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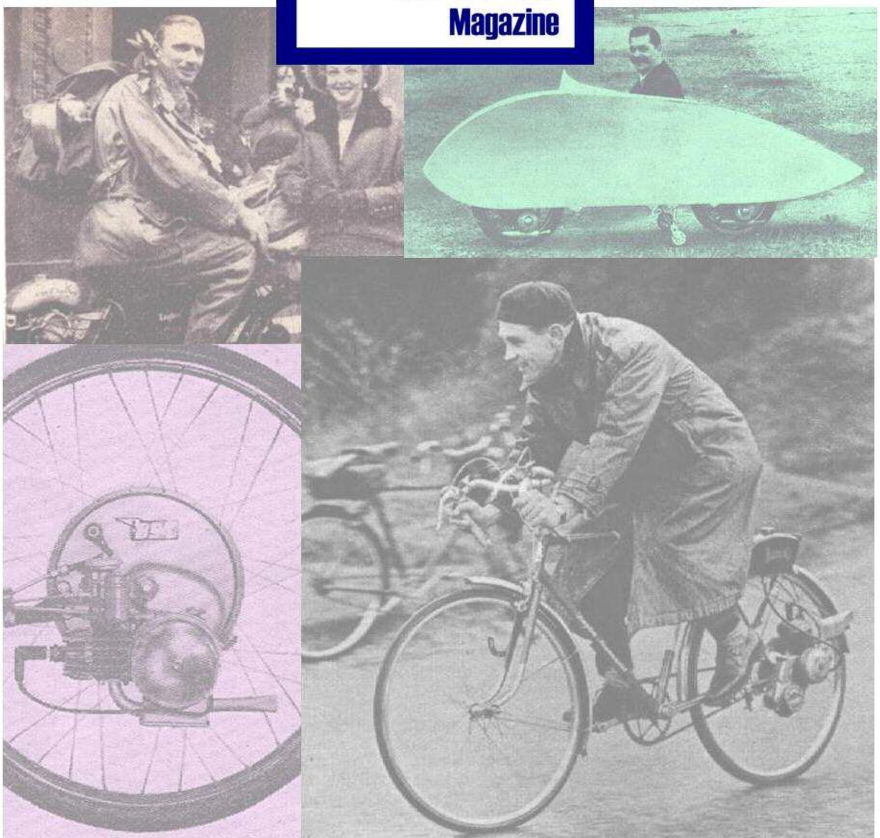

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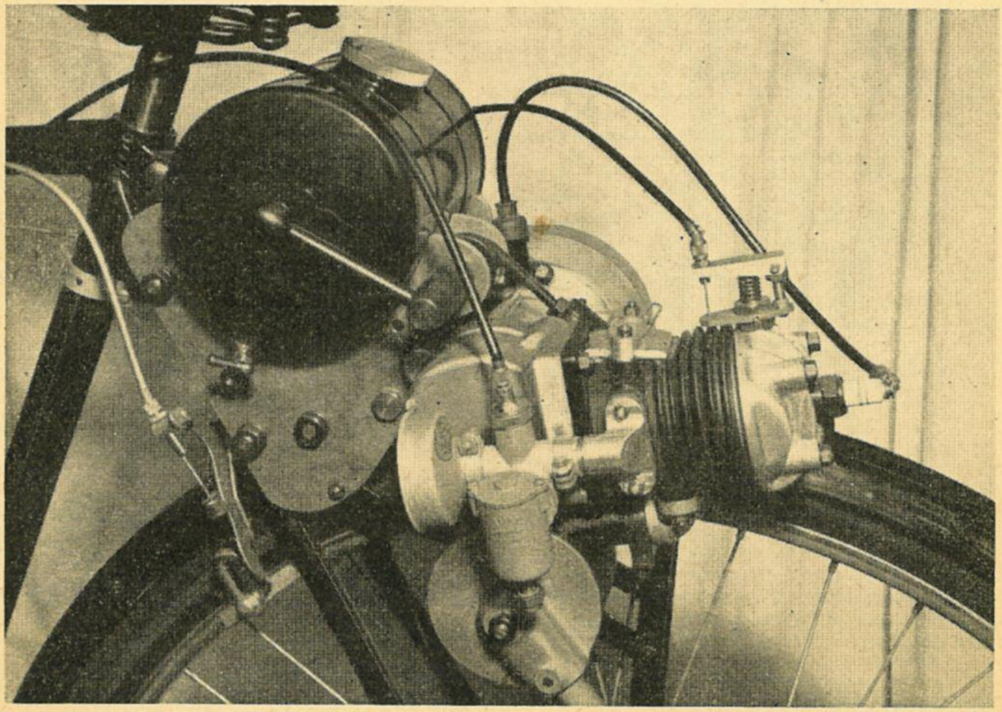
PETROL ENGINE TOPICS

A 50 c.c. Auxiliary Engine

by Edgar T. Westbury

THE tendency in the development of model i.c. engines during the last decade or so has been towards smaller and smaller capacity, and in some cases this has been carried *par reductio ad absurdum* almost to the vanishing point. While the ultra-tiny engine has its advantages for certain purposes, not to mention an irresistible fascination for a small number of constructors, it is hardly suited to the skill and facilities of the vast majority who constitute the rank and file of model engineers. Commercial manufacturers with special equipment for small scale precision work have exploited the possibilities of very small capacity engines to an extent which tends to discourage the amateur from pursuing this particular line of construction.

Be that as it may, however, it is a fact that, at the present time, there are definite signs of a return swing of the pendulum, and it is clear, from the opinions expressed by correspondents, that many of them are becoming interested in engines of larger capacity. Such engines are less exacting in respect of limits of accuracy in machining and fitting, but they give more scope for little refinements of detail design which help to make miniature engines look more like their full-size prototypes, and, what is still more important, to behave like them, too.

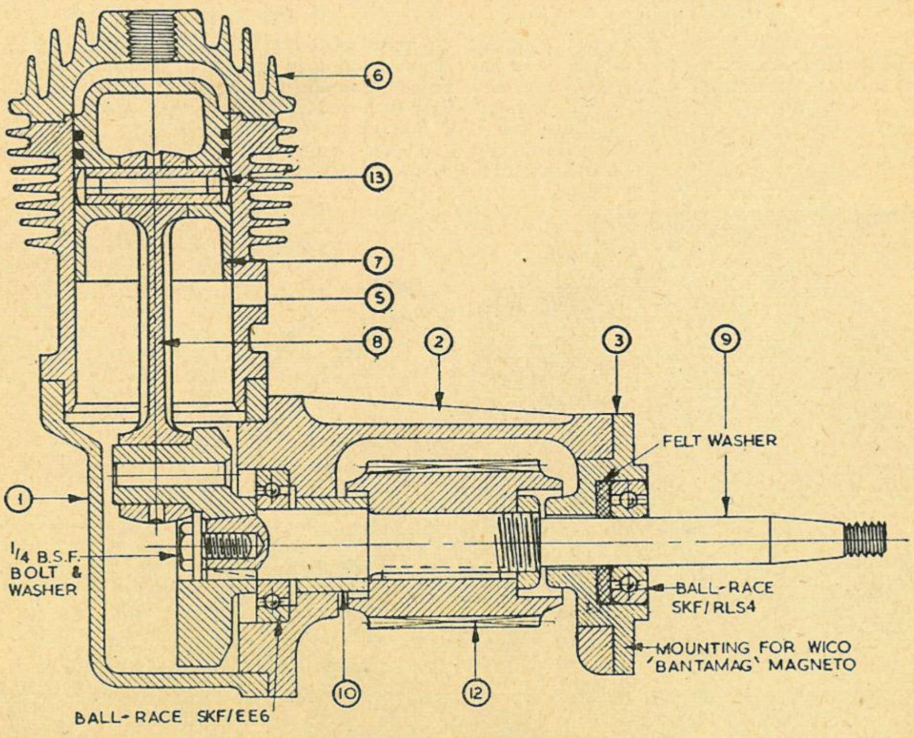


The "Busy Bee" engine mounted on cycle and driving rear wheel by means of a friction roller

For some years now, I have had discussions with readers on the subject of engines of fairly large size, as models go, which could be applied to utility purposes, such as generating current, pumping water, driving a lathe or turning the cutter cylinder of a small lawn mower. These readers have been very persistent, and their claims have not by any means been ignored. I have gone so far as to lay out two or three tentative designs for utility engines, both of the 2-stroke and 4-stroke type, as a basis for development, but the more popular demand for small engines have tended to push these projects into the background, and have prevented me doing much practical work on them until comparatively recently, when it became clear that engines of small capacity were beginning to attract much more attention, and proving themselves capable of very wide application.

In recent years, there has been almost a complete metamorphosis in the design of small-power stationary engines, from heavy and massive water-cooled types with large bore, long stroke and slow speed, to light small-capacity fan-cooled high-speed types. In motor-cycle practice, the popularity of the large "slogger" has declined in favour of small high-revving engines. A very important development of the modern era has been the practical realisation of a very early idea, namely, the application of an engine attachment to pedal cycles, and this has been rendered possible only by getting down to engines of sizes as small as 50 c.c. or less. The construction of such engines is well within the capacity of the amateur workshop, and it is not surprising to find that many readers of THE MODEL ENGINEER are definitely interested in this class of work.

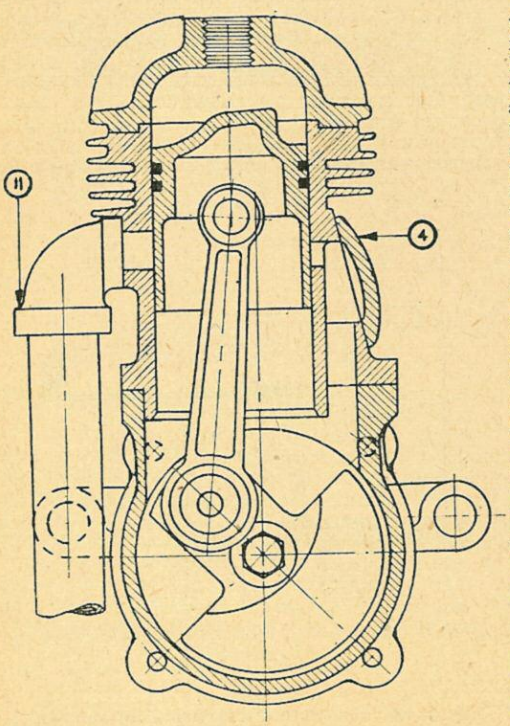
It would, of course, be idle to suppose that the reduction in the size of engines is an unmixed blessing. Large and massive engines have many advantages for stationary work where there are no urgent restrictions on weight or space occupied. By using a large cylinder displacement, it is possible to obtain the required power at low pressure and slow speed, which makes for free and comparatively silent running, with long wear of working parts and little vibration. Small high-speed engines are admittedly more noisy and fussy ; they lack flexibility and are generally more addicted to "a short life and a gay one." A large engine may be actually more economical to run than a small one for a given output, as it can be adjusted to run with a weak fuel setting, and its maintenance costs may also be lower. In automobile paractice, the merits of having ample engine capacity in hand are fully recognised, but are offset by the anomalies of the existing taxation system.



Side view of the "Busy Bee" 50-c.c. auxiliary engine, showing vertical cylinder arrangement

However, small engines, if well designed, are capable of doing very useful work, and have many advantages in respect of lightness, portability, and small bulk, not to mention low initial cost. In the case of engine attachments for cycles, small size and lightness are really essential factors to their success. The attachments which were produced in the early days of engine development usually failed because they were too heavy and bulky for the lightly-constructed standard cycle frame, which often gave way or quickly rattled itself to destruction. The intermediate stage between the true motor-cycle and the motor-assisted cycle, namely, the auto-cycle (a cycle with specially strengthened structure and adapted for power drive), owes its present success and popularity to the evolution of a light, but sturdy and reliable, engine and transmission unit.

A good many amateurs have attempted, with a varying degree of success, to build their own engines for pedal cycle attachments, and at least one of these efforts has been described in THE MODEL ENGINEER. I can claim to have done some pioneering in the application of miniature engines to "personal traction," though my experiments were not aimed at the development of a utility power unit, but simply to demonstrate what a small engine was capable of doing. They were carried out over 20 years ago, and consisted



End view, section on centre-line of cylinder

of mounting my now historic "Atom I" 52 c.c. engine, complete with a 24-in. airscrew, on the handlebars of a cycle. This simple "lash-up" proved capable of propelling the cycle (and rider) at a speed of 10 m.p.h. on the level, and of climbing moderate gradients, but airscrew drive is obviously inconvenient for use on the King's Highway, and probably illegal, though I do not know whether there is any definite ruling on this matter at present. No attempt was made at the time to develop an alternative form of transmission gear.

Since the war, I have followed with interest the development in the use of power attachments for cycles on the Continent, and I have made some further experiments which gave results sufficiently encouraging to justify the development on a special engine design. I would like to make it clear, however, that no commercial application of the idea was visualised, as I was of the opinion that the more conservative British cyclists would not be very keen on power drive; but it would appear from present indications, I was entirely wrong. My object was simply to produce an adaptable form of engine design suitable for amateur construction, and applicable to practically any utility purpose, within its power capacity.

Why an "Auxiliary Engine"?

I have called this an auxiliary engine because it was, and still is, intended to have a much wider application than that of a cycle motor. The literal meaning of the term as given by a well-known etymological dictionary is "rendering assistance, helping, aiding; subsidiary to." For some reason, modern technical usage favours the very similar word "ancillary" which is apparently taken to mean much the same thing, though it is derived from a Latin word which specifically denotes "female servants." I mention this because, in common with most writers, I am regarded as legitimate prey by those pedants who delight to split hairs over the exact meaning of technical terms, and somebody is sure to take me up over this one!

In a previous issue of THE MODEL ENGINEER I made some comments on the application of small engines to everyday utility work, and emphasised that the paramount qualities called for in such engines are stamina, durability and complete reliability. It is in this respect, apart from the mere matter of size, that they differ from the type of engine most commonly encountered within the sphere of model practice. The great majority of such engines are intended only to run for comparatively short periods, and have a relatively short life in actual working hours. As a result, it is possible to work to narrow margins of strength in their structural and working parts, and bearings are often restricted in diameter and surface area far below what would be considered adequate for continuous work.

Some model engineers have attempted to build engines for utility work which are practically scaled-up versions of popular high-efficiency racing engines, but the all-round results are not likely to be highly satisfactory. Not only is the life span of such engines too short to be worth while, but the porting of an engine intended to work at something well over 10,000 r.p.m. is by no means the best possible for one which is not likely to attain much more than one-fourth this speed, and in which flexibility and ability to pull at much lower speeds are highly desirable factors. A very strong objection to running utility engines at very high speed is that lubrication is difficult, and oil consumption heavy, apart from other disadvantages such as increased wear, noise and vibration. It is my firm belief that simplicity is a prime necessity in the practical success of the auxiliary engine as applied to cycles. Not only must the engine itself be simple, but the means of attachment to the machine, and the method of transmission, should conform to type. In this respect, the friction drive to the cycle tyre, although mechanically crude, gives remarkably good results in practice, and requires the minimum of adaptation or alteration to the cycle itself. This is the method recommended for the engine now to be described.

It will be seen from the general arrangement drawing that the engine is a straightforward type

(*Continued on page* 418)

in Fig. 5D, a $\frac{5}{8}$-in. washer is slipped on and rests on the surface of the vice-jaws. The height of the arbor in the vice is then adjusted to bring the pencil mark level with the upper surface of the washer. To form the first flat, the file, with its safe-edge downwards, is applied as shown in Fig. 5E and filing is continued until a micrometer measurement, Fig. 5F, shows that nearly 50-thousandths of an inch has been removed. At the same time, the file must be kept truly upright and the strokes made squarely across the vice-jaws. This operation is then repeated, without moving the arbor in the vice, to form the second flat parallel with the first and to reduce the distance across the two flats to approximately 0.534 in. It is, however, advisable to check the parallelism of the two flats from time to time with the micrometer during the filing operation, as represented in Fig. 5G. It now only remains to file the two flats in turn with a fine file until the spanner fits closely in place. As this spanner will be required so often when using the lathe, it should be kept where it can easily be found and not allowed merely to lie somewhere on the bench. Where the lathe is mounted on a wooden bench, the spanner can be attached to the front edge of the bench itself in a position near to the tailstock; two round-headed wood screws, fitted as shown in Fig. 6, make a convenient form of attachment. Spanners so mounted are very easily picked up and returned to their places; moreover, as they do not project below the bench top they are not liable to be knocked from their hangings when the operator is using the lathe.

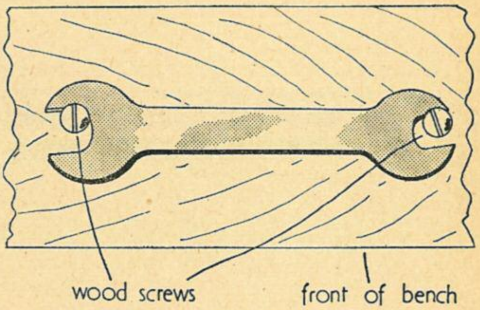


Fig. 6. Hanging the spanner on the bench

Petrol Engine Topics

(*Continued from page* 415)

of three-port two-stroke, in which the general working parts are fairly conventional in design, but the details have been adapted to suit the particular class of work for which it is intended. The bore is $1\frac{5}{8}$ in. and the stroke $1\frac{1}{2}$ in., giving a capacity of slightly over 50 c.c., but as there are no class restrictions at present in existence on these engines, I have not considered it necessary to keep within the 50 c.c. limit. The parts of the engine are individually simple, and though there is more work in actual construction than usually encountered in small model two-stroke engines, there are no operations which should give any difficulty to the constructor of average ability.

In the development of this engine, I have been very fortunate in securing the co-operation of the Myford Engineering Co. Ltd., of Beeston, Notts, who have used the engine as an exercise and practical demonstration in the operation of the M.L.7 lathe. As readers are well aware, the engine designs which I have described in THE MODEL ENGINEER have all been claimed as suitable for construction on a $3\frac{1}{2}$-in. lathe of the type generally used in model workshops. This applies, not only to actual turning operations, but all the machining processes. This policy has been followed in the case of the present engine, and its construction has amply demonstrated the suitability of the M.L.7 lathe for this class of work. Many of the photographs which will be used to illustrate the constructional processes were taken in the Myford works, but I would like to make it quite clear that the only machine tool used was the type of lathe already mentioned, and a standard lathe of exactly the same type as that available to readers was employed. Some of the machining processes on the engine were demonstrated on the Myford stand at last year's "M.E." Exhibition, and a finished engine, though at the time in the embryo stage of practical development, was shown fitted to a cycle on the same stand.

In order to simplify the work of construction, the engine has been made suitable for use with a commercially available type of carburettor and magneto, though in the case of both these items, I have prepared special designs which are well suited to amateur construction. Whether these will be described in detail will depend very largely on whether there is any great demand for them. It would, of course, be quite possible to employ coil ignition on this engine, and some readers may prefer to do this. The engine may be built with either horizontal or vertical cylinder (the latter is shown in the general arrangement drawing), without any actual alteration of its working parts, and when used for cycle propulsion, it may be fitted either on the front or rear of the machine, the latter position being used in the case of the engine seen in the photograph. For other purposes, some adaptation of the structural components of the engine is desirable.

I would like to make it quite clear that the engine is not designed for quantity production, but for individual construction by the methods and facilities available to amateurs. Castings for the construction of the engine, also the accessory components, can be obtained from Messrs. Braid Bros., 50, Birchwood Road, Hackbridge, Surrey. The name adopted for this engine is the "Busy Bee" which, in common with the names of my previous engines, means something—I hope!

(*To be continued*)

PETROL ENGINE TOPICS

*A 50 c.c. Auxiliary Engine

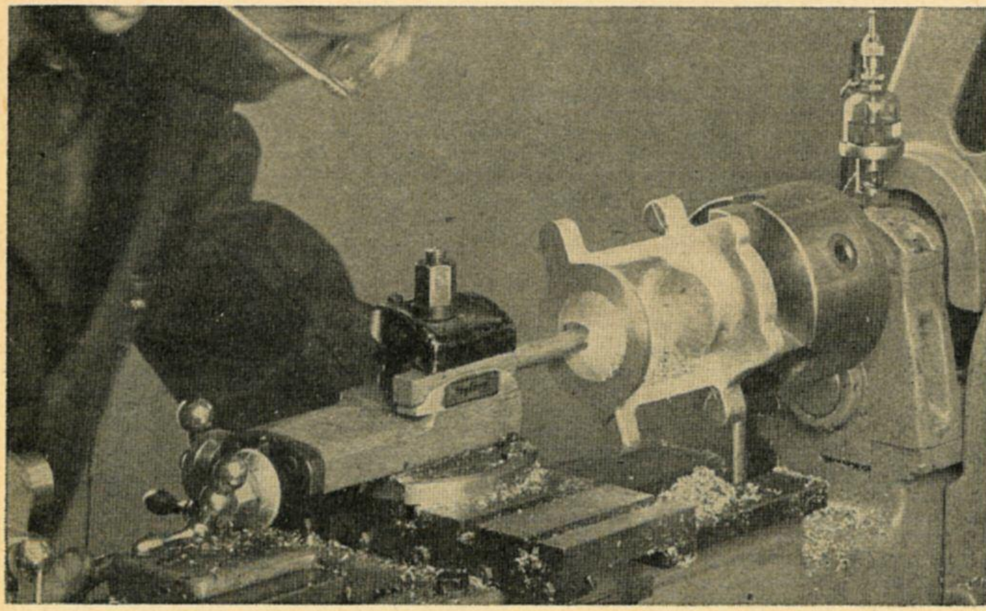
by Edgar T. Westbury

THE most important structural component of this engine is the main housing, and the machining of this casting may well be taken in hand first, though there is no rigid order of precedence in this respect. It will be seen that the two ends of the casting are bored in axial and concentric alignment to take the inner crankshaft ball-race and the outer-end spigot plate or housing, which in its turn carries a second ball-race. The alignment of the two races is obviously of the highest importance, as any error in this respect would cause them to bind, and though this trouble could be side-tracked by using self-aligning races, it would involve the equally serious trouble of binding in the packing bush.

There are several ways of machining the casting so as to ensure alignment of the two ends; a fairly obvious method would be to machine the inner-end first, including the two diameters for the ball-race recess and the bush seating, and then locate from these bores by mounting the casting on a stepped spigot mandrel held in the four-jaw chuck, for dealing with the outer-end. While this is fully practicable, however, it entails the necessity for turning up a large piece of material, which possibly may not be readily available in the small workshop, especially in these days of scarcity.

The method actually adopted was simpler in respect of preliminary preparation, and equally effective. As will be seen from the photograph, the casting was first held in the chuck, with the outer-end projecting, and set up so that the circular portion of the outside surface ran fairly true. The cored hole should not be taken as the reference surface, as it is always possible that the core may not have been placed exactly central when the casting was made. As I have often pointed out in articles on machining, castings should always be set up by reference to the surfaces which will finally be left unmachined, unless other surfaces are so badly out that they will not clean up to finished size, when some compromise must be made; this state of affairs, however, should not arise with good castings.

Provided that the surface of the inner-end spigot is reasonably clean, it is quite in order to hold the casting, by this surface, in the three-jaw chuck, as the work to be done on the outer-end



The first operation on main housing: facing and boring the outer-end

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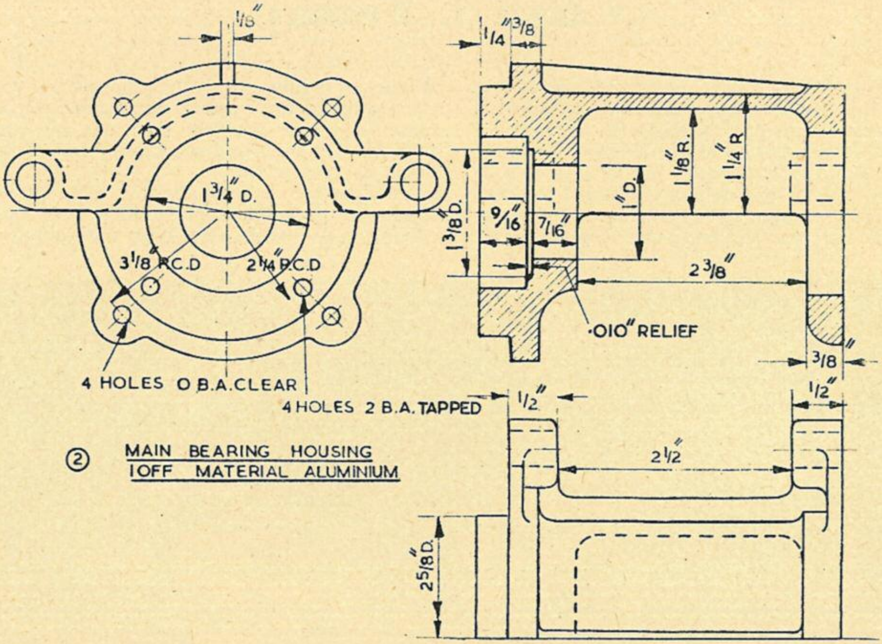
**Continued from page* 418, "*M.E.*," *March* 29, 1951.

is quite light. If bumps or flashes exist on the casting, they may be filed off before setting up ; no marking-out of the casting should be necessary before main machining operations, but a rough check-up to guard against major inaccuracies is desirable.

need not necessarily be dead true, if the disc is machined after mounting, and is not shifted before the casting is located on it. Two light clamps, over the lugs of the casting, will then secure the latter firmly against the faceplate.

Machining of the inner-end, including the



② MAIN BEARING HOUSING
1 OFF MATERIAL ALUMINIUM

spigot and the two diameters of the bore, is quite straightforward, but in the latter operations, exact sizes must be observed. The ball-bearing manufacturers specify that the outer race should be a neat push fit, but in my experience, a somewhat tighter fit is desirable in a light alloy housing, owing to the fact that the machined surface tends to hammer or burnish down slightly in the early stages of running, and the race is liable to become slack. It is not easy to fit a ball-race by "feel," as its axial alignment cannot be ensured, and I recommend making a temporary plug gauge, which may consist of a disc of metal held on a mandrel or bolt, and machined on the outside to about 0.001 in. smaller than the diameter of the race. When this will slide into the bore without shake, the fit of the race is about correct. I do not approve of boring housings slightly undersize, and fitting the races by hand scraping, as this may introduce inaccuracy, however carefully it is carried out.

The bore of the bush seating may have to be related to the diameter of a ready-made bush, and the amount of interference recommended by the makers should be observed. In the machining of the housing spigot and flange face, exact dimensions are less important, but it is desirable to finish these before the boring operations, so that the depth of the ball-race housing can be gauged. Do not forget to relieve the face of this recess so that the inner race does not foul ;

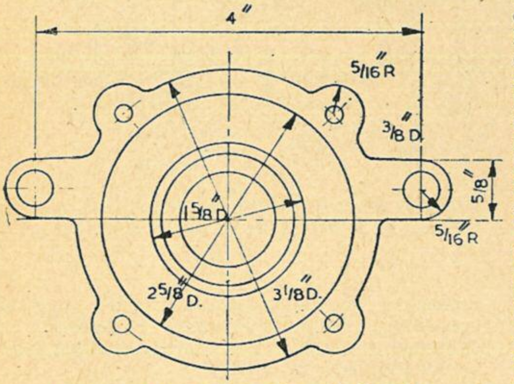
The outer-end face of the casting is then faced off, and the hole bored ; in neither case is critical accuracy of dimensions important, as there is no positive end location of the outer bearing, and, the spigot of its housing can be fitted to the bore, but it is obviously desirable to work as closely as possible to the given sizes. What is important is that the bore should be truly circular and the face flat, and at right-angles to it, both of which conditions should be automatically ensured by careful machining.

In the second operation, both these surfaces are used as reference faces to ensure that concentric and axial alignments are positively assured. The casting, as seen in the next photograph, is clamped to the faceplate, which, assuming the latter runs truly (and if it does not, it should be corrected before any attempt is made to carry out accurate work!) will provide true axial alignment ; its bore is located by means of a spigot or "bung" to take care of concentricity.

The locating spigot consists of a disc, which need not be of any great thickness, secured to the centre of the faceplate in any convenient way. In the example illustrated, I pressed a disc of light alloy on the parallel end of the Myford hollow centre, and after inserting the latter in the mandrel socket, machined the outside of the disc *in situ* to a push fit in the bore of the casting. Any old centre, or the shank of a broken Morse taper drill, may be used to carry the disc, and it only a few thousandths of an inch are necessary, and the relief should extend outwards to about the inner diameter of the outer race.

End-location of Ball-race

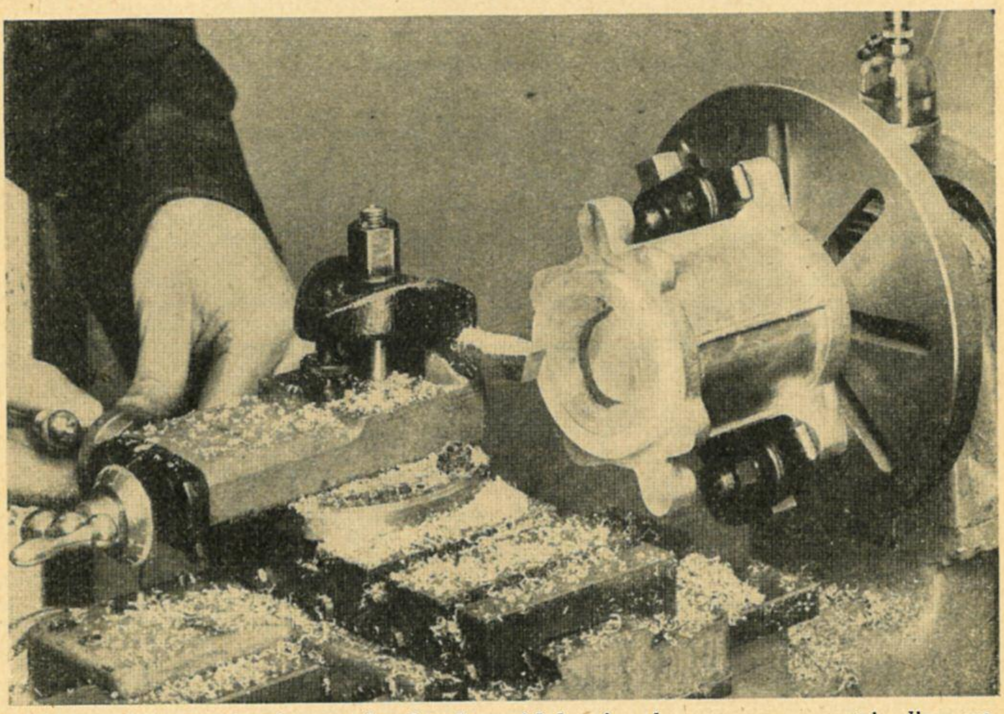
I have never found it necessary to clamp or otherwise end-locate ball-races in my engines, provided that they are properly fitted, and the shaft is prevented moving endwise, but if constructors wish to add some provision of this nature it is quite possible to do so. The simplest form of locating device is a circlip, preferably of the Seager (pressed steel) type, rather than a plain steel wire ring ; a groove to take this may be machined in the recess, immediately in front of the ball-race. If it is desired to clamp the race, a retaining flange, with an inner projecting lip, may be fitted to a suitable recess machined in the front face of the housing, and secured in place with four or more countersunk screws.



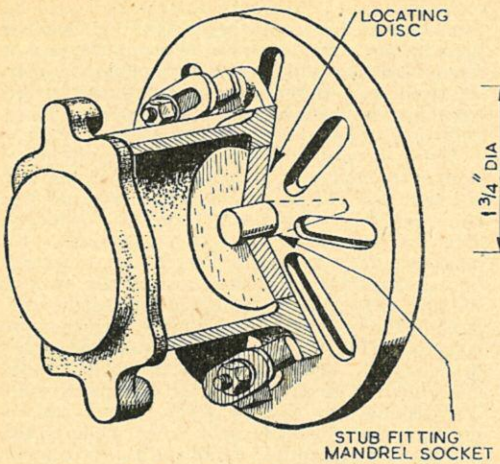
Inner-end face view of main housing

While the casting is still in the lathe, the positions of the stud holes in the flange may be marked out with the aid of an indexing device on the lathe mandrel, or better still, " spotted " by means of a drill spindle on the lathe cross-slide. To mark out the holes in the bearer lugs, a centre-line should first be struck horizontally with a scribing block on the lathe bed, across the end faces of the spigot and flange ; the scriber point is then raised $\frac{5}{16}$ in. and another line scribed across the face of the lugs, then produced on their ends, and extended to the other pair of lugs as well. The casting may then be reversed and held in the three-jaw chuck, a check being made to see that it is not perceptibly out of truth ; the centre-line of the lugs can then be picked up with the scriber and produced across the other end face. A point tool held in the tool post may be used to mark the radial position of the holes, which are 4 in. apart, but as they do not lie on the diametral centre of the flange, that is not the same thing as 2 in. radius.

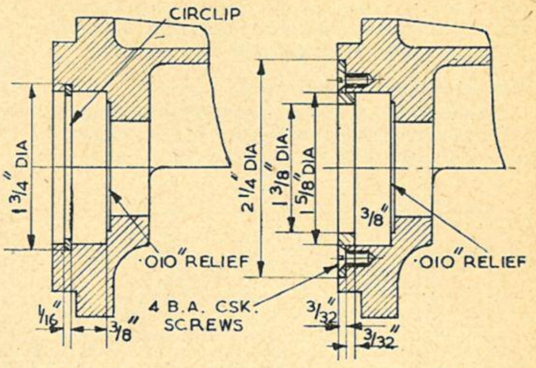
Unless one has a fairly large drilling machine —and not always then—I do not recommend attempting to drill the holes in the lugs directly to full size at one operation. It is better to drill small pilot holes, not more than $\frac{1}{8}$ in. diameter,



Main housing reversed and mounted on faceplate, with locating plug to ensure concentric alignment



How the main housing is located to ensure concentric alignment of bearings



Methods of end-locating the inner ball-race, by the use of either a circlip or a retaining plate

from both end faces, and open them out afterwards. As the accuracy of the holes is of some importance, it is advisable to finish them with a reamer. The inner faces of the lugs may be spot-faced, if a suitable cutter is available, or skimmed with a lathe tool while the casting is set up for the main operations.

(To be continued)

Models at the Packaging Exhibition

by F. J. Christall

THE use of models of various kinds as part of the exhibits at the recent Packaging Exhibition shows an increasing interest by firms wishing to make their exhibits more attractive and instructive.

Further, a well-made model is far more impressive than a photograph.

The biggest exhibit, and perhaps the one to attract most attention, was the *Van Leer Mobile Drum Factory* (full size) in which a complete steel drum, from the sheet steel to the finished enamelled drum, was made on lorries parked together to form a factory.

A model of the firm's factory at Ellesmere Port to a scale of 1 to 150 included a most attractive reproduction of an 0-4-0 saddle tank, *Stanlow*, with trucks and vans.

There was also a larger model of one bay of this factory, showing working models of some of the plant, and at one end another model of *Stanlow*, this time to a scale of 3/8 in. to 1 ft., and some covered vans.

The Johannesburg factory was also shown in model form with 3 ft. 6 in. gauge flat cars and box cars (bogie) of the South African Railways.

Another exhibit was of over 100 models of motor-cars, vans, trailers, etc., from the study of which the mobile factory was designed.

In the rest of the exhibition, in the main hall, the following were noticed :—

Printing, Packaging and Allied Trades Research Association.—Model of testing plant for various forms of packages, including " Impact," " Crush," and " Vibration " tests, etc. ; this was a working model about 3 ft. × 2 ft.

Parcels and General Assurance Association.—Leeds Model Company's 0-4-0 (smoke effect) tank and goods train on large oval, which must have covered a few miles during the course of the exhibition. Also on this stand were waterline models of cargo and passenger steamers and aircraft.

Export Packaging Service Ltd.—Factory, docks, waterline ship models, warehouse with sidings and Trackmaster trucks and vans.

Alite Filling Machines Ltd.—A 1 in. to 1 ft. model of a powder filling machine, forming the centre part of the decoration of the back of the stand.

Van Leer Mobile Factory.—Scenic model with a road climbing a hill (hairpin bend) and crossing itself on a girder bridge. At intervals along the road were models of the various vehicles used in the mobile factory—trailers, vans, cars, etc.

No doubt at future exhibitions a still larger number of models will be used to the interest of model makers and customer alike.

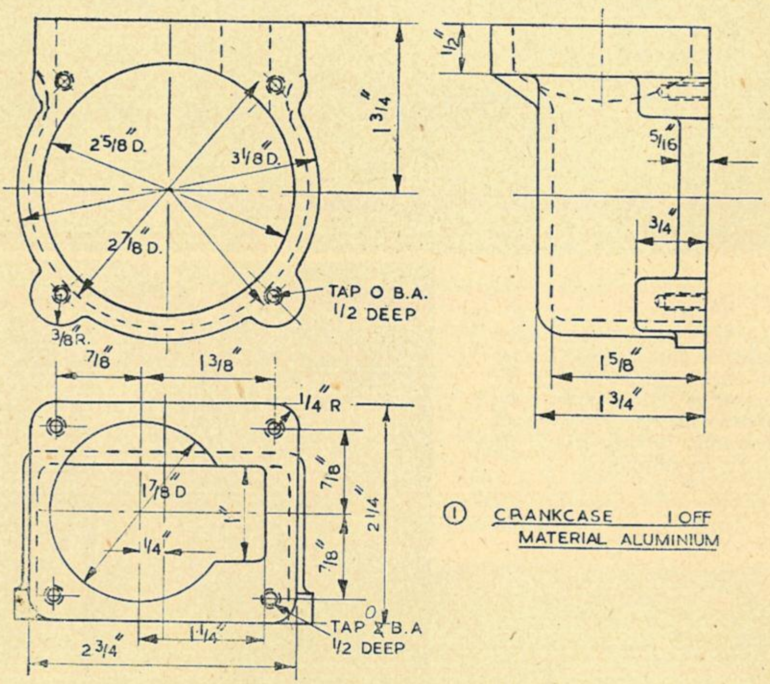
PETROL ENGINE TOPICS

*A 50 c.c. Auxiliary Engine

by Edgar T. Westbury

UNLIKE the majority of engines, the crankcase of this one contains no bearing housings, and is relatively simple to machine and fit, but care is necessary to obtain accurate register against the face of the main housing, and also to ensure squareness of the cylinder seating. It is not easy to hold this casting in the chuck, and the two main machining operations are best carried out by clamping it to an angle-plate. Marking out is desirable, to ascertain the amount of material which must be removed from the faces, and ensure that the cylinder seating centre is properly located. For this purpose, the cored hole should be plugged with hardwood or soft metal, and the centre-line marked-out with reference to the centre of the crankcase barrel.

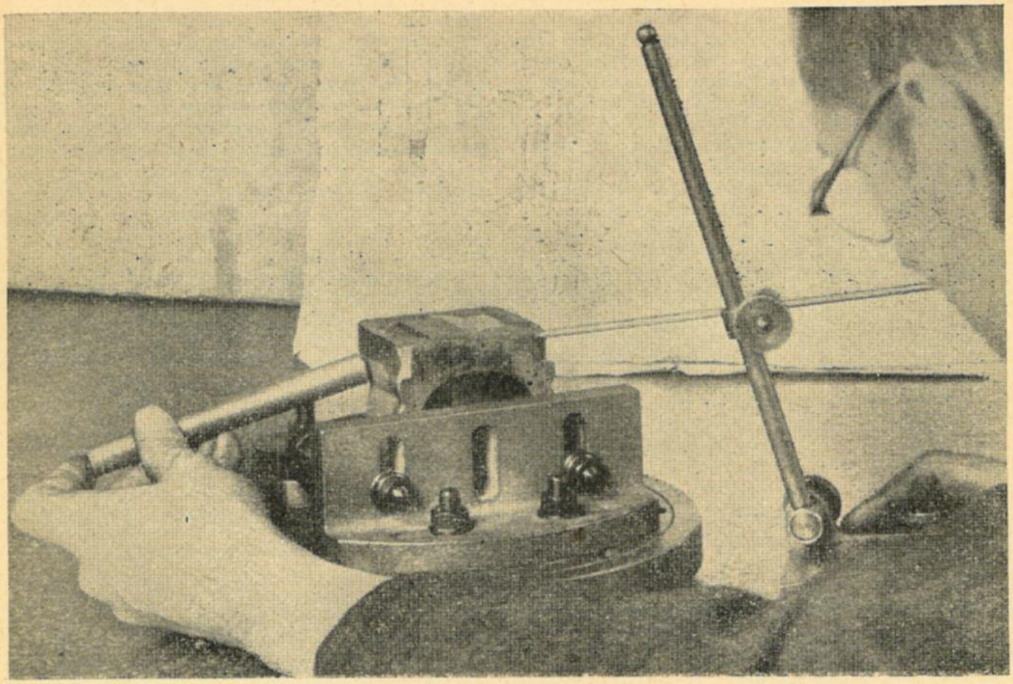
It will be noted that the cylinder centre is offset, or *desaxé*, to the extent of ¼ in. to the shaft axis, a feature which I have employed with advantage in several of my engines. It reduces the angularity of the connecting-rod on the power stroke, thereby easing side thrust on the piston, so that the life of the engine is increased and it tends to pull more smoothly, especially under conditions of heavy load at slow speed. Incidental advantages are that port timing can be slightly improved, and the opening period of exhaust and transfer ports increased, without making them excessively deep so as to reduce the effective power stroke of the piston.



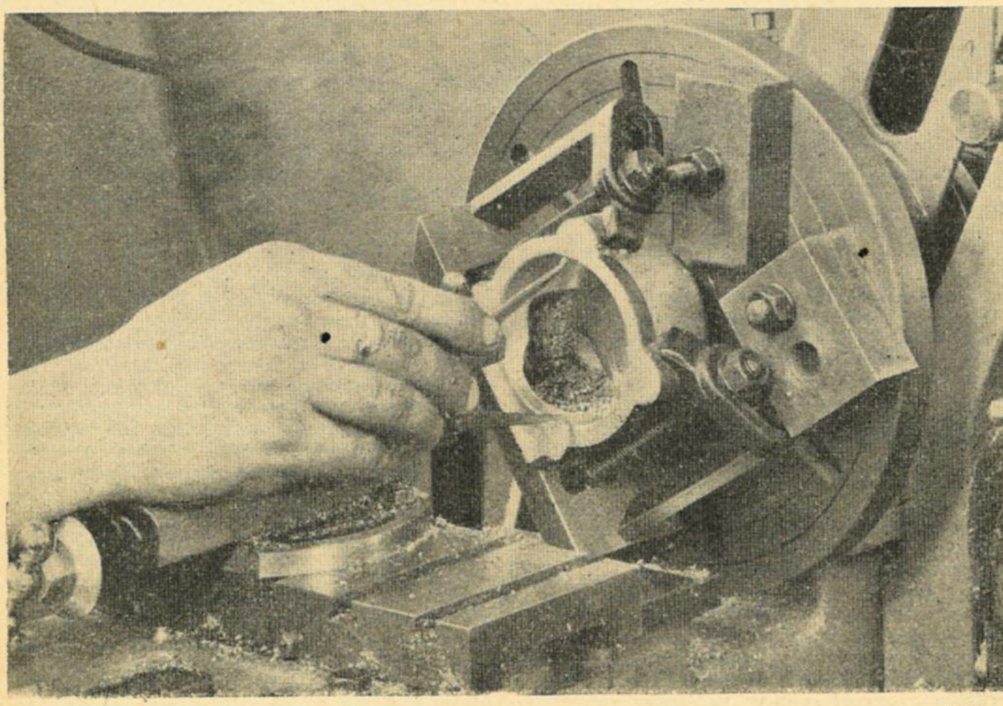
① CRANKCASE 1 OFF
MATERIAL ALUMINIUM

The casting is first set up by bolting the main face to an angle plate, which in turn is mounted on the faceplate. In the preliminary setting, and squaring up of the cylinder seating, it is a great advantage to lay the faceplate in a horizontal plane ; this enables the various bolts and clamps to be manipulated more easily, and if the faceplate is laid on a surface plate or other true surface, a scribing block may be used to check up squareness. The photograph shows how this operation is carried out ; it will be seen that the scriber is used to check the previously marked line which shows the position of the finished surface, and with the clamping bolts only partially tightened, the casting may be adjusted by gentle tapping on

* *Continued from page* 474, "*M.E.*," *April* 12, 1951.



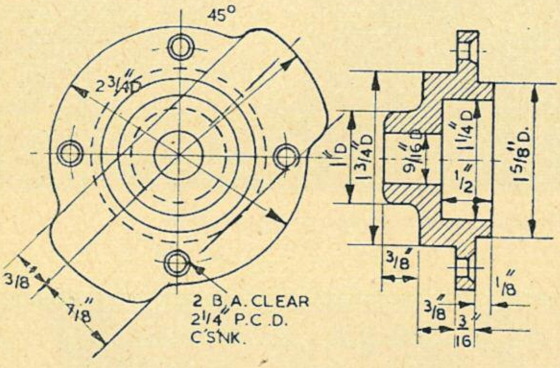
Setting up the crankcase for machining the top surface



Crankcase mounted on faceplate for facing and boring the barrel to fit spigot of main housing one side of the other. It may be remarked that the dodge of using a piece of metal rod for this purpose is often preferred by experienced hands as being more sensitive than using a hammer or mallet. The bolts clamping the casting are then fully tightened.

When the faceplate is attached to the lathe mandrel, the entire assembly of casting, clamps and angle-plate is shifted to centre the cylinder seating, working to the marked centre on the plug or bridge-piece, which is afterwards removed for boring out the cylinder register. It is, of course, necessary to balance the offset weight of the angle-plate by bolting pieces of metal to the faceplate on the opposite side.

Having machined the cylinder seating, the casting is now mounted by the face surface on the angle-plate for the second operation. Here it may be appropriate to check up on the squareness of the angle-plate itself, as it is most important to ensure that the two faces of the crankcase are



(3) MAGNETO MOUNTING FLANGE 1 OFF
MATERIAL ALUMINIUM.

exactly at right-angles when finished. A sheet of thin paper may be interposed between the cylinder seating surface and the angle-plate to avoid bruising the former and, incidentally, improve the grip.

The crankcase is now faced and bored to fit the spigot of the main housing; a really snug push fit is very desirable—to say the least—as slackness at this point would mean that all the working stress would have to be taken by the four crankcase studs. Unless one has an accurate reference gauge available to set the calipers to exact size, they should be set slightly undersize and the spigot fitted by "cut-and-try" methods. The common error of spoiling the job by going just a little too deep on the final cut may be avoided by offering up the spigot each time after entering the tool not more than $\frac{1}{16}$ in. into the bore; and slackness will then only be at the mouth of the hole and will not have serious results.

In both the faces of the crankcase, tapped holes have to be drilled for studs, and these are most easily located from the mating parts, namely the main housing and cylinder base respectively.

It may be remarked here that a few minor alterations have been made in dimensions and other details since the first engine was built; these do not in any way affect the general design or methods of machining, but have been found desirable as a result of experience. For example, the size of the studs which secure the main structural components has been increased, because while the original ones were strong enough for their primary purpose, they were liable to become worn or strained after the engine had been dismantled and reassembled a few times in the course of experiments.

The threads specified for most of the studs, nuts and screws are to B.A. standards, which are fairly readily available, and most model engineers own or have access to the taps and dies. If, however, other standard threads of comparable sizes are preferred, or more conveniently obtained, they can be used. Whitworth pitch threads are very suitable for screwing into aluminium, though rather on the coarse side for nuts on bolts or studs, where B.S.F. threads are better, as they provide greater core strength, and are less liable to shake loose.

Magneto Mounting Flange

This incorporates the housing for the outer main ball-race, and is therefore an essential item, irrespective of whether a magneto is fitted or not. The shape and dimensions are based on the assumption that a Wico-Pacy "Bantamag" is to be fitted, but if another type is used, it will only affect the shape and size of the outer flange, and the spigot or other form of register provided to keep the magneto backplate in concentric alignment with the bearing.

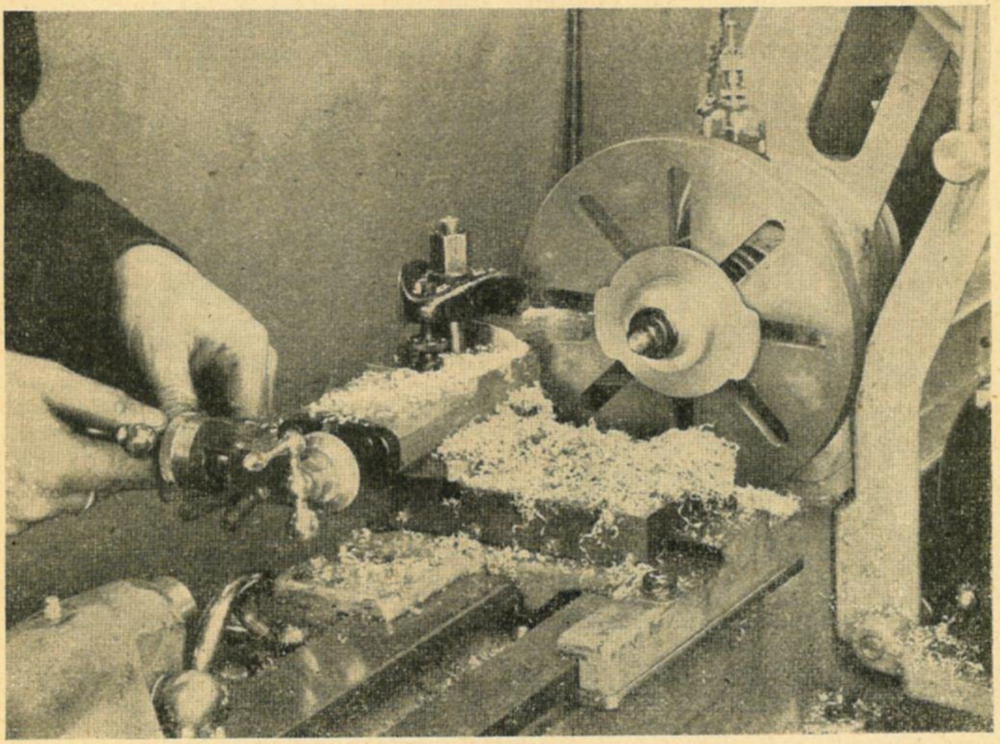
In the machining of this item, it will usually be found convenient to chuck it first by the inner boss, and carry out the entire machining of the ball-race housing, facing of front edge and outer flange, and turning the spigot to fit the recess in the magneto backplate. If the latter is not available at the time this casting is machined, the spigot may temporarily be left oversize, to be fitted at a later stage; but the advantage of carrying out all work on this side of the casting at one initial setting, if possible, will be obvious.

The $\frac{9}{16}$ in. hole which passes right through the casting forms a clearance for the shaft, and neither its exact size nor finish is of great importance, but it should at least be bored concentrically. In boring the recess for the ball-race, however, great care should be taken to ensure a good fit, and as in the case of the inner ball-race, a light press fit is recommended. It will be noted that the inner face of this recess is not relieved in the centre, as in this case the race is not pressed right home, but has a grease-impregnated felt washer behind it; the purpose of the latter being to ensure that the race is kept lubricated, and also to act as a gland to prevent ingress of dirt or water.

After all operations at this setting are completed, the casting is reversed for machining the inner side. It is necessary to ensure that the inner spigot is exactly concentric with the ball-race housing, and here again, several different methods of mounting the casting are possible. One of the simplest ways is to use a spigot mandrel held in the chuck, and this may with advantage incorporate both a large diameter register to fit the ball-race recess, and a small pilot extension to fit the clearance hole, thereby providing better security of mounting, and positive insurance against any risk of tilting. Alternatively, a mandrel running between centres and provided with similar two-diameter registers, may be used.

The method illustrated in the photograph, however, differs from both of these, though the principle of locating from the bore is the same. It entails the use of a plug or " bung," accurately machined *in situ* to fit the ball-race recess, similar to that employed in the case of the main housing ; but in this case it is not practicable to use clamps to hold the work back against the faceplate, as the only surface to which they could be applied has to be machined. Instead, a long bolt is used, which passes right through the hollow mandrel, and enables the work to be drawn firmly up to the faceplate, while being held in true concentric location by the bung.

It is, of course, essential that the inner spigot should be a neat fit in the bore at the outer end of the main housing, and that the flange face should be machined true at the same setting. Any errors in either respect would entirely defeat the object of providing means of locating the work accurately from the previously machined surfaces. The smaller boss on the inside of this casting is, however, relatively unimportant, and hardly needs to be machined at all, though it is worth while to clean it up, and will take only a few minutes to do so while the work is set up for the more important operations.



Second operation on magneto mounting flange, located by spigot in ball-race recess (machined at previous setting) and held against faceplate by means of a drawbolt

The four holes for the screws which secure this part should be marked out, preferably with the aid of an indexing device on the lathe headstock while the job is in the lathe. Although inaccuracy in locating these holes will not have any serious effects, if the tapping holes in the main housing are " spotted " off from them, it is worth while, in the interests of conscientious workmanship, to take pains to get things right. There is always the possibility that some day you may have to fit a new flange for some reason, and as it is not possible to " spot " the holes in the flange from those in the main housing, you will be very thankful you took these pains in the first place ! Excuse me harping on this theme, but I am constantly encountering examples of slovenly work, the excuse for which is that " It can't affect the efficiency of the engine " or—even

(*Continued on page* 544)

in half to allow room for the other meters which were flange mounting. Holes were cut in the metal panel for the four meters. Fig. 4 illustrates the back of the final assembly with the resistances mounted on a tag board.

The sockets for the test leads consisted of two chassis-type 5-pin British valve-holders bolted to the front face of the case. The advantage of this holder is that the outside sockets are equidistant from the centre one. This was discovered quite by chance and it was realised that, if the centre socket were used as the common connection of several ranges, a two-pin plug could be used instead of the usual two loose plugs on the test leads. A search in the junk-box produced an R.A.F. camera plug 5c/590 and socket 5c/457 having exactly the right spacing of $\frac{5}{16}$ in. between the pin centres. The plug had pins which were recessed and, therefore, unsuitable for insertion in the valve-holders, but by removing the pins from the plug body and mounting them in place of the metal sockets in the 5c/457 body a suitable two-pin plug was produced. A little work with a scriber and white ink produced neat + and — marking on the ebonite body. This is shown in Fig. 5, which illustrates the completed job. The leads from the two-pin plug were terminated by black and red radio type single split plugs to which can be attached either crocodile clips or test prods. The test prods were made from available material, namely $\frac{3}{4}$ in. lengths of tubing attached to 2 in. lengths of 6-B.A. rod. Suitable sleeving was pushed over each prod to cover all except $\frac{1}{8}$ in. at the end.

The making of this instrument has tidied up and increased the usefulness of a few loose meters, and although the accuracy of the individual meter cannot compare with the expensive Grade "1" multi-meter, it is sufficient for normal testing purposes where precise measurements are not required.

A final word on surplus meters generally: make sure the meter will work properly in the plane in which it will be used, be it horizontal or vertical. Also, if a movement tends to stick at certain points of the scale, don't maltreat it, but take it from its case carefully and ascertain the cause, which will probably be slight corosion or a flaking of the enamel due to the course of time. A gentle stroking with a camel haired brush will remove the offending particles. This applies particularly to the moving-iron type where the clearance for the "iron" is very small and the "iron," of course, is painted or otherwise coated. Flaking of the coating will cause the trouble mentioned. A few minutes thus spent may well repair an otherwise useless meter.

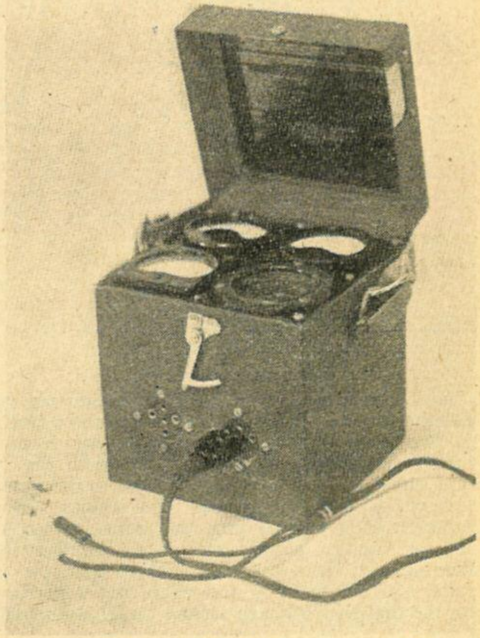


Fig. 5. The completed instrument with test leads, crocodile clips and prods

Petrol Engine Topics

(*Continued from page* 541)

worse!—"It will never be seen!" It is only by taking care even in the *apparently* insignificant details which don't seem to matter, that one acquires the *habit* of accuracy so essential to good craftsmanship. And so often it happens that these details do matter—a great deal more than one thinks!

The holes in the flange must be countersunk deeply enough to ensure that the screw heads cannot possibly project above the surface when fully home, as this would upset the seating of the magneto backplate when fitted in position. It is better to err on the side of sinking them too deep than otherwise. Note that when the magneto is fitted, the two screws or studs which secure the backplate will be tapped into the lugs of the mounting flange, but no details of the tapped holes are shown, in case a different type of magneto is used.

(*To be continued*)

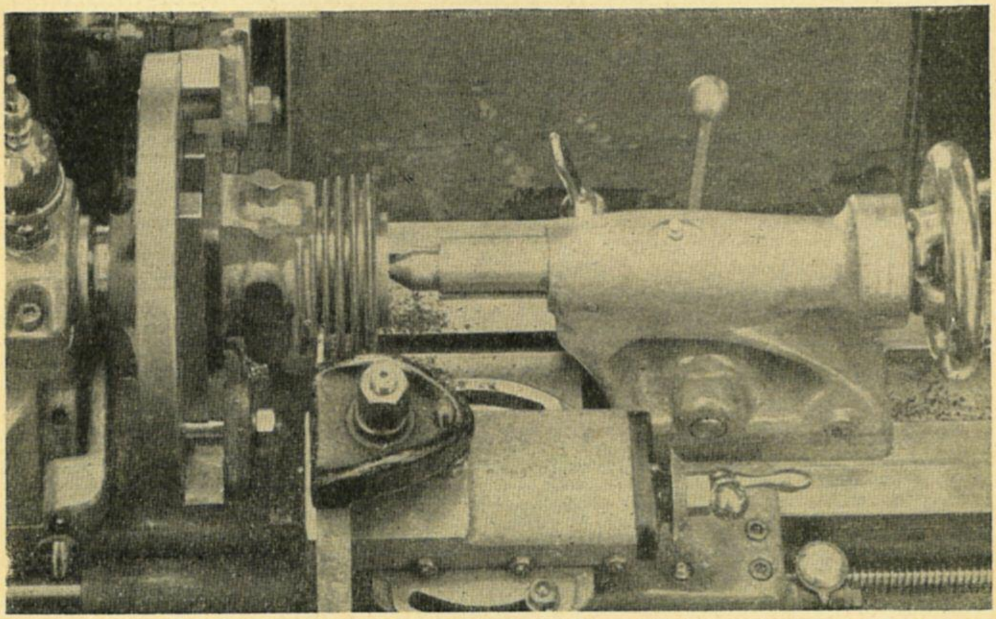
PETROL ENGINE TOPICS

*A 50-c.c. Auxiliary Engine

by Edgar T. Westbury

ON many occasions in the past I have stressed the importance of accuracy in the machining and finishing of cylinders for all types of i.c. engines, and two-stroke engines in particular. While this engine does not necessitate such meticulous precision in this respect as engines of very small capacity, it will be found worth while to take the utmost pains to ensure that the case, the boring of the actual working surface involves much the same procedure, and a fairly hard and durable metal for this surface is most essential.

I do not ignore the merits of using a light alloy cylinder with a thin inserted liner, which would enable a substantial amount of weight to be eliminated, and also improve heat conductivity.



Using grooving tool to clean up cylinder fins. (Note the steady pad on the mouth of cylinder to take back centre)

cylinder bore is exactly parallel, circular and highly finished, as these factors have far-reaching effects on the efficiency and durability of the engine. It may here be emphasised once more that we are aiming at an engine which will have a working life, in terms of running hours, far greater than that of most miniature engines.

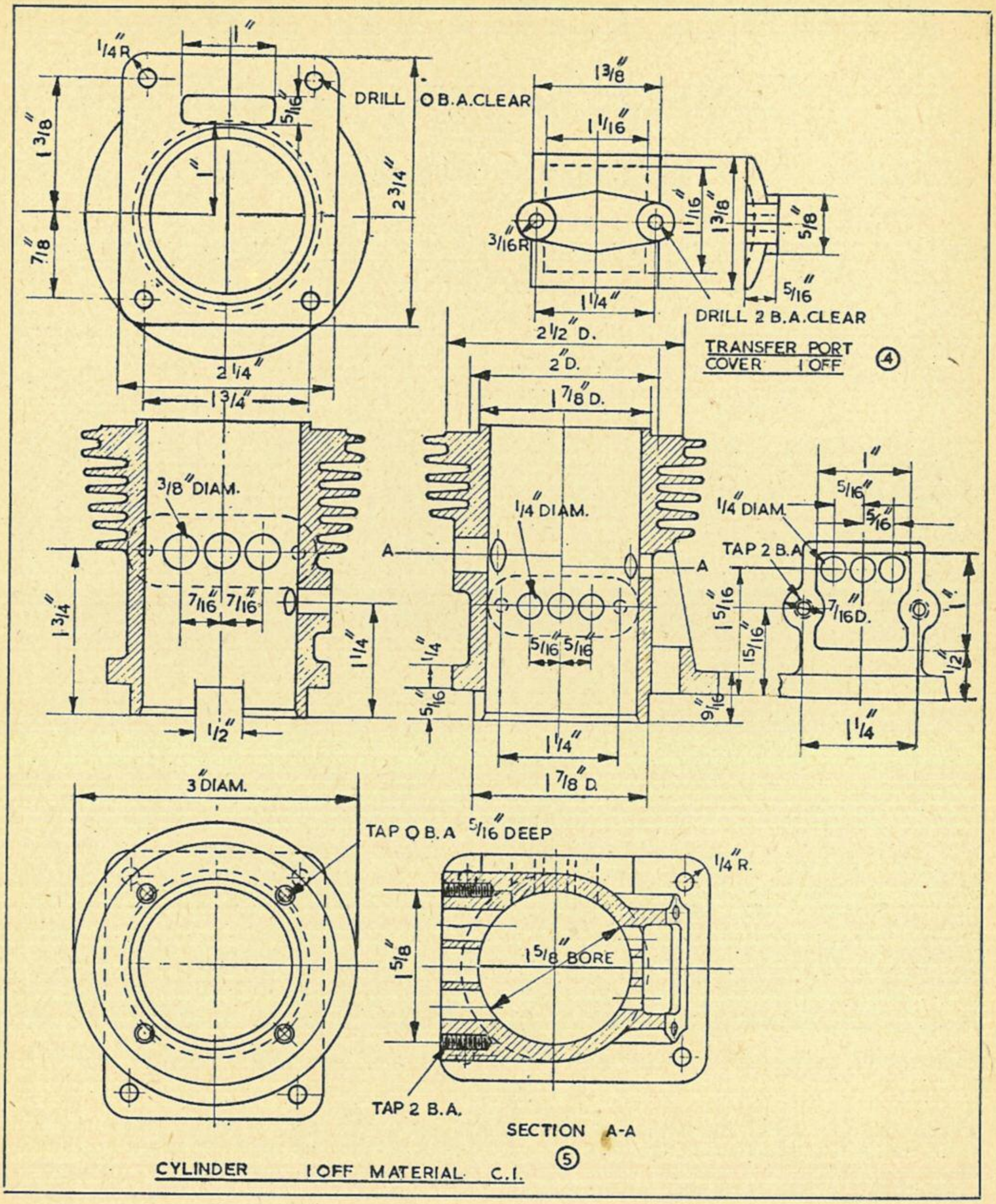
A solid iron casting has been chosen for the cylinder, after careful consideration of alternative forms of construction. Many amateur constructors tremble at the idea of machining a large cast-iron cylinder, but in actual fact the total amount of work involved is usually less than in a fabricated or inserted-liner type of cylinder ; in any

But the proper fitting of the liner is more difficult than it sounds, and any error in this respect may tend to cause distortion of the liner, or imperfect contact with the outer cylinder, which would impair cooling. The possibility of casting-in the liner, which would enable these risks to be avoided, has also been given careful consideration, but this entails a die-casting process which could only be justified in fairly large quantity production. It may be remembered that the "Ensign" 10-c.c. engine has a die-cast cylinder with a carbon steel liner cast in, and this has been quite successful in practice, but even in this size is hardly profitable to produce.

Cylinder Boring

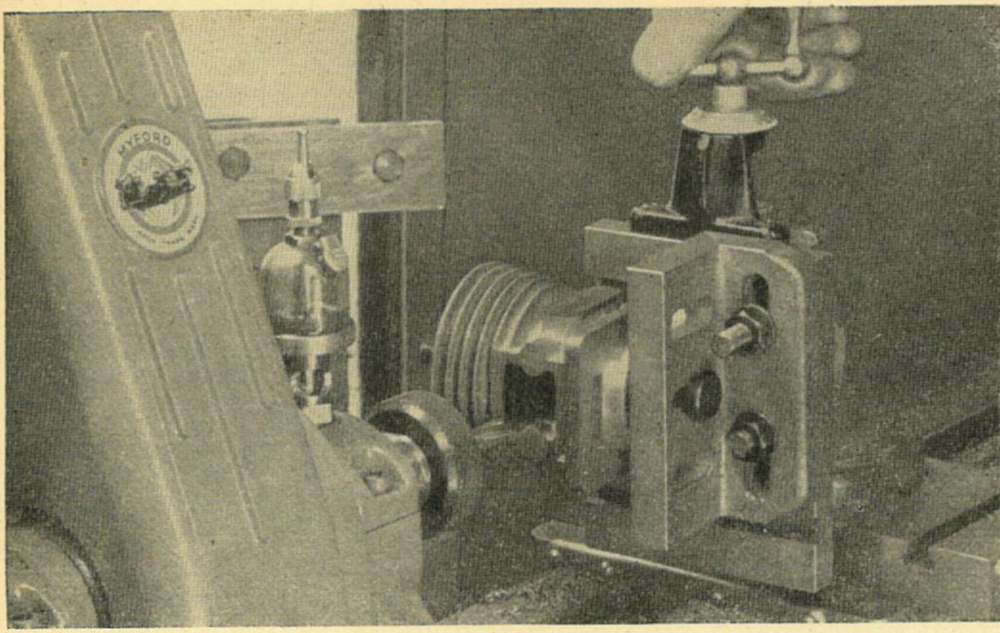
The cylinder casting does not need marking

**Continued from page* 544, "*M.E.*", *April* 26, 1951.



out, but a preliminary check of dimensions should be made, to locate the position of end faces relative to that of the port flanges, which must necessarily govern the amount of metal to be removed from the former. It is permissible to chuck the casting from the head end, gripping it over the outside of the fins in the four-jaw chuck, with soft metal pads under each jaw to distribute the pressure. This method could not be recommended in the case of a light cylinder casting, owing to the risk of distorting the bore by pressure on four points; but the large diameter fins and general solidity of the casting enable it to be done in this case. The alternative method, entailing a good deal more work, would be to face the top surface and machine the spigot first, then attach a register plate to the lathe faceplate and machine it on the bore and face to fit the cylinder spigot; the casting could then be held in place by suitable clamps to hold it back against the register plate.

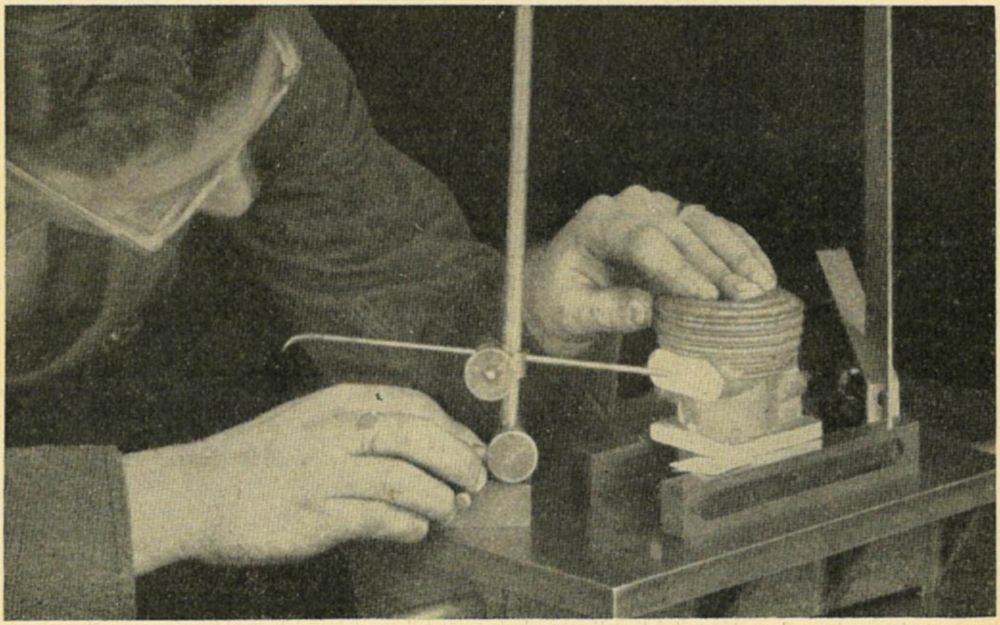
Whatever method of holding the cylinder is employed, however, it should be set up so that



Milling transfer port cover face

it runs reasonably truly over the outside of the fins, and also over the spigot at the skirt end; do not worry too much about the truth of the rough bore, unless there is any risk of not cleaning up properly to finished size, which should not normally arise.

A rigid boring tool is most essential for producing an accurate cylinder bore; I favour the use of a bar not less than 1 in. diameter, with a squared butt end to grip firmly in the toolpost, and an inserted cutter of $\frac{1}{4}$ in. square high-speed steel, set diagonally in the other end. Care should



Marking-out cylinder ports

be taken to avoid any risk of the cutter running beyond the bore and damaging the chuck face; the use of a parallel packing ring behind the casting will prevent this; alternatively, a mark may be made on the tool to show the depth limit, or a stop set to prevent excessive travel of the saddle.

Use the slowest back gear speed for the initial cut through the cylinder bore, and if possible, take a deep enough cut to get right under the skin of the metal. It is more than likely that the tool will very quickly become blunt in getting through the sand and scale in the cored hole, but do not worry if you have to regrind the tool two or three times before you get down to clean metal; and above all, never try to keep a blunt tool cutting by sheer brute force. The use of a fine self-acting feed is very desirable for cylinder boring, and carbide-tipped tools are extremely useful, avoiding the need for frequent regrinding, though by no means the necessity they are often represented to be.

Some small lathes may make rather heavy going on the machining of large iron castings, but patience and care will always win through in the end. It may, however, be stated that the Myford M.L.7 handled this job without turning a hair. It is obviously important that spring and deflection of the tool should be eliminated as much as possible, and correct adjustment of all slides is an important factor in this respect.

For roughing operations, an angular tipped tool, with zero or negative rake, will be found most efficient. After the skin has been removed, the lathe speed may be increased by shifting the belt to the middle cone, and top back-gear speed is permissible for finishing. The final cut may be made with a keen round-nose tool, and several passes should be made at the same setting of the cross-slide, to eliminate the effect of spring.

The bore should be left about 0.002 in. undersize for lapping allowance; this may be measured by setting inside callipers to a suitably adjusted 2 in. micrometer or vernier gauge, but if these instruments are not available it may be found possible to refer to some object of standard dimension, such as a shaft or ball-race. Although dimensional accuracy is not in itself of the highest importance, it should be noted that the engine is to be fitted with standard $1\frac{5}{8}$ in. piston rings, and any considerable deviation from this dimension may interfere with their proper fitting and function.

The outside of the cylinder spigot and the bottom face of the flange, are also machined at this setting, and the mouth of the cylinder is chamfered to an included angle of 60 deg. to give a "lead" to the piston rings on assembly. If the latter operation is done before facing the flange, a pipe centre may be used to steady the end of the casting during the latter operation. Note that the spigot must be a close fit in the bore of the crankcase seating.

For facing the top surface of the cylinder, the best method is to mount the casting on a mandrel, but as it may be difficult to find one of suitable size, an alternative way is to mount the casting on the faceplate, with a parallel distance ring or two parallel bars under the base flange, and clamps bearing upon the latter. Or it may be held over the flange in the four-jaw chuck, with the spigot bedded firmly against the chuck body. In either case, of course, the cylinder bore must be set to run truly.

At the same setting, it is desirable to run a narrow tapered tool between the cylinder fins to clean them up to their proper width and depth, as this cannot be assured in the rough casting. As this is a rather heavy operation, which must be done at the slowest speed, it is advisable to steady the casting with a centred disc held against the mouth by the back centre.

Milling the Port Faces

The three facings for exhaust, transfer and inlet ports respectively must be truly flat, but the means of attaining this end will depend upon the equipment available. They may, if desired, be hand filed and scraped, working to accurate "flats" of suitable size, such as slips of heavy plate glass. A small hand shaper will do the job more rapidly, and possibly more accurately. But following the principle of carrying out all the machining in the lathe, they were, in the examples illustrated, machined by milling processes, with the aid of the Myford swivelling vertical slide, and a small angle-plate attached thereto.

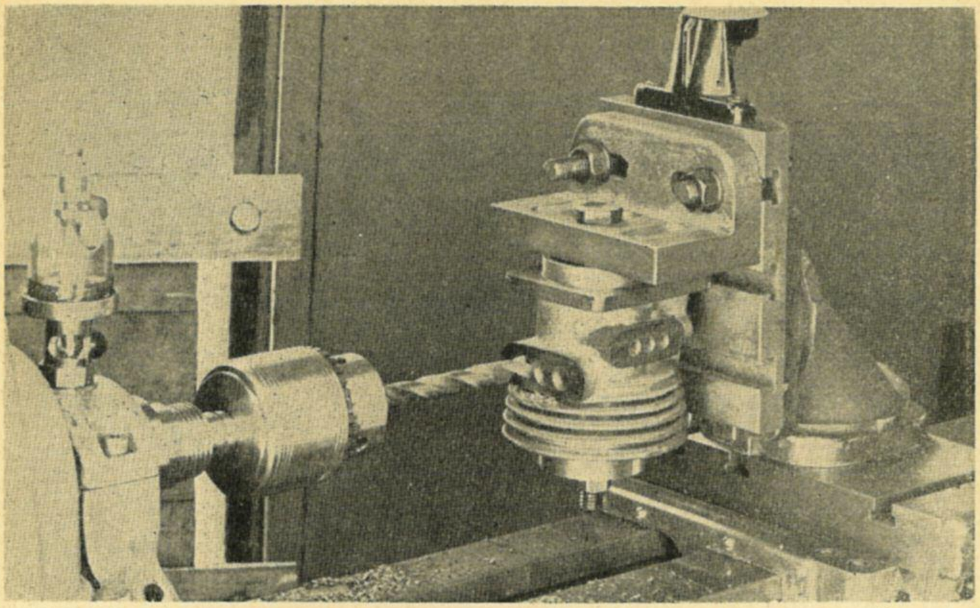
The exhaust and inlet facings are square with the cylinder both ways, and also with each other. As there is no machined reference face to locate them in the latter respect, and critical accuracy is unnecessary, it is sufficient to align the inlet facing from the long side of the base flange as closely as possible, and after machining, square the exhaust port from it. The cylinder is mounted on the angle-plate by a single $\frac{3}{8}$-in. bolt through its centre, and a flat disc at the top end; for dealing with these two faces it will be found most convenient to mount the angle-plate near the top of the vertical slide, with the cylinder inverted.

A somewhat different arrangement is necessary for milling the transfer port facing, the cylinder being set horizontally and the base of the vertical slide swivelled to suit the location of the face, which is inclined at an angle of 10 deg. to the cylinder axis, though square with the other two facings in the cross-plane. An end-mill, held in the Myford collet chuck, was used for these operations, though it could quite well have been held in the three-jaw chuck, and a home-made facing cutter would also have done the job just as effectively.

The location of these facings relative to the cylinder axis are not of critical importance; the essential thing is to ensure flatness and reasonably good finish of the surfaces, and the cutter should be run all over the exhaust and inlet faces, and all round the transfer port face, with the saddle feed locked, for the final cut.

Drilling Cylinder Ports

It will be seen that all the ports on this engine are in the form of round drilled holes, a procedure which has been found quite successful in several of my previous engines, and which has certain advantages in cases where it is not absolutely essential to use ports of maximum area. In the first place, it is easier to locate and form the ports



Drilling exhaust ports

than when they are rectangular or otherwise shaped; secondly, it avoids the need for pegging the piston rings, provided that the individual ports are not too large in diameter. This, however, is an optional feature, and it would be quite easy to square out or elongate the ports after drilling; I am not, however, prepared to guarantee that this would produce any improvement in performance, as the port areas are adequate for the speed at which the engine is intended to run under load.

The port positions should be marked out with the aid of a scribing block, working from the base flange; parallel packing should therefore be used to support the flange, and all height measurements taken from this point, such as by the use of a combination square set on the packing bars as shown in the photograph.

It is possible to drill the ports in a drilling machine, but if the vertical slide is available, it may as well be utilised for this operation, and it will help to ensure that the holes are truly located. A centre-drill should be used first of all to act as a pilot, and should be entered to the full depth of the countersink, after which the twist drill will follow without deviation. Note that any alteration in the sizes of holes will affect port timing, apart from their actual centre locations, so both points should be adhered to as closely as possible. It may, however, be mentioned that correction of port timing is possible after the engine is built, either by manipulation of piston length or by packing under the base flange, so it is not necessary to scrap a cylinder on account of minor errors in drilling the ports.

(*To be continued*)

A Souvenir Pamphlet

To commemorate the run of the last Ivatt G.N.R. Atlantic locomotive No. 62822, an eight-page pamphlet has just been issued by British Railways. On the front page, there is a small reproduction of the headboard which the engine carried on her smokebox door.

Three of the inside pages are devoted to six photographs taken on the occasion; these include a striking shot of the special train at speed near Maxey Crossing, and a nice reproduction of what, in our opinion, is one of the finest and most characteristic photographs ever taken of an Ivatt Atlantic—No. 62822 posed in the yard of her home shed, Grantham, just before she left it for the last time. Copies of the guard's journals for the outward and inward trips are included, together with a foreword and some notes about H. A. Ivatt and his Atlantics.

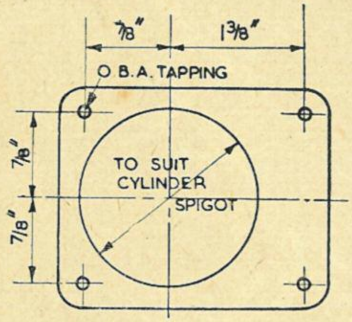
The pamphlet, called " Ivatt Atlantic Special," is available, price 6d., from the Public Relations and Publicity Officer, British Railways, Eastern Region, Marylebone Station, London, N.W.1.

PETROL ENGINE TOPICS

*A 50-c.c. Auxiliary Engine

by Edgar T. Westbury

IN drilling the clearance holes in the cylinder base flange, and the corresponding tapped holes in the top surface of the crankcase, to take the holding-down studs, some difficulty may be found in locating them sufficiently accurately to mate up without any trouble, as it is not practicable to " spot " the tapping holes through the clearance holes in this case. Careful marking out, with the aid of the scribing block, is helpful in this respect, but a much more positive method



Detail of jig plate for drilling holes in cylinder base and crankcase

is to make a simple jig from steel plate about ⅛ in. thick, which can be applied to each of the components in turn to locate the holes.

The plate is first filed up truly rectangular, and to the same size as the cylinder base flange, and is then marked out and bored to the same size as the aperture in the crankcase, or in other words, to fit the cylinder spigot. Using this bore as the reference surface, the positions of the four holes are marked out, pilot drilled and opened out to the tapping drill size. Identification marks should then be made to show clearly the top and bottom sides of the plate.

For drilling the cylinder base, the plate is placed over the cylinder spigot and clamped to the flange with two toolmaker's clamps, the surface marked " top " being in contact with the flange. The four holes can then be located from the jig-plate, and afterwards opened out to clearance size for the studs. In the case of the crankcase, the " bottom " surface of the plate is placed against the machined seating, and located by a plug machined to fit exactly in the centre hole, which should preferably be made with an enlarged rim and drilled through the centre, so that it can be used in conjunction with a bolt and bridge-piece, to clamp the plate to the crankcase.

*Continued from page 613, " M.E.," May 10, 1951.

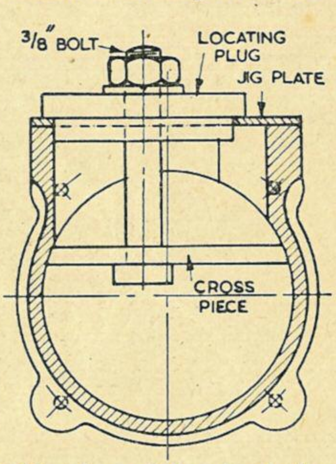
The remainder of the holes in the cylinder are the tapping holes for securing the cylinder head, transfer port cover, and exhaust pipe, which can all be " spotted " from their mating parts, and thus present no difficulties in their proper location.

Connecting-Rod Clearance

It will be found necessary to cut a slot ½ in. wide at the base of the cylinder to clear the connecting-rod at the point of maximum angularity. The detail drawing of the cylinder shows this slot on the exhaust side, but this is an obvious error, as the desaxe location of the cylinder which displaces it towards the exhaust port, makes it necessary to cut the clearance slot under the transfer passage. This slot may be milled if desired, but as it calls for no high precision, either in location or shape, filing is quite sufficient.

Cylinder Lapping

After all operations on the cylinder, including the drilling and tapping of holes as shown on the detail drawings, are completed, the bore surface should be lapped to correct minor inaccuracies and produce as high a finish as possible. I have given particulars on several previous occasions of



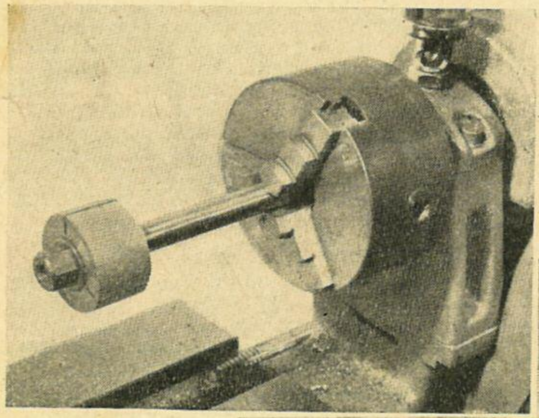
Method of locating and clamping the jig plate on crankcase

the method used in cylinder lapping and other writers have also contributed to the information available on this process.

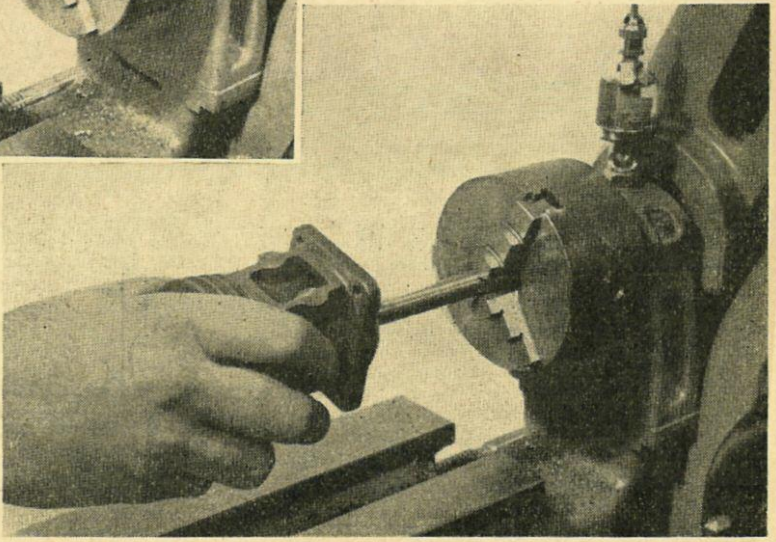
I always recommend the use of adjustable laps, made of some material softer than the surface to which they are applied, such as copper or aluminium. Lead laps are still more efficient, but not so easy to control when working to fine limits.

Special abrasive materials are available for lapping, but the quantities required are so small that it is hardly worth while to obtain them, as ordinary valve grinding paste works quite efficiently for rough lapping, and can be followed up by flour emery, aluminium oxide, tripoli, etc., the last-named being capable of producing a finish high enough for all practical purposes.

While it is generally recommended that a separate lap should be used for each grade of abrasive, I have found that if the lap is washed in paraffin and scrubbed with a file card after each stage, the few particles of coarse abrasive left do not visibly affect finish; and, as a matter of fact, minute criss-cross scratches distributed well over the cylinder surface are an advantage rather than otherwise.



Above — Adjustable lap, mounted on taper mandrel held in three-jaw chuck



Right — Cylinder applied by hand to revolving lap

The lap shown in the photograph is of soft and porous aluminium, and is fitted to a tapered and nutted mandrel, being split right through in one place and partly through in two others. It is run at medium speed, and the cylinder is applied by hand, as shown, being kept moving endwise throughout the entire operation, the amount of travel being just sufficient to reveal about half the length of the lap at each end. Abrasive paste is applied to the lap, which is kept adjusted to the size of the bore so that any difference in diameter can be detected by variation in friction. A little oil may also be applied, just sufficient to prevent the lap drying up. In the later stages of lapping, with finer abrasives, the adjustment of the lap should be on the tight side—eventually almost to the squeaking point—so that very small local discrepancies can readily be felt.

It cannot be too frequently or emphatically stated that the principal essential for successful lapping is patience, , this job cannot possibly be done in a hurry; each grade of abrasive should be worked until the "feel" is even all over and the appearance of the surface, when cleaned off, is perfectly uniform. Polish, as such, is much less important than accuracy, and judgment by the mere appearance of the bore surface may, in some cases, be misleading.

If constructors have access to honing appliances, cylinder finishing is much less tedious, but few of us are in this fortunate position, and I am writing for the benefit of the average model engineer rather than for those with special facilities. There are some engineers who prefer to avoid any kind of abrasive methods in finishing cylinders, and I am entirely with them—if they can guarantee accuracy by plain machining methods. It is often asserted that the presence of visible tool marks in the bore is actually an advantage, as it speeds up the bedding-in of the rings and also forms a "key" for the oil film. This is true up to a point, but in a small bore cylinder, the process of bedding-in will usually increase piston clearance, and, incidentally, the piston ring gaps, to an undesirable extent. The advantage of a high finish is that it requires little or no bedding-in, always provided that it is accurate and not a mere polishing of an inaccurate surface.

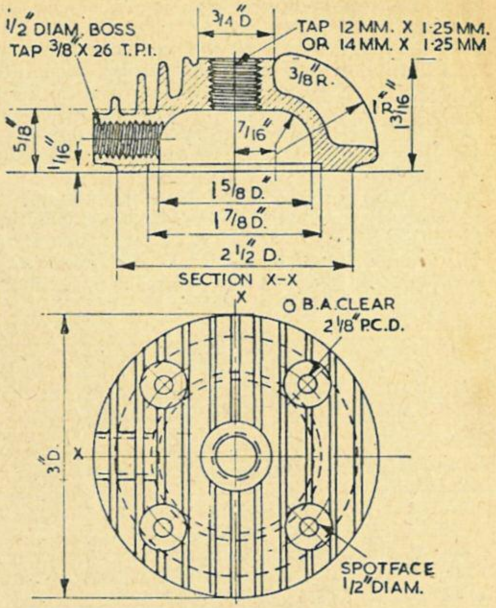
Objections to abrasive finishing methods are usually based on the idea that it is difficult—some say impossible—to avoid particles of abrasive becoming imbedded in the surface, and retained to play havoc later on. I have never found any trouble from this cause, however, provided that scrupulous care is taken to clean the surface after finishing, by soaking in paraffin for several hours, then syringing ports, passages and other interstices, scrubbing working surfaces with a stiff brush, and finally drying with soft, clean rags. In this matter, as in all others connected with engine construction, carefulness finds its own reward.

Transfer Port Cover

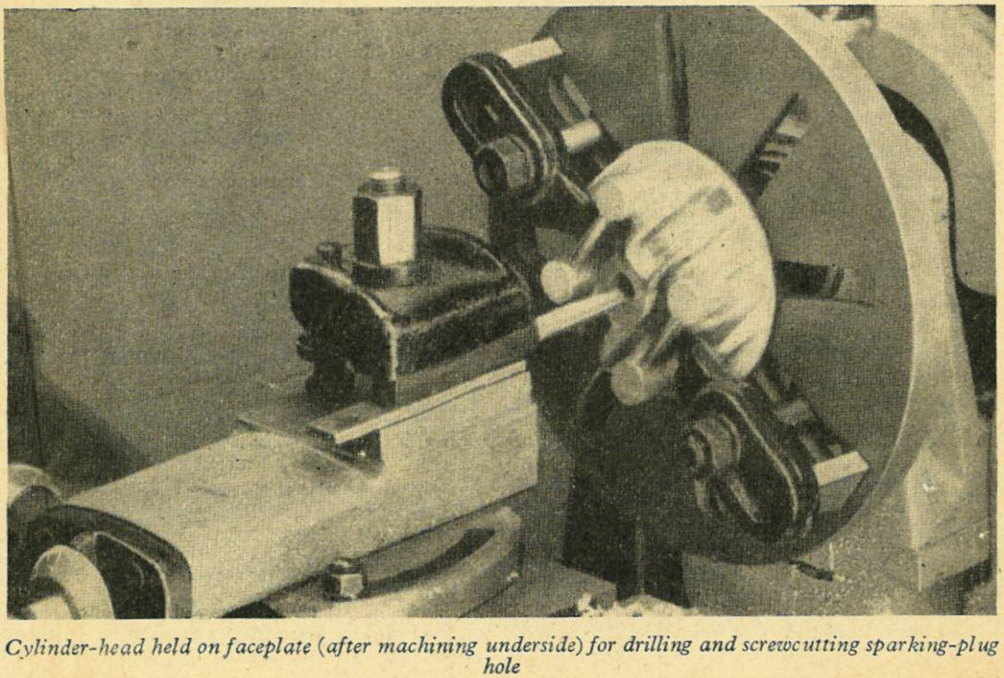
The detail drawing of this component was shown adjacent to the cylinder drawing on page 610 of the May 10th issue. It is a very simple item, requiring only a facing operation on the flat side, apart from drilling, and it may conveniently be held in the four-jaw chuck, taking care to set it to run as truly as possible on the face. After drilling the two holes, and spot facing them on the outside, it is a good idea to lap the joint face on a flat glass plate, to ensure a perfectly true surface, and thereby eliminate all possible risk of a leaky joint when the cover is clamped in position on the cylinder. This applies also to other joint surfaces where lapping is practicable.

Cylinder-Head

For machining the inside of the combustion space, facing the underside, and recessing the register surface, the casting may be held in the four-jaw chuck, over the tips of the stud bosses, which project far enough beyond the fins to enable a firm grip to be obtained on them. It should be set to run as truly as possible, both concentrically and on the face, after which all the above operations may be carried out at one setting. The recess should fit the spigot on the cylinder barrel, though it is not necessary to produce a tight " snap " fit in this case, and the depth should be about 0.005 in. less than the spigot, so that when assembled, the narrow inner face of the recess makes contact with the face of the spigot. These surfaces can be lapped together to make a

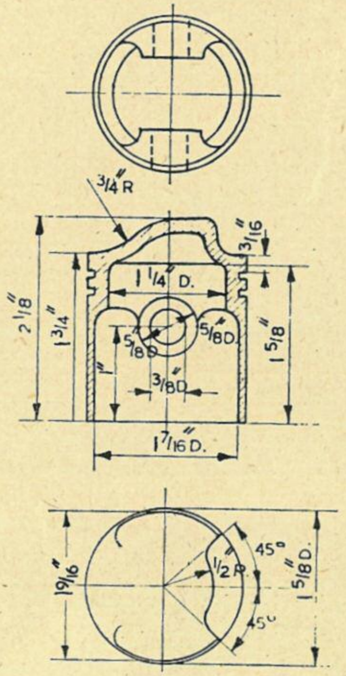


⑥ CYLINDER-HEAD 1 OFF
MATERIAL: ALUMINIUM



Cylinder-head held on faceplate (after machining underside) for drilling and screwcutting sparking-plug hole metal-to-metal joint and eliminate the need for packing.

If desired, the hole for the sparking-plug may be drilled and screwcut at this setting, though it may be found easier to do it from the outside, holding the head either on the faceplate, or over the chuck-jaws. It will be noted that the head may be adapted to take either 12 mm. or 14 mm. standard sparking-plugs, the latter being most readily available, though I consider they are definitely on the large side for an engine of this size, occupying more than their fair share of space in the head. In either case, however, the pitch of the thread is 1.25 mm.,



⑦ PISTON — 1 OFF
MATERIAL ALUMINIUM

which need not frighten anyone whose lathe is not equipped to cut metric pitches, as it is so close an approximation to 20 t.p.i. that scarcely any discrepancy is detectable in the length of a normal-reach plug. It is, of course, possible to obtain standard taps to cut these threads.

Alternative plug sizes are the 10 mm., as used on Packard and certain other full-size engines, and the $\frac{3}{8}$ in. × 24 t.p.i. miniature plugs, which give quite good running results, but are somewhat fragile mechanically for rough every-day usage. I do not advise attempting to use plugs of the original De Dion 18 mm. standard, which are out of all proportion to the size of the engine. Practically all two-stroke engines are rather finicky in their choice of plugs, and a great deal depends on getting just the right plug for the engine.

The outside of the plug boss should be carefully faced to provide a true seating, and the length of the hole should be adjusted to suit the reach of the plug. On no account should the hole be considerably deeper than the plug thread so that the spark gap is located in a pocket of inert gas, but on the other hand, it should not project so far into the combustion space that it encounters undue heat. Redundant threads on the inside of the head should be counterbored or chamfered, so that they do not form lodging places for the accumulation of carbon, or hot spots to start pre-ignition.

For drilling the stud holes, methods which have already been mentioned in connection with the main bearing housing are applicable with advantage. The outer face of each boss should be spot faced, and the height of the bosses should be uniform.

It may here be remarked that the castings for the cylinder head, as used on the original engines, do not correspond with the drawing in respect of the number of cooling fins, as the foundry was unable to make a sound job of the closely spaced fins specified. This has naturally resulted in some loss of cooling surface, but the engines have behaved satisfactorily in normal service. However, I would much prefer to see more efficient finning on the cylinder head, and steps have been taken to produce a die casting with a full complement of fins. If sufficient support is forthcoming from constructors, this improved head will be made available to them in due course.

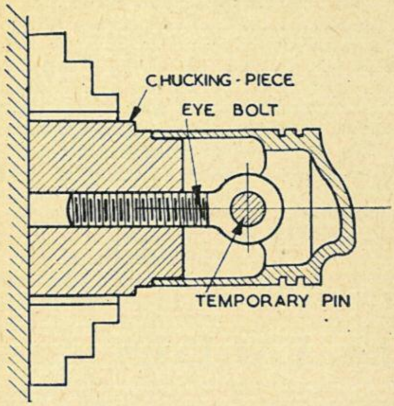
When the engine is used for driving a cycle, it is advisable to equip it with a compression release valve, known generally, but not strictly correctly, as a "decompressor." Provision has therefore been made in the head for this fitting, by way of a horizontal boss drilled and tapped in the side. It is advisable to carry out this operation by clamping the head on an angle plate, by a single bolt through the plug hole, taking care to avoid damage to the face of the hole by fitting a fibre washer at this point.

The head should be squared up by reference to the line of the fins, and the boss then set to run truly, when it can be faced, centre-drilled, drilled and tapped (or screwcut). This is much better than attempting to carry out the operation by "drill press" methods, and using a rotary cutter for facing.

Piston

The casting for this is made in a special alloy with a low coefficient of expansion, so that it will work with the minimum clearance. Many engine constructors like to see piston castings provided with chucking pieces, so that the entire working surface can be machined at one setting, but while this, as a general principle, is very sound, my experience is that it often leads to slipshod setting up, as it is so easy to grip the stalk in the chuck and worry about little else. My methods are, perhaps, a little outside standard practice, but they ensure accurate results if carefully carried out.

The casting is first held in the four-jaw chuck at the head end, leaving the major length projecting, up to well above the level of the gudgeon pin position. It is set to run as truly as possible on the *inside* surface, using a bent scriber to check up on the portion beyond the bosses, and not worrying about the external truth at all. This will ensure that, when the piston is finished, it will be of uniform thickness all round. The end is then faced, to correct length, the inside of the skirt bored out as far as the bosses will allow, and the outside turned, as far as the chuck jaws



Method of mounting piston for external finishing

will allow, to about 1/32 in. or so over finished size.

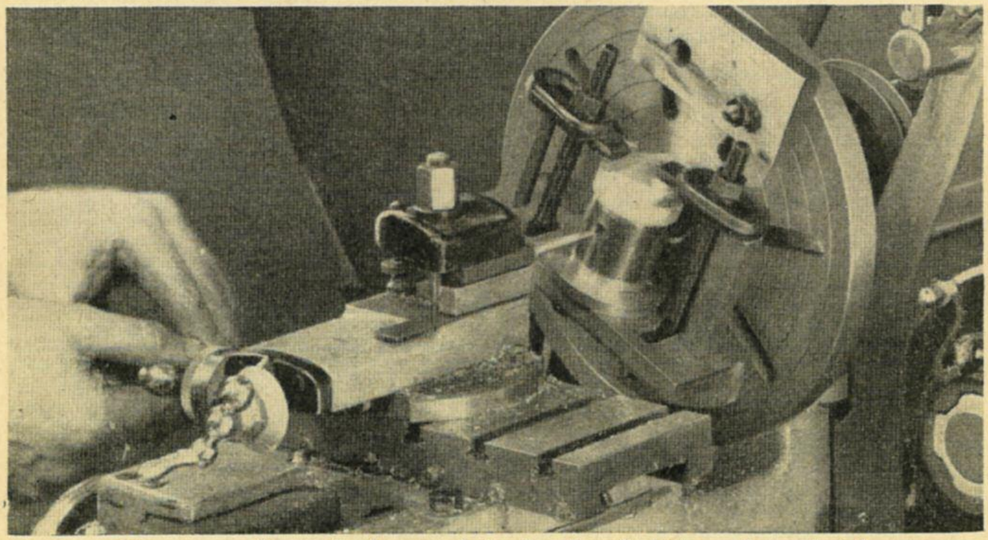
While it is still in the chuck, the centre line of the piston, in the plane of the gudgeon pin bosses, is marked out by means of a scribing block on the lathe bed or cross-slide, with the scriber set exactly to centre height. This line should be produced on both sides of the external surface, and then by means of a point tool in the toolpost, the position of the gudgeon pin centre, in relation to the end of the piston skirt, should be marked. This will locate the exact centre for the cross-hole on both sides of the piston.

For boring this hole, the piston is now mounted on an angle plate by two bolts and clamps or, alternatively, a single strap, bearing on the crown, but before placing it in position, a line should be scribed squarely across the face of the angle-plate, from front to back, and the centre lines on the piston are then placed so as to coincide with this line, and thereby ensure that the diametral centre of the piston is square-on to the faceplate ; in other words, parallel to the lathe axis. The assembly is then set up by shifting it bodily on the faceplate, to locate the marked centre of the gudgeon pin exactly concentric, and after balancing the offset weight of the angle-plate, the hole through both bosses can be centred, drilled undersize, bored, and finally reamered.

This method of cross-boring definitely ensures geometrical accuracy, that is, squareness of the hole with the axis, which is much more important than location in other planes, though this also should be observed as carefully as possible. It is, of course, essential that the angle-plate should be dead square, and the faceplate run exactly true on the surface.

It is most important that the piston should be held for external finishing in such a way that no stresses liable to distort are produced. Ordinary methods of chucking leave much to be desired in this respect, and the usual procedure is to locate the piston from a spigot fitting neatly, but not too tightly, inside the skirt, and held against it by end pressure, using a central drawbolt with an eye engaging a dummy gudgeon pin passing through the cross-holes.

In this position, the external surface of the piston can be finished throughout, including the piston ring grooves, and the sides of the deflector, which are $\frac{1}{16}$ in. smaller in diameter than the piston body. This part should be machined until the base of the deflector, both on exhaust and transfer sides, just shows a " witness " mark to ensure a clean cut-off point. The ring grooves should preferably be machined with a tool



Piston mounted on angle-plate attached to faceplate, for boring gudgeon-pin hole narrower than their full width, and opened out by taking side cuts rather than trying to finish them in a single plunge cut, as this may result in a poor finish and thereby impair the compression seal. The bottom clearance should be not less than about 0.005 in. (i.e. the groove should be that much deeper than the radial thickness of the ring), and the side clearance should be about 0.002 in., or such that a slight side shake is perceptible when the ring is entered in the groove "upside down."

Piston clearance is most important in two-stroke engines, as it is essential for it to be sufficient to avoid tightening up by expansion when the engine is hot, yet not so large as to impair the port-sealing efficiency. In this particular engine, with the particular light alloy used for the piston, it has been found that a clearance of not less than 0.0035 in. at the skirt is necessary, increasing above the gudgeon pin to 0.006 in. at the top end. The best way to measure these clearances, in the absence of elaborate measuring instruments, is to insert the piston in the cylinder bore and use feeler gauges.

For producing a good finish on the piston, a very keen narrow-edged tool should be used, and it may be found desirable to use a lubricant such as paraffin or turpentine. The use of emery cloth on the piston is not advised, and through filing is permissible, it will be found difficult to avoid "pinning" of the file with consequent scratching of the surface. The special piston alloy does not machine very easily, and in production practice it is usual to employ diamond turning tools for finishing pistons; but with care, it is possible to obtain quite good results with ordinary cutting tools.

(To be continued)

FUELS FOR SMALL ENGINES

The Shell laboratories, in co-operation with the engineers of International Model Aircraft Ltd., have recently developed two fuels especially for model engineers—Shell Powa-Mix for model diesel engines, and Shell Red Glow for hot coil ignition engines and for spark ignition engines which have too high a compression ratio for gasoline mixtures.

"Powa-Mix" (Compression Ignition)

The intention behind the introduction of this ready-to-use fuel (not requiring the addition of ether) was to provide one at a price well within the reach of the most impecunious enthusiast in the model engineering field. The use of costly chemical additives has been kept to the minimum consumate with performance, and by keeping the formula as simple and straightforward as possible, the makers have been able to ensure a continuity of supplies to the same specification.

"Red Glow" (Hot Coil or Spark Ignited)

This is basically an alcohol castor oil mixture. By ensuring that both these ingredients are of the highest possible (A.M. Specification) standard, Shell Mex & B.P. Ltd. have obviated the necessity of resorting to the use of dopes or additives to secure adequate mixing. They state that although they are fully aware that nitro-paraffins, nitro-methane or propane do give added performance, these are not emboded in this particular fuel, due to their very high cost with consequent additional premiums on the retail price. The addition of less than 12 per cent. of these nitro-paraffins, furthermore, does not give a performance increase to justify the additional cost.

An interesting point which has been quite definitely established in the Shell laboratories is that catalytic action does take place when using platinum wire (glow-plug), and alcohol fuel, and the addition of some of the dopes on the market tends to impair rather than improve this particular characteristic.

We have received samples of both these fuels, and they have been thoroughly tested under our supervision with excellent results. Both are marketed in half-pint pressure feed packs (see illustration) which obviate the necessity for painful decanting before refuelling can be affected.

Distributors: International Model Aircraft Ltd., Merton, London, S.W.19.

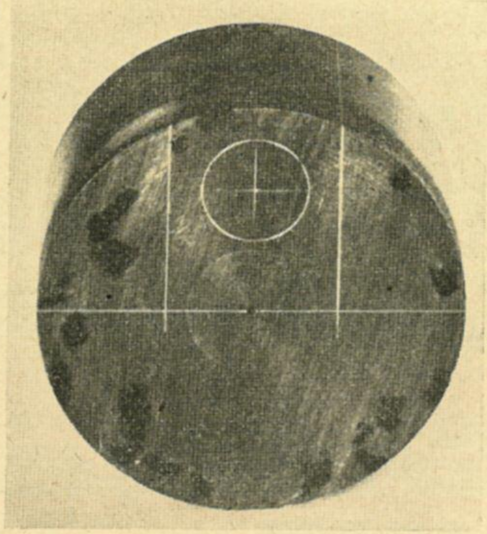
PETROL ENGINE TOPICS

*A 50-c.c. Auxiliary Engine

by Edgar T. Westbury

IT will be noted that in the detail drawing of the piston, the dimensions of the piston ring grooves are not specified, and just in case this may give rise to a flood of queries, I will explain that the reason for this is that it will probably be necessary to use whatever rings may be available for the particular bore diameter. The width of ring originally specified was 3/32 in., but I am informed that this width is difficult to obtain at present, and ⅛-in. rings are more readily available. It will make very little difference to the engine performance which of these is used; narrow rings exert a higher pressure on the cylinder walls and tend to bed down quicker, while their weight (and, therefore, inertia) is less, but the wider rings, which were the more usual practice a few years ago, give excellent results and are, if anything, more durable—provided in either case that, the cylinder bore is accurate and well finished.

In this, as in many other things nowadays, a policy of "making do" may be necessary, in view of the shortage both of raw materials and manufactured components. Even in manufacturing industries, it is not always possible to obtain the material specified, and the practicability of utilising substitutes must be given serious consideration.



Crank disc marked out to show position of crank-pin and outline of web

Some constructors may wish to make their own piston rings, but although this is by no means impossible, I do not think the facilities of the average home workshop are suitable for this specialised work. Manufacturers of piston rings in large quantities employ materials, processes and equipment not generally available to the amateur. I have on several occasions made piston rings for my own engines, but I do not consider them equal in quality to the Wellworthy rings which I usually recommend. The most suitable material for piston rings, should readers wish to try making them, is very fine-grained cast-iron; any metal which is ductile, or liable to take a permanent bend after machining, is definitely unsuitable.

Gudgeon-pin

This should, preferably, be made of mild-steel, and case-hardened. Silver-steel, in the "untreated" condition, is often used by amateurs for this purpose, but although not really hard enough to wear well, is liable to be somewhat brittle, and if hardened and tempered, is much worse in the latter respect. Open-hearth or "cyanide" hardening of mild-steel, or better still, "box" hardening, provides a combination of dead hard wearing surface and soft core, which is most suitable for the duty called for in this component. The technique of case-hardening is dealt with in "Novices' Corner" in this issue. After case-hardening, the surface of the pin should be highly polished.

It will probably be found necessary, or at least desirable, to machine the gudgeon-pin all over from steel bar larger than ⅜ in. diameter, as it must be a good fit both in the piston bosses and the little-end eye of the connecting-rod when finished. A very slight taper—about 0.0005 in. in the length—is permissible so that the pin may be inserted in the piston easily for about three-quarters of its length, and tapped in for the rest of the way. Too tight a fit of the pin in the piston is liable to cause distortion of the latter in inserting or removing it.

The end pads may be made of brass, soft bronze, or duralumin, and should be a light press fit in the bore. Their purpose, of course, is to prevent the risk of the pin moving endwise and scoring the cylinder bore, and while there are other methods employed in common practice for this purpose, this is the simplest I know of in the present circumstances.

Crankshaft

The somewhat unusual form of crankshaft construction which has been adopted in this engine is intended to economise both metal and machining time, in view of the fact that it is

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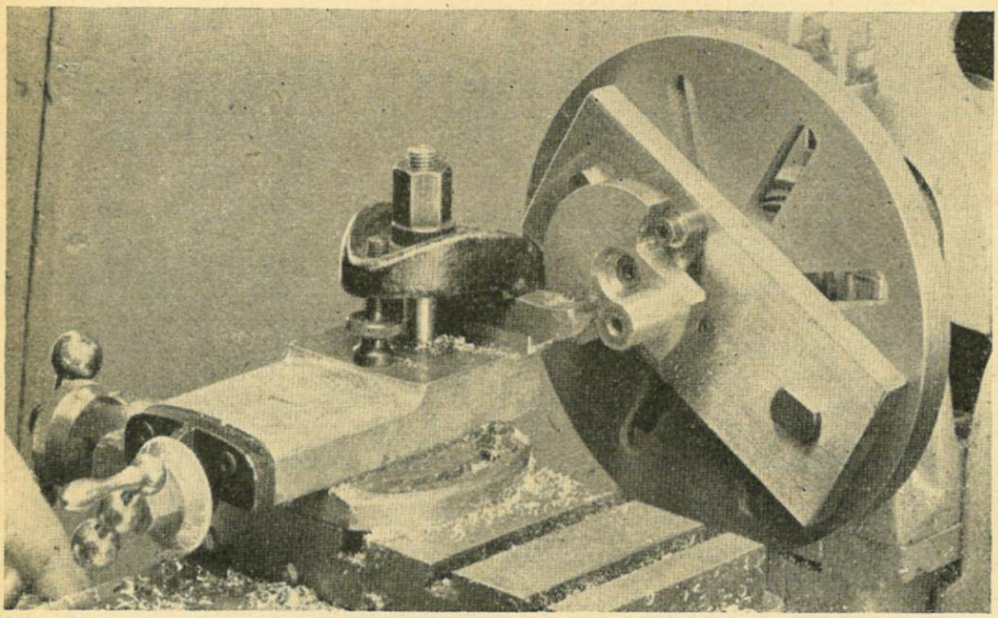
*Continued from page 674, "M.E.," May 24, 1951.

hardly practicable to obtain a suitable forging. It will be seen that the main journal portion of the shaft is of somewhat abnormal length, as compared with that of the usual small two-stroke, and, therefore, the machining of the complete crankshaft from solid would call for a billet of steel 2½ in. diameter by 8 in. long, most of which would have to be machined away, and this would be both a wasteful and a tedious process.

be able to report that a shaft made in this material has been found quite satisfactory. If, however, constructors have access to better material, such as 3 per cent. nickel or medium nickel chrome, by all means use it.

If the material used for the disc is reasonably clean and free frôm scale or pitting, it may only need a mere skim on the outside, but if not, larger material must be used, and rough-turned

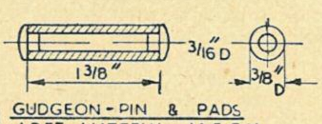


Crank disc mounted on a throw-plate for eccentric-turning operations

The two-piece construction shown enables a short piece of large diameter material to be used to form the web, balance weight and crankpin, and a longer piece of small diameter material for the journal; it has the further advantage that different grades of material, to suit the respective duties of the two portions, may be used if desired. I have employed this form of construction with success on earlier engines, notably the *Atom I*, and have no doubts as to its structural strength; as a matter of fact, three "Busy Bee" engines have been built with the form of shaft shown, and have so far shown no signs of disintegration under running tests. The joint by which the two parts are connected needs to be very carefully made, and calls for more metal in the centre of the crank disc than is necessary in a one-piece shaft, but this is not a very serious disadvantage, and does not add so much to the weight as might be expected.

It is advisable to make the "large end" first, as this involves the most awkward machining, and it is easier to fit the journal to it than *vice versa*. Although the material specified for the component is high tensile steel, and this is certainly desirable if it can be obtained, difficulties in the latter respect have caused me to investigate the possibilities of mild-steel, and I am glad to

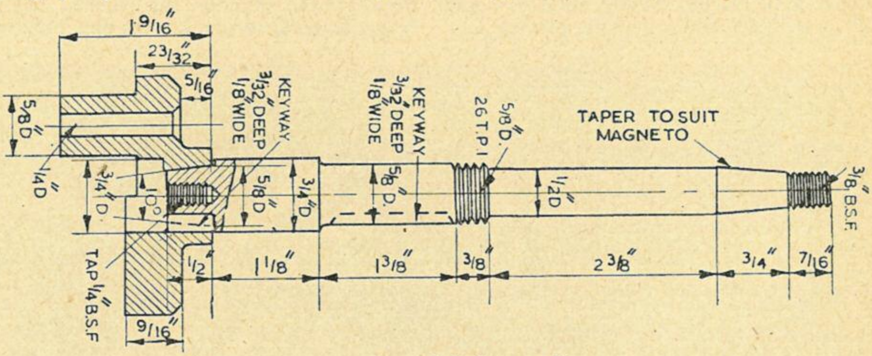
to just over finished size in the preliminary operation. The two ends are faced true and parallel, and one end is then marked out to show the position of the crankpin, at ⅞ in. radius from the main centre, also the outline of the web and balance weight. As these marks should be bold and clear, it is advisable to use spirit marking dye, or in the absence of this preparation, any quick-drying paint, such as cellulose, or pattern-



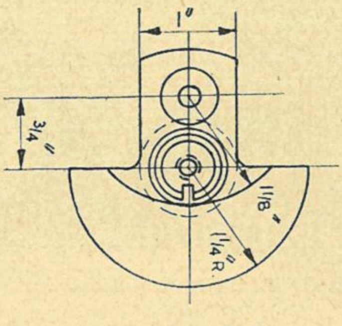
(13) GUDGEON-PIN & PADS
1 OFF MATERIAL M.S.C.H & BRASS

maker's colouring, may be used. The appearance of the marked face of the disc is shown in the photograph, and in view of the need to avoid removing these marks in immediately subsequent operations, the disc is chucked with this face inwards, so as to run truly on the diameter and end face. It may then be machined to form the centre boss, chamfered on the edge, and drilled and bored through the centre, a hole ½ in. dia.

being carried right through the disc, and the outer end bored to an included angle of 10 deg. Great care must be taken to produce a smooth and accurate finish of this surface, and the boring tool must be set with its cutting edge exactly at centre height. The exact dimensions or angle are not highly important—measurement of tapers would have served equally well if properly hardened and tempered. It was ground on the end face to produce a rake angle of about 10 deg., and clearance ground on both sides as for a parting tool, i.e., tapered towards the back, and for a sufficient length to clear for the full length of the slot (½ in.). If an adjustable tool rest is available



Details of crankshaft assembly



End view of crank disc

is extremely difficult, anyhow, unless special gauges are available—as the shaft can be fitted later, but the outer end of the hole should be approximately ⅝ in. diameter.

It is now advisable, temporarily, to reverse the disc and counterbore the centre hole to ¾ in. dia., to within ½ in. of the back face, though it is possible to carry out this operation at the original setting, if a suitable internal recessing tool is available. Most workers, however, object to "blind" boring in this way, and it certainly involves some risk of damage to the taper bore in view of the restricted clearance for the entry and withdrawal of the recessing tool.

The keyway for locating the disc on the shaft may be cut, by means of a suitable slotting tool, while held in the chuck. In the case illustrated, advantage was taken of the facilities offered by a special toolholder designed to fit the Myford height-adjusting packing block, but it should be noted that in this instance it is absolutely essential to keep the tool dead horizontal, and, therefore, its height had to be adjusted by parallel packing strips in the usual way. The cutter was made from a piece of 3/16 in. square high-speed steel, as used for standard forms of holders, though silver-steel

on the grinder, it will be quite easy to grind the clearance angle accurately, and in such a way that the full width of the stock is maintained at the cutting edge, a slight "witness" being left here, to be finally finished with a honing slip.

It will be noted that the keyway does not follow the angle of the tapered bore, but is cut parallel to the axis. This is a comparatively unimportant point so far as the fitting of the key is concerned, but it makes a great deal of difference to the task of slotting the keyway in the lathe, in the manner illustrated. If the line of the keyway was parallel to the angle of taper, it would be necessary to take the cut by operating the top-slide, and unless special fittings were made, this would entail the use of the feed screw. But by cutting on the axial plane, however, the rack feed of the saddle can be used, which is much less laborious, in spite of the fact that a greater total depth of cut must be taken in this case.

For setting the tool to centre height, it is a very good idea to remove the work from the lathe and set up a piece of 3/16 in. dia. round bar, preferably in a collet chuck, so that it runs quite truly. By bringing up the tool either to the end or rear side of the rod, any discrepancy in the height of the two will immediately be apparent, and may be checked still more accurately by laying a straight-edge across the rod and the extreme tip of the tool. The cutting face of the latter should be inclined about 5 deg. to the lathe axis, to provide back clearance.

Success in cutting slots in the lathe by this method is largely a matter of patience. It is no use whatever to try to take heavy cuts in this way; however firmly the tool is fixed, it will either shift, spring, or dig in if overloaded; much better to "make haste slowly" and take delicate nibbles, which will result in clean, easy cutting, and leave a polished surface if the tool is sharp. About 0.005 in. is about the deepest cut it is desirable to take, and a number of "running out" cuts should finally be taken at the same setting, to eliminate spring. I have on several occasions had to cut serrations or multiple splines in this way, and have even made an internal toothed gear by the same process.

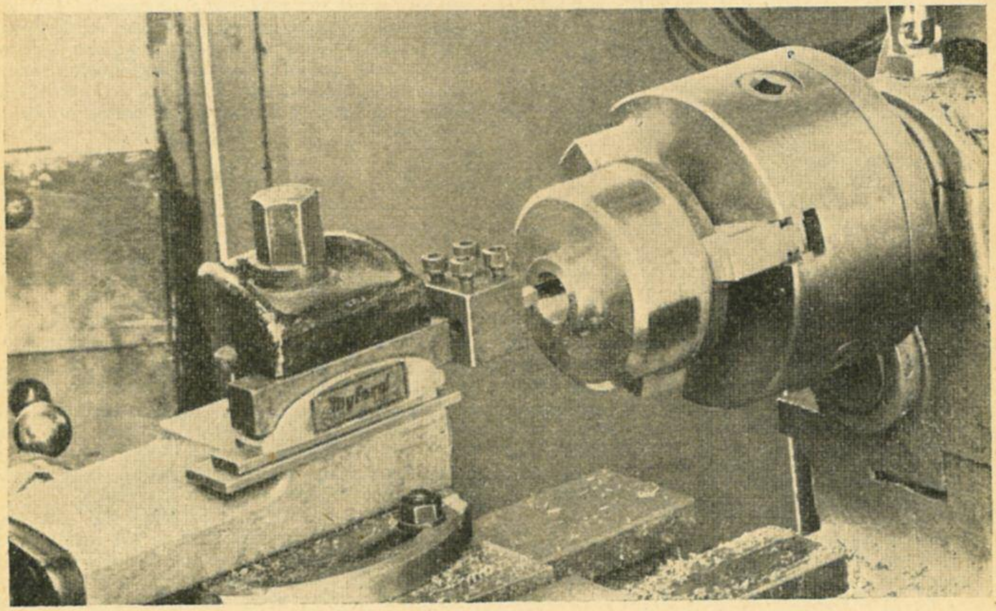
Removing Surplus Metal

It will no doubt be appreciated that in the operations so far carried out, the circular form of the disc has been left intact to facilitate holding it in the chuck ; but now it will be advisable to get rid of some of the unwanted material, to reduce the amount of work in machining the crankpin. The outline of the crank web may, therefore, be allowing a little extra for machining than otherwise.

Machining the Crankpin

The disc must now be set up with the crankpin centre running truly. Methods which have been described for machining overhung cranks in the past are not applicable here, as there is no parallel shaft or stalk available which can be held in a vee angle-plate or eccentric fixture.

It is, therefore, necessary to clamp the disc to the faceplate, using the flat face of the rear boss as



Cutting the internal keyway in the bore of crank disc

shaped, working to the lines already marked out on the back face, and utilising any methods which may be available. Most workers will probably have to resort to the use of " Armstrong's patent," as my old foreman used to call it—in other words, purely manual methods, in which the good old-fashioned hacksaw and file play an important part. In this case, it is advisable to mark out and drill two ¼ in. holes to touch the lines bounding the angle of the web and balance weight on each side ; these will form a useful guide in cutting and filing operations, and also form fillets to avoid sharp internal corners at these points.

After the two segments have been removed, a cut may be taken at right-angles to the axis, to remove the surplus metal from the front of the balance weight, leaving it $\frac{9}{16}$ in. thick, plus machining allowance. An axial cut will, of course, have to be made just below the crankpin to join up with this and detach the slide of metal. Take care to avoid risk of cutting into the crankpin when making either cut ; hacksaws often run away at queer angles, and in the stress of physical exertion, one's finer perceptions are sometimes a little below par, so it is better to err on the side of a bearing surface ; but here a difficulty arises, as the centre hole of the faceplate prevents it making a really good contact at the required radius, and clamping in such a way as to enable the front of the disc to be machined is also a problem. In these circumstances, a " false faceplate " or parallel packing plate, to which the disc may be clamped, and which in turn is mounted on the faceplate, offers the best solution. It is not absolutely essential to use a plate either so long or so broad as the one illustrated here, but it should be big enought to provide an adequate bearing surface, and should be checked for flatness and parallelism before use. A piece of bright mild-steel flat bar is suitable if it is free from bends, twists, burrs or bruises.

The disc is clamped to the plate by means of a central bolt having a head not more than ⅛ in. thick, as anything thicker will get in the way when machining the front of the web. It should either be screwed into a tapped hole in the plate, or secured by a sunk nut at the back. To prevent the disc turning under the torque stress of the machining operations, stop blocks or dogs should be attached to the plate, to bear against the sides of the web or balance weight, and these also should not project far enough to foul the cutting tool. The plate is drilled near the ends to take bolts for securing it to the faceplate, and the positions of these should be chosen so that they allow of centralising the crankpin.

In setting-up, the use of a "wobbler" or similar centre-finding device to work off the marked centre-pop will be found useful, but although accuracy in this respect is highly desirable, a few thousandths of an inch difference in the crankpin radius will not affect the working of the engine to any appreciable extent. The thing that really matters is that the crankpin should be truly parallel with the shaft axis, which is positively assured if this method is properly carried out.

All is plain sailing now for the machining of the crankpin, also the facing of the front of the web and balance weight, but here again, caution is called for, as the cut is mostly intermittent, at least in the early stages of the work, and attempts to force the pace may be disastrous. However, there is nothing in the job that the beginner cannot do by taking due care. A well-raked side tool with a small radius at the tip should be used. The crankpin should be turned to exactly $\frac{5}{8}$ in. dia., truly parallel, and with as high a finish as possible, to avoid the need for a great deal of abrasive polishing. Most of the facing can also be done with the same tool, with the exception of the inside radius where the balance weight is scooped out to clear the counterbore; this will call for the use of a boring tool or a small left-hand side tool with plenty of clearance. The hole through the centre of the crankpin can also be centred and drilled at this setting, and although there is no real necessity to do so, a skim off the face of the pin is desirable on the grounds of appearance. (*To be continued*)

BROOK FILMS AND FILMSTRIPS

WE have recently received from Messrs. Brook Motors, of Empress Works, Huddersfield, a pamphlet describing an interesting range of films and filmstrips which might well prove of interest to model engineering clubs and societies. They are available to all on free loan, together with special filmstrip projectors if required, and a commentary for each frame.

Filmstrip No. 1.—"General Motor Applications"

No. of frames 35. Approximate time 20 min.

A selection of photographs, showing the application of Brook motors, various types, to a wide range of trades from textile manufacturing to quarrying.

Filmstrip No. 2.—"Motors for Farms and Dairying"

No. of frames 30. Approximate time 20 minutes.

A fairly comprehensive coverage of the most suitable types of motors for use in farm and dairy machinery. Barn machines such as group cutters, food mixers, grinding mills, etc., are included together with pumping drives for milking and up-to-date driving equipment.

Filmstrip No. 3.—"Motors for Engineering"

No. of frames 30. Approximate time 20 min.

A helpful strip showing motor applications in this great industry; foundries, machine tools and cranes.

Filmstrip No. 4.—"Selecting the Right Motor"

No. of frames 40. Approximate time 30 min.

Covering a wide field, showing a selection of the most widely used motor types, with installation photographs as guides in each case. Of interest to all who install and maintain electrical motors in any trade.

These strips are most useful for making up an evening's programme in conjunction with the films. Technical and trade societies will find them interesting, particularly where they apply to members' own trade.

They also form a useful basis for teaching in courses involving electrical motor installation in the appropriate departments of technical colleges. It should, however, be clearly understood that neither films nor filmstrips are made as teaching mediums in themselves. Advertising has been kept to the minimum throughout, but they are intended to publicise the Brook products and services.

"Power Without Smoke"

A 16 mm. sound film, showing time approximately 20 min.

This film argues the case for the individual electric drive. It was shot on locations centred in the heart of Britain's textile areas, and endeavours to show how the application of the individual drive has been introduced into every process where mechanical movement takes place.

"Distinguished Company"

A 16 mm. sound film, showing time approximately 40 min.

In the production of this film it has been the intention of Brook Motors to present an over-all picture of their establishment which may help those people interested in up-to-date electrical motor construction to learn something of their methods and approach to modern production technique.

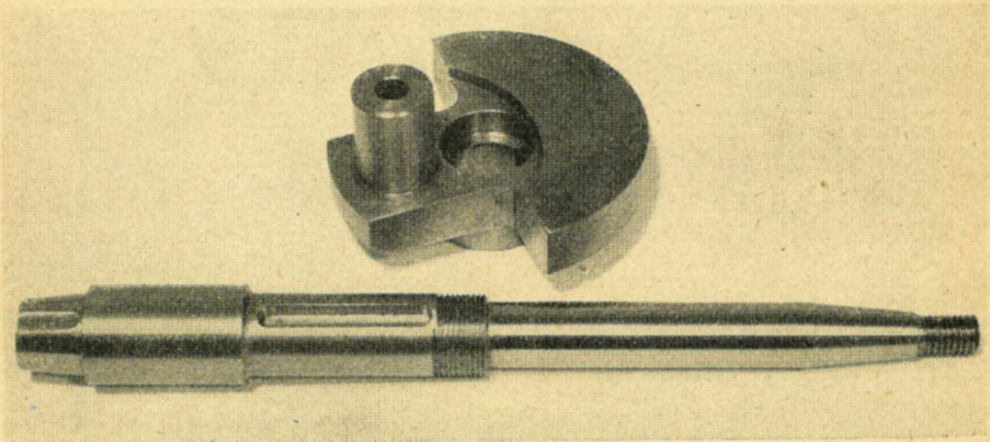
Copies of the leaflet in question may be obtained from the Brook Motors Ltd. Film Library, at the aforementioned address.

PETROL ENGINE TOPICS

*A 50-c.c. Auxiliary Engine

by Edgar T. Westbury

THE machining of the crankshaft journal is a fairly straightforward operation, which can be carried out between centres. At its largest point, the diameter of the finished shaft is ¾ in., so that it could confortably be machined from a bar 13/16 in. in diameter, though it is probable that the nearest available size will be ⅞ in. Both ends of the bar should be truly faced before centring, and as the material is too large to pass through the hollow mandrel, there will be a fairly considerable overhang from the chuck. It is desirable



Crank disc and shaft, completely machined and ready for assembly

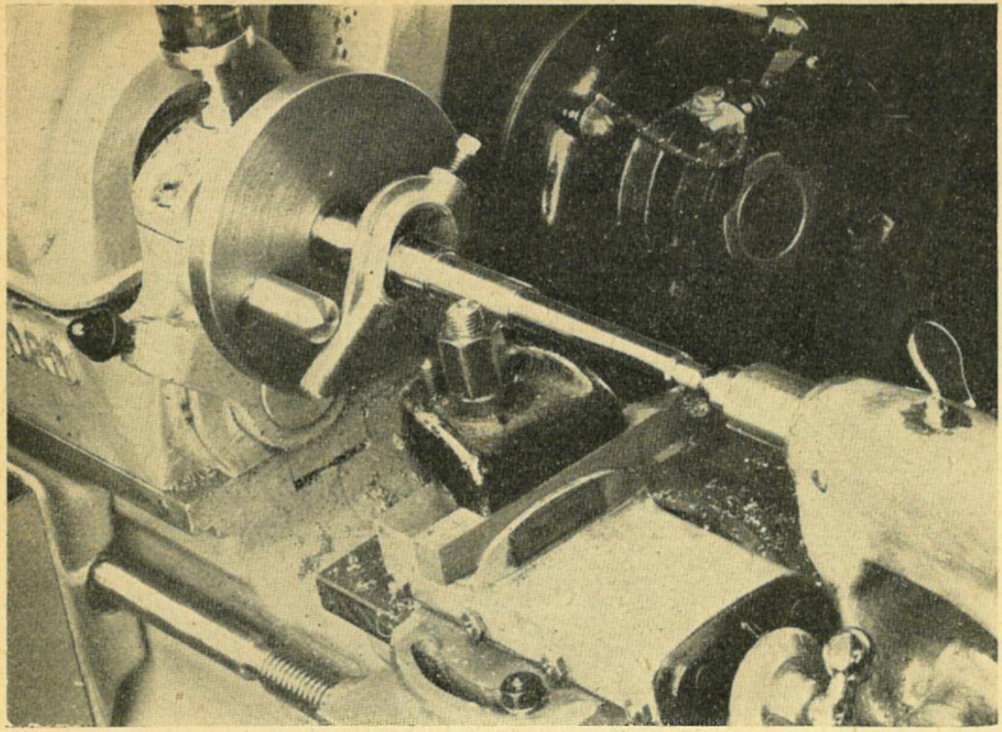
to support this in a fixed steady, if available, but failing this, an alternative method is to file the ends of the bar as squarely as possible, and mark out the centres with a bell punch or centre-finder, then drill each end in turn with a centre-drill held in the chuck, locating the other end on the back centre. The bar may be held in the hand firmly enough to resist drill torque, and feed applied from the tailstock. One of the centres—that at the crank web end—should be countersunk almost to the full depth, so that the centre is preserved after this end has been drilled and tapped for the ¼ in. retaining-screw, but the other centre should not be too deep, and the "pilot" of the drill should not be larger than 1/16 in., as this end will only be ⅜ in. dia. when finished.

If necessary, the ends of the bar may be faced after mounting between centres, by using a cut-away centre, which will allow of running in a right-handed knife tool. The length of the shaft is not critical, but any error should be plus rather than minus. In machining the outer diameters, it is advisable first to rough turn to within about 1/32 in. of finished size, working with the small end towards the tailstock and covering as much of the length as can be dealt with, short of fouling the carrier. Although the shaft is fairly slender, it can be turned without the necessity to rig up a steady, provided that the tool is sharp and properly set.

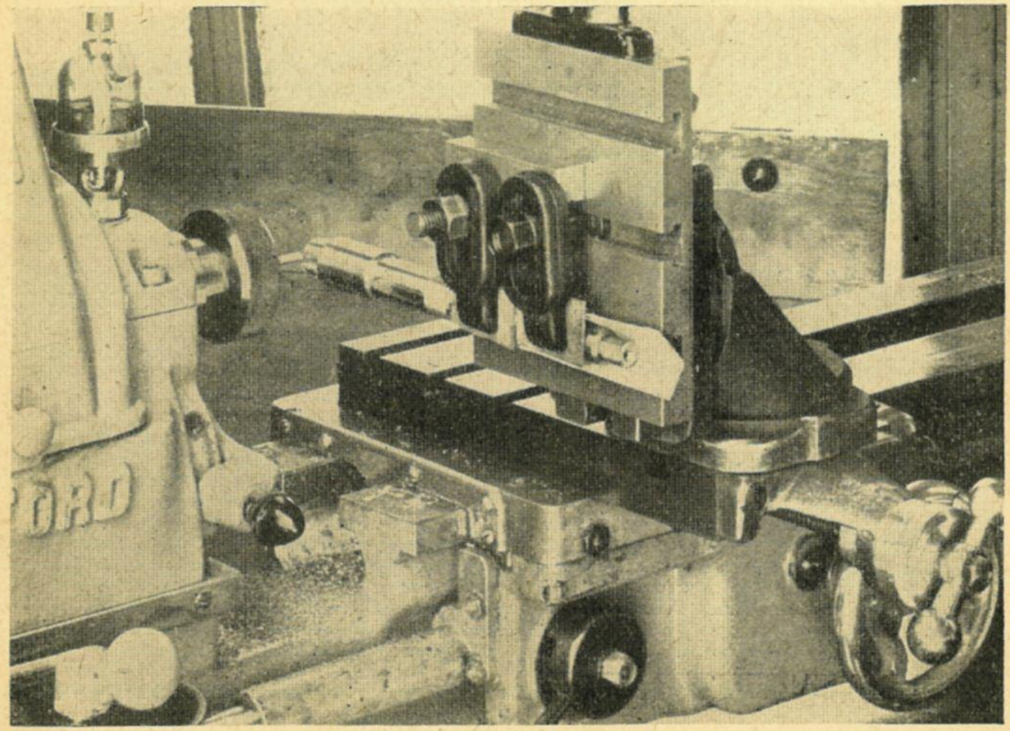
During the roughing operations, it is a good policy to check the surfaces for parallelism as the work proceeds. It is often found necessary to adjust the tailstock alignment, even when it has been set as truly as possible by preliminary tests, and as this may involve two or three trial cuts, it is obviously best to do this while there is plenty of material to play with. The Myford M.L.7 lathe has a set-over tailstock with adjusting screws front and back, but some types of lathes are less convenient and sometimes rather "chancy" to adjust; if no set-over movement is provided on the tailstock, it may be found necessary to improvise some arrangement, such as an eccentric back centre, to obtain this facility. It is necessary to ensure that the shaft is parallel, on its various steps, to fairly close limits—about 0.005 in. in the foot—and any error should be such that the diameters increase towards the crank disc end.

After roughing the major length of the shaft it may be reversed to deal with the part not

*Continued from page 736, "M.E.," June 7, 1951.

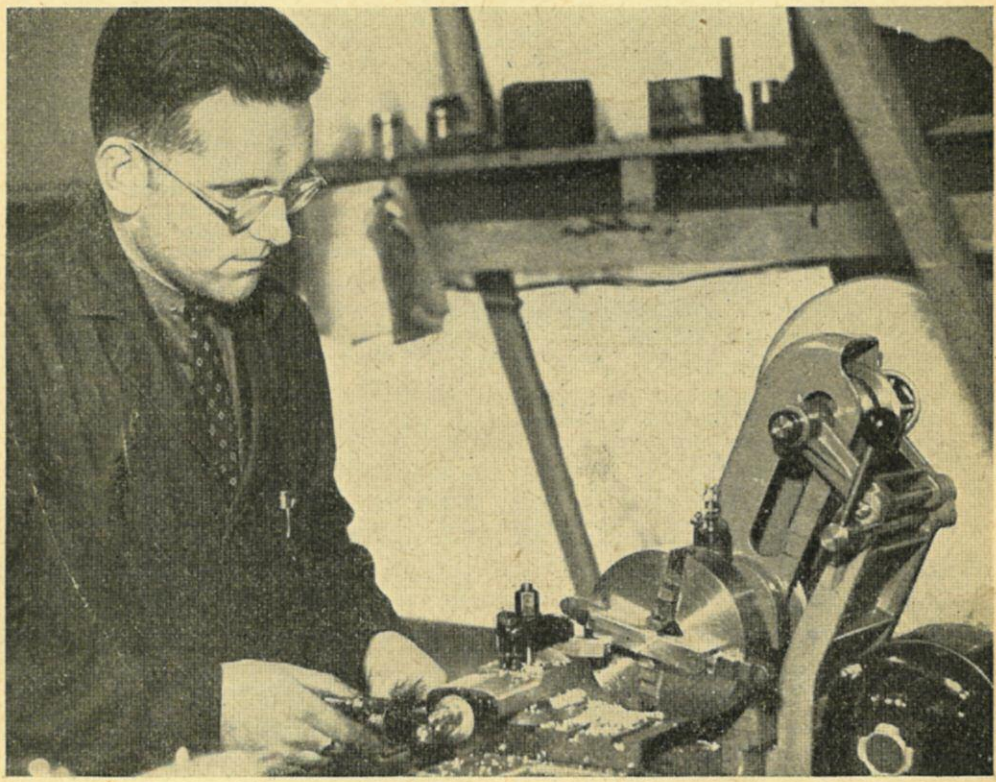


Screwcutting threads on crank journal



End-milling keyways in the crank journal previously accessible, and this may be finished right out to size, except for the taper, which is most conveniently left to a later stage. A fine self-acting feed is desirable for finishing, and the tool should have about 10 to 15 deg. top rake, with a rounded tip, honed to a keen edge. The large diameter portion of the shaft should be a light press fit in the bore of the ball-race, that is about 0.0005 in. over $\frac{3}{4}$ in. dia. and it is permissible to use a dead smooth Swiss file and emery-cloth for final fitting, though the use of a fine oilstone slip is better, especially as a part of this length runs in the packing bush. Lapping with a ring lap is better still ; the same applies to the other diameters of the shaft, which are, of course, finish-turned after replacing it in the original position. Incidentally, great care must be taken to see that the live centre in the mandrel socket runs perfectly true, and if not, the cause must be found, and due correction made before the finishing cuts are taken.

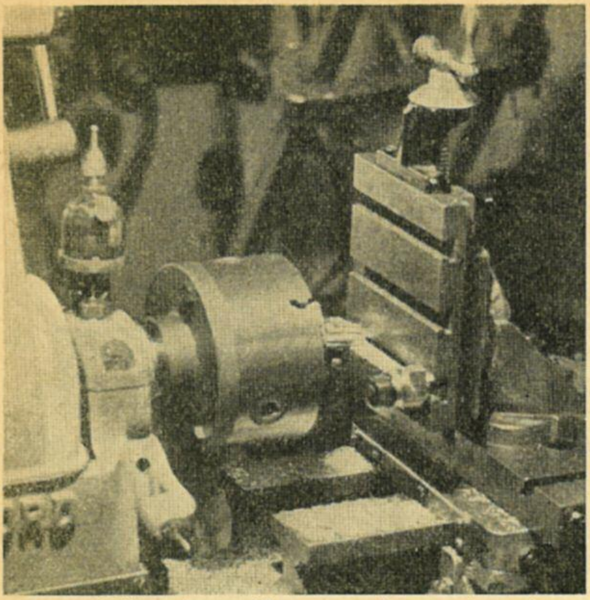
When turning the tapers on each end, it will be found advisable to swivel the lathe top-slide almost completely round, so that the handle is towards the headstock, as this avoids the need for excessive overhang of the tool or uncomfortable proximity of the handle to the tailstock. The angles at each end are, at least nominally, identical, but they should be individually fitted by trial, in the bores of the crank disc and magneto respectively, and tested with "mechanics' blue" or similar marking colour. Here again, it is permissible to use a Swiss file for final fitting, but do not attempt to correct errors by lapping the mating parts together. Correct fitting of the tapers is most essential for the success of the job, but failures in this respect, due to lack of care and patience are very often encountered, and the remedy is obvious.



First stage in machining connecting-rod from solid bar

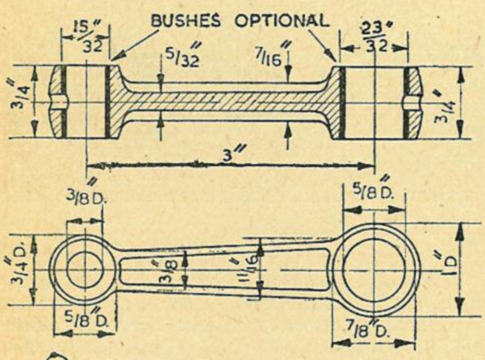
Screwcutting is called for on two diameters of the shaft, and this calls for little comment, as the necessary operations have been described on several occasions in THE MODEL ENGINEER. The pitch of the thread on the $\frac{5}{8}$ in. diameter portion is standard brass pipe thread, but it is unlikely that a suitable steel nut for this thread will be available ready made, and it will have to be produced. Note that the outside of this nut must be small enough to enable it to be manipulated by a tubular box spanner in the recess of the friction roller ; the size is as for $\frac{7}{16}$ in. Whitworth nuts, and the thickness of the nut is $\frac{1}{4}$ in.

The shaft may be held in the chuck, with the small end passing into the hollow mandrel, and a strip of soft metal wrapped around the large diameter to protect it from marking by the chuck jaws, for drilling the tapping hole in the end, which is $\frac{1}{2}$ in. deep and tapped $\frac{1}{4}$ in. B.S.F. A



Milling the outside contour of connecting-rod

high-tensile set-screw, with a standard hexagon head and a thick washer $\frac{3}{4}$ in. outside diameter is recommended here, an alternative being a socket-head Allen type screw, and a counter-bored bush. In either case the fit of the screw in the thread must be good, and the use of some form of keep, such as a shakeproof or single-turn spring washer, is desirable on final assembly. Note that the screw head must not project beyond the front face of the balance weight.



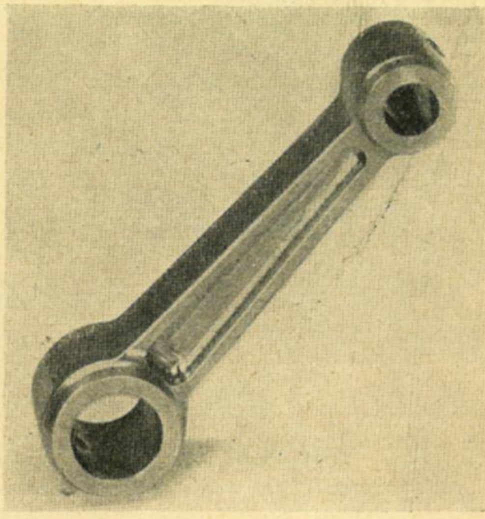
(8) CONNECTING-ROD - 1 OFF
MATERIAL DURALUMIN

Cutting Keyways

This operation may be conveniently carried out by end-milling, and the photograph shows the shaft mounted on the Myford vertical slide, with due precautions for protecting the finished surface, by the use of slips of soft metal behind the shaft and under the toes of the clamps. The cutter is held in a Myford collet chuck, but could be held in the three-jaw chuck if the latter is reasonably true; any error in this respect results in cutting over-width, and much less efficiently. The work must be set exactly horizontal, and may be checked by means of a scribing block on the ways of the bed, and the slide adjusted so that the height of the shaft axis is identical with that of the cutter axis, by the same means. Run the cross-slide as far as it will go in one direction to check on the centre at one end of the shaft, and then to the extreme position in the other direction for checking the other centre. Both keyways can then be cut at one setting. If no vertical slide is available, it would be possible to carry out the operation by using a vee-block clamped at the correct height on the vertical side of an angle-plate mounted on the cross-slide.

Connecting-rod

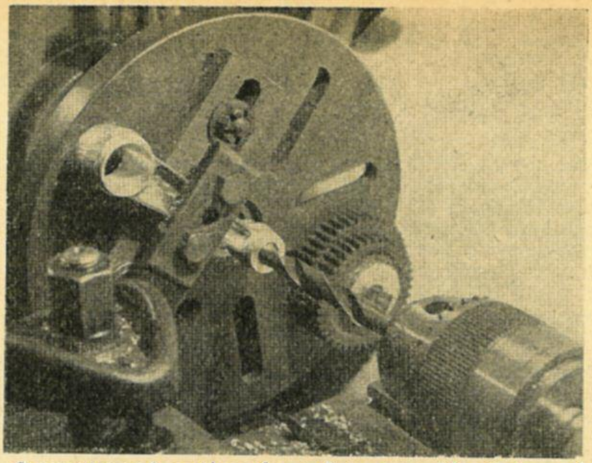
The connecting-rod used in the first "Busy Bee" engine was machined from the solid, and to those who are prepared to take the required amount of trouble, and have suitable material available, this method will produce a rod having maximum strength in relation to weight. But many constructors find this a rather tedious operation, and as it is not economically possible to provide a forging for the component, experiments have been made with rods cast in bronze and aluminium alloy, with success in each case. The bronze rod provides considerable strength, and does not require bushing, but has the disadvantage



A connecting-rod machined from the solid of somewhat excessive weight, though this can be counteracted to some extent by reducing the section all over. However, when all reasonably practicable work has been done in this direction, it is still too heavy to enable the engine to be balanced as well as it might be.

The light alloy casting eliminates this objection, and although a good deal lower in mechanical strength, it has been proved adequate under test. In this case it is desirable to bush both the eyes to obtain the maximum length of wear, but rods machined all over from duralumin or similar high-tensile alloy give excellent wear without bushing. I do not propose to deal in detail with making the rod from the solid, as it has been described on several previous occasions, but the photographs give a fairly clear explanation of two of the operations, namely, the shaping of the rectangular blank (which started, in the first place, as round bar) and milling over the outside edges of the rod, after the eyes were bored and the sides reduced to the required thickness by facing about the eye centres.

The amount of machining called for on the cast rod is quite small, consisting only of boring and facing each of the eyes and skimming the accessible portions of the bosses. It will be seen that the rod is mounted for boring by a method which I have described in previous articles, namely, by clamping it to a flat bar which may be adjusted on the faceplate to bring each of the eyes in turn into the central position. It should be noted that the clamp securing the rod to the larger bar is not loosened between the two operations, the entire assembly being shifted end for end; this ensures that the two eyes are bound to be bored parallel with each other, even though the rough-cast surfaces of the webs which form the clamping faces may not be perfectly true.



Connecting-rod casting clamped to reversible plate and mounted on faceplate for machining the eyes

It is, of course, necessary to see that the rod is reasonably parallel with the plate in the initial clamping up, and a slight dressing of the webs with a file may be found desirable. Side alignment of the eyes may be ensured by checking the distance of the front face from the faceplate, which should be the same for each end after machining. The outside of each boss should be machined, to a taper of about 15 deg. inclusive, as far as allowed by the webs. After removing from the clamp, the other side of each eye is faced to correct width, and the outside skimmed, by mounting the eyes on pin mandrels.

The edges of the bosses and webs may be filed for the sake of neatness, and to blend in the contour of the bosses to the machined parts so as to produce the barrel shape shown on the drawings. Bushes, if fitted, should be concentric inside and out and fitted to 0.001 in. interference, the oil holes being drilled after they have been inserted.

(*To be continued*)

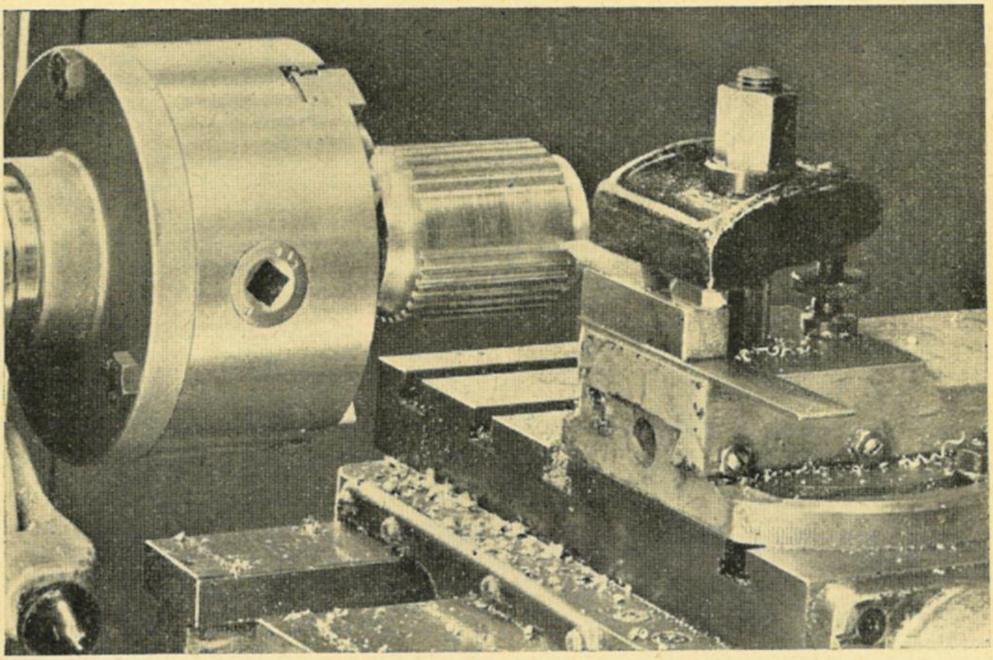
The Reading S.M.E.E. Exhibition

THE first exhibition staged by the society in Palmer Hall, Reading, was a great success, approximately 4,000 people visiting the exhibition during the three days. The opening ceremony by the president, Lord Northesk, and the vice-president, Mr. J. N. Maskelyne, was filmed and added to the club film. There were about 200 models of all classes, several excellent models being loaned by the Andover and District M.E.S. Among the working models was a miniature theatre, giving short stage and screen shows, "O" and "OO" railways and about 20 models were run on air. Ship models were of a very high standard and included a 6 ft. working model of H.M.S. *Hood* and a wireless-controlled tug. During the exhibition J.T.'s wandering microphone recorded visitors' remarks and played back through the hall speaker. The club workshop was the centre of interest, various jobs for the club's passenger track being performed.

PETROL ENGINE TOPICS
*A 50-c.c. Auxiliary Engine
by Edgar T. Westbury

A GOOD many readers have discussed with me the question of friction drive, which is used by most of the engines employed as attachments to cycles. In the past, the use of this form of drive, not only on motor vehicles but also on many other types of machinery, has often proved to be inefficient or troublesome, and as a result, it has earned the opprobrious tag " bad practice " in the best engineering circles. I have been asked, therefore, to give my views on this matter, and if possible, to describe some form of " positive " transmission which could be applied to an engine of this type.

I have to tread very warily in delivering any dogmatic opinions on this subject, because we are dealing with a method of propulsion which is in a class of its own, and cannot be directly compared to that of any other motor vehicle. It may be said to be still in the development stage—one might even say the " teething " stage—and various commercial makers and individual experimenters have tackled the problem in ways that seemed to them best for the particular conditions. I would not like to prejudice the minds of readers by criticising methods which have been used in practice—the old saying that " there are more ways of killing a cat " applies here—but, as I said in the introductory article on this engine, the friction drive is the simplest which can be used in the particular circumstances, and gives reasonable success in transmitting the available power.



Planing the teeth in the friction roller

It is often assumed the positive drive must obviously be more efficient than that in which any possibility of slip can occur, but this is by no means invariably true, especially in cases where conversion of speed and torque is involved ; and even apart from actual efficiency, the question of convenience, either in application or control, must be taken into consideration.

Some years ago I worked in a shop where the boss had what might be described as a " positive mania " about power drive to machine tools. Belts or clutches were anathema to him ; every machine had to be driven from the motor by

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*Continued from page 789, " M.E.," Vol. 104, June 21, 1951.

direct coupling or gearing. To cut a long (and painful) story short, he was eventually cured of his obsession, but not before a few motors had been burnt out, gears stripped, leadscrews twisted off, tools broken and work ruined. But in this class of work, the drive problem is much simpler than that of a mobile vehicle driven by an i.c. engine, and one may say that in the latter case, some form of "friction" drive (and this term includes friction clutches and belt drives) is practically a necessity.

The type of friction drive which involves direct contact of non-axial driving and driven members, either on the face, periphery or some intermediate angle, is of all types most open to criticism in respect of its ability to transmit torque efficiently, as the members have only line contact at best, and thus heavy pressure is necessary to secure reasonable adhesion when any substantial amount of power has to be dealt with. Nevertheless, such drives have been used with very fair success in motor vehicles, and they have been discarded less often for lack of efficiency or handiness than for their inability to stand up to the abuse they receive at the hands of careless drivers. Where it is possible to make one of the members of resilient material, such as rubber, something much better than the theoretical line contact is obtained in practice, and if such material can be made durable enough to give reasonable wear, the ultimate results can be, and often are, entirely satisfactory. Incidentally, every mechanically-propelled vehicle, unless it is driven by an aerial propeller or a jet motor, must ultimately rely on the "friction drive" provided by the contact of the driving wheel tyres with the road or track.

Readers may be assured, therefore, that I have not accepted friction drive simply because it is fairly popular, or without making practical investigation of its possibilities in comparison to other methods. The alternatives to friction drive must inevitably involve some complication at the very least. Belt drive has been very popular in the past, and can be made highly efficient; it became obsolete on motor-cycles mainly because of troubles with belt fasteners and tensioning devices, both of which objections could be eliminated by using modern endless belts. But direct (single-stage) belt drive from engine to road wheel is only practicable within a limited range of reduction ratio, and to obtain a sufficiently low gear ratio for the particular purpose in hand would call either for two stages of belt drive, or belt-cum-gearing. Much the same applies to chain drive, and a further complication in either case is that it is not easy to disengage the drive unless some form of clutch is added.

If any form of drive which applies torque to the cycle wheel, either through the hub or the spokes, is employed, it will almost inevitably be found necessary to strengthen the wheel structure to cope with the increased stresses produced by power drive. I know of more than one case where the spokes of the wheel have failed through neglect of this provision. There is yet another practical point in favour of the friction drive: so far from increasing the loading on the wheel bearings, as many people seem to believe, it actually relieves it, because a part of the combined weight of the rider, frame and engine is transmitted directly through the friction roller to the top of the wheel, instead of all having to be carried on the axle. This, of course, assumes that the roller is located at or near the top of the front or rear wheel, which is the most popular position.

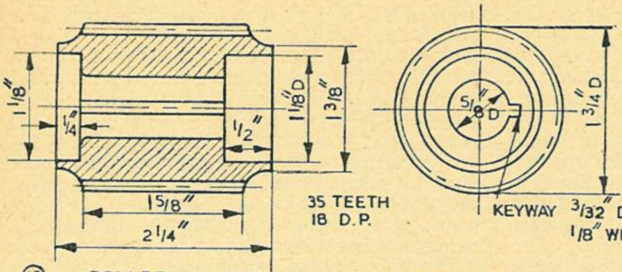
Various other details concerning engine position, centre of gravity and so on have been discussed with readers, but I do not consider it necessary to deal with them at present. The basic design of engine I have developed is sufficiently adaptable to enable readers who have any strong preferences about the way the engine should be applied, to exercise them to their hearts' content. The others, who are content to follow my recommendations, will find that they are quite capable of producing satisfactory practical results.

Friction Roller

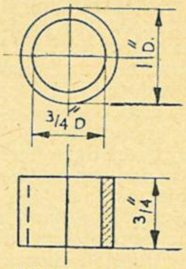
It would be idle to claim that complete finality has been reached as to the most suitable material for the roller; indeed, the manufacturers of cycle engines are as yet by no means agreed on this point, and all sorts of materials have been tried. The question is really a matter of finding the best compromise between three more-or-less incompatible factors, namely, durability of tyre, wearing life of roller, and avoidance of slip, especially on wet roads. I have made quite a number of experiments myself, but while these have not been conclusive, I do not wish to give readers the impression that the problem is likely to cause them a great deal of trouble; it is more a matter of searching for an ideal material than something which will work reasonably well.

Metal rollers give fairly good results and, generally speaking, the softer metals give best adhesion but wear out too quickly. The first "Busy Bee" engine had a cast aluminium alloy roller, but cast-iron has been found much more durable, although liable to acquire a hard glaze which encourages slip to some extent, particularly if machined to a smooth surface. By breaking up the continuity of the surface, the liability to slip is reduced, but there is risk of wearing out or damaging the cycle tyre if slip should under any circumstances occur. A very coarse but not too sharp knurl would drive well until the serrations became filled with dirt, which would not be very long. The best all-round results with metal rollers has been obtained by cutting straight grooves about $\frac{1}{16}$ in. to 3/32 in. wide, with lands of approximately the same width, axially across the surface. The roller grooved in this way is practically the equivalent of a gear wheel, though the tooth-form is not of any great importance.

Of other materials than metal, I have tried laminated fabric bakelite and bonded asbestos composition, both of which grip well, but results in respect of wear have so far been very disappointing. Abrasive-surfaced rollers give the best grip on wet roads, and are very durable, but solid abrasive wheels are difficult to mount truly and securely, and I have found that all forms of abrasive coatings so far tried have failed through imperfect bonding. However, experiments continue, and these materials seem to offer the most promising results if their inherent disadvantages can be overcome.



(12) ROLLER 1 OFF MATERIAL CAST-IRON



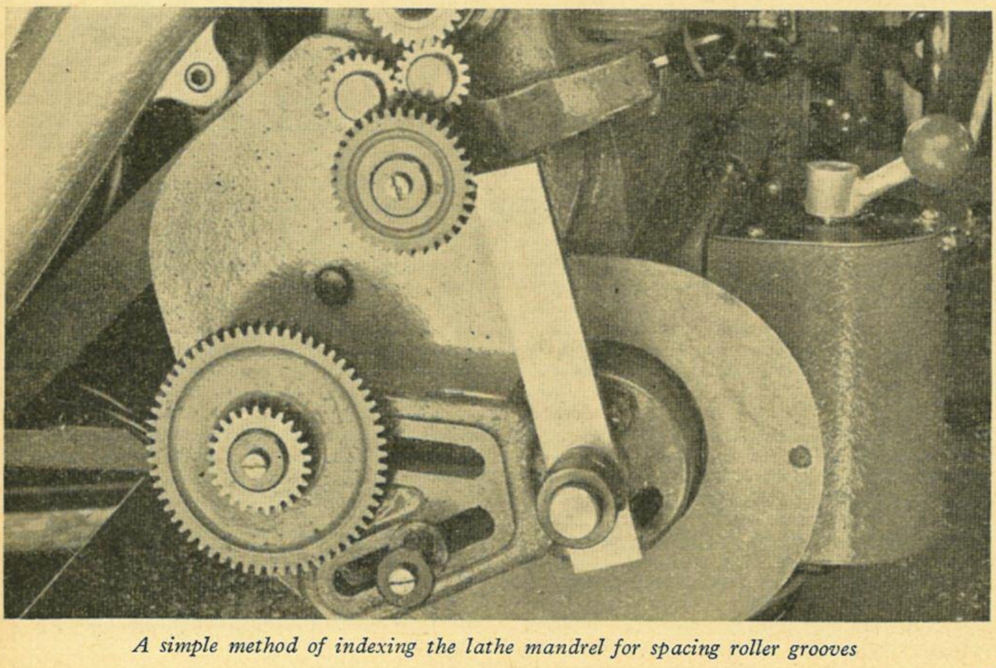
BUSH 1 OFF MATERIAL BRONZE OR OILITE (10)

The diameter of the roller, which influences the ratio of the drive, is also subject to experiment, but I have found that a roller of $1\frac{3}{4}$ in. dia. gives the best all-round efficiency with the engine power available, producing a speed of 18 m.p.h. at approximately 3,500 r.p.m. It should be noted that the size of the cycle wheel does not affect the ratio, as it forms merely an " idler " in the transmission system. If one neglects the effect of slip, the distance travelled by the cycle in one revolution of the engine is equal to the circumference of the roller, irrespective of the size of the cycle wheel, though the rotational speed of the latter will obviously vary in inverse proportion to its diameter, relative to that of the roller.

The machining of the roller is a fairly simple job ; it may be held in the four-jaw chuck for facing and recessing one end, boring to a neat push fit on the shaft seating, and roughing down the outside as far as can be reached, after which it is mounted on a pin mandrel for the remaining operations. It is best to chuck it with the deeply recessed end outwards, as this leaves less work at the second setting than if it is tackled the other way round. Note that these recesses act, in conjunction with the sealing bush at the inner end, and the boss of the magneto mounting plate at the other end, to form labyrinth packings for excluding water and dirt from the main bearings. They should, therefore, run with a small but sufficient clearance over these projections when fitted, and it should be remembered also that the deep recess accommodates the fixing nut as well, so it must be capable of admitting a tubular box spanner of the specified size ($\frac{7}{16}$ in. Whit.).

Cutting the internal keyway in the roller is carried out in the same way as that in the crank disc ; the work can be held for this operation in the three-jaw chuck, with its face bedded firmly against that of the chuck.

For serrating the outside of the roller, it should be remounted on the mandrel, and preferablv the



A simple method of indexing the lathe mandrel for spacing roller grooves outer end of the latter should be supported by the back centre. The grooves can then be planed by means of a short, rigid tool held on its side in the toolpost, and operated by racking the saddle backwards and forwards. It is not necessary to be too meticulous over the tool form, but something approximating an involute tooth form helps to keep the roller free from clogging. Some form of indexing device is required for spacing out the teeth, though here again, precision is not highly important, and if one cannot divide up the circumference into 35 parts, the nearest readily divisible number will be suitable.

If no means of indexing the lathe headstock is available, the method shown in the photograph gives sufficient accuracy for our requirements. It will be seen that a 35-toothed changed wheel is mounted on the cluster gear stud, and a piece of mild-steel flat bar is shaped at the end to form a detent to engage the teeth of the wheel, and pivoted on the leadscrew, located between two collars. The tumbler gear is, of course, engaged in either direction, and in order to avoid inaccuracy caused by backlash in the train of gears, the lathe mandrel should be turned always in one direction, and held so as to press the teeth of the change wheel downwards into firm engagement with the detent. Personally, I always prefer to mount the index wheel directly on the lathe mandrel and use a close-fitting detent, so that backlash can be positively eliminated ; (this has been fully described many times in THE MODEL ENGINEER and can also be found in the handbook *Milling in the Lathe*) but the method illustrated is much simpler to rig up at short notice, and suffices for a job of this nature, though I would not recommend it for gear-cutting or other precision work.

Packing Bush

The most suitable material here is "Oilite," or some similar impregnated bearing material, but there may be difficulties in obtaining supplies under present conditions, and as a substitute, solid bronze may be used if care is taken to avoid seizure or "picking up" during the running-in period, as the clearance must be kept as small as possible. There is virtue here in what would normally be considered "bad"—that is, soft and porous—material. A cast-iron bush is also permissible. This bush serves the double purpose of a supplementary main bearing and a packing gland to prevent the leakage of air to and from the crankcase. It does not take any very great bearing load, though it does steady the shaft, and experience has shown that its fit has an important influence on engine performance, as a good deal of mixture can be lost from a leaky bearing.

I have found that a plain bush is preferable for this purpose to the majority of the devices designed specially as bearing seals, and it imposes less friction on the shaft.

The use of a plain parallel bush, having no positive endwise location, may possibly be open to question, but the reason for it is that it is desirable to use a ready-made "Oilite" bush, and no shouldered bush of a suitable size is available, so far as can be ascertained. It is possible to machine this material if due care is taken, but its relatively low mechanical strength makes it liable to crumble, and on the whole, it is generally best to use a moulded bush of the specified size.

The amount of interference allowed for an "Oilite" bush should be greater than that for a solid bronze bush—about 0.002 in. in the 1 in. dia. specified—and when pressing it in, the bore should be supported against risk of collapse by means of an internal mandrel the same size as the shaft. It should be clear of the inner ring of the ball-race when inserted.

Though not specified in the drawings, I have found it advisable to fit a locating grub-screw to guard against shifting of the bush, but this should not bear hard on the latter to cause distortion.

(*To be continued*)

The Derby Museum

In our issue for September 8th, 1949, we published a preliminary announcement of an important project then to be put in hand at the County Borough of Derby Museum and Art Gallery. On May 26th this year, the project completed was formally opened by His Worship the Mayor of Derby.

There is now a new technical and industrial section displaying, in striking and convincing fashion, the principal industries of the town ; the policy which has governed the planning and arrangement of the new section is to put strong emphasis on collections which are primarily and frankly of local interest, and to reduce the number of those exhibits which deal with miscellaneous natural history. This is a bold policy, but one which can easily be justified ; for Derby is an important industrial centre, motor-cars, wearing apparel, clocks and printing machines being among the many manufactures that are produced there.

To most "M.E." readers, however, Derby's prominence centres upon the fact that, since 1851, railway locomotives, rolling stock and other equipment have been produced at the great factory which was formerly the headquarters of the Chief Mechanical Engineers' Department of the Midland Railway. This fact is duly featured in the new section of the museum by a 7-mm. scale railway some 50 ft. long and built by the official staff in collaboration with members of the Derby Society of Model Engineers. Miniature replicas of typical products of Derby Works can be seen running on this railway, which represents, in its turn, a typical stretch of English railway ; and we can think of no better representative prototype than the old Midland Railway for such a purpose.

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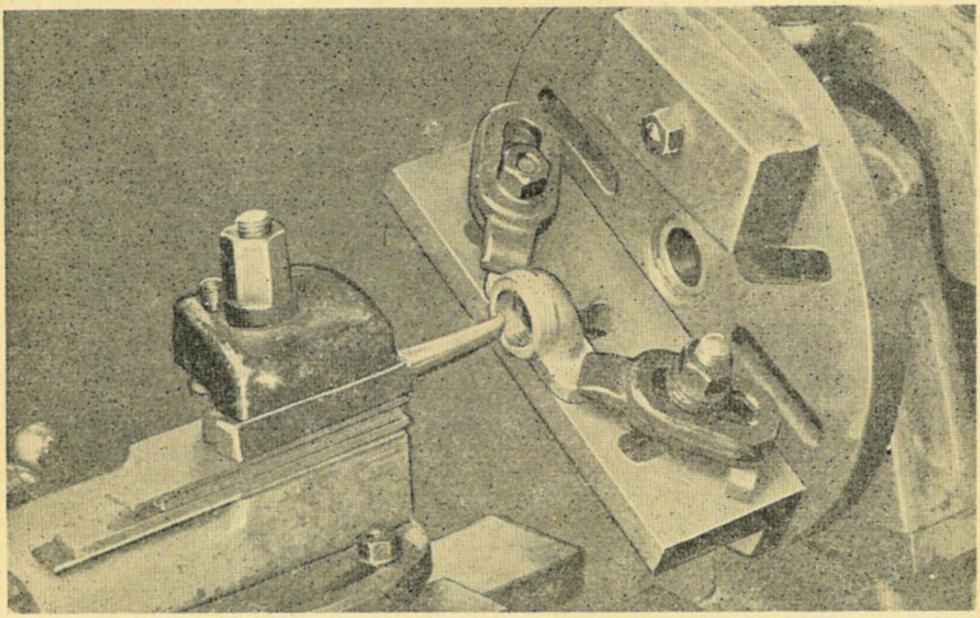
*A 50-c.c. Auxiliary Engine

by Edgar T. Westbury

AFTER the completion of the major components, as described in foregoing articles, it is necessary to consider final details of installation, and accessory fittings. The latter include the exhaust and inlet pipes, carburettor and magneto. With regard to the pipe fittings, a good deal will depend on the position of the engine when installed; it has already been pointed out that it is adaptable to various positions, including vertical, horizontal, or inverted, and readers may have their own individual views and preferences in these matters.

The engine will work quite well in either position, but there is a slight objection to inverted fitting, as the sparking plug is then in such a position that it collects any oil which drains down the cylinder walls while standing, or liquid fuel which is liable to accumulate through excessive flooding or choking when starting from cold. I have found, generally speaking, that if the engine can be relied upon to start instantly, (as all well-trained engines should!) there is no objection to the inverted cylinder, but if for any reason it does not do so, the natural thing for the operator to do is to "give it plenty of choke" to use a common but incongruous expression; and that is where the trouble is liable to start.

However, the tests of the engines which have so far been built have been mostly carried out with the cylinder horizontal, and as this position has also been found very convenient for installation, the fittings have been designed to suit this position. Readers who wish to modify the installation arrangements will no doubt find it quite a simple matter to alter the fittings as required.



Exhaust elbow set up on angle-plate for boring and screwcutting

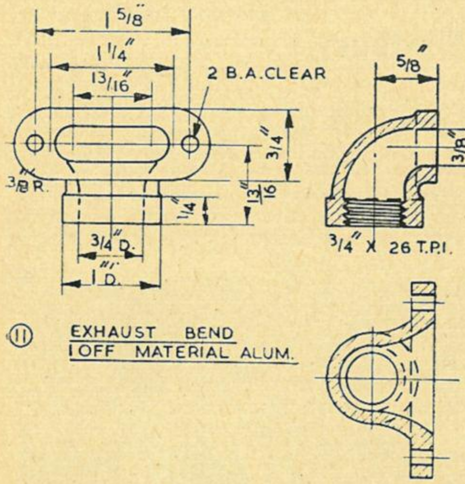
Exhaust Elbow

This is arranged to suit a special silencer designed for this engine, which will be described later. Although it is not, generally speaking, desirable to introduce sharp bends into the exhaust pipe, it has been found that no undue back pressure is set up if the bend is kept as smooth as possible and the cross-sectional area of the passage is adequate. A casting is available for this component, and machining is quite simple and straightforward.

The casting is first set up in the four-jaw

*Continued from page 8, "M.E.," July 5, 1951.

chuck for machining the joint face ; it may be found that there is a tendency for it to tilt in the chuck jaws, and the best way to avoid this is to hold it by three jaws only, two gripping the sides, immediately above the circular collar, and the third brought up against the underside,



with a flat packing-piece interposed, just sufficiently tightly to prevent it from tilting. It is, of course, unnecessary to centre the joint flange, but it should be as true as possible on the face, in both planes, and only one or two light cuts are necessary to produce a smooth flat surface.

It is then mounted on an angle-plate for facing, boring and screwcutting the outlet end, as shown in the photograph. Two clamps bearing on the lugs of the flange are used in this instance, but in some cases it may be found more convenient to drill the holes in the flange and use these to take bolts for clamping it to the angle-plate.

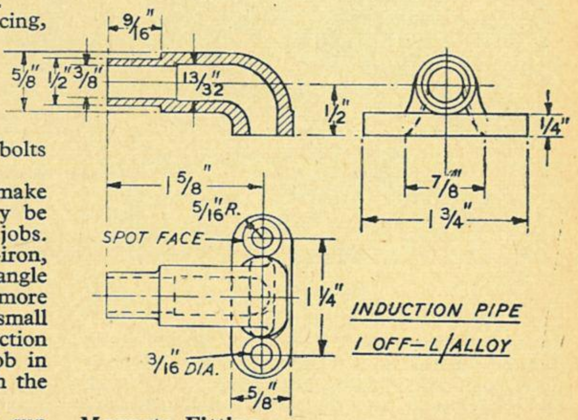
Incidentally, I may mention that I often make use of improvised angle-plates, which may be mounted on a small driver-plate, for light jobs. These are made from odd bits of angle-iron, which are filed or machined to a true right-angle (this is *most* important) and are often much more convenient than a heavy angle-plate for small finicky jobs ; moreover, one has no compunction about drilling holes in them to suit the job in hand, which never seems to match up with the holes in a standard angle-plate.

The casting must obviously be set to run truly on the circular boss face, and it can then be machined as required, including internal screw-cutting to a convenient fine thread, the pitch specified being standard brass pipe thread, which is most suitable for attaching light gauge pipe. This thread goes in about ¼ in., beyond which the cored passage is relieved to form a clearance, but it may be found that owing to difficulty in ensuring accuracy in locating the core, the passage is slightly eccentric, and a little judicious work in clearing it out may be desirable. In any case, it is a good idea to use a rotary file or riffler to clean out the passage and make it as smooth as possible.

The carburettor recommended for this engine is the Amal type 308, which is a very light and compact miniature edition of the type employed on many lightweight motor-cycles, adapted to the requirements of the 50 c.c. class of engines. This is made with a split clamp fitting to suit an inlet stub ½ in. diameter, having a maximum permissible bore of ⅜ in., so that these dimensions govern the size of the induction pipe itself. As the fitting was not definitely finalised at the time the patterns were made for the engine, no castings for the induction pipe are as yet available, but this deficiency will be rectified as soon as possible.

To machine the joint face of this casting, the best way is to clamp the straight part of the pipe in a small vee-block (a temporary one for this job can be made up in a short time) and mount this either on the faceplate or in the four-jaw chuck, so as to hold the flange square with the lathe axis in both planes, but with no regard to concentric running. After this face is machined, it can be set up on the angle-plate in the same way as the exhaust elbow for machining the inlet end. As the wall thickness at this end is only $\frac{1}{16}$ in., and cannot be increased without encroaching on the area of the bore, the cored hole must be set to run as true as possible, and should be cleaned out with a boring tool and finally finished with a reamer or D-bit. In this case also, cleaning of the cored passage with a riffler or rotary file is highly desirable, to avoid any possible restriction of the gas flow.

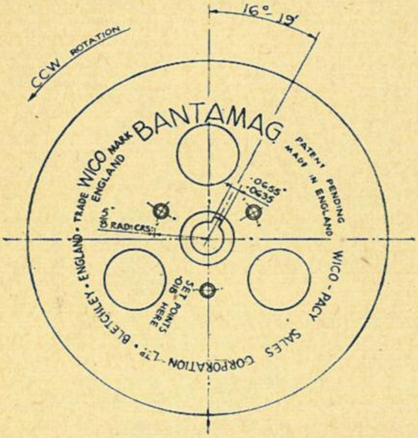
The fixing holes in the flange of the induction pipe, and also that of the exhaust elbow, should be spot-faced to form a true seating for the fixing nuts.



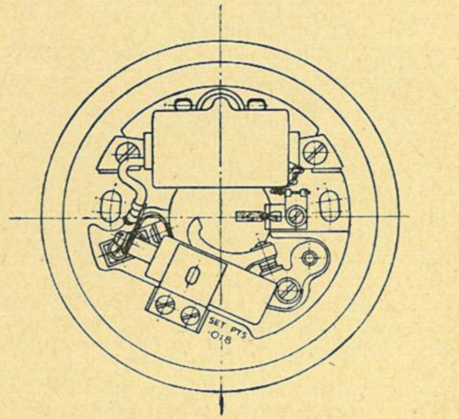
Magneto Fitting

It has already been stated that the Wico "Bantamag," which incidentally is the smallest commercially produced flywheel magneto available, is recommended for this engine, and has been successfully applied to the engines which have so far been built. At the time when these were first fitted, no definite particulars had been obtained from the makers as to method of timing, etc., and it was therefore impossible to specify, on the drawings of the crankshaft, the exact taper dimensions, or the position of the keyway for the flywheel and contact breaker cam, but these details have now been obtained, and are given herewith.

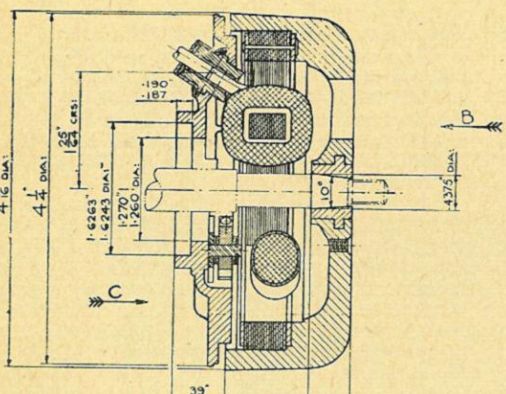
The "Bantamag" magneto, on account of its small size, and consequent lack of space in the centre of the assembly, does not have the contact-breaker cam integral with the flywheel hub, as is usual in larger magnetos of this type. Two possible methods of operating the contact-breaker are recommended, one being by the use of a separate cam keyed to the crankshaft, and the other by cutting a cam on the mainshaft itself. In either case, the relative positions of the cam and the rotary magnet system are of the greatest importance, (apart from the timing relative to the crank angle or piston stroke) as the cam must operate to break the circuit at the instant the current flow in the primary winding reaches its maximum. In fitting the magneto, therefore, two essential factors must be considered in conjunction with each other, namely, the position of the flywheel (to which the magnet system is positively attached) relative to the point at which the contacts break, and the timing of the break relative to the engine cycle. These two entirely separate but inter-related factors may prove confusing to some constructors, especially as they are affected by the direction of engine rotation, so the instructions for timing (from information furnished by the makers) are given below, and should be carefully studied.



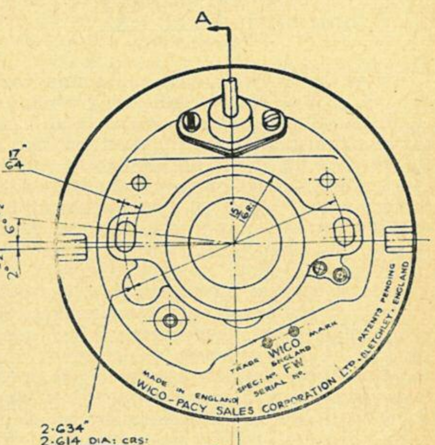
Front view of "Bantamag" flywheel, showing position of keyway at the instant of break



"Bantamag" backplate, showing stationary electrical system



Longitudinal section through "Bantamag" magneto

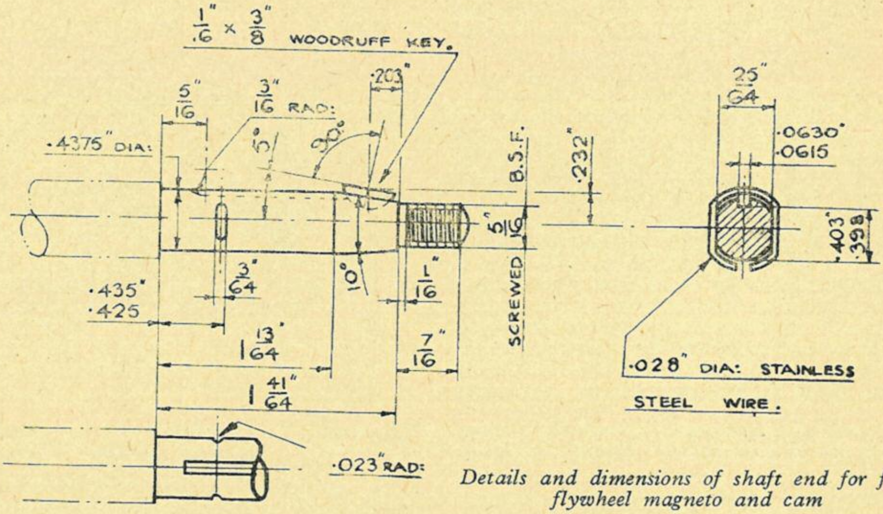


Rear view of "Bantamag" backplate

First of all, it is noted that the "Busy Bee" engine, when fitted for driving a cycle by friction roller, with the cylinder horizontal, and on the near side (left-hand, looking from the rear end), must run in an anti-clockwise direction, at the flywheel end. The drawing shows the outside of the flywheel, indicating the angular position of the keyway *at the instant of break*. This means to say that if the engine were timed to fire exactly at top dead centre, the key in the crankshaft should be fitted at such an angle so that the flywheel is in this position with the piston at T.D.C., assuming also that the backplate is fitted so that the high tension terminal is at the top, as in the views of the front and back of the backplate.

piston exactly at the top dead centre.

The best position for the high-tension terminal, when the engine is horizontal, is at the top; that is, at right-angles to the axis of the cylinder. Therefore, the angle of the keyway in the shaft relative to the crankpin, should be (90 deg. + 25 deg. + 16 deg. 19 min.) = 131 deg. 19 min. in an anti-clockwise direction. It should,



Details and dimensions of shaft end for fitting flywheel magneto and cam

But as the spark must be timed in advance of the top dead centre, for efficient running of the engine at its normal working speed, any angular advance must be superimposed on the angle shown. So far as running control is concerned, the ignition timing of these magnetos is fixed, though about 6 deg. of pre-adjustment can be obtained by the slots in the magneto backplate which take the fixing screws. Personally, I think that running control of spark timing would be a great advantage, but it would be difficult to obtain without considerable complication of these small magnetos, which can only be sold at their present low price by keeping them to their simplest essentials. If, however, constructors care to go to the trouble of devising a means of shifting the backplate by means of a control lever, it is by no means impossible to obtain this extra facility. Such movement would not in any way affect the essential relationship between the timing of break and the position of the rotary magnet (which determines optimum spark efficiency), but only the actual timing of the spark relative to the crank or piston of the engine.

A good many experiments have been made to find the best all-round timing for "fixed" ignition on an engine of this type for normal road work, and it has been found that about 25 deg. advance gives good results in cases where no very steep gradients are encountered, but in very hilly country it may be found desirable to retard the ignition to 20 deg., or less, before T.D.C. The actual timing of the keyway, therefore, should be at the specified angle of 16 deg. 19 min., *plus* the angle of advance, with the

however, be noted that the backplate may be set in any position round the clock, according to the position of the fixing screws, so long as this is allowed for in the timing of the keyway; and this may be found useful if an error should occur in the latter respect, but it does not allow compensation for errors in the relation of the cam with the flywheel.

The cam is bored to fit a shaft diameter of 7/16 in. and is located by a small pressed-in tongue of metal which serves the purpose of a key, as the driving torque is very light. Endwise movement of the cam is prevented by a small wire circlip which engages two slots machined or filed in the shaft. Should constructors wish to machine the cam on the shaft itself, it should be noted that the diameter of the shaft at this point is less than that specified for the cam circle, but I have found the latitude of contact-breaker adjustment enables it to work with a cam cut on an ½ in. diameter shaft. The fitting of a larger diameter ball-race at the magneto end, however, (there is plenty of room for it in the housing) would permit of making the cam to the correct specified size. I do not propose to give exact details of the cam contour here, but they can be supplied if the demand arises.

Note that the greatest care must be taken to mate the taper of the shaft to that of the flywheel. Don't condone any errors in this respect by the thought that the key will hold it, whether the taper is right or not; I can assure you, from actual evidence of sheared keys, that it will not do so, however tightly the shaft nut is screwed up.

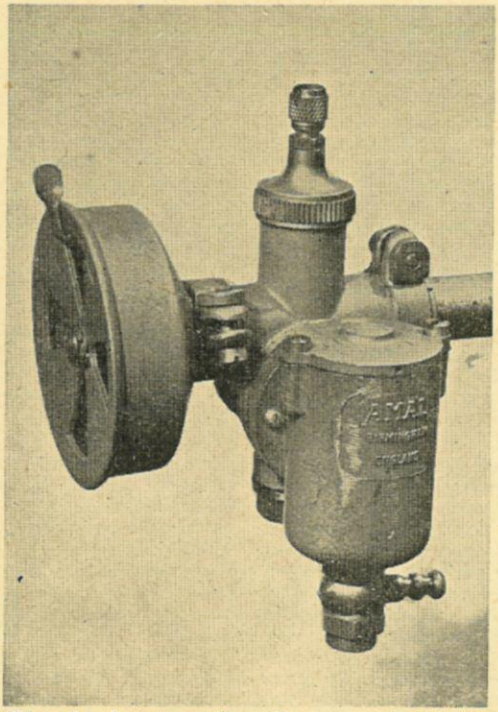
(To be continued)

PETROL ENGINE TOPICS

*A 50-c.c. Auxiliary Engine

by Edgar T. Westbury

IN an engine employed for propelling a cycle, it is very desirable to provide some means of releasing the compression, and in the past, it has usually been found worth while to incorporate this as a separate engine control, operating either a small poppet valve in the cylinder-head in the case of a two-stroke engine, or an exhaust valve lifting device in a four-stroke ; in a few cases the operation was performed more scientifically by means of a " half-compression " cam on the camshaft. Modern motor-cycle engines, however, usually dispense with this provision, as it is rendered unnecessary when a clutch and gearbox are provided, but many motor-cyclists will remember how indispensable was this control in the days of fixed single-ratio transmission.



The Amal, type 308, *carburettor suitable for engines of* 50 *c.c. capacity*

Now that the latter has returned, in the case of the motor-assisted cycle, it is found that the provision of a compression release valve, or " decompressor," again becomes very desirable, to say the least. It is true that some of the engines commercially produced for this purpose have not been so equipped, but they have often been somewhat difficult to start from rest, and when shutting down, are unable to coast gently and smoothly to a standstill, but tend to stop with a jerk. This, of course, assumes that the engine has a reasonably good compression ; in quite a few, however, the fit of the piston is so poor that the absence of a decompressor would hardly be noticed !

Although the decompressor is a simple and apparently straightforward device, both its design and construction call for considerable care, and some types have been found in practice to give a good deal of trouble. It is not the simplest of all jobs to keep a small valve permanently airtight, while capable of easy operation at any time ; and either a leaky or sticky valve can be not only a nuisance, but also cause considerable loss of engine efficiency.

I have made experiments with several types of decompressor valves, mostly in connection with methods of operation, the valve itself being of the spring-loaded mushroom type, but with variations in the means provided for opening it. These have included levers of the first and second order, and also bell cranks, all of which have worked quite satisfactorily, but have been open to criticism as being unnecessarily complicated and often unsightly. The lever of the decompressor, shown in photograph on page 413 of the March 29th issue, is a case in point ; it works quite well, but can hardly be said to look like an efficient device.

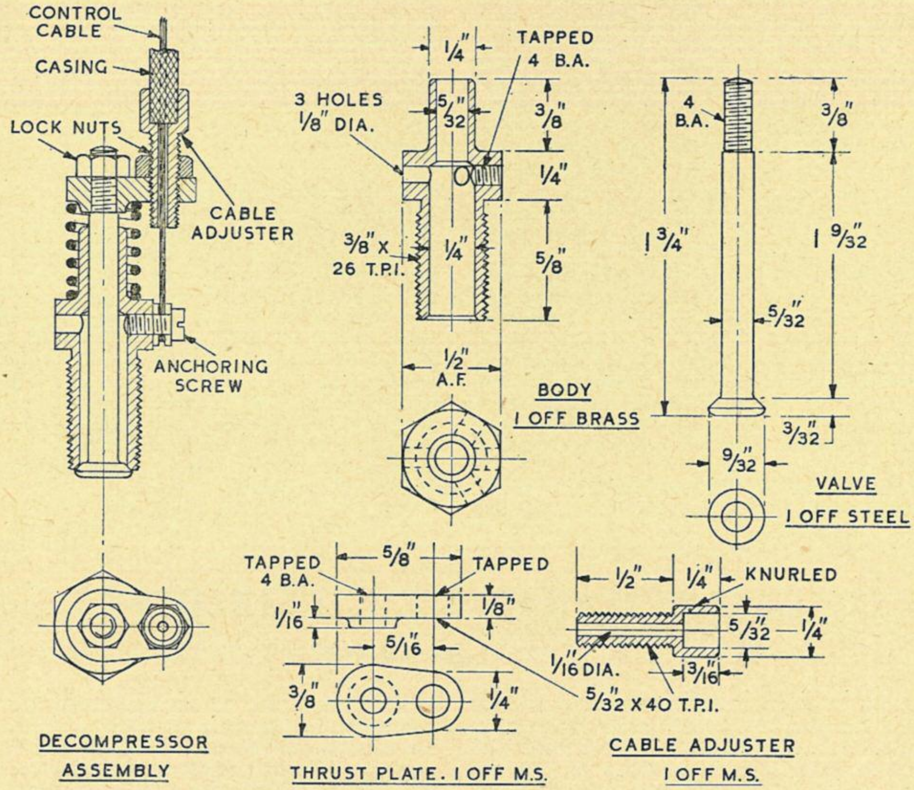
As usual in such cases, it has been found that the simplest method of operating the valve has been the most successful in practice, and I have therefore dispensed with the use of levers, and adopted a method of direct operation, as shown in the drawings. It will be seen that the valve stem is provided with a thrust plate which carries an adjusting nipple having a socket to take the casing of the Bowden control cable. The inner cable is anchored to the body of the valve. Although this method introduces a certain amount of side thrust, due to the pull being offset from the valve centre, it has proved quite successful in practice, so long as the offset is not excessive.

In most commercial applications of the decompressor to two-stroke engines, it is usual to connect the escape port of the valve to the

*Continued from page 80, " M.E.," July 19, 1951.

exhaust pipe, with the two-fold object of silencing the hiss of air escaping from the valve, and also carrying away oil spray. This has not been done in the present case, but it would be possible to make a slight modification in the design so as to enable a banjo union and escape pipe to be fitted, to lead into the exhaust pipe or silencer.

With regard to the control lever for the decompressor, this can, if desired, be incorporated in the dual type of carburettor control as fitted to be at all difficult if the work is run at high speed, deeply centred, and both the drilling and counterboring carried out with sharp drills. A 5/32-in. reamer or D-bit should be used to finish the bore of the guide. At the same setting, a small boring tool should be used, with the top-slide set over to 45 deg., to produce the slight chamfer (not more than 1/32 in. wide) which forms the valve seating. This could, perhaps, be carried out more simply with a countersinking cutter,



the older types of motor-cycles, but the usual method nowadays is to employ a single lever having a double action, one direction to open he carburettor throttle and the other to open he decompressor. A lever of this type is provided for the Amal type 308 carburettor, and it is also possible to obtain double-acting twist-grip controls on the same principle.

Decompressor Construction

The body of the valve should preferably be made of hexagonal brass, ½ in. diameter across flats, though steel is permissible, and may be more durable if the valve is made of a harder material. A departure from hexagonal section is also in order, so long as means can be provided for screwing the body firmly into the head.

The most important point in machining is to ensure that the bores of the guide and seating are concentrically aligned, and this should not but there is a risk of producing a chatter or wave in the surface which would be more trouble than it is worth to put right afterwards.

After turning down and screwing the outside (don't forget the undercut just sufficiently deep, and no more, to enable the body to screw right home in the head), it should be reversed and held in a tapped piece of stock to turn the top end, which is not of critical importance in respect of truth with the bore. The three escape ports are then drilled in alternate flats of the hexagon, and a fourth hole drilled and tapped 4 B.A. for the anchoring screw.

The valve may with advantage be machined from the stem of an old motor car valve, or from a high-tensile aircraft bolt. If these are unobtainable, mild-steel is permissible, but should not be used if the body is of the same material. It is possible to machine all essential surfaces at the same setting, with the work held in the chuck, and part off when finished. If the screwed end is turned to size first, it may be supported in a hollow centre while machining the main diameter, which should be dead parallel, well finished, and a good fit in the bore of the guide. Set the top-slide over to 45 deg. to finish the seating. After parting off, the valve stem may be held in a shim of metal foil for cleaning up the head. A slot may be cut across the head to take a screwdriver for grinding in, but very little of this treatment is either necessary or desirable ; I find it sufficient to twirl the other end of the valve between thumb and finger, using a little brick dust or Vim as an abrasive.

To make the thrust plate, a piece of round steel bar about ⅞ in. diameter may be used ; this is held in the chuck, faced, drilled and tapped 4 B.A., and a slight boss turned to locate the spring. It is then parted off and cleaned up on the top surface, after which the hole for the nipple is drilled and tapped $\frac{5}{16}$ in. off centre, and the unwanted metal cut away. This will be found easier and quicker than making the plate from flat or rectangular bar of more approximately correct initial shape.

The cable adjusting nipple is of the type very commonly used on Bowden cable fittings, and therefore calls for little comment. It will be found worth while to make this of mild-steel, which is more durable than brass, though the latter is often used for the sake of easy production. The recess in the head should form a close-fitting socket for the cable casing, and a hole giving free clearance for the inner cable is drilled right through.

When assembling the components, a spring strong enough to seat the valve positively and firmly should be fitted. Readers often expect me to give exact specifications of springs referred to in these articles, but that is not so easy as it sounds. The strength of a spring is not necessarily dependent entirely on the gauge of wire, number of turns, and diameter of the coil, as the elasticity of different spring materials varies within wide limits. Even in commercial practice, spring design is often tentative and experimental, and I know of many cases where several different springs have had to be tried before the desired result is achieved. In the present case, I suggest that a spring of about 20 gauge piano wire (without subsequent tempering), about ¼ in. internal diameter, and having six complete turns, excluding flattened end turns, will be about correct. The ends of the spring should be ground square with the axis, and the free length should be not less than ⅝ in.

As the end of the cable does not have to be fitted with a soldered nipple, it is not necessary to slot the thrust plate to get the cable in ; all that is required, after fitting the nipple and inserting the cable, is to bend the end of the latter into a tight loop with round-nose pliers and clamp it to the body with an ordinary 4 B.A. steel screw and a couple of washers. If subsequent shortening of the cable is found necessary, beyond the amount provided by the adjusting nipple, a new loop can be made and clamped again as before. By the way, I presume readers to have some knowledge of fitting cable controls, and if so, they will know that the cable ends should always be soldered to keep the strands together while fitting.

(To be continued)

LATHE TAILSTOCK ALIGNMENT

(Continued from page 149)

the bulk of metal being removed by drilling, sawing, chipping and filing. As the finished size was approached, periodic checks were made with a dial indicator, care being taken to keep the centre height safely above the nominal figure of 6 in. When it became evident that the final adjustment could be made by scraping to size, the measuring technique was changed. A dial indicator was clamped to a small faceplate on the lathe headstock spindle. The tailstock was then moved along the bed until the indicator plunger came into contact with the outside of the barrel. Hand rotation of the lathe spindle pulls the indicator round the end of the tailstock spindle in a planetary motion. The object to be attained is to ensure that, during one entire revolution, the indicator reading remains quite steady.

This particular operation was first performed with the tailstock barrel fully retracted and then repeated with the spindle projecting about 3 in. A succession of tedious adjustments were required before identical indicator readings were observed in the two cases. After each scraping process, all the dimensions were altered. Extreme caution was required in the final stages of the adjustment. It was then found that, by tightening the clamping set-screw at the end of the tailstock, there was sufficient spring in the castings to cause a slight vertical movement of the end of the tailstock spindle, amounting to about 0.002 in. This fault seemed unavoidable, but it causes negligible errors in plain turning, since there is no appreciable lateral motion of the spindle. All indicator readings were made with the tailstock barrel tightly locked.

It is clear that the standard design of this part of the lathe is open to a great deal of criticism, and the same inherent faults are often present in modern tool-room lathes. From the point of view of the model engineer, a complete redesign should be worth considering by some enterprising manufacturer. If the soleplate was constructed in the form of a long and rigid cross-slide and if the tailstock spindle was made of heavy square-section bar, capable of being clamped in two places along its length, a wide range of milling operations could be undertaken with the aid of simple attachments. Other accessories would convert the unit into a useful capstan head. Additional fittings could be provided for slotting, keyway cutting and internal grinding operations.

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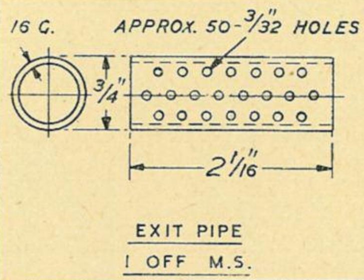
by Edgar T. Westbury

ONE or two points about the assembly of the engine should be noted, particularly in view of the fact that the general arrangement drawing on page 414 of the March 29th issue shows it assembled with the cylinder vertical, whereas the horizontal arrangement is being specially dealt with here. In the above drawing it will be noted that the inlet port is on the inner side, over the main bearing housing, but this position is clearly impracticable with the horizontal cylinder, and the inlet port is thus changed over to the outside. The transfer port cover is then at the top, and the exhaust port on the underside.



The order of assembly is as follows: First insert the inner main ball-race in the main housing, and press the crankshaft fully home. It is advisable to place the magneto mounting plate temporarily in position, with its ball-race, to guide the end of the shaft and prevent it tilting during this operation. When in place, the shoulder on the crankshaft should come practically flush with the end of the packing bush, so that when the roller is assembled and its securing nut tightened, it will just allow the shaft to turn freely, with no appreciable end play. If this is not so, it can be adjusted by skimming either the shoulder of the shaft or the end of the bush as required. The roller can then be fitted, taking care to see that the key does not foul in the depth of the keyway, but fits closely at the sides. If available, a $\frac{3}{8}$ in. shakeproof washer should be fitted between the recessed end face of the roller and the securing nut, the latter being then tightened up hard with a tubular box-spanner; during this operation, it is practicable to hold the crank web in the vice, using copper clamps to protect it from marking.

It should be noted that the aperture in the end of the main housing is large enough to enable the roller to be withdrawn without dismantling the entire crankshaft; this is a great convenience in servicing. The magneto mounting plate can now be secured by its four screws, which should be tightened up very firmly with a well-fitting screwdriver, and should on no account project above the machined surface. A felt washer, $\frac{3}{16}$ in. thick, is now made to fit in the ball-race housing (packing felt as fitted inside "war surplus" instrument cases is suitable) and is thoroughly soaked in melted grease before assembly, after which the ball-race is pressed home, and should lie flush with the face of the housing spigot.

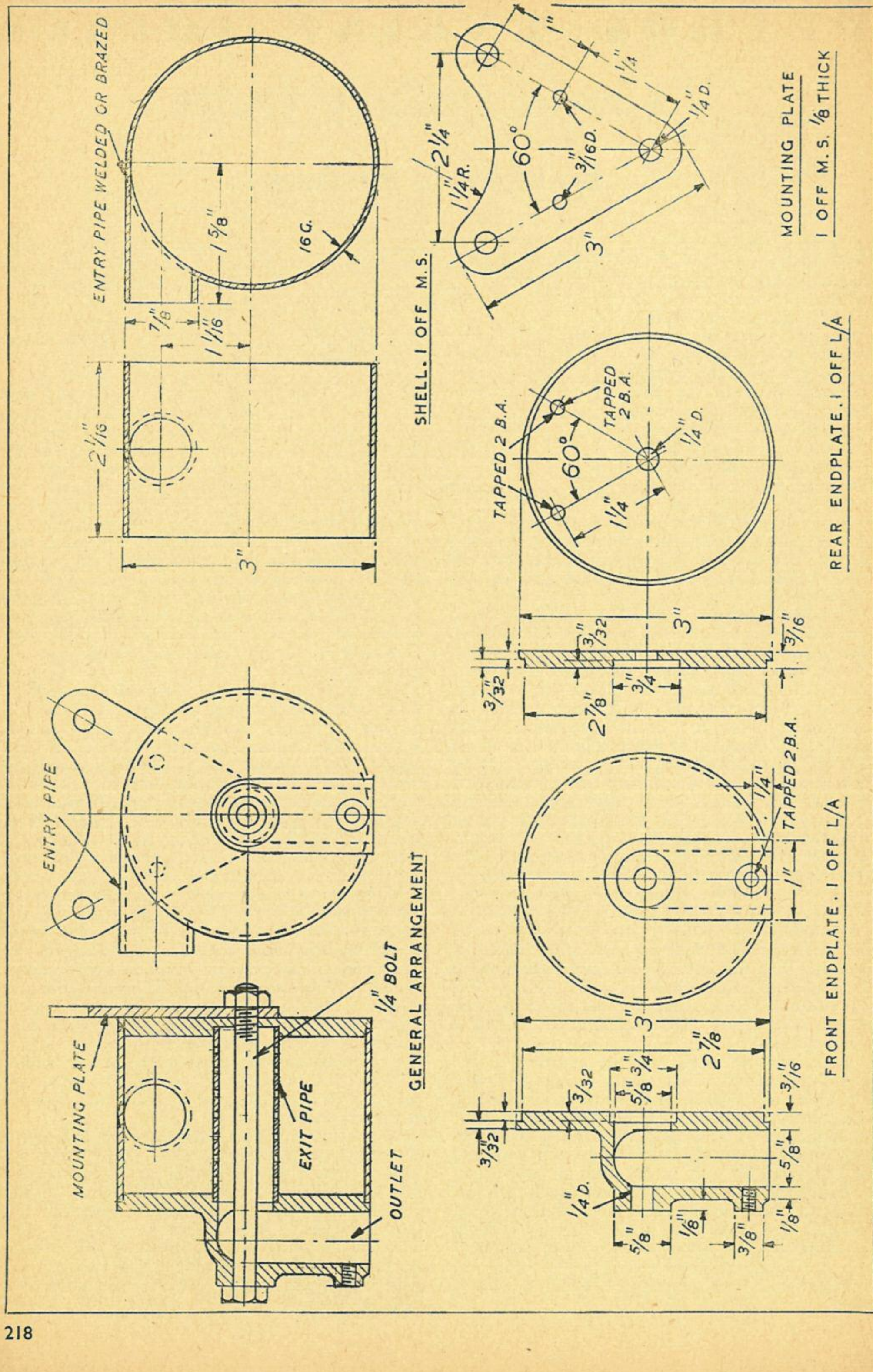
Next, the magneto backplate can be fitted, and held in place by two O B.A. screws and washers, tapped into the magneto mounting plate; these screws may, with advantage, penetrate into the end face of the mounting to obtain a greater length of thread than is possible in the mounting plate alone. Although not definitely specified, it is a good policy to fit another thin felt washer at the front of the ball-race to exclude foreign matter which may enter by way of the aperture in the backplate, but this washer should not be heavily charged with grease, or it may find its way on to the contact-breaker points.

The magneto cam and flywheel can now be fitted to the shaft, again taking care to see that the key fits properly and the surfaces are scrupulously clean. Again, the crank web can be held in the vice to enable the nut to be screwed up really tightly, but do not assume that the only limit to the force applied is that of your own physical strength, aided by the longest lever available. "There is reason in all things"—and one qualification of an engineer is to know how tight a nut should be set up!

While on this subject, it is advisable to point out that one should never attempt to remove the magneto with a hammer; at the best, the thread on the shaft is liable to be burred up, and at the worst, the shaft may be bent or the bearings ruined. There are three tapped holes in the hub of the "Bantamag" flywheel for attaching an extractor, which may be made in the form of a flanged steel socket having a central set-screw, and can be attached by three screws in these holes. It is well worth while, in view of the grief and pain it will save, to make up such an extractor at the very start.

When this group of components is assembled, it should be possible to spin the shaft quite freely; if not, find the reason why, and correct it. The crankcase can now be bolted to the housing, with the connecting-rod assembled on the crankpin. A paper joint can be used between the crankcase and housing, with a little shellac or other joint varnish to assist sealing the joint; a similar washer may be used under the cylinder base.

**Continued from page* 152, "*M.E.*," *August* 2, 1951.


ENTRY PIPE WELDED OR BRAZED
16G.
SHELL. 1 OFF M.S.
MOUNTING PLATE
1 OFF M.S. 1/8 THICK
1/4 D.
3/16 D.
1 1/4 R.
TAPPED 2 B.A.
REAR ENDPLATE. 1 OFF L/A
ENTRY PIPE
MOUNTING PLATE
1/4" BOLT
EXIT PIPE
OUTLET
GENERAL ARRANGEMENT
FRONT ENDPLATE. 1 OFF L/A

Before fitting the piston, the cylinder should be tried in place, to make sure that the connecting-rod lies truly in the centre and is not forced over when the piston is fitted. It is better to have a little end play on the crankpin than the other way. The clearance between the two faces of the little-end eye should be equal both sides, and it goes without saying that this should not vary at any point of rotation—but try it to make sure.

The piston, with its rings, can now be fitted—don't forget that the vertical edge of the deflector should be towards the transfer ports—and the gudgeon-pin pressed or gently tapped in till it clears the cylinder wall both sides. In fitting the cylinder-head, no gasket should be necessary, but be sure that the spigot bears evenly all round, and if necessary, the head should be lapped on the spigot to ensure this. A little jointing varnish should be sufficient to ensure a perfect seal; the same applies to the fitting of the decompressor, but a soft copper washer, as used for miniature sparking plugs, may be interposed here if desired. Paper washers are satisfactory for the transfer and inlet flanges, but a Hallite or Klingerite (asbestos compound) gasket is desirable for the exhaust flange.

Silencer

This has been designed specially to suit the horizontal cylinder arrangement, but is also applicable to other positions, with or without slight alteration of pipe fittings. The design is simple, but reasonably efficient, without setting up too much back pressure, and it can be quickly dismantled for cleaning, a rather important consideration in these small engines, which are liable to foul the exhaust system fairly rapidly. This silencer works on the well-known "vortex" principle, the gases entering tangentially in to a cylindrical expansion chamber, setting up a rotary swirl and thereby lowering the pressure at the centre of the casing, where the gases are allowed to escape.

The casing is intended to be made from a piece of seamless steel tubing 3 in. diameter, though it could be made by rolling a sheet of 16- or 18-gauge material and making a riveted, brazed or welded seam joint. Copper tube would be easier to work, but very difficult to obtain at present. A piece of 7/8 in. diameter tube is brazed or welded to this tube to form the tangential entry pipe, an elliptical aperture being cut in the casing at this point; this tube is intended to telescope over a short length of tube screwed into the exhaust elbow, and may be clamped by splitting the end and fitting a split collar and bolt, but this should not be necessary if the pipe is a good fit. It is, in fact, best to avoid a rigid joint, so as to allow for expansion.

The two endplates are machined with spigots to fit inside the casing tube, the inner one being a plain flat disc, and the outer one being a casting with a cored exit passage leading out at right-angles to the axis. An internal perforated pipe collects the gases from the centre of the casing, and is located by recesses in both endplates, a bolt passing through the centre holding the entire assembly together.

If the task of drilling about 50 small holes in the exit pipe is considered too tedious, they may be replaced by a series of slots cut with a fairly wide slotting saw, so as to produce a total aperture area about the same as that of the holes. The length of the pipe should be such that it has a slight end play in the recesses of the endplates when free, but is held firmly when the bolt is tightened up so as to spring the endplates together slightly.

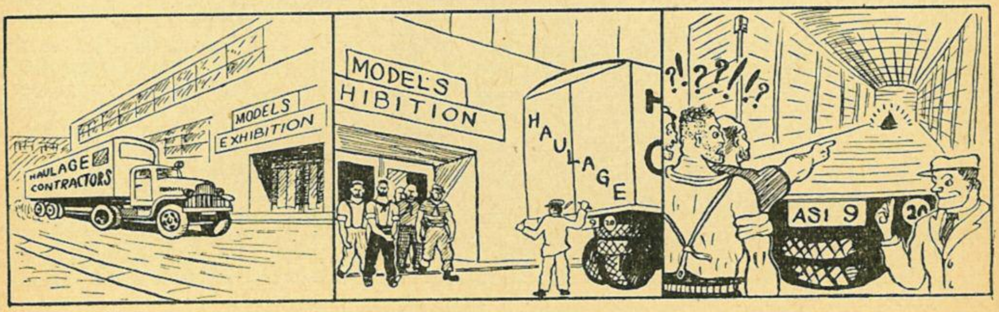
The silencer assembly is suspended underneath the crankcase by a triangular steel plate 1/8 in. thick, which fits on two of the crankcase studs at the top, while the lower hole takes the central silencer bolt, and two additional holes are provided for 2-B.A. screws tapped into the inner endplate. It will be seen that the outer endplate can be turned in any position, as convenient, and a tail pipe 5/8 in. diameter of any length, or bent as desired, can be attached by a single set-screw, provided that the pipe is a neat fit in the bore of the passage.

If the engine is used in any other than the horizontal position, the plate may have to be modified or a different method of attachment adopted, but subject to this reservation, it is almost universally adaptable and may be used on almost any type of engine if made of suitable size, proportional to cylinder capacity.

A Correction

I very much regret to inform readers that in spite of the care taken to work out the timing of the Wico "Bantamag" magneto, as described in the July 19th issue, I appear to have slipped up rather badly. I am going very carefully into this matter and will deal with it in a later issue, but meanwhile, if any constructors have already timed the magneto as instructed, it only means the cutting of another keyway to put matters right.

(To be continued)

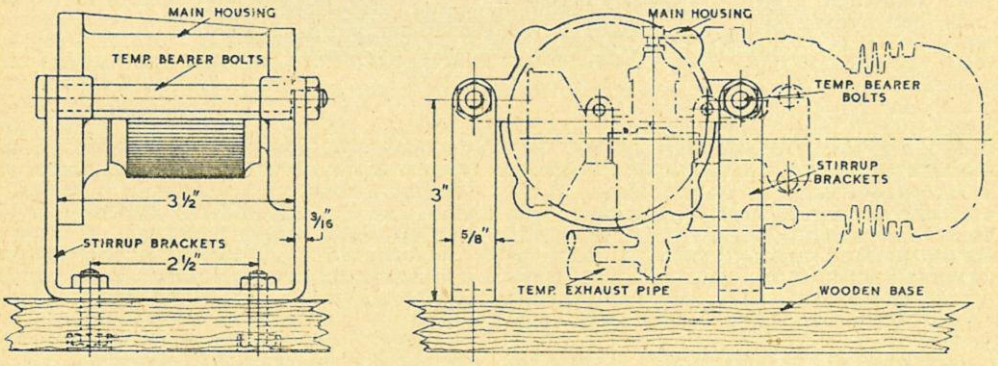


PETROL ENGINE TOPICS

*A 50-c.c. Auxiliary Engine

by Edgar T. Westbury

WHEN the engine is completely assembled, and the carburettor and magneto fitted, it should be carefully run in by means of an electric motor or other source of power, before any attempt is made to run it under its own power. For this purpose, it is advisable to build a temporary mounting, which may consist of a flat board with two U-shaped metal stirrups bolted to it, having ⅜ in. diameter holes in their upper extremities, to take cross-bolts which pass through the eyes of the main housing of the engine.



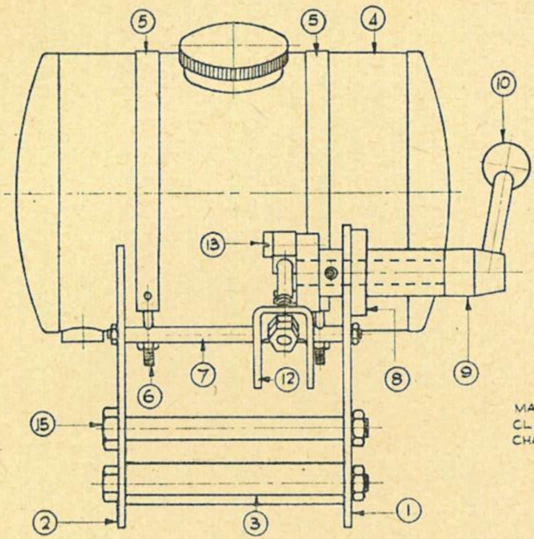
Temporary mounting for running-in and testing engine

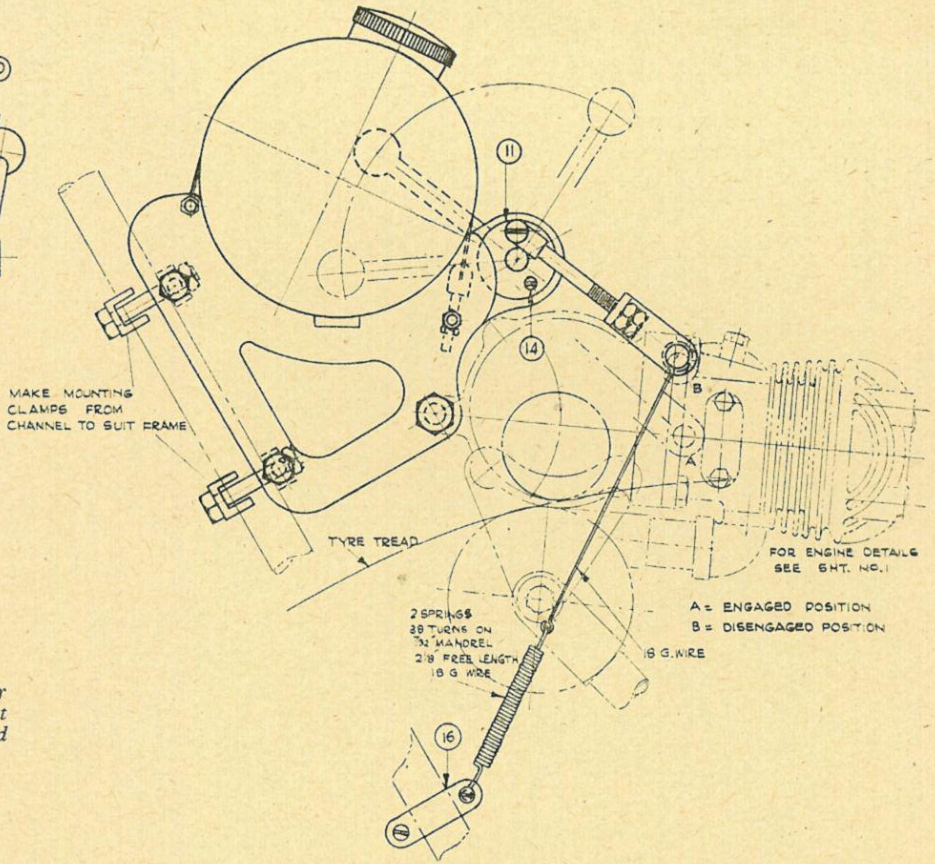
As this mounting may well serve as a test bench, after the initial running-in period, it may be equipped with a fuel tank, mounted a few inches higher than the engine. The baseboard should be long enough to enable it to be screwed or clamped down to the bench or other solid foundation.

The question now arises of providing some means of turning the engine for running-in or starting. It is possible to do this by rigging a countershaft under the engine, with a rubber-tyred friction wheel, such as a small perambulator wheel, to engage the friction roller on the engine shaft, and this is perhaps the most practical and satisfactory method of starting for test purposes. It is, however, a more elaborate arrangement than many constructors will care to set up, and something simpler will probably be preferred. It is possible to drive the engine by means of a flat belt on the outside of the magneto flywheel, but as this surface is tapered, the belt will tend to run to the largest diameter and possibly slip off. A better method is to make a small vee pulley, about 2 in. to 2½ in. diameter, which can be attached to the flywheel hub by three screws, in the tapped holes provided for the magneto extractor. (Incidentally, I have found it advisable to open these holes out to not less than 2 B.A. or $\frac{3}{16}$ in. Whitworth, to enable stronger extractor screws to be fitted.) The groove of the pulley may be made with a 40 deg. included angle to take a standard ½-in. vee belt drive, and if the engine should be intended to drive eventually by vee belt, the pulley sheave should have a double groove so that the outer groove is available for a starting pulley while the belt is in position in the inner groove.

While the engine is being run in, the sparking plug should be removed, and ample lubrication supplied by feeding oil into the air intake. A convenient method of providing a continuous oil feed is to supply it through the carburettor, either by using the fuel tank, or by filling the float chamber at intervals. The oil should be thinned by mixing it with about four parts of petrol, to enable it to pass freely through the carburettor jet, and it may be found advisable to close the choke partially to ensure sufficient suction to maintain the feed. Under normal conditions, the engine should noticeably ease off in the course of running in, until at the end of two or three hours it will spin freely, and with no signs of tight spots ; but it should be carefully watched, and if there is any tendency for it to become tighter instead of easier, the cause should be investigated immediately. Do not, under any circumstances, try to start up an engine that feels tight or "rough," under the idea that it will ease off when it warms up ; the reverse is just as likely, or even more so, and irreparable harm may be done to an engine that seizes up early in its career. The first few hours in the running life of any two-stroke may decide its entire future success or

*Continued from page 219, "M.E.," August 16, 1951.





General arrangement of engine mounting for attachment to rear stays of pedal cycle (subject to modification to suit cycle frame shape and dimensions) failure as an efficient working unit. I would point out here that it is very common for an engine to tighten up as a result of heat expansion when it is new ; this is not the same as a seizure, and does no harm if the engine is kept well lubricated and is shut down at the least sign of distress. In most cases it will ease off again in a few seconds, but if it remains tight after cooling down there is clearly something which calls for investigation in the mechanical system.

It is a very sound plan to strip the engine down after initial running-in, and examine carefully all bearing surfaces for the least signs of scoring, picking-up, or over-bright patches which suggest local tightness. If, however, everything appears to be perfectly free, this operation could be dispensed with, but the engine should be flushed through with normal petroil mixture to remove dirty oil and motored for a few minutes longer to get rid of excess liquid. The plug should now be screwed in, and the compression tested, making sure that the decompressor valve is closed. When the engine is turned towards top dead centre, it should feel distinctly " springy," and tend to return if released. Unless the compression is reasonably good, the engine can never be expected to run really efficiently ; it will be difficult to start, tend to run very hot, lose power at the least provocation, and have a heavy fuel consumption, under such conditions. But if it has been conscientiously built, according to the instructions given, there need be little fear that it will not go according to plan.

In the initial runs under power, only a very small throttle opening should be given ; the engine will probably four-stroke or fire intermittently under these conditions, but that is no cause for worry. It may be found necessary to close the choke partially or completely for a few seconds when starting from cold, but this should not be continued longer than is absolutely necessary. Do not attempt to open the throttle fully, even when satisfied that the engine is fully run in, without applying load of some kind. This may be provided by means of a fan brake, made of either wood or metal, roughly in the shape of an airscrew, about 24 in. diameter by 12 in. pitch, *and properly balanced*. It may be attached in the same way as the starting pulley, namely, by means of the three screws in the magneto hub. This will keep the engine cool and enable long continuous runs to be made at a speed of 2,500 to 3,000 r.p.m., which should be quite a comfortable speed for the engine " till the cows come home."

Attaching Engine to Cycle

Many readers have been impatient for details of the necessary fittings for attaching the engine to a cycle. There are, as I have already explained, many ways in which this can be done, and the following arrangement is not claimed to be " ideal," or even the most efficient possible method, but one which has been well tried and found quite practical, also adaptable to most types of cycles, and within the ability of most model engineers to construct.

It has been found, from a very careful survey of existing types of cycles, that there is no such thing as standardisation of shapes or dimensions of frames, and this greatly complicates the problem of designing a " universal " form of engine attachment. Incidentally, I nearly got myself arrested for " loitering with intent " on one occasion, when making a systematic examination of a large number of cycles parked near a sports ground !

Another, and perhaps even greater, difficulty in the design of the attachment is due to the restrictions in the supply of materials at the present time. In some respects, this problem is insuperable, but it can be mitigated to some extent, by making the design adapatable to use different metals or sections of material, and this is what I have attempted to do in this case. Many constructors will find some modification of the arrangement shown to be desirable in their particular case, either to suit the materials or methods available, or some peculiarity in the design of the cycle. The particular type of rear brake fitted may introduce a further complication ; the older types of tension-rod operated brakes, which were fitted horizontally, do not affect the fitting of the engine attachment, but some modern cable-operated caliper brakes, which are fitted to the top of the rear stays, are liable to get in the way of the clamps which hold the engine. It is not by any means impossible, or even really difficult, to make suitable modifications to deal with these individual features ; but it will, I trust, be apparent to constructors that a standard, immutable form of mounting to cope with all possible eventualities, and at the same time to be perfectly sound and secure, would be very difficult to devise.

Construction of Mounting Bracket

The main constructional member of the attachment consists of a frame comprising two side plates of sheet metal, with cross members of rectangular section to rest across the rear stays of the cycle, where they are secured by clamps, the bolts for which are centrally disposed between the stay tubes. A pivot bolt, passing across the open end of this frame, forms the suspension for the engine, which is free to hinge about this centre, and means are provided for lifting it clear of the tyre, or holding it in firm contact with the aid of tension springs, as required.

The upper part of the side plates is shaped to form a saddle for the fuel tank, which is made cylindrical for the sake of convenience, as such a tank is fairly easy to fabricate, and holds a large quantity of fuel, in relation to the amount of material used in its construction. There is scope for aesthetic design in the shape of the tank, and indeed of the entire mounting arrangement, but this obviously does not affect utility, which is the primary aim of the basic design as shown here. The tank is held down by two straps of strip metal, each having an eye formed at one end, and a tension bolt attached to the other end. A cross-bolt is provided near the top of the frame, on which the eyes of the straps are threaded, and a similar cross-bolt, having two holes drilled diametrically through it, is fitted near the horns of the frame to take the tension bolts ; these members, incidentally, help to strengthen the frame structure.

(*Continued on page* 302)

you want it, seems to stump the very folk you would imagine to be experts at it. I repaired a professionally-made engine for a friend. The engine was only a $2\frac{1}{2}$-in. gauge job, and cost a three-figure price, back in the cheaper days ; and believe it or not, as Ripley says, fully 40 per cent. of the holes in the frames had been filed oval, or otherwise enlarged, because they were originally drilled in the wrong place. Anyway, when you have drilled your hole truly through the boss, drive in a piece of 3/32-in. silver-steel. Cut off one end at $\frac{1}{2}$ in. from centre ; bend up the other, also $\frac{1}{2}$ in. from centre, and cut off at $\frac{3}{8}$ in. above the bend. Round off the cut ends nicely with a file, and the result should be as shown in the illustration.

To make the collars, chuck a piece of round rod in the three-jaw ; $\frac{1}{4}$ in. diameter brass or steel will do. Face, centre, and drill No. 32 for about $\frac{1}{2}$ in. down. Turn down a full $\frac{3}{16}$ in. length to 7/32 in. bare diameter, and part off a $\frac{3}{16}$ in. slice ; face the end again, and part off another $\frac{3}{16}$ in. slice, the full $\frac{1}{4}$ in. diameter. Ream both collars slightly until they fit tightly on the brake spindle. Put on the larger one, setting it at $\frac{1}{2}$ in. below the handle ; drill a No. 53 hole through collar and spindle, and squeeze in a bit of $\frac{1}{16}$ in. wire, filing flush both sides. Smear the spindle with a taste of oil, put it down the column, and put on the smaller collar, adjusting same so that the spindle turns freely but cannot move up or down ; then pin the collar to the spindle, as above mentioned.

Erecting and Connecting Up

At $\frac{5}{16}$ in. from the inner edge of the top of the back buffer beam, and exactly above the brake nut—that is, at $2\frac{3}{16}$ in. from the left-hand end of the beam—drill either a $\frac{1}{4}$ in. clearing hole, or a 7/32 in. hole, tapping the latter $\frac{1}{4}$ in. $\times$ 40. Put the bottom end of the brake spindle through the hole, and enter it into the brake nut, screwing about halfway through ; note, if a clearing hole has been drilled, a $\frac{1}{4}$ in. $\times$ 40 nut, made from $\frac{5}{16}$ in. hexagon rod, must be slipped over the brake spindle underneath the beam, before entering it into the brake nut. The screwed spigot of the brake column is then poked through the hole in the beam, and secured with the $\frac{1}{4}$ in. $\times$ 40 nut. If the hole in the beam has been tapped, simply screw the spigot into it.

All that remains, is to connect up ; for this, ten forks are needed, and five pieces of 3/32 in. round steel, for pull-rods. The forks are made from $\frac{1}{4}$ in. square brass or steel rod, as you fancy ; same process as described for valve gear forks, so you can call on your acquired experience for that job. Make nine of them to the sizes given in the last instalment, but make the slot in No. 10, $\frac{1}{8}$ in. wide, to fit over the drop arm, and drill it No. 30, to take a $\frac{1}{8}$ in. bolt for attaching it to same. An equalising link is also needed, but this is only a few minutes' work. It is merely a piece of $\frac{1}{4}$ in. $\times$ 3/32 in. flat steel strip, $1\frac{1}{2}$ in. long, with two No. 41 holes drilled in it at $1\frac{1}{4}$ in. centres, and the ends rounded off. A third No. 41 hole is drilled in the middle.

Starting from the back, the main pull-rod is a piece of 3/32 in. rod, 1 in. long, with $\frac{1}{8}$ in. of thread (3/32 in. or 7 B.A.) on each end. The wider-jawed fork is screwed on to one end of the rod ; and on the other, one of the narrower-jawed forks, which is pinned to the centre of the equalising link by a bit of 3/32 in. silver-steel squeezed through fork and link. The two short pull-rods are $1\frac{7}{16}$ in. long, screwed $\frac{1}{8}$ in. full at both ends, and furnished with forks. These are attached to the ends of the equalising link, and the trailing beam, by 3/32 in. pins, as mentioned above. If the wide-jawed fork is attached to the drop arm by a $\frac{1}{8}$-in. bolt—bit of $\frac{1}{8}$ in. round steel, screwed and nutted at both ends, as in the valve gear—and the brake handle turned, the rear brakes should go on and off nicely.

Now cut two $3\frac{5}{8}$ in. lengths of 3/32 in. rod, screw as above, and put a fork tightly on one end, pinning same to the leading beam. Screw the forks on the other end finger-tight, and couple up to the trailing beam temporarily with loose-fitting pins. Operate the brake handle. If the rear brakes come on first, screw up the forks a little more ; if the front brakes come on first, unscrew a shade. When all four blocks come on together, the adjustment is correct, and you can either pin the forks to the trailing beam as above, or open the holes in the forks to No. 41 size, and use 3/32 in. bolts, made in the same way as the drop-arm bolt. The latter makes any subsequent adjustment easy to carry out ; but as the brakes are only for ornament, or to keep the engine from running away when left standing unattended, it is a really unnecessary refinement.

Petrol Engine Topics

(*Continued from page* 298)

The device for raising and lowering the engine comprises a small crank, working in a bush attached to one of the side plates, and operated by a short hand lever. A bolt, similar to the main pivot bolt, and fitted opposite to it in the lugs of the main bearing housing, takes a small U-shaped stirrup, to which is attached a tension bolt, working on the lifting pin in the crank disc. The cross-bolt also serves as an anchorage for the hooks of two tension springs, the lower ends of the latter being attached to clamps which embrace the lower part of the rear stays. This arrangement gives a very wide range of adjustment in all ways ; first, by the positioning of the bracket assembly on the rear stays of the cycle, secondly, by the adjustment of the lock nuts on the tension bolt, and thirdly, the pressure of the friction roller on the tyre can be varied by shifting the spring anchoring clamps up or down the stays, or by changing the springs.

It is possible to arange the lifting gear so as to press the engine positively down on the tyre instead of relying on spring pressure, but I have generally found the methods illustrated to be most satisfactory under general working conditions.

(*To be continued*)

PETROL ENGINE TOPICS

*A 50-c.c. Auxiliary Engine

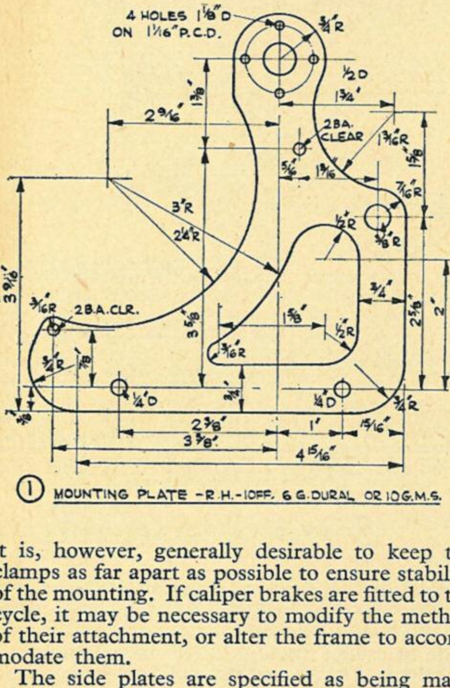
by Edgar T. Westbury

BEFORE making any attempt to construct the bracket, the cycle to which it is to be attached should be examined to see if any modifications are necessary or desirable. Some cycles have a very limited length of rear stay available between the wheel and the saddle bolt, which may necessitate placing the clamps closer together, and possibly altering the shape of the side plates ; it is, however, generally desirable to keep the clamps as far apart as possible to ensure stability of the mounting. If caliper brakes are fitted to the cycle, it may be necessary to modify the method of their attachment, or alter the frame to accommodate them.

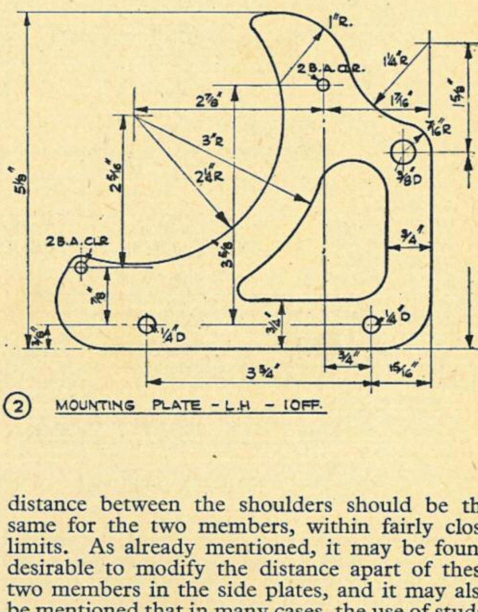
The side plates are specified as being made either in mild-steel or duralumin. Other materials are practicable, but pure aluminium or its softer alloys are not advised. Cast side members in a good quality alloy may, however, be used, but they should be not less than $\frac{1}{4}$ in. thick in the main section, and instead of being pierced for lightening, as shown, a recessed panel not less than $\frac{1}{8}$ in. thick should be formed. It may be mentioned that a cast aluminium bracket, in one piece, has been designed, and is quite satisfactory on some types of cycles, but is not sufficiently adaptable for recommendation as a standard feature.

Two cross-members (described in the detail drawings as " mounting blocks ") are made from mild-steel ; duralumin is permissible if the thickness is increased to $\frac{3}{8}$ in., and the screwed ends to $\frac{5}{16}$ in. These members are mounted in the four-jaw chuck, or marked out and drilled at each end for mounting between centres, for machining these extensions. It is important that the ends should be in true alignment, and that the distance between the shoulders should be the same for the two members, within fairly close limits. As already mentioned, it may be found desirable to modify the distance apart of these two members in the side plates, and it may also be mentioned that in many cases, the use of studs, tapped into the centre hole in each member, is preferable to bolts for securing the clamps. The latter are not drawn in detail ; they may be simply flat steel plates about 1 in. by $\frac{1}{4}$ in., long enough to span the stays, but clamps made of angle section steel or dural, notched out to fit the stays (note that the latter usually taper, so that the two clamps will have to be individually fitted), are much more rigid and provide more positive location, so as to prevent risk of slipping.

The cross-bolts for securing the tank straps call for little comment, except that only one of them need be cross-drilled, and that one may with advantage be made either larger in diameter or of square section. The tank straps are made from mild-steel or brass strip (baling strip is quite suitable material) and one end of each bent



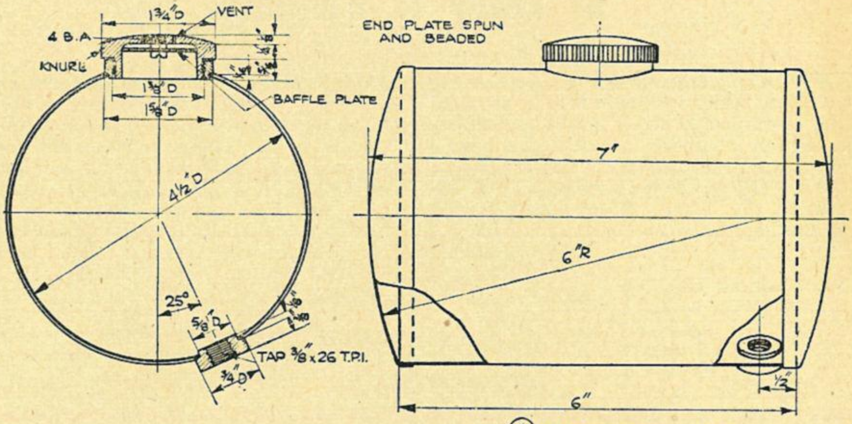
(1) MOUNTING PLATE - R.H. - 1OFF. 6 G. DURAL OR 10 G. M.S.



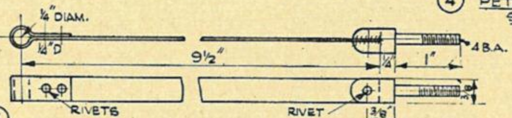
(2) MOUNTING PLATE - L.H. - 1OFF.

*Continued from page 302, " M.E.," August 30, 1951.

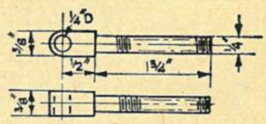
round to form an eye, secured by two 3/32-in. rivets. Round mild-steel bar, 3/8 in. diameter, may be used to make the tension bolts, which are turned down to 9/64 in. on the end and screwed 4 B.A., the other end being cross-drilled 3/32 in. diameter and slotted axially with a hacksaw or circular slitting saw. Before riveting these



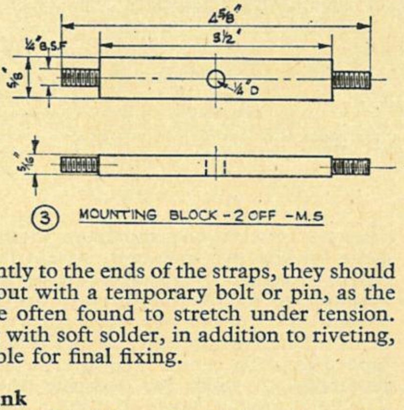
(4) PETROL TANK – 1 OFF. SHELL 20 G. ENDS 18 G M.S. OR BRASS SHT



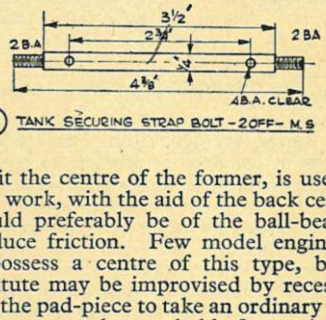
(5) TANK SECURING STRAP – 2 OFF – M.S. OR BRASS STRIP 20 G.



(6) TENSION BOLT – 1 OFF – M.S



(3) MOUNTING BLOCK – 2 OFF – M.S



(7) TANK SECURING STRAP BOLT – 2 OFF – M.S

permanently to the ends of the straps, they should be tried out with a temporary bolt or pin, as the straps are often found to stretch under tension. Sweating with soft solder, in addition to riveting, is advisable for final fixing.

Fuel Tank

If the cylindrical form of tank is to be used, it is recommended that the ends should be formed by spinning, which is quite easily carried out on the lathe, though workers with no previous experience of this technique may find it advisable to practise on some odd pieces of sheet material before attempting the actual work. The material should be well annealed, and in the case of brass, it is important that it should be of the right grade for working in this way, as some kinds of brass are inherently brittle, and very liable to develop cracks, however thoroughly or frequently annealed.

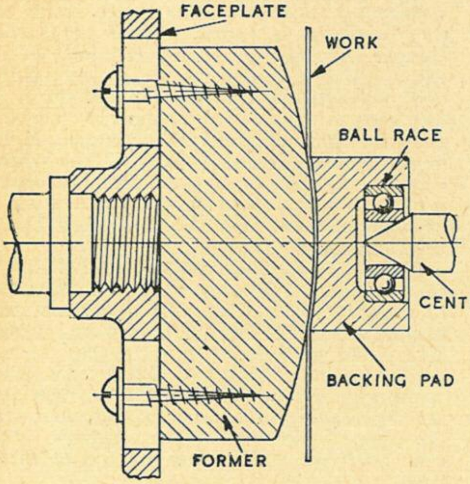
A former should be turned to the internal contour of the end plates, from a piece of close-grained hardwood, which should be attached to the faceplate by wood screws from the back, so as to ensure rigid support. The surface should be finished as smooth as possible, and a wood which takes a good natural finish from the tool, such as beech, is therefore desirable. A wooden backing pad, not less than about 2 in. diameter, and shaped to fit the centre of the former, is used to support the work, with the aid of the back centre, which should preferably be of the ball-bearing type to reduce friction. Few model engineers, however, possess a centre of this type, but a good substitute may be improvised by recessing the back of the pad-piece to take an ordinary ball-race, having a centre bore suitable for resting on the cone of the lathe centre, as shown in the drawing.

A hand-rest should be rigged on the cross-slide of the lathe, having a row of holes in the top surface to receive a pin, which is used as a fulcrum to provide sufficient leverage for working the material with the spinning tool. The latter is in the form of a long-handled burnisher, and may be made from an old file, by grinding the teeth away near the end, and carefully rounding off all edges, as shown in the drawing. The working surface should be finished to a high polish, and dead hard, so that it will not " pick up " or score the metal. Preliminary shaping of spun work is often carried out by wooden tools, but beginners generally find it easier to work with hardened burnishing tools, which are in any case desirable for finishing the formed surface.

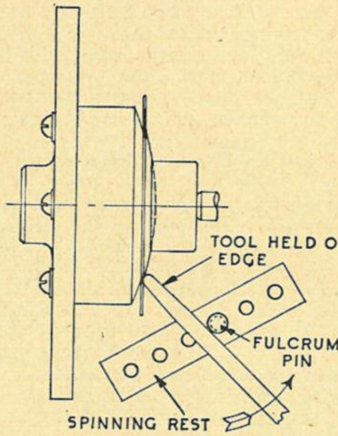
The discs for the endplates should be about 5 in. diameter, which is less than the area of the full projected surface, but the metal will stretch fairly considerably in the course of working, and some trimming of the edge will usually be found necessary when the endplates are finished. In the case of brass or copper, the discs should be annealed by heating uniformly all over to redness and quenching out in water. Steel endplates are not easy to form on a light lathe, as they require more force to deform them and are therefore liable to impose undue load on the mandrel bearings ; but if they should be used, note that they should be cooled as slowly as possible, by burying in ashes or lime, for annealing, in contrast to the rapid cooling in the case of brass or copper.

With the former and pad-piece mounted in the lathe, the disc to be formed is gripped lightly between them by adjusting the back centre, and set to run truly over the outside edge by tapping with a mallet. The pad-piece is then forced up to deform the centre of the plate and hold it in close contact with the former. A tenacious lubricant, such as soap or tallow, should be smeared over the exposed surface of the disc, and with the lathe running at top speed, the burnishing tool is used to force the metal to the shape of the former, working from the centre outwards. The beginner will be inclined to underestimate the amount of pressure required to do this, and will very likely harden up the metal by surface friction before any noticeable progress is made in forming it. A sheet of 18-gauge brass will probably require as much force as can be obtained with a tool having a leverage of 12 in., against a fulcrum pin suitably located to use this leverage to the best advantage.

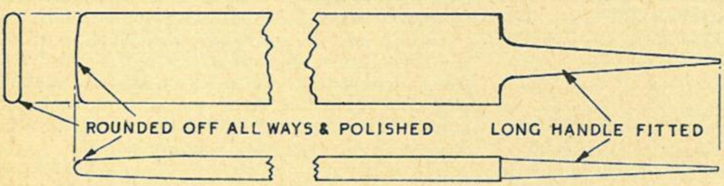
If the rectangular form of burnisher, as des-



Former mounted on faceplate, with supporting pad on tailstock centre

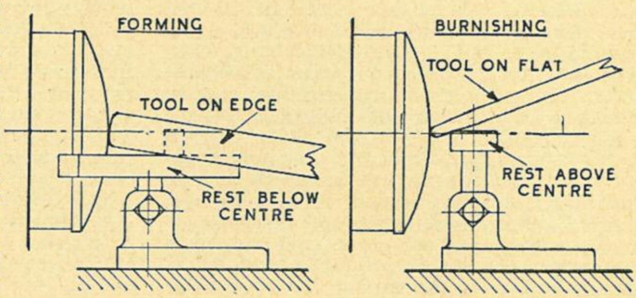


Plan view, showing spinning rest and tool in position



(*Left*) *Form of burnishing tool recommended*

(*Below*) *Positions of tool for forming and burnishing respectively*



cribed above, is employed, it will usually be found desirable to use it with the edge vertical for the main forming operation, and on the flat for finishing, the fulcrum pin being dispensed with in the latter case. Some workers may prefer an oval section or spherical burnisher, but this is largely a matter of individual preference, and I have generally found the rectangular type easiest to use on straightforward work of this nature. Always be sure that a film of lubricant is maintained on the work—oil is quickly thrown off by centrifugal force and is both messy and inefficient, hence the preference for solid lubricants. As soon as the metal hardens up under the tool, re-anneal it before proceeding further, or it will buckle and wrinkle or possibly crack, instead of lying down smoothly on the former.

Having formed the convex end surface, the fulcrum pin is shifted near the end of the rest, almost in line with the corner of the former, and with the tool still on edge, the rim can be formed. In these operations, the tool should be held more or less horizontal or with the handle slightly low. The work will fit the former closely enough to allow of removing the backing pad, and the burnisher can then be used to planish the surface to a high polish, the rest being set well above centre and the handle held high to obtain leverage against the edge of the rest.

Finally, the edge of the rim should be trimmed with a left-handed knife tool and all burrs removed. It will probably be found that some force will have to be used to remove the work from the former, the best way being to use a chisel against the edge, with a block of wood on the faceplate to serve as a fulcrum, and work gradually all round the rim, to avoid marking or distorting the finished work.

I have been at some pains to describe this spinning operation in detail, because the technique is not very well known, and it deserves far more attention in the home workshop than it has hitherto received. The forming of a pair of tank ends is about the simplest spinning job one could tackle, but it is excellent practice, and serves well as a preliminary exercise if one decides to attempt more elaborate work later one.

Tank Wrapper

This can be bent from sheet metal, taking care to avoid kinks, and the joint may be made by any sound mechanical method, such as by lapping and riveting, or seaming, sweating with soft solder afterwards to ensure that it is leakproof, in either case. Seaming calls for the use of a special tool, well known to tinsmiths, and it should be noted that the bulge of the seam should be inwards, so as not to interfere with the fitting of the end-plates. Those who are skilled in coppersmithing and take a pride in their craft may prefer to make a dovetailed joint and braze or silver-solder it so that it is practically invisible. A sound structure is essential for the tank as it will have to stand a great deal of vibration, but provided that all the parts are well fitted, and there are no large gaps to fill up, soft solder well sweated in is quite satisfactory for securing the endplates and the bushes for the tap and filler cap. The seam of the wrapper, if visible, should be disposed so that it is not conspicuous ; the filler cap is shown in the centre, though it may be found more convenient to locate it at one end, and the tap should obviously be at the end adjacent to the carburettor, and located at the lowest point of the tank.

The form of tap which has been found most satisfactory is the sliding cork-seated type, though the more orthodox taper-plug type is cheaper and easier to obtain. It should be fitted with a cylindrical gauze filter to project inside the tank, where it will always be washed clean. The feed pipe to the carburettor must be flexible, to allow for the movement of the engine, and the most suitable material is " P.V.C." or synthetic rubber ; do not on any account use ordinary rubber, or it will cause endless trouble by reason of small particles dissolving away and blocking the carburettor jet.

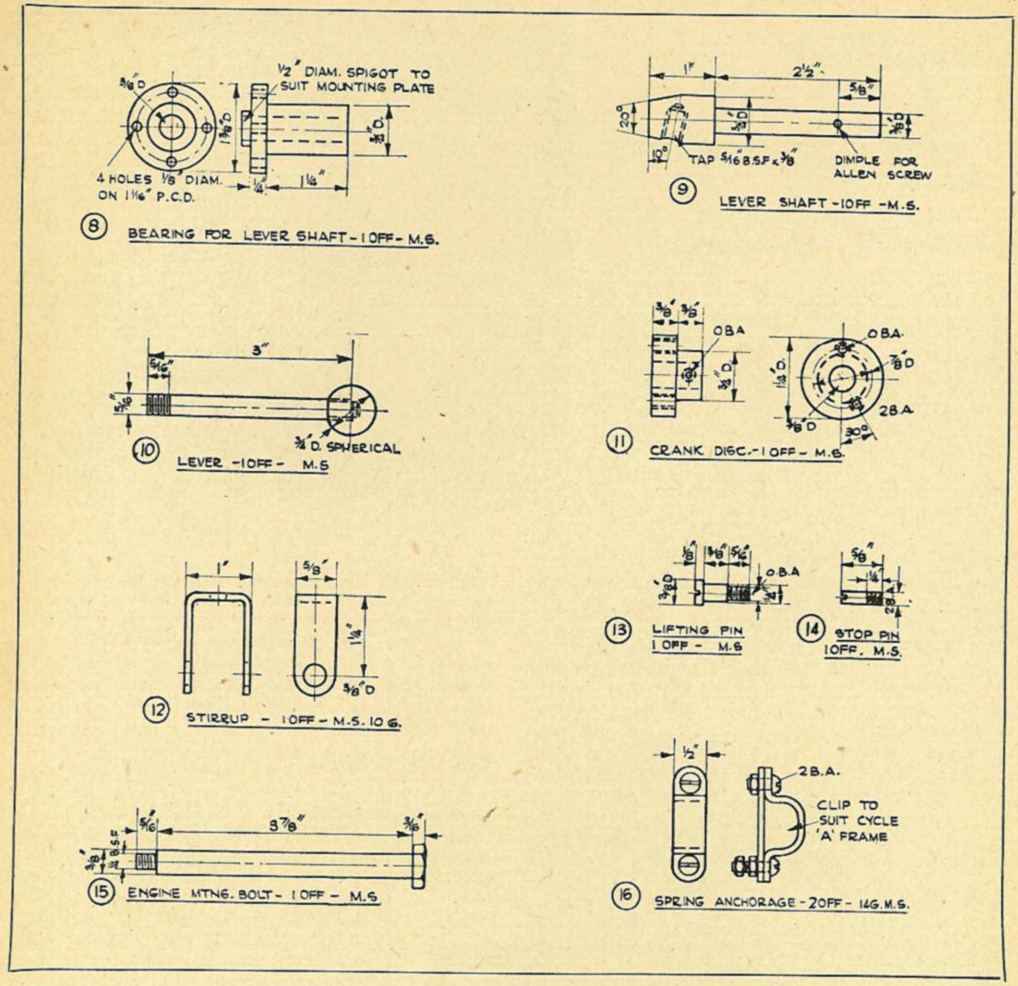
No exact details are shown of the filler cap construction, as any type of cap which is sound in design, ample in size, and properly air-vented, may be used. The example shown was machined from solid duralumin and screwcut 20 t.p.i., the bush being of brass to enable it to be soldered to the tank. An anti-splash baffle was fitted inside the cap, having just sufficient clearance, round the edge to allow air to pass, and two No. 60 vent holes were drilled in the top of the cap itself.

When the tank is strapped down to the bracket, it is advisable to cement two strips of $\frac{1}{16}$ in. rubber to the top edges of the plates to prevent chafing, and a turn of rubber tape round the tank, under each of the straps, will help to keep it secure without undue stress in tightening the latter.

Disengaging Gear

The operation of this is quite simple to follow, and its construction is equally straightforward. First the bearing for the lever shaft should be made either from mild-steel, duralumin or brass, and screwed or riveted to one of the plates of the mounting bracket. The lever shaft should preferably be machined from one piece of mild-steel, as shown, and the cross-hole for the lever drilled and tapped at an angle of 10 deg. Both ends of the lever are screwed, one to fit tightly in the above hole, and the other to take an ebonite or plastic knob. A fine thread, say 26 t.p.i., is recommended, though this is not highly important.

The crank disc should be made a neat fit on the lever shaft, where it is secured either by an Allen screw or a taper pin, but this should not be finally fitted until the gear is assembled and its proper location settled. This applies also to the position of the stop pin relative to the lifting pin in the face of the crank disc, particularly if, for any reason, the dimensions or general arrangement of the mounting should be modified. A piece of $\frac{3}{8}$ in. square mild-steel bar is most convenient for making the tension bolt, which is turned down for a length of $1\frac{3}{8}$ in. and screwed to take two $\frac{1}{4}$ in. B.S.F. lock nuts, the exact length of thread depending on the range of adjustment required. It remains only to bend the U-shaped stirrup from $\frac{5}{8}$ in. $\times$ $\frac{1}{8}$ in. strip steel and drill it as shown, to complete the actual disengaging mechanism.



When assembled, the disc crank should be temporarily grub-screwed to the shaft in such a position that the hand lever moves over a convenient range to lift the engine clear of the wheel, and the lifting pin goes slightly over the "dead centre," further movement being prevented by the tension bolt resting against the stop pin. The crank may then be permanently fixed by drilling a deep "dimple" or cutting a flat on the shaft to locate the end of the Allen screw, according to whether the latter is pointed or cup-ended. If the engine is to be pressed down positively on to the tyre, one of the tension bolt lock nuts should be placed inside the stirrup and the other outside, but otherwise, both should be inside.

If tension springs are used to hold the engine down, as recommended, the clips for anchoring the lower ends of the springs should be made to fit the section of the rear stay tubes; as these vary widely in different makes of cycles, it is impossible to specify standard dimensions. One might dispense with these clips, and anchor the springs from the rear spindle or the mudguard stays, but apart from unnecessary length of linkage in this case, and general obtrusiveness, fitting the clips has the advantage that it enables the spring tension readily to be varied if required.

I should, perhaps, have mentioned, before dealing with the mounting arrangements, that it is necessary to cut a section out of the rear mudguard to enable the friction roller to work on the tyre, though I trust this will be quite obvious to most readers. The rear part of the mudguard, when refitted, will require an additional stay, especially in view of the fact that it will also have to carry a number plate which, in this country at least, is required by law. It should hardly be necessary for me to describe in detail the operations involved here, which again are subject to the exact design of the cycle, but readers will undoubtedly be quite competent to work them out for themselves.

(To be continued)

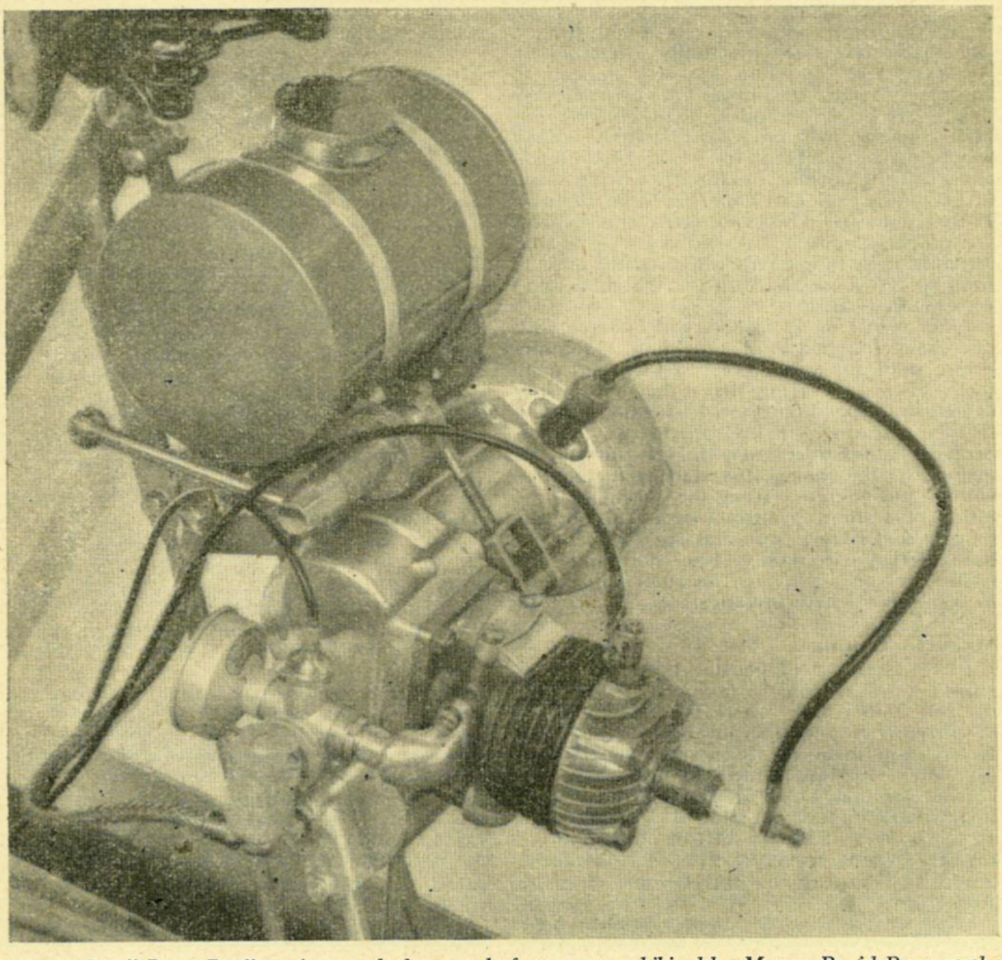
PETROL ENGINE TOPICS

*A 50-c.c. Auxiliary Engine

by Edgar T. Westbury

BEFORE concluding the description of the mounting bracket, it should be pointed out that its assembly is, like all other features of the complete design, capable of considerable variation to suit convenience. In the drawings of the mounting bracket, it is shown with the disengaging gear on the right-hand side, looking from the rear of the cycle ; but in many cases it will be found better to arrange it on the left, where it is well clear of the magneto and other components. This position has been adopted on the example shown in the photograph of the assembly displayed in the showcase of Messrs. Braid Bros. at the " M.E." Exhibition. No difference in the shape or dimensions of the individual components is entailed, but the right-hand mounting plate becomes the left-hand plate, and *vice versa.* Again, it may be found necessary to lengthen the tension bolt to suit certain types of cycles. Should there be a tendency for this bolt to rattle when the gear is in the working position, it may

**Continued from page* 367, " *M.E.*," *September* 13, 1951.



A complete " Busy Bee " unit attached to cycle frame, as exhibited by Messrs. Braid Bros. at the " M.E." Exhibition be prevented by fitting a light spring on the bolt, above the stirrup.

Not a Clutch

It is emphasised that the disengaging gear is not under any circumstances intended to serve as a clutch for use while the engine is running. There is a strong temptation to use it in this way, and some types of cycle engine attachments have been fitted with a lifting device actuated by means of a handle-bar clutch lever acting through a Bowden cable. If one could rely on riders *always* using this with intelligence and discretion, the added convenience of such a control would be an undoubted benefit ; but in practice it is found that it is very often abused, to the detriment of both the engine and the cycle tyre. Many riders have been known to " rev up " the engine and apply it to the tyre when the cycle is almost or completely at a standstill, with disastrous results to the tread of the tyre. Proper application of the control would demand that the cycle should *invariably* be pedalled away from rest, with the engine ticking over, and the latter engaged when the surface speeds of both friction wheel and tyre were practically synchronised. As such ideal conditions are very difficult to ensure in practice, it will be found just as easy to stop the engine and open the decompressor at each temporary halt, and re-starting in the normal way by pedalling off with the decompressor open, and gradually opening the throttle when a speed of five or six miles an hour has been attained. If the engine is in working order and controls are properly adjusted, it will start easily and certainly every time ; only when starting initially from cold is it necessary to use the choke, and very sparingly at that.

I know that many readers will disagree with me about the policy of providing a running control to the disengaging gear, so I will anticipate their criticism by saying, that if they have plenty of money to spend on tyres, I have no objection to their " tearing 'em up " in this way. Incidentally, some riders may find it difficult to manipulate the choke, after starting the engine, without dismounting from the machine ; the fitting of a simple control wire is the obvious remedy, and I know of several cases where it has been carried out, though I do not think this facility has been provided on any of the commercial types I have investigated.

Magneto Timing

I have already done penance in sackcloth and ashes for my error in the timing as described in the July 19th issue ; where I went wrong was in reckoning the " ignition advance " in the wrong direction, or in other words, retarding it to 25 deg. after top dead centre. Thus I gave the keyway position as 50 deg. from the correct angle relative to the crankpin. I am now showing a diagram which gives the true position of the keyway, looking from the flywheel end of the crankshaft, and trust that this will now clear the matter up.

I may add, in reply to those readers who have asked why it is necessary to set out the timing to odd minutes of a degree, that this is not my affair, as the figures are those given by the makers of the magneto. I agree that it is very difficult to measure angles to such ultra-fine limits, and as a matter of fact, this is only necessary when the cam is formed on the engine shaft. If the cam as supplied by the makers is used, and the flywheel key extended to locate the cam as recommended, the relative timings are automatically synchronised, so that it is quite in order to set out the angle of the keyway to the nearest degree, or even to wider limits, as this only affects spark *timing* (which is not usually very critical) as distinct from spark *efficiency*.

Again, I humbly apologise to those constructors who have been inconvenienced by my error in this matter ; I agree with them that there is no excuse for it, though there is quite a lot I could say in explanation of how mistakes do occur on the best regulated drawing boards, and in spite of all the care in the world. " To err is human "—and perhaps an occasional mistake is a blessing in disguise ; it keeps me down to earth and serves as a reminder that I am subject to human limitations. Otherwise, I might get the idea that I am infallible—which would be the most disastrous mistake of all !

Design of Accessories

I mentioned at the beginning of these articles that, although the use of a commercially-produced carburettor and magneto was recommended, as a measure of convenience, it is quite possible for the constructor to produce these for himself, and that designs would be forthcoming if a sufficient number of readers were interested. A good deal of correspondence has been received on this matter, though I am not sure whether it is sufficient to justify the work involved in developing these designs. However, there is another factor involved, and one which may seriously influence the success of the engine as a whole —namely, the difficulty of obtaining delivery of commercially-made accessories under the present conditions of restricted supplies. For this reason, it is very desirable that constructors should be enabled to produce these parts for themselves if they so desire.

The Carburettor

With regard to the carburettor, several designs which have been published in THE MODEL ENGINEER in the past could be adapted quite successfully for use on this engine. The " Atom Type R " carburettor, suitably enlarged to give a throat diameter of $\frac{5}{16}$ in., and having a diffuser of the same bore, would give quite satisfactory results, and the " Apex Minor " carburettor, also with its dimensions suitably adjusted, would serve equally well. The latter is the more convenient of the two to adapt for Bowden cable control, as it has a plunger throttle which could easily be modified for operation in the orthodox way. One of my correspondents reports great success with a carburettor of the type described for the " Phoenix " engine, and yet another is using one of the " Seal " type—in each case enlarged and equipped with float feed.

I am at present working on the development of a special carburettor for the " Busy Bee," having the orthodox features as used in motor-cycle practice, but specially adapted to the constructional facilities of the home workshop. This will be described in due course.

In the case of the magneto, things are rather more difficult, as the success of this component depends on the availability of high-efficiency magnet steel, which is very difficult to obtain at present. There is no trouble about producing a satisfactory design, but to publish one without being able to recommend a source of supply for the magnets would only involve me in mountains of fruitless enquiries. It is no use to attempt finding substitutes for the proper magnets, as the success of the modern miniature magneto, whether of the flywheel or any other type, depends entirely on magnets which are anything up to ten times as efficient as those used on the older and more cumbersome machines.

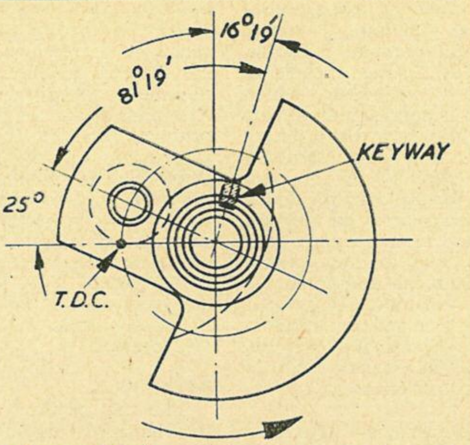


Diagram showing position of magneto keyway relative to crankpin angle, and position of crankpin at the instant of break. (Crankshaft viewed from flywheel end)

The "Atomag Minor" magneto, if properly constructed, will give quite satisfactory results on the "Busy Bee" engine, but it must be exceptionally well protected against damp or other influences which may affect the insulation of the coil. A still better magneto for this purpose is the "Atomax," which has the further advantage, in this particular application, that it could be adapted to supply lighting current as well, by the addition of a second stator unit located opposite the original one, and equipped with a coil of about 500 turns of 25 s.w.g. wire. Both these magnetos are described in THE MODEL ENGINEER handbook *Ignition Equipment*, together with other types which are equally suitable for adaptation to cycle engines.

I have done some preliminary work on a special design of magneto, and this will be described if and when the necessary arrangements for the supply of magnets can be made.

Applications of the "Busy Bee"

Although I have only shown the application of the engine to a cycle, it will be obvious to readers that its use for other purposes calls only for some ingenuity in installation or attachment. Up to the present, my time has been very fully occupied in the development and testing of the engine unit itself, and practical work on its various methods of application has been delayed, but I may be able to show some specific ways of using it at a later date. Among the most popular ideas is that of applying the engine to a lawn mower, and I have had many enquiries as to the best form of drive when it is used in this way. A good deal must necessarily depend on the details of the mower itself, and some of the popular types are so designed that it is difficult to apply any form of drive without structural alteration to the frame and other parts of the machine itself. If, however, these obstacles can be surmounted, there is little difficulty in applying the engine, and I have several ideas which I hope to expound when I have an opportunity of giving them a practical test.

The use of the engine as a marine power unit has also been discussed, and the simplest arrangement would be to use it either as a small "inboard" unit or equip it with a suitable bracket and propeller shaft to attach to the gunwale of a boat as a "sideboard" unit. Most of my correspondents, however, favour its adaptation as an "outboard" engine, but this involves modifications which may be so extensive as to make it easier to produce a completely new design. However, there are some interesting possibilities in this direction which, I assure you, are receiving due consideration. For this, and certain other classes of work, it may be desirable to convert the engine to water cooling, which, unless one is content with makeshift arrangements, involves a re-design of the cylinder barrel and head, and provision for water circulation.

Performance

Many readers have tackled me about this very important question, and have tried to tie me down to a definite statement on figures of horse-power or maximum road speed. But experience has made me very "canny" in committing myself to statements of this kind, not because I have any doubts as to the potential efficiency of the engine, but on account of the varying results which are always obtained by different constructors. It is a very popular fallacy that two engines built to the same "blue print" must necessarily be alike; in practice, they never are, and the amount of variation possible is in some cases astonishing. I usually tell constructors that the engine is "as good as you make it," and this statement, if very vague, is also very true.

Some readers have worked out an estimate of what the engine *ought* to do, based on the figures given for certain small engines, in terms of power output in relation to cylinder capacity, arriving at results which, of course, are fantastic for an engine of this type which neither runs at astronomical speeds, employs high cylinder pressures, nor uses fancy fuel; but on the other hand is required to produce a fairly good torque "low down," and to carry on like the babbling brook, whenever and as long as required to do so.

I will at least say that on actual test, a home-produced "Busy Bee" has maintained a steady ⅝ horse-power on runs of several hours' duration, and has proved capable of driving a cycle at 18 to 20 miles per hour continuously (which incidentally, is as fast as it is comfortable to ride a push-bike—and much too fast for ordinary cycle brakes!) with moderately good climbing power. Its general structure is robust, and bearing surfaces adequate for the duty for which it is intended. I do not claim it to be the best or most powerful of its kind in the world; it is simply a straightforward conscientious engine intended particularly to suit the constructional facilities of the average amateur. It will, I feel sure, give satisfaction to many constructors by providing an interesting workshop exercise, with the prospect of the additional thrill of achievement, and enjoyment of effortless cycling when it is completed.

One word of advice to intending constructors; if you do not wish to be let down or disappointed over the quality of castings or other components, get them from the *approved* suppliers. I am for ever receiving complaints from readers who have bought castings purporting to be for engines of my design, but find after spending many hours in machining them, that they are unsatisfactory in quality of material, or incorrect in shape or dimensions. It is with regret that I am obliged to tell these readers that I can do nothing to help them in these circumstances. Although I am not connected directly with the production or sale of any engines or castings, it is possible for me to co-operate with certain firms who are willing to accept my advice and criticism, and to submit their products at any time to my inspection. These are the firms I recommend, and with whom I have some powers of negotiation in the event of any complaints being made. With others who market castings and parts without my approval, though they may quote my name in advertising, I cannot exert any influence in this way.

Epilogue

The tale of the "Busy Bee" is now told; the name of this engine symbolises the happy combination of work and pleasure, applying equally to the many constructors who are at present "improving the shining hour"; whose workshop "hives" are now buzzing with activity, and will, in the due course of events, produce results well worthy of their efforts.

STEPHENSON MEMORIAL MINIATURE LOCOMOTIVE ASSOCIATION

Report of Third Annual Trials

THE third Annual Trials of the Stephenson Memorial Miniature Locomotive Association were held on the track of the Tyneside Society of Model and Experimental Engineers in Exhibition Park, Newcastle-upon-Tyne. A total of 17 entries was received consisting of six 5 in. gauge, eight 3½ in. gauge and three 2½ in. gauge locomotives. Before the commencement of the trials one 5 in. and two 3½ in. gauge entries were withdrawn leaving 14 locomotives to compete in the three groups. The weather was excellent throughout the day, in marked contrast to the very trying conditions under which the 1950 event was run, and competitors, friends and public had an enjoyable time.

The order of running was again in gauge groups starting with the heaviest load in 5 in. gauge mainly to minimise the physical labour of the loading crews. Most of the member societies provided officials for the many duties required in an event of this nature, although Tyneside naturally sent the majority in view of their capacity as hosts.

For this year's trials the association adopted a revised version of the 1950 formula, omitting the water factor, and allowing for the use of any special brand of fuel at the competitor's choice. To bring all results to a comparative basis each fuel was analysed for calorific value and the actual consumptions were corrected to a "standard" calorific basis.

The formula was as follows:

$K = \frac{D \times L}{T \times F}$, where K = points scored; D = distance run in feet; L = load hauled in lb.; T = time for run in minutes, and F = weight of fuel used in ounces.

"Standard" fuel was taken as 12,700 B.Th.Us. per pound and "F" in each case was corrected to that basis. Actual calorific values of the various fuels used ranged from 13,200 to 15,200.

Three competitors in the 3½ in. gauge group had to retire during the course of the trials, two on account of damage caused by derailments and one on account of seized motion. The derailments were caused by the wheels of the leading axle of the driving car slowly creeping outwards, so spreading the gauge of the car and causing it to ride up with the flanges on top of the rails, before coming off the track.

Each 5 in. gauge engine had to complete 15 laps of the track—a total distance of 10,500 ft. The corresponding figures for 3½ in. and 2½ in. gauge engines were 10 laps, 7,000 ft. and 6 laps, 4,200 ft. respectively.

The complete list of competitors in order of