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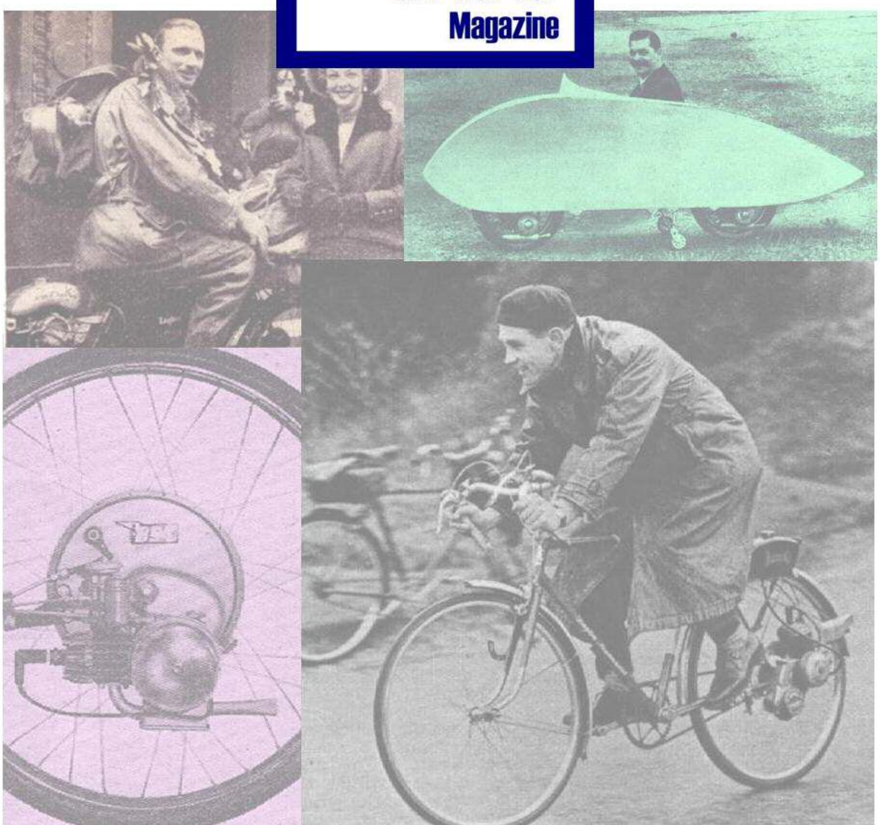

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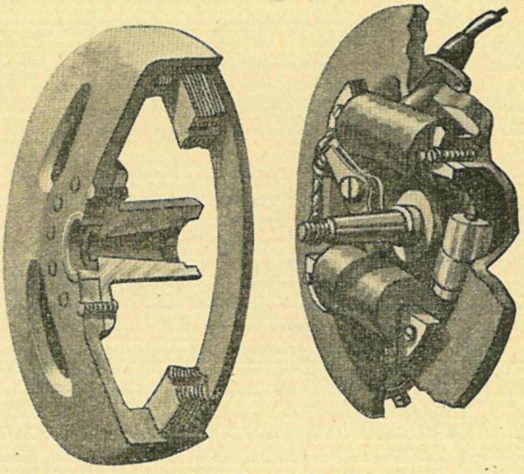
A Magneto for the "Busy Bee"

An entirely new design for a flywheel magneto-generator, suitable for all types of small power engines

by Edgar T. Westbury



Exploded part-sectional view of the "Busy Bee" magneto

THE fully detailed constructional description of a magneto, of a type and size suitable for autocycle or motor-assisted cycle engines, has never, so far as I am aware, been previously published in any journal, and in this respect it may be claimed that the design I am now offering represents a pioneer effort. There are several unique problems both in the design and production of such a highly specialised device, involving as it does both mechanical and electrical engineering, but lest readers should consider this work beyond their scope, I would assure them that, given a sound design, any reasonably competent model engineer will be able to carry it out quite successfully.

Since I first mentioned that I was working on an experimental magneto for the "Busy Bee," I have had many requests from readers to hurry up and describe it; and despite my statement a few weeks ago that there were difficulties, at present without a practical solution, in the supply of suitable magnets for a magneto of this type, the demand still continues. It has occurred to me that if a description of the magneto is published, someone who sees it may be in a position to help out with this particular problem, which in any case is only temporary, as I feel confident that the time is not far distant when manufacturers of raw materials will be glad to supply them to customers, however large or small the orders. For the rest, there are no problems beyond the scope of the home workshop and the ingenuity of the model engineer.

The present design is one of several which have been tried out quite successfully, and it has been selected for recommendation to constructors for several reasons, including not only facility for home constructors, but also avoiding any clashes with existing commercial designs, many of which are the subject of patents. I have myself been the victim of "patent piracy" on more than one occasion, and regard it as a very mean kind of dishonesty, for which the only possible (and not very certain) remedy is expensive litigation; for this reason I am very scrupulous in avoiding it in my own designs and research work, so far as is humanly possible.

Magnetic Materials

While this magneto involves no new functional principles, however, it can still be claimed as an entirely original design, as it is not a copy of any existing type, and the arrangement of its details is designed to promote simple construction and accessibility for adjustment. It is not the smallest magneto which could be devised for work of this particular nature, as ample margins of reliability have been allowed on all essential parts; and a feature which has been given particular attention is economy in the special, and relatively expensive, magnet steel employed in it. The use of one of the most efficient commercial magnet steels is fully justified, because although it would be quite practicable to employ a much less efficient steel in a similar magnet system, it would inevitably make the assembly larger in diameter and the actual magnets would have to be greater in length, so that no real economy would be effected. One of the features of modern high-efficiency magnets is that they can be made very short, as the cross-sectional area is the important factor, and thus the quantity of active magnet material is very small compared to older types of magnets, which had to be made in horse-shoe or semi-circular form to concentrate the flux across the poles. (I have made quite good magnetos with low-efficiency magnets, including the original "Atom" magneto, which has been described in the "M.E.," and also in my book *Ignition Equipment*; but reference to this design will show that it involves the need for a totally different, and inherently more cumbersome, design of the magnetic circuit; besides which, the magnets are more liable to risk of demagnetisation, precautions against which must be taken in the design.)

The rest of the magnetic circuit consists of ordinary soft iron or annealed mild-steel in the form of laminations. Special magnetic iron or alloy is not necessary, and in the ignition element at least, has not been found advantageous ; some of the modern transformer alloys would be definitely unsuitable. In the design of the stator, the quantity of iron is kept down to the minimum, as it is an axiom in magneto design that to make the most effective use of limited flux, the less iron which is subjected to alternating polarity the better. (I make my apologies to electrical experts for this crude and imperfect expression of involved electro-magnetic theories !)

A Dual-purpose Generator

Most of the popular types of magnetos used on small engines are designed to perform a single function only—the production of the high-tension spark. This applies not only to the separate unit magnetos which are driven by gear or chain from the engine, but also flywheel and other built-in magnetos. But the need for a supply of electric current for lighting and other purposes is felt, even on the humblest motor-propelled vehicles, and the possibility of utilising the magneto to produce both high- and low-tension current is often exploited. One of the earliest examples of a dual-purpose magneto-generator was the Villiers flywheel magneto, in its original two-pole form ; it may be said that in the flywheel type of magneto, there is the best possible scope for adding a second electrical unit, as it may often be fitted into space which would otherwise be wasted, with very little increase in the weight or complication of the complete unit. On the very smallest types of flywheel magnetos, however, it is common to employ an unsymmetrical type of rotary magnet system, which is highly efficient for producing a single spark per revolution, but unsuitable for generating a steady continuous current. (Incidentally, I may mention that I spent quite a lot of time once in attempting to add a low-tension generator to such a magneto without increasing its size or making other drastic alterations in design ; the results were only partially satisfactory, and it was found more desirable to redesign the magneto completely.)

In the present design, a symmetrical four-pole magnet system is employed, which not only favours smooth current generation, but is equally efficient for producing an ignition spark, particularly at low or medium speeds. It will be clear that, compared with a symmetrical two-pole system, the polarity of the stator poles changes twice as rapidly for a given rotor speed. Thus an effective spark is produced at quite a low engine speed, and in the low-tension supply, the fluctuation of voltage is less noticeable, so that when used for direct lighting (as is usual), flickering at low speed is avoided. It is generally agreed that two-pole lighting generators are at a disadvantage in this respect, unless driven at higher speeds than the minimum working speed of the engine.

I have not considered it necessary to give a detailed explanation of the working of this magneto, as it differs in no essential respect from that of any other flywheel magneto, and indeed it may be said that all ignition magnetos follow exactly the same principles, despite wide variation in the form and arrangement of their working parts. Anyone wishing to obtain a full description of ignition spark generators of all types may find it in the handbook *Ignition Equipment* previously mentioned, which is obtainable from the " M.E." Publishing Department. I will, however, proceed to describe the various parts of the magneto, and their functions.

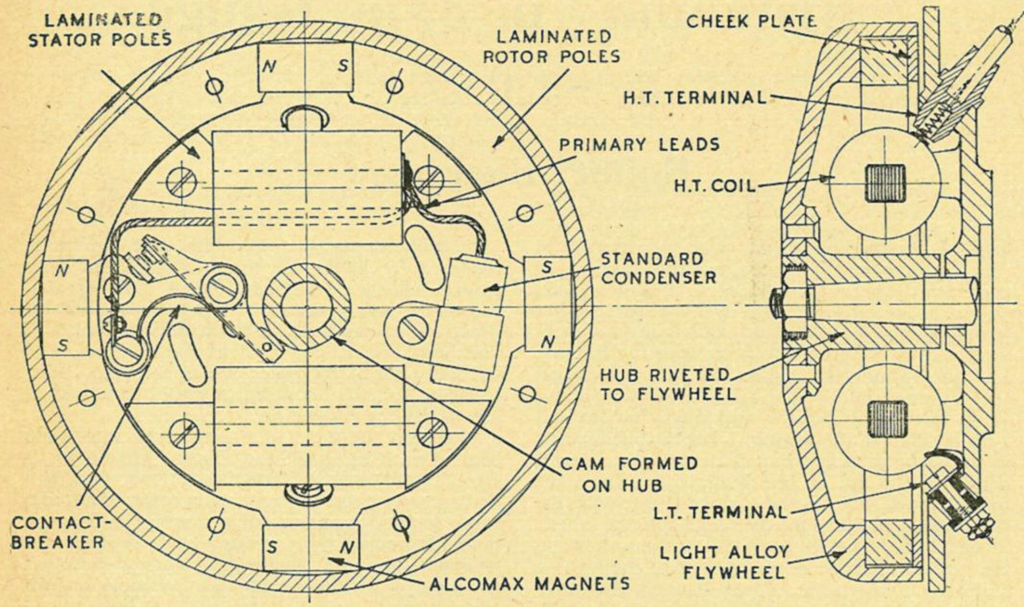
Flywheel Assembly

The rotating portion of the magneto is mounted on the engine shaft, and comprises a steel hub, to which is attached a dished flywheel of non-ferrous metal, the rim of which houses the complete magnetic system. This in its turn embodies the four short bar magnets with their laminated pole shoes, held in place by means of screws passing through an outer cheek plate, and tapped into the thick part of the flywheel rim. The magnets are arranged to produce alternate N and S salient poles in the pole shoes. It is, of course, highly important that the flywheel and cheek plate should be of non-magnetic material, otherwise the magnets would be short-circuited, and would fail to produce the necessary concentration of flux at the pole shoes. Aluminium alloy is specified for these parts, as although bronze or gunmetal would be equal or superior in mechanical strength, its weight would be a good deal greater ; and while plenty of rotating weight in a flywheel is desirable, it tends to retard any change of engine speed, which makes it less sensitive in responding to controls.

The steel hub has a cam formed on the end of the external surface, which operates the rocker arm of the contact-breaker, and is timed to break the circuit at the moment the pole shoes of the rotary magnet are in the appropriate juxtaposition to the stator poles. This relationship is quite independent of the timing of the spark relative to the position of the engine piston ; any change in the latter respect has no effect on the electrical efficiency of the magneto. As the magnet system has four poles, it would be possible to obtain four sparks per revolution, simply by using a four-lobed contact-breaker cam ; but this is, of course, neither necessary nor desirable in a single-cylinder engine. The four poles are, however, all usefully employed in generating low-tension current.

Stator Assembly

All the electrical components are mounted on a light alloy backplate, which is designed to be attached to the standard mounting plate, as specified in the engine drawings, by means of two studs or set screws, through slotted holes which allow of a limited amount of angular adjustment to advance or retard the spark timing. Four pillar bosses are provided on the backplate, to support two complete exciting coil assemblies with their laminated cores and pole shoes. The upper of these two assemblies is the ignition unit, which has both primary and secondary windings, the latter being heavily insulated, and its outer end terminating in a tag on the outside of the coil, making contact with the H.T. terminal by means of a spring. Both the inner end of the secondary and the outer end of the primary have a common con-



General arrangement of magneto. (*Half full size*)

nection to the " live " sides of the contact-breaker and the condenser, while the inner end of the primary is " earthed " to its core or the backplate. These connections are normal to any type of ignition magneto, and are the simplest it is possible to devise.

The lower coil assembly is the generator unit, which is provided with a single winding, one end of which is earthed, and the other connected directly to an insulated terminal screw in the backplate. Neither the coil insulation, nor that of the terminal, present any problems, as they have only to cope with low-tension current. It will be seen that the pole shoes of this unit have a greater angular length than those of the ignition unit, the object being to smooth out the alternating flux, and produce as nearly as possible a " sinusoidal " wave form, whereas in the case of the ignition coil, efficiency demands a more abrupt change, or in other words, a " peaky " wave form.

The ignition contact-breaker, although not identical in form with any standard type, works on normal principles, and calls for no special explanation. Two different types of breaker assemblies have been designed for this magneto, the second (not illustrated) being of the spring blade type. Both work quite satisfactorily, but the type shown is more in keeping with orthodox practice, and seems to be preferred by most people with whom the design has been discussed.

(*To be continued*)

The Allchin "M.E." Traction Engine

(*Continued from page* 576)

with " Easyflo " flux. Heat to dull red, and apply the tiniest amount of " Easyflo " to each joint, so as not to have any run into the slot.

Allow to cool, and clean up. Cut in two as indicated by the dotted lines, and finish-file to size. If necessary, clean out the slots with a needle-file. These brackets fit outside the horn-plates, with the slots uppermost, and will eventually be fitted with 8-B.A. hex.-headed screws and lock-nuts.

Damper-rod Bracket

A simple turning job finishes this week's list, being the bracket for the damper-rod. Probably the best way to turn it is to grip a stub of ¼ in. dia. mild-steel rod in the chuck, leaving about ¾ in. or so protruding. First turn the 7/32 in. long spigot and screw it 8 B.A., rough-turn the rest of the job to size, and part off.

Next, chuck a short end of brass rod, face and centre the end, tapping it 8 B.A.

Screw the bracket into the screw-chuck you have just made, finish it off to the dimensions given in the drawing, and that is all for the present!

(*To be continued*)

A Magneto for the "Busy Bee"

An entirely new design for a flywheel magneto-generator, suitable for all types of small power engines

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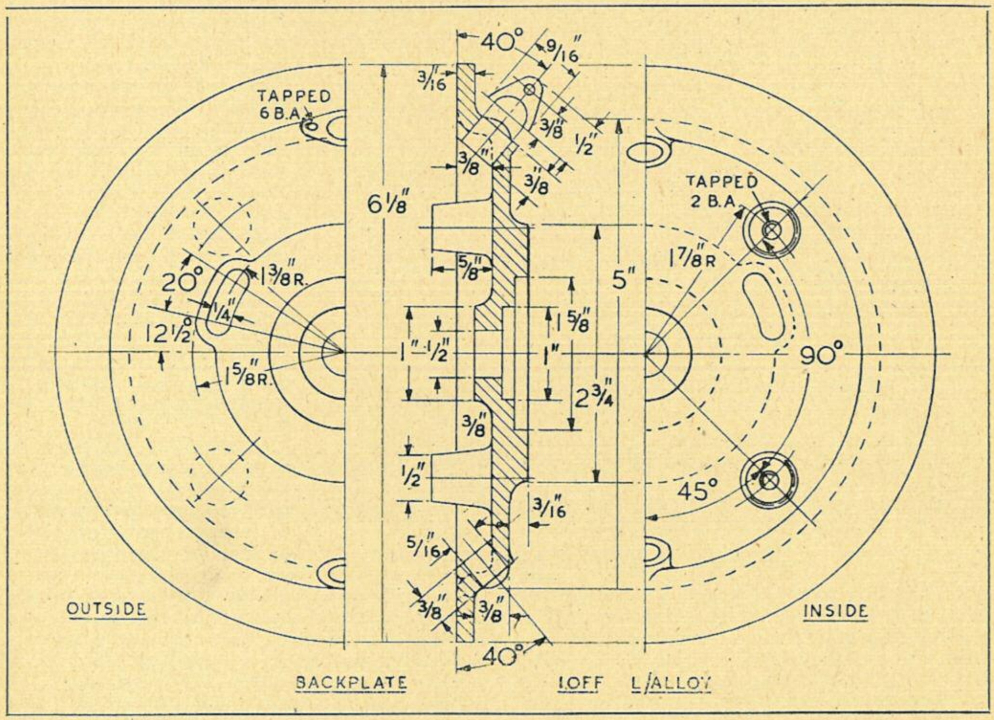
IN the construction of the magneto, two castings only are specified, namely, the backplate and the flywheel shell, both in aluminium alloy. Although it is by no means impracticable to dispense with castings altogether, by fabricating the parts or machining them from the solid, it will probably be just as difficult, or even more so, to obtain suitable raw material, and the work is, of course, very much simplified if castings are employed. In both cases the castings are of relatively simple form, and the constructor who essays to make his own patterns, or even undertake the foundry work as well, will find little difficulty with them.



Backplate

Assuming that this is cast with the four projecting bosses on the inner surface, as specified, it is possible to hold it over the outside of these bosses, in the inverted jaws of the four-jaw chuck, for machining the outer face, with its recesses, and also the rim. The casting should be set to run as truly as possible in both planes, the principal reference surfaces being those parts outside the flat bolting face, as these have to be left unmachined. It will be observed that this backplate is designed to fit the standard magneto mounting plate (which also incorporates the outboard main bearing housing) as specified on the original engine drawings, so that if this component has already been machined, the recess in the backplate should be machined to fit closely on its spigot, and thereby ensure a true concentric register of the backplate with the engine shaft. The hole through the centre is also drilled at the same setting; its diameter is given as ½ in., but it should not fit the shaft too closely, and may, if desired, be given a fairly ample clearance to ensure that it cannot under any circumstances interfere with free running of the engine.

The reverse side of the casting can be dealt with by clamping it to the faceplate by toe-clamps over the rim at two or three places; concentric setting is of relatively small importance, as only facing operations are called for, but it may be set fairly true by bringing up the back centre, and entering it in the centre hole to locate the casting while the clamps are being

**Continued from page 579, "M.E.," October 30, 1952.*

applied. All that has to be done at this setting is to face off the four bosses to the dimensions shown, ⅝ in. from the recessed portion of the casting, or ¼ in. from the face of the outstanding rim, and to skim the face of the centre boss.

If any form of indexing gear is available (even the simplest appliance of this nature will suffice) the four holes in the bosses, for the attachment of the stator laminations, may be marked out, and if a drilling spindle is available, they may be drilled *in situ* as well. For these operations, however, the work must be set up truly concentric with the back register, and it is, therefore, worth while to machine up a spigot 1⅝ in. diameter to fit this recess, and mount the plate on it. A hole may be drilled and tapped in the centre of the spigot to take a set-screw, which will pull the backplate firmly back against the spigot, and hold it securely enough for these light operations.

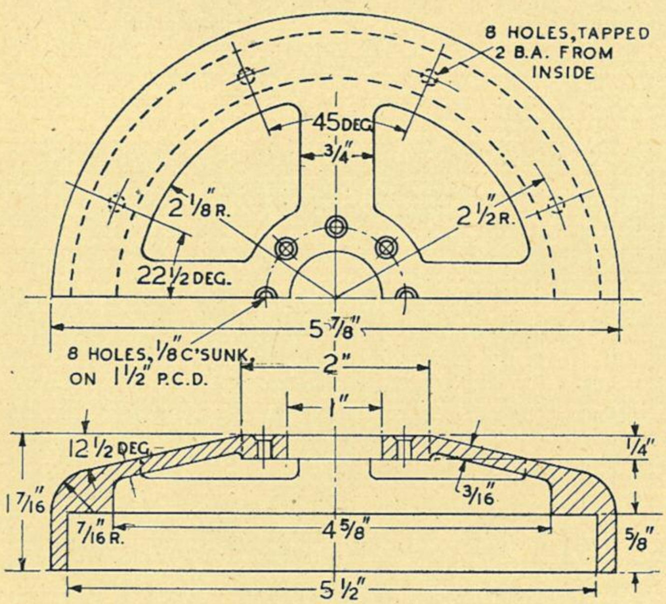
Some constructors, however, may prefer to leave the drilling of the bosses, until the stator laminations are fitted, and this is the most discreet course if the latter are pre-drilled, or made in the form of blanked and pierced stampings, as there is always the possibility that the distance between the holes in them may not coincide with that of the holes in the bosses, which are marked out in terms of angular and radial measurements. It is, however, always advisable to mark out the bosses as a guide to the proper location of the stators.

To drill and face the holes in the backplate which take the h.t. and l.t. terminals, the simplest method, if a vertical-slide with a swivelling base is available, is to clamp it to the slide-table, with the diametral centre-line of the holes horizontal, and swing the slide round to an angle of 50 deg., measured from the lathe faceplate (i.e. 40 deg. from the lathe axis). The angular setting is not absolutely critical, but should be as near as possible. A single tee-bolt will hold the casting, with the four feet resting on the slide-table, but as there is a danger of distorting it if the bolt is screwed up too tightly, a hardwood packing-piece of the appropriate thickness (5/16 in.) should be placed behind the centre boss to take the strain.

The vertical-slide will have to be overhung from the cross-slide to enable the large diameter casting to clear, but if there is any difficulty in this respect, it is quite practicable to mount the base of the slide directly on the lathe bed, or a plate attached thereto, as it does not have to be cross-traversed when once set up. After adjusting the casting to the correct centre-height, and verifying that the centre-line of the two holes is truly horizontal, the hole may be started with a centre-drill, opened out to finished size, and finally faced off truly with an end-mill. In the case of the h.t. terminal seating, the flange will have to be faced right across by traversing the work vertically; this is not necessary in the case of the l.t. seating, but it should be noted that this needs spot-facing on the inside surface, and it may be necessary to make or adapt a facing cutter or pin drill for this job.

If the use of a vertical-slide is impracticable, an alternative method of dealing with this operation would be to made a hardwood block, having a top face at 40 deg. to its base, and use this to mount the casting on the cross-slide at the required angle. The work is shifted up or down the inclined surface to adjust the height, and may be fixed in position by a single large wood-screw and washer. In this case the diametral centre-line is horizontal, in the cross plane relative to the lathe axis, and the traversing movement necessary for milling the flange face can be obtained on the cross-slide.

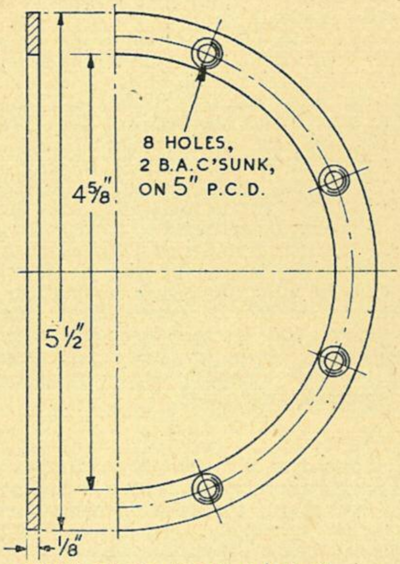
All that remains to be done on this casting is to drill and slot out the fixing holes in the mounting face—these may be either filed or milled, according to facilities available—and to drill and tap the 6-B.A. holes in the terminal flange, but the latter may be left until the insulator is fitted. Other holes have to be drilled for fixing the contact-breaker and condenser, but these also are best deferred until the time comes to fit the components in place.



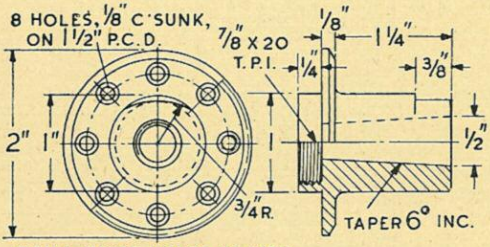
FLYWHEEL I OFF L/ALLOY

Flywheel

If, as is quite probable, this casting is too large to be held in the four-jaw chuck, a good deal of the essential work on it can be done by mounting it on the faceplate, by means of bolts through the four apertures, and suitable clamp plates to bridge across them. The outside should be dealt with first, as it will be found easier to obtain a reasonable finish on the outer rim when it is supported in this way than at a later stage in the operations. It should be set to run as truly as possible, and if there is any pronounced inaccuracy of the face, it may be found necessary, as a preliminary, to file this so that it rests fairly on the faceplate and does not produce side wobble.

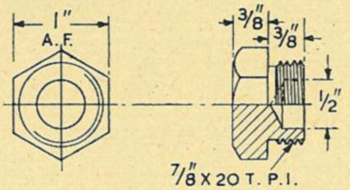


CHEEK PLATE 1 OFF L/ALLOY



DRILL RIVET HOLES IN SITU AFTER TIMING CAM

HUB, WITH BREAKER CAM 1 OFF M.S.



EXTRACTOR 1 OFF M.S.

The rim may be machined, approaching as closely as possible to the faceplate without digging into it, then the flat centre face; the centre hole may be bored undersize to produce a true reference surface, but should not be finished at this stage. It will also be possible to machine, or at least rough out, a part of the angular front face, so far as permitted by the clamps, and to round off the radius where this meets the rim.

The casting may now be reversed, the centre face being clamped against the faceplate, and set up to run truly, checking by the centre hole and also the machined portion of the rim. If one is lucky enough to possess a set of the old-fashioned "faceplate dogs" (now apparently obsolete, though just as useful as they ever were!) they may be set up to bear on the outside of the rim, with slips of wood or leather interposed, and not tightened up sufficiently to cause risk of distortion. These will not only assist in locating the work, and insure against the risk of it shifting, but also act as a very effective deterrent to chattering. The facing of the rim, and most of the internal machining except in the region of the clamps, may now be carried out; the centre hole is, of course, now bored out to finished size at this setting.

A spigoted mandrel may be used to mount the flywheel for machining those parts not hitherto accessible, but most constructors will probably find it more convenient to wait until the hub is fitted, and the assembly can be mounted on its own shaft for final truing up. Incidentally, the setting of the lathe top-slide for machining the face angle of 12½ deg. (not critical) may be found difficult in some cases, but can usually be "wangled" with a little ingenuity, and some of the contributors in THE MODEL ENGINEER have already given hints on ways and means of dealing with this problem.

If a chuck large enough to hold the flywheel in both positions happens to be available, procedure is very much simplified, and the whole of the external and internal angular surfaces can be reached; but when the work is gripped in this way, care must be taken to see that it is not distorted by the pressure of the jaws, and also that face truth is preserved.

The eight holes for the rivets which secure the flywheel to the hub should be marked out and drilled, preferably with the aid of indexing gear and a drilling spindle.

Hub

This is made from mild-steel, and may be machined on most of the essential surfaces at one setting if a surplus length of about ¾ in. is allowed on the material to serve as a chucking-piece. Alternatively, the centre may be drilled and taper bored, and then be mounted on a taper mandrel for external machining. This, of course, is the approved method "according to the book," but its success depends entirely upon the use of an absolutely true-running mandrel, and if this cannot be assured, it is but a snare and a delusion. I have found it quite satisfactory, and more expeditious, to employ the "one-setting" method, the spigot at the end being machined with a left-hand side tool, to micrometer measurement, and the same tool used for facing the flange.

Accurate Taper

The accuracy and finish of the taper are most important factors in any fitting of this nature, and not only myself, but "Duplex" and other writers have emphasised the necessity of setting the tool exactly on centre height, and "running out" the cut, by several passes at the final feed setting, to eliminate spring. If one has a good taper reamer of the correct angle, by all means use it to *finish* the surface—but only by taking a light scrape, not by entering it into a parallel hole and hoping for the best! The resultant hole will probably be far from circular, and possibly eccentric as well, if you do.

If the hub is made with a chucking-piece, it will be a sound policy to machine the cam surface on it before parting off. The chucking-piece is set over in the four-jaw chuck until the running centre is just about coincident with the edge of the hole, as can be checked by advancing the back centre until it almost touches the work. It is not necessary to work to fine limits in the amount of eccentricity, as the function of the curve produced by this operation is simply to avoid an abrupt change of contour on the cam, which might tend to cause bouncing of the contact-breaker rocker. As this magneto is not intended for use on a super-high-speed engine, this measure suffices for practical purposes, and it is not necessary to go to the trouble of generating a scientifically-designed cam contour.

A cut is taken for a length of $\frac{3}{8}$ in., to such a depth as to cut away about 90 deg. of the surface; here again, it is not necessary to split hairs, as the cam timing is, at this stage, capable of adjustment relative to the rotor poles, and in the interests of simplicity, it is intended that this operation should be left till the assembly stage. No doubt the precision experts would like to see everything tidied up and the exact angles of essential locations stated definitely on the drawings. This, of course, would be absolutely necessary in production work, and it would be the responsibility of the jig and tool designer to see that ways and means of working precisely to the specified angles were arranged. It should be noted that not only are the relative angular timing of the rotor and stator poles, and that of the cam, highly important, but precision in these respects could be rendered quite futile by a slight error in the location or dimensions of the contact-breaker components. While it is not by any means impossible to do all these things in the approved tool room manner, I have found by experience that it is much easier and quicker to "offer up" the job, and adjust accordingly; I think most of my readers will agree.

The slight corners where the concentric and eccentric curves meet should be eased off with a superfine file, and the cam then re-centred and polished with an oilstone slip while running, prior to parting-off. In the event of the cam being machined on a mandrel, the eccentric setting may be obtained by holding the mandrel in a Keats vee-angle plate or similar eccentric fixture. This cam is arranged to allow the contacts to close for slightly less than a complete half-cycle, thus giving ample time for full build-up of current in the primary circuit before the break takes place.

Another point which should be noted in the design of the hub is that the taper does not correspond with that specified for the fitting of the Bantamag. It could, of course, be made interchangeable if desired, but there are very good reasons for the difference, as the success of a taper fit in a flywheel depends largely on providing an adequate bearing surface area, not to mention ample strength in the shaft and the thread which takes the securing nut. In my opinion, and that of many other constructors, the original fitting dimensions leave much to be desired, but this matter was entirely outside my control. If the engine has already been built, it will, of course, be necessary to make a new shaft journal to conform to the new fitting, but this is not a very big job. Note that no keyway is shown in the hub; this also is optional, but it is unnecessary to key the flywheel if the taper fit is adequate, and I regard keying as a definite disadvantage, except in cases where assembly must be made absolutely foolproof, as applies in commercial production.

Extractor

The front end of the hub is recessed to allow the securing nut to be sunk flush with the surface, and I have shown this recess internally threaded to take an extractor. I regard the use of a simple extractor of this type as well worth while; taper-fitted components are often damaged, and indeed completely ruined, by trying to remove them with unsuitable tools. The extractor shown here is arranged to screw into the recess of the flywheel hub, after the shaft nut has been removed, and the depth of the centre hole is arranged so that the end of it will make contact with the end of the shaft before it is fully home in the hub. When screwed further in, it will draw the hub off the taper. Some extractors of this type are fitted with a centre set-screw to bear on the shaft, but there is no particular advantage in this unless a wide latitude, to suit varying lengths of shafts, is required. An alternative to the extractor would be to use a "captive nut," in other words a nut with an integral base collar, trapped in the recess by a ring or washer held in place by the rivets which secure the flywheel. This is a very effective device, but there are disadvantages in not being able to remove the nut from the hub in any circumstances, and I prefer to make the extractor a separate unit.

Cheek Plate

This is simply a ring which can be trepanned from $\frac{1}{8}$ in. light alloy sheet, and is used to clamp in place the magnets and their laminated poles. It should be made a good fit inside the flywheel rim, but its internal dimensions are not critical. The screw holes may be left until the laminations are ready to be fitted.

(*To be continued*)

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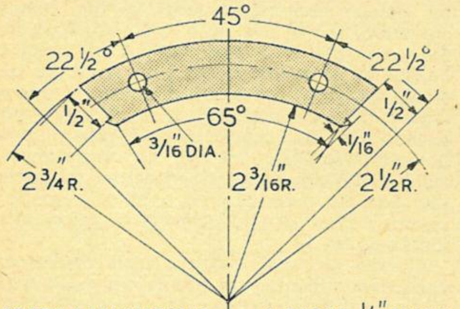
An entirely new design for a flywheel magneto-generator, suitable for all types of small power engines

by Edgar T. Westbury

WE come now to a stage in the construction where the work is perhaps a good deal less interesting than the straightforward machining and fitting of the main structural parts. I refer to the cutting out of the rotor and stator laminations, which some constructors find rather tedious, and may, therefore, be inclined to devote less care to than other operations ; but rough or inaccurate work should not be permitted to pass, as errors in the shape or location of pole surfaces may seriously affect the efficiency of the magneto.



ROTOR LAMINATIONS 4 PACKS ½" THICK

I have already observed that ordinary commercial sheet-iron or mild-steel is quite suitable for these laminations, and if one is lucky enough to have access to the scrap heap of a sheet metal works, there will be no difficulty in picking up enough offcuts of a suitable gauge of material. Slight rust or mill scale on the surface is no objection. Theoretically, the thinner the laminations the better, but there are mechanical objections to working very thin material, and I have found that anything between about 24- and 20-gauge (say, 0.020 in. to 0.030 in.) gives good results. The material should be as flat as possible, and well annealed either before or after cutting to shape.

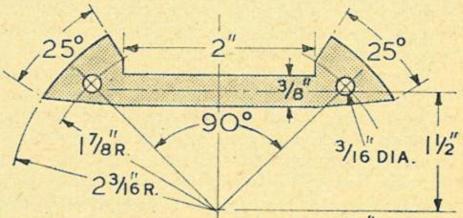
The entire set of laminations, therefore, can be made from a pack of 5½ in. diameter discs, 25 in number for 24-gauge and 17 for 20-gauge, by cutting out an annular ring for the four sets of rotor poles and using the inner disc for the stators, which, incidentally, are of less thickness, and do not require so many pieces in the pack.

Rotor Laminations

The most efficient way of cutting these out is by trepanning, and tools for this purpose are available, but I have not found the commercial "tank cutter" type of tool very convenient, except possibly for cutting out the sheets one at a time. I prefer to mount the complete pack on the lathe faceplate, and use a parting tool, suitably ground to give adequate side clearance. Assuming that square pieces about 6 in. diameter are used, they can be securely attached to the faceplate by bolts at the four corners, well clear of the outer circle ; a piece of wood or thick card is advisable as a backing, to avoid risk of digging into the faceplate as the tool comes through. The lathe should be run slowly on back gear, and plenty of lubricant, preferably soluble oil or suds, applied to the tool.

Before starting to take a cut—the inner circle, of course, should be cut out first—the circles should be marked out to check dimensions, and the centre-line of the bolting holes also marked. By using indexing gear, such as with a 40-tooth change wheel, counting every fifth tooth, the exact positions of the bolting holes can be marked, and they may even be drilled at the same setting if a drilling spindle is available. This will greatly facilitate accuracy and uniformity in the sets of pole-pieces.

The inner circle may now be trepanned out, cutting slightly inside the lines to allow a little for finishing the pole surfaces after assembly. As each sheet is penetrated, it will fall out, giving more working clearance for the tool on the inside, so that the tendency to jamming, which is often the bugbear of trepanning operations, is very much reduced. The outer circle is then dealt with in the same way, but in this case working exactly to the stated dimensions, so that the ring is a neat push fit in the flywheel rim, as can easily be checked when the first sheet is cut out. Remove the burrs carefully from all the pieces, and using the flywheel as an aligning jig, stack them in place and mark out for cutting the gaps between the poles ; if the magnets are available, they can be used as templates to ensure exact gap dimensions.



H.T. STATOR LAMINATIONS I PACK 3/8" THICK

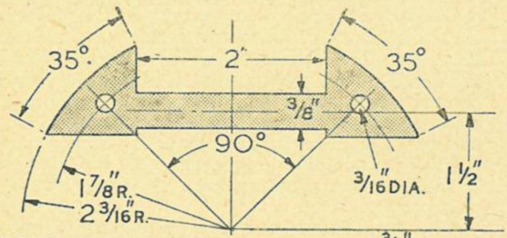
If the marking-out and drilling of the holes is done as advised above, it should be possible to make all the laminations interchangeable, but as a matter of discretion, it is perhaps better to make identification marks on them before separating the poles, in case individual pieces should get

Continued from page 674, "*M.E.*" *November* 20, 1952.

mixed up. The best way to do this is to clamp the set of rings together by temporary screws through three or four of the holes, and with a small saw or a three-cornered file, make distinct cuts on the outside of the ring, marking the poles *obliquely* thus: / — // — /// — ////. This will not only identify the four pole packs but also the locations of individual pieces in each pack; if any piece is out of its proper place, it will make a break in the continuity of the numbering marks.

In cutting out the gaps, it is essential that they should be kept on the tight side, so that no spaces are left when the magnets are fitted. The small projection on the inner edge of the gap is for the purpose of keeping the magnet hard up against the inside of the flywheel rim. This, of course, is ensured by centrifugal force when the engine is running, but in the absence of a retaining device, there is a risk of a magnet becoming loose and falling inwards when it is stationary.

Should magnets of different shape and size to those specified be obtained, they will be quite satisfactory if they are of the correct material,



L.T. STATOR LAMINATIONS 1 PACK 3/8" THICK

similar cross-sectional area, and properly arranged. The angular length of the pole-pieces—namely, 65 deg.—should be maintained by modifying the length of the projections on the pole tips if necessary to compensate for any variation in the length of the magneto. In order to obtain maximum efficiency, it is recommended that the magnets should be assembled in the inert state and magnetised *in situ* after all machining and fitting is completed. A fixture to enable this operation to be carried out in a standard two-pole magnetiser, as used by magneto repair specialists, will be described later.

When the set of magnets and pole-pieces has been assembled, and the cheek plate is put on to hold them in, it will probably be found that there is some discrepancy in thickness between the packs of laminations and the magnets. Test this by screwing the cheek plate down *lightly* and noting any tendency for it to distort, which would indicate that the magnets are "proud" of the laminations. Alternatively, it may be possible to clamp down hard on the latter, while a gap is left over the magnets; this can be checked by feeler gauges. In either case, the difference can be made up by paper of the required thickness; a little shellac or oil varnish may be used to hold the paper in position during assembly.

When the screws securing the assembly are fully tightened—the countersinking of the holes in the cheek plate should be deep enough to sink them in flush with the surface—a centre-punch may be used to throw up a burr into the end of the screw slots, and key them against any tendency to loosen. Finally, the flywheel should be mounted on its mandrel between centres, and the pole faces carefully skimmed—again using slow speed and plenty of lubricant—to ensure that they are exactly concentric.

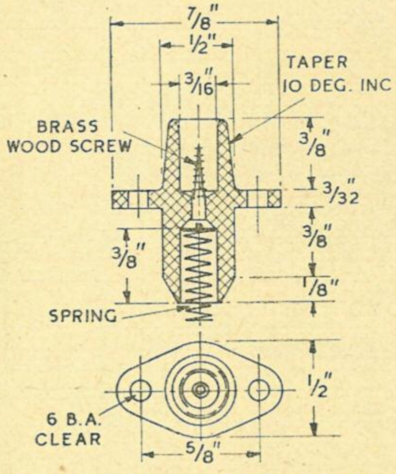
Stator Laminations

In view of the fact that these are located on the backplate by the screws in the bosses, it is clear that the positions of the fixing holes are of vital importance, and other essential dimensions are related from these points. It is advisable, therefore, that marking-out operations should commence by setting out these holes from a centre-point outside the piece, striking arcs at 1⅞ in. radius and intersecting them with radial lines at 90 deg. If the two packs are made from the inner circles produced in the previous operation, it will not be possible to work from the centre, as a certain amount of metal has inevitably been lost in the cut, and the discs would not clean up on the pole faces if this was done; it is thus necessary to work from a point beyond the disc centre in each case. It will however, facilitate matters if centre-lines at right-angles are first scribed across the face of the disc, as these can be used as a guide in ensuring symmetry and correct geometry in the marking-out.

Queries are often received from readers who encounter difficulties in setting out exact angles, and who seem to imagine that expensive instruments are necessary for this work. I would, however, assure them that although this may apply in some cases, a job of this nature can be done quite well with the aid of a cheap protractor of tin or celluloid, which can still be obtained for a few pence at any stationers, or at one of the philanthropic institutions which our American friends describe as "Five-and-tens." These instruments may not be marvels of precision, but they are accurate enough for most marking-out jobs in the home workshop, and I use them quite a lot myself. As a matter of fact, anyone who has really mastered the elements of plane geometry could do this job without a protractor at all, but it would take a good deal longer.

Having marked out the positions of the locating holes, and the radius of the pole faces (2 3/16 in.), the rest of the marking-out is fairly simple. It will be noted that the h.t. and l.t. stator laminations differ only in the angular length of the pole faces, for reasons which have already been explained. The angles embraced by these faces, 25 and 35 deg. respectively, should be adhered to as closely as possible. At a distance of 1½ in. from the centre point, a line is marked to show the centre of the yoke, which is ⅜ in. wide by 2 in. long.

When cutting out these laminations, it is advisable to drill the holes in the set of discs, using the marked one as a jig in all cases, and clamp them all together with four 2-B.A. bolts. Much of the cutting can be done with a hacksaw, but where this is not possible, I recommend drilling a row of holes and joining them up with an Abrafile or a spiral saw. The use of a hammer and chisel is best avoided, as it is almost bound to stretch and distort the metal, making it very difficult to produce a compact flat pack; and the same applies, in some measure, to the use of shears. While the pack is still clamped together, it may be filed up on the outside; it is advisable to leave about $\frac{1}{16}$ in. machining allowance on the pole faces, but the rest of the surfaces may be finished exactly to size. Mark the pack to ensure identification of the individual pieces,



H.T. TERMINAL 1 OFF EBONITE

as before; they can then be separated, and all the burrs removed from the edges.

If the coils are to be wound directly on the cores—a method which is quite convenient for the constructor who does the entire job himself, the pack may be permanently assembled, preferably with one or two iron rivets through the yoke, to keep it together when the screws are removed. These should be filed flush with the surface, and the sharp corners of the yoke taken off. It is also a good idea to varnish the individual laminations and assemble them while still tacky, to help keep the pack in a solid piece under all conditions.

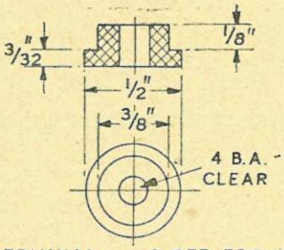
The two stator packs should now be fixed in place on the backplate for machining the pole faces. In the assembly drawing, 2-B.A. screws are shown for securing them; these are quite satisfactory for this purpose, but a more positive location can be obtained by using studs, having a plain central portion which is a dowel fit in the holes of the pack. The backplate is now mounted on a concentric spigot held in the lathe chuck, and the pole faces carefully machined to size, that is, 0.020 in. less over the diameter than the internal size of the rotor pole faces, so that the radial air gap, or running clearance, is 0.010 in.

If the coils are to be separately wound, the stator packs cannot be made in one piece, and, therefore, after they have been located on the backplate and machined, they must be taken off, separated, and each piece cut through with a fine saw about $\frac{1}{4}$ in. from the end of the yoke, the cuts being made at alternate ends so that they are interleaved in the same manner as transformer stampings. This procedure is not necessary for the l.t. stator, which can quite easily be wound on the yoke, even by hand if necessary; but it is possible that the ignition coils may be obtainable as a separate item, ready wound, less core, in which case it is necessary to assemble the stator packs in this way. Before dealing in detail with the windings, however, the other mechanical parts of the magneto can be produced ready for assembly.

H.T. Terminal

This is specified as being made in ebonite, an excellent insulator having a rubber base, which is most likely to be available. There are several other materials equally good or even better for this purpose, including certain grades of bakelite compositions, but unless one is well versed in the science of insulation it is easy to go wrong with these. Do not use vulcanised fibre, which is excellent stuff for many purposes, but not for holding back some 8 to 10 thousand volts! Its chief disadvantage is its liability to absorb moisture, which is fatal for high-voltage work.

The insulator is machined to the dimensions shown, and finished to a high polish—the best method with ebonite is to use plenty of soapy water as a lubricant, with a keen tool having plenty of top rake, and polish it with its own shavings. Do not use oil, which will not only discolour the surface, but also cause the material to perish, in time. The conductor is formed by a brass wood screw, about $\frac{3}{8}$ in. × 1-gauge, screwed in a tightly-fitting hole from the underside. A small coil spring, preferably brass, is fitted below this, the top turn being opened out so that it grips inside the lower socket. The dimensions of the upper socket are arranged to take a $\frac{3}{16}$ in. V.I.R. or P.V.C. high tension lead, which is simply screwed in so that the wood screw penetrates the stranded core, and expands the covering to grip the socket.

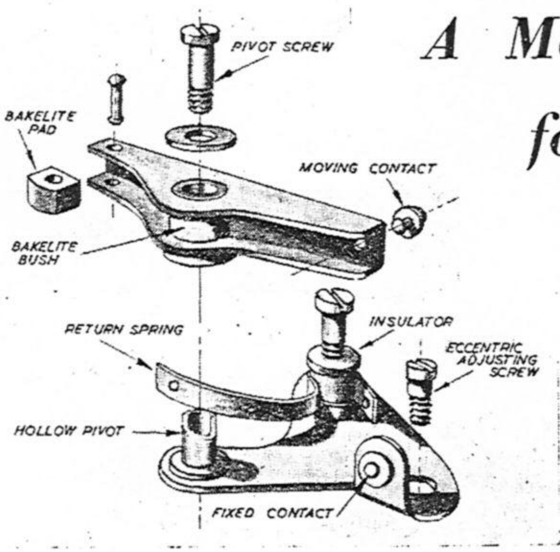


L.T. TERMINAL 2 OFF EBONITE

L.T. Terminal

The actual conductor is a 4-B.A. brass screw, inserted from the inside, and insulated by two bushes as seen in the assembly drawing. As these only deal with low voltage, there is a much wider choice of insulating material, but it should be mechanically strong enough to take the clamping pressure. Vulcanised fibre is quite suitable here. The terminal screw is fitted with plain washers each end and double-nutted outside, ordinary hexagon full nuts being preferable to anything in the nature of special or "fancy" terminal nuts.

(*To be continued*)



A Magneto for the "Busy Bee"

An entirely new design for a flywheel magneto-generator, suitable for all types of small power engines

by Edgar T. Westbury

THE contact-breaker assembly constitutes a complete self-contained unit, having a bracket or mounting plate carrying the stationary contact, and arranged to be adjustably mounted on the magneto backplate. A fixed pillar on this component forms a pivot for the rocker arm, which is insulated from it by a bakelite bush, and the return spring, riveted to the rocker, is also insulated from the bracket, and serves as a flexible conductor to convey low-tension current to the moving contact. The assembly is located in such a position that the bakelite pad on the heel of the rocker rests on the cam surface of the flywheel hub, and is pressed against it by the return spring.

Mounting Plate

This is made in mild-steel plate, $\frac{1}{16}$ in. thick (or 16-gauge) and has a lug bent up at right angles to carry the contact. In marking out, it is advisable to allow a little extra length for the lug, as the bend may not come out to exact dimensions, however carefully one works; and it is also best to mark out and drill the hole for the contact rivet after bending. To avoid possible risk of fracture at the bend, a slight radius should be allowed, and this can be done by using a bending block made from flat steel bar, with one edge smoothly rounded off. Clamp the plate and the block in the vice, with the line of the bend just showing, and form the bend with a wooden or hide mallet. The position of the hole can then be measured from the top surface of the plate, and the top radius of the lug struck from this centre.

The pivot pillar is turned from mild-steel, with a large seating collar, and a spigot to rivet into the plate as shown, the underside of the plate being slightly countersunk, so that the riveting can be filed off flush. Use a block with a 7/32 in. hole drilled in it, to support the *collar* while riveting, so as to avoid risk of damaging the surface of the pillar or the internal hole. Incidentally, if the magneto should be required to run in the reverse direction (i.e., clockwise) it is advisable to make the assembly "left-handed," and change over its position on the magneto backplate.

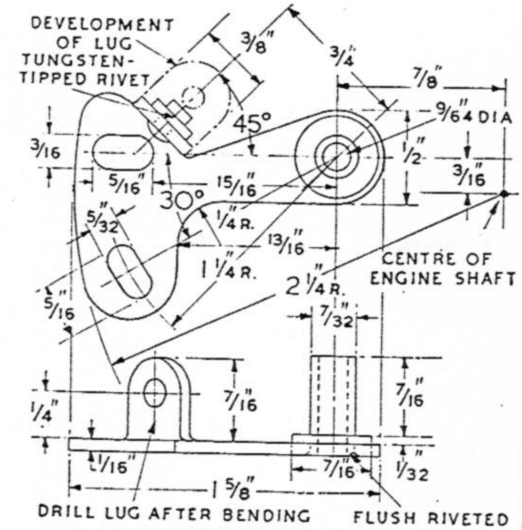
Rocker Arm

The material in this case also is mild-steel, but the thickness is 1/32 in. (or 20-gauge); a piece of the sheet steel used for the laminations may be found quite suitable. It is bent to channel section over a piece of $\frac{1}{4}$ in. flat mild-steel, both edges of which should have the corners slightly rounded off to avoid a dead sharp bend. After marking out and drilling the holes, the edges of the channel may be filed to the contour shown, care being taken to avoid distorting the metal in the process.

Both the bush and the pad should be made of a fine-texture laminated fabric bakelite composition, such as Tufnol or Paxolin. The bush should be made a fairly tight press fit in the rocker, and an *easy* working fit on the pillar. It is advisable to make the pad so that the plane of the laminations is at right angles to the rubbing surface, as this gives maximum resistance to wear; when fixing it in place with the single $\frac{1}{16}$ in. rivet, the latter should be an easy fit in the hole, to avoid risk of bursting the bakelite.

Try the rocker on its pivot to check up the correct alignment of the contacts; it may possibly be found advisable to adjust the thickness of the collar on the pivot bush to get them vertically in line. The radial position on the rocker, relative to the pivot position, may be correctly located by placing a distance piece of suitable thickness (to allow for the contact rivet dimensions) between the rocker and the lug of the mounting plate, and drilling through from the hole in the lug.

Continued from page 737, "M.E.," December 4, 1952.



MOUNTING PLATE 1 OFF M.S.

The size of the hole, in each case, will depend on the shank diameter of the contact rivet. Suitable rivets, having a welded-on tungsten tip, are obtainable in various sizes from ignition equipment specialists; the size most suitable in this case is that having a tip face of about ⅛ in. or 3 mm. diameter. Care must be taken not to damage the tips in riveting; they should be supported on a copper or aluminium block, and not hammered more than is necessary, but a firm hold is essential to avoid risk of imperfect contact.

Return Spring

This should preferably be made from annealed spring steel, and afterwards hardened and tempered, as fully-tempered steel cannot be bent to the shape shown. If, however, this is found difficult, it is permissible to use "half-hard" steel, which is capable of being bent, drilled, and used without further treatment; but in this case the thickness of the material should be increased to 0.020 in. to be on the safe side. The spring should be firmly riveted to the rocker arm, as shown, and a hole is provided in the free end, to take a 6-B.A. bolt for connecting up the l.t. lead to the coil.

Adjusting Screw

For the purpose of adjusting the contact clearance, a screw is provided having an eccentric collar under the head, to fit the slot in the mounting plate, adjacent to the fixed contact. The exact amount of eccentricity is not highly important, and the eccentric can be formed, after turning and screwing the shank, by setting the work over in the four-jaw chuck, or by inserting a slip of packing in one of the jaws of the self-centring chuck. The other two screws call for little comment; ordinary 4-B.A. screws could be used, but the larger and flatter heads shown are an advantage; all three screws fit tapped holes in the magneto backplate.

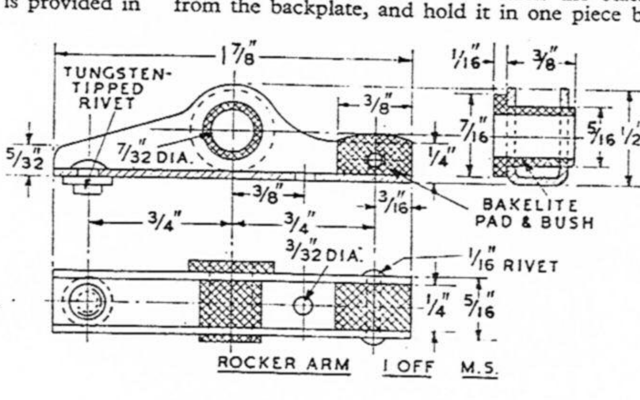
The insulating bush can be made from laminated bakelite, as described above, or vulcanised fibre. It acts not only as an l.t. insulator, but also as a clamping bush, so it must be mechanically sound. The spring is hooked round it, but is not positively fixed to it in any way; the waisted part of the bush, however, provides side location to prevent the spring swivelling on its fixing rivet and possibly "earthing" against the mounting plate.

The assembly drawing shows how the complete breaker is located, relative to the magneto shaft centre. It is best first to mark the position of the pivot, drill and tap the hole, and temporarily clamp the assembly in place, with the magneto backplate mounted on the engine (or temporary test mounting) and the hub on the shaft. Turn the hub so that the rocker pad rests on the concentric surface, and adjust the contact clearance by swinging the mounting plate around its pivot; correct clearance should be 0.010 in. It is now possible to mark the position of the adjusting screw and locking screws through their respective slots; they should be in the centre in each case, to allow latitude of adjustment both ways.

To adjust clearance at any time, it is necessary only to ease off the pivot and locking screws, and turn the eccentric screw as required, to vary the position of the fixed contact relative to that of the rocker; then re-lock the assembly by tightening both the main screws. This, of course, is the method adopted on most modern forms of contact breakers, and will readily be understood by all users.

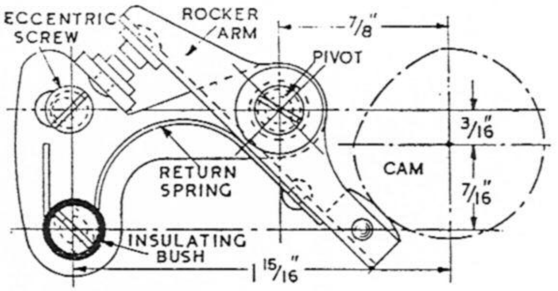
Coil Winding

I do not propose to devote a great deal of space to this subject, as it has been dealt with in minute detail in my series of articles on ignition equipment, and further recorded in the M.E. handbook of the same name. The l.t. stator coil is wound with approximately 500 turns of No. 24 gauge enamel-covered wire; quite an easy job, which could be done by hand if necessary, though it is, of course, desirable to detach the stator from the backplate, and hold it in one piece by

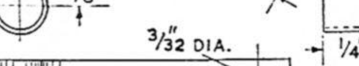


ROCKER ARM 1 OFF M.S.

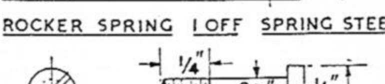
two temporary bolts. After rounding off the corners, a layer of stout paper should be wound on the core, and cemented in place with any non-aqueous and chemically inert adhesive; it is also advisable to fix a paper disc against the shoulders of the core to prevent risk of chafing the wire while it is being wound. Secure the beginning of the first layer with a strip of adhesive tape, or by tying with cotton, to avoid the possibility of it being pulled out afterwards. When the first layer has been wound, the second may follow it straight away if desired, but as there is plenty of room here, I prefer to interleave with a layer of paper, which helps to support the coil mechanically, and also improves insulation. It is, of course, desirable to wind the wire as evenly and closely as possible, to ensure a neat winding and avoid "slipped turns," which are always a nuisance, and may become a menace. The end of the winding should be secured, and the outside of the coil may be well varnished, taped, or otherwise protected; both ends of the wire should have soldered tags, one being "earthed" under the head of the adjacent fixing screw, and the other connected to the l.t. terminal bolt. (If one objects to an "earth return" circuit for the lighting, *both* ends can be connected to insulated terminals, as an alternative.)



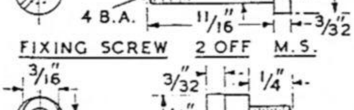
ROCKER SPRING 1 OFF SPRING STEEL



FIXING SCREW 2 OFF M.S.



0·015" ECCENTRIC ADJUSTING SCREW 1 OFF M.S.



INSULATING BUSH 1 OFF BAKELITE

The ignition coil is a rather more difficult proposition; it is possible to wind it in the lathe if care is taken, but it is desirable to fix up some method of counting the turns, and the stator must be mounted to run as truly as possible, either between centres, or on some simple form of jig. Rounding off the corners of the core is very important here, and a layer of paper should be put on as before. The primary consists of three layers of No. 24 gauge enamel-covered wire (about 180-200 turns), and the procedure is much the same as for the l.t. coil, except that as space is very important, interleaving must be dispensed with. It is a very good policy to test the primary winding before proceeding further, because, if there should happen to be a fault, or an "earth" to the core, it is much better to correct it now than to have to scrap the coil after the tedious job of winding the secondary is completed. Any simple test galvanometer, or even a battery and torch bulb, may be used for this check-up. A layer of paper about 0.005 in. thick should be cemented on the primary to form a smooth, even foundation for the fine secondary winding, which consists of approximately 12,000 turns of No. 44 gauge enamel-covered wire, wound in about 40 layers, each interleaved with paper, 0.002 in. thick. The inner end of the secondary is connected, by soldering, to the outer end of the primary.

Very careful handling is necessary in winding this fine wire, and it is advisable to arrange an automatic feed to ensure that it is laid evenly without overriding turns. The size of No. 44 gauge enamelled wire, over the enamel covering, is slightly under 0.004 in., but it is advisable to set the feed a little coarser, say, 0.005 in. per turn, so that a little space is allowed between turns. There should be a ¼ in. margin left at the ends of each layer of wire so that the actual winding is only 1½ in. long, but the paper interleaving should fill the full width of the core space, if anything a little on the tight side.

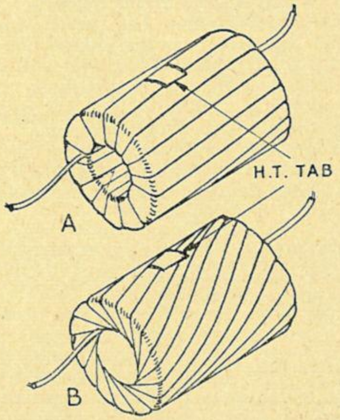
The outer end of the wire should be soldered to a strip of brass or copper foil, which is led out, through further layers of paper, to emerge at a suitable location for the h.t. spring contact when assembled. On no account allow the foil to make a complete *closed* turn, as this would be equivalent to a shorted transformer coil, and destroy efficiency. The entire coil, after a continuity check, should now be thoroughly impregnated with a high-resistance insulating varnish, as described in the handbook referred to above. This is the most important job of all in producing an efficient and permanently reliable coil.

(To be continued

A Magneto for the "Busy Bee"

by Edgar T. Westbury

AFTER the coil has been properly impregnated, and dried off at the temperature recommended for the particular varnish used, it should be given a spark test before final assembly in the magneto. A simple but efficient " hook-up " for coil testing is described in the handbook *Ignition Equipment*, in which a 4-volt accumulator is used as a source of current, and a coarse



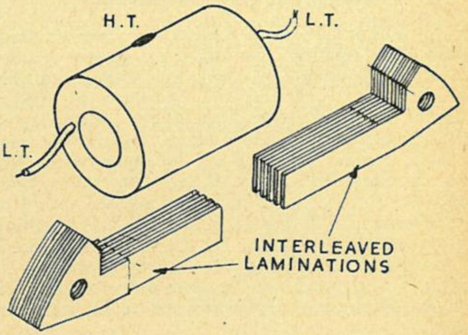
file is used to serve the purpose of a contact-breaker. The " live " side of the primary winding is attached to one terminal of the battery, and the " earth " side to the file. A probe, or a large nail, is connected to the second battery terminal, and the condenser which is to be used in the magneto is connected between this and the file. By rubbing the probe along the file, contact is rapidly made and broken, and under these conditions, it should be possible to obtain a $\frac{3}{16}$-in. spark between the h.t. tab of the coil and a conductor " earthed " to the file. Do not be tempted to use a larger gap at this stage, just to see how big a spark can be obtained ; and above all, do not attempt to apply the spark test *before* the coil is impregnated, or it will probably give one or two half-hearted sparks and then break down internally. In the case of a separately-wound coil, it will be necessary either to fit the interleaved core in place, or to pack it with a bundle of laminations or iron wires, in order to make the test.

Although the coil, when impregnated, should be practically solid and waterproof, some further covering, hermetically sealed against the entry of moisture, is necessary both for mechanical protection and extra insulation. From experience, I have found that the use of a bakelite tube, with end pieces cemented in, is very difficulty to improve upon, but a more common practice nowadays is to tape the coil, which is perfectly satisfactory if all joints are properly sealed with varnish afterwards. This treatment can be applied either to pre-wound or wound-on-core coils equally well.

The tape most commonly used for ordinary electrical work, such as armature or field coils of motors and generators, is usually already varnished, but this, in my experience, is not so suitable for the present purpose as " raw " (untreated) cotton or linen tape with " deckle edges," i.e. cut diagonally and without a selvedge, about $\frac{1}{4}$ in. to $\frac{3}{8}$ in. wide.

The usual method of taping a coil, shown at *A* in the drawing, is obviously inapplicable to coils wound directly on the core, but the method shown at *B* can be used for either this or separately wound coils. It will be seen that the tape passes diagonally, or more correctly spirally, around the coil, cuts across the chord at the ends, and returns in a spiral of the reverse hand on the other side. For either kind of taping, the tape must obviously be narrow and have " edge flexibility " to lay evenly, without puckers. The l.t. wires (which should be sleeved) and the h.t. strip, are brought out through the taping as shown. Finally, the coil is sealed by dipping in varnish and drying out under moderate heat, several times if necessary, till an impervious coating is obtained.

The method of assembling a separately-wound coil on a divided core is also shown, and requires little explanation. It is desirable to coat the lamina-



tions with tacky varnish, and to assemble them one at a time, in their correct order, short on the right and long on the left, then long on the right and short on the left, and so on. The fixing holes are lined up by pushing a taper rod through them, prior to assembling the complete stator on the backplate. Any slackness between the coil and stator, when in position, should be taken up by thin slips or wedges of fibre or bakelite, fitted as tightly as possible, and cemented in place, on each side of the core. Soldered tags, and P.V.C. or Systoflex sleeving, should be fitted to the connecting leads.

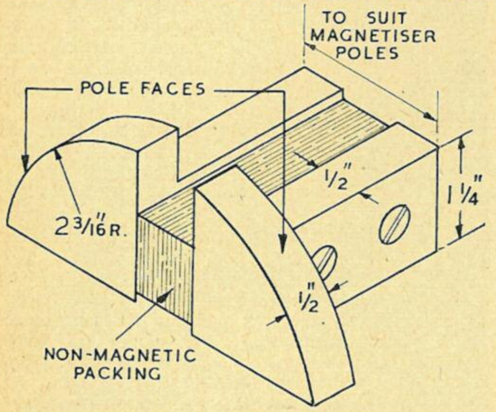
Connecting up the magneto is very simple, the

Continued from page 815, " *M.E.*," *December* 18, 1952.

inner end of the primary being earthed to the nearest screw, as in the case of the l.t. coil, while the combined OP-IS lead is taken to the contact-breaker spring, and also to the "live" side of the condenser. The latter, it should be mentioned, is the smallest automobile standard type, as made by all leading manufacturers, such as Lucas, Delco-Remy, Remax, etc., and it is secured to the backplate by a clip with a single screw, on the opposite side to the contact-breaker; a good electrical contact is essential.

Timing the Contact-Breaker

The magneto is assembled on the engine or test rig, less the flywheel, and the hub placed on the shaft; then the hub is turned in the direction of rotation, to the position where the points are just about to break; that is, when the resistance of the rocker spring begins to be felt. Next, the flywheel is placed on the spigot of the hub, and located so that the h.t. stator poles just



bridge the gaps of the rotor poles. Without moving the hub, the flywheel is turned, still in the same direction as the engine rotation, for a further 15 deg.; this is the position where it should be permanently fixed to the hub. It is, however, advisable first to *clamp* the flywheel to the hub, which can easily be done by using the extractor, with a thick washer under the head, to bear on the flywheel face. This will enable a test to be made before final fixing, the reason for this being that the exact optimum position of the break, relative to the magnet poles, varies slightly according to the magnetic properties of the iron in the pole pieces, and also the flux density of the circuit. When this point is finally settled, the flywheel may be fixed with rivets, or alternatively, with set screws having shakeproof washers under the head.

It should be noted that this process locates the position of the rotor and stator poles, relative to the breaking of the contact points, in order to obtain the maximum spark efficiency, and has nothing to do with *timing the spark*, relative to the position of the engine piston or crank. This is carried out in the usual way, by shifting the entire hub and flywheel assembly on the shaft, so that the break occurs at the specified time, that is, 20 to 25 deg. before top dead centre for the "Busy Bee" engine. The above instructions hold good for either direction of engine rotation.

Magnetising

As previously mentioned, this should preferably be done *after* the assembly is complete. Few people will have access to a suitable four-pole magnetiser, but most ignition repair shops have one of the two-pole type, adapted to take an ordinary magneto between its pole pieces, which are adjustable for width, and this can be adapted to magnetise a four-pole magnet by the use of a simple jig as shown. This can be made of mild steel or wrought iron, with solid or built-up limbs, and a non-magnetic packing piece of wood, fibre, brass or aluminium sandwiched between.

The poles should be arbitrarily marked 1,2,3,4, (pencil or chalk will suffice), and with the jig between the magnetiser poles, the curved shoes overhanging to one side, the flywheel is placed on it with poles 1 and 2 uppermost, and the current switched on for a brief "flash." It is then turned 180 deg., to bring poles 3 and 4 uppermost, and the process repeated. Then the jig is reversed in the magnetiser, so that the pole shoes overhang at the other side, and similar treatment applied to 2 and 3, then 4 and 1. This will ensure that all four of the magnets are equally saturated.

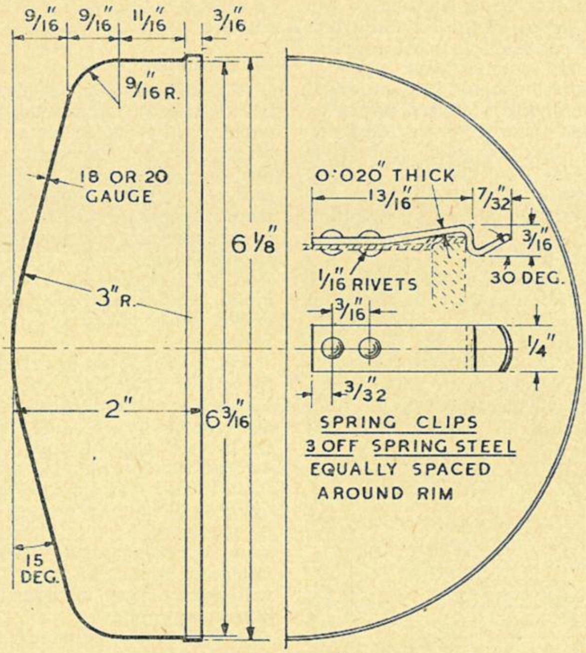
In commercial practice, a four-pole magnetiser, capable of dealing with the set of rotor poles simultaneously, would no doubt be employed. But in any case, it is most important that the magnetiser should be efficient, as the superior qualities of modern magnet steels cannot be obtained unless they are saturated to their maximum flux density.

Magneto Cover

This is not shown or indicated in the general arrangement drawings, but it is an obviously desirable, if not essential fitting, not only to protect the magneto from rain and dirt, but also to prevent the rider's clothing from getting caught up in the works. A cover is a standard fitting on the commercial magnetos used on cycle engines, but while the cover itself is quite sound, the method of fixing often leaves much to be desired. I have seen many of these engines on the road *minus* magneto covers; the latter, no doubt, are now serving in roadside cottages as extemporised crocus bowls, or as morions for juvenile Elizabethan pikemen!

The cover shown can be made by the methods best suited to the skill and facilities of the individual constructor, such as spinning, beating, or fabrication. I favour the former method, because it is the easiest, and usually produces the most accurate and neatest result, if one learns to master the technique. The shape can be formed on a hardwood former, by the methods which were described for the "Busy Bee" tank ends, though as the "draw" is much deeper, it will be rather more difficult, and call for several more annealings. Although 20 gauge material gives ample strength, most workers will probably find the thicker material easier to work where deep drawing is required.

The spring clips can be made from the "half hard " spring steel as described for the contact-breaker, which will bend to the shape shown without annealing if care is taken. Only a very slight " set " should be given to the long portion of the spring, so that it bears on the rim when riveted, and will snap firmly into place over the magneto back-plate. If more positive security is required, it is possible to fit a bolt and nut in place of the second rivet, shifting its position as close as possible to the rim ; the nut is tightened when the cover is in place, and holds the clip more firmly than is possible with its natural spring.



MAGNETO COVER 1 OFF ALUM^NM· OR COPPER

A magneto constructed in accordance with this design and these instructions will give efficient and trouble-free service both for ignition and lighting, over a very long period, on any small engine. If the coils are properly protected as specified, there is practically nothing to go wrong, and I have made long tests with the experimental types, with quite satisfactory results. Some readers may object to the size of the magneto, which is larger than some commercial types, but this is a deliberate policy, with the intention of promoting reliability and simple construction. It *could* have been made considerably smaller, but constructors with no special experience of coil winding would find it very difficult to wind efficient and reliable coils in the smaller size. As with the " Atomag Minor " and other magnetos I have described, I have allowed ample margins to cover various imperfections and spots of bother which may crop up ; and the many readers who have constructed these magnetos successfully will bear me out as to the soundness of this policy.

I have been asked for advice on running the " Busy Bee " on battery and coil ignition, or alternatively, on fitting a low-tension magneto to supply current to an ignition coil. While I have always believed and maintained that there is nothing to beat a good high-tension magneto, there is no doubt that battery ignition is perfectly satisfactory and reliable if properly carried out. Be sure to use a *really* good coil, and a battery of ample current capacity—not a 1 oz. coil with a Penlite dry cell ! The contact-breaker can be of the type described for this magneto, and operated by a cam on the flywheel hub in the same way. It is also possible to convert this magneto to a low-tension type by using *two* low-tension stators and coils, and connecting them in parallel to double the current output. As low-tension machines are often poor in performance at low r.p.m., starting voltage might be boosted by temporarily switching the coils into series, so long as the lighting circuit is disconnected at the time.

Our Business is Humming !

At this season, it is appropriate to acknowledge and reciprocate the greetings of many " Busy Bee-keepers," some of whom seem to have exhausted the apiarist's glossary in eulogising the engines they have built. It has been described as " a real worker," and " no drone," but the prize goes to a Transatlantic constructor, who remarks in his native picturesque idiom, " Boy, the Busy Bee sure is a HONEY ! "

The Lost Chord

(*Continued from page* 825)

Then Mr. Hockington made a few witty remarks, commending Joy and Alice for readily stepping into the breach—" I'd better not say breeches," he added, amid loud laughter—and for their skill in beating his engine by a short head. Joy made a suitable response, but a note of sadness in her voice was manifest to all ; and as the diners left the hall, Sir Roy took his daughter's arm and drew her aside. " Did you—was it——" he began.

" Yes," said Joy. " Just south of Kilsby Tunnel—the ' Lost Chord '—the voice of Curly."