Walbro WB 32 / 37c overhaul and adjustment (Updated oct. 2011)

I have been flying paramotors for 12 years and this article is based on my experiences with these 2 carbs.
All in all, I have been flying for more than 25 years, ultralights and many types of commercial aircraft.

The first years with a flycastelluccio mach 1 light / solo 210
Now with a fresh breeze sportix simonini / digital ignition

This article is aimed towards paramotors with either the Simonini mini 2 plus or the SOLO 210
I should think that this article will also pertain any paramotor using these carbs more or less..

My perspective in this article is a "right to the point" attitude, if you want to dig deeper into the matter, I suggest taking a look at the official Walbro handbook.

When it comes to flying, I really enjoy long XC`s and this calls for accurate carb tuning.
Lowest possible fuel consumption without frying the motor is also quite important.
I have done A LOT of experimenting with these objectives in mind.
I am very pleased with the way my motors perform now, and this is my experience on how to achieve a well tuned motor.

Always keep in mind that paramotor engines are quite temperamental and must NEVER be looked at like a car engine (witch almost never fails)
Always fly like the engine will quit at any time....

But that said;
If you take good care of your motor, and takes the time to understand it, failures are rare.
During my PPG years, I have never experienced an engine failure, never seized a piston, in fact, the 12 year old piston in my solo 210 is still running as new....

Engine monitoring is VERY important on a PPG engine - This is my way of keeping the engine

healthy.
It is the result of many years of steadily improving the layout - works great and has all the required instruments and swithches nicely centralized - Also note the checklists; I always use them.

Here, the engine has been switched off in flight -
There is 6,4 liters left in the tank, engine time is 0:48, CHT is 200F and EGT is 450F. RPM is 0
(The EGT is rapidly dropping as the engine has just been switched off - normal EGT is around 1000F)
The red light indicates that the starter circuit is online, heat master switch is off and timer is on
Radio master is off, GPS master is on ... (-;

Before we begin, I cannot express clearly enough : You **MUST** at least have a tachometer installed.
Ideally, you should also have CHT and EGT on you motor.
Correct tuning without a tach is impossible.

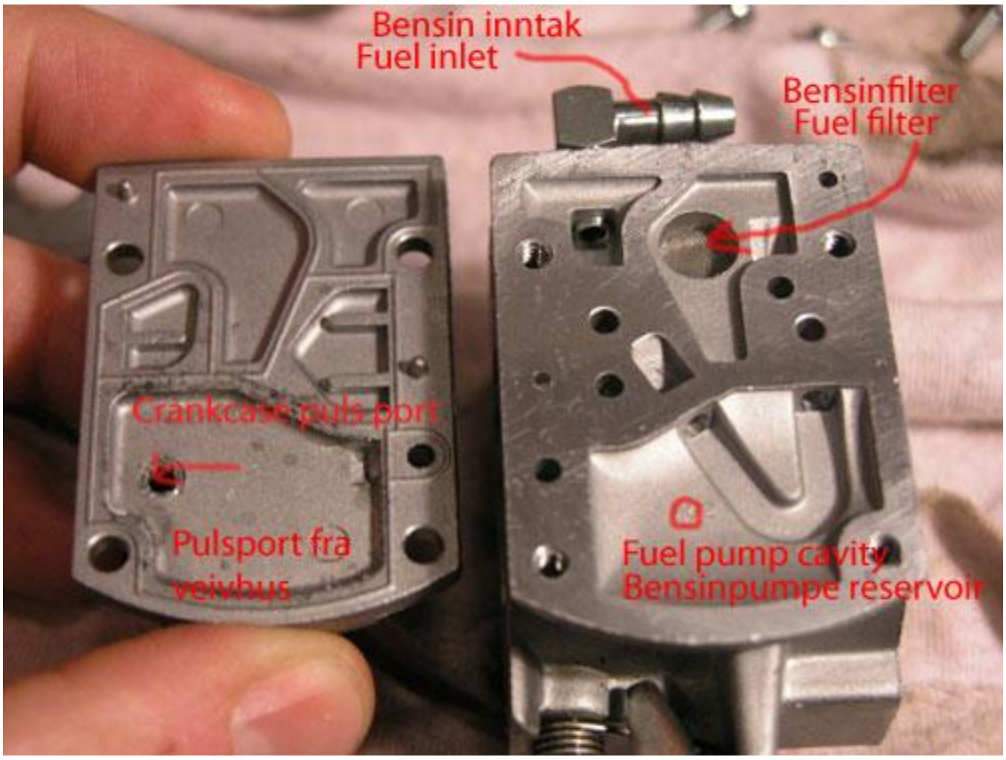
These 2 carbs are almost identical in build and operation.
There are a few differences, they are explained when appropriate

My method for advanced carbtuning (For experienced pilots)
The standard tuning is found in the text further down the article

Pump side of the carb

This is the pump side of the carb, Here the fuel enters.

This side is usually quite reliable, but remember to change the membrane regularly.
I change every 2 years.



Check at regular intervals that the internal fuel filter is free of debris. (I suggest every 10 hours)
More than 1 liter for every 15 minutes passes the filter, and it does not take much dirt to affect engine operation.
A typhical (and quite common) sympthom of filter clogging is engine "dying" at full power, while working fine al lower rpm`s
When fuel flow is high, the filter is blocking some of the stream, and leaning out the mixture.
This is not good for the engine (high temps and poor lubrication)

It is extremely important to have a 100% air tight fuel circuit.
- Check this way : Disconnect the fuel lina at the carb, close all vents and make sure the tank cap is secure.
Carefully pressurize through the fuel line (the hose you disconnected) to 5 PSI.
The system should hold pressure for several minutes.
If the pressure drops quickly; pressurize and spray soap water on all parts and locate the leak.

DO NOT FLY WITH A LEAKING FUEL SYSTEM!!!!!

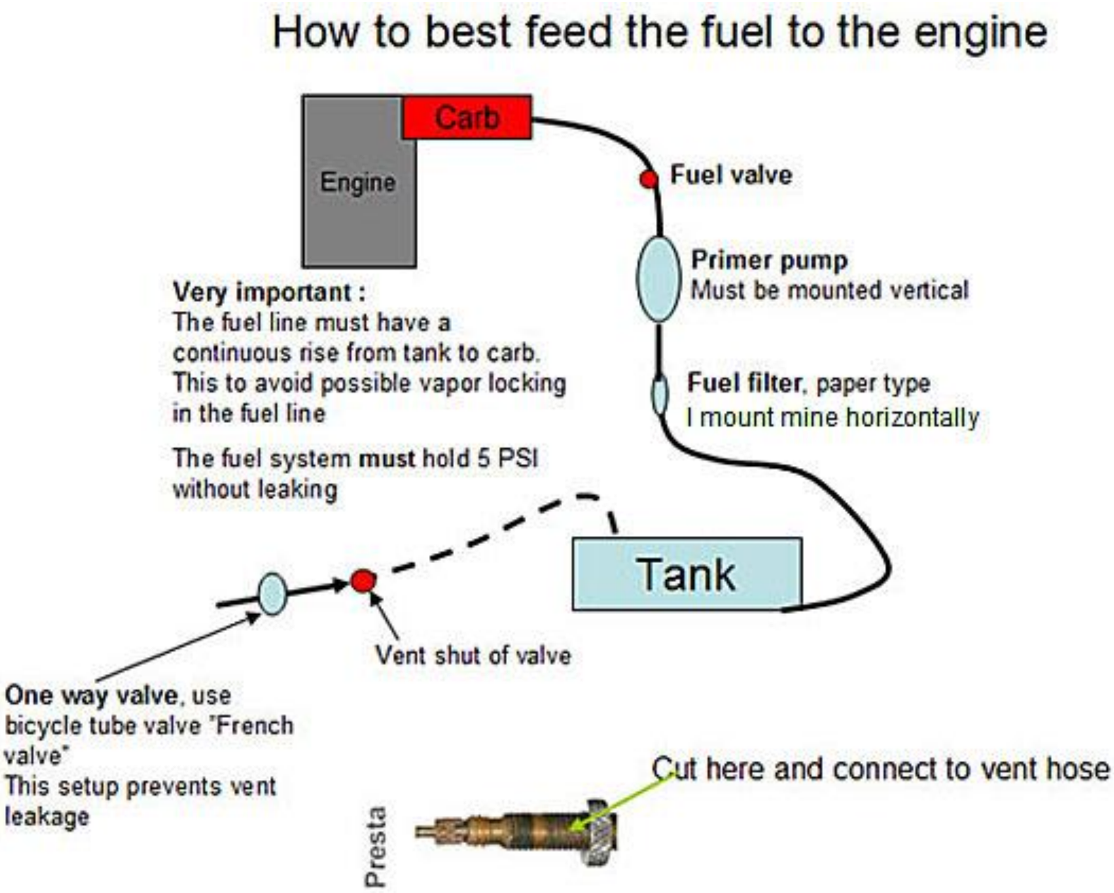
Important info concering the internal fuel screen :
Some people remove this screen on the basis that the filter on the fuel line will remove any dirt.
It is my definite experience that despite the best fuel procedures and filters, some debris will eventually reach the carburetor.

I DO NOT RECCOMEND REMOVING THE INTERNAL FUEL SCREEN!

iF YOU Fly with the fuel screen installed and debris collects at the screen, the engine will most likely not stop completely, but will allow for flight home with reduced rpm.
It is also quite easy to remove dirt from the screen.

If you fly without the screen and dirt reaches the carb, this debris will reach the membrane side of the carb.
Here the tolerances are much tighter and chances are that the engine will stop abruptly.
Removing dirt from the membrane side is much more difficult and can in extreme cases ruin the needle valve assembly (needle valve seating starts leaking)

Path of the fuel as it enters the carb.



Overhauling the carb.
The rebuild interval is somewhat of a rough estimate.
Some say every 5 years, but I personally do this every 2 years.

I fly around 50 hours pr year, and I never have had carb problems with this interval.
The rep kit is cheap, and it is quite easy to do the rebuild.

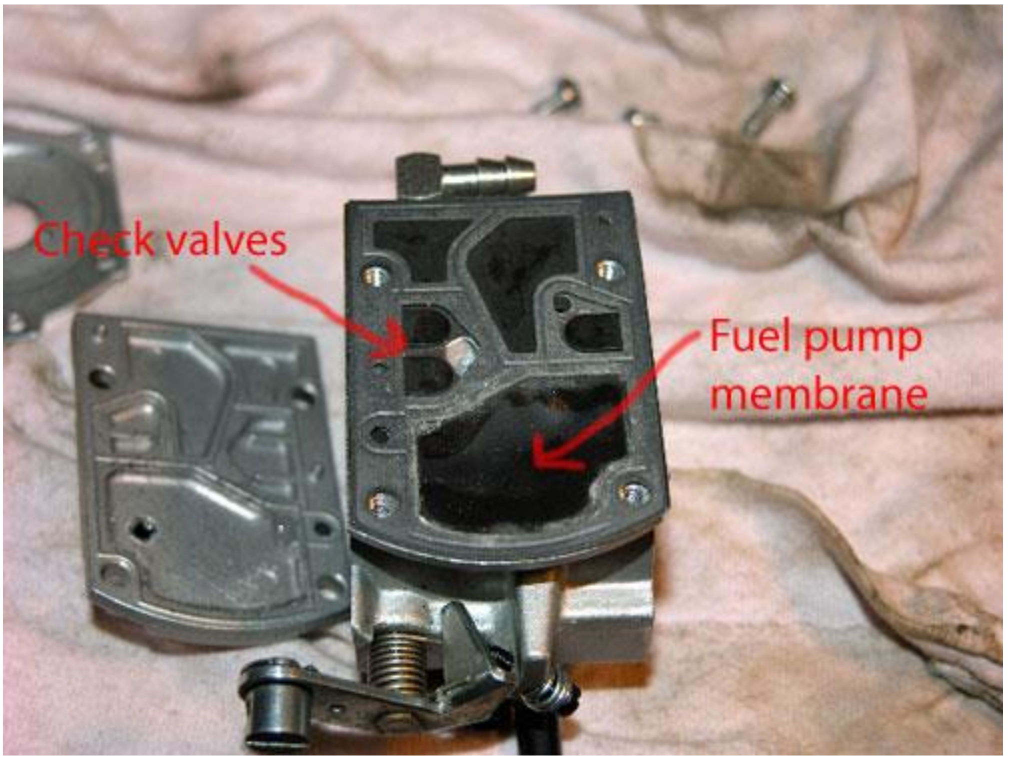
The required service kit is K 10 WB it is common for both WB32 and WB 37c

Remove the carb form the engine, and place the carb on a towel or clean soft paper.
Remove all removable parts from both the pump and membrane side, including;

- All gaskets
- All membranes
- The internal needle valve assembly
- The external needle valves (HI and LO)

The throttle disc assembly don`t need to be removed.
(unless you want to try the modification suggested later on...)

Clean the carb thorughly t, use pressurized air to make sure that all channels are clear.
Then you are ready to start rebuilding the carb.

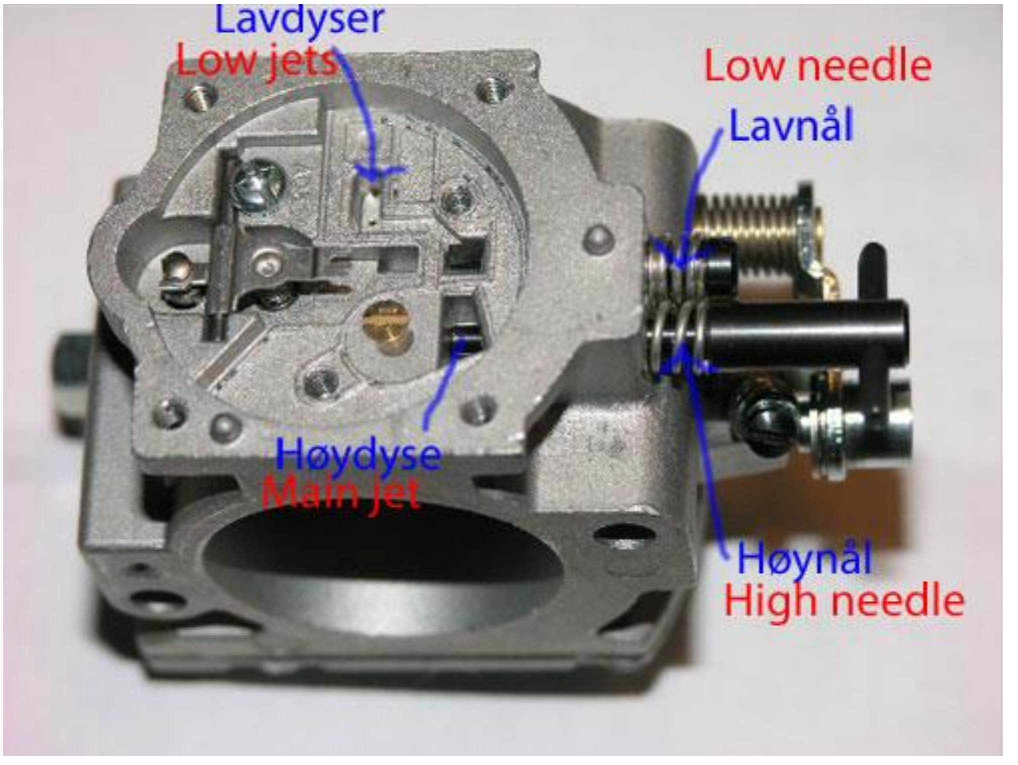


Replace the filter screen with a new from the rep kit.
Membrane goes on first, then the gasket.

Make sure eveything is clean and that the channel from the pump side to the needle valve seat is clear (use prezzurized air)

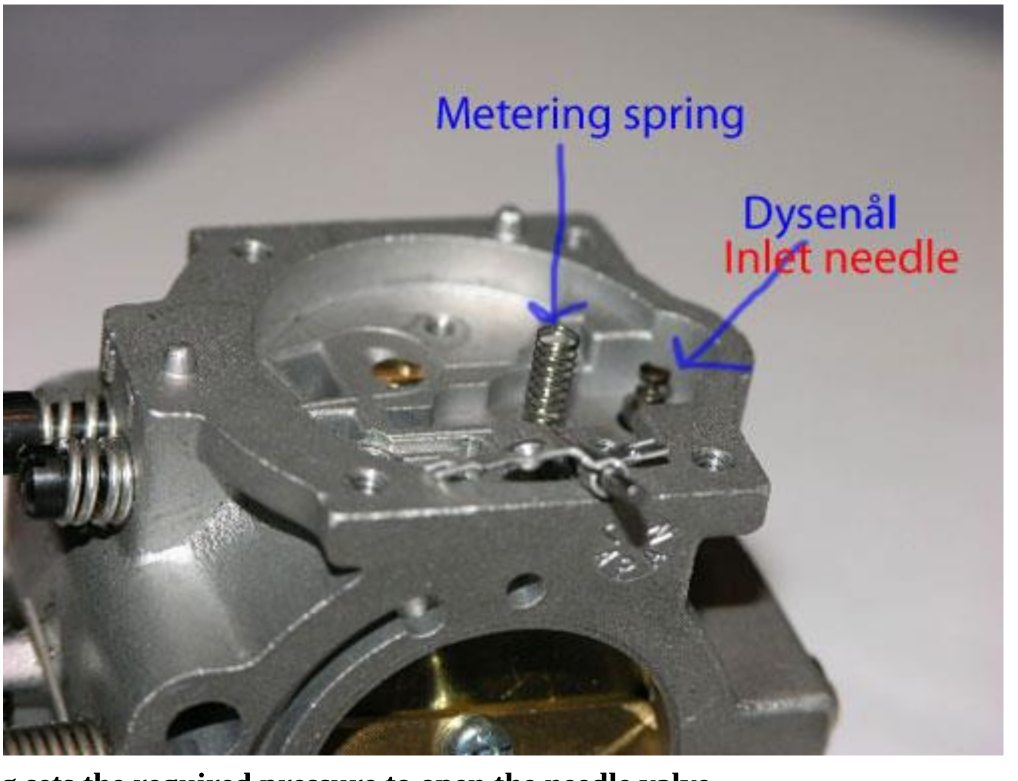
Carefully tighten the 4 screws in a diagonal pattern, slowly increasing torque one step at the time.
Do not over tighten!

Membrane side



Membrane side with all gaskets and membrane removed.
Internal needle valve assembly still in place

For those ouf you familiar with vacuum motorcycle carbs, the LO jet is operating in the range of first the pilot circuit, and secondly, the needle jet.
The Main jet is still the main jet.... (-:



The spring sets the required pressure to open the needle valve.
Stiffer spring means a leaner carb and vice versa.
It is very important that the needle valve assembly is within the required parameters.

The required opening pressure is called **POP OFF pressure.**
It is the pressure required to overpower the spring force, opening the needle valve.
Connect a pressure gauge to the fuel inlet port and pressurize until the needle stops rising.

The pressure will then drop until it settles at a value called the **RESEAT pressure.**
It is very important that this pressure stops at a certain value and that the pressure does not drops. (Dropping pressure means a leaking needle valve)
Also very important that the pressure never drops belov 10 PSI because this will cause the pump overpowering the needle valve spring, flooding the engine

This video (Norwegian language) shows how the needle rises towards the POP OFF pressure, and then drops to the RESEAT pressure.

Checking POP OFF and RESEAT pressure

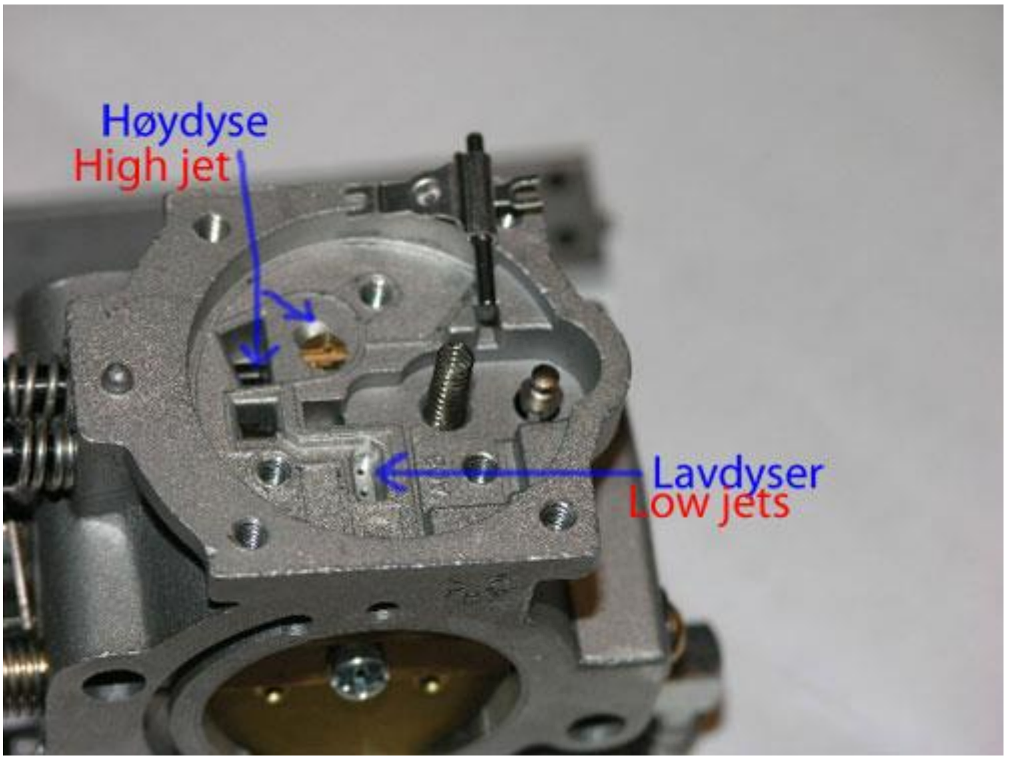
I have found that these values are correct for the SOLO 210 and Simonini mini 2

- **POP OFF** : 12-25 (ideally 18 PSI)
- **RESEAT** : 10 - 12 PSI (Ideally 12 PSI, never less than 10 PSI)

To adjust the pressures, carefully lenghten the spring if too low pressures
If to high pressures, squeese the sping with your fingers og (carefully) with a plier

Also important to note that you must measure these pressures WITHOUT the membranes installed.
The pressures must be measured with "a wet" needle valve - a few drops of fuel or CRC 5-56 in the
needle valve well does the trick.

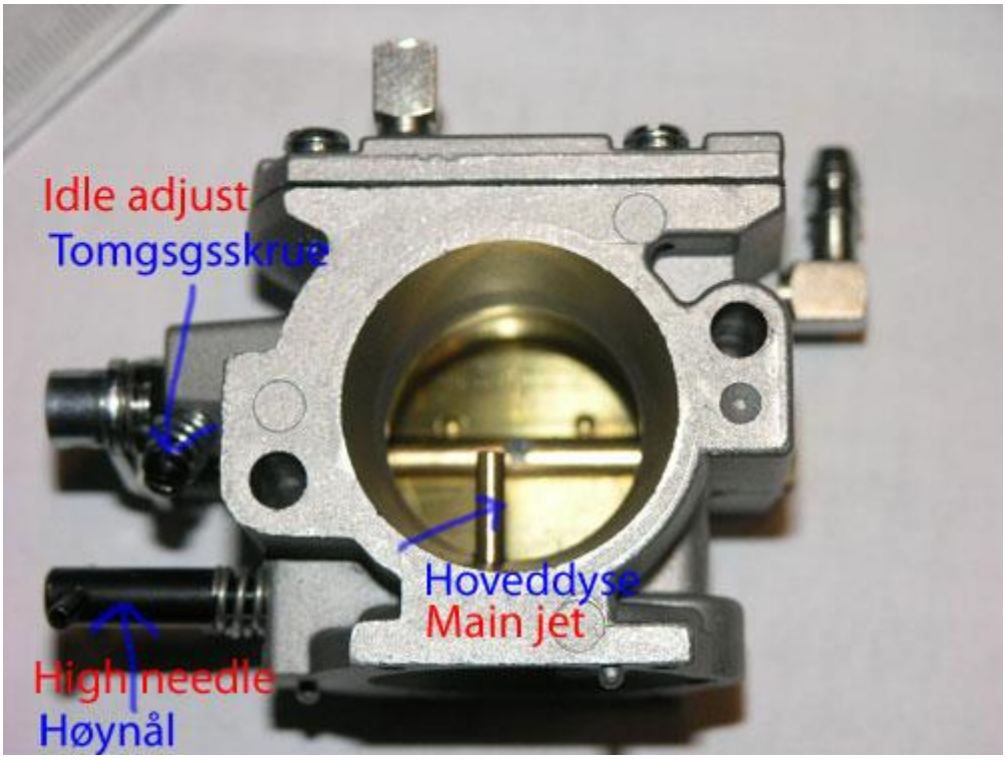
The spring works against the atomospherical pressure in the carb inlet.
As the pressure drops at inlet on the intake cycle, the membrane will push the needle valve down, opening the fuel supply to the jets.
For this to work correctly, is is very important that the channel between the pump and membrane side is clean.



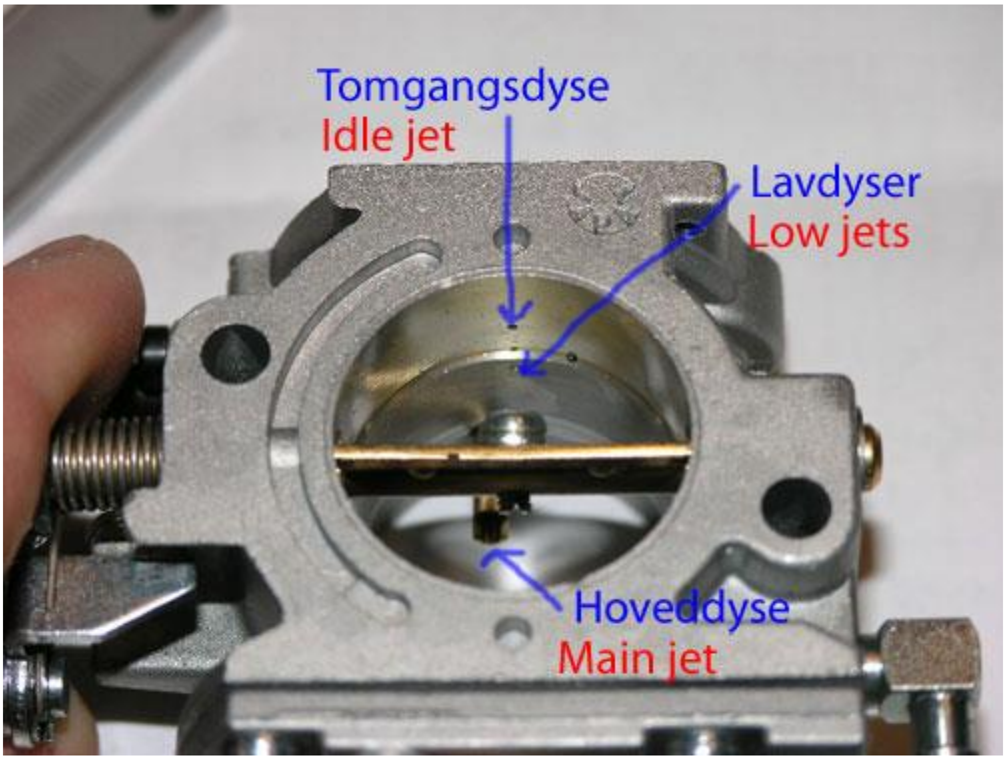
The fuel flow is feed from the pump (on the other side) though the internal needle valve, then it is directed to the HIGH and LOW jets

NOTE that all the mid jets and the idle jet is adjusted through the LOW needle

After blowing the needle valve channel clear, reassemble the internal needle valve ....

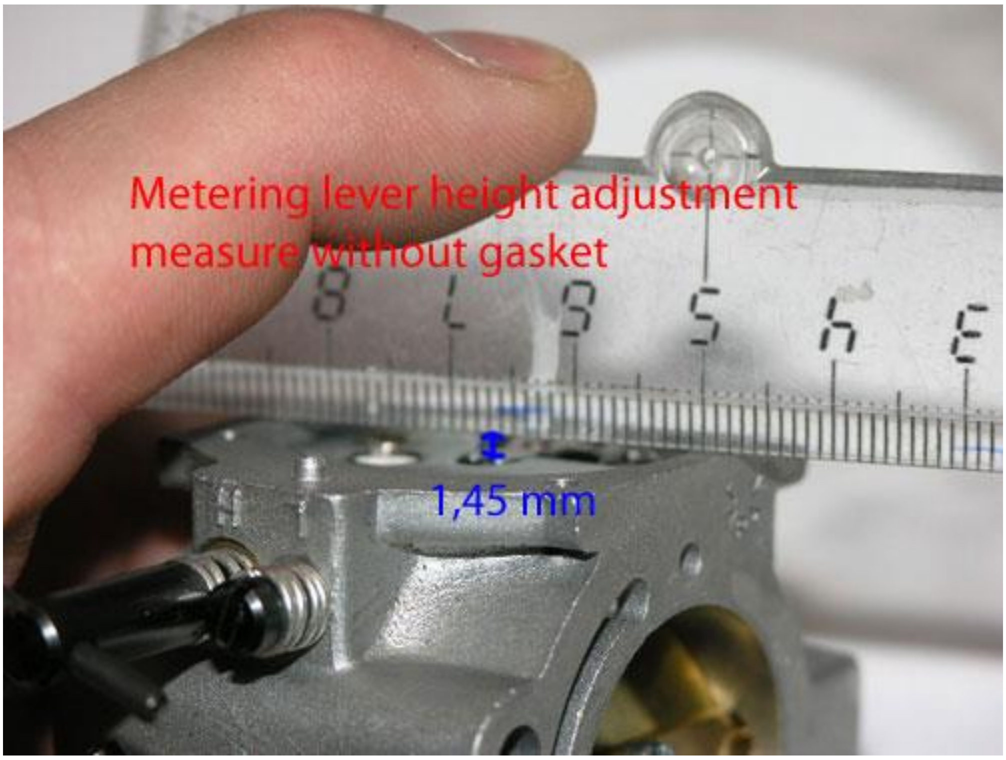


This is a WB 37C, it has the elevated main jet in the venturi.
The WB 32 only has a small hole in the venturi wall



Detail from the "engine side" of the venturi.

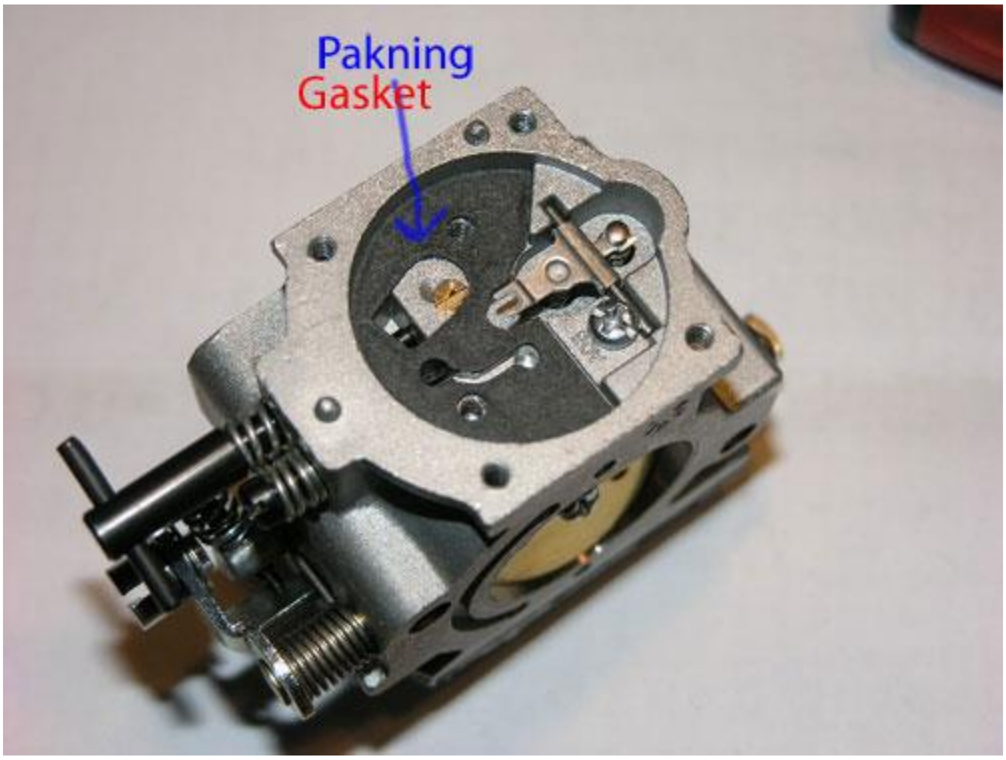
As you can see, the jets are quite small, and are easily clogged. Clean fuel is a must!



Measuring the metering lever height - IMPORTANT STEP!
Measure the distance between the carb body (no gasket) and the top of the metering lever.
For the WB carbs, this is 1,45 mm.

This distance determines the throw required for the needle valve to open, it is very important that it is correct, impossible to get a proper carb with this out of shape.....
Carefully bend the arm to the correct value.

A too little distance will cause a flooded carb, while too great distance causes a lean carb



Check that the POP OFF and RESEAT pressure is OK. Correct as required.
(See the details explained previously in the article)

- **POP OFF** : 12-25 PSI (ideally 18 PSI)

- **RESEAT** : 10 - 12 PSI (Ideally 12 PSI, never less than 10 PSI)

Then replace this gasket with the one from the service kit....

Install the check valve membrane (ONLY THE WB 32 HAS THIS MEMBRANE)
The WB 37c does NOT use this membrane

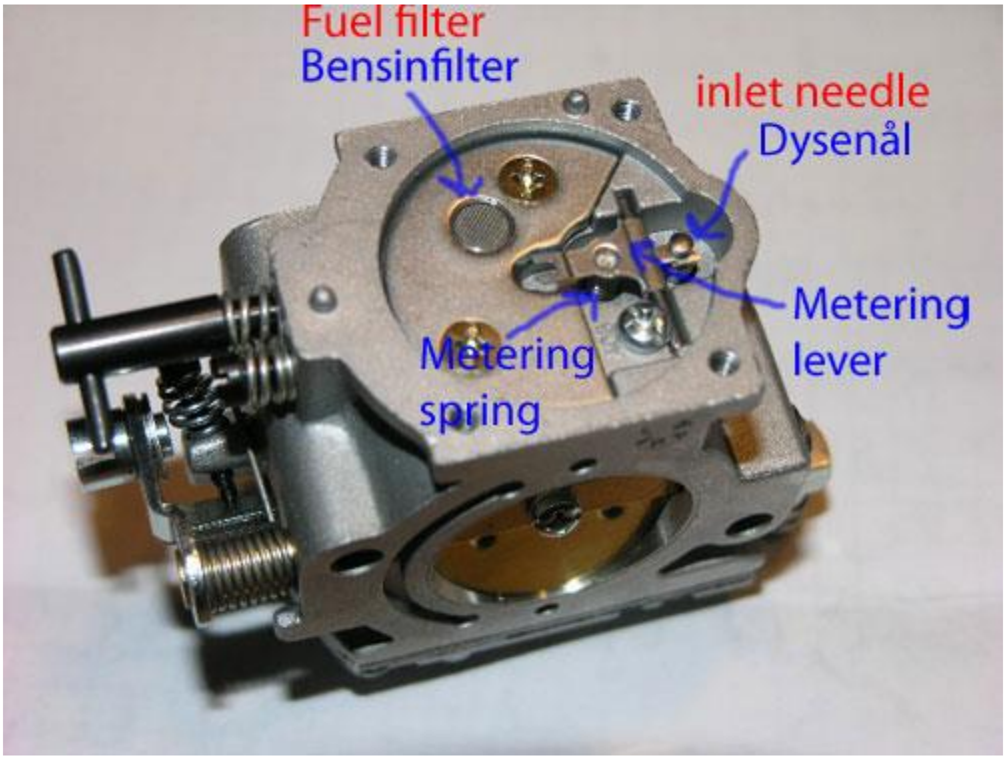
A note concerning the WB 37 and use of this check valve:
It is possible to fit this membrane on a WB 37 (it is the same membrane on the 32 and 37) .
If you do this, the fuel consumption will improve quite a lot - 25% improvement is possible!
This membrane / valve prevents some of the fuel flow that seeps out of the high speed jet below full throttle.

BUT.......

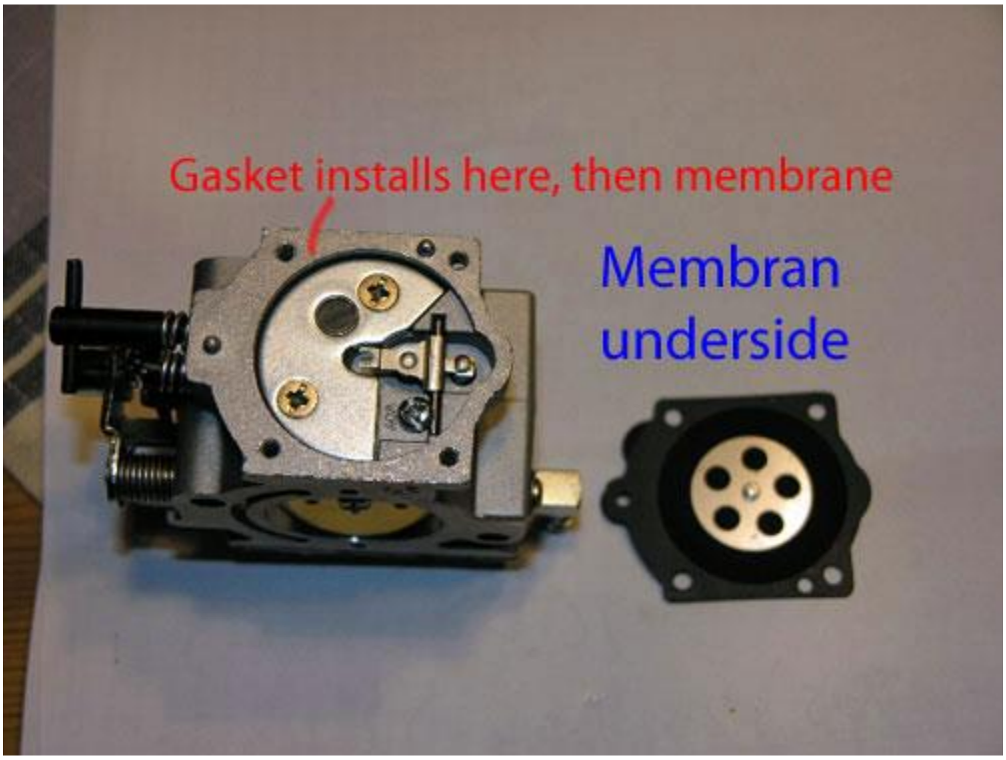
With this membrane on a WB 37, temperatures will be higher in the upper RPM regions, and will surely, if unmonitored burn your engine.....
You must understand that prolonged climbing at upper mid RPM`s is impossible, and the engine must either be cooled down by full power or settling back to level flight.
Needle settings is often the same wether or not membrane installed.

<u>NEVER NEVER NEVER do this unless you have both CHT and EGT monitoring on you engine!</u>

I fly with this membrane installed on flights where fuel consumption is a factor, like XC`s
Without a doubt, it has made my longest flights possible....
Also note that I have inflight adjustable needles, and I use that system all the time when I fly with the membrane installed.
When fuel consumption is no factor, I fly without this membrane

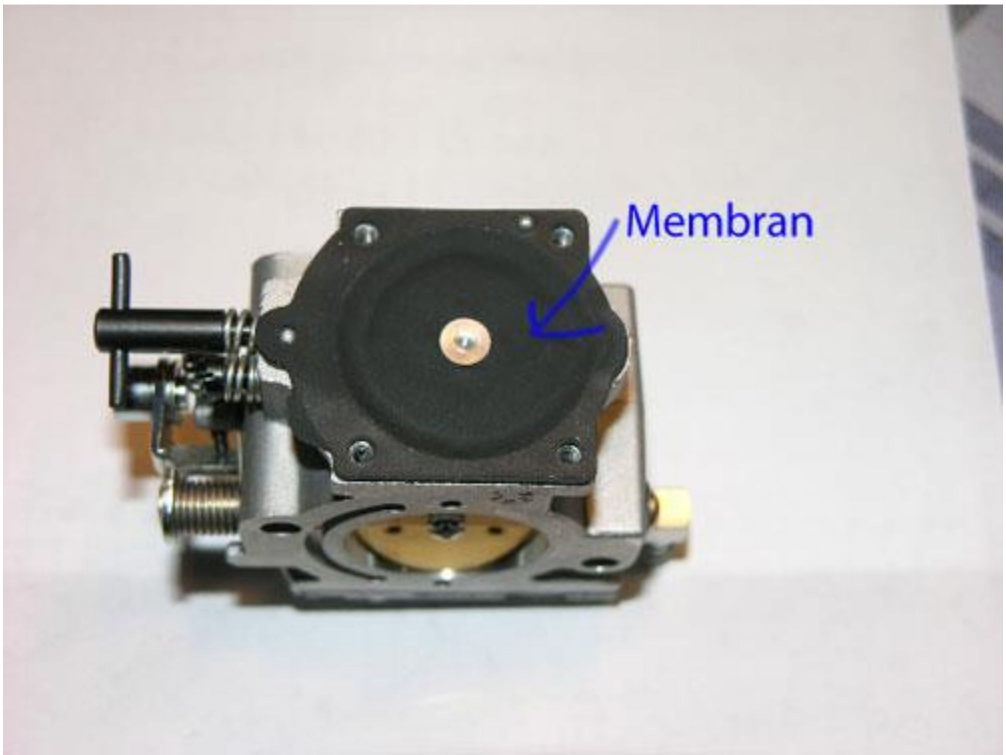


After the washer and (the check valve), then this metal plate goes on ....
Note that the screen is an additional filter that only affects the HI circuit, make sure that is is clean.

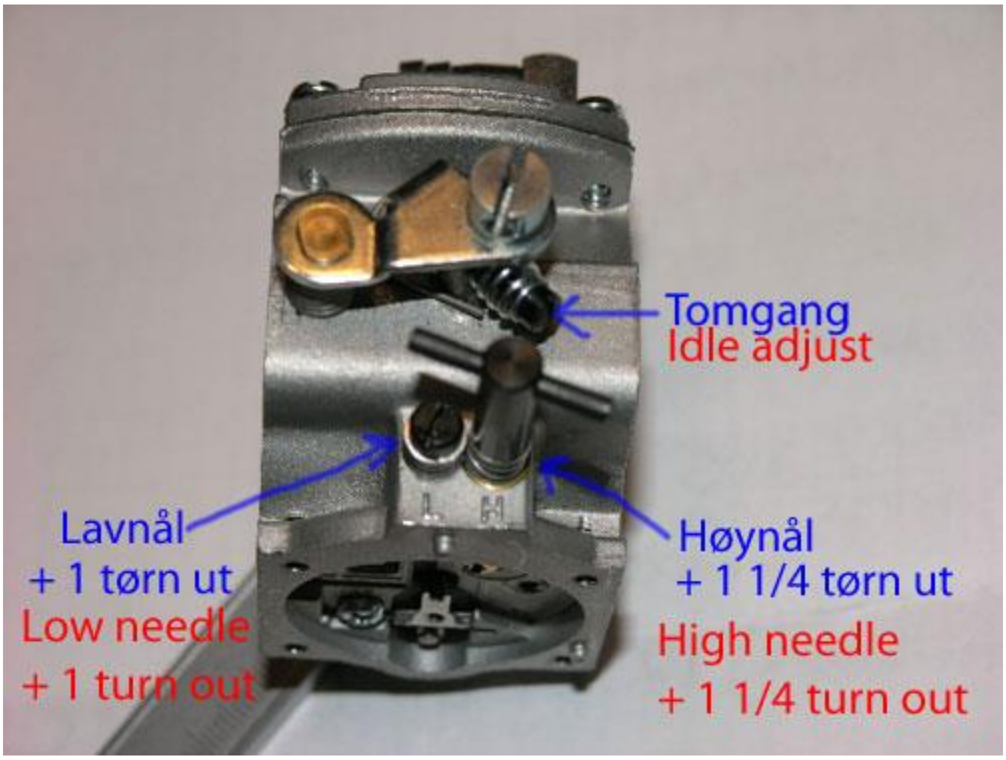


Install body gasket first, then the membrane, cover plate on top of that.

NOTE: be careful to interlock the fingers on the metering lever with the groove in the membrane cap.
Also be careful to gradually and diagonally tighten the 4 bolts holding the cover plate.
Do not over tighten!



Then you are ready to mount the carb onto the engine.....



The values in this picture indicates typhical needle settings for of a FULLY TUNED carb.
If you have overhauled your carb, I reccomend that you increase (counterclockwise) the values by 3/4 turn, this will make the carb on the rich side and a good starting point for the tuning.

Note that I have seen carburettors with different, finer threads that will render these values useless.
Walbros explanation to this is the increased emmission emphasis, causing the carburettors to be more finely tuned.
In the cases I have seen, 2 - 3 turns out is where you want to be.
Be aware of this !

Adjusting the carb, hints and tips....

Both the HIGH and LOW needles affect the mixture delivered throughout most of the RPM range.
The HIGH needle adjusts the flow to the high speed jet
The LOW needle adjusts the flow to the idle and 2 mid jets

The LOW needle is more sensitive than the HIGH needle
The LOW needle is the one that can do the most damage (overheating) if set to lean

If your engine is running hot at high RPM but fine or cool at mid RPM,
then you must enrichen the HIGH needle (counter clockwise) and lean out the LOW needle (clockwise)

If your engine is running fine or cool at high RPM but hot at mid RPM,
then you must lean the HIGH needle (clockwise) and enrichen the LOW needle
(counter clockwise)

DO NOT ADJUST MORE THAN 1/4 TURN AT A TIME

Be aware that most 2 stroke engines with carburettors have a tendency of developing a hotspot a few hundred RPM`s below max RPM.
EGT temps can be 50 - 100 C higher at slightly below max throttle.
The EGT gauge is a very valuable tool to detect such hot spots.
In almost all the engines I have operated (including fix wing aircraft) it has paid off to climb at full throttle. (speaking of the temperatures being lower at max throttle)

Should you enter such a hot spot RPM zone, it will often change the engine vibrations.
A "hard" medium frequency vibration that distintively differs from the motors normal behaviour is often noticed at too high EGT values.

Final adjustment of the carb...
First a note on what is called rich and lean drop off points;
Let`s say that you have a perfectly tuned carb, and then do the following:
You start to turn the needle clockwise (leaning out) and doing this until the rpm`s starts to drop.
The position of the needle where this happes is called the lean drop of point.
The mixture is too lean for proper combustion.

Once again, from a perfect carb you start turning anti clockwise (richening) until you notice that the rpm`s starts dropping.
This position is the rich drop of point. The mixture is to rich for proper combustion.

It is a well established thruth that the perfect setting is exactly mid way between these 2 points.
For the walbro this is a good way to set the LO needle.
For the HI needle; it is often hard to tell where exactly the drop points are, and therefore a tuning based on max rpm is often better, but I urge you to see wether or not your engine will give you sharp drop points, and thus enables you to use the mid position for the HI needle also.

OK, let`s tune the carb....

- Start the engine and let it heat up to a CHT of at least 100C

- Check that the idle is around 2200-2500 rpm, adjust if required (the idle screw)

- FROM IDLE: Slowly lean (clockwise) the LOW neddle while watching the RPM.
When you reach max RPM, enrichen the LOW needle so that the RPM is about 50 RPM below max.
The throttle should NOT be touched during this tuning, note the needle position.

Then do the following test for the LO needle:
From idle; gradually turn the LO needle clockwise until a drop in rpm is observed, then turn the needle anti-clockwise until the rpm`s drop once more.
Your final LO needle setting should be about midway between these 2 extreme points.
Compare these 2 tests; they should roughly produce the same needle position, if not, use the last test position.

After this the engine should respond crisply to sudden throttle blips, check it out a few times...
There should be no tendency for the engine to hesitate to accellerate as you quickly add throttle.
If it does, repeat the steps above, and make sure the engine is fully warmed up.

- FROM FULL THROTTLE: Slowly lean the HIGH needle to the point where max RPM is achieved.
Then enrichen the HIGH needle so that the RPM is about 150 - 200 RPM below max.

During the high speed tuning it is normal to exprience a zone near the max RPM where the needle seems to do little effect on the RPM, look for the point where the max RPM was first achieved when moving in from the rich side.

Also check to see if you are able to produce sharp drop points, if you can, use the mid position for final adjustment of the HI needle.

(On my fresh breeze simonini, the final setting is around 1/2 to 2/3 turns anti-clockwise from the lean drop point)

Then ...

- Adjust idle with the idle screw to about 2500 RPM.

- Repeat setting the LOW needle

- Repeat setting the HIGH needle

- Readjust the idle RPM if required.

Consider this when doing the final tuning:
- Be very careful when you do the HIGH speed tuning, the motor must be very vell secured.
I reccomend a 2. person to assist you.

- Be careful not to run the engine at max power for too long, the cooling is reduced and you might quicky overheat the engine

- If you have CHT / EGT monitoring, I suggest that you monitor closely on the first flight after tuning.
Check to see if temps are OK, it is quite common (for me) to make very small fine adjustments based
on temperature readings on various settings.
However; if you follow directions as above, your engine will be well within the "green zone".

Advanced carb tuning for experienced pilots

[Follow this link, and you will find a method I use for fine tuning of the carb.]

Engine monitoring very important....
A few words about 2 stroke engines and how to keep them running good..
The 2 stroke engine is lubricated very different from the 4 stroke engine.
Our motors get their lubrication directly from the fuel and is burned togheter with the fuel.
The fuel enters the crankcase and is simply "splashed" around onto the bearings.
The 4 stroker has a permanent amount of oil in the crankcase, and the bearings never get into contact with fuel.
Simply said, the 2 stroker has a much harder time keeping it`s parts properly lubricated.
Today`s fuel is actually quite harmful for bearings, increased amount of alcohol and additives to improve idling and starting acts as a solvent washing the oil off the bearings.
In addition to that, the 2 stroker often see higher working temperatures, especially air cooled motors.
Therefore it is extremely important only to use the best possible 2 stroke oil in the correct mix.

I only use Castrol TTS in 2,5% mix.

To be sure that your engine is running within limits, a set of instruments is invaluable.

The Tachometer
Reads out the RPM of the engine.
Primarily used for tuning the carburettor, looking at the varying RPM when adjusting the needles.
It is absolutely imperative to at least have this instrument installed.

It will also tell you many things when in flight.
A sudden increase in max RPM can indicate a slipping drive belt.
Slowly dropping RPM`s warns about possible ignition problems and so on.

The CHT gauge
Reads out the temperature below the spark plug.
This is often an indication of how hard the motor is working.
A long climb will mean rising temeperatures, while idling in a glide surely will give decreasing temps.

This gauge is rather slow in its response, often lagging several minutes before the correct indication occur after a power change.
You can therefore not directly tune a carb by using the CHT.
In a healthy, correct tuned engine, the CHT is the primary temperature of the motor.

The EGT gauge
Reads the temperatur of the exhaust gas in the manifold about 8-10 cm from the piston.
This is directly linked to the mixture of the carburettor, and you will instantly see a changing temperature if you alter the mixture.
In other words; it is very responsive to changes in mixture and is my second instrument when tuning a carb.
It is not affected by prolonged hard working like the EGT, once the temp is stable, it should remain
more or less constant at constant throttle if you fly in the same altitude.

In fact that is the thing that the EGT does really well; it is the primary "engine health" gauge.
First; it tells you wheter or not your mixture is correct.
Secondly; it tells you wheter or not the engine is stable....
The EGT should remain more or less constant with different RPM`s:
Every RPM has it`s corresponding EGT value.

Should these EGT readings start to change, it will certainly be an indication of inpending problems.

A rising EGT tendency usually means the mixture is leaning out, often caused by a leaking crankcase:
Overheating often follows.

A dropping EGT can indicate ignition problems, often inpending spark plug failure.

It must be said that the correct propeller for the given engine is also important for these instruments to be used correctly.
I am talking about the term **"overpropping"** when a propeller puts too much torque on the engine.
The term **"underpropping"** when a prop puts too little torque on the motor.
Overpropping causes the CHT to be too high despite correct carburation, while the EGT is too low.
Wice versa for underpropping.

So do not put on whatever prop that can fit, the type for your engine has to
be carefully matched...
The Over / Under prop effect is VERY real - take it seriously !

I only use high quality instruments, check out this range of gages.
Electronics international has several combinations of gages

Fuel monitoring form FDS

High end products when used for a paramotor, but worth every penny and they put an extra dimension into flying, you finally know what REALLY is going on behind your back....

Nice to know when flying alone a long long way from home over rugged terrain .... like I love to do..

SO: While in flight, check the EGT say, every 30 minutes to verify stable temperatures, if OK then check the CHT every 5 minutes to monitor the overall temperature of the motor.

When you climb with full throttle; check that the RPM`s are OK, increasing means a slipping belt...

This picture shows the "old instrument layout"

Operating temperatures for the Simonini mini 2 and SOLO 210

CHT
Idle - 100 C
"Cruise" - 120-150C (do not operate above 170C for long times)
Max temp - 200 C (Never to exceed this value)

EGT
Idle - 450 C
"Cruise" - 530 C
Max temp - 575 C

A few notes on fuel consumption.
Flying various reflex type gliders has shown quite similar flow rates, and a typhical figure for general flying, and a little bit of cruise, climb, descending, and playing
will give around 5.5 - 6.8 liters/hour, this is valid for most modern engines.
Steady cruise with fuel economy in mind will produce rates around 4,6-5,3 liters/hour.
Conventional gliders usually uses 1-2 liters less pr. hour.

A rule of thumb from the engineering textbooks says 0.3-0.45 liters pr. horsepower pr. hour.

So a steady 10 hp output should use 3-4,5 liters pr hour. (valid even for larger engines)
This is valid for 2 strokers only.

Rounding off this article, some final hints....
Should you. despite perfect rebuild and tuning procedures still not manage to get your engine running well.......
Then you most likely have a problem with the engine or ignition.
The most likely culprit is a leakage either in the crackshaft or the carb manifold.

.... Remove Carb and Exhaust, block both carb manifold and exhaust opening.
Then pressurize the crankcase through the puls port exit, and spray soap water on the entire assembly.
It should hold 5 PSI for several minutes.....

Good luck and happy flights (:

SOUTHWEST AIRSPORTS

paragliding training center

Walbro WG-8 Carburetor

by Had Robinson & others

Introductory Notes

WARNING: ALL CARBURETORS MUST BE REBUILT EVERY YEAR WHETHER THE ENGINE IS RUN OR NOT! The flexible parts of the carburetor begin to age when they contact gasoline, especially ethanol blends. Do not waste your time tuning your engine without first rebuilding the carburetor.

Pilots who are not experienced with working on carburetors should watch the Walbro carburetor service video. If a pilot is not willing to invest in about $100 of tools, he will just make things worse, more than likely, or wreck his carburetor.

I am constantly working to update this information to make it easier for the average pilot. Please be patient!

ZAMA Info If you want to understand how the Walbro works, the ZAMA carburetor is a Walbro knockoff. ZAMA has this technical guide which is simpler to understand than anything from Walbro. The guide contains instructions on how diaphragm (and other types) carburetors work, a troubleshooting chart, and how to disassemble and service them. They also have published some service tips which also apply to the WG-8. Note: no ZAMA carburetor will fit the Top 80, which is too bad. In tort lawyer heaven a.k.a. the U.S., Walbro will not even talk to anyone who mentions their name and the word "paramotor" as it is strictly against company policy to use their carburetors on anything to do with aviation. Using their carburetors in this way is illegal and dangerous -- in their minds.

If you do not want to do the repairs yourself but have a professional do it, we can help. Please contact us for details.

We are working on YouTube videos of some of the more important techniques listed below -- please be patient. Thank you.

Calibration & Modifications by Gerry Farell – A TECHNICAL discussion. Additional notes by Had Robinson.

Carburetor Failure – What are the most common points of failure?

Carburetor High Speed Adjustment

Carburetor Low Speed Adjustment

Carburetor Rebuild – see "Tune-up" below

Carburetor Service – This new video from Walbro is helpful for those who are not familiar with diaphragm type carburetors, among others. It is a good place to start and includes testing of the pop-off pressure. The WG-8 cannot be rebuilt properly without a pop-off pressure gauge.

Dimensions – by Gerry Farell – This information compares the dimensions of the various Walbro carburetors and is helpful if you are considering upgrading from the WG-8 to another Walbro model.

Disassembly and Modification – by Richard Cobb – A TECHNICAL discussion on problems with Walbro carburetors and how to fix them. Additional notes by Had Robinson

Drips – All diaphragm carburetors will drip. Do not attempt to fix this by putting RTV sealant all over the place.

Fuel Filter – Info, types, problems

Fuel System Test – A quick and easy way to tell if the system is functioning properly.

Jet Size Modification – A non-permanent way to modify the stock jets in a Walbro carburetor.

Metering Lever – How to adjust it.

Metering Lever function (from Walbro) - The tech at the Walbro group should have noted that the condition of too great/too little metering lever height refers to extremes. That is, bottoming or topping out of the metering lever diaphragm is a rare condition. See the first article above by Gerry Farell for more information on this.

Midrange Performance Problems – An annoying problem on the Miniplane engines. Here is the fix.

Parts Diagram – Note: the model used by Miniplane has a FIXED main jet instead of an adjustable "power needle".

Performance issues in the midrange – see "Midrange Performance Problems" above. Here is the section on general performance issues.

Pop-off Pressure – The pressure must be within specs for maximum performance, to prevent engine damage, and for a steady idle.

Priming a paramotor – see "Starting the Miniplane" below.

Purging the fuel system – It must be done if a paramotor is to be stored for more than a few weeks.

Service Manual – from Walbro. Also check out Walbro's new video "Carburetor Service" above.

Starting – How to start your engine the first pull, every time.

Throttle Cable – Cleaning, modifications, and cruise control info. For kill switch issues, see "kill switch problems".

Throttle Return Spring Replacement – Improve throttle response, lessen hand fatigue with this modification/replacement.

Throttle Shaft Play – A worn out shaft leaks air and causes the engine to idle poorly.

Tune-up – Here is how to do it.

Articles of Interest

Adjustable carb pop-off pressure by Keith Pickersgill - March 2010

Most paramotors use a Diaphragm-type carb, and not a float-type carb.

These can operate for extended periods at any attitude (even upside-down) and is not affected by G-forces, centrifugal force, etc, so they are perfectly suited to PPG flight.

They operate somewhat like a gas pressure regulator, with a diaphragm to sense atmospheric pressure, a spring to regulate the overall fuel-flow and a Low and High speed jet, or adjustable fuel-air mixture screws.

The High Jet (or adjuster) is much like the jet in a gas burner, controlling the amount of fuel introduced into the air-stream (same as on standard float carbs), when at wide-open throttle. It is important that the paramotor delivers maximum power for takeoff and when climbing hard through turbulence.

On the Low end of the RPM range, is usually always a Low-adjuster, controlling the fuel-air ratio when the engine is idling. It is important that the engine does not die at idle, hence this aduster so that the pilot can ensure the engine idles OK, and can pick-up from idle when he whacks the power. All carbs also have an idle-speed adjuster, which is a mechanical adjustment of how far the throttle closes when you release the accelerator.

The mid-range, however is another matter entirely... and is the subject of this article.

We have two main carb models on modern paramotors:

1. The Walbro WB series (WB32, WB37, etc) which has a Low and Hi Adjuster.
2. The Walbro WG8 which has a Low Adjuster, but a fixed Hi-Jet inside the carb.

However, the overall performance of the carb is set by adjusting the pop-off pressure. This is set by changing the spring on the needle-valve that the diaphragm presses on (via a lever).

So the fuel-pump tries to pump fuel into the carb, however the main needle-valve opens and closes to control the pressure of the fuel in a small reservoir, from where the fuel flows to the various jets (fixed and/or adjustable).

The pop-off pressure is so named because we measure it by fitting a small thumb-operated air-pump to the carb fuel-inlet nipple, which has a pressure-gauge integrated into it.

We first pressurise the supply side to approx half a bar (approx 7psi), then stop to ensure the needle-valve does not leak and is capable of holding that pressure. Then we gradually increase the pressure, until the spring holding the needle-valve is over-powered, the valve opens, and the pressure drops suddenly with a loud "pop" sound. The pressure just before the valve popped, is the pop-off pressure.

Increasing the pop-off pressure, by stretching the spring, or fitting a stronger spring, makes the entire carb run leaner...
whereas reducing the pop-off pressure, by cutting a turn off the spring or fitting a weaker spring, makes the carb run richer throughout its entire range.

Once the pop-off pressure is set, e.g. 15psi on my engine, then we correct the two ends of the range with the mixture-adjuster screws, or changing jets.

So if the carb is leaned out by increasing the pop-off pressure, then the bottom end and the top end must be richened to compensate.

So essentially, the mid-range is set by adjusting the pop-off pressure, then the idle and top end is fine-tuned with different sized fixed-jets or mixture-adjuster screws.

Here are the the main problems with this system:

Firstly, even the manufacturers of these engines are not always sure what the correct, or ideal pop-off pressure should be. We set according to their recommendations purely because we have no better indication of what setting is better.

If the mid-range is slightly too rich or too lean (or in many cases, much too rich or lean), the pilot would never know... All he cares about is that the engine does not die when it is idling, and that at full power, the engine is peaking.

If the engine is under-delivering in the mid-range (either too lean or too rich), the pilot simply adds more power by squeezing the accelerator a bit more... Both cases (too lean or too rich) are in-efficient.

Most pilots spend most of their flying in the mid-range while cruising. Full power for takeoff and hard climbs, idle for gliding and descending, but most level flight cruising is done slap-bang in the mid-range, where the carb is seldom set correctly.

If the mid-range is too rich, the fuel-consumption is higher than it should be, and the engine gradually fouls up with partially-burnt fuel clogging the spark-plug, the cylinder head, the exhaust port, the exhaust bypass valve, the decompression valve and also the tuned-pipe whose internal dimensions are quite critical.

If the mid-range is too lean, then the engine suffers very gradual, not noticable, cumulative damage that builds up insidiously until the day the pilot pushes the engine hard at full power, resulting in catastrophic failure of some critical part (rings, piston, bearings, etc)

I would guess that 95% of pilots are running far too rich in their mid-range, as evidenced by their very high fuel consumption on long cruising flights. I fly a smaller propeller diameter than others on the same engine, which should increase my fuel-burn very noticeably, yet my fuel-consumption appears lower than anyone else I fly with, even those with the same engine and wing and all-up weight. I can only explain this by my taking great pains to tweak my pop-off pressure to the ideal setting.

Now here is the single biggest problem with this entire system:

Adjusting the pop-off pressure is a painful, hit-and-miss affair that few pilots ever get right... or they don't appreciate how important this is.

First, you need a pop-off gauge, which is a delicate piece of equipment that get broken very easily. Then, you need to open the carb's metering side, which is not easy while its on the engine, so the carb should be removed from the engine.

Then, to increase the pop-off pressure, you need a set of different springs.
These are expensive and rather difficult to obtain.

Then, you need to fiddle around with the different springs, re-assemble the carb each time, measure, strip down, fiddle again, assemble. measure, and repeat until you get it right.

Most pilots do not have the set of different springs, so they start messing up their only spring, the one that was inside the carb when they bought the motor. Stretching the spring is considered an emergency field-repair and not a long-term solution. Cutting coils off the spring is permanent... and if you later try to re-stretch a shortened spring, it simply never works.

Even when the pilot gets the pop-off pressure readout on his pop-off gauge "according to the manual", its probably not correct, as the manufacturer of the engine has probably not taken the effort to measure and check the fuel/air ratio across the entire RPM band... as long as it seems to work, everyone seems to be happy... not an ideal situation.

Many pilots fit various sensors and instruments to their paramotor in an attempt to avoid costly repairs...

All of these instuments have their problems:

- Tachometer (RPM) - could indicate almost any problem without any indication of where to start looking.
- Cylinder Head Temperature (CHT) - the thermal inertia is far too high... by the time you see the temperature go high, its already too late!
- Exhaust Gas Temperature (EGT) - too easy to misinterpret... some seizures occur with a low EGT...

Strangely enough, **the most promising of all instruments, the Exhaust Gas Oxygen sensor (EGO)**, has not yet found its way into mainstream paramotoring, however that is about to change...

All the other instruments measure just symptons of the real problem -- and not the problem itself, i.e. the fuel/air ratio.

An **Exhaust Gas Oxygen (EGO)** readout will indicate the actual ratio of fuel/air being burnt, right across the entire range, without any lag and with no possibility of misinterpretation.

So, let's say a pilot gets his EGO set up... and then discovers his mid-range is running rich... he knows he should increase the pop-off pressure, but by how much? Trial and error, stripping the carb, fiddling with springs, re-assemble, go for another test flight watching the EGO indicator?

There must be a better way!

Here is where my new idea comes into play...

A screw-adjuster to tweak the pop-off pressure.

Without opening the carb, without removing the carb from the engine. As easy as adjusting one of the mixture-adjusting screws!

I built one some years ago and have been hunting for it, but will probably just build another one now to test with an EGO. We used my original one when developing paramotors, to ensure we found the optimum pop-off pressure, before EGO's were readily available.

Imagine being able to use the same screw-driver used to turn the mixture-adjusting screws, to adjust the pop-off pressure, without removing the carb from the engine, without opening the carb.

Though the main idea is for ground-adjustment, it could easily be extended to an in-flight adjuster using a twist-cable if desired, just as some pilots have added an in-flight high-mixture-adjuster.

Many LPG gas regulators already have this adjustment built in... if you see a plastic cap covering the protrusion above the diaphragm, simply pop it off (or screw it out by hand), where beneath it you find a slotted disk in a threaded housing, pressing on a spring on the outside of the diaphragm. By screwing the disk in, you apply more pressure to the outside of the diaphragm, increasing the gas pressure and hence its flow rate.

Now, how do we modify our carbs to achieve the same adjustability?

Actually its surprisingly easy... The current carb design allows for a simple modification.

Over the diaphragm, exists a hole in the carb-cover, to expose the diaphragm to ambient pressure. This is in the center of the diaphragm, directly over a small metal place in the diaphragm center.

If we attach to this hole, a tube on the outside of the cover, threaded internally, whose ID is suitable to hold a typical carb pop-off spring, then we can thread a grub-screw into the tube, to hold the spring in tension. Turn the grub-screw in deeper to add more pressure to the spring, to reduce the pop-off pressure, increasing the fuel flow-rate. So all we need to do now, is replace the original pop-off spring, with a stronger one, then set the new external spring until the pop-off pressure is identical to the original setting. (In fact, we move the original internal spring, to the new external mod).

Now we can test-run the motor in the mid-range, and adjust the pop-off pressure as required, for the smoothest possible mid-range. With a Tacho-meter, we could also find the highest RPM for a given throttle-setting in the mid-range. Then we can tweak the top-end and bottom end as before to compensate for the changed pop-off pressure.

However, with a EGO indicator, we can get the mid-range absolutely perfect!

Then we can also get the top-end perfect, as well as the bottom end, using the EGO.

So an EGO meter and a replacement carb-cover with the mod built onto it, makes a really great combo!

If pilots do not wish to purchase or make a modified carb cover, then they could borrow one to find the perfect mid-range setting, measure what pop-off pressure this delivers, then adjust their pop-off pressure in the old way until they get to this ideal setting.

Voila, a perfectly running engine, with minimal fouling, and maximum fuel economy!

I believe an EGO meter will become a very popular instrument, to keep an eye on the engine, measuring the actual fuel/air ratio and not some sympton of problems relating to this.

Some links:

Building a DIY pop-off tester:
www.kartingtechinfo.com/tech/popoff.htm

A commercial pop-off tester (this is the one I use)
www.shopswedetech.com/popg1_p/popg1.htm

From Footflyer (Jeff Goin, author of the PPG Bible)
footflyer.com/Equipment/mx/pop-off-pressure.htm

alex Varv's very informative pages:
www.aerocorsair.com/id27.htm - (how these carbs work)
www.aerocorsair.com/id28.htm - (pop-off adjustment)

Any comment or suggestions would be most welcome.

Write to *keith@xplorer.co.za*