Jet Setting

New Life for Old Carbs

By Bruce Smith

So you've decided to tear down your carburetors and rebuild them. You've read though Section F of the Porsche Workshop Manual and understand the basics of the float, the venturis, the idle and main circuits, and the accelerator pump. You've determined the original sizes of the various jets for your car – for both fuel and air. Now the challenge is figuring out whether the jets in your carb are what you need, or even what they are marked to be. Instead maybe you're looking for some performance improvement from your carburetors. Maybe you'd like to follow the factory rule-of-thumb 6% reduction in the main jet size for every 1,000 meters above sea level. Or you just may want to try your hand at dialing in your carbs a little better. Incrementally raising and lowering main jets sizes while monitoring driving performance through the rev range can result in selections that improve performance and/or gas mileage. This could be a worthwhile effort, especially if your engine is no longer at factory specs.

To enable any of this, you need to find jets covering the range of sizes, and maybe on both sides of the factory values. If you run Webers, some jets are commonly available and relatively cheap. If your carbs are Solex or Dellorto, you're probably limited to finding only standard jet sizes. But good luck if you're trying this with the Zenith carbs like those that came with your car. Versions of Zenith NDIX carbs were put into VWs, French cars, Italian cars, tractors, trucks, Swiss Army vehicles and industrial engines but many of the jets you might find are far from the sizes and increments that would be useful for your Porsche. So you're left with a few choices. You can trust that what you've got is good enough, you could search for jets that might come close, or you can do some DIY work to modify what you can get your hands on. The best choice these days is probably the latter, and the how-to of calibrating the flow thorough these jets is the subject addressed in this article.

The ins-and-outs of carburetor tuning are, however, beyond the scope here. There are vast geometry combinations and interrelationships that will impact fuel ratios, flow rate and performance. Without a dynamometer, much relies on trial-and-error or the experience of others. But to start with, you'll need to have the jets to play with.

Sources for Zenith replacement jets are the usual used parts markets, swap meets, and auctions. Though jets alone are often hard to come by, parts-carburetors are relatively common. There is also a market for Zenith NDIX carbs for trucks and tractors - so searching for Unimog, Pinzauger, or Haflinger 4x4 parts can turn up some sources. Jet sizes will probably not match those needed for a Porsche 1600. Main jets are usually too large (140 to 160) but resizing and re-stamping can turn them into them what you need. Though various jets are used throughout a carburetor to control the air and fuel through the idle, pump and main circuits, we're usually concerned with performance modifications through variations to the main jets. These are conventionally sized at 1.15mm for a 1600 normal engine (PO3 Zeniths) and 1.30mm for a supers (PO2 and PO19 Zeniths), stamped 115 and 130 respectively. Although alterations to the main fuel jets from Zeniths are described here, the basic process is the same regardless of your carburetor make.

Tools needed

The tools needed depend somewhat on whether you need to upsize or downsize. Upsizing requires reaming the jet and downsizing requires both soldering and reaming. Being prepared to carry out both might be a good idea. Pictured below is the array of tools to gather, including a pin gauge set, jet reamers, a 1mm stamp set, and some soldering supplies

Pin gauges are go / no go gauges used to check the size of an opening against tolerances, available in 'plus' or 'minus' versions. Plus pins are toleranced up by a certain amount (from 0.00002" to 0.0008", depending on the gauge tolerance class) while minus pins are toleranced down. Depending on the range of sizes you have available, a plus set of gauges would prevent insertion of the pin at the marked diameter (no-go) but allow insertion (go) of the smaller size. A minus set would allow insertion of the pin at the marked diameter. Details of gauging can be more involved, but these basics suffice for our purposes. A cheap yet decent hardened steel set of minus pins covering 0.01" to 0.060" in 0.001" steps (equivalent to 0.279mm to 1.524mm in 0.0254mm steps) with an accuracy of +0.0000", -0.0002" (class ZZ accuracy) can be found through the various on-line or 'import' tool sources.

Jet reamers are tapered square-sided hole cutters. The reamer is held in a pin vise, often included in a kit. Each tapered cutter covers a range of diameters and measuring along the length with calipers allows the best choice for a particular hole size. Marking the location of the desired diameter with a Sharpie and pin gauging as you go will ensure the correct opening. Once the opening is cleared, reaming from both sides will reduce the tapering in the jet itself. Making a precise, smooth, small bore isn't trivial. Variations in the orifice size, shape, roughness, and chamfer can influence the flow out of a jet. Stahlwille sells a German-made hardened steel jet reamer kit with a pin vise and 16 cutters ranging from 0.33mm to 2.0mm, with overlapping dimensions to cover the full range. Calibrated drill bits can also be used to open jet holes but can leave fluted cutting marks in the jet, which is avoided with the square cutting sides of the reamers. Starting a drill bit in a soldered hole using a pin vise is more difficult than with the pointed tip of a reamer. Once started though, a bit can open the hole for further reaming to size. Reaming can be done dry or with various cutting fluids. The counter-bore or chamfer at the end of the jet orifice is important to achieve the proper flow and flow pattern. A 3mm drill bit gives a good counter bore chamfer, close to the original.

Soldering supplies should include a soldering gun or butane torch, 50/50 or 40/60 acid-core solder, plumbing paste (flux) and fine grit sandpaper.

Jet sizing and flow

The air-fuel ratios and flow rates in a carburetor are the result of fairly complex combination of mass flow and fluid mechanics. Jet properties are influenced not only by their internal diameter but other geometry including length-to-diameter ratio, entrance and exit areas, surface roughness, and inlet/exit chamfer shape. It's possible for jets with similar hole sizes to exhibit quite different characteristics. The only true way to know the flow rate of a particular carburetor jet is to directly measure it at operating pressure. The Workshop Manual provides the factory specifications for fuel pressure, though a few calculations are necessary to translate to more conventional units. A range of 0.13 to 0.18 atü is given for the targeted fuel pump pressure while a 1.8m water column (WC) is listed as the pressure standard for the carburetor float level. Though not the familiar units of psi, these values are equivalent. The German term Atmosphären Überdruck (atü) is an obsolete measure of absolute pressure, which is about 0.98bar. This range converts to about 1.9 to 2.6 psi. Pressure in a water column can be calculated by using the density of water (0.434 psi/ft), which results in 2.6 psi at 1.8m. A water column is simple way to deliver constant relative water pressure. A column 1.55 meters high will deliver a pressure of 2.25 psi, the middle of the 1.9 to 2.6 psi range. To compare and test Zenith main jets, a 1.55 meter water column was built using PVC pipe, some fittings, and a flow gauge as shown below (contact me if you'd like a more complete description of the apparatus). Hanging the system from the ceiling into a laundry basin, connected by a hose to water supply (the faucet), delivers a constant 2.25 psi water pressure to jets for measuring flow rate.

A 1.55 meter water column constructed to measure the flow rate though main jets. Water flows through the bottom of the column, up 1.55 meters past the 'head' to a vented u-fitting and drains off and down. The jet under test is at the end of the head and receives water at the constant relative pressure of 2.25 psi.

Testing some jets straight out of the carbs

Sixteen main jets were removed from eight Zenith 32NDIX carburetors for testing. The flow characteristics of eight 130 super jets and eight 115 normal jets were measured and gauged before any cleaning was done to get an indication of their initial condition. Flow rate was measured over a 30 second period, after which each jet was removed and gauged with a pin gauge. The results are tabulated below. A good deal of variation can be seen in both the opening size and flow rate, with some variation in the correlation between the two. It's apparent that most of the jets weren't delivering what they were supposed to and most were open smaller than what they were labeled as. Differences were substantial (up to 50% and more) and the performance between them in a working carburetor would likely be noticeable.

Sizing and re-sizing

The first step before making any changes is cleaning. A good general method for brass parts cleaning is to use a small ultrasonic bath filled with hot water, into which a small open glass jar containing the parts is immersed. The jar should contain a mixture of 20 parts hot water to 1 part Pine Sol. Once the ultrasonic cleaning starts, the time that the glass jar is

115 Labeled Main Jets		130 Labeled Main Jets	
Flow Rate (ml/min)	Gauged (mm)	Flow Rate (ml/min)	Gauged (mm)
290	1.09	360	1.30
250	1.09	350	1.27
320	1.14	370	1.32
310	1.12	380	1.32
200	1.07	360	1.30
320	1.14	350	1.27
290	1.09	290	1.24
300	1.18	500	1.42

The baseline 2.25 psi flow rates and gauged diameters for sample 115 (1.15mm) and 130 (1.30mm) Zenith carburetor main jets.

in the bath should be monitored and limited to 1 to 3 minutes. This mild acid cleaner will quickly clean the brass with very slight etching. Too much time will remove zinc from the brass, leaving excess copper and a pinkish color on the surface. The same process can be done without an ultrasonic bath but it will take longer. Once clean, holes should be reamed from both sides of the jets to the corresponding depths measured (with calipers) marked (with a Sharpie) on the reamers. Different reamer depths will be necessary for the two sides of the jets. Here, reaming was done on all but the largest 115 and 130 jets, leading to new and acceptably similar flow rates of 320-330 ml/min. and 360-370 ml/min. respectively.

Modifying oversized jets to smaller sizes is more involved and requires soldering and then reaming. As an example, a 155 main jet from a Unimog Zenith is shown below, resized and re-stamped as a 130 jet. The process involves cleaning, filling, and reaming to size followed by the removal of the old stamping and re-stamping (if necessary).

The detailed steps involved are as follows:

1) The bore and end-face of the jet need to be clean and free from oxidation to accept solder. Clean the end of the jet with 500 grit or finer wet sand paper on a flat glass plate. Ream the opening of the jet slightly

Continued

A 155 main jet from a Unimog Zenith carburetor converted to a 130 main jet for use in a 1600 Zenith PO2 carburetor. The original jet orifice and stamping are shown in the left two photos. Results after cleaning and soldering are shown in the center and the final results with new stamping are pictured in the right two photos.

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larger to remove any remaining residue and apply a small amount of acid soldering flux. With the jet in a vise, apply heat with the torch to flow the flux down through the jet. Continue heating and follow with solder, allowing it to flow through and fill the opening but leaving a dimple remaining in the chamfered center.

2) Re-sand the end-face of the jet smooth and counter-bore the chamfer with a ~3mm drill bit in a pin vise, removing material to the original depth.

3) Opening a new hole is best done using a combination of reamers and a small drill bit. Start a center hole with the sharp tip of a larger reamer. Once started, opening the entire bore is made easier by clearing a smaller thru-hole with a drill bit. For example, 1mm drill bit in the pin vise will provide a starter hole for further reaming to 1.30mm. Go slow and use some light machine oil to help with the cutting.

4) Once the smaller thru-hole is complete, open it up using the tapered reamers at both ends, which should be calibrated and marked for the desired hole size. Oiling the reamer will help with cutting, as will removing it occasionally to clean. This is slow going as well and it will take several minutes to clear the opening to size. Measure progress along the way using the appropriate pin gauges.

5) Re-stamping is a matter of filing the old markings off with a fine file or fine grit sand paper on a glass slide. Holding the jet in a vise, lightly stamp it with 1mm numbering stamps. Clean and blow orifices clear of any bits or residue.

* * * *

A large part of the performance of our cars relies on well-behaved carburetors with the jets that belong in them. Increased performance can also be possible with some deviation from spec. This is challenging without an available supply of calibrated replacement jets. But with some time and a few basic tools, modifying what you've got isn't too difficult a task.

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