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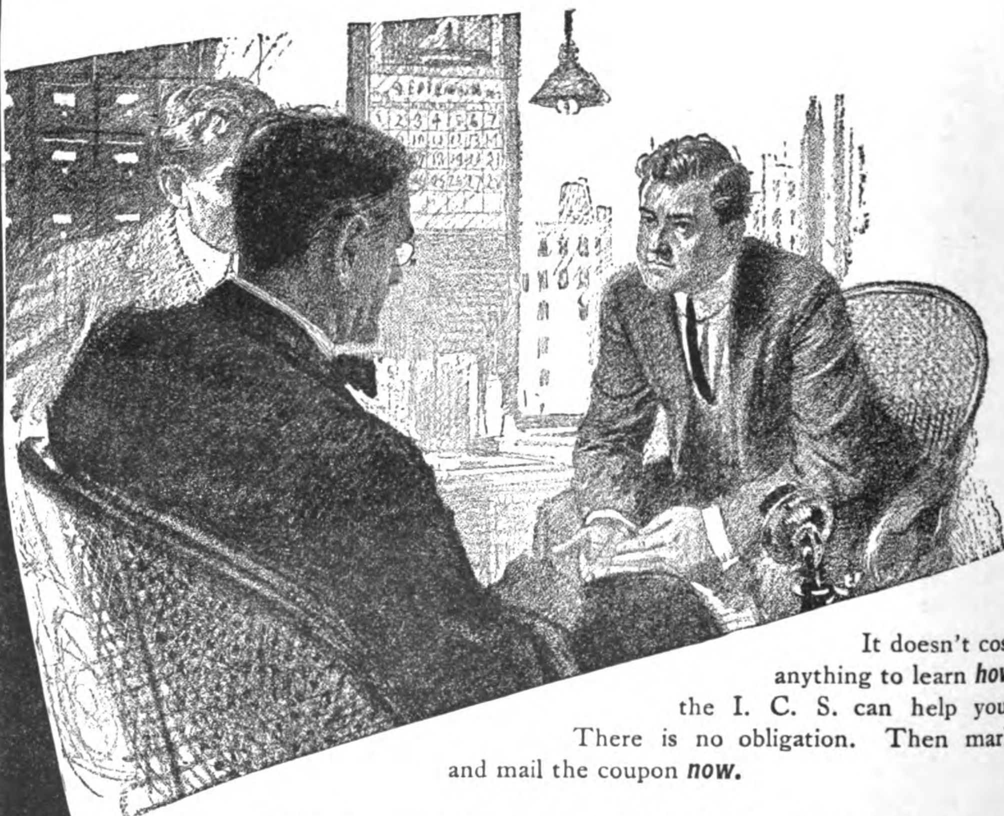
APRIL
1913

PUBLISHED MONTHLY BY
SAMPSON PUBLISHING COMPANY
BOSTON MASSACHUSETTS



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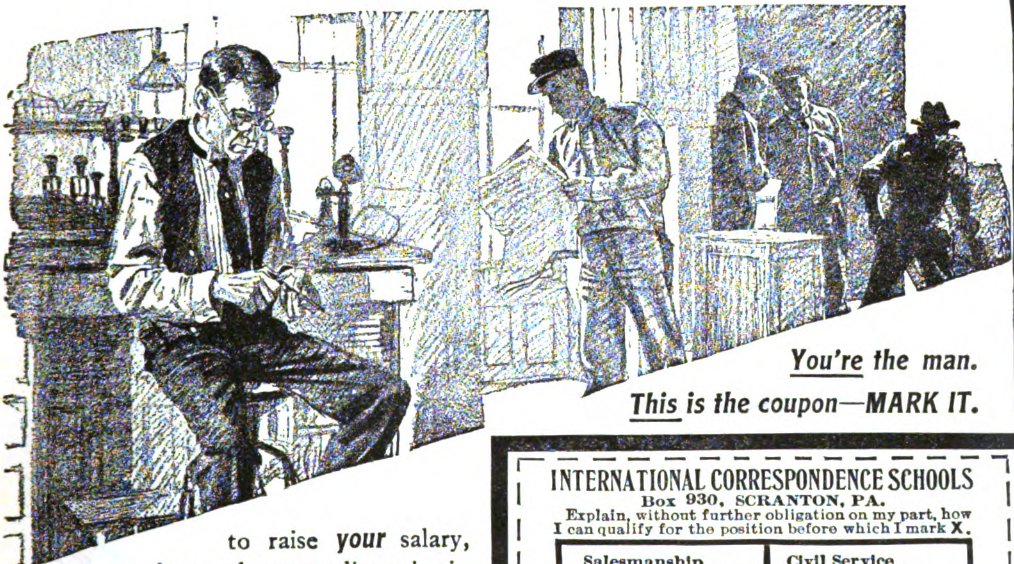

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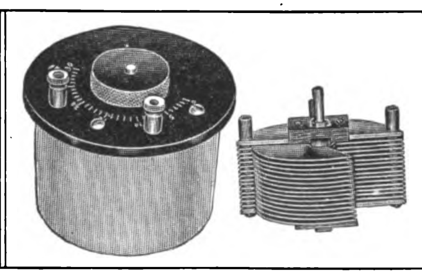

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Published monthly by the SAMPSON PUBLISHING CO., Boston, Mass.

F. R. Fraprie, M.Sc.Chem.F.R.P.S.; A. E. Watson, E.E., Ph.D.; M. O. Sampson, *Editors*

SUBSCRIPTION, IN ADVANCE, $1.50 PER YEAR, in the United States and dependencies, and Mexico. In Canada $1.85. Other Countries, $2.10. Single Copies, 15 cents. Subscribers wishing to have their addresses changed must give both old and new addresses. Notice of change of address must reach us by the first of the month to affect the number for the month following.

Advertising rates on application. Last Form closes on the first of the month preceding date of publication. Contributions on any branch of electrical or mechanical science, especially practical working directions with drawings or photographs are solicited. No manuscript returned unless postage is enclosed. All communications should be addressed SAMPSON PUBLISHING CO., 221 Columbus Ave., Boston, Mass.

ELECTRICIAN AND MECHANIC may be obtained from all newsdealers and branches of the American News Co.

Entered as Second-class Matter July 13, 1906, at the Post Office at Boston, Mass., under the Act of Congress of March 3, 1879

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ELECTRICIAN & MECHANIC

VOLUME XXVI APRIL, 1913 NUMBER 4

BENCH DRILL PRESS

LA ROSS VANDLING

It will be noticed in the construction of this machine that the counter shaft is independent of the base of the drill. This style of belting gives a more steady motion to the spindle and overcomes jars and jerks caused by unevenness of the belt. By running the belt moderately loose the strain of the belt is never on the spindle. Fig. 1 is the assembled machine. *A* is the feed lever, held to drill yoke by links *B*. The lug *C* is cast to the yoke to connect links. The spring *D* is attached to lever *A* and yoke *G* by means of two small eye-bolts. Two idler pulleys *E* run on shaft (not shown), secured and held in position by washer *F*. The drive pulley *H* and cone *J* are secured to drive shaft in bearing bracket *I*. Bracket *I* is screwed to base *S* with four 12-24 fillister head screws. The drill yoke *G* and base *S* are babbitted to standard *R* and held rigid with two setscrews in each boss. The standard *R* has a ½ in. hole tapped in the lower end for securing to bench. The arm *Q* slides on standard *R* and is secured by clamping bolt. The table *P* turns on arm *Q* and is also held rigid by clamping bolt. Spindle *O* runs in bearings *L* and *N* through pulley *M*. Pulley *M* has small key upon which spindle slides and is given rotary motion. The sleeve *K* is held to lever *A* by hardened pin. Two small set screws with hardened points are screwed partly through sleeve *K* into groove cut in spindle. The pins return lever to position when pressure is taken off of handle, assisted by spring *D*. A small fiber washer is placed between spindle and bottom of hole in sleeve. This washer is kept well oiled, as when in drilling the pressure is on the end of spindle and washer. The drill end of spindle is to be fitted to the drill chuck, which latter can be purchased at almost any price —$3.00 to $5.00. Get one capacity of 0-¼ in. While this range, 0-¼ in., is not the drill's maximum, it is well not to go beyond it, as the speed that the press requires for the smaller drills would prove disastrous for larger ones.

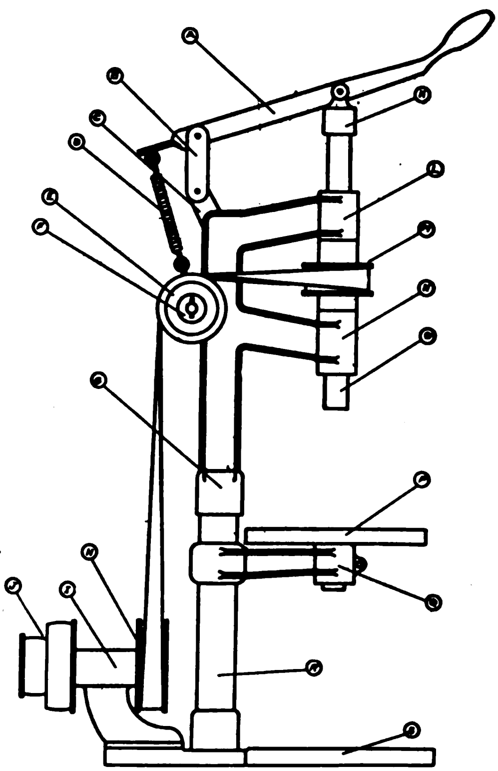


Fig. 1

The castings from Fig. 2 to Fig. 6 are all of iron and patterns will be required for these, as well as for Fig. 9 to Fig. 12 inclusive. Great care should be exercised in placing cores in Figs. 2, 3, and 4, as room for ⅛ in. of Babbitt-metal

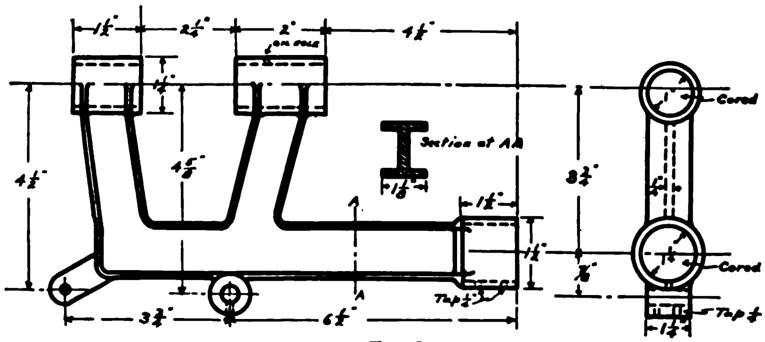


Fig. 2

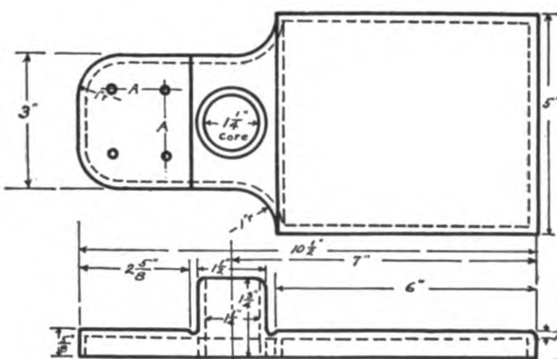


Fig. 3

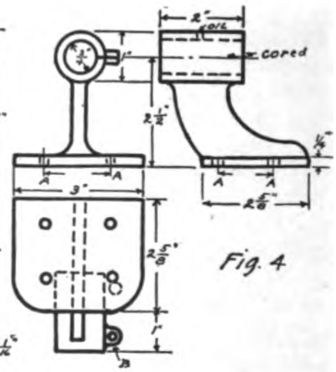


Fig. 4

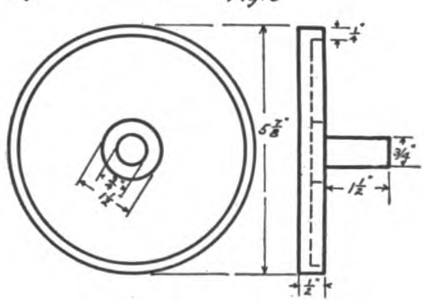


Fig. 5

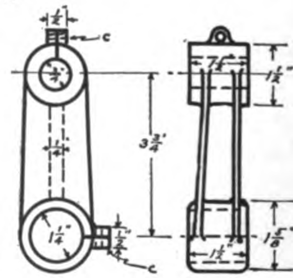


Fig. 6

should be provided, and if in the patterns the core prints are carelessly placed, the castings will not "line up." There is very little machine work on Fig. 2, the ends of the boss for the idler pulleys and slot for feed lever links being all that is required, and this can be done with a file, but care should be taken to get both sides parallel. Fig. 3 is the base and is faced top and bottom. The top of boss has just enough stock taken off to make it straight with the planed surfaces of the base plate. Fig. 4 is faced on each end of the boss and on bottom which sets on base. Four holes are drilled, a body fit for 12-24 screws. Fig. 5 is the table and is finished all over. Fig. 6 is the reach arm and has the two holes drilled and reamed. It is then split through clamping lugs, and clamping bolts made and put in place at *C-C*. Fig. 7 is the spindle, the distances at *C* and *D* are not determined until machine is being erected. Fig. 8 is the standard and is made from a piece of 1¼ in. cold drawn steel, centered perfectly true and the ends turned down. The pulleys are turned and cut within as shown by dotted lines to decrease weight, flanges being turned about 1-16 in. thick and face of pulleys given a good crown. In making pulleys, do not forget the one for the counter shaft. The sleeve, Fig. 15, is turned from brass and is good fit on the spindle.

ERECTING

In these instructions for erecting, reference will be made to Fig. 1 unless otherwise noted. After necessary holes have been drilled and tapped for bearing bracket *I*, place the base on a level part of the bench and place the long end of standard in the cored hole of the boss. Line the standard perfectly true with the planed surface of the base, insert the set screws until they just touch the end of standard. Having secured it in true alignment by means of clamps, turn it upside down, and having sealed up all cracks with putty or clay, pour babbitt in the space between standard and boss. Now set it in its original position and tighten up set screws. It would be best to file a flat place on the standard where the set screws come in contact, blind set screws being used for this purpose, as they give a better appearance. Now take the yoke casting and babbitt it in the spindle. To do this, place the pulley *M* on the spindle *O* and see that there is 1-16 in. space between the pulley hub and bearings on each end. This space becomes filled up with babbitt in pouring, and acts as thrust surfaces for the pulley *M*. In babbitting this the spindle should be flush with the top bearing and the long end towards the base of the machine. It is best not to use the spindle for this operation, as the keyway may give some trouble in babbitting. Before placing in position to babbitt, give the ¾ piece a good coating of white lead, as this will help greatly when removing it from the

Fig. 7

Fig. 8

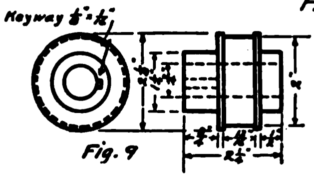


Fig. 9

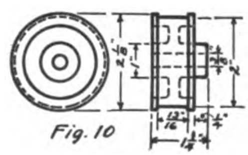


Fig. 10

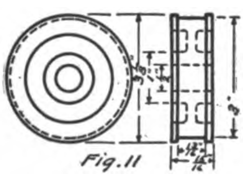


Fig. 11

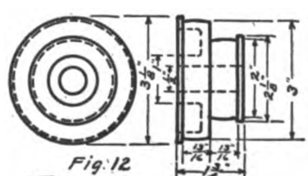


Fig. 12

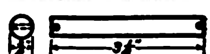


Fig. 13

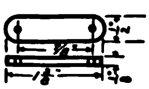


Fig. 14

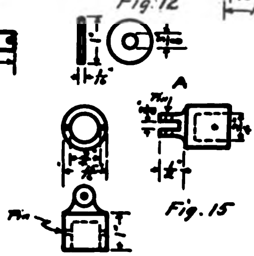


Fig. 15

Fig. 16

yoke. After drilling the necessary holes for pouring, also a vent hole, seal up as in the above mentioned case and pour in the babbitt. Now do not remove, the ¾ in. arbor for the present, but leave it in the yoke. Now place the arm *Q* permanently on the standard *R*, and clamp it to standard in a central position with the base. Insert the ¾ in. piece that is still in the yoke in the remaining hole in *Q*. Bring it down in position and evenly divide the clearance of hole in the yoke and the standard. When this is accomplished tighten the set screws in the yoke against standard end, tighten clamping bolts on *Q*, seal and babbitt. Tighten up set screws and remove ¾ piece in yoke. Be careful that the casting is not sprung in doing this, as you will find the rod pretty tight in bearings. Work it out a little at a time by means of a lathe dog attached to one end and worked out by twisting. Babbitt up the bracket *I* and screw in position. The shaft for this bearing is not on the drawings, an ordinary piece of the required size of steel is all that is needed. Drill an oil hole in bearing, place the pulleys on shaft and secure with set screws. Screw the bracket on the drill base and the lower part of the machine is completed.

Place the shaft for the idler pulleys, Fig. 13, in the boss on the yoke and secure with two set screws. The pulleys are a running fit on this shaft, and have a washer and pin on one side. Washer is shown as *A* Fig. 13. Do not forget to drill an oil hole in each pulley. Get a good running fit in the spindle bearings, and have the keyway cut in spindle in such a manner that when spindle is at its highest position there will be 1 in. of keyway in the pulley and 2 in. on the feed lever end of spindle. Get a good sliding fit on the key in the pulley. This key is held in pulley by two small screws. The feed lever parts are now to be connected and the machine is now ready for use. Some of the friction on the feed end of the spindle can be eliminated by substituting a pivot for the washer joint, or one that is still more elaborate having ball bearings and two hardened collars between the sleeve and spindle. Though more expensive at first, this method of caring for the thrust will pay in the end.

The groove cut in the end of spindle is 1-16 in. x 1-16 in. and is V shape and the screws that run in this groove are placed in such a manner that no pressure whatever comes on them, their only purpose being to assist in returning the feed lever to its upright position.

Now by giving the castings a good painting of flat black you have a machine that is good looking as well as very sensitive and accurate enough for almost any class of small drilling.

A stud is screwed in the tapped end of standard, long enough to reach through bench and give room for a nut and washer. Be sure that the base is setting on a level surface before tightening to the bench. As in the installation of all small machinery, it is preferable to place the counter shaft under the bench and use a long belt. In this machine the pulleys are for a ¾ in. single flat belt. Do not attempt to sew this belt, but make a good scarfed and glued joint, and before putting on belts give them a good dressing of castor oil to make them pliable and take out the natural stiffness.

Fire Engine Used to Thaw Cable Ducts

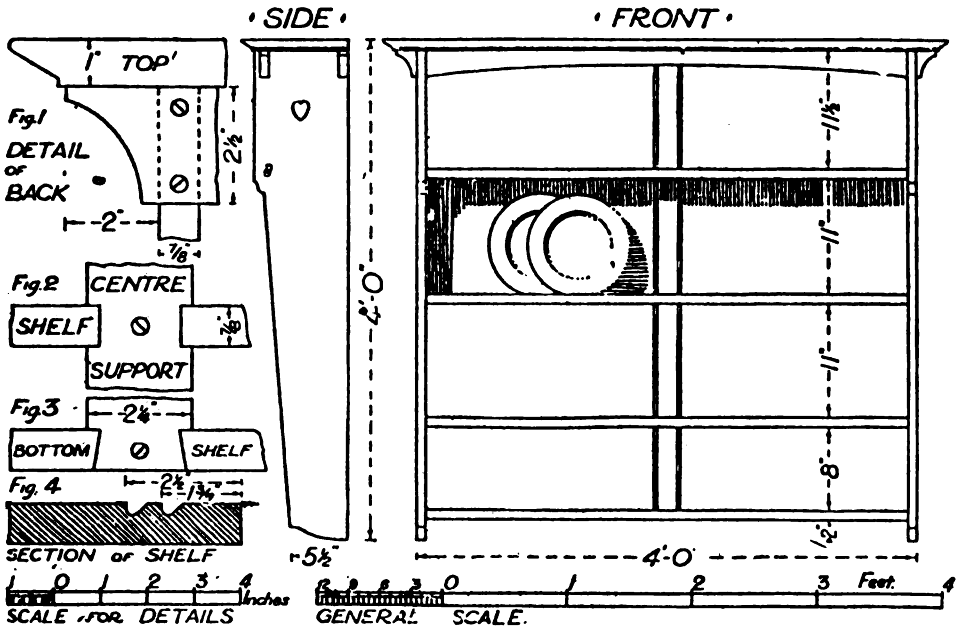
In a western city last winter it became necessary to pull some cable from a dozen blocks of underground duct which had frozen up as a result of the severe weather. The old cable was in cement-lined conduit which had been in the ground for a number of years and was badly out of alignment. Mud and water had collected in the depressions and, solidifying, held the cable fast. Several methods of melting the ice were suggested, the first plan proposed being that of sending a heavy current through the cable and sheath. It was feared, however, that the lead covering might be damaged by this procedure, so that the use of steam heat to melt the ice was decided upon. A fire engine was borrowed from the city department and stationed over the first manhole outlet, a hose from its steam line being led directly into the cable duct. With this equipment an average of a 300-ft. block was freed each day, so that the job was completed in about ten days. The engine was moved from day to day, the old cable being pulled out as rapidly as the ice was melted and new conductor drawn in in its place.—*Electrical World*.

A SIMPLE HANGING DRESSER

P. R. GREEN

The accompanying drawings show a design for a simple hanging dresser of elementary construction. Although it does not offer the accommodation usually provided in the serviceable but rather ugly kitchen dresser, yet it will be found to be a useful substitute in cases where the erection of the ordinary type of dresser is impracticable by reasons of economy and space. If constructed of 1 in. prepared deal, or of whitewood, it may be painted and finished in white enamel, or, as an alternative, staining dark bronze green and varnishing gives a pleasing finish.

the sides. Fig. 1 shows how the back rail is screwed flush to the back edges of the sides. The same figure shows a detail of the solid molded top which finishes 4 ft. 6½ in. by 10¼ in. by 1 in., and is secured by screwing down to both the rails and the sides. A 2¼ in. by ⅝ in. center support is notched and screwed into the back edges of the three upper shelves, as indicated at Fig. 2, and a dovetail joint is used at the bottom shelf, Fig. 3. The center support is also halved and screwed to the back rail and to the back edge of the top.



The front and side elevations show clearly the main dimensions and construction. Two sides, each 3 ft. 11 in. by 9 in. by ⅞ in., are diminished to 5½ in. wide at the lower ends, and housed (preferably with stopped dovetail grooves) to receive the four shelves, spaced as indicated on the front view. The sides are connected at the top by two curved rails, each 4 ft. 4 in. by 2½ in. by ⅞ in., the ends of which project 2 in. beyond the sides, the front rail being set back ½ in. from the front, and either nailed or screwed and neatly plugged to

Fig. 4 gives a detail of the grooves that are ploughed in the shelves to prevent the plates from slipping forward, this arrangement being neater than the somewhat clumsy method of nailing fillets. Two grooves are shown, to accommodate different sized plates, but in the bottom shelf the back groove only need be cut. The grooves are easily worked by ploughing from the back edge and finishing with round plane to a depth of about ¼ in. The dresser should be fixed with the top about 6 ft. 9 in. high.—*Carpenter and Builder.*

MECHANICAL DRAWING

P. LEROY FLANSBURG L. BONVOULOIR

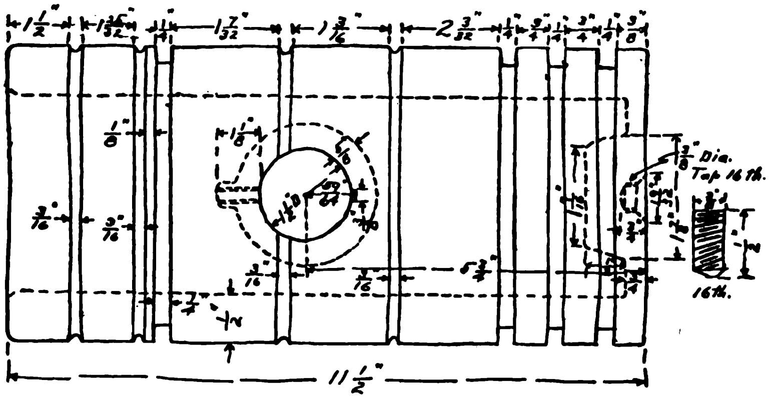
SKETCHING EXERCISES

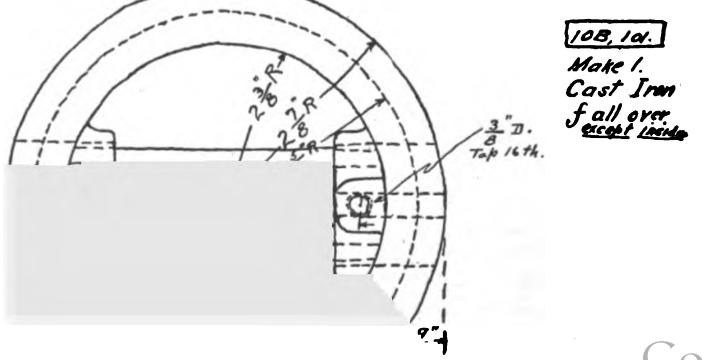
Fully Dimensioned Details

Generally, the objects of which drawings are to be made are located some little distance from the drawing room, and for this reason the ability to make quickly a neat, freehand sketch is one of the most important requirements of a draftsman. Not only must the sketch show all of the details of the object, but it must also be fully dimensioned in order that all subsequent work may be made entirely from the sketch. Since it is possible to acquire skill in freehand sketching only by persistent practice, it is best to do all machine sketching strictly freehand.

In making a drawing from a sketch an accurate idea is obtained as to the actual shape of the object, and the increased ease and facility with which a drawing can be read more than compensates for the additional labor required. This is especially true in the case of a complicated object.

It is best to always sketch such views





of the object as will give the greatest amount of information.

When it is desired to show the internal structure of some object or mechanism it is often necessary to pass one or more imaginary planes through the object at the desired place and then construct a view which will show the object as it would appear if all that part of the object in front of the plane or planes was removed. Such planes are called section planes and are quite largely used in Mechanical Drawing. An example of their use is in the case of the sketch or drawing of a symmetrical piece. In this case, it is of no advantage to sketch both halves alike, since the duplication of the work gives no added information. Instead, one-half of the object may be sketched as an outside view, while the other half of the object may be shown in section. The outside view of the object may be with or without dotted outlines or partial sections which show some internal part not elsewhere shown. The sectional view will always be so taken to give the maximum amount of information regarding the internal construction of the object.

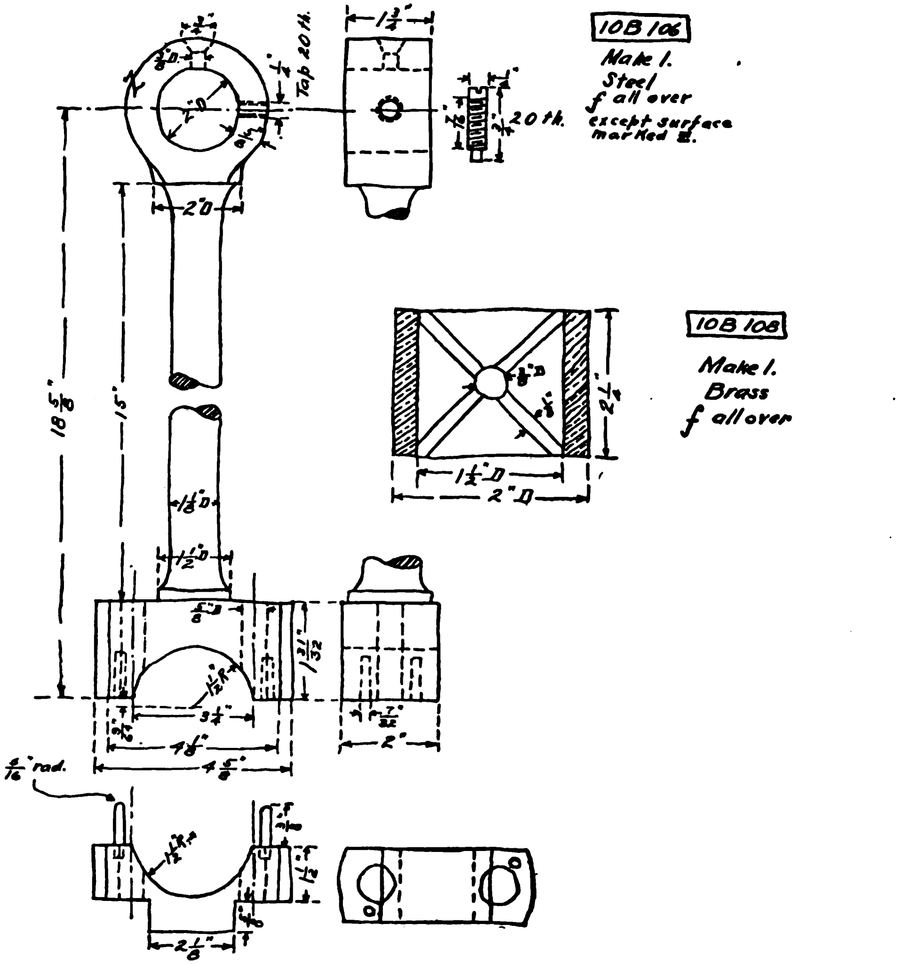


Fig. 2

All lines used in freehand sketching, both curved and straight, should be continuous, comparatively smooth, and distinct.

When more than one set of views of an object are placed upon one sheet of paper, they should all be so arranged as to be read with the paper in the same position. All views must be made sufficiently large as to permit of complete, readable di-

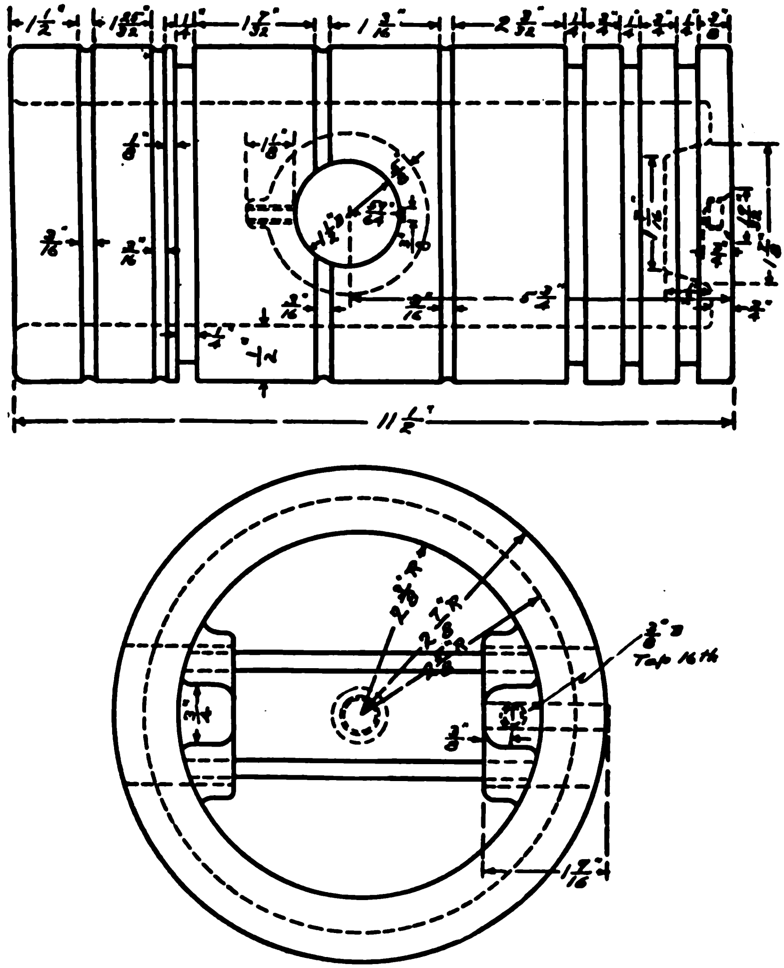


Fig. 3

mensioning, and each piece and part of the object must be sketched separately.

It is always best to draw center-lines whenever possible; and this applies not only to complete views, but equally so to every symmetrical portion of every view.

After making a sketch the object sketched should be considered with reference to finished surfaces, and such surfaces are indicated on the sketch by placing a small letter *f* across each line, which represents a finished surface in the view of the object where this surface appears as an edge.

In dimensioning a sketch, always give a complete series of successive dimensions and also the over all dimension for the series. Never measure a dimension from an unfinished surface, and if it is impossible to give a dimension which can be taken directly, be sure to record all dimensions from which the required dimension has been calculated.

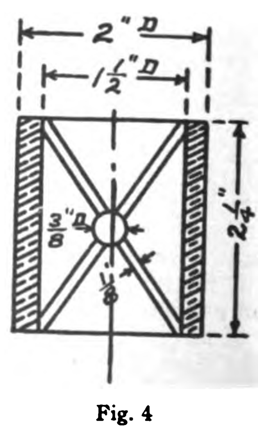


Fig. 4

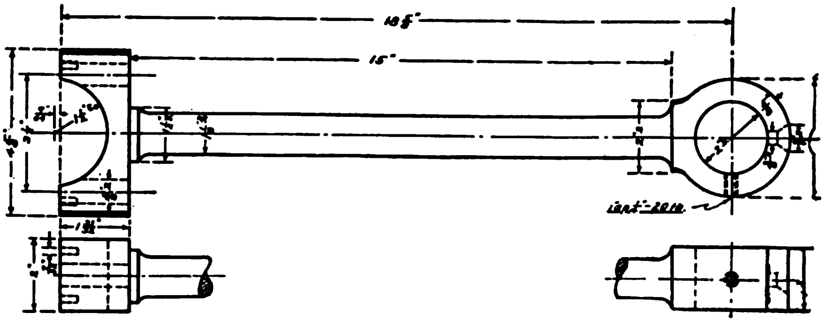


Fig. 5

The drawings which accompany this article will give some idea both of sketching and of detailing.

Fig. 1 is a sketch of a gas engine piston, showing the location and size of the piston ring grooves, oil grooves, etc. No attempt has been made to draw absolutely straight lines and the drawing is a good example of the type of work met in actual practice. It will be noticed that in dimensioning arcs the dimension is followed by the letter *R*, showing that the dimension is a radius. In the case of a tapped hole the size of the drilled hole and also the number of threads per inch on the tap are given. A small table is placed at one side of the drawing, and this contains any information which may be desired about the object.

Fig. 2 is another sketch, and one which shows some interesting points. It should be noticed that when cylindrical surfaces are shown without end views, the letter *D* or the abbreviation *Dia.* follows the dimension figures. 10*B*, 108 shows a sectional view of a brass bushing.

After making the sketch of the object, the next thing to do is to make a detail drawing from the sketch. This drawing should be scaled, and after the pencil drawing is completed a tracing should be made of the drawing.

Figs. 3, 4, 5 and 6 are detail drawings.

When the detail drawings have been completed they are used in making an "assembly." An "assembly" is a drawing which shows the completed object or mechanism, and these drawings will be described in the next issue of the *Electrician and Mechanic.*

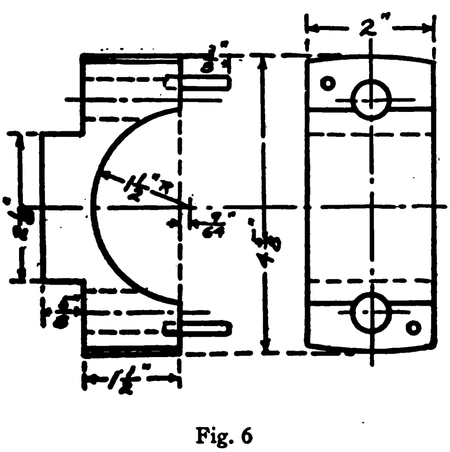


Fig. 6

Aluminium Paint

The following, taken from *Mechanical World*, may be of use to some readers requiring to mix their own aluminium paint. It is made from powdered aluminium, and contains about 91 per cent. of metallic aluminium, 6 per cent. of aluminium oxide, 1.5 per cent. of silica, and 1 per cent. of water. The powder is made by forcing gas or air under pressure into the molten metal at the time of setting, this being accompanied by vigorous mechanical stirring. The granulated metal thus formed is partly oxidized, and is easily pulverized in stamp mills, after which it is run through sieves and then polished in polishing mills. The powder is then mixed with a varnish of the following composition: Turpentine, 1.5 gal.; palest copal varnish, 0.5 gal.; palest terebine, 4 oz.; magnesium carbonate, 4 oz. The magnesia is allowed to settle, and the clear varnish is then drawn off. About 2 lb. of powder are mixed with 1 gal. of varnish.

PANELING—WHAT IT IS AND HOW TO DO IT

Paneling in the ordinary sense, consists of a comparatively stout framing filled in with thinner wood, which, breaking up the level surface, gives a more or less good effect as compared with a flat surface without any break. It may be formed by a great many methods. We may have sham paneling and real paneling, plain and molded, flat and raised, and so on almost indefinitely. Therefore, we propose to show in this article how the various kinds of paneling are formed, and the places and positions for which they are most suitable.

There are certain purposes for which soft wood is preferable to hard; and also where the reverse is the case, and where it is almost imperative that hard wood be used. These will be pointed out as we proceed.

In Fig. 1 we show the elevation of a paneled dado, made in the plainest possible style; one which lends itself to sham work, the difference in the real and the sham being almost impossible to detect. As for this purpose the sham is quite as good as the real, we will make a start with a description of this sham paneled dado.

Provided that the walls are straight and square, the making of this will be easy, all that is required being to board them up flat with a thin board and then fix the framing, consisting of the stiles, *A*, the rails (bottom and top) *B*, and the muntins, fitting and fixing them in the order given. The first lot of boarding will then, of course, form the panels.

Vertical sections on lines *A* and *B*, respectively, are shown at Figs. 7 and 8, and a horizontal section on line *C* is given in Fig. 4. If this kind of paneling is to prove successful, it is necessary that the joints in the "panels" should come

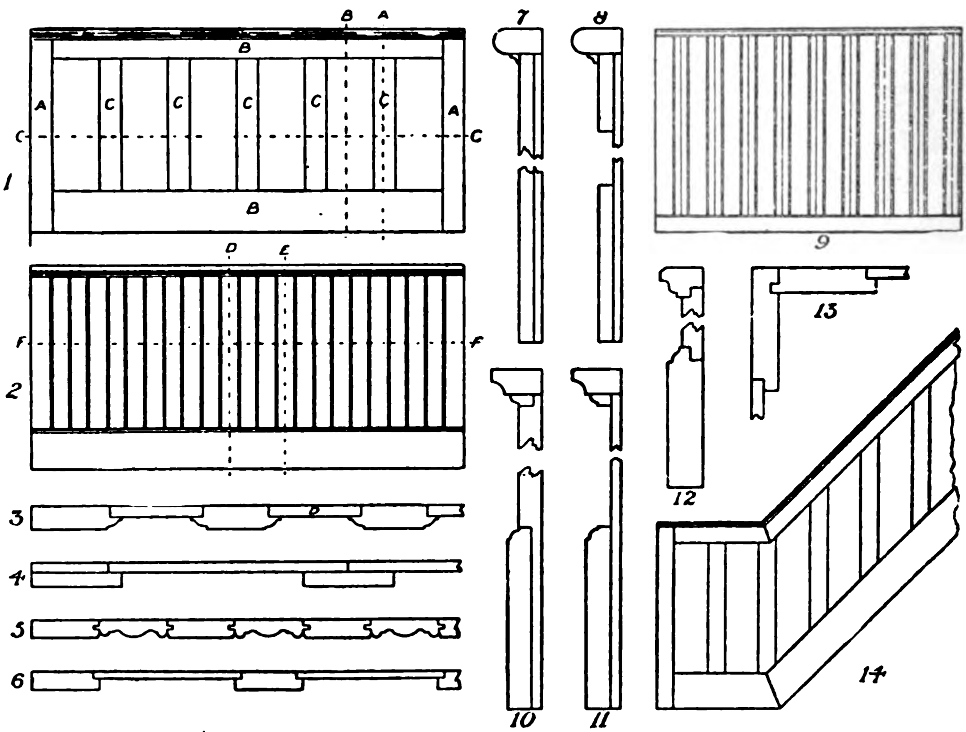


Fig. 1.—Elevation of Plain Sham Paneling. Fig. 2.—Elevation of Moulded Sham Paneling. Fig. 3.—Section of Fig. 2 on line FF. Fig 4.—Section of Fig 1 on line CC. Fig. 5.—Horizontal Section of Fig. 9. Fig. 6—Alternative Section for Fig. 1. Fig. 7.—Section of Fig. 1 on line A. Fig. 8.—Section of Fig. 1 on line B. Fig. 9.—Another Style of Plain and Moulded Paneling. Fig. 10.—Section of Fig. 2. on line D. Fig. 11.—Section of Fig. 2 on line E. Fig. 12.—Vertical Section of Fig. 9. Fig. 13.—Joining Paneling at Right Angles. Fig. 14.—Staircase Dado in Sham Paneling.

so that the muntins will cover them, as in Fig. 4, and to attain this end the wood may have to be cut up into irregular widths. The panel boards must also be of even thickness throughout, and must be fixed very firmly; screws should be used for preference, and the wall should be plugged. If care is taken that all the screw heads will be hidden by the stiles, rails, or muntins, there will be nothing unsightly about it when finished.

The wood which will form the framing must be even in thickness, also gauged accurately to the widths required and the edges planed quite straight and square. All the parts will then bed together as though they were one solid whole. However truly the framing is planed to thickness, there will be a certain amount of inequality at the joints; these must therefore be planed off after the paneling is finished.

The bottom rail should always be wider than the other framing. Double the width, as shown in Fig. 1, is as a rule correct. The stiles, muntins and top rail should all be the same width, and in making paneling which comes together at the corners, either internal or external, the stiles should be so arranged that they appear of equal width when finished. Thus, in fitting to an internal angle, one stile must be the thickness of the paneling *wider*, and for an external angle one must be the thickness *less* in width. For ordinary paneling 4 in. will be found a suitable width for stiles, rails and muntins, the bottom rail to be as wide again, and the panels to show some 8 or 9 in. wide according to the way they space out.

While we are on dado work, we will show another kind of sham paneling which has a good appearance and is very easily made and fixed. The elevation of this is shown in Fig. 2, and sections on lines *D*, *E* and *F* are given in Figs. 10, 11 and 3 respectively.

In this style, narrow panels as *D* are fixed to the wall at intervals as required, muntins should be shouldered so that the plinth will come as Figs. 10 and 11.

The procedure in fixing this dado is: First, the panels, which must be correct in width and thickness; then the muntins, which must be rebated to fit the panels and shouldered all alike to take plinth and capping; then the plinth; and lastly the capping. Or the above may be varied by fixing the plinth next after the panels *D*, following on with the muntins.

Yet another style, easy but effective, is shown in Fig. 9, the horizontal and vertical sections being as Figs. 5 and 12. Here the plinth is rebated at the back, and the boards forming the paneling proper are shouldered so as to fit down behind, as in Fig. 5. They are also cut at the top, so that the capping will fit onto them in the same way as the plinth. As a rule this is all the fixing required.

As the horizontal section, Fig. 5 shows, the panels are really tongued and grooved boards, plain and molded being used alternately. This method will be found a ready means of forming a cheap and effective dado.

Fig. 6 shows an improvement on Fig. 1. The effect as regards the appearance is the same, but the actual result is much more workmanlike and satisfactory, while the labor and materials required are very little more.

Sham paneling lends itself particularly to staircase dados, as Fig. 14; an effective dado being formed far more easily by this method of building up than in making the actual paneling. In the latter case beveled work is not easy, but in the former there is little difference whether square or beveled.

Fig. 13 illustrates the necessity of having one stile wider than the other for internal angles, and also shows a good method of fixing them together at the corner. The tongue and groove keep each piece in its proper place, which is sometimes rather difficult with a plain joint.

using if made in hard wood. In the latter case the grain should run vertically at the face. In the former it is immaterial which way it runs, but it is very important that, whether the hard wood faced or the alder throughout is used, it must be of good quality, otherwise there will be trouble with blisters.

If the wall where the paneling has to be fixed is inclined to be damp, it must either be treated with a damp-proof solution, or three-ply wood should not be used. Although supposed to be waterproof, it is not fair to put it to too severe a test in this respect. It will stand anything in reason if of good quality.

We will now take into consideration paneling proper, in which the framing is real and the panels genuine and not merely a background throughout. The framing is, as its name implies, framed together with mortise and tenon joints, the panels fitting into grooves made for them in the various parts of the framing; if done properly they will fit so closely into the grooves that they will form as it were one solid whole.

The simplest form in which real paneling can be done is the rectangular frame, filled in with a single panel, such as we see in cupboard and wardrobe doors. This we will pass over as being almost too simple for our purpose, and consider something with more work in it and requiring more skill to set out and construct. This we find in the paneling shown in Fig. 1, and even this we have divided into two portions, the one having two panels only in height, while the other has four smaller ones. Simple as even this is, both in theory and practice, the probability is that the majority of carpenters or joiners would, in working it, fail to make all the joints fit—this for a reason which we will give later on.

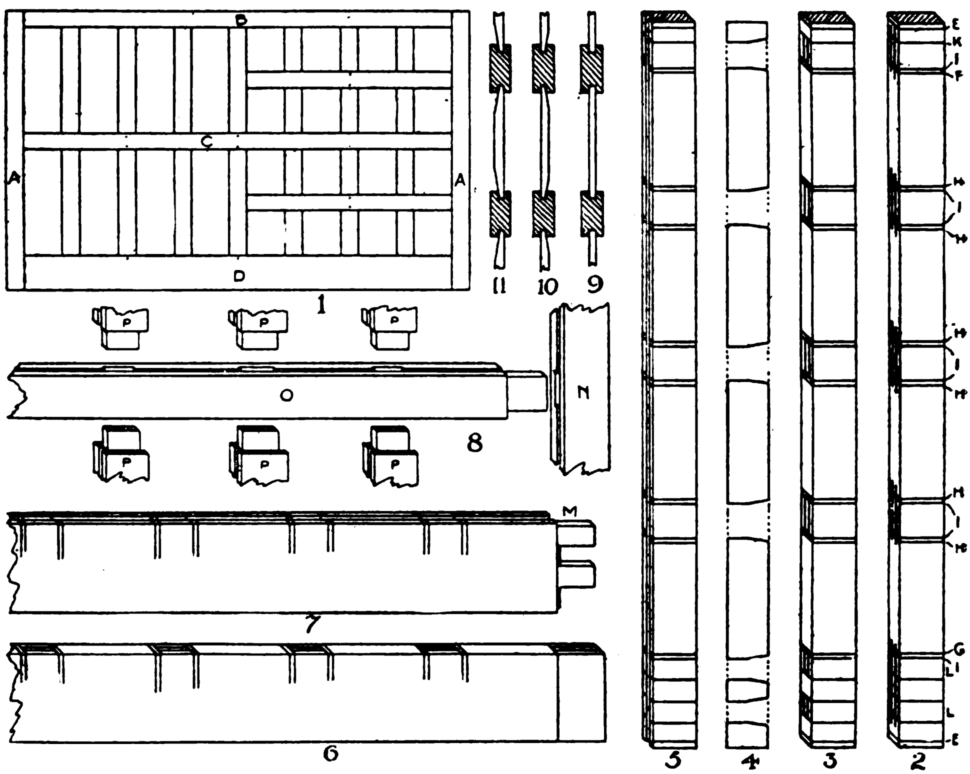


Fig. 1.—Elevation of Paneling (two treatments shown). Fig. 2.—Stile set out for mortising. Fig. 3.—Stile mortised. Fig. 4.—Section through Stile, showing "Wedging-in" mortises. Fig. 5.—Stile grooved for Panels. Fig. 6.—Bottom Rail set out and mortised. Fig. 7.—Bottom Rail mortised, grooved, tenoned and haunched. Fig. 8.—Portion of Panel ready for putting together. Fig. 9.—Section of Plain Panel. Fig. 10.—Section of Mulleted Panel. Fig. 11.—Section of Simple form of Raised Panel.

It will be noticed that the horizontal

pieces of the framing are continuous from stile to stile, and that it is the vertical parts which are cut to fit between. This is as it should be in most cases, though there are exceptions which must be treated on their merits. In all ordinary cases the worker should follow out the rule that stiles (outside vertical pieces) should run from top to bottom, all rails (horizontal pieces) should be continuous from stile to stile, and the muntins (inside vertical pieces) should be cut between the rails.

This rule then necessitates that the stiles will require mortising to take not only the top and bottom rails, but the intermediate ones as well, no matter how many of these there are. The rails will need tenoning at the ends to fit into the stiles, and mortising to take the muntin, the top and bottom on one edge only, the intermediate on both edges. This means in most cases that the mortises will be made quite through the rails. The muntins will be tenoned on both ends to fit into the rails, some of the tenons being long enough to be pinned, the others being shorter. Should pins not be allowed for fixing, the tenons may be secret wedged (to be explained later); in any case the tenons which come to the stiles should reach through the latter, and they can then be wedged up in the usual way on the outside.

In making paneling, as in other work, the first and also the most important part is to prepare the wood. Therefore to make the paneling shown in Fig. 1, we shall require (if it is to be made throughout, as shown on the left) two stiles *A*, three rails, *B*, *C* and *D* (top, middle and bottom) and fourteen muntins. If to bear the right half of Fig. 1, we shall want two additional rails and fourteen additional muntins. The former will be the same as the rails *B* and *C*, but the latter will be only half the length of the first; thus the first fourteen may be cut in two and the correct number is at hand. In cutting off the necessary material, each stile should be allowed 2 in. longer than the finished length, and each rail and muntin ½ in. longer. These extra lengths will allow for cleaning off when together, and in the former case will prevent splitting at the ends in wedging up.

In planing up, after each part is faced (that is, planed straight and out of twist and one edge squared accurately), all the inner pieces, to which other parts have to fit to both edges, must be gauged accurately to a certain width. The other edge may be squared at the same time, and then all the parts are ready for setting out. To do this, take the stiles and, laying them together face to face or back to back, mark on them the exact height the finished paneling has to be, as *EE*, Fig. 2. From this, at the one end, measure inwards the width of the top rail, as *F*, and from the other end measure the width of the bottom rail, as *G*. Between these two marks, space out equally for the other three rails, as shown by the marks *H*. Now from these marks *F*, *G* and *H* set off inwards ½ in., giving the marks *I*, and these (as regards the three intermediate rails) will give the size of the mortises. At the top end set off from the mark *I* a distance equal to three-fifths of the width of the top rail, thus getting the mark *K*, which will be the mortise. At the bottom end divide the space from *E* to *I* into four equal spaces as shown, and the mortises will be those marked *L*. The whole of these marks must be squared over the two stiles, on both edges and across the face, and then by gauging with a double-tooth gauge, or with two single-tooth gauges, the mortises are set out as shown.

The rails and muntins will be set out in a similar manner, always remembering that the mortises must be reduced in width, as shown, to allow for the panel grooves; the tenons must be set out to the full width of the stuff.

In setting out for a quantity of paneling, all the stiles and also all the rails should be done at once.

Fig. 3 gives the stile with the mortises made. Fig. 4 shows the same stile sectionally, this being given so that the method of opening out the mortises at the back or outside edge for the insertion of wedges can be seen and understood.

After the mortising is done, the grooves to take the panels have to be made, and the stile (after this is done) is shown in Fig. 5. Here the groove is shown as being the same width as the mortises, as it should be, but this is sometimes impossible; the rule is that the groove should come to the face of the mortise, leaving it to come as it will at the back.

In Fig. 6 we have the bottom rail set out and mortised, but the tenon not yet cut. This latter should be sawed in before the panel groove is made, but the shoulders should not be cut until after this is done.

Fig. 7 shows the rail with the groove made, the shoulders cut, and the tenon cut away to fit the double mortises in the stiles. The purpose of reducing the width of the mortises can now be seen, the width of the tenons being reduced by the cutting of the groove as at *M*.

In Fig. 8 we have a portion of the stile *N* with one of the intermediate rails *O* ready for placing in it, the muntins *P* also being ready for fitting into the rail. It will be noticed in this sketch that the panel groove is not so wide as the mortises, being made to suit panels only.

Figs. 9, 10 and 11 show sections of three kinds of panels, the first being parallel in thickness, so that it is faceable on both sides. The second, Fig. 10, is the ordinary mulletted panel beveled off the back to fit the groove. The last, Fig. 11, is beveled at the front, thus giving a rough effect of a raised panel. The method of preparing and fitting all these and others will be given later on when we have explained in detail the methods of setting out.

At the beginning of this article we promised to give the reason why so many workmen failed to make the joints fit in work such as we are now describing. The reason is this: If, in planing up the rails, some are wider than the others, and the setting out is done all alike, as it must be, it follows that if set out to suit the wider rails some of the muntins will come too short, whereas if set out to suit the narrower rails the same pieces will come too long, and difficulties will be met with in putting the work together. Therefore, it is necessary to impress on readers who are interested in this work that the timber must be gauged up truly if the work is to be turned out in a satisfactory manner.—*The Woodworker and Art Craftsman.*

DR. CHAFFEE SPEAKS ON WIRELESS TELEPHONY

On Saturday evening, March 1, Dr. E. L. Chaffee of Harvard University delivered before the New England Wireless Society, Boston, Mass., a very interesting talk on the subject, "The Application of the Chaffee Arc to Wireless Telephony." The Chaffee arc, as is known to persons familiar with wireless telephony, is a comparatively recent invention by Dr. Chaffee. It consists of a pair of electrodes in an atmosphere of hydrogen, the electrodes being of copper and aluminium. It is this particular combination that makes the arc distinctive. The aluminium plays a function here almost identical with the aluminium plate in the electrolytic rectifier. In practice these electrodes are about ½ in. in diameter, and are trued up perfectly square, as the spacing is but three thousandths of an inch between the electrodes. An interesting fact relating to the arc is that it was not originally made for wireless telephony, but for use in a study of cathode rays. Dr. Chaffee said that he could not find an arc that would give him the frequency that he desired, so he set about to make one and finally landed on the type which now bears his name.

The talk was accompanied by a large number of lantern slides which showed many interesting results obtained with this type of arc. One slide showed comparative aluminium and Chaffee arc spectra, and the only visible lines on the arc spectrum were three hydrogen lines, indication that the aluminium does not enter into the arc spectrum, and that it is purely a hydrogen one. Some of the other slides showed various forms of damping, including the straight line, and not the theoretical exponential, damping which results from the ordinary spark radio-telegraphic transmitter. After the talk Dr. Chaffee kindly volunteered to answer any questions on the subject which anyone desired to ask. A large number of the very interested audience availed themselves of this rare chance to get information on wireless telephony from such an authority, and the resulting discussions were very instructive. The next meeting of the Society will be held at Pierce Hall, Harvard University, Cambridge, Mass., on Saturday evening, April 5. Dr. A. E. Kennelly will address the meeting, and there is no charge for admission.

THE GREAT RECENT PROGRESS IN WIRELESS INVENTIONS

Sir Henry Norman, M.P., speaking before the Select Committee of the British House of Commons, which is inquiring into the circumstances of the agreement between the Marconi Company and the British Post Office for the establishment of a chain of wireless telegraph stations throughout the empire, said that the issue was largely a scientific one. The practice of wireless telegraphy had advanced with amazing speed, thanks largely to the work of Mr. Marconi. But during a time to be reckoned almost in months a revolutionary advance would appear to have been made for long-distance wireless. The original spark system, which consisted in flinging out into space by the discharge of a condenser across a gap trains of electromagnetic waves, at their maxiumm at the moment of discharge, and falling off rapidly in amplitude and energy, was employed on most of the Marconi ship and coast stations. For comparatively short distances it gave an excellent service. The researches of Professsor Wien pursued practically by the Telefunken Company produced the "quenched spark" system, or the method of "shock excitation," and it resulted immediately in the transmission of wireless signals to much greater distances with much less energy. The disc discharger invented by Mr. Marconi accomplished the same result, though possibly with less efficiency. The waves thus produced, because they were less damped, approached more nearly to the undamped or continuous waves which had always constituted the ideal of the wireless investigator.

But a more striking discovery was made by Mr. Duddell, which was that by including an electric arc, as seen in the familiar arc lamp, as part of an oscillating circuit, continuous or wholly undamped electric oscillations could be produced; and Mr. Poulsen, a Danish scientist, further discovered that by causing this arc to burn in hydrogen gas the heat of the arc was dissipated so rapidly that a much greater current could be passed through the arc without physical difficulties, and that by causing the arc to pass through a powerful magnetic field the strength and frequency of the oscillations could be increased. The Duddell-Poulsen system, supplemented by the invention of high-speed transmitting and receiving apparatus by Mr. Pedersen, another Danish scientist, marked a great advance in wireless telegraphy, and remarkable long-distance communication at very high speed, with comparatively small powers, had been accomplished. The system was already in use to some extent in both the British and German navies.

There remained, however, the further advance to be made of generating high-frequency continuous waves without the physical disabilities of either spark or arc, and this Dr. Goldschmidt, a German scientist, appeared to have accomplished. He had invented an alternator which transmuted mechanical rotation directly into oscillating current at a frequency of 60,000 cycles per second (or less, corresponding to a wave-length of 16,000 ft. or more, as required by the contract), without the mechanical difficulties of excessively high speed. A demonstration of a small alternator, generating 4 k.w., was given some months ago, and continuous day transmission by this was carried out, he believed, from Berlin to Paris. It was stated that large alternators, generating 150 k.w. had been constructed and had successfully passed the test of being run at full load for many consecutive hours, and that only the completion of the necessary high masts and aerials, which were being rapidly erected, one in Europe and one in the United States, was necessary for a transatlantic test to be made. If the Goldschmidt alternator could put 150 k.w. of a pure continuous wave at 60,000 periods per second into the antenna circuit, as was claimed, a day and night transmission at high speed over 2,000 miles was a certainty.

Moreover, if it would do this, wireless telephony would probably be accomplished. The difficulty of long-distance wireless telephony was to devise a microphone which would not be destroyed by the very heavy main current. In the Goldschmidt system the microphone would only have to carry the exciting current of the alternator, 7 or 8 k.w., instead of the main current. The signals would be untappable, except by a special receiving apparatus. Further, an advantage of great value for the purposes of these imperial stations, the signals could be changed in a minute from a silent wave only readable on the special receiver to a musical note readable by any ship on the ordinary detector and telephones of every receiving circuit. The purity of the wave rendered the system so selective that a station sending on a wave only differing by 5 per cent. would not interfere. Dr. Goldschmidt claimed that he could receive three different messages on the same aerial at the same time. Dr. Fleming, the scientific adviser to the Marconi Company, alluding in his recent address before the British Association to the inventions of Dr. Goldschmidt, said that telephony across the Atlantic was quite within possibility.

The points urged were: (1) That the future of long-distance wireless communication was almost certainly with a continuous wave system; and (2) that a few months would suffice to decide whether one or other continuous wave system could fulfil the conditions of the imperial wireless service. Sir Henry submitted that it was impossible to come, at this critical moment in the development of wireless telegraphy, to a correct decision without hearing scientific evidence from independent experts. He mentioned the names of Sir Oliver Lodge, remarking that though he received an annual fee from the Marconi company for scientific advice, everyone who was acquainted with him knew that that would not in the least affect his judgment upon any scientific issue, and of Sir Silvanus Thompson. Mr. W. D. Duddell, president of the Institution of Electrical Engineers, discovered the "singing arc," the patent of which was acquired by the Poulsen people, but he understood Mr. Duddell had no connection whatever with the Poulsen syndicate. Dr. Erskine-Murray was a leading consulting expert upon wireless telegraphy, and Captain Campbell-Swinton had not only expert knowledge of wireless but also wide experience of government contracts. Dr. Eccles was another wireless investigator of high qualifications. If the committee heard evidence from some of these gentlemen, it would be in a position to appreciate the scientific situation today as regarded wireless telegraphy.

THE U.S. NAVAL RADIO STATIONS AND THEIR USE IN AID OF SAFE NAVIGATION

In July, 1904, the President approved the conclusions and recommendations of the Inter-Departmental Board which had been appointed by him "to consider the entire question of wireless telegraphy in the service of the National Government." Among these conclusions were the following:

"That wireless telegraphy is of paramount interest to the Government through the Navy Department, and that its use by the Signal Corps of the Army for communication between military posts of the Army and other necessary links will be necessary both in peace and war, and that such use shall be unrestricted.

* * * * * *

"That coastwise wireless telegraphy is not a necessity for the work of the Weather Bureau of the Department of Agriculture, provided that the necessary meteorological data for that Department can be collected by the stations of the Navy Department from ships at sea and by them sent to the Weather Bureau of the Department of Agriculture;

"That the maintenance of a complete coastwise system of wireless telegraphy by the Navy Department is necessary for the efficient and economical management of the fleets of the United States in time of peace and their efficient maneuvering in time of war;

"That the best results can be obtained from stations under the jurisdiction of one Department of the Government only and that representatives of more than one Department should not be quartered at any station."

In accordance with the above, the only U.S. Government radio stations on shore are those under the War and Navy Departments, respectively. Those owned and operated by the Navy Department on shore, including those on lightvessels, are as follows:

LIST OF U.S. NAVAL RADIO STATIONS

Atlantic Coast

The usual wave-length is 600 meters, except for Arlington, which is much longer.

Power	Name of Station	Call Letters
3	Portland, Me.	NAB
2	Portsmouth, N.H.	NAC
5	Boston, Mass.	NAD
3	Cape Cod, Mass.	NAE
2	Nantucket Shoals Lightship	NLA
5	Newport, R.I.	NAF
3	Fire Island, N.Y.	NAG
2	New York, N.Y.	HAH
2	Philadelphia, Pa.	NAI
2	Cape Henlopen, Del.	NAJ
2	Annapolis, Md.	NAK
3	Washington, D.C.	NAL
100	Arlington, Va.	NAA
5	Norfolk, Va.	NAM
2	Diamond Shoal Lightship	NLB
3	Beaufort, N.C.	NAN
2	Frying Pan Shoals Lightship	NLC
3	Charleston, S.C.	NAO
3	St. Augustine, Fla. (wave-length, 300 meters)	NAP
3	Jupiter, Fla. (wave-length, 300 meters)	NAQ
25–2	Key West, Fla.	NAR
5	Pensacola, Fla.	NAS
5	New Orleans, La.	NAT
5	San Juan, P.R.	NAU
5	Guantanamo, Cuba	NAW
25–2	Colon, Isthmian Canal Zone	NAX
1	Porto Bello, R.P.	NAY

Pacific Coast, Etc.

The usual wave-length is 600 meters, with the following exceptions: Point Arguello, 300; St. George, 300.

Power	Name of Station	Call Letters
5	St. Paul, Pribilofs, Alaska	NPQ
1–2	St. George, Pribilofs, Alaska	NPY
10–3	Unalga, Alaska	NPV
5	Dutch Harbor, Alaska	NPR
5	Kodiak, Alaska	NPS
10	Cordova, Alaska	NPA
10	Sitka, Alaska	NPB
5	Bremerton, Wash.	NPC
3	Tatoosh, Wash.	NPD
10	North Head, Wash.	NPE
3	Cape Blanco, Ore.	NPF
5	Eureka, Cal.	NPW
5	Mare Island, Cal.	NPH
3	Farallons, Cal.	NPI
3	Point Arguello, Cal.	NPK
5	San Diego, Cal.	NPL
2	Honolulu, T.H.	NPM
2	Guam	NPN
2	Cavite, P.I.	NPO
5	Olongapo, P.I.	NPT
2	Peking, China	NPP

REPORTS OF DANGERS TO NAVIGATION

Shipmasters in the North Atlantic are invited to communicate reports of dangerous obstructions to navigation to the Hydrographic Office, Washington, D.C., or to the nearest Branch Hydrographic Office, by radio-telegraphy at or near the time of seeing the obstruction. Such messages should be brief and in English. They should be addressed via any naval or commercial radio station along the coast of the United States. The cost of their overland transmission will be borne by the Hydrographic Office. Particular attention is invited to the request that such messages from the ship to the shore should be addressed via a station in the United States.

Shipmasters in the North Pacific are similarly invited to report dangerous obstructions to the nearest Branch Hydrographic Office, by calling a naval radio station, without cost to themselves.

Messages of this kind are sent by the Hydrographic Office or a Branch Hydrographic Office to an appropriate U.S. naval radio station, and are there broadcasted four times daily, viz., at 8 a.m., noon (immediately after the time signal, if sent), 4 p.m. and 8 p.m. Similarly, with storm warnings received by the radio stations from the U.S. Weather Bureau. Ships within range of a naval radio station should be prepared to receive these hydrographic messages and storm warnings at the hours mentioned, and should avoid sending radio messages at these times. One vessel sending may prevent several others receiving information necessary to their safety.

Naval radio stations will furnish this information to passing vessels on request, whenever practicable, at other hours than those mentioned above. Should it not be practicable to send out this information on one of the hours scheduled, it will be held until the next scheduled time, except that important storm warnings, reports of lightships off station, etc., will be treated as urgent and sent out as soon as practicable after each hour scheduled.

In addition to the above treatment of wreck and derelict reports, the Hydrographic Office at once imparts to the Revenue-Cutter Service such reports as fall within the cognizance of that service in its work of assisting mariners in distress and recovering or removing floating dangers to navigation. Thus, on December 24, 1912, at about 5.30 a.m., the radio station at Brooklyn telephoned to the Officer in Charge of the Branch Hydrographic Office, New York, a radiogram from Captain Lindsay, of the steamer *Turrialba*, that he was ashore off Barnegat, afloat aft, fast forward, heavy snow squalls, wind increasing, assistance necessary.

The Officer in Charge replied by requesting the radio station to inform the Revenue-Cutter *Seneca*, then at anchor in New York Harbor. The *Seneca* immediately got up steam, but was unable to leave the harbor for several hours on account of a heavy snow storm, and she was thus unable to reach the *Turrialba* before 7 o'clock at night, even then having to go out of New York Harbor in the teeth of a gale. The *Seneca* successfully rescued all of the passengers of the *Turrialba* on the morning of the 25th and landed them in New York late that afternoon.

This incident well illustrates the efficiency and usefulness to shipping of the naval radio stations and the Branch Hydrographic Offices.

The Hydrographic Office in Washington was also notified of the wreck in a different manner, having received a radio direct from the *Turrialba* via Cape Henlopen. This radio was immediately telephoned to the Revenue-Cutter Service and also to the Division of Operations of the Navy Department.

Radiograms regarding floating dangers to navigation reaching the Hydrographic office or one of its branch offices, are at once communicated to the Revenue-Cutter Service or to the nearest revenue cutter, and thus assist toward their speedy removal.

PUBLICATION OF WRECK AND DERELICT REPORTS

The latest news relating to obstructions to navigation is also published by the Hydrographic Office in a "Daily Memo-

News of this kind from ships at sea is not considered a commercial message, and no charges are made thereon.

MOST AVAILABLE STATIONS

As a rule, it would be desirable for merchant vessels to communicate habitually with Cape Cod rather than Boston, Fire Island rather than New York, Cape Henlopen rather than Philadelphia, and Point Arguello, Farallons, or Eureka rather than Mare Island, on account of the importance of the official work of the radio stations in the navy yards mentioned. Other radio stations in navy yards and at naval stations are prepared to work directly with shipping.

TIME SIGNALS

Appropriate radio stations send out the noon signal broadcast every day, except Sundays and holidays, for the determination of chronometer errors, and hence time and longitude at sea.

The signals are sent from the Naval Observatory, Washington, for the Atlantic coast between 11.55 a.m. and noon of the 75th meridian west of Greenwich, and from the observatory at the Mare Island Navy Yard between 11.55 a.m. and noon of the 120th meridian west of Greenwich for the Pacific coast.

The wireless sending or relay key in each wireless station is connected to the Western Union lines by a relay at about 11.50 a.m., and the signals are made automatically direct from Washington or Mare Island.

Time signals from each of the observatories mentioned begin at 11.55 a.m., standard time, and continue for five minutes. During this interval every tick of the clock is transmitted, except the 29th second of each minute, the last five seconds of each of the first four minutes, and finally the last 10 seconds of the last minute. The noon signal is a longer contact after this longer break.

All ships should listen in and not at-

attendance. Any vessel provided with a small receiving apparatus with one or two wires hoisted as high as possible and insulated from all metal fittings, or preferably stretched between the mastheads with one wire led down to the receiver, may detect these signals when within range of one of the seacoast wireless stations.

These time signals have been used successfully by vessels for rating their chronometers and have been used by surveying vessels in the accurate determination of longitudes.

Shipmasters are requested to state in their marine data reports to the Hydrographic Office what success they have with this service; and the name or call letters of the station sending the time signal should be given in the report; also position of the ship, and her distance from the station.

This time service involves no charges against the ship receiving it.

The signal . — . . . (WAIT) and the following shall be used to cover cases of interference:

Signal	Question	Answer or Notice
QRM	Are you being interfered with?.....	I am being interfered with.
QRW	Are you busy?....................	I am busy (or: I am busy with....) Please do not interfere.
QRY	When will be my turn?...........	Your turn will be No.....
QRZ	Are my signals weak?.............	Your signals are weak.

PASSING SHIPS SHOULD CALL SHORE STATIONS

Ships passing along the coast should invariably call each naval coast station as they come within range, as important information may be on hand concerning dangers to navigation, storms expected, etc., or private radiograms, in case of stations which handle commercial business. Care should be taken not to interrupt the business of the station, which may be receiving signals at the time which can not be received on board ship on account of the lower aerial; the ship shall, therefore, cease calling promptly on demand.

The position of the ship should be given concisely, immediately after the call is acknowledged and the GO AHEAD signal — . — received from the coast station. The letters TR indicate that the position report follows. After the letters TR send:

(*a*) The approximate distance, in nautical miles, of the vessel from the coast station;

(*b*) The position of the ship given in a concise form and adapted to the circumstances of the individual case;

(*c*) The next port at which the ship will touch;

(*d*) The number of messages, if they are of normal length, or the number of words, if the messages are of exceptional length.

The speed of the ship in nautical miles shall be given specially at the express request of the coast station.

EXAMPLE

After station acknowledges ship's call, ending with —— . ——, the ship sends: TR 50 (nautical miles) off Cape Fear; Habana; 4 (number of messages).

Cleaning Gun Barrels

Lead and powder residue as well as rust can be easily removed from rifle and gun barrels, and if the barrel is not badly pitted, it can be restored to its original brightness and cleanness by using ordinary steel wool in cleaning, says a writer in *Popular Mechanics*. Take a wad of the steel wool just as large as can be conveniently drawn through the barrel and attach it to a stout cord or a small wire and draw it back and forth in the barrel. All rust and residue will be thoroughly removed from the barrel in a few minutes.

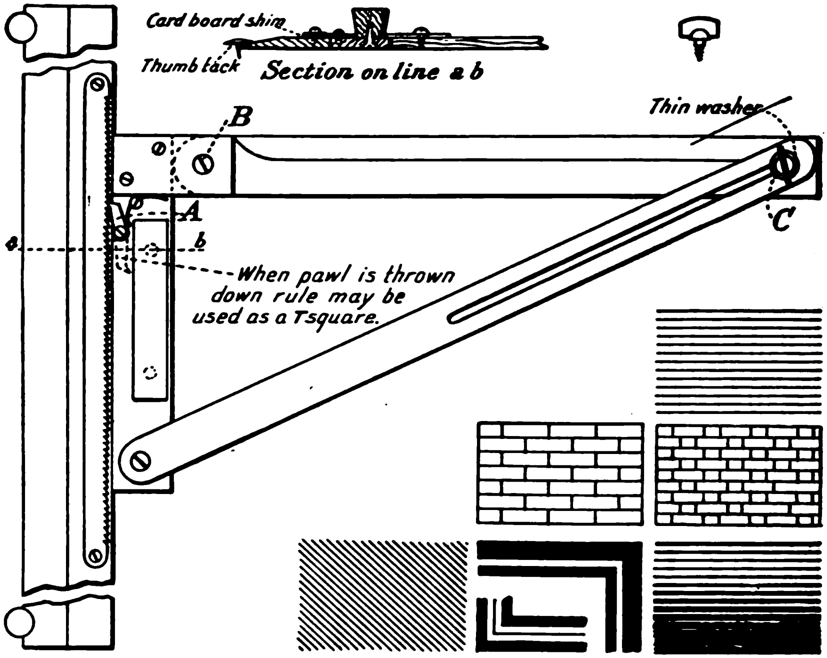
The steel wool will not scratch nor injure the barrel in the least. The No. 0 steel wool is the most desirable to use, and it can be obtained at almost any hardware store.

A PARALLEL RULER AND SECTION LINER

MAURICE COLEMAN

Those who are interested in mechanical drawing will find a section liner a very useful instrument. Following is a description of one that may be made by any amateur at a very small expense, as the pieces of wood required are easily obtained.

beginning ½ in. from one end and making it 6 in. long; slot should be wide enough for one of the ⅜ in. screws to slide easily. Round off end of the 12 in. strip and bevel the edge as shown. File the smaller piece of brass to shape *A*, and drill hole so that ¼ in. screw will have a close fit.



MATERIALS

1 piece wood 18 in. long, 1½ in. wide, 5/16 in. thick;
1 pc. 12 in. long, 1 in. wide, 5/16 in. thick;
1 pc. 6 in. long, 1 in. wide, 5/16 in. thick;
1 pc. 13 in. long, ¾ in. wide, 5/16 in. thick;
1 pc. 3 in. long, ⅝ in. wide, ½ in. thick;
2 round head brass screws, ⅜ in. long;
[illegible] head brass screws, ¼ in. long;

Place the larger piece of brass on the 6 in. strip to determine where holes should be drilled for fastening; drill the two holes and also the hole at *B*, making a close fit for ¼ in. screw. Solder a wing into the slot of one of the ⅜ in. screws. Round off the end of the 13 in. strip.

The saw is used as a ratchet and will be found accurately cut at the root of tooth, build it up slightly by placing a strip of cardboard under the saw, but not wide enough to interfere with the ratchet. Attach 2 in. piece of brass to 6 in. strip, as shown. Attach pawl so it will swing near the brass piece. Fasten spring in place. Adjust pawl to work easily with light pressure of spring. Screw the brass to the rounded end of 12 in. strip, making a swivel joint. Fasten plain end of the 13 in. strip to bottom of 6 in. strip. Place wing screw in slot and screw it into end of 12 in. strip. Attach the 3 in. block by countersinking screws in 6 in. strip. The block is used to hold ruler against 18 in. strip. When the ruler and straight edge form a right angle the ruling will be spaced equal to the cut of the ratchet; to reduce spacing release clamp *C* and drop ruler to desired position. If the left-hand side of straight edge is beveled about one-half its width it may be fastened in any position on drawing-board by using two thumb tacks.

FINISHING BRASSWORK

S. BETTS

Many amateurs in electrical work have, doubtless, admired the very pretty effect of "mottling," seen on shop-made brass instruments. I refer to the sort of veining, something like the veins in marble, running over the surface of the brasswork.

A smooth-finished brass surface readily shows up scratches, and is difficult to lacquer perfectly, evenly, and free from brush marks. On the mottled surface lack of skill is not so noticeable.

The "mottling" is really a series of very fine circles running into one another scratched on the surface of the brass. But the amateur will readily see for himself if he tries the following dodge.

Take a small round piece of wood (a piece of a penholder or pencil will do), put it into a drill chuck or self-centering chuck, leaving an inch or so projecting. Start the lathe, and with a smooth file make the end very slightly convex. From a piece of the very finest emery paper cut a circle about 1 in. or so in diameter. With scissors cut lines radially towards the center, leaving intact in the middle a piece the same diameter as the end of the prepared stick of wood, Fig. 1.

Place the paper against the wood and bring the cut portion over and secure with some stout cotton, Fig. 2.

Now, holding the piece of brasswork in the right hand (it is necessary to have a piece of paper between the brass and the fingers: the grease from the fingers prevents lacquering afterwards), the work being finished to a good surface, run the lathe as fast as possible, press the work lightly against the emery-covered wood, moving it steadily forward at right angles, and a sort of shaded vein will be seen where the rotating emery has cut lightly into the brass. You may follow any pattern you please—say, work diagonally from corner to corner, with other veins crossing at intervals; but the worker will soon be able to obtain some very nice results, and designs will suggest themselves to him.

If two or three diameters of wood are used, the veining may be of different widths. Different grades of emery may also be used, but anything like a coarse grain is useless. Do *not* use emery *cloth*, use only the finest emery *paper*, such as is used for polishing.

The orthodox method is to have sticks of emery composition, with the ends shaped by an old file, as in Fig. 3. This is over-wrapped with paper to strengthen.

A stick of wood may be prepared to this shape, the end then dipped into thin glue, and afterwards fine emery powder, and allowed to dry.

A composition stick may be made by thoroughly incorporating about equal quantities of resin, shellac, and fine emery powder, moistening with methylated spirits, forming it into a thick paste,

Fig. 1

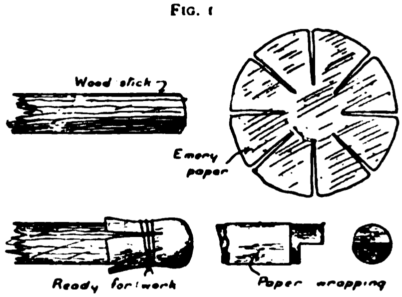


Fig. 2 Fig. 3

and ramming into a mould to dry, and then wrapping round with paper.

A wood mould may be made as follows: Plane one surface each of two small convenient pieces of wood, so that the planed surfaces lie perfectly flat on one another, fix them together by a screw at each corner. On the joint line, as center, drill three holes, so that when the pieces of wood are taken apart half a hole or trough is left on each surface; the planed surfaces are the parting line. Blacklead these holes thoroughly, so as to prevent the composition's sticking, screw together again, and ram in tight as much composition as you can into each hole. When dry, take the wood apart, and out drop the sticks. Shape up the business ends with an old knife and file. The holes may be 1 in. or more in length, and three-sixteenths, one-eighth, and one-sixteenth in diameter, the last size serving for very small jobs.

Commutator bars, levers of switches, etc., look well mottled. Do not lacquer any surfaces where electrical contact is to be made, and do not touch with the fingers. When the piece of brass to be lacquered is put into a clean flame (such as the flame of a spirit lamp) it sweats, and a cloud of moisture appears on the surface; as the metal gets hotter, this passes gradually away, and the moment it has all gone is the time to apply the lacquer (of course, away from the flame). Go over once only as evenly and smoothly as possible. Clean brushes, clean lacquer, and a light, firm hand, and all is well.

If the first attempt is not very good, take off the lacquer with a clean cloth dipped in spirits and try again.—*Model Engineer and Electrician.*

THE EIGHT TALLEST WIRELESS STATIONS IN THE WORLD

Announcement was made last month on behalf of the Marconi Company that contracts had just been let for the construction of eight of the largest wireless stations in the world.

After the erection of one station but one step will remain to jump across the Pacific to Japan. The receiving and sending stations will be 30 miles apart. They will be erected at Honolulu, Oahu, Sandwich Islands; Belinas, Cal.; Belmar, N.J., and along the eastern Massachusetts coast.

Following the erection of the Oahu plant Japan will locate a wireless station, and this will enable the company to throw messages entirely across the Pacific, a distance of 3,394 miles to the nearest land in Japan.

The Marconi Company says that it would have planted its Oriental station in Manila had not the United States Government objected. The Government has a large station there and it was afraid the more powerful Marconi stations might interfere with the receiving and transmitting of marine messages. After Japan the company will erect stations in India and thus communicate with Europe, completing the circle of the globe.

The stations, according to the announcement, will have the highest power and longest range of any in the world. The poles will be the tallest, ranging from 400 to 450 ft. in height. There will be twelve of these poles at each station, arranged in a semicircle, which will cover nearly a square mile. The antennae for these poles will be 80 miles in length and the grounding wires 40 miles, all underground.

The engines of the stations will develop a 1,000 h.p. spark. Because of the power generated the receiving and sending stations will be located on a line 30 miles apart. Closer than that the electric splash, as it is called, would make both stations useless. After 30 miles the etheric waves roll in regular order, which permits other waves to pass them.

The stations must all be attuned to different keys to keep them from interfering with each other and with other stations. Japan has a tuning system all its own and had the first choice of notes for the system, and thereafter the stations were permitted to choose such notes as had not already been preëmpted.

The stations will also be duplexed so they may send out different messages almost simultaneously. Four will go in such rapid succession that it will seem to be simultaneous.

CABLE NOW CLICKS MORSE MESSAGES

Remarkable Invention of Commercial Company's Employe Achieves It

A man sat in a cable office in London the other day and sent a cable message to New York. That doesn't sound remarkable and it isn't. The remarkable part was that the man who received the message at this end of the cable didn't have to read a waving line and translate its ups and downs into the dots and dashes of the Morse code, but instead heard the instrument at his elbow click off the message just as though it had come over a land line from a nearby town.

A message of congratulation went clicking back under the ocean to the man in London, and then there was a lot of handshaking in the offices of the Mackay Companies. The dream of all submarine cable engineers which they had been trying to make come true since the first transatlantic cable was laid in 1858 had at last become a reality, and the long search for a way to operate long-distance cables by sound was ended.

John Gott, chief electrician of the Commercial Cable Company since its organization in 1884, is the man who solved the puzzle. His achievement was announced last month in the annual report of the Mackay Companies to its shareholders made by Clarence H. Mackay, president of the company, on behalf of the trustees. The report says of Mr. Gott's achievement:

"He has invented a device by which the Morse dot and dash signals can be used on long submarine cables, that is to say, messages can be sent by the ordinary land line Morse key and read on a Morse sounder. This invention surpasses anything that has been added to the sub-marine cables since Sir William Thompson (Lord Kelvin) and Cromwell Varley first made the practical operation of long distance submarine cables possible fifty-five years ago.

"It is expected that Mr. Gott's invention will make the cable service as flexible as the land service. It links up cables or land lines, or both, or alternate cables and land lines and is an achievement which inventors and the foremost scientists in the world in cable working have striven to attain since the first Atlantic cable was laid.

"The far-reaching effect of this invention on all kinds of telegraph transmission, both by land and sea, cannot at this time be definitely stated, but the Commercial Cable Company believes that by this invention it will be possible to transmit through automatic repeaters telegraph signals around the world. The Commercial Cable Company has acquired the rights to this invention and has taken out patents all over the world."

By his invention, says the *New York Sun*, John Gott takes his place in the small group of men who have improved submarine cable transmission, and when the next book on submarine telegraphs comes out he will be mentioned with the late Charles Cuttriss, inventor of the vibrator, and the late T. J. Wilmot, who with Cuttriss invented the automatic transmitters. Both of these men, like Mr. Gott, were engineers of the Commercial Cable Company.

While this list of men who have wrestled successfully with the difficulties of cable transmission problems is a short one, the list of failures is very long. The very first transatlantic cable was destroyed by forcing too powerful a current through it in an attempt to work the Morse alphabet of dots and dashes, and the attempts since then to do what Mr. Gott has succeeded in doing have been numberless.

Even the great Edison failed in an attempt to apply the land-wire system to the cables. Some years ago he took what was considered a very promising automatic Morse arrangement to England and in the course of his experiments tried to send the dot and dash code through a cable about 1,000 miles long coiled in a tank. Dot and dash messages are recorded on a tape as well as announced by the click of the sounder.

When Mr. Edison signalled a "dot" at the sending end it came out on the receiving tape in a mark 28 ft. long. Mr. Edison laughed as he contemplated that superdot. He acknowledged that he had not been very successful, and added: "I thought that dot was never going to end."

The explanation of the experts is that

the cables don't discharge their current quickly enough for the system that Mr. Edison tried and so hung on to the dot altogether too long. Mr. Gott found a way to avoid that trick of the cables and the dots and dashes that come over the Commercial Cable Company's lines are as clear-cut as those on short-distance land wires.

But Mr. Gott's invention has just been born, and, although other people were experimenting during all the years since that first attempt burned out the Atlantic cable, they weren't allowed to experiment on the cables themselves, and other systems had to be used. The first of these, invented by Sir William Thomson, was the Thomson reflecting galvanometer, commonly known as the "mirror."

This instrument consisted of a coil of fine wire in the hollow center of which a tube carrying a tiny magnet suspended at right angles by a silk fiber was inserted. On the face of this magnet a small mirror of about ¼ in. diameter was cemented.

A beam of light thrown on this mirror was reflected on a scale placed at some distance from the instrument and the signals, made up of the flashes of light thrown from the mirror to right or left of a zero line, were read on this scale. Since a wire through which a current is passed possesses for the time being properties similar to those of a magnet, the mirror was acted upon by every current passed through the cable line into the coil windings.

It was not an easy job for eyes or nerves to keep track of the flashes of the mirror, but some operators became very expert at it, and in the cable world they still boast of some of the wonderful stunts done by the mirror men. The man who received these literal flashes from the cable read aloud to an assistant his translation of the movements of the beam of light and the assistant wrote the words down on the message forms. They will

in the field of a powerful magnet and the movements of the coil in response to the current sent through the cable are recorded on a narrow paper tape passed in front of a fine glass siphon attached by silk fibers to the suspended coil and dipping into an ink-well.

The business end of the siphon traces in ink a line on the tape, and this line goes up and down in response to the movements of the coil from side to side in response to a change in the polarity of the current. This makes a wavy line something like the graphic charts used to portray statistics of all sorts. When a peak of the line sticks up above a fixed point that means a dot, and a valley is a dash. It takes a keen eye and long training to pick out readily and accurately the slight differences produced when two or more dots or dashes come together, but a permanent record is made, and that was a big step forward in cable message science.

Still, at best the deciphering of the signals of either the old fashioned reflecting galvanometer or the modern siphon recorder was difficult and the signals could only be sent from cable office to cable office. Now with Mr. Gott's invention anyone who can read Morse code as clicked out by the receiver or recorded in printed dots and dashes on the tape will be able to handle cable messages and it looks as though some of the mystery attached to the old time method of cable transmission has departed.

But Mr. Gott's system does a great deal more than increase the accuracy and swiftness of cable message transmission. It hitches up the cables with the land wires so that very soon your cable message filed with the Commercial in an inland town or at San Francisco for transmission to an inland point in England will go right through without human agency except at the transmission and receiving points. With the

GEAR WHEELS AND GEARING SIMPLY EXPLAINED—Part II

ALFRED W. MARSHALL, M.I.MECH.E., A.M.I.E.E.

Gearwheels can be made in the form of a ring with teeth inside the circumference instead of outside. Such wheels are called internal or annular gearwheels. Such a wheel can obviously gear only with another which has external teeth, and is smaller in diameter, because the second wheel is placed inside the first. These wheels are calculated and set out according to the diameters of their pitch circles, as in the case of external toothed gears, the pitch circle of the pinion *P* being inside that of the wheel *W*, Fig. 15, and touching at the pitch point. If the diameter of the pitch circle of the wheel *W* is four times that of the pinion *P*, the latter will make four revolutions for one revolution of the wheel, and so on. The numbering and proportions of teeth apply as in the case of external gears. Cycloidal or involute curves can be used for the shape of the teeth. If cycloidal curves are used, they will be transposed in the case of the teeth of the wheel. The curve-generating circle for the faces of the teeth will roll inside the pitch circle, and therefore produce a hypocycloid, and that producing the flanks will roll outside the pitch circle and therefore produce an epicycloid (see Fig. 16). An internal gearwheel can engage with several pinions simultaneously. In such an instance the curve-generating circle for all the teeth should have a diameter equal to half that of the pitch circle of the smallest pinion. There is an important difference between the working of an internal and external pair of toothed wheels. If the wheels are external, they rotate in opposite directions, but if internal, they rotate in the same direction, as indicated by the arrows, Fig. 15.

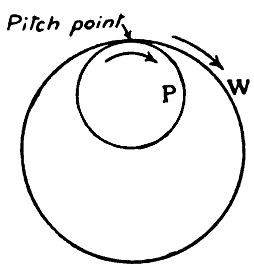


Fig. 15

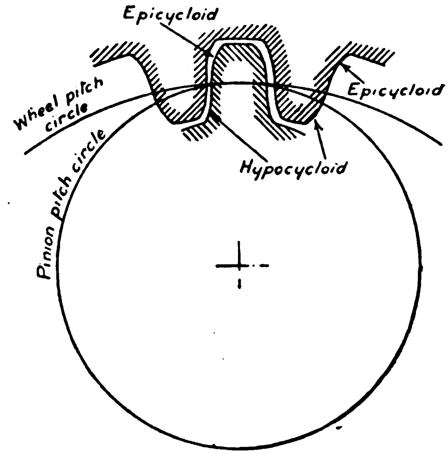


Fig. 16

If the teeth are made as so far explained, with a part projecting beyond the pitch circle as well as a part inside it, any pair will come into contact as they approach the line of centers, and this contact will be maintained to some distance after they have passed the line of centers. For example, a pair of wheels *A B*, Fig. 17, is in gear. The teeth of wheel *A* come into contact with those of *B* to the left of the line of centers *X Y*, the wheels rotating in the direction indicated by the arrows. They are then said to be engaging. After passing the line of centers they are said to be disengaging. The contact is maintained for some distance, but finally ceases as each pair of teeth passes out of gear. The distance through which they make contact when engaging is called the arc or angle of approach, and that through which they move when disengaging is called the arc or angle of recess. The actual path followed by the contact point is a curve in the case of cycloidal teeth, which consists of arcs of the tooth-generating circles *C C*, Fig. 17, any particular tooth commencing to make contact at a point in one circle, and leaving contact at a point in the other circle, as indicated by the full lines. In the case of involute teeth the path of tooth contact is along a straight line, such as *L C*, Fig. 14, commencing inside one pitch circle and ceasing inside the other pitch circle.

The teeth of gear wheels rub together while in motion, causing friction and wear of the surfaces. It is reduced by designing the teeth so that the path of contact is as short as possible. The friction which takes place during engagement in the arc of approach—this would be to the left of *X Y*, Fig. 17—is considered to be more detrimental than that which takes place during engagement in the arc of recess—this would be to the right of *X Y*, Fig. 17. The teeth rub to greater disadvantage when coming into contact than when disengaging. On this account designers of wheel gear in which it is of great importance that friction and wear should be eliminated as much as possible, such as watch and

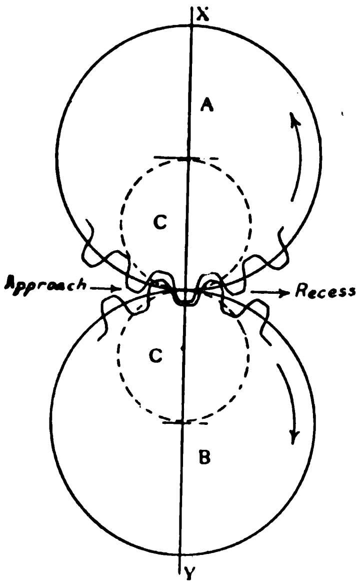


Fig. 17

clock gearing, have favored teeth which only make contact when they have reached the line of centers. Engaging friction is thus reduced to a minimum. This action will be accomplished if the driven-wheel teeth are made without points—that is, they should not have a part which projects beyond the pitch circle. For example, wheels having complete teeth, such as Fig. 17, come into engagement before the line of centers *X Y*. At this stage the flanks of teeth on wheel *B* make contact with the faces of the teeth on wheel *A*, assuming *B* is the driver. After passing the line of centers the faces of teeth on wheel *B*

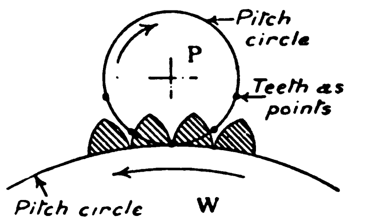


Fig. 18

make contact with the flanks of the teeth on wheel *A*. Therefore, if we desire that contact shall only be made after the line of centers, the points of the teeth on *A* should be removed. It follows from this that the roots of the teeth on *B* will not be required, and as the engagement is only to take place at, or after, the line of centers, *B* must be the driver. If *A* be the driver, the engagement will take place only after the line of centers, which is the condition in this instance to be avoided. The teeth having points are therefore to be put on the driver, and those having no points are to be upon the follower. If cycloidal teeth are used (they should be used), the curve of those upon the driver will be an epicycloid, and that of the teeth upon the driven wheel a hypocycloid. This leads to two distinct forms of teeth for the driven wheel. If the curve-generating circle is made to have a diameter equal to the radius of the pitch circle of the driven wheel, the hypocycloid becomes a straight line (as previously explained), and the teeth have merely straight radial lines for the shape of their flanks. In the second case the curve-generating circle is made to have a diameter equal to that of the pitch circle of the driven wheel; the hypocycloid then becomes a point

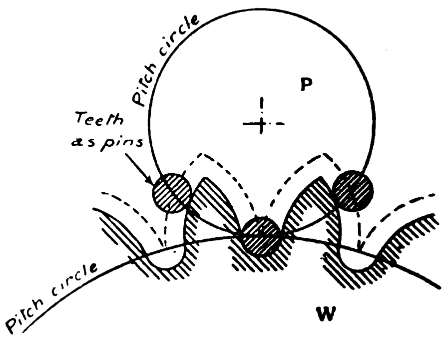


Fig. 19

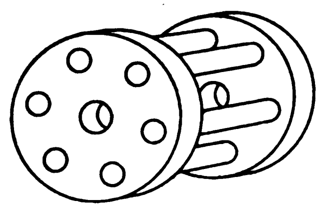


Fig. 20

and the teeth may be pins projecting at a right angle to the side of the wheel. This is the only instance in which the hypocycloid formed by a generating circle of such a proportion to the pitch circle is used for wheel teeth.

When the curve-generating circle is made of a diameter equal to that of the pitch circle in which it rolls, and the hypocycloid becomes a point, some practical modification is necessary, because the teeth are, theoretically, merely points, which, according to Euclid's definition, have no parts nor magnitude. Obviously the teeth must have some thickness, and they become pins as a practical construction. Fig. 18 is a diagram showing the teeth of a pinion *P* as points, being the hypocycloid we have produced by using a curve generating circle having a diameter equal to that of *P*. The teeth on the wheel *W* are entirely outside the pitch circle, and the faces are epicycloids produced by rolling the circle which has generated the point teeth of *P* upon the pitch circle of *W*. To make a practical working construction we fit cylindrical pins to *P* to form teeth. This is quite justifiable, as a circle is the equivalent of a point, and therefore in the particular instance is logically a hypocycloid. The teeth on *W* as originally formed to engage with points are represented by dotted lines, Fig. 19. If we enlarge the points and give them a sensible diameter so that they become pins, it will be necessary to cut away some portion of the teeth of *W*

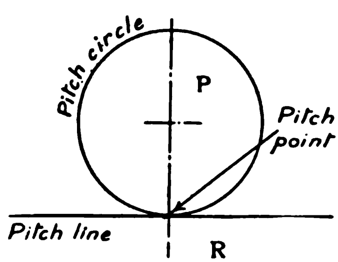


Fig. 21

to provide room for the pins to engage between the teeth; as already explained, we may not alter the distance between the centers of the wheels. Space for the pins is provided by cutting away a portion equal to half the diameter of one of the pins from each face of a tooth along a line parallel to the original curve of the face. This will leave the teeth with the size and shape as indicated by the full lines, Fig. 19, the curves still being epicycloids. To complete the clearance space a semi-circular space is cut away below the pitch line of *W* between each two pairs of teeth. This procedure may be understood by imagining the pin to be a milling cutter moving with its center coinciding with the original lines of the teeth, and thus cutting away the amount of metal necessary to allow the pins to engage. In such a gear, if *W* is the driver,

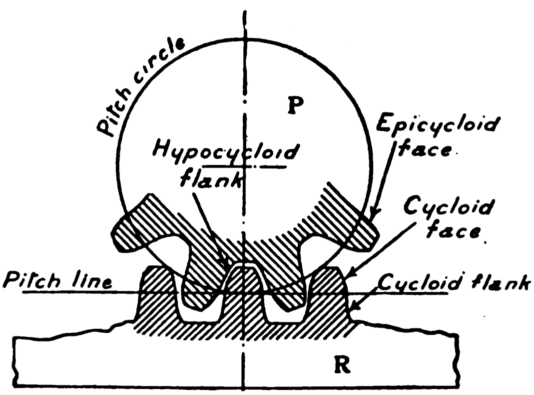


Fig. 22

the engagement of the teeth of the pair of wheels will take place almost entirely after the line of centers. As this is really the object for which the peculiar arrangement is designed, whenever it is used the wheel having the projecting teeth is always made to drive the one which is provided with pins. If the pins are made to drive the teeth, the engagement takes place before the line of centers, and the object of the design is lost. Gears of this kind may also be made in the form of a rack and pinion. The arrangement is much used in clockwork, the wheels with the pins appearing in the familiar form shown by Fig. 20; it is called a lantern pinion. In the main train of wheels of a clock the driving force passes through the gearing from the great wheel

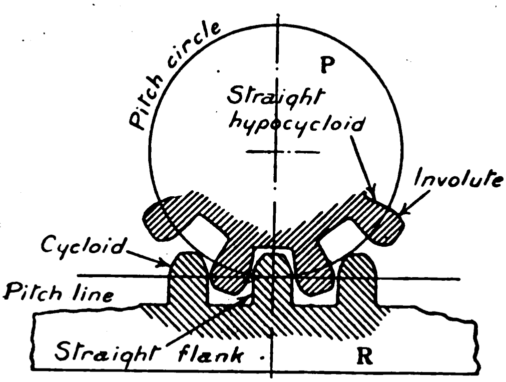


FIG. 23

which is driven by the spring or weight to the escapement. The wheels, therefore, drive the pinions, and the latter can be provided with pins as teeth, hence the extensive use of lantern pinions for clockwork. They have incidentally the advantage of being very strong and durable.

It is possible to design a pinion, also, to engage after the line of centers, with teeth having radial flanks. The number of teeth must be at least ten, and it may be necessary to cut the spaces between the teeth of the pinion with extra width. There would thus be a certain amount of play between the wheels, which would be permissible in clock-gearing where the teeth move slowly, and are kept in contact by a steady, constant pressure. Though the teeth of such pinions need not project beyond the pitch circle, they are usually made with a round end projecting beyond the pitch circle by an amount equal to half the thickness of the tooth, to ensure smooth engagement as the teeth come into action. Clock and watch gearing require large wheels driving very small pinions, and work under special conditions. Anybody contemplating the construction of time-keeping or similar mechanism should consult a treatise on clock and watch gearing. The principles upon which the teeth of the wheels are constructed are, however, precisely those which govern the design of wheel-gearing for machinery in general. Smooth action is very important, therefore the teeth must be of correct design to preserve the relative velocities of the pitch circles. Practical modifications would be introduced to meet the peculiar conditions of clock gearings. For example, the spaces at the roots of the teeth of *W*, Fig. 19, would probably be cut somewhat deeper than indicated, and rectangular instead of semicircular, the sides being radial lines. The teeth of *W* would be of less width than the spaces between the pins on *P*, this amount of play permitting engagement to take place at or very near to the line of centers. The best length for the teeth of *W* would probably be found by experiment.

A rack and pinion gear may be considered as a pair of toothed wheels, one of which, the rack, has a pitch circle of infinite radius—that is, it is a straight line. The teeth can, therefore, be shaped according to the principles already explained. Provided the rack is made of sufficient length, the pinion can be made to give any desired number of revolutions for one stroke of the rack or the rack to move any desired length of stroke for one revolution of the pinion. The gear is to be planned according to the principle used for designing a pair of toothed wheels. The pinion *P* is represented by its pitch circle, and the rack *R* by a pitch line, Fig. 21, which is really the pitch circle of a second wheel stretched out to form a straight line. They touch one another at pitch point *x*. The pinion may drive the rack, or, conversely, the rack may drive the pinion. As with a pair of wheels, the teeth should be of such a shape that the relative velocities of the pitch circle and line are maintained. The length of stroke which the rack will make for one revolution will depend upon the diameter of the pitch circle of the pinion. When planning a rack and pinion, therefore, the positions of the pitch circle of the pinion and pitch line of the rack should be determined first without regard to the teeth of either. The distance which the rack will move for one revolution of the pinion will be equal to the circumference of the pitch circle of the pinion. Thus, if the diameter of the pitch circle of the pinion be 4 in., the rack will move 12½ in. for each revolution of the pinion. Conversely, if the rack drives the pinion, the latter will be rotated one complete revolution if the rack be moved through a stroke of 12½ in., and so on.

If the rack or pinion are to be indiscriminately driver or follower, the teeth should be partly formed outside the pitch lines and partly inside, as in the case of a pair of wheels. The curves of the teeth of the pinion will be as follows—the faces epicycloid and the flanks hypocycloid. The curves of the teeth of the rack will be as follows—the faces cycloid, and the flanks cycloid also, because in each instance the curve-generating circle is rolled upon a straight line, Fig. 22; the diameter of this generating circle may be anything not exceeding the radius of the pitch circle of the pinion, and the same generating circle can be used to form the whole of the curves. If a set of wheels is required of different diameters and numbers of teeth, any one to work with the rack, the generating circle should be equal to the radius of the pitch circle of the smallest wheel. The pitch of the teeth is measured on the circumference of the pitch circle of the pinion and along the pitch line of the rack. It may be expressed as diametrical pitch in terms per inch of the pitch circle diameter of the pinion, as previously explained; it will thus also apply as pitch in number of teeth per inch length of the rack. When the curve generating circle has a diameter equal to the radius of the pinion pitch circle the teeth of the pinion will have straight radial lines for the flanks, as previously explained, and the rack teeth will have curved lines for both faces and flanks, the curves being a cycloid. The teeth of the rack may, however, be made to have straight radial flanks. As the radius of a straight line is of infinite length, the flanks of such teeth will be straight lines perpendicular to the pitch line. The faces will be a cycloid formed by the generating circle, which produces the straight radial flanks of the pinion.

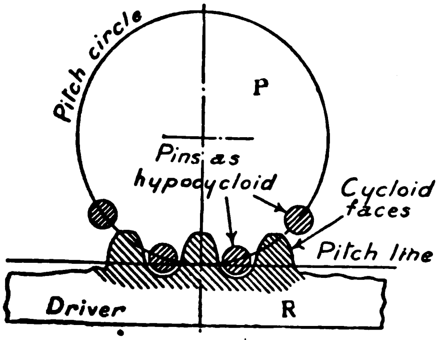


FIG. 24

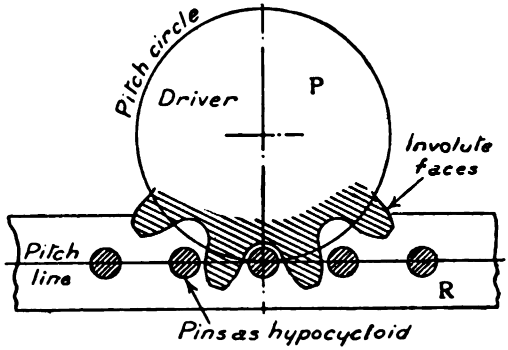


Fig. 25

The faces of the pinion teeth, however, should not be an epicycloid curve, because they should be produced by the generating circle which has produced the so-called radial flanks of the rack. But this circle is one of infinite radius—in fact, it is a straight line. Therefore, the faces of the pinion teeth should be curves produced by rolling a straight line upon the circumference of the pitch circle; the curve should thus be an involute of the pitch circle of the pinion, Fig. 23.

The rack of the pinion may be fitted with teeth in the form of pins on the principle explained with reference to Figs. 18 to 20. As in the case of a wheel and pinion, the pin teeth should be on the follower and not on the driver. If they are placed upon the pinion, the rack should therefore be the driver; if they are placed upon the rack, the pinion should be the driver. The pins represent a hypocycloid produced by a curve generating circle having a diameter equal to that of the pitch circle of the wheel upon which they are placed. Therefore, if they are placed upon the pinion, the teeth of the rack will be formed by a cycloid curve produced by a point on the pitch circle of the pinion when it is rolled upon the pitch line of the rack. The rack teeth will be composed of the part which projects above the pitch line, so that they will have faces only and no flanks, Fig. 24. If the pin teeth are placed upon the rack, they represent, as before, a hypocycloid produced by a curve generating circle having a diameter equal to the pitch circle upon which they are placed. In this case the pitch circle is a straight line, therefore the curves of the teeth of the pinion should be produced by rolling a straight line upon its pitch

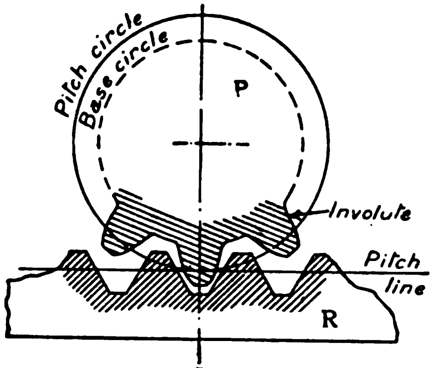


Fig. 26

circle. The curve thus produced will be an involute of that pitch circle. The teeth of the pinion are, therefore, shaped to an involute curve, and consist of the part which projects beyond the pitch circle, no flanks being required, Fig. 25. Gears on this principle should work very smoothly if properly made, as the friction between the teeth takes place almost entirely after they have passed the line of centers. Theoretically, the pin teeth are points, as in Fig. 18; the spur teeth of the driver are cut away to allow for the thickness of the pins, as previously explained with reference to Fig. 19.

The teeth of both rack and pinion may be formed on the involute principle, either to be indiscriminately the driver. In this instance the teeth of the pinion have both faces and flanks formed by one curve, namely—an involute formed by rolling the pitch line of the rack upon a suitable base circle, Fig. 26. The teeth of the rack must also be an involute in theory. But the involute of a circle of infinite radius is a straight line. The teeth will therefore be formed of a straight line for both faces and flanks, and the line should be inclined so that it is a tangent to the curve of the teeth of the pinion. As in the case of a pair of wheels, the pitch circle of the pinion and pitch line of the rack must be in contact, or the relative velocity will not be kept constant except when the teeth are formed upon the involute principle.

(*To be continued*)

PATTERN-MAKING METALS

Metal is used for making patterns in place of wood on account of its greater durability, the fact that it keeps its shape better, and also on account of the fact that more complicated designs can be executed than in wood. Among wooden patterns we find two materials used: pine for the heavier and more common patterns, and mahogany for the more expensive and more delicate patterns, and especially for those which will be in almost constant use.

Turning to metal pattern-making, we find an almost infinite variety of metals used. Where but few metal patterns are used in a shop, and the work is not extremely exact, so that slight variations in the size of pieces do not make much difference, it is common practice to pour the metal patterns from any metal which is being used in the foundry at the time. Castings which are made in this hazardous fashion are usually finished in the same happy-go-lucky way (says H. Malone in the *Pattern-maker*), and the castings made from these patterns certainly show it.

The different metals used for making patterns may be divided into iron and alloys. The alloys may be again subdivided into hard and soft alloys, or into brasses, bronzes and white metals.

Taking up iron first, we find that cast iron is very extensively used for patterns, especially for large moulding machine patterns. It has the advantages of cheapness and ability to keep its shape—that is, it is not only stiff so as to resist bending, but it is hard enough to resist any ordinary bruises. The iron for casting patterns should be what is known as a close-grained gray iron, suitable for the general run of light machinery castings.

Master-patterns are usually made in wood, and the necessary double shrinkage allowances made. If the pattern is to be of exact size, it is also necessary to make the finish allowances in the master-pattern. The pattern casting is then taken to the machine shop and finished either by machining or filing. All pattern-makers know that iron rusts very readily, and this is the greatest objection to the use of iron castings, as they must of necessity be in contact with the damp sand when in use. To protect the surface of the iron from corrosion, a number of different methods or devices are used. Sometimes the finished surface is rusted, either by dampening with salt water and allowing it to rust, or by dampening with water containing acid or sal-ammoniac. The pattern is then warmed to dry it thoroughly, and the extra rust brushed off with a soft brush. It takes several hours for the rust to penetrate deep enough to make a good surface, and in many cases the castings are left over night. After the surplus rust has been brushed off, the castings are usually given a coating of wax; sometimes this is accomplished by heating the pattern and applying beeswax, after which the surplus is scraped off and the surface rubbed down smooth.

Iron patterns require considerable care in the storage and maintenance, as if they are neglected for even a few days they are liable to rust seriously, and if there are any loose pieces or pins they are liable to rust fast.

As stated, iron patterns are frequently used where relatively large work is to be made. If such patterns were cast solid they would be extremely heavy to handle, and consequently they are generally cast hollow. Here, again, the nature of cast iron lends itself very well indeed to the necessities of the case; on account of the stiffness of the metal very thin patterns can be made, especially when any flat surfaces are supported by suitable ribs.

Cast-iron patterns are not suitable for small, light work for several reasons. One reason is that it is difficult to form delicate and complicated outlines in cast iron, and to prevent these from becoming injured through the corrosion of the metal.

Very frequently, indeed, an order comes into the foundry for quite a large number of castings, for which only one pattern is furnished. Where the pieces are small, the pattern can frequently be used for a master-pattern from which to make a number of other patterns, thus enabling the foundryman to turn out the work much more rapidly. One of the white metals is generally used for producing such patterns as this. An alloy commonly used is made of equal parts of tin and zinc. This alloy will shrink only about 1/64 in. per foot, and hence, especially in the case of small castings, there will be practically no difference between the size of the master-pattern and the other patterns made from it—in fact, in some cases the shaking of the master-pattern enlarges the mould to such an extent that the other patterns are actually larger than the master-pattern, and may require trimming down.

The alloy composed of equal parts of tin and zinc is rather soft, bends fairly easily, and is liable to injury. To overcome these difficulties, some pattern-makers prefer to use an alloy composed of 85 per cent. tin and 15 per cent. antimony. This is quite an expensive alloy, but is surprisingly stiff and hard, and so makes a fairly good metal for a gate of patterns from which only a relatively small number of castings are required. The shrinkage of the tin-antimony alloy mentioned is about 1/16 in. per foot, but in small work the rapping of the master-pattern will more than compensate for this.

In brass foundries the tin-zinc alloys are very largely used for temporary patterns on account of the fact that the old patterns can be melted down and used in making any alloy containing the above-mentioned metals. The tin-antimony alloy is not as good for brass foundries on account of the fact that antimony is not wanted in many standard alloys.

When aluminium first came into use, everyone thought it would make very fine patterns; but its use has not been so extensive as was hoped for. There are several reasons for this, one being that aluminium will not solder as other metals do. For the oxide of aluminium which forms on the surface cannot be dissolved by any of the ordinary fluxes, nor can it be reduced by the aid of any fluxing agent known; so it is practically impossible to get any solder to adhere to aluminium. White metal containing aluminium in any considerable proportions, and, in fact, in relatively small proportions, partakes of the nature of aluminium to such an extent that it cannot be soldered. It will readily be seen that this defect will rule out aluminium and aluminium alloys for use as pattern metals in most cases. Another great disadvantage of aluminium is that it cannot be melted in an iron pot, nor can it be melted and poured as readily as ordinary alloys, and hence it requires a regular melting furnace, and the services of an experienced melter. The other white metals mentioned can all be melted in iron pots with comparatively little deterioration of the quality of the metal.

A soft white alloy used by many pattern-makers is made by taking standard Babbitt-metal as a base, the metal being made in the following proportions: Babbitt-metal, 1 lb.; tin, 1 lb.; lead, 1 lb. The standard or original Babbitt is composed of tin, 50 lbs.; copper, 2 lbs.; antimony, 4 lbs.; or, in other words, 89.3 per cent. tin, 3.6 per cent. copper, and 7.1 per cent. antimony. Another authority gives the following composition for the original Babbitt: 83.3 per cent. tin; 8.3 per cent. copper, and 8.3 per cent. lead.

It will readily be seen that the effect of using Babbitt in the pattern alloy is to add a small percentage of copper and antimony, both of which have a tendency to harden and stiffen the metal. The large percentage of lead, however, makes the working of the metal easy.

One advantage of the softer white metals is that they are soft enough to be chipped, filed, or scraped with ease, and this greatly reduces the work necessary in making patterns. Not one of the white metals is stiff enough to give good service as gates: the antimony-tin alloy mentioned is sometimes used in cases where the gates are cast on the patterns for a temporary job; but in practically all cases white metal patterns should be provided with gates made from cast or rolled brass. Hand-rolled brass is to be preferred for this, on account of its greater density and consequent stiffness.

There is one advantage in using a white-metal pattern, even where a considerable number of castings are to be made—that is, in the case of experimental work a wooden pattern can be made, a few castings produced from it, and the necessary tests made. If the casting is found suitable for the purpose for which it is intended, a white-metal pattern can then be cast from the wooden pattern, and, owing to the small shrinkage of the white metal, this pattern will serve for making all future castings. If the patterns were to be made from brass or bronze, in many cases it would be necessary to make a wooden pattern, as brass or bronze shrinks more than the desired pattern. It will readily be seen that in such a case as this the use of the white-metal pattern for permanent work saves the cost of one wooden pattern.

For patterns for continual use, as, for instance, on standard work, brass or bronze patterns have become almost universal. They have the following advantages: They are stiffer than white-metal patterns, the gates can be cast with the patterns, and in some cases both gates and runners can be cast together, thus making a very much better and stronger job. The surface of brass resists the scouring action of the moulding sand better than the white metals, and also draws from the mould more freely. A good grade of bronze or gun-metal is very much superior to brass, and hence gun-metal or bronze makes the best patterns. A good standard gun-metal is composed of 32 parts copper, 1 part zinc, and 3 parts tin. A good bronze may be made with the following proportions: 16 parts copper, 1 part tin, 1 part zinc, ½ part lead. The exact composition of either of these alloys, however, is not an absolute essential; a good high-grade gun-metal or bronze will certainly make the best pattern metal available. Common yellow brass, which is composed of 16 parts copper, 8 parts zinc, and ½ part lead, is frequently used as a pattern metal. As already stated, when any of these metals is used, it is necessary first to make a pattern from which the metal pattern is to be cast. If the piece is large or chunky, this pattern may be made of wood; while if it is delicate in design, the master-pattern should be made of brass or bronze, sheet metal being generally employed for this purpose. The highest grade of bronze or gun-metal patterns needs no lacquer to make it draw from the sand freely. High-grade bronze patterns are frequently finished by chasing. This is especially true in the case of art work or leaf designs.—*Model Engineer and Electrician.*

The Russian duma has been asked to appropriate $515,000 for the erection and equipment of wireless stations on the Kara and White Seas. The project is intended to insure telegraphic communication via the Arctic Ocean between the northern and western parts of Siberia and St. Petersburg, Russia.

SHOWING THAT TWO CURRENTS CAN BE SENT ALONG ONE WIRE SIMULTANEOUSLY

G. G. BLAKE

The following is a description of a simple way of demonstrating the principles of a system invented by Edison for telegraphing to and from trains while in motion by means of currents of high voltage, induced on the outer surfaces of existing telegraph lines which run parallel to the railway, without interfering with any messages already being transmitted along them.

Fig. 1 shows the general arrangement of the apparatus. I will first describe the low-voltage transmitter and receiver.

The transmitter *A* consists simply of a battery of one or two dry cells *F*, one terminal of which is earthed at *E* by connecting it to a gas or water pipe. The other terminal is connected to a Morse key *G*, and then by wire *O* to *N*, where it is fastened to the end of a piece of 1/16 gauge well-insulated electric light cable; the end *M* of this cable is in turn connected to a length of bare 1/16 wire *K*, along which the two currents are to travel. The other end of *K* is connected at *L* to another piece of well-insulated 1/16 cable.

A wire is fastened to this at *P*, which leads to the receiver *B*; this consists simply of a galvanometer, the other terminal of which is earthed at *Q*.

Every time the Morse key *G* is pressed, a current of low voltage will travel along the wire *K* from the battery through the galvanometer, causing its needle to be deflected.

C represents the high-voltage transmitter, which consists of a battery or accumulator, which is connected to the primary of a small induction coil *H* through a Morse key *J*. One of the secondary terminals of this coil is earthed at *S*, while the other is connected to a piece of brass tube *T*, through which the insulated wire *MN* passes.

The receiver *D* is an ordinary telephone, one terminal of which is earthed at *W*, while the other is connected to a piece of brass tube *U*, which encases the insulated wire *PL*.

When the Morse key *J* is pressed, the brass tube *T* is charged with a current of very high voltage, which, by induction, creates a high-voltage current on the wire *NMKLP*, and this wire in its turn sets up a second induced current on the tube *U*, which passes to earth through the telephone *D*, causing its diaphragm to vibrate, and so giving an audible signal.

Now, after having made the necessary connections and tested both the high- and the low-voltage currents separately

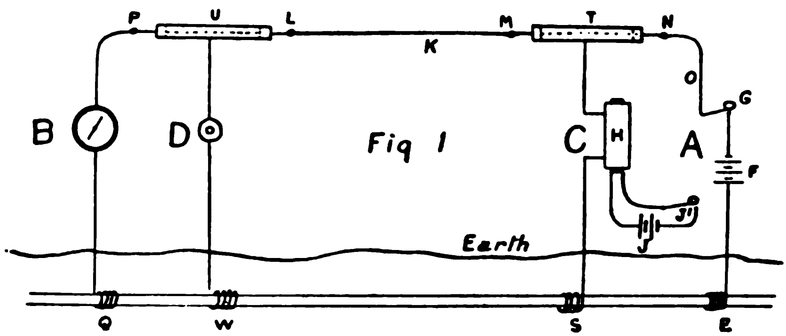


Fig 1

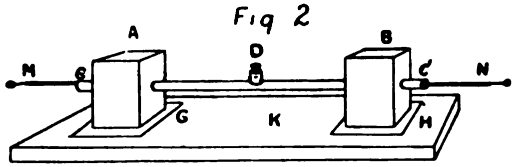


Fig 2

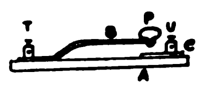


Fig 3

to see that they both work properly, it will be found that if the two transmitters are worked simultaneously, both the currents will travel along the wire *K* without in any way affecting each other, and both of the receivers will be affected by their own transmitters only.

The explanation of this experiment probably is that low-voltage currents travel practically along the whole section of the wire, while the high-voltage currents travel only on its surface.

Fig. 2 shows how the brass tubes *U* and *T* are fitted up.

A and *B* are two small blocks of wood 3 x 2 x 2 in., through the center of each of which is bored a hole, through which the brass rod *CC* passes; this is 5/8 in. in diameter and about 20 in. long. On the center of this rod is soldered a terminal *D*.

The insulated wire *MN* (which is of

Fig 4

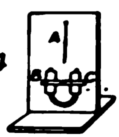
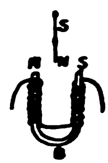


Fig 5.



1/16 gauge) passes through holes in two india-rubber corks which are fitted into each end of the tube.

The two wooden blocks *A* and *B* are glued to two small pieces of thin plate-glass 3 in. square, *G* and *H*, which serve as insulators, and these two pieces of glass are in turn glued to a wooden base-board *K*.

Fig. 3 shows the construction of a simple form of Morse key suitable for this experiment. *A* is a small block of wood, on which is fastened a short piece of steel clock-spring *B* connected to terminal *T*, and a small brass plate *C* connected to terminal *U*. *P* is a small wooden knob, which is fastened to the end of the clock-spring by a round-headed brass screw, the head of which, when the spring is pressed down, touches the brass plate *C*.

Fig. 4 shows a simple way of fitting up a suitable galvanometer for this experiment.

from an old electric bell would do nicely); *C* is a short piece of wood, through the center of which passes a screw; this holds the magnet in position. Now, if a current be passed through the coils of the magnet (see Fig. 5) the south pole will attract the needle, while the north pole of the magnet will repel it, so that the needle will at once swing to one side or the other, according to which way the current is passing.

Explosive Rock

The danger of explosion in mines is not entirely confined to inflammable gases, carelessly managed fuses, and neglected charges or cartridges. It has been observed that in lead mines some of the slate rocks are likely to burst on being scratched with a pick. The explosion is supposed to be due either to gases inclosed in the rocks, or to molecular strains.

Not long ago a severe explosion of slate rock occurred in a mine at Hillgrove, New South Wales, and the shock was felt for a mile or two over the surrounding country. In this instance, it is believed that the rock wall where the explosion occurred was subjected to a mechanical strain.

Locks, Bolts and Bars

The Egyptian lock, states the *Ironmonger*, was an assemblage of wooden pins or bolts. It is possible that this suggested to Burmah his remarkable invention. The Roman lock was practically a padlock, and it seems probable that the key was of Greek origin. In Latin countries the locksmith never confined himself to mere door furniture.

At the very beginning—as nowadays in France—his art embraced all the wrought ironwork which serves to close and secure our dwellings, from a monumental garden gate and railings to a simple latchkey. The art reached its apogee about the fifteenth or sixteenth century, so far as the former class of work was concerned.

Some mediaeval specimens—the hinges of the doors at Notre Dame, for instance

INDUCTION MOTORS AND HOW THEY WORK.—Part II

NORMAN E. NOBLE

The motor we have considered so far, Fig. 10, is a two-phase two-pole motor, from which we get a rotor speed of nearly 3,000 revolutions per minute; this is rather a high speed, from a mechanical point of view. So we will now consider means for reducing it. We could, of course, supply the motor from a lower frequency, say 25 cycles per second instead of 50; this would reduce the speed to 1,500 revolutions per minute. But this is not always convenient, hence the only alternative is to produce more poles in the revolving field. This can be done by winding more coils on the stator, as in Fig. 12, which represents the necessary slots in stator, to produce a four-pole field, or two slots per pole; we could have more slots per pole, but this example will serve our purpose. The full lines represent one phase, and the dotted lines the other phase; each of the two coils forming one phase is wound so as to produce like poles in that part of the stator they embrace. When the current in the coils *AB* and *CD* is a maximum, we should get a magnetic field, as shown by the letters *NN*, these causing consecutive poles *SS* to appear, as indicated in Fig. 12. When the current in these coils has diminished to zero, the current in the coils *EG* and *FH* would be a maximum, and would produce magnetic fields $N_1 N_1$, giving consecutive poles $S_1 S_1$. It is therefore evident that the stator field will move one-eighth of a revolution during a quarter of a period variation of the currents, or one revolution of the field to two periods variation of the currents. Therefore, for 50 periods per second supply, we get a rotor speed of practically

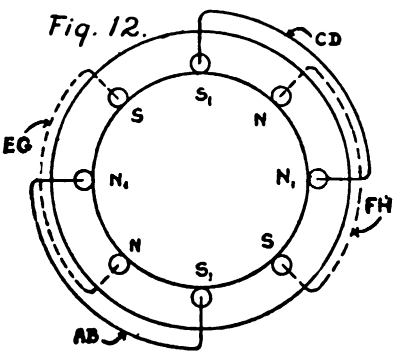


Fig. 12.

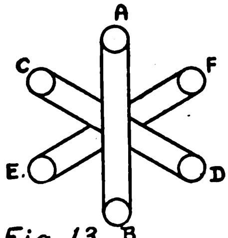


Fig. 13.

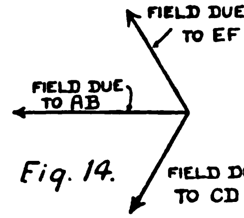


Fig. 14.

1,500 revolutions per minute. We could by increasing the number of poles still further reduce the field speed; therefore, the rotor speed. For instance, a six-pole field would give 1,000 revolutions per minute, and an eight-pole field 750 revolutions per minute, and so on; this is, of course, reckoning on a supply of 50 periods per second.

As pointed out before, induction motors can be made to run a three-phase supply, that is, each current differing in phase by 120 degrees, Fig. 6. If these currents were passed through the three coils (120 degrees apart), as shown in Fig. 13, each coil being similarly lettered to the phases in Fig. 6 (that is, phase *AB* passing through the coil *A B*), when the coil *A B* produces its maximum magnetic strength, which is horizontal, and its N. pole to be at the left of diagram (being assumed), at this same instant the fields due to the coils *CD* and *EF* are not at their maximum strength, but they have equal strengths, as will be seen from the curves, Fig. 6; so we shall get three fields directed as in Fig. 14 (the coils being suitably wound). At the point marked No. 2, Fig. 6, the fields due to the coils *CD* and *AB* have reversed their directions, the field due to *C D* being at a maximum, and *A B* at an intermediate value. The field due to the coils *E F* has still the same value and direction as at point No. 1, but it has passed through its maximum value, Fig. 6. From these we get a result, as shown in Fig. 15.

At the point No. 3, Fig. 6, the phase *E F* is a maximum value, and has changed its direction; *C D* has changed its direction, and is not at an intermediate value; and *A B* has the same magnitude and direction as at point No. 2. These cur-

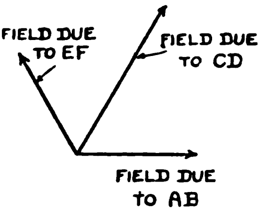


Fig. 15.

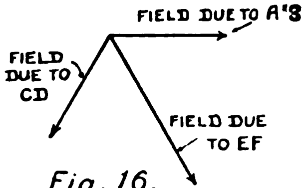


Fig. 16.

rents now produce a field, as indicated in Fig. 16. Finally, at the point marked No. 4, Fig. 6, we get the field, as shown in Fig. 14, which is the same as we commenced with. Thus we have one revolution of the magnetic field for one period of variation of the currents—that is, from point No. 1 to point No. 4, Fig. 6. In each case the three fields give one resultant field, having its direction the same as the strongest of the three, and the magnitude greater than the strongest field, because the other two fields are pulling in the same direction.

This is a two-pole field, and, as with the two-phase field, we get one revolution for one period variation. This three-phase two-pole field consequently suffers from the same disadvantage as the two-pole two-phase field, the speed being too high. To reduce this high speed, we do as we did in the case of the two-phase field—that is, we wind on the stator another set of coils, which produces another field either in front of or behind the original field; therefore, we get a four-pole field, which reduces the field speed to 1,500 revolutions per minute; a further increase in number of the poles reducing the speed still further, as pointed out with the two-phase field.

With regard to the rotor, a squirrel-cage rotor can be employed for either two- or three-phase and single-phase induction motors. In two- and three-phase motors the stator windings is the only place where a difference between the two can be distinguished, generally speaking.

We have yet to deal with the action of single-phase motors, as their action is somewhat different from two- and three-phase motors. A single-phase motor depends for its action on a pulsating field, and not a rotating field, as was the case with the others. Referring to Fig. 7, we found that, with such a winding as shown, we got a pulsating field. Let us assume that we had a two-phase motor in which each phase of the supply had an independent switch; now, while it is running on light load, let us open one of the switches and we shall find that the motor will run at its proper speed, and, what is more peculiar, we can derive mechanical energy, although it is running on one phase. We shall, however, be able to see the current in the phase which is running the motor is greater than when the motor was running on two phases. If we now open the switch of the remaining phase the motor will stop, and if we attempt to try to start the motor again with only one-phase connected, we shall find we are unable to do so; therefore, we conclude that a single-phase motor is not self-starting, but if, when we have opened the switch of the remaining phase to stop it as before, and close it again before the motor comes to rest, we shall find the motor will run up to speed again. This shows that a single-phase motor, if given an initial start as the current is switched on, will run up to its proper speed. Another peculiarity of single-phase motors is, that they will rotate in either direction, just whichever the initial start is given in. The reason for the non-starting of single-phase motors is, because we only have a pulsating field and not a rotating field, consequently no turning effort is given to the rotor, but merely a force first pulling, and then pushing at the rotor. From our mechanical knowledge, we know that a motion of this kind can be converted into circular motion—the treadle motion of a sewing machine affords a good example, Fig. 17.

It is, of course, necessary in the treadle motion that the crank should be past its dead center before the push of the connecting rod is of any use: thus, if we give the wheel a start by hand, it will continue

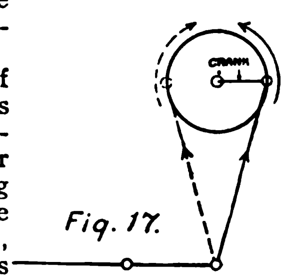


Fig. 17.

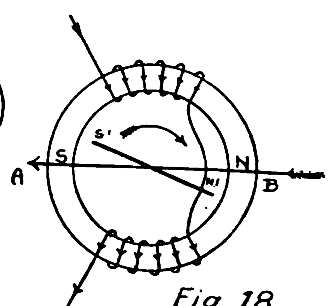


Fig 18.

to rotate in the direction in which it is started. The action of a single-phase motor is much the same: if we give the rotor a start, a revolving magnetic field is formed in the rotor which reacts on the stator pulsating field at that instant, and is reversed as the stator field reverses, the initial start carrying the rotor over what might be termed the dead centers. However, considering the matter electrically, what we have is this: when the current is switched on to the stator windings, a pulsating field is produced which, as it threads through the rotor windings, induces in them a current which itself produces a pulsating field in the rotor. This field, which we will call A, has always the same direction as the stator field, but attains its maximum strength when the stator field has its zero strength, or, in other words, it is 90 degrees out of phase with the stator field. This is so because the strength of any current induced by lines of force cutting a conductor depends on the rate at which the lines of force cut it, or the rate of change of the magnetic field, in this instance. At that instant when the current is at zero, that is, just when it is reversing its direction, the stator field is at its maximum rate of change, hence the induced current will be at its maximum value in the rotor conductors. Therefore, this rotor field A is in the same direction as the stator field, but 90 degrees out of phase with it. As soon as we give the rotor a turn by hand, the conductors cut the lines of force of the stator field; this induces in them a current, and thus produces a magnetic field (pulsating), which is at right angles to the field A. This second field we will call B, and its direction depends on the direction the initial start is given in. This field B is in phase with the stator field—that is, they both attain their maximum value at the same instant. These two rotor fluxes, 90 degrees out of phase with one another, and also at right angles to each other, produce between them a rotating field in the rotor, just as we got a rotating field from two alternating fluxes 90 degrees out of phase, and at right angles to one another, in the two-phase stator. Let the long arrow AB, in Fig. 18, indicate the direction of the stator field at that instant when it is at its maximum value. Now, when we give the rotor an initial start, we get a rotor revolving field as previously stated; let its position and direction at the instant under consideration be as shown by the arrow NS, Fig. 18. The stator field now acts upon this rotor revolving field and produces half a revolution of the rotor. The stator field now changes, owing to the current's changing its direction; that is, it changes its polarity, and we get another half revolution of the rotor.

The motor will now continue these operations and run up to its proper speed; we must not forget at any time, that no revolving field exists in the rotor until we have given it an initial start. As previously mentioned, a single-phase motor will run in either direction, whichever direction the initial start is given in, except in the case where starting devices are used, which will be dealt with later. The motor, as shown in Fig. 18, is a two-pole field motor, and the rotor speed will be almost equal to field speed on light load. The field on a 50-period supply would revolve at 3,000 revolutions per minute in this case. This speed is too high, but can be reduced by increasing the number of poles of the field, just the same as we did with the two- and three-phase motors, the only difference being that single-phase motors have a pulsating field and not a rotating field, as with two- and three-phase motors.

We shall now have to make some provision for making single-phase motors self-starting; in small motors which can easily be started by hand no difficulty will be experienced, but with larger motors it is very troublesome. If we could by any means introduce another current at starting which differed in phase from the main current a quarter of a period, or even less, and pass this extra current through an auxiliary winding on the stator, we should get a rotating field which would start the motor without trouble. This auxiliary starting phase could be connected to the starter in such a manner that it would be cut out on the last notch and the motor would be running as a single-phase machine. This auxiliary phase must be provided from the single-phase mains, the way it is produced being as follows: The auxiliary winding is put on the stator and produces a field nearly perpendicular to the main field and out of phase with it, the amount of phase difference between the two fields depending on the phase difference of the currents; of course, the winding is in series with a choking coil, and the whole lot in parallel with the main phase and then to the supply, Fig. 19. The choking consists of the usual laminated core, round which a coil of wire is wound, the high self-induction of the choker causes a phase difference between the volts and current in the auxiliary winding. There is, of course, a phase difference between the volts and current in the main phase due to self-induction in same, but is small compared with that in the starting phase caused by the choker; thus, it will be seen that there must exist under these conditions a phase difference between the current in the main phase windings

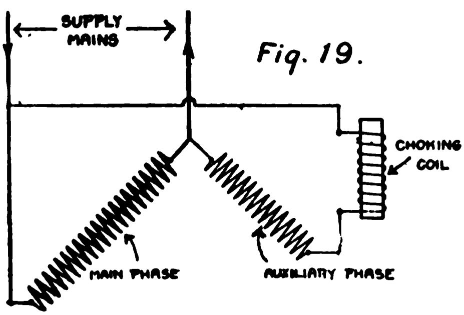


Fig. 19.

and the current in the starting or auxiliary phase windings; but the difference is never a full quarter of a period at any time; so we do not get a true rotating field, but one having rather an elliptical motion. This, however, is quite sufficient to start the motor, and as the lever is moved on to the last stud, the choker and auxiliary windings are cut out of circuit and the main phase runs the motor. We could, of course, get the same result if we substituted a capacity for the choker, but, generally speaking, choking coils are mostly used. There are other methods besides those mentioned, but they all depend on the same idea, and that being a phase difference to be created at starting and cut out when full speed is attained.

Single-phase motors suffer from two disadvantages; that is, they have a low starting torque, whereas two- and three-phase motors have a starting torque capable of dealing with even an overload, single-phase motors only exerting one-half, or even less, than full load torque. For this reason, if the starting load is high, fast-and-loose driving pulleys are provided on the machine or shaft, the belt being put on the fast pulley when full speed has been reached. The other disadvantage is that single-phase motors cannot be overloaded like two- and three-phase motors.

The reversing of alternating-current motors can be effected by interchanging the connections of any one phase in two- and three-phase motors, and by interchanging either the auxiliary phase or the main phase, but not both in a single-phase motor. Single-phase motors, without an auxiliary or starting phase, will rotate in that direction in which the initial start is given.

We have only dealt, so far, with squirrel-cage rotors, which consist of a number of short-circuited conductors, laid in slots, the conductors being permanently short-circuited by means of copper rings, Fig. 11. This type of rotor is only used in small motors, or motors which do not have to start up under load. Let us carefully consider what happens when a motor having a squirrel cage is started up. As soon as the main switch is closed the stator field revolves at full speed, and (leaving the rotor out of consideration for a moment) this revolving field cuts the stator and induces an opposition or back e.m.f., which reduces the supply voltage and allows only the necessary magnetizing current to flow (similar to a transformer with open secondary winding). Now, considering the rotor, the stator revolving field cuts the conductors of same and induces a current; now the rotor is stationary for an instant, and then starts and gathers speed, but it is a short time before it reaches a speed sufficiently high enough to reduce the relative velocity between itself and the rotating field. During this time the revolving field is cutting the rotor conductors at a very high velocity, thus inducing a large current in them, and producing a strong magnetic field in the rotor. This rotor magnetic field weakens the stator field (being in opposition to it) and reduces the back e.m.f. in stator winding, thus allowing a large current to flow from the mains. This is very objectionable from a supply company's

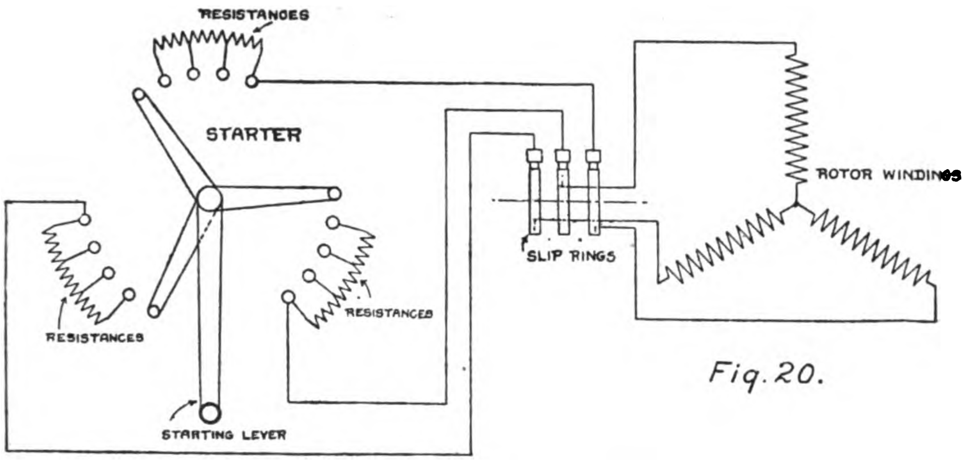


Fig. 20.

point, as it causes a fairly large phase difference between the current and volts, hence a low power factor. If we could put a resistance in series with the rotor conductors, it would help to keep the currents from attaining large values; but this is impossible with squirrel-cage rotors, because of the conductors' being permanently short-circuited. To get over this difficulty a different kind of rotor is employed (constructional), but the principle remains the same. In place of the short-circuited conductors, we use coils wound on the rotor, the ends being connected either in star or in mesh to three slip rings, in the case of a three-phase motor, or four rings in a two-phase (four mains) motor, and two in a single-phase motor; brushes running on the slip rings convey the rotor currents to regulating resistances (a resistance for each phase); Fig. 20 shows a general arrangement of a three-phase starting resistance. When the stator is switched on to the supply, under these conditions only, the necessary magnetizing current flows in the stator windings because the rotor circuits are open (the starting levers being on the dead studs, Fig. 20), and no current can flow to produce an opposition field to the stator field, which would weaken same. The stator field is now revolving at full speed round the stationary rotor. As we pass the starting levers on to the first stud, the rotor circuits are complete, and a current will flow in them, but cannot attain a high value because of the resistances in the circuits; the magnetic field in the rotor is produced, which starts the motor, and as we cut out the resistances the speed increases, and on the last studs it will be seen that the rotor windings are short-circuited, and rotor runs exactly as if it were a squirrel-cage rotor. For the purpose of cutting the starting resistances clear of the motor a special device is mounted on the slip-ring end of rotor shaft, which takes the form of a knob running loose on the shaft, which, when pushed in, connects the slip rings to one another, thus short-circuiting the rotor windings and allowing the starting lever to be put back ready for starting up again without interfering with the motor. In some starting devices the short-circuiting knob, when pushed in, cuts the last resistance steps out, instead of cutting it all out with the starter. Fig. 20 shows the previous method, the short-circuiting knob simply cutting the starter clear of motor. In some cases, where motors are to be put in inaccessible positions, where the short-circuiting knob would be difficult to get at, it is dispensed with, and the starting levers being on the last stud, short-circuits the windings, and they are left in that position as long as the motor is running. Fig. 20 shows this last method. The only objection to this type is that we depend on the brush contact on slip rings for keeping the rotor windings short-circuited; if anything should occur by which one phase of winding became disconnected—for instance, a carbon or brush breaking—we should get an uneven field in the rotor and the speed of motor would drop very considerably. However, it is not very often that it does happen, and with care and periodical inspection of brush gear very little trouble should occur. In those motors which have the slip short-circuiting device, care must be taken never to start the motor without ascertaining that the short-circuiting knob is pulled out; otherwise, we have a short-circuited rotor, and on closing the main switch a tremendous rush of current would take place; and then, again, the starting resistances would be useless, as they would be cut out, owing to the slip rings' being short-circuited. The introduction of resistance in the rotor circuits at starting has another great advantage, namely, that it causes the motor to exert a large starting torque; the proof of this fact is rather too mathematical to enter into here, so it must be taken for granted. It has been proved that for small values of slip, such as light load, that the torque is proportional to the $\frac{\text{slip}}{\text{resistance of rotor circuits}}$, and that for large values of slip the torque is proportional to the $\frac{\text{resistance of rotor circuits}}{\text{slip}}$. From this it is evident that if we increase the resistance of rotor circuit at starting, we can get an increased torque, which is just what is required.

Another method of starting induction motors of the squirrel-cage type, so as to avoid large currents at starting, is by means of what is known as a starting transformer. The starting switch is of the throw-over type; the main current is fed to the starting transformer, and one side of the switch takes a current from the transformer, which has generally about half the voltage of the mains. This gives the motor a chance of getting some speed up before full voltage is switched on. After the motor has gained speed the switch is thrown over to the running side, which cuts the transformer out of

supply, the speed of the stator field will be 1,500 revolutions per minute, and the rotor speed will be somewhat less than field speed. If it were possible for the rotor to attain the same speed as the field, we should get no rotor currents induced, because the conductors would not be cut by the revolving field; therefore, the rotor is bound to run at a less speed than the field. The difference between the two speeds is called the slip. Suppose that in the above case the rotor speed was 1,480 revolutions per minute, then the slip would be 20 revolutions per minute; that is, per cent.

$$\text{slip} = \frac{20 \times 100}{1500} = \frac{4}{3} = 1.3 \text{ per cent.}$$

If we increase the load on the motor, the rotor speed will drop slightly, thus increasing the slip, which in turn causes the revolving field to cut the conductors at a quicker rate and produces extra current to deal with the increased load. In first-class motors the slip seldom exceeds 5 per cent. at full load, except in very small motors, where the slip may be as large as 10 per cent. or even more. The currents in the rotor of an induction motor are alternating in character, the frequency of them depending on the amount of slip. Referring to the above case of the two-phase motor, where the slip was 20 revolutions per minute, we should get the same effect if the field was revolving at 20 revolutions per minute and the rotor was stationary; this would give us rotor currents having a periodicity of 40 per *minute*. The periodicity of the rotor currents can easily be calculated, knowing the slip and field speed, from the same formula as we calculated field speeds, *viz.*:

$$\text{Speed of field} = \frac{\text{Periodicity}}{\text{Number of pairs of poles}}$$

from which we get

$$\text{Periodicity} = \text{speed of field} \times \text{number of pairs of poles.}$$

Putting the values in for the case under the former equation being used to show the derivation. In making experiments, a tachometer is used to get the rotor speed, the field speed being calculated. There is a disadvantage in using a tachometer for the rotor speed, and that is: only tachometers, as a rule, are capable of reading within about 2 per cent., so that for small values of slip this method is hardly suitable. The method which gives the best results for small values of slip is by inserting an ammeter (preferably one with the zero in the middle) in one phase of the rotor windings, which, as the currents alternate, shows a deflection to the right and then to the left, one complete swing of the needle (*i.e.*, from left to right, and then back again) corresponding to one period variation of the current. This method loses its advantage when the rotor currents alternate quickly, as, with a large value of slip, then the oscillations of the needle become too rapid to be easily counted; then we have to resort to the tachometer method.

In cases where a motor is required to run at two different speeds on the same supply, a special switch is provided in the stator windings, which alters the numbers of pole of the field, thus changing the speed. With regard to speed variation of induction motors, it is safe to say that there are at present no satisfactory means for that purpose, beyond that mentioned. Inserting a resistance in the rotor circuits while under load has an effect upon the speed, but is accompanied by a decrease in efficiency of the motor; and then, again, the variation is very limited.

The efficiency of induction motors (two- and three-phase) at full load is generally about 85 per cent., and decreases with an overload; at light load, the efficiency is low, owing to a low power factor. Single-phase motors on full load do not show quite as high an efficiency, generally speaking.

The advantages of induction motors over all other alternating-current motors are numerous, and in drawing this article to a close, I think they may be enumerated with benefit: (1) Simplicity in construction and working parts, more particularly with squirrel-cage rotors, there being no starting resistances required, hence no slip rings; (2) these motors (excepting single-phase) can deal with very large overloads, and are capable of starting under full load; (3) owing to the fact that the current is led to stationary windings, much higher voltage can be employed, as the insulation is not impaired by having to withstand mechanical strain; (4) they do not require to be run up to speed by external means before being switched on to the supply, as synchronous motors do, but at the same time the speed is not absolutely constant, but varies with the load. With regard to single-phase motors and advantage No. 2, they are not capable of dealing with big overloads and starting up under load as two- and three-phase motors are. This is a point to which much attention has been given by engineers. Many things have been tried to produce a single-phase motor having the advantages of two- and three-phase motors; one of the latest productions on the market being a single-phase motor which can be used for crane-work, where a large starting torque is necessary. This motor is not a true induction at starting, but depends for its large torque on the principle of repulsion motors, which is a large torque at starting, which diminishes as the speed increases (just the opposite to an induction motor); when a certain speed has been attained, the armature (which is similar to a direct-current motor, but having short-circuited brushes placed midway between the maximum and minimum voltage positions) conductors are short-circuited, and the motor then operates as an induction motor. I have, however, had no opportunity for seeing these motors working, and consequently cannot make any statement of their efficiency; it is quite evident that they are not exactly as simple as ordinary induction motors.

There are a number of points which have not been dealt with, for the reason that it would necessitate a considerable amount of mathematics, thus preventing this article from serving its intended purpose, which is a description of induction motors suitable for amateur electrician readers to study without going too deeply into the matter. Nothing has been mentioned about the methods of winding, as this requires to be separately treated.—*The Model Engineer and Electrician.*

A SIMPLE MECHANICAL HARMONOGRAPH

A. H. AVERY, A.I.E.E.

The harmonograph is perhaps one of the most fascinating scientific instruments ever discovered. It deals with the subject of "harmonic" motion, and produces endless examples of most beautifully intricate and symmetrical figures, which are not only intensely pleasing to the eye, but at the same time of great scientific interest and value. The modern view of "energy" in all its various shapes and forms is to regard it as a *vibration*, or harmonic motion, in various complex combinations as regards direction, intensity and rate. Most people are familiar with the experiments of Lissajous, wherein a spot of light was reflected from mirrors attached to the ends of two vibrating tuning forks on to a screen; the result was a symmetrical pattern or figure caused by the spot of doubly-reflected light responding to the vibrations of the forks, and thus rendering, as it were, the sounds actually visible to the eye.

The name "harmonograph" really signifies *sound-writer* in fact, although its scope is by no means limited to acoustical problems. A simple harmonic motion is one recurring at regular intervals, caused by the application of a single disturbing force. Where two or more forces are exerted in regular cycles, the result is compound harmonic motion. Certain time ratios between the two or more applied rhythmic motions always produce the same harmonic figures when in the same relative phase. From what has been said above, it is evident that although it has nearly always been customary to associate harmonographs with the idea of sound waves, they are really instruments which can be used to analyze and imitate any form almost of harmonic wave-motion, whether it be of sound, light, heat, electricity or magnetic and

experience and workshop facilities to construct it. If the following directions are carefully carried out, there will be no difficulty experienced in making a successful apparatus that will produce many thousands of most beautiful figures, with much less labor than required in the making of the more elaborate pendulum-type instruments, as there is no delicate work involved calling for special skill.

Reference to Fig. 2 shows the appearance of the finished instrument, and the relative position of the assembled parts, while Fig. 1 is a scale drawing of the individual items required in building the

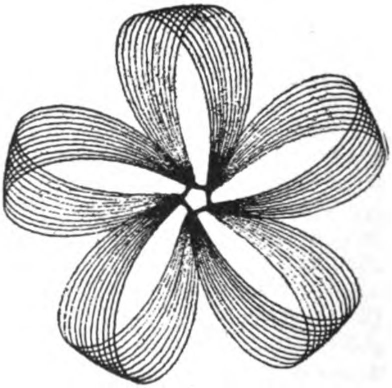


Figure Traced by Mechanical Harmonograph

complete harmonograph. The object to be attained in any form of harmonograph is, of course, to produce two or more harmonic vibrations or movements, and apply the compound impulses to a pen or pencil which is allowed to trace out the resultant motion in the form of a curve or "harmonogram" on a fixed paper. In some instruments the pen is influenced by the combined impulses, while in others the pen vibrates in accord with one impulse only and the paper with the other,

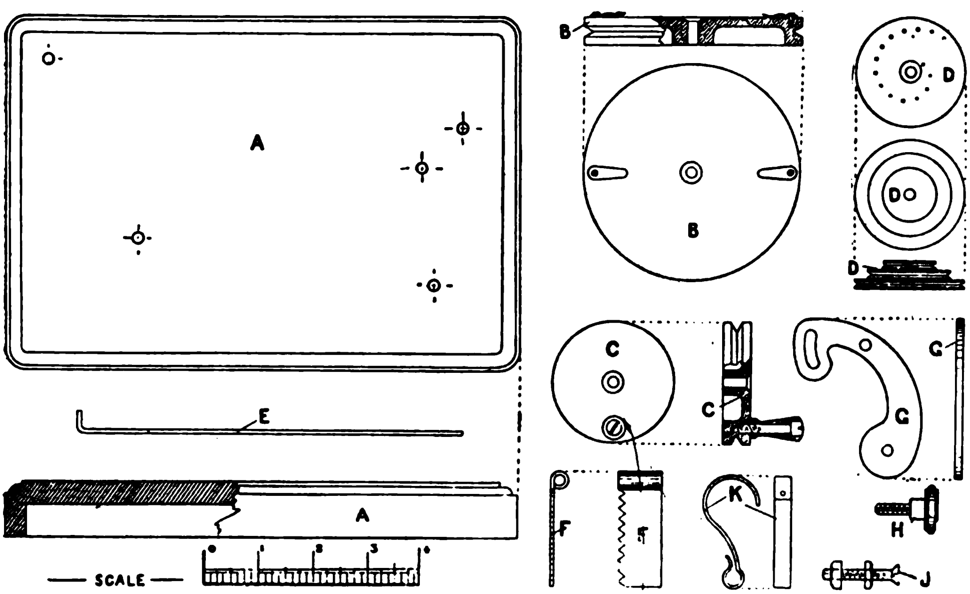


Fig. 1—Details of Complete Harmonograph

revolving pulleys *B*, *C* and *D*, arranged to turn easily on their pivots, one of which *B* forms a table for the paper to rest on, another *D* carrying the arm and penholder, while the third *C* forms the driving pulley, the latter operating the other two by means of an endless driving band.

Different ratios of motion between pen and paper are obtained by the 3-stepped pen pulley *D*. The amplitude, or size of figure, is governed by the throw of the rocker-bar *E*, which can be placed in any one of the fifteen holes shown at different radii in the top surface of pulley *D*, and also by the position of the bar *E* in the notched support *F* at its free end. Also the actual position of the penholder itself affects the contour of the figure as it is slid along the bar *E* to any convenient point.

The baseboard *A* is prepared from walnut or mahogany, nicely polished, and recessed underneath, as shown in section. Mark out five centers for the pivots, as shown in the drawing, and drill 3/16 in. through. Three of these are for the pivots *J*, on which the pulleys turn, the counter-sunk heads being recessed to lie flush with the tops of the pulleys, while the double nut at the other end holds the pivot rigid and vertical, leaving the pulleys free to turn quite easily but without shake. The pulleys themselves are made from hard vulcanized fiber, cut roughly to size, drilled squarely through, and finished up on a mandrel in the lathe.

The table pulley *B* has two little spring brass clips fitted, as shown, to hold the paper down and prevent it from shifting under the pressure of the pen.

The driving pulley *C* is similar to the table pulley, except for the addition of a handle for operating the instrument. The pen pulley *D*, as explained above, has three grooves, and instead of being pivoted direct to the baseboard its pivot is screwed to a swinging brass arm *G*, so that in shifting the driving band from one step to another, the slack in the belt can be taken up, after which the arm is

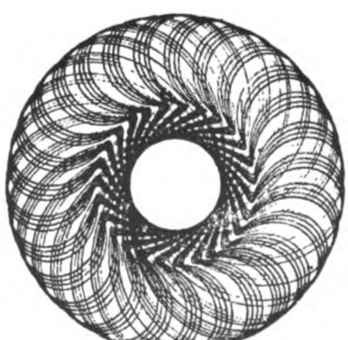
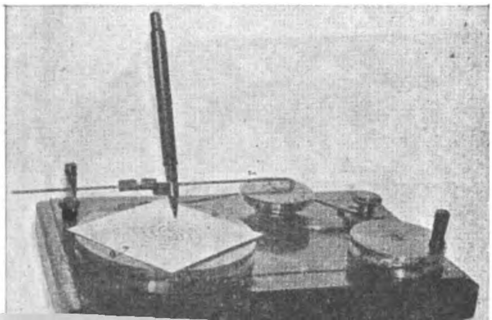


Figure Traced by Mechanical Harmonograph clamped by the milled head nut *H*. To set out the involute curved line on which the holes are drilled in pulley *D*, coil a piece of thread around a 3/16 in. rod passed through the center of the pulley, having a small loop at the free end. Insert a finely-pointed pencil or scriber in the loop and, keeping the thread taut and the scriber upright, carry the latter round the center rod, when the required curve is traced out. Afterwards the centers for drilling can be set out with dividers and equally spaced. These holes are not to be drilled right through the pulley, but only to a depth of 3/16 in., so that the cranked end of *E* rests at the bottom of the hole.

The penholder bar *E* is made from a length of 1/16 in. silver steel rod, the bent end being inserted in one of the top holes of *D* when in use, while the other end rests lightly by its own weight in any convenient notch on the support *F*. *F* is simply a piece of brass sheet bent round neatly into an eye at one end and screwed firmly to the wood base in a vertical position by a long screw passing through its eye.

The swinging arm *G* is also filed out of a piece of thick sheet brass, one end being slotted to allow sufficient play about the clamp screw *H* from the center hole where it is pivoted to the base, while the other circular-shaped end is drilled and tapped to receive the screw forming the pivot on which *D* rotates. This pivot requires to be a tight fit in *G* and must be flushed off on the underside.

H calls for no particular remark, being merely a milled head clamping screw passing though the slotted end of *G*, and through the base *A* into a stout piece of sheet brass screwed to the underside to form a nut.



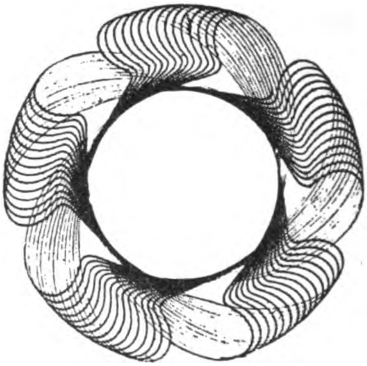


Figure Traced by Mechanical Harmonograph

The penholder *I* is easily formed up out of a piece of spring sheet brass about No. 22 gauge, the small open loop at one end being of suitable size to accommodate the pen, while the other end is turned to a larger radius and bored through at two opposite points in the bend to take the bar *E*. When threaded on to bar *E* with the pen in position, it forms a kind of hinged joint, free to rise and fall if necessary, and so keeping an even pressure on the paper. At the same time, there is sufficient resistance to lateral movement to prevent displacement.

While on the subject of pens, it might be well to mention that by far the most convenient and least troublesome kind for general use is the ordinary fountain pen with a rather fine flexible point, set to rest on the paper at a slight angle. Glass pens give a superior line of more even thickness when set vertically, but are very delicate things to make, and extremely liable to damage, for which reasons they are apt to be out of favor with amateurs. A good style pen works well if fine pointed and with not too heavy a spring. Carefully smoked glass and a needle-point "pen" can be made use of, too, if preferred, good specimens of figures being preserved by taking a photographic print from the tracing used as a negative.

The variety and beauty of the figures obtainable even with this little instrument is very striking; although not impossible, it is difficult to hit off the same figure twice unless the rockingbar *E* is graduated and the holes in *D* numbered for references as well as the notches in *F*.

Crossing the driving band to make the

THE TELEPHONE AS A MEASURING INSTRUMENT

V. W. DELVES-BROUGHTON

The use of a telephone for detecting small currents or small fluctuations of a current is well known to professional electricians; but in the writer's experience few amateurs use this simple device, although it is particularly applicable to their use, as a telephone is always ready at a moment's notice, and no elaborate adjustments are required before a measurement can be taken.

The necessary instruments are a telephone receiver, a microphone transmitter, a few cells, and an induction balance, which I shall first describe.

First obtain a bone knitting-needle, ⅜ in. in diameter if possible, but quite straight and of an even thickness; mine was made out of a ¼ in. needle, as I could not obtain a larger one.

Four bobbins should next be turned out of ebonite, about ½ in. between the flanges and 2 in. in diameter.

These should be made accurately in pairs, and it is most important that the diameter of the central stem, the width between the flanges, and the thickness of the latter should be most accurate.

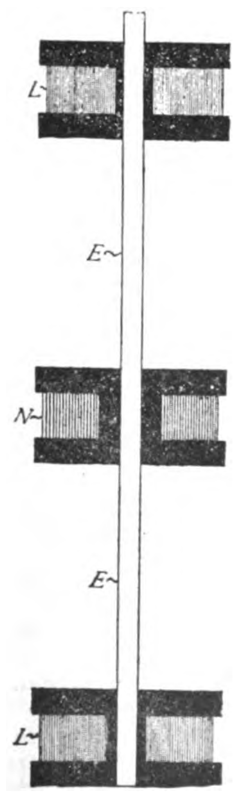


Fig. 1

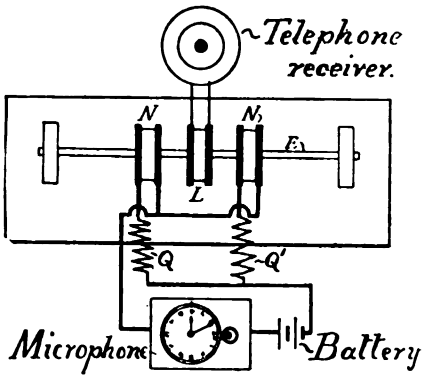


FIG. 2.

If ebonite cannot be obtained, boxwood may be used, but this should first be rough-turned, and then thoroughly boiled in paraffin wax, subsequently finishing to size.

The holes through the center should be made an accurate fit for the knitting-needle, so that they will slide without rocking.

Two of these coils should be wound with No. 24 d.s.c. copper wire, and the two others with No. 36 s.s.c. copper wire. These pairs of coils must each have exactly the same number of layers on each bobbin and the same number of turns in each layer, so that when wound each pair of coils will have exactly the same resistance and have exactly the same number of turns. The resistance of these coils must now be tested, and if one is found to have a higher resistance than the other, a few layers of the latter must be unwound and rewound with a slightly greater tension on the wire, in such a manner that it may be slightly stretched, which will add to the resistance.

Finally, the ends of the wire are led out by holes drilled in the edge of the flanges and attached to short pieces of twisted twin flexible wire, which, when in use, are fixed to terminals on the base which carries the knitting-needle.

The attachment of the needle to the base should be arranged in such a manner that it can be easily taken out and re-placed, so that the coils can be arranged in any sequence required.

Three coils only are used at a time, and the most useful arrangement is two of the No. 24 wire coils, with one No. 36 wire coil fixed between them and spaced at equal distances.

Fig. 1 shows the construction of the coils: L and L being the fine wire coils, N one of the coarse wire coils, and E the bone needle.

Fig. 2 shows the arrangement for comparing the resistance of two coils of wire Q and Q^1. N and N are two coarse wire coils connected so as to oppose one another. L is the fine wire coil placed exactly between N and N, so that the alternating current from the microphone in each of the coils N and N will induce exactly opposing currents in L, which consequently will produce no sound in the telephone receiver.

If, however, one of the resistances, Q or Q^1, is greater than the other, the balance will be upset, and a more powerful current will pass through one of the coils N than through the other, and to produce silence the central coil L will have to be moved nearer to that coil connected in series with the greatest resistance.

It will thus be seen that this instrument will not only detect the difference between two resistances, but will indicate which is the greater.

In Fig. 2 a watch is shown resting on the microphone, and this is an extremely easy manner of producing an unbroken and regular alternating current through the system, but any other appliance, such as a tuning-fork, may be used.

The only objection to this manner of electrical measurement is that it cannot be used for resistances which are non-inductively wound, as the capacity of such coils is quite sufficient to upset the balance between the coils. Two similarly wound coils can, however, be tested for resistance, as the capacity effect of each will neutralize that of the other.

If one of the N coils be mounted between two of the L coils, as shown in Fig. 1, the apparatus can be used as a test for hearing; N is connected in series with the microphone and battery, and the watch used as before. The telephone receiver is connected in series with the two coils L and L, which are again connected so as to oppose one another. On shifting N slightly out of the neutral position, the ticking of the watch will be heard slightly at first, increasingly strong as the balance is further upset.

If, therefore, a flat be filled on the upper side of E and a scale marked upon it, the hearing powers of different people can be tested, or you can test the right and left ears of all and sundry.

This is more a medical than an electrical question, but the same method can be used in making comparisons between different telephone receivers.

Telephone transmitters can be tested in the same manner, and a number of other uses can be found for the apparatus.

The period of an alternating current can be determined by the note produced in a telephone by comparing the note produced in the receiver with a tuning-fork producing a known number of vibrations—a C tuning-fork vibrates at 500 per second.—*Model Engineer.*

Cable now Clicks Morse Messages

(*Continued from page* 226)

"human equation" very considerably, and thus "around the world" messages, which the Commercial Company believes it will be able to transmit through automatic repeaters, will be even more accurate than those now passed on from land line to cable and back to land line in making the same journey.

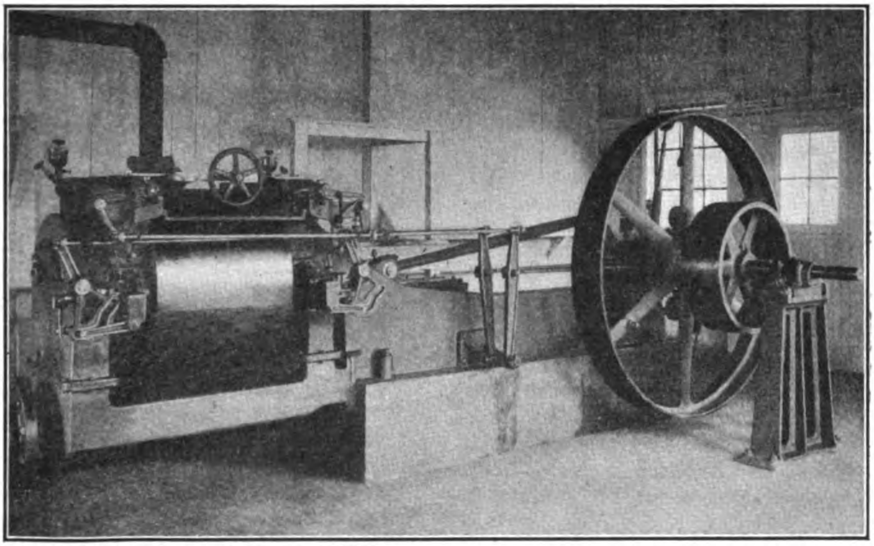
Just how Mr. Gott has overcome the difficulties that stumped the other submarine cable engineers is not being told at present, but it is said that very little new machinery is needed for the operation of this system. The same voltage is used and there is no difference in the actual use of the positive and negative current which operated the siphon recorder instrument. One feature of the Gott system is a delicate instrument which takes the faint note of the far-traveling dot or dash and increases the volume of sound into a full-grown and cheerful sounding "click."

Cable men have never worried much about possible invasion of their field by the wireless, but the Commercial Company says that while the wireless has never been able to compare in rapidity and reliability with cable communication Mr. Gott's invention still further increases the superiority of cable communication over wireless.

A SUN-POWER STEAM ENGINE OPERATING BELOW ATMOSPHERIC PRESSURE

FRANK C. PERKINS

The accompanying illustration shows one of the early installations, devised by Frank Shuman, for the direct utilization of the radiant energy received from the sun, whose experimental solar engine plants have created great interest. The simple engine taking steam at less than atmospheric pressure noted in illustration was tested by Prof. R. C. Carpenter and the data obtained are of the greatest interest. These tests performed on a low-pressure engine of the type used by Mr. Shuman may appear somewhat surprising to many engineers; for it is found that such an engine may be operated with remarkable economy.



Low Pressure Engine Operating with Steam below Atmospheric Pressure, Tacony, Pa., U.S.A.

But little information is available as to the economy of reciprocating engines when operating with less than atmospheric pressure, although numerous tests have been made of nearly all types of engines under the usual conditions of steam of less than atmospheric pressure. Prof. Carpenter states that the reciprocating piston engine with small clearances can be operated with low steam pressures and high vacuum with remarkable economy.

This engine has a cylinder 24 in. in diameter with 24-in. stroke and is double-acting, with admission-valve seats on the barrel of the cylinder near the end and exhaust-valve seats in the heads. It was developed to meet a special demand for a steam motor of small power which would give the highest possible economy with low steam pressure and a high vacuum to furnish power from steam generated by the heat of the sun in plate boilers which presented a large radiating surface. This plant has been installed in Egypt for practical irrigation work.

It is held that the best guaranteed performance for a 25 h.p. steam turbine which could be obtained from any builder required conditions an engine could be made more economical than the turbine.

It will be seen that the general appearance of the engine is not greatly different from that of others of similar size, except that its working parts are light, and it is provided with a rather long connecting rod. Two eccentrics are used to drive rocker arms, one of which operates the steam valves and the other the exhaust valves. The valves were constructed so as to reduce the clearance space to the lowest possible limit, and the two steam admission valves were of the slide-valve type, arranged to move parallel to the axis of the cylinder on a curved seat concentric with the cylinder.

The steam valve stems were driven by cams lifting against the action of a spring. The eccentric rod rocked the bell crank lever, which motion was communicated by links to the valve, and gave it a sliding motion on its seat. This design afforded steam ports with an opening 20 per cent. of the piston area. These are on the top part of the barrel of the cylinder near each end, and are provided by this construction with extremely short passages into the cylinder, thus making a small clearance loss.

It will be seen that the exhaust valves are unique, as they consist of thin steel plates situated inside the cylinder heads and are moved in a plane perpendicular to the axis of the cylinder. Such valves are extremely unusual in the construction of steam engines and their operation awakens a great deal of interest. The valve is a flat, thin disc provided with slots made to register with corresponding openings in the seat by the action of the valve-moving mechanism.

It is said this valve worked smoothly during the test, and that its continued use apparently even increased the tightness. The fact that the disc is very thin and is held in position by the pressure inside the cylinder doubtless explains why the results were so good. The exhaust valve, it will be noted, is so designed that the area of the exhaust ports when open is very large, amounting to 35 per cent. of the piston area. The exhaust valves are operated by connecting to an eccentric through the medium of rocker-arms, links, and cams.

It will be noted that the steam pipe is shown in the upper left hand corner of the picture, where it joins the steam chest, and the exhaust steam pipe is beneath the cylinders.

This plant was tested at Tacony, Pa., by Profs. R. C. Carpenter and W. M. Sawdon, who point out the facts that because the steam pressure was very low and that the work was done almost exclusively at less than atmospheric pressure, the method of testing which had to be adopted was quite unusual.

Regarding the arrangement of apparatus employed during the test, the engine was arranged to exhaust into a surface condenser connected to a vertical air pump. The water of condensation was delivered by a special hot-well pump into one of two tanks, which were placed on weighing scales and provided with suitable pipe connections and valves so that one could be filling while the other was emptying. The hot-well pump was provided with a governor for maintaining a constant level in the hot well. Observations of the water level were also taken by means of a glass gauge, and a correction applied for differences of level whenever necessary.

As a result of the tests, Prof. Carpenter states that with steam about 1 lb. above atmospheric pressure and with a vacuum of 28 in., the engine required 31.6 lb. of steam per brake horse-power. With the same steam pressure, but with a vacuum of 28.8 in., steam consumption was 28.8 lb. of steam per brake horse-power. These two tests indicate the very material effect of a high vacuum under such conditions of pressure. With a steam pressure of about 8 lb. absolute (6.75 below atmosphere) and 27-in. vacuum, 37.8 lb. of steam were required per brake horse-power per hour. With the same steam pressure but with a vacuum of 28.66 in., 35.7 lb. of steam were required per brake horse-power.

It is pointed out that as compared with the Rankine cycle, the efficiencies vary from 43.8 per cent. to 52.4 per cent., depending on the load and the steam pressures. In Mr. Ackermann's test of the same engine, the relative efficiency as compared with the Rankine cycle under best conditions was 53.8 per cent., which was slightly superior to the results in the above test. There was an independent test of the same engine made by E. P. Haines, and it is said these tests showed substantially the same results.

(*Continued on page* 252)

HOW TO MAKE A COMBINATION LOCK

MARK DAWSON

Some time ago someone asked how to make a lock which would only open when a certain combination of letters had been chosen (the said letters being, of course, attached to the mechanism which works the lock). The lock which I have sketched is on the same principle. This lock can be fitted to any kind of box and, if well-made, is very difficult to open by anyone not knowing where to place the hands of the sham clocks *A* and *B*, Fig. 1. The box which I have is intended to be a snuff box. It is made of sheet brass, being 3 in. long by 1⅝ in. wide by about ½ in. deep. The lid of the box (on the inside of which is fixed the mechanism for working the lock) is fitted between the two pieces *L* and *P*, which, as shown, are part of the box (soldered on). The lid *Q* is hinged to *P* as shown, and *G* is a button by which the sliding piece *E*, Fig. 2, can be slid down or up, as the case may be. The button *G*, which is fixed to the sliding piece *E*, as will be seen from the drawing, cannot slide down when the box is shut, unless the pieces *C* and *D* are so turned as to allow the spigots *H* and *K* to pass into the slots 1 and 2, which allows the lip *N* of the sliding piece *E* to clear the edge of the top of the box *L*. *E* is a piece of 1-16 in. brass sheet, and is kept in position by the sliders *L* and *M*, which are soldered on, and also by the rivet which fastens the button *G* to it. This rivet must be made just a working fit. *C* and *D* are made out of a piece of 1-16 in. brass, the slots 1 and 2 being filed out to exactly fit the spigots *H* and *K*, on the sliding piece *E*. The button *G* is just a piece of ⅛ in. brass, turned up into the shape shown, small

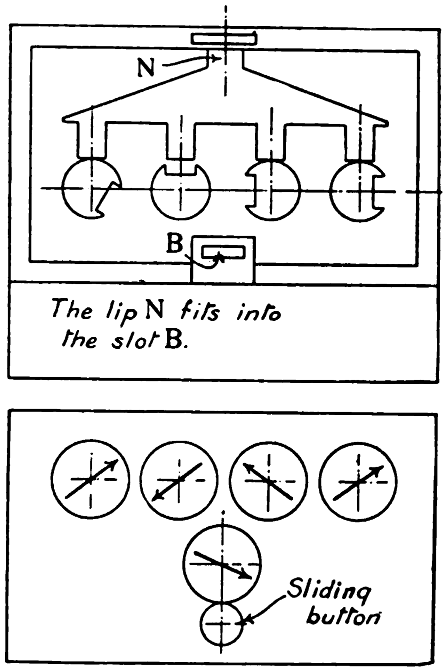


Fig. 3. Arrangement of a Four-Dial Lock

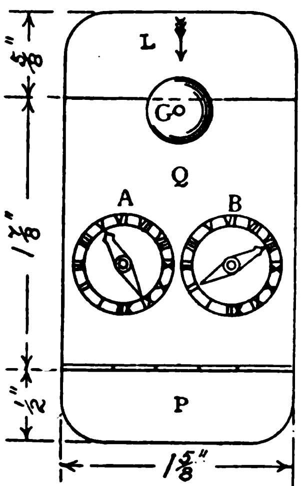


Fig. 1. Exterior of Box

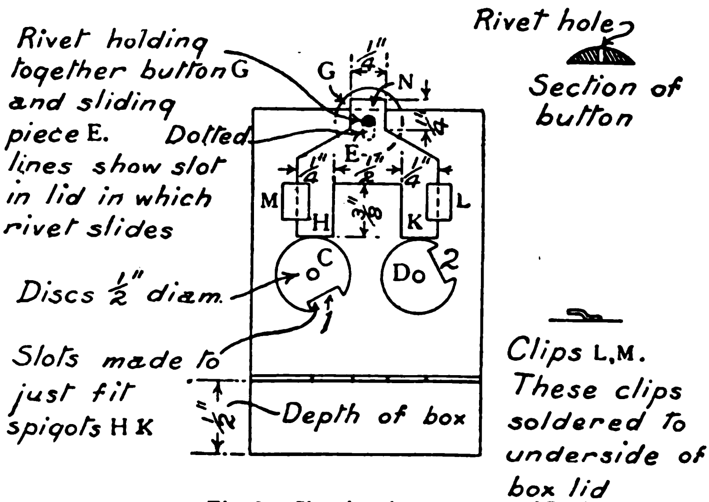


Fig. 2. Showing Arrangement of Lock

grooves being cut round it when turning in the lathe, for fancy appearance.

When the mechanism on the back of the lid is finished, and the position of the hands of the clock which will allow the box to open has been noted, a thin piece of tin can be soldered over the mechanism, to keep it clean. It will be seen that there is only one position of the hands of the clock which will allow the sliding piece *E* to move. This position can, of course, be made anything the maker desires.

A lock which is fitted to a desk is shown in Fig. 3. There are four sham clock faces on this desk. Two for the "minutes" and "hours," and two for the "seconds." The mechanism is the same as before, only there are four spigots instead of two. If one makes the box as it is shown, one might place a dummy sham clock face in the lower position. The clock *A* need not be connected to the mechanism of the lock at all, but would serve to baffle anyone who is trying to open it.

HARDENING FINE CIRCULAR SAWS

B. J. BUCKMAN

Seeing in these pages a short while ago a query on hardening saws, and having occasion to make a very fine circular saw for sawing a slot .015 in. wide, 7/8 in. deep, in the end of some pieces of 3/4 in. round steel, the following method may

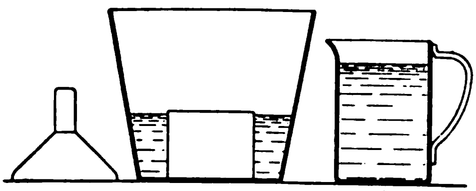


Fig. 1

prove useful to others. I found it an absolute impossibility to harden these saws without buckling in either of the following ways: First, slacking out in water, dipping quickly edgeways; result,

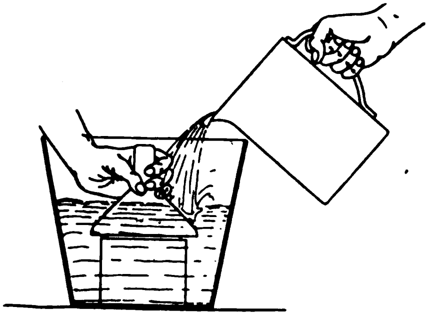


Fig. 2

serious buckle. Second, as above, but dipping indiscriminately; result, much worst buckle of the lot. Fourth, numerous trials on a blank—chisel indentations, dipping in oil, drawing temper from center, and dipping the edge only in a shallow tray of water; but in no case was any success experienced.

Happening to ask a friend of mine—a toolsmith—if he had had any experience with very fine saws, he said: "Yes, I'll do it for you in five minutes, if you will get me the necessary tackle." Needless to say, I soon procured him the tackle, which comprised a bucket, a can, and two pieces of flat-surfaced material larger than the saw. He placed one block in the bucket and filled with water barely to cover, as in Fig. 1. He then heated the saw to a nice red, placed it on the block in the bucket, immediately placing the other flat piece on top, and as quickly as possible covering the whole in water. The result was a dead-flat saw, beautifully hard. I have tried the same method since, and in every case success has been the result.

Sun-Power Steam Engine

(*Continued from page* 250)

It is poined out by Prof. Carpenter that as his tests and Mr. Ackermann's tests fall on the same straight line, it indicates the substantial accuracy of both series of tests. The straight line which characterizes results plotted as explained is frequently referred to as Willan's line,

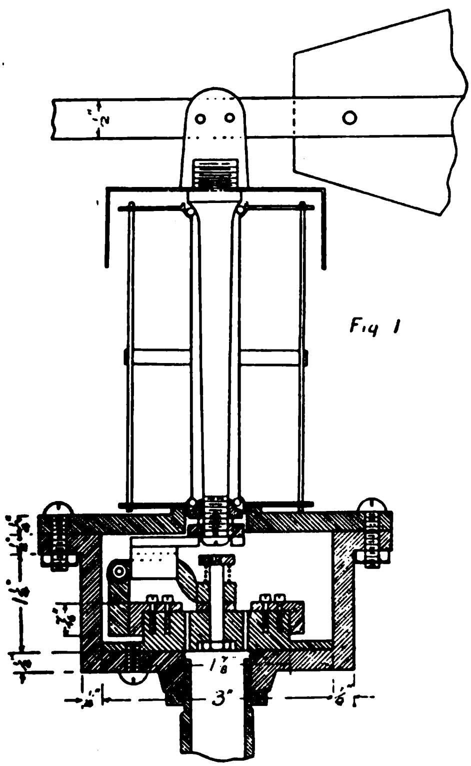
AN ELECTRIC WIND VANE

C. E. S.

Who does not take an interest in forecasting the weather—and, incidentally, in the direction of the wind? The apparatus to be described was devised on account of the writer's having to spend a great deal of his time out-of-doors, and of his living in a house from which no weathercock was visible.

It consists of a vane, on ball bearings, standing on the top of an iron box, which is attached to a standard of gas tubing. The box contains an eight-part commutator, which is actuated by the spindle of the vane, and from which wires pass, through the standard, to any suitable position in the house, where they are joined to the terminals of an indicator. The latter, on touching a push, shows from which of the eight main points the wind is blowing. The battery consists of three No. 2 Leclanché cells.

Fig. 1 shows the general arrangement of the vane and commutator. The vane, Fig. 2, is made to the dimensions shown,



General Arrangement of Electric Wind Vane

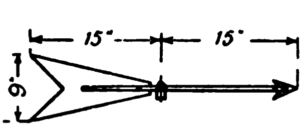


Fig 2

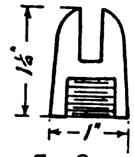


Fig 3

Fig 4

from two pieces of $\frac{1}{2}$ in. x $\frac{5}{32}$ in. bar iron, between which the sheet iron point and "feathers" are fastened by two rivets each. Two small strips of sheet lead are held by the rivets at the point, sufficient to make that end rather heavier than the other, when the vane is balanced at its center. If exactly balanced at this stage, it will be found, after two or three coats of paint, that the point will be too light. The balancing is necessary to prevent the vane's having a tendency to cock one end if the standard is not quite perpendicular.

The bearings consist of a right-hand rat-trap bicycle pedal, which can be bought second-hand for a few cents. To the end which originally screwed into the crank, and which is uppermost, is fitted a brass cap, which is shown in Fig. 3. This is slotted to admit the stem of the vane, to which it is attached by two rivets. A tinplate raincap, shaped like the lid of a cocoa tin, with a hole in the center, is held between the brass cap and the spindle. Fig. 1 shows it in position.

Examine the spindle of the pedal, and notice whether it projects through the nut which adjusts the bearings. If it does so to the extent of not less than $\frac{1}{16}$ in., it will save trouble; if not, the adjusting nut must be turned thinner until it projects that amount. Take out the spindle and file a second flat on the small end, opposite the existing one, extending about $\frac{1}{8}$ in. Drill a hole about $\frac{3}{8}$ in. deep up the spindle, and tap it $\frac{1}{8}$ in. This is shown in Fig. 4.

Three castings will be wanted: one of brass for the commutator, and two of iron for the containing box and its cover. The dimensions of the latter can be seen in Fig. 1. Notice that there is a boss at the bottom of the box, into which the standard will be screwed; also that there is a thin boss on the top of the cover to be threaded to receive that part of the pedal on which the dust cap was originally screwed. This boss need be only about 1/16 in. thick, its purpose being to allow the pedal to screw home, which without it would be impossible, owing to the sides of the pedal's projecting slightly beyond the end. Have both bosses cast solid.

The cover must be turned on the whole of its lower surface. It is then reversed in the chuck and the boss faced, drilled and threaded to fit the dust cap screw of the pedal. The thread was 36 per inch in the pedal which the writer used. The box must be faced on its upper surface, and rough turned inside. Reverse the chucking for drilling and screwing the boss, which is faced for a nut to bed upon. Screw it 14 per inch to fit ½ in. gas tubing. Fix the cover to the box by six 3/16 in. stove screws and nuts (see Figs. 1 and 5), drilling passing holes through both at once. Mark cover and box clearly so that the correct holes may be brought together again. The joint is made water-tight by a washer of thin asbestos millboard covered on both sides with red lead and oil, and not extending inside beyond the joint face. Give all the parts exposed to the weather two or three coats of paint. The commutator is shown in Figs. 1 and 6, in section and plan. The segments, arm, contact piece, and screws are all of brass, and the whole is mounted on vulcanite. The dimensions of the casting for the segments can be found from the figures, allowance being made for turning all over. After turning to size, if the lathe has a division plate, mark out the division lines, while still in the chuck. Then turn the vulcanite base to fit it nicely. The latter can be made from one piece ½ in. thick, or, more economically, from two pieces ⅜ in. and ⅛ in. thick, joined together by two recessed screws. Fit the sixteen screws holding the segments to the base, which are 3/32 in. in diameter, and are quickly made from 3/16 in. brass wire. Drill brass and vulcanite together, to ensure alignment, and afterwards enlarge those in the brass and tap those in the vulcanite. Do not use wood screws, as these often jam and break in vulcanite. Number brass and vulcanite 1 to 8. Saw the segments apart and clean their edges on a smooth file. No insulating material is needed between them; for the rubbing surfaces being perpendicular, any brass dust formed will fall to the bottom. Notch the inner sides of each segment, opposite the screw, with a rat-tail file, to allow the wires

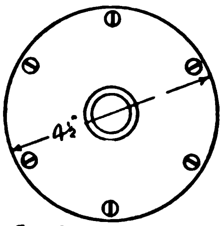


Fig 5

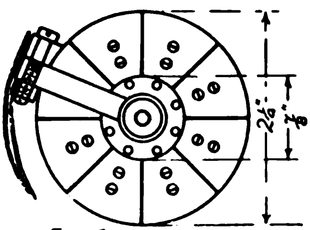


Fig 6

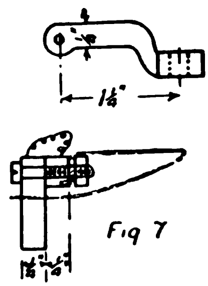


Fig 7

which pass up through the holes shown in the vulcanite to lie snugly against the segments. Otherwise they might foul the arm which carries the contact piece.

This arm is shown in Fig. 7, in side and end elevations. Make it from two pieces of brass. After turning the boss, file the other piece to shape and silver solder the two together. Figs. 1, 6 and 7 show the brass contact piece and the screw holding it in position. Drill a passing hole in the contact piece and a tapping hole in the arm, and fit a lock-nut. The wire spring, which keeps the contact piece up to the segments, is curved as shown to clear the containing box. It is bent into a ring and pinched in position by the lock-nut, and to prevent any chance of its shifting, the fixed end is bent at right angles and enters a small hole in the arm. To ensure good electrical connection between the arm and contact piece, the two are joined by a short length of thin copper wire.

The brass spindle about which the

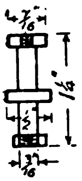
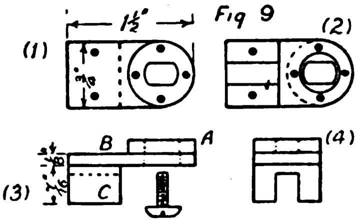


Fig 8



arm turns is shown in Fig. 8. It is fitted with a nut top and bottom—the latter to clamp it to the vulcanite base; and the former to act as a fixed point for a small coiled spring, shown in Fig. 1, which keeps the boss of the arm firmly pressed upon the flange of the spindle. To prevent this spring's cutting into the brass, two thin washers, not shown, are placed for it to bear upon. They can be made from softened clock spring.

The commutator is fixed to the containing box by three ⅜ in. stove screws, one of which is shown in Fig. 1, the vulcanite being tapped to receive them; they must not touch any segments.

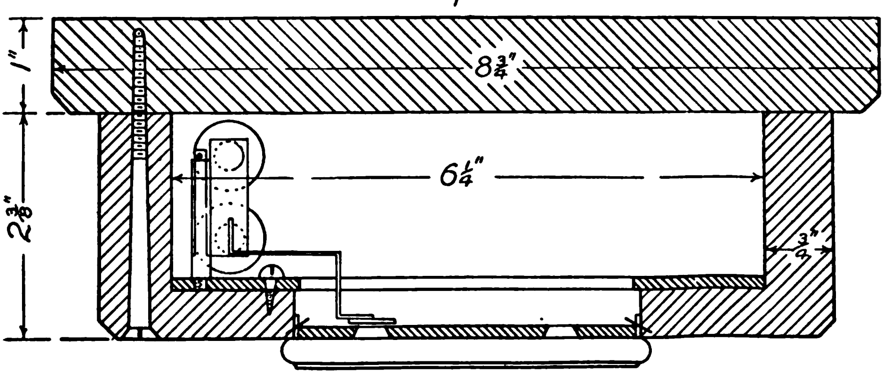
The claw which moves the commutator arm is shown in Fig. 9—(1) plan from above; (2) plan from below; (3) side elevation and (4) end elevation. *B* is vulcanite, to which are riveted the brass pieces *A* and *C*. Copper wire makes excellent rivets, which should be countersunk at each end. The piece *A* is rigidly attached to the lower end of the vane spindle (see Fig. 4), and has an oval hole for it to fit into. A hole is turned in the vulcanite *B* to allow a ⅛ in. screw, with a large thin head, to fix *A* to the spindle, and not project beyond the surface of *B*. The piece *C* has a slot filed to fit easily over the commutator arm. In making the claw the points to notice are, that *A* must be deep enough to allow *B* just to clear the cover of the containing box, and that *C* must engage with the commutator arm without fouling the segment screws. No part of the electric circuit must touch the containing box.

The height of the standard will depend upon circumstances. The writer's is 15 ft. high, to clear some chimney stacks, the upper part being ½ in. iron gas tubing and the lower half ¾ in., joined by a reduction socket. The method of fixing will depend upon whether it is placed outside an attic window or directly on the roof.

A terminal box is placed as close as convenient to where the wires enter the house, so that, if from wear or any other reason, it is necessary to examine the commutator, the aerial portion can be taken down and disconnected without cutting the wires. Having settled the height and position of the standard, find out the length of wire required to pass from the commutator through the standard to the terminal box; allow about 1 ft. extra, and cut off nine lengths. A suitable wire for use throughout from commutator to indicator is No. 22, such as is used in electric bell circuits. One wire is soldered to the bottom of the spindle, Fig. 8, and the other eight pass to the segments, being pinched under the inner screw in each case. The wires being attached, make them into a cable by winding linen tape over them to prevent them being chafed when drawn through the standard.

With an electric bell and battery, iden-

Fig 10



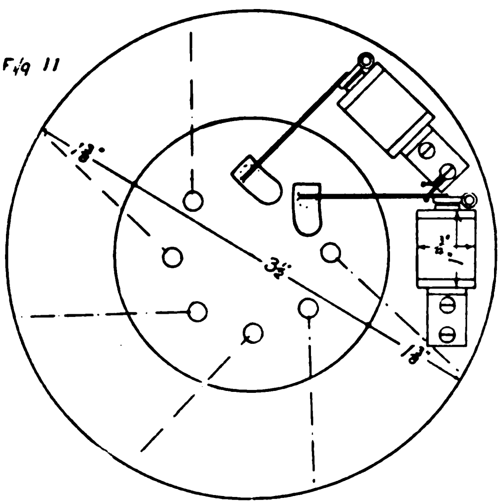
Horizontal Sections Through Indicator

tify the free ends of the wire, and mark them 1 to 8 and *B* (battery) for the common wire.

The indicator is shown in the photograph, and also diagrammatically in horizontal section, in Fig. 10. Fig. 11 shows some of the working parts from behind.

It is similar in construction to an eight-hole electric bell indicator, except that the holes, and hence the mechanism, are arranged in a circle. Each hole has behind it a tinplate flag, painted half white and half black, and when not in use the black is shown. Each flag is soldered to a bent-wire arm, which is itself soldered to a soft iron armature, and

Fig 11



Back View, Showing Mechanism

the whole can turn about a post screwed into vulcanite base. Each arm is placed at an angle of 45 degrees with its hole and is actuated by a two-pole electromagnet.

First make the base from vulcanite ⅛ in. thick. It is 6¼ in. in diameter, with a 3½ in. hole in the center (see Fig. 11). The piece cut from the center can be used to make the lower part of the commutator base, already described. The iron part of the electromagnets is shown in Fig. 12. The yoke, made from ½ in. x 5/32 in. iron, is bent at right angles to form a foot, which is attached to the vulcanite by two ⅛ in. iron screws, the vulcanite being tapped to receive them. The iron for yokes and cores should be annealed.

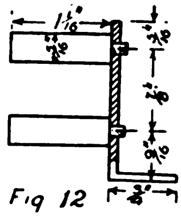


Fig 12

Magnet Cores

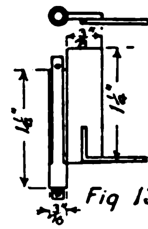


Fig 13

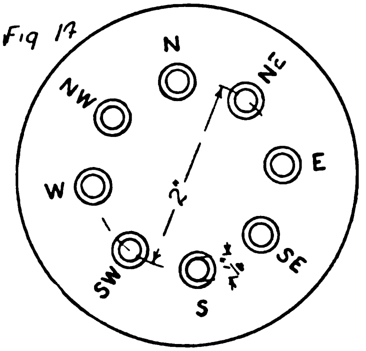
The Armature

The bobbins are shown clearly in Figs. 10 and 11, and they can be made from pear or any close-grained wood. They are wound on a mandrel in the lathe with No. 28 s.c.c. wire, and eight layers can be got on, leaving 3 or 4 in. at each end for connections. Half a pound of wire will be more than sufficient for all the bobbins. After winding, give them a coat of thin shellac varnish.

The armature, shown in Fig. 13, is made of annealed iron about 1/16 in. thick, and has soldered to it a thin brass tube, made out of wire in the lathe. To solder the tube and wire to the armature, cut a slight groove in a piece of wood for the tube to lie in, bring the armature and wire into position, and the two joints can be made in a moment. The wires are bent once at right angles before soldering, the other ends being left for the present.

The post supporting the armature is shown in Fig. 13. It has a shoulder below, and a hole to receive a wire pin above, to keep the armature in place. It is screwed ⅛ in. for attaching to the vulcanite. Number each magnet and armature. Drill and tap the holes in the vulcanite for the magnets, numbering the vulcanite to correspond, and then fix the armature posts.

Fig 14



Brass Dial Plate

Piano Wire Spring

Fig 15

Brass Terminal

Fig 16

From a clockmaker procure the case of an old French clock, the kind referred to being that with a brass cylindrical case about 2 in. deep and about 3⅝ in. in diameter; or of an ordinary alarm clock. The parts wanted are the glass and its retaining ring, which are shown in Fig. 10. Turn a dial-plate of brass about ⅛ in. thick to fit nicely behind the glass, and drill eight ¼-in. holes in it, countersinking them on the side next to the glass, Figs. 10 and 14. Then have the eight points of the compass engraved opposite the holes, and polish the front face and lacquer it.

For the indicator case two pieces of well-seasoned wood are needed. Sycamore is suitable, and looks well if treated with an oak stain and varnished. The front of the case is fastened to the back by three screws, the heads of which should be polished and lacquered. The hole in front will be turned to fit the retaining wing of the glass, and the latter is fixed into the case by two small nails seen in Fig. 10, which also keep the dial-plate in position.

A small push, similar to those used for electric bells, is screwed to the front of the case immediately below the glass. It is shown in the photograph, and needs no description beyond stating that it looks well made of brass and that its base can be made of vulcanite. It cannot exceed 1 in. in diam. as it would then cover one of the screws holding the two parts of the case together; the terminals prevent a screw's being placed at the top.

The vulcanite ring, on which the magnets are mounted, is fastened to the case by three screws, one being shown in Fig. 10. Bend the wire arms of the armatures to shape and solder on the flags, which are painted half white and half black, the latter being the round end. The screws fixing the magnets have each a second duty to perform. Those farthest from their bobbins hold little wire forks which limit the movement of the armature arms. One of these is shown in plan in Fig. 11, the two ends being up at right angles to the plane of the paper. It is made of brass wire, and a little experimenting will show the shape to give it.

The screws next to their bobbins hold springs which act upon the armature arms. They are made of steel piano wire, and one is shown in Fig. 15. It is like a hairpin about 1¼ in. high, with a small ring on one leg, so that it stands nearly vertically to the surface on which it is clamped. If the indicator were without springs, gravity would cause some of the armatures to lie close to their magnets; others would be too heavy for their magnets to attract, and one or two would work satisfactorily. Hence some of the arms will be placed inside the springs and will be pulled by them, and others will be outside and will be pushed. When the indicator is in its proper position each flag should show black, but a slight pull of the armature should make the white appear. In Fig. 11 both are showing white.

Eighteen small brass terminals are needed—nine with nuts and nine without. They are not worth making, as they can be bought for less than the cost of the rod from which to turn them.

Drill a small hole up the screwed stem of nine, Fig. 16, and into each solder about 1 ft. of copper wire. No. 22 cotton-covered is suitable for all connections in the indicator. Connect the two coils of each magnet by twisting together and soldering two beginning or two finishing ends, thus getting N. and S. poles.

To connect the various parts of the indicator, attach two 18-in. lengths of wire to the push, grooving the case inside to allow them to pass under the vulcanite ring and so to the back. Make nine holes through the top of the case, about ½ in. from the base, and spaced ⅜-in. center to center, and screw in the terminals.

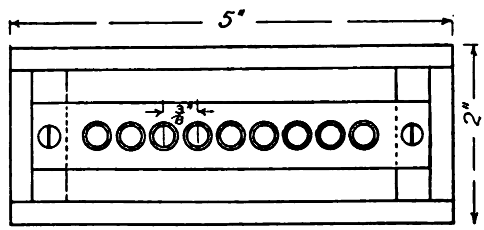
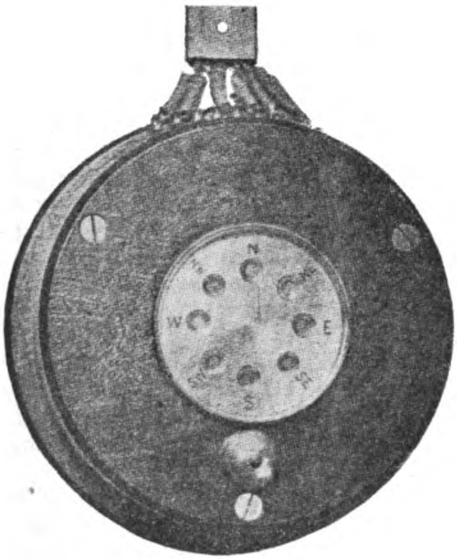


Fig 17

Plan of Terminal Box

Calling the terminal on the left No. 1, connect it with one wire (it is immaterial which) of the magnet which shows N; No. 2 with that showing N.E., and so on to No. 8 with that showing N.W. No. 9 is connected with one of the push wires. Make a ring about 3 in. in diameter of fairly thick uncovered copper wire, and connect with it the second wire of each magnet and the remaining wire from the push. Clean all wires before soldering the joints, and, if killed spirit of salt (zinc chloride) is used, be careful to rub an oily rag over the joint as soon as the solder has set.

Test the indicator with a battery, one wire going to the common terminal, and the other to each of the remaining eight in succession. On touching the push,



Photograph of Wind Vane Electric Indicator

the hole in circuit should show white with a sharp click. Two Leclanché cells should work it well on short-circuit, and if any hole does not act quickly, adjust the

The terminal box is shown in plan, with the lid removed, in Fig. 17. It is square in section and contains a strip of vulcanite into which nine terminals are screwed, the nuts of which serve to connect the wires from the indicator. Nine holes are bored through each side at a suitable level to admit the wires.

It only remains to connect the wires from the commutator in the right order, making the final adjustment by slightly rotating the standard until the points read correctly. This is most easily effected by using a battery and bell at the terminal box, *i.e.*, not making use of the lower part of the circuit. Let the wires from the standard be enclosed in rubber tubing until they enter the house.

A simpler indicator could be made by placing a small electric lamp behind each hole. The writer did not employ this method because the uncertain life of small lamps would probably necessitate fairly frequent renewals, and, further, more current would be used.—*The Model Engineer and Electrician.*

Brick for House Building

One of the greatest advantages of brick for house building is that it can be bought nearly everywhere as a home-made material. Almost every town and village has its brick-yard, by which it is possible to escape the added price of freight. A brick wall is substantial, dry and non-conducting. It can be made attractive in texture by various widths and colors in the joints. Brickwork is dependent on no other material for its trimmings, but is sufficient in itself.

A brick wall never needs paint. If it ever does become shabby, brush it down with a weak solution of muriatic acid, but don't paint it any more than you would paint stonework.

HOW A GRAMOPHONE RECORD IS MADE

A very interesting paper on "The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds," was recently read before the Royal Society of Arts by Mr. Lowell N. Reddie. We give the following extract, describing the method by which the records used on this popular instrument are produced:

I will now deal with the series of operations which go to make up a finished disc record of the Berliner or gramophone type. The person who is making the record sings or plays immediately before the mouth of a horn or funnel, the object of the horn being to concentrate the energy of the sound-waves upon the recording diaphragm. At the narrow end of the horn is the recording sound-box and machine and its attendant expert. The artist is on one side of the screen and the machine on the other, for in all the recording laboratories of talking-machine manufacturers the secrets of the operation of recording are most carefully guarded. The making of a good record is not so simple a matter for the artist as might appear; he often has to make several trials before he learns just how to sing into the trumpet, how near to stand, etc. When singing loud, high notes he must not come too near the mouth of the funnel, as otherwise the vibrations will be too powerful, and the result will be what is technically known as "shattering." When the artist is singing or playing to an accompaniment, another horn connected with the same sound-box is often provided, so that the person of the artist may not obstruct the sound-waves of the orchestra or other accompaniment.

The disposition, too, of the various instruments of an orchestra in the recording-room is of the very highest importance, if the best results are to be table rotates, it also travels laterally at a fixed and uniform speed, being carried on a revolving threaded spindle, and the wax tablet or blank is thus caused to travel slowly under the stationary recording-box. The sapphire cutting-point of the sound-box is lowered so as to enter the surface of the blank to the depth of about 3½ to 4-1000ths of an inch, and as the machine runs it cuts a fine spiral groove of uniform depth, running from the circumference of the blank to within 2 or 3 in. of the center, according to the length of the selection recorded.

The turn-table travels, as a rule, about 1-100th in. laterally for every revolution, so that the spiral cut comes round about 100 times in the width of 1 in. It will thus be evident that the lateral undulations of the sound-line must be minute in the extreme, as otherwise the lines would at points break into one another.

The recording blank is made of a soapy wax. Each laboratory has its own recipe for the composition of the blank, but, generally speaking, the compound is made up of stearine and paraffin. Many other substances have been suggested, amongst which may be mentioned barium sulphate, zinc white and stearine, ozokerit and paraffin.

The consistency of the blank material must be such that it is stiff enough to retain its shape when the sound-groove is cut in it, and at the same time it must not be so stiff as to offer any great resistance to the cutting-point. It must not chip nor flake, as otherwise the recording point will cut a groove with ragged sides, and this will increase the scratching sound made by the needle on subsequently reproducing. The best results are obtained by a tablet of such consistency that the cutting point detaches an unbroken shaving of wax.

The diameter of the recording blank

½ in. from the edge, it will in one revolution describe a line on the record of a length approximately equal to the circumference of a circle of 11 in. diameter—that is to say, 34.5 in. By the time the recording point has worked in another 3 in. towards the center of the tablet, the length of its path over the wax will approximately equal the circumference of a circle of 5 in. diameter, or 15.7 in. The rate of revolution of the tablet being uniform, the sound-line at the edge of the tablet is accordingly being cut at more than twice the speed that it is cut at nearer the center; and the speed at which the recording point can be made to cut the sound-groove satisfactorily can only be varied within certain limits. If the diameter of the tablet is increased, the outside speed will be too great for proper recording; and if the speed of the turn-table is correspondingly decreased, the ripples in the sound-line near the center will be too close together and cramped; there will be too many vibrations per inch of sound-line to allow of proper recording and reproduction. The obvious solution would be, of course, gradually to increase the speed of the turn-table as the recording point nears the center of the blank, but there then arises the necessity of using mechanism, for securing a corresponding gradual change of speed on the reproducing machine, in order to keep the selection in the proper key. Devices for securing an increased speed have been invented, but they have never come into general use.

The record in wax having been made, the next step is to produce a negative in copper. The wax tablet is dusted with graphite, which is worked into the grooves with a badger-hair brush, to make it electro-conductive, and is lowered into the electrolytic bath of copper salt solution. In order that this negative may be able to resist the pressure to which it is subjected in pressing records, it is necessary that the deposition of the copper should be thoroughly homogeneous. To this end, and also in order to hasten the process so that the blank may not be attacked by the solution, the blank is kept continuously in motion in the electrolytic bath. The process is continued until the copper shell is nearly .9 mm. in thickness. The negative thus formed may be termed the master negative, and from this master a few commercial samples of the record can be pressed by means of which the quality of the record can be tested. It is not, however, usual to press more than two or three records from this negative. Seeing that sometimes as many as 6,000 or more copies are sold of a single record, it is natural that the manufacturers should take steps to enable them to multiply copies without injuring their master negative or having it worn out, for it is not usual at this stage to obtain further negatives from the original wax record. They accordingly make duplicates of their master negative, by taking dubs or impresses of the master in a wax composition, from which in turn working matrices are made. Copper shells are obtained from these dubs in the same way as from the original wax tablet, but the metal is only deposited to the thickness of about ½ mm. The shells are made absolutely true and flat at the back, so that any irregularities caused in the electro-deposition may not be transferred in pressing to the front or face of the shell. They are then backed up or stiffened by a brass plate about 1-10 in. in thickness. The attachment of the backing plate and matrix is effected by sweating or soldering them together under pressure. The backing plate is supported on a heated table, a thin layer of solder is run over it, the shell is laid upon it and pressed firmly down, with an elastic protective cushion of asbestos, for example, placed over the face or recorded surface of the shell to prevent the sound-ridges in it from being injured. The matrix thus obtained is now nickel-plated on the recording side so as to present a better wearing surface, and after polishing is ready for use in the pressing machine.

Attempts have been made to use a recording blank of conductive material, or containing sufficient conductive material to allow of omitting the subsequent graphiting or metallizing of the blank; the objection to this procedure has always been that such substances offered too much resistance to the recording point.

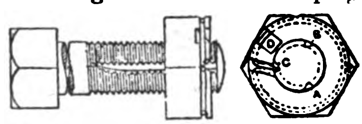
The commercial record is pressed in a substance the essential qualities of which are that it should be hard at normal temperature, but capable of being softened and made plastic by heat. It must be tough and elastic enough not to be easily broken when pressed into discs of about 2½ mm. in thickness; it must be thoroughly homogeneous; and it must not be gritty in composition, as otherwise it will augment the scratch of the needle and wear off the point. Finally, the record must be so hard, when cold, that it will retain the contour of the sound-groove, even after it has been played a large number of times. Various substances and compounds have been used or suggested for making records—celluloid, glass, papier-maché, vulcanized rubber, casein, and shellac with an admixture of crocus powder. In nearly all the compounds actually used, shellac is the principal ingredient.

The compound usually employed today is made up of shellac, wood charcoal, heavy spar (barium sulphate), and earthy coloring matter. Various animal and vegetable fibrous materials, such, for instance, as cotton flock, are added to give the record the required toughness. The several ingredients are first finely ground and then carefully measured and mixed according to formula. The mixture is put into a revolving drum, and the flock added. After being passed through a magnetic separator to remove any metallic particles, it is next mixed by heated rollers until a thoroughly homogeneous plastic mass is obtained. The mass is now passed through calender machines, which roll it out into thin sheets, and as it passes from the calender it is divided into sections, each section being about the requisite quantity for one record.

The records are pressed in hydraulic presses. The matrix is heated, and placed face upwards in a mould in the lower half of the press, being centered by a pin passing through the middle of it; the label for designating the selection is placed face downwards on the matrix, and on this is placed, in a warm, plastic state, the quantity of material required for one record. The press is operated, and the mass is immediately distributed all over the mould. Both halves of the press are furnished with cooling plates, through which a stream of water can be passed so that the pressing surfaces can be immediately cooled, and the record mass consequently hardens quickly and retains the impressions of the matrix. The record is removed, and its edges are trimmed up with emery wheels; for the record material is too hard to allow of any cutting instrument's being used. The record is then ready for sale.—*Model Engineer and Electrician.*

A Positive Locknut

The accompanying illustration (taken from the *Horseless Age*) shows a locknut and bolt invented by a Chicago man. The bolt has three grooves, *A*, *B* and *C*, which act as ratchet teeth. The upper part of the nut is so formed that a spring-ring encircles it, the end of the ring being turned inward, as shown at *C*, thus coming in contact with the side of the groove, and effectually preventing the nut from being turned in a left-hand direction. However, right-handed rotation is possible, as the grooves are so shaped that



A Positive Locknut.

the end of the spring-ring slides up the inclined surface easily. In order to release the nut, a slot *D* is provided, which allows the point of a nail, or any similar object, to be placed under the spring-ring, and thus raise the point out of the groove, when the nut can be taken off. This arrangement allows an adjustment at any time of one-third of a rotation.

British Government Refuses to Release Wireless Company

The English Government, acting on the advice of the Parliamentary select committee appointed to investigate the matter, has refused to release the Marconi Wireless Company from its agreement to establish a wireless chain of imperial stations. The Marconi company pleaded the expense as a reason for the annulment of the contract.

The contract for the establishment of wireless communication between the British dominions throughout the world was in part due to the combination of the Atlantic cable companies under American control. The Marconi company was to receive $300,000 for each station, exclusive of the site and building, and also 10 per cent. of the gross receipts for a term of 28 years from the date of the conclusion of the first six stations.

QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department, free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but, if he so requests, anything which may identify him will be withheld. Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of the letter, and only three questions may be sent at one time. No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for reply, but is simply to cover clerical expenses, postage and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time.

If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will, in every case, be notified if such a charge must be made, and the work will not be done unless desired and paid for.

1960. **Transformer Load.** J. W. G., Arlington, Md., says: Would you kindly advise me the safe load in amperes that could be taken at the lowest voltage, also at the highest voltage, when using the auto-transformer described in a recent issue of *Electrician and Mechanic*. Ans.—The entire winding is of No. 10 wire, which has a cross-section of about 10,000 circular mils. A good rule for such coils and for the field magnet winding of dynamos is to allow 1,000 circular mils per ampere. This indicates that 10 amperes will be a good working current for the auto-transformer described in the December magazine, but 15 amperes are permissible for perhaps an hour, or greater currents for shorter periods. Just what current may be flowing in any given coil of an auto-transformer is difficult to predict—the inter-relations requiring a close analysis. Your safe procedure will be to have an ammeter available to test each circuit as required.

1961. **Dynamo Winding.** W. R., Eldred, Pa., says: Please tell me through your inquiry department the proper wire and winding to get the maximum output from a generator frame and armature of the following size. Also please advise if any greater output could be had by making a new frame and poles out of sheet-iron stampings that would allow of larger field coils. The present frame is cast iron, 2-pole Edison type, poles 1⅞ in. diameter and room for coil 3 in. long, with space of ¾ in. between the poles. The armature is 2⅜ in. diameter by 2 in. long, has 10 round holes 7-16 in. diameter inside of insulation. Shaft ½ in. diameter. The commutator is about 1 in. diameter with 10 segments. Ans.—You do not state what voltage is desired, but an illustrative case for about 20 volts will undoubtedly be of help to you. Wind armature with 32 turns per coil—64 wires per slot—with No. 20 d.c.c. magnet wire. If a few more turns can be gotten into the slots, all the better. Wind field magnet coils with No. 23 s.c.c. magnet wire, about 100 turns per layer and 12 layers. Nearly 3 lbs. will be required. Speed should be about 2,500 revolutions per minute. Any other desired voltage would be computed by using the number of turns of wire in direct proportion, but in your particular case the commutator has too few segments to withstand a higher voltage and insufficient surface to handle much more current than two No. 20 wires will deliver, say 4 amperes. It would not be worth your effort to rebuild one part of the machine, but rather make an entirely new one.

1962. **Dynamo Winding.** F. S., Stuyvesant Falls, N.Y., says: I have a small dynamo made by the C.&C. Electric Motor Co., New York. Armature is 2½ in. long and has 15 slots; commutator has 15 segments; length of spool for winding 2⅝ in., depth ½ in. Will you please print in your next copy of *Electrician and Mechanic* what size wire to use to wind for 70 volts 2 amperes to light four 16 c.p. 70-volt lamps? Ans.—As you do not state the size of slots, we cannot compute the number of wires you can get into them. No. 23 d.c.c. magnet wire will be the smallest permissible size to use, and you must put in as many as possible. Wind slots Nos. 1 and 8 half full, and leave out a loop for connection to the commutator; then without cutting the wire, wind a similar coil in slots 2 and 9, and bring out a second loop; similarly in the pairs of nearly opposite slots until on the second round the slots are completely filled, the beginning and end of the wire being then twisted together for the 15th loop. For field you should use about 3½ lbs. of No. 26 s.c.c. magnet wire, wound 125 turns per layer and in 20 layers.

1963. **Dynamo Winding.** G. R. A., Pittsburgh, Pa., says: I have the parts of an electric small power motor that has been burned out. What I want to know is, what size of wire and how much it would take to rewind this motor to act as a generator to have a maximum output of 8 or 9 volts and as many amperes as I can get. I wish to wind it as a compound wound machine. The armature is 2¼ in. in diameter and 2¼ long. It has 16 slots ¼ in. in diameter. The commutator has 16 sections. The two field pieces are each 2¼ in. in diameter and 1¼ in. long with plenty of room for winding. This dynamo must stand 10 hours of continuous running. What is the best speed? Ans.—If you wish the machine to run quietly and with little wear, we would suggest that the speed should not exceed 1,800 revolutions per minute. This, of course, means a lower output than if you drove the machine faster. You can wind the armature with No. 20 d.c.c. magnet wire, getting 9 turns per coil, 18 wires per slot; series portion of field winding can consist of two layers per coil of No. 14 d.c.c. wire, and the shunt portion of 14 layers of No. 23 s.c.c. wire. It would be a good plan to wind the field coils first, put them in place, and provide for experimenting a little in order to determine just what the armature winding should finally be. To do this, wind the armature with only one turn per coil—two wires in a slot—of any wire that may be available.

Bell wire is excellent, for its thick insulation will give immunity from "grounds." Clean off the insulation in the 16 places to permit temporary connection to the commutator. Excite the shunt portion of the field winding from some 8- or 9-volt source, say from storage batteries. Drive the armature at the desired speed. Measure the voltage produced by the armature. Say 1 volt is indicated. Then for the final winding you will require nine times as many wires per slot, or the suggested 18. Any other number of volts can be secured by using the proportionate number of turns, but the field winding would then have to be altered to fit.

1964. **Induction Motor.** F. W. W., Portland, Ore., asks: (1) What is the size and number of turns of wire on the core of a General Electric phase splitter for a ½ h.p. 110-volt 60-cycle 7½-ampere induction motor? (2) What is the size of the core? (3) What effect will a 60-cycle current have on a 133-cycle recording wattmeter? Ans.—If you have no means of making sheet iron in the form regularly employed for such devices, you can readily make a coil in more elementary manner that will permit some adjustment to fit your particular conditions. Make a wooden spool by first boring a hole about 2 in. in diameter in a block of wood 3¼ in. square and 6½ in. long. Mount this upon an arbor and turn the inner portion to a diameter of 2¼ in., leaving flanges at the ends about ⅜ in. thick and as large in diameter as possible. Wind the space full of No. 14 d.c.c. magnet wire. Provide a coil of tinsmith's annealed iron wire. Pull it out in long lengths, such as may be convenient, say 50 to 150 ft., and forcibly stretch it. This act will leave the wire perfectly straight, and it can then be cut into lengths, say of 8 in. Fill the hole in the spool with the wires, and try the device with your motor. If motor starts too sluggishly, and the current does not seem extreme, remove some of the iron from the spool. If start is good, but current seems extreme, cut some longer wires that can be made to extend over the outside of winding on spool and complete the magnetic circuit. Sheet iron can be used as a substitute for the iron wire.

1965. **Dynamo Construction.** C. M. C., Fulton, N.Y., has a variety of armature and field magnet punchings, the former being 3¹¹⁄₁₆ x 2½ in. in diameter, with 37 round holes ¼ in. in size, the other a trifle over 3¹¹⁄₁₆ in. inside diameter and 7 in. outside, cut for 4, 6 or 8 poles, or with 24 internal slots. He wishes to make a dynamo that will give 6 volts and 8½ to 15 amperes, and asks what construction will give the best results, speed to be 600 to 1,200? Ans.—It will not be practicable to use more than four poles in so small a machine, and the sheet iron for the field magnet should be clamped between iron castings of the same shape as the sheets, but perhaps ¼ in. thick, else there will not be sufficient residual magnetism to permit the machine to be self-exciting. For the armature, however, solid iron must not extend to the slots. If the openings to the slots are too small 2¼ in. Each slot should receive 8 wires, and it is possible to get in that number with No. 16 d.c.c. in size, but you had better try it to make sure, and if you foresee difficulty, use No. 17 wire, though with that smaller size you will not be able to draw 15 amperes without undue heating. Armature winding will be of the series type, similar to that employed on railway motors. Formed coils, though "random" wound must be made, the two straight sides being about 2½ in. long, and the ends diamond-shaped, making angles with these sides of about 45 degrees, the leads being brought out at these angles. A given coil will extend from slot No. 1 to slot No. 10, and so on, each coil consisting of four turns, making eight wires per slot, when the sides of the two different coils are disposed in the same slot. The two ends of a given coil connect to segments of commutator that are most nearly opposite. Connect in all the bottom wires first, then there will be least trouble in locating the remaining ends. Field should be a plain shunt, consisting of No. 20 s.c.c. wire, between 4 and 5 lbs.—all you can get on.

1966. **Dynamo.** R. T. D., Lexington, Va., says: (1) I desire to know what size dynamo would it take to make electricity enough to run a ¹⁄₈₀ h.p. motor of 110 volts 60-cycle over 2,000 ft. of copper wire with the return wire or track of No. 12 or No. 9 iron wire. (2) What size should the copper wire be to carry the current at 110 volts pressure, and what size iron wire for the return to dynamo? (3) Could the dynamo be tuned by hand or would batteries be better? How many and what kind would be best? (4) Would be glad to know of some company where I could get a very small locomotive or motor to run on a single wire suspended similar to the telephone used at the Arnold Print Works at North Adams, Mass., as described in the May, 1912, number. Ans.—(1) and (2) To undergo the expense of such a transmission line for the sake of delivering ¹⁄₈₀ h.p. seems rather unwarranted, but of course it can be done. Such small motors may not have an efficiency above 25 per cent., so the amount of current transmitted would have to be on the basis of delivering about ⅟₂₀ h.p. As the 110 volts is the pressure at the supply end, the pressure at the receiving end will be less, due to the line losses. These losses will be almost entirely due to the ohmic resistance in the copper portion of the line, but in the iron portion there will be in addition a reactance loss due to the alternating character of the current quite as important as the ohmic. To use smaller than No. 12 B.&S. copper wire would involve mechanical weakness, and 2,000 ft. of this size has a resistance of about 4 ohms. Iron wire is estimated by the Birmingham wire gauge; and 2,000 ft. of No. 12 of the best quality would have a resistance between 6 and 8 ohms. The reactance would have the effect of increasing this figure to 10 or 12 ohms. The total line resistance would then be perhaps 15 ohms. Considering the fact, too, that such a motor

The expression "return circuit" is not altogether appropriate, for the alternating current goes as often by one wire as by the other. (3) We do not understand what you mean by "tuning" the dynamo. What dynamo? (4) Address the Carlisle & Finch Co., Cincinnati, O.

1967. **Transformers.** W. S. P., Winchester, Ind., wants to make two small stepdown transformers to operate on a 110-volt 60-cycle supply, one to light 25 2 c.p. 6-volt carbon filament miniature lamps, the other to ring 8 to 10 common vibrating bells. He asks for dimensions of the cores and for data as to the windings. Ans.—Considering the transformers to be of the "shell" type, the data for the larger one can be: width of tongue of core, 2 in., stack of iron 2 in. high; secondary winding, 28 turns of two No. 8 wires in parallel; primary, 460 turns of No. 23 wire. Smaller size, iron tongue 1 x 1 in., and 2 in. long. Secondary winding, 120 turns of No. 20 wire; primary, 1,800 turns of No. 28. In both cases the section of iron outside the winding should be one-half that of the tongue, but in consequence of two such sections comprising the magnetic circuit, there is no constricting of the magnetic path. The size of iron in these outer portions will then be 1 in. and ½ in. wide, respectively. You can make the iron portion smaller, if you prefer, if you will increase the number of turns in the inverse proportion. If you do not intend to operate all the lamps or bells at the same time, smaller transformers than these will suffice.

1968. **Electrical Lighter.** R. M., Manchester, N.H., says; What is the composition they use in the electrical cigar lighter? It is some kind of a cement that I mean, and what kind of wire do they use and how is it connected and insulated? Ans.—As I am not a smoker I do not catch on to the particular piece of apparatus the writer has in mind. By "cement" does he mean the sealing of tar and resin used on the top of a dry cell? The wire used is undoubtedly platinum, heated by the passage of the current. I saw a jimcrack of this sort some time ago, and maybe this is the sort asked about. If need be I will investigate further.

1969. **Information on Controllers.** J. K., New York City, says: I would like to know if you have any book on controllers for elevators, printing presses, etc., and if you have any, what the price will be. Ans.—We do not know of any regular publications on this subject, but you will find that the manufacturers of such apparatus will supply you with a very large variety *gratis*. Address the General Electric Co., Schenectady, N.Y., The Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa., the Cutler-Hammer Co., Milwaukee, Wis., The Otis Elevator Co., Yonkers, N.Y., and various other firms that advertise in the electric periodicals.

1970. **Casting.** A. C. H., Seymour, Mo., says: (1) What is the size and material of the sample of wire enclosed, and is its resistance high enough to be of any use in the construction of heating devices such as are described from time to time in *Electrician and Mechanic*? (2) Can old receiver shells, transmitter mouthpieces and other scraps of composition be remelted and cast in molds like the metals? (3) How are the plaster of Paris statuary made so as to be hollow? Ans.—(1) A chemical analysis would be required to give complete assurance of the material, but it appears to be ordinary "high" brass, that is, "hard" drawn. The size is No. 24 B.&S. gauge, and the resistance of the 20 in. length is about 2 ohms. This is altogether too low for use in heating devices. You will get valuable information on the proper sort of wire for the purpose in mind by addressing the Driver-Harris Wire Company, Harrison, N.J. (2) Unless you have a very large quantity of the material, and business in sight is of sufficient volume to require the continuous services of a chemist, you will find the recovery of hard rubber scrap inadvisable. Be satisfied to sell it to a junk man. (3) Differing from the method of making castings, the statues are gradually formed by working. Of course the mold is previously prepared in a shape to give the desired outside appearance. Its own exterior may be of crude and hardly recognizable form. Imagine the structure to be hollow like a barrel open at one end, and you were to make a hollow reproduction of the interior configuration. You could mix a quantity of the plaster and hastily spread it over the interior, rolling and tipping the barrel until the whole was evenly covered. If still thicker was wanted, stock could be added to any desired extent. After drying and baking, the hoops could be cut, when the staves would fall away, leaving a cast of the exact appearance of the interior desired. The principle you can readily apply to any desired object.

1971. **Dynamo Construction.** H. O. S., Toledo, Ohio, says: I have a toy motor (Knapp Type A), three-part commutator. Would like to know if I could rewind and use as a toy dynamo. If so, please tell me how. Ans.—All "good" motors can also be used as generators, but the one to which you refer is necessarily of inefficient design, and it will fail to generate for the reason that the entire output of the armature is insufficient to energize the field magnet. Still, it will be interesting to make some experiments. The motor has a series field magnet winding, therefore as a prime condition for its becoming a generator it must be driven in a direction *opposite* to that in which it runs as a motor. In case of motors with shunt-wound field magnets, the *same* direction for generating is required as it exhibits when running as a motor. Further, for the case of a series machine, the resistance of the external circuit must be low. The lowest you can get will be to place the machine on a short-circuit. Drive the armature as fast as possible without ruining it, and see if the iron of field exhibits any increased magnetism. If it does, this is evidence that machine is generating, but the chances are that when you try to introduce any external resistance, the generating will cease.

1972. **Storage Battery.** A. N., Toronto, Ont., Canada, says: With reference to the enclosed which appeared in your September issue last, I should be glad if I might ask two or three questions. Would the capacity be increased by using four lead cylinders in each jar or does the lead packing achieve the same object? Would the cylinder next to the jar be negative and the inner one positive, and if four plates were used in each cell would it be negative next to the jar, then positive, negative and positive? How shall I form the cells? What would be the charge and discharge rate and probable capacity of two cells about the size of a quart Daniel each? Ans.—The article to which reference is made was taken, as acknowledged, from the *Scientific American*. The directions are good as far as they go, but curiously, they stop too soon, for after exactly following them, all the builder would get would be *one* electrode per cell. There certainly must be *two*. Another pair of concentric lead cylinders should be made out of such smaller diameter as will permit placing within the former, and leave about ½ in. space between them. Instead of filling the gap between the plates of each pair with finely divided metallic lead, you will get a much quicker "formed" cell if you use the oxides of lead, namely, litharge, or yellow lead, for the electrode that is to be the negative—preferably the outer one—and red lead for the other. The paste should be formed by mixing only about half a teacupful at a time, in dilute sulphuric acid—5 to 1—and ramming it down in place with a stick. After drying, dip the plates momentarily in dilute acid daily for several days until the paste thoroughly "sets," then it will not loosen when final immersion is made. You will do well if you provide the outer plate with ears that can hook on to the upper edges of jar, so that lower edge will be at least 1 in. from bottom of vessel. Positive can stand directly on bottom, but will not thereby be in danger of short-circuiting with the sediment. You can permanently connect six or seven gravity cells to two storage cells of this sort, and in the course of several months the charging would be effected. If you use three storage cells, ten gravities will be needed. Of course for more serious work, a dynamo will be more economical.

1973. **Magneto.** C. B. T., West Middlesex, Pa., says: I have a Remy magneto, Type W2, which I took from an old automobile. What would be its voltage and amperage at 2,500 revolutions, and would it light an electric lamp? Ans.—Ordinarily an ignition magneto machine gives 4 to 8 volts, but you will understand that strength of magnets and speed of rotation are both concerned. It is common experience that the magnets have occasionally to be re-energized. As your machine was taken from an old automobile the chances are that the magnets are weak. We can hardly conjecture what the voltage would be, but it is such a simple test to make the actual trial, we would suggest that way of finding out. Put several 6-volt lamps in series, and find out how many to include to give normal brilliancy. If three in series burn dimly, while two burn too brightly, then you should get some standard 15-volt lamps for regular use.

1974. **Dynamo Construction.** E. H., Woonsocket, R.I., wishes to change a 1 h.p. Waverley automobile motor into a shunt generator. He has rewound the six field coils with No. 22 s.c.c. wire, 650 turns per coil, and though he has driven the armature at a speed of 1,200 revolutions per minute, it fails to generate. What can be done to make the change a success? Ans.—The armature of this particular motor is series wound, and can have two, four or six brushes, the ordinary equipment being with four, spaced, of course, 60 degrees apart, the lower semicircle of commutator being free in consequence of its comparative inaccessibility. You may find it advisable to utilize all six possibilities. Three alternate brushes are to be connected to furnish one terminal, the other three similarly providing the other terminal. No. 22 wire appears to be correct for the field winding, for since the average turn is about 9 in. in length, you have about 500 ft. of wire per spool, and thereby a resistance of about 8 ohms. Six such coils in series, offering 48 ohms, will permit a current of .8 ampere to flow when normal voltage, 40 volts, is acting. This means about 800 circular mils per ampere, which is the limit of safe running. The position of brushes is fixed by the construction of the machine, so you have no method of shifting them. In consequence of the sort of formed coils employed, the neutral points for the brushes are directly in line with the centers of poles. The segments on which the brushes touch connect with coils that lie midway between the poles—an imperative condition. Perhaps you have connected the field coils in a wrong manner. Your sketch is rather ambiguous. Test them with a compass, separately exciting the fields, armature being removed. Of the ends of field coils, connect first two inside ends, then two outside, and so on, finally leaving two outside ends to attach to the armature terminals. If these tests do not avail, separately excite the field magnets from any available source—not using, however, more than .8 ampere, and drive armature at the proposed speed, and see what voltage is produced. If voltage is in excess of the pressure impressed upon field terminals, the machine ought to be self-exciting; if less, then the case is hopeless at that speed, and the only recourse will be to drive the armature faster. In general, it is difficult to make a low-voltage machine self-exciting when carbon brushes are used. You might demonstrate this point by fitting the machine with temporary woven-wire copper brushes. Two brushes will determine the operation as well as the four or six.

1975. **Storage Battery.** J. O., Elizabeth, N.J., says: Will you please give me a design for building a storage battery to light from 20 to 25 miniature incandescent lamps of 3½ to 4 volts, one that will last from 6 to 10 hours without having to be recharged? Also can you tell me the best place to buy the material for same? And I would like to know how much it would cost to make such a battery. Ans.—The July, 1911, issue of *Electrician and Mechanic* was the "Storage Battery" number, and we believe you will find much profit in reading it. Directions are given for making cells, but you will find additional information in Watson's book on the subject. As you do not state what candle-power of lamps you propose to use, or whether they are to be of the carbon or tungsten sort, we cannot suggest what size and number of plates you will require. For 4 volts you will need at least two cells, but if the lamps are to be at some distance from the battery, we would suggest that you wire the circuits so as to have several lamps in series. This will permit you to use smaller wires, but with the accompaniment of more cells of a small size than otherwise. If you can give more explicit specifications, we will be pleased to advise you further.

1976. **Motor Parts.** W. R. M., Spokane, Wash., says: Where can I purchase stampings and finished parts to make a 1/20 h.p. induction motor? How and with how many turns of what size wire should this motor be wound? About what watt dynamo would this motor run and where could I purchase such a dynamo? Ans.—Perhaps F. E. Averill, Buffalo, N.Y., could supply them. Do you mean to drive a direct-current dynamo with this motor? It certainly would be very a small one, and you might find your need better supplied by use of batteries. Ten cells of gravity battery permanently connected to three small storage cells would be practical and always ready.

1977. **Meter Reading.** J. R. T., Itasca, Tex., says: The four dials of a recording electric light meter are numbered 1,000, 100, 10 and 1, respectively. At a particular time the fingers indicated 0, 3/4, 8 and 9, in same order. How should the meter be read in kilowatt-hours, and at 20 cents per kilowatt-hour, what should be the charge? Ans.—A complete revolution of the several fingers would mean, respectively, 1,000 k.w. hours, 100 k.w. hours, 10 k.w. hours and 1 k.w. hour. As the last one points on the 9, it has not made the complete revolution, therefore indicates 900 watt-hours—.9 k.w. hours. The next dial indicates 8 k.w. hours, the next between 70 and 80 k.w. hours, the total reading being then, 78.9 k.w. hours, and at the rate of 20 cents, the charge would properly be $15.78.

1978. **Armature Winding.** Mr. P., Cleveland, Ohio, asks for directions for winding a smooth core drum armature fitted with a 10-part commutator, dimensions being 2 in. in diameter and 3 1/8 in. in length. What will be its output as a generator when driven at a speed of 1,500 revolutions per minute? What is a good book describing construction of armatures? Ans.—There was a good description, illustrated with cuts, of such armatures in the November, 1908, issue of *Electrician and Mechanic*. In your case the fiber end plates should be divided into 10 parts, and cut with a hack-saw into which slots fiber pegs can be driven to hold the wire. For such a small machine, especially from its being your first, we would advise that you try to put on but two layers. The result will give a low-voltage machine, but will avoid difficulties inherent in a four-layer winding. Use No. 20 d.c.c. magnet wire; there will be room for 14 turns between pegs, and you can pass seven on each side of the shaft. With a suitably strong field magnet the pressure produced at a speed of 1,500 revolutions should be 10 volts, but 2,400 revolutions would not be too high for so small a machine. Current output could safely be 4 to 5 amperes. A good publication is gotten out by a concern in your own city—The Cleveland Armature Works—and we would advise you to examine a copy.

1979. **Wireless Instruction.** H. V., Port Whitby, Ont., says: (1) Could you tell me the cheapest and the best way to learn "Wireless Telegraphy," how long it would take, etc.? (2) Does the Marconi Co. or any other telegraph company take learners? (3) Does the wages paid to wireless operators include board? Ans.—(1) The best way to learn the wireless art is first to become a proficient operator, at least become sufficiently familiar with the Continental code so that you can send and receive at the rate of say 10 words per minute. You should then enter some school of wireless telegraphy where you can secure technical training and instruction in the methods of procedure in handling business by a commercial company. If you are absolutely unfamiliar with the Continental code you would require ten months of daily practice to become a good operator. (2) The Marconi Company accepts learners at their New York School. (3) The salary paid wireless operators aboard ship of course includes food and quarters free of charge. In addition to the salary paid the Marconi Company of America pays a 10 per cent. commission on the receipts of the particular ship on which the operator sails.

1980. **Castings.** T. M., Wilmington, Ohio, says: Will you kindly advise me regarding an article in the January, 1911, *Electrician and Mechanic*? Under the department "The Model-maker" a description and construction of a "Model Two-Cycle Motor" is given by C. F. Brierley, the article being taken from the *Model Engineer*. Where can I buy the castings in the rough or the finished bare motor? If they come from England, would they come in "duty free," or if a duty, how much? What would the castings cost, also the finished engine? Ans.—Perhaps Palmer Bros., Mianus, Conn., The Carlisle & Finch Co., Cincinnati, Ohio, or Mr. Houghton, of Waltham, Mass., would be able to supply the want.

1981. **Motors, etc.** L. R. B., Jeanette, Pa., says: (1) What are the disadvantages of the variable speed reversible alternating current motors, having laminated field, and sectional commutator with brushes, as is required with direct-current motors? (2) Where can I procure some substance that is a magnetic insulator; that is, a substance that magnetic lines of force will not penetrate? (3) What is the approximate cost of the materials to construct a wireless transmitting and receiving set suitable for about five miles' work? Ans.—(1) Such are known as "repulsion-induction" motors, invented by Latour in France, and Winter and Eichberg in Germany. They have a higher starting torque than simple induction motors, and in addition have the qualification of being fitted to run at speeds other than those near to synchronism. Thus a 4-pole 60-cycle motor would have its synchronous speed at 1,800 revolutions per minute, and at full load might run at 1,700 revolutions, but the exact speed would vary with the size of the motor. A machine of the type about which enquiry is made could be run at perhaps any speed between 1,200 and 2,000 revolutions. Such a variation is very desirable, say for operating printing presses. The efficiency of such motors, by reason of the greater resistance in the windings, is somewhat lower than is realized with the induction type. This means that more current may be required to operate it than the corresponding direct-current motor. The "power-factor," however, is higher, that is, it is free from the lagging current feature unavoidable with induction motors, therefore interferes less with the constancy of the voltage on the supply circuits. (2) In the same sense that glass is an insulator to electric currents there is no corresponding substance that is an insulator to magnetic lines of force. Iron is the best preventive for shielding instruments from the effects of outside magnetic disturbances. When accurate work is being done with galvanometers they are inclosed in an iron cage to keep out any outside magnetic disturbances. (3) The cost would depend on the type of set constructed. If a transformer was constructed the total cost of both sets should not exceed $40.00.

1982. **Wireless Telegraph Aerial.** R. F. A., Carmine, Tex., says: As I wish to erect a wireless telegraph aerial, therefore I beg to ask you a few questions about same, as follows: (1) The above aerial is to be of the inverted "L" type, and to be composed of six phosphor bronze wires (stranded) placed on spreaders 2 ft. apart, and in turn supported by two masts each 56 ft. high and 150 ft. apart. Is the above aerial proportioned correctly? (2) In what direction should an aerial run to get best results, in a north-south or east-west direction? Ans.—(1) It would be better, but not absolutely necessary, to increase the distance between wires to 3 ft. (2) That would depend on the direction in which you desired to do your best work. Have the open end opposite from the direction which you desire to do your best work.

1983. **Dynamo Construction.** Mr. W. F., Des Moines, Ia., asks: Please find enclosed sketch of a D.C. dynamo, and write me if the proportions are good for a machine that will generate 35 volts and 10 amperes at a speed of 2,000 to 2,500 revolutions per minute, and if they are good, tell me the size of wire and number of turns on armature and field and what kind of winding would be the most suitable for my purpose. I intend to build two of those machines, one for running incandescent light and the other charging storage battery at the same time, one engine running both. What part of a kilowatt will one machine be? Dimensions of the machine are given in the sketch. Ans.—The design is very good. Field winding should consist of about 2½ lb. per spool of No. 23 s.c.c. magnet wire, giving about 1,300 turns. The shape of coil will have to be bent in order to fit the curved place inside the circular magnet yoke. Armature should be wound with No. 18 d.c.c. magnet wire, about 30 wires per hole—15 for each half-winding. For your purposes plain shunt winding will be the most satisfactory, and if both machines are wound alike they will be exactly exchangeable—a convenience in case of accident. In fact, you ought to make one machine do most of the work. 10 amperes at 35 volts give 350 watts, about one-third of a kilowatt, or one-half an electrical horse-power.

1984. **Oil Furnace.** J. E. T., of Plessisville, Canada, asks: (1) What is wrong in a crude-oil furnace made especially to heat rivets in a boiler shop? It runs 2 or 3 minutes and stops, and when we rap on the pipe of the burner it begins again to heat and runs very well for a short time. (2) Is there any way to increase the pressure in a hot-water heating system? Does the Honeywell system with mercury increase the pressure? Ans.—(1) Perhaps you are heating the oil before it reaches the burner, that is, you are "pre-heating" it. This should not be done, for the result is to cause a thick deposit to form in the tube. The spray or jet of oil should be at its ordinary temperature until mixed with the jet of steam or hot air. (2) Yes, by increasing the height of the pressure pipe. The Honeywell system is the equivalent of this, only by the use of mercury the actual length of the pressure pipe is reduced. Increasing the pressure sometimes improves the working of the system from the reason that a somewhat higher temperature of the water is then possible. Naturally the higher temperature is beneficial, but partly for the reason that a more rapid flow, especially in otherwise nearly stagnant parts of the circuits, is realized. An increase of 10 lb. in pressure would probably be a safe limit.

1985. **Blitzen Receiving Transformer.** R. A. S., Sunbury, Pa., asks: Would you please inform me, either by letter or through your magazine, if the Blitzen receiving transformer has but one winding on the secondary or is there more than one layer, also its construction. Ans.—The Blitzen receiving transformer is wound in two grooves, the primary being 4 in. and the secondary 3 in. in diameter. The primary has a total of 90 turns with taps taken off every three turns. The secondary has a total of 100 turns with twelve taps.

1986. **Motor Efficiency.** J. O., Chatham, Can., asks: (1) How is the horse-power of a motor computed from readings given by a curve-drawing ammeter? The particular conditions are: three-phase alternating current supplied at 480 volts and 60 cycles, current in one main being 18 amperes. Please work out the solution. (2) How is the power factor determined? Ans.—This problem cannot accurately be solved unless you have the information sought in your second question, and to answer the second you must have a wattmeter. If, however, your motor is loaded to about its full rating, you will not be far from the truth in considering, the power-factor as 0.90, though it may not be above 0.85. Considering the current that flows in each of the three mains to be 18 amperes, the total effective current will be found by multiplying by the square-root of 3,—1.732, giving 31.1 amperes. Multiplying this by the number of volts, you get 15,000, the apparent number of watts, but really the "volt-amperes." If you had a wattmeter in circuit—even if it were of the recording sort, you could divide its reading by this 15,000 and get the power-factor. If the motor is operating with a power-factor of 0.9, multiply the 15,000 by this fraction, and you get 13,500 as the true or actual watts. Of course the motor does not have a mechanical efficiency of 100 per cent., for there are losses due to heating in the windings, the core, and the bearings, etc. Calling the efficiency as 90 per cent., the number of watts that are effective for producing power will be found by multiplying by this fraction, giving 12,750. Since there are 746 watts in a horse-power, dividing by this number, you will get 17.1 as the horse-power which the motor is probably exerting. This number is so close to the 18, which was the number of amperes stated, that it is a common rule in considering 3-phase 500-volt motors below 25 in horse-power, to estimate one actual horse-power per line ampere.

1987. **½ Kw. Transformer.** In the February issue under No. 1926 the answer to the second question should read, "Normally about 0.04 mf. is used, but with the requirement of a 200-meter wave-length it is impossible to use much over 0.01 mf." These figures were erroneously printed as .004 and .001 respectively.

TRADE NOTES

A NEW SHAPED TOOL for Telephone, Telegraph and Electric Light Workmen

Up to the present time it has been the custom of all tool manufacturers to follow and adhere to "so-called" standard designs and methods of shaping pliers. The regular bell hangers' plier as well as the standard side cutter that the lineman uses have been standard staple shapes for many, many years.

Tools of this kind have never been entirely satisfactory to the workman. One manufacturer will pull in the handles ¼ in., another would spread them ¼ in., but the result was always the same, an uncomfortable unreliable and unsatisfactory grip. The plier handles would raise blisters on the palm of the hand. The handles in another case would be so close that in cutting wires the knuckles would be pinched and bruised; still in another case the shape of the handles would be such that full pressure could not be put on the handles at all.

Noting this universal defect, the Smith & Hemenway Co., 150–152 Chambers St., New York, the manufacturers of "RED DEVIL" tools, undertook to build a plier on scientific principles. Principles that were so radical from the usual methods that it was many months before they demonstrated to several experts that the only correct way to make a plier was on scientific lines, just the same as an architect draws plans for a 40-story tower building or an engineer goes into the technical details of the current-carrying capacity of a piece of electrical copper with several bends or breaks in it. The result is an entirely new-shaped handle, as shown in the illustration. Follow closely the lines of these handles, note the peculiar bend, note the narrowness toward the head. Note the swell in the middle and offset at the end.

Look then at your own hand as you would grip a tool of this kind in actual use. Does it conform? It does, scientifically, accurately and comfortably, and we are assured by the Smith & Hemenway Co. that the feel of their scientifically-shaped handles is just as satisfying as a well-fitting glove. No possible chance to pinch the knuckles or fingers, no possible way to raise blisters on the palm of the user's hand, no matter how constant the use of the tool may be. Moreover, it has been the usual custom to knurl or check the handles, an unsatisfactory method. In these scientifically-made "RED DEVIL" Pliers knurling—or checking—is eliminated entirely, and scientific principles are again employed by "Dentyne Milling" them, a method

structed on these scientific principles, and our readers are requested to apply at any tool or hardware store in any city or town in the United States and examine these new and well-known electrical tools.

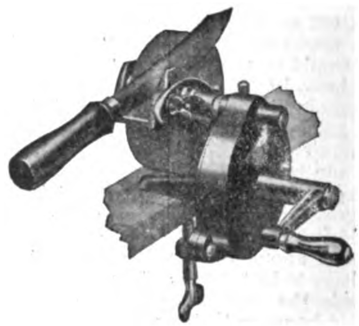
There are over 1,700 kinds, styles and sizes of Pliers alone as well as over 1,500 other tools and specialties that bear the "RED DEVIL" trademark.

So A Woman Can Use It

No matter how mechanically perfect any article may be, if it is not adapted to being used by the housewife with no more than ordinary feminine mechanical ability, it is not adapted to the household. This would be particularly true with fast-cutting grinders on which a woman might be afraid of injuring the tool she was trying to sharpen.

The small grinder here illustrated has been put out by the Luther Grinder Mfg. Co. for a number of years. However, the new tool rest that they have just put on it makes it far more valuable for home use than it has ever been before.

This consists of a special guide coming up on each side of the grinding wheel. The knife is sharpened on the side face of the wheel, the guides insuring that just the proper bevel is maintained. The wheel turns from the operator, which obviates any danger of the knife's being jammed between the guide and the wheel, as the wheel continually lifts the knife. Sharpening it on the side face of the wheel gives a finer, smoother edge than could be otherwise attained. It leaves it also with no graining, especially if the knife is moved forward and back while being sharpened.



This guide is also especially adapted for scissors so they can be easily held at exactly the proper bevel. Altogether it makes an ideal sharpening machine for the home.

Reliable Wireless Firm

Our good friends, the Wm. J. Murdock Co., of Chelsea, Mass., are getting out excellent wireless

BOOK REVIEWS

Radioactive Substances and their Radiations. By E. Rutherford, D.Sc., Ph.D., LL.D., F.R.S. Cambridge: at the University Press. New York: G. P. Putnam's Sons, 1913. Price $4.50 net.

Professor Rutherford, now of the University of Manchester, England, but formerly of Montreal, is one of the chemists best known in connection with the important subject of radioactivity. With his associate, Professor Soddy, he has been engaged in work on this subject for many years, and in this scholarly volume of 700 pages he has given a most interesting and thorough compilation of the known facts in regard to radioactivity and the substances which produce it. The subject is one of such enormous importance to present-day science that no scientist can afford to be without a book of this character in his library.

Electroplating. A treatise on the electrodeposition of metals with a chapter on Metal-coloring and bronzing. By William R. Barclay, A.M.I.E.E. and Cecil H. Hainsworth, A.M.I.E.E. Illustrated. New York, Longman's Green & Co. Price $2.10 net.

Most handbooks on electroplating have been written by practical workers who relied upon rule of thumb methods acquired by them in their years of experience. While such methods are usually trustworthy and yield good results in the hands of those accustomed to them, they have often offered difficulties to others, and not being founded upon scientific principles, a search for the source of trouble is made blindly. The present book is based on exact electro chemical experimental work, and the principles on which the authors' processes depend are so thoroughly set forth that the student who has mastered the introductory chapters will have no difficulty in tracing to their source any difficulties which may arise.

The Gasoline Engine on the Farm. By Xeno W. Putnam. Fully illustrated by 179 carefully selected engravings of great value to all interested in the efficient and economical application of farm power. New York, The Norman W. Henley Pub. Co., 1913. Price $2.50.

A practical, comprehensive treatise on the construction, repair, management and use of this great farm power as applied to all farm machinery and the farmer's work indoors and out. This treatise, because of the simple, non-technical exposition of mechanical principles, is especially valuable to those without previous mechanical knowledge who wish to become thoroughly familiar with the operation and care of gasoline engines, tractors and auxiliary devices. This is a complete worker's hand-book on the internal combustion motor and its many applications in modern farm life. Considers all the household, shop and field uses of this up-to-date prime mover and includes chapters on [illegible] power transmission, and the [illegible] power plant with re-

Elementary Principles of Electricity and Magnetism for Students in Engineering. By Robert Harbison Hough, Ph.D. and Walter Martinus Boehm, Ph.D. New York, The Macmillan Co., 1913. Price $1.10 net.

This little book is intended as a work for home study as a text-book for college students to be used in conjunction with a set of lectures properly illustrated with experiments. The amount of mathematics required for its proper comprehension is considerable, comprising at least a working knowledge of mechanics and trigonometry, while the student who does not at least accompany the study of the work with that of calculus is likely to be placed at some disadvantage. For students of these qualifications it will be found an excellent book, as the treatment is both concise and lucid.

Practical Mathematics for the Engineer and Electrician. By Elmer E. Burns and Joseph G. Branch, B.S., M.E. Chicago, The Joseph G. Branch Publishing Co., 1912. Price $1.00.

This books is not intended as a course in arithmetic, but as a collection of various tables and rules of everyday importance to the operating engineer and the working electrician. It covers a large variety of mathematical subjects which mechanics of these classifications must be familiar with to pass examinations and to meet the daily requirements of an expert in these lines, and should prove extremely useful to such workers.

The Slide Rule and Logarithms Simply Explained. By J. C. Peebles, E.E., M.M.E. Chicago, The Joseph G. Branch Publishing Co., 1912. Price 50 cents.

The slide rules are such a handy method of the application of mathematics and offer such a ready means for instantly solving without calculation many simple problems, especially those of multiplication, division, involution and evolution, that it is surprising that more people do not habitually use it. The accuracy is sufficient to three or four places of decimals, and the amount of time saved by the use of this tool is so great that every electrician should be familiar with it. This book gives a thorough understanding of the use of the rule and illustrates several of the more common commercial logarithms.

Opera Stories. Most persons attending an Opera wish to know only its story without reading its entire libretto. "Opera Stories" is published for this reason, and contains, in a few words, the stories (divided into acts) of 174 Operas, 6 Ballets and one Mystery Play; also portraits of leading singers. Henry L. Mason, Boston, 1913. Price 50 cents.

The great popularity of Grand Opera throughout the United States, and the fact that not only do all the large cities have seasons at the present time, but that many of the smaller places are visited by both the great companies and by less important stock companies, makes a book of

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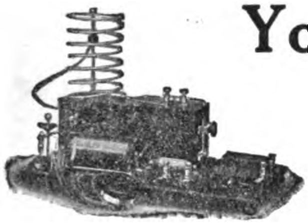

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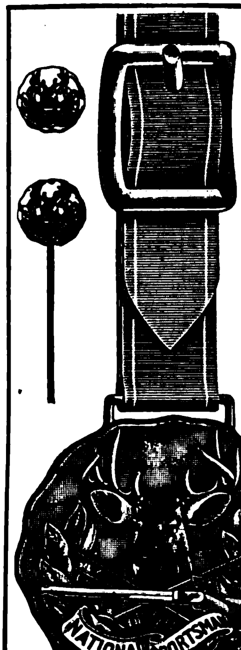

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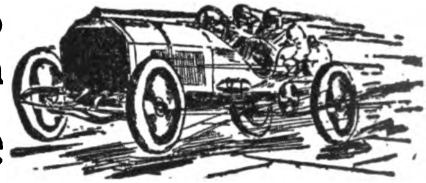

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My system of teaching by mail is a NEW IDEA—it's different from others. I will so thoroughly train you that you will not only be able to drive a car, but you can **repair motors, overhaul cars, repair tires, repair launch engines, repair stationary gasoline engines. You could go into the repair business if you wished to.**

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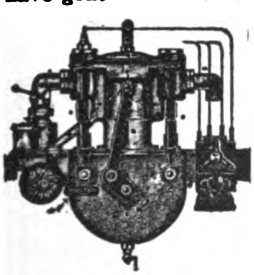
is something new. We use *real* working models—not just one but *five*. On these models you get actual practice, see the actual operation and learn more than you could from the auto itself. It's easy and quick. You don't have to study hard with this system—*we teach through the eye—a new idea.* We are the *originators* of the system of teaching by mail with models. We also use charts—175 of them and a 16-page manikin. Our 40 instructions and Repairman's Instructions are simplicity itself—simple as A B C.

If you will send for our FREE 24-PAGE CATALOG, we will tell you how to get into the Auto business; we will also show you TESTIMONIAL LETTERS from students everywhere who are now driving cars, working in Auto Repair Shops, who have gone into the Auto Repair Business and who are making money.

We will do more—we will show you actual reproduced letters from BARNEY OLDFIELD, CHAS. DURYEA (the man who built the first Automobile in America) and other leading Motor authorities—who endorse this system.

Surely this system must be something wonderful—and it is—let me tell you all about it.



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With this model you learn the principle of a gasoline engine, how to get valves, time the ignition, etc.

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There are other Models: one of a Magneto, Engine and Carbureter; also a *Manikin* of an Automobile. The Manikin can be taken apart and the models actually work. All moving parts on the models made of real metal. (Patents applied for.)

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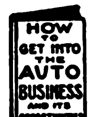

It will tell you all about the great Auto industry and the opportunities. It will show you how others got their start. It is interesting and instructive.

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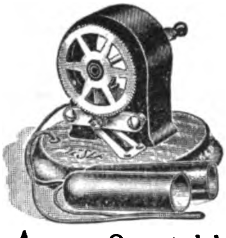

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