main circuit is not always to provide a full-power mixture to the engine. That is often-times left to the power valve enrichment circuit or “PVEC” for the additional mixture delivery under full-throttle conditions only.

If your carburetor has a PVEC, the main jets can be tuned a little leaner to allow a safe and powerful “spirited driving” mixture without going full rich and blowing unnecessary fuel through the exhaust. “Spirited driving” usually falls into the category where the throttle plates are beyond the progression circuit, roughly 2,000 rpm and up, with manifold vacuum levels no lower than 6 to 7 inches, which would usually engage the power valve.

The air/fuel ratio requirement under those conditions is typically from 13:1 to 14:1. The better the ignition is, the leaner you can go. When maximum demand is placed on the engine, manifold vacuum drops to near zero and activates the PVEC, which adds further enrichment. Wide open throttle air/fuel ratio requirements quickly fall into the 12.5:1 to 13:1 range. Again, this is a range and better mixture distribution characteristics and better ignitions will allow curving towards the higher end of the range.

For this section, it’s important to use a combination of “feel” and also the air/fuel monitor to gauge whether the engine is responding better to the leaner or to the richer end of the mixture range.



*This photo shows the jets of a Weber 38DGES. The large, brass jet in the middle of the fuel bowl is the power valve. Moving straight up in the photo, you'll find the main jets screwed in at an angle. Directly above the main jets and on top of the carburetors body are the air corrector jets. The emulsion tubes are below them and can be accessed once the air correctors are removed. The large, brass fitting at the top of the photo and in between the carburetor barrels is the accelerator pump jet.*

## **Power Valve Tuning**

Now let's get into some testing. The first thing we need to make sure of is manifold vacuum levels under wide open throttle at the high end of the engine's operating rpm. The last thing you need is to have the manifold vacuum raise to the point where the PVEC closes. This will lean out your mixture at the worst possible time. A vacuum gauge connected to a port on the manifold and run into the cab is all you need. Find a safe place, hopefully a legal one!, and simply watch the vacuum gauge as you take the engine up to the maximum rpm you intend to run it, at wide open throttle and note the highest number hit on the gauge. It will most likely remain below 3 inches but this is must-have information.

If you found that the manifold vacuum was at or near the activation point of your power valve at the top end of your high-speed test, this will have to be addressed before going further and a power valve with a lower number needs to be installed.

If you're uncertain of where the PVEC activates, a low-speed test can be run using the air/fuel monitor and vacuum gauge by slowly opening the throttle plate, keeping an eye on the vacuum gauge and the air/fuel ratio, and noting at what point on the vacuum gauge the mixture jumps to full rich. The power valve will typically open around 6 inches of manifold vacuum. When it opens, the air/fuel ratio will usually jump a full point richer. This test is safely and easily done by using a higher gear selection and a relatively low speed, basically 'lugging' the engine.

I need to address engines with performance camshafts and the resulting drop in manifold vacuum. If you have installed a performance camshaft and the manifold vacuum has been reduced, odds are good that your power valve is opening too soon and limiting both moderate power and economy due to full-power enrichment of the fuel mixture before it's necessary.

If you find that you can easily drop to say 5 inches of manifold vacuum under normal operation, the installation of a power valve that opens at 4 inches will likely be a good choice. The goal is to select a power valve whose opening rate sits lower than the moderate-load vacuum level and higher than the maximum vacuum level attained through your high-speed test. This will prevent it from opening too soon and blowing fuel through the exhaust but, more importantly, prevent a dangerous early closing at the top end of a full-power run.





*This photo shows the power valve actuating rod (long spring assembly between the floats) on a Weber 38 DGES. Manifold vacuum pulls against the spring which keeps the power valve closed. When demand is placed on the engine and manifold vacuum drops, the spring tension will overcome the manifold vacuums pull on the diaphragm, the activation rod will lengthen and open the power valve, allowing full-power fuel enrichment to the engine.*

Power valve selection on a Holley is as simple as ordering the correct one for your particular application from your favorite supplier. There are four power valve actuating rod options available for the Webers and a quick phone call to Redline with your carburetor model and desired change in opening time will get you squared away.

## **Main Jet Calibration**

The first thing we need to do here is to find out what the current jets are doing somewhere in the lower end of their operation. Depending on your float setting, they should come in between 1,800 and 2,200 rpm. You'll need a safe place to do this and a notepad. A buddy is quite helpful as well as safer! Bring the engine up to 2,500 rpm and apply the brakes as you move to wide open throttle, keeping the engine at 2,500 rpm, and record the air/fuel ratio. I've found higher gears allow a more stable reading. You may need to do this a few times to get an average.

Holley's are a little easier and I like to sneak up on a mixture that the car responds with the best acceleration in the right air/fuel range. Get it just a touch on the rich side and then tweak the high-speed air bleed by enlarging it just a bit and you should settle into a good fuel curve. If you don't have an a/f monitor, you can use 60 foot acceleration times for the best main jet size and then tweak the high-speed air bleed for the best ¼ mile mph.

If it's a progressive carburetor you're tuning, my recommendation is to isolate the mixture of the primary side and tune its delivery first.

To do this, you'll need to know just how much throttle is needed to open the primary to just the point before the secondary starts to open. Brake the engine at 2,500 rpms, while not exceeding that throttle position, and get a mixture reading from the gauge. Since this throttle position will usually fall under the category of "spirited driving" you should set your sights for the range of 13:1 to 14:1. I prefer the lower end of that range but this will be up to the way your engine responds.

Once you've established a main jet and air corrector combination that provides a good mixture delivery, somewhere around 13.5:1, from the primary, you can move your focus to the secondary side for the remainder of the wide-open-throttle procedures and mixture settings that are to follow.

If you pick up a lean condition on your air/fuel monitor right at the point at which the secondary barrel begins to open, a larger secondary "idle jet" is usually in order. For vacuum secondary Holleys, a change in spring tension will alter the opening of the secondary.

## **Tracking Results**

These are my findings using a 38DGES with the factory-installed 145 main jets and 170 air correctors. My intent is for you to follow along with me as I test, track results, and make changes so you'll know what I changed and why. I believe that using a similar procedure will help you to find the most economy and power out of your carburetor.

When braked at 2,500 rpm at wide open throttle in third gear, the air/fuel mixture was 12.0:1, but had also moved almost a full point higher to 12.9:1 by 4,000 rpm. Since I didn't feel like the 145 is really considered a large jet and it's smaller than the leanest jet provided in the jet kit, I had my suspicions about leaning it out, especially since it was moving lean at the top end. But because the next step in this situation would most commonly be to install a smaller main jet, and for the sake of good information, I installed 140 main jets and ran the test again.

My suspicions proved accurate as the 140 main jets provided a 13.5:1 full-rich mixture and the engine responded with detonation. Further confirmation came by way of a near 15.5:1 moderate-load ratio, meaning no additional enrichment provided by the PVEC.

So rather than reducing the amount of fuel being provided to the engine, let's increase the amount of air in the emulsion tube. This is done by way of the air corrector jets

## **Air Corrector Jets and Emulsion Tubes**

The purpose of the air corrector jets and emulsion tubes is to allow a metered amount of air into the fuel before it reaches the main discharge nozzle or 'auxiliary booster'. This metered air serves the purpose of correcting what would become an overly rich mixture as demand on the main circuit increases but also has the added benefit of creating an emulsion; which helps to further atomize the fuel.

When the auxiliary booster begins to flow, fuel in the emulsion well drops lower than the fuel in the float bowl. As demand increases, the fuel in the emulsion well will drop to a point where a hole or pattern of holes on the emulsion tube is exposed. When this happens, it gets mixed or emulsified with air from the air corrector jet which, when sized correctly, is designed to deliver the desired air/fuel ratio through out the entire operation of the main circuit.

As demand continues to increase and the fuel in the emulsion well continues to drop, more holes are exposed on the emulsion tube, continuing to lean the ever-increasing fuel flow. The trick is to size the air corrector jet and the emulsion tube hole pattern in a manner that holds the fuel curve flat through out the entire operation of the main circuit.



*Moving from left to right, this photo shows the emulsion tube, air corrector jet and shape of the soft wire used to lift the emulsion tube out. There will be one air corrector jet and emulsion tube for each barrel in most cases. Notice the row of holes in the tube that add more air to the mixture as the lowering fuel level exposes them.*

For the next test, let's go back to the original 145 main jets and move our attention to the air correctors. Being that the carburetor came with 170 air correctors and the smallest air corrector in the jet kit for a 38DGS is a 190, I think it's reasonable to assume that there's room for enlargement here. With that in mind I ordered a range of air corrector jets from Carbs Unlimited covering that distance and installed the 180s for the next test.

With the 145 main jets and 180 air correctors installed, I again held the engine at 2,500 rpm to get a full-rich mixture reading at the low end of the operating range. The mixture moved to 12.9:1 under full throttle conditions and held a constant 14.0:1 moderate load air/fuel ratio. This tells me that we're close and the 180 air correctors are now providing enough air to the emulsion well to allow fine tuning of the main circuit.

Being that we're now in the common range of air/fuel mixtures under full power, this is the point where you need to do some "seat-of-the-pants" feeling along with the use of the air/fuel monitor to determine how your particular engine responds to changes in mixture. Again, the better mixture distribution characteristics your engine has and the better your ignition system is, the leaner you can go, as long as you stay in the full-power mixture range of 12.5:1 to 13.1:1.

Based on the fairly poor mixture distribution of the inline 6 cylinder and the tendency of the outer cylinders to run leaner than the others, and the fact that the moderate-load mixture was still a little high at 14:0, I had a feeling that a further increase in the main jet was needed.

I installed the 150 main jets in place of the 145s and repeated the above mentioned test. This combination resulted in a near perfect 12.5:1 full-rich mixture at 2,500 rpm and a moderate-load mixture of 13.5:1 from 2,000 rpm up. Remember, I've chosen to stay a touch on the rich side.

Now that we have an air/fuel mixture that is known to be correct and powerful at the low end of the main circuit's operation, it's time to see if the mixture has a tendency to richen or to lean out towards the top end of the rpm range. For this test, attention is moved from the starting point of the main circuits operation to the high end of the rpm range that the engine is expected to run.

First, safety is a must and the track is the best place to do this! Accelerate the engine at wide open throttle and note the air fuel ratio at the end of the run. You're looking for the mixture to maintain the same ratio from the beginning of the main circuits operation to the upper end of the run.

I was very fortunate to land on the correct air corrector on the first adjustment and the air/fuel ratio remained flat at 12.5:1 from 2,500 rpm to 4,200 rpm but that won't always be the case. A simple camshaft change, different elevation or extended rpm range would likely yield a different result and require further adjustment.

Should that happen, here is the basic process. Once you have a point down low in the main jet's operating range where you know the mixture is correct, if it shows a tendency to lean out towards the top end, then a smaller air corrector is usually needed. Small changes are needed at this point, like moving from a 180 to a 175, for example. The opposite is true if the mixture shows a tendency to richen at the top end in which a slightly larger air corrector would be needed.

If the air corrector changes appear to do little or they fall outside the normal ratio of roughly 120% to 140% of the size of the main jet (150 main jet multiplied by 120% equals a 180 air corrector), then a change in the emulsion tube may be necessary. If you're as picky as me, drilling an air corrector that's a touch too small to the midway point of the next size up is perfectly acceptable.

The ratio of 120% to 140% mentioned above is usually more applicable to synchronous carbs mounted in an independent runner, higher rpm application. If you're tuning a Weber on a plenum style, lower maximum rpm engine, such as a Jeep, that doesn't see much more than 4,000 rpm, less air correction is usually needed to keep the fuel curve flat. In that case, you may find the best ratio of main jet to air corrector size right around 120%. It's not an absolute, but it does serve as a general guide.

The emulsion tube also plays a very important role in both how and where the main circuit tips in and the mixture under moderate acceleration. If you are unable to get the

fuel curve to flatten out using the above process or find that you have a lean or rich spot that you're unable to tune out with various jet combinations, it's likely that a change in emulsion tubes is needed. I suggest you call Redline and they'll be able to direct you to an emulsion tube based on the air/fuel mixture results, rpm range and throttle position you provide them.



*Here are three of the many different emulsion tubes that are available for a Weber. The tube on the left (F-50) has large holes placed high up on the tube and is considered pretty lean as it introduces a large amount of air into the fuel being drawn into the discharge nozzle. They get richer going from left to right and my emulsion tube of choice for a Weber 38 is the tube on the right (F-7) paired up with 145 main jets and 165 air correctors. I also think the center tube (F-6) or the F-7 would work extremely well in the secondary side of a progressive Weber carburetor.*

For emulsion tube tuning on Holley's, you're kind of screwed unless you do some machining in the base plate and have replaceable air jets installed. Holley style carbs aren't quite as sensitive as Weber emulsion tubes so this isn't usually necessary but some of the high-end carbs do come with replaceable air bleeds in the emulsion well.

## Torque Tip:

Once you've established a good air/fuel mixture from the beginning of the main circuits operation up to the end of the run, you can safely turn your attention to the ignition timing curve.

All of the engines I've tested in the past have made the most torque with between 32\* to 36\* degrees of total advance coming in usually no sooner than 2,800 to 3,000 rpm. Larger cammed engines can come in sooner. Higher initial advance, somewhere around 10\* to 12\*, with relatively small cams and assuming the air/fuel ratio is correct and intake heat is kept to a minimum, will lead to more torque and throttle response in the lower end of the engines operating range, especially when paired with manifold vacuum to the distributor. Bigger cams like initial timing as high as 20\*. Again, heat management is key when optimizing ignition timing. If the intake is too hot, water is too hot, even higher heat range spark plugs can lead to less-than-optimal timing to prevent detonation.

## **Accelerator Pump Tuning**

The accelerator pump is obviously used to cover the lean hole experienced when the throttle is opened rapidly. You can use your air fuel meter to determine how rich or lean the pump shot is and also track its discharge in relation to throttle travel.

Some accelerator pump set-ups have a tendency to discharge too much fuel too soon in relation to throttle travel. When this happens, very little volume is left in the pump well to be available when you snap the throttle open from the midway point.

For example, you'll have a nice pump discharge when leaving the stop light but very little should you quickly open the throttle from a cruising rpm. The higher the engines rpm is and the higher the manifold vacuum is at the point of rapid throttle opening, the more discharge will be required from the pump. Under higher rpm and higher manifold vacuum conditions such as a 2,000 rpm lean-cruise, a temporary air fuel ratio as low as 10.5:1 can often be needed by the accelerator pump to cover the lean hole.

If you're running a Holley, you're likely fortunate enough to have a whole array of pump nozzles, diaphragms of differing volumes and accelerator pump cams that can be used in various combinations to alter the timing and volume of the discharge. If it's Weber, most of your tuning will be done strictly with the pump jet.



*This photo shows the pump jet assembly on a Weber 38 DGES. The metering of the discharge is handled by the “jet” on the left. A little misleading, I know. There is a number stamped on the “jet” and a larger number will allow more fuel to pass through it while a smaller number will reduce it.*

Should you find a situation in which the pump shot is more than adequate from a dead stop but too lean when the throttle is fully opened from a cruising speed, by reducing the jet size it can reduce the initial volume of the pump shot in the beginning and reserve more fuel in the pump well for use later on in the accelerator pumps travel.

As primitive as it may sound, you’ll know you have the accelerator pump right when you get the slightest puff of smoke from the tail pipe when you snap the throttle open. It should be very faint but noticeable.

## **Summary**

I truly hope that I’ve described a method of tuning that you’ll find useful. I really feel that tuning with an air/fuel monitor is far easier, less time consuming and yields much better results than reading spark plugs. I think the key is to make small adjustments, make sure that you give the monitor a second or two to settle on its mixture reading and always run your tests with the carburetor hooked up with all of its accessories. Record

your original jetting and air fuel ratio and document every change you make. Using a steady foot and easing into the throttle will help you get accurate testing results.

One thing to keep in mind is engine temperature. Simply warming the engine up in the driveway until the choke opens and water temp shows a normal reading isn't good enough and can lead to poor tuning. Get it out and drive it fairly hard for a few blocks before taking official readings from the monitor, it'll make a big difference in your end result.

Also, don't get obsessive on the air/fuel mixture. The gauge is a great way to tell if you're in the ballpark but tuning for the best acceleration will yield the best results. Fuels have been changing, too, so what used to be 'stioch,' 14.7:1, may now be closer to 14:1. So again, use the gauge as a direction finder and tune for the best blend of low-speed performance, outright acceleration and the balance between the two.

Thanks so much for reading and I truly hope it helps you out.

Sincerely,

Shawn Watson





## **Recommended Reading and Resources**

Redline Weber/World Pac  
redlineweber.com (800) 733-7722

Carbs Unlimited  
carburetion.com  
(800) 994-2272

Holley Carburetors and Manifolds by Mike Urich and Bill Fisher

How To Build Horsepower Volume 2: Carburetors and Intake Manifolds  
by David Vizard

How To Tune And Win With Demon Carburetion by Ray T. Bohacz

Performance Oriented  
Paul Abbott  
[www.performanceoriented.com](http://www.performanceoriented.com)  
(530) 899-8371