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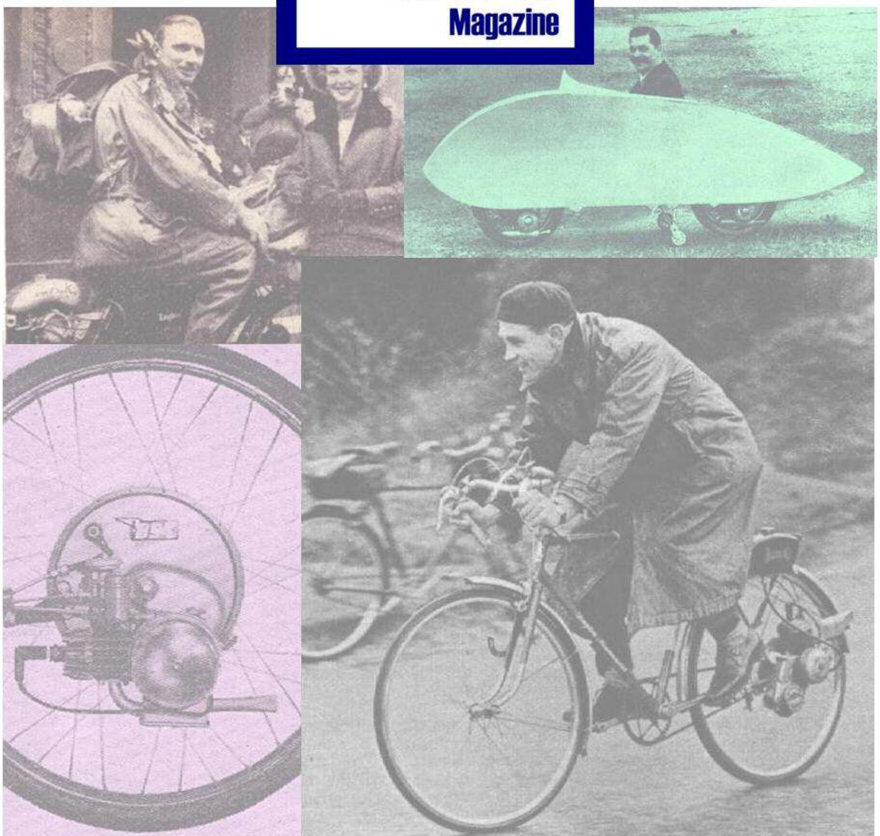

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A Carburettor for the "Busy Bee"

by Edgar T. Westbury

AT the conclusion of the articles on the "Busy Bee" 50 c.c. auxiliary engine, I informed readers that a special carburettor and magneto for this engine were in course of development, and would be described in due course. Since then, I have had many reminders of this promise from readers, and now that the engine has had time to become fully established as a practical proposition, both in respect of its facility for construction in the home workshop, and its successful performance when completed, I feel that the time is right to follow it up with the accessories referred to. In the opinion of some readers, the engine design is indeed incomplete without them, and I am in agreement with them to a certain degree, but the use of accessory components already available ready-made was recommended as a temporary measure, first of all to save time in the development of the engine design as such, and secondly, to reduce the amount of work which must necessarily be undertaken by constructors, some of whom might have considered the work involved in the accessories more difficult and tedious than that in the engine itself.

Almost a Swarm!

Incidentally, it may be mentioned that there are now quite a number of "Busy Bees" performing quite successfully on the road—to say nothing of those which have been or are being adapted to other purposes, including lawn mowers and even outboard marine motors. I have just heard of one which has been successfully employed as the power unit of a passenger-hauling locomotive—a fact which will probably horrify the "live steam" fraternity, but I understand that the constructor is quite regardless of the enormity of his crime, and is feeling very pleased with the results obtained. There have been a few instances where constructors have run into difficulties or failed to get the performance expected, but this has usually been due to some cause which was easily detectable, and mostly capable of correction, except where some major deviation from the design has been made. One constructor was rather disappointed, because I could not guarantee that the "Busy Bee" would provide adequate power for a tandem *plus* a sidecar for baby! (There ought to be a Society for the Prevention of Cruelty to Small Engines!)

To revert to the subject of our present discourse, a good deal of experimental work has been done on both the carburettor and the magneto, and both have given excellent results; what is more important, their constructional design has been arranged so that they will present no formidable difficulties to anyone capable of building the engine itself. So far as the carburettor is concerned, the supply of material for construction involves no serious problems, but in the case of the magneto, there is at present difficulty in the supply of suitable magnets, and the success of this item, from the constructor's point of view, will depend on whether the deficiency can be surmounted.

Carburettor Design

As readers are probably aware, I have designed quite a number of carburettors for small engines in the past, most of which have been described in THE MODEL ENGINEER, and detailed prints for their construction are available. I have often observed that any carburettor which gives really good results on a small engine will work at least as well on a larger one, and therefore any of these designs can be adapted to work on the "Busy Bee" engine. But the present design is of the type which may be considered "orthodox" for such engines, as it follows the established practice for motor-cycle carburettors, and employs the standard method of control by Bowden cable. It is not a copy, or even a near-copy, of any existing commercially-made carburettor, but does not involve any original principles of operation (indeed, it would be difficult to find any) and such differences of detail which it incorporates are intended mainly to simplify home construction and make it adaptable to any engines of the approximate size specified.

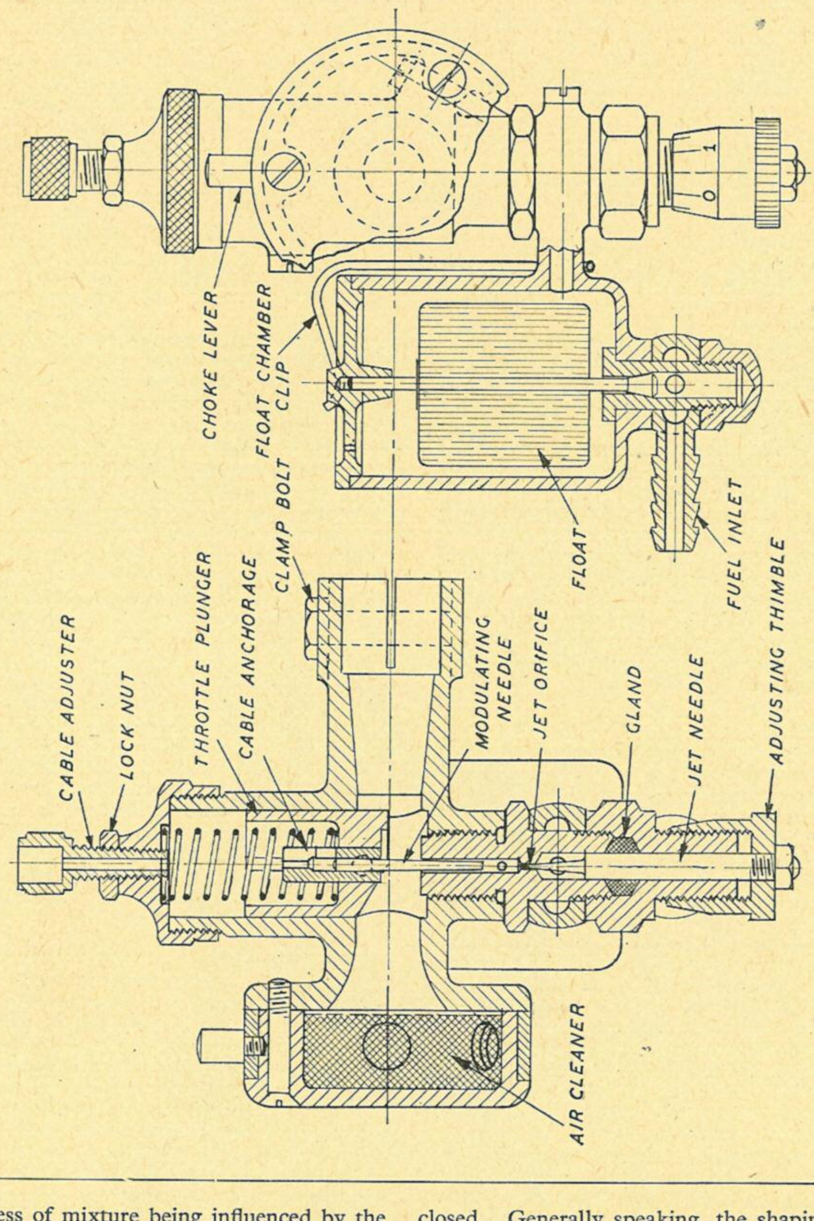
As will be seen from the drawings, the carburettor is of the straight-through horizontal type, with a vertical plunger throttle; and here it may be mentioned that although a few degrees deviation from this position is permissible, any drastic alteration in this respect would require redesign of the jet and fuel feed system. A normal float feed is employed, with a direct-acting float-valve, and the float chamber is connected to the body by a swivel union or "banjo" so that it can be set on either side, or swung through a limited angle, to suit convenience of installation; the fuel inlet to the float chamber is similarly arranged. The actual metering orifice to the jet is submerged, and is, under normal working conditions, constant after being adjusted to the conditions of running; in other words, "pre-set," but it may be made as a fixed calibrated orifice if preferred. The throttle plunger is cut away at an angle on the intake side to modify the depression in the region of the jet, and also has a modulating needle attached, which moves in the upper part of the jet tube, and influences the depression at the actual jet orifice.

A simple form of air cleaner is fitted to the air intake, incorporating a shutter or choke which is used only to assist starting from cold—it is definitely not intended as a running control.

The filter medium is a pad of steel wool, which is kept damped with oil, and is held in position by a disc of coarse gauze.

Compensation

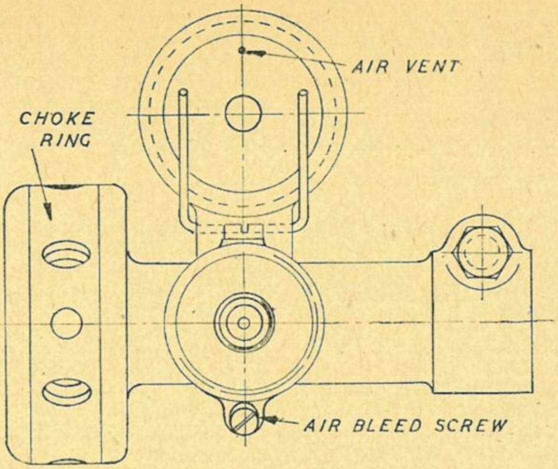
In common with most carburettors in this class, the compensation is mainly mechanical, the richness of mixture being influenced by the shape of the throttle plunger and the capillary annulus around the modulating needle. If the end of the plunger were cut off dead square, the mixture would tend to become weaker as the throttle was opened, due to the decrease in the air velocity over the mouth of the jet tube. On the other hand, if the plunger were made with no controlling edge on the intake side at all, the reverse would apply, as the velocity over the jet tube would decrease as the throttle was closed. Generally speaking, the shaping of the cutaway on the intake side of the throttle affects most strongly the acceleration range, but if relied upon entirely, tends to lose its influence



Side and end elevations of "Busy Bee" carburettor at the wider throttle openings, and, therefore, the modern tendency is to supplement it with a needle which works either directly in the jet orifice, or in a diffuser tube above the jet.

A very serious objection to attempting direct control of the jet orifice by a moving needle is that it is violent or critical; also, that very slight wear of the needle would make an enormous proportional difference in the area of the orifice. In a small carburettor, the needle would have to be so fine, and its contour so exact, that it would be very easily deranged. But a further disadvantage is that it makes the compensation entirely dependent on mechanical moving parts, and loses the most important virtue of the submerged jet.

The use of a larger and more robust needle in the extension of the jet tube gives considerably more latitude in adjustment; the taper is more readily measured and, if necessary, corrected, while the effect of any wear which may take place is less in proportion to the area of the controlled annulus. In some cases, it is found practicable to use a needle with no taper at all, its effect being obtained by varying the length of the capillary annulus around the needle, and consequent variation of jet friction.



Plan view of carburettor

"Air Bleed"

Further control of compensation, in this case independent of the position of the moving parts, can also be obtained by means of an "air bleed" to the jet tube. This consists of a device for admitting a small and controlled amount of air just above the metering orifice, in such a way that it reduces the depression in the jet tube, and thereby influences the amount of fuel discharged. It thereby rectifies the most serious limitation of the mechanically-compensated carburettor, namely its inability to allow for any changes of speed apart from those due to throttle control. For instance, a cycle running under power on a level road will obviously attain a higher speed than when climbing a hill, for a given throttle opening (it is assumed that the gear ratio is unchanged). With mechanical compensation, this would result in weakening of the mixture under the increased load, an obviously undesirable feature; but with the provision of the air bleed, the reduction in engine speed results in less air being drawn into the diffuser tube, and as the jet is submerged, it tends to be fed at a constant rate by gravity, so that the strength of the mixture is kept up, or can even be increased if this is considered desirable. Yet another advantage of the air bleed is that the small amount of air drawn over the jet orifice assists atomisation, and tends to promote efficient combustion and fuel economy.

The use of an air bleed in some form or other, or at least an equivalent load-compensation device is practically universal in modern automobile carburettors, but not always with full effect in motor-cycle carburettors. I have used it effectively in many of the devices I have described in the past, including the "Atom" and "Apex" carburettors, so I have no doubts as to its virtues in the present case.

The Variable Jet

Opinions are widely divided as to the merits of this device, which is often a great temptation to meddling fingers, and for this reason, has long been discarded by nearly all commercial carburettor manufacturers. But I think that all intelligent users of engines will agree that sizes of fixed jets are very difficult to assess properly, even in engines which are apparently all made to the same specification, and that some means of adjusting the jet orifice is often desirable. Model engineers are, as I hope and believe, sufficiently intelligent to know how to use such an adjustment with discretion; most of them have experience with tiny engines in which the only "control" worth mentioning is the jet needle. In any case, however, the variable jet specified for this carburettor is purely an optional feature, and a fixed jet may be fitted if preferred, or the arrangement modified so that the jet needle can be completely enclosed and sealed off from possible risk of interference when once adjusted.

A Useful Device

Alternatively, it may be mentioned that it is possible to fit a variable jet similar to this on existing carburettors, and in the development of the "Busy Bee" engine I found such a device extremely useful. During the running-in period, it is nearly always found that an engine calls for a comparatively large jet, particularly if oil is used liberally (as it should be), and when the engine has settled down and is running freely, the jet size can be considerably reduced. Any experiments with different oil-fuel ratios, or different makes of oil, will, however, call for slight readjustment of the jet, and so will varying climatic conditions, if the optimum performance is to be obtained from the engine.

Personally, I would not on any account be without some means of altering the jet adjustment without recourse to the use of tools and fitting of spares. This may be because I belong to an older generation of motor cyclists who were brought up on the good old "two-lever" carburettor, on which the mixture had to be adjusted to suit loads and speeds as one went along. Despite the disadvantages of this primitive device, which apart from its inconvenience, might well become a menace in modern traffic conditions, when one's full attention must be concentrated on driving, it did at least teach us the vital importance of having the mixture exactly right for the running conditions.

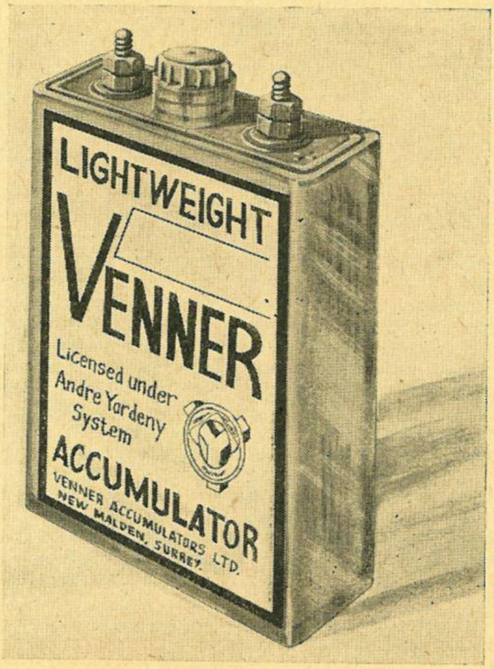
I have made the jet adjustment thimble similar to that of a micrometer, so that it is possible to provide easily legible graduations and figures; the divisions are, of course, purely arbitrary, but they provide a means of showing how much the jet orifice is opened and enable the adjustment to be returned to *status quo* after alteration, if need be. As the jet needle is below the fuel orifice, a packing gland must be provided to prevent leakage; this is of a simple type with no means of adjustment, as the amount of needle movement is so small that wear of packing is negligible.

(To be continued)

Venner Lightweight Alkaline Accumulators

SOME three or four years ago, a new type of alkaline storage battery was introduced by Messrs. Venner Accumulators Ltd., Kingston By-pass, New Malden, Surrey. These are of the silver-zinc couple type, using an alkaline electrolyte, as first developed in France by M. Henri André, and their special feature is their high capacity in relation to bulk and weight, which is achieved without sacrifice of durability or other desirable practical features. This renders them particularly well suited to many purposes within the sphere of model engineering, where space and weight are invariably restricted.

These accumulators are made in a wide variety of sizes and types, from 12 V, 40 A.h., weighing 13 lb. 2 oz. down to 1.5 V, 0.5 A.h., weighing ⅝ oz. The voltage per cell is in all cases 1.5 under normal discharge, and a notable feature is the constancy of voltage maintained throughout the discharge period. The cells are capable of being charged and discharged over a number of cycles comparable with, or even in excess of, that of the best types of lead-acid accumulators, and exceptionally high rates of discharge are possible without damage to the active elements.



We have conducted a long and very thorough series of tests with Venner accumulators, including the Type M (1.5 V, 5 A.h.) which measures 2 5/16 in. high, 2 1/16 in. wide and 13/16 in. thick, weighing 4 oz., and the Type D (1.5 V, 1 A.h.), which measures 2 in. high, 1⅛ in. wide and ⅝ in. thick, weighing 1 oz. These cells have behaved well, and have shown no signs of deterioration either in use, or when laid by for considerable periods without attention. Two of the Type D cells have given very good results in providing current for the ignition of a small petrol engine, which is usually regarded as one of the most arduous duties for a small battery. Charging can be carried out with an ordinary trickle charger, preferably at from ten to twenty hours rate, but if necessary much higher charging rates are possible with suitable voltage control. The cells are fully charged when the voltage reaches 2.1, but on discharge this drops rapidly to 1.5, continuing at this level until almost completely discharged.

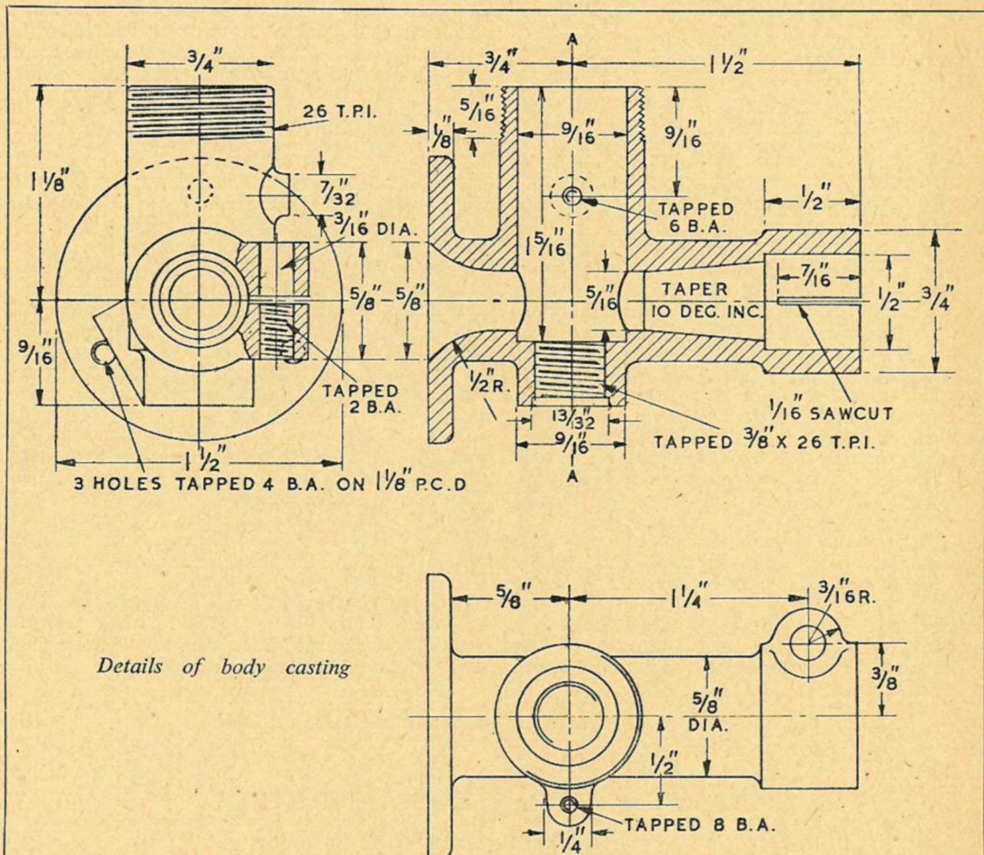
It should be remembered that these cells, in common with all alkaline types, are allergic to acid, and only the pure electrolyte supplied by the makers should be used, evaporation losses being made up by the addition of distilled water to a level slightly below the top of the plates.

An attractive illustrated brochure describing the full range of these accumulators, with examples of discharge curves and other data, has recently been issued, and can be obtained from the manufacturers.

★A Carburettor for the "Busy Bee"

by Edgar T. Westbury

IN the construction of the carburettor, three light alloy castings are specified : namely, the body, float chamber, and air cleaner cover. These are of a simple nature, and it is hoped that they will in due course be available to readers absolutely necessary. The body was made from a four-way duralumin pipe union, obtâined from the surplus market, and some of the other parts improvised from similar odds and ends. While this is quite a sound procedure in experimental



Details of body casting

through approved trade channels ; but alternatively, they could be fabricated or machined from the solid without much difficulty. The remainder of the parts can be made from stock material, mostly round or hexagonal bar, and there is a good deal of latitude in the choice of metal which can be used.

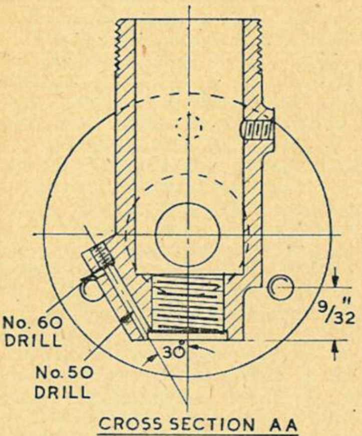
It may be mentioned that in the experimental carburettors, no castings were used, and in view of the probability that more or less extensive modifications might have to be made, no more work was done on the external form than was work, it involves a good deal more tinkering and scheming than is desirable in working to a more or less finalised design, and the finished appearance is somewhat crude. In common with my usual practice in these matters, the crude prototypes have been used as a basis for a cleaned-up design, in which neatness of form, and economy in machining and fitting, have both been given due attention.

Body

The casting for this may be held by the discharge end in the four-jaw chuck for the initial machining operation. It should be set to run

★*Continued from page* 9 " *M.E.*" *July 3rd,* 1952

true over the neck behind the clamp lug, and also that adjacent to the intake flange, preliminary to facing the flange, turning its outward edge, and drilling through the centre. The bore should be finished $\frac{5}{16}$ in. dia., and the flare may be formed by first using a 60 deg. countersink,

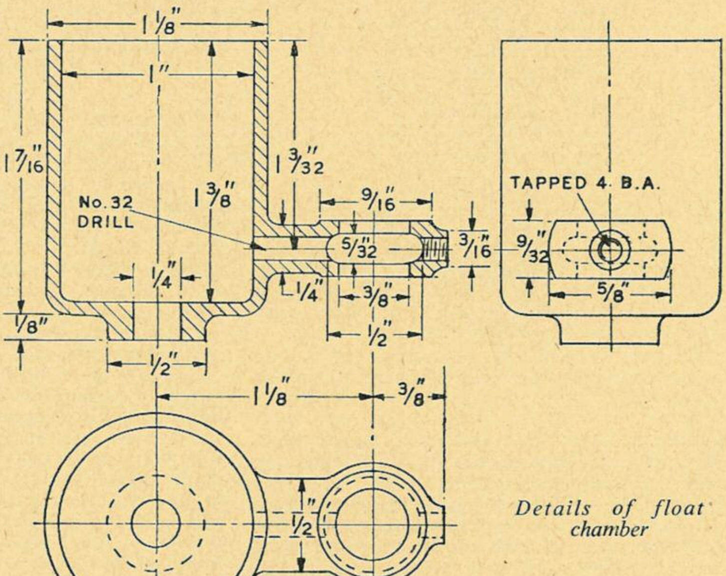


Cross section of body, showing air bleed passage

such as a large centre-drill, and then fairing out with a hand tool or half-round scraper. It is not necessary to split hairs about the exact radius of the flare, but it should give a good sweep, and blend nicely into the parallel bore, which should also be as smooth as possible.

To those who may be tempted to enlarge the bore of the passage, in the hope that it will improve the engine performance, my advice is—try it out first; it is much easier to enlarge the bore, *should it be found desirable*, than to make it smaller. The assumption that an engine will run faster if the intake area is increased does not always work out in practice; but even if it does, it is nearly always at the expense of flexibility or low-speed pulling power. There is an old story about an efficiency expert who saw a shepherd driving a large flock of sheep through a small opening in the pen, and suggested that if the opening were made twice as large, he would be able to get twice as many sheep through. "Ay, mister," was the reply, "but I ha'int got twice as many sheep!" Actually, the observer had missed the point of the narrow opening, which was to enable the sheep to be counted as they went through. Similarly, the object of restricting the throat diameter of a carburettor is often misunderstood; it is to ensure that under *all* conditions of working, the air velocity is sufficiently high to atomise and mix the fuel with the air, and if the passage is well designed, the throttling effect of the reduced bore is very much less than might be supposed.

The casting may now be reversed, and held over the intake flange in the internally-stepped jaws of the chuck, being set so that the bore runs as truly as possible, for counterboring the socket and tapering out the discharge end of the passage. It may be noted here that the clamp for securing the carburettor to the induction pipe is formed in the solid casting, instead of being made as a separate encircling collar, as is the usual commercial practice. The latter method, in conjunction with a socket split three or four ways, gives a wider adaptability to enable the fitting to grip pipes of slightly varying sizes. But there is no reason why this should be necessary in the present case; if the carburettor is bored to fit the induction pipe properly in the first place, only the merest contraction of the clamp is necessary to

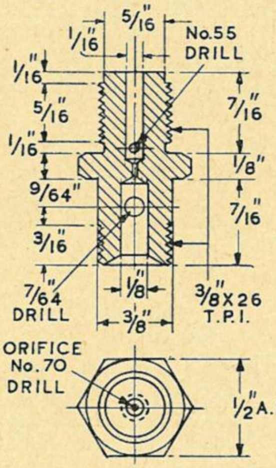


Details of float chamber

secure it immovably, and it is far more likely to produce an airtight joint than if it has to accommodate itself to a pipe three or four thousandths of an inch below specified size.

For machining the plunger barrel, the casting may be clamped to an angle-plate on the faceplate, the intake flange affording a true reference surface, and also a footing for a clamp on each side. Square up the barrel by sighting from a square held against the faceplate, and set it to run truly over the outside. It may then be faced, centre-drilled and bored ; if true drilling can be ensured, a $\frac{5}{16}$-in. drill can be run right through to form the tapping hole in the base. The bore for the plunger should be finished as smoothly as possible, one of the best tools for this purpose being a carefully-honed D-bit, used with paraffin lubricant, and not removing more than two or three " thous." ; this has a slight burnishing effect, which will not only polish the bore, but also work-harden it.

At the same setting, the outside surface at the top end of the barrel can be turned and screw-cut to receive the cap. The base can be machined by making a pin mandrel, a wringing fit for the bore of the barrel. After facing the end, the tapping hole is skimmed out to slightly under 11/32 in., and counterbored 13/32 in. at the end for a depth of $\frac{1}{16}$ in., then tapped $\frac{3}{8}$ in. by 26 t.p.i.,



Jet housing

or the nearest convenient *fine* thread pitch. (The threads recommended in all cases are standard brass pipe pitches.)

In slitting the clamp lug, take care that the saw-cut does not go right to the bottom of the socket, or a permanent air leak will be produced which may play havoc with good carburation. The air bleed hole is drilled at an angle of 30 deg. to the barrel axis ; this is not critical, but the hole should emerge in the clearance recess of the tapped hole and not encroach too much on the joint face. Note that the top of this hole is plugged with a screw, and a No. 60 hole is drilled in the side to form the entry to the air bleed passage. In this position, the risk of it becoming clogged with dirt is minimised. The three tapped holes for the screws securing the air cleaner can be left for the present, as they can be spotted from those in the latter component.

Float Chamber

This may be held by the base end for facing the top and boring the inside, the base hole being drilled through also at this setting if convenient. It is then reversed, preferably by mounting on a stub, for facing off the base. The casting is then mounted eccentrically on the faceplate for machining the " banjo " ; the top surface forms a convenient mounting surface, and it may be securely held by a single bolt through the centre, or an external bolt and clamp ; in the latter case, care must be taken to avoid bruising the machined base joint face. Set the centre of the banjo to run truly, for facing, centre-drilling, undersize drilling, and boring out. It may be found necessary to make or adapt a special internal recessing tool for chambering out the inside of the banjo. If a cutter bar not larger than $\frac{3}{8}$ in. dia. is available, the top face of the banjo may also be machined at this setting, by passing it through the hole and fitting a left-hand side cutter. This saves re-mounting the work in the reverse position, which is liable to involve some risk of getting the top face out of parallel with the bottom. The cross hole is then drilled through into the float chamber, its outer end being spot-faced and tapped for the plug-screw.

If it is decided to fabricate the float chamber, the method employed in the " Atom " Type R carburettor, namely, the use of a separate banjo, screwed into a thickned boss on the chamber and lock-nutted, will save a good deal of work, and also provide a means of adjusting the angle of the float chamber, if this should be desirable.

Jet Housing

This is preferably made from hexagonal brass bar, but round bar may be substituted, if flats are formed for screwing it up. The upper end should be machined first, and the $\frac{1}{16}$ in. hole drilled, with care to ensure that it is true, and the thread, which should either be screwcut or screwed with a tailstock dieholder, should on no account be a slack fit in the base of the body.

Note the undercut at the shoulder, which is most important, not only to ensure that the component goes fully home, but also to give a free air passage for the air bleed to the cross hole immediately above the orifice.

The lower end may be machined by holding it in a tapped nut or odd piece of stock, to ensure truth and freedom from damage. In the absence of any special fine-drilling appliance, the jet orifice can be drilled quite easily by holding the drill in a small pin-chuck and applying it *by hand* while the lathe is running at top speed. The exact size of the hole is not of critical importance, and if no suitable twist drill is available, it is possible to make one from a sewing needle by a little patient honing, and the aid of a magnifying lens.

For the benefit of those who wish to use a plain jet, or a type of variable jet which is not externally accessible, I propose later to describe modifications to this and other minor components, but the type shown conforms to the assembly shown in the general arrangement drawings.

(*To be continued*)

*A Carburettor for the "Busy Bee"

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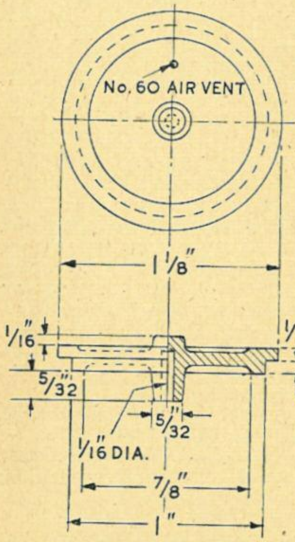
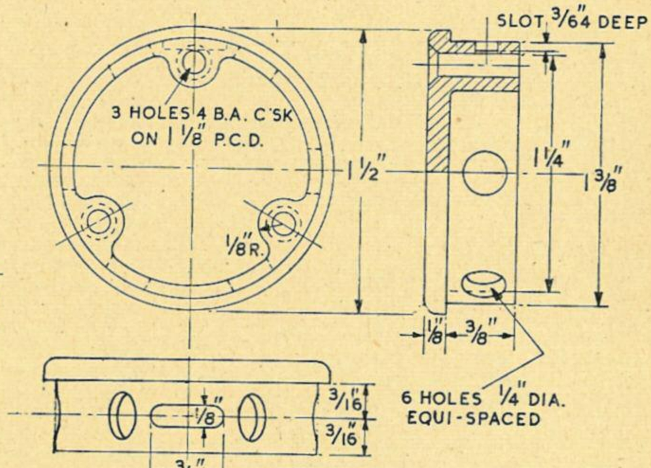
THE float chamber cover may be machined from a piece of aluminium alloy bar large enough to clean up to 1⅛ in. outside diameter, and all the work on the underside surfaces may be carried out at one setting, prior to parting off. It will be seen that the $\frac{1}{16}$-in. hole which forms the central guide for the float needle does not

Air Cleaner Cover

This is specified as a casting, but could be machined from alloy bar without much difficulty, the best method of shaping the inside to leave the three lugs for the fixing-screws being to bore out to maximum permissible clear size, which is ⅞ in. diameter, and then end-mill out the un-



FLOAT CHAMBER COVER
1 OFF L/ALLOY



AIR CLEANER COVER
1 OFF L/ALLOY

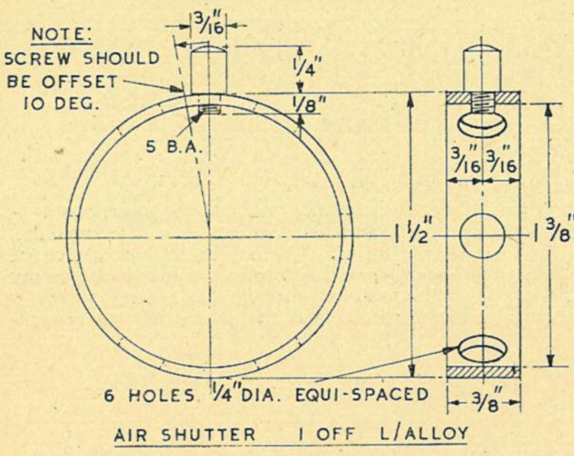
pass right through the cover; this is optional, but the object of making the hole "blind" is to deter users from the common practice of flooding the carburettor to assist engine starting, which is not only unnecessary, but also messy and wasteful. After drilling the hole, it should be burnished out with a piece of steel rod, such as a knitting needle, a little larger than the diameter of the float-needle, to ensure that the latter is quite an easy fit and works smoothly in the hole. The spigot of the cover should not be made too tight a fit in the bore of the float chamber; in cases where it becomes necessary to remove the cover, it is very irritating to have to use tools to prise it out, and quite unnecessary from the practical aspect. After parting off, the disc may be held lightly in the chuck, over the spigot, for facing and recessing the top surface. All that remains then to complete this component is to drill the small hole which serves as an air vent to the float chamber.

*Continued from page 84, "M.E.," July 17, 1952.

wanted material between the lugs; some method of indexing and partially rotating the work, such as a worm dividing appliance, is very helpful in this operation.

If, however, a casting is available, it is only necessary to chuck it by the rim, for facing the front surface, turning the outside and the face of the rim, at one setting. It may then be reversed in the chuck, a strip of copper or aluminium being used between the work and the chuck jaws, to prevent marking the finished surface, for cleaning up the outer face and the rim, the edge being rounded off as shown.

The three screw holes should be marked off on the inner face, at 120 deg., and coinciding as closely as possible with the centres of the lugs. After drilling, they are countersunk from the other side to take 4-B.A. screws, flush with the surface. The cover may then be clamped to the intake face of the body by a couple of small toolmaker's clamps, located as concentrically as possible (this can be checked by spinning the body in the lathe with the cover clamped in place) and the tapping holes in the intake flange



spotted through the clearance holes. In case of any inaccuracy in the spacing of the latter, mark the cover to show which way up.

It is advisable to leave the drilling of the air apertures and milling the limit slot in the periphery of the cover, till the air shutter has been made, as these are best located from corresponding points on the latter.

Air Shutter

This is simply a ring of aluminium alloy made to fit over the air cleaner cover in such a way as to enable the air inlet apertures to be partially or completely closed when necessary. In the experimental stages, a band of strip metal, bent at the ends to form lugs to take a fixing screw, was used, and served its purpose fairly well, but was crude and unsightly. It is better to turn a ring from solid alloy bar or tube, as shown ; this should be made a fairly tight push-fit on the outside of the cover, and its width arranged to just allow working clearance when the latter is fixed to the intake flange.

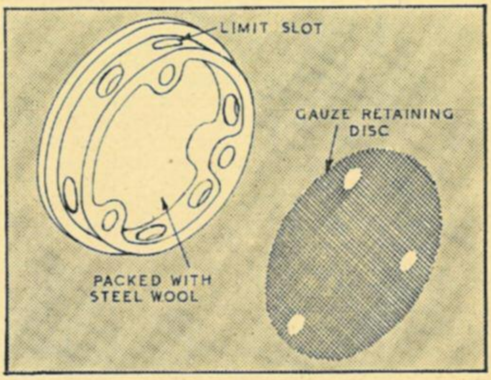
The six air apertures should be marked out on the ring, and it may then be fitted to the cover for drilling pilot holes only through both parts. If an attempt is made to drill the ¼-in. holes right away, there will probably be a good deal of snatching, and a burr will be thrown up which may jam the ring immovably, or at best cause bad scoring of one or both parts when it is removed. The ring should be detached for opening out the holes, and the best tool for this job is a piloted cutter or "pin drill," which will cut smoothly and cleanly, and produce a round hole—neither of which can be guaranteed if a twist drill is used. All burrs should then be removed from both parts.

A hole should then be drilled between the two uppermost holes in the ring and tapped 5 B.A. or ⅛-in. Whitworth, to take a special screw which forms both an operating handle and a limit stop. Although this screw is shown, for convenience, midway between two holes, it should actually be displaced about 10 degrees to one side to give the required range of movement. It will be seen that this projects through the ring, and a slot is formed in the air cleaner to allow just the right amount of movement to open or close the apertures. The ring should first be placed in position with the holes fully open, and a scriber used to mark through the tapped hole ; it is then shifted to the closed position and another similar mark made. This will define the required width of the slot ; if it is not convenient to mill the slot, ⅛-in. holes may be drilled at these points, and intermediately, and a small cross-cut chisel used to join them up.

Air Intake Design

It may here be advisable to give the reason why the air apertures are disposed radially around the air cleaner, instead of in the end face, as is much more common, and would appear to be more logical, as it conforms with the direction of air flow. This again, is an optional feature, but it is not done simply with the object of doing something "different." Most readers have, no doubt, heard the term "position errors," which is most commonly applied to clocks and watches, and refers to the influence of gravity on the time-keeping qualities of the movement, when it is placed in different positions. Great care and ingenuity is exercised by the makers of high-class movements to avoid or cancel out these errors. Quite so, say you—but what has this got to do with the design of carburettors ?

The fact is that "position errors" can occur in this case also, and apart from the influence of gravity, which is, or should be, looked after by the float chamber, the other disturbing factor is the direction of natural or incidental air flow in the region of the carburettor. In this particular case, one cannot guarantee that the latter will always be fitted in one position relative to the direction of movement of the cycle or other vehicle to which the engine is fitted, or predict the precise effect of eddy currents around it. If one examines a number of motor cycle engines,



Air intake cover and gauze disc for retaining the steel wool filter element it will usually be found that the carburettor position most favoured is with the air intake facing towards the rear. This may seem all wrong to many who study the theoretical aspect of design, and one of the most common (and fallacious) ideas for improving performance is to fit a large forward-facing scoop to the air intake, to utilise the forward movement of the vehicle in producing a "supercharging" effect. The reason why this usually fails is that the increase of air pressure obtained in this way, though too small in relation to induction pipe depression to influence performance to any marked extent, is subject to considerable fluctuation, often sufficient to upset the delicate balance of carburation on which efficient performance primarily depends. The effect can only be usefully employed when a considerable, and fairly dependable, airspeed is available, as in aircraft, and even then more or less elaborate air pressure balancing devices must be fitted to the carburettor.

Gusts play Havoc

In very small engines, the effect of gusts or eddies can play havoc with carburation (ask any of the speed boat enthusiasts !) and it becomes a matter of primary importance to eliminate or reduce them wherever possible. By placing the air inlets at right-angles to the direction of air flow through the main air passage, it is possible to ensure that, no matter where this is located relative to natural external air currents, the average intake air pressure remains substantially constant. The effect is much the same as the "static" element of a pitot tube, as used to measure airspeed. A common method of obtaining much the same effect is the air baffle or cowl fitted to many types of carburettors to modify or reverse the direction of air flow at the intake. No claim is made that anything original has been done in this particular design of intake, but I think that many readers, like myself, are interested in the "whys and wherefores" of the subject.

Filter Element

To complete the air cleaner, it may be fitted with the filter pad, which consists of a wad of steel wool, as used in domestic practice for cleaning culinary ware. A sufficient quantity is taken to fill the space in the cover fairly tightly (but not so that it must be rammed in by brute force), and this is rolled in the palms of the hands to coalesce the loose strands which might otherwise get in the apertures and jam the air shutter. The wad is held in place by a disc of coarse gauze or perforated metal, having holes punched in it to take the fixing-screws, and trimmed on the outside, flush with the edge of the intake flange.

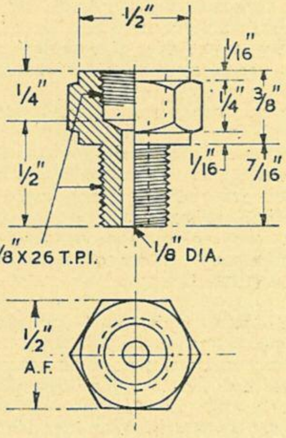
It will not be necessary in the case of a two-stroke engine with petroil lubrication to damp the filter with oil, as the occasional inevitable blowbacks will do this quite effectively ; but an occasional wash out with clean petrol will not only ensure that it is kept in working order, but also provide evidence of the amount of foreign matter which it collects, and which would otherwise find its way into the engine. I have found metal dust, granite chips and glass splinters in the filter, not to mention dead beetles and other unclassified entomological specimens ! The filter should always be fitted during engine tests, as its slight air resistance will modify the suction pressure and thereby influence the jet calibration.

It is, of course, permissible to modify the intake system as required to suit particular conditions of working or installation, such as by the addition of an air trunk to collect warm air from the region of the cylinder or exhaust pipe. Some form of air cleaner, however, is very desirable, to say the least, in any case. There are a number of proprietary air cleaners on the market which could readily be adapted, including *ex*-Service "surplus" types which are very elaborate, and presumably, of proportionate efficiency.

Incidentally, if the air shutter ring tends to work loose, this can be effectively cured by distorting it slightly before assembly so that it has to be sprung over the rim of the cover. This will ensure that there is sufficient friction to prevent inadvertent movement of the shutter.

Gland Housing

This serves both to secure the float-chamber to the jet housing, and also to carry the gland for the jet needle. As in the case of the jet housing, the important thing is to ensure that the threaded parts (in this case both external and internal) are axially true and concentric with each other. The lower end, with its external thread and centre hole, should be machined first, and reversed for facing, counterboring and tapping, being held by



GLAND HOUSING
1 OFF. BRASS

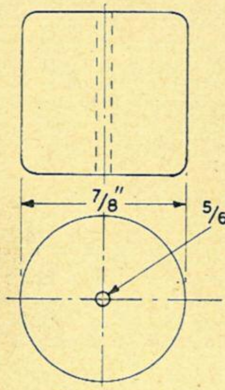
the threaded end in a "screw chuck"—in other words, a piece of stock held in the chuck and drilled and tapped concentrically *in situ*, the first thread or so being bored out to enable the component to screw right home to the shoulder, and thus locate it truly in both planes.

(To be continued)

A Carburettor for the "Busy Bee"

by Edgar T. Westbury

CARBURETTOR floats, in commercial practice, are generally made from two deep pressings in very thin copper or cartridge brass foil, with an equally thin tube through the centre, and a single soldered joint around the outside. Home-made metal floats are generally made with shallow spun endplates, with a lapped and seamed wrapper, to avoid the difficulty of deep drawing or spinning. I have made fairly successful floats by this method, and so have many other constructors ; but they have the obvious disadvantage of introducing *three* soldered joints



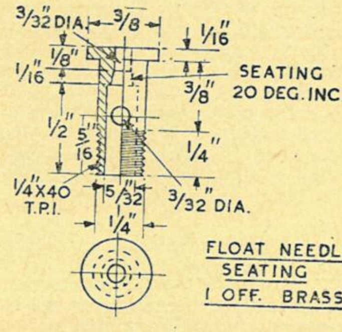
FLOAT 1 OFF
CORK OR BALSA

instead of one (neglecting the central tube), and despite every care to ensure that the minimum of solder is used, the buoyancy of the finished float is usually impaired to some extent. As it is most important that the float should perform its function efficiently, the lightest possible form of construction is essential, and for this reason, I have recommended that it should be made of cork or balsa, the latter being the lighter of the two materials.

In case it should be thought that this is shoddy practice, it may be mentioned that cork floats have been used with success in full-size carburettors, including those of aircraft engines, where reliability is the very first consideration. But, of course, the constructor has the option of making the float in any way, and of any material he chooses.

It is rather difficult to turn cork or balsa accurately to shape, and I have found it best to pare it with a sharp knife or razor blade, well oversize, and hold it in a piece of tube in the lathe chuck for finishing with glasspaper. The drilling of a truly concentric hole through the centre is also a tricky operation, and it will be found advisable to drill from each end, with a drill projecting only just sufficiently from the chuck to go half-way through, and run the lathe at the highest possible speed.

Cork or balsa must be thoroughly proofed with a non-soluble varnish to avoid absorption of fuel, which would impair buoyancy. For use with petrol, cellulose or (shellac) spirit varnish is satisfactory, but alcohol-base or other "fancy" fuels have powerful solvent properties, which present problems in proofing the float. Synthetic or phenol varnishes have, however, been used successfully with these fuels. Before varnishing, a suitable "filler" should be applied to stop the pores of the wood, which is otherwise liable to absorb varnish *ad infinitum* ; two or three coats



FLOAT NEEDLE SEATING
1 OFF. BRASS

of the filler may be found necessary. Don't forget that the bore of the hole must also be proofed ; the hole is drilled slightly oversize so that the thickness of the varnish film is allowed for.

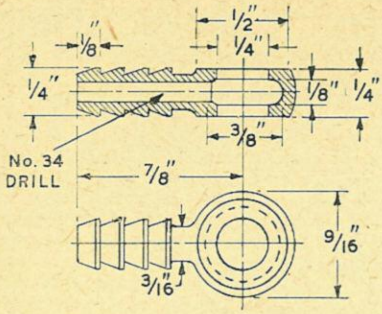
Float Needle Seating

This is turned from brass and is made a tight press fit in the hole in the float chamber base. It can be machined all over at one setting, care being taken to drill and counterbore the centre hole truly. To form the seating, it is advisable to make a small D-bit from silver-steel, with the end turned to an included angle of 20 deg., and filed away to exactly half its diameter. After hardening and tempering, the flat face should be oilstoned dead smooth and keen to ensure that it produces a high finish. The importance of a tight-sealing float valve, and its influence on carburation, cannot be over-estimated.

Fuel Inlet Union

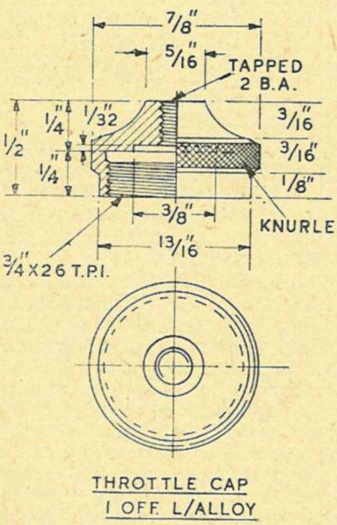
The "banjo" type of union shown here will generally be found most convenient to suit the fuel pipe line, especially where compactness is desired. It is intended to connect to flexible

Continued from page 159, "*M.E.*," *July* 31, 1952.



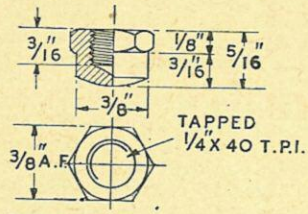
FUEL INLET UNION
1 OFF BRASS

p.v.c. or neoprene tubing, which will give reliable and durable service if properly fitted. To machine this item, I recommend that the serrated end should be turned first and the centre hole drilled to about $\frac{5}{8}$ in. depth. At the same setting, a part of the spherical end may be roughed out, a radius gauge being useful as a guide to its shape. It may then be parted off, and the serrated end held in the chuck for finishing the sphere. The use of a simple ball-turning attachment, such as I have described on previous occasions, is very useful for this job, but as the appearance is all that matters, a hand tool will do the job quite well if the radius gauge is used as a guide to the correct shape. It should, however, be noted that *slovenly* work will be very conspicuous when the cross hole is drilled and faced.



THROTTLE CAP
1 OFF L/ALLOY

For the latter operation, the component can be held at right-angles to its main axis in the three-jaw chuck ; the serrated end will pass between two of the jaws, and should be set parallel with the chuck body. A strip of foil may be used to prevent bruising of the spherical surface. Centre-drill the ball, and take a facing cut before drilling, which should be done by easy stages, as the grip of the chuck is a little precarious, and heavy thrust may cause the work to shift. A small internal recessing tool will be required to chamber out the inside. The other face can



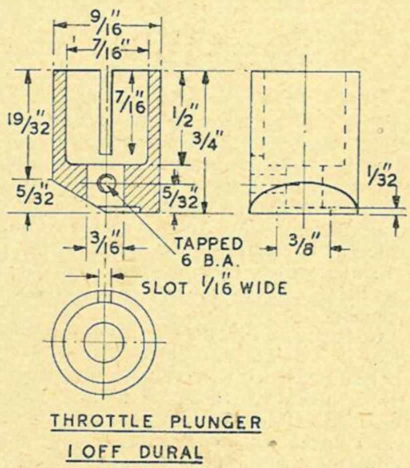
FUEL INLET CAP NUT
1 OFF BRASS

be machined by pressing the work on a pin mandrel. Finally, complete the drilling of the fuel passage.

The fuel inlet cap-nut is a simple item which requires little explanation, being simply a blind nut which holds the banjo in place and seals off the bottom of the seating. It is, however, important that the face should be truly flat and square with the thread, to ensure a tight joint.

Throttle Cap

Brass may be used for this item if a suitable piece of light alloy (preferably dural), is not available. It is screwcut inside to fit the thread on the outside of the barrel, and a recess is formed to locate the throttle spring, also a hole drilled and tapped through the centre to take the cable adjuster. The external machining is mainly a

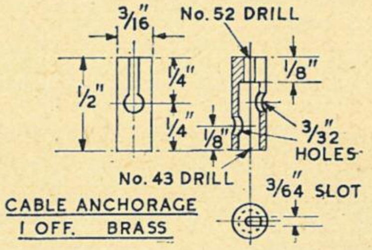


THROTTLE PLUNGER
1 OFF DURAL

matter of appearance, but knurling or serrating of the edge is essential to enable it to be screwed on firmly by hand. All machining can be done at one setting, and the job finally parted off.

Throttle Plunger

If dural is not available, bronze or stainless-steel should be used for this part, as it is the only part liable to any considerable wear; it should definitely be harder than the bore of the barrel. Nearly all the turning on it can be done at one setting; the external surface should be finished to a smooth and not too tight working fit in the barrel, but there should be no perceptible slackness. Before parting off, the $\frac{1}{16}$ in. guide slot may be cut in the side, the work being held by its chucking-piece in the toolpost and a small



CABLE ANCHORAGE
1 OFF. BRASS

slitting saw or Woodruffe cutter used. It would also be possible to shape the cutaway before parting off, and thus avoid the problem of clamping this rather fragile component.

The recess in the base is intended to fit over the top of the jet tube when the plunger is right down, and thus ensure that it cuts off completely at the discharge side. A hole is finally drilled and tapped, on the same line as the guide slot, for the needle clamping grub-screw.

Cable Anchorage

The means of attaching the Bowden cable, and also the modulating needle, to the plunger, differ from those most commonly adopted, and will be found to facilitate assembly and adjustment. The component shown may be made from brass rod, which should be turned to a close push fit in the base of the plunger and truly drilled and counterbored in the centre. Before parting off, the two 3/32-in. holes may be drilled in opposite sides (it is not essential that they should be in exact opposition). The slot may be cut with a small slitting saw; it may be taken below the cross hole if this is found necessary to get a clear cut into the centre hole, but should not pass through the full length of the component, if this can be avoided.

Float, Jet, and Modulating Needles

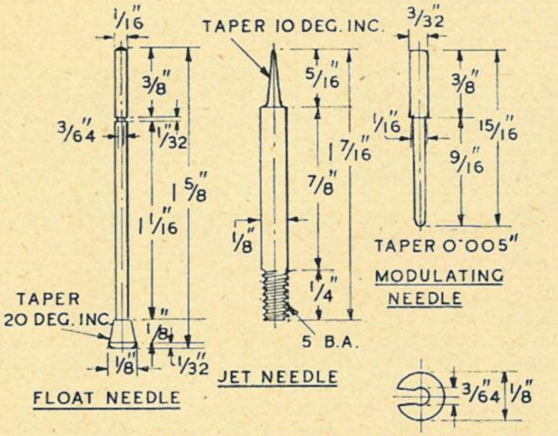
The most suitable material for these is stainless-steel, but this is rather difficult to obtain at present, and the next best substitutes are German-silver or phosphor-bronze. Hard brass, which is definitely inferior, may, however, be the only material available, and will serve its purpose if carefully handled.

The float needle should preferably be made from the solid, but this is a rather difficult operation unless a special running-down cutter or "box tool" is made. As an alternative, however, the head may be made separately, and screwed on; it is best to reverse this order, by turning up the head on a piece of $\frac{1}{8}$-in. rod, drilling and tapping it 10 B.A., and before parting off, screwing in tightly a piece of $\frac{1}{16}$-in. rod. In this way it is possible to verify that the shank of the needle is perfectly straight and runs truly with the head; if not, it is best to start all over again, as the needle will never be really satisfactory if this condition is not fulfilled.

Great care should be taken in finishing the angle of the seating so that little or no subsequent grinding-in is necessary. I find it an advantage to make the surface very slightly convex, by means of a hand tool, after turning as accurately as possible to the specified angle. The groove for the needle clip should not be cut until its correct position has been ascertained, on assembly, so that it allows approximately $\frac{1}{16}$ in. lift of the float.

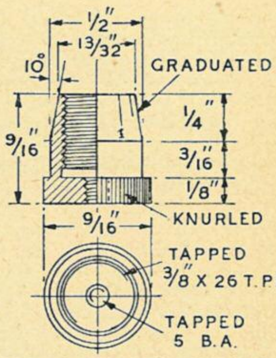
The needle clip is a small washer cut from thin sheet brass, and slotted out so that it can just be forced over the groove of the needle. Incidentally, it is always a problem to devise a satisfactory means of transmitting the float movement to the needle without introducing extra weight. I have devised many different forms of needle clips, all of which work if properly made and

(*Continued on page* 223)



FLOAT NEEDLE JET NEEDLE MODULATING NEEDLE

ENLARGED VIEW OF FLOAT NEEDLE CLIP



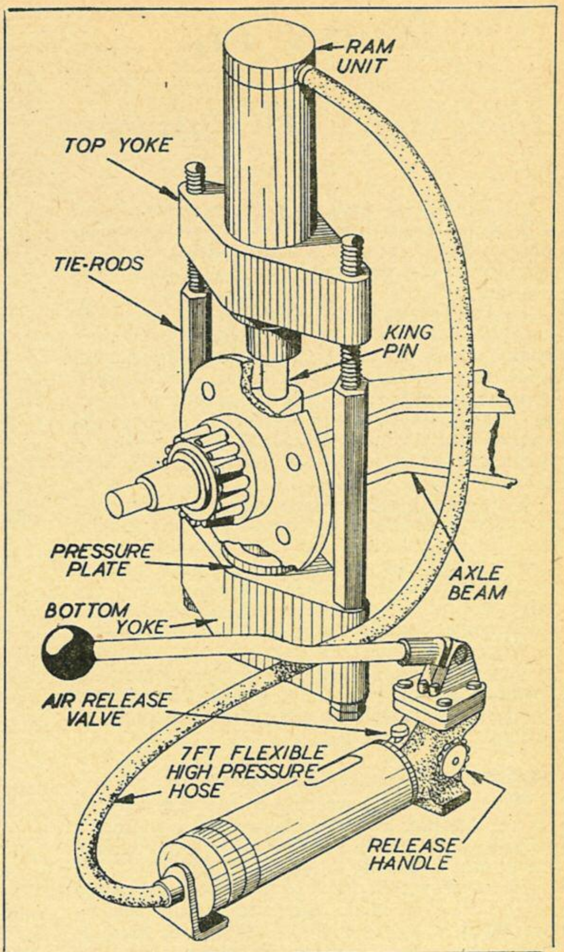
JET ADJUSTING THIMBLE
1 OFF BRASS

of the press is 6 in., and it will admit a maximum length of 12¾ in., with a width, between the tie rods, of 8 in.

Applications

The hand-operated pump can also be applied to a bench press having the same power capacity, or a hydraulic pipe-bending press, as shown in the photograph. The latter appliance employs the ratchet bending principle, the ram being offset, so that it produces a rotary motion of the former, which is made to fit exactly to the diameter of the pipe to be bent, and backed up by a roller with a straight former of similar contour. One complete stroke of the ram produces a bend of 60 deg. arc, and a back-stop pawl is used to prevent the tube springing back while the ram is withdrawn for a further stroke. Bends up to 180 deg. may be thus made, and can be started within 1 in. of the end of the tube. As the distortion or collapse of the tube is prevented by the all-round support of the former, at the point where force is applied, thin-walled tubing can be bent without filling. Compound bends in different planes can also be dealt with quite easily. The machine illustrated has a capacity from 1 in. to 2⅛ in. outside diameter pipe, of 16- to 19-gauge, and formers are available for sizes within these limits, in ⅛ in. increments.

These appliances are manufactured by Chamberlain Industries Ltd., Staffa Works, Leyton, E.10.



Right—A hand-operated hydraulic press removing a front axle king-pin on a lorry

A Carburettor for the "Busy Bee"

(*Continued from page* 221)

fitted, but only too often find that constructors have given up the struggle with them and resorted to the inevitable blob of solder—sometimes heavy enough to sink the float!

The jet needle is made from ⅛-in. rod, which should be chucked *truly* by whatever means is available, first for turning the point, and then in the reverse position for screwing the other end. Accurate chucking is also essential for dealing with the modulating needle; it is a good policy to make two or three of these with slightly varying degrees of taper for tuning purposes, but the necessary modification can be made by filing in the lathe with a dead smooth Swiss file. The end of the needle should always be rounded, or better still, pointed, to facilitate assembly.

Jet Adjusting Thimble

In machining this part, the important thing is to ensure concentric alignment of the internal threads. The larger bore should be flat-ended and undercut or "chambered" so that the maximum effective length of thread can be utilised. The external machining can be carried out at the same setting, also the incising of the graduations, by using a point tool on its side, exactly at centre height, the top-slide being set at the same angle as for turning the external taper. It does not matter how many divisions are used on the index, as they are purely arbitrary, but I suggest that ten or twelve (either obtainable by a 60-tooth index wheel) will be suitable, and they should be numbered. The thimble is screwed on the jet needle, and secured by a lock-nut, so that its initial setting is adjustable, but it may be fixed permanently, as by sweating on, if desired.

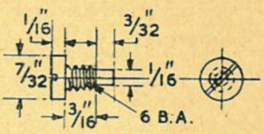
(*To be continued*)

A Carburettor for the "Busy Bee"

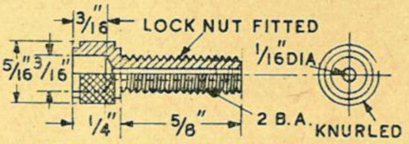
by Edgar T. Westbury

THE remaining components for the carburettor are small, and simple to produce, but not by any means insignificant. In the case of the guide screw for the throttle, it will probably be found just as quick, and certainly far more satisfactory, to make this outright, as to attempt adapting a standard 6-B.A. screw by turning down the end. It should be noted that this screw must be removed for assembling the throttle plunger, which will usually be found easier than having to "feel" for the locating pin or key while inserting the plunger and aligning the jet needle at the same time, as in the majority of motor-cycle carburettors. The screw should not project through the barrel so that the threaded part binds against the throttle plunger, but if this should occur, it can be remedied by putting a spring washer under the head.

The cable adjuster is of standard type, and I believe that it can be obtained ready made, but my experience is that one can make these and similar items much quicker than trying to explain what they are to salesmen who have "never 'eard of 'em!" They are sometimes made with a hexagonal head, and this, of course, is optional, but I have found a knurled head more convenient, the lock-nut, however, being hexagonal to enable it to be properly tightened.



GUIDE SCREW. I OFF M.S.

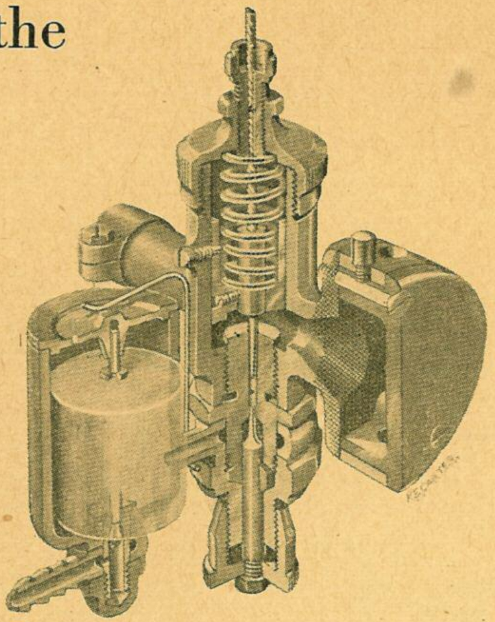


CABLE ADJUSTER. I OFF BRASS

Float Chamber Clip

There are many possible ways of holding on the lid of the float chamber, and all of them have been used more or less successfully in standard carburettors. The wire clip shown is simple to make and quite secure in use, enabling the cover to be removed by springing the ends upwards and outwards, but no claim is made that it is original, or has any special advantages over other devices for this purpose, so this also is optional.

Continued from page 223, "*M.E.*," *August* 14, 1952.



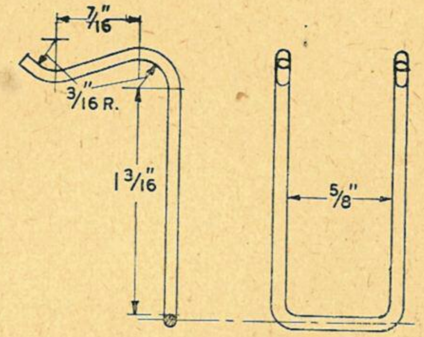
The "Busy Bee" carburettor in part section

Alternative Jet Arrangements

As previously mentioned, constructors who do not wish to adopt the form of variable jet specified can use either a fixed or pre-set jet, as shown in the illustrations herewith. The former uses a standard commercial type of jet, which is screwed 4 B.A., and the lower end of the jet housing is counterbored to take the head. It is important that the end of the counterbore should be flat and true, as any leakage at this seating will affect the jet calibration, and it is not very convenient to fit a washer or other packing to so small a jet. The orifices of these jets are generally calibrated in cubic centimetres per minute under a standard "head" or pressure; the larger the number, therefore, the more fuel they pass. Sizes from about 24 to 30 will usually be found to cover the range required for 50 c.c. two-strokes. If the jets are home-made, the orifices should be drilled from about 0.008 in. to 0.012 in. dia. and broached with a suitable needle broach.

In the second alternative form of jet, the orifice is made as specified, and is also varied with a taper needle, but adjustment is only possible by removing the cap-nut, and once set, is locked by means of a nut on the screwed needle. This cannot, of course, be adjusted while the engine is running, but it may be preferred by users who have friends anxious to help in improving the "tuning" of the engine!

There is little in the assembly that calls for any explanation, as the relative positions of the components are fairly obvious, and there should be no fitting required if they are made to specified dimensions. No allowance has been made for fitting washers or gaskets between any of the joint surfaces, as I have found these more trouble than they are worth, being liable to get lost or



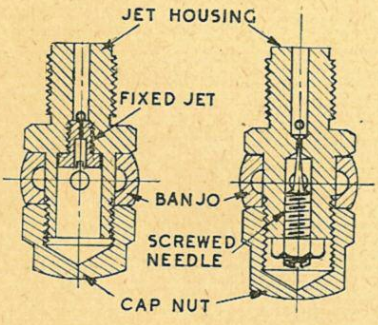
FLOAT CHAMBER CLIP
1 OFF 16 S.W.G. PIANO WIRE

squeezed out, always in circumstances where they are not readily replaceable. It is quite easy to ensure tight metal-to-metal joints, by reasonable care in machining, and using keen tools.

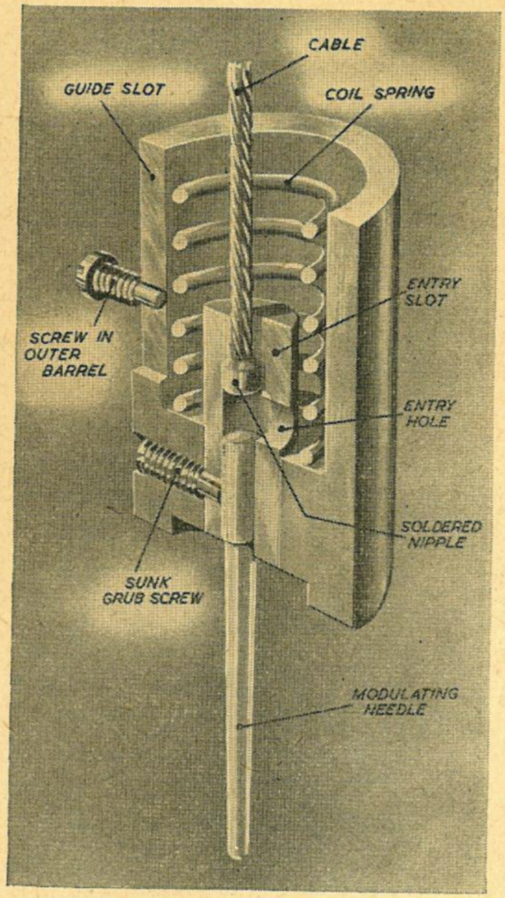
Take the utmost care to ensure that all passageways are perfectly clear before assembly, and syringe drilled passages with petrol to remove the least traces of swarf, metal dust, or fluff, which are capable of causing endless trouble if left in the system. One constructor who complained vehemently about the behaviour of a carburettor of my design, was found to have omitted to drill a small but very essential hole in the air bleed system !

The best way to make the gland packing for the jet needle is to cut a small cork down, by paring and glasspapering, till it can be forced into the top end of the gland housing, and part off about a $\frac{3}{16}$ in. length with a razor blade. Screw the gland housing on to the jet housing just tight enough to clamp the cork, and run a $\frac{1}{8}$-in. drill through the latter. It will now be found that when the gland housing is assembled in place, with the jet needle in position, the packing is perfectly petrol-tight, and will remain so indefinitely. Be careful to remove all the cork dust from the system.

When fitting the carburettor to the inlet stub of the engine, make sure that the latter is smooth and accurate, with the end face machined square, and that it makes contact with the face of the recess in the bore of the carburettor throat when pushed fully home. A smear of joint varnish on these surfaces, and also those of the jet and fuel inlet joints, is helpful as an insurance against leaks, but should not be regarded as an absolute necessity. Remember, however, that an air leak will upset the best-laid schemes of mice and men when it comes to adjusting a carburettor, and take due precautions against it accordingly.



FIXED JET PRE-SET JET

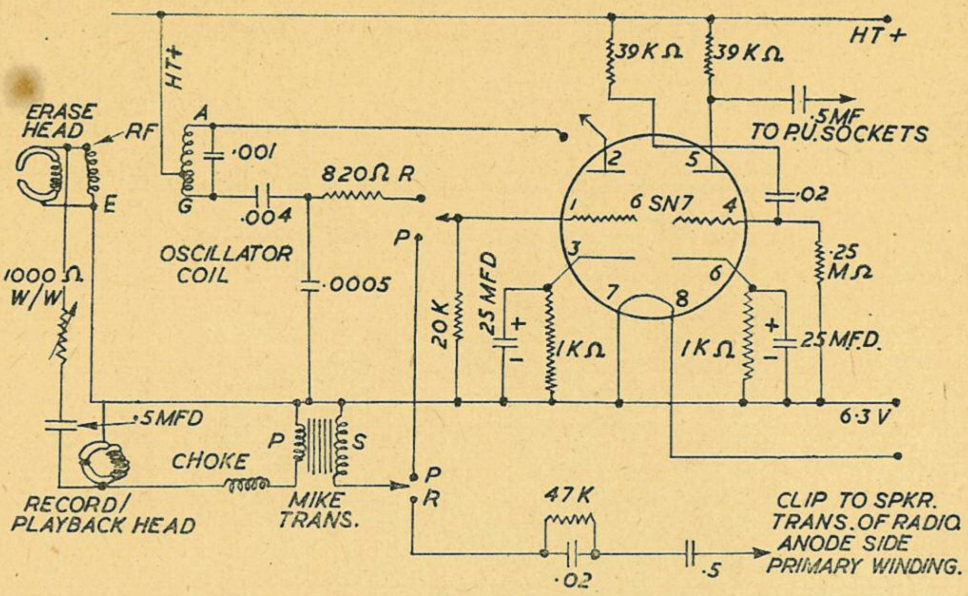


Section through throttle plunger, illustrating method of securing modulating needle, and attaching Bowden cable

Adjustment

The initial adjustment should be made with the throttle about one-third open. Adjust the jet so that the engine two-strokes evenly under load, trying the effect of slight increase and decrease of richness under actual working conditions if possible. Now open the throttle wider and note whether the mixture tends to become richer or weaker, checking this by altering the jet setting if necessary, so long as a note of the initial setting is kept. If the tendency is to weaken off at full throttle, the taper on the needle is too slight, and

(*Continued on page* 288)



cared for. When recording, the tape first passes over the erase head and is thus cleaned preparatory to receiving a recording from the recording-head. When the recording is replayed, the erase-head is automatically switched off, thereby not interfering with the recording on the tape. To rewind, the spools are simply placed about, thus passing the tape back to the original spool.

A Carburettor for the "Busy Bee"

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should be increased ; and the reverse, of course, applies if it tends to become richer under these conditions. Alterations, if found necessary, should be made by easy stages ; under certain conditions, departure from a constant angle of taper may be found desirable, but this is not usual for normal engines on moderate duty.

At the smaller throttle openings, the cutaway of the throttle plunger has a pronounced effect. If the mixture tends to become very rich when the throttle is nearly closed, the amount of cutaway may need to be increased. It is not always easy to judge this properly, as nearly all two-strokes tend to "four-stroke" when running slowly, particularly at light or no load, but this should not be confused with the effects of rich mixture, which are likely to cause surging or "hunting," excessive blue smoke, and a tendency to oil up plugs. Reluctance to start at low throttle openings when the engine is warm is often encountered.

The effect of the air bleed on carburettor adjustment is often found difficult to assess, as an alteration of the air bleed orifice may make no perceptible difference under stable working conditions. It does, however, make itself felt under changing load conditions, reducing the tendency of the engine to stall when overloaded, or to race away when load is removed. There should be no need to experiment with the size of the air bleed orifice, but if any alteration is made it will influence the function of the modulating needle, the taper of which may have to be increased if the orifice is enlarged.

It cannot be denied that carburettors, and small ones in particular, can be baffling things at times, and to get the best results from them demands patience and perseverance, not to mention a modicum of what is colloquially termed "common savvy." Older readers who may have had to wrestle with the intricacies of the fearfully and wonderfully conceived carburettors of the past (some of them having up to twelve jets !) will agree that tuning a modern carburettor is child's play. The working conditions of an auto-cycle carburettor are not exacting, as a "flat spot" or even a stall demand nothing more than what the ancients used to call "L.P.A." (light pedal assistance), but it is infinitely better if the engine is always on top of its job and does not have to be nursed under any conditions.

To those of my readers who have reminded me that a carburettor is not complete without its control lever, I would mention that this point has not been disregarded, and I shall be describing a specially designed dual-action control, to suit the "Busy Bee" or other auxiliary engines, right away.