

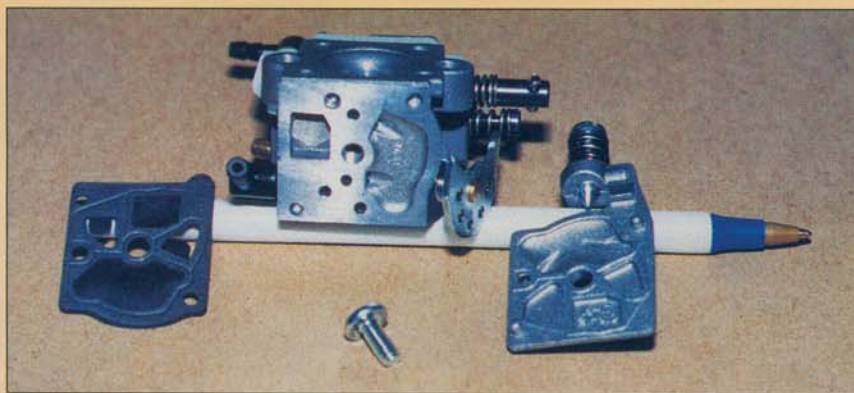
The Knowledge

MODEL WORLD

PART 14

CARB CRUD CLEAR-OUT

Stephen Bell on Overhauling Diaphragm Carbs and Theory of Operation



This photo shows the pumping chamber, internal passages and filter screen. The screen is in the square hole with one corner bevelled. The pump and valving diaphragm with the gasket are to the left and the cover is to the right. Notice the black nipple for crankcase pressure.

Most of you have probably not read any of my material before. I presently write technical articles for Model Helicopter World a sister magazine to this one. While I still enjoy fixed wing aircraft very much my attention is attracted to helicopters due to their mechanical nature. Most people fail to realise that while the helicopter is a little complicated it is also quite reliable and can be cheap to operate in its basic form. I invite you to sample MHW to find out more about this exciting hobby and promise you won't be disappointed.

I try as much as possible to cover new topics not previously found in other model aircraft magazines and I believe this is one of those precious times when I have something useful to share with various branches of the RC modelling community. I feel this article should be of assistance to anyone operating a small two cycle gasoline engine. Rather than only explain which parts to replace and in what order I will also cover basically how the pressure carburettor functions internally. By knowing how the system works it should offer the operator a sensible way to rectify a faulty unit. In any event I hope you learn something new and I shall endeavour to make this as 'Murphy proof' as possible. At first it may seem a rather complicated device next to the glow engine counterpart which is true to a point, but still overall, it is a simple enough device. Please view the schematic of the fuel system first noting the fuel flow and the internal components then refer back if

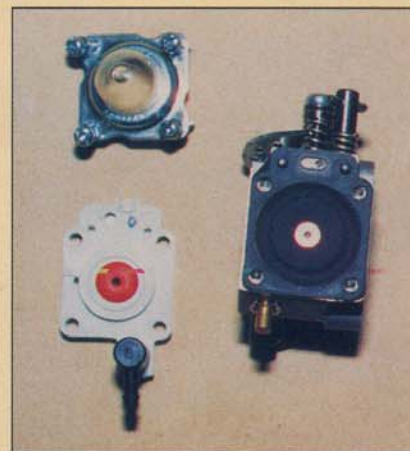


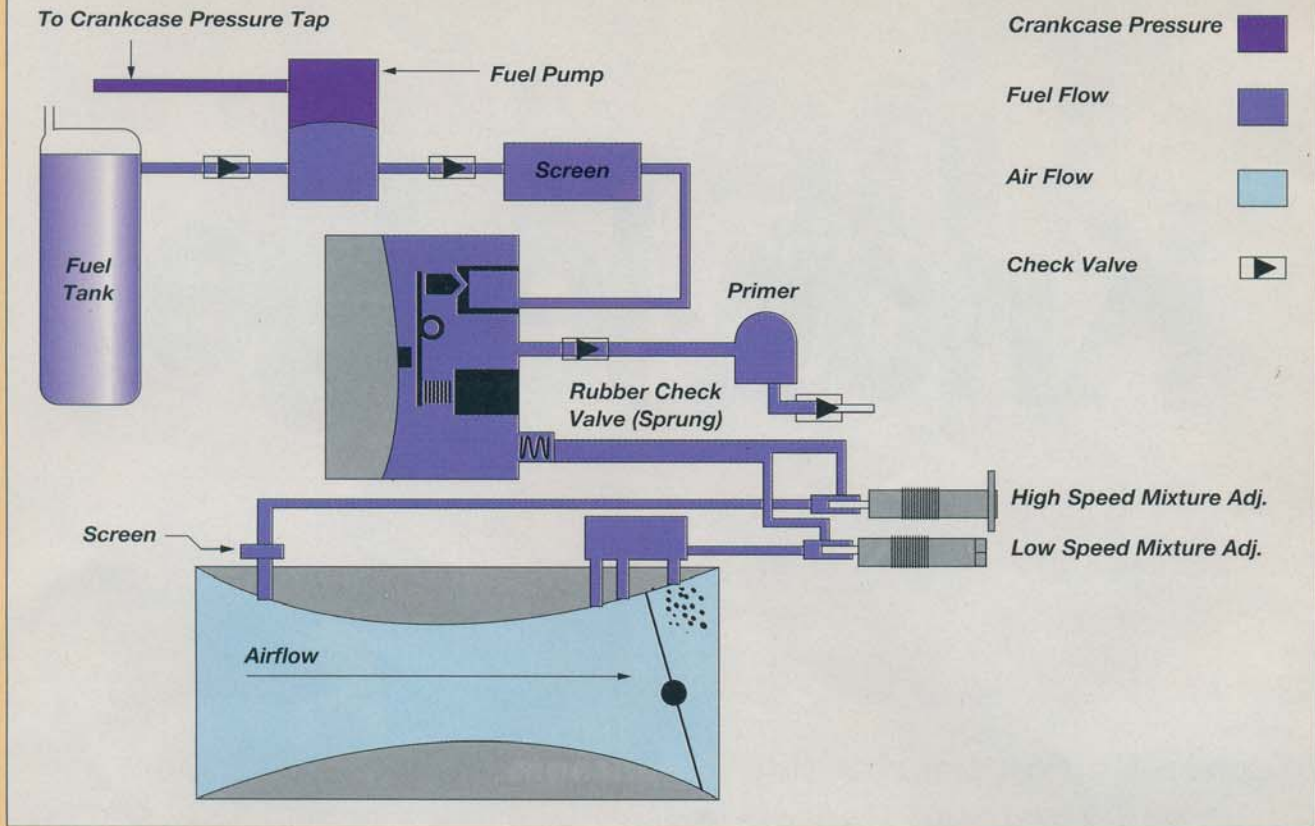
This photo depicts the carb rebuild kit. Notice the two bowl shaped Welsh plugs and the large washer on the metering diaphragm.

and when you need. As you can see I received a new Windows 95 colouring kit! Enough chit-chat, and so... on to the goods.

The glow carb relies on venturi pressure to draw fuel from the tank and is usually assisted by muffler pressure. A venturi is nothing more than a compartmentalised airfoil which creates a low pressure when air flows through it. By tapping into this venturi at

Here we have the primer assembly to the left. The red coloured rubber centre piece is a double check valve.

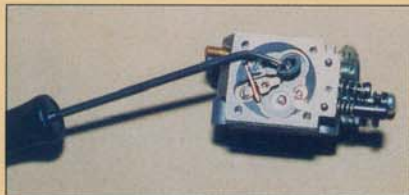




This is the schematic of the WA-167A carb.

specific points we can expect different pressures. This can be used to an advantage because the velocity and mass airflow will vary under different throttle openings and airflow. By clever designing an optimum fuel/air mixture can be assured through all throttle settings. Unlike the glow engine carb fuel is not drawn from the fuel tank by the low venturi pressure. The gasoline carb has an integrated fuel pump which uses engine crankcase pressure as the operational force. When the piston rises in the cylinder a negative crankcase pressure (suction) is created and when it falls a positive pressure develops here. Most engines use a passage through the cylinder to the carb insulator adapter for this purpose. Other engines have a tap off in the crankcase which is piped to a nipple on the carb. These carbs can be adapted to the G-23 for example by blocking the nipple and plugging the crankcase tap off. A small hole may need to be drilled into the carb to align its internal

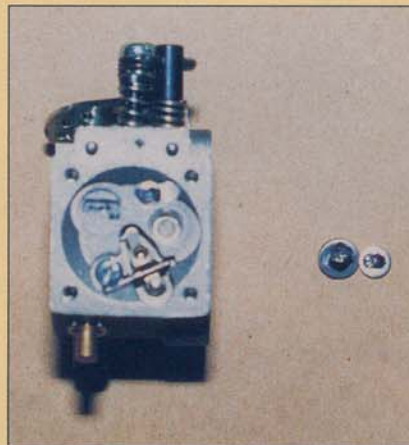
One of the soft metal Welsh plug being removed to gain access to the low speed jets.



chamber with the insulator passage. The reason I say 'may' is because some carbs have both a nipple and drilled passage. This is a very easy job to do if the need arises.

The pump is located under the front cover of the carb. This cover is retained by one large screw. The cover serves two purposes. One is to offer various tiny compartments and directed crankcase pressure to the pumping diaphragm which is located directly

Both Welsh plugs removed. The port to the right is the high speed with the second screen retained by a snap ring. Note the low speed port with 3 jets to the left. The round device between the two ports in the carb body (with black marker) is the check valve to both needle valves. Its only purpose is to allow the primer to function. Carbs without the primer have only a port here.



under it and the gasket. The gasket also helps to form these compartments. The other purpose is to act as the low and high throttle stop. The low stop is adjustable and this is where idle speed or engine cut-out is to be set after the completion of correct mixture settings.

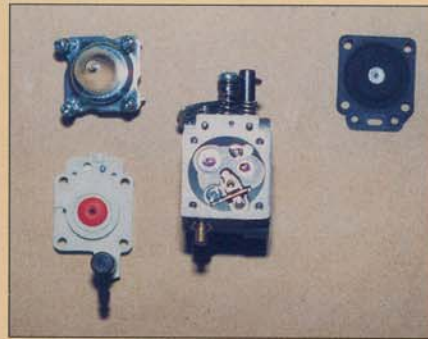
The pumping diaphragm moves in and out with crankcase pressure directed on one side. On the other diaphragm side is fuel from the tank. The pump has two check valves which are in the form of a flapper type or reed like in nature. The valves are schematically positioned on the fuel side of the diaphragm only. The pump inlet opens while the outlet closes so that the pump cavity can fill with fuel (negative crankcase pressure). When the crankcase pressure changes on the diaphragm towards a positive value the inlet valve closes and the outlet opens directing fuel into a passage leading to the carburetor internal filter. Once through this filter fuel is directed to the backside of the carb main body. Here it will wait behind the needle valve until commanded to flow by the metering diaphragm. The metering diaphragm is located under the back cover and is retained by four small screws. Depending on the specific unit it may or may not have a primer bulb attached at this end. The metering diaphragm through a lever opens and closed the needle valve on the opposite end of this lever. In actual operation the amount of opening and fuel flow will vary through the diaphragm operated needle valve. The point I want to make is that in operation it is not like a switch



The Welsh plugs in position for flattening with the flat punch and hammer. You can see the needle valve lever, pivot pin. The spring is under the left side of the lever and the needle is attached to the right side. The tiny hole between the two tits to the left goes into the diaphragm chamber close to the check valve.

on or off. When the engine is not running it will however be full seated blocking the fuel due to a spring force supplied to the lever. All weed eater pressure carburetors function similarly up to this point.

The thousand dollar question is how do we move the diaphragm to vary fuel flow? To expand further where does the fuel go from here? Well the diaphragm is moved by the venturi negative pressure (suction). The greater the negative pressure on the diaphragm the more the needle valve opens. Since pump displacement is a function of engine rpm we now have another variable that is implemented effectively since fuel demands are higher at higher rpm. Four fuel jets or ports are strategically located in the venturi so that at various throttle openings and mass air flow (rpm) a proper fuel/air ratio will be maintained. These jets are controllable by the high and low speed mixture screws. The low speed jets (3) are progressively located near the throttle butterfly valve in the venturi at more closed throttle positions, since air velocity is higher here in this operational configuration. As the throttle moves to a more open position the efficiency of these jets is reduced as the local pressure over them rises. So now the larger high speed jet (1) comes into effect which is fine tuned or adjusted by its own mixture adjustment screw. The high speed jet becomes effective because mass airflow over it has increased due to the bigger throttle opening. In both cases these screws control separate openings between the diaphragm fuel chamber and their respective jets. The low pressure from the jets does two things. It moves the diaphragm through low pressure changes over the jets and allows the varying but higher pressure fuel to flow



This is how the finished product should look before installing the primer assembly. This is also a good view of the check valve and primer passage. Note the direction of the diaphragm with the washer and the gasket inboard.

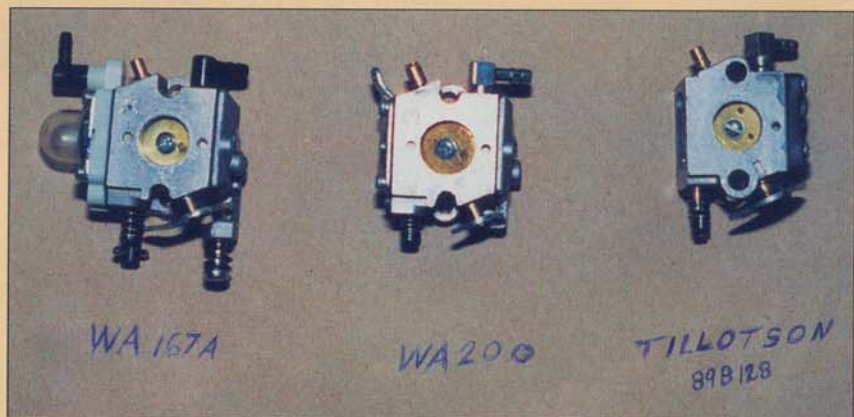
into the venturi and mix with incoming air. The theory is intended as very basic, but you must understand that each individual jet is more effective under different throttle and rpm conditions. I shall leave it at that for now.

The currently supplied carb for the very popular Zenoah G-23 model helicopter engine is part or model number WA167(A). For the fixed wing G-23 version the WA197 comes standard and does not have a primer. Both are made by Walbro. There are certain design features that distinguish one from the other. As mentioned one is a primer bulb which allows the diaphragm chamber to be quickly filled manually rather than pulling your guts out on the starter to slowly fill a fuel depleted system. I only wish all the G-23 engines came equipped with this

primer. The second is the manner in which the metering diaphragm fuel chamber and the passage ways to the mixture screws are connected. The WA167 has a rubber sprung check valve which has to be open for normal fuel to flow to occur. The higher fuel pressure will open it due to the lower pressure on the other side from the jets and this my friends is commonly referred to as differential pressure. The main purpose of this valve is to allow the primer circuit to function so that it will not pull air through the jets instead of fuel through the desired flow path. As a minor side benefit this valve also prevents fuel dripping out the jets from the diaphragm chamber while statically at rest. Don't be poking around here as this part is not included in carb overhaul kits. It is a chrome piece with a rubber centre pressed into the carb and located under the diaphragm. Also pressed into the carb are two Welsh plugs which respectively each cover the high and low speed fuel jet chambers. Underneath the high speed Welsh plug is another filter screen most people do not know about. It is retained to the chamber floor with a small ring and the Welsh plug has to be removed to gain access. Dirt and crud can get past the first screen located at the front section before the metering diaphragm needle. If everything else looks copasetic and you are having erratic running with an unexplained drop out look here. The proper carb repair kit comes with new Welsh plugs, two screens, snap ring, front diaphragm/valving, metering diaphragm/needle/lever/fulcrum/spring and all gaskets.

Let's get down to the business of overhauling the WA167. First soak the carb in varsol and thoroughly clean the exterior. Find a clean place to work

Three carbs which fit the G-23, the throttle butterfly installs from this side with the screw facing the cylinder. The crankcase pressure is fed through the small hole to the left. The two carbs to the left have only one nipple as they have no primer. Looking closely at the WA carbs you can see how the butterfly valve is indexed to the throttle shaft.



where you can't easily see or replace tiny parts. I'd suggest laying all the parts out on clean lint free rags. Remove the big screw on the front cover and notice that the gasket goes against the cover. The pump/valving diaphragm installs next to the main carb body. These two pieces are indexed with raised pins in the cover and mating tabs. If they are not torn, frayed or porous they can be reused. Under the pump/valving diaphragm in a deep port is located the first filter screen. This should be cleaned or replaced before carb re-assembly. In any event it can be gently removed with a straight pin.

Remove both mixture screws noting the retention springs and their positions as they are different. The newer WA167A carb versions use a 'T' type mixture adjuster for the high speed. Remove the back cover and primer sub assembly which is retained by four screws. The primer cover gasket mates with the carb body and the metering diaphragm mates with the plastic housing. The metal washer side of the diaphragm goes towards the carb body and is indexed with two pins here similar to that of the front pump cover. The centre 'tit' of the diaphragm pushes on the needle valve lever so it cannot be installed upside down and be expected to function properly.

The needle valve is held in position by the lever and fulcrum pin. The single screw is removed to allow disassembly of these three tiny parts, noting that a spring is located under the lever to hold the valve statically closed. The Welsh plugs are now carefully removed by gently stabbing them in the centre with a tiny screwdriver and prying out, being careful not to damage the carb. One chamber will have a small screen held with a snap ring which can be removed using a straight pin with a bent end. It is not snapped into a groove but is used only as a frictional retainer for the screen. Under the screen is one high speed jet which

must be cleaned and checked. The second Welsh plug which is to be removed in a similar fashion are three low speed jets. These are very tiny passages unprotected by a screen and must be clear into the venturi like the larger high speed jet.

While the butterfly valve and throttle shaft can be removed there is really no need to do so if all is well. If you want to remove it the circlip and butterfly screw will have to be taken apart. The screw should be installed with Locktite even though the threaded end is slotted and spread. The screw head faces away from the air filter and cannot be seen from the inlet side of the carb. It should be tightened with the throttle closed which includes the shaft retaining circlip and return spring in proper position. The butterfly valve is indexed to the throttle shaft by an indent which should point towards the pump section and return spring. The carb body should be immersed and cleaned using new varsol in a clean container. At this point one has access to all ports, chambers and passageways, so now is the time for one final close visual inspection prior to assembly.

The assembly procedure requires close attention to detail. The first thing to install is the screen in the high speed fuel jet chamber. Install it like a upside down bowl so it forms a compartment around the jet passage then carefully install the retaining ring. The new Welsh plug will be installed in the same 'upside down bowl' like manner and flattened with a suitable flat drift. Do the same with the new low speed Welsh plug.

Next install the diaphragm needle, pivot pin, lever and spring with the single screw using Locktite. It is a little tedious, but take your time as this is really the only aggravating part of the job. After these parts are in position the needle valve must be sprung closed and free to operate. To check the condition of the lever it should be noted that in

the resting position it will be lever with the surrounding flat surface. Install the gasket and diaphragm to the carb body with the 'tit' and integral metal washer facing in. Position the plastic cover and primer assembly next installing with four screws. Install the mixture screws and lightly seat. Back the high speed screw out to 1 and 1/4 turns. Back the low speed mixture screw out to 7/8 to 1 turn. You have now completed this end of the carb.

Finally it is time to put the pumping section together. Install a new gasket (sealing washer) under the screw. If you don't have one that is OK since it will work fine without it. Make sure the filter screen is in place before going any further. Locate the pump and check valve diaphragm next to the main carb body laying the gasket on top. Make sure the tabs and locating pins line up with these parts. Install the pump cover with the single large screw.

The carb rebuild kit is part number 'K20-WAT 737' and can be supplied from Walbro Engine Management, Aftermarket Division, Cass City, MI 48726. Other sources are locally in your area or through Blois Hobby on the net <bblois@ibm.net> The kit is compatible with both gasoline and methanol and fits most WA carbs used on our models.

A few suggestions before installing your fully overhauled or repaired carb. Sometimes other defects may cause one to make a misdiagnosis as similar symptoms of a diseased carburettor may be the result of a leaking intake system. If the gaskets between the insulator and the cylinder or carb leak externally or internally, expect poor running. To be more explicit with the internal leak this would be the case of the tiny passage way for the fuel pump in the carb loosing pressure into the engines non-pulsating intake path. I use the word non-pulsating loosely here. I would suggest a quality fuel filter between the tank and the carb. I personally frown upon the felt wrapped fuel tank clunks even when using a fine screened airframe fuel filter installed down stream. Somehow this felt can end up elsewhere in the carb. Select a clunk heavy enough to move the Tygon tubing freely within the fuel tank.

I have armed you with as much useful information as I presently have on this topic and feel that with time and care your gas machine will continue to maintain a happy smile upon your non-glow oil soaked face. That's about it kids..... and remember 'gas is a blast' and you'll never need glass cleaner for your shades!

How lucky we are to have a simple fuel metering device. This is the governor, fuel pump and fuel control from the popular 420 shaft HP Allison C-20B helicopter turboshaft engine.

