



## CARBURETOR FINE TUNING GUIDE

While there seems to be an abundant number of people selling "blue printed" carburetors and carb kits, there seems to be a desperate shortage of people who understand and can provide "understandable" carburetor operation and tuning information. The following guide is an easy to understand outline of "those basics". We hope you find them helpful.

### UNDERSTANDING SOME BACKGROUND

**Pumps:** Virtually all engines utilized the "round pump" Tillotson style carbs or pumps. These carbs come in various sizes up from 16mm to 30mm. The single stage "round pump" carbs perform well, but they may be somewhat temperamental on high output racing engines because the single stage diaphragm pumps may have difficulty supplying enough fuel. The two stage "round pump" style carbs produce more fuel delivery and pressure of the earlier single stage designs.

**Jets:** All of the carbs feature adjustable high speed and low speed jets. These adjustable external jets allow for very accurate mixture adjustment on a broad range of engine formats. The high speed fuel mixture screw governs fuel delivery in the 30%-100% throttle position range. The low speed fuel mixture adjustment screw governs fuel delivery in the 0%-35% throttle position range. As these screws are turned out, the fuel mixture is made richer. All adjustment settings are noted as "turns out" from the bottomed out position. That is, "1 TURN OUT" means one turn from the bottomed closed position.

**Pop off pressure:** This term refers to the amount of fuel pressure needed to push the fuel metering needle valve away from its sealing seat. Pop off pressure is checked with a hand pump that is fitted with an in line gage. The pump is connected to the fuel input fitting of the carb. (The high speed needle should be removed so that pressure vented during the pop off test does not put a strain on the fuel metering chamber diaphragm.) The pressure reached on the gauge when the needle gives way (pops) is called the pop off pressure. "Adjusting" the pop off pressure is discussed below. If you don't have a pop off pressure gauge, you should get one that has a gauge and pump capable of 20 psi. At the beginning, it's only important to check that the needle holds the pressure back with no leaking up to the point where it pops cleanly away from the seat. Perform the pop off test several times to confirm the actual pop off pressure. Initial pop off pressures on most Kart carbs should be between 10 - 13 psi. Obviously for each engine and set up, the combination of pop off, plus the low and high speed jet setting will have to be adjusted until you reach the best combination to match your engines fuel mixture requirements, and personal preferences.

**LOW SPEED ADJUSTMENT (0% - 35% throttle range)** The main objective of tuning the low speed mixture is to obtain a crisp throttle response from 'off throttle' to 'on throttle' as exiting a corner. A smooth idle is secondary. In most instances, the low speed mixture screw can be reasonably set to good starting point without driving the machine. Secure the kart on a spot on the ground, with the rear tires off the ground. Start by setting the mixture screw at about one turn out, start the engine and set the idle speed screw for an idle rpm that is slightly high but not so high that everything on the kart is "buzzing", (you'll know what I mean when you see it buzz). Run the engine for a few minutes, blipping the throttle occasionally until it is the engine completely warmed up. You can use the following procedure while the engine is warming up, but it is really only effective when the engine is warm. With the mixture screw at about one turn out, start by adjusting the low speed mixture screw in or out in 1/8



turn increments. As you get closer to the ideal setting, the engine rpm's will increase. As the idle speed increases adjust the idle speed adjustment screw down and continue the same process. At the ideal mixture setting, a 1/8 turn in either the richer or leaner direction will cause an un-steady idle and cause the engine to falter. Adjust the setting to the rich side of ideal. To fine tune your low speed mixture setting, you should take your kart on the circuit, if that is not possible, place the kart on the ground as before, and with the brake partially engaged to place a load on the engine briefly apply full throttle noting how crisply the engine responded, if it bogs or hesitates, it is a sign that the low speed setting is too lean. Alternatively if you are unsure try leaning out the low speed an 1/8 at a time until the hesitation occurs then richen it up till a crisp response is felt and heard. Listen to the intake and exhaust note carefully for a rapid and clean sound. If you are on the circuit setting your carb, do your checking and adjusting clear of other noises and listen for the same response, and try to also feel the difference.

**Low speed characteristics:** Some engines with heavy mid-range fuel demands may eventually require as much as 1/2 turn richer adjustment from this ideal setting point, however the need for an over rich low speed mixture setting usually indicates an unacceptable lean condition in the mid range, or a need to provide a cooling charge when you are 'off throttle' if you run a lean high rpm range. Avoid running an over rich low speed mixture screw setting in an effort to cure a mid range hesitation or lean condition. On clutch engines, a rich low speed setting is not so problematic. On direct drive engines it can really effect an engines response. With direct drive you are more throttle sensitive in your driving.

If you find that your ideal mixture setting is less than 3/4 turn out from bottoming, you should probably consider trying a slightly higher pop off. If you find that your ideal setting is beyond 1-1/2 turns out, you should consider a slightly lower pop off. In some cases, if your carb has been tuned and all the internal fuel orifices have been "blueprinted" you may find that your 3/4 turn or less mixture setting can not be cured, as the fuel flow capability of the orifices far exceeds the engines demand, which must be compensated for by the low speed jet. You may also find that at 3/4 turn or less the tuning range of the adjustment is very short and sensitive.

**HIGH SPEED ADJUSTMENT (30% - 100% throttle range)** The greatest fear of most racers is that of seizing an expensive engine as a result of running an excessively lean high speed fuel mixture. Some old racers contend that maximum horsepower is attained with a high speed fuel mixture that is at the brink of piston seizure. This is simply not true .. it never has been. Where high output kart engines are concerned, the ideal high speed mixture is the richest setting that still permits strong acceleration up to peak rpm. With this in mind, it is always wise to start out slightly over rich and slowly lean the mixture down. If the high speed mixture is too rich, the peak rpm's will "sign off" prematurely. If the high speed mixture is too lean, you'll experience weak or "lazy" mid range acceleration.

You'll eventually find a narrow adjustment range where peak rpm operation seems unchanged. However, within this range, there should be a noticeable difference in mid to high range acceleration. Finding the setting, within this range, that gives the best "middle through high range acceleration" usually requires a couple of back to back 10-15 minute practice sessions.

**TRANSITION RANGE ADJUSTMENT (20% - 50% throttle range)** The exotic manufacturers are the only carburetors manufactured with an external transition range adjustment screw. These cause much confusion for the average kart drivers and mechanics. The transition range of most carbs can be adjusted by changing the pop off pressure. These pop off pressure adjustments are made by way of various combinations of needle valves and fulcrum arm spring tensions.

In abbreviated terms, the transition circuit can be richened by reducing pop off pressure with a larger needle valve, and a shorter or weaker fulcrum arm spring. The various combinations of larger needle valves and weaker springs result in a wide range of lower pop off pressures. Usually, in karting, the most common adjustment is the varying of spring strength. Measuring the pop off pressure is how you normally determine whether you have made the transition circuit richer or leaner (higher pressures are leaner, lower pressures are richer) Most racing engines prefer low pop off pressures because they demand so much fuel in the mid range. Unfortunately excessively low pop off pressures can often create an undesired (and



unadjustable) rich condition in the 0 - 30% range. This unadjustable rich condition takes place at about 9 psi. Running pop of pressures that low is not recommended. Ideally, you want to run the highest possible pop off pressure that permits "hesitation free" mid range throttle response.

## AFTER TUNING

After you've found the best settings for your carb, make a record of it. Denote the final adjustment settings and the pop off pressure, as well as the day's temperature.

**READING SPARK PLUGS** - Determining proper fuel mixture by inspecting the color and condition of the spark plugs can be very helpful in situations where the engine is being operated constantly at full rpm under full load. "Reading plugs" for perfect fuel mixture is very common where the engines are nearly always run at full rpm and full load.

To get an accurate plug reading on an engine, a fresh spark plug should be run in the machine for 3-5 minutes at full throttle/full rpm on a relatively clear track. At the end of the full throttle running, the throttle should be chopped and the kill button pushed simultaneously (called a "plug cut"). If the engine is run at partial throttle for even 3 seconds after the full throttle run, the plug reading will be invalid.

After the full throttle running, and the plug chop, a combination flashlight/magnifying glass must be used to view the carbon deposit at the base of the porcelain (down inside the spark plug where the porcelain insulator and outer steel spark plug casing meet. A ring of dark brown at the base of the porcelain denotes ideal fuel mixture, light brown is lean, and a ring of black is over rich. This is the only area of the spark plug that accurately indicates fuel mixture. Furthermore, this reading only indicates full throttle fuel mixture. No part of the spark plug can indicate low speed or mid range fuel mixture. The upper part of the spark plug porcelain (by the electrodes) is often very light or white in color, however this coloring is mostly affected by additives in the gasoline and oil. The coloring of the end of the porcelain in no way indicates appropriate fuel mixtures of any throttle range. The cosmetic appearance of the spark plugs can help a kart mechanic to quickly diagnose the symptoms of a major operational problem. But as far as carb fine tuning is concerned reading plugs qualifies as a very questionable way to fine tune carbs. Very few professional engine builders recommend their customers to do carb fine tuning based on plug readings ... and even fewer engine builders do it themselves.

**THE WEATHER** - Weather and altitude definately is a factor to consider during fine tuning. The factors that will require you to go leaner are, higher altitude (changes of 1000 ft. or more), higher temperatures (changes of 6C or more), and higher humidity (changes of 20% or more).

**AIRLEAKS** - The lower end of a two cycle engine must be air tight to about 10 psi. Air leaks can cause on-going jetting problems, and possible piston siezure from over lean conditions.

As the castings of an engine expand and contract with heat, and crankshafts rotate in their bearings, so too can the air leaks change to admit greater and lesser amounts of outside air during operation. An engine with a small air leak will never carburate consistently. Remember ... air leaks never get smaller.

**REEDS** - If your reed petals are chipped or frayed in a way that does not permit perfect sealing, the low speed and mid range circuits will be very difficult, if not impossible, to set accurately. Damaged reed petals will cause a false low speed rich condition, not to mention hesitations in mid range that you will not be able to carburate out. Installing aftermarket reeds may often require significant changes in carb adjustment.

**CARB GASKETS** - Confirm that these gaskets have a soft drying sealer (like Hylomar) on them, and that the carb mounting bolts are torqued.

**CONFIRM FULL CLOSING AND OPENING** - With the airbox/ filter off, be sure that the carb butterfly(s) open fully and close completely



**PRESSURE TEST FUEL SYSTEM.** Any air leak in the fuel lines or connections that will permit air to enter the fuel system will also affect fuel delivery to the engine ... sometimes the symptoms can include a siezed piston.