Carburetor Cleaning Guide for ARFcom

Originally posted in the AR15.com Survival Forum, which can be found by going to AR15.com and then selecting ‘Outdoors’ followed by ‘Survival Discussions’

Introduction
There’s been a lot of talk in the SF lately about generators. The discussions have been timely for me because our town just went through a week-long outage caused by the April 25-28 tornado superoutbreak (http://en.wikipedia.org/wiki/April_25%E2%80%9328,_2011_tornado_outbreak). My wife and I ran our generator a few hours a day to chill our refrigerator and a neighbor’s, run a few fans, charge electronics, and take hot showers with our tankless natural gas water heater. For the most part it worked out very well. I did have to tear-down the carburetor mid-way through the outage to clean some debris out of it, but once that was done we had no more trouble with it. That small hiccup left me wondering how others would handle a carburetor failure with no available help. I've played shade-tree mechanic and I once stayed at a Holiday Inn Express, so I decided I would put together a guide to cleaning a carburetor for the SF. I know there are more knowledgeable posters here than myself concerning these matters, so, please, if you are one of those guys, by all means correct any errors I make and add any tips of your own that might help someone out down the road.

Enough of the talky stuff. What follows is a brief and general description of how a carburetor works, some common problems, and a step-by-step walkthrough of removal, disassembly, and cleaning of the carburetor on a Champion C46540 generator with a Honda GX200-clone engine. At the end is a short list of things you should have on hand to fix your generator when you can’t just run down the street to the parts store.

How Carburetors Work
Carburetors are simple devices for metering fuel and mixing it with air as it is inducted into the engine’s intake. They function on Bernoulli’s principle, which is the same bit of fluid dynamics that an airplane’s wing is designed to exploit. Bernoulli tells us that when air flows through a pipe and meets a constriction the air inside the constriction flows at a higher velocity but has a lower static pressure than the air outside the constriction. Basically, the air in the constriction speeds up and generates a vacuum. On an airplane wing (which is like a constricted pipe that’s cut down the middle and then rolled-out flat) this is how lift is generated. Inside a carburetor this is how a vacuum is created to draw fuel through a small jet’s orifice so that it is carefully metered and well-mixed with the air it is ejected into.

Now, for this to work properly you need a few things to work together. First, you need an adequate fuel supply flowing into the carburetor and held at a proper level. Fuel flows from your fuel tank through your fuel line and filter to reach your carburetor. It enters the carburetor through a barbed inlet and flows past an open needle valve to pour into the carburetor’s bowl. When the fuel reaches the proper level in the bowl the float puts pressure on the base of the needle and the needle seals against its seat to prevent additional fuel flow. As fuel is used, the level begins to drop in the bowl and thus relieves the float’s pressure on the needle which falls back to allow fuel to flow again until the proper level is again reached. With fuel at the proper level, the jet’s job is simply to accurately meter the correct amount of fuel for healthy engine
operation. Too much fuel will foul the sparkplug and cause smokey exhaust. Too little fuel can result in excessive heat buildup and engine damage. Neither condition is a good thing. To summarize, the jet(s) meter fuel in the carburetor but they can only meter it accurately if the needle and seat hold the fuel level at precisely the correct point.

There are two variable controls on the carburetor—the choke and the throttle. The choke normally only has two or three positions so that it can be turned on, off, and maybe somewhere half-way in between. The choke’s job is to allow cold starts by adding extra fuel to the mix. It ‘choke’s’ most air flow through the carburetor while the engine vacuum sucks fuel through the jet. If an engine only runs with the choke engaged, even part way, that means your engine is starving for fuel and there’s a problem in the carburetor. Like the choke, the throttle varies air flow through the carburetor, but it is continuously variable from fully open to almost fully closed. Rather than allow you to start a cold engine, the throttle varies air flow to change engine speed or power. For a generator engine the throttle is connected to an engine governor that maintains a consistent engine speed, so the throttle and governor in this case is actually varying power output rather than engine speed. (Inverter generators operate differently in that they actually throttle engine speed to allow for more efficient operation. They are able to do this because the inverter-generator head regulates the output frequency independent of engine speed whereas in traditional generators output frequency is strictly dependent upon engine speed. Both types of generator regulate voltage independent of engine speed.)
Common Carb Problems

There are two common sources of trouble in the carb: the needle-seat interface and the jets. Don’t start working on an engine by fiddling with the governor or adjusting the idle speed screw. Those things rarely go wrong. If it’s a fuel problem, check the needle, seat, and jets first.

The needle and seat can cause trouble in two ways. They can either let too much fuel into the bowl or too little. If a piece of varnish, rust, or debris gets between the needle and seat it can prevent them from sealing. A damaged needle or seat can do the same thing. This will overfill the bowl to the point that it will overflow through the jet orifices into the air filter housing and/or into the engine intake. You can often see this fuel dripping out of the carb when this happens, though on some engines fuel flows instead through the intake into the cylinder, flows past the rings, and collects in the crankcase. This can be harder to spot and will manifest as too much very thin oil in the crankcase. Oil that smells like gasoline is a telltale sign, and the net effect is a thinning of the oil which can result in ring and bearing failure. The opposite happens when the needle and seat don’t allow sufficient fuel flow to fill the carb. Then the engine will often start up ok after sitting for a while, but will run for only a short time before it sputters and dies. In this case there are two likely causes. Either the seat is clogged with debris or, in the case of carbs with solid needles and an o-ring for a seat, the o-ring may be swollen to the point that the passage through it is the size of a pinhole. With the bowl removed from the carb you should see fuel dripping out at a decent rate if you turn on the fuel, and then it should stop entirely with gentle upward pressure applied to the float. If fuel flow is very slow or if it doesn’t stop with pressure on the float, you’ve found a problem.

The second common source of trouble is the jets and their orifices. These can get badly clogged if varnish is allowed to form in the bowl or if the carb gets really dirty. The only cure for this is a thorough cleaning, and sometimes mechanical removal of built-up varnish is required. As I will describe below, I like to use a small copper wire to carefully clean each brass jet and cast aluminum orifice. Then I blast canned carb cleaner through all orifices and passages both to remove garbage and to test flow through them. Soaking metal parts in carb dip overnight helps with deep, hard-to-reach parts clogged with gunk. It will remove stuff that the canned spray cleaners won’t touch. You can also boil aluminum carb castings or brass jets in a weak solution of baking soda and water. This works ok, but I prefer a good bucket of carb dip.

Removal, Disassembly, and Cleaning of the Carb

Here’s the genset I worked on. I ran it about twenty hours over a week of outage and it did well for the most part. On the evening it malfunctioned it started-up alright but would only run with the choke engaged halfway. This indicated that it was starving for fuel (remember: the choke increases the fuel in the fuel-air mix), so I suspected a problem in the needle and seat. On the night in question I tore it down just far enough to remove the float and needle, and then I sprayed it out with carb cleaner. Sometimes this works, but it’s not a sure thing. You really need to clean a malfunctioning carburetor better than that, but it was late and I wanted a hot shower. It ran fine for the next few days, so after power was fully restored I set out to do a proper job of cleaning and inspecting the carb. The following is a walk-through of that process.
The 240V <-> 120V toggle switches between a single 120V 30A output through the three-pin RV plug or split-phase 240V 15A output via two 120V feeds 180-degrees out of phase and fused 15A each. Either way you end up with a maximum continuous power of 3500W (where 240V x 15A = 120V x 2 x 15A = approx. 3500W). Note that the 12V DC output is only 10A, or 120W total. That’s because the DC alternator section is a relatively puny stator cage built around the flywheel. DC is generated as the permanent magnet in the flywheel spins past several sets of field coils whose output is then rectified.
Here’s a shot of my generator’s data plate in case anyone is interested.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>C46540</th>
</tr>
</thead>
<tbody>
<tr>
<td>FREQUENCY</td>
<td>60 Hz</td>
</tr>
<tr>
<td>PHASE</td>
<td>SINGLE</td>
</tr>
<tr>
<td>POWER FACTOR</td>
<td>1.0</td>
</tr>
<tr>
<td>AC VOLTS</td>
<td>120/240</td>
</tr>
<tr>
<td>AC AMPS</td>
<td>29.2/14.6</td>
</tr>
<tr>
<td>AC WATTS</td>
<td>3500</td>
</tr>
<tr>
<td>DC VOLTS</td>
<td>12</td>
</tr>
<tr>
<td>DC AMPS</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Looking at the generator from the side you’ll see the air filter box directly below the choke/run label and the fuel shutoff valve between the air filter and the flywheel cover. The carburetor sits directly behind the air filter box.

The air filter cover pops off with the two visible wire clasps on top and bottom.
Then four screws come out to allow removal of the foam filter element.

With the filter out of the way you can now see the carburetor air inlet with studs on each side of it.
The two nuts on the carb mounting studs come out from the front...

...then the bolt that fastens the bottom of the filter box to a metal bracket comes out from the back. Here you can see the carburetor from the side, mounted between the filter box and the engine.
Slide the filter box off the studs to expose the front of the carb. The breather house (top left) will pull out of the box without too much trouble. The choke lever is visible above the air inlet and fuel line inlet. Just behind the choke lever you can see the thin rod and spring linkage to the governor.

Here’s a side view with the filter box off. You can see (starting from the right) the fuel shutoff valve and fuel line, carburetor with breather hose hanging overhead, valve cover with breather fed into it, and, above that, the sparkplug wire and boot.
Turn the throttle carefully by hand until its slot lines up with the long axis of the governor rod, unhook the spring, and carefully lift out the governor rod.

Make sure you’ve turned off the fuel at the fuel shutoff valve. If you forget you’ll soon be reminded.
Use a pair of pliers to compress the tabs of the fuel hose clamp on the fuel inlet and slide the clamp back up the hose away from the carb, then pull the hose off of the fuel inlet barb.

Look around the carb to make sure nothing is still attached, then slide it carefully off the mounting studs. Tip the inlet barb side towards a waste container to drain some of the fuel from the bowl.
Set the carb on a clean bench. (Dirt and debris cause no end of trouble in carburetors. The last thing you want to do now is to introduce more of them into the carb.)

Remove the small, off-axis screw first and drain any residual fuel into a waste container. Then remove the larger screw on the bottom.
Carefully pull the bowl down away from the carb. You may have to rock it or tap it, but be gentle. Don’t pry at it or pound on it. The goal here is to remove the bowl without warping it or damaging its gasket.

Inspect the bowl and clean it well. Varnish, rust, debris, and junk of all sorts can collect in here. Even the smallest flakes of rust or varnish can get stuck in the jets or the needle and seat.
The large white plastic donut here is the float. You can see the pin running through it and you can just make out the bottom of the needle surrounded by the brass seat insert.

Use your fingers or a pair of pliers to remove the pin. Be ready to catch the needle and a tiny wire retaining clip, if installed.
Lift off the float and don’t lose that needle!

In this carburetor the seat is solid brass and the needle has a soft plastic coating that forms the seal. That’s the black tip you see. Don’t scratch that coating or use any harsh chemicals on it.
Looking down into the brass seat (left) and main jet (center). The main jet is slotted for a screwdriver, but be careful if you try to remove it. In the case of my carb it couldn’t easily be removed, so I cleaned it in place. In carbs with a solid metal needle with no plastic tip you’ll see a seat o-ring in the bore on the left. You’ll need to remove that o-ring before dipping the carb (because the dip will dissolve it or cause it to swell). Don’t try to remove it if you don’t have a spare! They’re easy to damage during removal. If you don’t have a spare, try blowing air or gasoline into the inlet barb and through the seat o-ring before using a spraycan of carb cleaner because that stuff might harm the o-ring.

I wanted to dip the entire carb overnight in cleaner, so I had to remove all gaskets and soft parts. The cleaning dip is not friendly towards plastic or rubber. Unfortunately, the throttle and choke on this carb have a lot of plastic on them. I removed the phillips head screw on the throttle plate...
...then I removed the throttle plate itself from its shaft.

With the throttle plate removed the throttle shaft pulls out through the top of the carb.
Stop and read carefully before going any further! This is the idle speed screw. It acts as a stop to prevent the throttle from closing too far with the engine under no load. You need to know where it is set before you remove it because it’s really frustrating to find the right setpoint with no reference. I carefully counted the number of turns to turn it all the way IN until it stopped against the body of the carb, then I removed it. Later, when I reinstalled it, I turned it all the way in and then counted the number of turns out to match its previous setting. I only removed it because it is plastic on my carburetor. If yours is metal, leave it alone! The carb dip won’t hurt a metal screw.

Remove this plug. It functions as a stop and also houses a small idle jet.
Here’s the idle jet after removal. Don’t put this in the carb dip because it has lots of plastic and a rubber o-ring on it.

Remove the choke plate from its shaft. To do this, use a small flat head screwdriver to pry the half of the plastic shaft away from the scallops in the choke plate, then slide the plate out. Be careful doing this—don’t bend, break, or otherwise damage the plastic shaft. This is a little precarious.
Slide the plastic choke shaft out of the carb body.

Carefully remove the gaskets from the two mounting flanges of the carb. Here’s one side after carefully sliding a razor underneath. As you can see, I tore it up a bit, but it will still seal ok.
Determined to do a better job on the other side, I did exactly what should have expected. I royally screwed it up. However, it will also still seal ok. Try to do a better job of removing gaskets than I did. Old gaskets that have been in place for a long time are often unsalvageable, so be prepared to replace them. This may mean cutting new ones from sheets of gasket material. You should buy a few sheets and stick them in your tool box. Or, keep a rebuild kit for your carb on hand and always have a spare set of good gaskets. These gaskets are actually pretty important. Remember that the carb meters fuel and mixes it with air to get the right fuel-air mix. The performance and health of your engine depends on that mix being correct within very tight margins. Air leaks around these gaskets allow more air into the engine to make it run lean (if at all). Lean running on a small, air-cooled engine can quickly cause irreparable damage due to overheating and detonation.

Here you can see the main jet orifice (brass stub in the middle), two other orifices, and the bulged venturi constriction in the middle at the main jet orifice.
The whole carb body, the bowl, and any other solid metal parts go into the dip. I leave them overnight and agitate by shaking the bucket a few times.

When the dip is finished, take out each part and spray it off with a can of carb cleaning spray. I clean every orifice with a small piece of copper wire. Rebuild guides normally tell you not to do anything to the orifices, but I find that a badly clogged orifice can’t always be cleaned just by dipping alone. Copper wire is soft enough to be reasonably safe for this, but go slow and be careful. If you scratch or gouge an orifice or jet it may not meter fuel correctly. Don’t use anything hard for this like steel wire—it will easily gouge cast aluminum.

Reassembly is the reverse of removal. I know, I know. Nobody likes to hear that, but it’s true. Don’t overtighten things. Make sure your gaskets and sealing surfaces are clean and look ok. Try not to end up with a handful of parts left over at the end.

Before you reconnect your fuel line, check the fuel in your tank. Stick the fuel line into a glass jar and open the shutoff valve long enough to collect a few ounces. Look at fuel and smell it. If you see lots of particulate stuff, rust flakes, or other solid contaminants it should be drained. If it smells like varnish, drain it. If there’s water in the fraction you drained, drain more until you get to pure gasoline. (Gas, diesel, and oils are about 75% as dense as water, so they float on top of it.) I drain and discard any fuel I find with water in it.

In fact, while you’re at it and have things apart you should consider installing a fuel filter if your generator doesn’t have one. Buy one with two barb fittings of the right size for your fuel line. Buy one with a horsepower rating equal to or greater than the horsepower rating of your generator’s engine. Clear plastic filters are especially nice because they let you see fuel flowing and they let you see how much debris is in your fuel. To install your filter, use a sharp knife to cleanly cut your fuel line between the fuel shutoff valve and your carb. Make sure the cut is
square. Then, take your filter and look to see if it has a flow direction marked. Align the mark to
the direction your fuel should flow and push the two ends of the fuel line firmly onto the barbs.
That’s it. Pretty easy, huh? Now go buy a spare filter and throw it in your toolbox. (There’s more
on things to keep on hand at the end of the write-up.)

How to Avoid Future Problems

The biggest thing you can do to avoid trouble is to use good gas. I only run pure gasoline and
avoid E-10 like the plague because I have seen too many problems caused by ethanol. You may
have to look around for real gas, but it’s worth it, especially for small engines.

Secondly, don’t use the ignition killswitch. When you’re done running your generator, turn off
the fuel at the fuel shutoff valve and let it run until it dies. This uses most of the fuel in the
carburetor and prevents spoiled fuel from forming varnish in your carb bowl or clogging your
needle and seat. It also prevents fuel in the bowl from sitting and absorbing water from the
atmosphere if you are running E-10. (Seriously—don’t use that crap in your generator!)

Lastly, if you’re putting your generator up for a while drain the fuel from the tank. Just pop the
hose off the carb and stick it into a container to catch the fuel, then open the shutoff valve. It
takes a little time to do, but it will save you down-time later.

Things to Have on Hand for a Generator Failure

- Spray-cans of carb cleaner
- Bucket of carb cleaning dip
- Small copper wire (I use a single wire out of a twisted automotive wire)
- Wrenches, screwdrivers, utility knife, and needlenose pliers
- Spare carb rebuild kit (including jets, gaskets including bowl gasket, needle, set o-ring if
  applicable, etc.)
- Tube of fuel- and oil-resistant RTV for repairing or replacing torn gaskets (use sparingly
  and only if needed!)
- Sheet of gasket material for cutting gaskets
- Spare length of fuel line
- Spare fuel filter
- Good, clean fuel that hasn’t sat around for the last two years
- Extra sparkplug
- Multimeter and circuit schematic(s) for your generator