PETROL ENGINE TOPICS

* A 15-c.c. FOUR-CYLINDER ENGINE

By Edgar T. Westbury

A GOOD deal of thought has been devoted to the design of the carburettor, in order to produce a device which is compact, and simple both in construction and adjustment, while at the same time efficient and capable of a wide range of speed control. Simplicity is an essential virtue in a carburettor for so small an engine, because complication not only increases the difficulty of construction, but may also defeat its own purpose by introducing more things to go wrong or out of adjustment. At the same time, however, it is none the less essential to the success of the engine as a whole that the carburettor should do its job without fuss or continual nursing. The space available for the fitting of the carburettor is by no means unlimited, and it is desirable, even if only for appearance sake, to keep it more or less within some semblance of scale proportion.

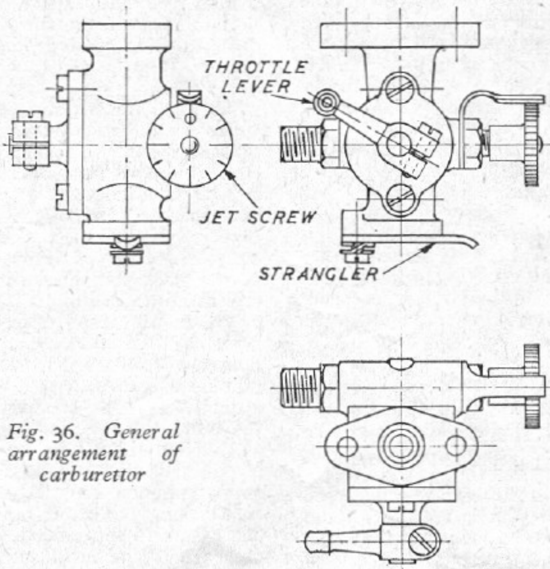


Fig. 36. General arrangement of carburettor

It has not been considered necessary to use float-feed on this carburettor, as small floats, although quite successful if properly made and adjusted, are frequently a source of trouble, and are worse than useless unless they can be relied upon not to flood or stick. Suction feed will give good results if the fuel tank is made fairly shallow and not too far below the jet level; the low position of the carburettor, when used as normally intended, on the underside of the manifold, favours a convenient arrangement and location of the tank.

The carburettor has a barrel throttle, which is designed to produce mechanical compensation of the mixture, as described in recent articles on carburation. Several successful carburettors of my design, including the "Kiwi" employed on the 15 c.c. engine of the same name, work on this principle, which is quite effective for speed control, though it gives no automatic compensation for varying load. It may be remarked, in passing, that a "Kiwi" carburettor is used on the 50 c.c. four-cylinder engine made by Mr. W. Savage (which has been mentioned and illustrated in THE MODEL ENGINEER in connection with magneto experiments) and has always given satisfactory and consistent results.

The jet is arranged horizontally at the back of the carburettor, this position being convenient for accessibility of adjustment, and also for connecting up the feed pipe. It is of more or less orthodox design, controlled by the usual screwed head and taper needle, but is not situated in the main air passage—a small air passage, little more than an "air bleed," being provided to act as a primary choke, and this communicates with a hole in the centre of the throttle barrel. The main air passage is tapered from the discharge end, and flared at the intake, to form a venturi tube, the centre part of which is formed in the throttle barrel, which registers with the main passage when fully open. (See Fig. 36.)

The operation of the carburettor should be quite clear to readers who have followed my articles on this subject, but may be briefly explained as follows: At full throttle, air flows rapidly through the bore of the main passage, which has a high coefficient of discharge, yet is so proportioned as to produce a suction effect sufficiently strong to induce extra air to flow through the primary choke and also draw fuel from the jet. Thus the primary choke discharges a rich air-fuel mixture into the main air stream, in the same manner as an "emulsion jet" used in many full-sized carburettors; the richness being adjusted by the screw-needle, so that, when diluted by the main air stream, it is of the correct strength for combustion.

When the flow of air is restricted by the partial closing of the throttle, changes in the air pressure and velocity take place which affect the discharge of fuel from the jet. The relative areas of the passage at the intake and discharge edges of the throttle barrel here exert a controlling influence, and must be adjusted to obtain the best results at all positions of throttle opening.

If the throttle were designed to cut off on the

*Continued from page 722, "M.E.," June 12, 1947.

discharge side only, while allowing a free flow at the intake side, it is clear that the suction at the aperture of the primary choke would rapidly diminish with the closing of the throttle, so that the discharge from the jet would fall off so much as to produce a weakening mixture under these conditions. But if closure takes place at the intake end only, the opposite effect is produced; suction at the primary choke is increased, and the mixture becomes richer as the throttle is closed.

Somewhere between these extremes, a state of affairs can be reached in which just sufficient suction can be diverted to the primary choke to maintain something approaching the correct mixture at all positions of throttle opening. In practice, it is found necessary to close the intake somewhat more rapidly than the discharge, which can be done quite conveniently by tapering the main air passage. But it must be emphasised that some "cutting and trying" is nearly always necessary to obtain the optimum result on any particular engine.

It is intended that the jet adjustment of this carburettor should remain constant when once set, though some slight readjustment may occasionally be found necessary to allow for climatic conditions or variation of fuel quality. But continual knob-twiddling is neither necessary nor desirable. To facilitate starting, a strangler is provided at the main intake, but it is again emphasised that this, also, is not intended to be used as a running control.

Carburettor Body

This is made from a casting, machined to the dimensions shown in Fig. 37. It is advisable first to machine the throttle-barrel housing, holding the casting across the four-jaw chuck for this operation. Do not drill the hole through the jet housing at this setting, as it may throw the drill out of truth when subsequently drilling the hole for the jet-tube; but it may be started with the pilot end of the centre drill, so that its position may be correctly located afterwards.

Bore the throttle housing parallel, and to a good finish; one does not aim at air-tightness in a throttle-valve, but the better it is finished, the smoother it will work. Before boring the main air passage, the throttle barrel should be turned and fitted, the cover also being machined, but with the register spigot left proud, so that when screwed down it will bear on the barrel and hold it tight for the boring operation. Assuming these parts are made, the passage can now be bored, holding the casting from the intake end and first drilling a centre hole right through 5/32 in. diameter and using a taper reamer or D-bit to open up the discharge end. The exact taper is not specified, nor can it be predetermined, to ensure correct operation of the carburettor beforehand; but an included angle of about 10 deg., as used for fitting shaft tapers, will be somewhere near correct, and in view of the general utility of a D-bit of this angle of taper, it will be worth while to make one. For preference, a long cutting angle, to cover sizes from $\frac{1}{8}$ in. to $\frac{3}{8}$ in. diameter, will be found most useful.

Do not, on any account, open up the bore to finished size right away, in view of the fact that adjustment of the bore will almost certainly be necessary, and as everyone knows, it is much easier to remove metal than to put it back afterwards! It will be sufficient to enter the reamer just far enough to taper out about half the length of the throttle barrel at first. The intake end of the passage may be flared out with a hand-tool, the casting being mounted on a taper plug held in the chuck.

The jet housing may be drilled in a drilling machine, but accuracy in centring the hole is facilitated if the casting is mounted, throttle housing face down, on a small angle-plate attached to the lathe faceplate. Drill the hole 9/64 in. diameter right through and face both ends truly. The No. 60 cross hole may now be drilled from the outside of the casting, and the 3/32 in. hole from the inside of the housing drilled to line up with it.

Jet Tube

This is made from hexagonal brass rod, approximately 7/32 in. across flats, and the plain portion should be turned to a sliding fit in the bore of the jet housing, the end being screwed 4-B.A. for a length of $\frac{3}{8}$ in. Take care to centre and drill the hole truly, running the work at the highest possible speed and using a sharp $\frac{1}{16}$ in. or No. 52 drill. If desired, the No. 70 hole may also be drilled at this setting, but there are some advantages in drilling it from the other end.

To ensure true running of the work when reversed, it should be chucked by drilling a true hole in a piece of rod held in the lathe chuck, and tapping it 4 B.A., with a 9/64-in. counterbore to a depth of $\frac{3}{16}$ in., so that it will screw in up to the shoulder. The screwed and internally-coned end of the jet tube, to provide for a union joint, is optional, but is considered preferable to the more common nipple end for rubber-tube connection. A flexible pipe-joint has its advantages, both in convenience and also as a means of preventing pipe breakage by vibration, but one wonders whether its adoption is not, in many cases, the line of least resistance on the part of the constructor.

The internal cone may be formed by means of the centre-drill, and a $\frac{1}{16}$ in. hole is then drilled to a depth of $\frac{7}{16}$ in. from the end, after which a No. 70 drill is used to form the jet orifice. I find it best to apply these tiny drills by hand, holding them in a small pin-chuck, with the lathe running at top speed.

After fitting the jet tube in position and securing it with a 4-B.A. nut at the end, the cross hole may be drilled to line up with the cross holes in the jet housing. It is, of course, essential that the jet tube should always be assembled with these cross holes in line, and it may be found advisable to provide some means of ensuring this, such as by marking the appropriate flats of the hexagon, or fitting a tiny snug key.

Jet Adjusting Screw

This is, strictly speaking, not a screw at all, being an internally-threaded knurled head, into which the tapered jet-needle is sweated after assembly. An ordinary dress-pin serves quite well for a jet-needle, though a stainless-steel or German silver needle is stronger and more durable; in either case, a fairly fine taper is desirable to facilitate exact adjustment. The knurled head should be screwed on to the end of the jet tube almost as far as it will go, after which the needle is pushed right home in the jet and sweated in position. Clean off the face of the knurled head, and make

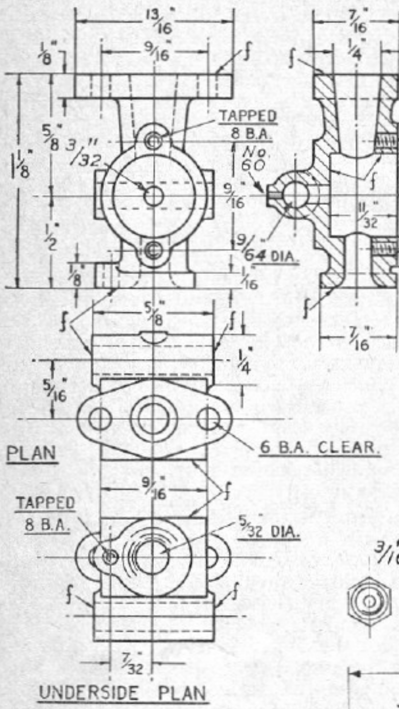


Fig. 37. Carburettor body

one or more radial marks on it to indicate its position.

The check spring may be filed to shape from any suitable material, such as phosphor-bronze strip or a piece of old clock-spring. The extended end should be formed into a concave channel by hammering it into a vee-block with the pane of the hammer, so that it will bear firmly on the knurling of the head when bent to the shape shown. It is secured under the jet-tube nut as shown in the general arrangement (Fig. 36).

Throttle Barrel and Cover

These are shown in the detail group (Fig. 38), and are quite a straightforward turning job, the barrel and shank being turned from brass rod at one setting. It should turn smoothly in the throttle housing, and as already described, is fitted in place for boring the cross hole. This should be done before drilling the 3/32-in. hole at the back to communicate with the primary choke.

As already stated, the cover is at first made with the register spigot long enough to clamp the barrel in place when the screws are tightened. The surplus length is afterwards faced off to allow the barrel to turn freely, but with little or no end-play, and if desired, the outer part of the face may be relieved slightly to reduce friction. Alternatively, it may be preferred to introduce friction, if control direct from the throttle lever is desired, and in this case, the centre hole may be counterbored to take a double-turn spring washer.

Throttle Lever

The form of this may be varied to suit the preference or convenience of the constructor. If direct control is used, the lever may be longer than that shown, and some form of quadrant plate attached to the throttle cover will be helpful. The form shown is suitable for use where control rods are fitted to enable the engine to be controlled from some remote point, and a pivot-pin or ball-socket joint may be fitted to the small end of the lever for this purpose.

The bore at the large end of the lever should be a fairly tight fit on the shank of the barrel before splitting, so that the minimum distortion takes place in clamping up. Fit the clamping

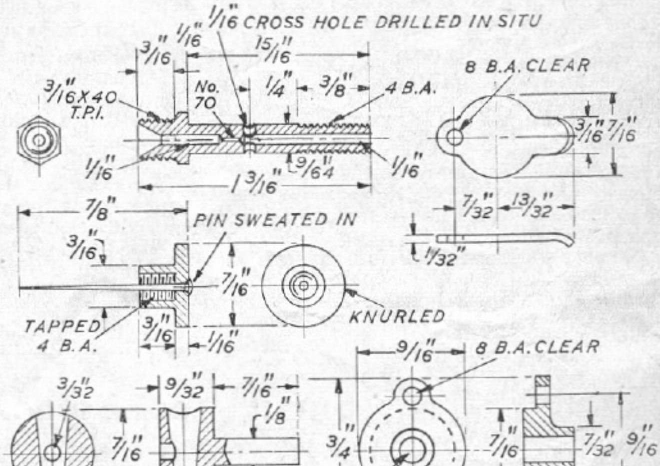


Fig. 38. Group of carburettor components

screw as close as possible to the shank, even to the extent of having to groove the latter to get it in, as this ensures maximum security of grip.

It will be noted that no means of limiting the throttle movement, or fitting a slow-running stop, are provided. The main reason for this is that it is desired to allow for fitting the lever in any position, for either vertical, horizontal or oblique motion of the control rod. In view of the small dimensions of the parts, a slow-running stop would be a rather finicky fitting, not only to make, but also to handle. If desired, pins may be fitted to the barrel cover in appropriate positions to limit the opening and closing movement of the lever, and one of these might be made eccentric to allow of slow running adjustment. Another method of providing an adjustable stop is to fit a screw horizontally through the side of the passage so that it abuts against the top edge of the barrel aperture, as in the " Kiwi " carburettor.

It should be noted that in the form shown, the throttle will close by turning in either direction; but should the axis of the barrel not coincide with that of the air passage, or any other deviation from symmetry be introduced, the compensation characteristics will not be the same for both directions, so it is best to legislate for one-way traffic only. A convenient method of operating the throttle, when a full control system is not fitted, is to fit a screwed vertical rod, passing through a hole in a bracket attached to the top of the manifold, and having a knurled adjusting nut and return spring. The slow-running stop could then consist of a couple of lock-nuts, adjusted to the required position on the rod and locked.

The strangler is simply a flat plate of brass or duralumin, filed to the shape shown, and attached by means of an 8-B.A. steel screw with a spring-washer to act as a friction pivot-joint. Tap the screw hole with a taper-tap, in such a way that the screw will fit tightly on the thread without compressing the washer hard up against the plate. A slight bend of the lug on the plate will assist operating it.

When the carburettor is first fitted, it should be adjusted to give the best results with the throttle wide open, and the engine running under load. Next try closing the throttle and note carefully whether the mixture gets weaker or richer. If the former is the case, the area of the discharge end of the throttle barrel should be increased relative to the intake end, by reamering out the bore of the passage with the barrel in position. If, however, the mixture tends to become richer as the throttle is closed, the intake end of the barrel should be opened out, or a vee-notch filed on the closing side; the latter is usually the best method of getting a fine adjustment of mixture at the lower end of the speed range. Some enrichment of the mixture is absolutely necessary to obtain good idling at low speed, but the engine should never " hunt " or " eight-stroke."

In order to be certain which side the error is on, if one is not certain, the jet-screw may be readjusted, for experimental purposes only, at various throttle positions, when it will easily be found whether it requires to be opened or closed to produce the best running results. It should never be necessary to alter the jet to suit varying throttle positions, once the proper proportions of the air passages have been arrived at. If the carburettor fails to give proper speed control on the throttle lever only, do not blame the design—blame your own lack of skill or patience in arriving at its initial adjustment.

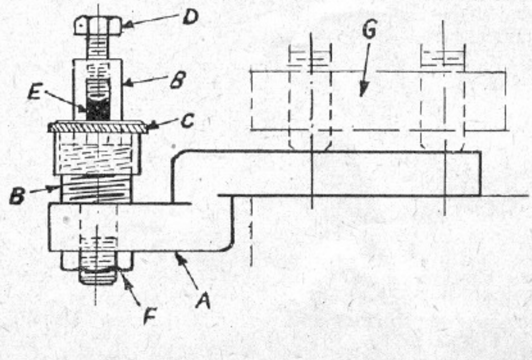
Sometimes it is found difficult to ensure easy starting with fixed jet settings, even when a strangler is used, due to the reluctance of the cold fuel to flow through the jet, especially if the latter is fairly high above the tank level. In such cases, it is permissible to open the jet temporarily for the first few seconds of run, while warming the engine up. An alternative method is the somewhat undignified but highly effective dodge of giving the fuel an initial lift by blowing down the air vent of the tank filler-cap.

(To be continued.)

Small Tool-Holders

THE article by Mr. Hall Bramley on a double tool holder, in the February 6th, issue was very interesting, but it does not appear to be generally known, that a small lantern-type tool-post fixed on the end of a cranked bar, will be found a most valuable appliance, enabling instrument turning to be done on a big lathe, with complete facility of adjustment of small cutters, and no messing about with packing-pieces.

I give a sketch and description and those who have occasional delicate jobs to do on a lathe will find this tool of assistance.



The principle may, of course, be extended, by making a rising barrel to sit on the slide-rest itself, with a slotted tool-post, this gives perfect height adjustment, and a curved pad or wedge will tilt to give an adjustment for rake as well.

Details of the tool-holder are: A— Cranked bar forming base of the tool-holder; BB—The screwed barrel and tool-post in one piece; C—The adjustable collar; D—The clamping bolt; E—The tool for turning or boring, etc.; F—Nut holding B to A, by loosening this the tool may be made to stand at any angle to the cranked bar, A; G—The clamp on the top slide of the lathe.

—H. H. McHALL.