KIWI MARK II

Continued from 15 September 1960, pages 322 to 324

By Edgar T. Westbury

Machining the crankshaft and other internal working parts of the famous little petrol engine now redesigned for the '60s

THE crankshaft' can be made from solid steel bar or fabricated by brazing the crankpin and main journals into the webs, according to which is the more convenient. Both methods have been described so many times in ME that it is hardly necessary to deal with them in detail. For machining from the solid, rectangular steel bar, 1-3/4 in. x 1/2 in. can be used; these are dead measurements which do not allow for cleaning up the sides or ends of the webs, but the dimensions are not critical, and no harm will be done if they finish slightly undersize.

While it would be an advantage to use high tensile steel for the crankshaft, there is always some difficulty in obtaining it,, and mild steel, as specified, will give satisfactory results for all except the most exacting duties. Even this is not always readily available in the sizes required; I had to cut a piece from a slab of 1/2 in. plate. It is advisable to normalise the steel before machining, by heating to dull red and cooling slowly.

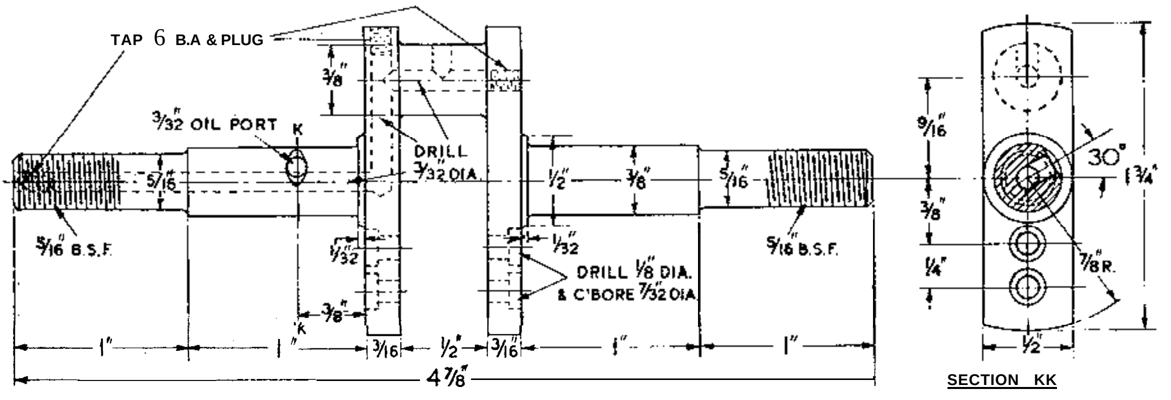
Some constructors may prefer to machine the crankshaft from round bar, with the balance weights integral with the webs. While this is quite satisfactory, it involves a good deal more machining and also waste of metal. Flat. bar is more economical in both respects, and a good deal of the unwanted metal can be cut away before machining the 'crankpin and journals. Marking out of the main and crank centres, and subsequent centre-drilling, call for the utmost care to ensure parallel alignment. The bar should be set up on a surface plate with suitable packing,. and preferably clamped so that it is not liable to move while marking the centre lines on both end faces with a scribing block (or surface gauge, according to where you were educated).

I always recommend machining the crankpin first, before cutting away metal from the sides of the journals; the gap can be cut out by drilling a row of small holes adjacent to the pin and sawing down the sides of the web; allowance, in each case, being left for cleaning up in the machining operations. It is necessary to use a tool with a long reach (not less than 1-1/4 in.) to clear the full depth of the web, but it should not be wider than necessary to ensure rigidity, and both sides should have cutting clearance, with a slight taper towards the back, and the front corners slightly rounded. In previous articles I have described a tool grooved or bifurcated on the end face so that it acts virtually as a double-round nosed tool; this relieves cutting load and reduces the tendency to spring or chatter. Parallel accuracy and a good tool finish are essential.

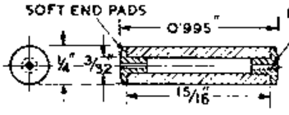
The surplus metal may now be cut away from the sides of the journals, and the shaft mounted on its main centres for the remainder of the machining. To avoid any tendency to spring, a gap piece should be made a neat push fit between the webs, and clamped in position by any convenient means. It is advisable to screwcut the threads at both ends of the journals, and all shoulders should have a slight fillet, rather than a sharp corner, to avoid a possible focus for starting cracks.

For a brazed crankshaft, the webs may either be made parallel or with integral balance weights (by making them in the form of discs and cutting away the part not required). Some constructors may prefer to make the main journals in one continuous piece and cut out the gap after brazing; I generally make them separate, with flanges which butt solidly against the webs, and increase the surface area of the brazed joint. Oversize journals, which can be machined between centres after brazing, are recommended, but it is possible to avoid the more awkward job of machining the crankpins, if care is taken in brazing to avoid superfluous metal and the formation of scale. I have not found it advantageous to pin the joints before brazing.

One advantage of a fabricated

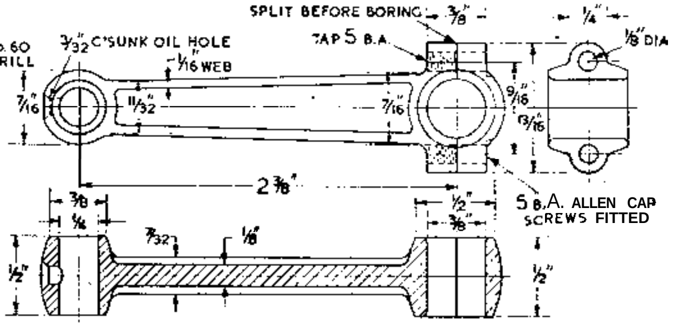


CRANKSHAFT 1 OFF M.S.

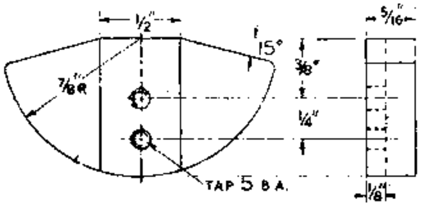


GUDGEON PIN

1 OFF M.S. C.H.



CONNECTING ROD 1 OFF BRONZE OR DURAL



BALANCE WEIGHT 2 OFF BRONZE

shaft is that high tensile steel-more readily obtainable in small sizes-may be used for the journals, and more particularly for the crankpin. Do not use high carbon steel (such as silver steel) which is liable to become brittle under shock and vibration. Welding, except possibly electric resistance welding, is not recommended for crankshafts.

Some model petrol engines have managed to get by with very sketchy lubrication of the so-called splash variety, in which a certain quantity of oil is injected into the crankcase at indeterminate intervals and left to find its way into the bearings as best it can. But it is obviously much better to provide some positive means of supplying oil direct to the most heavily loaded bearings. Only the big end bearing needs to be fed in this way, as the excess which escapes from the ends is flung all over the cylinder walls and other interior working parts.

The drilling of the oil passages may be considered difficult or tedious, but it is not necessarily so if sharp drills and high speed are used; in the case of a brazed shaft, the parts can be pre-drilled before assembly, but they should be properly cleared afterwards. Short 6BA grubscrews can be used to plug the holes where required, and the entry hole to the main journal should be located as shown so that it lines up with the feed inlet at TDC; the opening period of this port is increased by cross-tiling with a small round file so that it embraces about a 60 deg. chord of the journal.

Balance weights

Made in bronze as specified, the balance weights are just about the right size to give reasonably good balance in conjunction with the other working parts also specified, but if changes are made, the difference in the specific gravity of the metals should be allowed for. To ensure the secure attachment of the weights, the grooves should fit closely over the sides of the crank webs, and the screws, of good quality steel, should fit both the threads and the counterbore of the webs, into which the heads are sunk flush. When screwed home, an indent with a centre punch, adjacent to each end of the slot in the screw head, will produce a burr which firmly locks it against unscrewing. The attachment of balance weights in this way has often been criticised, but though many ***Kiwi*** engines have been built, I have never heard of one coming to any harm through this weakness. After fitting, final machining of the weights may be carried out ***in situ.***

Connecting rod

By making the rod in the form of a bronze casting, the amount of machining work on it is reduced to the minimum. Though bronze is not ideal for this component, experience has shown that it gives very satisfactory results for general purposes, except in the hands of users who think it great fun to rev. engines flat out with no load-a “test” which few connecting rods of any kind could reasonably be expected to stand. The alternative materials are steel (which would need to be bushed at both ends) or duralumin Tin which bushing is optional); the rod would have to be machined from the solid.

Assuming that a cast, or other form of semi-finished rod is used. the can of the big end bearing is normally made integral with the rod for convenience, and must be separated by sawing. Before doing this, it is a good policy to mark out and drill the holes for the setscrews, to ensure their correct position and alignment. One side of the bolting lug on both the cap and the rod should be marked to ensure correct assembly. After the cav has been sawn off. the cut surfaces should be accurately faced by machining or filing, and the two parts fastened together by temporary screws.

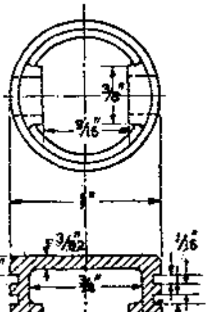
The simplest way to ensure that the eyes of the rod are bored parallel to each other is to clamp the shank of the rod crosswise to a flat bar. with the ends overhanging each side; and set this up on the faceplate to centralise each of the eyes in turn. As there may be some roughness on the edges of the fluted shank, it will probably be advisable to trim them with a file, and to check that the rod is parallel to the faceplate when clamped. The little end will need to be centre-drilled, followed by an undersize drill, then a boring tool and finally a reamer: care should be taken not to force the pace to cause risk of distortion or shifting the work. Only boring and reaming is necessary for the big end.

As the cap screws will be very heavily stressed in working conditions, they should be of good quality steel. Allen screws are ideal except that it is difficult, in the limited space available, to provide adequate means of locking them. I have seen screws of this type with cross-drilled heads which enable them to be wired for security, but I have been unable to obtain them in the size required, and owing to their toughness, it is very difficult to drill them, though I have done it successfully by using drills made from dental burrs, which are exceptionally hard. I need hardly point out that if these screws should loosen while the engine is running they may cause a major disaster; this has happened to several engines which have come to my notice.

Piston

Aluminium alloy is generally preferred for petrol engine pistons, especially when the maximum speed is required. Apart from being light, they conduct heat from the combustion head much better than cast iron pistons, though these have their own advantages-their wearing properties are better, and their expansion is much lower, so that piston slap can be eliminated and it is possible to fit them to a sufficiently-line clearance to dispense with the need for piston rings.

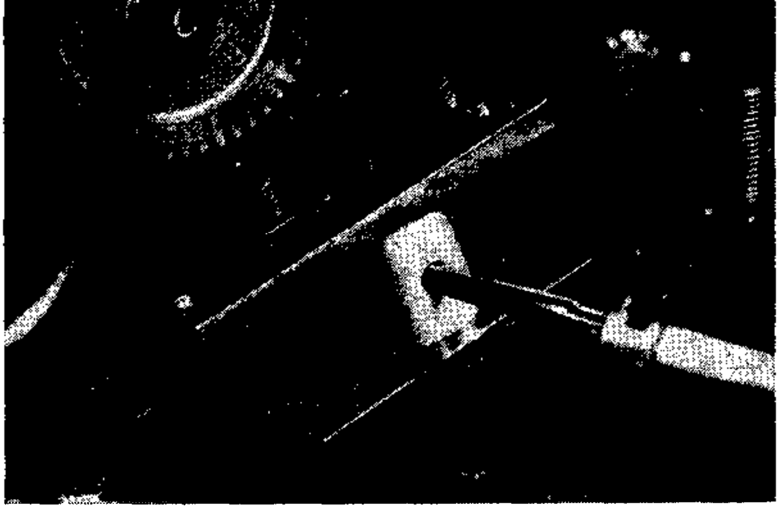
For a really hard slogging engine, running at speeds not exceeding 3,000 to 4,000 r.p.m., a cast iron piston would be preferable, but I have found it very difficult to obtain good castings in iron for these small components, and it will probably be necessary to machine them from the solid. I have in the past described methods of machining pistons, in which all operations can be carried out before parting the piston off from the parent bar.



PISTON 1 OFF

L.A. OR C.I.

CLEARANCES	L.A.	C.I.
TOP LAND	.006"	.002"
RING BELT	'004.	.OOI
SKIRT	'003"	'ooo5*



After rough machining, the piston is set up on the angle plate for the gudgeon pin hole to be bored

If a cast piston in either metal is available, the machining is considerably simplified. I do not recommend the use of a chucking piece on a piston casting (although this is the common practice) for reasons which I have already explained. I usually hold the pistons in the four-jaw chuck by the head end, with as much of its length projecting as is discreetly practicable, and set it up true by the cored interior surface-not the outside. The use of a feeler, such as a bent scriber held in the toolpost, will help to check the truth of the part above the gudgeon pin bosses. The outside can then be turned down to about l/32 in. oversize, the end of the skirt faced to length, measurement being taken from the bosses on the inside, and a witness cut taken in the mouth of the skirt, just sufficient to clean it up. A point tool is used to locate the distance of the gudgeon pin from the end of the skirt, and the cross centre of the bosses can be marked out with a scribing block set exactly at lathe centre height. The work is rotated so that the bosses lie as near horizontal as possible, and the marked line is produced on the end face and both sides of the piston, to intersect the lateral line already marked by the point tool; these intersections are centre-punched and witness circles 1/4 in. dia. are marked with dividers: For these and other delicate marking out jobs, I recommend the use of Spectra marking fluid; it is easily applied, dries almost immediately, and makes scribed lines stand out so clearly as to eliminate all indecision.

The piston may now be set up on an angle plate, and held thereto either by two clamps, or by a single strap and two bolts. for boring the gudgeon pin hole. Before attaching it, a line should be scribed square across the angle plate from front to back (this may be deeply incised for permanence, as it will always be useful) and the centre lines on the piston located to coincide with the line on both sides. This will ensure that the hole will pass squarely through the centre of the diameter, when the work is set up by shifting the assembly on the faceplate to centralise the visible punch mark, as accurately as possible.

The piston may now be centre-drilled, and then drilled about 3/16 in. dia. through the first boss. In case of any possible inaccuracy, this hole may be opened out with a small boring tool. A drill large enough to open it just a little further-but still under 1/4 in. is then put through, with ample lubrication, to follow through into the other boss, with caution. Both bosses can then be bored out and reamed, preferably on the tight side compared with the little end-eye of the connecting rod.

Final turning of the outside of the piston, including the ring grooves, and facing the crown, may now be carried out by a method which relieves it of all chucking stress. A suitable piece of metal-brass, steel, or light alloy-is held in the lathe chuck, and a spigot is turned on it to fit the inside of the piston; it is also centrally drilled and tapped about 1/4in. dia. Next, an eye bolt, or a screw with a large cross-drilled head, is made to fit the tapped hole. A dummy gudgeon pin, slightly less than 1 in. long, is passed through the piston and the eye bolt, and by screwing it up the piston is drawn up firmly and truly on to the spigot.

All the remaining work can now be carried ***out;*** the recommended clearances are shown on the detail drawing. This method is similar to that almost universally employed in large scale piston manufacture, though a more elaborate, permanent jig, with a long drawbolt, sometimes pneumatically operated, is generally fitted to the lathe.

** To be continued October 13*

*KIWI MARK **II***

By Edgar T. Westbury

Continued from 39 September 1960, papes 386 to 388

MOUNTING THE FLYWHEEL with a SPLIT COLLET

THE gudgeon pin, details of which were shown in the previous article in this series, is quite a simple machining job. It may be made from a piece of ¼ in. bright mild steel, which will not need external machining if it has a good surface and is a tight push fit; otherwise larger material, machined all over, must be used.

The centre hole should be drilled as truly as possible; the brass or aluminium end pads, the object of which is to prevent scoring of the cylinder walls if the pin moves endwise, should be tightly fitted, after the pin is case-hardened and polished; and the overall length over the pads should be a few thou less than the cylinder bore diameter.

As flywheels of large diameter are generally undesirable for engines installed in boats, owing to the necessity of keeping the shaft line low, the one shown has been kept small, consistent with smooth running at the slowest speed likely to be required. There is some advantage to be gained by increasing the size of the flywheel where it is permissible to do so, especially for a really slow tick-over.

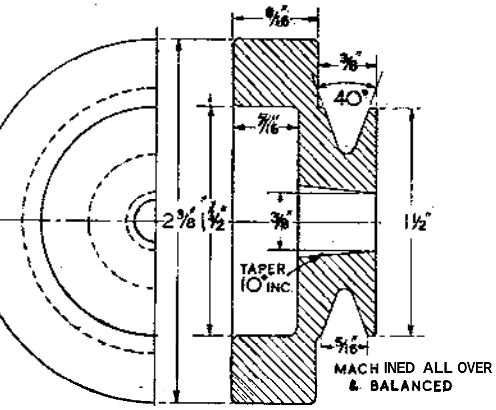
The recommended procedure for machining the flywheel is first to chuck it pulley-side outwards and rough machine all the external surfaces available, including the V-groove,_ to within about l/32 in. of finished size. It is then reversed, and chucked as truly as it can be by reference to the surfaces already dealt with, for machining the outer rim, the back face, and recess. The centre hole is centred, drilled and taper bored with great care to set the boring tool exactly at centre height and to produce an accurate finish. A tapered mandrel, turned in situ, is recommended for the final finishing of the pulley groove and other adjacent surfaces. The size and angle of the groove is of some importance in ensuring a good grip for the starting cord if the conventional mode of starting is emnloved: if it is not, the groove may be suitably modified.

I may be asked to explain the use of a split collet for mounting the flywheel, instead of the commoner method of tapering the shaft itself, as in the original ***Kiwi.*** There are several reasons why I have adopted the split collet in most of my later engines. First, it enables the shaft itself, including the thread on the end, to be kept larger at this vital point and, therefore, more robust. Secondly, in the event of a serious wrench which may cause scoring or tearing on the taper, the collet is easily renewed. Thirdly, it enables end play in the main bearing to be eliminated, even though the. flywheel itself is not positively end-located. If end thrust is applied to the shaft (this is not generally desirable, but cannot always be avoided) a hardened thrust washer, or even a ball thrust race, could be fitted behind the collet.

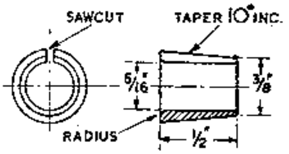
Matching the taper

The collet may, if desired, be machined with the large end outwards, retaining the setting of the top slide as used for boring the flywheel, so that the exact angle of taper is assured. It is a little more difficult to assess the diameter in this way as the flywheel cannot be offered up for fitting; but by taking a careful caliper measurement of the mouth of the taper bore, and making the extreme end of the collet about 3 thou larger than this, -the correct' amount of draw will be obtained. The bore of the collet should be made a press fit on the crankshaft, and its mouth radiused or chamfered to clear the fillet and enable it to abut closely against the shoulder. After slitting either by hand, or by a circular saw in the lathe, you should carefully remove any burrs formed both inside and outside.

The directions which have been given for making similar components for previous engines hold equally correct for valves and valve guides. Dimensions are the same, whether the water-cooled or air-cooled cylinder heads are fitted. Note that with water-cooled heads the valve guide must provide a watertight joint on the top



FLYWHEE'L I OFF C.I. or MS.

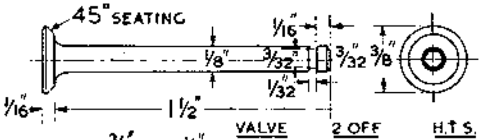


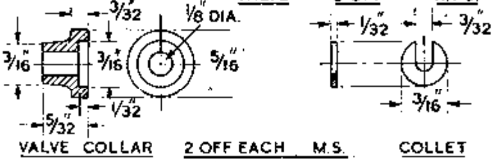
FLYWHEEL COLLET I OFF M.S,

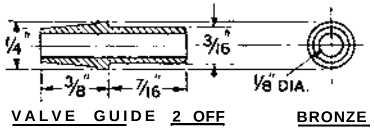
of the cover plate, and therefore, should be a good tight fit in the head. The shoulder should also abut firmly against the cover plate. When it is inserted, a little varnish or jointing compound should be applied to these surfaces.

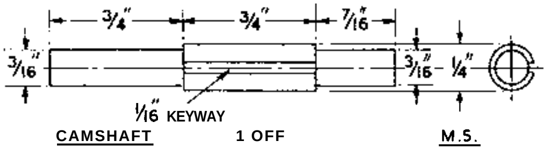
Suitable material for the valves can be obtained from old motor car valves or aircraft bolts, as discussed in previous articles. Wherever possible, machining of the head and stem should be carried out at one setting to ensure perfect concentricity. The fit of the stems in their guides should be as close as is consistent with free working; this is particularly important with the inlet valve, where a sloppy fit may cause an air leak serious enough to affect carburation.

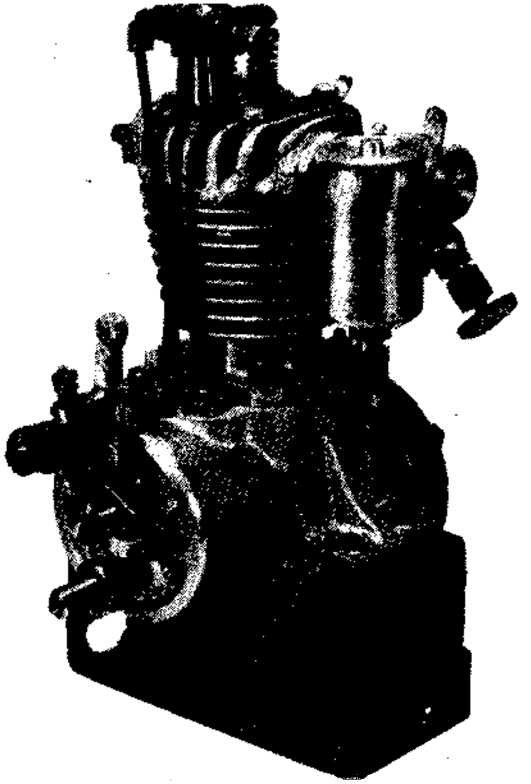
The valve collar should also fit nicely on the stem so that, when the horseshoe collar is snapped into its recess, there is no tendency for it to tilt and thereby force the valve out of truth.











Here is the air-cooled KIWI Mark II

Valve rockers are highly stressed parts, which some constructors find rather finicky to make; as a result, they are often made crudely and clumsily. Sometimes gunmetal cast rockers are used, but their wearing properties are not really good enough, unless hardened steel inserts are fitted at both ends. All things considered, I find it just as easy to machine them from solid steel.

Solid steel rockers

Take pieces of mild steel bar, 3/8 in. x 1/4 in. x 1-3/8 in. (+) long. The centre pivot holes are first drilled and reamed in each piece, and the pieces are mounted together on a bolt or nutted mandrel for filing or machining the outer contour. The individual pieces are then mounted each in turn on the mandrel for machining the sides; note that the bosses are offset, right-handed and left-handed respectively. A round-nosed tool with plenty of side clearance is used to reduce the web of the rocker, from the 5/16 in. dia. of the boss, to a radius of 15/32 in. on both sides.

To produce the 3/32 in. recess in the heel of the rocker, a round-ended flat drill may be made from 1/8 in. silver steel, or an old twist drill may be ground to shape. The mouth of the recess should be well tapered, so that the push rod does not bind on the sides at its maximum angularity. After the oil holes have been drilled and countersunk, the rockers are case-hardened, special care being taken to ensure that the bore of the pivot hole, the recess, and the underside of the toe, get full treatment; these surfaces are finally polished.

The rocker pillar should be made from 3/8 in. square mild steel, machined either in the chuck or between centres. Be sure that the square and circular parts are concentric. Before finishing the shoulder of the threaded end, it should be screwed into place in the head (with the cover plate fitted, in the water-cooled type), to make certain that the square will line up in its proper place; allowance being made for a shakeproof washer if it is available.

It is important that the pillar should not loosen so as to shift in working conditions. If this trouble is encountered, various means of locking it are possible, including drilling and tapping a hole horizontally in the head for a grubscrew to penetrate and lock the screwed end; but this has not been found necessary. The original ***Kiwi*** had a locknut instead of a squared shoulder on the shank. Though effective, both as a means of height adjustment and of locking, it was a rather clumsy-looking device; but you may adopt it if you wish.

After locating the position of the squared end of the pillar when in place, drill and tap the stud hole. Two studs are then made from 1/8in. mild steel to screw in from opposite sides, the threads being rather tight so that they are not likely to loosen. Make certain that no burrs are thrown up on the side faces of the square when these are screwed in.

The rocker bushes should be made of drawn gunmetal (not brass) or alternatively of steel, and subsequently case hardened. If you like, they may, instead of hexagonal heads have large knurled heads so that they can be adjusted by hand. The central hole-or, rather, the eccentric one-can be drilled by offsetting the work in the chuck before parting off; as the distance is not critical, a piece of strip metal about 15 thou thick under one jaw of the three-jaw chuck will produce the desired result.

I may say that as a result of long experience I have found the eccentric bush method of tappet adjustment to be not only the simplest but also the most reliable for small engines. Screwed tappets or push rods, with their essential lock nuts, are finicky to adjust and generally add to the reciprocating weight of the valve parts. To adjust tappet clearance on the Kiwi it is only necessary to slacken the nut on the end of the pivot stud, to turn the bush, either by hand or by a small spanner, as required, and then clamp it up again. The valves should, of course, be in the closed position while this is done, and a 2 thou feeler gauge or a slip of thin paper may be used to check the clearance.

The remaining small details on the drawing published here are straightforward, and do not call for much explanation. Note that the two camshaft bushes are of different lengths, the longer being fitted to the timing cover and projecting outside in order to carry the contact breaker. Both are fitted to about 1 thou interference. When the cover is assembled, a reamer may be passed through both of them to ensure perfect alignment. Oil holes are drilled at an angle into both bushes, from the inside of the crankcase and timing case.

As the extension of the crankshaft nut is not intended to take a close bearing in the timing cover, it is spirally grooved to retard the escape of oil at this point. Little more than a mere scratch is necessary,, and the pitch is not critical either. Right hand is for appropriate engines running anti-clockwise at the timing end (as is usual for convenience in using screwed shaft couplings) and for running in the reverse direction, a left-hand spiral should be applied. This nut could be combined with a driving dog or other form of coupling.

The water flanges are, of course, only necessary for the water-cooled type of engine, and are intended to be silver soldered or sweated to the service pipes. In order to keep down head room, the outlet will probably need a sharp bend or elbow, and the flange may be modified to facilitate the change in direction, if wanted.

Some latitude is permissible in the specification of the timing gear. As the obvious requirement is that the camshaft must run at half engine speed, it is only necessary to ensure that the gear on this shaft must have twice as many teeth as the pinion on the crankshaft; but if this entails any alteration in the pitch diameters of the gears, the distance between the shaft centres must also be varied.

Practical alternatives to the 40 d.p. gears shown are 36 d.p. (18 and 36 teeth) or 32 d.p. (16 and 32 teeth), if these are more readily obtainable. But don’t do as one ***Kiwi*** constructor did some years ago, that is, fit gears of 19 and 40 teeth under the impression that they would be near enough--L had quite a headache sorting out why his engine wouldn’t work !

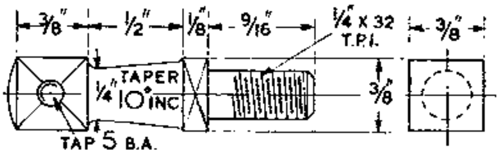
The pinion should be of steel, but the spur wheel may be of any other sound metal, as the width of gear face is adequate to cope with working conditions

It is also possible to vary the means of securing the gears on their shafts; the pinion, being limited in diameter, is hardly suitable for keying in the normal way, but as it takes little torque load when clamped by the shaft nut, a 1/16 in. pin or “ snug key ” sunk into the shaft, to engage with the notch ‘in the boss, will be quite sufficient. Its position may be located when the complete engine is assembled and timed.

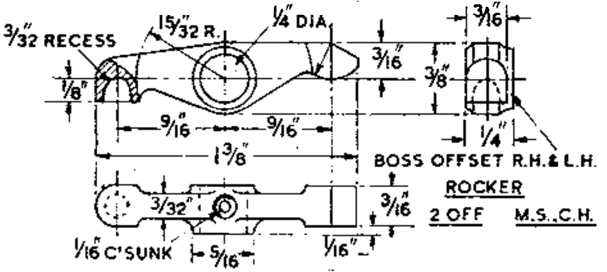
It is desirable, though not absolutely essential, that the keyway in the spur gear should line up with either a tooth or a tooth space, but this will be explained further when dealing with the cams.

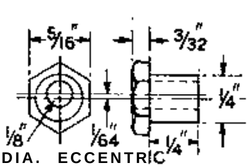
Incidentally, when turning the camshaft. it should be noted that the front extension of the journal is subject to variation according to the type of contact breaker and its cam fixing; it is best to leave the extension well on the long side until the type of contact breaker has been determined.

** To be continued on October 27*

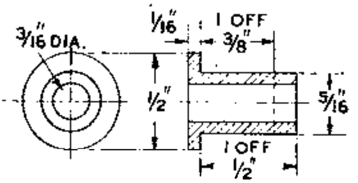


ROCKER PILLAR **I OFF** **M.S.**

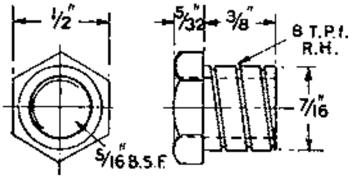




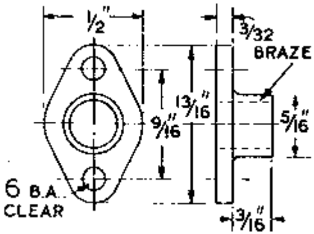
ROCKER BUSH
2 OFF G.M.

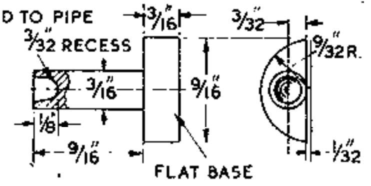


CAMSHAFT BUSH **BRONZE**



SHAFT NUT **I OFF** **M.S.**





WATER FLANGE 2 OFF **BRASS TAPPET 2 OFF** **M.S .C.H.**

KIWI MARK II

By Edgar T. Westbury

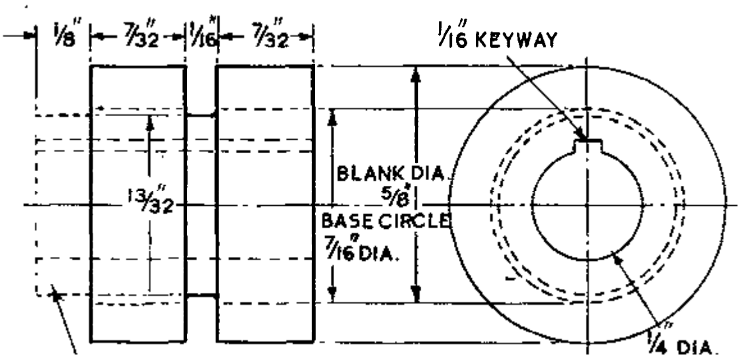
Continued from 13 October 1960. pages 458 to 466

TAKE CARE WITH THE CAMS

AMONG the many details which affect the success and efficiency of an engine, few are of greater importance than the design and production of the valve-operating cams. They have been the subject of much discussion in the past. Many inexperienced constructors have been confused by the conflicting ideas expressed, and have been led to think that it is very difficult to form and time cams properly. Judging by the letters I receive either querying or debating the finer points of cam design, there must be many readers who are deterred from building four-stroke engines by real or imaginary difficulties in this respect.

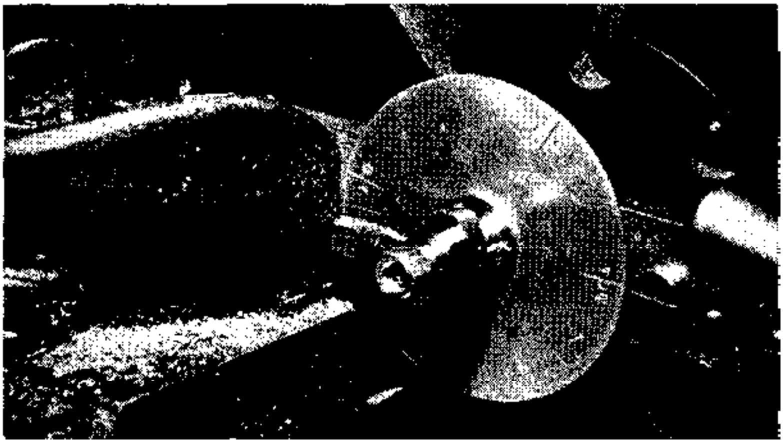
Where only moderate speed is required, the duty on the valve gear is relatively light, and almost anything goes in the matter of cam design. Even in manufactured engines, science is often subjugated to convenience in machining the cams; every engine tuner knows that standard maker's cams are nearly always capable of some improvement. In model engines, I have seen some very crude efforts in cam design which have produced more or less successful results. But in engines intended for high speed and performance, cam design is of the utmost importance, and any errors in the contour and timing angles inevitably result in loss of mechanical efficiency, calling for excessively strong valve springs which still further increase general wear and tear.

There are, of course, as many ways of producing cams as there are of exterminating a ***felis domesticus,*** and I have described most of them at various times in ME. Any of these methods may be applied to the ***Kiwi,*** an engine which may be claimed to be specially adaptable. In its original form, it was used as a test bench for various cams and valve timing, though in the published design the cams specified were selected mainly with a view to simple production rather than maximum efficiency; nevertheless, they worked quite well within their limits.



CUT'OFF AFTER FORMING & CASE HARDEN & POLISH CAMS

CAM BLANK I OFF M.S.



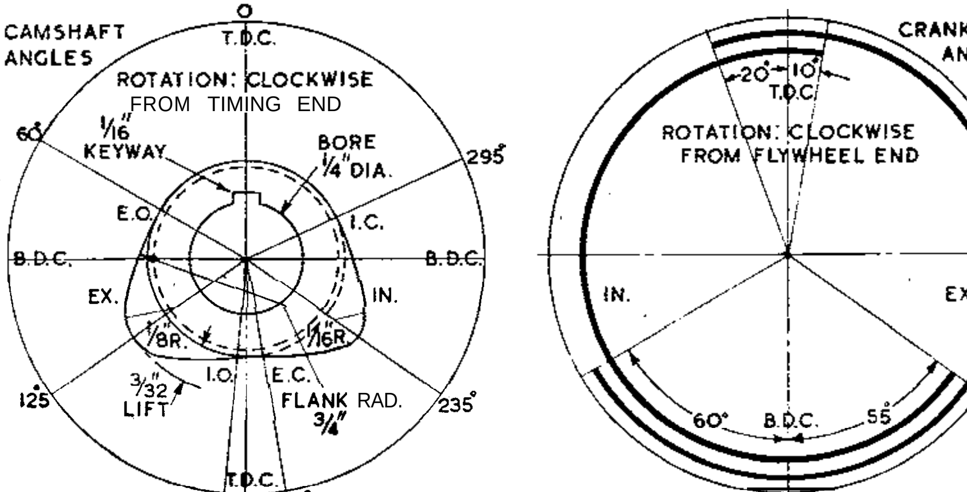
Cam blank, with division plate attached, set up eccentrically for machining the cam flanks

These cams were of the tangent type; that is, the flanks were straight-line tangents to the base circle, and faired into the nose with a slight radius, so that they could be formed with reasonable accuracy by filing. The followers. or tappets-which should always be considered an integral factor in the cam design-were rounded to a cylindrical curve on the contact face. This combination works out fairly well in practice, up to speeds which were considered high enough for most purposes at the time the engine was designed. The cams were made separately, and after the adjusting of their angular position on the shaft together with that of the gearwheel, the three components were drilled ***in situ*** and pinned together by a steel dowel passing endwise through them.

In the present arrangement, I have considered it better to key the cams to the shaft, not only to resist torque stress better, but also to locate them more positively. The two cams are shown as made in one piece, to locate their relative angular positions-for the adjustment is less easy than it looks-but they may be made separate if desired. Either the inlet or exhaust cam may be placed adjacent to the gearwheel, as it is possible to operate the appropriate valve from either tappet. To reverse the rotation of the engine, it is only necessary to turn the cams end for end and change the push rods over. Alternatively, change over the valves themselves, by reversing the positions of the carburettor and exhaust pipe.

The method recommended for forming the cams to the contour shown in the drawing is similar to that employed for the cams of the ***Dolphin*** engine-mounting the blank eccentrically on the faceplate, and indexing it into the required positions for shaping each of the flanks by a turning tool. The surplus metal around the base circle is then removed in a similar way or by circular milling, and the nose radius is filed by hand to blend smoothly into the flanks.

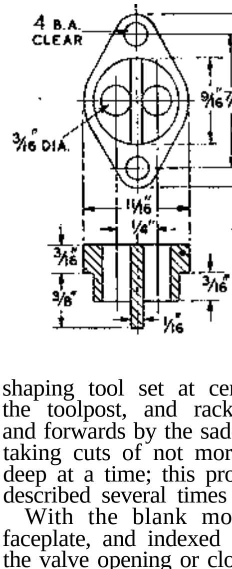
As the method involves the necessity of fixing a division plate temporarily to the cam blank, the detail drawing shows an extension piece for this purpose; any method of fixing, such as by pressing, soldering, or grub-screwing, is suitable so long as the plate is secure during its period of service. The plate, which may be marked out by a draughtsman's protractor! is a replica of the left-hand timing diagram which is set out in camshaft angles.



TIMING DIAGRAMS

To facilitate accurate mounting of the blank on the faceplate, a simple jig should be made, consisting of a flat steel plate with a fixed 1/4 in. stud, accurately fitting the blank centre and provided with a nut and washer for clamping; a plain zero index mark should be scribed on the plate for locating the angular index marks on the division plate. The eccentric setting to produce the flank radius of 3/4 in. is 3/4 in.- 7/32in. (base circle radius) = 17/32 in. at the stud centre.

If the cams are to be keyed to the shaft as specified, the keyway should be cut in the blank, and lined up as accurately as possible with the TDC zero mark on the division plate when the latter is fixed. The internal keyways in the blank, and also the gearwheel, and the external keyway in the camshaft, can be cut by a suitable shaping tool set at centre height in the toolpost, and racked backwards and forwards by the saddle movement, taking cuts of not more than 5 thou deep at a time; this process has been described several times in ME.



TAPPET GUIDE
1 OFF
BRONZE

With the blank mounted on the faceplate, and indexed to any one of the valve opening or closing positions, flank turning can begin. Use a tool not more than 1/16 in. wide so that it can run out into the clearance space between the cams; it should berounded on the nose. with ample tov rake for clean cutting. The depth of cut for the first flank can be measured by a micrometer (5/8 in. blank dia. - 3/32 in. lift = 17/32in.) but this is not possible for the second flank, and so it is advisable, once the setting has been found, to work to the cross-slide index or a fixed stop.

As it is very easy to make a mistake when nibbling away the base circle, I always recommend marking the tips of the cams by a spot of quick-drying paint or Spectra marking fluid so as to make their identification quite certain. This advice is born of bitter-or unfortunate-experience ! After the base circles have been machined dead concentric with the bore, the nose radius is filed on each cam, the important thing being to produce a smooth change of contour, as this part of the cam does not, or should not, do heavy work. Finally, the extension piece is machined off the end of the blank and both cams are case-hardened and polished.

Some constructors worry about the exact amount of tappet clearance to be allowed for, but in the interests of simplicity I have not specified this in the design. The main object of working to exact figures in full-size engines is to ensure that the valve timing is always as designed, and also to ensure quiet operation of the tappets. If nothing is allowed for tappet clearance in the cam design, some loss of the valve opening period is inevitable; but by keeping this on the full side, and setting the tappets to as fine a working clearance as permissible, very little loss of efficiency results.

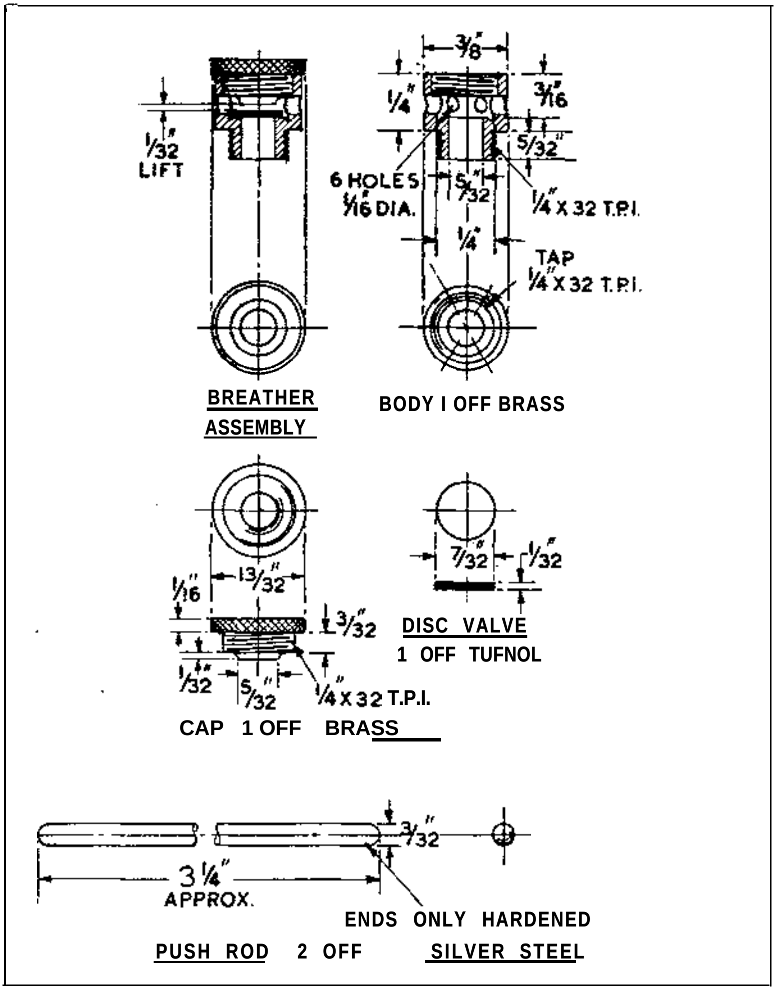
Constructors who wish to follow established practice to the letter, may reduce the radius of the base circle by the required amount-say 0.005 in. -and ease the contour to meet that of the flanks at the opening and closing points. I trust that this explanation will take care of the many queries which I have received on the subject of tappet clearance.

In timing the camshaft, it is only necessary to locate it so that the keyway is exactly at the top (assuming that the machining of the cams has been carried out as described) when the piston is at top dead centre. As a check on the accuracy of the timing, the right-hand (crankshaft) diagram may be marked out on sheet metal or stiff card, and temporarily attached to the flywheel end of the shaft, or even transferred, by scribing, to the flywheel itself. As already mentioned, a few degrees will be lost in the opening periods, owing to clearance and backlash, and it will be necessary to split the difference in errors so caused.

Both the tappets are housed in a single guide, in order to take up as little room as possible in the timing case, and also to avoid excessive angularity of the push rods. Details of the tappet were published in the group drawing in my last instalment. The guide, which is preferably made in gunmetal or bronze, may be chucked by the flange and turned parallel to fit the bored hole in the top of the timing case. It is then reversed and faced at the top, the positions of the two bores being located and marked out; after which it may be set up eccentrically either in the four-jaw chuck or in a Keats V-angle plate or similar fixture for centring, drilling and reaming the holes.

The tongue at the lower end of the guide is formed by machining or filing a step each side so as just to cut away the hole; the object of this, of course, is to keep the T-headed tappets from rotating, as there is not enough room to fit the usual circular floating mushroom tappets. Make certain that the tongue is deep enough, when the parts are assembled, to fulfil this purpose when the tappets are resting on the base circles of the cams. I have encountered cases where the tappet heads have dropped below the tongue, so that they can partly rotate and thus lock the mechanism when lifted by the cams.

The essential point in machining the tappets is that they should be a smooth working fit in the guide-with a sloppy or rough fit they tend to pump oil and make the engine untidy-and that the heads should be dead flat and smooth. At the top end, a recess is provided similar to that in the heel of the overhead rocker, and formed by the same tool. All working surfaces are finally case-hardened and polished.



In a single-cylinder four-stroke engine, or other type in which displacement of air takes place, it is desirable to release the air pressure caused in this way, as it not only results in quite unnecessary waste of power but tends to force oil out of the bearings and past the piston. A plain vent is often used, but it is better to fit a non-return valve, so that slight negative pressure is maintained in the crankcase; this helps to keep the outside of the engine clean and also assists the entry of oil when it is supplied by a gravity or suction feed.

ere is not a great amount of room in which to fit the breather on the ***Kiwi;*** it is desirable that it should be located in the timing compartment so that oil mist is conveyed effectively to the gears and cams. I have devised several types of breathers, including some which were mechanically operated by the camshaft, but nobody seems inclined to take the trouble to make them, and it must be admitted that the simple lift valve type seems to do all that is necessary.

The breather shown incorporates a disc valve, which is very light in action and capable of operating at very high speed. Paper-base bakelite (Tufnol or Paxolin) is suitable for the valve, and bits of it are to be found in old radio and electrical junk. The best way to make the disc is to turn up a punch, 7/32in. dia., and a die with corresponding bore, from any available bits of steel; hardening is not necessary except in making a number. With the die in the chuck and the punch in the tailstock,. the discs can be blanked out quickly and accurately.

Other parts of the breather are simple and call for no special comment. The complete assembly is screwed into the oblique tapped hole in the timing case, as shown in the crankcase detail drawings.

To be continued on November 10

KIWI MARK II

Continued from 27 October 1960, pages 508 to 510

By Edgar T. Westbury

Carburettors are never simple

CONSTRUCTORS of model petrol engines are nearly always reluctant to spend more time than they need on fittings and accessories, and particularly on the carburettor, which is often austerely simple, and sometimes crude, in design. I am all in favour of simplicity where it will produce the desired results. But the constructor must realise that most simple devices have their limitations, and also that by reducing construction to its simplest limitations one does not necessarily make the adjustment and operation of controls equally simple-quite the opposite often occurs.

From this aspect there is no such thing as a simple carburettor. Details which appear insignificant may have unexpected and far-reaching effects ; the shape and area of fuel and air passages, the pressure or suction at the jet orifice, and the throttle position in relation to other components, all influence working characteristics. In the carburettors which I have designed and described in ME, I have sought to avoid unnecessary complication, and at the same time to ensure reasonably good control and consistent performance. But some constructors have altered them in detail, or built near copies whose performance is entirely different.

Various types tried

Several types of carburettor have been experimentally employed on the original *Kiwi* engine. The first one tried was the Atom Baby, castings for which were once marketed by Tom Senior, was a simplified version of the Atom series of carburettors, the main characteristics of which were submerged jets and annular diffusers, in conjunction with float feed.

In D. H. Chaddock's brake tests of the *Kiwi* the best results were obtained with an Atom Mark III carburettor, but constructors at that time considered its features complicated and difficult to understand. Sometimes they attempted to use it with suction feed, not realising that in such conditions the jets were no longer submerged; obviously. some form of constant-head feed system is a necessity in carburettors of this type, if the compensation principle is to work as designed.

Thr *Kiwi* carburettor was designed to simplify construction and working principles as much as possible. It is a fairly straightforward plain jet type, with mechanical compensation by a barrel throttle; and though float feed is specified as generally desirable, it may be adapted to suction feed if this is preferred. In the Mark II version, no alteration in working principles or general design has been made, but several detail improvements have been introduced.

In this carburettor, the position of the jet tip, both laterally and vertically, is very important in obtaining good throttle control. When any difficulty has been encountered, I have usually found the cause to be either error or a deliberate change of the jet location. If the tip projects too far into the air passage, it reaches a zone of higher air velocity when the throttle is wide open, but-when the throttle is partly closed it may be in a much less favourable position. The effect of the primary air passing up and around the jet also depends on its height, in conjunction with the area of the entry hole and the annular passage. All these details can be varied to affect the compensation at different throttle openings. While the acceleration and load adjustment is inferior to those of the submerged jet type, the carburettor is capable of giving quite good control over a wide range of speeds, and has a high flat-out efficiency, as there is little obstruction to streamline air flow.

The carburettor body has been ma& slightly longer than that of -the Mark 1, and is provided with a circular flange on the intake end, to enable a choke plate, air cleaner, or trunk to be fitted if this is found desirable. To machine the casting, it should first be held by the intake end (a chucking piece on this end will be provided) for facing, centre-drilling, drilling and taper boring.

Note that the parallel part of the bore, which serves as the throat of a venturi orifice, should not be larger than 1/4 in. dia. for the *Kiwi* engine; if the engine is intended only for moderate speed. and maximum flexibility of control, it may with advantage be reduced to 3/16 in. In the prototype Mark II carburettor I have made some experiments in the size of the throat, by screwing in nipples of various sizes, and I find that with the bore reduced to 3/16 in. only the peak r.p.m. performance is affected.

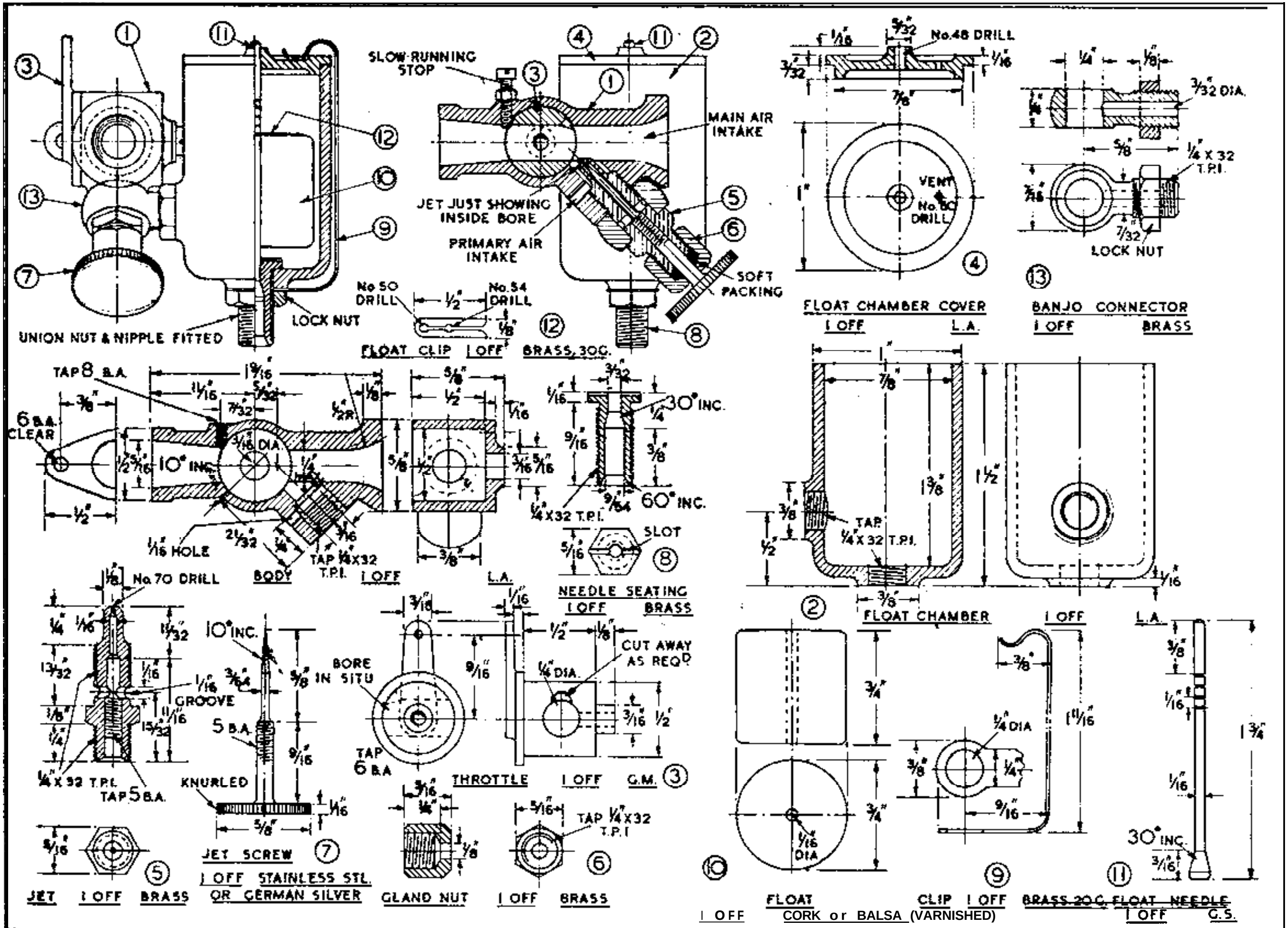
Streamlined intake

To face the intake end, and flare out the entry, a tapered plug mandrel may be turned and the body mounted on it. The exact shape of the flare is not critical, but it should blend smoothly into the bore to avoid turbulence. As it is unlikely that a suitable form tool will be available, the operation may be started with a countersink or large centre-drill, and finished with a half-round or triangular scraper.

The casting may be held on an angle plate or chucked by the rear boss for facing, drilling and boring the throttle housing. After the back of the boss has been faced, the throttle should be machined and fitted, on the tight side at first, to enable the cross bore to be drilled, or at least finished, in position. The body may then be re-chucked, but it should not be drilled to finished size. or a burr may be thrown up and make its removal difficult, and probably score the housing badly.

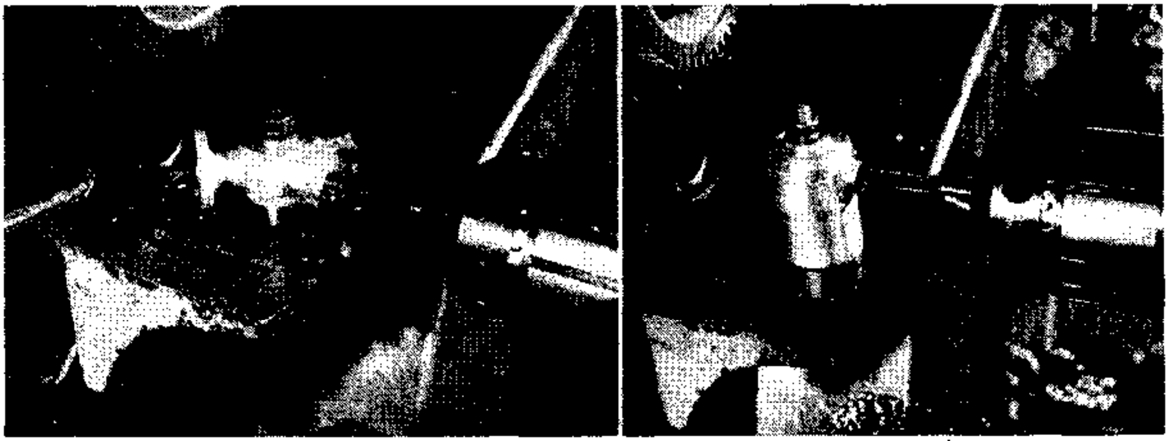
After boring out with light cuts, the constructor should finally fit the throttle by lapping with powdered bath brick or other mild abrasive, so that it works quite easily. Usually it will be found desirable to fit a large-headed retaining screw, with a friction washer interposed at the back of the boss, to prevent inadvertent movement.

Note that the position of the throttle



THE "KIWI" MARK II CARBURETTOR **FOR ENGINES** **10 TO 20cc**

HORIZONTAL, VERTICAL, OR ANGULAR **FITTING.**



Left: Carburettor body set up on an angle plate for drilling and tapping the jet housing. Right: Float chamber set upon an angle plate for drilling and tapping the connecting boss

lever may be varied to suit control requirements, but where rods or cables are not fitted it is usually convenient to set the lever at about 30 deg. from the vertical, towards the outlet, at full bore. This position must, of course, be settled before cross drilling. The stop screw fitted to the top of the body will limit the full opening, and also enable the idling speed of the engine to be closely adjusted.

The jet housing is drilled at an angle of 45 deg.. offset 5/32in. from the throttle centre, towards the intake end of the body. It is advisable to set it up on an angle plate, as the truth of the tapped hole, and of the joint face, is highly important.

A modification has been made to the float chamber casting to simplify construction. In the earlier version. a lug was cast on it, which had to be bored and faced at 45 deg. so that, when connected to the horizontal body, it was vertically located. Many constructors found the operation difficult; the location was inaccurate and fuel leaked at the joint faces.

The Mark II float chamber has a boss which is drilled and tapped to take a banjo connection, enabling the angle to be adjusted as required; it is possible to fit the carburettor with the body horizontal as shown, or in the vertical (updraught) position. The vertical may be found more convenient if it is desired to locate the carburettor at the lowest possible position, to facilitate gravity feed or compactness of installation. This, of course, necessitates fitting a right-angle bend in the induction pipe, which is sometimes liable to cause condensation or even freezing up. A separately mounted float chamber, with a flexible connection to the jet, may be preferred, to avoid risk of upsetting the float action by engine vibration: and a further alternative is to omit the float chamber. and feed directly to the jet by suction from a tank slightly below jet level. This gives less accurate metering than a properly working float, but is considered good enough for practical purposes, if the tank is not more than about 1 in. deep, to avoid wide variation of fuel level.

Float construction

Extra depth has been provided on the float chamber to eliminate spilling under vibration, though I have not found this necessary in test running. The float may be made of cork or of balsa, which is the more buoyant; after the pores have been stopped with a suitable filler, it should be finished with a petrol-resisting varnish, such as Phenoglaze, or one of the synthetic enamels. It is well worth taking the trouble to make either a metal foil float, or to fabricate a float of perspex or cellulose-acetate. Those who prefer to avoid such delicate operations may fit a ready-made float, as used in the carburettors of small mopeds or auxiliary engines. It is also possible to adapt the float needles of these carburettors; two or more grooves should be made in them to obtain the best fuel level.

For the home-made float, a clip will be required. While a wire one may appear simpler to make, the flat clip shown has been found most satisfactory. The holes may be drilled, before the clip is slotted with a miniature hacksaw, while it is temporarily soldered or cemented to a suitable solid backing. The simple bent clip for holding on the float chamber cover has also been arrived at as a result of experience. There are, of course, dozens of ways of effecting the same purpose, but when it becomes necessary to inspect the float at the pond-side the use of screws or other fixings which may drop into the works, or be lost, is obviously undesirable.

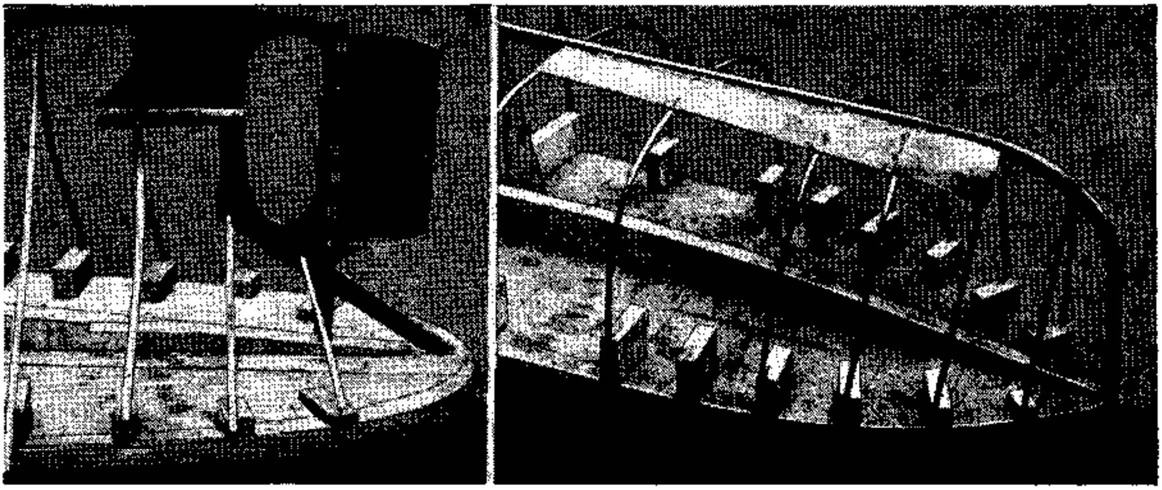
The brass components are mostly straightforward to machine. The spherical part of the banjo may be finished by means of hand tools while it is held by the screwed end in a nut or chucking piece. I have found that a hole of appropriate size drilled in sheet metal, with the unwanted part cut away, makes a convenient radius gauge. Of course, it is not essential that the part should be spherical, but it is worth while, on the grounds of appearance., to make it as neat in shape as possible. After cross drilling, the sides should be faced by mounting it on a stub mandrel.

For the float needle seating, you will find it best to make a simple D-bit to form the taper, as it is obviously important that this should be smooth and accurate to prevent leakage. The part is screwed in from the inside of the float chamber, and the slot in the head not only facilitates insertion but also prevents the float from blanking off the inflow of fuel when the chamber is empty,

In machining the jet tube, the important point is the concentric accuracy of the deep drilling. I have explained in previous articles how to obtain satisfactory results in this kind of work, using sharp drills, and running the lathe at the highest possible speed. The jet orifice is most conveniently drilled from the top end, with the screwed part mounted in a chucking piece; the outside of the jet may also be machined at the same setting.

The jet needle may be of composite

● *Continued on page 585*



Left: Cast gunmetal stern frame complete with rudder in position ready for the plating of the hull. Right: Plating begins. Short plates on the shorter spaced frames facilitate shaping

breast stay is, I will explain that it is the piece of plate that can be seen stretching across from the top of the bulwark rail; it is there to strengthen the bulwarks.

The pin is half-way down from the top of-the post to the breast plate. There is no hook this time; instead we have a small platform which is 18 in. high from the deck on Moorcock and 3/8 in. on the model. At full-size it is a piece of chequer plate; it could be imitated by scratching some lines on the piece of material. The size of the finished step is 3/8 in. x 9/32 in. Two brackets support the step, but as no one is going to stand on ours they can be omitted. Those who are real sticklers for detail, with Tom Thumb as their inspector, can amuse themselves.

It will be remembered that Mr Norman Kimbrey is building ***Moorcock*** to 1/2 in. scale and has adapted the method of making his hull with a bar keel and frame. He has now finished his hull.

The stern frame is particularly interesting because it is a gunmetal casting. Mr Kimbrey made his pattern to the drawing in this series and the method has saved him time and money. He tells me that his most anxious moment was in the drilling of the stem tube, for the hole is long, and extreme care must be exercised to see that the drill does not run off. Luckily his drill came through as near spot-on as makes no difference.

The bosses for the rudder hinge were not cast on but were silver soldered on afterwards in the manner which I recommended for the fabricating of the frame. The rudder is shaped from a piece of 1/8 in. thick brass plate and is operated exactly as on the full-size tug.

In the other photograph, Mr Kimbrey is just beginning his plating. Each plate has a lapped joint facing aft, which is correct for the bow and the stem. Amidships the plates should be butted, but Mr Kimbrey preferred to lap them to save himself the bother of lapping a butted joint on the inside of the hull. No one will quarrel with him; the work will not be seen when it is in the water, and when it is out it looks very smart. For those who know the tug extremely well will know exactly for what to look.

* *To be continued*

KIWI MARK II . . .

Continued from page 578

construction if desired, the head being screwed on and riveted, and the point inserted in a drilled hole in the shank. A plated gramophone needle is suitable; the important thing is that it should be both secure and concentric. Note that the thread on the shank should not extend into the gland, and the tapped hole in the base should be counterbored to a depth sufficient for the needle to screw right home.

If preferred, a plain drilled jet orifice may be used instead of the needle-controlled type, as the jet adjustment should not need to be altered when once it is properly set. It will be necessary to calibrate this type of jet by trial and error, as no exact dimensions of the hole can be specified. A number 80 drill-the smallest in the number size range-should be somewhere near correct, and a fine broach may be used to open it out if required; conversely, the bore may be reduced by swaging the tapered end with a burnisher or roller. Instead of making a one-piece jet of the external dimensions specified, the jets may be made separate and screwed into the top of the main portion, so that a range of jets, of different sizes, can be fitted.

In the assembly of the carburettor, the location of the jet tip should be carefully observed, by looking through the main air passage with the throttle wide open; it should just, and only just, be visible. The float should then be adjusted so that feed is cut off when a bead of fuel shows at the jet but does not overflow; note that the jet needle is opened fairly wide, so that it does not obstruct the flow. It may or may not be necessary to notch the opening edge of the throttle barrel, as shown, to obtain the correct mixture for slow running, as this is interdependent on the primary air intake.

No allowance has been made for the fitting of fibre joint washers above and below the banjo, as they obviously affect the jet location, and their thickness may be indeterminate. There should be no difficulty in making sound metal-to-metal joints with the aid of a little joint varnish. Whatever type of carburettor you employ, details such as these call for meticulous attention if consistent operation and good control are to be obtained.

* *To be continued*

KIWI MARK II

Continued from 10 November 1960, pages 576 to 578

By Edgar T. Westbury

With this instalment the modern version of the renowned little petrol engine is ready to give many years of faithful service

MANY of the troubles encountered with model petrol engines, and particularly the refusal of the engine to start at all, are caused by some deficiency in the ignition system. Apart from the actual electrical components, which usually comprise a battery and coil, the important mechanical item in the system is the contact-breaker which, though basically simple, is often badly designed or constructed, and therefore more troublesome than it need be.

At the time when the *Kiwi* was first introduced,, there was some difference of opinion on the respective merits of trembler and non-trembler ignition coils. Many users of model petrol engines preferred the trembler. It admittedly had certain points in its favour, not the least of which was that it provided its own circuit tester—an audible buzz when on contact—and a very convincing stream of sparks at the h.t. lead The very simplest type. of wine contact was sufficient for timing the spark, and the coil rarely gave much electrical or mechanical trouble, unless it had been badly made.

But the trembler coil is inherently inadequate to cope with the requirements of modem high-speed engines, and has now become almost entirely extinct. I doubt whether it would be possible to obtain one at all, and I mention it only because a few constructors still confuse the two types, and the distinctive ignition circuits and equipment associated with them. Most readers are sufficiently well acquainted with automobile electrics to know that the modem ignition coil employs a positive mechanical make-and-break device. which produces a spark at the time of the break, and not at the time of the make, as with the trembler coil.

To simplify the construction of the contact-breaker for the *Kiwi* engine as much as possible, and at the same time to ensure its reliable operation at high speed, I designed it for standard automobile components, which eliminated much of the finicky work involved in riveting or brazing contact tips, and so forth, not to mention the obtaining of. suitable contact materials. So far as I am aware, this form of construction was an innovation at the time, though it has been employed by many designers since; it is not necessarily the very best type of contact-breaker for small high-speed engines, and I have nut always employed it, but at least it operates with complete certainty.

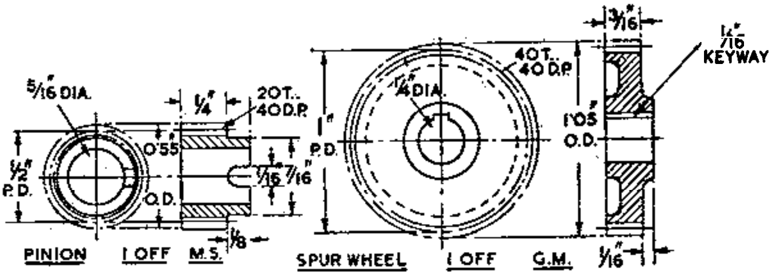
Some designers have used very small " scale model " contact-breakers, often of excellent workmanship.. While there is no apparent reason why very small breakers should not work quite well, they are mostly inaccessible, difficult to keep in proper adjustment, and liable to become oiled up: The inability of spark-ignition two-strokes to attain the high r.p.m. for which they are designed can often be traced to faults in contact-breaker design, as the spark frequency must be twice that of a four-stroke engine for a given speed.

The *Kiwi* contact-breaker has been used for several types of engines, both four-stroke and two-stroke, and will operate. at the highest speeds, if the cam is properly made. A specially light type of rocker arm is employed, and the electrical connections are positive; they are taken through the contact spring and not through pivots which may become partially insulated by a film of oil. It is, of course, possible to modify the design for other types of standard components, such as in the " 1831 " contact-breaker, which employs the Lucas bakelite bell-crank type of rocker arm.

Construction of the bracket is quite straightforward; a chucking piece is provided on the back of the casting, enabling it to be held for facing and. boring the boss, which should be made a tight wringing fit on the extended end of the camshaft bush-not relying on the ability of the clamping screw to make good an initially loose fit. as this distorts the bore so that it fits like a ready-made shirt on a gatepost.

The rear face of the boss may be machined by mounting the casting on a stub mandrel either before or after the split clamp is finished. It is advisable to drill and tap the hole for the clamping screw before slitting the lug, either by hand or by a small circular saw. The hole for the rocker pivot screw should be exactly parallel with the axis of the mounting boss, and it is worth while to set the job up on the faceplate, using a bolt through the hole in the boss, and clamping against the back face, for the facing and drilling operation.

Some care is necessary in locating both this and other holes so that the parts, particularly the contact screw, are correctly aligned when assembled. All the surfaces marked ***F*** in the draw-

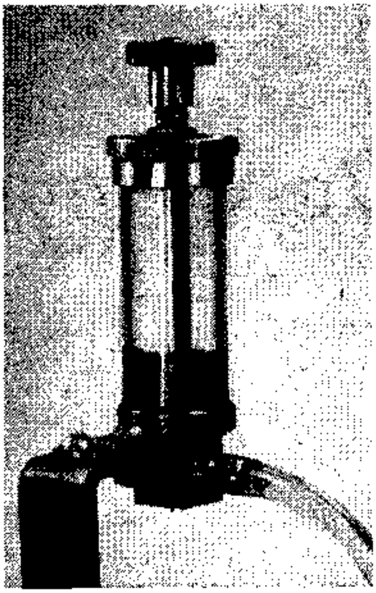


ings should be spot-faced or machined square with the axis of the holes. The pivot screw should be an easy fit in the fibre bush of the contact arm, and the screwed end preferably on the tight side; the lock nut is not absolutely essential, but is an added safeguard against working loose.

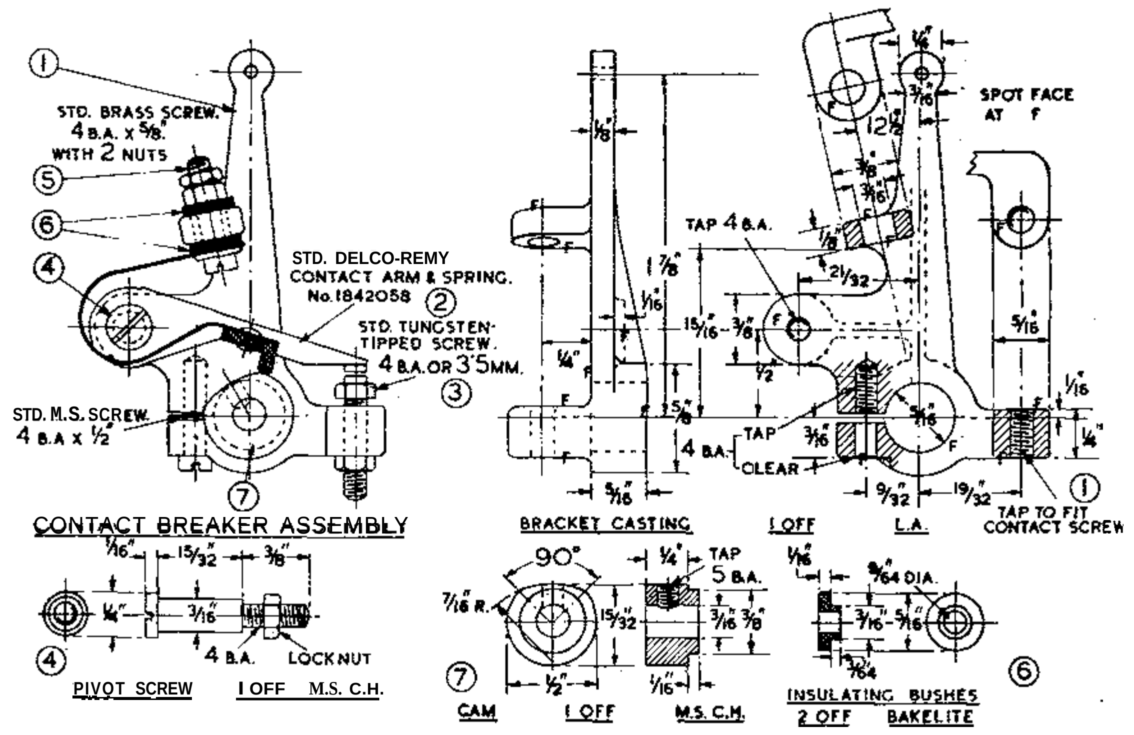
Either bakelite, ebonite or vulcanised fibre is suitable for the insulating bushes, which are clamped above and below the spring anchorage lug. A standard brass screw may be fitted; it serves to secure the end of the spring, with good electrical contact, and also as the 1.t terminal for the coil circuit. The cam is formed, after the machining of the blank, by setting it eccentrically and turning away about 90 deg. of the surface as shown; the amount turned away determines the length of time that the coil is on contact. For engines which run at relatively low speeds, the time may be reduced, to economise battery current; but at high speed a certain minimum time is necessary to energise the coil effectively, because of electro-magnetic inertia, or hysteresis. Some contact-breakers are made with just a flat filed on them. Though they apparently do all that is necessary, they cause unnecessary wear and tear of the contact arm, and are liable to cause it to bounce at high speed unless an abnormally strong spring is used.

The grubscrew shown for fixing the cam is effective if it is properly fitted, and a flat or dimple is provided on the camshaft; but an improved method would be to bore it taper and fit it to a correspondingly tapered shaft, with a screwed end for a draw nut. To time the cam, the engine should be set at t.d.c on the firing stroke, and the cam turned in the direction of rotation, so that it first makes contact, and then just barely breaks it, with the breaker lever in the vertical position; it is then secured permanently on the shaft. There is plenty of latitude for advance and retard adjustment while the engine is running. The contact clearance is not critical, but for high speed I have found that it is undesirable to exceed 10 thou, and if tbere should be any tendency to bounce, still less may be an advantage.

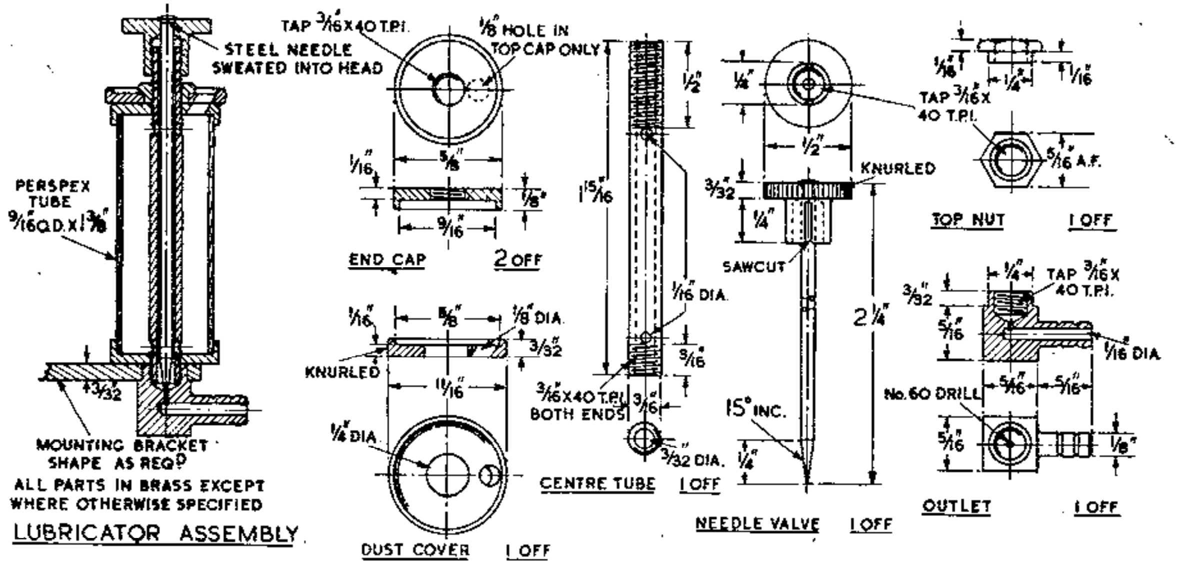
With the once-through or total loss, method of lubrication, as distinct from continuous oil circulation, some method of metering the oil is highly desirable;. the old method of hit-and-miss feeding would not be toler-



Here is the lubricator



THE "KIWI" MARK II CONTACT BREAKER ADAPTABLE TO ALL MODEL PETROL ENGINES



ated on modern engines, as it often results in alternate flooding and starvation of the working parts. Some users employ the spring-loaded syringe twe of oil injector. which works well if one does not forget to turn it on-and also off again at the end of the run-but it is rather fierce in action and calls for critical adjustment of the oil feed valve. With the crankcase pressure kept below atmospheric, oil can be fed quite effectively by suction, especially with modern oils which are much less gummy or viscous than those used in the early days of the ***Kiwi.***

The lubricator shown here is one that I have used for both suction and gravity feed on several types of engine; it is very simple to make and should preferably be fitted apart from the engine mounting so that it is not affected by vibration. The body is made from a transparent plastic test tube; no doubt some of the containers in which tablets and other medical commodities are supplied could be adapted for the purpose. Thin metal tubing is practicable as an alternative, but it is obviously an advantage to be able to see how much oil is available in the container. Glass needs careful fitting to avoid leakage, and is undesirably fragile. The assembly is held together by a length of 3/16 in. dia. brass tube, screwed at both ends, and cross-drilled for oil at the bottom and air at the top. Two recessed end caps, identical except that one is provided with a hole for filling, are used to clamp the body endwise; the plastic tube is faced accurately on the ends and fits closely in the recesses.

A rotatable disc cover is fitted over the top cap, and held down by a spigoted nut so that it is just free to move somewhat stiffly. The hole through both cover and cap may be drilled ***in situ;*** it should be as large as practicable, and may be elongated if desired to provide free access for filling. A steel, bronze or German silver needle valve, with the knurled head sweated or otherwise firmly secured, is fitted to regulate the oil flow. It will be seen that the lower part of the head is split, and is squeezed slightly inwards to provide a friction grip on the thread; this must be done very gently and discreetly to avoid complete collapse. Alternatively. a compression spring may be fitted between the head and the cover to provide the necessary friction

Details of the outlet connection. and of the mounting bracket, may have to be varied to suit the position and method of mounting; both parts may be permanently sweated to the bottom cap when these points have been settled The centre hole which forms the needle valve seating may be very slightly countersunk by an acute-pointed drill or a graver, and the position of the needle may be ascertained on assembly and sweated in position with a well-heated soldering bit

The only difference between suction and gravity feed is that in one case the lubricator is fitted below the engine feed inlet level and in the other above it; the former may be somewhat less positive, but has the advantage that the oil ceases to flow when the engine stops, and in this respect is more completely automatic. In either case the regulation of oil flow is soon found by trial, and is not very critical.

If the crankshaft is not drilled to convey oil to the big end bearing, oil may be fed directly into the crankcase, but it is better to retain the same feed inlet on the main bearing and to provide a longitudinal oilway in the bush, so that oil must always pass through it on the way to the crankcase. In this event, an oil hole must be drilled in the ***underside*** of the big end bearing.

I am often severely rapped by readers for neglecting to give details of valve springs, but it is difficult to specify essential dimensions, because ultimate strength and durability depend on several factors, including not only the quality and temper of the spring steel, but also the pre-stressing of the material in manufacture. For the best results, some experiment is called for; the springs which have been found satisfactory are 3/4 in. free length, 5/16 in. outside diameter, by 20 s.w.g., with six complete turns, not including the flattened end turns.

Most of the points affecting assembly I have dealt with in describing the details, and no particular problems should be met if all parts are accurately made and fitted. There is, however, a possibility that the connecting rod may foul the cylinder skirt on one or both sides, at its maximum angularity, and this may necessitate filing notches in the skirt at an appropriate angle so that it just clears. Do not emulate the engine constructor who provided clearance by filing notches in the connecting rod !

I have already indicated many ways in which this simple engine may be improved. To those who have not had previous experience of engine

● *Continued on page 656*

Christmas Shoppintg

contd.

Araldite epoxy resins, used industrially for high-grade electrical components and for corrosion-resistant coatings, have revolutionised the permanent bonding of metals, glass and other non-porous materials that have in the past proved almost insuperably difficult to join.

Araldite can also be used for sealing and filling cavities or. in conjunction with- glasscloth, for making reinforced plastics. It is supplied in 6s. two-tube packs from ironmongers.

Power pack

Whynot give your model railway -or your model railway owning friend-the Trainsmaster 622 ?

This is not just a new power pack (good as it is, at that) but is a form of control for two trains of an entirely novel conception.

Two trains on one track-six areas for separate control-two operators or one at immediate choice. It gives perfect control of locomotives at all speeds with maximum power.

Every unit is supplied with detailed illustrated instructions, and only seven wires are necessary to install it. Price is 9 gns. Bassett-Lowke will gladly send-full details on request.

Shims and gears

THOSE in search of materials might well profit by a visit to T. W. Senier and Co. Ltd, at 115-123 St John Street, Clerkenwell, London, ECl.

The policy of this old family business, which has been in existence since the reign of George III and the time that the American revolution drew to a close, is to give as much attention to the small order as the large.

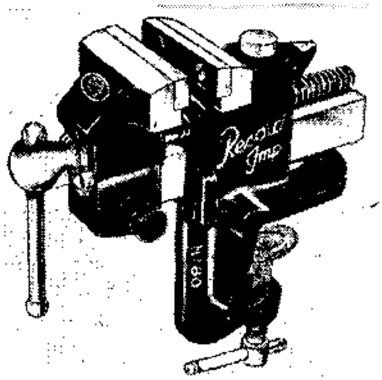
Their stock covers a vast range of materials and includes sheet metals in most gauges, brass, copper, steel and silver steel in various sections and angles, brass blanks, and ranges of BA screws, with nuts and washers, in cheesehead, roundhead and countersunk types.

It is not generally known that Seniers carry a tine stock of gears and that they can supply packets of shims in assorted sixes.

If a special soldering job crops up a visit to Seniers may prove worth while, for they have an excellent variety of solders, fluxes and spelters.

Their assistants are courteous and ready to offer advice.

Lightweight vice



THE Record No 80 Imp is a lightweight vice designed for use either on bench or table. It is sturdy and compact and embodies a wide range of features. For example, the clamp for alternative fixing may be bolted or screwed; it has hardened steel jaws, pipe grips, hardened steel anvil, and a pipe bender. The Imp is ideal for general instrument work or model engineering and, attractively finished in bright red, makes a useful gift. Price is 37s. 6d

Tools in the Fabrex 400 range already number several hundred but their number is constantly being increased to meet special needs. Among the popular items are a hand drill at 14s. 6d. and one slightly larger, at 23s. 6d., table vices at 13s. 6d. and 24s. 6d., light machine vices, 21s. and 35s., a bench grinder with 4 in. wheel for 33s. 6d., with **5 in.** wheel 39s. 6d. and 6 m. wheel **58s.**

In the workshop

HOLTS, a firm well known for their motor car preparations, manufacture several items which can usefully be kept in the home workshop cupboard.

Loy Cold Plastic Metal sets harder than lead and proves very effective for a minor ship modelling repair. It is sold in tubes of two sixes, 2s. and 3s.

For the small soldering job, Soldapaste, in which solder and flux is mixed in paste form, is efficient, needing only the heat of a match flame. Tubes cost 1s. 9d., 8 oz. tins 8s.

Rust, especially this time of year, is the curse of an outdoor workshop. Holts Thixotropic Rust Remover Paste has a powerful rust removing action. Being jelly-like it stays where it is put. Its action not only removes the rust but primes the metal surface ready to receive paint. A 4-oz. tin costs 3s., a 12-oz. 6s. 6d.

Ship modellers will find Twinbond, a new unique epoxide resin adhesive, a valuable general purpose cement. It is proof against boiling water, petrol, acids and does not shrink or expand when setting. Price is 5s.

KIWI . . .

Continued from page 635

construction, are recommend to build it in the form described at first, and to proceed thence by easy stages. Many of the possible improvements have been investigated and described in the course of experiments which culminated in the development of the Kittiwake 15 c.c. and Kittyhawke 30 c.c. engines. They included the addition of a " fit and forget " forced lubrication system, with a gravity sump and a submerged plunger pump, and also an inclined-valve cylinder head with larger ports and enclosed offset rockers. But any advance in engine performance necessarily imposes heavier duty on all working parts and, therefore, calls for the highest standard of workmanship; and for the beginner, at least, the standard ***Kiwi*** Mark II may be relied upon to give faithful service in any sphere of duty.