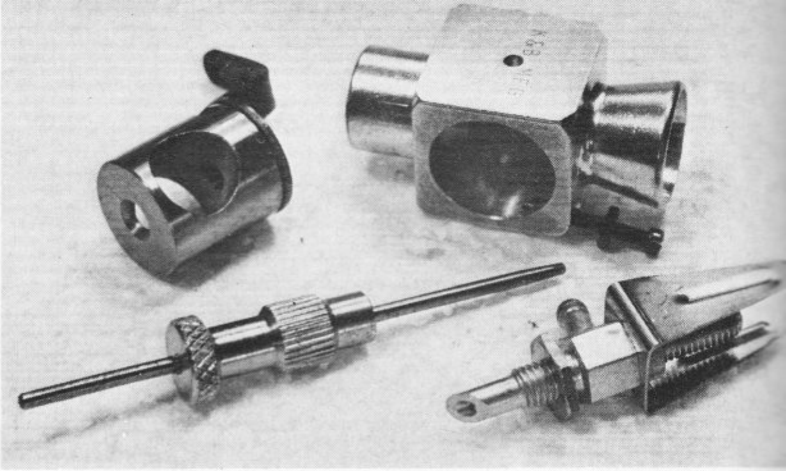


MOTOR MISCELLANY

Peter Chinn on
R/C CARBURETTORS

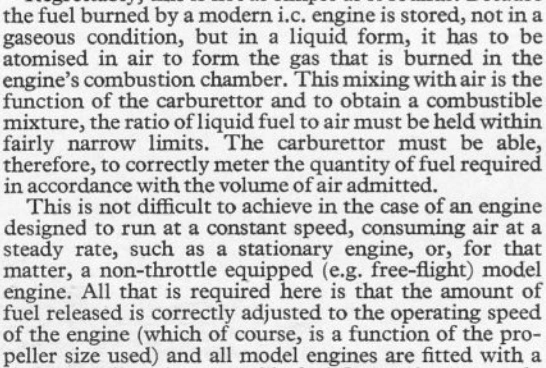
Many modellers have trouble in adjusting throttles, simply because they do not understand how they work. It's hoped these notes will throw some light on the matter.

MODEL AIRCRAFT motors, like full size internal-combustion engines, belong to that group of heat engines known as "gas engines". The amount of power that such a power unit develops depends, first and foremost, on the quantity of gas that is burned in the cylinder. Therefore, varying the power output would seem to be quite easy: all that should be required is a throttle-valve to regulate the amount of gas admitted to the combustion chamber.

Regrettably, this is not as simple as it sounds. Because the fuel burned by a modern i.c. engine is stored, not in a gaseous condition, but in a liquid form, it has to be atomised in air to form the gas that is burned in the engine's combustion chamber. This mixing with air is the function of the carburettor and to obtain a combustible mixture, the ratio of liquid fuel to air must be held within fairly narrow limits. The carburettor must be able, therefore, to correctly meter the quantity of fuel required in accordance with the volume of air admitted.

This is not difficult to achieve in the case of an engine designed to run at a constant speed, consuming air at a steady rate, such as a stationary engine, or, for that matter, a non-throttle equipped (e.g. free-flight) model engine. All that is required here is that the amount of fuel released is correctly adjusted to the operating speed of the engine (which of course, is a function of the propeller size used) and all model engines are fitted with a simple needle-valve to enable fuel flow to be accurately metered to suit these requirements. The needle-valve also makes it possible to compensate for other variables, such as fuel delivery pressure and different fuels and atmospheric conditions.

Heading shows one of the simplest types of barrel-throttle r/c carbs—early K&B with non-adjustable airbleed. *Below*: conventional type with adjustable airbleed. Area of hole adjusted with horizontal screw.



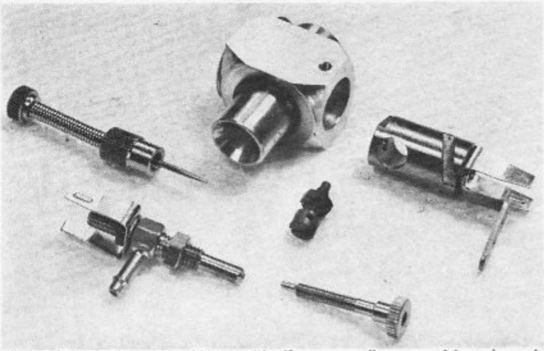
With "full-size" carburettors, the main problem to be overcome is the alteration in mixture strength that occurs as engine speed is varied. As rpm are increased and the rate of air flow through the carburettor is raised, the air pressure in the choke is reduced, thereby increasing suction at the jet, with the result that the mixture becomes richer at high speeds. Most full size carburettors therefore incorporate devices for automatically maintaining a more or less constant mixture strength, in the interests of fuel economy and performance.

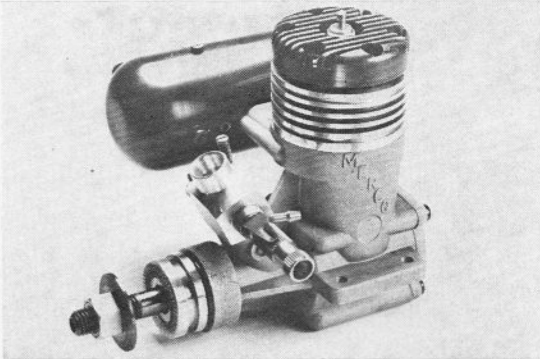
With model aircraft engine carburettors, the situation is rather different and, in fact, is more serious. The problem here is not simply a matter of maintaining good performance without wastage of fuel, but of actually keeping the engine firing at all times. In other words, it does not matter if the mixture strength departs from the *economical* optimum fuel-to-air ratio, so long as it remains within the upper and lower limits at which it is still *combustible*. A combustible mixture strength ratio must be maintained not only throughout the speed range of the engine, from idling to full power, but also through the variations in fuel delivery pressure resulting from the wide variety of attitudes and manoeuvres occuring in flight.

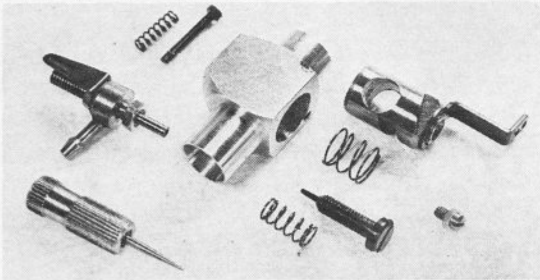
In order to satisfy the first of these conditions, it is desirable to incorporate some form of mixture control linked to throttle movement. To satisfy the second, the simplest solution is to use a relatively small choke area that will exert a strong suction at the jet at all times, but since a small choke also has the effect of reducing the engine's potential power output, it is becoming increasingly common to use some form of assisted fuel delivery from tank to carburettor, instead of relying only on suction feed.

For R/C engines, the most widely employed method of doing this is to pressurise the fuel tank by means of the gas pressure generated within the exhaust silencer. Most silencers are fitted with a brass outlet nipple and a length of silicon fuel tube is used to connect this to a sealed fuel tank. This method of pressurising the fuel system is much better than the old method of employing crankcase pressure which, with a throttle equipped motor, tended to cause the carburettor to run over-rich at low speeds. With an exhaust pressurised system, this does not occur as the pressure of the gases within the silencer diminishes as power is reduced and fuel pressure is thereby quite closely matched to the requirements of the carburettor.

With an exhaust pressurised system it is feasible to use carburettor choke areas 30-50 per cent larger than would normally be used with suction feed. Taking this a stage further, it is also possible to increase choke areas by







Webra TN carburettor. Idle needle (foreground) screwed into barrel, enters jet at low speed to reduce fuel flow. *Right:* Merco 61 IV also uses single-jet two needle type. Easier to adjust than earlier, more complex Micro-Flo design.

another 30-50 per cent (or to approximately double the "suction" size choke) by using a much more complex high-pressure system with a special regulator to meter the fuel supply to the carburettor. The American Perry-Pump and the Japanese YS Pressure Regulator, both used in conjunction with special carburettors, are examples of such an approach.

Basic carburettor types

Among the earliest forms of intake "throttle" used on model engines were simple pivoted flaps located in the mouth of the air intake. Such crude devices restricted only the amount of *air* reaching the carburettor and were effective in only partially reducing power. Closing the air valve beyond a certain point simply resulted in the engine's suction being transferred to the fuel jet (as occurs when one is choking the engine prior to starting) causing an excessively rich mixture on which the engine would not continue to run.

Barrel throttles

The throttle-valve most commonly employed by model engine carburettors since about 1960 has been the barrel throttle. This is generally in the form of a solid cylinder of brass or steel, located transversely in the carburettor choke and bored through diametrically to line up with it when the throttle is open. The barrel is usually drilled axially to take a spraybar or jet-tube so that fuel is discharged into its centre. Rotating the barrel reduces air admission on the "upstream" side and mixture admission on the "downstream" side.

In order to prevent too much suction at the fuel jet causing an over-rich mixture at idling speeds, the "upstream" opening may be made larger, or notched, so that more air is admitted. Alternatively, an airbleed hole may be drilled through the carburettor body so that extra air can enter the barrel when this is in the idling position.

Adjustable airbleeds

The basic barrel type throttle described above can be greatly improved by the addition of an *adjustable* airbleed. In this, the effective area of the airbleed hole (and thus the idle mixture strength) may be altered by means of a screw. Carburettors of this type are widely used, especially for the smaller and simpler types of motors.

Fuel metering systems

A well designed adjustable airbleed type throttle, properly set up, can be very reliable. It has, however, one distinct disadvantage, namely its fixed jet size. The fixed jet works well so long as fuel suction is primarily dependent on the depression created by the high speed air flow through the carburettor choke. However, as previously noted, when the air inlet is drastically reduced (i.e. during idling) the suction created in the engine crank chamber (a very efficient pump even at the lowest speeds) tends to draw an increasingly excessive amount of fuel from the jet and this strong suction is considerably reduced when air is fed in via the airbleed to avoid an over-rich mixture. To have to partially destroy suction in this way is a pity because it is when the engine is idling, especially when fuel level is low and model attitude changing, that we need to maintain a steady supply of fuel at the jet.

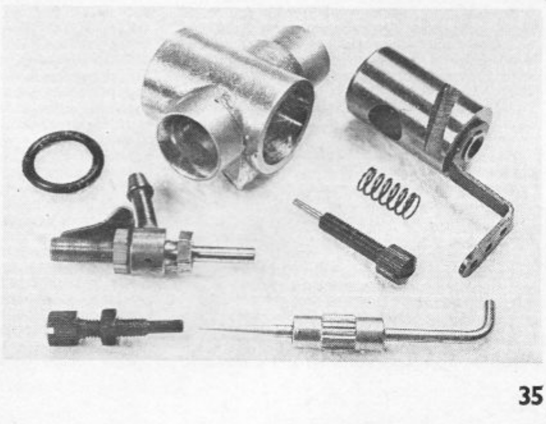
The way to achieve this without resorting to an externally pressurised fuel system, is to maintain suction at a high level by eliminating the airbleed and to employ a device for reducing the *quantity* of fuel actually released through the jet.

This is the principle on which most of the larger model engine carburettors now operate. Mechanical design varies quite a bit and such carburettors, which, collectively, may be referred to as "automatic mixture control" (AMC) or "automatic fuel metering" (AFM) or "two-needle" (TN) types, go under a variety of proprietary names. They include certain of the carburettors made by leading model engine manufacturers, such as HP, Merco, O.S., Super-Tigre and Webra, as well as those produced by accessory manufacturers such as Kavan and Perry.

Basic adjustments

It is impossible to deal in detail with the operation and adjustment of every type of carburettor, but the following information covers most of the more popular R/C

—Continued on page 60



Hirtenberg 2-needle carb works on the same principle as Webra TN and is fitted to some HP 61 and 40 engines.

R/C CARBURETTORS
—Continued from page 35

carburettors in current use. It is generally recommended that an exhaust-pressure assisted fuel system be used, unless the engine or carburettor manufacturer specifically states otherwise. The fuel tank should be positioned as close as possible to the engine and with its centre-line level with, or slightly below, the height of the carburettor jet, and the engine should first be run-in in accordance with the manufacturer's instructions before any attempt is made to fix carburettor adjustments.

Airbleed carburettors

Setting up an adjustable airbleed type carb is a fairly straightforward procedure. The engine is started and the needle-valve set with the throttle wide open. The desired needle setting is usually $\frac{1}{8}$ to $\frac{1}{4}$ turn on the rich side of the setting at which the engine runs fastest. This will reduce maximum speed by perhaps 200 rpm but means that there is a safety margin in the event of the mixture weakening when the model is in a steep climb with an almost empty fuel tank. This can be checked by pointing the model's nose vertically upward with the engine running. Make sure that the pressure line from silencer to carb is secure.

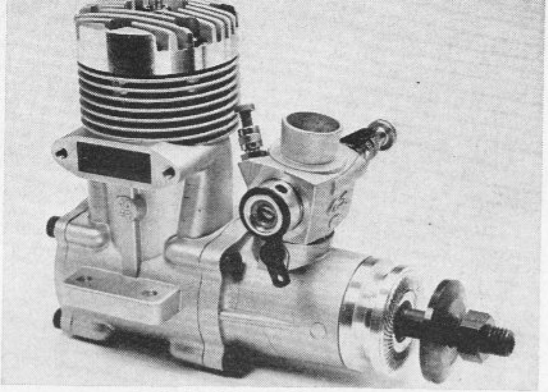
Now throttle down to a reasonable idling speed. A "reasonable" idling speed is between one-quarter and one-fifth of the full throttle speed. In other words, with an engine that turns at 12,000 rpm on the chosen prop, the idling speed should be between 2,400 rpm and 3,000 rpm.

If the motor immediately stops on throttling down, first make sure that you are not attempting to run it too slowly. If necessary, adjust the throttle stop screw for a slightly bigher idling speed. The other possibility here is that the mixture is too weak at idling speed. In which case, screw in the airbleed screw say, half a turn, to reduce the amount of air admitted and restart the engine.

Nowadays, most R/C engines will start on their idle settings and if the idle setting is too weak, one can gradually enrich the idle until the engine starts and idles satisfactorily. If, on the other hand, the idle mixture is too rich, it is best to open the air-bleed but to then burn off the excess fuel remaining in the engine by opening the throttle before trying the idle again.

Generally speaking, it should not be necessary to make drastic changes to carburettor adjustments. Most of the better quality engines leave their factories with idling adjustments set quite close to the optimum and anyone purchasing a new engine is therefore advised to persevere for a while before making readjustments to the original settings.

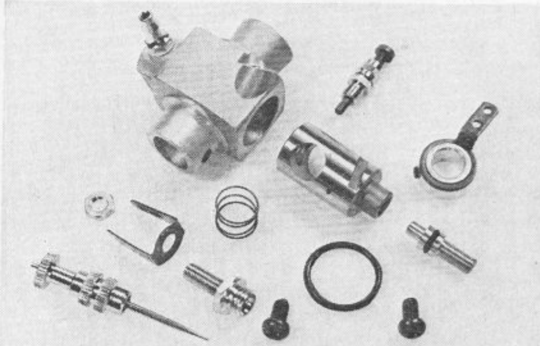
PART TWO—NEXT MONTH will deal with single-jet, two-needle carburettors and other single-jet automatic types, non-adjustable AFM types and the Fox twin-jet carbs.



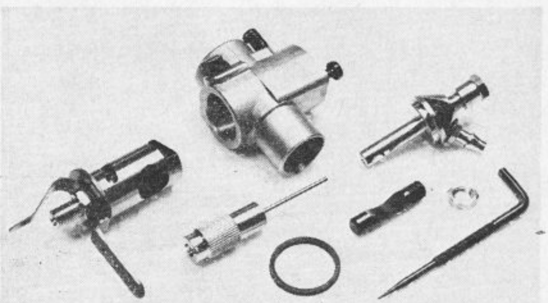
Peter Chinn's

MOTOR MISCELLANY

R/C CARBURETTORS PART 2



Above are the components of the O.S. type 4B carb. Mixture control valve (*right*) mounted in barrel, slides over spraybar, fixed in body. Shown at top fitted to 40F-SR engine. Recessed screw slot allows adjustment while running.



Super-Tigre Mag variant of single-jet 2-needle theme uses sliding rod in spraybar for idle mixture control. *Below:* Webra TN carburettor. Idle needle (foreground) screwed into barrel, enters jet at low speed to reduce fuel flow.

The second of this two-part feature aimed at clearing up some of the "mystique" which seems to surround setting up r/c throttles

ONE OF the most widely used of the automatic mixture control carburettors is the single-jet two-needle type which had its origins in the Webra TN type first used in 1967 on the Webra 61. In principle, these carburettors are relatively simple barrel throttle units having a single jet but with an extra needle which comes into operation to restrict fuel flow at part-throttle and idling speeds.

The main needle valve assembly is mounted in one side of the carburettor body. Its open-ended jet tube is concentric with the throttle barrel and protrudes into the centre of its choke. The barrel, inserted from the opposite side of the body, carries the idle needle, which can be screwed in or out and also protrudes into the choke. The throttle barrel does not simply rotate when closed: instead it describes a helical path, moving axially inwards as well, so that, at just below half throttle, the tip of the idle needle enters the jet and reduces fuel flow as the throttle moves towards the idle setting.

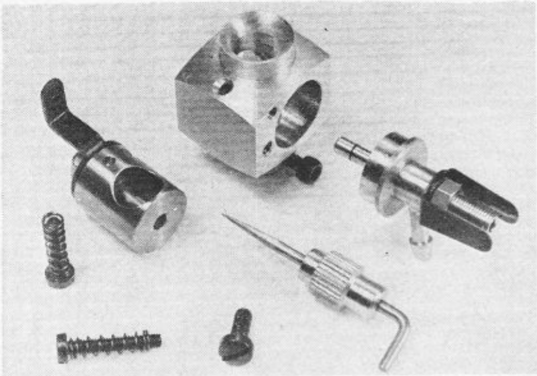
Several other engines have carburettors that use this principle including certain Merco, HP, Taipan and OPS models. The Super-Tigre "Mag" carburettors are also of this type but, with these, the jet tube is in the form of a full-width spraybar with a longitudinal slit type jet. Instead of having a tapered tip, the idle needle is in the shape of a thin rod which is a close fit in the spraybar and gradually reduces the effective length of the jet as the throttle closes.

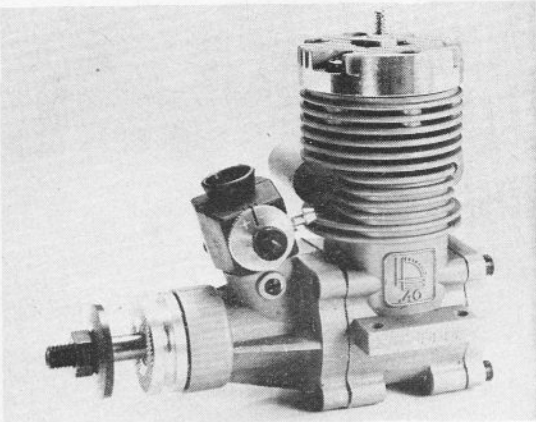
In general, all these carburettors work well and, since their operation is so easy to understand, adjusting them is quite simple. After setting the main needle at the full throttle position, the throttle is closed to the idle position and the idle needle is adjusted for the correct low-speed mixture.

The same basic procedure can be followed as has been described for air-bleed type carburettors but remember that the idle mixture adjustment works in the opposite mode: i.e., screwing in the idle needle weakens the mixture instead of enriching it.

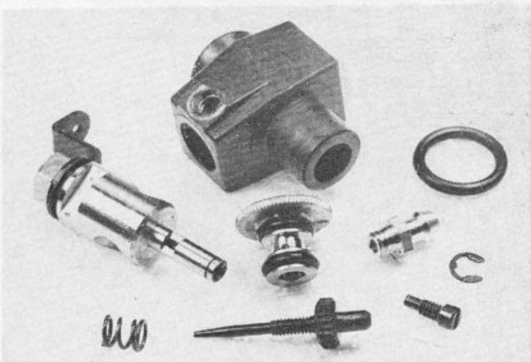
Other single-jet automatic carbs

Other single-jet AMC carbs include the Kavan, Perry and O.S. Type 4B and Type 7B carburettors. Of these, the O.S. retains the helical barrel movement of the TN type and has a full width spraybar with a longitudinal slit type jet like the ST Mag carb but, instead of an idle needle, it has a sleeve type mixture control valve which is





Left: well-known Kavan carb. Sleeve in barrel rotates around spraybar partially covering slit type jet at idling speed. *Below:* parts of the Perry. The reel-shaped component (*centre*) controls idle mixture strength. The Perry carb. is made in three sizes and the HB 40 above is one of the many motors so fitted. (Disc is for idle speed adjustment.)



a close sliding fit over the spraybar. This extends half-way across the choke bore at full throttle but moves along the spraybar reducing the length of the jet and also the effective area of the choke as the throttle closes. The mixture control valve is threaded into the throttle barrel and sealed against leakage or accidental movement by an O-ring. Adjustment is simple and positive via a recessed screwdriver slot and can be set while the engine is running. The Type 7B carb also has an optional choke insert giving a choice of choke areas for suction or pressure feed.

The Kavan carburettor, outwardly, looks like an orthodox barrel throttle carb with airbleed. The barrel does not move sideways. Instead, it incorporates a full length brass sleeve that rotates around a spraybar. The jet is in the form of a narrow radial slit in the centre of the spraybar and this is uncovered at full throttle, by a circular hole in the sleeve. As the throttle rotates towards the closed position, the exposed length of the slit is shortened, thereby reducing fuel flow. The extent to which fuel flow is reduced at part throttle openings can be changed by slackening a screw retaining the complete spraybar and needle-valve assembly and rotating it a few degrees: clockwise to weaken the idle mixture; anticlockwise to enrich it. An adjustable airbleed is retained for correcting the idling mixture.

The Perry carburettor, like the Kavan, uses rotational barrel movement, only, to meter the fuel but is of quite different design. The barrel is fitted with a fixed brass jet tube, the extended outer end of which passes through a small cylindrical chamber in the closed end of the plastic carburettor body and also carries the needle-valve. Fuel fills this chamber from an inlet nipple in the rear of the body and is transferred to the jet tube through a slot in the side of the latter after passing through a small slit in a reel shaped sleeve surrounding it. This sleeve, fitted with two O-rings, is an integral part of the *idle mixture disc* visible on the outside of the carb. Rotation of the disc alters the idle mixture strength, clockwise to weaken, anti-clockwise to enrich, but it is very sensitive to movement and needs to be turned only two or three degrees at a time.

There are two important things to watch with the Perry carb. First, the metering slit in the idling mixture control is very fine and effective fuel filtering is therefore essential. Secondly, when cleaning the carburettor, it is necessary to avoid *soaking* the plastic carburettor body. Petrol (in particular) and most of the usual solvents will ruin it. It is best to just rinse it in glow fuel and dry it off.

Non-adjustable AFM carburettors

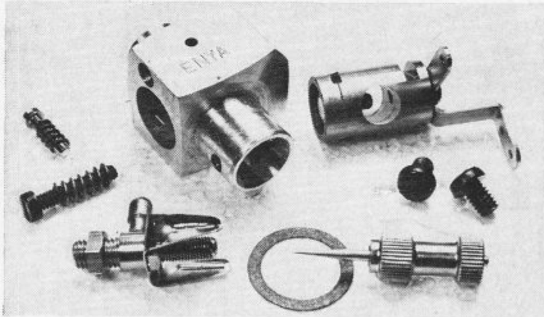
All the automatic carbs dealt with so far have had provision for adjusting the low speed fuel metering. An exception is the Enya "G" series carburettor. Here, fuel is fed from the carburettor body to the interior of the throttle barrel (and then to an open-ended jet tube) via a hole in the surface of the throttle barrel which, in order to reduce fuel flow, gives way to a fine groove as the throttle barrel rotates towards the idling position. Like the Kavan, the Enya "G" series relies on an airbleed to overcome any richness at idling speed.

Fox twin jet carbs

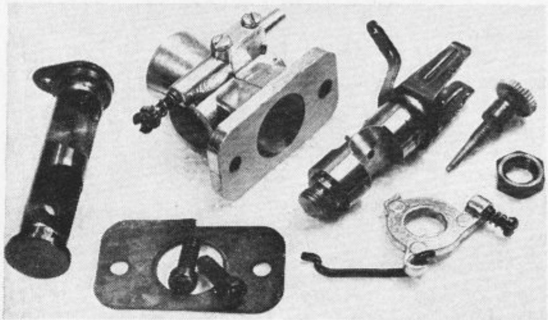
Finally, we come to those carburettors which use separate jets for high speed and lower speed operation, specifically the carburettors fitted to the medium and large Fox engines. At one period Fox carburettors included a triple-jet, triple needle type but, in the interests of simplified adjustment, the mid-range jet and needle assembly were eliminated in favour of a non-adjustable mid-range metering device.

Fox carburettors also differ from those previously described in that the throttle valve, while still a semi-rotary pattern, is not the usual barrel type, bored diametrically. Instead, it has a flat centre section so that, in effect, it operates as a butterfly valve. Operation is as follows:

Fuel enters the carburettor through an inlet nipple in the front of the body and takes two routes: (a) directly to an idling jet in the carb throat, the amount of fuel released being controlled by a small needle-valve and (b) to the main jet through a delivery hole in the left side of the carb body where it is picked up by a hole in the surface of

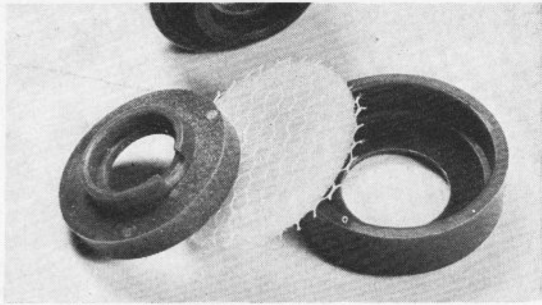


Enya type " G " carb. has non-adjustable automatic fuel metering via groove in barrel surface, plus airbleed for idle mix control. *Below:* unlike other carburettors, the Fox two-jet type has metered mixture control at high speeds, and runs on separate idling jet at low speed.



the steel throttle valve, conveyed to its interior and discharged through the main jet located in the middle of the flat centre section. The amount of fuel released here is adjusted by a large needle screw installed in the left hand end of the throttle valve.

At part-throttle settings, the pick-up hole in the throttle valve is no longer aligned with the delivery hole in the carb body. However, a fine groove in the surface of the rotor (as in the Enya G series previously described) allows a reduced quantity of fuel to be admitted and this automatically adjusts mixture strength to part-throttle requirements. Further rotation of the throttle cuts off the



The novel Perry air-intake filter is useful for dusty conditions—but fuel-line filters are much more important.

fuel to the main jet entirely so that the engine now runs on its idling jet only.

There is one important point to remember when adjusting a Fox twin-jet carburettor. Because the engine runs on the idling jet only at low speed but on both jets at intermediate and high speeds, it is necessary to adjust the idle needle valve *first* and to then open the throttle to full speed and set the main needle-valve. This, of course, is the exact opposite of the procedure applicable to all the other carburettors discussed.

Many modellers have trouble in adjusting carburettors simply because they do not understand how they work. It is hoped that the notes contained in this article will throw some light on the situation, particularly when read in conjunction with the manufacturers' instructions on carburettors.

Once a carburettor has been properly set up for a particular installation, it should not be necessary to make any further readjustment (except, perhaps, a slight change in the main needle-valve setting to cope with different fuels and atmospheric conditions) until such time as the effects of wear become apparent. The main thing to bear in mind is that R/C carburettors, particularly those using slit type metering jets, will not tolerate unfiltered fuel. It takes only a minute particle of fluff or dirt to partially block such a jet and completely upset throttle operation. Therefore, always use at least two fuel filters: one in the supply tube from the fuel container to fuel tank and one in the delivery line from tank to carburettor—and make sure that both are cleaned frequently.