

# Carburetion 101

By Don Kuhlman

One of the more commonly misunderstood systems on most motorcycles is its carburetor(s). Carburetors in general are mysterious things to many, and when you start putting a bunch of them on a multi-cylinder engine like most modern motorcycle manufacturers like to do, it simply adds to the confusion. Let's see if we can clear up some of this stuff including that darn "rejetting" thing all our self-proclaimed "knowledgeable" buddies are always talking about.

The basic function of a carburetor on a spark ignition engine is to mix the fuel with the incoming air in the proper proportions so that the engine can then burn it efficiently. Most carburetors also control the speed of the engine. They do this by **throttling** the amount of air the engine sees. Contrast this with a typical diesel engine that has its speed controlled by the amount of fuel injected into it, as it has no air throttle. (We'll also talk a little more about fuel injection towards the end.)

But first off, we need to identify some of the basic elements of a carburetor as this helps explain how they work. You need a minimum of three elements including a source of fuel, usually from a **fuel bowl**, a **venturi** that we'll talk about in a moment, and a fuel-metering device called a **jet**. If we want to use the carburetor to control the engine's speed, we'll also need some form of **throttle** to vary the amount of airflow going into the engine.

Taking it one piece at a time, the fuel bowl does a couple of things. As stated, it provides a source of fuel. But it does it in a very specific way. It keeps the air pressure over the fuel in the

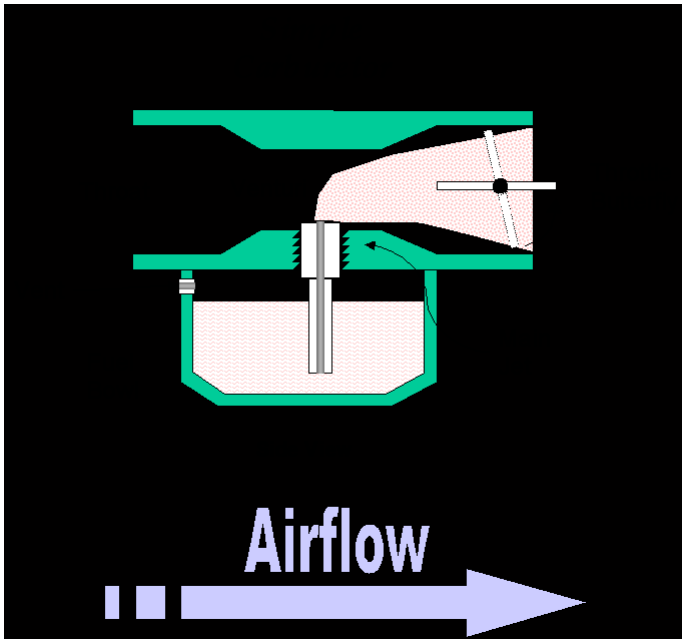
bowl at a normal outside atmospheric level. That is the job of the **fuel bowl vent** and one of the carburetor's key elements. The next item is the venturi, which is a portion of the carburetor's main air passage that momentarily narrows down. Connecting the two is the **fuel jet**. Here's how it all works.

One of the Bernoulli clan, Daniel I think it was, discovered this neat effect that as you accelerate the flow of a set volume of gas, air in this case, you decrease its relative pressure. Guess that's why they call it the **Bernoulli effect**, huh!

So, how can we accelerate our air coming into the engine? As luck would have it, another guy with the name of, you guessed it, **Venturi**, came along a bit after Bernoulli. This was Giovanni Battista Venturi and he found out that if you took a passageway like a tube, and narrowed it down just a bit in the middle, the air flowing through it would have to accelerate momentarily as it went through the narrowed down portion. It would then return to its normal speed at the other side of the narrow portion. By the way, this is also a subtle effect. Narrowed down too much and we've simply created a restriction to the airflow. But done just a little and the air molecules have to speed up a little so the same amount of them can get through the smaller passageway. They get to the other side where things open up again and they get to slow down and relax once more.

Now, remember Bernoulli's effect; as the airflow accelerates, its pressure drops. It's now less than the normal surrounding atmospheric pressure of 14.7 pounds per square inch. At least that's what it is at sea level. But, the air pressure in the fuel bowl is still at that normal atmospheric level and the difference

between the two is what draws the fuel up through the jet passage. It's also how birds and airplanes fly, but we won't go there today.



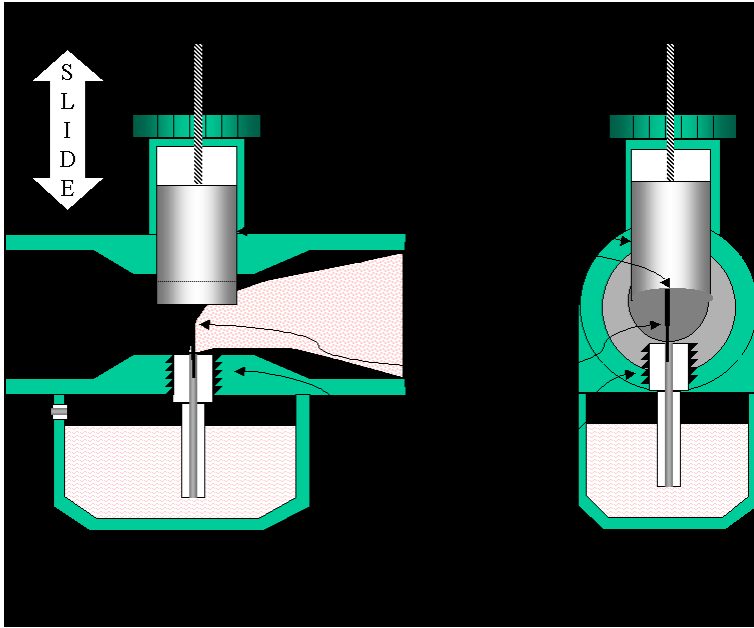
This is a carburetor in its simplest form and they've been around for quite awhile. The size of the fuel jet in relation to the air passage and venturi are what controls the fuel to air mixture. We're looking for a ratio of approximately 14 parts air to 1 part fuel for our gasoline burning engines. The throttle is there to control the amount of air going into the engine. In fact, many stationary engines have a fixed rate carburetor and don't vary the amount of airflow. We can still control the speed somewhat with the ignition, but again, it's not important for our discussion here.

What causes the air to go into the engine in the first place can also be confusing. In a normally aspirated engine (one that isn't supercharged) it's that good old atmospheric pressure again. As the piston goes down, it causes the volumetric size of the cylinder to increase. Now, where we only had a little air space before, we've got a bigger one. Greater volume of space

but same amount air and again we've decreased its pressure. Now if we open up the cylinder to the outside air pressure, air is going to rush in until the pressure in the cylinder is equal to the outside air pressure. As the air rushes in during this process, called the intake stroke, it passes through the carburetor's venturi and draws some fuel along with it. Actually, it's the outside air pressure in the top of the fuel bowl that forces the fuel through the jet.

If the jet does a good job of **atomizing** the fuel, which means it turns it into a fine spray, the fuel and air will be well mixed as they enter the cylinder. This is the basis really, as our engine is otherwise nothing more than an air pump. We add a bit of fuel to the air, ignite it to push the piston down again and we've got an internal combustion engine.

So, if it's all so simple, why all them gosh-dern parts, huh? In the early days there really wasn't much more to it. But as we've wanted to go faster and faster, we've had to come up with more sophisticated control systems. The first of these was combining the throttle with a variable jet system. These were the first slide carburetors and were used on many street motorcycles until the early 1980s.

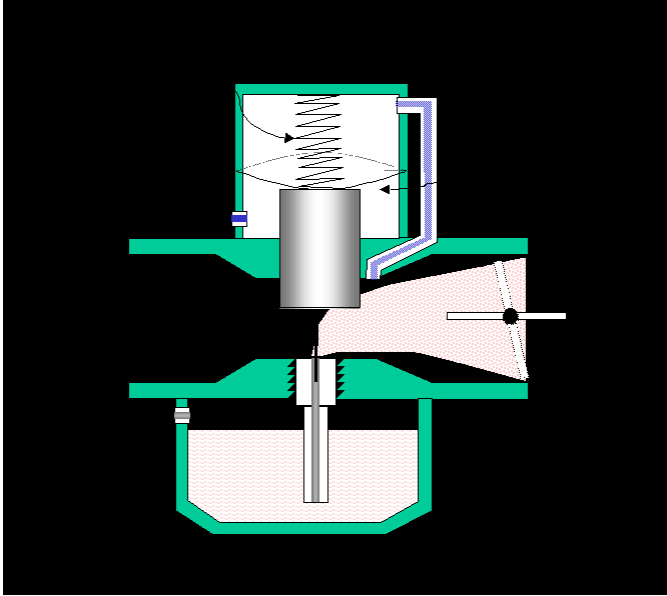


Instead of a throttle butterfly, we use a slide mechanism in the middle of the venturi. It opens and closes off the supply of air to the engine. But now, because we are varying the size of the venturi, we have to also vary the size of the fuel jet. No problem, as we'll just add a tapered needle to the bottom of our slide that runs down into the jet at partial throttle openings. Once we open the slide all the way, we are back to a standard venturi size, the needle is pulled out of the jet and we're back to our fixed air to fuel ratio. At least we are if the jet is the right size!

This type of carburetor is called a direct slide or simply a slide carburetor. They are still the carburetors of choice for racing motorcycles. The reasons are they are easy to tune, only have one major moving part, and when the slide is wide open, they don't present any restrictions to the airflow. The famous "flat-slide" carburetors are built this way. The slide itself is somewhat flat if looked at from the side when compared to the older round slide carburetor. The major benefits are lighter slides, less potential slide friction, and the ability to build a shorter venturi passage, increasing potential airflow a bit more. They are also harder (read more expensive!) to build.

The downfall of a slide carburetor is they don't work as well on the street. This is because they don't work well over a wide range of throttle setting, engine speeds, and engine loads. For example, let's say we're riding along in a higher gear at fairly low engine speeds. We want to accelerate quickly so we yank open the throttle on our slide carbs but nothing happens. Or least that is what it seems like at first. What we've really done is opened up the air passage into the cylinder all the way, but the engine's piston is still moving slowly. The engine gets a big gulp of air at first, not enough fuel to go with it and it has just stalled out momentarily. We can help this if we also squirt a little extra fuel down the throat along with the initial gulp of air, but our engine is still turning slow. Plus, we now have the added complication of that extra fuel squirter, commonly called an **accelerator pump**. If we're not careful in using the throttle, we'll also be squirting extra fuel in there all the time, certainly not helping our gas mileage out.

Because the engine speed is still slow, the carburetor size is not optimal, and is in fact, too big. It will eventually catch up, but our acceleration won't be as good. This is why we don't want to just grab a big handful of throttle on a slide carb engine, at least at low engine speeds. But all you old timers remember that now, don't you! Still, we like this being able to vary the size of the carburetor to the engine's speed and load so...



Yep, you guessed it. We're now talking about **constant velocity** carburetors. To do this trick, we simply take control of the slide away from the rider. We still need a throttle so we'll give 'em a throttle plate valve back to control the overall airflow. We control the opening of the slide by balancing it against the airflow. We can sense the airflow by porting the pressure from various places in the carburetor itself. As the airflow increases, it's pressure through the venturi decreases, relative to outside pressure, and this allows the slide mechanism to open. Good old atmospheric pressure back on the job!

Now when our rider yanks the throttle open, they only open the throttle plate. The slide opens up only as airflow increases, creating an ever-bigger carburetor. The velocity of the air through the venturi remains basically constant, hence the name. When we have less volume of air to flow, we want to keep the velocity high to ensure a good pressure drop across the main jet, good fuel atomization, optimal carburetion sizing, etc. To do this, we have to have a smaller opening. Then as we have more airflow, the carburetor throat can now be larger. So we now move more air but at the same speed or velocity that creates a good pressure drop, and all the rest of those

good carb things.

So constant velocity or CV carbs are a recent development, right? Not really, as they've been around, at least on British sports cars in the form of SUs, for quite some time. And as with everything else in life, there are also some tradeoffs. The first of these is the added complexity and the complications it brings to sizing and tuning. The throttle plate also adds some extra airflow restrictions compared to a direct slide carburetor, but we can compensate by using a larger overall carburetor. Because the slides are no longer directly controlled by the throttle, they can be a bit less responsive to rider input changes. Really though, the main reason so many people go to flat slide carbs when they perform a lot of changes to an engine is the tuning complexity associated with CV carbs. Add in a lot of valve timing in the form of racing camshaft profiles that also kill low engine speed airflow and it just gets to be too much for the poor old CV carbs to compensate for.

So, which carburetor type is better? For most of us with fairly stock engines, the CV style carbs that came with our bike will deliver the best overall performance over the widest set of conditions. They self-compensate well for changes in air density due to weather and altitude changes. They can usually handle changes to the exhaust system with little to no modifications. At least for most modern motorcycles built in the 1990s. A lot of the motorcycles built in the 1980s, in an effort to meet the then new emissions standards, were jetted too lean across the board including the main jets.

Where CV carbs get fooled and are tricky to work with is when changes are made to the air box/air filter system or large



changes to engine displacement and camshaft profiles. In addition to the usual main jet, needle and pilot jet changes, some tuners change the rate of the slide return spring or modify the slide itself by adding extra air bleed holes. But we've now made some major changes to the airflow characteristics of the engine and the porting of the airflow that controls the slide may be way off. Long camshaft timing, characterized by long duration opening specifications and lots of intake to exhaust timing overlap also means terrible airflow signal at lower engine speeds. This means lousy carburetion no matter what kind we're using, but the CV carbs will be particularly hard to set up properly.

So, if we're junking the airbox for some velocity stacks and separate K&N filters, installing that big-bore cylinder kit and stuffing the largest camshaft we can find in there, we're probably going to have some problems with our stock CV carbs. Chances are also good that we're not going to care all that much how the engine responds at lower speeds. Now we're just looking for as much horsepower as we can get. Here our slide carbs will be the best bet. They will be dimensionally smaller for the same carburetion size and much easier to tune. In addition to the usual main jet, pilot jet and needle changes, we can also play with the shape and size of the slide's cutaway. Some of the best racing carbs also have replaceable venturi throats making them adaptable to a wide variety of engine sizes and states of tune. You still need to be in the ballpark to begin with, but it's a lot easier to get there with a slide carb.

One of the other things about slide carbs that makes them easier to tune; they come with a built-in **computerized** compensation system. It's called the rider! That's right, you'll

tend to automatically compensate for the rate of opening for the engine's speed and load. What, you thought us old guys are so smooth with the throttle because that's the best way to ride well? Heck, it was all those years of trying to urge as much power as we could out of them old slide carbs! That and those old, skinny, rock-hard tires we had! There, now you know our secret.

## TUNING SECRETS OF THE STARS

So, what can we, the average backyard mechanic wannabe, do when it comes to making changes to our carbs? First, if you have a modern new motorcycle, it should be pretty darn good just as it comes from the factory. That is, if all the factory systems are still in place. And it's also legal. Making any modifications to the motorcycle's engine or its ancillary systems is illegal in many areas for bikes registered and used on the street.

Must be why so many aftermarket parts come with that warning that they are only intended for off-road racing use only!

So, for all you "racers" out there, here are some typical changes that can be made to our CV carburetor. In general descending order of frequency:

- Adjusting the low-speed mixture screw

- Shimming the main jet needle
- Replacing the main jet with a different size
- Replacing the main jet needle with a different taper/profile
- Adjusting the fuel level in bowl
- Changing the pilot jet size
- Changing the slide return spring
- Modifying the slide, i.e. drilling additional air-bleed holes

Now, take these times 2, 3, 4, or even 6 cylinders, and add in the requirement of ensuring the carbs are synchronized with one another and you've got a fair amount you can do. Or, a fair amount that can go wrong, depending on your point of view at the time.

A quick word on synchronization. There are two basic ways of accomplishing this. Adjust them all mechanically or using engine manifold vacuum as a guide. Basically, we want to get each carburetor opening and closing in concert with the others. Anytime you've taken them off the engine and worked on them, you should check them for mechanical synchronization. This means the throttle stop adjustments are the same and the throttle linkage is opening all the throttles at the same time and the same amount. Once installed on the engine, final tuning is best accomplished with a set of manifold vacuum gauges or carb sticks. And this will only work properly if everything else has been set such as valve lash adjustment, ignition timing and settings, and the engine is at its proper operating temperature.

Although not as prevalent as it once was, some engines also require staggered jetting where some cylinder's carbs are set differently from others. Usually you'll still find this practice on V

configuration engines where the rear cylinder(s) will be jetted just a little richer, over the front ones, to compensate for higher operating temperatures. Another example would be an air-cooled V engine like a lot of the Harley Davidsons that use a single carburetor. Here, you establish all the jetting for the hotter running rear cylinder and let the front one run a little rich. You'll also occasionally find it on some inline engines. Look for different sized intake manifolds and/or carb model numbers as a tip-off here.

## JETTING GUIDELINES

So when do we know we need to rejet and how many steps do we have to take? Fortunately for many of us, not nearly as often nor as much we might first think. If our motorcycle's systems are all stock like they came from the factory, we may not have to do anything at all. In some cases, a slight adjustment of the mixture screws and possibly some thin shims under the main jet needle clips may help get rid of some low to mid rpm range surging.

We're also going to stick to guidelines, as every individual configuration can be different. I've included some of what I refer to as "rule of thumb" information, but nowhere is it cast in concrete. What works well on your buddy's GSCBXRZZ-2000 may not even run on your Super Tour 900 Twin. Unless you're a fairly good wrench and are willing to chase through various configurations of parts, you should stick to known, proven combinations. In other words, ones that are known to work. You will also find that working with a carburetion tuner can really eliminate a lot of unnecessary time and frustration. Like the guy says on the commercial, "you'se can pay me now of

pay me later..."

And we would be most remiss if we didn't have a word or two advocating good old stock. Contrary to popular belief, most modern motorcycle engines do not have overly lean main jets as they come from the factory. At least those built since the early 1990s. There is no need for one thing, as the majority of EPA type testing is not conducted at wide open throttle or WOT. Plus, lean WOT operation runs the danger of damaging the engine, something else the factories try to avoid. Many Supersport racers who are required to run pure stock airboxes and exhaust systems will actually decrease main jet sizes slightly in some cases to obtain a little more power. This isn't advisable for street use by the way, as conditions vary too much during day to day operation.

## POPULAR MODIFICATIONS NECESSITATING REJETTING

Far and away, the single most popular mechanical modification to a motorcycle's engine is a different exhaust system. There are a lot of stated and unstated reasons including less weight, better ground clearance, more power, better looks, etc.. But we know that at least 90% of you are also are looking for a little more sound. Here again, federal and local regulations may come into play as to what is legal (hardly anything) and what is not. That is because the exhaust system can have a direct effect on both emissions and noise standards. Both of these areas get harder to comply with every year, and therefore, the factories spend a good deal of time here. Factory motorcycle exhaust systems are no longer the "throwaway" item they once were. In fact, many modern systems are quite efficient as long as the rest of the engine

remains stock. They also tend to be quite heavy. The tradeoff here is they are long lasting and often double-walled constructed to maintain their looks for many years.

Exhaust system changes range from simple modifications to the stock system all the way to complete trick racing systems made out of aluminum, stainless steel, titanium and carbon fiber. One of the more popular modifications on sport and cruiser style motorcycles is a new muffler(s). Commonly referred to as a "slip-on" system, the stock headpipes are often retained. This type of system can usually get by with adjusting the mixture screws and possibly shimming the main jet needles. That is as long as some form of muffler is still present.

Individual straight pipes are popular with many cruiser riders, also commonly known as drag pipes. Here, the major tradeoffs are less weight and some ear-splitting noise. It's also another popular myth that has developed over the years that individual straight pipes give an engine more power. The only case where this is true is if the factory system is highly restrictive to begin with or the exhaust design doesn't matter that much like on a positive displacement supercharged one.

Without going into a lot of "exhaustive" theory (terrible pun intended!), a single straight pipe provides little to no cylinder scavenging effect except at a specific rpm. Conversely, exhaust systems that pair cylinders together, when done properly, have the outgoing exhaust (and accompanying pressure waves) provide a scavenging effect between cylinders. This is why the best inline 4-cylinder systems use a 4into2into1 system. From there they may use a single muffler,

or they may split back out into two mufflers for more capacity. You'll notice that most big-bore sport bikes either have two mufflers or one very large one. This is to gain enough exhaust volume capacity while still providing adequate sound control.

So, straight pipes don't require jetting changes, right? Actually, they usually do. See it's a trick question. By not providing good cylinder scavenging, at least as good as the stock system, a couple of things happen. First, more exhaust mixture may remain in the cylinder, diluting the fresh charge for the next intake cycle. This may also mean that less fresh charge will enter the engine because we've effectively cut down on its ability to flow air. So now we open the throttle further in an effort to get some of our power back. But we're not providing as much signal to the main jet. What this all means is we often end up having to rejet the carburetor(s), usually richer, to get some of our power and driveability back. Gas mileage usually suffers as well. The motorcycle may sound like it's fast, but put it on a dynamometer and there may be little to no gain in power over a good stock system. This is in spite of the stock system's more restrictive mufflers.

Another common misunderstanding is the effect of exhaust system backpressure. A little can actually be a good thing, especially if it's timed right. Two-stroke expansion chambers use sound waves to help scavenge the cylinder at certain times, and help seal it with exhaust reversion sound pulses at others. An exhaust system can also over-scavenge a cylinder to the point where it is actually pulling fresh mixture out the exhaust port before the power cycle commences.

Now we'll go into some of those exhaust system rules of

thumb. Generally, a slip-on muffler system will work acceptably with simple mixture screw adjustments and possibly some slight shimming of the main jet needles. A couple more horsepower may be obtained by changing the main jets and needles as well. These are typically referred to as Stage I jet kits. Jet sizes are typically fairly close to the stock factory ones. Needles are usually included and tend to be more tapered in an effort to fatten up (richen) the midrange mixture.

Straight pipes, as outlined above, normally always require some rejetting, but with no other changes, it usually won't be radically different from stock. Most aftermarket pipe manufacturers either offer or recommend a jetting kit with their pipes. It will typically be a Stage 1 or Stage 2 system with a main jet(s) and needle(s) and instructions on how to install and adjust it for your carburetor.

A full exhaust system, especially one that is significantly different than stock will generally require jetting changes to be of any advantage. They usually work best in conjunction with air cleaner/airbox modifications and possibly, changes to the ignition advance curve. Some more on this subject later.

Next up is the air cleaner element change. Usually, this is going from a stock pleated paper element to an oiled foam or oiled gauze one. K&N offers one of the more popular lines of the latter type. In practically all cases, they are proven to flow more air than a pleated paper element of the same basic dimensions. They are more expensive as well but their reusability helps offset this somewhat.



The rule of thumb here is if the airbox housing is left completely stock, only minor jetting changes may be necessary, if at all. You'll also not see any appreciable power increase because you haven't markedly increased the airflow into the engine. And if there is one thing that varies significantly between motorcycle types, it's airbox design. Generally, the most restrictive tend to be the cruiser or custom styled bikes. That's because there often isn't any space for the much-needed capacity, what with everything out in the open. Ever wonder what is under that "dummy" fuel tank on a V-max? Yep, you guessed it, along with the dummy scoops, it all works as needed space for the airbox.

A lot of large displacement, standard style motorcycles such as the Suzuki Bandit 1200, Kawasaki ZRX1100 and Honda CB1000 have a fairly small airbox, confined as they are to the portion just behind the carburetors and shared with the battery box. Several tuning configurations for the big Bandit for example, have extracted an increase of as much as 25 hp over stock with just a slip-on muffler, timing advancer, eliminating the airbox and replacing it with dual open K&N elements, and oh yes, major jetting changes. This tends to be on the high end of what can be produced, but it is illustrative of what can be accomplished as well. The tradeoff, in addition to the extra noise produced, is giving up the waterproofing provided by the airbox. Not a real good idea if you live in a wet climate.

Currently, there is also a group of Bandit owners who are trying to get similar results by modifying the stock airbox by increasing the size of its intake port and adding an additional intake port. The last I heard, they had gotten close. The main point here though is this is what would be considered a fairly radical change. Getting the jetting matched up requires a lot of

work by private and/or professional tuners as they chase one set of changes after another to restore drivability. In the end, they may be doomed by the restriction of the stock airfilter element size, regardless of whether it is a K&N or not.

Most of the modern sportbikes, especially those that are considered race replicas such as the Yamaha R1, Honda CBR900RR, and Suzuki GSXR-750 have huge airbox capacities. Ever wonder why their huge gas tanks only hold 4 to 5 gallons of gasoline? That's right, it's mostly taken up by the large airbox underneath. Many of these newer bikes also use ram air systems, ducted from the front of the bike to help pressurize the airbox at higher speeds. Needless to say, making changes to one of these systems not only often fails to increase power, but in many cases, actually loses some. Even the stock paper elements are often adequately sized so that changing to a less restrictive material has little or no effect.

Here, generally a good slip-on muffler system, mixture settings and needle shimming or needle changes are all that's needed. And power increases over stock won't be nearly as dramatic as the example of the 1200 Bandit above. Then again, if you truly feel like you need more power on the street than one of these bikes has to offer stock, you're seriously kidding yourself!

### GET THEE TO A TUNER

If you're running a popular model and are only making a few minor and well-known modifications, you can often get very

good results from a standard jetting kit like those offered by Dynojet, Factory and others. Remember though that the jetting kits are designed to run best with a standard group of modifications. This is usually a freer flowing exhaust and air cleaner element and possibly an ignition advancer.

For those of you contemplating more radical modifications such as big-bore kits with higher compression pistons, cylinder head porting and more radical camshaft timing, you really have no choice but to do custom jetting work. Chances are also good that having gone to this much work on the engine's internal systems, you will also be changing the carburetors, probably to a direct slide type, and installing a tuned racing style exhaust.

Here is where the money spent with an experienced tuner/engine builder is really going to pay off. First, they'll be able to help you match all the components with one another to ensure they work in harmony with one another. For example, there is little to be gained by upping the compression ratio or using more camshaft timing each by themselves. They work in concert with one another. And both these modifications require enhancements to the intake and exhaust sides of the engine to get more air flowing. Putting a big racing specification part of any kind on an otherwise stock engine will practically guarantee a loss of power.

A competent tuner or engine builder will have spent many, many hours trying different combinations of parts to get just the right overall system. Add in the fact that they know what they're doing and they still have to work very hard to get everything just right. Now what do you, the novice or

uninformed mechanic, think your chances are of **lucking** into the right combination of parts? Yep, slim and none I'm afraid.

Tuners are also most useful at different levels. For basic cleaning up of a popular stock bike with an aftermarket pipe and aircleaner element, companies such as Dynojet and Factory can usually help with a phone call or two. Sometimes the aircleaner element and/or pipe manufacturer themselves has a kit or a recommendation. This includes companies such as K&N, Yoshimura, Two Brothers Racing, Vance and Hines, etc..

The next level will be a general local tuner, probably one who sets up a lot of the local racer's bikes. They will have a good general knowledge of jetting and a reasonably equipped shop with an exhaust gas analyzer (EGA) and/or a dynamometer. They are very helpful at verifying that any modifications you've made on your own are done right and are successful.

Next up are the national guys, usually a race team specializing in a certain manufacturer's equipment. This includes companies such as Ontario Motorsports (Honda), Graves Motorsports (Yamaha), Fast by Ferraci (Ducati) or Muzzy Racing (Kawasaki). They generally concentrate on current specific sports models and will recommend a package of modifications that work in concert with one another. Again, this may be in several stages, depending on how fast you want to go or how much money you've got to spend.

Finally, we get to the truly custom engine builders. Many of

them tend to concentrate on just certain brands or makes. Modifications can get extensive and expensive and may include headwork, increasing the displacement and a lot of custom machining of stock and/or aftermarket parts. This is definitely not for the faint of heart or light of pocketbook. And unless you're an engine wizard yourself, it's best to sit back and go with their recommendations. Most of them hate having a customer try to second-guess them or cut corners on what parts are needed. At the same time, don't be afraid to discuss what you want and expect in advance, and ask for and check on references. It's your money and you're going to be spending a lot of it before all is said and done. Just don't be too surprised when they tell you they'll be tossing your stock carbs and fitting up a new set of Flat Slides!

## FUEL INJECTION

While fuel injection is still something of a rarity on motorcycle engines, its gained wide acceptance on larger vehicles such as cars and trucks. And for good reason too. Properly set up, it's a much more precise method of getting the proper fuel to air ratio into the engine under widely varying conditions. Ultimately, a fuel-injected engine doesn't make any more power than one set up accurately with carburetors. Conversely, there is the tradeoff of extra complication and sometimes weight with fuel injection. But it is starting to make inroads. The first of the modern motorcycles to use it successfully was Ducati. At first they adapted basic automotive parts but later developed, along with their suppliers, fuel injection parts specifically for motorcycles.

Recently, Honda, Harley Davidson and Suzuki have added

fuel injection to some of their models, while BMW practically uses it across their entire model line now. You can certainly expect this trend to continue as tougher standards for emissions, gas mileage and noise make themselves felt.

As usual, I've run way longer than I originally expected and have, at best, only barely scratched the surface. Hopefully you'll be a little better informed the next time you need to delve into the mysteries of your carburetors or have someone else work on them for you.