How Do Carburetors Work?

by Lynn Bennett

In talking with my grown son, a college trained former Ford mechanic, it became obvious that he didn't know a thing about carburetors but lots about fuel injection. How many of you vintage motorcyclists understand how carbs work? Well, if you can follow my verbiage here goes.

Carbs work on the venturi principal. When the flow of air through a tube is constricted by a necked down portion of that tube, called a venturi, the velocity of the air in that section must increase and the pressure, relative to the atmosphere, must go down. This lower pressure is termed a vacuum. If a fluid, on whose surface the atmosphere acts, is plumbed to that point in a tube, it will be drawn into the constriction by the air pressure pushing on the fluid's surface. In a simple carb the float bowl's fuel is the surface and the jets are the plumbing to the carb's venturi or constriction. But carbs are a lot more complicated than that! The carb has "circuits" that provide its functionality. Those are the low speed circuit, the mid speed circuit, the high speed circuit, and the acceleration system. We will limit this article to an overview of common vintage carbs like the Amal Monobloc, and Amal Concentric. But guess what? They are all virtually the same. The differences are just how they look outside and how they are plumbed to get the same job done.

Physical Description:

The carb consists of a fuel bowl that is fed fuel through a float needle valve controlled by a float much like the float in your bathroom toilet tank. The level of fuel in the bowl is maintained at a specified level. The airflow through the carb is controlled by a slide that can block the flow of air or can be raised to incrementally increase the air flow to maximum when the slide is completely out of the air flow in the venturi. Attached to the bottom of the slide is a long tapered round rod called the needle that goes up and down with the slide. It pokes into a jet on the base of the venturi called the needle jet. As the needle rises from it's lowest position to the highest position, riding with the slide, the area created by the round hole of the jet and the needle blocked center section (annular area) is increased. The maximum diameter of the needle (at the bottom position of the slide) is such that some fuel can get through, while at the top the needle's diameter is blocked only by the minimal area of the end of the needle.
The supply of fuel for the needle is through the main jet. They are said to be in series. When selected correctly at some point in the slide's upward travel the needle/needle jet no longer controls the fuel flow but the main jet does. So from the bottom up we have the main jet, then the needle jet with the needle poking into it and then the bottom of the venturi. The pilot or idle jet also protrudes into the fuel in the float bowl but has it's own source of air and its' own port to dump air/fuel into the venturi just downstream from the bottom of the slide. The idle circuit also includes an adjustable screw for controlling the air/fuel mixture called the air screw on Amal carbs. Other carbs may have an idle fuel mixture screw instead which we will touch on latter.

High Speed Circuit:

This circuit is the venturi principal in its' simplest form. Air drawn through the engine creates a vacuum in the venturi of the carb drawing fuel from the float bowl through the main jet. The main jet is submerged in fuel down at the bottom of the fuel float bowl. At 3/4 throttle the needle jet's annular area is equal to the main jets area and from that point to full throttle the main jet is in control. But liquid fuel tends to remain in large droplets without some help. In the main jet's path to the venturi there is a tap in the plumbing that allows a metered amount of air to mix with the fuel to form an emulsion rather than a liquid. An emulsion, as used here, is a bubbly flow of air and fuel. That air starts at the carb's mouth, usually on a flat surface on the bottom, flows through the main air correction jet and on to the main circuit. Since the main jet supplies the needle jet the same effect works during the needle jet's operation.

Mid Speed Circuit:

For the range of throttle settings 1/4 to 3/4 the needle jet/needle control the fuel flow. The fuel flows through the larger main jet, to the needle jet, which is partially blocked by the needle. The taper and nominal maximum diameter needs to be chosen to get the correct air to fuel ratio at all throttle setting across the 1/4 to 3/4 range. Amals have only about three needle jets and usually only one needle taper but Mikuni's have hundreds of combinations making selection difficult.

Low Speed Circuit:

As explained above the idle circuit is almost a separate carb sized for the throttle setting range of 0 to 1/4. The air source is again at the carb mouth through the idle air jet, past the adjustable air screw, which directly controls the amount of air reaching the idle jet, and past the idle jet. The air flowing over the idle jet creates an atomizer effect pulling the idle jet metered fuel into the passage and on to the idle outlet port. That port is situated just down stream of the slide such that the engine pulls the air through the idle circuit. Since the air screw controls the amount of air and the idle jet's diameter is fixed, the idle air to fuel ratio is controlled by that screw. Screwing the air screw all the way in usually completely starves the engine for air and it stalls. While screwing the air screw all the way out floods the engine with too much air also starving it (for fuel) and it can stall. So obviously there is the perfect point somewhere in between the extremes where the engine speed will peak. If the correct idle jet has been selected the engine will usually peak between 1 to 3 turns out. If your engine peaks outside that range you probably have the wrong idle jet installed. As you are adding air the mixture is (fuel) leaner as the screw comes out and (fuel) richer as you screw it in. That information can help in selecting the next idle jet size if yours is not right. Some carbs, but not the Amal Concentric or the Monobloc or most Mikuni slide carbs, take a different approach for the idle circuit. They accurately select the idle jet and the idle air jet to get the correct air to fuel ratio and then put the idle adjustment screw down stream of the idle jet. This allows, it says here, more accurate control of the idle mixture. Read this as a smog control measure. The adjustment screw is termed the idle mixture adjustment.
These carbs usually won't peak or at least in my limited experience. You just set them where the manufacture says. The easy way to determine which system yours uses is usually the position of the adjustment screw. If it is mounted on the body of the carb closer to the mouth it is an air screw and if it is past the trailing edge of the slide it is perhaps an idle mixture screw.

Acceleration System:

When you jerk the throttle open the air, being low in mass, can surge into the engine rapidly while the fuel, being much more massive, is rather lethargic. If the fuel supply is made more readily available it is more likely to be taken up by the air flow. Some Amals use a small well around the needle jet/main jet opening in the bottom of the venturi to hold a small supply of fuel for that condition. Other Amals drill a multitude of holes in an extension of the needle jet allowing a more complete emulsification of the metered fuel before entering the venturi. Emulsified fuel is obviously less massive than un-emulsified fuel. Two strokes use the first style needle jets with the well while four strokes use the emulsion tube variety. You can have problems using the wrong one on you particular motorcycle so be aware. The other more important control for acceleration is the cutaway on the slide. The slide's leading and trailing edges are not cut square to the bottom of the slide. The leading edge is tapered up. This is an adjustment to the vacuum in the venturi for acceleration. The slide creates a leaner condition as the edge is made higher. A heavy response by the engine to a quick turn of the throttle is the measure for how lean the slide cutaway must be. The peak point of the cutaway is measured from the bottom and the number of 1/16 inch increments is the slide number. So a No. 1 slide is 1/16 inch and a No. 3 is 3/16 inches. This is not an easy adjustment to make. The "sharpness" is hard to feel and the slides are expensive. Usually the manufacture's original specified slide works well. You can make a slide leaner with a file but not richer.

Adjustments:

We've covered the idle air (mixture) screw adjustment. To set the engine to the correct idle speed after the idle air (mixture) screw adjustment, the idle speed adjustment screw is used. It is usually the angled screw adjustment on the side of the carb body. Screwing it in raise the speed while screwing it out reduces the speed. This adjustment simply raises the slide allowing more air through the carb venturi to mix with the air/fuel coming through the idle passage of the carb. This obviously makes the two adjustment interactive. So you must peak then set the idle speed then peak then set the idle speed, etc., until the correct idle RPM is reached. This usually takes two or three iterations. We've discussed the slide cutaway adjustment above. The needle can be adjusted vertically using the clip that rides in slots on the top of the needle. If you raise the needle (lower the clip) you make it richer at mid speeds while lowering the needle (raise the clip) make it leaner at mid speeds. The main jet selection is often overdone. Since the throttle position that corresponds to main jet operation is 3/4 to full throttle, it is highly unlikely that you can read your plugs after riding around town or even traveling legal speeds on the freeway to determine main jet size. The classic way for main jet selection is to start too rich and lean up to get the maximum top speed out of the bike. Your alley or the street in front of your house don't make good high speed test grounds. Stay with the manufacture's choice for the most part on most British bikes. You may want to choose a leaner jet if you

live and ride only at higher altitudes. Typically one size leaner is called for at elevations above 3000 feet elevation.

Conclusion:

I hope this helps with your understanding of carbs. Understanding how they work makes them less mysterious and might allow you to dive in and rebuild one. Remember when rebuilding one to clean it until it is spotless and to make sure those air jets in the carbs mouth are clear. Be sure to check all fuel and air paths by blowing high pressure air through them. Remember that the needle slides inside the needle jet and both wear. Replace them both to be sure. Amals have a history of slides sticking at full throttle, which could be very exciting and deadly. If yours sticks get new carbs. Resleeving only solves half the problem. The other half is that the bodies get distorted from over tightening the mounting nuts which bends the flange and distorts the slide bore. Some claim to have tricks for removing the distortion but nothing beats new.